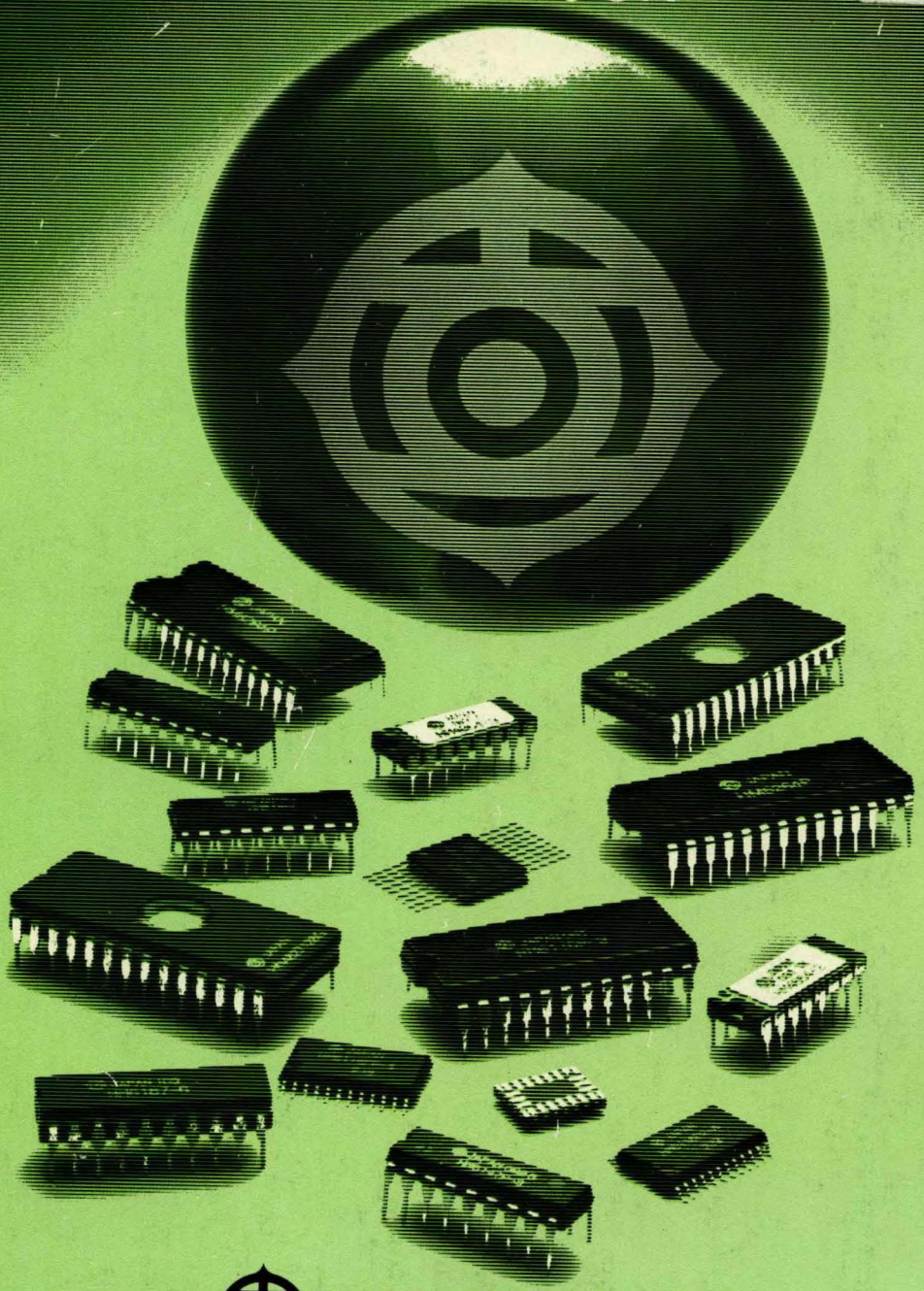
#M10

IC Memories Data Book

1984



HITACHI

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IC Memories Data Book

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HITACHI IC MEMORIES DATA BOOK

INDEX

■QUICK REFERENCE GUIDE TO HITACHI IC MEMORIES

■MOS RAM

Mode	Total Bit	Type No.	Process	Organization (word ×bit)	Access Time (ns) max	Cycle Time (ns) min	Supply Voltage (V)	Power Dissipation (W)	Package* Pin No.	CC	CG	G	P	FP	SP	Replacement	Page
Static	4k-bit	HM4334-3	CMOS	1024×4	300	460	+5	10μ/20m	18			●	●			HM-6514-9	52
		HM4334-4			450	640						●	●				52
		HM6148			70	70		0.1m/0.2				●	●			2148	58
		HM6148-6			85	85						●	●			2148-6	58
		HM6148L			70	70		5μ/0.2					●				64
		HM6148L-6			85	85							●				64
		HM6148H-35**			35	35		0.1m/0.2				●	●				70
		HM6148H-45**			45	45						●	●			2148-45	70
		HM6148H-55**			55	55						●	●			2148-55	70
		HM6148HL-35**			35	35		5μ/0.3					●				74
		HM6148HL-45**			45	45							●				74
		HM6148HL-55**			55	55							●				74
		HM6147		4096×1	70	70		0.1m/75m				●	●			2147	79
		HM6147-3			55	55						●	●				79
		HM6147L			70	70		5μ/75m					●				83
		HM6147L-3			55	55							●				83
		HM6147H-35			35	35		0.1m/0.15				●	●			2147H-1	87
		HM6147H-45			45	45						●	●			2147H-2	87
		HM6147H-55			55	55						●	●				87
		HM6147HL-35			35	35		5μ/0.15					●				93
		HM6147HL-45			45	45							●				93
		HM6147HL-55			55	55							●				93
	16k-bit	HM6116-2		2048×8	120	120		0.1m/0.18	24			●	●	●	●		97
		HM6116-3			150	150						●	●	●	●		97
		HM6116-4			200	200						●	●	●	●		97
		HM6116L-2			120	120		20μ/0.16					●	●	●		120
		HM6116L-3			150	150							●	●	●		120
		HM6116L-4			200	200							●	●	●		120
		HM6116A-10			100	100		0.1m/15m					●		●		150
		HM6116A-12			120	120							●		●		150
		HM6116A-15			150	150							●		●		150
		HM6116A-20			200	200							●		●		150
		HM6116AL-10			100	100		5μ/10m					●		●		154
		HM6116AL-12			120	120							●		●		154
		HM6116AL-15			150	150							●		●		154
		HM6116AL-20			200	200							●		●		154
		HM6117-3			150	150		0.1m/0.2					●	●			158
		HM6117-4			200	200							●	●			158
		HM6117L-3			150	150		10μ/0.18					●	●			168
		HM6117L-4			200	200							●	●			168

(to be continued)

Mode	Total Bit	Type No.	Process	Organization (word × bit)	Access Time (ns) max	Cycle Time (ns) min	Supply Voltage (V)	Power Dissipation (W)	Package*** Pin No.	CC	CG	G	P	FP	SP	Replacement	Page
SRAM	16k-bit	HM6168H-45*	CMOS	4096×4	45	45	+5	0.1m/0.25	20			●	●			2168	180
		HM6168H-55*			55	55						●	●				180
		HM6168H-70*			70	70						●	●				180
		HM6168HL-45*			45	45		5μ/0.25					●				181
		HM6168HL-55*			55	55							●				181
		HM6168HL-70*			70	70							●				181
		HM6167		16384×1	70	70		25m/0.15				●	●			2167	182
		HM6167-6			85	85						●	●			2167-6	182
		HM6167-8			100	100						●	●			2167-8	182
		HM6167L			70	70		5μ/0.15					●				188
		HM6167L-6			85	85							●				188
		HM6167L-8			100	100							●				188
		HM6167H-45			45	45		0.1m/0.2			●	●	●			IMS1400	192
		HM6167H-55			55	55					●	●	●				192
		HM6167HL-45			45	45		5μ/0.2					●				203
		HM6167HL-55			55	55							●				203
	64k-bit	HM6264-10		8182×8	100	100		0.1m/0.2	28				●				207
		HM6264-12			120	120							●				207
		HM6264-15			150	150							●				207
		HM6264L-10			100	100		10μ/0.2					●				211
		HM6264L-12			120	120							●				211
		HM6264L-15			150	150							●				211
DRAM	16k-bit	HM4716A-1	NMOS	16384×1	120	320	+12, +5, −5,	20m/0.46	16				●	●				218
		HM4716A-2			150	320							●	●			MK4116-2	218
		HM4716A-3			200	375							●	●			MK4116-3	218
		HM4716A-4			250	410							●	●			MK4116-4	218
		HM4816A-3			100	235		11m/0.15					●	●			2118-3	229
		HM4816A-3E			105	200							●	●				229
		HM4816A-4			120	270							●	●			2118-4	229
		HM4816A-7			150	320							●	●			2118-7	229
	64k-bit	HM4864-2		65536×1	150	270		20m/0.33		●			●	●				237
		HM4864-3			200	335				●			●	●				237
		HM4864A-12			120	230		20m/0.275			●**		●	●				256
		HM4864A-15			150	260					●**		●	●				256
		HM4864A-20			200	330					●		●	●				256
		HM4865A-12**			120	230	+5	20m/0.275					●	●				266
		HM4865A-15**			150	260							●	●				266
		HM4865A-20**			200	330							●	●				266
	256k-bit	HM50256-12**		262144×1	120	220		20m/0.35					●					273
		HM50256-15**			150	260							●					273
		HM50256-20**			200	330							●					273
		HM50257-12**			120	220		20m/0.35					●					280
		HM50257-15**			150	260							●					280
		HM50257-20**			200	330							●					280

* Under development

** Preliminary △HM6116LP Series : 10μW

*** The package codes of CC, CG, P, FP and SP are applied to the package materials as follows.
CC : Side-brazed Ceramic Leadless Chip Carrier, CG : Glass-sealed Ceramic Leadless Chip Carrier, G : Cerdip, P : Plastic DIP,
FP : Small Sized Plastic Flat Package(SOP), SP : Skinny Type Plastic DIP

■MOS ROM

Program	Total Bit	Type No.	Process	Organization (word×bit)	Access Time (ns) max	Supply Voltage (V)	Power Dissipation (W)	Package*** Pin No.	C	G	P	FP	Replacement	Page
Mask	64k-bit	HN61364	CMOS	8192×8	250	+5	5μ/0.05	28			●	●		288
		HN61365			250			24			●			290
		HN61366			250						●			292
	128k-bit	HN43128		16384×8 32768×4	6500		3m	28			●			294
		HN613128		16384×8	250		5μ/0.05	28			●	●		296
	256k-bit	HN61256		32768×8 65536×4	3500		7.5m	28			●	●		298
		HN613256		32768×8	250		5μ/75m				●	●		300
	1M-bit	HN62301**		131072×8	350		5m/60m	28	●		●			302
U. V. Erasable & Electrically	16k-bit	HN462716	NMOS	2048×8	450	+5	0.555	24	●	●			2716	306
	32k-bit	HN462532		4096×8	450		0.858	24	●	●			TMS2532	310
		HN462732					0.788		●	●			2732	314
		HN482732A-20			200		0.788			●			2732A-2	321
		HN482732A-25			250					●			2732A	321
		HN482732A-30			300					●			2732A-3	321
	64k-bit	HN482764		8192×8	250		0.555	28	●	●			2764	324
		HN482764-3			300				●	●			2764-3	324
		HN482764-4			450				●	●				324
		HN27C64G-20			200		40mW			●			2764	329
		HN27C64G-25			250					●			2764	329
		HN27C64G-30			300					●			2764	329
	128k-bit	HN4827128-25**	NMOS	16384×8	250		0.554	28		●				332
		HN4827128-30**			300					●				332
		HN4827128-45**			450					●				332
Electrically Erasable	16k-bit	HN48016	NMOS	16384×8	350	+5	0.16	24			●			336

* Under development
** Preliminary

*** The package codes of C, G, P and FP are applied to the package materials as follows.
C : Side-brazed Ceramic DIP, G : Cerdip, P : Plastic DIP, FP : Plastic Flat Package

■MOS MEMORIES OF WIDE OPERATING TEMPERATURE RANGE

Mode	Total Bit	Type No.	Organization (word×bit)	Operating Temperature Range (°C)	Access Time (ns) max	Power Dissipation (W)	Package*** Pin No.	P	G	Page
Static RAM	16k-bit	HM6116I-2	2048×8	−40 to +85	120	0.1m/0.18	24	●	●	103
		HM6116I-3			150			●	●	103
		HM6116I-4			200			●	●	103
		HM6116LI-2			120	20μ△/0.16		●	●	127
		HM6116LI-3			150			●	●	127
		HM6116LI-4			200			●	●	127
		HM6116K-3		−55 to +125	150	0.1m/0.18			●	146
		HM6116K-4			200				●	146
Dynamic RAM	64k-bit	HM4864I-2	65536×1	−40 to +85	150	15m/0.3	16		●	252
		HM4864I-3			200				●	252
		HM4864K-2		−55 to +85	150				●	252
		HM4864K-3			200				●	252
EPROM	32k-bit	HN462732I	4096×8	−40 to +85	450	0.1/0.788	24		●	318

△ HM6116LPI Series : 10μW

■BIPOLAR RAM

Level	Total Bit	Type No.	Organization (word × bit)	Output	Access Time (ns) max	Supply Voltage (V)	Power Dissipation (mW/bit)	Package** Pin No.	F	G	CC	Replacement	Page
ECL 10k	256-bit	HM10414	256×1	Open Emitter	10	−5.2	2.8	16		●		F10414	342
		HM10414-1			8					●			342
	1k-bit	HM2110	1024×1		35		0.5			●		F10415	346
		HM2110-1			25					●		F10415A	346
		HM2112			10		0.8			●			350
		HM2112-1			8					●			350
		HM10422	256×4		10		0.8	24	●	●		F10422	355
		HM10422-7			7		1.0		●	●			360
	4k-bit	HM10470	4096×1		25		0.2	18	●	●		F10470	363
		HM10470-1			15					●			363
		HM10470-15			15					●			368
		HM2142			10		0.3			●			371
		HM10474	1024×4		25		0.2	24	●	●		F10474	374
		HM10474-15			15				●	●			374
	16k-bit	HM10480	16384×1		25		0.03	20	●	●		F10480	379
ECL 100k	1k-bit	HM100415	1024×1		10	−4.5	0.6	16		●	●	F100415	382
		HM100422	256×4		10		0.8	24	●	●	●	F100422	385
	4k-bit	HM100470	4096×1		25		0.2	18		●		F100470	388
		HM100470-15			15					●			388
		HM100474	1024×4		25		0.2	24	●	●		F100474	391
		HM100474-15			15				●	●			391
	16k-bit	HM100480*	16384×1		25		0.05	20	●	●		F100480	396
TTL	256-bit	HM2504	256×1	Open Collector	55	+5	1.8	16		●		93411	399
		HM2504-1			45					●		93411A	399
	1k-bit	HM2510	1024×1		70		0.5			●			403
		HM2510-1			45					●		93415	403
		HM2510-2			35					●		93415A	403
		HM2511		3-state	70		0.5			●			407
		HM2511-1			45					●		93425	407

* Preliminary

** The package codes of F, G and CC are applied to the package material as follows.
F : Flat Package, G : Cerdip, CC : Side-brazed Ceramic Leadless Chip Carrier

■ BIPOLAR PROM

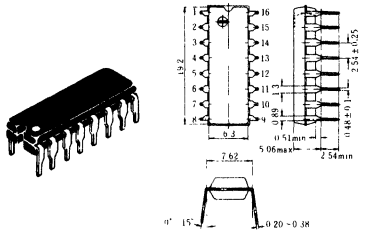
Level	Total Bit	Type No.	Organization (word × bit)	Output	Access Time (ns) max	Supply Voltage (V)	Power Dissipation (mW)	Package*				Replacement	Page
								Pin No.	F	G	P		
TTL	4k-bit	HN25044	1024×4	O/C	50	+5	500	18		●		82S136	414
		HN25045		3-s						●		82S137	414
	8k-bit	HN25084	2048×4	O/C	60		550	18		●		82S184	419
		HN25085		3-s						●		82S185	419
		HN25084S		O/C	50					●			422
		HN25085S		3-s						●			422
		HN25088	1024×8	O/C	60		600	24		●		82S180	425
		HN25089		3-s						●		82S181	425
		HN25088S		O/C	50					●			428
		HN25089S		3-s						●			428
		HN25088L		O/C	100		350			●			431
		HN25089L		3-s						●			431
	16k-bit	HN25168S	2048×8	O/C	60		600	24		●		82S190	434
		HN25169S		3-s						●		82S191	434

* The package code of G is applied to the material as follows.
G : Cerdip

■ PACKAGE INFORMATION (Dimensions in mm)

● Dual-in-line Plastic

● DP-16



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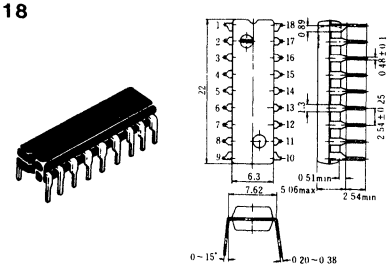

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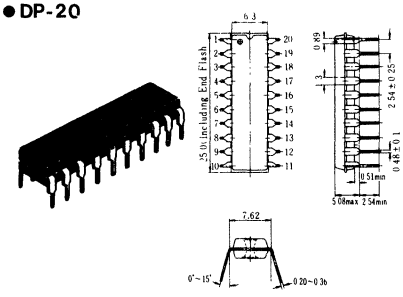

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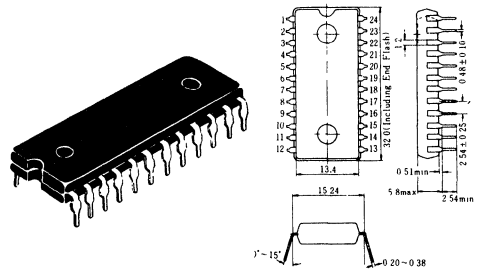

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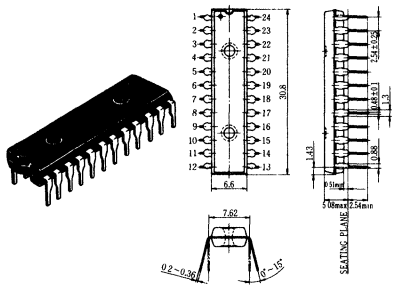

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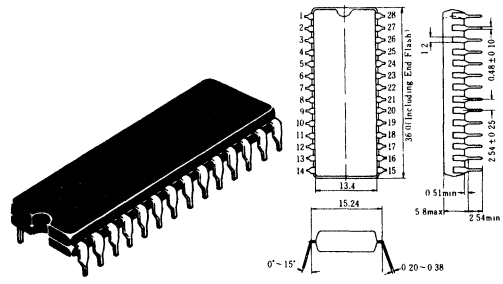


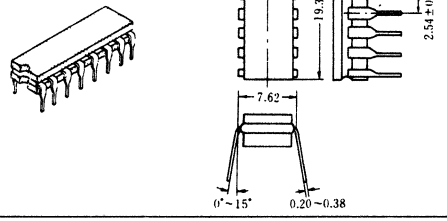
Applicable ICs

DP-16	HM4716AP-1, HM4716AP-2, HM4716AP-3, HM4716AP-4, HM4816AP-3, HM4816AP-3E, HM4816AP-4, HM4816AP-7, HM4864P-2, HM4864P-3, HM4864AP-12, HM4864AP-15, HM4864AP-20, HM4865AP-12, HM4865AP-15, HM4865AP-20
DP-18	HM4334P-3, HM4334P-4, HM4334P-3L, HM4334P-4L, HM6148P. HM6148P-6, HM6148LP, HM6148LP-6, HM6148HP-35, HM6148HP-45, HM6148HP-55, HM6148HLP-35, HM6148HLP-45, HM6148HLP-55, HM6147P, HM6147P-3, HM6147LP, HM6147LP-3, HM6147HP-35, HM6147HP-45, HM6147HP-55, HM6147HLP-35, HM6147HLP-45, HM6147HLP-55
DP-20	HM6168HP-45, HM6168HP-55, HM6168HP-70, HM6168HLP-45, HM6168HLP-55, HM6168HLP-70, HM6167P, HM6167P-6, HM6167P-8, HM6167LP, HM6167LP-6, HM6167LP-8, HM6167HP-45, HM6167HP-55, HM6167HLP-45, HM6167HLP-55
DP-24	HM6116P-2, HM6116P-3, HM6116P-4, HM6116LP-2, HM6116LP-3, HM6116LP-4, HM6116AP-10, HM6116AP-12, HM6116AP-15, HM6116AP-20, HM6116ALP-10, HM6116ALP-12, HM6116ALP-15, HM6116ALP-20, HM6117P-3, HM6117P-4, HM6117LP-3, HM6117LP-4, HN61365P, HN61366P, HN48016P, HM6116PI-2, HM6116PI-3, HM6116PI-4, HM6116LPI-2, HM6116LPI-3, HM6116LPI-4
DP-24A	HM6116ASP-10, HM6116ASP-12, HM6116ASP-15, HM6116ASP-20, HM6116ALSP-10, HM6116ALSP-12, HM6116ALSP-15, HM6116ALSP-20
DP-28	HM6264P-10, HM6264P-12, HM6264P-15, HM6264LP-10, HM6264LP-12, HM6264LP-15, HN61364, HN43128P, HN613128P, HN61256P, HN613256P, HN62301P

Package Information

●CERDIP

●DG-16



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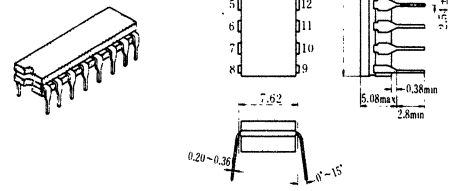

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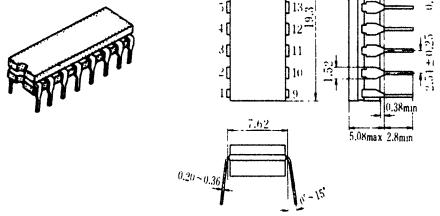

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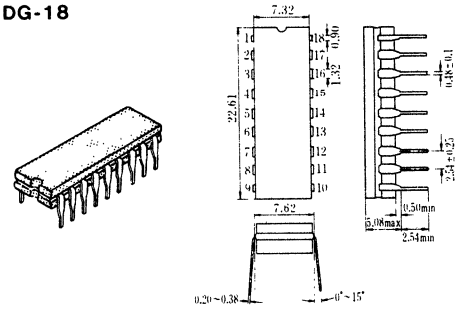

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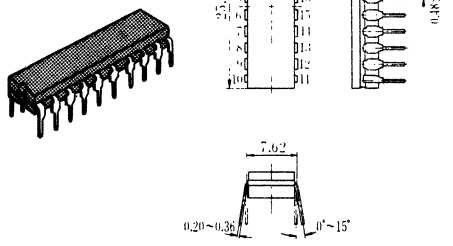
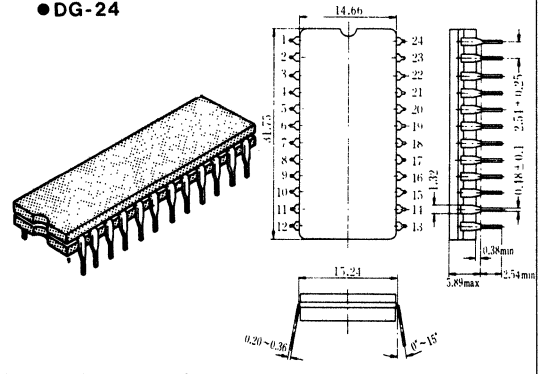
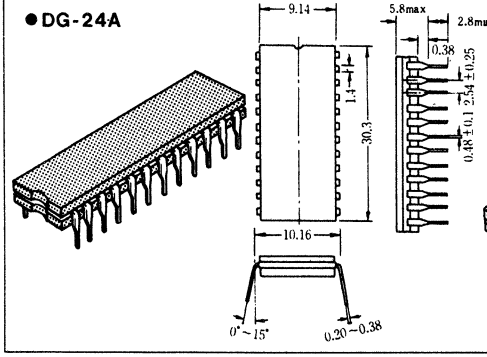


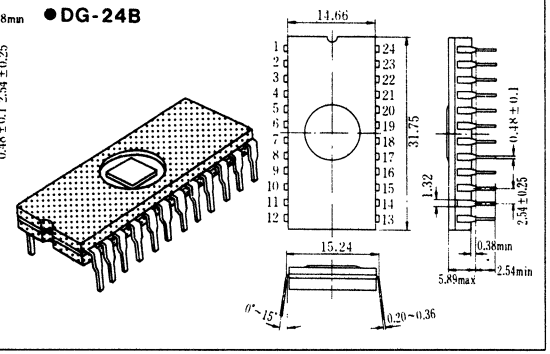
●DG-24



●DG-24A



●DG-24B



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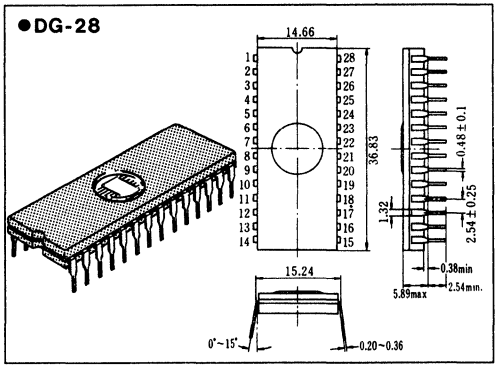
● DG-28

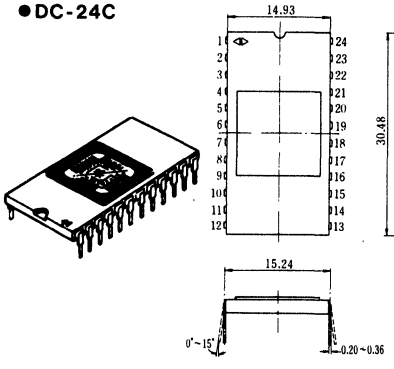


Applicable ICs

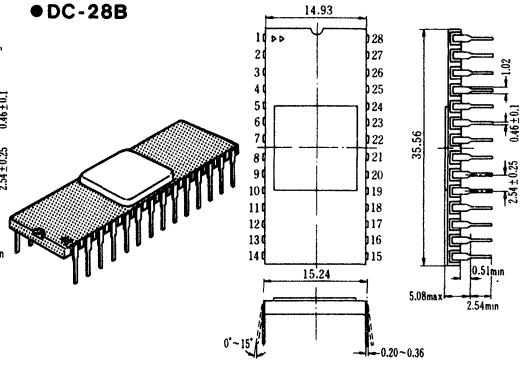
DG-16	HM10414, HM10414-1, HM2504, HM2504-1, HD2912
DG-16A	HM4716A-1, HM4716A-2, HM4716A-3, HM4716A-4, HM2110, HM2110-1, HM2112, HM2112-1, HM100415, HM2510, HM2510-1, HM2510-2, HM2511, HM2511-1, HD2916, HD2923
DG-16B	HM4816A-3, HM4816A-3E, HM4816A-4, HM4816A-7, HM4864-2, HM4864-3, HM4864A-12, HM4864A-15, HM4864A-20, HM50256-12, HM50256-15, HM50256-20, HM50257-12, HM50257-15, HM50257-20, HM4864I-2, HM4864I-3, HM4864K-2, HM4864K-3
DG-18	HM4334-3, HM4334-4, HM6148, HM6148-6, HM6148H-35, HM6148H-45, HM6148H-55, HM6147, HM6147-3, HM6147H-35, HM6147H-45, HM6147H-55, HM10470, HM10470-1, HM10470-15, HM2142, HM100470, HM100470-15, HN25044, HN25045, HN25084, HN25085, HN25084S, HN25085S
DG-20	HM6168H-45, HM6168H-55, HM6168H-70, HM6167, HM6167-6, HM6167-8, HM6167H-45, HM6167H-55, HM10480, HM100480
DG-24	HM6116-2, HM6116-3, HM6116-4, HM6116L-2, HM6116L-3, HM6116L-4, HM6116I-2, HM6116I-3, HM6116I-4, HM6116LI-2, HM6116LI-3, HM6116LI-4, HM6116K-3, HM6116K-4, HN25088, HN25089, HN25088S, HN25089S, HN25088L, HN25089L, HN25168S, HN25169S
DG-24A	HM10422, HM10422-7, HM10474, HM10474-15, HM100422, HM100474, HM100474-15
DG-24B	HN462716G, HN462532G, HN462732G, HN482732AG-20, HN482732AG-25, HN482732AG-30, HN462732GI
DG-28	HN482764G, HN482764G-3, HN482764G-4, HN4827128G-25, HN4827128G-30, HN4827128G-45

● Side-brazed Ceramic DIP

● DC-24C



● DC-28B

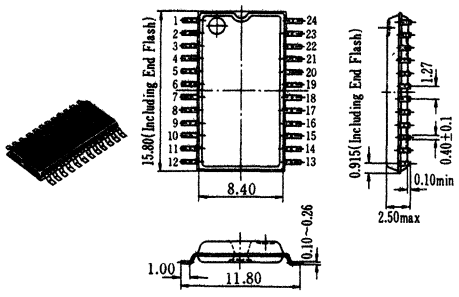


Applicable ICs

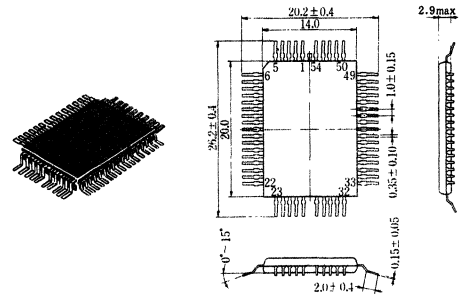
DC-24C	HN462716, HN462532, HN462732
DC-28B	HN482764, HN482764-3, HN482764-4

● Flat Packages

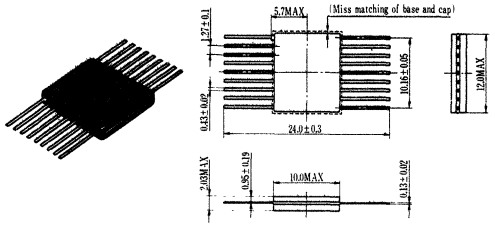
●FP-24



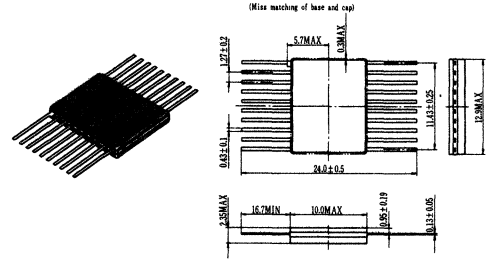
●FP-54



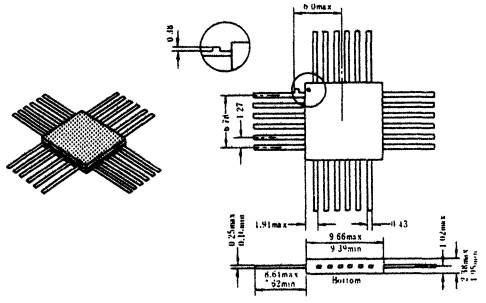
●FG-18



●FG-20



●FG-24

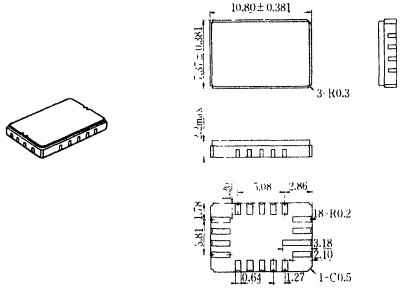


● Applicable ICs

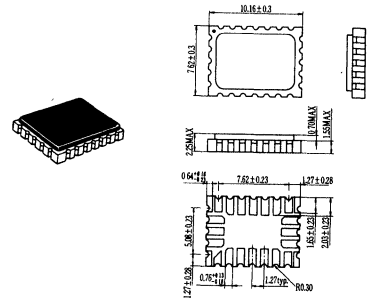
FP-24	HM6116FP-2, HM6116FP-3, HM6116FP-4, HM6116LFP-2, HM6116LFP-3, HM6116LFP-4, HM6117FP-3, HM6117FP-4, HM6117LFP-3, HM6117LFP-4
FP-54	HN61364FP, HN613128FP, HN61256FP, HN613256FP
FG-18	HM10470F
FG-20	HM10480F, HM100480F
FG-24	HM10422F, HM10422F-7, HM10474F, HM10474F-15, HM100422F, HM100474F, HM100474F-15

● Leadless Chip Carrier

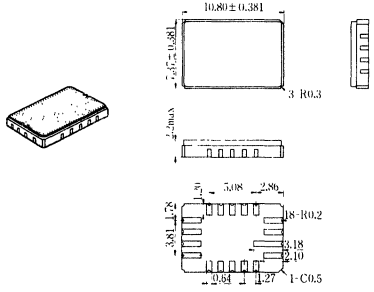
● CC-18



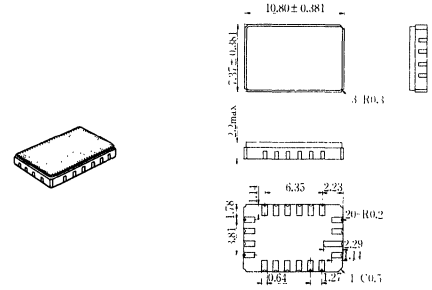
● CC-24



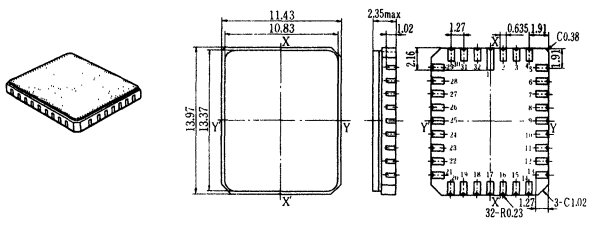
● CG-18



● CG-20



● CG-32



● Applicable ICs

CC-18	HM4864CC-2, HM4864CC-3
CC-24	HM100415CC, HM100422CC
CG-18	HM4864ACG-12, HM4864ACG-15 HM4864ACG-20
CG-20	HM6167HCG-45, HM6167HCG-55
CG-32	HM6116CG-2, HM6116CG-3, HM6116CG-4

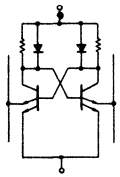
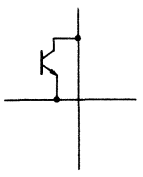
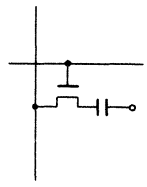
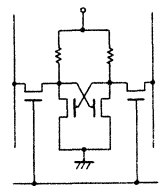
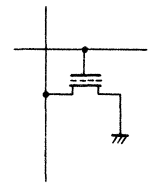
■ RELIABILITY OF HITACHI IC MEMORIES

1. STRUCTURE

IC memories are classified into Bipolar and MOS structural types, with unique, respective characteristics. Bipolar characteristics are high speed and small capacity, while MOS features large capacity.

Produced with the most advanced semiconductor manufacturing technologies, the LSI memory is integrated in high density by unit patterns called "cells." Despite differences in circuit design, pattern layout, and degree of integration, stable product reliability is achieved in the manufacturing process by incorporating past achievements in single cell design, and the proven reliability of each respective technology. Unified production standards are applied in design, manufacture, and inspection stages, and reliability is guaranteed by using TEG (Test Element Group) evaluation. Examples of Bipolar and MOS memory cell circuits are shown in Table 1.

● Table 1 Examples of Basic Cell Circuit of IC Memories

Classification	Bipolar memory (RAM)	Bipolar memory (PROM)	NMOS memory (Dynamic RAM)	NMOS, CMOS memories (Static RAM)	NMOS memory (PROM)
Application	Buffer memory, control memory of high-speed computer	Microcomputer control use	Main memory of computer, microcomputer memory		For microcomputer control
Example of basic cell circuit					

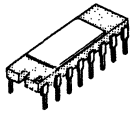
IC memory chips are produced in Ceramic, Cerdip, and Plastic packages. Leadless Chip Carriers (LCC's) for high package density, and Small Outline (SO) packages are currently being developed.

Hermetically sealed Ceramic and Cerdip packaging is suitable for high reliability equipment. Plastic, the leading semiconductor package, is used in a wide variety of applications. Hitachi's improved Plastic package provides a reliability level nearly that of the hermetically sealed Ceramic and Cerdip packages. Table 2 shows examples of IC memory package outlines.

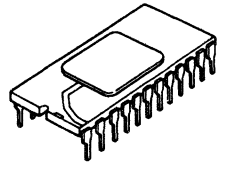
● Table 2 Examples of IC Memory Package Outlines

■ Ceramic DIP

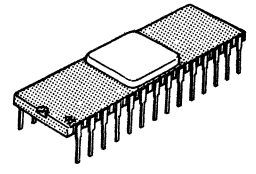
● 16 Pin



● 24 Pin

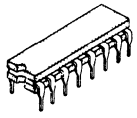


● 28 Pin

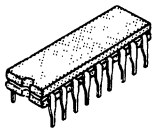


■ Cerdip

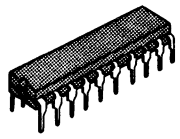
● 16 Pin



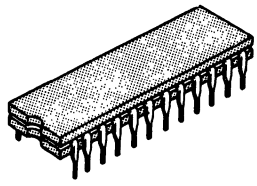
● 18 Pin



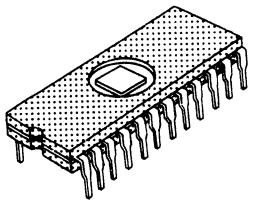
● 20 Pin



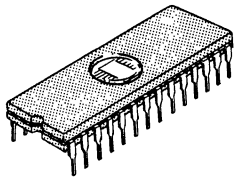
● 24 Pin



● 24 Pin with Lid

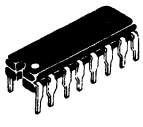


● 28 Pin with Lid

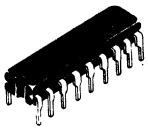


■ Plastic DIP

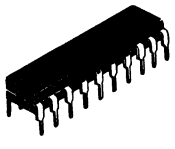
● 16 Pin



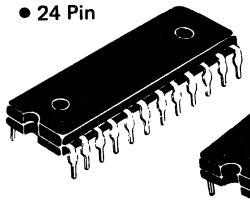
● 18 Pin



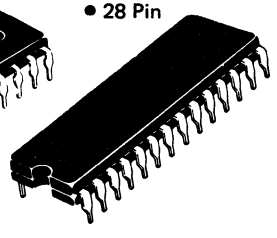
● 20 Pin



● 24 Pin



● 28 Pin



2. RELIABILITY DATA

2.1 Reliability test data on Bipolar memories

Reliability test data is shown in Tables 3 and 4. Since unified design and quality control standards are applied in the manufacturing process, reliability is assured in all device types. Results have further indicated that the greater the device capacity, the higher the reliability per bit.

● **Table 3 Results on Bipolar Memory Reliability Tests (1)**

Test item	Test condition	HM10470 (Cerdip)				HM100422 (Chip Carrier)				HN25089 (Cerdip)			
		Samples	Total component hours	Failures	Failure rate*	Samples	Total component hours	Failures	Failure rate*	Samples	Total component hours	Failures	Failure rate*
High-temperature (Operating)	Ta=125°C V_{EE}=−5.2V (HM10470) V_{CC}=5.5V (HN25089)	125	C.H. 4.0×10^{5}	0	1/hr 2.3×10^{-6}	—	—	—	—	36	C.H. 3.6×10^{4}	0	1/hr 2.6×10^{-4}
	Ta=150°C V_{EE}=−5.2V (HM10470) V_{EE}=−5.0V (HM100422) V_{CC}=5.5V, t_{cyc}=1 μs (HN25089)	80	2.7×10^{5}	0	3.4×10^{-6}	40	4×10^{4}	0	2.3×10^{-5}	10	1.0×10^{4}	0	9.2×10^{-5}
High-temperature storage	Ta=200°C	27	2.7×10^{5}	0	3.4×10^{-5}	40	4×10^{4}	0	2.3×10^{-5}	15	1.5×10^{4}	0	6.1×10^{-5}
	Ta=295°C	20	2.0×10^{5}	0	4.6×10^{-5}	40	4×10^{4}	0	2.3×10^{-5}	15	1.5×10^{4}	0	6.1×10^{-5}

* Estimated failure rate with confidence level 60%

● **Table 4 Results on Bipolar Memory Reliability Tests (2)**

Test item	Test condition	HM10470 (Cerdip)		HM100422 (Chip carrier)		HN25089 (Cerdip)	
		Samples	Failures	Samples	Failures	Samples	Failures
Temperature cycling	−65 °C ~ +150 °C, 10 cycles	120	0	40	0	45	0
Soldering heat	260 °C, 10 seconds	22	0	—	—	22	0
Thermal shock	0 °C ~ +100 °C, 10 cycles	36	0	20	0	22	0
Mechanical shock	1500G, 0.5 ms, Three times each for X, Y and Z	30	0	60	0	22	0
Variable frequency	100~2000Hz, 20G Three times each for X, Y and Z	40	0	60	0	22	0
Constant-acceleration	20000G, 1 minute, each for X, Y and Z	40	0	60	0	22	0

2.2 Reliability test data on MOS memories

Tables 5, 6, and 7 depict reliability test data on a representative group of MOS memory types—HM4864 64K DRAM, HM4716AP 16K DRAM, HM6116P 16K SRAM, HM6147P 4K SRAM, HN462732 and HN462532 32K EPROMs, and HN462716 16K EPROM.

● **Table 5 Results on MOS Memory Reliability Tests (1)**

Test item	Test condition	HM4864 (Ceramic)				HN462532/HN462732 (Cerdip)				Remarks
		Samples	Total component hours	Failures	Failure rate*	Samples	Total component hours	Failures	Failure rate*	
High-temperature dynamic operation	Ta=125°C V_{CC}=5.5V t_{cyc}=3μs	1872	C.H. 3.33×10^{6}	3*1	l/hr 1.25×10^{-6}	100	C.H. 1.0×10^{5}	0	l/hr 9.2×10^{-6}	*1 Oxide failure x 2 Unknown x 1
High-temperature storage	Ta=200°C	20	4.0×10^{4}	0	2.3×10^{-5}	140	1.4×10^{5}	0	6.6×10^{-6}	
High-temperature storage	Ta=259°C	—	—	—	—	100	5.0×10^{4}	0	1.8×10^{-5}	
High-temperature storage	Ta=295°C	—	—	—	—	100	4.2×10^{4}	1*2	4.8×10^{-5}	*2 Data disappearance

* Estimated failure rate with confidence level 60%

● **Table 6 Results on MOS Memory Reliability Tests (2)**

Test item	Test condition	HM4716AP (Plastic)				HM6116P/HM6147P (Plastic)				Remarks
		Samples	Total component hours	Failures	Failure rate*	Samples	Total component hours	Failures	Failure rate*	
High-temperature dynamic operation	Ta=125°C V_{DD}=13.2V (NMOS) V_{CC}=5.5V (CMOS) t_{cyc}=3μs	2330	C.H. 3.46×10^{6}	6*1	l/hr 2.12×10^{-6}	1216	C.H. 1.90×10^{6}	3*2	l/hr 2.19×10^{-6}	*1 Oxide failure x 6 *2 Oxide failure x 1 Electrostatic discharge x1 Unknown x 1
High-temperature storage	Ta=150°C	45	4.5×10^{4}	0	2.0×10^{-5}	20	2.0×10^{4}	0	4.6×10^{-5}	
High-temperature and high-humidity bias	Ta=85°C, RH=85% V_{DD}=12V (NMOS) V_{CC}=5.5V (CMOS)	3081	6.2×10^{6}	19*3	3.1×10^{-6}	630	1.3×10^{6}	4*4	4.0×10^{-6}	*3 Aluminium corrosion x 17 Unknown x 2 *4 Aluminium corrosion x 3 Unknown x 1

* Estimated failure rate with confidence level 60%.

● **Table 7 Results on MOS Memory Reliability Tests (3)**

Test item	Test condition	HM4864 (Ceramic)		HM4864 (Cerdip)		EPROM (Cerdip)		HM4716AP		HM6116P/ HM6147P	
		Samples	Failures	Samples	Failures	Samples	Failures	Samples	Failures	Samples	Failures
Temperature cycling	-65°C~RT~150°C 10 cycles	1208	0	260	0	50	0	–	–	–	—
Temperature cycling	-55°C~RT~150°C 10 cycles	–	–	–	–	310	0	7892	0	2080	0
Temperature cycling	-55°C ~ 150°C 1000 cycles	164	0	100	0	50	0	600	0	–	–
Thermal shock	-65°C ~ 150°C 15 cycles	22	0	60	0	72	0	190	0	–	–
Thermal shock	0°C ~ 100°C 15 cycles	–	–	–	–	197	0	138	0	60	0
Soldering heat	260°C, 10 seconds	22	0	22	0	22	0	128	0	60	0
Mechanical shock	1,500G, 0.5ms	22	0	38	0	38	0	–	–	–	–
Variable frequency	20~2,000Hz, 20G	22	0	38	0	38	0	–	–	–	–
Constant-acceleration	20,000G	22	0	38	0	38	0	–	–	–	–

2.3 Reliability of IC memory electrical characteristics

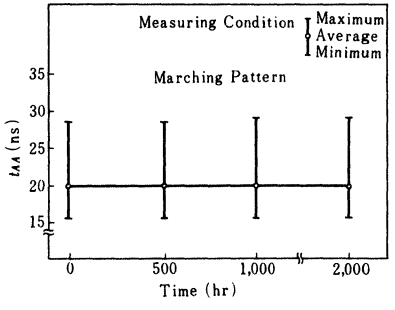
Internal elements of IC memory device types are designed to assure stability of electrical characteristics. Bipolar access time test data is given in Fig. 1. Dynamic operation test data on 64K DRAM is shown in Fig. 2 and 3.

Fig. 1 Example of Change in Bipolar Memory Characteristics

Example	
Device name	HM10470
Test condition	Ta=125°C, V_{EE}=-5.2V
Failure criteria	t_{AA}=25ns
Failure mechanism	Surface degradation

Results:
Access time (t_{AA}) is stabilized and is within the failure criteria.

Example of time change in access time for Bipolar memory



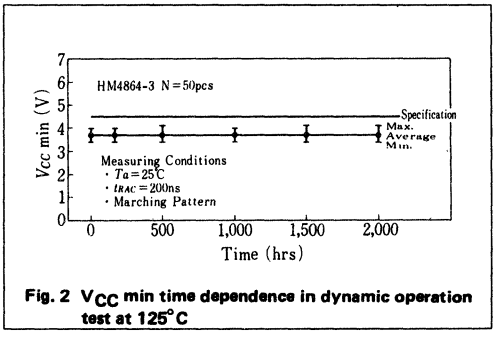


Fig. 2 V_{CC} min time dependence in dynamic operation test at 125°C

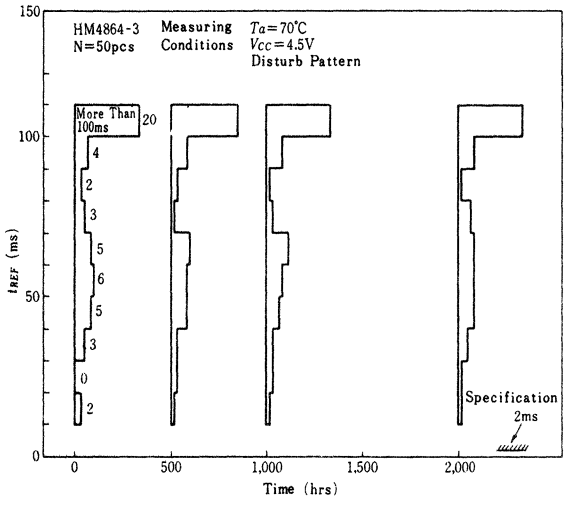


Fig. 3 Time dependence in refresh time (t_{REF}) in dynamic operation test at 125°C

2.4 Classification of failure modes

Examples of field failures are shown in Fig. 4 and 5. Hitachi eliminates latent defects such as pinholes, foreign materials, etc., in each respective stage of production.

Process data and field failure data is continuously analyzed, and high temperature burn-in screening is executed to further improve design, manufacture, and reliability.

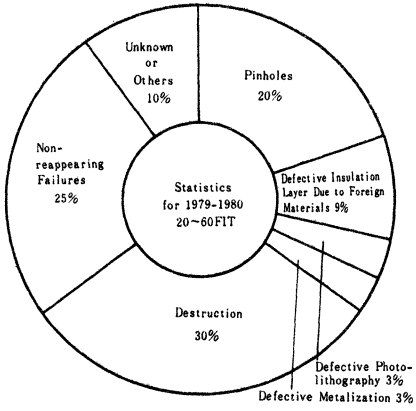


Fig. 4 Classification of Failure Modes of Bipolar Memory in the field

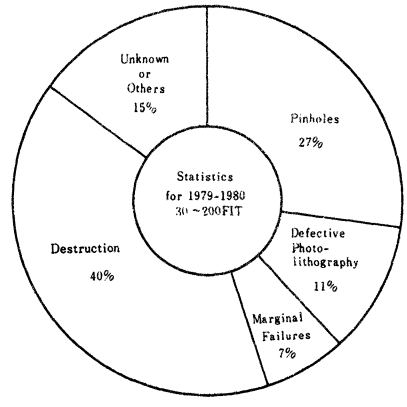


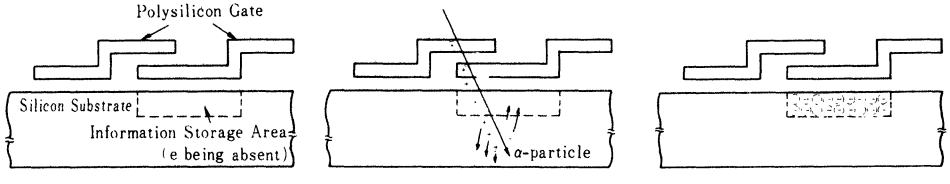
Fig. 5 Classification of Failure Modes of MOS Memory in the field

3. SOFT ERROR

3.1 Soft Error

Miniaturization of IC memories has reduced horizontal and vertical plane dimensions, signal level, and stored charge. One obstacle to further scaling is soft errors—"transitory failures in which normal memory operation can be recovered by reprogramming data." Soft errors are caused by alpha particles emitted from Uranium and Thorium contained in the packaging materials. When memory chips are exposed to alpha particles, many electron-hole pairs are induced in the Si substrate, causing memory data reversion. Fig. 6 shows the mechanism of data reversion in NMOS DRAMs. Negative voltage is applied to the Si substrate. Positive holes are drawn by the substrate, and only electrons cause information reversion (from data "1" to "0") in the memory cell.

Fig. 6 shows a misoperation defined as "Memory cell mode of soft errors," as distinguished from "Bit line mode of soft errors" shown in Fig. 7. As information in a memory cell is read out on the bit line, the bit line potential changes depending on the memory cell data. The change is small (several hundred mV), and compared with standard potential (potential read out from a dummy cell), it is amplified by the sense amplifier. If the bit line is exposed to alpha particles during the short period between read-out from the memory cell and amplification by the sense amplifier, the bit line potential decreases. As the potential becomes less than standard, misoperation occurs from "0" to "1." Both are called "Bit line mode" since errors appear at irradiation of alpha particles. Soft error dependence on cycle time is shown in Fig. 8.

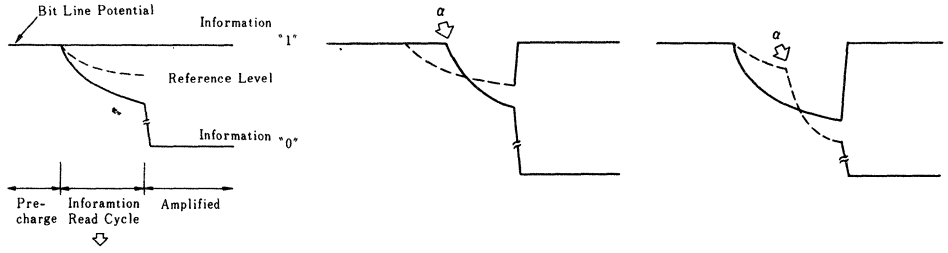


(a) Memory information at "1" (Electrons are absent) (1 Transistor type memory cell)

(b) Incident α-particle generate a large quantity of electron-hole pairs. Generated electrons enter the information storage area and holes are drawn to the substrate power supply.

(c) Inversion of memory information from "1" (electrons "absent") to "0" (electrons "filled")

Fig. 6 Misoperation in Memory Cell



(a) Read out memory information into bit line

(b) Inversion of information from "1" to "0" (fall of "1" potential)

(c) Inversion of information from "0" to "1" (fall of standard potential)

Fig. 7 Misoperation on Bit Line

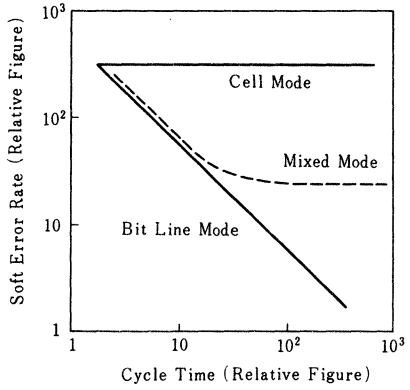


Fig. 8 Soft Error Rate's Dependence on Cycle Time

Actual products will have three types of failure modes—cell mode, bit line mode, and a mixture of both modes. Soft error mechanisms in static MOS and Bipolar memories are different from the above-mentioned mechanisms in dynamic MOS memories.

In static memory, current always flows through the cell to retain data in the flip-flop. When partial current induced by alpha particles exceeds the retention current, misoperation occurs due to reversion of the flip-flop.

3.2 Examples of soft error preventive measures

In 64K DRAM development, accelerated irradiation test data indicated a higher soft error rate than the expected design rate. Hitachi performed the following soft error preventive measures:

(1) Selection of packaging materials which emit minimal alpha particles
(2) Application of chip coating technology to prevent alpha particles from reaching the chip surface.
(3) Use of circuitry and layout technology with inherent ability to resist alpha particles.

As a result of these measures, soft errors in 64K DRAM have reached acceptable levels. These preventive measures also are applied to other device types (Fig. 9).

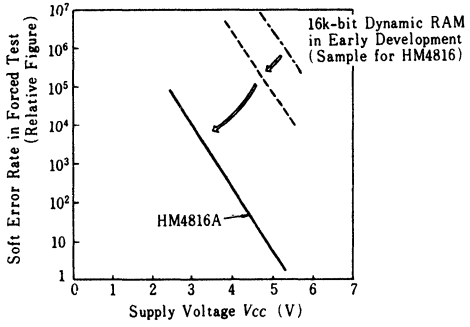


Fig. 9 Example of Soft Error Improvement on 16K-bit Dynamic RAM

3.3 System-level preventive measures

Hitachi's effort to reduce soft errors has resulted in almost trouble-free memories. System-level reliability can be further improved by supplying functions such as ECC for large memory systems, and a parity bit for small systems.

4. RELIABILITY CLASSIFICATION

In designing IC memories, Hitachi classifies memory reliability by the particular device application, and can control the flow of design, production and testing to suit that application.

Reliability can be classified according to the following general applications:

(1) Large scale computers and electronic exchanges
(2) Automotive applications
(3) General communication-industrial use.

When using our memories in any special equipment, please do not hesitate to consult our sales engineering staff regarding reliability in that application.

Precautions given below for handling IC memories will assist the designer in achieving optimum circuit designs, and prevent device malfunction.

1. BIPOLAR IC MEMORY

1.1 Prevention of static electricity

Bipolar memories are considered to have higher resistance to damage by static electricity than MOS ICs. However, presently available high-speed Bipolar memory ICs must be handled with suitable static electricity preventive measures. Since their diffused junctions have become thinner than conventional types in order to perform at high speed, the following measures are recommended:

(1) Keep all device terminals in a conductive mat to maintain equi-potential during transportation and storage. A conductive mat called "MOSPAK" is commercially available. Unless otherwise specified, all Hitachi IC memories are shipped in conductive mats. Memories should be stored in these mats.

(2) When handling IC memories for inspection or connection, grounding must be provided as shown in Fig. 1. The 1 M ohm resistor protects the handler from electric shock.

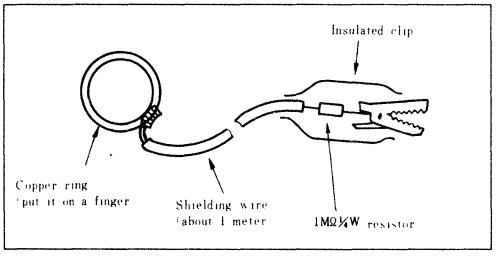


Fig. 1

(3) Control the ambient relative humidity at about 50 per cent.

(4) Wear cotton clothes instead of synthetic fabrics.

(5) Ground all soldering iron tips.

(6) Pack IC memories mounted on circuit boards in conductive mats.

1.2 Prevention of Reverse Insertion

Marking of No. 1 pin is clearly stamped on the device package to prevent incorrect insertion of ICs.

1.3 Mounting and Removal of ICs with Voltage Applied

If ICs are inserted or removed from a board when voltage is applied, the voltage induced at current on/off can destroy the ICs. Mount and remove ICs with power removed. The same precaution is necessary in measurements using a tester.

1.4 Prevention of Oscillation

ECL Bipolar memory has a high transistor cutoff frequency. Sometimes oscillation is caused by the external circuit, and IC misoperation occurs. In such cases, a high frequency capacitor (0.1μF) is recommended between the IC's ground and voltage supply line.

1.5 Precaution on Simple "H" Level of ECL Memories

If an IC's input is grounded to fix input level at "H," misoperation sometimes occurs due to the internal circuit composition. "H" and "L" input levels are specified $V_{IL(min)}$ and $V_{IH(max)}$, respectively. Please refer to these specifications to properly utilize ICs.

1.6 Cooling

The power dissipation of Bipolar memories is 400mW to 1000mW, depending on the device. When many Bipolar memories are mounted on a board, forced air cooling may be required. In addition, cooling will improve reliability as shown in Fig. 2. We recommend the junction temperature be kept lower than 85°C to achieve high reliability.

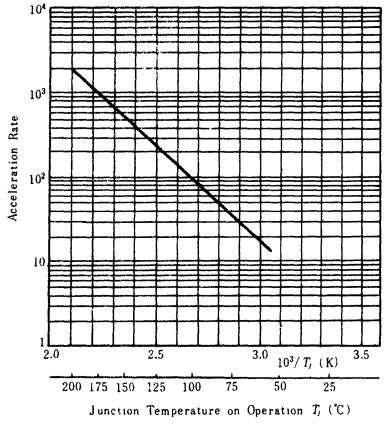


Fig. 2 Example of derating of ECL

1.7 Other Precautions

(1) Deforming of magazine and carrier:
Plastic magazine and carrier material for ECL flat packages is usually thermo-plastic, which deforms at temperatures higher than 40 to 50°C. If burn-in occurs in the field, use an aluminum magazine or other metal type fixture.

(2) Shock in transportation:
Normal handling tests and drop tests (JIS-C7021 A-8) on individual glass-sealed devices indicate no damage. However, strong shock received during transportation or loading of devices packed in magazines may cause damage. Even after devices are board-mounted, IC packages may be damaged if the board strength is insufficient to withstand strong deforming stress. Please contact Hitachi or its representatives regarding handling and transportation of Hitachi devices.

2. MOS IC MEMORY

2.1 Prevention of Static Electricity

The preventive measures referred to in Paragraph 1.1 should also be followed for MOS memories.

2.2 Reducing Power Source Noise

Current spikes can create a power source noise in dynamic memories. Since MOS memories are accessed while being refreshed, use of large capacitors is recommended (a 10μF capacitor for every 9 pieces of 16K-bit HM4716A), as well as an 0.1μF high-frequency capacitor for each memory.

2.3 Current Spikes in V_{BB} Power

Accidental current spikes on V_{BB} (formed by the rise or fall of clock pulse during access time) can be prevented by using a 0.1μF capacitor for every 2 or 3 memories.

2.4 Clock Drive ICs

Clock drive ICs have special designs which permit fast rise and fall times with high capacity loads. Prevent device damage by avoiding ground wire short-circuits to either V_{DD} or V_{CC} (Pin No. 1 and No. 16 respectively).

2.5 Power Application Sequence

We recommend designing circuits so that power is applied in the sequence of V_{BB}, V_{DD}, and then V_{CC}. It should be interrupted in a reverse sequence (with V_{BB} interrupted last).

Some small scale systems cannot apply power in the above sequence—as when V_{BB} is supplied by a DC to DC converter. Experiments conducted under the following test conditions proved that such systems of 200 to 300 memory devices are not affected by the power application sequence.

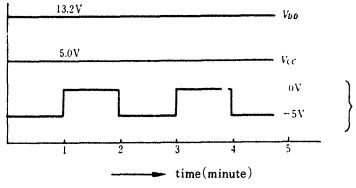
1.) Test method

(1) Ambient temperature: 25°C

(2) Power voltage: V_{DD}=13.2V, V_{CC}=5.0V, V_{IH}=5.0V

(3) Operation mode: AC operation ("0" to "16383" all bits scanning). t_{cyc}=10 μs
Read modify write operation

(4) V_{BB} power: ON (1 min.) — Floating (1 min.)



2.) Test results

Type No.	Number of cycles	Number of sample	Number of failures
HM4716A	2000 cycles	50	0

2.6 Assessing Memory System Designs

When evaluating system designs, power margin curves (shmoo plots) can be obtained by observing V_{BB} and V_{DD} power levels as they are gradually varied vs. system timing margin. Optimum curves are those which are closest to the margin shown for the memory device itself.

2.7 Parity Bit

Application of MOS static memories to microcomputers has increased because MOS static memory operates from a single 5V power source, without refresh. In some circuit design applications, all bits are used as information bits without a parity bit. However, we recommend adding a parity bit to thoroughly avoid memory error.

1. VIEWS ON QUALITY AND RELIABILITY

Basic views on quality at Hitachi are to meet the individual uers' required quality level and maintain a general quality level equal to or above that of the general market. The quality required by the user may be specified by contract, or may be indefinite. In either case, efforts are made to assure reliable performance in actual operating circumstances. Quality control during the manufacturing process, and quality awareness from design through production lead to product quality and customer satisfaction. Our quality assurance technique consists basically of the following steps:

(1) Build in reliability at the design stage of new product development.
(2) Build in quality at all steps in the manufacturing process.
(3) Execute stringent inspection and reliability confirmation of final products.
(4) Enhance quality levels through field data feed back.
(5) Cooperate with research laboratories for higher quality and reliability.

With the views and methods mentioned above, utmost efforts are made to meet users' requirements.

2. RELIABILITY DESIGN OF SEMICONDUCTOR DEVICES

2.1 Reliability Targets

The reliability target is an important factor in sales, manufacturing, performance, and price. It is not adequate to set a reliability target based on a single set of common test conditions. The reliability target is set based on many factors:

(1) End use of semiconductor device.
(2) End use of equipment in which device is used.
(3) Device manufacturing process.
(4) End user manufacturing techniques.
(5) Quality control and screening test methods.
(6) Reliability target of system.

2.2 Reliability Design

The following steps are taken to meet the reliability targets:

(1) Design Standardization
As for design rules, critical items pertaining to quality and reliability are always studied at circuit design, device design, layout design, etc. Therefore, as long as standardized processing and materials are used the reliability risk is extremely small even in the case of new development devices, with the exception of special requirements imposed by functional needs.

(2) Device Design
It is important for the device design to consider total balance of process, structure, circuit, and layout design, especially in the case where new processes and/or new materials are employed. Rigorous technical studies are conducted prior to device development.

(3) Reliability Evaluation by Functional Test
Functional Testing is a useful method for design and process reliability evaluation of IC's and LSI devices which have complicated functions.

The objectives of Functional Test are:

- Determining the fundamental failure mode.
- Analysis of relation between failure mode and manufacturing process.
- Analysis of failure mechanism.
- Establishment of QC points in manufacturing process.

2.3 Design Review

Design Review is an organized method to confirm that a design satisfies the performance required and meets design specifications. In addition, design review helps to insure quality and reliability of the finished products. At Hitachi, design review is performed from the planning stage to production for new products, and also for design changes on existing products. Items discussed and considered at design review are:

(1) Description of the products based on design documents.
(2) From the standpoint of each participant, design documents are studied, and for points needing clarification, further investigation will be carried out.
(3) Specify quality control and test methods based on design documents and drawings.
(4) Check process and ability of manufacturing line to achieve design goal.
(5) Preparation for production.
(6) Planning and execution of sub-programs for design changes proposed by individual specialists,

for test, experiments, and calculations to confirm the design changes.

(7) Analysis of past failures with similar devices, discussion of methods to prevent them, and planning and execution of test programs to confirm success.

3. QUALITY ASSURANCE SYSTEM

3.1 Activity of Quality Assurance

General views of overall quality assurance in Hitachi are as follows:

(1) Problems in each individual process should be solved in the process. Therefore, at the finished product stage the potential failure factors have been removed.

(2) Feedback of information is used to insure a satisfactory level of ability process.

3.2 Quality Approval

To insure quality and reliability, quality approval is carried out at the preproduction stage of device design, as described in section 2. Our views on quality approval are:

(1) A third party executes approval objectively from the standpoint of the customer.

(2) Full consideration is given to past failures and information from the field.

(3) No design change or process change without QA approval.

(4) Parts, materials, and processes are closely monitored.

(5) Control points are established in mass production after studying the process abilities and variables.

3.3 Quality and Reliability Control at Mass Production

Quality control is accomplished through division of functions in manufacturing, quality assurance, and other related departments. The total function flow is shown in Fig. 2. The main points are described below.

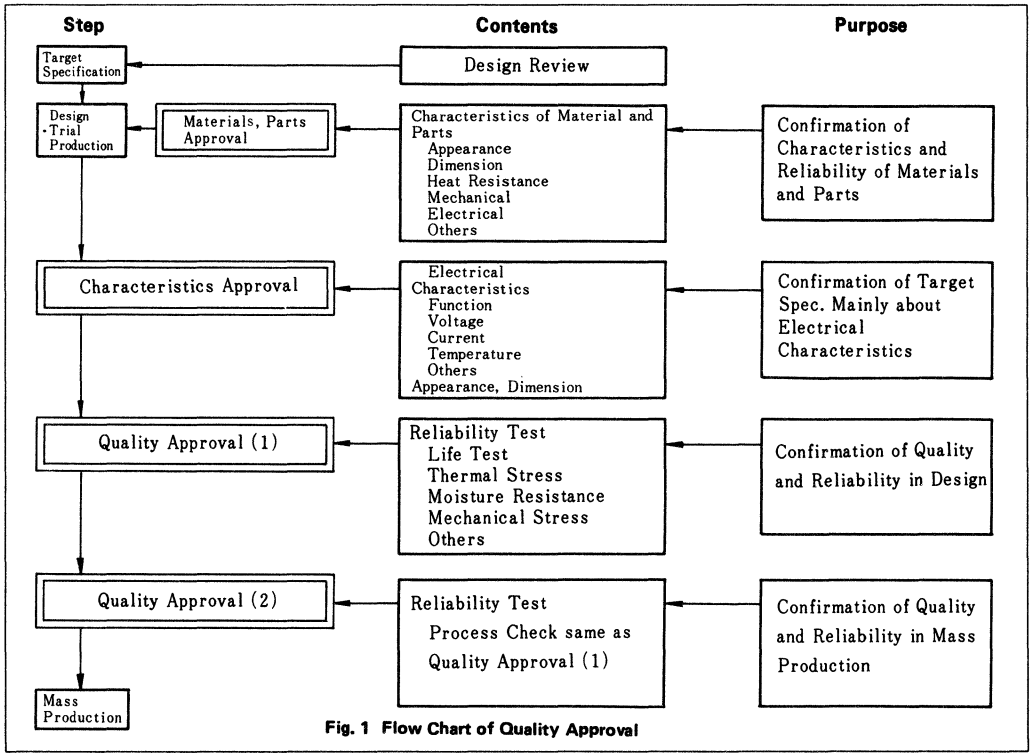


Fig. 1 Flow Chart of Quality Approval

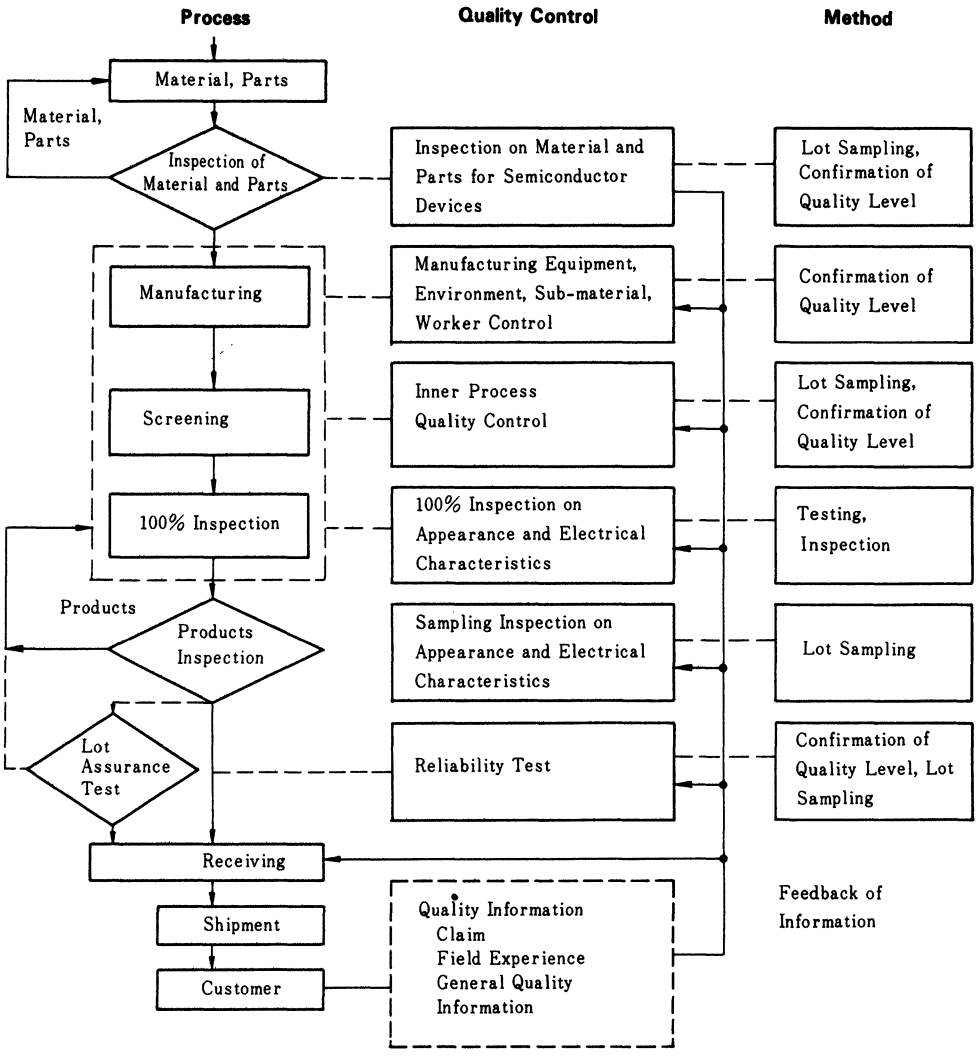


Fig. 2 Flow Chart of Quality Control in Manufacturing Process

3.3.1 Quality Control of Parts and Materials

As semiconductor devices tend towards higher performance and higher reliability, the importance of quality control of parts and materials becomes paramount. Items such as crystals, lead frames, fine wire for wire bonding, packages, and materials needed in manufacturing processes such as masks and chemicals, are all subject to rigorous inspection and control. Incoming inspection is performed based on the purchase specification and drawing. The sampling is executed based mainly on MIL-STD-105D.

The other activities of quality assurance are as follows:

(1) Outside vendor technical information meeting.
(2) Approval and guidance of outside vendors.
(3) Chemical analysis and test.

The typical check points of parts and materials are shown in Table 1.

• Table 1 Quality Control Check Points of Material and Parts (Example)

Material, Parts	Important Control Items	Point for Check
Wafer	Appearance	Damage and Contamination on Surface
	Dimension	Flatness
	Sheet Resistance	Resistance
	Defect Density	Defect Numbers
	Crystal Axis	
Mask	Appearance	Defect Numbers, Scratch
	Dimension	Dimension Level
	Resistoration	
	Gradation	Uniformity of Gradation
Fine Wire for Wire Bonding	Appearance	Contamination, Scratch, Bend, Twist
	Dimension	
	Purity	Purity Level
	Elongation Ratio	Mechanical Strength
Frame	Appearance	Contamination, Scratch
	Dimension	Dimension Level
	Processing Accuracy	
	Plating	Bondability, Solderability
	Mounting Characteristics	Heat Resistance
Ceramic Package	Appearance	Contamination, Scratch
	Dimension	Dimension Level
	Leak Resistance	Airtightness
	Plating	Bondability, Solderability
	Mounting Characteristics	Heat Resistance
	Electrical Characteristics	
	Mechanical Strength	Mechanical Strength
Plastic	Composition	Characteristics of Plastic Material
	Electrical Characteristics	
	Thermal Characteristics	
	Molding Performance	Molding Performance
	Mounting Characteristics	Mounting Characteristics

3.3.2 Inner Process Quality Control

Inner Process Quality Control performs very important functions in quality assurance of semiconductor devices. The manufacturing Inner Process Quality Control is shown in Fig. 3.

(1) Quality Control of Semi-final Products and Final Products

Potential failure factors of semiconductor devices are removed in the manufacturing process. To achieve this, check points are set-up in each process and products which have potential failure factors are not moved to the next process step. Manufacturing lines are rigidly selected and tight inner process quality controls are executed—rigid checks in each process and each lot, 100% inspection to remove failure factors caused by manufacturing variables and high temperature aging and temperature cycling. Elements of inner process quality control are as follows:

- Condition control of equipment and workers environment and random sampling of semi-final products.
- Suggestion system for improvement of work.
- Education of workers.
- Maintenance and improvement of yield.
- Determining quality problems, and implementing countermeasures.
- Transfer of quality information.

(2) Quality Control of Manufacturing Facilities and Measuring Equipment

Manufacturing equipment is improving as higher performance devices are needed. At Hitachi, the automation of manufacturing equipment is encouraged. Maintenance Systems maintain operation of high performance equipment. There are daily inspections which are performed based on related specifications. Inspection points are listed in the specification and are checked one by one to prevent any omission. As for adjustment and maintenance of measuring equipment, specifications are checked one by one to maintain and improve quality.

(3) Quality Control of Manufacturing Circumstances and Sub-Materials

The quality and reliability of semiconductor devices are highly affected by the manufacturing process. Therefore, controls of manufacturing circum-

stances such as temperature, humidity and dust, and the control of submaterials, like gas, and pure water used in a manufacturing process, are intensively executed.

Dust control is essential to realize higher integration and higher reliability of devices. At Hitachi, maintenance and improvement of cleanliness at manufacturing sites is accomplished through attention to buildings, facilities, air conditioning systems, delivered materials, clothes, work environment, and periodic inspection of floating dust concentration.

3.3.3 Final Product Inspection and Reliability Assurance

(1) Final Product Inspection

Lot inspection is done by the quality assurance

Process	Control Point		Purpose of Control
▽Purchase of Material			
Wafer	Wafer	Characteristics, Appearance	Scratch, Removal of Crystal Defect Wafer
○Surface Oxidation	Oxidation		Assurance of Resistance
□Inspection on Surface Oxidation		Appearance, Thickness of Oxide Film	Pinhole, Scratch
○Photo Resist	Photo Resist		
□Inspection on Photo Resist		Dimension, Appearance	Dimension Level
◇PQC Level Check			Check of Photo Resist
○Diffusion	Diffusion	Diffusion Depth, Sheet Resistance	Diffusion Status
□Inspection on Diffusion		Gate Width	Control of Basic Parameters (V_{TH}, etc) Cleaness of surface, Prior Check of V_{IH} Breakdown Voltage Check
◇PQC Level Check		Characteristics of Oxide Film Breakdown Voltage	
○Evaporation	Evaporation	Thickness of Vapor Film, Scratch, Contamination	Assurance of Standard Thickness
□Inspection on Evaporation			
◇PQC Level Check			
□Wafer Inspection	Wafer	Thickness, V_{TH} Characteristics	Prevention of Crack, Quality Assurance of Scribe
□Inspection on Chip Electrical Characteristics	Chip	Electrical Characteristics	
○Chip Scribe		Appearance of Chip	
□Inspection on Chip Appearance			
◇PQC Lot Judgement			
Frame			
○Assembling	Assembling	Appearance after Chip Bonding	Quality Check of Chip Bonding
		Appearance after Wire Bonding	Quality Check of Wire Bonding
◇PQC Level Check		Pull Strength, Compresion Width, Shear Strength	Prevention of Open and Short
□Inspection after Assembling		Appearance after Assembling	
◇PQC Lot Judgement			
Package			
○Sealing	Sealing	Appearance after Sealing Outline, Dimension	Guarantee of Appearance and Dimension
◇PQC Level Check	Marking	Marking Strength	
○Final Electrical Inspection			
◇Failure Analysis		Analysis of Failures, Failure Mode, Mechanism	Feedback of Analysis Information
□Appearance Inspection			
△Sampling Inspection on Products			
○Receiving			
Shipment			

Fig. 3 Example of Inner Process Quality Control

department for products which were judged good in 100% test . . . the final process in manufacturing. Though 100% yield is expected, sampling inspection is executed to prevent mixture of bad product by mistake. The inspection is executed not only to confirm that the products have met the users' requirements but also to consider potential quality factors. Lot inspection is executed based on MIL-STD-105D.

(2) Reliability Assurance Tests
To assure the reliability of semiconductor devices, reliability tests and tests on individual manufacturing lots that are required by the user, are periodically performed.

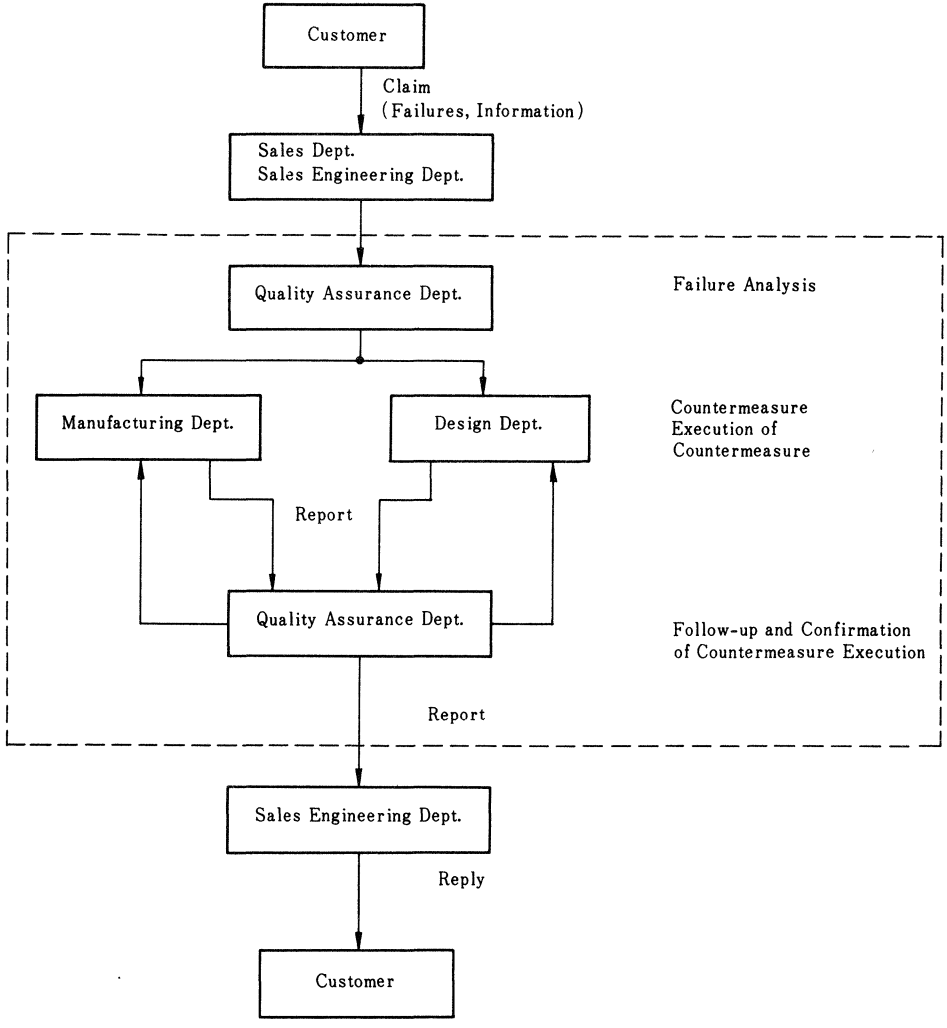


Fig. 4 Process Flow Chart of Field Failure

1. Inspection Methods

Compared to conventional core memories, all peripheral circuits such as decoder, write, and read circuits are contained within an IC memory.

A function test for TTL gates can be performed by a simple DC parameter facility.

IC memory quality cannot be determined by inspecting DC characteristics only, because the number of transistors relating to the DC pin characteristics only amount to 1/1000 of all elements. Systematic electrical inspection of IC memories requires a memory tester which generates an inspection pattern for the IC memory at high speed. When the address input becomes multiplexed, as in 16K memory, even generating the function test pattern becomes a serious problem. The following address patterns are representative of those used to determine whether internal circuits are functioning properly:

(1) All "Low," all "High"
(2) Checker flag
(3) Stripe pattern
(4) Marching
(5) Galloping
(6) Walking
(7) Ping-pong

From many possible address patterns, we have listed a group of patterns convenient for checking the mutual interference of bits, including some with maximum power dissipation. (1) to (4) are N patterns, capable of checking IC memories of N bits with several sequences of N against the IC memory of N bits. (5) to (7) are N^2 patterns which require several sequences of N^2.

A serious problem arises in using the N^2 patterns in large capacity memory. For example, a period of about 30 minutes is required to inspect 16K memory with a galloping pattern. Patterns (1) to (3) are comparatively simple and effective methods, but do not guarantee protection against a failure in the decoder. The simplest pattern for inspecting the necessary memory function is a Marching pattern.

2. Marching Pattern

As its name indicates, this is a pattern in which "1" marches into all bits written "0". The addressing method is explained in the following example for a simple 16-bit memory:

(1) Write "0" for all bits (Fig. 1a).
(2) Read "0" of 0th address and check that read data is "0". Hereafter, "Read" = "checking and judging the data."
(3) Write "1" in the 0th address (Fig. 1b).
(4) Read "0" of 1st address.
(5) Write "1" in 1st address.
(6) Read "0" of nth address.
(7) Write "1" in nth address (Fig. 1c).
(8) Repeat above procedures (6) and (7) up to the last. Finally all data will become "1."
(9) Since all data is "1" in this condition, replace "0" and "1" after procedure (2), and repeat once more up to procedure (8).

It is understood that 5N address patterns are necessary for the N bit memory in this method.

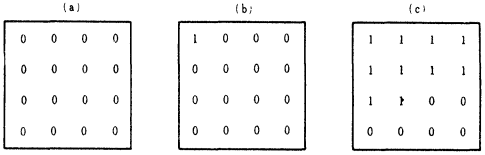


Fig. 1 Addressing method for 16 bits memory in the Marching pattern

3. Generation of Marching Pattern

A method of generating the marching pattern and displaying failed bits on the Braun tube is shown below. Fig. 2 shows the block diagram, with the address pattern generated by four synchronous 4-bit counters. All address patterns are shown in Fig. 4—an example of 16K bit memory. It can be seen that A14, which has half the frequency of the maximum address input A13, is the same as the data input. The A15 signal together with the HD74161 carrier signal is used to determine the sequence termination.

In the read and write cycles shown in Fig. 2, after clearing all bits, addressing is twice the period of clearing. This switching is performed at the binary gate, following the reference pulse generating circuit.

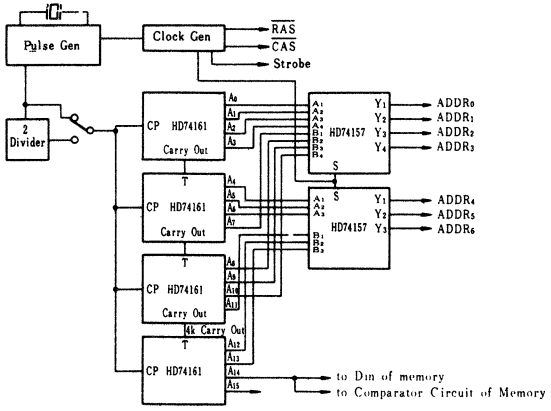


Fig. 2 Marching Pattern Generating Circuit

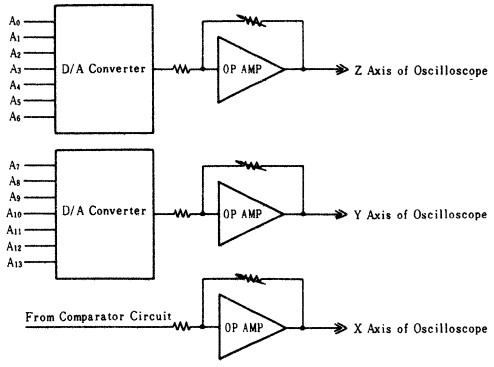


Fig. 3 Fail Bit Map Display Circuit

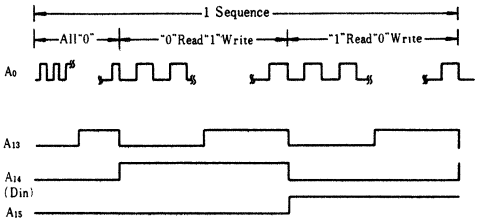


Fig. 4 Entire Pulse Relations

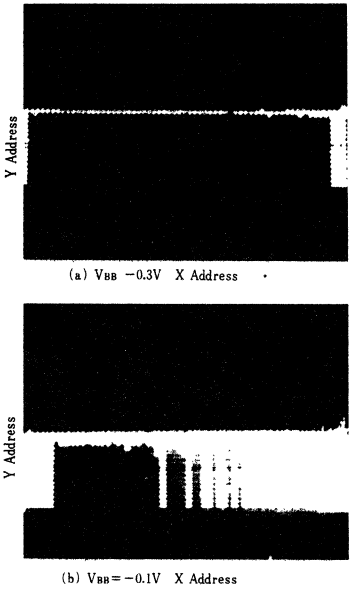


Fig. 5 Example of Dependency of Fail Bit Map on V_{BB}

The output of the HD74161 is input to the D/A converter, and the output of D/A converter is connected to the oscilloscope to display A X-Y matrix. The output of the comparator circuit is connected to the Z axis and performs luminous intensity modulation. In this way, the bit map can be displayed on the CRT.

Fig. 5 shows an example ot a voltage margin check. By changing V_{BB}, the increase and decrease of failed bits can be seen. The complicated operation of the memory can be seen dynamically by CRT display, rather than by pulse waveform observed with an ordi-

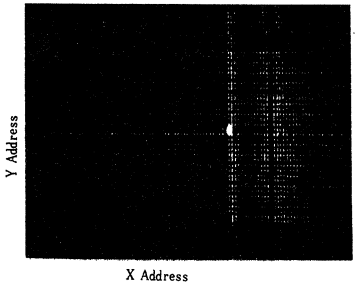


Fig. 6 Example of 1 bit solid fail

nary oscilloscope. The bit map as shown in Fig. 5 is extremely useful in observing IC memory operation.

4. Failure Mode

70~90% of failure at user end is called a solid failure—a mode which has no relation to access time, voltage margin and timing. In this failure mode, the memory is not capable of reading from or writing to certain specified bits, which are fixed at "0" or "1". An example of single bit solid failure is shown in Fig. 6. The convenient tester previously described can detect such failures. Except for special cases, it is rarely necessary to perform high-precision measurements such as those made by IC memory manufacturers.

Full inspection of IC memories under adverse conditions, performed by Hitachi, guarantees voltage and timing conditions listed in the data sheet.

An extremely accurate memory tester is required for performing high-precision inspection with 1ns accuracy. Hitachi is developing testers to supply newer high-efficiency memories with excellent characteristics and quality.

1. Power On

When power is applied to a semiconductor memory, power-on current varies with V_{CC} and clock conditions, as shown in Fig. 1. If the rise time of V_{CC} is in the 10μs range, the RAM does not operate dynamically, causing a surge of I_{CC} current. This I_{CC} current surge may be avoided by insuring that V_{CC} rise time is longer than 100μs.

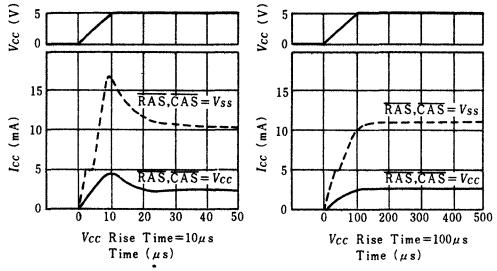


Fig. 1 Relationship between standard value of I_{CC} and V_{CC} during power-up

2. Operation Modes (See Fig. 2)

(1) Read-Cycle:
First decide the X address of the memory cell chosen, and start with trailing of $\overline{RAS}$. When the X address is held by the internal circuitry, change to Y address. Then trail $\overline{CAS}$ to take in the Y address. If the $\overline{WE}$ pin is at high, the output will appear on the Dout pin.

(2) Write Cycle:
The input at Din is written in the memory cell when $\overline{WE}$ turns to low before $\overline{CAS}$.

(3) Read/Modify/Write Cycle:
During this cycle, $\overline{CAS}$ and $\overline{WE}$ are trailed down to low, so that data is read out from, and written in, the same address in the same memory cycle.

(4) Page Mode Cycle:
In this cycle, $\overline{CAS}$ is cyclically moved after taking in the X address through $\overline{RAS}$, to scan only the Y address. This permits reading out and writing in only one column of data at high speed.

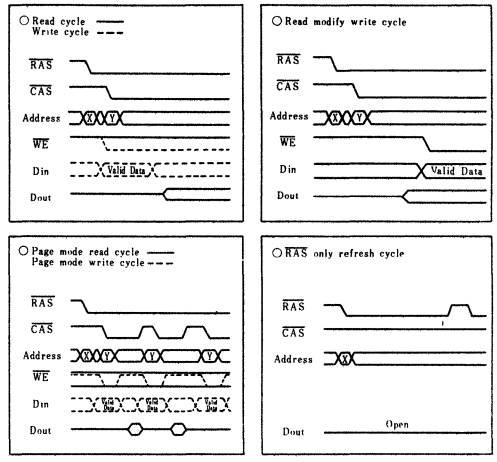


Fig. 2 Operating modes of Dynamic RAMs

2. Data Output

Dout is a TTL-compatible, three-state output with two TTL-load fan out. The output is controlled by the $\overline{CAS}$ signals. In the early write cycle, the output reaches high impedance to permit use as a common I/O terminal.

3. Refresh Cycle

Refresh is a process of periodical rewriting to offset the leakage of charge in the cell, and is implemented in the $\overline{RAS}$ only refresh cycle, and ordinary read cycle. Whether 16K- or 64K-bit, all bits can be refreshed by giving a 128-cycle scanning to only the X addresses between A0 and A6. Each cycle refreshes 128 bits for the 16K-bit DRAM, and 512 bits for the 64K-bit RAM.

The $\overline{RAS}$ only refresh cycle permits a power-efficient refresh that calls for approximately 75% of current consumed by the read cycle. With $\overline{CAS}$ fixed at high, the output reaches high impedance.

The HM4816A has a special function called hidden refresh which allows holding the output by turning $\overline{CAS}$ to low during $\overline{RAS}$ only refresh.

There are two methods of refreshing:
(1) Concentrated—giving a 128-cycle refresh after

operating the memory for a period of 2ms maximum.

(2) Deconcentrated—which repeats a refresh cycle every 16μs, following the initial 16μ memory operation (=2ms/128).

4. Operating Current in Dynamic RAMs

Fig. 3 shows the waveforms of current applied in various operating modes for HM4864. The mean operating current in each mode equals the value obtained by dividing the integrated result of each waveform by the cycle time. The first peak in each mode appears during memory access. On the other hand, the peak during standby appears due to the precharging operation in each circuit.

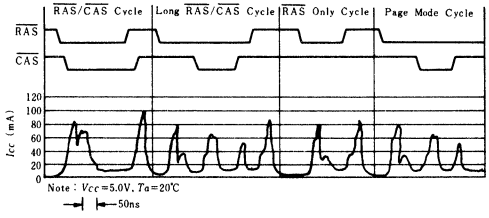


Fig. 3 Power supply voltage (HM4864)

DRAMs show different current peaks, depending upon $\overline{RAS}$ and $\overline{CAS}$ timing. The largest peak appears when both X and Y operate simultaneously. The maximum current peak for HM4864 is approximately 100mA. Current consumed during standby is expressed as a function of cycle time dependency in Fig. 4. During standby, with a once-in-every16μs refresh, HM4864 consumes approximately 3mA current.

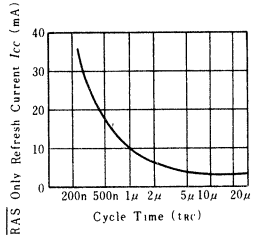


Fig. 4 Cycle time dependence of $\overline{RAS}$ only refresh current (HM4864)

5. Noise

Noise can be classified into power source noise, and input signal noise. The power source noise can be further classified as low- or high-frequency noise as shown in Fig. 5. To assure stable memory operation, peak-to-peak power supply voltage, in the presence of low- or high-frequency noise, should be held below 10% of standard level. To prevent power source noise, we recommend a condenser of 0.1μF for each one or two devices.

Input signal noise can be classified overshoot or undershoot. Overshoot should be held below the highest input level specified. To prevent input-undershoot-induced parasitic transistor effects, a −5V V_{BB} is used (three supply designs) or a built-in V_{BB} bias circuit is included on chip.

Design should provide that the input undershoot does not exceed the minimum specified for V_{IL}. Overshoot and undershoot in DRAMS can be reduced by inserting a damping resistance of several tens of ohms.

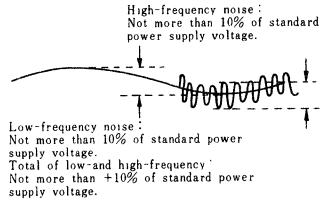


Fig. 5 Power source noise

1. PROGRAMMING AND ERASING EPROMs

1.1 Programming

Information is programmed into the memory cell of an EPROM by applying a high voltage to its drain and gate (Fig. 1 and 2). High voltage at the drain increases the energy of the electrons in the channel area, which become "hot electrons" capable of jumping across the oxide film. Pulled by high voltage at the gate, the hot electrons are admitted into the floating gate. The charge entering the floating gate changes the threshold voltage in the memory element, thereby storing new information.

When reading out, voltage is applied as in Fig. 3, and "1" and "0" are identified by checking whether or not current flows. Since the drain voltage for read-out is set at 3V, no erroneous writing takes place.

When shipped, all EPROM bits are held at logic "1" with all charge released (no programmed data). In changing "1" to "0" by applying the specified waveform and voltage, data is programmed. The higher the V_{PP} voltage, and the longer the program pulse width t_pW, the greater the quantity of electrons programmed in, as shown in Fig. 4.

If V_{PP} exceeds the rated value, as in overshoot, the memory's p-n junction may yield to permanent breakdown. To avoid this, check V_{PP} overshoot of the PROM programmer. Also check negative-voltage-induced noise at other terminals, which can create a parasitic transistor effect and reduce apparent yield.

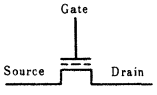


Fig. 1 Memory transistor circuit symbols

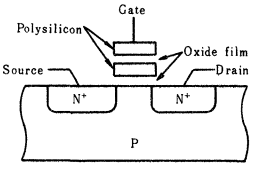


Fig. 2 Cross section of memory transistor

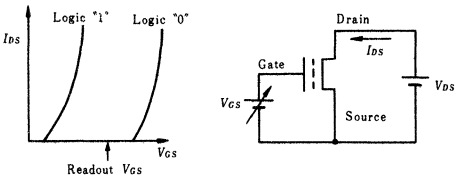
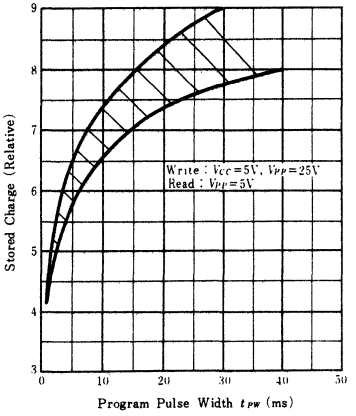


Fig. 3 Reading out stored information



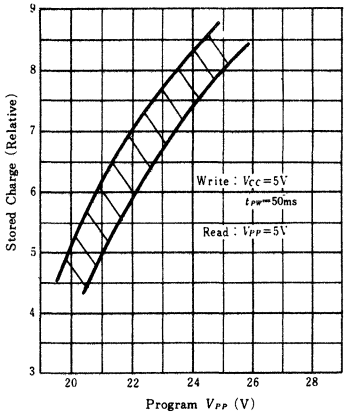


Fig. 4 Typical Programming Characteristics of EPROMs.

1.2 Erasing

Hitachi's EPROMs are usually capable of being written and erased more than 100 times. Data stored in the EPROM is erased by exposing the chip to ultraviolet light, which releases the electric charge from the floating gate. Electrons in the floating gate receive ultraviolet energy, become hot electrons again and jump into the control gate or substrate. This process erases the stored data.

Wavelength and minimum exposure of ultraviolet light are specified as 2,537Å, and 15W sec/cm² respectively. Erasure occurs by exposing a device to an ultraviolet lamp of 12,000μW/cm² at a distance of 1.2~3cm for approximately 20 minutes. The ultraviolet light transmission rate of the transparent lid is about 70%. Contamination or foreign material on the surface—which lowers transmission and prolongs erase time—should be eliminated by the use of alcohol or other solvent that will not damage the package. Fig. 5 shows typical EPROM erasure characteristics.

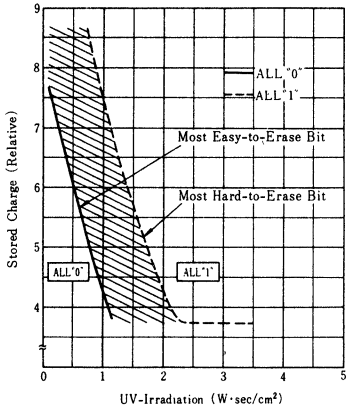


Fig. 5 Typical Erasing Characteristics

1.3 Data Retention

As a result of writing in, approximately 0.5 to 2.0 x 10^{-13} coulomb of electrons are accumulated at the floating gate. With the elapse of time, these electrons decrease, which can result in inversion of stored data. The mechanisms of electron dissipation are explained as follows:

(1) Data Dissipation by Heat
The accumulation of electrons at the floating gate is an unbalanced state, so the dissipation of thermally excited electrons is unavoidable. Data holding time is closely related to temperature. Fig. 6 shows typical data retention characteristics.

(2) Data Dissipation by Ultraviolet Light
Ultraviolet rays at a wavelength of not greater than 3,000~4,000Å will release the charge stored in EPROMs. Prolonged exposure to fluorescent light and sunlight, which contain some ultraviolet rays, can cause data corruption. Fig. 7 shows examples of data retention time using ultraviolet, sunlight, and fluorescent light sources.

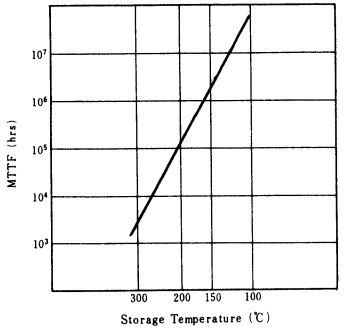


Fig. 6 Typical Data Retention Characteristics

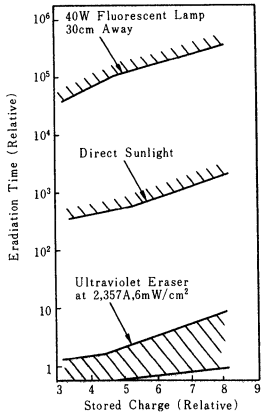


Fig. 7 EPROM's data retention time

(3) Data dissipation by voltage
This type of dissipation occurs while information is being written in. High voltage at other memory cells lying on the same word or data line as the cell being programmed, can cause dissipation of stored electric charge. Such defects are eliminated by inspection at the factory. The programing voltage and pulse width should always be kept within specified limits.

1.4 EPROM Programmer

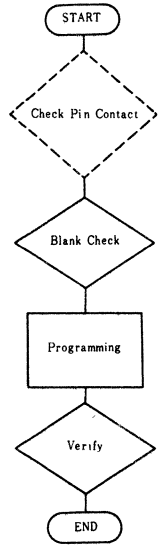
An EPROM Programmer stores program data from a source in its internal RAM, and writes the program data into an EPROM. A minimum of 3 functions are necessary to accomplish this: the Blank check function prior to programming, the Programming function, and the Verify function. As shown in the drawing, programmers also are provided with a reverse insertion checking function, or pin contact checking function, prior to the Blank Check. The diagram is outlined as follows:

(a) Pin contact check
Checking is performed by detecting the forward current of each EPROM pin. This forward biased resistance differs between product manufacturers.

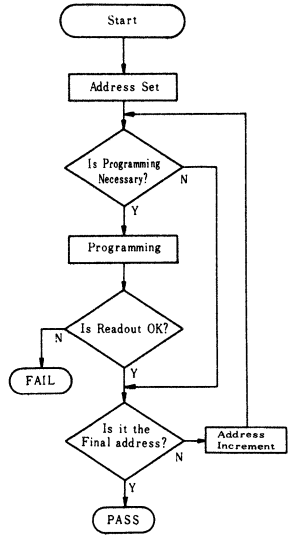
(b) Reverse insertion check
This check detects reverse insertion of the device, places the equipment in reset mode, and protects the device and equipment.

(c) Blank Check
This function is performed prior to programming to determine whether the EPROM is erased, or to prevent EPROM reprogramming. With output data in the erased condition at "1" (high), check whether or not data in the EPROM is also at "1." It will failstop, if any "0" is detected. Normally, a lamp or buzzer provides warning.

(d) Programming
Normal programming flow is shown below. An EPROM data word will be read out prior to programming, and compared with programming data. If they coincide, programming will be skipped; and if they differ, programming will be performed. Read out will be again compared with programming data, and if they coincide, it will progress to the next address.



(e) Verify
This function after programming completion, checks that the programming is correct when compared with data in the internal RAM of the programmer. It performs fail-stop when data does not coincide, lighting the fail lamp, and displaying the address and data.



(f) How to input the program
The following methods are given to input program data to the internal RAM of the programmer. Paper tape input and teletypewriter input are usually options.

Method	Content
Copy input	Input by copying the master ROM.
Manual input	Input by the keyswitch of the front panel. Used for correction or revision of program
Paper tape input	Read the paper tape furnished from the host system with the tape reader
Teletypewriter input	Input with the teletypewriter. Preparation, correction and list preparation of the program can be made.

1.5 Handling EPROMs

Contact with a charged human body, plastics, or dry cloth causes the glass window of an EPROM to generate static electricity which could cause device malfunction. Typical malfunctions are faulty blanking and write margin setting, which give the impression that information has been correctly written in. This malfunction is due to prolonged retention of electric charge on the glass window, resulting from the static electricity. It can be eliminated by neutralizing the charges through short exposure to ultraviolet rays—a procedure recommended before reprogramming, as it also reduces charges in the floating gate. To prevent charging of the window, use the following methods:

(1) Use a grounding system for the operator handling EPROMs, and avoid use of gloves that may develop a static charge.
(2) Refrain from rubbing the glass window with plastics and other substances that may develop a charge.
(3) Avoid use of coolant sprays which contain ions.
(4) Use shielding labels with conductive substances that can evenly distribute the established charge.

1.6 Shielding Labels

When using EPROMs in environments where ultraviolet exposure can occur, put a shield label over the glass window to absorb ultraviolet light. Specially prepared labels are marketed, and metal-loaded types are particularly effective. Few shielding labels meet all environmental requirements established for EPROMs. A suitable label must be chosen for each application by considering the following label characteristics:

(1) Adhesive Strength
Avoid repeated attaching and dusting which may reduce adhesive strength. Ultraviolet erasure and reprogramming are recommended after stripping off an attached label. If labels must be changed, attach the new label over the old, since peeling may develop a static charge.
(2) Temperature Range
Use a shielding label in an environment where temperature falls within the specified allowable range. Beyond this range, label paste may harden, or remain on the window glass even after the label is removed.
(3) Humidity Range
Use a shielding label where humidity does not exceed the specified allowable range.

2. PROGRAMMING BIPOLAR PROMS

2.1 Programming System

Bipolar PROM storage systems are classified as blown diode type, and fuse type. In the blown diode system, the Emitter-Base junction is short-circuited by A1, which has penetrated into the Base because of a current pulse applied to the E-B junction (Fig. 6). Hitachi devices use the blown diode system, which is considered to be more reliable.

In the fuse system (Fig. 5), the metal fuse is burned off by current, and a grow back phenomenon, or migration and recombination of the metal, can occur.

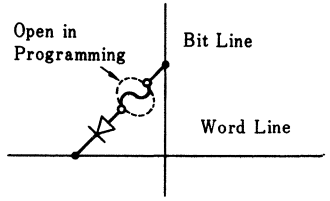


Fig. 5 Fuse system

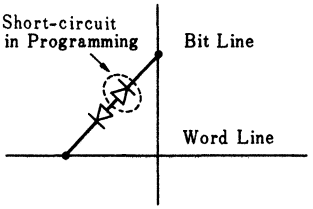


Fig. 6 Blown diode system

2.2 Programming Method

Programming is executed with conventional equipment (PROM writer), using a personality board suited to the product.

A Blank check is first performed. Next write the pattern you want to program, bit by bit. At every application of current pulse, confirm program by sensing the output level. This process should be performed for all bits into which you want to write. When programming is completed, Verify is performed.

At Blank Check, Sense and Verify, high output pin level (non-programmed), or low level (programmed) is checked by the sense current (I_S). $V_S - I_S$ characteristics for normal series and S series is shown in Fig. 8 and 9, respectively. Specified value of I_S for both series is 20mA, and voltage reference level is 7.5V.

Fig. 10 and 11 show the relationship between program current and program pulse number for 1 bit to be written. Program current is specified at 130mA in normal series, and at 90mA in S series.

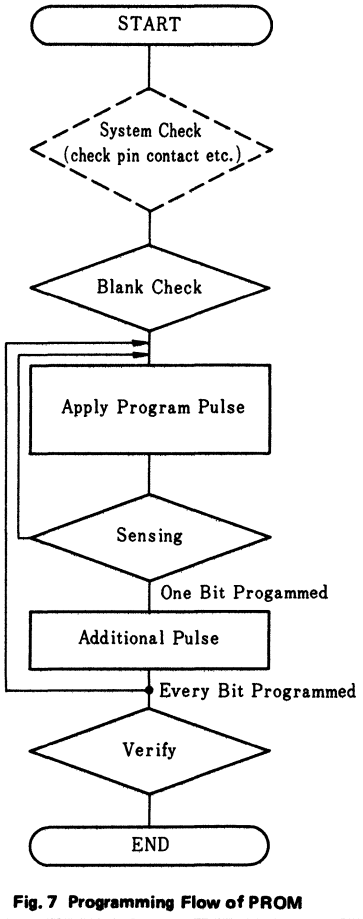


Fig. 7 Programming Flow of PROM

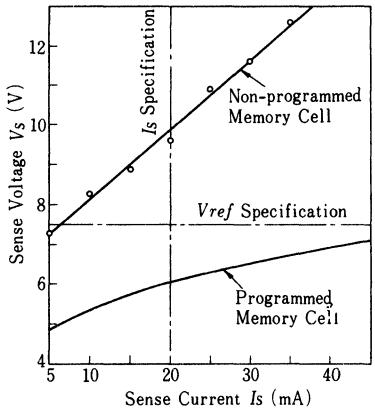


Fig. 8 Vs — Is Characteristic of Normal Series (HN25089)

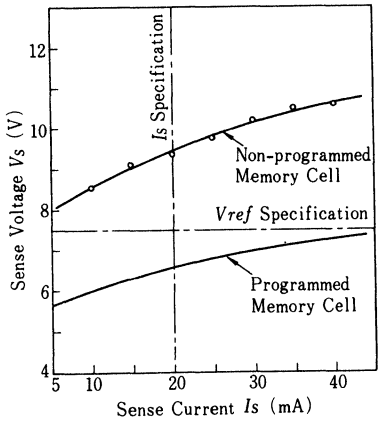


Fig. 9 Vs — Is Characteristic of S Series (HN25169S)

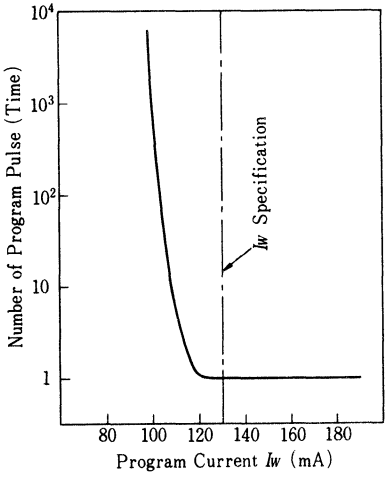


Fig. 10 Program Pulse — Iw Characteristic of Normal Series (HN25089)

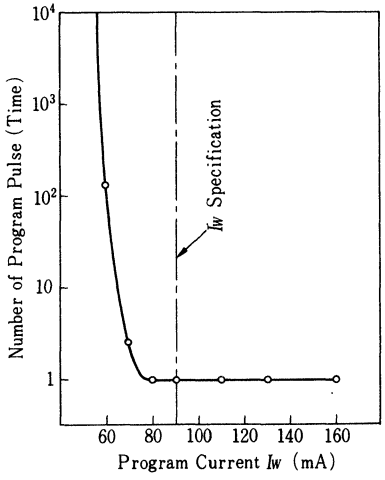


Fig. 11 Program Pulse — Iw Characteristic of S Series (HN25169S)

2.3 Programming Characteristics of Hitachi Bipolar PROMs

(a) Low program current
130mA for normal series, and 90mA for S series is required for programming, resulting in few instances of voltage breakdown and parasitic effects.

(b) Fast programming speed
As seen in Fig. 10 and 11, one program pulse per bit is usually sufficient, reducing the program time per device. For the example of 8k bits, only 2 or 3 seconds is required.

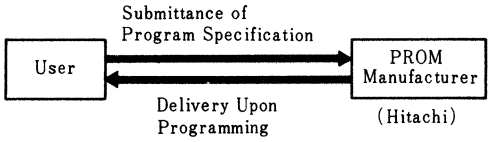
(c) High programming yield
Unlike MOS PROMs, Bipolar PROMs cannot be rewritten. Programming and inspection for product defects prior to delivery is not possible. Programming efficiency is 90~95% when performed at the user end. Special tests such as actual programming on the chip's dummy cell, and performing continuity tests of all memory cells, are executed at the factory, to minimize delivery of defective products.

2.4 Programming

There are two methods of programming PROMs, as follows:

2.4.1 Programming by the PROM manufacturer

As shown in the drawing below, the manufacturer receives specifications designating the program pattern, performs the writing function, and delivers the programmed PROM.



2.4.2 Programming by the user

The user purchases the following items certified for Hitachi products:

(1) PROM WRITER (Main unit of programming equipment)
(2) Personality board unique to manufacturer and device type.
(3) Minimum of one socket per product, purchased from the PROM WRITER manufacturer.

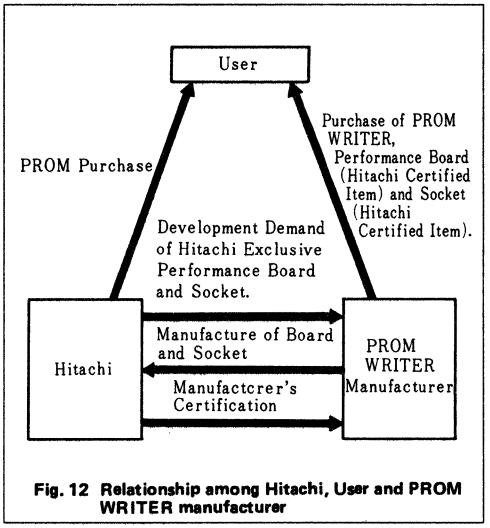


Fig. 12 Relationship among Hitachi, User and PROM WRITER manufacturer

2.5 Programming Device

There are about 10 programming device manufacturers, but not all manufacturer's devices are appropriate. A manufacturer must develop and qualify a board dedicated to Hitachi products. Hitachi can provide a list of recommended programming device manufacturers who meet all certification requirements. Please contact our sales engineering staff for this information.

The writing of custom program codes into mask ROMs is performed by the CAD system, using a large scale computer. ROM code data should conform to specifications given below, using either paper tape, EPROM or magnetic tape. Additional instructions, such as chip select and customer part number, should be given in the "ROM Specification Identification Sheet."

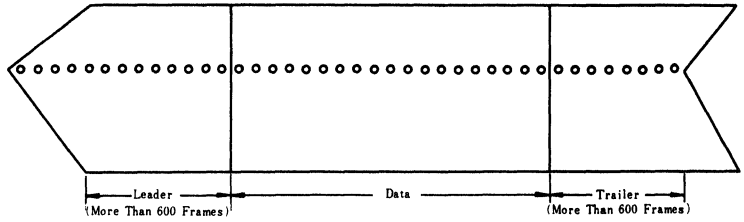
1. Overall Specifications

Since the submitted paper tape, card or magnetic tape is fed into a large scale computer, please observe the following specifications:

1.1 Paper Tape Specifications

1.1.1 1-inch-wide paper tape marketed for computers must be used. Any color may be used, although black is recommended.

1.1.2 Allow more than 600 frames for the leader and trailer.



1.1.3 Parity mode

The presence and type of parity must be clearly indicated in the "ROM Specification Identification Sheet."

Modes in the parity system are:

(1) With parity
  Even parity..... EVEN
  Odd parity ..... ODD
(2) Without parity

1.1.4 Use of the 8-unit ASC11 coding system is specified for the code.

1.2 Specification of Magnetic Tape

1.2.1 The following type of magnetic tape is specified, which can be entered in a magnetic tape device compatible with the IBM magnetic tape device:

(1) Length ..... 2,400 feet, 1,200 feet, or 600 feet
(2) Width..... ½ inch
(3) Channel.....9 channels
(4) Bit Density ..... 800 BPI or 1,600 BPI
  (clearly state bit density in the "ROM Specification Identification Sheet.")

1.2.2 Use EBCDIC code.

1.2.3 Follow the format for magnetic tape described as follows:

(1) No leading tape mark
(2) No label
(3) Record size _____ 80 byte/1 record
(4) Block size _____ 10 records/1 block
(5) Indicate end of the file with 2 successive tape marks (TM).

1.2.4 Ensure that magnetic tapes represent one roll for each chip. Extending the single-chip portion over several rolls is unacceptable.

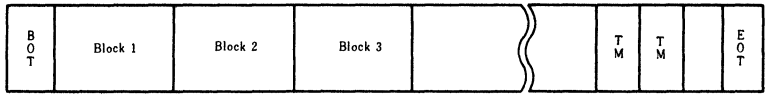
2. Data Mode

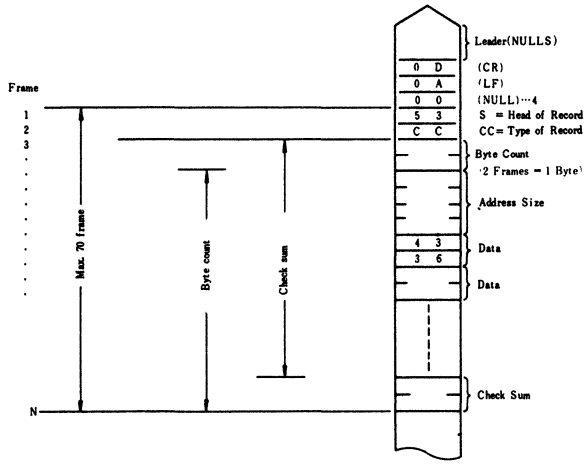
2.1 HMCS6800 Load Module Mode

This mode is the object mode output from the HMCS6800 assembler.

2.1.1 Divide the 8-bit code into the upper and lower 4-bit codes, and convert each into hexadecimal notations. (Example: The code of 1100 0110 is as follows under binary notation.)

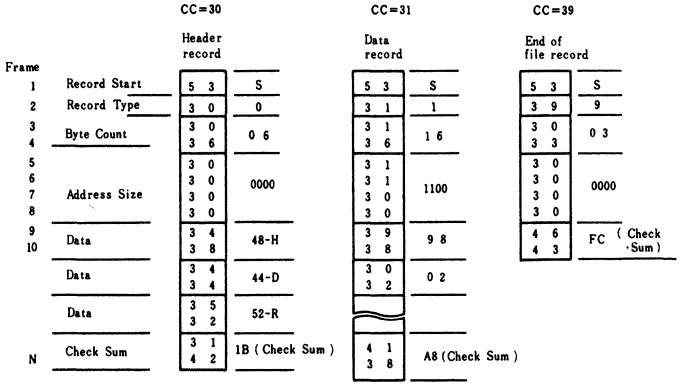
2.1.2 The composition of the load module mode is shown in the following example for paper tape. The numbers written in the tape are ASCII code hexadecimal numbers of the data.





(Note) The check sum is a technique which disregards the complement on one of each bit sum of the 8 bits.

2.1.3 The actual load module is shown as follows:



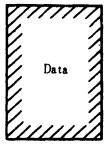
SO indicates the head of the file, and S9 indicates the end of the file. The actual data enters following S1 or from the address (hexadecimal) indicated in the address size. The address of the data recorder address is compared with the next data recorder address, by counting in 1-byte increments, and checking whether or not it is sequential. Where the address is skipped, 00 or FF data enters hexadecimally. A printed example on paper tape for the HMCS6800 load module mode is as follows:

Example

```
Header Record →S00B000058204558414D504CB5
Data Record   →S113F0007EF5587EF7897EFAA77EF9C07EF9C47E24
Data Record   →S112F010FA657EFA8B7EFAA07EF9DC7EFA247E06
End of
File Record   →S9030000FC
```

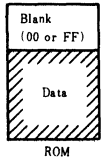
2.1.4 The ROM code data capability is indicated in the following four case types. A header recorder is required in front of the data recorder and an end of file recorder at the back of the data recorder.

(1) When the data reaches full ROM capacity:



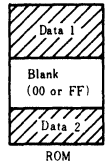
The ROM recorder for 1 chip enters into the data recorder. Since the address of the data recorder address size counts the data and checks whether or not it is in a sequential address, the address can not be skipped. The ROM head address column on the "ROM Specification Identification Sheet" is 0.

(2) When data is input from ROM enroute:



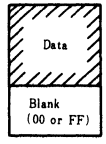
In this case, enter a decimal notation in the ROM head address column on the "ROM Specification Identification Sheet," to identify the ROM address chosen for data input. The 00 or FF data will enter into the blank address by hexadecimal notation.

(3) When data is input by skipping intermediate address:



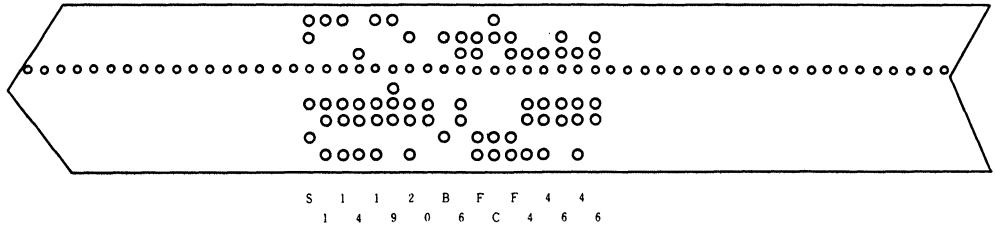
The address of the data recorder address size is counted in 1-byte increments, compared with the next data recorder address, and checked whether or not it is sequential. 00 data automatically enters by hexadecimal notation into the ROM code of the skipped address. Therefore, it is also possible to write data per the following drawing. In this case, note on the "ROM Specification Identification Sheet" that the ROM head address enters from 0 address for data I, and from which address it enters for data II.

(4) When the data is less than ROM full capacity:



Where data volume is less than ROM LSI total byte capacity when the end of file recorder appears, write the ROM code as shown in the following drawing.

(Example shows a paper tape when the data recorder is S1141920B6-FC...)



2.2 BNPF Mode

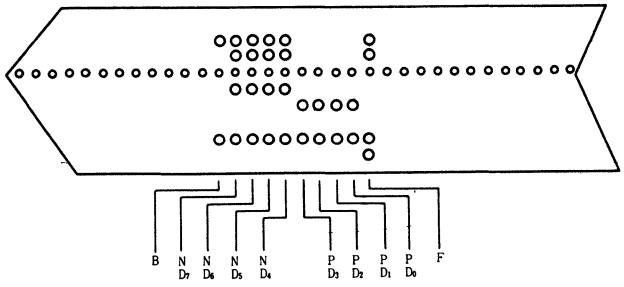
2.2.1 One word is symbolized by the word start mark (B). The bit content is represented by 8 characters of P and N, and the BNPF slice is composed of 10 successive characters of the word end mark (F).

2.2.2 The contents are ignored from F of one BNPF slice up to B of the next BNPF slice.

(Example: The OF code symbolized by hexadecimal notation is given for paper tape.)

2.2.3 The bit pattern (PNPF slice) must be designated on all ROM addresses. Therefore, the ROM head address is 0 on the "ROM Specification Identification Sheet."

B ..... Indicates starts of 1 word.
N ..... Indicates "0" of 1 bit data.
P ..... Indicates "1" of 1 bit data.
F ..... Indicates end of 1 word.

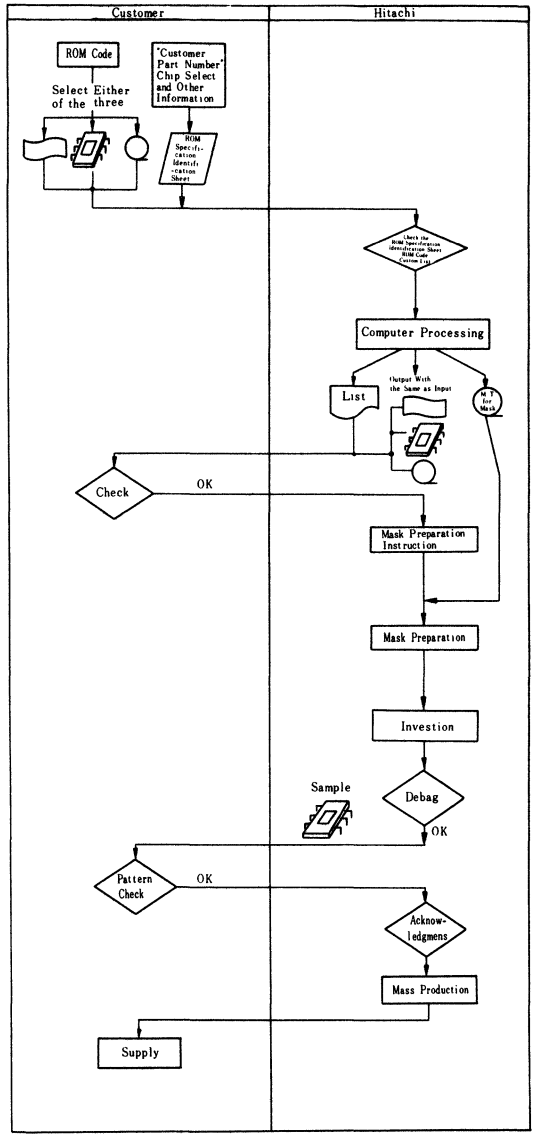


Note 1: Sometimes X is used in addition to P and N in the word content display, or BNPF slice. X means the user is not concerned whether the bit is P or N. However, since it is required for performing tests, Hitachi makes a selection, and a notation in the identification table.

Note 2: The BNPF slice contents are not only those with the continuation of NP; a B*nF also can be used to indicate that from this slice, contents of the previous slice will be repeated for n words. For example, when B*4F exists at the 10th word, the content of the 9th word will be repeated in the 10th, 11th, 12th, and 13th words. (It does not necessarily mean that X content in Note 1 above will be repeated.) n should start from 1, and be a number below the total ROM addresses.

Note 3: If a certain block is not used (existing unused ROM address), disposition is made per Notes 1 and 2.

Mask ROM Development Flowchart



DATA SHEETS

MOS STATIC RAM

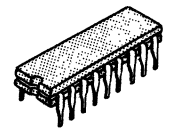
HM4334-3, HM4334-4
HM4334P-3, HM4334P-4

1024-word×4-bit Static CMOS RAM

■FEATURES

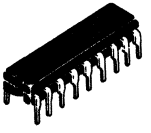
- Single 5V Supply
- Low Power Standby and Low Power Operation; Standby: 10μW (typ.) Operation: 20mW (typ.)
- Access Time; HM4334/P-3: 300 ns (max.) (5V±5%) HM4334/P-4: 450 ns (max.) (5V±10%)
- Directly TTL Compatible: All inputs and outputs
- Common Data Input and Output using Three-state Outputs
- On Chip Address Register

HM4334-3, HM4334-4



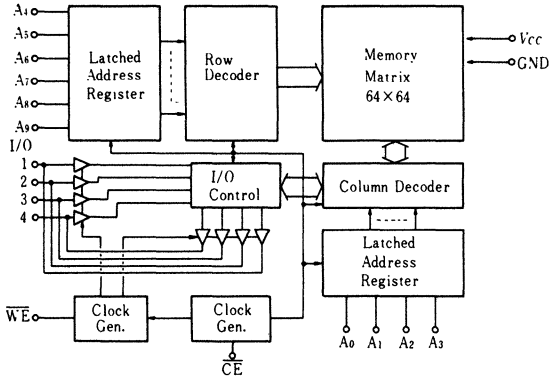
(DG-18)

HM4334P-3, HM4334P-4



(DP-18)

■BLOCK DIAGRAM

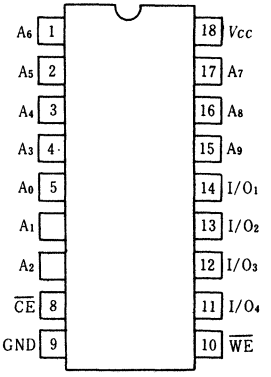


■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage On Any Pin*	V_T	−0.3 to V_{CC} +0.5	V
Power Supply Voltage*	V_{CC}	−0.3 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature (Plastic)	T_{stg}	−55 to +125	°C
Storage Temperature (Cerdip)	T_{stg}	−65 to +150	°C

* with respect to GND

■PIN ARRANGEMENT



(Top View)

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	HM4334/P-3			HM4334/P-4			Unit
		min	typ	max	min	typ	max	
Supply Voltage	V_{CC}	4.75	5.0	5.25	4.5	5.0	5.5	V
	GND	0	0	0	0	0	0	V
Input Voltage	V_{IH}	2.4	—	V_{CC}+0.5	2.4	—	V_{CC}+0.5	V
	V_{IL}	−0.3	—	0.8	−0.3	—	0.8	V

■DC AND OPERATING CHARACTERISTICS

(Ta=0 to +70°C, GND=0V, HM4334/P-3 : V_{CC}=5V±5%, HM4334/P-4 : V_{CC}=5V±10%)

Item	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{IN}=0 to V_{CC}	−1.0	—	+1.0	μA
Output Leakage Current	I_{LO}	$\overline{CE}$=V_{IH}, V_{out}=0 to V_{CC}	−1.0	—	+1.0	μA
Operating Power Supply Current	I_{CC1}	$\overline{CE}$=0V, V_{IN}=V_{CC}, $I_{I/O}$=0	—	—	1.0	mA
	I_{CC2}	$\overline{CE}$=0.8V, V_{IN}=2.4V, $I_{I/O}$=0	—	2.5	5.0	mA
Average Operating Current	I_{CC3}	V_{IN}=0 or V_{CC}, f=1MHz, duty 50%, $I_{I/O}$=0	—	4	7	mA
Standby Power Supply Current	I_{CCL}	$\overline{CE}$≧V_{CC}−0.2V	—	2	100	μA
Output Voltage	V_{OL}	I_{OL}=2.0mA	—	—	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	V

■CAPACITANCE (Ta=25°C, f=1MHz)

Item	Symbol	Test Condition	min	typ	max	Unit
I/O Terminal Capacitance	$C_{I/O}$	$V_{I/O}$=0V	—	7	10	pF
Input Capacitance	C_{in}	V_{in}=0V	—	3	5	pF

■AC CHARACTERISTICS

(Ta=0 to +70°C, GND=0V, HM4334/P-3 : V_{CC}=5V±5%, HM4334/P-4 : V_{CC}=5V±10%)

Item	Symbol		HM4334/P-3			HM4334/P-4			Unit
			min	typ	max	min	typ	max	
Read or Write Cycle Time*	TELEL	t_C	460	—	—	640	—	—	ns
Chip Enable Access Time	TELQV	t_{AC}	—	—	300	—	—	450	ns
Chip Enable to Output Active	TELQX	t_{CX}	50	—	—	50	—	—	ns
Output 3-state from Deselection	TEHQZ	t_{OFF1}	—	—	100	—	—	100	ns
Write Enable Output Disable Time	TWLQZ	t_{OFF2}	—	—	100	—	—	100	ns
Chip Enable Pulse Width**	TELEH	t_{CE}	300	—	—	450	—	—	ns
Chip Enable Precharge Time	TEHEL	t_P	120	—	—	150	—	—	ns
Address Hold Time	TELAX	t_{AH}	100	—	—	100	—	—	ns
Address Setup Time	TAVEL	t_{AS}	20	—	—	20	—	—	ns
Read Setup Time	TWHEL	t_{RS}	0	—	—	0	—	—	ns
Read Hold Time	TEHWL	t_{RH}	0	—	—	0	—	—	ns
Write Enable Setup Time	TWLEL	t_{WS}	−20	—	—	−20	—	—	ns
$\overline{WE}$ to $\overline{CE}$ Precharge Lead Time	TWLEH	t_{WPL}	300	—	—	450	—	—	ns
Chip Enable to Write Enable Delay Time	TELWL	t_{CWD}	300	—	—	450	—	—	ns
Write Enable Hold Time	TEHWH	t_{EWH}	0	—	—	0	—	—	ns
Write Hold Time	TELWH	t_{WH}	300	—	—	450	—	—	ns
Data Input Setup Time	TDVWH TDVEH	t_{DS}	200	—	—	350	—	—	ns
Data Hold Time	TWHDX TEHDX	t_{DH}	0	—	—	0	—	—	ns
Write Data Delay Time	TWLDV	t_{WDS}	100	—	—	100	—	—	ns
Chip Enable Rise/Fall Time	TT	t_T	—	—	300	—	—	300	ns

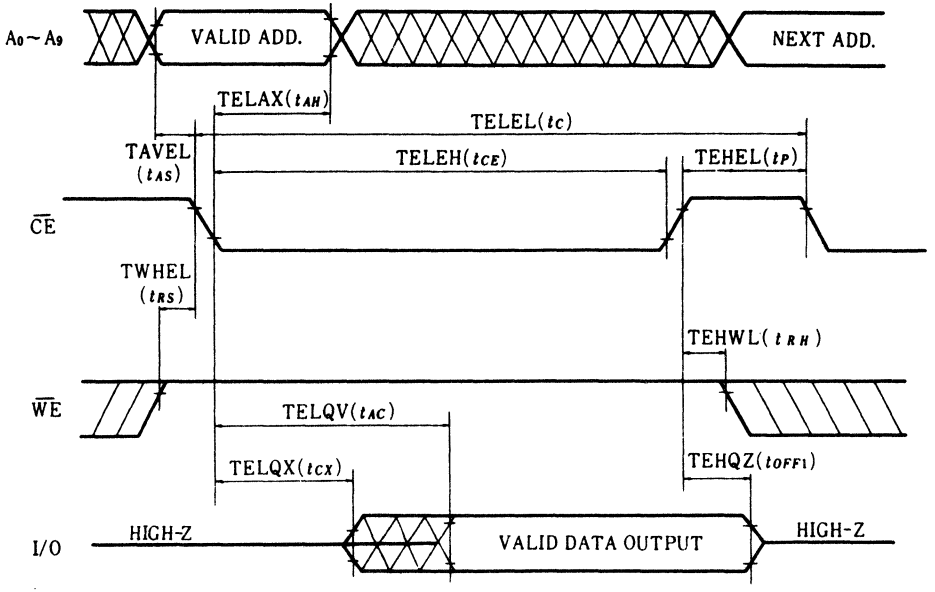
* TELEL(t_C)=TELEH(t_{CE})+TEHEL(t_P)+t_r(20ns)+t_f(20ns)

** For Read Modify Write Cycle, TELEH(t_{CE})=TELWL(t_{CWD})+TWLEH(t_{WPL})+t_f(20ns)

■AC TEST CONDITIONS

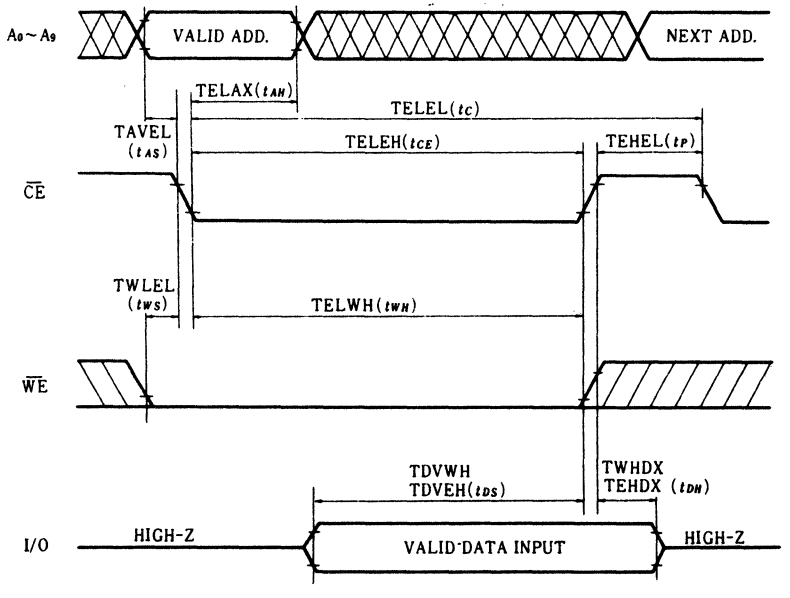
Input Level	2.4V, 0.8V
Input Rise and Fall Time	20ns
Timing Measurement Level	2.4V, 0.8V
Reference Level	V_{OH} = 2.0V, V_{OL} = 0.8V
Output Load	1 TTL and C_L = 100 pF

●READ CYCLE



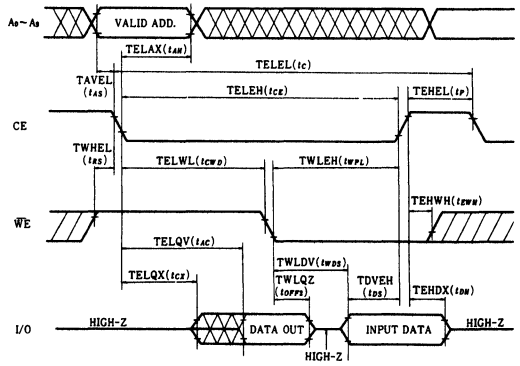
Note) *; TEHQZ (t_{OFF_1}) defines the time at which the outputs achieve the open circuit condition and is not referenced to output voltage levels.

●WRITE CYCLE



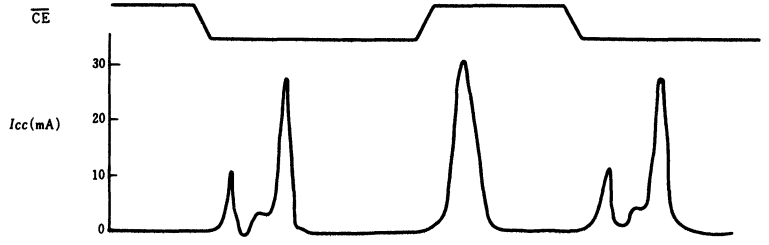
Note) t_{DS} and t_{DH} are measured from the earlier of $\overline{CE}$ or $\overline{WE}$ going high.

●READ MODIFY WRITE CYCLE



*; TWLQZ (t_{OFF_2}) defines the time at which the outputs achieve the open circuit condition and is not referenced to output voltage levels.

●CURRENT WAVEFORM



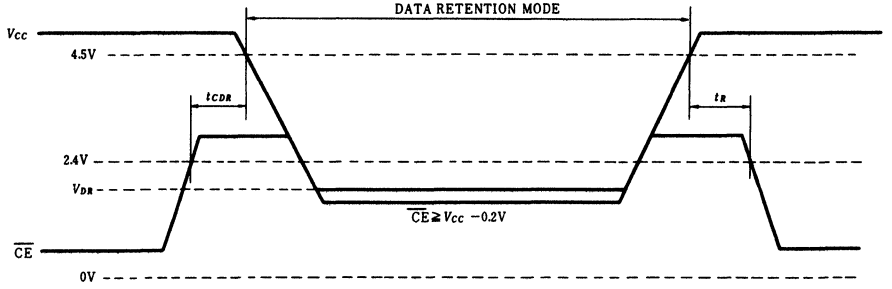
[NOTE] V_{CC} = 5.0V, T_a = 25°C

■LOW V_{CC} DATA RETENTION CHARACTERISTICS (Ta=0 to +70°C)

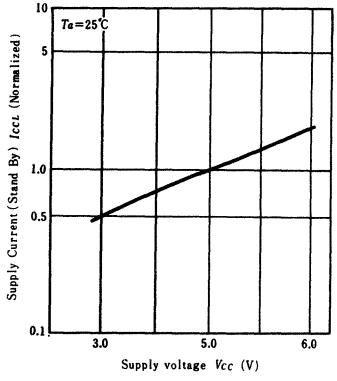
Item	Symbol	Test Condition	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CE} \geq V_{CC}-0.2V$	2.0	—	—	V
Data Retention Power Supply Current	I_{CCDR}	V_{DR}=3.0V	—	0.5	50	μA
Chip Deselection to Data Retention Time	t_{CDR}		0	—	—	ns
Operation Recovery Time	t_R		t_{RC}*	—	—	ns

* t_{RC}=Read Cycle Time

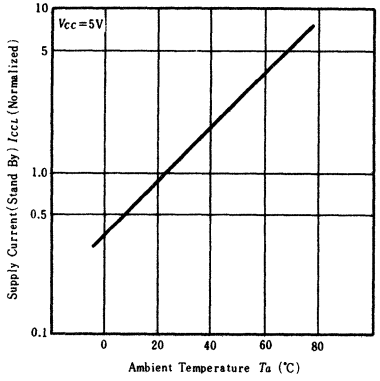
●LOW V_{CC} DATA RETENTION TIMING



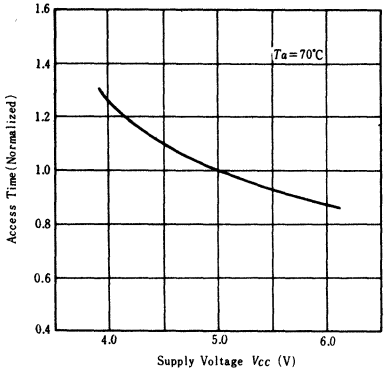
SUPPLY CURRENT vs. SUPPLY VOLTAGE



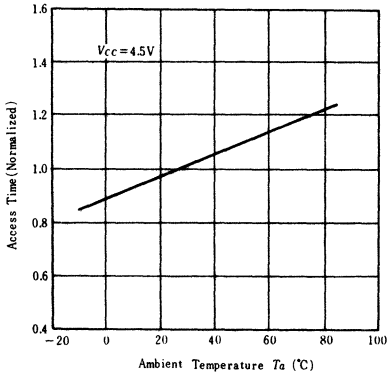
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



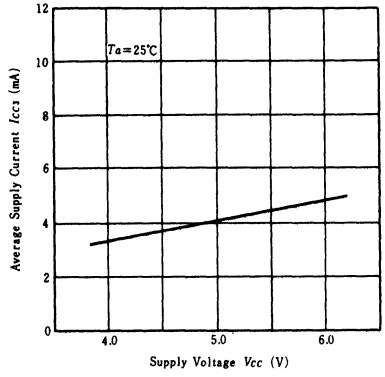
ACCESS TIME vs. SUPPLY VOLTAGE



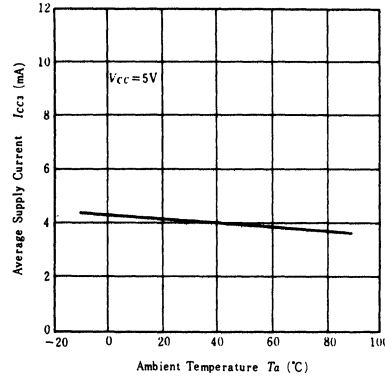
ACCESS TIME vs. AMBIENT TEMPERATURE



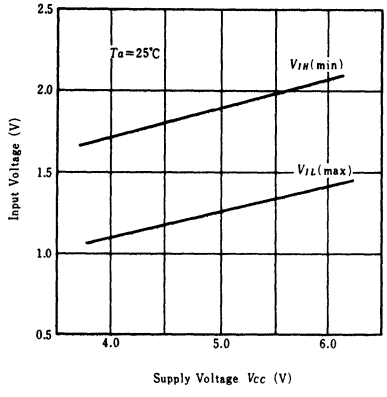
AVERAGE SUPPLY CURRENT vs. SUPPLY VOLTAGE



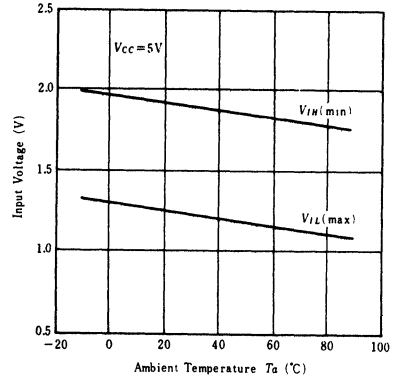
AVERAGE SUPPLY CURRENT vs. AMBIENT TEMPERATURE



INPUT VOLTAGE vs. SUPPLY VOLTAGE



INPUT VOLTAGE vs. AMBIENT TEMPERATURE



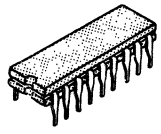
HM6148, HM6148-6
HM6148P, HM6148P-6

1024-word×4-bit High Speed CMOS RAM

■FEATURES

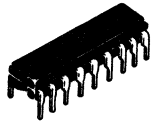
- Single 5V Supply
- Fast Access Time ..... HM6148/P 70 ns (max.)
  HM6148/P-6 85 ns (max.)
- Low Power Standby and Low Power Operation; Standby: 100μW (typ)
  Operation: 200mW (typ)
- Completely Static RAM; No Clock or Timing Strobe Required
- No Peak Power-On Current
- No Change of t_{ACS} with Short Deselected Time
- Equal Access and Cycle Times
- Directly TTL Compatible; All Inputs and Outputs
- Three State Output
- Common Data Input and Output
- Pin-Out Compatible with Intel 2148

HM6148, HM6148-6



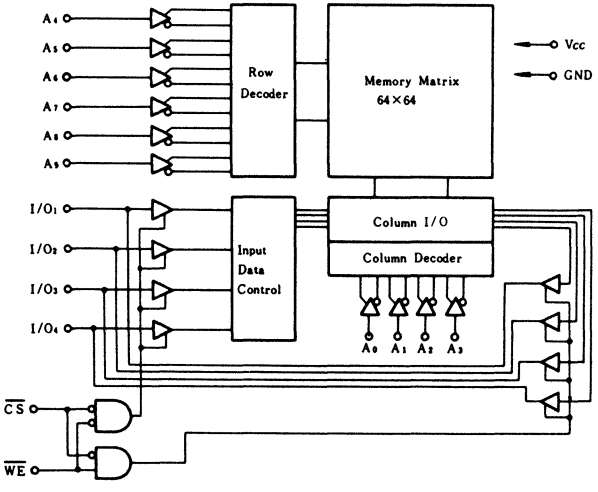
(DG-18)

HM6148P, HM6148P-6

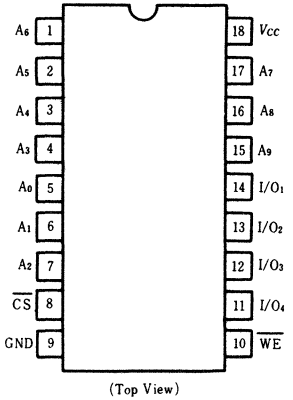


(DP-18)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Terminal Voltage*	V_T	−0.5△to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature (Plastic)	T_{stg}	−55 to +125	°C
Storage Temperature (Cerdip)	T_{stg}	−65 to +150	°C
Storage Temperature**	$T_{stg(bias)}$	−10 to +85	°C

* with respect to GND. △ −1.0V (Pulse Width ≦ 50ns)
** Under Bias

■TRUTH TABLE

$\overline{CS}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Reference Cycle
H	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	H	Read	I_{CC}	Dout	Read Cycle
L	L	Write	I_{CC}	Din	Write Cycle

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.4	3.5	6.0	V
	V_{IL}	−0.3*	—	0.8	V

* V_{IL} min=−1.0V (Pulse width≦50ns)

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Condition	min	typ*	max	Unit
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	2.0	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}=V_{IH}$, $V_{I/O}$=GND to V_{CC}	—	—	2.0	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, $I_{I/O}$=0mA	—	35	80	mA
	I_{CC1}	$\overline{CS}=V_{IL}$, Minimum Cycle, Duty=100%, $I_{I/O}$=0mA	—	40	80	mA
Average Operating Current	I_{CC2}**	Cycle=150ns, Duty=50%, $I_{I/O}$=0mA	—	35	—	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	5	12	mA
	I_{SB1}	$\overline{CS}\geqq V_{CC}-0.2V$, $V_{in}\leqq 0.2V$ or $V_{in}\geqq V_{CC}-0.2V$	—	20	800	μA
Output Voltage	V_{OL}	I_{OL}=8mA	—	—	0.4	V
	V_{OH}	I_{OH}=−3.2mA	2.4	—	—	V

Notes) * Typical limits are at V_{CC}=5.0V, Ta=25°C and specified loading.
** Reference only.

