

MICROCOMPUTER DIGEST

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Seasons Greetings!

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AMD & RAYTHEON SIGN 2900 AGREEMENT

Advanced Micro Devices has licensed Raytheon Semiconductor to build its proprietary 2900 bipolar microprocessor integrated circuit family.

The pact, signed by W. J. Sanders III, AMD's president, and Francis Dowd, Raytheon Semiconductor's vice president and general manager, initially transfers technical assistance for production of the Am2901 microprogrammable processor slice and the Am2909 microprogram sequencer.

Under terms of the license, for an undisclosed sum, AMD will supply detailed assistance for all current circuits in the family as well as those to be introduced through the end of 1976. (cont'd on page 2)

GI AND SEMI ENTER TRANSFER PACT

General Instrument's CP 1600 single chip, 16-bit microprocessor will be second-sourced by SEMI, Inc., a division of EMM.

In making the announcement, SEMI company officials said the technology exchange with GI had been sought because of customer demands for a numerical control machine that efficiently used memory and had a higher throughput than 8-bit microprocessors.

GI and SEMI have previously arranged technology exchanges in the past for several RAMs and ROMs.

INSIDE THIS ISSUE

SEMICONDUCTOR FIRMS are lowering their prices on microprocessors and kits. Stories on page 4.

SIGNETICS is in the midst of redesigning the 2650 chip. Story on page 4.

COURSES—Upcoming microcomputer courses for January, February and March on page 16.

NEW LOW-END 8-BIT MICROPROCESSOR

Electronic Arrays is about to enter the low-end 8-bit microprocessor market. Slated for entrance in the first quarter of 1976 is the EA9002 N-channel silicon gate MOS microprocessor.

Labeled by the firm as a microcontroller, the chip's design is directed toward the hard-wired control logic applications market. However, the 2 μ s instruction fetch and execution time allows the chip to be used in nearly all 8-bit microprocessor applications.

(cont'd on page 4)

INTERACTIVE BASIC COMPUTER STATION

A new interactive BASIC computer station that combines built-in computing, local mag tape, and storage display for graphics and alphanumeric has been unveiled by Tektronix. The unit is priced at \$6995 and closely compares with IBM's recently announced 5100.

The Tektronix unit is priced \$2000 under IBM's model. The 5100 has an additional 8K of memory but lacks the graphic capability of the Tektronix system.

The Tektronix 4051 has at its CPU heart a Motorola M6800 8-bit microprocessor. This device controls all internal operations and generates the six built-in character fonts used on the CRT. (cont'd on page 3)

MIPROC-16 AVAILABLE ON U.S. MARKET

Plessey Microsystems is now offering the Miproc 16 micro on the U.S. market. The device features a 350 ns cycle time and 82 instructions. The chip is configured for parallel fetch and execution and is available in standard and ruggedized versions.

Software support for the Miproc 16 consists of a FORTRAN IV cross assembler and a simulator for use on the Tymshare and GE Mark III timeshare systems.



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SPECIAL FEATURES:

AMD & RAYTHEON SIGN 2900 AGREEMENT

(from page 1)

The 2901 microprocessor contains an eight-function ALU, a two-port 16-word scratch pad memory, an additional accumulator register and shifting and control logic. This circuit can execute a read-modify-write cycle in 100 ns.

Raytheon is the second semiconductor firm to announce it will second source the 2901 (see MD, November 1975). Last month, AMD and Motorola's Semiconductor Products division signed a similar second source agreement in which no monetary or mask exchanges were included.

In a related move, AMD announced the availability of their Am2909, an expandable 4-bit microprogram sequencer with the capability of performing up to four levels of sub-routine. This low-power Schottky LSI element has the capability to generate, increment and store addresses. It is applicable in any microprogrammed situation, but was specifically designed for operation with the 2901 microprocessor.

AMD also introduced the Am2902 carry look generator, Am2918 two port register and the Am2950/51 256-bit, high speed bipolar RAMs. All devices are members of AMD's bipolar microprocessor family.



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NEW LOW-END 8-BIT μ P

(from page 1)

The chip is housed in a 28-pin package and incorporates a 12-bit program address counter, a 7 level subroutine address stack, an 8-bit ALU with carry, 8 general purpose registers, a 512-bit (64 x 8) scratch pad RAM, instruction register, interrupt input, 12-bit address register, and an 8-bit bidirectional data bus.

The instruction set provides for binary and BCD arithmetic logic operations, test, branch on condition, jump and I/O control. BCD arithmetic is hardwired such that a single instruction automatically performs the decimal correct function. The general register files allow most instructions to be programmed with single byte instructions. Seven 2-byte instructions are provided for reaching across the full 12-bit memory address capability.

INTERACTIVE BASIC COMPUTER STATION

(from page 1)

An optional external tape drive and an optional plotter both use a 6800 to control their operations.

The 4501 general purpose interface bus is compatible with the standard called out in IEEE Standard 488-1975. Also, Tektronix has used a direct view storage tube as the primary CRT to permit flicker-free operations.

μ C AID IN LAW ENFORCEMENT

One of the most effective tools of modern law enforcement agencies are large-scale communications systems with access to Federal, State, County and City data bases. An officer who stops a car for a minor violation must know, within a matter of seconds, whether or not the car has been stolen or is carrying potentially dangerous passengers. A detective needs the criminal record of a suspect he is questioning. A judge wants a probation report. Warrants for unpaid traffic tickets produce substantial revenues for local governments.

To meet these needs, minicomputer and large-scale computer Message Switching Systems (MSS) have been installed in major cities

throughout the nation over the past few years. Most recently, Action Communications has incorporated microcomputers in a new MSS designed for the New York City Police Department. The microcomputers, having up to four National Semiconductor IMP-16 microprocessors and National's 32K x 16 2102 memories, handle synchronous and asynchronous data from up to 16 lines. Additional lines can be accommodated by adding modules. The devices also calculate the Cyclic Redundancy Check (CRC) numbers using IBM's CRC equation.

The message switching system is controlled by a Data General Nova. Inquiries are transmitted by each user terminal in its own most convenient form to the IMP-16 which performs data checking and conversion to the form required by the data base. The request is transmitted under control of the Nova, to the appropriate data base. The reply from the data base is reconverted by the IMP-16 and transmitted back to the inquiring terminal, also under control of the Nova.

Communication occurs over a wide variety of data channels. The user normally originates an inquiry through a CRT or hard copy terminal via a direct line although microwave links, WATS, or Dial-Up (DDD) lines may be used depending on anticipated traffic and terminal location.

