12

Disk Menu

Disk Menu

The oscilloscope has a high-density, 3-1/2 inch, 1.44 MByte, MS-DOS® compatible disk drive. You can perform several operations with the disk menu.

- Save waveforms and front-panel setups to a disk
- Recall waveforms and front-panel setups from a disk
- Save screen images to a disk in TIFF, PCX or EPS formats
- Delete files from a disk
- Format a disk
- Make directories and subdirectories on a disk
- Load new system firmware

To load new system firmware

1 Place the disk containing the system firmware into the disk drive.

2 Press and hold any front-panel key while cycling the power.
This is referred to as performing a one-key-down powerup.

3 Press the blue shift key on the keypad to install new system firmware.
Otherwise, press any other front-panel key to continue with a normal power up.

If a disk is not in the disk drive or if the wrong disk is in the disk drive, the screen prompts you that it cannot find the system files. Simply install the system firmware disk, then press the shift key again to continue. If you do not want to continue loading new system firmware, simply cycle the scope's power again.

To access the disk menu.

- Press the blue shift key on the keypad, then press the **WFORM SAVE** key.

  The disk menu is a shifted function above the Wform (waveform) save key.

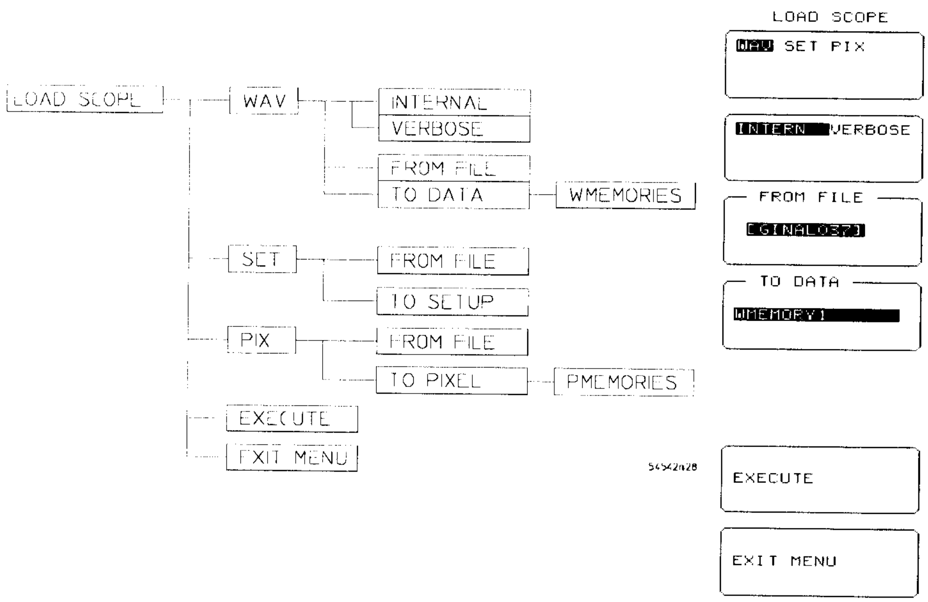
When you access the disk menu, you can choose from six disk operations: load scope, store scope, store image, delete, format, and directory. If there is a disk in the drive, you will also see the present working directory (PWD: \) plus a listing displayed on the screen of all the files and subdirectories in that directory. The directory listing includes the file name, date, time, and size of each file on the disk, as well as immediate subdirectories. If there is no disk in the drive, only the disk menu is displayed.

If the type of file is not recognized by the oscilloscope, the type field is not highlighted. Also, the oscilloscope lists only those files that are in the present working directory of the disk. All other directories on the disk are listed like files, except that a file extension is not appended to the filename and the file size is listed as 0 bytes. Any files that are not in the root directory are not included in the directory listing. You can view any additional files by changing to the directory that contains those files.

Load Scope

The load scope menu allows you to bring waveform, setup, or pixel files from a disk into the oscilloscope. You can only load files from the present working directory. To change to another directory, press the **directory** softkey. You can use the entry knob to scroll through the directory listing of the disk, or you can press the **from file** softkey to enter a file name. Pressing the **from file** softkey displays another menu that allows you to enter a file name. The **to** softkey allows you to pick where the data from the file is placed in the oscilloscope.

Figure 12–1



Type Softkey

The top softkey determines the type of file to load from the disk. The oscilloscope uses the file extension to determine the file type.

- .WAV for internal waveforms
- .TXT for text waveforms
- .PIX for pixel memories
- .SET for front-panel setups

Waveform The waveform file type is for loading waveforms from a disk into one of the four nonvolatile memories. The two waveform formats are internal and text verbose. The file extensions are .WAV for internal waveforms and .TXT for text waveforms.

When waveform is selected, the file format softkey is available that allows you to select internal or verbose formats. Waveform and text files are loaded into a waveform memory by overwriting any data previously stored in that memory, as long as the memory is not protected.

Setup A setup file is a copy of the front-panel setups, and it has a .SET file extension. Saving setups to a disk allows you to save more front-panel setups than the nine available in the oscilloscope. You can load the setup file as the current front-panel setup or as one of the nine front-panel setup memories. If you load the setup into a setup memory, the previous data is overwritten. Then, you must recall that setup to have it be the active configuration.

Pixel A pixel memory file has a .PIX file extension, and it is a copy of the pixel memory. It is a bitmapped file, so it does not contain any vertical or horizontal scaling information. You can use pixel files to store infinite persistence data on the screen, or to make timing diagrams for signal analysis. When you load a pixel file into the oscilloscope, it is loaded into one of the two selectable pixel memories by overwriting any data that was previously stored in that pixel memory.

File Format Softkey

The second softkey from the top is the **FILE FORMAT** softkey. The file format softkey is displayed only when waveform is selected as the file type. The two file formats are internal and text verbose.

Internal The internal format is a binary file format, which if you try to read it in a word processing program, you will see meaningless information. However, this is the preferred waveform-storage method because the files take up one-third as much disk space as text files. You can always convert them to text files at a later date. Internal format files have a .WAV file extension. The internal format is also compatible with the HP-IB preamble and data query commands.

Waveform files stored using the internal format contain the vertical and horizontal scaling parameters of the original waveform. Therefore, you can go into the waveform save menu and turn on the display for the waveform memory that the file was loaded into. Then, you can perform measurements on the waveform, compare it to other waveforms, rescale it horizontally, or use it as an operand in a math function.

Text Verbose The text verbose format is an ASCII file format that uses alphanumeric characters to represent the waveform. You can load text files into a word processing program.

Text verbose waveforms have the file extension .TXT. You may notice that text files use about three times more disk space than files stored to a disk using the internal format. Figure 12-3 through Figure 12-7 show examples of the text verbose format.

Waveforms loaded from disk

When waveforms are loaded from disk in internal or verbose mode, they are always referenced to the left of the screen in memory.

When a text waveform is read back into the oscilloscope, the header information can be in any order. Because the oscilloscope converts all characters to uppercase, the header information can be a mix of uppercase and lowercase characters. Also, there must be at least one space between a header and its corresponding data. For example, there must be at least one space between "Type" and "raw."

If you have modified the header information and a header field is omitted, the oscilloscope sets that field to the default value. The default values with a description of the header fields are listed in the **File Formats** section. If the header information is incorrect, you will get one of the following error messages.

"Waveform data is not valid" An error was detected in the waveform data. This error occurs if one of the data points is not a valid floating point number.

"Header information is not valid" An error was detected in the header information. This error occurs if one of the header fields or the header data is incorrect.

If the results are not what you expected after reading an ASCII waveform back into the oscilloscope, then the oscilloscope is interpreting your data differently than you expected. Try restoring the ASCII waveform from the waveform memory back to the disk. By comparing the restored data to what you had entered into the oscilloscope, you may find the error.

From File Softkey

The **FROM FILE** softkey selects a file for a disk operation. You may notice that the file name in the **FROM FILE** softkey matches the highlighted file name in the directory listing. You can use the entry knob to scroll through the list of files, or you can press the **FROM FILE** softkey to enter a file name. You can also use the **DIRECTORY** softkey to change to another directory.

Pressing the **FROM FILE** softkey displays another menu that allows you to spell out the name of the file you want. The entry knob positions the cursor over a letter or number in the character list. Press the top softkey to enter that character into the file name field. The **BACKSPACE** softkey backspaces over characters in the file name. The **DELETE** softkey deletes characters from the file name.

You do not add a file extension because the oscilloscope automatically assigns a file extension depending the type of file you selected.

- .WAV for internal waveforms
- .TXT for text waveforms
- .PIX for pixel memories
- .SET for front-panel setups

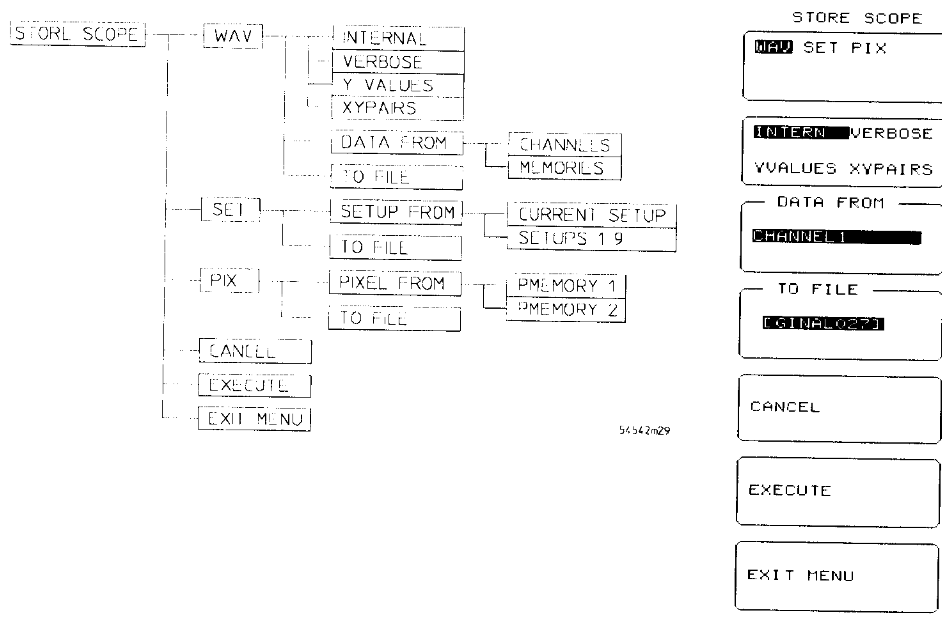
To Softkey

The TO softkey selects where the data from the file on the disk is placed. Waveforms are placed into one of the four waveform memories. Setups are loaded as the current setup or one of the nine setup memories. Pixel files are loaded into one of the two pixel memories.

Store Scope

The store scope menu allows you to store waveforms, pixel memories, or front-panel setups to a disk. Files are stored to the present working directory. Storing data to a disk allows you to transport the data to another oscilloscope, computer, or to keep a backup copy of your data. The oscilloscope contains four waveform memories, nine setup memories, and two pixel memories for your data. By using the disk drive, you can store additional data to a disk. You are limited only by the amount of data each disk can hold and the number of disks you are using.

Figure 12–2



Type Softkey

The top softkey determines the type of file to store to the disk. The oscilloscope automatically appends the correct file extension to the file depending on the type of file you select. The four files types are waveform, setup, pixel, and mask.

- .WAV for internal waveforms
- .TXT for text waveforms
- .PIX for pixel memories
- .SET for front-panel setups

Waveform Waveform is for storing waveforms to the disk. Waveform saves a copy of a waveform from any of the channels or any of the four waveform memories. When waveform is selected, the file format softkey is available that allows you to select among the four formats: internal, verbose, Y values, and XY pairs.

The verbose, Y value, and XY pairs formats make it easy to transfer files to personal computer applications. The internal format maximizes the use of disk space, and allows for a higher waveform transfer rate to and from the disk.

See also "File Format Softkey" in this chapter for information on the three file types.

Setup Setup saves a copy of the current front-panel setup or a copy of any of the nine setup memories. Setup files have a .SET file extension.

Pixel A pixel memory file has a .PIX file extension, and it is a copy of the pixel memory. It is a bitmapped file, so it does not contain any vertical or horizontal scaling information. You can use pixel files to store infinite persistence data on the screen, or to make timing diagrams for signal analysis.

From Softkey

The **FROM** softkey selects the data source for the file being stored to the disk. Waveforms are stored from any channel or waveform memory. Setups are stored from the current front-panel setup or any of the nine setup memories. Pixel data is stored from either of the two pixel memories.

To File Softkey

The **TO FILE** softkey selects a file name for a disk operation. You may notice that the file name in the **TO FILE** softkey matches the highlighted file name in the directory listing. You can use the entry knob to scroll through the list of file, or you can press the **TO FILE** softkey to enter a file name. You can also use the **DIRECTORY** softkey to change to another directory.

Pressing the **TO FILE** softkey displays another menu that allows you to spell out the name of the file you want. The entry knob positions the cursor over a letter or number in the character list. Press the top softkey to enter that character into the filename field. The filename can contain up to eight characters. The **BACKSPACE** softkey backspaces over characters in the file name, while the **DELETE** softkey deletes characters from the file name.

You do not need to add a file extension because the oscilloscope automatically assigns a file extension depending the type of file you selected.

