

I. SYSTEM DESCRIPTION

WARNINGS

BEFORE PLUGGING IN THE ML4400 TO AN AC POWER SOURCE, VERIFY THAT THE CORRECT VOLTAGE (115 OR 230) HAS BEEN SELECTED VIA THE VOLTAGE SELECTOR SWITCH AT THE UPPER RIGHT OF THE REAR PANEL.

DO NOT INSERT OR REMOVE ANY CAPTURE MODULE, AND DO NOT CONNECT OR DISCONNECT ANY LOGIC POD OR MICROPROCESSOR POD FROM THE ML4400, WITHOUT FIRST POWERING DOWN THE ML4400 VIA THE POWER SWITCH AT THE LOWER RIGHT OF THE REAR PANEL. FAILURE TO DO SO WILL DAMAGE THE ML4400.

A. SPECIFICATIONS

Complete specifications for the ML4400 are given in Appendix A.

B. OVERVIEW

A logic analyzer's basic function is to capture (record) the digital data on signal lines repetitively, either synchronously or asynchronously with the clock of the target system. Hardware logic timing problems are best approached via high-speed, asynchronous logic analysis, and software debugging is accomplished with low-speed, synchronous operation.

The Arium ML4400 Logic Analyzer is a high-performance, low-cost modular system for debugging, troubleshooting, and production testing. Its design emphasizes speed and ease of use. For example, the ML4400 is very portable (just 26 pounds); its HELP key calls up immediate on-screen tutorial information on each of the analyzer's operating features; it has nonvolatile storage of machine setups, captured data, and reference memories; and it has one-key access to most functions and screens.

The ML4400 system's modular design enables the user to start out with a minimum general-purpose logic analysis system at a modest cost, then expand it later with more sophisticated capabilities by adding optional components as they become needed. This flexibility in modules and pods, and the unit's portability, also make it easy for several users to share one analyzer, with each one quickly reconfiguring it as needed for his or her particular application.

The ML4400 can operate at 400 MHz with 16 channels (32,767 samples), at 100 MHz synchronous with 64 channels (8191 samples), or at 50 MHz synchronous with 160 channels (4095 samples). Configurable with up to four independent clocks, it has transitional timing, automatic TimeStamping, and 5-nsec glitch capture on 8 channels at 100 MHz (with the 200-MHz Logic Pod).

An ML4400 system can be configured to operate as four independent logic analyzers, with each analyzer called a group. Each group has its own set of screens and settings, such as trigger words, trigger sequence, search words, and display format. The groups can function independently, or can be used to arm and cross-trigger each other.

The ML4400's triggering capabilities are complex, and include Boolean, multi-level, and repeat functions, plus data qualification. Up to eight trigger words are available, depending upon the operating speed and data width. The trigger sequences expand upon the predefined and user-defined sequences of the earlier Arium ML4100. They include go to another level, record on some levels and not on others (level-dependent data qualification), counts and time, and cross-trigger to different groups, as well as trigger on the rising and falling edge of a probe, on a glitch, or on a range.

The basis of an ML4400 Logic Analyzer system is its mainframe (catalog number ML4400). The mainframe contains a 7-inch CRT, serial and parallel ports, a multisync-compatible color video interface, an IBM-PC-style keyboard interface, trigger outputs, ROM emulation software, and nonvolatile memory for storing captured data and up to eight machine setups.

The user also needs at least one Capture Module (an internal card), either Standard (SC-4400) or High-Speed (HS-4400), and at least one Logic Pod (100-MHz, 200-MHz, or 400-MHz) or Microprocessor Pod. The Capture Modules are inserted in four easily accessible slots (behind the front panel's hinged keyboard), and the Pods connect to the Modules. Depending upon the user's applications, a total of up to four Capture Modules, with up to four Logic Pods and/or Microprocessor Pods, may be connected.

A wide selection of Microprocessor Pods provides disassembly of most of the signed to accommodate all of the microprocessor pods of its predecessor, the ML4100, at nominal cost via a small Adaptor Pod (AD-4100).

The ML4400 is unique among standard logic analyzers in that it accommodates up to four microprocessor pods operating simultaneously, with cross-triggering between the pods and split-screen display of time-aligned trace.

