IV. OPERATION

NOTE: For descriptions of the various connections between the mainframe, capture modules, pods, peripherals, etc., see Section II. For information on setting up operating and display parameters, see Section III.

A. GENERAL

1. POWER ON/OFF SWITCH

WARNINGS

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

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

The Power On/Off Switch is a left-right rocker switch on the lower left side of the ML4400 rear panel, when reaching back from the unit's front.

Turning the power off (in accordance with the above warning) before connecting or disconnecting Capture Modules, Logic Pods, and Microprocessor Pods will NOT result in the loss of machine setups. The ML4400 has nonvolatile storage of up to 8 setup files and up to 8 Reference Memories, and all of them are unaffected by turning the power switch off.

2. HEADER LINE

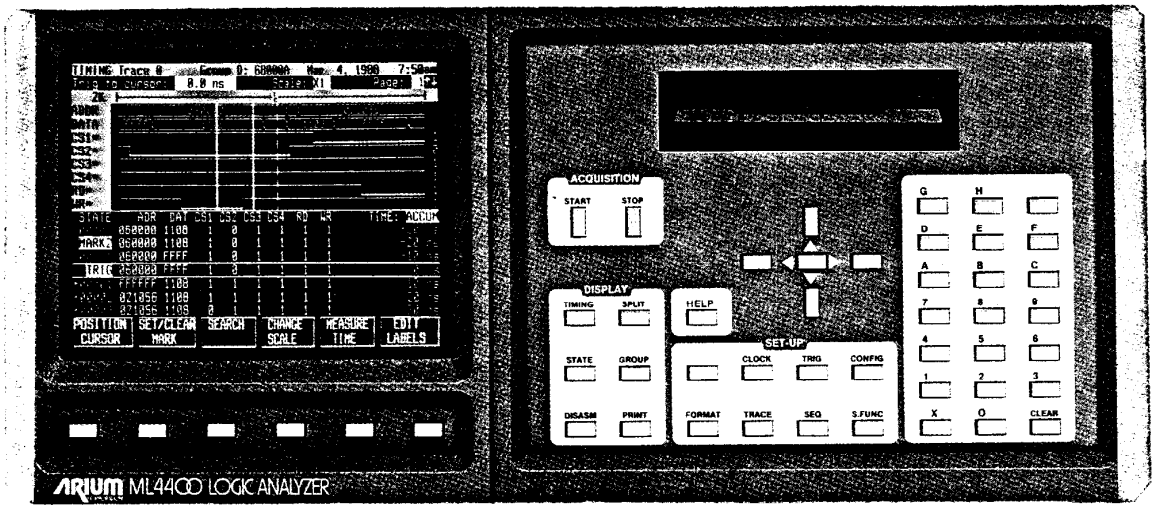
The top line of all screens is referred to as the "Header line", and contains (from left to right): the name of the screen; the label (A-D) and name of the selected Group; and current the date and time. (The group name may be specified by the user, but if not, defaults to the type of Logic or Microprocessor Pod which is installed.)

The Status screen, which is automatically displayed at powerup, carries the Arium Corporation name and copyright year instead of a screen name.

Display screens (Timing, State and Disassembly) also contain, just after the name of the screen, the type of memory being accessed, either the Trace Buffer ("Trace 0") or a Reference Memory ("Reference X", with X being l-8). "Trace" designates the most recently captured data, and "Reference" designates data previously captured and stored by the user in a particular Reference Memory. The Date/Time is overwritten at times to indicate a particular operational status, and the entire Header line may be overwritten with an error message. (To clear an error message, depress any Display or Setup key).

Figure IV-A

ML4400 FRONT PANEL



44-002

---

3. "HELP" INFORMATION

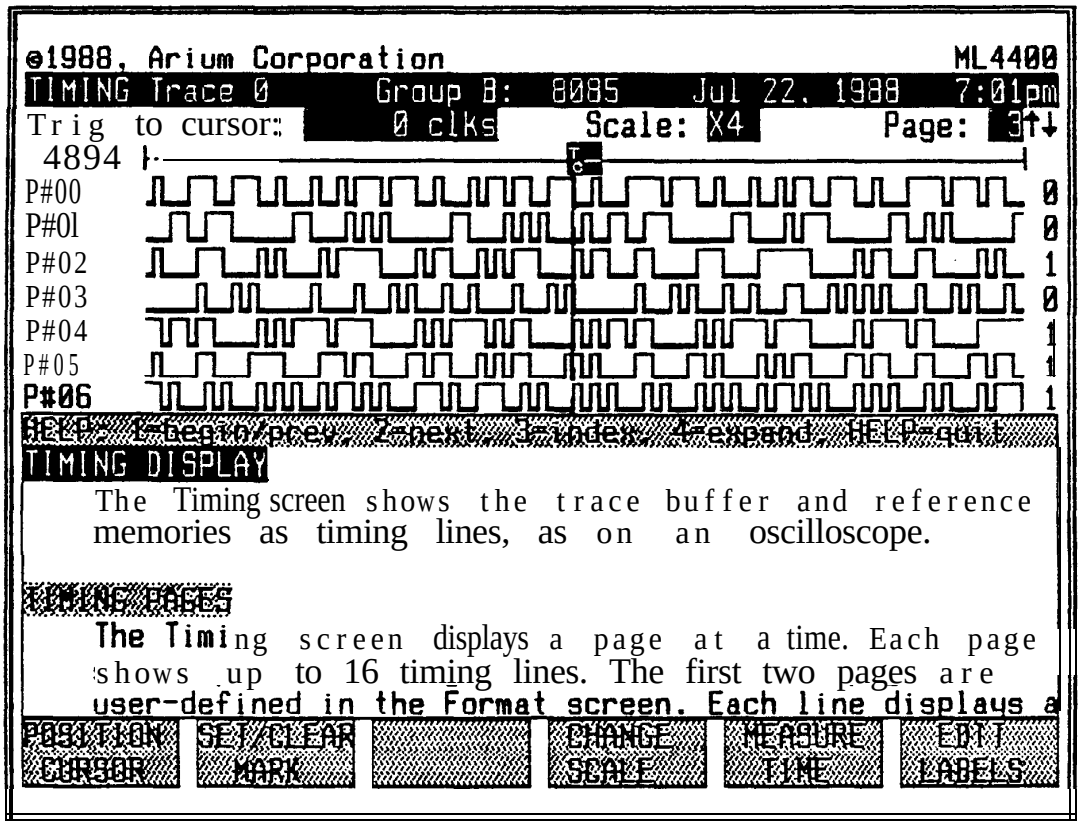
The HELP key on the front-panel keyboard accesses context-sensitive Help information for all ML4400 display screens; i.e., it displays only information related to the specific logic analyzer activity underway and to the particular analyzer system configuration. And when an error message occurs, depressing HELP displays an explanation of the message. With this basic information so easily available, the user will find that it often eliminates the need to consult the more detailed documentation in this manual.

To access a Help information window for a particular screen, change to that screen and depress HELP. To close the Help window and return to the original screen, &press HELP again. The Help window will be displayed on either the upper or lower half of the screen, depending upon the cursor location when HELP was depressed. To expand the Help window to full-screen size, depress 4 on the keypad.

All Help information is stored in the ML4400 as one long document (in alphabetical order by topic), so the user can cursor into any other topics (or read the entire Help document) without changing screens. Main topic headings are highlighted in a reverse video box, and subtopic headings are shown as all uppercase letters inside a shaded box.

Figure **IV-B**

HELP TOPIC ACCESS&D FROM TIMING SCREEN

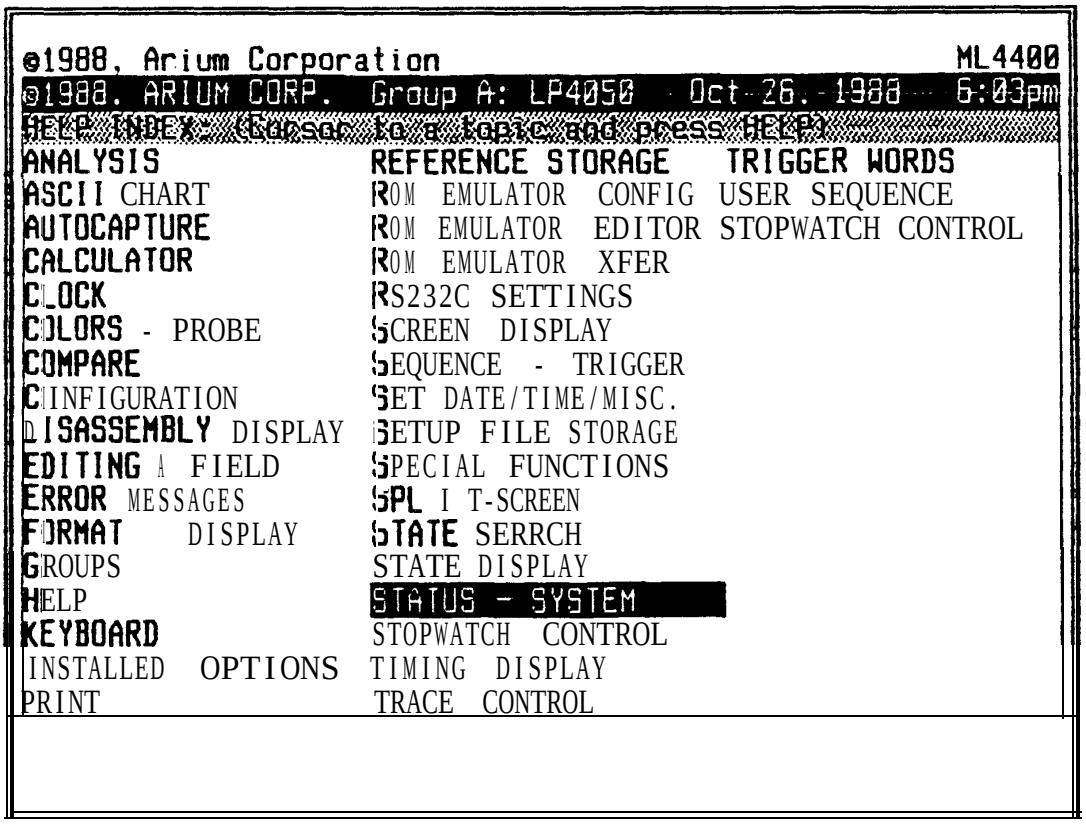


To scroll through the Help text one line at a time, use the UP and DOWN ARROW keys (they repeat). To scroll through one page (window) at a time, depress SHIFT together with an ARROW key. To scroll quickly back to the beginning of a Help topic, depress 1 on the keypad; if the cursor is already at the beginning of a topic, this will scroll to the beginning of the previous Help topic. To scroll to the beginning of the next Help topic, depress 2.

The Help document contains its own index of main topics; to access the Help index, &press 3; the previously accessed Help topic is highlighted in reverse video. To chance from one Help topic directly to another, cursor in the in-&x to the desired topic and depress HELP.

Figure IV-C

HELP TOPIC INDEX



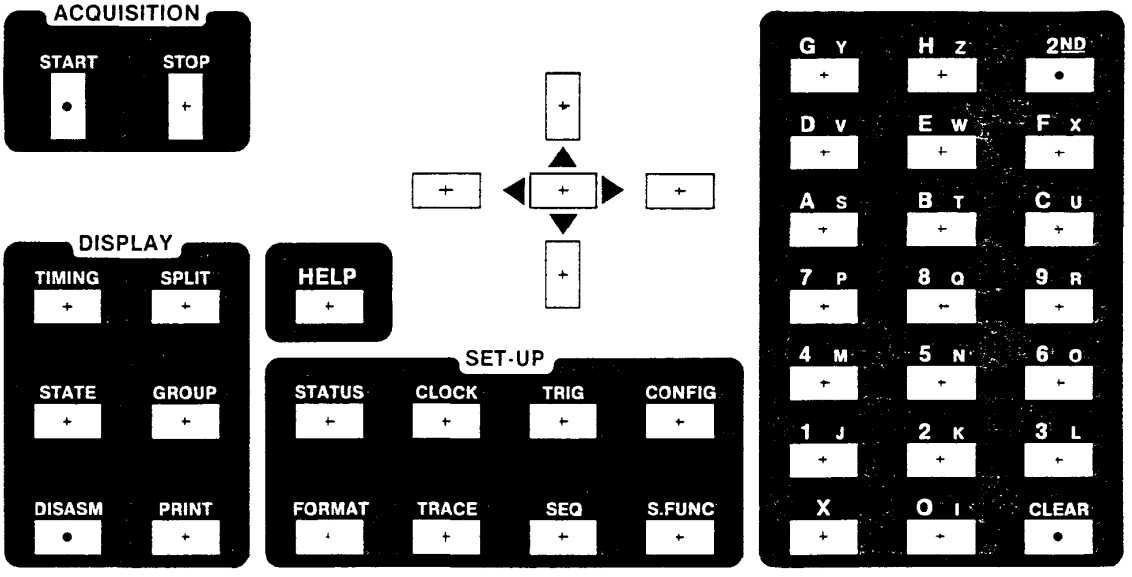
4. **KEYBOARD**

All operating functions of the ML4400 are controlled from the front-panel keyboard and softkeys. (For information about the softkeys, see Section IV.A.5, below.) All major analyzer functions are easily accessed via a single keystroke. Keyboard keys repeat when held down, including the softkeys (the six unlabeled keys under the CRT). If a key command is not accepted by the ML4400, a warning beep will sound.

NOTE re Coordination of Display between Modes: As in Arium's earlier ML4100 logic analyzer, the ML4400's three display modes (Timing, State, and Disassembly) are coordinated so that scrolling in any display mode changes the data displayed at the cursor position in the other display modes as well. In all three displays, the cursor is positioned at the same word in the recorded data. (The middle data line of the State and Disassembly display screens, outlined by a rectangular cursor box, corresponds to the vertical cursor position on the Timing display screen.)

Figure IV-D

ML4400 KEYBOARD



44-003

---

a. **START and STOP Keys**

The START and STOP keys control the acquisition and recording of data. (See Section IV-C, "Recording Data", below.) [Do not confuse "START" with the POWER ON/OFF switch, located on the rear panel; (see Section IV-A.l, above).] After START has been depressed, an "ACTIVE" message will overwrite the date and time on the Header line as long as data is being captured.

2ND, START and 2ND, STOP are used to simultaneously start and stop recording of groups which have been set up to cross-trigger, as specified in the "Trigger on" field in the Sequence setup screen: see the Sequence Help topic.

b. **HELP Key**

The HELP key accesses context-sensitive Help information on every ML4400 function. Its operation is described in Section IV-A.3, above.

c. **Arrow and Shift Keys**

ARROW KEYS: The four arrow keys (UP, DOWN, LEFT and RIGHT) move the cursor around in Setup screens, and scroll through data in Display screens (Timing, State, and Disassembly).

SHIFT: The (unlabeled) SHIFT key is in the center of the four ARROW keys, and speeds up the cursor movement. SHIFT increases the horizontal cursor movement from a character at at a time to a field at a time. SHIFT increases vertical cursor movement from a line at a time to a page (screen) at a time; if there is only one page, then SHIFT moves the cursor to the page's top or bottom.

d. **Hexadecimal Keypad (including G-Z, ASCII space, 2ND, X, and CLEAR)**

The hexadecimal keypad (on the right of the keyboard) is used to specify and change operating and display parameters, and to edit Reference Memory. The keypad contains 21 keys, most of which can be toggled via the 2ND key, providing a complete set of alphanumeric characters (including an ASCII space) --many more than just the hexadecimal 16-character set.

The keys' primary labels are O-9, A-H, 2ND, X, and CLEAR. Their secondary labels provide access to the remaining letters of the alphabet. The secondary label of the "F" key is ASCII "X"; this should not be confused with the key whose primary label is "X", which is used to enter a "Don't Care" in a field. The primary "X" key has a different function than the secondary (alphanumeric) "X" ; see description of the primary "X", below.

2ND: The 2ND key is a toggle key via which the user can access the secondary functions ("I" through "Z" and ASCII space) of the keypad. (It is not a shift key; it is depressed before--not simultaneously with--the depression of another key, and does not need to be held down.) The 2ND key is also used with CLEAR to undo the editing of a field (restore it to a previous value). When 2ND has been depressed (and before another key has been depressed), "2ND" will appear on the right of the Header line (in place of the date and time); some activities (such as changing to a Display screen) are suppressed while the 2ND key is active.

X/ASCII Space: The X key's primary function enters a "Don't Care" in a Trigger Word or Search field. Its secondary function (obtained by first depressing 2ND) is the ASCII space character. The primary "X" should not be confused with the secondary (alphanumeric) "X" obtained by depressing 2ND, then the primary "F" key.

CLEAR: The CLEAR key has three main functions. First, it clears a field; it restores a Select field to its default, and sets an editable field to all zeroes or spaces. Second, depressing CLEAR again just after clearing a field restores the field to its previous value. Third, depressing 2ND, CLEAR restores an editable field to its original value before the field was entered. Also, CLEAR sets some numeric fields to all "Don't Cares".

ALPHANUMERIC KEYS: The primary set comprises O-9 and A-H. The secondary set (the letters I-Z, plus an ASCII space) is accessed by first depressing the 2ND toggle key. Both character sets are used when editing Reference Memory and specifying operating and display parameters.

e. **Display Set** (TIMING, STATE, DISASM, SPLIT, GROUP, and PRINT)

The Display keys control the way in which data is displayed, either on the CRT screen or as hard-copy printouts. See Section IV-D, "Displaying Recorded Data", for a detailed discussion of the Display modes and screens.

NOTE: The ML4400 can be configured to act as up to 4 separate logic analyzers; each analyzer is called a "group" and is labeled A, B, C, or D. Each group has its own set of specified operating and display parameters, so each Timing, State or Disassembly display screen relates to one particular group (which is noted on the Header line of those screens). (See GROUP, below, and CONFIG, Section f, below.)

TIMING, STATE, and DISASM (Disassembly): Each of these display mode keys accesses a Display screen for a particular logic analyzer group. The user may change from one Display screen (one display mode) to another without having to recapture data. (See Section IV.D, "Displaying Recorded Data", or the on-screen Help topics, for detailed discussions of the Display modes and screens.

SPLIT: The SPLIT key splits the screen into two separate displays, showing time-aligned data from two different groups. The split is vertical for displays containing only State and/or Disassembly data, and horizontal for displays containing any Timing data. (See Section IV-D.5, "Split-Screen Display".)

To split the data display, change to the desired Display screen (via the TIMING, STATE, or DISASSM Display key), then depress SPLIT; the default split-screen will be displayed. To display a nondefault split-screen combination depress 2ND, then SPLIT, which accesses the Split window from which the user selects an alternate split combination. Depressing SPLIT a second time recalls the original Display screen. A split-screen display showing data from two different logic analyzer groups is available only if the current recorded data was captured using cross-trigger.

GROUP: The GROUP key, when depressed while in a Display or Setup screen, changes the screen from one logic analyzer group to the next. (See Section IV-D.6, "Groups".)

PRINT sends the contents of the display screen to the selected printer port (either serial or parallel) or to the floppy disk. (A floppy disk drive is an optional ML4400 accessory; a printer, also optional, is a user-installed item.) In Display screens, this enables the user to print all or a portion of the Trace Buffer or Reference Memory. (See Section IV-B, **Printing Displayed Data and Other Screens".)

f. Setup Set (STATUS, FORMAT, CLOCK, TRACE, TRIG, SEQ, CONFIG, and S. FUNC) (See Sec. III, "Setup of Operating Parameters".)

The STATUS key accesses the Status screen, a passive (display-only) screen providing an overview of the system parameters. Each of the other seven Setup keys accesses a screen with its same name. Six of these seven screens are interactive, and are the means by which the user specifies the major parameters *for* the recording and display *of* data. The seventh Setup key, S. FUNC (Special Function), provides access to a variety of operational and support screens (ROM Emulator screens, RS232 Settings, Setup File Storage, Reference Memory Storage, Compare, and Calculator), as well as several passive informational screens. (See Sections IV-F, IV-G, and IV-H.)

