



OPERATING MANUAL FOR
ML4100 LOGIC ANALYZER

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

REVISION RECORD

The following pages have been revised since the publication of this manual (June 2, 1986). On the revised pages, each revised line is marked with a vertical bar (|) in the right margin.

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I. INTRODUCTION

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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, AR-0321 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 labeling) 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 pre-defined 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:

<u>Catalog No.:</u>	<u>Microprocessors Supported:</u>
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 erasable ROM board.

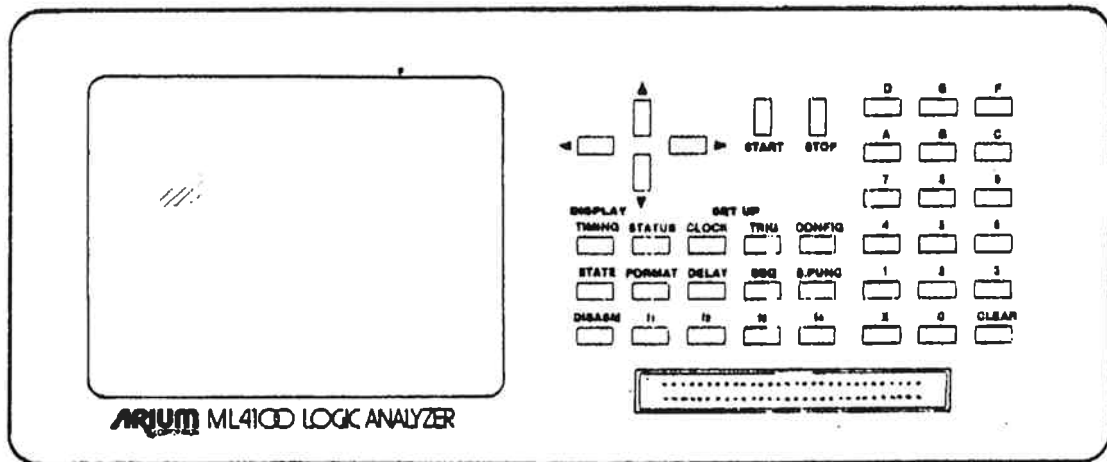
g. Setup Memory Option (SM-080)

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 bottom 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 1I.A for details of use.)

2. **KEYBOARD AND CRT SCREEN**

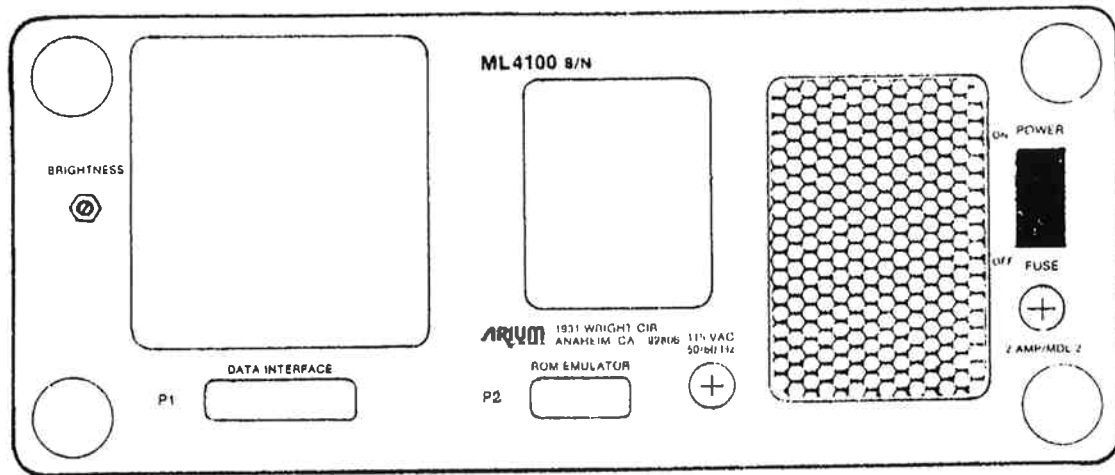
All operating functions are controlled from the front-panel keyboard. All keys will repeat if held down; use a quick and sure touch to avoid unwanted repeating.

