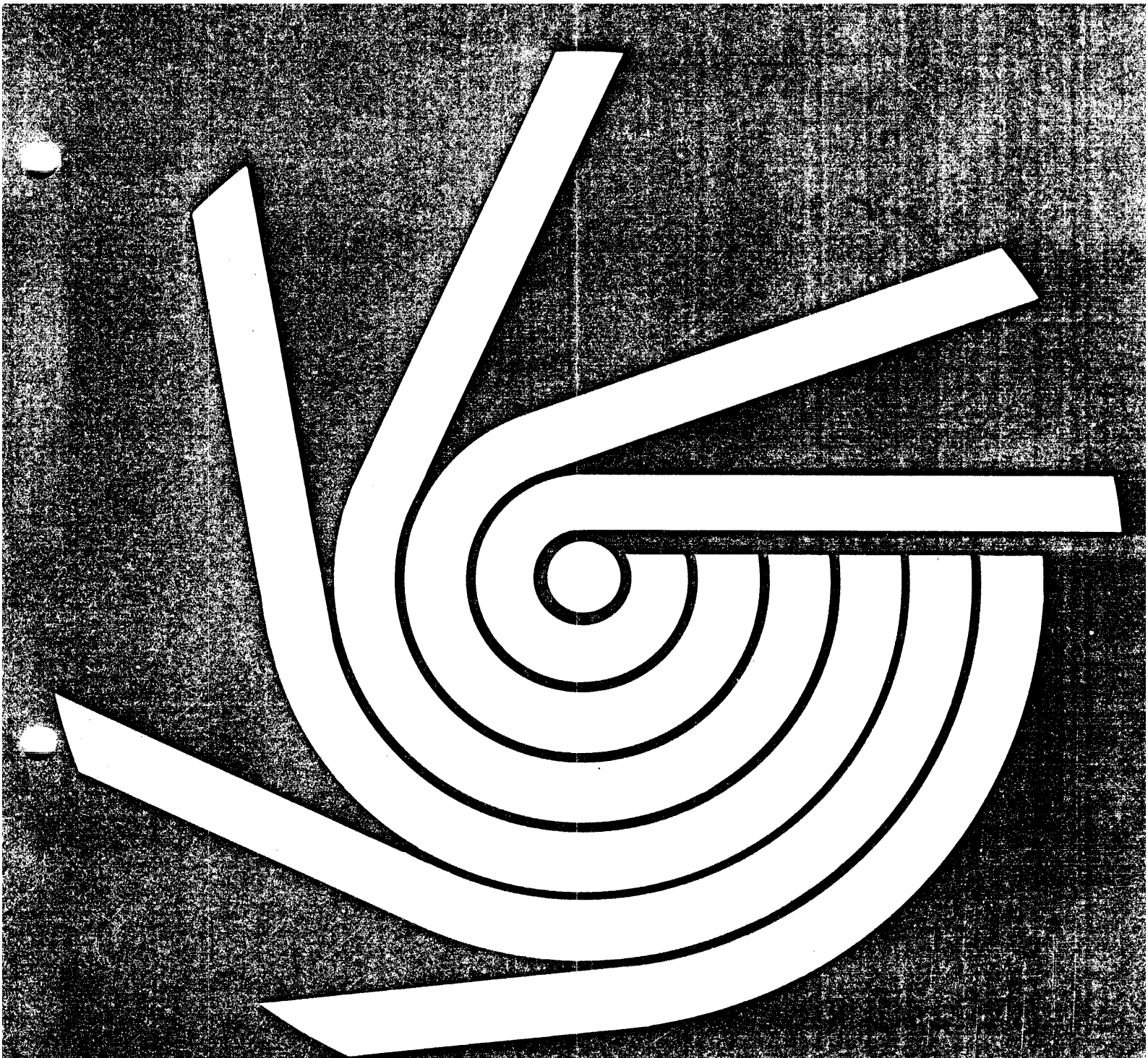

micromemory 7405

PRODUCT MANUAL

ELECTRONIC MEMORIES AND MAGNETICS CORPORATION

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January 1976

Add-on core memory system for PDP-11 Unibus.