NOTE: Users of Arium's earlier ML4100 will *recognize* that most ML4400 Setup keys correlate in function and name with those of the ML4100. However, the ML4100 DELAY key has been renamed "TRACE" (Trace Control) on the ML4400.

For detailed descriptions of using the Setup keys, see Section III, "Setup of Operating Parameters", or the on-screen Help information.

STATUS : The STATUS key accesses the Status screen, a passive (display-only) screen which provides a synopsis of the specified operating and display parameters for the active ML4400 group. (Depressing GROUP from this screen changes the active group.) Because of limited space, no more than four trigger words are shown here. This screen is automatically displayed at powerup and when the START key is depressed. The six major headings displayed in uppercase letters in shadowed boxes correlate with the main interactive Setup screens by which parameters are set. (This screen carries no "Status" title on the Header line: in its stead appears "c 1988, ARIUM CORP.".)

FORMAT (Format Display): The FORMAT key accesses the Format Display screen, an interactive screen by which the user can view and specify the formats for displaying data on the Disassembly, Timing, State, and Trigger Words screens. (The latter two screens share the same display format.) The formats are specified by bit groupings, number base, data sense and Microprocessor Pod.

CLOCK: The CLOCK key accesses the Clock screen, an interactive screen by which the user can view and specify the internal and external clocking parameters. The ML4400 uses either an internal clock (when analyzing logic, hardware and timing problems), or an external clock (when analyzing bus problems and software, and events synchronous to the user's system). The ML44OO's maximum clock rates are 100-400 MHz for an internal clock, and 25-100 MHz for an external clock. This screen is also used to select one of six TimeStamp periods.

TRACE (Trace Control): The TRACE key accesses the Trace Control screen, an interactive *screen* by which the user can view and specify the trigger delay and data qualification settings. The trigger delay specifies how many clock cycles after the trigger event at which data recording will be stopped. Data qualification (either combinational or state) enables the user to record only desired pieces of data, which conserves trace memory and makes problem areas more visible.

TRIG (Trigger Words): The TRIG key accesses the Trigger Words screen, an interactive screen by which the user can view and specify trigger words. The specified trigger words are then combined in the Trigger Sequence screen to define the trigger sequence. The maximum number of trigger words depends upon which capture module is being used and the operating speed (clock rate). With the High-Speed Capture Module, between one and four trigger words are available: with the Standard Capture Module, between two and eight words are available. The current trigger sequence (as specified in the Trigger Sequence screen) appears at the bottom of this screen. (See Section III-H, "Trigger Words Setup Screen".)

SEQ (Trigger Sequence): The SEQ key accesses the Trigger Sequence screen, an interactive screen by which the user can view and specify the trigger sequence. The sequence is a trigger word or a combination of up to 8 trigger words (as specified in the Trigger Word screen.) The particular combination may be selected from the predefined sequences on this screen, or a more complex combination may be user-defined via the User Sequence screen (accessed via a softkey on this screen). Up to 27 predefined sequences are available, depending upon the current group's configuration and the type of Capture Module(s) and Pods in use. (See Section III-I, "Trigger Sequence Setup Screen".)

CONFIG (Configuration): The CONFIG key accesses the Configuration screen, an interactive screen by which the user can view and specify group definitions and Logic Pod voltage thresholds. (The ML4400 can be configured to act as up to four separate logic analyzers, with each analyzer being called a "group".) The settings of each group are automatically saved in nonvolatile RAM; see Section IV-F, "Storing Setup Files".

S. FUNC (Special Functions): The S. FUNC key accesses the Special Functions screen, which in turn accesses a variety of screens (via an additional keypad or softkey keystroke), as shown below:

Screen	Key	Manual Sec.
Standard Analyzer Functions:		
Autocapture	B	IV-F.8
Calculator	F1	IV-H.1
Compare	9	IV-G.3
Performance Analysis	A	IV-F.7
Reference Memory Storage	8	IV-G.1
RS232C Settings	3	IV-F.6
Set Date/Time/Misc. Screen	F4	IV-H.3
Setup File Storage	7	IV-F.1
Stopwatch Control	F3	IV-H.2
Optional Analyzer Functions:		
ROM Emulator Configuration	5	IV-F.5, VIII
ROM Emulator Editor	6	IV-F.5, VIII
ROM Emulator Transfers	4	IV-F.5, VIII
Informational *Screens:*		
ASCII Chart	F2	IV-I.1
Installed Options List	F6	IV-I.2
Probe Colors	F5	II-A.4.c, App. B

5. **SOFTKEYS (Fl-F6)**

The MI4400 softkeys are the six unlabeled keys directly under the CRT screen. In this manual, their general designations are "F1" through "F6" (from left to right), but they will usually be referred to by their actual on-screen labels, which appear in shadowed boxes on the bottom two lines.

The functions of these softkeys vary, depending upon which screen has been accessed. The specific function and label of a particular softkey may also change as the user calls up various functions of that screen. E. g., the "Edit Sequence" label for the Fl key on the Trigger Sequence screen changes to "End Edit" while the editing function is available. Not all screens use all six softkeys; some or all may be left unlabeled and unused.

The specific softkey labels and functions for each screen are detailed in the sections of this manual which describe particular Setup or Display screens.

B. EDITING AND SCROLLING THROUGH SETUP AND DATA FIELDS

1. EDITING SETUP PARAMETERS AND DATA

On the ML4400 screens, the editable fields in which parameters are specified are highlighted in *reverse* video. The parameters are changed via the hexadecimal keypad.

The ML4400 has four types of editable fields:

a. Numeric Fields

Numeric fields accept only numbers as input. Their display base is usually decimal, although many numeric fields can be set to a different base. If an illegal value is entered, the field will display the nearest legal value, and the ML4400 will beep to warn the user.

To clear a numeric field to all zeroes, depress CLEAR. To undo the Clear, depress CLEAR again. To restore the previous value of an edited field, press 2ND, CLEAR.

b. Numeric Fields with "Don't Cares"

These fields function like numeric fields, except that a "Don't Care" may be entered, by depressing the X key. To set the entire field to "Don't Cares", depress CLEAR; this is a different use of the CLEAR key than in Section a, above.

c. Alphanumeric Fields

Alphanumeric fields are used to edit filenames, label timing lines, etc.

To enter 0-9 or A-H, depress the appropriate key on the hexadecimal keypad. To enter I-Z or an ASCII space, first depress 2ND (which accesses the secondary group of keys on the keypad), then the appropriate keypad key (X for a space). To clear an alphanumeric field to all spaces, depress CLEAR.

d. Selectable Fields

Select fields have a limited number of preset choices. To select one of the choices from the list, depress the designated keypad key. To reset the field to the first choice on the list (default), depress CLEAR (2ND, CLEAR doesn't work in Selectable fields.)

2. MOVING THE CURSOR--GENERAL

To move the cursor horizontally (one character at a time), use the RIGHT and LEFT ARROW keys. To move the cursor a field at a time, depress the SHIFT key (in the center of the ARROW keys) while also depressing the appropriate ARROW key.

To scroll through fields vertically (one line at a time), use the UP or DOWN ARROW keys. To scroll a page at a time, depress the SHIFT key while also depressing the UP or DOWN ARROW key. If the screen has only one page, then this will instead move the cursor to the top or bottom of the screen.

3. MOVING THE CURSOR--DATA DISPLAY SCREENS

Moving the cursor in any Display mode (Timing, State, or Disassembly) changes the data displayed at the cursor position in the other two Display modes; i.e., the cursor is always positioned at the same word in the recorded data in all three modes.

In any Display mode, to instantly position the cursor at the trigger event, depress the Display mode key (TIMING, STATE, or DISASM) while viewing that display.

In the State and Disassembly Display modes, the cursor is a rectangular box outlining one line of data and is fixed at mid-screen. The UP and DOWN ARROW keys will scroll the data lines down and up through this fixed cursor.

The cursor position in the State and Disassembly Display screens corresponds to the position of the moveable vertical cursor line on the Timing screen.

In the Timing Display mode, the cursor appears as a solid vertical line. It may be moved horizontally across the timing lines via the LEFT and RIGHT ARROW keys. The location of the trigger condition occurrence is indicated by a dashed vertical line, and the location(s) of up to 3 marks is shown by 3 wide solid vertical lines.

In this mode, the UP and DOWN ARROW keys scroll one page of timing lines at a time (instead of a line at a time).

C. RECORDING DATA

(Before recording data, the operating and display parameters should be specified by the user; see Section III, "Setup of Operating Parameters".)

To start recording data, depress START. To start all groups with like cross-trigger fields at the same time, depress 2ND, START; (see Section III-I, *"Trigger* Sequence Setup Screen").

While data is being recorded, the word "ACTIVE" will be displayed on the right side of the Header line of the screen, and the ML4400 will not accept any changes in setup or display parameters.

If the user has specified data qualification, but no qualified data valid clocks have occurred, then the ML4400 may be "started" without actually recording any data. In this case, the user must manually stop the "recording", at which time "NO DATA RECORDED" will be displayed on the screen's upper right.

Data recording will stop automatically when the trigger condition has been satisfied and the delay time has expired. To manually stop data recording, depress STOP or 2ND, STOP.

In the Autocapture mode, the ML4400 will continually recapture and display new trace data. To enable (or disable) Autocapture,-access the Autocapture screen via S. FUNC., then enter 1 (or 0). To stop recording in the Autocapture mode, depress STOP twice.

D. DISPLAYING RECORDED DATA

1. DISPLAY MODES--GENERAL

The three modes for displaying recorded data--Timing, State, and Disassembly--are accessed via the TIMING, STATE, and DISASM keys.

When recording stops, the Trace Buffer will be displayed according to the last Display mode selected. (Default at powerup is the State Display mode.)

To change the Display mode, depress TIMING, STATE, or DISASM; this will not require the capture of new data. Note that the format of these displays may be changed via the Format Display screen without disturbing the recorded data.

Detailed descriptions of each of these three Display modes are in Sections III-D.2, 3, and 4, inunediately below.

To chancre the memory accessed and displayed while in a Display screen, simply depress "0" (for Trace Buffer) or "l-8" (for a Reference Memory).

Two other ML4400 features affecting data display are split-screen display (via the SPLIT key) and the operation of the ML4400 as up to four separate analyzers (groups). (See Sections IV-D.5, "Split-Screen Display", and IV-D.6, "Groups".)

All screen displays may be printed out (using an optional Epson-graphics compatible printer) via the PRINT key; see Section IV-E, "Printing Displayed Data and Other Screens".

2. TIMING DISPLAY MODE (See also Section III, "Setup of Operating Parameters".)

a. General

The Timing Display screen shows the Trace Buffer or one of 8 Reference Memories as timing lines (diagrams) from any active probes, as in an oscilloscope display. The probe number of each timing line appears on its left, and its signal (0 or 1) at the location of the moveable cursor appears on its right. Up to 16 timing lines may be displayed on the screen, and comrise one page. The pages are numbered up to a maximum of 1 to 13, depending upon the MD4400 configuration.

The second line of the screen shows, in fields highlighted in reverse video (from left to right): the Trigger-to-Cursor time (in number of clocks), the scale (as selected by the user), and the number of the page being displayed.

The third (shadowed) line on the screen is the Trace Buffer/Reference Memory line; it gives an overall view of the memory being displayed. This line shows how the on-screen data (shown as a reverse-video block) relates to the entire memory; the cursor and mark locations ("C" = moveable cursor, "T" = trigger event, and "1", "2" & "3" = marks): the portion of the memory filled with data (a solid horizontal line); and the unused portion (a dotted horizontal line).

Figure IV-E

TIMING DISPLAY SCREEN (X4, WITH CURTAIN)

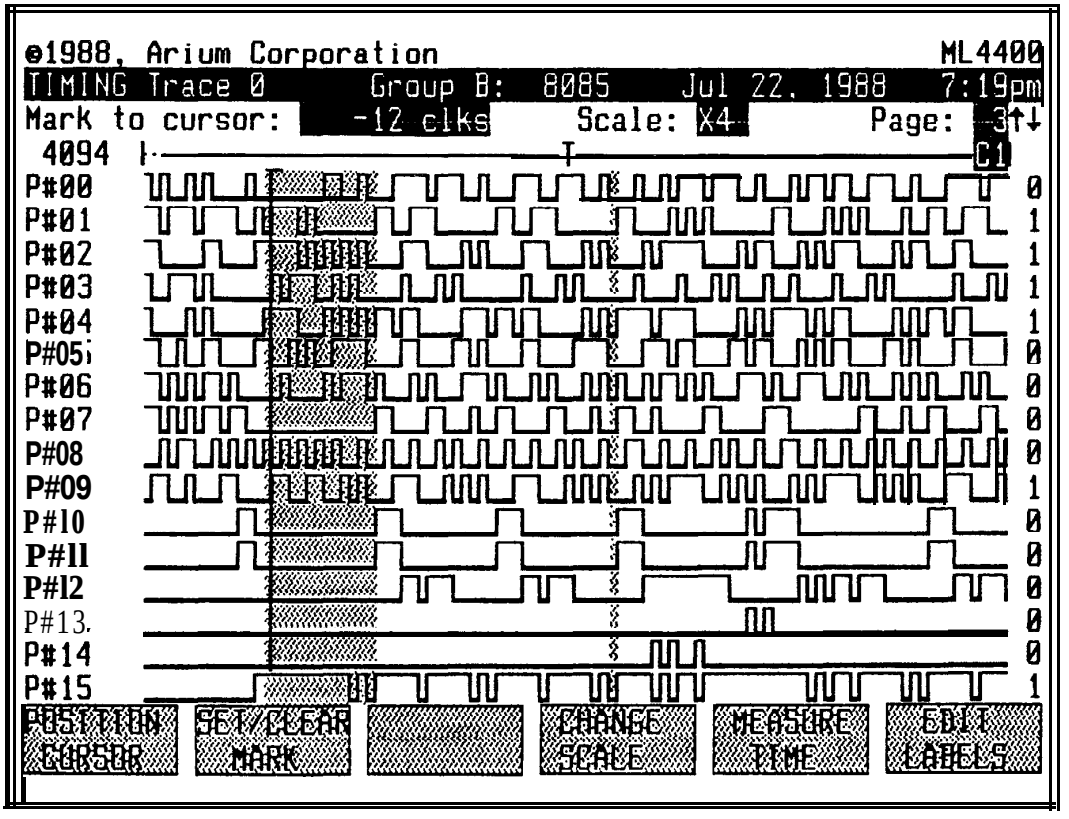
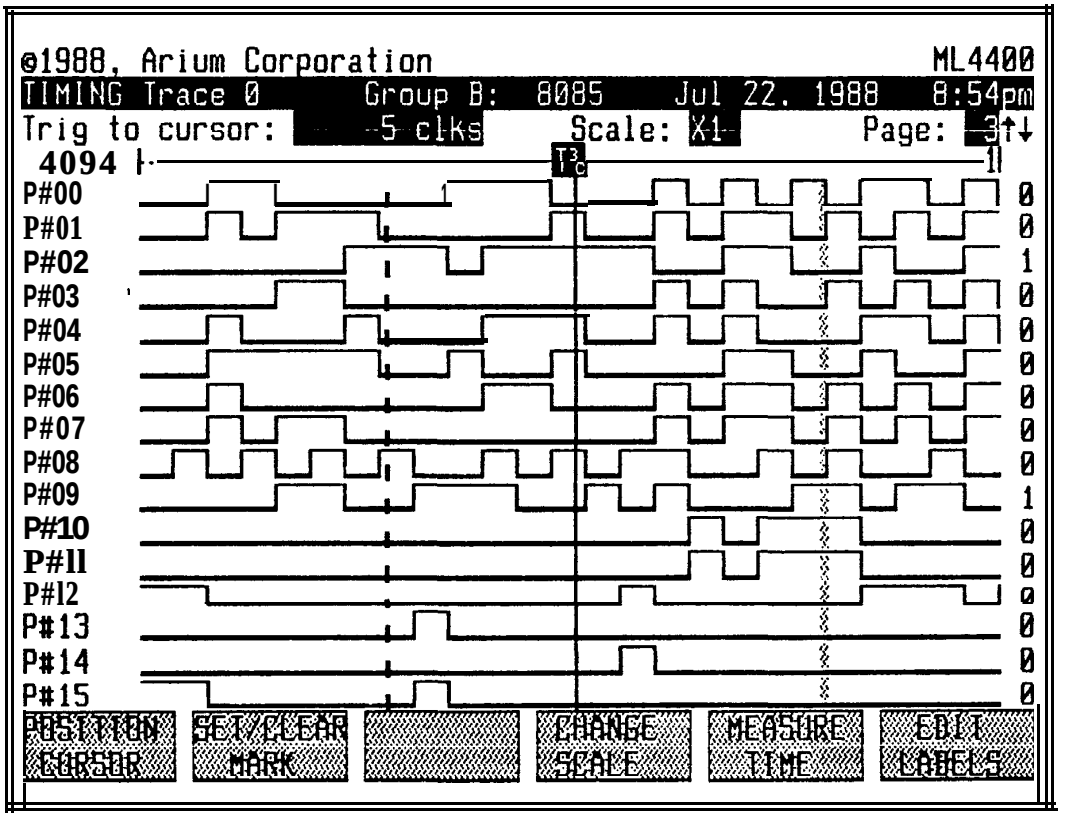


Figure IV-F

TIMING DISPLAY SCREEN
(Xl, WITH TRIGGER, CURSOR AND MARX)



(1) Timing Line Definition

A timing line may be defined (on the Format Display screen) as a single probe or (for address and data buses) a range of probes. A timing line definition consists of the number base, high and low probe numbers, and data sense (inverted/noninverted).

The Format Display screen shows a maximum of 12 timing line definitions; to access other timing line definitions, use the ROLL TIMING PG softkey.

(2) Scrolling Through Timing Lines

To scroll through the timing lines horizontally, use the RIGHT and LEFT ARROW keys. To move the cursor to the right or left edge of the screen, depress the SHIFT key (in the center of the ARROW keys) while also depressing the appropriate ARROW key. If the *cursor* is already at an edge, this will instead scroll a full screen at a time.

To scroll throuqh the timing lines vertically a page at a time, use the UP and DOWN ARROW keys. To scroll back to the first paqe of timing lines, depress SHIFT and the UP ARROW simultaneously; to scroll to the last paqe, depress SHIFT with the DOWN ARROW.

(3) Display Scale

The current display scale is shown in the Scale field at the top of the screen; default is X4. The higher the scale factor, the more cycles are displayed on the screen, as shown on the table below. At scale factors of 16 and above, there may be more transitions than can be handled by the screen resolution; if so, a portion of the timing line becomes a "fuzz" character indicating multiple transitions.

Scale	Cycles per Character	Cycles per Screen
Xl	0.5	25
x4	2	100
Xl6	8	400
X64	32	1600
Entire Trace	Trace Depth/50	Trace Depth

To change the display scale, depress the CHANGE SCALE softkey and use the Fl-F5 softkeys to select another scale factor.

b. **Display Format** (via Format Key; see Section III, "Setup of Operating Parameters.")

To select the exact display format for timing lines, use the Format Display screen, accessed via the Setup FORMAT key.

The Timing Display screen displays a page of timing lines, with up to 16 lines on a page. The first two pages are user-defined; the 16 lines on each of them can be put in any order, inverted, repeated or left blank (displayed as Probe # "Xx") . And any line can be used to display multiple probes so that bus values can be viewed directly in the Timing Display screen.

If the last 8 or more lines on one of these pages are turned off, then the remaining timing lines are automatically displayed in double height for easier viewing.

Timing lines on Pages 3 and above are displayed in a fixed format. The user may elect to use these default timing line displays rather than Pages 1 or 2.

The Timing Display screen may be split to show a half-screen of timing lines and a half-screen of the corresponding State or Disassembly display; (see Section IV-D.5, "Split-Screen Display"). The Timing/Disassembly and Timing/State splits are accessed by depressing 2ND, SPLIT (which opens up the Split Selection window), then selecting a split combination. Selections calling for display of another group's data will appear on this menu only if the groups have been cross-triggered at acquisition time, so that their data is time-aligned.

