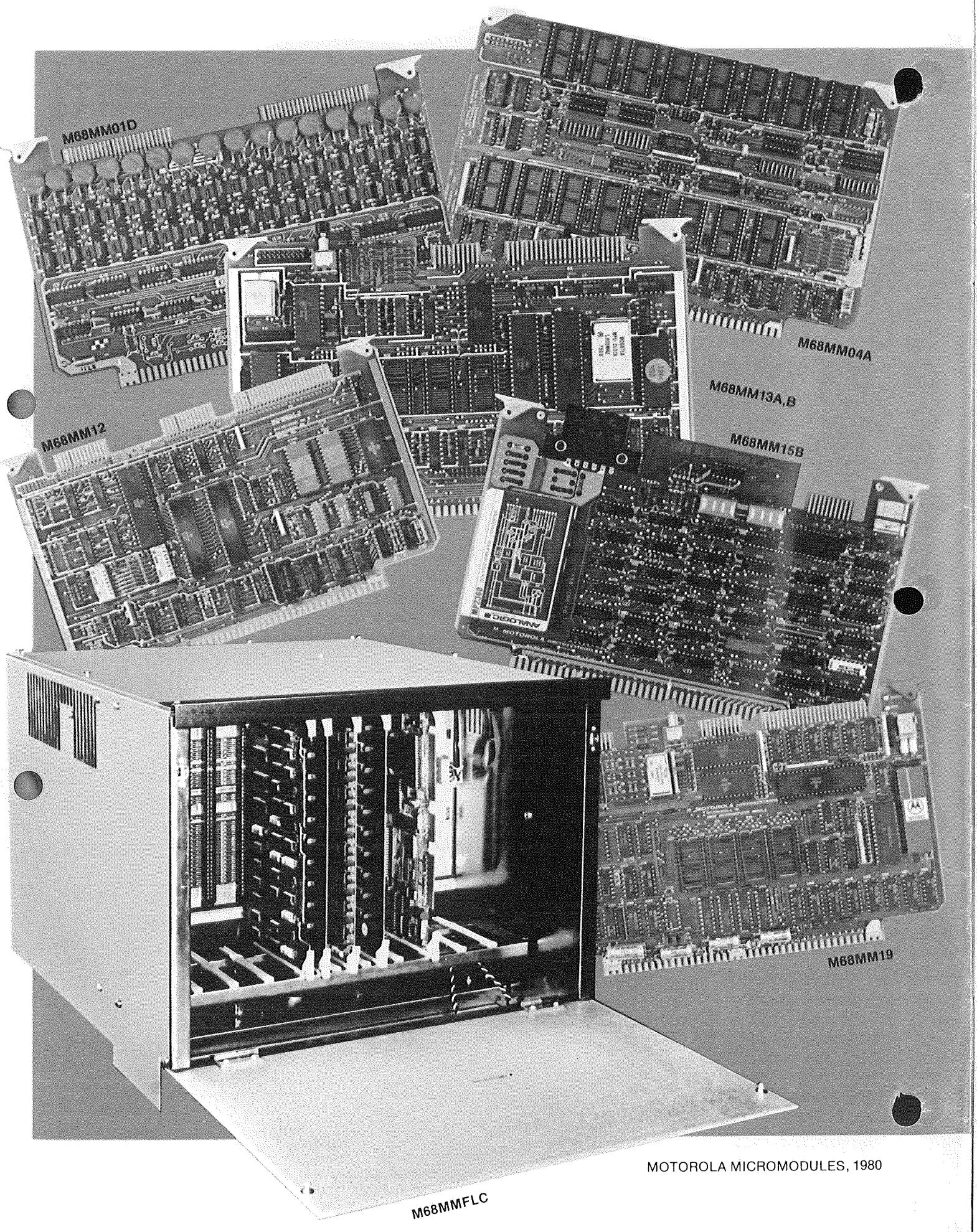


# MOTOROLA MICROMODULES

Innovative systems  
through silicon.



**MOTOROLA**



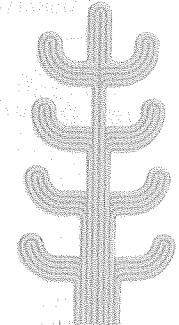
MOTOROLA MICROMODULES, 1980

# The Micromodule Family

## CONSISTS OF THE FOLLOWING ELEMENTS:

### • Microprocessor Modules

- Monoboard Microcomputers (MPU, ROM, RAM, and Input/Output)
- Microprocessor Subassemblies (MPU/APU and Timing/Control Logic)



### • Input/Output Digital Modules

- Parallel I/O (TTL Level, Reed Relay, Optically Isolated AC or DC)
- Serial I/O (Composite Video, Asynchronous, Synchronous or Byte Serial with Interface Drivers)

### • Input/Output Analog Modules

- Analog-to-Digital Converter (High-Level or Low-Level Thermocouple)
- Digital-to-Analog Converter (Voltage or Current)

### • Memory Modules

- Read Only Memory (Erasable or Mask ROM)
- Random Access Memory (Static or Dynamic Read/Write Memory)

### • Firmware and Software

- Monitor-Debug Firmware (ROM) - 6800
- SUPERbug (EPROM); Monitor/Debug, Linker, RAM Allocation, I/O and Utility Routines - 6809
- BASIC (ROM) - 6800
- BASIC-M (Mini-Diskette or MDOS diskette) - 6809
- Real-Time Fortran (MDOS diskette) - 6800
- Real-Time Multi-Tasking Executive (MDOS diskette) - 6809
- Software Support for GPIB Micromodules (MM12, 12A) (MDOS diskette)

### • Packaging and Special Function Hardware

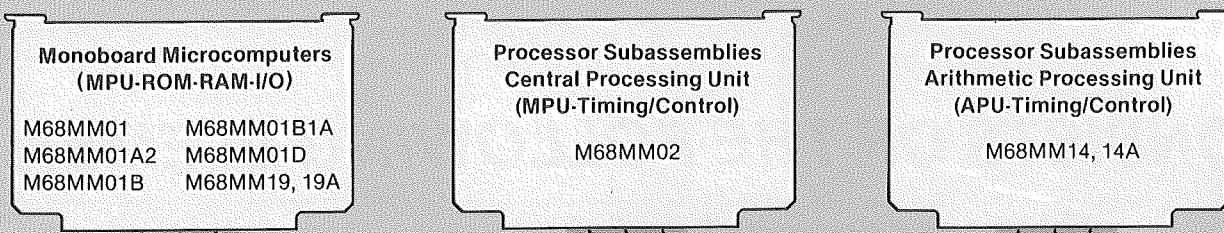
- Open-Frame Card Cages (5 or 10 Slot)
- Rack Mount Chassis (5 or 10 Slot, Power Supply, Cooling Fan)
- Front-Load Chassis (14 Slot, Power Supply, Cooling Fans)
- Power Supply (+ 5 Vdc, ± 12 Vdc)
- Power-Fail Detect Module (Optional Time-of-Day Clock with Battery Back-Up)
- Wirewrap Modules for Custom Circuits
- Extender Board
- CRT Monitor



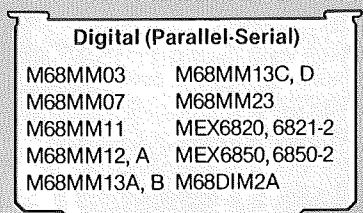
Each Micromodule is functionally tested, burned-in and retested to provide maximum reliability. The Micromodules are EXORbus compatible and can therefore be used in conjunction with the EXORciser or EXORset development systems and software. This Total Systems approach provides maximum flexibility in designing microprocessor hardware and software.

This brochure is intended to provide sufficient information to allow you to evaluate the use of Motorola's Micromodules in your application. For further information on any of the Micromodule products, System Development EXORciser Products, or new products not covered in this brochure, contact your nearest Motorola Semiconductor Sales Office or Motorola Distributor.

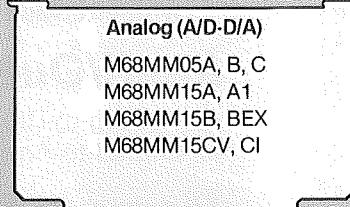
## MICROPROCESSOR MODULES



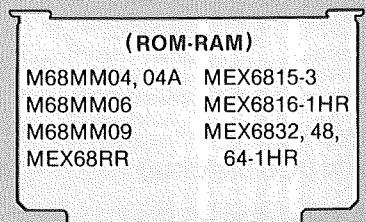
## INPUT/OUTPUT MODULES



## INPUT/OUTPUT MODULES



## MEMORY MODULES

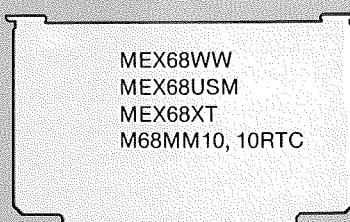


## FIRMWARE/SOFTWARE

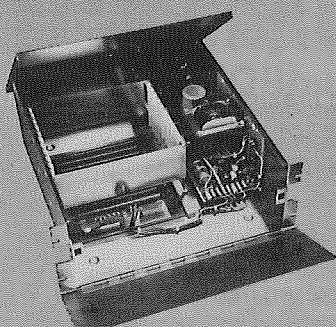
(ROM-Paper Tape/Cassette/Diskette)

|            |               |
|------------|---------------|
| M68MM08, A | M68MM12SWM    |
| M68EAM1    | M68MM12ASWM   |
| M68RTFR02M | M68MM19SB     |
| M68BASRM2  | M6809 BASIC-M |
| M6809RMS09 |               |

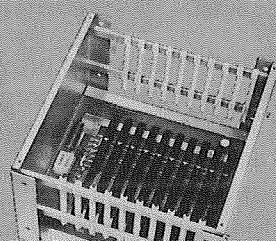
## AUXILIARY SUPPORT MODULES



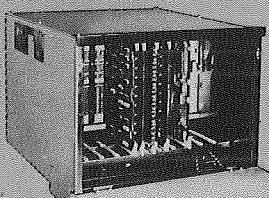
## PACKAGING/HARDWARE



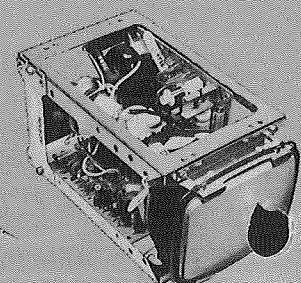
Chassis/Power Supply  
M68MLLC and M68MMSC  
M68MMPS1-1



Card Cage  
M68MMCC5 and  
M68MMCC10



M68MMFLC



M68MDM1

The Micromodule Family Tree

# **Applications WITH A MICROMODULE SOLUTION**

Motorola Micromodules provide cost-effective answers to a wide variety of problems in application fields typified by the following list:

## ***Industrial Process Control***

- Petro/Chemical Processing
- Food Processing
- Machine Control
- Metals Process Control
- Glass Process Control
- Automotive Process Control
- Agricultural Process Control
- Etc., Etc., Etc.

## ***Automatic/Semi-Automatic Testing***

- Factory In-Process Testing
- Factory Final Test
- Quality Assurance Testing
- Automotive Testing
- Railway Track Testing
- Highway Testing
- Etc., Etc., Etc.

## ***OEM Hardware***

- Medical Diagnosis
- Medical Analysis
- Smart Peripherals
- Ski Lift Controls
- Warehouse Controllers
- Environmental Control
- Energy Management
- Etc., Etc., Etc.

## ***System Prototyping***

- Prototyping of any system whose eventual production may or may not (for whatever reason) be implemented with standard Micromodules.

# Micromodule Selector Guide

## MICROPROCESSOR MODULES

### Monoboard Microcomputers

Choose from a selection of differently configured single-board microcomputers; add a suitable power supply and, perhaps, some additional external memory; put these into an appropriately available enclosure (or design your own); and you have a complete microcomputer — ready to receive your dedicated firmware and go to work.

Motorola's micromodule monoboard microcomputers offer a choice of variations to best match a particular end-use.

| Part No.    | Parallel Input/Output   | Serial I/O     |          |           | Memory            |     | MPU  | Clock (MHz)         | Options   |
|-------------|-------------------------|----------------|----------|-----------|-------------------|-----|------|---------------------|---|
|             |                         | RS-232         | RS-422   | 20mA      | ROM               | RAM |      |                     |   |
| M68MM01     | 3PIAs/60 Lines          |                |          |           | 4K                | 1K  | 6800 | 1                   | MM01-1;4.7K Termination Networks & 4 Connectors<br>MM01-2;330/220 Termination Networks & 4 Connectors |
| M68MM01A2   | 2 PIAs/40 Lines         | 1 ACIA         |          | Use MM11* | 4 or 8K EPROM/ROM | 1K  | 6800 | 1                   | MM01A2-1; MM01A2 with 4 Connectors  |
| M68MM01B    | 1 PIA/20 Lines<br>1 PTM |                |          |           | 4K                | 128 | 6802 | 1                   | Not Expandable  |
| M68MM01B1A  | 1 PIA/20 Lines<br>1 PTM | 1 ACIA         |          | Use MM11* | 4K                | 384 | 6802 | 1                   | Cassette I/O  |
| M68MM01D    | Printer Port<br>1 PTM   | 1 ACIA         | (OPT.) † | Use MM11* | 10K               |     | 6800 | 1, 1.5              | Use 2K RAMS in ROM Sockets  |
| M68MM19/19A | 1 PIA/20 Lines<br>1 PTM | 1 ACIA or SSDA | (OPT.) † | Use MM11* | 8K-16K            | 2K  | 6809 | 1(MM19)<br>2(MM19A) | Replace ACIA with SSDA †  |

#### NOTES:

PIA = 16 Programmable I/O Data Lines and 4 Control Lines  
 PTM = Three 16-bit Programmable Counter/Timers  
 ACIA = Asynchronous Communications  
 SSDA = Synchronous Communications  
 † = Option-requires slight board modification  
 \* = Option-requires additional Micromodule (MM11) (RS-232C to 20 mA Current Loop Adapter)

### Processor Subassemblies

When you need more design flexibility than a single monoboard computer can provide, choose from a wide selection of processor subassemblies to give your system the characteristics it needs, at an affordable cost. These subassemblies, in conjunction with the auxiliary boards on the following pages, allow almost limitless diversification or expansion of microcomputer functional capabilities.

All micromodules are electrically and mechanically compatible with each other, and with the EXORciser Development Systems. This means that they may be plugged into the EXORciser for hardware and software debugging, using the EXbug Firmware of the EXORciser DDebug Module.

#### Processor Module

| Part Number | MPU  | Clock MHz |
|-------------|------|-----------|
| M68MM02     | 6800 | 1         |

#### Arithmetic Module

| Part Number | APU  | Clock MHz |
|-------------|------|-----------|
| M68MM14     | 9511 | 2         |
| M68MM14A    | 9511 | 3         |

# INPUT/OUTPUT MODULES

If your system requires additional input or output capabilities, the Micromodule product line provides an extensive offering of both digital and analog, input and output modules. These input/output modules are all compatible with the various microprocessor modules.