■CAPACITANCE (Ta=25°C, f=1MHz)

Item	Symbol	Test Condition	min	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	—	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	—	12	pF

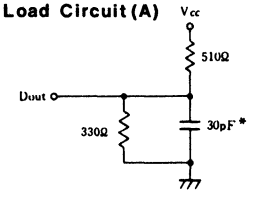
Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0 to +70°C, unless otherwise noted)

●AC TEST CONDITIONS

Input Pulse Levels ..... GND to 3.0V
Input Rise and Fall Times 10ns
Input and Output Timing Reference Levels 1.5V
Output Load ..... See Figure 1

Load Circuit (A)



* includes probe and jig capacitance

Load Circuit (B)

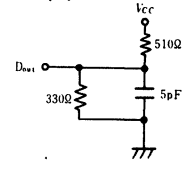


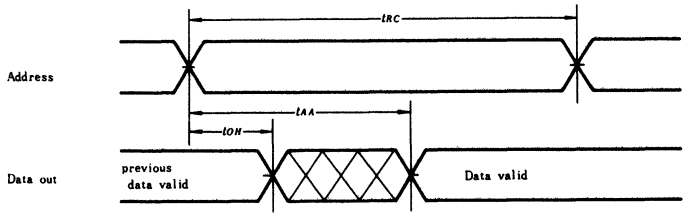
Fig. 1

■READ CYCLE

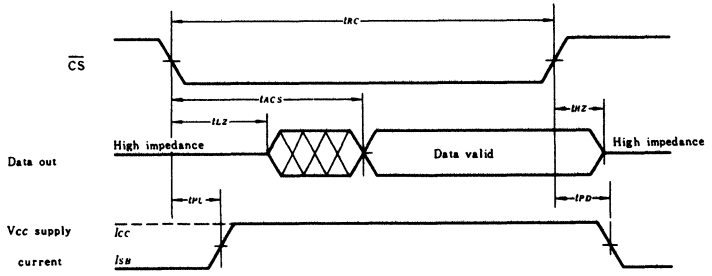
Parameter	Symbol	HM6148/P		HM6148/P-6		Unit
		min	max	min	max	
Read Cycle Time	t_{RC}	70	—	85	—	ns
Address Access Time	t_{AA}	—	70	—	85	ns
Chip Select Access Time	t_{ACS}	—	70	—	85	ns
Output Hold from Address Change	t_{OH}	5	—	5	—	ns
Chip Selection to Output in Low Z*	t_{LZ}	10	—	10	—	ns
Chip Deselection to Output in High Z*	t_{HZ}	0	40	0	40	ns
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	ns
Chip Deselection to Power Down Time	t_{PD}	—	40	—	40	ns

* Transition is measured ±500mV from high impedance voltage with Load B. This parameter is sampled and not 100% tested.

● TIMING WAVEFORM OF READ CYCLE NO.1 (1) (2)



● TIMING WAVEFORM OF READ CYCLE NO.2 (1) (3)



NOTES) 1. $\overline{WE}$ is high for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition low.

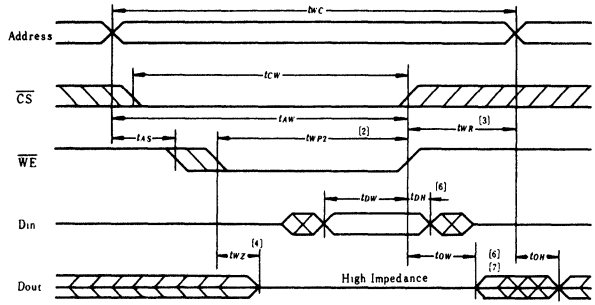
■ WRITE CYCLE

Parameter	Symbol	HM6148/P		HM6148/P-6		Unit
		min	max	min	max	
Write Cycle Time	t_{WC}	70	—	85	—	ns
Chip Selection to End of Write	t_{CW}	50	—	60	—	ns
Address Valid to End of Write	t_{AW}	65	—	80	—	ns
Address Setup Time	t_{AS}	15	—	15	—	ns
Write Pulse Width*	t_{WP1}	50	—	60	—	ns
	t_{WP2}	65	—	80	—	ns
Write Recovery Time	t_{WR}	5	—	5	—	ns
Data Valid to End of Write	t_{DW}	30	—	35	—	ns
Data Hold Time	t_{DH}	5	—	5	—	ns
Write Enabled to Output in High Z**	t_{WZ}	0	35	0	45	ns
Output Active from End of Write**	t_{OW}	0	—	0	—	ns

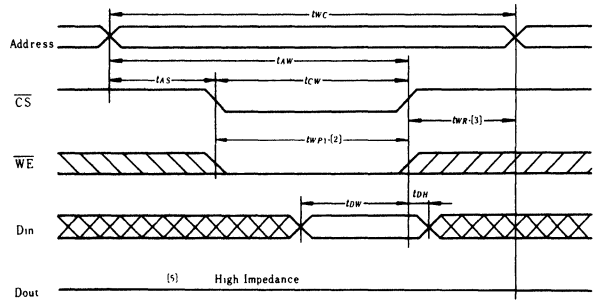
Notes) * When the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transition or after the $\overline{WE}$ transition, I/O pins remain in a high impedance state. In this case t_{WP1}, in the other case t_{WP2} ($=t_{WZ}+t_{DW}$).

** Transition is measured ±500mV from high impedance voltage with Load B. This parameter is sampled and not 100% tested.

● TIMING WAVEFORM OF WRITE CYCLE NO.1 ($\overline{WE}$ CONTROLLED) (1)



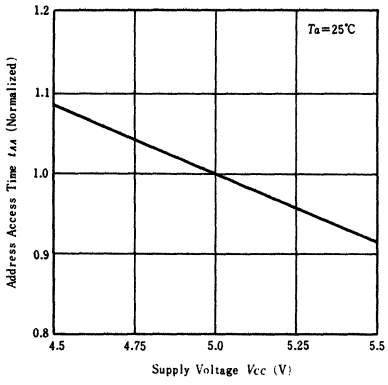
● TIMING WAVEFORM OF WRITE CYCLE NO.2 ($\overline{CS}$ CONTROLLED) (1)



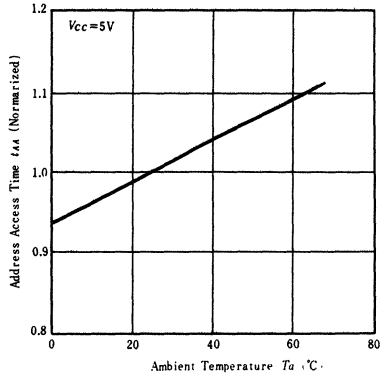
Notes)

1. $\overline{CS}$ and $\overline{WE}$ are paced in the WRITE state during low level period (t_W).
2. A write occurs during the overlap of a low $\overline{CS}$ and a low $\overline{WE}$. (t_{WP})
3. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
4. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
5. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transition or after the $\overline{WE}$ transition, the output buffers remain in a high impedance state.
6. If $\overline{CS}$ is low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.
7. Dout is the same phase of write data of this write cycle.

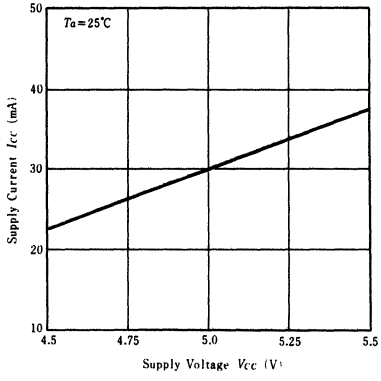
ACCESS TIME vs. V_{CC}



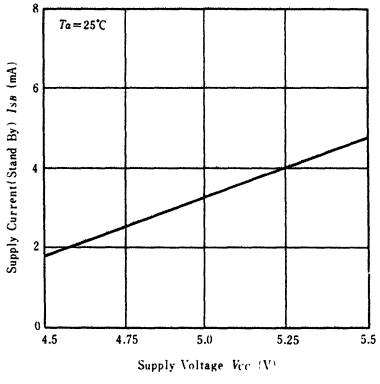
ACCESS TIME vs. Ta



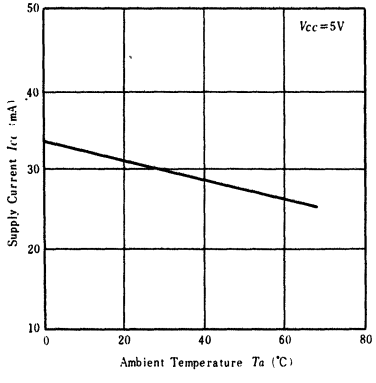
SUPPLY CURRENT vs. V_{CC}



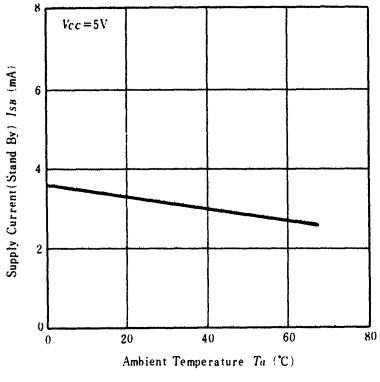
SUPPLY CURRENT vs. V_{CC}



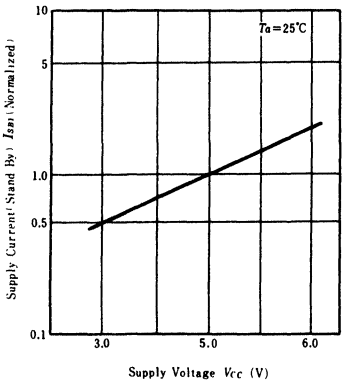
SUPPLY CURRENT vs. Ta



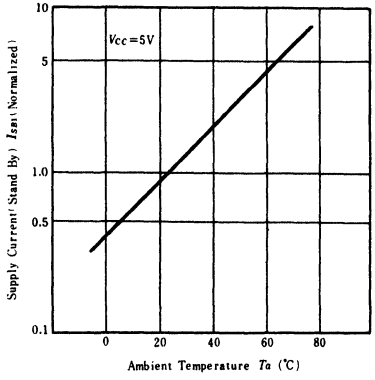
SUPPLY CURRENT vs. Ta



SUPPLY CURRENT vs. V_{CC} (STANDBY)



SUPPLY CURRENT vs. Ta (STANDBY)

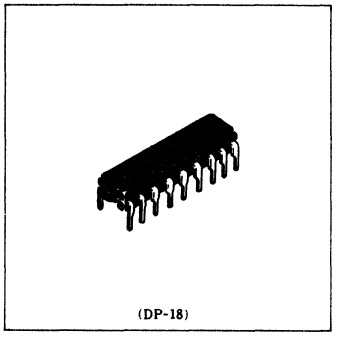


HM6148LP, HM6148LP-6

1024-word×4-bit High Speed Static CMOS RAM

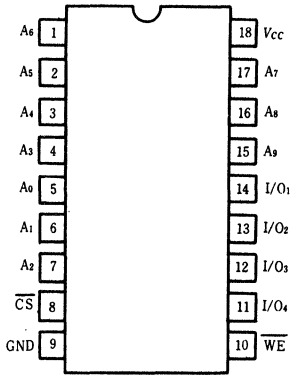
■FEATURES

- Single 5V Supply
- Fast Access Time ..... HM6148LP 70 ns (max.)
  HM6148LP-6 85 ns (max.)
- Low Power Standby and Low Power Operation;
  Standby: 5μW (typ) Operation: 200mW (typ)
- Completely Static RAM; No Clock or Timing Strobe Required
- No Peak Power-On Current
- No Change of t_{ACS} with Short Deselected Time
- Equal Access and Cycle Times
- Directly TTL Compatible; All Inputs and Outputs
- Three State Output
- Common Data Input and Output
- Capability of Battery Back Up Operation
- Pin-Out Compatible with Intel 2148



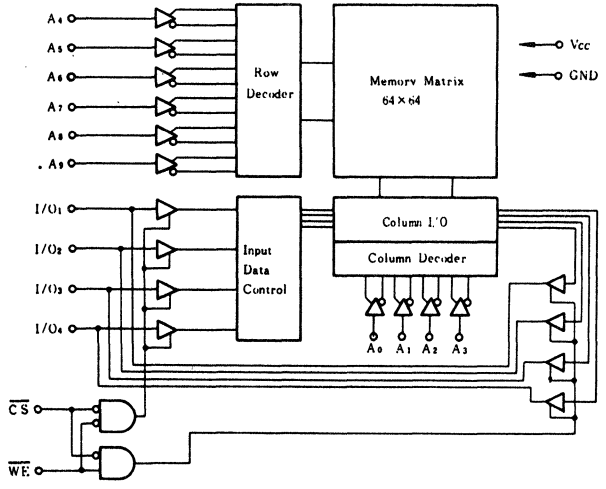
(DP-18)

■PIN ARRANGEMENT



(Top View)

■BLOCK DIAGRAM



■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Terminal Voltage*	V_T	−0.5△to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Storage Temperature**	$T_{stg(bias)}$	−10 to +85	°C

* with respect to GND. △ −1.0V (Pulse Width ≦ 50ns)
** Under Bias

■TRUTH TABLE

$\overline{CS}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Reference Cycle
H	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	H	Read	I_{CC}	Dout	Read Cycle
L	L	Write	I_{CC}	Din	Write Cycle

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.4	3.5	6.0	V
	V_{IL}	−0.3*	—	0.8	V

* V_{IL} min=−1.0V (Pulse width≦50ns)

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Condition	min	typ*	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	2.0	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CS}=V_{IH}$, $V_{I/O}$=GND to V_{CC}	—	—	2.0	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, $I_{I/O}$=0mA	—	35	80	mA
Average Operating Current	I_{CC1}	$\overline{CS}=V_{IL}$, Minimum Cycle, Duty=100%, $I_{I/O}$=0mA	—	40	80	mA
	I_{CC2}**	Cycle=150ns, Duty=50%, $I_{I/O}$=0mA	—	35	—	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	5	12	mA
	I_{SB1}	$\overline{CS}\geqq V_{CC}-0.2V$, $V_{in}\leqq 0.2V$ or $V_{in}\geqq V_{CC}-0.2V$	—	1	100	μA
Output Voltage	V_{OL}	I_{OL}=8mA	—	—	0.4	V
	V_{OH}	I_{OH}=−3.2mA	2.4	—	—	V

Notes) * Typical limits are at V_{CC}=5.0V, Ta=25°C and specified loading.
** Reference only.

■CAPACITANCE (Ta=25°C, f=1MHz)

Item	Symbol	Test Condition	min	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	—	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	—	12	pF

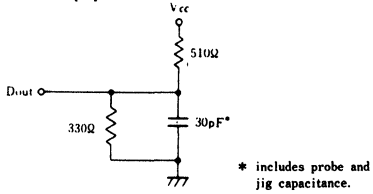
Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0 to +70°C, unless otherwise noted)

●AC TEST CONDITIONS

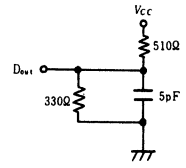
Input Pulse Levels ..... GND to 3.0V
Input Rise and Fall Times 10ns
Input and Output Timing Reference Levels 1.5V
Output Load ..... See Figure

Load Circuit (A)



* includes probe and jig capacitance.

Load Circuit (B)

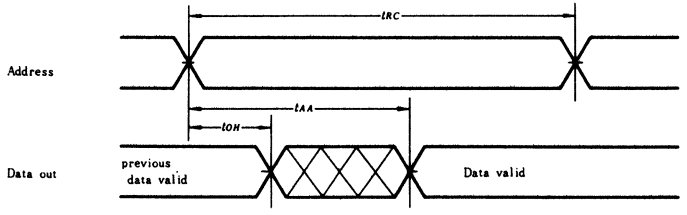


● READ CYCLE

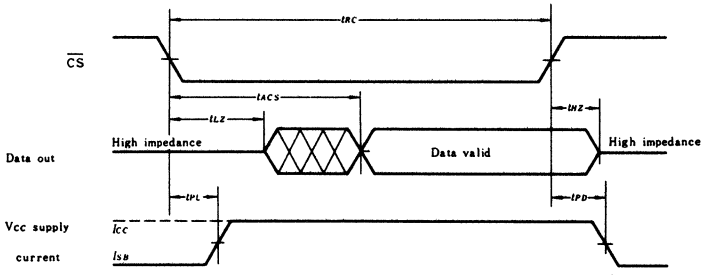
Parameter	Symbol	HM6148LP		HM6148LP-6		Unit
		min	max	min	max	
Read Cycle Time	t_{RC}	70	—	85	—	ns
Address Access Time	t_{AA}	—	70	—	85	ns
Chip Select Access Time	t_{ACS}	—	70	—	85	ns
Output Hold from Address Change	t_{OH}	5	—	5	—	ns
Chip Selection to Output in Low Z*	t_{LZ}	10	—	10	—	ns
Chip Deselection to Output in High Z*	t_{HZ}	0	40	0	40	ns
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	ns
Chip Deselection to Power Down Time	t_{PD}	—	40	—	40	ns

* Transition is measured ±500mV from high impedance voltage with Load B. This parameter is sampled and not 100% tested.

● TIMING WAVEFORM OF READ CYCLE NO.1 (1) (2)



● TIMING WAVEFORM OF READ CYCLE NO.2 (1) (3)



NOTES) 1. $\overline{WE}$ is high for Read Cycle.
2. Device is continuously selected, $\overline{CS} = V_{IL}$.
3. Address Valid prior to or coincident with $\overline{CS}$ transition low.

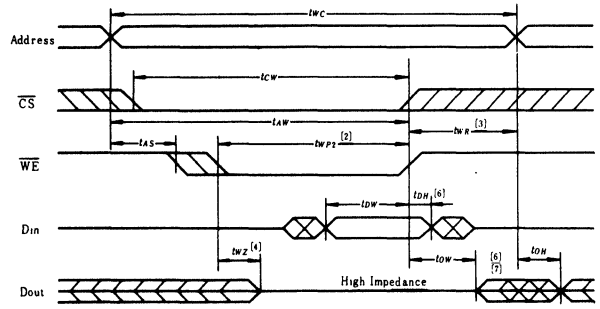
● WRITE CYCLE

Parameter	Symbol	HM6148LP		HM6148LP-6		Unit
		min	max	min	max	
Write Cycle Time	t_{WC}	70	—	85	—	ns
Chip Selection to End of Write	t_{CW}	50	—	60	—	ns
Address Valid to End of Write	t_{AW}	65	—	80	—	ns
Address Setup Time	t_{AS}	15	—	15	—	ns
Write Pulse Width*	t_{WP1}	50	—	60	—	ns
	t_{WP2}	65	—	80	—	ns
Write Recovery Time	t_{WR}	5	—	5	—	ns
Data Valid to End of Write	t_{DW}	30	—	35	—	ns
Data Hold Time	t_{DH}	5	—	5	—	ns
Write Enabled to Output in High Z**	t_{WZ}	0	35	0	45	ns
Output Active from End of Write**	t_{OW}	0	—	0	—	ns

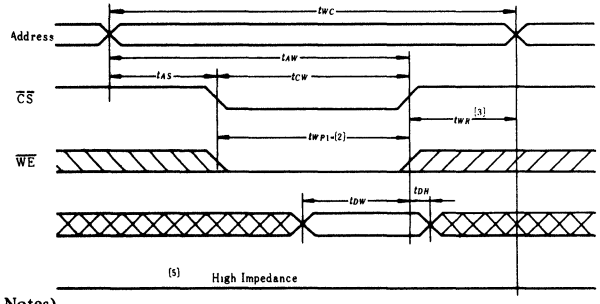
Notes) * When the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transition or after the $\overline{WE}$ transition, I/O pins remain in a high impedance state. In this case t_{WP1}, in the other case $t_{WP2} (= t_{WZ} + t_{DW})$.

** Transition is measured ±500mV from high impedance voltage with Load B. This parameter is sampled and not 100% tested.

● TIMING WAVEFORM OF WRITE CYCLE NO.1 ($\overline{WE}$ CONTROLLED)[1]



● TIMING WAVEFORM OF WRITE CYCLE NO.2 ($\overline{CS}$ CONTROLLED)[1]



Notes)

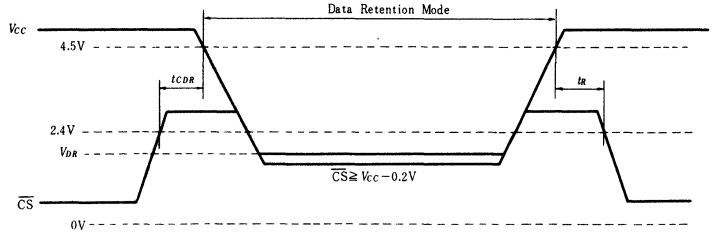
1. $\overline{CS}$ and $\overline{WE}$ are paced in the WRITE state during low level period (t_W).
2. A write occurs during the overlap of a low $\overline{CS}$ and a low $\overline{WE}$. (t_{WP})
3. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
4. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
5. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transition or after the $\overline{WE}$ transition, the output buffers remain in a high impedance state.
6. If $\overline{CS}$ is low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.
7. Dout is the same phase of write data of this write cycle.

■ LOW V_{CC} DATA RETENTION CHARACTERISTICS (Ta=0 to +70°C)

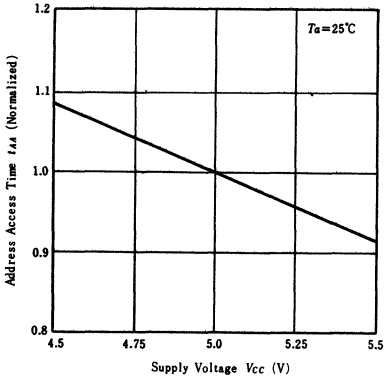
Parameter	Symbol	Test Condition	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geqq V_{CC}-0.2V$, $V_{in} \geqq V_{CC}-0.2V$ or $V_{in} \leqq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}	V_{CC}=2.0V, $\overline{CS} \geqq 1.8V$, V_{in}=1.8V or $V_{in} \leqq 0.2V$	—	—	40	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}*	—	—	ns

* t_{RC}=Read Cycle Time

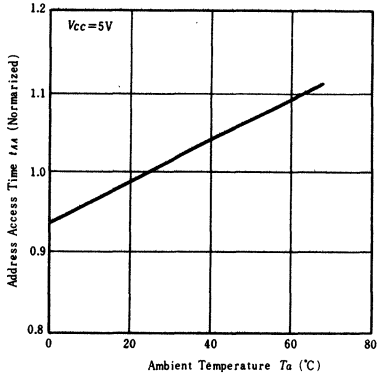
● LOW V_{CC} DATA RETENTION WAVEFORM



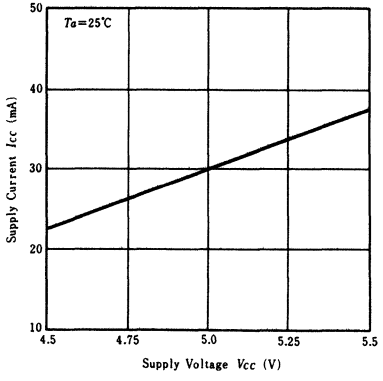
ACCESS TIME vs. V_{CC}



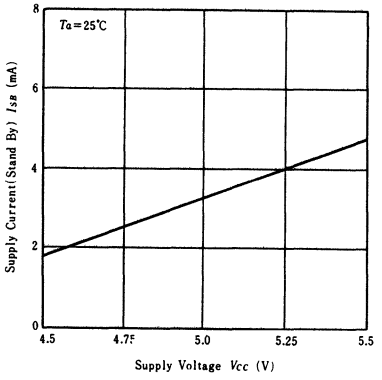
ACCESS TIME vs. Ta



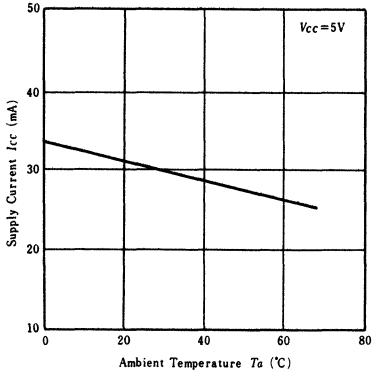
SUPPLY CURRENT vs. V_{CC}



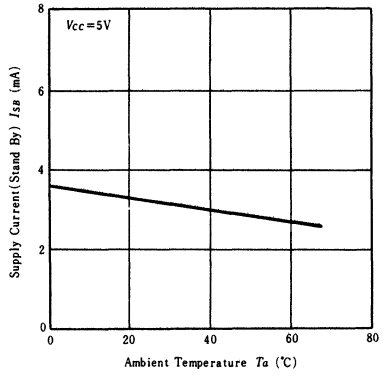
SUPPLY CURRENT vs. V_{CC}



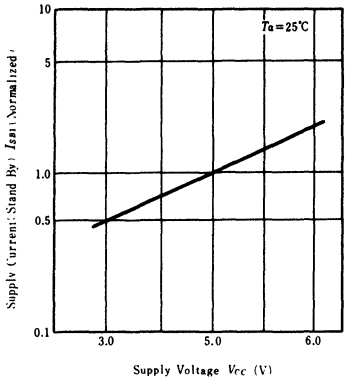
SUPPLY CURRENT vs. Ta



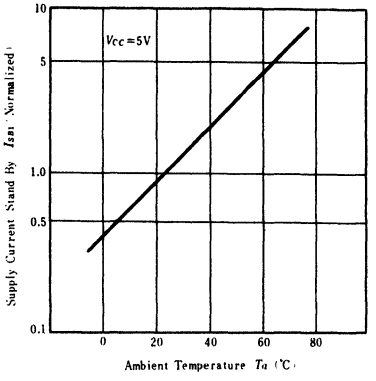
SUPPLY CURRENT vs. Ta



SUPPLY CURRENT vs. V_{CC} (STANDBY)



SUPPLY CURRENT vs. Ta (STANDBY)



HM6148H-35, HM6148H-45, HM6148H-55, HM6148HP-35, HM6148HP-45, HM6148HP-55

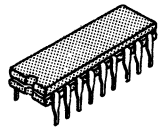
Preliminary

1024-word x 4-bit High Speed Static CMOS RAM

■ FEATURES

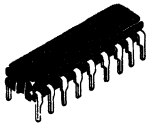
- Fast Access Time ..... 35/45/55ns (max)
- Low Power Standby and Low Power Operation; Standby: 100 μW (typ.), Operation: 200mW (typ.)
- Single 5V Supply
- Completely Static RAM: No Clock or Timing Strobe Required
- No Peak Power-On Current
- No Change of t_{ACS} with Short Deselected Time
- Equal Access and Cycle Times
- Directly TTL Compatible; All Inputs and Outputs
- Common Data Input and Output; Three-State Outputs
- Pin-Out Compatible with Intel 2148H

HM6148H Series



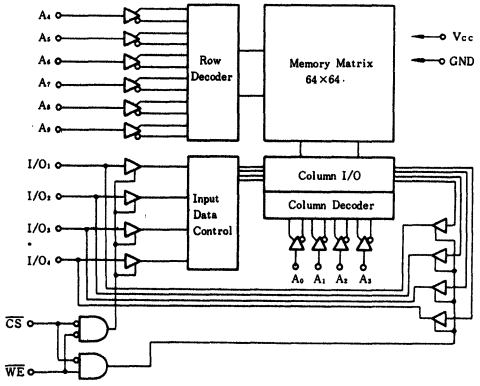
(DG-18)

HM6148HP Series

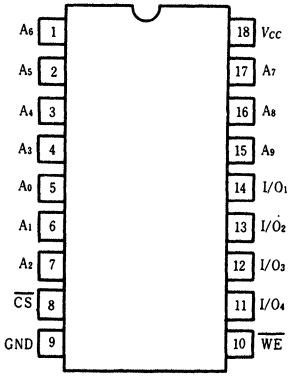


(DP-18)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Ratings	Unit
Terminal Voltage*	V_T	−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature (Plastic)	T_{stg}	−55 to +125	°C
Storage Temperature (Ceramic)	T_{stg}	−65 to +150	°C
Storage Temperature**	T_{bias}	−10 to +85	°C

* with respect to GND. $V_{IL\,min} = -3.5$V (Pulse width=20ns)
** under bias

■ TRUTH TABLE

$\overline{CS}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Reference Cycle
H	×	Not selected	I_{SB}, I_{SB1}	High Z	
L	H	Read	I_{CC}	Dout	Read Cycle 1, 2
L	L	Write	I_{CC}	Din	Write Cycle 1, 2

Note) The specifications of this device are subject to change without notice.
Please contact your nearest Hitachi's Sales Dept. regarding specifications.

HITACHI

■ RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	—	6.0	V
	V_{IL}	−0.5*	—	0.8	V

* −3.0V (Pulse width 20ns)

■ DC AND OPERATING CHARACTERISTICS[1] (Ta=0~70°C, V_{CC}=5V±10%, GND=0V)

Parameter	Symbol	Test Conditions	min	typ	max	Unit	Notes
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=max, V_{in}=GND to V_{CC}	—	—	2.0	μA	
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}$=V_{IH}, $V_{I/O}$=GND to V_{CC}	—	—	2.0	μA	
Operating Power Supply Current	I_{CC}	$\overline{CS}$=V_{IL}, $I_{I/O}$=0mA	—	35	80	mA	
Operating Power Supply Current : AC	I_{CC1}	min. cycle, $\overline{CS}$=V_{IL}, $I_{I/O}$=0mA	—	50	100	mA	[2]
Standby Power Supply Current : DC	I_{SB}	$\overline{CS}$=V_{IH}	—	5	20	mA	
Standby Power Supply Current(1) : DC	I_{SB1}	$\overline{CS}$≧V_{CC}−0.2V, V_{IN}≦0.2V or V_{IN}≧V_{CC}−0.2V	—	20	800	μA	
Output Low Voltage	V_{OL}	I_{OL}=8mA	—	—	0.4	V	
Output High Voltage	V_{OH}	I_{OH}=−4.0mA	2.4	—	—	V	

Notes) 1. Typical limits are at V_{CC}=5.0V, Ta=+25°C and specified loading.
2. 120mA max. for HM6148HP-35

■ CAPACITANCE (Ta=25°C, f=1MHz)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

Note) This parameter is sampled and not 100% tested.

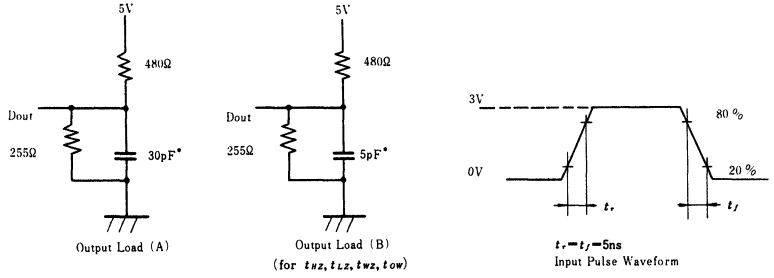
■ AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0 to +70°C)

●RISE FALL TIME

Item	Symbol	min	typ	max	Unit
Input Rise Time	t_r	—	5	100	ns
Input Fall Time	t_f	—	5	100	ns

●AC TEST CONDITIONS

Input pulse levels : GND to 3.0V
Input rise and fall times : 5ns
Input and Output timing reference levels : 1.5V
Output load : See Figure



* Including scope & jig.

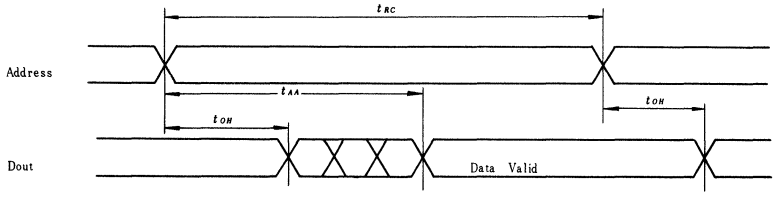
■AC CHARACTERISTICS (Ta=0 to 70°C, V_{CC}=5V±10%, unless otherwise noted.)

●READ CYCLE

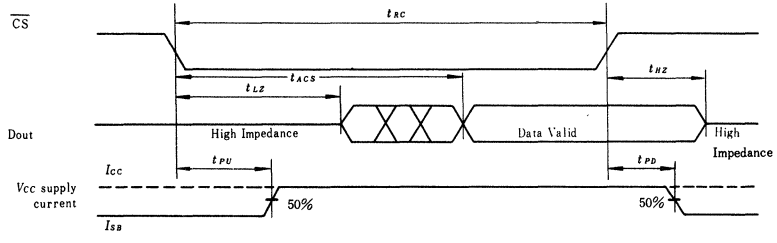
Item	Symbol	HM6148HP-35		HM6148HP-45		HM6148HP-55		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	35	—	45	—	55	—	ns
Address Access Time	t_{AA}	—	35	—	45	—	55	ns
Chip Select Access Time	t_{ACS}	—	35	—	45	—	55	ns
Output Hold from Address Change	t_{OH}	5	—	5	—	5	—	ns
Chip Selection to Output in Low Z	t_{LZ}*	10	—	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{HZ}*	0	20	0	20	0	20	ns
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	0	—	ns
Chip Deselection to Power Down Time	t_{PD}	—	30	—	30	—	30	ns

* Transition is measured ±500mV from high impedance voltage with Load(B). This parameter is sampled and not 100% tested.
At any temperature and voltage condition t_{HZ} max is less than t_{LZ} min.

●TIMING WAVEFORM OF READ CYCLE NO.1 (1)(2)



●TIMING WAVEFORM OF READ CYCLE NO.2 (1)(3)



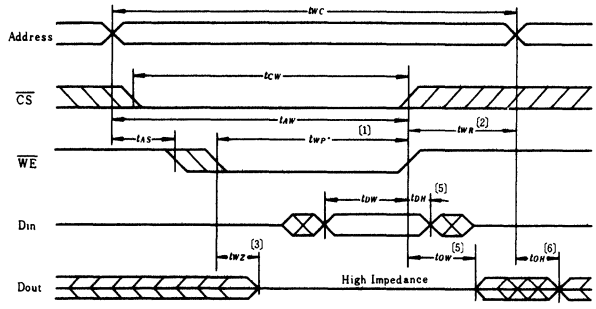
Notes) 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$= V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.

● WRITE CYCLE

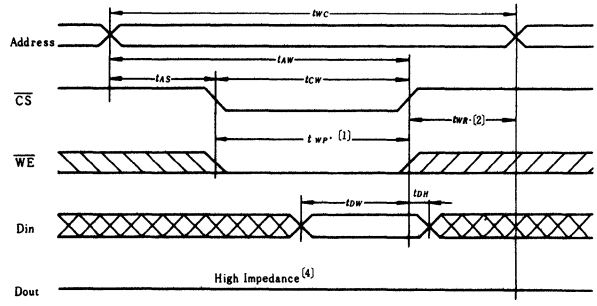
Item	Symbol	HM6148H/P-35		HM6148H/P-45		HM6148H/P-55		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	35	—	45	—	55	—	ns
Chip Selection to End of Write	t_{CW}	30	—	40	—	50	—	ns
Address Valid to End of Write	t_{AW}	30	—	40	—	50	—	ns
Address Setup Time	t_{AS}	0	—	0	—	0	—	ns
Write Pulse Width	t_{WP}	30	—	35	—	40	—	ns
Write Recovery Time	t_{WR}	5	—	5	—	5	—	ns
Data Valid to End of Write	t_{DW}	20	—	20	—	20	—	ns
Data Hold Time	t_{DH}	0	—	0	—	0	—	ns
Write Enabled to Output in High Z*	t_{WZ}	0	10	0	15	0	20	ns
Output Active from End of Write*	t_{OW}	0	—	0	—	0	—	ns

* Transition is measured ±500mV from high impedance voltage with Load B.
This parameter is sampled and not 100% tested.

● TIMING WAVEFORM OF WRITE CYCLE NO.1 ($\overline{WE}$ Controlled)



● TIMING WAVEFORM OF WRITE CYCLE NO.2 ($\overline{CS}$ Controlled)



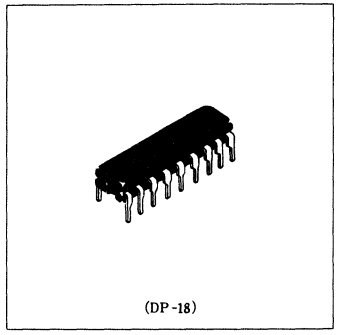
NOTES of Timing Waveform of Write

1. A write occurs during the overlap of a low $\overline{CS}$ and a low $\overline{WE}$. (t_{WP})
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transition or after the $\overline{WE}$ transition, the output buffers remain in a high impedance state.
5. If $\overline{CS}$ is low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.
6. *Dout* is the same phase of write data of this write cycle.

HM6148HLP-35, HM6148HLP-45, HM6148HLP-55

Preliminary

1024-word × 4-bit High Speed Static CMOS RAM

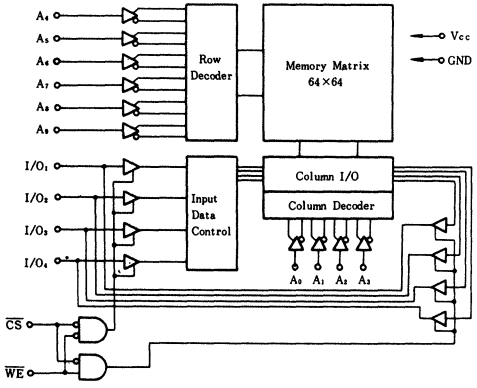


(DP-18)

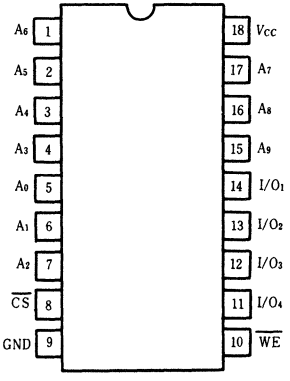
■ FEATURES

- Low Power Standby and Low Power Operation; Standby: 5μW (typ.), Operation: 300mW (typ.)
- Fast Access Time: 35/45/55ns (max)
- Capability of Battery Back Up Operation
- Single 5V Supply
- Completely Static RAM: No Clock or Timing Strobe Required
- No Peak Power-On Current
- No Change of t_{ACS} with Short Deselected Time
- Equal Access and Cycle Time
- Directly TTL Compatible: All Inputs and Outputs
- Three State Output
- Pin-Out Compatible with Intel 2148H

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Ratings	Unit
Terminal Voltage *	V_T	−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Storage Temperature **	T_{bias}	−10 to +85	°C

* with respect to GND. $V_{IL\ min} = -3.5$V (Pulse width = 20ns)
** under bias.

■ TRUTH TABLE

$\overline{CS}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Reference Cycle
H	×	Not selected	I_{SB}, I_{SB1}	High Z	
L	H	Read	I_{CC}	Dout	Read Cycle 1, 2
L	L	Write	I_{CC}	Din	Write Cycle 1, 2

Note) The specifications of this device are subject to change without notice.
Please contact your nearest Hitachi's Sales Dept. regarding specifications.

HITACHI

■ RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	—	6.0	V
	V_{IL}	−0.5*	—	0.8	V

* −3.0V (Pulse width 20ns)

■ DC AND OPERATING CHARACTERISTICS[1] (Ta=0~70°C, V_{CC}=5V±10%, GND=0V)

Parameter	Symbol	Test Conditions	min	typ	max	Unit	Notes
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=max, V_{in}=GND to V_{CC}	—	—	2.0	μA	
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}$=V_{IH}, $V_{I/O}$=GND to V_{CC}	—	—	2.0	μA	
Operating Power Supply Current : DC	I_{CC}	$\overline{CS}$=V_{IL}, $I_{I/O}$=0mA	—	35	80	mA	
Operating Power Supply Current : AC	I_{CC1}	min. cycle, $\overline{CS}$=V_{IL}, $I_{I/O}$=0mA	—	50	100	mA	[2]
Standby Power Supply Current : DC	I_{SB}	$\overline{CS}$=V_{IH}	—	5	20	mA	
Standby Power Supply Current(1) : DC	I_{SB1}	$\overline{CS}$≧V_{CC}−0.2V, V_{IN}≦0.2V or V_{IN}≧V_{CC}−0.2V	—	1	50	μA	
Output Low Voltage	V_{OL}	I_{OL}=8mA	—	—	0.4	V	
Output High Voltage	V_{OH}	I_{OH}=−4.0mA	2.4	—	—	V	

Notes) 1. Typical limits are at V_{CC}=5.0V, Ta=+25°C and specified loading.
2. 120mA max. for HM6148HLP-35

■ CAPACITANCE (Ta=25°C, f=1MHz)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

Note) This parameter is sampled and not 100% tested.

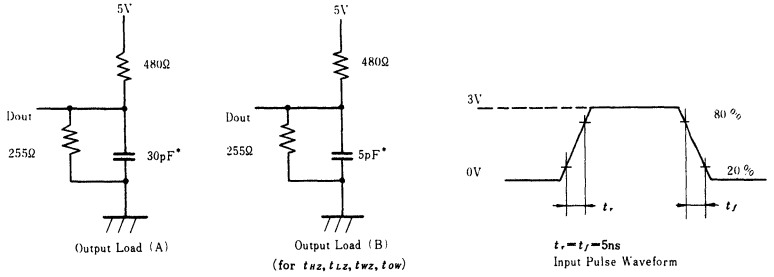
■ AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0 to +70°C)

● RISE FALL TIME

Item	Symbol	min	typ	max	Unit
Input Rise Time	t_r	—	5	100	ns
Input Fall Time	t_f	—	5	100	ns

● AC TEST CONDITIONS

Input pulse levels : GND to 3.0V
Input rise and fall times : 5ns
Input and Output timing reference levels : 1.5V
Output load : See Figure



* Including scope & jig.

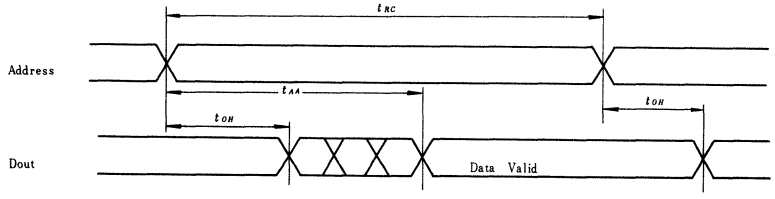
■AC CHARACTERISTICS (Ta=0 to 70°C, V_{CC}=5V±10%, unless otherwise noted.)

●READ CYCLE

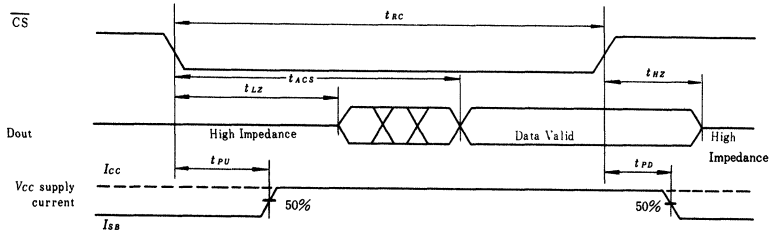
Item	Symbol	HM6148HLP-35		HM6148HLP-45		HM6148HLP-55		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	35	—	45	—	55	—	ns
Address Access Time	t_{AA}	—	35	—	45	—	55	ns
Chip Select Access Time	t_{ACS}	—	35	—	45	—	55	ns
Output Hold from Address Change	t_{OH}	5	—	5	—	5	—	ns
Chip Selection to Output in Low Z	t_{LZ}*	10	—	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{HZ}*	0	20	0	20	0	20	ns
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	0	—	ns
Chip Deselection to Power Down Time	t_{PD}	—	30	—	30	—	30	ns

* Transition is measured ±500mV from high impedance voltage with Load(B). This parameter is sampled and not 100% tested.
At any temperature and voltage condition t_{HZ} max is less than t_{LZ} min.

●TIMING WAVEFORM OF READ CYCLE NO.1 (1)(2)



●TIMING WAVEFORM OF READ CYCLE NO.2 (1)(3)



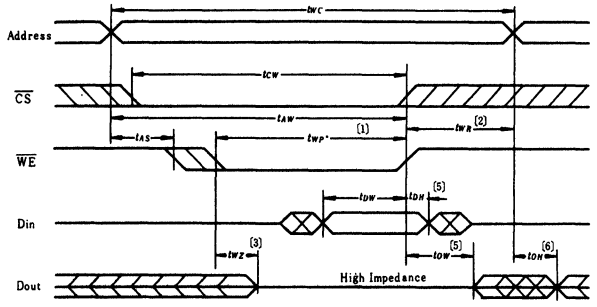
Notes) 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$= V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.

● WRITE CYCLE

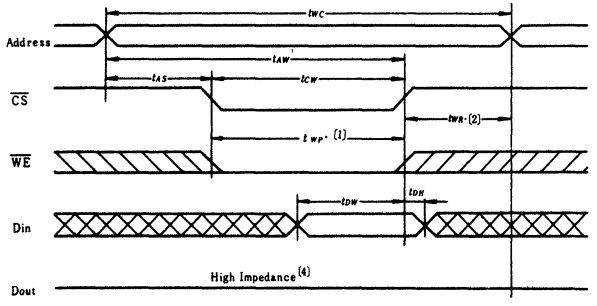
Item	Symbol	HM6148HLP-35		HM6148HLP-45		HM6148HLP-55		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	35	—	45	—	55	—	ns
Chip Selection to End of Write	t_{CW}	30	—	40	—	50	—	ns
Address Valid to End of Write	t_{AW}	30	—	40	—	50	—	ns
Address Setup Time	t_{AS}	0	—	0	—	0	—	ns
Write Pulse Width	t_{WP}	30	—	35	—	40	—	ns
Write Recovery Time	t_{WR}	5	—	5	—	5	—	ns
Data Valid to End of Write	t_{DW}	20	—	20	—	20	—	ns
Data Hold Time	t_{DH}	0	—	0	—	0	—	ns
Write Enabled to Output in High Z*	t_{WZ}	0	10	0	15	0	20	ns
Output Active from End of Write*	t_{OW}	0	—	0	—	0	—	ns

* Transition is measured ±500mV from high impedance voltage with Load B.
This parameter is sampled and not 100% tested.
All inputs t_r, t_f (rise and fall time) are less than 100ns.

● TIMING WAVEFORM OF WRITE CYCLE NO.1 ($\overline{WE}$ Controlled)



● TIMING WAVEFORM OF WRITE CYCLE NO.2 ($\overline{CS}$ Controlled)



Notes of Timing Waveform of Write :
1. A write occurs during the overlap of a low $\overline{CS}$ and a low $\overline{WE}$. (t_{WP})
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transition or after the $\overline{WE}$ transition, the output buffers remain in a high impedance state.
5. If $\overline{CS}$ is low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.
6. Dout is the same phase of write data of this write cycle.

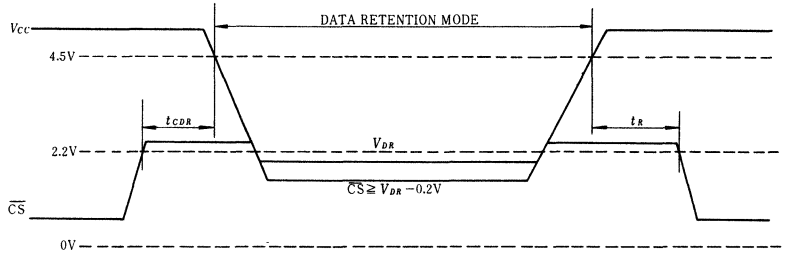
■LOW V_{CC} DATA RETENTION CHARACTERISTICS ($0℃ \leqq Ta \leqq 70℃$)

Parameter	Symbol	Test Conditions	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geqq V_{CC}-0.2V$ $V_{in} \geqq V_{CC}-0.2V$ or $0V \leqq V_{in} \leqq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}		—	—	30* 20**	μA
Chip Deselect to Data Retention Time	t_{CDR}		0	—	—	ns
Operation Recovery Time	t_R		$t_{RC(1)}$	—	—	ns

Note) 1. t_{RC}=Read Cycle Time.

* V_{CC}=3.0V
** V_{CC}=2.0V

●LOW V_{CC} DATA RETENTION WAVEFORM



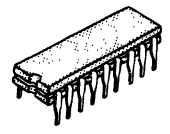
HM6147, HM6147-3
HM6147P, HM6147P-3

4096-word×1-bit High Speed Static CMOS RAM

■FEATURES

- Single 5V Supply and High Density 18 Pin Package
- High Speed: Fast Access Time 55ns/70ns Max.
- Low Power Standby and Low Power Operation, Standby: 100μW typ., Operation: 75mW typ.
- Completely Static Memory — No Clock nor Timing Strobe Required
- No Peak Power–On Current
- No Change of t_{ACS} with Short Chip Deselect Time
- Equal Access and Cycle Time
- Directly TTL Compatible — All Input and Output
- Separate Data Input and Output: Three State Output
- Pin-out Compatible with Intel 2147 NMOS STATIC RAM

HM6147, HM6147-3

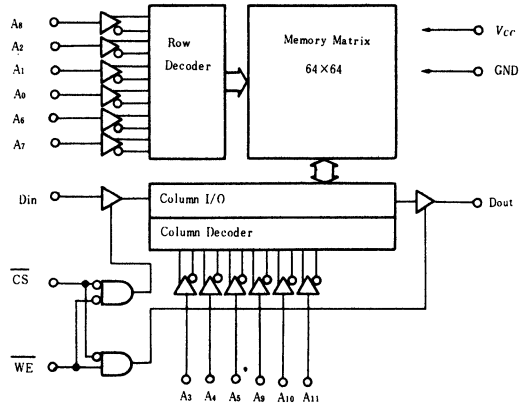


(DG-18)

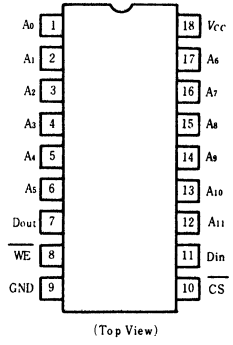
HM6147P, HM6147P-3

(DP-18)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin relative to GND*	V_T	−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature(Ceramic)	T_{stg}	−65 to +150	°C
Storage Temperature(Plastic)	T_{stg}	−55 to +125	°C

* V_{IN} min = −1.0V (Pulse Width ≦ 20ns)

■RECOMMENDED DC OPERATING CONDITIONS ($0°C \leqq Ta \leqq 70°C$)

Parameter	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High (logic 1) Voltage	V_{IH}	2.2	3.5	6.0	V
Input Low (logic 0) Voltage	V_{IL}	−0.3*	—	0.8	V

* V_{IL} min = −1.0V (Pulse width ≦ 20ns)

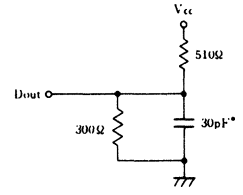
■DC AND OPERATING CHARACTERISTICS ($0°C \leqq Ta \leqq 70°C$, $V_{CC}=5V \pm 10\%$, GND=0V)

Parameter	Symbol	Test Conditions	min	typ	max	Unit	Notes
Input Leakage Current	$\|I_{LI}\|$	$V_{CC}=5.5V$, GND to V_{CC}	—	—	2.0	μA	
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}=V_{IH}$, $V_{out}=0 \sim V_{CC}$	—	—	2.0	μA	
Operating Power Supply Current(1) DC	I_{CC}	$\overline{CS}=V_{IL}$, Output open	—	15	35	mA	
Operating Power Supply Current(2) DC	I_{CC1}	$\overline{CS}=V_{IL}$, $V_{IN} \leqq 0.2V$ or $V_{IN} \geqq V_{CC}-0.2V$	—	12	—	mA	[2]
Average Operating Current(3)	I_{CC2}	Cycle 150ns, duty 50%	—	14	—	mA	[2]
Standby Power Supply Current(1) DC	I_{SB}	$\overline{CS}=V_{IH}$	—	5	12	mA	
Standby Power Supply Current(2) DC	I_{SB1}	$\overline{CS} \geqq V_{CC}-0.2V$, $V_{IN} \leqq 0.2V$ or $V_{IN} \geqq V_{CC}-0.2V$	—	20	800	μA	
Output Low Voltage	V_{OL}	$I_{OL}=12mA$	—	—	0.40	V	
Output High Voltage	V_{OH}	$I_{OH}=-8.0mA$	2.4	—	—	V	

Note) 1. Typical limits are at $V_{CC}=5.0V$, $Ta=25°C$ and specified loading.
2. Reference only

■AC TEST CONDITIONS

- Input pulse levels: GND to 3.5V
- Input rise and fall times: 10 ns
- Input and output timing reference levels: 1.5V
- Output load: See Figure 1



* Including scope & jig capacitance
Figure 1 Output Load

■CAPACITANCE ($Ta=25°C$, $f=1.0MHz$)

Item	Symbol	Conditions	max	Unit
Input Capacitance	C_{in}	$V_{in}=0V$	5	pF
Output Capacitance	C_{out}	$V_{out}=0V$	7	pF

Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS ($Ta=0°C$ to $70°C$, $V_{CC}=5V \pm 10\%$, unless otherwise noted.)

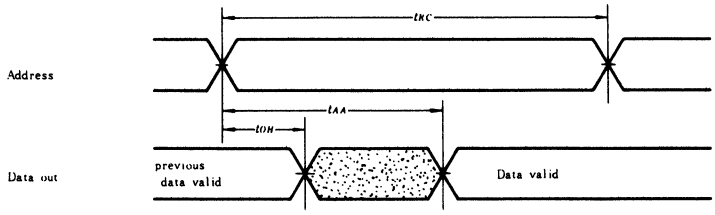
●READ CYCLE

Parameter	Symbol	HM6147/P-3		HM6147/P		Unit
		min	max	min	max	
Read Cycle Time	t_{RC}	55	—	70	—	ns
Address Access Time	t_{AA}	—	55	—	70	ns
Chip Select Access Time	t_{ACS}	—	55	—	70	ns
Output Hold from Address Change	t_{OH}	5	—	5	—	ns
Chip Selection to Output in Low Z	t_{LZ}	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{HZ}	0	40	0	40	ns
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	ns
Chip Deselection to Power Down Time	t_{PD}	—	30	—	30	ns

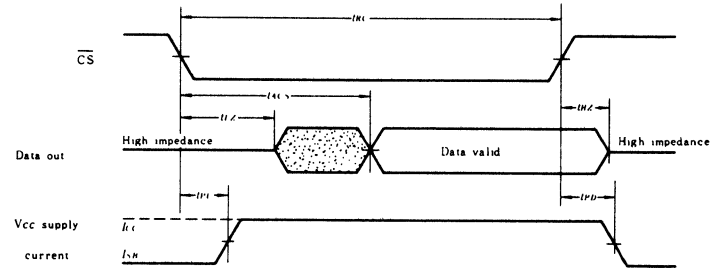
●WRITE CYCLE

Parameter	Symbol	HM6147/P-3		HM6147/P		Unit
		min	max	min	max	
Write Cycle Time	t_{WC}	55	—	70	—	ns
Chip Selection to End of Write	t_{CW}	45	—	55	—	ns
Address Valid to End of Write	t_{AW}	45	—	55	—	ns
Address Setup Time	t_{AS}	0	—	0	—	ns
Write Pulse Width	t_{WP}	35	—	40	—	ns
Write Recovery Time	t_{WR}	10	—	15	—	ns
Data Valid to End of Write	t_{DW}	25	—	30	—	ns
Data Hold Time	t_{DH}	10	—	10	—	ns
Write Enabled to Output in High Z	t_{WZ}	0	30	0	35	ns
Output Active from End of Write	t_{OW}	0	—	0	—	ns

● TIMING WAVEFORM OF READ CYCLE NO.1 (1) (2)

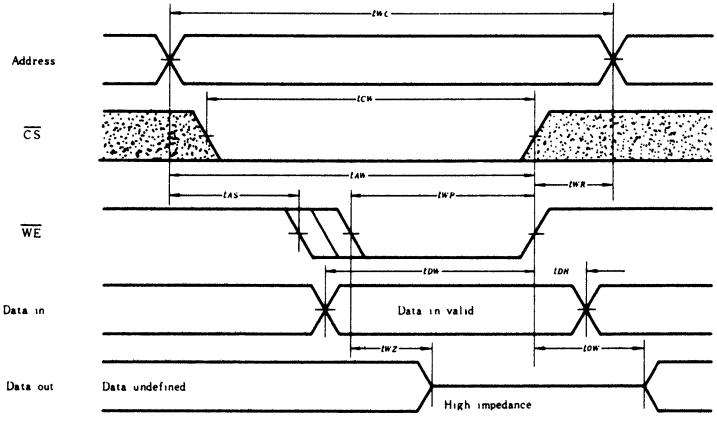


● TIMING WAVEFORM OF READ CYCLE NO.2 (1) (3)

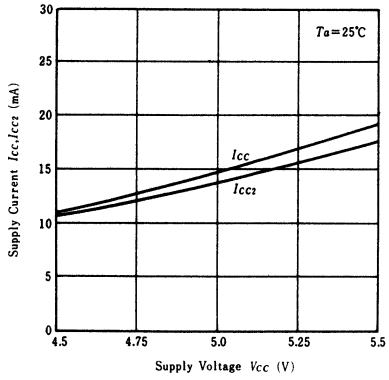


Notes: 1. $\overline{WE}$ is high for READ Cycle.
2. $\overline{CS}$ is low for READ Cycle.
3. Addresses valid prior to or coincident with $\overline{CS}$ transition low.

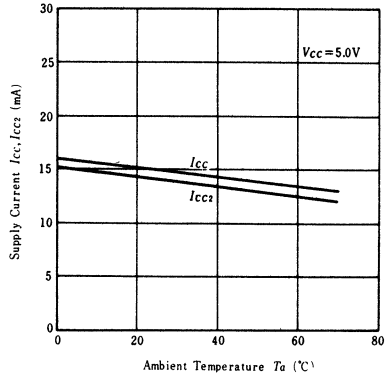
● TIMING WAVEFORM OF WRITE CYCLE



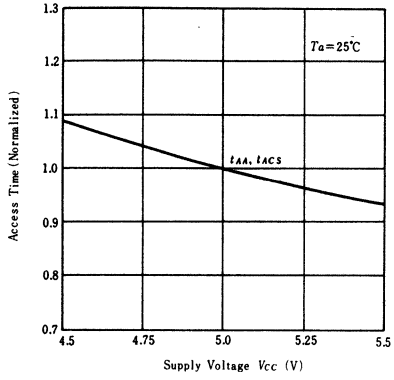
SUPPLY CURRENT vs. SUPPLY VOLTAGE



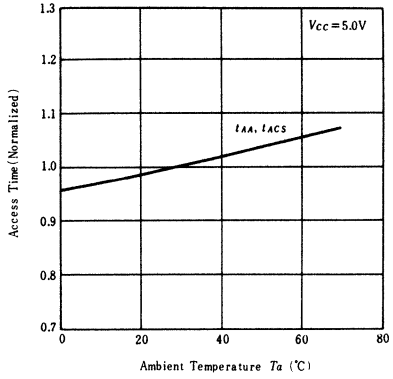
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



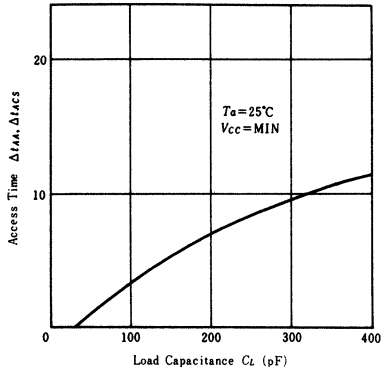
ACCESS TIME vs. SUPPLY VOLTAGE



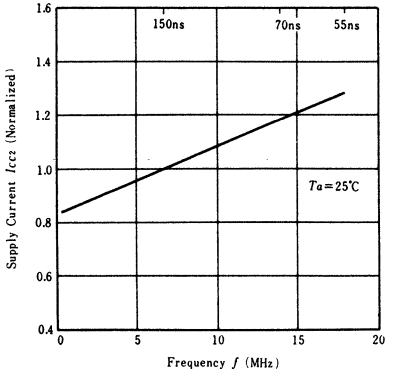
ACCESS TIME vs. AMBIENT TEMPERATURE



ACCESS TIME vs. LOAD CAPACITANCE



SUPPLY CURRENT vs. FREQUENCY

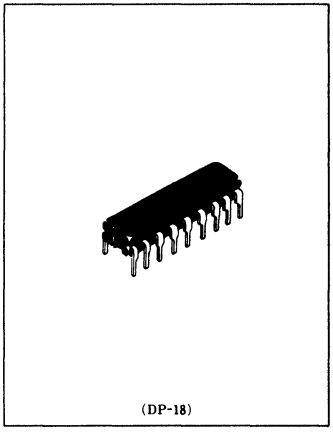


HM6147LP, HM6147LP-3

4096-word×1-bit High Speed Static CMOS RAM

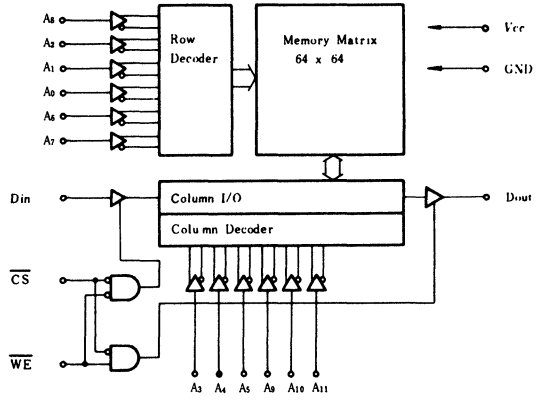
■FEATURES

- Single 5V Supply and High Density 18 Pin Package
- High Speed: Fast Access Time 55ns/70ns Max.
- Low Power Standby and Low Power Operation, Standby: 5μW typ. Operation: 75mW typ.
- Completely Static Memory — No Clock nor Timing Strobe Required
- No Peak Power–On Current
- No Change of t_{ACS} with Short Chip Deselect Time
- Equal Access and Cycle Time
- Directly TTL Compatible — All Input and Output
- Separate Data Input and Output: Three State Output
- Capability of Battery Back up Operation
- Pin-out Compatible with Intel 2147 NMOS STATIC RAM

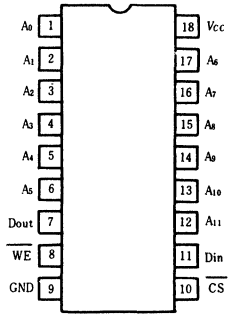


(DP-18)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin relative to GND*	V_T	−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C

* V_{IL} min = −1.0V (Pulse Width ≦ 20ns)

■RECOMMENDED DC OPERATING CONDITIONS ($0°C \leqq Ta \leqq 70°C$)

Parameter	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High (logic 1) Voltage	V_{IH}	2.2	3.5	6.0	V
Input Low (logic 0) Voltage	V_{IL}	−0.3*	—	0.8	V

* V_{IL} min = −1.0V (Pulse width ≦ 20ns)

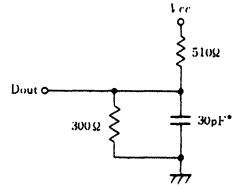
■DC AND OPERATING CHARACTERISTICS ($0°C \leqq Ta \leqq 70°C$, $V_{CC}=5V\pm10\%$, GND=0V)

Parameter	Symbol	Test Condition	min	typ	max	Unit	Notes
Input Leakage Current	$\lvert I_{LI}\rvert$	$V_{CC}=5.5V$, GND to V_{CC}	—	—	2.0	μA	
Output Leakage Current	$\lvert I_{LO}\rvert$	$\overline{CS}=V_{IH}$, $V_{out}=0\sim V_{CC}$	—	—	2.0	μA	
Operating Power Supply Current(1) DC	I_{CC}	$\overline{CS}=V_{IL}$, Output open	—	15	35	mA	
Operating Power Supply Current(2) DC	I_{CC1}	$\overline{CS}=V_{IL}$, $V_{IN}\leqq0.2V$ or $V_{IN}\geqq V_{CC}-0.2V$	—	12	—	mA	[2]
Average Operating Current(3)	I_{CC2}	Cycle 150ns, duty 50%	—	14	—	mA	[2]
Standby Power Supply Current(1) DC	I_{SB}	$\overline{CS}=V_{IH}$	—	5	12	mA	
Standby Power Supply Current(2) DC	I_{SB1}	$\overline{CS}\geqq V_{CC}-0.2V$, $V_{IN}\leqq0.2V$ or $V_{IN}\geqq V_{CC}-0.2V$	—	1	100	μA	
Output Low Voltage	V_{OL}	$I_{OL}=12mA$	—	—	0.40	V	
Output High Voltage	V_{OH}	$I_{OH}=-8.0mA$	2.4	—	—	V	

Note) 1. Typical limits are at $V_{CC}=5.0V$, $Ta=25°C$ and specified loading.
2. Reference only.

■AC TEST CONDITIONS

- Input pulse levels: GND to 3.5V
- Input rise and fall times: 10 ns
- Input and output timing reference levels: 1.5V
- Output load: See Figure 1



* Including scope & jig capacitance
Figure 1 Output Load

■CAPACITANCE ($Ta=25°C$, $f=1.0MHz$)

Item	Symbol	Condition	max	Unit
Input Capacitance	C_{in}	$V_{IN}=0V$	5	pF
Output Capacitance	C_{out}	$V_{out}=0V$	7	pF

Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS ($Ta=0°C$ to $70°C$, $V_{CC}=5V\pm10\%$, unless otherwise noted.)

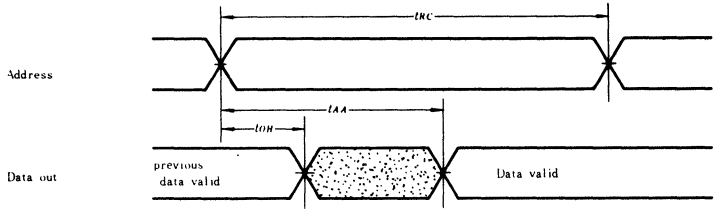
●READ CYCLE

Parameter	Symbol	HM6147LP-3		HM6147LP		Unit
		min	max	min	max	
Read Cycle Time	t_{RC}	55	—	70	—	ns
Address Access Time	t_{AA}	—	55	—	70	ns
Chip Select Access Time	t_{ACS}	—	55	—	70	ns
Output Hold from Address Change	t_{OH}	5	—	5	—	ns
Chip Selection to Output in Low Z	t_{LZ}	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{HZ}	0	40	0	40	ns
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	ns
Chip Deselection to Power Down Time	t_{PD}	—	30	—	30	ns

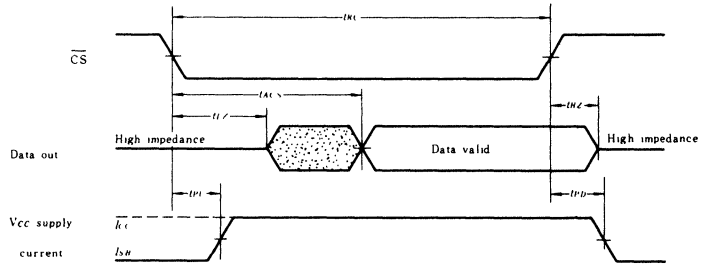
● WRITE CYCLE

Parameter	Symbol	HM6147LP-3		HM6147LP		Unit
		min	max	min	max	
Write Cycle Time	t_{WC}	55	—	70	—	ns
Chip Selection to End of Write	t_{CW}	45	—	55	—	ns
Address Valid to End of Write	t_{AW}	45	—	55	—	ns
Address Setup Time	t_{AS}	0	—	0	—	ns
Write Pulse Width	t_{WP}	35	—	40	—	ns
Write Recovery Time	t_{WR}	10	—	15	—	ns
Data Valid to End of Write	t_{DW}	25	—	30	—	ns
Data Hold Time	t_{DH}	10	—	10	—	ns
Write Enabled to Output in High Z	t_{WZ}	0	30	0	35	ns
Output Active from End of Write	t_{OW}	0	—	0	—	ns

● TIMING WAVEFORM OF READ CYCLE NO.1 (1)(2)

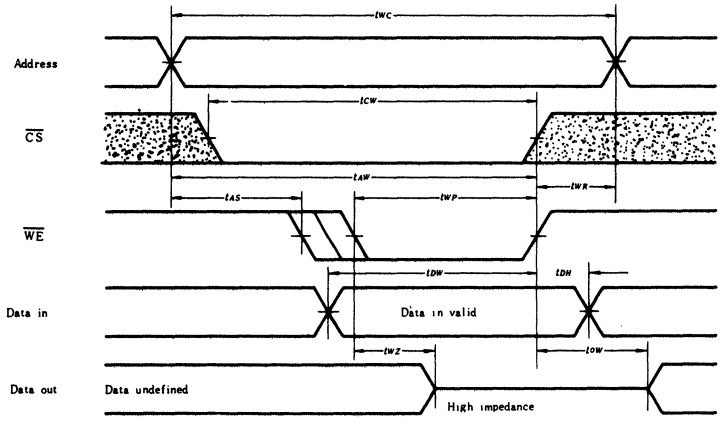


● TIMING WAVEFORM OF READ CYCLE NO.2 (1)(3)



NOTES: 1. $\overline{WE}$ is high for READ Cycle.
2. $\overline{CS}$ is low for READ Cycle.
3. Addresses valid prior to or coincident with $\overline{CS}$ transition low.

● TIMING WAVEFORM OF WRITE CYCLE

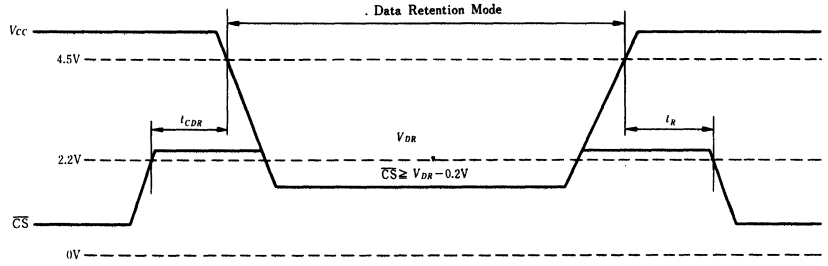


■ LOW V_{CC} RETENTION CHARACTERISTICS (Ta=0°C to 70°C)

Parameter	Symbol	Test Condition	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geq V_{CC}-0.2V$, $V_{in} \geq V_{CC}-0.2V$ or $\leq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}	$V_{CC}=2.0V$, $\overline{CS} \geq 1.8V$, $V_{in} \geq 1.8V$ or $\leq 0.2V$	—	—	40	μA
Chip Deselect to Data Retention Time	t_{CDR}		0	—	—	ns
Operation Recovery Time	t_R		t_{RC}*	—	—	ns

* t_{RC}=Read Cycle Time

● LOW V_{CC} RETENTION CHARACTERISTICS



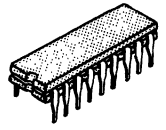
HM6147H-35, HM6147H-45, HM6147H-55, HM6147HP-35, HM6147HP-45, HM6147HP-55

4096-word×1-bit High Speed Static CMOS RAM

■FEATURES

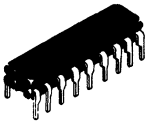
- Single 5V Supply and High Density 18 Pin Package
- High Speed: Fast Access Time 35ns/45ns/55ns Max.
- Low Power Standby and Low Power Operation, Standby: 100μW typ., Operation: 150mW typ.
- Completely Static Memory — No Clock nor Timing Strobe Required
- No Peak Power—On Current
- No Change of t_{ACS} with Short Chip Deselect Time
- Equal Access and Cycle Time
- Directly TTL Compatible — All Input and Output
- Separate Data Input and Output: Three State Output
- Plug-In Replacement with Intel 2147H NMOS STATIC RAM

HM6147H-35, HM6147H-45, HM6147H-55



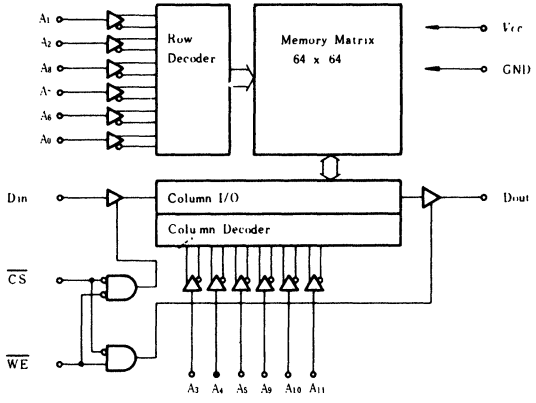
(DG-18)

HM6147HP-35, HM6147HP-45, HM6147HP-55

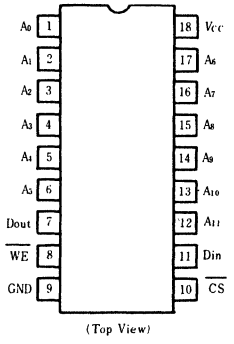


(DP-18)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin relative to GND	V_T	−3.5* to +7.0	V
DC Output Current	I_o	20	mA
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature (under bias)	$T_{stg(bias)}$	−10 to +85	°C
Storage Temperature (Ceramic)	T_{stg}	−65 to +150	°C
Storage Temperature (Plastic)	T_{stg}	−55 to +125	°C

* Pulse Width 20ns, DC : −0.5V

■RECOMMENDED DC OPERATING CONDITIONS ($0°C \leq Ta \leq 70°C$)

Parameter	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High (logic 1) Voltage	V_{IH}	2.0	3.0	6.0	V
Input Low (logic 0) Voltage	V_{IL}	−3.0*	—	0.8	V

* Pulse Width 20ns, DC : −0.5V

■DC AND OPERATING CHARACTERISTICS ($0°C \leq Ta \leq 70°C$, $V_{CC}=5V \pm 10\%$, GND=0V)

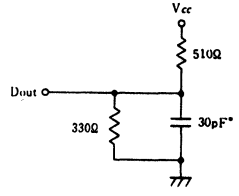
Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	$V_{CC}=5.5V$, GND to V_{CC}	—	—	10	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CS}=V_{IH}$, $V_{out}=0V \sim V_{CC}$	—	—	10	μA
Operating Power Supply Current(1) DC	I_{CC}	$\overline{CS}=V_{IL}$, Output open	—	30	80	mA
Operating Power Supply Current(2) DC	I_{CC1}	$\overline{CS}=V_{IL}$, Minimum Cycle	—	40	80	mA
Standby Power Supply Current(1) DC	I_{SB}	$\overline{CS}=V_{IH}$, V_{CC}=Min to Max	—	8	20	mA
Standby Power Supply Current(2) DC	I_{SB1}	$\overline{CS} \geq V_{CC}-0.2V$, $V_{IN} \leq 0.2V$ or $V_{IN} \geq V_{CC}-0.2V$	—	20	800	μA
Output Low Voltage	V_{OL}	$I_{OL}=8mA$	—	—	0.40	V
Output High Voltage	V_{OH}	$I_{OH}=-4mA$	2.4	—	—	V

Note) 1. The operating ambient temperature range is guaranteed with transverse air flow exceeding 400 linear feet minute.
2. Typical limits are at $V_{CC}=5.0V$, $Ta=25°C$ and specified loading.

■AC TEST CONDITIONS

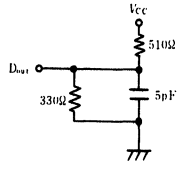
- Input pulse levels: GND to 3.0V
- Input rise and fall times: 5 ns
- Input timing reference levels: 1.5V
- Output load: See Figure
- Output timing reference levels: 1.5V (HM6147H/P-35)
  0.8 to 2.0V (HM6147H/P-45/55)

Output Load A



* Including scope & jig capacitance

Output Load B



■CAPACITANCE ($Ta=25°C$, $f=1.0MHz$)

Item	Symbol	Conditions	max	Unit
Input Capacitance	C_{in}	$V_{in}=0V$	5	pF
Output Capacitance	C_{out}	$V_{out}=0V$	6	pF

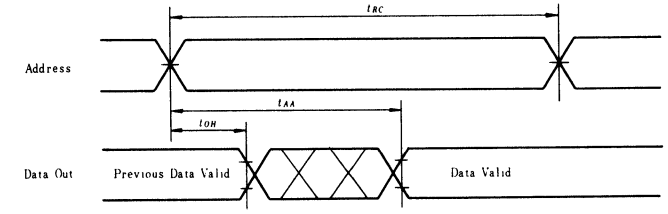
Note) This parameter is sampled and not 100% tested.

■ AC CHARACTERISTICS (Ta=0℃ to 70℃, V_{CC}=5V±10%, unless otherwise noted.)

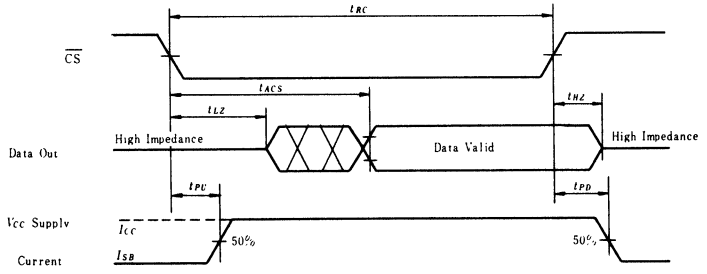
● READ CYCLE

Parameter	Symbol	HM6147H/P-35		HM6147H/P-45		HM6147H/P-55		Unit	Notes
		min	max	min	max	min	max		
Read Cycle Time	t_{RC}	35	—	45	—	55	—	ns	[1]
Address Access Time	t_{AA}	—	35	—	45	—	55	ns	
Chip Select Access Time	t_{ACS}	—	35	—	45	—	55	ns	
Output Hold from Address Change	t_{OH}	5	—	5	—	5	—	ns	
Chip Selection to Output in Low Z	t_{LZ}	5	—	5	—	5	—	ns	[2], [3], [7]
Chip Deselection to Output in High Z	t_{HZ}	0	30	0	30	0	30	ns	[2], [3], [7]
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	0	—	ns	
Chip Deselection to Power Down Time	t_{PD}	—	20	—	20	—	20	ns	

● TIMING WAVEFORM OF READ CYCLE NO.1 [4] [5]



● TIMING WAVEFORM OF READ CYCLE NO.2 [4] [6]

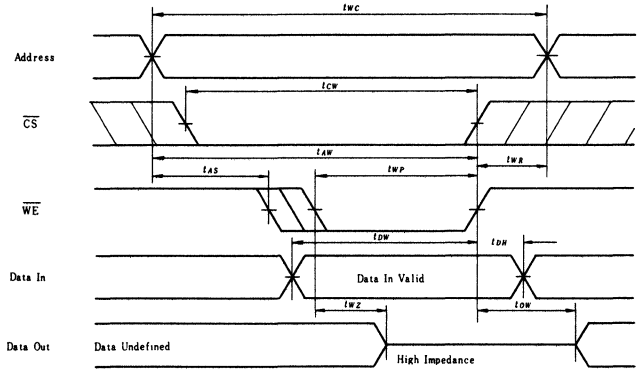


Notes:
1. All Read Cycle timings are referenced from last valid address to the first transitioning address.
2. At any given temperature and voltage condition, t_{HZ} max. is less than t_{LZ} min. both for a given device and from device to device.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. $\overline{WE}$ is high for READ Cycle.
5. Device is continuously selected, $\overline{CS}=V_{IL}$.
6. Addresses valid prior to or coincident with $\overline{CS}$ transition low.
7. This parameter is sampled and not 100% tested.

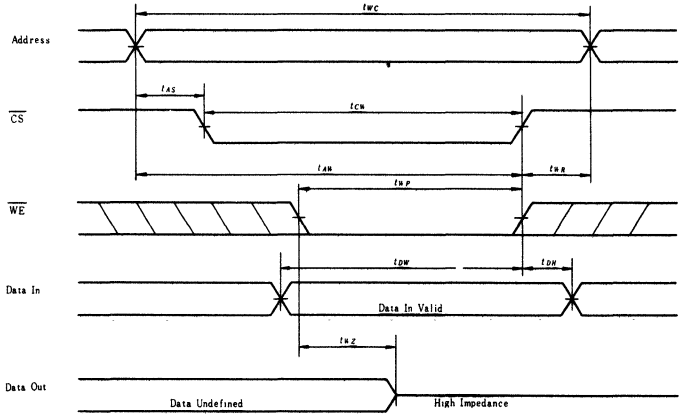
● WRITE CYCLE

Parameter	Symbol	HM6147H/P-35		HM6147H/P-45		HM6147H/P-55		Unit	Notes
		min	max	min	max	min	max		
Write Cycle Time	t_{WC}	35	—	45	—	55	—	ns	[2]
Chip Selection to End of Write	t_{CW}	35	—	45	—	45	—	ns	
Address Valid to End of Write	t_{AW}	35	—	45	—	45	—	ns	
Address Setup Time	t_{AS}	0	—	0	—	0	—	ns	
Write Pulse Width	t_{WP}	20	—	25	—	30	—	ns	
Write Recovery Time	t_{WR}	0	—	0	—	0	—	ns	
Data Valid to End of Write	t_{DW}	20	—	25	—	25	—	ns	
Data Hold Time	t_{DH}	10	—	10	—	10	—	ns	
Write Enabled to Output in High Z	t_{WZ}	0	20	0	25	0	30	ns	[3], [4]
Output Active from End of Write	t_{OW}	0	—	0	—	0	—	ns	[3], [4]

● TIMING WAVEFORM OF WRITE CYCLE ($\overline{WE}$ CONTROLLED)



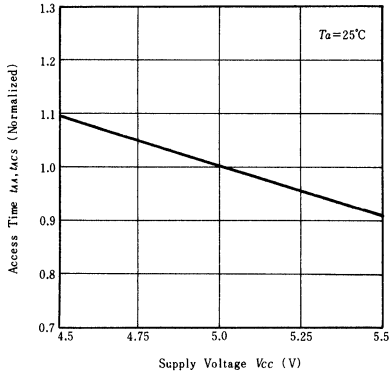
● TIMING WAVEFORM OF WRITE CYCLE ($\overline{CS}$ CONTROLLED)



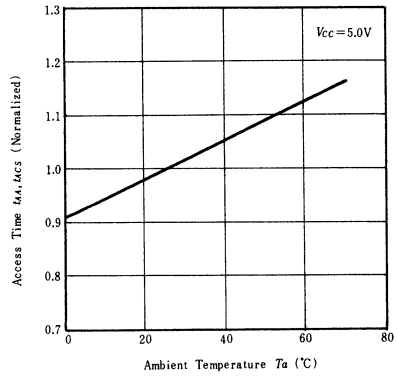
Note) $\overline{CS}$ or $\overline{WE}$ are High for Address Transition

Notes: 1. If $\overline{CS}$ goes high simultaneously with $\overline{WE}$ high, the output remains in a high impedance states.
2. All Write Cycle timings are referenced from the last valid address to the first transitioning address.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. This parameter is sampled and not 100% tested.

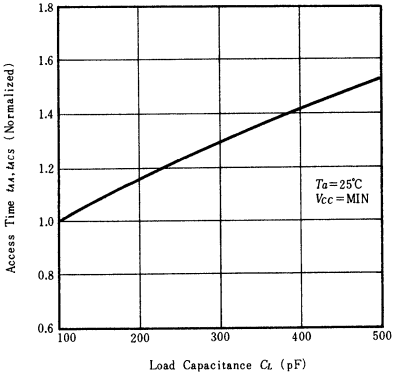
ACCESS TIME VS. SUPPLY VOLTAGE



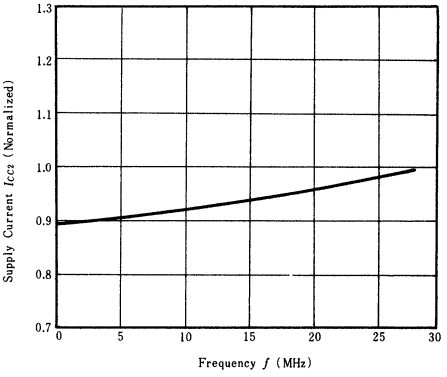
ACCESS TIME VS. AMBIENT TEMPERATURE



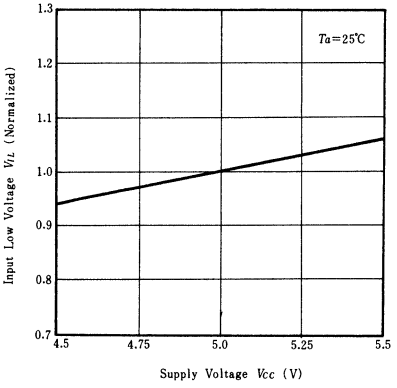
ACCESS TIME VS. LOAD CAPACITANCE



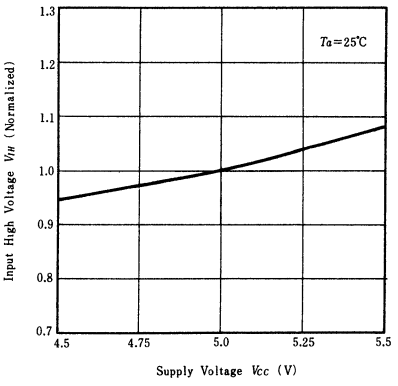
SUPPLY CURRENT VS. FREQUENCY



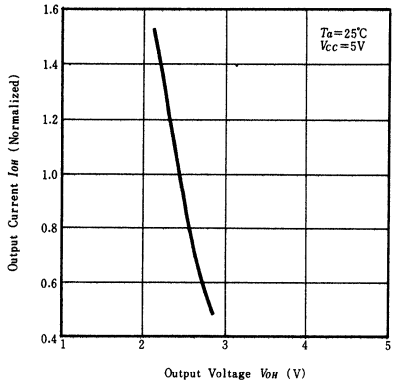
INPUT LOW VOLTAGE VS. SUPPLY VOLTAGE



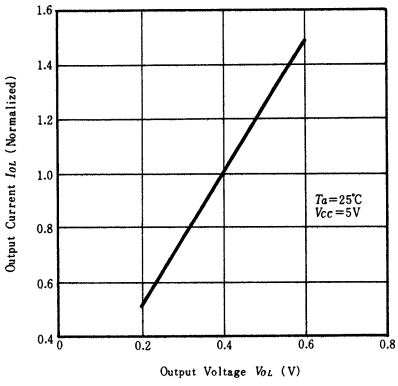
INPUT HIGH VOLTAGE VS. SUPPLY VOLTAGE



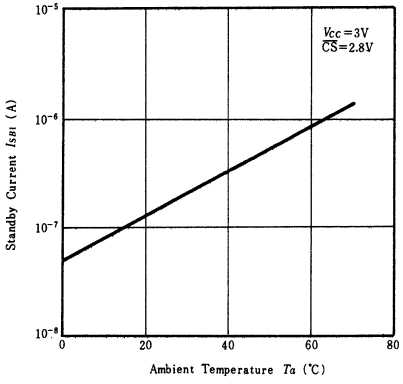
OUTPUT CURRENT VS. OUTPUT VOLTAGE



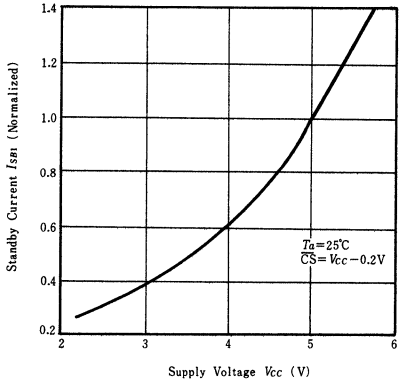
OUTPUT CURRENT VS. OUTPUT VOLTAGE



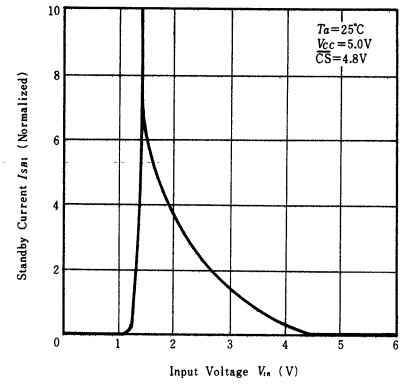
STANDBY CURRENT VS. AMBIENT TEMPERATURE



STANDBY CURRENT VS. SUPPLY VOLTAGE



STANDBY CURRENT VS. INPUT VOLTAGE

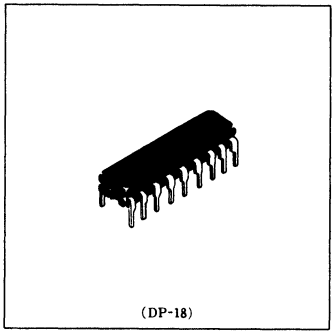


HM6147HLP-35, HM6147HLP-45, HM6147HLP-55

4096-word×1-bit High Speed Static CMOS RAM

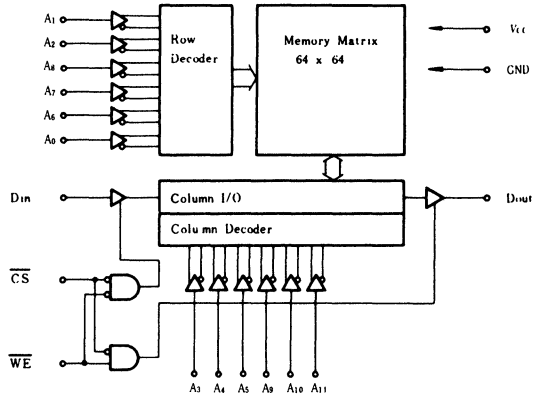
■FEATURES

- Single 5V Supply and High Density 18 Pin Package
- High Speed: Fast Access Time 35ns/45ns/55ns Max.
- Low Power Standby and Low Power Operation, Standby; 5μW typ., Operation: 150mW typ.
- Completely Static Memory — No Clock nor Timing Strobe Required
- No Peak Power–On Current
- No Change of t_{ACS} with Short Chip Deselect Time
- Equal Access and Cycle Time
- Directly TTL Compatible — All Input and Output
- Separate Data Input and Output: Three State Output
- Plug-In Replacement with Intel 2147H NMOS STATIC RAM
- Capable of Battery Back up Operation

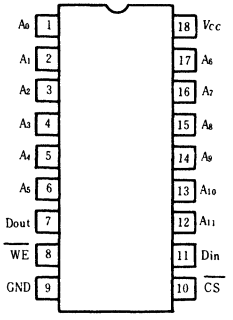


(DP-18)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin relative to GND	V_T	−3.5* to +7.0	V
DC Output Current	I_O	20	mA
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature (under bias)	$T_{stg\,(bias)}$	−10 to +85	°C
Storage Temperature	T_{stg}	−55 to +125	°C

* Pulse Width 20ns. DC : −0.5V

■RECOMMENDED DC OPERATING CONDITIONS ($0°C \leqq Ta \leqq 70°C$)

Parameter	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High (logic 1) Voltage	V_{IH}	2.2	3.0	6.0	V
Input Low (logic 0) Voltage	V_{IL}	−0.5*	—	0.8	V

* V_{IL} min = −3V (Pulse width ≦ 20ns)

■DC AND OPERATING CHARACTERISTICS ($0°C \leq Ta \leq 70°C$, $V_{CC}=5V \pm 10\%$, GND=0V)

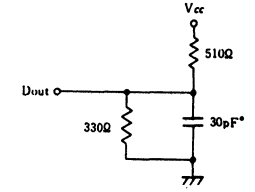
Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	$\|I_{LI}\|$	$V_{CC}=5.5V$, GND to V_{CC}	—	—	10	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}=V_{IH}$, $V_{out}=0V \sim V_{CC}$	—	—	10	μA
Operating Power Supply Current(1) DC	I_{CC}	$\overline{CS}=V_{IL}$, Output open	—	30	80	mA
Operating Power Supply Current(2) DC	I_{CC1}	$\overline{CS}=V_{IL}$, Minimum Cycle	—	40	80	mA
Standby Power Supply Current(1) DC	I_{SB}	$\overline{CS}=V_{IH}$, V_{CC}=Min to Max	—	5	15	mA
Standby Power Supply Current(2) DC	I_{SB1}	$\overline{CS} \geq V_{CC}-0.2V$, $V_{IN} \leq 0.2V$ or $V_{IN} \geq V_{CC}-0.2V$	—	1	100	μA
Output Low Voltage	V_{OL}	$I_{OL}=8mA$	—	—	0.40	V
Output High Voltage	V_{OH}	$I_{OH}=-4.0mA$	2.4	—	—	V

Note) 1. The operating ambient temperature range is guaranteed with transverse air flow exceeding 400 linear feet per minute.
2. Typical limits are at $V_{CC}=5.0V$, $Ta=25°C$ and specified loading.

■AC TEST CONDITIONS

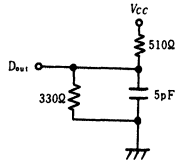
- Input pulse levels: GND to 3.0V
- Input rise and fall times: 5 ns
- Input timing reference levels: 1.5V
- Output load: See Figure
- Output timing reference levels:
  1.5V (HM6147HLP-35)
  0.8 to 2.0V (HM6147HLP-45/55)

Output Load A



* Including scope & jig capacitance

Output Load B



■CAPACITANCE ($Ta=25°C$, $f=1.0MHz$)

Item	Symbol	Conditions	max	Unit
Input Capacitance	C_{in}	$V_{in}=0V$	5	pF
Output Capacitance	C_{out}	$V_{out}=0V$	6	pF

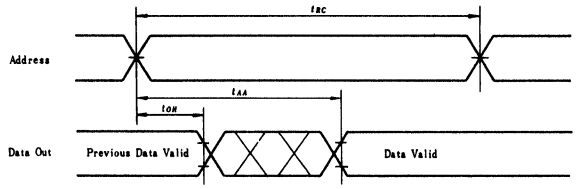
Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS ($Ta=0°C$ to $70°C$, $V_{CC}=5V \pm 10\%$, unless otherwise noted.)

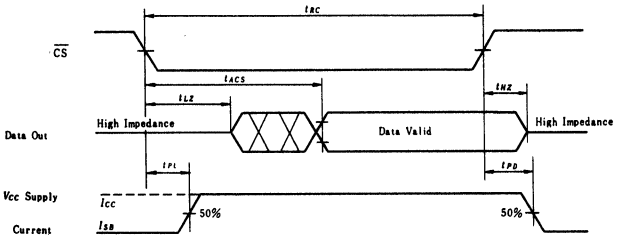
●READ CYCLE

Parameter	Symbol	HM6147HLP-35		HM6147HLP-45		HM6147HLP-55		Unit	Notes
		min	max	min	max	min	max		
Read Cycle Time	t_{RC}	35	—	45	—	55	—	ns	[1]
Address Access Time	t_{AA}	—	35	—	45	—	55	ns	
Chip Select Access Time	t_{ACS}	—	35	—	45	—	55	ns	
Output Hold from Address Change	t_{OH}	5	—	5	—	5	—	ns	
Chip Selection to Output in Low Z	t_{LZ}	5	—	5	—	5	—	ns	[2], [3], [7]
Chip Deselection to Output in High Z	t_{HZ}	0	30	0	30	0	30	ns	[2], [3], [7]
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	0	—	ns	
Chip Deselection to Power Down Time	t_{PD}	—	20	—	20	—	20	ns	

● TIMING WAVEFORM OF READ CYCLE NO.1 (4) (5)



● TIMING WAVEFORM OF READ CYCLE NO.2 (4) (6)

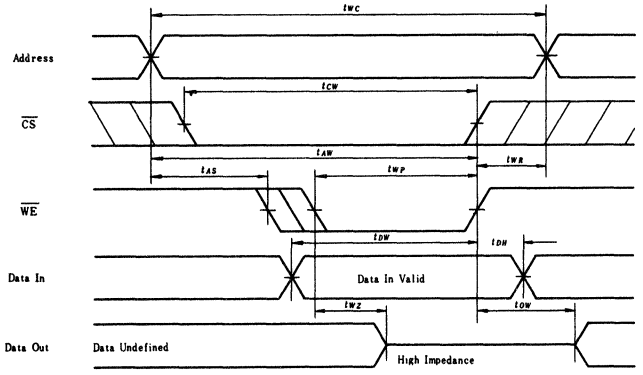


Notes:
1. All Read Cycle timings are referenced from last valid address to the first transitionining address.
2. At any given temperature and voltage condition, t_{HZ} max. is less than t_{LZ} min. both for a given device and from device to divice.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. $\overline{WE}$ is high for READ Cycle.
5. Device is continuously selected, $\overline{CS}=V_{IL}$.
6. Addresses valid prior to or coincident with $\overline{CS}$ transition low.
7. This parameter is sampled and not 100% tested.

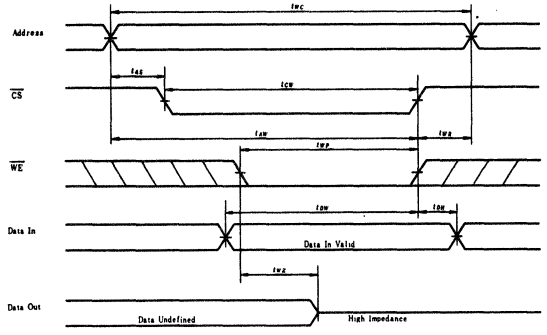
● WRITE CYCLE

Parameter	Symbol	HM6147HLP-35		HM6147HLP-45		HM6147HLP-55		Unit	Notes
		min	max	min	max	min	max		
Write Cycle Time	t_{WC}	35	—	45	—	55	—	ns	[2]
Chip Selection to End of Write	t_{CW}	35	—	45	—	45	—	ns	
Address Valid to End of Write	t_{AW}	35	—	45	—	45	—	ns	
Address Setup Time	t_{AS}	0	—	0	—	0	—	ns	
Write Pulse Width	t_{WP}	20	—	25	—	30	—	ns	
Write Recovery Time	t_{WR}	0	—	0	—	0	—	ns	
Data Valid to End of Write	t_{DW}	20	—	25	—	25	—	ns	
Data Hold Time	t_{DH}	10	—	10	—	10	—	ns	
Write Enable to Output in High Z	t_{WZ}	0	20	0	25	0	30	ns	[3], [4]
Output Active from End of Write	t_{OW}	0	—	0	—	0	—	ns	[3], [4]

● TIMING WAVEFORM OF WRITE CYCLE ($\overline{WE}$ CONTROLLED)



● TIMING WAVEFORM OF WRITE CYCLE ($\overline{CS}$ CONTROLLED)



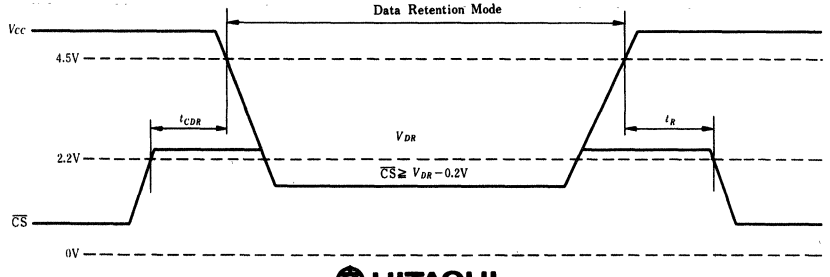
Notes:
1. If $\overline{CS}$ goes high simultaneously with $\overline{WE}$ high, the output remains in a high impedance states.
2. All Write Cycle timings are referenced from the last valid address to the first transitioning address.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. This parameter is sampled and not 100% tested.

■ LOW V_{CC} DATA RETENTION CHARACTERISTICS (Ta=0℃ to +70℃)

Item	Symbol	Test Condition	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geqq V_{CC}-0.2V$ $V_{IN} \geqq V_{CC}-0.2V$ or $V_{IN} \leqq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}	V_{CC}=3.0V, $\overline{CS} \geqq 2.8V$ $V_{IN} \geqq 2.8V$ or $V_{IN} \leqq 0.2V$	—	—	50	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}*	—	—	ns

* t_{RC} = Read Cycle Time.

● LOW V_{CC} DATA RETENTION WAVEFORM



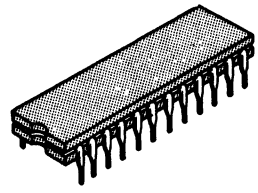
HM6116-2, HM6116-3, HM6116-4
HM6116P-2, HM6116P-3, HM6116P-4

2048-word×8-bit High Speed Static CMOS RAM

■FEATURES

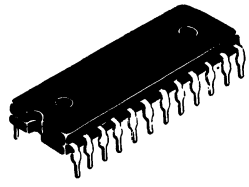
- Single 5V Supply and High Density 24 Pin Package
- High speed: Fast Access Time — 120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation — Standby: 100μW (typ.), Operation: 180mW (typ.)
- Completely Static RAM: No clock or Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time

HM6116-2, HM6116-3, HM6116-4



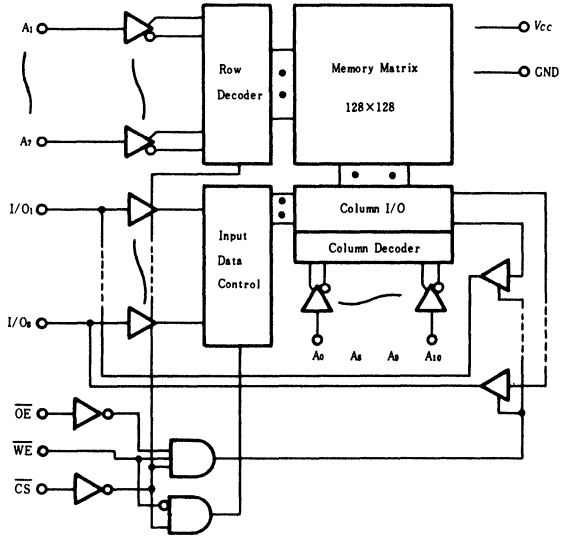
(DG-24)

HM6116P-2, HM6116P-3, HM6116P-4

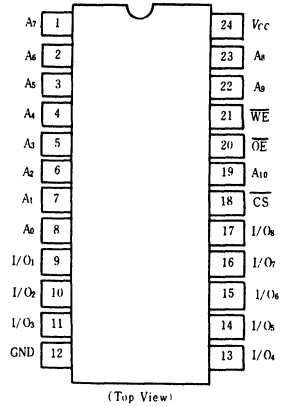


(DP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature (Plastic)	T_{stg}	−55 to +125	°C
Storage Temperature (Ceramic)	T_{stg}	−65 to +150	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5 V

■TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min=−0.3V

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Conditions	HM6116/P-2			HM6116/P-3/-4			Unit
			min	typ*	max	min	typ*	max	
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	10	—	—	10	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}=V_{IH}$ or $\overline{OE}=V_{IH}$, $V_{I/O}$=GND to V_{CC}	—	—	10	—	—	10	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, $I_{I/O}$=0mA	—	40	80	—	35	70	mA
	I_{CC1}**	V_{IH}=3.5V, V_{IL}=0.6V, $I_{I/O}$=0mA	—	35	—	—	30	—	mA
Average Operating Current	I_{CC2}	Min. cycle, duty=100%	—	40	80	—	35	70	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	5	15	—	5	15	mA
	I_{SB1}	$\overline{CS}\geqq V_{CC}-0.2V$, $V_{in}\geqq V_{CC}-0.2V$ or $V_{in}\leqq 0.2V$	—	0.02	2	—	0.02	2	mA
Output Voltage	V_{OL}	I_{OL}=4mA	—	—	0.4	—	—	—	V
		I_{OL}=2.1mA	—	—	—	—	—	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	2.4	—	—	V

* V_{CC}=5V, Ta=25°C
** Reference Only

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0 to +70°C)

●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6116/P-2		HM6116/P-3		HM6116/P-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	15	—	15	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	15	—	15	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	15	—	15	—	ns

● WRITE CYCLE

Item	Symbol	HM6116/P-2		HM6116/P-3		HM6116/P-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

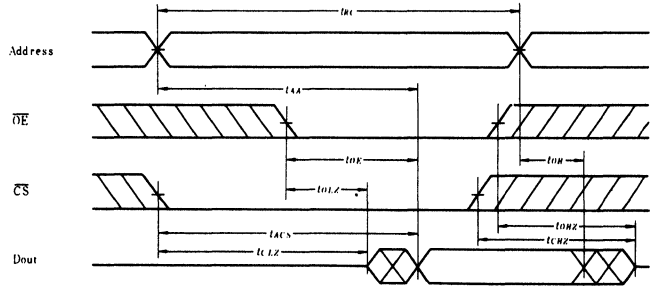
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

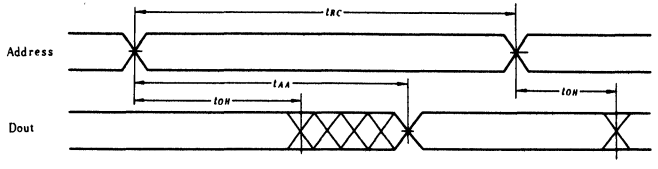
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

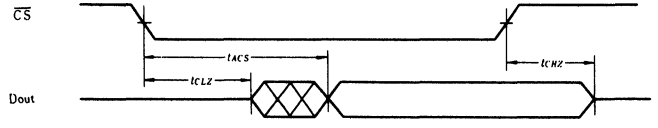
● READ CYCLE (1)[1]



● READ CYCLE (2)[1][2][4]

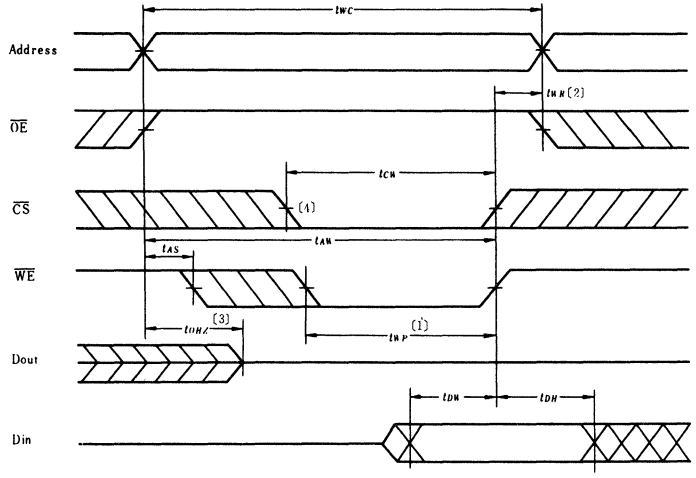


● READ CYCLE (3)[1][3][4]

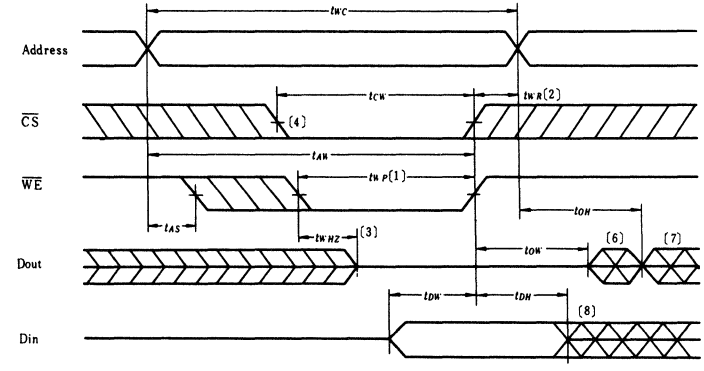


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

WRITE CYCLE (1)

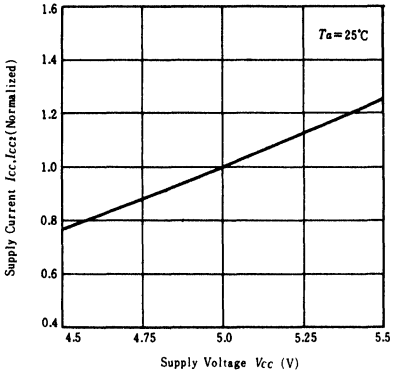


● WRITE CYCLE (2) (5)

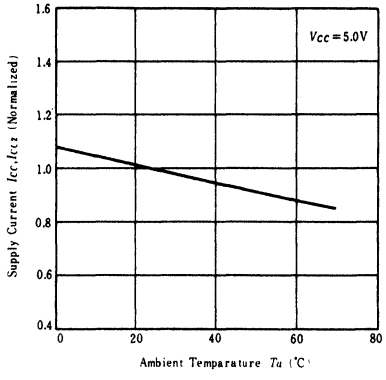


NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

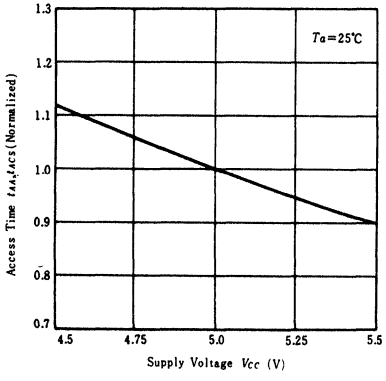
SUPPLY CURRENT vs. SUPPLY VOLTAGE



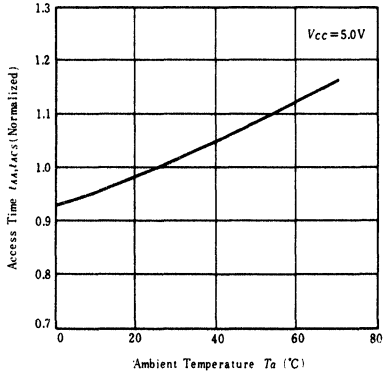
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



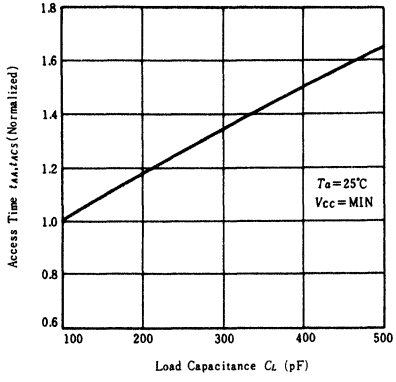
ACCESS TIME vs. SUPPLY VOLTAGE



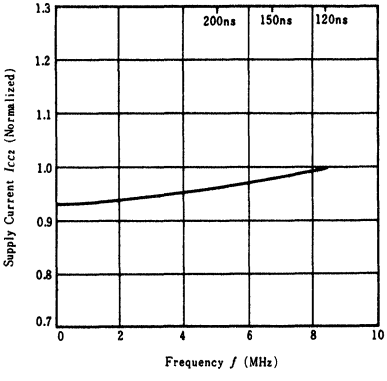
ACCESS TIME vs. AMBIENT TEMPERATURE



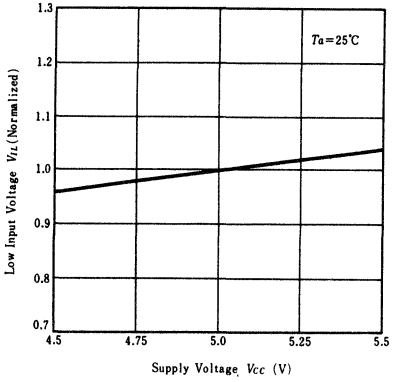
ACCESS TIME vs. LOAD CAPACITANCE



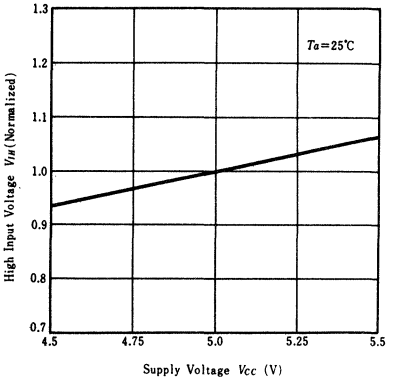
SUPPLY CURRENT vs. FREQUENCY



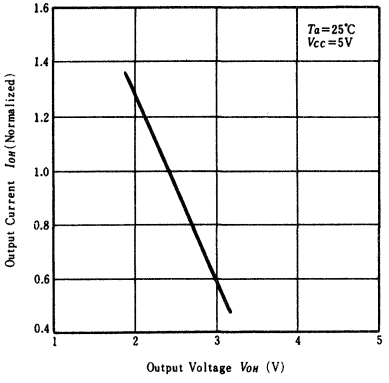
LOW INPUT VOLTAGE vs. SUPPLY VOLTAGE



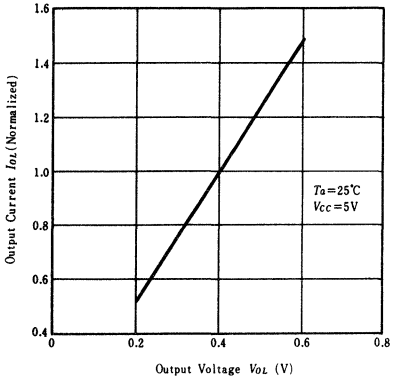
HIGH INPUT VOLTAGE vs. SUPPLY VOLTAGE



OUTPUT CURRENT vs. OUTPUT VOLTAGE



OUTPUT CURRENT vs. OUTPUT VOLTAGE

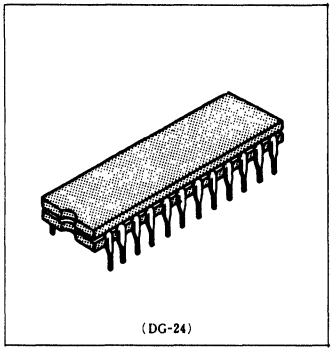


HM6116I-2, HM6116I-3, HM6116I-4 ——Wide Operating Temperature Range——

2048-word×8-bit High Speed Static CMOS RAM

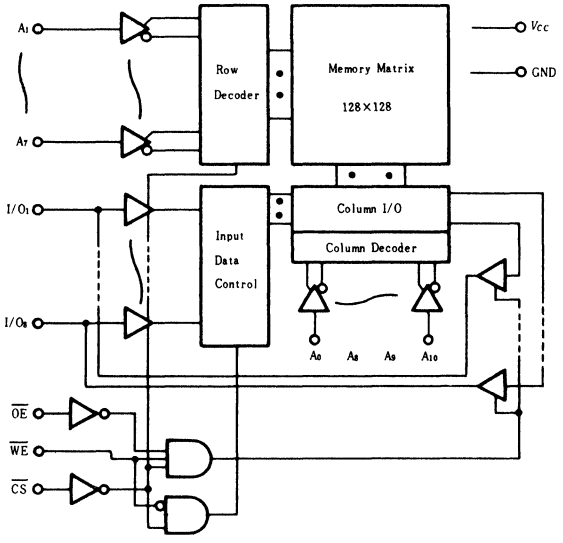
■FEATURES

- Wide Operating Temperature Range . . . . . −40~+85°C
- Single 5V Supply and High Density 24 Pin Package
- High speed: Fast Access Time 120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation — Standby: 100μW (typ.), Operation: 180mW (typ.)
- Completely Static RAM: No clock or Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time

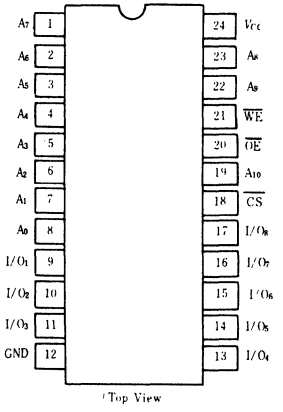


(DG-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	−40 to +85	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5V

■TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■RECOMMENDED DC OPERATING CONDITIONS ($Ta=-40$ to $+85°C$)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min = −0.3V

■DC AND OPERATING CHARACTERISTICS ($V_{CC}=5V\pm10\%$, GND = 0V, $Ta=-40$ to $+85°C$)

Item	Symbol	Test Conditions	min	typ*	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	$V_{CC}=5.5V$, V_{in} = GND to V_{CC}	—	—	10	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CS}=V_{IH}$ or $\overline{OE}=V_{IH}$, $V_{I/O}$ = GND to V_{CC}	—	—	10	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, $I_{I/O}$ = 0mA	—	35	90	mA
	I_{CC1}**	$V_{IH}=3.5V$, $V_{IL}=0.6V$, $I_{I/O}$ = 0mA	—	30	—	mA
Average Operating Current	I_{CC2}	Min. cycle, duty = 100%	—	35	90	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	4	20	mA
	I_{SB1}	$\overline{CS} \geq V_{CC}-0.2V$, $V_{in} \geq V_{CC}-0.2V$ or $V_{in} \leq 0.2V$	—	0.02	2	mA
Output Voltage	V_{OL}	$I_{OL}=2.1mA$	—	—	0.4	V
	V_{OH}	$I_{OH}=-1.0mA$	2.4	—	—	V

* $V_{CC}=5V$, $Ta=25°C$
** Reference Only

■AC CHARACTERISTICS ($V_{CC}=5V\pm10\%$, $Ta=-40$ to $+85°C$)

●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6116I-2		HM6116I-3		HM6116I-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	10	—	10	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	10	—	10	—	ns

● WRITE CYCLE

Item	Symbol	HM6116I-2		HM6116I-3		HM6116I-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

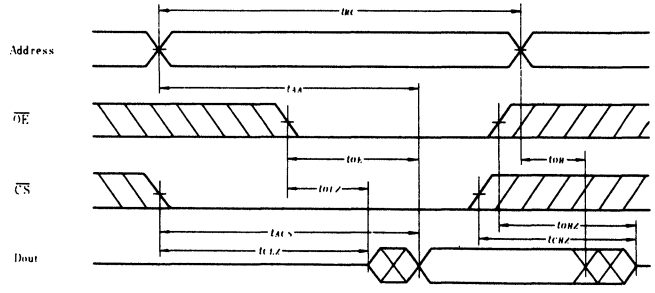
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

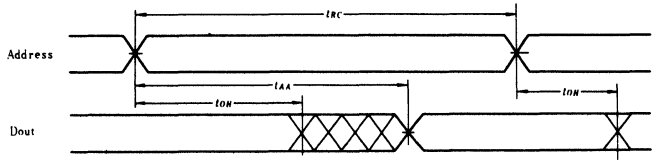
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

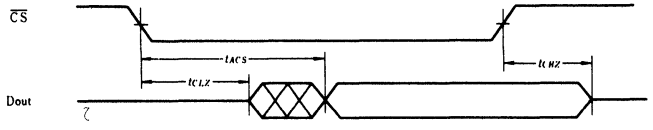
● READ CYCLE (1)[1,5]



● READ CYCLE (2)[1,2,4]

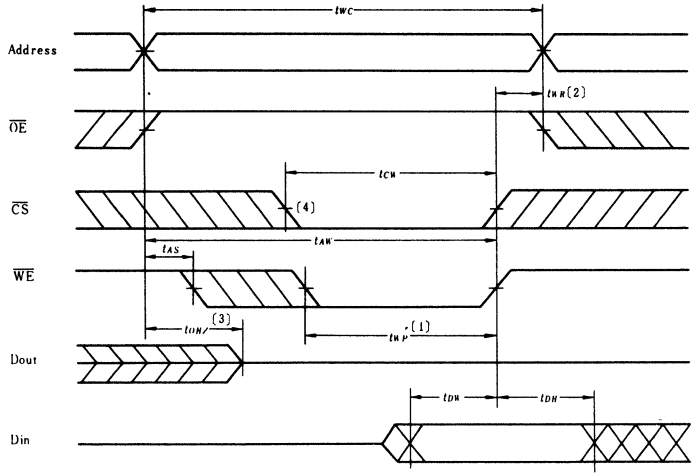


● READ CYCLE (3)[1,3,4]

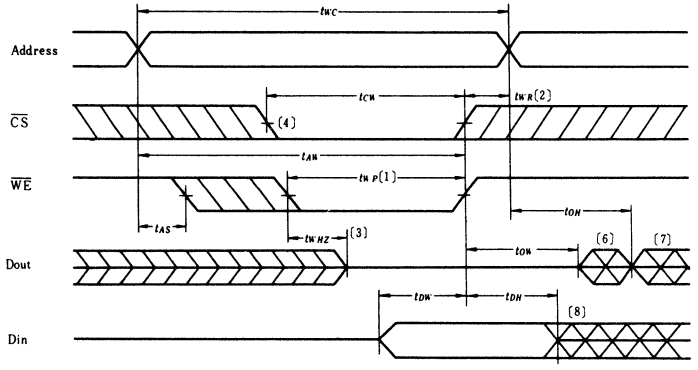


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

WRITE CYCLE (1)



● WRITE CYCLE (2)[5]



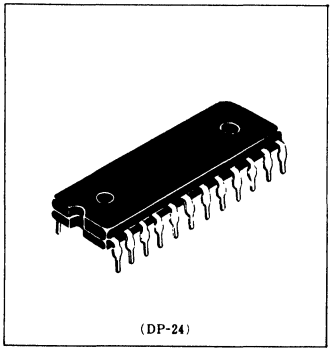
NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

HM6116PI-2, HM6116PI-3, HM6116PI-4 —Wide Operating Temperature Range—

2048-word×8-bit High Speed Static CMOS RAM

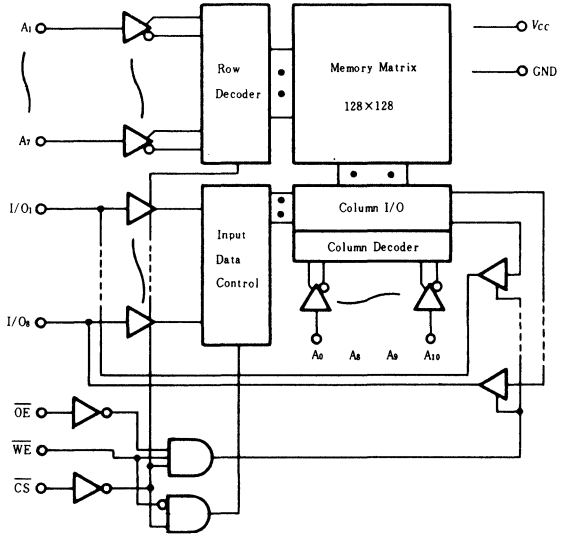
■FEATURES

- Wide Operating Temperature Range ..... −40~+85°C
- Single 5V Supply and High Density 24 Pin Package
- High speed: Fast Access Time 120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation Standby: 100μW (typ.) Operation: 180mW (typ.)
- Completely Static RAM: No clock or Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time

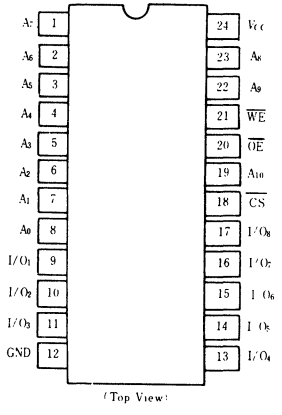


(DP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	−40 to +85	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5V

■TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■RECOMMENDED DC OPERATING CONDITIONS (Ta=−40 to +85°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min=−0.3V

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, GND=0V, Ta=−40 to +85°C)

Item	Symbol	Test Conditions	min	typ*	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	10	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CS}$=V_{IH} or $\overline{OE}$=V_{IH}, $V_{I/O}$=GND to V_{CC}	—	—	10	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}$=V_{IL}, $I_{I/O}$=0mA	—	35	90	mA
	I_{CC1}**	V_{IH}=3.5V, V_{IL}=0.6V, $I_{I/O}$=0mA	—	30	—	mA
Average Operating Current	I_{CC2}	Min. cycle, duty=100%	—	35	90	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}$=V_{IH}	—	4	20	mA
	I_{SB1}	$\overline{CS}$≧V_{CC}−0.2V, V_{in}≧V_{CC} −0.2V or V_{in}≦0.2V	—	0.02	2	mA
Output Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	V

* V_{CC}=5V, Ta=25°C
** Reference Only

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=-40 to +85°C)

●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6116PI-2		HM6116PI-3		HM6116PI-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	10	—	10	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	10	—	10	—	ns

● WRITE CYCLE

Item	Symbol	HM6116PI-2		HM6116PI-3		HM6116PI-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

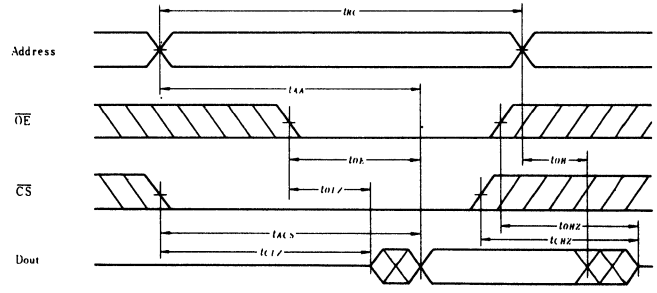
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

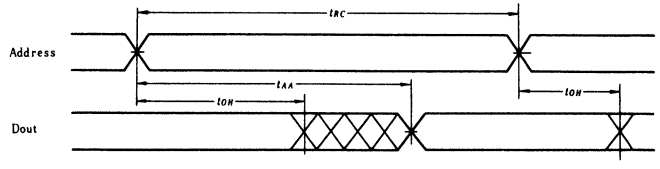
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

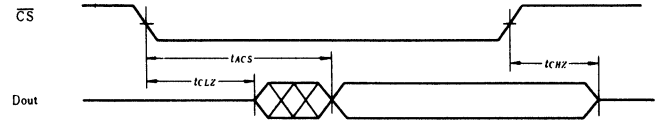
● READ CYCLE (1)[1]



● READ CYCLE (2)[1][2][4]

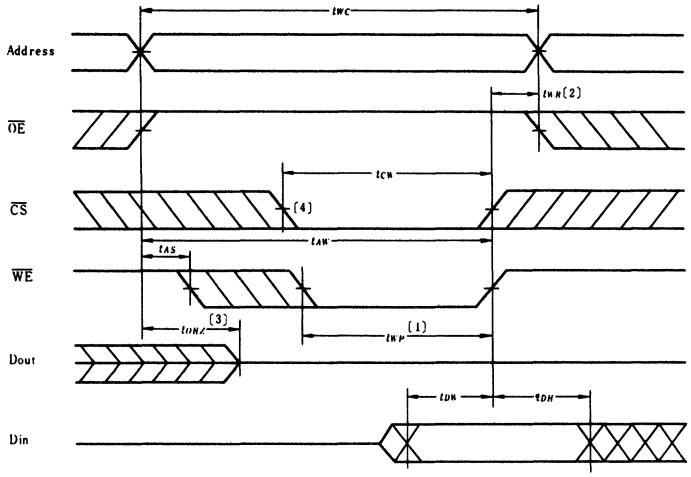


● READ CYCLE (3)[1][3][4]

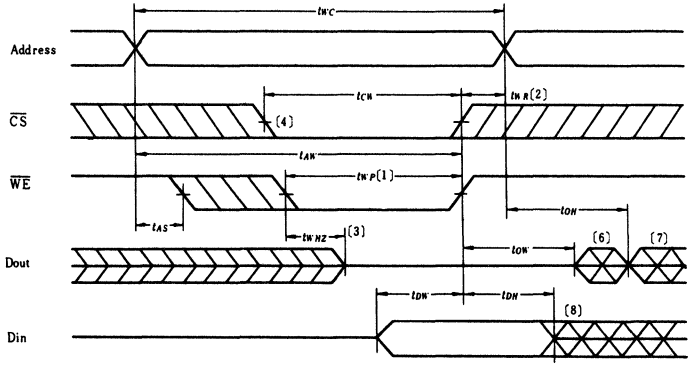


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

WRITE CYCLE (1)



● WRITE CYCLE (2) (5)



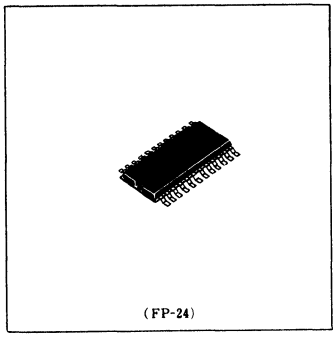
NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

HM6116FP-2, HM6116FP-3, HM6116FP-4

2048-word×8-bit High Speed Static CMOS RAM

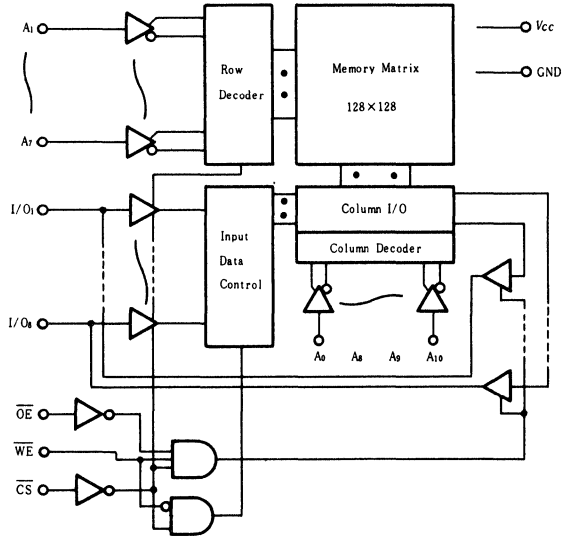
■FEATURES

- High Density Small-Sized Package
- Projection Area Redueced to One-Thirds of Conventional DIP
- Thickness Reduced to a Half of Conventional DIP
- Single 5V Supply
- High Speed: Fast Access Time 120ns/150ns/200ns (max.)
- Low Power Standby Standby: 100μW (typ.)
- Low Power Operation; Operation: 180mW (typ.)
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Equal Access and Cycle Time

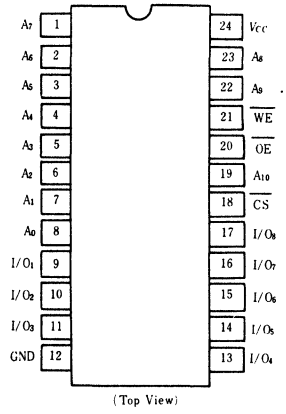


(FP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C
Power Dissipation	P_T	1.0	W

* V_{IN} min = −1.5V (Pulse Width ≦ 50ns)

■TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle(1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle(1)
L	L	L	Write	I_{CC}	Din	Write Cycle(2)

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min=−0.3V

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Conditions	HM6116FP-2			HM6116FP-3/-4			Unit
			min	typ*	max	min	typ*	max	
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	10	—	—	10	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}=V_{IH}$ or $\overline{OE}=V_{IH}$ $V_{I/O}$=GND to V_{CC}	—	—	10	—	—	10	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, $I_{I/O}$=0mA	—	40	80	—	35	70	mA
	I_{CC1}**	V_{IH}=3.5V, V_{IL}=0.6V, $I_{I/O}$=0mA	—	35	—	—	30	—	mA
Average Operating Current	I_{CC2}	Min. cycle, duty=100%	—	40	80	—	35	70	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	5	15	—	5	15	mA
	I_{SB1}	$\overline{CS}\geqq V_{CC}-0.2V$, $V_{in}\geqq V_{CC}$ −0.2V or $V_{in}\leqq 0.2V$	—	0.02	2	—	0.02	2	mA
Output Voltage	V_{OL}	I_{OL}=4mA	—	—	0.4	—	—	—	V
		I_{OL}=2.1mA	—	—	—	—	—	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	2.4	—	—	V

* V_{CC}=5V, Ta=25°C
** Reference Only

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0 to +70°C)

●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6116FP-2		HM6116FP-3		HM6116FP-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	15	—	15	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	15	—	15	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	15	—	15	—	ns

● WRITE CYCLE

Item	Symbol	HM6116FP-2		HM6116FP-3		HM6116FP-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

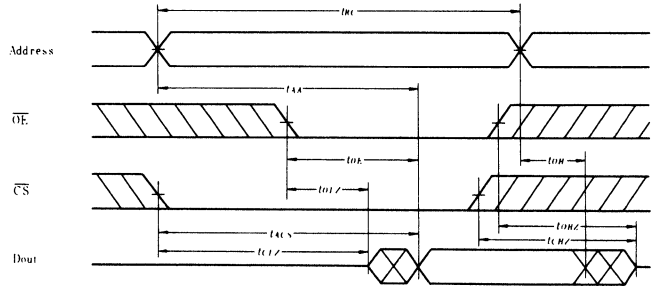
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

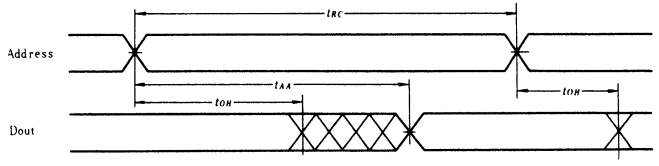
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

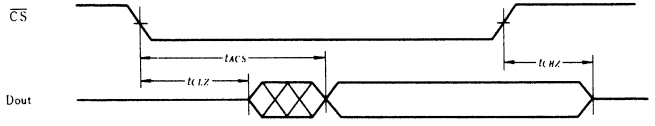
● READ CYCLE (1)[1]



● READ CYCLE (2)[1][2][4]



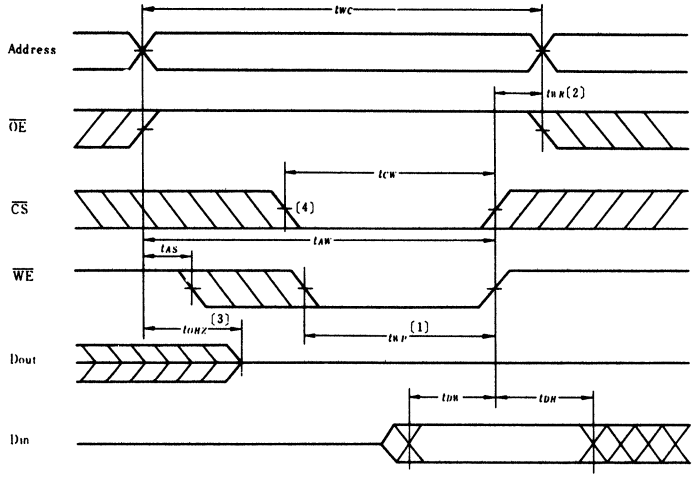
● READ CYCLE (3)[1][3][4]



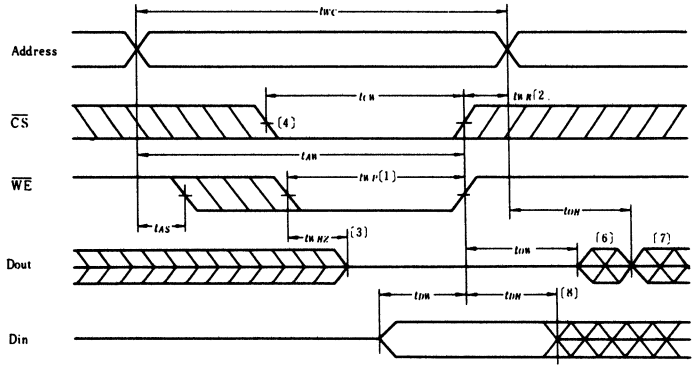
NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

■TIMING WAVEFORM

● WRITE CYCLE (1)[1]

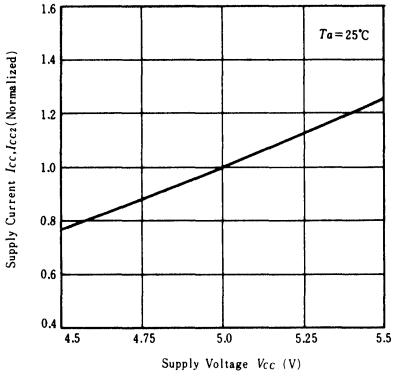


● WRITE CYCLE (2)[5]

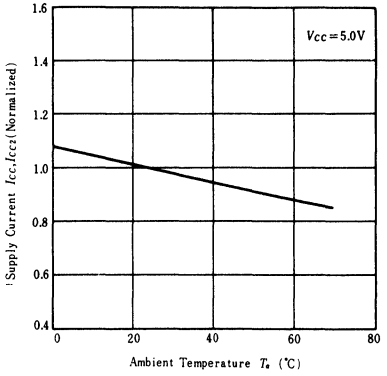


NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

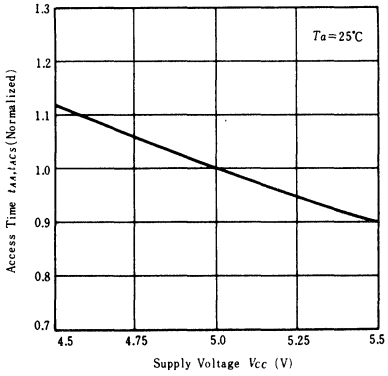
SUPPLY CURRENT vs. SUPPLY VOLTAGE



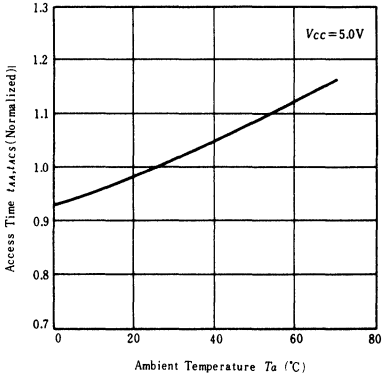
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



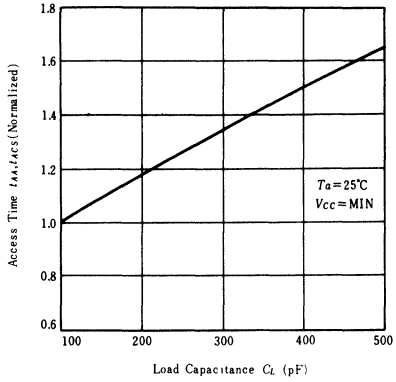
ACCESS TIME vs. SUPPLY VOLTAGE



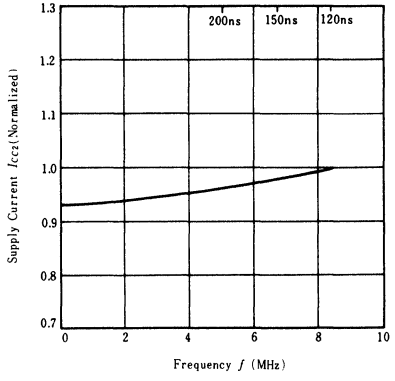
ACCESS TIME vs. AMBIENT TEMPERATURE



ACCESS TIME vs. LOAD CAPACITANCE



SUPPLY CURRENT vs. FREQUENCY



HM6116CG-2, HM6116CG-3, HM6116CG-4

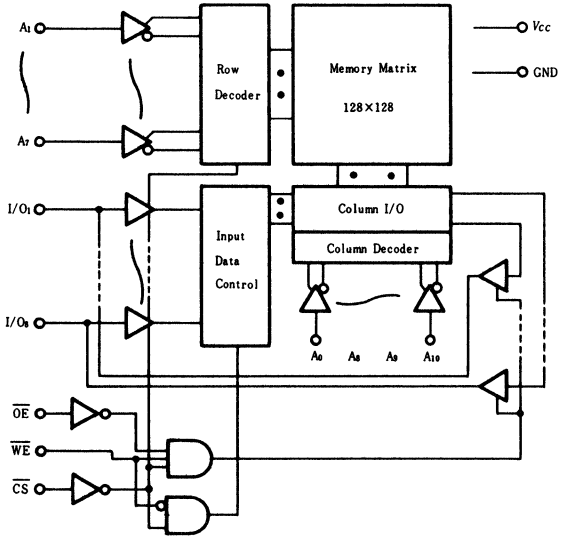
2048-word×8-bit High Speed Static CMOS RAM

■FEATURES

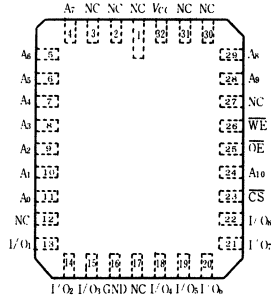
- Single 5V Supply and High Density 32 pin-Leadless-Chip Carrier
- High speed. Fast Access Time 120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation — Standby: 100μW (typ.), Operation: 180mW (typ.)
- Completely Static RAM: No Clock or Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Equal Access and Cycle Time

(CG-32)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5V

■TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min=−0.3V

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Conditions	HM6116CG-2			HM6116CG-3/-4			Unit
			min	typ*	max	min	typ*	max	
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	10	—	—	10	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}=V_{IH}$ or $\overline{OE}=V_{IH}$, $V_{I/O}$=GND to V_{CC}	—	—	10	—	—	10	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, $I_{I/O}$=0mA	—	40	80	—	35	70	mA
	I_{CC1}**	V_{IH}=3.5V, V_{IL}=0.6V, $I_{I/O}$=0mA	—	35	—	—	30	—	mA
Average Operating Current	I_{CC2}	Min. cycle, duty=100%	—	40	80	—	35	70	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	5	15	—	5	15	mA
	I_{SB1}	$\overline{CS}\geqq V_{CC}-0.2V$, $V_{in}\geqq V_{CC}-0.2V$ or $V_{in}\leqq 0.2V$	—	0.02	2	—	0.02	2	mA
Output Voltage	V_{OL}	I_{OL}=4mA	—	—	0.4	—	—	—	V
		I_{OL}=2.1mA	—	—	—	—	—	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	2.4	—	—	V

* V_{CC}=5V, Ta=25°C
** Reference Only

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0 to +70°C)

●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6116CG-2		HM6116CG-3		HM6116CG-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	15	—	15	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	15	—	15	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	15	—	15	—	ns

● WRITE CYCLE

Item	Symbol	HM6116CG-2		HM6116CG-3		HM6116CG-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

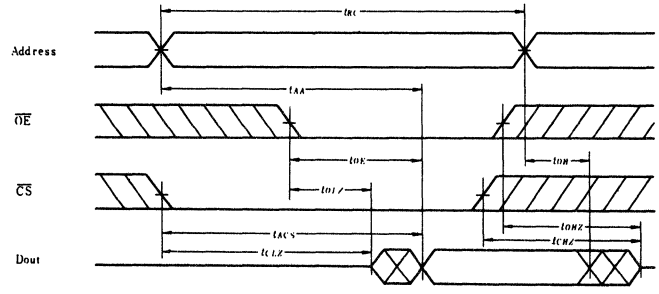
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

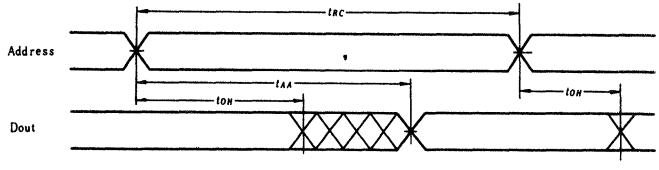
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

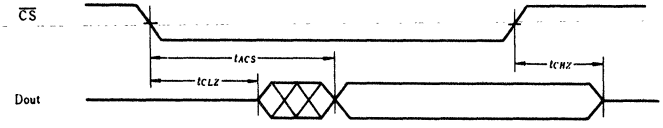
● READ CYCLE (1)[1]



● READ CYCLE (2)[1][2][4]

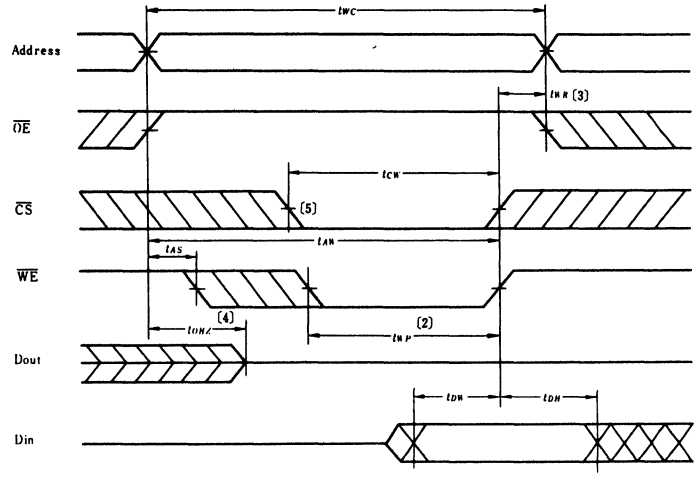


● READ CYCLE (3)[1][3][4]

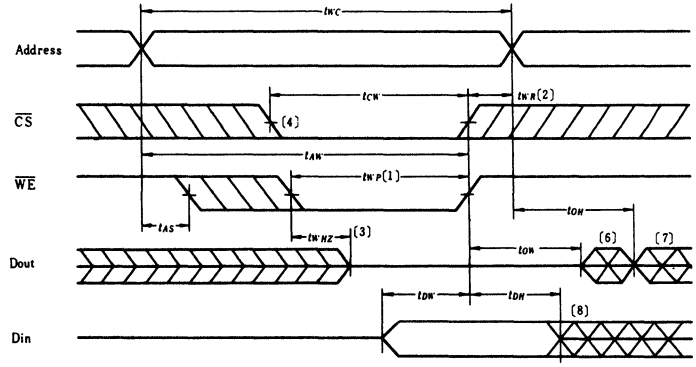


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

WRITE CYCLE (1) [1]



● WRITE CYCLE (2) [5]



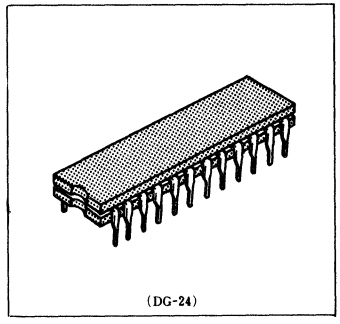
NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

HM6116L-2, HM6116L-3, HM6116L-4

2048-word×8-bit High Speed Static CMOS RAM

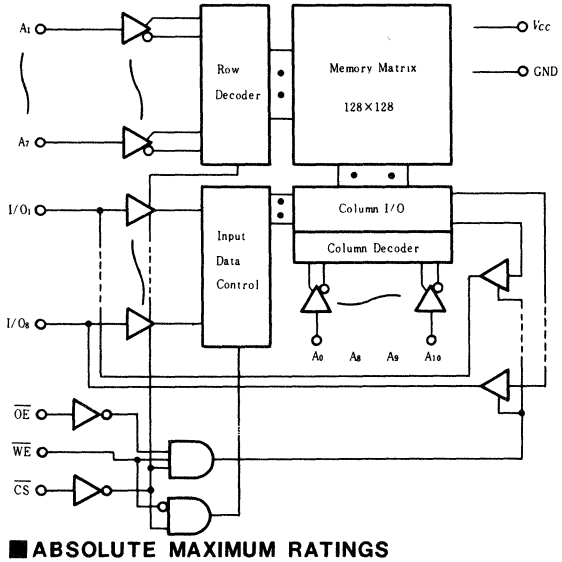
■ FEATURES

- Single 5V Supply and High Density 24 Pin Package
- High Speed: Fast Access Time 120ns/150ns/200ns (max.)
  Low Power Standby and Standby: 20μW (typ.)
- Low Power Operation; Operation: 160mW (typ.)
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time
- Capability of Battery Back up Operation

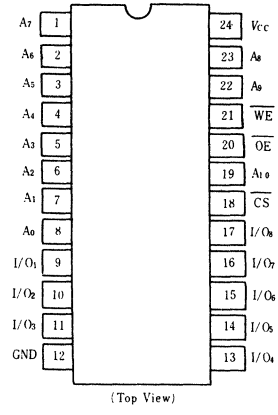


(DG-24)

■ FUNCTIONAL BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5V

■ TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min = −0.3V

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V ±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Conditions	HM6116L/P-2			HM6116L/P-3/-4			Unit
			min	typ*	max	min	typ*	max	
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	2	—	—	2	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}=V_{IH}$ or $\overline{OE}=V_{IH}$, $V_{I/O}$=GND to V_{CC}	—	—	2	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, $I_{I/O}$=0mA	—	35	70	—	30	60	mA
	I_{CC1}**	V_{IH}=3.5V, V_{IL}=0.6V, $I_{I/O}$=0mA	—	30	—	—	25	—	mA
Average Operating Current	I_{CC2}	min. cycle, duty=100%	—	35	70	—	30	60	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	4	12	—	4	12	mA
	I_{SB1}	$\overline{CS}\geqq V_{CC}-0.2V$, $V_{in}\geqq V_{CC}-0.2V$ or $V_{in}\leqq 0.2V$	—	4	100	—	4	100	μA
Output Voltage	V_{OL}	I_{OL}=4mA	—	—	0.4	—	—	—	V
		I_{OL}=2.1mA	—	—	—	—	—	0.4	
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	2.4	—	—	V

* : V_{CC}=5V, Ta=25°C
** : Reference Only

■AC CHARACTERISTICS (V_{CC}=5V ±10%, Ta=0 to +70°C)

●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6116L-2		HM6116L-3		HM6116L-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	15	—	15	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	15	—	15	—	ns
Chip deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	15	—	15	—	ns

● WRITE CYCLE

Item	Symbol	HM6116L-2		HM6116L-3		HM6116L-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

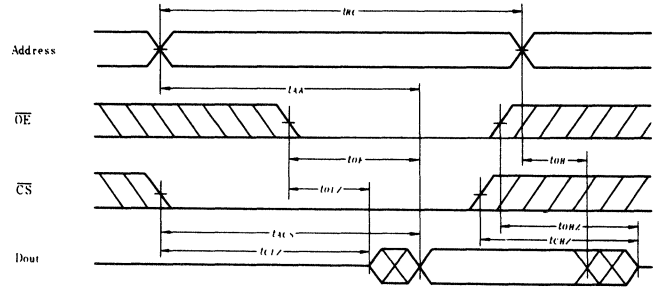
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

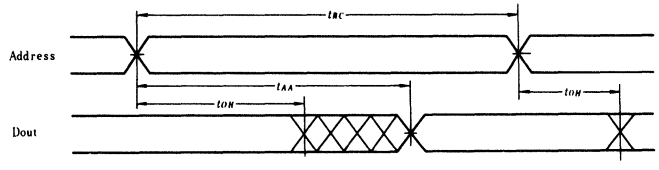
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

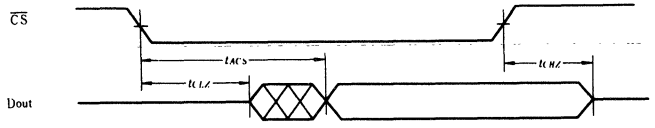
● Read Cycle (1) (1)



● Read Cycle (2) (1), (2), (4)

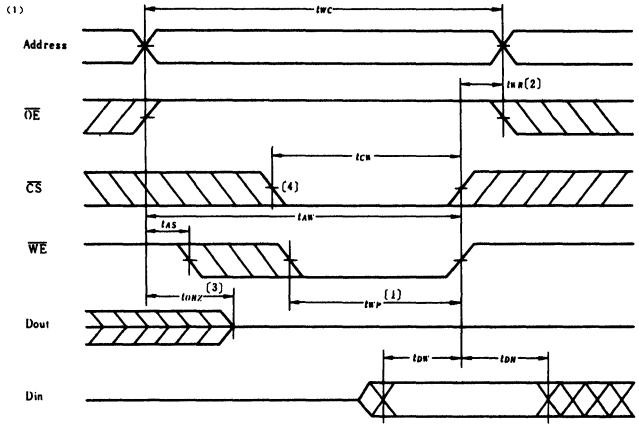


● Read Cycle (3) (1), (3), (4)

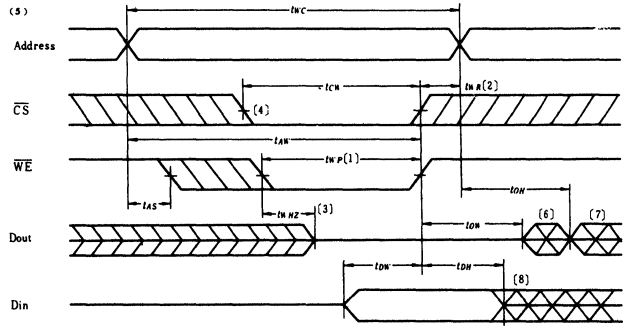


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

● **Write Cycle (1)**



● **Write Cycle (2)**



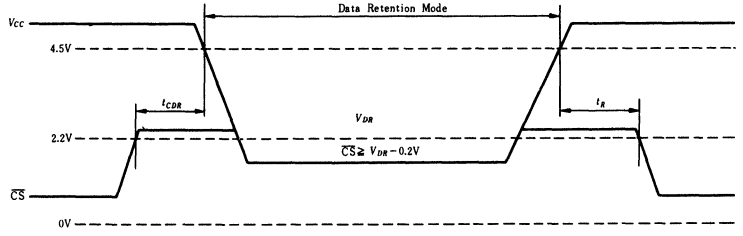
NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

■ LOW Vcc DATA RETENTION CHARACTERISTICS (Ta=0 to +70°C)

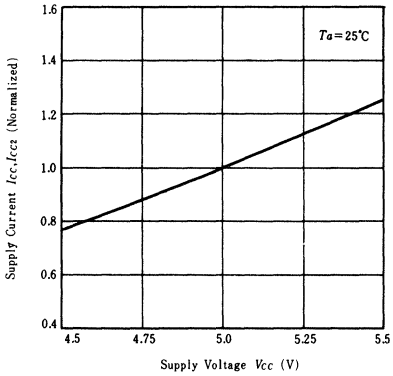
Item	Symbol	Test Conditions	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geq V_{CC}-0.2V$, $V_{in} \geq V_{CC}-0.2V$ or $V_{in} \leq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}*	V_{CC}=3.0V, $\overline{CS} \geq 2.8V$, $V_{in} \geq 2.8V$ or $V_{in} \leq 0.2V$	—	—	50	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}**	—	—	ns

* V_{IL}=−0.3V min.
** t_{RC}=Read Cycle Time.