Each microcomputer is capable of handling up to 19.2K baud rates; therefore, as an example, a single processor can handle two 9600 baud lines, four 4800 baud lines, or one 9600 and two 4800 baud lines.

With CRT terminals, the system produces a format mask for certain classes of messages. The operator keys information into the displayed form that identifies what information is required. The much slower TTY terminal requires that the operator key-in both format and information.

"Prior to the introduction of the microprocessor into the system design," says Mike Fannin, system designer, "Action used a minicomputer just to handle the asynchronous/synchronous functions. In one particular installation, a \$15,000 minicomputer handled two lines; when the system was converted to microcomputers, the cost came down to \$3,600, more than a 75% reduction."



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TECHNOLOGY:**SIGNETICS REDESIGNING 2650**

Officials at Signetics have announced that the company will expand its memory line and introduce a new version of the 2650 8-bit microprocessor. The 2650 is being redesigned by Signetics and will have a new, smaller die size of 169 x 195 mils. The CPU will have the same 2650 part number and is expected to be ready in the last half of 1976.

The memory line is being increased with the addition of eight types of 2101 256 x 4 static NMOS RAMs, a 1K RAM to be ready in March, two 1K x 8 bipolar ROMs, 1K x 4 bipolar PROM (also to be ready next March) and a 2K x 4 PROM that should be ready for introduction in May.

Signetics is currently sampling a field programmable logic array compatible with most bipolar and MOS microprocessors. The FPLA will reportedly be second sourced by Advanced Micro Devices.

DISTRIBUTORS TO STOCK TI SBP 0400

The first of 1976 will find Texas Instruments SBP 0400 I²L microprocessor stocked on distributors' shelves. The bipolar device will be offered in an "A" version, which the company says is approximately four times faster than the original design.

The microprocessor will also be offered with a 120 page applications manual, free microassembler and the prototyping hardware kit.

At the same time, a company spokesman revealed that TI is currently working on a 16-bit I²L microprocessor for introduction in spring. No details were given other than the micro would be more powerful than any model currently available.

NEC DROPS μ PD8080 PRICES

NEC Microcomputers, prompted by recent action from Intel and AMD, has dropped prices on their μ PD8080A microprocessor from \$150 to \$69 in quantities up to 24, from \$112 to \$57 for up to 99 and from \$92 to \$37 for over 100 quantities.

The 1MHz μ PD8080A-B was reduced from \$110 to \$52 in single quantities, from \$82 to \$42 for under 100, and from \$70 to \$27 for over 100 quantities. NEC also announced price reductions for evaluation kits from \$350.50 to \$269.50 for the uCOM-8/Kit 8A; from \$239 to \$177.90 for the uCOM-8/Kit 8B; from \$360.50 to \$279.50 for the uCOM-8/Kit 80A; from \$249 to \$191 for the uCOM-8/Kit 80B; and from \$995 to \$720 for the uCOM-8/EVAKIT-8.

The company reports they will continuously adjust their prices to keep them competitive with any changes Intel, AMD or TI might make.

DEC ORDERS 50,000 8080's

Some 50,000 Intel 8080 microprocessors are slated to be shipped to Digital Equipment Corp. over the next 18 months. The particular application the chips are to be used in is being kept quiet by DEC. However, evaluation is continuing on 8080-type devices from AMD, TI and NEC.

Sources are still unsure if the move by DEC means the company has settled on the 8-bit microprocessor as the company standard for future products.

NEW CDP 1801 PRICES

Not wanting to be left behind, RCA has reduced the prices for their two-chip CDP 1801 microprocessor to \$40 for single quantities. The company reports that the lower prices are a direct result of RCA's expertise in manufacturing CMOS devices.

The CDP 1801C (5v) is \$40 and the CDP 1801 (15v) is priced at \$56. The firm is also offering a Microkit hardware development system which includes manuals, software development programs and the prototype unit.

2650 PRICES LOWERED

Signetics has reduced prices for the 2650 microprocessor. At the same time, the company announced the availability of two software cross products for 16-bit computers.

The single unit prices for the 2650 were reduced by more than 50%, dropping from \$165 to \$72. A 25-99 quantity price of \$62 was also announced. Signetics reports that the



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price decrease represents the first in a series of price reductions planned by the firm as the 2650 progresses from small to large volume production. The company also expects to further reduce the price to \$30-35 in the early part of 1976.

The 16-bit assembler and simulator were generated in response to user demands for software design aids that operate on in-house minicomputers. In addition, Signetics offers the same software for 32-bit machines and on various time-sharing services. The price for the assemblers and simulators are \$1250 and \$750 respectively.

MICROCOMPUTER-BASED PRODUCTS:

FIRST CP-1600 PRODUCT UNVEILED

A new microcomputer controlled digital process control and data acquisition system has been unveiled by Honeywell's Process Control division. The system will initially be used in chemical, petroleum and petrochemical applications.

The Total Distributed Control system, TDC 2000, is the first product to use the CP-1600 16-bit microprocessor. The CP-1600 was designed in a joint effort by Honeywell and General Instruments (MD, April 1975). The TDC 2000 consists of microcomputer-based controllers, CP-1600-based CRT display stations, and operator interface for analog displays. The system can be interfaced with process computer hardware and software to provide flexibility for configuring simple process controllers to extremely sophisticated systems controllers. A digital controller built around the CP-1600 is the heart of the system.

Prices start at \$15,000 and total system cost, of course, depends upon the number of instruments, CRT stations, controllers, hardware, etc. used for a particular application.

Honeywell reports that they have already received two significant orders for the TDC 2000. The company identified one customer as Union Carbide but declined to identify the second customer. Industry sources, however, have tagged the Salt Lake City Kennecott Copper installation as the second purchaser.

EXTRA 80

The Extra 80, introduced by Canada's Display & Decisions Systems, Ltd. incorporates a 16-bit processing array, a microprogram control store (48 bits/word), and all external ancillary logic. The Extra 80 replaces the 8080A microprocessor, 8228 system controller, 8224 system clock and two 8226 three-state bus drivers. All input control signals are fully buffered and may be asynchronous; all output control signals are three-state. A memory address register with three-state bus drivers is available which can be employed for DMA requests.

The Extra 80 has a basic 200 ns microinstruction cycle time, is static, and the internal clock may be adjusted to run from DC to 4 MHz for single step operations.

Coding the 8080 instruction set requires 300 words on microprogram memory, leaving 200 words for user microprogrammed instructions. Any of the 8080's 12 undefined instructions are trapped. The user may define op codes in these 12 instructions using the remaining 200 microprogram words. If the extra instructions are insufficient, the Extra 80 architecture allows the user to specify a double byte (16) op code. For instance, a file move with directly specified 16 bit address fields and with an N-word move capability would require a 6-byte format, while using only one op code.