## Digital — Parallel

| Part Number / Name                               | TTL Level |               | Relay Output | Opto Isolated                |              |
|--|-----------|---------------|--------------|------------------------------|--------------|
|  | Input     | Output        |              | Input                        | Output       |
| M68MM03 32/32 Input/Output Module                | 32        | 32            |              |                              |              |
| MEX6820, 6821-2 (2MHz) Input/Output Module       |           | 2 PIAs/40 I/O |              |                              |              |
| M68MM13A Digital Output Module                   |           |               | 16           |                              |              |
| M68MM13B Digital Output Module                   |           |               | 32           |                              |              |
| M68MM13C Optically Isolated Digital Input Module |           |               |              | 24 (voltage in)              |              |
| M68MM13D Optically Isolated Digital Input Module |           |               |              | 24 (switch closures)         |              |
| M68MM23 Optically Isolated Input/Output Module   |           |               |              | 1 to 16 AC or DC I/O Modules |              |
| IAC5 AC Input — Input/Output Module              |           |               |              | 140 Vac                      |              |
| IAC5-A AC Input — Input/Output Module            |           |               |              | 280 Vac                      |              |
| IDC5 DC Input — Input/Output Module              |           |               |              | ±32 Vdc                      |              |
| OAC5 AC Load — Input/Output Module               |           |               |              |                              | 140 Vac @ 3A |
| OAC5-A AC Load — Input/Output Module             |           |               |              |                              | 280 Vac @ 3A |
| ODC5 DC Load — Input/Output Module               |           |               |              |                              | 60 Vdc @ 3A  |

## Digital — Serial

| Part Number/Name                               | Interface  |        |        |       | IEEE 488-1978 Bus          |
|--|--|--------|--------|-------|----------------------------|
|  | RS-232C  | RS-422 | RS-423 | 20 mA |                            |
| M68MM07 Quad Communications Module             | 4*   | 4*     | 4*     | 4*    |                            |
| MEX6850 ACIA Module                            | 1  |        |        | 1     |                            |
| MEX6850-2 2MHz ACIA/SSDA Module                | **   | **     | **     | **    |                            |
| M68MM11 RS-232C to TTY Adapter                 | RS-232C to 20 mA Translator                                |        |        |       |                            |
| M68MM12 GPIB Listener/Talker/Controller Module |  |        |        |       | Listener/Talker Controller |
| M68MM12A GPIB Listener/Talker Module           |  |        |        |       | Listener/Talker            |
| M68DIM2A Display Interface                     | Composite Video at 0.5V, 75Ω (Compatible with M68MDM1 CRT) |        |        |       |                            |

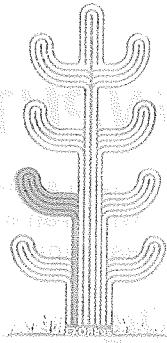
\*ACIA or SSDA and Interface are User Options. \*\*SSDA and Interface must be installed by the user.

## Analog

| Part Number/Name                     | A/D  |   | D/A         |             |
|--------------------------------------|--|---|-------------|-------------|
|                                      | High Level 12-Bit                                  | Low Level 16-Bit                                | Voltage     | Current     |
| M68MM05A High-Level, 12-Bit          | 8 Channel Differential                             |   |             |             |
| M68MM05B High-Level, 12-Bit          | 16 Channel Single Ended                            |   |             |             |
| M68MM15A High-Level, 12-Bit          | 8 Channel Differential<br>16 Channel Single Ended  |   |             |             |
| M68MM15A1 High-Level, 12-Bit         | 16 Channel Differential<br>32 Channel Single Ended |   |             |             |
| M68MM15B Low-Level, 16-Bit           |  | 1 Channel Isolated<br>Expandable to 16 channels |             |             |
| M68MM15BEX Low-Level Expander Module |  | 1-4 Channel Expander                            |             |             |
| M68MM05C Quad 12-Bit D/A Module      |  |   | 4 Channel   |             |
| M68MM15CV Voltage D/A Module         |  |   | 1-4 Channel |             |
| M68MM15CI Current D/A Module         |  |   |             | 1-4 Channel |

# MEMORY MODULES

System memory requirements for EPROM/ROM or RAM can be expanded through the inclusion of the various memory modules offered in the micromodule product line. Additional memory can be added to a system as the design requires.

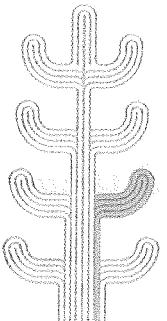


| Part Number/Name                                    | EPROM/ROM | RAM         |                 |                |
|---|-----------|-------------|-----------------|----------------|
|   |           | Static      | Dynamic Refresh | Hidden Refresh |
| M68MM04 16K EPROM/ROM Module                        | 1 to 16K  |             |                 |                |
| M68MM04A ROM/EPROM Module                           | 1 to 64K  | (2 to 32K)* |                 |                |
| M68MM06 2K Static RAM Module                        |           | 2K          |                 |                |
| M68MM09 4K Static CMOS RAM Module                   |           | 4K**        |                 |                |
| MEX6815-3 8K Dynamic RAM Module                     |           |             | 8K              |                |
| MEX6816-1HR 16K Dynamic RAM Module w/Hidden Refresh |           |             |                 | 16K †          |
| MEX68RR EPROM/RAM Module                            | 1 to 16K  | 512         |                 |                |

\*Using Pin Compatible RAMs \*\*With On-Board Battery Backup † 32K, 48K and 64K versions available.

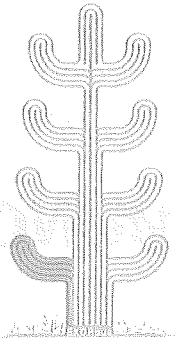
# FIRMWARE/SOFTWARE

The Micromodule product line includes an offering of Monitor/DEbug ROMs, a high-level language BASIC Interpreter, a Real-Time FORTRAN Compiler and a Real-Time Executive to assist you in operating software development and debugging.



| Part Number/Name                            | Functional Description  |
|---|---|
| M68MM08A MICRObug (6800)                    | Monitor/DEbug ROM for use with M68MM01A and M68MM01A2   |
| M68MM08 MICRObug with ACIA Module (MEX6850) | Monitor/DEbug ROM and ACIA for use with M68MM01 and M68MM02   |
| M68BASRC2 BASIC (6800)                      | BASIC in EPROMs for use with MICRObug   |
| M68BASRM2                                   | BASIC EPROMs on a module  |
| M68RTFR02M Real-Time FORTRAN (6800)         | Real-Time FORTRAN compiler with drivers for I/O Micromodules on MDOS Diskette.  |
| M6809BASICM BASIC-M (6809)                  | Interactive BASIC-M Compiler  |
| M6809RMS09 Real-Time Executive (6809)       | Multi-Task Real-Time Executive that is relocatable and ROMable  |
| M68MM12SWM Micromodule 12 Software (6800)   | Source code on MDOS diskette of on-board EPROM which provides implementation of GPIB protocol. Also includes a how-to-use training program. (M6800 systems only)                                |
| M68MM12ASWM Micromodule 12A Software (6800) | Source code on MDOS diskette of software required to implement the GPIB Listener/Talker protocol. Also includes a how-to-use training program and a demonstration package. (M6800 systems only) |
| M68MM19SB SUPERbug (6809)                   | MM19 System Monitor with Utility, I/O, and Linkage Routines   |

# PACKAGING/HARDWARE



System packaging offerings include open-frame card cages, rack-mount chassis with power supply and fan, and a triple output power supply. To support custom circuit prototyping, two versions of a wirewrap module are available.

## Card Cages, Chassis and Power Supply

| Part Number/Name                 | Dimensions (Inches)<br>L x W x H |
|----------------------------------|----------------------------------|
| <b>Card Cages Only</b>           |                                  |
| M68MMCC05                        | 5-slot Open-Frame Cage           |
| M68MMCC10                        | 10-slot Open-Frame Cage          |
| <b>Chassis With Power Supply</b> |                                  |
| M68MMSC                          | 5-slot Rack Mount Chassis        |
| M68MMLC                          | 10-slot Rack Mount Chassis       |
| M68MMFLC                         | 14-slot Rack Mount Chassis       |
| <b>Power Supply Only</b>         |                                  |
| M68MMPS1                         | Power Supply +5V, ±12V           |

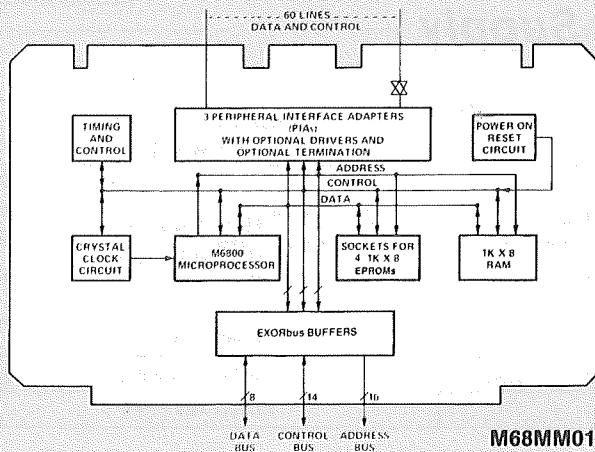
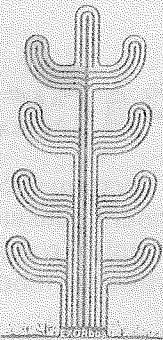
## Auxiliary Support Modules

| Part Number/Name   | Dimension              |
|--------------------|------------------------|
| MEX68WW            | 9.75 x 6.00            |
| MEX68USM           | 9.75 x 6.00            |
| MEX68XT            | 9.75 x 9.00            |
| M68MM10            | 9.75 x 6.00            |
| M68MM10RTC         | 9.75 x 6.00            |
| <b>CRT Monitor</b> |                        |
| M68MDM1            | 5" CRT Display Monitor |

## Mounting/Hardware

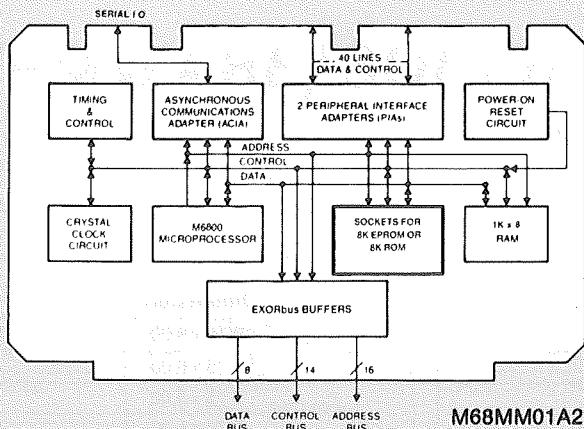
| Part Number/Name | Functional Description  |
|------------------|---|
| M68MMLK          | Rack Mounting slide kit for M68MMLC   |
| M68MMSK          | Rack Mounting slide kit for M68MMSC   |
| M68MMFLK         | Rack Mounting slide kit for M68MMFLC  |
| M68MM23IKIT      | Installation kit for mounting two Optically Isolated I/O Modules in an M68MMFLC |

# MONOBOARD MICROCOMPUTERS



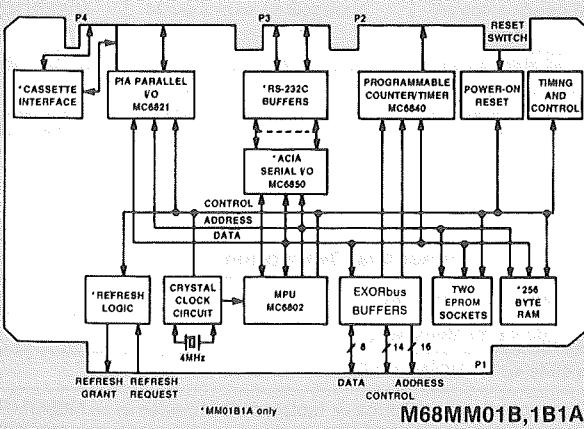
**Microcomputer With Parallel I/O**  
Basic MPU - MC6800

1 MHz Crystal-Controlled Clock  
1K byte Static RAM  
Sockets for four 1K EPROMs or ROMs  
Three MC6821 PIAs (60 peripheral I/O lines)  
36K bytes available for external memory  
Dynamic Memory Refresh Circuitry  
Buffered Address, Control, and Data Bus  
Optional I/O Terminations and Connector Kits



**Microcomputer With Parallel and Serial I/O**  
Basic MPU - MC6800

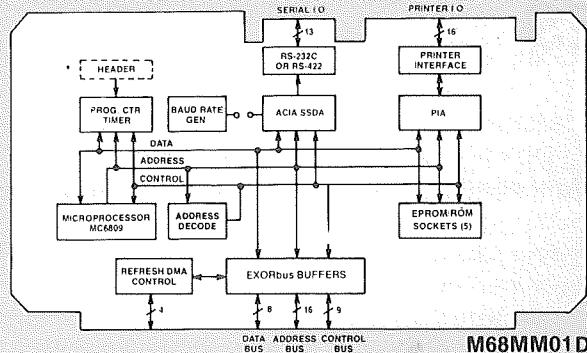
1 MHz Crystal-Controlled Clock  
1K byte Static RAM  
Sockets for four 1K or 2K EPROMs or masked ROMs  
Two MC6821 PIAs  
One MC6850 ACIA with RS-232C Interface  
Dynamic Memory Refresh Circuitry  
59K or 55K bytes of Unused Addresses Available  
(dependent on ROM Selection)  
Buffered Address, Control, and Data Bus  
Optional Connector Kit



**Microcomputer With Parallel and Serial I/O and Timer**  
Basic MPU - MC6802 with 128 bytes  
on-chip Static RAM

1 MHz Crystal-Controlled Clock  
Sockets for up to 4K EPROM  
20 Programmable I/O Lines (MC6821 PIA)  
Three 16-bit Binary Programmable Timers  
(MC6840 PTM)  
256 Additional bytes of Read/Write Static  
RAM (01B1A)  
Serial I/O Interface with RS-232C Drivers/  
Receivers and Software Programmable Baud  
Rate (110, 300, 1200 or 2400) (01B1A)  
Audio Tape Cassette Interface Circuitry (01B1A)  
Dynamic RAM Refresh Logic (01B1A)  
Buffered Address, Control, and Data Bus (01B1A)

# PROCESSOR SUBASSEMBLIES



- 1 MHz Crystal-Controlled Clock

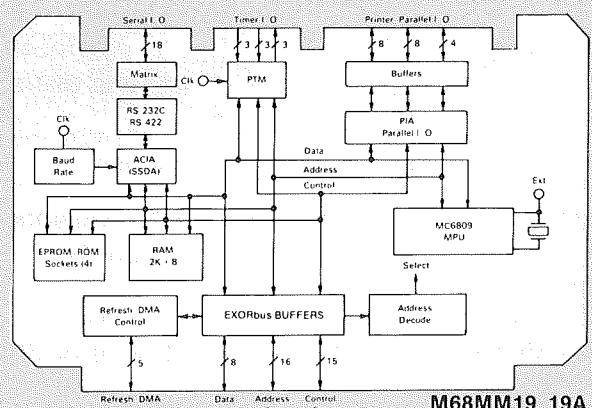
- Five sockets for 2K EPROMs, ROMs or pin compatible RAMs

- One MC6850 ACIA (can be replaced with an SSDA) with optional RS-232C or RS-422 interface

