



**M68SDT
EXORciser
Emulator for M6800
Based Systems**

M68SDT EXORciser Emulator for M6800 Based Systems

The EXORciser is a modularized, expandable instrument that permits "instant breadboarding" and evaluation of any M6800-based microcomputer system. It consists of a prewired, bus-oriented chassis and power supply, together with three basic modules — an MPU Module, a Debug Module and a Baud Rate Module. These provide the basic control and interface functions of a microcomputer, and house the system development and diagnostic programs. A number of separately available, optional memory modules and additional interface modules (up to twelve) may be added, simply by plugging them into existing prewired sockets, to convert the basic system into an exact prototype of a desired end system. Thus, the EXORciser, with its built-in EXbug Firmware, enables the designer to configure, evaluate and debug his final system hardware and software using actual M6800 components.

Features

- Reduces system development time and cost
- Emulates final system architecture and performance through modular building block concept with standard M6800 components
- Permits debugging of final system design through built-in diagnostic firmware
- Facilitates program development using separately available Resident Software

EXORciser Options

Basic Models:

M68SDTT1	110 Volt Table Top EXORciser
M68SDTT2	220 Volt Table Top EXORciser
M68SDTTU1	110 Volt Table Top EXORciser with USE
M68SDTTU2	220 Volt Table Top EXORciser with USE
(Dimensions:	19.25 x 17.5 x 7, W x D x H)
MEX68RK	Rack Mounted Conversion Kit
	(Converts standard table-top model for rack mounting.)

Optional Assemblies:

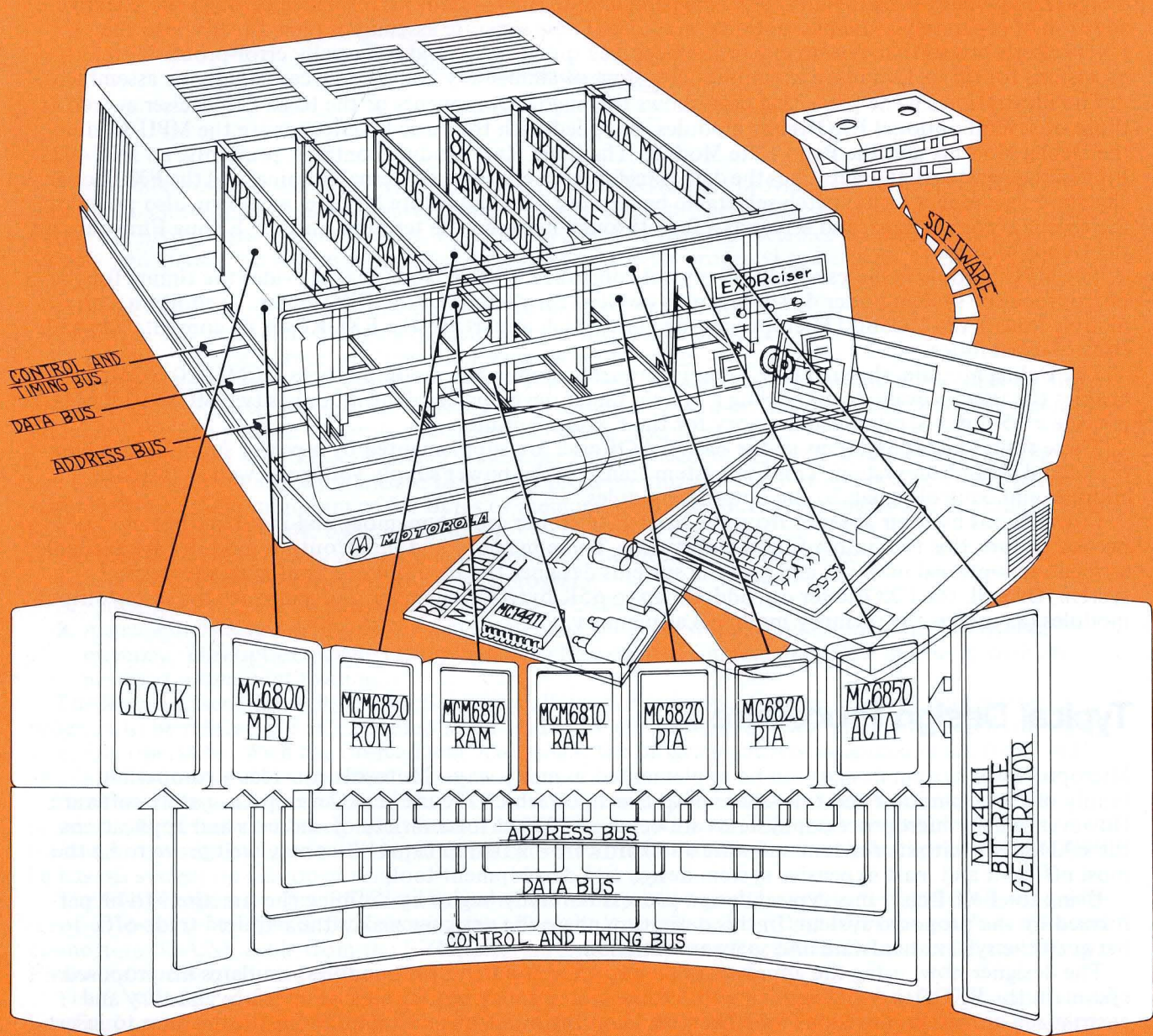
MEX6800	MPU Module (additional module)
MEX6812-1	2K Static RAM Module
MEX6815	8K Dynamic RAM Module
MEX6816-1	16K Dynamic RAM Module
MEX6820	Input/Output Module
MEX6850	ACIA Module
MEX68CT	MOTEST (Component Tester)
MEX681C	Input/Output Flatribbon Interconnect Cable
	(Two per Input/Output Module)
MEX68PP	PROM Programmer Module
MEX68RR	EROM/RAM Module
MEX68SA	Systems Analyzer
MEX68USE	USE (User's System Evaluator)
MEX68WW	Wirewrap Module
MEX68XT	Extender Module

