Display Menu

Display Menu

The display menu controls most of the features that dictate how the acquired data is displayed on the screen. These features include manipulating data for clarity, eliminating noise, and viewing selected memory segments.

This chapter describes the display menu, how to control all the features, and how to display the most meaningful waveform for measurements.

There are three display menus, depending on which acquisition mode the oscilloscope is set to in the time base menu.

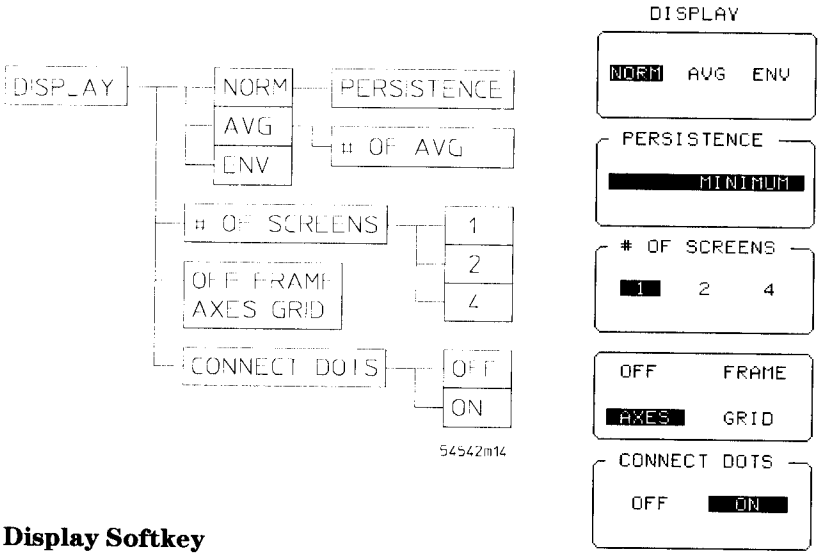
- Repetitive acquisition
- Real-time acquisition with sequential memory turned off
- Real-time acquisition with sequential memory turned on

The menu map for each of the three display menus is included with the topic that covers that menu.

Repetitive Acquisition Display Menu

The display menu selections available when the time base is set to the repetitive mode is shown below.

Figure 6–1



Display Softkey

The **DISPLAY** softkey selects one of three display modes: normal, averaged, and envelope.

Norm (Normal) The normal mode sets the time parameters for displaying data or selecting persistence. The range in the variable persistence mode is from minimum, very fast overwriting and updating of the display, to infinite with variable settings from 500 ms to 10 seconds. Persistence allows you to display data records to any of the persistence settings. For settings of less than infinite, the data is displayed for the specified period of time. When norm is selected, the function key below the normal field is activated. This field displays the current persistence setting. The following are some hints in using the normal display mode:

- Connect-the-dots is available in the minimum persistence, average, and envelope display modes.
- Use fast persistence settings when the input signal is changing and when immediate display feedback is needed.
- Use more persistence when observing long-term changes in the signal or in low-repetition-rate signals.
- Use infinite persistence for worst-case characterizations of signal noise, jitter, and drift. The persistence mode is similar to a storage oscilloscope.

At minimum persistence, a point is erased when a new point is acquired in the same time bucket on the display. Therefore, the waveform fills in quickly and each point remains for a minimum amount of time. Measurements are performed using the newest data in each pixel column.

When the keypad is used to change persistence settings, any entry longer than 10 seconds displays the message "value out of range... set to limit", and persistence is automatically set to infinite. Any entry less than 500 ms causes the same message to be displayed, and persistence is set to minimum.

Avg (Average) The averaged mode selects the number of waveform acquisitions that are averaged to generate the displayed waveform. The range for the averaging is from 1 to 2048 in powers of 2.

When the averaged mode is selected, the # of avg (number of averages) softkey is displayed.

Averaging significantly reduces displayed signal noise. As the number of averages increases from 1 to 2048, the display becomes less responsive to changes in the input signal. Using more averages reduces the effects of displayed signal noise and improves resolution.

Env (Envelope) The envelope mode needs no other parameters set. The display reflects the minimum and maximum voltages in each horizontal position. Use the envelope mode when viewing voltage or time jitter.

of Screens Softkey

The **NUMBER OF SCREENS** softkey allows you to choose how many graphs the waveform viewing area is divided into.

1 screen The entire waveform viewing area is one screen and any displayed waveforms are superimposed on top of each other.

2 screens The waveform viewing area is divided into two screens. On the 4-channel models, channels 1 and 2, memories 1 and 2, and functions 1 and 2 are displayed in the top screen, and channels 3 and 4, memories 3 and 4, and functions 3 and 4 are displayed in the bottom screen. On the 2-channel models, channel 1, memory 1 and 2, and function 1 and 2 are in the top screen, and channel 2, memory 3 and 4, and function 3 and 4 are in the bottom screen.

4 screens The waveform viewing area is divided into four screens. Each channel, memory, and function is displayed in the corresponding portion of the screen, starting with channel 1, memory 1, and function 1 at the top screen.

Off/Frame/Axes/Grid Softkey

This softkey selects one of the four display backgrounds.

Off Off turns the background graticule off. Displayed waveforms are not turned off.

Frame Frame displays the outside border with a measurement scale. The measurement scale is marked with major and minor divisions based on the vertical and horizontal measurement settings.

Axes Axes displays a background with the measurement scale crossing at midscreen.

Grid Grid displays a background that is a complete graticule with ten horizontal major divisions and eight vertical major divisions. Only the axes portion of the graticule has a minor division scale.

Connect Dots Softkey

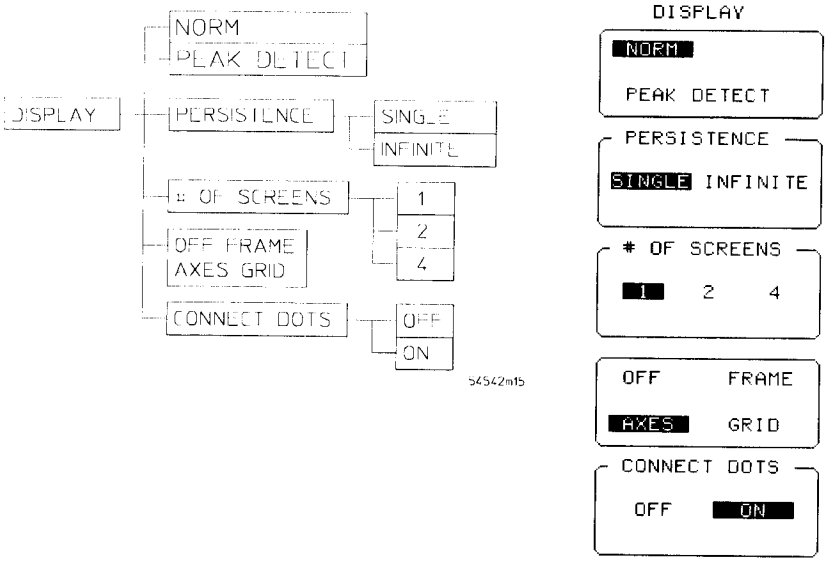
Connect-the-dots is a technique used to display waveforms with all the data points connected. This makes viewing waveforms easier because the signal is complete and has no breaks. Connect-the-dots connects data points linearly rather than generating new data points. Connect-the-dots is available in the minimum persistence, average, and envelope display modes.

Real-Time Acquisition Display Menu (seq off)

The display menu selections available when the time base acquisition mode is set to real time and sequential is set to off is shown below.

Only the softkeys that are added to the display menu in the real-time mode are discussed.

Figure 6–2



Normal Mode

This key is used to select persistence during the real-time mode. Persistence has two choices: single and infinite.

Single Single persistence is a very fast overwrite. As each new acquisition is displayed, it overwrites the previous data. The current display is always the most recent acquisition.

Infinite Infinite persistence is used for worst-case characterizations of signal noise, jitter, and drift. In this mode the oscilloscope is used as a storage oscilloscope because waveforms are not erased. Measurements are performed using the newest data in each pixel column.

Peak Detect Mode

Peak detect is only available in the real-time mode when the sampling rate is less than or equal to 250 MSa/s and with sequential single-shot turned off. When the sample rate is greater than 250 MSa/s, the peak detect mode is not displayed on the softkey. Peak detect is an acquisition mode rather than a display mode. An acquisition mode affects how the oscilloscope acquires data. A display mode does not affect how the data is acquired; rather, it is a postprocessing feature that affects how the data is displayed on the screen, like connect the dots and persistence.

Peak detect stores the minimum and maximum values (pairs) for each time bucket. Peak detect can detect excursions as narrow as 1 ns. When peak detect is on, the sample rate that appears in the time base menu is the sample rate at which the minimum and maximum pairs are stored. You may notice that peak detect functions at sample rates up to 250 MSa/s. Because peak detect stores two data points per sample clock, the memory size divides in half. For example, if the record length is set to 32,768 and you turn on peak detect, the record length changes to 16,384.

See Also "# of Screens Softkey" and "Off/Frame/Axes/Grid Softkey" earlier in this chapter for information on these keys.

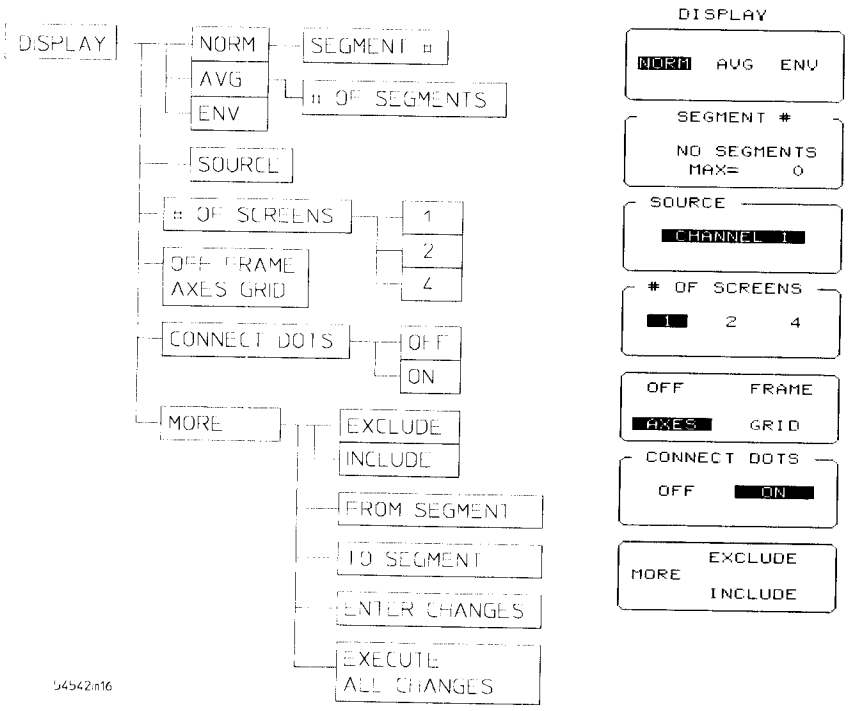
Real-Time Acquisition Display Menu (sequential on)

The real-time mode menu map, with sequential single-shot turned on, is shown below.

All measurements, waveform math functions, and pan and zoom features are available when displaying the previously captured segments. In the sequential single-shot mode, data interpolation does not occur and peak detect is not available.

Only the softkeys that are added to the display menu when the real-time mode is selected are discussed.

Figure 6–3



Display Softkey

The Display softkey selects one of three display modes: normal, averaged, and envelope.

Norm (Normal) The normal mode allows you to view each captured segment individually. The viewable segments are determined by the include exclude softkey.

When norm is selected, the function key below the display softkey is activated. This field displays the current segment number being viewed, and is set using either the knob or keypad. Selecting a segment number larger than the maximum captured causes all segments to be displayed (overlaid), where all the included segments from the selected source are displayed at one time. Selecting an excluded segment causes "segment X is excluded" to be displayed.

Measurements are performed using the newest data in each pixel column.

Avg (Average) The average mode averages each captured segment into a composite waveform. Only segments selected as included using the exclude include softkey are averaged. When average is selected, the segment number currently being averaged is displayed in the lower left corner of the screen, and the number of segments softkey is activated. The number of segments key displays the total number of segments that were averaged.

Env (Envelope) The envelope mode displays the minimum and maximum voltages in each captured segment. Only segments selected as include using the exclude include softkey are used. When envelope is selected, the segment number currently being evaluated is displayed in the lower left corner of the screen, and the number of segments softkey displays the total number of segments that were used.

Segment # Softkey

You can use the segment number softkey to select which captured segment to display. The range is 1 to n, where n is the number of segments selected in the time base menu. After n, the next selection is all segments. All segments overlays all of the captured segments allowing you to compare the segments for abnormalities.

Because sequential single-shot captures a series of segments, a time tag is displayed below the graticule area as each segment is displayed. The time tag tells you when each segment was captured relative to the trigger for first captured segment. When all segments is selected, the time tag is not displayed.

You may see the segment number softkey display one of the following messages:

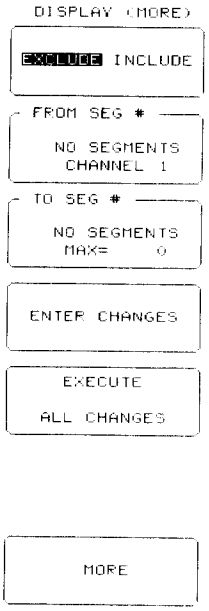
- no segments: displayed when there are no captured segments for the selected source.
- channel off: displayed when the selected source is turned off.

Source Softkey

This key specifies the source used during all display operations. Press it to highlight the field, then use the knob to enter the desired value. You can select any active channel as the source. If no previously captured segments exist for the selected channel, the status message "no segmentable data on channel n" is displayed and the number of segments key displays "no segments."

See Also

"# of Screens Softkey," "Off/Frame/Axes/Grid Softkey," and "Connect Dots Softkey" earlier in this chapter for information on these keys. "Sequential Softkey," in Chapter 4 for information on the sequential softkey selections.



More Exclude Include Softkey

Pressing this softkey brings up the **SEGMENT EXCLUDE INCLUDE** softkey menu.

Exclude Include softkey

This softkey is used to select which of the previously captured segments is used for display operations. Press the softkey to highlight the desired choice.

Exclude Segments specified using the **FROM SEG #** and **TO SEG #** softkeys cannot be viewed in the normal mode, and are not used during the average and envelope modes.

Include Previously excluded segments specified using the **FROM SEG #** and **TO SEG #** softkeys are now viewed, and are now used during the average and envelope modes.

All segments are initially acquired as included. A list of currently included segments are shown on the bottom left of the screen, along with a counter showing the current segment used in the average, envelope, or normal (when all segments is selected) mode.

From seg # softkey

This softkey is used to specify the beginning segment number when entering the range of segments to be excluded or included from display operations. Press the softkey to highlight the field, then use the keypad or knob to enter desired value. Any positive value within the number of segments currently acquired can be entered; however, the **FROM SEG #** softkey entry cannot exceed the **TO SEG #** softkey entry. The bottom of the softkey displays the currently selected source.

To seg # softkey

This key is used to specify the ending segment number when entering the range of segments to be excluded or included from display operations. Press the softkey to highlight the field, then use the keypad or knob to enter desired value. Any positive value within the number of segments currently acquired can be entered; however, the **TO SEG #** softkey entry cannot precede the **FROM SEG #** softkey entry. The bottom of the softkey displays the maximum number of segments acquired.

Enter changes softkey

Pressing this softkey enters the currently selected exclude include, **FROM SEG #**, and **TO SEG #** values. These entries are not implemented until the execute all changes softkey is pressed. Once the enter changes softkey is pressed, a status message is displayed at the top of the screen. To cancel the process without executing the changes, press the more softkey.

Execute all changes softkey

Pressing this softkey immediately processes all changes that were entered, and displays the new included segments list at the lower left portion of the screen. If the average or envelope modes are selected, the new composite waveform is generated using the updated segment list.

More softkey

Press this softkey to toggle to the other display menu choices. The best method of making changes is to enter all the desired changes. Then, press the execute all changes softkey.

Sequential Single-Shot Display Exercise

This exercise is a continuation of the "Sequential Single-Shot Exercise" in Chapter 4, "Horizontal." During that exercise, an acquisition of 10 segments of 100 points each was performed, and each segment was displayed. During the following exercise, a waveform that is the average of segments 5 through 10 is constructed and is displayed.

1. Use the **DISPLAY** softkey to select **AVG** (average).
2. Press the **MORE EXCLUDE INCLUDE** softkey.
3. Use the **EXCLUDE INCLUDE** softkey to select **EXCLUDE**.
4. Press the **FROM SEG #** softkey. Then, use the entry knob to select **1**.
5. Press the **TO SEG #** softkey. Then, use the entry knob to select **4**.
6. Press the **ENTER CHANGES** softkey.
7. Press the **EXECUTE ALL CHANGES** softkey.