When the cursor is moved in the Timing Display screen, the State or Disassembly data scrolls so that the location at the timing cursor is time-aligned with the cycle at the cursor in the lower window.

c. **Timing Line Labels**

Timing line labels on the two user-defined pages may be edited via the Edit mode. The default label is the probe number specified in the Format Display screen.

To enter the Edit mode, depress the EDIT LAPELS softkey. (The label fields will change to reverse-video, showing that the Edit mode is active.)

To edit a label, enter the Edit mode, use the ARROW keys to cursor to the appropriate label field, then enter the alphanumeric label via the hexadecimal keypad. **To enter a space,** use the SPACE (Fl) softkey or 2ND, X. **To label an active low signal,** use the * (F2) softkey.

To exit the Edit mode, depress the END EDIT (F6) softkey.

d. **Cursors and Marks**

The ML4400 Timing Display screen has two vertical cursors (moveable and trigger) and vertical "mark" lines. The cursor positions are shown on the Trace Buffer line as "C" (moveable cursor), "T" (trigger cursor), and "1", "2", and "3" (marks). Time difference measurements are available between these marks and the moveable cursor or the trigger cursor; see Section (f).

(1) Moveable Cursor (Solid Line)

The moveable cursor is tied to the State display cursor; when one is moved, the other is automatically moved to the same location. The value of each timing line at the cursor location is shown at the far right of the line. The relative position of this cursor representationally as "C" on the Trace Buffer line.

To position the moveable cursor at the trigger event, depress TIMING.

To position the moveable cursor at a specific cycle in memory depress the POSITION CURSOR softkey, enter the &sired state number in the window's highlighted field, then depress POSITION CURSOR again. To toggle +/- in this field, use the X key.

To position the moveable cursor at a mark, depress the POSITION CURSOR softkey, then depress MARX 1, MARX 2 or MARK 3. (To set a mark, see Section (3).)

To position the moveable cursor at the beqinning or end of the Trace Buffer, depress the POSITION CURSOR softkey, then depress BEGIN TRACE or END TRACE.

(2) Trigger Cursor (Dashed Line)

The trigger cursor shows the location of the trigger condition inmemory. Its location is represented on the Trace Buffer/Reference Memory line by "T".

(3) Marks (Wide Solid Lines)

A mark identifies a specific location in memory. Up to three marks are available. Their locations are represented on the Trace Buffer line by "1", "2", and "3". Marks are common to all three Display screens; setting a mark in one screen sets a mark in the other two as well.

To set a mark cursor at a specific cycle, position the Moveable Cursor at the cycle, and depress SET/CLEAR MARX, and SET MARX 1, 2, or 3. To return to the Timing Display screen without setting or clearing a mark, depress TIMING.

To position the moveable cursor at a mark, depress POSITION CURSOR, then MARX 1, 2, or 3. If the mark selected has not been defined, an error message will appear on the Header line.

To clear a mark, depress the SET/CLEAR MARX softkey, then CLEAR 1, 2, or 3.

As a shortcut, to set MARX 1 at the moveable cursor and draw a curtain, use the X key. (See Section f, re curtains.) To clear this mark, depress CLEAR.

e. Memory (Trace Buffer or Reference Memory)

The Header (first) line shows the current memory displayed, with 0 denoting the Trace Buffer, and l-8 denoting a particular Reference Memory. To change the memory displayed, depress O-8 on the keypad while in a Display screen.

f. Measuring Time

Time differences may be measured directly with shaded cursor "curtains". Time is measured in either actual time (Internal Clock, or External Clock with TimeStamp), or in clocks.

To measure time between a mark and the moveable cursor, depress the MEASURE TIME softkey. (The Trace Buffer line, which normally highlights the current screen contents within the trace, will change to highlight whatever marks are located on the screen.) Next select the mark to measure from by depressing MARK l, MARK2 or MARK 3.

A shaded "curtain" will be drawn between the mark and the moveable cursor. Also, the left field on the Trace Buffer line (normally labeled "TRIG to Cursor") will be relabeled "MARK to Cursor", and will show the time and units. The units are clocks if using an external clock, and nanoseconds, microseconds, or millisececonds if using an internal clock.

To move the curtain, use the RIGHT/LEFT ARROW keys. To extend the curtain to the Trigger, depress TIMING.

To clear the time-measuring curtain, depress the MEASURE TIME, then the CLEAR CURTAIN, softkeys.

For a shortcut when measuring time, use the X key to set Mark 1 at the moveable cursor location and manually draw a curtain with the LEFT or RIGHT ARROW. To clear the curtain, depress CLEAR.

3. STATE DISPLAY MODE (See also Section III "Setup of Operating Parameters".)

a. General

The State Display mode is the default Display mode at power-up.

The State Display screen shows the contents of the Trace Buffer or a Reference Memory on a cycle-by-cycle basis. The State column (at the far left) shows cycle numbers relative to the trigger event. Negative cycle numbers denote cycles that occurred before the trigger event, and positive numbers, those that occurred after it. State Number 0 (the trigger event) is designated "TRIG", highlighted in reverse vi&o, and cycles at which marks have been set are designated "MARKl", MARK2", or "MARK3", also highlighted.

(1) State Field Definition

Each line on this screen represents one data sample, displayed in bit groupings and *number* base as specified in the *Format* Display screen. A state field definition consists of the field label, number base, high and low probe numbers, and data sense (inverted/noninverted) . The Format Display screen shows a maximum of 12 state field definitions at a time.

The *number* base may be changed during operation without recapturing data. The same probe *number* data may be shown in more than one State field, and fields may overlap; the maximum field sire is 32 bits. Data inversion affects the values on the Trigger Display screen as well as the State Display screen.

(2) Display Format (via FORMAT key: see Section III, "Setup of Operating Parameters".)

The user can create custom probe combinations, number bases. and field labels, including the 3-character column headings on the State Display screen. To select the exact display format for state fields, use the Format Display *screen,* accessed via the Setup FORMAT key.

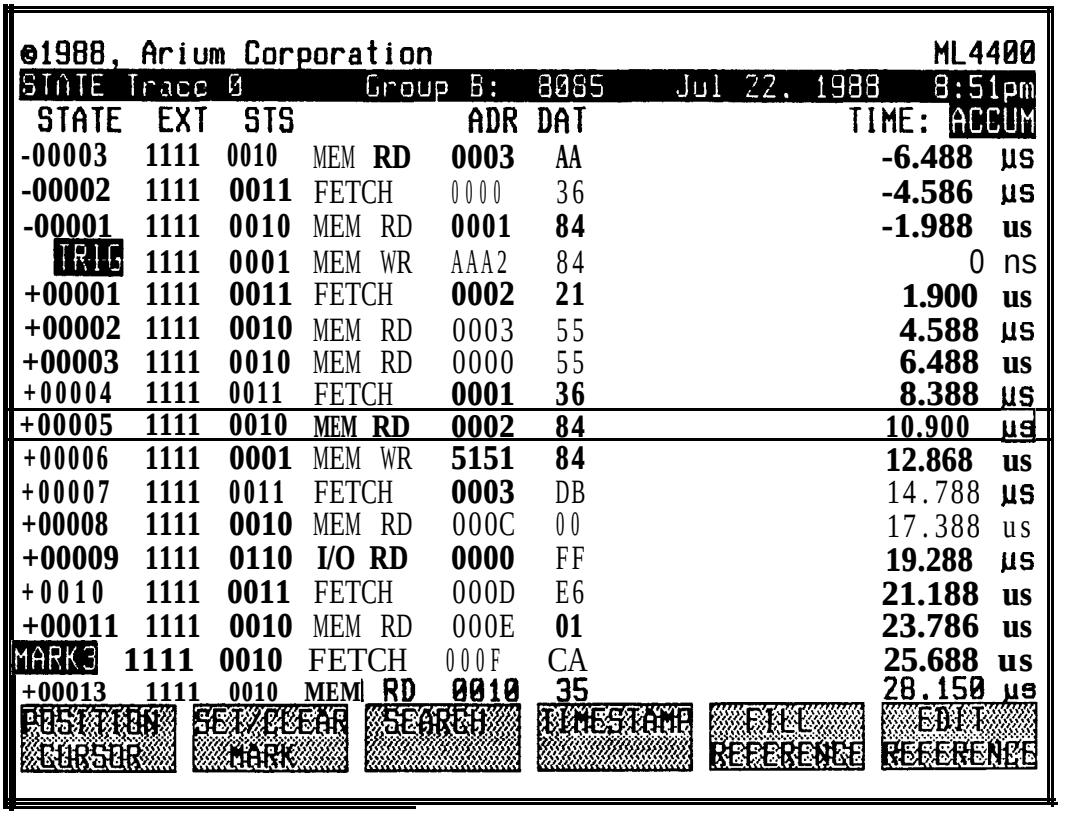
The State Display *screen* shows 12 columns *of* screen display of one group

The State Display screen may be split into two halves to show state data lines vs. time-aligned data from another group. (See Section IV-D.S, "Split-Screen Display".) To split the display from the State Display screen, depress 2ND SPLIT (which opens a window), then select a split from the menu.

When the cursor is moved in one half of the split Display screen, the cursor moves accordingly through the timing or data lines in the other half so that the two displays are time-aligned.

Figure IV-G

STATE DISPLAY SCREEN
(ACCUMULATE TIME MODE, WITH TRIGGER AND MARK)



b. Scrolling, Cursor, and Marks

(1) Scrolling

To scroll vertically through data one line at a time, use the UP and DOWN ARROW keys. UP moves backwards in memory; DOWN moves forward.

To scroll one page at a time, depress SHIFT (in the center of the ARROW keys) and UP or DOWN at the same time.

(2) Screen Cursor

The screen cursor is a rectangular box, fixed at mid-screen, that outlines one data line. It is tied to the Disassembly and Timing cursors; i.e., when one cursor is moved, the other is automatically moved to the same location.

To position the cursor at the trigger event while in the State Display *screen,* depress the STATE softkey.

To position the cursor at a specific cycle in memory, depress the POSITION CURSOR softkey (which opens a window), enter the desired state number in the highlighted field, then depress POSITION CURSOR again. To toggle +/- in this field, use the X key.

To position the cursor at a mark, depress the POSITION CURSOR softkey, then depress the MARE 1, 2, or 3 softkey. (To set a mark, see Section (2), below.)

To position the cursor at the beqinning or end of memory depress the POSITION CURSOR softkey, then depress the BEGIN TRACE or END TRACE softkey.

(3) Marks

Up to 3 marks may be set by the user to reference specific locations in memory. Their locations are shown in the State Number column by "MARK l", "MARK 2", and 'MARK 3", highlighted in reverse video.

Marks are common to all three Display screens ; setting a mark in one screen sets a mark in the other two as well.

To set a mark at a specific cycle, position the cursor at the cycle and depress the SET/CLEAR MARX softkey, then the MARE 1, 2, or 3 softkey.

To return to the State Display screen without setting or clearing a mark, depress STATE.

To position the cursor at a mark, use the POSITION CURSOR softkey (see Section (l), above). If the mark selected has not been defined, an error message will appear on the Header line.

To clear a mark, depress the SET/CLEAR MARX softkey, then CLEAR 1, 2, or 3.

c. **TimeStamp**

The TimeStamp feature enables the user to measure time between cycles in memory.

There are two TimeStamp modes: Delta Time, and Accumulate Time. (The current mode is displayed at the right of the second line of the screen.) Delta Time displays the execution time of each trace cycle; Accumulate Time displays the time accumulated from the trigger event, or any arbitrary point ("ZERO TIME").

Six TimeStamp clock periods are available: 50 nanoseconds (20 MHz), 1 microsecond (1 MHz), 10 us, (100 KHz), 100 us (10 KHz), 1 millisecond (1 KHz), and 10 ms (100 Hz). To select the TimeStamp frequency, use the Clock Setup screen. (See Section III, "Setup of Operating Parameters".)

To select Delta Time mode and display the cycle execution time, depress the TIMESTAMP and DELTA TIME softkeys.

To select Accumulate Time mode and display the accumulated time from the trigger event, depress the TIMESTAMP and ACCUM TIME softkeys. To display accumulated times from a cycle other than the trigger event, first depress the TIMESTAMP and ACCUM TIME softkeys; then position the cursor at the desired cycle and depress the TIMESTAMP and ZERO TIME softkeys.

If the TimeStamp range is exceeded, an overflow error message will appear.

d. **Search Function**

The Trace Buffer and Reference Memories can be searched for a pattern of up to 12 words (labeled l-C), which may be repeated, for a trigger word, or for a specific trace cycle. The user may search (forward or backward) for just one occurrence of the pattern, or *for* all occurrences of the pattern.

To access the Search function from the State Display screen, depress the SEARCH *(F3)* softkey; this calls up the Search screen. The softkeys are then relabeled to read (from left to right) CHANGE DIRECTION, CHANGE MODE, FIND/-FINDNEXT, SET WORD W/TRIGGER, SET WORD W/TRACE, and CLEAR WORD.

To change the search mode, depress the CHANGE MODE softkey, which toggles between "Find one occurrence" and "Find all occurrences". Default is "Find one occurrence" .

To change the search direction (only in "Find one occurrence" mode), depress the CHANGE DIRECTION softkey, which toggles between "Forward" and "Backward". Default is "Forward".

The search pattern consists of 1-12 words whose format is defined in the Format Display screen. To specify a search pattern, first cursor to the Search Word fields, and use the keypad to enter definitions for the search words. Then enter the minimum and maximun number of times the word maybe found and still match the search pattern; this is useful when an exact search pattern can't be specified (as in the Internal Clock mode, or to look for an event with respect to time). Next specify the words at which the search should begin and end (1-C); to search for just one word, enter the same value in both these fields.

To perform the search, depress FIND/FINDNEXT.

If the search mode is "Find one occurrence" and there is a match, the display will revert to the State screen, with the cursor located at the occurrence of the pattern. To then find the next occurrence, depress SEARCH, FIND/FINDNEXT. If there is no match,. the bell will sound.

If the mode is "Find all occurrences", the Search Results window will open and three softkeys will be relabeled: *F2* (FIND NEXT BACKWARD), F3 (FIND NEXT FORWARD), and F6 (CLEAR RESULTS). The window will show the state number of the First Match and the Last Match, as well as the Number of Matches.

To view the first match, depress STATE; the matched cycles are highlighted in the display. To find the next match, depress SEARCH, then FINDNEXT FORWARD or FINDNEXT BACKWARD.

To search *for* a triqqer word, depress the SET WORD W/TRIGGER softkey and use the keypad to enter the trigger word (A-H). Then depress SET WORD W/TRIGGER again.

To search for a particular trace cycle, depress the SET WORD W/TRACE softkey and use the keypad to enter the state number (default is the State cursor location), then depress SET WORD W/TRACE again.

To enter the last result from the Calculator screen in any of these fields, depress SHIFT, Z, while in the field.

To clear the search results, depress the CLEAR RESULTS softkey. To abort a Search, depress any key.

To change the type of memory to be searched, depress STATE to return to the Display screen, then 0 (for Trace Buffer) or 1-8 (for a Reference Memory).

To exit the Search screen, depress any Display or Setup key.

Figure IV-H

STATE DISPLAY SEARCH SCREEN
(WITH SEARCH RESULTS WINDOW)

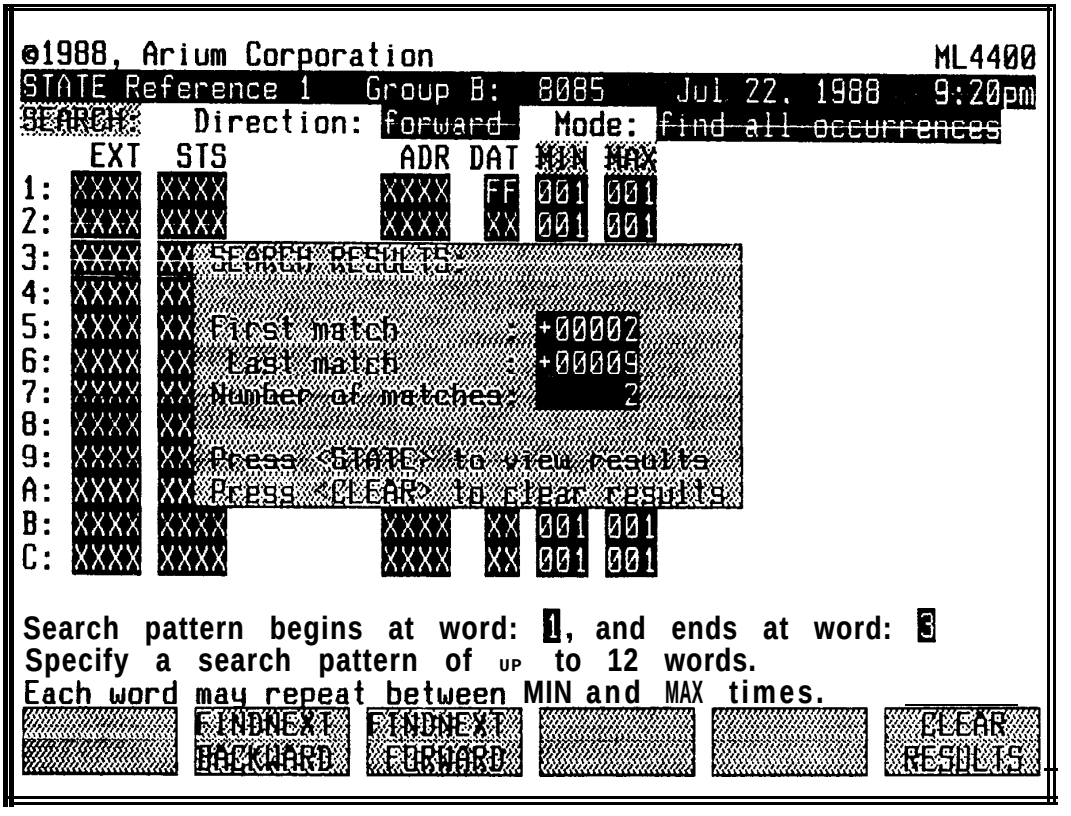
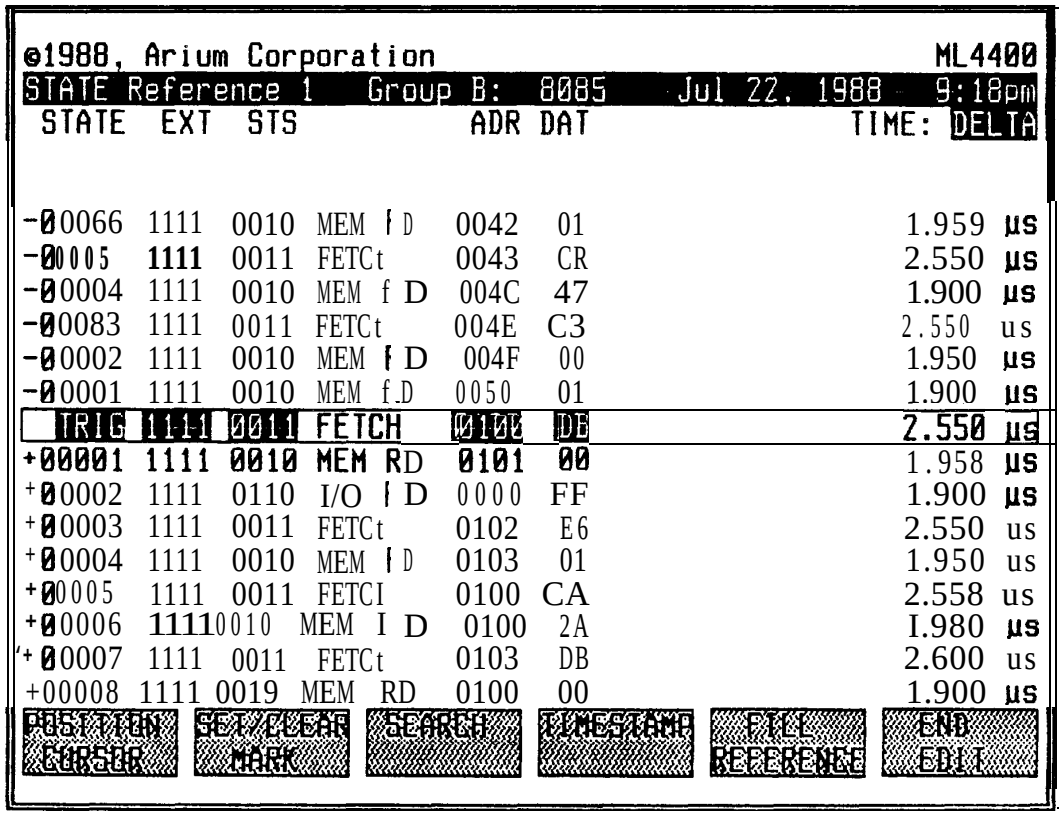