Support Software Programs:

M68ASMR021D	Resident Macro Assembler and Linking Loader on Diskette
M68XAE6812A	Resident Assembler/Editor on Cassette
M68XAE6812B	Resident Assembler/Editor on Paper Tape
M68XAE6812D	Resident Assembler/Editor on Diskette

EXORciser Specifications

Power Requirements	95-135/205-250 Vac 47-420 Hz 250 W
Word Size	
Data	8 Bits
Address	16 Bits
Instruction	8, 16, and 24 Bits
Memory Capability	65,536 bytes (maximum)
Instructions	72, variable length
Clock Cycle Time	Selectable: 1 μ s crystal control clock or provisions for an external clock between 1 μ s and 10 μ s.
Interrupt	Maskable real-time
Data Terminal Interface Characteristics	
Baud Rates	110, 150, 300, 600, 1200, 2400, 4800 and 9600
(Switch Selectable)	
Signal Characteristics	TTY (20 mA neutral current loop) or EIA RS-232C compatible
Reader Control Signal	Control signal for TTY devices modified for external control
Operating Temperature	0-55°C



The M68SDT EXORciser

Description and Operation

The basic EXORciser contains the common ingredients of a microcomputer and offers the system designer a low-cost, versatile means of achieving unique final-system performance through the selective addition of separately available, optional modules. These separate assemblies plug directly into the EXORciser's bus so that system expansion becomes quick, easy, and essentially error-proof. With provisions for up to 12 add-on assemblies, a system of almost any complexity can rapidly be assembled.

The illustration on the preceding page shows the major components of the basic EXORciser as well as those of several optional EXORciser modules. Supplied with the basic EXORciser are the MPU Module, the Debug Module, and the Baud Rate Module. The Baud Rate Module contains, primarily, an MC14411 Bit Rate Generator that determines the data transfer rate between an external terminal and the EXORciser. The module supplies eight switch selectable baud rates. The Baud Rate Module, as shown, also provides the terminal connections, and serves as a feed-through between the terminal and the EXbug Firmware on the Debug Module.

The MPU Module includes a built-in, crystal-controlled 1 MHz clock that provides the timing for the microprocessor system under development, as well as for the rest of the EXORciser. In addition, this module houses the MC6800 Microprocessing Unit which imparts to the EXORciser its computation and control capabilities.

The Debug Module, through its EXbug Firmware stored in the module's three MCM6830 ROMs, enables the user to evaluate and debug a system under development. The module's two MC6810 RAMs provide a 256 byte scratch-pad memory for the EXbug routines.

These functional subsystems of the basic EXORciser are supplemented by a power supply and a bus-oriented distribution system. This bus system transfers the power supply voltage as well as the data, address, and control signals to the optional modules.

Conspicuous by their absence from the basic EXORciser are the memory and input/output modules needed to turn this tool into a functional system. These memory and input/output modules are available as separate, optional modules and give the systems designer the flexibility to configure any desired system. Overall, the EXORciser can address up to 65K bytes of memory, and addresses the input/output modules (as well as the memory modules) as memory.

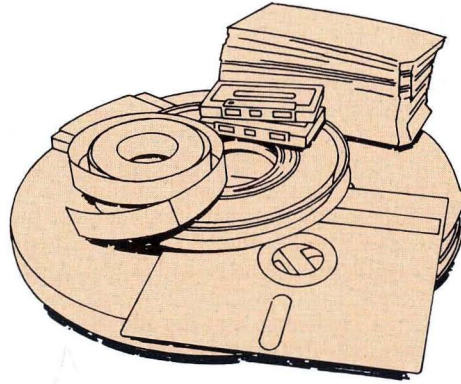
Typical Design Procedure

Microprocessor system designs can be implemented in many ways. Motorola provides a compatible family of host-computer and time-share programs upon which the user can develop his system software. However, where microprocessor systems are being developed for a variety of end uses and applications, the EXORciser with its resident software and hardware emulation capabilities may well prove to be the most efficient and least expensive system design and development tool.

Using the EXORciser in a typical design process normally begins by defining the functions to be performed by the proposed system. In this definition phase the designer makes the required trade-offs between the system hardware and software functions.

The designer now, using the appropriate memory and input/output modules, emulates his proposed system in the EXORciser. Recognizing that some systems may require special interface circuitry and customized circuitry, provisions have been made on the input/output modules for the designer to insert 14, 16 and 24 pin wirewrap sockets and construct the special interface circuitry. Also the designer can construct any customized circuitry on the Wirewrap Module.

The terminal, as illustrated, provides the means for communications between the designer and EXORciser. This can be done by means of the terminal keyboard, from paper tape, or from a cassette associated with the particular terminal in use.



The M6800 resident software, when loaded into the EXORciser, provides the designer with a powerful tool on which to develop his software. Using the capabilities of the M6800 Resident Editor, the designer enters a source program either via the terminal keyboard or from the selected medium. The user now can modify and change his source program as required to meet his proposed systems requirements. This includes:

- Printing out all or any part of the program for detailed examination;
- Changing any characters or string of characters in the source program;
- Deleting or adding instruction lines or characters anywhere in the program.

