ARIUM CORPORATION

OPERATING MANUAL FOR

ML4100 LOGIC ANALYZER

September 6, 1984, edition

(Revises and replaces
May 25, 1984, edition)

Published September 6, 1984

Arium Corporation · 1931 Wright Circle, Anaheim, CA 92806-6052 · Tel.: (714) 978-9531 · Telex: 754903 ARIUM UD

TABLE OF CONTENTS
(followed by LIST OF FIGURES)

I. INTRODUCTION

II. CONNECTION TO SYSTEM UNDER TEST

III. DISPLAY AND SETUP OF OPERATING PARAMETERS

VI. MICROPROCESSOR PODS

VII. STD BUS POD (8P-080)

VIII. ROM EMULATOR MODULE (RE-016)

IX. SETUP MEMORY OPTION (SM-080) AND SETUP/DATA MEMORY OPTION (AB-032)

APPENDIX A: SPECIFICATIONS

LIST OF FIGURES

(blank)

I. INTRODUCTION

(blank)

A. ML4100 DESCRIPTION

The Arium ML4100 Logic Analyzer provides full-featured logic analysis for the debugging and troubleshooting of digital and microprocessor-based products, including complex triggering with state, timing, and (optionally) microprocessor disassembly displays. Its basic function is to capture (record) the digital data on several signal lines, repetitively, and to do this synchronously or asynchronously with the clock of the system under test. High-speed, asynchronous operation is a powerful aid when solving hardware logic timing problems, while low-speed, synchronous operation is useful for debugging software.

The ML4100 operates at speeds of up to 100 MHz, at data widths of up to 32 channels, and at a memory depth of up to 8000 samples per channel. (At 100 MHz, the maximum number of channels is 4; when using 32 channels, the maximum speed is 12.5 MHz; and the maximum memory depth of 8000 samples per channel is available only when using up to 4 channels.)

Data and clock qualifiers can be used, as well as a trigger delay of up to 50,000 clocks. (Data qualification is available only with 32-channel operation.) The optional ROM Emulator Module (RE-016) provides in-circuit emulation and editing of code stored in 2716, 2732, 2764, and 27128 PROMs; it includes an RS-232C interface, which permits downloading or uploading of code. The expanded memory option (Setup/Data Memory, AB-032) permits both machine setups and data to be uploaded or downloaded, as well as stored while power is off.

The ML4100 contains a 5-inch, green-screen CRT which displays up to twelve channels of timing diagrams (with labelling) and has cursors for measuring time periods. The state display can be formatted and reformatted to achieve almost any conceivable digit combination in several number bases: ASCII, binary, octal, decimal, or hexadecimal.

Other options are microprocessor pods with one-clip connection to most popular microprocessors; the resulting disassembly display shows mnemonics for the various instruction and data sequences.

Four trigger words are available, and can be defined in binary, octal, decimal, or hexadecimal number base. These four words can be combined to form the trigger condition in many different ways. Nineteen trigger sequences are predefined and selectable, and the user may define his own sequence as well. All predefined sequences are available in the 32-channel mode, but these sequences are somewhat more limited in the other modes.

The ML4100 has been designed for simple setup and ease of operation. All setup and display screens contain complete prompting information which is self-explanatory for most situations. This enables the user to make productive use of this logic analyzer with a minimum of experience and, we hope, only infrequent reference to this manual.

B. OVERALL SYSTEM FUNCTIONS

1. RECORDS DIGITAL DATA AT:

   * Speeds (clock/sampling rates) of up to 100 MHZ (10 nsec between samples) (4 channels maximum at 100MHz)

   * Data (word) widths of 4 to 32 channels (bits) (12.5 MHz maximum at 32 channels)

   * Record depth (memory) of up to 8000 samples per channel (4 channels maximum at 8000 samples)

2. DISPLAYS DATA IN THREE MODES:

   * Timing (as on an oscilloscope)

   * State (a formatted word list)

   * Disassembly (microprocessor assembly code instructions)--optional

3. STANDARD ACCESSORY: 32-CHANNEL LOGIC POD (LP-320)

The ML4100 includes a 32-Channel Logic Pod (with Standard Probe Set) at no extra charge. This pod supports analyzer operation at all speeds and recording widths, with internal or external clocking; clock qualification is available with external clock. (See also Section II.A, re connection of this pod to the ML4100.)

4. OPTIONAL ACCESSORIES (available for separate purchase)

   a. 4-Channel (Glitch-Capture) Logic Pod (LP-040)

This pod operates at any speed of up to 100 MHz and a data width of 4 channels to provide advanced timing analysis with high-speed clock qualification and glitch capture. (See also Section II.A, re connection.)

   b. STD Bus Pod (8P-080)

This circuit board provides connection to an STD bus structure. It plugs into the bus as an extender card (not as a replacement card), and can thus be used in a backplane which is fully occupied. (See Section VII for further details.)

c. Microprocessor Pods

Microprocessor pods provide one-clip connection between the ML4100 and most popular microprocessors. The following such pods are available:

Catalog No.:	Microprocessors Supported:
8I-080	Intel 8085, 8031/8032, & 8035/8039/8040
8M-080	Motorola 6800/6802/6808
8M-089	Motorola 6809/6809E
8N-080	National Semiconductor NSC800
8R-065	Rockwell 6502, 6512 65C02/65C102, & 65C112
8Z-080	Zilog Z80, Z80A, Z80B, & Z80C
16M-680	Motorola 68000/68010

(See Section VI for further details.)

d. ROM Emulator Module (RE-016)

The ROM Emulator module emulates one to four Read-Only Memories per pod, up to a total of 16 Kbytes of memory, and is configurable for 2716, 2732, 2764, or 27128 PROMs. One or two pods may be used for a total of 32 Kbytes of emulation memory. The simulated ROM memory can be uploaded or downloaded, in several popular data transfer formats, to or from other equipment (such as computers and PROM programmers) via an RS-232C port on the back panel. Memory is then displayed on the ML4100 screen and can be changed directly with front-panel key entries.

(See Section VIII for further details.)

e. RS-232C Communication Control Card (RS-232)

This circuit board is contained within the ROM Emulator Module, but may also be purchased separately when the user wishes an interface between the ML4100 and other equipment, such as a computer or a printer. With this board, the user may specify operating parameters (baud rate, format, handshakes, etc.) from the ML4100 front panel.

f. Setup/Data Memory Option (AB-032)

This option provides the ML4100 with nonvolatile memory so that machine setups and capture data are permanently stored (even while the power is off) via an internally installed, electrically eraseable ROM board.

g. Setup Memory Option (SM-080)

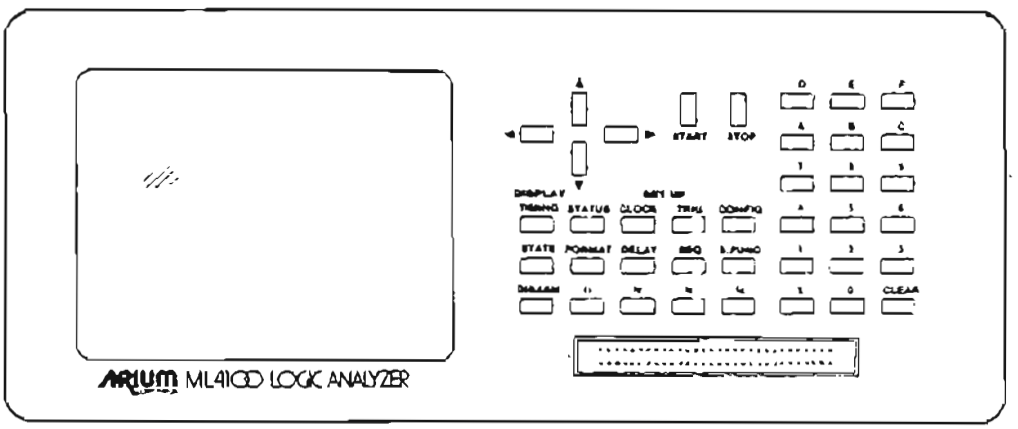
This option provides the ML4100 with nonvolatile memory of machine setups only. (See Item f above.)

C. SYSTEM SPECIFICATIONS

Detailed system specifications are given in Appendix A.

Figure 1

FRONT PANEL



D. FRONT-PANEL FUNCTIONS (See Figure 1)

1. CONNECTOR RECEPTACLE (At botton of right side of panel) -- For connecting a selected pod to the ML4100.

WARNING: DO NOT PLUG OR UNPLUG THE POD CONNECTOR WHILE UNIT IS POWERED UP.

(See Section II.A for details of use.)

2. KEYBOARD AND CRT SCREEN

All operating functions are controlled from the front-panel keyboard. All keys will repeat if held down; use a quick and sure touch to avoid unwanted repeating.

a. START and STOP Keys -- To start and stop recording of data. (To turn on the ML4100, use the POWER Switch (ON/OFF) on the back panel.)

b. Hexadecimal Keypad (on the right) -- To set and change recording and display parameters.

c. Four Arrow Keys -- To move the cursor on setup screens, and to scroll through the data on display screens.

d. Three "DISPLAY" Keys (TIMING, STATE, and DISASM) -- To select the data display mode.

e. Twelve "SETUP" Keys -- To access setup screens for specifying parameters for data recording and data display formatting.

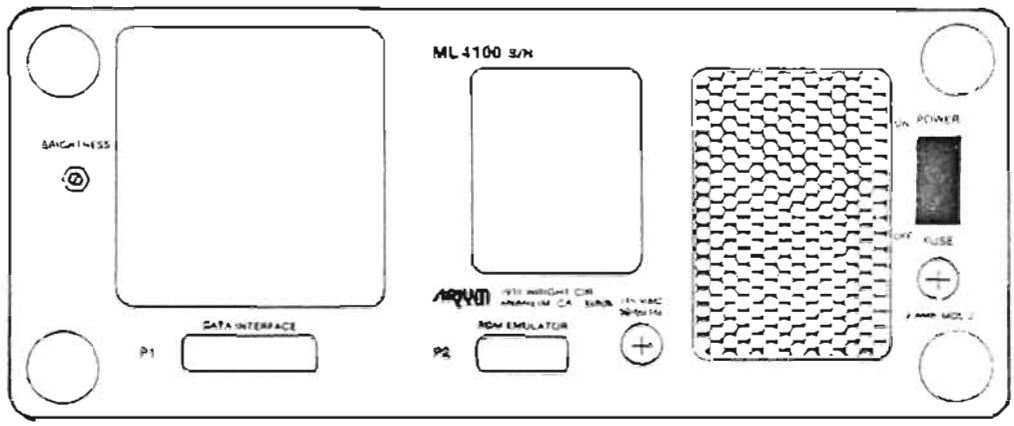
f. CRT Screen -- To display data and to set up recording and display parameters. Any setup screen may be accessed with only a single keystroke. Changeable fields are reverse-videoed and the cursor position blinks; the cursor automatically skips over nonchangeable fields. (The CRT has a 5-inch green screen.)

To change any setup or operating parameter, simply position the cursor into its field, then enter the desired parameter via the keypad; the new parameter (and any other value determined from it) will be updated and displayed. (Actual update occurs when the screen or field is exited via the setup keys or cursor.)

(See also Section IV.A.3, Moving the Cursor and Scrolling.)

Figure 2

BACK PANEL



E. BACK-PANEL FUNCTIONS (see Figure 2)

1. POWER SWITCH (ON/OFF)

2. P1/DATA INTERFACE -- Connector receptacle for RS-232C interface with a host computer or other equipment.

(See Section VIII, ROM Emulator Module, for details about use of this interface.)

3. P2/ROM EMULATOR -- Connector receptacle for ROM Emulator Module.

(See Section VIII for details about this module.)

4. BRIGHTNESS ADJUSTING SCREW -- To vary the intensity of the CRT screen.

F. AUDIBLE WARNINGS

1. ONE BEEP -- Warns that a wrong key has been depressed (including trying to move the cursor past the limits of the field or screen), and has been ignored by the system. For example, depressing a numeric key on a display screen will usually produce one beep.

2. TWO BEEPS -- Signal that data has stopped being recorded, i.e., that the trigger condition has occurred and the trigger delay has been satisfied.

3. THREE BEEPS -- Warn that setup entries are inconsistent, or that there are pod status errors. The screen will display an explanatory error message, such as "ALREADY STARTED" if the START key is depressed a second time, "POD CONNECTION ERROR" if the connection to the unit under test is wrong, "NO DATA RECORDED" if the STOP key is depressed before any data has been recorded, etc.

4. CONTINUOUS BEEPS -- Indicate that a wrong key is being depressed continuously and is repeating, or, at powerup, that a key is stuck.

(Blank)

II. CONNECTION TO SYSTEM UNDER TEST

A. CONNECTION VIA LOGIC POD

WARNING: DO NOT PLUG THE POD CONNECTOR INTO, OR UNPLUG IT FROM, THE FRONT-PANEL CONNECTOR RECEPTACLE WHILE THE ML4100 IS POWERED UP.

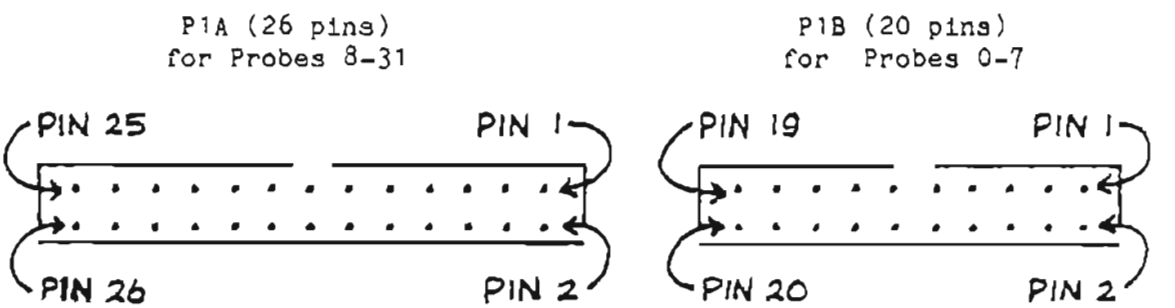
NOTE: Connection procedures are the same for both the 32-Channel (Standard) Logic Pod (LP-320) and the 4-Channel (Glitch-Capture) Logic Pod (LP-040).

The 32-channel pod has 42 wires (16 on one probe set and 26 on the other probe set), connectored and color-coded as described below. The 4-channel pod has 6 twisted wire pairs terminated in E-Z Hook test clips. Each signal lead has a resistor in the lead and adjacent to the signal clip to reduce reflection.

Each probe has 3 parts: the tip (body), the cap (plunger), and the wire; each part may be one of ten colors. Clock Probes have all three parts colored red; Clock Qualifier Probes are all blue; the grounds are all black. All remaining probes (32 for the 32-Channel Logic Pod, and 4 for the 4-Channel Logic Pod) have grey caps.

For the 32-Channel Logic Pod, the probe color coding is shown in Figure 3 and on the Logic Pod Color Codes screen (accessed via the Special Functions screen by depressing S. FUNC, then "2"); for the 4-Channel Logic Pod, the color codes are shown in Sections II.A.2 below and Section V.B.1. The data probes of the 32-Channel Logic Pod use the standard electronic color code, with the tip being the most significant digit and the wire being the least significant.

The header pin assignments are shown below; for the 32-Channel Logic Pod, P1B is the 20-pin header for Probes 0-7, and P1A is the 26-pin header for Probes 8-31. Note that the numbering on the connector receptacle does not match that on the mating connector. All pin numbers in this manual refer to the connector receptacle. (The connector is housed within the pod.)



CONNECTOR RECEPTACLES ON END OF 32-CHANNEL LOGIC POD

B. CONNECTION VIA MICROPROCESSOR PODS

WARNING: DO NOT PLUG THE POD CONNECTOR INTO, OR UNPLUG IT FROM, THE FRONT-PANEL CONNECTOR RECEPTACLE WHILE THE ML4100 IS POWERED UP.

To connect a microprocessor pod, insert its cable connector plug into the connector receptacle on the front panel, then clip the probe to the microprocessor; the brown wire on the colored ribbon cable connects to Pin 1 of the microprocessor. Information obtained internally from this probe will be used by the ML4100 to determine some of its setup parameters.

For setup procedures, see Section III.H, (Display) Format Setup Screen. For trigger configuration details and status codes, see Section VI, Microprocessor Pods.

C. CONNECTION VIA STD BUS POD (8P-080)

WARNING: DO NOT PLUG THE POD CONNECTOR INTO, OR UNPLUG IT FROM, THE FRONT-PANEL CONNECTOR RECEPTACLE WHILE THE UNIT IS POWERED UP.

The STD Bus Pod consists of a circuit board and a cable for connection to the ML4100.

To connect the STD Bus Pod, attach its cable connector plug to the connector receptacle on the front panel; then insert the circuit card into an unused slot in the STD bus backplane of the unit under test, or install it as an extender between the bus and a card on the bus.

For operating details, see Section VII, STD Bus Pod.

D. ROM EMULATOR MODULE (RE-016) CONNECTION

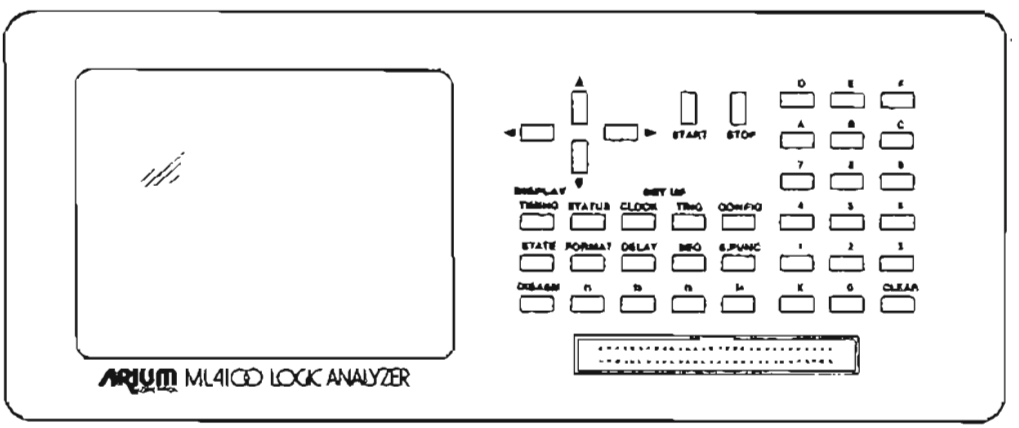
WARNING: DO NOT CONNECT OR DISCONNECT THE ROM EMULATOR MODULE WHILE THE ML4100 IS POWERED UP.