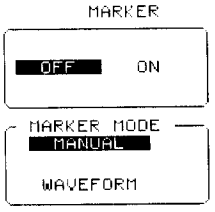
   The averaged waveform is recalculated and displayed using the average of segments 5 through 10.

Marker Menu

Marker Menu

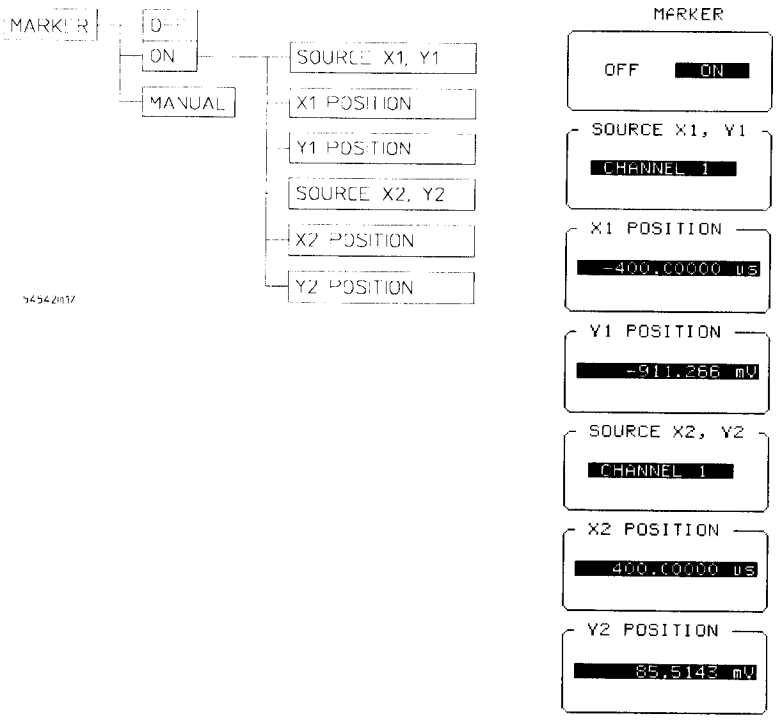
This chapter describes how to use the markers and make manual measurements on displayed waveforms. There are two marker modes available: manual and waveform.

When you press the Marker key on the front panel, the marker menu is displayed on the right hand portion of the screen. The marker menu is shown below.



When in the manual marker mode, there are two sets of x and y axis markers, each with a separately selectable source. The x markers (horizontal) measure voltage (or power in FFT mode), and the y markers (vertical) measure time (or frequency in FFT mode) for the currently selected source. Each marker is individually controlled and labeled. The menu map for manual markers is shown below.

Figure 7–1



Off On Softkey

This softkey toggles both sets of manual markers on and off when the marker mode is set to manual. When on, all markers are displayed on the waveform, and the current x/y marker position and source, delta x/y information, and 1/delta x information are displayed below the waveform viewing area.

The delta entries are calculated as follows:

marker 2 – marker 1 = delta

If the delta is negative, marker 1 is located at a more positive level or later time than marker 2.

If all delta information is full of dashes (- - - - -), then one of the sources currently selected is not turned on.

Source x1, y1 Softkey

This softkey selects the source for the x1 and y1 markers. Available sources for marker measurements include all channels, functions, and nonvolatile waveform memories that are currently turned on. Press the softkey. Then use the entry knob to select source that is turned on. If all sources are turned off,then all delta x/y information is filled with dashes and the Source x1, y1 softkey shows NONE.

x1 Position Softkey

This softkey selects the x1 marker for positioning on a waveform. When selected, the field is highlighted, and you use the entry knob to move the x1 marker across the display. The x1 marker is the vertical marker with longer dashes, and is marked on the top of the waveform viewing area as "x1."

The x1 marker is placed on the display respective to the trigger point. Positive time values are to the right of the trigger point and negative time values are to the left. Measurement information is displayed in the highlighted field and below the graticule area. The display units are seconds in all modes except FFT, where the display units are in Hz.

y1 Position Softkey

This softkey selects the y1 marker for positioning on a waveform. When selected, the field is highlighted, and you use the entry knob to move the y1 marker vertically. The y1 marker is the horizontal marker with longer dashes, and is marked on the left side of the display as "y1."

You can place the y1 marker at the desired level on the waveform. Measurement information is displayed in the highlighted field and below the graticule area. The display units are volts in all mode except FFT, where the display units are in dBm.

You can position the x/y markers on a selected source even though that source is not displayed. You may want to check which source the markers are assigned to before you move the markers or make measurements with the markers.

Source x2, y2 Softkey

The operation is identical to source x1, y1 softkey, except that the source is specified for the x2 and y2 markers.

x2 position Softkey

Operation is identical to x1 position softkey, except that the x2 marker is the vertical marker with shorter dashes, and is marked on the bottom of the display as "x2."

y2 position Softkey

Operation is identical to y1 position softkey, except y2 marker is the horizontal marker with shorter dashes, and is marked on the right side of the display as "y2."

Automatic measurements are usually made on waveforms displayed on the screen. One way you can make custom measurements with the markers is by placing them on the portion of the displayed waveform you are interested in. Then, reading the values directly from the x and y marker positions, or reading the differential values using the delta x and delay y values.

Another way to make custom measurements is by setting the meas window softkey to markers in the define measure menu. Then, you can use the markers to window on the displayed waveform, and you can use the automatic measurements to make the measurement.

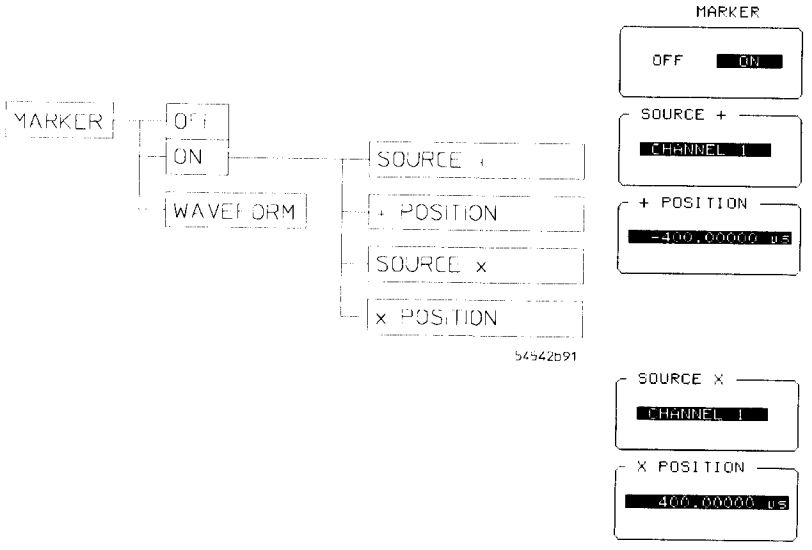
If the continuous softkey in the define measure is turned off, the markers are automatically turned on and they are placed on the displayed waveform showing you where the measurement was made.

Waveform Marker Mode

There are two waveform markers: + and x. The waveform markers track the waveform data in memory rather than on the displayed waveform. Because the waveform data in memory has a much greater resolution than the display, the measurements you make with the waveform markers are much more precise than measurements made with the manual markers.

The waveform markers track the timebase changes of the source signal. This allows you to make accurate delay measurements without having both markers on the display. Vertical amplitude is not available unless the waveform markers are on the display. The waveform marker menu map is shown below.

Figure 7–2



Off On Softkey

This softkey toggles both waveform markers on and off when the marker mode is set to waveform. When on, both markers are displayed on the waveform.

+ Source and X Source

You can set the marker sources as channels, functions, or memories which are currently turned on. For example, you can set the + Source function to a waveform memory and the X Source function to a channel. The scale used to position each marker on the display is based on the scale of the waveform source that the marker is tied to. If all sources are turned off, then all delta x/y information is filled with dashes and the + Source and X Source softkeys show "NONE." Also, when you are placing markers on a waveform, make sure that the source is set to that waveform.

+ Position and x Position

The + marker is controlled by the + Position function and the X marker is controlled by the X Position function. Use the knob, arrow keys, or keypad to position the markers on the signal.

The + marker is controlled by the + Position function and the x marker is controlled by the x Position function. Use the knob, arrow keys, or keypad to position the markers on the signal.

The marker position readouts are displayed near the bottom of the display. Each waveform marker has an X and a Y value. The Y value is determined by the waveform, and ΔY is the difference between the Y values of the + and x waveform markers. Timing measurements are made using the X values of the + and x markers, and ΔX is the difference between the X values. If you are using the markers to measure the period of a signal, then $1/\Delta X$ is the frequency of that signal.

Define Measure Menu

Define Measure Menu

This chapter contains a description of the measurement menu. The measurement functions are accessed with the define measure menu.

The Define measure gives you access to four other softkey menus. Which menu is displayed depends on the selection of the top softkey in the define measure menu.

- Measure Menu Sets the dynamic controls for the measurement.
- Define Measurement Menu Allows the choice of standard or user defined thresholds.
- Limit Test Menu Configures and initiates the measurement limit test.
- Waveform Compare Menu Configures and initiates the waveform compare test.

The menu map for each of the four menus is included with the topic that covers that menu.

Measurement Selection

Each key on the keypad has a secondary function. Above each key is a measurement selection printed in blue.

Make sure the measurement source is on. For example, if the measurement source is channel 3, make sure that channel 3 is turned on by checking the vertical menu or by looking at the LED by the channel 3 front-panel key.

To make a measurement:

1 Press the blue shift key.

2 Press the key that corresponds to the measurement you are making.

3 Use the Entry knob to select the measurement source.

The current measurement source is shown, in inverse video, next to the selected measurement on the display: channel number, c#; memory number, m#; or function number, f#.

4 Use the keypad to select the correct channel, function, or waveform memory.

To clear measurements from the display:

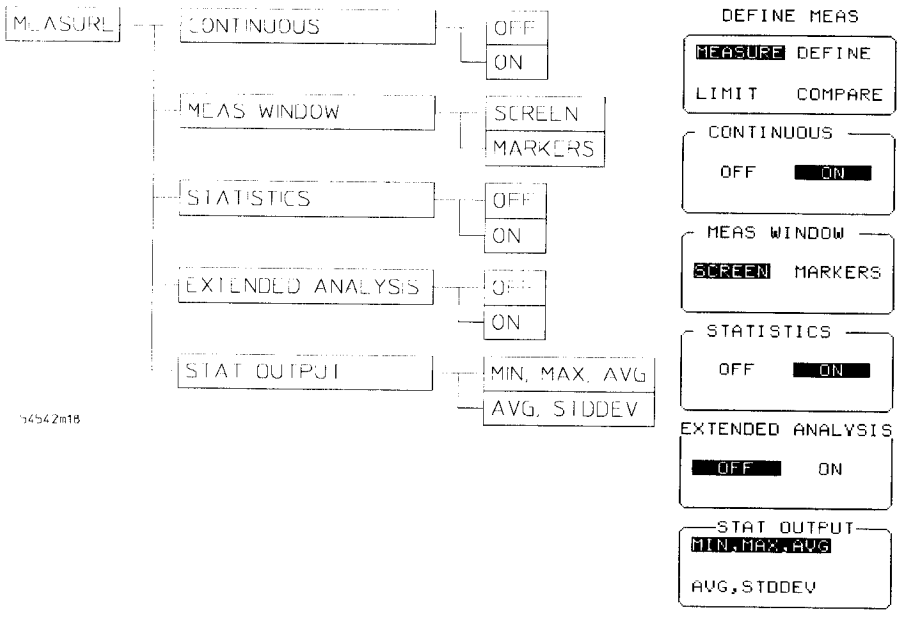
Press the blue shift key. Then, press the Clr meas key.

See also

Chapter 13, "Measurements," for complete details on measurement definitions and algorithms.

Measure Menu

When you set the top softkey to measure, the softkey menu at the left is displayed. The measure menu is the default selection for the define measure menu.



Continuous Softkey

When the **CONTINUOUS** softkey is set to off, the time and voltage markers are placed on the waveform showing where the measurement was made. The measurement is performed once, and you must repeat the measurement to get another measurement result.

When the **CONTINUOUS** softkey is set to on, the measurement is performed continuously and the results are updated each time the measurement is made. The time and voltage markers are not placed on the waveform. Also, the statistics softkey is displayed. If statistics is turned off, you can have up to eight measurements on the display at one time.

Statistics Softkey

The **CONTINUOUS** softkey must be on before the **STATISTICS** softkey is available. When the **STATISTICS** softkey is set to on, either the minimum, maximum, and average values are displayed or the average and standard deviation values are displayed. Which statistics are displayed depends on the selection of the statistics output softkey. Statistics operates on up to three measurements.

When the oscilloscope is in the Sequential Single Shot mode, statistics are only calculated for the currently displayed segment. If all segments are displayed, statistics are only calculated for the last segment in the list of displayed segments.

Measure Window Softkey

The **CONTINUOUS** softkey must be on before the measure window softkey is available. The **MEASUREMENT WINDOW** softkey allows you to customize where measurements are made. The choices are screen and markers.

Screen When screen is selected, the measurement is made on the waveform data that is displayed on the screen.

Markers When markers is selected, you can use the x1 and x2 markers to window the data on the display. Then, measurements are made on the data displayed within the window set by the markers. You turn on and position the markers from the marker menu.

By using the markers to set the measurement window, you can make a measurement on a particular portion of the data rather than on all of the data displayed on the screen.

See Also Chapter 7, "Marker Menu," for information on positioning the markers.

Extended Analysis

The **CONTINUOUS** softkey must be on before the **EXTENDED ANALYSIS** softkey is available. When extended analysis is turned off, certain measurements (like period, frequency, +width, and –width) are made on the first pulse or period that is displayed on the screen. When extended analysis is turned on, measurements are made on all pulses or periods that are displayed on the screen, and the results are averaged together.

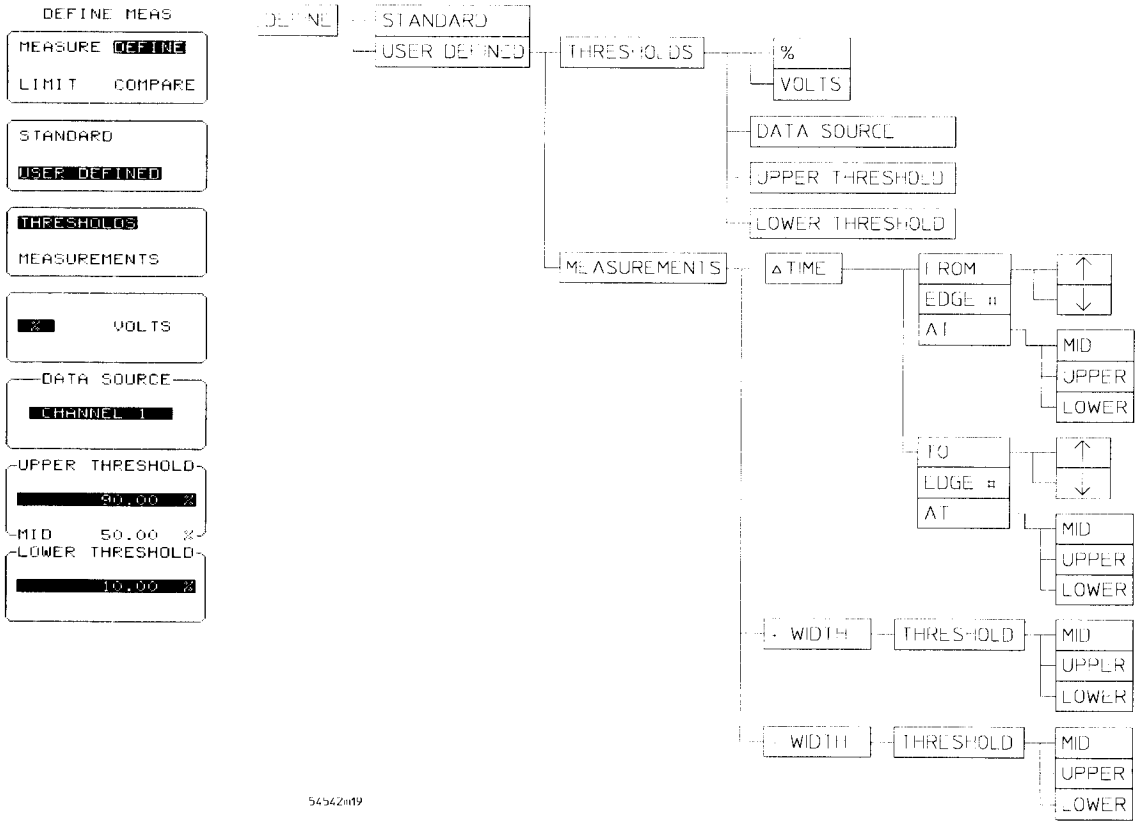
Statistic Output Softkey

The **CONTINUOUS** softkey must be on before the statistics output softkey is available. The **STATISTICS OUTPUT** softkey determines which set of statistics are displayed on the screen. The choice is either the minimum, maximum, and average values or the average and standard deviation values.