- .WAV for internal waveforms
- .TXT for text waveforms.
- .PIX for pixel memories
- .SET for front-panel setups

Cancel Softkey The **CANCEL** softkey is activated if you try to store to an existing file. The message FILE EXISTS: OVERWRITE? Y = EXECUTE N = CANCEL appears on the screen. To cancel the store operation, press the **CANCEL** softkey. To overwrite, press the **EXECUTE** softkey.

Execute Softkey

When you press the **EXECUTE** softkey, the data from the selected source is stored to the selected destination file. If the file already exists on the disk, a warning appears on the screen. To cancel, press the **CANCEL** softkey. To overwrite, press the **EXECUTE** softkey.

If the disk is full when the store function is executed, the message "The disk is full" is displayed on the status line, which is near the upper-left corner of the display.

File Formats

The following is a description of the verbose header format.

Type Type describes how the waveform was acquired: normal, raw, interpolate, average, or versus. When this field is read back into the oscilloscopes, all the modes, except versus, are converted to raw. The default value is normal.

Points Points indicates the number of data points contained in the waveform record. The number of points is set by the Record length softkey in the Acquisition menu. The default value is 500.

> The number of points stored when the oscilloscope is in the envelope display mode is twice the number of points shown in the verbose header. In this mode, two waveforms are stored: the minimum value points waveform and the maximum value points waveform.

Count Count represents the minimum number of hits at each time bucket in the waveform record when the waveform was created using an ensemble acquisition mode, like averaging. For example, when averaging, a count of four would mean every waveform data point in the waveform record has been averaged at least four times. Count is ignored when it is read back into the oscilloscope. The default value is 0.

XInc X increment is the time duration between data points on the X-axis. X increment is equal to the YData range value for versus waveforms. The default value is 2 E^{-6}.

XOrg X origin is the x-value of the first data point in the data record. X origin is equal to the YData center value for versus waveforms. The default value is −1.3107 E^{-6}

XRef X reference is always set to zero when it is read back into the oscilloscope. The default value is 3.125 E^{-2}.

YData range Y data range is the full voltage range covered by the A/D converter. If this field is omitted, it is calculated when read back into the oscilloscope. The default value is 0.

YData center YData center is voltage level at the center of the YData range. If this field is omitted, it is calculated when read back into the oscilloscope. The default value is 0.

Coupling Coupling is ignored when it is read back into the oscilloscope. The default value is dc 50 Ω.

XRange XRange is the time duration across 10 horizontal divisions of the display. The default value is 100 E $^{-6}$.

XOffset XOffset is the time at the left edge of the display. The default value is 0.

YRange YRange is the voltage across eight vertical divisions of the display. The default value is 4.0 E $^{-0}$.

YOffset YOffset is the voltage at the center of the display. The default value is 0.

Date Date is the date when the waveform was acquired. The default value is 10 AUG 1992.

Time Time is the time when the waveform was acquired. The default value is 01:00:00.

Frame Frame is the model and serial number of the oscilloscope that acquired the waveform. The default value is 54542A:00000A00000.

Acq mode Acquisition mode is the sampling mode used to acquire the waveform, either real time or equivalent time. The default value is real time.

Completion Completion represents the percent of the time buckets in the waveform record that contain data. The number of time buckets is equal to the number of points in the waveform record. Completion is ignored when it is read back into the oscilloscope. The default value is 100.

X Units X units is the horizontal scaling units set in the channel menu: unknown, volt, second, constant, or ampere. The default value is unknown.

Y Units Y units is the vertical scaling units set in the channel menu: unknown, Volt, second, constant, or Ampere. The default value is unknown.

Max bandwidth Maximum bandwidth is an estimation of the maximum bandwidth limit of the source signal. The default value is 500 MHz.

Min bandwidth Minimum bandwidth is an estimation of the minimum bandwidth limit of the source signal. The default value is 0.

Data The data is in exponential format with a value of 9.9999E+37 representing a data record which has no valid data.

The following figures show all of the different file formats that can be stored on disk for text waveforms.

Figure 12–3

```
Type:              Normal
Points:            500
Count:             1
XInc:              9.99999971718E-10
XOrg:              0.00000000000000E+00
XRef:              0
YData range:       1.60000E-01
YData center:      0.000000E+00
Coupling:          DC
XRange:            5.00000E-07
XOffset:           -2.50000000000000E-07
YRange:            1.60000E-01
YOffset:           0.00000E+00
Date:              1 NOV 1995
Time:              1:06:21
Frame:             54542A:3207A00101
Acq mode:          equivalent time
Completion:        100
X Units:           second
Y Units:           Volt
Max bandwidth:     500000000
Min bandwidth:     0
Data:
-3.14173E-02
-3.14173E-02
    .
    .
    .
4.04331E-02
4.02756E-02
```

Equivalent time acuisition mode type normal verbose format for a text waveform

Figure 12–4

Type:	Average
Points:	500
Count:	1
XInc:	9.99999971718E-10
XOrg:	0.00000000000000E+00
XRef:	0
YData range:	1.60000E-01
YData center:	0.000000E+00
Coupling:	DC
XRange:	5.00000E-07
XOffset:	-2.50000000000000E-07
YRange:	1.60000E-01
YOffset:	0.00000E+00
Date:	1 NOV 1995
Time:	1:06:21
Frame:	54542A:3207A00101
Acq mode:	equivalent time
Completion:	100
X Units:	second
Y Units:	Volt
Max bandwidth:	500000000
Min bandwidth:	0
Data:	
-3.14173E-02	
-3.14173E-02	
.	
.	
.	
4.04331E-02	
4.02756E-02	

Equivalent time acuisition mode type average verbose format for a text waveform

Figure 12–5

```
Type:             Envelope
Points:           500
Count:            1
XInc:             9.99999971718E-10
XOrg:             0.00000000000000E+00
XRef:             0
YData range:      1.60000E-01
YData center:     0.000000E+00
Coupling:         DC
XRange:           5.00000E-07
XOffset:          -2.50000000000000E-07
YRange:           1.60000E-01
YOffset:          0.00000E+00
Date:             1 NOV 1995
Time:             1:06:21
Frame:            54542A:3207A00101
Acq mode:         equivalent time
Completion:       100
X Units:          second
Y Units:          Volt
Max bandwidth:    500000000
Min bandwidth:    0
Data:
-3.14173E-02      ----------  Start of lower waveform
-3.14173E-02
   .
   .
   .
4.04331E-02
4.02756E-02
-3.14753E-02      ----------  Start of upper waveform
-3.147573E-02
   .
   .
   .
4.0E-02
4.02756E-02
```

Equivalent time acuisition mode type envelope verbose format for a text waveform

Figure 12–6

Type:	Normal
Points:	512
Count:	1
XInc:	9.99999971718E-10
XOrg:	0.00000000000000E+00
XRef:	0
YData range:	1.60000E-01
YData center:	0.000000E+00
Coupling:	DC
XRange:	5.00000E-07
XOffset:	-2.50000000000000E-07
YRange:	1.60000E-01
YOffset:	0.00000E+00
Date:	1 NOV 1995
Time:	1:06:21
Frame:	54542A:3207A00101
Acq mode:	real time
Completion:	100
X Units:	second
Y Units:	Volt
Max bandwidth:	500000000
Min bandwidth:	0
Data:	
-3.14173E-02	
-3.14173E-02	
.	
.	
.	
4.04331E-02	
4.02756E-02	

Real time acuisition mode (greater than 500 points) type normal verbose format for a text waveform

Figure 12–7

```
Type:               Sequential Normal
Acquisitions:       10 of 10 stored to disk
Points:             512
Count:              1
XInc:               9.99999971718E-10
XOrg:               0.00000000000000E+00
XRef:               0
YData range:        1.60000E-01
YData center:       0.000000E+00
Coupling:           DC
XRange:             5.00000E-07
XOffset:            -2.50000000000000E-07
YRange:             1.60000E-01
YOffset:            0.00000E+00
Date:               1 NOV 1995
Time:               1:06:21
Frame:              54542A:3207A00101
Acq mode:           real time
Completion:         100
X Units:            second
Y Units:            Volt
Max bandwidth:      500000000
Min bandwidth:      0
Data:
Timetag:            #1, 0.00000000000000E+00
-3.14173E-02
   .
   .
   .
4.04331E-02
   .
   .  ------------------------------------  Timetag 2 through 9
   .
Timetag:            #10, 1.11721189047721E-03
-3.14173E-02
   .
   .
   .
4.04331E-02
```

Real time acuisition mode type sequential normal verbose format for a text waveform

> This file format cannot be loaded into the oscilloscope waveform memories.

Figure 12–8

```
Type:               Sequential Average
Acquisitions:       10 averaged
Points:             500
Count:              1
XInc:               9.99999971718E-10
XOrg:               0.00000000000000E+00
XRef:               0
YData range:        1.60000E-01
YData center:       0.000000E+00
Coupling:           DC
XRange:             5.00000E-07
XOffset:            -2.50000000000000E-07
YRange:             1.60000E-01
YOffset:            0.00000E+00
Date:               1 NOV 1995
Time:               1:06:21
Frame:              54542A:3207A00101
Acq mode:           real time
Completion:         100
X Units:            second
Y Units:            Volt
Max bandwidth:      500000000
Min bandwidth:      0
Data:
-3.14173E-02
-3.14173E-02
     .
     .
     .
4.04331E-02
4.02756E-02
```

Real time acuisition mode type sequential average verbose format for a text waveform

Figure 12–9

```
Type:               Sequential Envelope
Acquisitions:       10 enveloped
Points:             500
Count:              1
XInc:               9.99999971718E-10
XOrg:               0.00000000000000E+00
XRef:               0
YData range:        1.60000E-01
YData center:       0.000000E+00
Coupling:           DC
XRange:             5.00000E-07
XOffset:            -2.50000000000000E-07
YRange:             1.60000E-01
YOffset:            0.00000E+00
Date:               1 NOV 1995
Time:               1:06:21
Frame:              54542A:3207A00101
Acq mode:           real time
Completion:         100
X Units:            second
Y Units:            Volt
Max bandwidth:      500000000
Min bandwidth:      0
Data:
-3.14173E-02        ------------------  Start of lower waveform
-3.14173E-02
    .
    .
    .
4.04331E-02
4.02756E-02
-3.14753E-02        ------------------  Start of upper waveform
-3.147573E-02
    .
    .
    .
4.0E-02
4.02756E-02
```

Real time acuisition mode type sequential envelope verbose format for a text waveform

Text Y values Text Y value files are identical to the text verbose files, except the header information is deleted from the front of the file. Figure 12-10 shows an example of the text Y value format for all modes except for the sequential normal type which is shown in figure 12-11. Text Y value files also have a .TXT file extension.

Text Y value files are intended for importing into other applications. They do not contain any header information. If they are loaded into the oscilloscope, the current horizontal setup of the oscilloscope is used but the vertical setup is adjusted to fit the waveform on screen.

Figure 12–10

```
5.657E-001
6.433E-001
5.974E-001
1.864E-001
8.05E-002
-3.147E-001
-3.057E-001
-4.77E-002
5.280E-001
6.296E-001
6.296E-001
2.297E-001
1.259E-001
-3.147E-001
-3.147E-001
-9.40E-002
```

Text Yvalue format

If the file is of type envelope which contains two waveforms then the loaded waveform will be the top waveform appended by the bottom waveform. The reason for this is there is no way to tell from the file that it is an envelope type without the header information.

Figure 12–11

```
Timetag:        #1, 0.00000000000000E+00
6.433E-001
   .
   .
   .
5.974E-001
   .
   .                                        Timetag 2 through 9
   .
Timetag:        #10, 9.59958496525758E-03
5.280E-001
   .
   .
   .
6.296E-001
```

Text Yvalues for sequential normal type format

> This file format cannot be loaded into the oscilloscope waveform memories.

XY pairs XY pairs files are identical to the text Y value files, except they also contain the relative time of the measurement. Like text Y value files, header information is deleted from the front of the file. XY pairs files also have a .TXT file extension.

Figure 12-12 through figure 12-18 show examples of the different XY pairs formats. The first column is the time, the second column is the voltage. Negative time indicates events before the trigger.

> XY pairs files are intended for importing into other applications and cannot be loaded into the oscilloscope.