To connect the ROM Emulator Module, insert the module's cable connector into the P2/ROM EMULATOR connector receptacle on the back panel. Then connect the proper DIP plug directly between the ROM sockets of the system under test and the ROM Emulator pod.

For operating details, see Section VIII, ROM Emulator Module.

III. DISPLAY AND SETUP OF OPERATING PARAMETERS

(Figure 1, repeated)
FRONT PANEL



A. GENERAL INFORMATION RE ALL SETUP AND DISPLAY SCREENS

To access the ML4100 for operation, use the front-panel setup keys: STATUS, CLOCK, CONFIG, TRIG, SEQ, DELAY, and FORMAT. Each of these keys calls up a CRT screen offering parameter selections and/or setup information. Changeable fields on the CRT display are reverse-videoed and the cursor position blinks; the cursor automatically skips over nonchangeable fields.

Each screen contains complete prompting information about how to set up each parameter, including exactly what the preset options are, the specific hexadecimal key designated to select each option, and the allowable ranges of parameter values. Also, the system protects against most wrong entries and selections by not accepting them, and beeping to warn the user.

As soon as a parameter has been set, any other parameter dependent upon it is updated and displayed, usually immediately. (In some cases, a dependent parameter is not updated until the cursor has left the field of the parameter being changed.)

To select or change any setup (operating) or display parameter, move the cursor to the parameter's field, which will cause it to blink, indicating its readiness to be set up. Each parameter may then be set in one of two ways: either there is a limited number (usually 2 or 3) of preset options which may be selected by the user, or the actual value of the parameter (usually numeric) may be entered by the user. Both operations are performed directly via the keys on the hexadecimal keypad, which contains a key for each digit from 0-9, a key for each letter from A-F, a CLEAR key, and an "X" key. (See Figure 1.)

While the ML4100 is recording, a blinking "ACTIVE" message is displayed in the upper right of the six setup screens; during this time, setup parameters may be viewed on each screen, but not changed. Recording must be stopped (by depressin- STOP) before any setup parameter may be changed.

B. (SYSTEM) STATUS SETUP SCREEN (VIA "STATUS" KEY) (See Fig. 4)

The (System) Status screen acts as a base of operations for the ML4100 user. It is a passive screen which only presents information, as compared with the six setup screens (Clock, Configuration, Trigger, Sequence, Delay and Format), which not only present information but also are interactive screens via which the user can select and change operating parameters.

The (System) Status screen gives an overall view of the six setup screens by showing how the ML4100 is currently set up, i.e., what major parameters have been selected (or defaulted to) on each of the setup screens. It is often more useful to view all these major parameters at once on this display, rather than to view them a few at a time as they are shown on each individual setup screen.

However, the user will want to move to the individual setup screens to view the setup parameters in greater detail, and the user must move to these other screens to select and change the setup parameters. An asterisk preceding a Status screen label denotes a key which accesses such a setup screen.

To view overall major system parameters on the (System) Status setup screen, depress the STATUS key on the front panel. (See Section 1 below for further details about the System Status setup screen.)

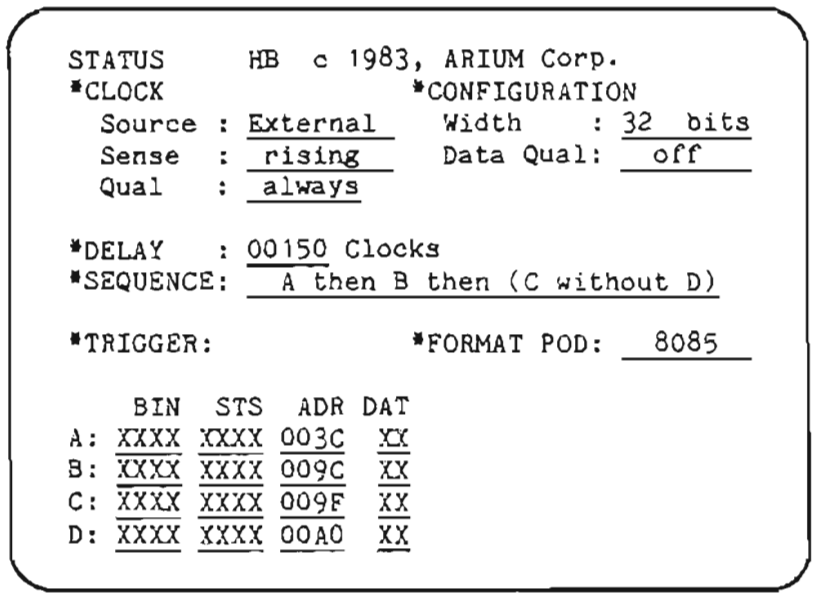
To view system parameters in greater detail than is shown on the (System) Status setup screen, to set up the ML4100 for initial operation, and/or to change any detailed system parameters while using the ML4100, use the following setup keys on the front panel:

CLOCK	Recording/sampling rate and clock qualification
CONFIG (Configuration)	Recording width/number of channels and data qualification
TRIG (Trigger) SEQ (Trigger Sequence) >
DELAY (Trigger Delay)	Triggering condition, which stops the recording process
FORMAT (or use default format)	Data display format

Refer to Figure 4, (System) Status Setup Screen, for an example of how one particular set of selections will be displayed.

Figure 4

(SYSTEM) STATUS SETUP SCREEN



NOTE: An asterisk preceding a Status screen label denotes a key which accesses that particular parameter.

Following are the system parameters as they are displayed on the (System) Status screen and the selections for each parameter available to the user.

1. CLOCK

Source:	External
Sense:	Rising or Falling (Edge)
Qual: (Clock qualification):	Always, Low or High
	--OR--
Source:	Internal
Period:	_____ (4-digit numeric value and units)

2. CONFIGURATION

Width:	32, 16, 8, or 4 bits
Data Qual:	Off
	--OR--
Width:	32, 16, 8, or 4 bits
Data Qual:	Comb.
Record:	Only or All but
Occur. of:	None or _____ (Trigger words)
	--OR--
Width:	32, 16, 8, or 4 bits
Data Qual:	State
Enable:	None or _____ (Trigger words)
Disable:	None or _____ (Trigger words)

3. (TRIGGER) DELAY: _____ Clocks (5-digit value) (Default = 00000)

4. (TRIGGER) SEQUENCE: _____

Displays the sequence from the 19 possible shown in Figure 8, Trigger Sequence setup screen, or "User-def. seq.", as shown in Figure 9.

5. TRIGGER:

A: XXXX 0011 0100 XX
B: XXXX 0011 0200 XX
C: XXXX XXXX XXXX XX
D: XXXX XXXX XXXX XX

Displays the selected trigger words in number base and the selected or default (State) display format. Default is all "Xs". In this example, trigger words A and B are set to match "fetches" at addresses 0100H and 0200H if an Intel pod is attached.

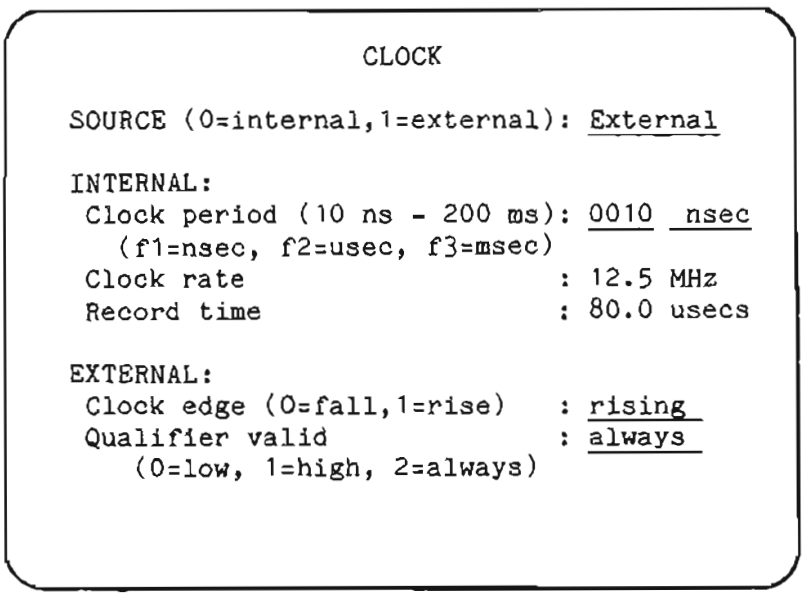
6. FORMAT: Pod: _____ (mode)

Most pods have more than one mode, in which case the f1, f2, f3, or f4 key is used to select the particular mode via the (Display) Format setup screen; e.g., the f1 key would select the 8085 mode of the 8I-080 microprocessor pod.

C. CLOCK SETUP SCREEN (VIA "CLOCK" KEY) (See Figure 5)

Figure 5

CLOCK SETUP SCREEN



To access the Clock setup screen, depress the CLOCK key. This screen displays the internal and external clocking parameters and is used to select and change specific parameters.

1. SELECTING CLOCK SOURCE

An internal clock is used when analyzing problems related to logic, hardware, and timing, and when measuring time. An external clock is used for analyzing bus problems and software, and occurrences synchronous to the user's system. External clock rates may not exceed 70 MHz (4-bit mode). (For rate limits in other modes, see the table in Section III.D.1.)

To select (clock) Source, move the cursor to the field labeled "Source", then select either "Internal" by depressing the 0 key on the keypad, or "External" by depressing the 1 key on the keypad. An internal clock uses time periods measured in nanoseconds (nsec), microseconds (usec), or milliseconds (msec).

2. USING AN INTERNAL CLOCK

To set the clock period (from 10 nsec to 200 msec), move the cursor to the first field to the right of "Clock period" and enter the desired value via the hexadecimal keypad; then move the cursor to the second field and select one of the three preset options for units by depressing f1 (nsec), f2 (usec), or f3 (msec). The corresponding clock (recording) rate, or frequency, and record time will be automatically displayed as soon as the cursor leaves the Clock Period numerical field.

Not every frequency is available; when an unavailable selection is made, the closest available clock frequency is used.

3. USING AN EXTERNAL CLOCK

The clock detection circuitry of both the LP-320 and the LP-040 is very high speed. To avoid extra clocks due to stray pickup, a connected ground lead should always be twisted with the clock lead. (The LP-040 leads are twisted pairs, but the LP-320 leads are not.) Failure to twist a connected ground lead with the clock lead is likely to produce extra ("double") clocking; if these clocks occur at a period of less than the minimum, the logic analyzer may function incorrectly.

Because of the ML4100's internal configuration, a minimum of 17 clocks must occur after the trigger condition for correct operation. These 17 clocks are automatically compensated for in all displays; the user need not be concerned about them unless the external clock stops within 17 clocks after the trigger condition.

a. Clock Edge

To select the Clock Edge (the edge of the clock at which data is to be sampled), depress the 0 key for "Falling" or the 1 key for "Rising". "Falling" means that the data is sampled on the high-voltage-to-low-voltage transition of the external clock input, as it crosses the threshold voltage; "Rising" means that data is sampled on the upward transition.

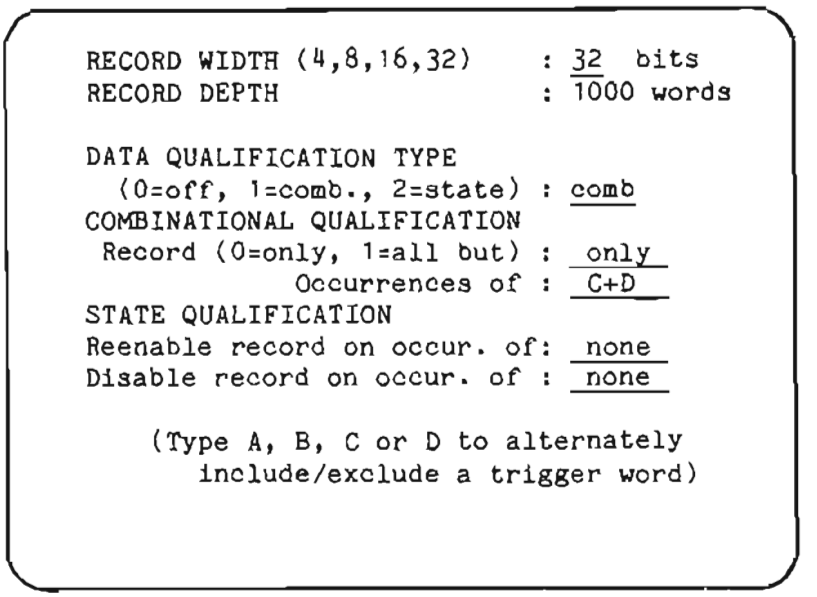
b. Clock Qualifier

To select the clock qualifier, depress 0 (Low), 1 (High), or 2 (Always) on the keypad. "Low" means that the clock qualifier is valid only when the qualifier input is low; "High" means that it is valid only when the input is high; and "Always" means that it is always valid. (External clocks are recognized only when the qualifier is valid.)

NOTE: The clock qualifier has no effect with an internal clock, and cannot be used with microprocessor pods.

D. CONFIGURATION SETUP SCREEN (VIA "CONFIG" KEY) (See Figure 6)

Figure 6
CONFIGURATION SETUP SCREEN



To access the Configuration setup screen, depress the CONFIG key.

1. RECORD WIDTH

To select Record Width, move the cursor to the field labeled "Record Width" and enter the number of bits (channels) (4, 8, 16, or 32) via the key-pad. (If any other value is entered, it will not be accepted, and the next highest of these four values will be displayed.) The record (word) depth available memory) will then be automatically displayed. (A wider word has less depth; e.g., 8000 samples per channel will be recorded in the 4-channel mode, and 1000 samples per channel in the 32-channel mode.)

The maximum clock rate (speed) for each record width varies from 100 MHz (for 4-bit) to 12.5 MHz (for 32-bit). The following chart shows the relationships between record width, clock rate (speed), and record depth.

Record Width	Maximum Clock Speed	Record Depth
4 bits (int. clock)	100 MHz	8000 samples/words
4 bits (ext. clock)	70 MHz	8000 samples/words
8 bits	50 MHz	4000 samples/words
16 bits	25 MHz	2000 samples/words
32 bits	12.5 MHz	1000 samples/words

2. DATA QUALIFICATION (in the 32-channel/bit mode only)

Data qualification is used to record only desired pieces of data to conserve memory and to make problem areas more visible. It permits determination on an individual (combinational) or sequential (state) basis as to whether or not any given word (data sample) will be recorded; it is available in 32-channel mode only. Note that data qualification does not affect recognition of trigger words, but does affect the trigger delay; i.e., a word included in the trigger sequence will be recognized regardless of whether or not data qualification allows it to be recorded, but only qualified words are counted in the trigger delay.

To select the type of Data Qualification, enter a 0 (Off), 1 (Combinational), or 2 (State) on the keypad.

To select the trigger words to be used as data qualifiers, use the A-D keys. When more than one word is entered, the display will automatically show a "+" between words, meaning "or". Each A-D key toggles on/off when depressed repeatedly, causing the character to alternately appear and disappear.

a. Combinational Data Qualification

To select a combinational data qualifier, depress 0 (Only) or 1 (All but) in the field labeled "Record", then enter A, B, C, and/or D in the "Occurrence of" field to indicate the trigger words upon which the selected qualifier will act. All four trigger words (A-D) may be used. (Setting of trigger words is described in Section III.E.)

For example, to record only program fetches in the area of 0100H to 02FFH when using a microprocessor pod, proceed as follows. First set Trigger Word C to fetches with the Address field 01XX and the Data field XX. Set Trigger Word D similarly, with 02XX in the Address field. Set Data Qualification Type to "comb"; then under Combinational Qualification set "Record" to "only" and set "Occurrences of" to "C+D". (This setup is depicted in Figure 6.)

b. State Data Qualification

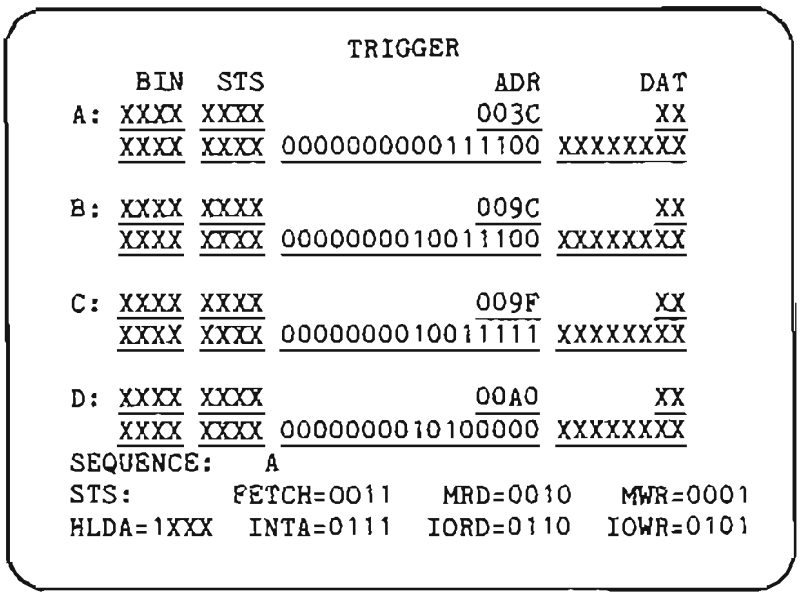
To select a state data qualifier, enter the selected trigger conditions upon which recording will be enabled/or disabled in the appropriate fields. Recording always begins enabled when the START key is depressed. Only one or two trigger words per field may be used; although the field is large enough to enter three or four words, the logic analyzer will not start recording data if more than two have been entered.

NOTE: When state data qualification is being used, trigger word "D" is not available for trigger sequence and, if either field ("Reenable..." or "Disable...") contains two words, then trigger word "C" is also unavailable for trigger sequence. (It is convenient to use "C+D" for data qualification, so as to leave A and B open for triggering.)

