# Agilent 86140B Series
# Measurement Applications
# User's Guide

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The laser radiation symbol. This warning symbol is marked on products which have a laser output.

∿ The AC symbol is used to indicate the required nature of the line module input power.

| The ON symbols are used to mark the positions of the instrument power line switch.

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# Contents

# 1



# Amplifier Test Application

# About the Application

The Amplifier Test applications for the 86140-series optical spectrum analyzers allow quick, accurate characterization of optical amplifiers with a minimum of user inputs. All specifications and characteristics are derived from the 86140-series specifications.

The applications measure the channel wavelengths, source power, gain, and noise figure of an amplifier using Interpolation Source Subtraction (ISS) or Time Domain Extinction (TDE) methods.

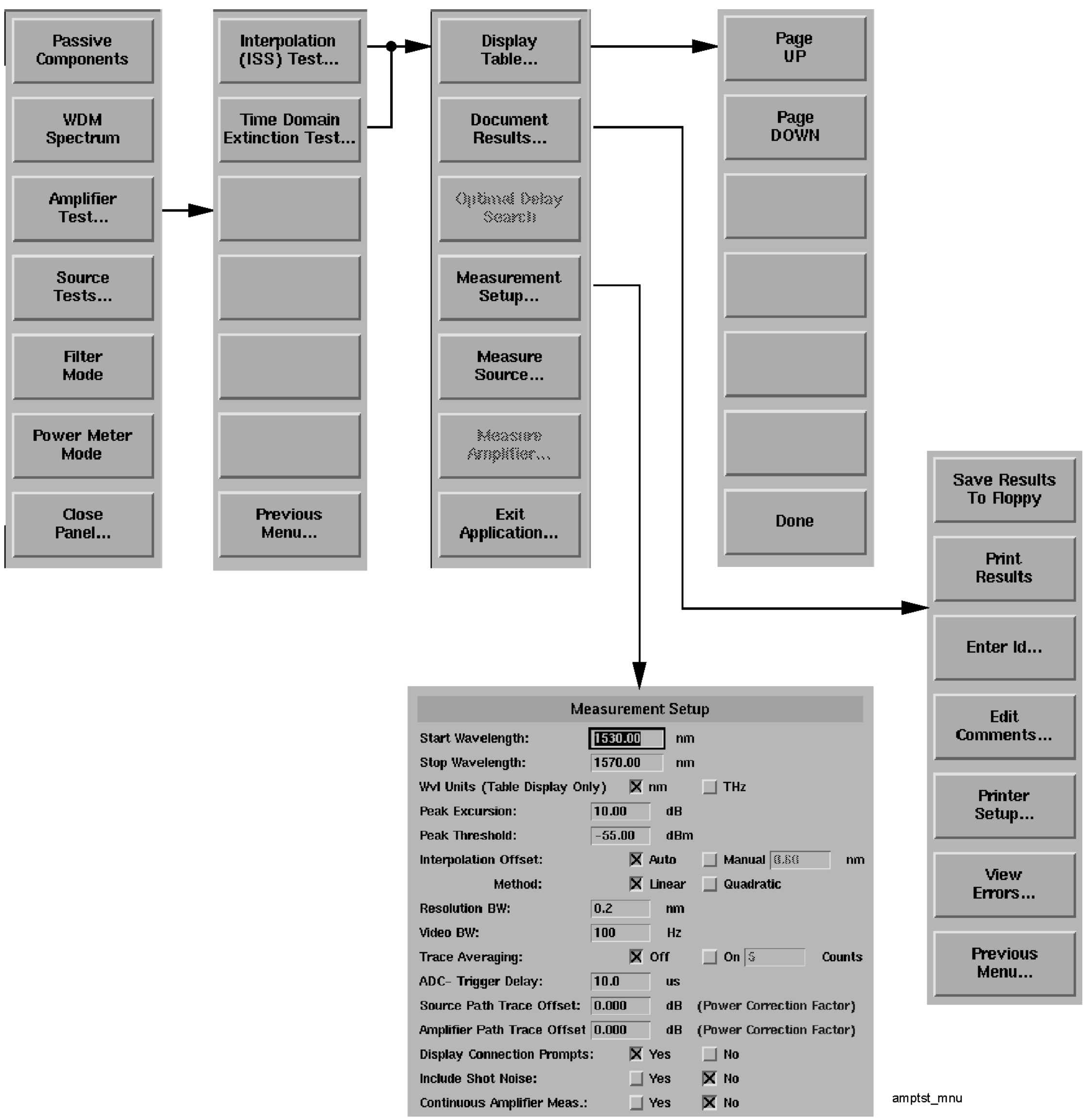
The ISS method is composed of one sweep to measure source signal wavelength, power, and spontaneous emission, and a second set of sweeps to measure the amplifier signal power and amplified spontaneous emission. These measured parameters are used to calculate the gain and noise figure for the amplifier. This method is suitable for all amplifier types.

The application calculates the following data and displays the results in the display table:

- Channel wavelength
- Source Power
- Gain
- Noise figure
- Source mean wavelength
- Sum of source signal power
- Amplifier mean wavelength
- Sum of amplifier signal power

The Time Domain Extinction (TDE) method, available only on the 86146B, measures the same parameters but uses time-domain extinction technique. It requires that laser sources to be synchronously modulated. This method is suitable only for amplifier types with slow time dynamics, for example, erbium-doped devices.

# The Amplifier Test Application Menus



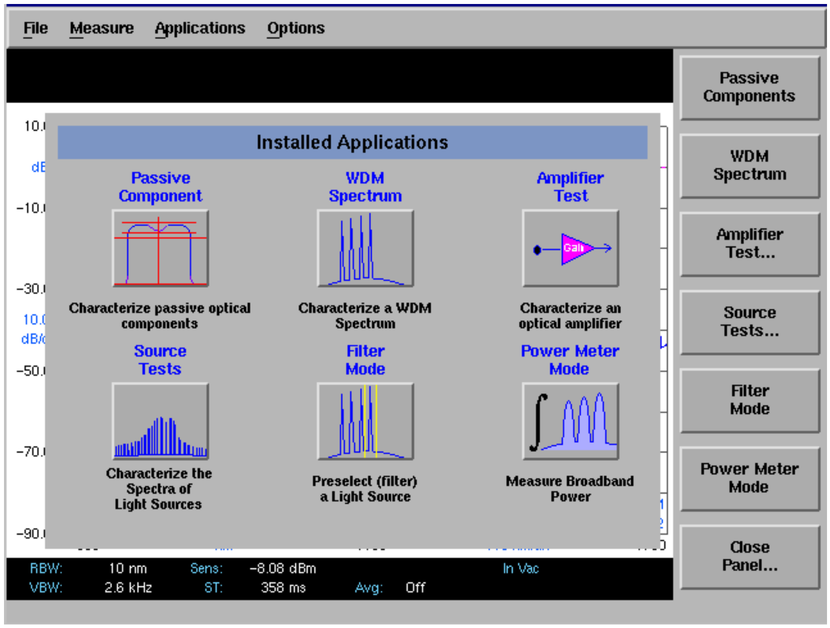
# Performing Measurements

This section explains how to start and use the Amplifier Test applications. The applications measure the channel wavelengths, source power, gain, and noise figure of an amplifier using Interpolation Source Subtraction (ISS) and Time Domain Extinction (TDE) methods.