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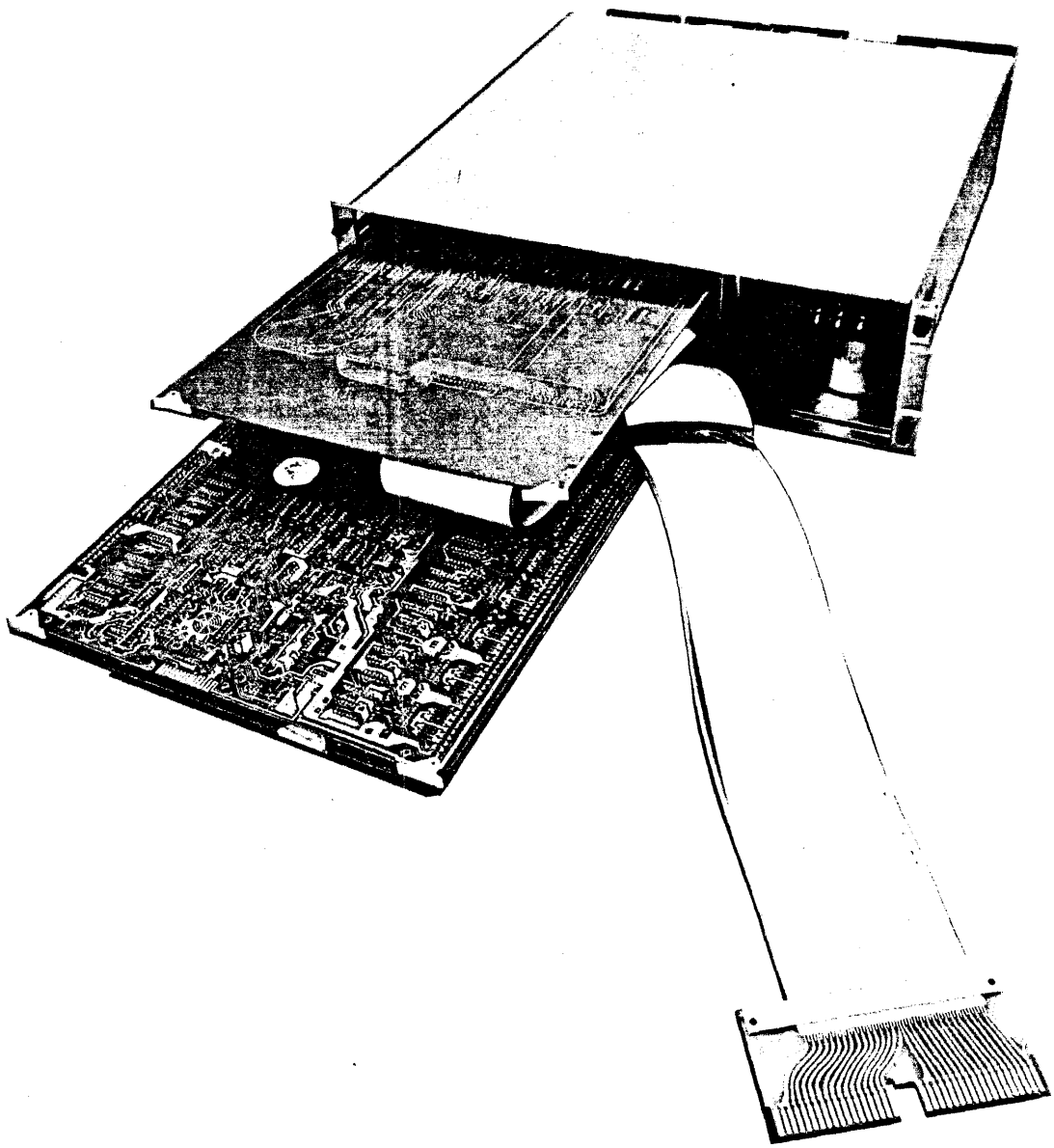
PRODUCT MANUAL

PDP-11 ADD-ON INTRODUCTION



This manual describes the MICROMEMORY 7405 core memory system designed, developed and manufactured by Electronic Memories & Magnetics Corporation, Hawthorne, California.

The MICROMEMORY 7405 is a system configured with 1, 2, 3 or 4 32K-word core memory cards, contained in a rack-mountable chassis with its own power supply. The system connects to any PDP-11 Unibus by means of flexible cables.

No special signals, wiring, or hardware not already part of the standard computer are required to install and operate the memory. The MICROMEMORY 7405 is available with or without the parity option.