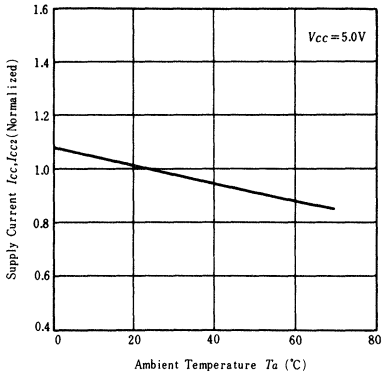
● **Low Vcc Data Retention Waveform**



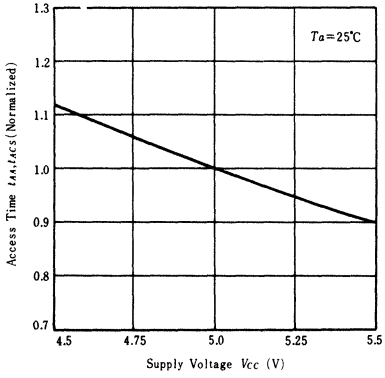
SUPPLY CURRENT vs. SUPPLY VOLTAGE



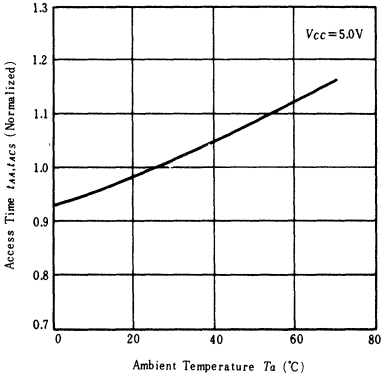
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



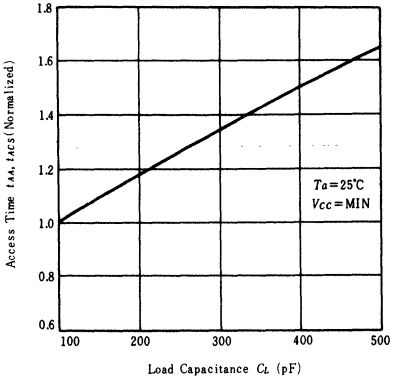
ACCESS TIME vs. SUPPLY VOLTAGE



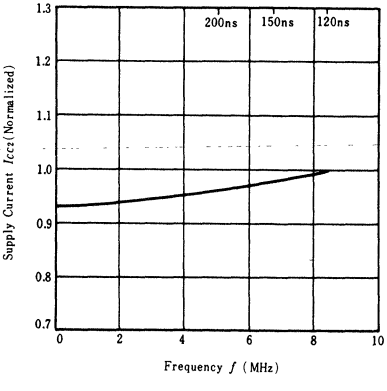
ACCESS TIME vs. AMBIENT TEMPERATURE



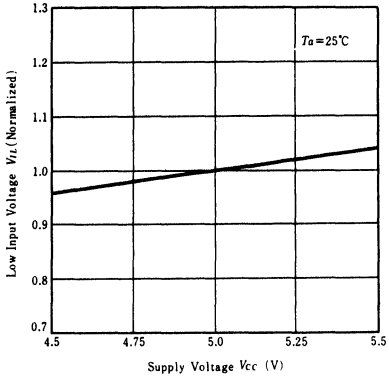
ACCESS TIME vs. LOAD CAPACITANCE



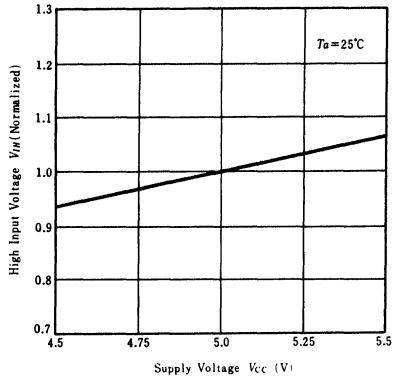
SUPPLY CURRENT vs. FREQUENCY



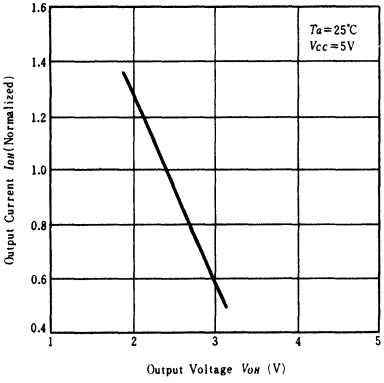
LOW INPUT VOLTAGE vs. SUPPLY VOLTAGE



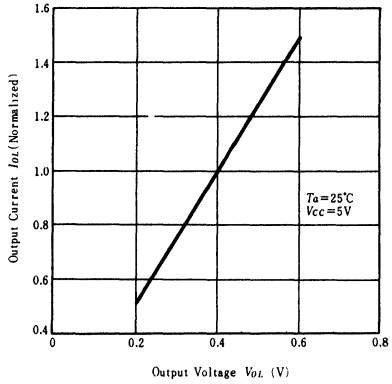
HIGH INPUT VOLTAGE vs. SUPPLY VOLTAGE



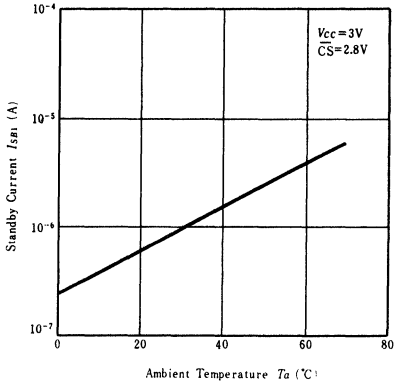
OUTPUT CURRENT vs. OUTPUT VOLTAGE



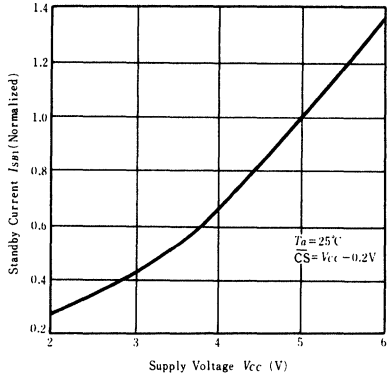
OUTPUT CURRENT vs. OUTPUT VOLTAGE



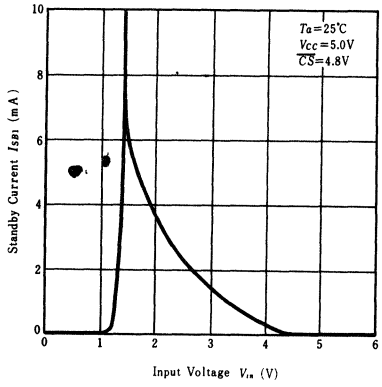
STANDBY CURRENT vs. AMBIENT TEMPERATURE



STANDBY CURRENT vs. SUPPLY VOLTAGE



STANDBY CURRENT vs. INPUT VOLTAGE

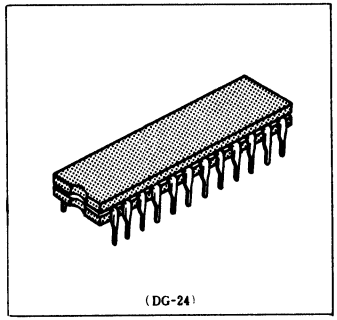


HM6116LI-2, HM6116LI-3, HM6116LI-4 —Wide Operating Temperature Range—

2048-word×8-bit High Speed Static CMOS RAM

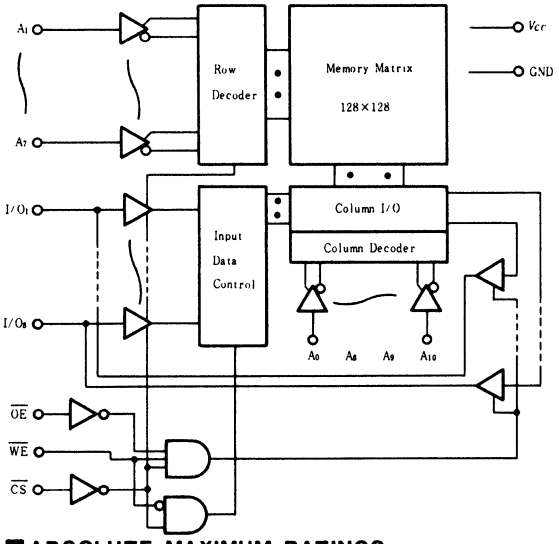
■FEATURES

- Wide Operating Temperature Range . . . . . −40~+85°C
- Single 5V Supply and High Density 24 Pin Package
- High Speed: Fast Access Time 120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation; Standby: 20μW (typ.) Operation: 160m W (typ.)
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time
- Capability of Battery Back up Operation

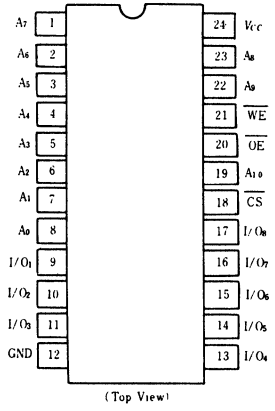


(DG-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	−40 to +85	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : − 1.5 V

■ TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■ RECOMMENDED DC OPERATING CONDITIONS ($Ta = -40$ to $+85°C$)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width: 50ns, DC: V_{IL} min = −0.3V

■ DC AND OPERATING CHARACTERISTICS ($V_{CC} = 5V \pm 10\%$, GND = 0V, $Ta = -40$ to $+85°C$)

Item	Symbol	Test Conditions	min	typ*	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{CC} = 5.5V, V_{in} = GND to V_{CC}	—	—	2	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CS} = V_{IH}$ or $\overline{OE} = V_{IH}$, $V_{I/O}$ = GND to V_{CC}	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS} = V_{IL}$, $I_{I/O}$ = 0mA	—	35	90	mA
	I_{CC1}**	V_{IH} = 3.5V, V_{IL} = 0.6V, $I_{I/O}$ = 0mA	—	30	—	mA
Average Operating Current	I_{CC2}	min. cycle, duty = 100%	—	35	90	mA
Standby Power Supply Current	I_{SB}	$\overline{CS} = V_{IH}$	—	4	20	mA
	I_{SB1}	$\overline{CS} \geqq V_{CC} - 0.2V$, $V_{in} \geqq V_{CC} - 0.2V$ or $V_{in} \leqq 0.2V$	—	4	200	μA
Output Voltage	V_{OL}	I_{OL} = 2.1mA	—	—	0.4	V
	V_{OH}	I_{OH} = −1.0mA	2.4	—	—	V

* : V_{CC} = 5V, Ta = 25°C ** : Reference Only

■ AC CHARACTERISTICS ($V_{CC} = 5V \pm 10\%$, $Ta = -40$ to $+85°C$)

● AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

● READ CYCLE

Item	Symbol	HM6116LI-2		HM6116LI-3		HM6116LI-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	10	—	10	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	10	—	10	—	ns
Chip deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	10	—	10	—	ns

● WRITE CYCLE

Item	Symbol	HM6116LI-2		HM6116LI-3		HM6116LI-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

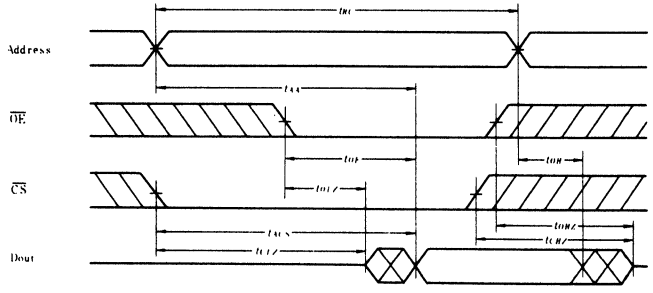
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

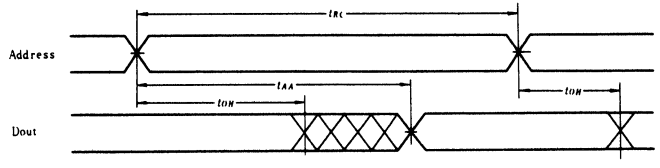
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

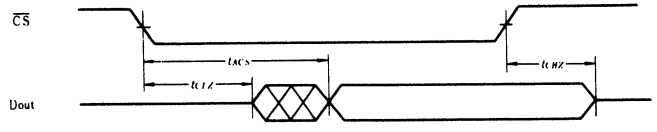
● Read Cycle (1) (1), (5)



● Read Cycle (2) (1), (2), (4)

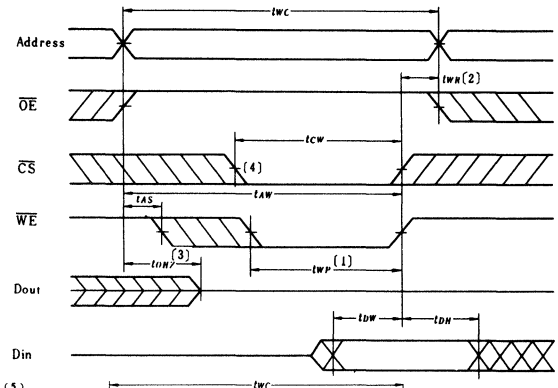


● Read Cycle (3) (1), (3), (4)

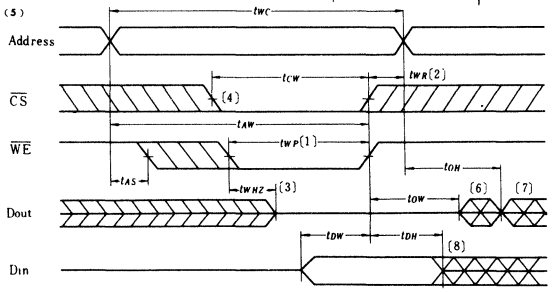


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

● **Write Cycle (1)**



● **Write Cycle (2)**



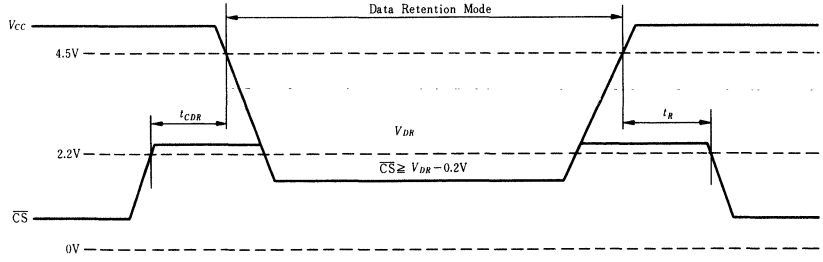
NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE}$ = V_{IL})
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

■ LOW Vcc DATA RETENTION CHARACTERISTICS (Ta = −40 to +85°C)

Item	Symbol	Test Conditions	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geq V_{CC} - 0.2V$, $V_{in} \geq V_{CC} - 0.2V$ or $V_{in} \leq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}*	V_{CC} = 3.0V, $\overline{CS} \geq 2.8V$, $V_{in} \geq 2.8V$ or $-0.3V \leq V_{in} \leq 0.2V$	—	—	100	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}**	—	—	ns

* V_{IL} = −0.3V min. ** t_{RC} = Read Cycle Time.

● **Low Vcc Data Retention Waveform**

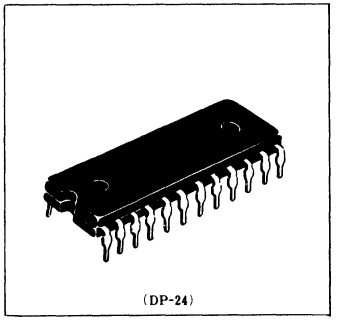


HM6116LP-2, HM6116LP-3, HM6116LP-4

2048-word×8-bit High Speed Static CMOS RAM

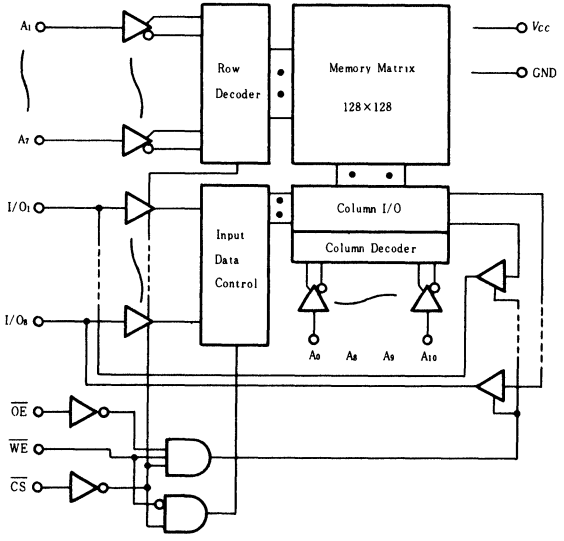
■FEATURES

- Single 5V Supply and High Density 24 Pin Package
- High Speed: Fast Access Time 120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation; Standby: 10μW (typ.) Operation: 160mW (typ.)
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time
- Capability of Battery Back up Operation

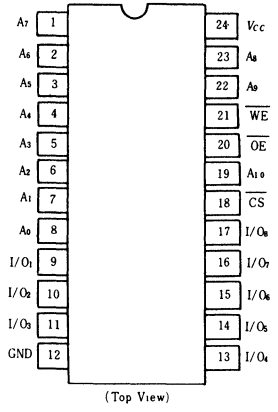


(DP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5V

■TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■ RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width: 50ns, DC: V_{IL} min = −0.3V

■ DC AND OPERATING CHARACTERISTICS (V_{CC}=5V ±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Conditions	HM6116LP-2			HM6116LP-3/-4			Unit
			min	typ*	max	min	typ*	max	
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	2	—	—	2	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}=V_{IH}$ or $\overline{OE}=V_{IH}$, $V_{I/O}$=GND to V_{CC}	—	—	2	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, $I_{I/O}$=0mA	—	35	70	—	30	60	mA
	I_{CC1}**	V_{IH}=3.5V, V_{IL}=0.6V, $I_{I/O}$=0mA	—	30	—	—	25	—	mA
Average Operating Current	I_{CC2}	min. cycle, duty=100%	—	35	70	—	30	60	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	4	12	—	4	12	mA
	I_{SB1}	$\overline{CS}\geq V_{CC}-0.2V$, $V_{in}\geq V_{CC}-0.2V$ or $V_{in}\leq 0.2V$	—	2	50	—	2	50	μA
Output Voltage	V_{OL}	I_{OL}=4mA	—	—	0.4	—	—	—	V
		I_{OL}=2.1mA	—	—	—	—	—	0.4	
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	2.4	—	—	V

* : V_{CC}=5V, Ta=25°C
** : Reference Only

■ AC CHARACTERISTICS (V_{CC}=5V ±10%, Ta=0 to +70°C)

● AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

● READ CYCLE

Item	Symbol	HM6116LP-2		HM6116LP-3		HM6116LP-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	15	—	15	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	15	—	15	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	15	—	15	—	ns

● WRITE CYCLE

Item	Symbol	HM6116LP-2		HM6116LP-3		HM6116LP-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

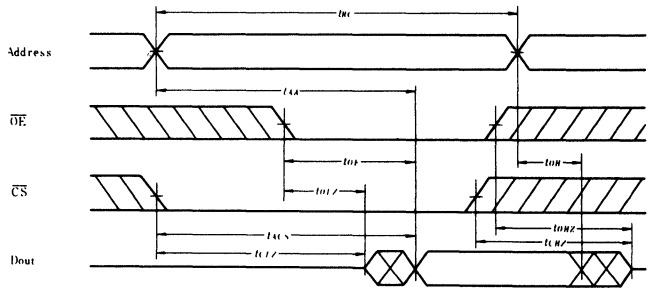
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

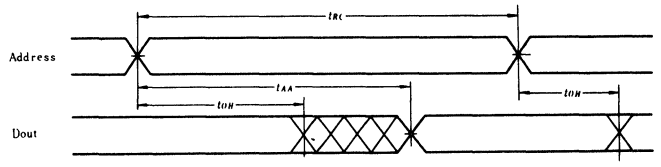
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

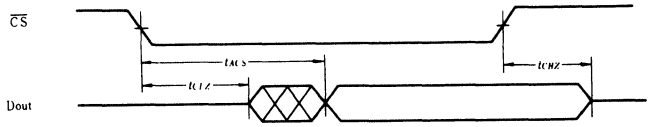
● Read Cycle (1) (1)



● Read Cycle (2) (1), (2), (4)

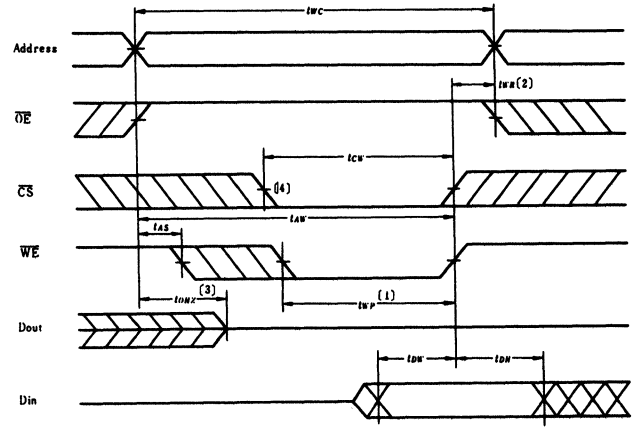


● Read Cycle (3) (1), (3), (4)

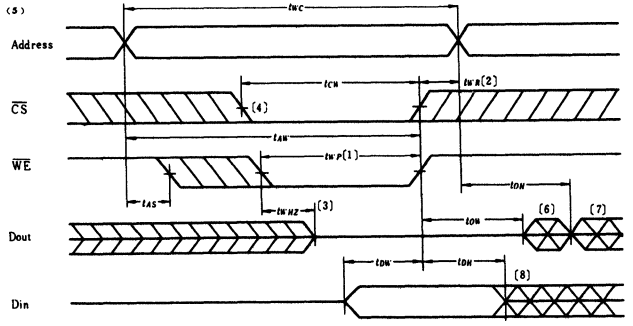


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

● **Write Cycle (1)**



● **Write Cycle (2)**



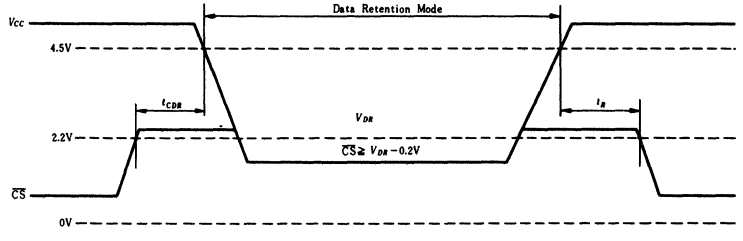
NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE}$ = V_{IL})
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

■ LOW Vcc DATA RETENTION CHARACTERISTICS (Ta=0 to +70°C)

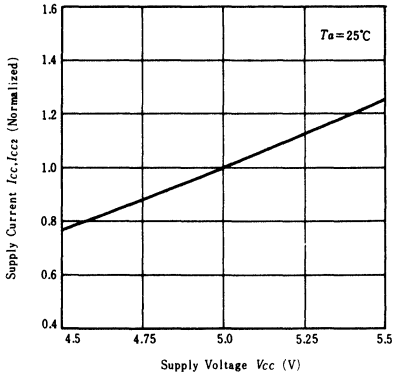
Item	Symbol	Test Conditions	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geq V_{CC}$ −0.2V, $V_{in} \geq V_{CC}$ −0.2V or $V_{in} \leq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}*	V_{CC}=3.0V, $\overline{CS} \geq 2.8V$, $V_{in} \geq 2.8V$ or $V_{in} \leq 0.2V$	—	—	30	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}**	—	—	ns

* 10 μA max at Ta=0°C to +40°C, V_{IL} min = −0.3V
** t_{RC} = Read Cycle Time.

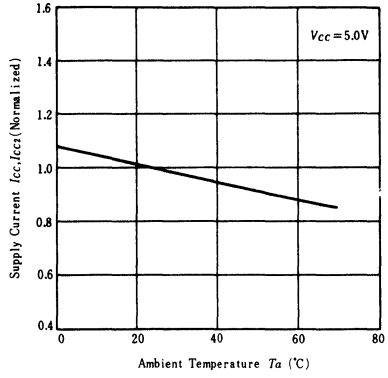
● **Low Vcc Data Retention Waveform**



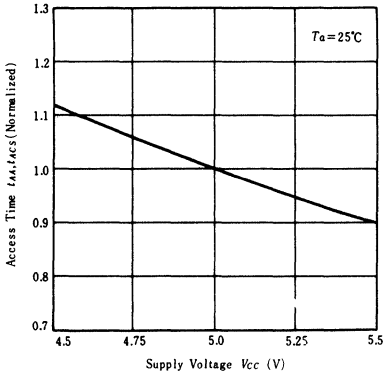
SUPPLY CURRENT vs. SUPPLY VOLTAGE



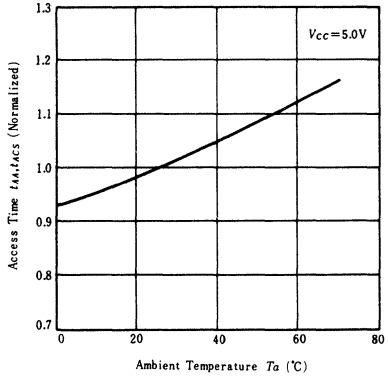
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



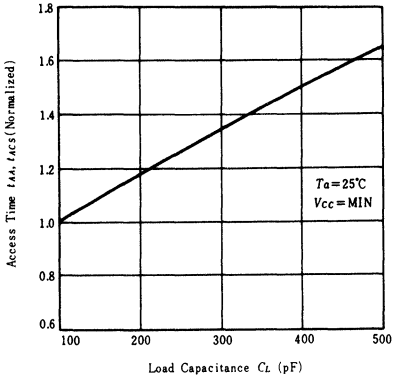
ACCESS TIME vs. SUPPLY VOLTAGE



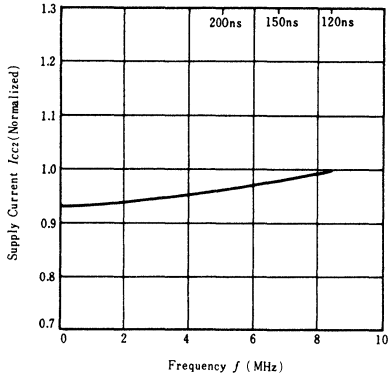
ACCESS TIME vs. AMBIENT TEMPERATURE



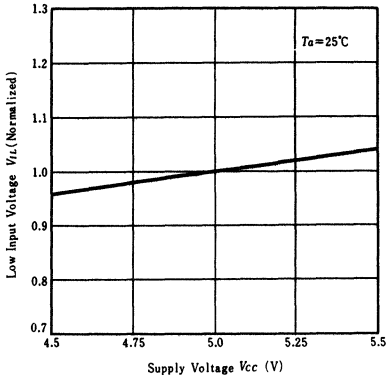
ACCESS TIME vs. LOAD CAPACITANCE



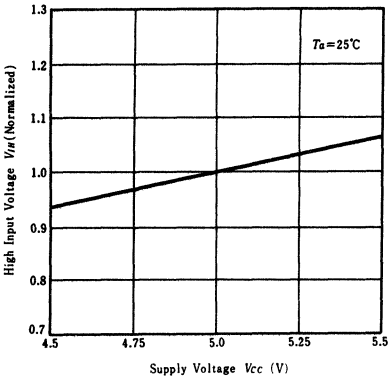
SUPPLY CURRENT vs. FREQUENCY



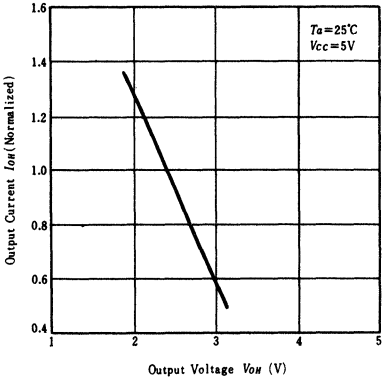
LOW INPUT VOLTAGE vs. SUPPLY VOLTAGE



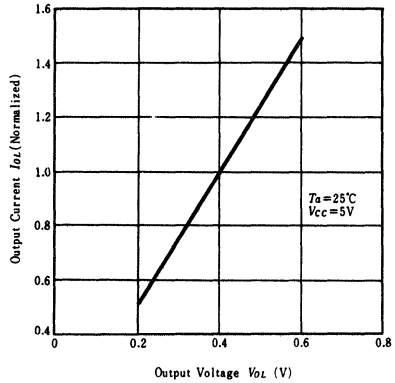
HIGH INPUT VOLTAGE vs. SUPPLY VOLTAGE



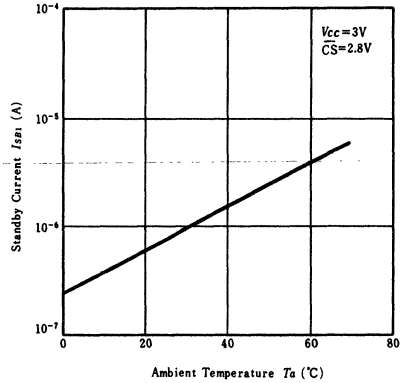
OUTPUT CURRENT vs. OUTPUT VOLTAGE



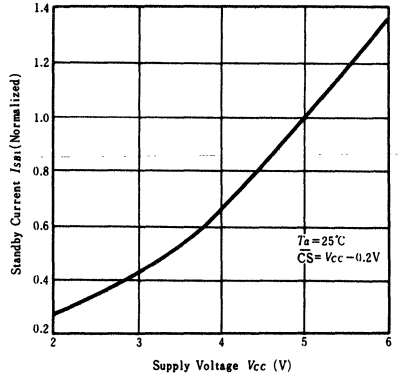
OUTPUT CURRENT vs. OUTPUT VOLTAGE



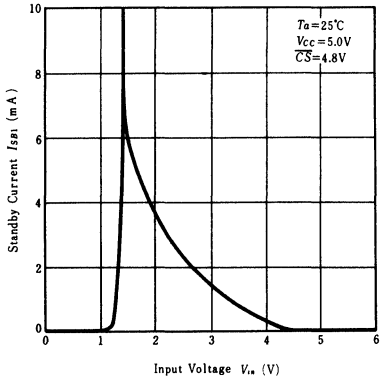
STANDBY CURRENT vs. AMBIENT TEMPERATURE



STANDBY CURRENT vs. SUPPLY VOLTAGE



STANDBY CURRENT vs. INPUT VOLTAGE

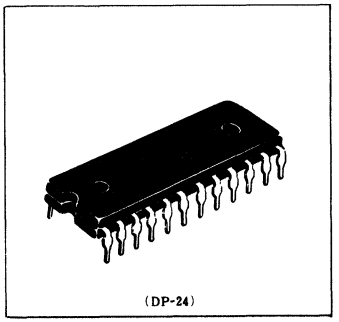


HM6116LPI-2, HM6116LPI-3, HM6116LPI-4 —Wide Operating Temperature Range—

2048-word×8-bit High Speed Static CMOS RAM

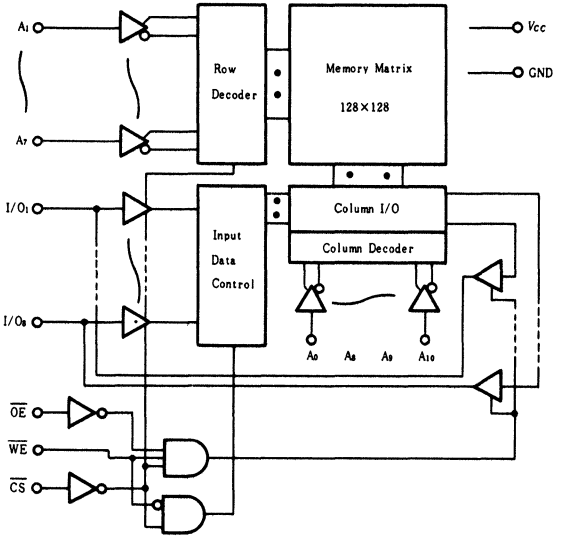
■FEATURES

- Wide Operating Temperature Range . . . . . −40~+85°C
- Single 5V Supply and High Density 24 Pin Package
- High Speed: Fast Access Time 120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation; Standby: 10μW (typ.) Operation: 160mW (typ.)
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time
- Capability of Battery Back up Operation

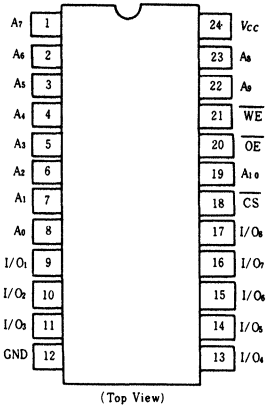


(DP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	−40 to +85	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5V

■ TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■ RECOMMENDED DC OPERATING CONDITIONS ($Ta = -40$ to $+85°C$)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min = −0.3V

■ DC AND OPERATING CHARACTERISTICS ($V_{CC} = 5V \pm 10\%$, GND = 0V, $Ta = -40$ to $+85°C$)

Item	Symbol	Test Conditions	min	typ*	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	$V_{CC} = 5.5V$, $V_{in} = GND$ to V_{CC}	—	—	2	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CS} = V_{IH}$ or $\overline{OE} = V_{IH}$, $V_{I/O} = GND$ to V_{CC}	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS} = V_{IL}$, $I_{I/O} = 0mA$	—	35	90	mA
	I_{CC1}**	$V_{IH} = 3.5V$, $V_{IL} = 0.6V$, $I_{I/O} = 0mA$	—	30	—	mA
Average Operating Current	I_{CC2}	min. cycle, duty = 100%	—	35	90	mA
Standby Power Supply Current	I_{SB}	$\overline{CS} = V_{IH}$	—	4	20	mA
	I_{SB1}	$\overline{CS} \geq V_{CC} - 0.2V$, $V_{in} \geq V_{CC} - 0.2V$ or $V_{in} \leq 0.2V$	—	2	100	μA
Output Voltage	V_{OL}	$I_{OL} = 2.1mA$	—	—	0.4	V
	V_{OH}	$I_{OH} = -1.0mA$	2.4	—	—	V

* : $V_{CC} = 5V$, $Ta = 25°C$
** : Reference Only

■ AC CHARACTERISTICS ($V_{CC} = 5V \pm 10\%$, $Ta = -40$ to $+85°C$)

● AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

● READ CYCLE

Item	Symbol	HM6116LPI-2		HM6116LPI-3		HM6116LPI-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	10	—	10	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	10	—	10	—	ns

● WRITE CYCLE

Item	Symbol	HM6116LPI-2		HM6116LPI-3		HM6116LPI-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

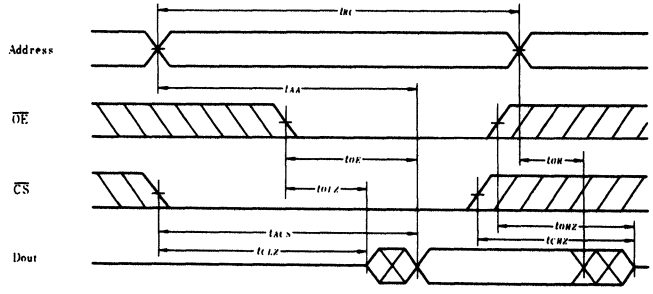
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

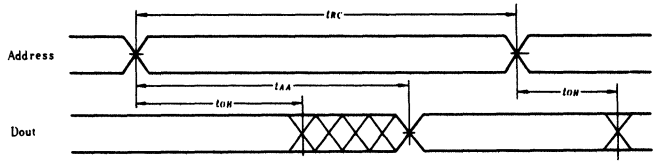
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

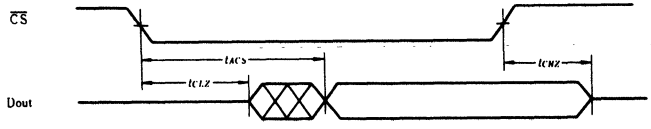
● Read Cycle (1) (1)



● Read Cycle (2) (1), (2), (4)

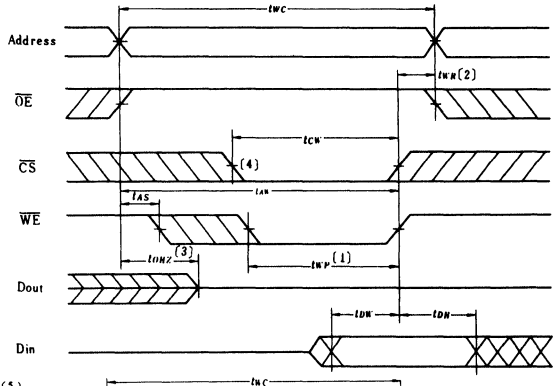


● Read Cycle (3) (1), (3), (4)

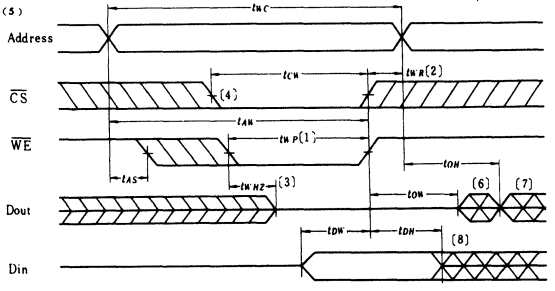


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

● **Write Cycle (1)**



● **Write Cycle (2)**



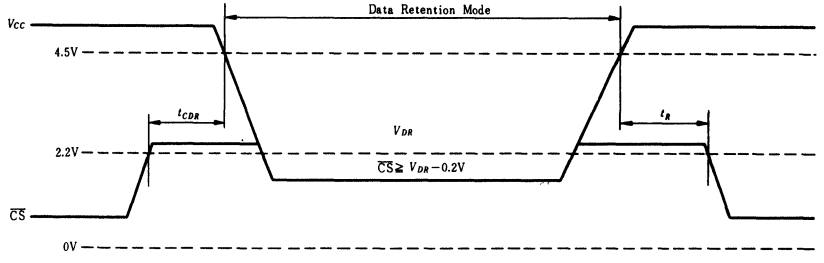
NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

■ LOW Vcc DATA RETENTION CHARACTERISTICS ($Ta = -40$ to $+85°C$)

Item	Symbol	Test Conditions	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geq V_{CC} - 0.2V$, $V_{in} \geq V_{CC} - 0.2V$ or $V_{in} \leq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}*	$V_{CC} = 3.0V$, $\overline{CS} \geq 2.8V$, $V_{in} \geq 2.8V$ or $-0.3V \leq V_{in} \leq 0.2V$	—	—	50	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}**	—	—	ns

* 10 μA max at $Ta = -40°C$ to $+40°C$ V_{IL} min $= -0.3V$
** t_{RC} = Read Cycle Time.

● **Low Vcc Data Retention Waveform**

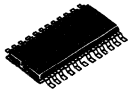


HM6116LFP-2, HM6116LFP-3, HM6116LFP-4

2048-word×8-bit High Speed Static CMOS RAM

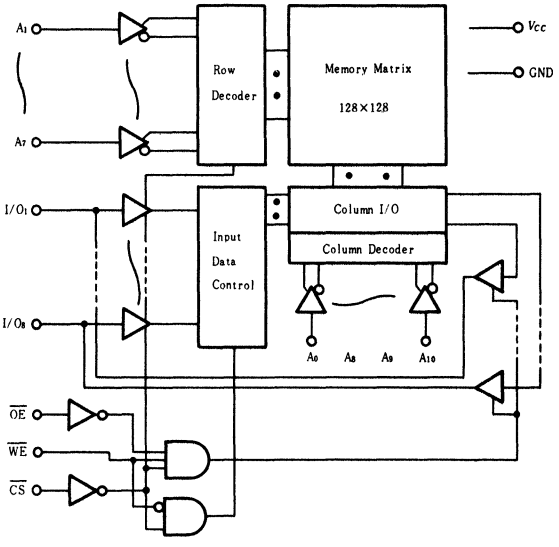
■FEATURES

- High Density Small-sized Package
- Projection Area Reduced to One-Thirds of Conventional DIP
- Thickness Reduced to a Half of Conventional DIP
- Single 5V Supply
- High Speed: Fast Access Time — 120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation; — Standby: 10μW (typ.), Operation: 160mW (typ.)
- Completely Static RAM: No Clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Equal Access and Cycle Time
- Capability of Battery Back up Operation

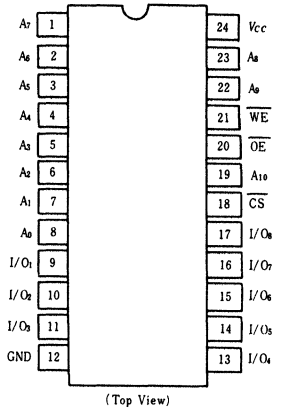


(FP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C
Power Dissipation	P_T	1.0	W

* V_{IN} min = −1.5V (Pulse Width ≦ 50ns)

■TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
.Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min= −0.3V.

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Conditions	HM6116LFP-2			HM6116LFP-3/-4			Unit
			min	typ*	max	min	typ*	max	
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	2	—	—	2	μA
Output Leakage Currnnt	$\lvert I_{LO} \rvert$	$\overline{CS}=V_{IH}$ or $\overline{OE}=V_{IH}$, $V_{I/O}$=GND to V_{CC}	—	—	2	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, $I_{I/O}$=0mA	—	35	70	—	30	60	mA
	I_{CC1}**	V_{IH}=3.5V, V_{IL}=0.6V, $I_{I/O}$=0mA	—	30	—	—	25	—	mA
Average Operating Current	I_{CC2}	Min cycle, duty=100%	—	35	70	—	30	60	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	4	12	—	4	12	mA
	I_{SB1}	$\overline{CS}\geqq V_{CC}-0.2V$, $V_{in}\geqq V_{CC}-0.2V$ or $V_{in}\leqq 0.2V$	—	2	50	—	2	50	μA
Output Voltage	V_{OL}	I_{OL}=4mA	—	—	0.4	—	—	—	V
		I_{OL}=2.1mA	—	—	—	—	—	0.4	
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	2.4	—	—	V

* : V_{CC}=5V, Ta=25°C
** : Reference Only

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0 to +70°C)

●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6116LFP-2		HM6116LFP-3		HM6116LFP-4		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	15	—	15	—	ns
Output Enable to Output Valid	t_{OE}	—	80	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	15	—	15	—	ns
Chip deselection to Output in High Z	t_{CHZ}	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	15	—	15	—	ns

●WRITE CYCLE

Item	Symbol	HM6116LFP-2		HM6116LFP-3		HM6116LFP-4		Unit
		min	max	min	max	min	max	
Write Cycle Time	t_{WC}	120	—	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	70	—	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	105	—	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	20	—	ns
Write Pulse Width	t_{WP}	70	—	90	—	120	—	ns
Write Recovery Time	t_{WR}	5	—	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	50	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	35	—	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	5	—	10	—	10	—	ns
Output Active from End of Write	t_{OW}	5	—	10	—	10	—	ns

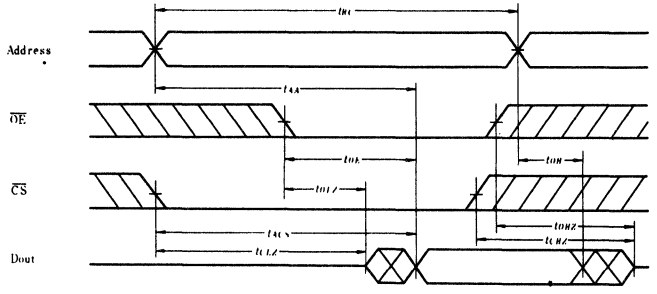
■CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	Cin	Vin=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

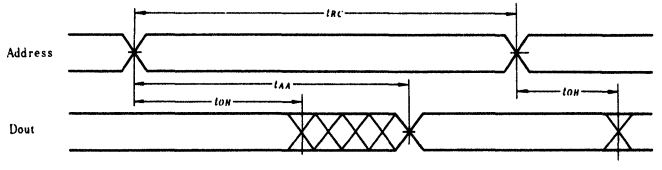
Note) This parameter is sampled and not 100% tested.

■TIMING WAVEFORM

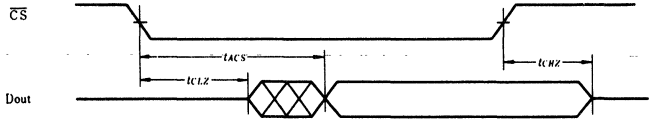
●READ CYCLE (1)[1]



●READ CYCLE (3)[1][3][4]

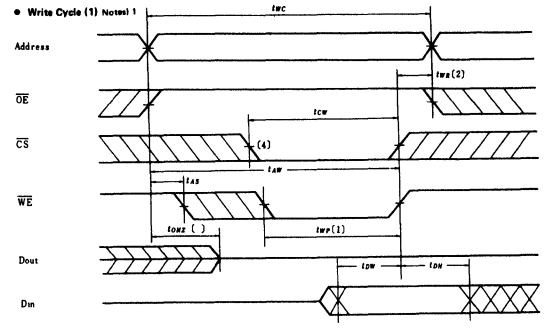


●READ CYCLE (2)[1][2][4]

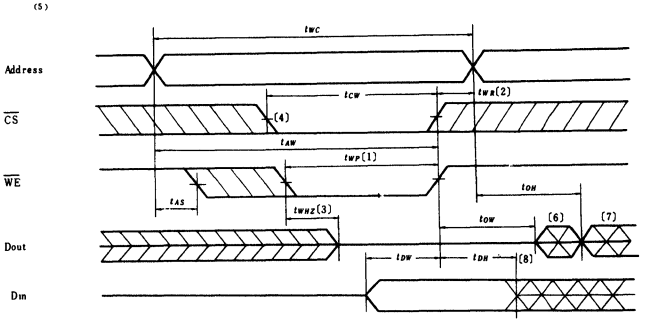


NOTES: 1. $\overline{WE}$ is High for Read Cycle
2. Device is continuously selected, $\overline{CS}$ = V_{IL}
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

●WRITE CYCLE (1)



●WRITE CYCLE (2)



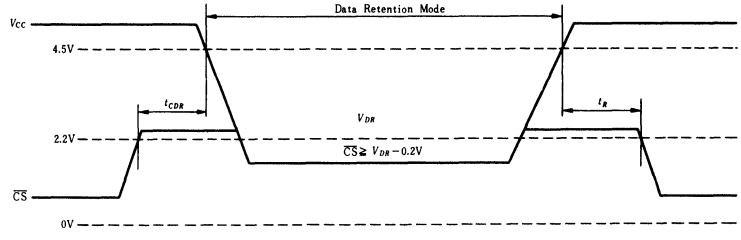
NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE}$ = V_{IL})
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

■LOW V_{CC} DATA RETENTION CHARACTERISTICS (Ta=0 to +70°C)

Item	Symbol	Test Conditions	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geqq V_{CC}-0.2V$ $V_{IN} \geqq V_{CC}-0.2V$ or $V_{IN} \leqq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}*	V_{CC}=3.0V, $\overline{CS} \geqq 2.8V$ $V_{IN} \geqq 2.8V$ or $V_{IN} \leqq 0.2V$	—	—	30	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		**t_{RC}	—	—	ns

* V_{IL} min=−0.3V, 10 μA max (at Ta=0 to +40°C)
** t_{RC}=Read Cycle Time.

●Low V_{CC} DATA RETENTION WAVEFORM

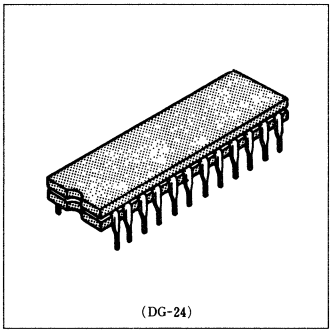


HM6116K-3, HM6116K-4

2048-word×8-bit High Speed Static CMOS RAM

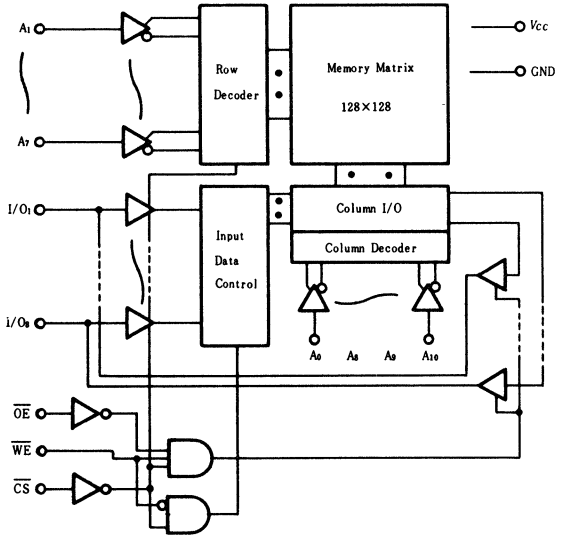
■FEATURES

- Industrial Temperature Range . . . . . 55 to +125°C
- Single 5V Supply and High Density 24 Pin Package
- High speed: Fast Access Time 150ns/200ns (max.)
- Low Power Standby and Low Power Operation — Standby: 100μW (type.) Operation: 180mW (typ.)
- Completely Static RAM: No clock or Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time

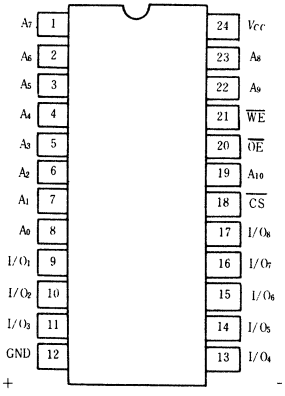


(DG-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	−55 to +125	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5V

■TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : $V_{IL\,min}$ = −0.3V

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, GND=0V, Ta= −55~+125°C)

Item	Symbol	Test Conditions	min	typ*	max	Unit
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	10	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}$=V_{IH} or $\overline{OE}$=V_{IH}, $V_{I/O}$=GND to V_{CC}	—	—	10	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}$=V_{IL}, $I_{I/O}$=0mA	—	35	90	mA
	I_{CC1}**	V_{IH}=3.5V, V_{IL}=0.6V, $I_{I/O}$=0mA	—	30	—	mA
Average Operating Current	I_{CC2}	Min. cycle, duty=100%	—	35	90	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}$=V_{IH}	—	4	20	mA
	I_{SB1}	CS≧V_{CC}−0.2V, V_{in}≧V_{CC} −0.2V or V_{in}≦0.2V	—	0.02	2	mA
Output Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	V

* V_{CC}=5V, Ta=25°C
** Reference Only

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=−55 to +125°C)

●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6116K-3		HM6116K-4		Unit
		min	max	min	max	
Read Cycle Time	t_{RC}	150	—	200	—	ns
Address Access Time	t_{AA}	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	10	—	ns
Output Enable to Output Valid	t_{OE}	—	100	—	120	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	10	—	ns

● WRITE CYCLE

Item	Symbol	HM6116K-3		HM6116K-4		Unit
		min	max	min	max	
Write Cycle Time	t_{WC}	150	—	200	—	ns
Chip Selection to End of Write	t_{CW}	90	—	120	—	ns
Address Valid to End of Write	t_{AW}	120	—	140	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	ns
Write Pulse Width	t_{WP}	90	—	120	—	ns
Write Recovery Time	t_{WR}	10	—	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	60	0	60	ns
Data to Write Time Overlap	t_{DW}	40	—	60	—	ns
Data Hold from Write Time	t_{DH}	10	—	10	—	ns
Output Active from End of Write	t_{OW}	10	—	10	—	ns

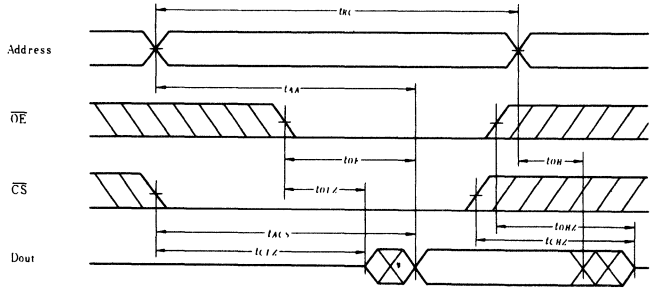
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

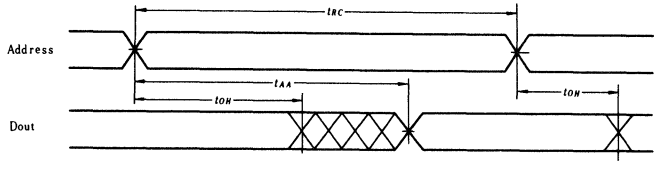
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

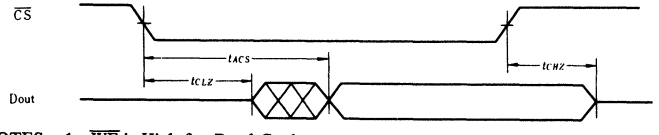
● READ CYCLE (1) [1]



● READ CYCLE (2) [1][2][4]

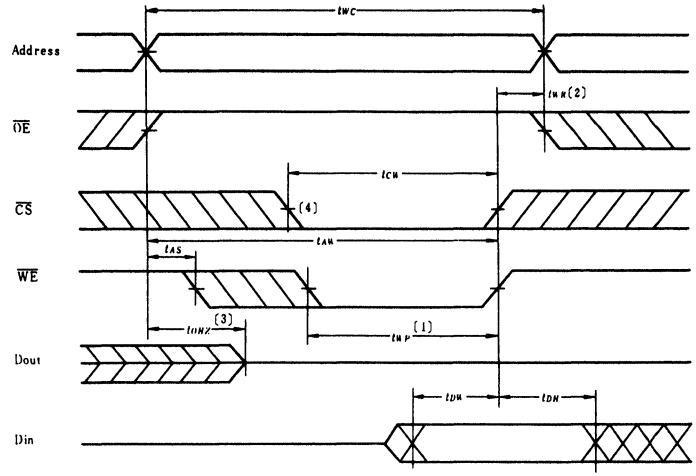


● READ CYCLE (3) [1][3][4]

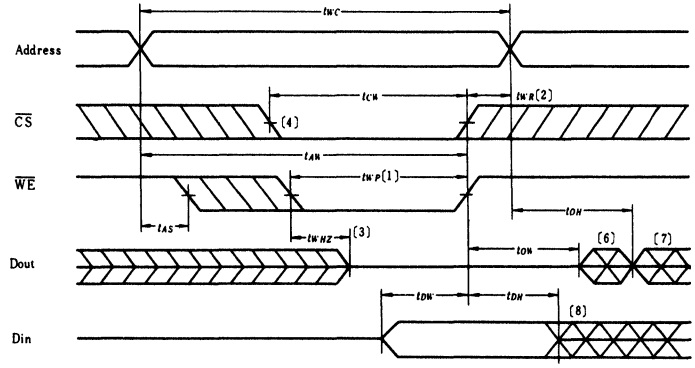


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

WRITE CYCLE (1)



● WRITE CYCLE (2) (5)



NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

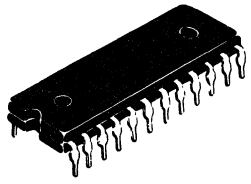
HM6116AP-10, HM6116AP-12, HM6116AP-15, HM6116AP-20, HM6116ASP-10, HM6116ASP-12, HM6116ASP-15, HM6116ASP-20

2048-word × 8-bit High Speed Static CMOS RAM

■ FURTURES

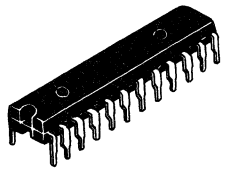
- High speed: Fast Access Time 100ns/120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation — Standby: 100μW (typ.) Operation: 15mW (typ.) (f = 1MHz)
- Single 5V Supply and High Density 24 Pin Package
- Completely Static RAM: No clock or Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time

HM6116AP Series



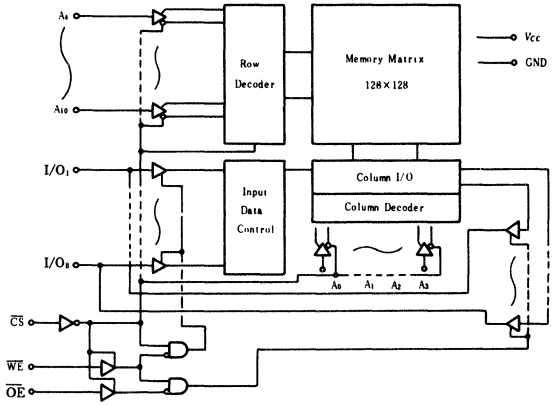
(DP-24)

HM6116ASP Series

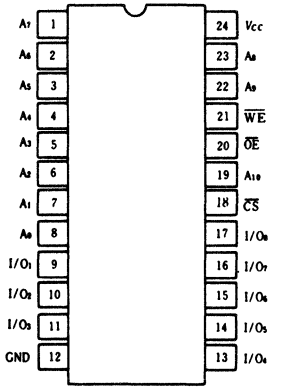


(DP-24A)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5V

■TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min= 0.3V

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Conditions	HM6116AP/ASP-10			HM6116AP/ASP-12			HM6116AP/ASP-15			HM6116AP/ASP-20			Unit
			min	typ*	max	min	typ*	max	min	typ*	max	min	typ*	max	
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	2	—	—	2	—	—	2	—	—	2	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}$=V_{IH} or $\overline{OE}$=V_{IH}, $V_{I/O}$=GND to V_{CC}	—	—	2	—	—	2	—	—	2	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}$=V_{IL}, $I_{I/O}$=0mA V_{in}=V_{IH} or V_{IL}	—	5	15	—	5	15	—	5	15	—	5	15	mA
	I_{CC1}	V_{IH}=V_{CC}, V_{IL}=0V, $\overline{CS}$=V_{IL}, $I_{I/O}$=0mA, f=1MHz	—	3	6	—	3	6	—	3	6	—	3	6	mA
Average Operating Current	I_{CC2}	min. cycle, duty=100%	—	40	70	—	35	60	—	25	45	—	20	35	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}$=V_{IH}	—	1	4	—	1	4	—	1	4	—	1	4	mA
	I_{SB1}	$\overline{CS}$≧V_{CC} −0.2V	—	0.02	2	—	0.02	2	—	0.02	2	—	0.02	2	mA
Output Voltage	V_{OL}	I_{OL}=4mA	—	—	0.4	—	—	0.4	—	—	0.4	—	—	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	2.4	—	—	2.4	—	—	2.4	—	—	V

* V_{CC}=5V, Ta=25°C

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0 to +70°C)

●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6116AP/ASP-10		HM6116AP/ASP-12		HM6116AP/ASP-15		HM6116AP/ASP-20		Unit
		min	max	min	max	min	max	min	max	
Read Cycle Time	t_{RC}	100	—	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	100	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	100	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	10	—	10	—	10	—	ns
Output Enable to Output Valid	t_{OE}	—	50	—	55	—	60	—	70	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	10	—	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	40	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	10	—	15	—	20	—	ns

● WRITE CYCLE

Item	Symbol	HM6116AP/ ASP-10		HM6116AP/ ASP-12		HM6116AP/ ASP-15		HM6116AP/ ASP-20		Unit
		min	max	min	max	min	max	min	max	
Write Cycle Time	t_{WC}	100	–	120	–	150	–	200	–	ns
Chip Selection to End of Write	t_{CW}	65	–	70	–	90	–	120	–	ns
Address Valid to End of Write	t_{AW}	80	–	105	–	120	–	140	–	ns
Address Set Up Time	t_{AS}	0	–	0	–	0	–	0	–	ns
Write Pulse Width	t_{WP}	60	–	70	–	80	–	100	–	ns
Write Recovery Time	t_{WR}	0	–	0	–	0	–	0	–	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	30	0	35	0	40	0	50	ns
Data to Write Time Overlap	t_{DW}	30	–	35	–	40	–	50	–	ns
Data Hold from Write Time	t_{DH}	0	–	0	–	0	–	0	–	ns
Output Active from End of Write	t_{OW}	10	–	10	–	10	–	10	–	ns

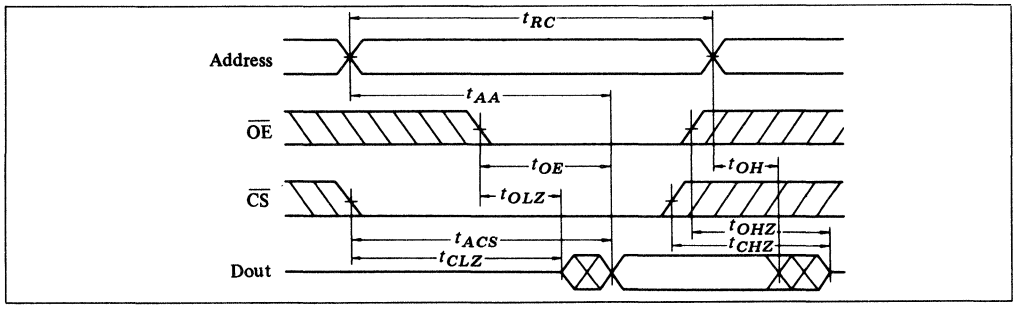
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

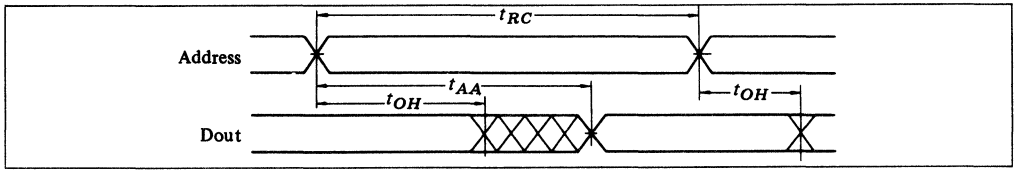
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

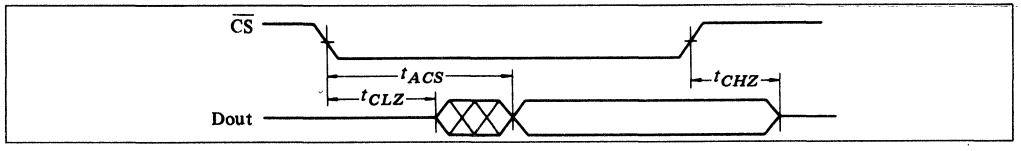
● READ CYCLE (1)[1]



● READ CYCLE (2)[1][2][4]

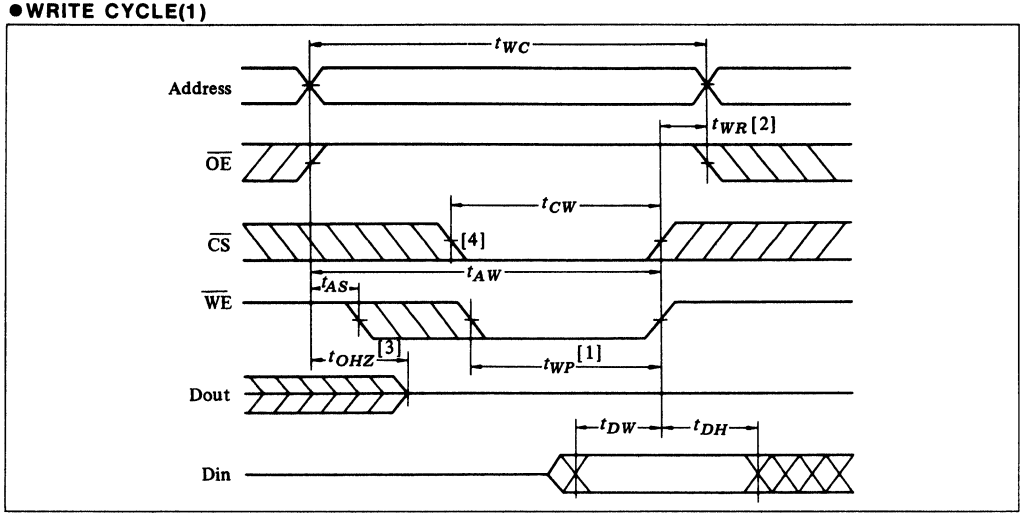


● READ CYCLE (3)[1][3][4]

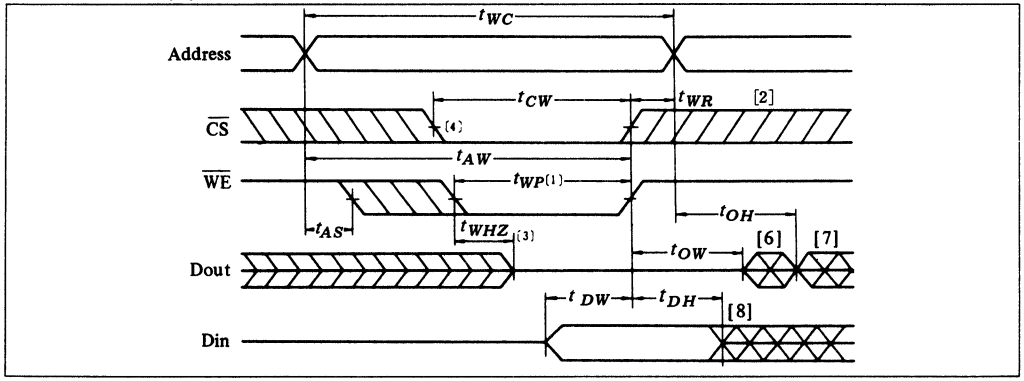


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

●WRITE CYCLE(1)



●WRITE CYCLE(2)[5]



NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

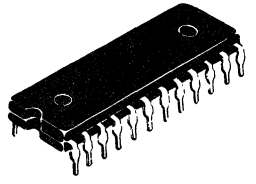
HM6116ALP-10, HM6116ALP-12, HM6116ALP-15, HM6116ALP-20, HM6116ALSP-10, HM6116ALSP-12, HM6116ALSP-15, HM6116ALSP-20

2048-word×8-bit High Speed Static CMOS RAM

■ FEATURES

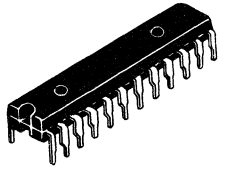
- High Speed: Fast Access Time 100ns/120ns/150ns/200ns (max.)
- Low Power Standby and Low Power Operation; Standby: 5μW (typ.) Operation: 10mW (typ.) (f = 1MHz)
- Capability of Battery Back up Operation
- Single 5V Supply and High Density 24 Pin Package
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Pin Out Compatible with Standard 16K EPROM/MASK ROM
- Equal Access and Cycle Time

HM6116ALP Series



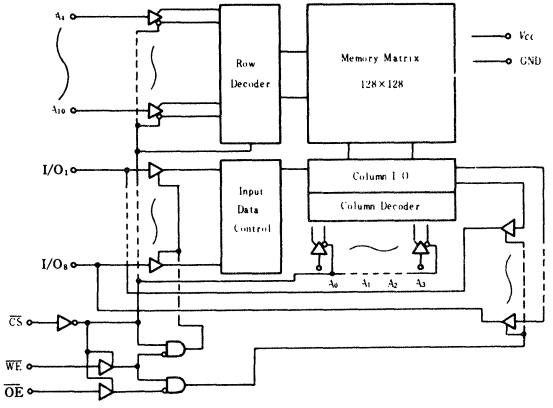
(DP-24)

HM6116ALSP Series

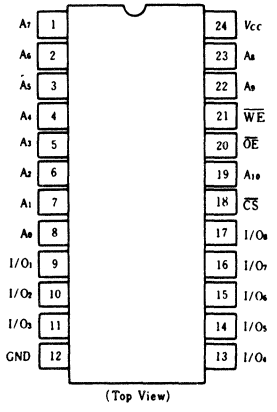


(DP-24A)

■ FUNCTIONAL BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	−0.5* to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C
Power Dissipation	P_T	1.0	W

* Pulse Width 50ns : −1.5V

■ TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin	Ref. Cycle
H	×	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	L	H	Read	I_{CC}	Dout	Read Cycle (1)~(3)
L	H	L	Write	I_{CC}	Din	Write Cycle (1)
L	L	L	Write	I_{CC}	Din	Write Cycle (2)

■ RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	3.5	6.0	V
	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : V_{IL} min = −0.3V

■ DC AND OPERATING CHARACTERISTICS (V_{CC}=5V ±10%, GND=0V, Ta=0 to +70°C)

Item	Symbol	Test Conditions	HM6116ALP/ ALSP-10			HM6116ALP/ ALSP-12			HM6116ALP/ ALSP-15			HM6116ALP/ ALSP-20			Unit
			min	typ*	max	min	typ*	max	min	typ*	max	min	typ*	max	
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{CC}=5.5V, V_{in}=GND to V_{CC}	—	—	2	—	—	2	—	—	2	—	—	2	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CS}$=V_{IH} or $\overline{OE}$=V_{IH}, $V_{I/O}$=GND to V_{CC}	—	—	2	—	—	2	—	—	2	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}$=V_{IL}, $I_{I/O}$=0mA V_{in}=V_{IH} or V_{IL}	—	4	12	—	4	12	—	4	12	—	4	12	mA
	I_{CC1}	V_{IH}=V_{CC}, V_{IL}=0V, $\overline{CS}$=V_{IL}, $I_{I/O}$=0mA, f=1MHz	—	2	5	—	2	5	—	2	5	—	2	5	mA
Average Operating Current	I_{CC2}	min. cycle, duty=100%	—	35	60	—	30	50	—	20	40	—	15	30	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}$= V_{IH}	—	0.5	3	—	0.5	3	—	0.5	3	—	0.5	3	mA
	I_{SB1}	$\overline{CS}$ ≧ V_{CC} −0.2V	—	1	50	—	1	50	—	1	50	—	1	50	μA
Output Voltage	V_{OL}	I_{OL}=4mA	—	—	0.4	—	—	0.4	—	—	0.4	—	—	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	2.4	—	—	2.4	—	—	2.4	—	—	V

* : V_{CC}=5V, T_a=25°C

■ AC CHARACTERISTICS (V_{CC}=5V ±10%, Ta=0 to +70°C)

● AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

● READ CYCLE

Item	Symbol	HM6116ALP/ ALSP-10		HM6116ALP/ ALSP-12		HM6116ALP/ ALSP-15		HM6116ALP/ ALSP-20		Unit
		min	max	min	max	min	max	min	max	
Read Cycle Time	t_{RC}	100	—	120	—	150	—	200	—	ns
Address Access Time	t_{AA}	—	100	—	120	—	150	—	200	ns
Chip Select Access Time	t_{ACS}	—	100	—	120	—	150	—	200	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	10	—	10	—	10	—	ns
Output Enable to Output Valid	t_{OE}	—	50	—	55	—	60	—	70	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	10	—	10	—	10	—	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	40	0	40	0	50	0	60	ns
Chip Disable to Output in High Z	t_{OHZ}	0	40	0	40	0	50	0	60	ns
Output Hold from Address Change	t_{OH}	10	—	10	—	15	—	20	—	ns

● WRITE CYCLE

Item	Symbol	HM6116ALP/ ALSP-10		HM6116ALP/ ALSP-12		HM6116ALP/ ALSP-15		HM6116ALP/ ALSP-20		Unit
		min	max	min	max	min	max	min	max	
Write Cycle Time	t_{WC}	100	–	120	–	150	–	200	–	ns
Chip Selection to End of Write	t_{CW}	65	–	70	–	90	–	120	–	ns
Address Valid to End of Write	t_{AW}	80	–	105	–	120	–	140	–	ns
Address Set Up Time	t_{AS}	0	–	0	–	0	–	0	–	ns
Write Pulse Width	t_{WP}	60	–	70	–	80	–	100	–	ns
Write Recovery Time	t_{WR}	0	–	0	–	0	–	0	–	ns
Output Disable to Output in High Z	t_{OHZ}	0	40	0	40	0	50	0	60	ns
Write to Output in High Z	t_{WHZ}	0	30	0	35	0	40	0	50	ns
Data to Write Time Overlap	t_{DW}	30	–	35	–	40	–	50	–	ns
Data Hold from Write Time	t_{DH}	0	–	0	–	0	–	0	–	ns
Output Active from End of Write	t_{OW}	10	–	10	–	10	–	10	–	ns

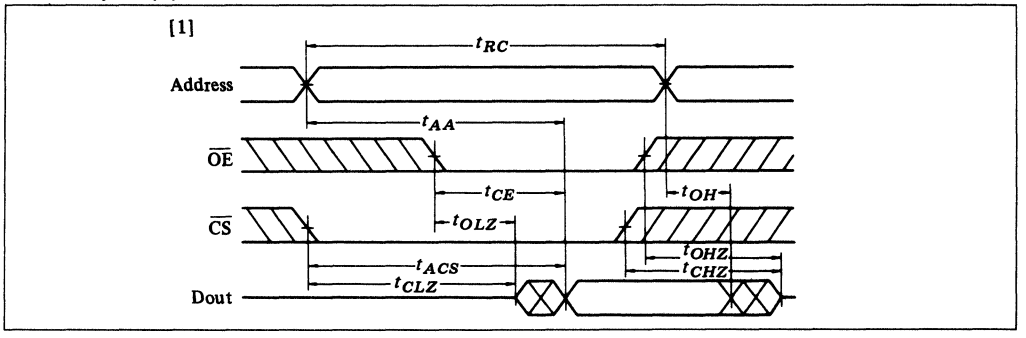
■ CAPACITANCE (f=1MHz, Ta=25°C)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

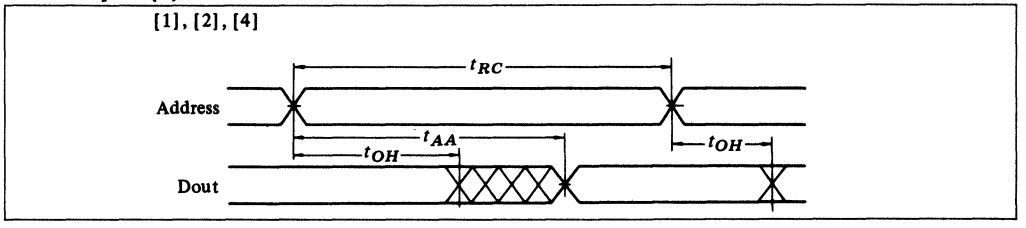
Note) This parameter is sampled and not 100% tested.

■ TIMING WAVEFORM

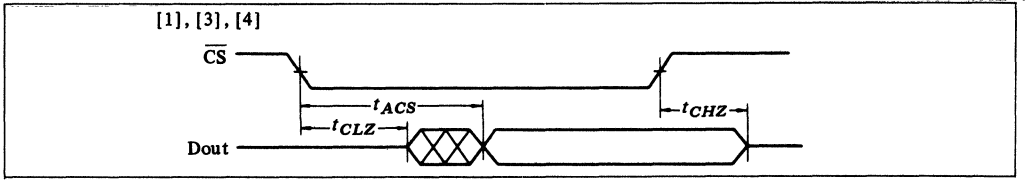
● Read Cycle (1)



● Read Cycle (2)

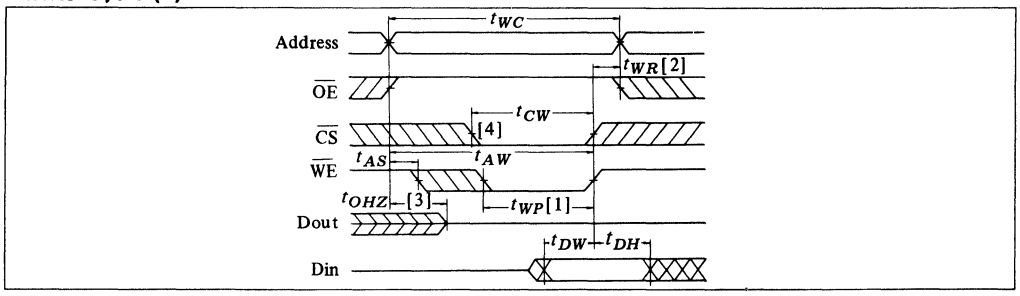


● Read Cycle (3)

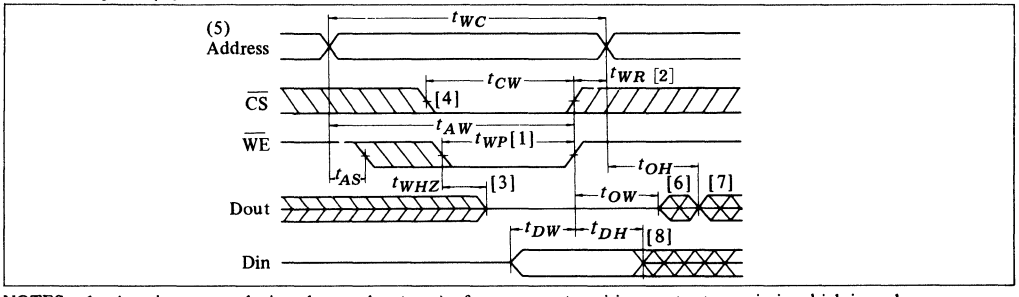


NOTES: 1. $\overline{WE}$ is High for Read Cycle.
2. Device is continuously selected, $\overline{CS}$ = V_{IL}.
3. Address Valid prior to or coincident with $\overline{CS}$ transition Low.
4. $\overline{OE}$ = V_{IL}.

● **Write Cycle (1)**



● **Write Cycle (2)**



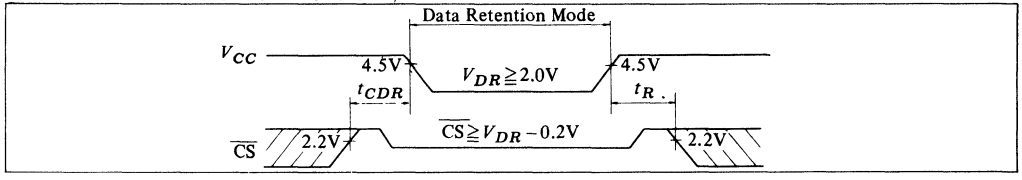
NOTES:
1. A write occurs during the overlap (t_{WP}) of a low $\overline{CS}$ and a low $\overline{WE}$.
2. t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
4. If the $\overline{CS}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transition, output remain in a high impedance state.
5. $\overline{OE}$ is continuously low. ($\overline{OE} = V_{IL}$)
6. D_{out} is the same phase of write data of this write cycle.
7. D_{out} is the read data of next address.
8. If $\overline{CS}$ is Low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

■ LOW Vcc DATA RETENTION CHARACTERISTICS (Ta=0 to +70°C)

Item	Symbol	Test Conditions	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geq V_{CC} - 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}*	V_{CC}=3.0V, $\overline{CS} \geq 2.8V$	—	—	30	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}**	—	—	ns

* 10 μA max at Ta=0°C to +40°C, V_{IL} min = −0.3V
** t_{RC} = Read Cycle Time.

● **Low Vcc Data Retention Waveform**

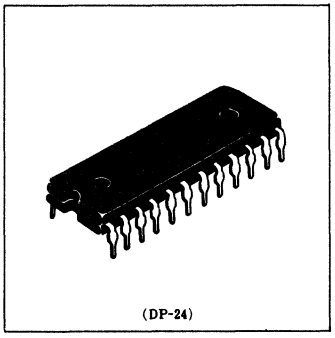


HM6117P-3, HM6117P-4

2048-word×8-bit High Speed Static CMOS RAM

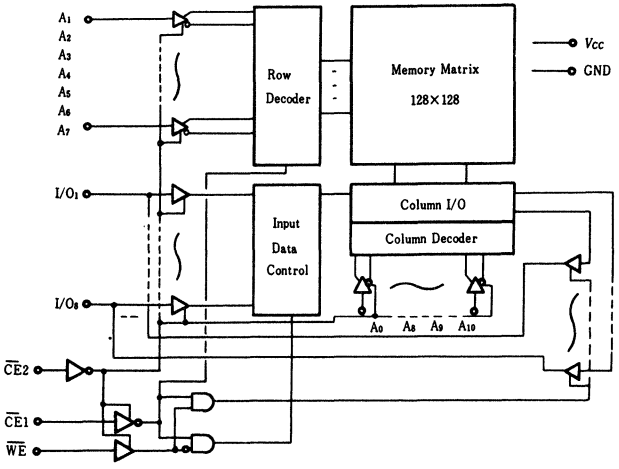
■FEATURES

- Single 5V Supply and High Density 24 pin Package.
- High Speed: Fast Access Time 150ns/200ns (max.)
- Low Power Standby and Low Power Operation: Standby: 100μW (typ.) Operation: 200mW (typ.)
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Equal Access and Cycle Time

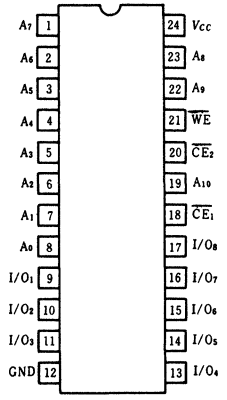


(DP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	*−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C

* Pulse width 50ns: −1.5V

■TRUTH TABLE

$\overline{CE_1}$	$\overline{CE_2}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin
H	×	×	Not Selected	I_{CCL1}	High Z
×	H	×	Not Selected	I_{CCL2}	High Z
L	L	H	Read	I_{CC}	Dout
L	L	L	Write	I_{CC}	Din

■RECOMMENDED DC OPERATING CONDITIONS ($0℃ \leqq Ta \leqq 70℃$)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High (logic 1) Voltage	V_{IH}	2.2	3.5	6.0	V
Input Low (logic 0) Voltage	V_{IL}	−1.0*	—	0.8	V

* Pulse width : 50ns, DC : $V_{IL_{min}} = -0.3V$

■DC AND OPERATING CHARACTERISTICS ($Ta=0℃$ to $+70℃$, $V_{CC}=5V \pm 10\%$, GND=0V)

Item	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{IN}=GND to V_{CC}	—	—	10	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CE_1}=V_{IH}$ or $\overline{CE_2}=V_{IH}$ $V_{I/O}$=GND to V_{CC}	—	—	10	μA
Operating Power Supply Current : DC	I_{CC}	$\overline{CE_1}=\overline{CE_2}=V_{IL}$, $I_{I/O}$=0mA	—	40	80	mA
Average Operating Current	I_{CC1}	Min cycle, duty=100% $\overline{CE_1}=V_{IL}$, $\overline{CE_2}=V_{IL}$	—	40	80	mA
Standby Power Supply Current (1) : DC	I_{CCL1}*	$\overline{CE_1} \geqq V_{CC}-0.2V$, $V_{IN} \geqq V_{CC}-0.2V$ or $V_{IN} \leqq 0.2V$	—	0.02	2	mA
Standby Power Supply Current (2) : DC	I_{CCL2}*	$\overline{CE_2} \geqq V_{CC}-0.2V$	—	0.02	2	mA
Output low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	V

Notes : 1) Typical limits are at V_{CC}=5.0V, Ta=+25℃
2) * : $V_{IL_{min}} = -0.3V$

■CAPACITANCE ($Ta=25℃$, $f=1.0MHz$)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{IN}	V_{IN}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS ($Ta=0℃$ to $+70℃$, $V_{CC}=5V \pm 10\%$ unless otherwise noted)

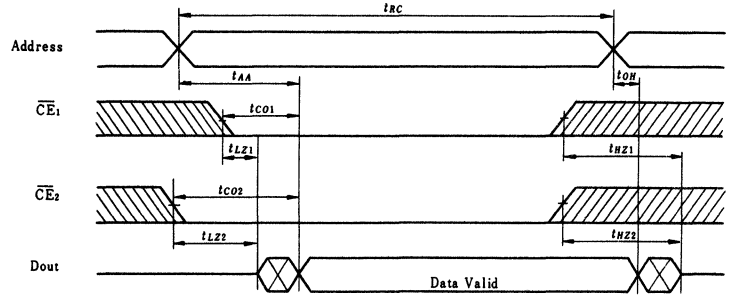
●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1 TTL Gate and C_L=100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6117P-3		HM6117P-4		Unit
		min	max	min	max	
Read Cycle Time	t_{RC}	150	—	200	—	ns
Address Access Time	t_{AA}	—	150	—	200	ns
Chip Enable ($\overline{CE_1}$) to Output	t_{CO1}	—	150	—	200	ns
Chip Enable ($\overline{CE_2}$) to Output	t_{CO2}	—	150	—	200	ns
Chip Enable ($\overline{CE_1}$) to Output in Low Z	t_{LZ1}	10	—	10	—	ns
Chip Enable ($\overline{CE_2}$) to Output in Low Z	t_{LZ2}	10	—	10	—	ns
Chip Disable ($\overline{CE_1}$) to Output in High Z	t_{HZ1}	0	70	0	80	ns
Chip Disable ($\overline{CE_2}$) to Output in High Z	t_{HZ2}	0	70	0	80	ns
Output Hold from Address Change	t_{OH}	15	—	15	—	ns

● TIMING WAVEFORM OF READ CYCLE (Notes 1)

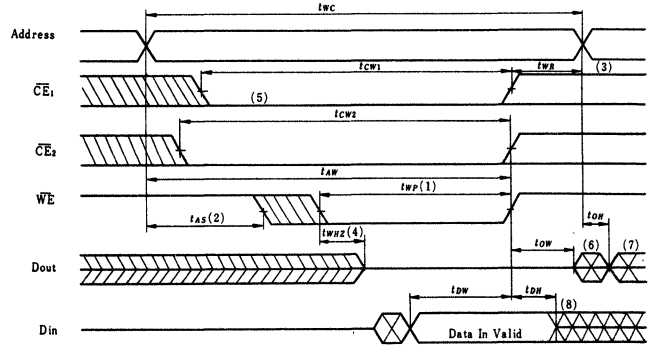


NOTES: 1. $\overline{WE}$ is High for Read Cycle.

● WRITE CYCLE

Item	Symbol	HM6117P-3		HM6117P-4		Unit
		min	max	min	max	
Write Cycle Time	t_{WC}	150	—	200	—	ns
Chip Enable ($\overline{CE_1}$) to End of Write	t_{CW1}	100	—	120	—	ns
Chip Enable ($\overline{CE_2}$) to End of Write	t_{CW2}	110	—	130	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	ns
Address Valid to End of Write	t_{AW}	130	—	150	—	ns
Write Pulse Width	t_{WP}	100	—	120	—	ns
Write Recovery Time	t_{WR}	15	—	15	—	ns
Write to Output in High Z	t_{WHZ}	0	60	0	70	ns
Data to Write Time Overlap	t_{DW}	50	—	60	—	ns
Data Hold from Write Time	t_{DH}	20	—	20	—	ns
Output Active from End of Write	t_{OW}	10	—	10	—	ns

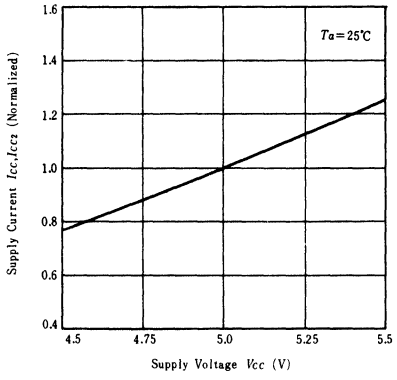
● TIMING WAVEFORM OF WRITE CYCLE



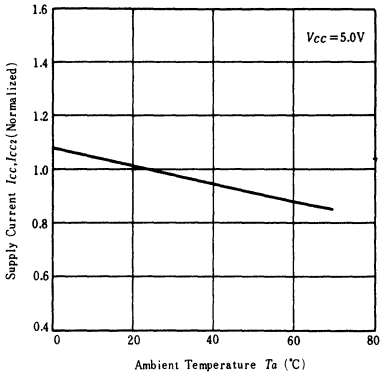
NOTES: 1 A write occurs during the overlap (t_{WP}) of low $\overline{CE_1}$, $\overline{CE_2}$ and $\overline{WE}$.

2. t_{AS} is measured from the address changes to the bigining of the write.
3. t_{WR} is measured from the earlier of $\overline{CE_1}$, $\overline{CE_2}$ or $\overline{WE}$ going high to the end/of write cycle.
4. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
5. If the $\overline{CE_1}$ or $\overline{CE_2}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transitions, output remain in a high impedance state.
6. Dout is the same phase of write data of this write cycle.
7. Dout is the read data of next address.
8. If $\overline{CE_1}$ and $\overline{CE_2}$ are low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

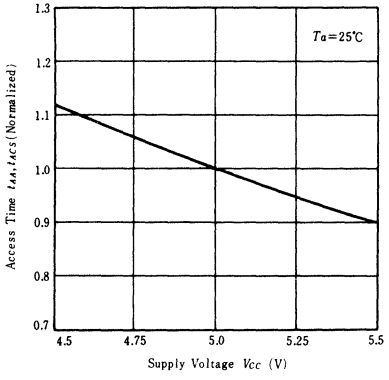
SUPPLY CURRENT vs. SUPPLY VOLTAGE



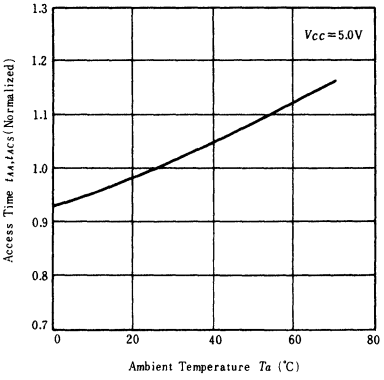
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



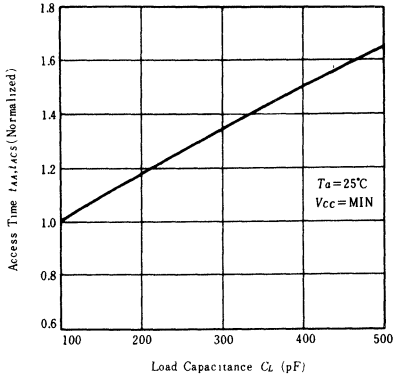
ACCESS TIME vs. SUPPLY VOLTAGE



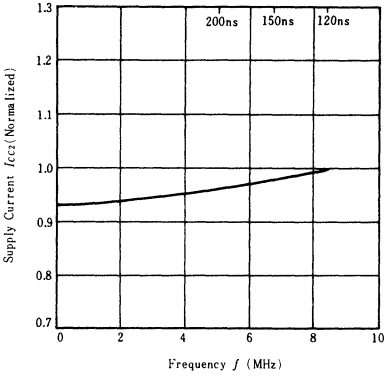
ACCESS TIME vs. AMBIENT TEMPERATURE



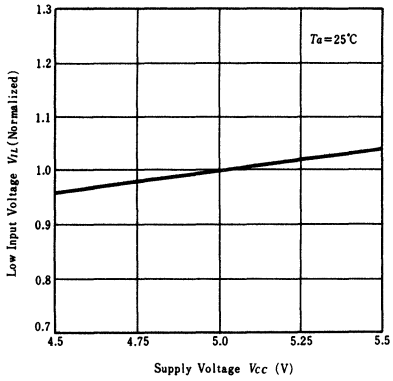
ACCESS TIME vs. LOAD CAPACITANCE



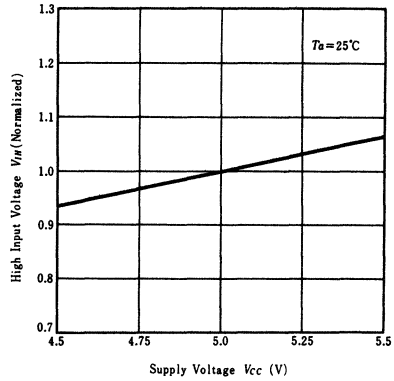
SUPPLY CURRENT vs. FREQUENCY



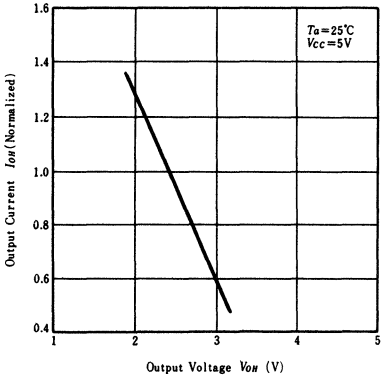
INPUT LOW VOLTAGE vs. SUPPLY VOLTAGE



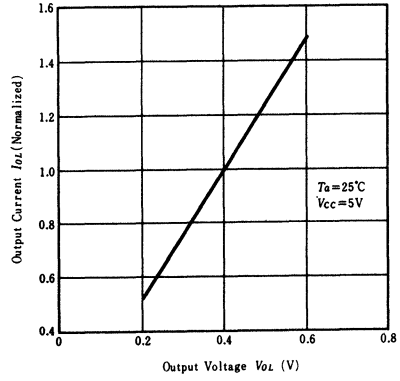
INPUT HIGH VOLTAGE vs. SUPPLY VOLTAGE



OUTPUT HIGH CURRENT vs. OUTPUT HIGH VOLTAGE



OUTPUT LOW CURRENT vs. OUTPUT LOW VOLTAGE

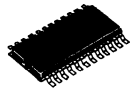


HM6117FP-3, HM6117FP-4

2048-word×8-bit High Speed Static CMOS RAM

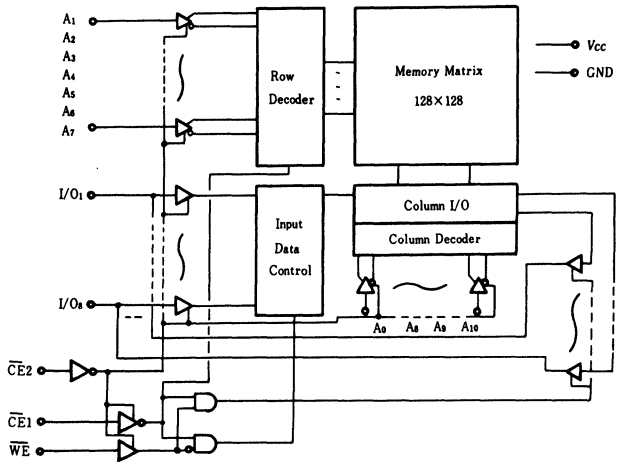
■FEATURES

- High Density Small Sized Package
- Projection Area Reduced to One-Thirds of Conventional DIP
- Thickness Reduced to a Half of Conventional DIP
- Single 5V Supply and High Density 24 pin Package.
- High Speed: Fast Access Time 150ns/200ns (max.)
- Low Power Standby and Low Power Operation: Standby: 100μW (typ.) Operation: 200mW (typ.)
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Equal Access and Cycle Time

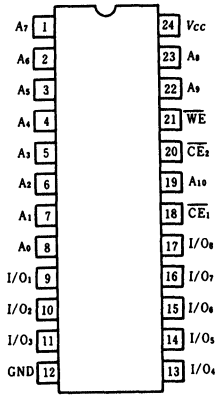


(FP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	*−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C

* Pulse width 50ns: −1.5V

■TRUTH TABLE

$\overline{CE_1}$	$\overline{CE_2}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin
H	×	×	Not Selected	I_{CCL1}	High Z
×	H	×	Not Selected	I_{CCL2}	High Z
L	L	H	Read	I_{CC}	Dout
L	L	L	Write	I_{CC}	Din

■RECOMMENDED DC OPERATING CONDITIONS ($0℃ \leqq Ta \leqq 70℃$)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High (logic 1) Voltage	V_{IH}	2.2	3.5	6.0	V
Input low (logic 0) Voltage	V_{IL}	−1.0*	—	0.8	V

* Pulse width : 50ns, DC : $V_{IL_{min}} = -0.3V$

■DC AND OPERATING CHARACTERISTICS ($Ta=0℃$ to $+70℃$, $V_{CC}=5V \pm 10\%$, GND=0V)

Item	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{IN}=GND to V_{CC}	—	—	10	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CE_1}=V_{IH}$ or $\overline{CE_2}=V_{IH}$ $V_{I/O}$=GND to V_{CC}	—	—	10	μA
Operating Power Supply Current : DC	I_{CC}	$\overline{CE_1}=\overline{CE_2}=V_{IL}$, $I_{I/O}$=0mA	—	40	80	mA
Average Operating Current	I_{CC1}	Min cycle, duty=100% $\overline{CE_1}=V_{IL}$, $\overline{CE_2}=V_{IL}$	—	40	80	mA
Standby Power Supply Current (1) : DC	I_{CCL1}*	$\overline{CE_1} \geqq V_{CC}-0.2V$, $V_{IN} \geqq V_{CC}-0.2V$ or $V_{IN} \leqq 0.2V$	—	0.02	2	mA
Standby Power Supply Current (2) : DC	I_{CCL2}*	$\overline{CE_2} \geqq V_{CC}-0.2V$	—	0.02	2	mA
Output low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	V

Notes : 1) Typical limits are at V_{CC}=5.0V, Ta=+25℃
2) * : $V_{IL_{min}} = -0.3V$

■CAPACITANCE ($Ta=25℃$, $f=1.0MHz$)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{IN}	V_{IN}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS ($Ta=0℃$ to $+70℃$, $V_{CC}=5V \pm 10\%$ unless otherwise noted)

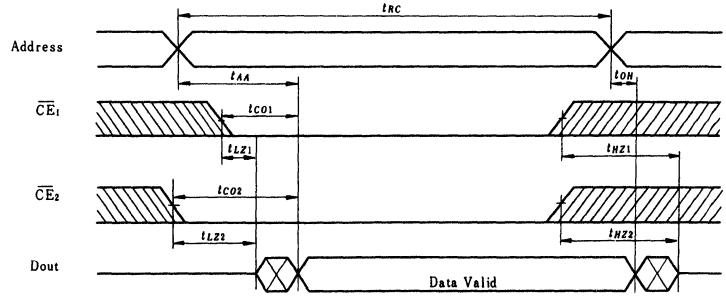
●AC TEST CONDITIONS

Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10 ns
Input and Output Timing Reference Levels: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

●READ CYCLE

Item	Symbol	HM6117P-3		HM6117P-4		Unit
		min	max	min	max	
Read Cycle Time	t_{RC}	150	—	200	—	ns
Address Access Time	t_{AA}	—	150	—	200	ns
Chip Enable ($\overline{CE_1}$) to Output	t_{CO1}	—	150	—	200	ns
Chip Enable ($\overline{CE_2}$) to Output	t_{CO2}	—	150	—	200	ns
Chip Enable ($\overline{CE_1}$) to Output in Low Z	t_{LZ1}	10	—	10	—	ns
Chip Enable ($\overline{CE_2}$) to Output in Low Z	t_{LZ2}	10	—	10	—	ns
Chip Disable ($\overline{CE_1}$) to Output in High Z	t_{HZ1}	0	70	0	80	ns
Chip Disable ($\overline{CE_2}$) to Output in High Z	t_{HZ2}	0	70	0	80	ns
Output Hold from Address Change	t_{OH}	15	—	15	—	ns

● TIMING WAVEFORM OF READ CYCLE (Notes 1)

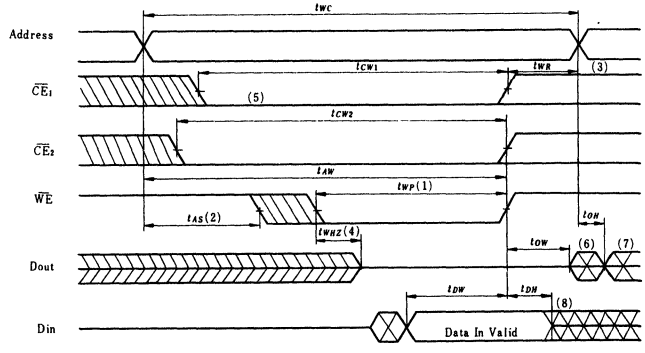


NOTES: 1. $\overline{WE}$ is High for Read Cycle.

● WRITE CYCLE

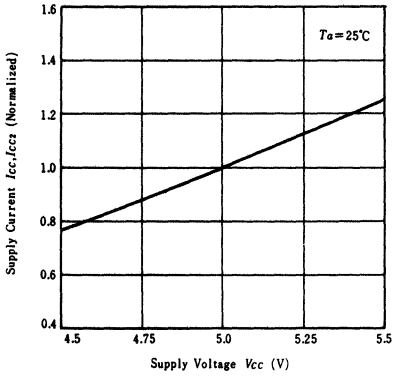
Item	Symbol	HM6117P-3		HM6117P-4		Unit
		min	max	min	max	
Write Cycle Time	t_{WC}	150	—	200	—	ns
Chip Enable ($\overline{CE_1}$) to End of Write	t_{CW1}	100	—	120	—	ns
Chip Enable ($\overline{CE_2}$) to End of Write	t_{CW2}	110	—	130	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	ns
Address Valid to End of Write	t_{AW}	130	—	150	—	ns
Write Pulse Width	t_{WP}	100	—	120	—	ns
Write Recovery Time	t_{WR}	15	—	15	—	ns
Write to Output in High Z	t_{WHZ}	0	60	0	70	ns
Data to Write Time Overlap	t_{DW}	50	—	60	—	ns
Data Hold from Write Time	t_{DH}	20	—	20	—	ns
Output Active from End of Write	t_{OW}	10	—	10	—	ns

● TIMING WAVEFORM OF WRITE CYCLE

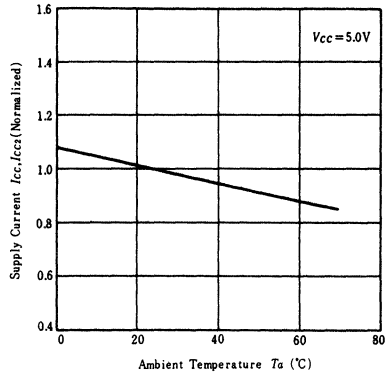


NOTES:
1. A write occurs during the overlap (t_{WP}) of low $\overline{CE_1}$, $\overline{CE_2}$ and $\overline{WE}$.
2. t_{AS} is measured from the address changes to the biginning of the write.
3. t_{WR} is measured from the earlier of $\overline{CE_1}$, $\overline{CE_2}$ or $\overline{WE}$ going high to the end/of write cycle.
4. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
5. If the $\overline{CE_1}$ or $\overline{CE_2}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transitions, output remain in a high impedance state.
6. Dout is the same phase of write data of this write cycle.
7. Dout is the read data of next address.
8. If $\overline{CE_1}$ and $\overline{CE_2}$ are low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

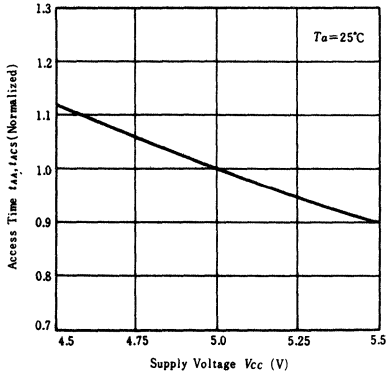
SUPPLY CURRENT vs. SUPPLY VOLTAGE



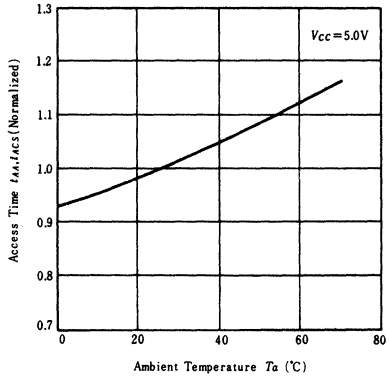
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



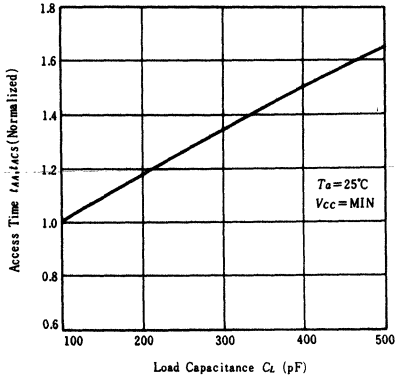
ACCESS TIME vs. SUPPLY VOLTAGE



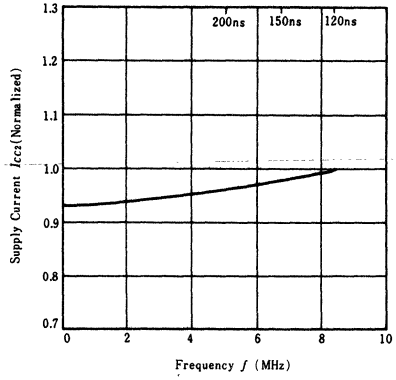
ACCESS TIME vs. AMBIENT TEMPERATURE



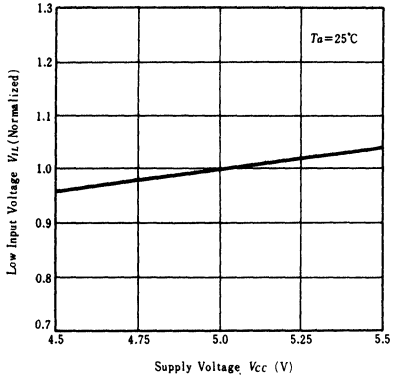
ACCESS TIME vs. LOAD CAPACITANCE



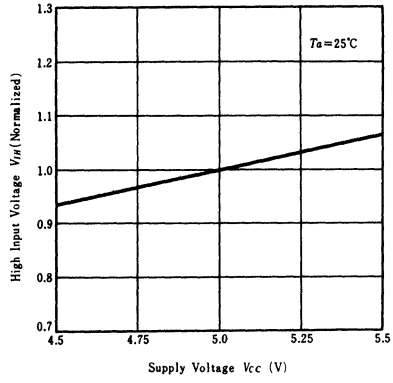
SUPPLY CURRENT vs. FREQUENCY



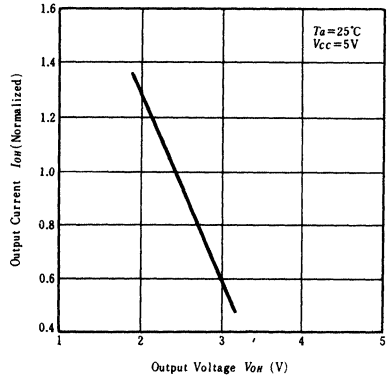
INPUT LOW VOLTAGE vs. SUPPLY VOLTAGE



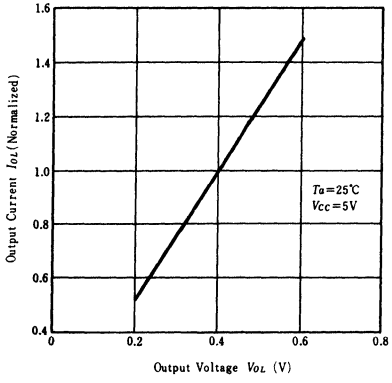
INPUT HIGH VOLTAGE vs. SUPPLY VOLTAGE



OUTPUT HIGH CURRENT vs. OUTPUT HIGH VOLTAGE



OUTPUT LOW CURRENT vs. OUTPUT LOW VOLTAGE

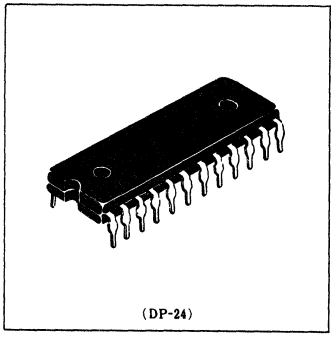


HM6117LP-3, HM6117LP-4

2048-word×8-bit High Speed Static CMOS RAM

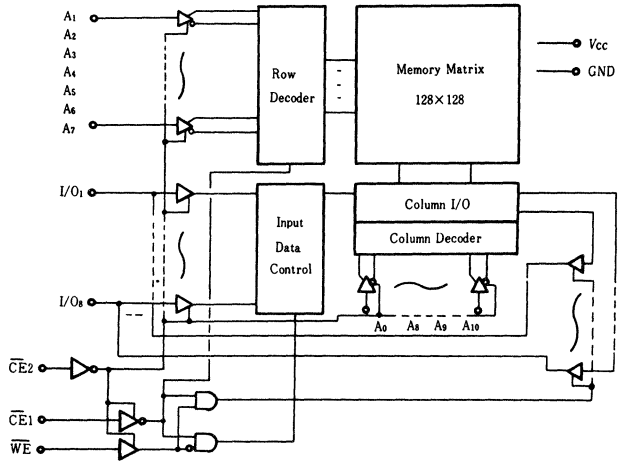
■FEATURES

- Single 5V Supply and High Density 24 Pin Package.
- High Speed: Fast Access Time 150ns/200ns max.
- Low Power Standby and Low Power Operation;
  Standby: 10μW (typ.) Two Chip Enable Input for Battery Back up
  Operation: 180mW (typ.)
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Equal Access and Cycle Time
- Capability of Battery Back up Operation

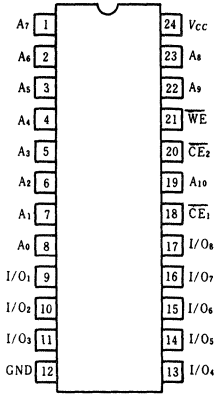


(DP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	*−0.5 to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C
Power Dissipation	P_T	1.0	W

* Pulse width 50ns: −1.5V

■TRUTH TABLE

$\overline{CE_1}$	$\overline{CE_2}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin
H	×	×	Not Selected	I_{CCL1}	High Z
×	H	×	Not Selected	I_{CCL2}	High Z
L	L	H	Read	I_{CC}	Dout
L	L	L	Write	I_{CC}	Din

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0℃ to+70℃)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High (logic 1) Voltage	V_{IH}	2.2	3.5	6.0	V
Input low (logic 0) Voltage	V_{IL}	−1.0*	—	0.8	V

* Pulse Width : 50ns, DC : $V_{IL_{min}}$ = −0.3V.

■DC AND OPERATING CHARACTERISTICS (Ta=0℃ to +70℃, V_{CC} = 5V±10%, GND = 0V)

Item	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{IN} = GND to V_{CC}	—	—	2	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CE_1} = V_{IH}$ or $\overline{CE_2} = V_{IH}$ $V_{I/O}$ = GND to V_{CC}	—	—	2	μA
Operating Power Supply Current : DC	I_{CC}	$\overline{CE_1} = \overline{CE_2} = V_{IL}$, $I_{I/O}$ = 0mA	—	35	70	mA
Average Operating Current	I_{CC1}	Min cycle, duty = 100% $\overline{CE_1} = V_{IL}$, $\overline{CE_2} = V_{IL}$	—	35	70	mA
Standby Power Supply Current (1) : DC	I_{CCL1}*	$\overline{CE_1} \geqq V_{CC}-0.2V$ $V_{IN} \geqq V_{CC}-0.2V$ or $V_{IN} \leqq 0.2V$	—	2	50	μA
Standby Power Supply Current (2) : DC	I_{CCL2}*	$\overline{CE_2} \geqq V_{CC}-0.2V$	—	2	50	μA
Output low Voltage	V_{OL}	I_{OL} = 2.1mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH} = −1.0mA	2.4	—	—	V

Notes : 1) Typical limits are at V_{CC} = 5.0V, Ta = +25℃
2) * : $V_{IL_{min}}$ = −0.3V

■CAPACITANCE (Ta=25℃, f=1.0MHz)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{IN}	V_{IN} = 0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$ = 0V	5	7	pF

Note : 1) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS (Ta=0℃ to +70℃, V_{CC} = 5V±10% unless otherwise noted)

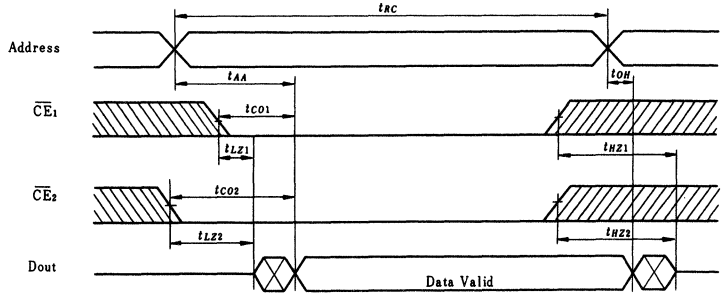
● AC TEST CONDITIONS

Input Pulse Levels ..... 0.8V to 2.4V
Input Rise and Fall Times 10ns
Input and Output Timing Reference Levels ... 1.5V
Output Load ..... 1 TTL Gate and C_L = 100pF (Including Scope & Jig)

● READ CYCLE

Item	Symbol	HM6117LP-3		HM6117LP-4		Unit
		min	max	min	max	
Read Cycle Time	t_{RC}	150	—	200	—	ns
Address Access Time	t_{AA}	—	150	—	200	ns
Chip Enable ($\overline{CE_1}$) to Output	t_{CO1}	—	150	—	200	ns
Chip Enable ($\overline{CE_2}$) to Output	t_{CO2}	—	150	—	200	ns
Chip Enable ($\overline{CE_1}$) to Output in Low Z	t_{LZ1}	10	—	10	—	ns
Chip Enable ($\overline{CE_2}$) to Output in Low Z	t_{LZ2}	10	—	10	—	ns
Chip Disable ($\overline{CE_1}$) to Output in High Z	t_{HZ1}	0	70	0	80	ns
Chip Disable ($\overline{CE_2}$) to Output in High Z	t_{HZ2}	0	70	0	80	ns
Output Hold from Address Change	t_{OH}	15	—	15	—	ns

● TIMING WAVEFORM OF READ CYCLE (Notes 1)

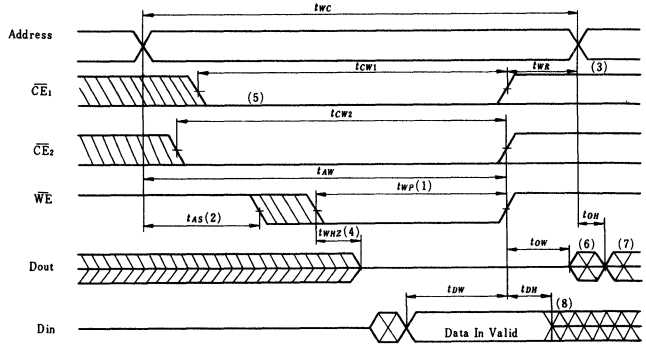


NOTES: 1. $\overline{WE}$ is High for Read Cycle.

● WRITE CYCLE

Item	Symbol	HM6117LP-3		HM6117LP-4		Unit
		min	max	min	max	
Write Cycle Time	t_{WC}	150	—	200	—	ns
Chip Enable ($\overline{CE_1}$) to End of Write	t_{CW1}	100	—	120	—	ns
Chip Enable ($\overline{CE_2}$) to End of Write	t_{CW2}	110	—	130	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	ns
Address Valid to End of Write	t_{AW}	130	—	150	—	ns
Write Pulse Width	t_{WP}	100	—	120	—	ns
Write Recovery Time	t_{WR}	15	—	15	—	ns
Write to Output in High Z	t_{WHZ}	0	60	0	70	ns
Data to Write Time Overlap	t_{DW}	50	—	60	—	ns
Data Hold from Write Time	t_{DH}	20	—	20	—	ns
Output Active from End of Write	t_{OW}	10	—	10	—	ns

● TIMING WAVEFORM OF WRITE CYCLE



NOTES: 1 A write occurs during the overlap (t_{WP}) of low $\overline{CE_1}$, $\overline{CE_2}$ and $\overline{WE}$.

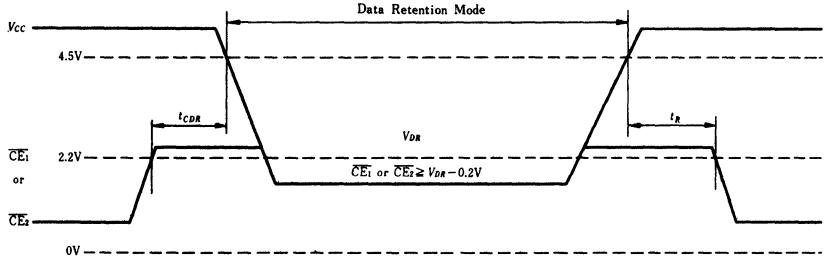
2. t_{AS} is measured from the address changes to the biginning of the write.
3. t_{WR} is measured from the earlier of $\overline{CE_1}$, $\overline{CE_2}$ or $\overline{WE}$ going high to the end/of write cycle.
4. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
5. If the $\overline{CE_1}$ or $\overline{CE_2}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transitions, output remain in a high impedance state.
6. Dout is the same phase of write data of this write cycle.
7. Dout is the read data of next address.
8. If $\overline{CE_1}$ and $\overline{CE_2}$ are low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

■LOW V_{CC} DATA RETENTION CHARACTERISTICS (Ta=0°C to +70°C)

Item	Symbol	Test Conditions	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR1}	$\overline{CE_1} \geqq V_{CC}-0.2V$, $V_{IN} \geqq V_{CC}-0.2V$ or $V_{IN} \leqq 0.2V$	2.0	—	—	V
V_{CC} for Data Retention	V_{DR2}	$\overline{CE_2} \geqq V_{CC}-0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR1}	V_{CC}=3.0V, $\overline{CE_1} \geqq 2.8V$, $V_{IN} \geqq 2.8V$ or $V_{IN} \leqq 0.2V$	—	—	30*	μA
Data Retention Current	I_{CCDR2}	V_{CC}=3.0V, $\overline{CE_2} \geqq V_{CC}-0.2V$	—	—	30*	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}**	—	—	ns

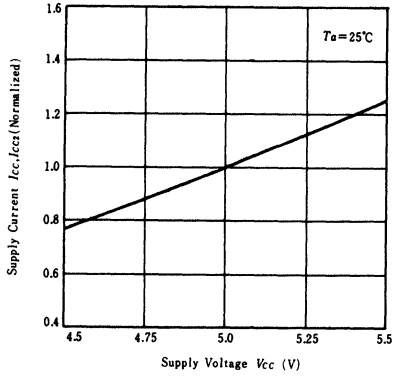
* 10μA max at Ta=0°C to +40°C, V_{IL} min=−0.3V
** t_{RC}=Read Cycle Time

●LOW V_{CC} DATA RETENTION WAVEFORM

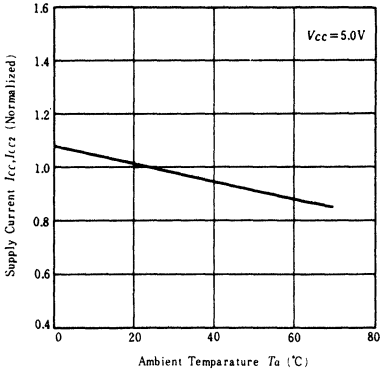


NOTE: 1. $\overline{CE_2}$ controls Address buffer, $\overline{WE}$ buffer, $\overline{CE_1}$ buffer and D_{IN} buffer. If $\overline{CE_2}$ controls data retention mode, V_{IN} level (address, $\overline{WE}$, $\overline{CE_1}$, $D_{I/O}$) can be in the high impedance state. If $\overline{CE_1}$ controls data retention mode, V_{IN} level (address, $\overline{WE}$, $\overline{DE_2}$, $D_{I/O}$) must be $V_{IN} \geqq V_{CC}-0.2V$ or $V_{IN} \leqq 0.2V$.

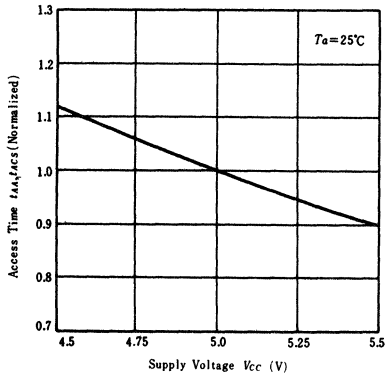
SUPPLY CURRENT vs. SUPPLY VOLTAGE



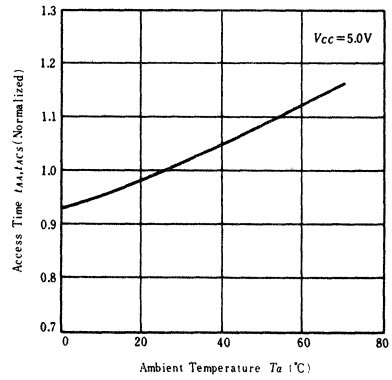
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



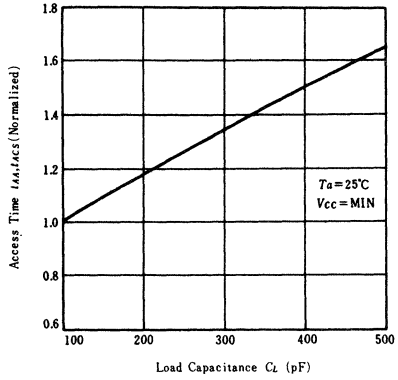
ACCESS TIME vs. SUPPLY VOLTAGE



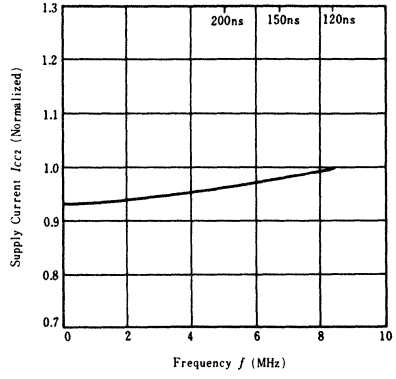
ACCESS TIME vs. AMBIENT TEMPERATURE



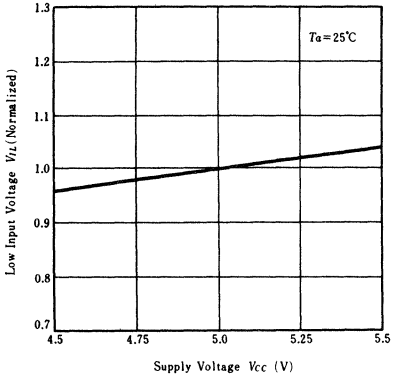
ACCESS TIME vs. LOAD CAPACITANCE



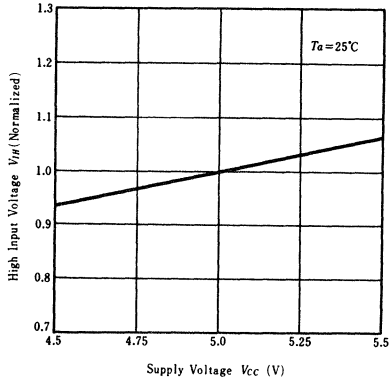
SUPPLY CURRENT vs. FREQUENCY



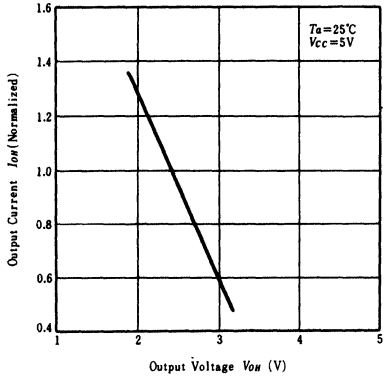
INPUT LOW VOLTAGE vs. SUPPLY VOLTAGE



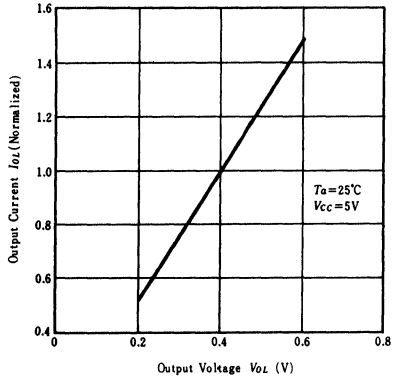
INPUT HIGH VOLTAGE vs. SUPPLY VOLTAGE



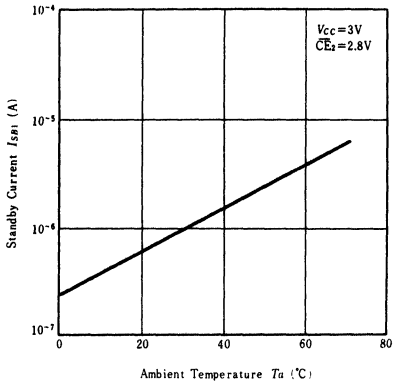
OUTPUT HIGH CURRENT vs. OUTPUT HIGH VOLTAGE



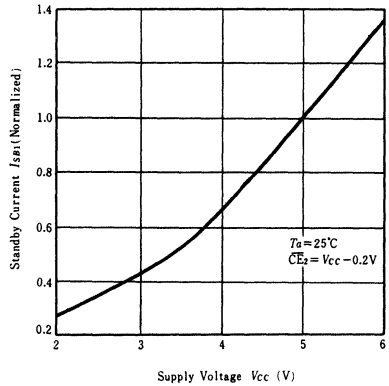
OUTPUT LOW CURRENT vs. OUTPUT LOW VOLTAGE



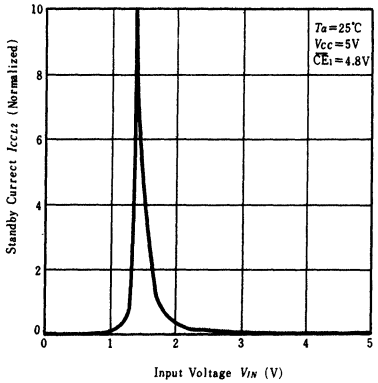
STAND-BY CURRENT vs. AMBIENT TEMPERATURE



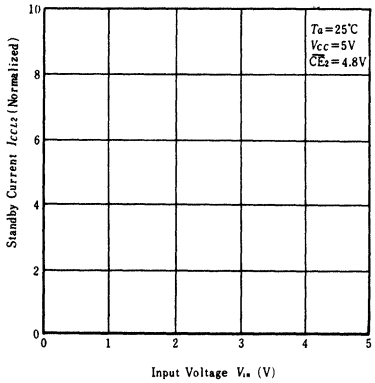
STAND-BY CURRENT vs. SUPPLY VOLTAGE



STAND-BY CURRENT vs. INPUT VOLTAGE



STAND-BY CURRENT vs. INPUT VOLTAGE

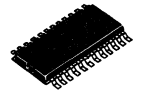


HM6117LFP-3, HM6117LFP-4

2048-word×8-bit High Speed Static CMOS RAM

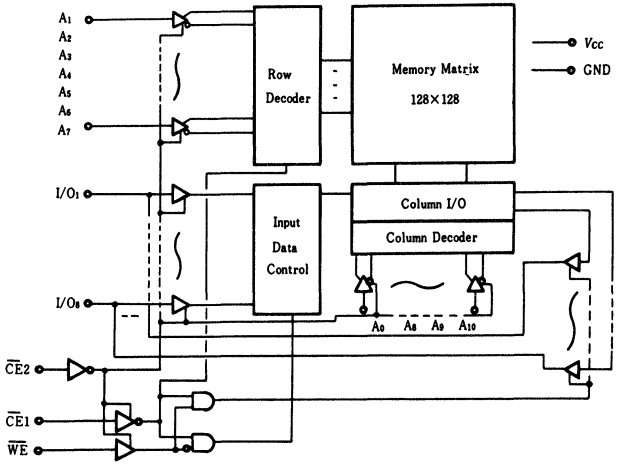
■FEATURES

- High Density Small-sized Packaged
- Projection Area Reduced to One-Thirds of Conventional DIP
- Thickness Reduced to a Half of Conventional DIP
- Single 5V Supply
- High Speed: Fast Access Time 150ns/200ns max.
- Low Power Standby and Low Power Operation;
  Standby: 10μW (typ.) Two Chip Enable Input for Battery Back up
  Operation: 180mW (typ.)
- Completely Static RAM: No clock nor Timing Strobe Required
- Directly TTL Compatible: All Input and Output
- Equal Access and Cycle Time
- Capability of Battery Back up Operation

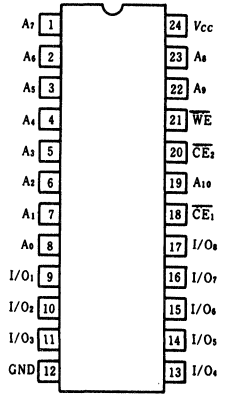


(FP-24)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_T	*−0.5 to +7.0	V
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C
Power Dissipation	P_T	1.0	W

* Pulse width 50ns : −1.5V

■TRUTH TABLE

$\overline{CE_1}$	$\overline{CE_2}$	$\overline{WE}$	Mode	V_{CC} Current	I/O Pin
H	×	×	Not Selected	I_{CCL1}	High Z
×	H	×	Not Selected	I_{CCL2}	High Z
L	L	H	Read	I_{CC}	Dout
L	L	L	Write	I_{CC}	Din

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0℃ to+70℃)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High (logic 1) Voltage	V_{IH}	2.2	3.5	6.0	V
Input low (logic 0) Voltage	V_{IL}	−1.0*	—	0.8	V

* Pulse Width: 50ns, DC: $V_{IL_{min}}$=−0.3V.

■DC AND OPERATING CHARACTERISTICS (Ta=0℃ to +70℃, V_{CC}=5V±10%, GND=0V)

Item	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{IN}=GND to V_{CC}	—	—	2	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CE_1}=V_{IH}$ or $\overline{CE_2}=V_{IH}$ $V_{I/O}$=GND to V_{CC}	—	—	2	μA
Operating Power Supply Current: DC	I_{CC}	$\overline{CE_1}=\overline{CE_2}=V_{IL}$, $I_{I/O}$=0mA	—	35	70	mA
Average Operating Current	I_{CC1}	Min cycle, duty=100% $\overline{CE_1}=V_{IL}$, $\overline{CE_2}=V_{IL}$	—	35	70	mA
Standby Power Supply Current (1): DC	I_{CCL1}*	$\overline{CE_1}\geqq V_{CC}-0.2V$ $V_{IN}\geqq V_{CC}-0.2V$ or $V_{IN}\leqq 0.2V$	—	2	50	μA
Standby Power Supply Current (2): DC	I_{CCL2}*	$\overline{CE_2}\geqq V_{CC}-0.2V$	—	2	50	μA
Output low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH}=−1.0mA	2.4	—	—	V

Notes: 1) Typical limits are at V_{CC}=5.0V, Ta=+25℃
2) * : $V_{IL_{min}}$=−0.3V

■CAPACITANCE (Ta=25℃, f=1.0MHz)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{IN}	V_{IN}=0V	3	5	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$=0V	5	7	pF

Note: 1) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS (Ta=0℃ to +70℃, V_{CC}=5V±10% unless otherwise noted)

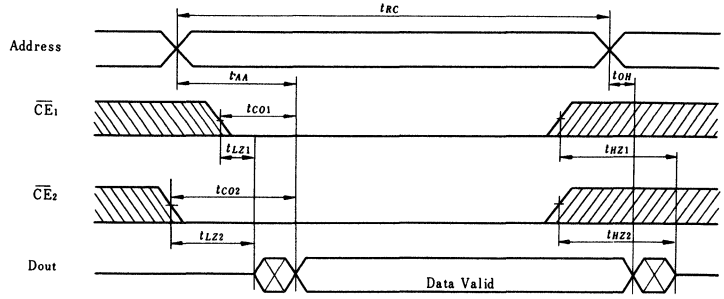
●AC TEST CONDITIONS

Input Pulse Levels ..... 0.8V to 2.4V
Input Rise and Fall Times 10ns
Input and Output Timing Reference Levels ... 1.5V
Output Load ..... 1 TTL Gate and C_L = 100pF (Including Scope & Jig)

●READ CYCLE

Item	Symbol	HM6117LFP-3		HM6117LFP-4		Unit
		min	max	min	max	
Read Cycle Time	t_{RC}	150	—	200	—	ns
Address Access Time	t_{AA}	—	150	—	200	ns
Chip Enable ($\overline{CE_1}$) to Output	t_{CO1}	—	150	—	200	ns
Chip Enable ($\overline{CE_2}$) to Output	t_{CO2}	—	150	—	200	ns
Chip Enable ($\overline{CE_1}$) to Output in Low Z	t_{LZ1}	10	—	10	—	ns
Chip Enable ($\overline{CE_2}$) to Output in Low Z	t_{LZ2}	10	—	10	—	ns
Chip Disable ($\overline{CE_1}$) to Output in High Z	t_{HZ1}	0	70	0	80	ns
Chip Disable ($\overline{CE_2}$) to Output in High Z	t_{HZ2}	0	70	0	80	ns
Output Hold from Address Change	t_{OH}	15	—	15	—	ns

● TIMING WAVEFORM OF READ CYCLE (Notes 1)

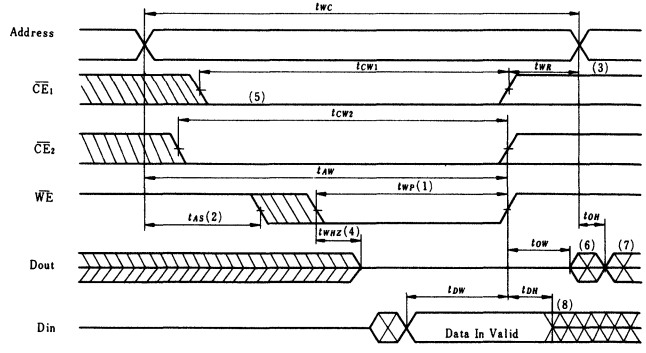


NOTES: 1. $\overline{WE}$ is High for Read Cycle.

● WRITE CYCLE

Item	Symbol	HM6117LFP-3		HM6117LFP-4		Unit
		min	max	min	max	
Write Cycle Time	t_{WC}	150	—	200	—	ns
Chip Enable ($\overline{CE_1}$) to End of Write	t_{CW1}	100	—	120	—	ns
Chip Enable ($\overline{CE_2}$) to End of Write	t_{CW2}	110	—	130	—	ns
Address Set Up Time	t_{AS}	20	—	20	—	ns
Address Valid to End of Write	t_{AW}	130	—	150	—	ns
Write Pulse Width	t_{WP}	100	—	120	—	ns
Write Recovery Time	t_{WR}	15	—	15	—	ns
Write to Output in High Z	t_{WHZ}	0	60	0	70	ns
Data to Write Time Overlap	t_{DW}	50	—	60	—	ns
Data Hold from Write Time	t_{DH}	20	—	20	—	ns
Output Active from End of Write	t_{OW}	10	—	10	—	ns

● TIMING WAVEFORM OF WRITE CYCLE



NOTES: 1 A write occurs during the overlap (t_{WP}) of low $\overline{CE_1}$, $\overline{CE_2}$ and $\overline{WE}$.

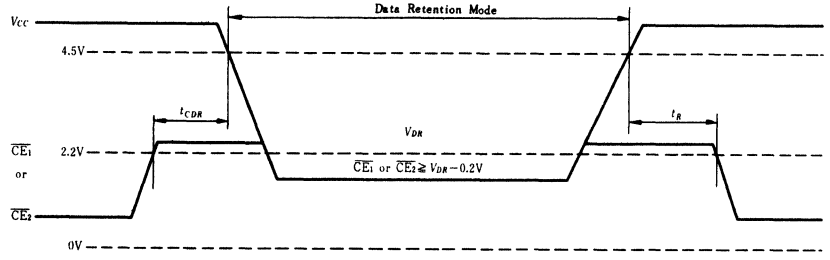
2. t_{AS} is measured from the address changes to the biginning of the write.
3. t_{WR} is measured from the earlier of $\overline{CE_1}$, $\overline{CE_2}$ or $\overline{WE}$ going high to the end/of write cycle.
4. During this period, I/O pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
5. If the $\overline{CE_1}$ or $\overline{CE_2}$ low transition occurs simultaneously with the $\overline{WE}$ low transitions or after the $\overline{WE}$ transitions, output remain in a high impedance state.
6. Dout is the same phase of write data of this write cycle.
7. Dout is the read data of next address.
8. If $\overline{CE_1}$ and $\overline{CE_2}$ are low during this period, I/O pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.

■LOW V_{CC} DATA RETENTION CHARACTERISTICS (Ta=0°C to +70°C)

Item	Symbol	Test Condition	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR1}	$\overline{CE_1} \geqq V_{CC}-0.2V$, $V_{IN} \geqq V_{CC}-0.2V$ or $V_{IN} \leqq 0.2V$	2.0	—	—	V
V_{CC} for Data Retention	V_{DR2}	$\overline{CE_2} \geqq V_{CC}-0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR1}	V_{CC}=3.0V, $\overline{CE_1} \geqq 2.8V$, $V_{IN} \geqq 2.8V$ or $V_{IN} \leqq 0.2V$	—	—	30*	μA
Data Retention Current	I_{CCDR2}	V_{CC}=3.0V, $\overline{CE_2} \geqq V_{CC}-0.2V$	—	—	30*	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}**	—	—	ns

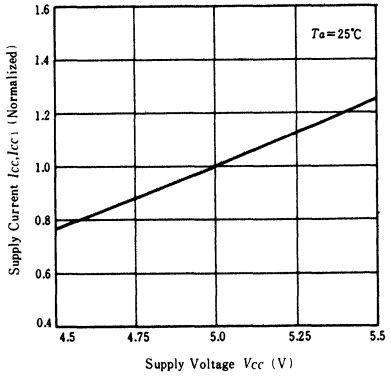
* 10μA max at Ta=0°C to +40°C, V_{IL} min=−0.3V
** t_{RC}=Read Cycle Time

●LOW V_{CC} DATA RETENTION WAVEFORM

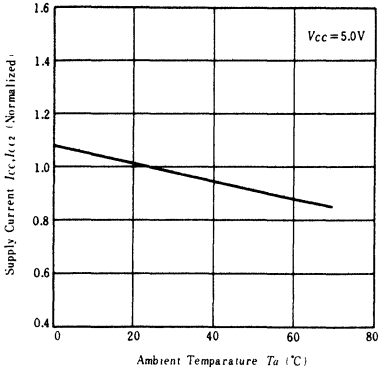


NOTE: 1. $\overline{CE_2}$ controls Address buffer, $\overline{WE}$ buffer, $\overline{CE_1}$ buffer and D_{IN} buffer. If $\overline{CE_2}$ controls data retention mode, V_{IN} level (address, $\overline{WE}$, $\overline{CE_1}$, $D_{I/O}$) can be in the high impedance state. If $\overline{CE_1}$ controls data retention mode, V_{IN} level (address, $\overline{WE}$, $\overline{CE_2}$, $D_{I/O}$) must be $V_{IN} \geqq V_{CC}-0.2V$ or $V_{IN} \leqq 0.2V$.

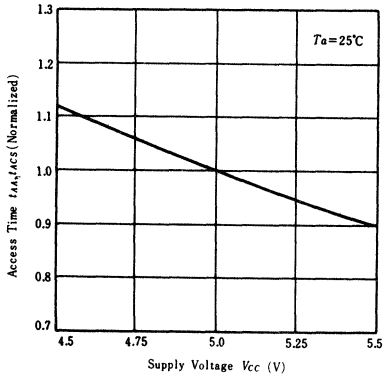
SUPPLY CURRENT vs. SUPPLY VOLTAGE



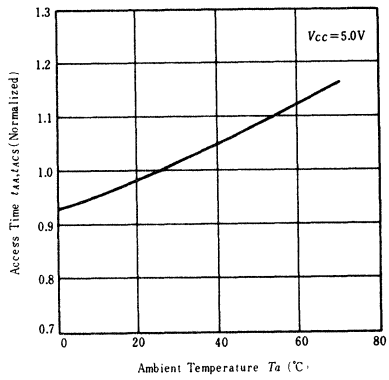
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



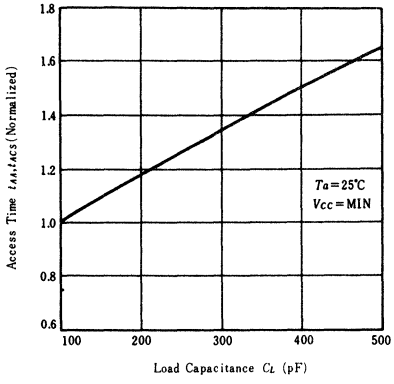
ACCESS TIME vs. SUPPLY VOLTAGE



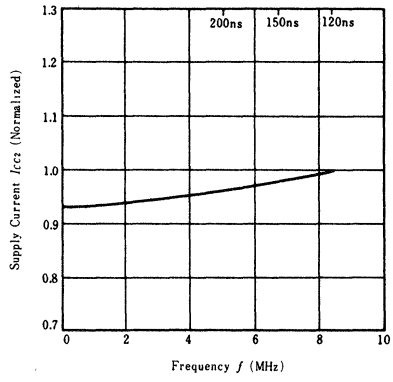
ACCESS TIME vs. AMBIENT TEMPERATURE



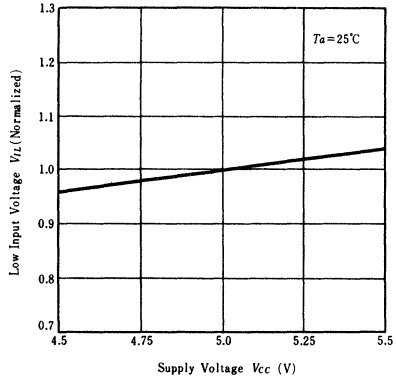
ACCESS TIME vs. LOAD CAPACITANCE



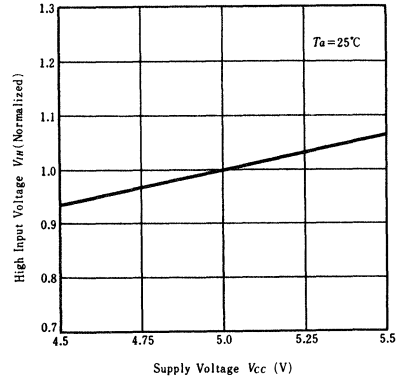
SUPPLY CURRENT vs. FREQUENCY



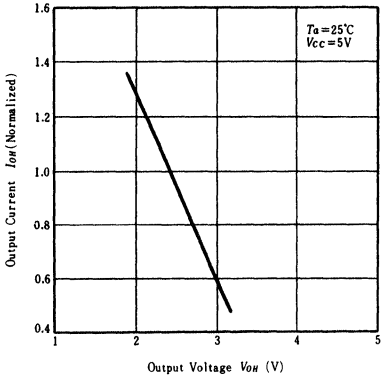
INPUT LOW VOLTAGE vs. SUPPLY VOLTAGE



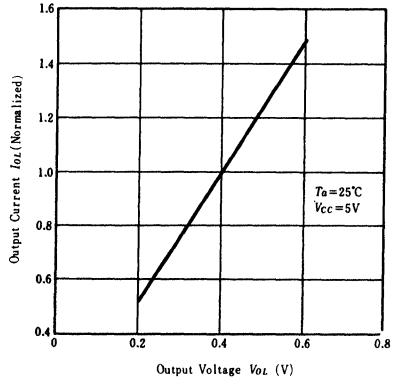
INPUT HIGH VOLTAGE vs. SUPPLY VOLTAGE



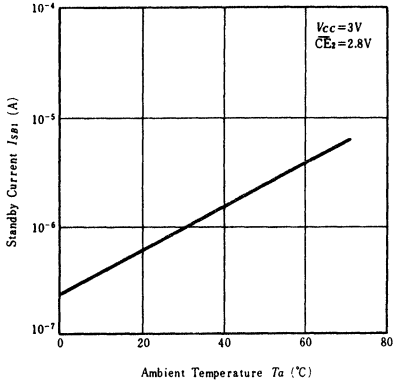
OUTPUT HIGH CURRENT vs. OUTPUT HIGH VOLTAGE



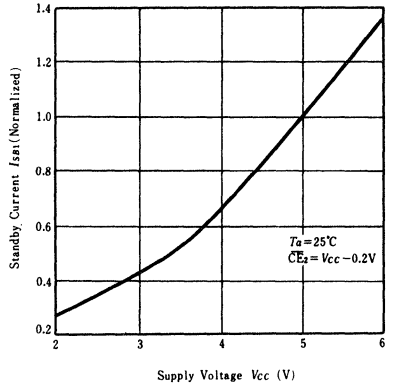
OUTPUT LOW CURRENT vs. OUTPUT LOW VOLTAGE



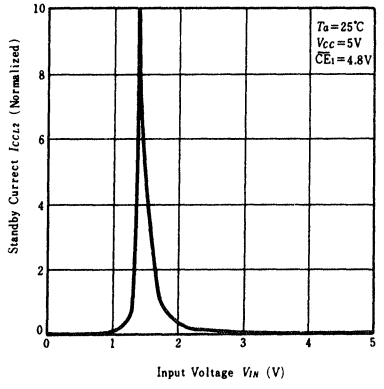
STAND-BY CURRENT vs. AMBIENT TEMPERATURE



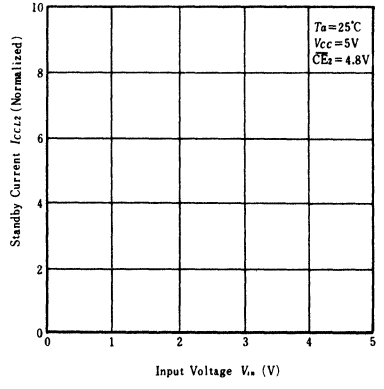
STAND-BY CURRENT vs. SUPPLY VOLTAGE



STAND-BY CURRENT vs. INPUT VOLTAGE



STAND-BY CURRENT vs. INPUT VOLTAGE



HM6168H-45, HM6168H-55, HM6168H-70, HM6168HP-45, HM6168HP-55, HM6168HP-70

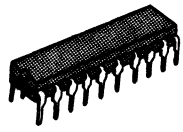
—Under Development

4096-word×4-bit High Speed Static CMOS RAM

■FEATURES

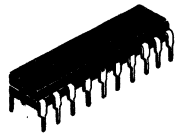
- High Speed: Fast Access Time 45/55/70 ns (max.)
- Single +5V Supply and High Density 20 Pin Package
- Low Power Standby and Low Power Operation;
  100μW typ. (Standby), 250mW typ. (Operation)
- Completely Static Memory
  No Clock or Timing Strobe Required
- Equal Access and Cycle Times
- Directly TTL Compatible — All Inputs and Outputs

HM6168H-45/55/70



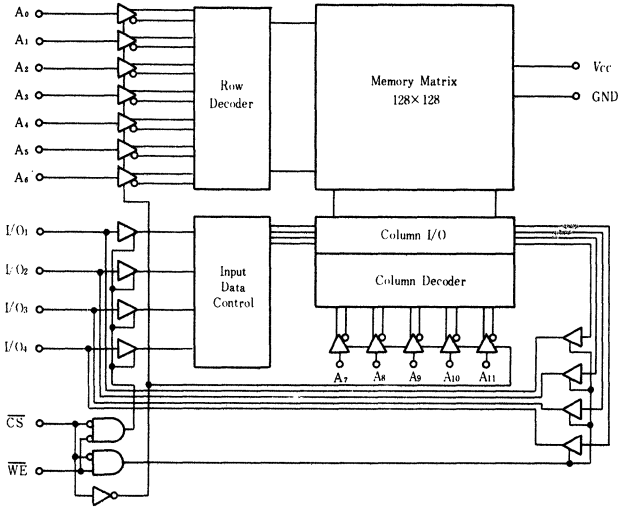
(DG-20)

HM6168HP-45/55/70

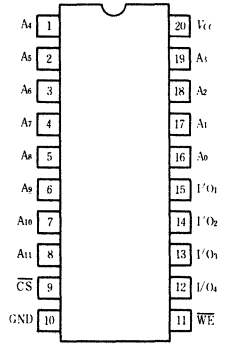


(DP-20)

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

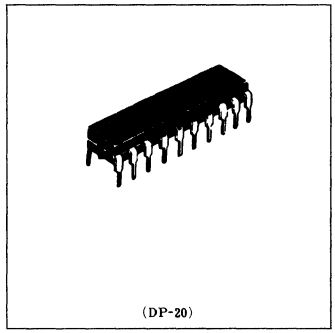
Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_{IN}	−3.5* to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature (Ceramic)	T_{stg}	−65 to +150	°C
Storage Temperature (Plastic)	T_{stg}	−55 to +125	°C
Temperature under Bias	T_{bias}	−10 to +85	°C

* Pulse Width 20ns, DC=−0.5V

Note) The specifications of this device are subject to change without notice.
Please contact your nearest Hitachis Sales Dept. reqarding specifications.

