

TEKTRONIX®

**LA 501W
LOGIC
ANALYZER**

OPERATORS

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
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Serial Number _____



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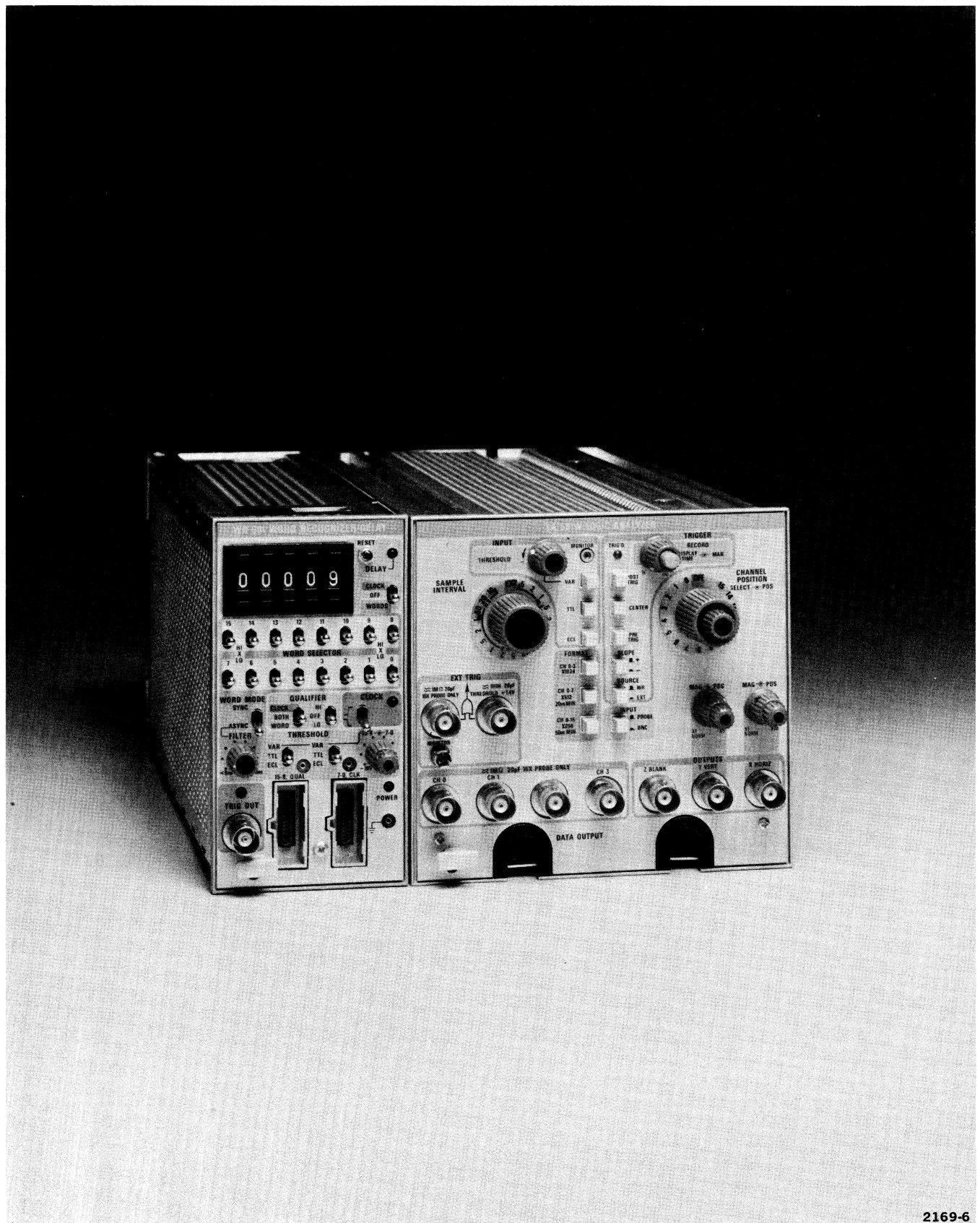
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The LA 501W Logic Analyzer.

INTRODUCTION

The LA 501W Logic Analyzer consists of an LA 501 Logic Analyzer and a WR 501 Word Recognizer/Delay. These two units are attached to form a three-compartment wide TM 500-Series plug-in. The LA 501W Logic Analyzer acquires, stores, and then outputs digital data for display on an oscilloscope or monitor. The display is in the form of a timing diagram with 4, 8, or 16 traces.

Data acquisition is through two 9-channel active—the P6451 Data Acquisition Probes. The probes provide 16 data inputs, one external clock input, and one qualifier input to the WR 501. Incoming signals are compared to the threshold levels set by the WR 501 controls. You can select either ECL, TTL, or VAR threshold levels. The external clock signal may be used by both the WR 501 and the LA 501. The qualifier can enable the external clock signal, act as a 17th data input, or both.

A word pattern match occurs when the data and qualifier inputs match the HI, LO, or X (don't care) settings of the WORD SELECTOR and QUALIFIER Value switches. Word recognition occurs in the ASYNC mode on a word pattern match and in the SYNC mode on the coincidence of an input clock edge and a word pattern match. In the ASYNC mode the WR 501 recognizes only words of longer duration than the Filter setting.

The WR 501 generates a trigger signal with or without a delay after word recognition occurs. The delay is from 0 to 99999 clock pulses or words. A word is counted once each time it occurs, provided it is longer than the filter setting in the ASYNC mode. The trigger signal is available at the TRIG OUT BNC connector on the front panel.

All signals are sent through internal cables between the WR 501 to the LA 501.

The LA 501 stores the data from 4, 8, or 16 data input channels in either 4 x 1024, 8 x 512, or 16 x 256-bit formats. The data is recorded continuously on a first-in first-out basis at a selected sample rate until the trigger signal arrives. After the trigger signal arrives, the data is permanently stored in memory which allows the data to be displayed later on a monitor or oscilloscope.

An internal time base in the LA 501 provides data sampling intervals from 10 ns to 5 ms. An external clock signal can also be selected to provide the sampling rate. The internal time base also controls the horizontal output to the display.

The data is output from the LA 501W in a timing diagram array in one of three modes—pre-trigger, center-trigger, or post-trigger. In the pre-trigger mode about 94% of the data displayed is pre-trigger (occurred before the arrival of the trigger signal) and 6% is post-trigger data (occurred after the trigger). In the center-trigger mode the data is split: 50% pre-trigger and 50% post-trigger. In the post-trigger mode about 6% of the data is pre-trigger and 94% is post-trigger. The display consists of 4, 8, or 16 traces arranged in groups of 4 with Channel 0 at the top of the screen. Each trace shows the HI and LO logic states of the data.

The output signals to the oscilloscope or monitor allow vertical and horizontal positioning and magnification from the controls on the front panel of the LA 501. A Z-axis blanking signal is also available. The vertical positioning system allows any channel to be positioned next to any other channel within the display.

The LA 501W can be used with any oscilloscope or monitor.

OPERATORS SAFETY INFORMATION



Turn the TM 500 Power Module off before installing the LA 501W; otherwise damage to the LA 501W may result.

The LA 501W is designed to operate safely while plugged into a TM 500-Series Power Module.

Refer servicing to qualified service personnel.

CONTROLS, CONNECTORS, and INDICATORS

This section describes the Controls, Connectors, and Indicators on the LA 501W.

FRONT PANEL

Refer to Fig. 2-1, 2-2, and Fig. 2-3.

- ① **CH 7-0, CLK and CH 15-8, QUAL Connectors:** Input connectors for the probes. Inputs are the data, qualifier, and clock channels. The clock and the 7-0 data channels come through the right-hand probe. The qualifier and the 15-8 data channels come through the left-hand probe. The WR 501 requires P6451 Data Acquisition probes.
- ② **THRESHOLD Selector Switches:** Select different logic threshold levels at the probe tips. Each switch controls the threshold level for the probe connected directly beneath it. The voltage levels are:

ECL: fixed at -1.26 V.

TTL: fixed at $+1.4$ V.

VAR: variable from $+10$ V to -10 V. Controlled by the THRESHOLD VAR control.
- ③ **THRESHOLD VAR Control:** Varies the threshold voltage level for the probes when the THRESHOLD Selector switch is in the VAR position. Consists of concentric controls—the inner knob is for Channels 15-8 and the qualifier inputs, and the outer knob is for Channels 7-0 and clock inputs.
- ④ **Monitor Pin Jacks:** The threshold voltages for each probe are present on these jacks. Used for setting the VAR Threshold voltage of each probe.
- ⑤ **POWER Indicator:** Comes on whenever there is power to the WR 501.
- ⑥ **Ground Pin Jack:** A ground point for an oscilloscope or DVM probe.
- ⑦ **TRIG OUT BNC Connector:** The trigger output connector. The WR 501 puts out a trigger signal after word recognition and the delay selected by the Delay

Count switches. If the DELAY Selector switch is in the OFF position (or the Delay Count switches are set to 00000), the trigger signal is output right after word recognition occurs.

- ⑧ **TRIG OUT Indicator:** Comes on momentarily whenever there is a trigger signal present at the TRIG OUT BNC connector.
- ⑨ **WORD MODE:** Determines whether word recognition occurs synchronously (SYNC) or asynchronously (ASYN).