At the end of the editing process, the Resident Editor will provide a source program that may be stored on paper tape, cassette, or diskette. This source program may be used in subsequent assembly operations on any of the compatible Motorola assemblers and cross assemblers.

The EXORciser's M6800 Co-Resident Assembler or the Resident Macro Assembler and Linking Loader can be used to automatically translate the source program into an object program. The Co-Resident Assembler requires a minimum of 8K bytes of memory while the Macro Assembler and Linking Loader requires a minimum of 14K bytes of memory.

The resultant Object Program is available from the EXORciser in three forms.

1. A printed assembly listing of the source program.
2. An Object Program on paper tape, cassette, or diskette.
3. A machine file, consisting of the machine-coded program stored directly into the EXORciser memory. This option permits the program to be executed immediately after assembly with no need for subsequent loading.

The Macro Assembler in its assembly process allows the assignment of the memory addresses of a program to be relocatable and assigned when loaded by the Linking Loader rather than fixed during the assembly operation. With the Co-Resident Assembler, the program address assignments are fixed and absolute in the assembly operation.

Once the designer has configured the EXORciser to emulate his hardware and has developed his programs, he is ready to debug his system. The EXORciser, with its EXbug system development Firmware, permits the user to debug both his system hardware and his system software as required until he has his system up and operating.

The EXORciser with its USE (User System Evaluator) option can be used to test and evaluate equipment external to its chassis. By removing the MC6800 Microprocessing Unit from the user's system and connecting the USE cable from the EXORciser into the MPU's socket, the EXORciser with its EXbug Firmware can be used to debug and troubleshoot microprocessor systems.

The EXORciser also can be used as a production tool. An EXORciser equipped with USE can be used in a final test area for testing the user's production system. With MOTEST, our component tester, the EXORciser also can be used to test the M6800 family of parts.

EXORciser Bus Signals

The EXORciser bus interfaces the MPU Module with other modules being used in the EXORciser. This bus permits the EXORciser to be configured to meet a user's specific application.

Data Bus (D0-D7) – These eight bi-directional lines, when enabled, provide a two-way transfer of data between the MPU Module and the selected memory location. The data bus drivers on the modules are three-state logic devices.

Address Bus (A0-A15) – These 16 lines, when enabled, transfer the MPU memory address to the selected memory location. The MPU Module controls the operation of these lines through its three-state bus drivers.

Read/Write (R/W) – This MPU output signal indicates whether the MPU Module is performing a memory read (high) or write (low) operation. The normal standby state of this line is read (high). Also, when the MC6800 MPU on the module is halted, this signal will be in the read state.

Valid Memory Address (VMA) – This line, when high, indicates that the address on the bus is valid.

Valid User's Address (VUA) – This line, when high, indicates that the address on the address bus is valid and the EXORciser is not addressing its EXbug program.

Memory Clock (MEMCLK) – This is the basic clock signal used by the MPU Module to generate its $\phi 1$ and $\phi 2$ non-overlapping clock signals.

Phase 1 ($\phi 1$) Clock – This signal is derived from the Memory Clock and is present during the MPU addressing time. This signal is controlled by the MPU Module.

Phase 2 ($\phi 2$) Clock – This signal also is derived from the Memory Clock and used to synchronize the transfer of data on the data bus. This signal is controlled by the MPU Module.

Bus Available (BA) – The Bus Available signal will normally be a low level. When activated, it will go high indicating that the address bus is available. This will occur if the Halt line is low or the MC6800 MPU is in the WAIT state as the result of executing a WAI instruction. At such time, all the MPU Module three-state output drivers will go to their off state and other outputs to their normally inactive state. An interrupt command or actuating the ABORT or RESTART switch removes the MPU from the WAIT state.

Interrupt Request (IRQ) – This level sensitive input, on going low, requests that an interrupt sequence be generated in the MC6800 MPU. The MPU will wait until it completes the current instruction that it is executing before it recognizes this request. At that time, if the interrupt mask bit in the MPU Condition Code Register is not set, the MPU will begin the interrupt sequence.

Non-Maskable Interrupt (NMI) – This level sensitive input, on going low, requests that an interrupt sequence be generated within the MC6800 MPU. The MPU will wait until it completes the current instruction that it is executing before it recognizes this request. At that time, the MPU will begin its non-maskable interrupt routine.

Reset – This edge sensitive signal initiates an MC6800 MPU power-on vectored interrupt initialize routine when power is first applied to the EXORciser and each time the EXORciser's RESTART switch is actuated. This signal, in addition to resetting the module's MPU, is used to reset and initialize the rest of the EXORciser.

Three-State Control (TSC) – This input, when high, causes all of the MPU Module's Address Bus lines and R/W line to go to their off or high-impedance state. The Valid Memory Address and Valid User's Address signal will be forced low. The Data Bus is not affected by the Three-State Control. This signal is initially jumpered to ground on the MPU Module.

Refresh Request (REFREQ) – This signal, when low, initiates a memory refresh operation. The MPU Module, on receiving this input, stops generating the $\phi 1$ and $\phi 2$ clock signals with $\phi 1$ high and, through the Refresh Grant command, instructs the initiating memory module to refresh itself.

Refresh Grant (REFGRANT) – The MPU Module, on receiving a Refresh Request input, generates a Refresh Grant signal to instruct the initiating module to refresh itself.

Memory Ready (MEMRDY) – This signal enables the MPU Module to work with slow memories. The MPU Module, on receiving a low level Memory Ready input, stops generating the $\phi 1$ and $\phi 2$ clock signals with $\phi 2$ high. The initiating module, on completing its memory operation, returns the Memory Ready signal to a high level.

