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About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual is the best copy we could find; it may be incomplete or contain dated information. If we find a more recent copy in the future, we will add it to the Agilent website.

Support for Your Product

Agilent no longer sells or supports this product. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available. You will find any other available product information on the Agilent Test & Measurement website, www.tm.agilent.com.

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. In other documentation, to reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product number/name was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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User's Guide

Publication Number 54655-90901
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HP 54655A and HP 54656A Test Automation Modules

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Introduction

The HP 54655A and HP 54656A Test Automation Modules provide semiautomated, or fully-automated testing capabilities to the HP 54600A and HP 54601A oscilloscopes. The HP 54655A HP-IB Test Automation Module is aimed at fully automated testing. The HP 54656A RS-232 Test Automation Module is better for semiautomated testing. The main features are:

- Full Programmability.
- Hard copy output.
- 100 nonvolatile sequence steps.
- 40 nonvolatile mask templates.
- 2 nonvolatile trace memories.
- Built-in automatic mask generation and mask editing capabilities.
- Protection of test sequence and mask template setup through software.

The HP 54656A has the following additional features:

- External input lines for Next, Previous, and Reset control.
- 5 user-definable output lines.
- Recessed protection switch.

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Accessories supplied with the HP 54655A and HP 54656A

- This User's Guide.
- The HP 54600A and HP 54601A Oscilloscopes Programmer's Guide.

Additional accessories supplied with the HP 54656A

- RS-232 adaptor cable, HP 98561-61604.
- One - 2 meter cable with an RJ-45 connector at one end and stripped, tinned leads at the other end.

Accessories available

- HP 54653A ScopeLink software package.
- HP 10833A 1 meter (3.3 feet) HP-IB cable.
- HP 10833B 2 meters (6.6 feet) HP-IB cable.
- HP 10833C 4 meters (13.2 feet) HP-IB cable.
- HP 10833D 0.5 meter (1.6 feet) HP-IB cable.
- HP 13242G 5 meters (16.7 feet) RS-232 cable for printer/plotter and HP Vectra 25-pin serial port.
- HP 17255M 1.2 meters (3.9 feet) RS-232 cable for printer/plotter and HP Vectra 25-pin serial port.
- HP 17255D 1.2 meters (3.9 feet) RS-232 cable for IBM PC/XT 25-pin serial port.
- HP 92219J 5 meters (16.7 feet) RS-232 cable for IBM PC/XT 25-pin serial port.
- HP 24542G 3 meters (9.9 feet) RS-232 cable for 9-pin serial port.

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In This Book

This book is the user's guide for the HP 54655A and HP 54656A Test Automation Modules. It contains six chapters.

- Chapter 1, "Quick Start," is a quick start guide that gives you a brief overview of the Test Automation Modules.
- Chapter 2, "Operating the Test Automation Module," is a series of exercises that guide you through the operation of the Test Automation Modules.
- Chapter 3, "Solutions," contains in depth information concerning how to solve particular testing problems when using the Test Automation Modules.
- Chapter 4, "Test Sequencing Programming," discusses the additional programming commands that allow you to access the test sequencing through the communication port.
- Chapter 5, "Reference Information," lists the reference information concerning the Test Automation Modules.
- Chapter 6, "HP 54653A ScopeLink 2.0 Software," discusses the HP 54653A ScopeLink 2.0 software which contains new commands to support the Test Automation Modules.

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1

Quick Start

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Introduction

The exercises in this chapter acquaint you with some of the basic functions and operations of the Test Automation Modules. The operation of the Test Automation Module is divided into two parts: set up and use. The test sequence is generally set up by a test administrator and used by the operators. Chapter 2 covers more detailed information concerning the tasks to be performed by both the administrator and operator.

The inside back cover of this book is a reference guide. This reference guide has a diagram of the softkey menu tree of the extended features in the Test Automation Modules.

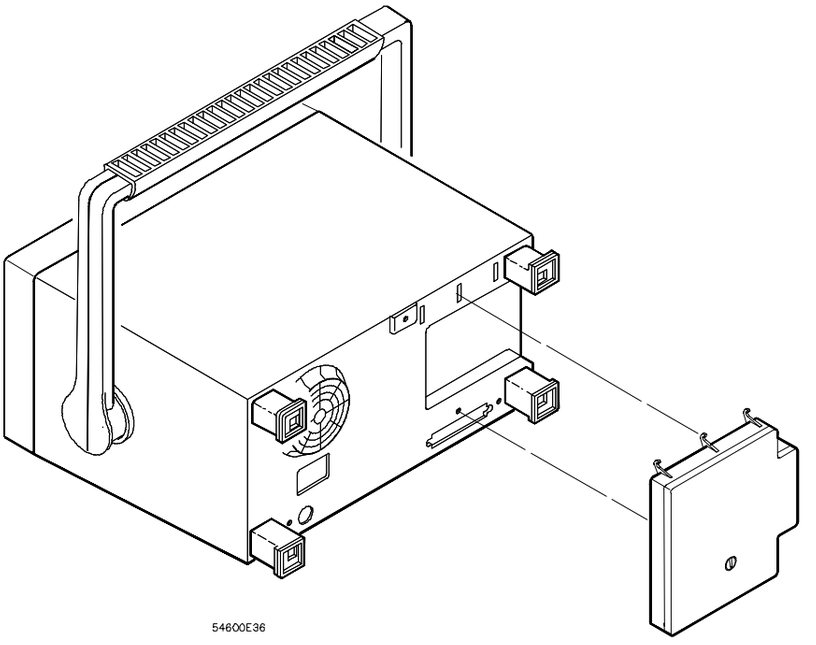
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To install the Test Automation Module

1. Turn off the oscilloscope.
2. Install the interface as shown in figure 1.

   The oscilloscope is reset after installation. The installed interface is reflected in the message displayed when you turn on the oscilloscope.

Figure 1



Installing the Test Automation Module

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To set up the Test Automation Module

In the next two exercises, the front panel calibration signal is used as the source signal. A probe is needed to connect the calibration signal to channel 1 of the oscilloscope. A mask template is created based on the calibration signal. Then a sequence step is created to test the signal. Failure of the test is also simulated.

1. Connect the front panel calibration signal to channel 1 of oscilloscope through a probe.
2. Set the correct probe attenuation factor by pressing `1`. Then toggle the `Probe` softkey to change the attenuation factor to match the probe you are using.
3. Press `Autoscale`.
4. Press `Display`, then toggle the `Grid` softkey to the off position.
5. Press `Print/Utility`.
6. Press the `Sequence Admin` softkey.

   If you cannot find the `Sequence Admin` softkey, press `Print/Utility` again to display it at the rightmost side of the softkey menu, then press the `Sequence Admin` softkey.

   If a warning message "Sequence Admin Protected" is displayed when you press the Sequence Admin softkey, the sequence is protected. To access the softkey, flip the recessed protection switch on the module to the unprotected position using the tip of a ball-point pen. Then press the `Sequence Admin` softkey.

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7 Press the `Define Automask` softkey.

8 Turn the knob closest to the Cursors key until the number highlighted under the `Mask` softkey is 1.

9 Press the `Create Mask` softkey.

A mask is generated from the signal on the screen. The mask consists of two lines: the maximum limit line and the minimum limit line.

10 Press the `Previous Menu` softkey, then press the `Define Sequence` softkey.

11 Press the `Step` softkey or turn the knob closest to the Cursors key until the number highlighted under `Step` is 1.

12 Press the `Save Setup` softkey.

13 Press the `Use Mask` softkey. Then press the `Use Mask` softkey, or turn the knob closest to the Cursors key, until the number highlighted is 1.

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To use the Test Automation Module

Now, the setup for the test is complete. In an actual application, this completes the administration portion. You can now proceed to use it for testing, just like an operator is going to use it for testing.

1. Press `Setup`.
2. Press the `Sequence Menu` softkey.
3. Press the `Reset` softkey to return to step number 1.

   The live signal is tested against the mask created during the set up process. A blinking PASS indicator appears in the lower-left corner of the display.
4. Press the orange ground button on the probe and hold it.

   This grounds the input and creates a failure condition. A blinking FAIL indicator appears in the lower-left corner of the display. Also, a fail-zone indicator bar just above the FAIL indicator shows where the failure occurs.
5. Release the orange ground button.

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2

Operating the Test Automation Module

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Introduction

The exercises in this chapter guide you through the operation of the Test Automation Modules. The exercises include detailed information about the tasks performed by both the administrator and the operator.

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To configure the interface

The Test Automation Module can be connected to a printer, a plotter, or a computer through the interface. The HP 54655A has an HP-IB interface while the HP 54656A has an RS-232 interface.

1 Connect the Test Automation Module to a printer, plotter, or computer through a suitable cable. Table 1 shows the HP part numbers of the proper cables.

Table 1 **Cable Part Numbers**

Model Number	Cable Function	HP Part Number	Description
HP 54655A (HP-IB)	Oscilloscope to Printer/Plotter Controller	HP 10833A	1 meter (3.3 feet)
		HP 10833B	2 meters (6.6 feet)
		HP 10833C	4 meters (13.2 feet)
		HP 10833D	0.5 meter (1.6 feet)
HP 54656A (RS-232)	Oscilloscope to Printer/Plotter HP Vectra 25-pin serial port	HP 13242G	5 meters (16.7 feet)
		HP 17255M	1.2 meters (3.9 feet)
	Oscilloscope to IBM 25-pin serial port	HP 92219J	5 meters (16.7 feet)
		HP 17255D	1.2 meters (3.9 feet)
	Oscilloscope to 9-pin serial port	HP 24542G	3 meters (9.9 feet)

See the section "RS-232 pin out" in chapter 5 for information on the pin outs of the RS-232 cables.

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2 Press `Print/Utility` .

If the `Previous Menu` softkey appears on the rightmost softkey, press `Print/Utility` again.

When the module is installed, an additional softkey appears at the second softkey from the left. For the HP 54655A, the label is `HP-IB Menu`. For the HP 54656A, the label is `RS-232 Menu`.

3 Press the `HP-IB Menu` softkey or the `RS-232 Menu` softkey.

For HP 54655A, a softkey menu with five choices appears. Four of them are related to the configuration of the HP-IB interface.

- `Connect to` Selects the device connected to the oscilloscope. Selections include HP plotter, HP printer, and computer.
- `Factors` Selects whether the printer or plotter output contains the information concerning the basic settings of the oscilloscope.
- `Resolution` Selects the resolution of the printer or plotter output.
- `Address` Selects the HP-IB address of the instrument. Valid addresses range from 0 to 30. To change the address, press the softkey or turn the knob closest to the Cursors key.
- `Previous Menu` Returns the oscilloscope to the previous softkey menu.

For HP 54656A, a softkey menu with six choices appears. Five of them are related to the configuration of the RS-232 interface.

- `Connect to` Selects the device that the oscilloscope is connected to. Selections include HP plotter, HP printer, Epson compatible printer, and computer.
- `Factors` Selects whether the printer or plotter output contains the information concerning the basic settings of the oscilloscope.
- `Resolution` Selects the resolution of the printer or plotter output.
- `Baud Rate` Selects the baud rate of the RS-232 port. Valid baud rates are 1200, 2400, 9600, and 19200.
- `Handshake` Selects the handshaking method used in the RS-232. DTR refers to the hardware handshaking using the DTR signal line. XON refers to the software handshaking using the XON/XOFF protocol.
- `Previous Menu` Returns the oscilloscope to the previous softkey menu.

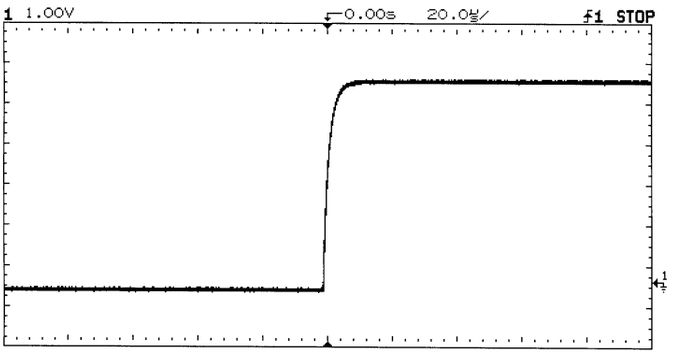
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4 Toggle the softkeys to select the correct configuration for your printer, plotter, or computer.

Print Factors

Oscilloscope factors may be turned on or off for hard copy prints and plots. All factors are printed on the hard copy when *on* is selected. When *factors* is selected for a hard copy plot, the plot is in portrait mode, with the factors plotted at the bottom. When factors is not selected for hard copy plot, the plot is plotted in landscape mode automatically to maximize the plot area. Figure 2 shows an example of a print with factors on. Figure 3 shows an example of a plot with factors off.

Figure 2



	State	Volts/Div	Position	Couplg	BW Lim	Invert	Probe
Chan 1	On	1.000 V	-2.366 V	DC	Off	Off	1:1
Chan 2	Off	100.0mV	0.000 V	DC	Off	Off	1:1
Chan 3	Off	100.0mV	0.000 V	DC	---	---	1:1
Chan 4	Off	100.0mV	0.000 V	DC	---	---	1:1

	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	20.00us/	0.000 s	Cntr	--------	-----

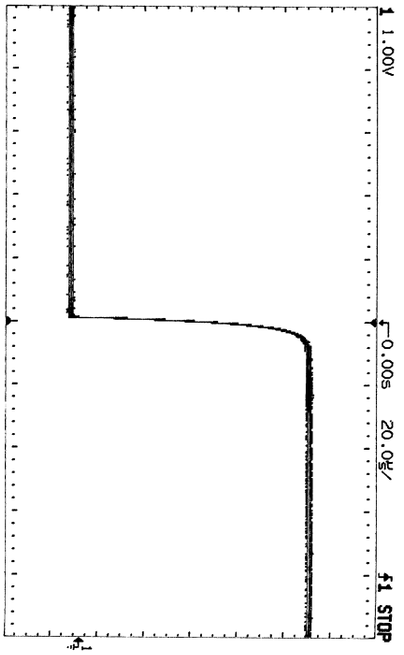
Trigger	Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
	AutoLvl	Ch 1	2.366 V	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Print with Factor ON

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Figure 3



Plot with Factors Off

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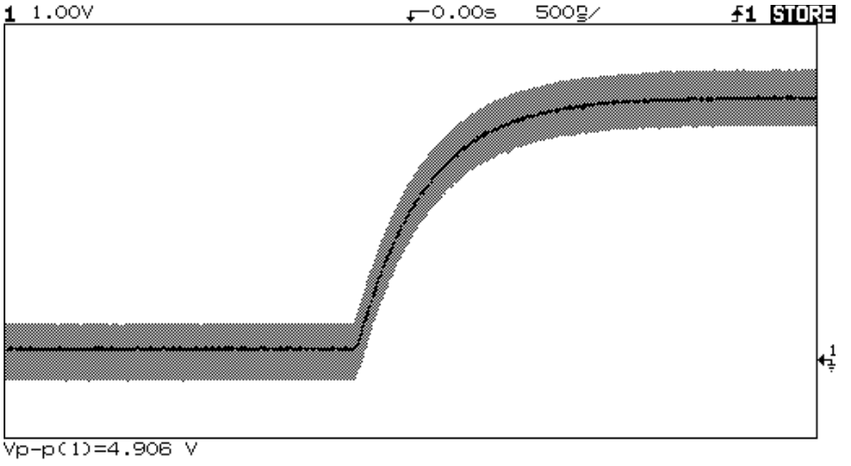
Print Resolution

High or low hard copy resolution can be selected for hard copy prints and plots. When *high resolution* is selected, the full-bright and half-bright traces on the oscilloscope screen are printed or plotted on the hard copy.