Figure 12–12

```
XYPairs: Normal
Acquistions: 1
Points: 500
-2.5763e-03,-1.04E+00
-2.5663e-03,-1.04E+00
    .
    .
    .
+2.3737e-03,-2.47E-02
+2.3837e-03,-2.47E-02
```

Equivalent time acuisition mode type normal format for XYpairs text waveform

Figure 12–13

```
XYPairs: Average
Acquistions: 1
Points: 500
-2.5763e-03,-1.04E+00
-2.5663e-03,-1.04E+00
    .
    .
    .
+2.3737e-03,-2.47E-02
+2.3837e-03,-2.47E-02
```

Equivalent time acuisition mode type average format for XYpairs text waveform

Figure 12–14

```
XYPairs:  Envelope
Acquistions: 1
Points: 500
-2.5763e-03,-1.04E+00      Start of lower waveform
-2.5663e-03,-1.04E+00
    .
    .
    .
+2.3737e-03,-2.47E-02
+2.3837e-03,-2.47E-02
-3.1475e-02,-2.00E-02      Start of upper waveform
-3.1475e-02,-2.00E-02
    .
    .
    .
4.0315e-02,-3.14E-02
4.0275e-02,-3.15E-02
```

Equivalent time acuisition mode type envelope format for XYpairs text waveform

Figure 12–15

```
XYPairs:  Normal
Acquistions: 1
Points: 512
-2.5763e-03,-1.04E+00
-2.5663e-03,-1.04E+00
    .
    .
    .
+2.3737e-03,-2.47E-02
+2.3837e-03,-2.47E-02
```

Real time acuisition mode (greater than 500 points) type normal format for XYpairs text waveform

Figure 12–16

```
XYPairs:  Sequential Normal
Acquistions: 10 of 10 stored to disk
Points/Acquisition: 512
Timetag: #1,  0.00000000000000E+00
-2.5535e-07,-3.11719E-02
     .
     .
     .
+2.5564e-07,3.96094E-02
     .
     .                              Timetag 2 through 9
     .
Timetag: #10,  9.5495896525758E-03
-2.5535e-07,-3.11719E-02
     .
     .
     .
+2.5564e-07,3.96094E-02
```

Real time acuisition mode type sequential normal format for XYpairs text waveform

Figure 12–17

```
XYPairs:  Sequential Average
Acquistions: 10
Points/Acquisition: 500
-2.5535e-07,-3.11719E-02
+2.5564e-07,-3.96094E-02
     .
     .
     .
-2.4234e-07,4.04395E-02
+2.4334e-07,4.02783E-02
```

Real time acuisition mode type sequential average format for XYpairs text waveform

Figure 12–18

```
XYPairs:  Sequential Envelope
Acquistions: 10 enveloped
Points/Acquisition: 500
-2.5535e-07,-3.11719E-02        Start of lower waveform
+2.5564e-07,-3.96094E-02
    .
    .
    .
-2.4234e-07,4.04395E-02
+2.4334e-07,4.02783E-02
-3.1475e-02,-2.00E-02           Start of upper waveform
-3.1475e-02,-2.00E-02
    .
    .
    .
4.0315e-02,-3.14E-02
4.0275e-02,-3.15E-02
```

Real time acuisition mode type sequential envelope format for XYpairs text waveform

Store Image

The store image menu allows you to store oscilloscope screen images to a disk in TIFF, PCX, or EPS formats. You can import files in these formats to a variety of computer programs. The size of the file stored to the disk depends on the settings of the **FORMAT**, **COMPRESSION**, and **RENDERING** softkeys.

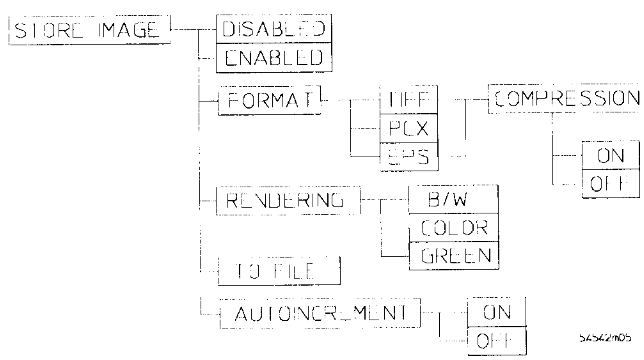
Disabled and Enabled Softkey

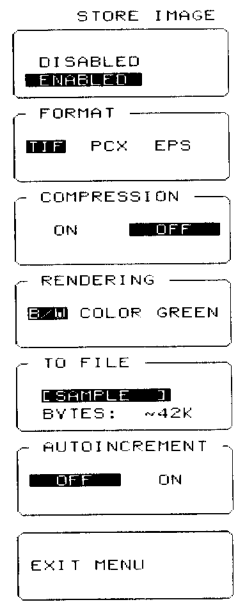
You store a screen image to the disk in a TIFF, PCX, or EPS format by setting this softkey to enabled and pressing the Print front-panel key when the screen of interest is displayed. The disabled setting allows you to set up the store image menu without altering the normal function of the Print front-panel key.

Format Softkey

The **FORMAT** softkey allows you to select TIFF, PCX, or EPS as the file format. TIFF stands for Tagged Image File Format, PCX is the PC Paintbrush format, and EPS stands for encapsulated PostScript format. TIFF files comply with the TIFF 6.0 specification, PCX files comply with revision 4 of the PCX technical reference manual, and EPS files comply with EPS version 3.0. All EPS images, except those with B/W rendering and compression off, use level 2 PostScript features.

Figure 12–19





Compression Softkey

This is lossless data compression using run length encoding as specified by the selected file format. Because compressed files take up less disk space, the default selection is on. You would turn compression off if you need to see the raw data, or if the importing application cannot properly interpret the compressed data.

Rendering Softkey

The B/W selection is black text on a white page, just like a hardcopy printout. Most applications use the black text on a white background. Color reproduces the yellow, just like the scope screen. Green is shades of green on a black background just like the scope screen.

To File Softkey

The **TO FILE** softkey selects a file name for a disk operation. You may notice that the file name in the **TO FILE** softkey matches the highlighted file name in the directory listing. You can use the entry knob to scroll through the list of files, or you can press the **TO FILE** softkey to enter a file name. You can also use the **DIRECTORY** softkey to change to another directory.

Pressing the **TO FILE** softkey displays another menu that allows you to spell out the name of the file you want. The entry knob positions the cursor over a letter or number in the character list. Press the the top softkey to enter that character into the filename field. The filename can contain up to eight characters. The **BACKSPACE** softkey backspaces over characters in the file name, while the **DELETE** softkey deletes characters from the file name.

You do not need to add a file extension because the oscilloscope automatically assigns a file extension depending on the type of file selected. LIF files do not have a file extension, but they have descriptions which appear in the directory listing.

- .TIF for TIFF files
- .PCX for PC Paintbrush files
- .EPS for encapsulated PostScript files

Autoincrement Softkey

Autoincrement allows you to store up to 100 files to a disk without having to return to the store image menu and rename the file. If the filename takes up six or less characters, *nn* is appended to the file name. If the filename takes up seven or eight characters, the filename is truncated to six characters and *nn* is appended to the filename.

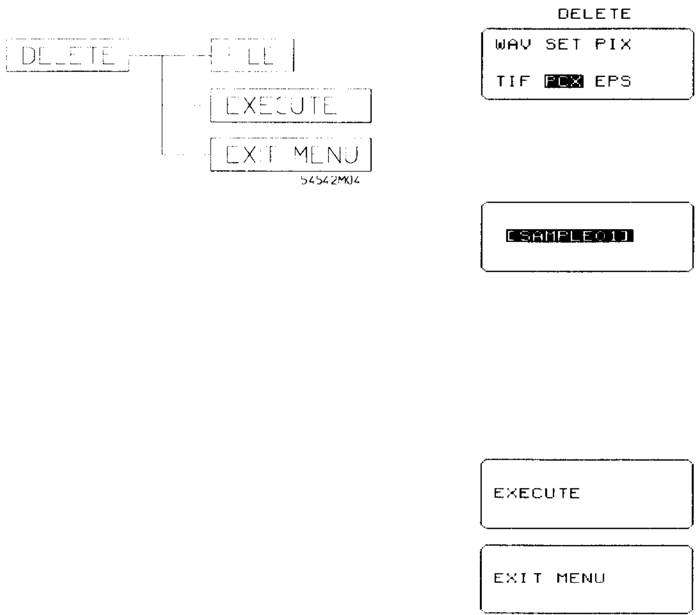
For example, if the filename is `TEST.TIF`, the filename changes to `TESTnn.TIF`. If the filename is `TESTING.TIF`, the filename changes to `TESTINnn.TIF`. As files are stored to the disk, nn increments from 00 to 99. Once 99 is reached, the value no longer increments and subsequent stores overwrite the file that has 99 appended to the filename. Because autoincrement always starts from 00, you cannot set it to start from any other number.

> When you return to the store image menu, the autoincrement automatically defaults to off. When autoincrement is turned on again, the numbering restarts from 00.

Delete

Delete allows you to delete a selected file or directory from the disk. Directories can only be deleted if there are no files in the directory. Simply use the entry knob to scroll through the directory listing of the disk, or press the File name softkey to enter a file name or directory name. Pressing the File name softkey displays another softkey menu that allows you to enter a file name. You can also use the **DIRECTORY** softkey to change to another directory.

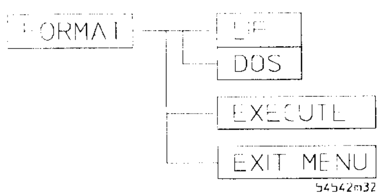
Figure 12–20



Format

Format allows you to format 3-1/2 inch, high-density disks in the oscilloscope. You can choose to format disk as MS-DOS or LIF. You can use the MS-DOS disk in other drives that are also MS-DOS compatible, however, you may notice that there is a faster disk access time when you use disks in the oscilloscope that were formatted by the oscilloscope. This is because some computers and disk drives format disks with a different disk interleave factor than that used by the oscilloscope. The interleave factor used when the oscilloscope formats a disk maximizes the data transfer rate to and from the internal disk drive.

Figure 12–21



Directory

The directory menu allows you to change the present working directory or make new directories on the disk. The present working directory is displayed next to PWD:\ on the screen, above the directory listing.

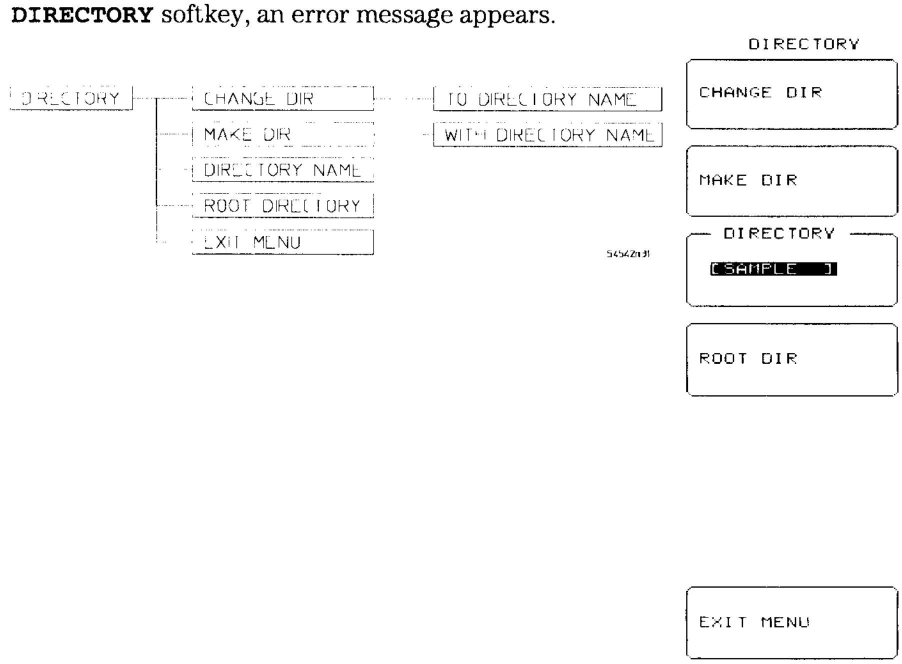
Change Directory Softkey

Pressing the **CHANGE DIRECTORY** softkey changes the present working directory to the directory shown in the **DIRECTORY** listing. You may notice that the directory name in the **DIRECTORY** softkey matches the highlighted directory name in the directory listing. You can use the entry knob to scroll through the list of directories.

Make Directory Softkey

The **MAKE DIRECTORY** softkey allows you to create a directory or subdirectory in the present working directory. Before making a directory, you have to enter the directory name using the **DIRECTORY** softkey. If you try to make a directory when an existing file name is shown in the **DIRECTORY** softkey, a subdirectory with that file name is created. If you try to make a directory when an existing directory name is shown in the **DIRECTORY** softkey, an error message appears.

Figure 12–22



Directory softkey

The **DIRECTORY** display selects a directory name for a disk operation. You may notice that the name in the **DIRECTORY** softkey matches the highlighted name in the directory listing. You can use the entry knob to scroll through the list, or you can press the **DIRECTORY** softkey to enter a name.

Pressing the **DIRECTORY** softkey displays another menu that allows you to spell out the name of the directory you want. The entry knob positions the cursor over a letter or number in the character list. Press the the top softkey to enter that character into the filename field. The filename can contain up to eight characters. The **BACKSPACE** softkey backspaces over characters in the file name, while the **DELETE** softkey deletes characters from the file name.

Root Directory Softkey

Pressing the **ROOT DIRECTORY** softkey returns you to the root directory of the disk.

13

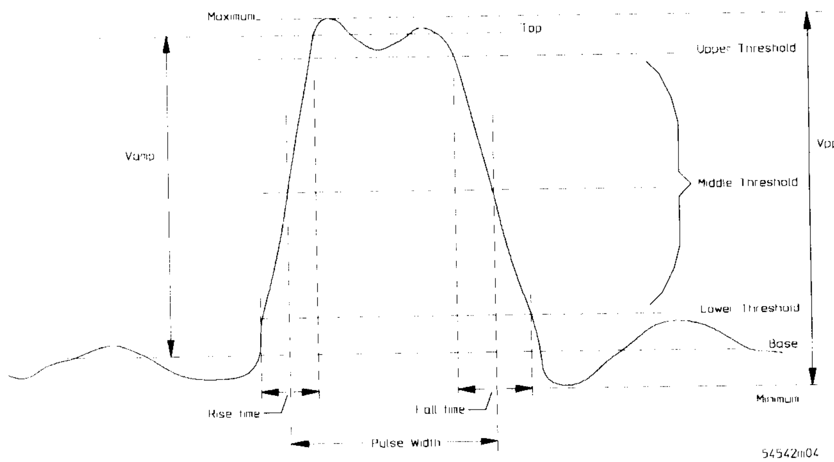
Measurements

Measurements

This chapter describes the process the oscilloscope uses to make waveform measurements. It also describes the parameters that are measured and how to set up measurements for the best solution. Like any tool, it is important to understand how to use the tool, its limitations, and methods that may overcome some of the shortcomings.