Define Measurement Menu

The define measurement menu sets the measurement points (thresholds) where the measurements are made. The menu influences the measurement algorithm by allowing you to use the standard IEEE measurement points, or by allowing you to customize the measurements with the user-defined settings.

Figure 8–2



Standard/User Defined Softkey

Standard uses the IEEE measurement points for all measurements. Figure 13-1 shows some of the standard measurement thresholds. User defined allows you to customize the measurements for your specific applications.

Thresholds/Measurements Softkey

Threshold settings apply to all user-defined front panel measurements. Thresholds sets the measurement points for all timing measurements.

Thresholds You can use the **PERCENT/VOLTS** softkey to set the thresholds as a percentage of the calculated top and base, or as a specific voltage.

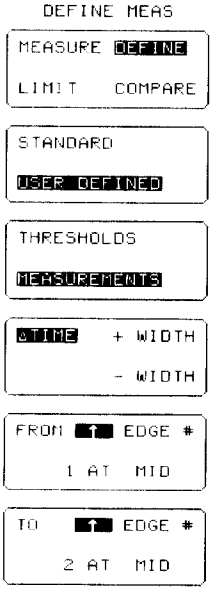
- The percentage range is from –25% to +125%
- Voltage levels from –250 kV to +250 kV

The **DATA SOURCE** softkey allows you to select a source that the upper and lower thresholds track. You can select any channel, function, or memory was a source, and you can set the thresholds individually for any source. For example, you can set the thresholds for channel 1 as 10%/90%, and you can set the thresholds for channel 2 as 20%/80%.

The upper threshold softkey and lower threshold softkey allows you to set the upper and lower measurement thresholds. The upper and lower thresholds must be set to levels that fall on the displayed waveform. The message "not found" is displayed if either threshold is not on the waveform.

This feature is used when measuring excessive overshoot or ringing. By defining the measurements, you can test for pass/fail criteria of any choice. You can test from the front panel, or you can set the oscilloscope in the limit test over HP-IB allowing the oscilloscope to collect measurement data without supervision.

If time measurements are performed and the signal does not exceed 8 A/D levels or 8 vertical pixel levels, the message "not found" is displayed in the measurement area. Expand the signal vertically so the oscilloscope can make the measurement.



Measurements The measurements selection allows you to further customize the +width, –width, and Δtime (delay) measurements. Width measurements allow you to select the threshold (upper, middle, or lower). Where these thresholds occur is defined by the thresholds softkey.

The Δtime choice allows you to select positive or negative slope, edge number, and threshold (upper, middle, or lower). The oscilloscope starts counting edges from the left edge of the screen, not at the reference point. The selected edge must be displayed. If the edge is not displayed, the message "not found" is displayed in the measurement results area below the screen.

You can use Δtime when measuring source-to-source delays or measuring time separation on the same source or a different source. The Δtime measurement is defined by edge slope, edge count (from 1 to 4000), and the part of the transition edge (upper, lower, mid) used as a reference point.

When setting edge count fields, use the fine key. In the coarse mode the oscilloscope increments/decrements by ten (1, 11, 21,...,4000). In the fine mode the increment/decrement sequence is by 1.

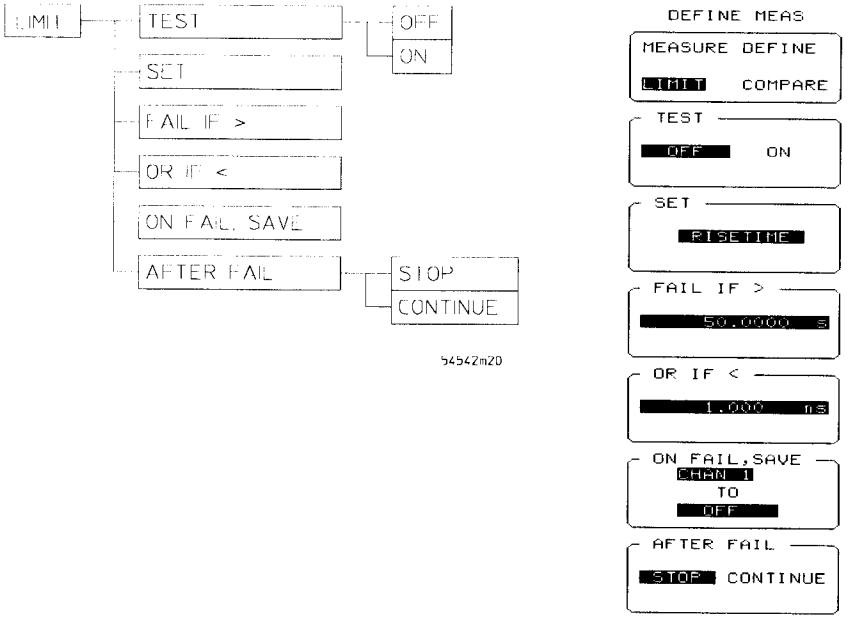
Because Δtime measurements are made between two sources, the display prompts you to select the source (c#, f#, m#) and the source number for each source.

Limit Test Menu

The oscilloscope can run limit tests on up to three measurements simultaneously. Using this menu, you can preset the test parameters and store any failure data for evaluation at a later time. You start the limit test in this menu, and you select the measurement from the front panel.

When a test is running, statistical data describing the test is displayed. You must have at least one measurement selected before limit test can run.

Figure 8–3



Test Softkey

The **TEST** softkey toggles the limit test on or off. When limit test is turned on, the oscilloscope starts running in the test mode on the most current measurements that are running.

Set Softkey

The **SET** softkey allows you to select a measurement so that you can set up the fail criteria for that test. The set softkey allows you to scroll through all of the measurements; these are the same measurements as are available on the keypad. The set softkey does not select the measurements on which the limit test operates, that selection is made from the keypad.

Fail if Softkey

The **FAIL IF** softkey sets the upper failure threshold. The upper range is dependent upon the units of the selected measurement.

or if Softkey

The **OR IF** softkey sets the lower failure threshold. The lower range is dependent upon the units of the selected measurement.

on Fail, Save Softkey

The **ON FAIL, SAVE** softkey allows you to determine what happens to the data from each source on a failure. You select the source and destination of the save function by pressing the softkey until the desired parameter is highlighted, then by turning the entry knob to scroll through the available choices. The source choices are any channel, function, or the screen. The destination choices are off (not saved), waveform memories, multiple memories, pixel memories, and hardcopy. The available destination choices depend on the source selected.

- Channel — off, nonvolatile memories, or multiple
- Function — off, nonvolatile memories, or multiple
- Screen — off, pixel memories, or hardcopy.

The type or amount of failure data saved depends on the destination selected. If the channel or function being sent to a destination is turned off, the message "data invalid nothing stored" is displayed.

When saving to a waveform memory, you can select one memory. Only the waveform viewing area is saved to the memory. If multiple failures occur, only the last failure data is saved because the most current data overwrites the memory contents. More than one source can use the same waveform memory. However, as each source is saved to that memory, the previous contents are overwritten. If a waveform memory is set to protected, the message "protect on: cannot store to memory" is displayed.

When saving to multiple memories, you can save up to 665 records (data includes a time/date stamp). Only the waveform viewing area is saved to the memory. If multiple failures occur and stop after fail mode is selected, then the test terminates after all available memory space is filled. If the continue after fail mode is selected, after the 665 memories are filled, the data records wrap around and new data overwrites previous data. If more than one source is specified with a multiple destination, then the data records are partitioned between the specified sources. Because the multiple memories are are volatile, cycling power results in a loss of data stored to them.

When saving to a pixel memory, the entire screen area is save to the pixel memory. New data is added to the pixel memory without overwriting the previously stored data. Because pixel memories do not contain any parametric data, you cannot make measurements on pixel data.

When saving to a hardcopy device, the entire screen area is sent to the peripheral device. Hardcopy stops if a device is not connected to the oscilloscope.

If the destination is set to off, data from that source is not saved.

You can set a different destination for each source. For example, you could save channel 1 data to waveform memory 3 and the entire screen to pixel memory 1.

After Fail Softkey

The **AFTER FAIL** softkey determines what action the oscilloscope takes after a failure: stop or continue.

Stop If the **ON FAIL, SAVE** softkey is set to a waveform memory, the test stops after a failure occurs. If the **ON FAIL, SAVE** softkey is set to multiple, the test continues to run until all of the 665 records are filled.

Continue If the **ON FAIL, SAVE** softkey is set to a waveform memory, the new fail data is written to the memory after each failure. The previous data is overwritten, unless the protect softkey is set to on in the waveform save menu. If the waveform protect softkey is set to on, the message "PROTECT ON: CANNOT STORE TO MEMORY #," and the data is not saved. If the **ON FAIL, SAVE** softkey is set to multiple, the test continues to run until all of the 665 memories are filled. Then, the test continues to run and starts overwriting the data that was previously stored in the memories. The test continues to run until you turn off the test with the test softkey or after fail softkey.

See also

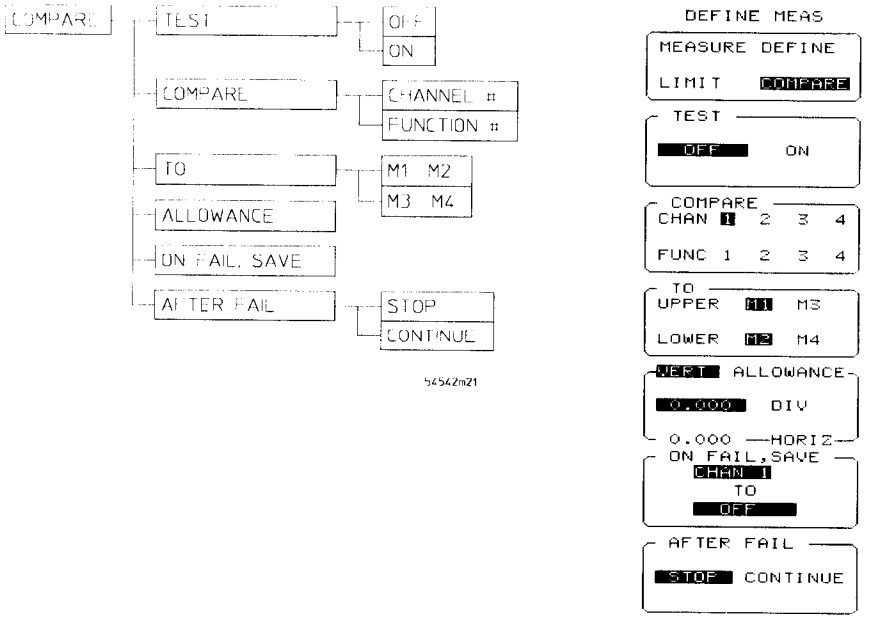
Chapter 9 "Waveform Save Menu," for information on displaying data that was saved to multiple memories or saved to waveform memories.

Waveform Compare Menu

The waveform compare test allows a point-by-point comparison of an input channel to a waveform memory pair (m1 and m2, or m3 and m4). The result is a displayed PASS or FAIL message. The menu allows you to compare your choice of input channel or function with a memory pair. You can enter a failure allowance value to give the effect of trace separation, where needed. On failure, the menu allows for storage of the data with a stop/continue option.

If limit test is on, you cannot turn on the compare test.

Figure 8–4



When the compare test is on, each point of the input channel or function is compared against the memory pair. The channel or function and the memory pair must have valid data stored in them and must be set to on. Holes are ignored during the test. If the input channel waveform point falls within the mask memory pair, the test passes. If the waveform falls outside the memory pair, the point is tested against the allowance value with a resulting PASS or FAIL message. If the test fails, a failbar is displayed above the graticule showing the point or points that failed the test. The compare test runs only on 500-point records.

In the compare mode, the 16-bit words in the memory and channel buffers are directly compared to the pulse mask memories. Because the compare is performed on the 16-bit unscaled data, this test is faster than the limit test.

If you are generating a mask without having the oscilloscope generate the mask for you, make sure the test is set up so that the upper mask is in memory m1 for memory pair m1 & m2 or memory 3 for memory pair m3 & m4. Likewise, the lower mask must be in memory m2 for memory pair m1 & m2 or m4 for memory pair m3 & m4. If the masks are stored to the reverse of the memory pairs, the test will fail.

Test Softkey

The **TEST** softkey toggles the compare test routine on or off. When the test is turned on, the oscilloscope compares the input channel waveform against the selected memory pair. PASS or FAIL is displayed when the test is complete. The memory bar is removed during test on and is replaced by the fail bar. If the test fails, the failed points are displayed above the graticule at the point of failure as a four-pixel high red line.

See also

"Mask Editor Menu" in Chapter 9 for more information on creating waveform masks.

Messages

PASS A channel or function waveform is contained in the memory pair.

FAIL Channel or function waveform is not contained in the memory pair and within the allowance value. The test has failed or the memory pair contents are reversed (upper waveform in memory 2 or 4 and lower waveforms in memory 1 or 3).

ER 0 Invalid data in the channel; Either the Clear display was pressed or a setting (like s/div or V/div) was changed to invalidate the data. The test is not performed.

ER 1 Either the channel or function or the compare waveform memory is off. The test is not performed.

ER 2 Versus mode is not a valid compare mode.

Only one measurement test routine may be turned on at one time. If the measurement limit test is on, the message "limit test on: cannot turn on" is displayed. If the compare test is on, the measurement limit test selection causes the message "comp test on: cannot turn on" to be displayed.

If an attempt is made to turn on a second test over the HP-IB, a message is displayed stating the command is ok but that the settings conflict.

Compare Softkey

The **COMPARE** softkey selects the channel or function for comparison to the memory pair.

To Softkey

The **TO** softkey selects the memory pair, m1 and m2 or m3 and m4, for comparison to the chosen input channel or function. Make sure that m1 is greater than m2 for all values across the screen when memory pair m1 & m2 is selected. When memory pair m3 & m4 is selected, make sure that m3 is greater than m4 for all values across the screen. If m1 is less than m2 or if m3 is less than m4, the compare test fails. The display is misleading in this case because the waveform appears to be in the bounds of the memory pair.

Allowance Softkey

When a point on the waveform fails the compare test, the point is tested again against the allowance set with the **ALLOWANCE** softkey. Allowance refers to the distance a point may be above the upper mask or below the lower mask and still pass the compare test. The distance is measured in divisions. The allowance range is from 0 to 8 divisions in 1/40 division increments.

On Fail, Save Softkey

The **ON FAIL, SAVE** softkey saves the data associated with the failure (from selected channel, function, or screen) to memories or to a hardcopy device. You can select the source and destination of the save by pressing the softkey until the desired parameter is highlighted, then by turning the entry knob to change selections. The source choices include any channel, function, or the screen. The destination choices include off (not saved), waveform memories, multiple memories, pixel memories, and hardcopy. The destination choices available depend on the source currently selected:

- Channel — off, nonvolatile memories, or multiple
- Function — off, nonvolatile memories, or multiple
- Screen — off, pixel memories, or hardcopy.

The type or amount of failure data saved depends on the destination selected.

If a destination is selected and the channel or function is off, a message is displayed indicating that the data is invalid and failure data is not stored.

When saving to a waveform memory, you can select one memory. Selection of the memory pair containing the comparison waveform is not allowed. If multiple failures occur, only the last failure data is saved because the most current data overwrites the memory contents. However, as each source is saved to that memory, the previous contents are overwritten. If a waveform memory is set to protected, the message "protect on: cannot store to memory" is displayed and the data is not saved.

When saving to multiple memories, you can save up to 665 records (data includes a time/date stamp). If multiple failures occur and the stop after fail mode is selected, then the test terminates after all available memory space is filled. If the continue after fail mode is selected, after the 665 memories are filled, the data records wrap around and new data overwrites previous data. If more than one source is specified with a multiple destination, then the data records are partitioned between the specified sources.

When saving to a pixel memory, the entire screen area is save to the pixel memory. New data is added to the pixel memory without overwriting the previously stored data. Because pixel memories do not contain any parametric data, you cannot make measurements on pixel data.

A save to hardcopy immediately sends the data to the peripheral device. If any source is designated as multiple, then the hard copy is performed after all 665 multiple memories are filled. Hardcopy is canceled if a device is not connected.

If the destination is set to off, data from that source is not saved.

If the compare test is on, with save to hardcopy, and after fail set to continue and a FAIL condition occurs, the hardcopy continues as long as the FAIL condition exists.

After Fail Softkey

The after fail softkey determines what action the oscilloscope takes after a failure.

Stop If the **ON FAIL, SAVE** softkey is set to a waveform memory, the test stops after a failure occurs. If the **ON FAIL, SAVE** softkey is set to multiple, the test continues to run until all of the 665 records are filled.

Continue If the **ON FAIL, SAVE** softkey is set to a waveform memory, the new fail data is written to the memory after each failure. The previous data is overwritten, unless protected in the waveform save menu. If the **ON FAIL, SAVE** softkey is set to multiple, the test continues to run until all of the 665 memories are filled. Then, the test continues to run and starts overwriting the data that was previously stored in the memories.

