

Y8950

(MSX-AUDIO)

■ OUTLINE

The MSX-AUDIO is a sound generator LSI developed as optional sound source for the MSX2 personal computer. To create realistic, exciting sounds, the MSX-AUDIO incorporates an FM sound generator, similar to that previously used in Yamaha Electones and the DX-7 synthesizer. This product also has ADPCM speech analysis/synthesis functions in addition to the composite sinusoidal modeling function of conventional FM sound generators.

This new function allows simplified sound data processing.

Either of the AD/DA converters built in the analysis/synthesis circuit can be used independently to process even analog data.

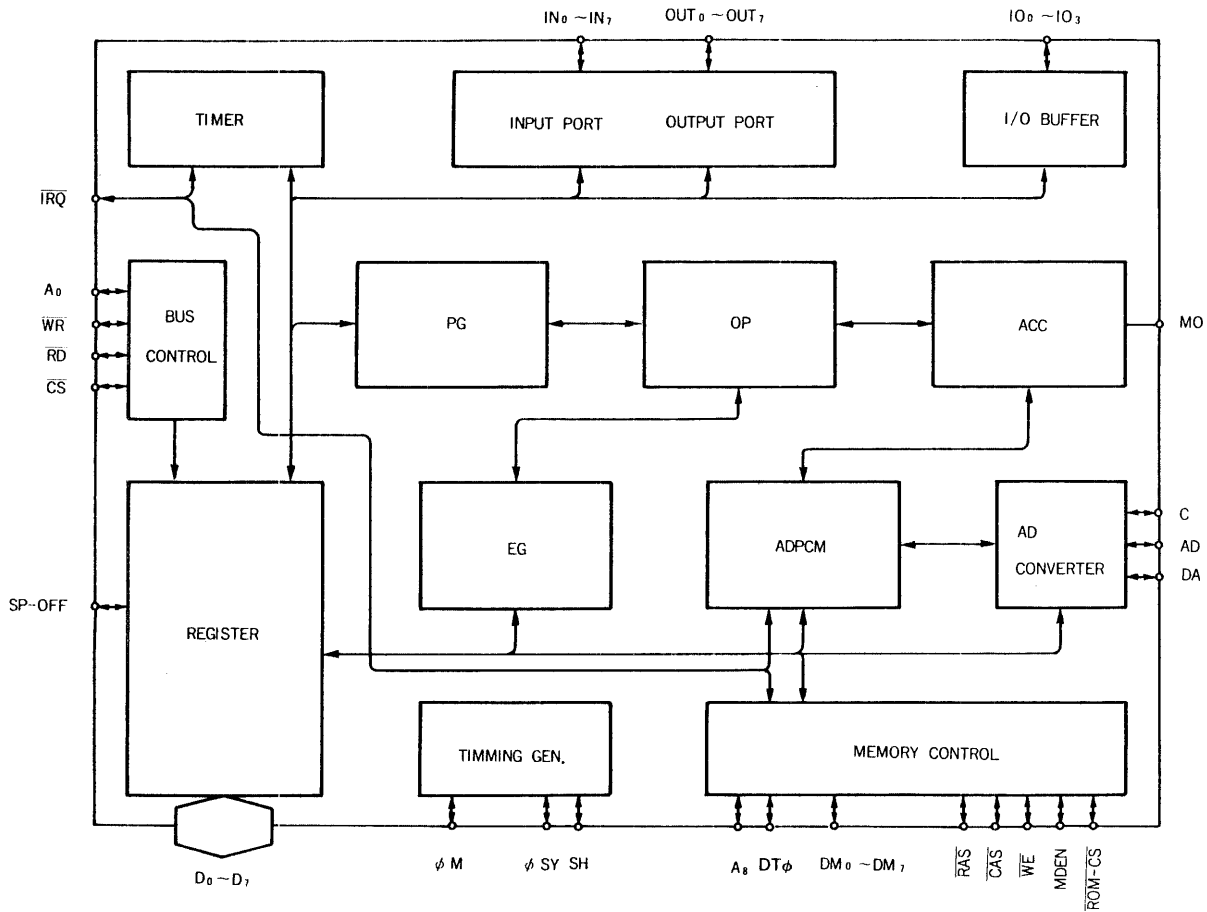
The MSX-AUDIO is equipped with input/output ports for a keyboard interface, as well as general-purpose input/output ports.