Additional options are a 3.5-inch Floppy Disk Drive (FD-003), a ROM Emulator Pod (RP-016), and a Serial Data Analysis Pod (8RS-232). The Floppy Disk option provides portable storage of machine setups and reference memories, a particularly useful feature in production test and field service applications. It is also a convenient way of protecting confidential data from unauthorized users. (The Floppy Disk Drive is not required to operate the analyzer, as all ML4400 software is firmware-resident.)

The optional ROM Emulator Pod supports in-circuit ROM emulation for real-time code patching and debugging. The Serial Data Analysis Pod provides the capability of capturing and displaying RS232C asynchronous data transmissions.

The mainframe's CRT display has drop-in window menus and on-screen labels for the front panel's six softkeys (keys whose functions change from screen to screen). The screen displays up to 16 timing lines; if 8 or fewer are selected, the timing lines can be presented in double height. Bus values can be displayed in hexadecimal (or any other standard number base) on timing diagrams. The user can scroll from one timing line to another, or to a different group, and can "mark" up to three locations, then move to and index from the marks to make delta time measurements.

The ML4400's special split-screen feature allows the user to conveniently compare two groups or show two modes of display at once (e.g., timing and state.)

Other convenient ML4400 features include Performance Analysis, Search and Compare functions, and Autocapture; a 9-function, multibase calculator; and a stopwatch and user-settable audible alarms.

C. HELP INFORMATION

The user may display context-sensitive "help" information for each ML4400 display screen and error message via the front panel's HELP key. With this key, the analyzer's functions can be quickly learned and used without referring to this operating manual. The user may also display a Help topic index.

Each Help topic displayed is tailored for the specific ML4400 configuration in use; e.g., if a High-Speed Capture Module is being used, information relating to the other (Standard) Capture Module will be omitted. It may be necessary to roll from one logic analyzer group to another to obtain Help information on different options.

For detailed information about Help functions, see Section IV-A.3.

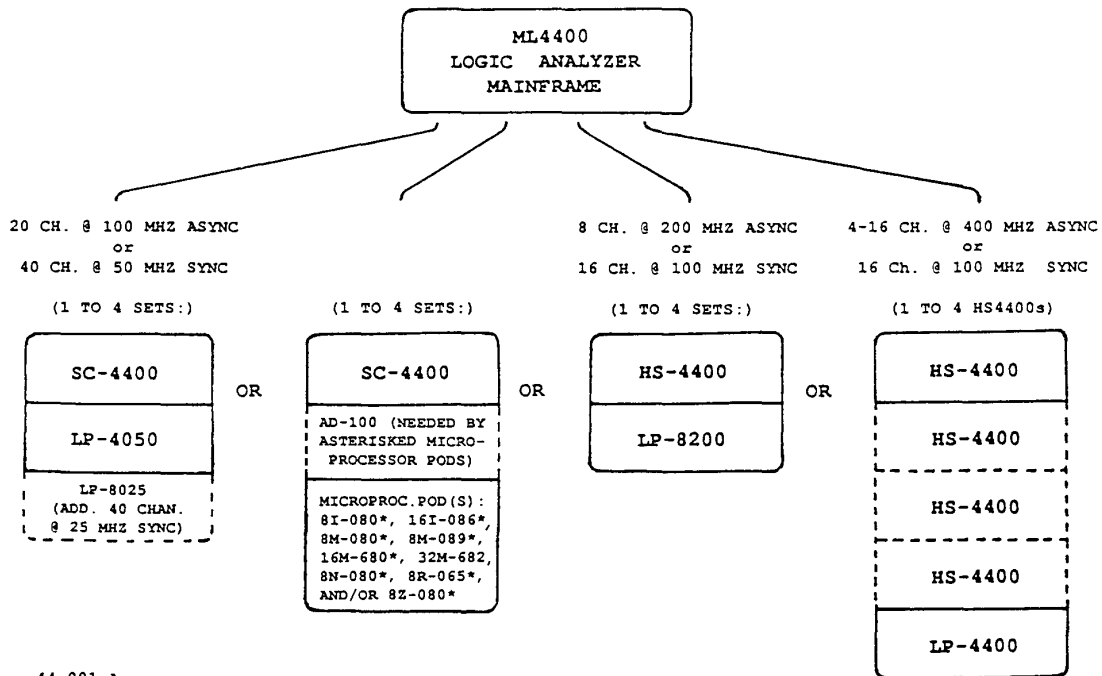
D. SYSTEM COMPONENTS AND CONFIGURATIONS (See also Section I-B, "Overview")