- One MC6821 PIA with buffers configured for parallel printer interface

- One MC6840 PTM triple 16-bit counter/timer  
50K or 56K bytes of continuous external memory space available

- Buffered Address, Control, and Data Bus



- 4 MHz Crystal - 1 MHz operation (MM19)

- 8 MHz Crystal - 2 MHz operation (MM19A)

- Four sockets for 2K or 4K EPROMs, ROMs or pin compatible RAMS

- 2K bytes of static RAM, accessible from ext. DMA

- One MC6821 PIA with strap selectable Input/Output buffering

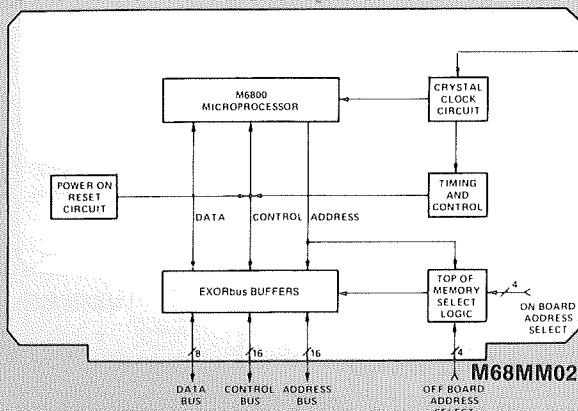
- One MC6850 ACIA (replaceable with an SSDA) with optional RS-232C or RS-422 interface

- One MC6840 PTM with three 16-bit programmable counter/timers

- Dynamic memory refresh control logic

- DMA control logic

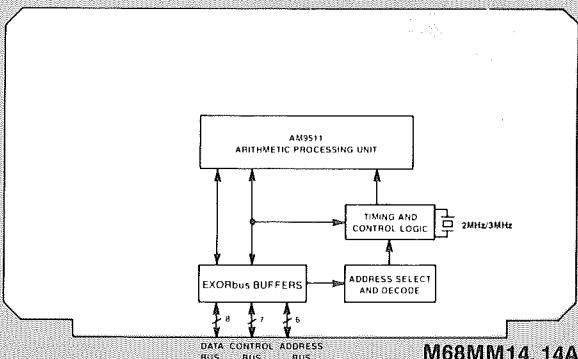
- Buffered Address, Control, and Data Bus



- 1 MHz Crystal-Controlled Clock

- Timing and control for three-state and halt operations and dynamic memory refresh

- Buffered Address, Control, and Data Bus



- Fixed point 16 and 32-bit and floating point 32-bit operations

- Add, subtract, multiply, and divide

- Trigonometric and inverse trigonometric functions

- Square roots, logarithms, exponentiation

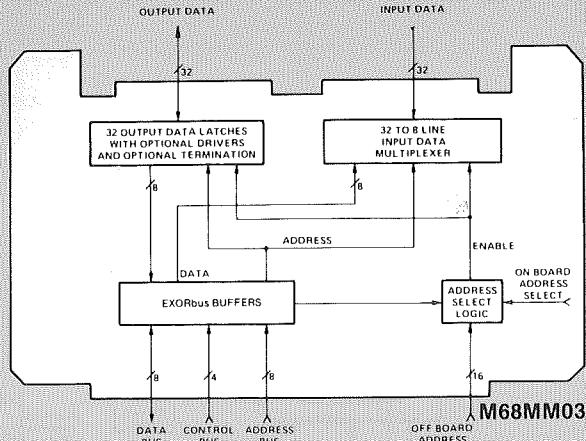
- Float to fixed and fixed to float conversions

- Example execution time (minimum) for 32-bit floating point multiply is  $73\ \mu s$  (2 MHz) for M68MM14 or  $49\ \mu s$  (3 MHz) for M68MM14A

- Buffered Address, Control, and Data Bus

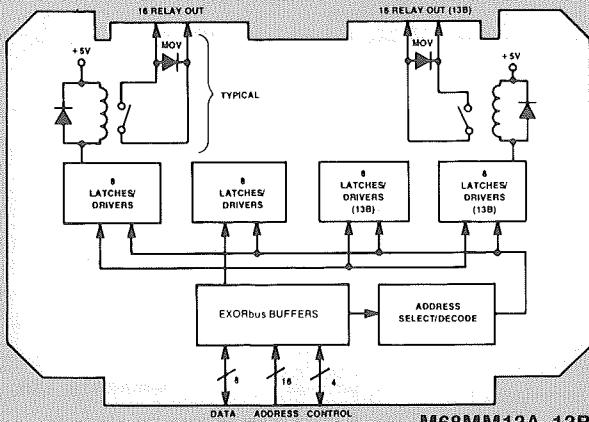
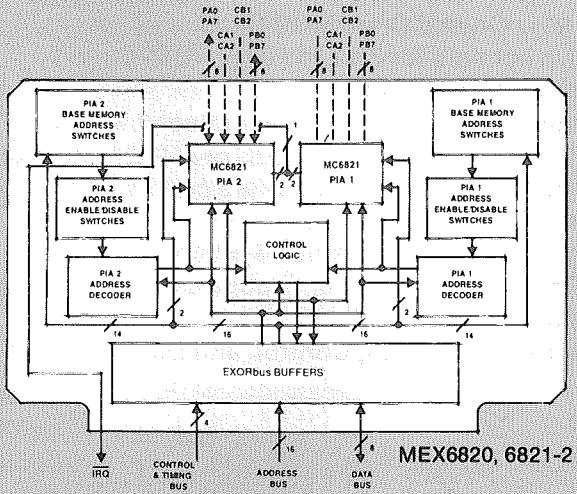
# INPUT/OUTPUT MODULES

## Digital (Parallel)



### Dedicated 32/32-Bit I/O

- 32 bits of parallel input in four contiguous 8-bit bytes
- 32 bits of latched and buffered parallel output in four contiguous 8-bit bytes
- User selectable input/output terminations
- User selectable base memory address
- Buffered Address, Control, and Data Bus
- Optional Terminations



### 16-32 Channel Relay Output Module

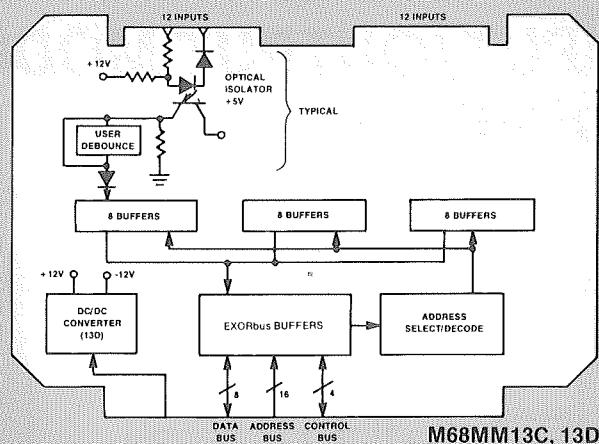
- Completely isolated digital output microperipheral (contact closure) on a board
- High isolation for system-to-microcomputer (600 Vdc) and channel-to-channel (300 Vdc)
- Low output impedance for high current drive
- 16 digital output channels (Micromodule 13A)
- 32 digital output channels (Micromodule 13B)
- On-board inductive load transient protection
- Full on-board address selection
- Buffered Address, Control, and Data Bus

### Universal PIA-Controlled I/O

- 1 MHz (MEX6820) or 2 MHz (MEX6821-2) Operation
- Four 8-bit input/output ports for peripheral interfacing
- Eight individually controlled interrupt lines — four of which may be used as peripheral control lines
- Program controlled maskable interrupt capability
- Each MC6821 Peripheral Interface Adapter addressed as memory
- Switch selectable base memory address for each of the two MC6821 Peripheral Interface Adapter devices
- Provisions on the module for wirewrap sockets to be used in constructing custom interface circuitry
- Buffered Address, Control, and Data Bus

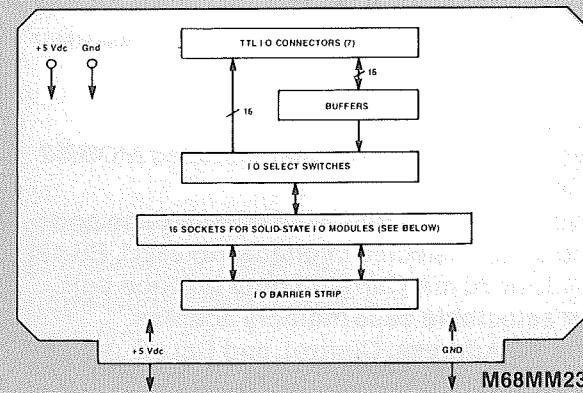
## 24-Channel Isolated Input Module

- Completely isolated digital input microperipheral (optically isolated) on a board
- High isolation for system-to-microcomputer (600 Vdc) and channel-to-channel (300 Vdc)
- 24 channels of optically isolated voltage inputs (Micromodule 13C)
- 24 channels of optically isolated contact closure inputs (Micromodule 13D) - on-board isolated dc/dc converter provides wetting current
- Area provided for user-supplied debounce and ac sense circuitry
- Full on-board address selection
- Buffered Address, Control, and Data Bus



## Optically Isolated I/O Module

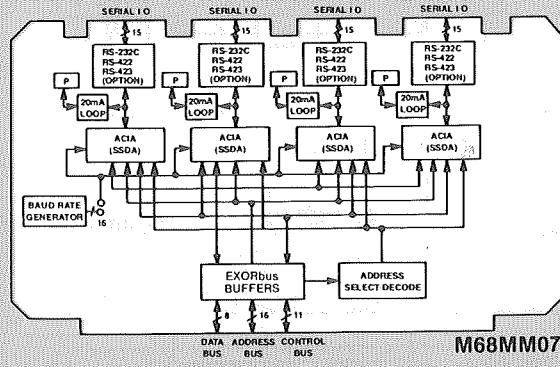
- Sockets for up to sixteen isolated ac or dc, Input or Output modules (IAC5, IAC5-A, IDC5, OAC5, OAC5-A, ODC5).
- Flat-Ribbon connectors for pin-to-pin connection with M68MM01, 01A, 01A2, 1B1A, and M68MM03.
- Screw-type barrier strip for ac/dc wiring
- LED status indicators for each channel
- Requires +5 Vdc only
- Mounting kit available for installing two MM23's in the Front-Load Chassis



| Specifications  | IAC5, 5-A                                 | IDC5                               | OAC5, 5-A                                      | ODC5                                 |
|---|---|------------------------------------|--|--------------------------------------|
|   |   |                                    |  |                                      |
| Input Line Voltage, 50–60 Hz  | 90–140 Vac (IAC5)<br>180–280 Vac (IAC5-A) |                                    |  |                                      |
| Input Voltage for On-State<br>Off-State   |   | +3.0 to +32 Vdc<br>-32 to +1.0 Vdc |  |                                      |
| Turn-On and Off Times   | 8.0–20 ms                                 | 4.0 ms Max.                        | 1/2 cycle Max.                                 | 500 µs Max. (on)<br>2.5 ms Max (off) |
| Isolation Voltage, Input to Output<br>(Pins 1, 2 shorted; Pins 3, 4, 5 shorted) | 3750 Vac Min.                             | 3750 Vac Min.                      | 3750 Vac Min.                                  | 3750 Vac Min                         |
| Output Current Rating<br>(1.0 ≥ P.F. ≥ 0.5, T <sub>A</sub> ≤ 45°C)              |   |                                    | 0.10–3.0 A (RMS)                               | 3.0 Adc Max.                         |
| Load Voltage Rating   |   |                                    | 12–140 V(RMS) (OAC5)<br>24–280 V(RMS) (OAC5-A) | 60 Vdc Max.                          |
| One-Second Surge Rating   |   |                                    |  | 5.0 Adc Max.                         |
| Frequency Range   |   |                                    | 25–65 Hz                                       |                                      |
| Peak Surge Current (Single cycle, 60 Hz)  |   |                                    | 80 A (peak)                                    |                                      |

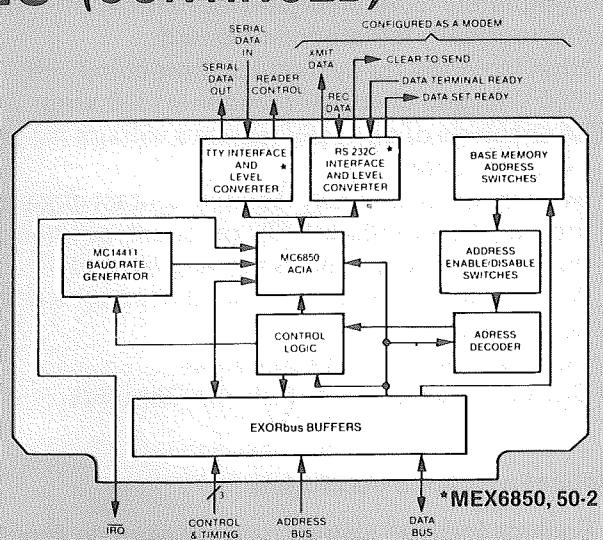
# INPUT/OUTPUT MODULES (CONTINUED)

## Digital (Serial)



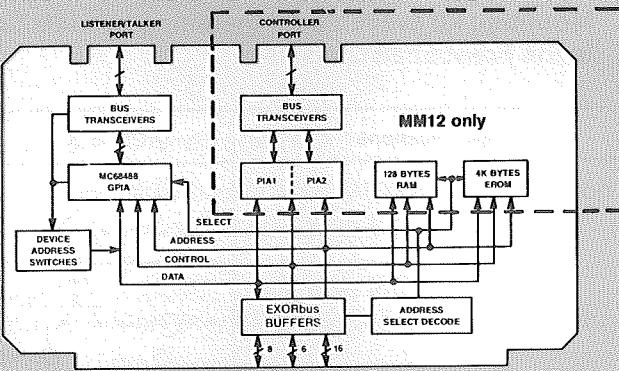
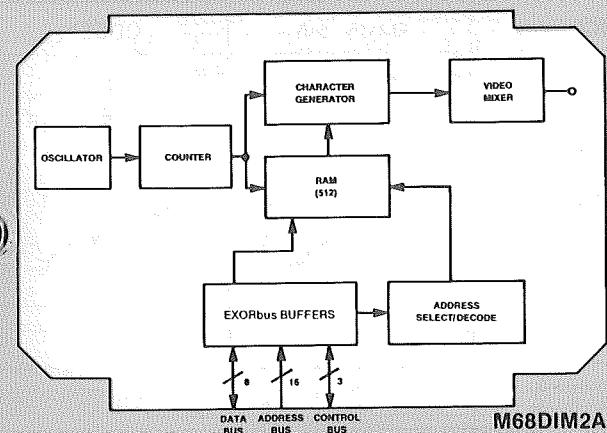
### Quad Serial I/O Module

- Four MC6850 (ACIA) or user installed MC6852 (SSDA)
- Strap-option selected baud rate for each port.
- Strap-option selected interface (RS-232C, RS-422, RS-423 or 20 mA Current Loop) for each port.
- User selectable base memory address.
- Buffered Address, Control, and Data Bus



### ACIA Module

- 1 MHz (MEX6850) or 2MHz (MEX6850-2) operation
- TTY and RS-232C data terminal interface capability (MEX6850)
- Eight switch-selectable baud rates between 110 and 9600 baud
- Buffered Address, Control, and Data Bus