For example, with state qualification, to record everything from the time an instruction is fetched at 3F27H until an instruction is fetched at 4010H, set trigger words C and D to fetches at those locations, respectively, enable state qualification, and then set "Reenable..." to C and "Disable..." to D.

E. TRIGGER SETUP SCREEN (VIA "TRIG" KEY) (See Figure 7)

Figure 7
TRIGGER SETUP SCREEN



To access the Trigger setup screen, depress the TRIG key. The TRIG key calls up the Trigger setup screen with which four trigger words (events), labeled "A", "B", "C", and "D", are displayed and defined. On the display, there are two lines for each trigger word. The word appears in the number base selected (via the State portion of the Display Format screen)-- binary, octal, decimal, or hexadecimal (but not ASCII)--on the upper line, and in binary on the lower line. (When specifying the number base via the Display Format screen, use the State fields.) For the user's convenience, the trigger sequence is also displayed, in a format identical to the State format.

Fields are displayed from left to right, in ascending numerical order (using the numerals labeling the fields on the Format screen); "off" fields are not displayed. All numbers are displayed with the least significant digit at the right of the field; for example, in a binary field of Probes 3-0, Bit 0 is at the right of the field.

To define a trigger word, move the cursor to either line and use the keypad to enter the appropriate value; the corresponding value on the other line will be automatically displayed. To change any character in a trigger word, just move the cursor to that character and enter the new character on the keypad.

With a logic pod, the default number base for the upper line is binary, and is so labeled on the screen. With microprocessor and bus pods, the default number base is hex for many fields, but is determined by the particular pod and its requirements. Microprocessor pods also label fields as "STS" (status bits), "ADR" (address), and "DAT" (data).

An attempt to enter a digit which is too large for the selected number base will be rejected, and will cause the unit to beep once as an error warning. In decimal number base, as further protection against entering unacceptable values, the ML4100 will truncate the upper bits of a value that is larger than allowed; e.g., in decimal number base, if "18" is entered in a 4-bit field, as soon as the cursor leaves the field, the lower 4 bits are used, leaving a "2", an acceptable value.

To change the number base from the default or previously set base, use the Display Format screen via the FORMAT key. (See Section III.H.) To indicate a "Don't Care" when entering a trigger word on either line, depress "X" on the keypad. Any resulting indeterminate character on the upper line will be displayed as a "?". In decimal number base, a "Don't Care" may not be entered for an individual digit because of the binary nature of the unit.

The bottom two lines of this screen may contain status code prompts (information about the status fields). The presence of such information depends upon which microprocessor pod is being used and whether the appropriate disassembler has been installed. Possible status code prompts are:

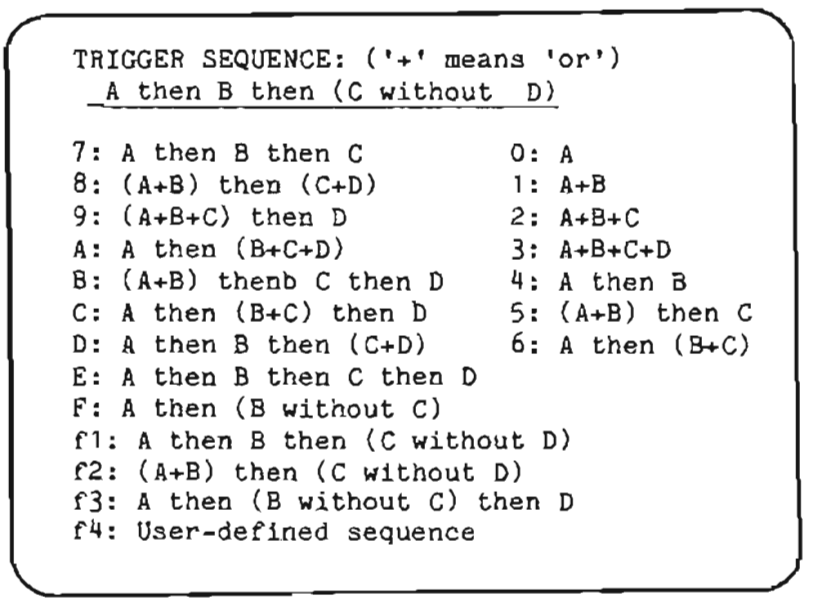
Prompt	Status Code
FETCH	Fetch
MRD	Memory Read
MWR	Memory Write
INTA	Interrupt Acknowledgment
IORD	I/O Read
IOWR	I/O Write

(For further status code details, see Section VI, Microprocessor Pods.)

Figure 7 shows four trigger words defined to be matched with any type of access (Fetch, Read, Write, etc.) to one of four addreses. In all four cases shown, the trigger condition is satisfied no matter what data is transferred during that cycle (Data XX).

F. TRIGGER SEQUENCE SETUP SCREEN (VIA "SEQ" KEY) (See Figure 8)

Figure 8
TRIGGER SEQUENCE SETUP SCREEN



To access the Trigger Sequence setup screen, depress the SEQ key. The trigger sequence defines the trigger condition which will stop the recording of data after the selected trigger delay. If the delay is zero, recording stops immediately upon occurrence of the trigger condition. (See Section III.G, Trigger Delay, and Figure 10).

A trigger sequence condition is formed by various combinations or sequences of the selected trigger words (events), up to four words (labeled A, B, C, and D) and four levels. (Trigger words are defined via the Trigger setup screen; see Section III.E and Figure 7).

The Trigger Sequence setup screen is used to select (and to change the selection of) any of the 19 predefined trigger sequences, and to access (via the f4 key) the User-Defined Sequence setup screen (see Section III.F.2, below).

1. PREDEFINED TRIGGER SEQUENCES (See Figure 8)

The Trigger Sequence setup screen displays the 19 predefined trigger sequences, along with the corresponding keypad entries for selecting them.

To select or change a predefined trigger sequence, depress the key which corresponds to the selected sequence; it will then be displayed on the second line of the screen, and may be changed via the keypad. The default is selection "0", predefined as "A".

Other selections include combinations or sequences of trigger words (events) to make up the trigger condition. For example, the sequence designated "7" ("A then B then C") will cause recording to continue until trigger word "A" is encountered, then until trigger word "B" is encountered, then until trigger word "C" is encountered. At this point, the entire trigger condition has been satisfied, and the delay will begin. (Recording will stop immediately if the delay is zero.)

Sequence f1 ("A then B then (C without D)") is identical to Sequence 7, except that, if "D" is encountered after "B" but before "C", then the ML4100 will begin again to search for "A". This sequence can be very useful when it is desired to trigger only when one event occurs immediately after another. To do this, use a sequence such as the f1 sequence, with "D" containing all "Don't Cares"; in this case, "B" and "C" will have to occur with no other cycles in between to satisfy the trigger condition.

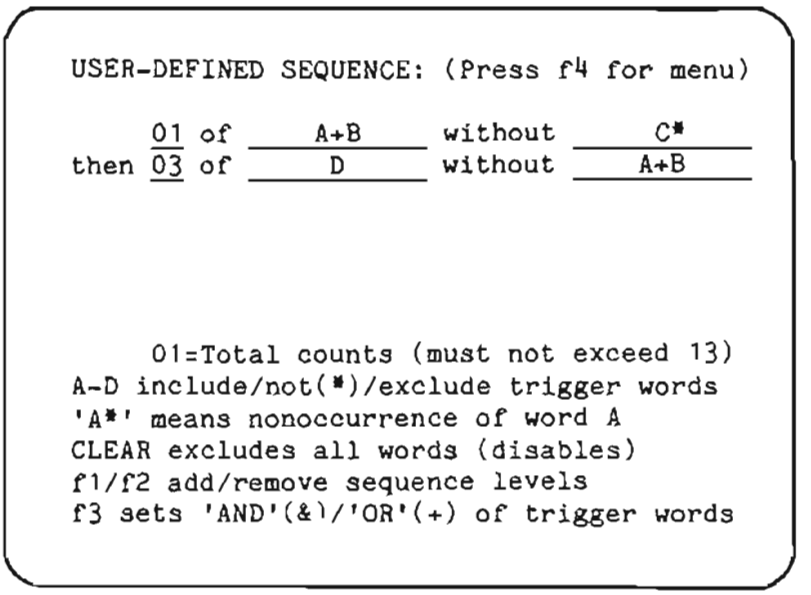
Only in the 32-channel operation are all 19 trigger sequences (including the user-defined sequence) available, as shown in the table below.

Recording Width	Available Trigger Sequences
4 channels	0, 1, 2, and 3
8 channels	0, 1, 2, and 3
16 channels	0, 1, 4, and f4*
32 channels	All (including user-defined)

* User-defined sequences

2. USER-DEFINED TRIGGER SEQUENCE (See Figure 9)

Figure 9
USER-DEFINED SEQUENCE SETUP SCREEN



To access the User-Defined Sequence setup screen for selecting or changing the user-defined trigger sequence, depress the f4 key (while viewing the Trigger Sequence setup screen). This brings up a new screen ("User-Defined Sequence") and presents a complex sequence format with one to four levels. Each level displays three fields: a 2-digit field for number of counts for that level, an 11-character field for a trigger word combination, and a second 11-character field for a "without" trigger word combination.

When recording, the ML4100 waits at each level until that condition has been satisfied, then proceeds to the next level. When the last level has been satisfied, the trigger condition is satisfied. If the entered count for a level is more than 1, then that level must be satisfied that number of times before the ML4100 proceeds to the next level. If the "without" condition is encountered at a level, then the whole sequence starts over at the first level.

This screen's default format displays only the first trigger sequence level. To add a trigger sequence level, depress f1; to remove the lowest level, depress f2.

To enter the number of counts for each level, enter the value via the keypad. Up to 13 total counts (among all 4 levels) are allowed. For example, if a total of 9 counts has been entered into the first three levels, then no more than 4 counts may be entered into the fourth level. After entry of the number of counts for a level, the new total number of counts is displayed as soon as the cursor is moved. Any level whose count is greater than 13 will be limited to 13 if its count field is exited. If the new total number of counts exceeds 13, any attempt to leave the screen causes the ML4100 to beep 3 times, flashes the "must not exceed 13" message, and does not allow leaving the screen.

To enter the trigger word combinations for each level, use the keypad to enter the desired combination of available trigger words ("A", "B", "C", and "D"). To include a trigger word in a sequence level, depress the appropriate key one time. (Take care to depress the key quickly and surely; do not linger on the key, or it will repeat and change the entry.) If a word has already been entered in the field, the new word will be entered as an "or" word (shown as "+") or an "and" word (shown as "&"), depending upon the mode. For example, in the "or" mode, if "A" is already in the field, depressing the B key will enter "+B", and the field will show "A+B", meaning "A or B".

To change an entered trigger word to a "not" condition, depress the same key a second time (with the cursor in the appropriate field), and the display will place a "*" ("not") on its right. E.g., if "A+B" is already in the field, depressing the B key will add an asterisk to the "B", and the field will show "A+B*", meaning "A or not B".

To exclude an entered trigger word, depress the same key a third time and the word (and its attached asterisk) will disappear from the field display. If the word was not a negative (i.e., had no asterisk) the key must be depressed twice toggling through the negative condition to get to the excluded one. Depressing the same key a fourth time will toggle back to include the trigger word, etc., repeating the pattern of inclusion/negation/exclusion endlessly.

To change (all of) the "+" ("or") characters in the trigger word to "&" ("and"), depress the f3 key; depressing f3 again toggles all the "&" characters back to "+" characters, in another repeating pattern.

To exclude (erase) an entire trigger word sequence from a field, depress CLEAR, and the display will show "(disabled)" in the field.

To return to the Trigger Sequence setup screen, depress the f4 key, which toggles the display back and forth between the Trigger Sequence and the User-Defined Sequence setup screens.

NOTE: When setting a user-defined sequence, be sure to exit from the User-Defined Sequence setup screen directly to any screen except the Trigger Sequence setup screen. Exiting from the User-Defined Sequence setup screen directly to the Trigger Sequence setup screen will reset the Trigger Sequence to its default condition (Sequence 0, which is "A"); the user-defined sequence will be remembered, but will not be used to trigger the analyzer.

To collect data without the possibility of a trigger condition stopping the recording of data (i.e., to collect data indefinitely until the STOP key is depressed), set the user-defined trigger sequence to exclude all trigger words by entering "01" as the number of counts, then depressing CLEAR to enter "disabled" in both trigger word fields. The display will then show "01 of (disabled) without (disabled)". (This works in the 32- and 16-channel modes.)

G. TRIGGER DELAY SETUP SCREEN (VIA "DELAY" KEY) (See Figure 10)

To access the Trigger Delay setup screen, depress the DELAY key.

To delay the stopping of recording ("storage") of data past the occurrence of the trigger condition, use the keypad to enter (in the top field) the number of qualified clocks after the trigger condition occurrence at which recording (storage) should stop. This top-field value is the "trigger delay".

Or, to begin recording at a selected number of clocks after or before the trigger condition occurrence, enter that number of clocks in the second field, then select "A" (after) or "B" (before) in the third field. (A sufficiently long trigger delay will place the entire recording interval after the trigger condition.)

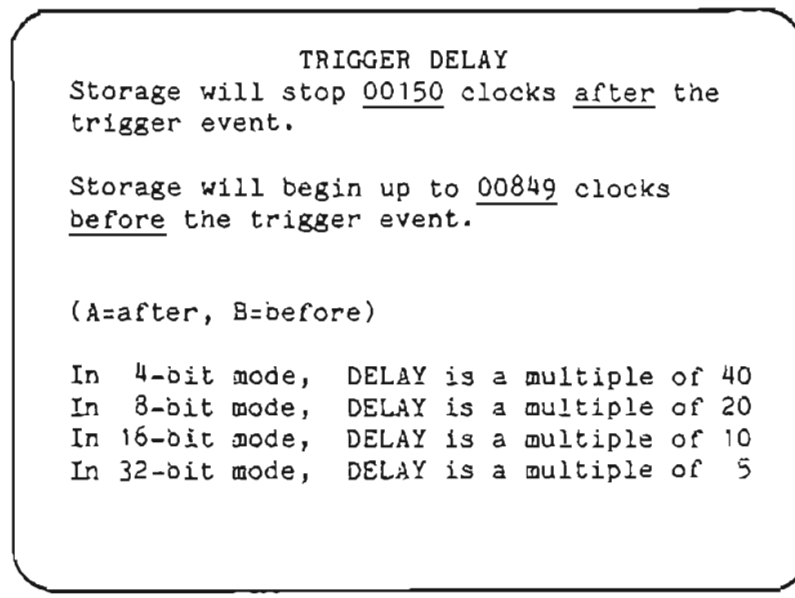
Only one of the two clock-number fields need to be entered; the corresponding number in the other number field will be automatically displayed. (The difference between these two numbers is the record depth.) The delay period includes only clock-qualified and data-qualified clocks.

NOTE: Because of the ML4100's internal configuration, a minimum of 17 clocks must occur after the trigger condition for correct operation. These 17 clocks are automatically accounted for in all displays; the user need not be concerned about them unless the external clock stops within 17 clocks of the trigger event. Only two clocks are required if the STOP key is depressed. (Rev H software and later only).

NOTE: Entering a number in the second field is only an alternate means of setting the trigger delay (the delay from the trigger event until stopping of the recording process). Trigger delay forces a number of data words to be stored after the trigger event. It cannot, however, guarantee the number of words before the trigger event. For example, if delay is set to 200, but the trigger condition is satisfied on the tenth clock, then there will be only ten data words prior to the trigger.

Sometimes this makes it difficult to capture the beginning of a software loop. This can be overcome by triggering on a second occurrence of a particular event. For example, trigger words "A and B" could be set to the same thing and a sequence of "A then B" set into the machine. Alternatively, a user-defined sequence of 13 occurrences of A would cause a minimum of 12 full copies of the loop to be captured prior to the trigger.

Figure 10
TRIGGER DELAY SETUP SCREEN



H. DISPLAY FORMAT SETUP SCREEN VIA "FORMAT" KEY (Figure 11)

To access the Display Format setup screen, depress the FORMAT key. This screen is used to view and select formats (bit groupings and number base) for displaying data on the Timing, State, Disassembly, and Trigger screens. (The Trigger setup screen uses the same format setup as does the State display screen, and so does not appear separately defined on this Format screen.) Data may be displayed in any of several number bases: binary, octal, decimal, hexadecimal, or (except for the Trigger screen) equivalent ASCII values. Data may be reformatted or redisplayed in any of the display modes without recapture (re-recording); this is especially convenient for displays in which a different base or bit grouping is needed.

Figure 11
DISPLAY FORMAT SETUP SCREEN

```
                    DISPLAY FORMAT

TIMING:
Line     1  2  3  4  5  6  7  8  9 10 11 12
Probe   28 29 30 31 XX XX XX XX XX XX XX XX

STATE:          STS ADR DAT
Field         1   2   3   4   5   6   7   8
Base        BIN BIN HEX HEX OFF OFF OFF OFF
Hig' Probe   31  27  23  07  00  00  00  00
 Low Probe   28  24  08  00  00  00  00  00
Data Sense  NON NON NON NON NON NON NON NON
Bases: A=ASC B=BIN C=OCT D=DEC E=HEX F=OFF
Senses: 0=NON (non-inverted), 1=INV

POD MODE (also sets defaults):  8085
f1= 8085   f2=8035/9  f3=8031/2
```

1. FORMAT FOR TIMING DISPLAY MODE (See Figure 11)

On the Display Format setup screen, the timing display assignments appear at the top, with up to 12 timing lines identified. Each field from (left to right) corresponds to a timing display position (from top to bottom) on the timing screen. The same probe may be displayed on more than one line, and blank ("XX") lines may be used for spacing.

To define or change a timing line, enter the probe number via the keypad. (When a probe number is defined, its timing line will be automatically displayed on the Timing display screen; when a probe number is changed, the line will be automatically relabeled.) For example, to display Probes 0-3 on the timing display, set the first four fields on the format screen to 0, 1, 2, and 3, respectively.

To disable display of a line, depress the "X" key, and "XX" will be displayed in the Probe field. (This will also automatically blank out that line on the TIMING display screen.)

