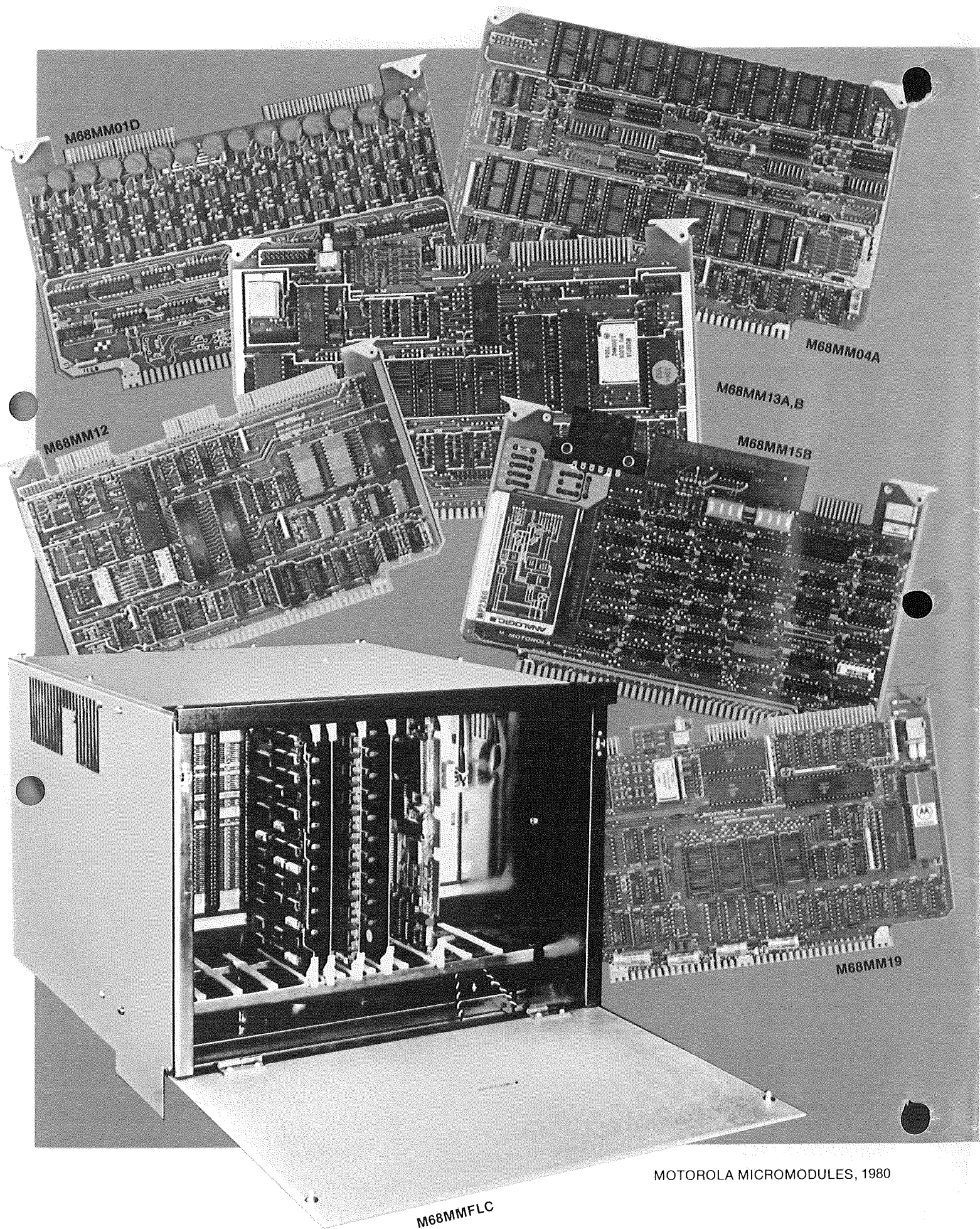


MOTOROLA MICROMODULES

Innovative systems
through silicon.



MOTOROLA

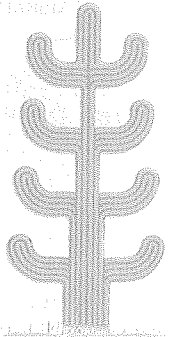


MOTOROLA MICROMODULES, 1980

● 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, $\pm$ 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

Monoboard Microcomputers (MPU-ROM-RAM-I/O)

M68MM01 M68MM01B1A
M68MM01A2 M68MM01D
M68MM01B M68MM19, 19A

Processor Subassemblies Central Processing Unit (MPU-Timing/Control)

M68MM02

Processor Subassemblies Arithmetic Processing Unit (APU-Timing/Control)

M68MM14, 14A

INPUT/OUTPUT MODULES

Digital (Parallel-Serial)

M68MM03 M68MM13C, D
M68MM07 M68MM23
M68MM11 MEX6820, 6821-2
M68MM12, A MEX6850, 6850-2
M68MM13A, B M68DIM2A

INPUT/OUTPUT MODULES

Analog (A/D-D/A)

M68MM05A, B, C
M68MM15A, A1
M68MM15B, BEX
M68MM15CV, CI

MEMORY MODULES

(ROM-RAM)

M68MM04, 04A MEX6815-3
M68MM06 MEX6816-1HR
M68MM09 MEX6832, 48,
MEX68RR 64-1HR

FIRMWARE/SOFTWARE

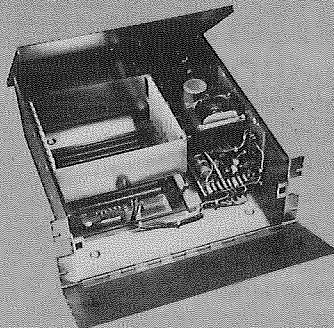
(ROM-Paper Tape/Cassette/Diskette)

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

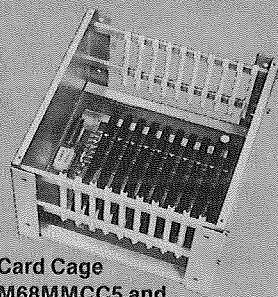
AUXILIARY SUPPORT MODULES

MEX68WW
MEX68USM
MEX68XT
M68MM10, 10RTC

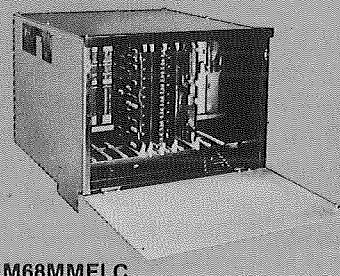
PACKAGING/HARDWARE



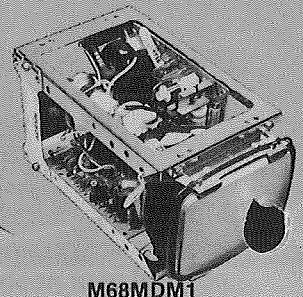
Chassis/Power Supply
M68MMLC and M68MMS C
M68MMPS1-1



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

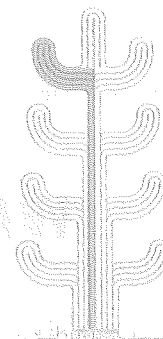
- Medical Diagnosis
- Medical Analysis
- Smart Peripherals
- Ski Lift Controls
- Warehouse Controllers
- Environmental Control
- Energy Management
- Etc., Etc., Etc.

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 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 1 PTM				4K	128	6802	1	Not Expandable
M68MM01B1A	1 PIA/20 Lines 1 PTM	1 ACIA		Use MM11*	4K	384	6802	1	Cassette I/O
M68MM01D	Printer Port 1 PTM	1 ACIA	(OPT.) †	Use MM11*	10K		6800	1, 1.5	Use 2K RAMS in ROM Sockets
M68MM19/19A	1 PIA/20 Lines 1 PTM	1 ACIA or SSDA	(OPT.) †	Use MM11*	8K-16K	2K	6809	1(MM19) 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 DEbug 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, 75 Ω (Compatible with M68MDM1 CRT)				

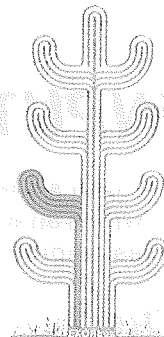
*ACIA or SSDA and Interface are User Options. **SSDA and Interface must be installed by the user.

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 16 Channel Single Ended			
M68MM15A1 High-Level, 12-Bit	16 Channel Differential 32 Channel Single Ended			
M68MM15B Low-Level, 16-Bit		1 Channel Isolated 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.

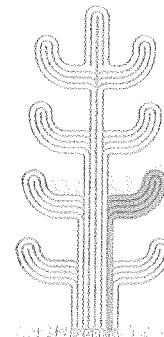


Part Number/Name	EPROM/ROM	RAM		
		Static	Dynamic Refresh	Hidden Refresh
M68MM04 16K EPROM/ROM Module	1 to 16K			
M68MM04A ROM/EPROM Module	1 to 64K	(2 to 32K)*		
M68MM06 2K Static RAM Module		2K		
M68MM09 4K Static CMOS RAM Module		4K**		
MEX6815-3 8K Dynamic RAM Module			8K	
MEX6816-1HR 16K Dynamic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

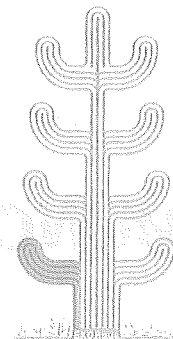
The Micromodule product line includes an offering of Monitor/Debug ROMs, a high-level language BASIC Interpreter, a Real-Time FORTRAN Compiler and a Real-Time Executive to assist you in operating software development and debugging.



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) L x W x H
Card Cages Only		
M68MMCC05	5-slot Open-Frame Cage	11.3 x 7.04 x 6.9
M68MMCC10	10-slot Open-Frame Cage	11.3 x 11.04 x 6.9
Chassis With Power Supply		
M68MMSC	5-slot Rack Mount Chassis	10.34 x 19 x 6.97
M68MMLC	10-slot Rack Mount Chassis	18.74 x 19 x 6.97
M68MMFLC	14-slot Rack Mount Chassis	19.50 x 19 x 13.75
Power Supply Only		
M68MMPS1	Power Supply + 5V, $\pm 12V$	9.5 x 6.25 x 5.0

Auxiliary Support Modules

Part Number/Name		Dimension
MEX68WW	Wirewrap Board	9.75 x 6.00
MEX68USM	Universal Support Module	9.75 x 6.00
MEX68XT	Extender Module	9.75 x 9.00
M68MM10	Power Fail Detect	9.75 x 6.00
M68MM10RTC	Power Fail Detect with Battery Backed-up Clock	9.75 x 6.00

CRT Monitor

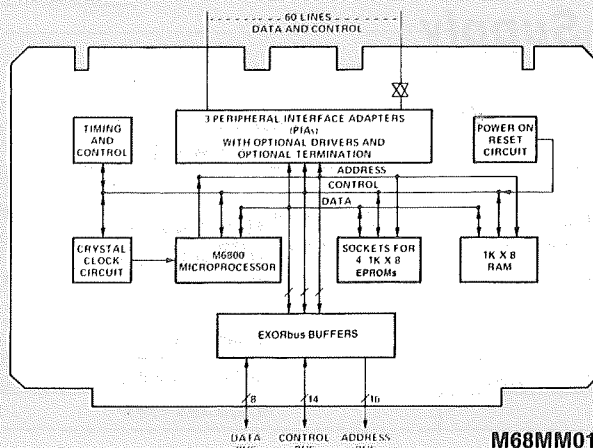
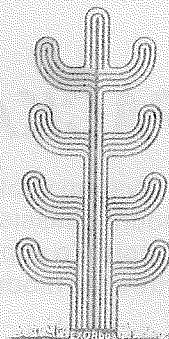
M68MDM1	5" CRT Display Monitor
---------	------------------------

