LeCroy LS-140
OPERATOR'S MANUAL

LeCroy

Innovators in Instrumentation

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Warranty

LeCroy warrants operation under normal use for a period of two years from the date of shipment. Replacement parts and repairs are warranted for 90 days. Accessory products not manufactured by LeCroy are covered by the original equipment manufacturers' warranties.

In exercising this warranty, LeCroy will repair or, at its option, replace any product returned to the factory or an authorized service facility within the warranty period only if the warrantor's examination discloses that the product is defective due to workmanship or materials and the defect has not been caused by misuse, neglect, accident, or abnormal conditions or operations.

The purchaser is responsible for transportation and insurance charges. LeCroy will return all in-warranty products with transportation prepaid.

This warranty is in lieu of all other warranties, express or implied, including but not limited to any implied warranty of merchantability, fitness, or adequacy for any particular purpose or use. LeCroy Corporation shall not be liable for any special, incidental, or consequential damages, whether in contract, or otherwise.

Product Assistance

LeCroy Corporation will gladly answer your questions. Write or call your regional field service office (see next page) or Test & Measurement Division, 700 Chestnut Ridge Road, Chestnut Ridge, New York 10977-6499. TEL: (914) 578-6020.

Maintenance Agreements

LeCroy offers a choice of customer support services to meet your individual needs. Extended warranty maintenance agreements let you budget maintenance costs after the initial warranty has expired. Other services such as installation, training, calibration, enhancements and on-site repair are available through specific Supplemental Support Agreements. Contact your regional field service office for details.

Service Procedure

Refer any servicing requiring removal of exterior enclosure panels to qualified LeCroy service personnel. Be prepared to describe the problem in detail.

WARNING: Do not remove chassis panels. Removing the exterior covers exposes parts which could cause electric shock.

If the product is under warranty, LeCroy will, at its option, repair or replace the LS-140 at no charge. For repairs after the warranty period, the customer must provide a Purchase Order Number before the service engineer can initiate repairs. The customer will be billed for the parts, labor, and shipping.

Shipping Guidelines

- First, attach a tag to the instrument which indicates:
- Purchase Order number.
- Owner's name and complete address.
- The service required including detailed operational problems .
- Person to contact for confirmation (include phone number).
- Ship the unit in its original packaging.
- Protect the finish by carefully wrapping the unit in polyethylene sheeting.
- Place adequate dunnage or urethane foam in the container (approximately 4 inch depth) and place the wrapped unit on it. Allow approximately four inches of space on all four sides and the top of the unit.

Fasten the container with packaging tape and/or industrial staples. Address the container to LeCroy's service location and include your return address.

How To Use This Manual

The LS-140 is designed to be operated without having to refer to this manual. This is made possible by the intuitive controls and guiding menus. Most of the basic oscilloscope functions are accessed using the Operation Keys clustered around the rotary knob. The other push buttons give access to the useful new features offered by this innovative instrument. A built-in Help library is provided for instant aid to answering questions while operating the oscilloscope.

It is suggested that this manual be used to:

- Gain an overview of the instrument
- Familiarize you with the terminology
- Provide detailed descriptions of the various scope functions
- Illustrate the use of the new features of the instrument

Perhaps the best way to use it is to read though the early sections and then browse though the later chapters in order to become familiar with the LS-140's capabilities. The Table of Contents is organized so that you can find the right information by locating the things you want to do.

General Purpose 100 MHz Oscilloscope

The LeCroy LS-140™ sets a new standard for problem solving. This exciting instrument combines connectivity features with a powerful digital oscilloscope to provide a measurement system well suited for digital circuit test and debug in R&D, Production Test, and Service applications.

- 100 MHz bandwidth, 500 psec/div (8 GS/s sampling) minimum Time base for repetitive signals.
- 200 MS/s sampling for single shot signals.
- Four channels with dual ADC's and dedicated memories.
- Alias protection on all sample ranges.
- Configurable AUTOSETUP.
- Vertical, and cursor presets for common logic families, CMOS, TTL, ECL.
- Waveform and Measurement Data formats for Spreadsheets, PSpice™, MATHCAD™.
- LeCroy Smart Probe™ for remote operation from the probe. (Optional)
- Ethernet network compatibility. (Optional)
- FAX Transmission. (Optional, U.S. Only)
- Automatic PASS/FAIL limit testing.
- 3.5" DOS compatible Floppy Disk for Waveforms, Setups, Measurements, and Graphics storage.
- Internal 170Mb Hard Disk Drive. (Optional)
- GPIB (Optional).
- SCPI 1993.0 compatible command set.
- ISA backplane.
- RS-232 & Centronics Interfaces.

This oscilloscope is easy to use with a fast, crisp display. In addition to the features listed above the LS-140 includes all of the expected features from a LeCroy oscilloscope such as, Panel storage, measurements, Waveform processing, and Smart Trigger™.

Accessories Supplied

- Four PP050 (150 MHz, 10:1 Probes)
- This Operator's Manual
- Remote Programmer's Manual
- Power cord for country of destination
- Protective Front Cover

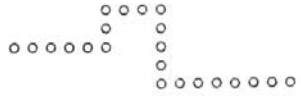
Available Accessories

• LS-RM	Rackmount Kit
• LS-SM	Service Manual
• LS-CART	Oscilloscope Cart
• LS-FC	Protective Front Cover
• LS-TRANS	Hardshell Transit Case
• LS-SOFT	Softshell Carrying Bag
• DC/GPIB	2 meter GPIB cable

Options

• LS-L1	Long Memory Version, 20k/channel + 170Mb Hard Disk
• PP051	Smart Probe (150 MHz, 10:1)
• LS-GPIB	GPIB Interface
• LS-FAX	Direct FAX output (U.S. only)
• LS-NET	Ethernet Interface

Oscillosocpe Users Guide



Oscilloscope Users Guide

This manual is organized by application topics, (e.g. CONNECTING SIGNALS and PASS/FAIL OPERATION) in order to provide rapid access to those areas of most use. When specific information concerning the operation of a particular push button or control is needed refer to the index of this guide or use the LS-140 's built-in HELP facility.

Using the Front Panel Controls

One of the first things to do is become familiar with the use of the front panel controls. Throughout this section of the manual exercises will be included to aid you in this process.

Referring to the front panel layout (figure 2). The front panel controls are divided into the following sections:

1. Operation Keys
2. Softkeys
3. Rotary dial
4. Numeric Key Pad

The beige Operation Keys are grouped according to their function; **CHANNEL**, **AUTOSETUP**, **TIMEBASE**, **TRIGGER**, **DISPLAY**, **CURSOR**, and **HELP**. Using these keys will bring up softkey menus on the display allowing you to access the features of the oscilloscope.

The blue Softkeys are defined by the Operation Keys. In many instances the softkey will show a toggle or slide switch to indicate the current oscilloscope setting. An example is shown in figure 1 for TRIGGER TYPE: EDGE or SMART.

Very often when a softkey is depressed the Rotary Dial and/or Keypad ICON(s) will appear enabling their use to make your choice. An example is shown in figure 1 for Trigger Level.

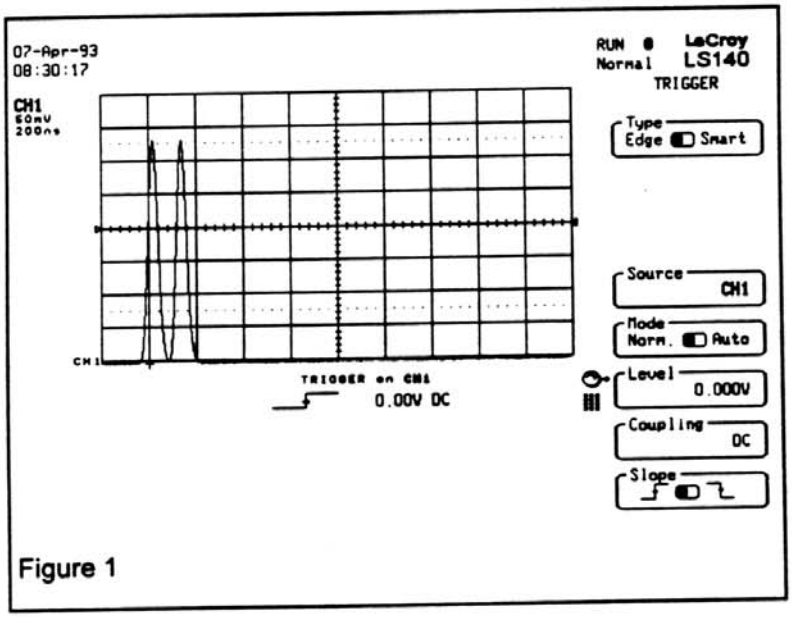
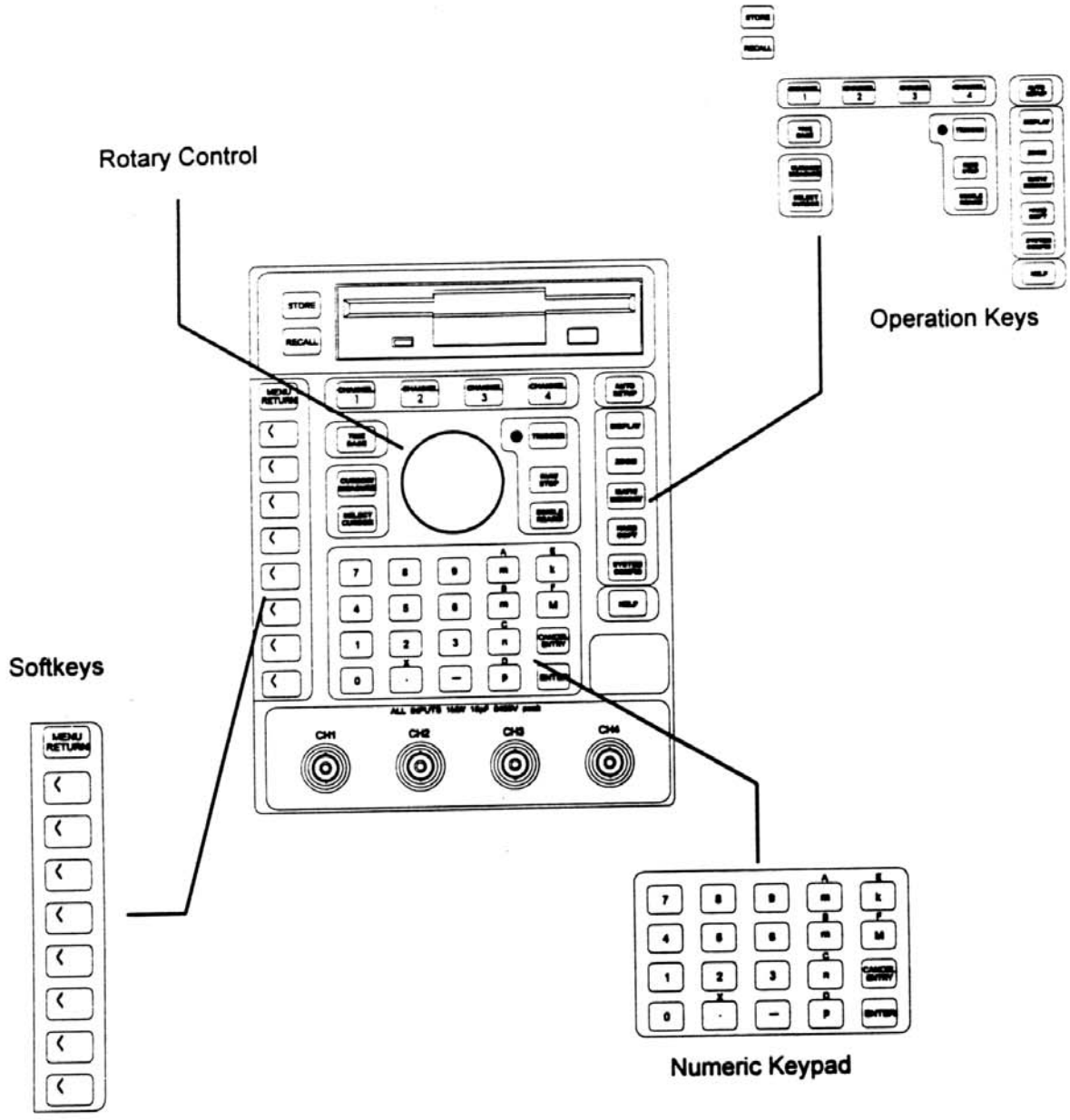


Figure 1

LS-140 Front Panel Layout



Using LS-140's On-Line Help

The LS-140 HELP facility is easily accessed by pressing the HELP operation key. To use the HELP facility simply follow the instructions on the screen after the HELP operation key is pressed. Specific information may be obtained in two ways:

1. **SCROLL** - Use the rotary dial and scroll through the HELP data.
2. **KEY** - Press the desired Operation Key.

Pressing the **MENU RETURN** Operation Key will exit the **HELP** facility.

Connecting Signals

BNC cables or Probes can be used to connect to your signals. When using LeCroy oscilloscope probes, manual adjustment of the probe attenuation is not required. The sense ring around the BNC automatically detects the probe type and the input sensitivity is rescaled for proper readout.

WARNING: The maximum input voltage allowed to avoid damaging the oscilloscope is 400 VDC plus PEAK AC (10kHz Max.).

Viewing Signals

The LS-140 is a four channel oscilloscope with two ADC's (Analog to Digital Converters). This means that channels 1 and 2 are sampled simultaneously followed by channels 3 and 4 on alternate sweeps. Simultaneous sampling is needed when single shot timing information between two signals (e.g. Clock to Data) is required.

The LS-140 uses two different types of sampling techniques; Real Time and Random Interleave. Real Time Sampling is very important when the signal type is transient or single event. The LS-140 samples in Real Time up to 5 nsec/sample (200 MS/sec). When the signal is repetitive, Random Interleaved Sampling (RIS) may be used to provide the highest signal fidelity. The LS-140 samples up to 125 psec/sample (8 GS/sec) in RIS.

Using Probes

High impedance probes use a compensated attenuator to provide uniform attenuation over the probe's bandwidth. For proper operation the value of the compensating capacitor must be adjusted to match the specific oscilloscope input to which it is connected. The adjustment is very simple.

PROBE ADJUSTMENT **Exercise 1**

1. Connect a probe from channel 1 to the Probe Adjust output on the front panel.
2. Press the operation key "**AUTOSETUP**". Then press the softkey "**ALL**" The signal from your probe will resemble one of the display traces of figure 3.
3. Adjust the low frequency compensation trimmer, located in the compensation box, at the BNC connector end of the cable using the non-metallic tool supplied with the probe, so that the base and top of the displayed squarewave are flat. The proper response is shown in the center trace of figure 3.

Oscilloscope probes should be compensated whenever they are connected to an oscilloscope. If the probes are left connected to the oscilloscope then the compensation should be checked, just before use. The compensation procedure not only guarantees optimum waveform fidelity, but, it also insures that the oscilloscope channel is working correctly.

AutoSetup

The LS-140 will display a signal automatically through the use of AUTOSETUP. When the AUTOSETUP operation key is pressed the softkey menu of figure 2 appears. Autosetup can adjust the T/div (Timebase), V/div, and Trigger level settings together or separately.

The following table describes the action of each AUTOSETUP softkey.

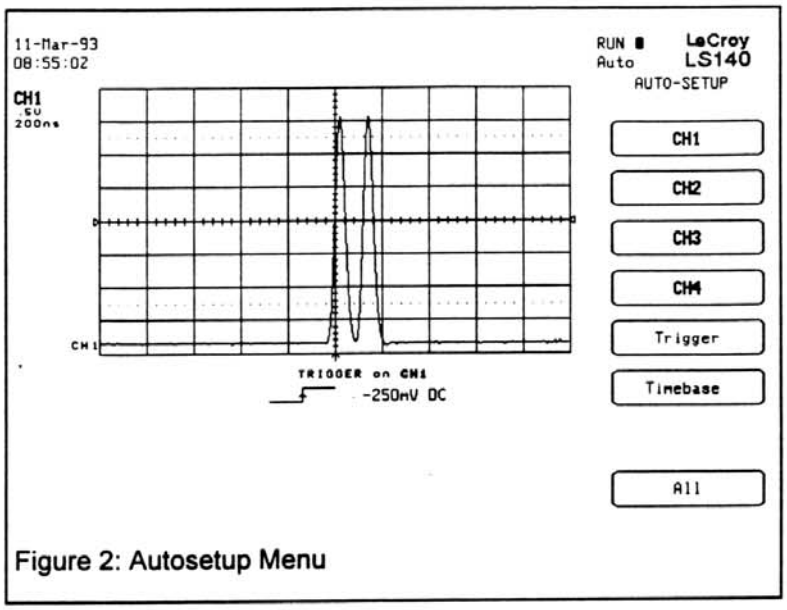


Figure 2: Autosetup Menu

AUTO-SETUP SOFTKEY MENU DEFINITION

SOFTKEY LABEL	*SOFTKEY FUNCTION*
CH1	Determine optimal offset and V/div settings for CH1 ONLY
CH2	Determine optimal offset and V/div settings for CH2 ONLY
CH3	Determine optimal offset and V/div settings for CH3 ONLY
CH4	Determine optimal offset and V/div settings for CH4 ONLY
Trigger	Optimize ONLY the trigger level
Timebase	Optimize ONLY the timebase setting
All	Optimize the timebase and trigger level setting for the assigned trigger channel. If no signal is found, input channels are scanned in 1-2-3-4 sequence to search for a suitable trigger signal. Optimize the V/div for all channels.

Table 1: Autosetup Menu Softkeys

Use the following exercise to become familiar with AUTOSETUP. Vary your input's period, amplitude and offset then use the features of AUTOSETUP to optimize the display.

AUTOSETUP EXERCISE **Exercise 2**

1. Press Operation key **RECALL**
2. Press softkey **SETUP**
3. Press softkey **SCOPE DEFAULTS**
4. Press **YES**

   Note: This will restore the LS 140 to a known setup.
5. Connect a signal to channel 1.
6. Press Operation key **AUTOSETUP**.
7. Press softkey **ALL**.

   Note: This option of **AUTOSETUP** optimizes all settings: T/div, V/div, Trigger Level.
8. Modify the input signal's amplitude and period.
9. Press the softkey **CH1**

   Note: This option of **AUTOSETUP** optimizes only the V/div and offset of channel 1.

Turning Traces On/Off and Setting their Vertical Characteristics

The vertical settings for each channel are setup independently using the operation keys Channel 1, Channel 2, Channel 3, Channel 4. The softkey menu for each channel is similar to channel 1 shown in figure 3.

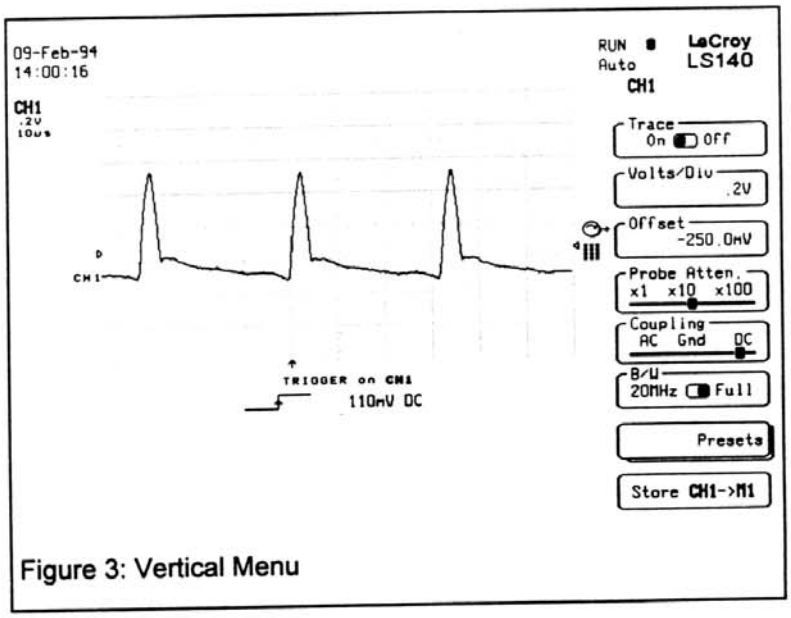


Figure 3: Vertical Menu

The following table describes the action of each VERTICAL CHANNEL softkeys.

VERTICAL SOFTKEY MENU DEFINITION

SOFTKEY LABEL	*SOFTKEY FUNCTION*
Trace	Trace display ON or OFF
Volts/Div	Sets the vertical over a range of 10 V/div to 5 mV/div in a 1-2-5 sequence.
Offset	Adjusts the input amplifier DC level over a range of æ 1V to æ 100V depending on V/div setting. The applied offset value is summed with the input signal i.e. increasing the offset will move the trace upwards on the screen.
Coupling	Select AC, GND, DC
Probe Atten.	Probe Attenuation, Automatically set if a probe with coding ring support is detected, x1, x10, and x100 probes are supported.
B/W	Select 100 MHz (full bandwidth) or a 20 MHz low-pass filter.
Presets	Select TTL, ECL, CMOS to preset both V/div and Offset for rapid probing of these logic families.
Store CH1 to M1	This softkey provides a simple shortcut to store waveform data to a memory.

Table 3: Vertical Menu Softkeys

Setting the Timebase and Acquisition Modes

The TIMEBASE controls the horizontal axis of the display. Pressing the operation key TIMEBASE the softkey menu of figure 4 is displayed.