2. FORMAT FOR STATE DISPLAY MODE (See Figure 11)

The state display format parameters appear in the middle of the Display Format setup screen. There are positions for describing eight fields which will corresppond to up to eight fields (columns) on the state and timing screens. The defined fields will appear left to right in ascending numerical order on the state and trigger screens. All fields are displayed with the least significant digit on the right For example, in binary fields, Bit 0 is in the rightmost position.

For each of 8 fields of data, there are 4 selections: (number) Base, High Probe, Low Probe and Data Sense. If the unit is connected to a microprocessor, Fields 2, 3, and 4 are typically labeled "STS" (Status), "ADR" (Address), and "DAT" (Data), respectively. "ADR" and "DAT" are set to "Hex" for the hexadecimal display on the State screen.

Data may be displayed in more than one field, and fields may overlap. Fields may be of any width, up to the limit of the number of probes or of space on the CRT display. Each field may contain a maximum of 22 bits.

To select number Base, use the keypad to enter "A" (ASCII), "B" (Binary), "C" (Octal), "D" (Decimal), "E" (Hexadecimal), or "F" (Off, which disables the field). (This will automatically change the data line for this field on the State display screen and on the Trigger setup screen.)

To enter Probe Range for each field, use the keypad to enter the high probe number and the low probe number, inclusive. The probe numbers included in the field will be consecutive, and the high probe number must not be less than the low probe number. These probe numbers (on the logic pods) refer to the input data channel numbers.

To select Data Sense, use the keypad to enter "0" (Noninverted) or "1" (Inverted). Any field may be inverted. Inverted fields will display the 1's complement of the data in the selected number base. Inversion does not affect the Timing display, and there is no provision for inverting timing lines. Inversion does affect the values on the Trigger display screen.

(The Timing and State displays may comprise entirely different combinations of probes.)

3. DISPLAY FORMAT FOR DISASSEMBLY (VIA MICROPROCESSOR PODS) AND OTHER MODES (See Figures 11 and 12)

At the bottom of the Display Format screen is the pod mode choice, which sets default parameters according to the type of pod, including the Disassembly display mode, which allows decoding of microprocessor instructions ("reverse assembly").

To select a particular pod mode, cursor to the bottom field and depress the appropriate key (f1, f2, f3, or f4), according to the prompt displayed on the bottom line.

(See Figure 12 for currently available pod mods.)

Figure 12
POD MODE DESIGNATIONS

Pod Catalog Number	Designation of Mode	Supports:
8I-080	8031/2	8031, 8032
	8035/9	8035, 8039, 8040
	8085	8085
8M-080	6800	6800
	6802/8	6802, 6808
8M-089	6809	6809
	6809E	6809E
8R-065	6502	6502
	6512	6512
	65C112	65C112
	65CX02	65C02, 65C102
8Z-080	Z80	Z80, Z80A, Z80B, Z80C
	Z80REF	Z80, Z80A, Z80B, Z80C (all with refresh recorded)
8P-080	STDBUS	STD bus bus controls
	STDINT	STD bus interrupt controls
	STD24B	STD bus with 24-bit addressing
LP-320	LOGIC4	4-channel operation
	LOGIC8	8-channel operation
	LOGC16	16-channel operation
	LOGC32	32-channel operation
LP-040	GLITCH	With glitch capture
	NOGLCH	Without glitch capture

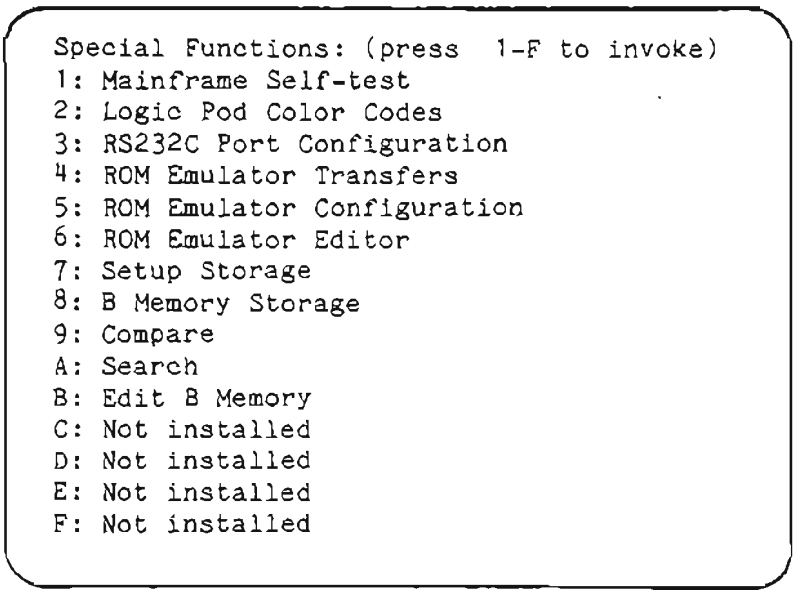
I. SPECIAL FUNCTIONS SETUP SCREEN (VIA "S. FUNC" KEY) (See Figure 13)

The ML4100 provides for up to 15 special functions (labeled "1" through "F"), of which some are standard and some are optional. To access the Special Functions setup screen and display a listing of the special functions, depress the S. FUNC key. Then, to select a particular special function, use the keypad to depress the hexadecimal character which corresponds to the function desired.

There are two standard special functions which are installed on all units: Mainframe Self-test (accessed by depressing the 1 key) and Logic Pod Color Codes (accessed via the 2 key). Other special functions are optional; if any has been installed on a unit, it will be listed by description on the Special Functions screen. Any optional special functions which are not installed on a unit will be listed on this screen as "Not installed".

The Special Functions setup screen will show some or all of the following screens, depending upon which options are installed in the ML4100. In the example below, the ML4100 has both an RE-016 ROM Emulator Module (Special Functions 3-6) and the AB-032 Setup/Data Memory Option (Special Functions 7-B) installed.

Figure 13
SPECIAL FUNCTIONS



1. MAINFRAME SELF-TEST (Standard)

The Mainframe Self-test includes:

ROM Checksum
RAM Test
Trace Address
Trace RAM
Trigger
Sequence

2. LOGIC POD COLOR CODES (Standard) (See Figure 3)

To display a list of the color codes for each probe of the two probe sets on the 32-Channel Logic Pod, depress the S. FUNC key, then 2 on the keypad. See also Section II.A.

3. RS-232C PORT CONFIGURATION
4. ROM EMULATOR TRANSFERS
5. ROM EMULATOR CONFIGURATION
6. ROM EMULATOR EDIT

ROM Emulator Module--
See Section VIII.B

7. SETUP STORAGE
8. B MEMORY STORAGE
9. COMPARE
10. SEARCH
11. EDIT B MEMORY

Setup Memory and
Setup/Data Memory--
See Section IX.B

IV. OPERATION

(after connection and setup, per Sections II and III)

A. GENERAL

1. RECORDING DATA

To begin recording, depress START. (Recording will automatically stop according to the parameters and conditions selected via the Trigger, Sequence, and Delay setup screens.) To manually stop recording, depress STOP.

Recording begins upon depressing START; recording stops either when the trigger condition has been satisfied and the delay time has expired, or when the STOP key has been depressed. During autosequencing or in the continuous compare mode with the Setup/Data Memory Option (AB-032), recording may also begin automatically after the end of a previous operation.

If the ML4100 user has specified data qualification, but no qualified data has occurred or no valid clocks have occurred, then the ML4100 may be "started" without actually recording any data, and a "No Data Recorded" message will be displayed when "recording" is stopped manually (via the STOP key).

2. DISPLAYING RECORDED DATA

There are three modes for displaying recorded data-- Timing, State, and Disassembly--and they are accessed via the TIMING, STATE, and DISASM keys, respectively, grouped under the "DISPLAY" label on the front panel of the ML4100.

When recording stops, the data will be displayed according to the last display mode selected. (Default at powerup is the Timing display mode.)

To change the display mode at any time during operation, simply depress TIMING, STATE, or DISASM; this will not require the capture of new data. Any changes in the format of these displays via the Format screen will not disturb the recorded data, providing convenient display of the same data in a different number base or bit grouping.

For further details, see Sections IV.B. Timing Display Mode; IV.C, State Display Mode; and IV. D, Disassembly Display Mode.

3. PRINTING DISPLAYED DATA

For ML4100B logic analyzers which have an RS-232C Communication Control Card installed and which are connected via that interface to a printer, the State and Disassembly data displays may be printed as hard-copy reports. The RS-232C interface is contained in the ROM Emulator Module (RE-016), and details of setup when using this interface are given in Section VIII.B.2.

To print a State or Disassembly data display, depress the f4 key while viewing either display. There is no prompt on the screen for printing via the f4 key.

4. MOVING THE CURSOR AND SCROLLING

In the State and Disassembly display modes, the vertical cursor position is fixed at the top data line of the screen, and the up and down arrow keys will scroll the data lines up and down through this fixed position. To instantly position the trigger event at the cursor position (on the top data line), depress either the STATE key or the DISASM key twice while viewing that display.

The top data line of the State and Disassembly display screens corresponds to the vertical cursor position on the Timing display screen.

In the Timing display mode, the cursor may be moved horizontally across any timing line via the left and right arrow keys. The location of the trigger condition occurrence is indicated by a vertical dashed line. To find the exact location of the trigger condition occurrence when the dashed line is shown outside of (to the far left or far right of) a timing line, move the cursor towards the dashed line until the line has scrolled onto the timing line. (Do not confuse the dashed line with the solid vertical line which serves as the cursor.) To instantly position the trigger event at the cursor position, depress the TIMING key twice while viewing the display.

Note that scrolling in any display mode affects the data displayed at the cursor position in the other display modes. In all three displays, the cursor is positioned at the same word in the recorded data.

To change the speed of the cursor when scrolling, depress the f2 key, which toggles the speed back and forth between "Fast" (one screen at a time) and "Slow" (one data word at a time). The current cursor speed mode is displayed at the lower right of each of the three display screens.

To find the current cursor position relative to the trigger condition, depress f1, which erases the bottom two lines of data, displays instead the current cursor position, and allows changing the position.

To change the cursor position (after depressing f1 as above), enter the new position (as the number of samples after or before the trigger condition) via the keypad in the field labeled "Position the cursor _____ clocks", then specify either "A" (After) or "B" (Before) in the other reverse-video field.

To move the cursor to the new position just entered, depress f1 again. If, while viewing a display screen, f1 is depressed and no repositioning of the cursor is desired, simply depress f1 again to return the screen to its former display.

B. TIMING DISPLAY MODE (See Figure 14)

(Be sure to first read the general remarks above, Section IV.A.)

Data is represented by timing lines (diagrams), as in an oscilloscope display; the exact format may be selected via the Display Format screen (Figure 11). Data is displayed (from any active probe) for 12 channels at a time, as selected via the Display Format screen. The 12 channels can be placed in any order, and/or repeated (displayed more than once on the screen), and lines may be left blank (displayed as Probe # "XX").

To scroll through the timing lines horizontally, use the right and left arrow keys.

To magnify (horizontally) the area around the cursor, depress the f3 key; the degree of magnification is a factor of ten, and this is shown (as "X10") on the lower right of the screen in the field labeled "Scale (f3)". Depressing the f3 key again will toggle the magnification off, and the Scale field will display "X1" to so indicate.

A dashed vertical line indicates the trigger condition occurrence; if this line appears outside of the timing line (either to its right or to its left), then the exact location of the trigger condition is not shown, but may be scrolled to by moving the cursor toward it.

When using an internal clock, the ML4100 automatically measures the time represented by the distance (on the timing line) between the trigger condition occurrence and the cursor location. This time is constantly displayed (in nsec, usec, or msec) on the upper right of the screen in the field labeled "Trigger to Cursor".

When using an external clock, distances are measured in units of "clocks". The time (in seconds if an internal clock, or in "clocks" if an external clock) between any two arbitrary locations may be measured by setting a reference line with the cursor at one location, then moving the cursor to the second location.

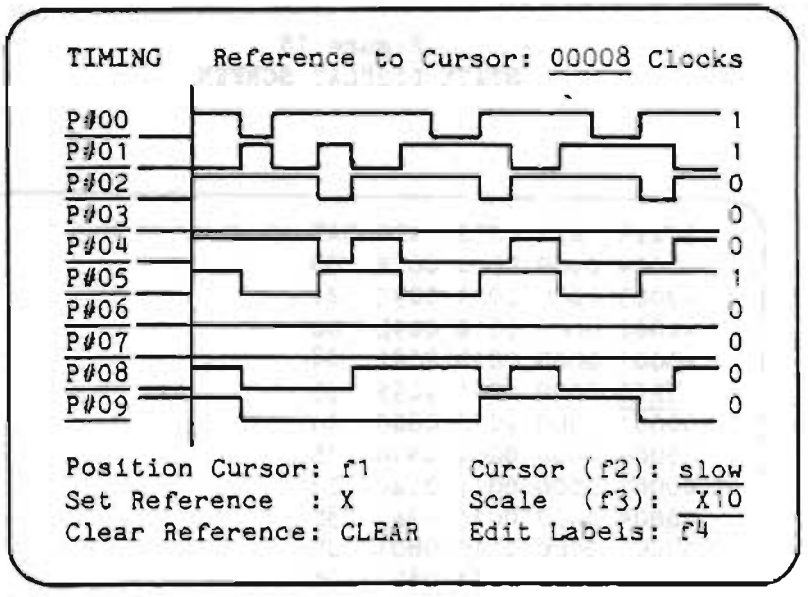
To set a reference line for measuring time, move the cursor to the desired position on a timing line and depress "X" on the keypad. The area between the reference line and the cursor location will be highlighted on the screen. The time represented by the highlighted area is then automatically measured, and will be displayed on the upper right of the screen in the field is "Reference to Cursor".

To clear the reference line and return to the "Trigger to Cursor" field, depress CLEAR on the keypad. To reposition the cursor to the trigger word. depress the TIMING key.

To relabel the timing lines, first depress the f4 key, which erases the bottom three lines of the screen, and displays instead three prompt lines about relabeling. To then advance a label character to the next higher character (e.g., from "C" to "D", or "5" to "6"), depress the f1 key; repeat this as many times as is needed to reach the desired character. To then retreat to the next lower character (e.g., from "C" to "B", or from "5" to "4"), depress the f2 key, and repeat as needed. (These keys automatically repeat when held down.) Use the arrow keys as needed to position the blinking cursor at the character to be changed.

To clear the three relabeling prompt lines from the bottom of the screen, depress the f4 key, which toggles back and forth the prompt lines and the relabeling activity.

Figure 14
TIMING DISPLAY SCREEN



C. STATE DISPLAY MODE (See Figure 15)

(Be sure to first read the general remarks in Section IV.A).

The values in the "STATE" column show sample numbers relative to the trigger. Zero is the trigger condition and is replaced by "TRIG"; negative values are before the trigger, and positive values are after the trigger. Each line of this screen represents one data sample, displayed in bit groupings and number base as selected via the Display Format screen. The trigger condition (or the first data-qualified word in storage which follows the trigger condition) is labeled "TRIG".

To display the trigger condition, scroll up or down via the arrow keys, or move directly to the trigger condition via the STATE key. To cursor to the trigger condition, depress STATE a second time.

To scroll up or down through the data samples, use the arrow keys. (Scrolling up accesses earlier samples, and scrolling down accesses more recent samples.)

To print a hard-copy report of the State display screen (on an ML4100B with an RS-232C installed), depress the f4 key; there is no on-screen prompt for this print function. (The ROM Emulator Module, RE-016, includes an RS-232C.)

Figure 15
STATE DISPLAY SCREEN

```
STATE  BIN  STS  ADR DAT
-0004 0000 0010 003E  00
-0003 0000 0011 009C  21
-0002 0000 0010 009D  00
-0001 0000 0010 009E  08
 TRIG 0000 0011 009F  35
00001 0000 0010 0800  16
00002 0000 0001 0800  15
00003 0000 0011 00A0  23
00004 0000 0011 00A1  35
00005 0000 0010 0801  07
00006 0000 0001 0801  06
00007 0000 0011 00A2  23
00008 0000 0011 00A3  35
00009 0000 0010 0802  07
Position Cursor: f1      Cursor (f2): slow
```

D. DISASSEMBLY DISPLAY MODE (OPTIONAL) (See Figure 16)

(First read Section IV.A above.)

The Disassembly mode displays data collected via an (optional) microprocessor pod, which enables the ML4100 to display the recorded data as assembly language microprocessor instructions ("reverse assembly").

When data qualification is being used, some ambiguities in the recorded data may result and the disassembler mode may not produce any disassembly output. In this case, the logic analyzer will try to disassemble the recorded data for about 30 seconds, and then will display only the top and bottom lines of the disassembly screen (i.e., will display no data, but just the label and prompt lines).

To print a hardcopy report of the Disassembly display screen (on an ML4100B with an RS-232C installed), depress the f4 key; there is no on-screen prompt for this print function. (The ROM Emulator Module, RE-016, includes an RS-232C.)

Figure 16
DISASSEMBLY DISPLAY SCREEN

```
STATE   PC   DISASSEMBLY   BUS ACTIVITY
-0011   00CD JMP  00DC
-0008        R7.5         0845<-00 0844<-DC
-0006   003C JMP  009C
-0003   009C LXI  H,0800
 TRIG   009F DCR  M       0800->16 0800<-15
00003   00A0 INX  H
00004   00A1 DCR  M       0801->07 0801<-06
00007   00A2 INX  H
00008   00A3 DCR  M       0802->07 0802<-06
00011   00A4 INX  H
00012   00A5 DCR  M       0803->01 0803<-00
00015   00A6 INX  H
00016   00A7 DCR  M       0804->04 0804<-03
00019   00A8 LDA  0800    0800->15
Position Cursor: f1       Cursor (f2): ____
```

(Blank)

V. FOUR-CHANNEL LOGIC POD (LP-040)

A. SPECIFICATIONS

Input Impedance:	50k in parallel with 6 pf
Input Voltage:	+/- 7.9 v
Setup:	5 nsec
Hold:	0.5 nsec
Minimum Detectable Glitch:	40 mV over threshhold for 5 nsec
Maximum Clock Frequency:	100 MHz internal, 75 MHz external
Overdrive:	40 mv

B. OPERATION

WARNING: THE 4-CHANNEL LOGIC POD (LP-040) CONTAINS SEVERAL HIGH-SPEED INTEGRATED CIRCUITS, WHICH DISSIPATE A LARGE AMOUNT OF HEAT. DO NOT USE IT IN ANY POSITION WHICH OBSTRUCTS THE NORMAL AIRFLOW AROUND IT.