The MICROMEMORY 7405 is only one of a comprehensive range of EMM memory systems for PDP-11 computers. Others include:

1. MICROMEMORY 7605. Similar to the MICROMEMORY 7405 but using semiconductor memory for high speed.
2. MICROMEMORY 7705. Plug-in memory for the Unibus. 16K words of fast semiconductor memory in only one hex-size card slot.
3. MICROMEMORY 7711. Plug-in memory for LSI-11 (PDP-11/03). 16K words of semiconductor memory provides four times the memory density available from DEC, and higher speed too.
4. MICROMEMORY 7805. Add-on memory for PDP 11/45 Fast-bus. Enhances DEC's system by putting up to 128K of memory on the Fast-bus.

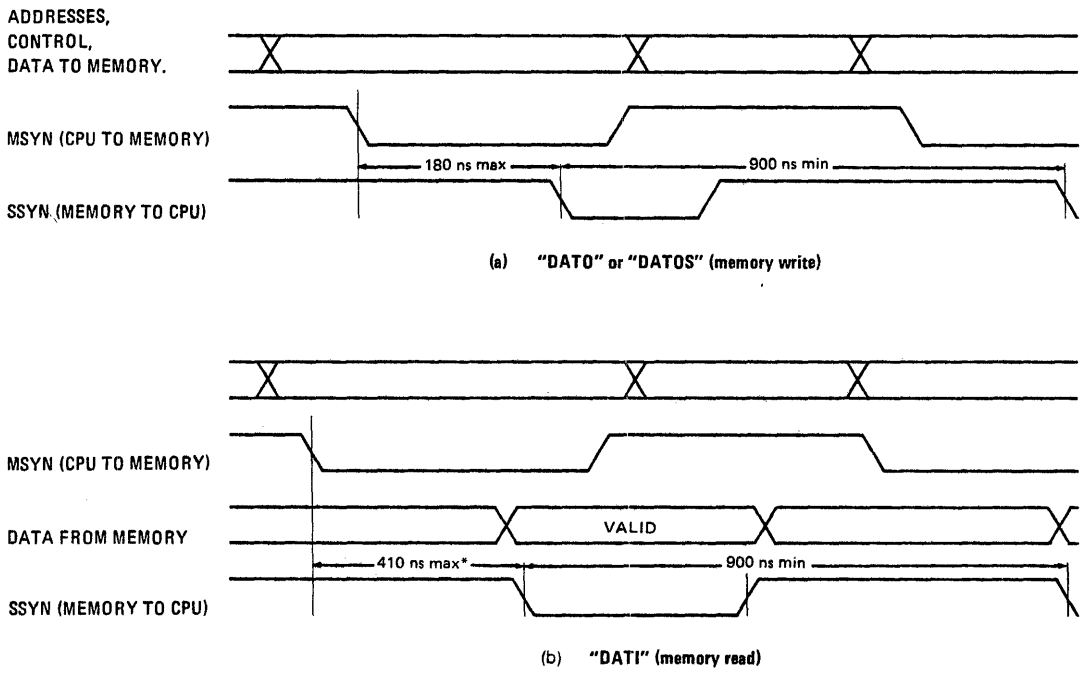


Figure 1.
MICROMEMORY 7405 Unibus Interface Timing.

A "DATIP" cycle (read-modify-write) on the MICROMEMORY 7405 is the same as a read cycle followed by a write cycle.

All PDP-11 computers are structured with a common input-output data bus known as the Unibus. A single Unibus address field is used to access peripheral devices, special-purpose registers and memory. All such devices communicate with the cpu by using a standard set of control and data signals, transmitted on the Unibus.

The MICROMEMORY 7405 connects to the cpu by a Unibus cable which plugs into any available Unibus slot. The electrical interface is completely Unibus compatible. The principal Unibus signals and their timing are shown in Figure 1.

The MICROMEMORY 7405 presents only one bus-load to the Unibus, regardless of the capacity of the memory. It draws no power from the cpu's D.C. power supply. Also, its connector occupies only one Unibus slot. This leaves the computer free to accept the maximum number of peripheral and other Unibus interfaces, while still having up to 124K words of main memory.