The waveform in figure 13-1 shows the pulse parameters that the oscilloscope measures. Hewlett-Packard has been using these parameters in its measurements for the past 10 years. This chapter defines these parameters and discusses how they are measured.

Figure 13–1



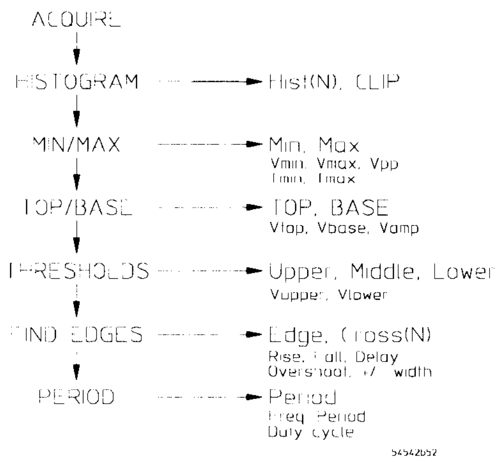
Pulse parameters the oscilloscope measures

Automatic Parametric Measurements

The illustration below shows the basic process used by the oscilloscope when making automatic parametric measurements, like rise time, Vp-p, or frequency. These measurements can be made on input signals, stored waveforms, or functions.

In order to start the measurement process, the oscilloscope captures a data record. From this data record, the oscilloscope builds a histogram, recording how many times each q level (a q level is an internal voltage representation) is present in the data record. From the histogram, and from the data record, the absolute maximum and minimum voltage levels, as well as relative maximum (top) and minimum (base) voltage levels, are determined. Using the top and base levels, threshold levels are calculated. The data record is again analyzed using the thresholds to determine signal edges. Finally, with all this information, the requested parametric measurements are calculated as shown in figure 13-2.

Figure 13–2



The oscilloscope uses this process for waveform measurement

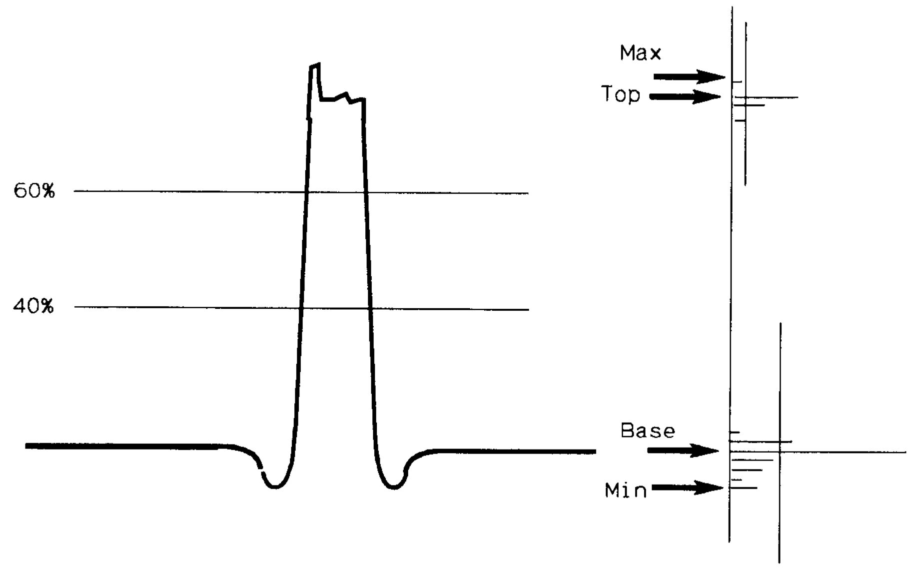
Data Collection

In order to make measurements on a signal, the instrument must first collect data. The data collected for input signals is used to make measurements on channels. The data record used for making measurements on waveform memories is the stored data. Finally, measurements being made on functions require that the function be calculated before the measurement process is started.

Building a Histogram

Once a data record is available, the measurement process builds a histogram of the distribution of the internal voltage levels as shown in figure 13-3. The histogram is built on eight bits of data, and, if in the average mode, does not represent the full resolution of the data as this would result in a very large histogram array. The oscilloscope uses the histogram to determine the statistical maximum (top) and minimum (base) of the data record.

Figure 13–3



Some measurements are made from the histogram

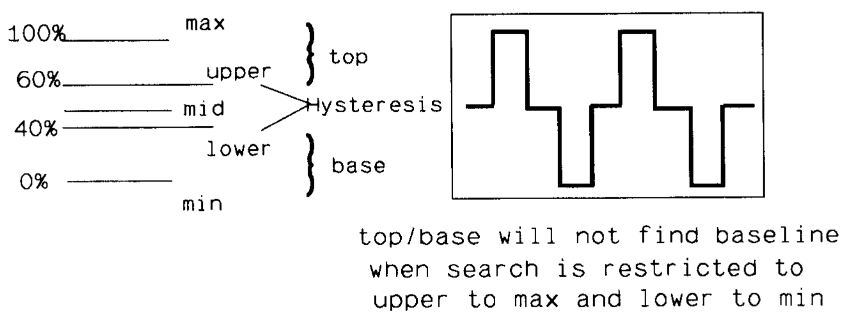
Calculating Minimum and Maximum from the Data Record

The maximum and minimum voltage levels are determined from the histogram. If the waveform is clipped, this information is also recorded. After the minimum and maximum measurements are complete, the Vmin, Vmax, Vp-p, Tmin, Tmax, and Tvolt measurements can be made. The remaining primitives of the measurement process (calculate thresholds, find edge, and period) are executed only if other measurements, such as fall time, frequency, or delta time, are requested.

Calculating Top and Base

The next measurements made are the top and base of the waveform. These measurements come directly from the histogram. The top 40 percent is scanned for the top, and the bottom 40 percent of the histogram is scanned for the base. The center portion of the histogram is not searched to prevent a baseline value from being chosen as the top or base as shown in figure 13-4.

Figure 13–4



The middle 20 percent of the waveform is ignored

The greatest number of data occurrences in the top half of the histogram corresponds to the top. If the occurrence count is less than five percent of the total, the top defaults to the value of the absolute maximum. Likewise, the base represents the level with the greatest number of occurrences in the bottom portion of the histogram. If the occurrence count is less than five percent of the total, the base defaults to the value of the absolute minimum. This may be the case for very irregular waveforms or those in which the voltage rises or falls slowly over time.

This selection technique prevents the top and base from jumping around on waves with even histogram distributions such as triangle waves. It also allows the detection of the top and base for low duty cycle signals.

Once the top and base measurements are complete, Vtop, Vbase, and Vamp measurements can be made.

Calculating Thresholds

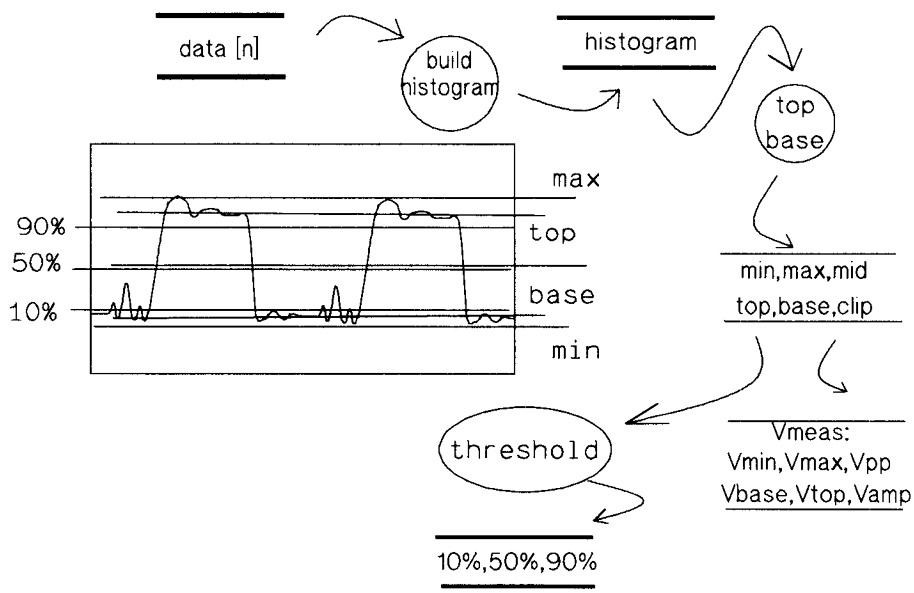
Top and base are are used to calculate the threshold levels used for timing measurements. These thresholds may be the IEEE values of 10, 50, and 90 percent, or values in percentages or volts that you set. These thresholds are called upper, middle, and lower thresholds in the measurement menu.

These thresholds are used by all timing measurements as they are needed to determine the presence of a rising or falling edge. In addition, the thresholds are used by various measurements. For example, rise time is measured from the lower threshold to the upper threshold of a rising edge. Period and frequency measurements use the middle threshold as shown in figure 13-5.

See also

Chapter 8, "Define Measure Menu," for information on manually setting the thresholds.

Figure 13–5



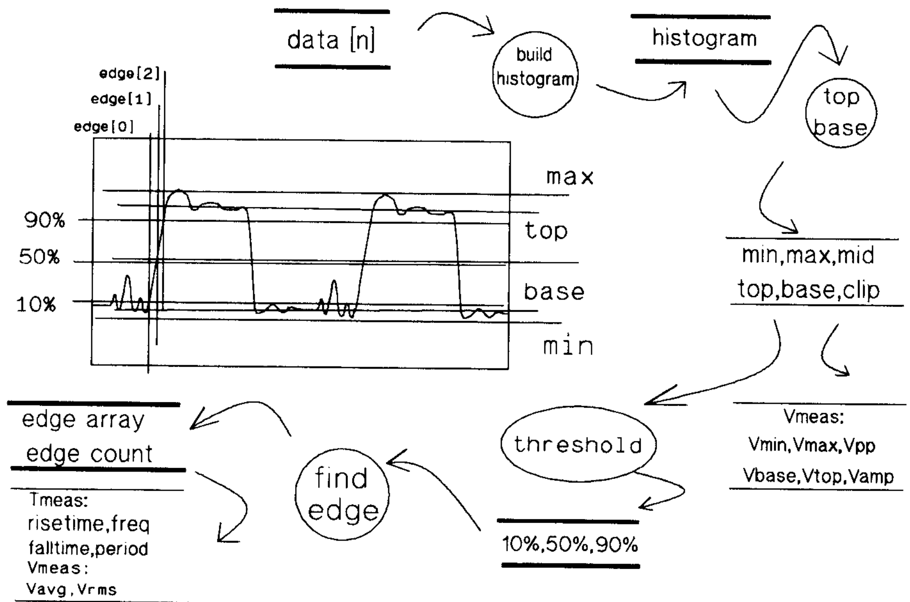
The oscilloscope calculates the 10, 50, and 90 percent thresholds

Determining Rising and Falling Edges

The final analysis needed to make timing measurements is to define the transition points of the waveform through the threshold levels and to define the rising and falling edges. A rising edge is defined as a transition that passes through the lower, middle, and upper threshold levels. A falling edge is defined as a transition that passes through the upper, middle, and lower threshold levels. For an edge to be present and defined, it must complete the transition through all three threshold levels.

Once the transition points and edges are identified, the instrument next calculates timing measurements (rise time, fall time, and frequency). Finally, it calculates voltage measurements that need timing information (Vrms cycle and Vavg cycle) as shown in figure 13-6.

Figure 13–6

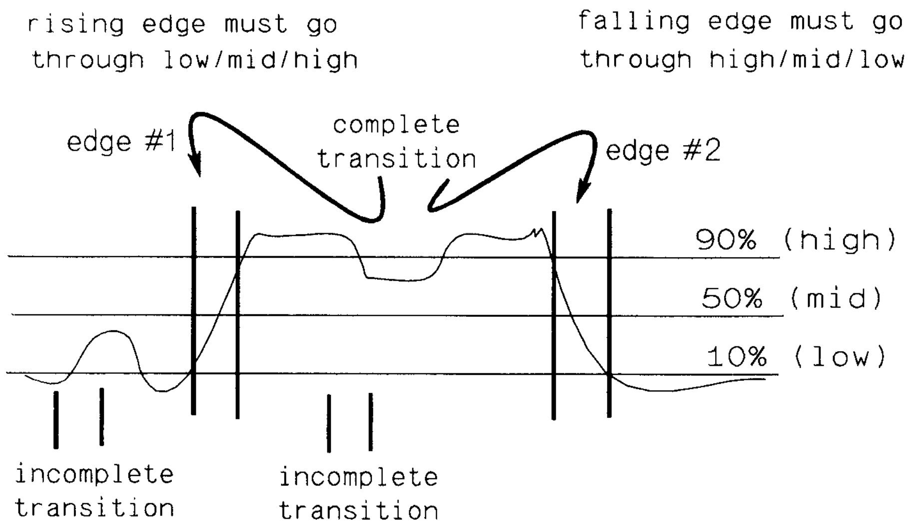


Thresholds are used to determine edges

If there are not enough points on an edge, the rise time measurement, for example, is either not made or is flagged as questionable.