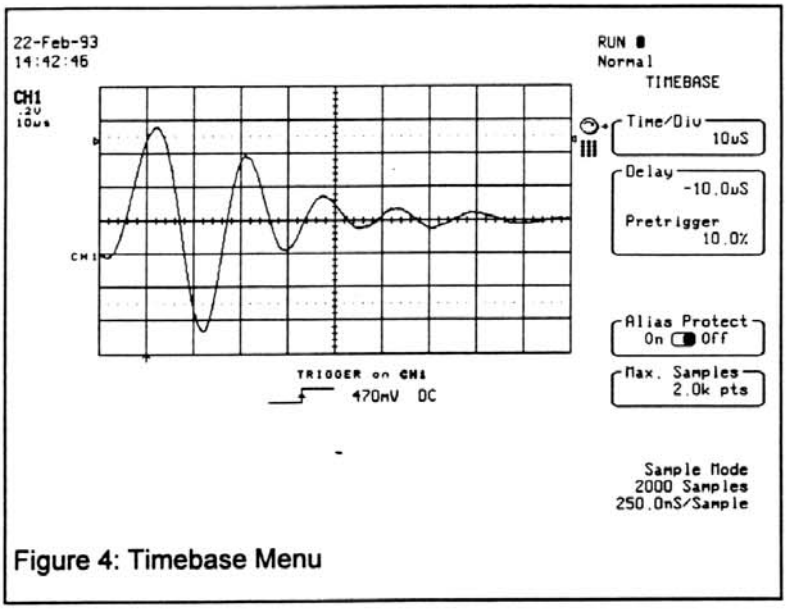


Figure 4: Timebase Menu

The following table describes the action of each TIMEBASE softkey.

TIMEBASE SOFTKEY MENU DEFINITION

SOFTKEY LABEL	*SOFTKEY FUNCTION*
Time/Div	Sets the horizontal axis over a range of 50 sec/div to 5 nsec/div in a 1-2-5 sequence.
Delay	Sets the time from the trigger to the time to the left edge of the display in a range of 0 to 10,000 divisions
Pretrigger	Sets the amount of time displayed before the trigger over a range of 0 to 100% of record length.
Alias Protect	When Alias protect is ON. The LS-140 will maintain maximum sample rate (5 nsec) on all timebase ranges from 0.2msec/div thru 50ms/div, and 10ns sample rate to 50s/div.
Max. Samples	Defines record length of 400 or 2000 points (4000, 10000, or 20000 may be selected on the -L1 Model).

Note: Delay and Pre-Trigger are coupled controls

Table 4: Timebase Menu Softkeys

SETTING THE TIMEBASE AND VERTICAL SCALES

Exercise 3

1. Connect a signal to channel 1.
2. Press **AUTOSETUP** ; **ALL**
3. Press **CHANNEL 1**
4. Press softkey **VOLTS/DIV**. Notice that the Keypad and Rotary Dial icons have appeared.

Rotary Dial Icon

Keypad Icon

5. Use the Rotary Dial to modify the Volts/Div setting of channel 1.

   Notice that as the dial is turned the Volts/Div setting sequence advances in a 1-2-5 order. (e.g. 100 mV, 200mV, 500 mV)
6. Press **TIMEBASE**
7. Press softkey "**TIME/DIV**". Notice that the Keypad and Rotary Dial icons have appeared.
8. Use the Rotary Dial to modify the Time/Div setting. Notice that as the dial is turned the Time/Div setting sequence in a 1-2-5 order. (e.g. 1 msec, 5 msec, 10 msec)
9. Use the keypad to set an explicit value.

   Type the following characters : " 1 . 0 u ".

   The timebase is now set to 1 msec/div.

   Type the following characters : " 3 . 2 u ".

   The LS-140 will automatically set the timebase to the next highest setting in the 1-2-5 sequence.

Using Zoom

The ZOOM feature of the LS-140 provides waveform expansion (without having to acquire additional data) for viewing greater detail of either live or stored waveforms. The figure below shows the ZOOM softkey menu. In this figure the math function F2 is setup as a copy of F1 and then expanded. The copy of trace Math Function was used so that the original and expanded waveforms could be viewed simultaneously.

The following table describes the action of each ZOOM softkey.

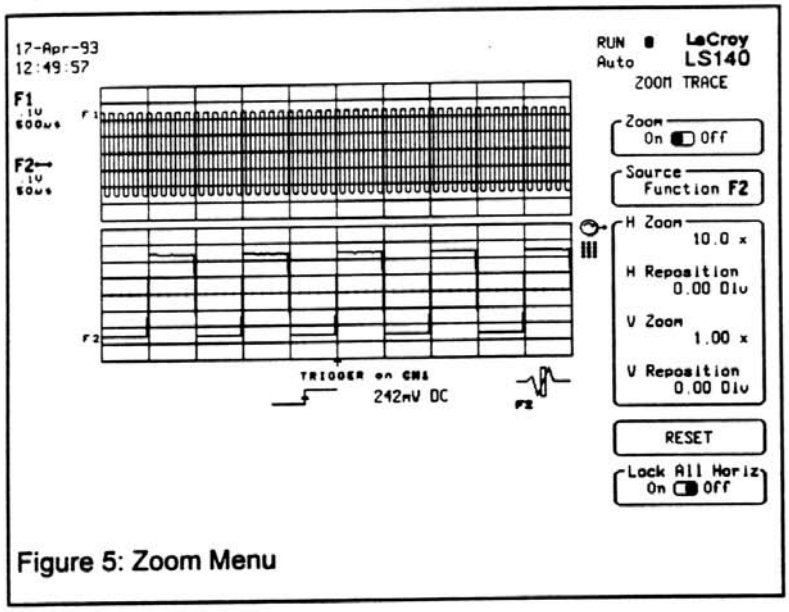


Figure 5: Zoom Menu

ZOOM SOFTKEY MENU DEFINITION

SOFTKEY LABEL	SOFTKEY FUNCTION
Zoom	Turns ON or OFF the Zoom feature.
Source	Select the Trace to expand
H Zoom	Select up to 500:1 Horizontal expansion
H Reposition	Select +/- 5 Divisions of Horizontal position
V Zoom	Select up to 10:1 Vertical expansion.
V Reposition	Select +/- 8 Divisions of Vertical position.
RESET	Return all expansion ratios to the default.
Lock All Horiz	Locks the horizontal expansion and relative horizontal position of all currently displayed traces.

Table 4: Zoom Menu Softkeys

Trigger Operation

Triggering techniques from simple to advanced and operation of the trigger controls will be discussed in the following section. The trigger system is used to obtain a stable trace on the screen by synchronizing the waveform sampling process with a known reference point in the input signal.Edge trigger allows this reference point to be specified as a voltage level and can be automatically adjusted using autosetup.Smart Trigger is an enhanced triggering capability and provides additional time qualification of the selected voltage reference point allowing stable acquisition of complex waveforms.

Edge triggering is normally used for continuous waveforms whereas Smart Trigger is used when you want to trigger on an anomaly of a waveform like a missing clock, a timing glitch or a runt pulse.Smart Trigger is also used to view TV signals.

When the TRIGGER operation key is pressed the softkey menu of figure 6 will appear. A functional description of each TRIGGER softkey key is shown below.

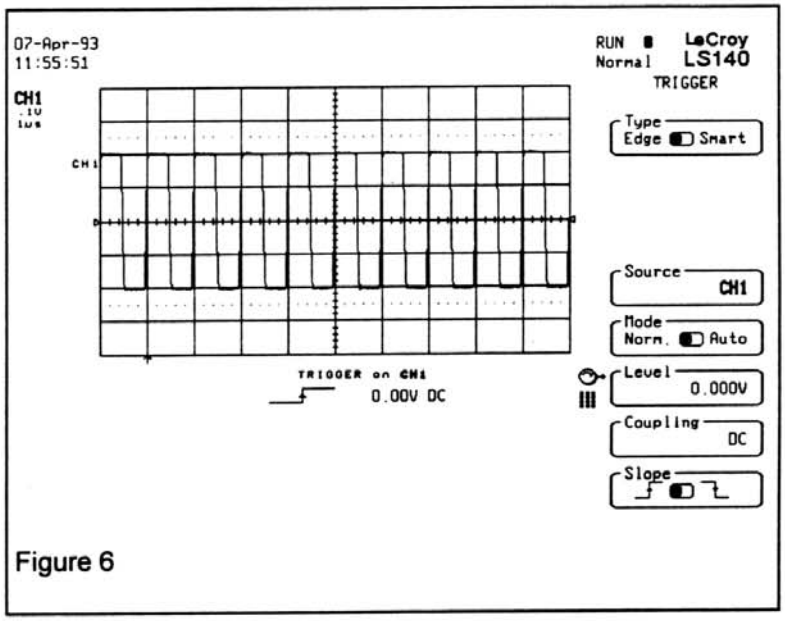


Figure 6

SOFTKEY LABEL	*SOFTKEY FUNCTION*
Type	Selects the trigger process. Either EDGE or SMART
Source	Channel 1, 2, 3, 4, or Line
Mode	AUTO: self trigger at 10 Hz rate in absence of qualified trigger event.
	NORMAL: trigger only for qualified events.
Level	Threshold voltage
Coupling	DC, DC BWL, AC, AC BWL (AC Coupled, i.e., DC Component of trigger signal is removed) LFR, LFR BWL (Low Frequency Reject), HFR (High Frequency Reject)

Table 6: Trigger Menu Softkeys

Acquiring a Single Event

AUTOSETUP will provide a stable oscilloscope display but only for continuous signals. When an event occurs infrequently or at unknown times SINGLE shot acquisition may be used to acquire the data.

Using the RUN/STOP Key

The Run/Stop operation key controls oscilloscope data acquisition. The normal indication is "RUN" located in the upper right corner of the display. "STOPPED" is shown when data acquisition has been frozen.

The status of the acquisition system is shown in the top right-hand corner of the display. This can be:-

Stopped	Acquisitions are frozen
ARM	Unit is waiting for a trigger
TRGD	A qualified trigger has been received and the unit is acquiring data.
Run	Unit being continuously triggered with data being acquired repeatedly.

Very often a waveform may be captured by manually pressing the RUN/STOP operation key.

When the instrument is the ARMed start, a manual trigger can be forced by pressing the front panel SINGLE REARM button.

SINGLE TRIGGER **Exercise 4**

1. Connect a signal to the oscilloscope
2. Press the TRIGGER operation key
3. Set (or Verify) the following softkeys setup

   TYPE: Edge
   SOURCE: as required
   LEVEL: set level to a reasonable value
   COUPLING: as required
   SLOPE: as required
4. Set single trigger mode by using the **RUN/STOP** operation key and set **STOPPED** acquisitions.
5. Press the **SINGLE REARM** operation key.

   Note: Pressing the SINGLE REARM key arms the trigger hardware and turns on the Trigger LED. As soon as a valid trigger occurs the oscilloscope will acquire data and the Trigger LED will extinguish.

   If a valid trigger does not occur, a second press of the SINGLE/REARM key will supply a software trigger.

Glitch Triggering

A Glitch is typically defined as a very narrow pulse that occurs at random times. It is very difficult to reliably trigger on such events using simple edge triggering.

Using the Alias protection feature of the LS-140 a glitch is manually captured (using the RUN/STOP operation key) and shown in figure 7.

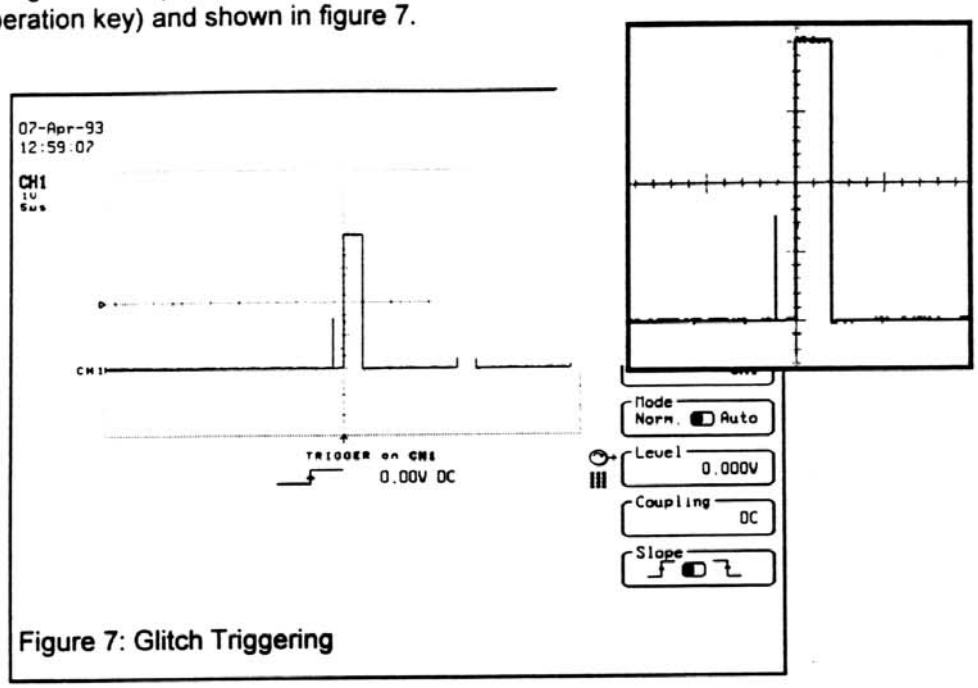


Figure 7: Glitch Triggering

Smart Trigger can be used to reliably trigger on this event. Figure 8 shows the Smart Trigger setup used to capture this glitch. In this case Smart Trigger Type "WIDTH <" was used to discriminate the narrow glitch from the normal pulse train.
Notice the pulse ICON below the graticule. This ICON is used to assist in setting up the different Smart Trigger types.

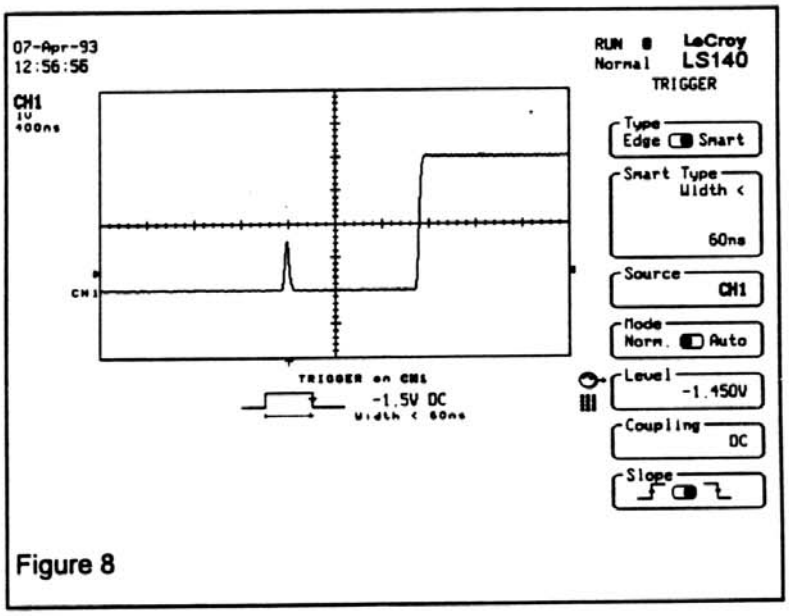


Figure 8

Triggering on complex waveforms

A complex but repetitive data pattern is shown in figure 9. As shown in this figure you may use EDGE Type, Single trigger Mode to manually acquire a sample of the waveform. This waveform has two distinctive periods; 3msec and 15msec.

Smart trigger type "INTERVAL" was used to lock on to the smaller period of the pulse train.

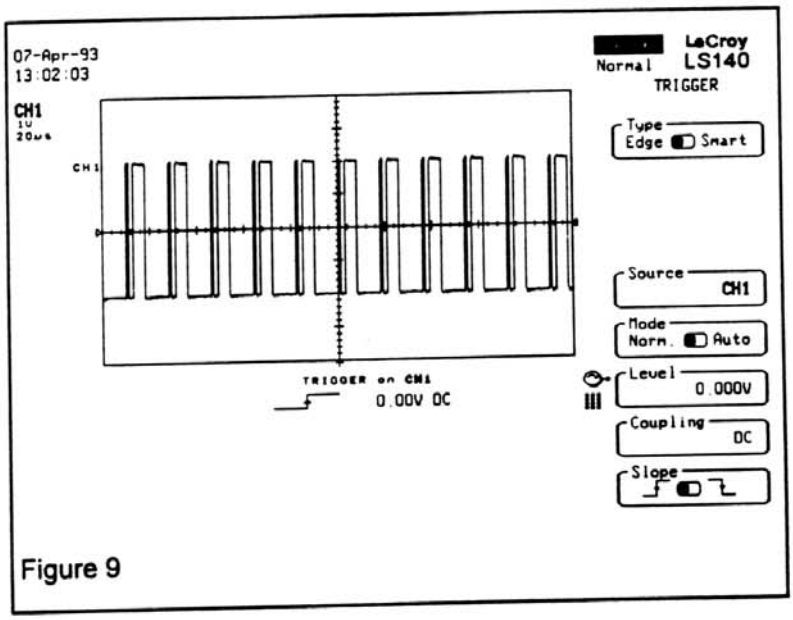


Figure 9

Again, notice the pulse ICON below the graticule. In the previous case WIDTH enabled triggering on a positive pulse. The trigger point is indicated by the UP-ARROW on the bottom of the graticule. Note that its position in respect of the acquired waveform matches the arrow on the trigger icon.

Below INTERVAL enables triggering upon a full cycle (i.e. positive edge to positive edge):

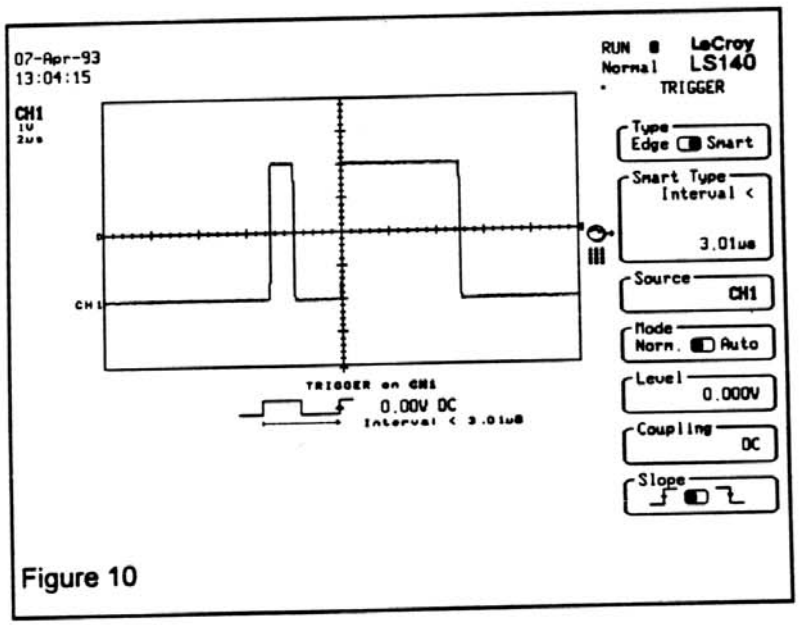


Figure 10

TV Trigger

When Smart Trigger Type: "TV" is selected the softkey menu of figure 11 is displayed. Notice the changes in the menu from the previous trigger softkey menus. Selections for television STANDARDS, control of FIELDS and LINES have replaced the usual Level, Coupling and Slope selections. Use the following exercise to become familiar with TV trigger.

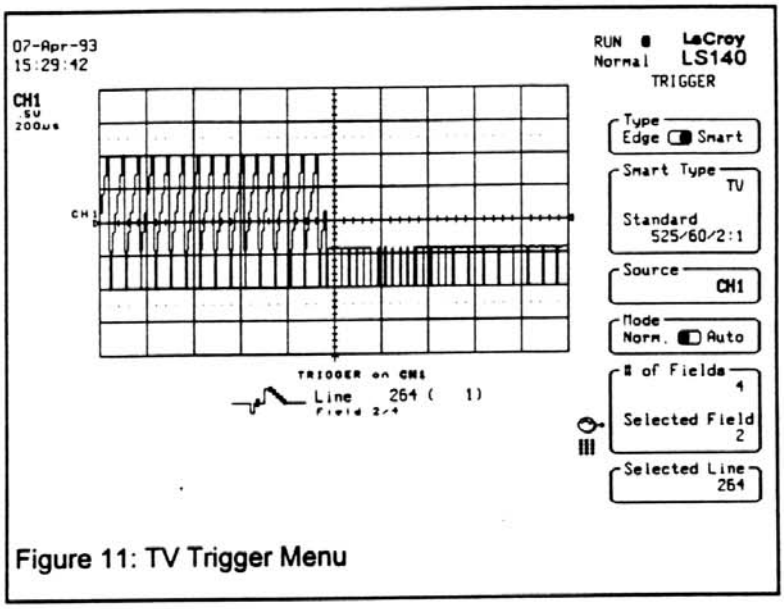


Figure 11: TV Trigger Menu

TV TRIGGER EXERCISE **Exercise 5**

1. Connect a TV signal to the oscilloscope
2. Press the TRIGGER operation key then select SMART trigger type by pressing the Type softkey.
3. Press the Smart Type softkey and use the Rotary Dial to select TV.
4. SET (or Verify) the remaining Trigger setup softkeys.