## Starting the Amplifier Test Application

**1** Press the front-panel APPL'S key or, on the **Applications** menu, select **Launch an Installed Application**.

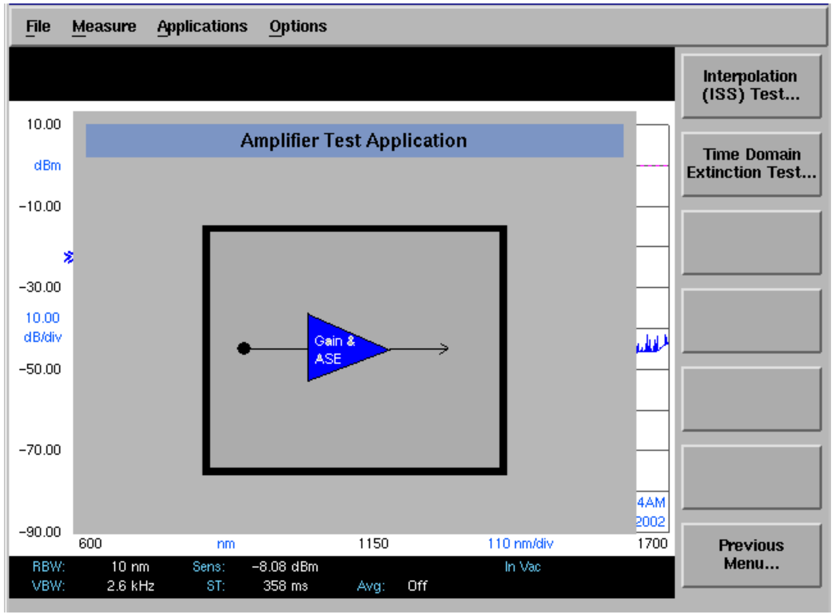
The following screen is displayed:




Applications Panel and Menu

The panel and the menu change whenever an application is installed or uninstalled. Each installed application has an icon on the panel and a corresponding softkey.

**2** Press AMPLIFIER TEST to bring up a second menu with a choice of amplifier tests.

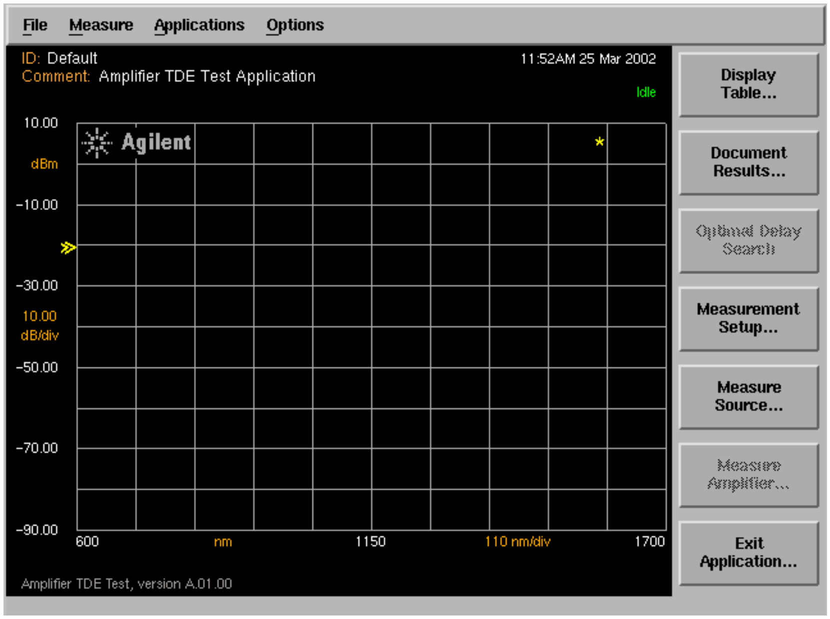



Amplifier Test Menu

**3** Select either INTERPOLATION (ISS) TEST OR TIME DOMAIN EXTINCTION TEST (TDE).

**Note**: Time Domain Extinction Test is available only on the 86146B.

When the test is launched, the corresponding test menu is displayed.



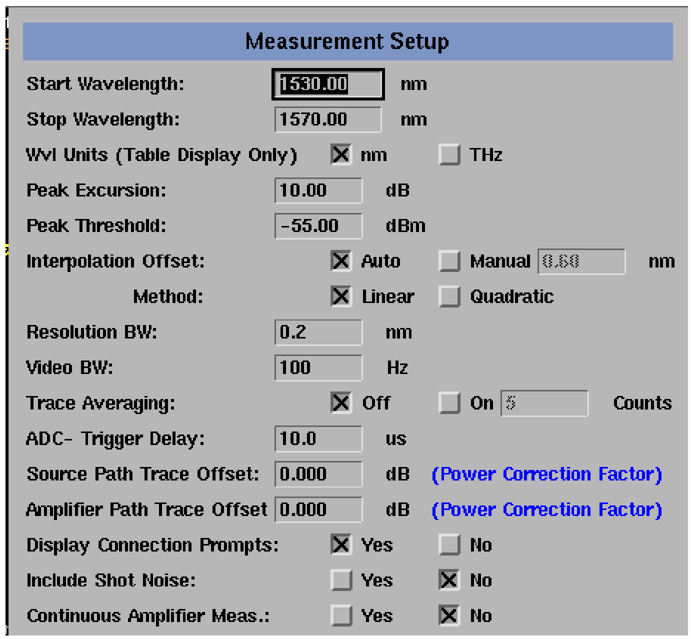

Status Panel

The status panel is always visible at the top of the screen when the application is running and consists of two lines of information. The top line contains the current Device ID on the left and the current date and time on the right. The second line contains a user-entered comment on the left and the measurement status on the right. Note that Optimal Delay Search is available only in the TDE measurement mode for the 86146B.

The above example indicates the application status is “Idle”.

## Setting Up a Measurement

The Measurement Setup dialog box allows you to define the parameters for the measurement.

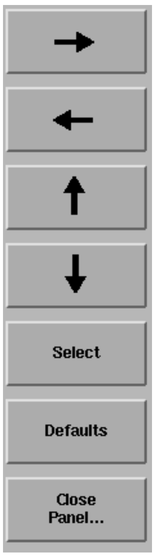



Amplifier Test Measurement Setup

The MEASUREMENT SETUP... softkey is enabled whenever the system is not actively measuring. Selecting this key opens the Measurement Setup dialog box.

## Navigating the Measurement Setup Window

The softkeys allow you to navigate through the measurement setup dialog box.




The **arrow** softkeys allow you to navigate from field to field in the dialog box. The highlighted parameter can be changed.

**Select** selects the highlighted parameter.

**Defaults** resets the parameters to their default condition.

**Close Panel...** saves the current setup and returns you to the previous menu.

The front-panel number keys, step keys, and knob on the OSA allow you to enter a numeric value in the highlighted field.

## Measurement setup parameters

Under manual operation, all measurement parameters are set to default by pressing the DEFAULTS softkey. Otherwise, they retain the previous setting from the last time the application was started. These settings are retained when PRESET is pressed. Values are entered from the keypad or incremented using the knob or step keys.

### *Start Wavelength*

Default: 1530 nm

Sets the start wavelength for the measurement span. Units are fixed in nm.

### *Stop Wavelength*

Default: 1570 nm

Sets the stop wavelength for the measurement span. Units are fixed in nm.

### *Wavelength Units*

Default: nm

Selects the wavelength units, either nm or THz. These units are used in the Display Table only.