### GPIB Listener/Talker/Controller Module

#### Display Interface Module

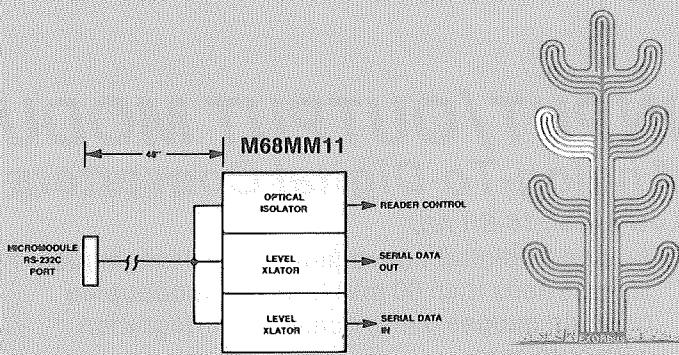
- 16 lines of 32 characters, one page memory
- Jumper selectable memory base address
- Composite 525 lines positive or negative video signal generator
- 128 character set
- Black-on-white or white-on-black display capability
- Interfaces with M68MDM1, the 5" CRT Display Monitor
- Buffered Address, Control, and Data Bus

### GPIB Listener/Talker Module

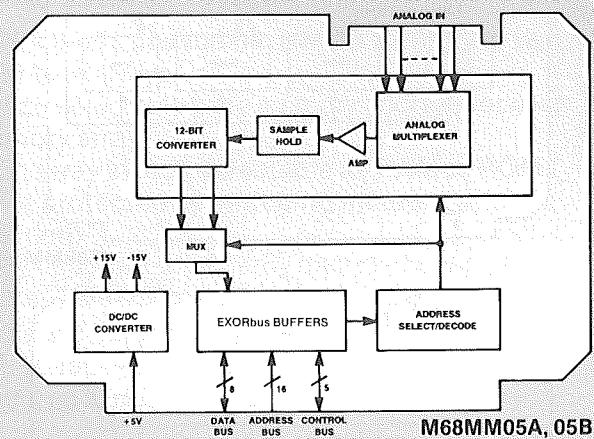
- Provides IEEE 488-1978 Listener, Talker and Controller functions (M68MM12).
- Meets IEEE 488-1978 specifications for signal levels and timing.
- Listener/Talker function provided by buffered GPIA chip.
- Controller function provided by buffered PIAs with EPROM and RAM.
- Base Address = C000-C7FF
- Buffered Address, Control, and Data Bus

### RS-232C to TTY Adapter

- Translates RS-232 serial data input/output to 20 mA neutral current loop data input/output.
- Compatible with Micromodules 1A, 1A2, 1B1A, 1D, and 19
- 48" Micromodule interconnecting cable.
- Housed in 7.5" x 4.5" x 1.0" high impact strength plastic case.

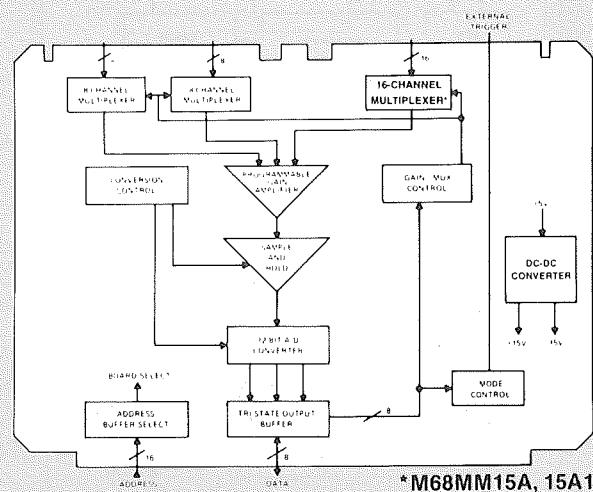


## Analog-To-Digital Converters



### High Level, 12-Bit A/D

8 differential (MM05A) or 16 single-ended (MM05B) analog input channels  
A/D converter of 12-bit nominal resolution  
Conversion time of 33  $\mu$ s(max.), MPU is halted  
Full scale inputs of 0 to 5V, 0 to 10V,  $\pm$  2.5V,  $\pm$  5V,  $\pm$  10V (Jumper selectable)  
Input current loop ranges of 4-20 mA or 10-50 mA (Resistor programmable)  
Amplifier gain range of 1 to 1000 V/V (Resistor programmable)  
Buffered Address, Control, and Data Bus



### High Level, 12-Bit A/D

16 single-ended or pseudo-differential or 8 true-differential analog input channels (MM15A)  
32 single-ended or pseudo-differential or 16 true-differential analog input channels (MM15A1)  
A/D converter of 12-bit nominal resolution.  
Conversion time of 40  $\mu$ s (max.)  
Full scale inputs of 0 to + 5 Vdc, 0 to + 10 Vdc,  $\pm$  5 Vdc,  $\pm$  10 Vdc (strap options)  
Software programmable gain amplifier: factors of X1, X2, X4, or X8.  
Software section of operating mode: Halt during conversion, interrupt at end of conversion, software or external trigger start of conversion.  
Single + 5 Vdc operation, on-board dc-to-dc converter provides  $\pm$  15 Vdc.  
Buffered Address, Control, and Data Bus

(Continued)

# INPUT/OUTPUT MODULES (CONTINUED)

## Analog-To-Digital Converters (Continued)

### Low-Level, 16-Bit A/D

Analog-to-digital conversion of low-level analog signals (less than 80 mV) from thermocouples or strain gauges using dual-slope integration with auto zero.

Resolution of up to 15 bits plus sign.

Conversion time of 133.33 ms (max.)

Isolated, floating inputs with common-mode voltage of  $\pm 500$  Vdc or 1000 V p-p.

Switch selectable linearization for type B, J, K, E, T, S, and R thermocouples.

On board cold junction compensation.

Expandable to a maximum of 16 channels.

Software selection of interrupt at end-of-conversion or BUSY bit test mode.

Single + 5 Vdc operation.

Base address of module is user selectable.

Buffered Address, Control, and Data Bus

### 1-4 Channel Expander A/D

One to four channel expander for M68MM15B

Analog-to-digital conversion of low-level analog signals

Resolution of up to 15 bits plus sign

Isolated, floating inputs with common-mode voltage of  $\pm 500$  Vdc or 1000 V p-p

On board cold-junction compensation

## Digital-To-Analog Converters

### 4-Channel Voltage Output DAC

Four 12-bit Digital-to-Analog (DAC) voltage outputs

Full-scale output voltages: 0 to 10V, 0 to 5V,

$\pm 2.5$ V,  $\pm 5$ V,  $\pm 10$ V (Jumper selectable)

Jumper selectable module base memory address

Single + 5Vdc operation, on board dc-to-dc converter provides  $\pm 15$ Vdc

Buffered Address, Control, and Data Bus

### 1-4 Channel Current /Voltage Output DAC

One to four 12-bit Digital-to-Analog-Converter (DAC) channels per module

Full-scale output voltages: 0 to + 10Vdc,  $\pm 10$ Vdc, 0 to + 5 Vdc and  $\pm 5$  Vdc each channel, M68MM15CV series (strap option)

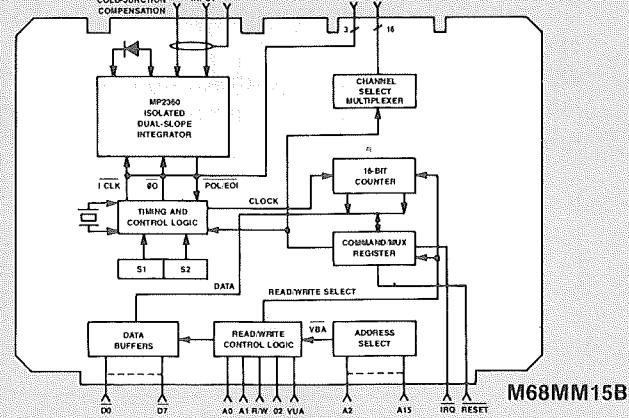
4 to 20 mAdc output, M68MM15CI series

Natural binary or two's complement input code (strap option)

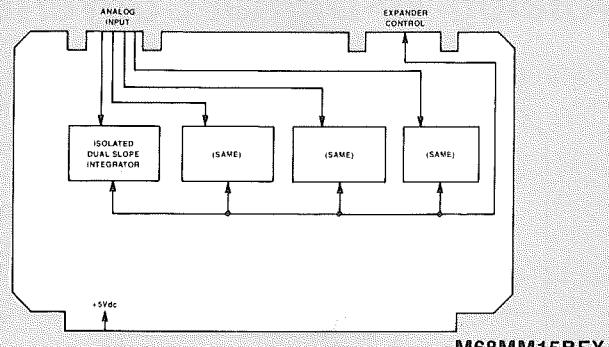
Strap selectable module base memory address, 0500 to FD3F hexadecimal

Single + 5 Vdc operation, on board dc-to-dc converter provides  $\pm 15$  Vdc.

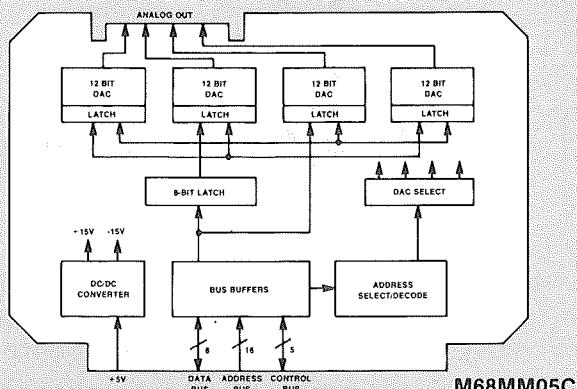
Buffered Address, Control, and Data Bus



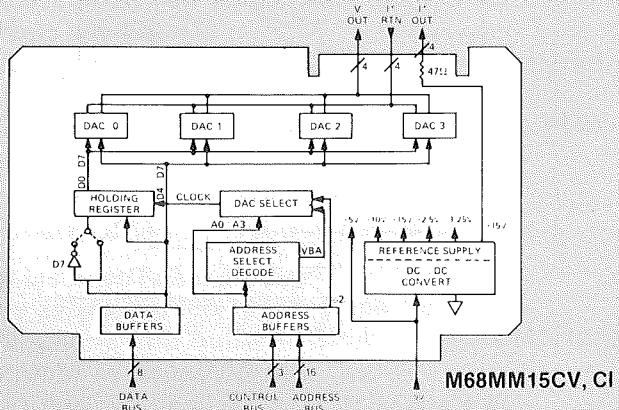
M68MM15B



M68MM15BEX



M68MM05C

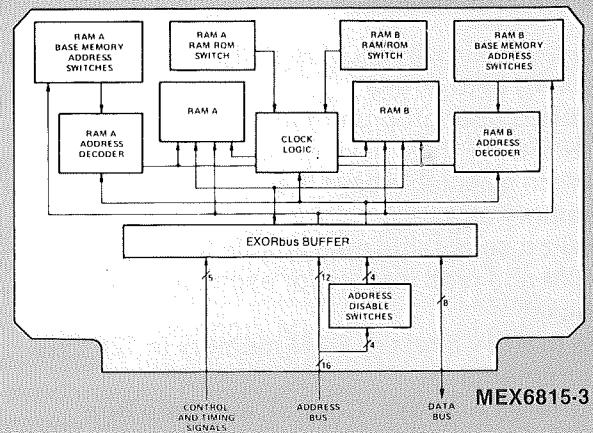


M68MM15CV, CI

# MEMORY MODULES

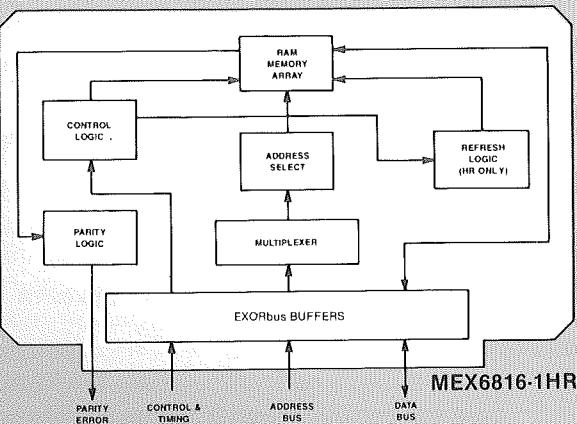
## Prewired Memory Boards — Populated

### Dynamic RAMs



#### 8K Dynamic RAM

- 8192 x 8-bits of dynamic NMOS memory in two 4096 byte arrays.
- Switch selectable base memory address for each memory array
- Each array switch selectable as RAM or ROM (RAM protected by inhibiting memory write function)
- Fully decoded or partially decoded module address selection
- Cycle stealing memory refresh operation
- TTL voltage compatible
- Buffered Address, Control, and Data Bus

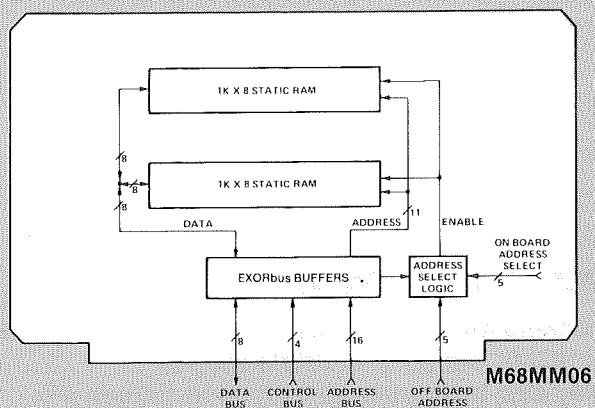


#### 16K Dynamic RAM With Parity

- 16,384 x 8 bits of dynamic NMOS memory in one array
- Switch selectable base memory address for the memory array
- Memory refresh without processor timing interruption
- Buffered Address, Control, and Data Bus

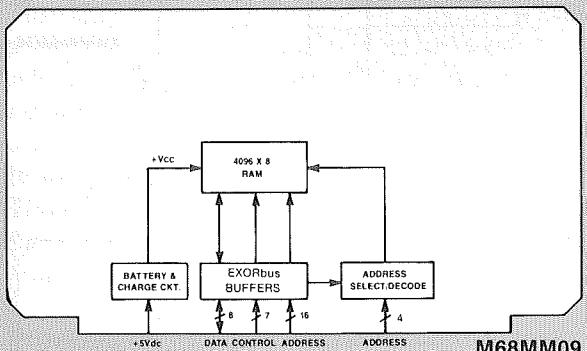
Note: 32K, 48K, 56K dynamic RAM modules and 2MHz versions are also available.