High resolution printing requires an HP-PCL compatible printer capable of printing at 300 dpi (dots-per-inch), such as an HP LaserJet Series printer. The half-bright trace is printed in gray shading while the full-bright trace is printed in black. Figure 4 shows an example of a high resolution print using the HP LaserJet II printer.

High resolution plot uses two pens for the hard copy. Half-bright traces are plotted with plotter pen 1 and full-bright traces are plotted with plotter pen 2.

Figure 4



Print in High Resolution mode using an HP LaserJet Series II printer

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To save a front-panel setup in the Test Automation Module memories

1. Press `Print/Utility` .
2. Press the `Sequence Admin` softkey.
   The Test Automation Module remembers which menu you were in last. If you cannot find the Sequence Admin softkey, press `Print/Utility` again to return to the root level of the menu tree. Then press the `Sequence Admin` softkey.
3. Press the `Define Sequence` softkey.
4. Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the memory location.
5. Press the `Save Setup` softkey to save a front-panel setup.

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To recall a front-panel setup from the Test Automation Module memories

1. Press `Setup` .
2. Press the `Sequence Menu` softkey.
3. Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the memory location.

   The front-panel setup corresponding to the displayed memory location is recalled.

To save or recall front-panel setups

The Test Automation Module provides another 100 nonvolatile memories for storing front-panel setups in conjunction with the 16 memories in the HP 54600A and HP 54601A oscilloscopes. To save or recall front-panel setups using the 16 memories in the oscilloscopes, refer to the instructions listed in the "HP 54600A and 54601A User and Service Guide."

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To create a label for a front-panel setup

Each front-panel setup stored in Test Automation Module can have a label up to 60 characters long to identify the setup.

1. Press `Print/Utility`.
2. Press the `Sequence Admin` softkey.

   The Test Automation Module remembers which menu you were in last. If you cannot find the Sequence Admin softkey, press `Print/Utility` again to return to the root level of the menu tree. Then press the `Sequence Admin` softkey.
3. Press the `Define Sequence` softkey.
4. Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the step number for adding the user message.
5. Press the `Define Step` softkey.
6. Press the `Messages` softkey.
7. Press the `Label` softkey.

   A softkey menu with six softkey choices appears. Five of them are related to editing the message.

   - `Enter` Enters the highlighted character in the character area into the message area under the cursor position.
   - `Space` Enters a space into the message area under the cursor position.
   - `Delete` Deletes the character in the message area under the cursor position.
   - `Insert` Toggles the insert function on or off. With insert on, pressing Enter or Space inserts the character or space into the message before the character at the cursor position. The rest of the message is shifted to the right by one character. With insert off, pressing Enter or Space replaces the character highlighted in the character area.
   - `Clear To End` Clears the characters from the cursor position to the end of the message including the character under the cursor.
   - `Done` Exits the editing of the message.

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8 Turn the Delay knob to move the cursor in the label to the position that you want to edit.

9 Turn the knob closest to the Cursors key to move the cursor in the character area to select the character that you want to enter.

10 Press the `Enter` softkey to enter the highlighted character into the user message, or press the `Space` softkey to enter a space into the user message.

11 Repeat procedures 8 through 10 until you are finished editing the message.

The maximum length of the label is 60 characters.

12 Press the `Done` softkey.

Your message is displayed when you execute the step in the Sequence menu.

Step label operating hint

The step label always occupies the top left corner of the screen. To prevent the step label for blocking the view of the waveform, make the label as short as possible. In extreme cases, you can turn off the label completely by deleting all of the characters in the label. In this case, no label will be shown on the screen.

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To create a setup sequence

A simple sequence of setups can be easily created to accomplish your test or measurement task.

1. Set up the oscilloscope front panel for your measurement.
2. Press `Print/Utility` twice.
3. Press the `Sequence Admin` softkey.
4. Press the `Define Sequence` softkey.
5. Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the step that starts your sequence.
6. Press the `Save Setup` softkey to save the current setup into the step.
7. Change the setup of the oscilloscope for the next measurement step.
8. If you changed the softkey menu, press `Print/Utility` .

   This returns you to the previous menu in the Sequence Admin menu tree.
9. Press the `Step` softkey, or turn the knob closest to the Cursors key, to change the step number to the next memory location.
10. Press the `Save Setup` softkey.
11. Repeat steps 7 to 10 until you have finished your sequence.

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To execute a sequence

1 Press `Setup` .

2 Press the `Sequence Menu` softkey.

A softkey menu with five softkey choices appears. Four of them are related to using the sequence.

- `Step` Selects the step number to be executed. Turning the knob closest to the Cursors key also changes the step number.
- `Next` Advances the sequence to the next step.
- `Previous` Recalls the previous step executed in the sequence. This allows you to recover from accidentally pressing the Next or Reset key. Only one previous step is memorized.
- `Reset` Resets the step number to step 1.
- `Stop Sequencing` Terminates sequencing and returns you to the previous softkey menu.

3 Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the step number where you want to start.

The sequence starts to execute. After the current step is finished, press the Next softkey to continue to the next step.

Sequence operating hint

For the HP 54656A RS-232 Test Automation Module, external switches can be used to substitute the three front-panel keys during execution of a sequence: Next, Previous, and Reset. See chapter 3, "Solutions," for further details on how to make your own external switches.

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To create a mask template using Automask

A mask template contains two limit lines: minimum and maximum. The Test Automation Module provides an easy way to create a mask. Automask allows you to generate a mask with tolerances from a signal on the screen.

1. Connect a known good signal to the oscilloscope.
2. Set up the oscilloscope with the settings that are required to test the signal.
3. Press `Display`, then toggle the `Grid` softkey to the off position.
4. Press `Print/Utility` twice.
5. Press the `Sequence Admin` softkey.
6. Press the `Define Automask` softkey.
7. Turn the knob closest to the Cursors key to select the mask number.
8. Press the `Tolerance` softkey, then turn the knob closest to the Cursors key to set the tolerance.
9. Press the `Create Mask` softkey to create the mask with the specified tolerance.

Tolerance operating hint

The tolerance used in Automask is expressed as a percentage of the full-scale time and voltage of the lowest number of all active channels. It does not represent the tolerance of the actual size of the input signal. To specify the tolerance as a percentage of the actual size of the input signal requires some additional calculations.

For example, a signal of 1 volt peak-to-peak is tested at a vertical sensitivity of 500 mV/div. The full-scale voltage equals the volts/div times the number of full-scale divisions (500 mV $\times$ 8 = 4 V). To specify a 4% tolerance on a 1 V peak-to-peak signal requires a 40 mV tolerance, but to specify a 40 mV tolerance on a full-scale voltage of 4 volts requires a 1% tolerance. Therefore, a 1% tolerance should be specified to generate the mask template.

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To create a mask template using Autostore

An envelop of the passing region can be generated using the Autostore function. Then the Automask function can read the autostore screen information and take the maximum and minimum limits of it as the limit lines of the mask template. This process allows you to create a mask template from a known good signal, allowing certain tolerance margins.

1. Connect a known good signal to the oscilloscope.
2. Set up the oscilloscope with the settings that are required to test the signal.
3. Press `Display`, then toggle the `Grid` softkey to the off position.
4. Press `Autostore`.
   Make sure that STORE is displayed in the status line. If STORE is not displayed, press `Autostore` again.
5. Set the voltage tolerance by moving the waveform up and down with the vertical position knob, creating a vertical envelop.
6. Set the time tolerance by moving the waveform back and forth with the horizontal delay knob, creating a horizontal envelop.
   You may need to repeat steps 5 and 6 to fine tune the envelop. Cursors can be used to accurately measure the margins.
7. Press `Print/Utility` twice.
8. Press the `Sequence Admin` softkey.
9. Press the `Define Automask` softkey.
10. Turn the knob closest to the Cursors key to select the mask number.

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11 Press the `Tolerance` softkey, then turn the knob closest to the Cursors key to set the tolerance to +/- 0.0%.

12 Press the `Create Mask` softkey to create the mask from the autostore information.

Automask using Autostore operating hint

The Automask function takes all the information displayed in half bright to create the mask. However, the display grid and the autostore information shares the same half-bright display. If the grid is turned on, and Autostore information is on the screen when the Create Mask softkey is pressed, a warning message is displayed: "Grid must be off to generate mask with Autostore." The Display Grid must be turned to off prior to creating the autostore data in order to use the Automask function. Turning the grid to off after the autostore data is created erases both the grid and the autostore data. Use of the cursors does not affect the Automask function and is highly recommended to ensure the proper testing margin in the autostore information.

If there is noise riding on the limit lines, you can use the smooth function in the mask editor to smooth out the noise.

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To create a mask using straight lines

The Test Automation Module has a built-in Mask Editor for creating or editing masks. It provides two editing tools: pixel editing and line drawing editing. The line drawing editing tool is used to create a mask using straight lines. To create the mask, you may want to first draw the mask on a piece of paper and mark the coordinates of the end points of each straight line.

1 Press `Print/Utility` twice.

2 Press the `Sequence Admin` softkey.

3 Press the `Mask Editor` softkey.

A softkey menu with five softkey choices appears. Four of them are related to the mask editing functions.

- `Edit Mask` Selects the mask number to be edited. Selection is made by turning the channel 1 position knob or by pressing the softkey. Each press increases the mask number by 1. Pressing the softkey when the mask number 40 is shown brings you back to 1.
- `Line Drawing - Mark and Connect` Mark and Connect are used for drawing straight lines in the mask. Their operation is explained later.
- `Smooth Mask` A running average of three pixels is used to smooth the mask. This is especially useful for smoothing a mask created by Automask which may contain noise.
- `Previous Menu` Returns you to the previous softkey menu.

4 To select the mask to be edited, turn the channel 1 position knob or press the `Edit Mask` softkey.

When your are changing the mask number, the mask corresponding to the current mask number is shown for easy identification.

5 Toggle the `Edit Line` softkey to select the limit line you want to edit.

6 Turn the Delay knob to move the X-coordinate of the cursor to the time corresponding to the first point.

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7 Turn the knob closest to the Cursors key to move the Y-coordinate of the cursor to the voltage corresponding to the first point.
8 Press the `Mark` softkey to mark this point as the first point of a line draw.
9 Turn the delay knob to move the X-coordinate of the cursor to the time corresponding to the second point.
10 Turn the knob closest to the Cursors key to move the Y-coordinate of the cursor to the voltage corresponding to the second point of the line.
11 Press the `Connect` softkey to draw the line.
12 Repeat procedures 5 through 11 for other lines.

Mask Editor operating hint

When you want to move the cursor to a particular location, it is essential to first move the X-coordinate of the cursor then the Y-coordinate. Otherwise, the movement of the Y-coordinate changes the position of a pixel at an undesired location.

After you press the Connect softkey, the two points are connected by a straight line. Points between the two end points are interpolated. However, if the voltage of a particular point during interpolation violates the rule of the voltage at the maximum limit ≥ voltage at the minimum limit, the voltage is set to the same value as the other limit.

After you have marked the first point, pressing the Mark softkey again cancels the previously marked point and starts the procedure over.

After you have connected the two points, pressing the Connect softkey again will undo the connect operation.

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To edit an individual pixel of a mask

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Mask Editor` softkey.
4. To select the mask to be modified, press the `Edit Mask` softkey, or turn the channel 1 position knob.
5. Toggle the `Edit Line` softkey to select the limit line that you want to edit.
6. Turn the Delay knob to move the cursor to the pixel that you want to modify.
7. Turn the knob closest to the Cursors key to edit the vertical position of the pixel.

Pixel editing operating hint

The time and voltage shown at the bottom of the screen corresponds to the current time base and vertical setting of lowest number of all active channels. If the mask is voltage and time dependent, make sure that the current time base and vertical setting are the same as the one that you are going to use during the actual testing.

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To edit the mask to test only a portion of a waveform

In certain testing, not all of the points on the waveform need to be tested. Only the area of interest needs to be tested. For example, to test the amount of overshoot of a pulse, you only need to test the portion of the waveform after the rising edge. By reducing the testing area, you can speed up the testing. You can select the test region by editing the shape of the mask template.

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Mask Editor` softkey.
4. Press the `Edit Mask` softkey, or turn the channel 1 position knob, to specify the mask that you want to edit.
5. Toggle the `Edit Line` softkey to select the limit line that you want to edit.
6. Turn the Delay knob to move the cursor to the starting location that you do not want to test.
7. Turn the knob closest to the Cursors key to move the voltage cursor until it reads Don't Care.
8. Press the `Mark` softkey.
9. Turn the Delay knob to move the cursor to the ending location of the region that you do not want to test.
10. Turn the knob closest to the Cursors key to move the voltage cursor until it reads Don't Care.
11. Press the `Connect` softkey.

This region of this particular limit line is not tested during mask testing.