Halt – When this input is low, all activity in the MC6800 MPU will be halted. This input is level sensitive. In the MC6800 MPU will be halted. This input is level sensitive. In the halt mode, the machine will stop at the end of an instruction, Bus Available will be high, Valid Memory Address and Valid User's Address will be low, and all other three-state lines will be in their off or high-impedance state.

Transition of the Halt line must not occur during the last 250 ns of $\phi 1$. To insure single instruction operation, the Halt line must go high for one $\phi 1$ clock pulse.

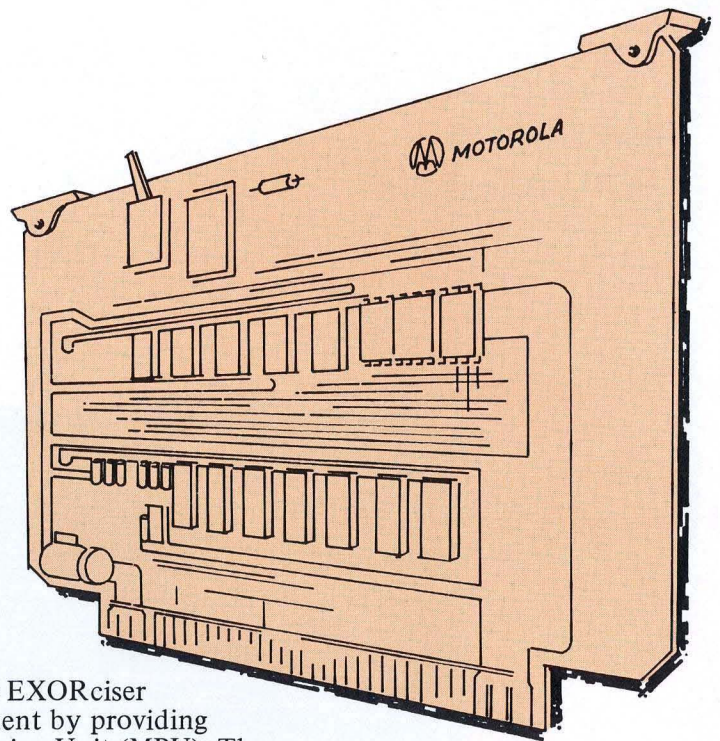
Refresh Clock (REFCLK) – This signal is generated by the dynamic memory module being used as the master refresh module. This signal is used to initiate a memory refresh operation on the dynamic modules functioning as slave refresh modules.

Stand By (STDBY) – This line is a low level during a power-fail condition and a high level during normal EXORciser operation.

Bus Control

It is possible for a module other than the MPU Module to gain control of the bus. This module would place a low level Halt on the bus and monitor the Bus Available signal. When the MPU Module completes the instruction it is performing, it generates a high level Bus Available signal. The module requesting control of the bus now must pull the Three-State Control line low, forcing the MPU Module address bus drivers to their high-impedance state. The requesting module now has control of the EXORciser bus until it elects to relinquish control.

MEX6800 MPU Module



- Provides the MPU and clock functions for both the EXORciser Debug system and the emulated user's system
- Crystal controlled 1 MHz clock
- Provisions for an external clock
- Automatic system initialization and restart capability
- Dynamic memory refresh capability on a cycle stealing basis
- Capable of working with slow external memories

The MEX6800 MPU Module is the heart of both the EXORciser Debug system and the user's system under development by providing both the system clock and the MC6800 Microprocessing Unit (MPU). The MPU Module also automatically initiates an EXORciser restart operation when power is first applied to the EXORciser.

The clock circuit generates a crystal-controlled 1 MHz signal, but the system may be operated with an external clock at frequencies between 100 kHz and 1 MHz by means of a switch mounted on the MPU Module.

In addition to generating the basic EXORciser timing signals, the clock circuit provides the EXORciser with the capability of refreshing dynamic memories and working with slow memories. The dynamic memories are refreshed on a cycle stealing basis. In working with slow memories, the MPU Module stretches the clock pulse to give the memory sufficient time to complete its assigned operation.