1. PROBES

The 4-Channel (Glitch-Capture) Logic Pod has six probes: four for data, one for an external clock, and one for clock qualification. (Clock qualification functions on this pod the same as it does on the 32-Channel Logic Pod, LP-320.)

Each probe consists of two microhooks attached to a length of twisted-pair cable. The all-black hook in each pair is a ground probe, and should be connected to a circuit ground local to the signal being observed. The remaining six hooks are color coded as follows:

FUNCTION:	BODY: (tip)	PLUNGER: (cap)
External Clock	Red	Red
Clock Qualifier	Blue	Blue
Channel 0	Grey	Black
Channel 1	Grey	Brown
Channel 2	Grey	Red
Channel 3	Grey	Orange

2. MEASURING THRESHOLD VOLTAGE

Provision is made for measuring threshold voltage by a pair of wires on the probe set which terminates in a Molex connector. The threshold voltage may be measured here with the contact on the flat end of the connector being at ground.

To adjust the threshold voltage, use the switch and potentiometer slot in the end of the pod. When the switch is towards the screwdriver slot, the potentiometer may be used to vary the threshold over a +/- 7.9-volt range. When the switch is away from the screwdriver slot, the threshhold is fixed at 1.4 v for use in TTL-level circuits.

3. SETUP

Selection of trigger and clock parameters is made in the same manner as for the 32-Channel Logic Pod (LP-320); (see Sections III.C and III.E.).

For the 4-Channel Logic Pod (LP-040), the user may also select either the Glitch or No-Glitch mode via the Format screen. In the No-Glitch mode, data is captured and presented as it is when using the 32-Channel Logic Pod. In the Glitch mode, if an even number of data transitions occur between successive sample clocks, then the displayed data will alternate during the two clock periods following the one in which the glitch occurred. I.e., in the clock period immediately following the glitch, the state will be forced in the direction indicated by the glitch. In the next clock period, the state will be forced to the opposite state, thus insuring that a glitch occurrence (even near a transition) is always displayed as an "isolated bump." Suspected glitches may be examined by switching back and forth between the Glitch and the No-Glitch modes.

(Blank)

VI. MICROPROCESSOR PODS

A. GENERAL

(See also Section II.B, Connection via Microprocessor Pod, and Section IV.D, Disassembly Display Mode.)

Although all 8-bit microprocessor pods operate similarly, there are a few differences among them.

For all 8-bit pods, Data Inputs 0-7 are Data Bus Bits 0-7 (demultiplexed if required). Data Inputs 8-23 are Address, although some bits (high-order) may not be used. Data Inputs 24-31 contain Status and extra Data Input lines. (Data Inputs are labeled on the Format screen as probe numbers.)

On most microprocessor pods, two or four of the high-order inputs are supplied as separate TTL inputs via a connector on the side of the pod. To use these TTL input lines, remove the 8-channel probe set from the 32-Channel Logic Pod (the 20-pin connector) and attach it to the connector on the side of the microprocessor pod.

Clock signals are derived as required from the signals on each microprocessor. (Clock qualification is not used with microprocessor pods.)

The ML4100 will automatically configure itself at powerup for synchronous microprocessor cycle data collection. This configuration may, however, be changed, just as configurations may be changed with other pods.

The default trigger configuration has four fields: "BIN", a binary field for the extra probes; "STS" (Status); "ADR" (Address); and "DAT" (Data). These fields are modifiable as desired. On the bottom of the Trigger screen are the status codes for easy reference.

Details of the data configuration for each microprocessor pod follow.

B. 8I-080 MICROPROCESSOR POD

(Supports Intel 8085, 8035/8039/8040, and 8031/8032 microprocessors)

Data	Data Lines 0- 7	
Address	Data Lines 8-23	(8-19 for 8035/8039/8040)
Status	Data Lines 24-27	
Spare	Data Lines 28-31	(Wires 0-3 on Standard Probe Set of 32-Channel Logic Pod)

STATUS CODES

	8085	8035/39/40	8031/32
Fetch (or PSEN)	0011	X011	X011
Memory Read	0010	X010	X010
Memory Write	0001	X001	X001
I/O Read	0110	X1XX	N.A.
I/O Write	0101	X1XX	N.A.
Interrupt Acknowldgment	0111	N.A.	N.A.
Hold Acknowledgment	1XXX	N.A.	N.A.
Bit 24 =	S0	WR or PSEN	WR or PSEN
Bit 25 =	S1	RD or PSEN	RD or PSEN
Bit 26 =	IO/$\overline{M}$	PROG	N.A.
Bit 27 =	HLDA	N.A.	N.A.

C. 8M-080 MICROPROCESSOR POD

(Supports Motorola 6800, 6802, and 6808 microprocessors)

Data	Data Lines 0- 7
Address	Data Lines 8-23
Status	Data Lines 24-27
Spare	Data Lines 28-31

STATUS CODES

Read	01X1
Write	01X0
Halt/bus avail.	1X0X
Bus available	1XXX
Bit 24 =	R/$\overline{W}$
Bit 25 =	$\overline{HALT}$
Bit 26 =	VMA
Bit 27 =	BA

SWITCH SETTINGS

For proper operation of the 6800/6802/6808 microprocessor pod, follow the switch settings. The switches are located on the same side of the pod as the auxiliary probe connector, and are labeled 1, 2, 3, and 4. Up (toward the pod label) is open; down is closed.

	6802 and 6808	6800
Switch 1	Open	Write Clocking: Open--fall of 02 Closed--fall of DBE
Switch 2	(Unused--leave open)	(Unused--leave open)
Switch 3	(Unused--leave open)	(Unused--leave open)
Switch 4	(Unused--leave open)	(Unused--leave open)

NOTE: To detect a reversed pod connection error, the 6800 pod loads the target processor's VCC pin with 200 ohms to VSS. If this 25-mA load is unacceptable, remove R7 from the pod's circuit board, or replace R7 with a resistor of a higher value.

D. 8M-089 MICROPROCESSOR POD

(Supports Motorola 6809 and 6809E microprocessors)

	Data Lines	
	6809	6809E
Data	0- 7	0- 7
Address	8-23	8-23
Status	24-27	24-29
Spare	28-31	30-31

STATUS CODES

Last Instruction Cycle	N.A.	X1XXXX
Read	00X1	XX00X1
Write	00X0	XX00X0
Interrupt Acknowledgment	01XX	XX01XX
Sync. Acknowledgment	10XX	XX10XX
Bus Grant Due to Halt	110X	XX110X
Bus Grant	11XX	XX11XX
Bit 24 =	R/$\overline{W}$	R/$\overline{W}$
Bit 25 =	$\overline{HALT}$	$\overline{HALT}$
Bit 26 =	BS	BS
Bit 27 =	BA	BA
Bit 28 =	(Side Probe 0)	LIC
Bit 29 =	(Side Probe 1)	AVMA
Bit 30 =	(Side Probe 2)	(Side Probe 0)
Bit 31 =	(Side Probe 3)	(Side Probe 1)

NOTE: To detect a reversed pod connection error, the 6809 pod loads the target processor's VCC pin with 200 ohms to VSS. If this 25-mA load is unacceptable, remove R7 from the pod's circuit board, or replace R7 with a resistor of a higher value.

E. 8R-065 MICROPROCESSOR POD

(Supports Rockwell 6502, 6512, 65C02, 65C102, and 65C112 microprocessors)

Data	Data Lines 0- 7
Address	Data Lines 8-23
Status	Data Lines 24-27
Spare	Data Lines 28-31

STATUS CODES

	6502 & 6512	65C02, 65C102, & 65C112
Fetch	1X11	1X11
Memory Read	0X11	0X11
Memory Write	0XX0	0X10
Set Overflow Bit	X0XX	X0XX
Bit 24 =	R/$\overline{W}$	R/$\overline{W}$
Bit 25 =	RDY	RDY
Bit 26 =	S.O.	S.O.
Bit 27 =	SYNC	SYNC

SWITCH SETTINGS

For proper operation of the 6502 microprocessor pod, follow the switch settings below. The switches are located on the same side of the pod as is the auxiliary probe connector. and are labeled 1, 2, 3, and 4. Up (towards the pod label) is open; down is closed.

	6502	65C02, 65C102, 65C112	6512
Switch 1	Open	Open	Write Clocking: Open--Use S2 choice Closed--Fall of DBE
Switch 2	Open	Open	Read Clocking: Open--Fall of Φ2 Closed--Rise of Φ1
Switch 3	Closed	Open	Open
Switch 4	Open	Open	Closed

NOTE: To detect a reversed pod connection error, the 6502 pod loads the target processor's VCC pin with 220 ohms to VSS. If this 23 mA load is unacceptable, remove R7 from the pod's circuit board, or replace R7 with a resistor of a higher value.

F. 8Z-080 MICROPROCESSOR POD

(Supports Zilog Z80 microprocessor)

Data	Data Lines 0- 7
Address	Data Lines 8-23
Status	Data Lines 24-27
Spare	Data Lines 28-31

STATUS CODES

Fetch	1011
Memory Read	1010
Memory Write	1001
I/O Read	1110
I/O Write	1101
Interrupt Acknowledgment	1111
Bus acknowledgment	0XXX
Refresh	1000

Bit 24 =	Write or Fetch or Interrupt Acknowledgment
Bit 25 =	Read or Fetch or Interrupt Acknowledgment
Bit 26 =	I/O or Interrupt Acknowledgment
Bit 27 =	$\overline{\text{BUSAK}}$

G. 8N-080 MICROPROCESSOR POD

(Supports National Semiconductor NSC800 microprocessor)

Data	Data Lines 0- 7
Address	Data Lines 8-23
Status	Data Lines 24-28
Side Probes (3)	Data Lines 29-31

STATUS CODES

Fetch	X1011
Memory Read	X1010
Memory Write	X1001
I/O Read	X1110
I/O Write	X1101
Interrupt Acknowledgment	X1111 (Pod's encoding, not microprocessor's)
Bus Acknowledgment	X0XXX
Refresh	X1100 (Pod's encoding, not microprocessor's)
Halt	X1000
Processor was reset	1XXXX

Bit 24 = S0, High for Write or Fetch or Interrupt Acknowledgment

Bit 25 = S1, High for Read or Fetch or Interrupt Acknowledgment

Bit 26 = IO/$\overline{M}$, High for I/O or Interrupt Acknowledgment

Bit 27 = $\overline{BUSAK}$

Bit 28 = Reset: High for each processor cycle during which Reset Out was high. plus one additional cycle

Bit 29 = Side Probe 0

Bit 30 = Side Probe 1

Bit 31 = Side Probe 2

During operation with internal clock (i.e., asynchronous to the microprocessor), only the data lines are totally "transparent". Both address bytes are registered with D-type registers, and changes only on the falling edge of ALE. The Status lines, while not registered, are affected by the encoding logic which marks Refresh cycles (if in NSCREF mode), and Interrupt Acknowledgment cycles.

H. 16M-680 MICROPROCESSOR POD

(Supports Motorola 68000/68010 microprocessors)

Detailed information about this pod was not yet available for publication at presstime, but may be obtained from Arium Corporation by telephone, (714) 978-9531.

(blank)

VII. STD BUS POD (8P-080)

A. INTRODUCTION

The STD Bus Pod enables the ML4100 to capture bus cycles asynchronously (with the internal clock) or synchronously (with the external clock). To install the STD Bus Pod, insert it into an unoccupied bus slot or use it as an extender card, by plugging the card which normally occupies the bus slot into the STD Bus Pod (at J1), then inserting the STD Bus Pod into the bus slot.

B. POD MODES

The pod has three modes, as shown on the Format setup screen: STDBUS, STDINT, and STD24B. The first 24 data lines are the same in each mode; the remaining 8 data lines differ among the modes, and, by altering jumpers on the board, the signals presented in the first two modes can be selected by the user. Data lines for each of the three modes are shown in the table below.

Data Lines	STDBUS Mode (Default)	STDINT Mode	STD24B Mode
0- 7	Data	Data	Data
8-23	Address (lower 16 bits)	Address (lower 16 bits)	Address (lower 16 bits)
24	RD*	INTRQ* (see jumper options)	- - - - - - - - |
25	WR*	INTAK*	|
26	IORQ*	IORQ*	|
27	MEMRQ*	PCI	|
28	IOEXP (if IORQ* is active) MEMEX (if MEMRQ* is active)	PCO	Address (upper 8 bits) | |
29	BUSRQ*	REFRESH*	|
30	BUSAK*	STATUS0*	|
31	WAITRQ*	STATUS1*	- - - - - - - -

Data lines 24-31 in the STDBUS (default) mode, with default jumpering, present the main data transfer control signals of the bus. These lines in the STDINT mode, with default jumpering, present primarily those signals related to interrupts.

In the STD24B mode, data lines 24-31 present the upper 8 bits of a 24-bit address. These bits are clocked from the data bus into an octal register on the pod at the rising edge of the MCSYNC* bus signal; the outputs of this register drive data lines 24-31. None of the jumpering options affects the STD24B mode. (NOTE: Early versions of the ML4100 code display these bits in two 4-bit binary fields.)

C. JUMPERING OPTIONS

1. DATA LINES 24-31

In the STDBUS and STDINT modes, the signals presented on Data Lines 24-31 may be selected by the user. Any eight signals may be selected from the signals available at jumper posts to be displayed in either of these two modes. The table below shows the signals available, the mode/data-line destinations, and the default connections.

Sources		Destinations		
Signal	Jumper Pin	Jumper Pin	Mode	Data Line
IOEXP/MEMEX	JP3- 1	JP3- 2	STDBUS	28
PCO	JP3- 3	JP3- 4	STDINT	28
BUSAK*	JP3- 5	JP3- 6	STDBUS	30
STATUS0*	JP3- 7	JP3- 8	STDINT	30
BUSRQ*	JP3- 9	JP3-10	STDBUS	29
REFRESH*	JP3-11	JP3-12	STDINT	29
WAITRQ*	JP3-13	JP3-14	STDBUS	31
STATUS1*	JP3-15	JP3-16	STDINT	31
MEMRQ*	JP4- 1	JP4- 2	STDBUS	27
PCI	JP4- 3	JP4- 4	STDINT	27
IORQ*	JP4- 5	JP4- 6	STDBUS	26
IORQ*	JP4- 7	JP4- 8	STDINT	26
RD*	JP4- 9	JP4-10	STDBUS	24
INTRQ*	JP4-11	JP4-12	STDINT	24
WR*	JP4-13	JP4-14	STDBUS	25
INTAK*	JP4-15	JP4-16	STDINT	25
SYSRESET*	JP5- 1			
PBRESET*	JP5- 2			
NMIRQ*	JP5- 3			
CLOCK*	JP6- 1			
CNTRL*	JP6- 2			

2. REFRESH CYCLES

During synchronous recording of bus cycles, the pod will record each Read, each Write, and each Interrupt Acknowledge cycle. Also Refresh cycles may be recorded if a card on the bus supplies them. Either Z80 or NSC800 Refresh cycles may be captured. or Refresh cycles may be ignored according to the table below.

Refresh Type	Jumpers Patch	
	(JP1)	(JP2)
Refresh ignored (default)	2-3	(Don't Care, default = 2-3)
Z80	1-2	2-3
NSC800	1-2	1-2

3. INTRQ* AND BUSRQ*

When the pod is used as an extender card, and the card plugged into J1 is one which may issue INTRQ* and/or BUSRQ*, then the corresponding request signal available to the ML4100 may be either the actual request signal on the STD Bus or the request signal emanating from the card. The table below shows the options available.

Request Signal	Connections on JP7
BUSRQ* Source:	
Bus (default)	1-3
Card	3-5
INTRQ* Source:	
Bus (default)	2-4
Card	4-6

Note that, if the card must receive the request from the bus, then the request source must be the bus; the option of having the card as source is not available in that situation.

D. ASYNCHRONOUS OPERATION

When the STD Bus Pod is used asynchronously, the user should note that the signals traveling to the ML4100 typically pass through two buffers (one high-speed CMOS buffer and one LS TTL buffer), plus a resistor network.

Since different signals pass through different buffers, the timing relationships between signals will be altered slightly, due to differences in path delays. This timing skew should be less than 20 ns, with one exception: the address signals A0 through A15 are intentionally delayed approximately 30 ns more than all other signals for proper synchronous operation with the Z80 STD Bus. (The Z80 CPU, after an opcode fetch, very quickly outputs the refresh address, and without the delay the address of the opcode fetch may not be captured properly at the clock edge occurring at the end of the fetch.)

To remove this added delay in the address lines during asynchronous operation, change the resistor networks in Locations 5E and 6C to 270-ohm, individual-resistor networks (16 pins, 8 resistors). These locations are socketed. Save the original resistor networks for synchronous operation.

VIII. ROM EMULATOR MODULE (RE-016)

A. INTRODUCTION

The ROM Emulator Module option enables the ML4100 to emulate one or more 27XX-series EPROMS, giving it a powerful tool for debugging code in microprocesor-based systems. Code can be downloaded to the emulator and then patched as required.

The ROM Emulator Module consists of two assemblies: the ROM Emulator Control Board, Catalog Number RS-232, (an internal card) and the ROM Emulator Pod, RP-016, (an external pod box). With one pod, up to 16 Kbytes of memory may be emulated, and configured as four 2716s, four 2732s, two 2764s, or one 27128. With a second pod, twice the memory can be emulated. (The ML4100 accommodates no more than two ROM Emulator Pods.)

B. SETUP AND EDITING

1. GENERAL

To access the ROM Emulator Module, depress the Special Function key on the ML4100 front panel, then select one of four screens via the keypad, as shown below:

Key	Function
3	RS-232C Port Configuration
4	ROM Emulator Transfers
5	ROM Emulator Configuration
6	ROM Emulator Edit

Before using any ROM Emulator, the user must first specify the configuration; failure to do so will probably cause error messages and/or incomplete function of the ROM Emulator. Before making any data transfers (uploading or downloading), the user must first specify the configuration of the RS-232C port, via the RS-232 Port Configuration screen. Both these screens are accessed by depressing the Special Function key, then by depressing a key on the keypad to select the appropriate screen (as shown on the table above).