### *Peak Excursion*

Default: 10 dB

Sets the peak excursion value in dB. This is the amount of amplitude the trace must rise and fall to be considered a peak. Lower values lead to more signals being discerned, but if peak excursion is set too low, peaks in the noise floor may be discerned as signals. If peak excursion is set too high, legitimate peaks may not be discerned as signals.

### *Peak Threshold*

Default: -55 dBm

Sets the peak threshold value in dBm. Power levels below this threshold are not considered for peak search.

***Interpolation Offset***

Default: Auto

The offset can be entered manually, or calculated automatically. Auto mode, uses (0.5×RBW+0.5nm)for the offset. Either Interpolation Method (that is, Linear or Quadratic) can be used.

***Interpolation Method***

Default: Linear

**Linear** sets the noise marker 'noise offset' interval to the left and right of the channel when making a noise power measurement. The noise power at the channel wavelength is the interpolation value of the noise markers to the left and right of the channel. The offset can be entered manually, or calculated automatically using (0.5×RBW+0.5nm).

The system measures half the distance between channels and compares this amount to the entered offset. If the half distance figure is closer to the channel, the system will override the manually entered offset value with the half distance value. This prevents adjacent channels from interfering with noise measurements.

**Quadratic** uses four measured points. Two points are used on each side of the channel to interpolate the noise floor at channel wavelength. The user specifies the offset value for the two measured points closest to the channel wavelength. The offsets for the outer two points are determined internally by the application.

***Resolution Bandwidth***

Default: 0.2 nm

Sets the resolution bandwidth value to be used during peak sweep. This determines the analyzer's ability to display two closely spaced signals as two distinct responses. Decreasing the resolution bandwidth provides a more detailed sweep but increases the scan time.

The resolution bandwidth can be set to one of the following values:

- **For 86140B Option 025, 86143B option 025, 86141B:**
  0.07 nm, 0.1 nm, 0.2 nm, 0.3 nm, 0.5 nm, 1 nm, 2 nm, 5 nm, 10 nm.
- **For 86140B, 86142B, 86143B, 86145B:**
  0.06 nm, 0.1 nm, 0.2 nm, 0.3 nm, 0.5 nm, 1 nm, 2 nm, 5 nm, 10 nm.
- **For 86144B, 86146B internal path:**
  0.06 nm, 0.07 nm, 0.1 nm, 0.14 nm, 0.2 nm, 0.33 nm, 0.5 nm, 1 nm, 2 nm, 5 nm, 10 nm.
- **For 86144B, 86146B external path:**
  0.04 nm, 0.05 nm, 0.07 nm, 0.1 nm, 0.2 nm, 0.3 nm, 0.5 nm, 1 nm, 2 nm, 5 nm, 10 nm.

### *Video Bandwidth*

Default: 100 Hz

Reduces noise and thus improves measurement repeatability. However, the measurement time increases as the video bandwidth setting is decreased.

For the source and amplifier initial sweeps, the video bandwidth is fixed at 3 kHz. The default for source and amplifier noise and peak sweeps is 100 Hz. The allowable input range is from 100 mHz to 3 kHz.

### *Trace Averaging*

Default: Off

Improves measurement repeatability by smoothing out the noise. For measurements involving slow polarization scrambling, trace averaging is generally faster than video averaging.

When trace averaging is on, the initial default average count is 5. The allowable input range is 1 to 1000 average counts.

### *ADC - Trigger Delay*

Default: 10 ms.

Sets the trigger delay for the amplified spontaneous emission (ASE) measurement for TDE. The sources are square-wave modulated. The trigger delay should be set to 25% of the square-wave period plus 0.8 ms. The Optimal Delay Search function will automatically calculate trigger delay.

#### *Source Path Trace Offset*

Default: 0.000 dB

Sets an offset to compensate for any losses caused by cables and connections in the source path.

#### *Amplifier Path Trace Offset*

Default: 0.000 dB

Sets an offset to compensate for any losses caused by cables and connections in the amplifier path.

#### *Display Connection Prompts*

Default: Yes

Displays equipment setup prompts when Measure Source or Measure Amplifier are selected.

#### *Include Shot Noise*

Default: No

Sets a flag to include or exclude the 1/Gain term in noise figure calculations.

#### *Continuous Amplifier Measurement*

Default: Single

Allows you to select either single sweep measurement or continuous sweep measurement mode.

## Linear and Quadratic Interpolation

The setup panel and remote commands are provided for selecting the linear or quadratic interpolation and the corresponding offset. For the linear method, the offset is the distance of the two measured points from the channel wavelength. For the quadratic method (four measurement points are used), the offset refers to the two measured points closest to the channel wavelength. The offsets for the outer two points are determined internally by the application.

To derive the value of amplified spontaneous emission (ASE) to calculate noise figure, interpolation around each signal is used. Linear interpolation is best when channel spacing is narrow. When channel spacing is wider, it is possible to measure ASE at two points on either side of each signal (that is, quadratic interpolation). The quadratic interpolation method will more accurately estimate the ASE at the channel wavelengths in the gain region with high curvature.

For narrow channel spacing, an inner point in the quadratic (four points) set may become too close to an adjacent channel. The interpolation offset is clipped to half the distance between the adjacent channels. When an outer point in the 4-point set falls too close to an adjacent channel, the point is put on the far side of the adjacent channel.

For the two boundary channels (at the low and high end of the span), any shortage of data points on a boundary may cause the two points on the same side of a boundary channel to become too close to each other. The program automatically reverts to using a linear interpolation on a channel by channel basis.

**Linear** sets the noise marker ‘noise offset’ interval to the left and right of the channel when making a noise power measurement. The noise power at the channel wavelength is the interpolation value of the noise markers to the left and right of the channel. The offset can be entered manually, or calculated automatically using (0.5×RBW+0.5nm).

The system measures half the distance between channels and compares this amount to the entered offset. If the half distance figure is closer to the channel, the system will override the manually entered offset value with the half distance value. This prevents adjacent channels from interfering with noise measurements.

**Quadratic** uses four measured points. Two points are used on each side of the channel to interpolate the noise floor at channel wavelength. The user specifies the offset value for the two measured points closest to the channel wavelength. The offsets for the outer two points are determined internally by the application.

# ISS Test

There are two possible equipment configurations. Figure 1 uses a patchcord to bypass the DUT for source calibraton while Figure 2 uses optical switches to bypass the DUT.

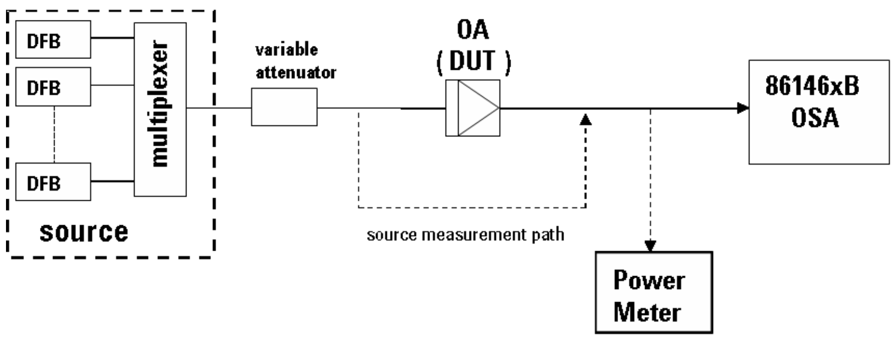



Figure 1 Patch cord used to bypass the DUT

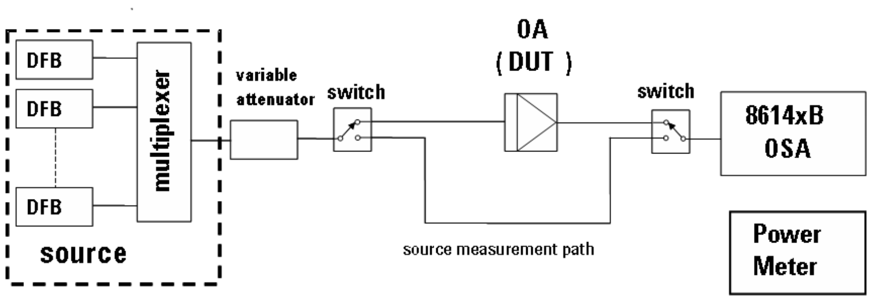



Figure 2 Optical Switches to bypass the DUT

## Calibrating the Signal Path Offsets

To compensate for any losses caused by the cables and connections in the signal paths, it is necessary to determine the path offsets using a power meter, such as the 8163A lightwave multi-meter with an 81634A power sensor module.