- 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.

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II. CONNECTION TO SYSTEM UNDER TEST

Figure 3
 COLOR CODES OF PROBES FOR 32-CHANNEL LOGIC POD

	<u>BODY:</u> (tip)	<u>PLUNGER:</u> (cap)	<u>WIRE:</u>	<u>CONNECTOR/ PIN:</u>
External Clock	Red	Red	Red*	P1B-16
Clock Qualifier	Blue	Blue	Blue*	P1B-14
Grounds (8)	Black	Black	Black*	
Probe 0	Black	Grey	Black	P1B-2
Probe 1	Black	Grey	Brown	P1B-3
Probe 2	Black	Grey	Red	P1B-5
Probe 3	Black	Grey	Orange	P1B-6
Probe 4	Black	Grey	Yellow	P1B-8
Probe 5	Black	Grey	Green	P1B-9
Probe 6	Black	Grey	Blue	P1B-11
Probe 7	Black	Grey	Violet	P1B-12
Probe 8	Black	Grey	Grey	P1A-2
Probe 9	Black	Grey	White	P1A-3
Probe 10	Brown	Grey	Black	P1A-4
Probe 11	Brown	Grey	Brown	P1A-5
Probe 12	Brown	Grey	Red	P1A-6
Probe 13	Brown	Grey	Orange	P1A-7
Probe 14	Brown	Grey	Yellow	P1A-8
Probe 15	Brown	Grey	Green	P1A-9
Probe 16	Brown	Grey	Blue	P1A-10
Probe 17	Brown	Grey	Violet	P1A-11
Probe 18	Brown	Grey	Grey	P1A-12
Probe 19	Brown	Grey	White	P1A-13
Probe 20	Red	Grey	Black	P1A-15
Probe 21	Red	Grey	Brown	P1A-16
Probe 22	Red	Grey	Red	P1A-17
Probe 23	Red	Grey	Orange	P1A-18
Probe 24	Red	Grey	Yellow	P1A-19
Probe 25	Red	Grey	Green	P1A-20
Probe 26	Red	Grey	Blue	P1A-21
Probe 27	Red	Grey	Violet	P1A-22
Probe 28	Red	Grey	Grey	P1A-23
Probe 29	Red	Grey	White	P1A-24
Probe 30	Orange	Grey	Black	P1A-25
Probe 31	Orange	Grey	Brown	P1A-26

* Optional disconnectible probes have yellow sleeves at end, to distinguish these wires from the data probes when the probe tips have been removed.

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), connected 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 11210; 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.)

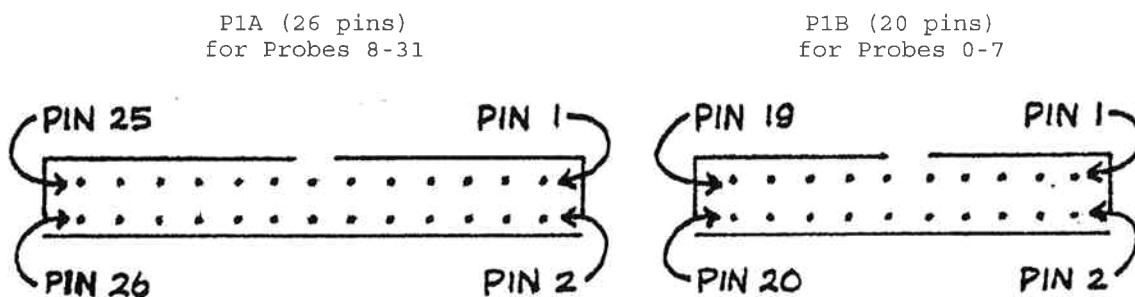


Figure 3

CONNECTOR RECEPTACLES ON END OF 32-CHANNEL LOGIC POD

1. 32-CHANNEL LOGIC POD PROBES

The probe set with 16 wires is called the 8-Channel Probe Set; it contains the Clock Probe, the Clock Qualifier Probe, Probes 0-7 and six grounds. (This group is equipped for high-speed recording.) The probe set with 26 wires is called the 24-Channel Probe Set, and contains Probes 8-31 and two grounds.