To specify setup parameters on any of the four screens named above, cursor to a field, then, using the hexadecimal keypad on the front panel, either select one of the given parameters as indicated by the screen prompting labels, or enter the desired value directly into the field.

Figure 17
RS-232C SERIAL PORT CONFIGURATION

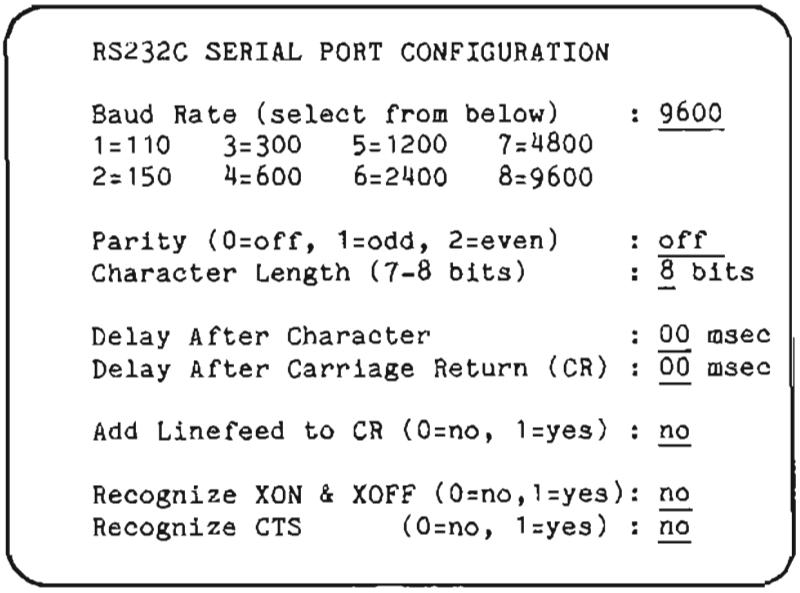


Figure 18
ROM EMULATOR TRANSFERS

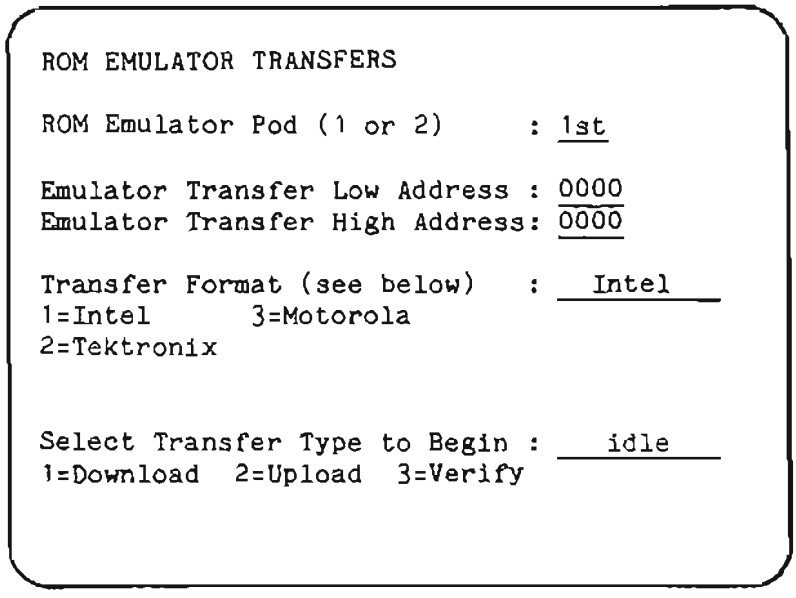
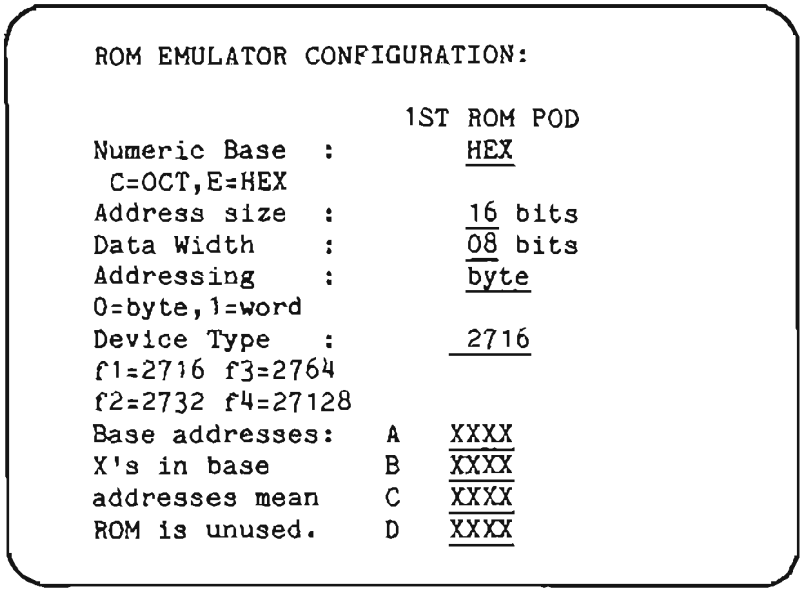


Figure 19
ROM EMULATOR CONFIGURATION



C. HARDWARE CONSIDERATIONS

The ROM Emulator hardware is capable of detecting whether a ROM socket has been plugged in backwards, has not been plugged in, or has been plugged into a system with no power. The software will make checks when the user exits the Edit screen. These checks, if they run into an inconsistency, will flag an error. Selecton of ROMS to be used is accomplished on the Configuration screen. If the base address is set with "Xs", it is treated as unused.

If a parity error occurs during transfers, a beep will be generated. If an overrun or framing error occurs, or if an illegal character is encountered, then the transfer will immediately stop. Transfers will also be stopped by depressing the STOP key. On download, a byte is entered into the ROM Emulator if the address of that byte is between the lower and upper address bounds entered on the Transfers screen and is also being emulated, as defined by the blocks of one of the address bases determined by the length of the device being emulated (either 2 Kbytes up to 16 Kbytes) and by the base address of the given ROMs.

NOTE: While editing or downloading or uploading from the ROM Emulator, it is not accessible as ROMs. Therefore, it will probably be necessary to reset the target after any of these operations.

There are two handshake methods of starting and stopping the RS-232C data stream to or from the ML4100. One method uses the RTS and CTS lines of RS-232C; the other uses DC1 and DC3 (XON and XOFF) of U. S. ASCII. The selection of these is described in Section B.2, above.

The following pins are on the back panel Data Interface connector:

Pin No.	Signal Name (per RS-323C)	Input to ML4100	Output from ML4100
1	Safety ground	X	X
2	TXD		X
3	RXD	X	
4	RTS		X
5	CTS	X	
7	Signal ground	X	X

The ML4100 is a "DTE" device, i.e., it appears at the RS-232C interface as would a standard CRT terminal.

Note that ROM Emulator control cards with serial numbers of 001 through 025 do not pull Pin 4 high.

IX. SETUP MEMORY OPTION (SM-080) AND SETUP/DATA MEMORY OPTION (AB-032)

(blank)

A. INTRODUCTION

The ML4100 has two memory options: the Setup Memory Option (SM-080) and the Setup/Data Memory Option (AB032). The Setup/Data Memory Option has all the basic capabilities of the Setup Memory Option, plus enhanced data memory capabilities as well. With the addition of either option, the ML4100 logic analyzer becomes an even more effective instrument for data analysis, portable field service work, and production test.

1. SETUP MEMORY OPTION (SM-080)

The Setup Memory Option saves eight complete machine setups (trigger words, timing line labels, format specifications, etc.) in nonvolatile memory. These setups are retained when power is turned off.

This storage of setup files permits rapid, convenient paging between different analysis methods for any given piece of captured data (i.e., paging between different sets of timing lines with alternate labels and positions on the display screen.) Similarly, without re-entering any labeling or triggering conditions, the user can switch from a 32-channel, state, data-qualified mode to a 4-channel, 100-MHz mode immediately, and have all of the data capture parameters already defined. Also, complex setup data need not be lost when there are interruptions and the user needs to be away from the logic analyzer for long periods of time.

2. SETUP/DATA MEMORY OPTION (AB-032)

The Setup/Data Memory option, in addition to saving eight complete machine setups, expands the ML4100's capabilities further by adding a B (reference) Memory. The B Memory is the same size as the machine's A (record) Memory (1,000 samples deep at 32 channels wide, and 8,000 samples deep at 4 channels wide). With the B Memory in this option, Compare and Search functions have been added to the ML4100 to facilitate more extensive data analysis. In addition, B Memory may be edited to allow the Search and Compare functions to be more selective. B Memory may also be saved in nonvolatile memory.

3. INSTALLATION

Both the SM-080 and AB-032 options are contained on a single option card, which may be field-installed by the user.

B. OVERALL OPERATION

The Setup Memory function of storing setups is operated via the Setup Storage screen. The Setup/Data Memory Option uses the Setup Storage screen, plus four other screens: B Memory Storage, Compare, Search, and Edit B Memory.

To access the Setup Memory functions, first depress the Special Function key, then depress the key on the keypad which corresponds to the function:

Key	Function
7	Setup Storage
8	B Memory Storage*
9	Compare*
A	Search*
B	Edit B Memory*

* In AB-032 only

1. SETUP STORAGE (See Figures 21a, 21b, and 21c)

The Setup Storage screen is shown in three figures in this section. Figure 21a shows the screen when the user has positioned the cursor in the Action field; Figure 21b shows it with the cursor in the Name field; and Figure 21c shows it with the cursor in the Status field. User activities via these three screens are detailed in Sections a, b, and c below.

On this screen, the Mode field indicates the setup file mode, i.e., 8085, Z80, LOGIC4, etc. The correct pod must be connected to the ML4100 before recalling a setup file or a Pod Conflict error will occur.

In the Setup column, an asterisk to the left of the file number indicates the current setup file in use (last file accessed). An "M" to the right of the file number indicates that the setups currently in the ML4100 have been modified and differ from the values in the file.

a. Saving Setups (See Figure 21a)

Up to eight ML4100 setup files can be saved. A setup file contains all setup parameters selected by the user (including those of the RS-232 Communications Control Card and the RE-016 ROM Emulator), except for search words.

To save a setup file, cursor to its action field and depress the f1 key (SAVE setups), then depress f1 again (to verify the action). To recall a setup file, cursor to its action field and depress the f2 key (RECALL setups), then depress f2 again (to verify the action); current setups will be replaced by the setups recalled from the file selected.

In the Setup column, an asterisk to the left of the file number indicates the current setup file in use (last file accessed). An "M" to the right of the file number indicates that the setups currently in the ML4100 have been modified and differ from the values in the file.

If the RS-232 Communication Control Card or the RE-016 Rom Emulator Module has been installed in the ML4100, then machine setups may also be uploaded and downloaded via this screen. To upload or download setups, cursor to an Action field and depress the f3 key ("UPLOAD B") or the f4 key ("DOWNLOAD B"). Setups are uploaded to or downloaded from machine memory rather than the files themselves, so the location of the cursor in the action column is unimportant. Downloaded setups may then be saved in a setup file.

Figure 21a
SETUP STORAGE SCREEN
(Cursor in Action field)

```
                SETUP FILE DIRECTORY
SETUP     NAME       STATUS        MODE     ACTION
* 1       TEST1    UNPROTECTED     Z80       SAVE
  2       TEST2    UNPROTECTED     8085      ----
  3                AVAILABLE                 ----
  4       PROD1    UNPROTECTED     8085      RECALL
  5       PROD2    UNPROTECTED     8085      RECALL
  6       PROD3    UNPROTECTED     8085      RECALL
  7       PROD4    UNPROTECTED     8085      RECALL
  8                UNPROTECTED    LOGIC4     ------
CURSOR TO ACTION FIELD AND USE f KEYS
f1=SAVE setups          f2=RECALL setups
f3=UPLOAD setups        f4=DOWNLOAD setups
POWERUP FIELD: 1
AUTOSEQUENCING: start file: 4 end file: 7
*=setup file in use      M=setups modified
```

b. File Names (See Figure 21b)

Setup files can be assigned names of up to six characters, before saving the file. To enter a setup file name, cursor to each space in the Name field and enter one character at a time, using the f1 and f2 keys to alphabetically advance or retreat characters, until the desired character is displayed in each space. The f3 key (clear field) may be used to clear the entire name field.

To change a setup file name, edit the name field one character at a time, using the f1 and f2 keys, then save the file again. If a file name is changed without the file being resaved, a warning message will be issued if an attempt is made to exit the screen.

Figure 21b
SETUP STORAGE SCREEN
(Cursor in Name field)

SETUP FILE DIRECTORY

SETUP	NAME	STATUS	MODE	ACTION
* 1	TEST1	UNPROTECTED	Z80	SAVE
2	TEST2	UNPROTECTED	8085	----
3		AVAILABLE		----
4	PROD1	PROTECTED	8085	RECALL
5	PROD2	PROTECTED	8085	RECALL
6	PROD3	PROTECTED	8085	RECALL
7	PROD4	PROTECTED	8085	RECALL
8		UNPROTECTED	LOGIC4	----

CURSOR TO NAME FIELD AND USE f KEYS
f1=advance character f2=retreat character
f3=clear name
POWERUP FIELD: 1
AUTOSEQUENCING: start file: 4 end file: 7
*=setup file in use M=setups modified

c. Status (Protected, Unprotected, Available) (See Figure 21c)

Setup files normally have a status of "Unprotected," but may also be "Protected." To protect a setup file, cursor to the Status field, depress the f3 key (protected), then save the file. When the file is saved, a security code will be requested; this is a 2-digit hexadecimal number which is entered on the keypad. (If more than two keys are depressed, only the last two are used.) The security code will not be displayed on the screen. This security code will be required to write over the file in the future, and it is strongly recommended that it be written down and stored for future use.

To change a setup file from Protected to Unprotected, cursor to the Status field, depress the f2 key, and save the file, using the correct security code. To erase a setup file, cursor to the Status field, depress the f1 key to change its status to Available, and save the file.

Figure 21c
SETUP STORAGE SCREEN
(Cursor in Status field)

```
                SETUP FILE DIRECTORY
SETUP    NAME      STATUS       MODE    ACTION
* 1      TEST1   UNPROTECTED     Z80     SAVE
  2      TEST2   UNPROTECTED    8085     ----
  3              AVAILABLE                ----
  4      PROD1     PROTECTED     8085    RECALL
  5      PROD2     PROTECTED     8085    RECALL
  6      PROD3     PROTECTED     8085    RECALL
  7      PROD4     PROTECTED     8085    RECALL
  8              UNPROTECTED   LOGIC4
CURSOR TO ACTION FIELD AND USE f KEYS
f1 = available          f2 = unprotected
f3 = protected
POWERUP FIELD: 1
AUTOSEQUENCING: start file: 4 end file: 7
*=setup file in use      M=setups modified
```

d. Powerup Field

To designate a powerup setup file, cursor to the Powerup field and enter the setup file number; this setup file will then be automatically recalled upon powerup. To disable the powerup setup, cursor to the Powerup field and enter 0.

e. Autosequencing Start and End (AB-032 only)

The autosequencing start and end file fields apply only to the AB-032 option. These fields select the setup files to be used in autosequencing, a method of automatically running up to eight different tests a preset number of times. (See Section IX.3.c, Autosequencing, for operating details.)

2. B MEMORY STORAGE (AB-032 only) (See Figures 22a, 22b, and 22c)

Data captured by the ML4100 can be copied to B Memory to be used as reference data for Compare operations. If nonvolatile storage is wanted, this B Memory can be saved in a B Memory file.

The user has the option of configuring B Memory storage into one full-sized 4000-byte segment, two 2000-byte segments, four 1000- byte segments, or eight 500-byte segments. This feature permits storage of up to eight reference memories if the user decides (as in many cases) that only a portion of the trace buffer needs to be used for a Compare. Note the distinction between B Memory and a B Memory file; the machine contains only one B Memory, but may have up to eight saved B Memory files.

The B Memory Storage screen is shown in three figures in this section. Figure 22a shows the screen when the user has positioned the cursor in the Action field; Figure 22b shows it with the cursor in the Name field; and Figure 22c shows it with the cursor in the Status field. User activities via these three screens are detailed in Sections 2a-e below.

The width of the stored data (32, 16, 8, or 4 channels) is shown for each file. The selected word width of the ML4100 must match the width of the B memory file or an error will occur on recall.

As with the Setup Storage screen, an asterisk to the left of the file number indicates the current B Memory file in use (last file accessed). An "M" to the right of the file number indicates that B Memory currently in the ML4100 differs from the file indicated by the asterisk.

a. B Memory Configuration (See Figure 22a)

To select the configuration for saved B Memory, cursor to the B Memory Configuration field and enter 1, 2, 4 or 8 to specify the number of memories. Changing the configuration will change the size of the B Memory segments. As soon as B Memory is saved in a B Memory file, the B Memory directory is automatically updated to show the new number of files available.

For example, Figure 22a shows that there are eight B memory files available for use; changing the configuration to one would set the B Memory size to a 4000-byte memory. The B Memory Storage screen, however, would still show the eight files saved in nonvolatile memory, until a Save action is executed. At that time, the B Memory Storage screen would be updated to show only one B Memory file.

b. Copying Data (See Figure 22a)

To copy captured data in A Memory to B Memory, depress the "X" key. If saved B Memory is configured to any size except one, start and end addresses for the copy will be requested. If B Memory is configured to one, the entire A memory will be copied. If there is insufficient data in A Memory to fill B Memory (a trigger occurred before a full buffer of data was recorded), then B Memory will be padded with Don't Cares. B Memory may now be edited or used for Compare and Search operations.

c. Storing Data in Saved B Memory (See Figure 22a)

There must be data in B Memory before executing a Save; this data can be generated either by executing a copy A to B, a recall of a B Memory file, or a download of a B Memory.

To save B memory in nonvolatile storage, cursor to the Action field and depress the f1 key ("SAVE B"), then depress f1 again to verify the action. To recall a B Memory file, cursor to the Action field and depress the f2 key ("RECALL B"), then depress f2 again to verify the action. The current B Memory will be overwritten by the B Memory file selected.