HM6168HLP-45, HM6168HLP-55, HM6168HLP-70 — Under Development

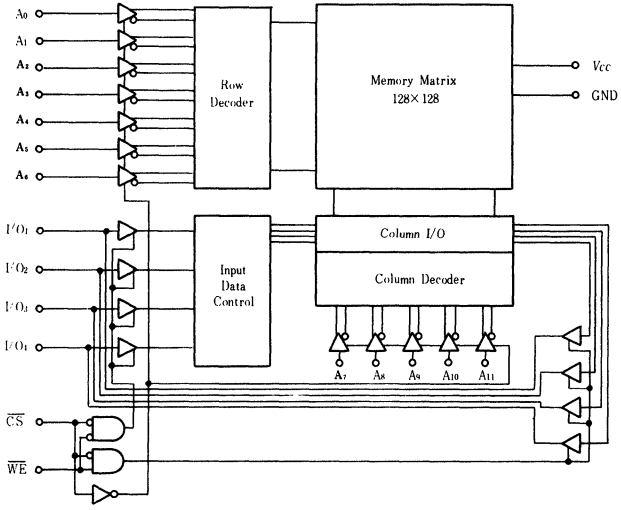
4096-word×4-bit High Speed Static CMOS RAM



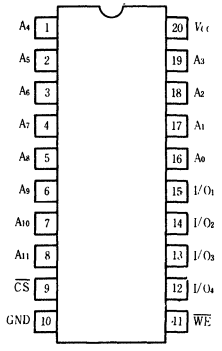
■FEATURES

- High Speed: Fast Access Time 45/55/70ns (max.)
- Single +5V Supply and High Density 20 Pin Package
- Low Power Standby and Low Power Operation;
  5μW typ. (Standby), 250mW typ. (Operation)
- Completely Static Memory
  No Clock or Timing Strobe Required
- Equal Access and Cycle Times
- Directly TTL Compatible—All Inputs and Outputs
- Capable of Battery back up Operation

■FUNCTIONAL BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin Relative to GND	V_{IN}	−3.5* to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Temperature under Bias	T_{bias}	−10 to +85	°C

* Pulse Width 20ns, DC=−0.5V

Note) The specifications of this device are subject to change without notice.
Please contact your nearest Hitachi's Sales Dept. regarding specifications.

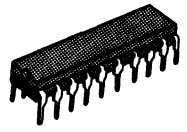
HM6167,HM6167-6,HM6167-8,
HM6167P,HM6167P-6,HM6167P-8

16384-word×1-bit High Speed Static CMOS RAM

■FEATURES

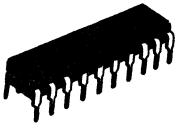
- Single +5V Supply and High Density 20 Pin Package
- Fast Access Time — 70ns/85ns/100ns
- Low Power Stand-by and Low Power Operation
  Stand-by 25mW Typ. and Operating 150mW Typ.
- Completely Static Memory . . . . . No Clock nor Refresh Required
- Fully TTL Compatible — All Inputs and Output
- Separate Data Input and Output . . . . . Three State Output
- Pin-Out Compatible with Intel 2167 Series

HM6167, HM6167-6,
HM6167-8



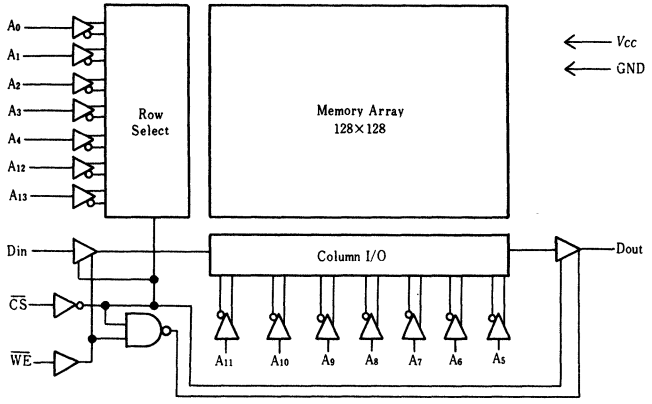
(DG-20)

HM6167P, HM6167P-6,
HM6167P-8

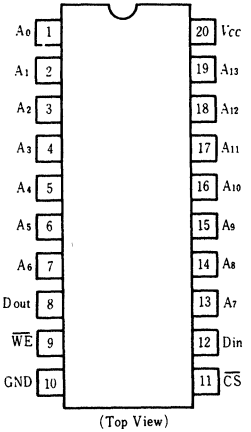


(DP-20)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Terminal Voltage with Respect to GND	V_T	−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature(Plastic)	T_{stg}	−55 to +125	°C
Storage Temperature(Ceramic)	T_{stg}	−65 to +150	°C

■RECOMMENDED DC OPERATING CONDITIONS

(0°C ≦ Ta ≦ 70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High Voltage	V_{IH}	2.2	—	6.0	V
Input Low Voltage	V_{IL}	−0.5	—	0.8	V

■TRUTH TABLE

$\overline{CS}$	$\overline{WE}$	Mode	V_{CC} Current	Output Pin	Reference Cycle
H	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	H	Read	I_{CC}	Dout	Read Cycle 1, 2
L	L	Write	I_{CC}	High Z	Write Cycle 1, 2

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, Ta=0℃ to +70℃)

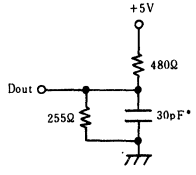
Item	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{IN}=0V~V_{CC}	—	—	2	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}$=V_{IH}, V_{OUT}=0V~V_{CC}	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}$=V_{IL}, Output Open	—	30	60	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}$=V_{IH}	—	5	20	mA
	I_{SB1}	$\overline{CS}$=V_{CC}−0.2V V_{IN}≦0.2V or ≧V_{CC}−0.2V	—	0.02	2	mA
Output Low Voltage	V_{OL}	I_{OL}=8mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH}=−4mA	2.4	—	—	V

Note) Typical limits are at V_{CC}=5.0V, Ta=25℃ and specified loading.

■AC TEST CONDITIONS

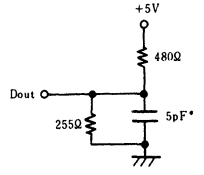
Input pulse levels: GND to 3.0V
Input rise and fall times: 5 ns
Input timing reference levels: 1.5V
Output reference levels: 1.5V
Output load: See Figure

Output Load A



* Including scope and jig.

Output Load B
(for t_{HZ}, t_{LZ}, t_{WZ} & t_{OW})



■CAPACITANCE (Ta=25℃, f=1.0MHz)

Item	Symbol	max	Unit	Conditions
Input Capacitance	C_{IN}	5	pF	V_{IN}=0V
Output Capacitance	C_{OUT}	6	pF	V_{OUT}=0V

Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0℃ to 70℃, unless otherwise noted.)

●READ CYCLE

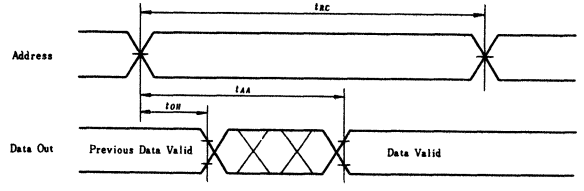
Item	Symbol	HM6167, HM6167P		HM6167-6, HM6167P-6		HM6167-8, HM6167P-8		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	70	—	85	—	100	—	ns
Address Access Time	t_{AA}	—	70	—	85	—	100	ns
Chip Select Access Time	t_{ACS}	—	70	—	85	—	100	ns
Output Hold from Address Change	t_{OH}	5	—	5	—	5	—	ns
Chip Selection to Output in Low Z	t_{LZ}	5	—	5	—	5	—	ns
Chip Deselection to Output in High Z	t_{HZ}	0	30	0	40	0	40	ns
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	0	—	ns
Chip Deselection to Power Down Time	t_{PD}	—	35	—	40	—	45	ns

● WRITE CYCLE

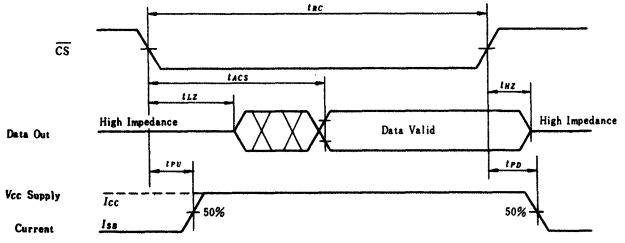
Item	Symbol	HM6167, HM6167P		HM6167-6, HM6167P-6		HM6167-8, HM6167P-8		Unit	Notes
		min	max	min	max	min	max		
Write Cycle Time	t_{WC}	70	—	85	—	100	—	ns	2
Chip Selection to End of Write	t_{CW}	55	—	65	—	80	—	ns	
Address Valid to End of Write	t_{AW}	55	—	65	—	80	—	ns	
Address Setup Time	t_{AS}	0	—	0	—	0	—	ns	
Write Pulse Width	t_{WP}	40	—	45	—	55	—	ns	
Write Recovery Time	t_{WR}	0	—	0	—	0	—	ns	
Data Valid to End of Write	t_{DW}	30	—	35	—	40	—	ns	
Data Hold Time	t_{DH}	0	—	0	—	0	—	ns	
Write Enable to Output in High Z	t_{WZ}	0	30	0	40	0	40	ns	3, 4
Output Active from End of Write	t_{OW}	0	—	0	—	0	—	ns	3, 4

Notes) 1. If $\overline{CS}$ goes high simultaneouly with $\overline{WE}$ high, the output remains in a high impedance state.
2. All Write Cycle timings are referenced from the last valid address to the first transitioning address.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. This parameter is sampled and not 100% tested.

● TIMING WAVEFORM OF READ CYCLE NO. 1 [1), 2)]

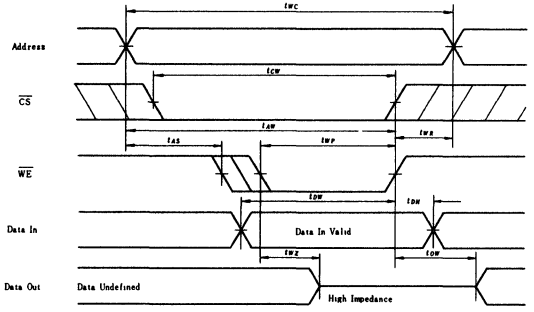


● TIMING WAVEFORM OF READ CYCLE NO. 2 [1), 3)]



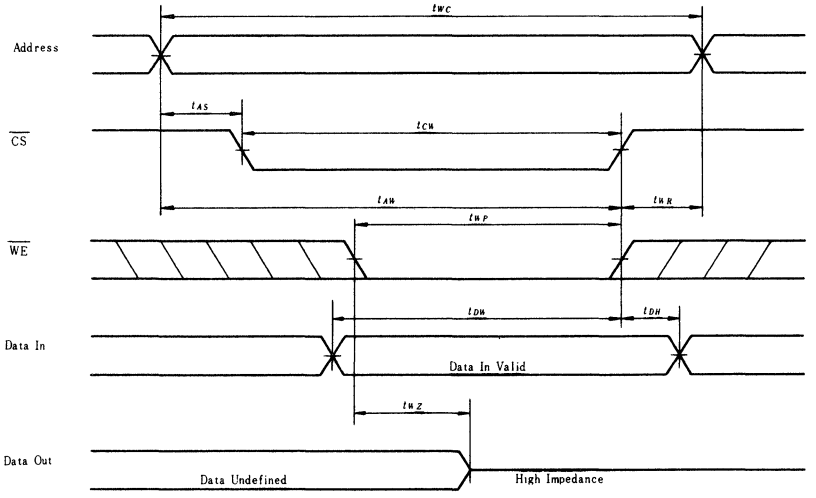
NOTES: 1. $\overline{WE}$ is high and $\overline{CS}$ is low for READ cycle.
2. Addresses valid prior to or coincident with $\overline{CS}$ transition low.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.

● TIMING WAVEFORM OF WRITE CYCLE NO. 1 ($\overline{WE}$ Controlled)



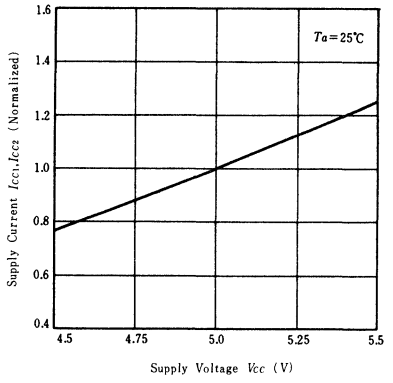
NOTE: 1. Transition is measured ±500mV from steady state voltage with specified loading in Load B.

● TIMING WAVEFORM OF WRITE CYCLE No. 2 ($\overline{CS}$ Controlled)

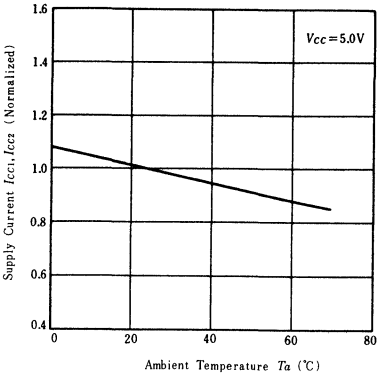


Note) Transition is measured ±500mV from steady state voltage with specified loading in Load B.

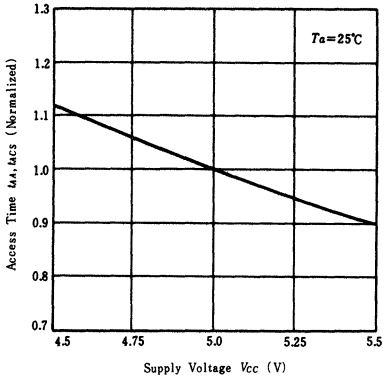
SUPPLY CURRENT vs. SUPPLY VOLTAGE



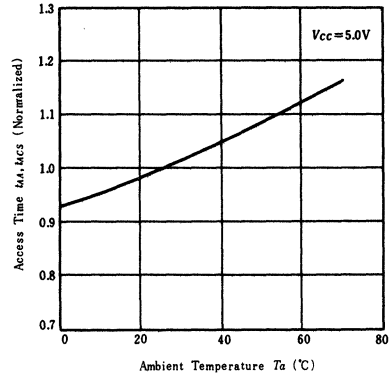
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



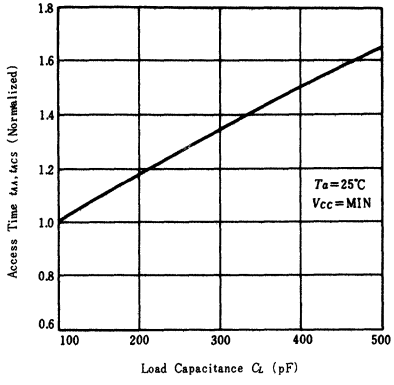
ACCESS TIME vs. SUPPLY VOLTAGE



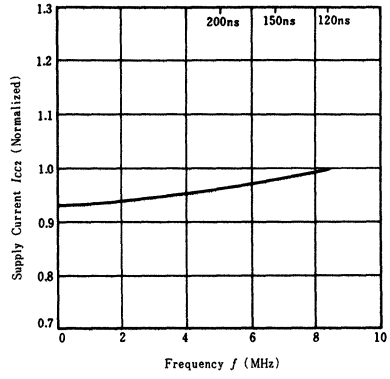
ACCESS TIME vs. AMBIENT TEMPERATURE



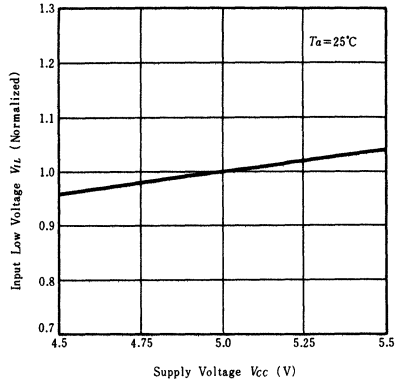
ACCESS TIME vs. LOAD CAPACITANCE



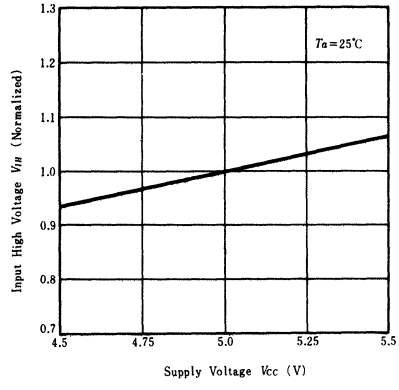
SUPPLY CURRENT vs. FREQUENCY



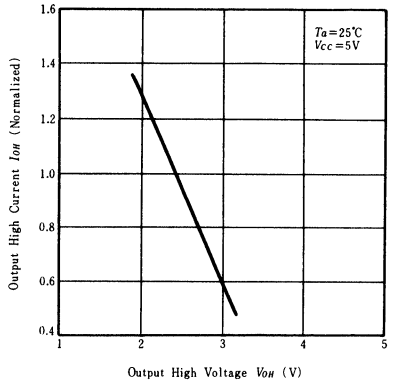
INPUT LOW VOLTAGE vs. SUPPLY VOLTAGE



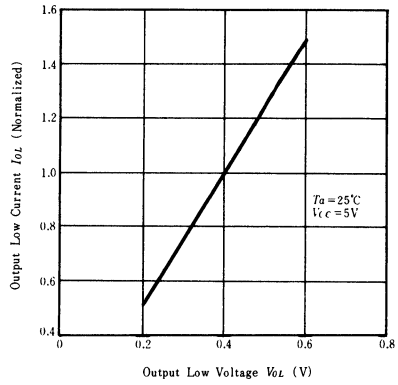
INPUT HIGH VOLTAGE vs. 'SUPPLY VOLTAGE



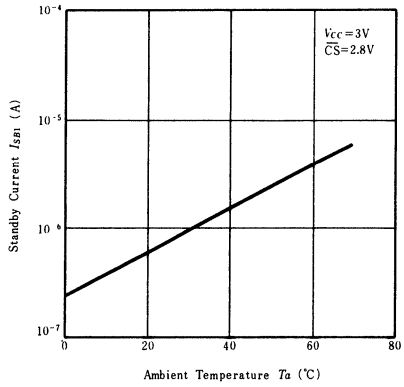
OUTPUT HIGH CURRENT vs. OUTPUT HIGH VOLTAGE



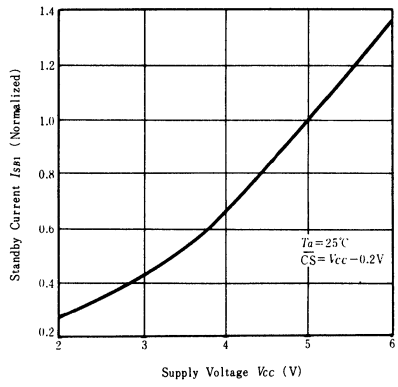
OUTPUT LOW CURRENT vs. OUTPUT LOW VOLTAGE



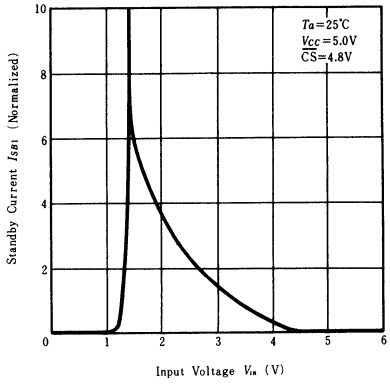
STANDBY CURRENT vs. AMBIENT TEMPERATURE



STANDBY CURRENT vs. SUPPLY VOLTAGE



STANDBY CURRENT vs. INPUT VOLTAGE

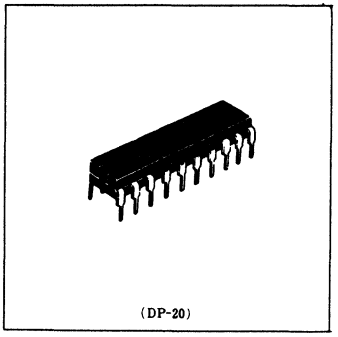


HM6167LP, HM6167LP-6, HM6167LP-8

16384-word×1-bit High Speed Static CMOS RAM

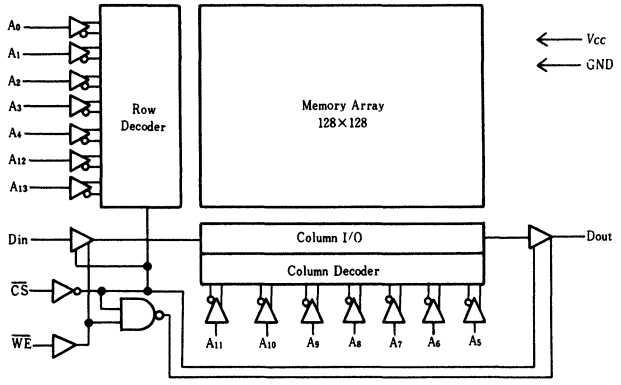
■FEATURES

- Single +5V Supply and High Density 20 Pin Package
- Fast Access Time 70ns/85ns/100ns
- Low Power Stand-by and Low Power Operation
  Stand-by 5μW (typ) and Operating 150mW (typ.)
- Completely Static Memory. . . . . .No Clock or Refresh Required
- Fully TTL Compatible . . . . . .All Inputs and Output
- Separate Data Input and Output . . . . . .Three State Output
- Capable of Battery Back up Operation

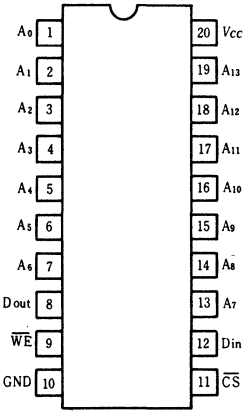


(DP-20)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Terminal Voltage with Respect to GND	V_T	−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C

■RECOMMENDED DC OPERATING CONDITIONS ($0°C \leqq Ta \leqq 70°C$)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High Voltage	V_{IH}	2.2	—	6.0	V
Input Low Voltage	V_{IL}	−0.5	—	0.8	V

■TRUTH TABLE

$\overline{CS}$	$\overline{WE}$	Mode	V_{CC} Current	Output Pin	Reference·Cycle
H	×	Not Selected	I_{SB}, I_{SB1}	High Z	
L	H	Read	I_{CC}	Dout	Read Cycle 1, 2
L	L	Write	I_{CC}	High Z	Write Cycle 1, 2

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, Ta=0~+70°C)

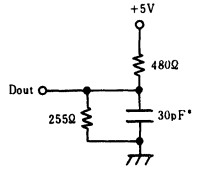
Item	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V V_{IN}=0V~V_{CC}	—	—	2	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}$=V_{IH}, V_{out}=0V~V_{CC}	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}$=V_{IL}, Output Open	—	30	60	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}$=V_{IH}	—	5	20	mA
	I_{SB1}	$\overline{CS}$=V_{CC}−0.2V V_{IN}≦0.2V or ≧V_{CC}−0.2V	—	1	50	μA
Output Low Voltage	V_{OL}	I_{OL}=8mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH}=−4mA	2.4	—	—	V

Note) Typical limits are at V_{CC}=5.0V, Ta=25°C and specified loading.

■AC TEST CONDITIONS

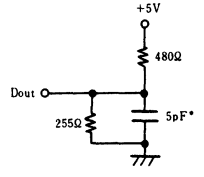
Input pulse levels: GND to 3.0V
Input rise and fall times: 5 ns
Input timing reference levels: 1.5V
Output reference levels: 1.5V
Output load: See Figure

Output Load A



* Including scope and jig.

Output Load B
(for t_{HZ}, t_{LZ}, t_{WZ} & t_{OW})



■CAPACITANCE (Ta=25°C, f=1.0MHz)

Item	Symbol	max	Unit	Conditions
Input Capacitance	C_{IN}	5	pF	V_{IN}=0V
Output Capacitance	C_{OUT}	6	pF	V_{OUT}=0V

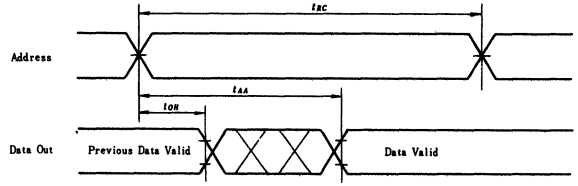
Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS (Ta=0°C to +70°C, V_{CC}=5V±10%, unless otherwise noted.)

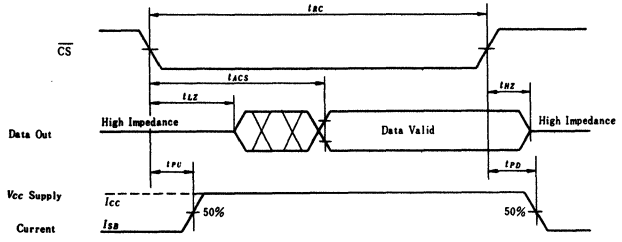
●READ CYCLE

Item	Symbol	HM6167LP		HM6167LP-6		HM6167LP-8		Unit
		min	max	min	max	min	max	
Read Cycle Time	t_{RC}	70	—	85	—	100	—	ns
Address Access Time	t_{AA}	—	70	—	85	—	100	ns
Chip Select Access Time	t_{ACS}	—	70	—	85	—	100	ns
Output Hold from Address Change	t_{OH}	5	—	5	—	5	—	ns
Chip Selection to Output in Low Z	t_{LZ}	5	—	5	—	5	—	ns
Chip Deselection to Output in High Z	t_{HZ}	0	30	0	40	0	40	ns
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	0	—	ns
Chip Deselection to Power Down Time	t_{PD}	—	35	—	40	—	45	ns

● TIMING WAVEFORM OF READ CYCLE NO. 1 [1), 2)]



● TIMING WAVEFORM OF READ CYCLE NO. 2 [1), 3)]



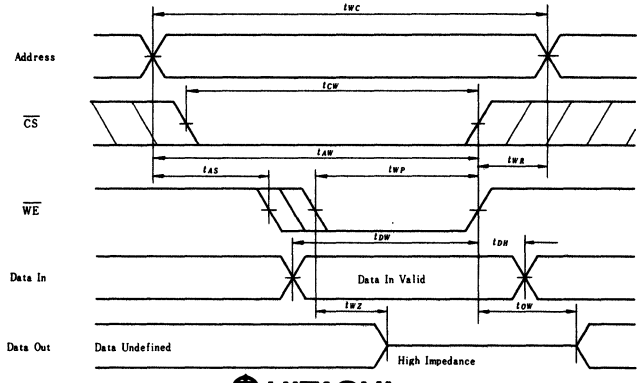
NOTES: 1. $\overline{WE}$ is high and $\overline{CS}$ is low for READ Cycle.
2. Addresses valid prior to or coincident with $\overline{CS}$ transition low.
3. Transition is measured ±500mV from steady state voltage with specified loading B.

● WRITE CYCLE

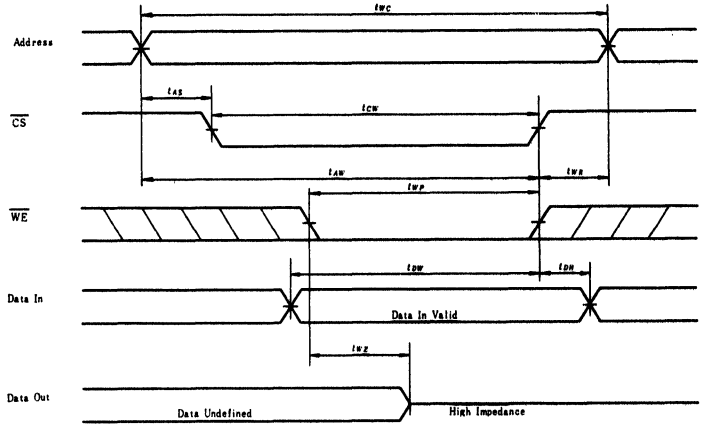
Item	Symbol	HM6167LP		HM6167LP-6		HM6167LP-8		Unit	Notes
		min	max	min	max	min	max		
Write Cycle Time	t_{WC}	70	—	85	—	100	—	ns	2
Chip Selection to End of Write	t_{CW}	55	—	65	—	80	—	ns	
Address Valid to End of Write	t_{AW}	55	—	65	—	80	—	ns	
Address Setup Time	t_{AS}	0	—	0	—	0	—	ns	
Write Pulse Width	t_{WP}	40	—	45	—	55	—	ns	
Write Recovery Time	t_{WR}	0	—	0	—	0	—	ns	
Data Valid to End of Write	t_{DW}	30	—	35	—	40	—	ns	
Data Hold Time	t_{DH}	0	—	0	—	0	—	ns	
Write Enable to Output in High Z	t_{WZ}	0	30	0	40	0	40	ns	3, 4
Output Active from End of Write	t_{OW}	0	—	0	—	0	—	ns	3, 4

Notes) 1. If $\overline{CS}$ goes high simultaneouly with $\overline{WE}$ high, the output remains in a high impedance state.
2. All Write Cycle timings are referenced from the last valid address to the first transitioning address.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. This parameter is sampled and not 100% tested.

● TIMING WAVEFORM OF WRITE CYCLE NO. 1 ($\overline{WE}$ Controlled)



●TIMING WAVEFORM OF WRITE CYCLE No. 2 ($\overline{CS}$ Controlled)



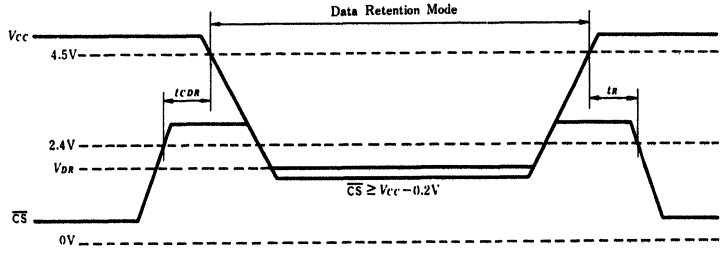
■LOW V_{CC} DATA RETENTION CHARACTERISTICS (Ta=0°C to 70°C)

Parameter	Symbol	Test Condition	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}	$\overline{CS} \geq V_{CC}-0.2V$ $V_{in} \geq V_{CC}-0.2V$ or $0V \leq V_{in} \leq 0.2V$	2.0	—	—	V
Data Retention Current	I_{CCDR}		—	—	20*	μA
			—	—	30**	
Chip Deselect to Data Retention Time	t_{CDR}		0	—	—	ns
Operation Recovery Time	t_R		t_{RC}△	—	—	ns

△ t_{RC}=Read Cycle Time

* V_{CC}=2.0V
** V_{CC}=3.0V

■LOW V_{CC} DATA RETENTION WAVEFORM



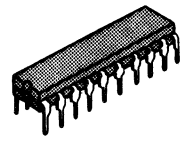
HM6167H-45, HM6167H-55, HM6167HP-45, HM6167HP-55

16384-word x 1-bit High Speed Static CMOS RAM

■ FEATURES

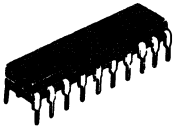
- Fast Access Time. . . . . .HM6167H/P-45 45ns (max)
  HM6167H/P-55 55ns (max)
- Low Power Standby and Low Power Operation
  Standby 100μW (typ), Operating 200mW (typ)
- Single +5V Supply and High Density 20 Pin Package
- Completely Static Memory . . . .No Clock nor Refresh Required
- Fully TTL Compatible . . . . . .All Inputs and Output
- Separate Data Input and Output. . . . . .Three State Output

HM6167H-45, HM6167H-55



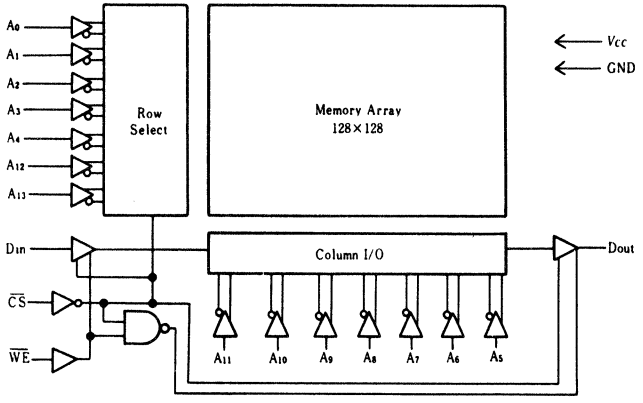
(DG-20)

HM6167HP-45, HM6167HP-55

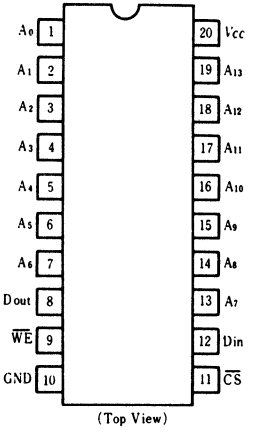


(DP-20)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Terminal Voltage with respect to GND	V_T	−3.5* to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature (Plastic)	T_{stg}	−55 to +125	°C
Storage Temperature (Ceramic)	T_{stg}	−65 to +150	°C
Storage Temperature (under bias)	T_{bias}	−10 to +85	°C

* Pulse Width 20ns, DC: −0.5V

■ RECOMMENDED DC OPERATING CONDITIONS (T_a = 0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	–	6.0	V
	V_{IL}	−3.0*	–	0.8	V

* Pulse Width: 20ns, DC: V_{IL} (min) = −0.5V

■ TRUTH TABLE

$\overline{CS}$	$\overline{WE}$	Mode	V_{CC} Current	Dout Pin	Ref. Cycle
H	×	Not selected	I_{SB}, I_{SB1}	High-Z	
L	H	Read	I_{CC}	Dout	Read Cycle
L	L	Write	I_{CC}	High-Z	Write Cycle

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, Ta=0℃ to +70℃)

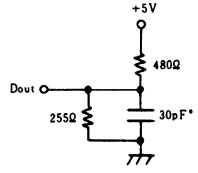
Item	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V, V_{IN}=0V~V_{CC}	—	—	2	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}$=V_{IH}, V_{OUT}=0V~V_{CC}	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}$=V_{IL}, Output Open	—	40	80	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}$=V_{IH}	—	10	20	mA
	I_{SB1}	$\overline{CS}$≧V_{CC}−0.2V V_{IN}≦0.2V or ≧V_{CC}−0.2V	—	0.02	2	mA
Output Low Voltage	V_{OL}	I_{OL}=8mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH}=−4mA	2.4	—	—	V

Note) Typical limits are at V_{CC}=5.0V, Ta=25℃ and specified loading.

■AC TEST CONDITIONS

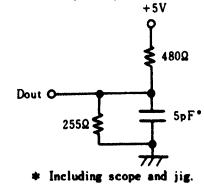
Input pulse levels: GND to 3.0V
Input rise and fall times: 5 ns
Input timing reference levels: 1.5V
Output reference levels: 1.5V
Output load: See Figure

Output Load A



* Including scope and jig.

Output Load B
(for t_{HZ}, t_{LZ}, t_{WZ} & t_{OW})



* Including scope and jig.

■CAPACITANCE (Ta=25℃, f=1.0MHz)

Item	Symbol	typ	max	Unit	Conditions
Input Capacitance	C_{IN}	3	5	pF	V_{IN}=0V
Output Capacitance	C_{OUT}	5	7	pF	V_{OUT}=0V

Note) This parameter is sampled and not 100% tested.

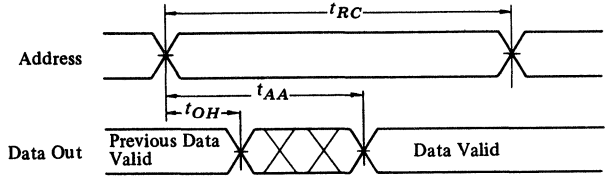
■AC CHARACTERISTICS (V_{CC}=5V±10%, Ta=0°C to 70°C, unless otherwise noted.)

●READ CYCLE

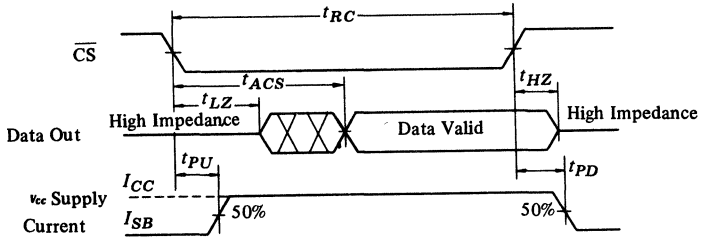
Item	Symbol	HM6167H/P-45		HM6167HP-55		Unit	Notes
		min	max	min	max		
Read Cycle Time	t_{RC}	45	–	55	–	ns	(1)
Address Access Time	t_{AA}	–	45	–	55	ns	
Chip Select Access Time	t_{ACS}	–	45	–	55	ns	
Output Hold from Address Change	t_{OH}	5	–	5	–	ns	
Chip Selection to Output in Low Z	t_{LZ}	5	–	5	–	ns	(2) (3) (7)
Chip Deselection to Output in High Z	t_{HZ}	0	30	0	30	ns	(2) (3) (7)
Chip Selection to Power Up Time	t_{PU}	0	–	0	–	ns	
Chip Deselection to Power Down Time	t_{PD}	–	30	–	30	ns	

NOTES: 1. All Read Cylce timing are referenced from last valid address to the first transitioning address.
2. At any given temperature and voltage condition, t_{HZ} max. is less than t_{LZ} min. both for a given device and from device to device.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. $\overline{WE}$ is High for READ cycle.
5. Device is continuously selected, $\overline{CS}$ = V_{IL}.
6. Addresses valid prior to or coincident with $\overline{CS}$ transition low.
7. This parameter is sampled and not 100% tested.

●TIMING WAVEFORM OF READ CYCLE NO.1 [4), 5)]



●TIMING WAVEFORM OF READ CYCLE NO.2 [4), 6)]

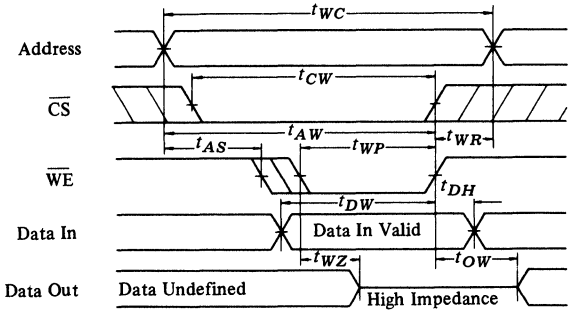


• WRITE CYCLE

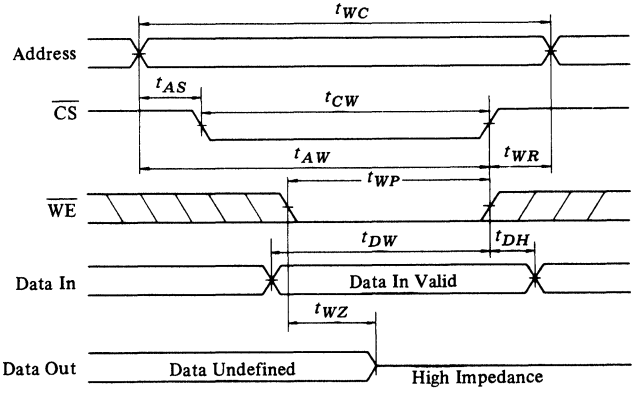
Item	Symbol	HM6167H/P-45		HM6167H/P-55		Unit	Notes
		min	max	min	max		
Write Cycle Time	t_{WC}	45	–	55	–	ns	(2)
Chip Selection to End of Write	t_{CW}	40	–	50	–	ns	
Address Valid to End of Write	t_{AW}	40	–	50	–	ns	
Address Setup Time	t_{AS}	0	–	0	–	ns	
Write Pulse Width	t_{WP}	25	–	35	–	ns	
Write Recovery Time	t_{WR}	0	–	0	–	ns	
Data Valid to End of Write	t_{DW}	25	–	25	–	ns	
Data Hold Time	t_{DH}	0	–	0	–	ns	
Write Enable to Output in High Z	t_{WZ}	0	25	0	25	ns	(3) (4)
Output Active from End of Write	t_{OW}	0	–	0	–	ns	(3) (4)

NOTES: 1. If $\overline{CS}$ goes high simultaneously with $\overline{WE}$ high, the output remains in a high impedance states.
2. All write cycle timings are referenced from the last valid address to the first transitioning address.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. This parameter is sampled and not 100% tested.

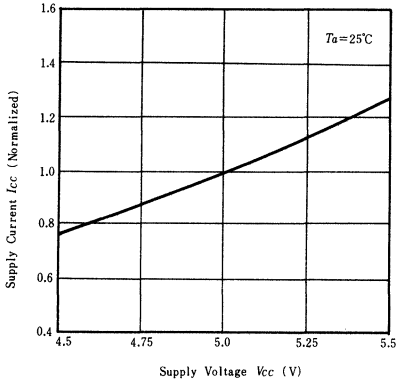
• TIMING WAVEFORM OF WRITE CYCLE ($\overline{WE}$ Controled)



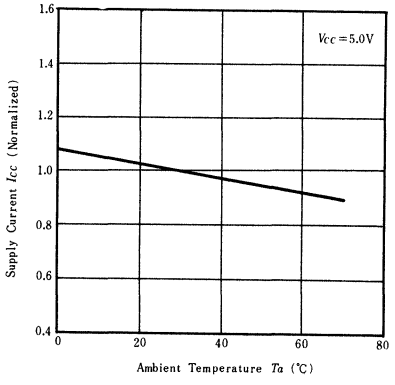
• TIMING WAVEFORM OF WRITE CYCLE ($\overline{CS}$ Controled)



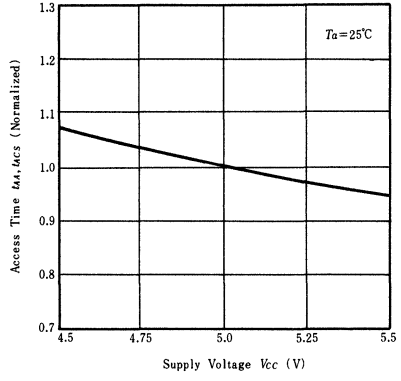
SUPPLY CURRENT vs. SUPPLY VOLTAGE



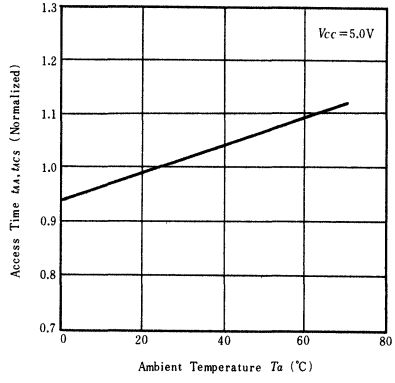
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



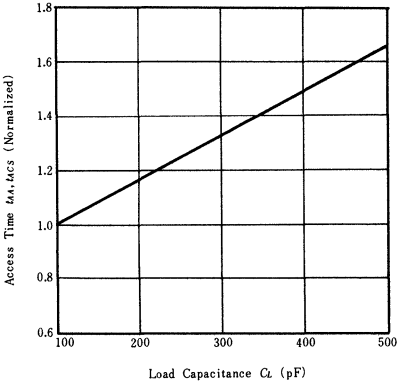
ACCESS TIME vs. SUPPLY VOLTAGE



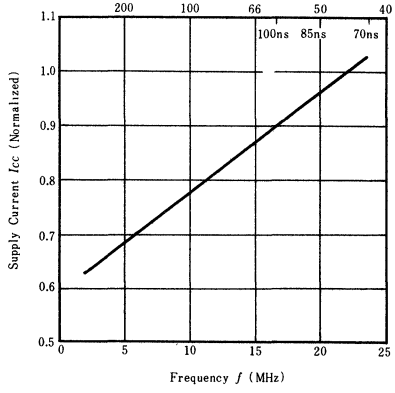
ACCESS TIME vs. AMBIENT TEMPERATURE



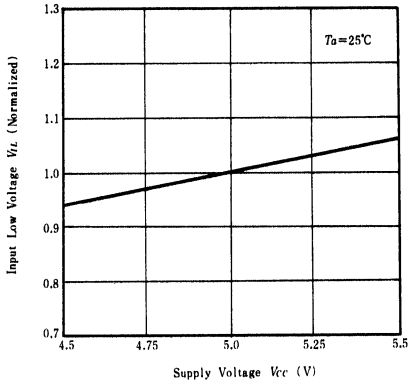
ACCESS TIME vs. LOAD CAPACITANCE



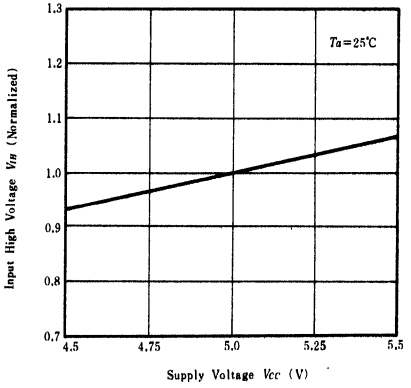
SUPPLY CURRENT vs. FREQUENCY



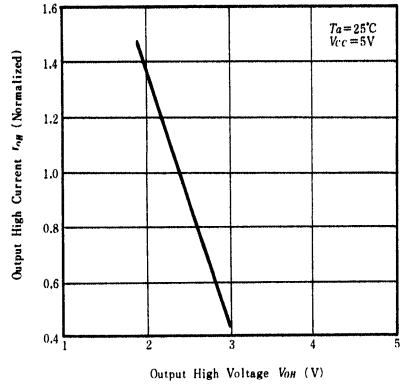
INPUT LOW VOLTAGE vs. SUPPLY VOLTAGE



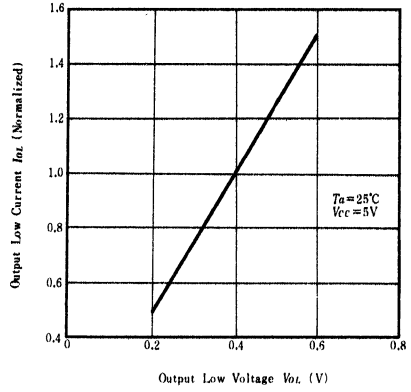
INPUT HIGH VOLTAGE vs. SUPPLY VOLTAGE



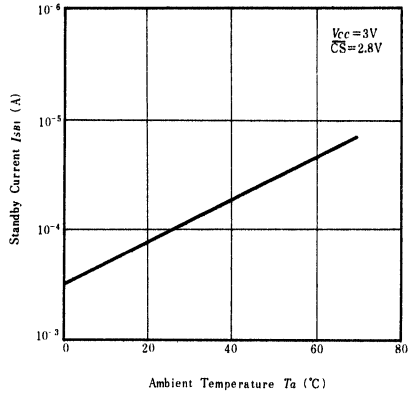
OUTPUT CURRENT vs. OUTPUT VOLTAGE



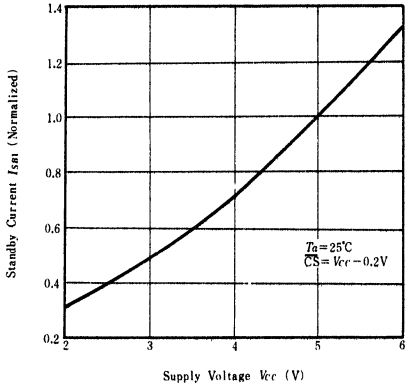
OUTPUT CURRENT vs. OUTPUT VOLTAGE



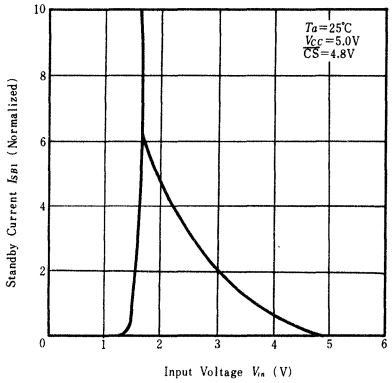
STANDBY CURRENT vs. AMBIENT TEMPERATURE



STANDBY CURRENT vs. SUPPLY VOLTAGE



STANDBY CURRENT vs. INPUT VOLTAGE

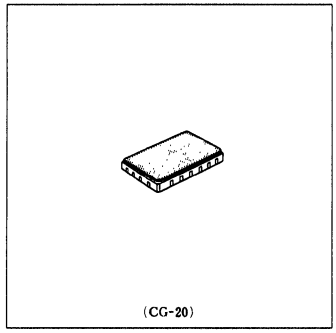


HM6167HCG-45, HM6167HCG-55

16384-word×1-bit High Speed Static CMOS RAM

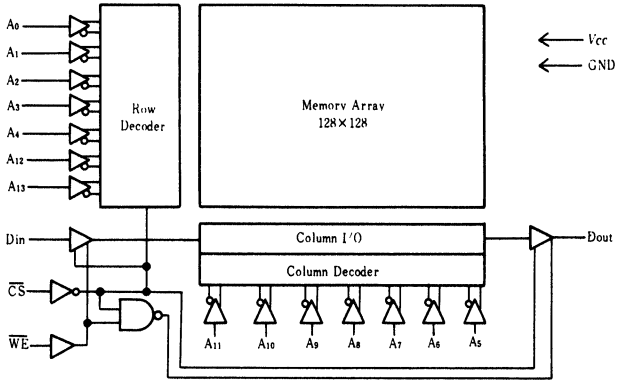
■FEATURES

- High Density 20 pin Leadless Chip Carrier
- High Speed: Fast Access Time 45/55ns Max.
- Low Power Standby and Low Power Operation
  Standby: 100μW typ., Operation: 200mW typ.
- Completely Static Memory;
  No Clock or Timing Strobe Required
- Equal Access and Cycle Times
- Directly TTL Compatible; All Inputs and Output

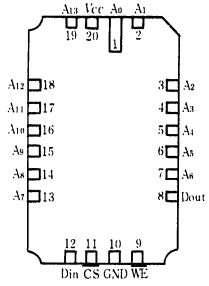


(CG-20)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Bottom View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin*	V_T	−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−65 to +150	°C
Temperature Under Bias	T_{bias}	−10 to +85	°C

* with respect to GND. V_{IN} min = −3.5V (Pulse width 20ns)

■TRUTH TABLE

$\overline{CS}$	$\overline{WE}$	Mode	V_{CC} Current	Dout Pin	Ref. Cycle
H	×	Not selected	I_{SB}, I_{SB1}	High-Z	
L	H	Read	I_{CC}	Dout	Read Cycle
L	L	Write	I_{CC}	High-Z	Write Cycle

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	—	6.0	V
	V_{IL}	−0.5*	—	0.8	V

* −3.0V (Pulse width 20ns)

■DC AND OPERATING CHARACTERISTICS (V_{CC}=5V ±10%, Ta=0 to +70°C)

Item	Symbol	Test Conditions	min	typ*	max	Unit
Input Leakage Current	$\lvert I_{LI} \rvert$	V_{CC}=5.5V, V_{IN}=0V to V_{CC}	—	—	2	μA
Output Leakage Current	$\lvert I_{LO} \rvert$	$\overline{CS}=V_{IH}$, V_{OUT}=0V to V_{CC}	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}=V_{IL}$, Output Open	—	40	80	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}=V_{IH}$	—	10	20	mA
	I_{SB1}	$\overline{CS} \geqq V_{CC}-0.2V$, $V_{IN} \leqq 0.2V$ or $V_{IN} \geqq V_{CC}-0.2V$	—	20	2000	μA
Output Voltage	V_{OL}	I_{OL}=8mA	—	—	0.4	V
	V_{OH}	I_{OH}=−4mA	2.4	—	—	V

Note) * : Typical limits are at V_{CC}=5.0V, Ta=25°C and specified loading.

■CAPACITANCE (Ta=25°C, f=1MHz)

Item	Symbol	Test Conditions	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	3	5	pF
Output Capacitance	C_{out}	V_{out}=0V	5	7	pF

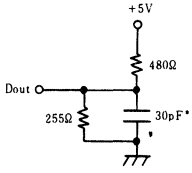
Note) This parameter is sampled and not 100% tested.

■AC CHARACTERISTICS (V_{CC}=5V ±10%, Ta=0 to +70°C)

●AC TEST CONDITIONS

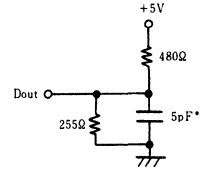
Input Pulse Levels: GND to 3.0V
Input Rise and Fall Times: 5 ns
Output Reference Levels: 1.5V

Output Load A



* Including scope and jig.

Output Load B
(for t_{HZ}, t_{LZ}, t_{WZ} & t_{OW})

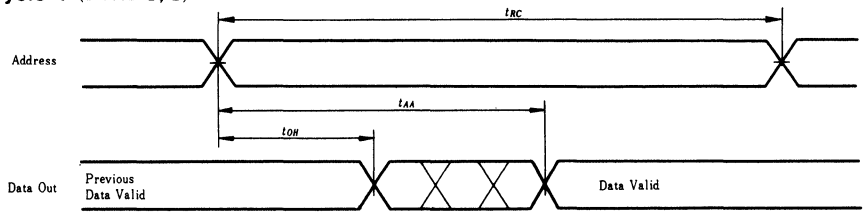


●READ CYCLE

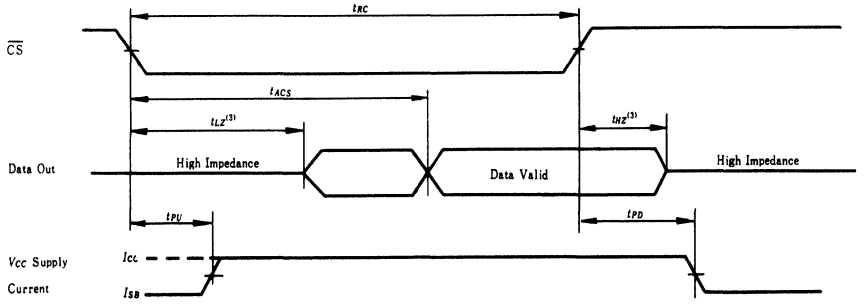
Item	Symbol	HM6167HCG-45		HM6167HCG-55		Unit	Notes
		min	max	min	max		
Read Cycle Time	t_{RC}	45	—	55	—	ns	1
Address Access Time	t_{AA}	—	45	—	55	ns	
Chip Select Access Time	t_{ACS}	—	45	—	55	ns	
Output Hold from Address Change	t_{OH}	5	—	5	—	ns	
Chip Selection to Output in Low Z	t_{LZ}	5	—	5	—	ns	2, 3, 4
Chip Deselection to Output in High Z	t_{HZ}	0	30	0	30	ns	2, 3, 4
Chip Selection to Power Up Time	t_{PU}	0	—	0	—	ns	
Chip Deselection to Power Down Time	t_{PD}	—	30	—	30	ns	

Notes) 1. All Read Cycle timings are referenced from last valid address to the first transitioning address.
2. At any given temperature and voltage condition, t_{HZ} max is less than t_{LZ} min both for a given device and from device to device.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. This parameter is sampled and not 100% tested.

●Read Cycle-1 (Notes 1, 2)



●Read Cycle-2 (Notes 1, 3)



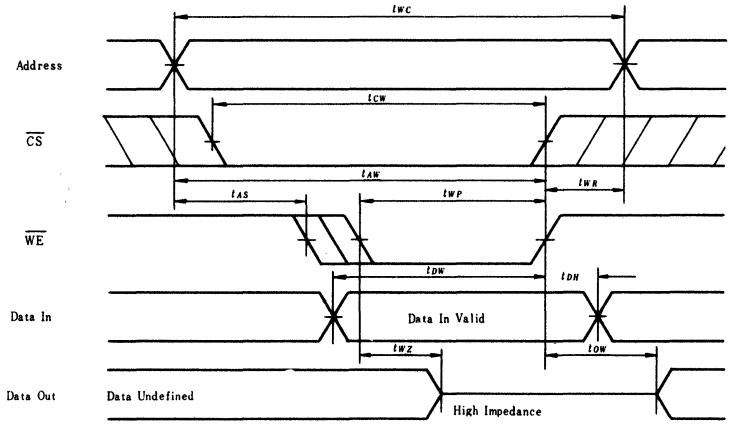
Notes) 1. $\overline{WE}$ is high for Read Cycle.
2. Address valid prior to or coincident with $\overline{CS}$ transition low.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.

●WRITE CYCLE

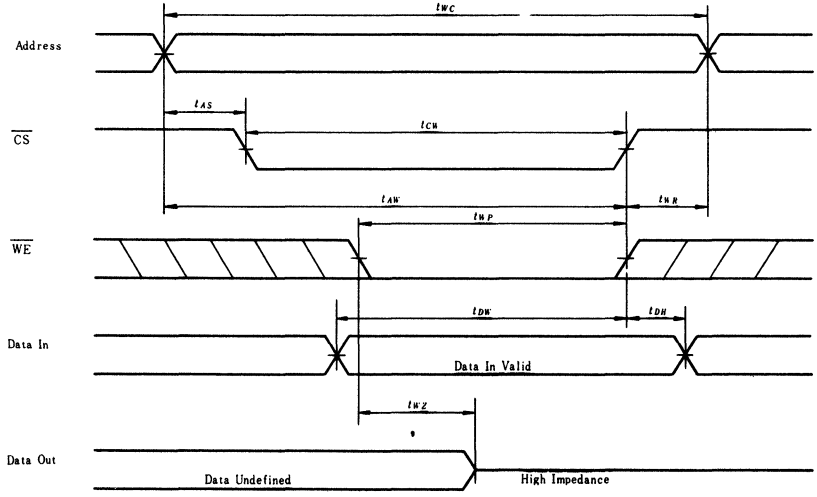
Item	Symbol	HM6167HCG-45		HM6167HCG-55		Unit	Notes
		min	max	min	max		
Write Cycle Time	t_{WC}	45	—	55	—	ns	2
Chip Selection to End of Write	t_{CW}	40	—	50	—	ns	
Address Valid to End of Write	t_{AW}	40	—	50	—	ns	
Address Setup Time	t_{AS}	0	—	0	—	ns	
Write Pulse Width	t_{WP}	25	—	35	—	ns	
Write Recovery Time	t_{WR}	0	—	0	—	ns	
Data Valid to End of Write	t_{DW}	25	—	25	—	ns	
Data Hold Time	t_{DH}	0	—	0	—	ns	
Write Enable to Output in High Z	t_{WZ}	0	25	0	25	ns	3, 4
Output Active from End of Write	t_{OW}	0	—	0	—	ns	3, 4

Notes) 1. If $\overline{CS}$ goes high simultaneouly with $\overline{WE}$ high, the output remains in a high impedance state.
2. All Write Cycle timings are referenced from the last valid address to the first transitioning address.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. This parameter is sampled and not 100% tested.

●Write Cycle-1 ($\overline{WE}$ Controlled)



●Write Cycle-2 ($\overline{CS}$ Controlled)

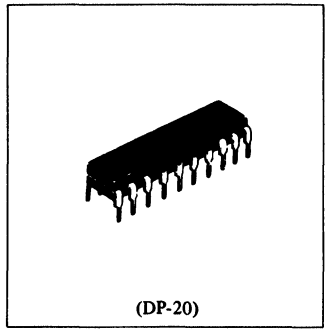


HM6167HLP-45, HM6167HLP-55

16384-word x 1-bit High Speed Static CMOS RAM

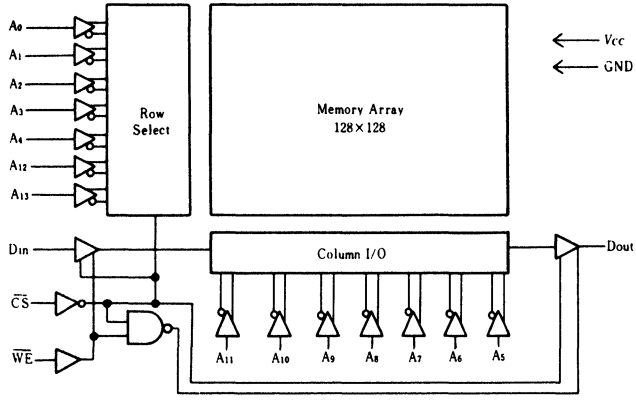
■ FEATURES

- Fast Access Time. . . . . .HM6167HLP-45 45ns (max)
  HM6167HLP-55 55ns (max)
- Low Power Standby and Low Power Operation
  Standby 5μW (typ) and Operating 200mW (typ)
- Capable of Battery Back-up Operation
- Single +5V Supply and High Density 20 Pin Package
- Completely static Memory
  No Clock or Timing Strobe Required
- Equal Access and Cycle Times
- Directly TTL Compatible . . . . .All Inputs and Output

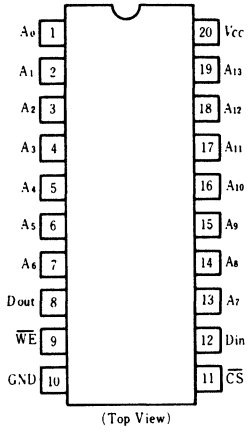


(DP-20)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Terminal Voltage with respect to GND	V_T	−3.5* to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Storage Temperature Under Bias	T_{bias}	−10 to +85	°C

* Pulse Width 20ns, DC: −0.5V

■ RECOMMENDED DC OPERATING CONDITIONS (T_a = 0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	–	6.0	V
	V_{IL}	−3.0*	–	0.8	V

* Pulse Width 20ns, DC: V_{IL} min = −0.5V

■ TRUTH TABLE

$\overline{CS}$	$\overline{WE}$	Mode	V_{CC} Current	Dout Pin	Ref. Cycle
H	×	Not selected	I_{SB}, I_{SB1}	High-Z	
L	H	Read	I_{CC}	Dout	Read Cycle
L	L	Write	I_{CC}	High-Z	Write Cycle

■ DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±10%, Ta=0~+70°C)

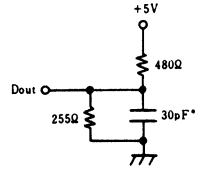
Item	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	$\|I_{LI}\|$	V_{CC}=5.5V V_{IN}=0V~V_{CC}	—	—	2	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS}$=V_{IH}, V_{out}=0V~V_{CC}	—	—	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS}$=V_{IL}, Output Open	—	40	80	mA
Standby Power Supply Current	I_{SB}	$\overline{CS}$=V_{IH}	—	10	20	mA
	I_{SB1}	$\overline{CS}$=V_{CC}−0.2V V_{IN}≦0.2V or ≧V_{CC}−0.2V	—	1	50	μA
Output Low Voltage	V_{OL}	I_{OL}=8mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH}=−4mA	2.4	—	—	V

Note) Typical limits are at V_{CC}=5.0V, Ta=25°C and specified loading.

■ AC TEST CONDITIONS

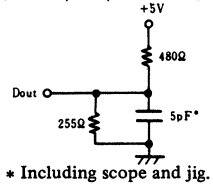
Input pulse levels: GND to 3.0V
Input rise and fall times: 5 ns
Input timing reference levels: 1.5V
Output reference levels: 1.5V
Output load: See Figure

Output Load A



* Including scope and jig.

Output Load B
(for t_{HZ}, t_{LZ}, t_{WZ} & t_{OW})



* Including scope and jig.

■ CAPACITANCE (Ta=25°C, f=1.0MHz)

Item	Symbol	typ.	max	Unit	Conditions
Input Capacitance	C_{IN}	3	5	pF	V_{IN}=0V
Output Capacitance	C_{OUT}	5	7	pF	V_{OUT}=0V

Note) This parameter is sampled and not 100% tested.

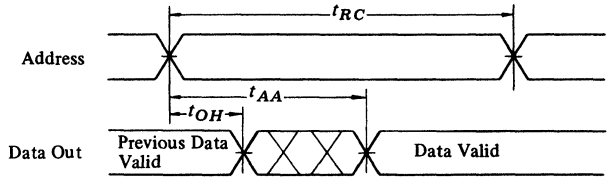
■ AC CHARACTERISTICS (Ta=0°C to +70°C, V_{CC}=5V±10%, unless otherwise noted.)

● READ CYCLE

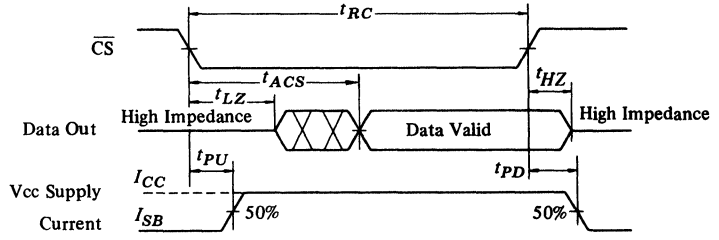
Item	Symbol	HM6167HLP-45		HM6167HLP-55		Unit	Notes
		min	max	min	max		
Read Cycle Time	t_{RC}	45	–	55	–	ns	(1)
Address Access Time	t_{AA}	–	45	–	55	ns	
Chip Select Access Time	t_{ACS}	–	45	–	55	ns	
Output Hold from Address Change	t_{OH}	5	–	5	–	ns	
Chip Selection to Output in Low Z	t_{LZ}	5	–	5	–	ns	(2) (3) (7)
Chip Selection to Output in High Z	t_{HZ}	0	30	0	30	ns	(2) (3) (7)
Chip Selection to Power Up Time	t_{PU}	0	–	0	–	ns	
Chip Deselection to Power Down Time	t_{PD}	–	30	–	30	ns	

NOTES:
1. All Read Cylce timing are referenced from last valid address to the first transitioning address.
2. At any given temperature and voltage condition, t_{HZ} max. is less than t_{LZ} min. both for a given device and from device to device.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. $\overline{WE}$ is High for READ cycle.
5. Device is continuously selected, $\overline{CS}$ = V_{IL}.
6. Addresses valid prior to or coincident with $\overline{CS}$ transition low.
7. This parameter is sampled and not 100% tested.

● TIMING WAVEFORM OF READ CYCLE NO. 1 [4) 5)]



● TIMING WAVEFORM OF READ CYCLE NO. 2 [4) 6)]

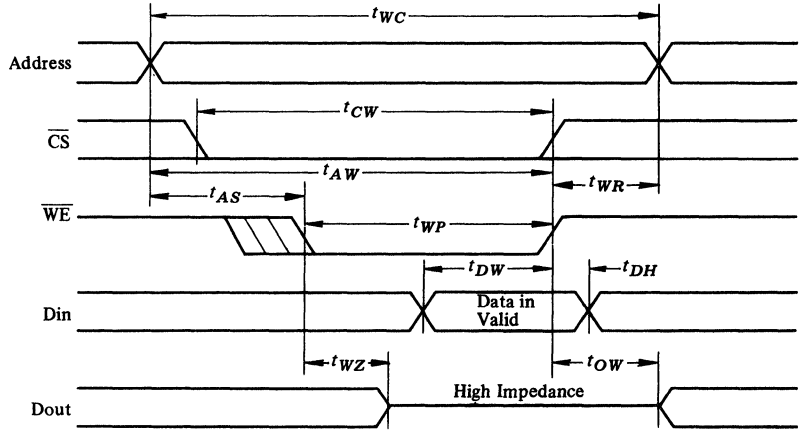


● WRITE CYCLE

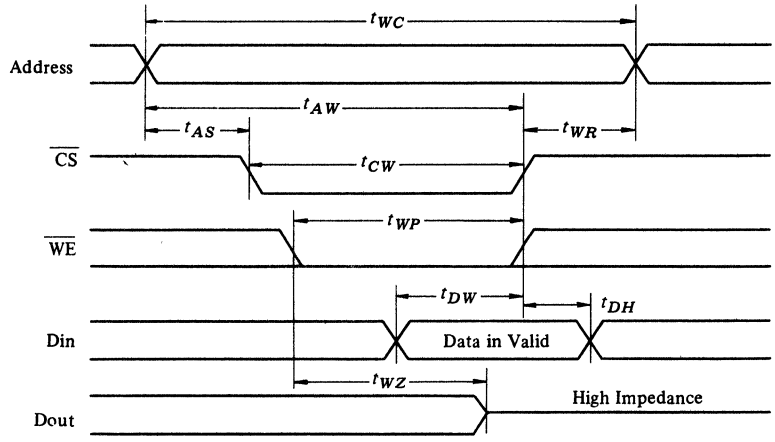
Item	Symbol	HM6167HLP-45		HM6167HLP-55		Unit	Notes
		min	max	min	max		
Write Cycle Time	t_{WC}	45	–	55	–	ns	(2)
Chip Selection to End of Write	t_{CW}	40	–	50	–	ns	
Address Valid to End of Write	t_{AW}	40	–	50	–	ns	
Address Setup Time	t_{AS}	0	–	0	–	ns	
Write Pulse Width	t_{WP}	25	–	35	–	ns	
Write Recovery Time	t_{WR}	0	–	0	–	ns	
Data Valid to End of Write	t_{DW}	25	–	25	–	ns	
Data Hold Time	t_{DH}	0	–	0	–	ns	
Write Enable to Output in High Z	t_{WZ}	0	25	0	25	ns	(3) (4)
Output Active from End of Write	t_{OW}	0	–	0	–	ns	(3) (4)

NOTES: 1. If $\overline{CS}$ goes high simultaneously with $\overline{WE}$ high, the output remains in a high impedance states.
2. All Write Cycle timings are referenced from the last valid address to the first transitions address.
3. Transition is measured ±500mV from steady state voltage with specified loading in Load B.
4. This parameter is sampled and not 100% tested.

● TIMING WAVEFORM OF WRITE CYCLE NO. 1 ($\overline{WE}$ Controlled)



● **TIMING WAVEFORM OF WRITE CYCLE NO. 2** ($\overline{CS}$ Controlled)



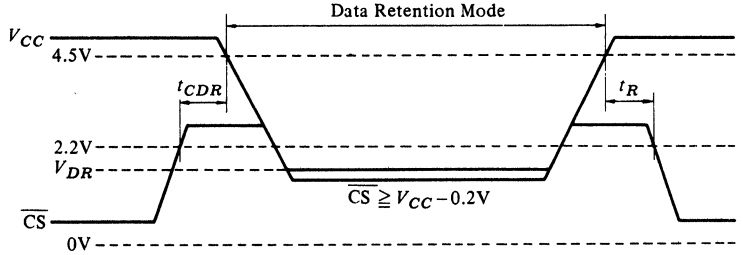
■LOW V_{CC} DATA RETENTION CHARACTERISTICS (Ta=0°C to 70°C)

Parameter	Symbol	Test Condition	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR}		2.0	—	—	V
Data Retention Current	I_{CCDR}	$\overline{CS} \geqq V_{CC}-0.2V$	—	—	20*	μA
		$V_{in} \geqq V_{CC}-0.2V$ or	—	—	30**	
Chip Deselect to Data Retention Time	t_{CDR}	$0V \leqq V_{in} \leqq 0.2V$	0	—	—	ns
Operation Recovery Time	t_R		t_{RC}△	—	—	ns

△ t_{RC}=Read Cycle Time

* V_{CC}=2.0V
** V_{CC}=3.0V

● **LOW V_{CC} DATA RETENTION WAVEFORM**

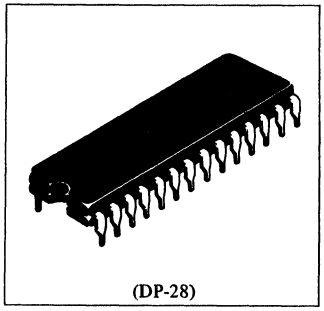


HM6264P-10, HM6264P-12, HM6264P-15

8192-word x 8-bit High Speed Static CMOS RAM

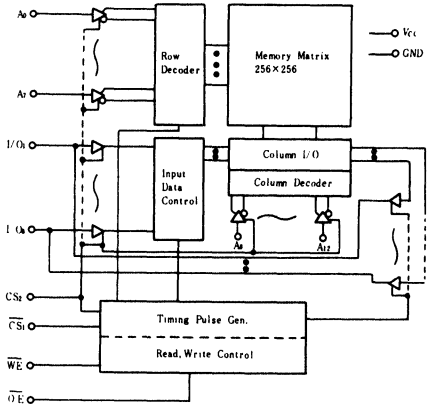
■ FEATURES

- Fast access Time — 100ns/120ns/150ns (max.)
- Low Power Standby — Standby: 0.1mW (typ.)
  Low Power Operation — Operating: 200mW (typ.)
- Single +5V Supply
- Completely Static Memory. . . . . No clock or Timing Strobe Required
- Equal Access and Cycle Time
- Common Data Input and Output, Three State Output
- Directly TTL Compatible: All Input and Output
- Standard 28pin Package Configuration
- Pin Out Compatible with 64K EPROM HN482764

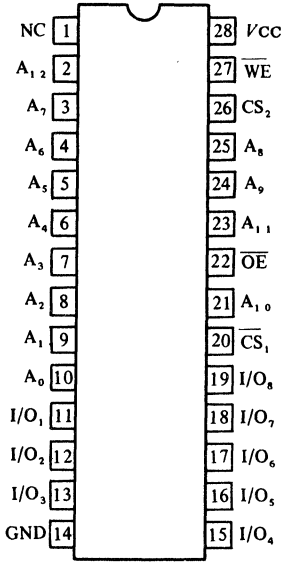


(DP-28)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Terminal Voltage *	V_T	−0.5 ** to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Storage Temperature (Under Bias)	T_{bias}	−10 to +85	°C

* With respect to GND. ** Pulse width 50ns: −3.0V

■ TRUTH TABLE

$\overline{WE}$	$\overline{CS_1}$	CS_2	$\overline{OE}$	Mode	I/O Pin	V_{CC} Current	Note
X	H	X	X	Not Selected (Power Down)	High Z	I_{SB}, I_{SB1}	
X	X	L	X		High Z	I_{SB}, I_{SB2}	
H	L	H	H	Output Disabled	High Z	I_{CC}, I_{CC1}	
H	L	H	L	Read	Dout	I_{CC}, I_{CC1}	
L	L	H	H	Write	Din	I_{CC}, I_{CC1}	Write Cycle (1)
L	L	H	L		Din	I_{CC}, I_{CC1}	Write Cycle (2)

× : Don't care.

■ RECOMMENDED DC OPERATING CONDITIONS (T_a = 0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	–	6.0	V
	V_{IL}	−0.3*	–	0.8	V

* Pulse Width 50ns: −3.0V

■ DC AND OPERATING CHARACTERISTICS (V_{CC} = 5V±10%, GND = 0V, T_a = 0 to +70°C)

Item	Symbol	Test Condition	min	typ*	max	Unit
Input Leakage Current	$\|I_{LI}\|$	V_{in}=GND to V_{CC}	–	–	2	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS1}$=V_{IH} or CS2=V_{IL} or $\overline{OE}$=V_{IH}, $V_{I/O}$=GND to V_{CC}	–	–	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS1}$=V_{IL}, CS2=V_{IH}, $I_{I/O}$=0mA	–	40	80	mA
Average Operating Current	I_{CC1}	Min. cycle, duty=100%, $\overline{CS1}$=V_{IL}, CS2=V_{IH}	–	60	110	mA
Standby Power Supply Current	I_{SB}	$\overline{CS1}$=V_{IH} or CS2=V_{IL}, $I_{I/O}$=0mA	–	1	3	mA
	I_{SB1}**	$\overline{CS1}$≧V_{CC}−0.2V, CS2≧V_{CC}−0.2V or CS2≦0.2V	–	0.02	2	mA
	I_{SB2}**	CS2≦0.2V	–	0.02	2	mA
Output Voltage	V_{OL}	I_{OL}=2.1mA	–	–	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	–	–	V

* Typical limits are at V_{CC}=5.0V, T_a=25°C and specified loading.
** V_{IL} min=−0.3V

■ CAPACITANCE (f = 1MHz, T_a = 25°C)

Item	Symbol	Test Condition	typ	max	Unit
Input Capacitance	C_{in}	V_{in} = 0V	–	6	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$ = 0V	–	8	pF

Note) This parameter is sampled and not 100% tested.

■ AC CHARACTERISTICS (V_{CC} = 5V±10%, Ta = 0 to +70°C)

• AC TEST CONDITIONS

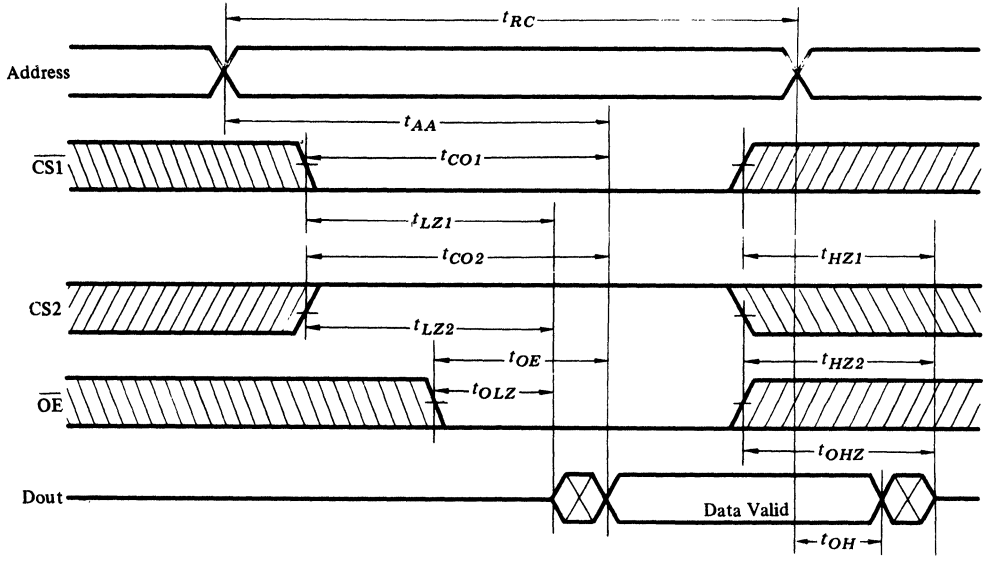
Input Pulse Levels: 0.8 to 2.4V
Input Rise and Fall Times: 10ns
Input and Output Timing Reference Level: 1.5V
Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)

• READ CYCLE

Item		Symbol	HM6264P-10		HM6264P-12		HM6264P-15		Unit
			min	max	min	max	min	max	
Read Cycle Time		t_{RC}	100	–	120	–	150	–	ns
Address Access Time		t_{AA}	–	100	–	120	–	150	ns
Chip Selection to Output	$\overline{CS1}$	t_{CO1}	–	100	–	120	–	150	ns
	CS2	t_{CO2}	–	100	–	120	–	150	ns
Output Enable to Output Valid		t_{OE}	–	50	–	60	–	70	ns
Chip Selection to Output in Low Z	$\overline{CS1}$	t_{LZ1}	10	–	10	–	15	–	ns
	CS2	t_{LZ2}	10	–	10	–	15	–	ns
Output Enable to Output in Low Z		t_{OLZ}	5	–	5	–	5	–	ns
Chip Deselection to Output in High Z	$\overline{CS1}$	t_{HZ1}	0	35	0	40	0	50	ns
	CS2	t_{HZ2}	0	35	0	40	0	50	ns
Output Disable to Output in High Z		t_{OHZ}	0	35	0	40	0	50	ns
Output Hold from Address Change		t_{OH}	10	–	10	–	15	–	ns

NOTES: 1 t_{HZ} and t_{OHZ} are defined as the time at which the outputs achieve the open circuit condition and are not referred to output voltage levels.
2 At any given temperature and voltage condition, t_{HZ} max is less than t_{LZ} min both for a given device and from device to device.

• **READ CYCLE**

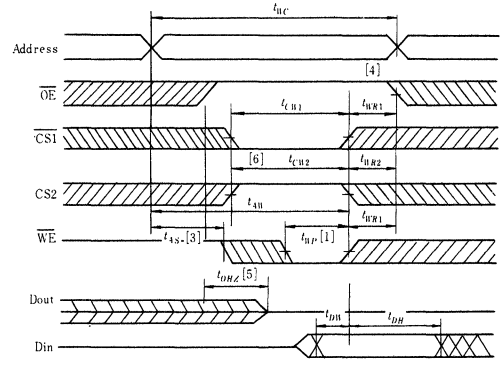


NOTE: 1) $\overline{WE}$ is high for Read Cycle

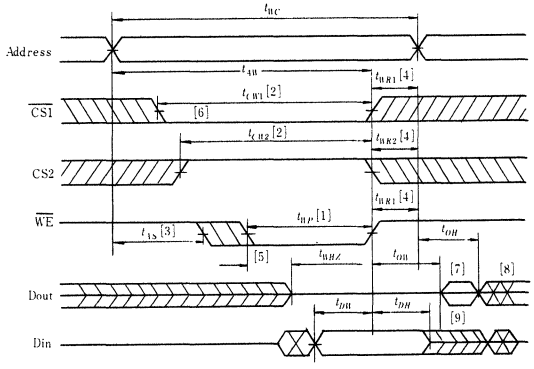
• **WRITE CYCLE**

Item		Symbol	HM6264P-10		HM6264P-12		HM6264P-15		Unit
			min	max	min	max	min	max	
Write Cycle Time		t_{WC}	100	–	120	–	150	–	ns
Chip Selection to End of Write		t_{CW}	80	–	85	–	100	–	ns
Address Setup Time		t_{AS}	0	–	0	–	0	–	ns
Address Valid to End of Write		t_{AW}	80	–	85	–	100	–	ns
Write Pulse Width		t_{WP}	60	–	70	–	90	–	ns
Write Recovery Time	CS1, $\overline{WE}$	t_{WR1}	5	–	5	–	10	–	ns
	CS2	t_{WR2}	15	–	15	–	15	–	ns
Write to Output in High Z		t_{WHZ}	0	35	0	40	0	50	ns
Data to Write Time Overlap		t_{DW}	40	–	50	–	60	–	ns
Data Hold from Write Time		t_{DH}	0	–	0	–	0	–	ns
$\overline{OE}$ to Output in High Z		t_{OHZ}	0	35	0	40	0	50	ns
Output Active from End of Write		t_{OW}	5	–	5	–	10	–	ns

• **WRITE CYCLE (1) ($\overline{OE}$ clock)**



• **WRITE CYCLE (2) ($\overline{OE}$ Low Fix)**



NOTES: 1) A write occurs during the overlap of a low $\overline{CS1}$, a high CS2 and a low $\overline{WE}$. A write begins at the latest transition among $\overline{CS1}$ going low, CS2 going high and $\overline{WE}$ going low. A write ends at the earliest transition among $\overline{CS1}$ going high, CS2 going low and $\overline{WE}$ going high. t_{WP} is measured from the beginninng of write to the end of write.

2) t_{CW} is measured from the later of $\overline{CS1}$ going low or CS2 going high to the end of write.

3) t_{AS} is measured from the address valid to the beginning of write.

4) t_{WR} is measured from the end of write to the address change.
t_{WR1} applies in case a write ends at $\overline{CS1}$ or $\overline{WE}$ going high.
t_{WR2} applies in case a write ends at CS2 going low.

5) During this period, I/O pins are in the output state, therefore the input signals of opposite phase to the outputs must not be applied.

6) If $\overline{CS1}$ goes low simultaneously with $\overline{WE}$ going low or after $\overline{WE}$ going low, the outputs remain in high impedance state.

7) Dout is in the same phase of written data of this cycle.

8) Dout is the read data of the new address.

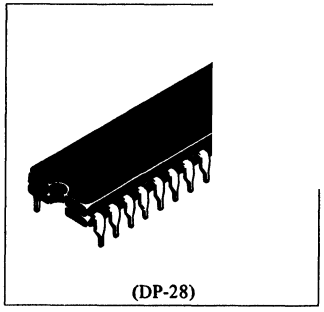
9) If $\overline{CS1}$ is low and CS2 is high during this period, I/O pins are in the output state. Therefore, the input signals of opposite phase to the outputs must not be applied to them.

HM6264LP-10, HM6264LP-12
HM6264LP-15

8192-word x 8-bit High Speed Static CMOS RAM

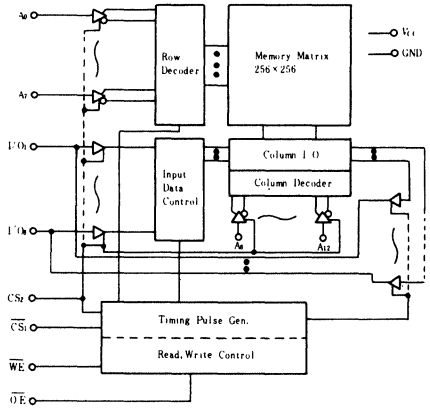
■ FEATURES

- Fast access Time — 100ns/120ns/150ns (max.)
- Low Power Standby — Standby: 0.01mW (typ.)
  Low Power Operation — Operating: 200mW (typ.)
- Capability of Battery Back-up Operation
- Single +5V Supply
- Completely Static Memory. . . . . No clock or Timing Strobe Required
- Equal Access and Cycle Time
- Common Data Input and Output, Three State Output
- Directly TTL Compatible: All Input and Output
- Standard 28pin Package Configuration
- Pin Out Compatible with 64K EPROM HN482764

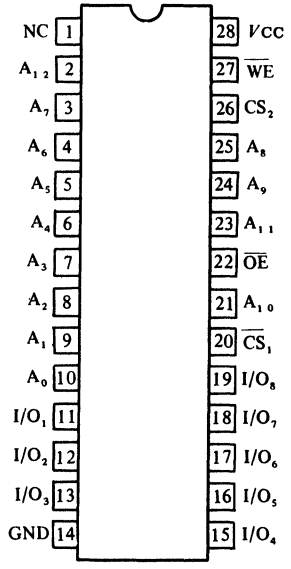


(DP-28)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Terminal Voltage *	V_T	−0.5 ** to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Storage Temperature (Under Bias)	T_{bias}	−10 to +85	°C

* With respect to GND. ** Pulse width 50ns: −3.0V

■ TRUTH TABLE

$\overline{WE}$	$\overline{CS_1}$	CS_2	$\overline{OE}$	Mode	I/O Pin	V_{CC} Current	Note
X	H	X	X	Not Selected (Power Down)	High Z	I_{SB}, I_{SB1}	
X	X	L	X		High Z	I_{SB}, I_{SB2}	
H	L	H	H	Output Disabled	High Z	I_{CC}, I_{CC1}	
H	L	H	L	Read	Dout	I_{CC}, I_{CC1}	
L	L	H	H	Write	Din	I_{CC}, I_{CC1}	Write Cycle (1)
L	L	H	L		Din	I_{CC}, I_{CC1}	Write Cycle (2)

× : Don't care.

■ RECOMMENDED DC OPERATING CONDITIONS (T_a = 0 to +70°C)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input Voltage	V_{IH}	2.2	–	6.0	V
	V_{IL}	−0.3*	–	0.8	V

* Pulse Width 50ns: −3.0V

■ DC AND OPERATING CHARACTERISTICS (V_{CC} = 5V±10%, GND = 0V, T_a = 0 to +70°C)

Item	Symbol	Test Condition	min	typ*	max	Unit
Input Leakage Current	$\|I_{LI}\|$	V_{in}=GND to V_{CC}	–	–	2	μA
Output Leakage Current	$\|I_{LO}\|$	$\overline{CS1}$=V_{IH} or CS2=V_{IL} or $\overline{OE}$=V_{IH}, $V_{I/O}$=GND to V_{CC}	–	–	2	μA
Operating Power Supply Current	I_{CC}	$\overline{CS1}$=V_{IL}, CS2=V_{IH}, $I_{I/O}$=0mA	–	40	80	mA
Average Operating Current	I_{CC1}	Min. cycle, duty=100%, $\overline{CS1}$=V_{IL}, CS2=V_{IH}	–	60	110	mA
Standby Power Supply Current	I_{SB}	$\overline{CS1}$=V_{IH} or CS2=V_{IL}, $I_{I/O}$=0mA	–	1	3	mA
	I_{SB1}**	$\overline{CS1}$≧V_{CC}−0.2V, CS2≧V_{CC}−0.2V or CS2≦0.2V	–	2	100	μA
	I_{SB2}**	CS2≦0.2V	–	2	100	μA
Output Voltage	V_{OL}	I_{OL}=2.1mA	–	–	0.4	V
	V_{OH}	I_{OH}=−1.0mA	2.4	–	–	V

* Typical limits are at V_{CC}=5.0V, T_a=25°C and specified loading.
** V_{IL} min=−0.3V

■ CAPACITANCE (f= 1MHz, T_a = 25°C)

Item	Symbol	Test Condition	typ	max	Unit
Input Capacitance	C_{in}	V_{in} = 0V	–	6	pF
Input/Output Capacitance	$C_{I/O}$	$V_{I/O}$ = 0V	–	8	pF

Note) This parameter is sampled and not 100% tested.

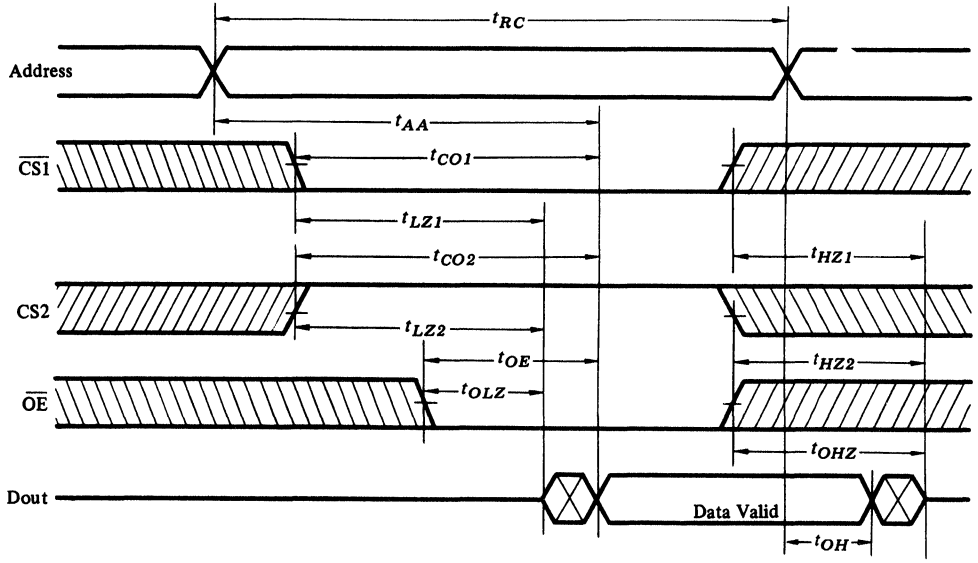
■ AC CHARACTERISTICS (V_{CC} = 5V±10%, Ta = 0 to +70°C)

- **AC TEST CONDITIONS**
  - Input Pulse Levels: 0.8 to 2.4V
  - Input Rise and Fall Times: 10ns
  - Input and Output Timing Reference Level: 1.5V
  - Output Load: 1TTL Gate and C_L = 100pF (including scope and jig)
- **READ CYCLE**

Item		Symbol	HM6264LP-10		HM6264LP-12		HM6264LP-15		Unit
			min	max	min	max	min	max	
Read Cycle Time		t_{RC}	100	–	120	–	150	–	ns
Address Access Time		t_{AA}	–	100	–	120	–	150	ns
Chip Selection to Output	$\overline{CS1}$	t_{CO1}	–	100	–	120	–	150	ns
	CS2	t_{CO2}	–	100	–	120	–	150	ns
Output Enable to Output Valid		t_{OE}	–	50	–	60	–	70	ns
Chip Selection to Output in Low Z	$\overline{CS1}$	t_{LZ1}	10	–	10	–	15	–	ns
	CS2	t_{LZ2}	10	–	10	–	15	–	ns
Output Enable to Output in Low Z		t_{OLZ}	5	–	5	–	5	–	ns
Chip Deselection to Output in High Z	$\overline{CS1}$	t_{HZ1}	0	35	0	40	0	50	ns
	CS2	t_{HZ2}	0	35	0	40	0	50	ns
Output Disable to Output in High Z		t_{OHZ}	0	35	0	40	0	50	ns
Output Hold from Address Change		t_{OH}	10	–	10	–	15	–	ns

NOTES: 1 t_{HZ} and t_{OHZ} are defined as the time at which the outputs achieve the open circuit condition and are not referred to output voltage levels.
2 At any given temperature and voltage condition, t_{HZ} max is less than t_{LZ} min both for a given device and from device to device.

• **READ CYCLE**

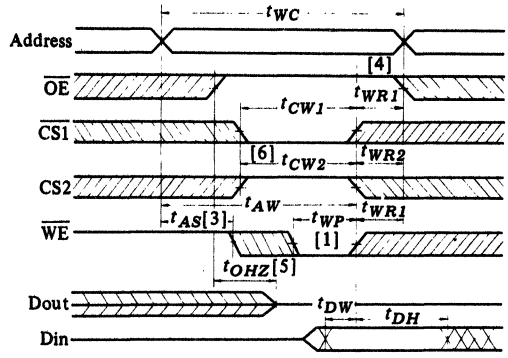


NOTE : 1) $\overline{WE}$ is high for Read Cycle

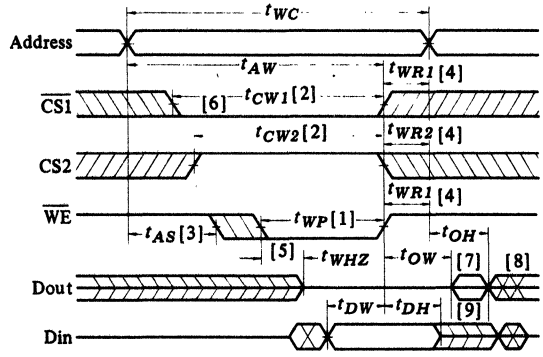
• **WRITE CYCLE**

Item		Symbol	HM6264LP-10		HM6264LP-12		HM6264LP-15		Unit
			min	max	min	max	min	max	
Write Cycle Time		t_{WC}	100	–	120	–	150	–	ns
Chip Selection to End of Write		t_{CW}	80	–	85	–	100	–	ns
Address Setup Time		t_{AS}	0	–	0	–	0	–	ns
Address Valid to End of Write		t_{AW}	80	–	85	–	100	–	ns
Write Pulse Width		t_{WP}	60	–	70	–	90	–	ns
Write Recovery Time	$\overline{CS1}$, $\overline{WE}$	t_{WR1}	5	–	5	–	10	–	ns
	CS2	t_{WR2}	15	–	15	–	15	–	ns
Write to Output in High Z		t_{WHZ}	0	35	0	40	0	50	ns
Data to Write Time Overlap		t_{DW}	40	–	50	–	60	–	ns
Data Hold from Write Time		t_{DH}	0	–	0	–	0	–	ns
$\overline{OE}$ to Output in High Z		t_{OHZ}	0	35	0	40	0	50	ns
Output Active from End of Write		t_{OW}	5	–	5	–	10	–	ns

• **WRITE CYCLE (1) ($\overline{OE}$ clock)**



• **WRITE CYCLE (2) ($\overline{OE}$ Low Fix)**



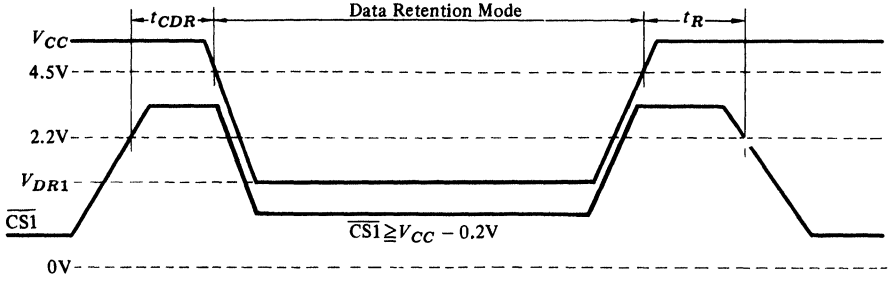
NOTES: 1) A write occurs during the overlap of a low $\overline{CS1}$, a high CS2 and a low $\overline{WE}$. A write begins at the latest transition among $\overline{CS1}$ going low, CS2 going high and $\overline{WE}$ going low. A write ends at the earliest transtion among $\overline{CS1}$ going high, CS2 going low and $\overline{WE}$ going high. t_{WP} is measured from the beginninng of write to the end of write.
2) t_{CW} is measured from the later of $\overline{CS1}$ going low or CS2 going high to the end of write.
3) t_{AS} is measured from the address valid to the beginning of write.
4) t_{WR} is measured from the end of write to the address change.
t_{WR1} applies in case a write ends at $\overline{CS1}$ or $\overline{WE}$ going high.
t_{WR2} applies in case a write ends at CS2 going low.
5) During this period, I/O pins are in the output state, therefore the input signals of opposite phase to the outputs must not be applied.
6) If $\overline{CS1}$ goes low simultaneously with $\overline{WE}$ going low or after $\overline{WE}$ going low, the outputs remain in high impedance state.
7) Dout is in the same phase of written data of this cycle.
8) Dout is the read data of the new address.
9) If $\overline{CS1}$ is low and CS2 is high during this period, I/O pins are in the output state. Therefore, the input signals of opposite phase to the outputs must not be applied to them.

■ LOW V_{CC} DATA RETENTION CHARACTERISTICS (T_a = 0 to +70 °C)

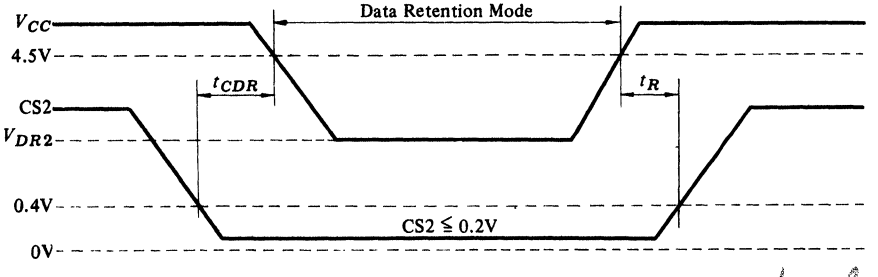
Item	Symbol	Test Condition	min	typ	max	Unit
V_{CC} for Data Retention	V_{DR1}	$\overline{CS1} \geqq V_{CC} - 0.2V$, $CS2 \geqq V_{CC} - 0.2V$ or $CS2 \leqq 0.2V$	2.0	–	–	V
	V_{DR2}	$CS2 \leqq 0.2V$	2.0	–	–	V
Data Retention Current	I_{CCDR1}	V_{CC} = 3.0V, $\overline{CS1} \geqq V_{CC} - 0.2V$, $CS2 \geqq V_{CC} - 0.2V$ or $CS2 \leqq 0.2V$	–	1	50*	μA
	I_{CCDR2}	V_{CC} = 3.0V, $CS2 \leqq 0.2V$	–	1	50*	μA
Chip Deselect to Data Retention Time	t_{CDR}	See Retention Waveform	0	–	–	ns
Operation Recovery Time	t_R		t_{RC}**	–	–	ns

* V_{IL} min = −0.3V
** t_{RC} = Read Cycle Time

• LOW Vcc DATA RETENTION WAVEFORM (1) ($\overline{CS1}$ Controlled)



• LOW Vcc DATA RETENTION WAVEFORM (2) (CS2 Controlled)



NOTE: CS_2 controls Address buffer, $\overline{WE}$ buffer, $\overline{CS_1}$ buffer and Din buffer. If CS_2 controls data retention mode, Vin level (Address, $\overline{WE}$, $\overline{CS_1}$, I/O) can be in the high impedance state. If $\overline{CS_1}$ controls data retention mode, CS_2 must be $CS_2 \geqq Vcc - 0.2V$ or $CS_2 \leqq 0.2V$. The other inputs level (address, $\overline{WE}$, I/O) can be in the high impedance state.

can be left open current, no need for pull ups/downs

i.e. not on a floating input must be pulled high or low!

MOS DYNAMIC RAM

HM4716A-1, HM4716A-2, HM4716A-3, HM4716A-4, HM4716AP-1, HM4716AP-2, HM4716AP-3, HM4716AP-4

16384-word × 1-bit Dynamic Random Access Memory

The HM4716A is a 16,384 word by 1 bit MOS random access memory circuit fabricated with HITACHI's double poly N-channel silicon gate process for high performance and high functional density. The HM4716A uses a single transistor dynamic storage cell and dynamic control circuitry to achieve high speed and low power dissipation. Multiplexed address inputs permit the HM4716A to be packaged in a standard 16 pin DIP on 0.3 inch centers. This package size provides high system bit densities and is compatible with widely available automated testing and insertion equipment. The HM4716A is designed to facilitate upgrading of the 16-pin 4K RAM. However, the data output latch incorporated in the present 4K design is not appropriate for 16K RAM's. This new generation of memory products (16K RAM's) requires a slightly modified output stage to allow more system flexibility. Instead of the conventional latch, the HM4716A output is controlled by the Column Address Storobe ($\overline{CE}$). Data out of the HM4716A will remain valid from the access time from the Column Address Strobe until $\overline{CE}$ goes into precharge logic 1). However, in early write cycles ($\overline{W}$ active low before $\overline{CE}$ goes low), the data output will remain in the high impedance (open-circuit) state throughout the entire cycle. This type of output operation results in some very significant system implications.

1. Common I/O Operation

If all write operation are handled in the "early write" mode, then data in can be connected directly to data-out on a printed circuit board.

2. Data Output Control

Data will remain valid at the output during a read cycle from TCELQV until $\overline{CE}$ returns to precharge.

This allows data to be valid from one cycle up until a new memory cycle begins.

3. Two Methods of Chip Selection

Both $\overline{CE}$ and/or $\overline{RE}$ can be decoded for chip selection.

4. Refresh

Refreshing can be accomplished every 2 ms by either of the two following methods:

(1) normal read or write cycles on 128 addresses, A0 to A6.

(2) $\overline{RE}$ only cycles on 128 addresses, A0 to A6.

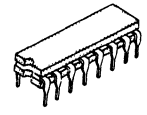
A write cycle will refresh stored data on all bits of the selected row except the bit which is addressed.

$\overline{RE}$ only refreshes results in a substantial reduction in operating power.

5. Page Mode Operation

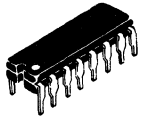
The HM4716A is designed for page mode operation.

HM4716A-1, HM4716A-2, HM4716A-3, HM4716A-4



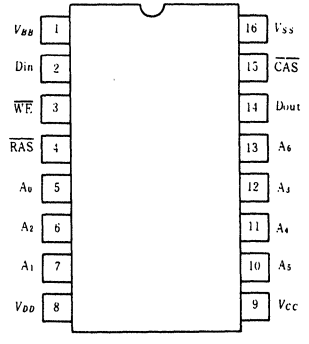
(DG-16A)

HM4716AP-1, HM4716AP-2, HM4716AP-3, HM4716AP-4



(DP-16)

■ PIN ARRANGEMENT



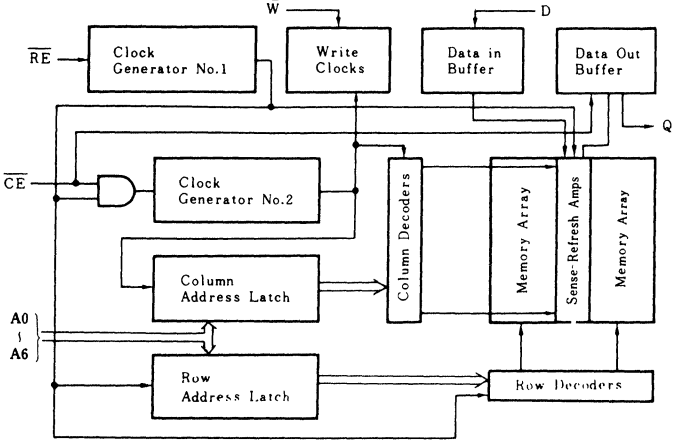
(Top View)

Old	New	Definitions
A_0-A_6	A0-A6	Address Inputs
$\overline{CAS}$	$\overline{CE}$	Column Address Strobe
D_{IN}	D	Data In
D_{OUT}	Q	Data Out
$\overline{RAS}$	$\overline{RE}$	Row Address Strobe
$\overline{WRITE}$	$\overline{W}$	Read/Write Input
V_{BB}	VBB	Power (−5V)
V_{CC}	VCC	Power (+5V)
V_{DD}	VDD	Power (+12V)
V_{SS}	VSS	Ground

■ FEATURES

- All Inputs Including Clocks TTL Compatible
- Input Latches for Address and Data in
- Three-State TTL Compatible Output
- Common I/O Capability
- Only 128 Refresh Cycles Required Every 2ms
- Standard Power Supplies +12V, +5V, −5V (All with 10% tolelance)
- Maximum Access Time
  - HM4716A-1 ..... 120ns
  - HM4716A-2 ..... 150ns
  - HM4716A-3 ..... 200ns
  - HM4716A-4 ..... 250ns
- Read or Write Cycle Time
  - HM4716A-1 ..... 320ns
  - HM4716A-2 ..... 320ns
  - HM4716A-3 ..... 375ns
  - HM4716A-4 ..... 410ns

■ FUNCTIONAL BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Voltage on any Pin Relative to VBB ..... -0.5V to +20V
Voltage on VDD, VCC Supplies Relative to VSS ..... -0.5V to +15V
Voltage on Q Pin Relative to VSS ..... -0.5V to +10V
Operating Temperature, TA (Ambient) ..... 0°C to +70°C
Storage Temperature (Ambient)* ..... -65°C to +150°C
Short-Circuit Output Current 50mA
Power Dissipation 1W

* In case of HM4716AP Series are -55°C to +125°C.

■ RECOMMENDED DC OPERATING CONDITIONS (TA = 0 to +70°C)

Parameter	Symbol	min.	typ.	max.	Unit	Notes
Supply Voltage	VDD	10.8	12.0	13.2	V	1
	VCC	4.5	5.0	5.5	V	
	VSS	0	0	0	V	
	VBB	−4.5	−5.0	−5.5	V	
Input High (logic 1) Voltage $\overline{RE}$, $\overline{CE}$, $\overline{W}$	VIHC	2.7	—	6.5	V	1
Input High (logic 1) Voltage All inputs except $\overline{RE}$, $\overline{CE}$, $\overline{W}$	VIH	2.4	—	6.5	V	1
Input Low (logic 0) Voltage all inputs	VIL	−1.0	—	0.8	V	1

■ DC ELECTRICAL CHARACTERISTICS

(Ta=0 to +70°C, V_{DD}=12V±10%, V_{CC}=5V±10%, V_{BB}=−5V±10%, V_{SS}=0V)

Parameter	Symbol	min	max	Unit	Notes
OPERATING CURRENT	I_{DD1}	−	35	mA	2
Average Power Supply Operating Current	I_{CC1}	−	−	mA	3
($\overline{RE}$, $\overline{CE}$ Cycling; TRELREL=375ns)	I_{BB1}	−	300	μA	2
STANDBY CURRENT	I_{DD2}	−	1.5	mA	
Power Supply Standby Current	I_{CC2}	−10	10	μA	5
($\overline{RE}$=$\overline{CE}$=V_{IHC})	I_{BB2}	−	100	μA	
REFRESH CURRENT	I_{DD3}	−	27	mA	2
Average Power Supply Current, Refresh Mode	I_{CC3}	−10	10	μA	5
($\overline{RE}$ Cycling, $\overline{CE}$=V_{IHC}; TRELREL=375ns)	I_{BB3}	−	300	μA	2
PAGE MODE CURRENT	I_{DD4}	−	27	mA	
Average Power Supply Current, Page-mode Operation	I_{CC4}	−	−	mA	3
($\overline{RE}$=V_{IL}, $\overline{CE}$ Cycling; TCELCEL=225ns)	I_{BB4}	−	300	μA	
INPUT LEAKAGE Input Leakage Current, any Input (V_{BB}=−5V, V_{IN}=0 to +7V, all other pins not under test=0V)	I_{IL}	−10	10	μA	
OUTPUT LEAKAGE Output Leakage Current (Q is Disabled, V_{OUT}=0 to +5.5V)	I_{OL}	−10	10	μA	5
OUTPUT LEVELS Output High (Logic 1) Voltage (I_{OUT}=−5mA)	V_{OH}	2.4	V_{CC}	V	4
Output Low (Logic 0) Voltage (I_{OUT}=4.2mA)	V_{OL}	0	0.4	V	

NOTES

1. All voltages referenced to VSS, VBB must be applied before and removed after other supply voltage.
2. Current depend on cycle rate: maximum current is measured at the fastest cycle rate.
3. ICC depends upon output loading. The VCC supply is connected to the output buffer only.
4. Output voltage will swing from VSS to VCC when activated with no current loading. For purposes of maintaining data in standby mode, VCC may be reduced to VSS without affecting refresh operations or data retention. However, the VOH (min) specification is not guaranteed in this mode.
5. ICC2, ICC3 and IOL consists of leakage current only.
6. AC measurements assume TT = 5ns.
7. VIHC (min) or VIH (min) and VIL (max) are reference levels for measuring timing of input signals. Also, transition times are measured between VIHC or VIH and VILS.
8. Assumes that TRELCEL = TRELCEL (max.) If TRELCEL is greater than the maximum recommended value shown in this table, TRELQV exceeds the value shown.
9. Assumes that TRELCEL = TRELCEL (max).
10. Measured with a load circuit equivalent to 2TTL loads and 100pF (in case of HM4716A-2:1 TTL and 50pF). And VSS + 0.8V, VSS + 2.0V are the reference level for measuring timing of Q.
11. TCEHQZ (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
12. Operation with the TRELCEL (max) limit insures that TRELQC (max) can be met TRELCEL (max) is specified as a reference point only; if TRELCEL is greater than the specified TRELCEL (max) limit, then access time is controlled exclusively by TCELQV.
13. These parameters are reference to $\overline{CE}$ leading edge in early write cycles and to $\overline{W}$ leading edge in delayed write or read-modify-write cycles.
14. TWLCEL, TCELWL and TRELWL are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if TWLCEL = TWLCEL (min), the cycle is an early write and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if TCELWL = TCELWL (min) and TRELWL will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.
15. Capacitance measured with Boonton Meter or effective capacitance measuring methods.)
16. $\overline{CE}$ = VIHC to disable Q.

■ ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS

(Ta=0 to +70°C, V_{DD}=12V±10%, V_{CC}=5V±10%, V_{SS}=0V, V_{BB}=−5V±10%)

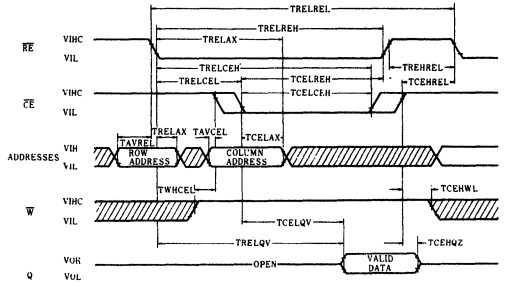
Parameter	Symbol		HM4716A-1		HM4716A-2		HM4716A-3		HM4716A-4		Unit	Notes
	Old	New	min	max	min	max	min	max	min	max		
Random Read or Write Cycle Time	t_{RC}	TRELREL	320	—	320	—	375	—	410	—	ns	
Read-Write Cycle Time	t_{RWC}	TRELREL	320	—	320	—	375	—	515	—	ns	8
Page Mode Cycle Time	t_{PC}	TCELCEL	160	—	170	—	225	—	275	—	ns	
Access Time From $\overline{RE}$	t_{RAC}	TRELQV	—	120	—	150	—	200	—	250	ns	8, 10
Access Time From $\overline{CE}$	t_{CAC}	TCELQV	—	80	—	100	—	135	—	165	ns	9, 10
Output Buffer Turn-off Delay	t_{OFF}	TCEHQZ	0	35	0	50	0	60	0	70	ns	11
Transition Time (Rise and Fall)	t_T	TT	3	35	3	35	3	50	3	50	ns	7
$\overline{RE}$ Precharge Time	t_{RP}	TREHREL	100	—	100	—	120	—	150	—	ns	
$\overline{RE}$ Pulse Width	t_{RAS}	TRELREH	120	10000	150	10000	200	10000	250	10000	ns	
$\overline{RE}$ Hold Time	t_{RSH}	TCELREH	80	—	100	—	135	—	165	—	ns	
$\overline{CE}$ Pulse Width	t_{CAS}	TCELCEH	80	10000	100	10000	135	10000	165	10000	ns	
$\overline{CE}$ Hold Time	t_{CSH}	TRELCEH	120	—	150	—	200	—	250	—	ns	
$\overline{RE}$ to $\overline{CE}$ Delay Time	t_{RCD}	TRELCEL	15	40	25	50	30	65	40	85	ns	12
$\overline{CE}$ to $\overline{RE}$ Precharge Time	t_{CRP}	TCEHREL	0	—	−20	—	−20	—	−20	—	ns	
Row Address Set-up Time	t_{ASR}	TAVREL	0	—	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	TRELAX	15	—	20	—	25	—	35	—	ns	
Column Address Set-up Time	t_{ASC}	TAVCEL	−5	—	−5	—	−5	—	−5	—	ns	
Column Address Hold Time	t_{CAH}	TCELAX	40	—	45	—	55	—	75	—	ns	
Column Address Hold Time Reference to $\overline{RE}$	t_{AR}	TRELAX	80	—	95	—	120	—	160	—	ns	
Read Command Set-up Time	t_{RCS}	TWHCEL	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time	t_{RCH}	TCEHWL	0	—	20	—	20	—	20	—	ns	
Write Command Hold Time	t_{WCH}	TCELWH	40	—	45	—	55	—	75	—	ns	
Write Command Hold Time Reference $\overline{RE}$	t_{WCR}	TRELWH	80	—	95	—	120	—	160	—	ns	
Write Command Pulse Width	t_{WP}	TWLWH	40	—	45	—	55	—	75	—	ns	
Write Command to $\overline{RE}$ Lead Time	t_{RWL}	TWLREH	50	—	60	—	80	—	100	—	ns	
Write Command to $\overline{CE}$ Lead Time	t_{CWL}	TWLCEH	50	—	60	—	80	—	100	—	ns	
Data-in Set-up Time	t_{DS}	TDVCEL	0	—	0	—	0	—	0	—	ns	13
Data-in Hold Time	t_{DH}	TCELDX	40	—	45	—	55	—	75	—	ns	13
Data-in Hold Time Referenced $\overline{RE}$	t_{DHR}	TRELDX	80	—	95	—	120	—	160	—	ns	
$\overline{CE}$ Precharge Time (for Page-mode Cycle Only)	t_{CP}	TCEHCEL	60	—	60	—	80	—	100	—	ns	
Refresh Period	t_{REF}	TRVRV	—	2	—	2	—	2	—	2	ms	
$\overline{W}$ Command Set-up Time	t_{WCS}	TWLCEL	0	—	−20	—	−20	—	−20	—	ns	14
$\overline{CE}$ to $\overline{RE}$ Delay	t_{CWD}	TCELWL	60	—	70	—	95	—	125	—	ns	14
$\overline{RE}$ to $\overline{W}$ Delay	t_{RWD}	TRELWL	100	—	120	—	160	—	200	—	ns	14
$\overline{RE}$ Precharge to $\overline{CE}$ Hold Time	t_{RPC}	TREHCEL	0	—	0	—	0	—	0	—	ns	

■ AC ELECTRICAL CHARACTERISTICS

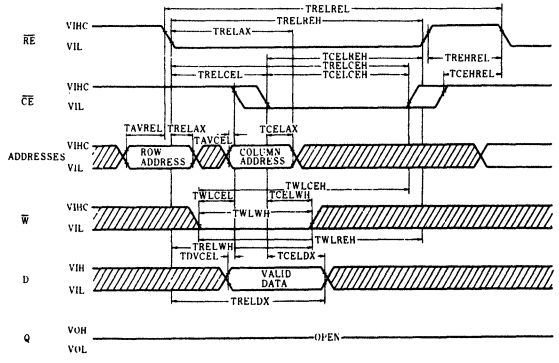
Parameter	Symbol	typ	max	Unit	Notes
Input Capacitance (A_0-A_6, D)	C_{I1}	—	5	pF	15
Input Capacitance $\overline{RE}$, $\overline{CE}$, $\overline{W}$	C_{I2}	—	10	pF	15
Output Capacitance (Q)	C_Q	—	7	pF	15, 16

■ TIMING WAVEFORMS

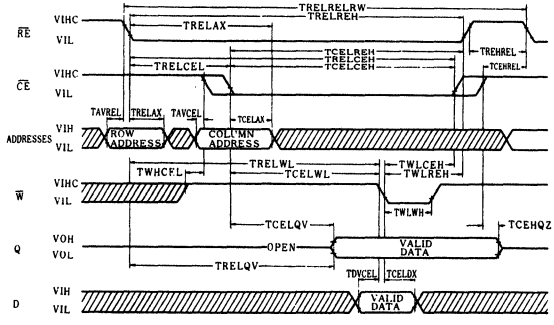
● READ CYCLE



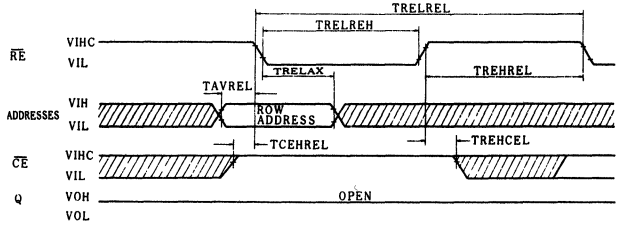
● WRITE CYCLE (EARLY WRITE)



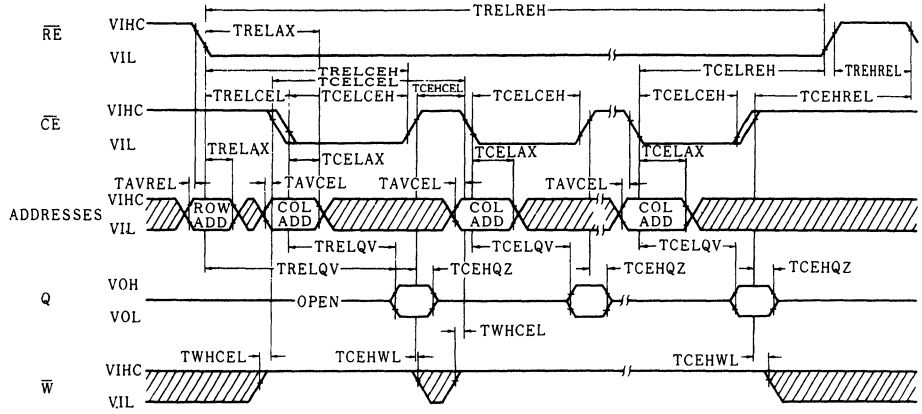
● READ-WRITE/READ-MODIFY-WRITE CYCLE



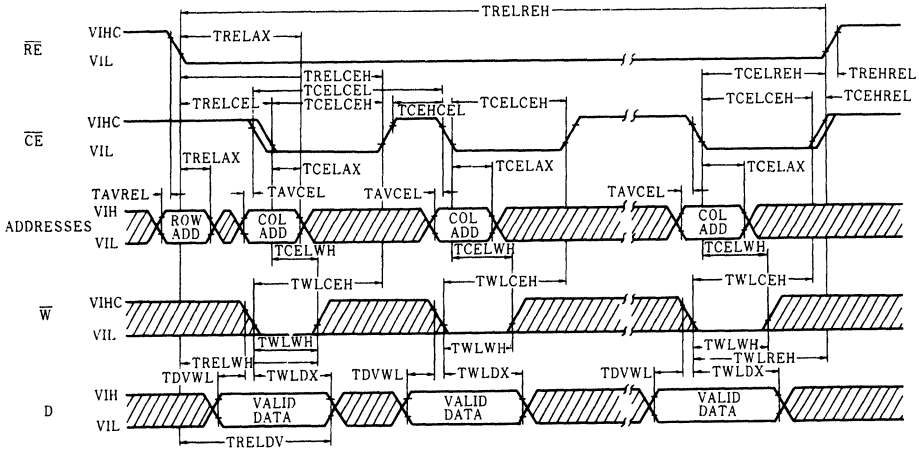
● "$\overline{RE}$ ONLY" REFRESH CYCLE



●PAGE MODE READ CYCLE

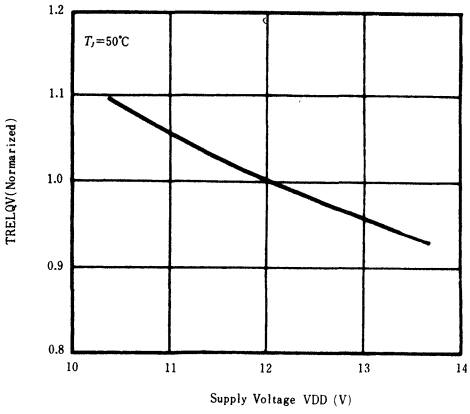


●PAGE MODE WRITE CYCLE

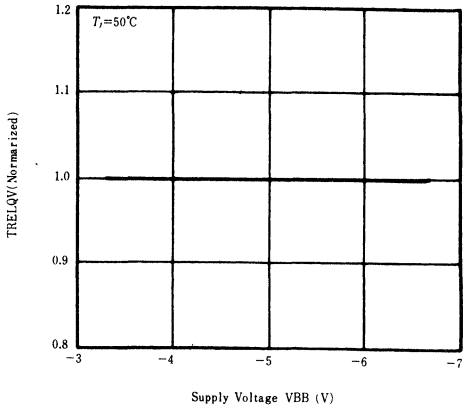


■ TYPICAL CHARACTERISTICS

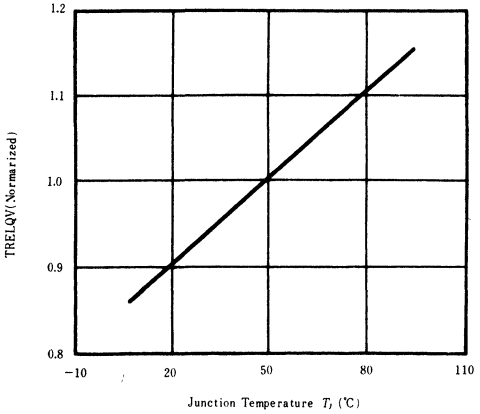
ACCESS TIME (NORMARIZED) vs. V_{DD}



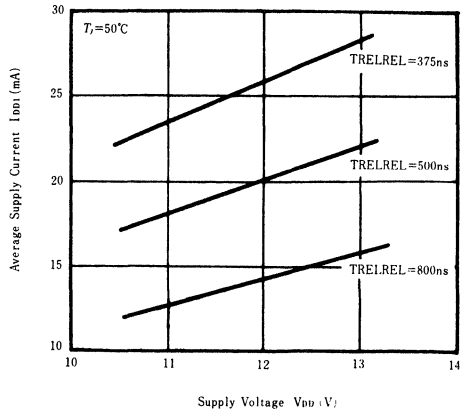
ACCESS TIME (NORMARIZED) vs. V_{BB}



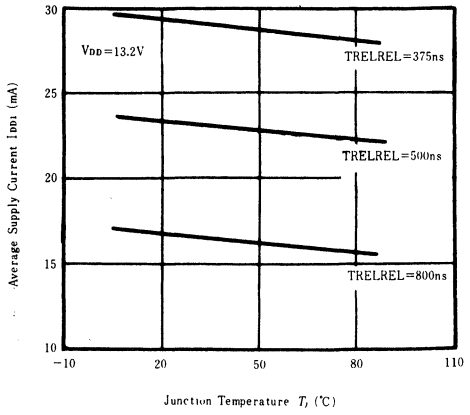
ACCESS TIME (NORMARIZED) vs. T_j



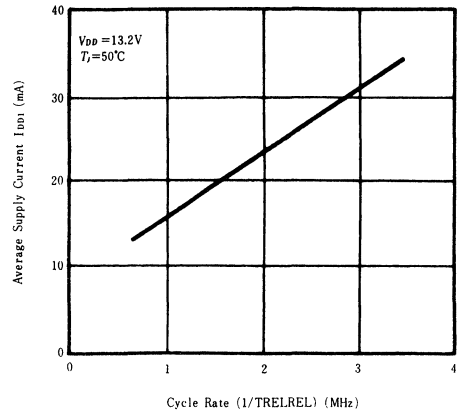
IDDI vs. V_{DD}



IDDI vs. T

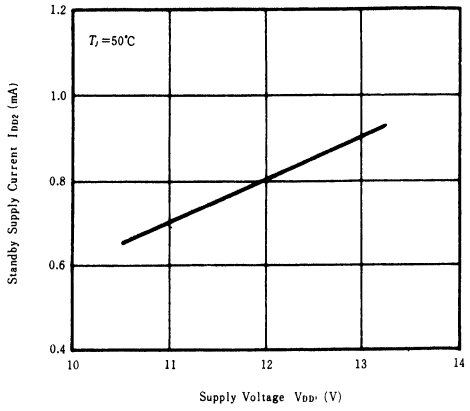


IDDI vs. CYCLE RATE

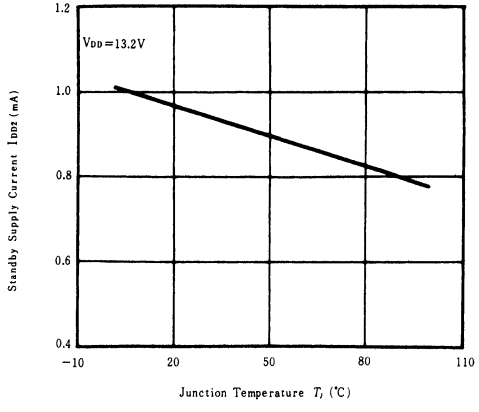


HITACHI

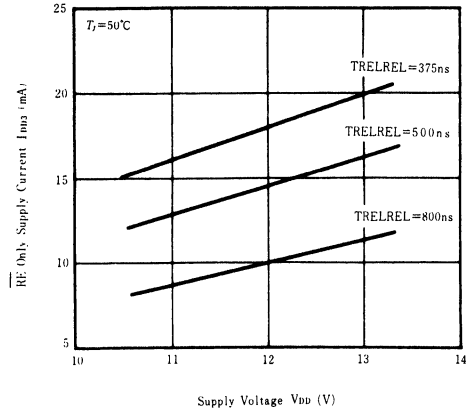
IDD2 (STANDBY) vs. V_{DD}



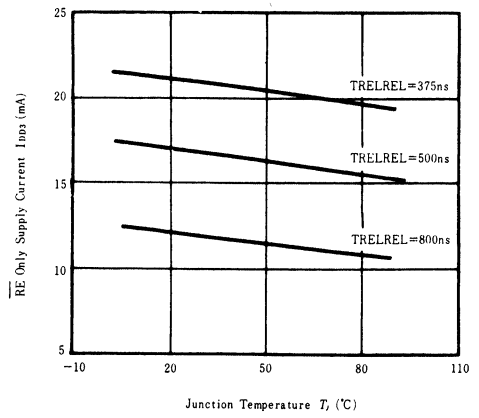
IDD2 (STANDBY) vs. T_j



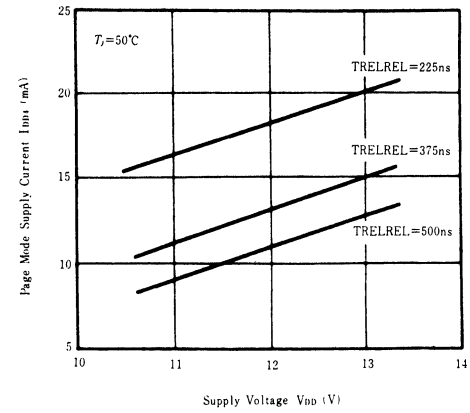
IDD3 ($\overline{RE}$ ONLY CYCLE) vs. V_{DD}



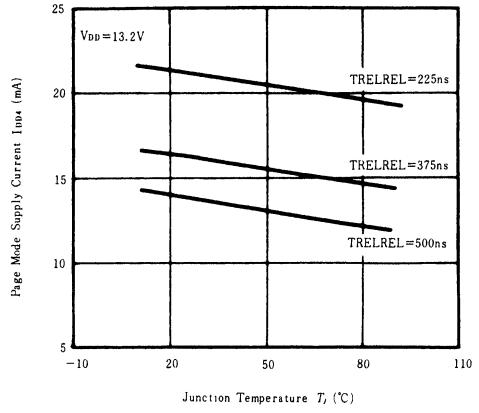
IDD3 ($\overline{RE}$ ONLY CYCLE) vs. T_j



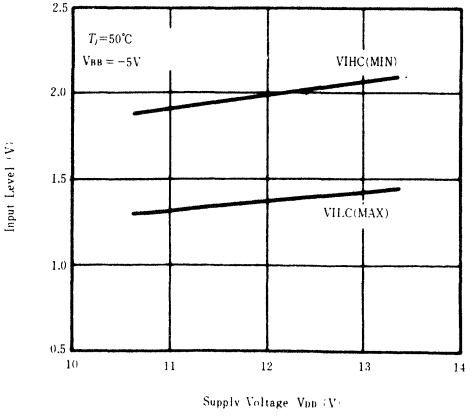
IDD4 (PAGE-MODE CYCLE) vs. V_{DD}



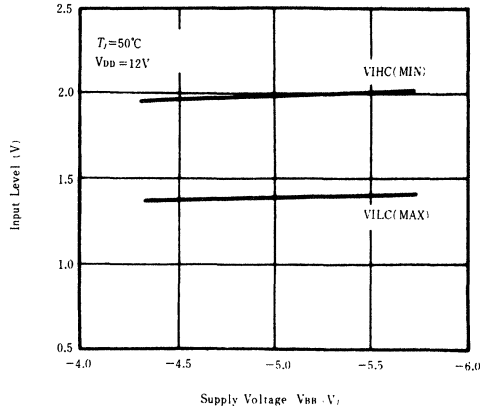
IDD4 (PAGE-MODE CYCLE) vs. T_j



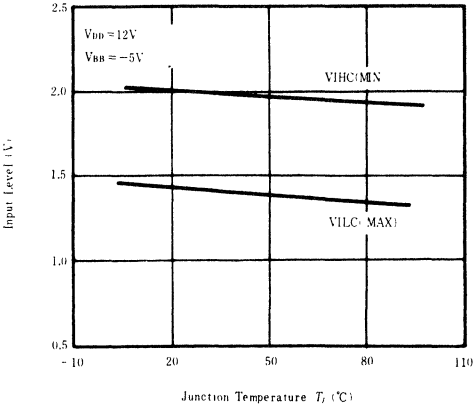
CLOCK INPUT LEVELS vs. V_{DD}



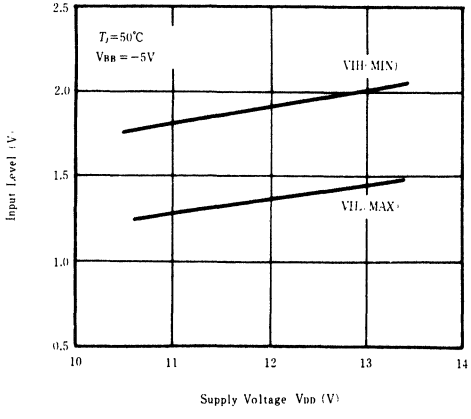
CLOCK INPUT LEVELS vs. V_{BB}



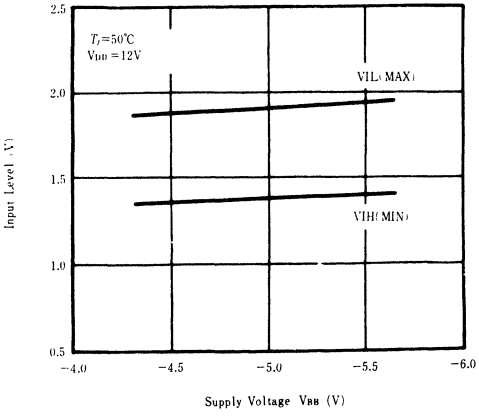
CLOCK INPUT LEVELS vs. T_j



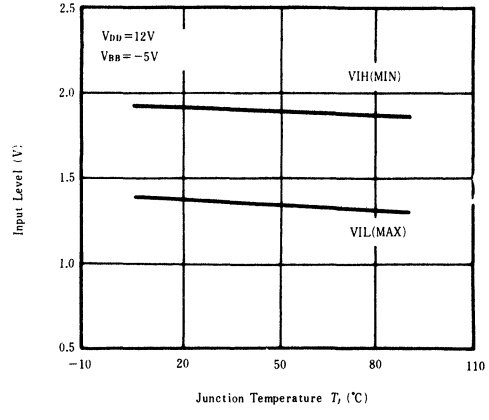
ADDRESS AND DATA INPUT LEVELS vs. V_{DD}



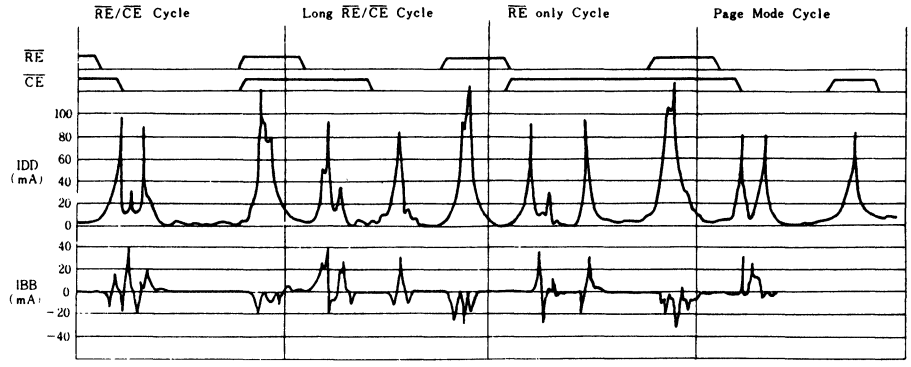
ADDRESS AND DATA INPUT LEVELS vs. V_{BB}



ADDRESS AND DATA INPUT LEVELS vs. T_j



■CURRENT WAVEFORMS



NOTE : VDD = 13.2V, VBB = −4.5V, Ta = 25°C

APPLICATION INFORMATION

• READ CYCLE;

A read cycle begins with addresses stable and a negative going transistion of $\overline{RE}$. The time delay between the stable address and the start of $\overline{RE}$-on is controlled by parameter TAVREL.

Following the time when $\overline{RE}$ reaches its low level, the row address must be held stable long enough to be captured.

This controlling parameter is TRELAX. Following this interval, the address can be changed from row address to column address.

When the column address is stable, $\overline{CE}$ can be turned on.

The leading edge of $\overline{CE}$ is controlled by parameter TRELCEL.

The basic limit on the $\overline{CE}$ leading edge is that $\overline{CE}$ cannot start until the column address is stable, and this is controlled by parameter TAVCEL.

The column address must be held stable long enough to be captured.

The controlling parameter is TCELAX. Note that TRELCEL(max) is not an operating limit of the HM4716A though its specification is listed on the data sheets. If $\overline{CE}$ becomes on later than TRELCEL(max), the access time from $\overline{RE}$ will be increased by the time which TRELCEL exceeds TRELCEL(max).

Following the time when $\overline{CE}$ reaches its low level, the data-out pin remains in a high impedance state until a valid data appears. This parameter is TCELQV-access time from $\overline{CE}$. The access time from $\overline{RE}$-TRELQV is the time from $\overline{RE}$-on to valid Q. The minimum value of TRELQV is derived as the sum of TRELCEL(max) and TCELQV. The selected output data is held valid internally until $\overline{CE}$ becomes high, and then Q pin becomes high impedance. This parameter is TECHQZ.

• WRITE CYCLE;

A write cycle is performed by bringing $\overline{W}$ low before or during $\overline{CE}$-on.

Two different write cycles can be defined as;

Write cycle – Write data are available at the beginning of the $\overline{CE}$-on so that the write operation starts at the beginning. In this mode, D and $\overline{W}$ signal times are not in any critical path for determining cycle time.

Following the time when $\overline{W}$ reaches its low level, $\overline{W}$ must be held stable long enough to be captured. This $\overline{W}$-on pulse duration is called TWLWH.

The time required to capture write data in a latch is called TWLDX.

This cycle is called an "early write"

Read Write cycle – This cycle starts as a read cycle, but as soon as the device specification is met, a write cycle is initiated. $\overline{W}$ and D are delayed until after Q. This cycle is called a "delayed write". A "Read-modify-write" cycle is a variation of this operation. In this mode, D and $\overline{W}$ become critical path signals for determining cycle time.

• CLOCK-OFF TIMING;

$\overline{RE}$ and $\overline{CE}$ must stay on for Q stabilized to valid data. In the case of $\overline{CE}$, this is controlled by parameter TCELCEH (min). In the case of $\overline{RE}$, this controlled by parameter TCELREH(min).

Following the end of $\overline{RE}$, $\overline{CE}$ must stay off long enough to precharge internal circuits. The only parameter of concern is TREHREL.

Normally $\overline{CE}$ is not required to be off for a minimum time of TCEHREL.

However, in a page mode memory operation, there is a TCEHCEL(min) specification to control the $\overline{CE}$-off time.

• DATA OUTPUT;

Q is three-state TTL compatible with a fan-out of two standard TTL loads.

When $\overline{CE}$ is high, Q is in a high impedance state. When $\overline{CE}$ is low, valid data appears after TCELQV at a read cycle and Q is not valid at an early-write cycle.

• REFRESH;

Refresh of the HM4716A is accomplished by performing A memory cycle at each of the 128 row addresses within each two millisecond time interval.

Any cycle in which $\overline{RE}$ signal occurs refreshes the entire selected row.

$\overline{RE}$-only refresh results in substantial reduction in operating power.

This reduction in power is reflected in the IDD3 specification.

• PAGE MODE;

Page mode operation allows faster successive memory operations at multiple column locations of the same row address with increased speed.

This is done by strobing the row address into the chip and maintaining $\overline{RE}$ at a logic low throughout all successive $\overline{CE}$ memory cycles in which the row address is latched. As the time normally required for strobing a new row address is eliminated, access and cycle times can be decreased and the operating power is reduced. These are reflected in the TCELQV, TCEHCEL, IDD4 specifications.

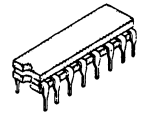
HM4816A-3, HM4816A-3E, HM4816A-4, HM4816A-7, HM4816AP-3, HM4816AP-3E, HM4816AP-4, HM4816AP-7

16384-word by 1-bit Dynamic Random Access Memory

The HM4816A is a new generation MOS dynamic RAM circuit organized as 16,384 words by 1 bit. As a state-of-the art MOS memory device, the HM4816A (16K RAM) incorporates advanced circuit techniques designed to provide wide operating margins, both internally and to the system user, while achieving performance levels in speed and power.

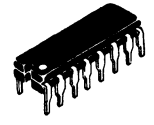
The use of dynamic circuitry throughout, including sense amplifiers, assures that power dissipation is minimized without any sacrifice in speed or operating margin. These factors combine to make the HM4816A a truly superior RAM product. Multiplexed address inputs permits the HM4816A to be packaged in standard 16-pin DIP. Non-critical clock timing requirements allow use of the multiplexing technique while maintaining high performance.

HM4816A-3, HM4816A-3E,
HM4816A-4, HM4816A-7



(DG-16B)

HM4816AP-3, HM4816AP-3E,
HM4816AP-4, HM4816AP-7



(DP-16)

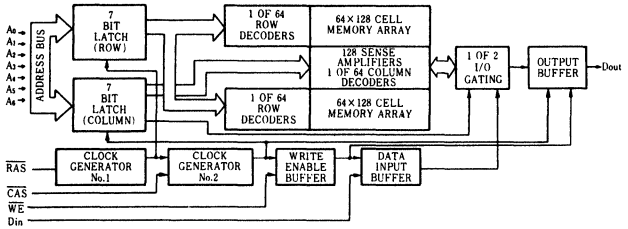
■ FEATURES

- Single 5V supply
  Low power standby and operation
  (Standby: 11mW max., operation: 150mW max.)
- Fast access time & cycle time

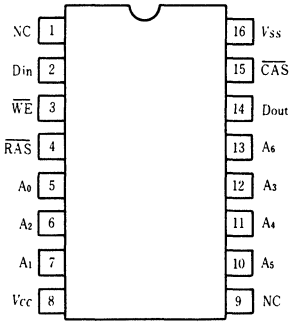
	HM4816A-3 HM4816AP-3	HM4816A-3E HM4816AP-3E	HM4816A-4 HM4816AP-4	HM4816A-7 HM4816AP-7
Maximum Access Time (ns)	100	105	120	150
Read, Write Cycle (ns)	235	200	270	320
Read-Modify-Write Cycle (ns)	285	235	320	410

- Directly TTL compatible: All inputs & outputs
- Output data controlled by $\overline{CAS}$ and unlatched at end of cycle to allow two dimensional chip selection and extended page boundary.
- Common I/O capability using "easy write" operation.
- Read modify write, $\overline{RAS}$ only refresh and page mode capability
- Only 128 refresh cycle required every 2ms
- Compatible with Intel 2118-3/-4/-7

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item		Symbol	HM4816A or AP	Unit
Voltage on any pin relative to GND		V_T	−1.0 ~ +7.0	V
Power supply voltage relative to GND		V_{CC}	−0.5 ~ +7.0	V
Short-circuit Output Current		I_{out}	50	mA
Power Dissipation		P_T	1.0	W
Operating Temperature		T_{opr}	0 ~ +70	℃
Storage Temperature	Cerdip	T_{stg}	−65 ~ +150	℃
	Plastic		−55 ~ +125	℃

■ RECOMMENDED DC OPERATING CONDITIONS

Item	Symbol	min	typ	max	Unit	Notes
Supply voltage	V_{CC}	4.5	5.0	5.5	V	1
	V_{SS}	0	0	0	V	1, 2
Input high (logic 1) voltage $\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$	V_{IHC}	2.4	—	7.0	V	1
Input high (logic 1) voltage except $\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$	V_{IH}	2.4	—	7.0	V	1
Input low (logic 0) voltage all inputs	V_{IL}	−2.0	—	0.8	V	1

Notes : 1. All voltage referenced to V_{SS}.
2. Output voltage will swing from V_{SS} to V_{CC} when activated with no current loading.

■ DC AND OPERATING CHARACTERISTICS (1)

(Ta=0℃ to 70℃, V_{CC}=5V±10%, V_{SS}=0V, unless otherwise noted.)

Parameter	Symbol	Test Conditions		min	typ (2)	max	Unit	Notes
Input Load Current (any input)	$\|I_{LI}\|$	$V_{IN}=V_{SS}$ to V_{CC}		—	0.1	10	μA	
Output Leakage Current for High Impedance State	$\|I_{LO}\|$	Chip Deselected; $\overline{CAS}$ at V_{IH}, V_{OUT}=0 to 5.5V		—	0.1	10	μA	
V_{CC} Supply Current. Standby	I_{CC1}	$\overline{CAS}$ and $\overline{RAS}$ at V_{IH}	HM4816AP-3, 4, 7 HM4816A-3, 4, 7	—	1.2	2	mA	
			HM4816A, AP-3E	—	1.2	3	mA	
V_{CC} Supply Current. Operating	I_{CC2}	HM4816A, AP-3 $t_{RC}=t_{RCMIN}$		—	23	27	mA	3
		HM4816A, AP-3E $t_{RC}=t_{RCMIN}$		—	27	35	mA	3
		HM4816A, AP-4 $t_{RC}=t_{RCMIN}$		—	21	25	mA	3
		HM4816A, AP-7 $t_{RC}=t_{RCMIN}$		—	19	23	mA	3
V_{CC} Supply Current; $\overline{RAS}$-Only Cycle	I_{CC3}	HM4816A, AP-3 $t_{RC}=t_{RCMIN}$		—	16	18	mA	3
		HM4816A, AP-3E $t_{RC}=t_{RCMIN}$		—	20	25	mA	3
		HM4816A, AP-4 $t_{RC}=t_{RCMIN}$		—	14	16	mA	3
		HM4816A, AP-7 $t_{RC}=t_{RCMIN}$		—	12	14	mA	3
V_{CC} Supply Current. Standby. Output Enabled	I_{CC5}	$\overline{CAS}$ at V_{IL}, $\overline{RAS}$ at V_{IH}		—	3	6	mA	3
Output Low Voltage	V_{OL}	I_{OL}=4.2mA		0	—	0.4	V	
Output High Voltage	V_{OH}	I_{OH}=−5mA		2.4	—	V_{CC}	V	

Notes : 1. All voltages referenced to V_{SS}.
2. Typical values are for Ta=25℃ and nominal supply voltages.
3. I_{CC} is dependent on output loading when the devices output is selected. Specified I_{CC} MAX is measured with the output open.