SYNC: Word recognition occurs on the coincidence of a word pattern match (the data and qualifier in-

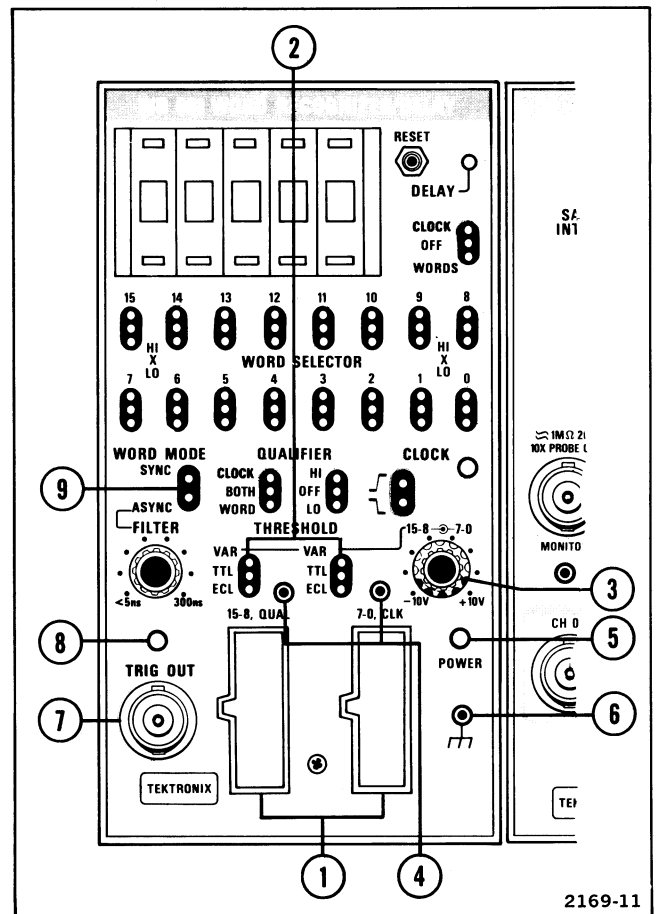


Fig. 2-1. LA 501W front panel (partial) controls, connectors, and indicators.

Controls and Connectors—LA 501W Operators

puts match the settings of the WORD SELECTOR and QUALIFIER Value switches) and the selected clock edge.

ASYNC: Word recognition occurs when the data and qualifier inputs match the settings of the WORD SELECTOR and QUALIFIER Value switches. Only words of longer duration than the FILTER setting are recognized, however.

- ⑩ **FILTER:** A variable pulse-width filter that operates only in the ASYNC WORD MODE. In the ASYNC mode, words must be of longer duration than the FILTER setting for word recognition to occur. The required duration can be varied from less than 5 ns to 300 ns.

- ⑪ **CLOCK:** Determines which edge of the external clock signal is used by the word recognizer, the delay counter, and the LA 501.

┐ Word recognition and data storage occur on the positive-going edge of the clock signal (LO to HI transition).

┐ Word recognition and data storage occur on the negative-going edge of the clock signal. (HI to LO transition).

- ⑫ **CLOCK Indicator:** Comes on whenever an external clock signal is available for word recognition, the delay counters, or the LA 501.

- ⑬ **QUALIFIER Value Switch:** Determines the logic level that the incoming qualifier signal is compared to, HI, LO, or OFF. The incoming qualifier signal must match the setting of the QUALIFIER Value switch before either word recognition or the clock is qualified.

- ⑭ **QUALIFIER Selector Switch:** Determines whether word recognition, the external clock signal, or both are qualified.

CLOCK: Both the clock and qualifier signals must be present for either SYNC word recognition to occur, for clock pulses to be counted by the Delay Counters or for data to be stored in the LA 501

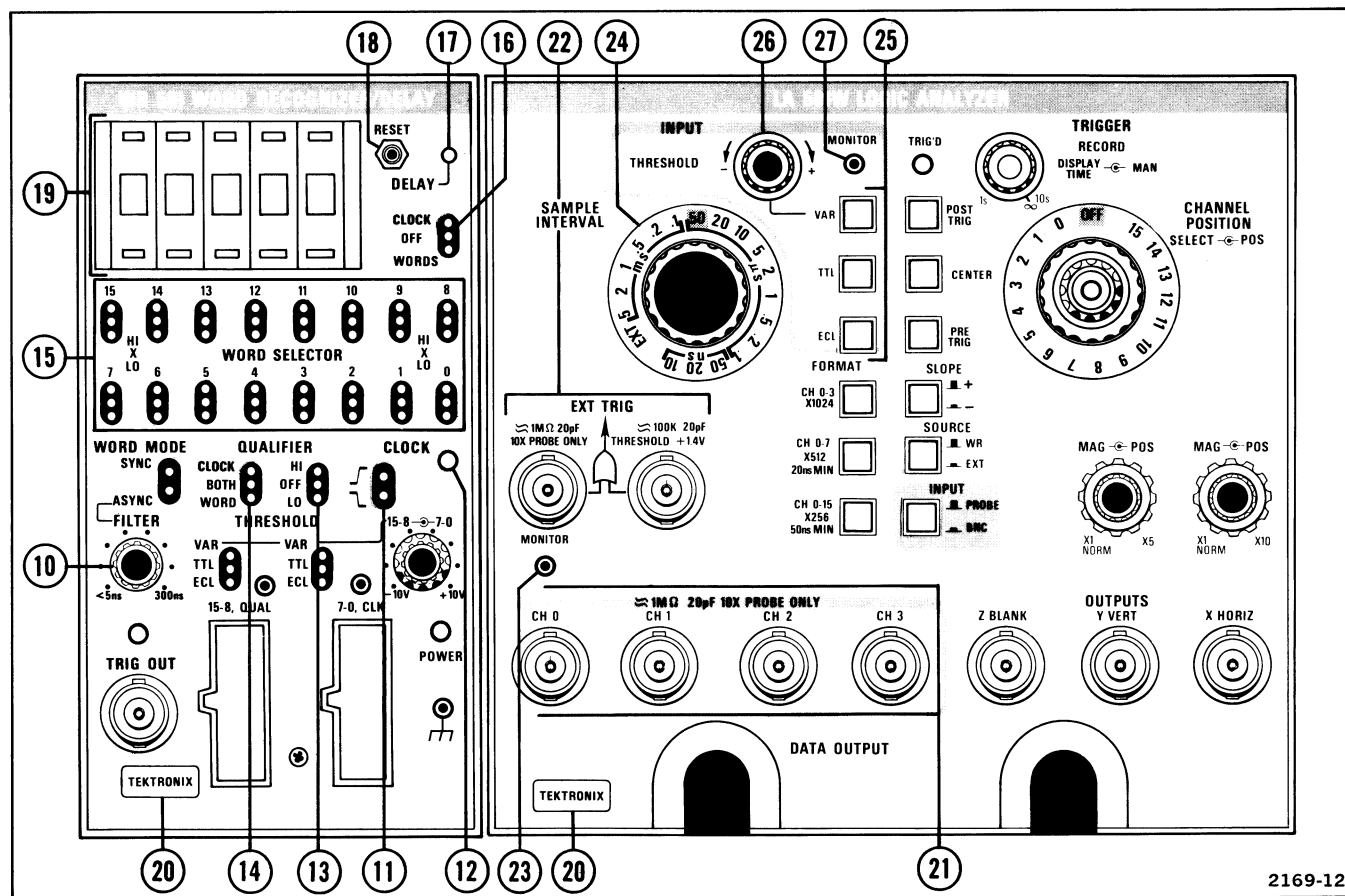


Fig. 2-2. LA 501W front panel controls, connectors, and indicators.

when SAMPLE INTERVAL is set to EXT. The qualifier signal must also match the setting of the QUALIFIER Value switch.

WORD: The qualifier signal must match the setting of the QUALIFIER Value switch and the data must match the settings of the WORD SELECTOR Switches before word recognition occurs. Acts like a 17th data input.

BOTH: Both the clock signal and word recognition are qualified by the qualifier signal.

- 15 WORD SELECTOR Switches:** Each three position switch selects the logic level that the corresponding data channel is compared to. The incoming data must match the HI or LO settings of the switches before word recognition occurs. When a switch is in the X (don't care) position, the corresponding channel is ignored.

- 16 Delay Selector Switch:** Determines the source of the events used by the delay counter.

CLOCK: The delay counter counts external clock pulses. Be sure you have the CLK lead (C input) of the probe connected to an external clock source. The CLOCK switch determines which edge is counted.

OFF: The delay counter is turned off and a trigger signal is output every time word recognition occurs.

WORDS: The delay counter counts word recognition events. A word is counted once for each word recognition regardless of duration.

- 17 DELAY Indicator:** Comes on whenever a delay count is in progress.

- 18 RESET Push Button:** When pushed in, interrupts the delay count and resets the delay counters. Word recognition must occur again in order to start the delay count.

- 19 Delay Count Switches:** Five switches that set the delay count. Pushing a lower push button once increases the corresponding digit by 1. Pushing an upper push button once decreases the corresponding digit by 1. The delay count can be set from 00000 to 99999.

- 20 Release Latches:** Pull to remove the instrument from the power module.

- 21 CH 0 through CH 3 BNC Connectors:** For use with 10X probes. The data from these connectors is stored in the memory when the INPUT switch is in the BNC position. The 10X probes must be compensated for use with the LA 501W. Refer to the Operating Information section for instructions. The threshold level for the CH 0 through CH 3 BNC connectors is controlled by the THRESHOLD push buttons.