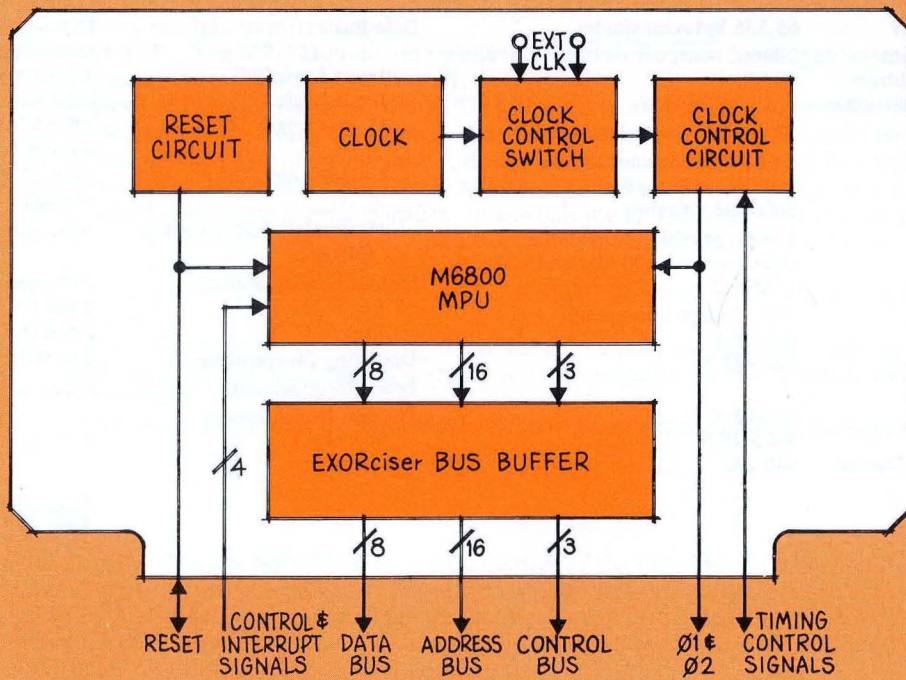
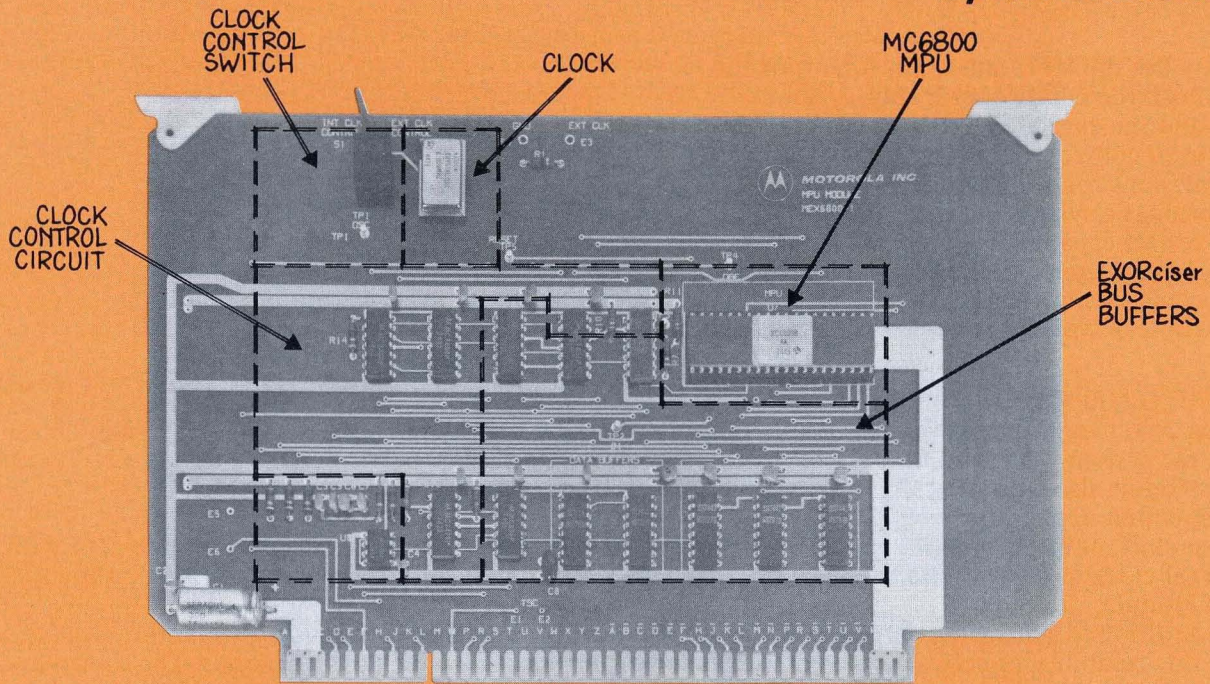
Specifications

(Note: Positive current flow is defined as flowing into the terminal, negative current flow as flowing from the terminal.)

Memory Size Capability	65,536 bytes maximum	Data Bus	Three-state TTL voltage compatible
Word Size	Data 8-bits Address 16-bits Instruction 8, 16, or 24 bits	Input Logic "0"	0.0-0.8 V (-200 μ A at 0.4 V)
Instruction Set	72 variable length instructions	Input Logic "1"	2.0-5.25 V (25 μ A at 5.25 V)
Interrupts	Maskable and non-maskable real-time interrupts Software interrupt	Output Logic "0"	0.0-0.5 V (40 mA at 0.5 V through a resistor to V_{CC})
Clock Signal	1 MHz; provision for external clock between 100 kHz and 1 MHz	Output Logic "1"	2.6-5.25 V (-10 mA at 2.6 V through a resistor to ground)
Input Control Signals	TTL Voltage Compatible	Output Off-State Leakage Current	100 μ A at 2.6 V
Logic "0"	0.0-0.8 V	Output Control Signals	TTL voltage compatible
Logic "1"	2.0-5.25 V	Logic "0"	0.0-0.4 V
Address Bus and R/W		Logic "1"	2.4-5.25 V
Logic "0"	0.0-0.5 V	Operating Temperature	0 to 70°C
Logic "1"	2.4-5.25 V	Power Requirements	5 Vdc at 700 mA
Off-State Leakage Current	-40 μ A	Physical Dimensions: W x H x T	9.75 x 5.75 x 0.062 in.