Figure IV-I

STATE DISPLAY SCREEN
WITH SEARCH RESULTS



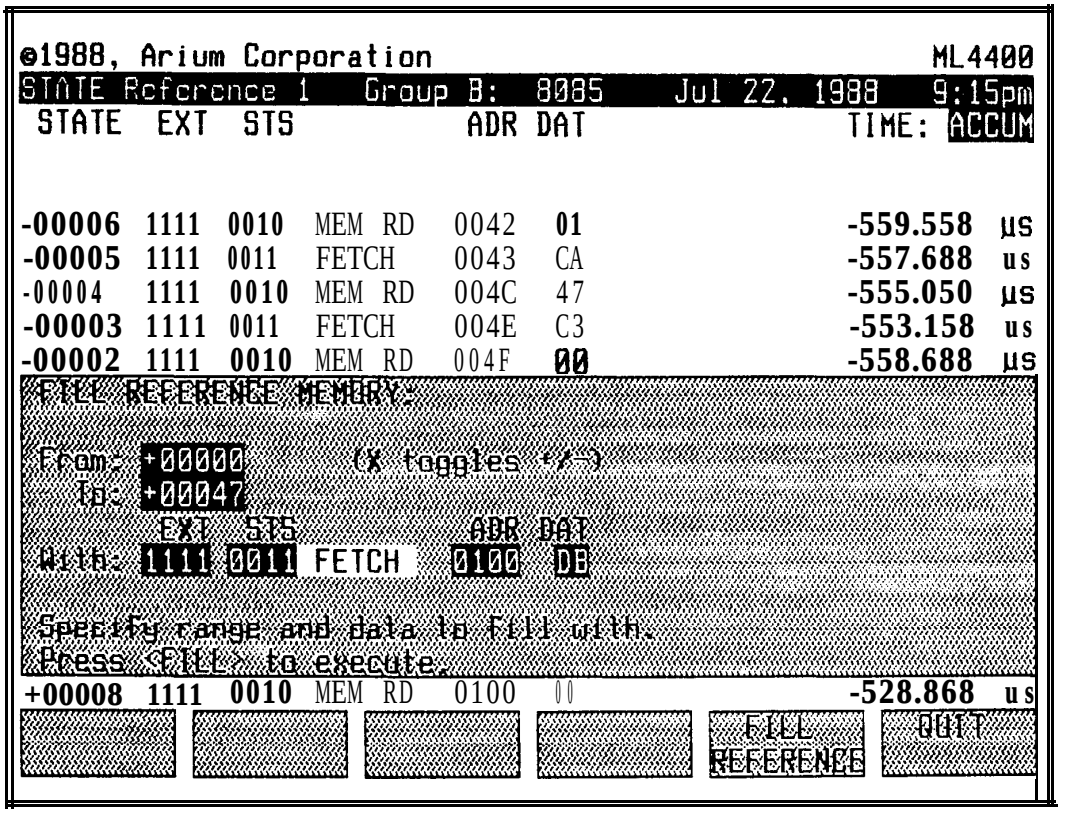
e. **Filling and Editing Reference Memory** (See also Section IV-F.2, "Storing Reference Memory".)

Up to 8 Reference Memories may be defined in the Reference Storage screen, accessed via the S. FUNC key and 8. Reference Memories may be edited and filled; (the Trace Buffer cannot). Editing a Reference Memory allows Search and Compare operations to be more selective: a typical reason to edit might be to enter Don't Cares (Xs) in some fields so that a Compare will ignore extraneous data. Reference Memories are often used in making repetitive Compares of known valid data against that in the Trace Buffer.

The Header line shows (just after the name of the screen) the active memory displayed, with 0 denoting the Trace Buffer, and 1-8 denoting a particular Reference Memory. To change the memory accessed, depress 0-8 on the keypad.

Figure IV-J

FILL REFERENCE MEMORY WINDOW
(IN STATE DISPLAY SCREEN)



(1) Filling Reference Memory

To fill a range of Reference Memory with a value, first depress the FILL REFERENCE softkey while in the State Display screen; this opens the Fill Reference Memory window. Then, enter the beginning and ending cycle numbers of the range to fill and the data with which to fill. To execute the fill, depress FILL REFERENCE again.

To fill a range of Reference Memory with a portion of a word, access the Format Display screen and turn off fields to be left undisturbed. Then, to execute the fill, return to the State screen and depress FILL REFERENCE.

To abort a fill, depress any key.

(2) Editing Reference Memory

To edit Reference Memory, first depress the EDIT REFERENCE softkey; the fields at the cursor will be highlighted in reverse video to show that the Edit mode is enabled. Then use the ARROW keys to position the cursor in the appropriate fields, and the keypad to enter values (including "X" for "Don't Care").

To exit the Edit mode, depress the END EDIT softkey. (The Edit mode is automatically exited, with all edits left intact, when the State Display screen is exited).

4. **DISASSEMBLY DISPLAY MODE (Optional)** (See also Section III, "Setup".)

a. **General**

The Disassembly Display screen displays data in memory as assembly language microprocessor instructions. Disassembly requires using at least one of the ML4400's optional Microprocessor Pods.

When data qualification is used, some ambiguities in the recorded data may result which preclude disassembly. In this case, the ML4400 will try to disassemble the recorded data, but may display no data output.

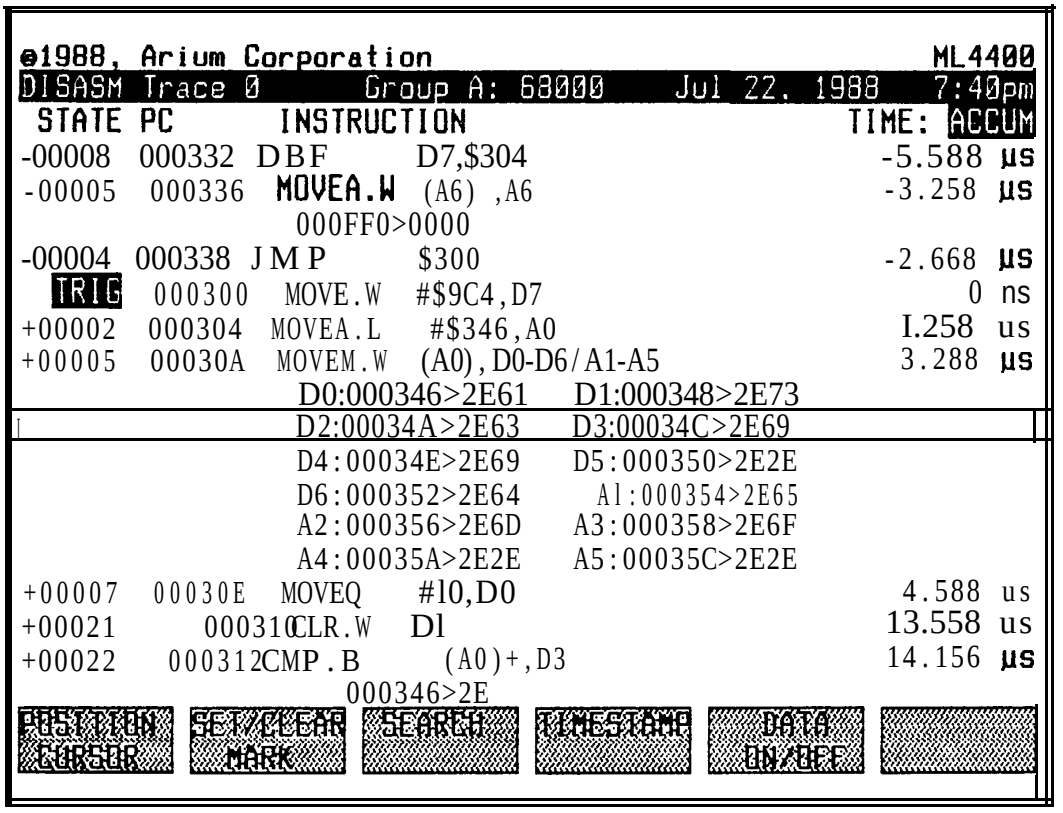
See Section IV-3.a, "State Display Mode, General", for general information about this screen, field definition, and display format.

The Disassembly Display screen has five columns of fields (from left to right): State Number, Program Counter, Instruction, Data, and Time (in Delta or Accumulated mode). The softkey labels in this screen are (from left to right): POSITION CURSOR, SET/CLEAR MARK, SEARCH, TIMESTAMP, and DATA ON/OFF; the sixth softkey is unused in this screen.

To manually stop (abort) disassembly, depress STOP twice.

Figure IV-K

DISASSEMBLY DISPLAY SCREEN



b. **Scrolling, Cursor, and Marks**

(1) **Scrolling**

To scroll vertically through data one line at a time, use the UP and DOWN ARROW keys. Since the cursor is a box fixed at mid-screen, its movement is relative to that of the data lines; i.e., UP ARROW appears to move the data lines down through the cursor, and vice versa for DOWN ARROW.

To scroll one page at a time, depress the SHIFT key (in the center of the ARROW keys) and Up or DOWN ARROW at the same time.

(2) Screen Cursor

The screen cursor is a box outlining one line, and is fixed at the vertical midpoint of the screen. It is tied to the State Display cursor box and the Timing Display Moveable Cursor (a solid line); when one cursor is moved, the other is automatically moved to the same location.

To position the cursor at the trigger event at any time while in the Disassembly Display screen, depress the DISASM softkey.

Depressing the POSITION CURSOR softkey opens a window with a highlighted field for specifying a new cursor position by state cycle number, and relabels five of the softkeys for specifying a new cursor position by mark number (MARE 1, MARX 2, and MARE 3) or the beginning or end of the Trace Buffer (BEGIN TRACE and END TRACE).

To position the cursor at a specific cycle in the active memory, depress the POSITION CURSOR softkey (which opens a window), enter the desired state number in the highlighted field, then depress POSITION CURSOR again. To toggle +/- in this field, use the X key.

To position the cursor at a mark, depress the POSITION CURSOR softkey, then depress the MARX 1, 2, or 3 softkey. [To set a mark, see Section (3), below.]

To position the cursor at the beginning or end of the active memory depress the POSITION CURSOR softkey, then depress the BEGIN TRACE or END TRACE softkey twice.

(3) Marks

A mark identifies a specific location in memory. Up to three marks are available. Their locations are shown in the State Number column by "MARK 1", "MARK 2", and "MARK 3", highlighted in reverse video. Once a mark has been set, two keystrokes move the cursor to it (see Section (1), above).

Marks are common to all three Display screens; setting a mark in one screen sets a mark in the other two as well.

To set a mark at a specific cycle, position the cursor at the cycle and depress the SET/CLEAR MARK softkey, then the SET MARK 1, 2, or 3 softkey; the state number will be replaced by "MARK 1", MARK 2", or "MARK 3", highlighted in *reverse* video. To return to the Disassembly Display screen without setting or clearing a *mark,* depress DISASM.

To position the cursor at a mark, use the POSITION CURSOR softkey (see Section (1), above). If the mark selected has not been defined, an error message will appear on the Header line.

To clear a mark, depress the SET/CLEAR MARK softkey, then CLEAR 1, 2, or 3.

c. TimeStamp

The TimeStamp feature enables the user to quickly display and compare actual measured execution times for specific portions of the Trace Buffer.

There are two TimeStamp modes: Delta Time, and Accumulate Time. (The current mode is displayed at the right of the second line of the screen.) Delta Time mode displays the execution time of each trace cycle, and Accumulate Time Mode displays time accumulated from the trigger event or any arbitrary point ("ZERO TIME").

Six TimeStamp clock periods are available: 50 nanoseconds (25 MHz), 1 microsecond (1 MHz), 10 us, (100 KHz), 100 us (10 KHz), 1 millisecond (1 KHz), and 10 ms (100 Hz). To select the TimeStamp frequency, use the Clock Setup screen. (See Section III, "Setup of Operating Parameters".)

To select Delta Time mode and display the cycle execution time, depress the TIMESTAMP and DELTA TIME softkeys.

To select Accumulate Time mode and display the accumulated time, depress the depress the TIMESTAMP and ACCUM TIME softkeys. To display accumulated time from a cycle other than the trigger event, first depress the TIMESTAMP and ACCUM TIME softkeys; then position the cursor at the desired cycle and depress the TIMESTAMP and ZERO TIME softkeys.

If the TimeStamp range is exceeded, an overflow error message will appear.

d. **Search Function**

The Trace Buffer and Reference Memories can be searched in the Disassembly Display mode for a pattern of up to 32 characters. The Search mode is to find the next occurrence in the specified search direction.

To access the Search function, depress the SEARCH softkey, which opens a Search window and relabels the softkeys to (from left to right): CHANGE DIRECTION (F1), FIND/FINDNEXT (F3), ? (F4), * (F5), and QUIT (F6).

To chance the Search direction, depress the CHANGE DIRECTION softkey, which toggles between "Forward" and "Backward". Default is "Forward".

To specify a Search pattern, enter ASCII characters in the "Pattern" field via the keypad, the UP/DOWN ARROWS and the "?" and "*" softkeys.

The keypad provides the digits 0-9, 26 uppercase letters, and an ASCII space (2ND, X). To access the full set of ASCII characters (the digits 0-9, 26 uppercase letters, 26 lowercase letters, plus the nonalphanurneric characters), use the UP ARROW to cycle forward through them one at a time, and the DOWN ARROW to cycle backward. To match any single character during the Search, use the "?" softkey; to match any sequence of characters, use the "*" softkey.

To perform the pattern Search, depress FIND/FINDNEXT; if there is a match, the cycle containing the match will be positioned at the cursor. To then find the next occurrence, depress SEARCH, FIND/FINDNEXT. To abort a Search, depress any key.

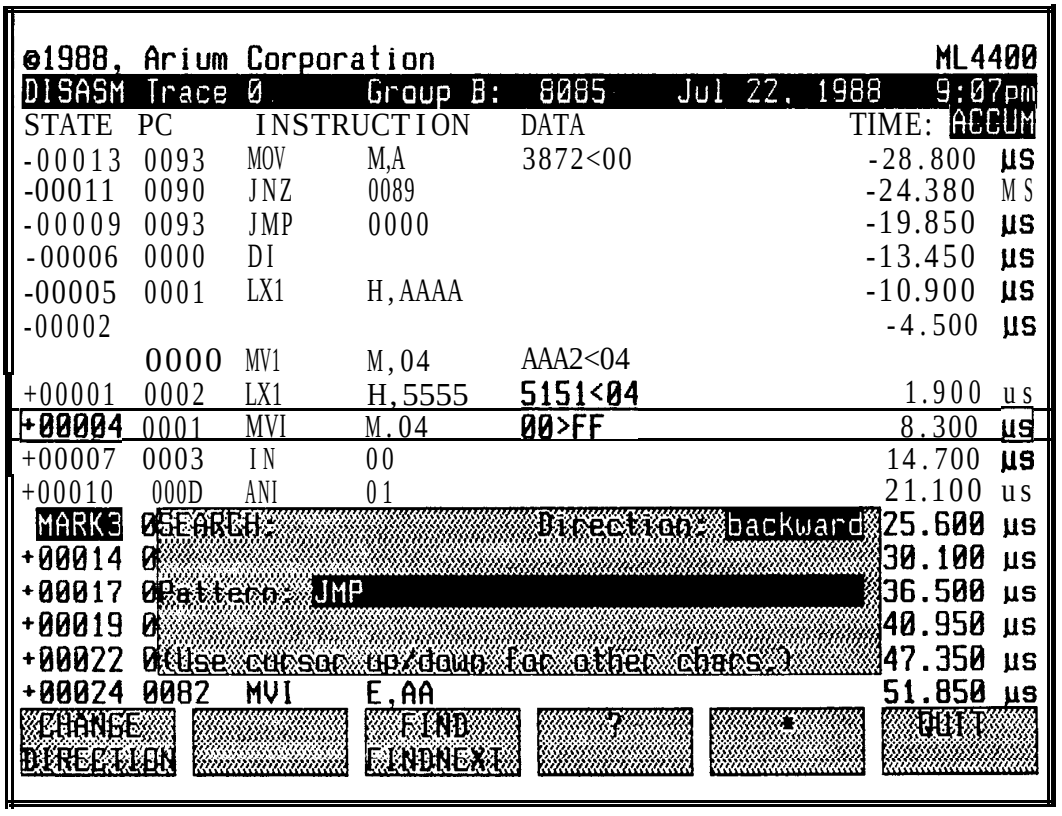
If there is no match, the bell will sound.

To change the memory to be searched, depress DISASSEMBLY to return to the Display screen, then 0 (for Trace Buffer) or 1-8 (for a Reference Memory).

To exit the Search mode, depress the QUIT softkey (which returns the Disassembly Display screen) or depress any Display or Setup key.

Figure IV-L

DISASSEMBLY DISPLAY SCREEN
(WITH SEARCH WINDOW)



f. **Data Field Display**

To suppress or bring back display of the microprocessor data cycles, depress the DATA ON/OFF softkey. Default is "ON".

5. **SPLIT-SCREEN DISPLAY (via SPLIT** Key)

The Timing, State and Disassembly Display screens may be split to display time-aligned data from two groups or in two different display modes. The available splits are Timing/State, Timing/Disassembly, and State/State.

The cursor is time-aligned in the two halves of the display.

The split is horizontal (with upper and lower halves) if Timing is one of the selected display modes, and vertical (with side-by-side halves) if Timing is not one of the selected display modes.

To split a display screen, first change to the Display screen whose display is to be shown on top or on the left of the split screen, then depress SPLIT. If there is more than one split choice, a window will open and the user will be prompted by a menu with selections. Selections calling for display of another group's data will appear on this menu only if the groups have been cross-triggered at acquisition time, so that their data is time-aligned.

To display a Timing/State split screen, depress SPLIT while in a Timing screen. To display other split-screen combinations, depress 2ND, then SPLIT.

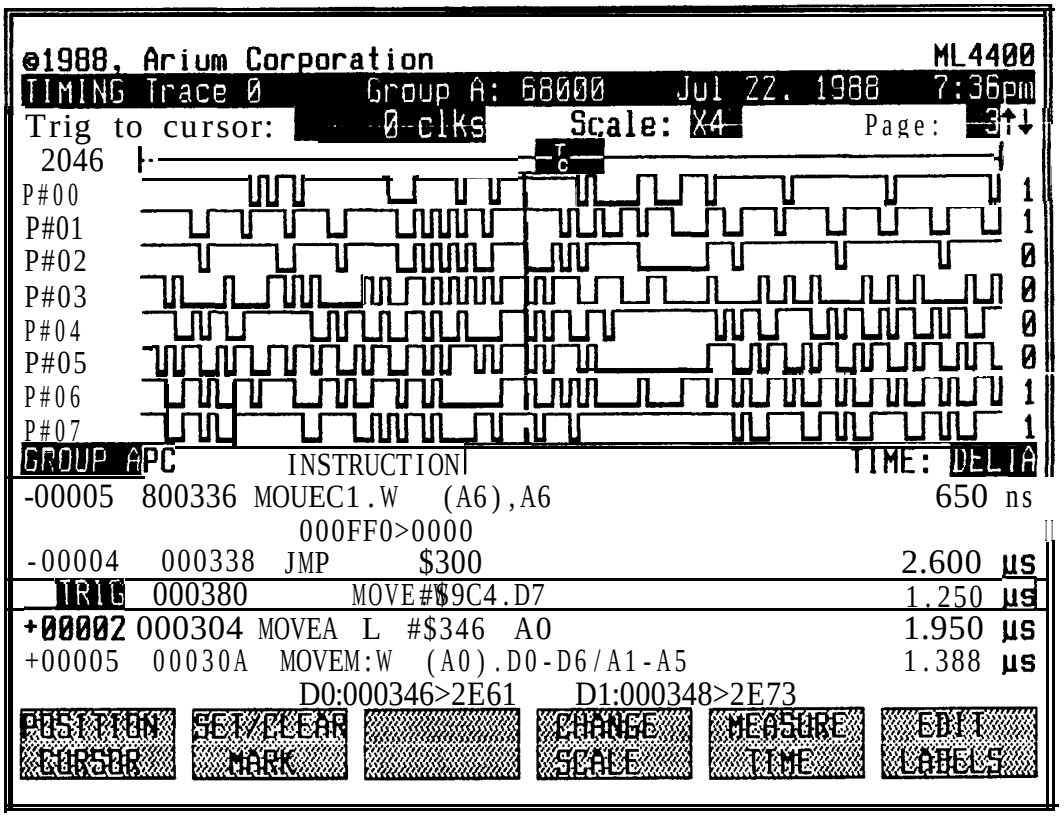
The user should note that, when working with two or more groups, displays may not be split under the following conditions:

* When the groups did not begin delay based on the same event (did not cross-trigger).