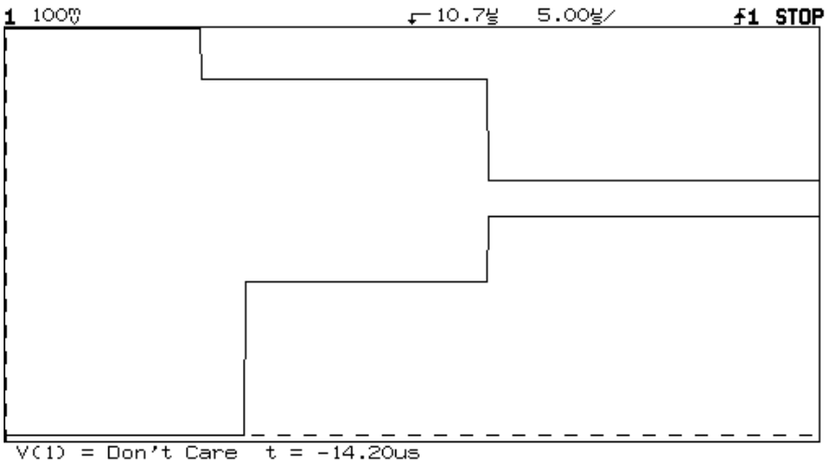
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Mask editing operating hint

Each limit line can have its own selectable test region. The testing time is generally proportional to the size of the test region.

Figure 5 shows a mask that tests the overshoot of the waveform. Note that only the part you are interested in is tested. The test region can be set individually for the maximum and minimum limit.

Figure 5



Example mask template with selectable test region

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To assign a testing mask to a step

Before using a testing mask in a test step, the mask must be created and stored in one of the forty mask memories.

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Define Sequence` softkey.
4. Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the step number for the testing mask number.
5. Press the `Use Mask` softkey.
6. Press the `Use Mask` softkey, or turn the knob closest to the Cursors key, to select the mask number for testing.

   Selecting the mask immediately assigns it to the selected step.

Mask Template Testing operating hint

When a mask template is used in a step, it compares the signal of the lowest number of all active channels against the mask template. For example, if channels 1, 3, and 4 are active, channel 1 is compared against the mask template; if channels 2, 3, and 4 are active, channel 2 is compared against the mask template.

Mask template testing cannot be used in conjunction with the delay sweep, roll mode, or math functions.

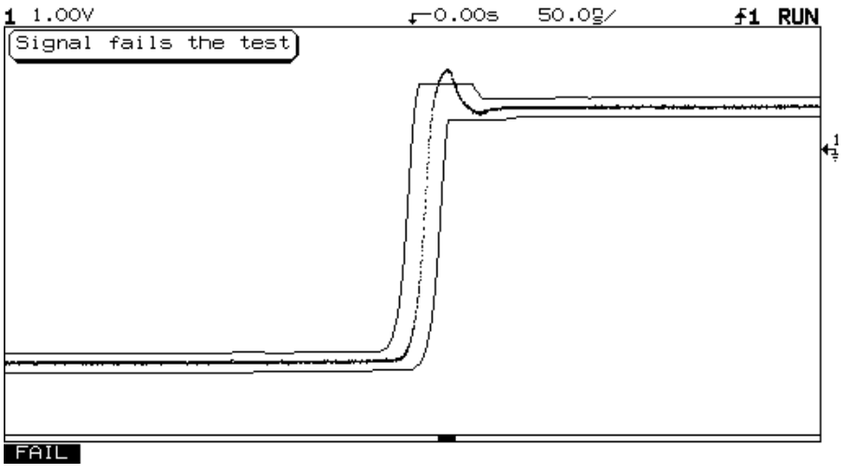
To use mask template testing in the XY mode, refer to the section "To use mask template testing in the XY mode" in this chapter.

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To spot the failure area

There is a fail zone indicator at the bottom of the screen when a mask is used in a step for testing. The fail zone indicator indicates where the signal fails either the maximum or the minimum limit. Figure 6 shows an example of a signal failing the test.

Figure 6



Example of a signal failing the mask

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To define action messages

In each sequence step, you can define three different action messages to prompt the operator. The action messages are displayed at the bottom of the screen according to the result of the mask template testing. If no mask template testing is used, the action messages are not displayed.

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Define Sequence` softkey.
4. Press the `Define Step` softkey.
5. Press the `Messages` softkey.

   A softkey menu with six softkey choices appears.

   - `Label` Defines the label of the step. The label is always displayed at the upper-left corner when the step is executed. It can be used to prompt the operator to perform a specific task such as connect the probe to a particular test point.
   - `Pass` Defines the message for passing the test. This message is displayed at the lower-left corner in blinking inverse video. It can be used to prompt the user to continue the sequence, or to affix a pass label to the device under test.
   - `Fail Min` Defines the message for failing the minimum limit. This message is displayed at the lower-left corner in blinking inverse video. It can be used to prompt the user to do a particular adjustment, to continue the sequence, or to affix a failure label to the device under test.
   - `Fail Max` Defines the message for failing the maximum limit. This message is displayed at the lower-left corner in blinking inverse video. It can be used to prompt the operator to do a particular adjustment, to continue the sequence, or to affix a failure label to the device under test.

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- `Default Messages` Sets all four messages in this step as the default. The default messages are :

Label	** Test #xx **
	(where the step number is filled in after the # sign).
Pass	PASS
Fail Min	FAIL
Fail Max	FAIL

- `Previous Menu` Returns you to the previous softkey menu.

6 Press the softkey corresponding to the message that you want to modify and the message edit screen appears.

7 Edit the message, then press the `Done` softkey when you are finished.

Refer to the section "To create a label for a front-panel setup" in this chapter for information on using the message editor.

8 Repeat procedures 6 and 7 until all modifications are finished.

The maximum length for action messages is 30 characters. When an action message does not contain any characters, nothing is displayed on screen.

Action Message operating hint

When the signal fails both maximum and minimum limit lines, the action message for Fail Min is displayed.

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To use a mask template for adjustment

A mask template can be used as the guideline, as well as for verifying an adjustment on a port on the device under test. For the purpose of adjustment, a good interactive display is important. This requires the maximum possible update rate. In the Test Automation Module, there is an Adjust mode for mask template testing. When the adjust mode is turned on, the Test Automation Module optimizes for maximum update rate. In order to achieve the maximum update rate, some of the displayed data may not be tested. The testing rate is maintained at an acceptable level for the interactive display of action messages. To turn on the adjust mode:

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Define Sequence` softkey.
4. Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the step number for the testing mask number.
5. Press the `Define Step` softkey.
6. Press the `Test Modes` softkey.
7. Toggle the `Adjust` softkey to turn on the adjust mode.

Adjustment operating hint

The Fail Min and Fail Max message can be used as a pair for prompting the operator for adjustment. For example, the adjustment of the output voltage from a power supply. When the signal fails the maximum limit, the operator needs to adjust the variable resistor in the clockwise direction. When the signal fails the minimum limit, the operator needs to adjust the variable resistor in the counter-clockwise direction.

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To set up the mask template testing for "Fail when In" testing

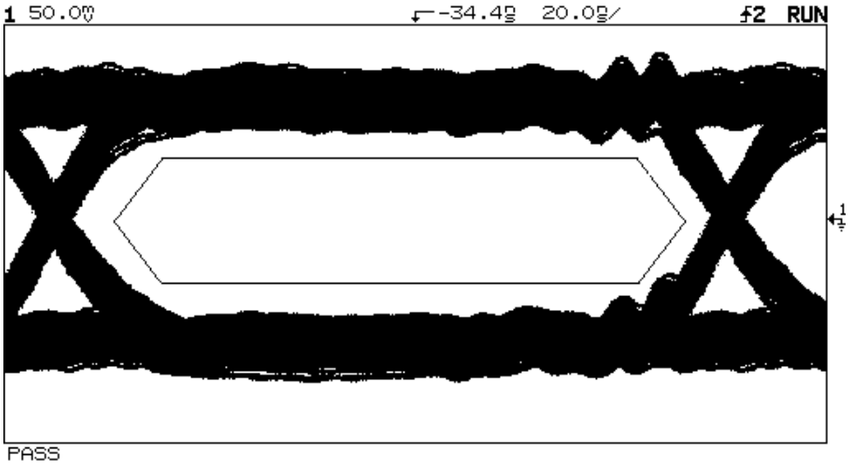
Normally, the mask template test signals pass when the signal lies inside the maximum and minimum limit. However, in certain cases, such as eye pattern testing, you may want to set up a region in which the signal fails the test when it lies inside this region. The Test Automation Module allows you to select the failure condition to be inside or outside the maximum and minimum lines.

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Define Sequence` softkey.
4. Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the step number for the testing mask number.
5. Press the `Define Step` softkey.
6. Press the `Test Modes` softkey.
7. Toggle the `Fail when` softkey to select `In`.

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When the failure condition of inside is selected, instead of displaying the two limit lines on the screen, the failure regions are displayed as enclosed polygons. Figure 7 shows an example of selecting inside as the failure condition.

Figure 7

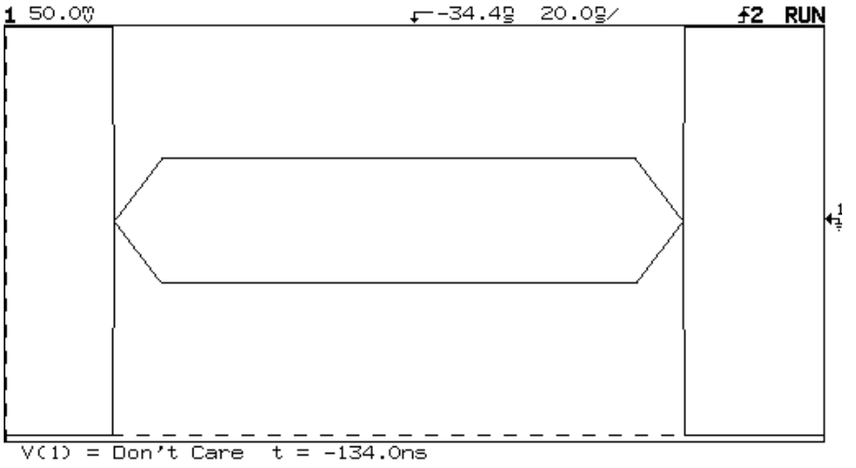


Example of selecting inside as the failure condition

The mask template for the inside failure condition is created and edited the same way as mask templates used for normal testing. When it is edited, two limit lines are displayed. Failure regions can be changed by editing the two limit lines. Figure 8 shows the two limit lines of the mask template shown in Figure 7.

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Figure 8



Limit lines of mask template shown in Figure 7

Mask Template for Inside failure condition operating hint

When selecting the failure condition to be inside, an extra requirement is placed on the mask template. The mask template can only do testing with both maximum and minimum limits present. Therefore, at a certain time bucket, if one of the two limit lines is set to be "Don't Care," this time bucket is not tested.

When the signal fails the test, the action message for Fail Min is displayed.

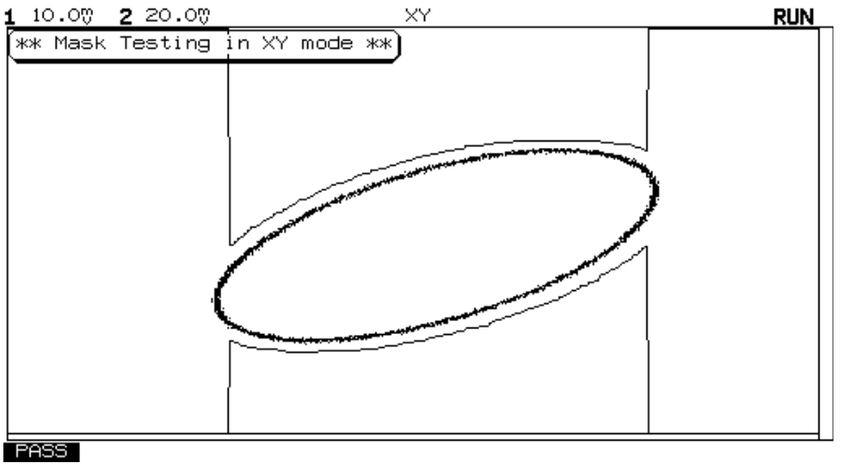
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To use mask template testing in the XY mode

The mask generated by the Automask or the mask editor can also be used to test signals in the XY mode. However, there are a couple of things that you should be aware of:

- The display width in the XY mode is a little bit wider than the normal mode. Therefore, the mask cannot cover the whole width of the screen in the XY mode. Approximately 2.5% of the screen at the right side is not tested against the mask. It is recommended that you avoid the use of the right side of screen. Figure 9 shows an example of a mask template used in the XY mode.
- In the XY mode, the Adjust mode setting has no effect. It is always turned on in order to optimize the update rate of the XY mode.

Figure 9



Example of a mask template used in the XY mode

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To define the output lines (HP 54656A only)

The HP 54656A RS-232 Test Automation Module has five output lines in its I/O jack. These output lines can be used to drive a lamp, a LED, a counter IC, or a switch to perform various tasks required for testing. Chapter 3, "Solutions," has some examples on how to use the output lines.

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Define Sequence` softkey.
4. Press the `Step` softkey, or turn the cursor knob, to select the step number to be defined.
5. Press the `Define Step` softkey.
6. Press the `Outputs` softkey.

   A softkey menu with six softkey choices appears. The first five are used to define the output lines. The `Previous Menu` softkey returns you to the previous softkey menu.

   For each `Output` softkey, the current setting of the corresponding output line is highlighted. There are eight different settings for each output line.

   - `OFF` The output line remains low all of the time when this step is executed.
   - `ON` The output line remains high all of the time when this step is executed.
   - `START` When this step starts to execute, the output line goes high for 1 ms, then back to low for the rest of this step.
   - `END` The output line remains low until the end of this step. At the end of this step, the output line goes high for 1 ms, then back to low again.

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- `PASS` If no testing mask is defined in this step, the output line remains low all during this step. If a testing mask is defined, the output line goes high if the test passes and remains low if the test fails.
- `FAIL` If no testing mask is defined in this step, the output line remains low all during this step. If a testing mask is defined, the output line goes high if the test fails and remains low if the test passes.
- `Fail Min` If no testing mask is defined in this step, the output line remains low all during this step. If a testing mask is defined, the output line goes high if the testing signal fails the minimum limit line and remains low if it passes the minimum limit line.
- `Fail Max` If no testing mask is defined in this step, the output line remains low all during this step. If a testing mask is defined, the output line goes high if the testing signal fails the maximum limit line and remains low if it passes the maximum limit line.
- The default values for the output lines in each step are:

Output 1	PASS
Output 2	FAIL
Output 3	OFF
Output 4	OFF
Output 5	OFF

7 Press the softkey corresponding to the output line that you want to change until the desired output mode is shown.

8 Repeat step 7 until all of the output lines are modified to your needs.

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To create a branching sequence

Each sequence step can be branched to different steps depending on the result of the mask testing.