Consequently, one MSX-AUDIO unit allows you to perform a variety of data processing for sound production.

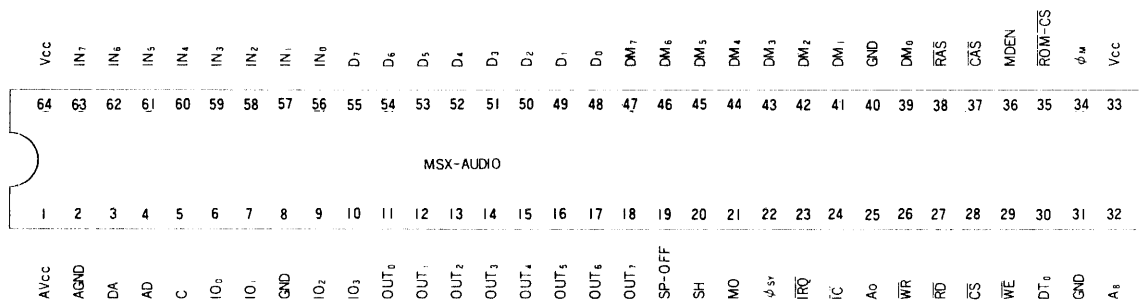
■ FEATURES

- Realistic sound due to FM sound generator. The FM sound generator is compatible with the YM3526.
- Selection of two sound-generation modes: simultaneous sounding of nine tones or six melodies and five rhythms (compatible with the Character and Pattern Telephone Access Information Network system and Teletex)
- The vibrato and AM oscillators are built in.
- 4-bits ADPCM speech analysis/synthesis circuits are built-in.
- AD/DA converters are built in.
- External 256-Kbytes memory (ROM or RAM) can be connected (as ADPCM data storage or auxiliary CPU storage)
- 8-bits input/output ports are built in for keyboard scanning.
- Two built-in general-purpose timers
- TTL compatible input/output
- Si-gate CMOS LSI
- 5V single power supply