■ CAPACITANCE (Ta=25℃, V_{CC}=5V±10%, V_{SS}=0V, unless otherwise noted.)

Parameter	Symbol	typ	max	Unit
Address. Data In	C_{I1}	3	5	pF
$\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$, Data Out	C_{I2}	4	7	pF

Notes : Capacitance measured with Boonton Meter or effective capacitance calculated from the equation:
$C=\frac{I\Delta t}{\Delta V}$ with ΔV equal to 3 volts and power supplies at nominal levels.

■ AC CHARACTERISTICS [1,2,3] (Ta=0°C to 70°C, V_{CC}=5V±10%, V_{SS}=0V, unless otherwise noted.)

● READ, WRITE, READ-MODIFY-WRITE AND REFRESH CYCLES

Parameter	Symbol	HM4816A-3 HM4816AP-3		HM4816A-3E HM4816AP-3E		HM4816A-4 HM4816AP-4		HM4816A-7 HM4816AP-7		Unit	Notes
		min	max	min	max	min	max	min	max		
Access Time From $\overline{RAS}$	t_{RAC}	—	100	—	105	—	120	—	150	ns	4, 5
Access Time From $\overline{CAS}$	t_{CAC}	—	55	—	60	—	65	—	80	ns	4, 5, 6
Time Between Refresh	t_{REF}	—	2	—	2	—	2	—	2	ms	
$\overline{RAS}$ Precharge Time	t_{RP}	110	—	70	—	120	—	135	—	ns	
$\overline{CAS}$ Precharge Time (non-page cycles)	t_{CPN}	50	—	50	—	55	—	70	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	0	—	0	—	0	—	0	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	25	45	25	45	25	55	25	70	ns	7
$\overline{RAS}$ Hold Time	t_{RSH}	70	—	60	—	85	—	105	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	100	—	105	—	120	—	165	—	ns	
Row Address Set-up Time	t_{ASR}	0	—	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	15	—	15	—	15	—	15	—	ns	
Column Address Set-up Time	t_{ASC}	0	—	0	—	0	—	0	—	ns	
Column Address Hold Time	t_{CAH}	15	—	25	—	20	—	20	—	ns	
Column Address Hold Time to $\overline{RAS}$	t_{AR}	60	—	70	—	75	—	90	—	ns	
Transition Time (Rise and Fall)	t_T	3	50	3	50	3	50	3	50	ns	8
Output Buffer Turn Off Delay	t_{OFF}	0	45	0	50	0	50	0	60	ns	

● READ AND REFRESH CYCLES

Random Read Cycle Time	t_{RC}	235	—	200	—	270	—	320	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	115	10000	105	10000	140	10000	175	10000	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	55	10000	60	10000	65	10000	95	10000	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	0	—	0	—	ns	
Read Command Hold Time	t_{RCH}	10	—	10	—	10	—	10	—	ns	

● WRITE CYCLE

Random Write Cycle Time	t_{RC}	235	—	200	—	270	—	320	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	115	10000	105	10000	140	10000	175	10000	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	55	10000	60	10000	65	10000	95	10000	ns	
Write Command Set-up Time	t_{WCS}	0	—	0	—	0	—	0	—	ns	9
Write Command Hold Time	t_{WCH}	25	—	30	—	30	—	45	—	ns	
Write Command Hold Time to $\overline{RAS}$	t_{WCR}	70	—	75	—	85	—	115	—	ns	
Write Command Pulse Width	t_{WP}	25	—	30	—	30	—	50	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	60	—	45	—	65	—	110	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	45	—	45	—	50	—	100	—	ns	
Data-in Set-up Time	t_{DS}	0	—	0	—	0	—	0	—	ns	
Data-in Hold Time	t_{DH}	25	—	30	—	30	—	45	—	ns	
Data-in Hold Time to $\overline{RAS}$	t_{DHR}	70	—	75	—	85	—	115	—	ns	

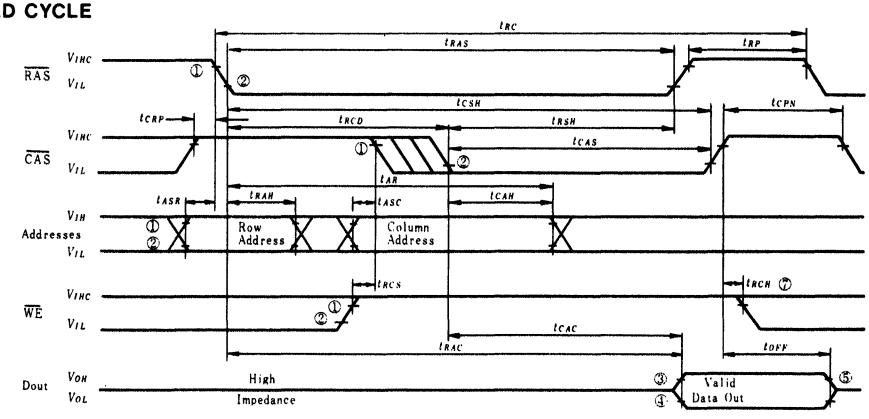
● READ-MODIFY-WRITE CYCLE

Read-Modify-Write Cycle Time	t_{RWC}	285	—	235	—	320	—	410	—	ns	
RMW Cycle $\overline{RAS}$ Pulse Width	t_{RRW}	165	10000	155	10000	190	10000	265	10000	ns	
RMW Cycle $\overline{CAS}$ Pulse Width	t_{CRW}	105	10000	110	10000	120	10000	185	10000	ns	
$\overline{RAS}$ to $\overline{WE}$ Delay	t_{RWD}	100	—	105	—	120	—	150	—	ns	9
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	55	—	60	—	65	—	80	—	ns	9

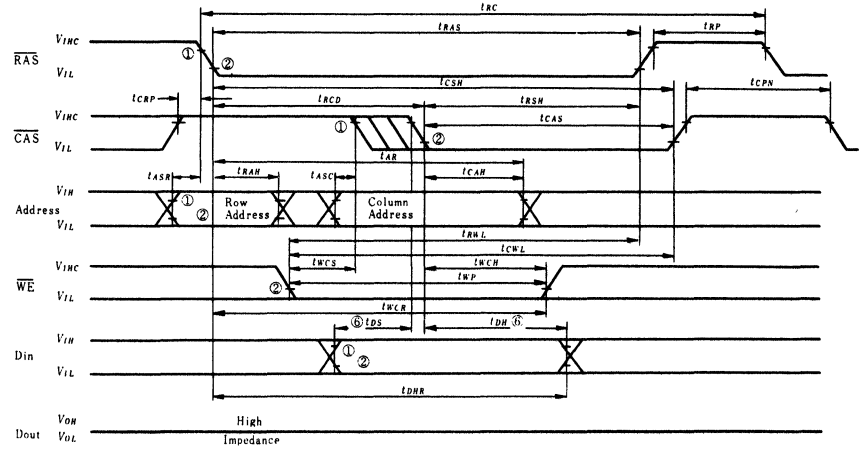
Notes:
1. All voltages referenced to V_{SS}
2. Eight cycles are required after power-up or prolonged periods (greater than 2ms) of $\overline{RAS}$ inactivity before proper device operation is achieved. Any 8 cycles which perform refresh are adequate for this purposes.
3. AC Characteristics assume t_T=5ns
4. Assume that $t_{RCD} \leqq t_{RCD}$ (max.) If t_{RCD} is greater than t_{RCD} (max.) then t_{RAC} will increase by the amount that t_{RCD} exceeds t_{RCD} (max.)
5. Load = 2 TTL Loads and 100pF
6. Assumes $t_{RCD} \geqq t_{RCD}$ (max.)
7. t_{RCD} (max.) is specified as a reference point only. If t_{RCD} is less than t_{RCD} (max.) access time is t_{RAC}. If t_{RCD} is greater than t_{RCD} (max.) access time is t_{RCD} + t_{CAC}.
8. t_T is measured between V_{IH} (min.) and V_{IL} (max.)
9. t_{WCS}, t_{CWD} and t_{RWD} are specified as reference points only. If $t_{WCS} \geqq t_{WCS}$ (min.) the cycle is an early write cycle and the data out pin will remain high impedance throughout the entire cycle. If $t_{CWD} \geqq t_{CWD}$ (min.) and $t_{RWD} \geqq t_{RWD}$ (min.), the cycle is a read-modify-write cycle and the data out will contain the data read from the selected address if neither of the above conditions is satisfied, the condition on the data out is indeterminate.

■ WAVEFORMS

● READ CYCLE

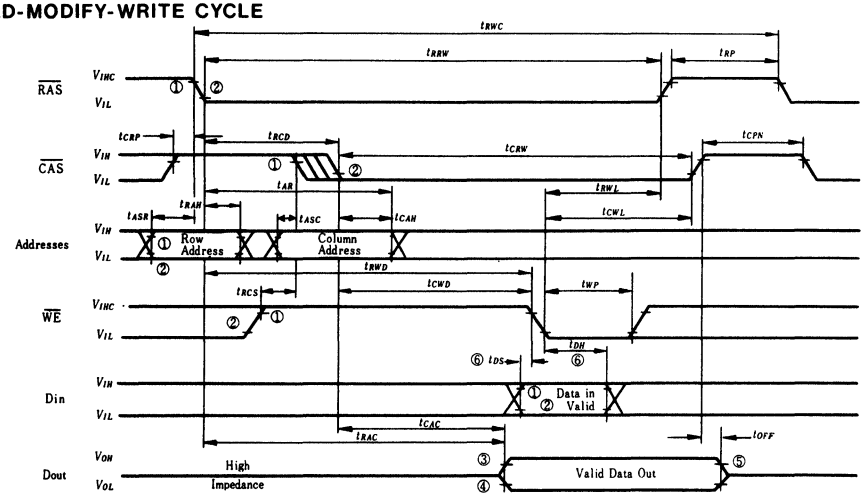


● WRITE CYCLE

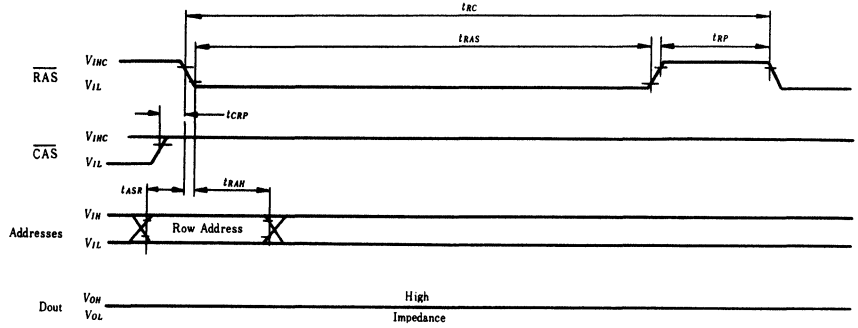


Notes:
1.2. $V_{IH\ MIN}$ and $V_{IL\ MAX}$ are reference levels for measuring timing of input signals.
3.4. $V_{OH\ MIN}$ and $V_{OL\ MAX}$ are reference levels for measuring timing of D_{OUT}.
5. t_{OFF} is measured to $I_{OUT} < |I_{LO}|$.
6. t_{DS} and t_{DH} are referenced to $\overline{CAS}$ or $\overline{WE}$, whichever occurs last.
7. t_{RCH} is referenced to the trailing edge of $\overline{CAS}$ or $\overline{RAS}$, whichever occurs first.
8. t_{CRP} requirement is only applicable for $\overline{RAS}$/$\overline{CAS}$ cycles preceeded by a $\overline{CAS}$-only cycle (i.e., for system where $\overline{CAS}$ has not been decoded with $\overline{RAS}$).

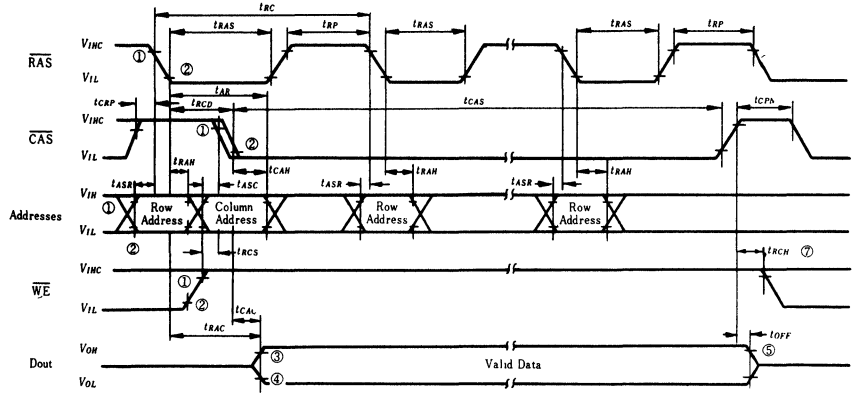
●READ-MODIFY-WRITE CYCLE



●RAS-ONLY REFRESH CYCLE



●HIDDEN REFRESH CYCLE



Notes:

1.2. $V_{IH\ MIN}$ and $V_{IL\ MAX}$ and reference levels for measuring timing of input signals.

3.4. $V_{OH\ MIN}$ and $V_{OL\ MAX}$ are reference levels for measuring timing of D_{OUT}.

5. t_{OFF} is measured to $I_{OUT} \leqq |I_{LO}|$

6. t_{DS} and t_{DH} are referenced to $\overline{CAS}$ or $\overline{WE}$, whichever occurs last.

7. t_{RCH} is referenced to the trailing edge of $\overline{CAS}$ or $\overline{RAS}$, whichever occurs first.

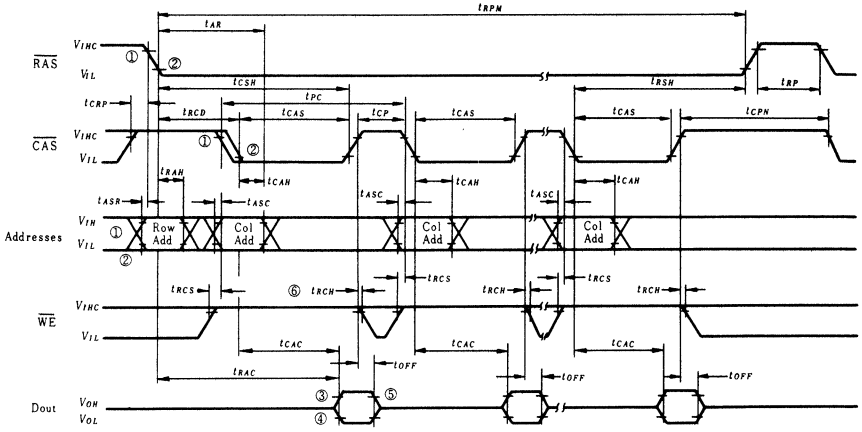
8. t_{CRP} requirement is only applicable for $\overline{RAS}/\overline{CAS}$ cycles preceeded by a $\overline{CAS}$-only cycle (i.e., for systems where $\overline{CAS}$ has not been decoded with $\overline{RAS}$).

■ DC AND AC CHARACTERISTICS, PAGE MODE [7.8.]

(Ta=0°C to 70°C, V_{CC}=5V±10%, V_{SS}=0V, unless otherwise noted.)

Parameter	Symbol	HM4816A-3 HM4816AP-3		HM4816A-3E HM4816AP-3E		HM4816A-4 HM4816AP-4		HM4816A-7 HM4816AP-7		Unit
		min.	max.	min.	max.	min.	max.	min.	max.	
Page Mode Read or Write Cycle	t_{PC}	125	—	130	—	145	—	190	—	ns
Page Mode Read Modify Write Cycle	t_{PCM}	175	—	180	—	200	—	280	—	ns
$\overline{CAS}$ Precharge Time, Page Cycle	t_{CP}	60	—	60	—	70	—	85	—	ns
$\overline{RAS}$ Pulse Width, Page Mode	t_{RPM}	115	10000	105	10000	140	10000	175	10000	ns
$\overline{CAS}$ Pulse Width	t_{CAS}	55	10000	60	10000	65	10000	95	10000	ns
V_{DD} Supply Current Page Mode. Minimum t_{PC}. Minimum t_{CAS}	I_{DD4}	—	23	—	23	—	21	—	18	mA

● PAGE MODE READ CYCLE



Notes:

1.2. $V_{IH\ MIN}$ and $V_{IL\ MAX}$ are reference levels for measuring timing of input signals.

3.4. $V_{OH\ MIN}$ and $V_{OL\ MAX}$ are reference levels for measuring timing of D_{OUT}.

5. t_{OFF} is measured to $I_{OUT} \leqq |I_{LO}|$.

6. t_{RCH} is referenced to the trailing edge of $\overline{CAS}$ or $\overline{RAS}$, whichever occurs first.

7. All voltages referenced to V_{SS}.

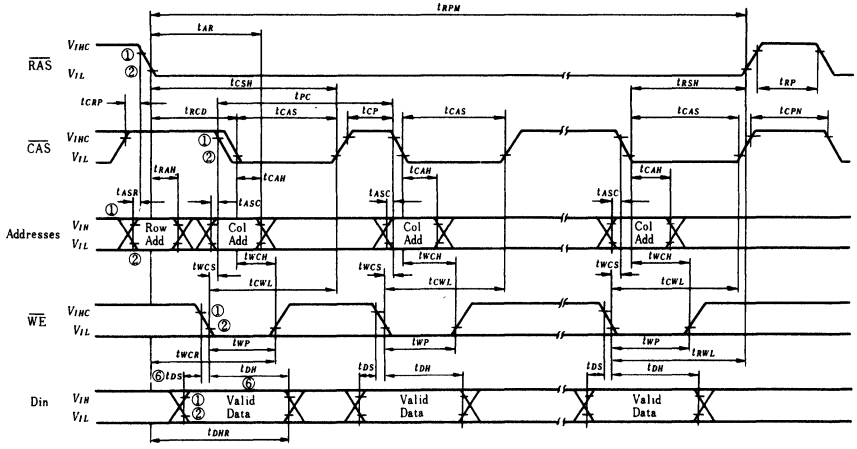
8. AC Characteristic assume t_T=5ns.

9. See the typical characteristics section for values of this parameter under alternate conditions.

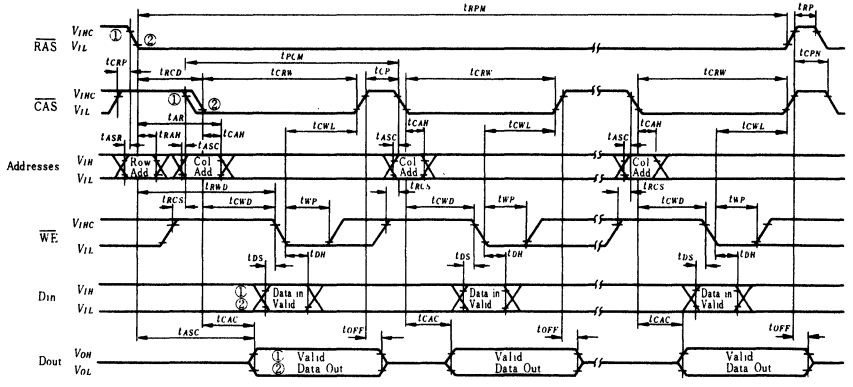
10. t_{CRP} requirement is only applicable for $\overline{RAS}$/$\overline{CAS}$ cycles preceeded by a $\overline{CAS}$-only cycle (i.e., for systems where $\overline{CAS}$ has not been decoded with $\overline{RAS}$).

11. All previous specified A.C. and D.C. characteristics are applicable to their respective page mode device.

●PAGE MODE WRITE CYCLE



●PAGE MODE READ-MODIFY-WRITE CYCLE



1.2. $V_{IH\ MIN}$ and $V_{IL\ MAX}$ are reference levels for measuring timing of input signals.

3.4. $V_{OH\ MIN}$ and $V_{OL\ MAX}$ are reference levels for measuring timing of D_{OUT}.

5. t_{OFF} is measured to $I_{OUT} \leqq |I_{LO}|$.

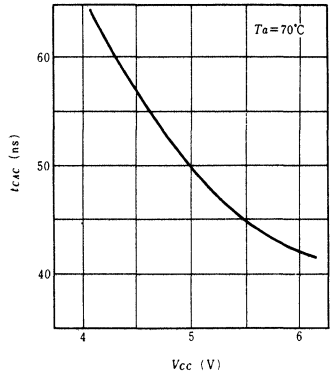
6. t_{DS} and t_{DH} are referenced to $\overline{CAS}$ or $\overline{WE}$, whichever occurs last.

7. t_{RCH} is referenced to the trailing edge of $\overline{CAS}$ or $\overline{RAS}$, whichever occurs first.

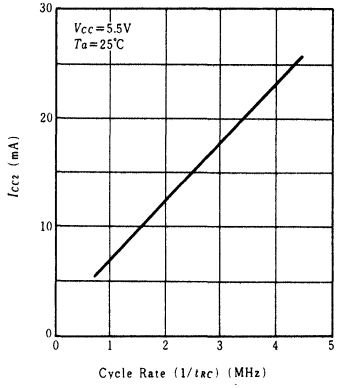
8. t_{CRP} requirement is only applicable for $\overline{RAS}$/$\overline{CAS}$, cycles preceeded by a $\overline{CAS}$-only cycle (i.e., for systems where $\overline{CAS}$ has not been decoded with $\overline{RAS}$).

● Typical Characteristics of HM4816A

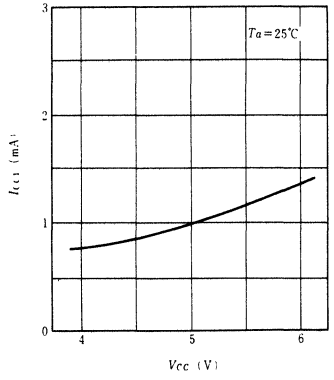
TYPICAL ACCESS TIME t_{CAC} vs. V_{CC}



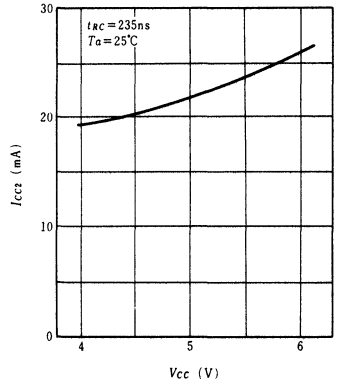
TYPICAL OPERATING CURRENT I_{CC2} vs. CYCLE RATE



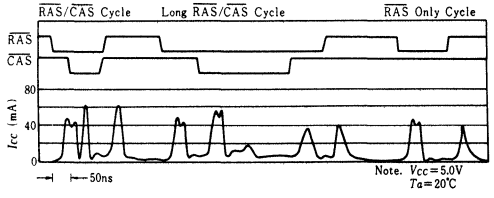
TYPICAL STANDBY CURRENT I_{CC1} vs. V_{CC}



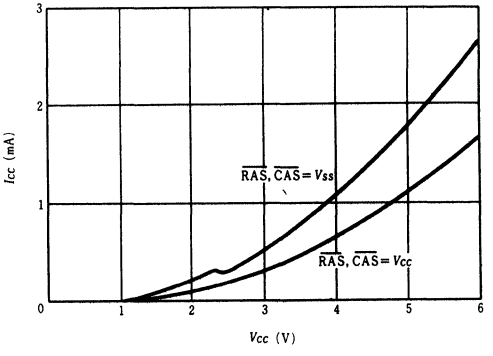
TYPICAL OPERATING CURRENT I_{CC2} vs. V_{CC}



● TYPICAL SUPPLY CURRENT WAVEFORMS



TYPICAL I_{CC} vs. V_{CC} DURING POWER UP



HM4864-2, HM4864-3
HM4864P-2, HM4864P-3

65536-word × 1-bit Dynamic Random Access Memory

The HM4864 is a 65,536-words by 1-bit, MOS random access memory circuit fabricated with HITACHI's double-poly N-channel silicon gate process for high performance and high functional density. The HM4864 uses a single transistor dynamic storage cell and dynamic control circuitry to achieve high speed and low power dissipation.

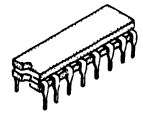
Multiplexed address inputs permit the HM4864 to be packaged in a standard 16 pin DIP on 0.3 inch centers.

This package size provides high system bit densities and is compatible with widely available automated testing and insertion equipment. System oriented features include single power supply of +5V with ±10% tolerance, direct interfacing capability with high performance logic families such as Schottky TTL, maximum input noise immunity to minimize "false triggering" of the inputs, on-chip address and data registers which eliminate the need for interface registers, and two chip select methods to allow the user to determine the appropriate speed/power characteristics of this memory system. The HM4864 also incorporates several flexible timing/operating modes.

In addition to the usual read,write, and read-modify-write cycles, the HM4864 is capable of delayed write cycles, page-mode operation and $\overline{RAS}$-only refresh.

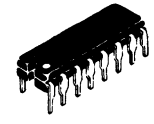
Proper control of the clock inputs ($\overline{RAS}$, $\overline{CAS}$, and $\overline{WE}$) allows common I/O capability, two dimensional chip selection, and extended page boundaries (when operating in page mode).

HM4864-2, HM4864-3



(DG-16A)

HM4864P-2, HM4864P-3

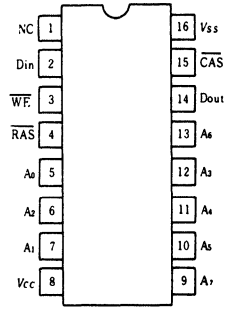


(DP-16)

■FEATURES

- Recognized industry standard 16-pin configuration
- 150ns access time, 270ns cycle time (HM4864-2, HM4864P-2)
- 200ns access time, 335ns cycle time (HM4864-3, HM4864P-3)
- Single power supply of +5V±10% with a built-in V_{BB} generator
- Low Power; 330 mW active. 20 mW standby (max)
- The inputs TTL compatible, low capacitance, and protected against static charge
- Output data controlled by $\overline{CAS}$ and unlatched at end of cycle to allow two dimensional chip selection and extended page boundary
- Common I/O capability using "early write" operation
- Read-Modify-Write, $\overline{RAS}$-only refresh, and Page-mode capability
- 128 refresh cycle

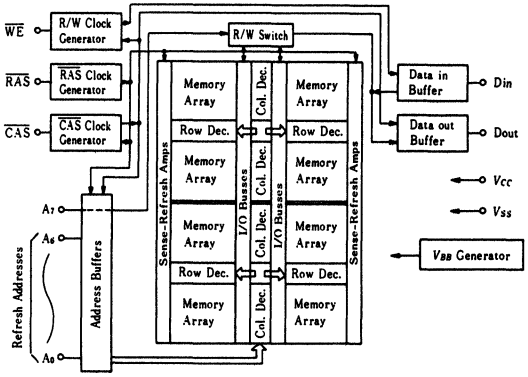
■PIN ARRANGEMENT



(Top View)

A_0-A_7	Address Inputs
$\overline{CAS}$	Column Address Strobe
Din	Data In
Dout	Data Out
$\overline{RAS}$	Row Address Strobe
$\overline{WE}$	Read/Write Input
V_{CC}	Power (+5V)
V_{SS}	Ground
A_0-A_6	Refresh Address Input

■ FUNCTIONAL BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} . . . . . -1.0 to +7V
Operating Temperature, Ta (Ambient) . . . . . 0 to +70°C
Storage Temperature (Ambient) . . . . . -65 to +150°C (Cerdip)
-55 to +125°C (Plastic)
Short-circuit Output Current . 50 mA
Power Dissipation . . . . . 1 W

■ RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Parameter	Symbol	min	typ	max	Unit	Notes
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	1
	V_{SS}	0	0	0	V	
Input High Voltage	V_{IH}	2.4	—	6.5	V	1
Input Low Voltage	V_{IL}	−1.0	—	0.8	V	1

■ DC ELECTRICAL CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	min	max	Unit	Notes
OPERATING CURRENT Average Power Supply Operating Current ($\overline{RAS}$, $\overline{CAS}$ Cycling; t_{RC}=min.)	I_{CC1}	—	60	mA	2, 4
STANDBY CURRENT Power Supply Standby Current ($\overline{RAS}$=V_{IH}, Dout=High Impedance)	I_{CC2}	—	3.5	mA	2
REFRESH CURRENT Average Power Supply Current, Refresh Mode ($\overline{RAS}$ Cycling, $\overline{CAS}$=V_{IH}; t_{RC}=min.)	I_{CC3}	—	45	mA	2, 4
PAGE MODE CURRENT Average Power Supply Current, Page-mode Operation ($\overline{RAS}$=V_{IL}, $\overline{CAS}$ Cycling; t_{PC}=min.)	I_{CC4}	—	45	mA	2, 4
INPUT LEAKAGE Input Leakage Current, any Input (V_{in}=0 to +6.5V, all other pins not under test=0V)	I_{LI}	−10	10	μA	
OUTPUT LEAKAGE Output Leakage Current (Dout is disabled, V_{out}=0 to +5.5V)	I_{LO}	−10	10	μA	3
OUTPUT LEVELS Output High (Logic 1) Voltage (I_{out}=−5mA) Output Low (Logic 0) Voltage (I_{out}=4.2mA)	V_{OH} V_{OL}	2.4 0	V_{CC} 0.4	V V	

NOTES
1. All voltages referenced to V_{SS}.
2. I_{CC} depends on output loading condition when the device is selected. I_{CC} max. is specified at the output open condition.
3. I_{LO} consists of leakage current only.
4. Current depends on cycle rate: maximum current is measured at the fastest cycle rate.

■ AC ELECTRICAL CHARACTERISTICS

Parameter	Symbol	typ	max	Unit	Notes
Input Capacitance (A_0-A_7, Din)	C_{in1}	—	7	pF	1
Input Capacitance ($\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$)	C_{in2}	—	10	pF	1
Output Capacitance (Dout)	C_{out}	—	7	pF	1, 2

NOTES
1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$ = V_{IH} to disable D_{OUT}.

■ ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS [1], [2]

(Ta=0 to +70°C, V_{CC}=5V±10%, V_{SS}=0V)

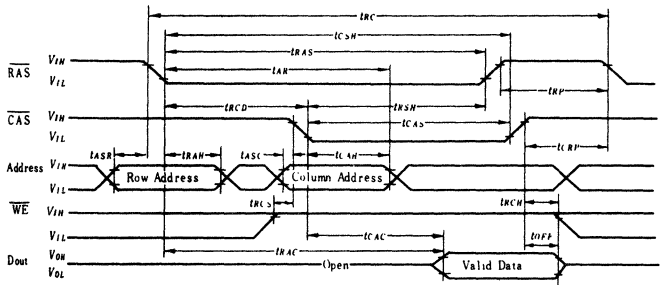
Parameter	Symbol	HM4864-2/P-2		HM4864-3/P-3		Unit	Notes
		min	max	min	max		
Random Read or Write Cycle Time	t_{RC}	270	—	335	—	ns	
Read-Write Cycle Time	t_{RWC}	270	—	335	—	ns	
Page Mode Cycle Time	t_{PC}	170	—	225	—	ns	
Access Time from $\overline{RAS}$	t_{RAC}	—	150	—	200	ns	4, 6
Access Time from $\overline{CAS}$	t_{CAC}	—	100	—	135	ns	5, 6
Output Buffer Turn-off Delay	t_{OFF}	0	40	0	50	ns	7
Transition Time (Rise and Fall)	t_T	3	35	3	50	ns	3
$\overline{RAS}$ Precharge Time	t_{RP}	100	—	120	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	150	10000	200	10000	ns	
$\overline{RAS}$ Hold Time	t_{RSH}	100	—	135	—	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	100	—	135	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	150	—	200	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	20	50	25	65	ns	8
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	−20	—	−20	—	ns	
Row Address Set-up Time	t_{ASR}	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	20	—	25	—	ns	
Column Address Set-up Time	t_{ASC}	−10	—	−10	—	ns	
Column Address Hold Time	t_{CAH}	45	—	55	—	ns	
Column Address Hold Time referenced to $\overline{RAS}$	t_{AR}	95	—	120	—	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	ns	
Read Command Hold Time	t_{RCH}	0	—	0	—	ns	
Write Command Hold Time	t_{WCH}	45	—	55	—	ns	
Write Command Hold Time referenced to $\overline{RAS}$	t_{WCR}	95	—	120	—	ns	
Write Command Pulse Width	t_{WP}	45	—	55	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	45	—	55	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	45	—	55	—	ns	
Data-in Set-up Time	t_{DS}	0	—	0	—	ns	9
Data-in Hold Time	t_{DH}	45	—	55	—	ns	9
Data-in Hold Time referenced to $\overline{RAS}$	t_{DHR}	95	—	120	—	ns	
$\overline{CAS}$ Precharge Time (for Page-mode Cycle Only)	t_{CP}	60	—	80	—	ns	
Refresh Period	t_{REF}	—	2	—	2	ms	
Write Command Set-up Time	t_{WCS}	−20	—	−20	—	ns	10
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	60	—	80	—	ns	10
$\overline{RAS}$ to $\overline{WE}$ Delay	t_{RWD}	110	—	145	—	ns	10
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	—	0	—	ns	

NOTES

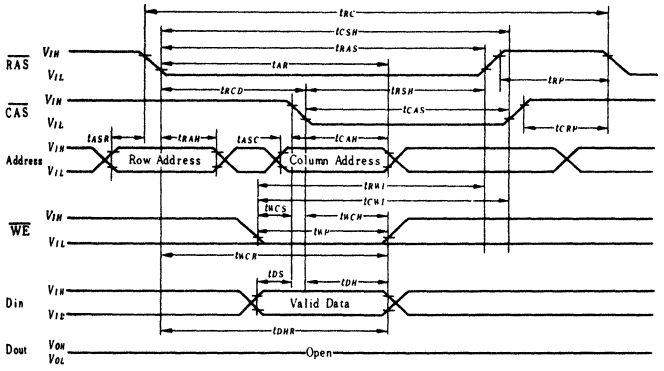
1. AC measurements assume t_T = 5ns.
2. 8 cycles are required after power-on or prolonged periods (greater than 2ms) of $\overline{RAS}$ inactivity before proper device operation is achieved. Any 8 cycles which perform refresh are adequate for this purpose.
3. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
4. Assumes that $t_{RCD} \leqq t_{RCD}$ (max). If t_{RCD} is greater than the maximum recommended value shown in this table t_{RAC} exceeds the value shown.
5. Assumes that $t_{RCD} \geqq t_{RCD}$ (max).
6. Measured with a load circuit equivalent to 2TTL loads and 100 pF.
7. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
8. Operation with the t_{RCD} (max) limit insures that t_{RAC} (max) can be met, t_{RCD} (max) is specified as a reference point only; if t_{RCD} is greater than the specified t_{RCD} (max) limit, then access time is controlled exclusively be t_{CAC}.
9. These parameters are reference to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge in delayed write or read-modify-write cycles.
10. t_{WCS}, t_{CWD} and t_{RWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if $t_{WCS} \geqq t_{WCS}$ (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geqq t_{CWD}$ (min) and $t_{RWD} \geqq t_{RWD}$ (min) the cycle is a read/write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.

■ TIMING WAVEFORMS

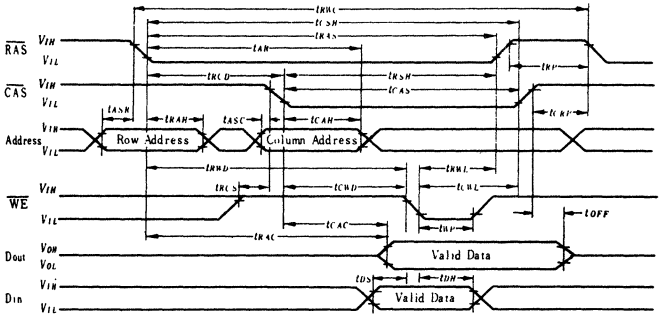
● READ CYCLE



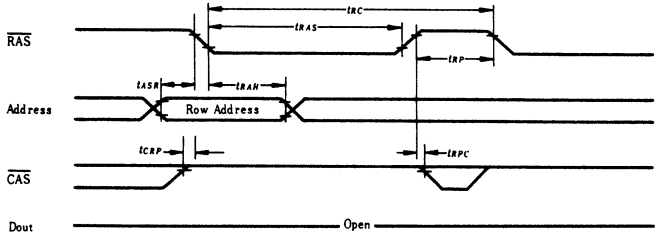
● WRITE CYCLE



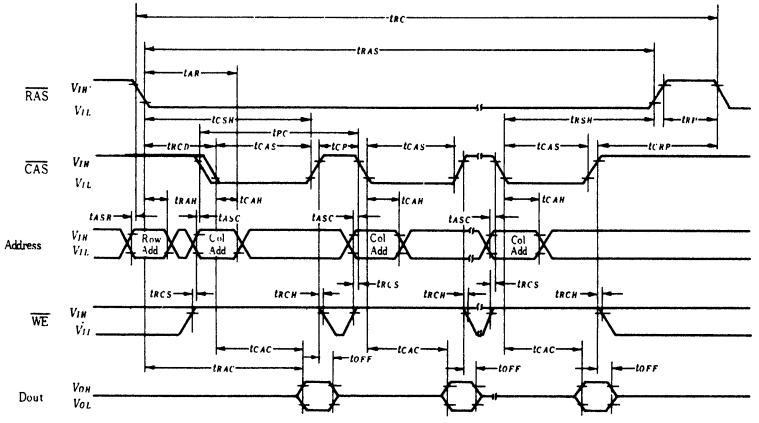
● READ-WRITE/READ-MODIFY-WRITE CYCLE



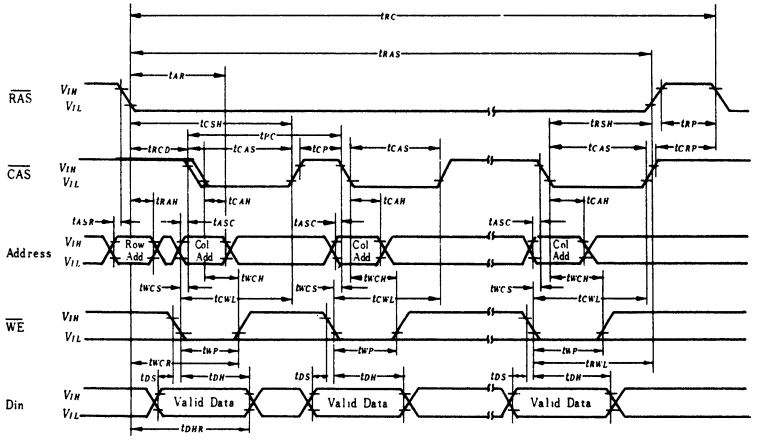
●"$\overline{RAS}$-ONLY" REFRESH CYCLE



●PAGE MODE READ CYCLE

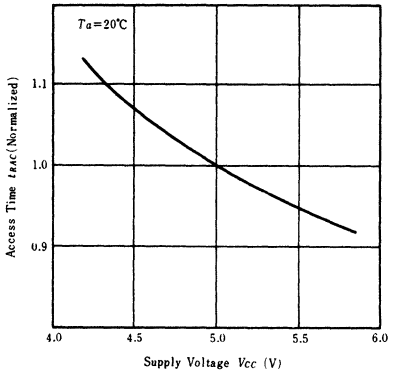


●PAGE MODE WRITE CYCLE

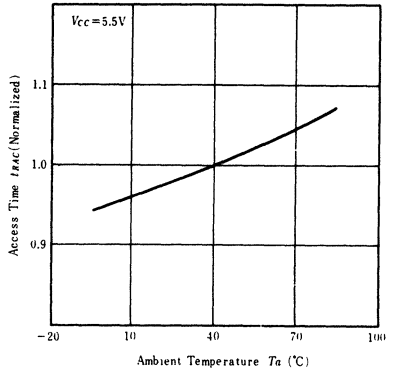


■ TYPICAL CHARACTERISTICS

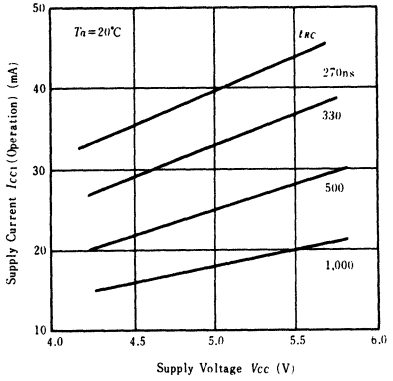
ACCESS TIME vs. SUPPLY VOLTAGE



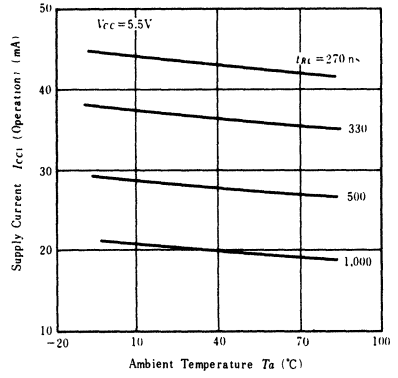
ACCESS TIME vs. AMBIENT TEMPERATURE



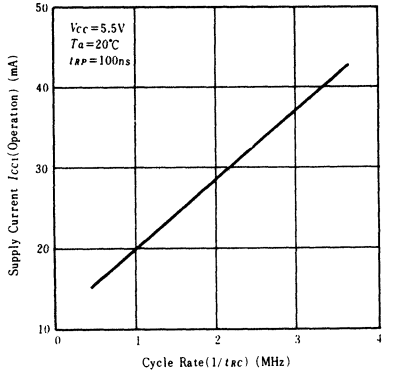
SUPPLY CURRENT vs. SUPPLY VOLTAGE



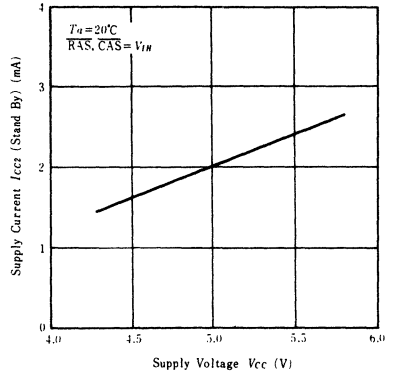
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



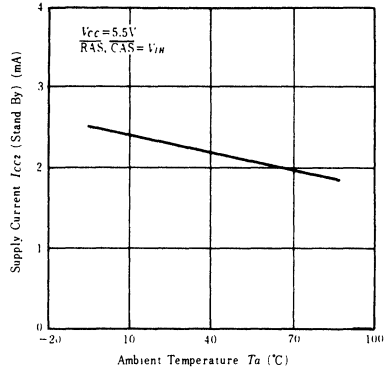
SUPPLY CURRENT vs. CYCLE RATE



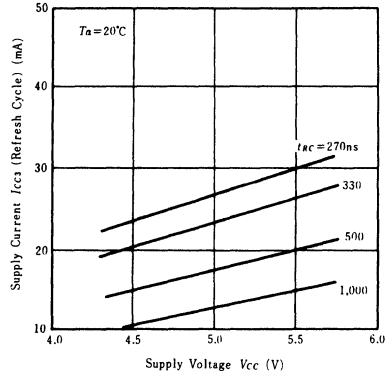
SUPPLY CURRENT vs. SUPPLY VOLTAGE



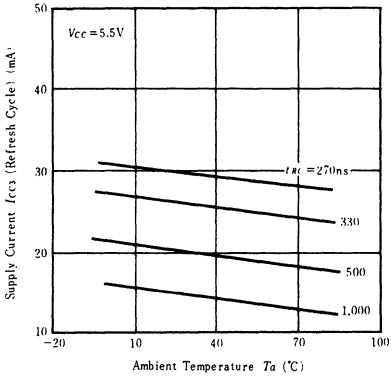
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



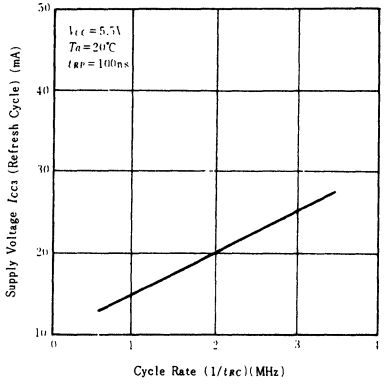
SUPPLY CURRENT vs. SUPPLY VOLTAGE



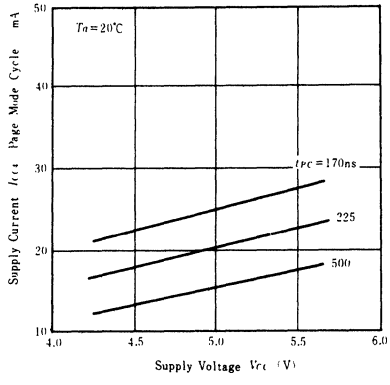
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



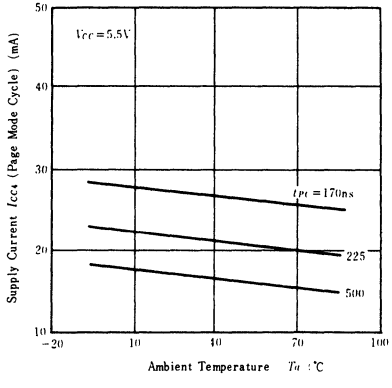
SUPPLY CURRENT vs. CYCLE RATE



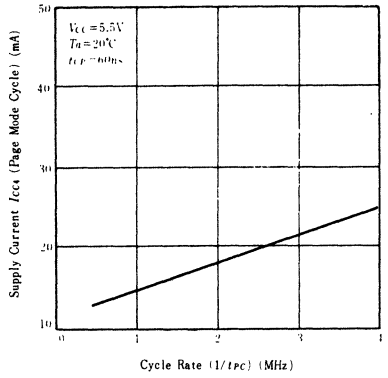
SUPPLY CURRENT vs. SUPPLY VOLTAGE



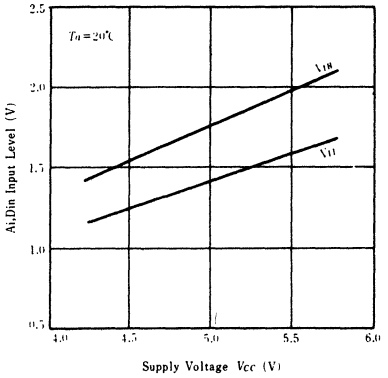
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



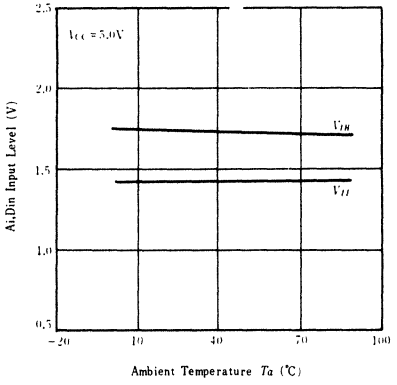
SUPPLY CURRENT vs. CYCLE RATE



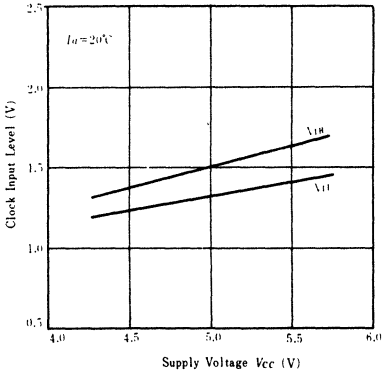
INPUT LEVEL vs. SUPPLY VOLTAGE



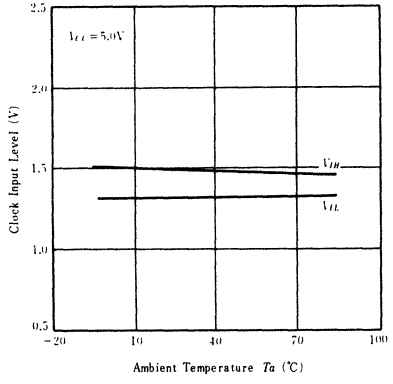
INPUT LEVEL vs. AMBIENT TEMPERATURE

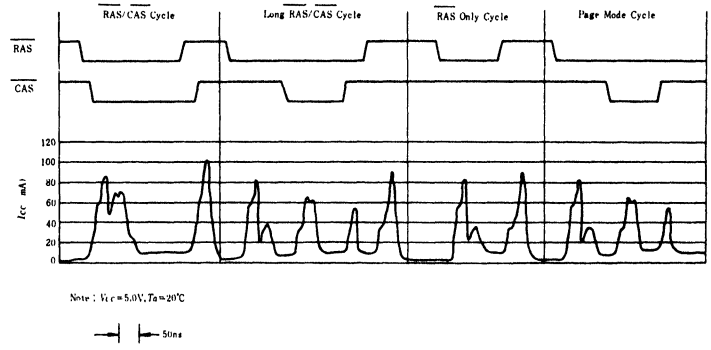


CLOCK INPUT LEVEL vs. SUPPLY VOLTAGE



CLOCK INPUT LEVEL vs. AMBIENT TEMPERATURE





■ APPLICATION INFORMATION

●POWER ON

An initial pause of 500 μs is required after power-up and a minimum of eight (8) initialization cycle,(any combination of cycles containing a $\overline{RAS}$ clock such as $\overline{RAS}$-only refresh) must follow an initial pause.

The V_{CC} current (I_{CC}) requirement of the HM4864 during power on is, however, dependent upon the input levels ($\overline{RAS}$, $\overline{CAS}$) and the rise time of V_{CC}, as shown in Fig. 1.

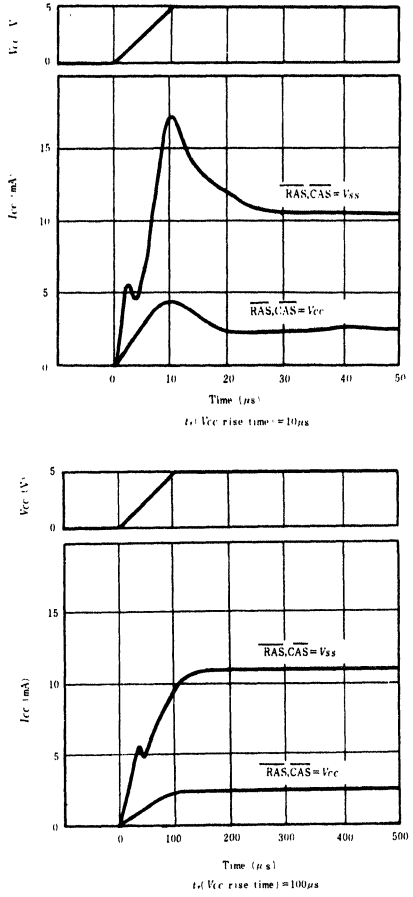


Fig.1 I_{CC} vs. V_{CC} during power up.

●READ CYCLE

A read cycle begins with addresses stable and a negative going transition of $\overline{RAS}$. The time delay between the stable address and the start of $\overline{RAS}$-on is controlled by parameter t_{ASR}.

Following the time when $\overline{RAS}$ reaches its low level, the row address must be held stable long enough to be captured. This controlling parameter is t_{RAH}. Following this interval, the address can be changed from row address to column address. When the column address is stable,$\overline{CAS}$ can be turned on. The leading edge of $\overline{CAS}$ is controlled by parameter t_{RCD}. The basic limit on the $\overline{CAS}$ leading edge is that $\overline{CAS}$ can not start until the column address is stable, and this is controlled by parameter t_{ASC}. The column address must be held stable long enough to be captured. The controlling parameter is t_{CAH}. Note that t_{RCD} (max) is not an operating limit of the HM4864 though its specification is listed on the data sheets. If $\overline{CAS}$ becomes on later than t_{RCD} (max), the access time from $\overline{RAS}$ will be increased by the time which t_{RCD} exceeds t_{RCD} (max).

Following the time when $\overline{CAS}$ reaches its low level, the data-out pin remains in a high impedance state until a valid data appears. This parameter is t_{CAC}-access time from $\overline{CAS}$.

The access time from $\overline{RAS}$–t_{RAC}–is the time from $\overline{RAS}$-on to valid Dout.

The minimum value of t_{RAC} is derived as the sum of t_{RCD} (max) and t_{CAC}.

The selected output data is held valid internally until $\overline{CAS}$ becomes high, and then Dout pin becomes high impedance. This parameter is t_{OFF}.

• WRITE CYCLE

A write cycle is performed by bringing $\overline{WE}$ low before or during $\overline{CAS}$-on.

Two different write cycles can be defined as;

Write cycle—Write data are available at the beginning of the $\overline{CAS}$-on so that the write operation starts at the beginning. In this mode, Dout and $\overline{WE}$ signal times are not in any critical path for determining cycle time.

Following the time when $\overline{WE}$ reaches its low level, $\overline{WE}$ must be held stable long enough to be captured. This $\overline{WE}$-on pulse deration is called t_{WP}. The time required to capture write data in a latch is called t_{DH}. This cycle is called an "early write".

Read Write cycle—This cycle starts as a read cycle, but as soon as the device specification is met, a write cycle is initiated.

$\overline{WE}$ and Din are delayed until after Dout. This cycle is called a "delayed write". A "Read-modify-write" cycle is a variation of this operation. In this mode, Din and $\overline{WE}$ become critical path signals for determining cycle time.

• CLOCK-OFF TIMING

$\overline{RAS}$ and $\overline{CAS}$ must stay on for Dout stabilized to valid data. In the case of $\overline{CAS}$, this is controlled by parameter t_{CAS} (min).

In the case of $\overline{RAS}$, this is controlled by parameter t_{CAS} (min). Following the end of $\overline{RAS}$, $\overline{CAS}$ must stay off long enough to precharge internal circuits. The only parameter of concern is t_{RP}. Normally $\overline{CAS}$ is not required to be off for minimum time of t_{CRP}. However, in a page mode memory operation, there is a t_{CP} (min) specification to control the $\overline{CAS}$-off time.

• DATA OUTPUT

Dout is three-state TTL compatible with a fan-out of two standard TTL loads.

When $\overline{CAS}$ is high, Dout is in a high impedance state. When $\overline{CAS}$ is low, valid data appears after t_{CAC} at a read cycle, and Dout is not valid as an early-write cycle.

• REFRESH

Refresh of the HM4864 is accomplished by performing a memory cycle at each of the 128 row addresses within each two millisecond time interval. A0 to A6 are refresh address pin compatible with standard 16K RAM (HM4716A, HM4816A). During refresh, either V_{IL} or V_{IH} is permitted for A7. Any cycle in which $\overline{RAS}$ signal occurs refreshes the entire selected row. $\overline{RAS}$-only refresh results in substantial reduction in operating power. This reduction in power is reflected in the I_{CC3} specification.

• PAGE MODE

Page mode operation allows faster successive memory operations at multiple column locations of the same row address with increased speed.

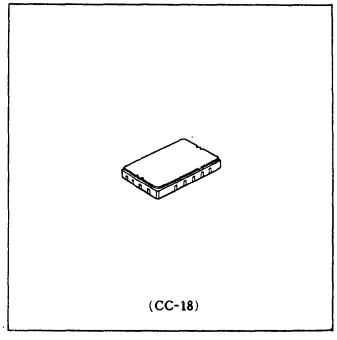
This is done by strobing the row address into the chip and maintaining $\overline{RAS}$ at a logic low throughout all successive $\overline{CAS}$ memory cycles in which the row address is latched. As the time normally required for strobing a new row address is eliminated, access and cycle times can be descreaded and the operating power is reduced. These are specifications.

HM4864CC-2, HM4864CC-3

65536-word × 1-bit Dynamic Random Access Memory

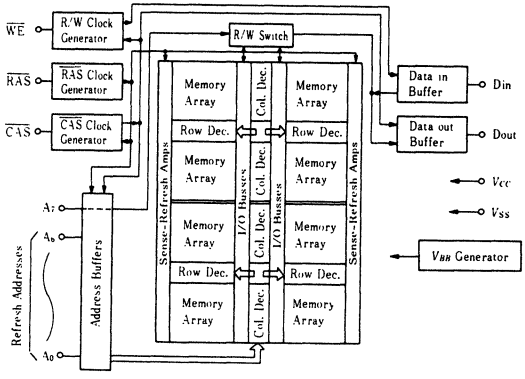
■ FEATURES

- 18-pin Leadless Chip Carrier
- 150ns access time, 270ns cycle (HM4864CC-2)
  200ns access time, 335ns cycle (HM4864CC-3)
- Single power supply of 5V ± 10% with a built-in V_{BB} generator
- Low power: 330mW active, 20mW standby (max)
- The inputs TTL compatible, low capacitance, and protected against static charge.
- Output data controlled by $\overline{CAS}$ and unlatched at end of cycle to allow two dimensional chip selection and extended page boundary.
- Common I/O capability using "early write" operation
- Read-Modify-Write, $\overline{RAS}$-only Refresh, and Page-mode capability 128 refresh cycle

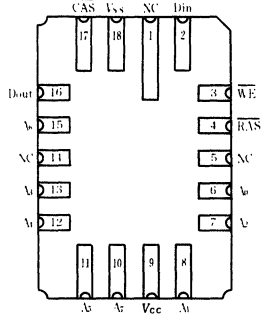


(CC-18)

■ FUNCTIONAL BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Bottom View)

A_0-A_7	Address Inputs
$\overline{CAS}$	Column Address Strobe
Din	Data In
Dout	Data Out
$\overline{RAS}$	Row Address Strobe
$\overline{WE}$	Read/Write Input
V_{CC}	Power (+5V)
V_{SS}	Ground
A_0-A_6	Refresh Address Input

■ ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} . . . . . -1.0 to +7V
Operating Temperature, Ta (Ambient) . . . . . 0 to +70°C
Storage Temperature (Ambient) . . . . . -65 to +150°C
Short-circuit Output Current . 50 mA
Power Dissipation . . . . . 1 W

■ RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Parameter	Symbol	min	typ	max	Unit	Notes
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	1
	V_{SS}	0	0	0	V	
Input High. Voltage	V_{IH}	2.4	—	6.5	V	1
Input Low Voltage	V_{IL}	−1.0	—	0.8	V	1

■ DC ELECTRICAL CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	min	max	Unit	Notes
OPERATING CURRENT Average Power Supply Operating Current ($\overline{RAS}$, $\overline{CAS}$ Cycling; t_{RC}=min.)	I_{CC1}	—	60	mA	2, 4
STANDBY CURRENT Power Supply Standby Current ($\overline{RAS}$=V_{IH}, Dout=High Impedance)	I_{CC2}	—	3.5	mA	2
REFRESH CURRENT Average Power Supply Current, Refresh Mode ($\overline{RAS}$ Cycling, $\overline{CAS}$=V_{IH}; t_{RC}=min.)	I_{CC3}	—	45	mA	2, 4
PAGE MODE CURRENT Average Power Supply Current, Page-mode Operation ($\overline{RAS}$=V_{IL}, $\overline{CAS}$ Cycling; t_{PC}=min.)	I_{CC4}	—	45	mA	2, 4
INPUT LEAKAGE Input Leakage Current, any Input (V_{in}=0 to +6.5V, all other pins not under test=0V)	I_{LI}	−10	10	μA	
OUTPUT LEAKAGE Output Leakage Current (Dout is disabled, V_{out}=0 to +5.5V)	I_{LO}	−10	10	μA	3
OUTPUT LEVELS Output High (Logic 1) Voltage (I_{out}=−5mA) Output Low (Logic 0) Voltage (I_{out}=4.2mA)	V_{OH} V_{OL}	2.4 0	V_{CC} 0.4	V V	

NOTES
1. All voltages referenced to V_{SS}.
2. I_{CC} depends on output loading condition when the device is selected. I_{CC} max. is specified at the output open condition.
3. I_{LO} consists of leakage current only.
4. Current depends on cycle rate: maximum current is measured at the fastest cycle rate.

■ AC ELECTRICAL CHARACTERISTICS

Parameter	Symbol	typ	max	Unit	Notes
Input Capacitance (A_0-A_7, Din)	C_{in1}	—	7	pF	1
Input Capacitance ($\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$)	C_{in2}	—	10	pF	1
Output Capacitance (Dout)	C_{out}	—	7	pF	1, 2

NOTES
1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$ = V_{IH} to disable D_{OUT}.

■ ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS [1), 2)]

(Ta=0 to +70°C, V_{CC}=5V±10%, V_{SS}=0V)

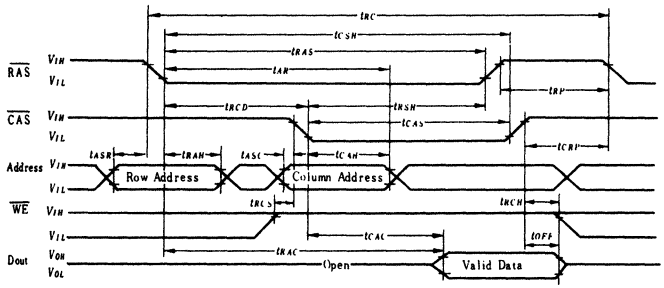
Parameter	Symbol	HM4864CC-2		HM4864CC-3		Unit	Notes
		min	max	min	max		
Random Read or Write Cycle Time	t_{RC}	270	—	335	—	ns	
Read-Write Cycle Time	t_{RWC}	270	—	335	—	ns	
Page Mode Cycle Time	t_{PC}	170	—	225	—	ns	
Access Time from $\overline{RAS}$	t_{RAC}	—	150	—	200	ns	4, 6
Access Time from $\overline{CAS}$	t_{CAC}	—	100	—	135	ns	5, 6
Output Buffer Turn-off Delay	t_{OFF}	0	40	0	50	ns	7
Transition Time (Rise and Fall)	t_T	3	35	3	50	ns	3
$\overline{RAS}$ Precharge Time	t_{RP}	100	—	120	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	150	10000	200	10000	ns	
$\overline{RAS}$ Hold Time	t_{RSH}	100	—	135	—	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	100	—	135	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	150	—	200	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	20	50	25	65	ns	8
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	−20	—	−20	—	ns	
Row Address Set-up Time	t_{ASR}	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	20	—	25	—	ns	
Column Address Set-up Time	t_{ASC}	−10	—	−10	—	ns	
Column Address Hold Time	t_{CAH}	45	—	55	—	ns	
Column Address Hold Time referenced to $\overline{RAS}$	t_{AR}	95	—	120	—	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	ns	
Read Command Hold Time	t_{RCH}	0	—	0	—	ns	
Write Command Hold Time	t_{WCH}	45	—	55	—	ns	
Write Command Hold Time referenced to $\overline{RAS}$	t_{WCR}	95	—	120	—	ns	
Write Command Pulse Width	t_{WP}	45	—	55	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	45	—	55	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	45	—	55	—	ns	
Data-in Set-up Time	t_{DS}	0	—	0	—	ns	9
Data-in Hold Time	t_{DH}	45	—	55	—	ns	9
Data-in Hold Time referenced to $\overline{RAS}$	t_{DHR}	95	—	120	—	ns	
$\overline{CAS}$ Precharge Time (for Page-mode Cycle Only)	t_{CP}	60	—	80	—	ns	
Refresh Period	t_{REF}	—	2	—	2	ms	
Write Command Set-up Time	t_{WCS}	−20	—	−20	—	ns	10
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	60	—	80	—	ns	10
$\overline{RAS}$ to $\overline{WE}$ Delay	t_{RWD}	110	—	145	—	ns	10
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	—	0	—	ns	

NOTES

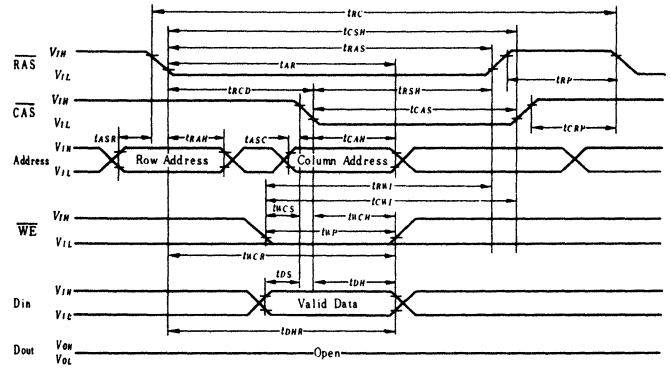
1. AC measurements assume t_T = 5ns.
2. 8 cycles are required after power-on or prolonged periods (greater than 2ms) of $\overline{RAS}$ inactivity before proper device operation is achieved. Any 8 cycles which perform refresh are adequate for this purpose.
3. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
4. Assumes that $t_{RCD} \leqq t_{RCD}$ (max). If t_{RCD} is greater than the maximum recommended value shown in this table t_{RAC} exceeds the value shown.
5. Assumes that $t_{RCD} \geqq t_{RCD}$ (max).
6. Measured with a load circuit equivalent to 2TTL loads and 100 pF.
7. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
8. Operation with the t_{RCD} (max) limit insures that t_{RAC} (max) can be met. t_{RCD} (max) is specified as a reference point only; if t_{RCD} is greater than the specified t_{RCD} (max) limit, then access time is controlled exclusively by t_{CAC}.
9. These parameters are reference to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge in delayed write or read-modify-write cycles.
10. t_{WCS}, t_{CWD} and t_{RWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if $t_{WCS} \geqq t_{WCS}$ (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geqq t_{CWD}$ (min) and $t_{RWD} \geqq t_{RWD}$ (min) the cycle is a read/write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.

■ TIMING WAVEFORMS

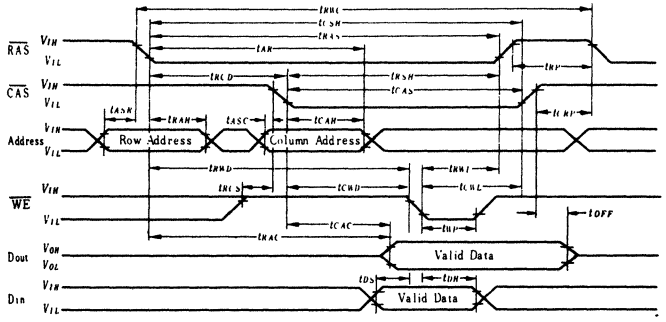
● READ CYCLE



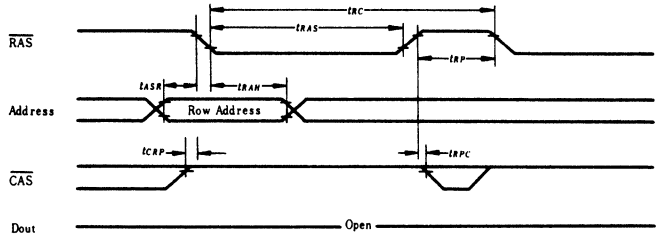
● WRITE CYCLE



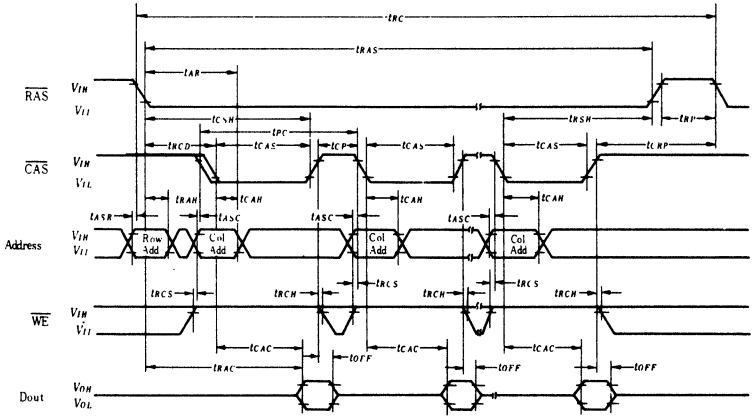
● READ-WRITE/READ-MODIFY-WRITE CYCLE



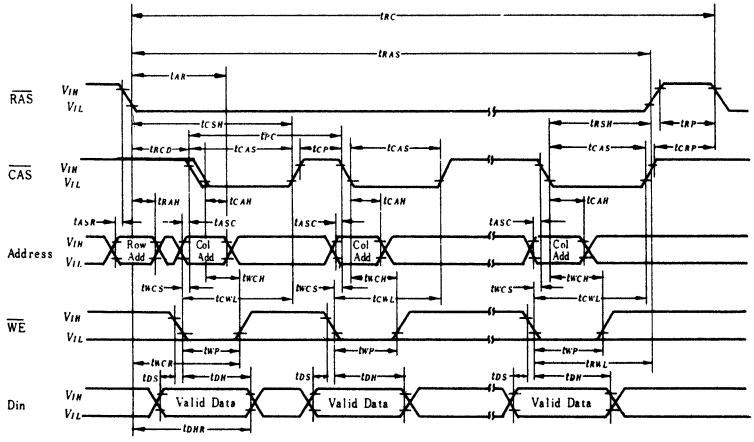
● "$\overline{RAS}$-ONLY" REFRESH CYCLE



● PAGE MODE READ CYCLE



● PAGE MODE WRITE CYCLE



HM4864I-2, HM4864I-3, HM4864K-2, HM4864K-3

Wide Operating Temperature Range

65536-word × 1-bit Dynamic Random Access Memory

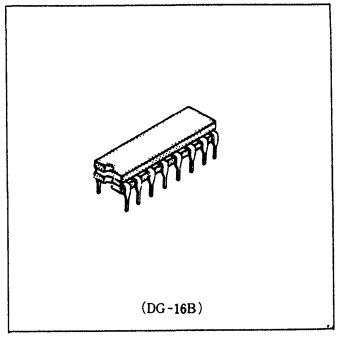
The HM4864 is a 65,536-words by 1-bit, MOS random access memory circuit fabricated with HITACHI's double-poly N-channel silicon gate process for high performance and high functional density. The HM4864 uses a single transistor dynamic storage cell and dynamic control circuitry to achieve high speed and low power dissipation.

Multiplexed address inputs permit the HM4864 to be packaged in a standard 16 pin DIP on 0.3 inch centers.

This package size provides high system bit densities and is compatible with widely available automated testing and insertion equipment. System oriented features include single power supply of +5V with ±10% tolerance, direct interfacing capability with high performance logic families such as Schottky TTL, maximum input noise immunity to minimize "false triggering" of the inputs, on-chip address and data registers which eliminate the need for interface registers, and two chip select methods to allow the user to determine the appropriate speed/power characteristics of this memory system. The HM4864 also incorporates several flexible timing/operating modes.

In addition to the usual read,write, and read-modify-write cycles, the HM4864 is capable of delayed write cycles, page-mode operation and $\overline{RAS}$-only refresh.

Proper control of the clock inputs ($\overline{RAS}$, $\overline{CAS}$, and $\overline{WE}$) allows common I/O capability, two dimensional chip selection, and extended page boundaries (when operating in page mode).



(DG-16B)

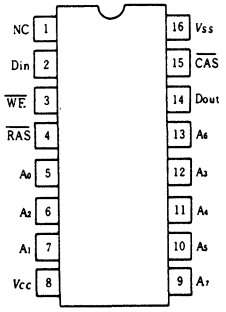
■ FEATURES

- Wide Operating Temperature Range

HM4864I-2/-3	−40~ +85°C
HM4864K-2/-3	−55~ +85°C

- Recognized industry standard 16-pin configuration
- 150ns access time, 270ns cycle time (HM4864I-2, HM4864K-2)
- 200ns access time, 335ns cycle time (HM4864I-3, HM4864K-3)
- Single power supply of +5V±10% with a built-in V_{BB} generator
- Low Power; 330 mW active. 22 mW standby (max)
- The inputs TTL compatible, low capacitance, and protected against static charge
- Output data controlled by $\overline{CAS}$ and unlatched at end of cycle to allow two dimensional chip selection and extended page boundary
- Common I/O capability using "early write" operation
- Read-Modify-Write, $\overline{RAS}$-only refresh, and Page-mode capability
- 128 refresh cycle

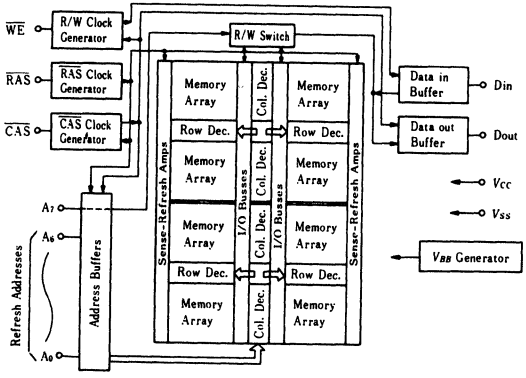
■ PIN ARRANGEMENT



(Top View)

A_0-A_7	Address Inputs
$\overline{CAS}$	Column Address Strobe
Din	Data In
Dout	Data Out
$\overline{RAS}$	Row Address Strobe
$\overline{WE}$	Read/Write Input
V_{CC}	Power (+5V)
V_{SS}	Ground
A_0-A_6	Refresh Address Input

■ FUNCTIONAL BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} . . . . . -1.0 to +7V
Operating Temperature, Ta
(Ambient) . . −40 to +85°C (HM4864I Series)
−55 to +85°C (HM4864K Series)
Storage Temperature
(Ambient) . . . . . -65 to +150°C
Short-circuit Output Current . 50 mA
Power Dissipation . . . . . 1 W

■ RECOMMENDED DC OPERATING CONDITIONS ($Ta = -40$ to $+85°C$)*

Parameter	Symbol	min	typ	max	Unit	Notes
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	1
	V_{SS}	0	0	0	V	
Input High Voltage	V_{IH}	2.4	−	6.5	V	1
Input Low Voltage	V_{IL}	−1.0	−	0.8	V	1

*: HM4864K Series; $T_a = -55$ to $+85°C$

■ DC ELECTRICAL CHARACTERISTICS ($Ta = -40$ to $+85°C$,* $V_{CC} = 5V \pm 10\%$, $V_{SS} = 0V$)

Parameter	Symbol	min	max	Unit	Notes
OPERATING CURRENT Average Power Supply Operating Current ($\overline{RAS}$, $\overline{CAS}$ Cycling; t_{RC} = min.)	I_{CC1}	−	60	mA	2, 4
STANDBY CURRENT Power Supply Standby Current ($\overline{RAS} = V_{IH}$, Dout = High Impedance)	I_{CC2}	−	4	mA	2
REFRESH CURRENT Average Power Supply Current, Refresh Mode ($\overline{RAS}$ Cycling, $\overline{CAS} = V_{IH}$; t_{RC} = min.)	I_{CC3}	−	45	mA	2, 4
PAGE MODE CURRENT Average Power Supply Current, Page-mode Operation ($\overline{RAS} = V_{IL}$, $\overline{CAS}$ Cycling; t_{PC} = min.)	I_{CC4}	−	45	mA	2, 4
INPUT LEAKAGE Input Leakage Current, any Input (V_{in} = 0 to +6.5V, all other pins not under test = 0V)	I_{LI}	−10	10	μA	
OUTPUT LEAKAGE Output Leakage Current (Dout is disabled, V_{out} = 0 to +5.5V)	I_{LO}	−10	10	μA	3
OUTPUT LEVELS Output High (Logic 1) Voltage ($I_{out} = -5$mA) Output Low (Logic 0) Voltage ($I_{out} = 4.2$mA)	V_{OH} V_{OL}	2.4 0	V_{CC} 0.4	V V	

NOTES
1. All voltages referenced to V_{SS}.
2. I_{CC} depends on output loading condition when the device is selected. I_{CC} max. is specified at the output open condition.
3. I_{LO} consists of leakage current only.
4. Current depends on cycle rate: maximum current is measured at the fastest cycle rate.
5. *: HM4864K Series; $T_a = -55$ to $+85°C$

■ AC ELECTRICAL CHARACTERISTICS ($V_{CC} = 5V \pm 10\%$, $Ta = 25°C$)

Parameter	Symbol	typ	max	Unit	Notes
Input Capacitance (A_0-A_7, Din)	C_{in1}	−	7	pF	1
Input Capacitance ($\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$)	C_{in2}	−	10	pF	1
Output Capacitance (Dout)	C_{out}	−	7	pF	1, 2

NOTES
1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS} = V_{IH}$ to disable D_{OUT}.

■ ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS [1), 2)]

(Ta=−40 to +85°C*, V_{CC}=5V±10%, V_{SS}=0V)

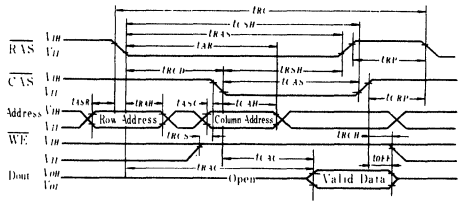
Parameter	Symbol	HM4864I/K-2		HM4864I/K-3		Unit	Notes
		min	max	min	max		
Random Read or Write Cycle Time	t_{RC}	270	—	335	—	ns	
Read-Write Cycle Time	t_{RWC}	270	—	335	—	ns	
Page Mode Cycle Time	t_{PC}	170	—	225	—	ns	
Access Time from $\overline{RAS}$	t_{RAC}	—	150	—	200	ns	4, 6
Access Time from $\overline{CAS}$	t_{CAC}	—	100	—	135	ns	5, 6
Output Buffer Turn-off Delay	t_{OFF}	0	40	0	50	ns	7
Transition Time (Rise and Fall)	t_T	3	35	3	50	ns	3
$\overline{RAS}$ Precharge Time	t_{RP}	100	—	120	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	150	10000	200	10000	ns	
$\overline{RAS}$ Hold Time	t_{RSH}	100	—	135	—	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	100	—	135	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	150	—	200	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	20	50	25	65	ns	8
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	−20	—	−20	—	ns	
Row Address Set-up Time	t_{ASR}	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	20	—	25	—	ns	
Column Address Set-up Time	t_{ASC}	−5	—	−5	—	ns	
Column Address Hold Time	t_{CAH}	45	—	55	—	ns	
Column Address Hold Time referenced to $\overline{RAS}$	t_{AR}	95	—	120	—	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	ns	
Read Command Hold Time	t_{RCH}	0	—	0	—	ns	
Write Command Hold Time	t_{WCH}	45	—	55	—	ns	
Write Command Hold Time referenced to $\overline{RAS}$	t_{WCR}	95	—	120	—	ns	
Write Command Pulse Width	t_{WP}	45	—	55	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	45	—	55	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	45	—	55	—	ns	
Data-in Set-up Time	t_{DS}	0	—	0	—	ns	9
Data-in Hold Time	t_{DH}	45	—	55	—	ns	9
Data-in Hold Time referenced to $\overline{RAS}$	t_{DHR}	95	—	120	—	ns	
$\overline{CAS}$ Precharge Time (for Page-mode Cycle Only)	t_{CP}	60	—	80	—	ns	
Refresh Period	t_{REF}	—	2	—	2	ms	
Write Command Set-up Time	t_{WCS}	−10	—	−10	—	ns	10
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	60	—	80	—	ns	10
$\overline{RAS}$ to $\overline{WE}$ Delay	t_{RWD}	110	—	145	—	ns	10
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	—	0	—	ns	

NOTES

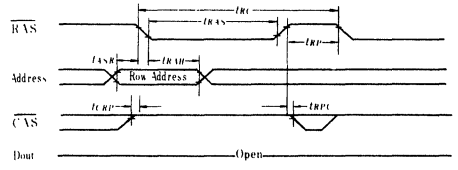
1. AC measurements assume t_T = 5ns.
2. 8 cycles are required after power-on or prolonged periods (greater than 2ms) of $\overline{RAS}$ inactivity before proper device operation is achieved. Any 8 cycles which perform refresh are adequate for this purpose.
3. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
4. Assumes that $t_{RCD} \leqq t_{RCD}$ (max). If t_{RCD} is greater than the maximum recommended value shown in this table t_{RAC} exceeds the value shown.
5. Assumes that $t_{RCD} \geqq t_{RCD}$ (max).
6. Measured with a load circuit equivalent to 2TTL loads and 100 pF.
7. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
8. Operation with the t_{RCD} (max) limit insures that t_{RAC} (max) can be met, t_{RCD} (max) is specified as a reference point only; if t_{RCD} is greater than the specified t_{RCD} (max) limit, then access time is controlled exclusively be t_{CAC}.
9. These parameters are reference to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge in delayed write or read-modify-write cycles.
10. t_{WCS}, t_{CWD} and t_{RWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only: if $t_{WCS} \geqq t_{WCS}$ (min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geqq t_{CWD}$ (min) and $t_{RWD} \geqq t_{RWD}$ (min) the cycle is a read/write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.
11. *: HM4864K Series; T_a=−55 to +85°C

■ TIMING WAVEFORMS

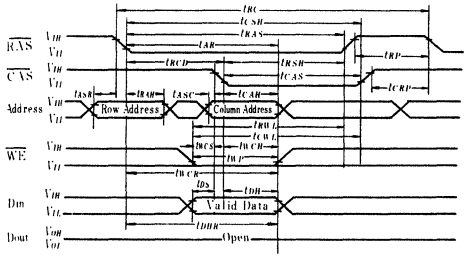
● READ CYCLE



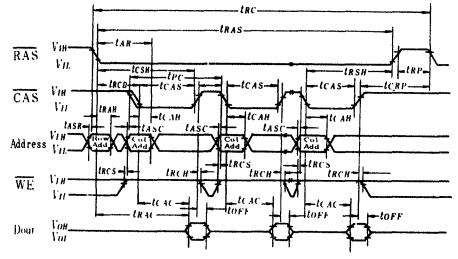
● "RAS-ONLY" REFRESH CYCLE



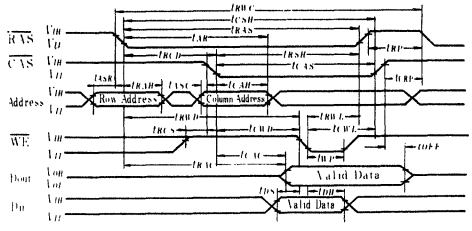
● WRITE CYCLE



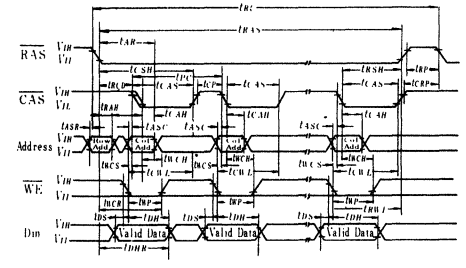
● PAGE MODE READ CYCLE



● READ-WRITE/READ-MODIFY-WRITE CYCLE



● PAGE MODE WRITE CYCLE



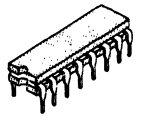
HM4864A-12, HM4864A-15, HM4864A-20, HM4864AP-12, HM4864AP-15, HM4864AP-20

65536-word × 1-bit Dynamic Random Access Memory

■ FEATURES

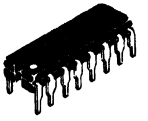
- Industry standard 16-Pin DIP (plastic, Cerdip)
- Single 5V (±10%)
- On chip substrate bias generator
- Low Power: 250mW active, 18mW standby
- High speed: Access Time 120ns / 150ns / 200ns
- Common I/O capability using early write operation
- Page mode capability
- Output data controlled by $\overline{CAS}$
- TTL compatible
- 128 refresh cycles – (2ms)
- Hidden refresh capability

HM4864A-12, HM4864A-15, HM4864A-20



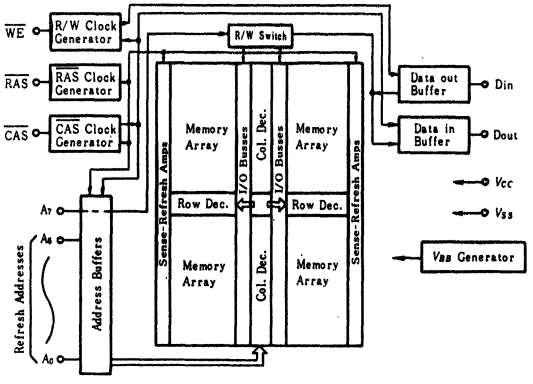
(DG-16B)

HM4864AP-12, HM4864AP-15, HM4864AP-20

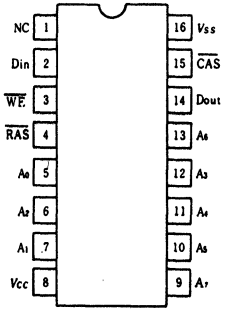


(DP-16)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS}	–1V to 7V
Operating temperature, Ta (Ambient)	0°C to 70°C
Storage temperature (Cerdip)	–65°C to 150°C
Storage temperature (Plastic)	–55°C to 125°C
Power dissipation	1 W
Short circuit output current	50 mA

■ RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to 70°C)

Parameter	Symbol	min.	typ.	max.	Unit	Notes
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	1
Input High Voltage	V_{IH}	2.4	—	6.5	V	1
Input Low Voltage	V_{IL}	−1.0	—	0.8	V	1

Notes : 1. All voltages referenced to V_{SS}

A0–A7 : Address Inputs
$\overline{CAS}$: Column Address Strobe
Din : Data In
Dout : Data Output
$\overline{RAS}$: Row Address Strobe
$\overline{WE}$: Read/Write Input
V_{CC} : Power (+5V)
V_{SS} : Ground
A0–A6 : Refresh Address Inputs

HITACHI

■ DC ELECTRICAL CHARACTERISTICS (Ta=0 to 70°C, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	HM4864A/P-12		HM4864A/P-15		HM4864A/P-20		Unit	Notes
		min	max	min	max	min	max		
Operating Current($\overline{RAS}$,$\overline{CAS}$ Cycling:t_{RC}=min)	I_{CC1}	—	55	—	50	—	44	mA	1,2
Standby Cnrrent($\overline{RAS}$=V_{IH},Dout=High Impedance)	I_{CC2}	—	3.5	—	3.5	—	3.5	mA	
Refresh Current($\overline{RAS}$ Cycling,$\overline{CAS}$=V_{IH},t_{RC}=min)	I_{CC3}	—	42	—	38	—	33	mA	2
Standby Current($\overline{RAS}$=V_{IH},Dout Enable)	I_{CC5}	—	5.5	—	5.5	—	5.5	mA	1
Page Mode Current($\overline{RAS}$=V_{IL},$\overline{CAS}$ Cycling;t_{PC}=min)	I_{CC6}	—	38	—	35	—	31	mA	1,2
Input Leakage(0<V_{out}<6.5V)	I_{LI}	−10	10	−10	10	−10	10	μA	
Output Leakage(Dout is disabled,0<V_{out}<5.5V)	I_{LO}	−10	10	−10	10	−10	10	μA	
Output Levels High(I_{out}=−5mA)	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	
Output Levels Low(I_{out}=4.2mA)	V_{OL}	0	0.4	0	0.4	0	0.4	V	

Notes) 1. I_{CC} depends on output loading condition when the device is selected, I_{CC} max. is specified at the output open condition.
2. Current depends on cycle rate: maximum current is measured at the fastest cycle rate.

■ CAPACITANCE (V_{CC}=5V±10%, Ta=25°C)

Parameter		Symbol	typ	max	Unit	Notes
Input Capacitance	A_0~A_7, Din	C_{in1}	—	5	pF	1
	$\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$	C_{in2}	—	10	pF	1
Output Capacitance	Dout	C_{out}	—	7	pF	1, 2

Notes) 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$=V_{IH} to disable Dout.

■ ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS

(Ta=0 to 70°C, V_{CC}=5V±10%, V_{SS}=0V)

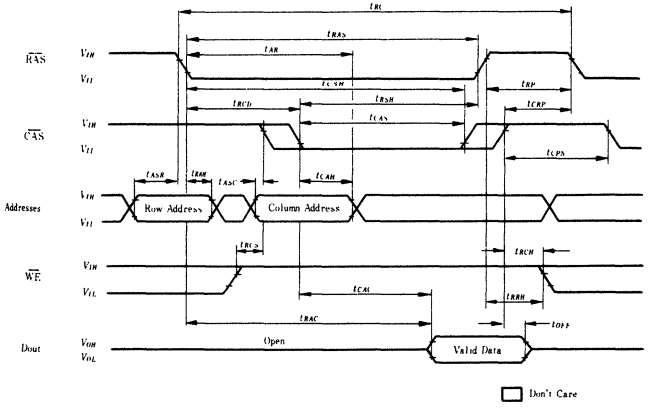
Parameter	Symbol	HM4864A-12		HM4864A-15		HM4864A-20		Unit	Notes
		min	max	min	max	min	max		
Access Time From $\overline{RAS}$	t_{RAC}	—	120	—	150	—	200	ns	2,3
Access Time From $\overline{CAS}$	t_{CAC}	—	60	—	75	—	100	ns	3,4
Output Buffer Turn-off Delay	t_{OFF}	—	35	—	40	—	50	ns	5
Transition Time (Rise and Fall)	t_T	3	35	3	35	3	50	ns	6
Random Read or Write Cycle Time	t_{RC}	220	—	260	—	330	—	ns	
$\overline{RAS}$ Precharge Time	t_{RP}	90	—	100	—	120	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	120	10000	150	10000	200	10000	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	60	10000	75	10000	100	10000	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	25	60	25	75	30	100	ns	7
$\overline{RAS}$ Hold Time	t_{RSH}	60	—	75	—	100	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	120	—	150	—	200	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	−10	—	−10	—	−10	—	ns	
Row Address Set-up Time	t_{ASR}	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	15	—	15	—	20	—	ns	
Column Address Set-up Time	t_{ASC}	0	—	0	—	0	—	ns	
Column Address Hold Time	t_{CAH}	20	—	25	—	30	—	ns	
Column Address Hold Time Referenced to $\overline{RAS}$	t_{AR}	80	—	100	—	130	—	ns	
$\overline{WE}$ Command Set-up Time	t_{WCS}	0	—	0	—	0	—	ns	8
Write Command Hold Time	t_{WCH}	40	—	45	—	55	—	ns	
Write Command Hold Time Referenced to $\overline{RAS}$	t_{WCR}	100	—	120	—	155	—	ns	
Write Command Pulse Width	t_{WP}	40	—	45	—	55	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	40	—	45	—	55	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	40	—	45	—	55	—	ns	
Data-in Set-up Time	t_{DS}	0	—	0	—	0	—	ns	9
Data-in Hold Time	t_{DH}	40	—	45	—	55	—	ns	9
Data-in Hold Time Referenced to $\overline{RAS}$	t_{DHR}	100	—	120	—	155	—	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	0	—	ns	
Read Command Hold Time Referenced to $\overline{CAS}$	t_{RCH}	0	—	0	—	0	—	ns	
Read Command Hold Time Referenced to $\overline{RAS}$	t_{RRH}	10	—	10	—	10	—	ns	
Refresh Period	t_{REF}	—	2	—	2	—	2	ms	
Read-Write Cycle Time	t_{RWC}	245	—	280	—	345	—	ns	
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	40	—	45	—	55	—	ns	8
$\overline{RAS}$ to $\overline{WE}$ Delay	t_{RWD}	100	—	120	—	155	—	ns	
Page Mode Cycle Time	t_{PC}	120	—	145	—	190	—	ns	
$\overline{CAS}$ Precharge Time (for Page-mode Cycle Only)	t_{CP}	50	—	60	—	80	—	ns	
$\overline{CAS}$ Precharge Time	t_{CPN}	30	—	35	—	45	—	ns	
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	—	0	—	0	—	ns	

Notes

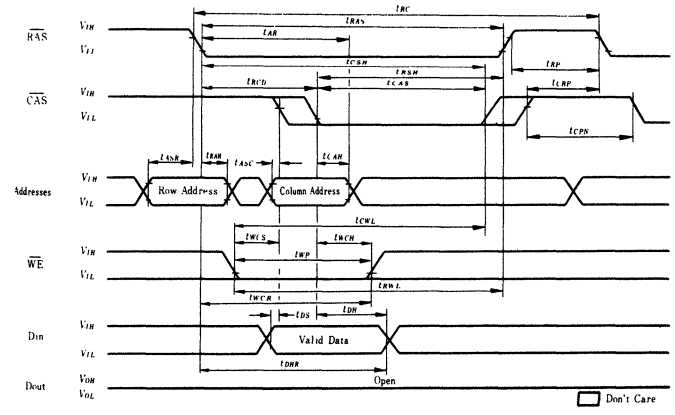
1. AC measurements assume t_T = 5ns.
2. Assumes that $t_{RCD} \leqq t_{RCD}$ (max). If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
3. Measured with a load circuit equivalent to 2TTL loads and 100pF.
4. Assumes that $t_{RCD} \geqq t_{RCD}$ (max).
5. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not reference to output voltage levels.
6. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
7. Operation with the t_{RCD} (max) limit insures that t_{RAC} (max) can be met, t_{RCD} (max) is specified as a reference point only, if t_{RCD} is greater than the specified t_{RCD} (max) limit, then access time is controlled exclusively by t_{CAC}.
8. t_{WCS}, t_{CWD} and t_{RWD} are not restrictive operating parameters.
   They are included in the data sheet is electrical characteristics only; if $t_{WCS} \geqq t_{WCS}$ (min), the cycle is an early write cycle and the data output pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geqq t_{CWD}$ (min) and $t_{RWD} \geqq t_{RWD}$ (min) the cycle is a read-write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.
9. There parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge is delayed write or read-modify-write cycles.
10. An initial pause of 100μs is required after power-up followed by a minimum of 8 initialization cycles.

■ TIMING WAVEFORMS

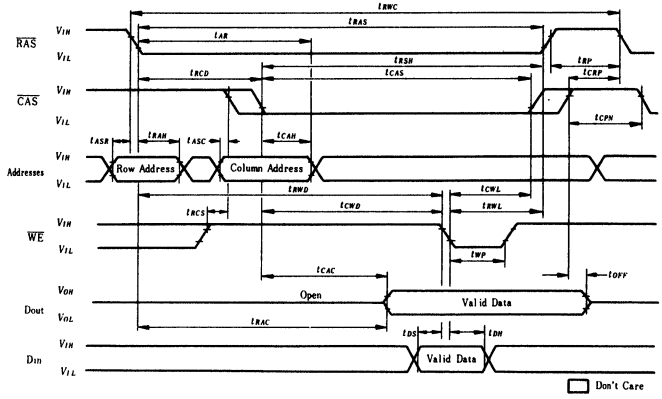
● READ CYCLE



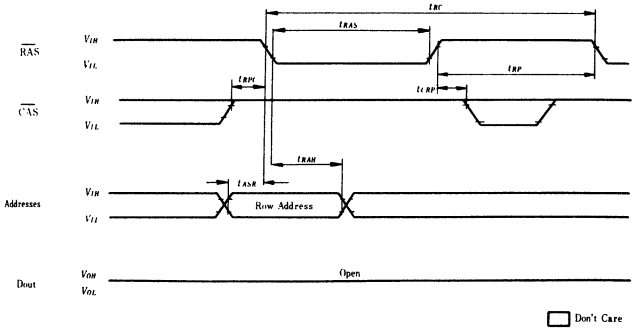
● WRITE CYCLE (EARLY WRITE)



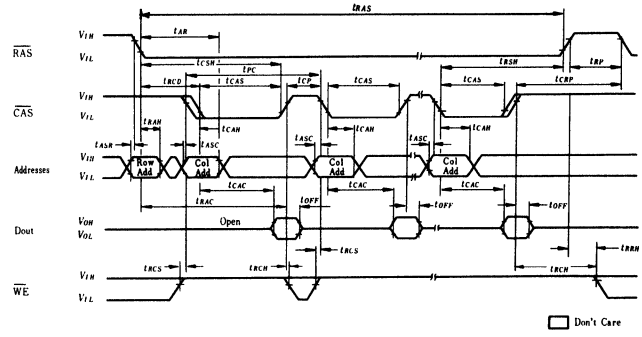
●READ-WRITE/READ-MODIFY-WRITE CYCLE



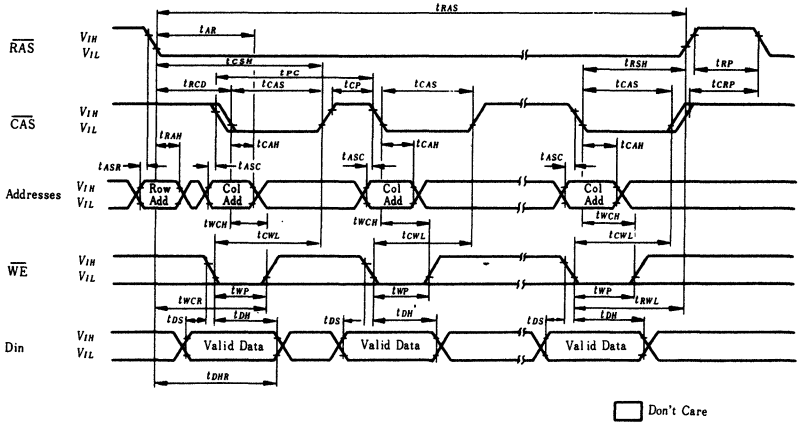
●"RAS-ONLY" REFRESH CYCLE



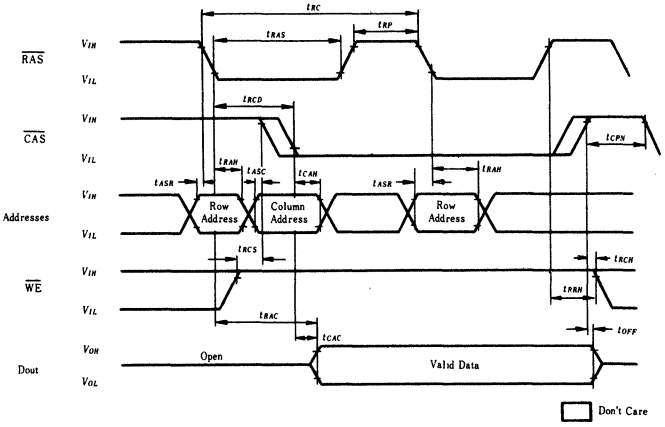
●PAGE MODE READ CYCLE



●PAGE MODE WRITE CYCLE



●HIDDEN REFRESH CYCLE



HM4864ACG-12, HM4864ACG-15, HM4864ACG-20

Preliminary

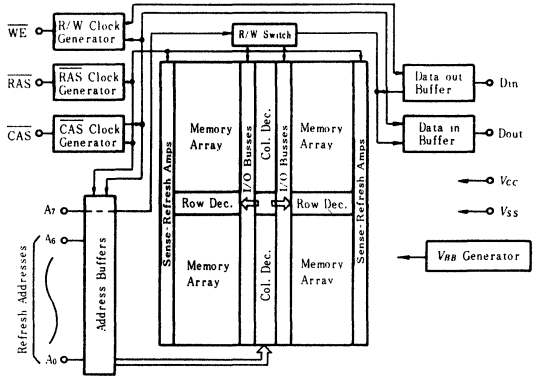
65536-word × 1-bit Dynamic Random Access Memory

■ FEATURES

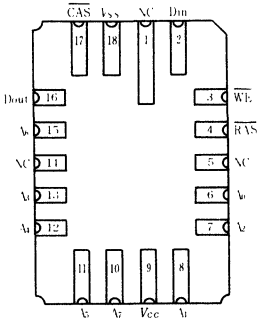
- 18-pin Leadless Chip Carrier
- Single 5V (±10%)
- On chip substrate bias generator
- Low Power: 250mW active, 18mW standby
- High speed: Access Time 120/150/200ns (max)
- Common I/O capability using early write operation
- Page mode capability
- Output data controlled by CAS
- TTL compatible
- 128 refresh cycles/2ms
- Hidden refresh capability

(CG-18)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Bottom View)

A0–A7	:	Address Inputs
$\overline{CAS}$	:	Column Address Strobe
Din	:	Data In
Dout	:	Data Output
$\overline{RAS}$	:	Row Address Strobe
$\overline{WE}$	:	Read/Write Input
V_{CC}	:	Power (+5V)
V_{SS}	:	Ground
A0–A6	:	Refresh Address Inputs

■ ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} . . . . . −1V to +7V
Operating temperature, Ta (Ambient) . . . . . 0°C to +70°C
Storage temperature . . . . . −65°C to +150°C
Power Dissipation 1W
Short circuit output current 50mA

■ RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to 70°C)

Parameter	Symbol	min.	typ.	max.	Unit	Notes
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	1
Input High Voltage	V_{IH}	2.4	—	6.5	V	1
Input Low Voltage	V_{IL}	−1.0	—	0.8	V	1

Notes : 1. All voltages referenced to V_{SS}

Note) The specifications of this device are subject to change without notice.
Please contact your nearest Hitachi's Sales Dept. regarding specifications.

■ DC ELECTRICAL CHARACTERISTICS (Ta=0 to 70°C, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	HM4864ACG-12		HM4864ACG-15		HM4864ACG-20		Unit	Notes
		min	max	min	max	min	max		
Operating Current($\overline{RAS}$,$\overline{CAS}$ Cycling:t_{RC}=min)	I_{CC1}	—	55	—	50	—	44	mA	1,2
Standby Cnrrent($\overline{RAS}$=V_{IH},Dout=High Impedance)	I_{CC2}	—	3.5	—	3.5	—	3.5	mA	
Refresh Current($\overline{RAS}$ Cycling,$\overline{CAS}$=V_{IH},t_{RC}=min)	I_{CC3}	—	42	—	38	—	33	mA	2
Standby Current($\overline{RAS}$=V_{IH},Dout Enable)	I_{CC5}	—	5.5	—	5.5	—	5.5	mA	1
Page Mode Current($\overline{RAS}$=V_{IL},$\overline{CAS}$ Cycling;t_{PC}=min)	I_{CC6}	—	38	—	35	—	31	mA	1,2
Input Leakage(0<V_{in}<6.5V)	I_{LI}	−10	10	−10	10	−10	10	μA	
Output Leakage(Dout is disabled,0<V_{out}<5.5V)	I_{LO}	−10	10	−10	10	−10	10	μA	
Output Levels High(I_{out}=−5mA)	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	
Output Levels Low(I_{out}=4.2mA)	V_{OL}	0	0.4	0	0.4	0	0.4	V	

Notes) 1. I_{CC} depends on output loading condition when the device is selected. I_{CC} max. is specified at the output open condition.
2. Current depends on cycle rate: maximum current is measured at the fastest cycle rate.

■ CAPACITANCE (V_{CC}=5V±10%, Ta=25°C)

Item		Symbol	typ	max	Unit	Notes
Input Capacitance	A_0~A_7, Din	C_{in1}	—	5	pF	1
	$\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$	C_{in2}	—	10	pF	1
Output Capacitance	Dout	C_{out}	—	7	pF	1, 2

Notes) 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$=V_{IH} to disable Dout.

■ ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS (Ta=0 to 70°C, V_{CC}=5V±10%, V_{SS}=0V)

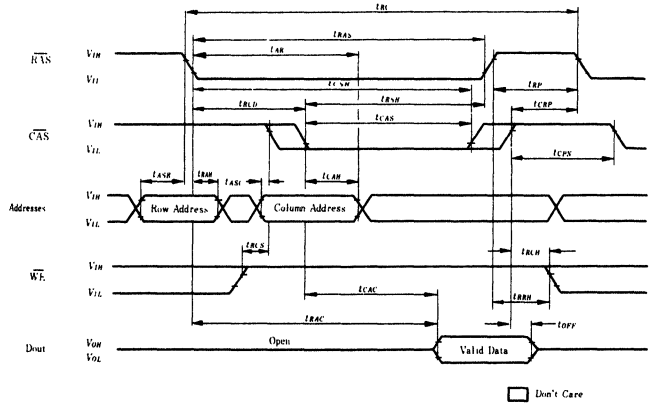
Parameter	Symbol	HM4864ACG-12		HM4864ACG-15		HM4864ACG-20		Unit	Notes
		min	max	min	max	min	max		
Access Time From $\overline{RAS}$	t_{RAC}	—	120	—	150	—	200	ns	2, 3
Access Time From $\overline{CAS}$	t_{CAC}	—	60	—	75	—	100	ns	3, 4
Output Buffer Turn-off Delay	t_{OFF}	—	35	—	40	—	50	ns	5
Transition Time (Rise and Fall)	t_T	3	35	3	35	3	50	ns	6
Random Read or Write Cycle Time	t_{RC}	220	—	260	—	330	—	ns	
$\overline{RAS}$ Precharge Time	t_{RP}	90	—	100	—	120	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	120	10000	150	10000	200	10000	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	60	10000	75	10000	100	10000	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	25	60	25	75	30	100	ns	7
$\overline{RAS}$ Hold Time	t_{RSH}	60	—	75	—	100	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	120	—	150	—	200	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	−10	—	−10	—	−10	—	ns	
Row Address Set-up Time	t_{ASR}	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	15	—	15	—	20	—	ns	
Column Address Set-up Time	t_{ASC}	0	—	0	—	0	—	ns	
Column Address Hold Time	t_{CAH}	20	—	25	—	30	—	ns	
Column Address Hold Time Referenced to $\overline{RAS}$	t_{AR}	80	—	100	—	130	—	ns	
$\overline{WE}$ Command Set-up Time	t_{WCS}	0	—	0	—	0	—	ns	8
Write Command Hold Time	t_{WCH}	40	—	45	—	55	—	ns	
Write Command Hold Time Referenced to $\overline{RAS}$	t_{WCR}	100	—	120	—	155	—	ns	
Write Command Pulse Width	t_{WP}	40	—	45	—	55	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	40	—	45	—	55	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	40	—	45	—	55	—	ns	
Data-in Set-up Time	t_{DS}	0	—	0	—	0	—	ns	9
Data-in Hold Time	t_{DH}	40	—	45	—	55	—	ns	9
Data-in Hold Time Referenced to $\overline{RAS}$	t_{DHR}	100	—	120	—	155	—	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	0	—	ns	
Read Command Hold Time Referenced to $\overline{CAS}$	t_{RCH}	0	—	0	—	0	—	ns	
Read Command Hold Time Referenced to $\overline{RAS}$	t_{RRH}	10	—	10	—	10	—	ns	
Refresh Period	t_{REF}	—	2	—	2	—	2	ms	
Read-Write Cycle Time	t_{RWC}	245	—	280	—	345	—	ns	
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	40	—	45	—	55	—	ns	8
$\overline{RAS}$ to $\overline{WE}$ Delay	t_{RWD}	100	—	120	—	155	—	ns	
Page Mode Cycle Time	t_{PC}	120	—	145	—	190	—	ns	
$\overline{CAS}$ Precharge Time (for Page-mode Cycle Only)	t_{CP}	50	—	60	—	80	—	ns	
$\overline{CAS}$ Precharge Time	t_{CPN}	30	—	35	—	45	—	ns	
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	—	0	—	0	—	ns	

Notes

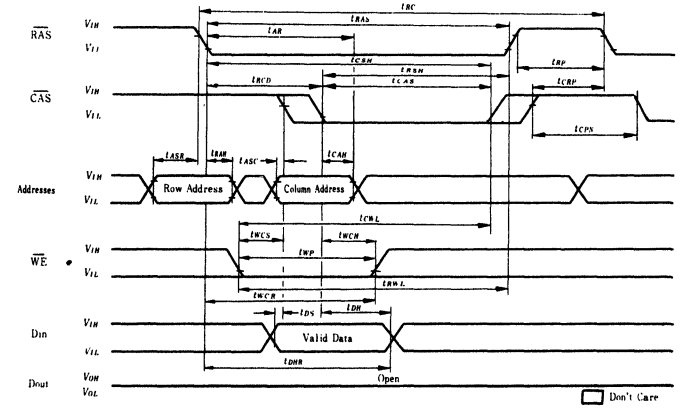
1. AC measurements assume t_T = 5ns.
2. Assumes that $t_{RCD} \leqq t_{RCD}$ (max). If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
3. Measured with a load circuit equivalent to 2TTL loads and 100pF.
4. Assumes that $t_{RCD} \geqq t_{RCD}$ (max).
5. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not reference to output voltage levels.
6. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
7. Operation with the t_{RCD} (max) limit insures that t_{RAC} (max) can be met, t_{RCD} (max) is specified as a reference point only, if t_{RCD} is greater than the specified t_{RCD} (max) limit, then access time is controlled exclusively by t_{CAC}.
8. t_{WCS}, t_{CWD} and t_{RWD} are not restrictive operating parameters.
   They are included in the data sheet is electrical characteristics only; if $t_{WCS} \geqq t_{WCS}$ (min), the cycle is an early write cycle and the data output pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geqq t_{CWD}$ (min) and $t_{RWD} \geqq t_{RWD}$ (min) the cycle is a read-write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.
9. There parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge is delayed write or read-modify-write cycles.
10. An initial pause of 100μs is required after power-up followed by a minimum of 8 initialization cycles.

■ TIMING WAVEFORMS

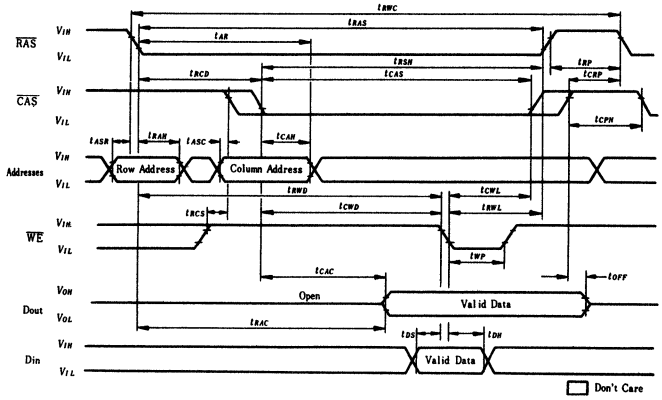
● READ CYCLE



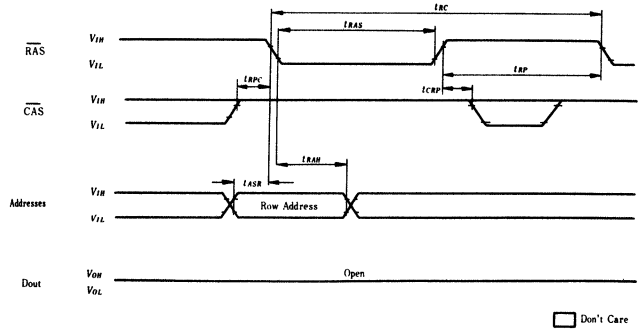
● WRITE CYCLE (EARLY WRITE)



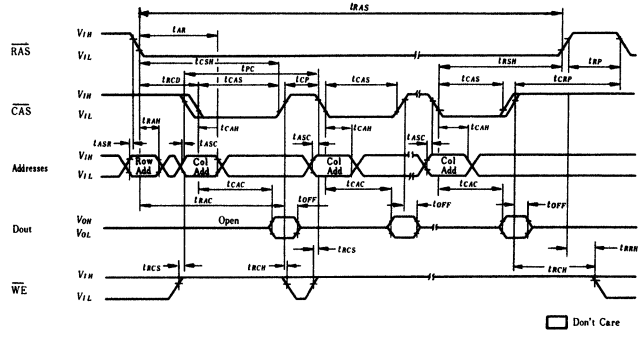
●READ-WRITE/READ-MODIFY-WRITE CYCLE



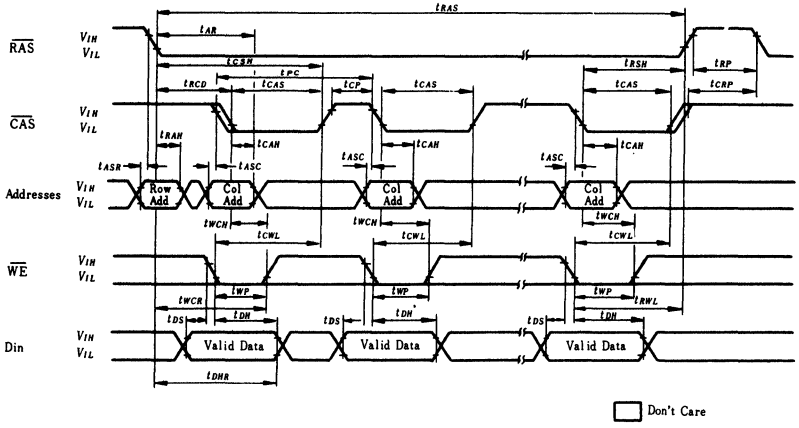
●"RAS-ONLY" REFRESH CYCLE



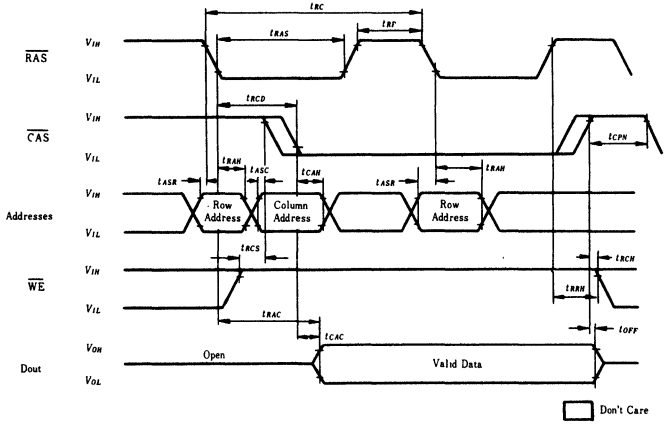
●PAGE MODE READ CYCLE



●PAGE MODE WRITE CYCLE



●HIDDEN REFRESH CYCLE

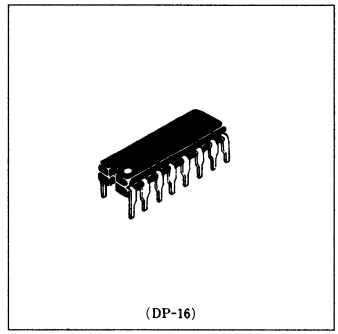


HM4865AP-12, HM4865AP-15
HM4865AP-20

65536-word × 1-bit Dynamic Random Access Memory

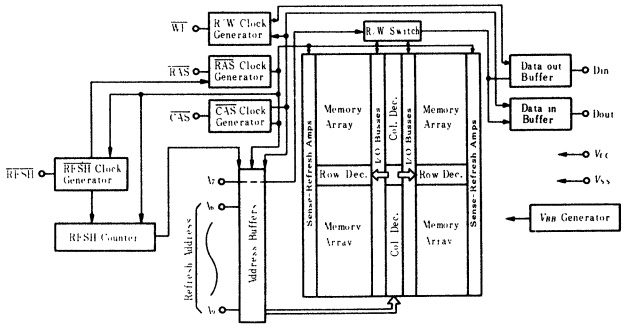
■FEATURES

- Auto Refresh Function
- Single power supply of 5V ± 10%
- High speed: Access time 120ns/150ns/200ns (max.)
- Low Power. 250mW active, 18mW standby
- On chip substrate bias generator
- Common I/O capability using early write operation
- Page mode capability
- Output data controlled by $\overline{CAS}$
- TTL compatible
- 128 refresh cycles/2ms
- Hidden refresh capability

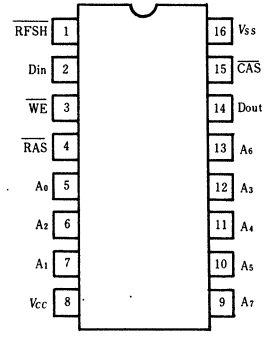


(DP-16)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

$\overline{RFSH}$	Refresh
$A_0 \sim A_7$	Address Inputs
$\overline{CAS}$	Column Address Strobe
Din	Data In
Dout	Data Out
$\overline{RAS}$	Row Address Strobe
$\overline{WE}$	Read/Write Input
V_{CC}	Power (+5V)
V_{SS}	Ground
$A_0 \sim A_6$	Refresh Address Inputs

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Voltage on any pin	V_T	−1.0 to +7.0	V
Supply Voltage	V_{CC}	−1.0 to +7.0	V
Short Circuit Output Current	I_{out}	50	mA
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	℃
Storage Temperature	T_{stg}	−55 to +125	℃

* with respect to V_{SS}

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70℃)

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	V_{SS}	0	0	0	V
Input Voltage	V_{IH}	2.4	—	6.5	V
	V_{IL}	−1.0	—	0.8	V

Note) All voltages referenced to V_{SS}.

■ DC ELECTRICAL CHARACTERISTICS (Ta=0 to 70°C, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	HM4865A/P-12		HM4865A/P-15		HM4865A/P-20		Unit	Notes
		min	max	min	max	min	ma x		
Operating Current($\overline{RAS}$,$\overline{CAS}$ Cycling:t_{RC}=min)	I_{CC1}	—	55	—	50	—	44	mA	1,2
Standby Cnrrent($\overline{RAS}$=V_{IH},Dout=High Impedance)	I_{CC2}	—	3.5	—	3.5	—	3.5	mA	
Refresh Current($\overline{RAS}$ Cycling,$\overline{CAS}$=V_{IH},t_{RC}=min)	I_{CC3}	—	42	—	38	—	33	mA	2
Standby Current($\overline{RAS}$=V_{IH},Dout Enable)	I_{CC5}	—	5.5	—	5.5	—	5.5	mA	1
Page Mode Current($\overline{RAS}$=V_{IL},$\overline{CAS}$ Cycling;t_{PC}=min)	I_{CC6}	—	38	—	35	—	31	mA	1,2
Auto Refresh Current ($\overline{RFSH}$=Cycle, $\overline{RAS}$=V_{IH})	I_{CC7}	—	44	—	40	—	35	mA	
Input Leakage(0<V_{out}<6.5V)	I_{LI}	−10	10	−10	10	−10	10	μA	
Output Leakage(Dout is disabled,0<V_{out}<5.5V)	I_{LO}	−10	10	−10	10	−10	10	μA	
Output Levels High(I_{out}=−5mA)	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	
Output Levels Low(I_{out}=4.2mA)	V_{OL}	0	0.4	0	0.4	0	0.4	V	

Notes) 1. I_{CC} depends on output loading condition when the device is selected, I_{CC} max. is specified at the output open condition.
2. Current depends on cycle rate : maximum current is measured at the fastest cycle rate.

■ CAPACITANCE (V_{CC}=5V±10%, Ta=25°C)

Parameter		Symbol	typ	max	Unit	Notes
Input Capacitance	A_0~A_7, Din	C_{in1}	—	5	pF	1
	$\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$	C_{in2}	—	10	pF	1
Output Capacitance	Dout	C_{out}	—	7	pF	1, 2

Notes) 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$=V_{IH} to disable Dout.

■ ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS (Ta=0 to 70°C, V_{CC}=5V±10%, V_{SS}=0V)

■ AC CHARACTERISTICS (V_{CC}=5V±10%, V_{SS}=0V, Ta=0 to +70°C)[1), 2)]

Item	Symbol	HM4865AP-12		HM4865AP-15		HM4865AP-20		Unit	Notes
		min	max	min	max	min	max		
Random Read or Write Cycle Time	t_{RC}	220	—	260	—	330	—	ns	
Read-Write Cycle Time	t_{RWC}	245	—	280	—	345	—	ns	
Page Mode Cycle Time	t_{PC}	120	—	145	—	190	—	ns	
Access Time from $\overline{RAS}$	t_{RAC}	—	120	—	150	—	200	ns	4, 6
Access Time from $\overline{CAS}$	t_{CAC}	—	60	—	75	—	100	ns	5, 6
Output Buffer Turn-off Delay	t_{OFF}	—	35	—	40	—	50	ns	7
Transition Time(Rise and Fall)	t_T	3	35	3	35	3	50	ns	3
$\overline{RAS}$ Precharge Time	t_{RP}	90	—	100	—	120	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	120	10000	150	10000	200	10000	ns	
$\overline{RAS}$ Hold Time	t_{RSH}	60	—	75	—	100	—	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	60	10000	75	10000	100	10000	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	120	—	150	—	200	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	25	60	25	75	30	100	ns	8
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	−10	—	−10	—	−10	—	ns	
Row Address Set-up Time	t_{ASR}	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	15	—	15	—	20	—	ns	
Column Address Set-up Time	t_{ASC}	0	—	0	—	0	—	ns	
Column Address Hold Time	t_{CAH}	20	—	25	—	30	—	ns	
Column Address Hold Time referenced to $\overline{RAS}$	t_{AR}	80	—	100	—	130	—	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	0	—	ns	
Read Command Hold Time	t_{RCH}	0	—	0	—	0	—	ns	
Write Command Hold Time	t_{WCH}	40	—	45	—	55	—	ns	
Write Command Hold Time referenced to $\overline{RAS}$	t_{WCR}	100	—	120	—	155	—	ns	
Write Command Pulse Width	t_{WP}	40	—	45	—	55	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	40	—	45	—	55	—	ns	

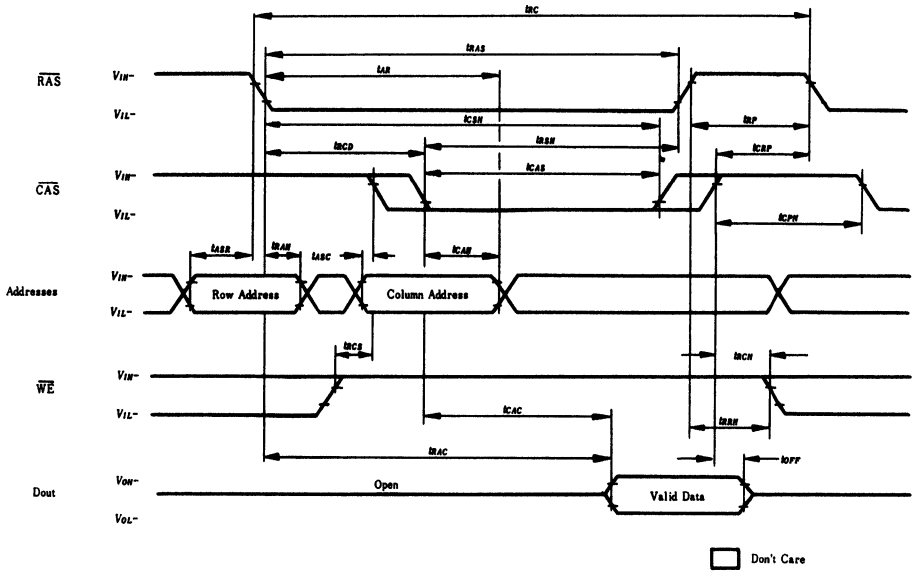
(to be continued)

Item	Symbol	HM4865AP-12		HM4865AP-15		HM4865AP-20		Unit	Notes
		min	max	min	max	min	max		
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	40	—	45	—	55	—	ns	
Data-in Set-up Time	t_{DS}	0	—	0	—	0	—	ns	9
Data-in Hold Time	t_{DH}	40	—	45	—	55	—	ns	9
Data-in Hold Time referenced to $\overline{RAS}$	t_{DHR}	100	—	120	—	155	—	ns	
$\overline{CAS}$ Precharge Time(for Page-mode Cycle Only)	t_{CP}	50	—	60	—	80	—	ns	
Refresh Period	t_{REF}	—	2	—	2	—	2	ns	
Write Command Set-up Time	t_{WCS}	0	—	0	—	0	—	ns	10
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	40	—	45	—	55	—	ns	10
$\overline{RAS}$ to $\overline{WE}$ Delay	t_{RWD}	100	—	120	—	155	—	ns	
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	—	0	—	0	—	ns	
Read-modify-write Hold Time	t_{RRH}	10	—	10	—	10	—	ns	
$\overline{CAS}$ Precharge Time	t_{CPN}	30	—	35	—	45	—	ns	
$\overline{RFSH}$ Set-up Time	t_{FSR}	90	—	100	—	120	—	ns	
$\overline{RAS}$ to $\overline{RFSH}$ Delay Time	t_{RFD}	90	—	100	—	120	—	ns	
$\overline{RFSH}$ Cycle Time	t_{FC}	220	—	260	—	330	—	ns	
$\overline{RFSH}$ Pulse Width	t_{FP}	120	5000	150	5000	200	5000	ns	
$\overline{RFSH}$ Precharge Time	t_{FI}	90	—	100	—	120	—	ns	

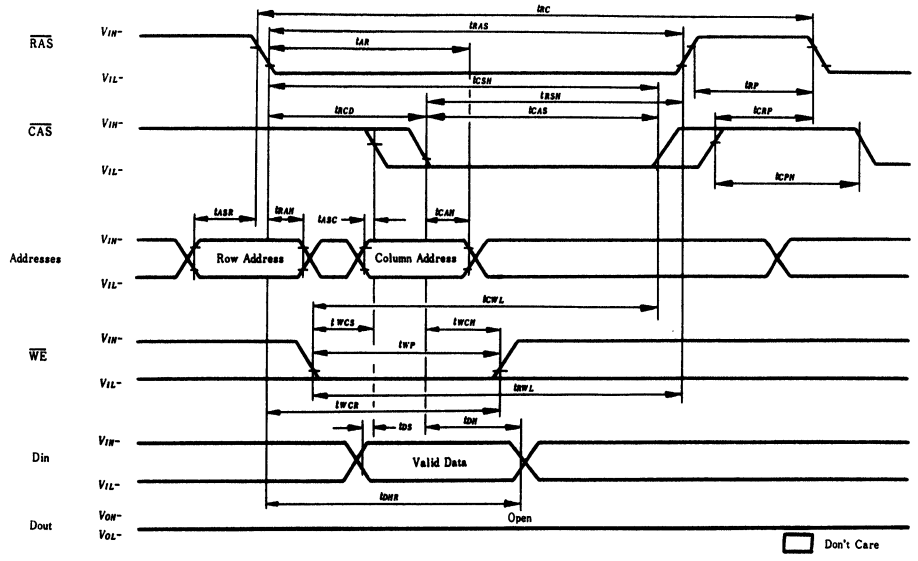
Notes)
1. AC measurements assume t_T = 5ns.
2. An initial pause of 100μs is required after power-up followed by a minimum of 8 initalization of cycles.
3. V_{IH}(min) and V_{IL}(max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
4. Assumes that $t_{RCD} = t_{RCD}$(max). If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
5. Assumes that $t_{RCD} \leq t_{RCD}$(max).
6. Measured with a load circuit equivalent to 2TTL loads and 100pF.
7. t_{OFF}(max) defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
8. Operation with the t_{RCD}(max) limit insures that t_{RAC}(max) can be met, t_{RCD} (max) is specified as a reference point only, if t_{RCD} is greater than the specified t_{RCD}(max) limit, then access time is controlled exclusively by t_{CAC}.
9. These parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WRITE}$ leading edge in delayed write or read-modify-write cycles.
10. t_{WCS}, t_{CWD} and t_{RWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only; if $t_{WCS} \geq t_{WCS}$(min), the cycle is an early write cycle and the data out pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geq t_{CWD}$(min) and $t_{RWD} \geq t_{RWD}$(min) the cycle is a read/write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.

■ TIMING WAVEFORM

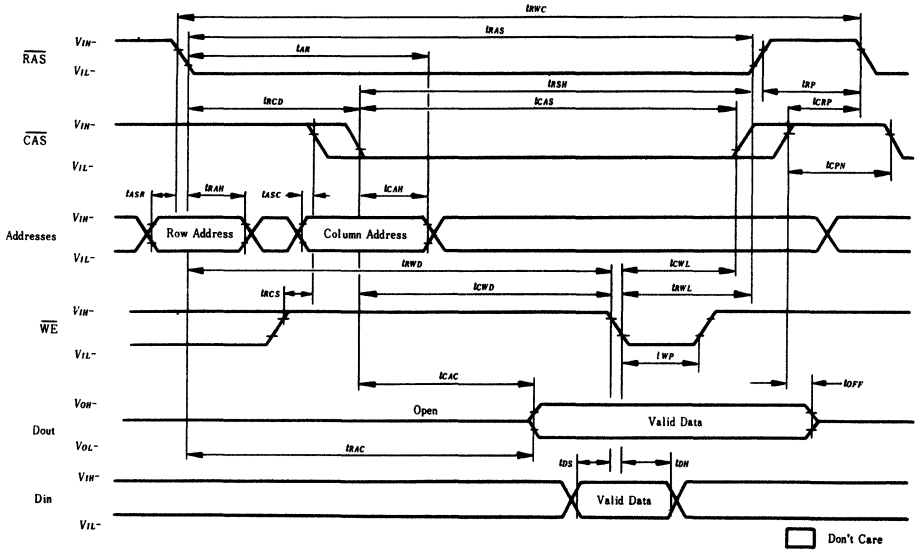
● READ CYCLE



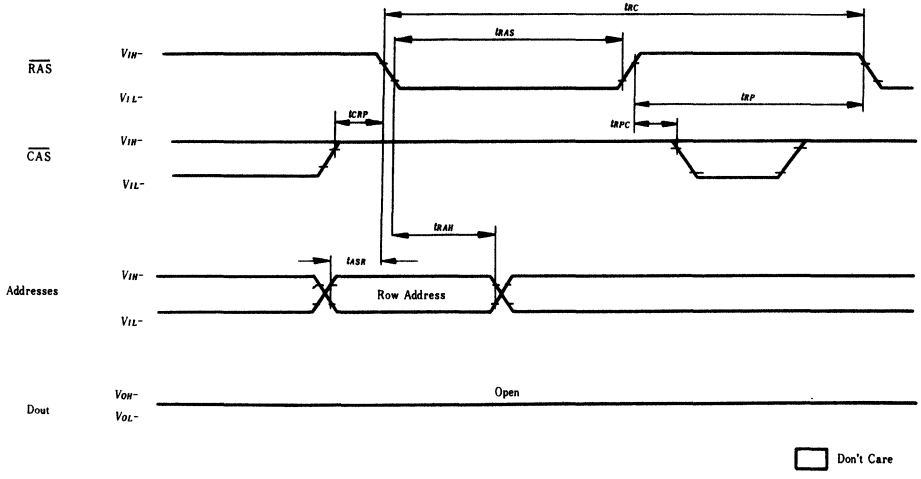
● WRITE CYCLE (EARLY WRITE)



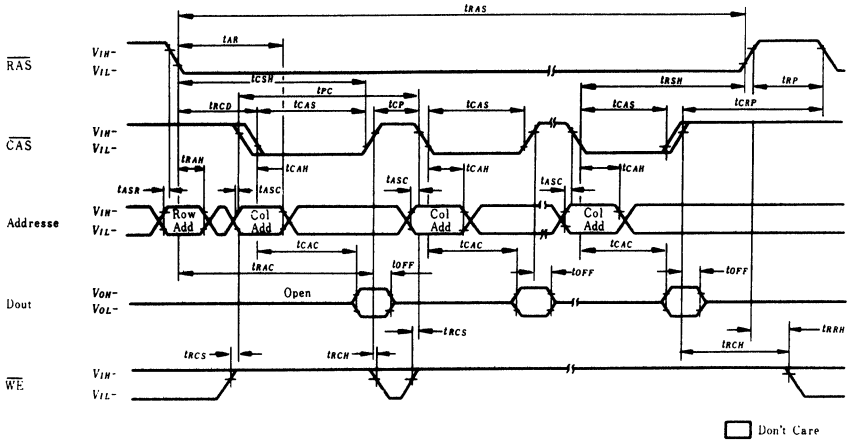
● READ-MODIFY-WRITE CYCLE



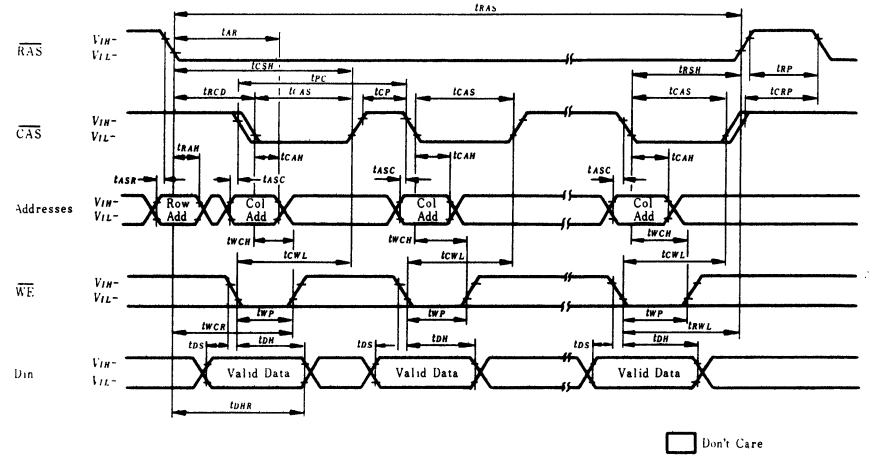
● $\overline{\text{RAS}}$ ONLY REFRESH CYCLE



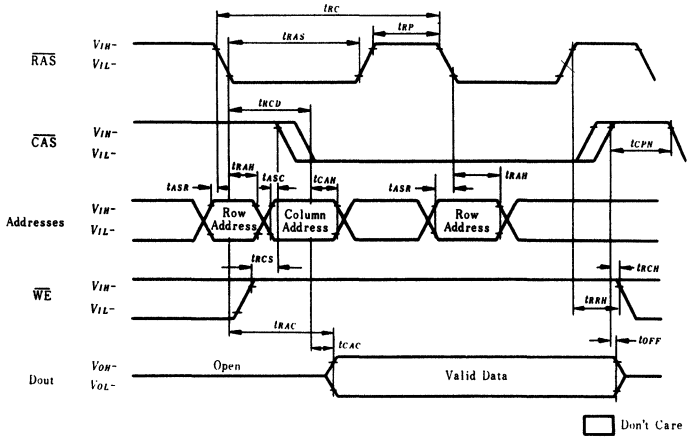
● PAGE MODE READ CYCLE



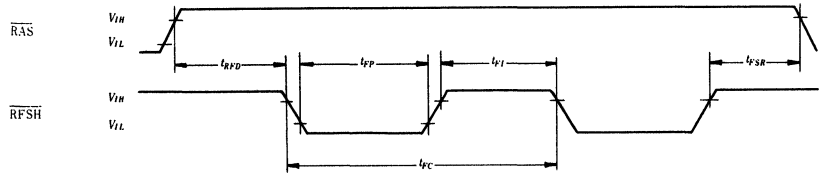
● PAGE MODE WRITE CYCLE



● HIDDEN REFRESH CYCLE



● $\overline{\text{RFSH}}$ (PIN 1) REFRESH CYCLE

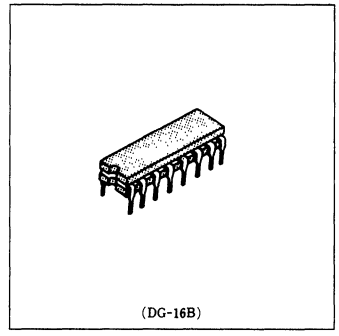


HM50256-12, HM50256-15 —Preliminary
HM50256-20

262144-word×1-bit Dynamic Random Access Memory

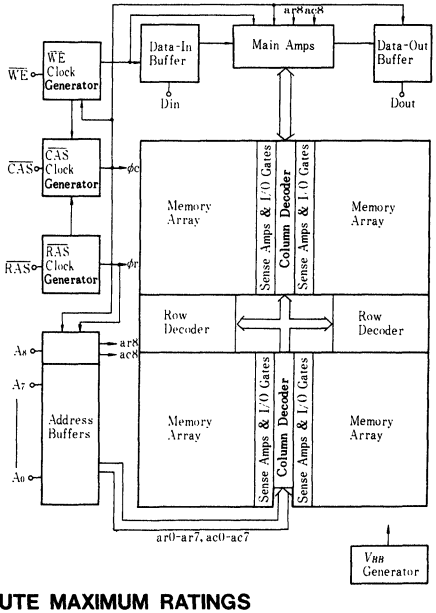
■FEATURES

- Industry Standard 16-Pin DIP
- Single 5V (±10%)
- On chip substrate bias generator
- Low Power: 350mW active, 23mW standby
- High speed: Access Time 120ns/150ns/200ns(max.)
- Common I/O capability using early write operation
- Page mode capability
- TTL compatible
- 256 refresh cycles.....(4 ms)
- 3 variation of refresh . . . $\overline{RAS}$ only refresh
  $\overline{CAS}$ before $\overline{RAS}$ refresh
  Hidden refresh

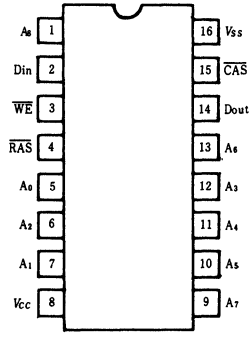


(DG-16B)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

A_0~A_8	Address Inputs
$\overline{CAS}$	Column Address Strobe
Din	Data In
Dout	Data Out
$\overline{RAS}$	Row Address Strobe
$\overline{WE}$	Read/Write Input
V_{CC}	Power (+5V)
V_{SS}	Ground
A_0~A_7	Refresh Address Inputs

■ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} . . . . . −1V to +7V
Operating temperature, Ta (Ambient) . . . . . 0°C to +70°C
Storage temperature . . . . . −65°C to +150°C
Power dissipation 1W
Short circuit output current 50mA

Note) The specifications of this device are subject to change without notice.
Please contact your nearest Hitachis Sales Dept, regarding specifications.

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Parameter	Symbol	min	typ	max	Unit	Note
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	1
Input High Voltage	V_{IH}	2.4	—	6.5	V	1
Input Low Voltage	V_{IL}	−1.0	—	0.8	V	1

Note) 1. All voltages referenced to V_{SS}

■DC ELECTRICAL CHARACTERISTICS (Ta=0 to +70℃, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	HM50256-12		HM50256-15		HM50256-20		Unit	Notes
		min	max	min	max	min	max		
Operating Current($\overline{RAS}$, $\overline{CAS}$ Cycling : t_{RC}=min)	I_{CC1}	—	83	—	70	—	55	mA	1
Standby Current($\overline{RAS}$=V_{IH}, Dout=High Impedance)	I_{CC2}	—	4.5	—	4.5	—	4.5	mA	
Refresh Current($\overline{RAS}$ only Refresh, t_{RC}=min)	I_{CC3}	—	62	—	53	—	42	mA	
Standby Current($\overline{RAS}$=V_{IH}, Dout Enable)	I_{CC5}	—	10	—	10	—	10	mA	1
Refresh Current($\overline{CAS}$ before $\overline{RAS}$ Refresh, t_{RC}=min)	I_{CC6}	—	69	—	58	—	45	mA	
Input leakage(0< V_{out} <7V)	I_{LI}	−10	10	−10	10	−10	10	μA	
Output leakage(0< V_{out} <7V)	I_{LO}	−10	10	−10	10	−10	10	μA	
Output levels High(I_{out}=−5mA)	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	
Output levels Low(I_{out}=4.2mA)	V_{OL}	0	0.4	0	0.4	0	0.4	V	

Notes) 1. I_{CC} depends on output loading condition when the device is selected. I_{CC} max is specified at the output open condition.

■CAPACITANCE (V_{CC}=5V±10%, Ta=25℃)

Parameter		Symbol	typ	max	Unit	Notes
Input Capacitance	Address, Data-in	C_{I1}	—	5	pF	1
	Clocks, Data-out	C_{I2}	—	7		1, 2

Notes) 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$=V_{IH} to disable Dout.

■ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS

(Ta=0 to +70℃, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	HM50256-12		HM50256-15		HM50256-20		Unit	Notes
		min	max	min	max	min	max		
Access Time from $\overline{RAS}$	t_{RAC}	—	120	—	150	—	200	ns	2, 3
Access Time from $\overline{CAS}$	t_{CAC}	—	60	—	75	—	100	ns	3, 4
Output Buffer Turn-off Delay	t_{OFF}	—	30	—	40	—	50	ns	5
Transition Time(Rise and Fall)	t_T	3	50	3	50	3	50	ns	6
Random Read or Write Cycle Time	t_{RC}	220	—	260	—	330	—	ns	
$\overline{RAS}$ Precharge Time	t_{RP}	90	—	100	—	120	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	120	10000	150	10000	200	10000	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	60	10000	75	10000	100	10000	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	25	60	25	75	30	100	ns	7
$\overline{RAS}$ Hold Time	t_{RSH}	60	—	75	—	100	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	120	—	150	—	200	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	10	—	10	—	10	—	ns	
Row Address Set-up Time	t_{ASR}	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	15	—	15	—	20	—	ns	
Column Address Set-up Time	t_{ASC}	0	—	0	—	0	—	ns	
Column Address Hold Time	t_{CAH}	20	—	25	—	30	—	ns	
Column Address Hold Time referenced to $\overline{RAS}$	t_{AR}	80	—	100	—	130	—	ns	
$\overline{WE}$ Command Set-up Time	t_{WCS}	0	—	0	—	0	—	ns	8
Write Command Hold Time	t_{WCH}	40	—	45	—	55	—	ns	
Write Command Hold Time referenced to $\overline{RAS}$	t_{WCR}	100	—	120	—	155	—	ns	
Write Command Pulse Width	t_{WP}	40	—	45	—	55	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	40	—	45	—	55	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	40	—	45	—	55	—	ns	
Data-in Set-up Time	t_{DS}	0	—	0	—	0	—	ns	9
Data-in Hold Time	t_{DH}	40	—	45	—	55	—	ns	8, 9
Data-in Hold Time referenced to $\overline{RAS}$	t_{DHR}	100	—	120	—	155	—	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	0	—	ns	
Read Command Hold Time referenced to $\overline{CAS}$	t_{RCH}	0	—	0	—	0	—	ns	
Read Command Hold Time referenced to $\overline{RAS}$	t_{RRH}	10	—	10	—	10	—	ns	
Refresh Period	t_{REF}	—	4	—	4	—	4	ms	

(to be continued)

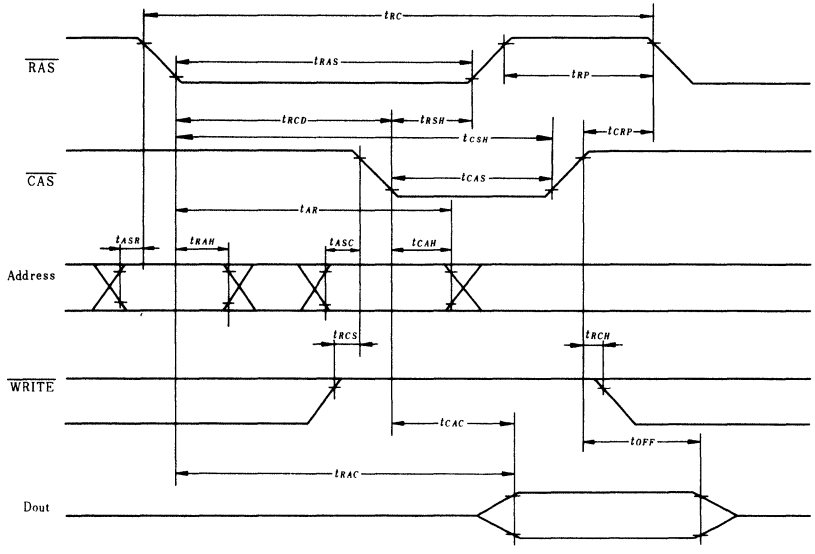
Parameter	Symbol	HM50256-12		HM50256-15		HM50256-20		Unit	Notes
		min	max	min	max	min	max		
Read-Write Cycle Time	t_{RWC}	265	—	310	—	390	—	ns	
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	60	—	75	—	100	—	ns	8
$\overline{RAS}$ to $\overline{WE}$ Delay	t_{RWD}	120	—	150	—	200	—	ns	
$\overline{CAS}$ Precharge Time	t_{CPN}	50	—	60	—	80	—	ns	
$\overline{CAS}$ Setup Time	t_{CSR}	10	—	10	—	10	—	ns	
$\overline{CAS}$ Hold Time ($\overline{CAS}$ before $\overline{RAS}$ Refresh)	t_{CHR}	120	—	150	—	200	—	ns	
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	—	0	—	0	—	ns	

Notes

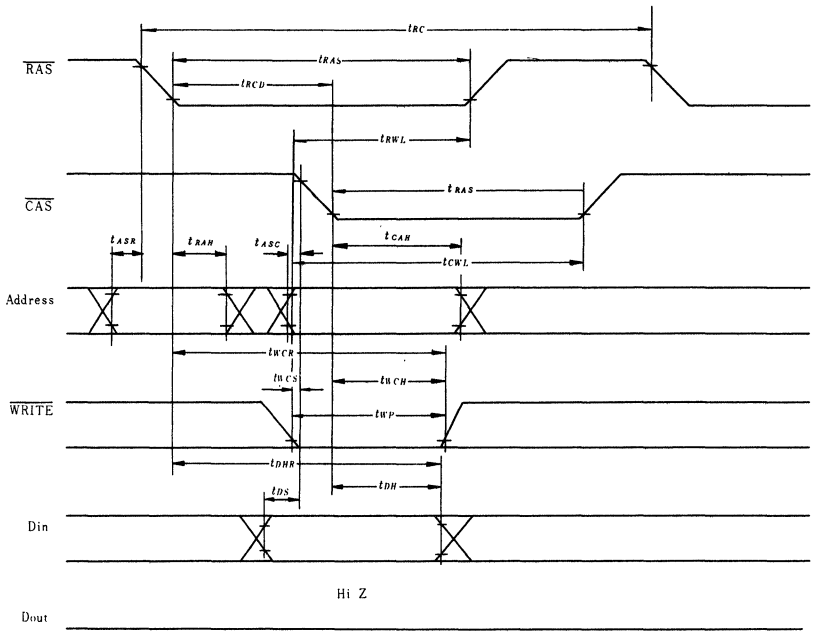
1. AC measurements assume t_T = 5ns.
2. Assumes that $t_{RCD} \leqq t_{RCD}$ (max). If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
3. Measured with a load circuit equivalent to 2TTL loads and 100pF.
4. Assumes that $t_{RCD} \geqq t_{RCD}$ (max).
5. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not reference to output voltage levels.
6. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
7. Operation with the t_{RCD} (max) limit insures that t_{RAC} (max) can be met, t_{RCD} (max) is specified as a reference point only, if t_{RCD} is greater than the specified t_{RCD} (max) limit, then access time is controlled exclusively by t_{CAC}.
8. t_{WCS}, t_{CWD} and t_{RWD} are not restrictive operating parameters.
   They are included in the data sheet is electrical characteristics only; if $t_{WCS} \geqq t_{WCS}$ (min), the cycle is an early write cycle and the data output pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geqq t_{CWD}$ (min) and $t_{RWD} \geqq t_{RWD}$ (min) the cycle is a read-write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.
9. There parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge is delayed write or read-modify-write cycles.
10. An initial pause of 100μs is required after power-up followed by a minimum of 8 initialization cycles.
11. Minimum of 8 $\overline{CAS}$ before $\overline{RAS}$ refresh cycle is required before using internal refresh counter.