Mounting/Hardware

Part Number/Name		Functional Description
M68MMLK	Slide Kit, Long Chassis	Rack Mounting slide kit for M68MMLC
M68MMSK	Slide Kit, Short Chassis	Rack Mounting slide kit for M68MMSC
M68MMFLK	Slide Kit, Front-Load Chassis	Rack Mounting slide kit for M68MMFLC
M68MM23IKIT	Installation Kit, Micromodule 23	Installation kit for mounting two Optically Isolated I/O Modules in an M68MMFLC

Micromodule Functional Features

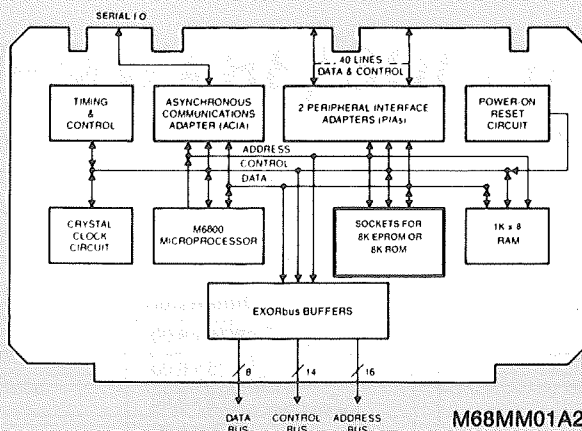
MONOBOARD MICROCOMPUTERS



M68MM01

Microcomputer With Parallel I/O Basic MPU - MC6800

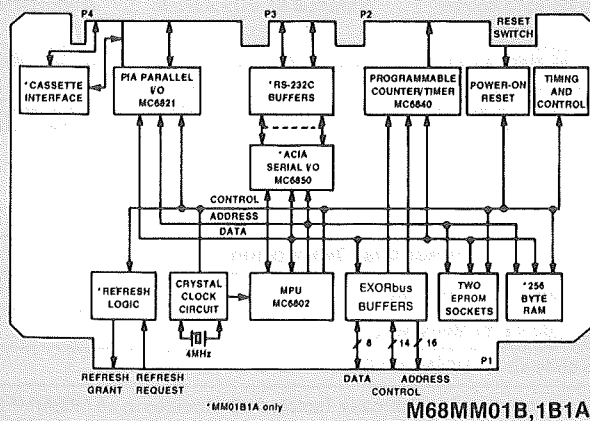
- 1 MHz Crystal-Controlled Clock
- 1K byte Static RAM
- Sockets for four 1K EPROMs or ROMs
- Three MC6821 PIAs (60 peripheral I/O lines)
- 36K bytes available for external memory
- Dynamic Memory Refresh Circuitry
- Buffered Address, Control, and Data Bus
- Optional I/O Terminations and Connector Kits



M68MM01A2

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

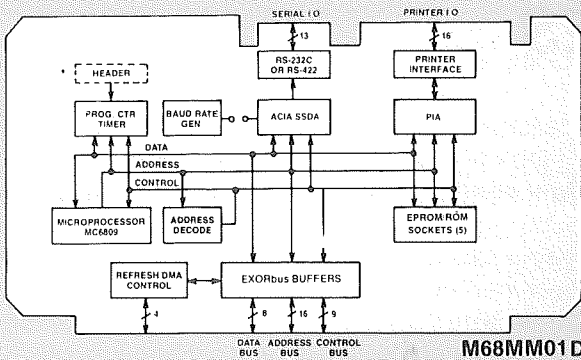
- 1 MHz Crystal-Controlled Clock
- 1K byte Static RAM
- Sockets for four 1K or 2K EPROMs or masked ROMs
- Two MC6821 PIAs
- One MC6850 ACIA with RS-232C Interface
- Dynamic Memory Refresh Circuitry
- 59K or 55K bytes of Unused Addresses Available (dependent on ROM Selection)
- Buffered Address, Control,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



M68MM01B,1B1A

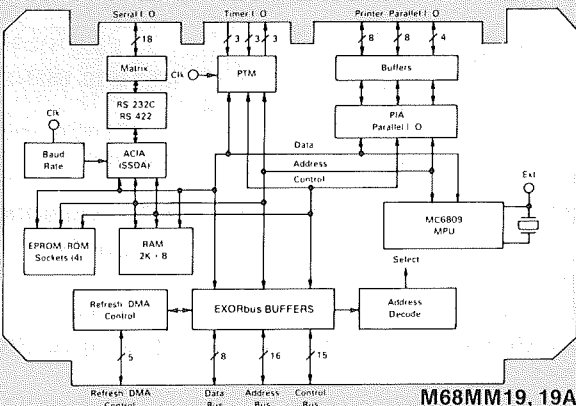
Microcomputer With Parallel and Serial I/O and Timer Basic MPU - MC6802 with 128 bytes on-chip Static RAM

- 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)



Microcomputer With Printer, Serial and Timer I/O
Basic MPU - MC6800

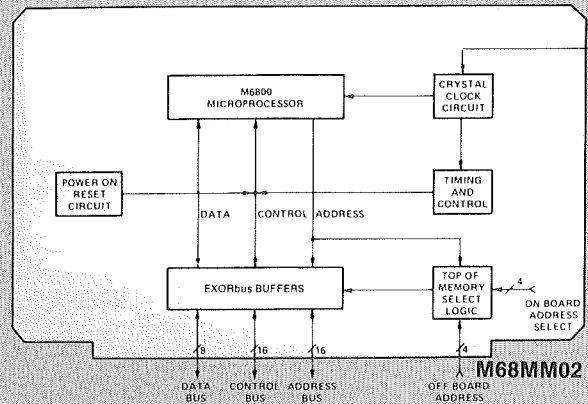
- 1 MHz Crystal-Controlled Clock
- Five sockets for 2K EPROMs, ROMs or pin compatible RAMs
- One MC 6850 ACIA (can be replaced with an SSDA) with optional RS-232C or RS-422 interface
- One MC6821 PIA with buffers configured for parallel printer interface
- One MC6840 PTM triple 16-bit counter/timer
- 50K or 56K bytes of continuous external memory space available
- Buffered Address, Control, and Data Bus



Microcomputer With Parallel, Serial and Timer I/O
Basic MPU - MC6809

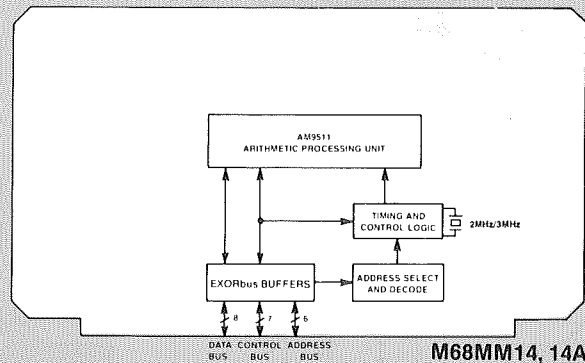
- 4 MHz Crystal - 1 MHz operation (MM19)
- 8 MHz Crystal - 2 MHz operation (MM19A)
- Four sockets for 2K or 4K EPROMs, ROMs or pin compatible RAMs
- 2K bytes of static RAM, accessible from ext. DMA
- One MC6821 PIA with strap selectable Input/Output buffering
- One MC6850 ACIA (replaceable with an SSDA) 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

PROCESSOR SUBASSEMBLIES



Central Processing Unit (MPU-Timing/Control)
Basic MPU - MC6800

- 1 MHz Crystal-Controlled Clock
- Timing and control for three-state and halt operations and dynamic memory refresh
- Buffered Address, Control, and Data Bus

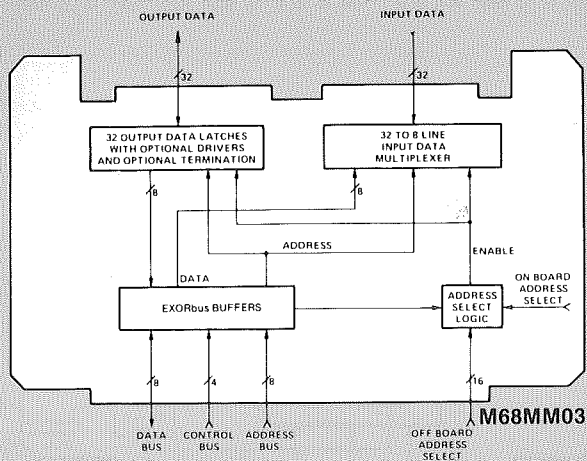


Arithmetic Processing Unit (APU-Timing/Control)
Basic APU - AM9511

- 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 μ s (2 MHz) for M68MM14 or 49 μ s (3 MHz) for M68MM14A
- Buffered Address, Control, and Data Bus

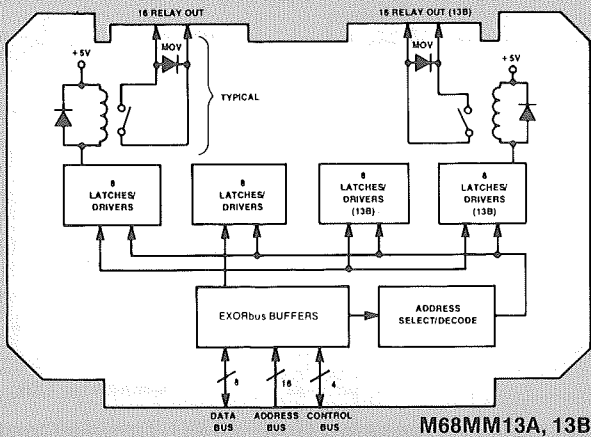
INPUT/OUTPUT MODULES

Digital (Parallel)



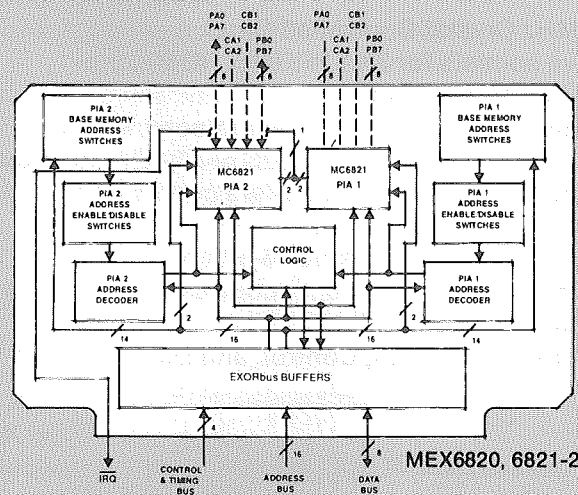
Dedicated 32/32-Bit I/O

- 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

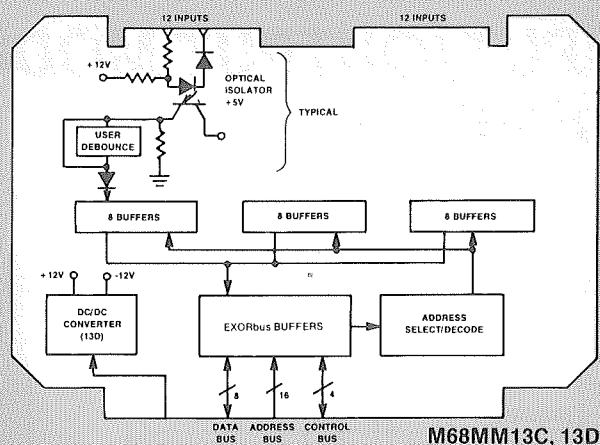


Universal PIA-Controlled I/O

- 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

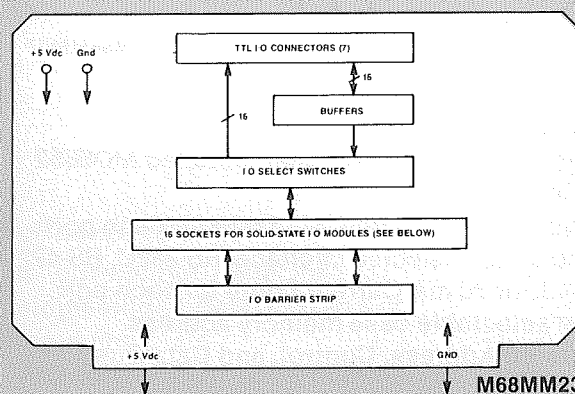
- Completely isolated digital input microperipheral (optically isolated) on a board
- High isolation for system-to-microcomputer (600 Vdc) and channel-to-channel (300 Vdc)
- 24 channels of optically isolated voltage inputs (Micromodule 13C)
- 24 channels of optically isolated contact closure inputs (Micromodule 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