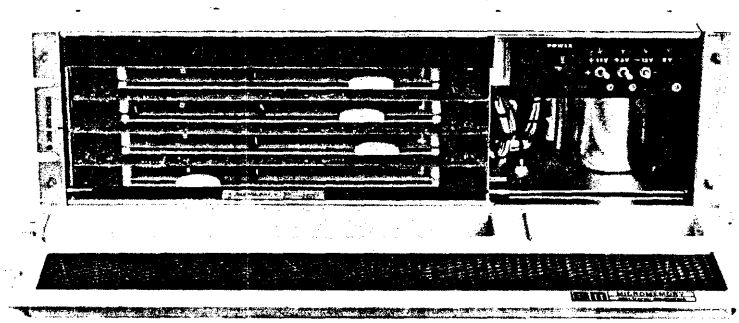


Figure 2.
MICROMEMORY 7405 Chassis

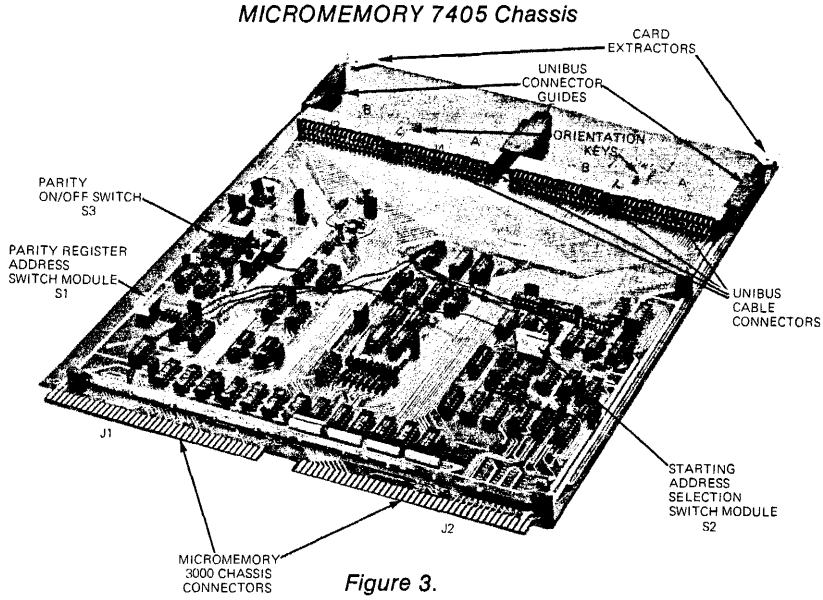


Figure 3.
Interface Card

The MICROMEMORY 7405 is housed in a 5¼-inch high, 19-inch wide rack-mountable chassis (Figure 2). Major components of the system are the power supply, cooling fans, Interface card with Unibus cables and the memory cards.

The power supply operates from a 110/240V, 48/63 Hz single phase line voltage supply. It provides D.C. power for the memory cards and the Interface card. Line voltage is also supplied to the fans, which provide airflow to cool the electronic cards and the power supply.

A combination on-off switch and circuit breaker is provided on the front panel.

The Interface card (Figure 3) contains circuitry to provide the Unibus-compatible electrical interface, and connectors for insertion of Unibus cables or terminator blocks. Circuits for providing the parity function (if this option is selected) and special power-failure detection circuits required to ensure DEC-compatible performance under power-transient conditions are also provided on the Interface card. Card insertion/extraction levers are included to facilitate card removal and replacement.

The Interface card also contains convenient DIP-packaged switch modules for selecting the address range of the card and (with the parity option) the address of the parity register.

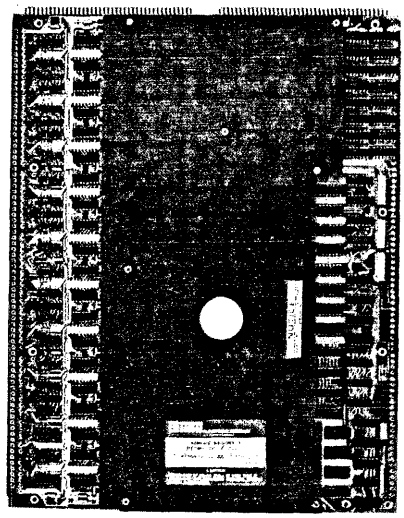


Figure 4.
MICROMEMORY 3000QD Core Memory Card.

The memory cards (Figure 4) are EMM's standard MICROMEMORY 3000QD (quad-density) core memory cards. Each is a completely self-contained 32K-word memory of 16 bits per word (parity option: 18 bits per word).

Each MICROMEMORY 3000QD consists of the following two sub assemblies.