This pod contains a potentiometer and a switch for selecting either "Fixed" or "Variable" voltage threshold. The "Fixed" position sets the voltage threshold at TTL levels (1.4 V). The "Variable" position allows setting the voltage threshold between -9 V and +9 V by turning the adjusting screw. To measure the voltage, use the reference line that is (internally) connected to Pin 19 on the pod's 20-pin connector, and use a high-impedance meter. The impedance of this node is about 1 Kohm.

Probe color codes are shown in Figure 3.

2. 4-CHANNEL LOGIC POD 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:

	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

3. CONNECTING LOGIC POD TO SYSTEM UNDER TEST

To connect a logic pod to the circuit under test, insert the pod's cable connector plug into the connector receptacle on the front panel. Then connect the desired number of probes (which corresponds to the number of selected input channels) to the points on the circuit to be tested.

To sample data synchronously with an external clock, connect probes for the clock and (optionally) the clock qualifier to the circuit. The input buffers for clock, clock qualifier, and Data Channels 0-3 have been designed to be very fast, and care must be taken to minimize coupled noise.

WARNING: THE CLOCK AND CLOCK QUALIFIER WIRES SHOULD ALWAYS BE TWISTED WITH A CONNECTED GROUND LEAD. FOR OPERATION ABOVE 10 MHz, THE LOWER DATA CHANNELS SHOULD ALSO BE TWISTED WITH THE GROUND LEADS PROVIDED.

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.

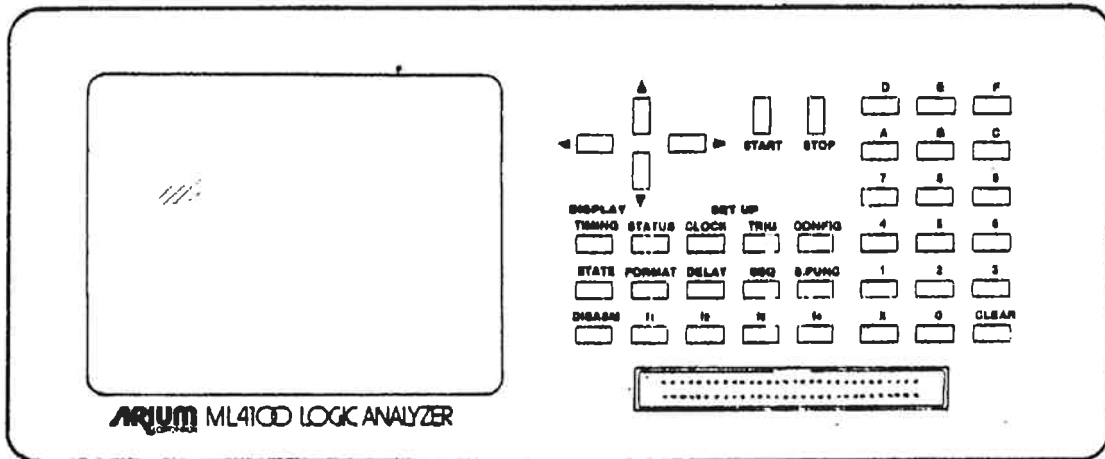
For operating details, see Section VIII, ROM Emulator Module.

(blank)

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 depressing - STOP) before any setup parameter may be changed.

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

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

```

STATUS      HB  c 1983, ARIUM Corp.
*CLOCK      *CONFIGURATION
Source : External      Width  : 32 bits
Sense  : rising      Data Qual: off
Qual   : always

*DELAY      : 00150 Clocks
*SEQUENCE:  A then B then (C without D)

*TRIGGER:           *FORMAT POD: 8085

      BIN  STS  ADR  DAT
A: XXXX XXXX 003C XX
B: XXXX XXXX 009C XX
C: XXXX XXXX 009F XX
D: XXXX XXXX 00A0 XX

```

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

```

                                CLOCK

SOURCE (0=internal,1=external): External

INTERNAL:
Clock period (10 ns - 200 ms): 0010 nsec
  (f1=nsec, f2=usec, f3=msec)
Clock rate                       : 12.5 MHz
Record time                       : 80.0 usecs

EXTERNAL:
Clock edge (0=fall,1=rise)       : rising
Qualifier valid                  : always
  (0=low, 1=high, 2=always)