- 22 EXT TRIG BNC Connectors:** Two BNC connectors for external trigger input to the LA 501W. The left BNC connector is used with a 10X probe, and its threshold level is controlled by the THRESHOLD push buttons. The right BNC connector has a fixed threshold voltage of +1.4 V. The trigger inputs are OR'd together inside the instrument. Either signal can trigger the LA 501 when SOURCE is set to EXT. The 10X probe must be compensated for use with the LA 501W. Refer to the Operating Information section for instructions.

- 23 MONITOR Jack:** Used for 10X probe compensation. Refer to Operating Information, Section 2, for details.

- 24 SAMPLE INTERVAL Switch:** Sets the sampling rate for storing data in the memory either internal or external. The internal sampling intervals range from 5 ms to 10 ns in a 1-2-5 sequence. An indicator beneath the knob skirt illuminates the selected sample rate and blinks when the sample interval is too fast for 8 channel (10 ns) or 16 channel (10 or 20 ns) data storage. In the EXT position the sample rate is determined by the clock input of the Channel 7-0, CLK probe.

- 25 THRESHOLD Push Buttons:** Allow the user to select different logic levels for the 10X probes (including the 10X probe EXT TRIG input).

TTL: fixed at +1.4 V.

ECL: fixed at -1.25 V.

VAR: variable from +10 V to -10 V. Controlled by the THRESHOLD VAR control.

- 26 THRESHOLD VAR Control:** Varies the threshold voltage level for the 10X probes when the VAR push button is pushed in.

- 27 MONITOR Jack:** The threshold voltage (for the 10X probe inputs) is present on this jack.

Controls and Connectors—LA 501W Operators

- 28** **FORMAT Push Buttons:** Determines the number of data channels that are stored.

CH 0-3 x 1024: The memory records 1024 bits of data from channels 0 through 3. The minimum sample interval is 10 ns.

CH 0-7 x 512: The memory records 512 bits of data from channels 0 through 7. The minimum sample interval is 20 ns.

CH 0-15 x 256: The memory records 256 bits of data from all the channels from 0 to 15. The minimum sample interval is 50 ns.

- 29** **Data Position Push Buttons:** Determine the trigger position with respect to the data—both stored and displayed.

POST TRIG: About 6% of the data stored and displayed is pre-trigger and 94% of the data is post-trigger.

CENTER: The displayed data is split—50% before the trigger and 50% after the trigger.

PRE TRIG: About 94% of the stored and displayed data is pre-trigger and 6% of the data is post-trigger.

- 30** **RECORD Control:** Sets the time that the data is displayed before a new store cycle begins.

DISPLAY TIME: The display time is variable from 1 to 10 seconds, or the display can be held on screen indefinitely by using the ∞ (infinite) position.

MAN: The center push button momentarily overrides the DISPLAY TIME control when pushed in. Stops the display cycle and starts a new store cycle.

- 31** **CHANNEL POSITION Control:** Allows one selected channel to be positioned next to any other channel within the display raster.

SELECT: Allows any channel from 0 through 15 to be selected for repositioning. An indicator beneath

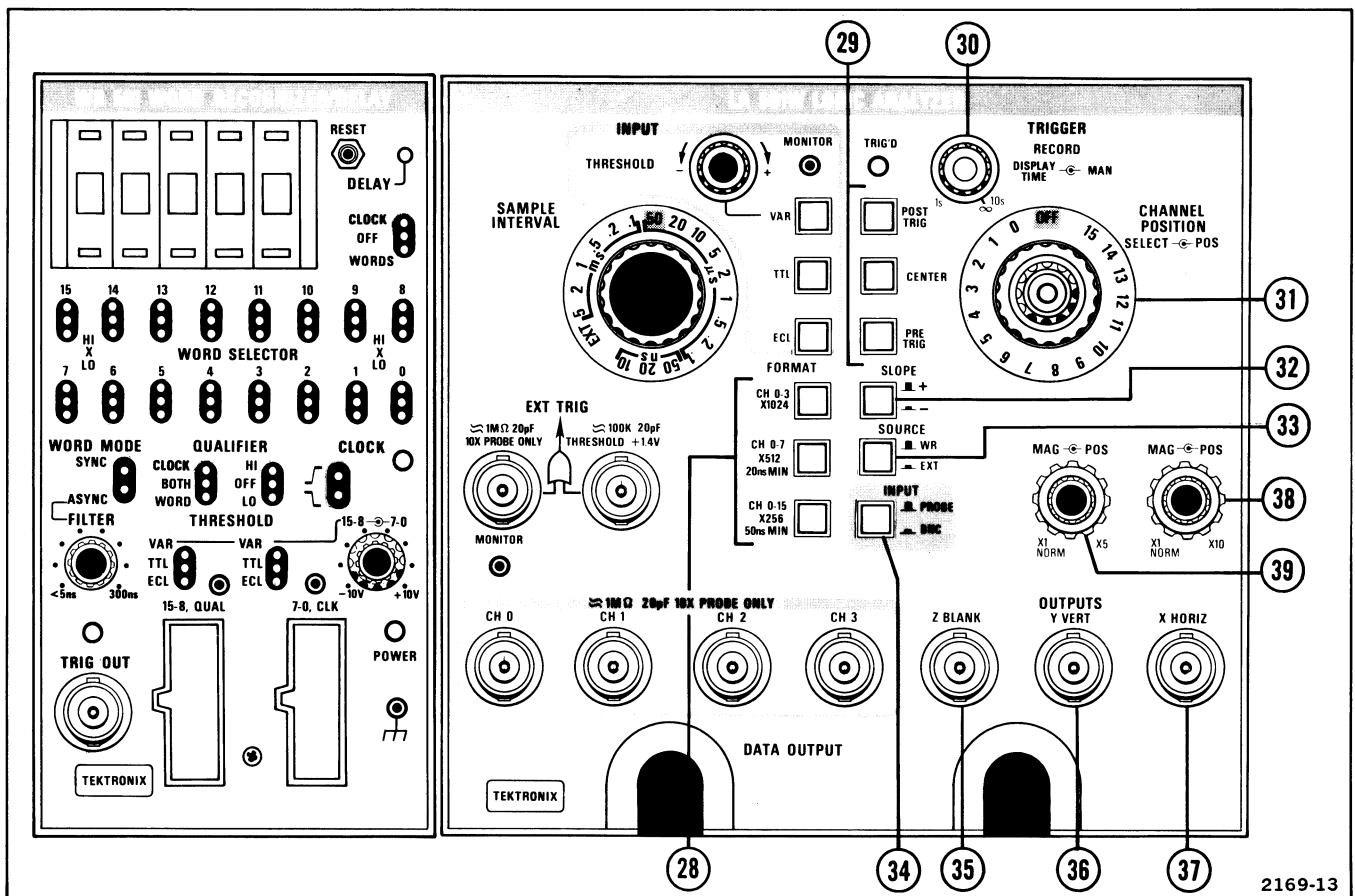


Fig. 2-3. LA 501W front panel controls, connectors, and indicators.

Controls and Connectors—LA 501W Operators

the knob skirt illuminates the selected channel number.

POS: The center knob. Moves the channel selected by the SELECT control vertically within the display raster.

- 32 SLOPE:** Selects the active edge of the trigger signal. The — (in) position selects the falling edge of the trigger signal and the + (out) position selects the rising edge of the trigger signal. Push twice to get a display without a trigger signal.

- 33 SOURCE:** Determines the source of the trigger signal. The EXT position (in) selects the trigger signal from the EXT TRIG BNC connectors. The WR position (out) selects the trigger signal from the WR 501 (the signal goes through an internal line).

- 34 INPUT:** Determines the source of the data that is stored in the memory. The BNC position (in) selects the data from the CH 0 through CH 3 BNC connectors. The PROBE position (out) selects the data from probe inputs to the WR 501. In either position the remaining channels— CH 4 through 15— always come from the WR 501.

- 35 Z BLANK OUTPUT, BNC Connector:** Provides a Z-axis blanking signal to an oscilloscope or monitor.

Positive or negative blanking pulses are selected by the Blanking Polarity switch on the side panel.

- 36 Y VERT OUTPUT, BNC Connector:** Provides the output signal for the vertical input of an oscilloscope or monitor. Channel 0 is at the top of the screen and the rest of the data is displayed in groups of four. A dc offset voltage provides the vertical separation between channels.

- 37 X HORIZ OUTPUT, BNC Connector:** Provides the output signal (sweep) for the horizontal input of an oscilloscope or monitor. The sweep rate is determined by the setting of the FORMAT switches.

- 38 Horizontal MAG Control:** Provides variable horizontal magnification of the display from X1 NORM to X10.

Horizontal POS Control: Positions the display horizontally within the display area.

- 39 Vertical MAG Control:** Provides variable vertical magnification of the display from X1 NORM to X5.

Vertical POS Control: Positions the display vertically within the display area.

Controls and Connectors—LA 501W Operators

SIDE PANEL

There are several switches on the side panel of the LA 501, but only one of them is used in the LA 501W, the Blanking Polarity switch.

The WR 501 and the LA 501 are connected with latches and a hinge. This arrangement allows the WR 501 to be moved away from the LA 501 for access to the side panel, as shown in Fig. 2-4.