See also

Chapter 9 for information on displaying data saved to multiple memories and data saved to waveform memories.

Waveform Save Menu

Waveform Save Menu

This chapter describes how to select the waveform, pixel, multiple, and mask memories on the oscilloscope. The chapter is divided into four menus:

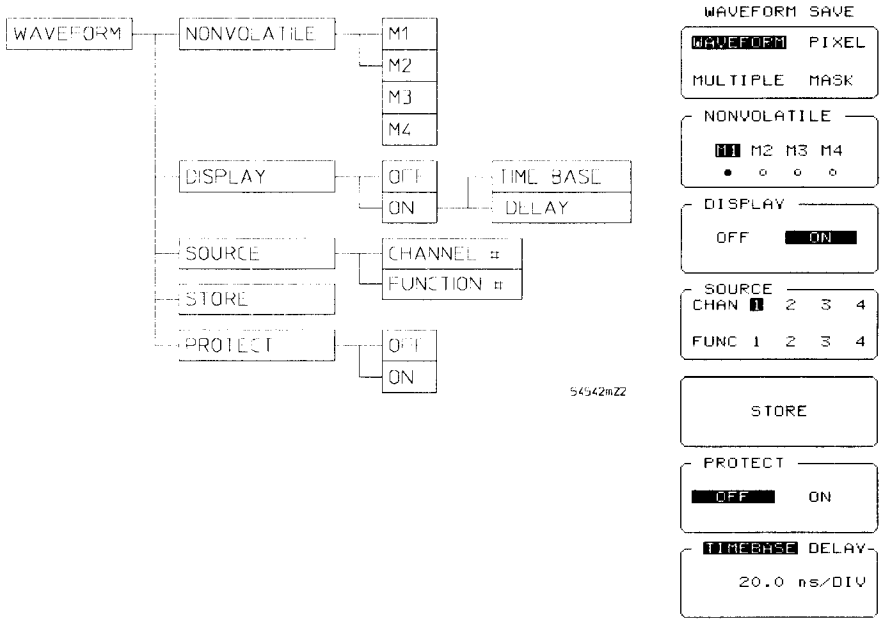
- Waveform Menu used to store and display the four nonvolatile waveform memories.
- Pixel Menu used to store and display the two volatile pixel memories.
- Multiple Menu used to store and view failure data from the limit and waveform compare tests that were saved to the multiple memories.
- Mask Menu used to generate masks in memory pairs m1 and m2 or m3 and m4.

When you press the Waveform Save key on the front panel, one of four softkey menus is displayed on the right hand portion of the screen. The menu that is displayed depends on the selection of the top softkey in the waveform save menu. The menu map for each of the four menus is included with the topic that covers that menu.

Waveform Save Menu

The waveform save menu has four memories: m1, m2, m3, and m4. These memories are nonvolatile and are not cleared by pressing the Autoscale key, by pressing the Recall key, or by recycling the power. Because the memories are nonvolatile, you can disconnect the power and transport the oscilloscope without losing the contents of the waveform memories.

Figure 9–1



A waveform memory consists of a single waveform record, including the horizontal and vertical scaling parameters. The scaling parameters allow measurements on previously stored waveform and function data. Also, you can set the x and y markers on stored waveforms when they are displayed on the screen.

When the oscilloscope is in the envelope display mode and a waveform store is executed, the minimum value and maximum value are stored separately. The maximum value is stored in m1 if m1 or m2 are the selected store locations, or in m3 if m3 or m4 are the storage locations. The minimum values are stored in m2 or m4 respectively. A message is displayed above the waveform display area indicating the storage locations of both values.

Nonvolatile Softkey

The **NONVOLATILE** softkey lets you select which memory to use. The selections are nonvolatile memories m1, m2, m3 and m4. When a memory is turned on, the small circle below the label is highlighted. When the memory is protected, the small circle has an "x" through it. The waveform memories are record memories that store up to 32K points in the real-time mode or 500 points in the repetitive mode.

Display Softkey

The **DISPLAY** softkey toggles the selected waveform memory display on or off. When on is selected, the **TIME BASE DELAY** softkey is displayed that shows the time base and delay settings when the waveform was stored. You can use the show menu to see the vertical and trigger settings.

Source Softkey

The **SOURCE** softkey selects the source waveform to store in the selected memory. You can select any channel or function as a source.

Store Softkey

The **STORE** softkey is the active softkey in the menu. When pressed, the memory is erased and new data is stored to the memory. If the destination memory is protected, the message "protect on: cannot store waveform" is displayed, indicating that the store was not successful.

Protect Softkey

The **PROTECT** softkey toggles the selected waveform memory write-protect to on or off. When on is selected, any attempt to store data is not allowed, and the message "protect on: cannot store waveform" is displayed, indicating that the store was not successful.

Timebase/Delay Softkey

The **TIME BASE DELAY** softkey is displayed when the selected memory is turned on. It initially displays the time base and delay settings when the waveform was stored. Pressing the softkey cycles between the time base and delay values. If the data was saved in the real-time mode, you can use the knob to change the values to pan and zoom displayed waveforms.

Waveform Save Exercise

This exercise demonstrates how to store and recall a waveform.

1. Press the Recall key. Then, press the Clr key.
2. Connect a coaxial cable between the rear-panel AC connector and channel 1.
3. Disconnect any other signals connected to other inputs.
4. Press the Autoscale key.
5. Press the Wform save key. Then, select **WAVEFORM**.
6. Use the **NONVOLATILE** softkey to select **M3** as the waveform memory.
7. Use the **SOURCE** softkey **CHAN 1** as the source.
8. Press the **STORE** softkey.

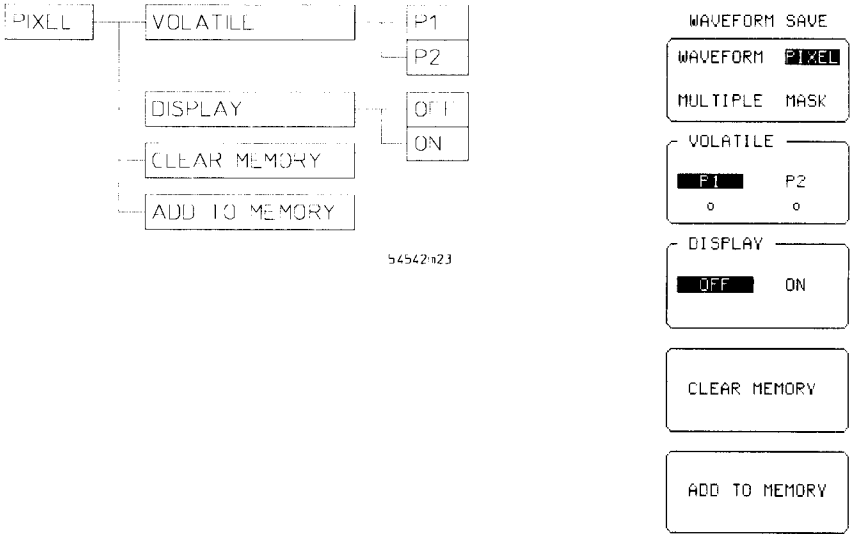
   The currently displayed waveform is saved in nonvolatile waveform memory, m3.
9. Set the **DISPLAY** softkey to **ON** to display the contents of memory m3.
10. Use the vertical position knob to move the channel signal vertically so that you can see the stored waveform.

    The waveform from channel 1 overlaps the display of the waveform memory. You can either turn off the display of channel 1 or move the display of channel 1, so that you can see the stored waveform in m3.

Pixel Menu

The pixel menu selects the pixel memories. These memories are useful when additive memory capabilities are needed or for storing infinite persistence data.

Figure 9–2



Volatile Softkey

The **VOLATILE** softkey selects between pixel memories 1 or 2. The pixel memories are complete pixel saves of the waveform area (excluding the graticule and markers) in volatile memory. Data stored to a volatile memory is lost when the power is cycled.

The entire 256 by 500 point display area is saved in pixel memory. Therefore, data is mapped directly onto the display and displayed in half-bright. Because the pixel memories do not contain any scaling parameters, there are no measurement capabilities on pixel memories.

Pixel memories are additive. If new data occurs in the same pixel as old data, the new data overwrites the old data.

Display Softkey

The **DISPLAY** softkey toggles the selected pixel memories on or off.

Clear Memory Softkey

The **CLEAR MEMORY** softkey purges all data from the selected pixel memory.

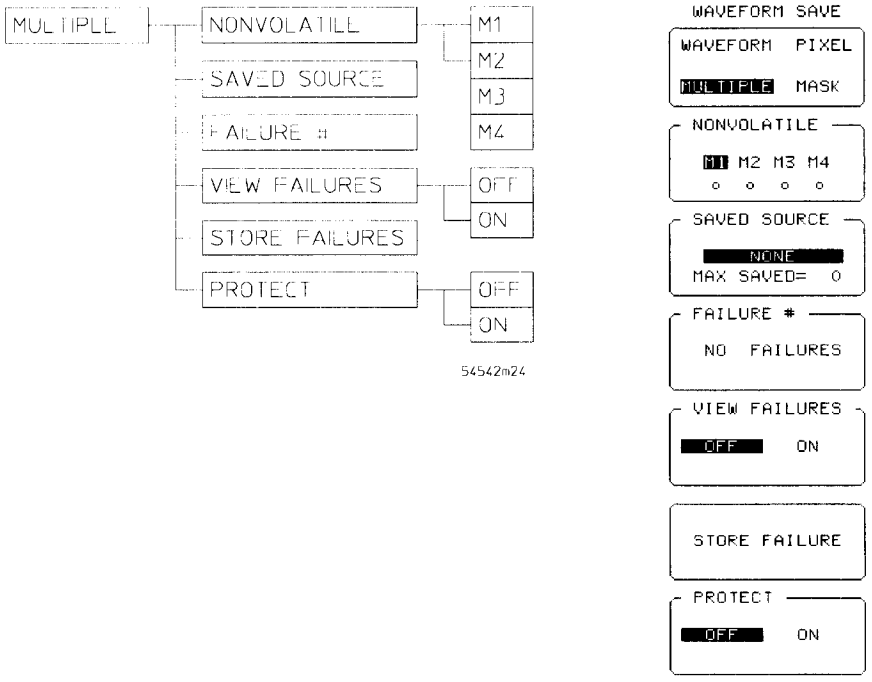
Add to Memory Softkey

The **ADD TO MEMORY** softkey adds the currently displayed screen to the specified pixel memory.

Multiple Menu

You can use the multiple menu to display one of the 665 possible volatile failure memories. These are the memories where failure data from both the limit and waveform comparison tests are saved. Failure data stored in volatile multiple memories can be viewed, or transferred to nonvolatile memories m1 through m4. The multiple memories store 500 points of waveform information (no raw data) in each memory. Measurements are not performed unless the data is first transferred into one of the nonvolatile memories.

Figure 9–3



Nonvolatile Softkey

The **NONVOLATILE** softkey selects which of the four nonvolatile memories to use when transferring multiple memory failure data. The selections are nonvolatile memories m1, m2, m3 and m4. When a memory is turned on (using the waveform menu), the small circle below the label is highlighted. When the memory is protected, the small circle has an "x" through it.

Saved Source Softkey

The **SAVED SOURCE** softkey selects the multiple memory source to view or to transfer. The source alternatives are any channel or function that has failure data saved, as selected when configuring the limit or compare tests in the define measurement menu. When the **SAVED SOURCE** softkey displays "None", no failure data is available (max saved=0). The maximum number of data records saved is also displayed on the bottom portion of the softkey display.

Failure # Softkey

The **FAILURE #** (number) softkey selects a specific multiple memory to view or to transfer. Also, it displays the time and date the selected record was saved. The source is specified using the saved source softkey. The maximum number records available are displayed at the bottom of the saved source softkey. When "NO FAILURES" is displayed, no failure data is available.

View Failures Softkey

The **VIEW FAILURES** softkey toggles the multiple memory display on or off. If failure data was not saved, the softkey remains off and a message stating that the multiple memory is empty is displayed.

Store Failure Softkey

The **STORE FAILURE** softkey saves the specified multiple memory to the currently selected nonvolatile memory location. When pressed, the memory is erased and new data is stored to the memory. If the destination memory is protected, the message "protect on: cannot store waveform" indicating that the store was not successful is displayed. If failure data was not saved, the status message "no valid data... nothing stored" is displayed.

Protect Softkey

The **PROTECT** softkey toggles the selected waveform memory write protect to on or off. When on is selected, any attempt to store data is not allowed, and the message "protect on: cannot store to memory" is displayed.

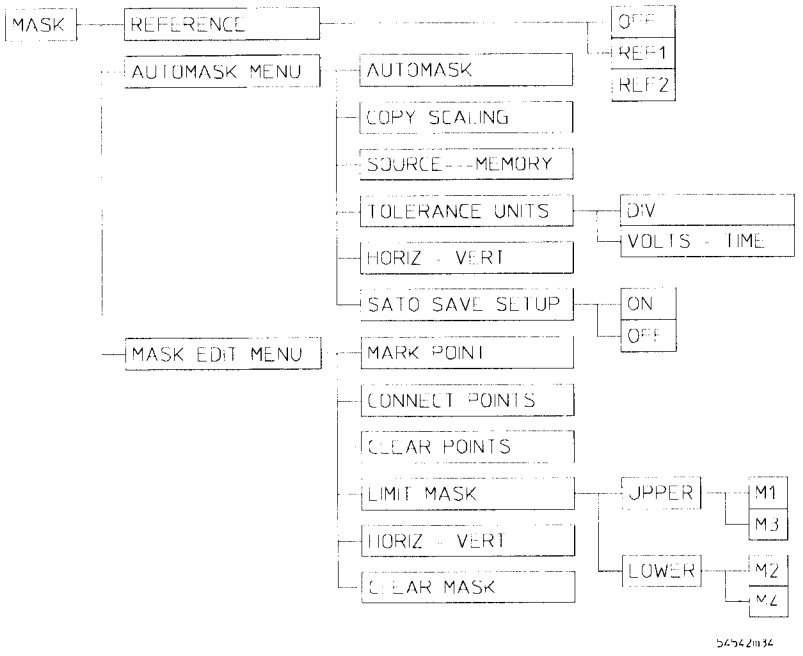
Any data stored to the multiple memories is lost when the power is cycled.

Mask Menu

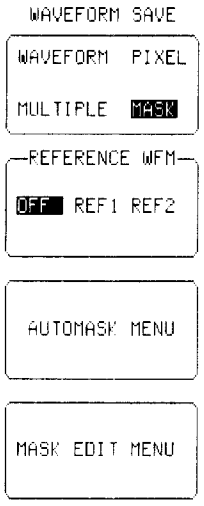
The mask menu allows you to create upper and lower limit masks (or templates) for the waveform compare test. You can create these templates automatically using a sample signal and entering specific tolerance levels, or generating the template manually on the screen using the cursor.

The mask menu is comprised of the following three menus: main mask menu, automask menu, and mask editor menu.

Figure 9–4



Main Mask Menu



This menu is displayed when mask is selected from the waveform save menu. The mask main menu allows you to view the reference waveforms, or to select the automask or mask editor menus.

Reference Wfm Softkey

The **REFERENCE WFM** (waveform) softkey allows you to view the waveform that was used to automatically generate the upper and lower limit masks during generation of the automask. Ref1 displays the waveform used to generate the masks in memory pair m1 and m2, and ref2 displays the waveform used to generate the masks in memory pair m3 and m4. Off clears the display of the reference waveforms.

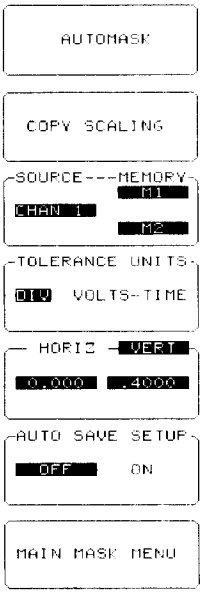
Automask Softkey

The **AUTOMASK** softkey brings up the automask menu on the display.

Mask Editor Softkey

The **MASK EDITOR** softkey brings up the mask editor menu on the display.

Automask Menu



The Automask menu contains the selections used to generate the upper and lower limit masks at defined tolerances using the data from a selected source. Masks are generated and stored in waveform memory pairs m1 and m2 or m3 and m4.

Automask Softkey

The **AUTOMASK** softkey generates the upper and lower limit mask for the selected source waveform at the specified tolerance. Each mask is stored in the selected nonvolatile memory pair.

Once an automask is generated, the previous contents of the selected memory pair are overwritten. Any data previously stored is lost.

Prior to performing an automask, verify that the data for the selected source is valid, the source selected is set to on, the destination memories are not protected, and the horizontal and vertical tolerance are specified.

Make sure you set the **SOURCE---MEMORY, TOLERANCE UNITS**, and **HORIZ-VERT** softkeys correctly. Otherwise, the mask may not generate, or it may generate incorrectly.