```

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". "Fall-ing" means that the data is sampled on the high-voltage-to-low-voltage tran-sition 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 (Al-ways) 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

```

RECORD WIDTH (4,8,16,32) : 32 bits
RECORD DEPTH              : 1000 words

DATA QUALIFICATION TYPE
(0=off, 1=comb., 2=state) : comb
COMBINATIONAL QUALIFICATION
Record (0=only, 1=all but) : only
Occurrences of : C+D

STATE QUALIFICATION
Reenable record on occur. of : none
Disable record on occur. of : none

(Type A, B, C or D to alternately
include/exclude a trigger word)

```

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 keypad. (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.

<u>Record Width</u>	<u>Maximum Clock Speed</u>	<u>Record Depth</u>
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 "Occurrences 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

TRIGGER				
	BIN	STS	ADR	DAT
A:	<u>XXXX</u>	<u>XXXX</u>	<u>003C</u>	<u>XX</u>
	<u>XXXX</u>	<u>XXXX</u>	<u>000000000111100</u>	<u>XXXXXXXXXX</u>
B:	<u>XXXX</u>	<u>XXXX</u>	<u>009C</u>	<u>XX</u>
	<u>XXXX</u>	<u>XXXX</u>	<u>0000000010011100</u>	<u>XXXXXXXXXX</u>
C:	<u>XXXX</u>	<u>XXXX</u>	<u>009F</u>	<u>XX</u>
	<u>XXXX</u>	<u>XXXX</u>	<u>0000000010011111</u>	<u>XXXXXXXXXX</u>
D:	<u>XXXX</u>	<u>XXXX</u>	<u>00A0</u>	<u>XX</u>
	<u>XXXX</u>	<u>XXXX</u>	<u>0000000010100000</u>	<u>XXXXXXXXXX</u>
SEQUENCE: A				
STS:		FETCH=0011	MRD=0010	MWR=0001
HLDA=1XXX	INTA=0111	IORD=0110	IOWR=0101	

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:

<u>Prompt</u>	<u>Status Code</u>
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 addresses. 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

```

TRIGGER SEQUENCE: ('+' means 'or')
  A then B then (C without D)

7: A then B then C           0: A
8: (A+B) then (C+D)         1: A+B
9: (A+B+C) then D          2: A+B+C
A: A then (B+C+D)          3: A+B+C+D
B: (A+B) then C then D     4: A then B
C: A then (B+C) then D     5: (A+B) then C
D: A then B then (C+D)     6: A then (B+C)
E: A then B then C then D
F: A then (B without C)
f1: A then B then (C without D)
f2: (A+B) then (C without D)
f3: A then (B without C) then D
f4: User-defined sequence

```

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.

<u>Recording Width</u>	<u>Available Trigger Sequences</u>
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

```

USER-DEFINED SEQUENCE: (Press f4 for menu)

  01 of  A+B  without  C*
then 03 of  D    without  A+B

      01=Total counts (must not exceed 13)
      A-D include/not(*)/exclude trigger words
      'A*' means nonoccurrence of word A
      CLEAR excludes all words (disables)
      f1/f2 add/remove sequence levels
      f3 sets 'AND'(&)/'OR'(+)' of trigger words
  
```

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 11" 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

TRIGGER DELAY
Storage will stop 00150 clocks after the
trigger event.

Storage will begin up to 00849 clocks
before the trigger event.

(A=after, B=before)

In 4-bit mode, DELAY is a multiple of 40
In 8-bit mode, DELAY is a multiple of 20
In 16-bit mode, DELAY is a multiple of 10
In 32-bit mode, DELAY is a multiple of 5

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	<u>28</u>	<u>29</u>	<u>30</u>	<u>31</u>	<u>XX</u>	<u>XX</u>	<u>XX</u>	<u>XX</u>	<u>XX</u>	<u>XX</u>	<u>XX</u>	<u>XX</u>
STATE:												
			STS	ADR	DAT							
Field		1	2	3	4	5	6	7	8			
Base		<u>BIN</u>	<u>BIN</u>	<u>HEX</u>	<u>HEX</u>	<u>OFF</u>	<u>OFF</u>	<u>OFF</u>	<u>OFF</u>			
High Probe		<u>31</u>	<u>27</u>	<u>23</u>	<u>07</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>			
Low Probe		<u>28</u>	<u>24</u>	<u>08</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>			
Data Sense		<u>NON</u>	<u>NON</u>	<u>NON</u>	<u>NON</u>	<u>NON</u>	<u>NON</u>	<u>NON</u>	<u>NON</u>			
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): <u>8085</u>												
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 correspond 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 modes.)