As with the Setup Storage screen, an asterisk to the left of the file number indicates the current B Memory file in use (last file accessed). An "M" to the right of the file number indicates that B Memory currently in the ML4100 differs from the file indicated by the asterisk.

If the RS-232 Communication Control Card or the RE-016 ROM Emulator Module has been installed in the ML4100, then B Memory can also be uploaded and downloaded. To upload or download B Memory, cursor to the Action column and depress the f3 key ("UPLOAD B") or the f4 key ("DOWNLOAD B"). The B Memory is uploaded or downloaded to B Memory rather than a B Memory file, so the location of the cursor in the Action column is unimportant. The B Memory may then be saved in a B Memory file, if desired.

Figure 22a
B MEMORY STORAGE SCREEN
(Cursor in Action field)

SAVED B MEMORY DIRECTORY

B MEM	NAME	STATUS	WIDTH	ACTION
1	PRODM1	PROTECTED	32	RECALL
2	PRODM2	PROTECTED	32	RECALL
* 3 M	PRODM3	PROTECTED	32	RECALL
4	PRODM4	PROTECTED	32	RECALL
5		AVAILABLE		----
6		AVAILABLE		----
7	GLITCH	UNPROTECTED	4	SAVE
8	GLTCH2	UNPROTECTED	16	SAVE

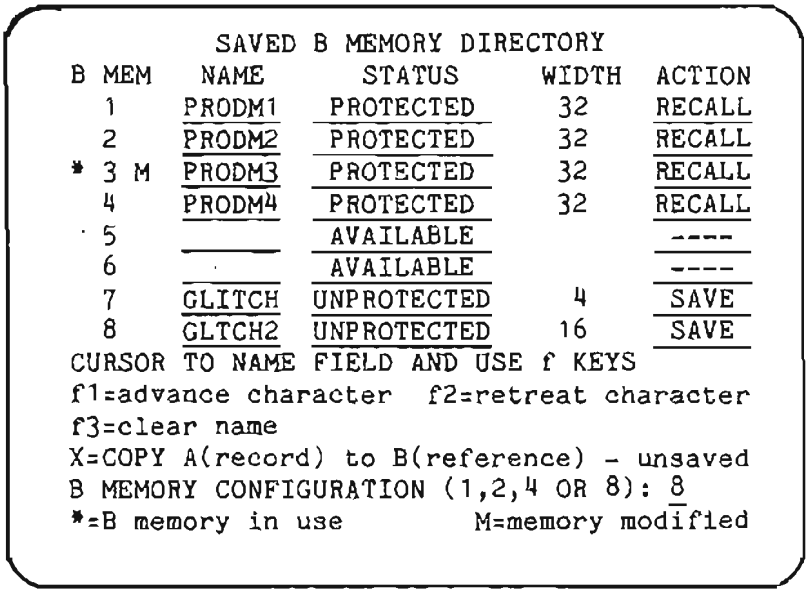
CURSOR TO ACTION FIELD AND USE f KEYS
f1 = SAVE B f2 = RECALL B
f3 = UPLOAD B f4 = DOWNLOAD B
X=COPY A(record) to B(reference) - unsaved
B MEMORY CONFIGURATION (1,2,4 OR 8): 8
*=B memory in use M=memory modified

d. B Memory File Names (See Figure 22b)

B Memory files can be assigned names of up to six characters, before saving the file. To enter a B Memory file name, cursor to each space in the Name field and enter one character at a time, using the f1 and f2 keys to alphabetically advance or retreat characters until the desired character is displayed in each space. The f3 key (clear field) may be used to clear the entire name field.

To change a B Memory file name, edit the name field one character at a time, using the f1 and f2 keys, then save the file again. If a file name is changed without the file being resaved, a warning message will be issued if an attempt is made to exit the screen.

Figure 22b
B MEMORY STORAGE SCREEN
(Cursor in Name field)



e. Status (Protected, Unprotected, Available) (See Figure 22c)

B Memory files normally have a status of "Unprotected," but may also be "Protected." To protect a B Memory file, cursor to the Status field, depress the f3 key (protected), then save the file. When the file is saved, a security code will be requested; this is a 2-digit hexadecimal number which is entered on the keypad. (If more than two keys are depressed, only the last two digits are used.) This security code will not be displayed on the screen.

This code will be requested prior to any future attempt to write over the file. If a security code is used to protect files, it is strongly recommended that it be written down somewhere.

To change a Protected file to Unprotected, cursor to the Status field, depress the f2 key (unprotected), and save the file again, using the correct security code. To erase a B Memory file, cursor to the Status field and depress the f1 key (available), and save the file again.

Figure 22c
B MEMORY STORAGE SCREEN
(Cursor in Status field)

SAVED B MEMORY DIRECTORY

B MEM	NAME	STATUS	WIDTH	ACTION
1	PRODM1	PROTECTED	32	RECALL
2	PRODM2	PROTECTED	32	RECALL
* 3 M	PRODM3	PROTECTED	32	RECALL
4	PRODM4	PROTECTED	32	RECALL
5		AVAILABLE		----
6		AVAILABLE		----
7	GLITCH	UNPROTECTED	4	SAVE
8	GLTCH2	UNPROTECTED	16	SAVE

CURSOR TO STATUS FIELD AND USE f KEYS
f1 = available f2 = unprotected
f3 = protected
X=COPY A(record) to B(reference) - unsaved
B MEMORY CONFIGURATION (1,2,4 OR 8): 8
*=B memory in use M=memory modified

3. COMPARING DATA (AB-032 only) (See Figs. 23a, 23b, 23c, and 23d)

The Compare screen is used to compare A (record) Memory to B (reference) Memory, using one of three methods:

* A Single Compare of already-captured data in A Memory to B Memory.

* A Continuous Compare where data is recaptured according to the machine setups, and compared to B Memory after each recapture.

* An Autosequencing Compare, which is similar to a Continuous Compare, except that up to 8 different machine setups and up to 8 different B memories (and thus up to 8 different Compares) are performed a selected number of times.

To execute any Compare, first use the Compare screen to specify several basic Compare parameters. Then, to execute a Compare, depress the f2, f3 or f4 key; results will be displayed on the screen.

To clear the results of a Compare, either depress the CLEAR key while in the Compare screen, or depress the START key to recapture data. To abort a Compare, depress the STOP key.

a. Single Compare (See Figure 23a)

Before comparing data, the user must select several comparison parameters:

* Data ranges for both A and B Memories (by specifying the A Memory Start Address, the B Memory Start Address, and the B Memory End Address)

* Comparison Mode (bit-to-bit or word-to-word)

* Skew Tolerance (jitter)

* Comparison Condition (A≠B or A=B)

Before performing a Single Compare, there must already be captured data in A Memory and reference data in B Memory. The data in B Memory may consist of previously captured data that was copied to B Memory with the Copy command, a B Memory file that was recalled from the Saved B Memory Directory, or data which was downloaded via the RS-232C interface.

To specify the data ranges for A and B Memories, cursor to the Address fields and enter the A Memory Start Address, the B Memory Start Address, and the B Memory End Address. The two ranges of data to be compared must be the same size. (The A Memory End address will be calculated and displayed automatically after the other three addresses are entered.)

There are two modes of compare: (1) Bit compare, in which words are compared on a bit-to-bit (channel-to-channel) basis, and (2) Word compare, in which words are compared on a word-to-word basis. To specify the comparison Mode, cursor to the Mode field and depress either 0 (bit) or 1 (word).

The maximum amount of skew allowed is +/- 9 words. Skew allows the Compare algorithm to be more flexible in comparing A to B Memories. For example, microprocessor cycles sampled with the internal clock may appear a varying number of times in the buffer, depending upon how the internal clock and the microprocessor clock happened to line up at a given time. Allowing some skew in the Compare lets the Compare algorithm look up to skew words on either side of the word in reference memory to try to find a match.

The Skew value will directly affect the amount of time it takes to compare A and B Memories. As the value of allowable skew goes up, the number of checks that the machine must perform increases dramatically. For faster execution times, it is recommended that the Skew value, along with the range of addresses to compare, be kept no larger than is absolutely necessary.

To specify Skew Tolerance, cursor to the Skew Tolerance field and enter a value between 0 and 9.

To specify the compare Condition, cursor to the Condition field and depress either 0 (to select A≠B) or 1 (to select A=B). (When it is desired to compare A and B Memories for differences, specify A≠B; for matches between A and B Memories, specify A=B. Occurrences of the differences or matches will be then be counted and highlighted in the state display.)

To execute a Single Compare (after specifying the above parameters), depress the f2 key (Single Compare). This will cause the screen to display the Compare Results, as shown in Figure 23b.

Figure 23a
COMPARE Screen

```
COMPARE:              A MEMORY   B MEMORY
Start address:         +00000     +00000
End address:           +00124     +00124
Mode (0=bit, 1=word)            : word
Skew tolerance (in samples)     : +0
Condition (0=A≠B, 1=A=B)        : A=B

CONTINUOUS COMPARE:
Mode (0=halt if, 1=count if): count if A=B
Pass if (0=A≠B, 0=A=B)      : A=B
AUTOSEQUENCING:
Memory to use: 1  Passes to run: 00100

f1=toggle +/-          f3=continuous compare
f2=single compare      f4=begin autosequence
```

Figure 23b
COMPARE Screen
(Single Compare Results)

```
COMPARE:              A MEMORY   B MEMORY
Start address:         +00000     +00000
End address:           +00124     +00124
Mode (0=bit, 1=word)              : word
Skew tolerance (in samples)       : +0
Condition (0=A≠B, 1=A=B)          : A=B

          COMPARE RESULTS
NUMBER OF OCCURRENCES (A=B)=00125
FIRST OCCURRENCE=+00000
LAST OCCURRENCE =+00124


f1=recapture and compare
Press STATE to view results
Press CLEAR to clear results
```

After a Single Compare, the number of occurrences of the compare condition, along with the address of the first and last occurrences, are displayed on the Compare screen (Figure 23b above). The occurrences of the compare condition are highlighted in the STATE display.

To clear the results of a Compare, either depress the CLEAR key while in the Compare screen, or depress the START key to recapture data. To recapture data and perform another Compare, depress the f1 key. To abort a Compare, depress the STOP key.

It is often necessary to compare only selected fields in A and B Memories. This can be done by using B Memory edit to fill the fields to ignore with "Don't Cares", or by accessing the Format screen and turning off the fields to ignore. Turning off fields does not destroy data in B Memory. However, once B Memory has been edited to Don't Cares, there is no way to "un-Don't Care" the data; it must be saved and recalled from B Memory to restore the areas set to Don't Cares.

b. **Continuous Compare** (See also Section 3.a above)

Continuous Compare is helpful in finding an intermittent bug that only seems to show itself when no one is looking for it. Catching such a failure by performing Single Compares over and over again until it happens to be found is tedious; instead, the Continuous Compare feature can be used to direct the ML4100 to do the looking itself, then either stop when it catches the failure or else count the number of times it sees it.

To perform a Continuous Compare, first specify the addresses, Compare mode, skew tolerance, and Compare condition as described in the Section 3.a above (Single Compare). Then specify the Continuous Compare mode (whether the ML4100 should ""Halt If" the condition is seen, or just "Count If" the condition is seen) and the pass condition (A≠B or A=B). For example, if there is a known good "picture" in B Memory, then A=B would be a "Pass"; conversely, if a known bad picture has been seen (possibly a recurring fault found in production test), then A=B is a failure, and the pass condition would be A≠B.

To specify the Continuous Compare mode, cursor to the Continuous Compare Mode field and depress either the 0 key ("Halt If") or the 1 key ("Count If"). To specify the pass condition, depress either the 0 key (A≠B) or the 1 key (A=B). To execute a Continuous Compare after specifying all of the necessary parameters, depress the f3 key. The results will be displayed, as shown in Figure 23c below. To abort a Continuous Compare, depress the STOP key.

Figure 23c
COMPARE Screen
(Continuous Compare Results)

```
COMPARE:              A MEMORY   B MEMORY
Start address:         +00000     +00000
End address:           +00124     +00124
Mode (0=bit, 1=word)            : word
Skew tolerance (in samples)     : ±0
Condition (0=A≠B, 1=A=B)        : A=B

CONTINUOUS COMPARE:
Mode (0=halt if, 1=count if): count if A=B
Pass if (0=A≠B  1=A=B)      : A=B


PASS: 00178  FAIL: 00000   ATTEMPTS: 00178


COMPARING  - PRESS STOP TO ABORT
```

The results of a Continuous Compare (number of passes, fails, and attempts) will be continuously displayed and updated on the Compare screen. If the "Count If" Continuous Compare mode was specified, the compares will be executed forever, or until the STOP key is depressed. If the "Half If" mode was specified, the compares will be performed only until the condition specified has been met or until the STOP key is depressed.

If a Continuous Compare halts itself, to display the results of the last Compare that caused the halt, depress the CLEAR key once. As in a Single Compare, these results are highlighted in the State display. To clear the Compare results, depress the CLEAR key a second time.

Note that the Compare Condition to halt on and the condition specified as a failure (inverse of the Pass Condition) are two separate things; the Compare does not halt on a failure, but halts when the Compare Condition is met.

The Pass, Fail, and Attempt counters roll over to zero at 65535.

c. Autosequencing (See Figures 23a and 23d)

Autosequencing was designed with production test in mind. It is a very powerful feature which allows up to eight totally unrelated Compares to be made between captured data and saved reference data.

To perform autosequencing, first specify the parameters detailed in both Section 3.a (Single Compare) and Section 3.b (Continuous Compare), using the Compare screen. Then specify two more parameters (also using the Compare screen): the (B) Memory To Use for Compare (an already saved B Memory file) and the number of Passes To Run.

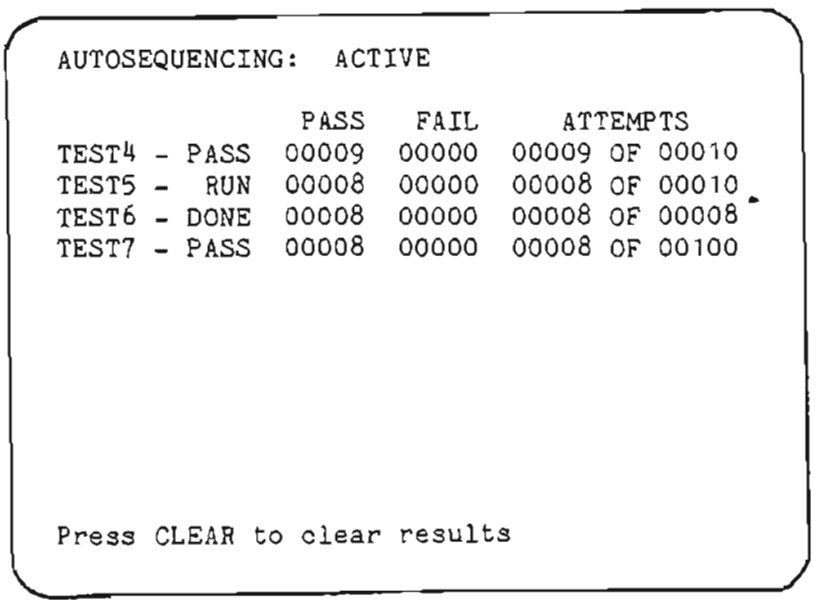
To specify the (B) Memory To Use, cursor to the Memory To Use field and enter the B Memory file number. To specify the number of Passes To Run, cursor to the Passes To Run field and enter the number (between 0 and 65535).

Next select the number of different Compares to perform by specifying the Autosequencing Start and End Files, using the Setup Directory screen. For example, to run four different tests requiring capturing and comparing data at four different locations, set up the ML4100 to trigger at the first location and capture data to use as a reference memory. Then save this data in a B Memory file for later use, and also save the machine setups used to capture this data in a setup file.

If the user has selected setup file number 4 and file number 1 for the B Memory data, then this process should be repeated 3 more times, saving the setup parameters used in setup files 5, 6 and 7, and the B Memory pictures in B Memory files 2, 3 and 4. Then the selected Autosequencing Start File would be setup file 4, and the End File would be setup file 7. (Note that setup files to use in Autosequencing must be in consecutive order; B Memories, however, may be in any order.)

To execute Autosequencing, depress the f4 key while in the Compare screen. Autosequencing results will be displayed and updated continuously on the Autosequencing Results screen (Fig. 23d); this screen is displayed automatically when an Autosequence is begun. To abort Autosequencing, depress the STOP key.

Figure 23d
AUTOSEQUENCING RESULTS



As Autosequencing begins, setup file number 4 is read; it specifies the B Memory (file number 1) to load to use for the Compare. Data is captured, the Compare is made, and the progress of Test 4 is updated. Next, setup file number 5 is read. It specifies a B Memory file (file number 2) of its own to use as reference data. The machine captures new data, performs a new Compare, and continues. Each Autosequencing test runs until the Number of Passes to Run (specified in the Compare screen of each setup file) has been executed.

Test numbers correspond to the setup files in which the setups are stored. The number of passes, fails and attempts for each test is continuously updated, and the status of each test is displayed.

"RUN" means that the test is currently being run; "PASS" means that the last time the test was run, it passed; "FAIL" means that the last time the test was run, it failed; "DONE" means that the test has been run the number of passes requested and is now finished; and "HALT" means that Autosequencing has been halted because this test has encountered a "Halt If" condition.

To print a hard-copy record of the Autosequencing results (only if the RS-232 Communications Control Card or the RE-016 ROM Emulator Module is installed and the logic analyzer is a ML4100B), depress the f4 key. (There is no on-screen prompt for this print function of the f4 key.)

4. SEARCH (AB-032 only)

The Search screen is used to search for a pattern of 1 to 10 words labeled 0-9) in either A or B Memory. To define each word to be searched for, cursor to each of its fields and enter it via the numeric, X, and CLEAR keys on the keypad.

To specify which Memory to search, cursor to the Memory To Search field and enter A or B. To define the pattern to search for, cursor to the Search Sequence fields and enter the numbers of the first and last words which define the pattern to search for. (To search for a single word, enter the same number for both the first and last word.) To execute the Search, depress the f3 key.