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Define Sequence` softkey.
4. Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the step number to be modified.
5. Press the `Define Step` softkey.
6. Press the `Branching` softkey.

   A softkey menu with five softkey choices appears. Four of them are used to define branching.

   - `Pass, Fail Min, Fail Max` Selects the branching destination for different test results: pass, fail minimum limit, or fail maximum limit. The destination step is selected by turning the knob closest to the Cursors key. Possible selections are step number, Next, or Same.
   - `Default Branching` Sets the branching destination for all test results to Next.
   - `Previous Menu` Returns you to the previous softkey menu.
7. Press the branching destination softkey corresponding to the test result.
8. Turn the knob closest to the Cursors key to change the branching destination.

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Step Branching operating hint

In the case where no testing mask is specified in a particular step, the module always treats the test result as PASS and branches to the step specified in the pass condition.

The "Same" setting in the branching destination branches back to the same step. This allows you to repeat a step until a certain test result is found. For example, if the branching destination of Fail Min and Fail Max are both set to "Same," the sequencing does not branch to another step unless the signal passes the test or the operator aborts the sequencing by pressing the Reset or Stop Sequencing softkey.

If the signal fails both minimum and maximum limit lines, the branching path corresponding to Fail Min is chosen.

When the fail region is defined as "In," the branching path corresponding to Fail Min is selected for a failure condition.

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To prevent the operator from changing the setup

Once the setups for each measurement step are properly set up, you may not want the operator to change anything in the setup, especially when the mask is related to a particular sensitivity and position setting. However, in some other situations, you may want the operator to make fine adjustments to fit the signal inside the testing mask. This is especially true with a mask that tests the shape of the signal but not the absolute amplitude. The Test Automation Module allows you to choose three different levels of operator permission.

- `All` Allows the operator to change all of the setups in this step. All the knobs and keys can be operated by the operator.
- `Adjust` Allows the operator to operate the following knobs: Delay, Time/Div, Volts/div, Position, and the softkeys. All of the other menu keys are disabled. This allows the operator to fine adjust the fit of the signal inside the mask. The Volt/Div and Time/Div verniers can be turned on in the setup for fine adjustments.
- `None` The operator is not allowed to change the setup. All of the knobs and keys except the softkeys and the knob closest to the Cursors key are disabled.

1 Press `Print/Utility` twice.

2 Press the `Sequence Admin` softkey.

3 Press the `Define Sequence` softkey.

4 Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the step number that you want to modify.

5 Press the `Define Step` softkey.

6 Press the `Test Modes` softkey.

7 Press the `Permit` softkey until the desired access ability is shown.

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Permit operating hint

Different levels of permit can be set for different steps of a sequence. To allow the operator to make fine adjustments to fit the signal into the mask, specify the permit to be Adjust. Only knobs in the vertical and horizontal system can be accessed by the operator. The vernier mode of either the vertical or horizontal system may be turned on prior to saving the setup. Then, the operator can have fine adjustment on either the vertical or horizontal directions to fit the signal into the mask.

If the operator accesses keys or knobs that are disabled, the warning message "Access not permitted" is displayed.

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To view the configuration of a sequence step

1 Press `Print/Utility` twice.

2 Press the `Sequence Admin` softkey.

3 Press the `Define Sequence` softkey.

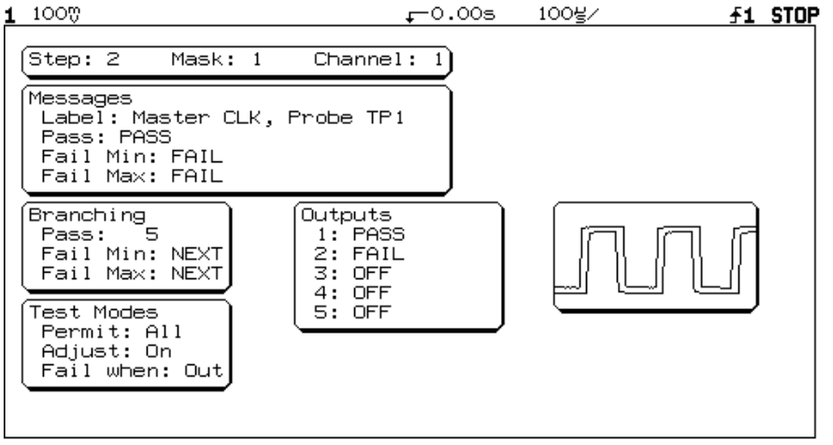
4 Press the `Step` softkey, or turn the knob closest to the Cursors key, to select the step that you want to see.

5 Press the `Show Step` softkey to show the configuration of the step.

An example of the result of show step is shown in figure 10.

6 To view the configuration of another step, turn the knob closest to the Cursors key to scroll through the steps.

Figure 10 **Sequence step configuration**



7 To stop viewing a configuration, press `Erase`.

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Show Step operating hint

The picture of the mask displayed by Show Step is 25% of the size of the original mask. Due to limited display resolution, small details of the mask may be omitted. To examine the mask in more detail, use the Mask Editor.

For documentation of the current step, connect a hard copy device to the oscilloscope and perform a print screen.

The step label can contain up to 60 characters. However, due to limited space, only the first 50 characters are shown in the Show Step operation.

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To copy a step or a mask

To edit the sequence of steps in a sequence, use the copy function in the Test Automation Module. This allows you to copy a step or a mask from one location to another. This can help you organize the sequence.

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Copy Step/Mask` softkey.

   A softkey menu with six softkey choices appears. Four of them are related to copying a step or a mask.

   - `Type` Selects the type of information to be copied. It can be either a step or a mask.
   - `Source` Selects the source step or mask number to be copied.
   - `Dest` Selects the destination where the step or mask will be copied.
   - `Copy` Starts the copy.
   - `Default Dest` Sets the step or mask specified in the Dest softkey to the default value.
   - `Previous Menu` Returns you to the previous softkey menu.
4. Toggle the `Type` softkey to select copying a step or a mask.
5. Press the `Source` softkey. Then press the Source softkey, or turn the knob closest to the Cursors key, to select the source number.
6. Press the `Dest` softkey, then press the Dest softkey, or turn the knob closest to the Cursors key, to select the destination number.
7. Press the `Copy` softkey to start the copy.

   After the copy is finished, a message "Step X copied to step y" or "Mask X copied to mask Y" is displayed.

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To set a step or mask to default values

1. Press `Print/Utility` twice.
2. Press the `Sequence Admin` softkey.
3. Press the `Copy Step/Mask` softkey.
4. Toggle the `Type` softkey to select a step or a mask.
5. Press the `Dest` softkey.
6. Press the `Dest` softkey, or turn the knob closest to the Cursors key, to select the number of the step or mask.
7. Press the `Default Dest` softkey to set the step or mask to its default values.

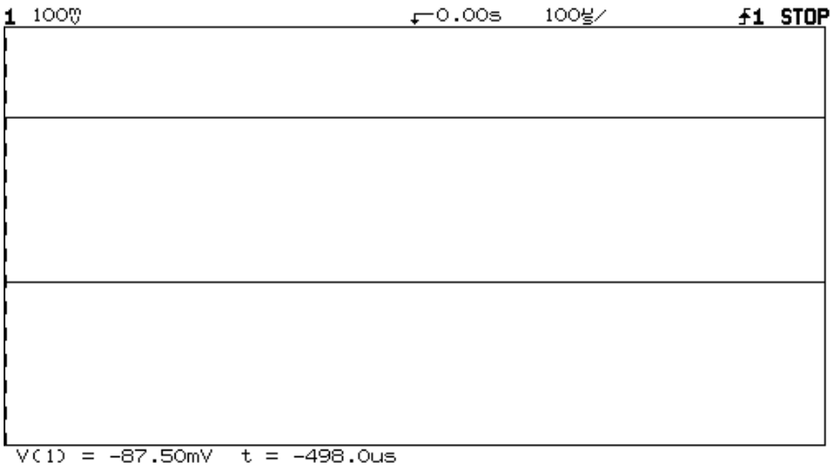
   The default settings of a step are:

Mask	None	**Branching**	
Test Mode		Pass	Next
Adjust Mode	On	Fail Min	Next
Permit	All	Fail Max	Next
Fail when	Out	**Outputs**	
Message		1	PASS
Label	** Test #XX **	2	FAIL
Pass	PASS	3	OFF
Fail Min	FAIL	4	OFF
Fail Max	FAIL	5	OFF

Figure 11 shows the default settings for a mask.

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Figure 11



Default setting for a mask template

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To set all of the steps and masks to default values

1. Press and hold the third softkey from the left on the oscilloscope.
2. Turn the oscilloscope off.
3. Turn the oscilloscope on.
4. When the message "Keydown power up executed" appears on the oscilloscope screen, release the softkey.

   The table on page 54 lists the default settings for each step. Figure 11 shows the default settings for a mask.

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To backup and duplicate sequences

To duplicate a sequence from one oscilloscope to another, or to backup a sequence, you must use an instrument controller. The instrument controller can read the learn string of the entire sequence setup from an oscilloscope and save it in memory or write it to another oscilloscope. See chapter 4, "Test Sequencing Programming" for information on reading the learn string and sending it to another oscilloscope.

The HP 54653A ScopeLink 2.0 software supports the backup and duplication of sequences as well. See chapter 6, "HP 54653A ScopeLink 2.0 Software" for detailed information.

Module operating hint

All the configuration of the sequences including the masks are stored inside the nonvolatile memory in the module. The module can be detached from one oscilloscope and attached to another oscilloscope of same model without losing any configuration. In some situations, you can even carry multiple modules with you, each having a different test sequence for a particular test. Then you can easily change the modules to configure the oscilloscope for different testing tasks.

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To protect sequences through the communication port

Sequences can be protected through the communications port by issuing a SEQUENCE:PROTECT ON command. Once the test sequence is protected, a warning message "Sequence Admin Protected" is displayed when the Sequence Admin softkey is pressed. The protection can be disabled by issuing the SEQUENCE:PROTECT OFF command through the communication port. See chapter 4, "Test Sequencing Programming" for more information on these commands.

HP 54653A ScopeLink sequence protection

For your convenience, the HP 54653A ScopeLink 2.0 software can also protect sequences by sending the proper command to your oscilloscope. For more information, see chapter 6 "HP 54653A ScopeLink 2.0 Software."

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To protect sequences with the recessed switch (HP 54656A only)

The HP 54656A RS-232 Test Automation Module has a small recessed switch between the 9-pin RS-232 connector and the RJ-45 output lines connector. Flipping the switch towards the label side of the module protects the sequences from being changed by the operator. When the Sequence Admin softkey is pressed with the protection on, a warning message "Sequence Admin Protected" is displayed.

When you want to edit the sequence again, flip the switch away from the label side to regain access to the Sequence Admin menu.

To protect the sequences

Once the whole test sequence and masks are properly set up, you may not want to have any other people change it. Protection of the test sequence and the mask templates are provided by both modules. Note that the protection does not include the protection of the two nonvolatile trace memories in the module.

For the HP 54656A RS-232 Test Automation Module, the protection is in effect when either the recessed switch is flipped to the protected position or the protection command is issued through the RS-232 port.

A small piece of sealing label can be used to cover the small opening that accesses the protection switch. A more complete protection can be accomplished by sending commands to the Test Automation Modules through the communication ports.

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To document a single step

A single step can be documented by displaying the contents of the step on the screen and performing a print screen to the printer. This does not require the use of an instrument controller.

1. Set up the interface to output to a printer.

   See "To configure the interface" in this chapter for details on setting up the output for a printer.

2. Press `Print/Utility` twice.
3. Press the `Sequence Admin` softkey.
4. Press the `Define Sequence` softkey.
5. To change the step number to be documented, press the Step softkey, or turn the knob closest to the Cursors key, until the desired step number appears under the `Step` softkey.
6. Press the `Show Step` softkey.
7. Press `Print/Utility` twice to return to the root level of the softkey menu tree.
8. Press the `Print Screen` softkey to dump the current screen to the hard copy device.

Single step documentation hint

The mask shown on the screen is 25% of its original size. Small details of the mask may be omitted due to insufficient resolution. For full size documentation of the mask, the HP 54653A ScopeLink software 2.0 and a PC or compatible computer is required. See chapter 6, "HP 54653A ScopeLink 2.0 Software" for information on performing the documentation.

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3

Solutions

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Introduction

This part of the manual provides information on how to solve your specific problems using the Test Automation Modules.

This chapter contains solutions that fall into four different categories:

- Solutions on how to create a mask template for testing a particular characteristic of a signal.
- Solutions on how to use the input/output lines on the HP 54656A RS-232 Test Automation Module.
- Solutions on how to optimize the performance of mask template testing.
- An example of a test sequence.

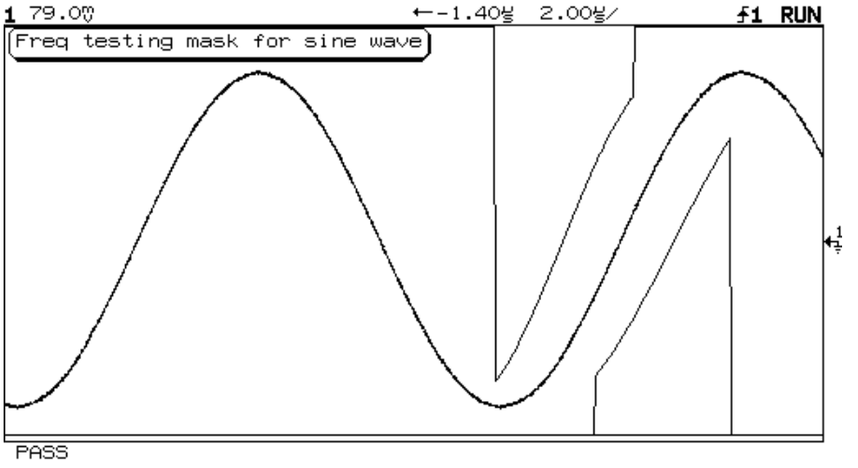
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Creating a frequency testing mask

A mask can be used to test the frequency of the input signal. The shape of the mask varies depending on the shape of the signal to be tested. A mask designed for testing a sine wave cannot be used to test a square wave. Different masks are needed for different shapes of signals. Using the calibrated vertical vernier, position, and time base of the HP 54600-series oscilloscope, a mask can be reused to test signals of similar shapes but different frequencies and amplitudes.