M68MM13C, 13D

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

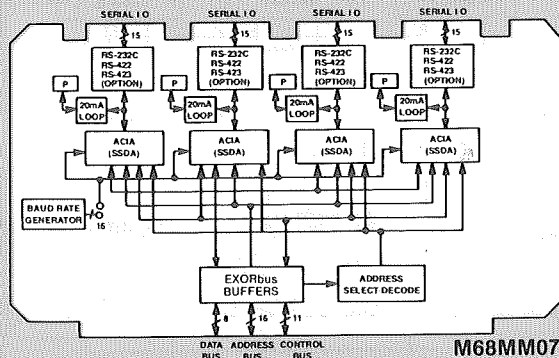


M68MM23

Specifications	IAC5, 5-A	IDC5	OAC5, 5-A	ODC5
Input Line Voltage, 50-60 Hz	90-140 Vac (IAC5) 180-280 Vac (IAC5-A)			
Input Voltage for On-State Off-State		+3.0 to +32 Vdc -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) 2.5 ms Max (off)
Isolation Voltage, Input to Output (Pins 1, 2 shorted; Pins 3, 4, 5 shorted)	3750 Vac Min.	3750 Vac Min.	3750 Vac Min.	3750 Vac Min
Output Current Rating (1.0 > P.F. > 0.5, T _A ≤ 45°C)			0.10-3.0 A (RMS)	3.0 Adc Max.
Load Voltage Rating			12-140 V(RMS) (OAC5) 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)

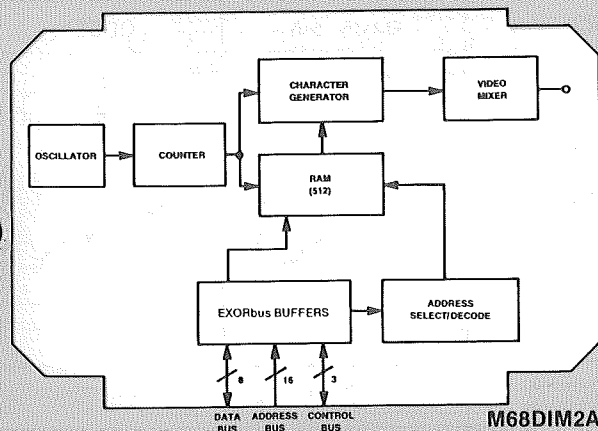
Digital (Serial)



M68MM07

Quad Serial I/O Module

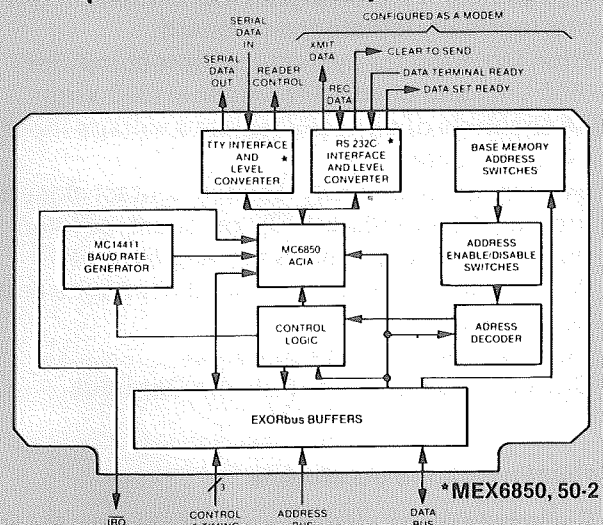
- Four MC6850 (ACIA) or user installed MC6852 (SSDA)
- Strap-option selected baud rate for each port.
- Strap-option selected interface (RS-232C, RS-422, RS-423 or 20 mA Current Loop) for each port.
- User selectable base memory address.
- Buffered Address, Control, and Data Bus



M68DIM2A

Display Interface Module

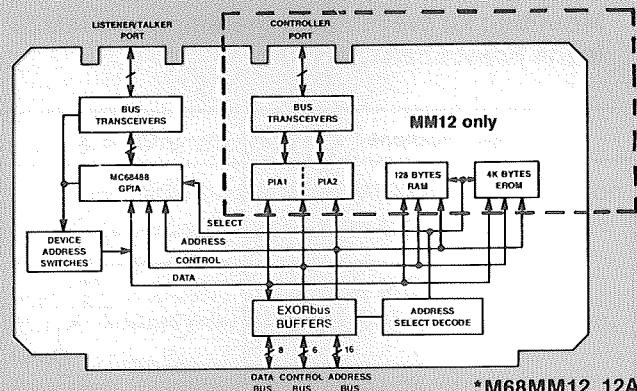
- 16 lines of 32 characters, one page memory
- Jumper selectable memory base address
- Composite 525 lines positive or negative video signal generator
- 128 character set
- Black-on-white or white-on-black display capability
- Interfaces with M68MDM1, the 5" CRT Display Monitor
- Buffered Address, Control,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



*MEX6850, 50-2

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



*M68MM12, 12A

GPIB Listener/Talker/Controller Module

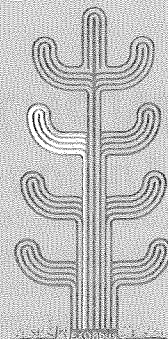
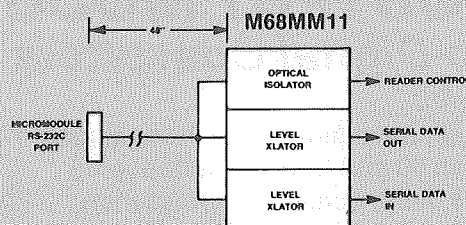
- Provides IEEE 488-1978 Listener, Talker and Controller functions (M68MM12).
- Meets IEEE 488-1978 specifications for signal levels and timing.
- Listener/Talker function provided by buffered GPIA chip.
- Controller function provided by buffered PIAs with EPROM and RAM.
- Base Address = C000-C7FF
-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

GPIB Listener/Talker Module

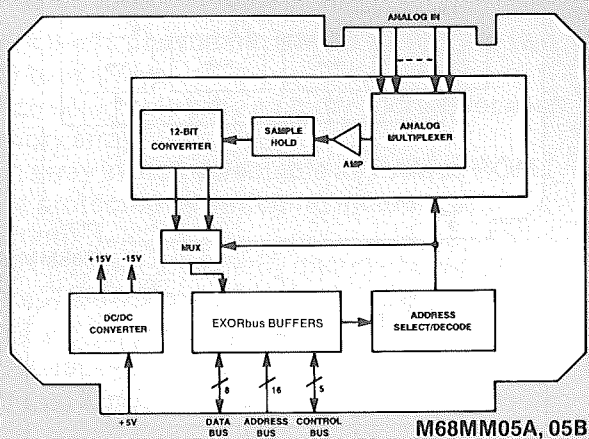
- Provides IEEE 488-1978 Listener and Talker Functions with buffered GPIA Chip (M68MM12A).
- Selectable Base Address.
- Buffered Address, Control, and Data Bus

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.

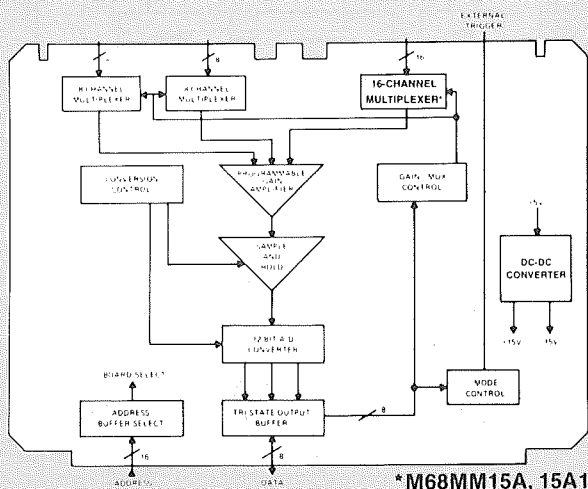


Analog-To-Digital Converters



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 μ s(max.), MPU is halted
- Full scale inputs of 0 to 5V, 0 to 10V, ± 2.5 V, ± 5 V, ± 10 V (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 μ s (max.)
- Full scale inputs of 0 to +5 Vdc, 0 to +10 Vdc, ± 5 Vdc, ± 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 ± 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 ± 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 ± 500 Vdc or 1000 V p-p
- On board cold-junction compensation

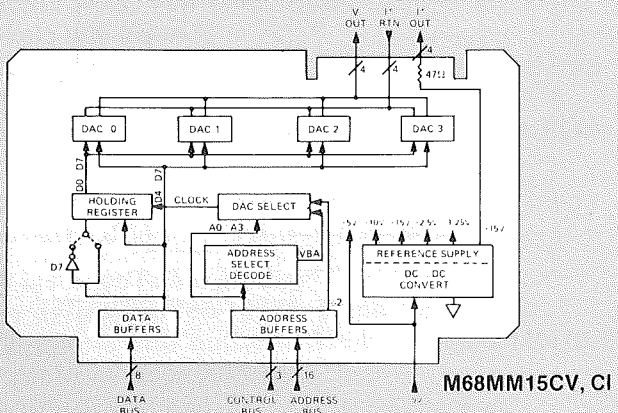
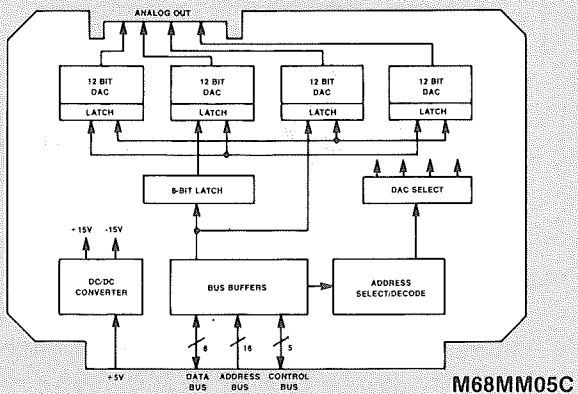
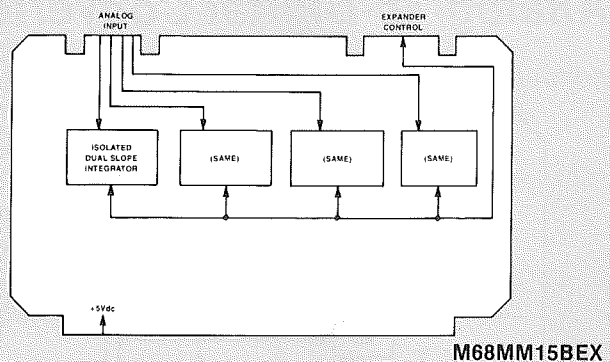
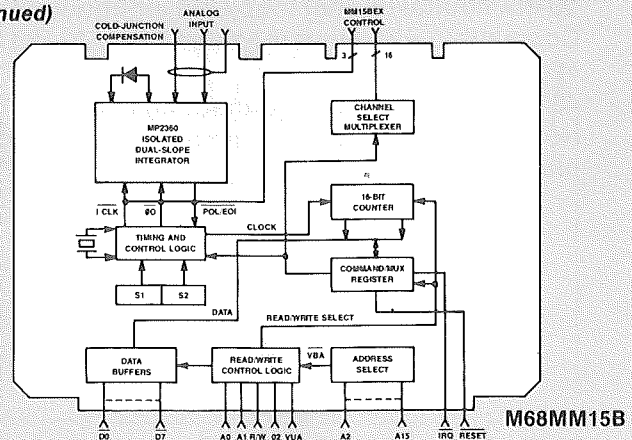
Digital-To-Analog Converters