1. BLOCK DIAGRAM



2. PIN LAYOUT



3. DESCRIPTION OF TERMINAL FUNCTIONS

Pin No.	Signature	Description																														
1 33, 64	AVcc Vcc	+5V power terminal																														
2 8,31,40	AGND GND	Ground terminal																														
3 4 5	DA AD C	Terminal for AD conversion, DA connects DAC output (reference data). AD is an analog input terminal and it is AD convertible within the range of $V_{cc}/2 \pm V_{cc}/4$. C terminal is a capacity terminal to samplehold analog data.																														
6, 7 9, 10	$\overline{IO}_0 \sim \overline{IO}_2$	General purpose IO ports.																														
11 ~ 18 56 ~ 63	$OUT_0 \sim OUT_7$ $IN_0 \sim IN_7$	Input ports ($IN_0 \sim IN_7$) and output ports ($OUT_0 \sim OUT_7$) for keyboard scanning. Input ports are pulled up and output ports are open drain type.																														
19	SP-OFF	At AD conversion, DA converter is used as a reference voltage generator. For that, the amplifier and speaker must be disconnected and this terminal is a control terminal to be used then.																														
20 21 22	SH MO ϕSY	MO is sound/speech output of MSX-AUDIO. As this output is 13 bits (Mantissa 10 bits, exponent 3 bits) serial data, it must be converted into analog value by means of ϕSY synchronous clock, SH synchronizing signal and DA converter (YM3014).																														
23	\overline{IRQ}	Interrupt signal output from two timers and ADPCM/memory control. Maskable depending on program.																														
24	\overline{IC}	Initializes MSX-AUDIO operation.																														
25 26 27 28	A_0 \overline{WR} \overline{RD} CS	Controls $D_0 \sim D_7$ data bus. <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>CS</th> <th>RD</th> <th>WR</th> <th>A_0</th> <th></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td>Writes MSX-AUDIO address.</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>Writes MSX-AUDIO register contents.</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>Reads MSX-AUDIO status.</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>Reads MSX-AUDIO register contents. (specific register only)</td> </tr> <tr> <td>1</td> <td>x</td> <td>x</td> <td>x</td> <td>$D_0 \sim D_7$ bus line becomes high impedance.</td> </tr> </tbody> </table>	CS	RD	WR	A_0		0	1	0	0	Writes MSX-AUDIO address.	0	1	0	1	Writes MSX-AUDIO register contents.	0	0	1	0	Reads MSX-AUDIO status.	0	0	1	1	Reads MSX-AUDIO register contents. (specific register only)	1	x	x	x	$D_0 \sim D_7$ bus line becomes high impedance.
CS	RD	WR	A_0																													
0	1	0	0	Writes MSX-AUDIO address.																												
0	1	0	1	Writes MSX-AUDIO register contents.																												
0	0	1	0	Reads MSX-AUDIO status.																												
0	0	1	1	Reads MSX-AUDIO register contents. (specific register only)																												
1	x	x	x	$D_0 \sim D_7$ bus line becomes high impedance.																												
29 37 38	\overline{WE} \overline{CAS} \overline{RAS}	Control signal of the external memory. When the external memory is DRAM, it is connected to the terminal to which RAM corresponds and it becomes address latch signal (RAS-CAS) when the external memory is ROM.																														
30 32	DT_0 A_8	A_8 is an external memory address (A_8) and DT_0 is likewise data out (DO_0).																														
34	ϕM	MSX-AUDIO master clock, with 3.57954 MHz as a standard.																														
35 36	$\overline{ROM-CS}$ MDEN	Applies timing to take in the external memory data. When MDEN is "1", it allows DRAM data on $DM_1 \sim DM_7$ and when $\overline{ROM-CS}$ is "0", it allows ROM data on $DM_1 \sim DM_7$. (Data out 0 on DT_0)																														
41 ~ 47	$DM_0 \sim DM_7$	Multiplexes the external memory address ($A_0 \sim A_7$), data IN ($DI_0 \sim DI_7$) and data out ($DO_1 \sim DO_7$; DO_0 are different terminals) signals to each terminal of $DM_0 \sim DM_7$.																														
56 ~ 63	$D_0 \sim D_7$	8 bits bi-directional data bus. Transmits and receives data with the processor.																														

4. ELECTRIC CHARACTERISTICS

(1) Absolute Maximum Rating

Item	Rated value	Unit
Terminal voltage	-0.3~7.0	V
Operating ambient temperature	0~70	°C
Storage temperature	-50~125	°C

(2) Recommended Operating Conditions

Item	Symbol	Minimum	Typical	Maximum	Unit
Power voltage	V _{CC}	4.75	5.0	5.25	V
	V _{SS}	0	0	0	V