### Static RAMs



#### 2K Static RAM

- 2048 bytes of static random access memory
- User selectable base address
- Buffered Address, Control, and Data Bus



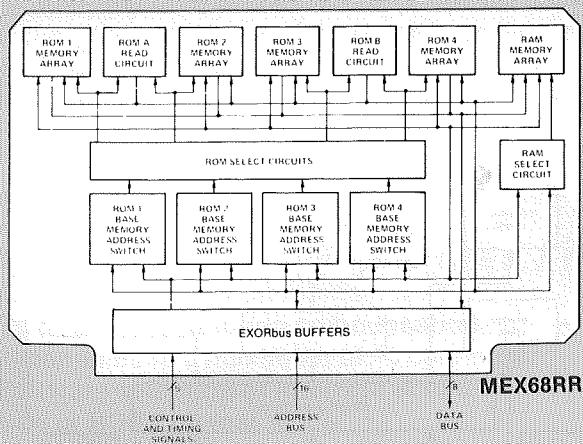
#### 4K CMOS RAM With Battery Backup

- 4K bytes of static, low power CMOS RAM
- On and off-board base address select
- On-board battery, with charging circuit, for minimum of 7-day data retention
- Requires off-board power fail detect (M68MM10)
- Slow memory control logic when used at 2MHz
- Buffered Address, Control, and Data Bus

(Continued)

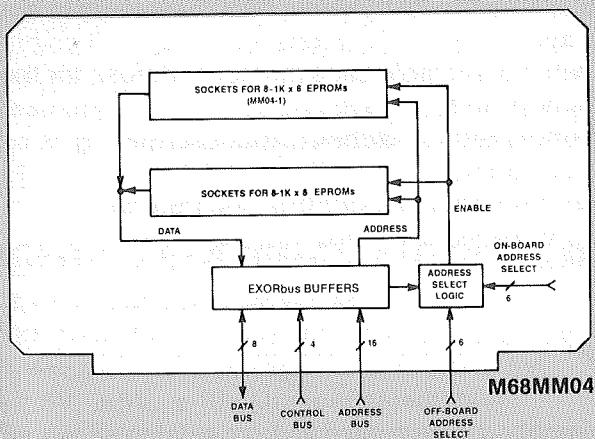
# MEMORY MODULES (CONTINUED)

## Prewired Memory Boards — Unpopulated



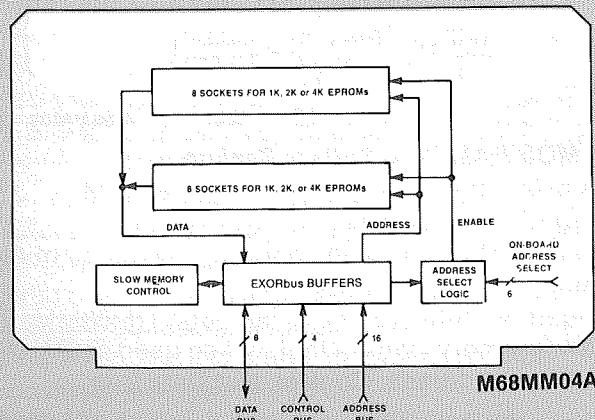
### ROM/RAM Combination

- Up to 16,384 x 8 bits of ROM/PROM memory in four 4K byte arrays
- Utilizes user-programmed 1024 x 8-bit or 512 x 8-bit ROM/PROM devices (four devices per array)
- Switch selectable base memory address for each memory array
- Switch selectable read enable for each installed ROM and read disable for each unused ROM socket
- Up to 512 x 8-bits of RAM memory in 128 byte increments
- Buffered Address, Control, and Data Bus



### ROM/EPROM 16K Bytes

- Sockets for up to sixteen 1K x 8-bit EPROMs or ROM devices (multiple supply)
- User selectable base memory address in two blocks
- Buffered Address, Control, and Data Bus



### ROM/EPROM up to 64K Bytes

- Sockets for up to sixteen 1K, 2K, or 4K EPROMs or ROMs (single or multiple supply)
- May also be populated with up to sixteen pin-compatible RAMs
- Slow memory control logic when used at 1.5 or 2 MHz
- User selectable base memory address in two blocks
- Buffered Address, Control, and Data Bus

# FIRMWARE/SOFTWARE

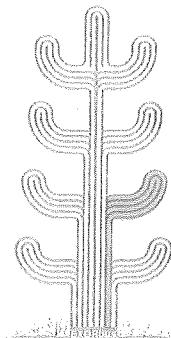
## MICRObug Monitor DEbug

### *Micromodule 8, 8A*

Micromodule M68MM08/08A provides the users of Micromodules with a system software and hardware development and debugging capability. Micromodule MM08A is a firmware ROM containing the MICRObug monitor/debug functions, and is intended for use with Monoboard Microcomputer M68MM01A or M68MM01A2, which contains its own serial communications port. Micromodule MM08 consists of the MICRObug ROM and an MEX6850 Asynchronous Communications Interface Adapter (ACIA) module, and is intended for use with Micromodules MM01 or MM02.

#### **Features**

- User interactive program
- Provides 13 user commands as follows:
  - Load formatted tape
  - Open memory locations; display, change contents
  - Print/punch dump
  - Display MPU Register contents
  - Set communications speed
  - Set Breakpoints
  - Remove one Breakpoint
  - Remove all Breakpoints
  - Print all Breakpoints
  - Continue program from current location
  - Go to specified location and begin program execution
  - Execute next instruction only
  - Trace N instructions
- MICRObug source code listing provided



## Real-Time FORTRAN (6800)

### *M68RTFR02M - MDOS Diskette*

Resident Real-Time FORTRAN is a high level programming language which provides the programmer with the capability of writing real-time software for the 6800 MPU. In addition to the scientific and engineering problem solving features normally found in FORTRAN, Real-Time FORTRAN also contains an execution-time operating system. Driver routines are also included for the various digital and analog input/output Micromodules. The Real-Time FORTRAN Compiler translates the source program into a relocatable object module which the linking loader converts into an executable object unit. The Real-Time FORTRAN Compiler requires 48K bytes of memory for compilation.

## Real-Time Executive (6809)

### *M6809RMS09 — MDOS Diskette*

The 6809 Real-Time Executive provides a multi-task control capability for 6809 based systems. The RTEX is relocatable and ROMable and may be used with Micromodule 19 or other similar systems. Some features of this RTEX are:

- Interrupt handling
- Timer support
- Services up to 255 tasks with task scheduling based on priority levels
- Support for I/O control
- Provides for interactive system control task
- Task oriented debugger with trace capability available for optional inclusion
- Permits resource sharing

(Continued)

# FIRMWARE/SOFTWARE (CONTINUED)

## Resident ROM Basic Interpreter

For use with MICRObug

M68BASRC2 - seven preprogrammed EPROMs

M68BASRM2 - M68BASRC2 EPROMs on EPROM Module

The MICRObug Resident BASIC Interpreter allows the user to take advantage of the high-level BASIC language in developing his Micromodule programs. The features of this ROM BASIC are:

- All mathematical operations are performed in BCD (Binary Coded Decimal) arithmetic
- User programs may be saved and loaded from cassette or paper tape
- Most arithmetic functions and transcendentals are implemented as directly executable subprograms
- String variables and two-dimensional arrays are permitted
- Most program statements may be executed in the direct mode (no statement numbers required for immediate calculations)
- Memory sizing capability (workspace buffer is sized upon initiation of the interpreter)

## Basic-M Compiler

M6809BASICM - MDOS Diskette or with

EXORset 30

The M6809 BASIC-M Interactive Compiler is an easy-to-learn and easy-to-use high level language which provides the power to solve a wide variety of problems with particular emphasis on real-time, process control and business-related applications. BASIC-M has a number of facilities commonly associated with other higher level languages plus enhancements specifically oriented toward microprocessors. BASIC-M requires 48K bytes of RAM for compilation.

## Micromodule 12, 12A Software

M68MM12SWM - MDOS Diskette

M68MM12ASWM - MDOS Diskette

This source-code software provides the user with the source-code that can be used to implement the GPIB protocol. In addition, a how-to-use training program and demonstration program are also provided.

## SUPERbug Firmware (M6809)

SUPERbug (M68MM19SB) is the combination of two separate Program Modules. Program Module I, a 4K program, contains SUPERlink, SUPERio, and SUPERutil. Program Module II, a 2K relocatable monitor routine, contains SUPERmon. These Program Modules may be installed in the ROM sockets provided on Micromodule M68MM19. SUPERbug uses the 2K of RAM provided on Micromodule 19 for the program linkage table, the RAM allocation manager and for the system and user stack operations. The main features of these programs are:

- SUPERmon — A high-performance system monitor in a separate 2K Program Module, to be used with Program Module I. This module is intended for use during the debug phase of development and may be removed from the final production configuration.
- SUPERlink — A program linkage and RAM allocation manager which allows physically disassociated, position-independent Software/Firmware Micromodules to intercommunicate.
- SUPERio — An extensive device independent macro input/output support package.
- SUPERutil — contains the various routines utilized by SUPERmon which are fully available to the user.

# PACKAGING/HARDWARE

## Chassis, Card Cages and Power Supplies

Bringing your modularized microcomputer system on line is simple with these accessories designed to match the Micromodule architecture and your end use. Choose from a variety of chassis with power supply, and card cages with separate power supply to tailor the system to your requirements...

### 5, 10, and 14 Slot Chassis

Micromodule chassis with Power Supply for standard RETMA 19" rack mounting. Available in two pre-wired ready-to-use top-load models; long 10-card chassis, M68MMLC, and short 5-card model, M68MMSC. A front-load, 14-slot chassis (M68MMFLC) is also available. All versions use 15 A (@5 V) triple dc output power supply with specifications of M68MMPS1-1, below.

### 5 and 10 Slot Card Cages

Want to use a separate power supply? The two card cages with 10-card (M68MMCC10) or 5-card (M68MMCC5) capacity are sized to handle your Micromodule requirements effectively and efficiently. Cages may be mounted in five possible orientations and have accommodations for power connection.

### Triple Power Supply

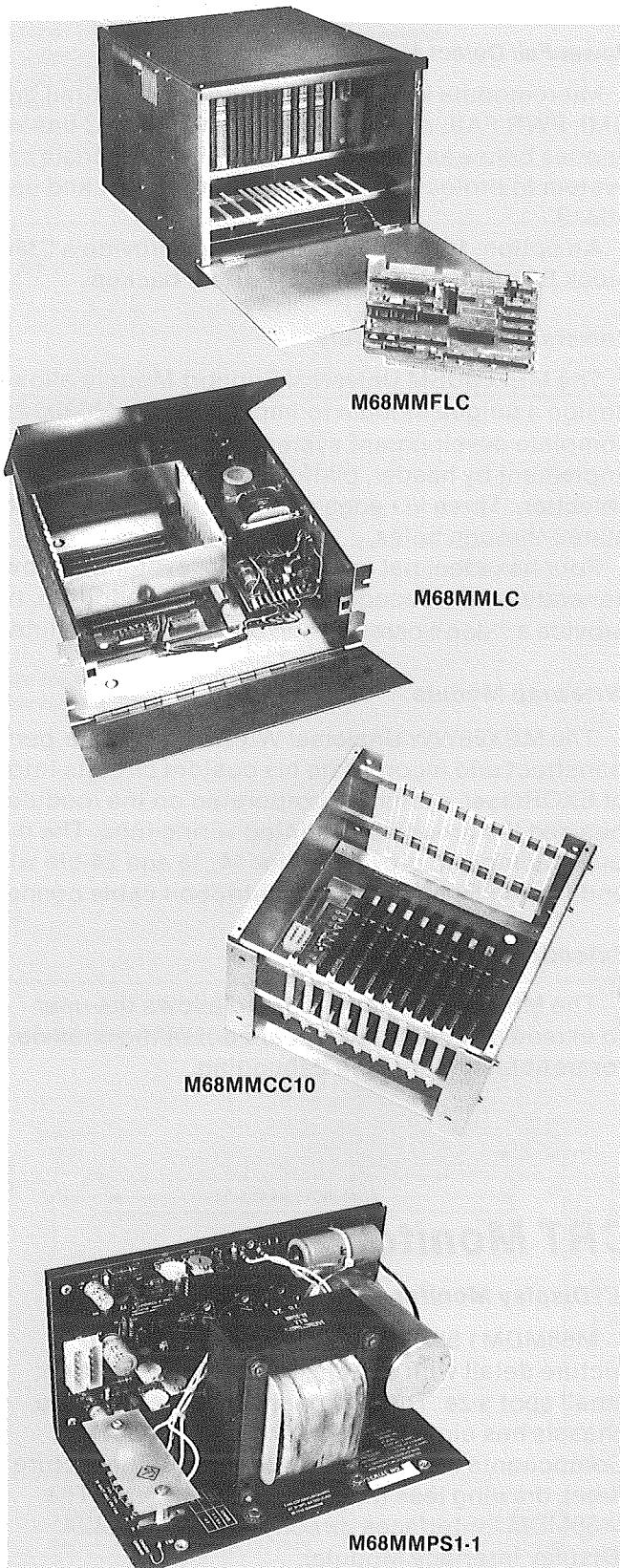
Triple Output Power Supply (M68MMPS1) designed to handle voltage and current requirements for up to 14 Micromodules. Offers 15 A output at 5 Volts for five-volt MPU systems, plus separate +12 V and -12 V outputs (2.5 and 1.5 A, respectively) for associated memory systems and other accessories. Dimensioned for mounting on either side of card cages described above.

### Mounting Hardware

Rack mount slide kits are available for all three chassis types:

- M68MMLK - Used with the long chassis, M68MMLC
- M68MMSK - Used with the short chassis, M68MMSC
- M68MMFLK - Used with the front-load chassis, M68MMFLC

An installation kit is available for mounting one or two optically-isolated I/O modules, M68MM23, in the space available at the rear of the front-load chassis. The kit part number is M68MM23IKIT.



# PACKAGING/HARDWARE (CONTINUED)

## Auxiliary Support Modules

### **Power-Fail Detect Module**

Micromodule M68MM10 provides a power-fail detect sequence; NMI, PWR FAIL and RESET whenever the AC line voltage drops cycles or goes below an adjustable level. These signals can be used in a system to protect critical data in battery backed up RAM, MM09 or MM19.

An option, M68MM10RTC will also provide a CMOS Time-of-Day clock function with on-board battery backup.

### **Universal Support Module**

The MEX68USM Universal Support Module allows the user to design a unique module to implement the M6800 family of parts. The complete development system bus is available for the user to implement by header, platforms, wirewrap sockets, or switch selection. Three I/O edge connectors provide 120 lines accessible at plated-through holes.

Four hexadecimal address select switches allow the user to generate a fully decoded chip select. In addition, two header areas provide a "don't care" option on each address line.

### **Wirewrap Module**

The MEX68WW Universal Wirewrap Module permits the user to construct and incorporate his custom circuits into a Micromodule or EXORciser system. Incorporated on the module are the power bus and the ground bus printed wiring runs. The module has standard pin spacing and provisions for 14, 16 and 24-pin wirewrap sockets and for two 50-pin wirewrap flatribbon cable connectors.

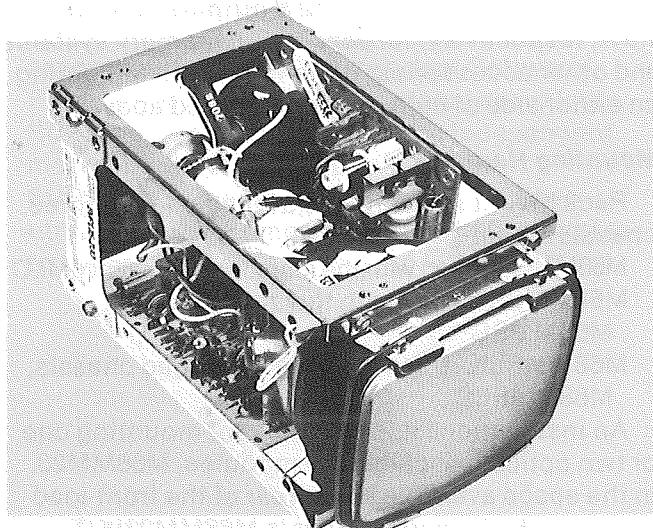
### **Extender Board**

The MEX68XT Extender Board allows the user to extend a micromodule board out of the chassis for troubleshooting and debugging.