   STANDARD: 625 lines or 525 lines
   SOURCE: as required
   MODE: NORMAL
   # of FIELDS: 1, 2, 4, or 8
   SELECTED FIELD: as required
   SELECTED LINE: as required
5. Adjust the Amplitude and Timebase controls to view the signal.
6. Select the TRIGGER softkey menu to use the FIELD and LINE selections to analyze the waveform.

Cursor Operation

Cursors are enabled by pressing the CURSOR/MEASURE operation key then softkey "Cursors: ON - OFF" to "ON". The different cursor types which may be selected are defined below.

Cursor Types

Amplitude	Used to make absolute and relative voltage measurements.
Time	Used to make absolute and relative time measurements.
Attached	Used to make simultaneous absolute or relative time and voltage measurements.
Logic Level	Provides multiple horizontal markers for viewing of standard { ECL TTL CMOS } or custom voltage thresholds.
Measure Gate	Time cursors used to select a section of a waveform over which to calculate measurements or perform pass/fail testing.

EXAMPLE LOGIC LEVEL CURSORS :TTL

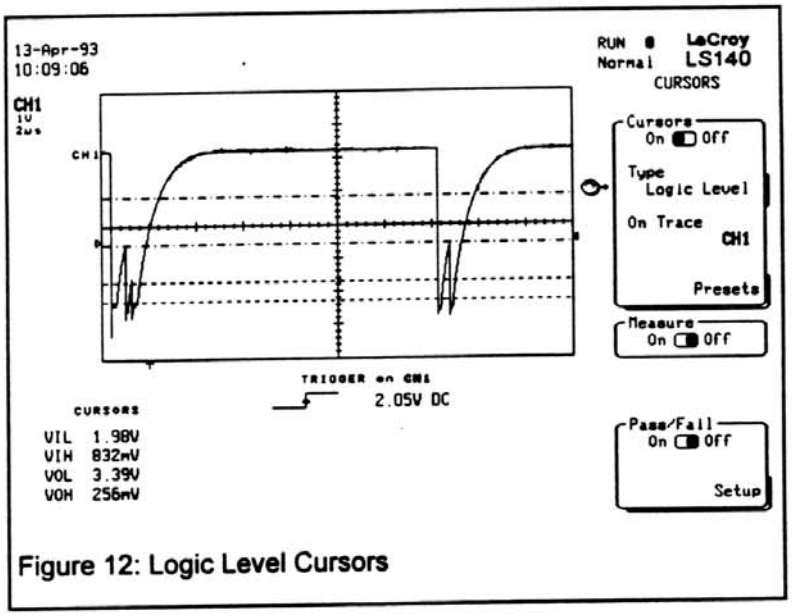


Figure 12: Logic Level Cursors

AMPLITUDE, TIME, and LOGIC LEVEL cursor types are used only for a specified trace. The ATTACHED cursor type provides both absolute and relative time and voltage information on all displayed traces. Attached cursors can be positioned off-screen.

Use the following exercise to become familiar with using cursors.

CURSOR OPERATION EXERCISE **Exercise 6**

1. Acquire a waveform into Channel 1
2. Press **CURSOR** operation key
3. Set "CURSORS: ON - OFF" softkey to "ON"
4. Press **TYPE** softkey and select **AMPLITUDE**

   Note: The **CURSOR** readout for each cursor type is located in the lower left hand corner of the display.
5. Press **ON TRACE** softkey and select CH1

   Note: When using cursor types **TIME**, **AMPLITUDE**, or **ATTACHED RELATIVE** you may control the two cursors independently or as a pair. The **SELECT CURSOR** operation key is used to attach the Rotary Dial to control either one or both cursors.
6. Press **SELECT CURSOR** operation key and attach the Rotary Dial to one of the horizontal cursors. Use the Rotary Dial to position the cursor on the display. Press **SELECT CURSOR** again and position the other horizontal cursor.
7. As the horizontal cursors are positioned the absolute voltage of each and their relative voltage is displayed.

Waveform Measurements

The LS-140 will display 6 waveform measurements for any selected trace. There are 20 unique measurements which may be chosen through the MEASURE SETUP softkey menu:

Amplitude	Base Level	Cycles
Delay	Duty Cycle	Fall Time
Frequency	Maximum Level	Mean Level
Minimum Level	Overshoot Negative	Overshoot Positive
Peak to Peak	Period	Rise Time
RMS	Std Deviation	Top Level
Width Negative	Width positive	

Table 7: Waveform Measurements

***NOTE**: A description of each measurement is contained in the appendix.*

When the CURSOR/MEASURE operation key is pressed and the "MEASURE: ON - OFF" softkey is "ON" the softkey menu of figure 13 is displayed.

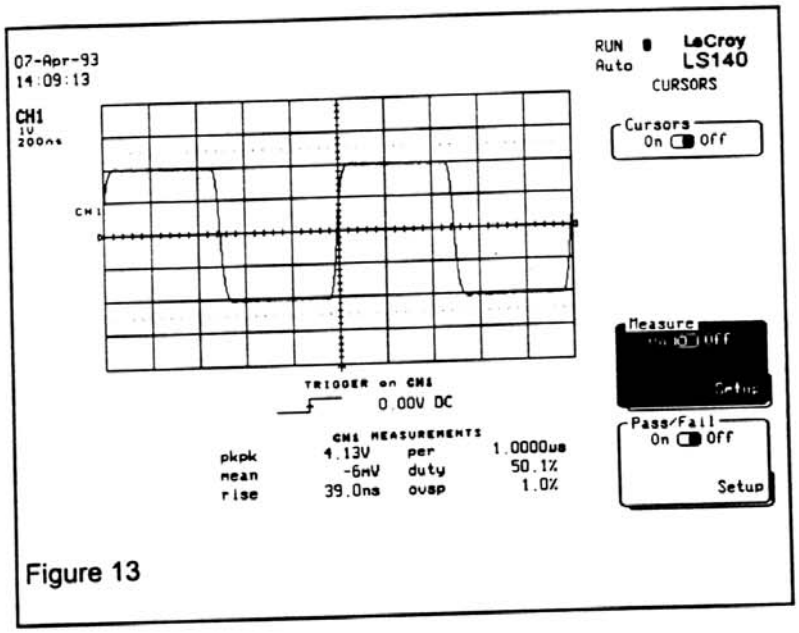


Figure 13

Pressing the MEASURE SETUP softkey will display a menu to select the desired measurements. In the MEASURE softkey area up to six measurements may be specified. Measurements are calculated upon the trace specified in the ON TRACE box.

Measurements on Waveform Segments

Normally measurements use the entire waveform to perform a calculation. When the waveform is not continuous (example: FM Signal) this may produce an unexpected result (example: Calculating the period). In this case you can define the region of interest with measure gate cursors.

Exercise 7

MEASURE GATE EXERCISE

Use the following procedure to perform measurements of waveform segments.

1. Press the **CURSOR/MEASURE** operation key and turn "CURSORS ON:OFF" to "ON".
2. Press the TYPE softkey and select **MEASURE GATE** cursors.
3. Turn "**MEASURE ON:OFF**" to "**ON**" then press the **SETUP** softkey.
4. Press the **ON TRACE** softkey then select the appropriate Trace.
5. Use the **SELECT CURSOR** operation key and set the left and right cursor positions.
6. Measurements will now be calculated upon the pieces of waveform in between the time cursors.

This capability (as shown in figure 14) is very useful for complex waveforms such as video signals or gated waveforms.

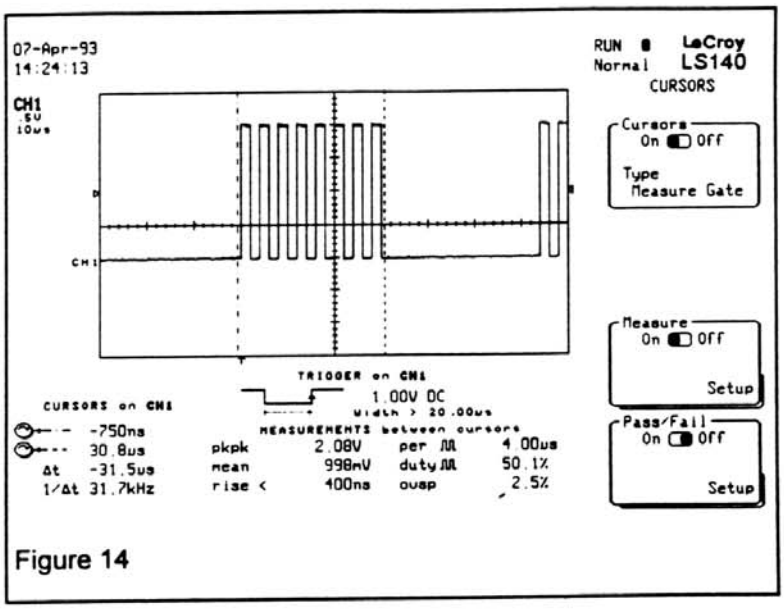


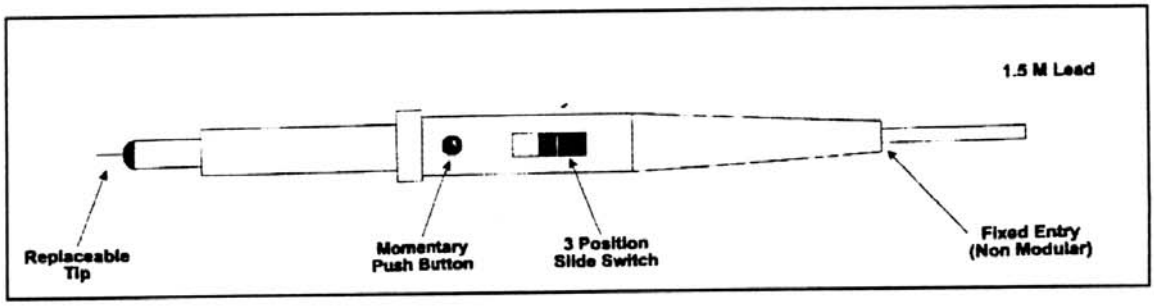
Figure 14

Smart Probe Basics

The LeCroy Smart Probe Model PP051 provides a unique finger tip control of the most common features of the LS-140. The illustration below shows the probe body with its push button and three position slide switch. Smart Probe may be used as a standard 150 MHz, 10:1 probe with or without the push button and slide switches enabled.

As an example of using Smart Probe consider needing to use "AUTOSETUP CH1" while probing a circuit. By pressing the Smart Probe's push button the AUTOSETUP function could be executed each time a test point is probed without moving your hand from the probe.

The slide switch allows for three separate function assignments of the push button. Simply by moving the slide to position 1, 2, or 3 the Smart Probe push button provides remote control of 13 LS-140 functions.



Smart Probe Functions:

Function	*Description*
SINGLE/REARM	Probe Push-Button directly controls front panel SINGLE/REARM button
RUN/STOP	Probe Push-Button directly controls front panel RUN/STOP button
Autosetup All	Probe Push-Button is used to initiate an autosetup of all settings
Autosetup Chan	Probe Push-Button initiates an autosetup of the V/Div and offset settings for the channel to which the Smart Probe is connected
Autosetup Trig	Probe Push-Button initiates a trigger level autosetup
Store Snapshot	Executes a snapshot storage operation using the settings in the STORE SNAPSHOT menu
Custom Store	Executes a custom storage operation using the settings in the CUSTOM STORE menu
Recall Test	Executes a Recall Test operation using the settings in the RECALL TEST menu
Cascade Next	Selects next cascade trace. Only Active when Cascade Display mode is selected
Cascade Prev	Selects previous cascade trace. Only Active when Cascade Display mode is selected
Rotary Right	Each press of the probe push-button emulates the rotary control being rotated right (clock-wise) by one detent
Rotary Left	Each press of the probe push-button emulates the rotary control being rotated left (anti-clockwise) by one detent
HARDCOPY	Executes a HARDCOPY operation using the settings in the HARDCOPY menu

Table 7: Smart Probe Functions

Using your Smart Probe for remote control

The Smart Probe controls are enabled through the SYSTEM CONFIG menu. In the figure below, showing the Smart Probe softkey menu, the probe has been connected to channel 1 (CH1) and three actions have been assigned; RUN/STOP, SINGLE/REARM, AUTOSETUP CH1.

Follow exercise 8 and use Smart Probe to AutoSetup the LS-140.

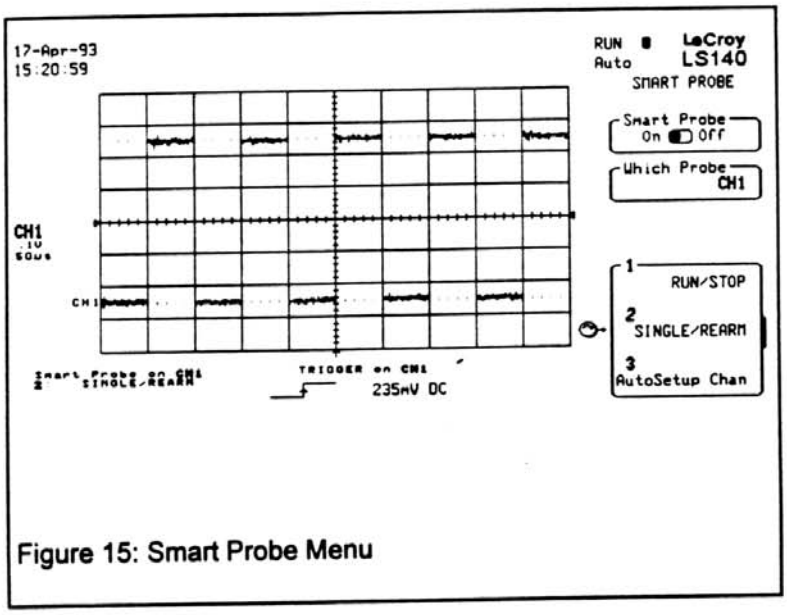


Figure 15: Smart Probe Menu

USING Smart Probe **Exercise 8**

1. Connect Smart Probe to channel 1.
2. Press the operation key **SYSTEM CONFIG**.
3. Press softkey **Smart Probe**.
4. Press softkey **Smart Probe ON : OFF** to **ON**.
5. Press softkey **WHICH Probe** and select **CH1**
6. Press softkey **1** and select **AUTOSETUP CHAN**.
7. Press softkey **2** and select **STORE SNAPSHOT**.
8. Press softkey **3** and select **HARDCOPY**.
9. Connect the **Smart Probe** to the front panel probe calibrator, select position 1 on the slide switch and press its push-button.

* In this configuration you may probe a circuit then either store or print the results by remote control from the probe.

Store and Recall

The Store and Recall features of LS-140 provides a powerful facility for data communication.

- Multiple Destinations

  Waveforms and oscilloscope setups may be stored or recalled from; internal memories, floppy disk or the Network.

- Multiple Formats

  The LS-140 provides several unique waveform data formats.

  (1) **Spreadsheet**
  This format is an "output only" ASCII format used to send waveform or measurements directly to your spreadsheet.

  (2) **MATHCAD**
  Format for direct input into MathCad analysis software.

  (3) **PSpice**
  Format for direct input into PSpice simulation software.

  (4) **LeCroy Binary**
  Used for Input/Output and provides compatibility with LeCroy 7200, 9400 and 9300 series oscilloscopes. Provides the most comprehensive and efficient storage format for trace data.

- Automatic Operation

  A series of waveforms may be easily stored or recalled by using the filename Auto-increment feature.

Using Auto-increment **Exercise 9**

An example of the use of Auto-increment (Store, Recall) would be in the area of production test. Using Store TEST with Auto-increment enabled, a series of golden waveforms (or test limits) would be stored in sequence. Then as each new device is tested, the stored waveforms could be recalled in sequence with one keystroke (e.g. using Smart Probe with RECALL TEST defined as one of the functions).

How to Format a Floppy Diskette

The LS-140 supports 1.44 Mbyte, High Density (HD) diskettes. To format a floppy press either the STORE or RECALL operation key. The softkey menu of figure 17A will be displayed.

Floppy Formatting:

1. Press the **STORE** or **RECALL** operation key.

2. Press the **DISK UTILS** softkey.

3. Insert a **1.44 Mbyte** floppy diskette into the floppy drive.

4. Press the **FORMAT FLOPPY** softkey.

5. Press the **YES** softkey.

***NOTE**: If an Unformatted Diskette is inserted before entering the DISK UTILS menu there will be a delay of several seconds while the system attempts several times to read the diskette. To avoid this delay insert the diskette after entering the DISK UTILS menu.*

Using Store

As is shown in the softkey menu of figure 17A there are several methods to store waveform data within the LS-140. Each method and its purpose will be explained in the following section.

TRACE: Storage is used to selectively store a single waveform to either internal memories or to a disk file.

SNAPSHOT: Storage is used when a complete representation of the current LS-140 operation needs to be preserved (i.e. all displayed traces and scope setup).

TEST: Storage is used to setup the LS-140 for waveform comparisons. Storing a TEST saves everything except live trace data. When a test is recalled, oscilloscope settings are restored, these include selected automated measurements, displayed reference traces (memories and functions) and pass/fail limits. The RUN/STOP state of the unit is not modified by the recall test operation.

- Comparing live signals to "Golden Waveforms"
- Sequencing through a series of test or calibration routines.
- Easier and faster automated testing under remote control.

CUSTOM: Allows the user to preset the required storage format and associated data options. This selection can then be used automatically by the Pass/Fail system or can be initiated using the SmartProbe.

When the STORE operation key is pressed the softkey menu of figure 17A is displayed. Table 8 shows an overview of the capability of each storage type.

Using Internal Memories {M1 and M2}

There are two non-volatile waveform memories in the LS-140, M1 and M2. Memories are used to provide temporary copies of waveform data and may be used in any Cursor, Measure or Math operation.

EXAMPLE: A typical application for using Memories would be in template comparisons. By placing a reference waveform into Memory 1 each time a new sample waveform is collected the MATH operation { F1 = M1 - CH1 } could be computed to show the difference.

STORING TO INTERNAL MEMORIES **Exercise 10**

1. Press Operation key STORE
2. Press softkey TRACE then select the Source of the data by pressing one of the softkeys {CH1 CH2 CH3 CH4 M1 M2 F1 F2}.
3. Select the destination of the data by pressing one of the softkeys {M1 M2}.
4. Whenever waveform data is stored to an internal memory that Trace Memory will be immediately displayed.

To display and position one or both of the internal memories M1 or M2 use the Operation key MATH/MEMORY. The MATH/MEMORY softkey menu is shown in the figure below.

The V Reposition function allows reference waveforms stored in memory to be easily repositioned for visual comparison with other waveforms. This feature is also available in the ZOOM control section.

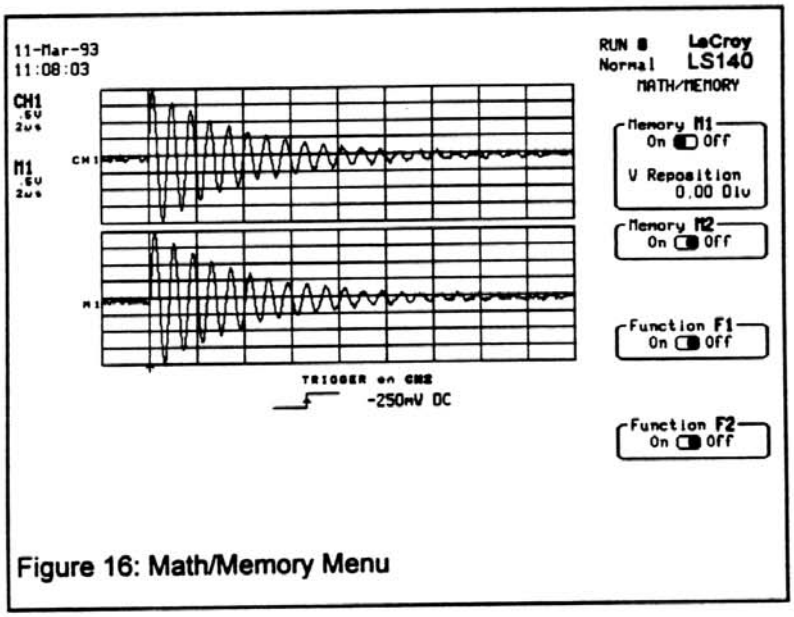


Figure 16: Math/Memory Menu

Store to Floppy Disk

This section is an explanation of the use of the floppy disk for storage of waveforms, measurement results, setups, test sequences, graphics and hardcopy images. Floppy diskettes are MS-DOS compatible and are interchangeable with those used in the LeCroy 7200A and 9300 series oscilloscopes.

The simplest method for storing data to a floppy disk is to use the Storage Type "TRACE". Use the exercise on the following page to become familiar with floppy disk storage.

STORING TO FLOPPY DISK **Exercise 11**

1. Press Operation key **STORE**
2. Press softkey **TRACE** then select the Source of the data by pressing one of the softkeys {CH1 CH2 CH3 CH4 M1 M2 F1 F2}.
3. Press softkey **FILE** as the destination of the data.
4. Press the **FORMAT** softkey and review the choices of how the waveform will be stored { LeCroy Binary, Spreadsheet, MATHCAD, PSPICE }. Select LeCroy Binary.
5. The **DESTINATION** softkey will default to Floppy.
6. In the **FILENAME** softkey menu filename has defaulted to the trace name that was chosen in step 2. Filename may be modified.
7. Press **EXECUTE** and the waveform will be stored.
8. If several waveforms are to be stored then enable auto-increment; AUTO INCR: YES / NO to YES. The Index may be initialized to any number from 1 to 999 (999 maximum). The filename that is written to disk will be "Filename_Index". (Example: CH1_001)

   Each time the Execute softkey is pressed the Index will automatically increment.