1. MAJOR SYSTEM COMPONENTS AND CONFIGURATIONS

Figure I-A below shows configurations of the ML4400 Logic Analyzer using the major system components: the mainframe, Capture Modules (internal cards), and the Logic Pods and Microprocessor Pods (both external accessories). The ML4400 system requires the use of at least one Capture Module, plus at least one Logic Pod or Microprocessor Pod. Up to a total of four of each of these may be used, depending upon the user's application, the number of channels needed, and the desired operating speeds.

Figure I-A

ML4400 MAJOR SYSTEM COMPONENTS



2. MAINFRAME

a. Internal

The ML4400's operating software resides in ROMs (accessible through the rear panel). (The 3-1/2-inch Floppy Disk Drive is available as an option for convenient storage, transporting and documenting of data and set-ups, but all major logic analyzer operating functions are available and fully usable without it.)

Figure I-B

ML4400 MAINFRAME INTERNAL COMPONENTS

Item	Part/Cat.No.	Location
-----	-----	-----
Main Logic Board	PN 920-1015	On top (right side), just under cover
CRT	PN 920-1080	On upper left of front panel
Power Board	PN 920-1069	Behind the CRT, with the Reg. Board
Regulator Board	PN 920-1070	Behind the CRT, with the Power Board
Fan		Behind the Power/Regulator Boards
Capture Module Slots		Behind the keyboard, at the bottom
Mother Board	PN 920-1016	Behind the Capture Module Slots, near the rear panel
ROM Board	PN 920-1030	Behind the Mother Board, against (and accessed via) the rear panel
Floppy Disk Drive (opt.)	FD-003	Behind the keyboard, at the top
Expansion Slots		Behind the Floppy Disk Drive
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The Arium ML4400 has been designed so that under normal operation there is no need to access these internal components, other than the Capture Module slots via the hinged keyboard on the front panel (see Section b, "Front Panel," below). When further access is needed, it may be obtained via the top cover. To remove the top cover, unfasten the six screws securing it (two on each side and two in the rear).

HIGH-VOLTAGE WARNING: BOTH THE CRT AND THE POWER BOARD CONTAIN HIGH VOLTAGE, AND THE USER SHOULD TAKE STANDARD HIGH-VOLTAGE SAFETY PRECAUTIONS WHEN THE ML4400 TOP COVER IS OFF.

b. Front Panel

The ML4400 front panel is the main user interface from which all operating functions are controlled.

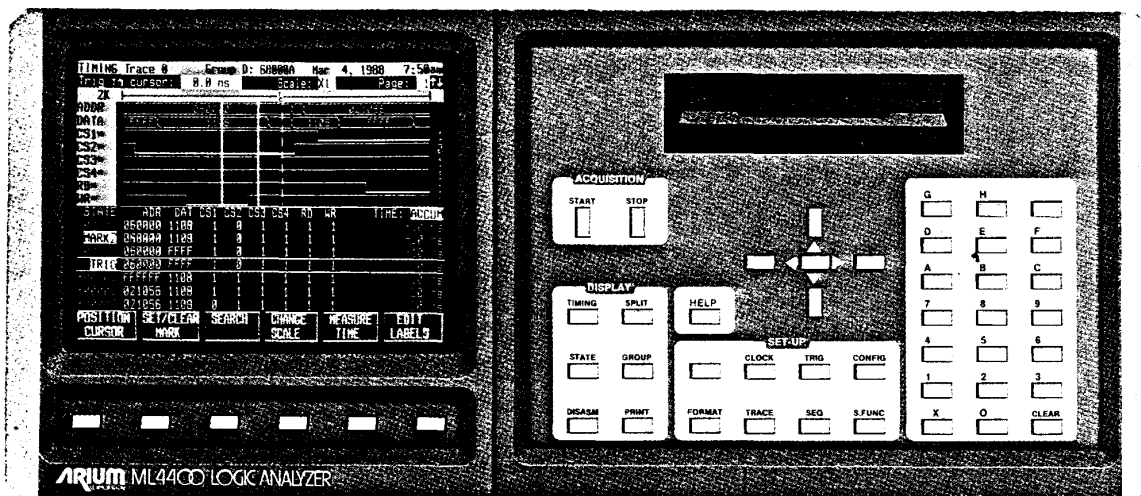
On the left is the 7" green-screen CRT for display of data, setups, and other information (such as Help screens). Below it is a row of six unlabeled soft-keys; these are keys whose functions change (depending upon which screen is being displayed) and whose labels appear on the bottom line of each screen.