## **CRT Monitor**

### **5" Display Monitor**

M68MDM1 5" Display Monitor offers sharp picture detail with 650 line horizontal resolution, small spot size. The compact, easily serviceable chassis has circuitry on two removable boards. Components are all solid-state (except the picture tube), drawing less than one amp at 12 Vdc. The M68MDM1 interfaces directly with M68DIM2A (Display Interface Module).



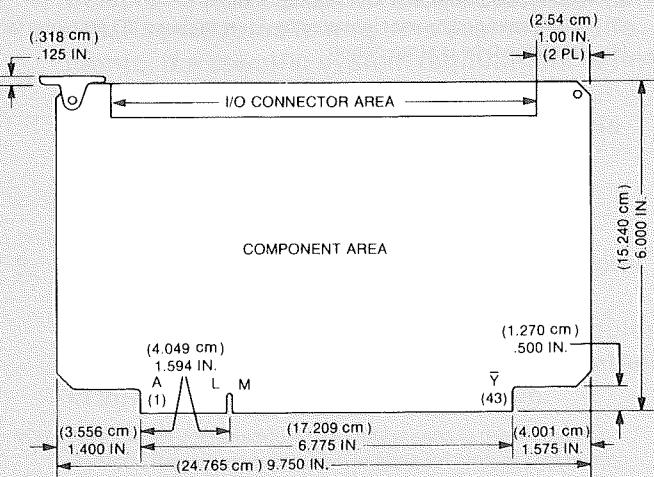
# Micromodule Power and I/O Connector Requirements

| PART NO.        | POWER (AMPS) (1) |      |       | I/O CONNECTORS (Qty.) or EQUIVALENT  |
|-----------------|------------------|------|-------|--|
|                 | +5V              | +12V | -12V  |  |
| M68MM01         | 1.1              | 0    | 0.5mA | 3M No. 3415-0001 (2), 3461-0001 (1); -1 and -2 versions include 4 connectors |
| M68MM01A2       | 1.1              | 0.02 | 0.025 | 3M No. 3415-0001 (2), 3461-0001 (1); A2-1 version includes 4 connectors      |
| M68MM01B        | 0.35             | —    | —     | 3M No. 3415-0001 (1), 3464-0001 (1)  |
| M68MM01B1A      | 0.55             | 0.02 | 0.025 | 3M No. 3415-0001 (1), 3461-0001 (1), 3464-0001 (1)                           |
| M68MM01D        | 1.7              | 0.02 | 0.025 | 3M No. 3415-0001 (1), 3461-0001 (1)  |
| M68MM19, 19A    | 1.5              | 0.02 | 0.025 | 3M No. 3415-0001 (1), 3461-0001 (2)  |
| M68MM02         | 1.0              | —    | —     | None   |
| M68MM14, 14A    | 0.7              | 0.1  | —     | None   |
| M68MM03         | 0.8              | —    | —     | 3M No. 3415-0001 (2)   |
| MEX6820, 6821-2 | 2.0              | —    | —     | Cable available as Part No. MEX68IC  |
| M68MM13A        | 0.4              | —    | —     | 3M No. 3415-0001 (1)   |
| M68MM13B        | 0.7              | —    | —     | 3M No. 3415-0001 (2)   |
| M68MM13C        | 0.4              | —    | —     | 3M No. 3415-0001 (2)   |
| M68MM13D        | 0.4              | 0.1  | —     | 3M No. 3415-0001 (2)   |
| M68MM23         | 0.5              | —    | —     | 3M No. 3425 (1 or 4)   |
| M68MM07         | 1.0              | 0.16 | 0.16  | 3M No. 3461-0001 (4) or 3406-0000 (2)  |
| MEX6850, 6850-2 | 0.5              | 0.05 | 0.05  | Cinch DP-25P   |
| M68MM11         | 0.2              | 0.3  | 0.1   | Cinch 50-6A-20   |
| M68MM12         | 2.2              | —    | —     | 3M No. 3462-0001 (2), 3M No. 3415-0001 (1)                                   |
| M68MM12A        | 1.4              | —    | —     | 3M No. 3462-0001 (2), 3M No. 3415-0001 (1)                                   |
| M68DIM2A        | 1.5              | 0.07 | —     | Monitor cable included   |
| M68MM05A        | 1.0              | —    | —     | Cable included   |
| M68MM05B        | 1.0              | —    | —     | Cable included   |
| M68MM05C        | 1.0              | —    | —     | Cable included   |
| M68MM15A        | 1.2              | —    | —     | 3M No. 3415-0001 (1)   |
| M68MM15A1       | 1.2              | —    | —     | 3M No. 3415-0001 (2)   |
| M68MM15B        | 2.0              | —    | —     | Connector included, expander requires 3M No. 3461-0001 (1)                   |
| M68MM15BEX      | 0.2              | —    | —     | Connector included, expander requires 3M No. 3461-0001 (1)                   |
| (Add per Ch.)   | 0.2              | —    | —     |  |
| M68MM15CV       | 0.6              | —    | —     | 3M No. 3415-0001 (1)   |
| (Add per Ch.)   | 0.22             | —    | —     |  |
| M68MM15CI       | 0.6              | —    | —     | 3M No. 3415-0001 (1)   |
| (Add per Ch.)   | 0.22             | —    | —     |  |
| M68MM04A        | 0.7              | 0    | 8.0mA | None   |
| M68MM06         | 1.5              | —    | —     | None   |
| M68MM09         | 0.3              | —    | —     | None   |
| MEX6815-3       | 0.6              | 0.25 | 0.05  | None   |
| MEX6816-1HR     | 1.0              | 0.16 | 8.0mA | None   |
| MEX68RR         | 0.4              | 0    | 0.5mA | None   |

NOTE:

(1) All power requirements are maximum but do not include ROM or EPROM devices that are user-installed.

## Micromodule Dimensions



# Micromodule Feature Summary

| FEATURE              | PRODUCT  | Monoboard |        |       |         |       |           | CPU<br>APU | Input/output Extension |      |      |          |          |          | Memory Extension |      |      |        |      |       |      |      |      |        |          |  |
|----------------------|----------|-----------|--------|-------|---------|-------|-----------|------------|------------------------|------|------|----------|----------|----------|------------------|------|------|--------|------|-------|------|------|------|--------|----------|--|
|                      |          | MM01      | MM01A2 | MM01B | MM01B1A | MM01D | MM19, 194 |            | MM02                   | MM14 | MM03 | MM134, B | MM13C, D | MM23     | 6820, 21, 2      | MM07 | 6850 | 6850-2 | MM04 | MM04A | 68RR | MM06 | MM09 | 6815-3 | 6816-1HR |  |
| Parallel I/O Lines   | 48       | 32        | 16     | 16    |         |       | 16        |            |                        |      | 64   | 16/32    | 24       | 1-16     | 32               |      |      |        |      |       |      |      |      |        |          |  |
|                      | 24       | 32        | 16     | 16    |         |       |           |            |                        |      |      |          |          |          | 32               |      |      |        |      |       |      |      |      |        |          |  |
| TTL Buffered In      | 12/0 (1) |           |        |       |         |       | 16(2)     |            |                        |      | 32   |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
|                      | 12/24(1) |           |        |       |         |       | 16(2)     |            |                        |      | 32   |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
| Handshake Lines      | 12       | 8         | 4      | 4     |         |       | 4         |            |                        |      |      |          |          |          |                  |      |      | 8      |      |       |      |      |      |        |          |  |
| Printer Port         |          |           |        |       |         |       | 1         | 1(2)       |                        |      |      |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
| Relay Closure        |          |           |        |       |         |       |           |            |                        |      |      | 16/32    |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
| Optical Isolated In  |          |           |        |       |         |       |           |            |                        |      |      |          | 24       | 1-16 (3) |                  |      |      |        |      |       |      |      |      |        |          |  |
| Optical Isolated Out |          |           |        |       |         |       |           |            |                        |      |      |          |          | 1-16 (3) |                  |      |      |        |      |       |      |      |      |        |          |  |
| Serial I/O Ports     | 1        |           | 1      | 1     | 1       |       |           |            |                        |      |      |          |          |          |                  |      |      | 4      | 1    | 1     |      |      |      |        |          |  |
|                      | ✓        |           | ✓      | (4)   | (4)     |       |           |            |                        |      |      |          |          |          |                  |      |      | (4)    | (4)  |       |      |      |      |        |          |  |
|                      |          |           |        | (4)   | (4)     |       |           |            |                        |      |      |          |          |          |                  |      |      | (4)    |      |       |      |      |      |        |          |  |
|                      |          |           |        |       | (4)     |       |           |            |                        |      |      |          |          |          |                  |      |      | (4)    |      |       |      |      |      |        |          |  |
|                      |          | (8)       | (8)    | (8)   | (8)     |       |           |            |                        |      |      |          |          |          |                  |      |      | (4)    | (4)  |       |      |      |      |        |          |  |
| Triple Timer         |          | 1         |        | 1     | 1       | 1     |           |            |                        |      |      |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
| Memory               | 4K       | 8K        | 4K     | 4K    | 10K     | 16K   |           |            |                        |      |      |          |          |          |                  |      |      |        | 16K  | 64K   | 16K  |      |      |        |          |  |
|                      | 1K       | 1K        | 128    | 384   | (5)     | 2K(5) |           |            |                        |      |      |          |          |          |                  |      |      |        | (5)  | 512   | 2K   | (6)  | (7)  |        |          |  |
| MPU                  | ✓        | ✓         |        |       | ✓       |       |           |            |                        |      | ✓    |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
|                      |          |           | ✓      | ✓     |         |       |           |            |                        |      |      |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
|                      |          |           |        |       |         |       |           |            |                        |      |      |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
|                      |          |           |        |       |         |       |           |            |                        |      |      |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
| 6800                 |          |           |        |       |         |       |           |            |                        |      |      |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
| 6802                 |          |           |        |       |         |       |           |            |                        |      |      |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
| 6809                 |          |           |        |       |         |       |           |            |                        |      |      |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |
| 9511 (Math)          |          |           |        |       |         |       |           |            |                        |      |      |          |          |          |                  |      |      |        |      |       |      |      |      |        |          |  |

## NOTES:

- (1) Buffered I/O determined by user installed devices
- (2) Buffered I/O or Printer Port is strap option
- (3) I/O determined by user installed devices, requires I/O port interface
- (4) Interface type is strap option
- (5) Optional RAM devices may be installed
- (6) CMOS RAM with battery backup
- (7) 32K, 48K and 56K versions available
- (8) Provided by Micromodule 11

# System Design Procedure

## System Planning Worksheet

|   |  |
|---|--|
| <b>Procedure:</b>   |  |
| 1. Analyze your system interface input/output signal requirements and enter on the worksheet.<br>2. Estimate the memory requirements and enter on the worksheet.<br>3. Determine if a specific microprocessor is required.<br>4. Correlate the Worksheet information with the Micromodule Selector Guide and select the appropriate Micromodules to meet the requirements.<br>5. Select the appropriate packaging hardware.<br>6. Determine if any additional special function is required.   |  |
| <b>I. System</b><br>A. Digital-Parallel<br>1. TTL Level-Input ..... Number _____<br>TTL Level-Output ..... Number _____<br>TTL Level-Printer I/O ..... <input type="checkbox"/><br>2. Relay Output ..... Number _____<br>3. Optically Isolated — DC Input ..... Number _____, Level _____ Vdc<br>Optically Isolated — AC Input ..... Number _____, Level _____ Vac<br>4. Optically Isolated — DC Output ..... Number _____, Level _____ Vdc _____ Amps.<br>Optically Isolated — AC Output ..... Number _____, Level _____ Vac _____ Amps.<br>5. Switch Closure Input ..... Number _____<br>6. Programmable Timer ..... Number _____ |  |
| B. Digital-Serial<br>1. Number of I/O Ports ..... Number _____<br>2. Asynchronous or Synchronous .....<br>3. Interface Type<br>a. RS-232C ..... <input type="checkbox"/><br>b. RS-422 ..... <input type="checkbox"/><br>c. RS-423 ..... <input type="checkbox"/><br>d. 20 mA Current Loop ..... <input type="checkbox"/><br>4. IEEE 488-1978 Bus<br>a. Listener/Talker ..... <input type="checkbox"/><br>b. Listener/Talker/Controller ..... <input type="checkbox"/>   |  |
| C. Analog<br>1. High Level Analog-to-Digital Converter<br>a. Number of Channels ..... Number _____<br>b. Differential or Single-Ended ..... _____<br>2. Low-Level Analog-to-Digital Converter<br>a. Number of Channels ..... Number _____<br>3. High-Level Digital-to-Analog Converter<br>a. Number of Channels ..... Number _____<br>b. Voltage or Current Output ..... _____  |  |
| <b>II. Estimated Memory Requirements</b><br>A. EPROM/ROM ..... _____<br>B. RAM ..... _____  |  |
| <b>III. Microprocessor Required</b><br>A. 6800 - 6802 - 6809 ..... _____  |  |
| <b>IV. Micromodule Selection</b><br>1. _____ 11. _____<br>2. _____ 12. _____<br>3. _____ 13. _____<br>4. _____ 14. _____<br>5. _____<br>6. _____<br>7. _____<br>8. _____<br>9. _____<br>10. _____   |  |
| Total Number of Modules ..... _____   |  |
| <b>V. Packaging Selection</b> ..... _____   |  |
| <b>VI. Additional Special Function Requirements</b> ..... _____   |  |

- Determine the system's input/output signal requirements, including the number of signals, the signal levels and type, and special interface requirements. Enter this information on the System Planning Worksheet.
- Estimate the amount of program memory (EPROM/ROM) and scratch-pad memory (RAM) that the system will require and enter this information on the System Planning Worksheet. (Additional RAM or EPROM/ROM can be added later, if required.)
- Determine which microprocessor, i.e., 6800, 6802 or 6809, is best suited to the application.
- Use the information from the System Planning Worksheet to correlate with the Micromodule

Selector Guide to choose the best combination of Micromodules to meet the system requirements. If a specific system requirement is not shown on the Selector Guide, contact your local Motorola Sales Office or Motorola Distributor to see if the desired functional capability has recently been added to the product line.

- Software development and hardware/software/system debugging is best done using a Motorola EXORciser. Note that Micromodules and EXORciser Modules can be used together in an EXORciser or in the end system.