1. A core stack card
2. An electronics card

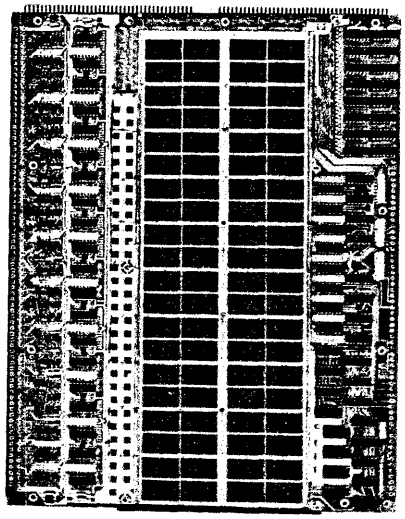


Figure 5.
Core Stack (covers removed)

The Core Stack (Figure 5) is the storage array for the 7405. This sub-system consists of:

1. a printed circuit board which holds the memory cores, and contains stack circuitry.
2. sixteen (eighteen for the parity option) core mats, each containing 32,768 lithium-ferrite wide temperature cores strung in 3D-3 wire configuration.
3. covers to protect the core mats.
4. drive and sense line terminating resistors.
5. drive line decoding diodes.
6. sense amplifiers.
7. pins to provide electrical contact to the electronics card.

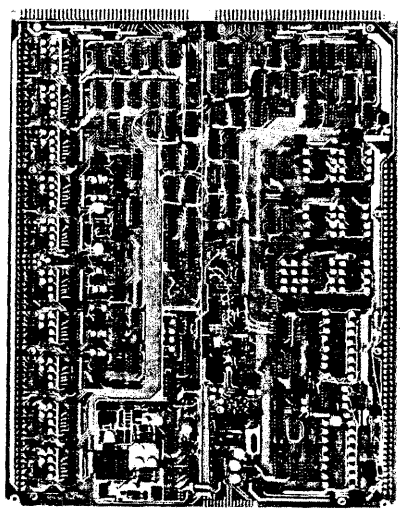


Figure 6.
Electronics Card

The Electronics Card (Figure 6) consists of:

1. mating receptacles to accept the stack card.
2. card ejectors to facilitate memory insertion into and extraction from the cpu chassis.
3. stiffeners to maintain board flatness and board-to-board clearance within the chassis.
4. temperature compensation/current regulation circuits to assure wide operating margins throughout the operating temperature range.
5. circuitry to drive, inhibit, and control the memory under cpu command.
6. timing and control circuits.

PARITY

The optional parity version of the MICROMEMORY 7405 includes one extra memory bit per byte, parity generation and checking circuitry, and a parity register. The parity register controls the operation of the parity circuits for all memory installed in the MICROMEMORY 7405. *Note: The contents of the parity register are generated partially by the cpu (as "instructions" to the memory), and partially by the memory in the event of a parity error (as "information" about the error, to the cpu).*

A 4-bit switch module (Figure 3) is provided to select the Unibus address of the parity register.

PARITY TRAP

In the event of a parity error, the standard parity-version MICROMEMORY 7405 generates a signal which causes the cpu to execute a trap to location 114 or 116 (the standard DEC parity error trap). As an optional alternative, the MICROMEMORY 7405 can inhibit generation of that signal and instead, fail to provide an "SSYN" (slave sync) signal to the cpu. A time-out error results causing a trap to location 4. *Note: This enables the benefits of a parity memory to be realized in applications where the cpu itself is not equipped with a parity option.*

INTERLEAVING

MICROMEMORY 7405 systems with two or four cards installed are configured so that consecutive addresses alternate between different cards. This allows memory accesses at consecutive addresses to take place at 450ns intervals instead of the usual 900ns. (On "read" cycles, Unibus and cpu delays limit the repetition rate to about 650ns.)

This "interleaved" configuration is set at the factory, and no user action is required to take advantage of it. A non-interleaved system may be field modified to an interleaved system by adding memory card(s) to the required even numbered capacity, and changing jumper wires according to instructions available from EMM.

LINE VOLTAGE

Standard line voltage is 115V (+10%), 48/63 Hz, single-phase. Optional alternatives are 110V, 120V, 208V, 220V, 230V, or 240V.

CAPACITY

By using 1, 2, 3, or 4 MICROMEMORY 3000QD memory cards, capacities of 32K, 64K, 96K, or 124K are available. To address more than 28K of memory, the cpu must be equipped with "Memory Management." Intermediate capacities of 16K, 48K, 80K, and 112K are also available. *Note: Although 128K of memory can be installed, the top 4K of addresses are reserved for non-memory Unibus devices.*

Memory cards may be added to the MICROMEMORY 7405 in the field without alteration or adjustment of the Interface card or any other part of the system. Systems with the Interleaving option can only be field-expanded from two to four memory cards.