To test the frequency of the signal, the period of the signal is tested instead of actually measuring the frequency. The test can be conducted by triggering on an edge of the signal and testing for the location of the second edge. An example mask is shown in the following figure.

Figure 12



Example mask for testing the frequency of a sine wave

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The following procedure can be used to setup a mask template for testing the frequency of a sine wave or a square wave. Similar methods can be used to generate masks for testing the frequency of signals of other shapes. In the oscilloscope setup, the vertical sensitivity and position should be adjusted so that the amplitude is almost full scale. The trigger level should be adjusted to the middle of the input signal. The mask template can be created by using a function generator to generate a signal of variable frequency but of similar shape and amplitude to the one that is going to be tested.

1. Connect the output of a function generator to the oscilloscope.
2. Set the function generator to generate a waveform with a similar shape to the one that you are going to test.
3. Adjust the amplitude of the output until it is similar to the signal that you are going to test.
4. Press `Time` on the oscilloscope, then press the `Freq` softkey to turn on the automatic measurement for frequency.
5. Adjust the frequency of the output of the function generator to the lower test limit.

   The frequency can be verified by the automatic measurement.
6. Press `Autostore`.
7. Adjust the frequency of the output of the function generator to the upper test limit.

   An envelop of the test limit is generated.
8. Create a mask in the Define Automask menu with a tolerance of 0.0%.

   For more information, refer to "To create a mask template using Autostore" in chapter 2.
9. Specify your test region in the Mask Editor menu.

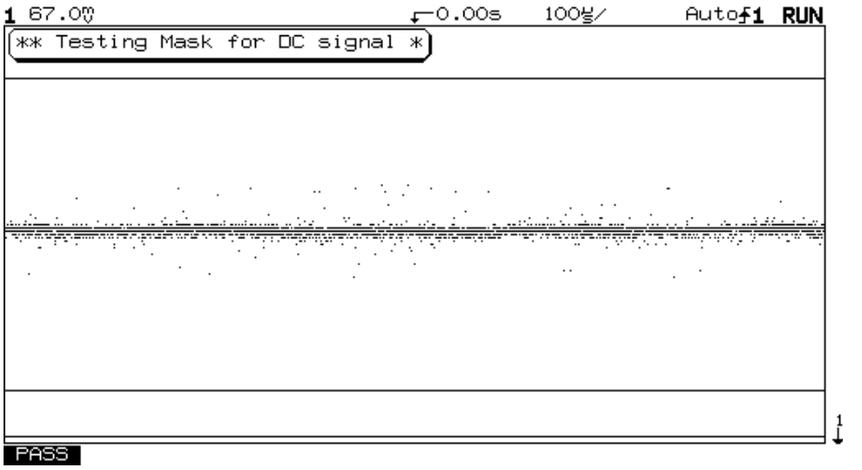
   A smaller horizontal test region has a faster testing speed.

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Creating a DC voltage testing mask

A mask can be used to test the proper voltage of a DC signal. The shape of the mask is very simple: just two horizontal straight lines. By varying the Volts/div knob and the position setting, the same DC voltage testing mask can be used to test any DC signals. To create the DC testing mask, you must have the testing limits. The testing limits are the upper voltage limit and the lower voltage limit. To maximize the accuracy, the two limit lines should cover as much vertical resolution as possible. Due to the calibrated vertical verniers and vertical position of the HP 54600-series oscilloscopes, the Volts/div can be expanded in small increments and remain calibrated. An example mask is shown below.

Figure 13



Example mask for testing the voltage of a DC signal

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In order to maximize the vertical accuracy, the upper limit line should be located approximately one division below the top of the screen. Similarly, the lower limit should be located approximately one division above the bottom of the screen.

Example

The following example creates a mask to test a 5 volt signal with an upper limit of 5.2 volts, and a lower limit of 4.8 volts.

1. Set the vertical sensitivity.

   In this case, the difference between the upper and lower limit is 0.4 volts. Separation between the upper and lower limit is six divisions. Therefore, the sensitivity of the oscilloscope is set to 67 mV/div (0.4 volts / 6 divisions).

2. Set the vertical position.

   The center of the screen is at 5 volts ((5.2 + 4.8) volts / 2). So, the position setting for this test is –5 volts.

3. Create the mask.

   Use the cursor readout of the voltage and the line drawing capabilities of the mask editor to draw two lines: one at 5.2 volts and the other at 4.8 volts.

DC voltage testing hint

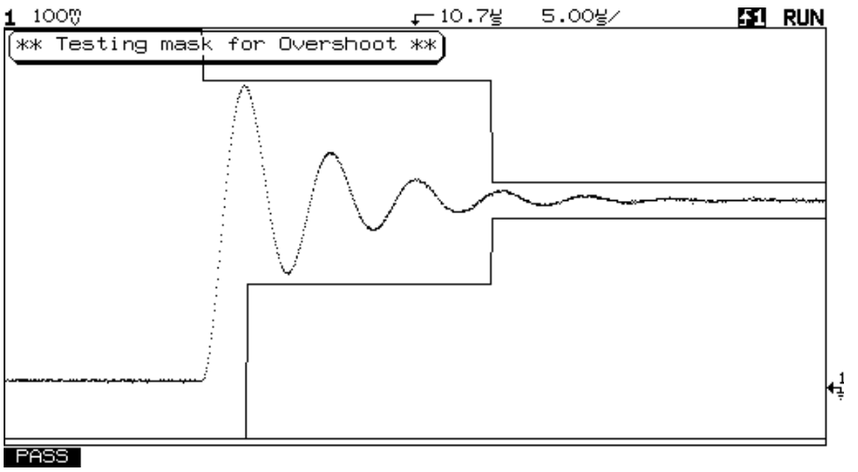
When testing a DC voltage using a mask, be aware of the probe that you are using. Remember to have the probe factor in the scope set up correctly. Also, when a x1 probe is used for volts/div less than 200 mV/div, the maximum offset is only 2 volts. A x10 probe is recommended for testing. This probe can give you at least 20 volts offset even in the most sensitive setting.

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Creating an overshoot testing mask

There are two parameters associated with the overshoot of a signal: the percentage of overshoot and the settling time of the overshoot. A mask template can be created to test the upper limit of these two parameters at the same time. Figure 14 shows an example of a mask template for testing overshoot.

Figure 14



Example of a mask template for testing overshoot

The critical factors for creating the mask template are:

- To optimize testing speed, the information on the signal before the rising edge should not be tested since it is not required for overshoot testing.
- The vertical window of the middle region of the mask template determines the upper limit of the overshoot.
- The horizontal window of the middle region determines the upper limit of the settling time.
- The vertical window of the rightmost region determines the settling window. Normally, the settling window is ±5% or ±10% of the V top voltage.

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Creating a rise time testing mask

Mask template testing can be used to test the rise time of a signal, including specifying an upper limit for rise time. For example, you can specify that the rise time must be 15 ns or faster to pass the test.

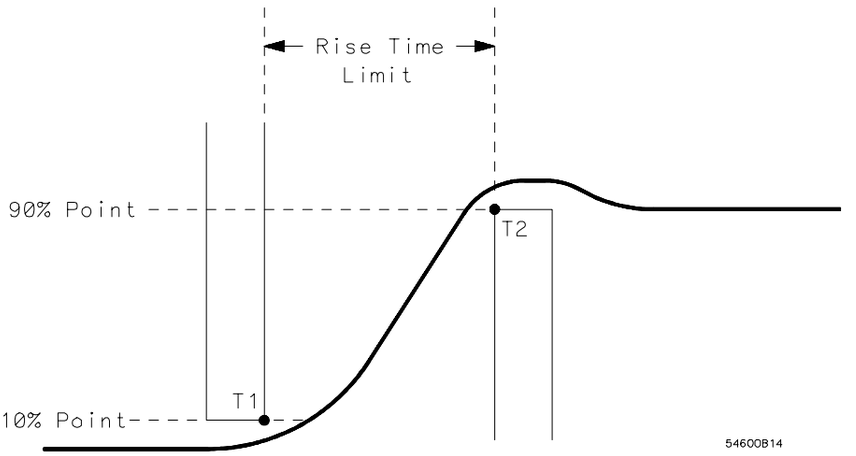
1. **Determine the top and base of the signal.**

   Use the automatic measurement `V top` and `V base` of the oscilloscope to determine these values.

2. **Calculate the 10% and 90% points.**
3. **Determine the upper limit for the rise time.**
4. **Draw the mask template using the mask editor.**

   The mask should look similar to the one in figure 15. Use the voltage and time read outs of the mask editor to ensure the correct settings. In the figure 15, T1 and T2 are the critical points for determining the maximum rise time limit (Rise time limit = T2 - T1).

Figure 15



Rise time testing mask

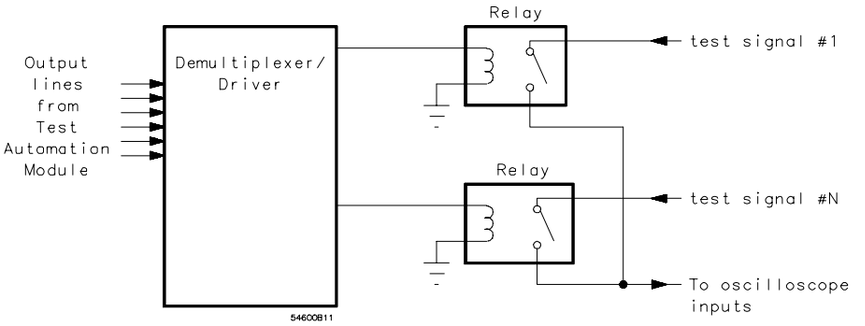
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Toggling switches in the test fixture (HP 54656A only)

The user-definable output lines of HP 54656A can be used to toggle switches in the test fixtures. The output lines of HP 54656A can be configured to drive both level sensitive or edge sensitive switching units. A demultiplexer or a counter IC with a demultiplexer can be used to extend the driving capabilities of HP 54656A to more switching combinations.

For level sensitive switching units, define the corresponding output lines to be always on or always off in a particular step to toggle the switches in the test fixture to test the corresponding signals.

Figure 16

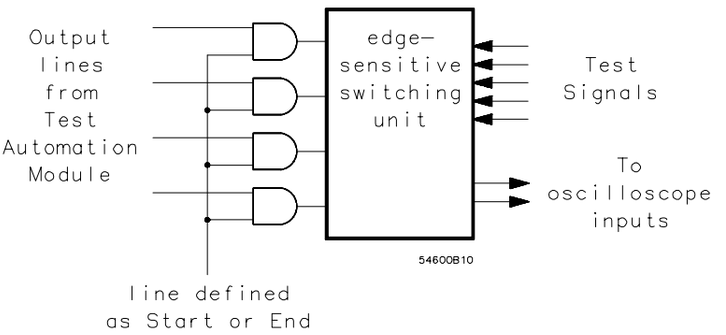


Example of a circuit for controlling switches in a test fixture using a level sensitive circuit

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For edge sensitive switching units, the corresponding output lines should be defined as always on or always off according to the combination required. These signals should be ANDed with an output line defined as an edge at the start of the step. Thus, edge signals are generated for edge sensitive devices.

Figure 17



Example of a circuit for controlling switches in a test fixture using an edge sensitive circuit

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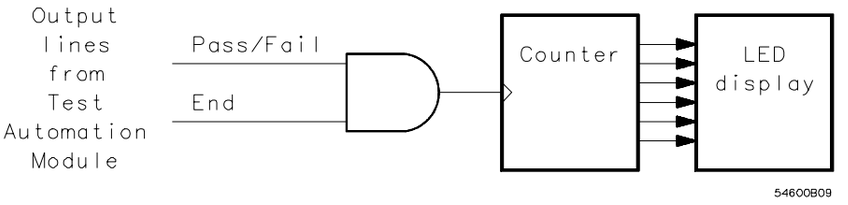
Counting the numbers of units passing or failing (HP 54656A only)

The external output lines from an HP 54656A can be used to count the number of tests, the number of units passing, and the number of units failing.

A simple counter IC can be used to count the number of occurrences. Normally, a counter IC requires an edge for counting. The counter counts the results of the testing when the operator hits the Next switch.

The Output line, which is defined as Pass or Fail, should be ANDed with another output line defined as END in order to serve as the input to the counter IC.

Figure 18



Example of a circuit for counting the occurrence of pass or fail using the output lines

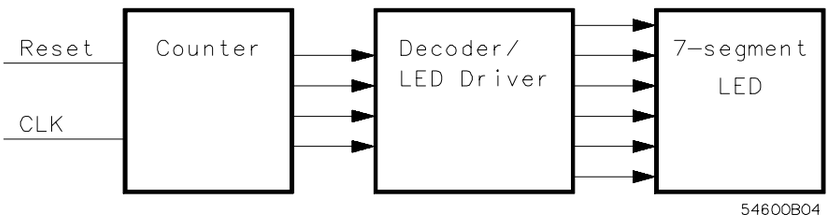
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Displaying the sequence steps through the output lines (HP 54656A only)

Sometimes, it is convenient to display the step number in a remote unit hosting the Next and Reset key. This can be achieved by a simple circuit which uses the user-definable output lines.

Two output lines can be used to drive a simple circuit consisting of a counter IC, LED driver, and a seven-segment LED. A sample circuit is shown in the following figure.

Figure 19



Example circuit for displaying the sequence step number using the output lines

Output line 1 is used as a reset signal to the counter. Output line 2 is used to drive the counter when a step is executed. The counter in turn drives the LED driver and the sequence step number is displayed on the seven-segment LED.

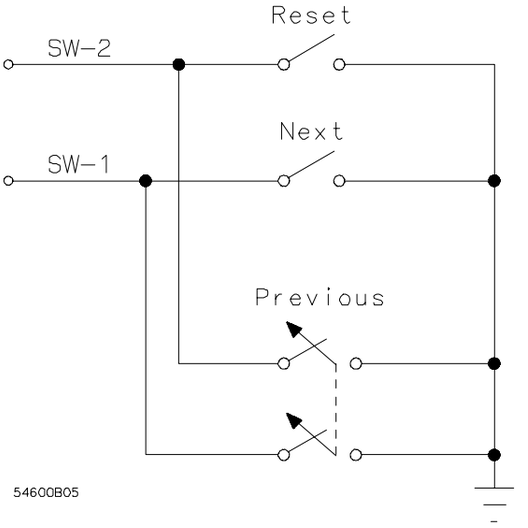
If additional output lines are available, they can be toggled on and off to drive the decoder/LED driver directly without using a counter. A maximum of 32 combinations can be generated by the five output lines.