Copy Scaling Softkey

The **COPY SCALING** softkey copies the scaling information from the selected source to the specified nonvolatile memory pair. Both the source and the memory pair are selected using the **SOURCE---MEMORY** softkey. You can use the **COPY SCALING** feature when you plan to make measurements on the mask or make comparisons to the mask.

Source---Memory Softkey

The **SOURCE---MEMORY** softkey is used to select both the source of the waveform used during an automask function, and the destination memory pair for the resulting upper and lower limit masks. All channels, functions, and reference waveforms are available as source selections. Memory pairs are either m1 and m2 or m3 and m4. The upper limit mask is stored in m1 or m3, and the lower limit mask is stored in m2 or m4.

Tolerance Units Softkey

The **TOLERANCE UNITS** softkey allows you to select the vertical and horizontal tolerance units used during an automask function to generate the upper and lower limit masks. You can specify tolerance as divisions or in volts and time (seconds). Once desired units are selected, use the **HORIZ-VERT** softkey to enter the tolerance.

Horiz-Vert Softkey

The **HORIZ-VERT** softkey is used to select and enter the horizontal and vertical tolerance parameters. The horizontal parameter defines the maximum signal excursion right and left of the selected source. The vertical parameter defines the maximum signal excursion above and below the selected source.

The maximum signal excursion is equal in both directions from the selected source, except when the source is channel and the display mode is envelope. In that case, the upper and lower limit masks are generated as follows:

- If the vertical and horizontal tolerances are set to zero, then the lower limit mask is the minimum envelope waveform and the upper limit mask is the maximum envelope waveform.
- If vertical and horizontal tolerances are set to any value other than zero, then the lower limit mask is the minimum envelope waveform with the specified tolerance applied, and the upper limit mask is the maximum envelope waveform with the specified tolerance applied.

You can enter the tolerance either in divisions or in volts and seconds, depending on the current selection of the tolerance units softkey.

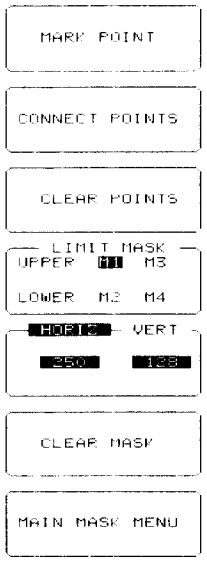
When units are divisions, horizontal entries of from 0.000 to 1.000 are allowed, and vertical entries of from 0.000 to 8.000 are allowed.

When units are volts-time, horizontal entries are limited to the current time base setting. Entries from 0.00000 to 200.0000 seconds are allowed. However, if the entered value exceeds the current time base value (time/division), it is automatically adjusted to the maximum value allowed. Vertical entries are limited to the currently selected source's vertical setting. Entries from 0.00000 to 40.0000 volts are allowed. However, if entered value exceeds eight times the vertical volts/division value for the source selected, it is automatically adjusted to the maximum value allowed.

Main Mask Menu Softkey

The **MAIN MASK** softkey returns you to the main mask menu.

Mask Edit Menu



The Mask Edit menu contains the selections used to edit previously generated or stored masks using the automask menu. By using the mask editor menu, it is also possible to clear any existing masks and create a new one using the mark and connect-point method.

If the active limit mask (defined by the limit mask softkey) is not displayed, pressing any softkey in the mask editor menu (except clear mask or main mask menu) causes the active limit mask to display.

Mark Point Softkey

The **MARK POINT** softkey records the current horizontal and vertical field values. This point is used as the anchor point when connecting or clearing points from the screen. These values are displayed in the horiz-vert softkey, and represented on the screen at the junction of the x2/y2 markers. When the softkey is pressed, the current values are saved, and the x1/y1 markers are moved to that point on the screen (imposed over the x2/y2 markers).

Connect Points Softkey

The **CONNECT POINTS** softkey replaces the portion of the existing active limit mask from the mark point (junction of x1/y1 markers) to the connect point (junction of x2/y2 markers) with a straight line.

Clear Points Softkey

The **CLEAR POINTS** softkey replaces the portion of the existing active limit mask from the mark point (junction of x1/y1 markers) to the connecting point (junction of x2/y2 markers) with a hole.

Limit Mask Softkey

The **LIMIT MASK** softkey selects the active limit mask for the mask editor menu functions. Limit masks are stored in pairs, where m1 or m3 contains the upper limit mask and m2 or m4 contains the lower limit mask.

Horiz-Vert Softkey

The **HORIZ-VERT** softkey changes the horizontal and vertical field values, and the position of the x2/y2 markers on the screen during mask edits. The acceptable vertical settings are from 0 (y2 at the bottom of the screen) to 255 (y2 the at top of the screen). The acceptable horizontal settings are from 0 (x2 at the left of the screen) to 500 (x2 at the right of the screen).

When horizontal is selected, the vertical y2 marker is slaved to the horizontal x2 marker. As the x2 marker is changed, the y2 marker follows the displayed active limit mask and updates the data values at each location. If the mask has a hole present, the y2 marker are not changed.

You can move the x1/y1 only when the mark point softkey is pressed.

Clear Mask Softkey

The **CLEAR MASK** softkey replaces the entire active limit mask with holes (blanks the screen).

Main Mask Menu Softkey

The **MAIN MASK** softkey returns you to the main mask menu.

Mask Exercise

This exercise demonstrates how to generate upper and lower masks using a reference waveform at a tolerance of ± one-half a horizontal and vertical division.

1. Press the Recall key. Then, press the Clr key.
2. Connect a coaxial cable between the rear-panel AC connector and channel 1.
3. Disconnect any other signals connected to other inputs.
4. Press the Autoscale key.
5. Press the Display key. Then, set **CONNECT DOTS** to on.
6. Press the Wform save key. Then, select **MASK**.
7. Press the **AUTOMASK MENU** softkey.
8. Use the **SOURCE---MEMORY** softkey to set the source to chan 1 and memory to m1/m2.
9. Use the **TOLERANCE UNITS** softkey to select div.
10. Use the **HORIZ-VERT** softkey to select **HORIZ**. Then, use the entry knob or keypad to set the horizontal tolerance to 0.500.
11. Use the **HORIZ-VERT** softkey to select **VERT**. Then, use the entry knob or keypad to set the vertical tolerance to 0.500.
12. Press the **AUTOMASK** softkey.

    You may notice that the message "upper stored in mem 1, lower stored in mem 2" is displayed.

10

Math/FFT Menu

Math/FFT Menu

The Math/FFT menu allows you to perform waveform math functions and FFT functions. You can define one of four math functions, and the operands for the functions can be any channel or one of four waveform memories.

A function is generated by mathematically manipulating one or two operands into a new waveform called a function. You can generate a new waveform with one of the following nine operations:

- + (add)
- – (subtract)
- × (multiply)
- vs (versus)
- magnify
- inv (invert)
- int (integrate)
- diff (differentiate)
- FFT

The vertical display and offset are adjusted to place the function for best viewing.

When the function is calculated, it can be used in the following ways:

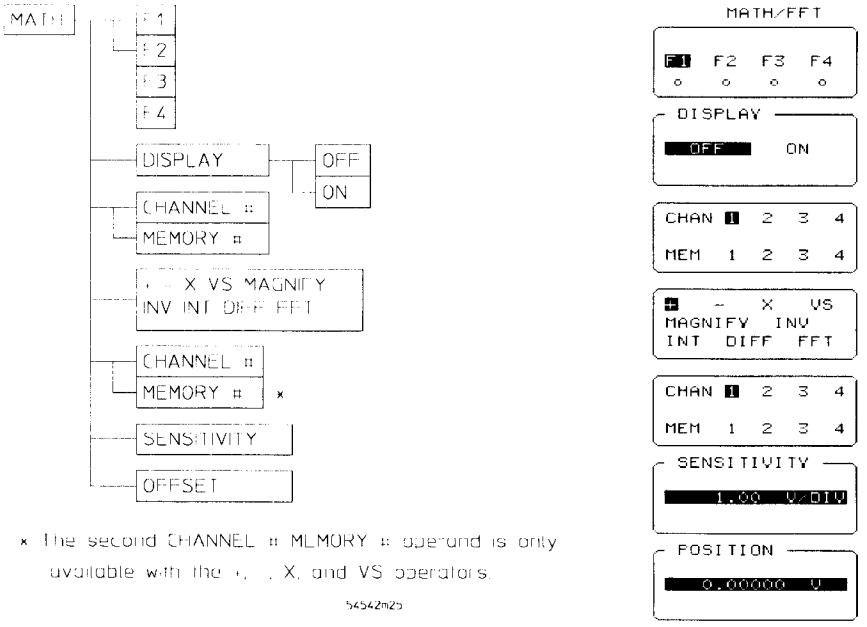
- Displayed on the screen
- Evaluated with the measurement features
- Stored in memory
- Transferred over HP-IB

Functions are transferred over the HP-IB by storing the function to a memory. Then, the contents of the memory are transferred over HP-IB.

When you press the Math/FFT key on the front panel, the waveform math menu is displayed on the right-hand portion of the screen. The Math and FFT softkey menu and menu map are shown below. When you select FFT as the math operator, additional keys are available which allow you to define the FFT function. The FFT menu and menu map are described later in this chapter.

See also "FFT Softkeys" later in this chapter for information on the FFT functions.

Figure 10–1



Defining a Function

The Waveform Math/FFT menu selects and presets any of various operations, sources, and displayed results.

Function Softkey

The **FUNCTION** softkey selects one of the four functions.

Display Softkey

The **DISPLAY** softkey turns the selected function on or off. The display of the functions depends on the display mode in the display menu. When the number of screens is set to 1, the functions are displayed in one screen. When the number of screens is set to 2, functions 1 and 2 are displayed in the top screen and functions 3 and 4 are displayed in the lower screen. When the number of screens is set to 4, each functions is displayed in its own area, starting with function 1 on the top.

Chan/Mem Softkey

A math operand is defined by the **CHAN/MEM** softkey. The math operators +, −, ×, and vs use two operands, while the math operators magnify, inv, int, diff, and FFT, use one operand. The **CHAN/MEM** softkey defines the first operand of the mathematical operation, or the waveform to be manipulated. If two operands are required, a second **CHAN/MEM** softkey is displayed that allows you to define the second operand. You can define the operand to be any channel or waveform memory (if there is a waveform stored in that memory).

Operator Softkey

The **OPERATOR** softkey selects any of the nine functions. Continue pressing the selection softkey until the operation desired is highlighted.

Because math operators are post-processing techniques, functions are calculated after the data is acquired.

+ (add) The voltages of the two selected operands are added together in a point-by-point manner.

– (subtract) The voltage of the second operand is subtracted from the first operand in a point-by-point manner.

× (multiply) The voltages of the two selected operands are multiplied together in a point-by-point manner.

Vs (versus) The voltage of the first operand is used to determine the displayed point's vertical position, and the voltage of the second operand is used to determine the displayed point's horizontal position.

Because the versus functions does not create a single valued waveform, you cannot store a versus function in a waveform memory or make measurements on the resultant waveform. However, you can store it in a pixel memory, and you can place markers on the versus function. The voltage range of the first operand is used to determine the horizontal range.

Magnify The voltage of the operand is scaled and positioned in a point-by-point manner.

Inv (inverse) The voltage of the operand is inverted in a point-by-point manner.

Int (integrate) The voltage of the operand is intergrated in a point-by-point manner. If a data point is not encountered in the operand, integration uses the next valid data point. Only the available data is integrated. Default scaling is determined by the original operand.

Diff (differentiate) The voltage of the operand is differentiated in a point-by-point manner. If a data point is not encountered in the operand, differentiation uses the next valid data point. Only the available data is differentiated

Default scaling is determined by the original operand. The differentiation function, by nature, amplifies noise effects. Therefore, use differentiation on signals with high signal-to-noise ratios.

FFT (fast Fourier transform) When FFT is selected, a fast Fourier transform of the specified channel or memory is displayed. Selecting this mode adds FFT specific controls to the math menu. When the FFT function is selected, the readout for the horizontal axis changes from time to Hertz and the vertical readout changes from volts to dBm.

Chan/Mem Softkey

The **CHAN/MEM** softkey selects the second operand for use by the selected operator. You can choose any displayed channel or waveform memory. This softkey is not available for the magnify, inv, int, diff, or FFT operators.

Sensitivity Softkey

The **SENSITIVITY** softkey scales the function on the screen. Sensitivity does not affect the hardware settings in the scope. Sensitivity is adjusted with the knob or keypad.

Offset Softkey

The **OFFSET** softkey moves the function vertically on the screen. Offset is adjusted with the knob or keypad. Also, offset is the value at the center of the graticule area.

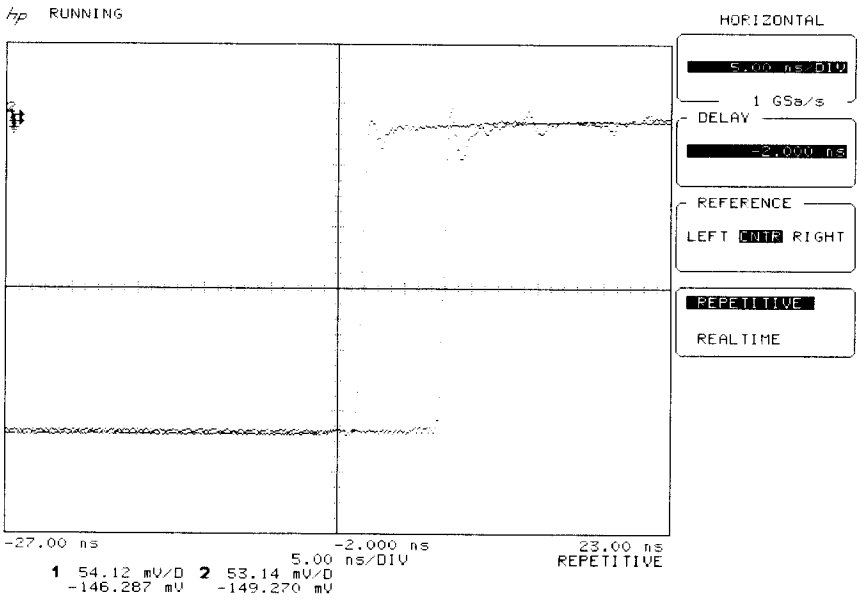
Subtracting Waveforms Exercise

In this exercise you subtract two waveforms in the Math menu.

1. Press the Recall key. Then, press the Clr key.
2. Connect a power splitter or BNC Tee to channel 1. Connect a coaxial cable between the rear-panel AC cal connector and one side of the BNC Tee. Then, connect a one-meter coaxial cable between the other side of the BNC Tee and channel 2.

   A power splitter provides better signal fidelity than a BNC Tee. The extra cable length between channels provides a time delay between the signals on the oscilloscope. The propagation of a 1-meter coaxial cable is about 6 to 7 ns. This delay is used to demonstrate the math function.
3. Press the Vertical 1 key. Then, set the channel 1 and channel 2 input coupling to 50 Ω dc.
4. Press the Autoscale key.
5. Use the time/div knob to change the time base to 5 ns/div. Then, use the delay knob to position the waveforms on the screen.
6. Press the Horizontal Setup key. Then, select the **REPETITIVE** mode.

Figure 10–2



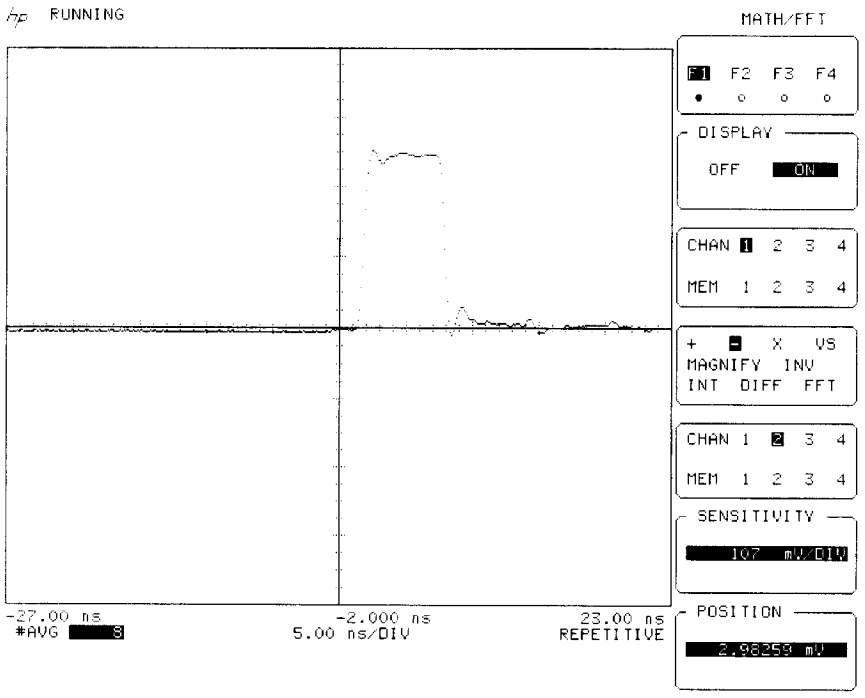
7 Press the Display key. Select the **AVG** (average) mode. Then, set the **# OF AVG** to 8.