Figure 12
POD MODE DESIGNATIONS

Pod Catalog Number	Designation of mode	Supports
8I-080	8031/2 8035/9 8085	8031, 8032 8035, 8039, 8040 8085
8M-080	6800 6802/8	6800 6802, 6808
8M-089	6809 6809E	6809 6809E
8R-065	6502 6512 65C112 65CX02	6502 6512 65C112 65C02, 65C102
8Z-080	Z80 Z80REF	Z80, Z80A, Z80B, Z80C Z80, Z80A, Z80B, Z80C (all with refresh recorded)
8P-080	STDBUS STDINT STD24B	STD bus bus controls STD bus interrupt controls STD bus with 24-bit addressing
LP-032	LOGIC4 LOGIC8 LOGC16 LOGC32	4-channel operation 8-channel operation 16-channel operation 32-channel operation
LP-040	GLITCH NOGLCH	With glitch capture 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

```
Special Functions: (press 1-F to invoke)
1: Mainframe Self-test
2: Logic Pod Color Codes
3: RS232C Port Configuration
4: ROM Emulator Transfers
5: ROM Emulator Configuration
6: ROM Emulator Editor
7: Setup Storage
8: B Memory Storage
9: Compare
A: Search
B: Edit B Memory
C: Not installed
D: Not installed
E: Not installed
F: Not installed
```

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	\	ROM Emulator Module
5.	ROM EMULATOR CONFIGURATION	/ >	See Section VIII.1.B
6.	ROM EMULATOR EDIT	/	
7.	SETUP STORAGE	\	
8.	B MEMORY STORAGE		
9.	COMPARE	\ >	Setup Memory and Setup/Data Memory
10.	SEARCH	/	See Section IX.B
11.	EDIT B MEMORY		

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-0161, 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.

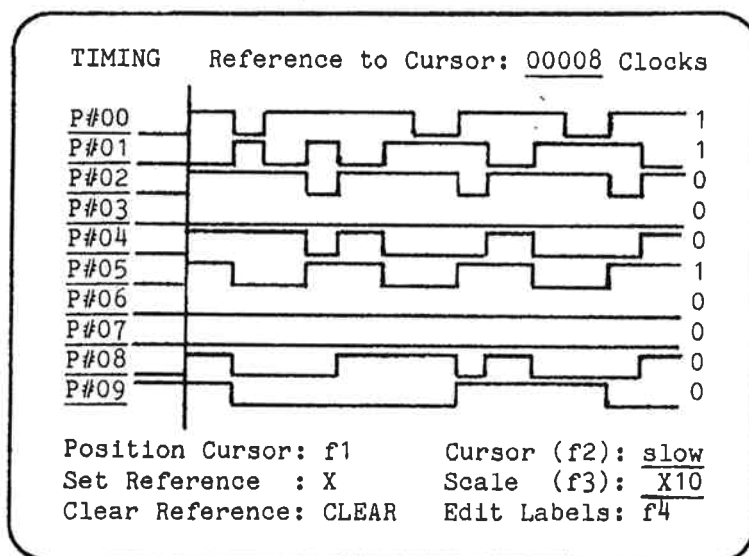
To set a reference line for measuring time, move the cursor to the desired position on a timing line and depress "X" on the keypad. The area between the reference line and the cursor location will be highlighted on the screen. The time represented by the highlighted area is then automatically measured, 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 relabelling. 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 relabelling prompt lines from the bottom of the screen, depress the f4 key, which toggles back and forth the prompt lines and the relabelling 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 labelled "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
<u>TRIG</u>	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): <u>slow</u>

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 threshold 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 threshold 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)