On the right is the ML4400 keyboard, plus access to a 3-1/2-inch floppy disk drive at the top (if installed). As shown in Figure I-D (below), the keyboard has five groups of keys, including a hexadecimal-plus keypad. The use of the keypad is detailed in Section IV, "Operation."

The keyboard is hinged at the top. To open the keyboard, depress the release button on the bottom on the unit (just behind the "X" key on the keypad) and pull the lower edge out and up. (A support for the raised keyboard swivels out at the upper margin of the opening.) This gives easy access to the four slots which hold the Capture Modules. Thus, Capture Modules can be quickly inserted or removed, and Logic and/or Microprocessor Pods can be conveniently connected to the Capture Modules, with their cables extending through an opening in the bottom.

Figure I-C

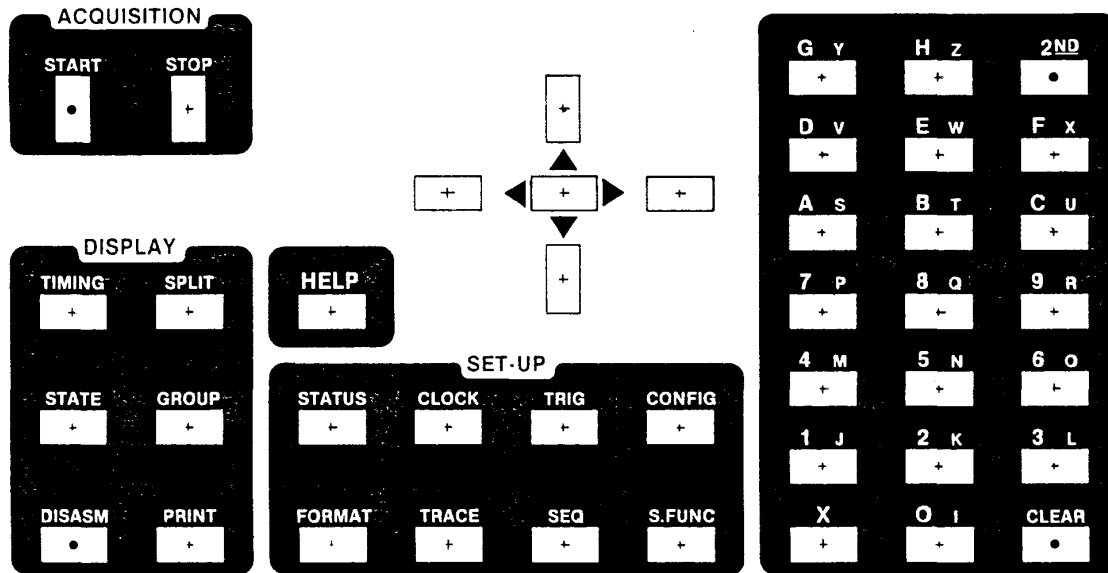
ML4400 FRONT PANEL



44-002

Figure I-D

ML4400 KEYBOARD



44-003

c. Rear Panel

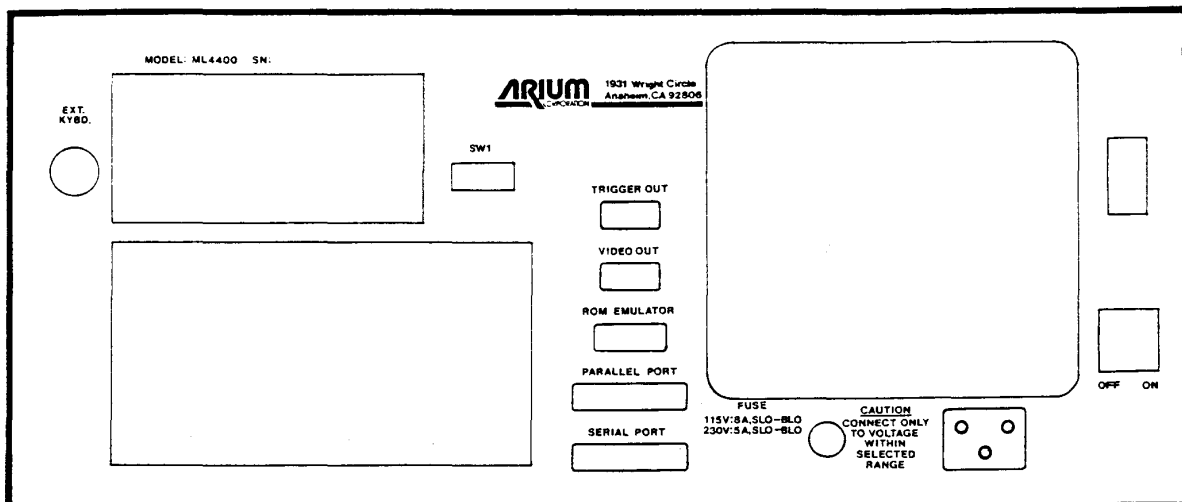
Figure I-E

ML4400 REAR PANEL COMPONENTS
(See Figure I-F, below, for locations)

Socket for AC power cord
On/Off Power Switch
Voltage Selector, 115/230 (slide switch)
Fuse (8- or 5-Amp, time-delay)
Connectors for optional peripheral equipment:
 External Keyboard (IBM-PC-style)
 Trigger Out
 Video Output (CGA-EGA-compatible monitor; 19-KHZ
 horizontal rate)
 ROM Emulator (Arium RP-016)
 Parallel Port (printer)
 Serial Port (printer, upload, and download)
8-position Switch (for factory testing use)
Access to ROM Board (via lower left opening)

Figure I-F

ML4400 REAR PANEL



44-004

3. CAPTURE MODULES ("CAPTURE CARDS") (See also Figure I-A.)

a. General