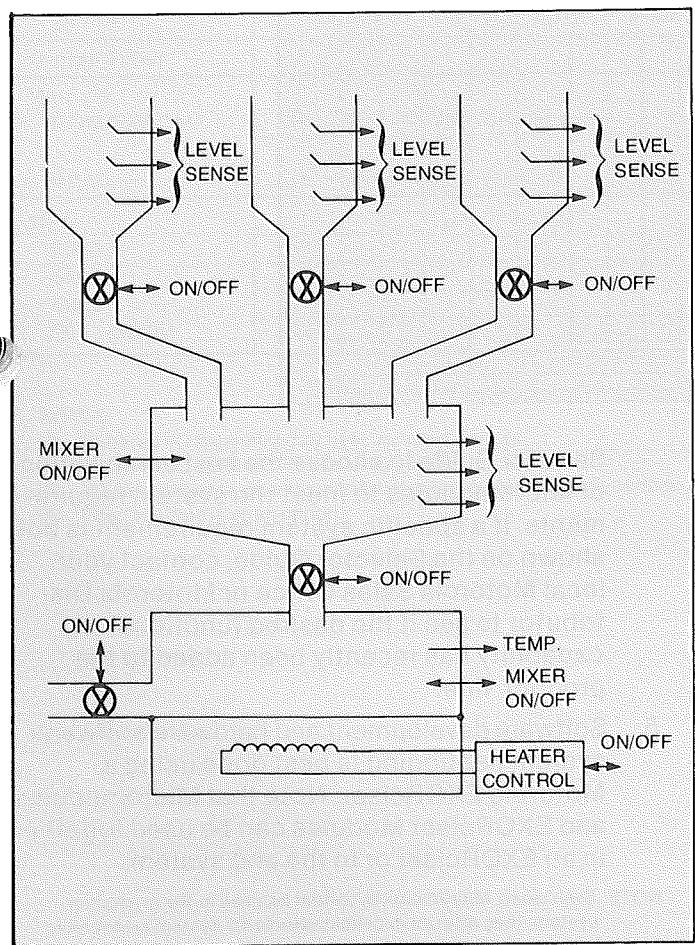
**NOTE:** Even when Micromodules cannot be used in the production system, they offer an excellent vehicle for system prototyping prior to developing your proprietary system boards.

# APPLICATION EXAMPLE ONE

## Application: Process Control

This example APPLICATION deals with the need to replace a manually operated process control system with an automated, distributed process controller in order to improve the quality and throughput of this portion of an overall process. The process to be monitored and controlled consists of:

- Three bins of raw material with three level sense switches per bin
- Five flow control valves with control inputs and monitor outputs.
- A mixing bin with three level sense switches and a mixer control input and monitor output
- Temperature controlled mixing furnace with temperature and mixer monitor and controls



### System Configuration

1. Level Sense - 12 Switch Closures
2. Valve Controls - 5 Valves @ 110 Vac, 2A
3. Valve Monitor - 5 Valves @ 110 Vac
4. Mixer Controls - 2 Mixers @ 28 Vdc, 1A
5. Mixer Monitor - 2 Mixers @ 28 Vdc
6. Heater Control - 1 Controller @ 110 Vac, 1A
7. Heater Monitor - 1 Controller @ 110 Vac
8. Temp. Monitor - 1 Type R Thermocouple
9. Control Panel
  - a. LED Display of Level Sense and Valve ON/OFF - 17 LEDs
  - b. Three Digit Display of Temperature
  - c. Auto/Manual Mode Select Switch
  - d. Manual ON/OFF Valve Control - 5 switches
  - e. Manual Control of Temperature - 3 Decimal Switches
  - f. Manual ON/OFF Mixer Control - 2 Switches
10. The Controller must be isolated from the system
11. This Distributed Process Controller must be able to communicate with a Master Controller via an RS-232C Serial Data Link.

# Solution: Micromodules

The SOLUTION to this Process Control APPLICATION consists of:

1. Listing the Process Controller Input/Output and functional requirements.
2. Entering these requirements on the System Planning Worksheet.
3. Selecting the appropriate Micromodules from the Configuration Chart.
4. Developing the operating software and debugging the hardware and software in an EXORciser.

## Controller Functional Requirements

1. Monitor Function - Inputs
  - a. Level Sense - 12 Switch Closures
  - b. Valves - 5 @ 110 Vac
  - c. Mixers - 2 @ 28 Vdc
  - d. Heater - 1 @ 110 Vac
  - e. Temp. - 1 Type R Thermocouple
2. Control Function - Outputs
  - a. Valves - 5 @ 110 Vac, 2A
  - b. Mixers - 2 @ 28 Vdc, 1A
  - c. Heater - 1 @ 110 Vac, 1A
3. Control Panel Functions
  - a. LED displays - 17 output TTL signals plus display drivers
  - b. Temp. display (3 digit) - 12 output TTL signals plus display drivers
  - c. Auto/Manual control logic
4. Communications Port - One ACIA with RS-232C interface
5. Rack Mount Chassis with front panel, power supply and fan

## System Planning Worksheet

### Procedure:

1. Analyze your system interface input/output signal requirements and enter on the worksheet.
2. Estimate the memory requirements and enter on the worksheet.
3. Determine if a specific microprocessor is required.
4. Correlate the Worksheet information with the Micromodule Selector Guide and select the appropriate Micromodules to meet the requirements.
5. Select the appropriate packaging hardware.
6. Determine if any additional special function is required.

### I. System

|   |        |          |
|---|--------|----------|
| A. Digital-Parallel                       | Number | 8 (MM23) |
| 1. TTL Level-Input                        | Number | 2 (MM23) |
| TTL Level-Output                          | Number | 2 (MM23) |
| TTL Level-Printer I/O                     | Number | 2 (MM23) |
| 2. Relay Output                           | Number | 2 (MM23) |
| Optically Isolated — DC Input             | Number | 2 (MM23) |
| Optically Isolated — AC Input             | Number | 2 (MM23) |
| 3. Optically Isolated — DC Output         | Number | 2 (MM23) |
| Optically Isolated — AC Output            | Number | 2 (MM23) |
| 4. Switch Closure Input                   | Number | 12       |
| 5. Programmable Timer                     | Number | 12       |
| B. Digital-Serial                         | Number | 1        |
| 1. Number of I/O Ports                    | Number | 1        |
| 2. Asynchronous or Synchronous            | Number | 1        |
| a. RS-232C                                | Number | 1        |
| b. RS-422                                 | Number | 1        |
| c. RS-423                                 | Number | 1        |
| d. 20 mA Current Loop                     | Number | 1        |
| 4. IEEE 488-1978 Bus                      | Number | 1        |
| a. Listener Talker                        | Number | 1        |
| b. Listener Talker Controller             | Number | 1        |
| C. Analog                                 | Number | 1        |
| 1. High Level Analog-to-Digital Converter | Number | 1        |
| a. Number of Channels                     | Number | 1        |
| b. Differential or Single-Ended           | Number | 1        |
| 2. Low-Level Analog-to-Digital Converter  | Number | 1        |
| a. Number of Channels                     | Number | 1        |
| 3. High-Level Digital-to-Analog Converter | Number | 1        |
| a. Number of Channels                     | Number | 1        |
| b. Voltage or Current Output              | Number | 1        |

### II. Estimated Memory Requirements

|              |        |        |
|--------------|--------|--------|
| A. EPROM/ROM | Number | 8K MAX |
| B. RAM       | Number | 1K MAX |

### III. Microprocessor Required

|                       |        |      |
|-----------------------|--------|------|
| A. 6800 - 6802 - 6809 | Number | 6800 |
|-----------------------|--------|------|

### IV. Micromodule Selection

|    |                                     |    |
|----|-------------------------------------|----|
| 1  | M68MM012(SERIAL % OF CONTROL PANEL) | 11 |
| 2  | M68MM023 (% TO MM 23)               | 12 |
| 3  | M68MM234                            | 13 |
| 4  | 42-M680AC5                          | 13 |
| 5  | 42-M680DC6                          | 14 |
| 6  | 42-M681AC5                          |    |
| 7  | 42-M681DC5                          |    |
| 8  | M68MM131(SWITCH CLOSURE)            |    |
| 9  | M68MM150(THERMOCOUPLE)              |    |
| 10 |                                     |    |

Total Number of Modules ..... 5 MOUNT MM23 ON REAR CHASSIS  
 V. Packaging Selection ..... M68MM012  
 VI. Additional Special Function Requirements ..... SPECIAL LOGIC ON A BOARD MOUNTED ON CONTROL PANEL FOR DISP DRIVERS, AUTO/MAN

## APPLICATION EXAMPLE TWO

# Application: Automatic System Testing

This example APPLICATION deals with the need to automate the final system testing of a unit that has analog, digital, RF and variable unit power input stimuli and has analog, digital and RF output responses. The purposes for automating the test are reduced test time, improved repeatability of test measurements and automatic generation of test data sheets. The Automated Test Equipment must provide the following functional requirements:

Operator interaction (display and control) with the tester to allow modifications to the test parameters or test sequence for troubleshooting or equipment adjustment purposes.

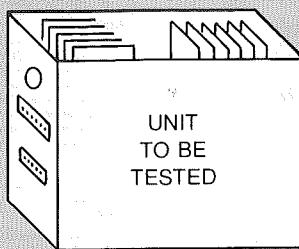
Provide an IEEE 488-1978 General Purpose Interface Bus controller function to program the commercial test equipment.

Provide a print-out of the test data sheets at the completion of each unit test.

Generate the required input stimuli and monitor the output responses from the unit under test.

### Input Stimuli

1. Digital Control = 26 TTL Level signals.
2. Analog Control = Four  $\pm 10$  V max. signals.
3. RF Signal = 100 MHz with programmable controlled frequency sweeping and RF Signal level.
4. Unit Power = Programmable to 20.4V, 24V, 27.6V.



### Output Response

1. Digital Out = 17 TTL Level Signals
2. Analog Out = 6 Differential,  $\pm 8$ V Signals
3. RF Out =  $20 \mu\text{W}$  to  $8 \text{ mW}$  at  $100 \pm 20$  MHz.

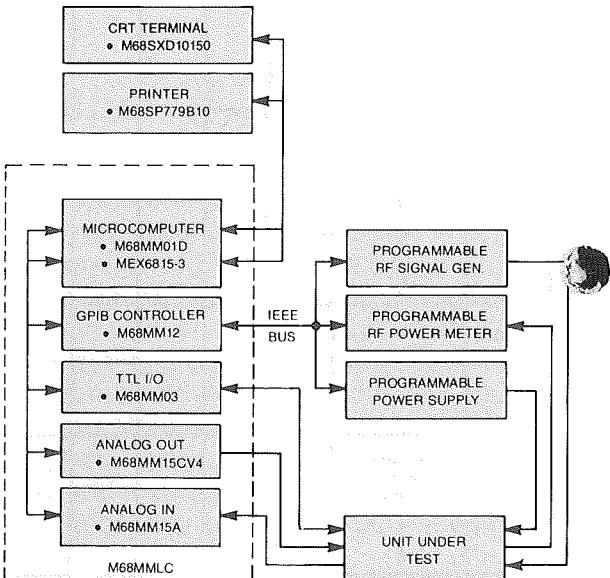
# Solution: Micromodules

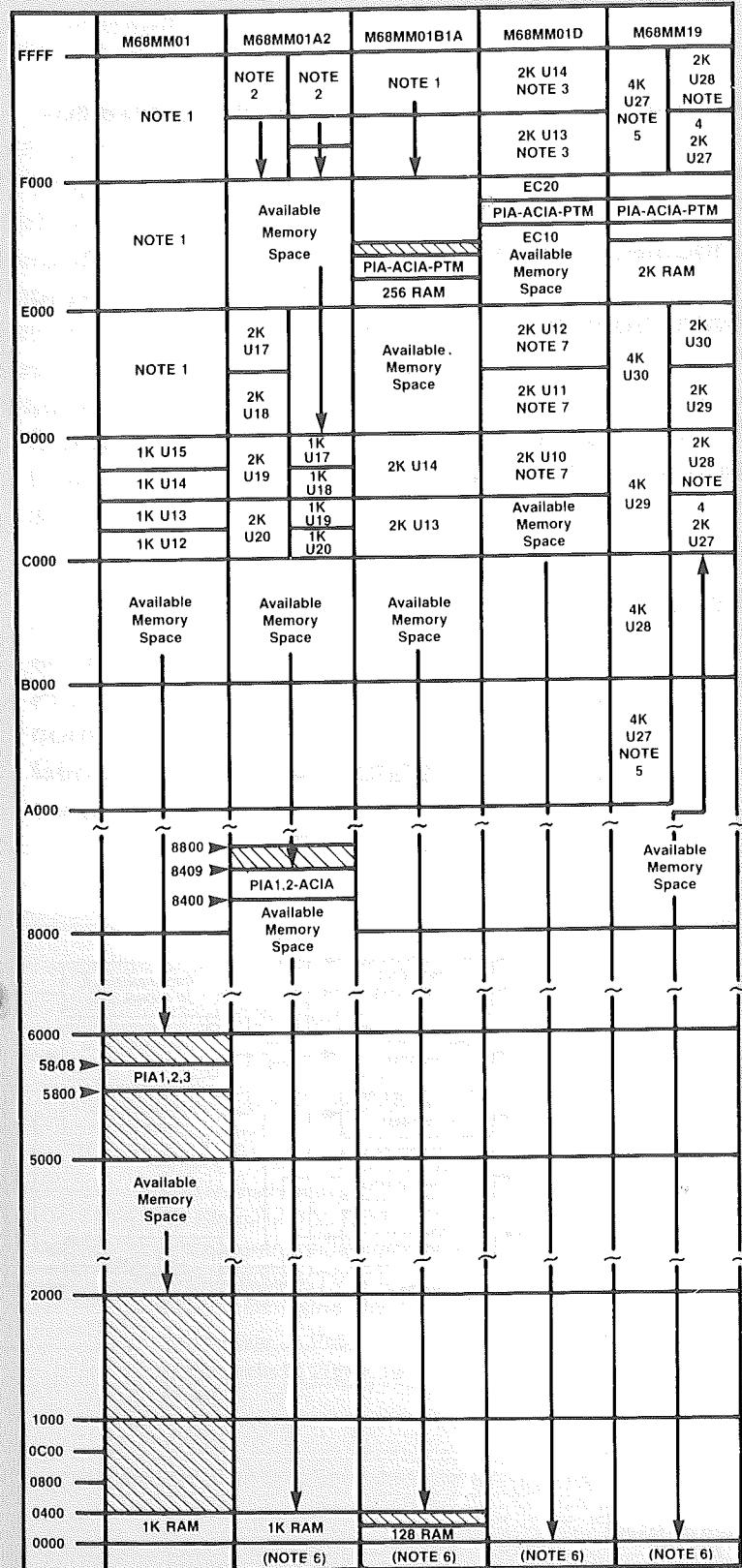
The SOLUTION to this Automated Testing APPLICATION consists of:

1. Entering the system Input/Output Signals on the System Planning Worksheet.
2. Selecting the appropriate Micromodules from the Configuration Chart.
3. Selecting a CRT Terminal and Printer from the EXORciser product line.
4. Selecting the IEEE 488-1978 compatible RF Signal Generator, RF Power Meter and Power Supply.
5. Developing the software and debugging the hardware and software in an EXORciser.