The oscilloscope scans the waveform data and records the transitions through the three thresholds. If a waveform data point does not exactly correspond to the threshold level value, the system interpolates between the two points about the threshold. Then the location of the transition point is recorded in an edge array. The system ignores incomplete transitions and glitches as shown in as shown in figure 13-7.

Figure 13–7

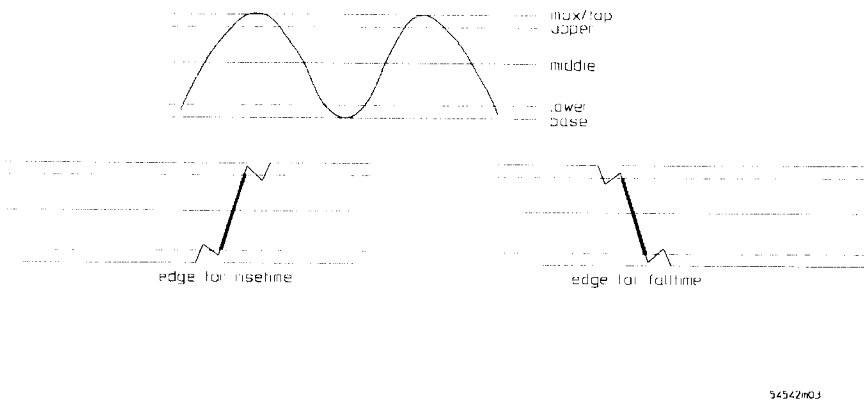


The system ignores incomplete transitions when defining edges

The oscilloscope defines the points on a rising edge as the last point before crossing the lower threshold to the first point crossing the upper threshold. The points on a falling edge include the last point before crossing the upper threshold to the first point crossing the lower threshold. This will measure the fastest rise and fall times.

As shown in figure 13-8, it is clear that measuring the rise time from the first point crossing the lower threshold to the last point through the upper threshold gives a different answer than the shaded line that uses the edge definition given in the previous paragraph.

Figure 13–8



Waveform period is measured at the middle threshold

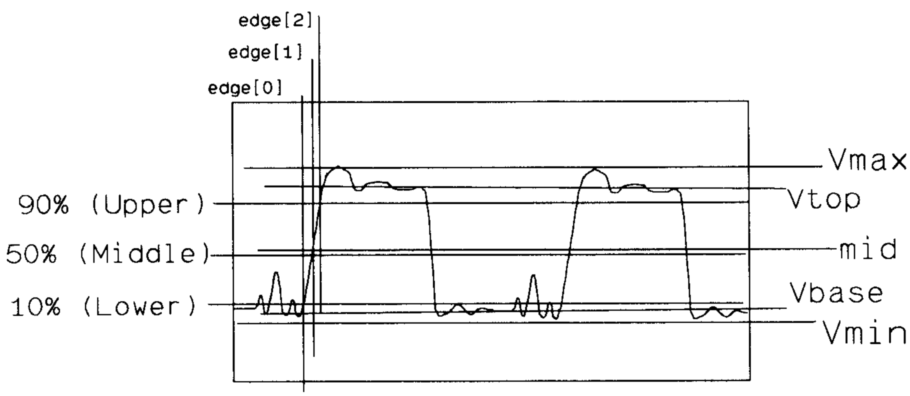
Voltage Measurements

Once the top and base calculations are completed, most of the voltage measurements can be made.

- Vmin = voltage of the absolute minimum level
- Vmax = voltage of the absolute maximum level
- Vp-p = Vmax – Vmin
- Vbase = voltage of the statistical minimum level
- Vtop = voltage of the statistical maximum level
- Vamp = Vtop – Vbase

Vbase may be equal to Vmin for many waveforms, such as triangle waveforms. Likewise, Vtop may be equal to Vmax. Figure 13-9 shows where these waveform definitions occur.

Figure 13–9



Waveform definitions used to make voltage measurements

Several of the voltage measurements require threshold and edge information before they can be made.

- Vavg = average voltage of the first cycle of the signal
- Overshoot = a distortion which follows a major transition

  If first edge is rising

    then overshoot = local max – top

    else overshoot = base – local min
- Preshoot = a distortion which precedes a major transition

  If first edge is falling

    then preshoot = base – local min

    else preshoot = local max – top

Timing Definitions

Once the edges and transition points have been defined, timing measurements are made. Timing measurements are made on the first rising or falling edge on the display.

- Rise time = time at the upper threshold – time at the lower threshold on the first rising edge
- Fall time = time at the lower threshold – time at the upper threshold on the first falling edge
- Period = If the first edge is rising

  then period = mid-threshold crossing of second rising edge – mid-threshold crossing of first rising edge

  else period = mid-threshold crossing of second falling edge – mid-threshold crossing of first falling edge
- Frequency = 1/period
- +Width = if first edge is rising

  then +width = mid-threshold crossing of first falling edge – mid-threshold crossing of first rising edge

  else +width = mid-threshold crossing of second falling edge – mid-threshold crossing of first rising edge
- –Width = if first edge is rising

  then –width = mid-threshold crossing of second rising edge – mid-threshold crossing of first falling edge

  else –width = mid-threshold crossing of first rising edge – mid-threshold crossing of first falling edge
- Duty Cycle = (+width/period)(100)

User Defined Δ Time

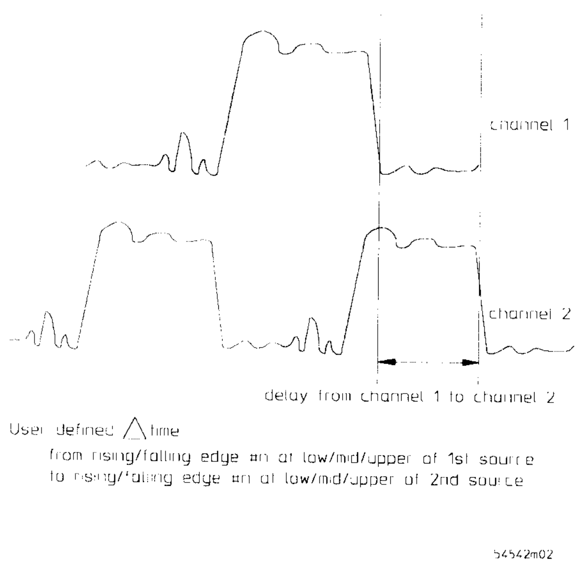
On the oscilloscope, you may select the threshold level (lower/middle/upper), polarity of edge (either rise or fall), and the edge number. The measurement is then calculated as the time from the first source's edge to the second source's edge.

This gives flexibility in defining Δ time measurements between channels or on a single channel between edges. To avoid confusing the delay measurement with time base delay and trigger delay, the delay measurement has been called Δ time as shown in figure 13-10.

See also

Chapter 7, "Define Measure Menu," for information on delay measurements.

Figure 13–10



You may define Δ time

Measurement Considerations

In the repetitive and real-time modes, measurements are made two or three times per second when continuous is on and statistics is off. When statistics is on, measurements are made every time the oscilloscope triggers.

When continuous is turned off, the markers are placed on the display showing where the measurement was made. This helps you verify that the oscilloscope is measuring the correct phenomena and to aid you in windowing the signal for measurement.

Statistics are available on the oscilloscope, so you may display the mean, standard deviation, min, and max for each measurement result.

In the user defined mode, you may also define some of the measurement you want to make. Specify your own thresholds rather than using the standard 10, 50, and 90 percent levels. Specify the IEEE standard definitions of thresholds and measurements. Or set thresholds in either voltage or percent. You may rely on the oscilloscope to set top and base, or define those levels yourself in voltage. The Δtime, +width, –width measurement is also under your control.

Making Automatic Measurements from the Front Panel

The oscilloscope makes its measurements using the data showing on the display (except for Δt measurements in the real-time mode). Therefore, it is important that you correctly window the display to get accurate measurements. Windowing allows you to pick one pulse out of a series of pulses to make measurements on.

If more than one waveform, edge, or pulse is displayed, automatic time measurements are made on the first (leftmost) portion of the displayed waveform that can be used. Voltage measurements, like Vp-p, use the whole waveform

When making measurements on non symmetrical waveforms, expand the signal as necessary and move the baseline out of the window. This will avoid having the baseline selected as the top of the signal.

If the signal is clipped, the oscilloscope cannot make some automatic measurements. You will get a warning or error message if this occurs.

If the measurement window is set to markers, the measurement is made on the data between the X1 and X2 markers.

Period and Frequency Measurements

At least one full cycle of the waveform, with at least two like edges, must be displayed for period and frequency measurements.

Additionally, you can increase the accuracy of frequency measurements by windowing on multiple pulses. Automatic waveform measurements use a single pulse and may have significant errors introduced by interpolation. By placing marker 1 on edge 1 and marker 2 on edge 20, for example, you can get an average that negates errors that may be introduced in automatic measurements. This becomes even more important when using the deep memory feature of the oscilloscope.

Set the markers to accomplish average frequency measurements from the front panel by using the Δt measurement in the define measure menu.

Pulse Width Measurements

A complete positive pulse must be displayed to make a +Width measurement.

A complete negative pulse must be displayed to make a −Width measurement.

Remember that an edge must pass through all three thresholds to be recognized as an edge. Therefore, it is important that the pulse be positioned so that all three thresholds are displayed on the screen.

Rise Time, Fall Time, Preshoot, and Overshoot Measurement

The leading (rising) edge of the waveform must be displayed for rise time and rising edge preshoot and overshoot measurements.

The trailing (falling) edge of the waveform must be displayed for fall time and falling edge preshoot and overshoot measurements.

Remember that an edge must pass through all three thresholds to be recognized as an edge. Therefore, it is important that the pulse be positioned so that all three thresholds are displayed on the screen.

Rise time, fall time, preshoot, and overshoot measurements will be more accurate if you expand the edge of the waveform by selecting a faster sweep speed. Expanding the waveform will provide more data points on the edge and thus a more accurate measurement.

14

Specifications and Characteristics

Specifications and Characteristics

This chapter contains the specifications and characteristics for the HP 54542C, HP 54540C, HP 54522C, and HP 54520C Oscilloscopes.

Specifications

Specifications are valid after a 30 minute warm-up period.

Vertical

Bandwidth (-3dB, dc coupled)

Repetitive (all models) dc to ≥500 MHz (equivalent time)

Real Time

HP 54520C dc to ≥125 MHz (2 channels on),
dc to ≥250 MHz (1 channel on)

HP 54522C dc to ≥500 MHz

HP 54540C dc to ≥125 MHz (3 or 4 channels on),
dc to ≥250 MHz (2 channels on)
dc to ≥500 MHz (1 channel on)

HP 54542C dc to ≥500 MHz

Rise Time [1]

Repetitive (all models) ≤700 ps

Real Time

HP 54520C ≤2.8 ns (2channels on),
≤1.4 ns (2channels on)

HP 54522C ≤700 ps

HP 54540C ≤2.8 ns (3 or 4 channels on),
≤1.4 ns (2 channels on)
≤700 ps (1 channel on)

HP 54542C ≤700 ps

Input R (selectable) 1 MΩ ±1% or 50 Ω ±1%

⚠ **Maximum Input Voltage**

1M Ω ±250 V [dc + peak ac(<10 kHz)]

50 Ω 5 V_{rms}

Offset Accuracy [2] ±(1.25% of channel offset + 2% of full scale)

Voltage Measurement Accuracy (dc) 2,3

Dual Cursor ±[1.25% of full scale + (0.032)(V/div)]

Single Cursor ±[1.25% of full scale + offset accuracy + (0.016)(V/div)]

Time Base

Delta-t Accuracy

Repetitive (≥8 averages) ±[(0.005%)(delta-t) + (0.1%)(full scale)+ 100 ps]
Real Time [4] ±[(0.005%)(delta-t) + (0.2)(sample period)]
Peak Detect ±[(0.005%)(delta-t) + 1 sample period]

Trigger

Sensitivity [2]

	dc to 100 MHz	100 MHz to 500 MHz
Internal	0.5 division	1.0 division
External (HP 54520C/54540C)	0.0225 × signal range	0.045 × signal range

Auxiliary dc to 50 MHz, 250 mVp-p

⚠ **Maximum Input Voltage**

External Trigger (HP 54520C and 54522C)
1M Ω ±250 V [dc + peak ac(<10 kHz)]
50 Ω 5 V_{rms}
Auxiliary Trigger ±15 V

Notes:

1) Rise time figures are calculated from: t_r = 0.35/Bandwidth.

2) Magnification is used below 7 mV/div range so the vertical resolution and accuracies are correspondingly reduced. Below 7 mV/div, full scale is defined as 56 mV.

3) The voltage measurement accuracy decreases 0.08% of full scale per °C from the firmware calibration temperature. This specification is valid for a temperature range ±10°C from the firmware calibration temperature. The specification applies to both the repetitive and real time modes.

4) The specification applies for bandwidth limited signals (tr = 1.4 × sample interval). The sample interval is defined as 1/(sample rate). The specification also applies to those automatic measurements computing time intervals on pulses with identical slope edges (i.e. pos-pos, neg-neg).