The objective of measuring and calculating the offsets is to transfer the amplitude accuracy of the power meter to the application at it’s reference plane.

Refer to “Measuring the Source” on page 22 and to “Measuring the Amplifier” on page 1-24 for information on how to use the application to obtain source and amplifier path wavelength and power values. These values are used in calculating the path offsets.

To ensure accurate measurements, the system must be properly warmed up and calibrated. All OSA specifications apply when the instrument’s internal temperature has been stabilized after 1- hour of continuous operation, the auto align routine has been run.

**NOTE** As in all optical measurements, it is critical to follow good connector care practices. Always clean the connector interfaces before connecting. Refer to “Cleaning Connections for Accurate Measurements” in the optical spectrum analyzer user’s guide.

**CAUTION** Limit the power applied to the OSA to a maximum of +30 dBm total, +12 dBm per channel. To avoid exceeding the total safe input power, an attenuator should be installed at the OSA input. A 10 dB optical attenuator is available as option 030 for your OSA. Following this calibration procedure insures that this attenuation value will be subtracted from the measurement.

### To perform an Auto Align

Before entering the Amplifier Test application, connect a reference signal to the instrument, then press AUTO ALIGN. This starts an automatic alignment procedure that should be performed whenever the instrument has been moved, subjected to large temperature changes, or warmed up at the start of each day.

## To calculate offsets in a standard measurement setup

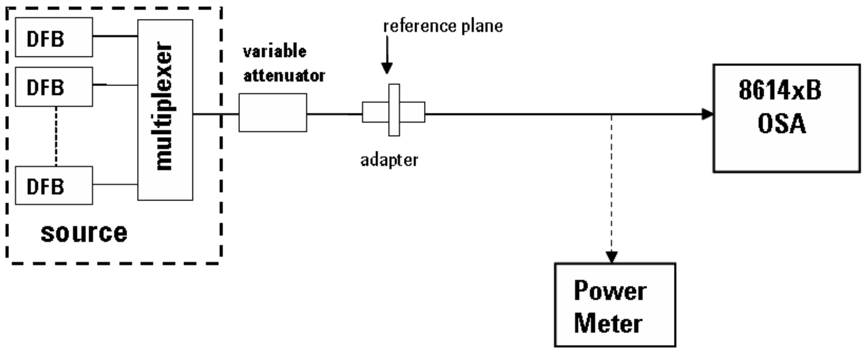



Figure 3 Reference Measurement

1 Connect the equipment as in Figure 3. Connect the source output and OSA input fibers at the reference plane.

2 Measure the source path using the OSA Amplifier Test application Measure Source function.

3 Without changing the setup, perform the Measure Amplifier function in the Amplifier Test application. This step is necessary to have the source data appear in the Display Table.

4 Record the source mean wavelength and sum of source signal power values from the Display Table.

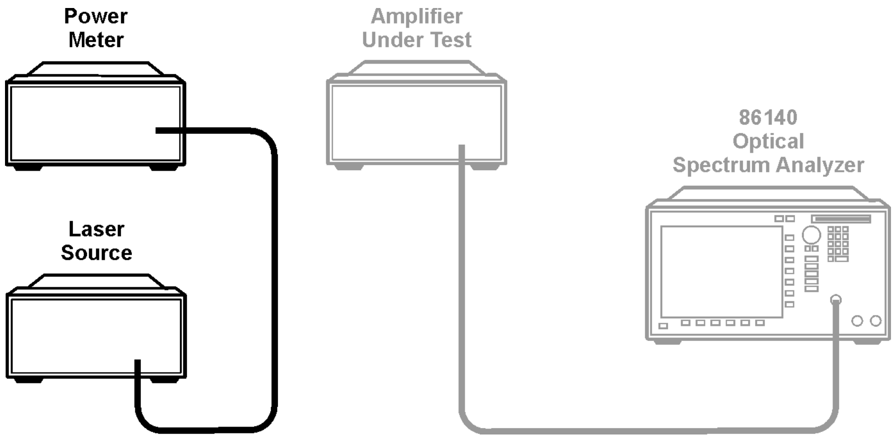



Figure 4 Power Meter Measurement

**5** Connect the source to the power meter as in Figure 4. Set the power meter wavelength parameter to the source mean wavelength value.

**6** Measure the power and record the value.

**7** Calculate the difference between the power meter reading and the application reading using:

Offset = Power Meter Reading – Application Sum of Source Signal Power.

**8** Enter the calculated value into the Measurement Setup dialog box as Source Path Trace Offset and Amplifier Path Trace Offset. For a standard measurement setup, the offsets in the source and amplifier paths will be the same.

**9** To verify the offset is correct, repeat Measure Source and Measure Amplifier. The source total power should read the same as measured by the power meter in Step 6. The gain should be 0.0 dB for each channel.

**10** After measuring and verifying the path offsets, you can connect the amplifier under test as in Figure 1.

### To calculate offsets in a measurement setup with optical switches

More complex measurement setups can provide an alternative path for measuring the source. When this is the case, the offsets in the source and amplifier paths will be different. This second procedure accounts for these additional losses in a sample test configuration using switches.

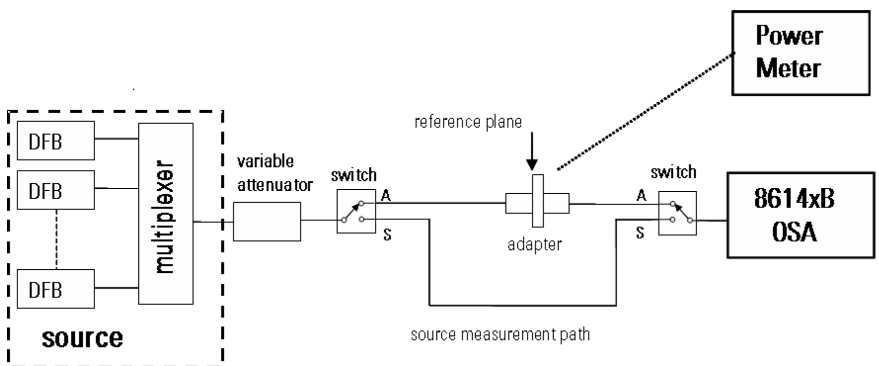



Figure 5 Source Path Measurement

1 Connect the source output and receiver input fibers as shown in Figure 5.
2 Set switches to the source path (S) positions.
3 Measure the source path with the Measure Source function.
4 Without changing the setup, measure the source path with the Measure Amplifier function.
5 From the Display Table, record the Source Mean Wavelength and Sum of Source Signal Power.
6 Set the switches to the amplifier path (A) positions.
7 Measure the amplifier path with the Measure Amplifier function.
8 From the Display Table, record the Sum of Amplifier Signal Power.
9 Connect the power meter to the adapter at the reference plane as shown in Figure 5. Set the power meter wavelength parameter to the source mean wavelength value.