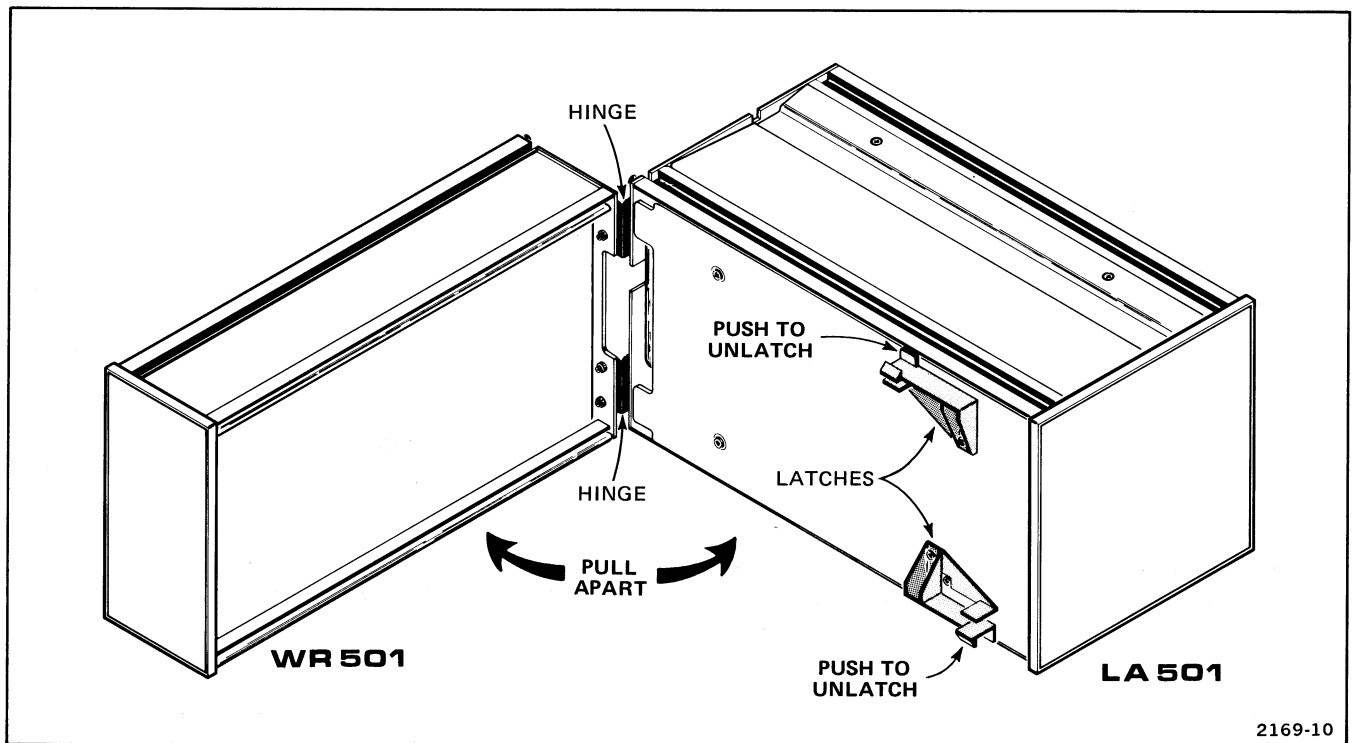


Fig. 2-4. Separating the LA501 and the WR 501.

Controls and Connectors—LA 501W Operators

Blanking Polarity Switch (S720): Selects the polarity (see Fig. 2-5) of the Z-axis blanking pulses at the Z BLANK OUTPUT connector. In the up position, positive blanking (+5 V) is selected. In the down position, negative blanking

(−5 V) is selected. The LA 501W is shipped from the factory with the Blanking Polarity switch in the up position—positive blanking.

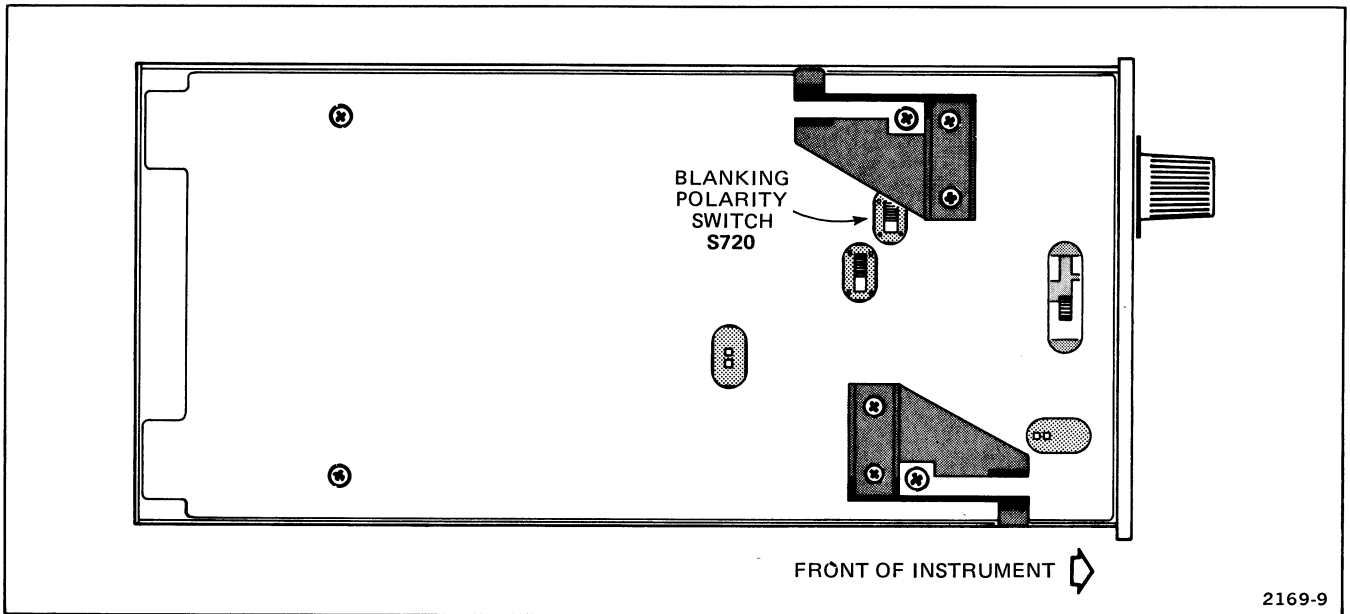


Fig. 2-5. Side panel of the LA 501.

OPERATING INFORMATION

INSTALLING THE LA 501W IN A TM 500 POWER MODULE

The LA 501W is calibrated and ready for use when received. The instrument was designed to operate in a TM 500 Power Module.

CAUTION

Turn the power module off before inserting or removing the LA 501W to prevent damage to the LA 501W.

To install the LA 501W in a power module, align the upper and lower rails of the LA 501W with the tracks in the power module as shown in Fig. 3-1. Now insert the

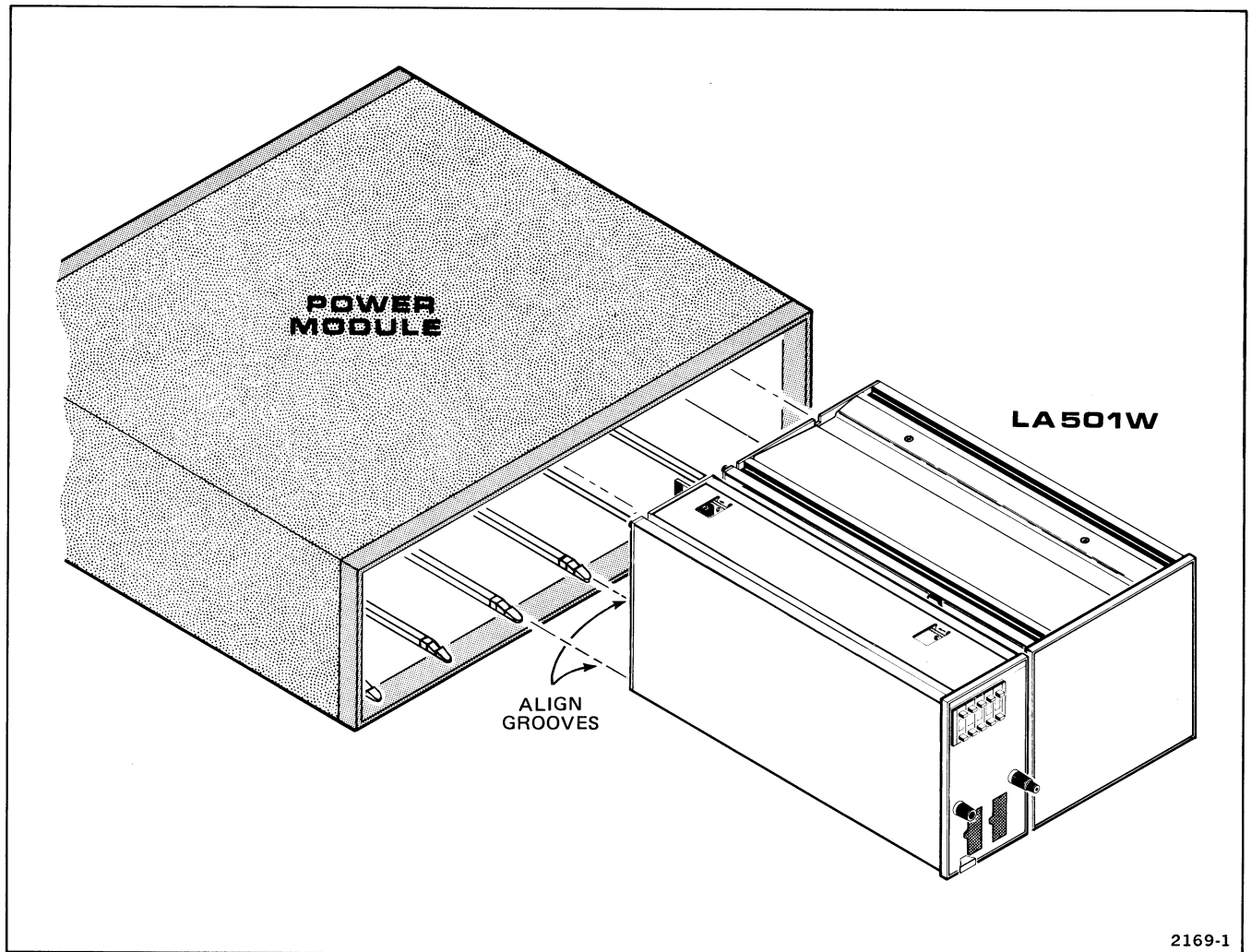


Fig. 3-1. Installing LA 501W in a TM 500 power module.