4-Channel Voltage Output DAC

- Four 12-bit Digital-to-Analog (DAC) voltage outputs
- Full-scale output voltages: 0 to 10V, 0 to 5V, ± 2.5 V, ± 5 V, ± 10 V (Jumper selectable)
- Jumper selectable module base memory address
- Single +5Vdc operation, on board of dc-to-dc converter provides ± 15 Vdc
- Buffered Address, Control, and Data Bus

1-4 Channel Current/Voltage Output DAC

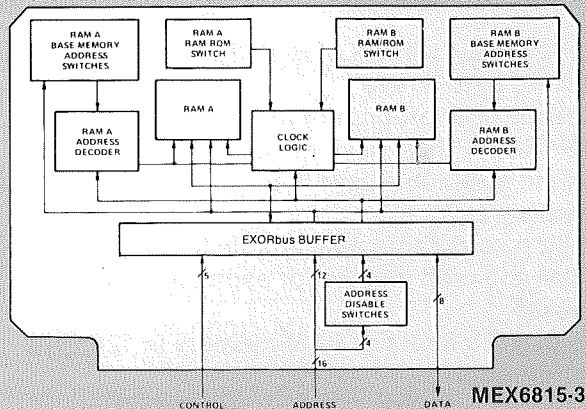
- One to four 12-bit Digital-to-Analog-Converter (DAC) channels per module
- Full-scale output voltages: 0 to +10Vdc, ± 10 Vdc, 0 to +5 Vdc and ± 5 Vdc each channel, M68MM15CV series (strap option)
- 4 to 20 mAdc output, M68MM15CI series
- Natural binary or two's complement input code (strap option)
- Strap selectable module base memory address, 0500 to FD3F hexadecimal
- Single +5 Vdc operation, on board dc-to-dc converter provides ± 15 Vdc.
- Buffered Address, Control, and Data Bus



MEMORY MODULES

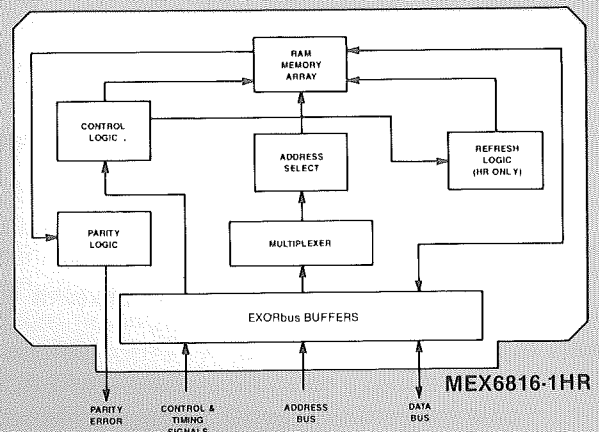
Prewired Memory Boards — Populated

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

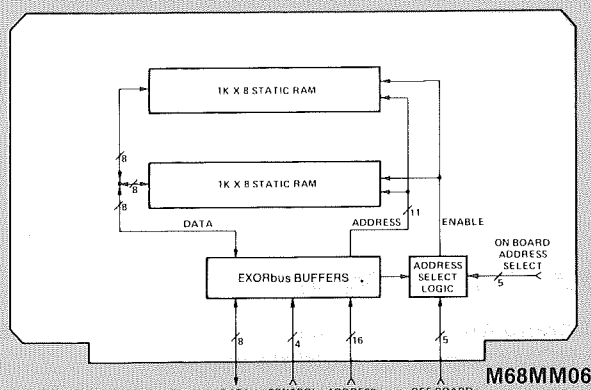


16K Dynamic RAM With Parity

- 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

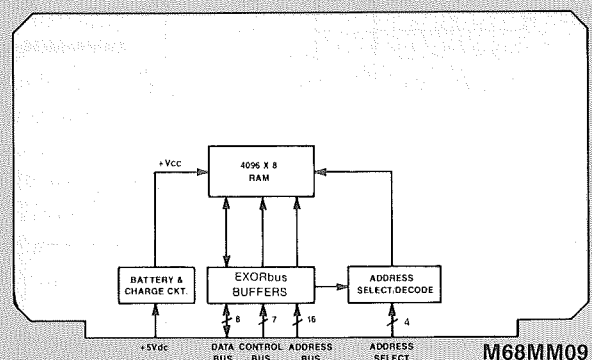
Note: 32K, 48K, 56K dynamic RAM modules and 2MHz versions are also available.

Static RAMs



2K Static RAM

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



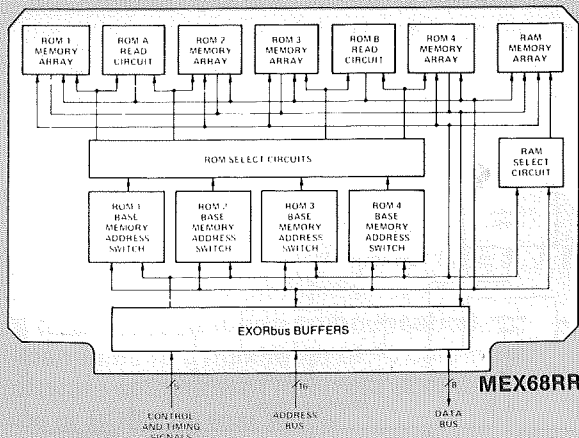
4K CMOS RAM With Battery Backup

- 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)

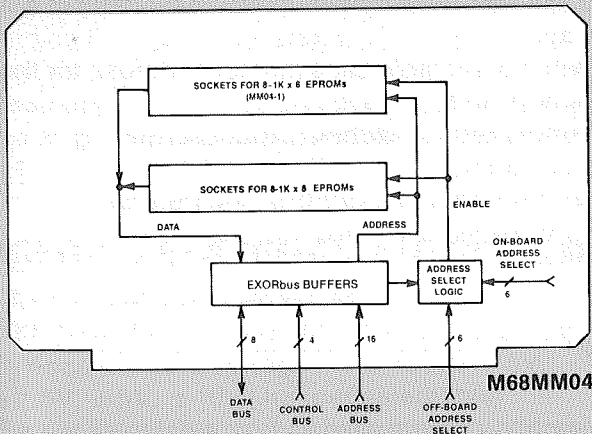
MEMORY MODULES (CONTINUED)

Prewired Memory Boards — Unpopulated



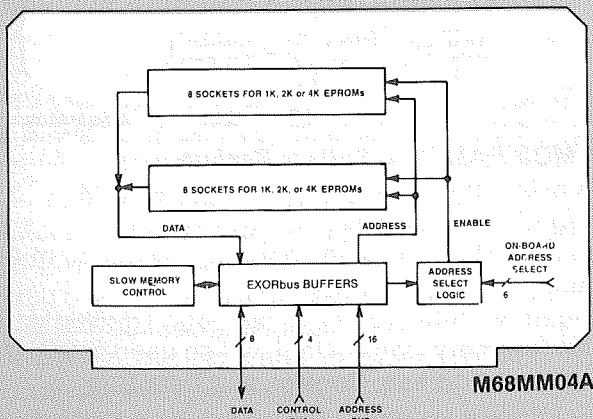
ROM/RAM Combination

- 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

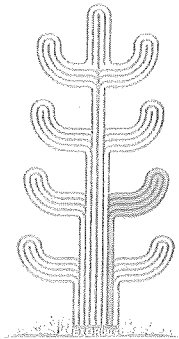
MICRObug Monitor DEbug

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 transcendental functions 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 dis-associated, 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

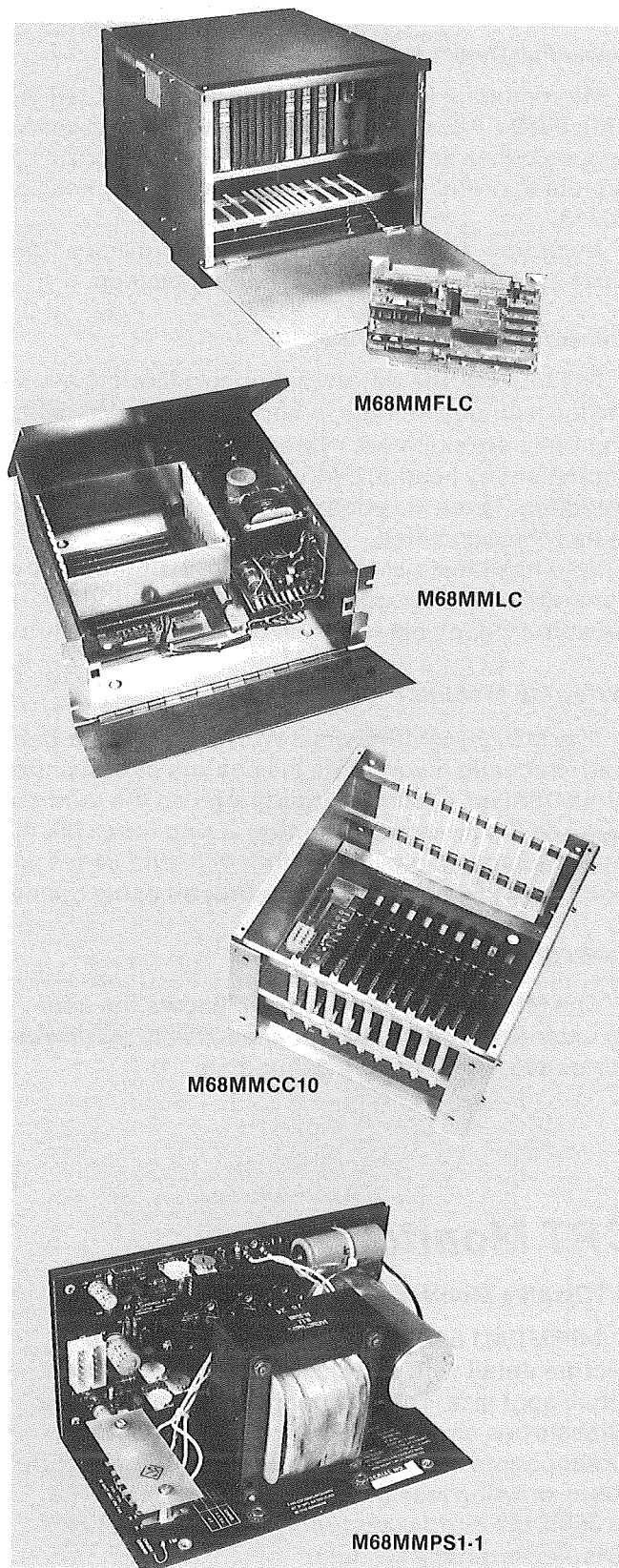
M68MMSK - Used with the short chassis,

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.



M68MMFLC

M68MMLC

M68MMCC10

M68MMPS1-1

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.

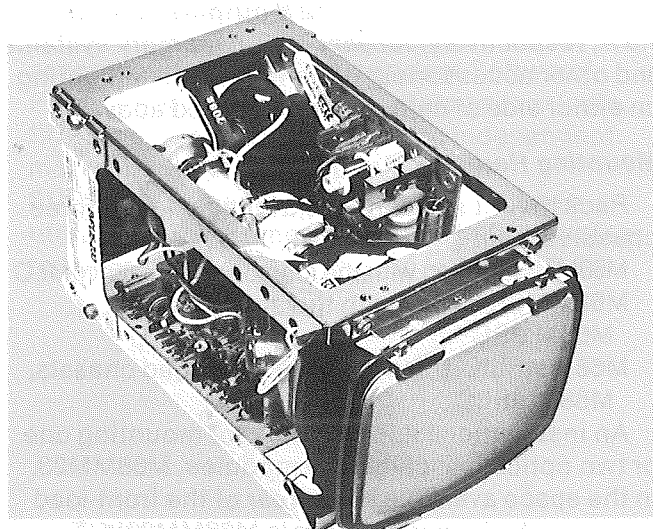
Extender Board

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).