MEX6800 MPU Module

Resident
*(also available as additional
Optional Module)*



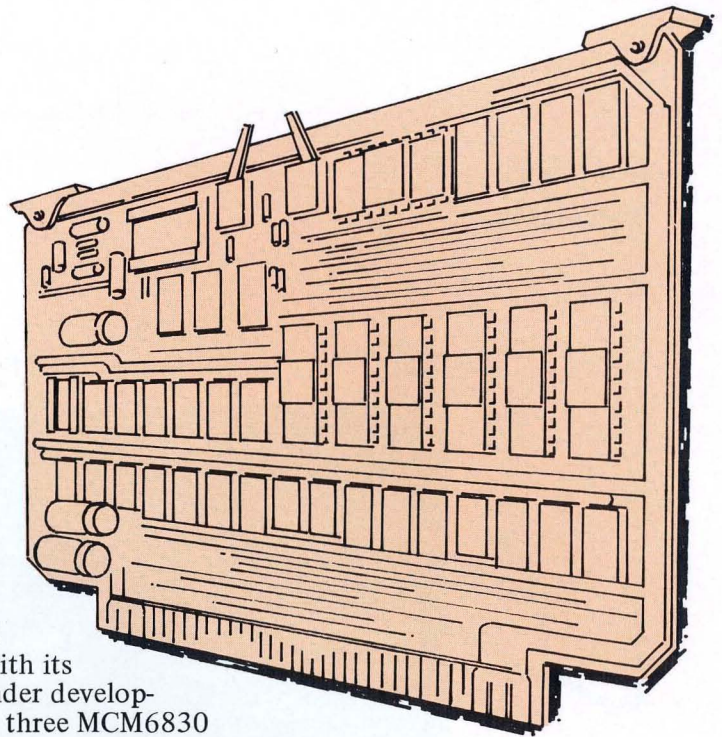
Debug Module

- Provides EXbug system development Firmware
- Contains the special hardware to implement the EXbug functions
- Enables the user to communicate with the EXbug Firmware via a data terminal
- Interfaces EXORciser front panel switches and controls with the MPU

The Debug Module, through its EXbug Firmware and implementation hardware, provides the EXORciser with its unique capabilities to evaluate and debug a system under development. The EXbug Firmware is stored in the module's three MCM6830 ROMs with the module's two MCM6810 RAMs serving as a scratch pad memory for the EXbug routines.

Using the EXbug routines provides the designer virtually unlimited freedom in examining and debugging his proposed system hardware and software. He can, for example, search the input medium for a file, load a file into EXORciser memory, verify the contents in the EXORciser memory, print out the contents of the EXORciser memory, and record the memory contents on the selected medium. In between these input/output functions, the user can examine and, if required, change the memory contents. He can insert and remove one hardware breakpoint and up to eight software breakpoints. He also can run in real time or trace through the user's program or a selected portion of the user's program. While using these routines, the user modifies his hardware and software as required until he has his system up and running. The DISABLE switch on the module may be used to disable the EXbug routines.

The user communicates with EXbug via an external terminal working in conjunction with the Baud Rate Module and the Debug Module. The STOP-ON-ADDRESS/SYNC ENABLE switch on the Debug Module is used to generate a sync pulse at a pre-selected address or to enable the hardware breakpoint function.



Specifications

(Note: Positive current flow is defined as flowing into the terminal, negative current flow as flowing from the terminal.)

Address and Control Bus

- Logic "0"
- Logic "1"

Data Bus

- Input Logic "0"
- Input Logic "1"
- Output Logic "0"
- Output Logic "1"

Operating Temperature

Power Requirements

Physical Dimensions

W x H x T

TTL voltage compatible

- 0.0-0.85 V (-200 μ A max at 0.5 V)
- 2.0-5.25 V (25 μ A max at 5.25 V)

Three-state TTL voltage compatible

- 0.0-0.85 V (-200 μ A max at 0.5 V)
- 2.0-5.25 V (25 μ A max at 5.25 V)
- 0.5 V max at 40 mA through a resistor to V_{CC}
- 2.6 V min at -10 mA through a resistor to ground