**10** Measure the power and record the value.

**11** Calculate the difference between the power meter reading and the application source reading using:

Offset = Power Meter Reading – Application Sum of Source Signal Power.

**12** Enter the calculated value into the Measurement Setup dialog box as the Source Path Trace Offset.

**13** Calculate the difference between the power meter reading and the application amplifier reading using:

Offset = Power Meter Reading – Application Sum of Amplifier Signal Power.

**14** Enter the calculated value into the Measurement Setup dialog box as the Amplifier Path Trace Offset.

**15** To verify the offsets are correct, repeat Measure Source and Measure Amplifier. The source and amplifier total power should read the same as measured by the power meter in Step 10. The gain should be approximately 0.0 dB for each channel.

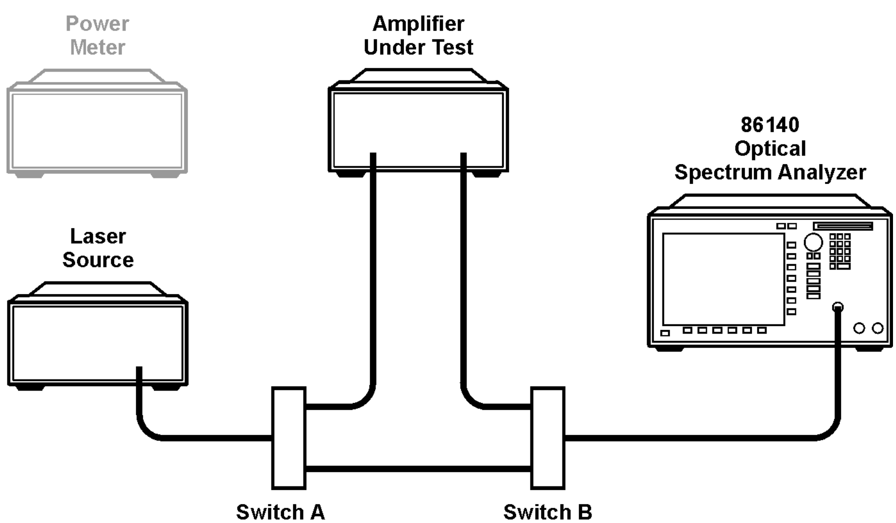


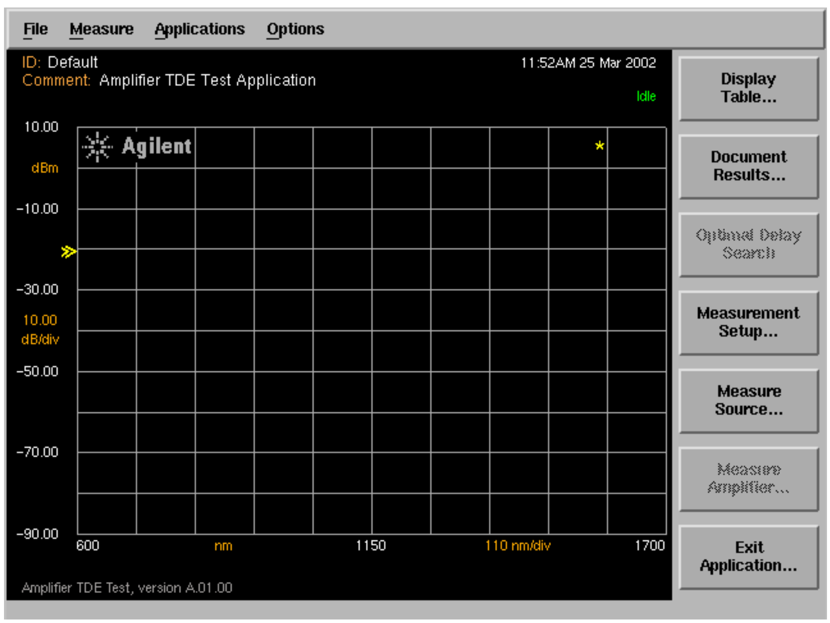

Figure 6 Amplifier Measurement

**16** After measuring and verifying the path offsets, you can connect the amplifier under test as in Figure 2.

## Measuring the Source

After the offsets are calculated as described in the previous section, you can proceed with the amplifier measurement. The first step of the two-step ISS method is a set of sweeps that measure signal wavelength, power, and spontaneous emission of the source. A second set of sweeps will measure the amplifier signal power and amplified spontaneous emission.

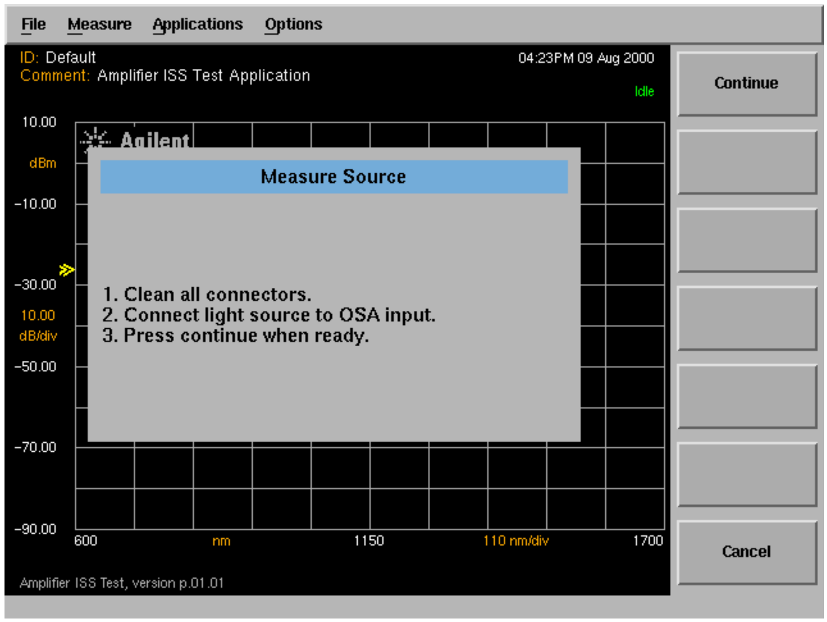
The Measure Source step must be repeated if there is any change in the measurement parameters or the source wavelength and power. Source data will be lost when exiting the application and must be remeasured.




Measuring the Source

**1** From the Interpolation ISS Test menu, select MEASURE SOURCE....

Note that the MEASURE AMPLIFIER... softkey is disabled until the source measurement is completed.




Source Measurement Prompts

**2** The system prompts you to connect the source to the OSA.

The display connection prompts can be turned off in the measurement setup dialog box, in which case MEASURE SOURCE... will immediately initiate the measurement.