(3) DC Characteristics

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Input high-level voltage	Input except for IN ₀ ~7	V _{IH1}	2.0			V
	IN ₀ ~7	V _{IH2}	3.5			V
Input low-level voltage	Input except for IN ₀ ~7	V _{IL1}			0.8	V
	IN ₀ ~7	V _{IL2}			1.2	V
Input leak current	A ₀ , \overline{WR} , \overline{RD} , DTO	I _{IL}	V _{IN} =0~5V	-10	10	μA
Three-state (offset-state) input current	D ₀ ~D ₇ , DM ₀ ~DM ₇	I _{TSL}	V _{IN} =0~5V	-10	10	μA
	IO ₀ ~IO ₃					
Output high-level voltage	Output except for \overline{IRQ} , OUT ₀ --7	V _{OHI1}	I _{OHI1} =0.4mA	2.4		V
		V _{OHI2}	I _{OHI2} =40μA	3.3		V
Output low-level voltage	All output	V _{OL}	I _{OIL} =2mA		0.4	V
Output leak current (offset state)	\overline{IRQ} , OUT ₀ ~7	I _{OIL}	V _O =0~5V	-10	10	μA
Analog input voltage	AD, DA	V _A		V _{CC} /4	3V _{CC} /4	V
Pull-up resistor	\overline{IC} , \overline{IRQ}	R _{P1}		60	600	KΩ
	IN ₀ ~7	R _{P2}		5	10	KΩ
Input capacity	All input	C _{IN}	f=1MHz		10	pF
Output capacity	All output	C _O	f=1MHz		10	pF
Power supply current		I _{CC}			70	mA

(4) AC Characteristics

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit	
Input clock frequency	ϕM	fc	A-1	3	3.58	4	MHz
Input clock duty	ϕM			40	50	60	%
Input clock rise time	ϕM	T_{CR}	A-1			50	ns
Input clock fall time	ϕM	T_{CF}	A-1			50	ns
Address setup time	A_0	T_{AS}	A-2, A-3	10			ns
Address hold time	A_0	T_{AH}	A-2, A-3	10			ns
Chip select write width	\overline{CS}	T_{CSW}	A-2	380			ns
Chip select read width	\overline{CS}	T_{CSR}	A-3	380			ns
Write pulse write width	\overline{WR}	T_{WW}	A-2	380			ns
Write data setup time	$D_0 \sim D_7$	T_{WDS}	A-2	10			ns
Write data hold time	$D_0 \sim D_7$	T_{WDH}	A-2	30			ns
Read pulse width	\overline{RD}	T_{RW}	A-3	380			ns
Read data access time	$D_0 \sim D_7$	T_{ACC}	A-3			380	ns
Read data hold time	$D_0 \sim D_7$	T_{RDH}	A-3	10			ns
Output port fall time	$OUT_0 \sim 7$	T_{OPF}	$C_L = 500\text{pF}$ (Note)	20			μs
Memory data set time	DM_{1-7}, DT_0	T_{MDS}	A-6	70			ns
Memory data hold time	DM_{1-7}, DT_0	T_{MDH}	A-6	10			ns
Output rise time	$DM_{0-7}, \overline{RAS}, \overline{CAS}, \overline{WE}, A_8, \overline{MDEN}, \overline{ROM-CS}, \phi_{SY}$	T_{OR1}	A-4			100	ns
	SH, MO	T_{OR2}	A-4			150	ns
Output fall time	$DM_{0-7}, \overline{RAS}, \overline{CAS}, \overline{WE}, A_8, \overline{MDEN}, \overline{ROM-CS}, \phi_{SY}$	T_{OF1}	A-4			100	ns
	SH, MO	T_{OF2}	A-4			150	ns
Reset pulse width	\overline{IC}	N_{IC}	A-5	80			cycle

(Note)

A time period from when the output request was issued through the output ports until the output port voltage becomes 1.0 V.

5. MAJOR FEATURES

The MSX-AUDIO has such major operating features as the FM sound generator, ADPCM speech analysis/synthesis, external memory control, AD/DA converters and input/output ports for keyboard scanning.

(a) FM sound generator

The FM sound generator has three sounding modes: simultaneous generation of nine tones, generation of six melodies and five rhythms, and composite sinusoidal modeling. One of the three modes is selected by software according to the application. Because this FM sound generator is equivalent to that of the OPL (YM3526), the software for the OPL can be used with the MSX-AUDIO.