Performance Characteristics

Vertical

Switchable Bandwidth Limits

ac-coupled (lower –3 dB frequency) 10 Hz
LF reject (lower –3 dB frequency) 400 Hz
Bandwidth Limit (upper –3 dB frequency) 30 MHz

Number of Channels (Simultaneous Acquisition)

HP 54520C/54522C 2
HP 54540C/54542C 4

Vertical Sensitivity Range 1 mV/div to 5 V/div

Vertical Gain Accuracy (dc)[1,2] ±1.25% of full scale

Vertical Resolution[2] 8 bits over 8 divisions (±0.4%), 10 bits over HP-IB with averaging (±0.1%)

Maximum Sample Rate (Realtime Mode)

HP 54520C 500 MSa/s (2 CH on), 1 GSa/s (1 CH on)
HP 54522C 2 GSa/s
HP 54540C 500 MSa/s (3 or 4 CH on), 1 GSa/s (2 CH on), 2 GSa/s (1 CH on)
HP 54542C 2 GSa/s

Waveform Record Length[3]

Real Time 32,768 pts (Selectable in powers of 2: 512, 1024, 2048 . . .)
When peak detect is on, 16,384 (Selectable in power of 2)
Repetitive 501 points

Input C 7 pF nominal

Input Coupling ac, dc

Offset Range
1 mV - 50 mV/div ±2 V
>50 mV - 250 mV/div ±10 V
>250 mV - 1.25 V/div ±50 V
>1.25 V - 5 V/div ±250 V

Dynamic Range ±(1.5 × full scale) from the center of the screen

Channel-to-channel Isolation (with channels at equal sensitivity)
dc to 50 MHz 50 dB
50 to 500 MHz 40 dB

Horizontal

Time Base Range 500 ps/div to 5 s/div
(The 500 ps and 1 ns time base settings are not available with the 500 MSa/s models.)

Time Base Resolution 10 ps

Time Tag Accuracy ±(0.005% of reading + 100 ps)

Time Tag Resolution 100 ps

Delay Range
Posttrigger 10^7 × sample period
Pretrigger 32k × sample period

Trigger

Trigger Pulse Width (minimum)
Internal and External 1 ns
Auxiliary 15 ns

Trigger Level Range
Internal ±(1.5 × full scale) from the center of the screen
External (HP 54520C and 54540C) Selectable: ±1 V, ±5 V, ±25 V
Auxiliary ±5 V

Auxiliary Input R 4k Ω

FFTs

	54520C	54522C	54540C	54542C
Freq Range[3] dc to:	250 MHz	1GHz	250 MHz (3-4 CH) 500 MHz (1-2 CH)	1GHz
Freq Resolution				
Minimum (max sample rate/(512 pts)	977 kHz	3.9 MHz	997 kHz (3-4 CH) 1.95 MHz (1-2 CH)	3.9 MHz

Maximum (minimum sample rate)(32768 points): 0.305 mHz (all models)

–3 dB Frequency Range dc to 500 MHz (analog bandwidth)

Frequency Accuracy

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

Spectrum Displays

Amplitude Power in dBm

Signal-to-noise Ratio 55 to 65 dB (typical). Noise floor can be reduced by increasing the number of points in the FFT.

Sensitivity Range 1 dBm/div to 100 dBm/div

Dynamic Range 55 to 65 dB (typical)

Offset Range –200 dBm to +200 dBm

Notes:

1) The gain accuracy decreases 0.08% of full scale per °C from the firmware calibration temperature. This characteristic is valid for a temperature range ±10°C from the firmware calibration temperature. The characteristic applies to both modes; repetitive and real time (single acquisition).

2) Expansion is used below 7 mV/div range so vertical resolution and accuracies are correspondingly reduced. Below 7 mV/div full scale is defined as 56 mV.

3) The available waveform record length over HP-IB is 32,768 points in the real-time mode and 500 points in the repetitive mode.

Operating Characteristics

Vertical

Deflection Factors All input channels: With a single screen selected, you can adjust deflection factors from 1 mV/div to 5 V/div in a 1-2-5 sequence with the knob. You can make fully calibrated vernier adjustments using direct keypad entry or the using the knob with Fine selected.

Probe Attenuation Factors You can enter values from 0.9 to 1000 to scale the oscilloscope for external probes or attenuators attached to the channel inputs. When probe tip calibration is performed, this value is calculated automatically. The front-panel, probe compensation output source impedance is 500 Ω, so with low probe impedances, automatic calibration accuracy is dependent on the impedance of the probe.

Input Impedance 1 MΩ or 50 Ω , selectable for channels and the external trigger.

Bandwidth Limit (HF Reject) A low-pass filter with a –3 dB point at about 30 MHz for both triggering and signal display. You can select HF reject for each front-panel input individually, whether vertical or external trigger.

LF Reject A high-pass filter with a –3 dB point at about 400 Hz for the triggering and vertical signal. You can selected LF reject for each front-panel input individually, whether vertical or external trigger.

ac Coupling A high-pass filter with a –3 dB point at about 10 Hz for both triggering and signal display. You can selected ac coupling for each front-panel input individually, whether vertical or external trigger.

ECL/TTL Presets For ECL and TTL levels, you can preset the vertical deflection factor, coupling, offset, and trigger level independently on any vertical input channel. It is not available for the external trigger input.

Effective Resolution The maximum sample rate and the number of bits in an oscilloscope's digitizer are too often used for comparing oscilloscopes. These specifications, however, do not describe performance under dynamic signal conditions. Effective Resolution is a figure of merit that describes the digitizing oscilloscope's performance under dynamic conditions, and is measured using the sinewave curve fit test. This method considers:

- Quantization error
- Non-linearities (including preamp and ADC)
- System noise
- Frequency of input signal

All of these affect the effective resolution of the instrument. Some manufacturers specify effective bits using half-scale sinewaves. While the effective bits performance using half-scale testing is overstated when compared to full-scale testing, Hewlett-Packard publishes both sets of numbers for the oscilloscope so that, when comparing effective bits performance between digitizing oscilloscopes, a fair comparison can be made. The oscilloscope's typical performance for a single acquisition is shown below:

Frequency	**50 kHz**	**1 MHz**	**20 MHz**	**50 MHz**	**100 MHz**	**250 MHz**	**500 MHz**
Full scale	7.5	7.4	6.6	5.8	5.8	5.2	5.2
Half scale	7.6	7.4	7.0	6.5	6.5	5.8	5.5

Horizontal

Pan and Zoom Changing the Time/div and/or Delay values once acquisition is stopped allows access to all captured data on each acquisition in the real-time sampling mode only.

The record length control sets the number of points (512 to 32,768) acquired with each acquisition. The auto adjust softkey allows setting the sample rate independent of the time base. The entire record length may be displayed when the oscilloscope is in the run mode.

Delay Between Channels You can null out differences in delay between channels to compensate for differences in input cables or probe length using the probe null feature.

Reference Location You can set the reference point at the left edge, center, or right edge of the display. The reference point is the trigger point plus the delay time.

Trigger

Auto Trigger Auto trigger provides an acquisition when no trigger is present. When set to auto, if the instrument does not see a trigger within about 20 ms, it will automatically start an acquisition. When set to trg'd, it will wait for the next qualified trigger.

Trigger Holdoff Trigger can be held off either by time or events over the ranges:

- time: 40 ns - 320 ms
- events: 2 - 16,000,000

An event is defined as the specified trigger condition. A separate holdoff setting (time or events) is available for each trigger mode except delayed trigger, which is set to 40 ns. Holdoff is not available for the auxiliary or line trigger. The maximum event counting rate is 70 MHz.

Noise Reject Trigger Reject provides improved triggering on noisy signals by increasing trigger hysteresis (internal trigger only). When set on, noise reject is active for all trigger modes.

Trigger Modes

Edge Trigger

You can select a positive or negative edge for trigger on any channel, the external trigger input (HP 54520C/54540C), or the auxiliary input. For the channel and external trigger sources, you can set coupling to dc, ac (10 Hz) , or lfrej (low frequency reject, 50 kHz). Trigger coupling is independent of the vertical signal coupling and noise reject. This coupling only applies in the edge mode. In all other trigger modes, the channel and external trigger coupling is set to dc. You can also select line trigger in the edge trigger menu. Trigger coupling is automatically set to dc for all sources in all trigger modes, except in the edge trigger mode.

Pattern Trigger

You can specify a pattern using any front panel channel or external trigger input. Each input can be specified as a high, low, or don't care with respect to the level setting in the edge trigger menu. The trigger can be selected to occur on the last edge to enter the specified pattern or the first edge to exit the specified pattern. This pattern must be present for at least 1.75 ns before the trigger will respond.

Time Qualified Pattern Trigger A trigger occurs on the first edge to exit a pattern only if it meets the specified time criteria. The available time qualified modes are (user-specified time is in brackets):

- pattern present < [time]
- pattern present > [time]
- range: pattern present > [time1] and < [time2]

The time settings are adjustable from 20 ns to 160 ms (±3% ±2 ns). The time filter recovery time is ≤12 ns. In the "pattern present < [time]" mode, the pattern must be present for at least 1.75 ns before the trigger will respond.

Glitch Pattern Trigger Pattern triggering can be used to glitch trigger in conjunction with a pattern. Using any front panel channel or external trigger input. Use "pattern present < [time]" with [time] selected such that it is just less than the nominal pulse width of the signal you are analyzing. The minimum glitch width is 1 ns.

You can use the Glitch Trigger mode for glitch triggering on single sources with glitch widths from 1 ns to 160 ms.

State Trigger

After selecting any front panel channel or external trigger input as a clock, a pattern is specified using any of the remaining front panel inputs. The user may specify that a trigger will occur on the rising or falling edge of the input specified as the clock, when the pattern is present or not present. Setup time for the pattern with respect to the clock is 10 ns or less and hold time is zero.

Delayed Trigger

Event-Delayed Mode The trigger can be qualified by an edge, pattern, time qualified pattern, or state. The delay can be specified as a number of occurrences of a rising or falling edge of any one of the selected channels. After the delay, an occurrence of a rising or falling edge of any channel or external trigger inputs generates the trigger. The trigger occurrence value is selectable from 1 to 16,000,000. The maximum edge counting rate is 70 MHz.

Time-Delayed Mode The trigger can be qualified by an edge, pattern, or state. The delay is selectable from 30 ns to 160 ms. After the delay, an occurrence of a rising or falling edge of any one of the selected channels or external trigger generates the trigger. The trigger occurrence value is selectable from 1 to 16,000,000. The maximum edge counting rate is 70 MHz.

TV Trigger

60 Hz / 525 Lines Trigger source is selected to be any one of the four inputs (three inputs in two channel models). Trigger level is adjustable for the selected trigger source. Polarity is selected for positive or negative synchronizing pulses. A trigger occurs on the selected line and field of a 2/1 interlaced composite video signal. Line numbering is 1 to 263 for field 1 and 1 to 262 for field 2. This TV trigger mode is compatible with broadcast standard M.

50 Hz / 625 Lines Same as 60 Hz / 525 lines except that line numbering is 1 to 313 for field 1 and 314 to 625 for field 2. This TV trigger mode is compatible with broadcast standards B, C, D, G, H, I, K, K1, L, and N.

User-Defined Mode Source is selected to be any one of the three inputs. Trigger level is adjustable for the selected source. The trigger is qualified with a high or low pulse that meets a selectable time range. The trigger is an occurrence of a rising or falling edge of the source after the qualifying pulse. The time settings for the qualifier are selectable from 20 ns to 160 ms. The trigger occurrence value is selectable from 1 to 16,000,000.

Glitch Trigger

Used to trigger the oscilloscope on a positive or negative glitch that is less than or greater than a selectable setting. Settings are 2.5 ns, 5 ns, 10 ns, 20 ns, 40 ns, 60 ns . . .. The oscilloscope will trigger on glitches from 1 ns to 160 ms. Glitch accuracy from 2.5 to 10 ns is ±1.5 ns and from 20 ns to 160 ms is ±(3% + 2 ns).

Display

Data Display Resolution 501 points horizontally by 384 points vertically.

Number of Screens You can select 1, 2, or 4 screens. This can provide overlapping channels or memories for comparison, or separate displays on a split viewing area.

Screen Update Rate (typical at 500 ns/div, no measurements, and trigger frequency ≥50 kHz)

Real Time	**Record Length**	512	8K	16K	32K
	Updates/s	150	100	72	47
Repetitive	**Mode**	normal	8 averages	128 averages	
	Updates/s	150	91	91	

Display Modes

Graticules You can choose full grid, axes, frame, or no graticule.

Number of Screens You can select 1, 2, or 4 screens.

Connect-the-Dots Provides a continuous display, connecting the sample points with straight lines. Connect-the-dots is operative for modes in which a single-valued waveform can be connected, including average, envelope, single, and minimum-persistence modes. Connect-the-dots is not available in the variable or infinite persistence mode.

Time Base in the Repetitive Mode

Averaging You can specify the number of averages in powers of 2, up to 2,048. On each acquisition, $1/n$ times the new data is added to $(n\text{-}1)/n$ of the previous value at each time coordinate. Averaging operates continuously, except for the HP-IB digitize command, for which averaging terminates at the specified number of averages.

Envelope Provides a display of the running maximum and minimum voltage levels at each horizontal time position.

Minimum Persistence One waveform data value is displayed in each horizontal time position of the display. The waveform is updated as new data is acquired for a particular horizontal time position.

Variable Persistence You can vary from 500 ms to 10 seconds, the time that each data point is retained on the display, or display the points indefinitely by using the infinite persistence mode.