TYPE	WAVEFORM SOURCE	DESTINATION	DATA FORMAT
Trace	CH1 CH2 CH3 CH4 M1 M2 F1 F2	(1) Internal Memories M1 or M2 OR (2) Disk FILE with user assigned name and user option for auto-increment	(1) Internal waveform format OR (2) LeCroy Binary Spreadsheet MATHCAD PSPICE
Snapshot	All displayed Traces plus current SETUP	Disk FILE with user assigned name and user option for auto-increment	SCPI compatible text file
Test	All displayed Traces plus current SETUP	Disk FILE with user assigned name and user option for auto-increment	SCPI compatible text file
Custom	All displayed Traces plus user option for current SETUP AND/OR Measurement Results	(1) Disk FILE with user assigned name and user option for auto-increment AND/OR (2) Spreadsheet Disk File with user option for APPEND	(1) LeCroy Binary Spreadsheet MATHCAD PSPICE (2) Spreadsheet

Table 8: Storage Types

Setup Storage

LS-140's SETUP information is separated into two unique files; SCOPE and I/O. The SCOPE file includes all of the Acquisition, Display and Processing functions, while the I/O file includes only the Hardcopy and External Interface information.

Figure 17 shows the Store Setup softkey menu.

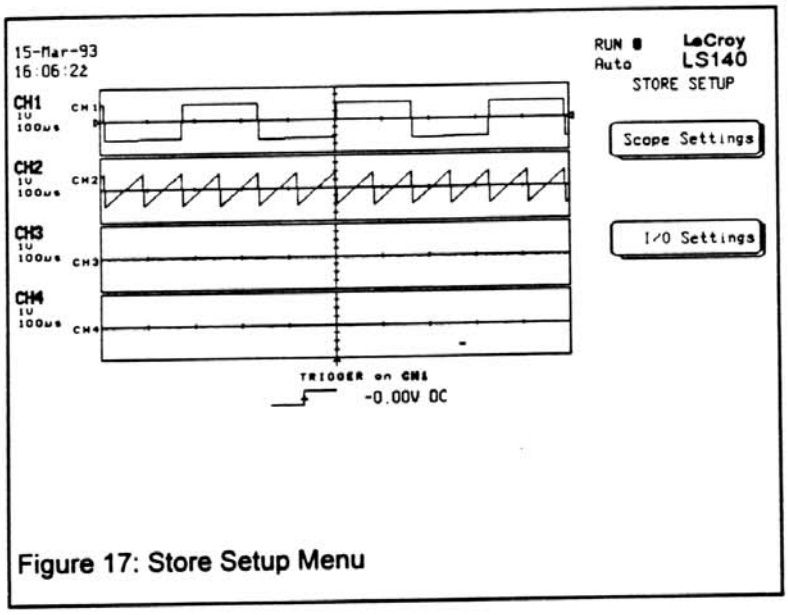


Figure 17: Store Setup Menu

LS-140's Setups are stored in several ways.

(1) Whenever the LS-140 is powered off the current SCOPE and I/O settings are preserved in battery backed memory. These settings are automatically recalled when the instrument is next powered on.

(2) Scope Settings information is stored to floppy disk as part of SNAPSHOT, and TEST storage types.

(3) By using the SETUP storage type.

Note: I/O SETTINGS can only be stored to disk by using the SETUP storage type.

Using Recall

The LS-140 is able to format and store several different data types (i.e. Spreadsheet, MATHCAD, PSPICE), but these formats are only for export to other computers. The only data that can be recalled are Setups and Waveforms stored in LeCroy Binary format.

As shown in the following table each RECALL: "TYPE" performs a slightly different function.

TRACE: Recall is used to selectively recall any single waveform to an internal memory.

SNAPSHOT: Recalls any SNAPSHOT file and sets the LS-140 to STOP Acquisitions. The purpose for stopping data acquisitions is to allow Channel data or Function data to be recalled and not be immediately erased by new acquisitions.

TEST: Recalls any TEST file. The TEST storage type is provided as an aid for sequential waveform comparisons (e.g. a manual board test procedure). The difference between TEST and SNAPSHOT storage types is that TEST only contains reference waveforms and does not effect the Run/Stop status. This allows for channel and memories to be displayed simultaneously but channel data will be the current live input.

USING TEST RECALL **Exercise 12**

The TEST recall type assumes that a series of "Golden Waveforms" and test setups have been stored to a floppy disk or network using the TEST storage type. The following procedure is used to illustrate the operation of TEST Recall.

1. Press operation key **RECALL**
2. Press softkey **TEST**
3. Set **AUTO**increment to **YES**
4. Press softkey **EXECUTE**

4a. Alternatively setup **Smart Probe** for **RECALL TEST**.

A TEST file is recalled which initialize the LS-140 with the required acquisition, display and processing Setup and restores one or both memories.

5. Acquire live data and compare to the recalled waveforms.
6. Press softkey **EXECUTE** and repeat step 5 until the sequence is complete.

RECALL OPERATION

TYPE	WAVEFORM SOURCE	DESTINATION	DATA FORMAT
Trace	Disk File with default name:CHX_nnn.LWF Where: X = {1,2,3,4} nnn = {0 to 999)	Internal Memories M1 or M2	LeCroy Binary
Snapshot	Disk File with default name:SNAPnnn.LSF Where:nnn = {0 to 999}	Restores exact SETUP with all Channels, Memories, and Functions. Sets RUN/STOP to STOP, to prevent channel updating.	LeCroy Binary
Test	Disk File with default name:TESTnnn.LTF Where:nnn = {0 to 999)	Restores exact SETUP and Memories. System remains in RUN.	LeCroy Binary

Table 9: Recall Operation

File Naming Conventions

LS-140 uses a standardized scheme for filenames when storing and recalling files from disk.

All files adhere to the DOS convention of an 8 character name and 3 character extension.The default extensions are defined below for each of the data formats supported by LS-140:-

.PLT Hardcopy Plotter format file*
.PRN Hardcopy Printer format file
.PCX PC-Paintbrush compatible graphics file
.BMP Windows Bit-Map compatible graphics file
.TIF Tag-Image format compatible graphics file

.LWF LeCroy Binary waveform file (LeCroy waveform format)
.PNL LeCroy Scope Settings file*

.CFG LeCroy I/O settings file*
.LSF LeCroy Snapshot file*
.LTF LeCroy Test File*

.PWL PSpice Piece-wise linear format file*
.PRN MathCad import compatible file*
.TXT Spreadsheet Import compatible file*

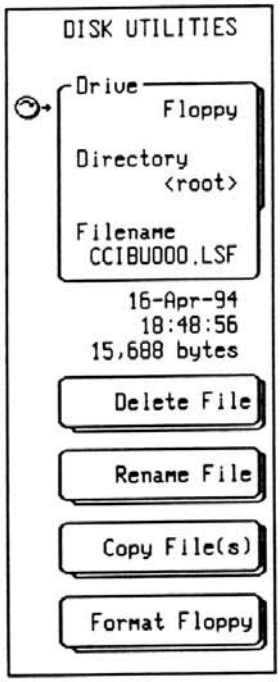
Many of the file formats supported in LS-140 can also accommodate a unique numeric index to facilitate an auto-incrementing filename.

When the auto-increment feature is supported, for a particular file format, a three-digit numeric index is accommodated in the last 3 digits of the 8 character filename, see "nnn" in table 9.

Note that files with extension marked * are ASCII text files and may be read or edited using a standard text editor.

Disk Utilities

The Disk Utilities Menu can be found in both the "STORE" and "RECALL" menus. This menu supports various file operations such as copying between storage media, changing directories, deleting files, renaming files, and formatting floppy disks.



SOFTKEY LABEL	*SOFTKEY FUNCTION*
Drive	Select one of: Floppy, Hard Disk, Network Disk.
Directory	Select active directory for selected drive.
Filename	Select file from those available, or <All Files>.
Delete File	Delete the selected file(s).
Copy Files	Copy the selected file(s) to a different drive.
Format Floppy	Format a 1.44Mb Floppy Disk.

Figure 17A

The STORE, RECALL and HARDCOPY system use a default directory (or path) for all file related operations. The default directory for each drive is specified using the "Directory" Softkey in the "DISK UTILS" menu.

Independent directories may be specified for the floppy disk, hard disk (if installed), and any attached network accessible disk (only applicable when the LS-NET option is installed).

The "Directory" menu allows the user to change the default directory as well as create new sub-directories and remove unwanted directories. When editing the directory path, the currently selected default is displayed in a status line above the graticule. Note than in order for a directory to be removed all files and sub-directories within it must first be removed.

The amount of free space on the currently selected drive is displayed in the status line above the graticule when in the disk utilities menu.

SOFTKEY LABEL	*DOS COMMAND EQUIVALENT*	*SOFTKEY FUNCTION*
Goto Previous	"CD.."	Go back one level in the directory structure.(e.g. If the current directory is \test\pcb_1 then pressing "GOTO PREVIOUS" will change the directory to \test)
Subdirectory		SUBDIRECTORY is used to select the directory path. (NONE indicates no sub-directories in this path)
Go Into	"CD 'name'"	When a Subdirectory selection is made press GO INTO to make the selected Subdirectory current
Goto Root	"CD\"	Return to the top of the directory structure
Make Directory	"MKDIR ;name'"	Creates a Subdirectory
Remove Dir.	"RMDIR name"	Remove a Subdirectory (Subdirectory must be empty)
Directory Name		Subdirectory name used by MAKE DIRECTORY.

Table 10: Directory Menu Softkeys

The current full directory path is displayed in the status line above the graticule.

Processing Waveforms

When the MATH/MEMORY operation key is pressed the softkey menu of figure 18 is displayed.

There are two math function traces F1 and F2 and nine math functions. Each function is described in the following MATH FUNCTIONS table. When FUNCTION F1 is enabled and the setup softkey depressed the setup menu of figure 19 is displayed. This figure illustrates addition of an input channel to a memory. Table 8 describes the full list of standard processing options.

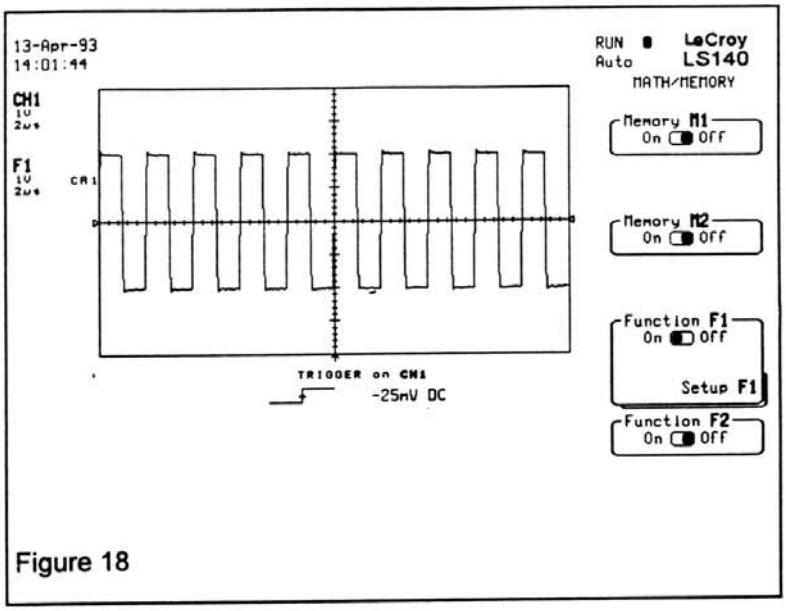


Figure 18

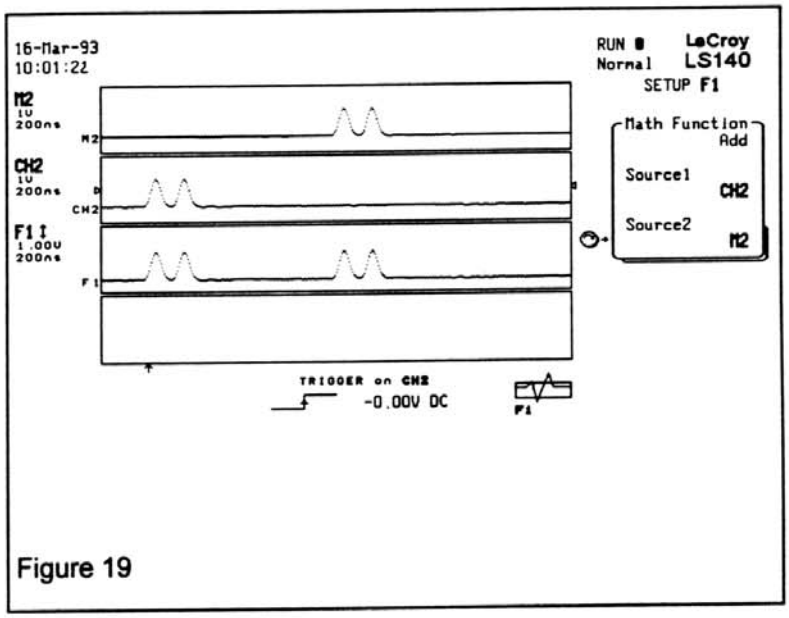


Figure 19

Math Functions

Function Name	*Function Definition*
Copy of Trace	F(X) = Source Where: X is defined as (1 or 2)
Invert	F(X) = -Source Where: X is defined as (1 or 2)
Add	F(X) = Source1 + Source2 Where: X is defined as (1 or 2)
Subtract	F(X) = Source1 - Source2 Where: X is defined as (1 or 2)
Continuous Avg.	$F(X)_i = ((Weight-1) * F(X)_{i-1} + Source)/Weight$ (Reference Figure 20) Where: X is defined as (1 or 2) Weight is user selectable (1, 3, 7, 15, 31, 63, 127) i is the current sweep (or trigger)
Summation Avg.	F(X) = is the repeated addition, with equal weight, of successive source waveform records Where: X is defined as (1 or 2)
Envelope	F(X) = is a dual value waveform formed from the extrema (Floor and Roof) values over multiple acquisitions of the source. Where: X is defined as (1 or 2)
Roof	F(X) = is a display of the floor function of the source, that is, the minima of the source from multiple acquisitions. Where: X is defined as (1 or 2)
Floor	F(X) = is a display of the roof function of the source, that is, the maxima of the source from multiple acquisitions Where: X is defined as (1 or 2)
Smooth	F(X) = an N-POINT moving average of the Source. (Reference Figure 21) This is a form of digital filtering which reduces the effective bandwidth of the Source. Where: X is defined as (1 or 2) Points is user selectable (3, 5, 7, 25, 49, 55)

Table 11: Waveform Processing Functions

Use averaging for noise reduction

Waveform averaging is a powerful tool for recovering signals buried in noise. The LS-140 supports both Continuous (or weighted) averaging, and Summation averaging.

Using Continuous averaging each time a new waveform is acquired it is weighted and then added to the final result. The advantage of this type of averaging is that not only does it provide noise reduction but it also follows slow changes in the signal.

Depending on the amount of noise different weights may be used to achieve a reasonable display. The larger the Weight the longer the time to acquire a stable waveform. This technique only works when a reliable trigger signal is available, i.e. the waveform is repetitive.

Summation averaging consists of the repeated addition, with equal weight, of successive source waveform records. If a stable trigger is available the resulting average has a reduced random noise component compared to a single shot record. When the specified number of sweeps has been reached the system either restarts the average, or stops depending upon the state of the **Auto Restart** toggle switch. Note that a maximum of 1000 sweeps may be averaged in summation mode.

When summation averaging is turned on the function trace updates at a slower rate than normal. This allows a much higher averaging rate. To maximize the averaging rate the source channel may be switched off.

Combining the 'Store to M1' Pass/Fail action with waveform averaging can allow selective averaging, i.e. only waveforms which meet the pass/fail criteria may be averaged. See the Pass/Fail section of this manual for more information.

The figure below shows a noisy input from Channel 2 and its average in Function 1.

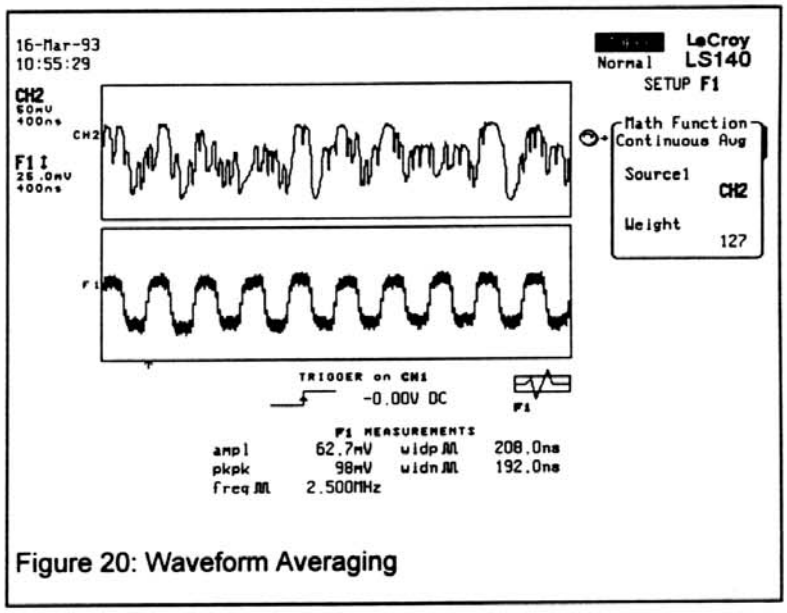


Figure 20: Waveform Averaging

Use Smoothing filters for noise reduction

Smoothing filters may be used to improve signal fidelity when the interfering noise is a higher frequency than the signal. The advantage of smoothing filters over averaging is that it does not need a repetitive input signal . Smoothing filters operate on each waveform independently so a single acquisition is all that is required. Figure 21 depicts the use of a smoothing filter.

A disadvantage of smoothing filters is the reduction of bandwidth. As the number of points are increased the more noise reduction (filtering) that is applied and therefore the more bandwidth reduction. Table 12 shows the effective bandwidth for each smoothing filter as a function of several sampling rates.

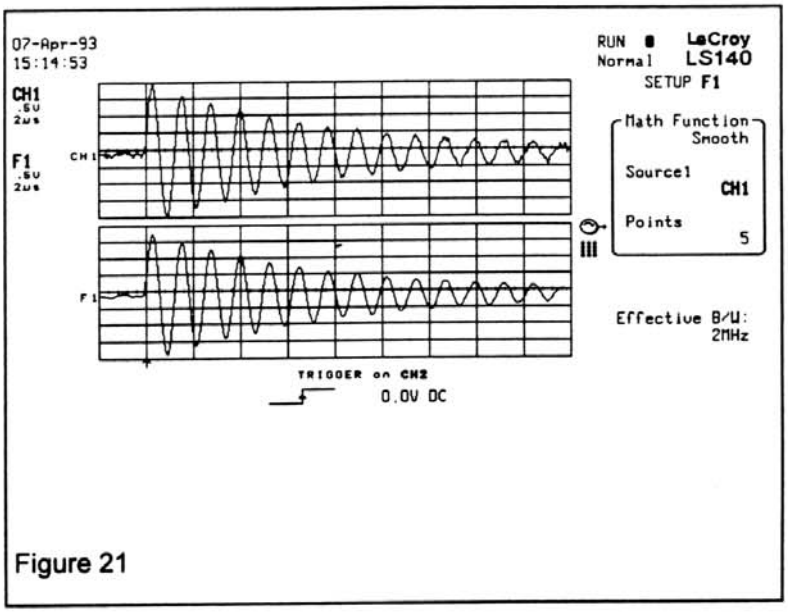


Figure 21

Smoothing Filter (Points)	*10 nS/Sample*	*5 nS/Sample*	*500 pS/Sample*
None	50 MHz (Nyquist)	100 MHz (Nyquist)	100 MHz (System Limit)
3	15 MHz	30 MHz	100 MHz
5	9 MHz	18 MHz	99 MHz
7	6 MHz	13 MHz	98 MHz
25	2 MHz	4 MHz	82 MHz
49	903 KHz	2 MHz	59 MHz
55	804 KHz	2 MHz	54 MHz

Table 12: Smoothing Filter Bandwidths

Perform differential measurements

Very often a simple differential measurement may be used to discriminate a noise source. By setting one channel as the reference and subtracting a second channel the common signals between the two channels will be removed.

In figure 22 the F1 trace is the result of subtracting CH2 from CH1. In this example a high frequency interference has been eliminated and therefore must be coming from the channel 2 source.