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Implementing external switches through the input lines (HP 54656A only)

The HP 54656A RS-232 Test Automation Module can be controlled remotely through the two input lines. By using multiplexing, three functions can be achieved by these two input lines: Next, Reset, and Previous. The following circuit diagram shows you how to connect these two lines to passive circuits to perform the three functions.

Figure 20



Example circuit for using input lines to implement external switches

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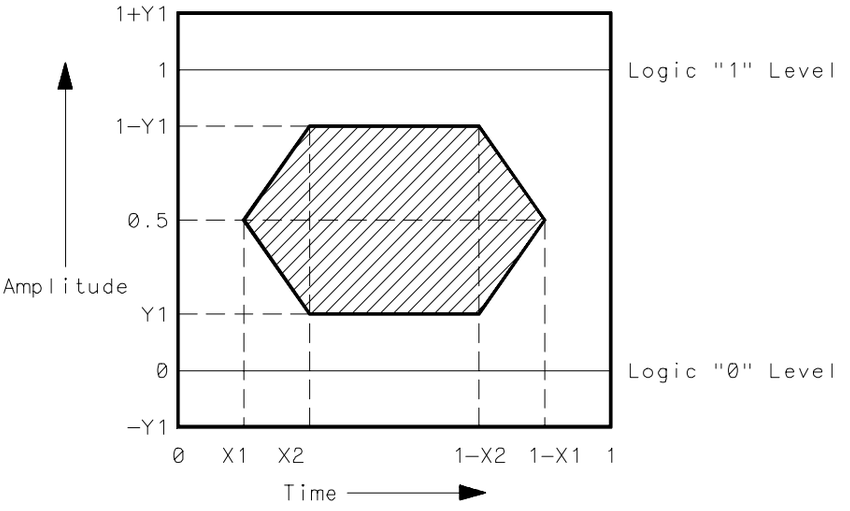
Testing the eye opening of an eye pattern signal

There are generally two tests that you want to perform on an eye pattern signal: an eye boundary test and an eye opening test. Since the eye boundary can be easily tested by using normal mask template testing, this section mainly focuses on how to create the mask for testing the eye opening.

A fail region in the shape of a hexagon is usually used to test the eye opening. Figure 21 shows an example of the shape of the mask.

Example of the definition of an eye-pattern testing mask

Figure 21



X1	X2	Y1
0.15	0.35	0.20

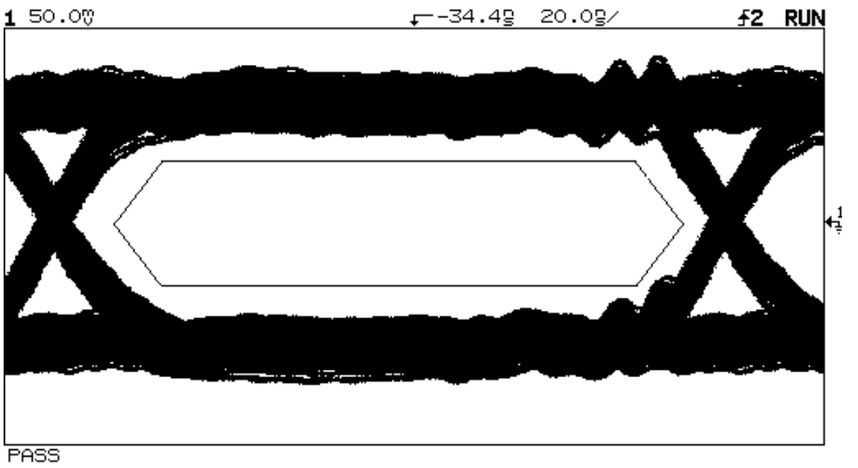
54600B12

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1 Set up the oscilloscope for proper viewing of the eye-pattern signal.
2 Determine the fail region.
3 Create the mask using the line drawing capabilities of the mask editor.

   The voltage and time readouts in the mask editor can be used to ensure the correct shape and position of the mask. Figure 22 shows how the mask template looks during testing.
4 Select the fail region as Inside of the mask template.

Figure 22



Example of a mask template used for eye-opening testing

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Optimizing the mask testing speed

The mask testing speed can vary with different setups of the oscilloscope and the size of the test region.

Proper oscilloscope setup

Certain features in the oscilloscope slow down the mask testing speed considerably. For maximum testing speed, the following settings should be avoided:

- Averaging.
- Time base vernier with time base settings at 1 µs/div or faster.
- Time base at 2 ns/div.

Horizontal test region

In a lot of cases, you are only interesting in testing a part of a waveform. For example, you do not need to test the full cycle of a waveform to test the overshoot of the waveform. In these cases, the mask can be defined so that only the portion that is required is tested. The testing speed is generally proportional to the number of points tested. Refer to the section "To edit the mask to test only a portion of a waveform" in chapter 2 for information on how to create the selectable test region.

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Optimizing the mask testing accuracy

The testing accuracy can be divided into two parts: vertical accuracy and horizontal accuracy.

Vertical accuracy

The HP 54600-series oscilloscopes have fully calibrated vertical verniers. To achieve the highest accuracy, the vertical sensitive should be placed in the vernier mode and adjusted so that the input signal occupies the entire screen (full scale).

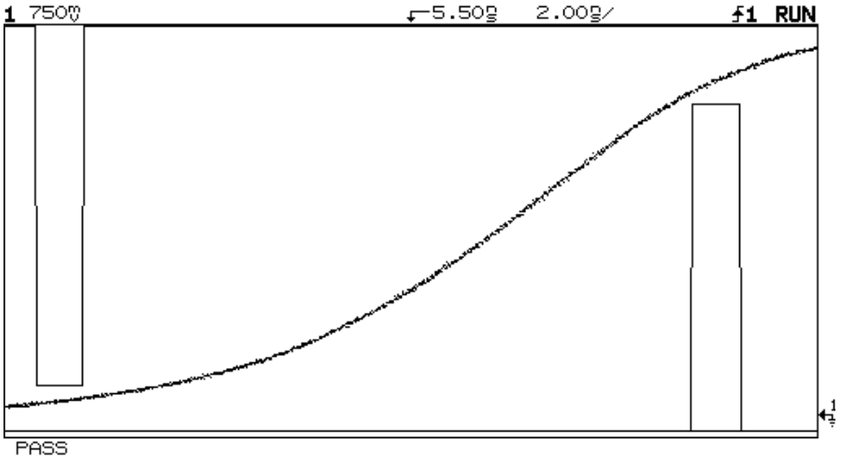
For testing a DC signal, use the fully calibrated position control to get rid of the dc component. With a x10 probe, a maximum of 20 volts of calibrated offset can be used even at the most sensitive setting.

Horizontal accuracy

The HP 54600-series of oscilloscopes have fully calibrated time base verniers. For testing time related parameters such as frequency and rise time, it is recommended that the portion of the signal that contains the parameter occupies approximately the whole screen width. Figure 23 shows how to set up the oscilloscope to test rise time.

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Figure 23



An example of an oscilloscope setting for testing rise time

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Storing multiple sequences for multiple devices

The Test Automation Module can store 100 sequence steps and 40 mask templates. In most cases, a test sequence uses less than 100 steps and 40 mask templates. Therefore, you can store multiple sequences in one Test Automation Module for testing multiple devices.

The guideline for storing multiple sequences is that each sequence resides in its own section. An extra header step is added to each sequence. The header step should contain the following information:

- A label that clearly identifies the corresponding test sequence for the header step.
- The pass branching which should branch to the first step of the corresponding test sequence when the header step is selected.

These header steps should be placed together at the beginning of the sequencing memory, from step 1, like a table of contents. When the operator wants to start one of the sequences in the module, the following procedure should be performed.

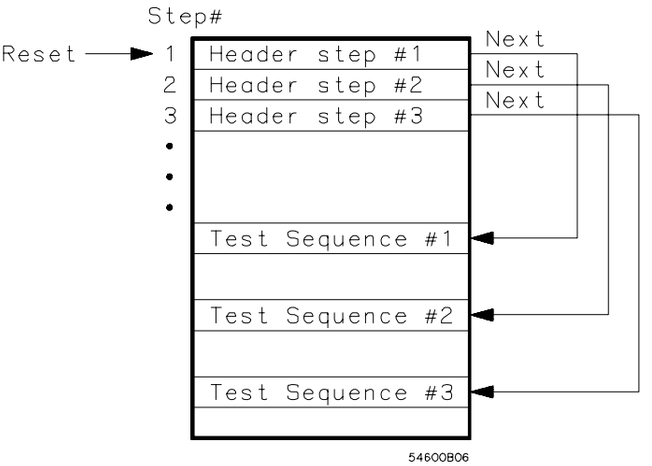
1. Press `Setup`.
2. Press the `Sequence Menu` softkey.
3. Press the `Reset` softkey to reset the step number to 1.
4. Press the `Step` softkey, or turn the knob closest to the Cursors key, until the header step of the desired sequence appears.

   Since all of the first steps of the sequences are gathered around the top of the module's memory, you can easily scroll through them and find the one that you want to execute.

   The figure 24 shows how to place the sequences in the module's memory.

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Figure 24



Memory usage in implementing multiple sequences

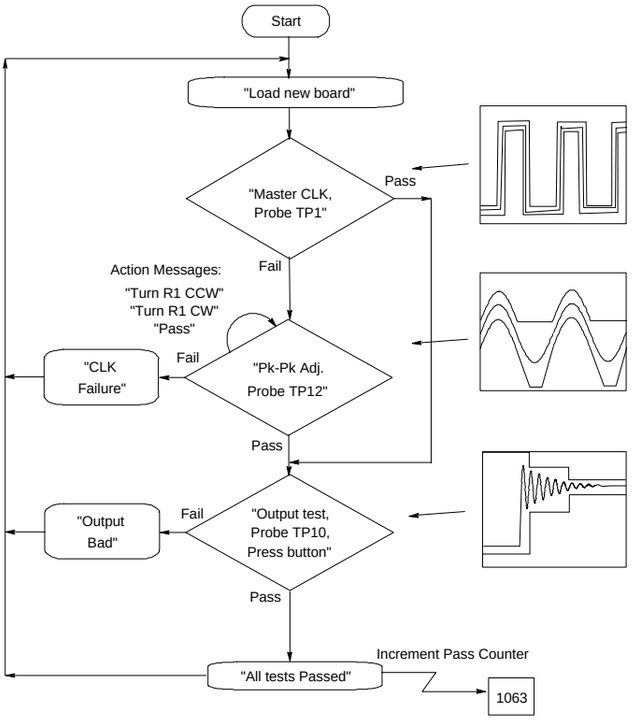
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Test sequence example

This example uses the HP 54654A Operator's Training Kit. A test sequence is set up to test various signals on the board. This includes testing two signals and conditionally performing one adjustment. First, the example test sequence tests whether the master clock has the correct amplitude and frequency. If the master clock fails the test, an adjustment should be performed. If the adjustment cannot be made, the board is declared a failure.

Finally, the example tests the overshoot of an output signal on the board. The test sequence is shown in the following flow chart.

Figure 25

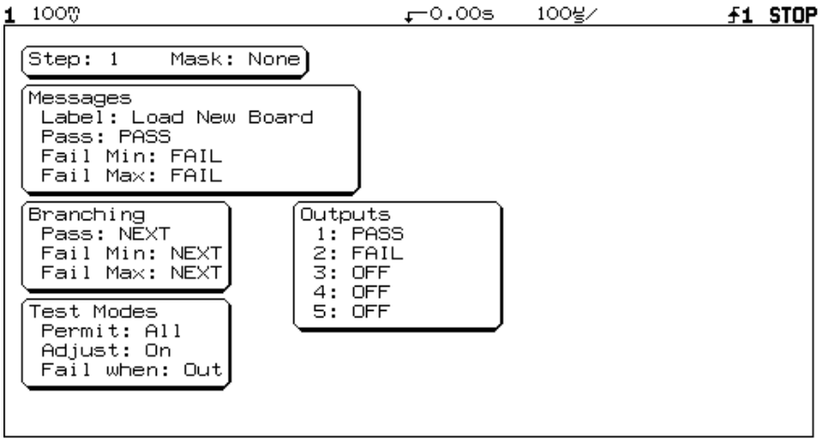


Flow Chart of the test sequence example

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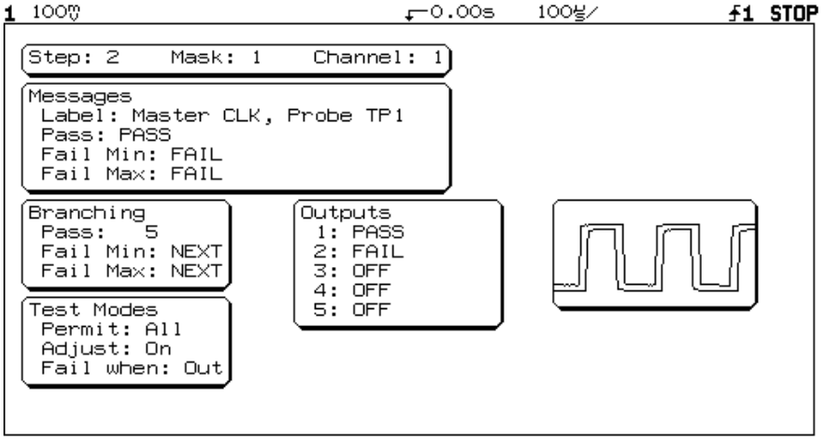
The testing sequence can be implemented in the Test Automation Module. All together, 7 steps and 3 mask templates are required. Each step is documented below.