## System Planning Worksheet

|  |   |
|--|---|
| <b>Procedure:</b>  |   |
| 1 Analyze your system interface input output signal requirements and enter on the worksheet  |   |
| 2 Estimate the memory requirements and enter on the worksheet  |   |
| 3 Determine if a specific microprocessor is required   |   |
| 4 Correlate the Worksheet information with the Micromodule Selector Guide and select the appropriate Micromodules to meet the requirements |   |
| 5 Select the appropriate packaging hardware  |   |
| 6 Determine if any additional special function is required   |   |
| <br>   |   |
| <b>I. System</b>   |   |
| A. Digital-Parallel  |   |
| 1 TTL Level-Input  | Number <u>17</u>  |
| TTL Level-Output   | Number <u>X</u>   |
| TTL Level-Printer I/O  | Number <u>26</u>  |
| 2 Relay Output   | Number <u>  </u>  |
| 3 Optically Isolated — DC Input  | Number <u>  </u>  |
| Optically Isolated — AC Input  | Number <u>  </u>  |
| 4 Optically Isolated — DC Output   | Number <u>  </u>  |
| Optically Isolated — AC Output   | Number <u>  </u>  |
| 5 Switch Closure Input   | Number <u>  </u>  |
| 6 Programmable Timer   | Number <u>  </u>  |
| B. Digital-Serial  |   |
| 1 Number of I/O Ports  | Number <u>1</u>   |
| 2 Asynchronous or Synchronous  | Number <u>ASYNC</u>   |
| 3 Interface Type   | Number <u>X</u>   |
| a RS-232C  | Number <u>  </u>  |
| b RS-422   | Number <u>  </u>  |
| c RS-423   | Number <u>  </u>  |
| d 20 mA Current Loop   | Number <u>  </u>  |
| 4 IEEE 488-1978 Bus  | Number <u>  </u>  |
| a Listener Talker  | Number <u>  </u>  |
| b Listener Talker Controller   | Number <u>  </u>  |
| C. Analog  |   |
| 1 High Level Analog-to-Digital Converter   | Number <u>6</u>   |
| a Number of Channels   | Number <u>  </u>  |
| b Differential or Single-Ended   | Number <u>  </u>  |
| 2 Low-Level Analog-to-Digital Converter  | Number <u>  </u>  |
| a Number of Channels   | Number <u>  </u>  |
| 3 High-Level Digital-to-Analog Converter   | Number <u>4</u>   |
| a Number of Channels   | Number <u>  </u>  |
| b Voltage or Current Output  | Number <u>VOLTAGE</u>   |
| <br><b>II. Estimated Memory Requirements</b>   |   |
| A EPROM/ROM  | 8K MAX  |
| B RAM  | 4K MAX  |
| <br><b>III. Microprocessor Required</b>  |   |
| A 6800 - 6809  | 6800  |
| <br><b>IV. Micromodule Selection</b>   |   |
| 1 M68MM01D (MPU-ROM SERIAL-PRINTER)  | 11  |
| 2 MM03 (TTL I/O)   | 12  |
| 3 MM12 (GPIB CONTROLLER)   | 13  |
| 4 MM15A (A/D)  | 14  |
| 5 MM15CV4 (D/A)  |   |
| 6 MEX6815-3 (8K RAM)   |   |
| 7  |   |
| 8  |   |
| 9  |   |
| 10   |   |
| Total Number of Modules  |   |
| V. Packaging Selection   | M68MLC  |
| VI. Additional Special Function Requirements   | M68SXDI0150 (CRT TERM), M68SP779A10 (PRINTER) SELECTED TEST EQUIP |





| M68MM-   | As Shipped<br>Base Addr. | Size | Module (Base)        |
|----------|--------------------------|------|----------------------|
| 03       | 9FFC                     | 4    | 4 (9E00)<br>4 (8E00) |
| 04       | A000                     | 8K   | 8K (0000)            |
|          | C000                     | 8K   | 8K (2000)            |
| 04A      | 8000                     | 8K   | 8K 16K               |
|          | C000                     | 8K   |                      |
| 05A      | EF00                     | 16   | 16 (0000)            |
| 05B      | EF00                     | 32   | 32 (0000)            |
| 05C      | EF00                     | 8    | 8 (0000)             |
| 06       | 7800                     | 2K   | 2K (0000)            |
| 07       | EC20                     | 8    | 8 (8C00)             |
| 09       | 0000                     | 4K   | 4K (0000)            |
| 12       | B800                     | 2K   | 2K (0000)            |
| 12A      | —                        | 8    | 8 (0000)             |
| 13A      | 91FE                     | 2    | 2 (0000)             |
| 13B      | 91FC                     | 4    | 4 (0000)             |
| 13C,D    | 90FC                     | 4    | 4 (0000)             |
| 14       | EC30                     | 4    | 4 (0000)             |
| 15A,A1   | 9D00                     | 4    | 4 (0500)             |
| 15B      | 9D10                     | 4    | 4 (0500)             |
| 15C      | 9D08                     | 8    | 8 (0500)             |
| DISK     | E800                     | 1K+8 | —                    |
| PROM PR. | EC08                     | 8    | —                    |
| SYST. AN |                          | 528  | —                    |
| MACE     | EE10                     | 8    | —                    |

#### NOTES

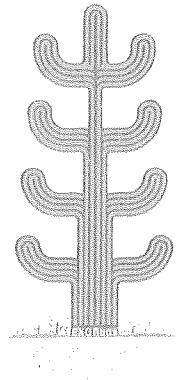
1. Ambiguous ROM Addresses
2. Ambiguous ROM Addresses if NOT used with DEBUG board
3. Removed from map when used with DEBUG board
4. U27 & U28 moved from F000 to C000 when used with DEBUG board
5. U27 moved from F000 to A000 when used with DEBUG board
6. Address Map may be modified by a reprogrammed device as follows:

|        |                     |
|--------|---------------------|
| MM1A2  | — 82S129 PROM       |
| MM1B1A | — 2ea 82S 129 PROMs |
| MM1D   | — 82S103 FPGA       |
| MM19   | — 82S100 FPLA       |

7. Sockets U10, 11 & 12 may be disabled to extend Available Memory Space

Not available

# Hardware/Software Development (M6800/09) Product



The development, testing and debugging of the operating software for a Micromodule System is best done in one of the Motorola EXORciser/EXORterm/EXORset Development Systems. These Development Systems allow the user to take advantage of various high-level languages (Resident MPL, COBOL, BASIC-M, FORTRAN and PASCAL) and the Resident Editor, Macro Assembler, and Linking Loader that will minimize the

time and effort required for software development. Additionally, since all the micromodules are EXORciser compatible, these Development Systems can also be used to troubleshoot and debug the hardware/software combination prior to committing to the final configuration. A PROM Programmer is available with these Development Systems to allow the user to program his EPROMs or PROMs for use on the Micromodules.

## **EXORciser II**

Contains an MPU II module, a Debug II module, and an appropriate RAM module. The MPU module mounts the MC6800 or MC6809 MPU, with clock frequencies of 1.0, 1.5, and 2.0 MHz. This system, through its expanded Debug II capability, can operate in a "dual memory map" mode. This permits the debug programs to reside in an independent memory, leaving the full 64K memory capacity of the M6800 system available for the user's program. The motherboard has provisions for up to 10 add-on plug-in assemblies so that a system of almost any complexity can be rapidly assembled.

## **System Options**

EXORDisk - dual floppy disk

EXORprint - dot-matrix printers

EXORterm 155 - display terminal

*(Continued)*

# Hardware/Software Development (M6800/09) (continued)

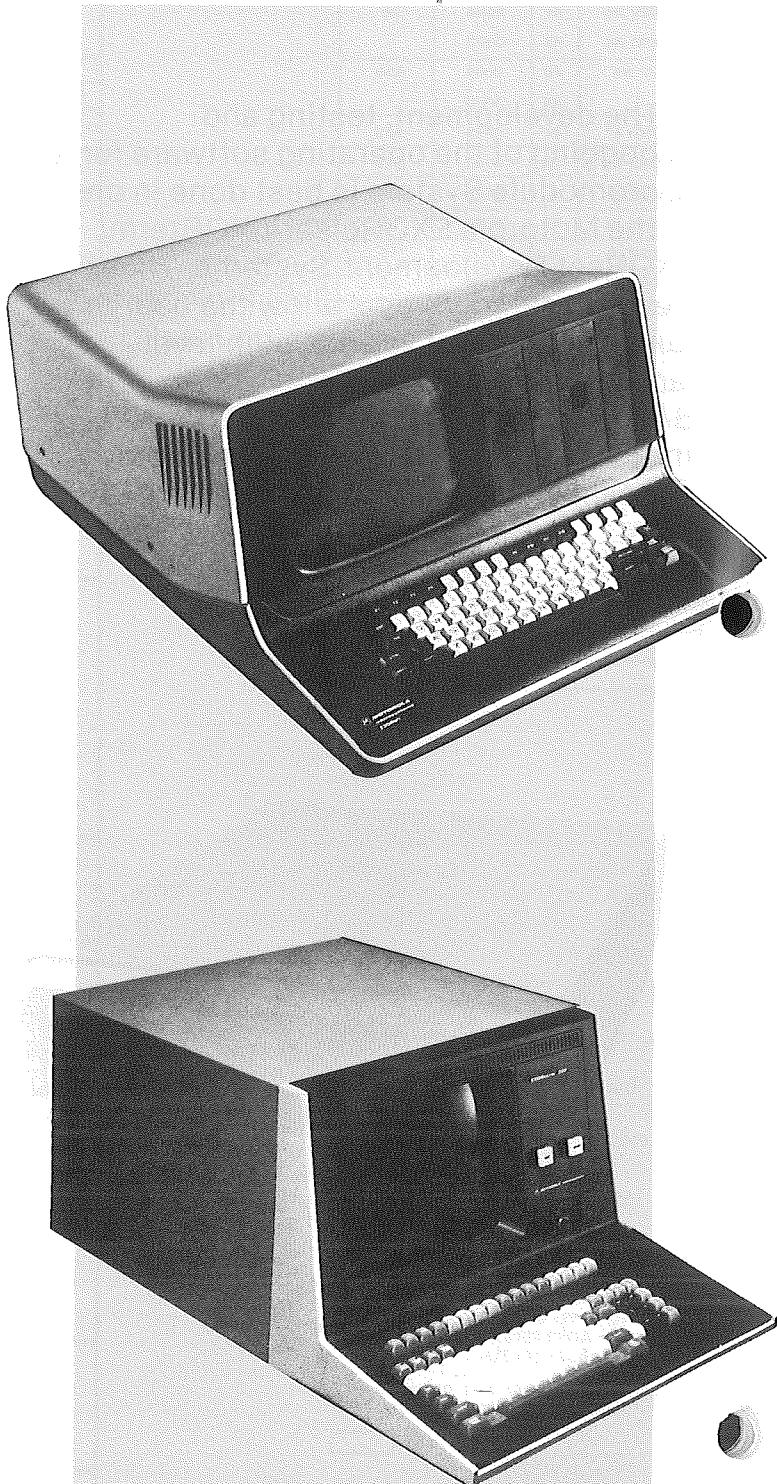
## EXORset 30

EXORset 30 is a development system with a complete man/machine interface consisting of a full-size ASCII keyboard and 16 user-assigned function keys and a high resolution 9" CRT display capable of displaying 22 lines of 80 or 16 lines of 40 characters and simultaneously a full 320 x 256 dot graphic image. A standard parallel printer interface allows the user to connect a printer of any selected performance. The memory consists of 48K bytes of RAM, expandable to 56K using standard memory boards, and 12 EPROM/ROM sockets accept up to 24K bytes of user firmware. The powerful EXORbug monitor controls the keyboard and displays operations and offers complete debugging facilities. Dual mini-floppy disk drives provide 160K bytes of mass storage and the XDOS operating system takes care of all operations and file management.

Three EXORciser/Micromodule compatible connectors are available for the disk controller and two additional modules such as RAM, Input/Output or any of the other compatible Motorola Modules. The memory map, EXORbug monitor, and XDOS operating system are compatible with the EXORciser, allowing program portability between different development systems. An RS-232 serial interface is provided for interconnection to an EXORciser-based system.

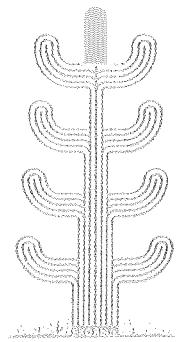
## EXORterm Development Stations

The EXORterm Development Stations add video display and keyboard entry facilities to the capabilities of the basic EXORciser II. They consist, fundamentally, of an integral card cage containing the EXORciser Debug Module and the MPU module. The cage has provisions for 6 more standard EXORciser modules, thereby providing considerable system design flexibility.



# VERSAmodule System

## BOARD-LEVEL PRODUCTS BASED ON THE 16-BIT M68000 MPU



- VERSAbus Compatible\*
- Asynchronous Bus Transfers
- Direct Addressing to 16 M Bytes
- Supports Multiple Processors
- Board-Level Fault Detection
- I/O thru Backplane Connectors
- EXORMacs Board Compatibility
- VERSAbus Adapter Module for Micromodule Compatibility

### M68000 Monoboard Microcomputer

- 68000 MPU
- Up to 64K Bytes RAM w/parity
- Up to 64K Bytes ROM/EPROM
- 2 RS-232/RS-422 Ports
- 4 8-bit Parallel Ports With Handshake (40 Lines)
- 3 Programmable Timers

### M68000 RAM/EPROM I/O Expansion

- Same RAM/EPROM I/O Capacity as Monoboard Microcomputer

#### Accessories

- Card Cages
- Power Supplies
- Chassis

#### Software

- Self-Test and Debug Firmware
- OEM Real Time Execution
- OEM Real Time Operating System

#### EXORMacs Development Support

### M68000 Future Board Products

- Mass Storage Bus Interface (Hard Disk, Floppy, etc.)
- Bubble Memory
- High Speed Multi-Protocol Communication
- Analog & Discrete I/O

\*VERSAbus is Motorola's 16/32-Bit Standard System Bus...  
The Standard of the Future!

# EXORmacs

## 16/32-BIT DEVELOPMENT SYSTEM

Supports M68000 Chip-Level  
and VERSAmodule Board-Level  
Development ...Plus Future 32-Bit MPU

### *Advanced Systems Architecture*

- M68000 Based MPU
- VERSAbus Compatible\*
- User/Supervisory Memory Protection
- Dual Memory Map
- Multiple Processor
- Distributed Resources
- Advanced Self-Diagnostics

### *Modular Operating System*

- Multi-Tasking
- Real Time
- Multi-User
- Logical I/O
- Disk Based File Management

### *Support Tools*

- User System Emulator
- Universal I/O Modules
- Bus State Analyzer
- Hardware Development Stations
- Field Service
- Training
- Future Growth

### *Development Software*

- Pascal
- Fortran
- CRT Editor
- 68000 Structured Macro Assembler
- Linkage Editor
- Symbolic Debug

\*VERSAbus is Motorola's 16/32-Bit Standard System Bus... The Standard of the Future!



132-Column, 180-CPS Line Printer

EXORDisk III, 1-Megabyte, Dual-Drive,  
Dual-Sided, Floppy Disk

EXORMacs  
16/32-Bit Development System

EXOTerm 155  
M6800-Based Intelligent Terminal  
24-lines x 80 columns, 9600 baud, programmable  
function keys, local page edit features

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