Operating Information—LA 501W Operators

LA 501W into the power module. The front panel will be flush with the front of the power module when the LA 501W is properly installed.

To remove the LA 501W from the power module, pull on the release latches on the bottom of the front panel. The LA 501W will unlatch and you can pull it out of the power module by pulling on the release latches.

INITIAL OPERATION

Use this procedure when you turn your instrument on for the first time. To see the output signal connect the LA 501W output to an oscilloscope or monitor. Return to this procedure whenever you have problems getting an output from the LA 501W. You will need P6451 Data Acquisition Probe(s), three 50 Ω cables, a TM 500-Series Power Module, an oscilloscope or monitor, probe to BNC adaptors, and a periodic signal source. The calibrator signal from an oscilloscope can be used as a signal source.

CAUTION

Complete performance check and adjustment should be referred to a qualified service person. Turn off the power to the TM 500-Series Power Module, before inserting the LA 501W into or removing it from the power module.

Install the LA 501W in the TM 500-Series Power Module.

Connect the P6451 Data Acquisition Probes to the connectors.

Turn the power module on.

Initial Control Settings:

| | |
|----------------------|--------------------------------------|
| WORD SELECTOR | X (don't care) — the center position |
| Switches (all) | OFF |
| DELAY Switch | OFF |
| QUALIFIER | ASYN |
| WORD MODE | < 5 ns (fully counter-clockwise) |
| FILTER | 00000 |
| Delay Count Switches | ∞ (infinite DISPLAY TIME) |
| RECORD | |

| | |
|------------------|----------------------------------|
| TRIGGER Mode | CENTER |
| SOURCE | WR (button out) |
| SLOPE | + (button out) |
| INPUT | PROBE (button out) |
| FORMAT | CH 0-3 x 1024 (button in) |
| Vertical MAG | X1 NORM (fully counterclockwise) |
| Horizontal MAG | X1 NORM (fully counterclockwise) |
| CHANNEL POSITION | OFF |

The settings of the THRESHOLD and SAMPLE INTERVAL Controls depend on your signal source. If you have a TTL or ECL voltage source you can use the TTL or ECL setting of the THRESHOLD controls. Otherwise set the THRESHOLD controls to VAR and adjust the variable THRESHOLD knobs — one for channels 15-8 and the other for channels 7-0 — until the threshold level is set at the midpoint of your signal. You can set the SAMPLE INTERVAL control for any interval except EXT, but a good interval to start with is .5 ms.

Set your oscilloscope for X-Y operation.

Connect the Y VERT OUTPUT to the Vertical input (Y), the X HORIZ OUTPUT to the Horizontal input (X), and Z BLANK OUTPUT to the Z-axis blanking input of your oscilloscope or monitor. (See Fig. 3-2.)

NOTE

The LA 501W is shipped from the factory with the Z BLANK OUTPUT set for positive Z-axis blanking. If your oscilloscope has negative Z-axis blanking, change the setting of the Blanking Polarity switch (S720). Refer to Fig. 2-5.

Push the SLOPE switch twice to get a display.

Adjust the POS controls so that the display is on the oscilloscope screen.

Push MAN to end the display.

Connect channel 0 to the signal source, and the ground lead to signal source ground.

Set the channel 0 WORD SELECTOR switch to the HI position (up).

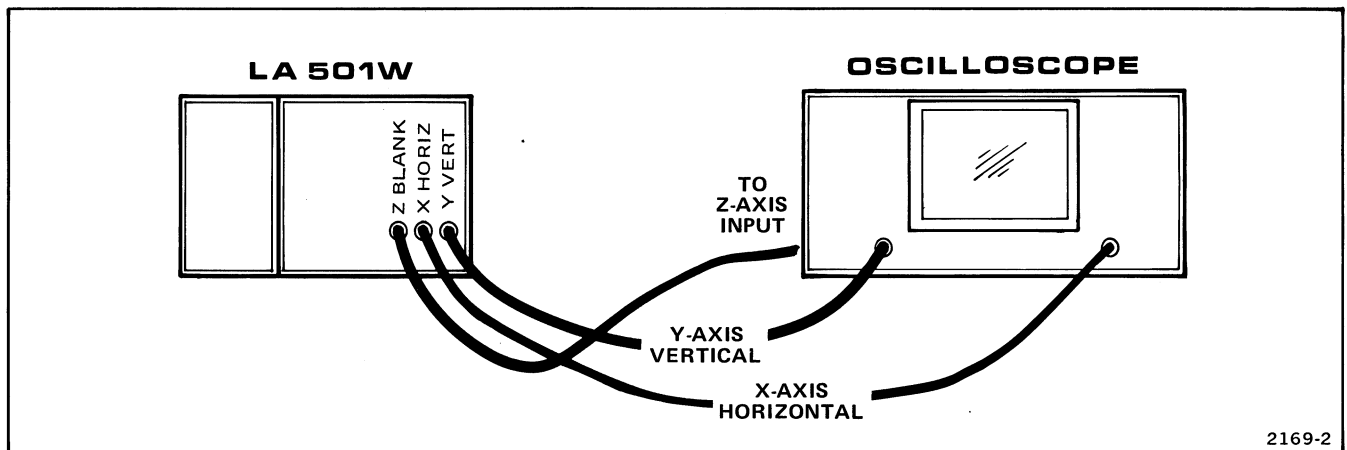


Fig. 3-2. Connecting the LA 501W to an oscilloscope.

Adjust the POS controls so that the display is on the oscilloscope screen.

Push MAN to end the display.

You should now have a display consisting of four traces one that goes HI and LO and three that are straight lines. A clock tick appears at the end of each sample interval. The clock ticks are useful for distinguishing between bits of data on the screen.

DATA ACQUISITION

With the P6451 Data Acquisition Probe

Data is acquired via the P6451 Data Acquisition Probes. The P6451 Data Acquisition Probes are active probes that minimize loading of the circuit under test. Each probe has 10 leads—8 data channels, one for a qualifier or clock signal (labeled Q or C on the probes) and one ground lead. The probe leads are connected to the probe pod with colored wires that allow the user to identify the leads. Each probe tip has a retractable hook that grasps a lead or wire firmly.

To use the retractable probe tip, push the base of the probe tip until the hook appears. See Fig. 3-3. The hook can be attached to a lead, wire, or test point in a circuit.

The probe in the right-hand connector of the WR 501 provides the data inputs for channels 7 through 0 and for the external clock signal (labeled C on the probe). The probe in the left-hand connector of the WR 501 provides the data inputs for channels 15 through 8 and for the qualifier signal (labeled Q on the probe).

To insure proper operation of the P6451 Data Acquisition Probes, the ground leads should always be connected to a ground point in the circuit under test.

With a 10X Probe

Data for channels 0 through 3 can also be acquired through 10X probes connected to the BNC input connectors on the LA 501. The 10X probes should meet the specifications in Section 6, Specifications, of this manual. The P6108 is recommended. In order to use the BNC input connectors, you will need up to four probes—one for each channel you want to use. The probes should be compensated each time you connect to the LA 501. Fig. 3-4 shows how to compensate a 10X probe to match the LA 501 input BNC connectors.

The INPUT switch allows you to choose the source of channels 0 through 3. In the BNC position (in), data from the 10X probe connectors is stored for channels 0 through 3. In the PROBE position (out), data from the P6451 Data Acquisition Probes is stored. In either position, data for channels 4 through 15 is available through the P6451 Data Acquisition Probes connected to the WR 501.

Setting the Threshold Levels

FOR THE P6451 DATA ACQUISITION PROBES.

There are two THRESHOLD controls on the WR 501—one for each probe. The THRESHOLD Selector switches select TTL, ECL, or VAR (variable) voltage levels to which the probes compare the incoming signals. The TTL level is fixed at +1.4 V (about the midpoint of TTL voltage swings) and the ECL level is fixed at -1.26 V (about the midpoint of ECL voltage swings). The VAR (variable) level can be varied from -10 V to +10 V.