A single precision multiply-divide is provided as a standard extension to the 8080 instruction set. The multiply executes in approximately 3.2 μ s, 40 times faster than an 8080. The Extra 80 is implemented using Intel's 3000 bipolar microcomputer elements.

Extra instructions will be microcoded by Display & Decision Systems Ltd. on a consulting basis. Kits are priced at \$680 plus \$80 for PCBs compatible with the Altair bus structure.

FIRST PROCESSOR TO USE 16K RAM CHIPS

Four Phase's Network Processor, NP/80, is the first computer to be introduced utilizing 16K-bit RAM devices. The 16K N-channel silicon gate RAMs are designed and manufactured

(cont'd next page)



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Four-Phase Systems' new NP/80 Network Processor meets the communications and data base management requirements of large regional and district offices.

The first computer to be introduced with 16K-bit RAM devices, the NP/80 enables network users to geographically distribute their data base in a hierarchical form that closely parallels the organizational structure of most major corporations.

The new processor can support a local data base of up to 270 million bytes for access by up to 64 local displays through direct connection of two Four-Phase System IV/70's. While communicating with the central mainframe at speeds up to 50K baud, the NP/80 can concurrently control an extensive network of remote Four-Phase systems over multiple 9600 baud lines.

The heart of the NP/80 is a powerful 16-bit computer with 500 nanosecond cycle time and up to 256K bytes of MOS/LSI memory. The hand in the foreground contains all the 16K-bit RAM chips needed for a 256K byte memory including error correction. These devices, designed and manufactured by Four-Phase, will occupy a single printed circuit board when assembled.

by Four-Phase Systems. The firm has also designed a 4K static RAM that will be used in smaller memory configurations of the NP/80. The announcement of the NP/80 follows Four-Phase's introduction in 1970 of the industry's first computer with LSI semiconductor memory and an LSI central processing unit.

The heart of the NP/80 is a powerful 16-bit computer implemented with TTL and MSI devices with 500 ns cycle time and up to 256 bytes of MOS/LSI memory. However, the company said that although initial deliveries of the NP/80 will consist of the TTL and MSI implemented CPU, future NP/80s will not. The company is currently integrating the CPU design into a three chip LSI microcomputer.

Lease prices for the various configurations of memory can be obtained by contacting Four-Phase. All lease prices include a channel interface to a System IV/70, maintenance, software, systems engineering support, and systems education services. Initial deliveries of the system will be made during the first calendar quarter, 1976.

ALTAIR 680 ANNOUNCED

Mits, Inc. has introduced the Altair 680, a new microcomputer kit based on the 6800 microprocessor chip. The 680 is available in three versions, as a development system, a turnkey system and as a MPU processor board.

The MPU consists of the 8-bit parallel 6800 microprocessor, 16-bit address bus and has the ability to address 65K bytes of memory. The chip has 72 basic instructions and a typical cycle time of 4 μ s.

The 680 development system comes with power supply, front panel control board, MPU board with 1K RAM, built-in I/O that can be configured for RS232 or 20 mA or 60 mA current loop, and provisions for 1K of PROM or ROM. The chassis measures 11" wide x 11" deep x 4-11/16" case.

The unit is priced at \$293 in kit form and \$420 fully assembled. The turnkey model (excludes front control panel board) is \$240/kit and \$280 assembled. The 680 MPU board kit price is \$180 and \$275 assembled.

MICROCOMPUTER PRINTER/PLOTTER

The new Versatec 4472 plotter and 4472A printer/plotter introduced by Versatec, not only produces plots on 72-inch wide paper, but also uses a microcomputer to offer versatility and simplify system control. The plotters do not use paper drive stepper motors as is commonly used, but have been designed with shaft encoder and servo motor drive.

The 4472 is priced at \$43,500 and the 4472A is available for \$46,900. Paper costs less than 2¢ a square foot. OEM and quantity discounts are available and delivery is 180 days ARO.

NEW FIRM OFFERS 4040 PRODUCTS

The newly formed microcomputer company, International Microsystems, Inc. has introduced their first product, the IM4041, a single card CPU unit designed to fit a standard 4½" x 9" Cambion bin.

The unit includes the Intel 4040 microprocessor, clock, 1K x 8 RAM, provision for 1K x



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8 of PROM, and an 80 x 4 data RAM. The user's program can be executed from RAM or PROM. Also included is a test PROM which tests all system I/O. The module provides separate input and output data busses as well as three latched DCL lines, and the entire I/O structure is TTL compatible.

Power requirements are +5 and 0-12v. A terminal control board, front panel monitor, and a wired bin with power supplies are available. The IM4041 is priced at \$395 in single units with delivery in 30 days ARO.

HIGH PERFORMANCE 8-BIT μ C SYSTEM

A three-card 8-bit high-performance microcomputer featuring DMA with priority, and available for \$1,500 in OEM quantities, has been introduced by System Integration Associates (SIA).

Designated SIA-3000, the set includes a processor board, RAM board, utility board and a card cage that can hold up to five boards. Power supplies are also available. The 3000 can be used in designing systems to perform significant multiple processor applications.

The processor board includes the 8080 microprocessor, crystal clock circuitry, I/O port decoding, interrupt logic, system interconnect logic, data bus logic, and provision for 16K bytes of PROM memory. Clock cycle is 540 ns. A RAM board houses three priority controlled channels to a maximum of 16K bytes of RAM and the necessary refresh logic for the dynamic RAM.

A single system is offered for \$2000 and delivery is 60 days ARO.

IN-CIRCUIT MICROCOMPUTER ANALYZER

A portable microcomputer analyzer system, designated MAS-80, features as its only connection to the users systems, a cable plug that inserts into the 40-pin socket that normally contains the users 8080 microprocessor. The control panel enables the user to monitor and control his system without developing special modules or test devices.

Introduced by California Micro Computer, the MAS-80 can be used in production test to monitor the state of the 8080 signals prior to inserting a good 8080 on an untested board.

The MAS-80 module contains its own 8080 that is protected against damage by buffer circuits.

The system is priced at \$850 and delivery is from stock to four weeks.

INTEL OFFERS 8080 KIT

Intel Corporation has unveiled a ready-to-assemble, pre-programmed microcomputer system kit. The new kit provides a complete system based on Intel's new 8080A CPU Group and programmable LSI input-output blocks, which allow the system to control and communicate with numerous classes of peripheral equipments.