An ML4400 Capture Module (often called "Capture Card") is an 8" x 13-1/2" printed circuit board which provides the ML4400 with its basic data capture memory, triggering and start/stop logic. At least one is required to operate the analyzer; up to four can be used, depending upon the user's application. The board is inserted by the user directly into the ML4400 mainframe from the front panel; the Capture Module slots are behind the hinged keyboard.

b. Standard Capture Module (SC-4400)

Operation of the ML4400 logic analyzer with an SC-4400 features:

- * Basic data width of 40 channels at 50 MHz synchronous, or 20 channels at 100 MHz asynchronous
- * Automatic TimeStamp of each recorded sample to a resolution of 50 ns
- * Up to 8 trigger words and up to 4 trigger sequence levels
- * One timer/counter

(1) Basic Logic Use

The SC-4400 can be used with a 100-MHz Logic Pod (LP-4050), providing an operating capability of 20 channels at 100 MHz, or 40 channels at 50 MHz synchronous. To expand this capability to an additional 40 channels at 25 MHz synchronous (a total of 80 channels), one Expansion Logic Pod (LP-8025) is connected to the LP-4050.

In turn, the user can configure the system with up to four SC-4400/LP-4050 sets, all clockable together, yielding as many as 160 channels at 50 MHz synchronous. This capability is significant in many synchronous test applications, such as those involving ASICs, micros, or high-speed buses.

The ML4400 can also handle a 32-bit Microprocessor Pod, such as the 68020, with a single SC-4400, because it multiplexes by a factor of two in the Pod.

(2) Microprocessor Disassembly

Generally, for software debugging and microprocessor disassembly applications, the user will need one or more Standard Capture Modules. For microprocessor disassembly of one target microprocessor, the appropriate Microprocessor Pod is attached to the SC-4400. Disassembly of more microprocessors (up to a total of four) requires an additional SC-4400/Microprocessor Pod set for each microprocessor.