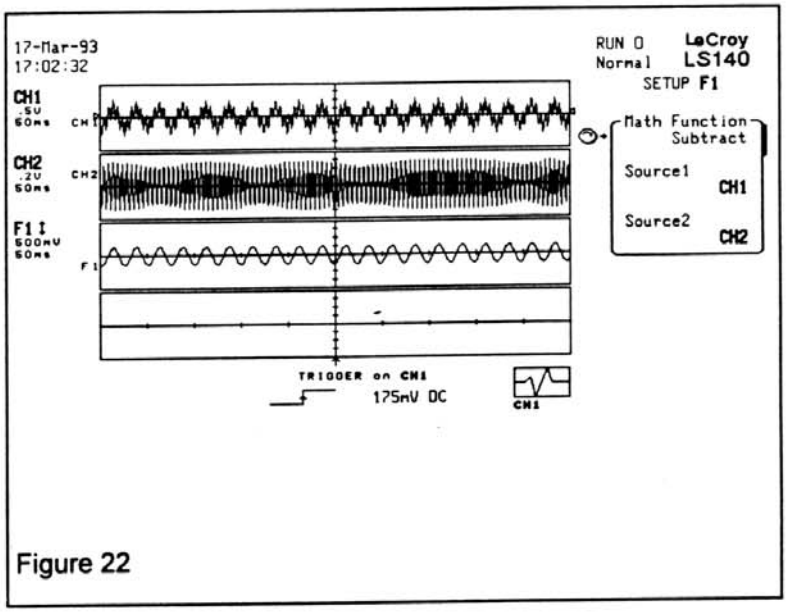


Figure 22

Extrema functions (Roof, Floor, Envelope)

Extrema waveforms are computed by a repeated comparison of successive source waveform records with the already accumulated extrema waveform which consists of a maxima record (roof), and a minima record (floor). Whenever a given datapoint of the new waveform exceeds the corresponding max. value in the roof record, or is smaller that the corresponding value in the floor record, it replaces it.

This has the effect of recording the maximum and minimum envelope of all waveform records accumulated. The Roof functions displays only the roof, Floor displays only the floor, and Envelope shows both.

If the source to one of the extrema functions extrema function is an extrema waveform itself (i.e. an alias-protected trace) then the roof of the roof waveform, and floor of the floor waveform is computed.

When the selected number of sweeps has been reached the system either restarts the enveloping process, or stops depending upon the state of the Auto Restart toggle switch.

Note: Setting the **# Sweeps** value to 1 and turning **Auto Restart** On can be used to generate the instantaneous roof or floor of an alias-protected (or envelope) function.

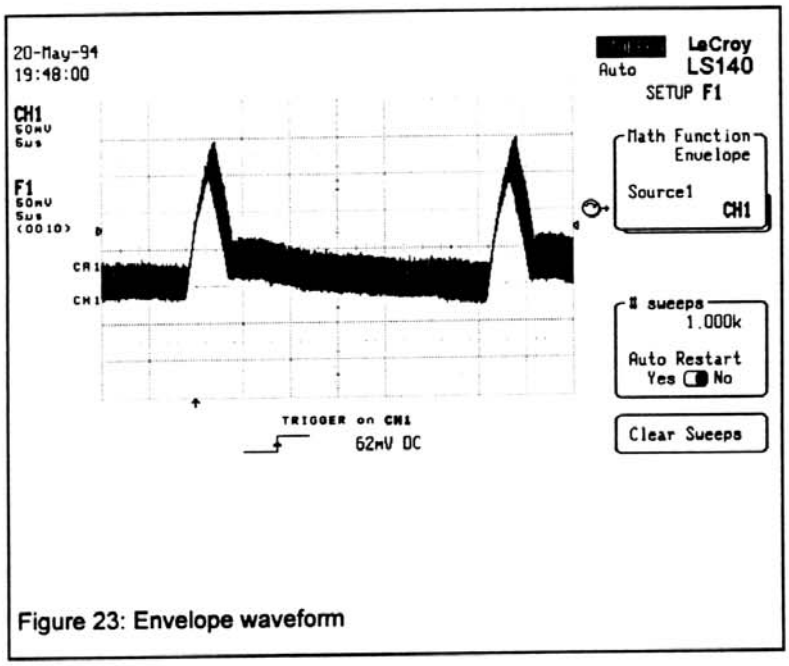


Figure 23: Envelope waveform

Pass/Fail

Pass/Fail is an operation of comparing a set of reference measurements or waveform masks with the current inputs and then automatically taking action upon meeting the Pass or Fail criteria. The types of actions that may be enabled include; audible alert (beep), storing measurements to a spreadsheet file, sending a fax, or storing the offending waveforms to a floppy or network file. Interrupts are also automatically sent via GPIB. Multiple PASS/FAIL setups may be stored on floppy disk and used either manually or via remote I/O.

Pass/Fail Basics

The PASS/FAIL softkey menus are contained under the operation key CURSOR/MEASURE. Pass/Fail monitoring is enabled by setting the "Pass/Fail On:Off" softkey to ON as shown in figure 24.

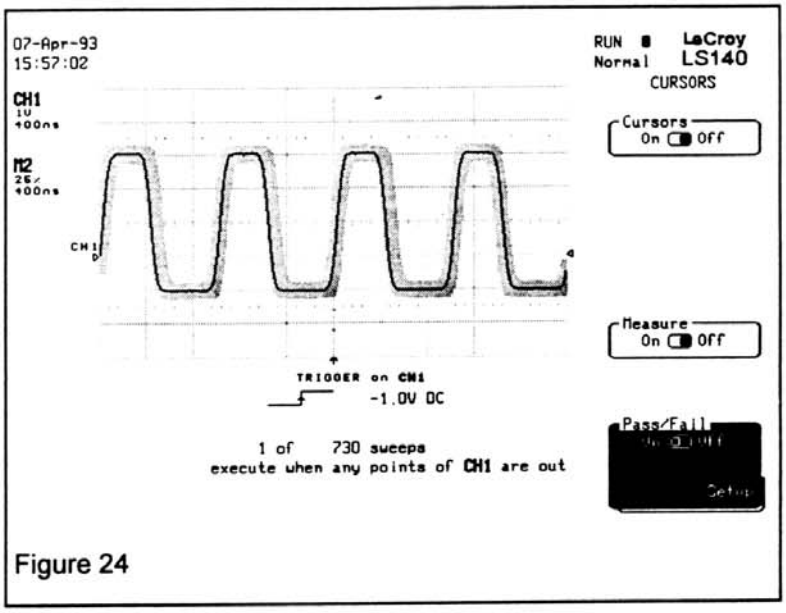


Figure 24

The comparison of the selected trace with either a mask or a set of three measurements is selected and controlled through these setup menus. In this figure a Mask comparison is being performed. The information at the bottom shows a counter of the total number of "SWEEPS" or trials and the number of "MATCHES" to the Pass/Fail criteria.

In addition the description of the selected Pass/Fail criteria is also displayed (When using masks : "execute when **ANY** points of **CH1** are **OUT**"). i.e. When any part of the acquired waveform falls outside the mask.

Using MASKS for Pass/Fail

To setup the Pass/Fail operation press the CURSOR MEASURE operation key and then the PASS/FAIL SETUP softkey. The softkey setup menu of figure 25 will be displayed.

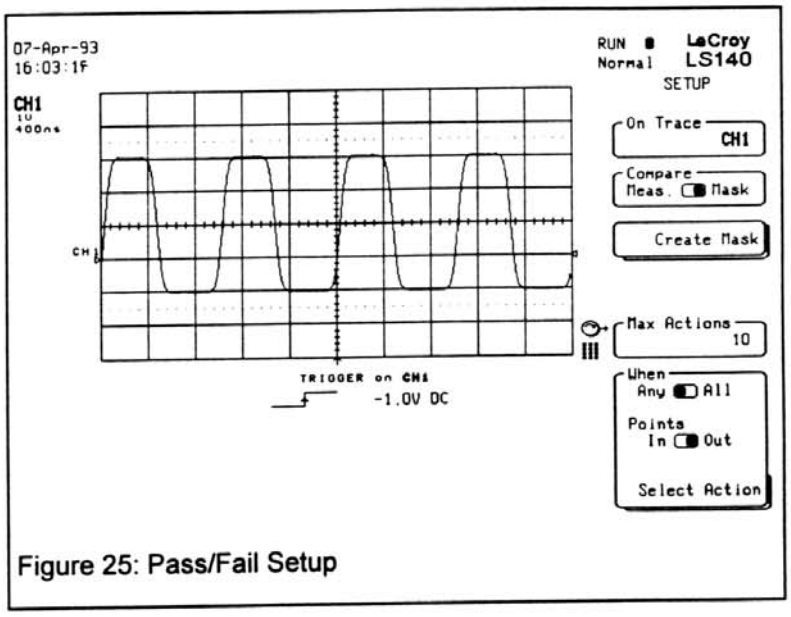


Figure 25: Pass/Fail Setup

The Pass/Fail monitoring feature operates upon only one source trace. This trace maybe a live input {CH1 CH2 CH3 CH4} a Function {F1 F2} or a Memory {M1 M2}. Use the following exercise to become familiar with the setup of Pass/Fail.

Creating and Saving Masks

Masks (or templates) used during Pass/Fail operation must be loaded into Memory **M2**. Masks may be created internally using the internal mask creation capability or loaded externally from disk, GPIB or the network. Once a mask has been created use the STORE feature to save it to disk or the network.

A mask was created internally in Exercise 13. This feature provides a simple method to create masks (OR Templates) by using acquired waveforms. In Exercise 13 the default values for Delta V and Delta T were used (ΔV = 500 mDiv and ΔT = 300 mDiv). These parameters are defined in divisions for ease of setup. The ΔV and ΔT values create a mask which is symmetrical in both voltage and time about the acquired waveform.

A further method of creating a mask is to accumulate an envelope of the known good signals over many acquisitions. This can be done using a function (F1 or F2). Once the desired envelope has been generated it is copied to memory M2, additional tolerance bands can be added around the envelope waveform by using "Create Mask from Trace M2" any Pass/Fail Mask operation (create mask with M2 as source or switching Pass/Fail On) will automatically convert the envelope waveform into a mask.

The only difference between an envelope waveform and a mask is that the envelope is displayed at the trace intensity whereas a mask is displayed at the graticule intensity allowing a waveform to be seen within a mask.

PASS/FAIL with MASKS EXERCISE **Exercise 13**

Use the following procedure to setup up Pass/Fail to operate with Masks.

1. Connect and display a simple signal using Channel 1.
2. Press the **CURSOR/MEASURE** operation key.
3. Press the **PASS/FAIL SETUP** softkey.
4. Press the **ON TRACE** softkey and select **CH1**
5. Press the **COMPARE** softkey and select **MASK**.
6. Press the **CREATE MASK** softkey.
7. Press **FROM TRACE** and select **CH1**
8. Press **EXECUTE**.

   The default values of Delta V and Delta T should be reasonable.
9. Press **MENU RETURN**.
10. The **MAX ACTIONS** softkey is used to limit the number of Pass or Fail events which can occur before Pass/Fail monitoring will be disabled.
11. Select the monitoring criteria using the **"WHEN ANY:ALL"** and **"POINTS IN:OUT"** softkeys.
12. Press the **SELECT ACTION** softkey and enable **BEEP**.
13. Press **MENU RETURN** twice and return to the **CURSOR/MEASURE** softkeys of figure 26.
14. Enable PASS/FAIL by setting **"PASS/FAIL ON:OFF"** to **"ON"**.
15. Adjust (or disconnect) the input to channel 1. The beeper will sound as many times as the **MAX ACTIONS** softkey has been set.

Using Measurements for Pass/Fail

To setup measurements for Pass/Fail operation press the Pass/Fail SETUP softkey and then use the "COMPARE Meas : Mask" softkey and select Measurements. The softkey setup menu of figure 26 will then be displayed.

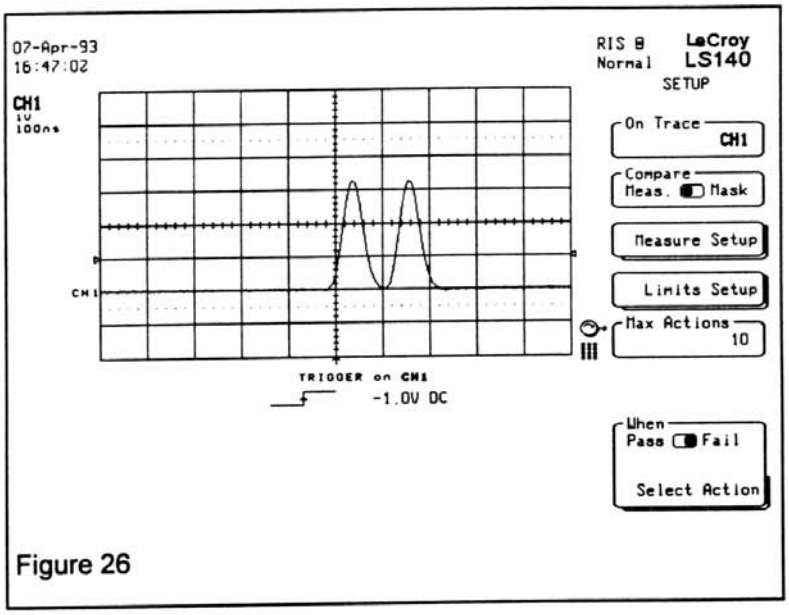


Figure 26

The MEASURE SETUP softkey is used to select up to three measurements. The LIMITS SETUP softkey menu is shown in figure 27 and is used to establish the pass/fail criteria for the selected measurements. Reviewing figure 26 the softkey menu assists in establishing the testing logic as you work from the top to the bottom of the menu.

EXAMPLE: The **TEST**: **PASSES or FAILS** if Measurement 1 is **GREATER THAN** or **LESS THAN** the limit value **AND** if Measurement 2 is **GREATER THAN or LESS THAN** the limit value **AND** if Measurement 3 is **GREATER THAN** or **LESS THAN** the limit value.

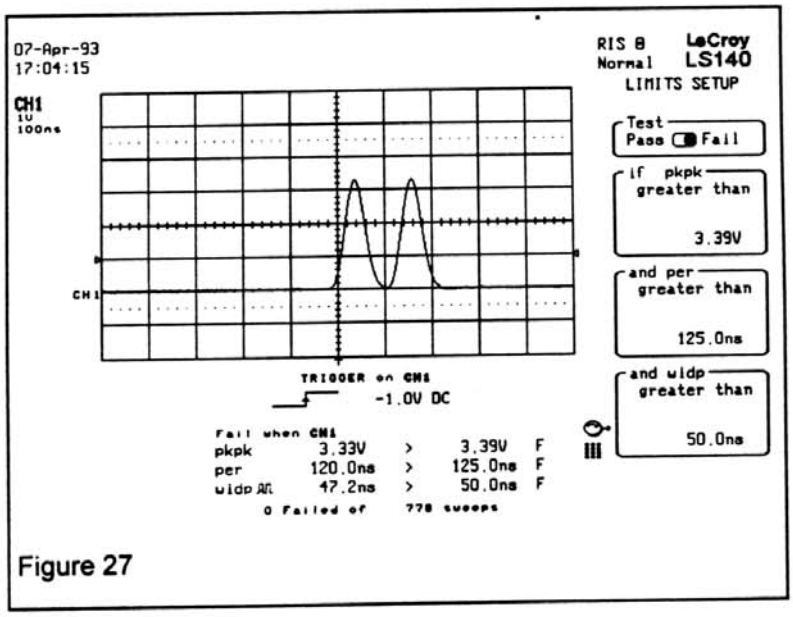


Figure 27

The actual measurements and the test criteria are always displayed at the bottom of the display while Pass/Fail Measurements is enabled.

After the test criteria has been setup select the ACTIONS to be taken and then enable Pass/Fail monitoring.

Automatic Operations During Pass/Fail

ACTION	*DESCRIPTION*
STOP ACQ	Stop acquisitions. When this action is selected the first time the Pass/Fail criteria is meet all further acquisitions will be prevented regardless of the MAX ACTIONS setting.
CUSTOM STORE	Performs the current Custom Store setup. (Defined in custom store menu)
SNAPSHOT	Performs a Snapshot storage type of all currently displayed traces.
HARDCOPY	Performs the current Hardcopy setup (Defined in hardcopy menu)
PULSE OUT	Generates a short pulse on a pin on the rear-panel Centronics printer port.
STORE TO M1	Stores the current source waveform into memory M1.
BEEP	Sound an audible warning.

Table 13: Pass-Fail Actions

Any combination of the actions listed in the previous table will occur for each valid Pass/Fail criteria. (Note: Remember STOP ACQ halts any further processing after the occurrence of the first valid event)

GPIB Interrupt

When the LS-GPIB option is installed it is possible to enable SRQ generation during each Pass/Fail event. After the interrupt is received reading the GPIB's main status register will indicate if Pass/Fail was the cause. The details for enabling SRQ generation and reading status registers are contained in the LS-140 Remote Programmer's Manual.

Pulse Out

The Pulse-Out operation generates a 5mS pulse on the SELECT INPUT line of the 25-way 'D' type Centronics Printer connector when the Pass/Fail criteria have been matched. This may be used to trigger external devices.

Store to M1

The Store to M1 option transfers a copy of the pass/fail source waveform (as specified by the pass/fail 'On Trace menu selection) into memory M1 when a pass/fail event occurs. This may be used in conjunction with waveform averaging using M1 as a source to selectively average only waveforms which meet (or fail) selected criteria.

FAX Transmission on System Fault

When the LS-FAX option is installed you may have the LS-140 send a fax of the display after a Pass/Fail event. Refer to the section "Transmitting a Fax" in the Connectivity Users Guide section of this manual for the proper Hardcopy setup. Then as described above enable HARDCOPY as one of the selected actions. The use of the Max actions selection is highly recommended to limit the number of fax transmissions in the event of continuous Pass/Fail actions being performed.

Pass/Fail with Hardcopy

If one of the enabled Pass/Fail actions is hardcopy and during the hardcopy the Cancel Entry key is pressed, both the Hardcopy and Pass/Fail testing will be aborted (i.e. hardcopy terminates and Pass/Fail is switched off).

Using Max Actions

Max Actions limits the number of Pass/Fail tests performed by switching off Pass/Fail after the pre-selected number of tests. Examples of its use are to limit the amount of data stored to disk or restrict the number of faxes that are sent. When the Pass/Fail test count reaches the Max Actions limit, the pass/fail system is automatically switched off.

Waveform Storage to the NETWORK

When the LS-NET option is installed you may store waveform data automatically after a Pass/Fail event. Refer to the Store and Recall section for setting the data destination as Network for SNAPSHOT or CUSTOM storage types. Then enable either (or both) SNAPSHOT or CUSTOM store as a selected action for Pass/Fail.

Display Operation

The DISPLAY system provides controls that affect the representation of acquired data on the screen. This includes type, intensity, persistence.
The display type allows the user to define the presentation of the trace data on the screen. The available types are described below:
LS-140 provides many display types to assist in viewing your data.

Type	Description
Single	All traces are displayed on same grid.
Dual	Traces are separated onto multiple grids for ease of viewing.
XY	Displays first trace (X) against second trace (Y)
XY & YT	As (XY) above but includes a Y-T graticule for simultaneous viewing of data as Y-Y and X vs. Y
Cascade	See Below

Table 14: Display Softkey Descriptions

The grid style can be any of the following:-

FULL The conventional 10x8 division grid with small sub-division markers.

CROSS-HAIR Only the central vertical and horizontal grid lines are displayed with their sub-division markers.

BORDER Only the screen border is displayed, this is useful when there is a larger amount of data on the screen or when persistence mode is switched on.

Arranging Traces on the Display

LS-140 can display up to 8 traces simultaneously (CH1 CH2 CH3 CH4, M1, M2, F1, F2).The way the traces are displayed in multiple grid displays, X-Y and cascade is contingent on their respective position in the Trace List. The trace list consists of 8 slots. When a trace is switched on it occupies the first vacant position in the trace list. To re-order traces, all traces must be switched off and then switched back on in the desired order.
X-Y display uses the first two traces in the display list. The first is the X-axis., The second is the Y-axis. Cascade display uses the first trace in the trace list. Multiple grid displays arrange the traces from top to bottom in the order they are found in the trace list.

Persistence and Intensity

Typically, each of the displayed waveforms is erased before the newly acquired waveform is displayed. Persistence mode stores previously displayed traces to allow comparison of a number of successive waveform acquisitions. These previous acquired waveforms are displayed at a different intensity to the most recently displayed trace.LS-140 can display an infinite number of sweeps i.e. infinite persistence. When persistence display is ON, the accumulated persistence map can be cleared manually by using the PERSISTENCE CLEAR menu item.

The Intensity control affects the brightness of the waveform traces and text. The Grid Intensity control affects the brightness of the grid, Pass/Fail mask and persistence map.

Cascade Display operation

The Cascade display type provides a simultaneous display of either 12 or 24 waveforms. This multi-trace display is created from the first trace in the trace list (any of CH1, CH2, CH3, CH4, F1, F2, M1, M2) i.e. the first trace switched on. Figure 28 shows the softkey menu for the Cascade display type.

To create a cascade display use the PREVIOUS and NEXT softkeys to position the trace cursor located on the left edge of the graticule. As shown in figure 28 the current (live) channel 1 input is located at trace CA2.
Each time the trace cursor is moved the previous trace location is preserved.