* When the groups were not set up to cross-trigger, or (even if the groups were set up to cross-trigger) the groups were started at different times and so one is triggered early. (See Section IV-A.4.a, "2ND, START".)

Figure IV-M

TIMING/DISASSEMBLY SPLIT-SCREEN DISPLAY



6. **GROUPS (See also Section III-D, "Configuration Setup Screen".)**

The ML4400 may be configured to act as up to four separate logic analyzers, with each analyzer called a group and labeled A, B, C or D. In addition to a label, each group also carries a name, which may be specified by the user (up to 6 characters), via the Configuration Setup screen. The default name is the group's pod (e.g., LP4400 or 68000).

A group is &fined by the Capture Modules it contains: the ML4400 accommodates up to four Capture Modules, which may be grouped separately or together:. Groups are defined in the Configuration Setup screen, accessed via the CONFIG key.

Only Capture Modules connected to LP-4050 LP-8200 and LP-4400 Logic Pods (l00-MHz, 200-MHz, and 400-MHz, respectively) may be grouped together; the LP-8025 (Expansion Logic Pod) and the Microprocessor Pods cannot be grouped.

Each group has its own particular set of specified operating and display parameters, such as trigger words, trigger sequence, search words, and display format. (These group settings are automatically saved in battery-backed-up RAM.) Therefore, each Timing, State or Disassembly Display screen relates only to the particular analyzer group which is currently active, and the label and name of the active group appears on the Header line of these screens.

Parameters specified in the Configuration, Set Date/Time/Misc., and RS232C Settings screens are common to all groups. Groups can function independently, or they can arm and/or cross-trigger one another (see Sec. III-I, "Trigger Sequence Setup Screen"). Timing, State and Disassembly Display screens may be split to enable the user to easily compare time-aligned trace in one group with that in another (see Section IV-D.S, "Split-Screen Display").

To view the specified parameters for each active group, depress GROUP while in any Setup screen, which rolls the display from one group to the next. To change the group for which data is displayed (while in a Display screen), depress GROUP, which rolls the display from one group to the next. To set or change the operating and display parameters for a group, use the Configuration Setup screen, accessed via the CONFIG Setup key. (See Section III-D, "Configuration Setup Screen".)

E. PRINTING DISPLAYED DATA AND OTHER SCREENS (via PRINT key)

All ML4400 screens may be printed out via an optional, user-installed serial or parallel printer, connected to the ML4400 via a port on the rear panel (see Section II, "Connections"). For most screens, the entire screen image will be reproduced. For State and Disassembly Display screens, the user may select between printing the entire screen image, or all or a portion of the Trace Buffer or a Reference Memory.

Long Display screen printouts are done on a character-to-character basis to speed printing; screen dumps to the floppy disk are also character-to-character. An exact reproduction of the ML4400 character font, lines and shadings may be obtained on printouts via a graphics printing mode, which uses a pixel-by-pixel basis. Most screens are printed on a pixel-by-pixel basis, including Disassembly and State screen displays. But when printing a specified data range or the entire data record from a State or Disassembly Display screen, the printing is in ASCII characters.

To specify printing parameters, access the Set Date/Time/Miscellany screen via the S. FUNC and F4 softkey and use the "SELECT PRINTER" fields. To select the printer device, use the keypad to enter 0 (parallel) or 1 (serial), or use the ROLL CHOICES softkey to toggle between the two; default is parallel. To specify the *number* of lines per page to be printed, enter a number (0-99), or use the INCREASE/DECREASE softkey until the desired number is displayed; default is 60. (This causes a formfeed character to be sent to the printer after the specified number of lines.) To specify no page breaks for a printout, enter 0.

To print a full screen, depress the PRINT key while viewing the *screen.* For all *screens* except the State and Disassembly Display screens, this will cause the printer to exactly reproduce the full contents of the screen. (A special header line is also printed, identifying the printout with the Arium ML4400.)

For the State and Disassembly Display screens, depressing PRINT calls up a window and relabeled softkeys via which the user can specify printing not only the full screen, but also either a particular data range, or the complete data file. The softkeys are (from left to right) PRINT SCREEN (F1), PRINT RANGE (F2), PRINT ALL (F3), and QUIT (F6).

To print a full State or Disassembly Display screen, depress PRINT, then the PRINT SCREEN softkey. To print a particular range of a State or Disassembly Display screen, depress PRINT, use the keypad to enter the beginning and ending cycle numbers in the window fields, then depress PRINT RANGE. To print the complete data range of a State or Disassembly Display screen, depress PRINT, then the PRINT ALL softkey. To abort a print, depress any key.

The "PRINT RANGE" and "PRINT ALL" printouts show only the specified full data lines, with none of the surrounding displayed screen information.

F. MISCELLANEOUS OPERATING FUNCTIONS

1. STORING SETUP FILES

To access the Setup File Storage Screen, depress S. FUNC, then 7. The available softkeys are (from left to right): SAVE FILE, LOAD FILE, UPLOAD FILE, DOWNLOAD FILE, CLEAR FILE, and LOAD DEFAULTS.

Up to 8 complete sets of ML4400 operating parameters can be stored (in nonvolatile storage) via the Setup File Storage screen. These settings include trigger words, trigger sequence, timing and state labels, display format, etc. On this screen, the current setup file (last file accessed) is denoted by a right arrow at the left of the file number. An asterisk to the right of the file number indicates that the current settings have been changed and do not match the values in the file.

NOTE: The ML4400 automatically saves the current macine setup once a minute; when ML4400 power is turned off, then on again, the settings in effect at powerdown are restored. (Any setup changes which were made between the last automatic save and powerdown are lost.)

A setup file is by definition tied to a particular group configuration. For example, it would be meaningless to load a setup file saved from a ganged pair of LP-4050 Logic Pods into a group containing a 280 Microprocessor Pod. (The Clock screens wouldn't match, nonexistent probe numbers would be referenced, etc.) To be loaded into a group, a setup file must have been created from a group consisting of the same number and type of Capture Modules and Pods. (Capture Modules are ganged to form wider groups.) The Modules needn't occupy the same slots on the ML4400. Given these conditions, loading a setup file will change all other parameters to match those of the setup file (such as display format and clock configuration).

To save a setup file, enter the filename (8 characters maximum) using the keypad. Then depress the SAVE FILE softkey, enter a file number (1-8), and depress SAVE FILE again. (The file number defaults to the current cursor position.) The setup file is saved and the file type and date/time fields are updated.

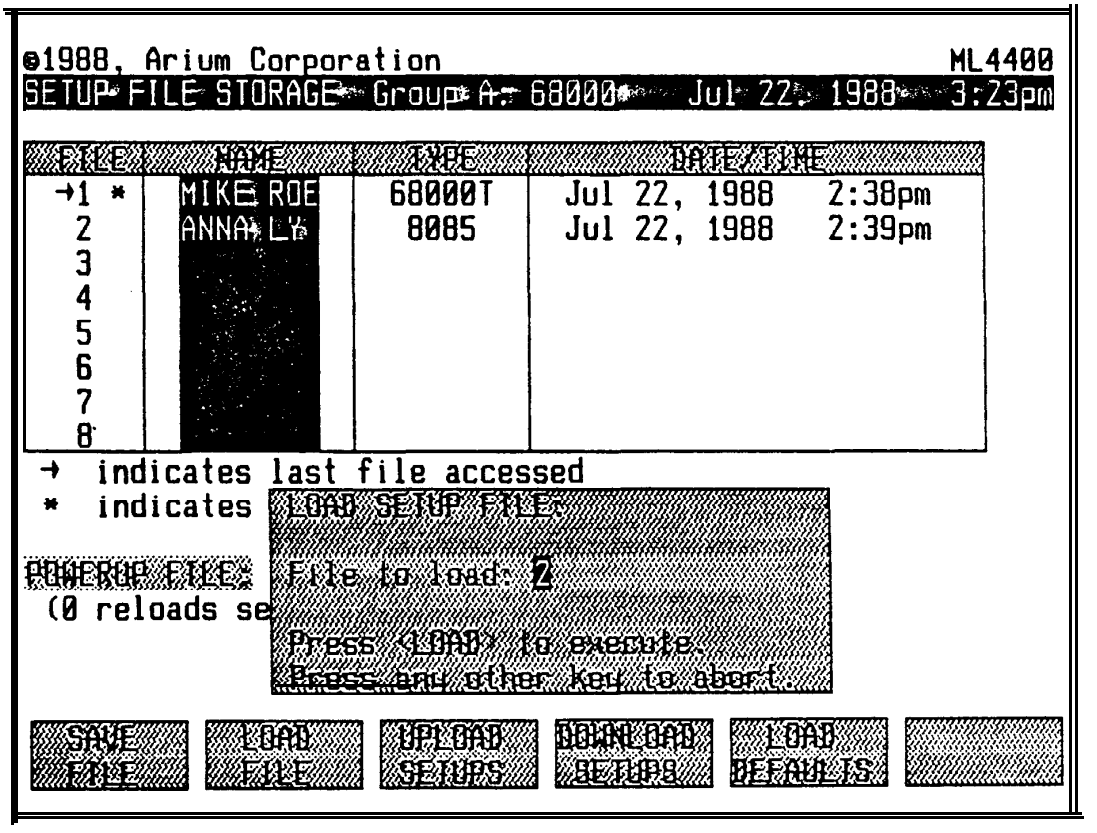
To load a setup file, depress the LOAD FILE softkey, enter the file number, then depress LOAD FILE again. (The file number defaults to the current cursor position, and the pod mode displayed on the Format Display Setup screen is ? updated to match that of the loaded file.) The current group type must be the same as that of the setup file, file, or an error will occur.

To specify a powerup setup file (to be loaded automatically at powerup), enter in the "POWERUP FILE:" field either a file number (1-8) or 0 (powerdown). There is a powerup setup file associated with each logic analyzer group; to specify a powerup setup file for another group, use the ROLL GROUP softkey.

Setup files may also be uploaded via the RS232C port to other equipment. (See Section 6, below.)

Figure IV-N

SETUP FILE STORAGE SCREEN
(WITH LOAD SETUP FILE WINDOW)



2. STORING REFERENCE MEMORY (See also Section IV-D.3.e, "Filling and Editing Reference *Memory".)*

Up to eight Reference Memories may be defined and saved (in battery-backed-up RAM) using the Reference Storage screen, accessed via the S. FUNC key and 8. A Reference Memory is a copy of all or part of a Trace Buffer, and is often used in making repetitive Compares of known valid data against that in the Trace Buffer.

Reference Memories may be edited and filled; (the Trace Buffer cannot). Editing a Reference Memory allows Search and Compare operations to be more selective: a typical reason to edit might be to enter Don't Cares (Xs) in some fields so that a Compare will ignore extraneous data.

Reference Memory may also be uploaded and downloaded to and from other equipment via the RS232C port.

The total storage available for Reference Memories is about 40,000 bytes, and the amount remaining for undefined Reference Memories is displayed on the bottom line of the Reference Storage screen. Including Don't Cares in a Reference Memory will double its size; including Time-Stamp values will increase the size by 4 bytes per cycle.

The last-accessed Reference Memory is &noted on the screen by a "->" to the left of its number.

To copy all or a portion of the Trace Buffer to a Reference Memory, depress the TRACE -> REFERENCE softkey (which opens the Copy Trace window). (To name the Reference Memory at this point, position the blinking cursor in one of the unused "Name" fields and enter a name (up to 8 characters.)

Then cursor to the "From trace cycle" and "To trace cycle" fields and enter the beginning and ending cycle numbers of the portion of the Trace Buffer to be copied. (The default beginning number is the cursor location in the Display screen; the default ending number is the end of the Trace Buffer.)

Next enter the number (l-8) of the Reference Memory to use in the "Into Ref" field (the default is the location of the screen cursor), whether or not Don't Cares are allowed ("0" for no, "1" for yes), and whether TimeStamp is to included ("0" for no, "1" for yes). Lastly, depress TRACE -> REFERENCE again.

The Reference Storage screen will then automatically display the size and type of Reference Memory, whether or not Don't Cares are allowed (under "X"), whether Time-Stamp is included (under "T"), plus the date and time.

To abort storing Reference Memory, depress any key.

To display a Reference Memory, change to a Timing, State or Disassembly Display screen, then select the Reference Memory to be displayed by depressing its number (l-8). To redisplay the Trace Buffer, depress 0. (The number of the current memory being displayed appears on the Header line.)

To clear a Reference Memory, depress the CLEAR REFERENCE softkey; to verify, depress CLEAR REFERENCE again. This frees up the previously allocated memory.

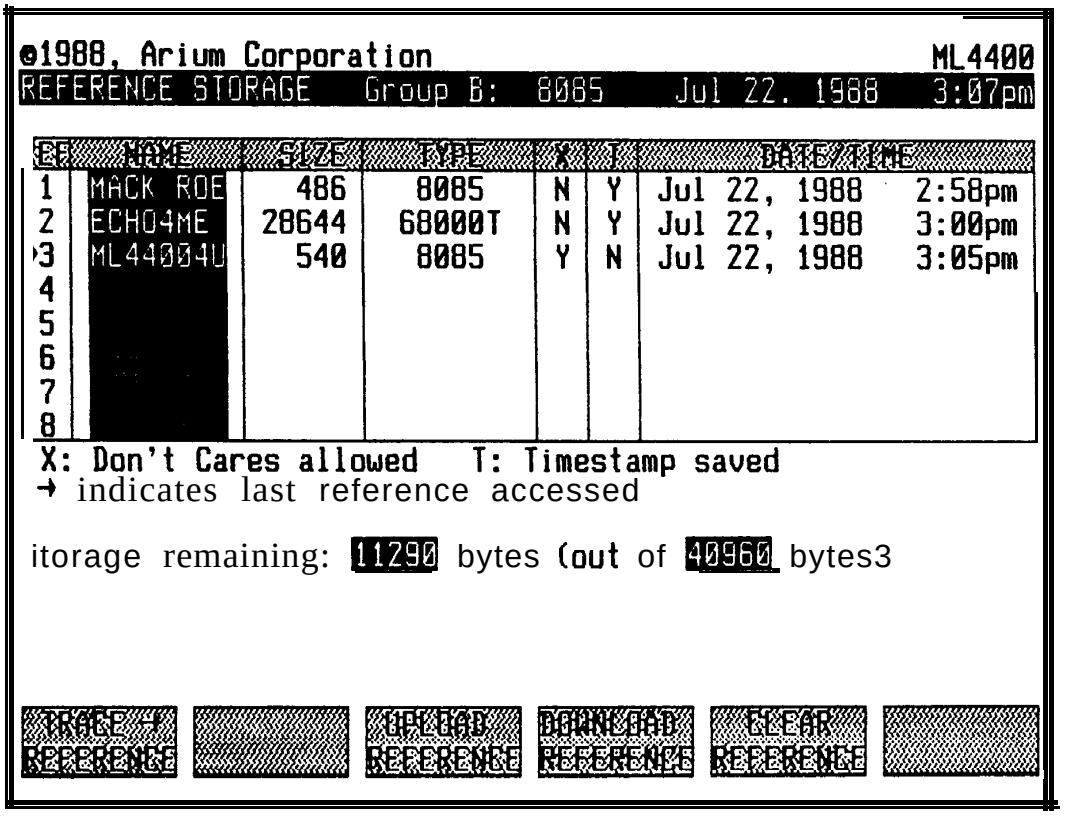
To upload a Reference Memory, first specify the RS232C communication parameters (see Section IV-F.6, "RS2323C Port Settings"). Then depress the UPLOAD REFERENCE softkey, enter the number (l-8) of the Reference Memory to be uploaded (default is the current cursor position), and depress UPLOAD REFERENCE again. The Reference Memory will be transfered in Intel hex format out the serial port.

To download a Reference Memory, first make sure that the current Pod type matches the Pod type of the Reference Memory. Then depress the DOWNLOAD REFERENCE softkey, enter the number (l-8) of the Reference Memory to be downloaded (default is the current cursor position), and depress DOWNLOAD REFERENCE again. The ML4400 will then automatically update the related fields in the Reference Storage screen (Size, Type, Don't Cares, TimeStamp, and Date/ Time).

To abort an upload or download, depress any key.

Figure IV-O

REFERENCE STORAGE SCREEN



3. **COMPARE FUNCTION**

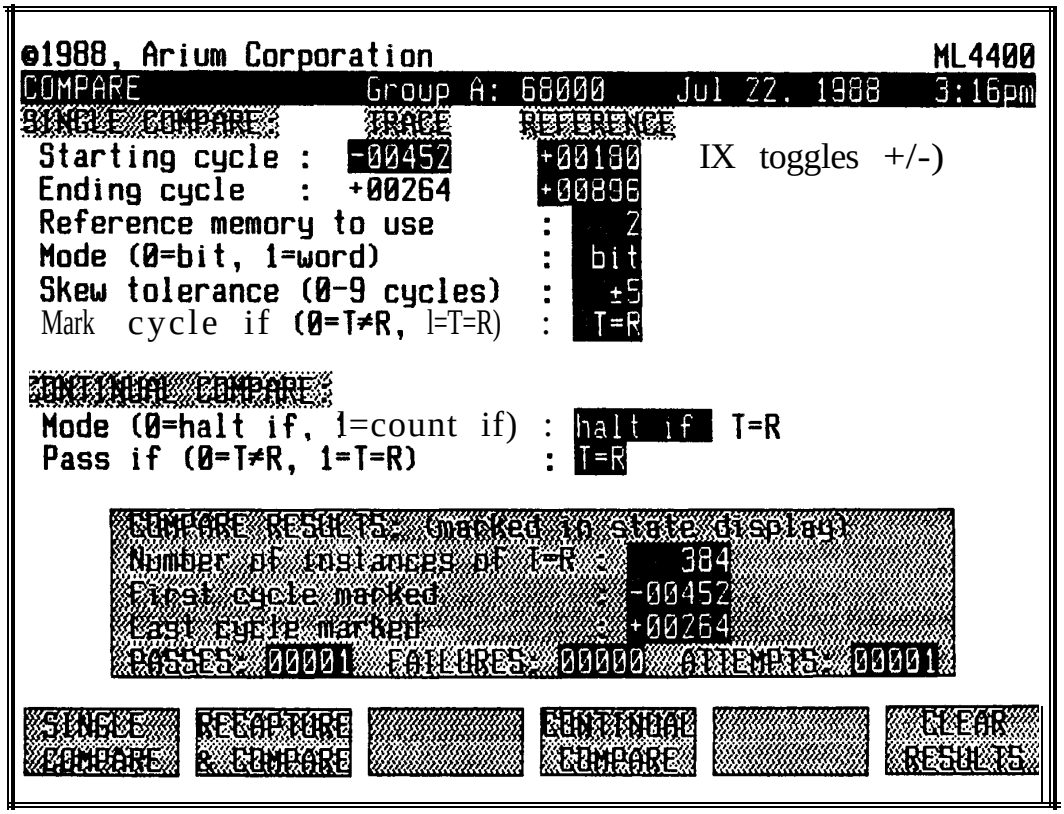
To access the Compare screen, depress S. FUNC, 9. The Compare softkeys are (from left to right): SINGLE COMPARE (F1), RECAPTURE & COMPARE (F2), CONTINUAL COMPARE (F4), and CLEAR RESULTS (F6).