8 Press the Vertical 1 key. Then, turn off channel 1 and channel 2.

9 Press the Math/FFT key. Then, select function f1, display on, channel 1 subtract channel 2.

The function subtracts channel 2 from channel 1. The propagation delay between channels results in a 6- to 7-ns spike.

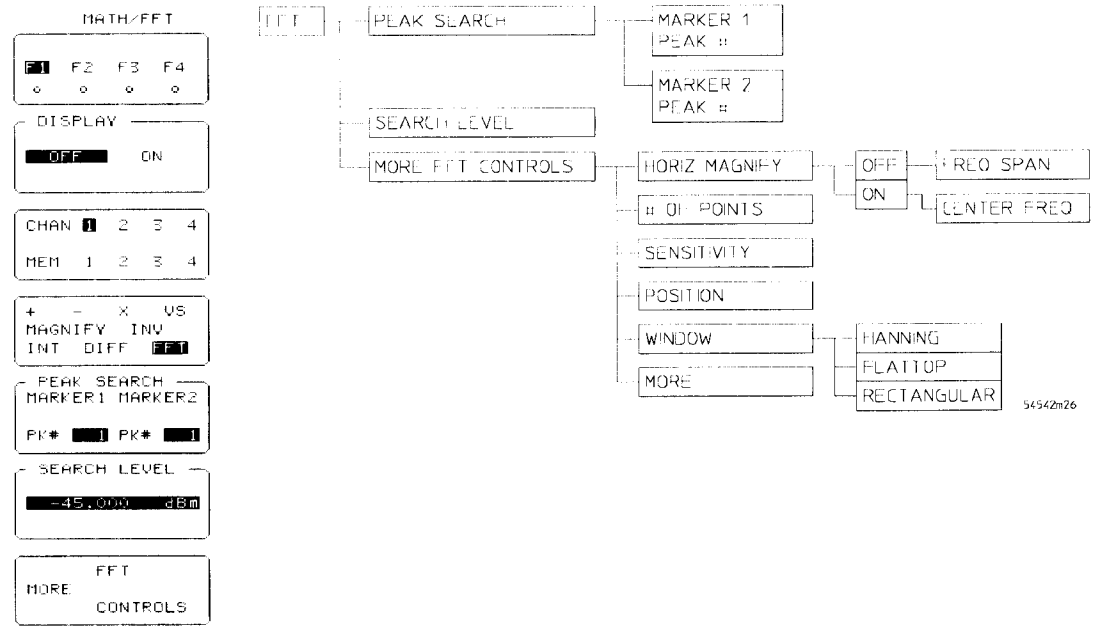
Figure 10–3



FFT Softkeys

When you select FFT as the math operator, additional control keys are available to define the FFT function. The FFT menu and menu map are shown below.

Figure 10–4



Peak Search Softkey

You can use the **PEAK SEARCH** softkey to measure the amplitude and frequency of peaks on the display generated by the FFT function. To qualify as a peak, the amplitude of the peak must be at least one display division, (half a division in the splitscreen mode), and the peak must also be greater than the search level specified.

The peak search softkey also turns on the markers. The markers are set to the selected peaks in the peak search field. Markers x1 and y1 are set on the first peak specified, and markers x2 and y2 are set on the second peak specified. You can select peak numbers from 1 to 99.

To remove the markers from the display.

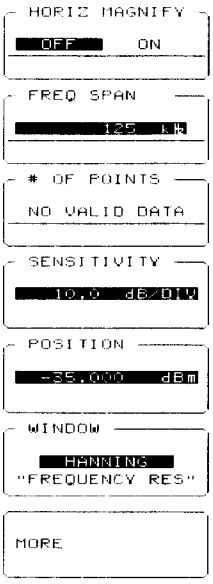
Press the `Shift` key. Then, press the `Clr meas` key.

A peak search for both peaks is performed every time the peak search softkey is pressed. If a peak is not found, a message is displayed, the vertical marker is set to the right side of the waveform area, and the horizontal marker is set to the bottom of the waveform area.

For maximum frequency accuracy when using peak search, turn on the FFT horizontal magnify function, and use both the **CENTER FREQ** and **# OF POINTS** softkeys to isolate the peak of interest.

Search Level Softkey

The **SEARCH LEVEL** softkey sets the minimum search level for the peak search.



More Softkey

The **MORE** softkey selects the second level of the math menu when the FFT function is selected.

Horiz Magnify Softkey

The **HORIZONTAL MAGNIFY** softkey allows expansion of the frequency record. Use the **MAGNIFY OFF** mode for viewing the entire FFT spectrum. Use the **MAGNIFY ON** mode for looking at two frequencies that are close together and for making maximum accuracy measurements. When on is selected, the **CENTER FREQ** softkey is available for centering on the desired frequency. The **CENTER FREQ** softkey uses software expansion to center the frequency record to the desired frequency.

The number of points displayed on the screen for FFT functions is always 500. When magnify is off, a compression algorithm is used to compress all of the FFT points into 500 points. The algorithm accurately displays peaks and most noise. However, low points in the noise are occasionally missed. When magnify is on, the actual FFT points are displayed, 500 points at a time.

Freq Span Softkey

The **FREQUENCY SPAN** softkey controls the span, the maximum frequency, of the FFT record when the **HORIZONTAL MAGNIFY** softkey is set to off Changing the span of the FFT record with a channel source causes the time base setting to change. The span is the sample frequency divided by two. Because the sample frequency for memories is fixed, once a record is stored, the span is also fixed and cannot be changed.

The keypad does not have keys for entering MHz or kHz. But, the keypad does have a key for enter exponents, Eex. For example, to set the span frequency to 125 kHz, press the following keys: 1, 2, 5, Eex, 3, Enter.

Center Freq Softkey

The **CENTER FREQUENCY** softkey allows centering of the frequency record to the desired frequency when horizontal magnify is set to on.

of Points Softkey

The **# OF POINTS** softkey assigns the number of data points to be used for the FFT computation. The number of points affects the computation speed, frequency resolution, and the noise floor. The frequency resolution of an FFT is Fs/N, where Fs is the sampling frequency and N is the number of points. The maximum signal-to-noise ratio of an FFT is related to both the A/D converter bits of resolution and the number of points.

An FFT performed on a small number of points is computed faster. But, an FFT performed on a large number of points has better frequency resolution and a lower noise floor. The resolution affects how accurately frequencies are measured and how well two frequencies that are close together are resolved.

If the oscilloscope is in the repetitive mode, or the operand is a memory that was stored from the repetitive mode, the number of points defaults to 512 and cannot be changed.

When the operand is a repetitive source, onscreen data is used for the FFT. When the operand is a real-time source, the FFT is performed on data in the selected record length, but not necessarily on the data that is displayed on the screen. The points used from the record are selected based on the time base reference setting of left, center, or right. When the reference is set to left, data at the beginning of the record is used. When center is selected, data in the middle of the record is used. When right is selected, data at the end of the record is used.

The memory bar above the graticule indicates what portion of the acquisition record is used for the FFT time record. The memory bar shows the FFT record whenever a FFT menu is selected. An exception is that the compare mode fail bar replaces the memory bar when compare mode is on.

In the Math/FFT and Math/FFT More menus with functions on and FFT selected, the memory bar refernces the FFT mode. In all other menus either the channel or the waveform memories control the memory bar.

An FFT with an input record of N points is transformed into a frequency record of N points. Because half of the points are above the Nyquist frequency and provide redundant information, they are not used, so the frequency points are half that of the input. The FFTs are computed on records that are in powers of two.

If the number of FFT points is 512, 256 additional frequency points are created by interpolating between the actual points to give 512 frequency points. The number of FFT points and the resultant frequency points is listed below.

Input points	Frequency points
512 (repetitive)	512
512 (real time)	512
1024	512
2048	1024
4096	2048
8192	4096
16384	8192
32768	16384

Sensitivity Softkey

The **SENSITIVITY** softkey scales the function vertically by using software expansion. It does not affect the hardware settings. The scaling units are in dB per division. For example, if the scale is set to 10 dB/div, and a peak is two divisions high, you know that the amplitude of the frequency peak is 20 dB. This setting is for ease of viewing and making measurements on the function.

Position Softkey

The **POSITION** softkey positions the function vertically on the screen. Position is the offset value at the center of the graticule area. If you adjust the offset so that a peak is at the vertical center of the graticule area, then you know that the peak magnitude is the offset value. For example, if the peak of the spike is at the vertical center of the graticule area, and the position reading is –16.2 dBm, then you know that the peak magnitude is –16.2 dBm.

Window Softkey

The **WINDOW** softkey allows you to select from three windows: rectangular, Hanning, and flattop. The FFT operation assumes that the time record repeats indefinitely. Unless there is an integral number of cycles of the sampled waveform in the record, a discontinuity is created at the end of the record. This is referred to as leakage. In order to minimize spectral leakage, windows that approach zero smoothly at the beginning and end of the signal are employed as filters to the acquired data record.

Windows work by weighting points in the middle of the waveform record higher than those at the ends of the record. For example, a Hanning window looks like the first half of a sine wave. The Hanning window multiplies the points in the center of the record by 1 and multiplies the points at the start and the end of the record by zero.

The rectangular window multiplies all the points in the record by 1. The rectangular window is used for transients signals and signals where there are an integral number of cycles in the time record. The Hanning window is used for frequency resolution and general purpose use. It is good for resolving two frequencies that are close together or for making frequency measurements. The flattop window is the best window for making accurate amplitude measurements of frequency peaks.

More Softkey

The **MORE** softkey returns to the previous Math/FFT softkey menu.

Vertical Scaling Units

The fundamental measuring units of an oscilloscope are volts/division on the vertical axis and time/division on the horizontal axis. This philosophy is used for all the function operations except for FFTs. No provisions were made to manage units for all combinations of operands and operations.

For example, if you applied a +2 V level to channel 1 and a –3 V level to channel 2. The oscilloscope displays the product as –6 V, when in reality it is $-6\ V^2$.

Making FFT Measurements

The following information will help you to make optimum measurements in the frequency spectrum.

Connect the Dots

It is easier to view FFTs with connect the dots turned on. You can turn connect the dots on in the Display menu.

Amplitude Measurements

For best vertical accuracy on peak measurements:

- Make sure the source impedance and probe attenuation is set correctly. If the operand is a channel, the impedance and probe attenuation are set in the channel menu.
- Set the source sensitivity so that the input signal is near full screen, but not clipped.
- Use the flattop window.
- Set the FFT sensitivity to a sensitive range, like 2 dB/division, in the single-screen mode or 4 dB/division in the dual-screen mode.

Frequency Measurements

For best frequency accuracy on peaks:

- Turn on magnify.
- Use the Hanning window.
- Set the frequency span so that the signal of interest is in the upper part of the screen (not down at dc).
- Set both the record length and the number of points to 32,768, or as high as possible if computation time is a consideration. (The greater the record length, the longer the computation time.)

The frequency accuracy is the sum of two terms. The first term is supplied because there are a limited number of frequency bins. The measurement is accurate to plus or minus half a bin. The second term is related to the accuracy of the internal oscillator which generates the sample clock.

$$accuracy = \pm\left(\frac{frequency\ resolution}{2}\right) + (signal\ frequency \times 0.005\%)$$

$$= \pm\left(\frac{sample\ frequency}{2 \times number\ of\ points}\right) + (signal\ frequency \times 0.005\%)$$

$$= \pm\left(\frac{frequency\ span}{number\ of\ points}\right) + (signal\ frequency \times 0.005\%)$$

Computation of dBm

The vertical units of the FFT functions are dBm. 0 dBm is defined as a 1 milliwatt signal. The formula for converting a signal of power P into dBm is:

$$dBm = 10\log\left(\frac{P\ in\ mW}{1mW}\right)$$

A handier formula, and the one that is used in the instrument is for calculating dBm from the peak voltage.

$$dBm = 20\log\left(\frac{V_p\ in\ volts}{0.316228V}\right)$$

The bottom term, 0.316228 Volts, is the peak voltage of a 1 milliwatt signal into a 50 Ω resistor.

$$V_P = \frac{V_{rms}}{0.707107} = \frac{\sqrt{P \times R}}{0.707107}$$

$$= \frac{\sqrt{1\ mW \times 50\ \Omega}}{0.707107})$$

$$= 0.316228\ Volts$$

If you are measuring the power of a signal, then terminate the source into 50 Ω in order to get the correct dBm reading. However, if you are measuring a voltage, the 50-Ω source impedance is not a requirement. The above equation for dBm as a function of peak voltage still applies.

Computation of dBV

Another common unit of amplitude is dBV. A 0 dBV signal is defined as a 1 Volt rms signal. A dBm reading is converted to a dBV reading by subtracting 13.01 dB.

$$dBV = 20\log(0.707107 \times V_p \; in \; volts)$$
$$= 20\log\left(\frac{V_p}{0.316228}\right) + 20\log(0.707107 \times 0.316228)$$
$$= dBm \; value - 13.01 \; dB$$

dc Value

The FFT computation produces a dc value that is incorrect. It does not take the offset at center screen into account and is 1.41421 times greater than its actual value. The dc value is not corrected in order to accurately represent frequency components near dc.

Aliasing

When using FFTs, make sure you avoid signal aliasing. Aliasing occurs when there are insufficient samples on each cycle of the input signal to recognize the signal. It occurs whenever the frequency of the input signal is greater than the Nyquist frequency (sample frequency divided by 2).

When a signal is aliased, it shows up in the FFT spectrum as a signal of a lower frequency. Because the frequency span goes from 0 to the Nyquist frequency, the best way to prevent aliasing is to make sure that the frequency span is greater than the frequencies present in the input signal. Keep in mind that most periodic signals that are not sine waves have frequency components that are much higher than the frequency of the signal.

Presetting FFT Parameters

The FFT vertical parameters, magnify and center frequency are preset whenever the operand or operator is changed.

Displaying Functions

In the single screen mode and with a function tuned on, the mathematical results and the operands are displayed using the full display area.

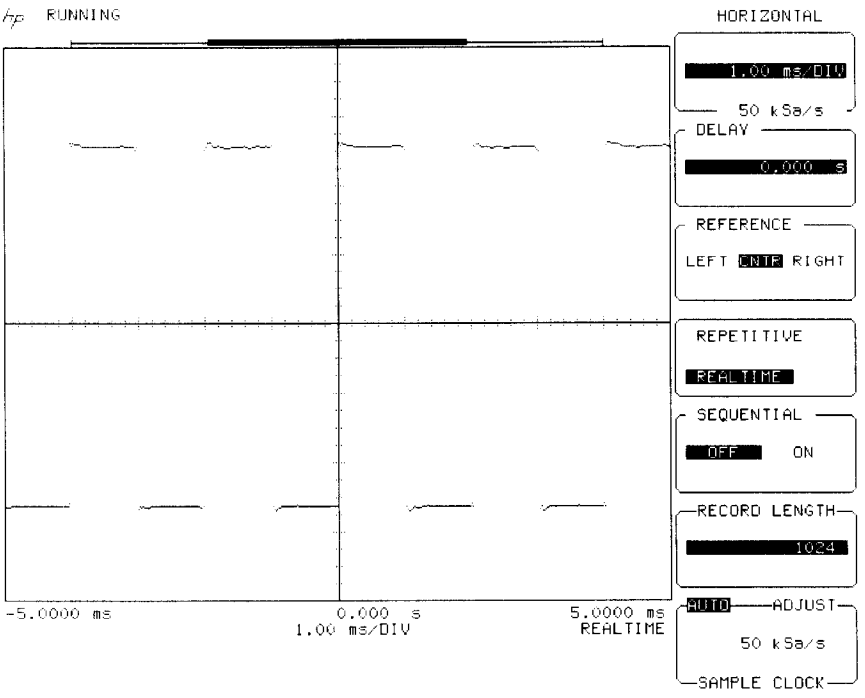
In the 2-screen mode, functions 1 and 2 are displayed in the top half of the screen, and functions 3 and 4 are displayed in the bottom half. In the 4-screen mode, each function is in its own area starting with function 1 at the top of the waveform viewing area.

FFT Exercise

In this exercise you have the oscilloscope calculate the FFT function on a square wave connected to channel 1. Then, you demonstrate the effect of the three different FFT windows, and you measure the magnitude of several FFT peaks.