Called the MCS-80 Microcomputer System Design Kit, it provides the following components and software for only \$350: 8080A microprocessor, 8224 clock generator, 8228 system controller, 8251 programmable communications interface, 8255 programmable peripheral interface, two 8205 1-out-of-8 binary decoders, two 8708 8K EPROMs, two 8111 1K RAMs, clock crystal, PC board, connectors, all required discrete components, system monitor program, and documentation.

The kit was developed primarily for system prototyping by equipment designers. However, it is also suitable for other users, such as engineering school students and computer hobbyists.

The system monitor firmware in one 8708 PROM provides a general purpose operating system. (cont'd next page)



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tem program to facilitate design evaluations and tests. The other 8708 PROM can be used to develop specialized applications programs, operating in conjunction with the system monitor or independently. Intel also has an extensive collection of applications programs available to members of the company's user's library.

8080A-BASED CPU BOARD

The MML, an 8-bit 8080A based microcomputer has been introduced by Control Logic, Inc. The CPU board can accommodate 1K RAM and 4K PROM. Memory is expandable to 64K bytes.

The CPU board is priced at \$550 in single unit quantities and \$350 in 100 quantities. Options include powered rack-mounted chassis or desktop enclosure, digital I/O, serial interface, real-time clock, priority interrupt and memory. Any combination of 1K RAM and PROM is priced at \$100 and \$80 in 100 quantities.

XEROX INTRODUCES TWO μ C SYSTEMS

Xerox Data Systems has announced two terminal products, the Model 3010 Communications Terminal and Models 3020/3030 Intelligent Display System.

The 3010 is a microprocessor-driven keyboard/printer that provides reliable and quiet operation while offering users ATS/TEXT and APL capabilities on one ASCII-compatible terminal. Based on the Diablo HyType print mechanism, the Model 3010 has up to 14 different type fonts and prints with either cloth or carbon ribbons. The terminal also has special standard features such as backward print, read/black ribbon shift, variable horizontal and/or vertical spacing, and plot mode. In addition, the terminal's extensive off-line diagnostics can be initiated by the operator to detect malfunctions to the system module level.

The 3020/3030 Intelligent Display System (IDS) has a display processor (microprocessor) and one or more display stations. It provides inquiry/response and data entry/retrieval capabilities for all Xerox computer systems. IDS will receive and format messages from a host computer, automatically perform the nec-

essary control interactions and check the validity of information received. Extensive editing capabilities are standard, including rollover (when inserted or deleted characters exceed a line), cursor control, and text justification. A unique plug-in maintenance control card is used to verify proper operation down to the module group level.

PRICES LOWERED

The price for the Microcomputer Development System manufactured by Control Logic has been reduced to \$2500. The 1024-byte RAM card for memory address decoding has been cut to \$125.

MICROCOMPUTER SOFTWARE:

INTEL CUTS SOFTWARE RATES

A 50% reduction in microcomputer software royalty rates has been announced by Intel Corp. The cuts, which went into effect worldwide on November 1, will result in a savings to Intel users of some 25% of time-shared computer charges. They apply to all Intel software used through time-shared networks to program microcomputer systems, but do not apply to programs used in a background batch or Remote Job Entry environment.

The new rates apply to the PL/M compilers, macro assemblers, and simulator packages used to program Intel's four MOS microcomputer families, and to the cross microprogramming system (CROMIS), used to program bipolar systems based on the Series 3000 bipolar microcomputer elements.

These packages are provided through General Electric, Tymshare and United Computing in the U.S.; General Electric in Canada; Honeywell Timesharing Ltd. and Tymshare in Europe; Dentsu in Japan; and Honeywell in Australia.

μ C CROSS ASSEMBLERS FOR PDP-10's & 11's

The Boston Systems Office, Inc. is offering a series of cross-assemblers for PDP-10's and PDP-11's that assemble code for Intel 8080, 8008, 4040, 4004, Motorola M6800, Fairchild F8, and MOS Technology 6500 devices. The software is also available on several na-



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tionwide timesharing services as well as being available for both sale and rental.

In addition to the cross assemblers, the firm has written resident assemblers, compilers, drivers, editors, and disc operating systems for Intel, Motorola and Fairchild 8-bit microcomputers. These packages are also being offered for sale as off-the-shelf products or can be custom designed for a particular hardware configuration. Interested persons should contact the consulting firm for a price list.

NCSS μ C SOFTWARE SUPPORT

National CSS has announced the availability of a series of programs to assist the development of microprocessor software. Included are cross assemblers and simulators for the AMD 9080, TI 8080/1000, Intel 8080/8008, Intel 4040/4004, Fairchild/Mostek F-8, National PACE/IMP-16, AMI/Motorola 6800, MOS Technology MCS6501/MCS6502, Signetics 2650, Rockwell PPS-4/PPS-8 and Rapid, an all purpose cross assembler from SMS.

The programs are accessed through a communications terminal which is connected by standard telephone lines to National CSS Data Center.

8080 BASIC LANGUAGE INTERPRETER

Mits Inc. has announced a powerful BASIC language interpreter for 8080 microprocessors, the ALTAIR BASIC (Version 3.1), which requires a minimum of 6K bytes of memory.

Features include those not normally found in BASIC such as Boolean operators (AND, OR NOT) which can be used in IF statements or for bit manipulation, INP and OUT which can read or write a byte from any I/O port, and PEEK and POKE to read or write a byte from any memory location. Variable length strings (up to 255 characters) are provided as well as the LEFT\$, RIGHT\$ and MID\$ functions to access substrings of strings, a concatenation operator and VAL\$ and STR\$ to convert between strings and numbers. Number representation is 32-bit floating point. Both string and numeric arrays of up to 30 dimensions may be used, and can be allocated dynamically during program execution. Nesting of loops and sub-

routine calls is limited only by available memory. Intrinsic functions are SIN, COS, TAN, LOG, EXP, SQR, SGN, ABS, INT, FRE, RND and POS, in addition to TAB and SPC in PRINT statements.

An extended version of BASIC will be ready later this month, and will have double precision (64-bits) floating point variables and integer (16-bit) variables, as well as strings and single precision floating point. PRINT disc file I/O and many other enhancements will also be included.

SINGLE PASS 8080 ASSEMBLER

A one pass assembler for the Intel 8080 microprocessor is being marketed by Micro Systems. The program generates object code directly into memory from a compatible subset of the Intel language. The \$495 assembler is housed in approximately 2K bytes of memory.