**3** Press CONTINUE to initiate the measurement.

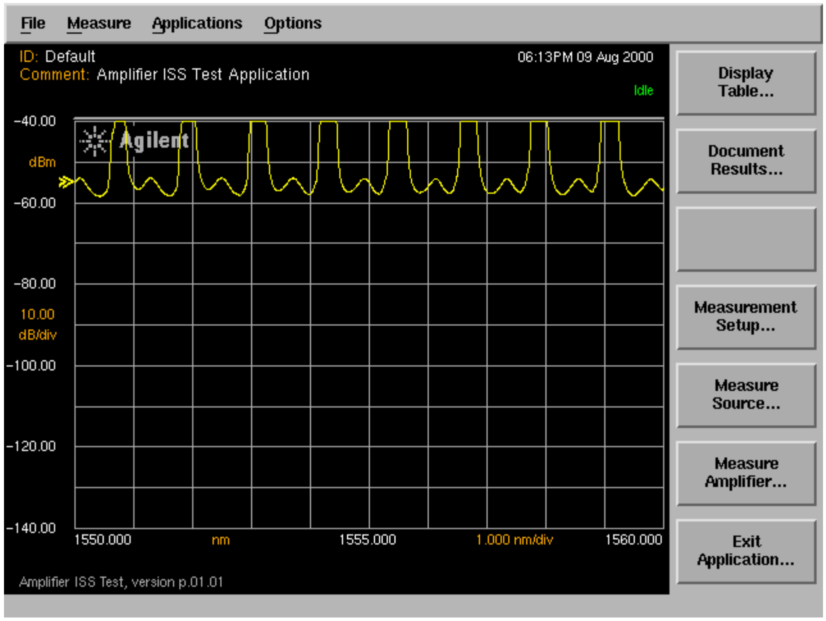
MEASURE SOURCE... is replaced with STOP SOURCE MEASUREMENT... while the measurement is in progress.

**4** The progress of the measurement is noted on the status panel:

**a** An initial sweep is taken to set references, indicated by “Source Initial Sweep...”.

**b** A second sweep measures the peak of the signal, indicated by “Source Peak Sweep...”.

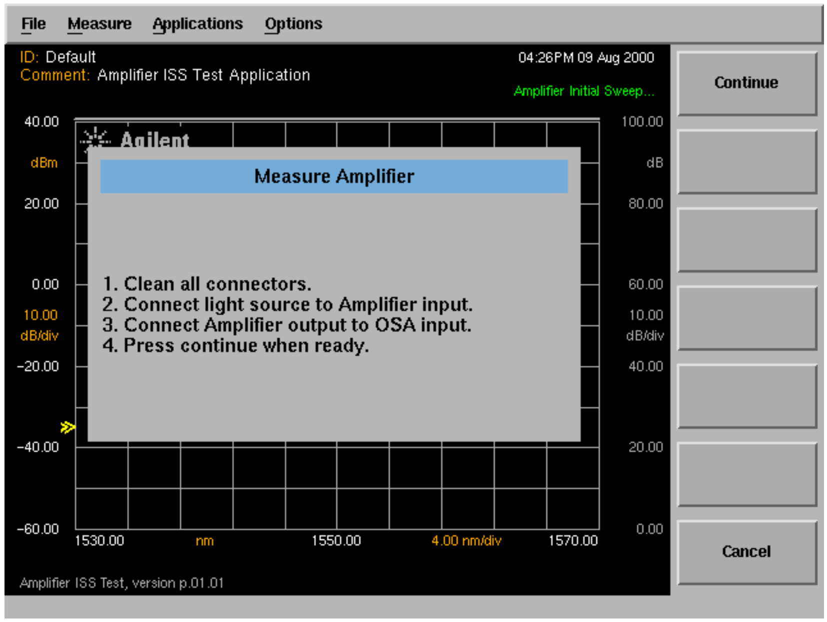
c  A third sweep measures the noise level, indicated by “Source Noise Sweep...”.




5  When the measurement is complete, the MEASURE AMPLIFIER... softkey is enabled. The progress status label reads “Idle”.

## Measuring the Amplifier

In the second step of the two-step process the amplifier is connected between the source and the OSA. The system measures the peak and noise power for the wavelengths measured in Measuring the Source and creates/updates the Display Table.




Amplifier Measurement Prompts

**1** Press MEASURE AMPLIFIER... to begin the process.

**2** The system prompts you to install the device to be tested.

The display connection prompts can be turned off in the measurement setup dialog box, in which case MEASURE AMPLIFIER... will immediately initiate the measurement.

**3** Press CONTINUE to initiate the measurement.

The MEASURE SOURCE... softkey is disabled. MEASURE AMPLIFIER... is replaced with STOP AMP MEASUREMENT... while the measurement is in progress.

**4** The progress of the measurement is noted on the status panel:

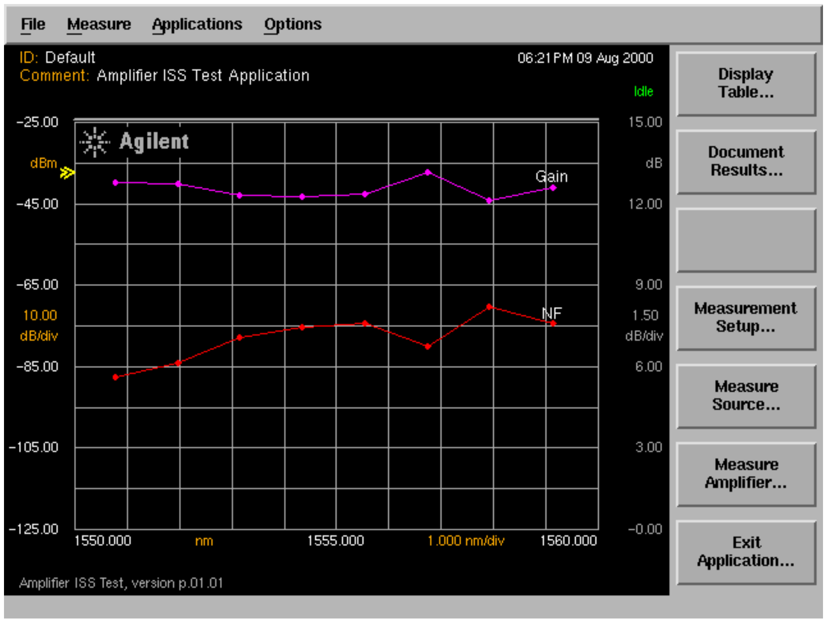
**a** An initial sweep is taken to set references, indicated by “Amplifier Initial Sweep...”.

**b** A second sweep measures the peak of the signal, indicated by “Amplifier Peak Sweep...”.

**c** A third sweep measures the noise level, indicated by “Amplifier Noise Sweep...”.

**d** After all the data is received, the application calculates the measurement results. The progress label reads “Calculating Results...”.

**5** When the measurement is complete, the progress status label reads “Idle”.




Amplifier Measurement Results

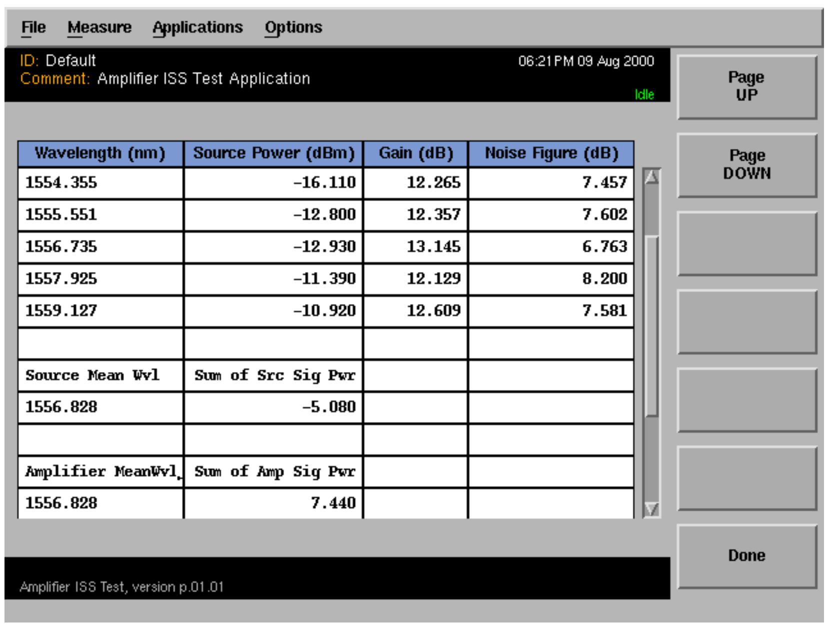
**6** The measurement results will be displayed graphically. The points indicating the amplifier gain and noise figure are displayed relative to the dB scale on the right side of the graph.