- Simultaneous nine-tone generation:

This mode simultaneously generates nine FM sounds of FM sounds of different tone colors. Both the rhythm selection bit (R) and composite sinusoidal modeling bit (CSM) should be specified with "0" for this mode.

- Six-melodies/five-rhythms sounding:

This five available rhythmic sounds are bass drum, snare drum, tom-tom, high-hat cymbals, and top cymbal.

- Composite sinusoidal modeling:

This is a speech synthesis mode to simulate sounds by using three to six sine waves.

(b) ADPCM speech analysis/synthesis

This function provides the speech analysis and synthesis using 4-bits ADPCM. The sampling rate for modulation can be arbitrarily programmed within 1.8 KHz—16 KHz (analysis) and 1.8 KHz—50 KHz (synthesis). Analysis results and synthesis data can be stored in either external memory (ROM or RAM) or the processor's storage.

(c) External-memory control

This function controls the external memory used to store the analysis/synthesis data processed through ADPCM. Available external memories are 256 K-bytes DRAM, 64 K-bytes DRAM, and the ROMs accessible in units of byte. The maximum storage capacity is 256 K-bytes (both RAM and ROM).

(d) AD/DA converters

The AD/DA converters in the ADPCM unit can be operated independently.

In this AD/DA conversion mode, FM sound generation and ADPCM speech analysis/synthesis are ineffective.

(e) Keyboard input/output ports

These are 8-bit input/output ports for external keyboard scanning.

In addition to the above-mentioned functions, the MSX-AUDIO is equipped with vibrato and amplitude-modulation oscillators for further natural sound generation, two general-purpose timers for various interface signals, and general-purpose 4-bits input/output ports.

6. ADDRESS MAP

1. Address D₇ D₆ D₅ D₄ D₃ D₂ D₁ D₀

0 0	--CONTROL--							
1 F	--CONTROL--							
2 0	AM		VIB		EG-TVD		MULTI	
3 5	AM		VIB		EG-TVD		MULTI	
4 0	KSL		TL					
5 5	KSL		TL					
6 0	AR				DR			
7 5	AR				DR			
8 0	SL				RR			
9 5	SL				RR			
A 0	F-Number (L)							
A 8	F-Number (L)							
B 0	KON		Block			F-Num (H)		
B 8	KON		Block			F-Num (H)		
B D	AM DEP	VIB DEP	R	BD	SD	TOM	TC	HH
C 0	FB				C			
C 8	FB				C			

--STATUS--

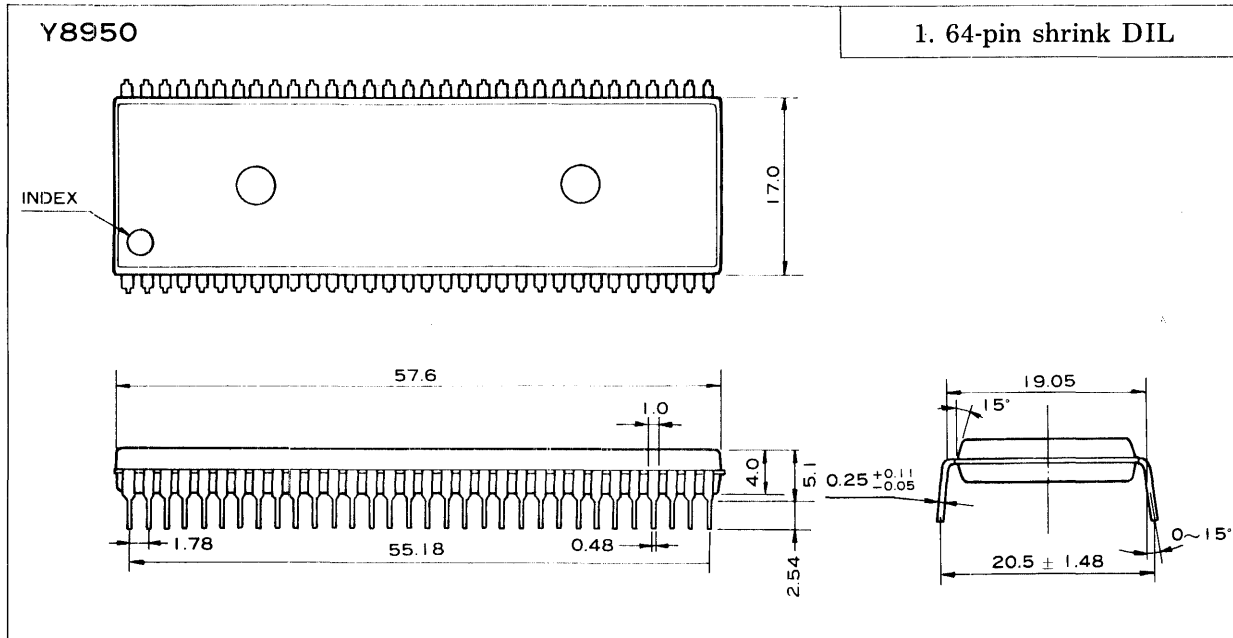
INT	T1	T2	EOS	BUF RDY	PCMSY
-----	----	----	-----	---------	-------