Time Base in the Real Time Mode

Single Persistence One waveform data value is displayed in each horizontal time position. The entire waveform is replaced with each new acquisition.

Peak Detect Displays the amplitude of pulses that have a pulse width of 1 ns or wider regardless of the time base setting. Peak detect works in real-time mode only at sample rates ≤250 MSa/s.

Infinite Persistence Waveform data is allowed to continuously accumulate on the screen, and remains until display is cleared.

Oversampling Filter On time/division settings when less than 500 points are acquired across the screen, a built-in digital filter automatically reconstructs the data. This filter is a combination between a (Sin X)/X and a Gaussian filter (also known as interpolation).

Time Base in Sequential Single-Shot

Used to view previously captured segments as defined in the time base menu. You can exclude, select, or view individual segment numbers from any channel. Viewing options include:

Normal Selection and viewing of any or all previously captured segments.

Average Averages and displays previously captured segments into a composite waveform.

Envelope Displays the minimum and maximum voltages of all previously captured segments.

Markers

Dual voltage and time markers are available. You can independently assign voltage markers to channels, memories, or functions.

Waveform Math

Four independent functions are provided for waveform math. The operators are +, −, ×, vs, magnify, inv (invert), int (integrate), and diff (differentiate), and FFT. You can use the vertical channels or any of the waveform memories for waveform math. Sensitivity and offset for these functions are adjusted independently.

Fast Fourier Transforms (FFT)

Peak Search Peak search automatically snaps cursors to any two selected peaks located anywhere in the displayed frequency span. You can select peaks from peak number 1 up to peak number 99. Frequency and dBm are automatically displayed at the bottom of the screen together with the difference in frequency between the two selected peaks. Peak search saves time by eliminating the need to manually set cursors.

Channels or Memories FFTs can be executed on any of the oscilloscope input channels, or on waveforms stored in any of four nonvolatile memories.

Variable Sensitivity and Offset Sensitivity and offset (vertical position) can be controlled to display an optimum view of the spectrum. Sensitivity is calibrated in dB per division; offset is calibrated in dBm.

Selectable Number of Points You can set the number of points the oscilloscope uses to calculate the FFT, from 512 to 32,768 (in powers of 2). Increasing the number of points improves frequency resolution at the expense of update speed. The point choices available are dependent on the data being operated upon.

Horizontal Magnify Mode This mode allows you to specify the frequency that is displayed at center screen, and magnify the frequency-domain display about that point. Magnification increases as the number of time-record samples increases. At the maximum of 32,768 points, magnification reduces the displayed frequency span to about 12% of that in the unmagnified display. Horizontal magnification allows you to zero in on and expand desired portions of the frequency-domain display.

Center Frequency Control Enabling horizontal magnification allows you to set the center of the display to a frequency of interest. The display is magnified about that point so that you get a closer view.

Selectable Windows Three windows are selectable: Hanning, for best frequency resolution and general purpose use; flattop, for best amplitude accuracy; and rectangular, for single-shot signals such as transients and signals where there are an integral number of cycles in the time record.

Maximum Displayed Frequency 5 Hz to 500 MHz selectable (real-time acquisition). Display is from dc to a selectable upper frequency, in steps from 5 Hz to 500 MHz. Maximum frequency displayed is 1/2 the sample rate.

Window Characteristics The window characteristics are shown below.

Window	Highest Side Lobe (dB)	3 dB Bandwidth (bins)	6 dB Bandwidth (bins)	Scallop Loss (dB)
Rectangular	−13	0.89	1.21	3.92
Hanning	−32	1.44	2.00	1.42
Flattop	−70	3.38	4.17	0.005

Highest Side Lobe The minimum attenuation in the stop band. It indicates the level of leakage present in the filter; that is, how high the skirts are in relation to the main peak.

3 dB bandwidth The width of the peak at a level 3 dB down. A narrow 3 dB bandwidth helps in separating frequency peaks that are close together.

6 dB Bandwidth The width of the peak at a level 6 dB down.

Bins The distance between frequency points. One bin equals the resolution.

Scallop Loss The attenuation of the peak half way between bins. The scallop loss determines the amplitude accuracy of a window. It measures the attenuation of a signal that falls between frequency bins versus one that is exactly on a frequency bin.

Split display operation A time-domain waveform and its FFT spectrum can be displayed simultaneously on the top and bottom halves of the screen. Four FFT spectra can be displayed simultaneously in the same way. Four sets of time-domain waveforms and their spectra may also be displayed simultaneously.

Log Display Sensitivity and offset can be set by the user.

Waveform Save

The oscilloscope contains four, nonvolatile waveform memories, two volatile pixel memories, and 665 multiple failure memories. The four nonvolatile memories can store four waveforms up to 32K each. The 665 multiple failure memories store 500 point records. Waveform memories store single-valued waveforms, such as an averaged waveform. If an envelope waveform is stored to a waveform memory, it is automatically stored with the upper waveform in one waveform memory and the lower waveform in another. You can perform automatic measurements on the four nonvolatile waveform memories but not the volatile pixel memories.

Waveform memory pairs m1/m2 and m3/m4 also store the upper and lower limit masks used during compare testing. You can create and edit these masks using sample signals, or you can create them manually.

Pixel memories store an entire screen of waveform data. Use them for storing multiple overlapping waveforms and infinite persistence waveforms.

Multiple memories store failure data from limit and compare tests. You can view or transfer this data to the waveform memory for nonvolatile storage or measurement.

Waveform and pixel memories can be saved to the disk drive (Disk menu).

Automatic Pulse Parameter Measurements

The oscilloscope offers 23 automatic pulse parameter measurements from the front panel (shown below) and over HP-IB. The standard measurements are performed with 10%, 50%, and 90% voltage thresholds, as defined by IEEE standard 194-1977, "*IEEE Standard Pulse Terms and Definitions.*"

Automatic measurements available on the oscilloscopes

Rise	Fall	Frequency	Period	preshoot	time at max voltage
+width	−width	Duty cycle	Δ Time	overshoot	time at min voltage
V p-p	V min	V max	V avg	voltage at time	time at voltage
V amptd	V base	V top	V ac rms		
			V dc rms		

User-definable Measurement Thresholds The oscilloscope allows you to set your own thresholds for automatic measurements. You can set both the upper and lower thresholds from −25% to 125%, as long as the upper threshold value is always greater than or equal to the lower threshold. The middle threshold is always equal to the midvalue between the upper and lower threshold.

Continuous Measurements You can turn continuous measurements on or off. With continuous measurements off, the voltage (y) and time (x) markers are placed on the waveform to indicate where the last measurement was taken.

Measurement Statistics The maximum, minimum, average, standard deviation, and most recent of continuously updated measurements are calculated and displayed. You can select any three measurements for simultaneous display.

Measurement Limit Test You can set the maximum and minimum limits for any three of the front-panel automatic measurements. These continuously updated measurements are compared to the maximum and minimum limits. If the measurements are outside the defined limits, you can store the waveform in a memory or print the screen on a hardcopy device. In addition, the HP-IB Service Request line can be set to flag the controller. You can set the measurement limit test to stop after test limits are exceeded, or to continue testing.

Setup Aids

Autoscale Pressing the Autoscale button automatically adjusts the vertical, horizontal, and trigger to best display the input signals. Autoscale requires a signal with a duty cycle greater than 0.5% and a frequency greater than 50 Hz. Autoscale is effective only for relatively stable input signals.

Undo autoscale Undo autoscale returns the instrument to the setup previous to the autoscale. (See Recall 0.)

Save/Recall You can save nine front panel setups (1-9) in nonvolatile memory.

Recall Clear Pressing the Recall key followed by the Clr key resets the oscilloscope to its default settings.

Recall 0 If Autoscale, ECL or TTL preset, or recall setup are inadvertently selected, recall 0 restores the instrument to the previous setup.

Show Displays instrument status, including volts/div, offset, and trigger condition.

Disk Drive

There is a high density, 3.5-inch, MS-DOS® compatible disk drive on the front panel.

Hardcopy

You can transfer the display, including menus and measurement answers, directly to a wide variety of HP graphics printers and plotters.

Full HP-IBand RS-232 Programmability

The oscilloscope is fully programmable. Instrument settings and operating modes, including automatic measurements, are remotely programmed over RS-232 or HP-IB (IEEE-488). HP-IB programming complies with IEEE 488.2-1988 "Standard Codes, Formats, Protocols, and Common Commands."

Sequential Single-shot Data Acquisition and Transfer Rate Using the front-panel time base menu or HP-IB command "Raw Data," the oscilloscope can automatically capture, store, and label a waveform; and rearm the trigger; and then repeat this process until the oscilloscope's entire 400K word RAM (volatile) is filled. Once the specified number of waveforms are captured and stored, the oscilloscope can transfer the entire block of waveforms to the external computer. HP-IB bus users can specify the number of points to store and the number of waveforms to capture. Repetition rates vary depending on record length and time base setting (slower sampling rates).

Data Transfer Rate Approximately 120 Kbytes per second.

CAL Signals

Probe Compensation, ac Calibrator Output A square wave signal is provided on the front panel and rear panel for probe compensation and other uses. The default frequency is approximately 500 Hz, but it is adjustable from approximately 250 mHz to about 32 kHz. During instrument self-calibration, this output is used to provide other calibration signals, as described in the Service Guide.

The rear panel BNC connector is also used for trigger output. The utility menu allows the user to switch the BNC from probe compensation and calibration signals to a trigger output pulse. The rising edge, with amplitude from about –400 mV to 0 V (when terminated into 50 Ω), is synchronous with system trigger. The falling edge of this pulse is approximately at the start of the acquisition. The rising edge should be used as the edge synchronous with trigger.

dc Calibrator Output This output is used for vertical calibration of the oscilloscope, as described in the Service Guide.

Product Support

Built in Self-Test and Calibration Routines Internal self-test capabilities provide a 90% confidence the oscilloscope is operating properly. External test procedures in the Service Guide provide a 100% confidence. Self-calibration routines, also selected through the front-panel "utility" menu, ensure that the instrument is operating with its greatest accuracy and require no external test equipment.

Low Cost of Ownership The oscilloscope includes a standard three year, return to HP warranty.

To minimize the repair and calibration times, the oscilloscope was designed with only one main assembly adjustment per channel. In addition, Hewlett-Packard's board exchange program assures economical and timely repair of units, reducing the cost of ownership.

Reliability Estimated mean time between failures (MTBF) for this oscilloscope is 30,000 hours. MTBF is computed using an instrument usage of 2,000 hours per year.

Solutions Hewlett-Packard's System Engineering Organization can help you configure an HP-IB system and provide software support for your application, developing solutions to meet your measurement needs. Contact your HP Sales and Service office for more information.

General Characteristics

These general characteristics apply to the HP 54520/42C oscilloscope.

Environmental Conditions

The instruments meet Hewlett-Packard's environmental specifications (section 750) for class B-1 products with exceptions as described for temperature and condensation. Contact your local HP field engineer for complete details.

Temperature

Operating 0 °C to +55 °C (32 °F to +131 °F)
Non-operating –40 °C to +70 °C (–40 °F to +158 °F)

Humidity

Operating up to 95% relative humidity (non-condensing) at +40 °C (+104 °F)
Non-operating up to 90% relative humidity at +65 °C (+149 °F)

Altitude

Operating up to 4,600 meters (15,000 ft)
Non-operating up to 15,300 meters (50,000 ft).

Vibration

Operating Random vibration 5-500 Hz, 10 minutes per axis, 0.3 grms
Non-operating Random vibration 5-500 Hz, 10 minute per axis, 2.41 grms; Resonant search, 5 to 500 Hz swept sine, 1 Octave/minute sweep rate, 0.75g, 5 minute resonant dwell at 4 resonances per axis.

Power Requirements

⚠ **Voltage** 115/230 Vac, –25% to +15%, 48-440 Hz.

Power 170 W maximum

Weight

Net Approximately 10 kg (22.02 lb.)

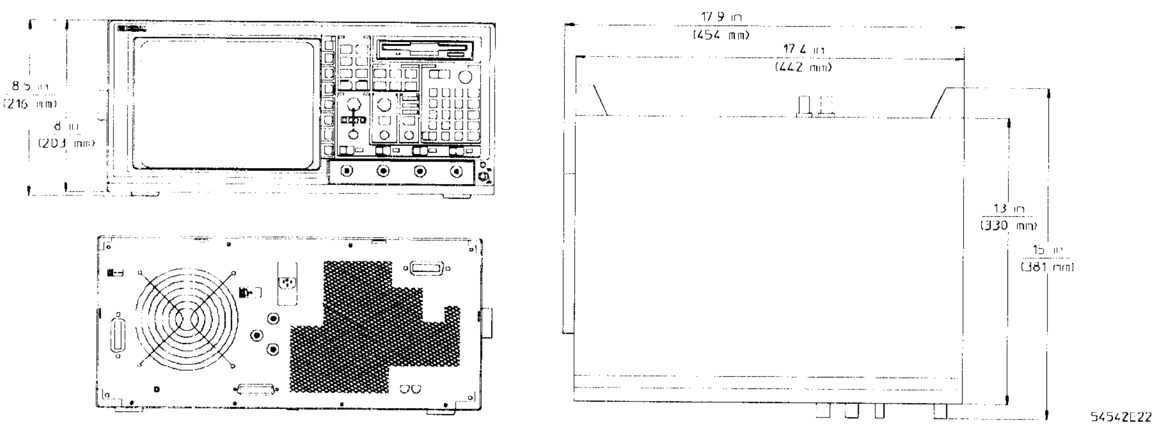
Shipping Approximately 20 kg (44.03 lb.)