1. Press the Recall key. Then, press the Clr key.
2. Connect a coaxial cable between the rear-panel AC cal connector and channel 1.
3. Press the Autoscale key.
4. Use the time/div knob to change the time base to 1 ms/div.
5. Press the Horizontal Setup key. Select the **REAL-TIME** mode. Then, set the record length to 1024

Figure 10–5

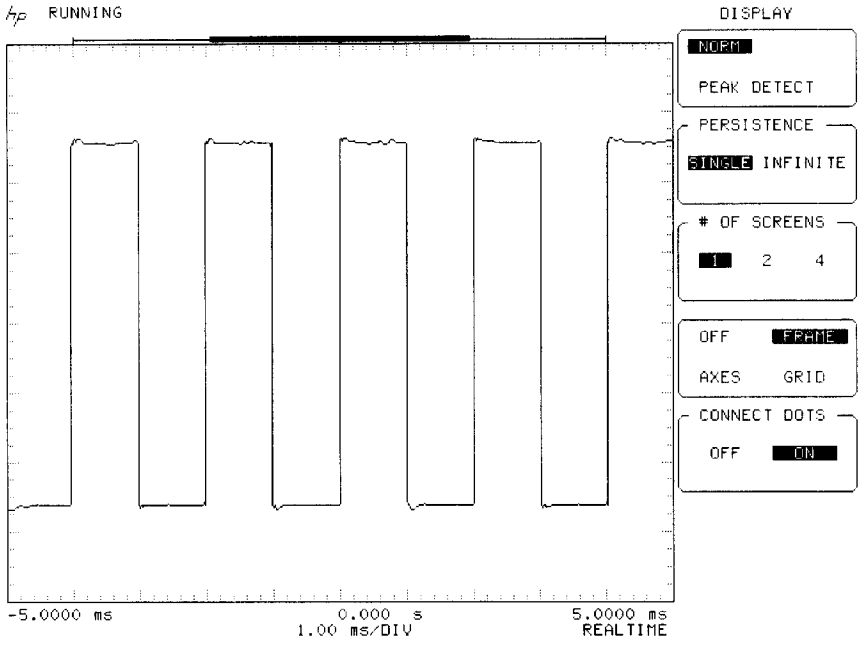


6 Press the Display key. Then, select the **FRAME** display mode and turn on connect the dots.

7 Press the Fine key. Then, adjust the volts/div knob and the position knob so that the signal almost fills the screen vertically without clipping the signal.

The oscilloscope cannot compute a correct FFT from a clipped signal, and errors from noise can occur if the signal is too small.

Figure 10–6



8 Press the Vertical 1 key. Then, turn off channel 1.

9 Press the Math/FFT key. Then, select function f1, set the display to **on**, select channel 1, and set the operator to **FFT**.

10 Press the **MORE FFT CONTROLS** softkey. Set the **# OF POINTS** to 1024. Then, set the window to **RECTANGULAR**.

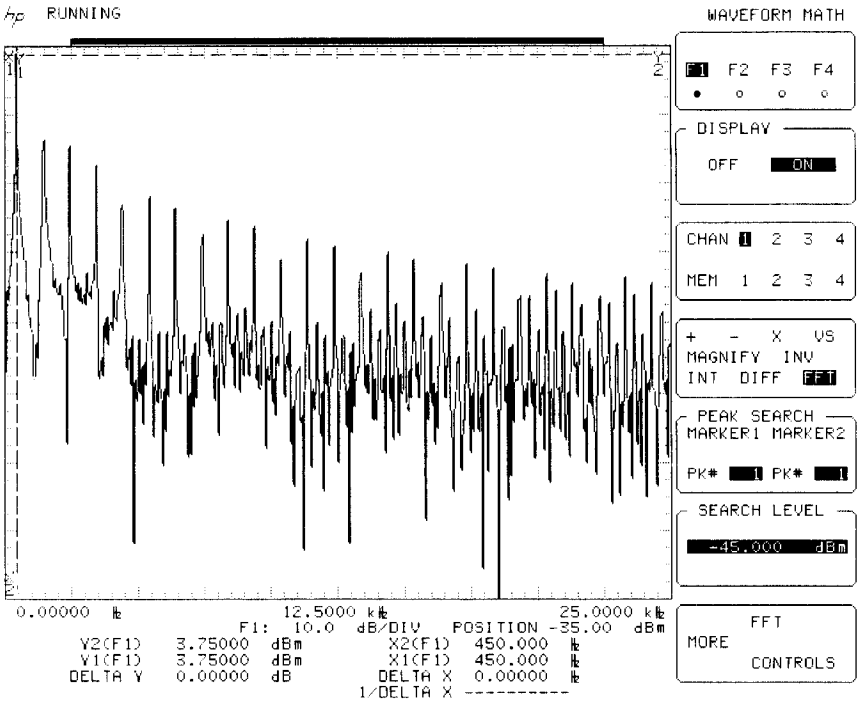
11 Press the **MORE** softkey.

You can use the oscilloscope to make automatic peak measurements in the Math/FFT menu.

12 Using the **PEAK SEARCH** softkey and the entry devices, set marker 1 and marker 2 to the first peak.

When FFT is the selected operator, the time base settings beneath the waveform viewing area change from time values to frequency values, like Hz or kHz. Also, when the **PEAK SEARCH** softkey is pressed, the marker source is slaved to the FFT function. This feature saves you time because you do not have to access the marker menu to set the markers to the FFT function. Because both markers are on the same peak, they have the same marker reading.

Figure 10–7



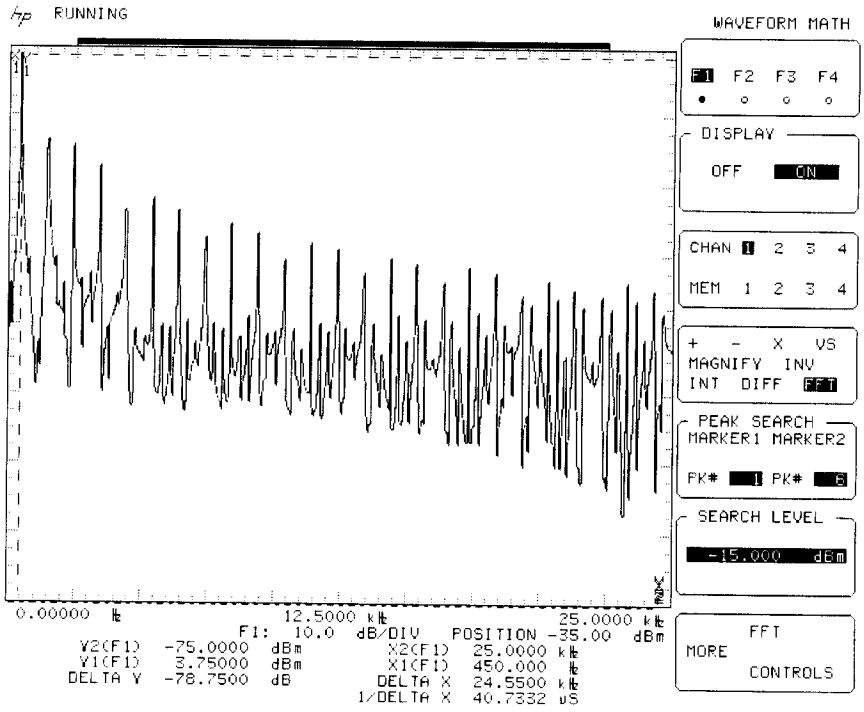
12 Set the search level to –15 dBm.

The search level sets a threshold for peak detection. All peaks below the search level are ignored during peak search. The first peak from the left side of the display that is above the search level is considered by the oscilloscope as peak number one.

13 Select the **PEAK SEARCH** softkey. Then, use the entry knob to slowly move marker 2 to peak number 6.

You may notice that as you select each peak, marker 2 snaps to the next peak above the search level. Depending on the setup of your oscilloscope and the signal you are using, somewhere around peak number 4 the search level will be above the peak. When the oscilloscope cannot find any additional peaks, the message "marker 2 peak not found" is displayed, and marker 2 snaps to the right edge of the display.

Figure 10–8



To display both channel 1 and the function.

Select 2 screens in the display menu. Then, set the FFT to function 3 or function 4.

See also

"Displaying Functions" in this chapter for information on where the oscilloscope places channels, functions, and memories on the display.

11

Utility Menu

Utility Menu

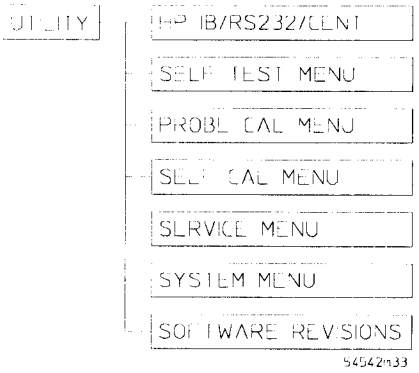
The utility menu accesses the calibration and service functions, as well as sets up the HP-IB interface. The menus include self-test, calibration, service, system, a listing of the current firmware revision date, and access to the product-update registration form.

Also, this menu controls all of the service functions that maintain the reliable performance of the oscilloscope.

The utility menu actually consists of several other menus that you access through the utility menu.

- HP-IB menu
- Self-test menu
- Probe cal menu
- Self-cal menu
- Service menu
- System menu
- Software Revisions

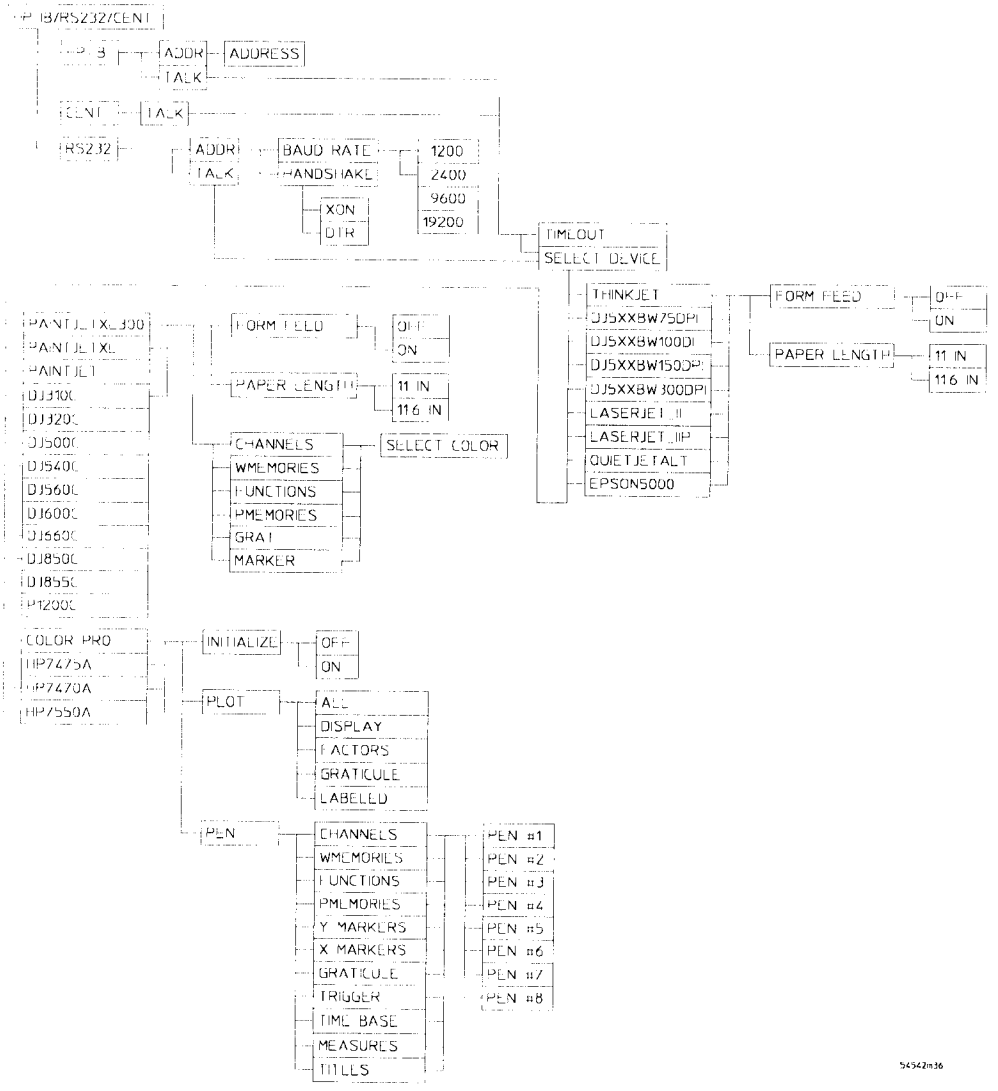
The menu map for each of these menus is included with the topic that covers that menu.

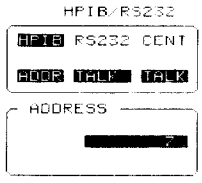


HP-IB/RS-232/CENT Menu

The HP-IB menu makes settings so the oscilloscope can talk to peripheral devices. This interface includes three primary settings: HP-IB talk, HP-IB addressed, RS232 talk, RS-232 addressed, and Centronics.

Figure 11–1





HP-IB

The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's implementation of IEEE Standard 488-1978, "Standard Digital Interface for Programmable Instrumentation." The HP-IB is a carefully defined interface that simplifies the integration of various instruments and computers into systems.

The HP-IB interface uses an addressing technique to ensure that each device on the bus (interconnected by HP-IB cables) receives only the data that is intended for it. To accomplish this, each device is set to a different address and this address is used to communicate with other devices on the bus. You can use the **HPIB ADDR** mode to set the address of the scope from 0 to 30.

The **HPIB TALK** mode sets the oscilloscope to print hardcopies without intervention from an external controller. Make sure the attached printer or plotter is in the listen only or listen always mode. You can set the amount of time that the oscilloscope attempts to talk to the printer or plotter (time out) while the scope is in the talk only mode.

RS-232

The RS-232C interface is Hewlett-Packard's implementation of EIA Recommended Standard RS-232C, "Interface between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange." The RS-232 interface sends data one bit at a time and characters are not synchronized with preceding or subsequent data characters. Each character is sent as a complete entity without relationship to other events.

Talk/Addr Mode

The HP-IB and RS232 interfaces can be in talk or address mode. Use the entry knob to toggle between talk and address.

In address mode, the RS232 interface provides a selection mode for baud rate and handshake. The HP-IB address mode provides an address selection. In talk mode, all three interfaces provide various output configurations.

Baud rate The baud rate is the rate at which bits are transferred between the interface and the peripheral device. The baud rate must be set to transmit and receive at the same rate as the peripheral device.

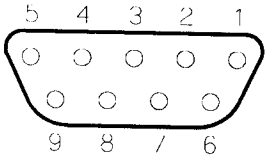
Handshake You can use handshake to select either a hardware or software handshake. Data Terminal Ready (DTR) is a hardware handshake. A three-wire interface using DTR does not allow the sending or receiving device to control data flow. No control over the data flow increases the possibility of missing data or transferring incomplete data. With an extended hardwire interface, selecting DTR allows a hardware handshake to occur that uses hardware signals to control data flow.

XON is a software handshake that uses Transmit On (XON) and Transmit Off (XOFF). A software handshake allows the receiving device to control the data flow by requesting that the transmitting device temporarily stop sending data until the receiving device is ready to receive additional data. XOFF stops data transfer while XON resumes data transfer.

RS232 Connector Pin Out

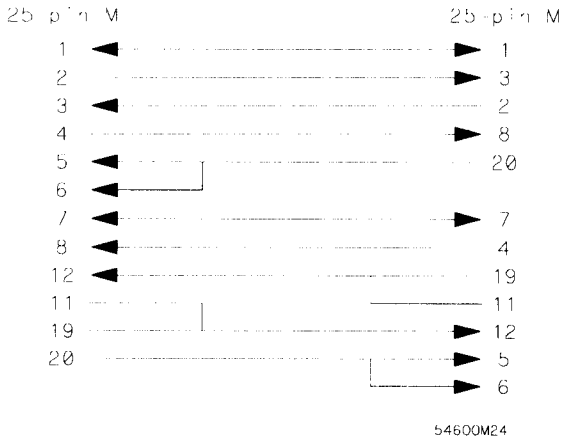
Pin Number	Signal
1	Data Terminal Ready
2	Transmit
3	Receive
4	Request to Send
5	Clear to Send
6	Data Set Ready
7	Ground
8	Data Carrier Detected
9	Ring
Shell	Protective Ground

Figure 11–2



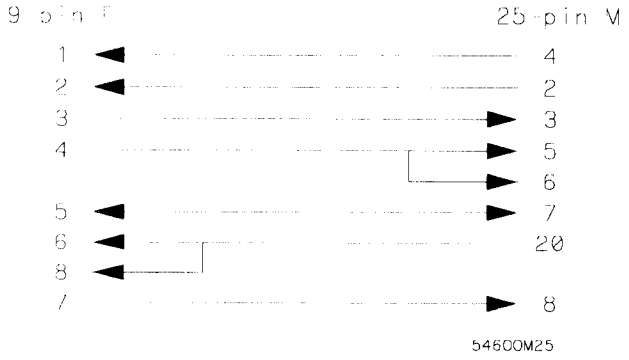
Pin out of RS-232 port looking into the connector

Figure 11–3



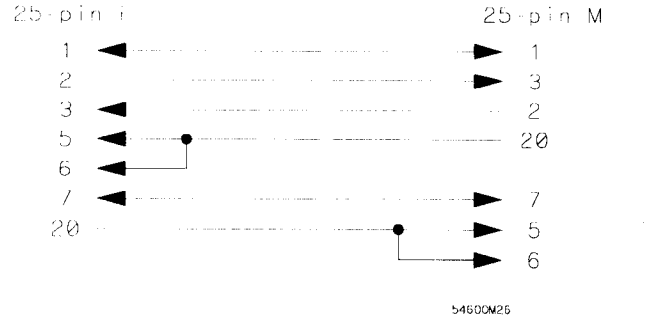
RS-232 cable pin out for connecting 25 pin male to 25 pin male

Figure 11–4

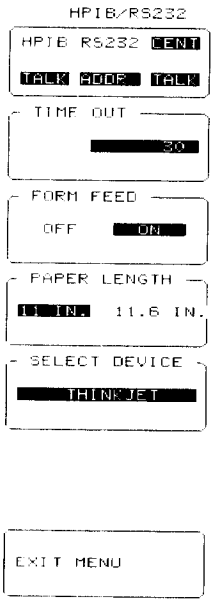


RS-232 cable pin out for connecting 9 pin female to 25 pin male

Figure 11–5



RS-232 cable pin out for connecting 25 pin female to 25 pin male



Centronics

The **CENT TALK** selection is for printing to Centronics compatible printers that the use the Hewlett-Packard Printer Control Language (HP PCL). When **CENT TALK** is selected, the Print key will output through the Centronics port on the back of the oscilloscope. If no device is connected to the Centronics port, the message `NO LISTENERS HARDCOPY ABORTED` will eventually appear on the screen.