**NOTE**

If Continuous Amplifier Measurement mode is selected in the measurement setup dialog box, the measurement will continue to update the points on the display and in the Display Table at the end of each measurement.

## Viewing the Display Table

The DISPLAY TABLE... softkey is enabled when an amplifier measurement is complete and valid data is available. The results are displayed in a table similar to the one shown below. The Page Up and Page Down keys display previous and next pages of data if available.




| Wavelength (nm) | Source Power (dBm) | Gain (dB) | Noise Figure (dB) |
|---|---|---|---|
| 1554.355 | -16.110 | 12.265 | 7.457 |
| 1555.551 | -12.800 | 12.357 | 7.602 |
| 1556.735 | -12.930 | 13.145 | 6.763 |
| 1557.925 | -11.390 | 12.129 | 8.200 |
| 1559.127 | -10.920 | 12.609 | 7.581 |
| | | | |
| Source Mean Wvl | Sum of Src Sig Pwr | | |
| 1556.828 | -5.080 | | |
| | | | |
| Amplifier MeanWvl, | Sum of Amp Sig Pwr | | |
| 1556.828 | 7.440 | | |

When in continuous sweep mode the Interpolation ISS Test application continues to sweep and update the tabular data at the end of each measurement.

At the end of the table, after all channels present have been measured, the table will display values of source mean wavelength, sum of source signal power, amplifier mean wavelength, and sum of amplifier signal power.

For a description of mathematical calculations refer to “Theory of Operation” on page 49.

# TDE Test

As with ISS, there are two possible equipment configurations as in Figure 1 and Figure 2. The main difference is the trigger signal from the synchronously modulated source is required for the OSA. Figure 7 is the TDE setup for the patchcord configuration for source measurement.

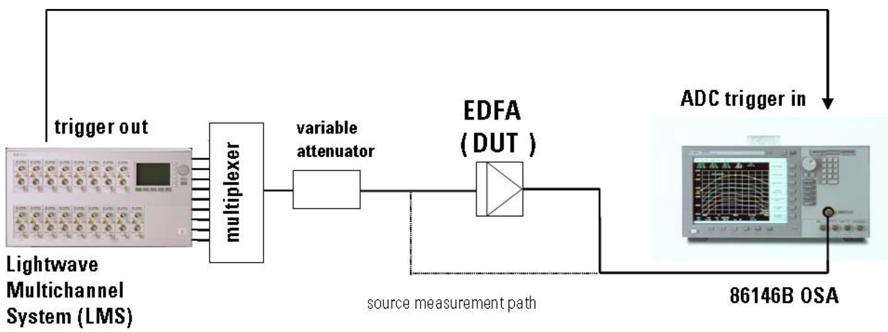



Figure 7 TDE setup for the patchcord configuration

## Setting up the Source Modulation

To use TDE, it is necessary to setup synchronous source modulation on the 8166B lightwave multi-channel system and plug-in modules, or the 8164B lightwave measurement system and plug-in modules. Any of the plug-in modules including DFB lasers, tunable lasers, or compact tunables can be configured for synchronous square-wave modulation. The internal modulation source from one of the lasers is used to trigger all of the lasers from synchronous modulation.

The modulation frequency may be from 20 kHz to 200 kHz. The 81662A and 81663A DFB modules may be modulated up to 100 kHz. A setting of 65 kHz is a good initial setting for most erbium-doped fiber amplifiers.

For synchronized modulation of two or more laser modules in the same mainframe, the setup is as follows:

**1** Choose the “master” laser and set as follows:

  **a** Menu > Modulation Source > Internal

  **b** Menu > Modulation frequency > desired value

  **c** Menu > Output trigger mode > Modulation

**2** Set all “slave” modules:

  **a** Menu > Modulation Source > Backplane (DFB modules require firmware version 4.0 or higher)

  **b** Menu > Output trigger mode > disabled (important)

**3** To pass the master trigger to the slaves, set up the mainframe through the Config button under the screen:

  Config > Trigger > Feedback (or Loopback)

**Note**: The master laser must always be turned on, if one or more slaves are on. Otherwise, it causes an error due to the missing trigger.

If an additional mainframe is used, a BNC cable can connect its input trigger to the master mainframe. Then this mainframe’s trigger configuration should be left on default and all modules set to modulate on the backplane. A BNC cable is required from the slave mainframe Input Trigger to the Output Trigger of the Master mainframe. Finally, as indicated on Figure 7, a BNC cable is required from the Source Trigger Out to the OSA ADC Trigger.

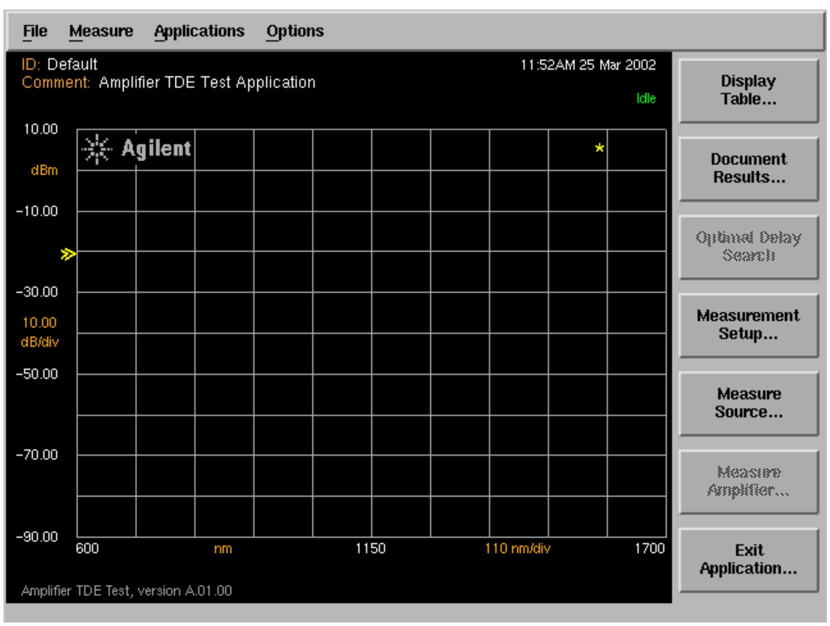
## Calibrating the Signal Path Offsets

Refer to “Calibrating the Signal Path Offsets” on page 17.

## Measuring the Source

After the offsets are calculated as described in the previous section, we can proceed with the amplifier measurement. The first step of the two-step TDE method is a set of sweeps that measure signal wavelength and power of the source. A second set of sweeps will measure the amplifier signal power and amplified spontaneous emission.