NOTE: For the 68030 and 80386 Microprocessor Pods, two SC-4400s are required, so the maximum number of these Pods in the system configuration is two.

c. High-Speed Capture Module (HS-4400)

Operation of the ML4400 logic analyzer with an HS-4400 features:

- * Basic data width of 16 channels at 100 MHz synchronous and asynchronous
- * Up to 4 channels at 400 MHz asynchronous
- * Transitional data recording in both modes
- * Four trigger words and 14 levels of trigger sequence

This Module is used with either the 200-MHz Logic Pod (LP-8200) or the 400-MHz Logic Pod (LP-4400), with the following operating characteristics:

LP-8200: 8 channels at 200 MHz
 16 channels at 100 MHz
 8 channels at 100 MHz with glitch capture

(In glitch mode, glitches are uniquely displayed with their own special characters, as are "Don't Cares" from a Reference Memory when shown in timing display mode.)

LP-4400: 4 channels at 400 MHz
 16 channels at 100 MHz

(One LP-4400 may be connected to 1-4 HS-4400s, yielding 4-16 channels at 400 MHz asynchronous.)

This Module is primarily used for high-speed timing (asynchronous) analysis, but can also be used for 100-MHz synchronous data capture. (Both Pods offer 16 channels at 100 MHz synchronous or asynchronous.) The LP-8200 offers 8 channels of 5-nsec glitch capture. With four HS-4400s, the following maximum performances can be realized:

16 channels, 400 MHz (LP-4400)
32 channels, 200 MHz (LP-8200)
64 channels, 100 MHz synchronous or asynchronous (either Pod)

These high-speed capture systems can be triggered or armed from other High-Speed Capture Modules or from configurations with a Standard Capture Module. Capture systems may be ganged to perform like one analyzer or operated independently as up to four logic analyzers.

4. LOGIC PODS (See also Figure I-A)

The ML4400 system has four types of Logic Pods:

- LP-4050, 100-MHz Logic Pod
- LP-8025, Expansion Logic Pod (used with LP-4050 only)
- LP-8200, 200-MHz Logic Pod
- LP-4400, 400-MHz Logic Pod

The first two Pods (LP-4050 and LP-8025) are used only with Standard Capture Modules (SC-4400). The LP-4050 connects directly to the Capture Module, whereas the LP-8025 connects to (and extends the capability of) the LP-4050.

The other two Pods (LP-8200 and LP-4400) are used only with High-Speed Capture Modules (HS-4400), and both Pods connect directly with the Capture Module.

The catalog number of each Logic Pod signifies its capability in terms of number of available data channels and operating speed; to wit:

- LP-4050: 40 channels at 50 MHz (also 20 channels at 100 MHz)
- LP-8025: 80 channels at 25 MHz (when used with LP-4050)
- LP-8200: 8 channels at 200 MHz
- LP-4400: 4 channels at 400 MHz

5. MICROPROCESSOR PODS (used with SC-4400 only)

a. Microprocessor Disassembly

The ML4400 supports a wide selection of microprocessors. For processors that prefetch instructions, data cycles are grouped with their respective instructions, not next to the instruction fetched at the time nearest to it over the bus. The TimeStamp capability can be viewed in either cumulative or delta mode, and can be re-referenced to any arbitrary point, enabling the user to quickly display and compare actual measured execution times for specific pieces of code.

The general application of the Microprocessor Pods, and the ML4400 system configurations in which these Pods are used, are explained in Section I-D.3.b, "Standard Capture Module" (above). For detailed information about performing microprocessor disassembly with these Pods, see Section IV-D.4, "Disassembly Display Mode". For information about a Pod, see Sections V, VI, or VII, (re 8-bit, 16-bit, and 32-bit Pods, respectively).

All the Microprocessor Pods of Arium's earlier ML4100 Logic Analyzer may be used with the ML4400 via an Adaptor (AD-4100); one Adaptor per pod is needed.

b. Types

Figure I-G, below, lists the ML4400 Microprocessor Pods that are available or under development as of publication time. Those asterisked are the ML4100 pods which require an Adaptor (AD-4100) for use with the ML4400. One Adaptor is needed for each pod being used simultaneously, so the maximum number of Adaptors that might be needed is four.