Figure 26



Documentation of step #1

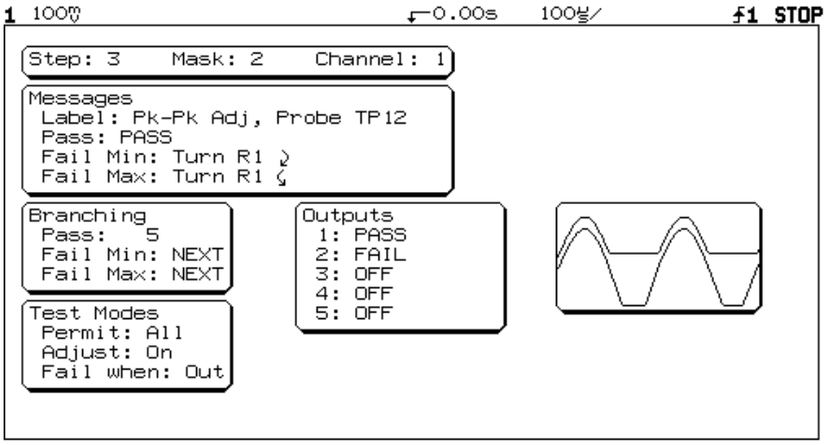
Figure 27



Documentation of step #2

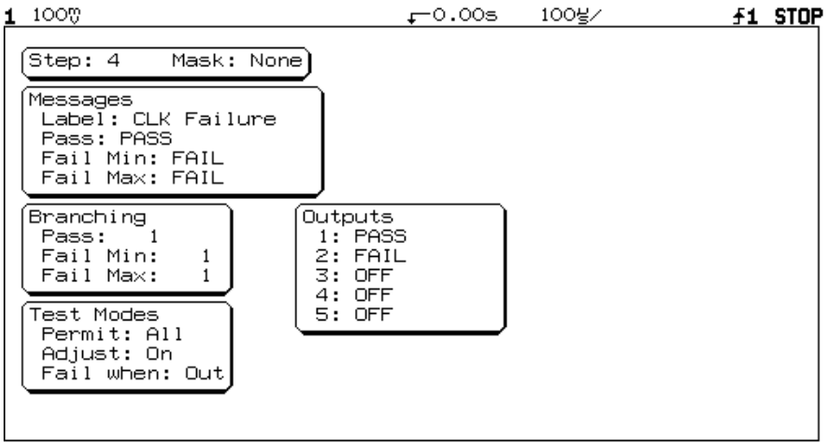
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Figure 28



Documentation of step #3

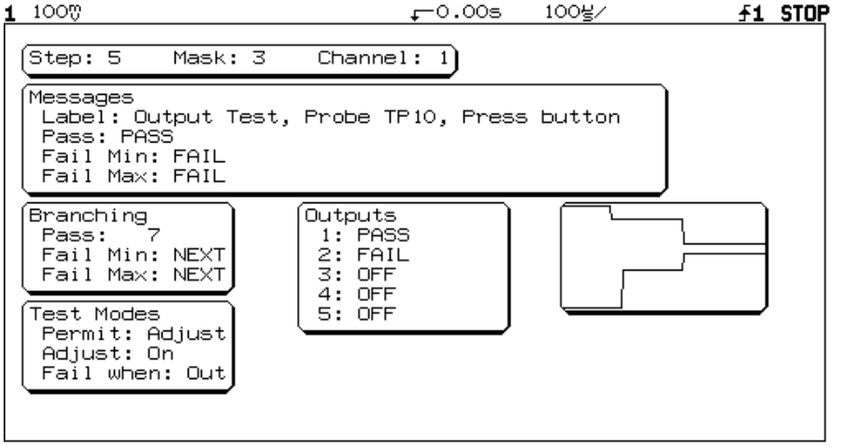
Figure 29



Documentation of step #4

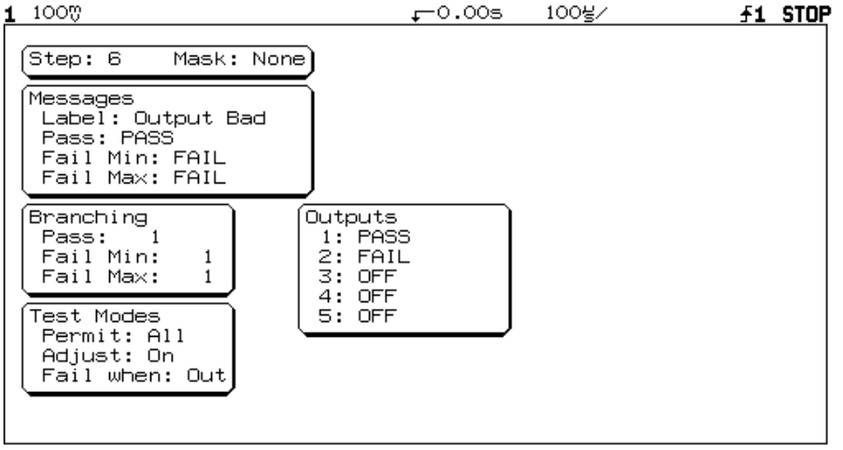
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Figure 30



Documentation of step #5

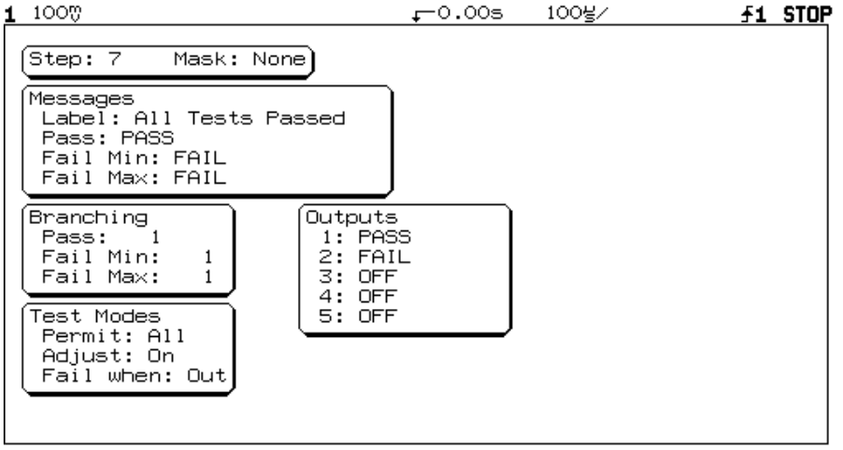
Figure 31



Documentation of step #6

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Figure 32



Documentation of step #7

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4

Test Sequencing Programming

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Introduction

The Test Automation Module provides fully automated testing capabilities. Sequencing can be activated through the RS-232 or HP-IB interface. Test sequences and mask templates can be downloaded from an instrument controller into the Test Automation Module. The execution of the sequences can be controlled by the instrument controller.

There is a clear advantage of using the Test Automation Module for fully automated testing. The testing setups and mask templates can be downloaded into the Test Automation Module and reside in the nonvolatile memories in the module. Without the Test Automation Module, the instrument controller needs to pull the waveform data from the oscilloscope and do the comparison against a pre-defined mask template inside the instrument controller. This requires a lot of data transfer and consumes a lot of testing time. With the Test Automation Module, the test is performed inside the oscilloscope. Very little bus communication is required to perform the testing. Therefore, the test throughput is greatly improved.

This section lists the commands available for executing sequences over the bus. The programming examples in this section are written in HP BASIC 5.0 for an HP 9000 Series 200/300 Controller.

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Programming Conventions

`< >` Angle brackets enclose words or characters that symbolize a program code parameter or an HP-IB command.

`::=` is defined as. For example, <A> ::= <B> indicates that <A> can be replaced by <B> in any statement containing <A>.

`|` or. Indicates a choice of one element from a list. For example, <A> | <B> indicates <A> or <B>, but not both.

`...` Ellipses (trailing dots) indicate that the preceding element may be repeated one or more times.

`[ ]` Square brackets indicate that the enclosed items are optional.

`{ }` When several items are enclosed by braces, only one of these elements must be selected.

Uppercase and Lowercase Conventions

The commands in this section are shown in the long form and short form using upper and lowercase letters. As an example, SEQuence:PROTect indicates that the long form of the command is SEQUENCE:PROTECT and the short form of the command is SEQ:PROT.

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:SEQuence:NEXT

Command

```
:SEQuence:NEXT
```

The :SEQUENCE:NEXT command sets the current step to be the next step number according to the test results and the step branching destinations specified by the branching settings in the current step.

Example

```
OUTPUT 707;":SEQUENCE:NEXT"
```

This command operates similar to pressing the Next softkey on the front panel of the oscilloscope during sequencing.

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:SEQuence:PREVious

Command

```
:SEQuence:PREVious
```

The :SEQUENCE:PREVIOUS command sets the current step in sequencing to the previous step number.

Example

```
OUTPUT 707; ":SEQUENCE:PREVIOUS"
```

The operation of the PREVious command is similar to pressing the Previous softkey on the front panel of the oscilloscope. Only one previous step is memorized by the oscilloscope.

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:SEQuence:PROTect

Command

```
:SEQuence:PROTect [ {ON|OFF} ]
```

The :SEQUENCE:PROTECT command turns the protection for the test sequence setup on and off.

Example

```
OUTPUT 707; ":SEQ:PROT ON"
```

Query

```
:SEQuence:PROTect?
```

The SEQuence:PROTect query outputs the current status of the protection.

Returned Format

```
{ON | OFF}<NL>
```

Example

```
10  OUTPUT 707;":SEQUENCE:PROTECT?"
20  ENTER 707;Protect$
30  PRINT Protect$
40  END
```

In the HP 54656A RS-232 Test Automation Module, the setting of the software protect is ORed with the setting of the recessed protection switch.

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:SEQuence:RESet

Command

```
:SEQuence:RESet
```

The :SEQUENCE:RESET command sets the current sequencing step back to step 1.

Example

```
OUTPUT 707; ":SEQ:RESET"
```

The operation of the RESet command is similar to pressing the Reset softkey on the front panel of the oscilloscope.

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:SEQuence:SETup

Command

```
:SEQuence:SETup [{MASK|STEP},<number>,]
<header><setup_string>
```

The :SEQUENCE:SETUP command sets up the whole test sequence, a step, or a mask as defined by the data in the setup string.

Query

```
:SEQuence:SETup? [ {MASK|STEP},number ]
```

Return Format

```
<header><setup_string><NL>
```

The :SEQUENCE:SETUP query outputs the setup string of the whole test sequence, a step, or a mask.

`MASK` `STEP` Choose one of these to specify whether you are sending or querying the setup string of an individual mask or an individual step. If neither is specified, you are sending or querying the whole test sequence setup string .

`<number>` Specifies the mask number or step number that you are sending or querying.

`<header>` Specifies the type of setup to be sent or returned:

For individual masks,<header> ::= #800001000
For individual steps,<header> ::= #800000244
For whole sequences,<header> ::= #800064122

`<setup_string>` Contains the setup string to be sent.

For individual masks,<setup_string> ::= 1,000 byte string.
For individual steps,<setup_string> ::= 244 byte string.
For whole sequences,<setup_string> ::= 64,122 byte string.

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Example

```
10  DIM Set$[1100]
20  OUTPUT 707; ":SEQ:SETUP? MASK,1"
30  ENTER 707 USING "-K"; Set$
40  PAUSE
50  OUTPUT 707; ":SEQ:SETUP MASK,1,"; Set$
60  END
```

-K is an HP BASIC image specifier which places the block data in a string, including carriage returns and line feeds until EOI is true or when the dimensioned length of the string is reached.

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:SEQuence:STEP

Command

```
:SEQuence:STEP <number>
```

The :SEQUENCE:STEP command sets the current step to be the step number specified in the command.

`<number>` The step number which is set as the current step.

Example

```
OUTPUT 707; ":SEQ:STEP 5"
```

Query

```
:SEQuence:STEP?
```

Return Format

```
<step_number><NL>
```

The :SEQUENCE:STEP query returns the current step number.

`<step_number>` An integer, 1 to 100 (NR1 format).

Example

```
10  OUTPUT 707; ":SEQ:STEP?"
20  ENTER 707; Step
30  PRINT Step
40  END
```


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:SEQuence:TEST?

Query `:SEQuence:TEST?`

Return Format `<Result><NL>`

The :SEQUENCE:TEST query performs a mask template test and returns the result of the testing.

`<Result>` An integer, 0 to 3 (NR1 format).

0= Pass.
1= Fail minimum limit line.
2= Fail maximum limit line.
3= Fail both minimum and maximum limit line.

Example

```
10  OUTPUT 707; ":SEQ:TEST?"
20  ENTER 707; Result
30  PRINT Result
40  END
```

When the fail condition is set to be inside, only 0 or 3 is returned.

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5

Reference Information

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Introduction

This chapter contains reference information for the Test Automation Modules including its operating characteristics, connector pin outs, and the timing for its output lines.

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Operating Characteristics

Trace Memories

Number of Memories:	2, nonvolatile.

Step Sequencing

Number of Steps	100, nonvolatile
Instrument Setup	Whole front panel setups. When mask template testing is used, automatic measurements are not displayed.
Messages	Label (60 characters). Pass message (30 characters). Fail Min message (30 characters). Fail Max message (30 characters).
Branching	Branch based on the test result of Pass, Fail Min, or Fail Max with each selectable as step number, Same, or Next.
Operator access permission	"None" mode only allows the operator to use the softkeys for sequencing. "Adjust" mode allows the operator to use softkeys, vertical sensitivity knobs, position knobs, delay knob, and time base knob. "All" mode allows the operator to use all of the keys and knobs.
Sequencing control	Three softkeys control the sequencing: Next, Previous, and Reset.
Editing	Copy a single step or mask template to a destination.

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Mask Template Testing

Number of mask templates	40, nonvolatile.
Mask template generation	Automask generates a mask from Autostore or trace data with variable tolerances. Mask editor allows pixel-by-pixel editing and line drawing editing. Smooth mask function performs a running average of 3 pixels. Mask template testing cannot be used in conjunction with the delay sweep, roll mode, or math functions
Adjust mode	Adjust mode is optimized for fastest screen update. Some of the displayed data may not be tested.
Test Region	Each pixel is selectable to be tested or not.
Fail Region	Inside - signal fails if it falls inside the region bounded by the maximum and minimum limit lines. Outside - signal fails if it falls outside the region bounded by the maximum and minimum limit lines.
Failure indication	Failure zone indicator shows where the signal fails the mask template.

Hard copy Output

Printer/ Plotter Supported	HP ThinkJet, HP QuietJet, HP PaintJet, and HP LaserJet printer. HP-GL compatible plotters. HP 54656A only: Epson FX-80 or compatible printer

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RS-232 Configurations

Connector Type	With the adapter cable connected, at the end of the cable is a 25 pin DTE port; a printer cable is required to connect it to hard copy devices or a computer.
Protocols	XON/XOFF, hardware.
Data Bits	8
Stop Bits	1
Parity	none.
Baud Rates	1200, 2400, 9600, 19200.