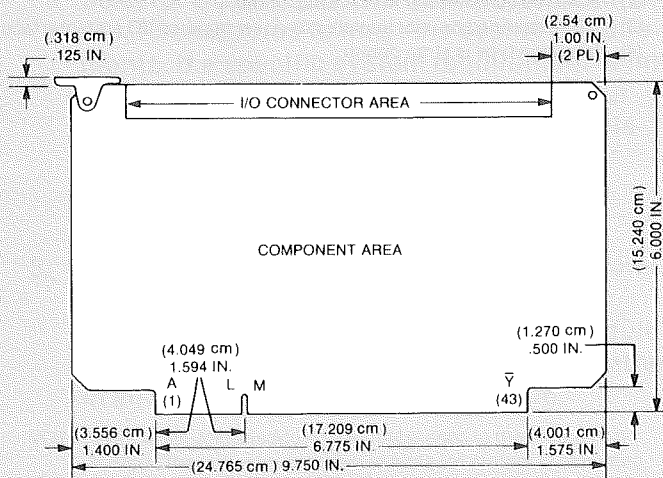
Micromodule Power and I/O Connector Requirements

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 APU	Input/output Extension						Memory Extension									
		MM01	MM01A2	MM01B	MM01B1A	MM01D	MM19, 19A	MM02	MM14	MM03	MM13A, B	MM13C, D	MM23	6820, 21-2	MM07	6850	6850-2	MM04	MM04A	68RR	MM06	MM09	6815-3	6816-1HR
Parallel I/O Lines PIA 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															
TTL Buffered Out		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								
RS-232		✓		✓	(4)	(4)								(4)	(4)									
RS-422					(4)	(4)								(4)										
RS-423						(4)								(4)										
20 mA			(8)		(8)	(8)	(8)							(4)	(4)									
Tripple Timer			1		1	1	1																	
Memory ROM/EPROM		4K	8K	4K	4K	10K	16K										16K	64K	16K					
RAM		1K	1K	128	384	(5)	2K(5)										(5)	512	2K	4K	8K	16K		
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

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

1. TTL Level-Input Number _____
- TTL Level-Output Number _____
- TTL Level-Printer I/O ☐
2. Relay Output Number _____
3. Optically Isolated — DC Input Number _____, Level _____ Vdc
- Optically Isolated — AC Input Number _____, Level _____ Vac
4. Optically Isolated — DC Output Number _____, Level _____ Vdc Amps.
- Optically Isolated — AC Output Number _____, Level _____ Vac Amps.
5. Switch Closure Input Number _____
6. Programmable Timer Number _____

B. Digital-Serial

1. Number of I/O Ports Number _____
2. Asynchronous or Synchronous _____
3. Interface Type
 - a. RS-232C ☐
 - b. RS-422 ☐
 - c. RS-423 ☐
 - d. 20 mA Current Loop ☐
4. IEEE 488-1978 Bus
 - a. Listener/Talker ☐
 - b. Listener/Talker/Controller ☐

C. Analog

1. High Level Analog-to-Digital Converter
 - a. Number of Channels Number _____
 - b. Differential or Single-Ended _____
2. Low-Level Analog-to-Digital Converter
 - a. Number of Channels Number _____
3. High-Level Digital-to-Analog Converter
 - a. Number of Channels Number _____
 - b. Voltage or Current Output _____

II. Estimated Memory Requirements

- A. EPROM/ROM _____
- B. RAM _____

III. Microprocessor Required

- A. 6800 - 6802 - 6809 _____

IV. Micromodule Selection

- | | | | |
|----|-------|----|-------|
| 1 | _____ | 11 | _____ |
| 2 | _____ | 12 | _____ |
| 3 | _____ | 13 | _____ |
| 4 | _____ | 14 | _____ |
| 5 | _____ | | |
| 6 | _____ | | |
| 7 | _____ | | |
| 8 | _____ | | |
| 9 | _____ | | |
| 10 | _____ | | |

Total Number of Modules _____

V. Packaging Selection

- A. _____

VI. Additional Special Function Requirements

- A. _____

1. 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.
2. 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.)
3. Determine which microprocessor, i.e., 6800, 6802 or 6809, is best suited to the application.
4. 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.

5. 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.

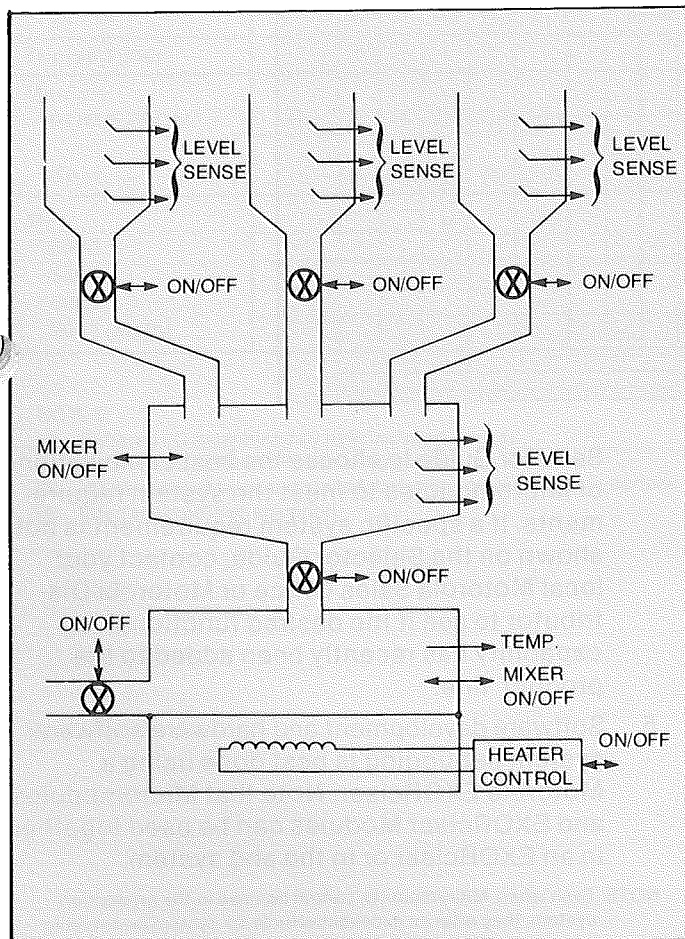
NOTE: Even when Micromodules cannot be used in the production system, they offer an excellent vehicle for system prototyping prior to developing your proprietary system boards.

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

- | | | | |
|----------------------------------|--------|---------------------------|---------------|
| 1. TTL Level-Input | Number | 8 (MM23) | |
| TTL Level-Output | Number | 29 (CONTROL PANEL & MM23) | |
| TTL Level-Printer I/O | Number | | |
| 2. Relay Output | Number | | |
| 3. Optically Isolated — DC Input | Number | 2 | Level 28 Vdc |
| Optically Isolated — AC Input | Number | 6 | Level 110 Vac |
| Optically Isolated — DC Output | Number | 2 | Level 28 Vdc |
| Optically Isolated — AC Output | Number | 6 | Level 110 Vac |
| 5. Switch Closure Input | Number | 12 | 1/2 Amps |
| 6. Programmable Timer | Number | | |

B. Digital-Serial

- | | | |
|--------------------------------|-------------------------------------|------|
| 1. Number of I/O Ports | Number | 1 |
| 2. Asynchronous or Synchronous | | ASYN |
| 3. Interface Type | | |
| a. RS-232C | ☒ | |
| b. RS-422 | ☐ | |
| c. RS-423 | ☐ | |
| d. 20 mA Current Loop | ☐ | |
| 4. IEEE 488-1978 Bus | | |
| a. Listener Talker | ☐ | |
| b. Listener Talker Controller | ☐ | |

C. Analog

- | | | |
|---|--------|---|
| 1. High Level Analog-to-Digital Converter | | |
| a. Number of Channels | Number | |
| b. Differential or Single-Ended | | |
| 2. Low-Level Analog-to-Digital Converter | | |
| a. Number of Channels | Number | 1 |
| 3. High-Level Digital-to-Analog Converter | | |
| a. Number of Channels | Number | |
| b. Voltage or Current Output | | |

II. Estimated Memory Requirements

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

III. Microprocessor Required

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

IV. Micromodule Selection

- | | | |
|----|-------------------------------------|----|
| 1 | M68MM012 (SERIAL I/O CONTROL PANEL) | 11 |
| 2 | M68MM023 (70 MM 23) | 12 |
| 3 | M68MM230 | 13 |
| 4 | *6-M680AC6 | 14 |
| 5 | *2-M680DC6 | |
| 6 | *6-M68/AC6 | |
| 7 | *2-M68/DC6 | |
| 8 | M68MM130 (SWITCH CLOSURE) | |
| 9 | M68MM150 (THERMOCOUPLE) | |
| 10 | | |

Total Number of Modules

- | | |
|--|---|
| V. Packaging Selection | 5 MOUNT MM23 ON REAR CHASSIS |
| VI. Additional Special Function Requirements | SPECIAL LOGIC ON A BOARD MOUNTED ON CONTROL PANEL FOR DISB DRIVERS 1 AND MM |

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.

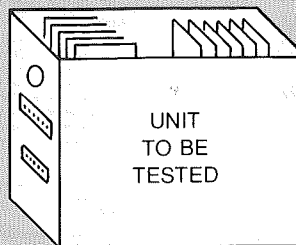
Provide an IEEE 488-1978 General Purpose Interface Bus controller function to program the commercial test equipment.

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 ± 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, ± 8 V Signals
3. RF Out = 20 μ W to 8 mW at 100 ± 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

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

- | | | | | | |
|-----------------------------------|--------|-----------|-------|-----|------|
| 1. TTL Level-Input | Number | <u>17</u> | | | |
| TTL Level-Output | Number | <u>26</u> | | | |
| TTL Level-Printer I/O | X | | | | |
| 2. Relay Output | Number | | | | |
| 3. Optically Isolated — DC Input | Number | | Level | Vdc | |
| Optically Isolated — AC Input | Number | | Level | Vac | |
| 4. Optically Isolated — DC Output | Number | | Level | Vdc | Amps |
| Optically Isolated — AC Output | Number | | Level | Vac | Amps |
| 5. Switch Closure Input | Number | | | | |
| 6. Programmable Timer | Number | | | | |

B. Digital-Serial

- | | | |
|--------------------------------|-------------|----------|
| 1. Number of I/O Ports | Number | <u>1</u> |
| 2. Asynchronous or Synchronous | <u>ASYN</u> | |
| 3. Interface Type | | |
| a. RS-232C | X | |
| b. RS-422 | | |
| c. RS-423 | | |
| d. 20 mA Current Loop | | |
| 4. IEEE 488-1978 Bus | | |
| a. Listener Talker | | |
| b. Listener Talker Controller | X | |

C. Analog

- | | | |
|---|----------------|----------|
| 1. High Level Analog-to-Digital Converter | | |
| a. Number of Channels | Number | <u>6</u> |
| b. Differential or Single-Ended | <u>DIFF</u> | |
| 2. Low-Level Analog-to-Digital Converter | | |
| a. Number of Channels | Number | |
| 3. High-Level Digital-to-Analog Converter | | |
| a. Number of Channels | Number | <u>4</u> |
| b. Voltage or Current Output | <u>VOLTAGE</u> | |