Dimensions

Refer to the outline drawings

Notes

1. Dimensions are for general information only. If dimensions are required for building special enclosures, contact your HP field engineer.
2. Dimensions are in millimeters and (inches).



Product Regulations

Safety

IEC 1010
UL 3111
CSA Standard C22.2 No. 1010.1-92

EMC

This product meets the requirement of the European Communities (EC) EMC Directive 89/336/EEC.

Emissions EN55011/CISPR 11 (ISM, Group 1, Class A equipment)

Immunity

EN50082-1	Code[1]	Notes[2]
IEC 801-2 (ESD) 4kV CD, 8kV AD	2	
IEC 801-3 (Rad.) 3 V/m	2	
IEC 801-4 (EFT) 1kV	2	

1 Performance Codes:
1 PASS - Normal operation, no effect.
2 PASS - Temporary degradation, self recoverable.
3 PASS - Temporary degradation, operator intervention required.
4 FAIL - Not recoverable, component damage.

2 Notes:
(None)

Glossary

Acquisition The process of sampling and digitizing instantaneous values of a continuous analog waveform and storing the values in memory.

Acquisition system A combination of hardware and firmware that performs the acquisition process and assembles individual waveform samples into coherent waveform records.

Averaging Before updating the display or measurements, the oscilloscope averages newly acquired data with existing data. The higher the number of averages, the less impact each new waveform has on the composite averaged waveform.
Averaging is typically used to eliminate random noise from a repetitive waveform.

Bit map A two-dimensional array in which each element stores the state of a corresponding pixel (dot) on a video display. Typically, there is one bit in the array for each pixel on the display. The bit indicates whether the pixel is illuminated (1) or off (0).

Connect dots A straight line is drawn between two-adjacent data points on the display. Connect dots is a display feature; it has no affect on the waveform record stored in memory or on measurements.

Delay Delay moves the waveform horizontally on the display. Digitizing oscilloscopes allow you to view events that happened before the trigger event. A negative delay value is time before the trigger event, and a delay position value is time after the trigger event. Some oscilloscopes refer to delay as position.

Delay-by-events triggering The trigger circuitry arms on an edge from one of the channel or trigger inputs, waits for a number of events, then triggers on an edge from any of the channel or trigger inputs. Basically, it is two edge triggers separated by a selectable number of events.

Delay-by-time triggering The trigger circuitry arms on an edge from one of the channel or trigger inputs, waits for a time period, then triggers on an edge from any of the channel or trigger inputs. Basically, it is two edge triggers separated by a selectable time period.

Edge triggering The traditional triggering mode. A trigger event is defined as a transitioning edge of a specified polarity crossing a specified voltage threshold.

Equivalent-time sampling
A term that is used on other oscilloscopes to refer to repetitive

sampling. The terms are interchangeable. See "Repetitive sampling" in this glossary.

Flash ROM A type of electronically erasable and programmable read only memory (EEPROM) used to store the instrument's firmware. The use of this variety of memory makes it possible to upgrade the instrument's firmware using only a floppy disk without having to touch or change any of the internal components.

Glitch triggering Glitch triggering allows the oscilloscope to trigger on pulses less than or greater than a selected width.

Internal waveform file format A binary file format that the oscilloscope uses to store waveforms to a disk. The binary file format uses less disk space than the text file formats. Also, the binary file format is a convenient method for transporting waveforms from oscilloscope to oscilloscope, or from a disk back into the oscilloscope.

Interpolate A finite impulse response digital filter that makes the best possible reconstruction of the waveform. The reconstruction is done by using digital signal processing to add data points between the acquired data points. Then, linear interpolation is performed with the higher sample density.

Linear interpolation Another term for *connected dots*. A straight line is drawn between two adjacent data points.

Logic triggering Logic triggering allows you to qualify the trigger event further than the standard edge trigger mode. Basically, logic triggering is like adding a 4-bit logic analyzer trigger to your oscilloscope.

Memory depth Another term for *record length*. See "Record length" in this glossary.

Offset Another term for Position. Refer to "*Position*" in this glossary.

Panning Panning is used when the acquisition is in the stopped mode. Panning is moving the acquired waveform horizontally on the display. It is controlled by the time base delay controls in the real-time mode. Increasing delay moves the waveform to the left and decreasing delay moves the waveform to the right.

Pattern triggering Pattern triggering qualifies the trigger event by having the oscilloscope search for a pattern across the oscilloscope inputs. You can define the pattern as a combination of highs, lows, or don't care levels. Voltages above the trigger level are a high, and voltages below the trigger level are a low.

Peak detect Peak detect stores the minimum and maximum values (pairs) for each time bucket. Peak detect can detect excursions as narrow as 1 ns, and it functions on sample rates up to 250 MSa/s.

Pixel memory A pixel memory is a volatile, screen image, storage area. It is essentially a snap shot of the display and has no vertical or horizontal scaling factors associated with it.

Position Position (offset) moves the waveform vertically on the display. It is similar to the vertical position control on analog oscilloscopes except that it is precisely calibrated. The position voltage is the voltage at the center of the graticule area.

Real-time sampling All the data points that make up a waveform come from a single trigger event. The real-time sampling mode is typically used on events that occur either once or infrequently.

Reconstruction Also known as *interpolation*. Sampling theory indicates that if a signal is bandwidth-limited to less than half of the sampling frequency (the Nyquist frequency), the continuous signal can be determined exactly from the sequence of samples. Two problems exist in the real world to prevent exact determination of the continuous input. First, many signals are not bandwidth-limited, and second, the ideal determination requires an infinite number of samples. Reconstruction uses the assumption that the signal has minimal frequency components above the Nyquist frequency in order to accurately (but not exactly) rebuild the continuous signal from the finite set of discrete samples.

Record length The number of waveform samples stored in the waveform record. The greater the memory depth, the greater the amount of sampled data that is available for analysis or measurements.

Repetitive sampling A waveform is reconstructed from data points that are acquired from several trigger events. The repetitive sampling mode is typically used on repetitive signals.

Sample rate The rate at which the acquisition system samples a waveform. In the real-time mode, all samples in a given waveform record are taken from one trigger event and are evenly spaced in time at a distance of 1/sample rate. In the repetitive mode and when less than 500 points are captured on each acquisition, a waveform record is built up by interleaving samples taken from multiple trigger events. This process allows samples in the waveform record to be spaced more closely together for repetitive waveforms. As a result, the waveforms appear to have been sampled at a much higher rate, sometimes referred to as an *effective sample rate*. The effective sample rate is record length/time length of the record. This is the same as 1/(time between the sample points) or 1/(time base resolution).

Scale (channel) Channel scale controls the vertical scaling of displayed waveforms.

Scale (time base) Time base scale controls the horizontal scaling of displayed waveforms. Time base scale is often referred to as *sweep speed* in other oscilloscopes.

Skew Skew changes the horizontal position of a waveform on the display independent of any other waveforms on the display. The time base position control moves all of the waveforms on the display at the same time, whereas skew moves individual waveforms. Skew is typically used for overlaying waveforms, or eliminating timing difference caused by diverse cable and probe lengths.

State triggering State triggering is an edge qualified, pattern trigger. A trigger event occurs if a 3-bit pattern is present when an edge occurs on the designated clock waveform.

Text verbose An ASCII text file format that uses alphanumeric characters to represent a waveform. This format includes header information about the waveform and when it was acquired. The text file formats are a convenient method for transferring waveforms to desktop publishing programs.

Text Y values Similar to the text verbose file format, except that the header information is deleted from the beginning of the file.

Throughput Throughput is the rate at which the oscilloscope can acquire, display, and make measurements on a waveform. The faster the throughput of an oscilloscope, the more waveforms per second that it can process.

Time base reference A reference point along the time axis (X axis) of the waveform. This point can be either the left side of the display, the center, or the right side. The time of this point, relative to the trigger event, is set using the time base position control. When the time base scale is changed, the time location at the time base reference remains fixed and the waveform display either expands or contracts about the reference point.

Time bucket A storage location within a waveform record which is used to hold a waveform data sample. A waveform record is made up of a series of waveform data samples stored in ascending time order. Each waveform sample is stored in a specific time bucket within the waveform record based upon its time relationship to the other samples. The waveform record length (number of points) determines the number of time buckets in a record. A time bucket is considered "full" if it contains a waveform data sample.

Time tag Time tag is used in the sequential mode. The time tag number associated with the *n*th trigger or acquisition is the time from the first trigger to the *n*th trigger.

Trigger event A change of some type in the trigger source waveform which causes the acquisition system to begin storing waveform samples into the waveform records. The time at which the trigger event occurs is the time reference for the waveform and is, by definition, 0 seconds.

Waveform memory A waveform memory is a convenient, nonvolatile, waveform storage area. A waveform memory contains a single waveform record along with the vertical and horizontal scaling factors for that waveform.

Zooming Zooming is used when the acquisition is in the stopped mode. Zooming either expands or compresses the acquired waveform on the horizontal axis of the display. It is controlled by the time base time/div controls for expansion or compression of a single-shot waveform in the real-time mode. Decreasing time/div expands the waveform and is referred to as "zooming in." Increasing time/div compresses the waveform and is referred to as "zooming out."

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DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Hewlett-Packard Company

Manufacturer's Address: 1900 Garden of the Gods Road
Colorado Springs , CO 80907
U.S.A.

Declares, That the product

Product Name: Digitizing Oscilloscope

Model Number(s): HP 54542C, 54540C, 54522C, 54520C

Product Options: All

Conforms to the following Product Specifications:

Safety: IEC 1010-1: 1990+A1/EN 61010-1: 1993
UL 3111
CSA - C22.2 No. 1010.1: 1993

EMC: CISPR 11:1990 /EN 55011: 1991 Group 1 Class A
IEC 801-2:1991 /EN 50082-1: 1992 4 kV CD, 8 kV AD
IEC 801-3:1984 /EN 50082-1: 1992 3 V/m, {1 kHz 80% AM, 27-1000 MHz}
IEC 801-4:1988 /EN 50082-1: 1992 0.5 kV Sig. Lines, 1 kV Power Lines

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE marking accordingly.
This product was tested in a typical configuration with Hewlett-Packard test systems.

Colorado Springs, March 15, 1995

John Strathman, Quality Manager

European Contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH, Department ZQ / Standards Europe, Herrenberger Strasse 130, 71034 Böblingen Germany (FAX: +49-7031-143143)

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This apparatus has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. This is a Safety Class I instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under "Safety Symbols."

Warning

- Before turning on the instrument, you must connect the protective earth terminal of the instrument to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. You must not negate the protective action by using an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock of fire hazard.
- Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.
- If you energize this instrument by an auto transformer (for voltage reduction), make sure the common terminal is connected to the earth terminal of the power source.
- Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.
- Use caution when exposing or handling the Flat Panel Display (FPD). Handling or replacing the FPD shall be done only by qualified maintenance personnel.

Safety Symbols

⚠

Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product.

ϟ

Hazardous voltage symbol.

⏚

Earth terminal symbol: Used to indicate a circuit common connected to grounded chassis.

WARNING

The Warning sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a Warning sign until the indicated conditions are fully understood and met.

CAUTION

The Caution sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a Caution symbol until the indicated conditions are fully understood or met.

Hewlett-Packard
P.O. Box 2197
1900 Garden of the Gods Road
Colorado Springs, CO 80901

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This Hewlett-Packard product has a warranty against defects in material and workmanship for a period of three years from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products that prove to be defective.

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About this edition

This is the first edition of the *HP 54520C and HP 54540C Series Oscilloscope User's Reference.*

Publication number 54542-97048

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First edition, March 1996

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by you. The dates on the title page change only when a new edition is published.

A software or firmware code may be printed before the date. This code indicates the version level of the software or firmware of this product at the time the manual or update was issued. Many product updates do not require manual changes; and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

The following list of pages gives the date of the current edition and of any changed pages to that edition.

All pages original edition

HP 54500C Series Oscilloscope
Registration Form

Please complete this form and FAX or MAIL it to Hewlett-Packard to ensure that HP can contact you when software updates or new product information becomes available. Anyone responsible for the maintenance of this product as well as the end user should register. Please register even if you are not the original purchaser. This form can also be used to inform us if your address changes.

Provide as much information as possible so Hewlett-Packard can contact you.

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How would you prefer to be contacted? ________ Mail __________FAX ________ Phone

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Software Upgrade Service/EMD
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Optional Information

What are you making measurements on?

______ Computers

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______ Lasers

______ Instrumentation

______ Datacomm

______ Microprocessors (#______________)

______ High-Energy Research

______ Other (Please describe)

______ Disk Drives

______ ICs

______ Fiber Optics

______ Video

______ Telecomm

______ RF/Microwave Communications

______ TV

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What is the primary application for this product?

______ General Troubleshooting

______ Digital Design and Debug

______ Analog Design Verification

______ Device Characterization/Test

______ Transient Waveform Capture

______ Computer Aided Test (CAT)

______ Data Acquisition

______ Go/No Go Measurement Limit Testing

______ Go/No Go Waveform Compare Testing

______ Other (Please describe)

____

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Any additional comments about this product?

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