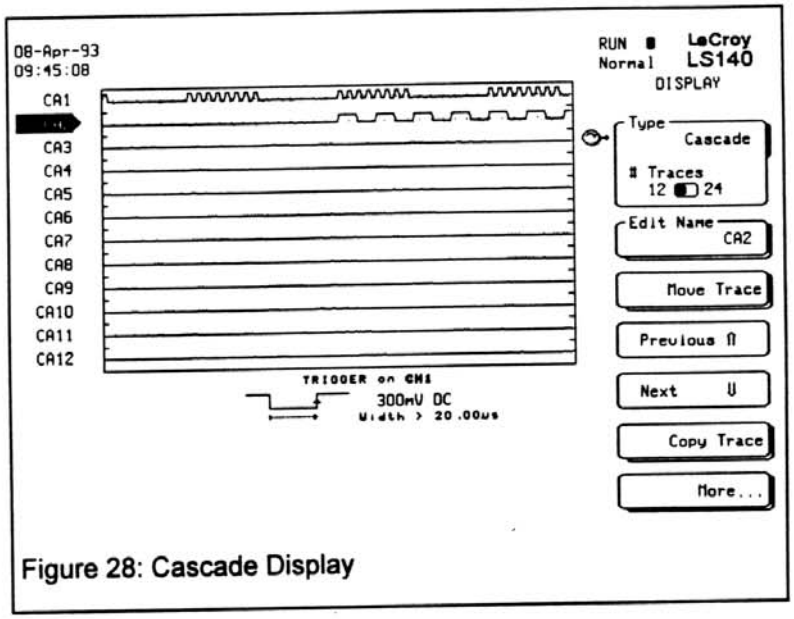


Figure 28: Cascade Display

The display is constructed over a number of acquisitions. If timing correlation is required between cascade traces, a stable trigger must be used. Only one trace is selected at any time and is indicated by its trace name being displayed in inverse video. When a trace is selected its trace label may be edited and traces moved for documentation or comparison purposes. As with all other display types Cascade may be stored and recalled using the SNAPSHOT storage type.

Using Measurements or Math Functions

Any two cascade traces can be copied to internal memory (M1 & M2) for further detailed analysis using the copy trace softkey. Once the data is in memory it can be operated on using most oscilloscope features including zoom functions and measurements.

Several uses of this display type are listed below :

(1) Create a Timing or State diagram

When analyzing a digital circuit a simple timing or state diagram can be created using the cascade display. To create this picture a repetitive input is required since each trace of the display is acquired at different times. (e.g. accessing the same memory location continuously)

For one hand operation use the Smart probe Cascade Next and Cascade Previous to control the location on the screen and SINGLE REARM to acquire data.

(2) Create a sequence record or visual history.

Cascade display can be used as a general purpose visual store of up to 24 reference waveforms. A selection of reference waveforms can be grouped together as a library, each waveform being named. This library can then be stored and recalled as a set using the snapshot storage type. When one of the waveforms is required it is simply selected using Previous/Next and copied to a memory for use.

As shown in the following figure several lines from a television signal are displayed for review.

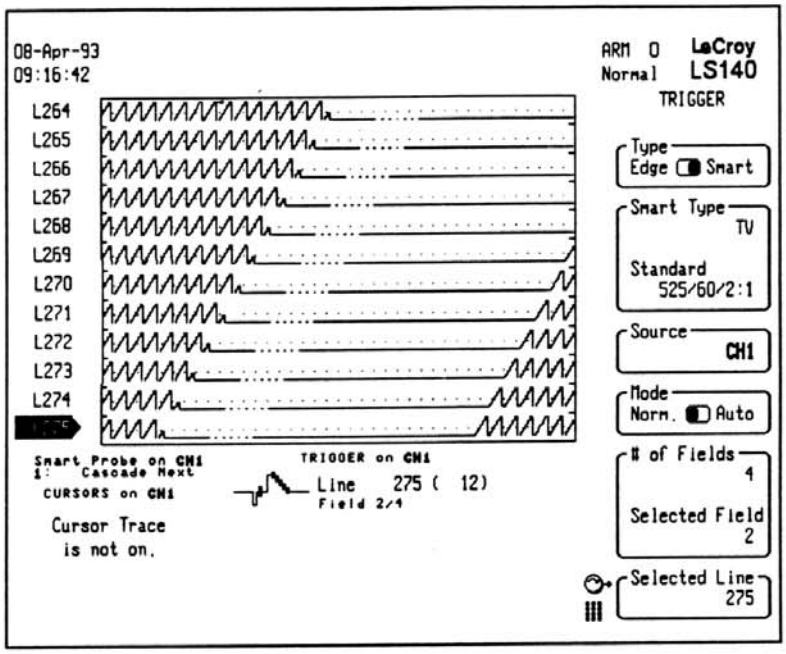


Figure 29: Cascade Display of TV Signal

Connectivity Users Guide

The LS-140 has extensive capabilities to communicate information. Supporting printers and plotters over the Centronics, RS-232, and GPIB interfaces is just the beginning. This section of the manual will cover the setup and use of all the external interfaces including:

- CENTRONICS
- RS-232
- GPIB
- FAX
- NETWORK
- EXTERNAL VIDEO

In addition, the selection of several graphics and data formats are provided to allow for direct compatibility between the oscilloscope data and your application. The type of formats supported include:

GRAPHICS

- .PCX PC Paintbrush
- .BMP Windows Bit Map
- .TIF Tag-Image Format

TEXT

- Spreadsheet
- MATHCAD™
- PSPICE™

Figure 30 shows a full system configuration of the I/O ports. Use this diagram to aid in identifying each interface as it is discussed.

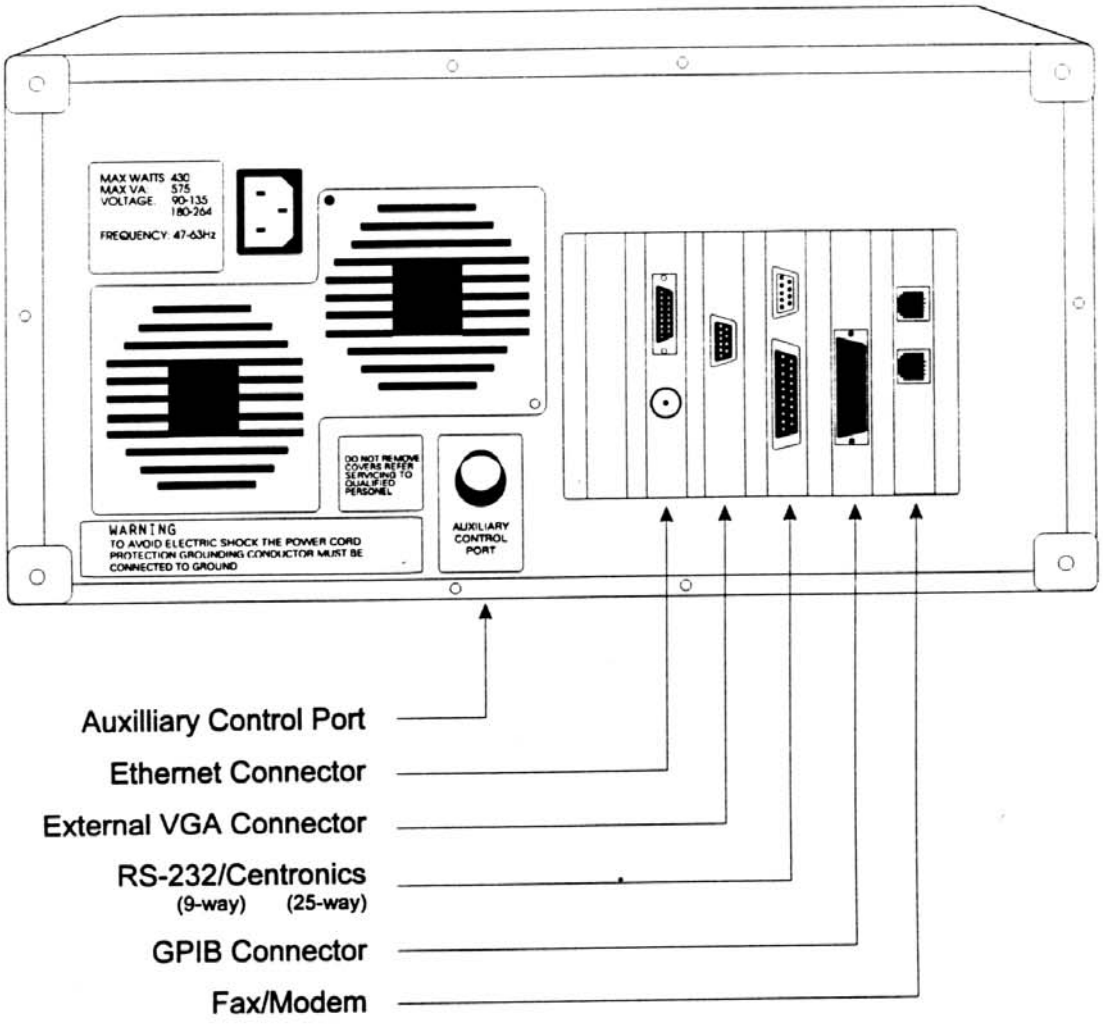


Figure 30: Back Panel of LS140 showing I/O Ports

RS-232-C Serial Interface Basics

The Serial or RS-232-C interface is used for both remote control and data communications. Configuration of the interface is accomplished through the SYSTEM CONFIG menu.

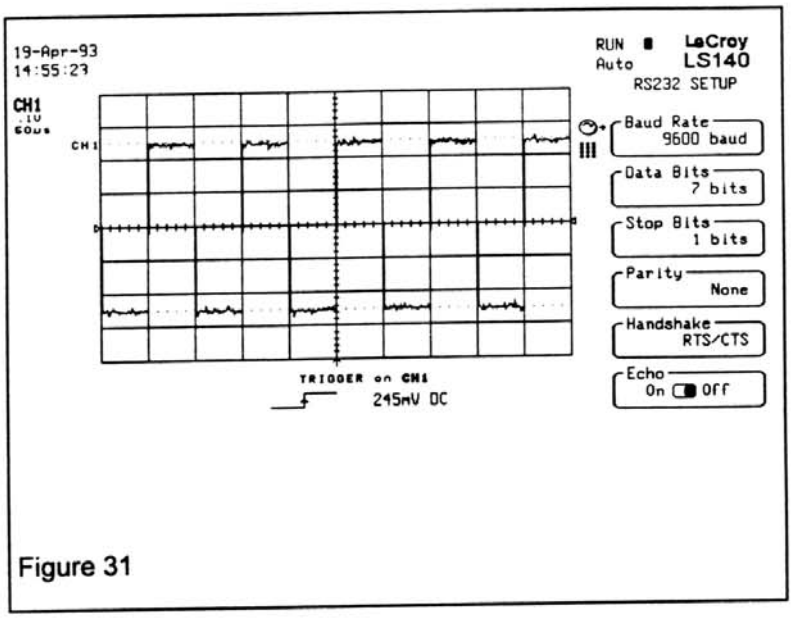


Figure 31

The RS-232 SETUP softkey menu shown in the figure above is obtained by;

Pressing the **SYSTEM CONFIG** Front Panel operation key.

Pressing the **COMMS SETUP** softkey.

Pressing the **RS-232 SETUP** softkey.

Each of the setup softkeys are defined in the following table.

Parameter	*Description*
Baud Rate	Transmission rate in characters per second. Transmission rate selections are: 50, 110, 300, 1200, 2400, 4800, 9600, 19200.
Data Bits	7 or 8 bits.
Stop Bits	1 or 2 bits.
Parity	None, Odd, or Even.
Handshake	Xon / Xoff (software handshake) or RTS / CTS (hardware handshake)
Echo	ON or OFF - When "ON" the scope echoes (transmits back over RS232) each character it receives. When connected to a terminal you probably want it ON. When performing remote control from a computer, turn it OFF.

Table 15: Serial Comms Setup

Referring to the figure 32 (rear panel), locate the RS-232-C (DB-9, D type, male) connector on the rear of the LS-140. The pin assignments for this connector are listed below.

PIN	*DEFINITION*		*DIRECTION*
1	CD	Carrier Detect	Input
2	Rx	Receive Data	Input
3	Tx	Transmitted Data	Output
4	DTR	Data Terminal Ready	Output
5	Ground		
6	DSR	Data Set Ready	Input
7	RTS	Request to Send	Output
8	CTS	Clear to Send	Input
9	RI	Ring Indicator	Input

Table 16: LS140 9-pin Serial Connector

The LS-140's RS-232-C output port is configured as a Data Terminal Equipment so that data is sent from pin 3 and received on pin 2. For remote operation, the RS-232-C port must be connected to a computer terminal. The necessary cable configuration is dependent on the type of device which will be connected and its requirements. Use the following cable arrangement examples as a guide.

DB9 to DB9

This wiring configuration is used for computers with DB-9-D connectors configured as Data Terminal Equipment. For example, this cable would be used to connect an IBM PC/AT compatible computer to the scope.

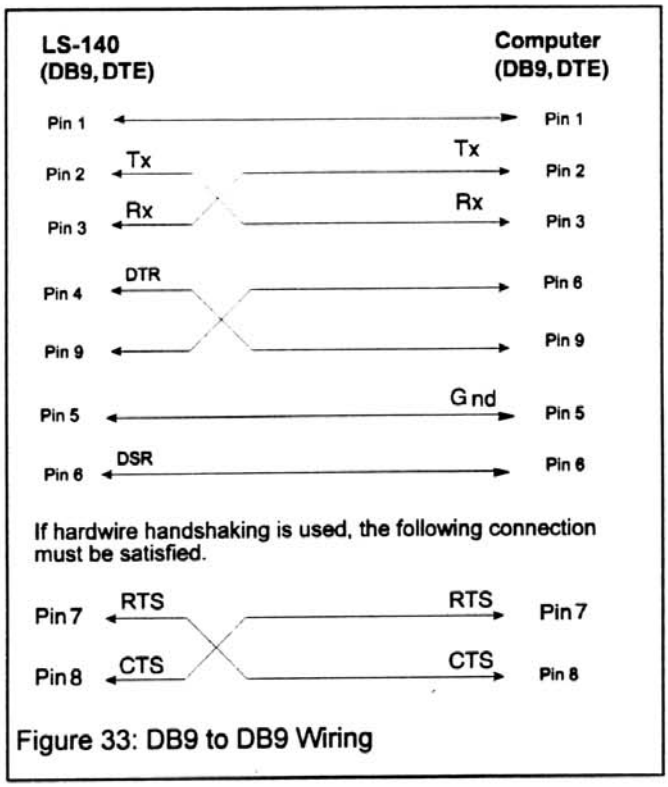


Figure 33: DB9 to DB9 Wiring

Centronics Interface Basics

The LS-140 uses a standard 25 pin (DB-25), D type, female connector as the Centronics (Parallel) output port. An adapter cable is required to convert the DB-25-D connector to the standard 36-pin bail lock connector used on most Centronics (parallel) printers.

LS-140 Parallel Interface Pin Assignments

Signal Pin assignments are shown for the 25-pin LS-140 connector, with the corresponding standard 36-way connector assignment in parenthesis.

Signal Pin LS-140 (Printer)	***Signal Name***	***Direction***	***Description***
1 (1)	Strobe	Out	A pulse is output to clock data to the printer
2 (2)	Data 0	Out	Data bits 0..7 transfer a byte of data to printer
3 (3)	Data 1	Out	
4 (4)	Data 2	Out	
5 (5)	Data 3	Out	
6 (6)	Data 4	Out	
7 (7)	Data 5	Out	
8 (8)	Data 6	Out	
9 (9)	Data 7	Out	
10 (10)	Acknowledge	In	Printer sends a low going pulse on this line to indicate that it has accepted a byte of data from the parallel printer interface
11 (11)	Busy	In	A high on this line indicates the printer cannot receive data
12 (12)	Paper Empty	In	A high on this line indicates the printer is out of paper
13 (13)	Select	In	A high on this indicates the printer is selected
15 (32)	Error	In	A low level on this line indicates that a connected
16 (31)	Reset	Out	A pulse can be output on this line to reset the printer
17 (36)	Select In	Out	A high on this selects the printer*
18..25 (19..30 & 33)	Ground		

Table 17: Centronics Interface Pin Connections

The parallel interface described above is highly standardized and is common to many PC computers. Standard Interface cables are readily available.

*Note that the Pass/Fail system can be configured to pulse pin 17 of the printer port for 5ms when pass/fail criteria are met. See the Pass/Fail section for more information

The devices on the GPIB network may be connected in any combination of a STAR or LINEAR arrangements (reference figure 34). Standard IEEE 488.2 cables must be used to connect all the devices and total length must not exceed 20 meters. The devices must conform to these rules:

- At least half the devices on the network must be turned on.
- One network can connect no more than 15 devices (including the controller).
- One device must be connected for every two meters of cable, assuming one device presents one standard device load.
- Each device must have a unique bus address.

The LS-140 communicates across the GPIB as a Talker or a Listener to receive remote host commands and send responses. The LS-140 implements the IEEE 488.2 interface standard as defined by the table on the following page.

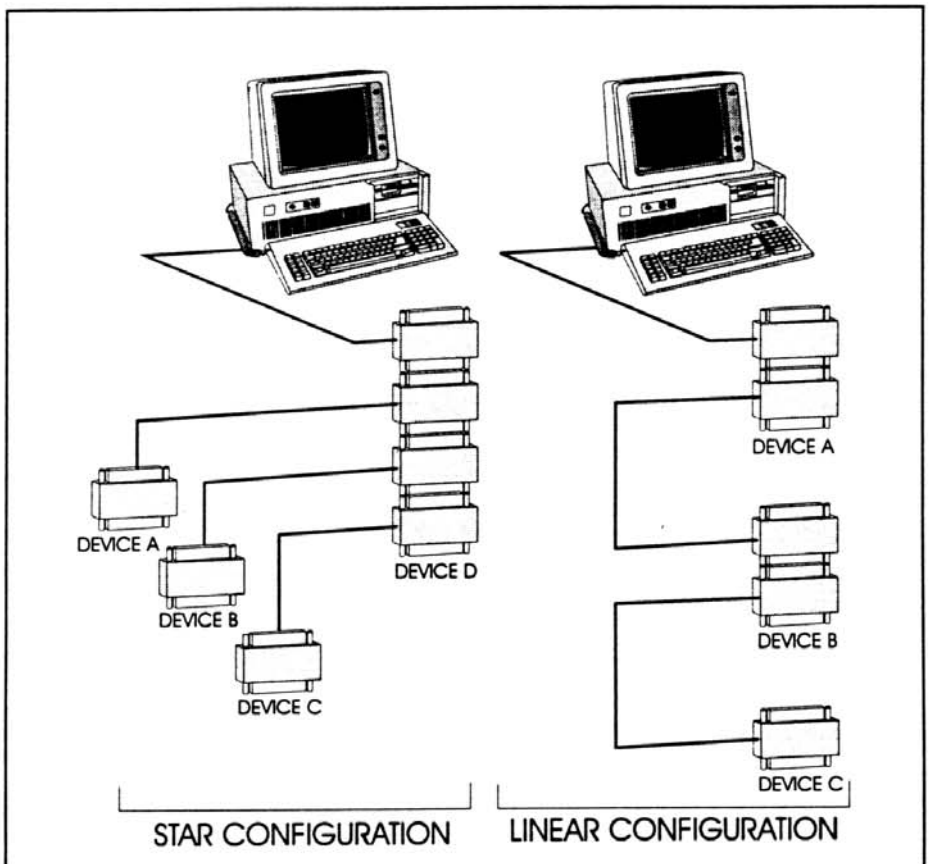


Figure 34: Examples of GPIB Network Arrangements

IDENTIFIER	*DESCRIPTION*
SH1	Sources Handshake complete capability.
AH1	Acceptor handshake complete capability.
T5	Basic Talker, Serial Poll, Talk Only Mode, Unaddress If MLA
L4	Basic Listener, No Listen Only Mode, Unaddress if MTA
SR1	Service request complete capability
RL1	Remote/Local complete capability
PP0	No Parallel poll capability
DC1	Device clear and Selected device clear, complete capability
DT1	Device trigger complete capability
C0	No controller capability
E2	Tri-state lines (except SRQ, NRFD, NDAC)

The GPIB SETUP softkey menu shown in the adjacent figure is obtained by;

Pressing the **SYSTEM CONFIG** operation key.

Pressing the **COMMS SETUP** softkey.

Pressing the **GPIB SETUP** softkey.

Address selection is the only setup parameter. Addresses from 1 to 31 may be selected. 6 is the default I/O setting.

Network I/O Basics

The LS-140's LS-NET option includes all the necessary hardware and software to access directories, files and printers on Novell NetWare servers. This allows LS-140 to:

- Send and receive Waveform and Setup data using the network disk.
- Hardcopy output to the network printer or network file.

The LS-140 supports the following network definition:

SPECIFICATION	*DEFINITION*
Server	Novell 2.1X to 3.11
Packet Styles	Ethernet 802.3
	Ethernet 802.2
	Ethernet SNAP
	Ethernet II
Connectors	BNC type Thin-Ethernet (10 Base 2)
	Twisted-Pair Ethernet (10-Base T)
	D-type Thick-Ethernet (10 Base 5)

Table 18: Network Support

You can easily set the LS-140 network configuration through the SYSTEM CONFIG:softkey menu shown below. To fully configure your network setup, both "COMMS SETUP" and "DISK PATHS" softkey menus will be used.

Your Network Login information is contained in the Network Setup softkey menu. To access this menu press "COMMS SETUP: NETWORK". Once this configuration has been entered it will be retained in non-volatile memory and may be saved using STORE: I/O SETUP.