JOLT MINI CROSS-ASSEMBLER

Microcomputer Associates Inc. has announced a JOLT cross-assembler written in standard Fortran IV and designed to run on 16-bit minicomputers. The Fortran cross assembler is easily modified to run on any 16-bit minicomputer that supports Fortran IV. The cross assembler is priced at \$15 for the Fortran listing and \$30 for the source paper tape. An HP 2100 version is immediately available and a NOVA version will be available within a few weeks.

The cross assembler generates object code for MAI's JOLT microcomputer systems. Prices for JOLT microcomputer kits begin at \$25, with complete 4K byte systems priced at \$339.50. Free brochures are available on request.

MEMORIES AND PERIPHERALS:

F-8 μ P HARDWARE KIT

The PS-710 F-8 microprocessor hardware kit offered by Pronetics Corp is a fully assembled PC card with sockets for the F-8 microprocessor kit ICs. The \$65 card can be used for proto-

(cont'd next page)



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type and development systems or as a standard hardware module for production systems. Memory expansion is accomplished quite easily as all necessary functions are available on a standard edge connector.

8K RAM DUE IN '76

Advanced Memory Systems has disclosed plans to market an 8K RAM during the first half of 1976. The device, says the company, will be only twice the size of memory chips now available, but will offer users savings of 20-40% if the 8K memory is used as a bridge between 4K and 16K RAMs.

The 22-pin device will be pin-compatible with existing 4K memories. The company expects to have the device on the market for two years before it comes into heavy competition with 16K RAMs. No prices were given at this time by the firm.

NEW FC&I 2K RAM AIMED AT μ C MARKET

Fairchild Camera & Instrument Corp has announced availability of the 3539, a 2K TTL compatible static N-channel RAM that is said to be ideally suited for microprocessors and other applications in peripheral equipment.

The 256 x 8 RAM is available in two versions with maximum access times of 650 and 500 ns.

The 3539 has two separate chip-select inputs, a power dissipation rating of less than 500 mw, and requires only a single 4v supply.

The RAMs are available in standard 22-pin DIP packages with pricing in 100 quantities at \$8.50 for the 650 ns 3539, and \$9 for the 400 ns 3539-2.

TIME DIVISION MULTIPLEXOR

Micom Systems Inc. has announced the DDM 40/01 Time Division Multiplexor. This low-cost unit, with prices starting at \$1000, multiplexes synchronous and asynchronous terminals or modem links into a synchronous serial data stream compatible with voice grade, broadband or digital data service (DDS). Interfaces are available for direct connection to either the Bell DSU or CSU.

The DDM 40/01 uses a unique timing concept

that permits use with multiple dial-up synchronous channels. Asynchronous lines, either dedicated or dial up, can be intermixed with the synchronous lines. For example, a small number of asynchronous terminals can intermix with a higher speed device such as an RJE terminal for transmission over a single leased line. Synchronous lines of practically any speed can be intermixed for transmission over a link with excellent efficiency at speeds of 500 bps to over 230,000 bps.

The Micro DDM 40/01 is available from stock and a working system with units at both ends of the link is priced at \$2800.

INTERMIL'S NEW CMOS TIMING CIRCUITS

Intersil is adding seven new CMOS devices to its line of timing microcircuits. The new devices include the 7045, which times intervals from 0.01 seconds to 24 hours, comes in a 28-pin DIP and typically dissipates 0.9 mW. The 7205, is a 24-pin DIP, times from 0.01 seconds to 1 hour and dissipates 2.5 mW typical. The price is \$17 for the 7045 and \$11 for the 7205.

The 7208 is a 7-digit unit counter and is priced at \$9.95. The 7038A is a CMOS oscillator, frequency divider and driver for synchronous motors. It is packaged in an 8-pin DIP and costs \$2.50. The 7207 is a complete frequency counter timebase packaged in a 14-pin DIP, and dissipates less than 5 mW at 5v. It is also priced at \$2.50.

The 7209 is a high frequency clock generator for 5v systems, accomodating crystals from 10 kHz to 10 MHz. It is packaged in an 8-pin DIP and is priced at \$1.50. The 7213 is an oscillator, divider and waveshaping circuit using crystals from 1 to 6 MHz. It is packaged in a 14-pin DIP and costs \$2.50

All prices are for 1000 quantities.

Another new Intersil circuit, the ICM7207, provides a timebase for frequency or time interval counters. It operates with a 6.5536 MHz quartz crystal and dissipates less than 5 MW at 5v.

When used with the crystal, the chip provides a two decade range counting system. The count window may be changed by a factor of 10.

Pricing for an ICM7207 DIP in quantities of 100-999 is \$15.05



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CMOS A/D CONVERTERS

Teledyne Semiconductor has introduced a series of CMOS A/D converters which combine on a single chip, all linear and digital circuits required to convert the analog signal.

The series includes the Teledyne 8700 8-bit, 8701 10-bit and 8702 12-bit CMOS A/D converters. All three utilize a sophisticated integrating conversion technique, called incremental charge balancing, to achieve high linearity and monotonic performance. The single chip CMOS construction reduces power dissipation to 20 mW or less.

One feature of the new series is latched parallel binary outputs, which make the converters logically compatible with microcomputers and minicomputers. They can be used to store measurement data or to facilitate operations such as sampling and multiplexed transmission.

In 100 quantities, prices for the 8700 are \$16; 8701 \$22.50; and the 8702 \$29.50.

QUAD BUS TRANSCEIVER

A quad high-speed bus transceiver with tri-state outputs that is guaranteed over the full military temperature range is now in volume production by Advanced Micro Devices.

This Schottky interface circuit, Am8T26, consists of four sub driver and receiver pairs all with tri-state outputs. Each driver output and receiver input pair is connected to form the bus. Worst case delays through the driver and through the receiver are specified at better than 20 ns. Prices begin at \$3.90 in 100 quantities.

110 CPS PRINTER WITH HP2640A INTERFACE

Users of the Hewlett-Packard 2640A CRT Terminal can now tie their display unit to the Okidata CP110 (110 cps) printer using a new plug-compatible interface package from Okidata Corp.

The interface, including six feet of cable and a HP connector, provides direct access to the printer, enabling it to operate like a standard HP printer. The Okidata CP110 Printer is a tabletop unit that produces 80 columns

of 5 x 7 dot matrix characters at 110 cps or 60 lpm.

The printer/cable interface in quantities of 1-9 is \$1,500 for the roll paper model and \$1,710 for the tractor feed model. OEM discounts are available and the interfaces will be delivered 60 days ARO.