■ TIMING WAVEFORMS

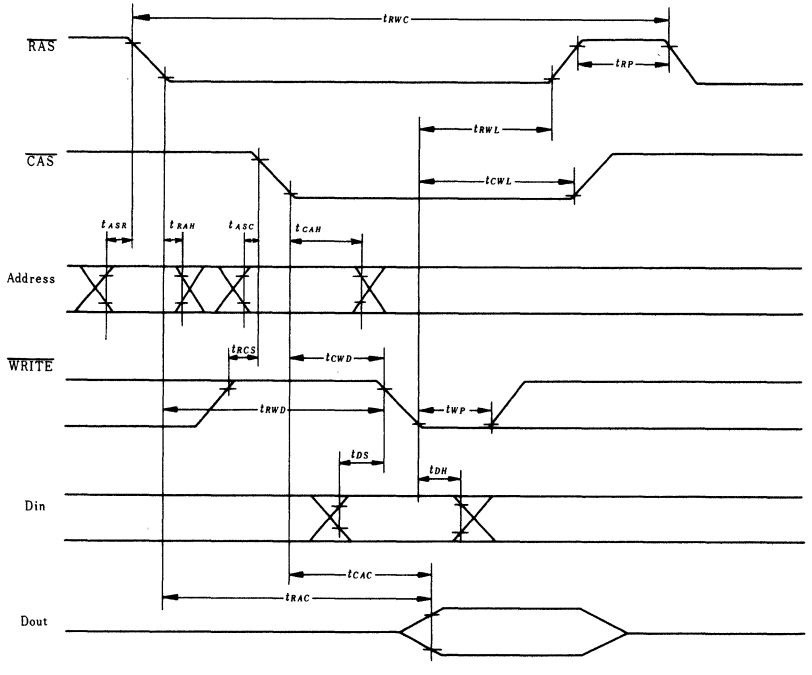
● READ CYCLE



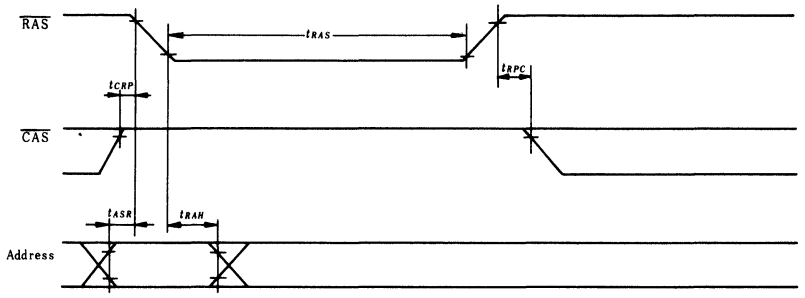
● WRITE CYCLE



● READ MODIFY WRITE CYCLE

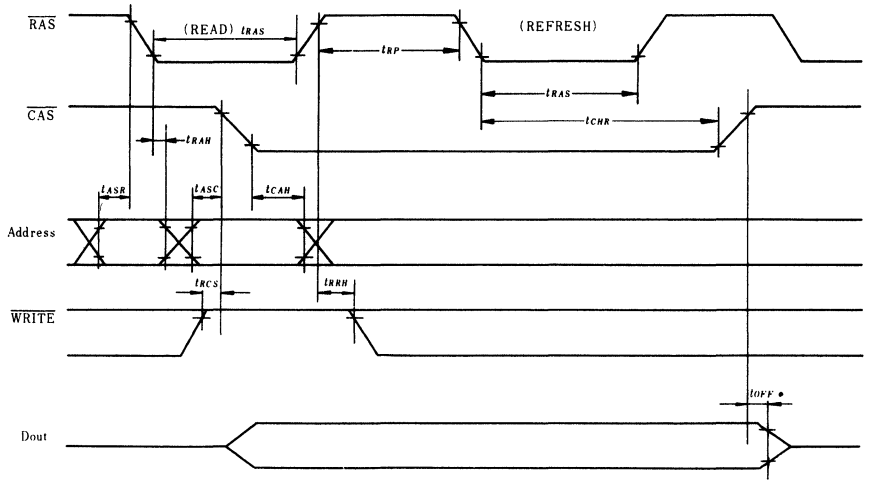


● $\overline{RAS}$ ONLY REFRESH CYCLE

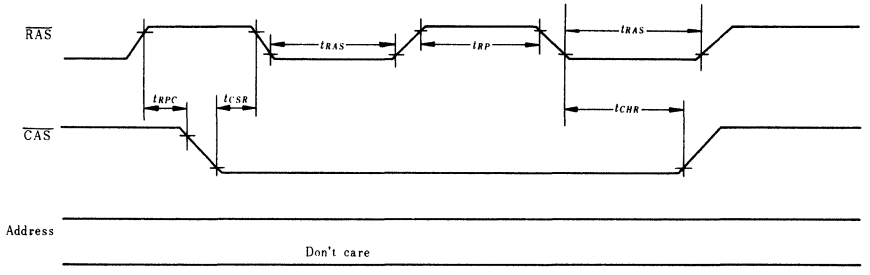


* REFRESH ADDRESS $A_0 - A_7$ ($AX_0 - AX_7$)

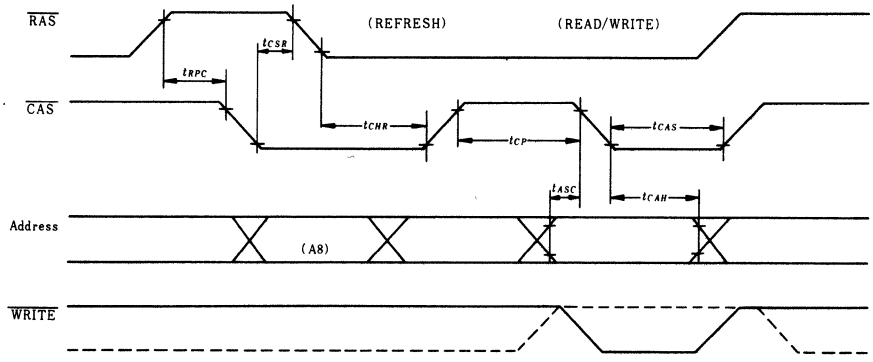
● HIDDEN REFRESH CYCLE



● $\overline{CAS}$ BEFORE $\overline{RAS}$ REFRESH CYCLE



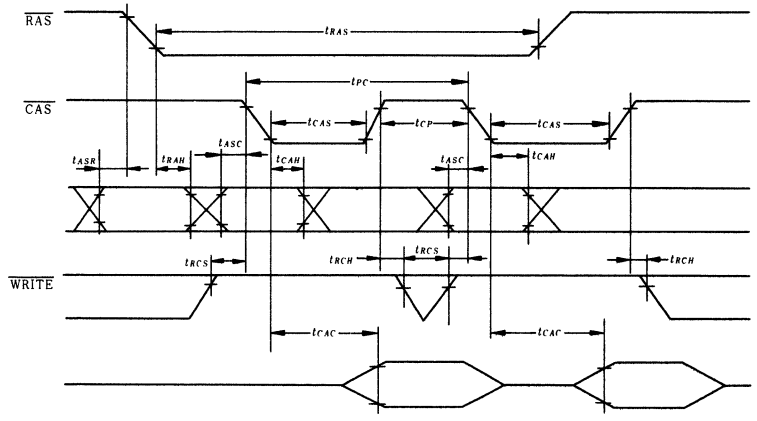
●COUNTER TEST



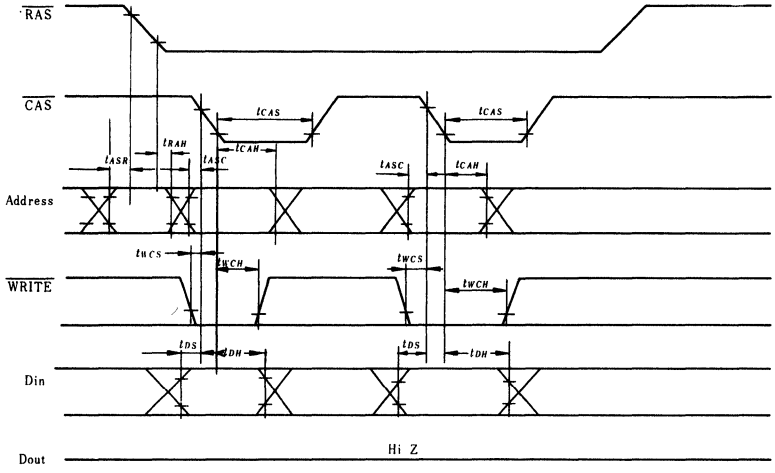
■PAGE MODE CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	HM50256-12		HM50256-15		HM50256-20		Unit
		min	max	min	max	min	max	
Page Mode Supply Current	I_{CC7}	—	57	—	48	—	37	mA
Page Mode Read or Write Cycle	t_{PC}	120	—	145	—	190	—	ns
$\overline{CAS}$ Precharge Time, Page Cycle	t_{CP}	50	—	60	—	80	—	ns
Page Mode Read Modify Write Cycle	t_{PCM}	165	—	195	—	250	—	ns

●PAGE MODE READ CYCLE



● PAGE MODE WRITE CYCLE

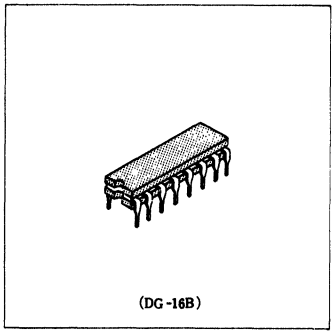


HM50257-12, HM50257-15, HM50257-20 — Preliminary

262144-word × 1-bit Dynamic Random Access Memory

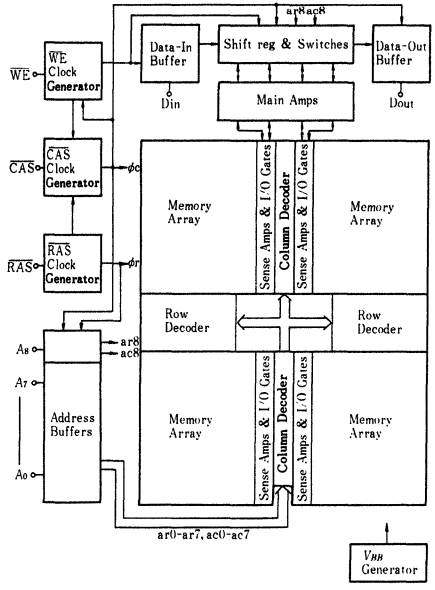
■ FEATURES

- Industry standard 16-pin DIP
- Single 5V (±10%)
- On chip substrate bias generator
- Low Power: 350mW active, 20mW standby
- High speed: Access Time 120ns/150ns/200ns (max.)
- Common I/O capability using early write operation
- Nibble mode capability
- Indifinite Dout hold using $\overline{CAS}$ control
- TTL compatible
- 256 refresh cycles . . . . . (4ms)
- 3 Variations of refresh; $\overline{RAS}$ only refresh, $\overline{CAS}$ befor $\overline{RAS}$ refresh, Hidden refresh

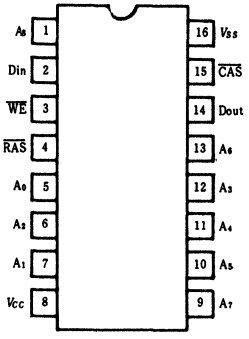


(DG-16B)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

$A_0 \sim A_8$	Address Inputs
$\overline{CAS}$	Column Address Strobe
Din	Data In
Dout	Data Out
$\overline{RAS}$	Row Address Strobe
$\overline{WE}$	Read/Write Input
V_{CC}	Power (+5V)
V_{SS}	Ground
$A_0 \sim A_7$	Refresh Address Inputs

■ ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to V_{SS} . . . . . -1V to +7V
Operating temperature, Ta (Ambient) . . . . . 0°C to +70°C
Storage temperature . . . . . -65°C to +150°C
Power dissipation 1W
Short circuit output current 50mA

■ RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to +70°C)

Parameter	Symbol	min	typ	max	Unit	Note
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	1
Input High Voltage	V_{IH}	2.4	—	6.5	V	1
Input Low Voltage	V_{IL}	−1.0	—	0.8	V	1

Note 1) All voltages referenced to V_{SS}.

Note)
The specifications of this device are subject to change without notice.
Please contact your nearest Hitachis Sales Dept, regarding specifications.

HITACHI

■DC ELECTRICAL CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	HM50257-12		HM50257-15		HM50257-20		Unit	Notes
		min	max	min	max	min	max		
Operating Current ($\overline{RAS}$, $\overline{CAS}$ Cycling: t_{RC}=min)	I_{CC1}	—	83	—	70	—	55	mA	1
Stand by Current ($\overline{RAS}$=V_{IH}, Dout=High Impedance)	I_{CC2}	—	4.5	—	4.5	—	4.5	mA	
Refresh Current ($\overline{RAS}$ only Refresh, t_{RC}=min)	I_{CC3}	—	62	—	53	—	42	mA	
Standby Current ($\overline{RAS}$=V_{IH}, Dout Enable)	I_{CC5}	—	10	—	10	—	10	mA	1
Refresh Current ($\overline{CAS}$ before $\overline{RAS}$ Refresh, t_{RC}=min)	I_{CC6}	—	69	—	58	—	45	mA	
Input leakage (0<V_{out}<7V)	I_{LI}	−10	10	−10	10	−10	10	μA	
Output leakage (0<V_{out}<7V)	I_{LO}	−10	10	−10	10	−10	10	μA	
Output levels High (I_{out}=−5mA)	V_{OH}	2.4	V_{CC}	2.4	V_{CC}	2.4	V_{CC}	V	
Output levels Low (I_{out}=4.2mA)	V_{OL}	0	0.4	0	0.4	0	0.4	V	

Notes) 1. I_{CC} depends on output loading condition when the device is selected I_{CC} max, is specified at the output open condition.

■CAPACITANCE (V_{CC}=5V±10%, Ta=25°C)

Parameter		Symbol	typ	max	Unit	Notes
Input Capacitance	Address, Data-In	C_{I1}	—	5	pF	1
	Clocks, Data-Out	C_{I2}	—	7		1, 2

Notes) 1. Capacitance measured with Boonton Meter or effective capacitance measuring method.
2. $\overline{CAS}$=V_{IH} to disable Dout.

■ELECTRICAL CHARACTERISTICS AND RECOMMENDED AC OPERATING CONDITIONS (Ta=0 to +70°C, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	HM50257-12		HM50257-15		HM50257-20		Unit	Notes
		min	max	min	max	min	max		
Access Time from $\overline{RAS}$	t_{RAC}	—	120	—	150	—	200	ns	2, 3
Access Time from $\overline{CAS}$	t_{CAC}	—	60	—	75	—	100	ns	3, 4
Output Buffer Turn-off Delay	t_{OFF}	—	30	—	40	—	50	ns	5
Transition Time (Rise and Fall)	t_T	3	50	3	50	3	50	ns	6
Random Read or Write Cycle Time	t_{RC}	220	—	260	—	330	—	ns	
$\overline{RAS}$ Precharge Time	t_{RP}	90	—	100	—	120	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	120	10000	150	10000	200	10000	ns	
$\overline{RAS}$ Pulse Width	t_{CAS}	60	10000	75	10000	100	10000	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	25	60	25	75	30	100	ns	7
$\overline{RAS}$ Hold Time	t_{RSH}	60	—	75	—	100	—	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	120	—	150	—	200	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	10	—	10	—	10	—	ns	
Row Address Set-up Time	t_{ASR}	0	—	0	—	0	—	ns	
Row Address Hold Time	t_{RAH}	15	—	15	—	20	—	ns	
Column Address Set-up Time	t_{ASC}	0	—	0	—	0	—	ns	
Column Address Hold Time	t_{CAH}	20	—	25	—	30	—	ns	
Column Address Hold Time referenced to $\overline{RAS}$	t_{AR}	80	—	100	—	130	—	ns	
$\overline{WE}$ Command Set-up Time	t_{WCS}	0	—	0	—	0	—	ns	8
Write Command Hold Time	t_{WCH}	40	—	45	—	55	—	ns	
Write Command Hold Time referenced to $\overline{RAS}$	t_{WCR}	100	—	120	—	155	—	ns	
Write Command Pulse Width	t_{WP}	40	—	45	—	55	—	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	40	—	45	—	55	—	ns	
Write Command to $\overline{CAS}$ Lead Time	t_{CWL}	40	—	45	—	55	—	ns	
Data-in Set-up Time	t_{DS}	0	—	0	—	0	—	ns	9
Data-in Hold Time	t_{DH}	40	—	45	—	55	—	ns	8, 9
Data-in Hold Time referenced to $\overline{RAS}$	t_{DHR}	100	—	120	—	155	—	ns	
Read Command Set-up Time	t_{RCS}	0	—	0	—	0	—	ns	
Read Command Hold Time referenced to $\overline{CAS}$	t_{RCH}	0	—	0	—	0	—	ns	
Read Command Hold Time referenced to $\overline{RAS}$	t_{RRH}	10	—	10	—	10	—	ns	
Refresh Period	t_{REF}	—	4	—	4	—	4	ns	

(to be continued)

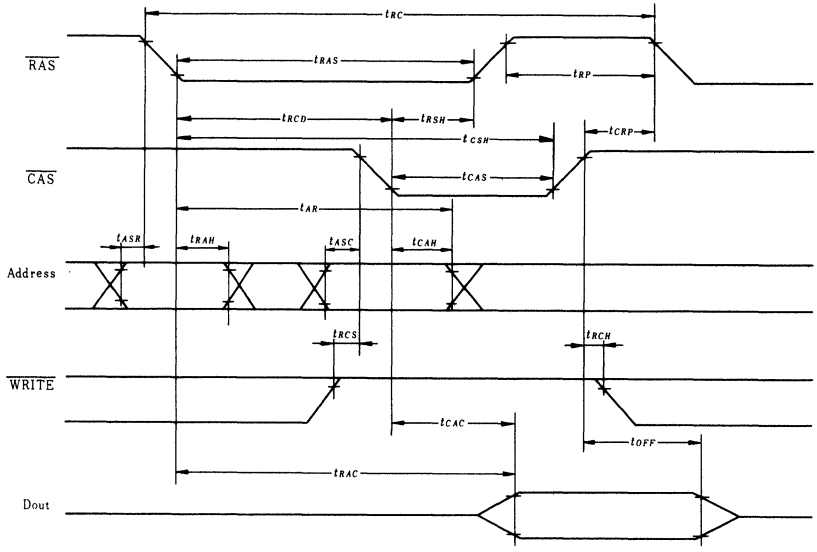
Parameter	Symbol	HM50257-12		HM50257-15		HM50257-20		Unit	Notes
		min	max	min	max	min	max		
Read-Write Cycle Time	t_{RWC}	265	—	310	—	390	—	ns	
$\overline{CAS}$ to $\overline{WE}$ Delay	t_{CWD}	60	—	75	—	100	—	ns	8
$\overline{RAS}$ to $\overline{WE}$ Delay	t_{RWD}	120	—	150	—	200	—	ns	
$\overline{CAS}$ Precharge Time	t_{CPN}	50	—	60	—	80	—	ns	
$\overline{CAS}$ Setup Time	t_{CSR}	10	—	10	—	10	—	ns	
$\overline{CAS}$ Hold Time($\overline{CAS}$ before $\overline{RAS}$ Refresh)	t_{CHR}	120	—	150	—	200	—	ns	
$\overline{RAS}$ Precharge to $\overline{CAS}$ Hold Time	t_{RPC}	0	—	0	—	0	—	ns	

Notes

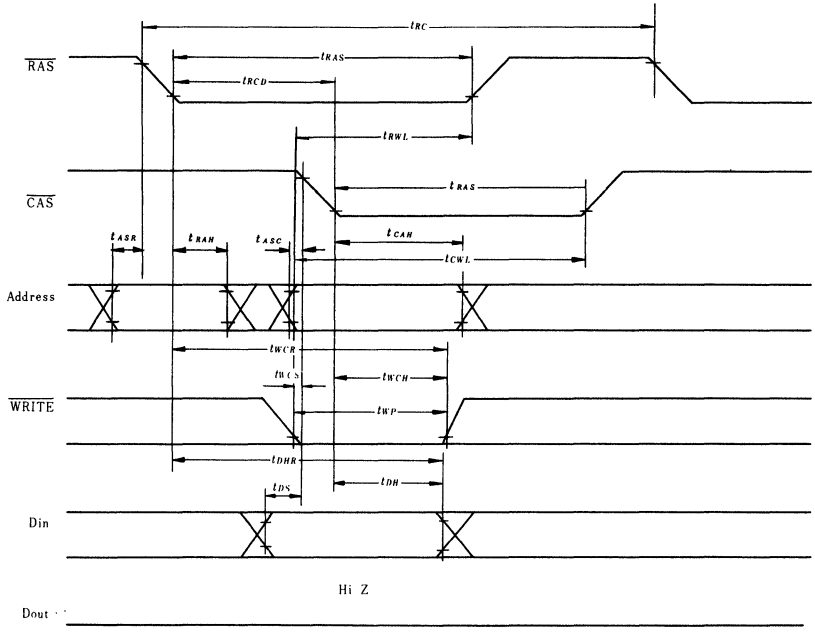
1. AC measurements assume t_T = 5ns.
2. Assumes that $t_{RCD} \leqq t_{RCD}$ (max). If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} exceeds the value shown.
3. Measured with a load circuit equivalent to 2TTL loads and 100pF.
4. Assumes that $t_{RCD} \geqq t_{RCD}$ (max).
5. t_{OFF} (max) defines the time at which the output achieves the open circuit condition and is not reference to output voltage levels.
6. V_{IH} (min) and V_{IL} (max) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
7. Operation with the t_{RCD} (max) limit insures that t_{RAC} (max) can be met, t_{RCD} (max) is specified as a reference point only, if t_{RCD} is greater than the specified t_{RCD} (max) limit, then access time is controlled exclusively by t_{CAC}.
8. t_{WCS}, t_{CWD} and t_{RWD} are not restrictive operating parameters.
   They are included in the data sheet as electrical characteristics only; if $t_{WCS} \geqq t_{WCS}$ (min), the cycle is an early write cycle and the data output pin will remain open circuit (high impedance) throughout the entire cycle; if $t_{CWD} \geqq t_{CWD}$ (min) and $t_{RWD} \geqq t_{RWD}$ (min) the cycle is a read-write and the data output will contain data read from the selected cell; if neither of the above sets of conditions is satisfied the condition of the data out (at access time) is indeterminate.
9. There parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge is delayed write or read-modify-write cycles.
10. An initial pause of 100μs is required after power-up followed by a minimum of 8 initialization cycles.
11. Minimum of 8 $\overline{CAS}$ before $\overline{RAS}$ refresh cycle is required before using internal refresh counter.

■ TIMING WAVEFORMS

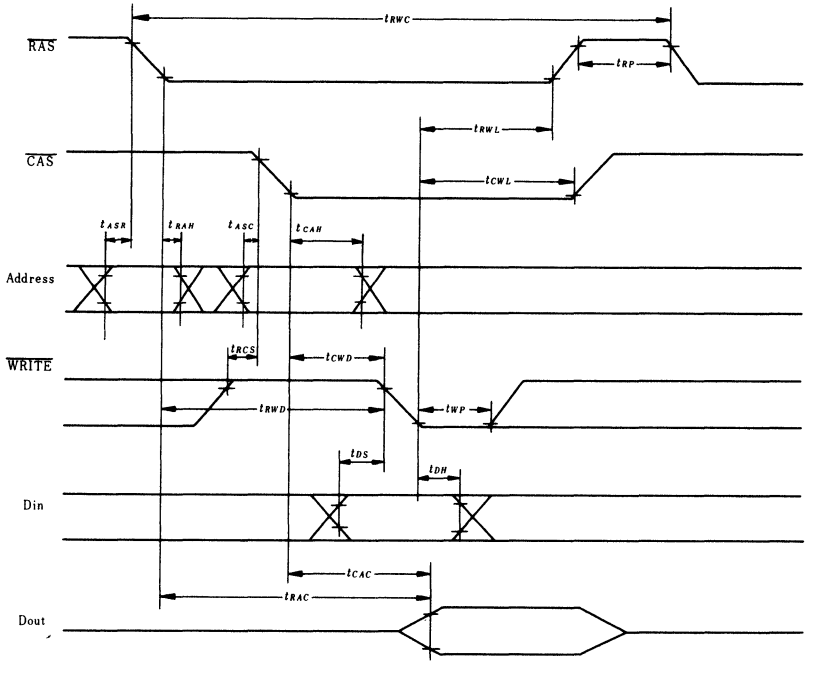
● READ CYCLE



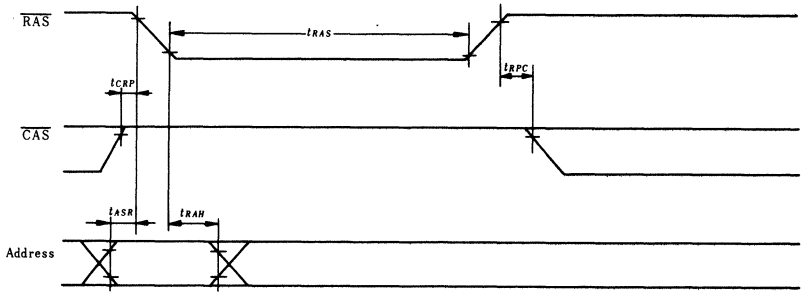
● WRITE CYCLE



● READ MODIFY WRITE CYCLE

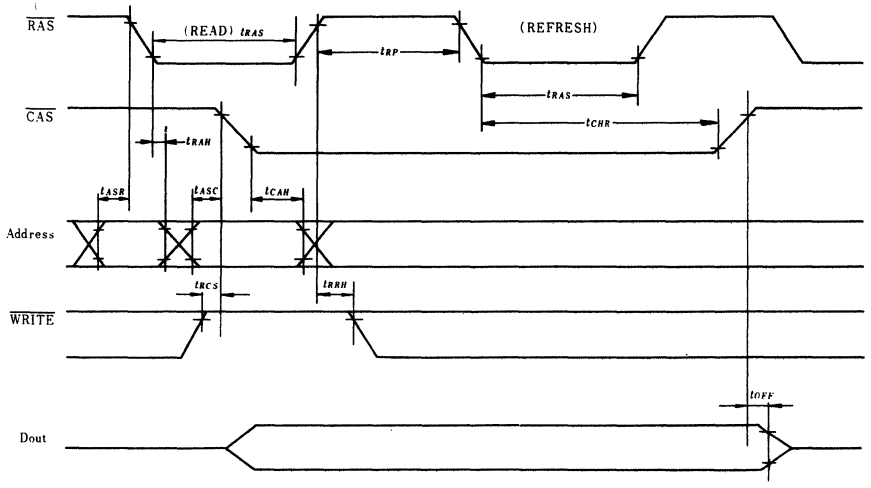


● $\overline{RAS}$ ONLY REFRESH CYCLE

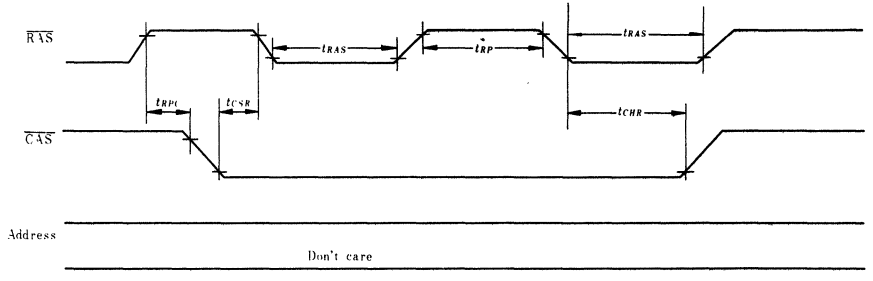


* REFRESH ADDRESS A_0-A_7(AX_0-AX_7)

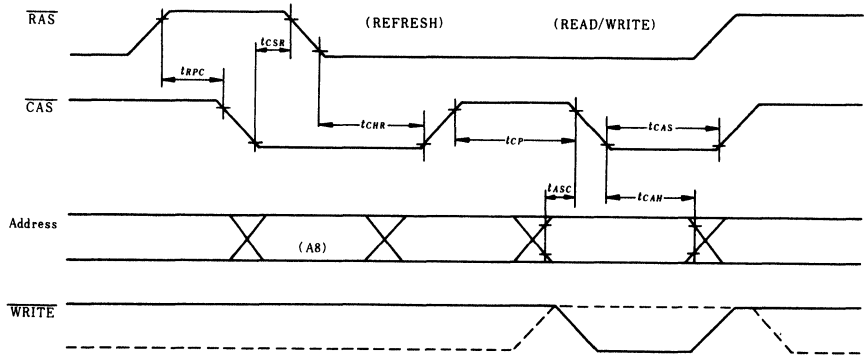
● HIDDEN REFRESH CYCLE



● $\overline{CAS}$ BEFORE $\overline{RAS}$ REFRESH CYCLE



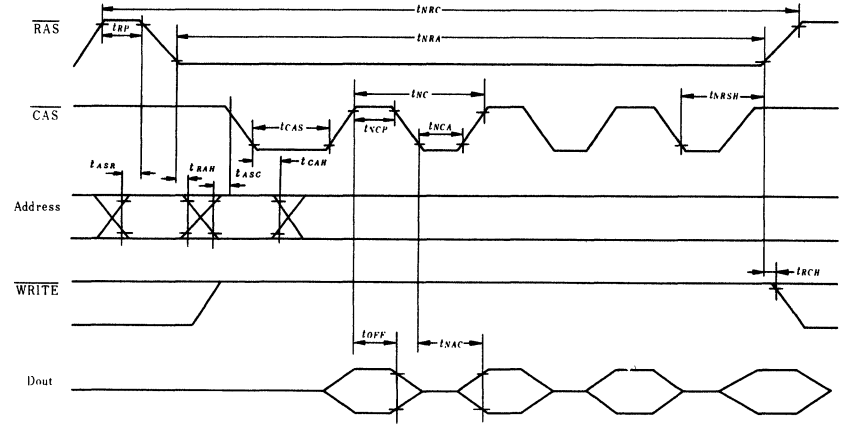
● COUNTER TEST



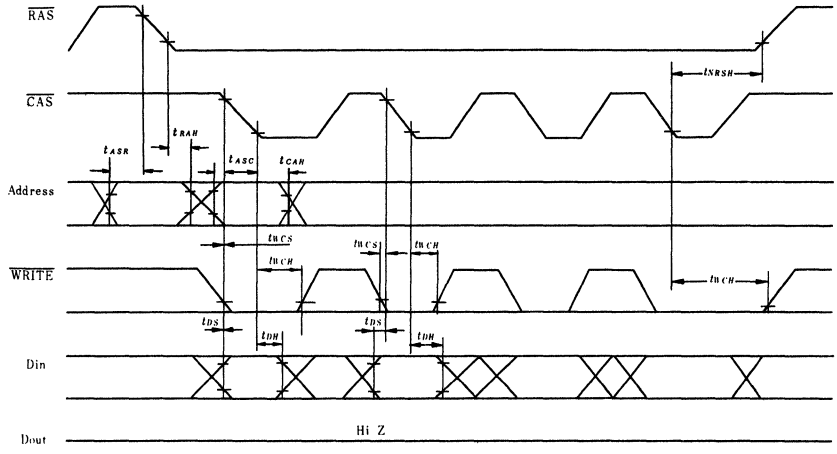
■ NIBBLE MODE CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±10%, V_{SS}=0V)

Parameter	Symbol	HM50257-12		HM50257-15		HM50257-20		Unit
		min	max	min	max	min	max	
Nibble Mode Supply Current	I_{CC8}	—	57	—	48	—	37	mA
Nibble Mode Access Time	t_{NAC}	—	20	—	25	—	35	ns
Nibble Mode $\overline{RAS}$ Cycle Time	t_{NRC}	390	—	460	—	590	—	ns
Nibble Mode $\overline{RAS}$ Pulse Width	t_{NRA}	290	—	350	—	460	—	ns
Nibble Mode Cycle Time	t_{NC}	50	—	60	—	80	—	ns
Nibble Mode $\overline{CAS}$ Precharge Time	t_{NCP}	20	—	25	—	35	—	ns
Nibble Mode $\overline{CAS}$ Pulse Width	t_{NCA}	20	—	25	—	35	—	ns
Nibble Mode $\overline{RAS}$ Hold Time	t_{NRSH}	40	—	45	—	55	—	ns

● NIBBLE MODE READ CYCLE



● NIBBLE MODE WRITE CYCLE



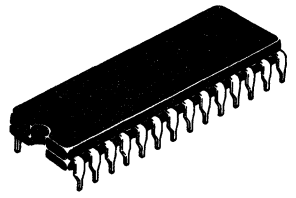
MOS MASK ROM

HN61364P, HN61364FP

8192-word x 8-bit Mask Programmable Read Only Memory

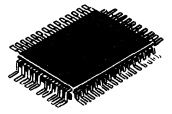
The HN61364P/FP is a mask-programmable, byte-organized memory designed for use in bus-organized systems.
To facilitate use, the device operates from a single power supply, has compatibility with TTL, and requires no clocks or refreshing because of static operation.
The active level of the CS, $\overline{OE}_0 \sim \overline{OE}_2$ inputs and the memory content are defined by the user. The Chip Select input deselects the output and puts the chip in a powerdown mode.

HN61364P



(DP-28)

HN61364FP

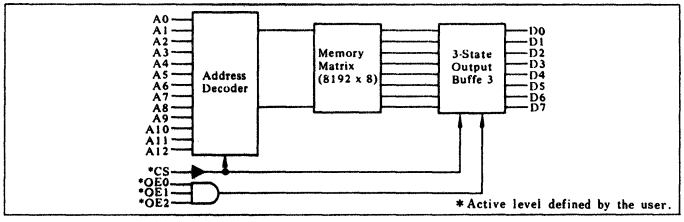


(FP-54)

■ FEATURES

- Fully Static Operation
- Automatic Power Down
- Single +5V Power Supply
- Three-state Data Output for OR-ties
- Mask Programmable Chip Select and Output Enable
- TTL Compatible
- Maximum Access Time; 250ns
- Low Power Standby and Low Power Operation; Standby 5μW (typ), Operation 50mW (typ)
- Pin Compatible with EPROM

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Supply Voltage*	V_{CC}	−0.3 to +7.0	V
Input Voltage*	V_{in}	−0.3 to +7.0	V
Operating Temperature	T_{opr}	−20 to +75	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Bias Storage Temperature	T_{bias}	−20 to +85	°C

* with respect to V_{SS}

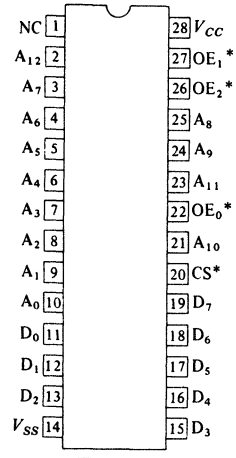
■ RECOMMENDED DC OPERATING CONDITIONS

Item	Symbol	min	typ	max	Unit
Supply Voltage *	V_{CC}	4.5	5.0	5.5	V
Input Voltage *	V_{IL}	−0.3	–	0.8	V
	V_{IH}	2.2	–	V_{CC}	V
Operating Temperature	T_{opr}	−20	–	75	°C

* with respect to V_{SS}

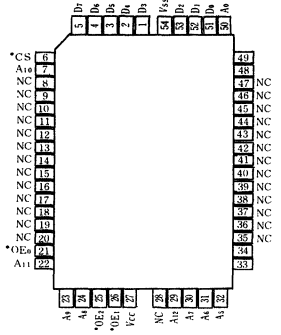
■ PIN ARRANGEMENT

● HN61364P



(Top View)

● HN61364FP



(Top View)

■ ELECTRICAL CHARAGTERISTICS (V_{CC} = 5V±10%, V_{SS} = 0V, T_a = −20 to +75°C

Item		Symbol	Test Condition	min	typ	max	Unit
Input High-level Voltage		V_{IH}		2.2	–	V_{CC}	V
Input Low-level Voltage		V_{IL}		−0.3	–	0.8	V
Output High-level Voltage		V_{OH}	I_{OH}=−205μA	2.4	–	–	V
Output Low-level Voltage		V_{OL}	I_{OL}=3.2mA	–	–	0.4	V
Input Leakage Current		I_{in}	V_{in}=0 to 5.5V	–	–	2.5	μA
Output High-level Leakage Current		I_{LOH}	V_{out}=2.4V, CS=0.8V, $\overline{CS}$=2.2V	–	–	10	μA
Output Low-level Leakage Current		I_{LOL}	V_{out}=0.4V, CS=0.8V, $\overline{CS}$=2.2V	–	–	10	μA
Supply Current	Active	I_{CC} *	V_{CC}=5.5V, I_{out}=0mA	–	10	25	mA
	Standby	I_{SB}	V_{CC}=5.5V, $\overline{CS}$≧V_{CC}−0.2V, CS≦0.2V	–	1	30	μA
Input Capacitance		C_{in}	V_{in}=0V, f=1MHz, T_a=25°C	–	–	10	pF
Output Capacitance		C_{out}		–	–	15	pF

* steady state current

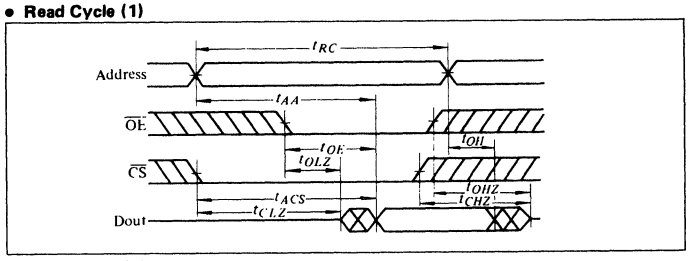
■ RECOMMENDED AC OPERATING CONDITIONS (READ SEQUENCE)

(V_{CC}=5V±10%, V_{SS}=0V, Ta=−20 to +75°C, t_r=t_f=20ns)

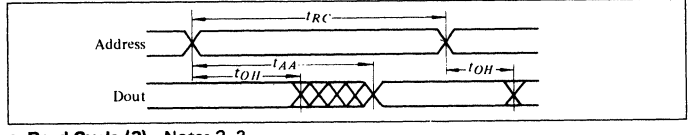
Item	Symbol	min	max	Unit
Read Cycle Time	t_{RC}	250	–	ns
Address Access Time	t_{AA}	–	250	ns
Chip Select Access Time	t_{ACS}	–	250	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	–	ns
Output Enable to Output Valid	t_{OE}	–	100	ns
Output Enable to Output in Low Z	t_{OLZ}	10	–	ns
Chip Deselection to Output in High Z	t_{CHZ}	0	100	ns
Chip Disable to Output in High Z	t_{OHZ}	0	100	ns
Output Hold from Address Change	t_{OH}	10	–	ns

■ TIMING WAVEFORM

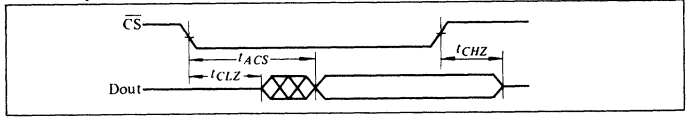
• Read Cycle (1)



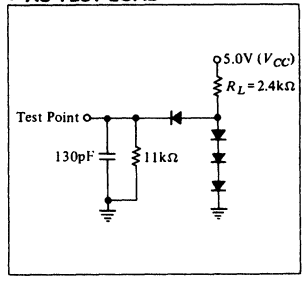
• Read Cycle (2) Notes 1, 3



• Read Cycle (3) Notes 2, 3



• AC TEST LOAD



Notes) 1. t_r=t_f=20ns
2. C_L includes jig capacitance.
3. All diodes are 1S2074Ⓗ.

NOTES:
1. Device is continuously selected.
2. Address Vaild prior to or coincident with $\overline{CS}$ transition low.
3. $\overline{OE}$ = V_{IL}

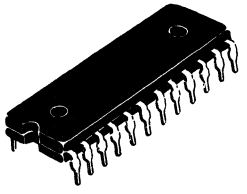
HN61365P

8192-word×8-bit Mask Programmable Read Only Memory

The HN61365P is a mask-programmable, byte-organized memory designed for use in bus-organized systems.

To facilitate use, the device operates from a single power supply, has compatibility with TTL, and requires no clocks or refreshing because of static operation.

The active level of the CS input and the memory content are defined by the user. The chip select input deselects the output and puts the chip in a power-down mode.

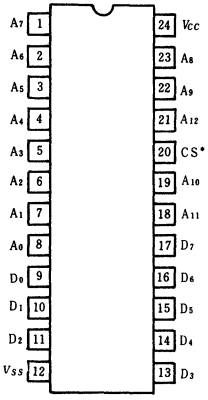


(DP-24)

■FEATURES

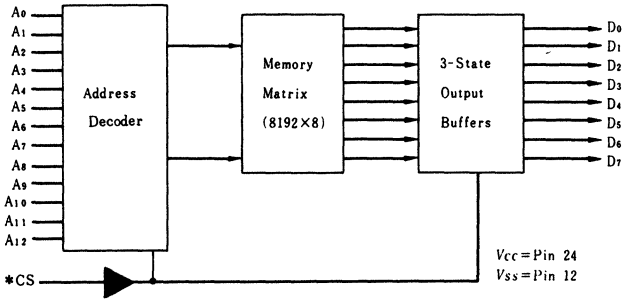
- Fully Static Operation
- Automatic Power Down
- Single +5 Volt Power Supply
- Three-State Data Output for OR-Ties
- Mask Programmable Chip Select
- TTL Compatible
- Maximum Access Time; 250ns
- Low Power Standby and Low Power Operation; Standby 5μW (typ.), Operation 50mW (typ.)
- Pin Compatible with EPROM

■PIN ARRANGEMENT



(Top View)

■BLOCK DIAGRAM



* Active level defined by the user.

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Supply Voltage*	V_{CC}	−0.3 to +7.0	V
Input Voltage*	V_{in}	−0.3 to +7.0	V
Operating Temperature	T_{opr}	−20 to +75	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Storage Temperature (under bias)	T_{bias}	−20 to +85	°C

* with respect to V_{SS}

■RECOMMENDED DC OPERATING CONDITIONS

Item	Symbol	min	typ	max	Unit
Supply Voltage*	V_{CC}	4.5	5.0	5.5	V
Input Voltage*	V_{IL}	−0.3	—	0.8	V
	V_{IH}	2.2	—	V_{CC}	V
Operating Temperature	T_{opr}	−20	—	75	℃

* With respect to V_{SS}

■ELECTRICAL CHARACTERISTICS (V_{CC}=5V ±10%, V_{SS}=0V, Ta=−20 to +75℃)

Item	Symbol	Test Conditions		min	typ	max	Unit
Input Voltage	V_{IH}			2.2	—	V_{CC}	V
	V_{IL}			−0.3	—	0.8	V
Output Voltage	V_{OH}	I_{OH}=−205μA		2.4	—	—	V
	V_{OL}	I_{OL}=3.2mA		—	—	0.4	V
Input Leakage Current	I_{LI}	V_{IN}=0~5.5V		—	—	2.5	μA
Output Leakage Current	I_{LOH}	CS=0.8V, $\overline{CS}$=2.2V	V_{out}=2.4V	—	—	10	μA
	I_{LOL}		V_{out}=0.4V	—	—	10	μA
Active Supply Current	I_{CC}*	V_{CC}=5.5V, I_{DOUT}=0mA		—	10	25	mA
Stand by Supply Current	I_{SB}	$\overline{CS}$≧V_{CC}−0.2V, CS≦0.2V, V_{CC}=5.5V		—	1	30	μA
Input Capacitance	C_{in}	V_{in}=0V, f=1MHz, Ta=25℃		—	—	10	pF
Output Capacitance	C_{out}			—	—	15	pF

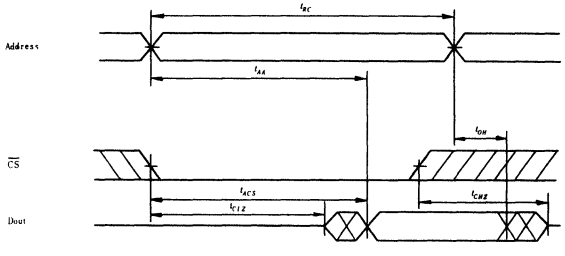
* Steady state current

■RECOMMENDED AC OPERATING CHARACTERISTICS

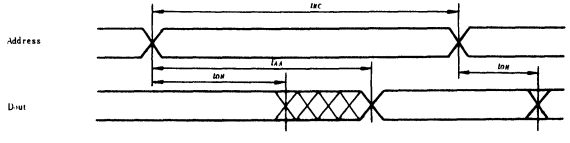
●READ SEQUENCE (V_{CC}=5V±10%, V_{SS}=0V, Ta=−20 to +75℃, t_r=t_f=20ns)

Item	Symbol	min	max	Unit
Read Cycle Time	t_{RC}	250	—	ns
Address Access Time	t_{AA}	—	250	ns
Chip Select Access Time	t_{ACS}	—	250	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	ns
Chip deselection to Output in High Z	t_{CHZ}	0	100	ns
Output Hold from Address Change	t_{OH}	10	—	ns

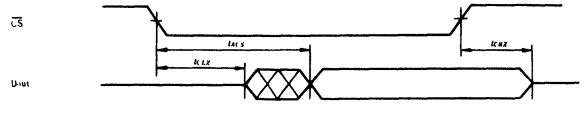
●READ CYCLE (1)



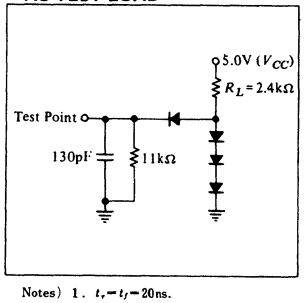
●READ CYCLE (2) (Notes 1)



●READ CYCLE (3) (Notes 2)



● AC TEST LOAD



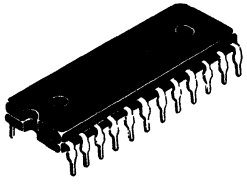
Notes) 1. t_r=t_f=20ns.
2. C_L includes jig capacitance.
3. All diodes are 1S2074Ⓗ.

Notes)
1. Device is continuously selected
2. Address Valid prior to or coincident with $\overline{CS}$ transition low.

HN61366P

8192-word×8-bit Mask Programmable Read Only Memory

The HN61366P is a mask-programmable, byte-organized memory designed for use in bus-organized systems.
To facilitate use, the device operates from a single power supply, has compatibility with TTL, and requires no clocks or refreshing because of static operation.
The active level of the OE input and the memory content are defined by the user.

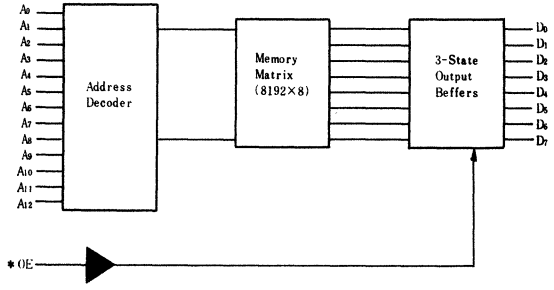


(DP-24)

■FEATURES

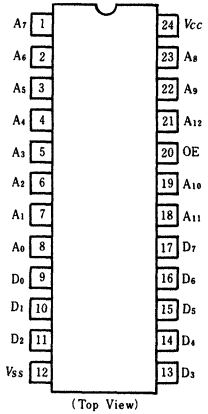
- Fully Static Operation
- Single +5V power supply
- Three-State Data Output for OR-Ties
- Mask Programmable Output Enable
- TTL Compatible
- Maximum Access Time; 250ns
- Low Power Operation; 50mW (typ.)
- Pin Compatible with EPROM

■BLOCK DIAGRAM



* Active level defined by the user.

■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Supply Voltage*	V_{CC}	−0.3 to +7.0	V
Input Voltage*	V_{in}	−0.3 to +7.0	V
Operating Temperature	T_{opr}	−20 to +75	°C
Storage Temperature	T_{stg}	−55 to +125	°C
Storage Temperature (under bias)	T_{bias}	−20 to +85	°C

* With respect to V_{SS}

■RECOMMENDED DC OPERATING CONDITIONS

Item	Symbol	min	typ	max	Unit
Supply Voltage*	V_{CC}	4.5	5.0	5.5	V
Input Voltage*	V_{IL}	−0.3	—	0.8	V
	V_{IH}	2.2	—	V_{CC}	V
Operating Temprature	T_{opr}	−20	—	75	°C

* With respect to V_{SS}

■ELECTRICAL CHARACTERISTICS (V_{CC}=5V±10%, V_{SS}=0V, Ta=−20 to +75°C)

Item	Symbol	Test Conditions		min	typ	max	Unit
Input Voltage	V_{IH}			2.2	—	V_{CC}	V
	V_{IL}			−0.3	—	0.8	V
Output Voltage	V_{OH}	I_{OH}=−205μA		2.4	—	—	V
	V_{OL}	I_{OL}=3.2mA		—	—	0.4	V
Input Leakage Current	I_{LI}	V_{IN}=0~5.5V		—	—	2.5	μA
Output Leakage Current	I_{LOH}	OE=0.8V, $\overline{OE}$=2.2V	V_{OUT}=2.4V	—	—	10	μA
	I_{LOL}		V_{OUT}=0.4V	—	—	10	μA
Operating Supply Current	I_{CC}*	V_{CC}=5.5V, I_{OUT}=0mA		—	10	25	mA
Input Capacitance	C_{in}	V_{in}=0V, f=1MHz, Ta=25°C		—	—	10	pF
Output Capacitance	C_{out}			—	—	15	pF

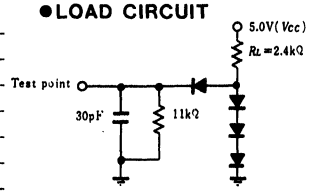
* Steady state current

■RECOMMENDED AC OPERATING CONDITIONS

●READ CYCLE (V_{CC}=5V±10%, V_{SS}=0V, Ta=−20~+75°C, t_r=t_f=20ns)

Item	Symbol	min	max	Unit
Read Cycle Time	t_{RC}	250	—	ns
Address Access Time	t_{AA}	—	250	ns
Output Enable to Output Valid	t_{OE}	—	100	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	ns
Output Disable to Output in High Z	t_{OHZ}	0	100	ns
Output Hold from Address Change	t_{OH}	10	—	ns

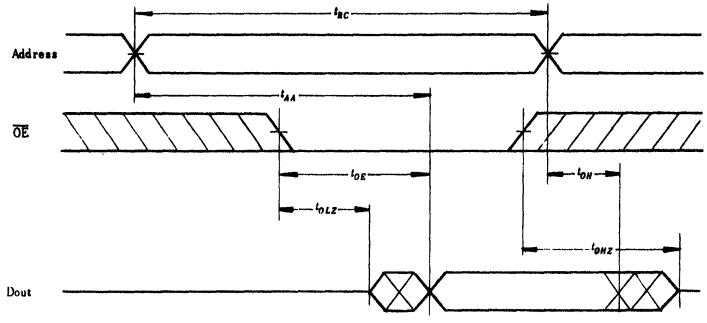
●LOAD CIRCUIT



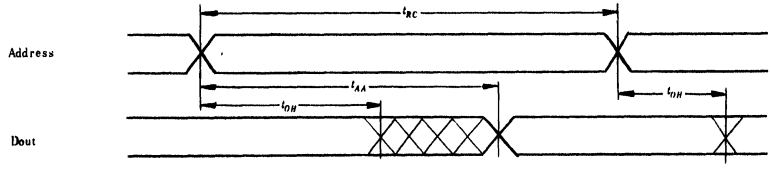
Notes) 1. t_r=t_f=20ns
2. C_L includes jig capacitance.
3. All diodes are 1S2074Ⓗ.

■TIMING WAVEFORM

●READ CYCLE (1)



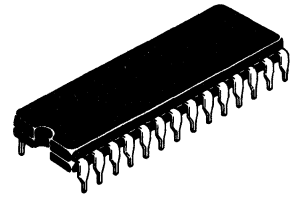
●READ CYCLE (2) Note 1)



Note) 1. $\overline{OE}$=V_{IL}

16384 × 8-bit or 32768 × 4-bit CMOS Mask Programmable Read Only Memory

The Hitachi HN43128P is a mask programmable, 16384x8-bit or 32786x4-bit CMOS read only memory. It operates from a single power supply and is compatible with TTL and DTL. Low power consumption makes this memory well-suited for battery-operation or hand-held personal computers. Memory expansion can be implemented through two chip select inputs. Either active "High" or active "Low" of chip select inputs and a chip enable input is defined at mask level. The organization of 8 bit or 4 bit is designed by the user.

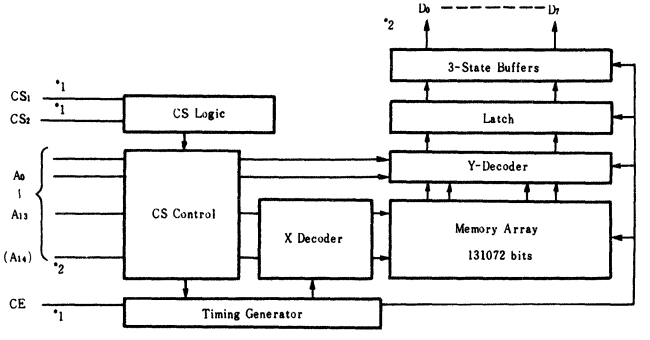


(DP-28)

■ FEATURES

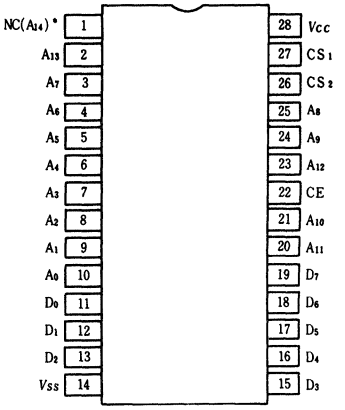
- Mask-programmable for either 4-bit or 8-bit organization.
- Three-state outputs, can be wired-OR.
- Two mask programmable chip select terminals facilitate memory expansion.
- A single 5V power supply (±10%).
- Low power consumption: Operation 3mW (typ.),
- Standby 3μW (typ.)
- TTL compatible
- Access time: 6.5μs (max)

■ BLOCK DIAGRAM



*1 Active level defined at mask level.
*2 Mask programmable selection of either 4-bit or 8-bit organization.
In 4-bit organization, data outputs are D_0 to D_3.

■ PIN ARRANGEMENT



(Top View)

*The most significant address in 4-bit organization.

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage*	V_{CC}	−0.3～+7.0	V
Input Voltage*	V_{in}	−0.3～+7.0	V
Operating Temperature Range	T_{opr}	−20～+75	℃
Storage Temperature	T_{stg}	−55～+125	℃
Bias Storage Temperatore	T_{bias}	−20～+85	℃

Note : * Referenced to V_{SS}.

■ ELECTRICAL CHARACTERISTICS (V_{CC}=5V±10%, V_{SS}=0V, Ta=−20～+75℃)

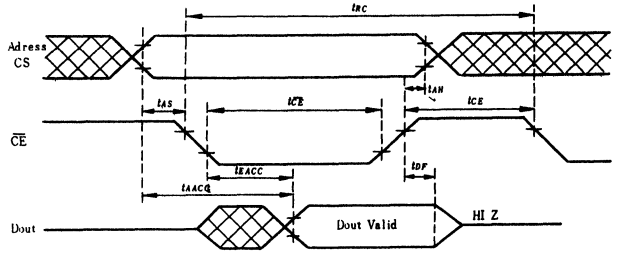
Item		Symbol	Test Condition		min	typ	max	Unit
Input "High" Level Voltage		V_{IH}			2.4	—	V_{CC}	V
Input "Low" Level Voltage		V_{IL}			0	—	0.8	V
Output "High" Level Voltage		V_{OH}	I_{OH}=−100μA		2.4	—	—	V
Output "Low" Level Voltage		V_{OL}	I_{OL}=1.6mA		—	—	0.4	V
Input Leakage Current		I_{in}	V_{in}=0～5.5V		—	—	2.5	μA
Output "High" Level Leakage Current		I_{LOH}	CE=0.8V	V_{out}=2.4V	—	—	5	μA
Output "Low" Level Leakage Current		I_{LOL}	$\overline{CE}$=2.4V	V_{out}=0.4V	—	—	5	μA
Supply Current	In stand-by	I_{SB}	$\overline{CS}\geq V_{CC}-0.2V$ $CS\geq V_{SS}+0.2V$	V_{CC}=5.5V	—	1	30	μA
	In operation	I_{CC} *	t_{RC}=7.5μs		—	0.6	1.5	mA
Input Capacitance		C_{in}	V_{in}=0V, f=1MHz, Ta=25℃		—	—	10	pF
Output Capacitance		C_{out}			—	—	12.5	pF

* Steady state current

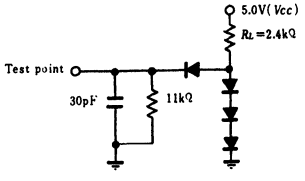
■ AC OPERATING CHARACTERISTICS

● READ SEQUENCE (V_{CC}=5V±10%, V_{SS}=0V, Ta=−20 to +75℃, t_r=t_f=20ns)

Item	Symbol	min	max	Unit
Read Cycle Time	t_{RC}	7.5	—	μs
Address Access Time	t_{AACC}	—	6.5	μs
Chip Enable Access Time	t_{EACC}	—	6.0	μs
Data Hold Time from Address	t_{DF}	0.05	0.5	μs
Address Set-up Time	t_{AS}	0.5	—	μs
Address Hold Time	t_{AH}	0	—	μs
Chip Enable ON Time	$t_{\overline{CE}}$	6.0	—	μs
Chip Enable OFF Time	t_{CE}	1.0	—	μs



● LOAD CIRCUIT



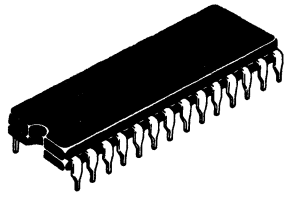
Notes : 1. t_r=t_f=20ns.
2. C_L includes jig capacitance.
3. All diodes are 1S2074 Ⓗ.

HN613128P, HN613128FP

16384-word×8-bit Mask Programmable Read Only Memory

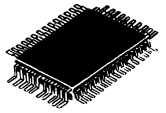
The HN613128P/FP is a mask-programmable, byte-organized memory designed for use in bus-organized systems. To facilitate use, the device operates from a single power supply, has compatibility with TTL, and requires no clocks or refreshing because of static operation. The active level of the CS, OE_0, OE_1 input and the memory content are defined by the user. The Chip Select input deselects the output and puts the chip in a power-down mode.

HN613128P



(DP-28)

HN613128FP

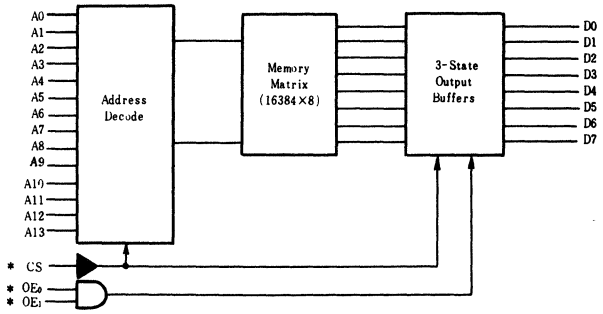


(FP-54)

■FEATURES

- Fully Static Operation
- Automatic Power Down
- Single +5-Volt Power Supply
- Three-State Data Output for OR-Ties
- Mask Programmable Chip Select, Output Enable
- TTL Compatible
- Maximum Access Time; 250ns
- Low Power Standby and Low Power Operation;
  Standby: 5μW (typ.)
  Operation: 50mW (typ.)
- Pin Compatible with EPROM

■BLOCK DIAGRAM



* Active level defined by the user.

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Supply Voltage*	V_{CC}	−0.3 to +7.0	V
Input Voltage*	V_{in}	−0.3 to +7.0	V
Operating Temperature Range	T_{opr}	−20 to +75	℃
Storage Temperature Range	T_{stg}	−55 to +125	℃
Storage Temperature Range (under bias)	T_{bias}	−20 to +85	℃

* With respect to V_{SS}.

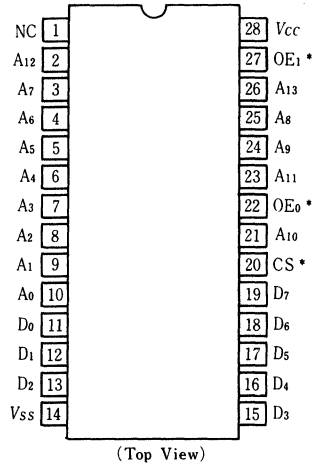
■RECOMMENDED DC OPERATING CONDITIONS

Item	Symbol	min.	typ.	max.	Unit
Supply Voltage*	V_{CC}	4.5	5.0	5.5	V
Input Voltage*	V_{IL}	−0.3	—	0.8	V
	V_{IH}	2.2	—	V_{CC}	V
Operating Temperature	T_{opr}	−20	—	75	℃

* With respect to V_{SS}.

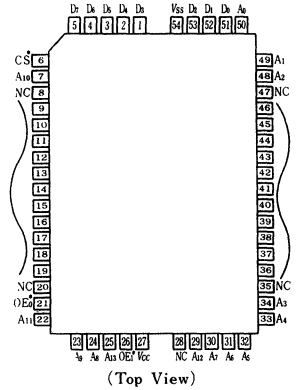
■PIN ARRANGEMENT

●HN613128P



(Top View)

●HN613128FP



(Top View)

HITACHI

■ ELECTRICAL CHARACTERISTICS (V_{CC}=5.0V±10%, V_{SS}=0V, Ta=−20 to +75°C)

Item	Symbol	Test Condition	min	typ	max	Unit
Input High-level Voltage	V_{IH}		2.2	—	V_{CC}	V
Input Low-level Voltage	V_{IL}		−0.3	—	0.8	V
Output High-level Voltage	V_{OH}	I_{OH}=−205μA	2.4	—	—	V
Output Low-level Voltage	V_{OL}	I_{OL}=3.2mA	—	—	0.4	V
Input Leakage Current	I_{in}	V_{in}=0 to 5.5V	—	—	2.5	μA
Output High-level Leakage Current	I_{LOH}	V_{out}=2.4V, CS=0.8V, $\overline{CS}$=2.2V	—	—	10	μA
Output Low-level Leakage Current	I_{LOL}	V_{out}=0.4V, CS=0.8V, $\overline{CS}$=2.2V	—	—	10	μA
Supply Current (Active/Standby)	I_{CC}*/ I_{sb}	V_{CC}=5.5V, I_{DOUT}=0mA/$\overline{CS}$≧V_{CC}−0.2V, CS≦0.2V	—	10/1	25/30	mA/μA
Input Capacitance	C_{in}	V_{in}=0V, f=1.0MHz, Ta=25°C	—	—	10	pF
Output Capacitance	C_{out}	V_{in}=0V, f=1.0MHz, Ta=25°C	—	—	15	pF

* Steady state current

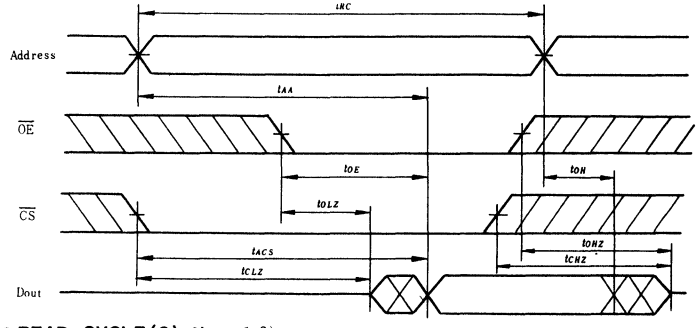
■ RECOMMENDED AC OPERATING CONDITIONS (READ SEQUENCE)

(V_{CC}=5.0V±10%, V_{SS}=0V, Ta=−20 to +75°C, All timing with t_r=t_f=20ns)

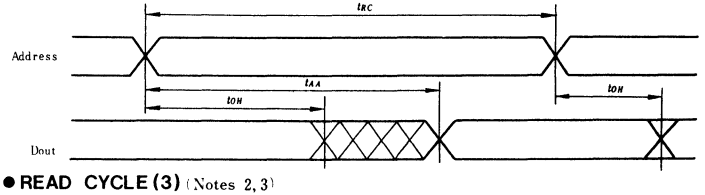
Item	Symbol	HN613128P		Unit
		min	max	
Read Cycle Time	t_{RC}	250	—	ns
Address Access Time	t_{AA}	—	250	ns
Chip Select Access Time	t_{ACS}	—	250	ns
Chip Selection to Output in Low Z	t_{CLZ}	10	—	ns
Output Enable to Output Valid	t_{OE}	—	100	ns
Output Enable to Output in Low Z	t_{OLZ}	10	—	ns
Chip deselection to Output in High Z	t_{CHZ}	0	100	ns
Chip Disable to Output in High Z	t_{OHZ}	0	100	ns
Output Hold from Address Change	t_{OH}	10	—	ns

■ TIMING WAVEFORM

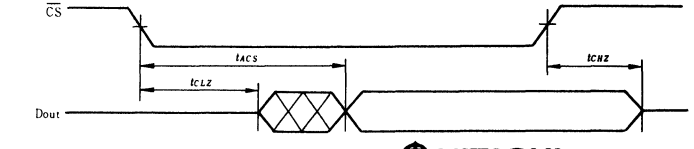
● READ CYCLE (1)



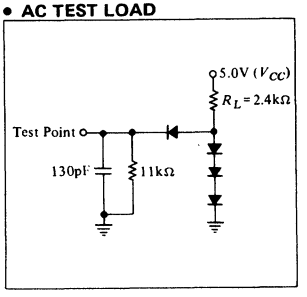
● READ CYCLE (2) (Notes 1, 3)



● READ CYCLE (3) (Notes 2, 3)



● AC TEST LOAD



Notes) 1. t_r=t_f=20ns.
2. C_L includes jig capacitance.
3. All diodes are 1S2074Ⓗ.

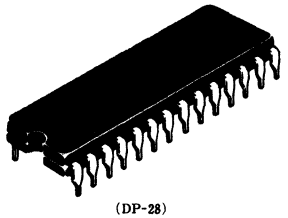
NOTES:
1. Device is continuously selected.
2. Address Valid prior to or coincident with $\overline{CS}$ transition low.
3. $\overline{OE}$ = VIL.

HN61256P, HN61256FP

32768×8-bit or 65536×4-bit CMOS Mask Programmable Read Only Memory

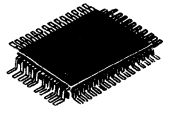
The Hitachi HN61256P/FP is a mask programmable 32768 x 8-bit or 65536x4-bit CMOS read only memory. It operates from a single power supply and is compatible with TTL. Low power consumption makes this memory well-suited for battery-operation or hand-held personal computers. Memory expansion can be implemented through one chip select input. Either active "High" or active "Low" or chip select input and a chip enable input are defined at mask level. The organization of 8 bit or 4 bit is defined by the user.

HN61256P



(DP-28)

HN61256FP

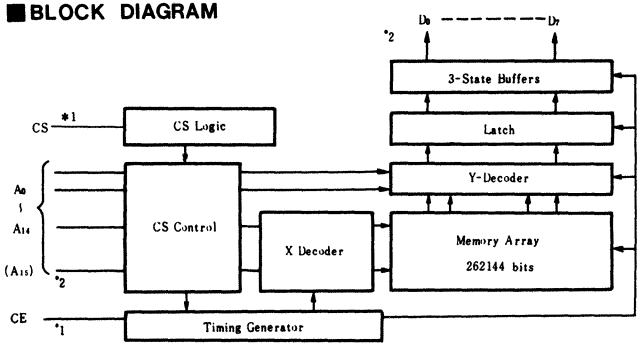


(FP-54)

■FEATURES

- Mask-programmable selection of either 4-bit or 8-bit organization
- Three-state outputs, can be wire-ORed.
- One mask programmable chip select terminal facilitates memory expansion.
- A single 5V power supply (±10%)
- Low power consumption: Operation 7.5mW (typ.), Standby 5μW (typ.)
- TTL compatible
- Access time: 3.5μs (max)

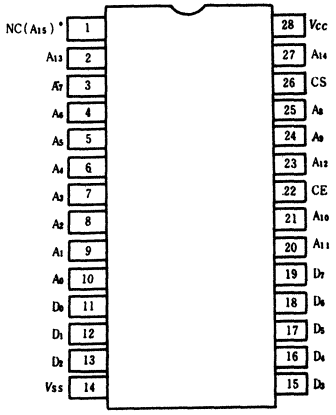
■BLOCK DIAGRAM



*1 Active level defined at mask level.
*2 Mask programmable selection of either 4-bit or 8-bit organization.
In 4-bit organization, data outputs are D_0 to D_3.

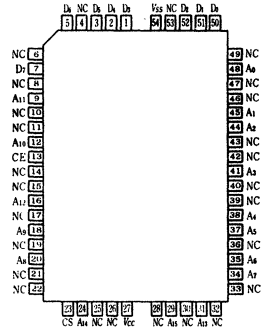
■PIN ARRANGEMENT

●HN61256P



(Top View)

●HN61256FP



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage*	V_{CC}	−0.3～+7.0	V
Input Voltage*	V_{in}	−0.3～+7.0	V
Operating Temperature Range	T_{opr}	0～+75	℃
Storage Temperature Range	T_{stg}	−55～+125	℃
Bias Storage Temperature Range	T_{bias}	−20～+85	℃

Note : * Referenced to V_{SS}.

■ ELECTRICAL CHARACTERISTICS

(V_{CC}=5V±10%, V_{SS}=0V, Ta=0～+75℃)

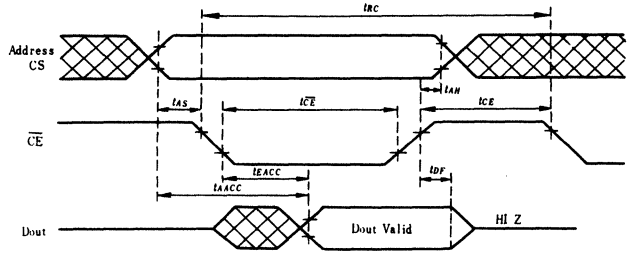
Item		Symbol	Test Condition		min	typ	max	Unit
Input "High" Level Voltage		V_{IH}			2.4	—	V_{CC}	V
Input "Low" Level Voltage		V_{IL}			0	—	0.8	V
Output "High" Level Voltage		V_{OH}	I_{OH}=−100μA		2.4	—	—	V
Output "Low" Level Voltage		V_{OL}	I_{OL}=1.6mA		—	—	0.4	V
Input Leakage Current		I_{in}	V_{in}=0～5.5V		—	—	2.5	μA
Output "High" Level Leakage Current		I_{LOH}	CE=0.8V	V_{out}=2.4V	—	—	5	μA
Output "Low" Level Leakage Current		I_{LOL}	$\overline{CE}$=2.4V	V_{out}=0.4V	—	—	5	μA
Supply Current	In stand-by	I_{SB}	$\overline{CS}\geqq V_{CC}-0.2V$, $CS\leqq V_{SS}+0.2V$	V_{CC}=5.5V	—	1	30	μA
	In operation	I_{CC}*	t_{RC}=4.0μs		—	1.5	3.0	mA
Input Capacitance		C_{in}	V_{in}=0V, f=1MHz, Ta=25℃		—	—	10	pF
Output Capacitance		C_{out}			—	—	12.5	pF

* Steady state current

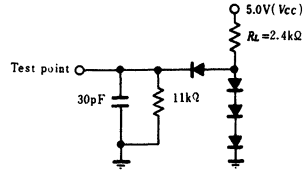
■ AC OPERATING CONDITION AND CHARACTERISTICS

● READ SEQUENCE (V_{CC}=5V±10%, V_{SS}=0V, Ta=0～+75℃, t_r=t_f=20ns)

Item	Symbol	min	max	Unit
Read Cycle Time	t_{RC}	4.0	—	μs
Address Access Time	t_{AACC}	—	3.5	μs
Chip Enable Access Time	t_{EACC}	—	3.0	μs
Data Hold Time from Address	t_{DF}	0.05	0.5	μs
Address Set-up Time	t_{AS}	0.5	—	μs
Address Hold Time	t_{AH}	0	—	μs
Chip Enable ON Time	$t_{\overline{CE}}$	3.0	—	μs
Chip Enable OFF Time	t_{CE}	0.5	—	μs



● LOAD CIRCUIT



Notes : 1. t_r=t_f=20ns.
2. C_L includes jig capacitance.
3. All diodes are 1S2074Ⓗ.

HN613256P, HN613256FP

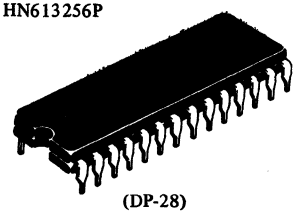
32768-word x 8-bit Mask Programmable Read Only Memory

The HN613256P/FP is a mask-programmable, byte-organized memory designed for use in bus-organized system.

To facilitate use, the device operates from a single power supply, has compatibility with TTL, and requires no clocks nor refreshing because of static operation.

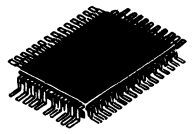
The active level of the CS and OE input, and the memory content are defined by the user. The Chip Select input deselects the output and puts the chip in a power-down mode.

HN613256P



(DP-28)

HN613256FP

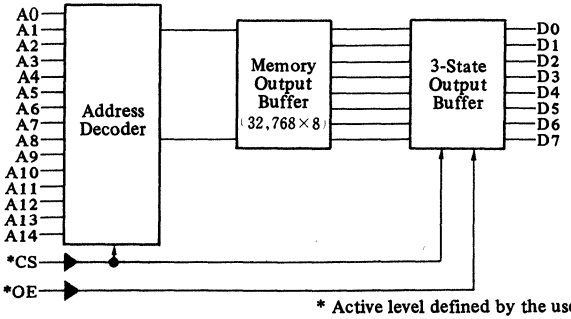


(FP-54)

■ FEATURES

- Fully Static Operation
- Automatic Power Down
- Single +5V Power Supply
- Three-state Data Output for OR-ties
- Mask Programmable Chip Select and Output Enable
- TTL Compatible
- Maximum Access Time: 250ns
- Low Power Standby and Low Power Operation; Standby 5μW (typ.), Operation 50mW (typ.)
- Pin Compatible with EPROM

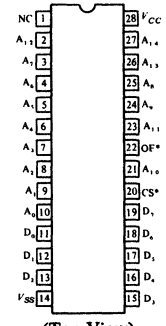
■ BLOCK DIAGRAM



* Active level defined by the user.

■ PIN ARRANGEMENT

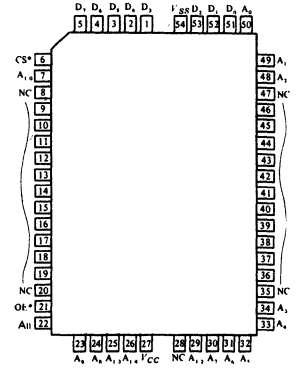
- **HN613256P**



(Top View)

* Active level can be defined by the customer.

- **HN613256FP**



(Top View)

* Active level can be defined by the customer.

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Supply Voltage*	V_{CC}	−0.3 to +7.0	V
Input Voltage*	V_{in}	−0.3 to +7.0	V
Operating Temperature Range	T_{opr}	−20 to +75	°C
Storage Temperature Range	T_{stg}	−55 to +125	°C
Storage Temperature Range (Under Bias)	T_{bias}	−20 to +85	°C

*With respect to V_{SS}

■ RECOMMENDED DC OPERATING CONDITIONS

Item	Symbol	min.	typ.	max.	Unit
Supply Voltage*	V_{CC}	4.5	5.0	5.5	V
Input Voltage*	V_{IL}	−0.3	—	0.8	V
	V_{IH}	2.2	—	V_{CC}	V
Operating Temperature	T_{opr}	−20	—	75	°C

* With respect to V_{SS}.

■ ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0V±10%, V_{SS} = 0V, T_a = –20 ~ +75 °C)

Item		Symbol	Test Condition		min	typ	max	Unit
Input Voltage		V_{IH}			2.2	–	V_{CC}	V
		V_{IL}			–0.3	–	0.8	V
Output Voltage		V_{OH}	I_{OH} = –205 µA		2.4	–	–	V
		V_{OL}	I_{OL} = 3.2 mA		–	–	0.4	V
Input Leakage Current		I_{in}	V_{in} = 0 ~ 5.5V		–	–	2.5	µA
Output Leakage Current		I_{LOH}	CS = 0.8V, $\overline{CS}$ = 2.2V	V_{out} = 2.4V	–	–	10	µA
		I_{LOL}		V_{out} = 0.4V	–	–	10	µA
Supply Current	Active	I_{CC}*	V_{CC} = 5.5V, I_{out} = 0 mA		–	10	30	mA
	Standby	I_{SB}	V_{CC} = 5.5V, $\overline{CS} \geqq V_{CC}$ – 0.2V, CS ≦ 0.2V		–	1	30	µA
Input Capacitance		C_{in}	V_{in} = 0V, f = 1 MHz, T_a = 25 °C		–	–	10	pF
Output Capacitance		C_{out}			–	–	15	pF

* Steady state current

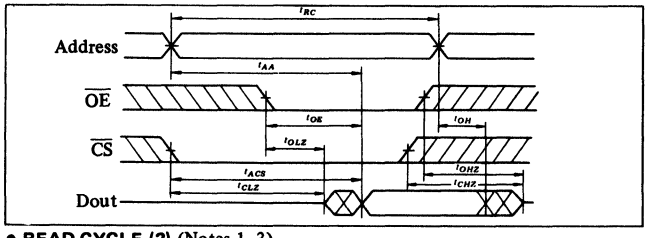
■ RECOMMENDED AC OPERATING CONDITIONS (READ SEQUENCE)

(V_{CC}=5V±10%, V_{SS}=0V, Ta=–20~+75°C, t_r=t_f=20ns)

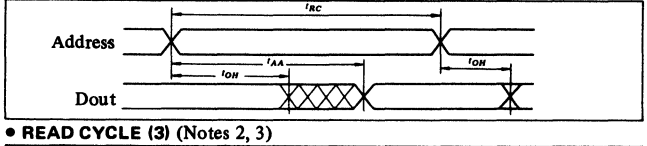
Item	Symbol	min	max	Unit
Read Cycle Time	tRC	250	–	ns
Address Access Time	tAA	–	250	ns
Chip Select Access Time	$tACS$	–	250	ns
Chip Selection to Output in Low Z	$tCLZ$	10	–	ns
Output Enable to Output Valid	tOE	–	100	ns
Output Enable to Output in Low Z	$tOLZ$	10	–	ns
Chip Deselection to Output in High Z	$tCHZ$	0	100	ns
Chip Disable to Output in High Z	$tOHZ$	0	100	ns
Output Hold from Address Change	tOH	10	–	ns

■ TIMING WAVEFORM

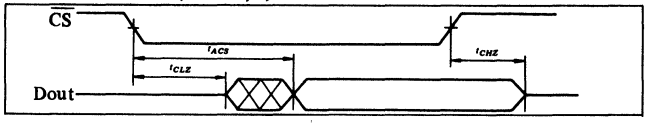
• READ CYCLE (1)



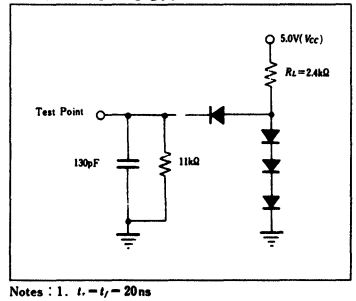
• READ CYCLE (2) (Notes 1, 3)



• READ CYCLE (3) (Notes 2, 3)



• LOAD CIRCUIT

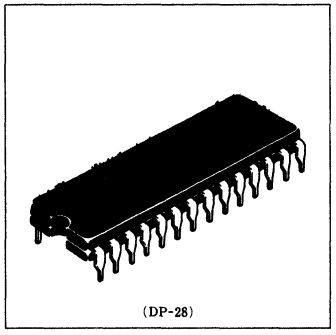


Notes : 1. $t_r = t_f$ = 20ns
2. C_L includes jig capacitance
3. All diodes are 1S2074Ⓗ

NOTES:
1. Device is continuously selected.
2. Address Valid prior to or coincident with $\overline{CS}$ transition low.
3. $\overline{OE}$ = VIL.

131,072-word×8-bit Mask Programmable Read Only Memory

The HN62301P is a mask-programmable, byte-organized memory designed for use in bus-organized systems. To facilitate use, the device operates from a single power supply, has compatibility with TTL, and requires no clocks or refreshing because of static operation. The Chip Enable and the memory content are defined by the user. The Chip Enable input deselects the output and puts the chip in a power-down mode.

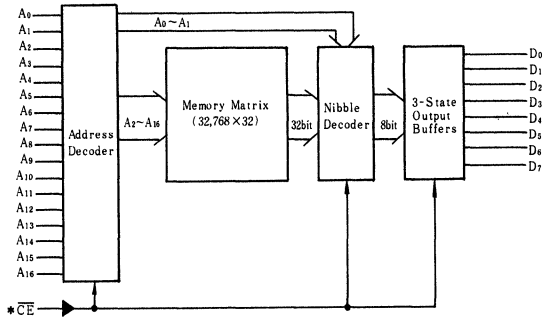


(DP-28)

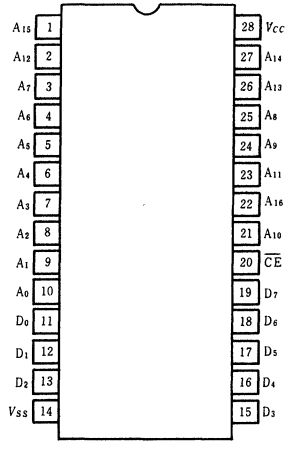
■FEATURES

- Static Operation
- Automatic Power Down
- Single +5-Volt Power Supply
- Three-State Data Output for OR-Ties
- TTL Compatible
- Maximum Access Time-350ns
- Lower Power Standby and Low Power Operation; Standby: 2mW (typ.), Operation: 75mW (typ.)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Supply Voltage*	V_{CC}	−0.3 to +7.0	V
Input Voltage*	V_{in}	−0.3 to +7.0	V
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−55 to +125	°C
Bias Storage Temperature Range	T_{bias}	−20 to +85	°C

* With respect to V_{SS}

Note) The specifications of this device are subject to change without notice.
Please contact your nearest Hitachis Sales Dept, regarding specifications.

■RECOMMENDED DC OPERATING CONDITIONS (Ta=0 to 70℃)

Item	Symbol	min	typ	max	Unit
Supply Voltage *	V_{CC}	4.5	5.0	5.5	V
Input Voltage*	V_{IL}	−0.3	—	0.8	V
	V_{IH}	2.2	—	V_{CC}	V

* with respect V_{SS}

■ELECTRICAL CHARACTERISTICS (V_{CC}=5V±10%, V_{SS}=0V, Ta=0 to +70℃)

Item	Symbol	Test Conditions		min	typ	max	Unit
Normal Operating Current	I_{CC1}*	t_{RC1}=min, V_{CC}=5.5V, I_{out}=0mA		—	15	50**	mA
Nibble Operating Current	I_{CC2}*	t_{RC2}=min, V_{CC}=5.5V, I_{out}=0mA		—	15	50**	mA
Stand by Current	I_{SB}	$\overline{CE} \geq V_{CC}-0.2V$, V_{CC}=5.5V		—	0.4	10	mA
Input Leakage Current	I_{LI}	V_{IN}=0 to 5.5V, other 0V		−10	—	10	μA
Output Leakage Current	I_{LOH}	$\overline{CE}$=2.2V	V_{out}=2.4V	—	—	10	μA
	I_{LOL}		V_{out}=0.4V	—	—	10	μA
Output Voltage	V_{OH}	I_{out}=−205μA		2.4	—	—	V
	V_{OL}	I_{out}=3.2mA		—	—	0.4	V

* Steady state current
** TBD

■CAPACITANCE (V_{CC}=5V±10%, Ta=25℃, 1MHz V_{in}=0V)

Item	Symbol	typ	max	Unit
Input Capacitance (A_0~A_{16}, $\overline{CE}$)	C_{in}	TBD	10	pF
Output Capacitance (D_0~D_7)	C_{out}	TBD	15	pF

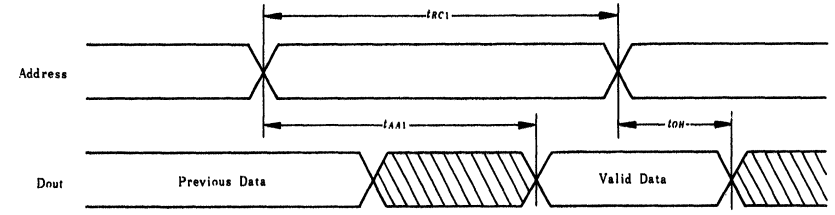
■AC CHARACTERISTICS (V_{CC}=5V±10%, V_{SS}=0V, Ta=0 to +70℃, t_r=t_f=20ns)

Mode	Item	Symbol	min	max	Unit
Normal	Cycle Time	t_{RC1}	350	—	ns
	Address Access Time	t_{AA1}	—	350	ns
	Data Hold Time	t_{OH}	10	—	ns
$\overline{CE}$ operation	$\overline{CE}$ Access Time	t_{ACE}	—	350	ns
	$\overline{CE}$ Enable Pulse Width	t_{CE}	350	—	ns
	$\overline{CE}$ Disable Pulse Width	$t_{\overline{CE}}$	15**	—	ns
	Address Set up Time	t_{AS}	0	—	ns
	Data Hold Time from $\overline{CE}$	t_{CHZ}	10**	—	ns
	Data Set Time from $\overline{CE}$	t_{CLZ}	10	—	ns
Nibble operation	Nibble Address Access Time*	t_{AA2}	—	50	ns
	Nibble Cycle Time	t_{RC2}	50	—	ns
Turn-on & Turn-off Time		t_T	—	40	ns

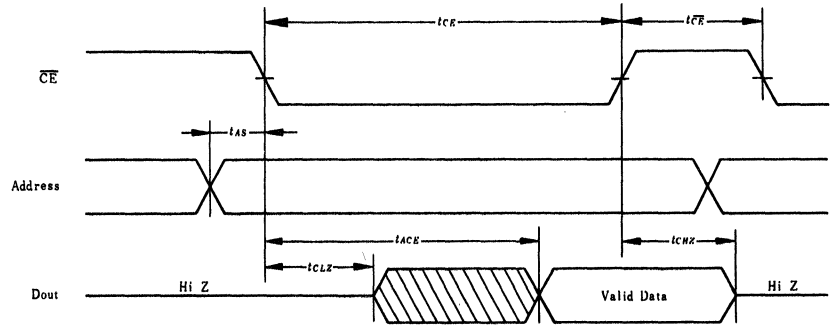
* Nibble Address A_0, A_1
** TBD

■TIMMING CHART

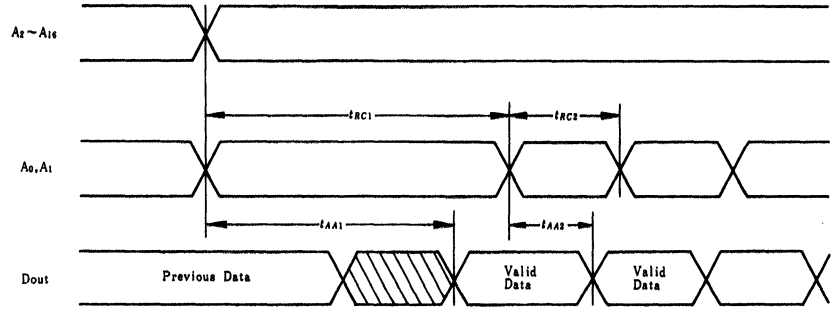
●NORMAL CYCLE ($\overline{CE}$=Low)



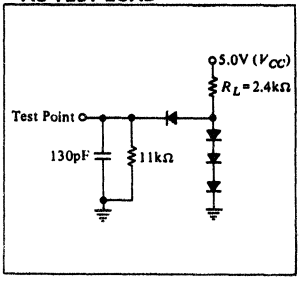
●$\overline{CE}$ CYCLE



●NIBBLE CYCLE



● AC TEST LOAD



Notes) 1. t_r=t_f=20ns
2. C_L includes jig capacitance.
3. All diodes are 1S2074Ⓗ.

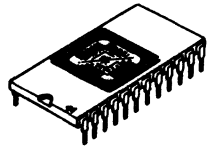
MOS PROM

2048-word × 8-bit U.V. Erasable and Electrically Programmable Read Only Memory

The HN462716 is a 2048 word by 8 bit erasable and electrically programmable ROMs. This device is packaged in a 24-pin, dual-in-line package with transparent lid. The transparent lid allows the user to expose the chip to ultraviolet light to erase the bit pattern, whereby a new pattern can then be written into the device.

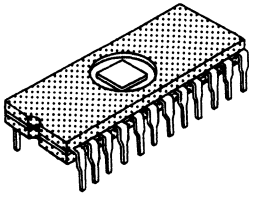
- Single Power Supply ···· +5V ±5%
- Simple Programming ···· Program Voltage: +25V DC
  Programs with One 50ms Pulse
- Static ·· No Clocks Required
- Inputs and Outputs TTL Compatible During Both Read and Program Modes
- Fully Decoded-on Chip Address Decode
- Access Time ····· 450ns Max.
- Low Power Dissipation ·· 555mW Max. Active Power
  161mW Max. Standby Power
- Three State Output ····· OR-Tie Capability
- Interchangeable with Intel 2716

HN462716



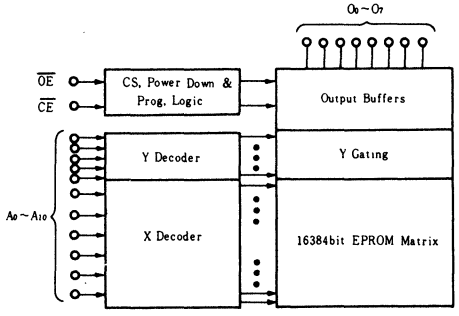
(DC-24C)

HN462716G

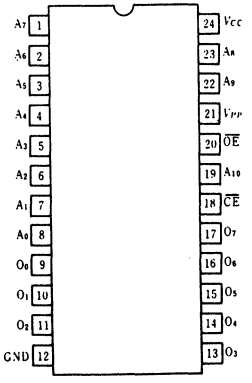


(DG-24B)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ PROGRAMMING OPERATION

Mode \ Pins	$\overline{CE}$ (18)	$\overline{OE}$ (20)	V_{PP} (21)	V_{CC} (24)	Outputs (9~11, 13~17)
Read	V_{IL}	V_{IL}	+5	+5	Dout
Deselect	Don't Care	V_{IH}	+5	+5	High Z
Power Down	V_{IH}	Don't Care	+5	+5	High Z
Program	Pulsed V_{IL} to V_{IH}	V_{IH}	+25	+5	Din
Program Verify	V_{IL}	V_{IL}	+25	+5	Dout
Program Inhibit	V_{IL}	V_{IH}	+25	+5	High Z

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−65 to +125	°C
All Input and Output Voltages*	V_T	−0.3 to +7	V
V_{PP} Supply Voltage*	V_{PP}	−0.3 to +28	V

* With respect to Ground

■ READ OPERATION

● DC AND OPERATING CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V)

Item	Symbol	Test Condition	min.	typ.	max.	Unit
Input Leakage Current	I_{LI}	V_{IN}=5.25V	—	—	10	μA
Output Leakage Current	I_{LO}	V_{OUT}=5.25V/0.4V	—	—	10	μA
V_{PP} Current	I_{PP1}	V_{PP}=5.85V	—	—	5	mA
V_{CC} Current (Standby)	I_{CC1}	$\overline{CE}$=V_{IH}, $\overline{OE}$=V_{IL}	—	13	25	mA
V_{CC} Current (Active)	I_{CC2}	$\overline{OE}$=$\overline{CE}$=V_{IL}	—	56	100	mA
Input Low Voltage	V_{IL}		−0.1	—	0.8	V
Input High Voltage	V_{IH}		2.0	—	V_{CC}+1	V
Output Low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH}=−400μA	2.4	—	—	V

Note : V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.

● AC CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Address to Output Delay	t_{ACC}	$\overline{OE}$=$\overline{CE}$=V_{IL}	—	—	450	ns
$\overline{CE}$ to Output Delay	t_{CE}	$\overline{OE}$=V_{IL}	—	—	450	ns
$\overline{OE}$ to Output Delay	t_{OE}	$\overline{CE}$=V_{IL}	—	—	120	ns
$\overline{OE}$ High to Output Float*	t_{DF}	$\overline{CE}$=V_{IL}	0	—	100	ns
Address to Output Hold	t_{OH}	$\overline{OE}$=$\overline{CE}$=V_{IL}	0	—	—	ns

* : t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

● CAPACITANCE (Ta=25°C, f=1MHz)

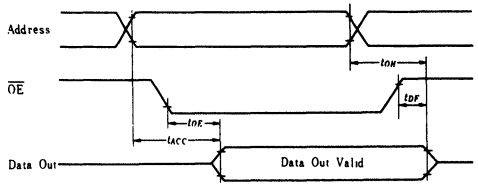
Item	Symbol	Test Condition	typ.	max.	Unit
Input Capacitance	C_{in}	V_{IN}=0V	—	6	pF
Output Capacitance	C_{out}	V_{OUT}=0V	—	12	pF

● SWITCHING CHARACTERISTICS

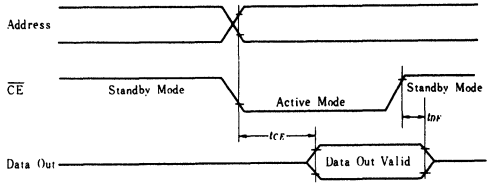
Test Conditions

Input Pulse Levels:	0.8V to 2.2V
Input Rise and Fall Times:	≤ 20 ns
Output Load:	1TTL Gate + 100 pF
Reference Level for Measuring Timing:	Inputs 1V and 2V
	Outputs 0.8V and 2V

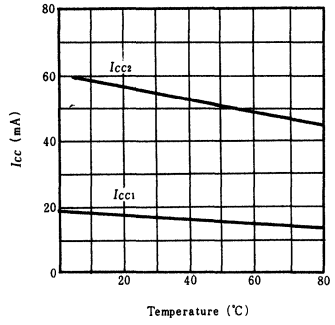
READ MODE ($\overline{CE}$=V_{IL})

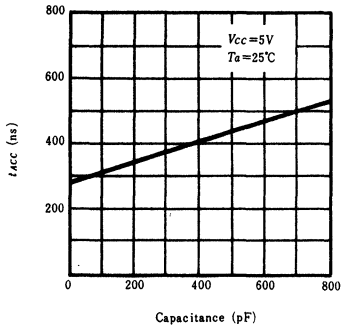


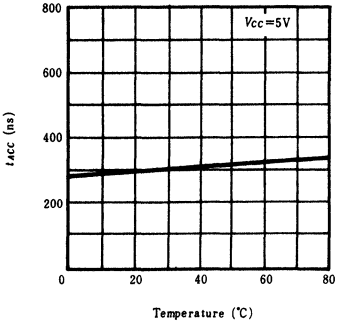
STANDBY MODE ($\overline{OE}$=V_{IL})

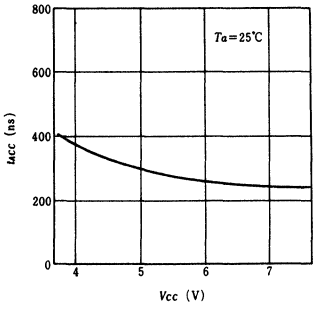


● TYPICAL CHARACTERISTICS









● DC PROGRAMMING CHARACTERISTICS (T_a=25℃±5℃, V_{CC}=5V±5%, V_{PP}=25V±1V)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Input Leakage Current	I_{LI}	V_{IN}=5.25V	—	—	10	μA
V_{PP} Supply Current	I_{PP1}	$\overline{CE}=V_{IL}$	—	—	5	mA
V_{PP} Supply Current During Programming	I_{PP2}	$\overline{CE}=V_{IH}$	—	—	30	mA
V_{CC} Supply Current	I_{CC}		—	—	100	mA
Input Low Level	V_{IL}		−0.1	—	0.8	V
Input High Level	V_{IH}		2.0	—	V_{CC}+1	V

● AC PROGRAMMING CHARACTERISTICS (T_a=25℃±5℃, V_{CC}=5V±5%, V_{PP}=25V±1V)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Address Setup Time	t_{AS}		2	—	—	μs
$\overline{OE}$ Setup Time	t_{OES}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		2	—	—	μs
$\overline{OE}$ Hold Time	t_{OEH}		5	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
$\overline{OE}$ to Output Float Delay*	t_{DF}	$\overline{CE}=V_{IL}$	0	—	120	ns
$\overline{OE}$ to Output Delay	t_{OE}	$\overline{CE}=V_{IL}$	—	—	120	ns
Program Pulse Width	t_{PW}		45	50	55	ms
Program Pulse Rise Time	t_{PRT}		5	—	—	ns
Program Pulse Fall Time	t_{PFT}		5	—	—	ns

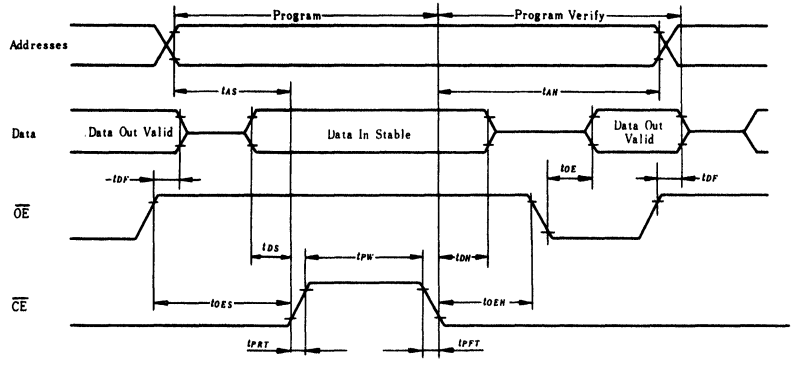
Notes : V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.
* : t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

●SWITCHING CHARACTERISTICS

Test Conditions

Input Pulse Level: 0.8V to 2.2V
Input Rise and Fall Times: ≤ 20 ns
Output Load: 1 TTL Gate + 100 pF
Reference Level for Measuring Timing:
Inputs; 1V and 2V, Outputs; 0.8V and 2V

●PROGRAMMING WAVEFORMS



●ERASE

Erasure of HN462716 is performed by exposure to ultraviolet light with a wavelength of 2537Å, and all the output data are changed to "1" after this erasure procedure.
The minimum integrated close (i.e., UV intensity x exposure time) for erasure is 15W • sec/cm^2

■DEVICE OPERATION

● READ MODE

Dataout is available 450ns (t_{ACC}) from addresses with $\overline{OE}$ low or 120ns (t_{OE}) from $\overline{OE}$ with addresses stable.

● DESELECT MODE

The outputs may be OR-tied together with the other HN462716s. When HN462716s are deselected, the $\overline{OE}$ inputs must be at high TTL level.

● POWER DOWN MODE

Power down is achieved with $\overline{CE}$ high TTL level. In this mode the outputs are in a high impedance state.

● PROGRAMMING

Initially, and after each erasure, all bits of the HN462716 are in the "High" state (Output High). Data is introduced by selectively programming "low" into the desired bit locations. In the programming mode, Vpp power supply is at 25V and $\overline{OE}$ input is at high TTL level. Data to be programmed are presented 8-bits in parallel, to the data output lines (O0 to O7).

The addresses and inputs are at TTL levels.
After the address and data setup, a 50 ms, active high program pulse is applied to the $\overline{CE}$ input. The $\overline{CE}$ is at TTL level.
The HN462716 must not be programmed with a DC signal applied to the $\overline{CE}$ input.

● PROGRAM VERIFY

The HN462716 has a program verify mode. A verify should be performed on the programmed bits to determine that they were correctly programmed. In this mode Vpp is at 25V.

● PROGRAM INHIBIT

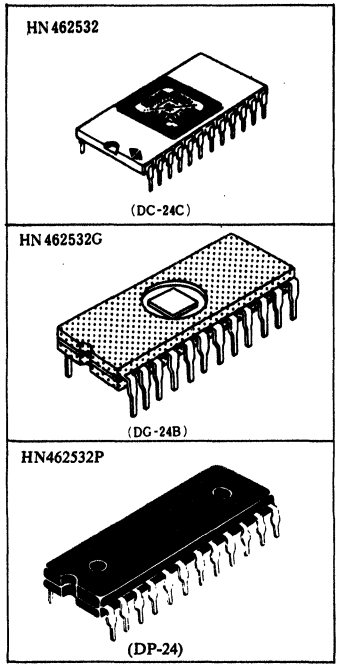
Programming of multiple HN462716s in parallel with different data is easily accomplished by using this mode. Except for $\overline{CE}$, all like inputs of the parallel HN462716s may be common.
A TTL program pulse applied to a HN462716's $\overline{CE}$ input will program that HN462716. A low level $\overline{CE}$ inhibits the other HN462716s from being programmed.

HN462532, HN462532G, HN462532P

4096-word × 8-bit U. V. Erasable and Programmable Read Only Memory

The HN462532 is a 4096 word by 8 bit erasable and electrically programmable ROM. This device is packaged in a 24-pin, dual-in-line package with transparent lid. The transparent lid allows the user to expose the chip to ultraviolet light to erase the bit pattern, whereby a new pattern can then be written into the device.

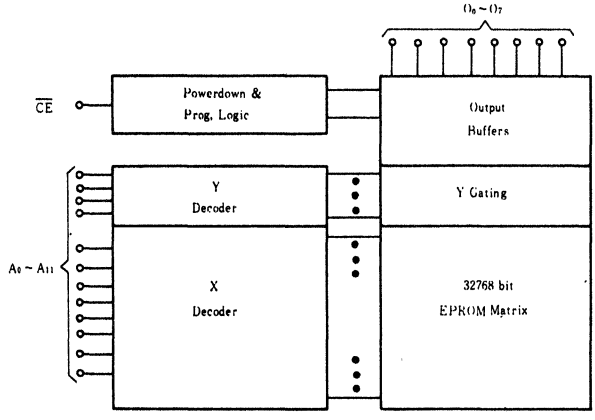
The HN462532P is a 4096 word by 8 bit, one time programmable ROM. This device is packaged in a 24-pin, dual-in-line plastic package.



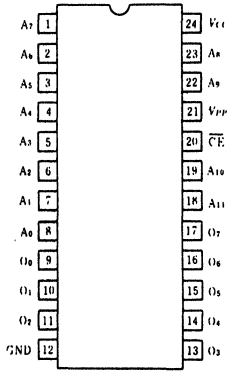
■ FEATURES

- Single Power Supply ..... +5V ±5%
- Simple Programming ..... Program Voltage: +25V D.C.
  Program with One 50ms Pulse
- Static ..... No Clocks Required
- Inputs and Outputs TTL Compatible During Both Read and Program Modes
- Fully Decoded On-Chip Address Decode
- Access Time ..... 450ns (max.)
- Low Power Dissipation .... 858mW (max) Active Power
  201mW (max) Standby Power
- Three Stste Output ..... OR-Tie Capability
- Compatible with TMS2532

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ MODE SELECTION

Mode \ Pins	$\overline{CE}$ (20)	V_{PP} (21)	V_{CC} (24)	Outputs (9 to 11, 13 to 17)
Read	V_{IL}	+5	+5	Dout
Stand by	V_{IH}	+5	+5	High Z
Program	Pulsed V_{IH} to V_{IL}	+25	+5	Din
Program Inhibit	V_{IH}	+25	+5	High Z

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
All Input and Output Voltages*	V_T	−0.3 to +7	V
V_{PP} Voltage*	V_{PP}	−0.3 to +28	V
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−65 to +125	°C

* With respect to GND.

■ READ OPERATION

● DC AND OPERATING CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{in}=5.25V	—	—	10	μA
Output Leakage Current	I_{LO}	V_{out}=5.25V/0.4V	—	—	10	μA
V_{PP} Current	I_{PP1}	V_{PP}=5.85V	—	—	12	mA
V_{CC} Current (Standby)	I_{CC1}	$\overline{CE}$=V_{IH}	—	—	25	mA
V_{CC} Current (Active)	I_{CC2}	$\overline{CE}$=V_{IL}	—	—	150	mA
Input Low Voltage	V_{IL}		−0.1	—	0.8	V
Input High Voltage	V_{IH}		2.0	—	V_{CC}+1	V
Output Low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.4	V
Output High Voltage	V_{OH}	I_{OH}=−400μA	2.4	—	—	V

Note : V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.

● AC CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V)

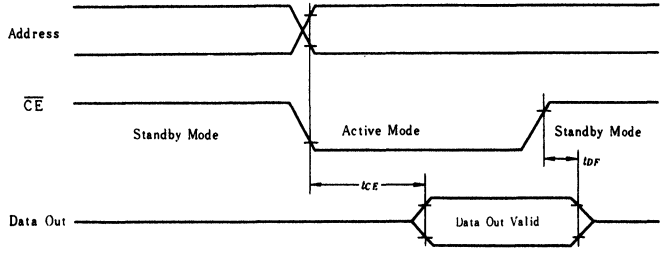
Parameter	Symbol	Test Condition	min	typ	max	Unit
Address to Output Delay	t_{ACC}	$\overline{CE}$=V_{IL}	—	—	450	ns
$\overline{CE}$ to Output Delay	t_{CE}		—	—	450	ns
$\overline{CE}$ High to Output Float*	t_{DF}		0	—	100	ns
Address to Output Hold	t_{OH}	$\overline{CE}$=V_{IL}	0	—	—	ns

* : t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

● SWITCHING CHARACTERISTICS

Test Conditions

Input Pulse Levels:	0.8V to 2.2V
Input Rise and Fall Times:	≤ 20 ns
Output Load:	1TTL Gate + 100pF
Reference Level for Measuring Timing:	Inputs; 1V and 2V, Outputs; 0.8V and 2V



● CAPACITANCE (Ta=25°C, f=1MHz)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	—	—	6	pF
Output Capacitance	C_{out}	V_{out}=0V	—	—	12	pF

■ PROGRAMMING OPERATION

● DC PROGRAMMING CHARACTERISTICS (Ta=25°C±5°C, V_{CC}=5V±5%, V_{PP}=25V±1V)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{in}=5.25V/0.4V	—	—	10	μA
V_{PP} Supply Current During Programming	I_{PP2}	$\overline{CE}=V_{IL}$	—	—	30	mA
V_{CC} Supply Current	I_{CC}		—	—	150	mA
Input Low Level	V_{IL}		−0.1	—	0.8	V
Input High Level	V_{IH}		2.0	—	V_{CC}+1	V

● AC PROGRAMMING CHARACTERISTICS (Ta=25°C±5°C, V_{CC}=5V±5%, V_{PP}=25V±1V)

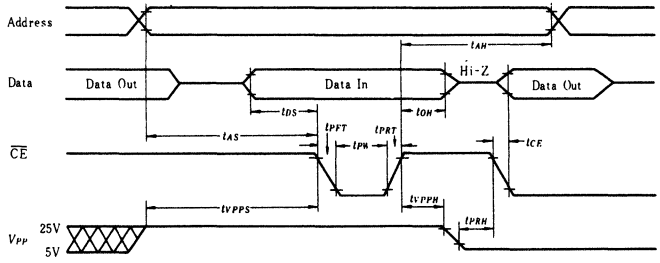
Parameter	Symbol	Test Condition	min	typ	max	Unit
Address Setup Time	t_{AS}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		2	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
Setup Time from V_{PP}	t_{VPPS}		0	—	—	ns
Program Pulse Hold Time	t_{PRH}		0	—	—	ns
V_{PP} Hold Time	t_{VPPH}		0	—	—	ns
Program Pulse Width	t_{PW}		45	50	55	ms
Program Pulse Time	t_{PRT}		5	—	—	ns
Program Pulse Time	t_{PFT}		5	—	—	ns

Note : V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.

● SWITCHING CHARACTERISTICS

Test Conditions

Input Pulse Level:	0.8V to 2.2V
Input Rise and Fall Times:	≤ 20 ns
Output Load:	1TTL Gate + 100pF
Reference Level for Measuring Timing:	Inputs; 1V and 2V, Outputs; 0.8V and 2V

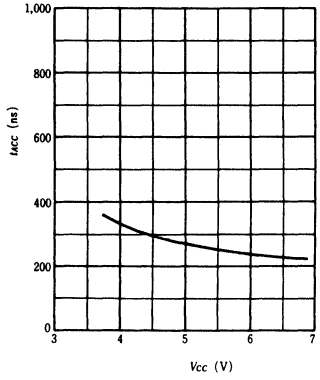


● ERASE

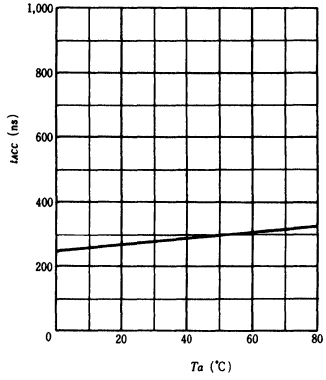
Erasure of HN462532 is performed by exposure to ultraviolet light with a wavelength of 2537Å, and all the output data are changed to "1" after this erasure procedure.
The minimum integrated close (i.e., UV intensity x exposure time) for erasure is 15W · sec/cm².

NOTE THAT THE HN462543P CANNOT BE ERASED.

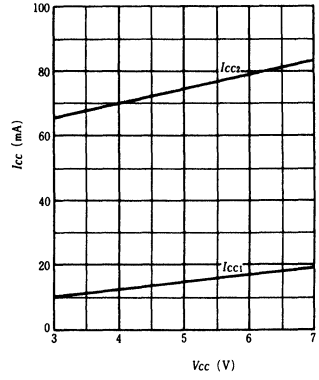
ACCESS TIME vs. SUPPLY VOLTAGE



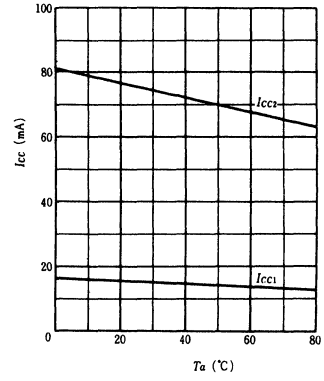
ACCESS TIME vs. AMBIENT TEMPERATURE



SUPPLY CURRENT vs. SUPPLY VOLTAGE



SUPPLY CURRENT vs. AMBIENT TEMPERATURE



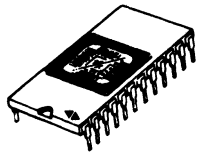
HN462732, HN462732G, HN462732P

4096-word × 8-bit U.V. Erasable and Programmable Read Only Memory

The HN462732 is a 4096 word by 8 bit erasable and electrically programmable ROM. This device is packaged in a 24-pin, dual-in-line package with transparent lid. The transparent lid allows the user to expose the chip to ultraviolet light to erase the bit pattern, whereby a new pattern can then be written into the device.

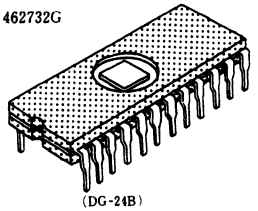
The HN462532P is a 4096 word by 8 bit, one time programmable ROM. This device is packaged in a 24-pin, dual-in-line plastic package.

HN462732



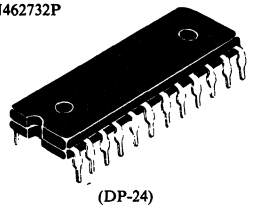
(DC-24C)

HN462732G



(DG-24B)

HN462732P

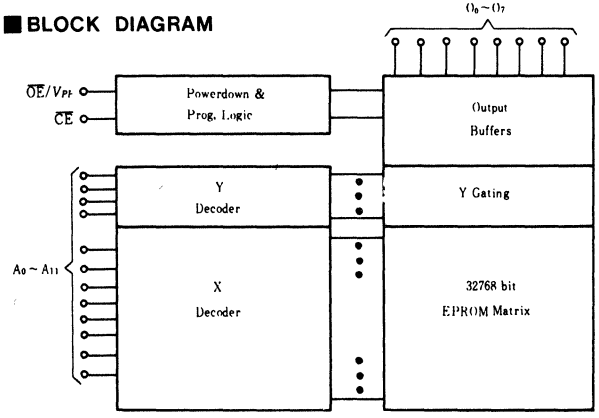


(DP-24)

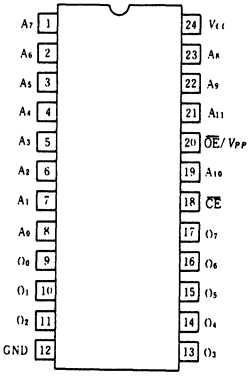
■ FEATURES

- Single Power Supply ..... +5V ±5%
- Simple Programming ..... Program Voltage: +25V D.C.
  Program with One 50ms Pulse
- Static ..... No Clocks Required
- Inputs and Outputs TTL Compatible During Both Read and Program Modes
- Fully Decoded On-Chip Address Decode
- Access Time ..... 450ns (max)
- Low Power Dissipation .... 150mA (max) Active Currents
  30mA (max) Standby Current
- Three State Output ..... OR-Tie-Capability
- Compatible with INTEL 2732

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ MODE SELECTION

Mode \ Pins	$\overline{CE}$ (18)	$\overline{OE}/V_{PP}$ (20)	V_{CC} (24)	Outputs (9~11, 13~17)
Read	V_{IL}	V_{IL}	+5	Dout
Stand by	V_{IH}	Don't Care	+5	High Z
Program	V_{IL}	V_{PP}	+5	Din
Program Verify	V_{IL}	V_{IL}	+5	Dout
Program Inhibit	V_{IH}	V_{PP}	+5	High Z

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−65 to +125	°C
All Input and Output Voltage*	V_T	−0.3 to +7	V
V_{PP} Voltage*	$\overline{OE}/V_{PP}$	−0.3 to +28	V

* With respect to GND

■ READ OPERATION

● DC AND OPERATING CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±5%, $V_{PP}=V_{CC}$±0.6V)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Input Leakage Current (Except $\overline{OE}/V_{PP}$)	I_{LI1}	V_{IN}=5.25V	—	—	10	μA
$\overline{OE}/V_{PP}$ Input Leakage Current	I_{LI2}	V_{IN}=5.25V	—	—	10	μA
Output Leakage Current	I_{LO}	V_{out}=5.25V	—	—	10	μA
V_{CC} Current (Standby)	I_{CC1}	$\overline{CE}=V_{IH}$, $\overline{OE}=V_{IL}$	—	—	30	mA
V_{CC} Current (Active)	I_{CC2}	$\overline{OE}=\overline{CE}=V_{IL}$	—	—	150	mA
Input Low Voltage	V_{IL}		−0.1	—	0.8	V
Input High Voltage	V_{IH}		2.0	—	V_{CC}+1	V
Output Low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.45	V
Output High Voltage	V_{OH}	I_{OH}=−400μA	2.4	—	—	V

● AC CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±5%, $V_{PP}=V_{CC}$±0.6V)

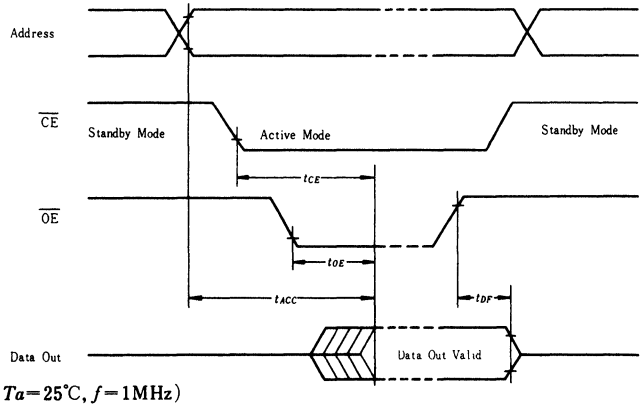
Parameter	Symbol	Test Condition	min	typ	max	Unit
Address to Output Delay	t_{ACC}	$\overline{CE}=\overline{OE}=V_{IL}$	—	—	450	ns
$\overline{CE}$ to Output Delay	t_{CE}	$\overline{OE}=V_{IL}$	—	—	450	ns
Output Enable to Output Delay	t_{OE}	$\overline{CE}=V_{IL}$	—	—	120	ns
Output Enable High to Output Float *	t_{DF}	$\overline{CE}=V_{IL}$	0	—	100	ns
Address to Output Hold	t_{OH}	$\overline{CE}=\overline{OE}=V_{IL}$	0	—	—	ns

* t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

● SWITCHING CHARACTERISTICS

Test Condition

Input Pulse Levels: 0.8V to 2.2V
Input Rise and Fall Times: ≤ 20ns
Output Load: 1TTL Gate + 100pF
Reference Level for Measuring Timing: Inputs 1V and 2V
Outputs 0.8V and 2V



● CAPACITANCE (Ta=25°C, f=1MHz)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Input Capacitance (Except $\overline{OE}/V_{PP}$)	C_{IN1}	V_{IN}=0V	—	—	6	pF
$\overline{OE}/V_{PP}$ Input Capacitance	C_{IN2}	V_{IN}=0V	—	—	20	pF
Output Capacitance	C_{out}	V_{out}=0V	—	—	12	pF

■ PROGRAMMING OPERATION

● DC PROGRAMMING CHARACTERISTICS (V_{CC} = 5V ± 5%, V_{PP} = 25V ± 1V, Ta = 25°C ± 5°C)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Input Leakage Current	I_{LI}	V_{IN} = 5.25V/0.4V	—	—	10	μA
Output Low Voltage During Verify	V_{OL}	I_{OL} = 2.1mA	—	—	0.4	V
Output High Voltage During Verify	V_{OH}	I_{OH} = −400μA	2.4	—	—	V
V_{CC} Supply Current	I_{CC}		—	—	150	mA
Input Low Level	V_{IL}		−0.1	—	0.8	V
Input High Level (All Input Except $\overline{OE}/V_{PP}$)	V_{IH}		2.0	—	V_{CC}+1	V
V_{PP} Supply Current	I_{PP}	$\overline{CE} = V_{IL}$, $\overline{OE} = V_{PP}$	—	—	30	mA

● AC PROGRAMMING CHARACTERISTICS (V_{CC} = 5V ± 5%, V_{PP} = 25V ± 1V, Ta = 25°C ± 5°C)

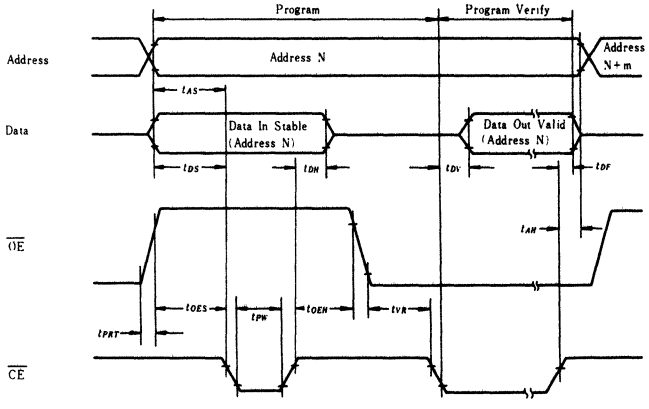
Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Address Setup Time	t_{AS}		2	—	—	μs
$\overline{OE}$ Setup Time	t_{OES}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		0	—	—	μs
$\overline{OE}$ Hold Time	t_{OEH}		2	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
Chip Enable to Output Float Delay*	t_{DF}		0	—	120	ns
Data Valid from $\overline{CE}$	t_{DV}	$\overline{CE} = V_{IL}$, $\overline{OE} = V_{IL}$	—	—	1	μs
$\overline{CE}$ Pulse Width During Programming	t_{PW}		45	50	55	ms
$\overline{OE}$ Pulse Rise Time During Programming	t_{PRT}		50	—	—	ns
V_{PP} Recovery Time	t_{VR}		2	—	—	μs

* t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

● SWITCHING CHARACTERISTICS

Test Conditions

Input Pulse Level:	0.8V to 2.2V
Input Rise and Fall Times:	≤ 20ns
Output Load:	1TTL Gate + 100pF
Reference Level for Measuring Timing:	Inputs; 1V and 2V, Outputs; 0.8V and 2V



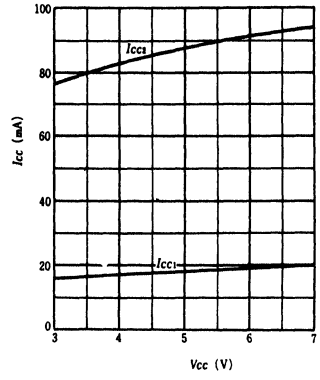
● ERASE

Erasure of HN462732 is performed by exposure to Ultraviolet light of 2537Å, and all the output data are changed to "1" after this prosedure.

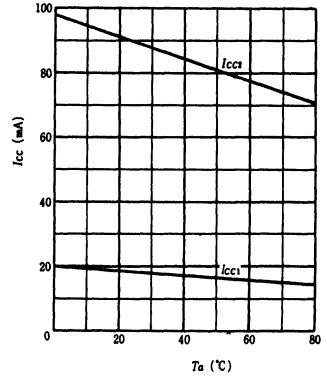
The minimum integrated close (i.e., UV intensity x exposure time) for erasure is 15W • sec/cm².

NOTE THAT THE HN462743P CANNOT BE ERASED.

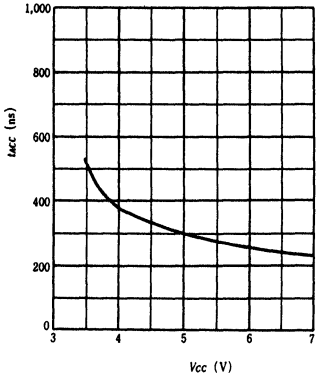
SUPPLY CURRENT vs. SUPPLY VOLTAGE



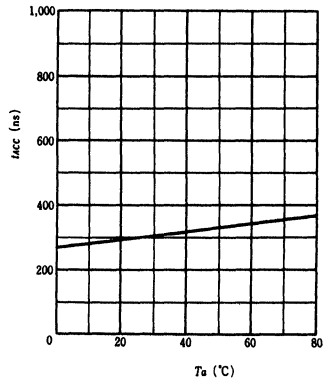
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



ACCESS TIME vs. SUPPLY VOLTAGE



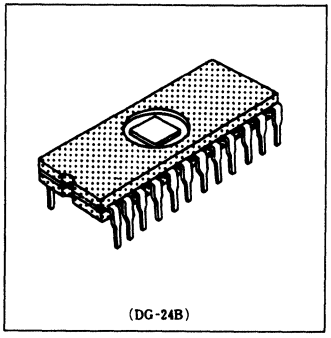
ACCESS TIME vs. AMBIENT TEMPERATURE



HN462732GI ——————Wide Operating Temperature Range

4096-word × 8-bit U.V. Erasable and Programmable Read Only Memory

The HN462732GI is a 4096 word by 8 bit erasable and electrically programmable ROM. This device is packaged in a 24-pin, dual-in-line package with transparent lid. The transparent lid allows the user to expose the chip to ultraviolet light to erase the bit pattern, whereby a new pattern can then be written into the device.

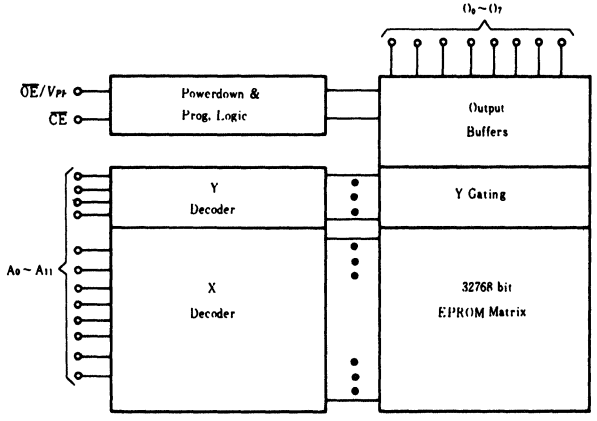


(DG-24B)

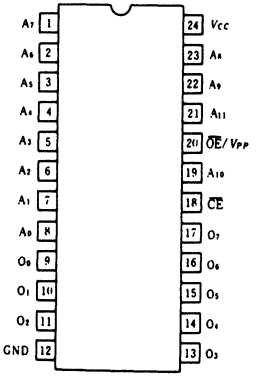
■ FEATURES

- Extended Operating Temperature Range . . . . . −40 ~ +85°C
- Single Power Supply . . . . . +5V ±5%
- Simple Programming . . . . . Program Voltage: +25V D.C.
  Program with One 50ms Pulse
- Static . . . . . No Clocks Required
- Inputs and Outputs TTL Compatible During Both Read and Program Modes
- Fully Decoded On-Chip Address Decode
- Access Time . . . . . 450ns (max)
- Low Power Dissipation . . . . 150mA (max) Active Currents
  30mA (max) Standby Current
- Three State Output . . . . . OR-Tie-Capability

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ MODE SELECTION

Mode \ Pins	$\overline{CE}$ (18)	$\overline{OE}/V_{PP}$ (20)	V_{CC} (24)	Outputs (9~11, 13~17)
Read	V_{IL}	V_{IL}	+5	Dout
Stand by	V_{IH}	Don't Care	+5	High Z
Program	V_{IL}	V_{PP}	+5	Din
Program Verify	V_{IL}	V_{IL}	+5	Dout
Program Inhibit	V_{IH}	V_{PP}	+5	High Z

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Operating Temperature Range	T_{opr}	−40 to +85	°C
Storage Temperature Range	T_{stg}	−65 to +125	°C
All Input and Output Voltage*	V_T	−0.3 to +7	V
V_{PP} Voltage*	$\overline{OE}/V_{PP}$	−0.3 to +28	V

* With respect to GND

■ READ OPERATION

● DC AND OPERATING CHARACTERISTICS (Ta = −40 to + 85°C, V_{CC}=5V ±5%,)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Input Leakage Current (Except $\overline{OE}/V_{PP}$)	I_{LI1}	V_{IN}=5.25V	—	—	10	μA
$\overline{OE}/V_{PP}$ Input Leakage Current	I_{LI2}	V_{IN}=5.25V	—	—	10	μA
Output Leakage Current	I_{LO}	V_{out} = 5.25V/0.45V	—	—	10	μA
V_{CC} Current (Standby)	I_{CC1}	$\overline{CE}=V_{IH}$, $\overline{OE}=V_{IL}$	—	—	30	mA
V_{CC} Current (Active)	I_{CC2}	$\overline{OE}=\overline{CE}=V_{IL}$	—	—	150	mA
Input Low Voltage	V_{IL}		−0.1	—	0.8	V
Input High Voltage	V_{IH}		2.0	—	V_{CC}+1	V
Output Low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.45	V
Output High Voltage	V_{OH}	I_{OH}=−400μA	2.4	—	—	V

● AC CHARACTERISTICS (Ta = −40 to +85°C, V_{CC} = 5V ±5%)

Parameter	Symbol	Test Condition	HN462732GI			Unit
			min.	typ.	max.	
Address to Output Delay	t_{ACC}	$\overline{CE}=\overline{OE}=V_{IL}$	—	—	450	ns
$\overline{CE}$ to Output Delay	t_{CE}	$\overline{OE}=V_{IL}$	—	—	450	ns
Output Enable to Output Delay	t_{OE}	$\overline{CE}=V_{IL}$	—	—	150	ns
Output Enable High to Output Float*	t_{DF}	$\overline{CE}=V_{IL}$	0	—	130	ns
Address to Output Hold	t_{OH}	$\overline{CE}=\overline{OE}=V_{IL}$	0	—	—	ns

* t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

● SWITCHING CHARACTERISTICS

Test Condition

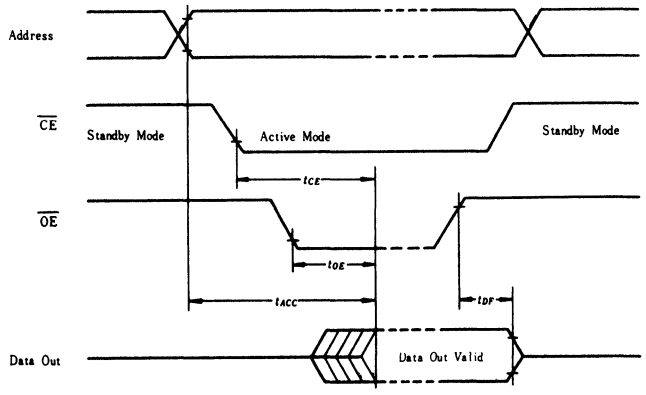
Input Pulse Levels: 0.8V to 2.2V

Input Rise and Fall Times: ≤ 20ns

Output Load: 1TTL Gate + 100pF

Reference Level for Measuring Timing: Inputs 1V and 2V

Outputs 0.8V and 2V



● CAPACITANCE (Ta=25°C, f=1MHz)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Input Capacitance (Except $\overline{OE}/V_{PP}$)	C_{IN1}	V_{IN}=0V	—	—	6	pF
$\overline{OE}/V_{PP}$ Input Capacitance	C_{IN2}	V_{IN}=0V	—	—	20	pF
Output Capacitance	C_{out}	V_{out}=0V	—	—	12	pF

■ PROGRAMMING OPERATION

● DC PROGRAMMING CHARACTERISTICS (V_{CC}=5V±5%, V_{PP}=25V±1V, Ta=25°C±5°C)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Input Leakage Current	I_{LI}	V_{IN}=5.25V/0.4V	—	—	10	μA
Output Low Voltage During Verify	V_{OL}	I_{OL}=2.1mA	—	—	0.4	V
Output High Voltage During Verify	V_{OH}	I_{OH}=−400μA	2.4	—	—	V
V_{CC} Supply Current	I_{CC}		—	—	150	mA
Input Low Level	V_{IL}		−0.1	—	0.8	V
Input High Level (All Input Except $\overline{OE}/V_{PP}$)	V_{IH}		2.0	—	V_{CC}+1	V
V_{PP} Supply Current	I_{PP}	$\overline{CE}=V_{IL}$, $\overline{OE}=V_{PP}$	—	—	30	mA

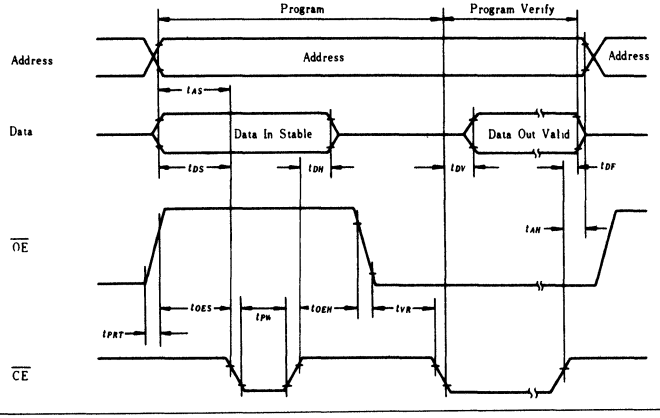
● AC PROGRAMMING CHARACTERISTICS (V_{CC}=5V±5%, V_{PP}=25V±1V, Ta=25°C±5°C)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Address Setup Time	t_{AS}		2	—	—	μs
$\overline{OE}$ Setup Time	t_{OES}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		0	—	—	μs
$\overline{OE}$ Hold Time	t_{OEH}		2	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
Chip Enable to Output Float Delay*	t_{DF}		0	—	120	ns
Data Valid from $\overline{CE}$	t_{DV}	$\overline{CE}=V_{IL}$, $\overline{OE}=V_{IL}$	—	—	1	μs
$\overline{CE}$ Pulse Width During Programming	t_{PW}		45	50	55	ms
$\overline{OE}$ Pulse Rise Time During Programming	t_{PRT}		50	—	—	ns
V_{PP} Recovery Time	t_{VR}		2	—	—	μs

* t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

● SWITCHING CHARACTERISTICS

Test Conditions
Input Pulse Levels: 0.8V to 2.2V
Input Rise and Fall Times: ≤20ns
Output Load: 1TTL Gate + 100pF
Reference Level for Measuring Timing: Input; 1V and 2V
Outputs; 0.8V and 2V



● ERASE

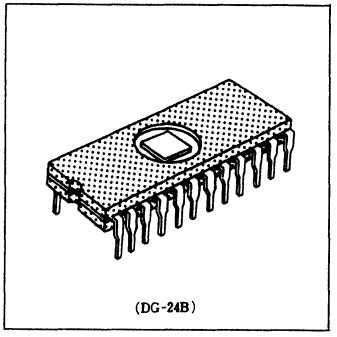
Erasure of HN462732 is performed by exposure to Ultraviolet light of 2537A, and all the output data are changed to "1" after this prosedure.
The minimum integrated close (i.e., UV intensity x exposure time) for erasure is 15W · sec/cm^2.

HN482732AG-20, HN482732AG-25, HN482732AG-30

4096-word × 8-bit U. V. Erasable and Programmable Read Only Memory

The HN482732A is a 4096-word by 8-bit erasable and electrically programmable ROM. This device is packaged in a 24 pin dual-in-line package with transparent lid.

The transparent lid on the package allow the memory content to be erased with ultraviolet light.

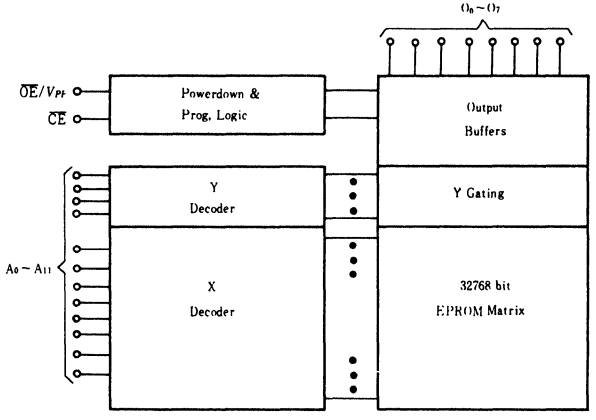


(DG-24B)

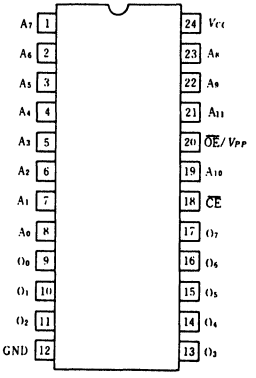
■ FEATURES

- Single Power Supply ..... +5V ±5%
- Simple Programming ..... Program Voltage: +21V D.C
  Program with one 50ms Pulse
- Static..... No clocks Required
- Inputs and Outputs TTL Compatible During Both Read and Program Mode
- Access Time ..... HN482732AG-20 200ns (max)
  HN482732AG-25 250ns (max)
  HN482732AG-30 300ns (max)
- Absolute Max. Rating of Vpp Pin ... 26.5V
- Low Stand-by Current ..... 35mA (max)
- Compatible with Intel 2732A

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ MODE SELECTION

MODE \ Pins	CE (18)	OE/VPP (20)	Vcc (24)	Outputs (9~11, 13~17)
Read	V_{IL}	V_{IL}	+5	D_{out}
Stand by	V_{IH}	Don't Care	+5	High Z
Program	V_{IL}	V_{PP}	+5	D_{in}
Program Verify	V_{IL}	V_{IL}	+5	D_{out}
Program Inhibit	V_{IH}	V_{PP}	+5	High Z

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−65 to +125	°C
All Input and Output Voltages*	V_{in}, V_{out}	−0.3 to +7	V
V_{PP} Voltage*	$\overline{OE}/V_{PP}$	−0.3 to +26.5	V
V_{CC} Voltage*	V_{CC}	−0.3 to +7	V

* with respect to GND

■ READ OPERATION

● D.C. AND OPERATING CHARACTERISTICS (Ta=0 to 70°C, V_{CC}=5V±5%)

Parameter	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{IN}=5.25V	—	—	10	μA
Output Leakage Current	I_{LO}	V_{out}=5.25V	—	—	10	μA
V_{CC} Current (Standby)	I_{CC1}	$\overline{CE}=V_{IH}$, $\overline{OE}=V_{IL}$	—	—	35	mA
V_{CC} Current (Active)	I_{CC2}	$\overline{OE}=\overline{CE}=V_{IL}$	—	—	150	mA
Input Low Voltage	V_{IL}		−0.1	—	0.8	V
Input High Voltage	V_{IH}		2.0	—	V_{CC}+1	V
Output Low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.45	V
Output High Voltage	V_{OH}	I_{OH}=−400μA	2.4	—	—	V

● AC CHARACTERISTICS (Ta=0 to 70°C, V_{CC}=5V±5%)

Parameter	Symbol	Test Conditions	HN482732AG-20		HN482732AG-25		HN482732AG-30		Unit
			min	max	min	max	min	max	
Address to Output Delay	t_{ACC}	$\overline{CE}=\overline{OE}=V_{IL}$	—	200	—	250	—	300	ns
$\overline{CE}$ to Output Delay	t_{CE}	$\overline{OE}=V_{IL}$	—	200	—	250	—	300	ns
$\overline{OE}$ to Output Delay	t_{OE}	$\overline{CE}=V_{IL}$	10	90	10	100	10	150	ns
$\overline{OE}$ High to Output Float	t_{DF}	$\overline{CE}=V_{IL}$	0	80	0	90	0	130	ns
Address to Output Hold	t_{OH}	$\overline{CE}=\overline{OE}=V_{IL}$	0	—	0	—	0	—	ns

● SWITCHING CHARACTERISTICS

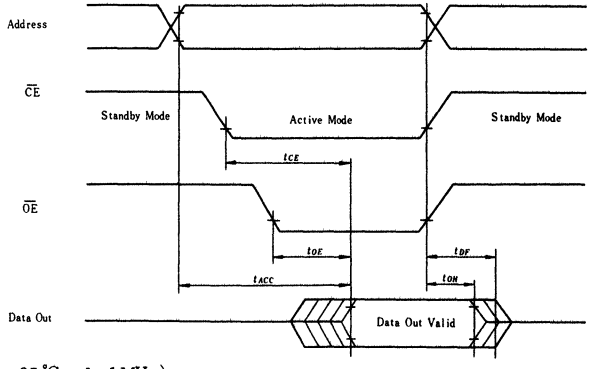
Test Conditions

Input Pulse Level: . . . . . 0.8V to 2.2V

Input Rise and Fall Times: . . . . . ≦ 20ns

Output Load: . . . . . 1 TTL Gate + 100PF

Reference Level for Measuring Timing . . . . . Inputs, 1V and 2V, Outputs; 0.8V and 2V



● CAPACITANCE (Ta=25°C, f=1MHz)

Parameter	Symbol	Test Conditions	min	typ	max	Unit
Input Capacitance (Except $\overline{OE}/V_{PP}$)	C_{IN1}	V_{IN}=0V	—	—	6	pF
$\overline{OE}/V_{PP}$ Input Capacitance	C_{IN2}	V_{IN}=0V	—	—	20	pF
Output Capacitance	C_{out}	V_{out}=0V	—	—	12	pF

■ PROGRAMMING OPERATION

● DC PROGRAMMING CHARACTERISTICS (Ta=25℃±5℃, V_{CC}=5V±5%, V_{PP}=21V±0.5V)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	$V_{IN}=V_{IL}$ or V_{IH}	—	—	10	μA
Output Low Voltage During Verify	V_{OL}	I_{OL}=2.1mA	—	—	0.4	V
Output High Voltage During Verify	V_{OH}	I_{OH}=−400μA	2.4	—	—	V
V_{CC} Supply Current	I_{CC}		—	—	150	mA
Input Low Level	V_{IL}		−0.1	—	0.8	V
Input High Level (All Inputs Except $\overline{OE}/V_{PP}$)	V_{IH}		2.0	—	V_{CC}+1	V
V_{PP} Supply Current	I_{PP}	$\overline{CE}=V_{IL}$, $\overline{OE}=V_{PP}$	—	—	30	mA

● AC PROGRAMMING CHARACTERISTICS (Ta=25℃±5℃, V_{CC}=5V±5%, V_{PP}=21V±0.5V)

Parameter	Symbol	Test Conditions	min	typ	max	Unit
Address Setup Time	t_{AS}		2	—	—	μs
$\overline{OE}$ Setup Time	t_{OES}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		0	—	—	μs
$\overline{OE}$ Hold Time	t_{OEH}		2	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
Chip Enable to Output Float Delay*	t_{DF}		0	—	130	ns
Data Valid from $\overline{CE}$	t_{DV}	$\overline{CE}=V_{IL}$, $\overline{OE}=V_{IL}$	—	—	1	μs
$\overline{CE}$ Pulse Width During Programming	t_{PW}		45	50	55	ms
$\overline{OE}$ Pulse Rise Time During Programming	t_{PRT}		50	—	—	ns
V_{PP} Recovery Time	t_{VR}		2	—	—	μs

* t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

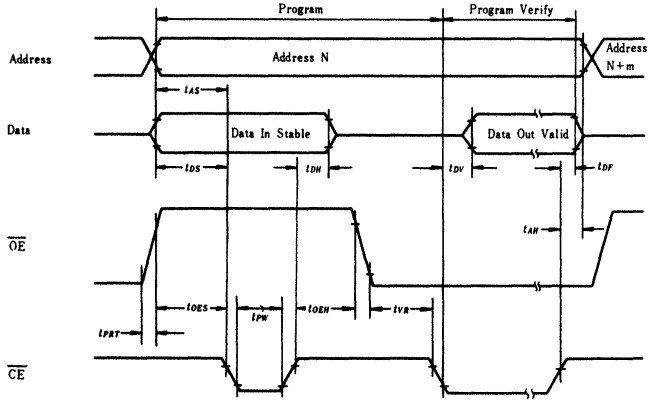
● SWITCHING CHARACTERISTICS

Test Condition

Input Pulse Level . . . . . 0.8V to 2.2V

Input Rise and Fall Time . . . . . ≤ 20ns

Reference Level for Measuring Timing: . . . . . Inputs 1V and 2V; Outputs 0.8V and 2V



● ERASE

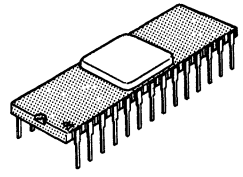
Erasure of HN482732A is performed by exposure to ultraviolet light of 2537Å and all the output data are changed to "1" after this erasure procedure. The minimum integrated dose (i.e. UV intensity x exposure time) for erasure is 15W-sec/cm^2

HN482764, HN482764-3, HN482764-4, HN482764G, HN482764G-3, HN482764G-4

8192-word × 8-bit U. V. Erasable and Programmable Read Only Memory

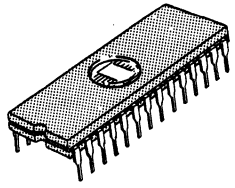
The HN482764 is a 8192 word by 8 bit erasable and electrically programmable ROM. This device is packaged in a 28 pin dual-in-line package with transparent lid. The transparent lid on the package allows the memory content to be erased with ultraviolet light.

HN482764, HN482764-3, HN482764-4



(DC-28B)

HN482764G, HN482764G-3, HN482764G-4

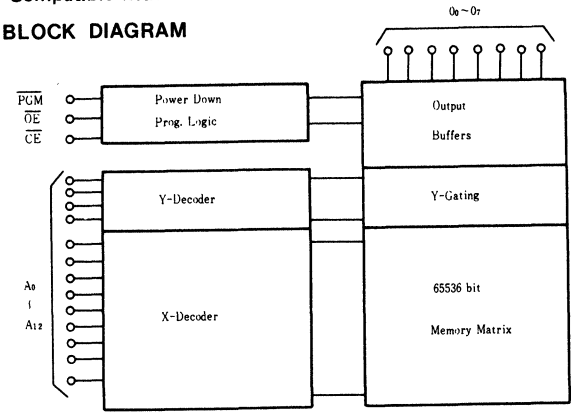


(DG-28)

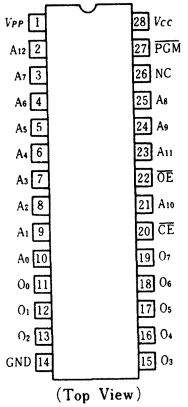
■ FEATURES

- Single Power Supply . . . . . +5V ± 5%
- Simple Programming . . . . . Program Voltage: +21V D.C.
  Program with one 50ms Pulse
- Static . . . . . No Clocks Required
- Inputs and Outputs TTL Compatible During Both Read and Program Mode.
- Access Time . . . . . HN482764/G 250ns max
  HN482764/G-3 300ns max
  HN482764/G-4 450ns max
- High Performance Programming Available
- Low Standby Current . . . . . 35mA max.
- Compatible with Intel 2764

■ BLOCK DIAGRAM



■ PIN ARRANGMENT



(Top View)

■ MODE SELECTION

Mode \ Pins	$\overline{CE}$ (20)	$\overline{OE}$ (22)	$\overline{PGM}$ (27)	V_{PP} (1)	V_{CC} (28)	Outputs (11~13, 15~19)
Read	V_{IL}	V_{IL}	V_{IH}	V_{CC}	V_{CC}	Dout
Stand-by	V_{IH}	×	×	V_{CC}	V_{CC}	High Z
Program	V_{IL}	×	V_{IL}	V_{PP}	V_{CC}	Din
Program Verify	V_{IL}	V_{IL}	V_{IH}	V_{PP}	V_{CC}	Dout
Program Inhibit	V_{IH}	×	×	V_{PP}	V_{CC}	High Z

× : don't care

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−65 to +125	°C
All Input and Output Voltage*	V_T	−0.3 to +7	V
V_{PP} Voltage	V_{PP}	−0.3 to +26.5	V

* : with respect to GND

HITACHI

■ READ OPERATION

● DC AND OPERATING CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{CC}=5.25V, V_{in}=5.25V	—	—	10	μA
Output Leakage Current	I_{LO}	V_{CC}=5.25V, V_{out}=5.25V/0.4V	—	—	10	μA
V_{PP} Current	I_{PP1}	V_{PP}=V_{CC}+0.6V	—	—	15	mA
V_{CC} Current (Standby)	I_{CC1}	$\overline{CE}$=V_{IH}	—	—	35	mA
V_{CC} Current (Active)	I_{CC2}	$\overline{CE}$=$\overline{OE}$=V_{IL}	—	100	150	mA
Input Low Voltage	V_{IL}		−0.1	—	0.8	V
Input High Voltage	V_{IH}		2.0	—	V_{CC}+1	V
Output Low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.45	V
Output High Voltage	V_{OH}	I_{OH}=−400μA	2.4	—	—	V

● AC CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V)

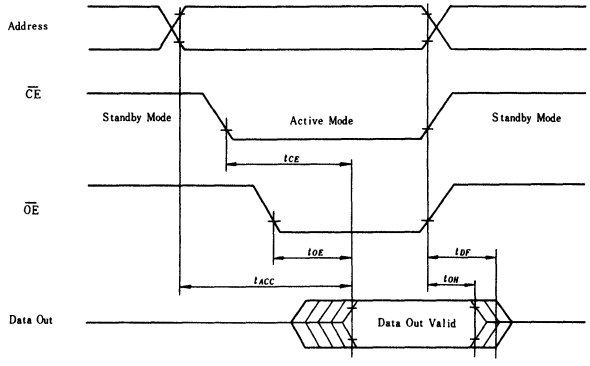
Parameter	Symbol	Test Conditions	HN482764/G		HN482764/G-3		HN482764/G-4		Unit
			min	max	min	max	min	max	
Address to Output Delay	t_{ACC}	$\overline{CE}$=$\overline{OE}$=V_{IL}	—	250	—	300	—	450	ns
$\overline{CE}$ to Output Delay	t_{CE}	$\overline{OE}$=V_{IL}	—	250	—	300	—	450	ns
$\overline{OE}$ to Output Delay	t_{OE}	$\overline{CE}$=V_{IL}	10	100	10	150	10	150	ns
$\overline{OE}$ High to Output Float	t_{DF}	$\overline{CE}$=V_{IL}	0	90	0	130	0	130	ns
Address to Output Hold	t_{OH}	$\overline{CE}$=$\overline{OE}$=V_{IL}	0	—	0	—	0	—	ns

Note : t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

● SWITCHING CHARACTERISTICS

Test Condition

Input Pulse Levels:	0.8V to 2.2V
Input Rise and Fall Time:	≤ 20ns
Output Load:	1TTL Gate + 100pF
Reference Level for Measuring Timing:	Inputs; 1V and 2V Output; 0.8V and 2.0V



● CAPACITANCE (Ta=25°C, f=1MHz)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	—	4	6	pF
Output Capacitance	C_{out}	V_{out}=0V	—	8	12	pF

■ PROGRAMMING OPERATION

● DC PROGRAMMING CHARACTERISTICS (Ta=25℃±5℃, V_{CC}=5V±5%, V_{PP}=21V±0.5V)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{IN}=5.25V	—	—	10	μA
Output Low Voltage During Verify	V_{OL}	I_{OL}=2.1mA	—	—	0.45	V
Output High Voltage During Verify	V_{OH}	I_{OH}=−400μA	2.4	—	—	V
V_{CC} Current (Active)	I_{CC2}		—	—	150	mA
Input Low Level	V_{IL}		−0.1	—	0.8	V
Input High Level	V_{IH}		2.0	—	V_{CC}+1	V
V_{PP} Supply Current	I_{PP}	$\overline{CE}$=$\overline{PGM}$=V_{IL}	—	—	30	mA

● AC PROGRAMMING CHARACTERISTICS (Ta=25℃±5℃, V_{CC}=5V±5%, V_{PP}=21V±0.5V)

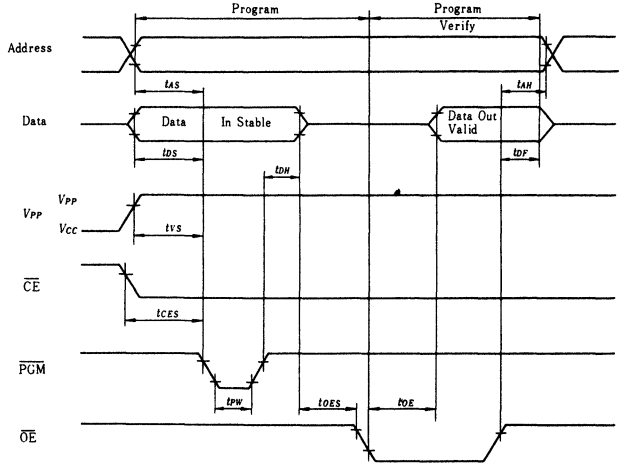
Parameter	Symbol	Test Condition	min	typ	max	Unit
Address Setup Time	t_{AS}		2	—	—	μs
$\overline{OE}$ Setup Time	t_{OES}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		0	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
$\overline{OE}$ to Output Float Delay	t_{DF}		0	—	130	ns
V_{PP} Setup Time	t_{VS}		2	—	—	μs
$\overline{PGM}$ Pulse Width During Programming	t_{PW}		45	50	55	ms
$\overline{CE}$ Setup Time	t_{CES}		2	—	—	μs
Data Valid from $\overline{OE}$	t_{OE}		—	—	150	ns

Note : t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

● SWITCHING CHARACTERISTICS

Test Condition

Input Pulse Level:	0.8V to 2.2V
Input Rise and Fall Time:	≤ 20 ns
Reference Level for Measuring Timing:	Input; 1V and 2V Output; 0.8V and 2V

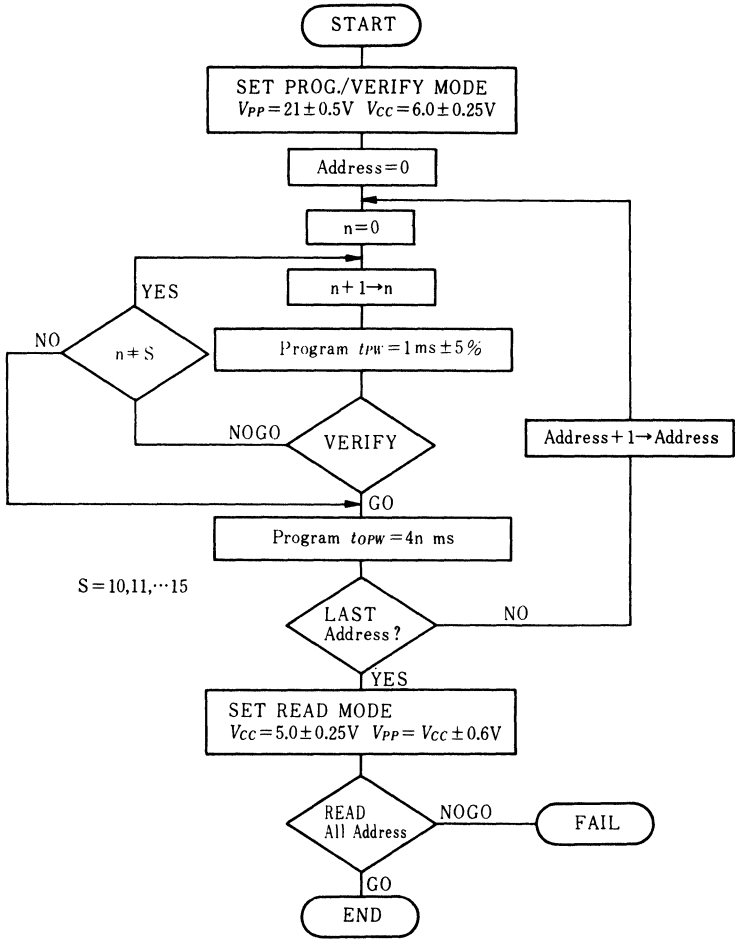


■ ERASE

Erasure of HN482764 is performed by exposure to Ultraviolet light of 2537Å, and all the output data are changed to "1" after this erasure procedure. The minimum integrated dose (i.e. UV intensity x exposure time) for erasure is 15W • sec/cm²

■ HIGH PERFOMANCE PROGRAMMING

This device can be applied the High Performance Programming algorithm shown in following flowchart. This algorithm allows to obtain faster programming time without any voltage stress to the device nor deterioration in reliability of programmed data.