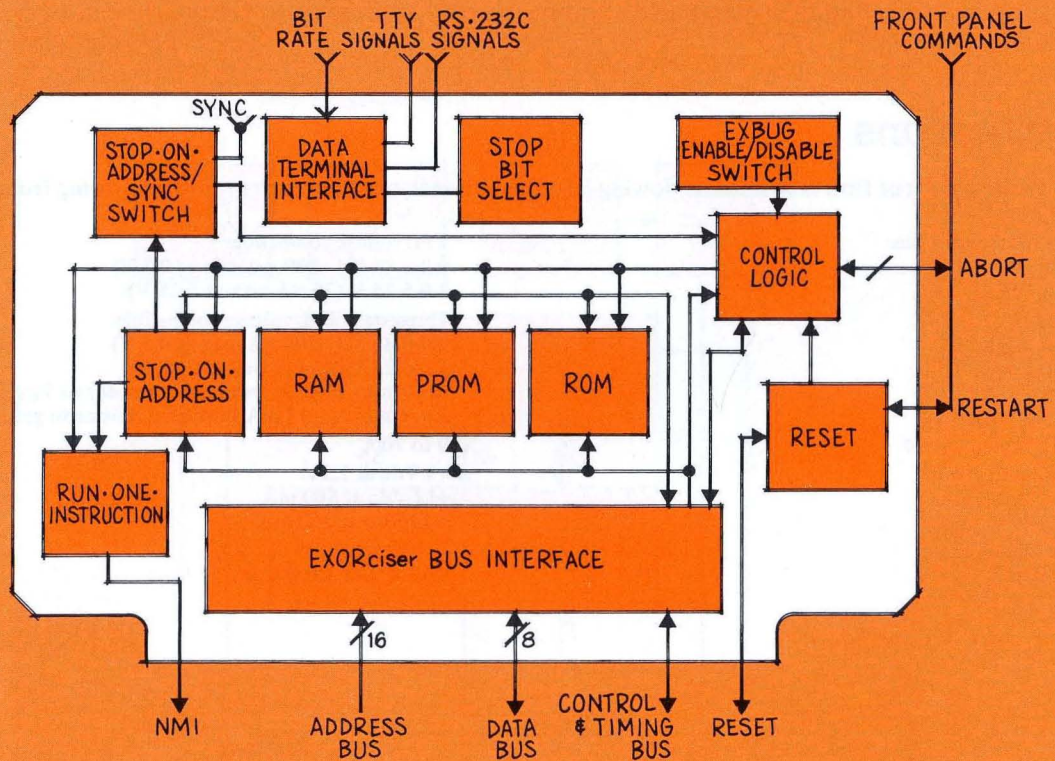
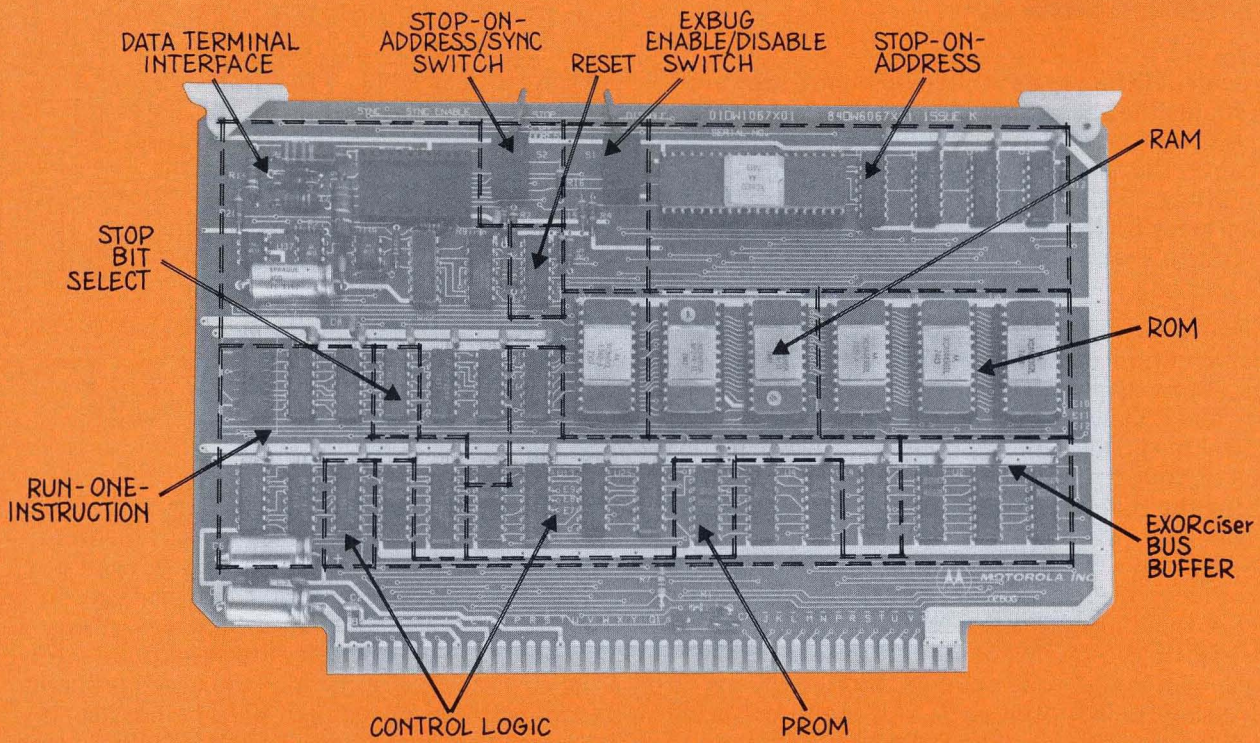
0 to 70°C

- +5 Vdc at 1.3 A
- +12 Vdc at 500 mA
- 12 Vdc at 500 mA

9.75 x 5.75 x 0.062 in.

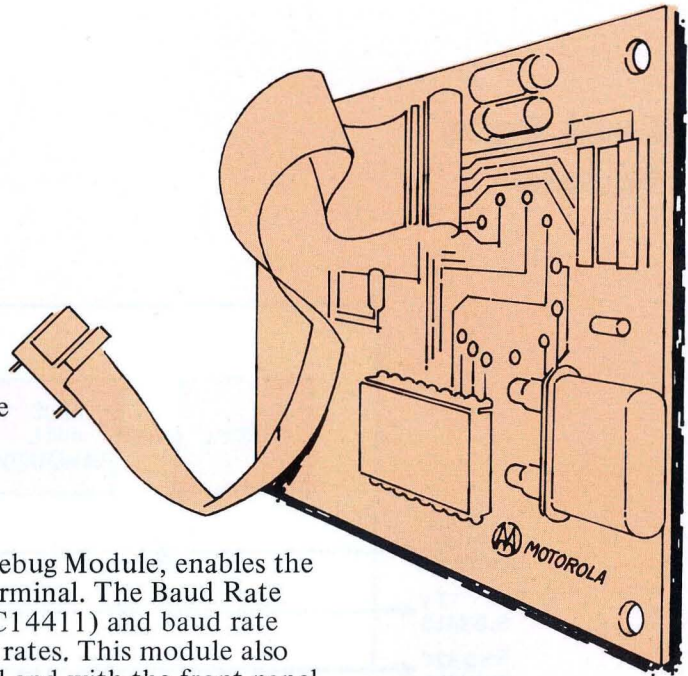
Debug Module

Resident



Baud Rate Module

- Provides the EXORciser with eight switch-selectable baud rates between 110 and 9600.
- Provides an interface between the Debug Module and the selected data terminal
- Provides an interface between the front panel and the Debug Module



The Baud Rate Module, in conjunction with the Debug Module, enables the designer to communicate with EXbug via a data terminal. The Baud Rate Module's crystal oscillator baud rate generator (MC14411) and baud rate switch provide the EXORciser with eight standard rates. This module also interconnects the Debug Module to a data terminal and with the front panel. Included with the module is the front panel interconnect cable.