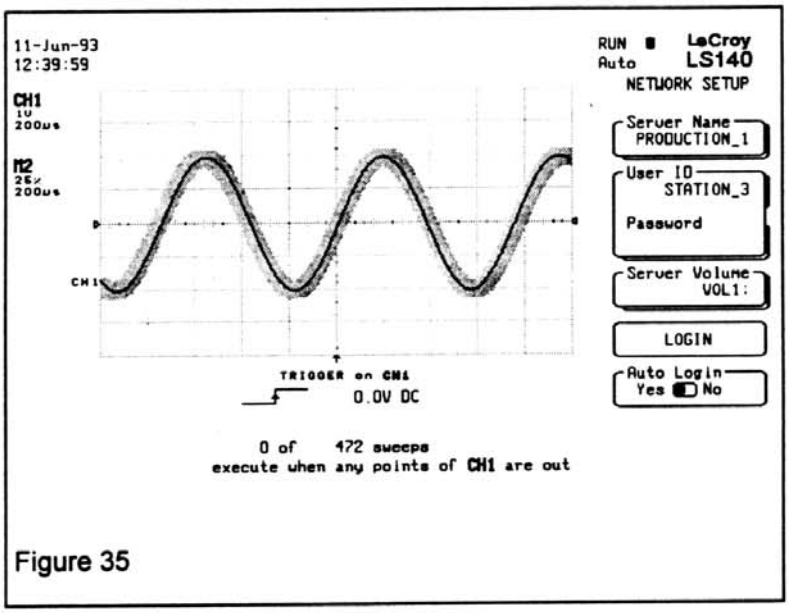


Figure 35

SOFTKEY LABEL	*SOFTKEY FUNCTION*
Server Name	The Name of the File Server
User ID	The User ID is the Login Name
Password	Optional Password associated with User ID For security reasons once entered this password will never be displayed again, but instead will be replaced with '*' characters.
Server Volume	The Volume name which will be mapped as the Network Disk. (SYS: or VOL1: are commonly used).
LOGIN	When this softkey is pressed, a manual Login process will be initiated using the selected server, user ID, password, and server volume.
Auto Login	If YES is selected, LS-140 will automatically Login to the server on power-up. If NO is selected, a manual Login must be performed, using the LOGIN softkey, to connect to the server

Table 19: Network Menu Softkeys

To set your disk directory, use the SYSTEM CONFIG and DISKPATH softkey menu and select "Network Path".

The "NETWORK PATH" softkey menu provides the capability to setup the required directory and file locations. As with all I/O configuration information this setup is restored automatically during power-on and may be preserved to a floppy or network file.

Using Network Disks and Printers

When the LS-Net option is installed and LS-140 is logged-in, STORE, RECALL and HARDCOPY operations can be directed to the network. Using the Network Disk is as simple as using the floppy disk and uses the same file naming conventions.

Using Network printers simply requires the HARDCOPY Destination to be selected as NET PRINTER. If more than one network printer is available (currently up to five are supported), an additional menu item called PRINTER NUMBER allows selection of which network printer to use. The printer number can be any of 0,1,2,3 or 4. To aid in identifying hardcopies generated on network printers, a banner can be printed which identifies the originator (i.e. user name) of the hardcopy.

Figure 36 below shows the HARDCOPY softkey menu when a Net Printer is selected.

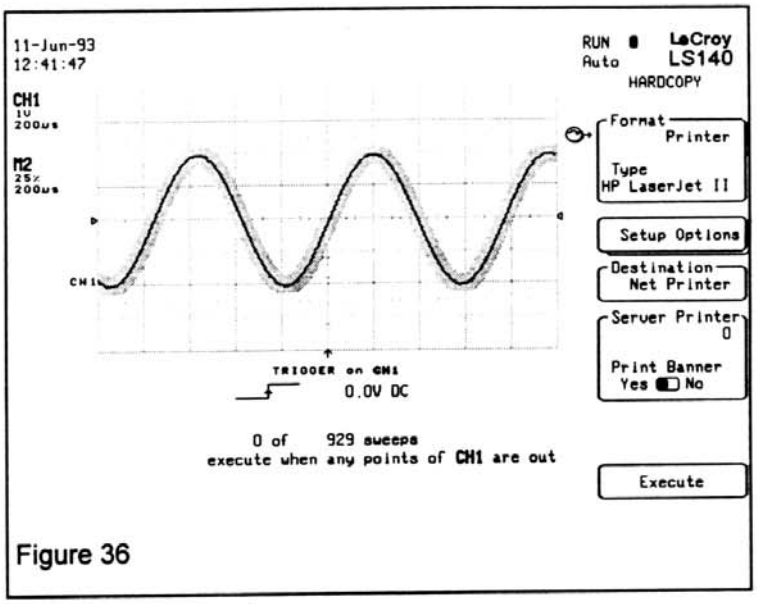


Figure 36

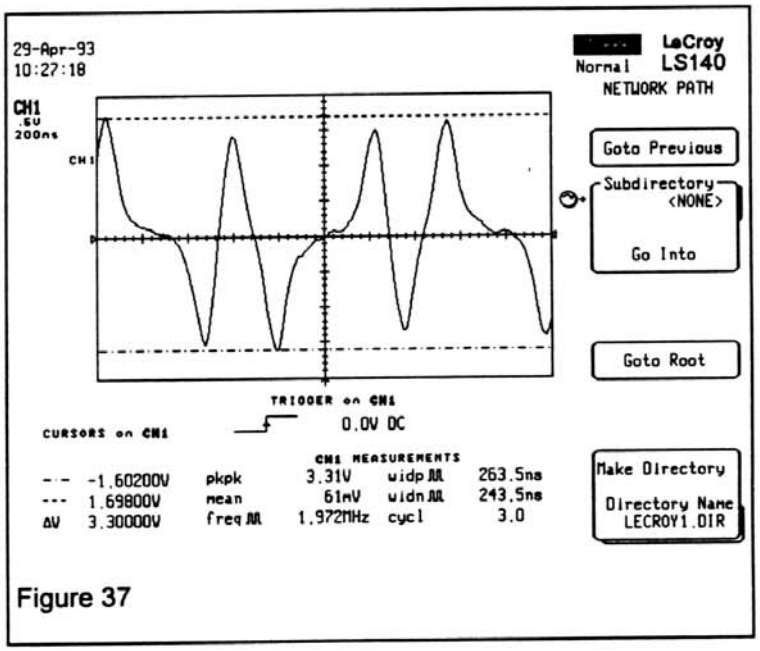


Figure 37

Connecting to Thick-Ethernet

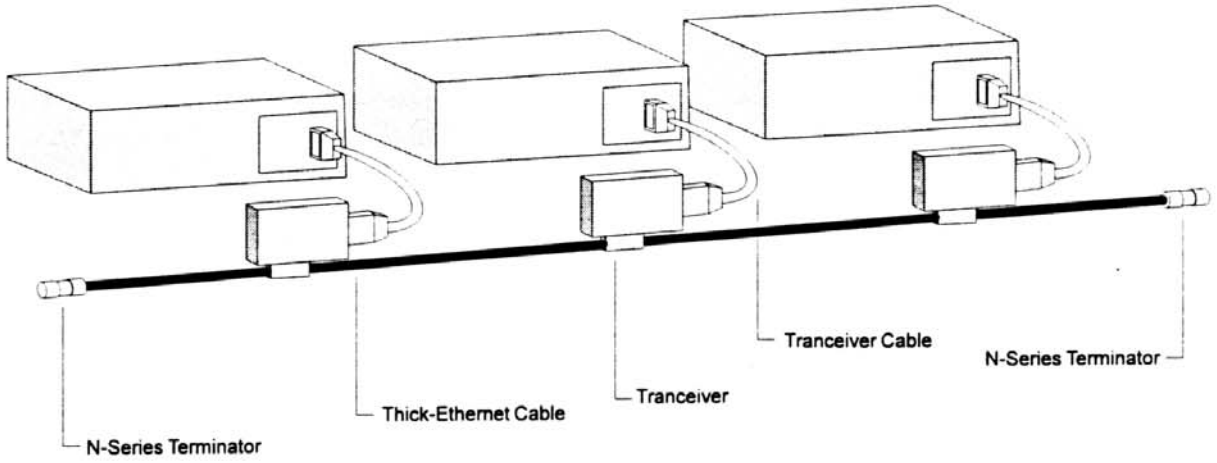


Figure 38: Example Thick-Ethernet System

Connecting to Thin-Ethernet

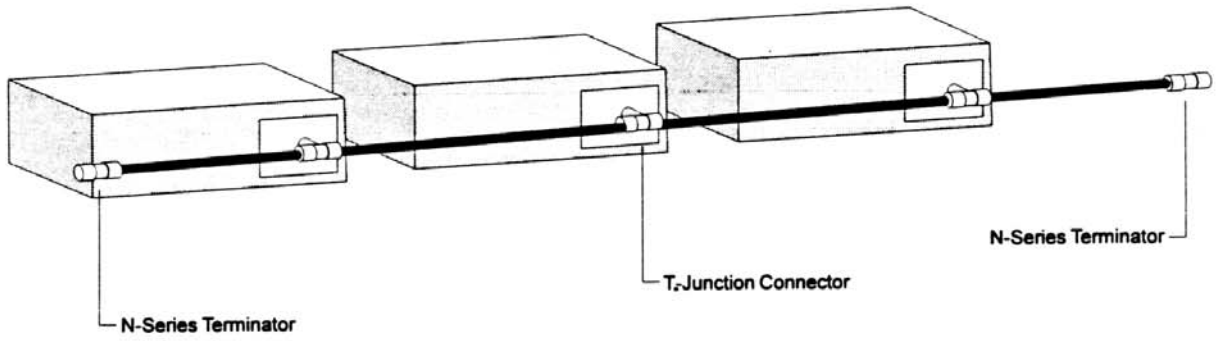


Figure 39: Example Thin-Ethernet System

Hardcopy

LS-140's hardcopy output provides screen images in graphics file, printer or Fax formats. If the output format is capable of high resolution, the output quality can be selected as either proof or draft.

Draft output provides a monochrome output only. Trace, Grid, Text, Persistence Display and Pass/Fail masks are all printed as black on white.

Proof output takes advantage of the extra available output resolution to provide differentiation between trace data and Grid/Persistence and Pass/Fail masks. This output selection is of particular importance if a trace is required to be viewed within a Pass/Fail mask for example.

Note: Fax Output automatically defaults to proof quality output. If the remote Fax machine is not capable of high resolution (200 DPI) printing then draft quality will then be used.

Using HARDCOPY for Printing

The HARDCOPY softkey menu is shown in figure 40. To send a picture of the current display to your printer perform the following steps:

1. Set **FORMAT** to PRINTER

2. Set **TYPE** to (As defined below)

Types:	**Epson MX/FX**	Epson compatible 9 Pin Dot matrix printer
	Epson LQ	Epson compatible 24 Pin Dot matrix printer
	HP LaserJet II	HP LaserJet Series II and compatibles
	HP LaserJet IV	HP LaserJet IV and compatibles
	HP ThinkJet	HP ThinkJet Compatible

3. Setup **OPTIONS** (as defined below)

SIZE:	**Notebook**: 4.2" x 3.0" (10.66 mm x 7.62 mm)	
	Presentation: 8.4" x 6.0" (21.33 mm x 15.24 mm)	
PAGE FEED:	**On**:	Automatic formfeed for each page
	Off:	Requires manual or externally generated formfeed.
QUALITY:	**Proof**:	High quality
	Draft:	Standard quality

4. Set **DESTINATION** (choices are listed below)

Destination:	Centronics, RS-232-C, Floppy, Hard Disk, GPIB, Network Disk, Network Printer

Note: Refer to "Interface Basics" Sections of this guide for configuring the RS-232, GPIB or Network interfaces.

5. Press **EXECUTE**

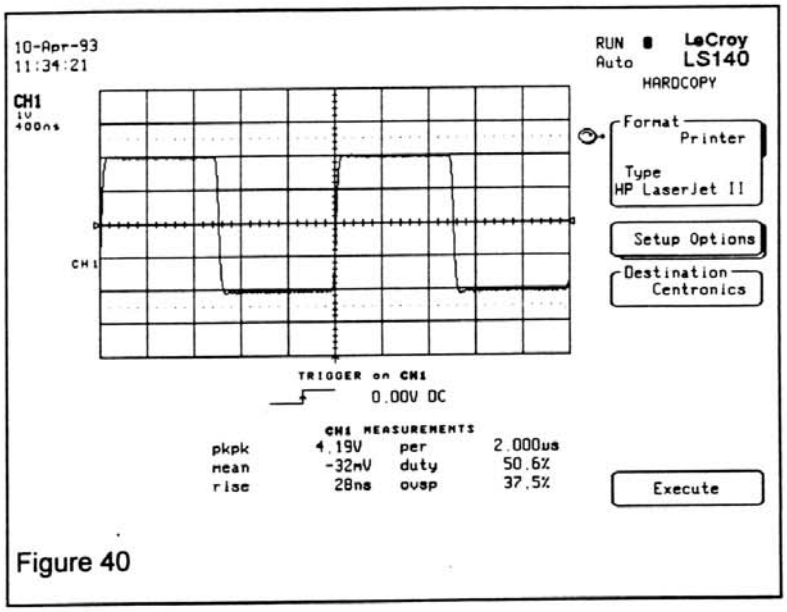


Figure 40

Using HARDCOPY for Plotting

LS-140 provides support for HP-GL plotters compatible with the HP74xx and HP75xx series.

Unlike the printer menu, no selection is available for hardcopy size. This is because the plotter output is scaled to fit the P1 and P2 plotter page limits. These limits can usually be changed on the plotter thereby providing full control over plot size (refer to your plotter manual for more details).

The LS140 will automatically send commands to the plotter to set it's handshake mode to match the setting in the Comms Setup menu.

Exporting Data

The LeCroy LS-140 can supply data in many forms, acquired and processed waveforms as well as measured parameters derived from waveforms. Many test applications require that data be archived for later analysis, trending, or lot acceptance records. The LS-140 provides the required data formats for analysis of Measurements and Waveforms using spreadsheets, databases, math and simulation programs. This section of the Connectivity Guide will describe several examples for interfacing with these analysis programs.

Communicating with your Spread Sheet : Waveforms

As shown in the Format field of the softkey menu, the data is being saved to disk in comma delimited ASCII format. Both amplitude and time values are stored for each data point in the oscilloscope trace. This format is compatible with spreadsheet programs such as Microsoft's Excel and can be easily imported using the following steps:

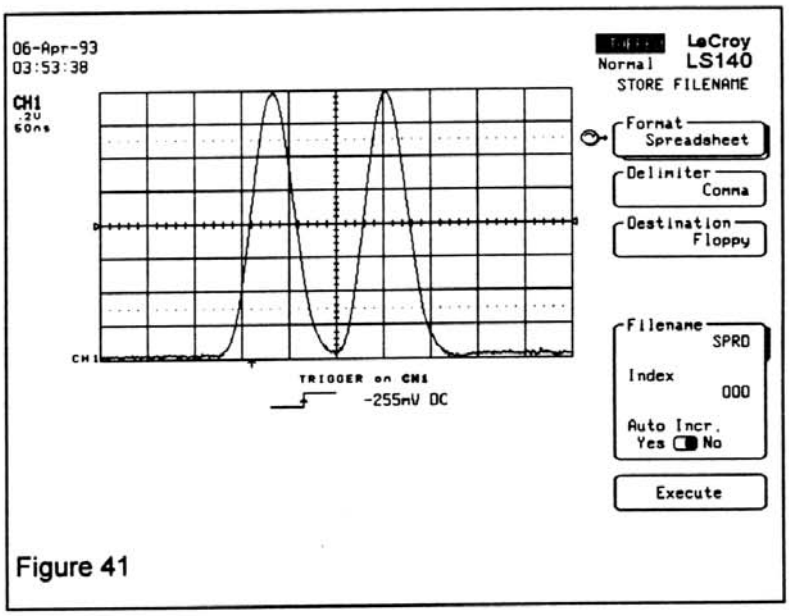


Figure 41

1. Acquire a waveform and then store it to floppy using Storage type TRACE with "Spreadsheet" format as shown in figure 41.

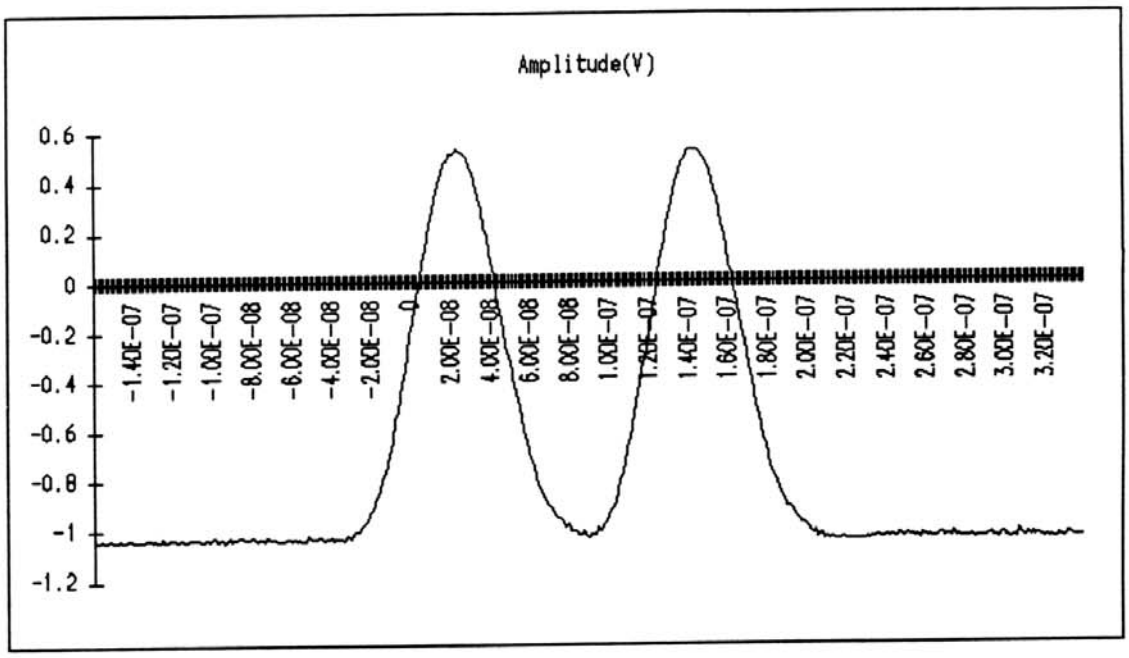
2. Insert the LS-140's diskette with the stored waveform into your computer's floppy disk drive. Start the Excel program. (Note: Also compatible with other spreadsheet programs like; LOTUS, QUATTRO PRO and Database programs like Microsoft ACCESS.)

3. Use the mouse to select OPEN from the FILE pull down menu in the Excel window. The OPEN dialog box should appear, select the drive which contains the floppy disk with the waveform file. Select the TEXT (*.TXT) file type from the LIST FILE OF TYPE menu.

4. Click on the TEXT button. Select the delimiter to match the LS-140s setting, "COMMA" in this example. The FILE ORIGIN should be Windows. Click on the OK button to close the TEXT dialog box.

5. Point to the desired filename, "SPRD000.TXT" in this example, and click to highlight it. Press the OK button to exit the open dialog box.

6. The waveform data file is now visible in the spreadsheet with the time data in column A and the amplitude data is in column B. You can now process or graph the waveform data as desired. The data from the waveform in this example is plotted in the adjoining figure.



Communicating with your Spread Sheet : Measurements

The LeCroy LS-140 can store, in spreadsheet compatible format, not only waveforms but also a series of parameter measurements. The custom store capability of the LS-140 can transfer the displayed Measurements to a file in spreadsheet format (along with associated trace data if required). The following figure shows the CUSTOM STORE softkey menu which is used to set up this file.