A complex word from a trigger word or from Memory may be loaded into the search list. To fill a search word with a trigger word, position the cursor in the word to fill, and depress the f1 key (Set Word with Trigger); then select the trigger word to use (A, B, C, or D) and depress the f1 key to execute the fill.

To fill a search word with a Memory location, first cursor to the Memory To Search field and select either A or B (the Memory in which the word is located); next position the cursor in the word to be filled, and depress the f2 key. Then (using the cursor, numeric, f1 and CLEAR keys) edit the address of the memory location to use, and execute the fill by depressing f2.

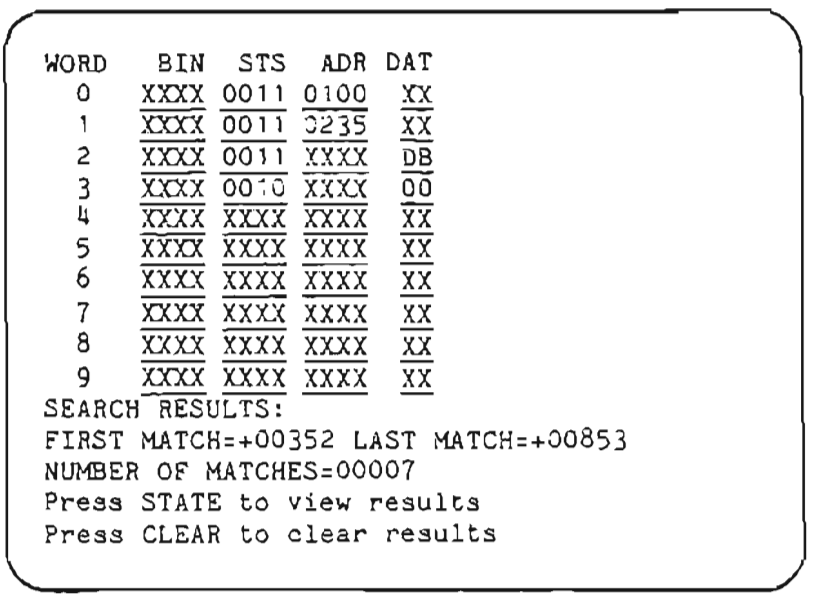
Figure 24a
SEARCH SCREEN

```
WORD   BIN  STS  ADR DAT
  0    XXXX 0011 0100  XX
  1    XXXX 0011 0235  XX
  2    XXXX 0011 XXXX  DB
  3    XXXX 0010 XXXX  00
  4    XXXX XXXX XXXX  XX
  5    XXXX XXXX XXXX  XX
  6    XXXX XXXX XXXX  XX
  7    XXXX XXXX XXXX  XX
  8    XXXX XXXX XXXX  XX
  9    XXXX XXXX XXXX  XX
SEARCH:
Memory to search (A or B): A
Search sequence: first: 2   last: 3
f1=set word w/trigger
f2=set word w/memory      f3= egin search
```

As soon as a Search has been executed, the Search results will be displayed on the Search screen. For example, Figure 24b shows the results of a Search in A Memory for an input from Port 0 (opcode fetch of a DB followed by a memory read of a 00). The number of search matches found, along with the addresses of the first and last matches, are shown on the screen. To view these matches highlighted on the State display screen, depress STATE.

To clear the results of a Search, either depress CLEAR while in the Search screen, or depress START to capture new data.

Figure 24b
SEARCH SCREEN
(Results)



5. B MEMORY EDIT (AB-032 only) (See Figure 25)

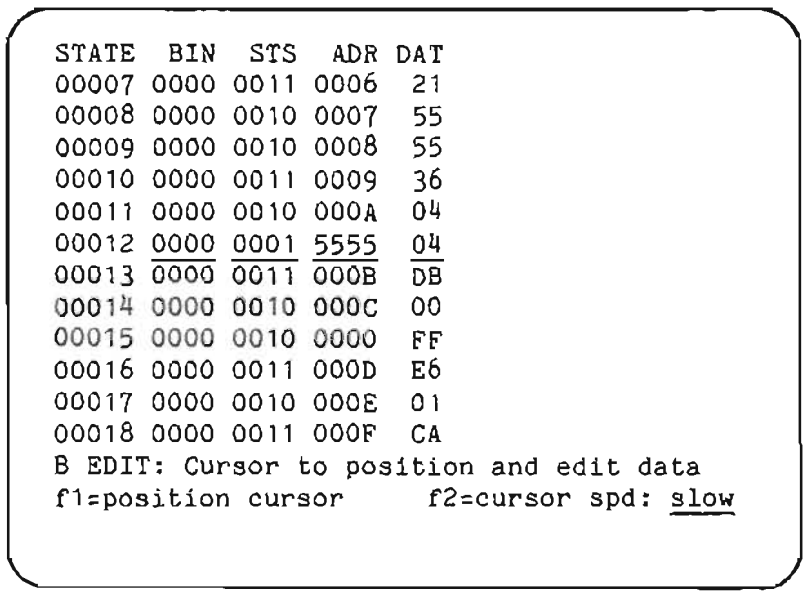
With this screen, the user can edit reference data (in B Memory). A typical use might be to enter Xs (Don't Cares) in some positions in some fields so that a Compare will ignore extraneous data. As with all ML4100 data displays, the user can direct the cusor to any desired address in the buffer via the f1 key, and the cursor speed can be changed via the f2 key.

To edit B Memory data, use the f1 key and the Up and Down arrow keys to position the word to edit in the highlighted edit window. Use the numeric, X, left and right cursor, and CLEAR keys to edit the data to the desired value.

A range of addresses may be filled with a particular word or portion of a word. To fill a range of addresses with a word, first position one address of the range to fill (either Start or End Address), in the edit window, and depress the f3 key; then edit the data to the desired word to fill with. Next position the other address of the fill range in the edit window, using the Up and Down arrows or the f1 key, then depress the f3 key to execute the fill.

To fill a range of addresses with a portion of a word, first depress the FORMAT key and change the display format to selectively turn off the fields that are to be left undisturbed by the fill. Next execute the fill as described above, then return to the Format screen and turn all fields back on again. Note: One disadvantage of this method is that portions of trigger words are reset to Don't Cares; this problem can be alleviated by recalling a setup file to restore the original trigger words.

Figure 25
B MEMORY EDIT SCREEN



6. B MEMORY DISPLAY

B Memory is displayed only on the State screen. A highighted field at the bottom of the State display screen indicates whether A or B Memory is being displayed. To display A or B Memory, access the State display screen and depress either A or B to select the Memory to be displayed.

As with A Memory, a pointer indicates the last displayed location in B Memory. When the State display screen is exited and re-entered, this pointer "remembers" the last area of Memory displayed. In addition, as the cursor is moved through one memory, the pointer to the other Memory not being displayed is moved at the same time. If a corresponding address does not exist in the other Memory, the pointer is left undisturbed.

To print a hard-copy record of any portion of A or B Memory (in an ML4100B with either the RS-232C Communications card or the ROM Emulator Module, RE-016) depress the f4 key while viewing the State display screen. There is no on-screen prompt for this print function of the f4 key.

C. EXECUTION TIMES

1. SETUP STORAGE TIMES

The time required to save a setup file is directly proportional to the difference, in number of bytes, between the current machine setups and the old file to write over. This time is at most 2.5 seconds, but on the average is less than 1 second.

2. B MEMORY STORAGE TIMES

The time required to save a B Memory file is directly proportional to the difference, in number of bytes, between the current B Memory and the old B Memory file to write over. In addition, the number of bytes in B Memory varies according to the B Memory configuration.

Storage times are:

Configuration	Max. Storage Time
1	20.0 seconds
2	10.0 seconds
4	5.0 seconds
8	2.5 seconds

3. COPY A TO B EXECUTION TIMES

The time required to copy A Memory to B Memory is directly proportional to the number of samples to copy. Number of samples is dictated by the width of the machine.

Width	Approx. Copy Time
4	15.0 seconds
8	7.5 seconds
16	4.3 seconds
32	2.6 seconds

4. SEARCH EXECUTION TIMES

The time required to search a memory depends on the number of words to search (width of machine), the size of the memory (B Memory only) and, to a lesser degree, the number of matches found and the size of the search pattern.

a. A Memory

Width	Approx. Search Time
4	16.0 seconds
8	8.0 seconds
16	4.0 seconds
32	2.0 seconds

b. B Memory

	Approx. Search Time (in sec.)			
	Configuration			
Width	1	2	4	8
4	5.0	2.5	1.3	0.6
8	2.5	1.3	0.6	0.3
16	1.3	0.6	0.3	0.2
32	0.8	0.4	0.2	0.1

5. COMPARE EXECUTION TIMES

The time required to compare A Memory to B Memory is dependent upon the size of the Compare range, the allowable skew in the Compare, and, to a lesser degree, the Compare mode (word or bit) and the number of Compare occurrences found. Note also that, in Continuous or Autosequencing Compares, the machine may not need to compare the entire memories if "Count If" is selected. Sample Compare times are:

Approx. 3.5 seconds for:
- 32 bits wide
- Word compare
- 0 skew
- 1000 samples
- No occurrences found

Approx. 135 seconds for: (Worst case)
- 4 bits wide
- Bit compare
- +/-9 skew
- 8000 samples
- No occurrences found

To keep Compare execution times to a minimum, keep the size of the Compare range and the allowable skew only as large as necessary. This is especially important in Continuous and Autosequencing Compares, since the Compare time represents "dead" time regarding catching a failure. A typical Compare of microprocessor data needs a Compare range of 100 samples and 0 skew; this Compare would take less than 1 second.

(blank)

APPENDIX A

SPECIFICATIONS

D. DATA QUALIFICATION
(32-channel mode only)

Qualification Modes	
State	Occurrence of selected words toggles recording on/off
Combinational	Records only those words which match qualification words

E. MEMORY

At Recording Width:	Recording Depth:
4 channels	8000 samples/channel
8 channels	4000 samples/channel
16 channels	2000 samples/channel
32 channels	1000 samples/channel

F. STATE DISPLAY MODE	Formatted word list (14 recorded words in up to 8 fields)
Selectable number base for each field	ASCII, binary, octal, decimal, hexadecimal
Selectable bit groupings for each field	Up to 32 bits wide
Data is repeatable in different number bases and field groupings	

G. TIMING DISPLAY MODE	Up to 12 timing lines (any may be repeated)
Cursors (two)	Current position and reference line
Magnification (horizontal)	Times ten; centered around cursor
Time Measurement	
Units	Clocks (external clock) or time units (internal clock)
Distance measured	If reference line is set, reference-to-cursor; if no reference line is set, trigger-to-cursor

H. DISASSEMBLY DISPLAY MODE	For address, operand(s), bus activity, instruction mnemonic

O. 32-CHANNEL LOGIC POD (LP-320) (included with mainframe)	4-, 8-, 16-, and 32-channel; operates at full rated speed of mainframe

P. OPTIONAL PODS

4-Channel Logic Pod (LP-040)	100 MHz; glitch capture
Microprocessor Pods	
8I-080	For 8085; 8031/8032; and 8035/8039/8040
8M-080	For 6800/6802/6808
8M-089	For 6809, 6809E
8R-065	For 6502, 6512, 65C02, 65C102, and 65C112
8Z-080	For Z80 and Z80A/B/C
(First pod requires a Disassembly ROM Board, DI-012)	
STD Bus Pod (8P-080)	

APPENDIX B

ASCII (USA STANDARD CODE FOR INFORMATION INTERCHANGE)

APPENDIX C

INTEL HEX FORMAT

APPENDIX D

ML4100B PRICE LIST
(September 6, 1984)

Replacement or Spare Parts

Catalog Number:	Item:	Price:
LP-320	32-Channel (Standard) Logic Pod (includes Standard Probe Set, which is LP-321 plus LP-322)	$450.00
LP-320W**	32-Channel (Standard) Logic Pod, Disconnectible (includes Disconnectible Probe Set, which is LP-321W plus LP-322W)	536.00
LP-321	8-Channel Probe Set for LP-320	63.00
LP-321W**	8-Channel Probe Set, Disconnectible, for LP-320W	99.00
LP-322	24-Channel Probe Set for LP-320	96.00
LP-322W**	24-Channel Probe Set, Disconnectible, for LP-320W	146.00
LP-323	Probe Set Wire for Standard Probe Set (Specify colors of tip, cap, and wire for each; minimum quantity = 5)	5.00
LP-323W**	Probe Set Wire, Disconnectible, for Standard Probe Set (Specify colors of tip, cap, and wire for each; minimum quantity = 5)	7.00
8X-001	40-Pin DIP Clip (with terminated ribbon cable) for microprocessor pods	94.00
	Nonwarranty Repairs (Customer must approve cost estimate before work will begin; min. = 1 hr.)	38/hr.
	Volume Discount (Minimum quantity = 20 per item; must be on same purchase order and delivery date)	2.5%

** The "W" suffix on a catalog number specifies disconnectible probe clips, so that the wires may be connected to wire-wrapped or backplane pins on the device under test.

WARRANTY POLICY (within continental U. S. only): Arium warrants its products against all defects in materials and workmanship for one year from shipment date from factory. Arium performs all repairs at its plant in Anaheim, CA, and will pay return shipment costs (via UPS ground service) from Anaheim after warranty repairs have been made.

These prices are as of Sept. 6, 1984, are subject to change without notice, and they apply only to equipment sold and delivered within the United States.

APPENDIX E

ERROR MESSAGES

	Message (Screen)	Condition
1.	1 OR 2 WORDS ONLY (Configuration)	In state qualification only two words are allowed for each entry.
2.	ACCESS DENIED (Setup Directory and B Memory Directory)	The wrong security code was entered while trying to read a protected setup or B Memory file.
3.	ADDRESS NOT FOUND (Search and Compare)	One of the 3 addresses specified in a Compare was not found in either A or B Memory, or the address specified in Fill with Memory (Search) was not found.
4.	ALREADY STARTED (any)	The START key was depressed when the ML4100 was already active.
5.	CANNOT WRITE OVER PROTECTED FILES (B Memory Directory)	An attempt was made to write a B Memory file, with a new configuration differing from the stored configuration, over a protected file; the protected file must be unprotected first.
6.	CHECKSUM ERROR--FILE LOST (Setup Directory, B Memory Directory, and Status)	A checksum error occurred while reading a setup or B Memory file; this indicates a hardware problem on the A/B memory card.
7.	DIRECTORY CHECKSUM ERROR--ALL FILES LOST (Setup Directory, B Memory Directory, and Status)	A checksum error occurred while reading the EEPROM directory information; this indicates a hardware problem on the A/B memory card.
8.	FILE CONFLICTS WITH POD TYPE (Setup Directory)	An attempt was made to read a setup file with the wrong pod connected to the ML4100.
9.	FILE DOES NOT EXIST (Setup Directory and B Memory Directory)	An attempt was made to read an available (non-existent) setup or B Memory file.
10.	FILE NO. INCONSISTENT WITH CONFIGURATION (B Memory Directory)	An attempt was made to save a B Memory file in a file number larger than the new B Memory configuration. (This can occur only when changing to a smaller B configuration.)
11.	FILE WIDTH DIFFERS FROM MACHINE WIDTH (B Memory Directory)	An attempt was made to read a B Memory file stored with a width differing from the current width of the ML4100.

12.	FORMAT INCONSISTENT WITH WIDTH (Timing and State)	"Probe" numbers higher than those used in the selected configuration have been used in the display format (see Format screen).
13.	ILLEGAL COMBINATION (Status)	The two flashing parameters may not be set to their current values at the same time.
14.	IMPROPER FILE ORDER FOR AUTOSEQUENCING (Setup Directory)	An attempt was made to exit the Setup Directory screen with the autosequencing start file number larger than the autosequencing end file number.
15.	INCORRECT SEARCH SEQUENCE (Search)	An attempt was made to execute a Search with the first search word after the last search word.
16.	LOW PROBE MUST BE LESS THAN HIGH PROBE (Format)	When defining display fields via the Format screen, the "Low Probe" must have a lower probe number than the "High Probe".
17.	MEMORY CONFIGURATION INCONSISTENT (B Memory Directory)	An attempt was made to read a B Memory file stored under a configuration differing from the current B Memory configuration.
18.	NO DATA IN B MEMORY (B Memory Directory, Search, Compare, Edit, and State)	An attempt was made to save, edit, display, search, or upload B Memory while B Memory is empty.
19.	NO DATA RECORDED (any)	The START and STOP keys were depressed but fewer than two qualified clocks occurred after starting but before stopping.
20.	NO FIELDS TO EDIT (Edit)	An attempt was made to Edit B Memory with all fields in the Format screen turned off.
21.	NO RECORDED DATA (B Memory Directory and State)	An attempt was made to copy A Memory to B Memory when A Memory was empty, or a display key was pressed to view A Memory when it was empty.
22.	NO POD INSTALLED (any)	(Self-explanatory.)
23.	NOT ACTIVE (any)	The STOP key was depressed when the ML4100 was not active.

24. POD CONNECTION ERROR
(any)

The connection from the "pod" to the circuit under test is either not made or made incorrectly, or the processor is not powered (microprocessor pods). (In the case of the 8086/88 pod, if the MIN/MAX DIP-switch setting on the pod does not agree with the target microprocessor's mode, this error message will appear; to correct the error, change the DIP-switch setting and turn the ML4100 off, then on again.)

25. POD x ROM x NOT USED BUT INSTALLED
(when exiting ROM Emulator editor)

The specified DIP cable is installed in a ROM socket but is not defined on the "ROM Emulator Configuration" Screen.

26. POD x ROM x INSTALLATON ERROR
(when exiting ROM Emulator editor)

The specified DIP cable is not installed correctly in a powered ROM socket but is defined on the ROM Emulator Configuration Screen.

27. SELECTED FORMAT TOO WIDE FOR SCREEN
(Format)

If a display was created from the keyed in parameters one or more of the fields would extend off the right side of the screen.

28. START ADDRESS > END ADDRESS
(Compare)

An attempt was made to execute a Compare with a starting address in memory larger than an ending address.

29. WARNING--UNSAVED NAME & STATUS WILL BE LOST
(Setup Directory and B Memory Directory)

An attempt was made to leave the Setup Directory screen or the B Memory Directory screen without saving a file after changing its name and/or status.

INDEX

(blank)