II. Estimated Memory Requirements

- | | |
|--------------|----------------|
| A. EPROM/ROM | <u>8K MAX</u> |
| B. RAM | <u>64K MAX</u> |

III. Microprocessor Required

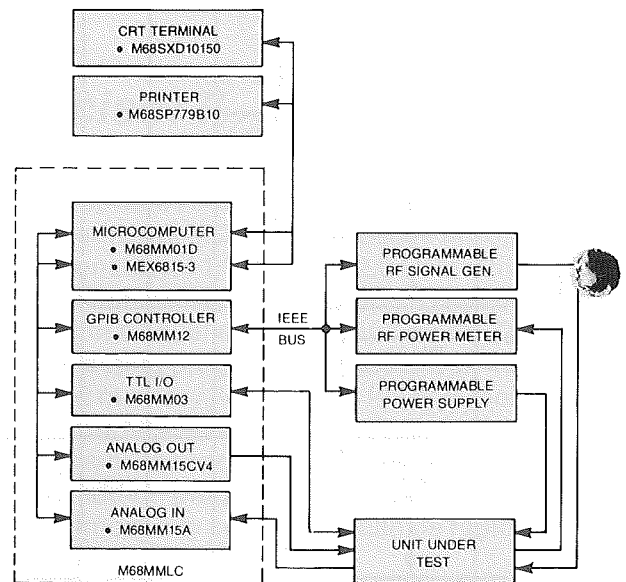
- | | |
|-----------------------|-------------|
| A. 6800 - 6802 - 6809 | <u>6800</u> |
|-----------------------|-------------|

IV. Micromodule Selection

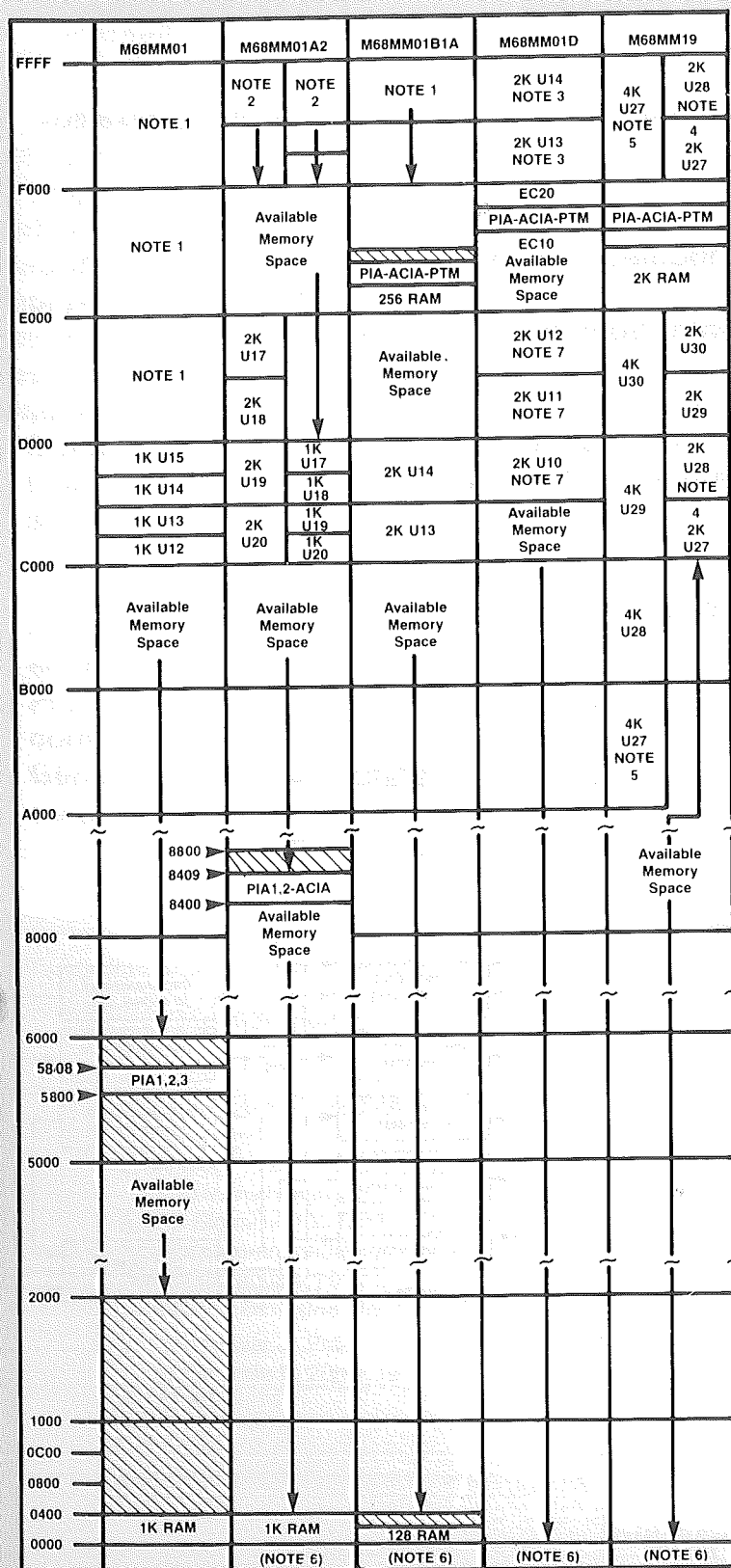
- | | | | |
|----|--|----|--|
| 1 | <u>M68MM01D (MPU-ROM SERIAL-PRINTER)</u> | 11 | |
| 2 | <u>MM03 (TTL I/O)</u> | 12 | |
| 3 | <u>MM12 (GPIO CONTROLLER)</u> | 13 | |
| 4 | <u>MM15A (A/D)</u> | 14 | |
| 5 | <u>MM15CV4 (D/A)</u> | | |
| 6 | <u>MEX6815-3 (8KRAM)</u> | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |

Total Number of Modules

- | | |
|--|---|
| V. Packaging Selection | <u>M68MMMLC</u> |
| VI. Additional Special Function Requirements | <u>M68SXD10150 (CRT TERM), M68SP179A10 (PRINTER) SELECTED TEST EQUIP.</u> |



Micromodule Composite Memory Map



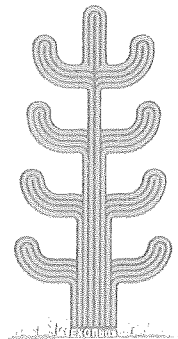
M68MM-	As Shipped Base Addr.	Size	Module (Base)
03	9FFC	4	4 (9E00) 4 (8E00)
04	A000	8K	8K (0000)
	C000	8K	8K (2000)
04A	8000	8K	8K 16K
	C000	8K	
05A	EF00	16	16 (0000)
05B	EF00	32	32 (0000)
05C	EF00	8	8 (0000)
06	7800	2K	2K (0000)
07	EC20	8	8 (8C00)
09	0000	4K	4K (0000)
12	B800	2K	2K (0000)
12A	—	8	8 (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

- Ambiguous ROM Addresses
- Ambiguous ROM Addresses if NOT used with DEBUG board
- Removed from map when used with DEBUG board
- U27 & U28 moved from F000 to C000 when used with DEBUG board
- U27 moved from F000 to A000 when used with DEBUG board
- 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
- Sockets U10, 11 & 12 may be disabled to extend Available Memory Space

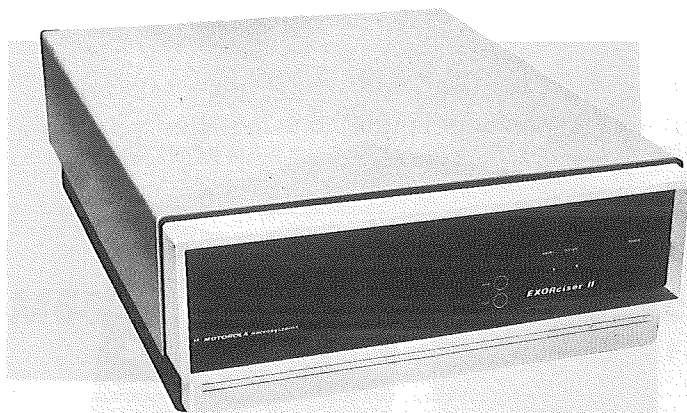
Not available

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)

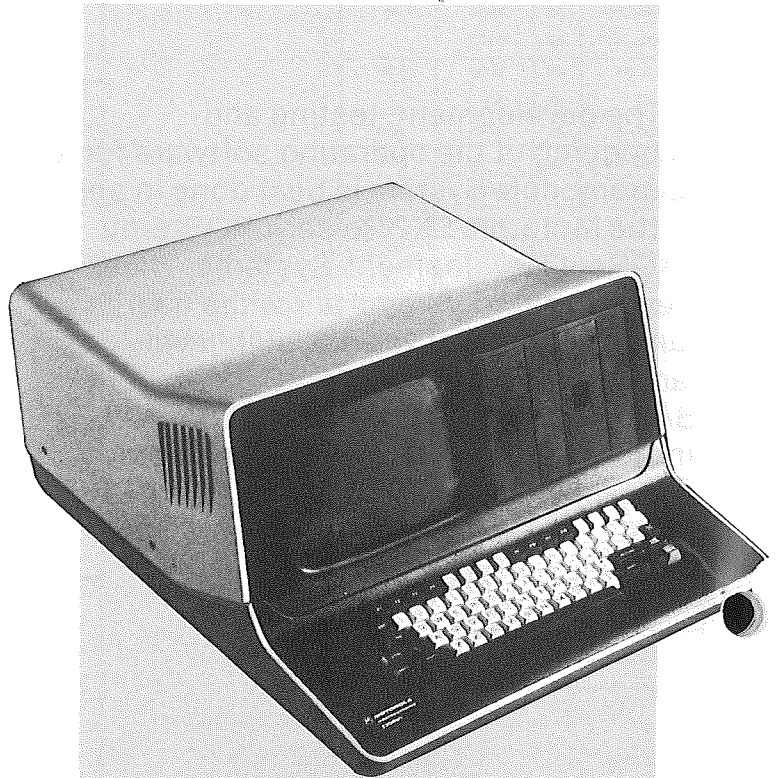
Hardware/Software Development

(M6800/09) (continued)

EXORset 30

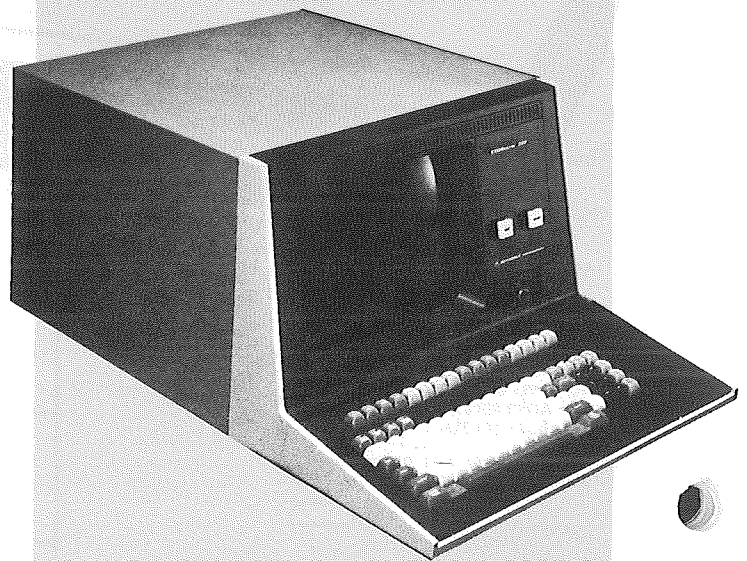
EXORset 30 is a development system with a complete man/machine interface consisting of a full-size ASCII keyboard and 16 user-assigned function keys and a high resolution 9" CRT display capable of displaying 22 lines of 80 or 16 lines of 40 characters and simultaneously a full 320 x 256 dot graphic image. 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

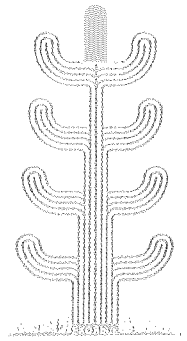
The EXORterm Development Stations add video display and keyboard entry facilities to the capabilities of the basic EXORciser II. They consist, fundamentally, of an integral card cage containing the EXORciser Debug Module and the MPU module. The cage has provisions for 6 more standard EXORciser modules,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