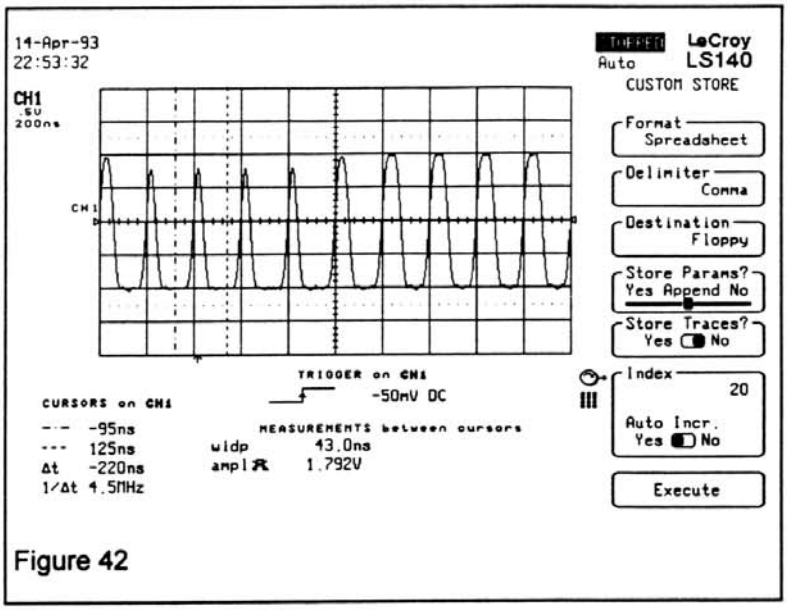
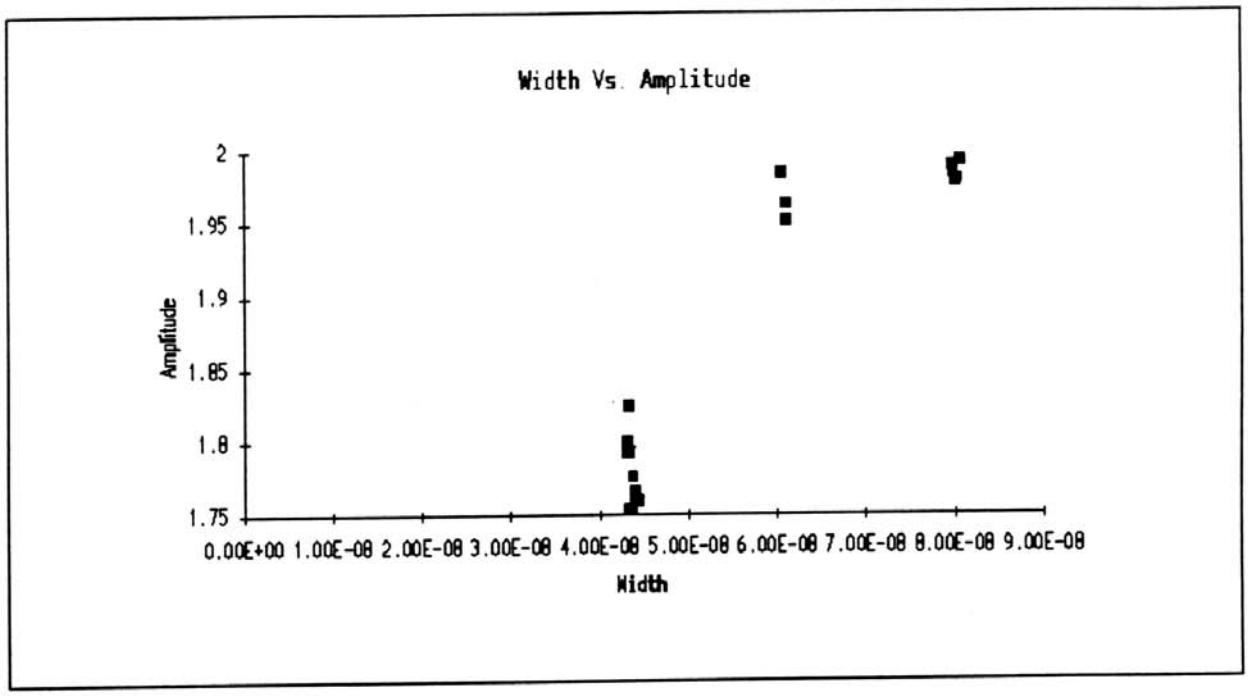


Figure 42

In this example the width and amplitude of a width modulated pulse are measured repeatedly. After each acquisition, the width and amplitude parameters, along with a time stamp, are transferred into a file which can be read by a spreadsheet. The CUSTOM STORE menu provides the ability to store waveform traces and/or parameters. Additionally, if the Store "PARAMS" switch is set to Append, then a series of parameter values will be accumulated in the file.

The resulting file, PARAMS.TXT, can be imported into a spreadsheet, such as Microsoft's Excel, and analyzed. Any of the spreadsheet analysis tools and graphing features can be used to explore relationships within the data. The figure below shows an Excel generated scatter diagram of pulse Width vs. Amplitude. It shows the very obvious relationship between the two parameters, indicated by the "clustering" of the data points.



Communicating with MATHCAD

The LS-140 can generate waveform data in a format that is directly compatible with the MathCad software package. The following steps show how to take a waveform trace and display it in MathCad.

1. Acquire a waveform and then store it to floppy using storage type TRACE with "MATHCAD" format.
2. Storing the desired waveform in the MathCad format, produces a structured data file with the extension .PRN. Start MathCad and insert the diskette, with the .PRN file into the computer.
3. Use Associate Filename, found in the MathCad FILE pull down menu to associate the LS-140 file with a MathCad matrix variable, LS_DATA in this example.
4. Use the READPRN(LS_DATA) command in MathCad to read the data from the file into the matrix LS_DATA, as shown in the figure 44.

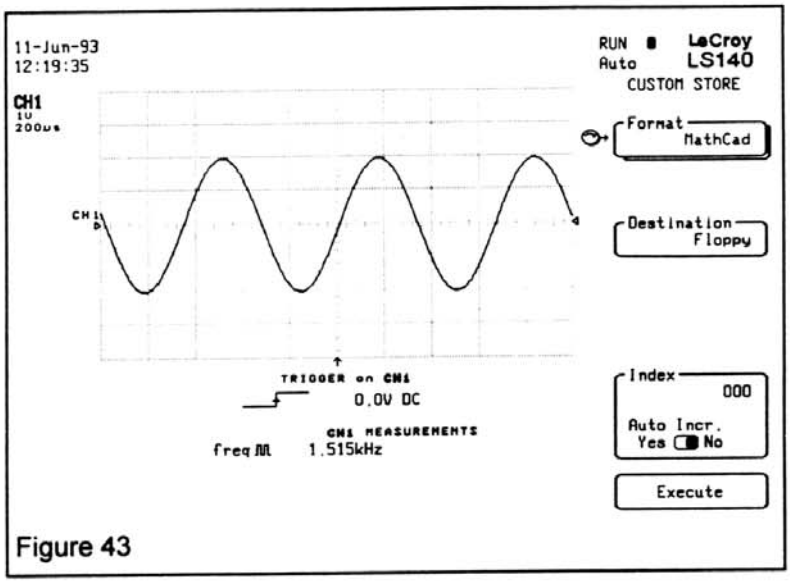


Figure 43

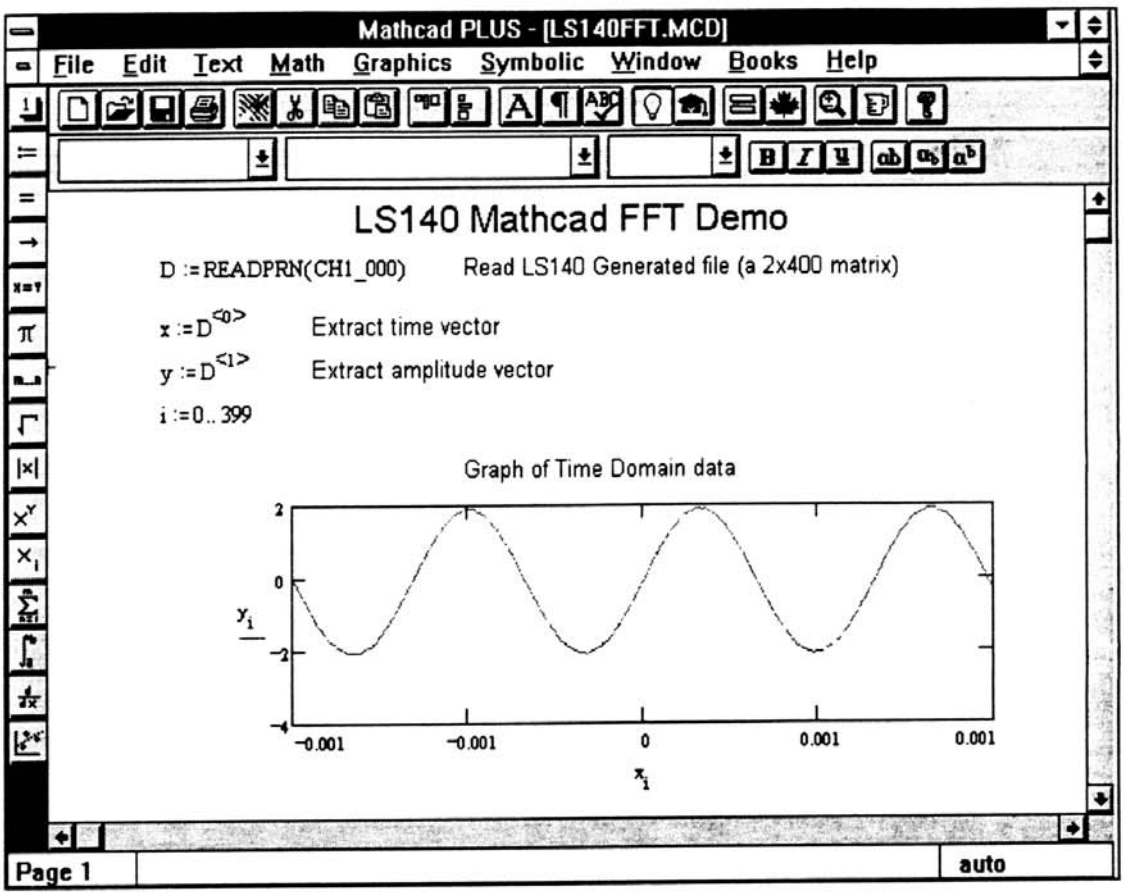

Mathcad PLUS - [LS140FFT.MCD]
File Edit Text Math Graphics Symbolic Window Books Help
LS140 Mathcad FFT Demo
D := READPRN(CH1_000) Read LS140 Generated file (a 2x400 matrix)
x := D<0> Extract time vector
y := D<1> Extract amplitude vector
i := 0.. 399
Graph of Time Domain data
2
0
-2
-4
-0.001
-0.001
0
0.001
0.001
Page 1
auto

Figure 44

Communicating with PSpice

LS-140 provides a data output format compatible with PSpice analog simulation software package.

Waveforms stored for the PSpice circuit simulation program are formatted as a piecewise linear waveform file with a .PWL extension. The files are used to describe a voltage source waveform using the following steps:

1. Acquire a waveform and then store it to floppy using storage type TRACE with "PSpice" format.

2. The file must be included into the Spice net list as the description of a voltage source waveform. A partial net list, showing the instructions for including the file, PSPIC000.PWL, is shown in the adjoining figure. The commands associated with defining and "connecting" the voltage waveform are shown in bold type.

3. The file itself must be copied into the appropriate PSpice directory. In this example it must be copied into the "Circuits" Subdirectory.

```
**** LS140 PSPICE Demonstration

**** The ilt5 statement below sets the iteration limit
**** to infinity. The default limit is 5000. With the
**** high timing resolution PWL file from the Scope the
**** 5000 point limit could easily be reached with even
**** a simple circuit.
.options acct reltol=0.001 itl5=0 list
.probe
.tran 1ns 1000ns

vgnd 300 0 0

**** The following line includes the PWL output file
**** from the LeCroy LS140. This will appear as a
**** voltage source with the label LS_xxx where xxx
**** was the trace name on the scope.
.inc a:\pspic000.pwl

**** Load the voltage source make a simple circuit
R1 LS_CH1 0 1K
```

Figure 45: PSpice Net List

FAX/Modem Basics

IMPORTANT

Various country specific restrictions apply relating to connection of equipment to the public telephone network. Before attempting to use the Fax output refer to the "**Fax/Modem Restriction of use**" at the beginning of this manual.

Do not use any other telephone line cord than that supplied with the LS-140.

Transmitting a FAX

To FAX a picture of the current display perform the following steps. Refer to the next section "Fax Setup" for this example.

1. Press the Operation key "HARDCOPY"
2. Set **FORMAT** to "FAX (Group 3)"
3. Use **SETUP OPTIONS** to enable the desired dialing method, if they are not correct.
4. Select or define a telephone Entry
5. Enter Subject (optional)
6. Press **EXECUTE**

Fax Setup

Referring to the rear panel figure, the Fax/Modem has two modular RJ-11C phone jacks (although this may differ for some countries) on the rear of the LS-140. You will need to connect your modem to a telephone wall outlet with a telephone cable. For ease of use connect the LS-140's modem to a dedicated line that does not go through a switchboard.

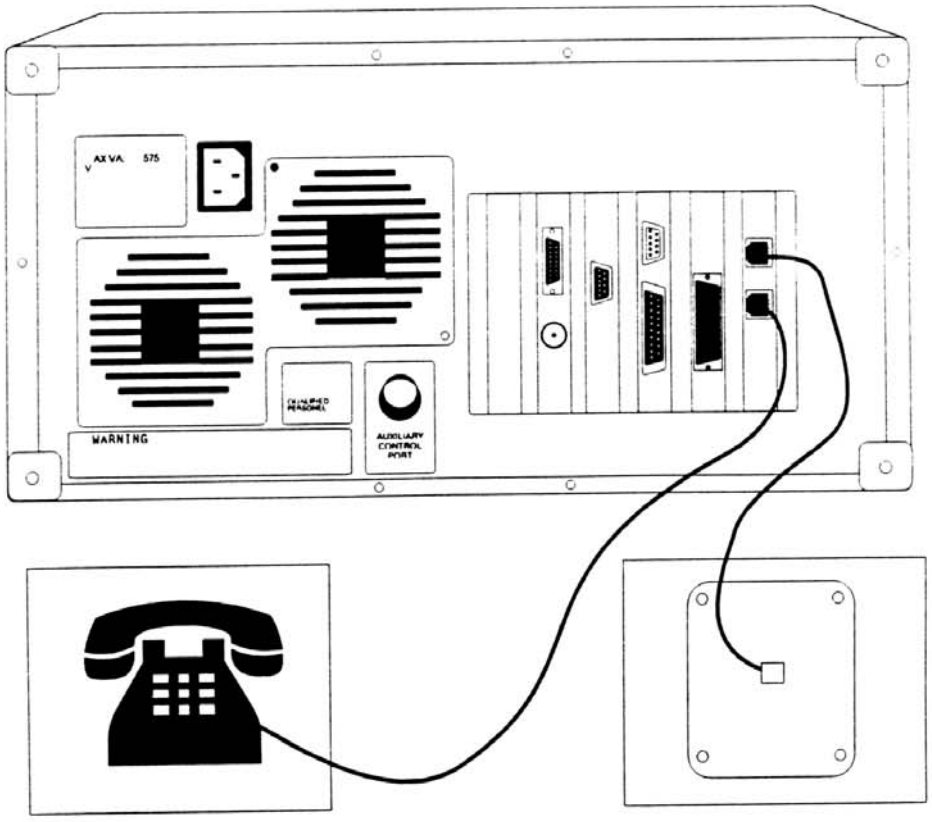


Figure 46: Fax-Modem Connections

You may also connect a telephone set to the modem, figure 46, enabling the use of the phone when the modem is idle.

SPECIFICATION	*DEFINITION*
Compatibility	CCITT group III send/receive FAX format CCITT T.30 and T.4 CCITT V.29 at 9600 bps with fall back to 7200 bps CCITT V.27 send/receive at 4800, 2400 bps CCITT V.21 Channel-2 send/receive at 300 bps
Telephone Connectors	Two RJ11C jacks (The output connectors may differ for some countries) for Telephone and Line Compatible with RJ11, RJ12, RJ13, RJ14

Table 20

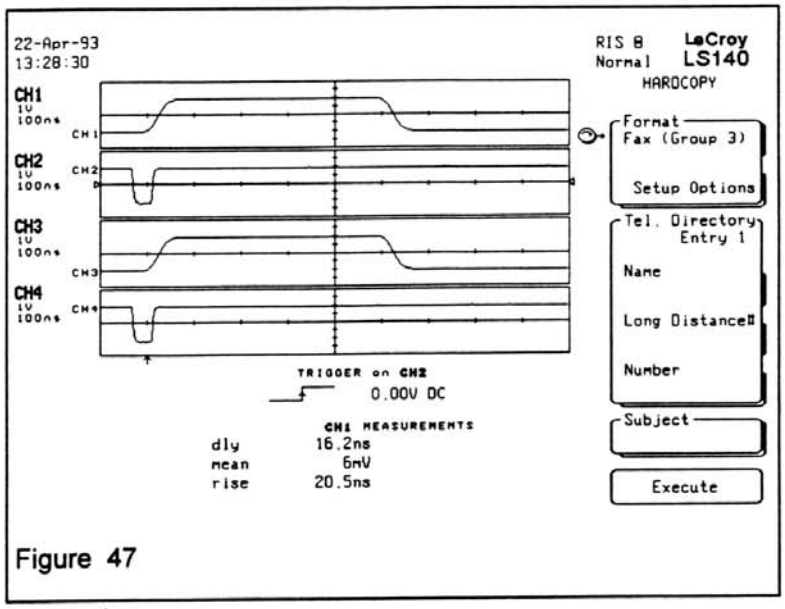


Figure 47

Referring to the FAX softkey menus in Table 20 the Setup Options are used to select the type of telephone equipment and dialing method which will be used. This setup only needs to be performed when the LS-140's FAX is connected to a different telephone line since it is remembered in internal non-volatile memory.

- **Dial Method: Tone or Pulse**
  - Is used to select push button (Tone) or rotary dial (Pulse) type phone service.
- **Outside Line #**
  - Defines the dialing sequence necessary to establish a dial tone for calls beyond the local switchboard. The outside line dialing sequence is always dialed before the Telephone directory selection.
  - Example: "9-" dials a 9 then a 2 second pause.
  - Should be blank if not required.
- **Manual Dial: On or Off**

  Manual Dial: On
  Allows a call to be established manually, bypassing LS-140's AutoDialer. The Execute softkey should be pushed when a call has been established and tones are heard from the remote FAX machine. This allows the user to manually dial when using a digital PBX.

  Manual Dial: Off
  The LS-140 dials automatically.

Up to eight telephone entries may be on line at any time. Multiple Telephone Directories are easily managed through the LS-140's I/O setup recall capability (i.e. STORE (or RECALL): SETUP: I/O SETTINGS).

The Subject is a 14 character field which should be used to add a unique identification to the FAX transmission (e.g. The production test bench location, The LS-140's serial number, etc.).

HARDCOPY (FAX FORMAT) SOFTKEY MENU DEFINITION

Format	Format FAX (Group 3)	
	Setup Options	Dial Method: Tone or Pulse
		Outside Line: Standard numeric sequence to obtain outside dial tone.{0 through 9} {"-" is a two second pause}
		Manual Dial: On or Off
Telephone Directory	Entry (n)	Select from eight on-line entries
	Name	Used to identify the FAX recipient
	Long Distance	Used for Country and/or Area codes
	Number	Used for the local Telephone number
Subject	Enter 14 Character subject using EDIT TEXT softkeys	
Execute	·Perform FAX transmission	

Table 21

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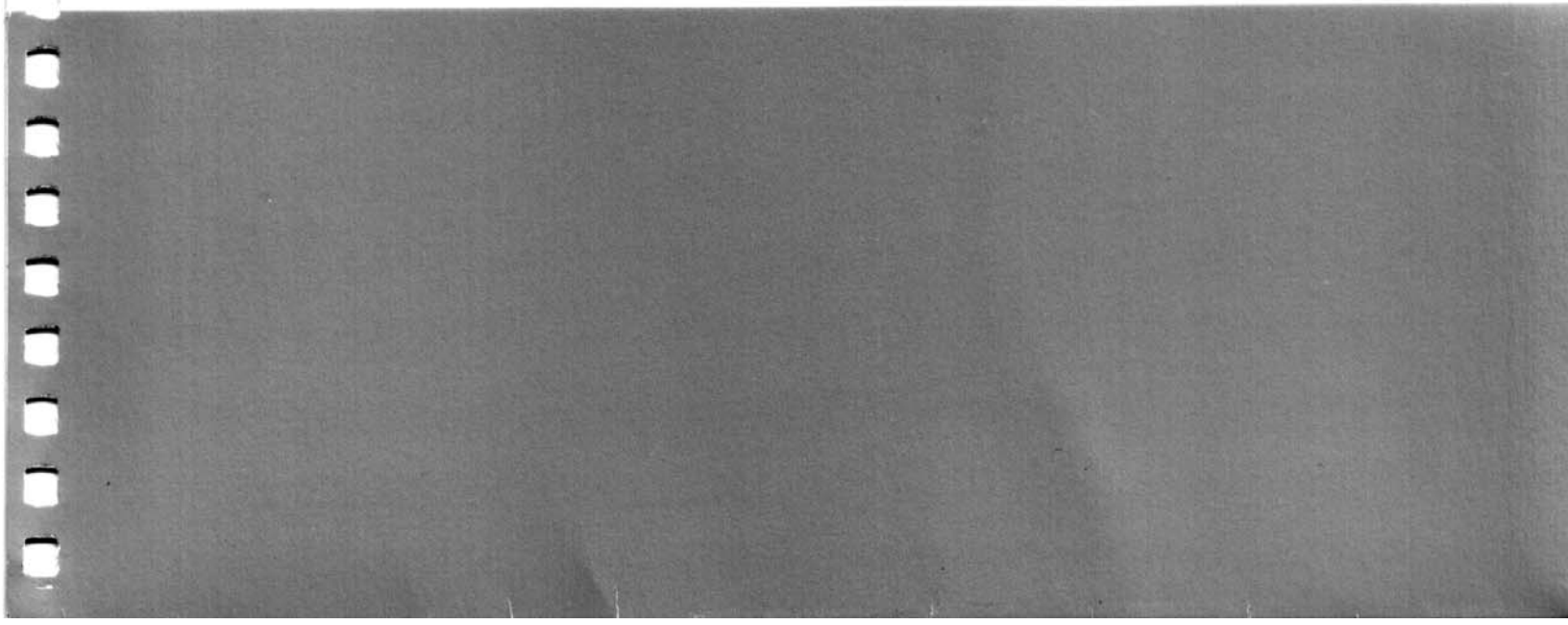

LeCroy