2. Address D₇ D₆ D₅ D₄ D₃ D₂ D₁ D₀

0 0	TEST							
0 1	TEST							
0 2	TIMER 1							
0 3	TIMER 2							
0 4	I/O RST	T1 MSK	T2 MSK	EOS MSK	BR MSK	ST2	ST1	
0 5	Key Board IN *							
0 6	Key Board OUT							
0 7	STA RT	REC	MEM DATA	REPT	SP OFF	RST		
0 8	CSM	NOTE SEL	Sam pl	DA AD	64K	ROM		
0 9	START ADD (L)							
0 A	START ADD (H)							
0 B	STOP ADD (L)							
0 C	STOP ADD (H)							
0 D	PRESCALE (L)							
0 E	PRESCALE (H)							
0 F	ADPCM-DATA *							
1 0	DELTA-N (L)							
1 1	DELTA-N (H)							
1 2	EG-CTRL							
1 5	DAC DATA (H)							
1 6	DAC DATA (L)							
1 7							SHIFT	0
1 8	I/O-CTRL							
1 9	I/-DATA *							
1 A	PCM-DATA *							

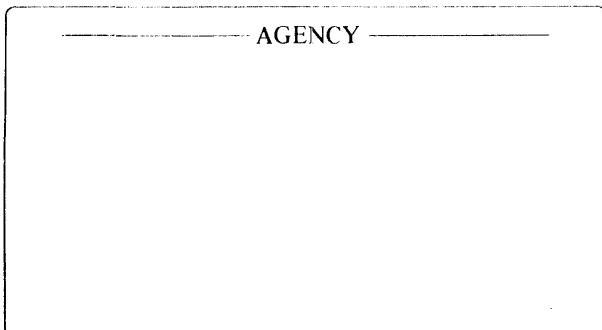
3. * Accessible register

PACKAGE DIMENSIONS



(Note) Specifications of this product are subject to change for purpose of improvement without prior notice.

The specifications of this product are subject to improvement changes without prior notice.



NIPPON GAKKI CO., LTD.

Address inquiries to:
Electronic System Division

- Toyooka Factory 203, Matsunokijima, Toyooka-mura,
Iwata-gun, Shizuoka-ken, 438-01
Electronic Equipment business section
Tel. 053962-3125
- Tokyo Office 3-4, Surugadai Kanda, Chiyoda-ku,
Tokyo, 104
Ryumeikan Bldg. 4F
Tel. 03-255-4481
- Osaka Office 1-6 Shin-ashiya shita, Suita-city.
Osaka-fu. 565
Tel. 06-877-4481