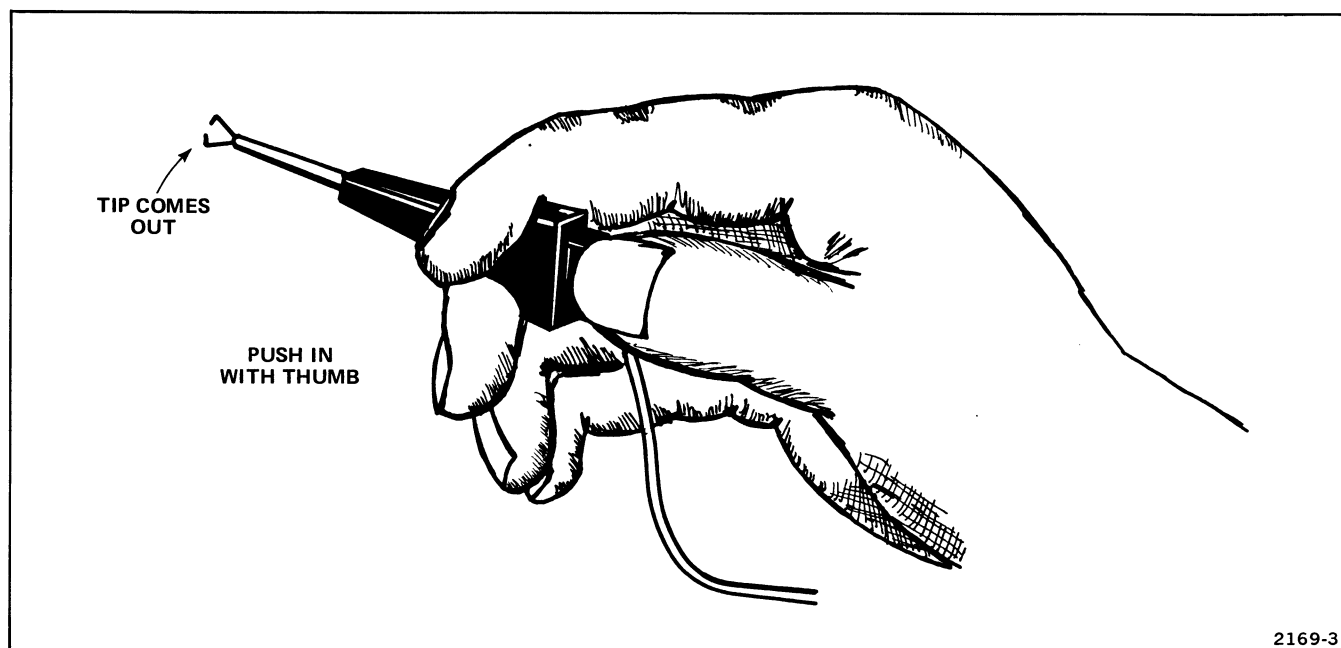


Fig. 3-3. P6451 Data Acquisition Probes have retractable probe tips.

To set the VAR levels, connect a digital multimeter to the Monitor jack above the connector of the probe level to be set. Put the THRESHOLD Selector switch in VAR position. Adjust the THRESHOLD VAR control until the digital multimeter indicates the desired voltage.

FOR THE 10X PROBES. The THRESHOLD push buttons on the LA 501 select the threshold voltage level for the CH 0 through CH 3 10X probe connectors and for the 10X EXT TRIG BNC connector. The TTL push button selects a fixed voltage of +1.4 V and the ECL push button control to adjust the voltage level from -10 V to +10 V. Use a digital multimeter to monitor the output at the MONITOR jack near the VAR control, and adjust the control for the desired voltage level.

WORD RECOGNITION

The WR 501 recognizes digital words of up to 16 bits by comparing the incoming data from the probes with the settings of the WORD SELECTOR switches. The data must match the settings of the WORD SELECTOR switches before word recognition occurs. Word recognition can occur either synchronously or asynchronously. The trigger signal is generated after word recognition with or without a delay.

Setting the WORD SELECTOR Switches

The WORD SELECTOR switches set the logic levels for each of the 16 data channels. The incoming data must match the HI, LO, or X (don't care) settings of the WORD SELECTOR switches before word recognition occurs. Note that the HI and LO levels are with respect to the voltages set by the THRESHOLD controls. For example when the THRESHOLD Selector switch is set to ECL, ground is a HI logic level. When a WORD SELECTOR switch is in the X (don't care) position, the signal or lack of signal on that particular input channel is ignored. The data must be present at the probe tips for a time greater than the minimum for the data to be recognized by the WR 501. Refer to Section 4, Specifications, for more information.

Word Mode

The WORD MODE switch selects either asynchronous (ASYN) or synchronous (SYNC) word recognition. In the ASYN mode the data and qualifier inputs must match the settings of the WORD SELECTOR and QUALIFIER Value switches (a word pattern match) for word recognition to occur. In the SYNC mode word recognition occurs on the coincidence of a word pattern match and a selected clock edge.

ASYNCR WORD MODE. In the ASYNCR mode the FILTER control selects the required duration of the word recognized by the WR 501. Only words of duration longer than the control setting are recognized. Thus, you can set the WR 501 to ignore narrow words or pulses that you don't want to trigger on.

SYNCR WORD MODE. In the SYNCR mode an external clock signal must be present at the clock input of the 7-0, CLK probe (the one on the right). The CLOCK control determines which edge of the clock signal that word recognition occurs on.

Using the Qualifier

The Qualifier can enable the external clock, word recognition, or both. To use the Qualifier to enable word recognition, set the QUALIFIER Selector switch to WORD and the QUALIFIER Value switch to either HI or LO and connect a signal to the Qualifier input of the 15-8, QUAL probe (the left one). To use the Qualifier to enable the clock, set the QUALIFIER Selector switch to CLOCK with a signal connected to the Qualifier input. When the QUALIFIER Value switch is in the OFF position, the qualifier signal is ignored.

When the QUALIFIER Selector switch is in the WORD position, word recognition occurs when the 16 data inputs match the settings of the WORD SELECTOR switches and the qualifier input matches the setting of the QUALIFIER Value switch. The Qualifier input acts like a 17th data input.

When the QUALIFIER Selector switch is in the CLOCK position, the Qualifier signal enables the clock signal. The clock signal is blocked unless the qualifier signal matches the setting of the QUALIFIER Value switch. The same clock signal that is used for word recognition can also be used by the delay counters and by the LA 501 for an EXT sample interval.

When the QUALIFIER Selector switch is in the BOTH position, the qualifier signal enables both the clock and word recognition.

TRIGGER OUTPUT AND DELAY

The trigger signal is generated after word recognition, with or without a delay.

Delay by Clock

To delay the trigger output by clock pulses, set the DELAY Selector switch to CLOCK, enter a number on the Delay Count switches, and connect the clock input to a signal. The external clock signal can be any signal that you want to use to clock events through the LA 501W system. The delay counters count clock signal transitions — either positive going or negative going. The CLOCK switch determines which transition is used. A word-recognition event must occur before the delay counters start counting clock pulses. The DELAY indicator will come on as soon as the delay count starts. When the delay count is finished the WR 501 will generate a trigger signal and the TRIG OUT indicator will come on.

Delay by Words

To delay the trigger output by word recognition events (words), set the DELAY Selector switch to WORDS and enter a number on the Delay Count switches. The DELAY Indicator will come on as soon as the delay count starts. As soon as the delay count is finished the WR 501 will generate a trigger signal and the TRIG OUT indicator will come on momentarily. A word is counted each time word recognition occurs regardless of duration provided it is longer than the FILTER setting in the ASYNCR mode.

Manual Reset of the Delay Count

To interrupt the delay count, push the RESET button. Pushing the RESET button causes the delay counters to be reset and to start counting again from the next word-recognition event.

Using The Trigger Output

To use the trigger output signal to trigger an oscilloscope, connect a 50 Ω cable between the TRIG OUT connector and the oscilloscope external trigger input. Set the oscilloscope for external trigger and connect the oscilloscope vertical input to a signal.

You can trigger your oscilloscope from either edge of the trigger signal. When the oscilloscope is set to trigger on the positive slope, triggering occurs on the occurrence of word recognition. When the oscilloscope is set to trigger on the negative slope, triggering occurs when word recognition ends.

In the LA 501W system, the trigger signal goes automatically to the LA 501 via an internal connection. The SOURCE switch on the LA 501 determines whether or not the trigger signal from the WR 501 is used.

STORING DATA

The data from the P6451 Data Acquisition Probes is stored in the LA 501 memory. The data is continuously updated until the trigger signal arrives, then the data is stored permanently for display.

Setting The Sample Interval

The SAMPLE INTERVAL switch determines the rate at which the data at the P6451 probe tips is sampled and stored. In the EXT position of the SAMPLE INTERVAL switch the data is stored synchronously with the external clock signal at the CLK input of the WR 501. A signal must be present at the CLK input for the LA 501 to store data. In the other positions of the SAMPLE INTERVAL switch, the LA 501 uses the clock signal from its internal time base to set the sampling rate.

In general, the sampling rate should be faster than the rate at which the data is changing. The timing resolution is determined by the number of samples taken during a time period of interest. A rough rule for timing measurements is to set the sampling rate at least 2-1/2 times the rate at which the data is changing.