As a result of EMM's years of dedication to the design of memory systems, numerous design innovations have been developed. Many of these innovations are incorporated in the MICROMEMORY 7405 to provide *high reliability, manufacturability* and *performance.* These are exemplified in the following features.

32K-word Core Memory Cards
State-of-the-art core density is achieved by the use of advanced low-noise memory cores, precision manufacturing techniques and EMM's proprietary circuit design techniques.

This allows the entire Unibus memory complement for any PDP-11 computer to be accomodated in a single 5¼-inch high chassis.

Power Reduction
The majority of the power consumption of any core memory results from the inhibit currents. They pass in parrallel in all bits of the word length when writing zeros. This is a substantial power drain. The transient nature of these pulses and their variable total magnitude (depending on the number of zeros in the word being written) make the inhibit circuits a major potential source of electrical noise problems.

EMM's design is based on: 1. a transformer-coupled Inhibit Drive circuit which minimizes generation of radiated and conducted noise. 2. an Inhibit-Boost circuit that provides the transient power required for a fast rise time. The effect of the Inhibit-Boost circuit is to reduce the average inhibit power by a factor of two, as compared with conventional designs. This results in a reduction in power consumption, operating temperature rise, and electrical noise.

Drive Current Margins
EMM's X and Y drive currents are derived from a single, temperature-compensated, square-loop bias current source by a simple drive matrix using shared drive transformer techniques. Besides providing the necessary functions with a minimum of components, this scheme automatically results in matched X and Y Read and Write pulses at all temperatures.

The temperature-compensation circuits have been developed and improved over many years. They provide superior temperature tracking with resulting wide margins at all operating temperatures.

Address Assignment Switches
For user convenience, assignment of the memory to the desired address block is accomplished using DIP-packaged switch arrays. Moving soldered jumper wires is, therefore, unnecessary. Similarly, the parity address assignment and parity enable/inhibit are implemented using convenient switches instead of jumpers. All switches are clearly identified on the card with "on" and "off" designations.

Manufacturability Features
EMM's ability to deliver in quantity and at low prices results from design features developed over the years to improve manufacturability. They include: 1. appropriate test points at the rear of the card to monitor correct operation of internal functions. 2. an easily pluggable core-stack to allow independent stack test and to facilitate troubleshooting. 3. simplified timing and control circuits. As the design is basically the same as other memories in the MICROMEMORY series, the experience of EMM's manufacturing staff and technicians is directly applicable to the production of the MICROMEMORY 7405.

STEP 1 / Unpacking and Inspection
a. Open shipping container
b. Remove all packing material
c. Visually inspect the memory modules
If there is damage, notify the shipping carrier and Electronic Memories and Magnetics Corporation, Commercial Memory Products Division.

STEP 2 / Starting Address Selection
The MICROMEMORY 7405 is addressed by a contiguous block of Unibus addresses. The initial address of the block is set into the memory by the use of switch module "S2" (Figure 3). Starting addresses are in 4K increments. The length of the address block is automatically determined by the number of memory cards installed in the MICROMEMORY 7405.

The possible initial addresses which may be used and the corresponding positions of the S2 switches are shown in Table 1.

STEP 3 / Parity Register Address Selection
If the MICROMEMORY 7405 is equipped with the Parity option, check that the parity "ON/OFF" switch (S3, Figure 3) is on. Set the parity register address selection switches (S1, Figure 3) to select the required parity register address. Table 2 shows the switch positions used to assign any of the sixteen allowable Unibus addresses to the parity register.

Table 1. Starting Address Selection

STARTING ADDRESS	S2 SWITCH POSITION (1 = ON, 0 = OFF)				
	S2-1	S2-2	S2-3	S2-4	S2-5
0	1	1	1	1	1
4096	0	0	0	0	0
8192	1	0	0	0	0
12288	0	1	0	0	0
16384	1	1	0	0	0
20480	0	0	1	0	0
24576	1	0	1	0	0
28672	0	1	1	0	0
32768	1	1	1	0	0
36864	0	0	0	1	0
40960	1	0	0	1	0
45056	0	1	0	1	0
49152	1	1	0	1	0
53248	0	0	1	1	0
57344	1	0	1	1	0
61440	0	1	1	1	0
65536	1	1	1	1	0
69632	0	0	0	0	1
73728	1	0	0	0	1
77824	0	1	0	0	1
81920	1	1	0	0	1
86016	0	0	1	0	1
90112	1	0	1	0	1
94208	0	1	1	0	1