Figure I-G

ML4400 MICROPROCESSOR PODS
[* = Requires AD-100]

INTEL

Available:

8I-080* Supports 8085, 8031/32, 8035/39/40
16I-086* Supports 8086/8088

Under Development:

16I-186 Supports 80186/80188
16I-286 Supports 80286
32I-386 Supports 80386 (needs 2 SC-4400s)

MOTOROLA

Available:

8M-080* Supports 6800, 6802/6808
8M-089* Supports 6809, 6809E
16M-680* Supports 68000, 68010
32M-682 Supports 68020

Under Development:

8M-011 Supports 68HC11
32M-683 Supports 68030 (needs 2 SC-4400s)

OTHER

Available:

8N-080* Supports NSC800
8R-065* Supports 6502, 65CX02, 6512, 65C112
8Z-080* Supports Z80

6. MISCELLANEOUS ARIUM COMPONENTS (OPTIONAL)

a. 3-1/2-inch Floppy Disk Drive (FD-003)

The addition of a floppy disk drive to an ML4400 system makes it convenient to document, archive, and transport large volumes of analysis data, as well as the machine setups with which they were obtained. One common application is the production test or field service environment, in which standard test conditions and results must be preserved in order to verify performance of a given circuit. The Arium FD-003 has a 720-Kbyte capacity, is DOS-compatible, and is accessible from the ML4400 front panel.

b. ROM Emulator Pod (RP-016)

The ROM Emulator Pod enables the ML4400 to provide in-circuit emulation of one or more 27XX series EPROMs for real-time code patching, providing more power when debugging code in microprocessor-based systems. Code may be downloaded to the Emulator Pod, then patched as required. Up to 32 Kbytes of memory may be emulated. For detailed information about ROM emulation operation, see Section VIII, "ROM Emulator".

(This pod is identical to Arium's earlier ML4100 ROM Emulator Pod. However, the ML4400 ROM emulation software resides in the ML4400 mainframe as standard equipment, whereas the ML4100 ROM emulation software resides in an optional accessory.)

c. Serial Data Analysis Pod (8RS-232)

The Serial Data Analysis Pod enables the ML4400 to monitor and analyze all transfers occurring over an EIA RS232C/V.24 serial interface. Up to 4000 synchronous or asynchronous events, during either full-duplex or half-duplex channel operations, can be collected. All bus activity, including data transfers, control bits, and framing, parity and overrun errors, can be displayed for analysis. Data and triggering formats are binary, octal, decimal, or hexadecimal; data may also be displayed in ASCII.

Captured information may be displayed in timing, state, disassembly, or text mode. Data may be viewed as received, transmitted, or both in combination; data word lengths may be 5, 6, 7, or 8 bits.

All of the ML4400's standard operating features (such as settable delays, immediate data capture upon powerup, up to eight trigger words, data qualification, and customized formatting of displayed data) are present when using this pod. In addition, the pod provides a special bit when using the internal clock which is used to synchronize on complete character transmissions. Any RS232C/V.24 data, control, or protocol activity can be used as a trigger event.

The Serial Data Analysis Pod has two parts: an Arium 8RS-232A and a Philips PM8811A. The Arium part plugs into an AD-4100 Adaptor Pod, which is connected to an SC-4400 (accessed via the hinged ML4400 keyboard), and the Philips part connects to the external RS232C link. The pod is physically in series with other devices on the channel, but electrically in parallel with them. This allows all monitoring and analysis of the communications interface to be completely transparent to the channel's operation.

Up to four Serial Data Analysis Pods may be used at once, with each connecting to a Standard Capture Module. (NOTE: This pod is identical to Arium's earlier ML4100 Serial Data Analysis Pod, and requires one Adaptor (AD-4100) per pod.)

For detailed information about the operation of this pod, see Section IX, "Serial Data Analysis Pod". For information about connecting this pod, see Section II-B.1, "Serial Data Analysis Pod."

E. NON-ARIUM PERIPHERAL EQUIPMENT

1. EXTERNAL KEYBOARD

For users who prefer to operate with an IBM-PC-style keyboard, the ML4400 provides a keyboard interface connector on its rear panel. (As of publication time, this feature has not yet been activated.)

2. VIDEO MONITOR

This feature provides the display, in color, of any ML4400 screen on an NEC multisync or equivalent monitor.

3. PARALLEL PRINTER

The ML4400 can print any screen on a printer which supports Epson graphics characters and a standard Centronic parallel port.

4. SERIAL PORT

The ML4400 supports RS232C data transmissions at up to 38,400 baud via its serial port. This port is used for serial printers, uploading and downloading of ROM Emulator data, remote control, and uploading and downloading of machine setups and Reference Memory.

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