TRIGGERING THE LA 501

A trigger signal is necessary to change the operating mode of the LA 501 from acquiring data to displaying the acquired data. The trigger signal from the WR 501 is automatically supplied to the LA 501 via the interconnecting cable inside the LA 501W. The SOURCE switch determines whether the trigger signal from the WR 501, or the trigger signal from the EXT TRIG connectors on the front panel is used. The SLOPE switch selects which edge of the trigger signal will be used by the LA 501. You can trigger the LA 501 when word recognition ends by setting SLOPE to the negative-slope.

The TRIG'D indicator comes on when the LA 501 receives a triggering signal. The indicator is held on until the next acquisition cycle starts.

Using The EXT TRIG Inputs

Two EXT TRIG connectors are provided on the front panel. The two input signals are OR'd inside the instrument. The probe used for the 10X probe input must be compensated to match the input. To compensate a probe to match an LA 501 input see Fig. 3-4. The 10X probe input thresh-

old is controlled by the THRESHOLD controls and push buttons on the LA 501. The threshold for the 100 k Ω probe input is fixed at +1.4 V.

DISPLAYING THE DATA

To display the data on an oscilloscope or monitor, connect the OUTPUTS as shown in Fig. 3-5. Remember to put the oscilloscope in the X-Y mode. The LA 501W provides the horizontal and vertical positioning and magnification controls for the display. The horizontal controls are directly above the X HORIZ BNC connector, and the vertical controls are directly above the Y VERT BNC connector. The X HORIZ output BNC provides about 0.05 V/div of deflection, and the Y VERT output BNC provides about 0.1 V/div of deflection.

Clock Ticks

The clock ticks are timing marks that appear on the traces one sample interval apart. The clock ticks go negative when the trace is HI and positive when the trace is LO.

SETTING THE DATA FORMAT

The memory stores 4096 bits of information which can be formatted in three ways. The FORMAT push buttons determine which format the data is stored in:

CH 0-3 x 1024: Data from channels 0 through 3 is recorded; 1024 bits from each channel.

CH 0-7 x 512: Data from channels 0 through 7 is recorded; 512 bits from each channel.

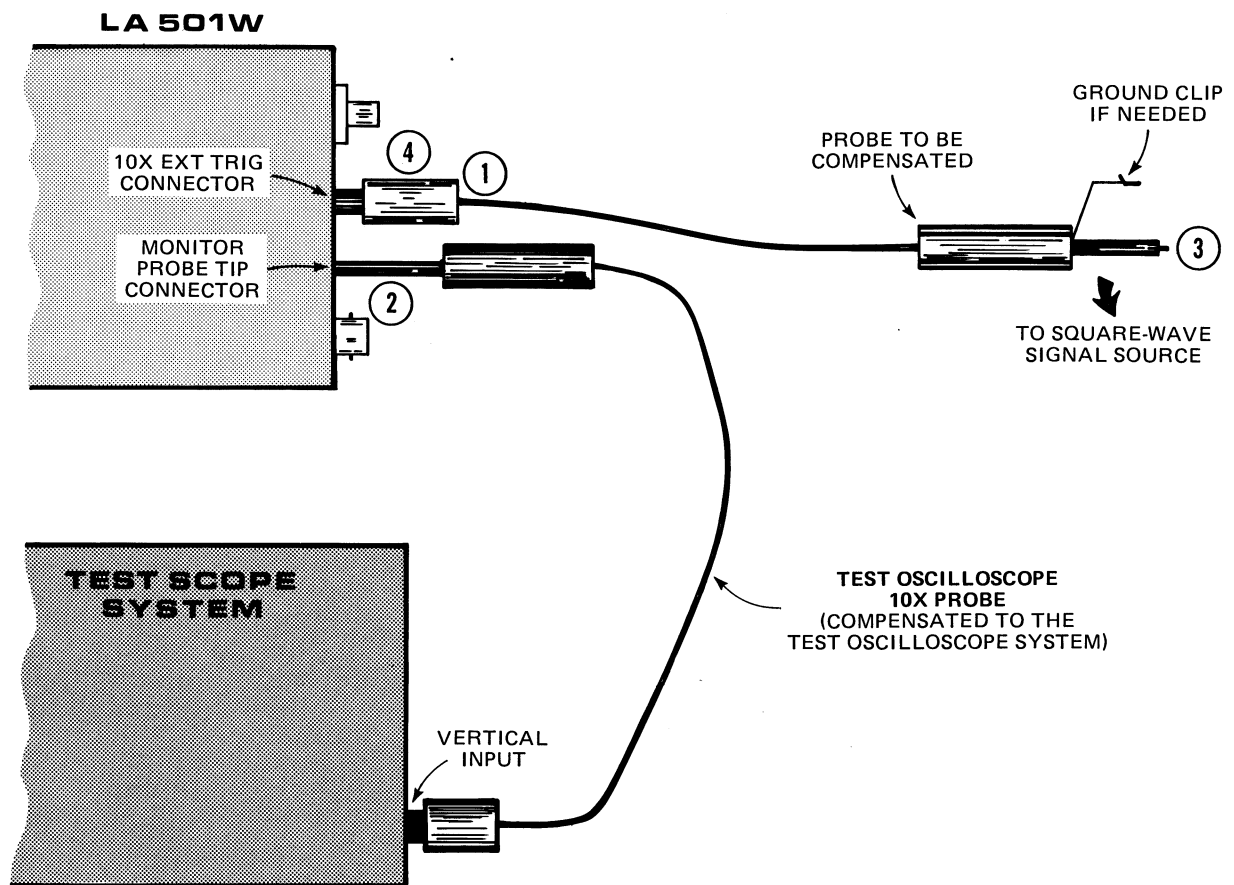
CH 0-15 x 256: Data from channels 0 through 15 is recorded; 256 bits from each channel.

SETTING THE DATA POSITION

Since the memory of the LA 501 records data continuously, you can look at events that occurred before a triggering event. The Data Position push buttons determine how much of the data is stored and displayed after the trigger occurs.

POST TRIG: About 6% of the data displayed is pre-trigger (was recorded before the trigger signal occurred) and 94% of the data is post-trigger.

CENTER: The data is split; 50% before the trigger and 50% after the trigger.



- ① Connect the 10X probe to be compensated to the LA 501W 10X EXT TRIG connector.
- ② Insert the 10X probe from the test oscilloscope into the EXT TRIG MONITOR jack below the connectors. The test oscilloscope bandwidth should be set at least 100 MHz.
- ③ Connect the probe to be compensated to about a 600 mV, fast-rise, about 1 kHz square wave signal (such as an oscilloscope calibrator).
- ④ See the 10X probe manual or data sheet for the location of its adjustments. Adjust the probe compensation adjustments for an optimum square front corner and flat top on the test oscilloscope display.

Use the same procedure for each probe used with the CH 0 through CH 3 BNC connectors and for the probe used with the 10X EXT TRIG connector.

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Fig. 3-4. 10X Probe compensation.

Operating Information—LA 501W Operators

PRE TRIG: About 94% of the data is pre-trigger and 6% of the data is post-trigger.

SETTING THE DISPLAY TIME

The **RECORD** control determines the length of time the LA 501 stays in the display mode before it switches back to the store mode. The control consists of two concentric controls — the outer one controls the display time and the inner one is a push button for restarting the store mode. To set the display time, turn the **DISPLAY TIME** control to any position between 1 s and 10 s or to ∞ (infinity). When the **DISPLAY TIME** control is set between 1 s and 10 s, the display mode is ended and a new store mode is started automatically. When the **DISPLAY TIME** control is in the ∞ (infinity) position, the display mode ends only when the **MAN** control is pushed. The screen is automatically blanked after display time ends.

USING THE CHANNEL POSITION CONTROL

The **CHANNEL POSITION** control allows you to select any channel and move it vertically anywhere within the display raster. The outer control selects the channel and the inner control moves the trace up and down the screen. When the **SELECT** control is in the **OFF** position, all 16 channels are displayed in sequence, with channel 0 at the top of the screen.

USING THE CURSOR

The cursor works only during the display mode of the LA 501. To use the cursor, wait until the display cycle has started, then put the **DELAY** Selector in the **OFF** position and set a count on the Delay Count switches. The delay counters will count display clock ticks from the beginning of the trace and output a intensified Z-axis signal on the count set by the delay count switches. There will be an intensified spot on each trace of the display.

The cursor can be used to measure time differences between points on the display:

- 1) After the LA 501W is in the display mode, set the Delay Selector switch to **OFF**.
- 2) To move the cursor to the point of interest, change the setting of the Delay Count switches. Note the setting of the Delay Count switches.
- 3) Now move the cursor to the second point by changing the setting of the Delay Count switches. Note the setting of the Delay Count switches.
- 4) The difference between the two settings of the Delay Count switches is the number of sample intervals between the two points on the display.
- 5) To get the time difference between the points, multiply the number of sample intervals by the setting of the **SAMPLE INTERVAL** switch.