High Performance Programming Flowchart

● AC PROGRAMMING CHARACTERISTICS (Ta=25℃±5℃, V_{CC}=6V±0.25V, V_{PP}=21V±0.5V)

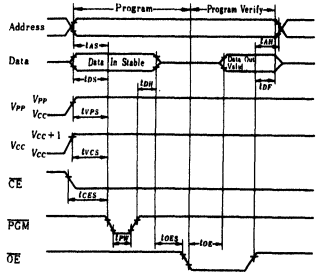
Parameter	Symbol	Test Condition	min	typ	max	Unit
Address Setup Time	t_{AS}		2	—	—	μs
$\overline{OE}$ Setup Time	t_{OES}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		0	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
$\overline{OE}$ to Output Float Delay*	t_{DF}		0	—	130	ns
V_{PP} Setup Time	t_{VPS}		2	—	—	μs
V_{CC} Setup Time	t_{VCS}		2	—	—	μs
$\overline{PGM}$ Pulse Width during Initial Program	t_{PW}		0.95	1.0	1.05	ms
$\overline{PGM}$ Pulse Width during Over Program**	t_{OPW}		3.8	—	63	ms
$\overline{CE}$ Setup Time	t_{CES}		2	—	—	μs
Data Valid from $\overline{OE}$	t_{OE}		—	—	150	ns

Notes) * t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
** t_{OPW} is defined as mentioned in flort chart.

● SWITCHING CHARACTERISTICS

Test Condition

Input Pulse Level:	0.8V to 2.2V
Input Rise and Fall Time:	≤ 20 ns
Reference Level for Measuring Timing:	Input; 1V and 2V Output; 0.8V and 2V

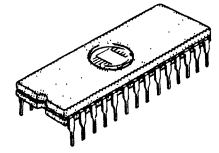


HN27C64G-20
HN27C64G-25, HN27C64G-30

8192-word X 8-bit UV Erasable and Programmable Read Only Memory

The HN27C64G is a 8192 word by 8-bit erasable and electrically programmable ROM. This device is packaged in a 28 pin dual-in-line package with transparent lid. The transparent lid on the package allows the memory content to be erased with ultraviolet light.

HN27C64G-20,
HN27C64G-25, HN27C64G-30

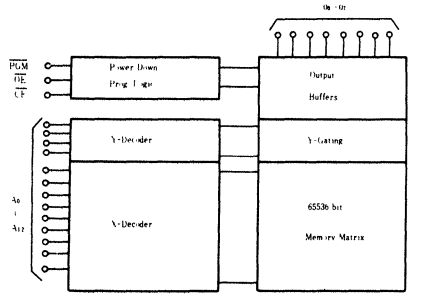


(DG-28)

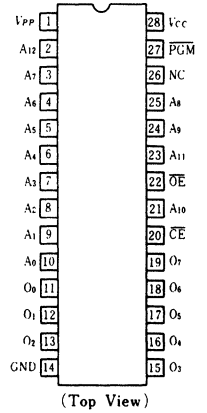
■ FEATURES

- Single Power Supply ..... +5V ± 5%
- Simple Programming ..... Program Voltage: +21V D.C.
  Program with one 50ms Pulse
- Static ..... No clocks Required
- Inputs and Outputs TTL Compatible During Both Read and Program Mode.
- Access Time ..... HN27C64G-20 200ns Max.
  HN27C64G-25 250ns Max.
  HN27C64G-30 300ns Max.
- High Performance Programming Available
- Low Power Dissipation ..... 40mW/MHz (Active Mode)
  525μW Max. (Stand-by Mode)

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ MODE SELECTION

Mode \ Pins	$\overline{CE}$ (20)	$\overline{OE}$ (22)	$\overline{PGM}$ (27)	V_{PP} (1)	V_{CC} (28)	Outputs (11~13, 15~19)
Read	V_{IL}	V_{IL}	V_{IH}	V_{CC}	V_{CC}	Dout
Stand-by	V_{IH}	X	X	V_{CC}	V_{CC}	High Z
Program	V_{IL}	X	V_{IL}	V_{PP}	V_{CC}	Din
Program Verify	V_{IL}	V_{IL}	V_{IH}	V_{PP}	V_{CC}	Dout
Program Inhibit	V_{IH}	X	X	V_{PP}	V_{CC}	High Z

X : don't care

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−65 to +125	°C
All Input and Output Voltage*	V_{in}, V_{out}	−0.6 to +7.0	V
V_{PP} Voltage	V_{PP}	−0.6 to +25	V
V_{CC} Voltage*	V_{CC}	−0.6 to +7.0	V

* : with respect to GND

■ READ OPERATION

• DC AND OPERATING CHARACTERISTICS (Ta = 0 to +70° C, V_{CC} = 5V ± 5%, V_{PP} = V_{CC} ± 0.6V)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{CC} = 5.25V, V_{in} = GND to V_{CC}	-	-	2	μA
Output Leakage Current	I_{LO}	V_{CC} = 5.25V, V_{out} = GND to V_{CC}	-	-	2	μA
V_{PP} Current	I_{PP1}	V_{PP} = V_{CC} + 0.6V	-	1	100	μA
V_{CC} Current (Standby-1)	I_{SB1}	$\overline{CE}$ = V_{IH}	-	-	1	mA
V_{CC} Current (Standby-2)	I_{SB2}	$\overline{CE}$ = V_{CC} ± 0.3V	-	1	100	μA
V_{CC} Current (Active-1)	I_{CC1}	$\overline{CE}$ = V_{IL}, V_{out} = OmA	-	-	30	mA
V_{CC} Current (Active-2)	I_{CC2}	f = 5MHz, I_{out} = OmA	-	-	30	mA
Input Low Voltage	V_{IL}		-0.1	-	0.8	V
Input High Voltage	V_{IH}		2.0	-	V_{CC} + 0.3V	V
Output Low Voltage	V_{OL}	I_{OL} = 2.1mA	-	-	0.45	V
Output High Voltage	V_{OH}	I_{OH} = −400μA	2.4	-	-	V

• AC CHARACTERISTICS (Ta = 0 to +70° C, V_{cc} = 5V ± 5%, V_{PP} = V_{CC} ± 0.6V)

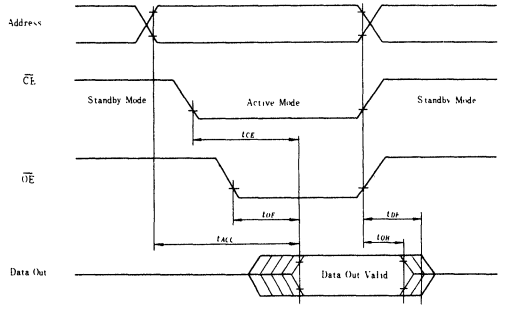
Parameter	Symbol	Test Conditions	HN27C64-20		HN27C64-25		HN27C64-30		Unit
			min	max	min	max	min	max	
Address to Output Delay	t_{ACC}	$\overline{CE}$ = $\overline{OE}$ = V_{IL} $\overline{PGM}$ = V_{IH}	-	200	-	250	-	300	ns
$\overline{CE}$ to Output Delay	t_{CE}	$\overline{OE}$ = V_{IL} $\overline{PGM}$ = V_{IH}	-	200	-	250	-	300	ns
$\overline{OE}$ to Output Delay	t_{OE}	$\overline{CE}$ = V_{IL}	10	70	10	100	10	150	ns
$\overline{OE}$ High to Output Float	t_{DF}	$\overline{CE}$ = V_{IL}	0	60	0	90	0	130	ns
Address to Output Hold	t_{OH}	$\overline{CE}$ = $\overline{OE}$ = V_{IL} $\overline{PGM}$ = V_{IH}	0	-	0	-	0	-	ns

Note : t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

• SWITCHING CHARACTERISTICS

Test Condition

Input Pulse Levels:	0.8V to 2.2V
Input Rise and Fall Time:	≤ 20 ns
Output Load:	1TTL Gate + 100pF
Reference Level for Measuring Timing:	Input; 1V and 2V
	Output; 0.8V and 2V



• CAPACITANCE (Ta = 25° C, f = 1MHz)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}	V_{in} = 0V	-	4	6	pF
Output Capacitance	C_{out}	V_{out} = 0V	-	8	12	pF

■ PROGRAMMING OPERATION

• DC PROGRAMMING CHARACTERISTICS ($Ta = 25°C \pm 5°C$, $V_{CC} = 5V \pm 5\%$, $V_{PP} = 21V \pm 0.5V$)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	$V_{in} = 5.25V/0.45V$	-	-	2	μA
Output Low Voltage During Verify	V_{OL}	$I_{OL} = 2.1mA$	-	-	0.45	V
Output High Voltage During Verify	V_{OH}	$I_{OH} = -400\ \mu A$	2.4	-	-	V
V_{CC} Current (Active)	I_{CC2}		-	-	30	mA
Input Low Level	V_{IL}		-0.1	-	0.8	V
Input High Level	V_{IH}		2.0	-	$V_{CC}+0.3$	V
V_{PP} Supply Current	I_{PP}	$\overline{CE} = \overline{PGM} = V_{IL}$	-	-	30	mA

NOTE:
1. V_{CC} must be applied before V_{PP} and removed after V_{PP}.
2. V_{PP} must not exceed 25V including overshoot.
3. An influence may be had upon device reliability if the device is installed or removed while $V_{PP} = 21V$.
4. Do not alter V_{PP} either V_{IL} to 21V or 21V to V_{IL} when CE = PGM = Low.

• AC PROGRAMMING CHARACTERISTICS ($Ta = 25°C \pm 5°C$, $V_{CC} = 5V \pm 5\%$, $V_{PP} = 21V \pm 0.5V$)

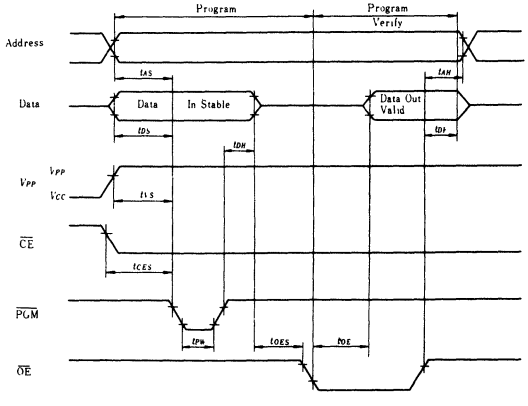
Parameter	Symbol	Test Condition	min	typ	max	Unit
Address Setup Time	t_{AS}		2	-	-	μs
$\overline{OE}$ Setup Time	t_{OES}		2	-	-	μs
Data Setup Time	t_{DS}		2	-	-	μs
Address Hold Time	t_{AH}		0	-	-	μs
Data Hold Time	t_{DH}		2	-	-	μs
$\overline{OE}$ to Output Float Delay*	t_{DF}		-	-	130	ns
V_{PP} Setup Time	t_{VS}		2	-	-	μs
$\overline{PGM}$ = Pulse Width During Programming	t_{PW}		25	50	55	ms
$\overline{CE}$ Setup Time	t_{CES}		2	-	-	μs
Data Valid from $\overline{OE}$	t_{OE}		-	-	150	ns

Note : t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

• SWITCHING CHARACTERISTICS

Test Condition

Input Pulse Level:	0.8V to 2.2V
Input Rise and Fall Time:	≤ 20 ns
Reference Level for Measuring Timing:	Input; 1V and 2V
	Output; 0.8V and 2V



■ ERASE

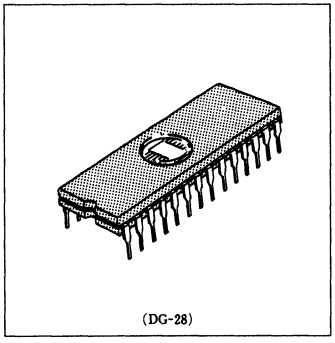
Erasure of HN27C64G is performed by exposure to Ultraviolet light of 2537Å, and all the output data are changed to "1" after this erasure procedure. The minimum integrated dose (i.e. UV intensity x exposure time) for erasure is 15W • sec/cm²

HN4827128G-25, HN4827128G-30, HN4827128G-45

Preliminary

16384-Word x 8-bit UV Erasable and Programmable Read Only Memory

The HN4827128 is a 16384 word by 8 bit erasable and electrically programmable ROM. This device is packaged in a dual-in-line package with transparent lid. The transparent lid allows the user to expose the chip to ultraviolet light to erase the bit pattern, whereby a new pattern can then be written into the device.

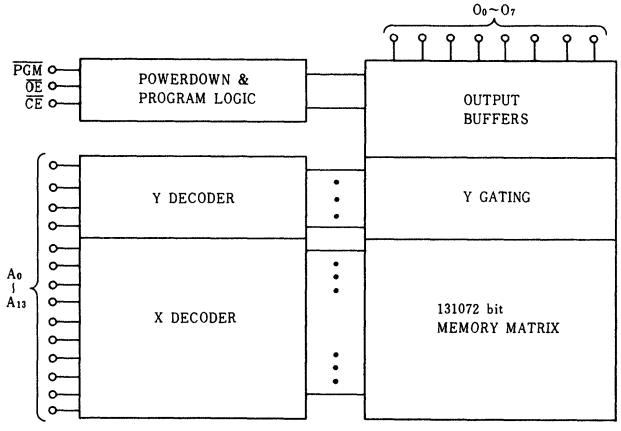


(DG-28)

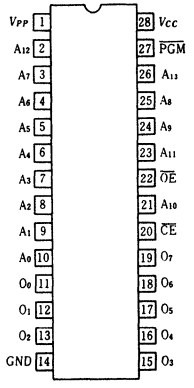
■FEATURES

- Single Power Supply ..... +5V ± 5%
- Simple Programming ..... Program Voltage: +21V DC
  Program with One 50ms Pulse
- Static ..... No Clocks Required
  Inputs and Outputs TTL Compatible During Both Read and Program Mode.
- Access Time 250ns/300ns/450ns
- Absolute Max. Rating of Vpp Pin 26.5V
- Low Stand-by Current 35mA
- High Performance Programming Available
- Compatible with INTEL 27128

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■MODE SELECTION

Pins / MODE	CE (20)	OE (22)	PGM (27)	V_{PP} (1)	V_{CC} (28)	Outputs (11~13, 15~19)
Read	V_{IL}	V_{IL}	V_{IH}	V_{CC}	V_{CC}	Dout
Stand by	V_{IH}	×	×	V_{CC}	V_{CC}	High Z
Program	V_{IL}	×	V_{IL}	V_{PP}	V_{CC}	Din
Program Verify	V_{IL}	V_{IL}	V_{IH}	V_{PP}	V_{CC}	Dout
Program Inhibit	V_{IH}	×	×	V_{PP}	V_{CC}	High Z

Note) The specifications of this device are subject to change without notice.
Please contact your nearest Hitachi's Sales Dept. regarding specifications.

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−65 to +125	°C
All Input and Output Voltages*	V_{IN}, V_{out}	−0.3 to +7	V
V_{PP} Voltage*	V_{PP}	−0.3 to +26.5	V
V_{CC} Voltage*	V_{CC}	−0.3 to +7	V

* with respect to GND

■READ OPERATION

●DC AND OPERATING CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V)

Parameter	Symbol	Test Conditions	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{CC}=5.25V, V_{IN}=5.25V	—	—	10	μA
Output Leakage Current	I_{LO}	V_{CC}=5.25V, V_{out}=5.25V/0.4V	—	—	10	μA
V_{PP} Current	I_{PP1}	V_{PP}=V_{CC}+0.6V	—	—	5	mA
V_{CC} Current (Standby)	I_{CC1}	$\overline{CE}$=V_{IH}	—	—	35	mA
V_{CC} Current (Active)	I_{CC2}	$\overline{CE}$=$\overline{OE}$=V_{IL}	—	60	100	mA
Input Low Voltage	V_{IL}		−0.1	—	0.8	V
Input High Voltage	V_{IH}		2.0	—	V_{CC}+1	V
Output Low Voltage	V_{OL}	I_{OL}=2.1mA	—	—	0.45	V
Output High Voltage	V_{OH}	I_{OH}=−400μA	2.4	—	—	V

●AC CHARACTERISTICS (Ta=0 to 70°C, V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V)

Parameter	Symbol	Test Condition	HN4827128G-25		HN4827128G-30		HN4827128G-45		Unit
			min	max	min	max	min	max	
Address to Output Delay	t_{ACC}	$\overline{CE}$=$\overline{OE}$=V_{IL}	—	250	—	300	—	450	ns
$\overline{CE}$ to Output Delay	t_{CE}	$\overline{OE}$=V_{IL}	—	250	—	300	—	450	ns
$\overline{OE}$ to Output Delay	t_{OE}	$\overline{CE}$=V_{IL}	—	100	—	120	—	150	ns
$\overline{OE}$ High to Output Float	t_{DF}	$\overline{CE}$=V_{IL}	0	85	0	105	0	130	ns
Address to Output Hold	t_{OH}	$\overline{CE}$=$\overline{OE}$=V_{IL}	0	—	0	—	0	—	ns

* t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

●SWITCHING CHARACTERISTICS

Test Condition

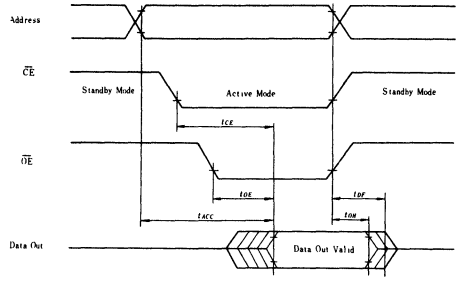
Input Pulse Levels: 0.8V to 2.2V

Input Rise and Fall Time: ≤ 20 ns

Output Load: 1 TTL Gate + 100 pF

Reference Level for Measuring Timing: Inputs; 1V and 2V

Outputs; 0.8V and 2.0V



●CAPACITANCE (Ta=25°C, f= 1 MHz)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	—	4	6	pF
Output Capacitance	C_{out}	V_{out}=0V	—	8	12	pF

■PROGRAMMING OPERATION

●DC PROGRAMMING CHARACTERISTICS (Ta=25°C±5°C, V_{CC}=5V±5%, V_{PP}=21V±0.5V)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{IN}=5.25V	—	—	10	μA
Output Low Voltage During Verify	V_{OL}	I_{OL}=2.1mA	—	—	0.45	V
Output High Voltage During Verify	V_{OH}	I_{OH}=−400μA	2.4	—	—	V
V_{CC} Current (Active)	I_{CC2}		—	—	100	mA
Input Low Level	V_{IL}		−0.1	—	0.8	V
Input High Level	V_{IH}		2.0	—	V_{CC}+1	V
V_{PP} Supply Current	I_{PP}	$\overline{CE}$=$\overline{PGM}$=V_{IL}	—	—	30	mA

●AC PROGRAMMING CHARACTERISTICS (Ta=25°C±5°C, V_{CC}=5V±5%, V_{PP}=21V±0.5V)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Address Setup Time	t_{AS}		2	—	—	μs
$\overline{OE}$ Setup Time	t_{OES}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		0	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
$\overline{OE}$ to Output Float Delay	t_{DF}		0	—	130	ns
V_{PP} Setup Time	t_{VS}		2	—	—	μs
$\overline{PGM}$ Pulse Width During Programming	t_{PW}		45	50	55	ms
$\overline{CE}$ Setup Time	t_{CES}		2	—	—	μs
Data Valid from $\overline{OE}$	t_{OE}		—	—	150	ns

Note : t_{DF} defines the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.

●SWITCHING CHARACTERISTICS

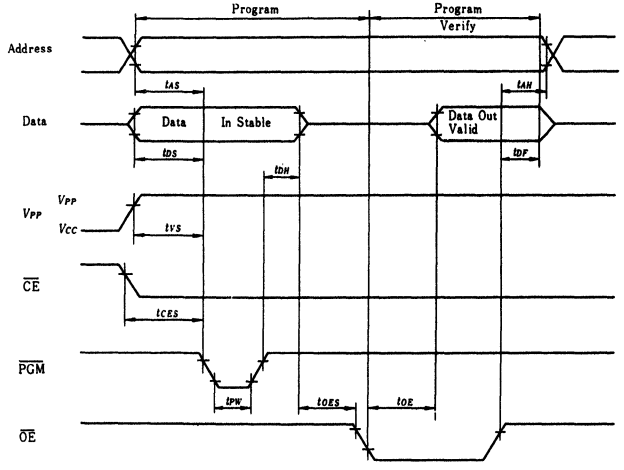
Test Condition

Input Pulse Level: 0.8V to 2.2V

Input Rise and Fall Time: ≤ 20 ns

Reference Level for Measuring Timing: Input; 1V and 2V

Output; 0.8V and 2V

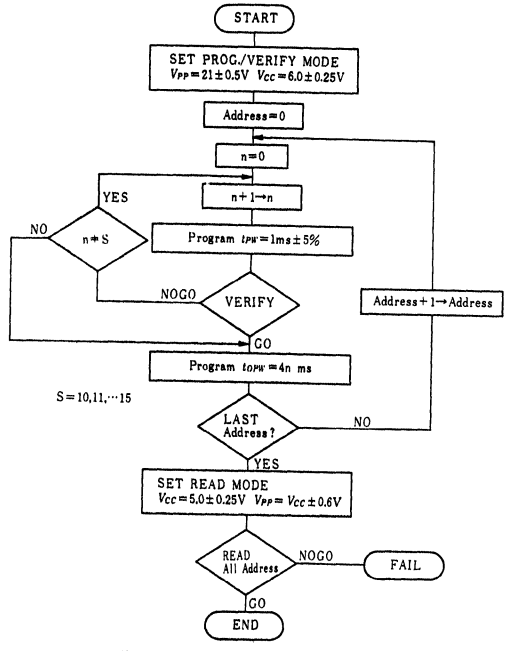


●ERASE

Erasure of HN4827128 is performed by exposure to ultraviolet light of 2537Å and all the output data are changed to "1" after this erasure procedure. The minimum integrated dose (i.e. UV intensity x exposure time) for erasure is 15 W•sec/cm^2.

■HIGH PERFORMANCE PROGRAMMING

This device can be applied the High Performance Programming algorithm shown in following flow chart. This algorithm allows to obtain faster programming time without any voltage stress to the device nor deterioration in reliability of programmed data.



High Performance Programming Flowchart

●AC PROGRAMMING CHARACTERISTICS (Ta=25°C±5°C, V_{CC}=6V±0.25V, V_{PP}=21V±0.5V)

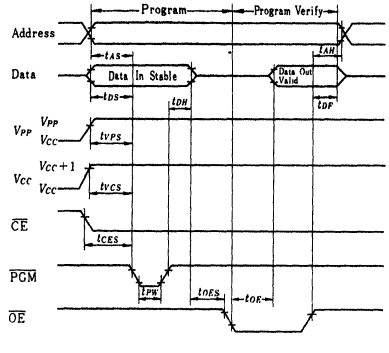
Parameter	Symbol	Test Condition	min	typ	max	Unit
Address Setup Time	t_{AS}		2	—	—	μs
$\overline{OE}$ Setup Time	t_{OES}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		0	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
$\overline{OE}$ to Output Float Delay*	t_{DF}		0	—	130	ns
V_{PP} Setup Time	t_{VPS}		2	—	—	μs
V_{CC} Setup Time	t_{VCS}		2	—	—	μs
$\overline{PGM}$ Pulse Width during Initial Program	t_{PW}		0.95	1.0	1.05	ms
$\overline{PGM}$ Pulse Width during Over Program**	t_{OPW}		3.8	—	63	ms
$\overline{CE}$ Setup Time	t_{CES}		2	—	—	μs
Data Valid from $\overline{OE}$	t_{OE}		—	—	150	ns

* t_{DF} defines the time at which the output achieves the open circuit conditions and is not referenced to output voltage levels.
** t_{OPW} is defined as mentioned in flow chart.

●SWITCHING CHARACTERISTICS

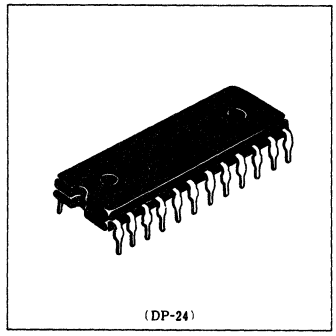
Test Condition

Input Pulse Level:	0.8V to 2.2V
Input Rise and Fall Time:	≤ 20 ns
Reference Level for Measuring Timing:	Input; 1V and 2V
	Output; 0.8V and 2V



2048-word × 8-bit Electrically Erasable and Programmable ROM

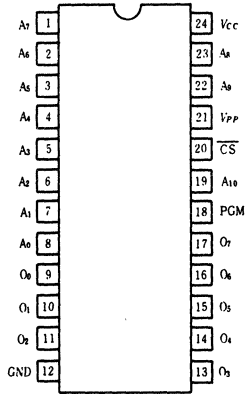
This device operates from a single power supply and features fast single address location programming. All the words are erased by one TTL level pulse. Erasing the bit pattern and programming new pattern can be made within 42 seconds.


(DP-24)

■ FEATURES

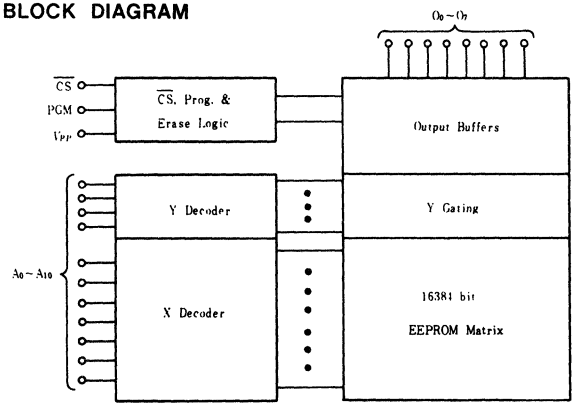
- Single Power Supply ..... +5V ±5%
- Simple Programming ..... Program voltage: +25V D.C.
  Program with one 20ms pulse.
- Electrically Erasing ..... Erase Voltage: +25V D.C.
  Erase all words with one 200ms pulse.
- Fully Static ..... No clocks required.
- Inputs and Outputs TTL compative during read, program and erase mode.
- Fully Decoded ..... On-Chip Address Decode.
- Access Time ..... 350ns Max.
- Low Power Dissipation .... 300mW Max.
- Three State Output ..... OR-Tie Capability
- Pin-out Compatible with Intel 2716.

■ PIN. ARRANGEMENT



(Top View)

■ BLOCK DIAGRAM



■ MODE SELECTION

Mode \ Pins	PGM (18)	$\overline{CS}$ (20)	V_{PP} (21)	V_{CC} (24)	Outputs (8~11, 13~17)
Read	V_{IL}	V_{IL}	+5	+5	Dout
Deselect	Don't Care	V_{IH}	+5	+5	High Z
Program	Pulsed V_{IL} to V_{IH}	V_{IH}	+25	+5	Din
Program Verify	V_{IL}	V_{IL}	+25	+5	Dout
Program Inhibit	V_{IL}	V_{IH}	+25	+5	High Z
Erase	Pulsed V_{IL} to V_{IH}	V_{IL}	+25	+5	High Z

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
All Input and Output Voltage	V_{IN}, V_{out}	−0.3 to V_{CC} +0.3 or V_{PP} +0.3	V
V_{CC} Voltage	V_{CC}	−0.3 to +7.0	V
V_{PP} Voltage	V_{PP}	−0.3 to +28	V
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−55 to +125	°C

■ READ OPERATION

● DC AND OPERATING CHARACTERISTICS (V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V,* Ta=0 to +70°C)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{IN}=5.25V	—	—	10	μA
Output Leakage Current	I_{LO}	V_{OUT}=5.25V	—	—	10	μA
V_{CC} Current	I_{CC1}	$\overline{CS}$=V_{IH}/V_{IL}	—	32	50	mA
V_{PP} Current	I_{PP1}	V_{PP}=5.85V	—	4	7	mA
Input Voltage	V_{IL}		−0.1	—	0.8	V
	V_{IH}		2.0	—	—	V
Output Voltage	V_{OL}	I_{OL}=1.6mA	—	—	0.4	V
	V_{OH}	I_{OH}=−100μA	2.4	—	—	V

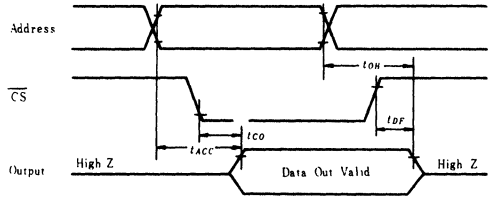
* The tolerance of 0.6V allows the use of a driver circuit for switching the V_{PP} supply pin from V_{CC} in read to 25V for programming.

● AC CHARACTERISTICS (V_{CC}=5V±5%, V_{PP}=V_{CC}±0.6V, Ta=0 to +70°C)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Address to Output Delay	t_{ACC}	PGM=$\overline{CS}$=V_{IL}	—	200	350	ns
Chip Select to Output Delay	t_{CO}	PGM=V_{IL}	—	70	150	ns
Chip Deselect to Output Float	t_{DF}		0	40	100	ns
Address to Output Hold	t_{OH}	PGM=$\overline{CS}$=V_{IL}	10	—	—	ns

● TEST CONDITION

Input pulse levels: 0.8V to 2.0V
Input rise and fall time: ≦ 20ns
Output load: 1TTL Gate + 100 pF
Reference level for Measuring Timing: Inputs 1V and 1.8V
Outputs 0.8V and 2.0V



● CAPACITANCE (Ta=25°C, f=1MHz)

Parameter	Symbol	Test Condition	typ	max	Unit
Input Capacitance	C_{in}	V_{in}=0V	—	7.5	pF
Output Capacitance	C_{out}	V_{out}=0V	—	15	pF

■ PROGRAM OPERATION

● DC PROGRAMMING CHARACTERISTICS (V_{CC}=5V±5%, V_{PP}=25V±1V, Ta=0 to +70℃)

Parameter	Symbol	Test Condition	min	typ	max	Unit
Input Leakage Current	I_{LI}	V_{IN}=5.25V	—	—	10	μA
V_{CC} Supply Current	I_{CC2}		—	32	50	mA
V_{PP} Supply Current	I_{PP2}		—	10	20	mA
Input Voltage	V_{IL}		−0.1	—	0.8	V
	V_{IH}		2.0	—	—	V

● AC PROGRAMMING CHARACTERISTICS (V_{CC}=5V±5%, V_{PP}=25V±1V, Ta=0 to +70℃)

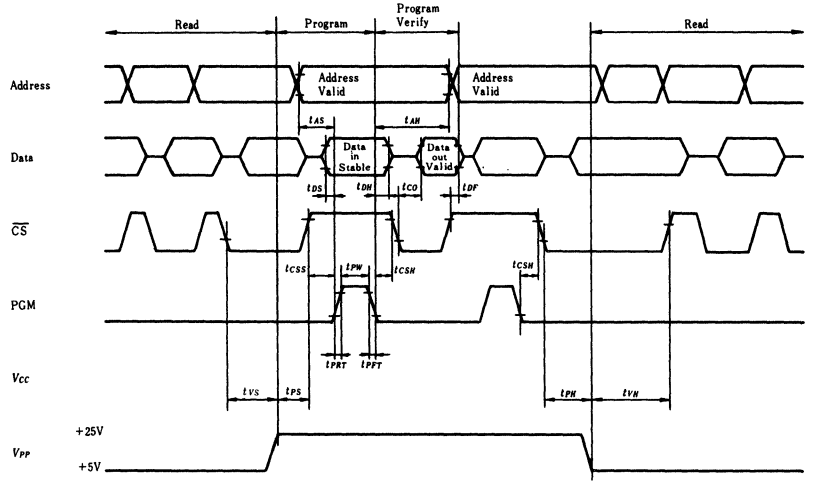
Parameter	Symbol	Test Condition	min	typ	max	Unit
Address Setup Time	t_{AS}		2	—	—	μs
$\overline{CS}$ Setup Time	t_{CSS}		2	—	—	μs
Data Setup Time	t_{DS}		2	—	—	μs
Address Hold Time	t_{AH}		2*	—	—	μs
$\overline{CS}$ Hold Time	t_{CSH}		7	—	—	μs
Data Hold Time	t_{DH}		2	—	—	μs
Chip Deselect to Output Float Delay	t_{DF}		0	40	100	ns
Chip Select to Output Delay	t_{CO}		—	70	150	ns
Program Pulse Width	t_{PW}		15	20	25	ms
Program Pulse Rise Time	t_{PRT}		5	—	—	ns
Program Pulse Fall Time	t_{PFT}		5	—	—	ns
V_{PP} Setup Time	t_{PS}		10	—	—	μs
V_{PP} Hold Time	t_{PH}		10	—	—	μs
$\overline{CS}$ to Program Mode Time	t_{VS}		10	—	—	μs
V_{PP} Read Mode Time	t_{VH}		10	—	—	μs

* If the mode changes from program mode to program verify mode sequentially (in the same address), t_{AH} must be larger than t_{CSH} + t_{CVS}.

● TEST CONDITION

Test Condition

Input pulse levels:	0.8V to 2.0V
Input rise and fall time:	20ns (10% to 90%)
Reference level for Measuring Timing:	Input; 1V and 1.8V
	Output: 0.8V and 2.0V



■ ERASE OPERATION

● DC ERASING CHARACTERISTICS (V_{CC}=5V±5%, V_{PP}=25V±1V, Ta= 0 to +70℃)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
Input Leakage Current	I_{LI}	V_{IN}=5.25V	—	—	10	μA
V_{CC} Supply Current	I_{CC3}		—	32	50	mA
V_{PP} Supply Current	I_{PP3}		—	10	20	mA
Input Voltage	V_{IL}		−0.1	—	0.8	V
	V_{IH}		2.0	—	—	V

● AC ERASING CHARACTERISTICS (V_{CC}=5V±5%, V_{PP}=25V±1V, Ta= 0 to +70℃)

Parameter	Symbol	Test Condition	min.	typ.	max.	Unit
$\overline{CS}$ Setup Time	t_{ECSS}		2	—	—	μs
PGM to Output Delay	t_{EO}		7	—	—	μs
Erase Pulse Width	t_{EW}		190	200	210	ms
Erase Pulse Rise Time	t_{ERT}		5	—	—	ns
Erase Pulse Fall Time	t_{EFT}		5	—	—	ns
V_{PP} Setup Time	t_{ES}		10	—	—	μs
V_{PP} Hold Time	t_{EH}		10	—	—	μs
Erase Program Time t_{EP}	t_{EP}		10	—	—	μs
Program Enase Time t_{PE}	t_{PE}		10	—	—	μs

● TEST CONDITION

Test Condition

Input pulse levels:	0.8V to 2.0V
Input rise and fall time:	20ns (10% to 90%)
Reference level for Measuring Timing:	Input; 1V and 1.8V
	Output; 0.8V and 2.0V

■ POWER SUPPLY SEQUENCE PRECAUTIONS

To protect the written data, power supply to the HN48016P should be turned on and off in the following order:

- **Power On-Off Order and Input Level Limitation for $\overline{CS}$ and PGM Terminals**

Table 1 shows the relationship between the order in which power supply for the HN48016P should be turned on and off and the input levels of the $\overline{CS}$ and PGM terminals.

(1) For the 5V V_{PP} and V_{CC}, there is no limitation as to the order in which power is turned on and off the state of the input terminals $\overline{CS}$ and PGM.

(2) When turning on and off power supply for the 25V V_{PP}, keep V_{CC} at between 4.5V and 7V, and PGM at "Low."

(3) When turning on and off power supply for the 5V V_{CC} while V_{PP} equals 25V ± 1V (this being a rare case for the HN48016P), make sure to keep PGM at "Low."

Fig. 1 shows the timing order in which power is turned on and off.

● Table 1. Power On-Off Order for HN48016P

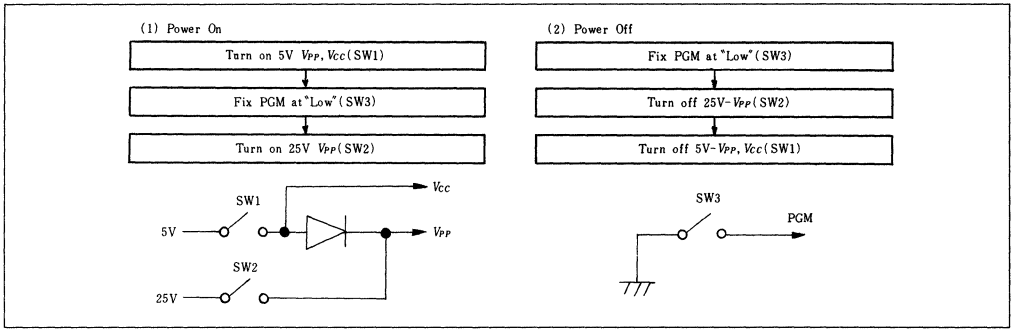
Input Level		Power On-Off	
PGM	$\overline{CS}$	5V-V_{PP}-V_{CC}	25V-V_{PP}
V_{IL}	V_{IL}	Possible	Possible only when V_{CC}=4.5~7V*2
V_{IL}	V_{IH}		
V_{IH}	V_{IL}	Possible	impossible*2
V_{IH}	V_{IH}		

Note 1. If Power for the 25V Vpp were turned on or off while V_{CC} = −0.3V to +4.5V, the data holding characteristic would probably deteriorate.

Note 2. If the 25V Vpp were operated to choose a "write" or "erase" mode while PGM = "V_{IH}," contents of ROM would probably change.

● Example of Standard Power Supply Sequence

The following is an example of standard power supply sequence:



● Inter-mode Timing

The HN48016P has six operating modes, 5V V_{PP} read-out, non-selected, 25V V_{PP} write, write check, write inhibit, and erase. To protect the written data, keep the terminal PGM at "Low" for a period of 10μs before and after turning the terminal V_{PP} from 5V to 25V and vice versa.

The following describes the inter-mode timing for a system that uses the HN48016P.

● Readout→Write→Readout

Before turning the terminal V_{PP} to 25V, keep the terminal PGM at "Low" for a period of 10μs minimum (as indicated by t_{VS}). After the terminal V_{PP} has been turned to 25V, keep the terminal $\overline{CS}$ at "Low" for a period of 10μs minimum (as indicated by t_{PS}). Before turning the terminal V_{PP} to 5V, keep the terminal $\overline{CS}$ at "Low" for a period of 10μs minimum (as indicated by t_{PH}). After the terminal V_{PP} has been turned to 5V, keep the terminal PGM at "Low" for a period of 10μs minimum (as indicated by t_{VH}).

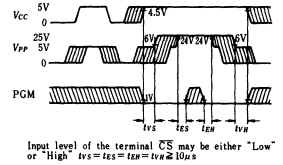
● Readout→Erase→Readout

This timing sequence is shown in Fig. 3. After turning the terminal V_{PP} to 25V, keep the terminal PGM at "Low" for a period of 10μs minimum (as indicated by t_{ES}). Keep the terminal PGM at "Low" for a period of 10μs minimum (as indicated by t_{EH}) before turning the terminal V_{PP} to 5V, as well.

● Erase→Write→Erase

This timing sequence is shown in Fig. 4. Before turning the terminal $\overline{CS}$ to "High (write mode)," keep the terminal.

PGM at "Low" for a period of 10μs minimum (as indicated by t_{EP}). Before turning from "write" to "erase," keep the terminal $\overline{CS}$ at "Low" for a period of 10μs minimum (as indicated by t_{PE}).



Input level of the terminal $\overline{CS}$ may be either "Low" or "High" $t_{VS} = t_{ES} = t_{EH} = t_{VH} \geq 10\mu s$

Fig. 1. Power on-off timing sequence.

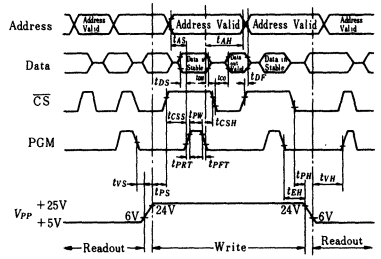


Fig. 2. "Readout→Write→Readout" timing

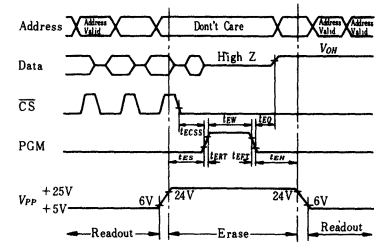


Fig. 3. "Readout→Erase→Readout" timing.

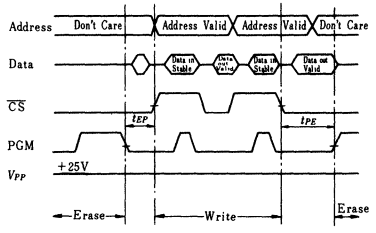


Fig. 4. "Erase→Write→Erase" timing.

BIPOLAR RAM

HM10414, HM10414-1

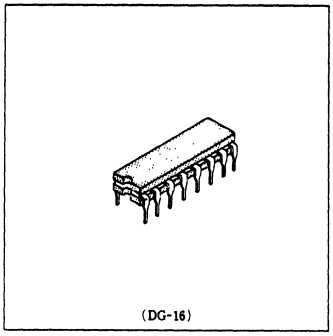
256-word × 1-bit Fully Decoded Random Access Memory

The HM10414 is ECL 10K compatible, 256-word x 1-bit, read write, random access memory developed for high speed systems such as scratch pad and control/buffer storages.

The fabrication process uses the Hitachi's low capacitance, oxide isolation method with double metalization.

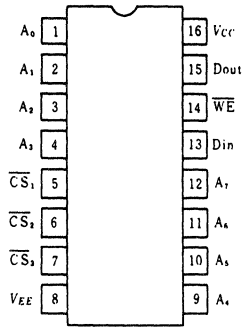
The HM10414 is encapsulated in cerdip-16pin package, compatible with Fairchild's F10414.

- Fully compatible with 10K ECL level
- Address access time: HM10414: 10ns (max.)
  HM10414-1: 8ns (max.)
- Write pulse width: 6ns (min.)
- Three chip select pins
- Output obtainable by wired-OR (open emitter)



(DG-16)

■ PIN ARRANGEMENT



(Top View)

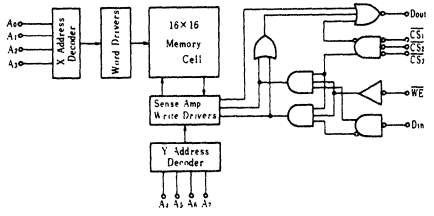
■ TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
any one H	×	×	L	Not Selected
all L	L	L	L	Write "0"
all L	L	H	L	Write "1"
all L	H	×	Dout*	Read

× : Don't care

* : Read out non-inverted

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS (V_{EE} = −5.2V, R_L = 50Ω to −2.0V, Ta = 0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min (B)	typ	max (A)	Unit
Output Voltage	V_{OH}	V_{IN} = V_{IHA} or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−960	—	−810	
			+75°C	−900	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	V_{IN} = V_{IHB} or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1145	—	−840	mV
			+25°C	−1105	—	−810	
			+75°C	−1045	—	−720	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1870	—	−1490	
			+25°C	−1850	—	−1475	
			+75°C	−1830	—	−1450	
Input Current	I_{IH}	V_{IN} = V_{IHA}	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{CS}$; V_{IN} = V_{ILB}	0 to +75°C	0.5	—	170	
		Other		−50	—	—	
Supply Current	I_{EF}	All Input and Output Open, Test Pin 8	+75°C	—	−130	—	mA
			0°C	−180	−140	—	

● AC CHARACTERISTICS

(V_{EE} = −5.2V±5%, Ta = 0 to +75°C, air flow exceeding 2m/sec, see test circuit and waveforms)

1. READ MODE

Item	Symbol	Test Condition	HM10414			HM10414-1			Unit
			min	typ	max	min	typ	max	
Chip Select Access Time	t_{ACR}		—	3	6	—	3	6	ns
Chip Select Recovery Time	t_{RCS}		—	3	6	—	3	6	ns
Address Access Time	t_{AA}		—	7	10	—	6	8	ns

2. WRITE MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Write Pulse Width	t_W	t_{WSA} = 2ns	6	4	—	ns
Data Setup Time	t_{WSD}		1	0	—	ns
Data Hold Time	t_{WHD}		1	0	—	ns
Address Setup Time	t_{WSA}	t_W = 6ns	2	0	—	ns
Address Hold Time	t_{WHA}		2	0	—	ns
Chip Select Setup Time	t_{WSCS}		1	0	—	ns
Chip Select Hold Time	t_{WHCS}		1	0	—	ns
Write Disable Time	t_{WS}		—	—	5	ns
Write Recovery Time	t_{WR}		—	—	5	ns

3. RISE/FALL TIME

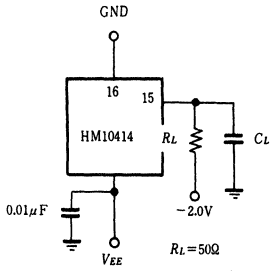
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	1.5	2.5	ns
Output Fall Time	t_f		—	1.5	2.5	ns

4. CAPACITANCE

Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	3	5	pF
Output Capacitance	C_{out}		—	5	8	pF

■ TEST CIRCUIT AND WAVEFORMS

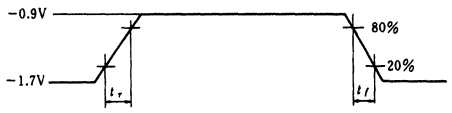
1. LOADING CONDITIONS



R_L=50Ω

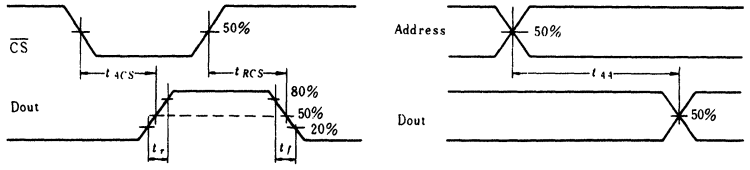
C_L=30pF(includes jig and stray capacitance)

2. INPUT PULSE

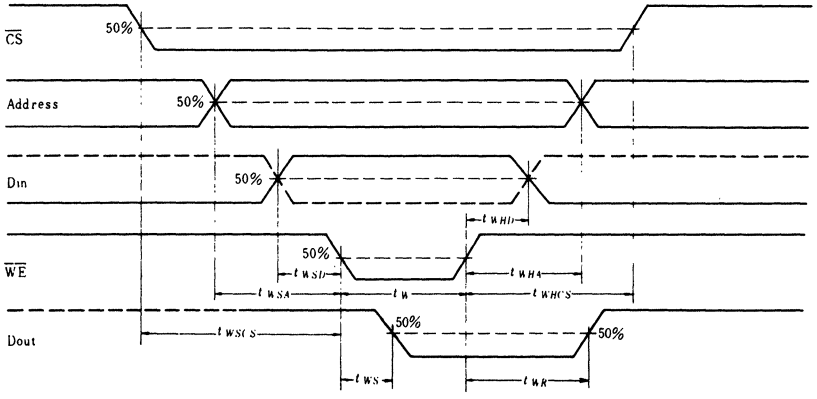


$t_r = t_f$ = 2.0ns typ

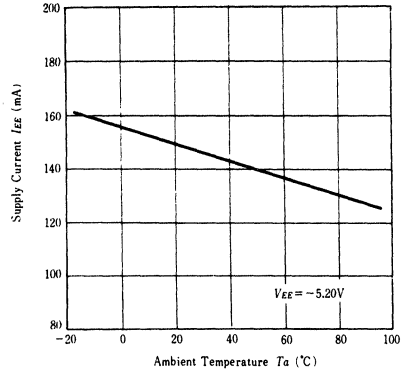
3. READ MODE



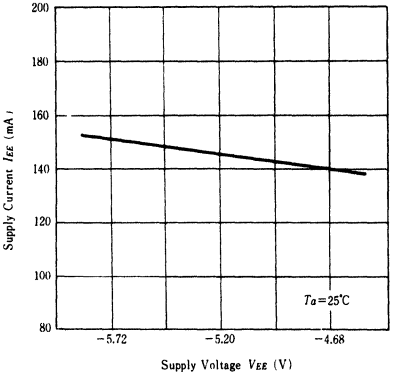
4. WRITE MODE



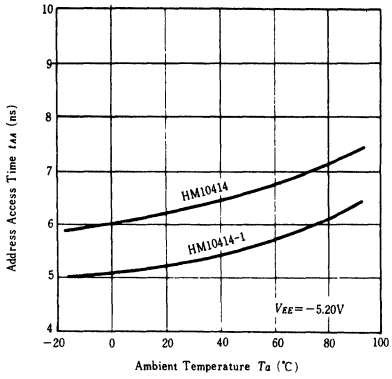
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



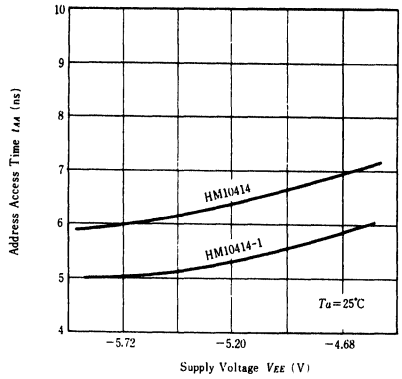
SUPPLY CURRENT vs. SUPPLY VOLTAGE



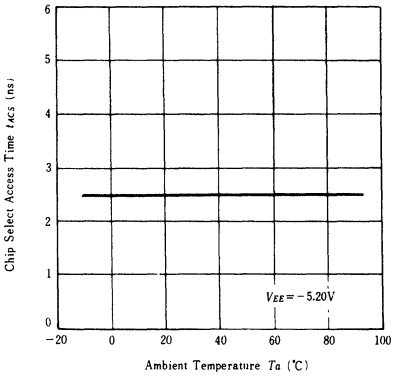
ADDRESS ACCESS TIME vs. AMBIENT TEMPERATURE



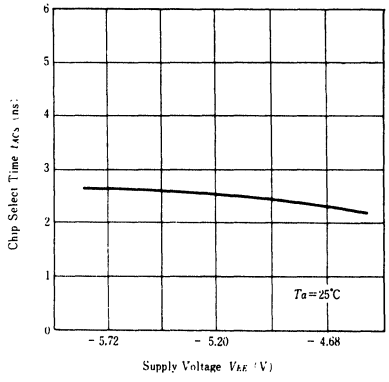
ADDRESS ACCESS TIME vs. SUPPLY VOLTAGE



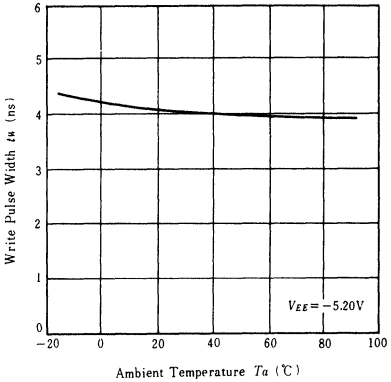
CHIP SELECT ACCESS TIME vs. AMBIENT TEMPERATURE



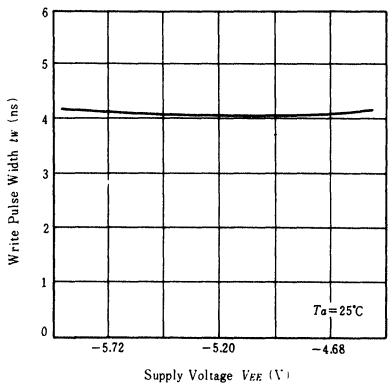
CHIP SELECT ACCESS TIME vs. SUPPLY VOLTAGE



WRITE PULSE WIDTH vs. AMBIENT TEMPERATURE



WRITE PULSE WIDTH vs. SUPPLY VOLTAGE

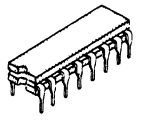


HM2110, HM2110-1

1024-word × 1-bit Fully Decoded Random Access Memory

The HM2110 Series item is an ECL compatible, 1024-word x 1-bit, read/write, random access memory developed for application to scratch pads, control and buffer memories, etc. which require high speeds.

- It is compatible with 10K ECL logic.
- Chip select access time .....10ns (max.)
- Address access time ..... HM2110: 35ns (max.)
  HM2110-1: 25ns (max.)
- Power consumption ,..... 0.5mW/bit (typ)
- Output obtainable by Wired-OR (open emitter).



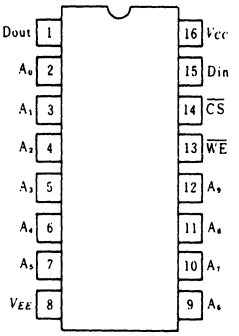
(DG - 16A)

■ TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

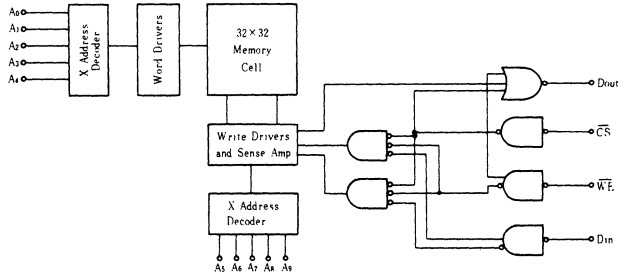
× : irrelevant
* : Read out noninverted

■ PIN ARRANGEMENT



(Top View)

■ BLOCK DIAGRAM



■ ABSOLUTE MAXMUM RATINGS

Item	Symbol	HM2110 Series	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS ($V_{EE}=-5.2V$, $R_L=50\Omega$ to $-2.0V$, $Ta=0$ to $+75°C$, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min(B)	typ	max(A)	Unit
Output Voltage	V_{OH}	$V_{IN}=V_{IHA}$ or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−960	—	−810	
			+75°C	−900	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	$V_{IN}=V_{IHB}$ or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1145	—	−840	mV
			+25°C	−1105	—	−810	
			+75°C	−1045	—	−720	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1870	—	−1490	
			+25°C	−1850	—	−1475	
			+75°C	−1830	—	−1450	
Input Current	I_{IH}	$V_{IN}=V_{IHA}$	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{CS}$ / $V_{IN}=V_{ILB}$	0 to +75°C	0.5	—	170	
		Other		−50	—	—	
Supply Current	I_{EE}	All Input and Output Open, Test Pin 8	$0 \leqq Ta < 25°C$	−150	−100	—	mA
			$Ta \geqq 25°C$	−125	−90	—	

●AC CHARACTERISTICS

($V_{EE}=-5.2V \pm 5\%$, $Ta=0$ to $+75°C$, air flow exceeding 2m/sec, see test circuit and waveforms)

1. READ MODE

Item	Symbol	Test Condition	HM2110			HM2110-1			Unit
			min	typ	max	min	typ	max	
Chip Select Access Time	t_{ACS}		—	7	10	—	7	10	ns
Chip Select Recovery Time	t_{RCS}		—	7	10	—	7	10	ns
Address Access Time	t_{AA}		—	20	35	—	15	25	ns

2. WRITE MODE

Item	Symbol	Test Condition	HM2110			HM2110-1			Unit
			min	typ	max	min	typ	max	
Write Pulse Width	t_W	$t_{WSA}=8ns$	25	—	—	25	—	—	ns
Data Setup Time	t_{WSD}		5	—	—	5	—	—	ns
Data Hold Time	t_{WHD}		5	—	—	5	—	—	ns
Address Setup Time	t_{WSA}	$t_W=25ns$	8	—	—	8	—	—	ns
Address Hold Time	t_{WHA}		2	—	—	2	—	—	ns
Chip Select Setup Time	t_{WSCS}		5	—	—	5	—	—	ns
Chip Select Hold Time	t_{WHCS}		5	—	—	5	—	—	ns
Write Disable Time	t_{WS}		—	—	10	—	—	10	ns
Write Recovery Time	t_{WR}		—	—	10	—	—	10	ns

3. RISE/FALL TIME

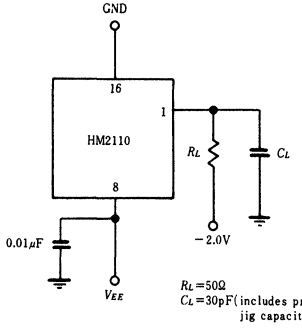
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	5	—	ns
Output Fall Time	t_f		—	5	—	ns

4. CAPACITANCE

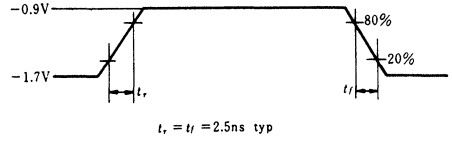
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	4	5	pF
Output Capacitance	C_{out}		—	7	8	pF

■ TEST CIRCUIT AND WAVEFORMS

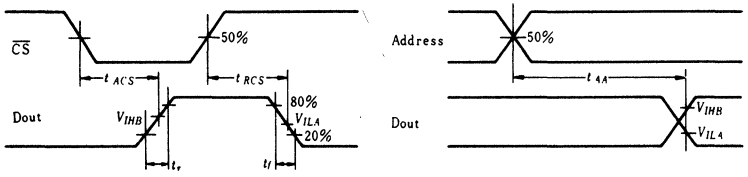
1. LOADING CONDITION



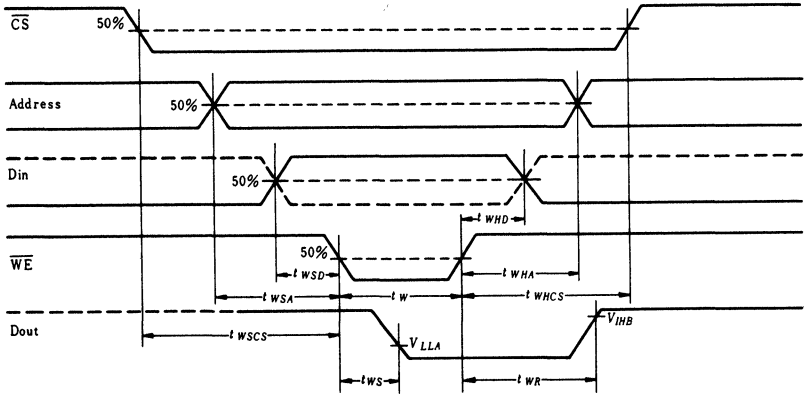
2. INPUT PULSE



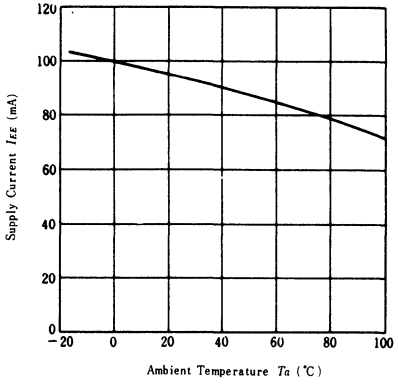
3. READ MODE



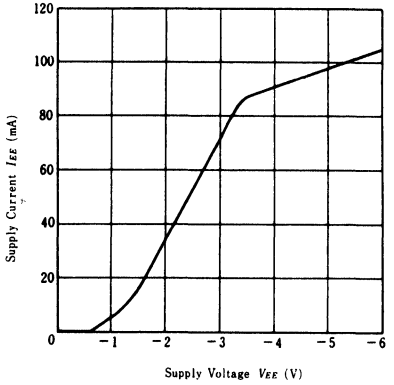
4. WRITE MODE



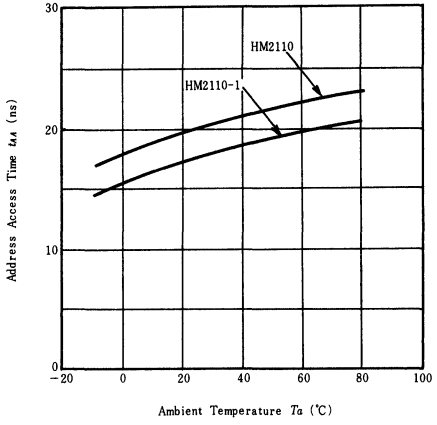
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



SUPPLY CURRENT vs. SUPPLY VOLTAGE



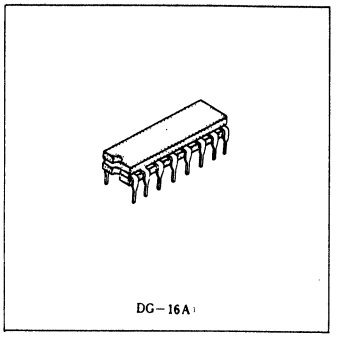
ADDRESS ACCESS TIME vs. AMBIENT TEMPERATURE



HM2112, HM2112-1

1024-word×1-bit Fully Decoded Random Access Memory

The HM2112 is an ECL compatible, 1024-word x 1-bit, read/write, random access memory developed for application to scratch pads, control and buffer memories, etc. which require high speeds.



■FEATURES

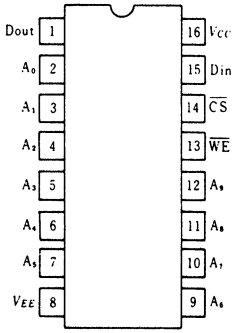
- Level ..... 10k ECL Compatible
- Construction ..... 1024-word by 1-bit
- Address Access Time ..... HM2112 10ns (max.)
  HM2112-1 8ns (max.)
- Chip Select Access Time ..... 5ns (max.)
- Power Consumption ..... 0.8mW/bit (typ)
- Output Obtainable by Wired-OR (open emitter)
- Fully Pin Compatible with F10415

■TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

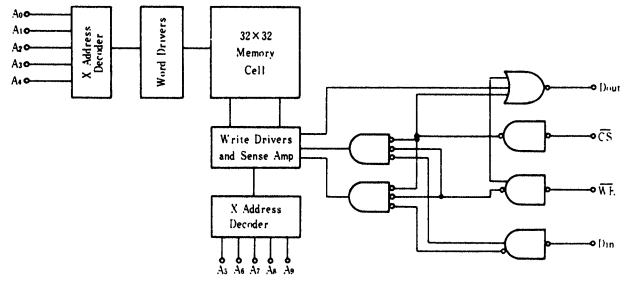
× : Irrelevant
* : Read out noniverted

■PIN ARRANGEMENT



(Top View)

■BLOCK DIAGRAM



■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	HM2112	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg} (Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

(V_{EE} = −5.2V, R_L = 50Ω to −2.0V, Ta = 0 to +75°C, air flow exceeding 2m/sec)

● DC CHARACTERISTICS

Item	Symbol	Test Condition		min(B)	typ	max(A)	Unit
Output Voltage	V_{OH}	$V_{IN} = V_{IHA}$ or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−960	—	−810	
			+75°C	−900	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	$V_{IN} = V_{IHB}$ or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1145	—	−840	mV
			+25°C	−1105	—	−810	
			+75°C	−1045	—	−720	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1870	—	−1490	
			+25°C	−1850	—	−1475	
			+75°C	−1830	—	−1450	
Input Current	I_{IL}	$V_{IN} = V_{IHA}$	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{CS}$ / $V_{IN} = V_{ILB}$	0 to +75°C	0.5	—	170	
		Other		−50	—	—	
Supply Current	I_{EE}	All Input and Output Open, Test Pin 8	Ta = 0°C	−200	—	—	mA
			Ta = 75°C	−170	—	—	

● AC CHARACTERISTICS

(V_{EE} = −5.2V ±5%, Ta = 0 to +75°C, air flow exceeding 2m/sec, see test circuit and waveforms)

1. READ MODE

Item	Symbol	Test Condition	HM2112-1			HM2112			Unit
			min	typ	max	min	typ	max	
Chip Select Access Time	t_{ACS}		1	3	5	1	3	5	ns
Chip Select Recovery Time	t_{RCS}		1	3	5	1	3	5	ns
Address Access Time	t_{AA}		3	6.5	8	3	7.5	10	ns

2. WRITE MODE

Item	Symbol	Test Condition	HM2112-1			HM2112			Unit
			min	typ	max	min	typ	max	
Write Pulse Width	t_W	t_{WSA} = 3ns	6	2	—	6	2	—	ns
Data Setup Time	t_{WSD}		1	0	—	1	0	—	ns
Data Hold Time	t_{WHD}		1	0	—	1	0	—	ns
Address Setup Time	t_{WSA}	t_W = 6ns	3	0	—	3	0	—	ns
Address Hold Time	t_{WHA}		2	0	—	2	0	—	ns
Chip Select Setup Time	t_{WSCS}		1	0	—	1	0	—	ns
Chip Select Hold Time	t_{WHCS}		1	0	—	1	0	—	ns
Write Disable Time	t_{WS}		1	3	5	1	3	5	ns
Write Recovery Time	t_{WR}		1	3	5	1	3	5	ns

3. RISE/FALL TIME

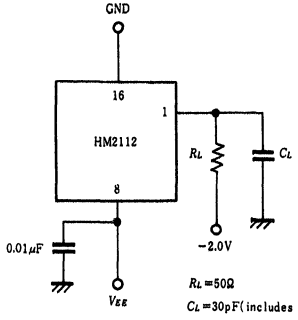
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		0.8	1.5	2.5	ns
Output Fall Time	t_f		0.8	1.5	2.5	ns

4. CAPACITANCE

Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		1	3	5	pF
Output Capacitance	C_{out}		3	5	8	pF

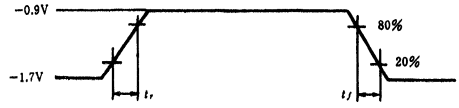
■ TEST CIRCUIT AND WAVEFORMS

1. LOADING CONDITION



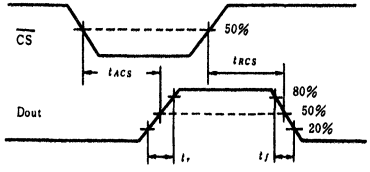
R_L=50Ω
C_L=30pF(includes probe and jig capacitance)

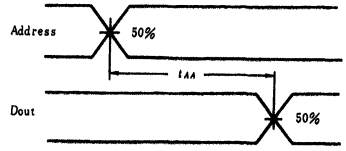
2. INPUT PULSE



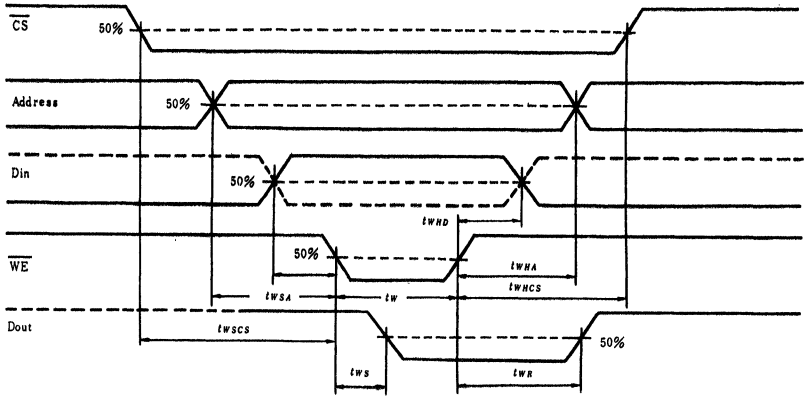
$t_r = t_f$=2.0ns typ

3. READ MODE

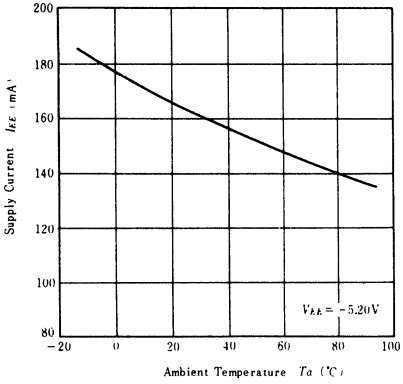




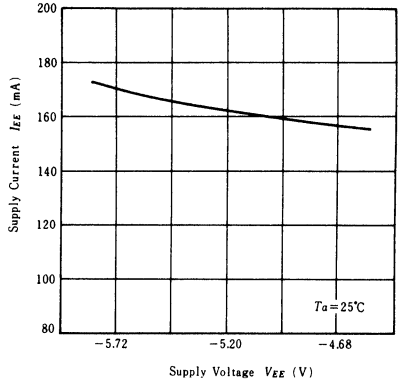
4. WRITE MODE



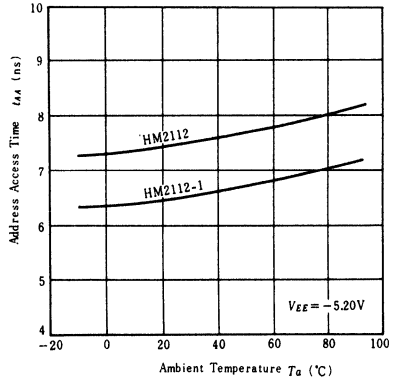
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



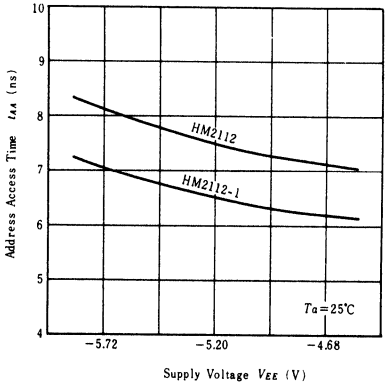
SUPPLY CURRENT vs. SUPPLY VOLTAGE



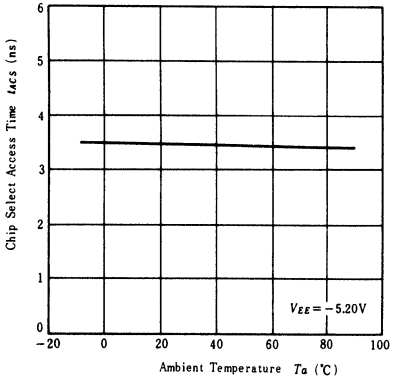
ADDRESS ACCESS TIME vs. AMBIENT TEMPERATURE



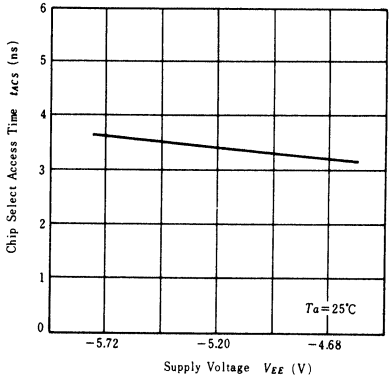
ADDRESS ACCESS TIME vs. SUPPLY VOLTAGE



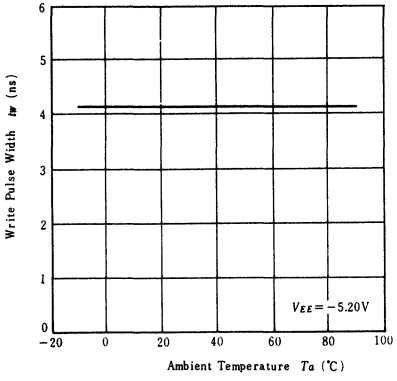
CHIP SELECT ACCESS TIME vs. AMBIENT TEMPERATURE



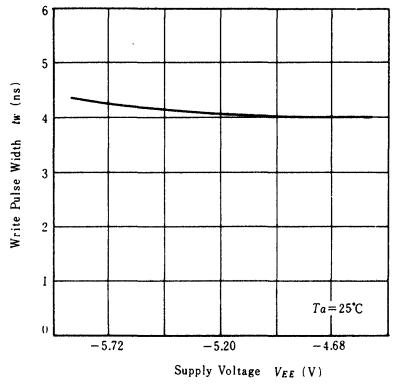
CHIP SELECT ACCESS TIME vs. SUPPLY VOLTAGE



WRITE PULSE WIDTH vs. AMBIENT TEMPERATURE



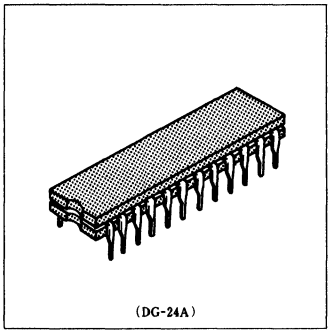
WRITE PULSE WIDTH vs. SUPPLY VOLTAGE



HM10422

256-word×4-bit Fully Decoded Random Access Memory

The HM10422 is ECL 10K compatible, 256-word x 4-bit, read write, random access memory developed for high speed systems such as scratch pads and control buffer storages.
Four active Low Block Select lines are provided to select each block independently.
The fabrication process is the Hitachi's low capacitance, oxide isolation method with double metalization.
The HM10422 is encapsulated in cerdip-24 pin package, compatible with Fairchild's F10422.



(DG-24A)

■ FEATURES

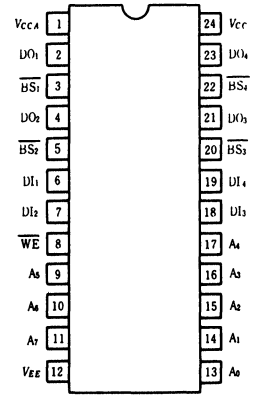
- 256-word x 4 bit organization.
- Fully compatible with 10K ECL level
- Address access time: 10ns (max)
- Write pulse width: 6ns (min)
- Power dissipation: 0.8mW/bit
- Output obtainable by wired-OR (open emitter)

■ TRUTH TABLE

Input			Output	Mode
$\overline{BS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

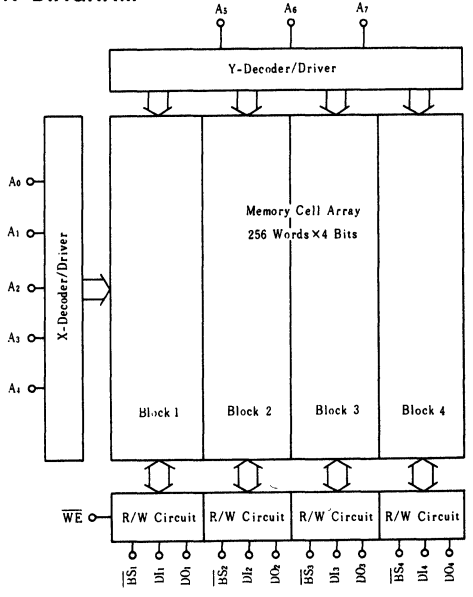
Notes) × : Irrelevant
* : Read out noninvert

■ PIN ARRANGEMENT



(Top View)

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

(V_{EE}=−5.2V, R_L=50Ω to −2.0V, Ta=0 to +75°C, air flow exceeding 2m/sec)

● DC CHARACTERISTICS

Item	Symbol	Test Condition		min(B)	typ	max(A)	Unit
Output Voltage	V_{OH}	$V_{IN}=V_{IHA}$ or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−960	—	−810	
			+75°C	−900	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	$V_{IN}=V_{IHB}$ or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1145	—	−840	mV
			+25°C	−1105	—	−810	
			+75°C	−1045	—	−720	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1870	—	−1490	
			+25°C	−1850	—	−1475	
			+75°C	−1830	—	−1450	
Input Current	I_{IH}	$V_{IN}=V_{IHA}$	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{BS}$ / $V_{IN}=V_{ILB}$	0 to +75°C	0.5	—	170	
		Other		−50	—	—	
Supply Current	I_{EE}	All Input and Output Open, Test Pin 12	Ta=0°C	−200	−160	—	mA
			Ta=75°C	—	−145	—	

● AC CHARACTERISTICS

1. READ MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Block Select Access Time	t_{ABS}		—	—	5	ns
Block Select Recovery Time	t_{RBS}		—	—	5	ns
Address Access Time	t_{AA}		—	7	10	ns

2. WRITE MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Write Pulse Width	t_W	t_{WSA}=2ns	6	4.5	—	ns
Data Setup Time	t_{WSD}		2	0	—	ns
Data Hold Time	t_{WHD}		2	0	—	ns
Address Setup Time	t_{WSA}	t_W=6ns	2	0	—	ns
Address Hold Time	t_{WHA}		2	0	—	ns
Block Select Setup Time	t_{WSBS}		2	0	—	ns
Block Select Hold Time	t_{WHBS}		2	0	—	ns
Write Disable Time	t_{WS}		—	4	5	ns
Write Recovery Time	t_{WR}		—	4.5	9	ns

3. RISE/FALL TIME

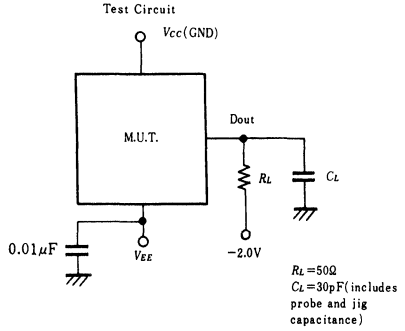
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

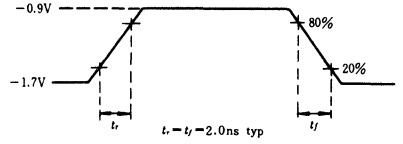
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	4	—	pF
Output Capacitance	C_{out}		—	7	—	pF

■ TEST CIRCUIT AND WAVEFORMS

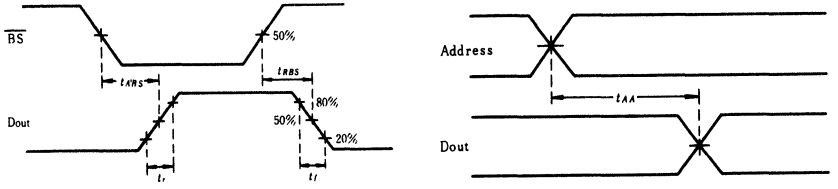
1. LOADING CONDITION



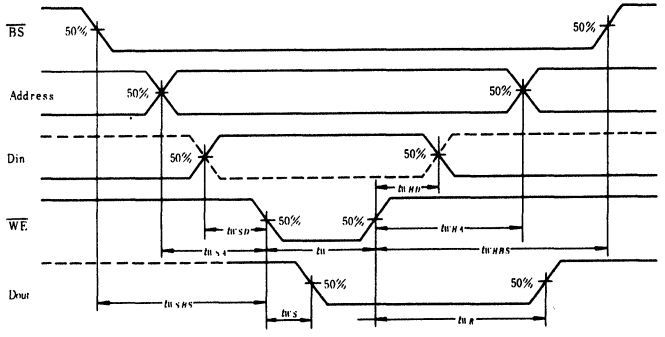
2. INPUT PULSE



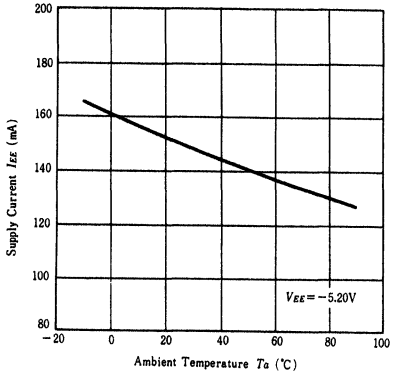
3. READ MODE



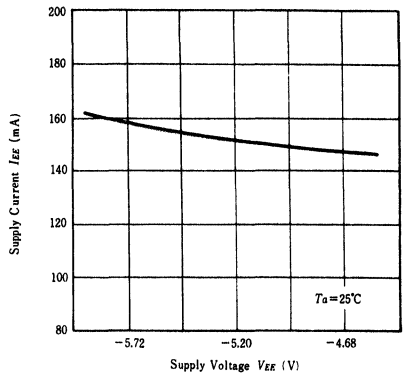
4. WRITE MODE



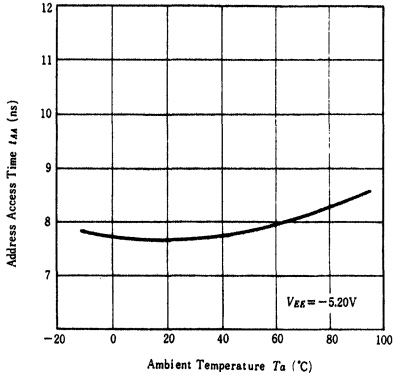
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



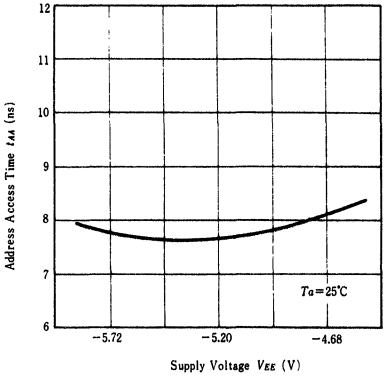
SUPPLY CURRENT vs. SUPPLY VOLTAGE



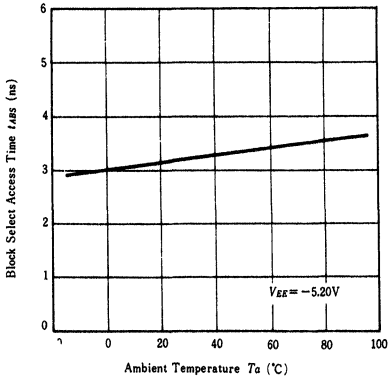
ADDRESS ACCESS TIME vs. AMBIENT TEMPERATURE



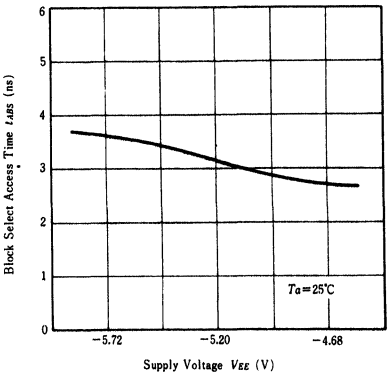
ADDRESS ACCESS TIME vs. SUPPLY VOLTAGE



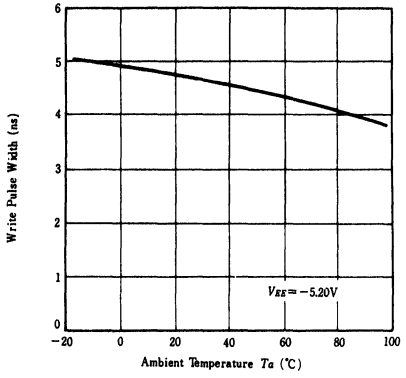
BLOCK SELECT ACCESS TIME vs. AMBIENT TEMPERATURE



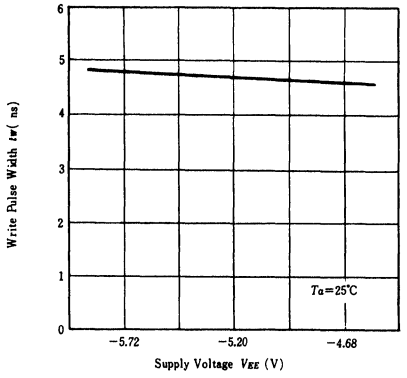
BLOCK SELECT ACCESS TIME vs. SUPPLY VOLTAGE



WRITE PULSE WIDTH vs. AMBIENT TEMPERATURE



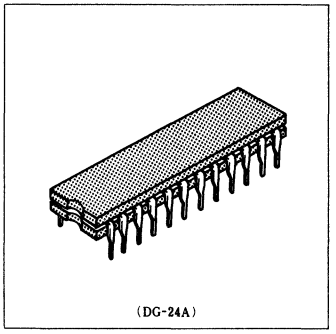
WRITE PULSE WIDTH vs. SUPPLY VOLTAGE



HM10422-7

256-word × 4-bit Fully Decoded Random Access Memory

The HM10422 is ECL 10K compatible, 256-word x 4-bit, read write, random access memory developed for high speed systems such as scratch pads and control buffer storages.
Four active Low Block Select lines are provided to select each block independently.
The fabrication process is the Hitachi's low capacitance, oxide isolation method with double metalization.
The HM10422 is encapsulated in cerdip-24 pin package, compatible with Fairchild's F10422.


(DG-24A)

■ FEATURES

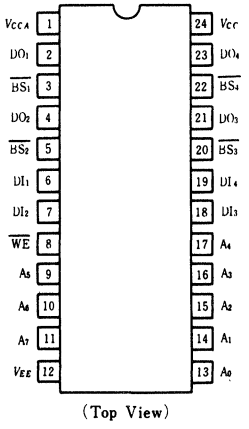
- 256-word x 4 bit organization
- Fully compatible with 10K ECL level
- Address access time: 7ns (max)
- Write pulse width: 4ns (min)
- Power dissipation: 1.0 mW/bit
- Output obtainable by wired-OR (open emitter)

■ TRUTH TABLE

Input			Output	Mode
$\overline{BS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

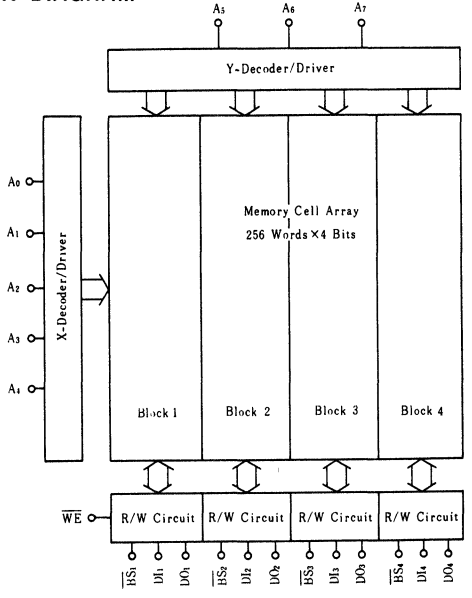
Notes) × : Irrelevant
* : Read out noninvert

■ PIN ARRANGEMENT



(Top View)

■ BLOCK DIAGRAM



HITACHI

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

(V_{EE}=−5.2V, R_L=50Ω to −2.0V, Ta=0 to +75°C, air flow exceeding 2m/sec)

● DC CHARACTERISTICS

Item	Symbol	Test Condition		min(B)	typ	max(A)	Unit
Output Voltage	V_{OH}	$V_{IN}=V_{IHA}$ or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−960	—	−810	
			+75°C	−900	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	$V_{IN}=V_{IHB}$ or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1145	—	−840	mV
			+25°C	−1105	—	−810	
			+75°C	−1045	—	−720	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1870	—	−1490	
			+25°C	−1850	—	−1475	
			+75°C	−1830	—	−1450	
Input Current	I_{IH}	$V_{IN}=V_{IHA}$	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{BS}$ $V_{IN}=V_{ILB}$	0 to +75°C	0.5	—	170	
		Other		−50	—	—	
Supply Current	I_{EE}	All Input and Output Open, Test Pin 12	Ta=0°C	−240	−200	—	mA
			Ta=75°C	—	−180	—	

● AC CHARACTERISTICS

1. READ MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Block Select Access Time	t_{ABS}		—	—	5	ns
Block Select Recovery Time	t_{RBS}		—	—	5	ns
Address Access Time	t_{AA}		—	4	7	ns

2. WRITE MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Write Pulse Width	t_W	t_{WSA}=2ns	4	3	—	ns
Data Setup Time	t_{WSD}		1		—	ns
Data Hold Time	t_{WHD}		1		—	ns
Address Setup Time	t_{WSA}	t_W=4ns	2		—	ns
Address Hold Time	t_{WHA}		1		—	ns
Block Select Setup Time	t_{WSBS}		1		—	ns
Block Select Hold Time	t_{WHBS}		1		—	ns
Write Disable Time	t_{WS}		—	3	5	ns
Write Recovery Time	t_{WR}		—	3	5	ns

3. RISE/FALL TIME

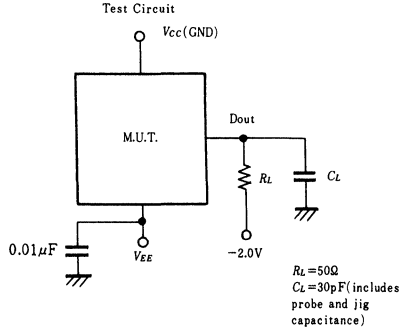
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

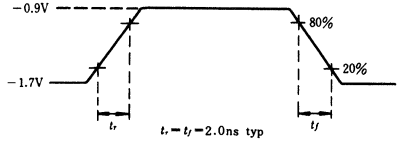
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	3	—	pF
Output Capacitance	C_{out}		—	5	—	pF

■ TEST CIRCUIT AND WAVEFORMS

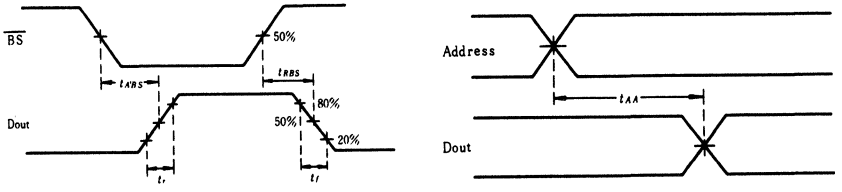
1. LOADING CONDITION



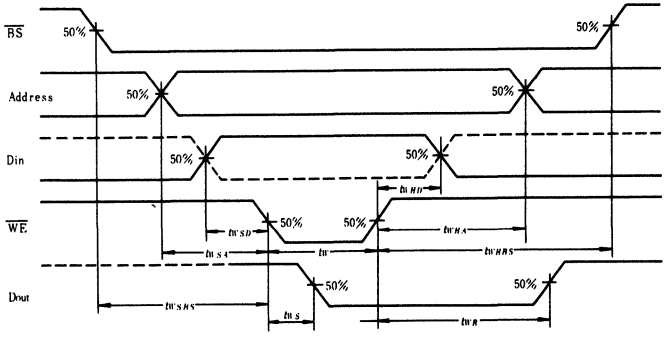
2. INPUT PULSE



3. READ MODE



4. WRITE MODE



HM10470, HM10470-1, HM10470F

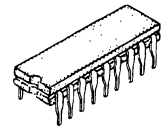
4096-word x 1-bit Fully Decoded Random Access Memory

The HM10470/F is ECL 10K compatible, 4096-words x 1-bit, read write random access memory developed for high speed systems such as scratch pads and control/buffer storages.

The fabrication process is the Hitachi's low capacitance, oxide isolation method with double metalization.

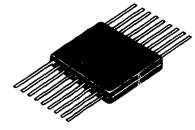
The HM10470/F is encapsulated in cerdip-18 pin and Flat-18 pin package, compatible with Fairchild's F10470.

HM10470, HM10470-1



(DG-18)

HM10470F



(FG-18)

■ FEATURES

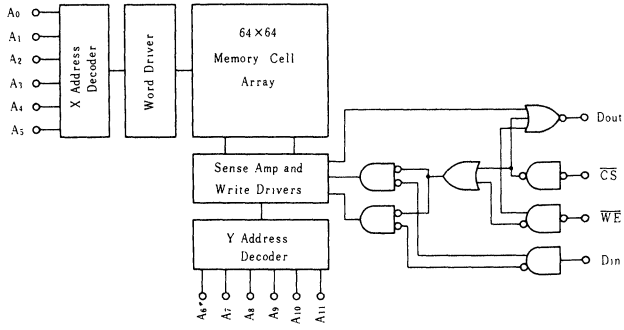
- 4096-word x 1-bit organization
- Fully compatible with 10K ECL level
- Address access time: HM10740/F 25ns (max)
  HM10470-1 15ns (max)
- Write pulse width: HM10470/F 25ns (min)
  HM10470-1 15ns (min)
- Low power dissipation: 0.2mW/bit
- Output obtainable by wired-OR (open emitter)

■ TRUTH TABLE

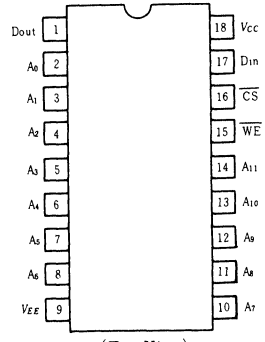
Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

Notes) × : Irrelevant
* : Read Out Noninvert

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ TEST CIRCUIT AND WAVEFORMS

● DC CHARACTERISTICS (V_{EE} = −5.2V, R_L = 50Ω to −2.0V, Ta = 0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min (B)	typ	max (A)	Unit
Output Voltage	V_{OH}	V_{IN} = V_{IHA} or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−960	—	−810	
			+75°C	−900	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	V_{IN} = V_{IHB} or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1145	—	−840	mV
			+25°C	−1105	—	−810	
			+75°C	−1045	—	−720	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1870	—	−1490	
			+25°C	−1850	—	−1475	
			+75°C	−1830	—	−1450	
Input Current	I_{IH}	V_{IN} = V_{IHA}	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{CS}$ / V_{IN} = V_{ILB}	0 to +75°C	0.5	—	170	
		Other		−50	—	—	
Supply Current	I_{EE}	All Input and Output Open, Test Pin 9	Ta = 0°C	−200* / −280**	−160* / −200**	—	mA
			Ta = 75°C	—	−145	—	

* HM10470/F
** HM10470-1

● AC CHARACTERISTICS (V_{EE} = −5.2V ±5%, Ta = 0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition	HM10470/F			HM10470-1			Unit
			min	typ	max	min	typ	max	
Chip Select Access Time	t_{ACS}		—	—	10	—	—	8	ns
Chip Select Recovery Time	t_{RCS}		—	—	10	—	—	8	ns
Address Access Time	t_{AA}		—	15	25	—	12	15	ns

2. WRITE MODE

Item	Symbol	Test Condition	HM10470/F			HM10470-1			Unit
			min	typ	max	min	typ	max	
Write Pulse Width	t_W	t_{WSA} = 3ns	25	—	—	15	—	—	ns
Data Setup Time	t_{WSD}		2	—	—	2	—	—	ns
Data Hold Time	t_{WHD}		2	—	—	2	—	—	ns
Address Setup Time	t_{WSA}	t_W = $t_{W\,min}$	3	—	—	3	—	—	ns
Address Hold Time	t_{WHA}		2	—	—	2	—	—	ns
Chip Select Setup Time	t_{WSCS}		2	—	—	2	—	—	ns
Chip Select Hold Time	t_{WHCS}		2	—	—	2	—	—	ns
Write Disable Time	t_{WS}		—	—	10	—	—	8	ns
Write Recovery Time	t_{WR}		—	—	10	—	—	8	ns

3. RISE/FALL TIME

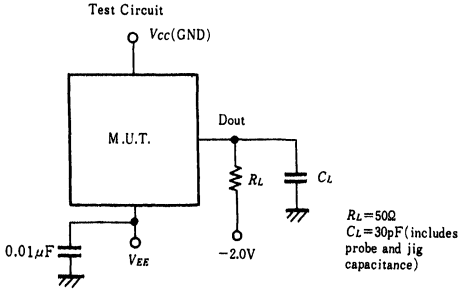
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

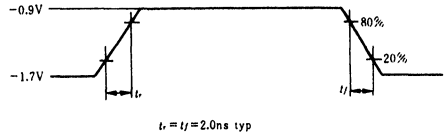
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	3	—	pF
Output Capacitance	C_{out}		—	5	—	pF

■ TEST CIRCUIT AND WAVEFORMS

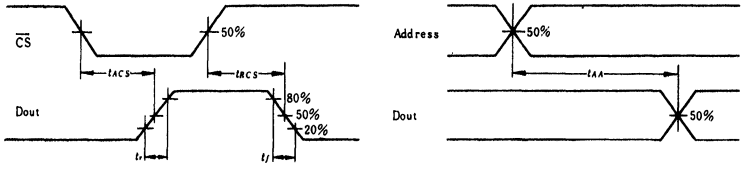
1. LOADING CONDITION



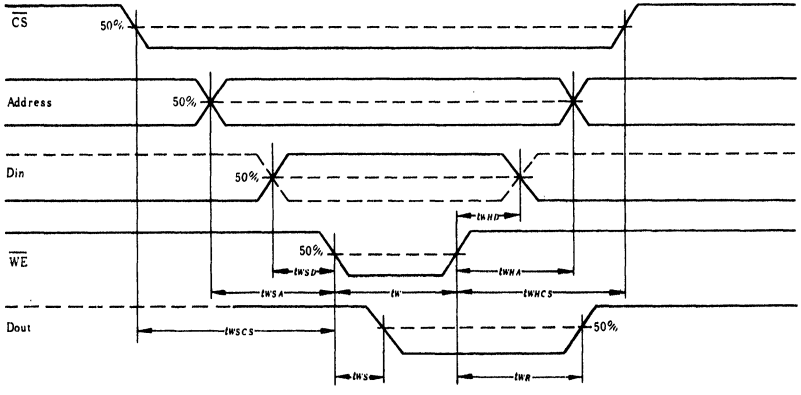
2. INPUT PULSE



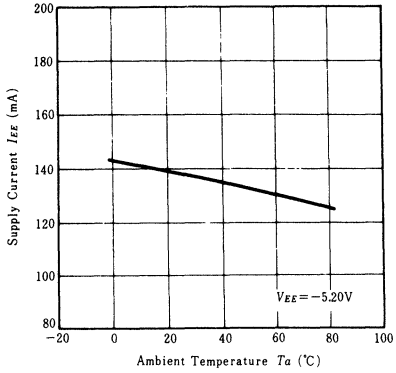
3. READ MODE



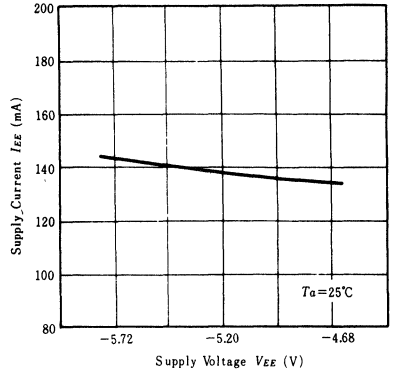
4. WRITE MODE



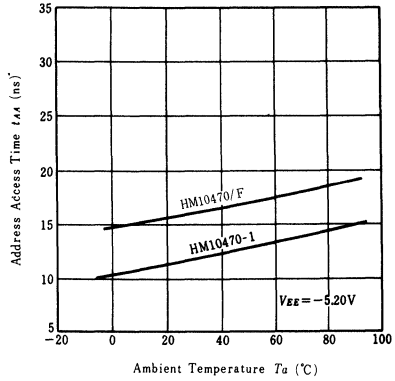
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



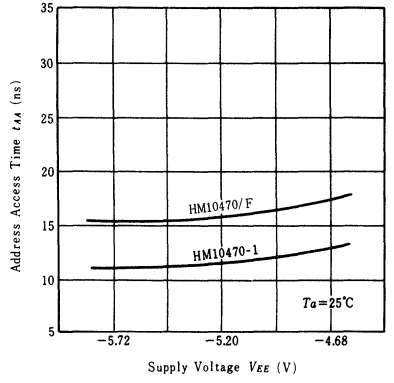
SUPPLY CURRENT vs. SUPPLY VOLTAGE



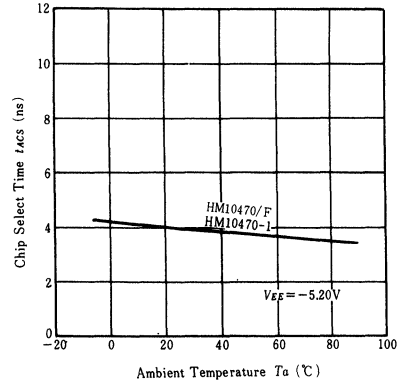
ADDRESS ACCESS TIME vs. AMBIENT TEMPERATURE



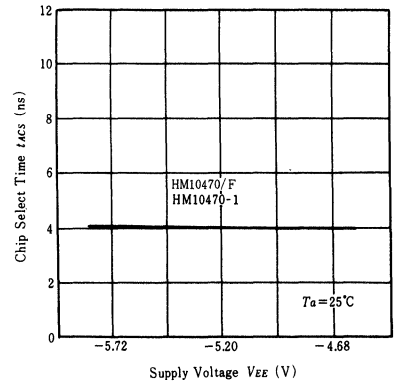
ADDRESS ACCESS TIME vs. SUPPLY VOLTAGE



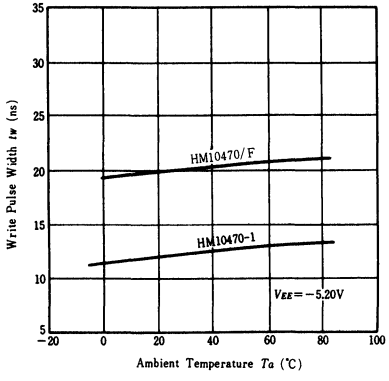
CHIP SELECT ACCESS TIME vs. AMBIENT TEMPERATURE



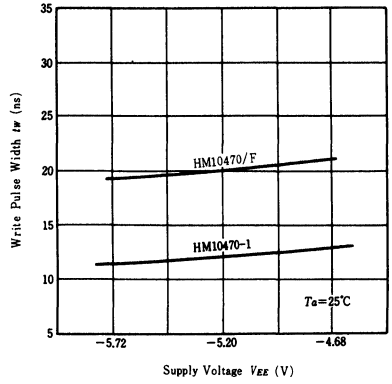
CHIP SELECT ACCESS TIME vs. SUPPLY VOLTAGE



WRITE PULSE WIDTH vs. AMBIENT TEMPERATURE



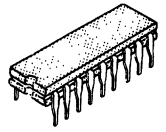
WRITE PULSE WIDTH vs. SUPPLY VOLTAGE



HM10470-15

4096-word × 1-bit Fully Decoded Random Access Memory

The HM10470 is ECL 10K compatible, 4096-words x 1-bit, read/write, random access memory developed for high speed systems such as scratch pads and control/buffer storages.
The fabrication process uses the Hitachi's low capacitance, oxide isolation method with double metalization.
The HM10470 is encapsulated in cerdip-18 pin package, compatible with Fairchild's F10470.



(DG-18)

■ FEATURES

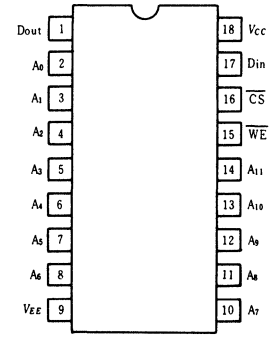
- 4096-word x 1-bit organization
- Fully compatible with 10K ECL level
- Address access time: 15ns (max)
- Write pulse width: 15ns (min)
- Low power dissipation: 0.2 mW/bit
- Output obtainable by wired-OR (open emitter)

■ TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout *	Read

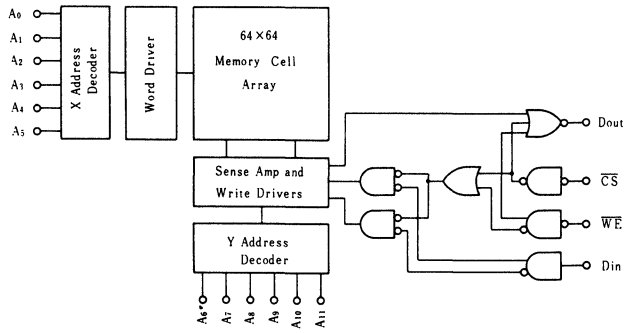
Notes) × : Irrelevant
* : Read Out Nonivert

■ PIN ARRANGEMENT



(Top View)

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS (Ta=25 °C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg} (Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS (V_{EE} = −5.2V, R_L = 50Ω to −2.0V, Ta = 0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min (B)	typ	max (A)	Unit
Output Voltage	V_{OH}	V_{IN} = V_{IHA} or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−960	—	−810	
			+75°C	−900	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	V_{IN} = V_{IHB} or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1145	—	−840	mV
			+25°C	−1105	—	−810	
			+75°C	−1045	—	−720	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1870	—	−1490	
			+25°C	−1850	—	−1475	
			+75°C	−1830	—	−1450	
Input Current	I_{IH}	V_{IN} = V_{IHA}	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{CS}$ / V_{IN} = V_{ILB}	0 to +75°C	0.5	—	170	
		Other		−50	—	—	
Supply Current	I_{EE}	All Input and Output Open, Test Pin 12	Ta = 0°C	−200	−160	—	mA
			Ta = 75°C	—	−145	—	

● AC CHARACTERISTICS (V_{EE} = −5.2V±5%, Ta = 0 to +75°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Chip Select Access Time	t_{ACS}		—	—	8	ns
Chip Select Recovery Time	t_{RCS}		—	—	8	ns
Address Access Time	t_{AA}		—	—	15	ns

2. WRITE MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Write Pulse Width	t_W	t_{WSA} = 3ns	15	—	—	ns
Data Setup Time	t_{WSD}		2	—	—	ns
Data Hold Time	t_{WHD}		2	—	—	ns
Address Setup Time	t_{WSA}	t_W = 15ns	3	—	—	ns
Address Hold Time	t_{WHA}		2	—	—	ns
Chip Select Setup Time	t_{WSCS}		2	—	—	ns
Chip Select Hold Time	t_{WHCS}		2	—	—	ns
Write Disable Time	t_{WS}		—	—	8	ns
Write Recovery Time	t_{WR}		—	—	8	ns

3. RISE/FALL TIME

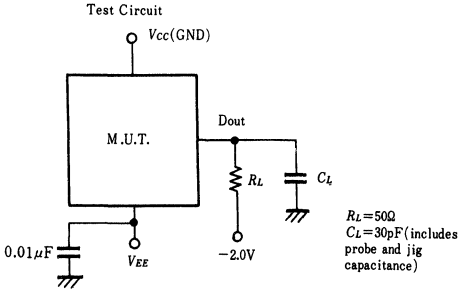
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

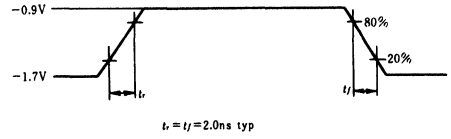
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	3	—	pF
Output Capacitance	C_{out}		—	5	—	pF

■ TEST CIRCUIT AND WAVEFORMS

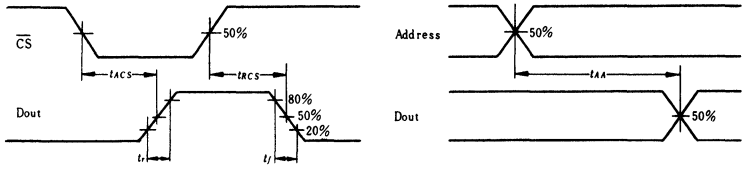
1. LOADING CONDITION



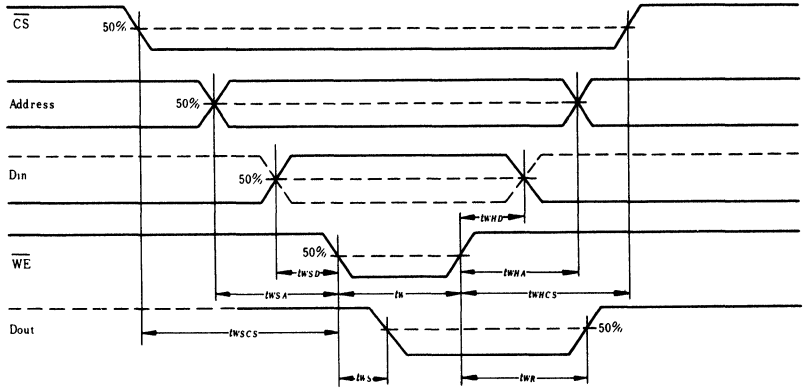
2. INPUT PULSE



3. READ MODE



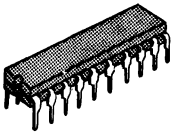
4. WRITE MODE



HM2142

4096-words × 1-bit Very High Speed Random Access Memory

The HM2142 is 4096-words x 1-bit very high speed read/write, random access memory developed for high speed systems such as pads and control/buffer storages.
The fabrication process uses the Hitachi's low capacitance, oxide isolation method with double metalization.
The HM2142 is encapsulated in cerdip-20 pin package.



(DG-20)

■ FEATURES

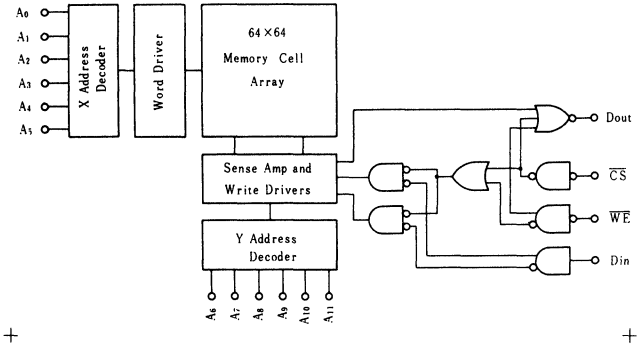
- 4096-words x 1 bit organization
- Very high speed address access time: 10ns (max)
- Write pulse width: 10ns (min)
- Power dissipation: 0.3 mW/bit
- Output obtainable by wired-OR

■ TRUTH TABLE

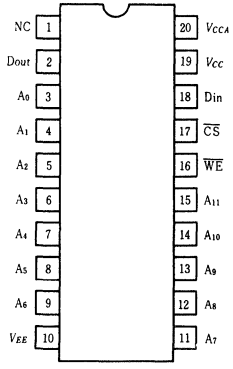
Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout *	Read

Notes) × : Irrelevant
* : Read Out Nonivert

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS (V_{EE}=−5.2V, R_L=50Ω to −2.0V, Ta=0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min(B)	typ	max(A)	Unit
Output Voltage	V_{OH}	V_{IH}=V_{IHA} or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−980	—	−810	
			+75°C	−950	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	V_{IH}=V_{IHB} or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1165	—	−880	mV
			+25°C	−1165	—	−880	
			+75°C	−1165	—	−880	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1810	—	−1560	
			+25°C	−1810	—	−1560	
			+75°C	−1810	—	−1560	
Input Current	I_{IH}	V_{IN}=V_{IHA}	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{CS}$	0 to +75°C	0.5	—	170	
		Others		−50	—	—	
Supply Current	I_{EE}	All Input and Output Open.	Ta=0°C	−270	−240	—	mA
			Ta=75°C	—	−220	—	

● AC CHARACTERISTICS (V_{EE}=−5.2V±5%, Ta=0 to +75°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Chip Select Access Time	t_{ACS}		—	—	6	ns
Chip Select Recovery Time	t_{RCS}		—	—	6	ns
Address Access Time	t_{AA}		—	—	10	ns

2. WRITE MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Write Pulse Width	t_W	t_{WSA}=3ns	10	—	—	ns
Data Setup Time	t_{WSD}		1	—	—	ns
Data Hold Time	t_{WHD}		1	—	—	ns
Address Setup Time	t_{WSA}	t_W=10ns	3	—	—	ns
Address Hold Time	t_{WHA}		2	—	—	ns
Chip Select Setup Time	t_{WSCS}		1	—	—	ns
Chip Select Hold Time	t_{WHCS}		1	—	—	ns
Write Disable Time	t_{WS}		—	—	6	ns
Write Recovery Time	t_{WN}		—	—	6	ns

3. RISE/FALL TIME

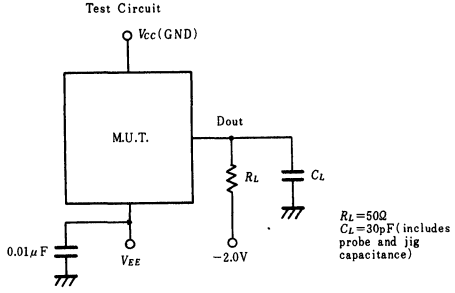
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

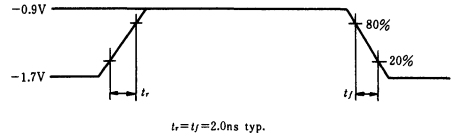
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	3	—	pF
Output Capacitance	C_{out}		—	5	—	pF

■ TEST CIRCUIT AND WAVEFORMS

1. LOADING CONDITION

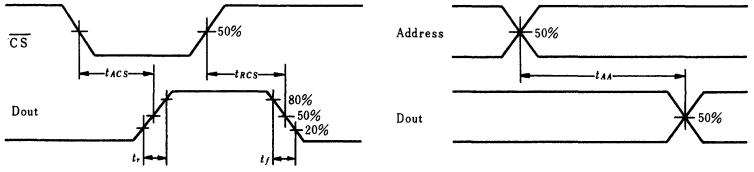


2. INPUT PULSE

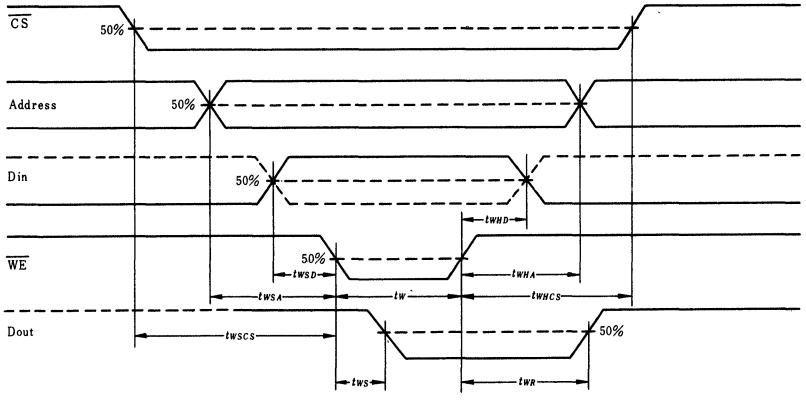


$t_r = t_f = 2.0$ns typ.

3. READ MODE



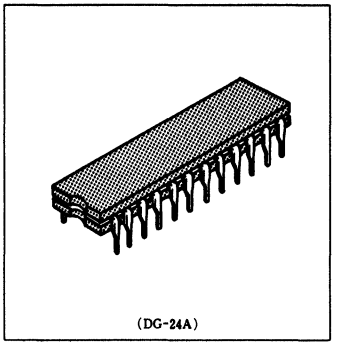
4. WRITE MODE



HM10474, HM10474-15

1024-word×4-bit Fully Decoded Random Access Memory

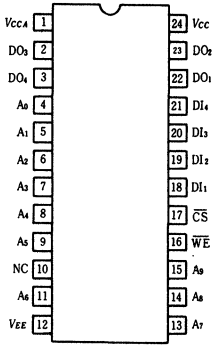
The HM10474 is ECL 10k compatible, 1024-words x 4-bit, read write, random access memory developed for high speed systems such as scratch pads and control/buffer storages.
The fabrication process is the Hitachi's low capacitance, oxide isolation method with double metalization.
The HM10474 is encapsulated in cerdip-24pin package, compatible with Fairchild's F10474.


(DG-24A)

■ FEATURES

- 1024-word x 4-bit organization
- Fully compatible with 10K ECL level
- Address access time: HM10474 25ns (max)
  HM10474-15 15ns (max)
- Write pulse width: HM10474 25ns(min)
  HM10474-15 15ns (min)
- Low power dissipation: 0.2mW/bit
- Output obtainable by wired-OR (open emitter)

■ PIN ARRANGEMENT



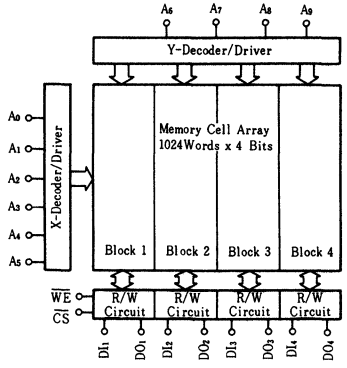
(Top View)

■ TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

Notes) × : Irrelevant
* : Read Out Nonivert

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

HITACHI

■ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{EE} = −5.2V, R_L = 50Ω to −2.0V, Ta = 0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min (B)	typ	max (A)	Unit
Output Voltage	V_{OH}	V_{IN} = V_{IHA} or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−960	—	−810	
			+75°C	−900	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	V_{IN} = V_{IHB} or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1145	—	−840	mV
			+25°C	−1105	—	−810	
			+75°C	−1045	—	−720	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1870	—	−1490	
			+25°C	−1850	—	−1475	
			+75°C	−1830	—	−1450	
Input Current	I_{IH}	V_{IN} = V_{IHA}	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{CS}$ / V_{IN} = V_{ILB}	0 to +75°C	0.5	—	170	
		Others		−50	—	—	
Supply Current	I_{EE}	All Input and Output Open, Test Pin 12	Ta = 0°C	−200	−160	—	mA
			Ta = 75°C	—	−145	—	

●AC CHARACTERISTICS (V_{EE} = −5.2V ±5%, Ta = 0 to +75°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	HM10474			HM10474-15			Unit
			min	typ	max	min	typ	max	
Chip Select Access Time	t_{ACS}		—	—	10	—	—	8	ns
Chip Select Recovery Time	t_{RCS}		—	—	10	—	—	8	ns
Address Access Time	t_{AA}		—	15	25	—	—	15	ns

2. WRITE MODE

Item	Symbol	Test Condition	HM10474			HM10474-15			Unit
			min	typ	max	min	typ	max	
Write Pulse Width	t_W	t_{WSA} = 3ns	25	15	—	15	—	—	ns
Data Setup Time	t_{WSD}		2	—	—	2	—	—	ns
Data Hold Time	t_{WHD}		2	—	—	2	—	—	ns
Address Setup Time	t_{WSA}	t_W = $t_{W\,min}$	3	—	—	3	—	—	ns
Address Hold Time	t_{WHA}		2	—	—	2	—	—	ns
Chip Select Setup Time	t_{WSCS}		2	—	—	2	—	—	ns
Chip Select Hold Time	t_{WHCS}		2	—	—	2	—	—	ns
Write Disable Time	t_{WS}		—	—	10	—	—	8	ns
Write Recovery Time	t_{WR}		—	—	10	—	—	8	ns

3. RISE/FALL TIME

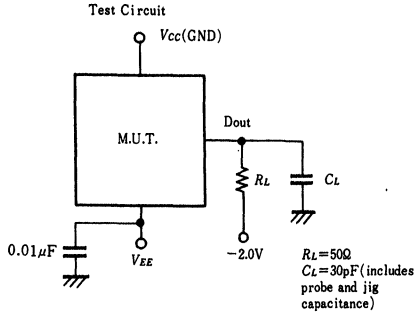
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

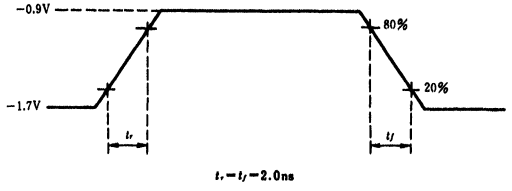
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	4	—	pF
Output Capacitance	C_{out}		—	7	—	pF

■ TEST CIRCUIT AND WAVEFORMS

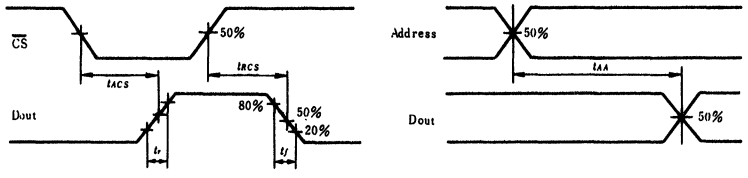
1. LOADING CONDITION



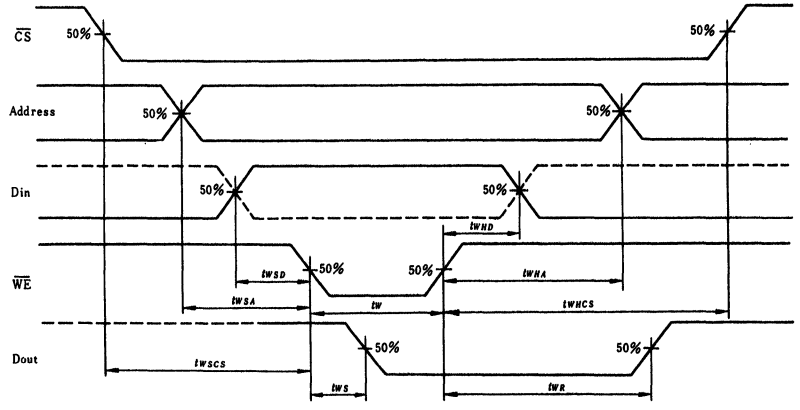
2. INPUT PULSE



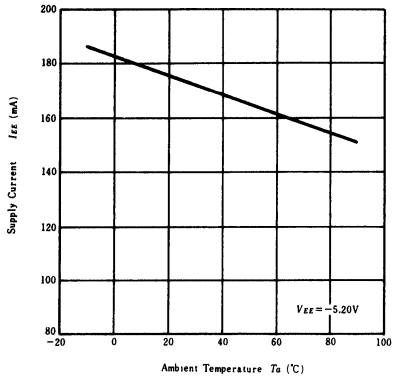
3. READ MODE



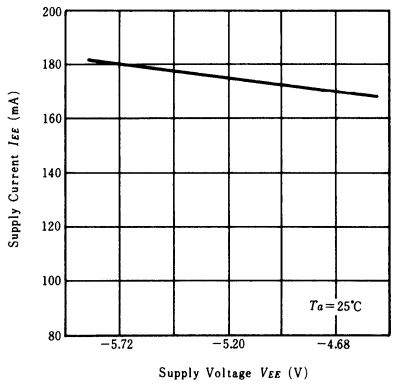
4. WRITE MODE



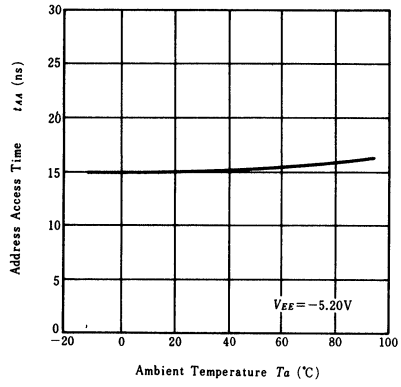
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



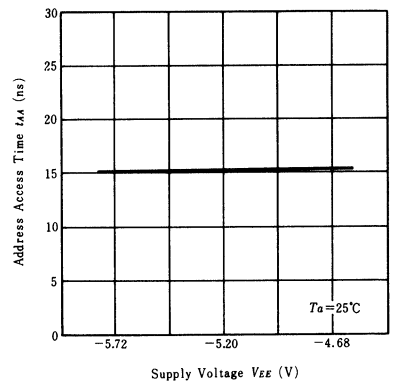
SUPPLY CURRENT vs. SUPPLY VOLTAGE



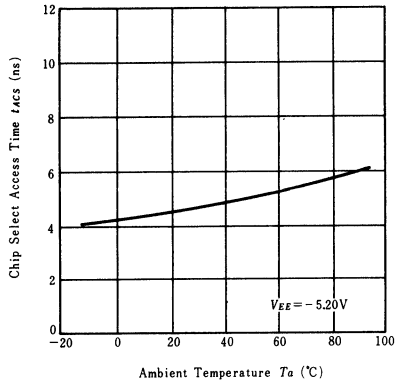
ADDRESS ACCESS TIME vs. AMBIENT TEMPERATURE



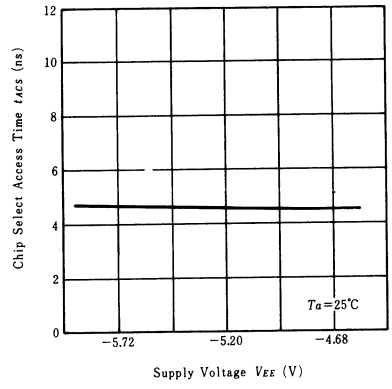
ADDRESS ACCESS TIME vs. SUPPLY VOLTAGE



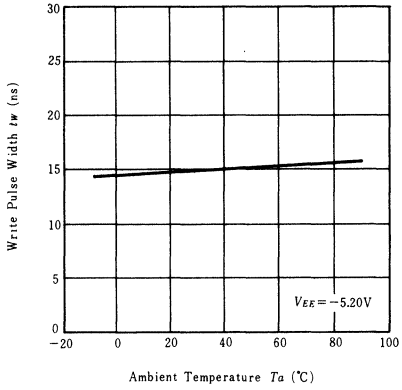
CHIP SELECT ACCESS TIME vs. AMBIENT TEMPERATURE



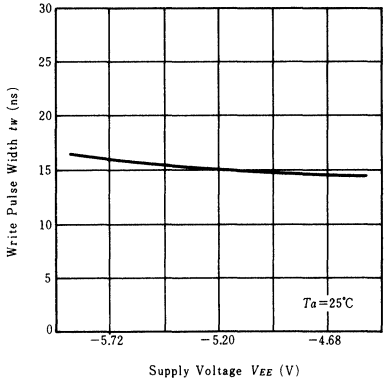
CHIP SELECT ACCESS TIME vs. SUPPLY VOLTAGE



WRITE PULSE WIDTH vs. AMBIENT TEMPERATURE



WRITE PULSE WIDTH vs. SUPPLY VOLTAGE

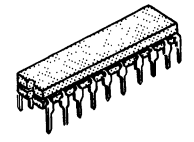


HM10480, HM10480F

16,384-words × 1-bit Fully Decoded Random Access Memory

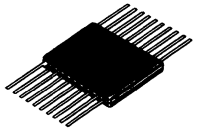
The HM10480 is ECL 10K compatible, 16,384-words x 1-bit, read/write random access memory developed for high speed systems such as scratch pads and control/buffer storages.
The fabrication process uses the Hitachi's low capacitance, oxide isolation method with double metalization.
The HM10480 is encapsulated in cerdip-20 pin and flat 20-pin package, compatible with Fairchild's F10480.

HM10480



(DG-20)

HM10480F



(FG-20)

■FEATURES

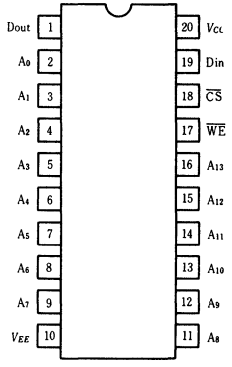
- 16,384-words x 1-bit organization
- Fully compatible with 10K ECL level
- Address access time: 25ns (max)
- Write pulse width: 25ns(min)
- Low power dissipation: 0.05mW/bit
- Output obtainable by wired-OR (open emitter)

■TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

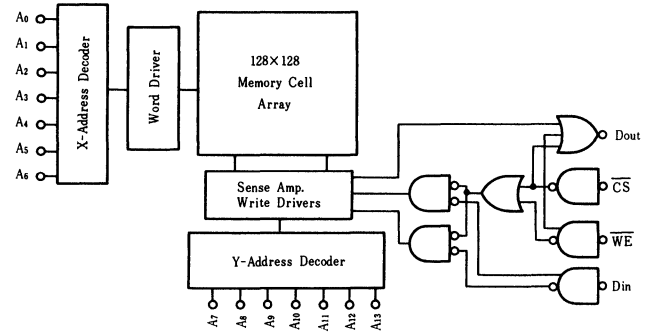
Notes) × : Irrelevant
* : Read Out Noninvert

■PIN ARRANGEMENT



(Top View)

■BLOCK DIAGRAM



■ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS (V_{EE} = −5.2V, R_L = 50Ω to −2.0V, Ta = 0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min (B)	typ	max (A)	Unit
Output Voltage	V_{OH}	V_{IN} = V_{IHA} or V_{ILB}	0°C	−1000	—	−840	mV
			+25°C	−960	—	−810	
			+75°C	−900	—	−720	
	V_{OL}		0°C	−1870	—	−1665	
			+25°C	−1850	—	−1650	
			+75°C	−1830	—	−1625	
Output Threshold Voltage	V_{OHC}	V_{IN} = V_{IHB} or V_{ILA}	0°C	−1020	—	—	mV
			+25°C	−980	—	—	
			+75°C	−920	—	—	
	V_{OLC}		0°C	—	—	−1645	
			+25°C	—	—	−1630	
			+75°C	—	—	−1605	
Input Voltage	V_{IH}	Guaranteed Input Voltage High for All Inputs	0°C	−1145	—	−840	mV
			+25°C	−1105	—	−810	
			+75°C	−1045	—	−720	
	V_{IL}	Guaranteed Input Voltage Low for All Inputs	0°C	−1870	—	−1490	
			+25°C	−1850	—	−1475	
			+75°C	−1830	—	−1450	
Input Current	I_{IH}	V_{IN} = V_{IHA}	0 to +75°C	—	—	220	μA
	I_{IL}	$\overline{CS}$	0 to +75°C	0.5	—	170	
		Others; V_{IN} = V_{ILB}		−50	—	—	
Supply Current	I_{EE}	All Input and Output Open, Test Pin 10	Ta = 0°C	−170	−140	—	mA
			Ta = 75°C	—	−130	—	

● AC CHARACTERISTICS (V_{EE} = −5.2V ±5%, Ta = 0 to +75°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Chip Select Access Time	t_{ACS}		2	—	10	ns
Chip Select Recovery Time	t_{RCS}		2	—	10	ns
Address Access Time	t_{AA}		3	15	25	ns

2. WRITE MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Write Pulse Width	t_W	t_{WSA} = 5ns	25	—	—	ns
Data Setup Time	t_{WSD}		5	—	—	ns
Data Hold Time	t_{WHD}		5	—	—	ns
Address Setup Time	t_{WSA}	t_W = 25ns	5	—	—	ns
Address Hold Time	t_{WHA}		5	—	—	ns
Chip Select Setup Time	t_{WSCS}		5	—	—	ns
Chip Select Hold Time	t_{WHCS}		5	—	5	ns
Write Disable Time	t_{WS}		—	—	10	ns
Write Recovery Time	t_{WR}		—	—	10	ns

3. RISE/FALL TIME

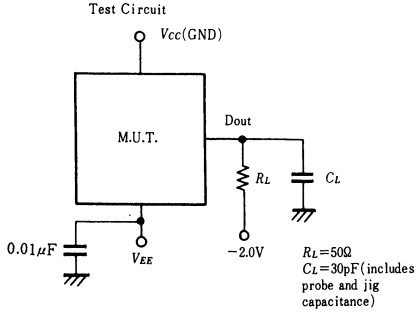
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

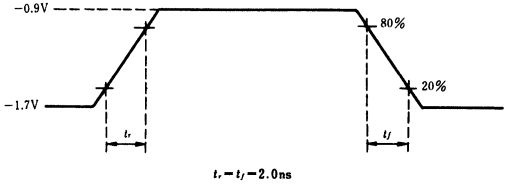
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	4	—	pF
Output Capacitance	C_{out}		—	7	—	pF

■ TEST CIRCUIT AND WAVEFORMS

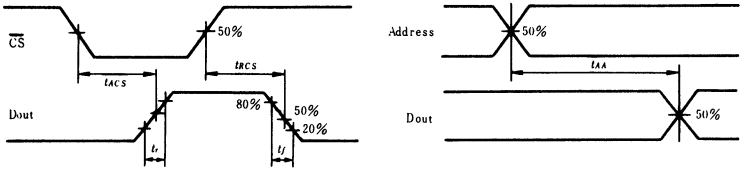
1. LOADING CONDITION



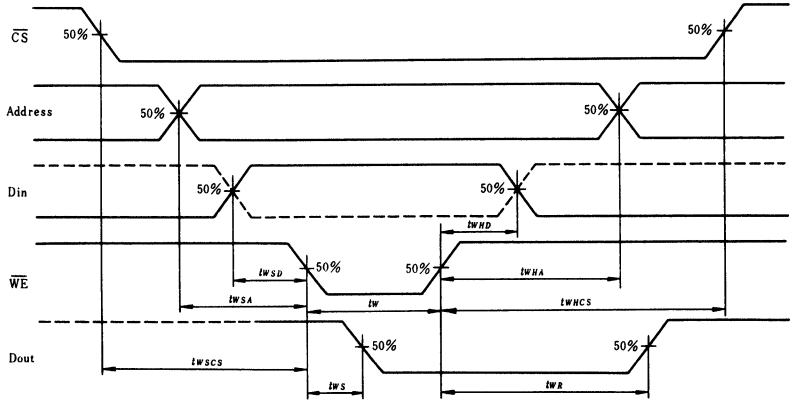
2. INPUT PULSE



3. READ MODE



4. WRITE MODE

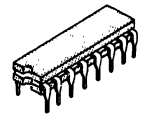


HM100415,HM100415CC

1024-word×1-bit Fully Decoded Random Access Memory

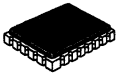
The HM100415 is a 1024-word x 1-bit, read/write random access memory developed for application to scratch pads, control and buffer storages which require very high speeds.
The HM100415 is compatible with the HD100K families and includes on-chip voltage and temperature compensation for improved noise margin. This memory is encapsulated in cerdip-16pin package.

HM100415



(DG-16A)

HM100415CC



(CC-24)

■FEATURES

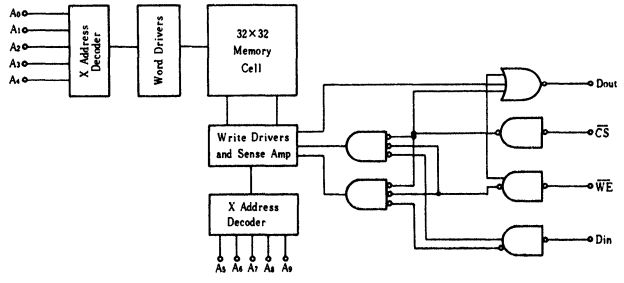
- Level ..... 100K ECL Compatible
- Organization ..... 1024-word by 1-bit
- Address Access Time ..... 10ns (max)
- Chip Select Access Time ..... 5ns (max.)
- Power Consumption ..... 0.6mW/bit (typ)
- Output Obtainable by Wired-OR (open emitter)
- Compatible with Fairchild F100415.

■TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

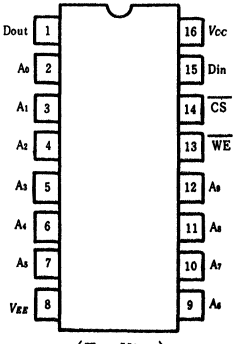
Notes) × : Irrelevant
* : Read Out Noninvert

■BLOCK DIAGRAM



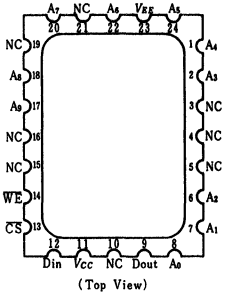
■PIN ARRANGEMENT

●HM100415



(Top View)

●HM100415CC



(Top View)

■ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

HITACHI

■ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{EE} = −4.5V, R_L = 50Ω to −2.0V, Ta = 0 to +85°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min(B)	typ	max(A)	Unit
Output Voltage	V_{OH}	V_{in} = V_{IHA} or V_{ILB}		−1025	−955	−880	mV
	V_{OL}			−1810	−1715	−1620	mV
Output Threshold Voltage	V_{OHC}	V_{in} = V_{IHB} or V_{ILA}		−1035	—	—	mV
	V_{OLC}			—	—	−1610	mV
Input Voltage	V_{IH}	Guaranteed Input Voltage		−1165	—	−880	mV
	V_{IL}	High/Low for All Inputs		−1810	—	−1475	mV
Input Current	I_{IH}	V_{in} = V_{IHA}		—	—	220	μA
	I_{IL}	V_{in} = V_{ILB}	$\overline{CS}$	0.5	—	170	μA
			Others	−50	—	—	
Supply Current	I_{EE}	All Inputs and Outputs Open		−200	−150	—	mA

●AC CHARACTERISTICS (V_{EE} = −4.5V ±5%, Ta = 0 to +85°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Chip Select Access Time	t_{ACS}		—	3	5	ns
Chip Select Recovery Time	t_{RCS}		—	3	5	ns
Address Access Time	t_{AA}		—	7	10	ns

2. WRITE MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Write Pulse Width	t_W	t_{WSA} − 2ns	6	4	—	ns
Data Setup Time	t_{WSD}		2	0	—	ns
Data Hold Time	t_{WHD}		2	0	—	ns
Address Setup Time	t_{WSA}	t_W − 6ns	2	0	—	ns
Address Hold Time	t_{WHA}		2	0	—	ns
Chip Select Setup Time	t_{WSCS}		2	0	—	ns
Chip Select Hold Time	t_{WHCS}		2	0	—	ns
Write Disable Time	t_{WS}		—	3	5	ns
Write Recovery Time	t_{WR}		—	3	5	ns

3. RISE/FALL TIME

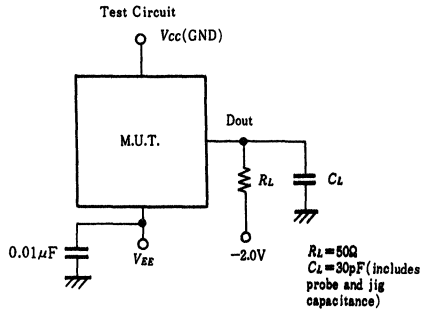
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

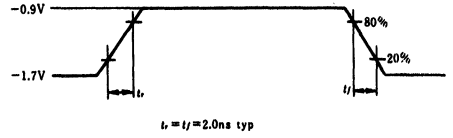
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	3	—	pF
Output Capacitance	C_{out}		—	5	—	pF

■ TEST CIRCUIT AND WAVEFORMS

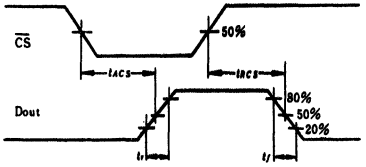
1. LOADING CONDITION

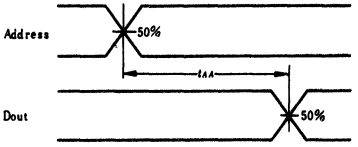


2. INPUT PULSE

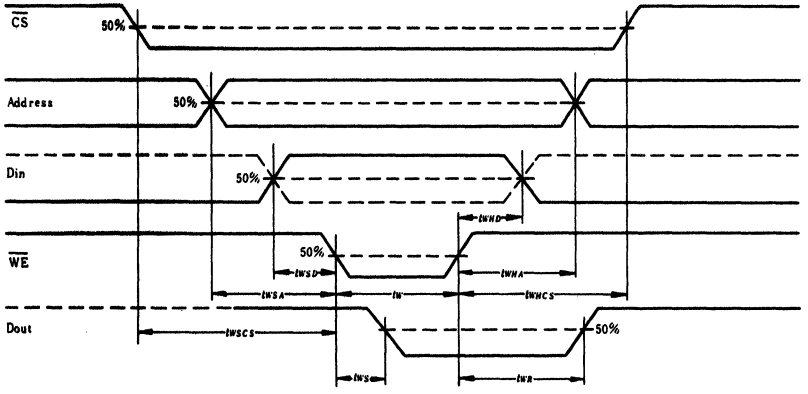


3. READ MODE





4. WRITE MODE



HM100422,HM100422F
HM100422CC

256-word×4-bit Fully Decoded Random Access Memory

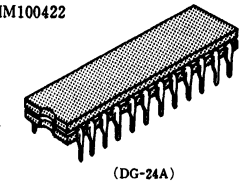
The HM100422 is ECL 100K compatible, 256-word x 4-bit, read write, random access memory developed for high speed system such as scratch pads and control/buffer storages.

Four active Low Block Select lines are provided to select each block independently.

The fabrication process is the Hitachi's low capacitance, oxide isolation method with double metalization.

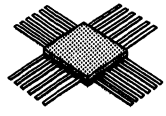
The HM100422 is encapsulated in cerdip-24pin package, or 24pin flat package compatible with Fairchild's F100422.

HM100422



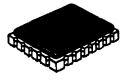
(DG-24A)

HM100422F



(FG-24)

HM100422CC



(CC-24)

■FEATURES

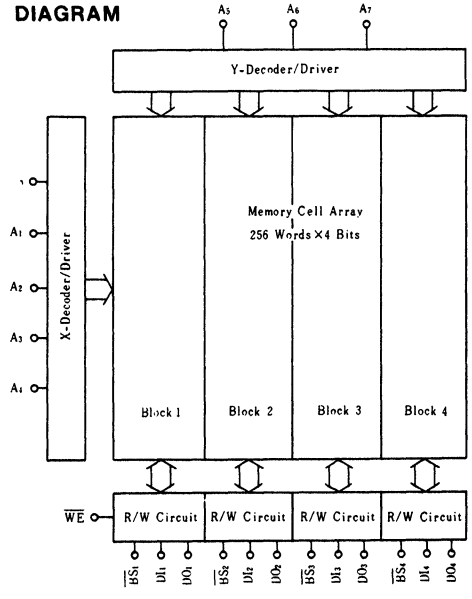
- 256-word x 4-bit organization
- Fully compatible with 100K ECL level
- Address access time: 10ns (max.)
- Minimum write pulse width: 6ns (min.)
- Low power dissipation: 0.8mW/bit
- Output obtainable by wired-OR (open emitter)

■TRUTH TABLE

Input			Output	Mode
$\overline{BS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

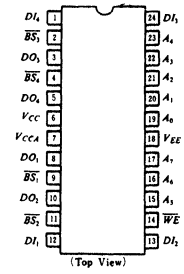
Notes) × : Irrelevant
* : Read Out Noninvert

■BLOCK DIAGRAM



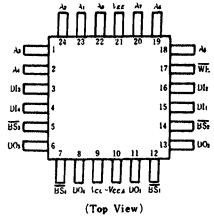
■PIN ARRANGEMENT

●HM100422



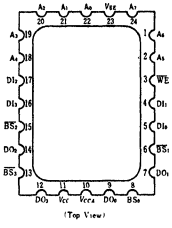
(Top View)

●HM100422F



(Top View)

●HM100422CC



(Top View)

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS (V_{EE}=−4.5V, R_L=50Ω to −2.0V, Ta=0 to +85°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min(B)	typ	max(A)	Unit
Output Voltage	V_{OH}	V_{in}=V_{IHA} or V_{ILB}		−1025	−955	−880	mV
	V_{OL}			−1810	−1715	−1620	mV
Output Threshold Voltage	V_{OHC}	V_{in}=V_{IHB} or V_{ILA}		−1035	—	—	mV
	V_{OLC}			—	—	−1610	mV
Input Voltage	V_{IH}	Guaranteed Input Voltage		−1165	—	−880	mV
	V_{IL}	High/Low for All Inputs		−1810	—	−1475	mV
Input Current	I_{IH}	V_{in}=V_{IHA}		—	—	220	μA
	I_{IL}	V_{in}=V_{ILB}	$\overline{BS}$	0.5	—	170	μA
			Others	−50	—	—	
Supply Current	I_{EE}	All Inputs and Outputs Open		−200	−165	—	mA

● AC CHARACTERISTICS (V_{EE}=−4.5V ±5%, Ta=0 to +85°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Block Select Access Time	t_{ABS}		—	—	5	ns
Block Select Recovery Time	t_{RBS}		—	—	5	ns
Address Access Time	t_{AA}		—	7	10	ns

2. WRITE MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Write Pulse Width	t_W	t_{WSA}=2ns	6	4.5	—	ns
Data Setup Time	t_{WSD}		2	0	—	ns
Data Hold Time	t_{WHD}		2	0	—	ns
Address Setup Time	t_{WSA}	t_W=6ns	2	0	—	ns
Address Hold Time	t_{WHA}		2	0	—	ns
Block Select Setup Time	t_{WSBS}		2	0	—	ns
Block Select Hold Time	t_{WHBS}		2	0	—	ns
Write Disable Time	t_{WS}		—	4	5	ns
Write Recovery Time	t_{WR}		—	4.5	9	ns

3. RISE/FALL TIME

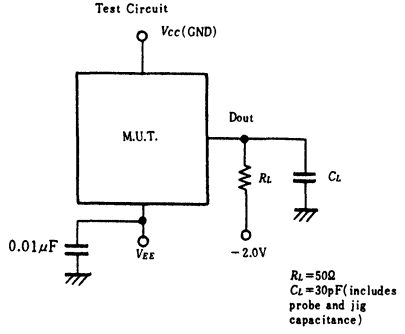
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

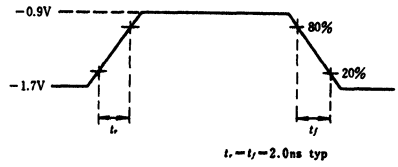
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	4	—	pF
Output Capacitance	C_{out}		—	7	—	pF

■ TEST CIRCUIT AND WAVEFORMS

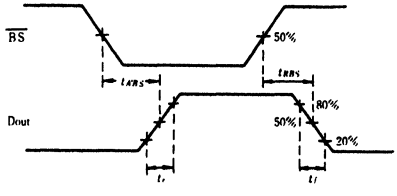
1. LOADING CONDITION

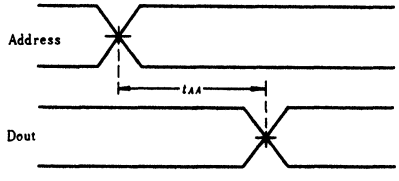


2. INPUT PULSE

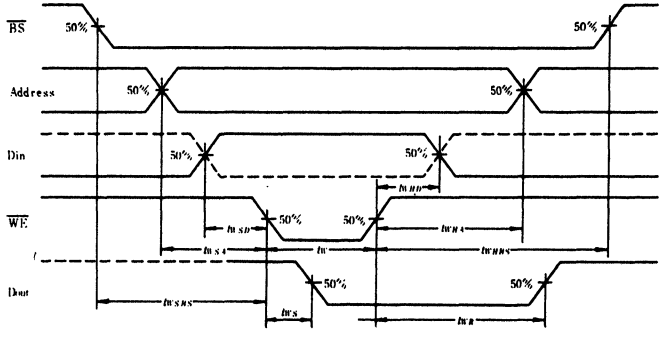


3. READ MODE





4. WRITE MODE



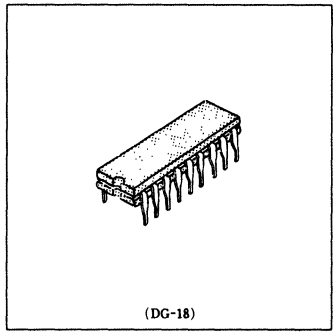
HM100470,HM100470-15

4096-word×1-bit Fully Decoded Random Access Memory

The HM100470 is a 4096-words x 1-bit, read/write, random access memory developed for high speed systems such as scratch pads and control buffer storages.