Table 2. Parity Register Address Selection

PARITY REGISTER ADDRESS	S1 SWITCH POSITION (1 = ON, 0 = OFF)			
	S1-1	S1-2	S1-3	S1-4
772136	0	0	0	0
772134	1	0	0	0
772132	0	1	0	0
772130	1	1	0	0
772126	0	0	1	0
772124	1	0	1	0
772122	0	1	1	0
772120	1	1	1	0
772116	0	0	0	1
772114	1	0	0	1
772112	0	1	0	1
772110	1	1	0	1
772106	0	0	1	1
772104	1	0	1	1
772102	0	1	1	1
772100	1	1	1	1

STEP 4 / Cable Installation
Connect a Unibus cable of suitable length to connectors J3 and J4 on the Interface card (Figure 3). The "A" section of the Unibus connector connects to J4, and the "B" section to J3. This is designated on the Interface card. Keying is provided on the Interface card to prevent incorrect installation of the Unibus cables.

If the MICROMEMORY 7405 is to be part of a "daisy-chain," connect the second Unibus cable to connectors J5 and J6 on the Interface card in the same way. If not, connect a DEC M-930 Unibus terminator block to connectors J5 and J6.

STEP 5 / Interface Card Installation
With the MICROMEMORY 7405 chassis front panel removed, insert the Interface card with THE COMPONENT SIDE DOWN into the top chassis slot position (location A, Figure 7). Make sure the card passes within the card guides provided on each side of the chassis. When it has engaged with the connectors at the far end of the chassis, press firmly on the card ejectors until the card is firmly seated.

Route the Unibus cables to pass through the front panel recess (Figure 8) when the front panel is replaced.

STEP 6 / Memory Card Installation
If only one card is used, it must be installed in chassis location B. Additional cards used must be inserted in the next lower empty slots, C through E, in sequence (Figure 7).

Insert memory cards COMPONENT SIDE DOWN (i.e., with the solder side of the Electronics card uppermost). Make sure they engage properly within the card guides and seat firmly in their connectors, as described above for the Interface card.

To remove a card, pull the two card ejectors equally. This will exert leverage on the card and it will be disengaged smoothly and easily from the connector.

A	INTERFACE CARD	POWER SUPPLY
B	FIRST MEMORY CARD	
C	SECOND MEMORY CARD (if used)	
D	THIRD MEMORY CARD (if used)	
E	FOURTH MEMORY CARD (if used)	

Figure 7.
MICROMEMORY 7405 Chassis Slot Position

STEP 7 / Chassis Installation
With the Unibus cables passing through the recess, replace the front panel. Install in any EIA standard 19-inch rack-type cabinet. All rack-mounted PDP-11 computers use this standard cabinet. It can be secured at the front panel using four 5/8-inch, 10-32 pan head screws. The installation should use slides or brackets to support the weight of the MICROMEMORY 7405.

STEP 8 / Unibus Connection
With cpu power off, connect the Unibus cable from the MICROMEMORY 7405 to any available Unibus slot in the computer or extension chassis. If the MICROMEMORY 7405 is part of a "daisy-chain," connect the second Unibus cable to the next device in the chain.

STEP 9 / Power Connection
The available line voltage must correspond to the input voltage which the MICROMEMORY 7405 power supply is set. It must support a load of 800 volt-amps. Plug the MICROMEMORY 7405 into the line.

STEP 10 / Memory Verification
Turn on the power to the cpu ano the MICROMEMORY 7405. Memory operation is verified through the use of a memory module diagnostic routine. Operating instructions for the appropriate memory diagnostic are presented in the computer reference manual. The results of the memory diagnostic are displayed on the computer front panel, peripheral display and/or terminal printout.

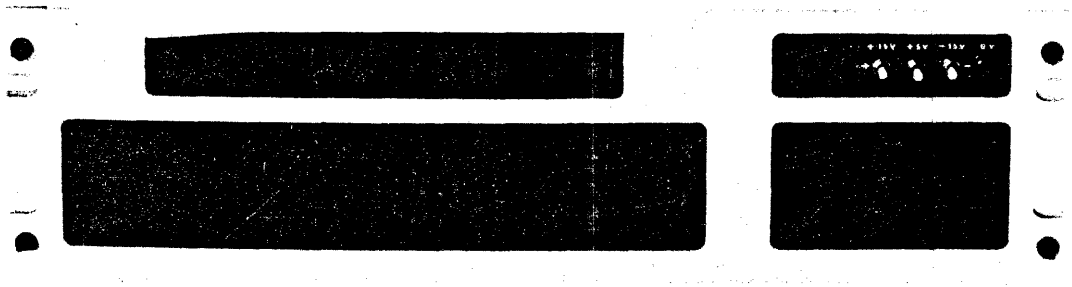


Figure 8.
MICROMEMORY 7405 Front Panel

STEP 11 / Operation

Assuming the diagnostic procedures verify correct memory operation, the memory requires no further attention.