Programmability

All Instrument settings and operating modes may be remotely programmed via RS-232 and HP-IB (IEEE-488).

Input/Output (HP 54656A only)

Input Lines	Two lines for the remote control of Next, Previous, and Reset functions during sequencing.
Output Lines	Five output lines definable in each step. Selections are: on, off, pulse at the start of a step, pulse at the end of a step, pass, fail, fail min, and fail max. Output levels are 0 to 5V. Output resistance is 120 ohms. Maximum output current is ± 24 mA.

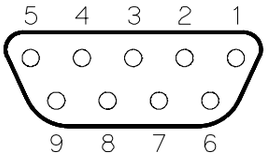
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RS-232 pin out

The following figures show the pin outs of the RS-232 cables used with HP 54656A. The signals for the RS-232 port on the HP 54656A are listed below:

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

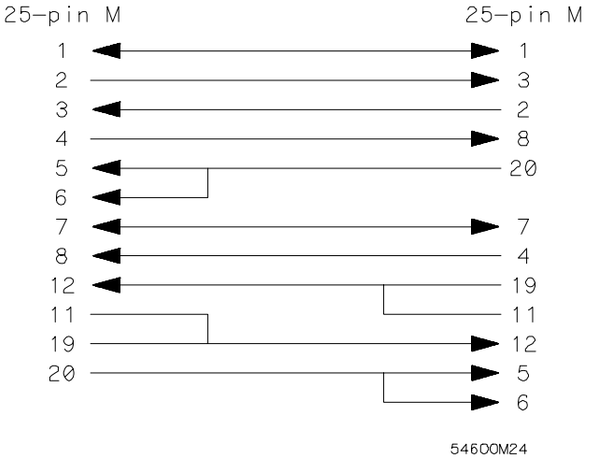
Figure 33



Pin out of RS-232 port in HP 54656A looking into DB9 connector

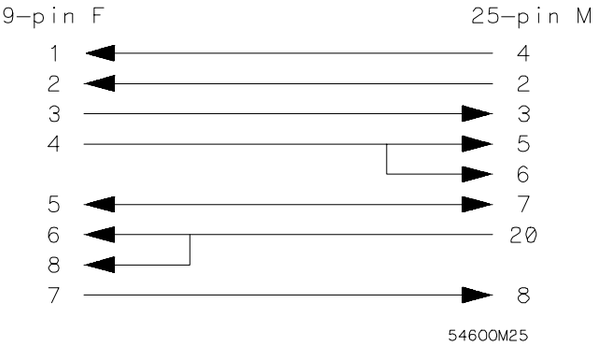
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Figure 34



Pin out of RS-232 cable for connecting to Printer/Plotter/HP Vectra 25-pin serial port

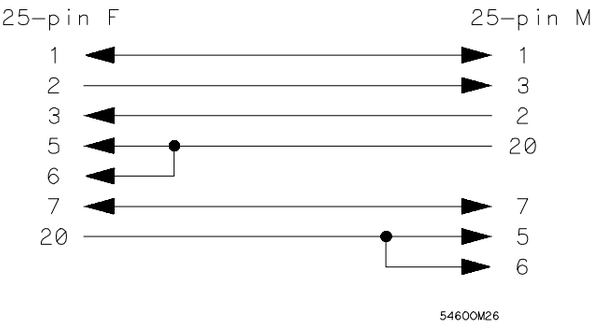
Figure 35



Pin out of RS-232 cable for connecting to 9-pin serial port

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Figure 36



Pin out of RS-232 cable for connecting to IBM PC/XT 25-pin serial port

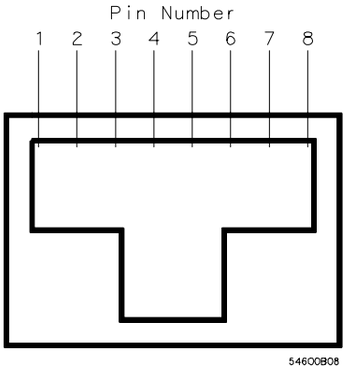
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I/O lines pin outs (HP 54656A only)

The table below shows the pin outs of the RJ-45 I/O port on the HP 54656A.

Pin Number	Function
1	Output Line #1
2	Output Line #2
3	Output Line #3
4	Output Line #4
5	Output Line #5
6	External Switch #1
7	External Switch #2
8	Ground

Figure 37



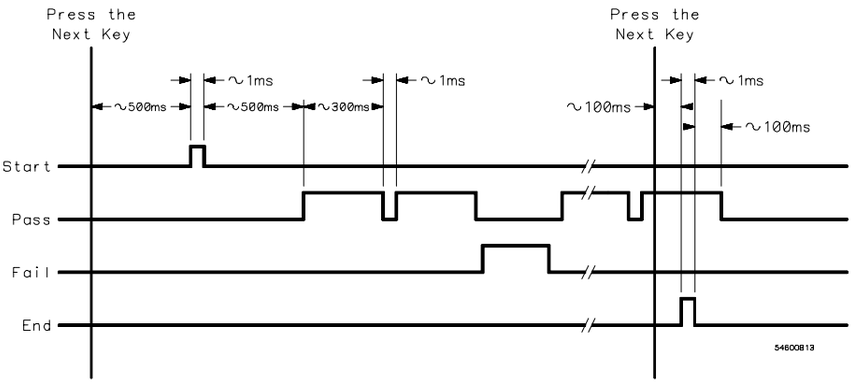
Pin out of the I/O port of HP 54656A looking into RJ-45 I/O connector

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Timing of the output lines (HP 54656A only)

Figure 38 shows the timing of the output lines in the HP 54656A. The main step shown in the figure has four output lines defined as Start, Pass, Fail, and End. The time values shown are only approximate times. The actual time may vary depending on the configuration of the oscilloscope, the configuration of the test step, and the input signal.

Figure 38



Timing of the output lines

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6

HP 54653A ScopeLink 2.0 Software

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Introduction

This part of the manual contains information on the enhanced commands in the HP 54653A ScopeLink software version 2.0. These commands support the Test Automation Modules.

The HP 54653A ScopeLink product is a software package that provides a communication link between a personal computer (PC) and the HP 54600-series oscilloscopes. It is not included as part of the Test Automation Modules. For more information on the HP 54653A ScopeLink software 2.0, refer to the "HP 54653A ScopeLink User's Guide," and the README.TXT file on the ScopeLink disk.

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To protect a test sequence setup

The HP 54653A ScopeLink software 2.0 can enable or disable the protection of a test sequence setup in the Test Automation Modules.

1. Select `Data Transfer` from the menu bar, then select `Test Automation`.
2. The Test Automation Panel is displayed. To enable the protection, select `Protect On`. To disable the protection, select `Protect Off`.

HP 54656A protection operating hint

The HP 54656A also has a recessed switch for enabling the protection. The protection of test sequence is enabled if either the recessed switch or the software protection is enabled.

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To transfer the setup of an entire test sequence

The HP 54653A ScopeLink software 2.0 can transfer an entire test sequence from the oscilloscope to the PC and store it as a file. The file can be used as a backup of the test sequence. To restore the test sequence, simply send the file back to the oscilloscope. The file can also be used for duplication of a test sequence to other HP 54600-series oscilloscopes.

1. Select `Data Transfer` from the menu bar, then select `Test Automation`.
2. When the Test Automation Panel appears, check the box labelled `All` for transferring the whole test sequence.
3. Enter the filename into the `Filename` box.

   The extension of the filename must be ".SLA", which is automatically appended to the filename if no extension is given.
4. To retrieve the test sequence, check the box labelled `Receive`. To send the test sequence, check the box labelled `Send`.
5. Select `Okay` to start the transfer. To return to the main menu, select `Quit`.

   The progress of transfer is displayed. Over HP-IB, it takes about twenty seconds to complete a transfer. Over RS-232 with a baud rate of 9600, it takes about 2 minutes to complete a transfer.

   After the transfer of the test sequence from the oscilloscope to the PC is completed, it is saved to the file specified in the Filename box.

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To transfer the setup of an individual step

The HP 54653A ScopeLink software 2.0 can transfer the setup of an individual step from the oscilloscope to the PC and store it as a file. The file can then be used as a backup of the individual step. To restore the individual step, simply send the file back to the oscilloscope. This file can also be used as a part of a test library. A test sequence can be constructed by using individual steps and mask templates stored in the PC.

1. Select `Data Transfer` from the menu bar, then select `Test Automation`.
2. When the Test Automation Panel appears, check the box labelled `Step` for transferring an individual step.
3. Select the box trailing the label number, and enter the step number that you want to work on.

   Valid step numbers are from 1 to 100.
4. Enter the filename into the `Filename` box.

   The extension of the filename must be ".SLS", which is automatically appended to the filename if no extension is given.
5. To retrieve the setup of an individual step, check the box labelled `Receive`.
   To restore the setup of an individual step, check the box labelled `Send`.
6. Select `Okay` to start the transfer. To return to the main menu, select `Quit`.

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To transfer an individual mask template

The HP 54653A ScopeLink software 2.0 can transfer the setup of an individual mask template from the oscilloscope to the PC and store it as a file. The file can be used as a backup of the individual mask template. To restore the individual mask template, simply send the file back to the oscilloscope. The file can also be used as a part of a test library. A test sequence can be constructed by using individual steps and mask templates stored in the PC.

1. Select `Data Transfer` from the menu bar, then select `Test Automation`.
2. When the Test Automation Panel appears, check the box labelled `Mask` for transferring an individual mask template.
3. Select the box trailing the label number, and enter the mask template number that you want to work on.

   Valid mask template numbers are from 1 to 40.
4. Enter the filename into the `Filename` box.

   The extension of the filename must be ".SLM", which is automatically appended to the filename if no extension is given.
5. To retrieve an individual mask template, check the box labelled `Receive`.
   To restore an individual mask template, check the box labelled `Send`.
6. Select `Okay` to start the transfer. To return to the main menu, select `Quit`.

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To document a test sequence

The HP 54653A ScopeLink software 2.0 can document a test sequence to a printer. The documenation for each step includes the setup of the oscilloscope, the setup of the step, and the corresponding mask template. You can document a complete test sequence, or a range of steps.

1. Select `Print` from the menu bar, then select `Test Automation`.
2. When the Test Automation panel appears, enter the filename into the `Filename` box.

   The extension of the filename must be ".SLA", which is automatically appended to the filename if no extension is given.
3. If you want to document a complete test sequence, check the box labeled `ALL`.

   To document a complete test sequence, you must transfer the test sequence to the computer prior to documenting it.
4. If you want to document a range of steps, check the box labelled `Range`. Then enter the starting step number in the `Start` box and the ending step number in the `End` box.

   Valid step numbers are from 1 to 100.
5. Select `Okay` to start the documentation process. To return to the main menu, select `Quit`.

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Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

Safety

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this user's guide must be heeded.

Safety Symbols

WARNING

The Warning symbol 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 symbol until the indicated conditions are fully understood and met.

CAUION

The Caution symbol 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.

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About this edition

This is the first edition of the HP 54655A and HP 54656A Test Automation Modules User's Guide. Edition dates are as follows:

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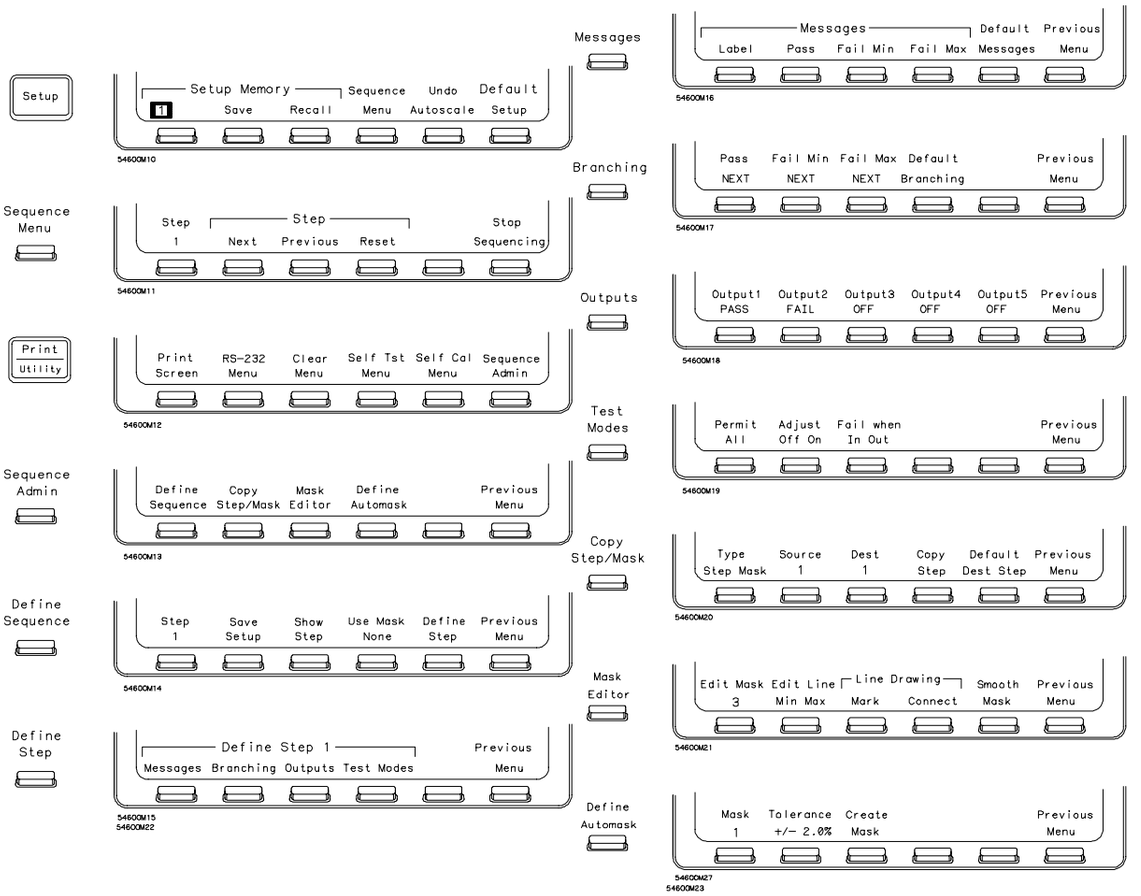
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A software or firmware code may be printed before the date. This code indicates the version level of the software or firmware of this product at the time the manual or update was issued. Many product updates and fixes do not require manual changes; 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.

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