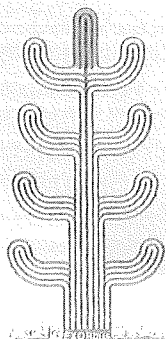
Support Tools

- 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

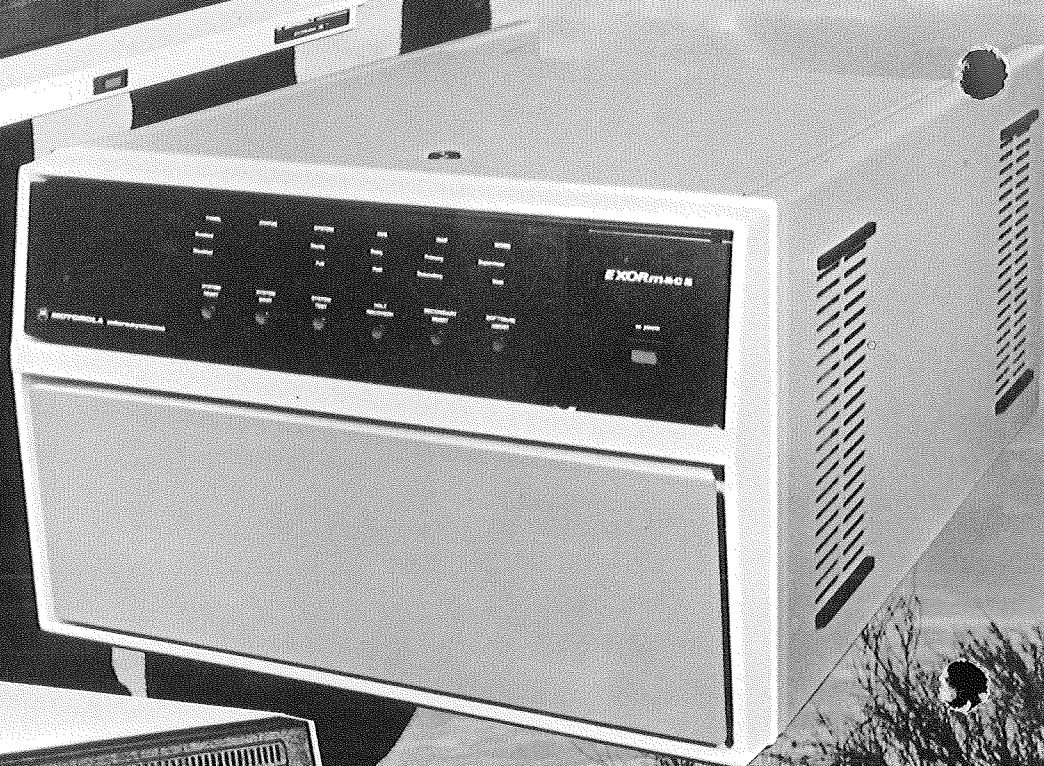
*VERSAbus is Motorola's 16/32-Bit Standard System Bus... The
Standard of the Future!





132-Column, 180-CPS Line Printer

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



EXORmacs
16/32-Bit Development System



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

MOTOROLA SEMICONDUCTOR SALES OFFICES - EUROPE and AFRICA

AUSTRIA

Motorola Ges.m.b.H.
Prinz Eugenstrasse 18
A-1040 Wien
Tel. (0222) 65 01 26

DENMARK

Motorola A/S
Gladsaxevej 370
2860 Søborg
Tel. (01) 67 44 22

FRANCE

Motorola Semiconducteurs S.A.
Main Sales Office
15-17, avenue de Ségur
75007 Paris
Tel. 555 91 01
Sales Office
Chemin de Malacher-Zirist
38240 MEYLAN (Grenoble)
Tel. (76) 90 22 81
Sales Office
Zone artisanale
35740 Faye
Tel. (99) 60 65 48

AGENCE Sud-Ouest

Avenue Général-Eisenhower
31023 Toulouse Cedex
Tel. (61) 411 11 88

WEST GERMANY

Motorola GmbH,
Geschäftsbereich Halbleiter
Main Sales Office
Arabell-Strasse 17
8000 MÜNCHEN 81
Tel. (089) 92 720
Sales Offices
Hans-Böckler-Strasse 30
3012 Langenhagen — Hannover
Tel. (0511) 78 20 37/38
Sales Office
Vinsbergerstrasse 43
8500 Nürnberg
Tel. (0911) 6 57 61
Sales Office
Stralsunder-Strasse 1
7032 Sindelfingen
Tel. (0703) 18 30 74/75
Sales Office
Abraham-Lincoln-Strasse 28
6200 Wiesbaden
Tel. (06121) 76 19 21

HOLLAND

Motorola B.V.
Semiconductor Division
Maarssebroeksedijk 37
3606 AQ Maarsse
Tel. (030) 44 38 08

ITALY

Motorola S.p.A.
Divisione Semiconduttori
Main Sales Office
Viale Milanofort-Stabile A1C
20094 Assago (Milano)
Tel. 824 20 21 (5 linee)
Sales Office
Via del Barrocco 2
40156 Bologna
Tel. (051) 53 34 46
Sales Office
Via Costantino Maes 68
00162 Roma
Tel. 831 47 46

NORWAY

Motorola Norway AS
Nils Hansens Vel 4, Bryn
Oslo 6
Tel. (02) 267 14 67/8

SOUTH AFRICA

Motorola South Africa (Pty) Ltd.
5th Street, Wynberg, Transvaal
P.O. Box 39586, Bramley, 2018
Tel. 786-1139, 786-1149, 786-1184

SPAIN

Motorola España S.A.
Albert Alcover, 46 dpdo
Madrid 16
Tel. 457 82 04

SWEDEN

Motorola AB.
Dalvägen 2
S-17139 Solna
Tel. (08) 82 02 95

SWITZERLAND

Motorola (Schweiz) AG
Main Sales Office
Wilikonstr. 9
8952 Schlieren
Tel. (01) 730 40 16
Sales Office
16, chemin de la Voie-Creuse
P.O. Box 8 — 1211 Genève 20
Tel. (022) 99 11 11

UNITED KINGDOM

Motorola Ltd.
Main Sales Office
York House, Empire Way
Wembley, Middlesex
Tel. (01) 902 88 36
Sales Office
Colvilles Road, Kelvin Estate
East Kilbride, Scotland
Tel. (3552) 3 91 01
Marketing Office
88 Tanners Drive, Blakelands
Milton Keynes MK14 5 BP
Tel. (4908) 61 46 14

HEADQUARTERS EUROPEAN OPERATIONS SWITZERLAND

Motorola Inc.
European Semiconductor Division
16, chemin de la Voie-Creuse
P.O. Box 8 — 1211 Genève 20
Tel. (022) 99 11 11

MOTOROLA SEMICONDUCTOR DISTRIBUTORS - EUROPE and AFRICA

AUSTRIA

ELBATEX GmbH
Endrestrasse 54 — 1238 Wien — Tel. (222) 88 56 11

BELGIUM

DIODE BELGIUM
Rue Picard 202-204 — 1020 Bruxelles
Tel. (02) 428 51 05

DENMARK

DISTRIBUTOREN INTERTEL APS
Silovvej 18 — DK-2690 Karlund
Tel. (03) 14 07 00
DANELEC ELECTRONIC APS
Gladsaxevej 356-382 — DK-2660 Søborg
Tel. (01) 69 05 11

FINLAND

FIELD OY
Veneentekijantie 18 — SF-00210 Helsinki 21
Tel. (09) 692 25 77

FRANCE

ALFATRONIC (Main Office)
Tour d'Asnières — 4, av. Laurent-Cely
92006 Asnières — Tel. (01) 791 44 44
ALFATRONIC
20, bd Eugène-Darcel — Immeuble Britannia
69003 Lyon — Tel. (7) 895 14 12
ALFATRONIC
24, avenue de Crimée — 35100 Rennes
Tel. (99) 53 13 33
BELLION ELECTRONIQUE (Main Office)
Zone Industrielle de Kersco/Brest
29219 Le Relecq-Kerhuon — B.P. 16
Tel. (98) 28 03 03
BELLION ELECTRONIQUE
1bis, rue L. Videment — 44200 Nantes
Tel. (40) 48 09 44
BELLION ELECTRONIQUE
7, bd de Beaumont — 35100 Rennes
Tel. (99) 30 35 78
CELDIS S.A. (Main Office)
53, rue Charles-Fridot — 94250 Gentilly
Tel. (01) 546 13 13
CELDIS S.A.
15, avenue Foch, Tour Kennedy
54000 Nancy — Tel. (8) 341 26 01
ÉTS. F. FEUTRIER S.A. (Main Office)
Rue des Trois-Glorieuses
42270 St-Priest-en-Jarez (St-Etienne)
Tel. (77) 74 67 33
ÉTS. F. FEUTRIER S.A.
Avenue Laplace — Zone Industrielle
13470 Carnoux — Tel. (42) 82 16 41
ÉTS. F. FEUTRIER
69, rue Riquet — 31000 Toulouse — Tel. (61) 62 34 72
ÉTS. F. FEUTRIER
22, rue Bascalan, Immeuble Concorde
33075 Bordeaux — Tel. (56) 39 51 21
FEUTRIER ILE DE FRANCE
6, rue Benoit-Malon — 92150 Suresnes
Tel. (01) 772 46 46
ÉTS. GROS S.A. (Main Office)
13, rue Victor-Hugo — B.P. 63
93950 Saint-André-lez-Lille — Tel. (20) 51 21 33
ÉTS. GROS S.A.
5, rue Pascal — 94800 Villejuif — Tel. (01) 678 27 27
S.C.A.L.B. S.A.
80, rue d'Arcueil — Sillit
94523 Rungis Cedex — Tel. (01) 687 23 13
SCIENTECH
11, avenue Ferdinand-Buisson
75016 Paris — Tel. (1) 609 91 36
STÉ COMMERCIALE TOUTÉLECTRIC (Main Office)
15-17, Boulevard Bonrepos — 31008 Toulouse
Tel. (61) 62 11 33
STÉ COMMERCIALE TOUTÉLECTRIC
80-83, quai des Queyries — 33100 Bordeaux
Tel. (56) 88 50 31
S.C.E. (SCAIB-CLÉ-ELECTRONIQUE)
112, avenue Jean-Jaures — 69037 Lyon
Tel. (07) 869 81 10

GERMANY

DISTRON GmbH & Co.
(Main Office)
Behaimstrasse 3 — 1000 Berlin 10
Tel. (030) 342 10 41/45
DISTRON GmbH & Co.
Lederstrasse 10 — 8000 München 2
Tel. (089) 217 7102
ELEDIS RUGGABER GmbH (Main Office)
Herlichstrasse 41 — D-7250 Leonberg 1
Tel. (07152) 4 70 81