The Compare function compares data in the Trace Buffer with the data in a Reference Memory, by one of two methods: Single and Continual. The Single-Compare method compares already-captured data with that in a Reference Memory, and the ContinualCompare method continually recaptures data according to the ML4400 setup parameters, making the comparison to the Reference Memory after each recapture. The Reference Memory data may be previously captured data that was copied to a Reference Memory from the Trace Buffer, or data which was downloaded to a Reference Memory via the RS232C interface.

The user specifies the comparison operation to find either differences or matches. The number of cycles which meet this comparison condition are shown as part of the comparison results, and the specific cycles are highlighted in the State Display screen by dimming all other cycles.

Figure IV-P

COMPARE SCREEN
(WITH RESULTS WINDOW)



(a) Single Compare

To set parameters for a Single Compare, use the keypad to enter the following parameters: compare ranges, Reference Memory to use, Compare mode (bit-by-bit or word-by-word), skew tolerance, and the Compare condition (Trace ≠ Reference or Trace = Reference).

To specify the Compare ranges, enter state numbers for the starting cycle in the Trace Buffer, and the starting and ending cycles in the Reference Memory. The data ranges must be equal in size. (The ML4400 automatically calculates and displays the Trace Buffer ending cycle after the other cycles have been entered.)

To specify the Reference Memory, enter its number (l-8). (Reference Memories are defined in the Reference Storage screen; see Section IV-F.2.)

To select the Single-Compare mode, enter 0 (bit) or 1 (word). Using Bit Compare, cycles are compared on a bit-to-bit (channel-to-channel) basis; using Word Compare (the default), cycles are compared cycle-by-cycle. The selection of mode matters only when skew is specified to be nonzero.

To specify the skew tolerance ("jitter"), enter the desired number of cycles (0-9). Skew allows the compare algorithm to be more flexible. For example, microprocessor cycles sampled with an internal clock may appear a varying number of times in the Trace Buffer, depending upon how the internal clock and the microprocessor clock happened to line up at a given time. Allowing some skew lets the compare algorithm look up to skew words on either side of the work in Reference Memory to try to find a match.

The skew value will directly affect the amount of time the Compare operation will take: as the allowable skew increases, the number of checks that the ML4400 must perform increases dramatically. For faster Compare execution times, the skew value (and compare range) should be no larger than necessary.

To set the Compare condition, enter 0 (T=R, differences will be highlighted), or 1 (T=R, matches will be highlighted).

To perform the Single Compare after setting the above parameters, depress the SINGLE COMPARE softkey. This opens the COMPARE RESULTS window, which displays the number of instances that the Compare condition was met, and the state numbers of the first and last cycles marked. (The bottom three fields--the number of passes, failures, and attempts--are used only in the continual-compare mode.) The results of the Compare are highlighted in the State Display.

To recapture data and do another Single Compare, depress RECAPTURE & COMPARE.

To clear the results (from the State Display screen) and to close the Search Results window, depress the CLEAR RESULTS softkey or depress TIMING, STATE or DISASSEMBLY. To abort a Compare, depress any key.

(b) **Continual Compare**

To set parameters for a Continual Compare, first use the keypad to enter the above-discussed parameters in the Single Compare fields. Then enter these additional parameters in the Continual Compare fields: Compare mode ("Halt if" or "Count if") and the pass condition (T=R or T=R).

To specify the Continual-Compare mode, enter 0 ("Halt if" the pass condition is seen) or 1 ("Count if" the pass condition is seen). "Halt if" executes Compares until the condition specified has been met, or STOP has been depressed. "Count if" executes compares forever, or until STOP has been depressed.

If "Halt if" is selected, the ML4400 will reacquire and Compare until it finds the condition (= or ≠) specified for marking data (last field above). If "Count if" is selected, the two results (pass and fail) will be displayed and accumulated for all captures; the pass condition is set separately from the "mark"/"Halt if" condition.

To specify the pass condition, enter 0 (T=R) or 1 (T=R).

To perform the Continual Compare after setting the above parameters, depress the CONTINUAL COMPARE softkey. *This opens* the COMPARE RESULTS window, and also highlights the resulting cycles in the State Display screen. This window shows the *number* of instances that the compare condition was met, the state numbers of the first and last cycles marked, and the number *of* passes, failures and attempts. All this information is continuously displayed and updated in the window. (During the Continual Compare operation, a blinking "ACTIVE" will overwrite the date and time on the Header line.)

The counters for passes, failures, and attempts roll over to zero at 65535.

To clear the results (from the State Display screen) and **to close the Search Results window,** depress the CLEAR RESULTS softkey or depress TIMING, STATE or DISASSEMBLY. **To abort a Compare,** depress any key.

4. SEARCH FUNCTION

See Sections IV-D.3.d and IV-D.4.d for discussions of the Search function in the State and Disassembly Display screens, respectively.

5. ROM EMULATION (Optional)

The ROM Emulator Pod (RP-016), an optional ML4400 accessory, enables the ML4400 to emulate one or more 27XX-series EPROMs, giving it a powerful tool for debugging code in microprocessor-based systems. Code can be downloaded to the Emulator and then patched as required. The ML4400 can accommodate a second pod, which doubles the memory which can be emulated.

There are three ROM Emulator screens: ROM Emulator Configuration, ROM Emulator Editor, and ROM Emulator Transfers. To access the ROM Emulator screens, depress S. FUNC, then 5 (Configuration), 6 (Editor), or 4 (Transfers). See Section VIII, "ROM Emulator Pod", for detailed descriptions of these screens.

6. RS232C PORT SETTINGS

To access the RS232C Settings screen, depress S. FUNC, 3. This screen configures the RS232C serial port, which is used to upload and download setup files, Reference Memories, and ROM Emulator files, and to connect with a serial printer. The user should set the RS232C parameters (listed below) such that they are compatible with whatever &vice is communicating with the ML4400.

To set all parameters to defaults, depress the DEFAULT SETTINGS softkey.

To select the baud rate at which messages will be sent and received by the ML4400, enter O-B. Selections are 110, 150, 300, 600, 1200, 1800, 2400, 4800, 7200, 9600, 19200, and 38400. Default is 9600.

(The ML4400 can accept data continuously at 9600 baud.)

To select the parity, depress 0 (off), 1 (odd), or 2 (even). Default is off.

To set the character length, depress 0 (7 bits) or 1 (8 bits). Default is 8.

To specify delays (in ms) after sending a character or after a carriage return (for devices that are slow to receive characters), enter O-999. Default is 0. Specification of delays is needed when interfacing with devices which cannot

accept characters at the selected baud rate without losing some. so that data will not be lost when sending from the ML4400. If a handshaking protocol (see below) is implemented when sending to a slower device, no delay is needed.

To set the End-of-File character, enter OOH-1FH. Default is lAH, the DOS End-of-File character.

To set the End-of-Line character, enter 0 (CR, carriage return), 1 (LF, linefeed), or 2 (CRLF). Default is CRLF. When using the RS232C interface to send data or screen displays to a CRT or a printer, some systems automatically will add a LF after each CR; if the system does not, the user should specify adding a LF to prevent overprinting each line on the previous line. When communicating with a computer, higher throughput is achieved by not adding a LF after each carriage return.

To enable XON and XOFF (Control S & Control Q), enter 1; to disable, enter 0. Default is disabled.

To enable RTS/CTS (REQUEST TO SEND & CLEAR TO SEND), enter 1; to disable, enter 0. Default is disabled. The actual handshake protocol is the RxRts protocol, as defined by Signetics.

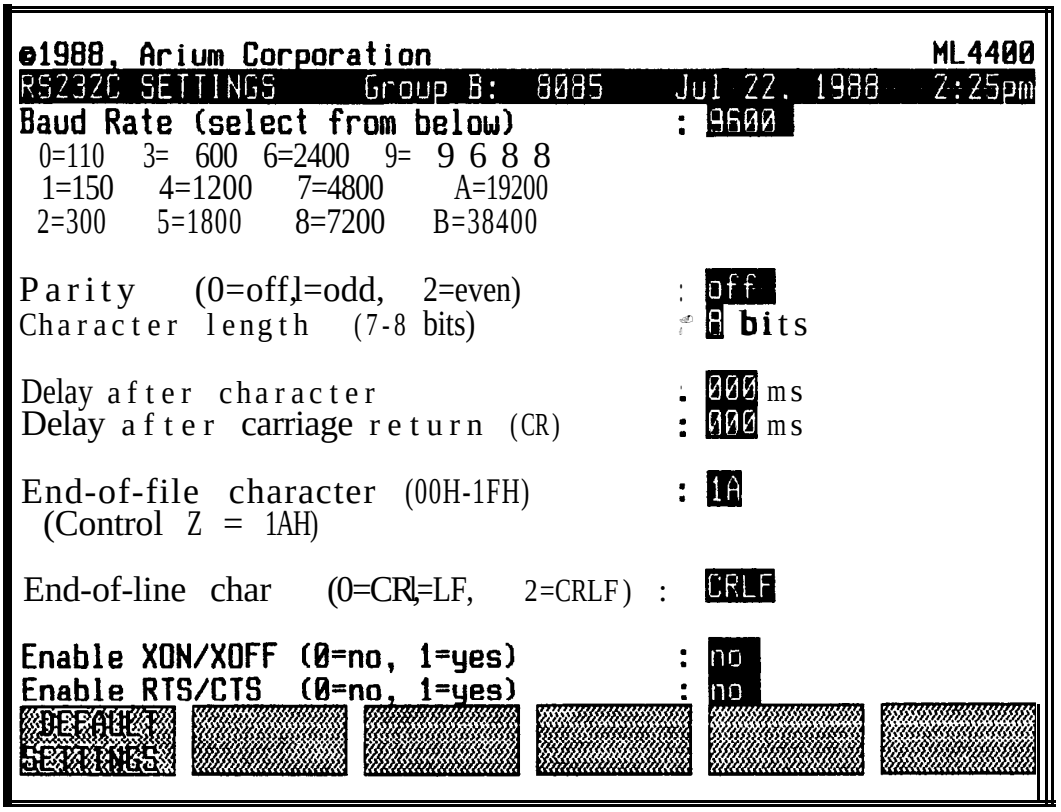
The following pins are on the ML4400 rear panel Serial Port connector:

Pin No.	Signal Name (per RS-323C)	Input to ML4400	output from ML4400
1	Safety ground	X	X
2	TXD		X
3	RXD	X	
4	RTS		X
5	CTS	X	
7	Signal ground	X	X

The ML4400 is a "DTE" device; i.e., it appears at the RS-232C interface as would a standard CRT terminal.

Figure IV-Q

RS232C SETTINGS SCREEN



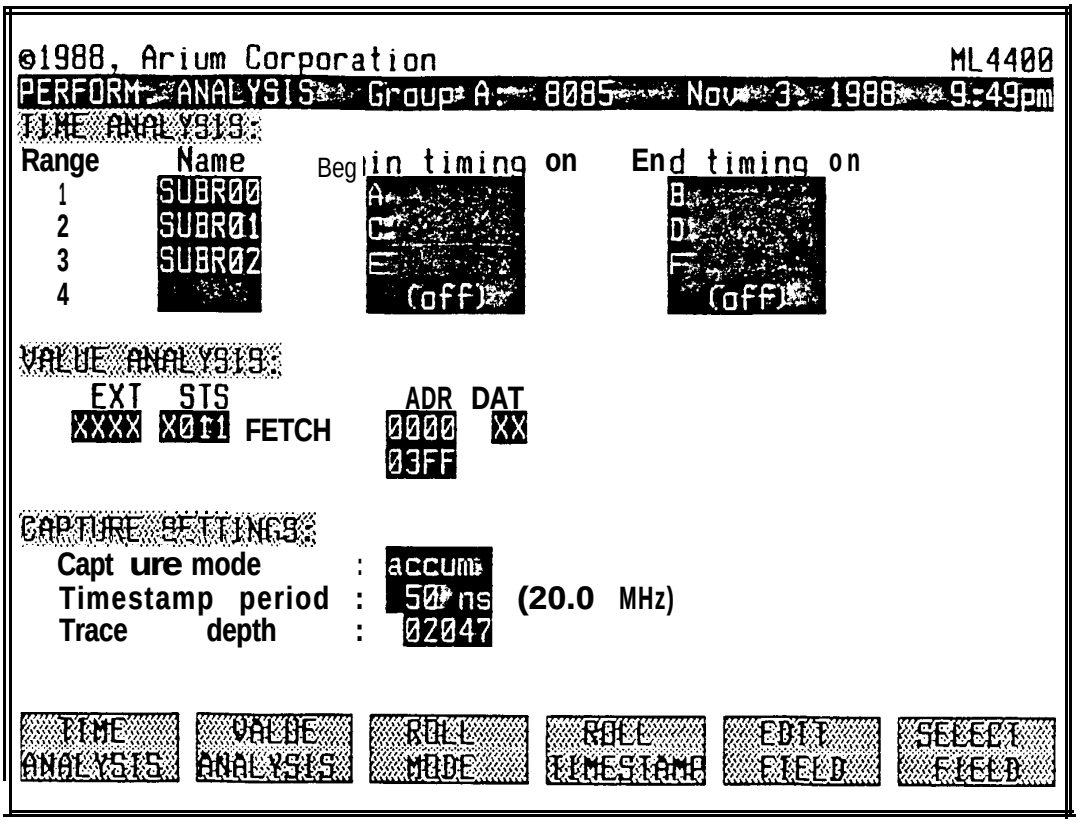
7. PERFORMANCE ANALYSIS

a. General

The Performance Analysis screen is accessed via S. FUNC, A. It presents both time analysis and value analysis of a specified range or ranges of data in the Trace Buffer, in one of three data capture modes (Single, Continual, and Accumulate). Analysis results are displayed dynamically (as they fluctuate in real time) by both numerical values and bar graphs.

Figure IV-R

PERFORMANCE ANALYSIS SCREEN



b. **Data Capture Settings**

The three "Capture Settings" fields on the bottom of the Perfomance Analysis screen are used for both time and value analysis.

To set the capture mode, use the ROLL MODE softkey to toggle among the three modes: Single, Continual, and Accumulate. The Continual mode does repetitive single captures, and the Accumulate mode accumulates results as it does repetitive captures.

To select the TimeStamp period, depress ROLL TIMESTAMP until the desired value appears in the "Timestamp period" field. The hardware TimeStamp counter is 14 bits long, and can measure time between events as large as 819 us with a period of 50 ns, and as large as 163 sec with a period of 10 ms. The period selected should be short enough to give a high resolution of times, but long enough so that the TimeStamp counter doesn't overflow. (If it does overflow, an "OVERFLOW" message will be displayed in place of a time value.)

Note that changing the TimeStamp period on this screen will also change the TimeStamp period on the Clock screen.

To set the number of cycles to be captured, cursor to the "Trace depth" field and enter a decimal number between 1 and the Trace Buffer depth. (A number larger than the depth will not be accepted, and the field will default to the Buffer depth.) Usually this number should be large, so that there is more meaningful data to work with. But if an event occurs infrequently, this number may be reduced to decrease the capture time.

c. **Time Analysis**

Time Analysis measures the time between events, such as the beginning and ending addresses of a microprocessor subroutine that is suspected of taking too long to execute. Combinational data qualification is used to capture only the beginning and ending events, one trace cycle per event. Because of this, the Trace Buffer can hold thousands of occurrences of a range, which makes the time analysis more meaningful than if all cycles had been captured and checked for the particular range. Time Analysis uses ML4400 hardware TimeStamp information to measure the actual times (both inside and outside a range).

The user may specify up to four ranges, with each being defined by a beginning and ending event. An event is &fined by a combination of trigger words. This enables the ML4400 to analyze mulitiple entry and/or exit points for a section of code.

A specified range may be nested, and the time measured inside it is not included in the accumulated time for an outer range. This permits excluding interrupts when time-analyzing a section of code.

To label a range, cursor to a Name field and enter a name (of up to six characters; this name will be used to label the bar graph results for the range.

To specify the range (by trigger words), cursor to the "Begin timing on" and "End timing on" fields and depress the A-H keys to alternately include, "not", or exclude particular trigger words. Trigger words are, by default, "or'd" together. To "and" words, use the EDIT FIELD softkey.

To specify the capture settings, see Section b, above.

Then, to perform the time analysis, depress TIME ANALYSIS. The results will be displayed on the lower part of the screen in two sections. The upper section shows the percentage of time each range was active (in both numbers and bar graphs). The lower section shows the following statistics for each range:

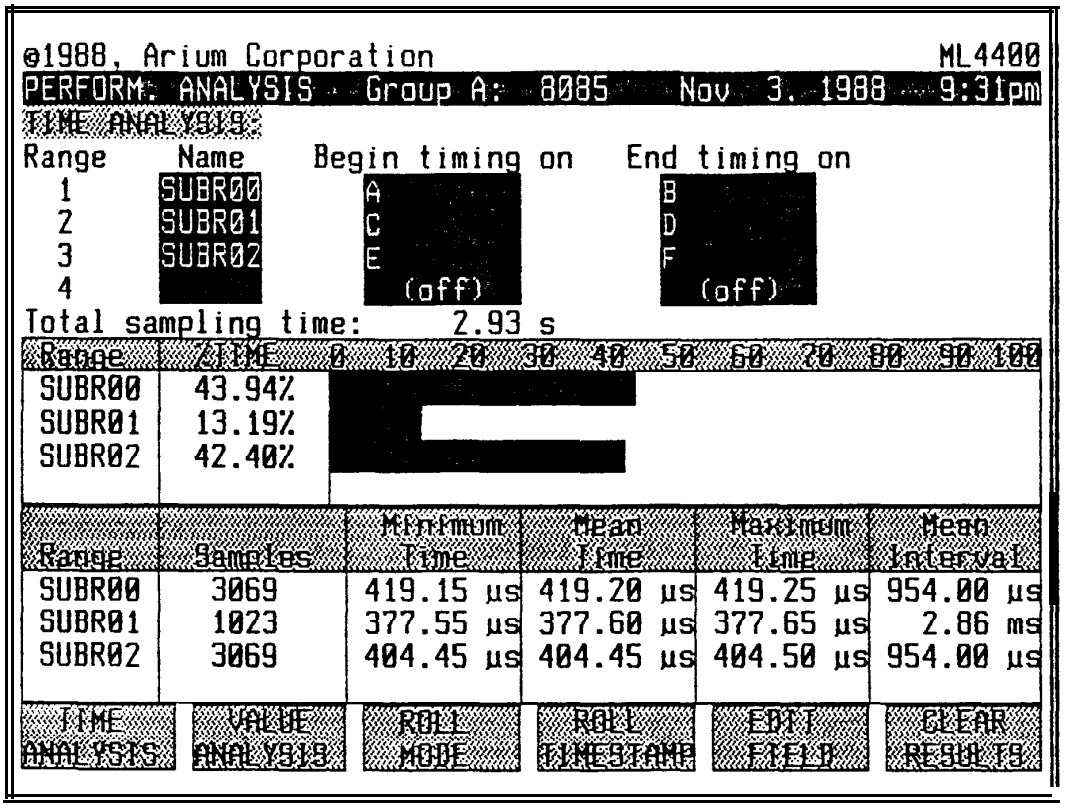
* The number of times it was encountered
* Its minimum, maximum, and mean times
* Its mean interval (average time between its occurrences)

For example: The user wants to analyze the execution time of an interrupt routine that begins at lOOOH and ends at 1124H while excluding a higher-priority interrupt at 2000H to 2100H. Define Trigger Words A, B, C, and D as fetches at lOOOH, 1124H, 20008, and 2100H, respectively. Then specify that one range begin timing on A and end timing on B, and the second range to begin on C and end on D, and do the analysis. (The remaining two ranges should be "off".)

To return to the full Performance Analysis screen, depress CLEAR RESULTS. To stop analysis in the Continual or Accumulate mode, depress STOP twice.