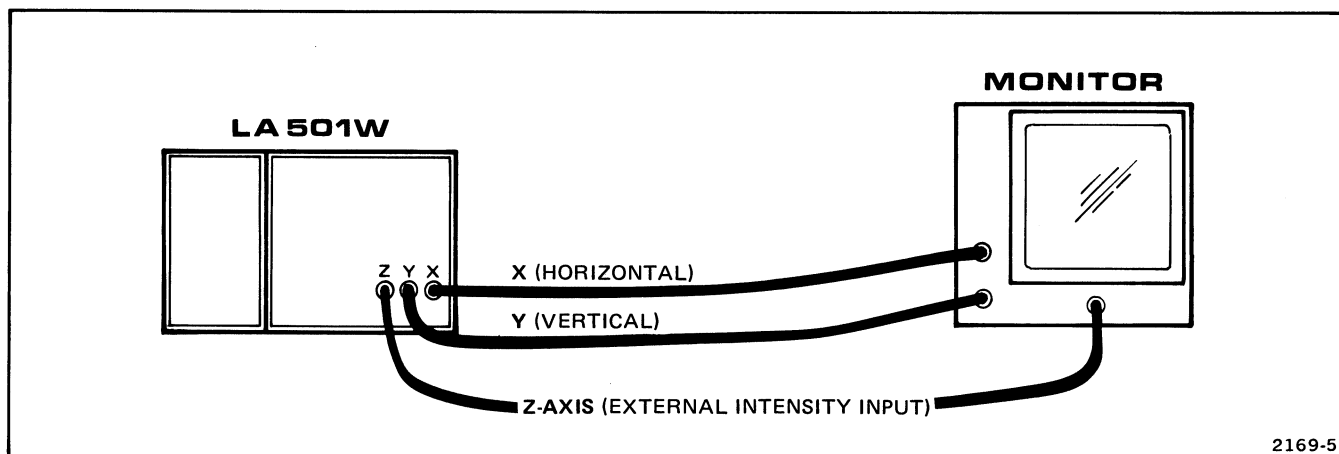


Fig. 3-5. Connecting the LA 501W to a monitor.

SPECIFICATIONS

The following instrument specifications apply over an ambient temperature range of 0° to +50°C with the LA 501W in a TM 500-Series Power Module unless otherwise indicated. Re-adjustment should be referred to qualified service personnel.

TABLE 4-1
Electrical

| Characteristics | Performance Requirement |
|---|--|
| P6451 Probe INPUTS (CLOCK, DATA, and QUALIFIER) | |
| Input R and C | 1 M Ω \pm 5%, paralleled by 5 pF \pm 1 pF. |
| Threshold Voltage (at the probe tips) | |
| VAR | –10 V or less, to at least +10 V. |
| TTL | +1.4 V \pm 0.2 V. |
| ECL | –1.26 V \pm 0.1 V. |
| Minimum Input Swing | (500 mV plus 2% of threshold voltage) p-p or less, centered about the threshold voltage. |
| Maximum Input Swing | –60 V or less, to at least threshold voltage plus 10 V. |
| Maximum Non-Destructive Input Voltage | –60 V or less to at least +60 V. |
| Minimum Data Setup Time | |
| Ch 0-3 x 1024 | 18 ns or less. |
| Ch 0-7 x 512 | 18 ns or less. |
| Ch 0-15 x 256 | 23 ns or less. |
| Minimum Data Hold Time | 0 ns or less. |
| Input Delay Between Channels | 10 ns or less. |
| DATA INPUT BNC CONNECTORS | |
| Input R and C | 1 M Ω \pm 1%, paralleled by approximately 20 pF. |
| Threshold voltage (at 10X probe tip) | |
| VAR | –10 V or less, to at least +10 V. |
| TTL | +1.4 V \pm 0.25 V. |
| ECL | –1.25 \pm 0.06 V. |
| MONITOR Output | Within 3% of threshold level at data input BNC connectors. |
| Minimum Input Swing (at 10X probe tips) | 600 mV p-p or less, centered on the threshold voltage. |
| Maximum Non-Destructive Input Voltage (at 10X probe tips) | –500 V or less, to at least +500 V. |
| Minimum Data Setup Time (at 10X probe tips) | –5 ns or less. |
| Minimum Data Hold Time | 25 ns or less. |
| Input Delay Between Channels | 6 ns or less. |

TABLE 4-1 (cont)
Electrical

| Characteristics | Performance Requirement |
|---|---|
| SAMPLING MODES | |
| Synchronous (external clock) | |
| Minimum Clock Period | |
| Ch 0-3 x 1024 | 20 ns or less—HI for at least 10 ns and LO for at least 10 ns. |
| Ch 0-7 x 512 | 20 ns or less—HI for at least 10 ns and LO for at least 10 ns. |
| Ch 0-15 x 256 | 50 ns or less—HI for at least 25 ns and LO for at least 25 ns. |
| Asynchronous (internal clock) | |
| Minimum Sample Interval | |
| Ch 0-3 x 1024 | 10 ns or less. |
| Ch 0-7 x 512 | 20 ns or less. |
| Ch 0-15 x 256 | 50 ns or less. |
| Minimum Data Pulse Width (to insure re- cording) | 1 sample interval plus 5 ns. |
| WORD RECOGNITION | |
| SYNC Word Mode | |
| Minimum Clock Period | 20 ns or less — HI for at least 10 ns and LO for at least 10 ns. |
| Minimum Setup Time (Data and Qualifier Inputs) | 18 ns or less. |
| Minimum Hold Time (Data and Qualifier Inputs) | 0 ns or less. |
| ASYNC Word Mode | |
| Minimum Input Pulse Width for 5 ns Output Pulse at the TRIG OUT BNC. | |
| Any single channel | 10 ns or less. |
| Any combination of channels (word) | 15 ns or less. |
| Filter | At least 300 ns, continuously variable to a minimum of less than 5 ns. |
| Input Delay Difference Between Channels and/or Qualifier | 7 ns or less. |
| Delay by Clock Mode | |
| Minimum Clock Period | 20 ns or less — HI for at least 10 ns and LO for at least 10 ns. |
| Delay by Word Mode | |
| Minimum Word Period | 30 ns or less — HI for at least 15 ns and LO for at least 15 ns. |
| Trig Out BNC | |
| Level | HI Level ≥ 2.2 V. LO Level ≤ 0.6 V. |

TABLE 4-1 (cont)
Electrical

| Characteristics | Performance Requirement |
|--------------------------------|--|
| WORD RECOGNITION (cont) | |
| Delay | |
| SYNC Mode | Trigger out ≤ 50 ns after edge of clock input and word pattern match at the probe tips. |
| ASYNCR Mode | Trigger out ≤ 50 ns plus Filter time after work pattern match at the probe tips. |
| Output Impedance | $50 \Omega \pm 10\%$. |

TRIGGER

| | |
|--|--|
| Trigger Sources | |
| WR | 16 Data inputs and Qualifier. Output is true when conditions match switch settings (HI, don't care, LO). |
| TTL External Trigger Input | |
| Input R and C | $\approx 100 \text{ K}\Omega$ paralleled by approximately 20 pF. |
| Threshold | +1.4 V ± 0.2 V (TTL level). |
| Minimum Input Swing | 1.0 V p-p or less, centered on +1.4 V. |
| Maximum Non-Destructive Input Voltage | –15 V or less, to at least +15 V. |
| Minimum Pulse Width | 10 ns or less. |
| 10X Probe External Trigger Input | |
| Input R and C | 1 M $\Omega \pm 1\%$ paralleled by approximately 20 pF. |
| Threshold | VAR, TTL, or ECL selected by Input push buttons. |
| Minimum Input Swing (at 10X probe tip) | 600 mV p-p or less, centered on the threshold voltage. |
| Maximum Non-Destructive Input Voltage (at 10X probe tip) | –500 V or less, to at least +500 V. |
| Minimum Pulse Width | 10 ns or less. |

INTERNAL CLOCK

| | |
|------------------------------|---|
| Crystal Oscillator Frequency | 100 MHz ± 0.005 MHz (50 parts per million). |
| Sample Intervals | 10 ns to 5 ms/sample in 1-2-5 sequence. |

DISPLAY

| | |
|-------------------|---|
| Vertical output | 0.1 V/div $\pm 10\%$. |
| Magnify | X1 to X5 $\pm 10\%$. |
| Horizontal Output | 0.05 V/div $\pm 10\%$. |
| Linearity | Pulse width constant within 10% from 1% to 100% of the sweep. |
| Magnify | X1 to X10 $\pm 10\%$. |

TABLE 4-1 (cont)
Electrical

| Characteristics | Performance Requirement |
|-----------------------|---|
| DISPLAY (cont) | |
| Blanking Output | 0 V to +5 V or 0 V to -5 V ± 1 V (internal switch). |
| Blanking Time | |
| Ch 0-3 | 4.2 μ s $\pm 20\%$ (2 bits). |
| Ch 0-7 | 2.2 μ s $\pm 20\%$ (1 bit). |
| Ch 0-15 | 1.2 μ s $\pm 20\%$ (1/2 bit). |
| Display Time Range | Approximately 1 s to 10 s, followed by reset; or infinite hold. |
| Manual Reset | Resets to store mode when button is pushed. |
| Display Format | |
| Ch 0-3 x 1024 bits | 1 group of 4 traces. |
| Ch 0-7 x 512 bits | 2 groups of 4 traces each. |
| Ch 0-15 x 256 bits | 4 groups of 4 traces each. |

TABLE 4-2
Environmental

| Characteristics | Performance Requirement |
|-----------------------|---|
| LOGIC ANALYZER | |
| Temperature | |
| Operating | 0°C to +50°C in TM 506. 0°C to +40°C in other mainframes. |
| Storage | -40°C to +75°C |
| Altitude | |
| Operating | To 4.5 km (15,000 ft). |
| Storage | To 15 km (50,000 ft). |
| Transportation | Qualified under National Safe Transit Committee Test Procedure 1A, Category II. |