PEOPLE, LITERATURE AND EVENTS:

MOTOROLA SUES MOS TECHNOLOGY

Motorola is seeking an injunction against MOS Technology to halt the manufacture, marketing and filling of orders for MCS 6500 microprocessor products. The injunction action is intended to stop MOS Technology from further 6500 activities until the outcome of a pending trial of a suit filed in Federal Court in Philadelphia PA by Motorola. As of yet, the injunction attempts have been unsuccessful.

Motorola, citing several Motorola patents that led to the development of its own MC6800 microprocessor, alleges that seven former employees of Motorola (Charles J. Peddle, Rodney H. Orgill, William D. Mensch, Wilbur L. Mattys, Terry N. Holdt, Ernie B. Hirt, and Harry E. Bawcom) left Motorola and joined MOS Technology in similar posts and helped establish that firm's line of MCS6500 microprocessors.

The suit seeks triple damages plus all profits MOS Technology has made on the 6500 product line. MOS Technology has denied the allegations and stated that Motorola's claims are unfounded.

NATIONAL & FAIRCHILD SETTLE DISPUTE

National Semiconductor Corp. has entered into an agreement which would settle the lawsuit brought by Fairchild Camera & Instrument against National and Martin J. Alter.

In the settlement, Fairchild abandoned its claim that Alter should be prevented from working for National as the manager of its high-density bipolar memory effort. Fairchild also recognizes the right of National to employ Alter in any capacity of National's choosing, and the settlement recognizes Alter's
(cont'd next page)



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right to seek employment opportunities outside of Fairchild.

Under the terms of the agreement, the court will enter an order which does not limit Alter's position at National. Alter and National will be enjoined from using specified trade secrets and confidential information related to Fairchild's high-density bipolar memory products.

Fairchild and National have also agreed that a technical expert, the identity of whom will be agreed upon by the two companies, would act as a Special Master through June of 1977. This expert will conduct periodic reviews to provide both National and Fairchild with assurances that none of the specified trade secrets are transmitted to National by Alter.

At Fairchild's insistence, National has agreed not to hire any professional employees from Fairchild's bipolar and ECL group to work in that same area at National prior to August 1, 1976.

GI FILES SUIT AGAINST MOSTEK

General Instrument has filed suit against Mostek Corp. for allegedly infringing on several of GI's MOS processing and device design patents. The most important (3,388,009) involves GI's process for forming pn junctions with an ionic beam.

ELMAR EXPANDS μ C CENTER CAPABILITIES

Elmar Electronics has enlarged their Mt. View Microcomputer Design Center to include Data I/O's FPLA programmer and PROM programmers, Motorola's EXORcisor, PACE Development System, and Intellec MDS system with ICE-80. Each system includes high-speed paper tape readers, TTY, and in many cases, floppy discs.

Elmar established the center to provide customers with the capability of running benchmarks for selecting microprocessors, demonstrating machine capabilities, and to aid in customer product development. A one day PROM programming service is provided. Customer programs are stored at the Center for easy re-order by phone. Elmar handles Intel, Intersil, National, Fairchild, RCA, and Motorola μ Ps.

SCHWEBER OPENS μ C DESIGN CENTER

Schweber Electronics is opening a microcomputer design center at its Westbury NY center. The center consists of a technical training area, a hands-on demonstration section and equipment for benchmarking and determining the cost-effectiveness of microcomputer designs. The distributor also has available an IBM 360/135 for the development and debugging of microcomputer programs.

Schweber handles the AMD, AMI, Fairchild, Intersil, Motorola, National, RCA, and Signetics line of microprocessors.

ARROW TO STOCK μ C SUPPLIES

Arrow Electronics has announced that it will be stocking Lambda Electronics' new microcomputer power supplies at all Arrow locations. The distributor currently handles eight lines of microprocessors, including: AMI, Intersil, Monolithic Memories, Mostek, Motorola, RCA, Signetics, and Texas Instruments.

MOS TECHNOLOGY 6502/6530 COURSES

Microcomputer Associates has announced the first of their "Saturday Matinee" microcomputer courses. "MOS Technology 6502 and 6530 Microcomputer Fundamentals" is scheduled for January 31 and March 27 in Palo Alto CA and February 28 in Los Angeles. The one day courses will run from 9 to 4:30 followed by an informal no host cocktails hour.

The Saturday Matinee courses are intended to facilitate attendance by those with limited weekday schedules as well as for the growing number of microcomputer hobbyists. Tuition for the courses is \$50 or the purchase of a JOLT CPU or RAM kit priced from \$159.

NEW DIVISION FORMED BY FC&I

Fairchild Camera & Instrument Corp. has formed a new Microsystems Division with central responsibility for company activities in the field of microprocessors, microcomputers and related products. The company also said it will enter the memory systems market and



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has established a separate Memory Systems Unit for that purpose.

David L. Hahn, former general manager of the Communications Equipment Unit, has been named general manager of the Microsystems Division. He will continue to report to James D. Bowen, vice president and general manager of the Systems Technology Group. Engineering and product marketing personnel currently assigned to microprocessors within the MOS Products Division will be transferred to the new division.

Heading the Memory Systems Unit will be Chester A. Burns, director of advanced systems development for the Memory and Logic Group. He will continue to report to Dr. Thomas A. Longo, group vice president.

MOSTEK EXPANDS 4K RAM TESTING

Mostek has purchased five additional IC testers for production testing of the company's 4K RAM, the MK 4096. The \$600,000 order was placed with Siemens Corp. for its Model 203 tester. The systems will be used to supplement the existing 4K RAM test facility at Mostek. The five testers are scheduled for delivery between now and May 1976.

MINI/MICRO COMPUTER CONFERENCE

The exploding applications impact of the multi-billion dollar minicomputer/microcomputer area will be the subject matter of a new conference and exposition to be held in the Brooks Hall/Civic Auditorium complex in San Francisco next October.

The first annual Mini/Micro Computer Conference and Exposition has been scheduled for October 19-21, 1976. It is to be sponsored by the Minicomputer Industry National Interchange (MINI), a recently formed, national non-profit organization, with participation by other computer industry associations expected. Jon David, president of Systems RDI Corp. and founder and former chairman of ACM's Special Interest Committee on Minicomputers, is the president of the MINI association.

At least twelve conference sessions consisting of about 50 papers, a product display of 300 booth units, and an audience of 10,000 have been forecast by the Rankin Expo Mgmt.

COMPCON 76 SPRING

COMPCON 76 Spring, scheduled for February 24-26, 1976, will open with addresses from two distinguished figures in the computer industry, according to Dr. Sidney Fernbach of Lawrence Livermore Laboratories, conference general chairman.