ELEDIS RUGGABER GmbH

Aplerbecker Marktplatz 17
D-4600 Dortmund-Aplerbeck
Tel. (0231) 45 60 16
ELEDIS RUGGABER GmbH
Ziegelhofstrasse 31 — D-7600 Freiburg-Lehen
Tel. (0761) 8 31 43
EBV Elektronik Vertriebs-GmbH (Main Office)
Oberweg 6 — D-8025 Unterhaching — Tel. (089) 61 10 51
EBV Elektronik Vertriebs-GmbH
Kiebitzrain 18 — D-3006 Burgwedel 1/Hannover
Tel. (05139) 50 38
EBV Elektronik Vertriebs-GmbH
Oststrasse 129 — D-4000 Düsseldorf — Tel. (0211) 848 46
EBV Elektronik Vertriebs-GmbH
Schenckstrasse 99 — D-6000 Frankfurt 90
Tel. (0611) 78 50 37
EBV Elektronik Vertriebs-GmbH
Alexanderstrasse 42 — D-7000 Stuttgart 1
Tel. (0711) 24 74 81/3
JERMYN GmbH (Main Office)
Schulstr. 84 — D-6277 Bad Camberg — Tel. (06434) 231
JERMYN GmbH
Rathelbeckstr. 282 — D-4000 Düsseldorf 12
Tel. (0211) 20 30 94/5
JERMYN GmbH
Am Joachimshagen 14 — D-7033 Herrenberg
Tel. (07032) 50 74
JERMYN GmbH
Wellenfelder Str. 6 — D-8011 Helmsletten
Tel. (089) 903 80 01/4
MÜTRON, MÜLLER GmbH & Co. (Main Office)
Bornstrasse 22 — D-2800 Bremen 1 — Tel. (0421) 3 05 60
MÜTRON, MÜLLER GmbH & Co.
Hausaring 32 — D-5000 Köln 1
Tel. (0221) 12 24 24
MÜTRON, MÜLLER GmbH & Co.
Segeberger Chaussee 34 — D-2000 Norderstedt
Tel. (040) 527 38 77
MÜTRON, MÜLLER GmbH & Co.
Ludwigstr. 22 — 8700 Würzburg
Tel. (0931) 5 29 44/6
A. NEYE — ENATECHNIK GmbH
Schillerstrasse 14 — 2085 Quickborn — Tel. (04106) 61 21
A. NEYE — ENATECHNIK GmbH
Brunowstr. 7 — 1000 Berlin — Tel. (030) 4 33 30 52
A. NEYE — ENATECHNIK GmbH
Hildesheimerstr. 31 — 3000 Hannover
Tel. (0511) 81 60 38
A. NEYE — ENATECHNIK GmbH
Birkenstr. 107 — 4000 Düsseldorf — Tel. (0211) 66 61 45
A. NEYE — ENATECHNIK GmbH
Rheinstr. 24 — 6100 Darmstadt — Tel. (06151) 2 64 46
A. NEYE — ENATECHNIK GmbH
Breitwiesenstr. 25 — 7000 Stuttgart 80
Tel. (0711) 7 80 04 57
A. NEYE — ENATECHNIK GmbH
Maria-Theresa-Strasse 6 — 8000 München 80
Tel. (089) 47 30 23
SASCO Vertrieb von elektronischen Bauelementen GmbH
(Main Office)
Hermann-Oberth-Str. 16 — D-8011 Putzbrunn b. München
Tel. (089) 461 11
SASCO Vertrieb von elektronischen Bauelementen GmbH
Märkische Str. 56-58 — D-4600 Dortmund
Tel. (0231) 57 92 06
SASCO Vertrieb von elektronischen Bauelementen GmbH
Lorenz Str. 15-17 — D-8500 Nürnberg
Tel. (0911) 20 41 62/3
SASCO Vertrieb von elektronischen Bauelementen GmbH
Stallfellenbergstr. 24 — D-7000 Stuttgart 1
Tel. (0711) 24 45 21
SASCO Vertrieb von elektronischen Bauelementen GmbH
Mittlerer Hasenpfad 64 — 6000 Frankfurt 70
Tel. (089) 22 74 17
SASCO Vertrieb von elektronischen Bauelementen GmbH
Amelungshof 38 — D-3000 Hannover 27
Tel. (0511) 87 20 13
SPOERLE ELECTRONIC KG (Main Office)
Max-Planck-Str. 1 — D-6072 Dreieich
Tel. (06103) 30 41
SPOERLE ELECTRONIC KG
Am Westfalendamm 84-86 — D-4600 Dortmund
Tel. (0231) 57 93 15
SPOERLE ELECTRONIC KG
Münchinger Str. 30 — D-7141 Schwieberdingen
Tel. (07150) 36 26
SPOERLE ELECTRONIC KG
Zweibrückenstr. 1 — D-8000 München 2
Tel. (089) 22 74 17
SPOERLE ELECTRONIC KG
Volksplatz, 62 — D-2000 Hamburg 54
Tel. (040) 54 50 68
TECHNOPROJEKT GmbH (Main Office)
Heinrich-Baumann-Str. 30 — D-7000 Stuttgart 1
Tel. (0711) 28 02 81

TECHNOPROJEKT GmbH

Schildstr. 4 — D-4600 Dortmund 30
Tel. (0231) 43 36 82
GREECE
COMTEL LTD.
20-22, Georges St. — Athens 141 — Tel. (01) 361 43 00
HOLLAND
B.V. DIODE
Hollandaan 22 — Utrecht — Tel. (030) 88 42 14
MANUDAX NEDERLAND B.V.
Meerdstraal 7 — 5473 ZG Heeswijk (N.B.)
P.O. Box 25 — Tel. (041) 39 29 01
ITALY
ADELSY S.p.A. (Main Office)
Via Novara 570 — 20153 Milano — Tel. (02) 452 46 51
ADELSY S.p.A.
Via di Vigna Murata 1/A — 00143 Roma
Tel. (06) 5915417
ADELSY S.p.A.
Corso Matteotti, 32a — 10121 Torino
Tel. (011) 539141/543175
(ADELSY S.A.) S.I.D.E. SRL
Via Cervellati 3 — 40122 Bologna
Tel. (051) 267922/22216
ADELSY S.p.A.
Piazza della Vittoria 15 — Int. 25 — 16121 Genova
Tel. (010) 589674/581761
ADELSY S.p.A.
Strada Statale 16, km 311 — 60028 Osimo Scalo (AN)
Tel. (071) 793077/79017
ADELSY S.p.A.
Via Pellizzo 23/10 — 35100 Padova
Tel. (049) 45600/45778
CELDIS ITALIANA S.p.A. (Main Office)
Via F.lli Gracchi 36 — 20092 Cinisello Balsamo (MI)
Tel. (02) 612 00 41 (5 linee)
CELDIS ITALIANA S.p.A.
Via Lorenzo Il Magnifico 109 — 00162 Roma
Tel. (06) 42 38 55
CELDIS ITALIANA S.p.A.
Via Massarenti 219/4 — 40136 Bologna
Tel. (051) 55 48 83
CELDIS ITALIANA S.p.A.
Via Mombarcato 96 — 10136 Torino — Tel. (011) 35 93 12
CELDIS ITALIANA S.p.A.
Via Savelli 15 — 35100 Padova — Tel. (049) 77 21 35
CRAMER ITALIA S.p.A. (Main Office)
Via Cristoforo Colombo 134 — 00147 Roma
Tel. (06) 51 79 61 (10 linee)
CRAMER ITALIA S.p.A.
Via S. Simeoniano 2 — 20121 Milano
Tel. (02) 80 93 26 (4 linee)
CRAMER ITALIA S.p.A.
Via Ferrarese 10/2 — 40128 Bologna
Tel. (051) 37 27 77 (3 linee)
CRAMER ITALIA S.p.A.
Corso Traiano 109 — 10127 Torino
Tel. (011) 619 20 62/619 20 67
CRAMER ITALIA S.p.A.
Via Consalvo 107 — 80125 Napoli — Tel. (081) 63 61 43
SILVERSTAR LTD. S.p.A. (Main Office)
Via dei Gracchi 28 — 20146 Milano
Tel. (02) 49 96 (12 linee)
SILVERSTAR LTD. S.p.A.
Via Paisiello 30 — 00198 Roma
Tel. (06) 844 88 41 (5 linee)
SILVERSTAR LTD. S.p.A.
Piazza Adriano 9 — 10139 Torino — Tel. (011) 44 32 75/6
SILVERSTAR LTD. S.p.A.
Via S. Sofia 15 — 35100 Padova — Tel. (049) 22 33 8
SILVERSTAR LTD. S.p.A.
Via del Porto 30 — 40122 Bologna — Tel. (051) 52 22 31

PORTUGAL

DECADA, Equipamentos de Electronica Lda.
Rua Pedro Nunes 47 — Lisbon 1 — Tel. (19) 57 49 84
SOUTH AFRICA
STANDARD TELEPHONE AND CABLES
P.O. Box 286 — Boksburg 1460 — Tel. (011) 52 8311
BELLCO ELECT CO. (PTY) LTD.
Box 3730 — Cape Town 8000 — Tel. (021) 47 1100
ADVANCED SEMICONDUCTOR DEVICES
P.O. Box 2944 — Johannesburg 2000 — Tel. (011) 29 2856

SPAIN

COMELTA
Emilio Munoz 41 — Nave 1.1.2
Madrid 17 — Tel. (01) 754 30 01
HISPANO ELECTRONICA S.A. (Main Office)
Polígono Industrial «Urtina»
Apartado de Correos 48 — Alcorcón (Madrid)
Tel. (01) 619 41 08
HISPANO ELECTRONICA S.A.
Figols, 27-29
Barcelona 14 — Tel. 259 05 22/23
ITT DISTRIBUCIÓN
Miguel Aguado, 21 — Madrid 10
Tel. (01) 419 09 57
SWEDEN
ITT MULTIKOMPONENT
Box 1330 — S-17126 Solna
Tel. (08) 83 00 20
ÅB GÖSTA BÄCKSTRÖM
Ålströmargatan 22 — Box 12009
10221 Stockholm — Tel. (08) 54 10 80
TRACO AB.
Elektronikdistributören — Box 103
S-123 22 Farsta — Tel. (08) 13 21 60
SWITZERLAND
ELBATEX AG
Alb. Zwysig-Strasse 28 — 5430 Wettlingen
Tel. (056) 27 01 27
OMNI RAY AG
Dufourstrasse 56 — 8008 Zürich
Tel. (01) 252 07 66
TURKEY
ERA Elektronik Sanayi Ve Ticaret A.Ş.
Eski Büyükdere Cad. 49/A, 4. Levent İstanbul
Tel. (1) 64 65 00

UNITED KINGDOM

AMEX ELECTRONICS LTD.
3, Blackhorse Lane — Stevenage Road
Hitchin, Herts — SG4 9EE — Tel. (0462) 520 82
AXIOM ELECTRONICS LTD.
Turnpike Road — Cressux Industrial Estate
High Wycombe — Bucks, HPQWQ enr.
Tel. (0494) 44 21 81
CELDIS LTD.
37-39 Loversock Road
Reading, Berks, RG3, 1ED
Tel. (0734) 555 171
GOTHIC CRELLON
380, Bath Road — Slough, Berks SL1 6UE
Tel. (06280) 44 34
HAWKE ELECTRONICS LTD.
Amotex House, 45 Hanworth Road
Sunbury on Thames, Middlesex TW 16 8 DA
Tel. (01) 979 77 99
ITT ELECTRONIC SERVICES
Edinburgh Way — Harlow, Essex CM20 (2DF)
Tel. Harlow (0278) 26 777
JERMYN DISTRIBUTION
Vestry Estate — Sevenoaks, Kent
Tel. (0732) 5 01 44
LOCK DISTRIBUTION
P.O. Box 0154
Neville Street — Oldham, Lancs OL9 6PY
Tel. (061) 652 73 11
MACRO-MARKETING LTD.
Burnham Lane — Slough, Berks SL1 6LN
Tel. (06280) 4422
THAME COMPONENTS LTD.
Thame Park Rd. — Thame, Oxon OX 9 3 XD
Tel. (084) 421 31 46
THE RADIO RESISTOR CO. LTD.
St. Martin Industrial Estate
Cambridge Rd. — Bedford MK 42 0LF
Tel. (0234) 4 71 88

YUGOSLAVIA

ELEKTROTEHNA LJUBLJANA
Export-Import — Titova 61 — P. Box. 34-1
61000 Ljubljana — Tel. (61) 34 77 49
ELEKTROTEHNA LJUBLJANA
Tozd Elzas — Karadjordje TRG 13
11060 Beograd — Tel. (11) 69 69 24

EUROPEAN SEMICONDUCTOR FACTORIES

FRANCE

Motorola Semiconducteurs S.A.
Avenue Général-Eisenhower
31023 Toulouse CEDEX
Tel. (61) 40 11 88

GERMANY

Motorola GmbH
Behaimstrasse 18
8043 Unterföhring
Tel. (089) 92 481

UNITED KINGDOM

Motorola Limited
Colvilles Road, Kelvin Estate
East Kilbride/Glasgow (Scotland)
Tel. (3552) 3 91 01