Figure IV-S

PERFORMANCE ANALYSIS SCREEN
WITH TIME ANALYSIS RESULTS



d. **Value Analysis**

Value analysis gives histograms of the relative frequency of a range of values, such as (for a microprocessor) an address range, a data range at a particular address, or a range of status codes. Combinational data qualification is used to capture only cycles that fall within the specified range, making the data analysis more meaningful than if all cycles had been captured and then checked, whether or not they were within the range.

The format of the "Value Analysis" fields is that specified in the Format Display Setup screen. (See Section III-E.)

To specify the values to be histogrammed, cursor to the "Value Analysis" fields and depress SELECT FIELD. Then use the keypad to enter the beginning and ending address values for the range, and other values (or Don't Cares) as appropriate in the other fields.

To specify the capture settings, see Section b, above.

Then, to perform the value analysis, depress VALUE ANALYSIS. The screen display will be replaced by a histogram of the values within the specified range, which is divided into 16 equal-sized subranges. The display shows, for each subrange, the percentage of time that a value was within the range, both as a number and as a bar graph.

Example 1: To histogram all data values at *Address* lOOOH in an 8085, enter:

EXT	STS	ADDR	DAT
XXXX	XXXX	1000	00
			FF

Example 2: To histogram all instruction fetches in an 8085, enter:

EXT	STS	ADDR	DAT
XXXX	XXXX	0000	xx
		FFFF	

Example 3: To histogram the amount of time spent in user and supervisor modes in a 68000, enter:

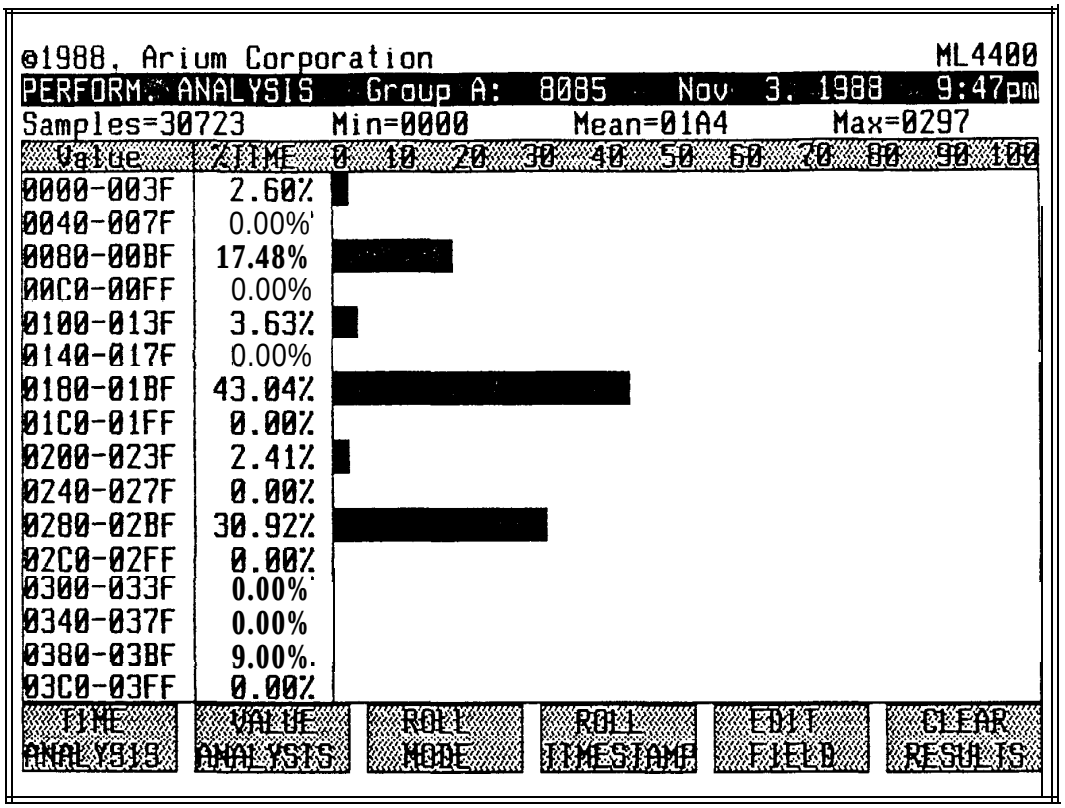
EXT	STS	ADDR	DAT
XXXX	0	XXXXXX	XXXX
	1		

where the Status field has been defined (in the Format screen) to contain only Bit 66 (User/Supervisor bit).

To return to the Performance Analysis screen, depress CLEAR RESULTS. To stop analysis in the Continual or Accumulate mode, depress STOP twice.

Figure IV-T

PERFORMANCE ANALYSIS SCREEN
WITH VALUE ANALYSIS RESULTS



8. **AUTOCAPTURE**

The Autocapture screen is accessed via S. FUNC., B. It is used to enable and disable the Autocapture function. When Autocapture is enabled, the MI4400 will continually recapture and display updated trace data after START has been depressed.

To enable Autocapture, enter "1" in the "Autocapture mode" field; to disable it, enter "2". Default is off. To stop Autocapture, depress STOP twice.

9. FLOPPY DISK FUNCTIONS

To access the Disk Functions screen, depress S. FUNC, D. The Disk Function softkeys are (from left to right) SORT BY NAME, SORT BY EXT, and SORT BY DATE.

This screen provides access to an optional 3-l/2-inch floppy diskette. In addition to disk operations, files may be printed directly to the disk by selecting the disk as the printer device; see "Settings for Date, Time...", Section IV-G.3. Also, setup files, Reference Memories, and ROM Emulator files may be read or written directly from their display screens.

The Floppy Disk Drive (optional ML4400 equipment) can read, write and format any 720K DOS diskette.

On the Disk Functions screen, the line below the Header lines gives the name of the directory currently accessed, and the amount of space available on the disk. Below it is a list of files in that directory, showing the name, size, attributes, and creation date for each. This list may be arranged by filename, by extension, or by creation date: to re-sort the directory files, depress the appropriate softkey (SORT BY NAME, SORT BY EXT, and SORT BY DATE).

The cursor is a reverse-video bar which highlights one of the files, and may be used to select a file during file operations. To move the cursor a line at a time, depress the UP/DOWN arrows; to move to the top/bottom of the screen or to an adjacent page, depress the Shift key with an UP/DOWN arrow.

a. File Operations

For most file operations, a window opens and prompts the user for a filename; the default filename in this window is the filename at the cursor. To abort any operation while this window is open, depress the QUIT softkey.

To enter a filename, use the keypad to enter up to 8 alphanumeric characters and, optionally, an extension (a "." followed by 3 characters); then depress the OK softkey. (A new set of softkeys provides a space, "\", "*", and ".", plus OK and QUIT.)

To copy a file, depress 1, enter the source filename and depress OK; then enter the destination filename and depress OK. A copy may take the following forms:

```
Copy File     to File
Copy File(s) to Dir
Copy File(s) to AUX        (AUX = serial port)
Copy AUX     to file       (AUX = serial port)
Copy File(s) to PRN        (PRN = parallel port)
```

To delete a file, depress 2, enter the filename and depress OK.

To rename a file, depress 3, enter the original filename and depress OK; then enter the new filename and depress OK. (Wildcards are not permitted.)

To compare two files, depress 4, enter the first filename and depress OK; then the second filename and depress OK. (The two files must be the same size.) If the files do not match, the line number and character position of the first difference are displayed.

b. **Directory Operations**

To change directories, depress 5, enter the name of the directory to change to, and depress OK. The contents of the new directory are displayed and the Directory field at the top of the screen is updated.

To make a new directory, depress 6, enter the name of the directory, and depress OK.

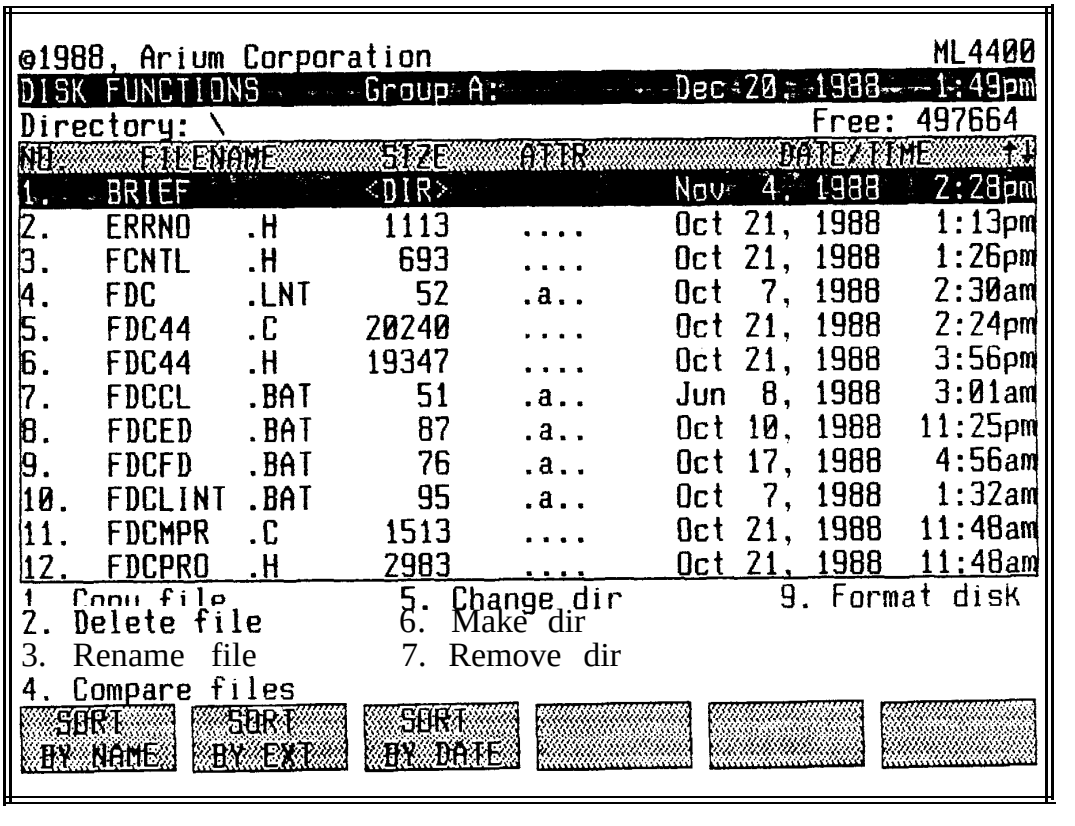
To remove a directory, depress 7 and enter the directory name, then depress OK. (The directory must be empty.)

c. **Formatting the Disk**

To format the diskette, depress 9, then depress 9 again to verify the operation. The disk is formatted and all prior data is lost. After formatting, an optional Volume Label is requested. To label the volume (disk), enter the label; to skip this step, depress QUIT.

Figure IV-U

DISK FUNCTIONS SCREEN



G. SUPPORT FUNCTIONS

1. CALCULATOR

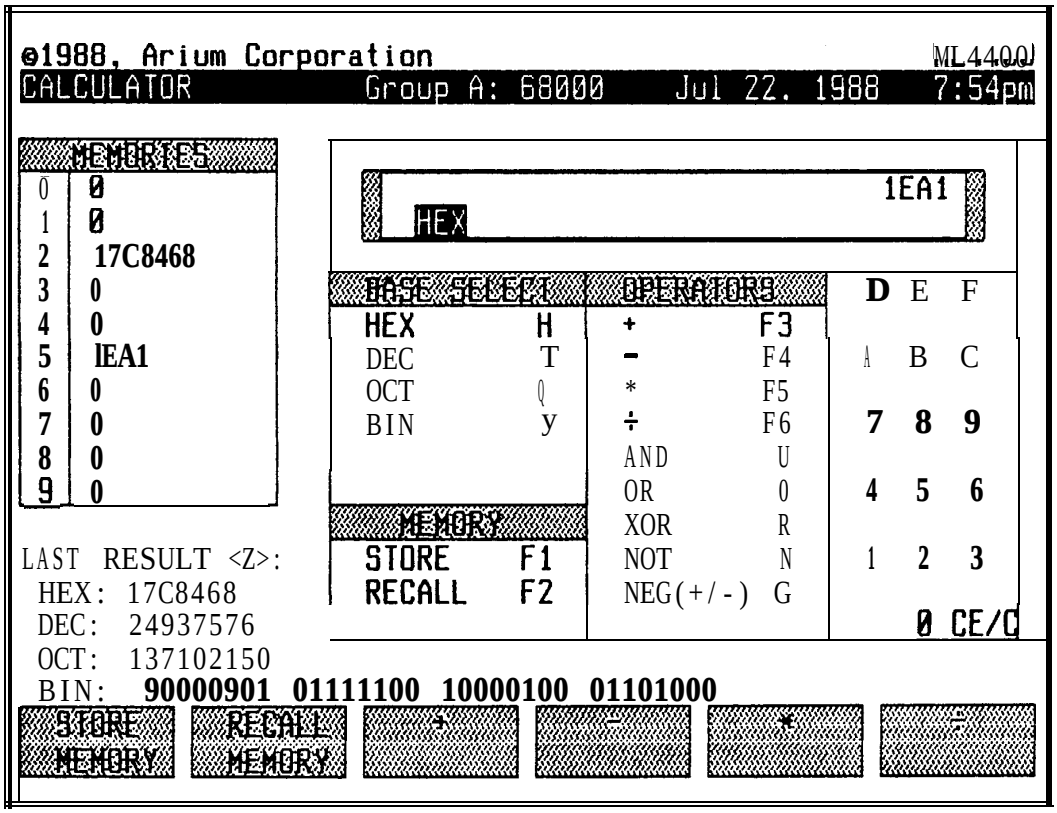
To access the Calculator screen, depress S. FUNC, F1. The Calculator softkeys are (from left to right): STORE MEMORY, RECALL MEMORY, +, -, * and -. The ML4400 provides a g-function calculator which performs all operations with 32-bit accuracy and operates in any of four number bases (hexadecimal, decimal, octal, and binary). It has ten memories for constants and/or symbol offsets, and nine basic operator functions (+, -, *, +, AND, OR, XOR, NOT, and NEG) .

The results of the last calculation are displayed in all bases in the "Last Result" area. This value is assigned to the Z key, and may be entered into any ML4400 numerical field simply by depressing Z (2ND, H) while in that field. Values in memory are displayed in the memory window in the upper left of the screen.

The results window (in the upper right) displays the number being entered and calculation result, and indicates the current number base, current operator, and "STORE" or "RECALL" when memory is being accessed.

Figure IV-V

CALCULATOR SCREEN



The calculator operator functions are accessed via four softkeys, plus six of the keypad keys:

Function	Description	Key
+	Addition	F3
	Subtraction	F4
*	Multiplication	F5
	Division	F6
=	Equals	X
AND	Arithmetic and	U (2ND, 9)
OR	Arithmetic or	O (2ND, 6)
XOR	Exclusive or	R (2ND, 9)
NOT	l's complement	N (2ND, 5)
NEG	2's complement (+/-)	G
CE	Clear entry	CLEAR
C	Clear window	CLEAR, CLEAR

To select a number base, use the keypad and depress H for hexadecimal, T (2ND, B) for decimal, Q (2ND, 8) for octal, or Y (2ND, G) for binary. Changing the number base affects both the results window and the memory displays, except when binary has been selected; in this case, the value in memory is displayed in decimal (because of space limitations on the screen).

To enter a number for calculation, use the alphanumeric characters O-F on the keypad. To clear the current number, depress CLEAR. To clear all numbers and operators entered so far, depress CLEAR twice. (This does not clear the memories.)

To store a displayed value into a memory location, depress the STORE MEMORY softkey, then use the keypad to enter the number of the memory (O-9) in which to store the value. (Storing a value in memory overwrites any value previously stored there.) To recall a value from memory and use it in a current calculation, depress the RECALL MEMORY softkey, then enter the number of the the memory from which to recall the value. When either STORE MEMORY or RECALL MEMORY has been depressed, but the number of the memory has not yet been entered, the user will be prompted by either "STORE" or "RECALL" being displayed in the results window.

To transfer the last result to a numeric field on any ML4400 screen, change to that screen, cursor to the field, and depress Z (2ND H). The number will remain in the Calculator results window.

2. STOPWATCH

The Stopwatch function is accessed via the Stopwatch Control screen. Stopwatch operates either as an independent timer (Mode 1), with its start and stop being controlled via softkeys on the Stopwatch Control screen, or as a measurer of the data recording time (from depressing START to the occurrence of a trigger or depressing STOP) (Mode 2). Time is measured in hours (up to 99), minutes, seconds, and hundredths of seconds.

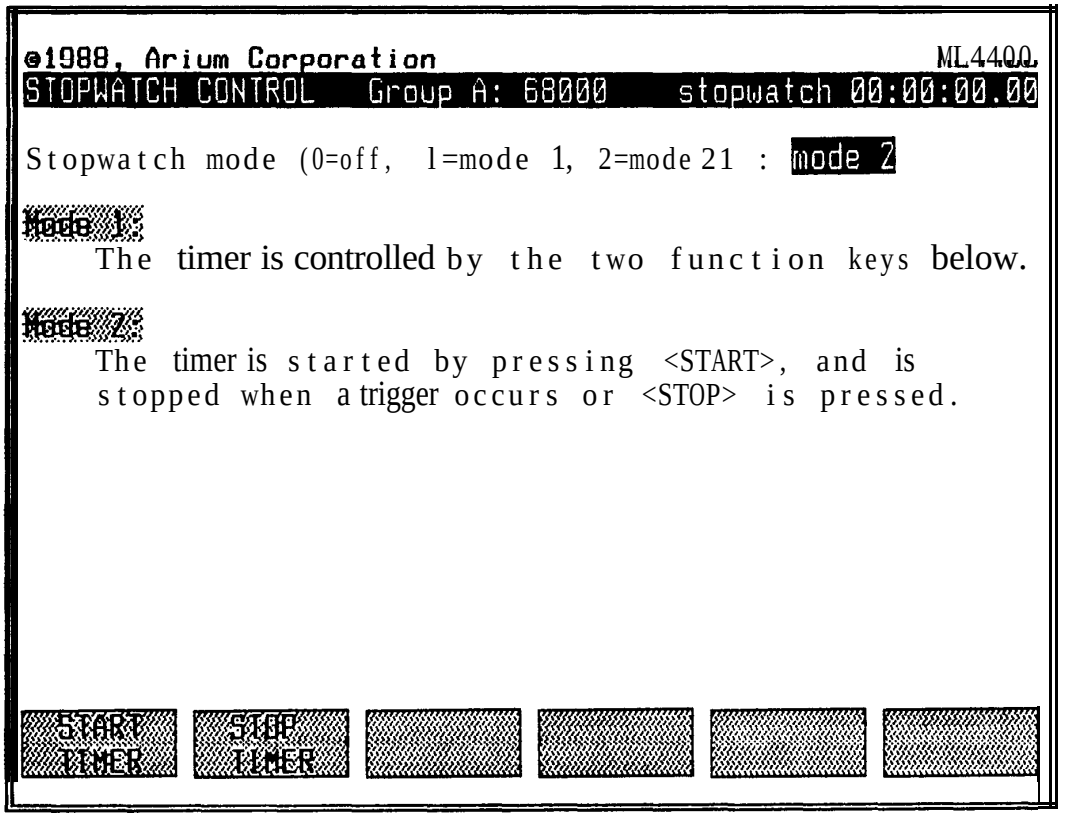
To access the Stopwatch Control screen, depress S. FUNC, then the STOPWATCH CONTROL softkey. The screen has two softkeys: START TIMER (F1) and STOP TIMER (F2).

To select the Stopwatch mode, enter 0 (off), 1 (Mode 1), or 2 (Mode 2).

When the Stopwatch is active, the date and time on the Header line of all screens is overwritten with the current timer value.

Figure IV-W

STOPWATCH CONTROL SCREEN



3. SETTINGS FOR DATE, TIME, ALARMS, PRINTER, VIDEO, AND TRIGGER BELL

The Set Date/Time/Misc. Screen controls the ML4400 calendar (date and time, audible alarms and alarm messages, printer port selection and lines per page , and characteristics of the video display and trigger bell.