The keynote address will be given by Dr. Edward E. David, Jr., executive vice-president of research and development for Gould, Inc., who will speak on the conference theme, "The next Five Years—Evolution or Revolution."

Dr. J. Persper Eckert of Sperry Univac, will deliver a special talk on "The Beginnings". His talk will mark the official opening of the Computer Society's 25th Anniversary celebration.

PEOPLE ON THE MOVE

ROBERT M. WALKER has joined the Components Division of Intel Corp. as manager of marketing communications. Previously, he was with Fairchild Camera & Instrument Corp. where he was manager of product planning and marketing for the Digital Products Division.

BILL LATTIN has left Motorola to join Intel as an engineering program manager. Lattin reports to Les Vadasz, Intel engineering vice president, and he is reportedly working on an MOS microprocessor design project.

DONALD L. MILLER and DOUGLAS J. FELDER have joined the Memory Systems Division of National Semiconductor Corp. reporting to Robert H. Welch, director of OEM marketing. Both men were formerly with Electronic Memories & Magnetics Corp.

A new shuffle at Signetics has resulted in new responsibilities for many managers, including LARRY REGIS who is now manager of special projects; LIONEL KINTON is the new general manager of the MOS division; and RICHARD FORTE has been named the new general manager of bipolar memories.

ROBERT W. SARNOFF has resigned as chairman and chief executive officer of RCA Corp. ANTHONY L. CONRAD, president and chief operating officer, has assumed the position of chief executive.

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RICHARD J. HALL has been appointed to the new position of director, MOS Manufacturing Operations for RCA Solid State Division. He will direct manufacturing operations for RCA's MOS product lines, including CMOS and NMOS integrated circuits, memories and microprocessors.

HARALD F. STAUDE has been appointed as manager of software for Versatec. Reporting directly to the Versatec president, Staude is responsible for all software development for the firm's microcomputer-based peripherals.

RECENT LITERATURE

"An Introduction To Microcomputers" (text)
Adam Osborne and Associates
December 1975

This handbook answers the prayers of all feverishly waiting for a microcomputer reference. The \$7.95 text is extremely easy to read and can be used as an instructional text or as a reference. The book divides itself into three major sections: fundamentals, advanced theory and commercial microcomputers.

Chapters 1, 2 and 3 assume the reader has had no exposure to computers. The first chapter begins with the evolution of computers and traces history to today's 16-bit micro. Chapters 2 and 3 cover number systems, Boolean algebra and basic computer logic.

The heart of the book lies in Chapters 4, 5 and 6. Here Mr. Osborne begins his tutorial on microcomputers. In a fundamental and systematic approach, he describes each element in a microprocessor and carefully constructs a model microcomputer complete with memory, I/O and peripherals. Each element and component is described such that the novice will have no difficulty in grasping their operations separately or as a working system. Once the model has been firmly established, a model instruction set is generated. Each command is analyzed by definition, address modes and resultant operation in the CPU.

After thorough discussion of the model, several commercially available microprocessors are compared in Chapter 7. These include the Fairchild F-8, National Semiconductor PACE and SCAMP, Intel 8080, Motorola M6800, Rockwell PPS-8 and Signetics 2650. Mr. Osborne spends considerable time on each system, ex-

amining their architecture, memory, support circuitry and instruction sets relative to the model. The last chapter fittingly covers selection, benchmarks and the economies of microprocessors.

"An Introduction to Microcomputers" is concise, well written and extremely informative. It is bound to become an industry reference. The only suggestions we make is the addition of a concordance and changing Mr. Osborne's definition of a microprocessor versus a microcomputer. In the text Mr. Osborne implies no difference; however, we would define a microprocessor as the CPU section implemented on one or more LSI chips. A microcomputer contains CPU, memory and support circuitry.

"Microprocessors Simplify Industrial Control Systems"

Alan J. Weissberger

Electronic Design October 25, 1975

This excellent article is a discussion of how to overcome the numerous hurdles encountered in the design of distributed microcomputer systems in industrial environments. Mr. Weissberger lists these obstacles and analyzes their remedies. He also illustrates how National IMP-16 and PACE microcomputers have been used in several industrial sites to overcome noise, limitations caused by the physical distance between sources of variables, power consumption and dissipation, I/O interfacing, and future expansion plans.

"2-1/2-Generation uP's—\$10 Parts That Perform Like Low-End Mini's"

Robert Cushman

EDN September 20, 1975

In its continuing microcomputer design series, EDN is now concentrating on microprocessors intentionally designed for minimum parts and extremely low cost. EDN first looks at the MOS Technology 6502 and will examine the National SCAMP, and Electronic Array's 9002 chips in future articles.

This particular discussion highlights the 6502 architecture and its differences from Motorola's 6800. For micro buffs who are a little confused about their exact differences, this article is a must. Mr. Cushman has effectively stepped through the 6502 architecture
(cont'd next page)



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ture pointing out differences between the two chips and their negative or positive results in machine functions.

"European Microprocessors" (Text)
Staff

Frost & Sullivan, August 1975

This report covers the potential European microcomputer market for the ten year period, 1974-1984. It's goal has been to identify the dollar potential of applications by year and by country. Frost & Sullivan estimates "total European usage of microcomputer equipment to reach \$100 million by 1978 and \$2.5 billion by 1984. Of this value, some \$1.04 billion will consist of microprocessor components, with \$850 million for memories (29% ROM, 71% RAM), \$550 million for I/O interfaces and \$75 million for other ancillary circuits."

The report identifies France, Germany and the United Kingdom as the heavy users of microprocessors. Italy, Benelux and Scandinavia will also represent significant markets. Potential European marketeers would do well to study this report.

"uP Simplifies Design Of Flexible Specialized Test Equipment"

R. M. Roth

EDN September 5, 1975

The author discusses the advantages and the need of incorporating microprocessors into dedicated test systems. Mr. Roth outlines the steps Westinghouse undertook in designing and generating the programs for a 4040-based tester for permanent magnet generators.

"Operator's Console Considerations In Microprocessor System Design"

Jeff Little and A. Thampy Thomas

Computer Design November 1975

This unusual article discusses the architectural features needed in microprocessors to facilitate the use of a control panel. Four machines are discussed, the National IMP-16, Intellec 8, Motorola 6800 and the Intersil 6100.

The authors conclude that "the 6100 serves as an example of how a microprocessor design can facilitate panel functions. Although there are various ways of implementing these same features, the IM6100 approach is simple and straight-forward." The article is an ex-

tremely useful tool for chip designers in considering possible avenues for new microprocessor chip designs.