Time Out Softkey

The **TIME OUT** softkey is available when talk only mode is selected. The **TIME OUT** softkey sets the amount of time that the oscilloscope attempts to talk to an external device. If the oscilloscope does not hear back from the external device within the time frame set by the **TIME OUT** softkey, the scope assumes there is a problem with the external device and stops trying to communicate with the external device. The time out range is from 0 to 3600 seconds.

If you set the time out to 0, the oscilloscope will time out before it even starts the plot. A normal setting for time out is 5 to 10 seconds. However, on some plotters, it may be necessary to increase the time out value in order for the plotter to have enough time to communicate back to the scope.

Address Softkey

The **ADDRESS** softkey is available when the HP-IB address mode is selected. The address softkey sets the address of the oscilloscope, so that the oscilloscope can selectively talk or listen to external devices. The address of the oscilloscope is set while the oscilloscope is in the addressed mode. The address range is from 0 to 30.

Form Feed Softkey

The **FORM FEED** softkey allows you to select on or off. If **FORM FEED** is set to on, the printer performs a form feed at the end of the hardcopy. If **FORM FEED** is off, the page is scrolled up four lines when the hardcopy is complete.

Paper Length Softkey

The **PAPER LENGTH** softkey selects between 11-inch or 11.6-inch page lengths for auto form feed. The 11-inch page is a U.S. standard and the 11.6-inch page is a U.K. and European standard.

Device Mode Softkey

The **DEVICE MODE** softkey selects whether the hardcopy goes to a printer or plotter. Plotters must speak the Hewlett-Packard Graphics Language (HP GL), and printers must speak Hewlett-Packard Printer Control Language (HP PCL). The supported printers and plotters are: ThinkJet, Deskjet at 75, 100, 150, and 300 dpi, LaserJetII, LaserJetII_P, QuietJetAlt, PaintJetXL, Color Pro, HP 7470A, HP 7475A, HP 7550A, DeskJet 310C, DeskJet 320C, DeskJet 500C, DeskJet 540C, DeskJet 560C, DeskJet 600C, DeskJet 660C, DeskJet 850C, DeskJet 855C, DeskJet 1200C, QuietJetAlt, and Epson 5000.

When PaintJet and DeskJet printers are selected, an additional softkey is provided; this softkey provides a choice of colors for channels, wmemories, functions, pmemories, graticule, and markers When a plotter is selected, three additional softkeys are available: initialize, plot, and pen.

Initialize When off, the plotter is not initialized. Off allows you to setup the plotter so that the hardcopy from the oscilloscope is plotted to a specific area of the paper installed in the plotter. When on, the plotter is initialized. On is like sending the `IN` command over the bus to the plotter.

See also

The manual for your plotter for information on setting up the plotter, and for information on what the IN command initializes on the plotter.

Plot The **PLOT** softkey allows you to choose what information the oscilloscope sends to the plotter. There are five plot options: graticule, display, factors, labeled, and all.

- Graticule plots only the graticules without waveforms or setup information.
- Display plots only the waveform data without the graticule or setup information.
- Factors plots only the setup of the oscilloscope without graticules or waveform data.
- Labeled plots the graticules, waveform data, and setup factors. Also, the plotted image is reduced and a label is placed on the right side of the paper for each channel that is turned on. Then, a line is drawn from each label to its corresponding waveform.
- All plots the graticules, waveform data, and factors without labels.

Pen The **PEN** softkey allows you to assign a pen color to nineteen of the display parameters. You can assign any pen number from 1 to 8 to each parameter for assorted plotter pen colors. You can select the following parameters:

channels 1 to 4*	x1 marker	graticule
waveform memories 1 to 4	x2 marker	trigger
pixel memories 1 and 2	y1 marker	time base
functions 1 to 4	y2 marker	measurements
		titles

* Channels 3 and 4 are available on 4-channel models only.

Exit Menu Softkey

The **EXIT MENU** softkey returns you to the utility menu.

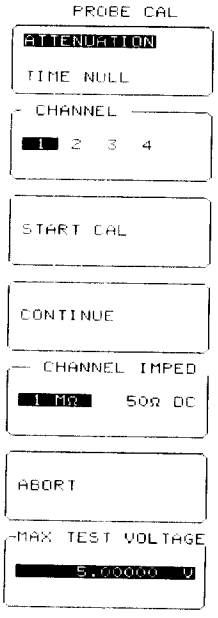
Self-Test Menu

The self-test menu is for performing service work on the oscilloscope. Refer to the Service Guide supplied with the oscilloscope for details on the features in this menu.

Probe Cal Menu

The probe cal menu allows you to calibrate the attenuation factor for high-impedance probes, and to compensate for variations in probe lengths. You can select from two probe calibration procedures: attenuation and time null.

Attenuation Menu



The attenuation menu calibrates the channel gain to the tip of the probe on high impedance probes. The oscilloscope calibrates to correct for channel gain through probe attenuation down to a 0.9 attenuation factor.

Below 0.9 the message "attenuation less than 1, see manual for action" is displayed. The corrective action is to perform a self-calibration on the oscilloscope.

If the probe is not connected to the DC cal output connector on the rear panel, the probe compensation connector on the front panel, or the probe attenuation exceeds 250, the error message "attenuation too high or bad connection" is displayed. The corrective action is to check the connections and redo the probe calibration. If recalibration is unsuccessful, refer to the Service Guide.

If the probe attenuation calibration is successful, the displayed message "probe attenuation = n.nnnnn this value has been entered into your channel probe setting" is displayed.

Probe Attenuation Calibration Error

Impedance Approximate error

100 kΩ 0.5%

1 MΩ 0.05%

10 MΩ 0.005%

Channel Softkey

The **CHANNEL** softkey selects which channel to calibrate.

Start Cal Softkey

The **START CAL** softkey displays the instructions for the probe calibration.

Continue Softkey

The **CONTINUE** softkey actually begins the calibration process.

Channel Impedance Softkey

The **CHANNEL IMPEDANCE** softkey key allows you to select the impedance of the probe connected to the channel input. Use the 50-Ω selection for active probes that have a high input impedance, and use the 1MΩ selection for BNC cables.

Abort Softkey

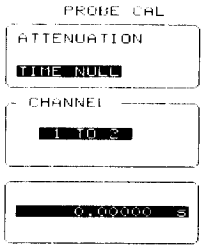
The **ABORT** softkey is the only active key during the calibration process. The calibration process is terminated and the previous calibration factors are left intact when the abort softkey is pressed.

Max Test Voltage Softkey

CAUTION

The MAX TEST VOLTAGE softkey allows you to set a maximum voltage for the calibration signal. The maximum voltage is the dc voltage output of the rear panel DC cal output connector, or front-panel probe compensation connector. To prevent damage to the probe connected to the channel input, select a maximum voltage for the probe you are using. Normally, a maximum voltage of 5 volts is acceptable for most probes. However, some probes, like the HP 1141A, require a lower maximum voltage.

Time Null Menu



The time null menu sets the timing of all channels to correspond to channel 1 at the probe tip. This eliminates time discrepancies between channels caused by variations in cable lengths. Also, you can use time null to manually adjust for any differences in cable length by horizontally overlaying displayed waveforms that are time-skewed.

Channel Softkey

The **CHANNEL** softkey selects which channel to skew as referenced to channel 1.

Time Softkey

This is an unlabelled softkey. The **TIME** softkey shows the time null setting between the selected channels. You can use the entry knob or keypad to change the time null setting. The range of time null is ± 70 ns.

Exit Menu Softkey

The **EXIT MENU** softkey returns you to the utility menu.

Self-Cal Menu

The self-cal menu is typically used for performing service work on the oscilloscope. Refer to the Service Guide supplied with the oscilloscope for details on the features in this menu.

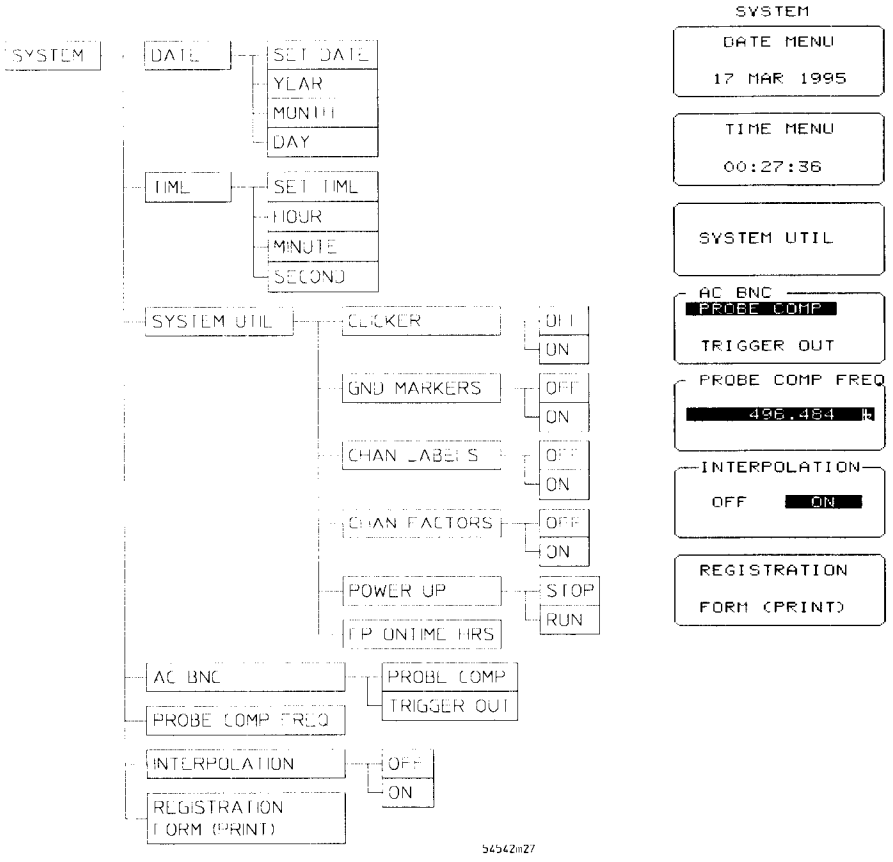
Service Menu

The service menu is for performing service work on the oscilloscope. Refer to the Service Guide supplied with the oscilloscope for details on the features in this menu.

System Menu

The System menu is used to set the real-time clock, rear panel AC BNC output, clicker, disable interpolation, and print registration forms.

Figure 11–6



Date Softkey

The **DATE MENU** softkey allows you to change the date. The date is used to time- and date-stamp hardcopy files and files stored to the disk. Also, the date-time stamp is used on files stored to multiple memory on failures in the measure limit and waveform compare tests. When you press the **DATE MENU** softkey, additional softkeys are displayed that allow you to set the year, month, and day.

Time Softkey

The **TIME MENU** softkey allows you to change the time. The time is used to time- and date-stamp hardcopy files and files stored to the disk. Also, the date-time stamp is used on files stored to multiple memory on failures in the measure limit and waveform compare tests. When you press the **TIME MENU** softkey, additional softkeys are brought up on the display that allow you to set the hour, minute, and second.

System Util Softkey

The **SYSTEM UTIL** softkey brings up another menu that has six additional softkeys.

Clicker Softkey The **CLICKER** softkey turns on and off the clicker. When the clicker is turned on, an audible click is heard each time a key is pressed.

Ground Markers Softkey The **GND MARKERS** softkey turns on and off the ground markers that are displayed on the screen. When turned on, there is a ground marker on the left side of the display for each channel that is turned on. The ground markers give you a visual indication of where the ground reference point is for each channel that is turned on. If the ground reference for a channel is positioned vertically off the screen, the ground marker turns into an arrow that points in the direction of the ground reference. Ground markers are printed with hardcopy prints.

Channel Labels Softkey The **CHAN LABELS** softkey turns on and off the channel labels that are displayed on the screen. When turned on, there is a channel label on the right side of the display for each channel that is turned on.

Channel Factors Softkey The **CHAN FACTORS** softkey turns on and off the display of the channel factors. When on, the volts/div and offset for each channel that is turned on is displayed on the screen. If measurements and markers are both turned off, the channel factors are displayed below the graticule area. If either measurements or markers are turned on, the channel factors are displayed near the bottom of the graticule area. With the **CHAN FACTORS** softkey turned on or off, you can also press the Show front-panel key to see the complete setup of any channels that are turned on.

Power Up Softkey The Power Up key allows the oscilloscope to be powered on with the oscilloscope in a stopped state and the compare/limiters tests turned off. This protects any data in memories WMem1-4. The selections are run and stop. The default is run.

Front Panel Ontime Softkey The **FP ONTIME HRS** key allows you to set the number of hours that the front panel display will be on with no activity before the timeout takes effect. The timeout turns the display off, which increases the life of the backlight. The choices are 1 to 12 hours or infinite (timeout inactivated) When the display is off due to reaching the specified number of hours with no activity, three events will turn it back on and restart the timeout period: a trigger, a front panel key depression, or an HPIB command. The default is six hours.

AC BNC Softkey

The **AC BNC** softkey selects between a probe compensation signal and the system trigger. When probe comp is selected, the probe comp signal is an output at the rear-panel BNC connector and at the front-panel probe compensation terminals. When trigger out is selected, the trigger signal is an output at the rear-panel BNC connector and at the front-panel probe compensation terminals. The default signal is the probe compensation signal which is a square wave of about 500 Hz.

Both the probe comp signal and the trigger out signal are about 0 V to –800 mV into a high impedance, and about 0 V to –400 mV into 50 Ω. You can vary the frequency of the probe comp signal from 250 mHz to about 32 kHz. The signal at the rear-panel AC BNC connector has a rise of time of about 400 ps, while the signal at the front-panel probe compensation connector has a rise time of about 1 µs.

Interpolation Softkey

When in the real-time sampling mode with the sample clock set to auto and on time ranges faster than 20 ns/div, data is normally routed through an interpolation filter that calculates and adds additional data points. These additional data points fill in the time buckets between the acquired data points. You can set the **INTERPOLATION** softkey to off to bypass the interpolation filter and to view the actual nonfiltered (raw) data points for all active channels (running or stopped). Active memories with real-time data displayed at faster than 20 ns are also displayed as dots. Turning interpolation to off also turns off any active measurements, and any attempt to perform measurements is not allowed. Either select on or exit the system menu to turn on the filter again.

You can also use the sequential capture mode in the time base menu to view the raw data points. You can measure, store, and transfer over the bus the raw data points acquired in the sequential capture mode.

Registration form (Print) Softkey

The **REGISTRATION FORM (PRINT)** softkey allows you to print out a registration form to an externally connected printer.

You can complete the form and fax or mail it to Hewlett-Packard to ensure that Hewlett-Packard can contact you when either software updates or new product information becomes available. Anyone responsible for the maintenance of the oscilloscope and anyone who is using the oscilloscope can register. You can fill out the form even if you are not the original purchaser. You can also use this form to notify Hewlett-Packard of an address change.

You can print out a copy of the registration by simply connecting a printer to the oscilloscope, then pressing the registration form softkey. If a printer is not available, make a copy of the form that is at the end of this chapter.

Software Revisions

The **SOFTWARE REVISIONS** softkey lists the installed date code and revision number of the Boot ROM firmware, Boot ROM software, System software, and Keyboard firmware.