Simplified Troubleshooting

If operational difficulties are encountered with the memory, perform one or more of the following simplified procedures:

1. Check the power supply circuit breaker (Figure 2). Reset if tripped. If it continues to trip, check for short-circuit condition.
2. Check the "power-on" light for illumination when the MICROMEMORY 7405 power-on/circuit breaker switch is activated.
3. Check that all cables and cards are firmly seated.
4. If the system is still not operational, remove the cards. Visually inspect for damage, and wipe edge connector pins with a clean cloth. Clean and inspect the Unibus cables and connectors.
5. Check the starting address switches on the Interface card for proper setting.
6. Reinstall cards. Carefully follow Installation Steps 5 and 6.
7. If the system is still not operational, interchange memory cards, or reassign address ranges as required. Use the results to determine whether the problem is in the memory, the interface or the cpu.

PDP-11 ADD-ON RELIABILITY

Reliability

Reliability is one of the major criteria considered in EMM's memory system design The following areas emphasize the confi dence in design and the establishment of thc overall product reliability concept:

1. MTBF Calculation
2. Component Selection
3. Test Methods

MTBF Calculations

The MTBF calculations utilize EMM's standard set of failure rate data based upon actual field experience. These failure rates are based on the maximum stress levels specified in EMM's design standard EMDS 10-1, which defines the design rules used in EMM memory systems. They have been verified through a study of field data from 1649 MICROMEMORY 3000 cards. The MTBF for a typical MICROMEMORY 7405 configuration of 64K words of 18 bits is calculated to be 11200 hours. Based on manufacturing and test techniques, a 20% improvement in long-term MTBF is estimated over the prediction.

Component Selection

The MICROMEMORY 7405 uses enhanced reliability components throughout. These include:

1. Integrated circuits with ceramic packages.
2. Hermetically sealed semiconductor devices.
3. Diodes custom made to EMM's specification.
4. All ICs are preconditioned with a 5-cycle 0° to 100°C temperature shock test and a 96-hour, 125°C burn-in.
5. All other components purchased to EMM specifications.

Test Methods

To achieve higher long term reliability and to reduce field failures from infant mortality, special testing is performed as follows:

1. Timing
   All interface signals are examined for correct timing relationship.
2. Voltage Margin
   The voltages are varied individually and in combination to appropriate margins.
3. Voltage Shmoos
   Vx-y and Vth Shmoos must meet established criteria.

MICROMEMORY 7405
SPECIFICATION SUMMARY:

Parameter	Specification
Word Length	16 bits (18 with parity option)
Capacity	32K, 64K, 96K, 124K words
Operating Modes*	DATO (write 16-bit word) DATOB (write 8-bit byte) DATI (read 16-bit word) DATIP (read-modify-write 16-bit word)
Access Time* *	410ns max
Cycle Time	900ns min
Operating Temperature	0°C to +50°C
Storage Temperature	-40°C to +80°C
Humidity	95% without condensation
Operating Altitude	-1000 ft. to +10,000 ft.
Storage Altitude	+40,000 ft.
Width	19 inches (48.3 cm)
Height	5¼ inches (13.3 cm)
Depth	22.5 inches (57.2 cm)
Power (+10% tolerance)	115VAC, 48-63 Hz. 800 volt-amps. (Other line-voltages optional).

**Unibus standard data transfer modes.*

** *parity version equals 450 ns max*

PDP-11 ADD-ON WARRANTY

WARRANTY

The MICROMEMORY 7405 features 100% burn in, proven core technology, and fast delivery. Because of the improved performance and reliability, EMM offers the following standard warranty which is superior to that offered by the minicomputer manufacturers.

Electronic Memories and Magnetic Corporation warrants that for a period of twelve (12) months from date of shipment, the MICROMEMORY 7405 shall be free of defects in material and workmanship under normal use. During the warrant period, EMM will, at its option, repair, replace, or issue credit for any unit determined by EMM to be defective.

NOTES