"SCAMP Microprocessor Aims To Replace Mechanical Logic"

Jack H. Morris, Hash Patel, Milt Schwartz
Electronics September 18, 1975

This article, published at SCAMP's introduction, is a good description of the 8-bit, single chip, P/MOS microprocessor. The article defines application areas and then delves into a tutorial on chip architecture and instruction set. Most interesting are the application examples given on the last two pages. Here the authors describe the microprocessors functions in home entertainment products, automotive ignition controls, water quality control systems for fish, and home appliance controls.

Although it is common knowledge that microprocessors are rapidly moving our society into computerized living, this particular article crystalizes just how soon that day is dawning. Users seriously considering low-cost dedicated microprocessors for their equipment would do well to read this article.

"Hobbyist Interchange Tape System"

Jerry Ogdin

Popular Electronics September 1975

Jerry Ogdin has presented a standard for the exchange of programs between microcomputer enthusiasts. Designated HIT (Hobbyist Interchange Tape), the system uses an ordinary low-cost audio cassette tape recorder as its medium.

Although useable with any micro, this particular article describes how HIT can be implemented using an 8080 microprocessor. The suggestions put forth by Mr. Ogdin will certainly set a hobbyist standard (even if only for a lack of an existing standard), and should be required reading for all those desirous of their very own microcomputer kit.

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EDUCATION:

MICROCOMPUTER COURSES, SEMINARS, CONFERENCES. Date, title, cost, location, sponsoring organization (addresses on page 18).

December

- 15-17 Microprogramming—Concepts, Trends and Applications \$320 Washington DC George Washington University
- 15-18 Advanced Programming \$395 Miami FL National Semiconductor
- 15-18 IMP-16 PACE Applications \$395 Santa Clara CA National Semiconductor
- 15-19 Motorola M6800 Course \$430 Ft. Washington PA Motorola
- 16 Fairchild F-8 Microprocessor Free Palo Alto CA Elmar Electronics
- 16-18 Motorola M6800 Course \$430 Ft. Lauderdale FL Motorola

January

- 5 Microprocessor Digital Design Cupertino CA Each Tuesday during semester De Anza College
- 5 Motorola's 6800 vs. Intel's 8080 \$150 San Francisco CA Integrated Computer Systems
- 5- 8 Advanced Programming \$395 Santa Clara CA National Semiconductor
- 5- 8 Microprocessor Fundamentals \$395 Dallas TX National Semiconductor
- 5- 9 Advances In Electronics Technology \$425 Washington DC George Washington University
- 5- 9 Minicomputers & Microprocessors In Instrumentation & Control \$375 Madison WI University of Wisconsin
- 7 Motorola's 6800 vs. Intel's 8080 \$150 San Diego CA Integrated Computer Systems
- 7 PROM Programming—A Systems Approach Free San Jose CA Data I/O Corp.
- 9 Motorola's 6800 vs. Intel's 8080 \$150 Costa Mesa CA Integrated Computer Systems

- 10 Motorola's 6800 vs. Intel's 8080 \$150 Los Angeles CA Integrated Computer Systems
- 12 Motorola's 6800 vs. Intel's 8080 \$150 Dallas TX Integrated Computer Systems
- 12-13 Intel MDS 8080 Class \$225 Mountain View CA Elmar Electronics
- 12-13 Software Engineering For Microprocessors \$300 San Francisco CA Yourdon, Inc.
- 12-14 3000 Bipolar Microcomputer Course \$350 Santa Clara CA Intel Corp.
- 12-15 IMP-16 PACE Applications \$395 Dallas TX National Semiconductor
- 12-15 8080 Microcomputer Course \$350 Boston MA Intel Corp.
- 12-23 LSI-11 & PDP-11/03 Hardware & Interfacing \$750 Maynard MA Digital Equipment Corp.
- 13-15 Motorola M6800 Course \$430 San Diego CA Motorola
- 14 Motorola's 6800 vs. Intel's 8080 \$150 Chicago IL Integrated Computer Systems
- 16 Motorola's 6800 vs. Intel's 8080 \$150 Washington DC Integrated Computer Systems
- 19 Motorola's 6800 vs. Intel's 8080 \$150 Philadelphia PA Integrated Computer Systems
- 19-21 Microprocessors & Microcomputers—Using Tomorrow's Technology In Today's Systems \$395 Washington DC Institute For Science & Public Affairs
- 19-22 Advanced Programming \$395 Dallas TX National Semiconductor
- 19-22 Microprocessor Fundamentals \$395 Miami FL National Semiconductor
- 19-22 8080 Microcomputer Course \$350 Santa Clara CA Intel Corp.
- 20-22 Motorola M6800 Course \$430 Atlanta GA & Los Angeles CA Motorola
- 21 Motorola's 6800 vs. Intel's 8080 \$150 New York NY Integrated Computer Systems



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January

- 23 Motorola's 6800 vs. Intel's 8080 \$150
Boston MA Integrated Computer Systems
- 26-28 PL/M Microcomputer Programming \$350
Santa Clara CA Intel Corp.
- 26-29 IMP-16 PACE Applications \$395 Miami
FL National Semiconductor
- 26-30 Motorola M6800 Course \$430 Phoenix
AZ Motorola
- 27 Intel 8080A & 3000 Technical Invita-
tional Mt. View CA Elmar Electronics
- 31 MOS Technology 6502/6530 Microcomputer
Fundamentals \$50 or JOLT Kit Purchase
Palo Alto CA Microcomputer Associates

February

- 2- 5 Microprocessor Fundamentals \$395
Santa Clara CA National Semiconductor
- 3- 5 Motorola M6800 Course \$430 Cleveland
OH Motorola
- 4 PROM Programming—A Systems Approach
Free San Jose CA Data I/O Corp.
- 9 Microprocessor Management Seminar In-
vitational Mountain View CA Elmar
Electronics
- 9-12 Advanced Programming \$395 Miami FL
National Semiconductor
- 9-12 IMP-16/PACE Applications \$395 Santa
Clara CA National Semiconductor
- 9-12 8080 Microcomputer Course \$350 Bos-
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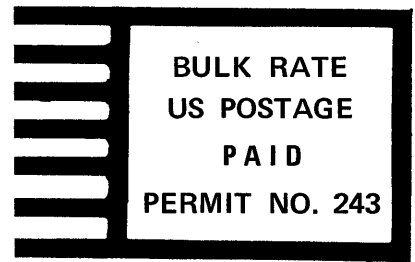


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