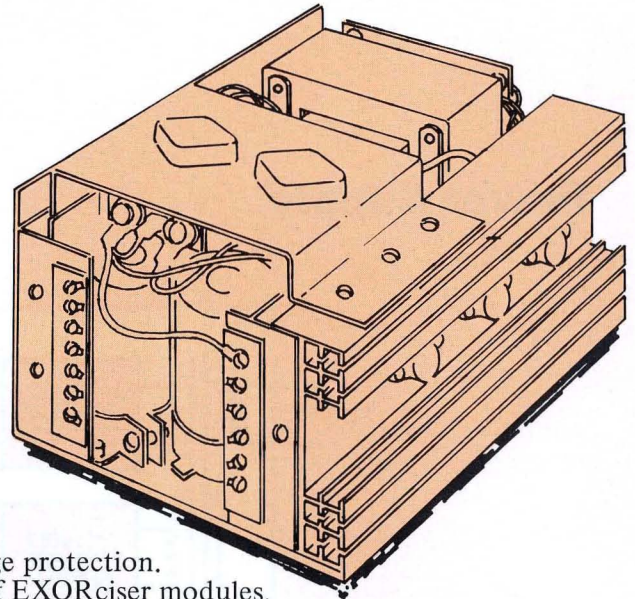
Specifications

Baud Rates: 110,150,300,600,1200,
(Switch Selectable) 2400,4800, and 9600

Physical Dimensions: 3.688 x 5.25 x 0.062 in.
W x H x T

Power Supply

- Provides all required EXORciser voltages
- Capable of supporting a full EXORciser rack of Modules



The power supply provides the EXORciser with +5 Vdc, +12 Vdc and -12 Vdc power sources. The +5 Vdc regulated source has both overload and overvoltage protection. This power source is capable of driving a complete rack of EXORciser modules.

The +12 Vdc and -12 Vdc sources are used to power portions of the interface circuitry between the EXORciser and a data terminal. These sources have overload protection and may be used to power custom circuitry on other modules.

Specifications

Output Voltages: +5 Vdc @ 15 A
-12 Vdc @ 1.5 A
+12 Vdc @ 2.5 A

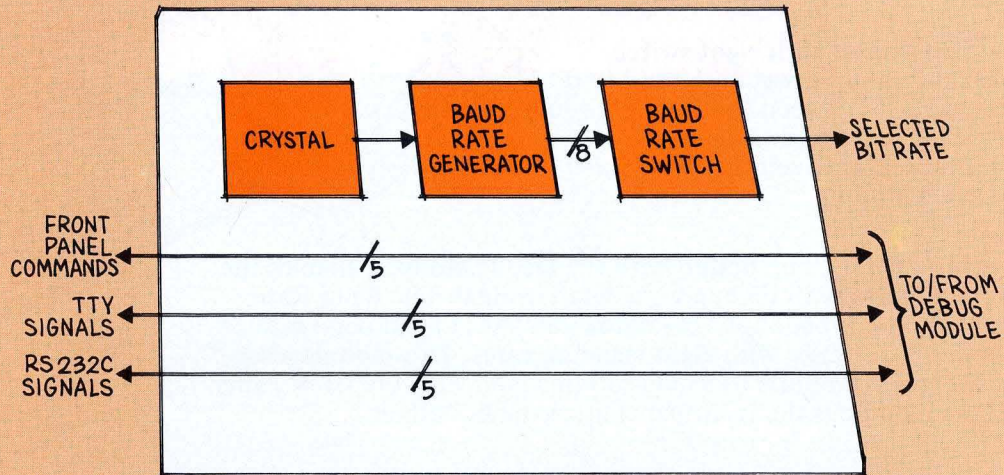
Input Voltage: 95-125/205-250 Vac

Input Frequency: 47 to 420 Hz, Single Phase

Physical Dimensions: 9.50 x 6.25 x 5.00 in.
L x W x H

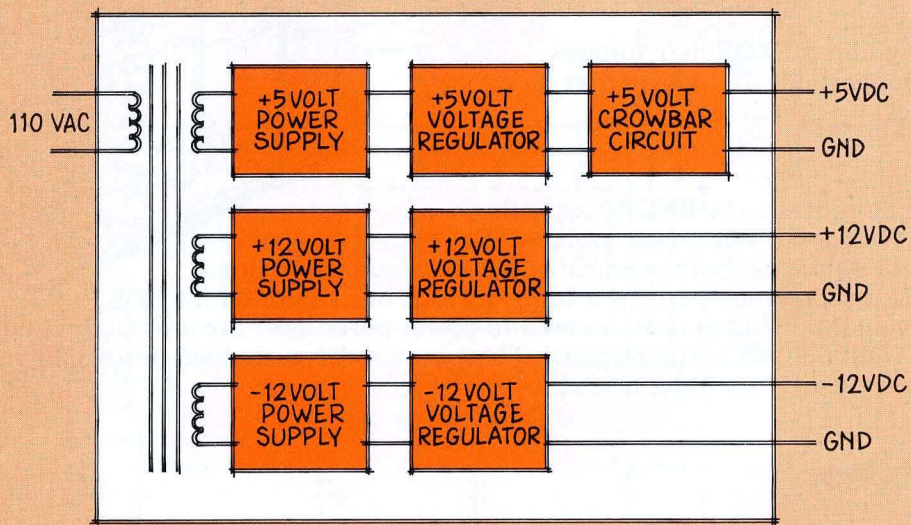
Baud Rate Module

Resident



Power Supply

Resident



MOTOROLA Semiconductor Products Inc.

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