To access the Set Date/Time/Misc. screen, depress S. FDNC, then the SET DATE/TIME softkey. The softkeys are ROLL CHOICES (Fl), INCREASE VALUE (F3), and DECREASE VALUE (F4).

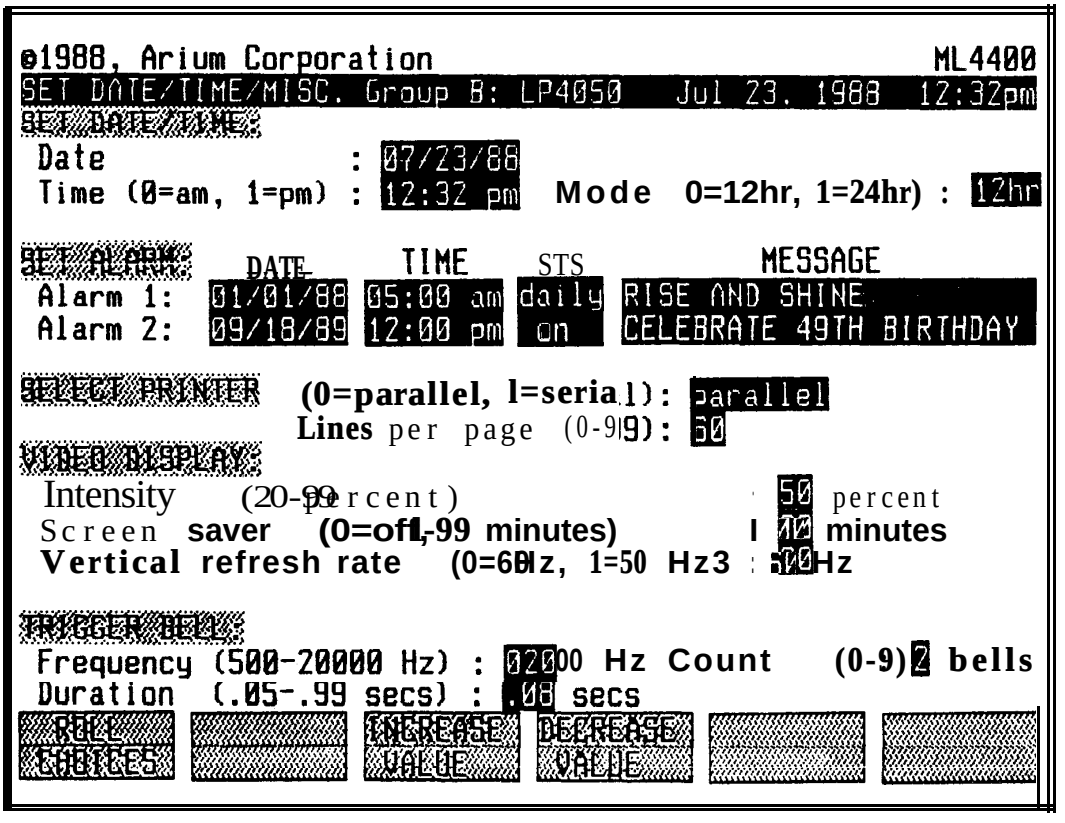
In all numerical fields (except the Vertical Refresh Rate field) there are two methods of entering values. The user may either use the keypad to directly enter the specific numerical value, or use the INCREASE VALUE and/or DECREASE VALUE softkeys. one

Similarly, in a field whose selections are "0" *or* "l", the user may either use the keypad to enter 0 or 1, or depress ROLL CHOICES to toggle between the two.

The calendar and alarm use American-style numerical dates (month/day/year).

Figure IV-X

SET DATE/TIME/MISC. SCREEN



a. **Date and Time**

The ML4400 is factory set with the current date and time, but is resettable by the user; both 12-hour and 24-hour display modes are available.

To chance the date or time value, cursor to the Date and Time fields and enter the desired values, plus 0 (for am) or 1 (for pm). NOTE: Regardless of whether the display mode is 12-hour or 24-hour, the time is always set here in 12-hour mode. Any year value less than 88 is assumed to be in the 21st century; e.g., "85" means 2085, not 1985.

To change the time display mode, cursor to the Mode field and use the keypad to enter 0 (12-hour) or 1 (24-hour).

b. **Audible Alarms and Alarm Messages**

The ML4400 can be set for two general-purpose audible alarms. In addition, the user may specify an alarm message to be displayed on the Header line. The duration of the audible alarm (beeps) and displayed alarm message is one minute, or until any key is depressed.

Four alarm statuses are available: to alarm at a specified time on a specified date ("on"); to alarm every day at a specified time ("daily"); to alarm at a specified time and date, then disable the alarm ("once"); and "off".

To set an audible alarm, cursor to the Date and Time fields and enter the desired values; next use the ROLL CHOICES softkey to select "am" or "pm"; then cursor to the STS (Status) field and use the ROLL CHOICES softkey to select the mode (on, daily, or once).

To specify an alarm message to be displayed, cursor to the Message field and use the keypad to enter the message (up to 24 alphanumeric characters).

To disable the alarm, cursor to the STS field and use the ROLL CHOICES softkey to select "off". To disable the alarm after a particular alarm, use the "once" mode; see above paragraph.

c. **Printer Selection and Lines per Page**

To select the printer device, cursor to the Select Printer field and enter 0 (parallel) or 1 (serial). If the serial port is selected, the settings in the RS232C Settings Screen (accessed via S. FUNC, 3) may need to be changed.

To specify the number of lines per printed page, cursor to the Lines per Page field and enter the desired value (l-99); a formfeed character is sent to the printer after the specified number of lines. To specify no page breaks, enter 0.

d. **Video Characteristics**

The user may vary the intensity of the CRT display, activate a Screen Saver function, and change the vertical refresh rate. The Screen Saver will blank the screen after a specified time has elapsed without any keyboard activity; depression of any key will repaint the screen. The vertical refresh rate is set at the factory (at 50 or 60 Hz), depending upon the shipment destination, and should not be changed unless the operating power frequency of the ML4400 is changed.

To specify the screen intensity, cursor to the Intensity field and enter the desired value (20-99%).

To use the Screen Saver, cursor to the Screen Saver field and enter the number of minutes (l-99) to elapse before the screen is blanked. To disable the Screen Saver, enter 0.

e. **Trigger Bell Characteristics**

Many ML4400 users operate in environments with multiple logic analyzers. To distinguish the beep of one machine from another, each ML44OO's trigger bell can be set to a specific pitch, duration, and number of beeps.

To specify the trigger bell pitch, cursor to the Frequency field and enter the desired value (500-20,000 Hz); default is 2000 Hz. To specify the number of trigger bell beeps, cursor to the Count field and enter the desired number (l-9): default is 2 beeps. To disable the beep, enter 0. To specify the duration of the trigger bell, cursor to the Duration field and enter the desired value (.05-.99 seconds). Default is .08 second.

H. INFORMATIONAL DISPLAY SCREENS

1. ASCII CHART

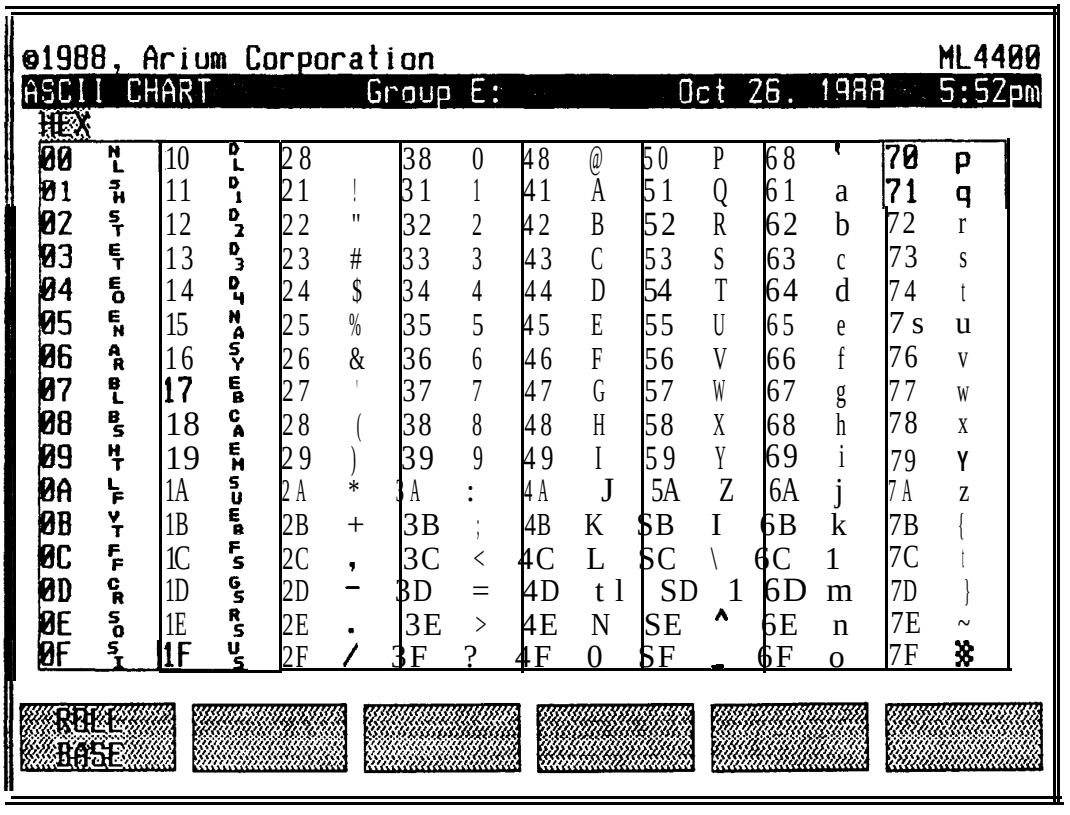
To access the ASCII Chart screen, depress S. FUNC, then the F2 softkey.

This screen displays the ASCII 128-character set and their numeric equivalents in one of three number bases (octal, decimal, and hexadecimal). The active number base is shown in the upper left of the screen.

To change the number base, use the ROLL BASE softkey. Default is hexadecimal.

Figure IV-Y

ASCII CHART (HEX)



2. PROBE COLORS

To access the Probe Colors screen, depress S. FUNC, then the PROBE COLORS softkey (FS). This screen display varies, depending upon which type of Microprocessor or Logic Pod is connected to the ML4400.

See Section II-A.4.d ("Probe Set Color Coding").

Figure IV-Z

SAMPLE PROBE COLORS SCREEN
(FOR LP-4050)

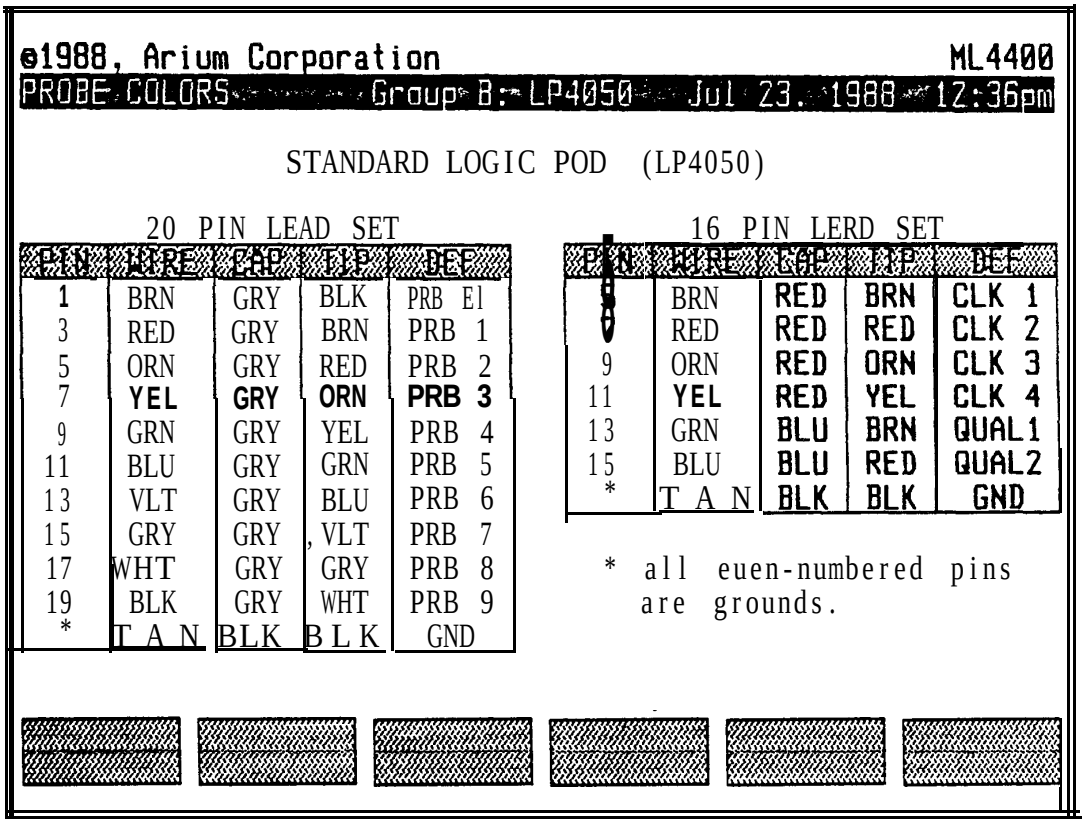
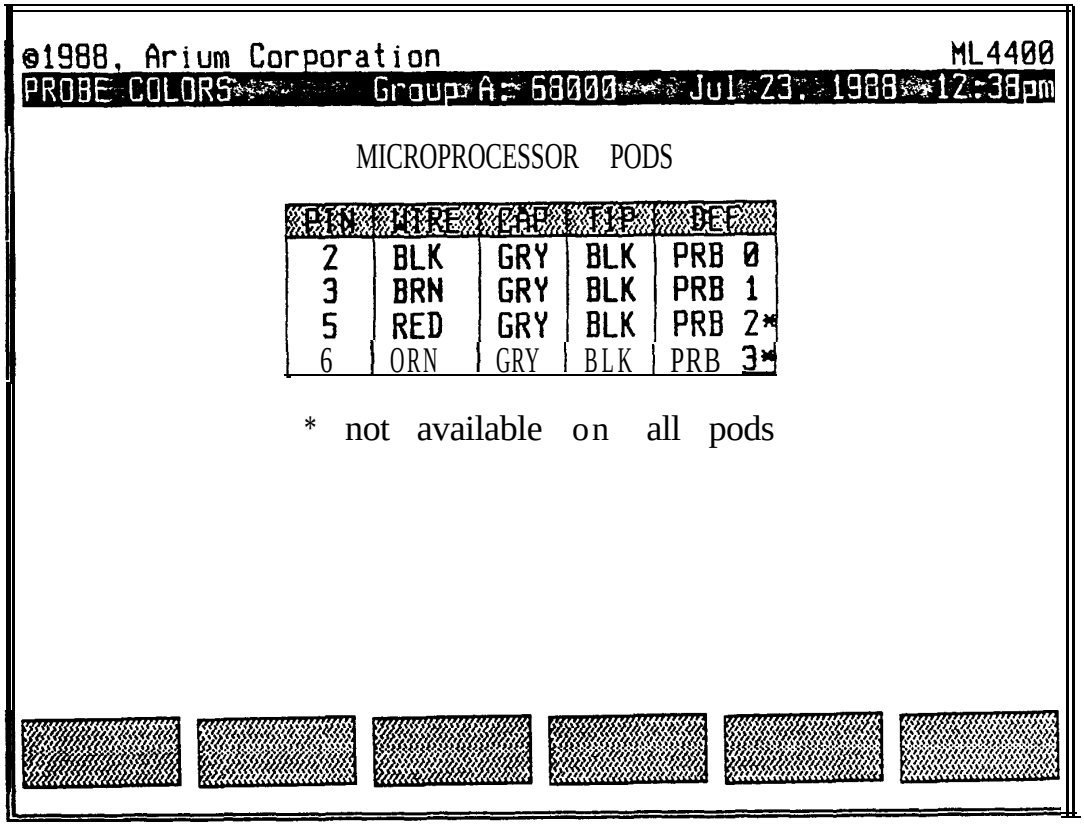


Figure IV-AA

SAMPLE PROBE COLORS SCREEN
(16M-680 MICROPROCESSOR POD)



3. INSTALLED OPTIONS

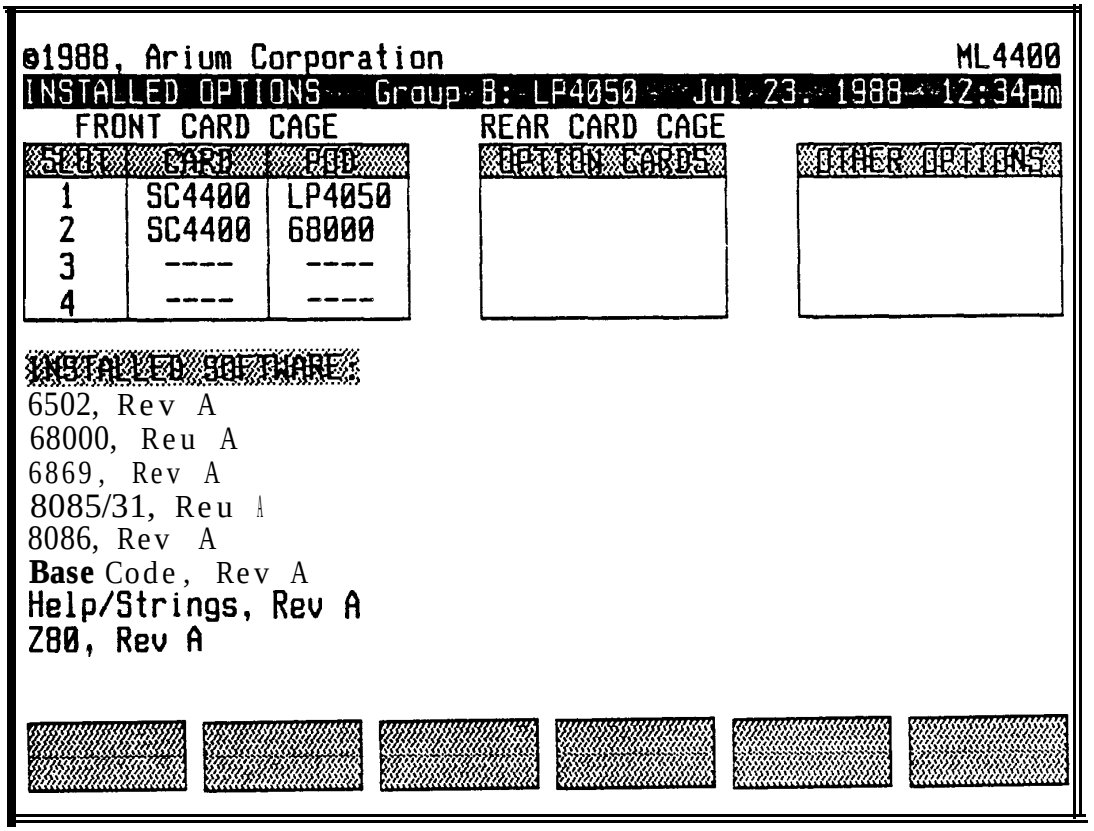
To access the Installed options List screen, depress S. FUNC, then the F6 softkey. This screen displays the hardware and software options installed on the user's ML4400, in four categories:

a. The Front Card Cage table lists the installed Capture Modules and the Logic and/or Microprocessor Pods connected to them. (This cage is located behind the hinged keyboard on the ML4400 front panel.)

b. The Rear Card Cage table lists any installed option cards. (This rear cage is located in the upper left corder of the ML4400 rear panel.)

c. The Other Options table includes such options as a floppy disk drive.

d. The Installed Software table lists ROMs and their revision levels. Two ROMs are standard (Base Code and Help/Strings). Optional ROMs may include those in the microprocessor disassemblers, the ROM Emulator Pod, etc.

Figure IV-AB

INSTALLED OPTIONS SCREEN