The fabrication process is the Hitachi's low capacitance, oxide isolation method with double metalization.

The HM100470 is compatible with the HD100K ECL families and includes on-chip voltage and temperature compensation for improved noise margin. This device is encapsulated in cerdip-18pin package, compatible with Fairchild's F100470.



(DG-18)

■ FEATURES

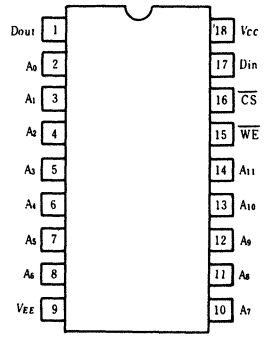
- 4096-word x 1-bit organization
- Full compatible with 100K ECL level
- Address access time: HM100470 25ns(max)
- HM100470-15 15ns(max)
- Write pulse width: HM100470 25ns (min)
- HM100470-15 15ns (min)
- Output obtainable by wired-OR (open emitter)

■ TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

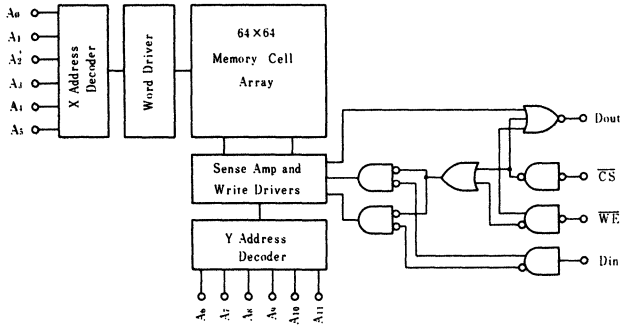
Notes) × : Irrelevant
* : Read Out Nonivert

■ PIN ARRANGEMENT



(Top View)

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{EE} = −4.5V, R_L = 50Ω to −2.0V, Ta = 0 to +85°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min (B)	typ	max (A)	Unit
Output Voltage	V_{OH}	V_{in} = V_{IHA} or V_{ILB}		−1025	−955	−880	mV
	V_{OL}			−1810	−1715	−1620	mV
Output Threshold Voltage	V_{OHC}	V_{in} = V_{IHB} or V_{ILA}		−1035	—	—	mV
	V_{OLC}			—	—	−1610	mV
Input Voltage	V_{IH}	Guaranteed Input Voltage High/Low for All Inputs		−1165	—	−880	mV
	V_{IL}			−1810	—	−1475	mV
Input Current	I_{IH}	V_{in} = V_{IHA}		—	—	220	μA
	I_{IL}	V_{in} = V_{ILB}	$\overline{CS}$	0.5	—	170	μA
			Others	−50	—	—	
Supply Current	I_{EE}	All Inputs and Outputs Open		−200	−165	—	mA

●AC CHARACTERISTICS (V_{EE} = −4.5V ±5%, Ta = 0 to +85°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	HM100470-15			HM100470			Unit
			min	typ	max	min	typ	max	
Chip Select Access Time	t_{ACS}		—	—	8	—	—	10	ns
Chip Select Recovery Time	t_{RCS}		—	—	8	—	—	10	ns
Address Access Time	t_{AA}		—	—	15	—	—	25	ns

2. WRITE MODE

Item	Symbol	Test Condition	HM100470-15			HM100470			Unit
			min	typ	max	min	typ	max	
Write Pulse Width	t_W	t_{WSA} = 3ns	15	—	—	25	—	—	ns
Data Setup Time	t_{WSD}		2	—	—	2	—	—	ns
Data Hold Time	t_{WHD}		2	—	—	2	—	—	ns
Address Setup Time	t_{WSA}	t_W = twmin	3	—	—	3	—	—	ns
Address Hold Time	t_{WHA}		2	—	—	2	—	—	ns
Chip Select Setup Time	t_{WSCS}		2	—	—	2	—	—	ns
Chip Select Hold Time	t_{WHCS}		2	—	—	2	—	—	ns
Write Disable Time	t_{WS}		—	—	8	—	—	10	ns
Write Recovery Time	t_{WR}		—	—	8	—	—	10	ns

3. RISE/FALL TIME

Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

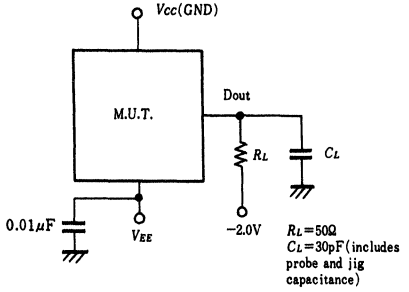
4. CAPACITANCE

Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	3	—	pF
Output Capacitance	C_{out}		—	5	—	pF

■ TEST CIRCUIT AND WAVEFORMS

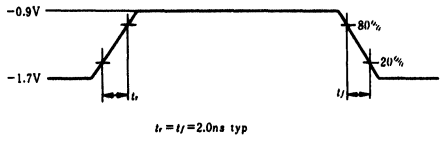
1. LOADING CONDITION

Test Circuit



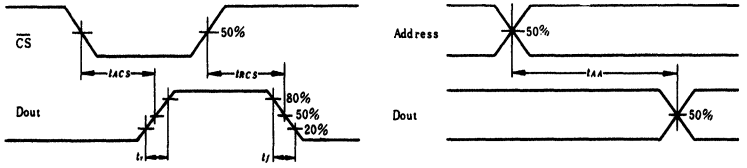
R_L=50Ω
C_L=30pF(includes probe and jig capacitance)

2. INPUT PULSE

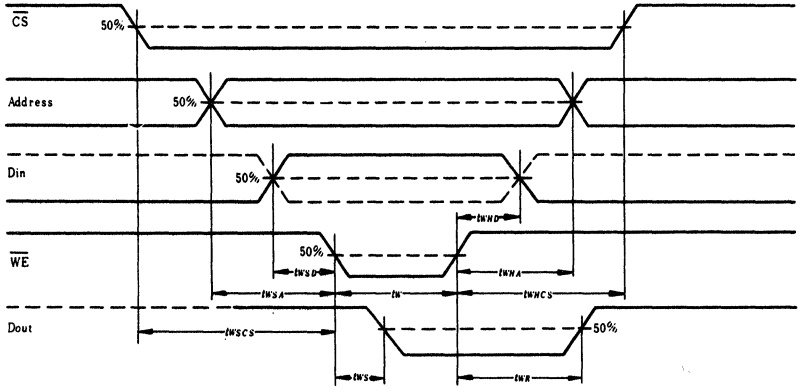


$t_r = t_f$=2.0ns typ

3. READ MODE



4. WRITE MODE



HM100474,HM100474-15
HM100474F,HM100474F-15

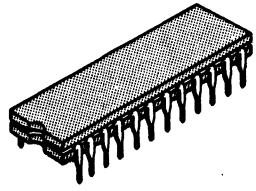
1024-word×4-bit Fully Decoded Random Access Memory

The HM100474 is a 1024-words x 4-bit, read/write, random access memory developed for high speed systems such as scratch pads and control/buffer storages.

The fabrication process is the Hitachi's low capacitance, oxide isolation method with double metalization.

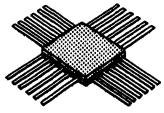
The HM100474 is compatible with the HD100K ECL families and includes on-chip voltage and temperature compensation for improved noise margin. This device is encapsulated in cerdip-24-pin and flat 24pin package, compatible with Fairchild's F100474.

HM100474, HM100474-15



(DG-24A)

HM100474F, HM100474F-15



(FG-24)

■FEATURES

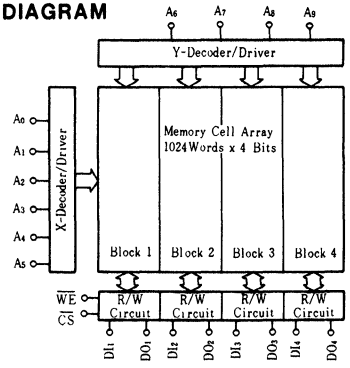
- 1024-word x 4-bit organization
- Fully compatible with 100K ECL level
- Address access time: HM100474/F 25ns(max)
  HM100474/F-15 15ns(max)
- Write pulse width: HM100474/F 25ns(min)
  HM100474/F-15 15ns(min)
- Output obtainble by wired-OR (open emitter)

■TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selected
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

Notes) × : Irrelevant
* : Read Out Nonivert

■BLOCK DIAGRAM



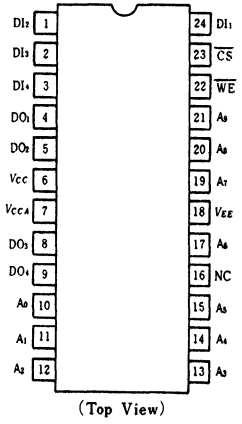
■ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

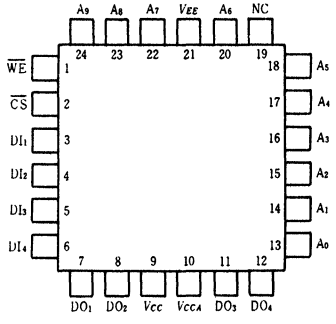
■PIN ARRANGEMENT

●HM100474,HM100474-15



(Top View)

●HM100474F,HM100474F-15



(Top View)

■ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{EE} = −4.5V, R_L = 50Ω to −2.0V, Ta = 0 to +85°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min(B)	typ	max(A)	Unit
Output Voltage	V_{OH}	V_{in} = V_{IHA} or V_{ILB}		−1025	−955	−880	mV
	V_{OL}			−1810	−1715	−1620	mV
Output Threshold Voltage	V_{OHC}	V_{in} = V_{IHB} or V_{ILA}		−1035	—	—	mV
	V_{OLC}			—	—	−1610	mV
Input Voltage	V_{IH}	Guaranteed Input Voltage High/Low for All Inputs		−1165	—	−880	mV
	V_{IL}			−1810	—	−1475	mV
Input Current	I_{IH}	V_{in} = V_{IHA}		—	—	220	μA
	I_{IL}	V_{in} = V_{ILB}	$\overline{CS}$	0.5	—	170	μA
			Others	−50	—	—	
Supply Current	I_{EE}	All Inputs and Outputs Open		−200	−165	—	mA

●AC CHARACTERISTICS (V_{EE} = −4.5V ±5%, Ta = 0 to +85°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	HM100474/F-15			HM100474/F			Unit
			min	typ	max	min	typ	max	
Chip Select Access Time	t_{ACS}		—	—	8	—	—	10	ns
Chip Select Recovery Time	t_{RCS}		—	—	8	—	—	10	ns
Address Access Time	t_{AA}		—	—	15	—	15	25	ns

2. WRITE MODE

Item	Symbol	Test Condition	HM100474/F-15			HM100474/F			Unit
			min	typ	max	min	typ	max	
Write Pulse Width	t_W	t_{WSA} = 3ns	15	—	—	25	15	—	ns
Data Setup Time	t_{WSD}		2	—	—	2	—	—	ns
Data Hold Time	t_{WHD}		2	—	—	2	—	—	ns
Address Setup Time	t_{WSA}	t_W = twmin	3	—	—	3	—	—	ns
Address Hold Time	t_{WHA}		2	—	—	2	—	—	ns
Chip Select Setup Time	t_{WSCS}		2	—	—	2	—	—	ns
Chip Select Hold Time	t_{WHCS}		2	—	—	2	—	—	ns
Write Disable Time	t_{WS}		—	—	8	—	—	10	ns
Write Recovery Time	t_{WR}		—	—	8	—	—	10	ns

3. RISE/FALL TIME

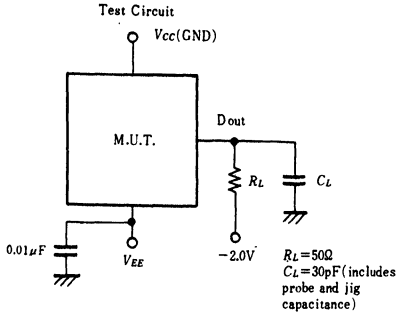
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

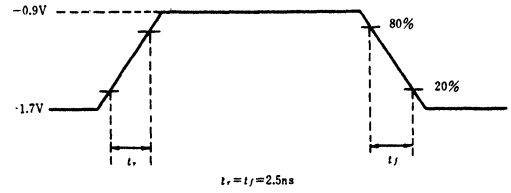
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	4	—	pF
Output Capacitance	C_{out}		—	7	—	pF

■ TEST CIRCUIT AND WAVEFORMS

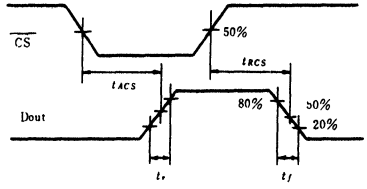
1. LOADING CONDITION

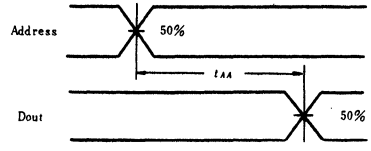


2. INPUT PULSE

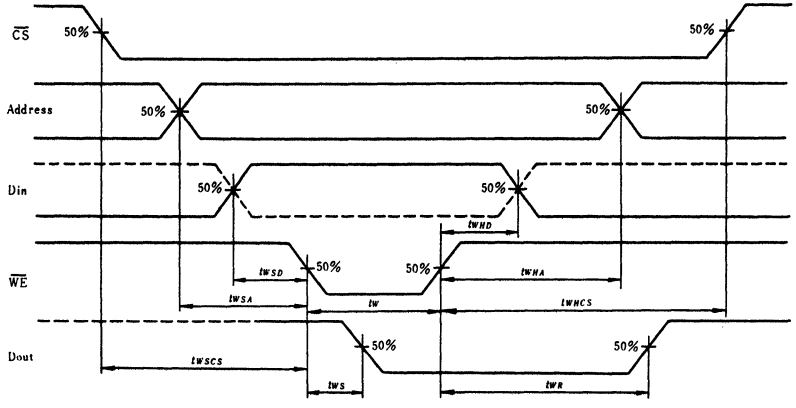


READ MODE

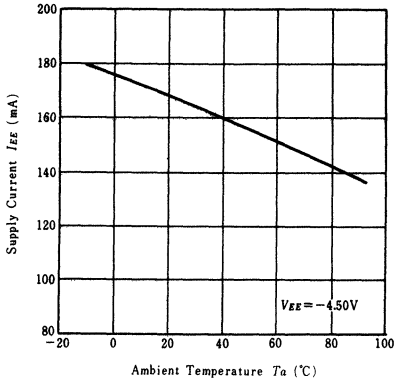




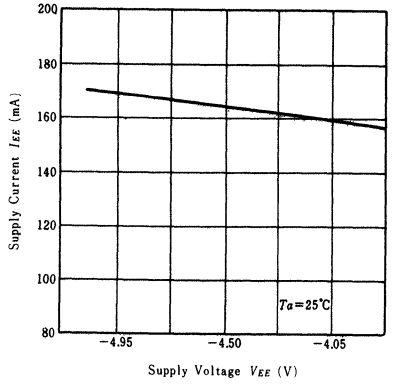
4. WRITE MODE



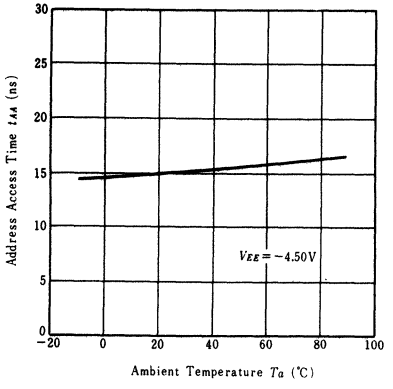
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



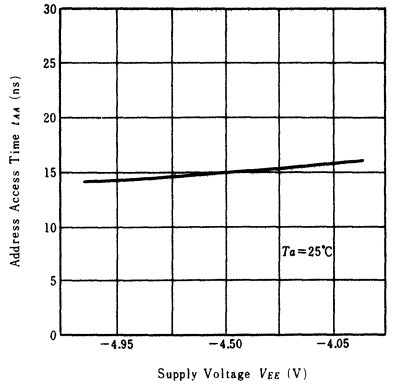
SUPPLY CURRENT vs. SUPPLY VOLTAGE



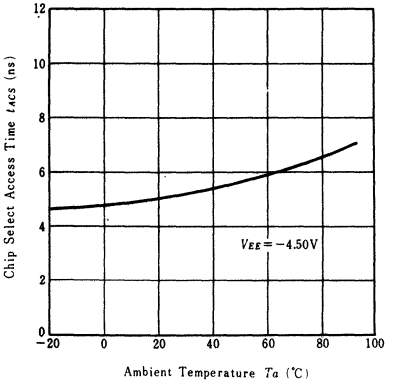
ADDRESS ACCESS TIME vs. AMBIENT TEMPERATURE



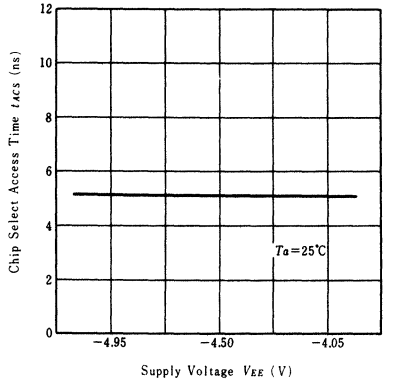
ADDRESS ACCESS TIME vs. SUPPLY VOLTAGE



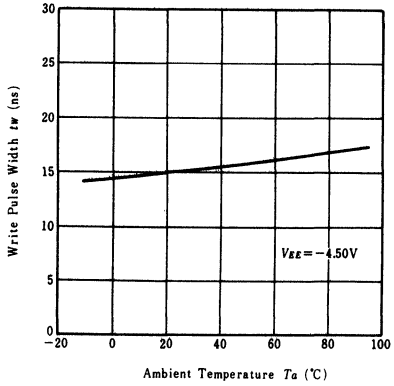
CHIP SELECT ACCESS TIME vs. AMBIENT TEMPERATURE



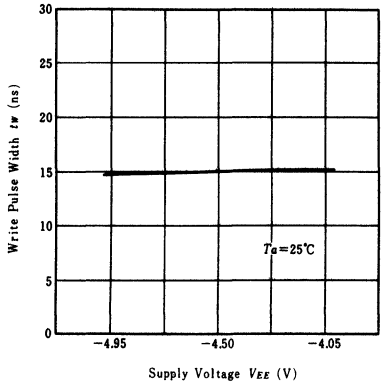
CHIP SELECT ACCESS TIME vs. SUPPLY VOLTAGE



WRITE PULSE WIDTH vs. AMBIENT TEMPERATURE



WRITE PULSE WIDTH vs. SUPPLY VOLTAGE

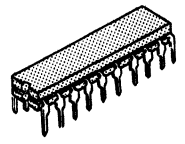


HM100480, HM100480F

16,384-words×1-bit Fully Decoded Random Access Memory

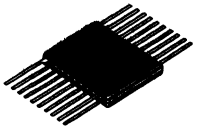
The HM100480 is ECL 100K compatible, 16,384-words x 1-bit, read/write random access memory developed for high speed systems such as scratch pads and control/buffer storages.
The fabrication process uses the Hitachi's low capacitance, oxide isolation method with double metalization.
The HM100480 is encapsulated in cerdip-20 pin and flat-20 pin package, compatible with Fairchild's 100480.

HM100480



(DG-20)

HM100480F



(FG-20)

■FEATURES

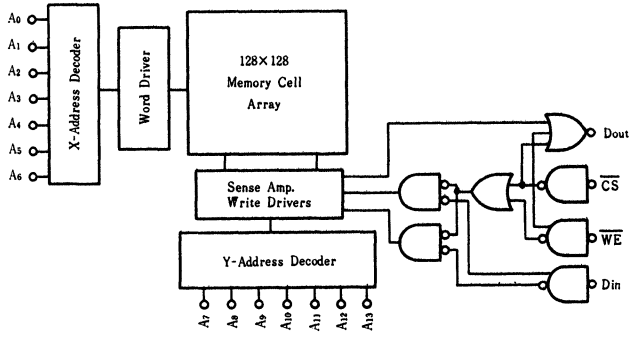
- 16,384-words x 1-bit organization
- Fully compatible with 100K ECL level
- Address access time: 25ns (max)
- Write pulse width: 25ns (min)
- Low power dissipation: 0.05mW/bit
- Output obtainable by wired-OR (open emitter)

■TRUTH TABLE

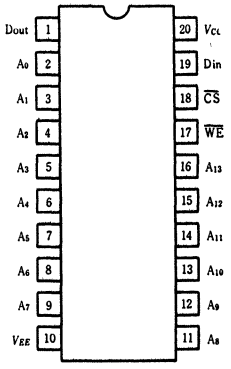
Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	L	Not Selcted
L	L	L	L	Write "0"
L	L	H	L	Write "1"
L	H	×	Dout*	Read

Notes) × : irrelevant
* : Read Out Noninvert

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

■ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

HITACHI

■ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{EE} to V_{CC}	+0.5 to −7.0	V
Input Voltage	V_{in}	+0.5 to V_{EE}	V
Output Current	I_{out}	−30	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS(V_{EE}=−4.5V, R_L=50Ω to −2.0V, Ta=0 to +85°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		min(B)	typ	max(A)	Unit
Output Voltage	V_{OH}	V_{in}=V_{IHA} or V_{ILB}		−1025	−955	−880	mV
	V_{OL}			−1810	−1715	−1620	mV
Output Threshold Voltage	V_{OHC}	V_{in}=V_{IHB} or V_{ILA}		−1035	—	—	mV
	V_{OLC}			—	—	−1610	mV
Input Voltage	V_{IH}	Guaranteed Input Voltage		−1165	—	−880	mV
	V_{IL}	High/Low for All Input		−1810	—	−1475	mV
Input Current	I_{IH}	V_{in}=V_{IHA}		—	—	220	μA
	I_{IL}	V_{in}=V_{ILB}	$\overline{CS}$	0.5	—	170	μA
			Others	−50	—	—	
Supply Current	I_{EE}	All Inputs and Outputs Open		−200	−165	—	mA

●AC CHARACTERISTICS (V_{EE}=−4.5V±5%, Ta=0 to +85°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Chip Select Access Time	t_{ACS}		2	—	10	ns
Chip Select Recovery Time	t_{RCS}		2	—	10	ns
Address Access Time	t_{AA}		3	—	25	ns

2. WRITE MODE

Item	Symbol	Test Condition	min	typ	max	Unit
Write Pulse Width	t_W	t_{WSA}=5ns	25	—	—	ns
Data Setup Time	t_{WSD}		5	—	—	ns
Data Hold Time	t_{WHD}		5	—	—	ns
Address Setup Time	t_{WSA}	t_W=t_W min	5	—	—	ns
Address Hold Time	t_{WHA}		5	—	—	ns
Chip Select Setup Time	t_{WSCS}		5	—	—	ns
Chip Select Hold Time	t_{WHCS}		—	—	5	ns
Write Disable Time	t_{WS}		—	—	10	ns
Write Recovery Time	t_{WR}		—	—	10	ns

3. RISE/FALL TIME

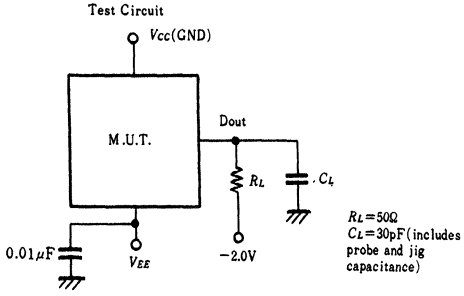
Item	Symbol	Test Condition	min	typ	max	Unit
Output Rise Time	t_r		—	2	—	ns
Output Fall Time	t_f		—	2	—	ns

4. CAPACITANCE

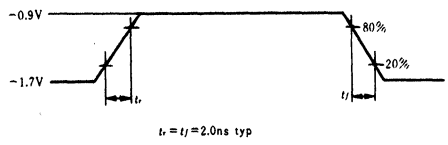
Item	Symbol	Test Condition	min	typ	max	Unit
Input Capacitance	C_{in}		—	3	—	pF
Output Capacitance	C_{out}		—	5	—	pF

■ TEST CIRCUIT AND WAVEFORMS

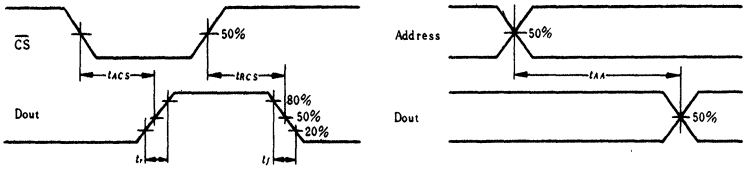
1. LOADING CONDITION



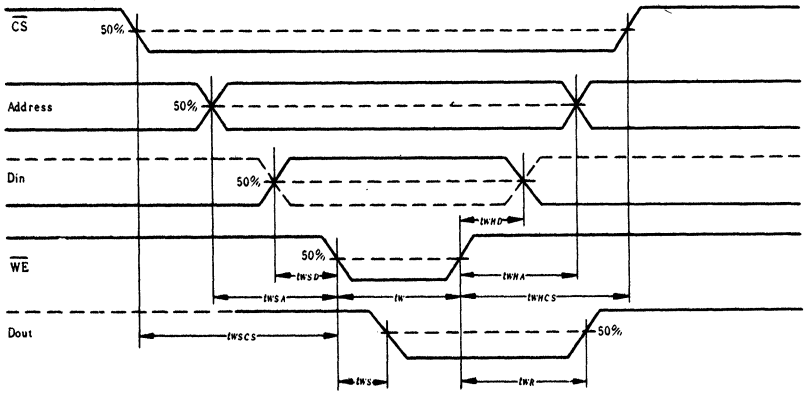
2. INPUT PULSE



3. READ MODE



4. WRITE MODE

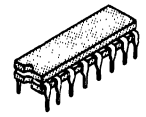


HM2504, HM2504-1

256-word×1-bit Fully Decoded Random Access Memory

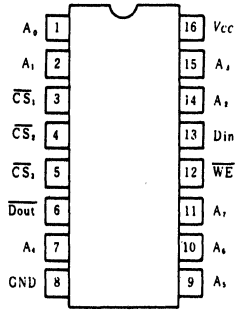
The HM2504 Series item is a TTL compatible, 256-word x 1-bit, read/write random access memory developed for application to buffer memories, control memories, high-speed main memories, etc. This is a fully decoded, read/write random access memory perfectly compatible with the TTL logic family, designed as an open collector output type for simplicity of expansion.

- Level ..... TTL compatible
- Construction ..... 256-word x 1 bit
- Read access time ..... HM2504: 55ns (max)
  HM2504-1: 45ns (max.)
- Chip select access time ..... 30ns (max.)
- Power consumption ..... 1.8mW/bit (typ)
- Output ..... Open collector



(DG-16)

■PIN ARRANGEMENT



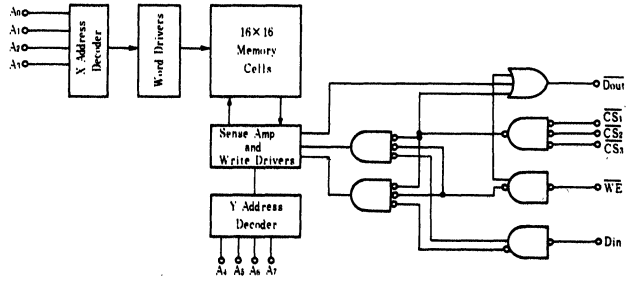
(Top View)

■TRUTH TABLE

Inputs			Output Open Collector	Mode
$\overline{CS}$	$\overline{WE}$	Din		
any one H	×	×	H	Not Selected
all L	L	L	H	Write "0"
all L	L	H	H	Write "1"
all L	H	×	$\overline{Dout}$*	Read

Notes) × : Don't care
* : Read out inverted

■BLOCK DIAGRAM



■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	HM2504, HM2504-1	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Input Current	I_{in}	−12 to +5.0	mA
Output Voltage (Output High)	V_{out}	−0.5 to +5.5	V
Output Voltage (DC Output Low)	I_{out}	+20	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS (V_{CC}=5.0V ±5%, Ta=0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		HM2504 Series			Unit
				min	typ	max	
Output Voltage	V_{OL}	V_{CC}=4.75V, I_{OL}=16mA		—	0.3	0.45	V
Input Voltage	V_{IH}	Guaranteed Input Voltage High		2.0	1.6	—	V
	V_{IL}	Guaranteed Input Voltage Low		—	1.5	0.85	V
Input Current	I_{IH}	V_{CC}=5.25V, V_{in}=4.5V		—	0	20	μA
	I_{IL}	V_{CC}=5.25V, V_{in}=0		—	−530	−800	μA
Output Leakage Current	I_{CEX}	V_{CC}=5.25V, V_{out}=4.5V		—	0	50	μA
Input Clamp Voltage	V_I	V_{CC}=5.25V, I_{in}=−10mA		—	−1.0	−1.5	V
Supply Current	I_{CC}	V_{CC}=5.25V All input GND	0<Ta<25°C	—	—	135	mA
			Ta≧25°C	—	—	130	mA

● AC CHARACTERISTICS

(V_{CC}=5.0V ±5%, Ta=0 to +75°C, air flow exceeding 2m/s, see test circuit and waveforms)

1. READ MODE

Item	Symbol	Test Condition	HM2504			HM2504-1			Unit
			min	typ	max	min	typ	max	
Chip Select Access Time	t_{ACS}		—	12	30	—	12	30	ns
Chip Select Recovery Time	t_{RCS}		—	18	25	—	18	25	ns
Address Access Time	t_{AA}		—	35	55	—	30	45	ns

2. WRITE MODE

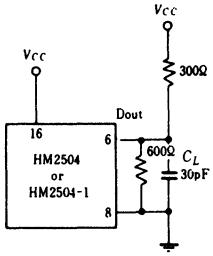
Item	Symbol	Test Condition	HM2504			HM2504-1			Unit
			min	typ	max	min	typ	max	
Write Pulse Width	t_W	t_{WSA}=0ns	30	8	—	30	8	—	ns
Data Setup Time	t_{WSD}		0	0	—	0	0	—	ns
Data Hold Time	t_{WHD}		5	0	—	5	0	—	ns
Address Setup Time	t_{WSA}	t_W=30ns	0	0	—	0	0	—	ns
Address Hold Time	t_{WHA}		5	0	—	5	0	—	ns
Chip Select Setup Time	t_{WSCS}		0	0	—	0	0	—	ns
Chip Select Hold Time	t_{WHCS}		5	0	—	5	0	—	ns
Write Disable Time	t_{WS}		—	14	35	—	14	35	ns
Write Recovery Time	t_{WR}		—	12	40	—	12	40	ns

3. CAPACITANCE

Item	Symbol	Test Condition	HM2504			HM2504-1			Unit
			min	typ	max	min	typ	max	
Input Capacitance	C_{in}		—	3	5	—	3	5	pF
Output Capacitance	C_{out}		—	6	8	—	6	8	pF

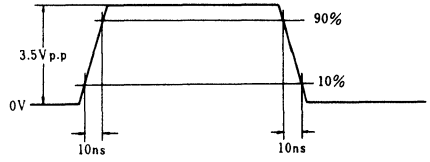
■ TEST CIRCUIT AND WAVEFORMS

1. LOADING CONDITION

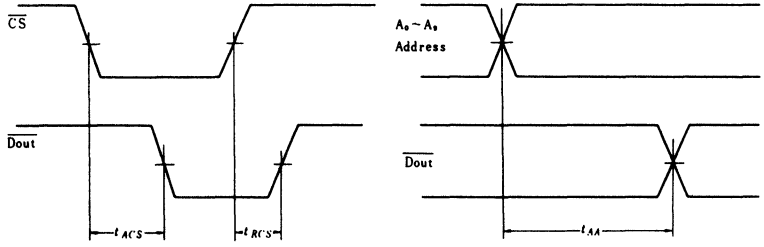


Note: C_L includes jig and stray capacitance

2. INPUT PULSE

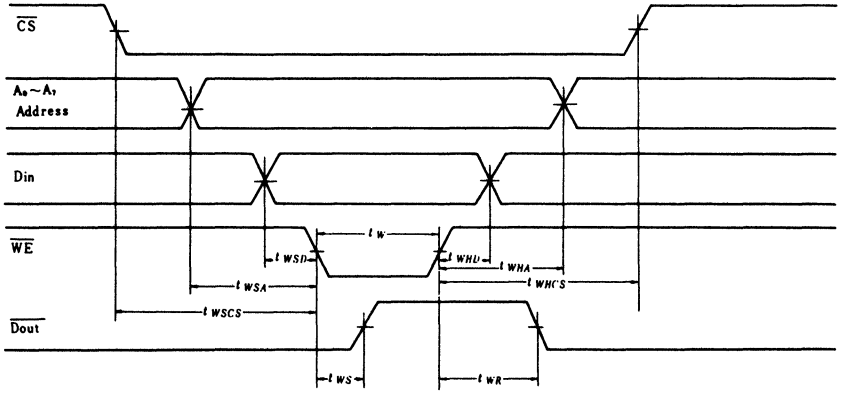


3. READ MODE



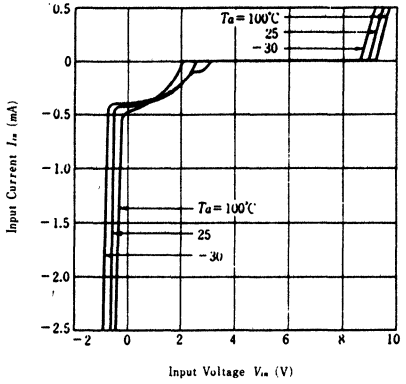
(All time measurements refer to 1.5V)

4. WRITE MODE

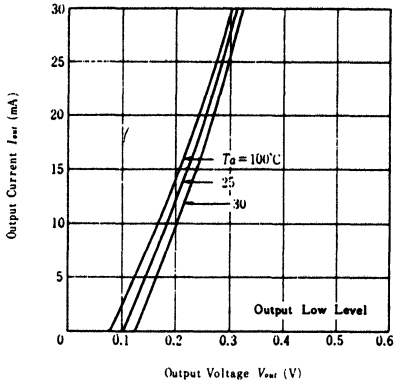


(All time measurements refer to 1.5V)

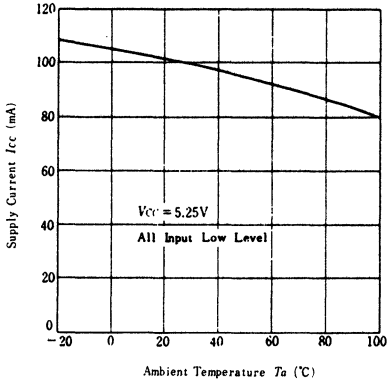
INPUT CHARACTERISTICS



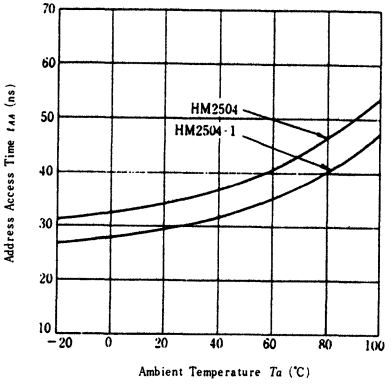
OUTPUT CHARACTERISTICS



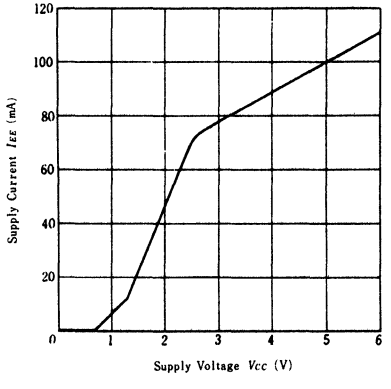
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



ADDRESS ACCESS TIME vs. AMBIENT TEMPERATURE



SUPPLY CURRENT vs. SUPPLY VOLTAGE

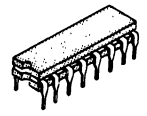


HM2510, HM2510-1, HM2510-2

1024-word×1-bit Fully Decoded Random Access Memory

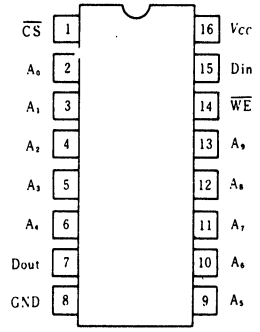
The HM2510 Series item is a 1024-word x 1-bit read/write random access memory developed for application to buffer memories, control memories, high-speed main memories, etc. It is a fully decoded, read write, random access memory perfectly compatible with TTL logic families, designed as an open collector output type for simplcity of expansion.

- Level ..... TTL compatible
- Construction ..... 1024-word x 1 bit
- Read access time ..... HM2510: 70ns (max.)
  HM2510-1: 45ns (max)
  HM2510-2: 35ns (max.)
- Chip select access time ..... HM2510: 40ns (max.)
  HM2510-1: 30ns (max.)
  HM2510-2: 25ns (max.)
- Power consumption 0.5mW/bit
- Output ..... Open collector



(DG-16A)

■ PIN ARRANGEMENT



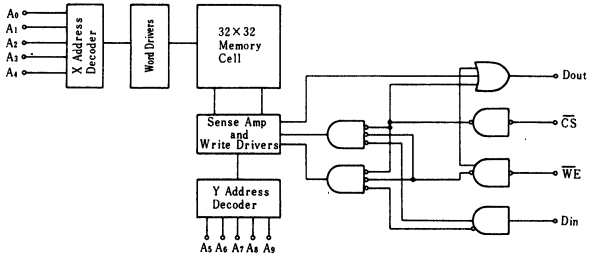
(Top View)

■ TRUTH TABLE

Inputs			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	H	Not Selected
L	L	L	H	Write "0"
L	L	H	H	Write "1"
L	H	×	Dout*	Read

Notes) × : Don't care
* : Read out non-inverted

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	HM2510 Series	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Input Current	I_{in}	−12 to +5.0	mA
Output Voltage (Output High)	V_{out}	−0.5 to +5.5	V
Output Voltage (DC Output Low)	I_{out}	+20	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS (V_{CC}=5.0V ±5%, Ta=0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition		HM2510 Series min	HM2510 Series typ	HM2510 Series max	Unit
Output Voltage	V_{OL}	V_{CC}=4.75V, I_{OL}=16mA		—	0.3	0.45	V
Input Voltage	V_{IH}	Guaranteed Input Voltage High		2.1	1.6	—	V
	V_{IL}	Guaranteed Input Voltage Low		—	1.5	0.80	V
Input Current	I_{IH1}	V_{CC}=5.25V, V_{in}=4.5V		—	0	40	μA
	I_{IH2}	V_{CC}=5.25V, V_{in}=5.25V		—	0	1.0	mA
	I_{IL}	V_{CC}=5.25V, V_{in}=0.4V		—	−250	−400	μA
Output Leakage Current	I_{CEX}	V_{CC}=5.25V, V_{out}=4.5V		—	0	100	μA
Input Clamp Voltage	V_I	V_{CC}=5.25V, I_{in}=−10mA		—	−1.1	−1.5	V
Supply Current	I_{CC}	V_{CC}=5.25V, All input GND	0< Ta <25°C	—	—	155	mA
			Ta≧25°C	—	95	130	mA

● AC CHARACTERISTICS (V_{CC}=5.0V ±5%, Ta=0 to +75°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	HM2510 min	HM2510 typ	HM2510 max	HM2510-1 min	HM2510-1 typ	HM2510-1 max	HM2510-2 min	HM2510-2 typ	HM2510-2 max	Unit
Chip Select Access Time	t_{ACS}		—	15	40	—	—	30	—	15	25	ns
Chip Select Recovery Time	t_{RCS}		—	25	40	—	—	30	—	17	25	ns
Address Access Time	t_{AA}		—	40	70	—	35	45	—	25	35	ns

2. WRITE MODE

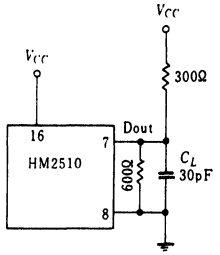
Item	Symbol	Test Condition	HM2510 min	HM2510 typ	HM2510 max	HM2510-1 min	HM2510-1 typ	HM2510-1 max	HM2510-2 min	HM2510-2 typ	HM2510-2 max	Unit
Write Pulse Width	t_W	t_{WSA}=min	50	10	—	35	10	—	25	10	—	ns
Data Setup Time	t_{WSD}		5	0	—	5	—	—	5	0	—	ns
Data Hold Time	t_{WHD}		5	0	—	5	—	—	5	0	—	ns
Address Setup Time	t_{WSA}	t_W=min	15	0	—	5	—	—	5	0	—	ns
Address Hold Time	t_{WHA}		5	0	—	5	—	—	5	0	—	ns
Chip Select Setup Time	t_{WSCS}		5	0	—	5	—	—	5	0	—	ns
Chip Select Hold Time	t_{WHCS}		5	0	—	5	—	—	5	0	—	ns
Write Disable Time	t_{WS}		—	20	40	—	20	35	—	15	25	ns
Write Recovery Time	t_{WR}		—	30	55	—	30	45	—	15	25	ns

3. CAPACITANCE

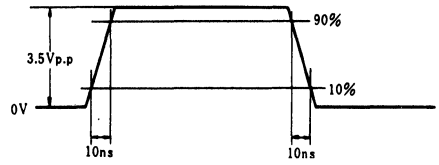
Item	Symbol	Test Condition	HM2510 Series			Unit
			min	typ	max	
Input Capacitance	C_{in}		—	3	5	pF
Output Capacitance	C_{out}		—	6	8	pF

■ TEST CIRCUIT AND WAVEFORMS

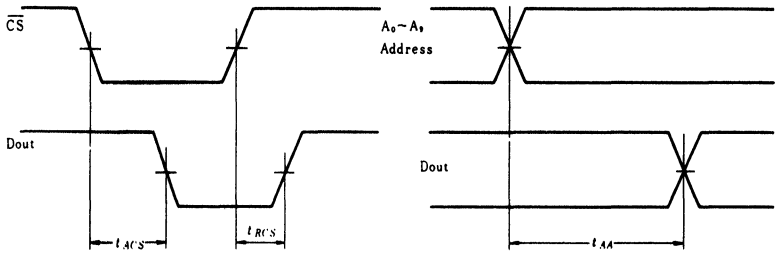
1. LOADING CONDITION



2. INPUT PULSE

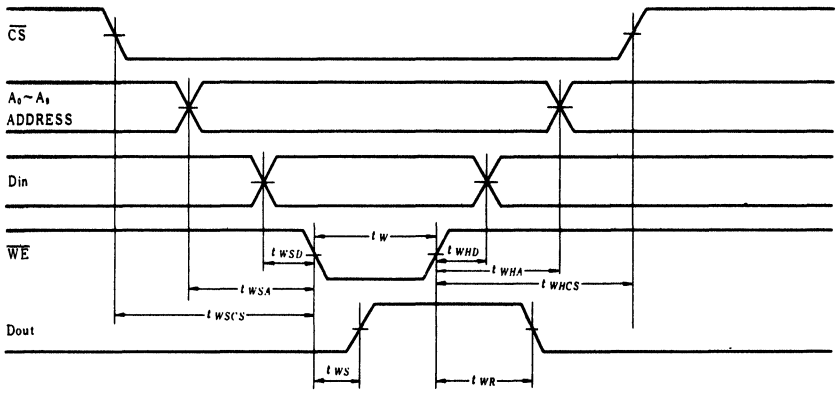


3. READ MODE



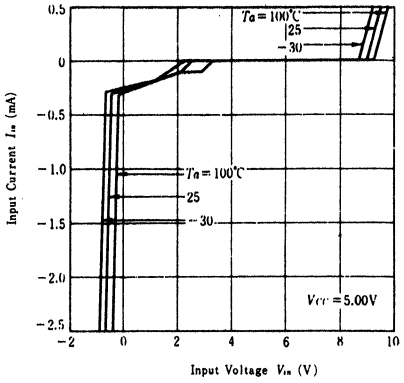
(All time measurements refer to 1.5V)

4. WRITE MODE

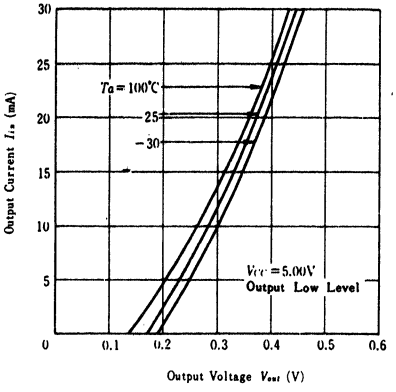


(All time measurements refer to 1.5V)

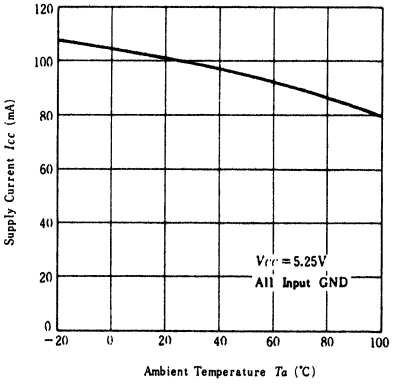
INPUT CHARACTERISTICS



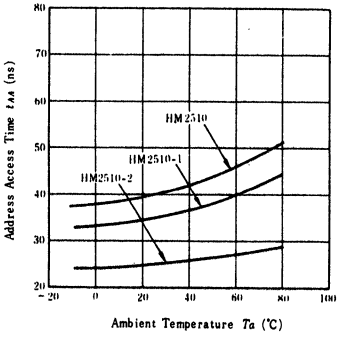
OUTPUT CHARACTERISTICS



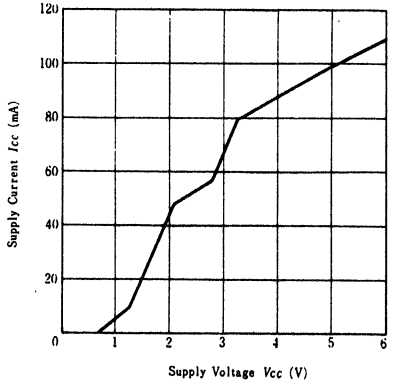
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



ADDRESS ACCESS TIME vs. AMBIENT TEMPERATURE



SUPPLY CURRENT vs. SUPPLY VOLTAGE

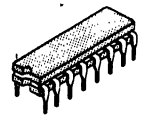


HM2511, HM2511-1

1024-word×1-bit Fully Decoded Random Access Memory

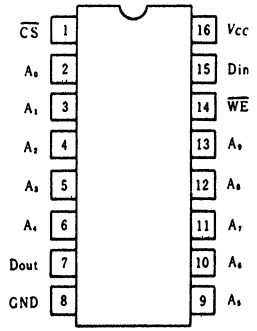
The HM2511 Series item is a 1024-word x 1-bit read/write random access memory with three-state output developed for application to buffer memories, control memories, high-speed main memories, etc. It is a fully decoded, read/write, random access memory perfectly compatible with TTL logic families.

- Level ..... TTL compatible
- Construction ..... 1024-word x 1 bit
- Read access time ..... HM2511: 70ns (max)
  HM2511-1: 45ns (max)
- Chip select access time ..... HM2511: 40ns (max)
  HM2511-1: 30ns (max)
- Power consumption 0.5mW/bit
- Output ..... three-state



(DG-16A)

■ PIN ARRANGEMENT



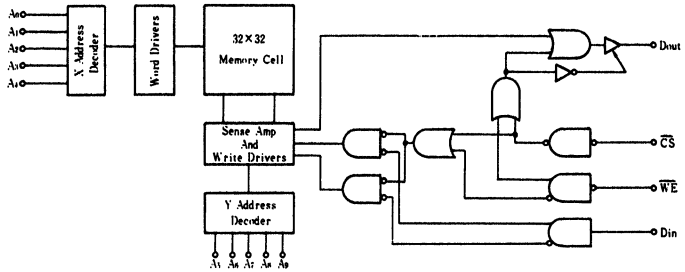
(Top View)

■ TRUTH TABLE

Input			Output	Mode
$\overline{CS}$	$\overline{WE}$	Din		
H	×	×	High Z	Not Selected
L	L	L	High Z	Write "0"
L	L	H	High Z	Write "1"
L	H	×	Dout*	Read

Notes) × : Don't care
* : Read out noninverted

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	HM2511 Series	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Input Current	I_{in}	−12 to +5.0	mA
Output Voltage (Output High)	V_{out}	−0.5 to +5.5	V
Output Voltage (DC Output Low)	I_{out}	+20	mA
Storage Temperature	T_{stg}	−65 to +150	°C
Storage Temperature	T_{stg}(Bias)*	−55 to +125	°C

* Under Bias

■ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{CC}=5.0V ±5%, Ta=0 to +75°C, air flow exceeding 2m/sec)

Item	Symbol	Test Condition	HM2511 Series			Unit
			min	typ	max	
Output Low Voltage	V_{OL}	V_{CC}=4.75V, I_{OL}=16mA	—	0.3	0.45	V
Input Voltage	V_{IH}	Guaranteed Input Voltage High	2.1	1.6	—	V
	V_{IL}	Guaranteed Input Voltage Low	—	1.5	0.8	V
Input Current	I_{IH1}	V_{CC}=5.25V, V_{in}=4.5V	—	0	40	μA
	I_{IH2}	V_{CC}=5.25V, V_{in}=5.25V	—	0	1.0	mA
	I_{IL}	V_{CC}=5.25V, V_{in}=0.4V	—	−250	−400	μA
Output Current (High Z)	I_{OFF1}	V_{CC}=5.25V, V_{out}=2.4V	—	—	50	μA
	I_{OFF2}	V_{CC}=5.25V, V_{out}=0.5V	—	—	−50	μA
Output Current Short Circuit to Ground	I_{OS}	V_{CC}=5.25V,	—	—	−100	mA
Output High Voltage	V_{OH}	I_{OH}=−10.3mA, V_{CC}=5.0V ±5%	2.4	—	—	V
Input Clamp Voltage	V_I	V_{CC}=5.25V, I_{in}=−10mA	—	−1.0	−1.5	V
Supply Current	I_{CC}	V_{CC}=5.25V, All input GND; 0≦Ta<25°C	—	—	155	mA
		V_{CC}=5.25V, All input GND; Ta≧25°C	—	95	130	mA

●AC CHARACTERISTICS (V_{CC}=5.0V ±5%, Ta=0 to +75°C, air flow exceeding 2m/sec)

1. READ MODE

Item	Symbol	Test Condition	HM2511			HM2511-1			Unit
			min	typ	max	min	typ	max	
Chip Select Access Time	t_{ACS}		—	15	40	—	—	30	ns
Chip Select to High Z	t_{ZRCS}		—	20	40	—	—	30	ns
Address Access Time	t_{AA}		—	40	70	—	35	45	ns

2. WRITE MODE

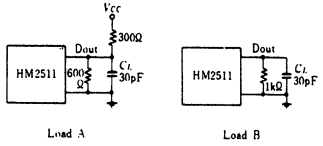
Item	Symbol	Test Condition	HM2511			HM2511-1			Unit
			min	typ	max	min	typ	max	
Write Pulse Width	t_W	t_{WSA}=min	50	25	—	35	10	—	ns
Data Setup Time	t_{WSD}		5	0	—	5	—	—	ns
Data Hold Time	t_{WHD}		5	0	—	5	—	—	ns
Address Setup Time	t_{WSA}	t_W=min	15	0	—	5	—	—	ns
Address Hold Time	t_{WHA}		5	0	—	5	—	—	ns
Chip Select Setup Time	t_{WSCS}		5	0	—	5	—	—	ns
Chip Select Hold Time	t_{WHCS}		5	0	—	5	—	—	ns
Write Disable to High Z	t_{ZWS}		—	20	40	—	20	35	ns
Write Recovery Time	t_{WR}		—	42	55	—	30	45	ns

3. CAPACITANCE

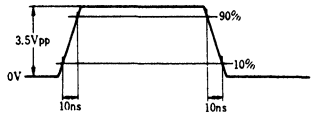
Item	Symbol	Test Condition	HM2511 Series			Unit
			min	typ	max	
Input Capacitance	C_{in}		—	3	5	pF
Output Capacitance	C_{out}		—	9	11	pF

■ TEST CIRCUIT AND WAVEFORMS

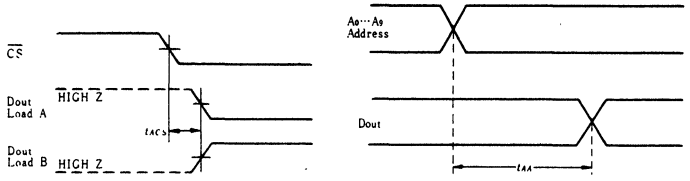
1. LOADING CONDITION



2. INPUT PULSE

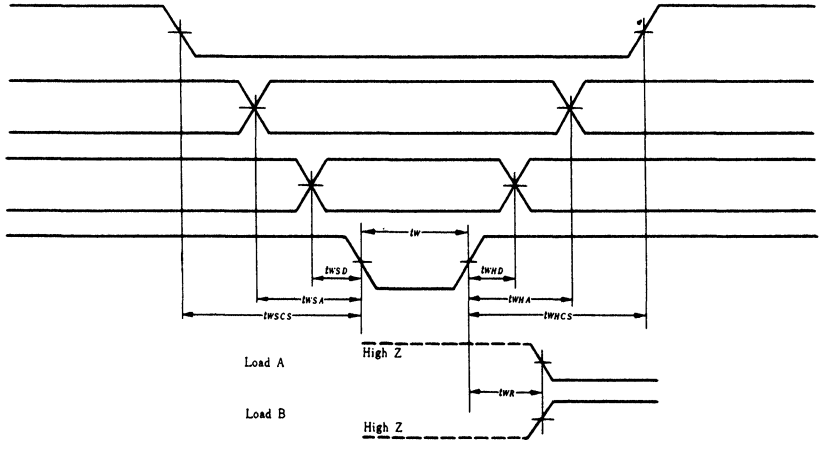


3. READ MODE



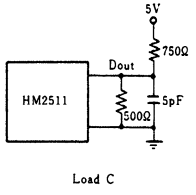
(All time measurements refer to 1.5V)

4. WRITE MODE

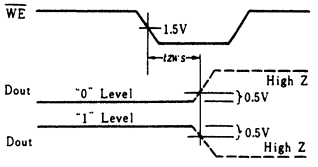


(All time measurements refer to 1.5V)

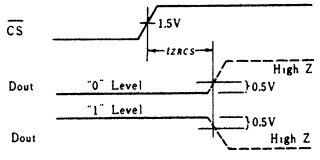
5. WRITE ENABLE TO HIGH Z DELAY



Load C



6. PROPAGATION DELAY FROM CHIP SELECT TO HIGH Z



(All t_{ZXXX} parameters are measured at a delta of 0.5V from the logic level and using Load C)

BIPOLAR PROM

■ PROGRAMMING INFORMATION

Hitachi's sophisticated Fine Emitter technology and programming pulse method enables higher programmability and faster programming time ordinary PROMs, for the highest reliability.

Fast programming time of typically 7.5μs/bit is achieved with a fine emitter cell which requires less programming energy; thus, negligible thermal stress. Further, Hitachi advanced technology allows very high programmability.

To assure that the element is programmed properly an additional four programming pulses are applied immediately after a sense pulse indicates conduction in the programmed (one programming pulse: Series) bit. This high reliability feature virtually eliminates aluminum migration in the programmed cell.

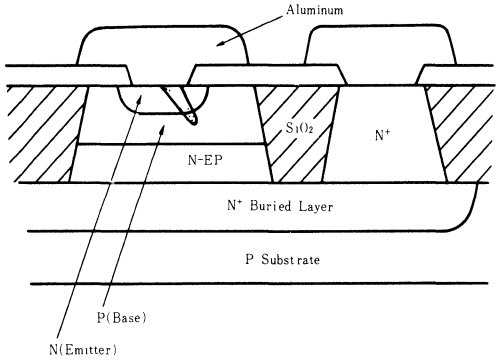
One extra row and one extra column of test cells, plus additional circuitry built into the PROM chip, allow improved factory testing of DC, AC and programming characteristics. These test cells and test circuitry provide enhanced correlation between programmed and unprogrammed circuits in order to guarantee high programmability and eliability.

The device is manufactured with outputs low (positive logic "zero") in all storage cells. To make an output high at a particular cell, a junction must be changed from a blocking state to a conducting state. This procedure is called programming.

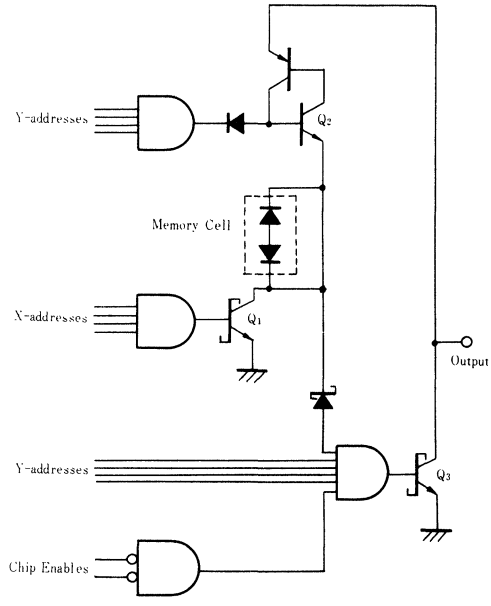
A logic "one" can be permanently programmed into a selected bit location. The desired bit for programming is selected using ten address inputs to turn on transistors Q1 and Q2. By taking either (or both) chip enable inputs high, the chip is disabled and transistor Q3 is held off. Then, a train of programming pulses applied to the desired output flows through the junction into transistor Q1. This programming current changes the junction to the conducting state. The pulse train is stopped as soon as the sensed voltage indicates that the selected bit is in the logic in state.

An additional 4 programming pulses (1 programming pulse: S-series) are required to ensure that the bit is fully programmed, and to achieve high reliability. One output must be programmed at a time, since the internal decording circuit is capable of sinking only one unit of programming current at time.

PROGRAMMED CELL (CROSS SECTION)



INTERNAL PROGRAMMING CIRCUIT



■HITACHI PROMS AND PROGRAMMING CURRENT

Memory Size	Organization	Output	N-Series	S-Series
4k	1k×4	O.C.	HN25044 (50ns max)	—
		3 S	HN25045 (50ns max)	—
8k	2k×4	O.C.	HN25084 (60ns max)	HN25084S(50ns max)
		3 S	HN25085 (60ns max)	HN25085S(50ns max)
	1k×8	O.C.	HN25088 (60ns max) HN25088L(100ns max)	HN25088S(50ns max)
		3 S	HN25089 (60ns max) HN25089L(100ns max)	HN25089S(50ns max)
16k	2k×8	O.C.	—	HN25168S(60ns max)
		3 S	—	HN25169S(60ns max)
Programming Current			130mA(typ)	90mA(typ)

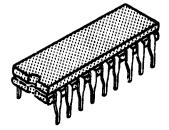
Note) O.C. : Open Collector Output
3 S : Three State Output

Hitachi's PROM has two families in accordance with the program specifications. They are usually discriminated by the suffix of the model name. For the S-series PROM, the production technique established for the N-series PROM is further improved to attain very small memory cell area and chip area as well as high performance.

HN25044, HN25045

1024-word×4-bit Programmable Read Only Memory

The HITACHI HN25044 and HN25045 are high speed electrically programmable, fully decoded TTL Bipolar 4096 bit read only memories organized at 1024 words by 4 bits with on-chip address decoding and two chip enable inputs. The HN25044 and HN25045 are fabricated with logic level "zeros" (low); logic level "ones" (high) can be electrically programmed in the selected bit locations. The same address inputs are used for both programming and reading.

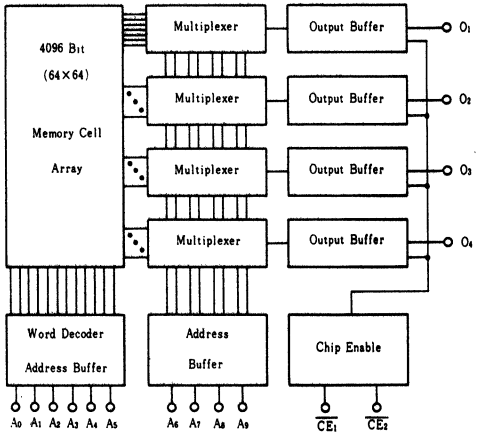


(DG-18)

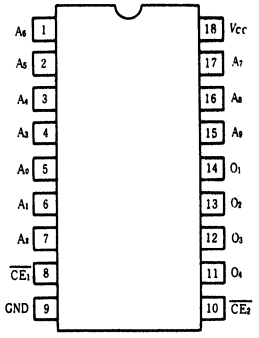
■ FEATURES

- 1024 words x 4 bits organization (fully decoded)
- TTL Compatible inputs and outputs
- Fast read access time; 30 ns typ. (50 ns max.)
- Medium power consumption; 500 mW typ.
- Two Chip enable inputs for memory expansion
- Open collector outputs (HN25044)/Three-state outputs (HN25045)
- Standard cerdip 18-pin package

■ BLOCK DIAGRAM



■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Output Voltage	V_{out}	−0.5 to +5.5	V
Output Current	I_{out}	50	mA
Operating Temperature	T_{opr}	−25 to +75	°C
Storage Temperature	T_{stg}	−65 to +150	°C

■ DC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to +75°C)

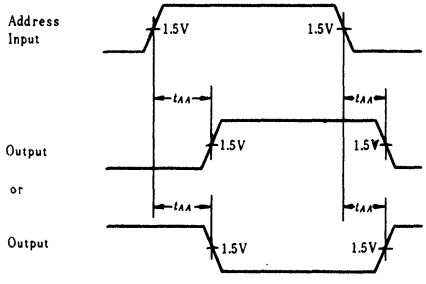
Item	Symbol	Test Condition	HN25044			HN25045			Unit
			min	typ	max	min	typ	max	
Input Voltage	V_{IH}		2.0	—	—	2.0	—	—	V
	V_{IL}		—	—	0.8	—	—	0.8	V
Output Voltage	V_{OH}	I_{OH}=−2mA	—	—	—	2.4	—	—	V
	V_{OL}	I_{OL}=16mA	—	—	0.45	—	—	0.45	V
Input Current	I_{IH}	V_{IH}=2.7V	—	—	40	—	—	40	μA
	I_{IL}	V_{IL}=0.4V	—	—	−0.4	—	—	−0.4	mA
Output Leakage Current	I_{OLK}	V_{out}=5.5V	—	—	100	—	—	100	μA
		V_{out}=0.4V	—	—	40	—	—	40	
Input Clamp Voltage	V_I	I_{in}=−18mA	—	—	−1.2	—	—	−1.2	V
Power Supply Current	I_{CC}	Input Either Open or at Ground	—	100	130	—	100	130	mA
Output Short-circuit Current	I_{OS}	V_{out}=0V	—	—	—	15	30	60	mA
Input Capacitance	C_{in}	V_{in}=2V, V_{CC}=0V	—	5	10	—	5	10	pF
Output Capacitance	C_{out}	V_{out}=0V, V_{CC}=0V	—	7	12	—	7	12	pF

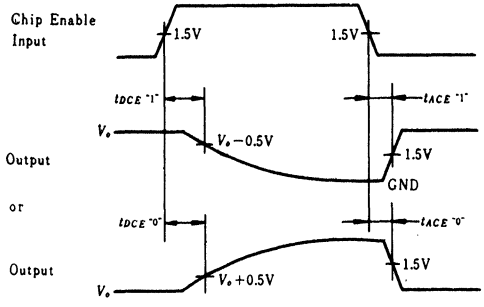
■ AC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to 75°C)

Item	Symbol	min	typ	max	Unit
Address Access Time	t_{AA}	—	35	50	ns
Chip Enable Access Time	t_{ACE}	—	20	30	ns
Chip Enable Disable Time	t_{DCE}	—	20	30	ns

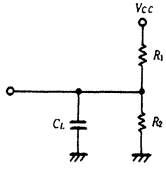
Notes: 1. Typ. value is at V_{CC}=5.0 V and T_a = 25°C
2. Output disable time is the time taken for the output to reach a high resistance state when either chip enable is taken high. Output enable time is the time taken for the output to become active when both chip enables are taken low. The high resistance state is defined as a point on the output waveform equal to a ΔV of 0.5 V from the active output level.

■ SWITCHING WAVEFORMS





■ SWITCHING TIME TEST CONDITIONS



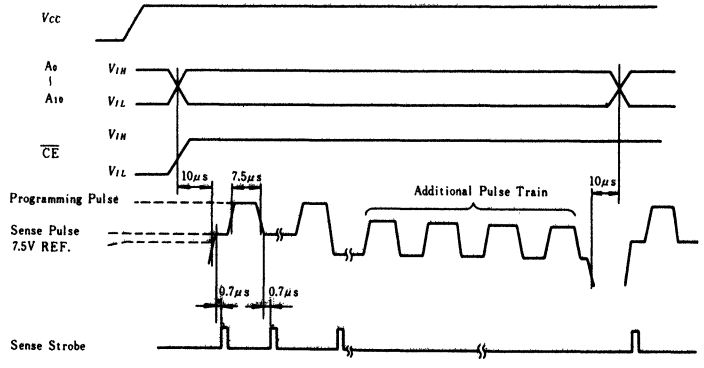
SWITCHING PARAMETER	HN25044			HN25045		
	R_1	R_2	C_L	R_1	R_2	C_L
t_{AA}	300Ω	600Ω	30pF	300Ω	600Ω	30pF
t_{ACE} "1"	—	—	—	∞	600Ω	10pF
t_{ACE} "0"	300Ω	600Ω	10pF	300Ω	600Ω	10pF
t_{DCE} "1"	—	—	—	∞	600Ω	30pF
t_{DCE} "0"	300Ω	600Ω	30pF	300Ω	600Ω	30pF

INPUT CONDITIONS
Amplitude - 0V to 3V
Rise and Fall time - 5ns from 1V to 2V
Frequency - 1MHz

■ PROGRAMMING SPECIFICATION

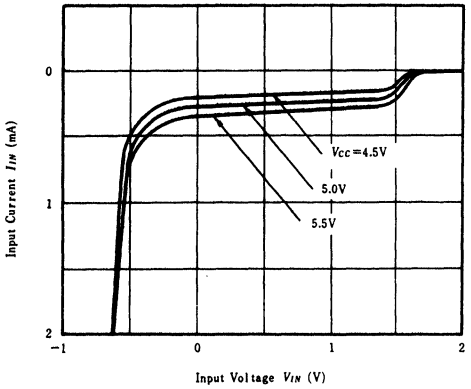
Characteristic	Limit	Unit	Notes
Ambient Temperature	25±5	°C	
Programming Pulse			
Amplitude	130±5%	mA	
Clamp Voltage	20+0%−2%	V	
Ramp Rate	70max	V/μs	
Pulse Width	7.5±5%	μs	10V point/150Ω load
Duty Cycle	70% min		
Sense Current			
Amplitude	20±0.5	mA	
Clamp Voltage	20+0%−2%	V	
Ramp Rate	70max	V/μs	10V point/150Ω load
Sense current interruption before and after address change	10min	μs	
Programming V_{CC}	5.0+5%−0%	V	
Maximum Sensed Voltage for programmed "1"	7.5±0.1	V	
Delay from trailing edge of programming pulse before sensing output voltage	0.7min	μs	
Programming Time Allocation/Bit	100max	ms	
Additional Programming Pulse Number	4	Time	

■ TYPICAL WAVEFORMS

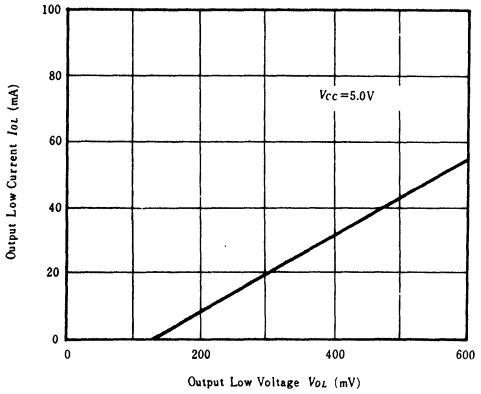


■ TYPICAL DC CHARACTERISTICS

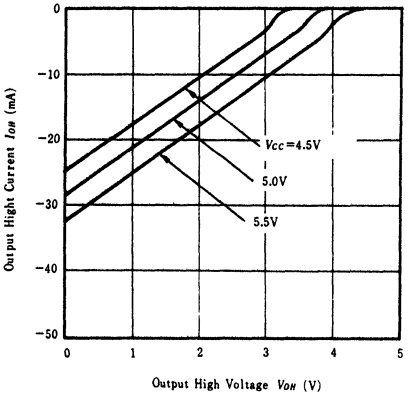
INPUT CURRENT vs. INPUT VOLTAGE



OUTPUT LOW CURRENT vs. OUTPUT LOW VOLTAGE

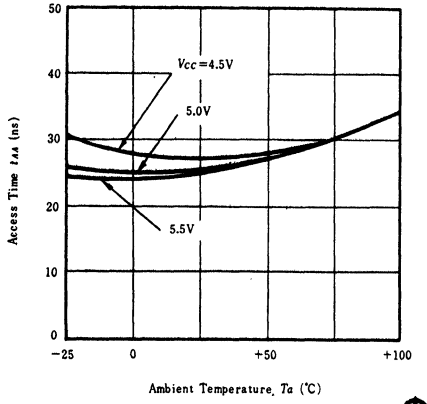


OUTPUT HIGH CURRENT vs. OUTPUT HIGH VOLTAGE (HN25045)

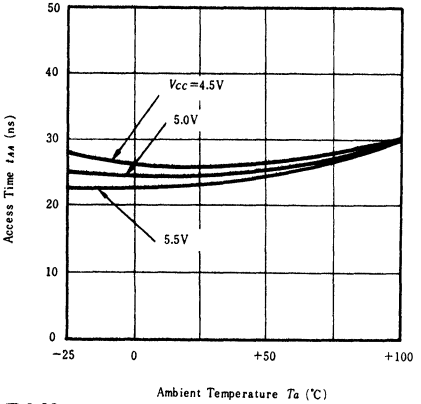


■ TYPICAL AC CHARACTERISTICS

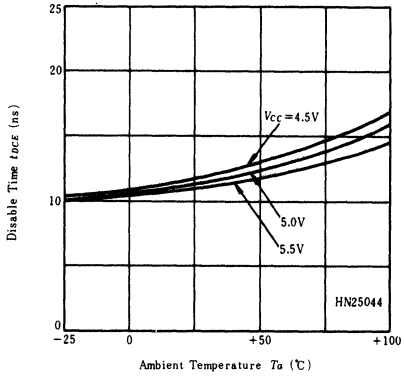
ACCESS TIME vs. AMBIENT TEMPERATURE (HN25044)



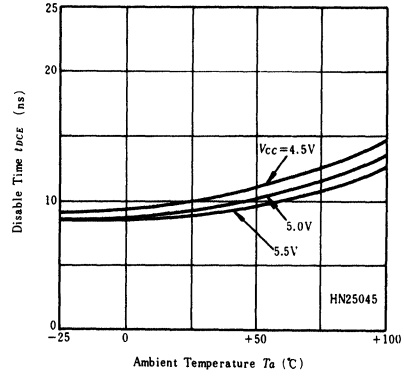
ACCESS TIME vs. AMBIENT TEMPERATURE (HN25045)



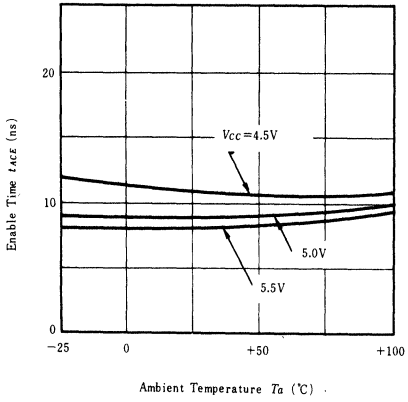
DISABLE TIME vs. AMBIENT TEMPERATURE (HN25044)



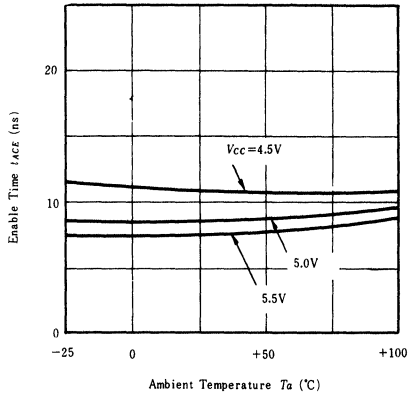
DISABLE TIME vs. AMBIENT TEMPERATURE (HN25045)



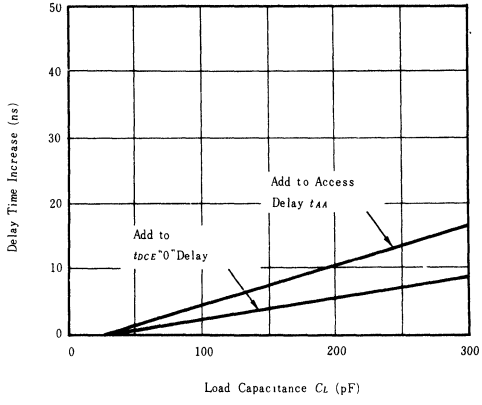
ENABLE TIME vs. AMBIENT TEMPERATURE (HN25044)



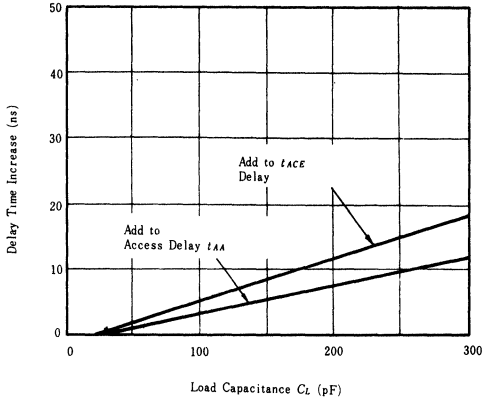
ENABLE TIME vs. AMBIENT TEMPERATURE (HN25045)



DELAY TIME INCREASE vs. LOAD CAPACITANCE (HN25044)



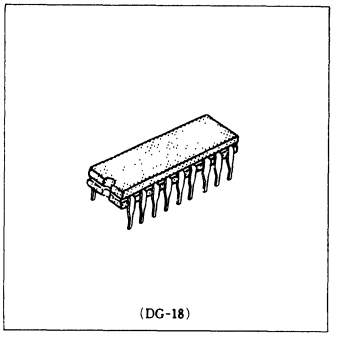
DELAY TIME INCREASE vs. LOAD CAPACITANCE (HN25045)



HN25084, HN25085

2048-word×4-bit Programmable Read Only Memories

The HITACHI HN25084 and HN25085 are high speed electrically programmable, fully decoded TTL Bipolar 8192 bit read only memories organized as 2048 word by 4 bit with on-chip address decoding and one chip enable input. The HN25084 and HN25085 are fabricated with logic level "zeros" (low); logic level "ones" (high) can be electrically programmed in the selected bit locations. The same address inputs are used for both programming and reading.



(DG-18)

■ FEATURES

- 2048 word x 4 bit organization (fully decoded)
- TTL compatible inputs and outputs
- Fast read access time: 40 ns typ. (60 ns max)
- Medium power consumption: 550 mW typ.
- One chip enable input for memory expansion
- Open collector outputs (HN25084)/Three-state outputs (HN25085)
- Standard cerdip 18-pin dual in-line package

■ OPERATION

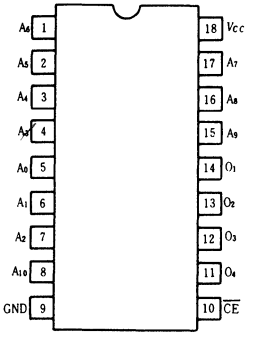
- **Programming**

A logic one can be permanently programmed into a selected bit location by using programming equipment. First, the desired word is selected by the ten address inputs in TTL level. The device is disabled by bringing $\overline{CE}$ to a logic "one". Then a train of high current programming pulses is applied to the desired output. After the sensed voltage indicates that the selected bit is in the logic "one" state, an additional pulse train is applied, then is stopped.

- **Reading**

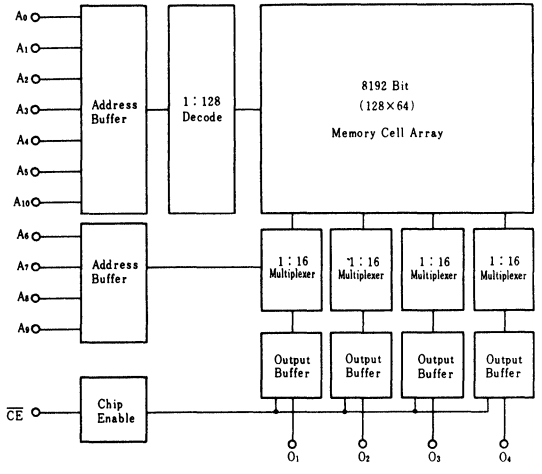
To read the memory the device is enabled by bringing $\overline{CE}$ to a logic "zero". The outputs then correspond to the data programmed in the selected word.

■ PIN ARRANGEMENT



(Top View)

■ LOGIC DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Output Voltage	V_{out}	−0.5 to +5.5	V
Output Current	I_{out}	50	mA
Operating Temperature	T_{opr}	−25 to +75	°C
Storage Temperature	T_{stg}	−65 to +150	°C

■ DC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to 75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Input High Voltage	V_{IH}		2.0	—	—	V
Input Low Voltage	V_{IL}		—	—	0.8	V
Input High Current	I_{IH}	V_I=2.7V	—	—	40	μA
Input Low Current	$-I_{IL}$	V_I=0.4V	—	—	0.40	mA
Output Low Voltage	V_{OL}	I_{OL}=16mA	—	—	0.45	V
Output Leakage Current	I_{OLK1}	V_O=5.25V	—	—	100	μA
Output Leakage Current	I_{OLK2}	V_O=0.4V	—	—	40	μA
Input Clamp Voltage	V_I	I_I=−18mA	—	—	−1.2	V
Power Supply Current	I_{CC}	Inputs Either Open or at Ground	—	110	150	mA
Output High Voltage*	V_{OH}	I_O=−2mA	2.4	—	—	V
Output Short Circuit Current*	$-I_{OS}$	V_O=0V	15	—	60	mA

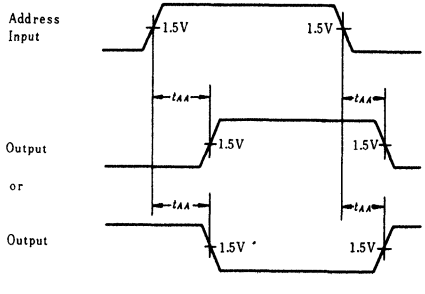
* Note: Applicable to HN25089 only.

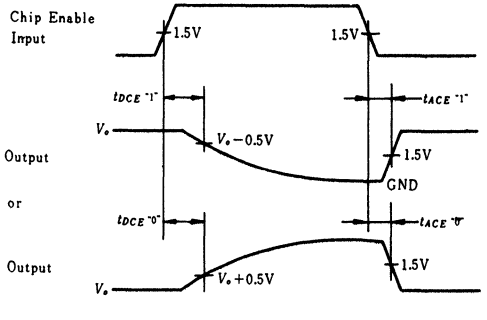
■ AC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to 75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Address Access Time	t_{AA}		—	40	60	ns
Chip Enable Access Time	t_{ACE}		—	25	35	ns
Chip Enable Disable Time	t_{DCE}		—	25	35	ns

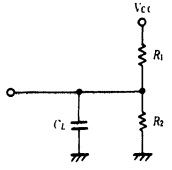
Note) 1. Output Load: See Test Circuit.
2. Measurement Reference: 1.5V for both inputs and outputs.

■ SWITCHING WAVEFORMS





■ SWITCHING TIME TEST CONDITIONS



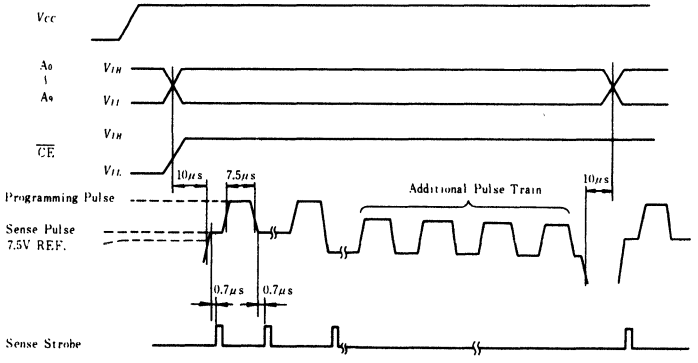
SWITCHING PARAMETER	HN25084			HN25085		
	R_1	R_2	C_L	R_1	R_2	C_L
t_{AA}	300Ω	600Ω	30pF	300Ω	600Ω	30pF
t_{ACE} "1"	—	—	—	∞	600Ω	10pF
t_{ACE} "0"	300Ω	600Ω	10pF	300Ω	600Ω	10pF
t_{DCE} "1"	—	—	—	∞	600Ω	30pF
t_{DCE} "0"	300Ω	600Ω	30pF	300Ω	600Ω	30pF

INPUT CONDITIONS
Amplitude − 0V to 3V
Rise and Fall time − 5ns from 1V to 2V
Frequency − 1MHz

■ PROGRAMMING SPECIFICATION

Characteristic	Limit	Unit	Notes
Ambient Temperature	25±5	°C	
Programming Pulse			
Amplitude	130±5%	mA	
Clamp Voltage	20±2%	V	
Ramp Rate	70max	V/μs	
Pulse Width	7.5±5%	μs	10V point/150Ω load
Duty Cycle	70% min		
Sense Current			
Amplitude	20±0.5	mA	
Clamp Voltage	20±2%	V	
Ramp Rate	70max	V/μs	
Sense Current Interruption before and after address change	10min	μs	
Programming V_{CC}	5.0+5%−0%	V	
Maximum Sensed Voltage for programmed "1"	7.5±0.1	V	
Delay from trailing edge of programming pulse before sensing output voltage	0.7min	μs	
Programming Pulse Number	100max	ms	
Additional Programming Pulse Number	4	Time	

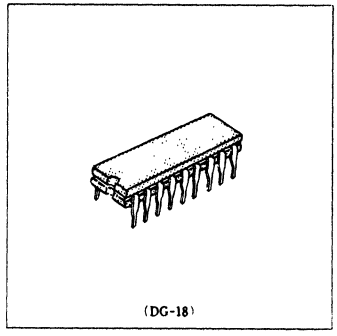
■ TYPICAL WAVEFORMS



HN25084S, HN25085S

2048-word × 4-bit Programmable Read Only Memories

The HITACHI HN25084S and HN25085S are high speed electrically programmable, fully decoded TTL Bipolar 8192 bit read only memories organized as 2048 words by 4 bits with on-chip address decoding and one chip enable input. The HN25084S and HN25085S are fabricated with logic level "zeros" (low); logic level "ones" (high) can be electrically programmed in the selected bit locations. The same address inputs are used for both programming and reading.



■ FEATURES

- 2048 words x 4 bits organization (fully decoded)
- TTL compatible inputs and outputs
- Fast read access time: 25 ns typ. (50 ns max)
- Medium power consumption: 550 mW typ.
- One chip enable input for memory expansion
- Open collector outputs (HN25084S)/Three-state outputs (HN25085S)
- Standard cerdip 18-pin dual in-line package

■ OPERATION

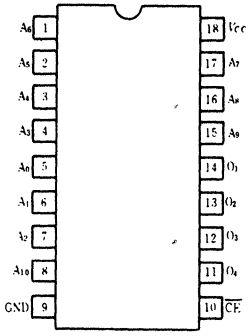
- **Programming**

A logic one can be permanently programmed into a selected bit location by using programming equipment. First, the desired word is selected by the ten address inputs in TTL level. The device is disabled by bringing $\overline{CE}$ to a logic "one". Then a train of high current programming pulses is applied to the desired output. After the sensed voltage indicates that the selected bit is in the logic "one" state, an additional pulse train is applied, then is stopped.

- **Reading**

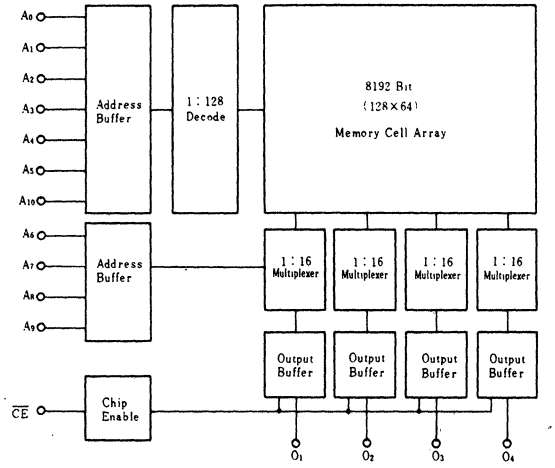
To read the memory the device is enabled by bringing $\overline{CE}$ to a logic "zero". The outputs then correspond to the data programmed in the selected word.

■ PIN ARRANGEMENT



(Top View)

■ LOGIC DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Output Voltage	V_{out}	−0.5 to +5.5	V
Output Current	I_{out}	50	mA
Operating Temperature	T_{opr}	−25 to +75	°C
Storage Temperature	T_{stg}	−65 to +150	°C

■ DC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to 75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Input High Voltage	V_{IH}		2.0	—	—	V
Input Low Voltage	V_{IL}		—	—	0.8	V
Input High Current	I_{IH}	V_I=2.7V	—	—	40	μA
Input Low Current	$-I_{IL}$	V_I=0.4V	—	—	0.40	mA
Output Low Voltage	V_{OL}	I_O=16mA	—	—	0.45	V
Output Leakage Current	I_{OLK1}	V_O=5.25V	—	—	100	μA
Output Leakage Current	I_{OLK2}	V_O=0.4V	—	—	40	μA
Input Clamp Voltage	V_I	I_I=−18mA	—	—	−1.2	V
Power Supply Current	I_{CC}	Inputs Either Open or at Ground	—	110	160	mA
Output High Voltage*	V_{OH}	I_O=−2mA	2.4	—	—	V
Output Short Circuit Current*	$-I_{OS}$	V_O=0V	15	—	60	mA

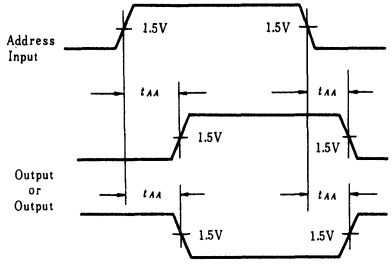
* Note: Applicable to HN25089 only.

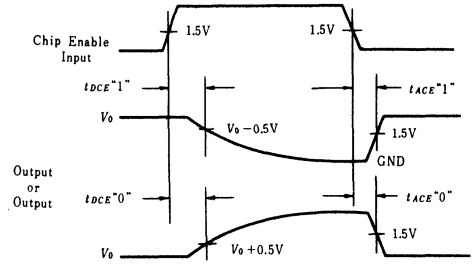
■ AC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to 75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Address Access Time	t_{AA}		—	25	50	ns
Chip Enable Access Time	t_{ACE}		—	20	35	ns
Chip Enable Disable Time	t_{DCE}		—	15	35	ns

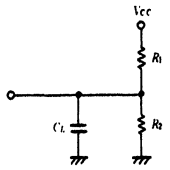
Note) 1. Output Load: See Test Circuit.
2. Measurement Reference: 1.5V for both inputs and outputs.

■ SWITCHING WAVEFORMS





■ SWITCHING TIME TEST CONDITIONS

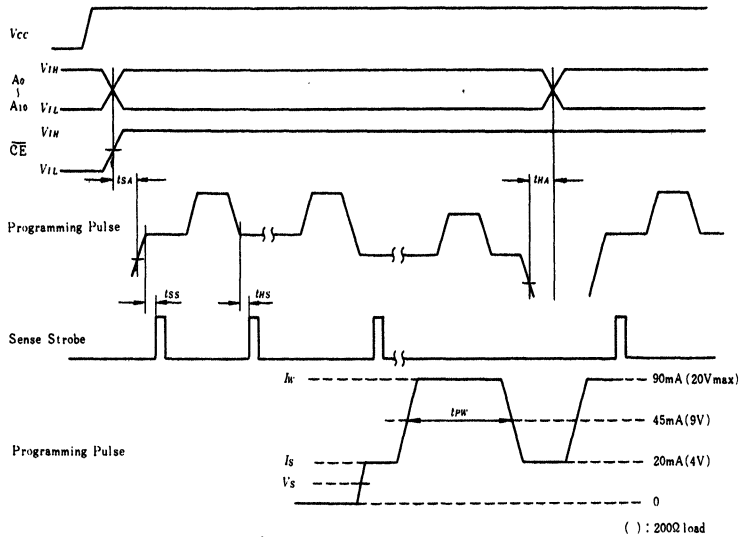


SWITCHING PARAMETER	HN25084S			HN25085S		
	R_1	R_2	C_L	R_1	R_2	C_L
t_{AA}	300Ω	600Ω	30pF	300Ω	600Ω	30pF
t_{ACE} "1"	—	—	—	∞	600Ω	10pF
t_{ACE} "0"	300Ω	600Ω	10pF	300Ω	600Ω	10pF
t_{DCE} "1"	—	—	—	∞	600Ω	30pF
t_{DCE} "0"	300Ω	600Ω	30pF	300Ω	600Ω	30pF

INPUT CONDITIONS
Amplitude – 0V to 3V
Rise and Fall time – 5ns from 1V to 2V
Frequency – 1MHz

■ PROGRAMMING SPECIFICATION

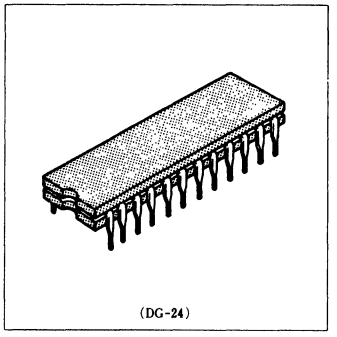
PARAMETER	Symbol	min	typ	max	Unit	Note
Ambient Temperature	Ta	20	25	30	°C	
Programming V_{CC}	V_{CC}	4.75	5.0	5.25	V	
Programming Pulse						
Amplitude	I_W	88	90	92	mA	
Clamp Voltage	V_W	19.0	19.5	20.0	V	
Ramp Rate		10	—	70	V/μs	
Pulse Width	t_{PW}	7.1	7.5	7.9	μs	9V point/200Ω load
Duty Cycle		70	—	—	%	
Sense Current						
Amplitude	I_S	19	20	21	mA	
Sense Voltage	V_S	7.4	7.5	7.6	V	
Clamp Voltage		19.0	19.5	20.0	V	
Ramp Rate		70	—	—	V/μs	
Address Setup Time	t_{SA}	10	—	—	μs	
Address Hold Time	t_{HA}	10	—	—	μs	
Sense Setup Time	t_{SS}	0.7	—	—	μs	
Sense Hold Time	t_{HS}	0.7	—	—	μs	
Additional Programming Pulse		1	1	1	time	
Programming Pulse Number per bit	n	—	—	10000	time	



HN25088, HN25089

1024-word × 8-bit Programmable Read Only Memories

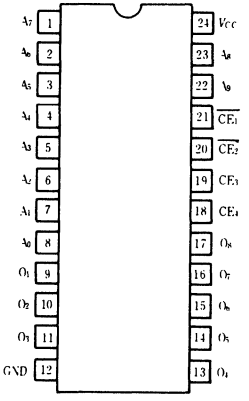
The HITACHI HN25088 and HN25089 are high speed electrically programmable, fully decoded TTL Bipolar 8192 bit read only memories organized as 1024 words by 8 bits with on-chip address decoding and four chip enable inputs. The HN25088 and HN25089 are fabricated with logic level "zeros" (low); logic level "ones" (high) can be electrically programmed in the selected bit locations. The same address inputs are used for both programming and reading.


(DG-24)

■ FEATURES

- 1024 words x 8 bits organization (fully decoded)
- TTL compatible inputs and outputs
- Fast read access time: 40 ns (typ), 60 ns (max)
- Medium power consumption: 600 mW typ.
- Four chip enable inputs for memory expansion
- Open collector outputs (HN25088)/Three-state outputs (HN25089)
- Standard cerdip 24-pin dual in-line package

■ PIN ARRANGEMENT



(Top View)

■ OPERATION

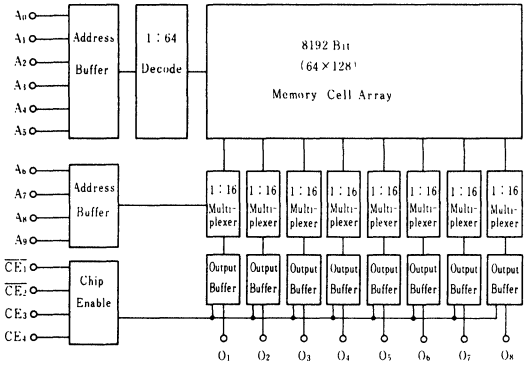
- **Programming**

A logic one can be permanently programmed into a selected bit location by using programming equipment. First, the desired word is selected by the ten address inputs in TTL level. The device is disabled by bringing $\overline{CE1}$ and/or $\overline{CE2}$ to as logic "one" or CE3 and/or CE4 to a logic "zero". Then a train of high current programming pulses is applied to the desired output. After the sensed voltage indicates that the selected bit is in the logic one state, an additional pulse train is applied, then is stopped.

- **Reading**

To read the memory the device is enabled by bringing $\overline{CE1}$ and $\overline{CE2}$ to a logic "zero". CE3 and CE4 to a logic "one". The outputs them correspond to the data programmed in the selected word.

■ LOGIC DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Output Voltage	V_{out}	−0.5 to +5.5	V
Output Current	I_{out}	50	mA
Operating Temperature	T_{opr}	−25 to +75	°C
Storage Temperature	T_{stg}	−65 to +150	°C

■ DC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to +75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Input High Voltage	V_{IH}		2.0	—	—	V
Input Low Voltage	V_{IL}		—	—	0.8	V
Input High Current	I_{IH}	V_I=2.7V	—	—	40	μA
Input Low Current	$-I_{IL}$	V_I=0.4V	—	—	0.40	mA
Output Low Voltage	V_{OL}	I_{OL}=16mA	—	—	0.45	V
Output Leakage Current	I_{OLK1}	V_O=5.25V	—	—	100	μA
Output Leakage Current	I_{OLK2}	V_O=0.4V	—	—	40	μA
Input Clamp Voltage	V_I	I_I=−18mA	—	—	−1.2	V
Power Supply Current	I_{CC}	Inputs Either Open or at Ground	—	120	160	mA
Output High Voltage*	V_{OH}	I_{OH}=−2mA	2.4	—	—	V
Output Short Circuit Current*	$-I_{OS}$	V_O=0V	15	—	60	mA

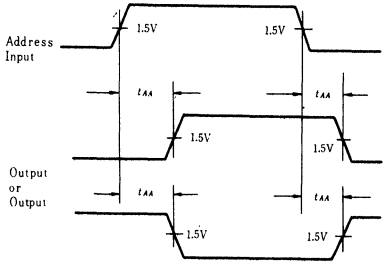
* Note : Applicable to HN25089 only.

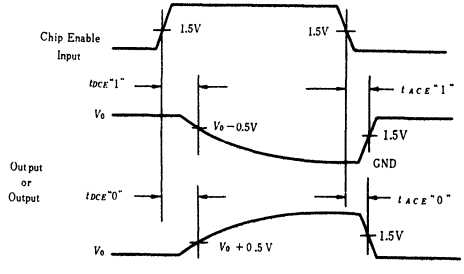
■ AC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to 75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Address Access Time	t_{AA}		—	40	60	ns
Chip Enable Access Time	t_{ACE}		—	20	35	ns
Chip Enable Disable Time	t_{DCE}		—	20	35	ns

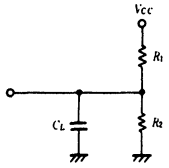
Note) 1. Output Load : See Test Circuit.
2. Measurement Reference : 1.5V for both inputs and outputs.

■ SWITCHING WAVEFORMS





■ SWITCHING TIME TEST CONDITIONS

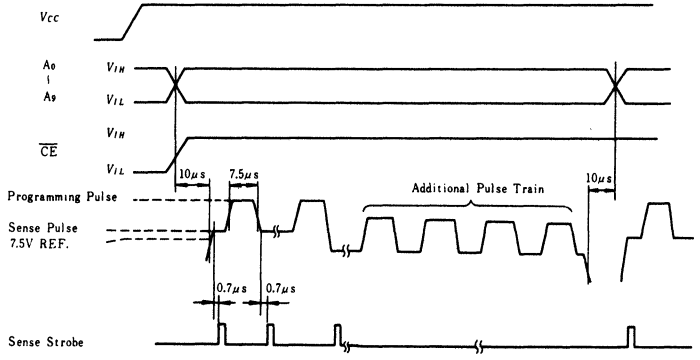


SWITCHING PARAMETER	HN25088			HN25089		
	R_1	R_2	C_L	R_1	R_2	C_L
t_{AA}	300Ω	600Ω	30pF	300Ω	600Ω	30pF
t_{ACE} "1"	—	—	—	∞	600Ω	10pF
t_{ACE} "0"	300Ω	600Ω	10pF	300Ω	600Ω	10pF
t_{DCE} "1"	—	—	—	∞	600Ω	30pF
t_{DCE} "0"	300Ω	600Ω	30pF	300Ω	600Ω	30pF

INPUT CONDITIONS
Amplitude − 0V to 3V
Rise and Fall time − 5ns from 1V to 2V
Frequency − 1MHz

■ PROGRAMMING SPECIFICATION

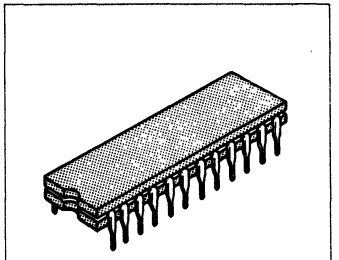
Characteristic	Limit	Unit	Notes
Ambient Temperature	25±5	°C	
Programming Pulse			
Amplitude	130±5%	mA	
Clamp Voltage	20±2%	V	
Ramp Rate	70max	V/μs	
Pulse Width	7.5±5%	μs	10V point/150Ω load
Duty Cycle	70% min		
Sense Current			
Amplitude	20±0.5	mA	
Clamp Voltage	20±2%	V	
Ramp Rate	70max	V/μs	
Sense Current Interruption before and after address change	10min	μs	
Programming V_{CC}	5.0+5%−0%	V	
Maximum Sensed Voltage for programmed "1"	7.5±0.1	V	
Delay from trailing edge of programming pulse before sensing output voltage	0.7min	μs	
Programming Pulse Number	100max	ms	
Additional Programming Pulse Number	4	Time	



HN25088S, HN25089S

1024-word×8-bit Programmable Read Only Memories

The HITACHI HN25088S and HN25089S are high speed electrically programmable, fully decoded TTL Bipolar 8192 bit-read only memories organized as 1024 words by 8 bits with on-chip address decoding and four chip enable inputs. The HN25088S and HN25089S are fabricated with logic level "zeros" (low); logic level "ones" (high) can be electrically programmed in the selected bit locations. The same address inputs are used for both programming and reading.

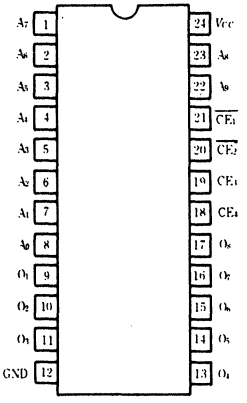


(DG-24)

■ FEATURES

- 1024 words x 8 bits organization (fully decoded)
- TTL compatible inputs and outputs
- Fast read access time: 25 ns typ. (50 ns max)
- Medium power consumption: 600 mW typ.
- Four chip enable inputs for memory expansion
- Open collector outputs (HN25088S)/Three-state outputs (HN25089S)
- Standard cerdip 24-pin dual in-line package

■ PIN ARRANGEMENT



(Top View)

■ OPERATION

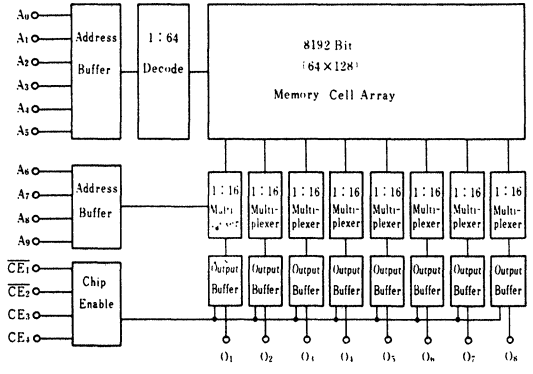
- **Programming**

A logic one can be permanently programmed into a selected bit location by using programming equipment. First, the desired word is selected by the ten address inputs in TTL level. The device is disabled by bringing $\overline{CE1}$ and/or $\overline{CE2}$ to as logic "one" or CE3 and/or CE4 to a logic "zero". Then a train of high current programming pulses is applied to the desired output. After the sensed voltage indicates that the selected bit is in the logic one state, an additional pulse train is applied, then is stopped.

- **Reading**

To read the memory the device is enabled by bringing $\overline{CE1}$ and $\overline{CE2}$ to a logic "zero", CE3 and CE4 to a logic "one". The outputs then correspond to the data programmed in the selected word.

■ LOGIC DIAGRAM



HITACHI

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Output Voltage	V_{out}	−0.5 to +5.5	V
Output Current	I_{out}	50	mA
Operating Temperature	T_{opr}	−25 to +75	°C
Storage Temperature	T_{stg}	−65 to +150	°C

■DC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to +75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Input High Voltage	V_{IH}		2.0	—	—	V
Input Low Voltage	V_{IL}		—	—	0.8	V
Input High Current	I_{IH}	V_I=2.7V	—	—	40	μA
Input Low Current	$-I_{IL}$	V_I=0.4V	—	—	0.40	mA
Output Low Voltage	V_{OL}	I_{OL}=16mA	—	—	0.45	V
Output Leakage Current	I_{OLK1}	V_O=5.25V	—	—	100	μA
Output Leakage Current	I_{OLK2}	V_O=0.4V	—	—	40	μA
Input Clamp Voltage	V_I	I_I=−18mA	—	—	−1.2	V
Power Supply Current	I_{CC}	Inputs Either Open or at Ground	—	120	160	mA
Output High Voltage*	V_{OH}	I_{OH}=−2mA	2.4	—	—	V
Output Short Circuit Current*	$-I_{OS}$	V_O=0V	15	—	60	mA

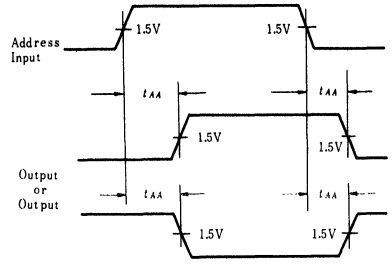
* Note: Applicable to HN25089S only.

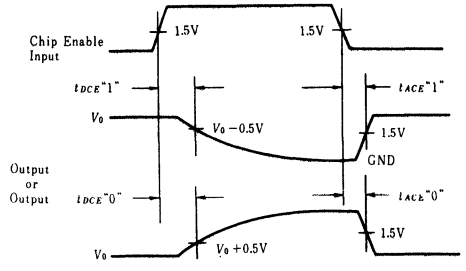
■AC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to 75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Address Access Time	t_{AA}		—	25	50	ns
Chip Enable Access Time	t_{ACE}		—	20	35	ns
Chip Enable Disable Time	t_{DCE}		—	15	35	ns

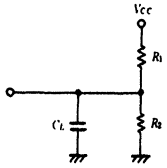
Note) 1. Output Load: See Test Circuit.
2. Measurement Reference: 1.5V for both inputs and outputs.

■SWITCHING WAVEFORMS





■ SWITCHING TIME TEST CONDITIONS

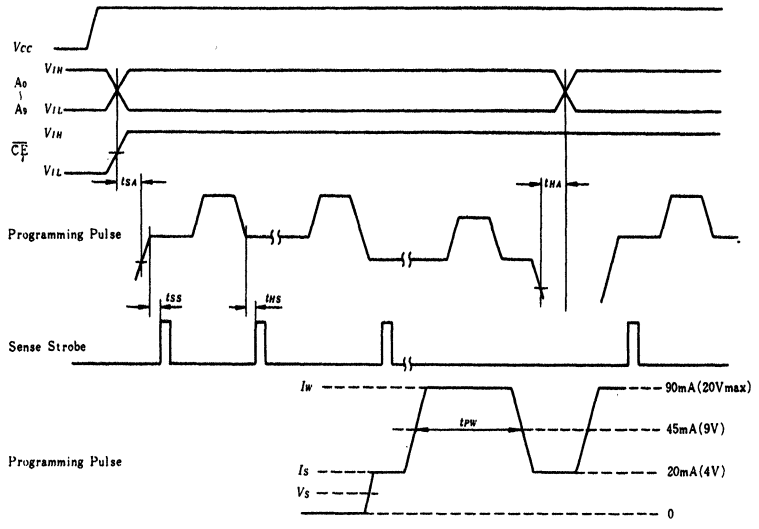


SWITCHING PARAMETER	HN25088S			HN25089S		
	R_1	R_2	C_L	R_1	R_2	C_L
t_{AA}	300Ω	600Ω	30pF	300Ω	600Ω	30pF
t_{ACE} "1"	—	—	—	∞	600Ω	10pF
t_{ACE} "0"	300Ω	600Ω	10pF	300Ω	600Ω	10pF
t_{DCE} "1"	—	—	—	∞	600Ω	30pF
t_{DCE} "0"	300Ω	600Ω	30pF	300Ω	600Ω	30pF

INPUT CONDITIONS
Amplitude—0V to 3V
Rise and Fall time—5ns from 1V to 2V
Frequency—1MHz

■ PROGRAMMING SPECIFICATION

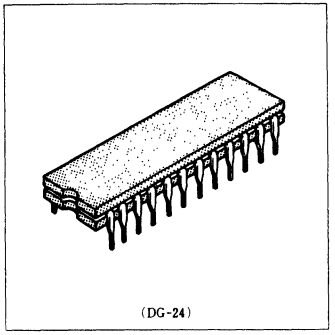
PARAMETER	Symbol	min	typ	max	Unit	Note
Ambient Temperature	Ta	20	25	30	°C	
Programming V_{CC}	V_{CC}	4.75	5.0	5.25	V	
Programming Pulse						
Amplitude	I_W	88	90	92	mA	
Clamp Voltage	V_W	19.0	19.5	20.0	V	
Ramp Rate		10	—	70	V/μs	
Pulse Width	t_{PW}	7.1	7.5	7.9	μs	9V point/200Ω load
Duty Cycle		70	—	—	%	
Sense Current						
Amplitude	I_S	19	20	21	mA	
Sense Voltage	V_S	7.4	7.5	7.6	V	
Clamp Voltage		19.0	19.5	20.0	V	
Ramp Rate		70	—	—	V/μs	
Address Setup Time	t_{SA}	10	—	—	μs	
Address Hold Time	t_{HA}	10	—	—	μs	
Sense Setup Time	t_{SS}	0.7	—	—	μs	
Sense Hold Time	t_{HS}	0.7	—	—	μs	
Additional Programming Pulse		1	1	1	time	
Programming Pulse Number per bit	n	—	—	10000	time	



1024-word × 8-bit Programmable Read Only Memories

The HITACHI HN25088L and HN25089L are low power and high speed electrically programmable, fully decoded TTL Bipolar 8192 bit read only memories organized as 1024 words by 8 bits with on-chip address decoding and four chip enable inputs.

The HN25088L and HN25089L are fabricated with logic level "zeros" (low); logic level "ones" (high) can be electrically programmed in the selected bit locations. The same address inputs are used for both programming and reading.

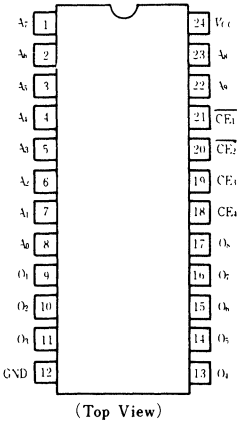


(DG-24)

■ FEATURES

- 1024 words x 8 bits organization (fully decoded)
- TTL compatible inputs and outputs
- Fast read access time: 60ns typ. (100ns max.)
- Low power consumption: 350mW typ.
- Four chip enable inputs for memory expansion
- Open collector outputs (HN25088L)/Three-state outputs (HN25089L)

■ PIN ARRANGEMENT



(Top View)

■ OPERATION

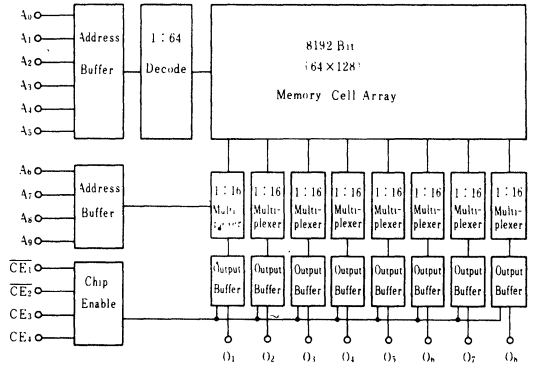
- **Programming**

A logic one can be permanently programmed into a selected bit location by using programming equipment. First, the desired word is selected by the ten address inputs in TTL level. The device is disabled by bringing $\overline{CE1}$ and/or $\overline{CE2}$ to as logic "one" or CE3 and/or CE4 to a logic "zero". Then a train of high current programming pulses is applied to the desired output. After the sensed voltage indicates that the selected bit is in the logic one state, an additional pulse train is applied, then is stopped.

- **Reading**

To read the memory the device is enabled by bringing $\overline{CE1}$ and $\overline{CE2}$ to a logic "zero", CE3 and CE4 to a logic "one". The outputs then correspond to the data programmed in the selected word.

■ LOGIC DIAGRAM



■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Output Voltage	V_{out}	−0.5 to +5.5	V
Output Current	I_{out}	50	mA
Operating Temperature	T_{opr}	−25 to +75	℃
Storage Temperature	T_{stg}	−65 to +150	℃

■DC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to +75℃)

Item	Symbol	Test Conditions	min	typ	max	Unit
Input Voltage	V_{IH}		2.0	—	—	V
	V_{IL}		—	—	0.8	V
Output Voltage	V_{OH}*	I_{OH}=−2mA	2.4	—	—	V
	V_{OL}	I_{OL}=16mA	—	—	0.45	V
Input Current	I_{IH}	V_I=2.7V	—	—	40	μA
	$-I_{IL}$	V_I=0.4V	—	—	0.4	mA
Output Leakage Current	I_{OLK}	V_O=5.25V	—	—	100	μA
		V_O=0.4V	—	—	40	
Supply Current	I_{CC}	Inputs Either Open or at Ground	—	70	100	mA
Output Short-circuit Current	$-I_{OS}$*	V_O=0V	8	—	30	mA
Input Clamp Voltage	V_I	I_I=−18mA	—	—	−1.2	V

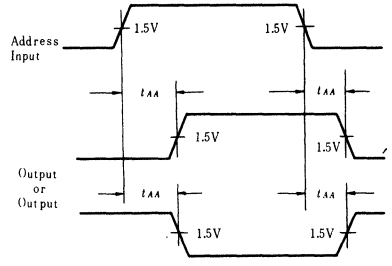
* Applicable to HN25089L only.

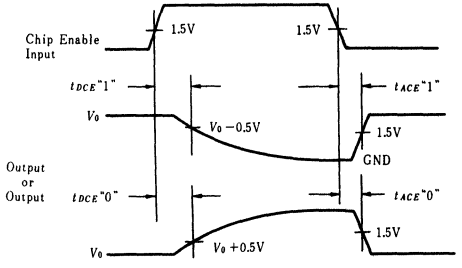
■AC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to +75℃)

Item	Symbol	min	typ	max	Unit
Address Access Time	t_{AA}	—	60	100	ns
Chip Enable Access Time	t_{ACE}	—	40	70	ns
Chip Enable Disable Time	t_{DCE}	—	40	70	ns

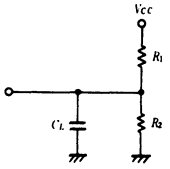
Notes) 1. Output Load: See Test Circuit
2. Measurement Reference: 1.5V for both inputs and outputs

■SWITCHING WAVEFORMS





■ SWITCHING TIME TEST CONDITIONS

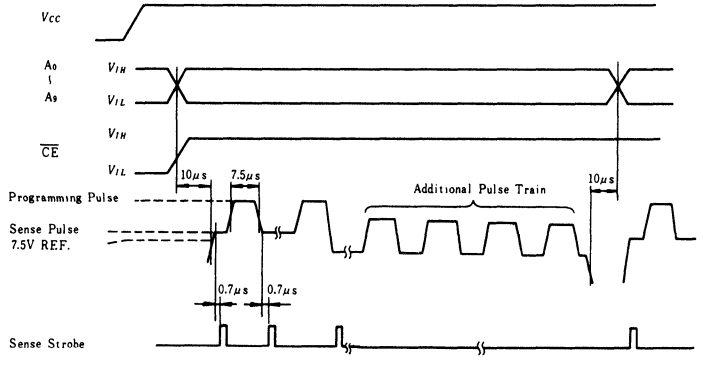


SWITCHING PARAMETER	HN25088L			HN25089L		
	R_1	R_2	C_L	R_1	R_2	C_L
t_{AA}	300Ω	600Ω	30pF	300Ω	600Ω	30pF
t_{ACE} "1"	—	—	—	∞	600Ω	10pF
t_{ACE} "0"	300Ω	600Ω	10pF	300Ω	600Ω	10pF
t_{DCE} "1"	—	—	—	∞	600Ω	30pF
t_{DCE} "0"	300Ω	600Ω	30pF	300Ω	600Ω	30pF

INPUT CONDITIONS
Amplitude − 0V to 3V
Rise and Fall time − 5ns from 1V to 2V
Frequency − 1MHz

■ PROGRAMMING SPECIFICATION

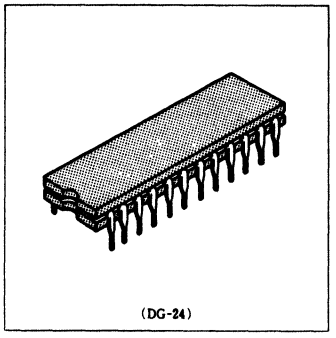
Characteristic	Limit	Unit	Notes
Ambient Temperature	25±5	°C	
Programming Pulse			
Amplitude	130±5%	mA	
Clamp Voltage	20±2%	V	
Ramp Rate	70max	V/μs	
Pulse Width	7.5±5%	μs	10V point/150Ω load
Duty Cycle	70% min		
Sense Current			
Amplitude	20±0.5	mA	
Clamp Voltage	20±2%	V	
Ramp Rate	70max	V/μs	
Sense Current Interruption before and after address change	10min	μs	
Programming V_{CC}	5.0+5%−0%	V	
Maximum Sensed Voltage for programmed "1"	7.5±0.1	V	
Delay from trailing edge of programming pulse before sensing output voltage	0.7min	μs	
Programming Pulse Number	100max	ms	
Additional Programming Pulse Number	4	Time	



HN25168S, HN25169S

2048-word × 8-bit Programmable Read Only Memories

The HITACHI HN25168S and HN25169S are high speed electrically programmable, fully decoded TTL Bipolar 16384 bit read only memories organized as 2048 words by 8 bits with on-chip address decoding and three chip enable inputs. The HN25168S and HN25166S are fabricated with logic level "zeros" (low); logic level "ones" (high) can be electrically programmed in the selected bit locations. The same address inputs are used for both programming and reading.

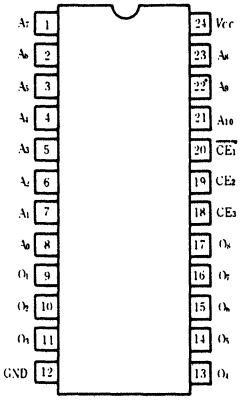


(DG-24)

■ FEATURES

- 2048 words x 8 bits organization (fully decoded)
- TTL compatible inputs and outputs
- Fast read access time: 40 ns typ. (60 ns max)
- Medium power consumption: 600 mW typ.
- Three chip enable inputs for memory expansion.
- Open collector outputs (HN25168S)/Three-state outputs (HN25169S)
- Standard cerdip 24-pin dual in-line package

■ PIN ARRANGEMENT



(Top View)

■ OPERATION

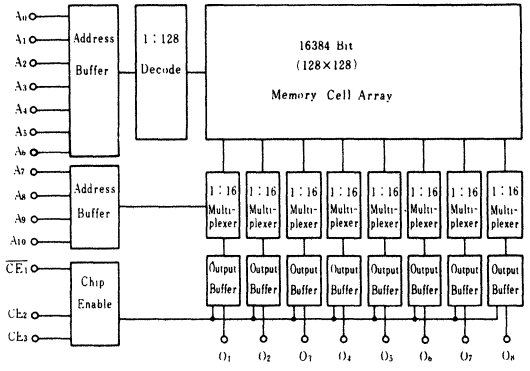
- **Programming**

A logic one can be permanently programmed into a selected bit location by using programming equipment. First, the desired world is selected by the eleven address inputs in TTL level. The device is disabled by bringing $\overline{CE1}$ to as logic "one" or CE2 and/or CE3 to a logic "zero". Then a train of high current programming pulses is applied to the desired output. After the sensed voltage indicates that the selected bit is in the logic one state, an additional pulse is applied, then is stopped.

- **Reading**

To read the memory the device is enabled by bringing $\overline{CE1}$ to a logic "zero", CE2 and CE3 to a logic "one". The outputs then correspond to the data programmed in the selected word.

■ LOGIC DIAGRAM



HITACHI

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Supply Voltage	V_{CC}	−0.5 to +7.0	V
Input Voltage	V_{in}	−0.5 to +5.5	V
Output Voltage	V_{out}	−0.5 to +5.5	V
Output Current	I_{out}	50	mA
Operating Temperature	T_{opr}	−25 to +75	°C
Storage Temperature	T_{stg}	−65 to +150	°C

■ DC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to +75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Input High Voltage	V_{IH}		2.0	—	—	V
Input Low Voltage	V_{IL}		—	—	0.8	V
Input High Current	I_{IH}	V_I=2.7V	—	—	40	μA
Input Low Current	$-I_{IL}$	V_I=0.4V	—	—	0.40	mA
Output Low Voltage	V_{OL}	I_{OL}=16mA	—	—	0.45	V
Output Leakage Current	I_{OLK1}	V_O=5.25V	—	—	100	μA
Output Leakage Current	I_{OLK2}	V_O=0.4V	—	—	40	μA
Input Clamp Voltage	V_I	I_I=−18mA	—	—	−1.2	V
Power Supply Current	I_{CC}	Inputs Either Open or at Ground	—	120	170	mA
Output High Voltage*	V_{OH}	I_{OH}=−2mA	2.4	—	—	V
Output Short Circuit Current*	$-I_{OS}$	V_O=0V	15	—	60	mA

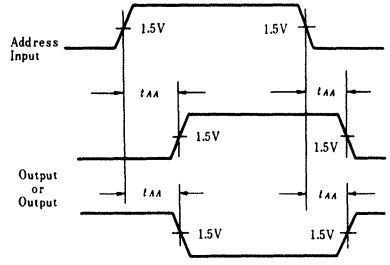
* Note: Applicable to HN25169S only.

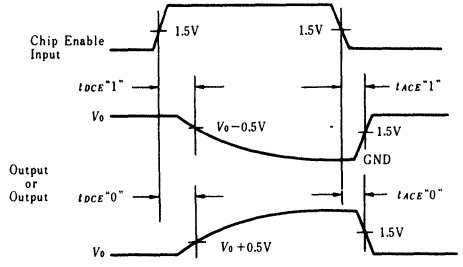
■ AC CHARACTERISTICS (V_{CC}=4.75 to 5.25V, Ta=0 to 75°C)

Characteristic	Symbol	Test Conditions	min	typ	max	Unit
Address Access Time	t_{AA}		—	40	60	ns
Chip Enable Access Time	t_{ACE}		—	20	35	ns
Chip Enable Disable Time	t_{DCE}		—	20	35	ns

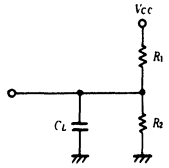
Note) 1. Output Load: See Test Circuit.
2. Measurement Reference: 1.5V for both inputs and outputs.

■ SWITCHING WAVEFORMS





■ SWITCHING TIME TEST CONDITIONS

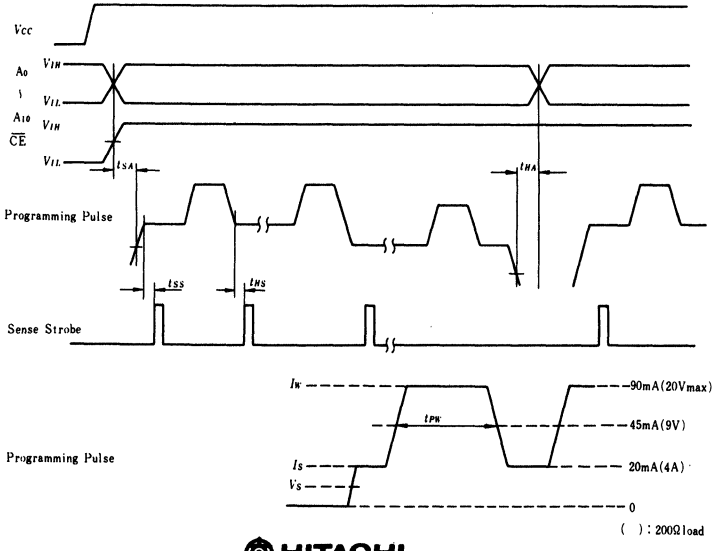


SWITCHING PARAMETER	HN25168S			HN25169S		
	R_1	R_2	C_L	R_1	R_2	C_L
t_{AA}	300Ω	600Ω	30pF	300Ω	600Ω	30pF
t_{ACE} "1"	—	—	—	∞	600Ω	10pF
t_{ACE} "0"	300Ω	600Ω	10pF	300Ω	600Ω	10pF
t_{DCE} "1"	—	—	—	∞	600Ω	30pF
t_{DCE} "0"	300Ω	600Ω	30pF	300Ω	600Ω	30pF

INPUT CONDITIONS
Amplitude—0V to 3V
Rise and Fall time—5ns from 1V to 2V
Frequency—1MHz

■ PROGRAMMING SPECIFICATION

PARAMETER	Symbol	min	typ	max	Unit	Note
Ambient Temperature	Ta	20	25	30	°C	
Programming V_{CC}	V_{CC}	4.75	5.0	5.25	V	
Programming Pulse						
Amplitude	I_W	88	90	92	mA	
Clamp Voltage	V_W	19.0	19.5	20.0	V	
Ramp Rate		10	—	70	V/μs	
Pulse Width	t_{PW}	7.1	7.5	7.9	μs	9V point/200Ω load
Duty Cycle		70	—	—	%	
Sense Current						
Amplitude	I_S	19	20	21	mA	
Sense Voltage	V_S	7.4	7.5	7.6	V	
Clamp Voltage		19.0	19.5	20.0	V	
Ramp Rate		70	—	—	V/μs	
Address Setup Time	t_{SA}	10	—	—	μs	
Address Hold Time	t_{HA}	10	—	—	μs	
Sense Setup Time	t_{SS}	0.7	—	—	μs	
Sense Hold Time	t_{HS}	0.7	—	—	μs	
Additional Programming Pulse		1	1	1	time	
Programming Pulse Number per bit	n	—	—	10000	time	

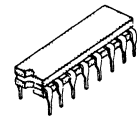


MEMORY SUPPORT CIRCUITS

HD2912

Quadruple TTL-to-MOS Clock Drivers

The HD2912, a clock driver for the MOS memory, has basically the NAND function. Its input is a TTL level and its output becomes and N MOS clock input level. It operates on two power supplies – V_{CC} (5V) and V_{DD} (12V). It anticipates taking as its load a maximum of ten units of 4K-bit N MOS memories and can drive a load capacity of 400 pF at high speed.



(DG-16)

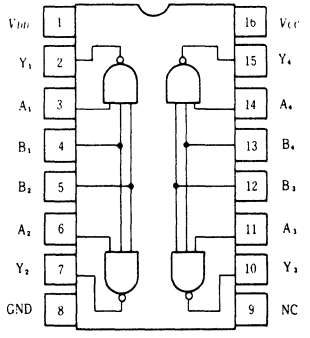
- TTL-MOS level converter circuit
- Switching time: 50 ns (max.)
- Load capacity drivable: 600pF
- Mounted with 4 circuits
- Applicable temperature: 0 to 70°C

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	HD2912	Unit
Supply Voltage	V_{CC}*	7.0	V
	V_{DD}*	18.0	V
Input Voltage	V_{in}*	5.5	V
Load Capacitance	C_L**	600	pF
Power Dissipation	P_T***	800	mW
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−65 to +150	°C

* With respect GND
** per circuit
*** per package

■PIN ARRANGEMENT



(Top View)

■RECOMMENDED OPERATING CONDITIONS

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.75	5.0	5.25	V
	V_{DD}	11.4	12	12.6	V
Operating Temperature	T_{opr}	0	25	70	°C
Load Capacitance	C_L	100	—	600	pF
Damping Resistance	R_D	10	—	—	Ω

■ELECTRICAL CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V ±5%, V_{DD}=12V ±5%)

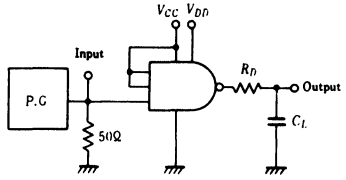
Item		Symbol	Test Condition	min	typ*	max	Unit
Input Voltage		V_{IL}		2.0	—	—	V
		V_{IH}		—	—	0.8	V
Output Voltage		V_{OL}	V_{in}=2V, I_{OL}=0.1mA	—	0.45	0.6	V
		V_{OH}	V_{in}=0.8V, I_{OH}=−0.1mA	V_{DD}−0.9	11.5	—	V
Input Current	A	I_{IL}	V_{in}=0.4V	—	−1	−1.6	mA
	B	I_{IL}		—	−2	−3.2	mA
	A	I_{IH}	V_{in}=2.4V	—	—	40	μA
	B	I_{IH}		—	—	80	μA
		I_I	V_{in}=5.5V	—	—	1	mA
Power Supply Current		I_{DDH}	V_{in}=0V	—	16	24	mA
		I_{DDL}	V_{in}=5V	—	—	0.5	mA
		I_{CCH}	V_{in}=0V	—	12	18	mA
		I_{CCL}	V_{in}=5V	—	67	100	mA
Input Clamp Voltage		V_I	I_{in}=−12mA	—	—	−1.5	V

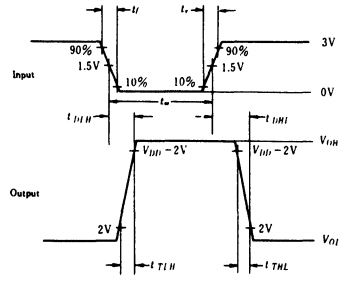
* V_{CC}=5V, V_{DD}=12V

■ SWITCHING CHARACTERISTICS (Ta=0 to +70°C, V_{CC}=5V, V_{DD}=12V)

Item	Symbol	Test Condition	min	typ	max	Unit
Rising Delay Time	t_{DLH}	C_L=300pF R_D=0Ω	—	35	50	ns
Falling Delay Time	t_{DHL}		—	25	45	ns
Rise Time	t_{TLH}		—	12	25	ns
Fall Time	t_{THL}		—	12	25	ns

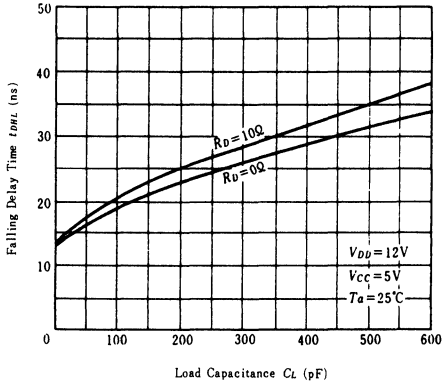
● TEST CIRCUIT AND WAVEFORMS



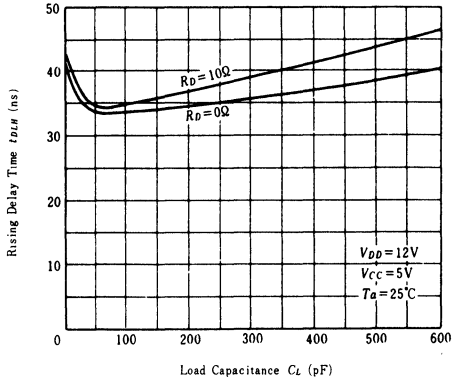


t_w = 250ns, t_{duty} = 350ns, t_f = t_r = 10 ± 1ns

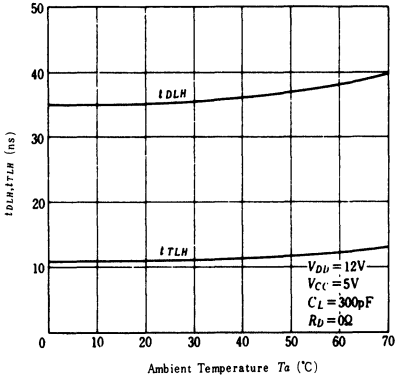
FALLING DELAY TIME vs. LOAD CAPACITANCE (1)



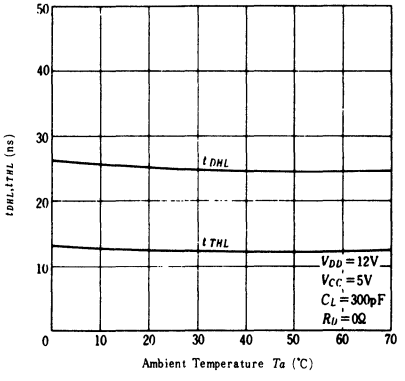
RISING DELAY TIME vs. LOAD CAPACITANCE (2)



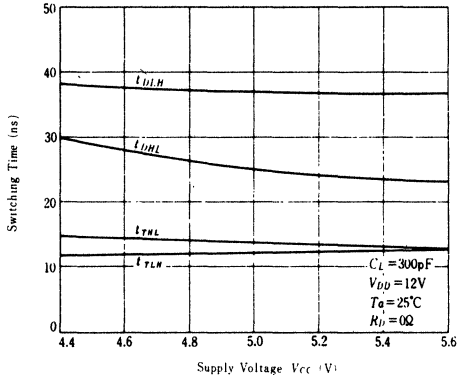
RISE TIME AND RISING DELAY TIME vs. AMBIENT TEMPERATURE



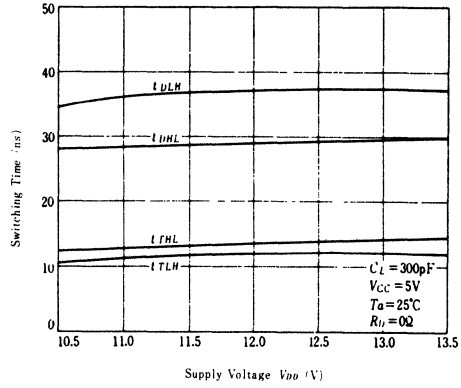
FALL TIME AND FALLING DELAY TIME vs. AMBIENT TEMPERATURE



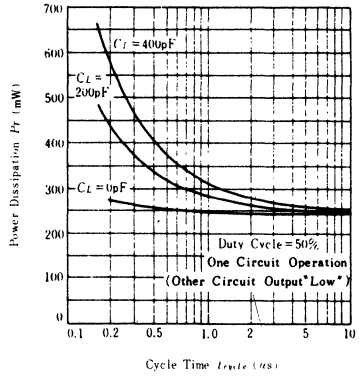
SWITCHING TIME vs. SUPPLY VOLTAGE (1)



SWITCHING TIME vs. SUPPLY VOLTAGE (2)



POWER DISSIPATION vs. CYCLE TIME



■ITEMS REQUIRING CARE WHEN USING THE HD2912

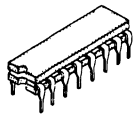
When measuring or mounting the HD2912, consider the following.

1. At the time of "H" level output, if a short circuit occurs between the output terminal and the other terminal (the GND terminal or input terminal), the element will breakdown.
2. When measuring the input/output characteristic of the circuit, do not place the input level in the vicinity of the threshold voltage (about 1.5V) for more than 10 seconds. If this caution is neglected, the element may breakdown.
3. If its load capacity is less than a certainalue (100pF), sometimes this element cannot fully provide its function. Take note of this fact when designing a system.
4. When mounting this element, it is recommended providing the output terminal with a damping resistor (R_D) or a diode terminating circuit.

HD2916

Quadruple TTL-to-NMOS Clock Drivers

The HD2916, a clock driver for the MOS memory, basically possesses a NAND function. Its Input is a TTL level and its output becomes N MOS clock input level. It operates on two power supplies – V_{CC} (5V) and V_{DD} (12V). Assuming that a maximum of five units of 4K-bit N MOS memories may be connected, it is designed to drive a load capacity of 200pF at high speeds.

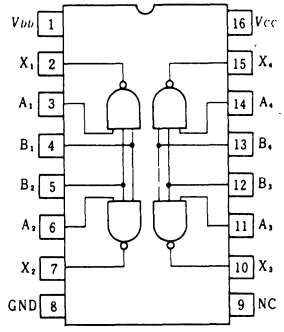


(DG-16A)

■ FEATURES

- TTL-MOS level converter
- Switching time: 50 ns (max.)
- Average power consumption: 600mW (max.)
- Load capacity drivable: 300pF
- Mounted with 4 circuits
- Applicable temperature: 10 to 65°C

■ PIN ARRANGEMENT



(Top View)

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	HD2916	Unit
Supply Voltage	V_{CC}*	−0.5 to +7	V
	V_{DD}*	−0.5 to +15	V
Input Terminal Voltage	V_{IN}*	−0.5 to +5.5	V
Output Load Capacitance	C_L**	300	pF
Power Dissipation	P_T***	700	mW
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature	T_{stg}	−50 to +150	°C

* With respect to GND
** Per circuit
*** Per package

■ RECOMMENDED OPERATING CONDITION

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.75	5.0	5.25	V
	V_{DD}	11.4	12.0	12.6	V
Operating Temperature	T_{opr}	10	25	55	°C
Input Voltage Level	V_{IH}	2.0	—	5.5	V
	V_{IL}	−0.5	—	0.8	V

■ ELECTRICAL CHARACTERISTICS (Ta=10 to 55°C, V_{CC}=5V ±5%, V_{DD}=12V ±5%)

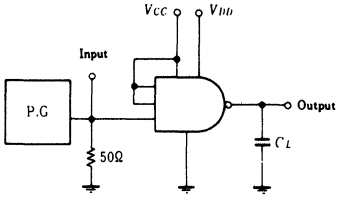
Item		Symbol	Test Condition	min	typ*	max	Unit
Input Current	A	I_{IH}	V_{IN}=2.4V	—	—	40	μA
		I_{IL}	V_{IN}=0.4V	—	−1	−2	mA
	B	I_{IH}	V_{IN}=2.4V	—	—	80	μA
		I_{IL}	V_{IN}=0.4V	—	−2	−4	mA
Output Voltage		V_{OH}	V_{IN}=0.8V, I_{OH}=−50μA	V_{DD}−0.7	V_{DD}−0.4	—	V
		V_{OL}	V_{IN}=2.0V, I_{OL}=50μA	—	0.3	0.45	V
Supply Current		I_{DDH}	V_{IN}=0V	—	13	20	mA
		I_{CCH}	V_{IN}=0V	—	13	40	mA
		I_{DDL}	V_{IN}=5V	—	—	39	mA
		I_{CCL}	V_{IN}=5V	—	40	60	mA
Average Power Dissipation		P_{TA}	C_L=300pF, f=1MHz t_W=0.5μs, one circuit operation	—	300	600	mW

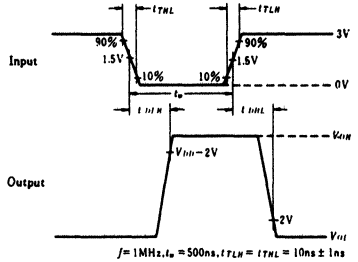
* V_{CC}=5V, V_{DD}=12V

■ SWITCHING CHARACTERISTICS (Ta=10 to 55°C, V_{CC}=5V ±5%, V_{DD}=12V ±5%)

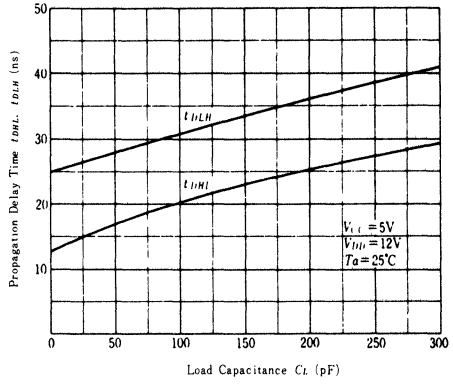
Item	Symbol	Test Condition	min	typ	max	Unit
Output Delay Time	t_{DLH}	C_L=200pF f=1MHz t_w=0.5μs	—	—	50	ns
	t_{DHL}		—	—	50	ns

● TEST CIRCUIT & WAVEFORMS

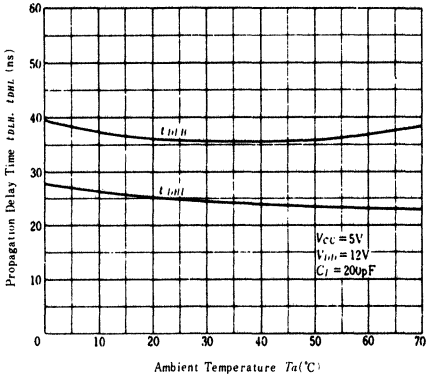




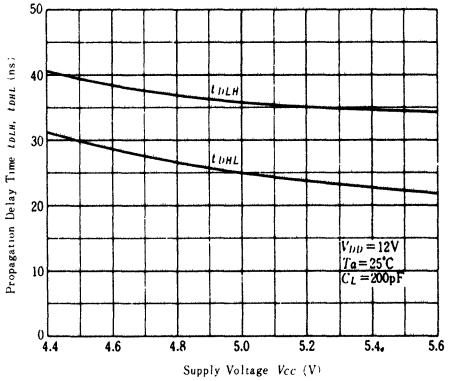
PROPAGATION DELAY TIME vs. LOAD CAPACITANCE



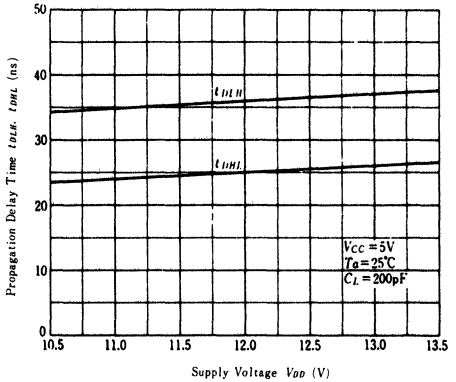
PROPAGATION DELAY TIME vs. AMBIENT TEMPERATURE



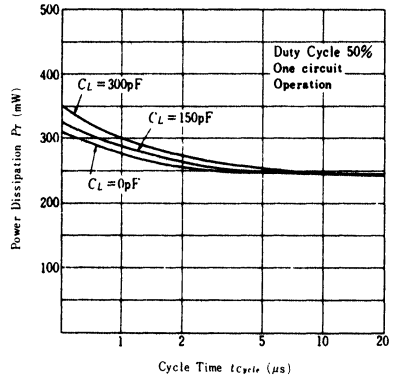
PROPAGATION DELAY TIME vs. SUPPLY VOLTAGE



PROPAGATION DELAY TIME vs. SUPPLY VOLTAGE



POWER DISSIPATION vs. CYCLE TIME



■ ITEMS REQUIRING CARE WHEN USING THE HD2916

When measuring or mounting the HD2916, consider the following:

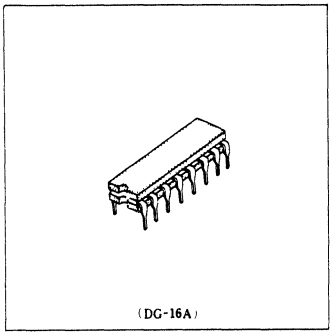
1. At the time of "H" level output, if a short circuit occurs between the output terminal and the other terminal (the GND terminal or input terminal), the element will breakdown.
2. When measuring the input/output characteristic of the circuit, do not place the input level in the vicinity of the threshold voltage (about 1.5V) for more than 10 seconds. If this caution is neglected, the element may breakdown.

HD2923

Quadruple ECL to TTL Drivers

The HD2923 is a monolithic, high speed Quadruple ECL to TTL Driver which accepts ECL input signals. It provides high output current suitable for driving the TTL clock inputs or other address multiplexing inputs of N-channel MOS memories such as the HM4816A of MK4116. Power supply requirements are ground, +5.0 Volts and −5.2 Volts. The HD2923 requires no particular power supply sequencing in order to assure standby mode of memories, because the outputs are always "high" at applying the power. Propagation delay is 10ns MAX.

The HD2923 is fabricated by means of HITACHI's Schottky Bipolar technology to assure high performance over the 0°C to 75°C ambient temperature range.



(DG-16A)

■ FEATURES

- High Speed ..... t_{pd} = 10ns MAX. (50% to 2.2V dc out or to +1.0V dc out, 200pF Load)
- Low Power ..... 250mW typ. (DC)
- 10K ECL Compatible Inputs
- Pin Compatibility ..... MC10125 or HD10125

■ ABSOLUTE MAXIMUM RATINGS

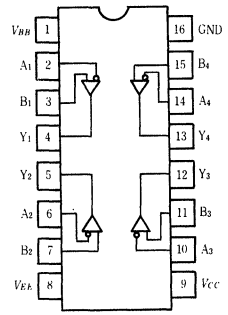
Item	Symbol	Value	Unit
Supply Voltage	V_{CC}	−0.5 to +7	V
	V_{EE}	−7 to +0.5	V
Input Voltage	V_{in}	V_{EE} to +0.5	V
Output Voltage	V_{out}	−1.0 to V_{CC}+1	V
Power Dissipation	P_T	1.0	W
Operating Temperature*	T_{opr}	−10 to +85	°C
Storage Temperature	T_{stg}	−65 to +150	°C

* under bias

■ RECOMMENDED OPERATING CONDITIONS

Item	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.75	5.0	5.25	V
	V_{EE}	−5.46	−5.2	−4.94	V
Input Voltage	V_{IH}	−1.025	—	—	V
	V_{IL}	—	—	−1.520	V
Operating Temperature	T_{opr}	0	—	75	°C

■ PIN ARRANGEMENT



(Top View)

The V_{BB} reference voltage is available on pin 1 for use in single ended input biasing

■ TRUTH TABLE

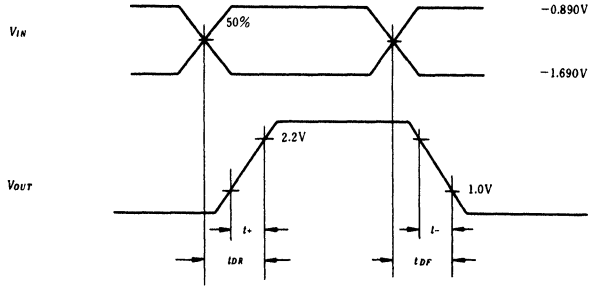
Input		Output
A	B	Y
H	V_{BB}	L
L	V_{BB}	H
H	L	L
L	H	H
V_{BB}	H	H
V_{BB}	L	L
Open	Open	H

■DC CHARACTERISTICS

Item	Symbol	Test Condition	min	typ	max	Unit
Power Supply Drain Current	$-I_{EE}$	$V_{EE}=-5.2V$, $V_{CC}=5.0V$	—	22	27	mA
	I_{CCH}		—	23.5	29	mA
	I_{CCL}		—	34.5	42	mA
Input Current	I_{inH}	$V_{IN}=-0.81V$	—	—	115	μA
Input Leakage Current	I_{CBO}	$V_{IN}=-5.2V$	—	—	1.0	μA
Output Voltage	V_{OH}	$I_{OH}=-1.0mA$	2.7	—	—	V
	V_{OL}	$I_{OL}=5.0mA$	—	—	0.5	V
Threshold Voltage	V_{OHA}	$V_{IH}=-1.1V$, $I_{OH}=-1.0mA$	2.7	—	—	V
	V_{OLA}	$V_{IL}=-1.48V$, $I_{OL}=5.0mA$	—	—	0.5	V
Indeterminate Input Protection Tests	V_{OHS}	All inputs $=V_{EE}$	2.7	—	—	V
		All inputs = Open	2.7	—	—	
Reference Voltage	V_{BB}		−1.420	—	−1.150	V
Common Mode Rejection Tests	V_{OHC}	$V_{INH}=0.300V$, $V_{INL}=-0.825V$	2.7	—	—	V
		$V_{INH}=-1.890V$, $V_{INL}=-2.890V$	2.7	—	—	
	V_{OLC}	$V_{INH}=0.300V$, $V_{INL}=-0.825V$	—	—	0.5	V
		$V_{INH}=-1.890V$, $V_{INL}=-2.890V$	—	—	0.5	

■AC CHARACTERISTICS

Item	Symbol	Test Condition	min	typ	max	Unit
Propagation Delay Time	t_{DR}	50% to +2.2V, $C_L=200pF$	—	—	10	ns
	t_{DF}	50% to +1.0V, $C_L=200pF$	—	—	10	ns
Rise Time	t^+	+1.0V to +2.2V, $C_L=200pF$	—	—	5	ns
Fall Time	t^-	+2.2V to +1.0V, $C_L=200pF$	—	—	5	ns



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