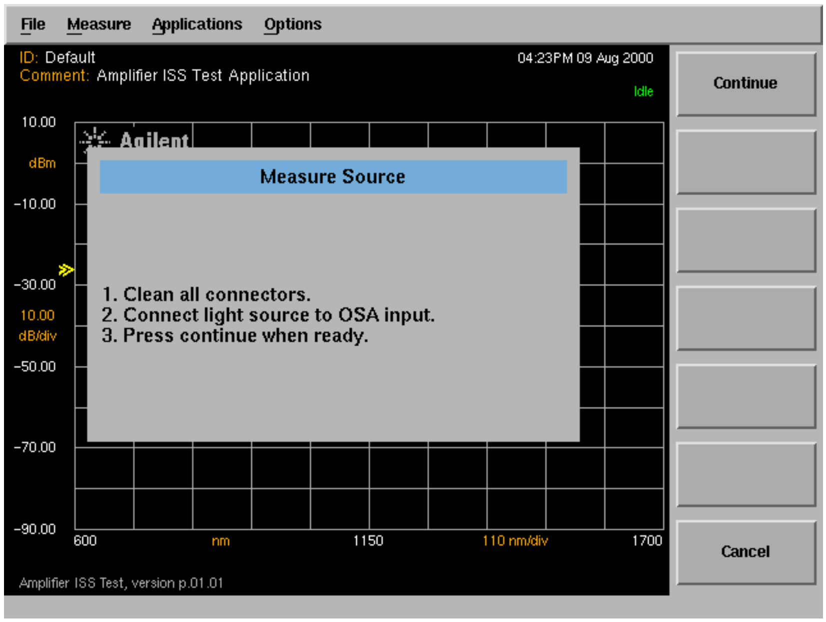
The Measure Source step must be repeated if there is any change in the measurement parameters or the source wavelength and power. Source data will be lost when exiting the application and must be remeasured.




Measuring the Source

**1** From the TDE Test menu, select MEASURE SOURCE....

Note that the MEASURE AMPLIFIER... softkey is disabled until the source measurement is completed.




Source Measurement Prompts

**2** The system prompts you to connect the source to the OSA.

The display connection prompts can be turned off in the measurement setup dialog box, in which case MEASURE SOURCE... will immediately initiate the measurement.

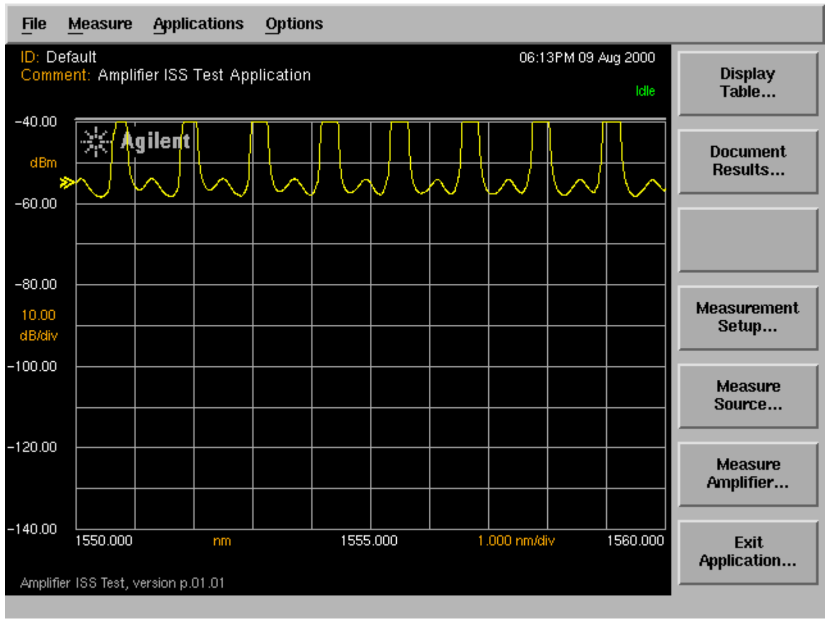
**3** Press CONTINUE to initiate the measurement.

MEASURE SOURCE... is replaced with STOP SOURCE MEASUREMENT... while the measurement is in progress.

**4** The progress of the measurement is noted on the status panel:

**a** An initial sweep is taken to set references, indicated by “Source Initial Sweep...”.

**b** A second sweep measures the peak of the signal, indicated by “Source Peak Sweep...”.




**5** When the measurement is complete, the MEASURE AMPLIFIER... softkey is enabled. The progress status label reads “Idle”.

## Using the Optimal Delay Search

**1** Connect the amplifier as shown in Figure 7.

**2** Press Optimal Delay Search on the TDE application menu.

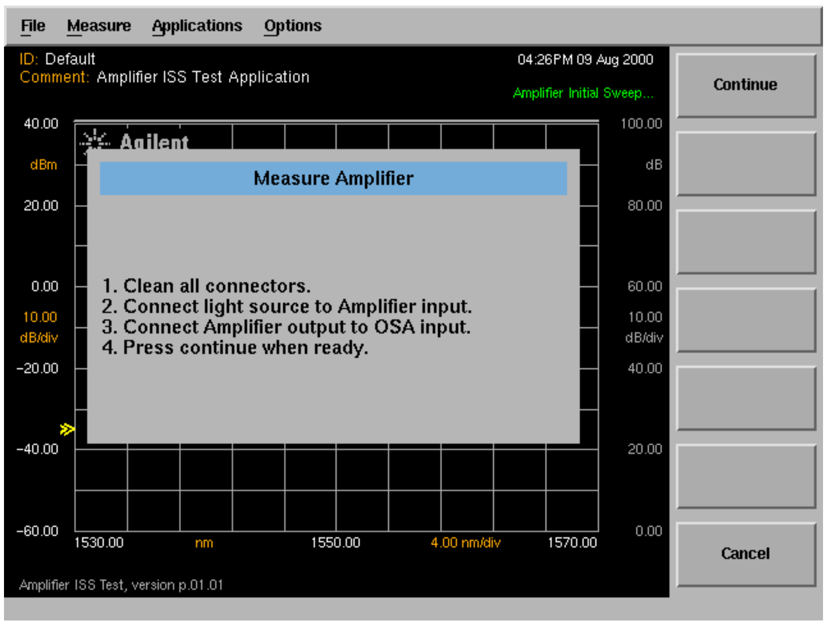
This routine will search for the optimal trigger delay for the source modulation rate. The optimal delay sets the ASE measurement point to the midpoint of the source Off period.

Occasionally, the Optimal Delay Search will not be able to find an optimal setting. In this case, enter the trigger delay manually. The value should be 25% of the modulation period plus 0.8 ms.

For a 65 kHz modulation rate, the period is 15.4 ms. The appropriate trigger delay is 0.25 x 15.4 ms + 0.8 ms = 4.6 ms.

## Measuring the Amplifier

In the second step of the two-step process the amplifier is connected between the source and the OSA. The system measures the peak and noise power for the wavelengths measured in Measuring the Source and creates/updates the Display Table.




Amplifier Measurement Prompts

**1** Press MEASURE AMPLIFIER... to begin the process.

**2** The system prompts you to connect the device to be tested.

The display connection prompts can be turned off in the measurement setup dialog box, in which case MEASURE AMPLIFIER... will immediately initiate the measurement.

**3** Press CONTINUE to initiate the measurement.

The MEASURE SOURCE... softkey is disabled. MEASURE AMPLIFIER... is replaced with STOP AMP MEASUREMENT... while the measurement is in progress.

4 The progress of the measurement is noted on the status panel:

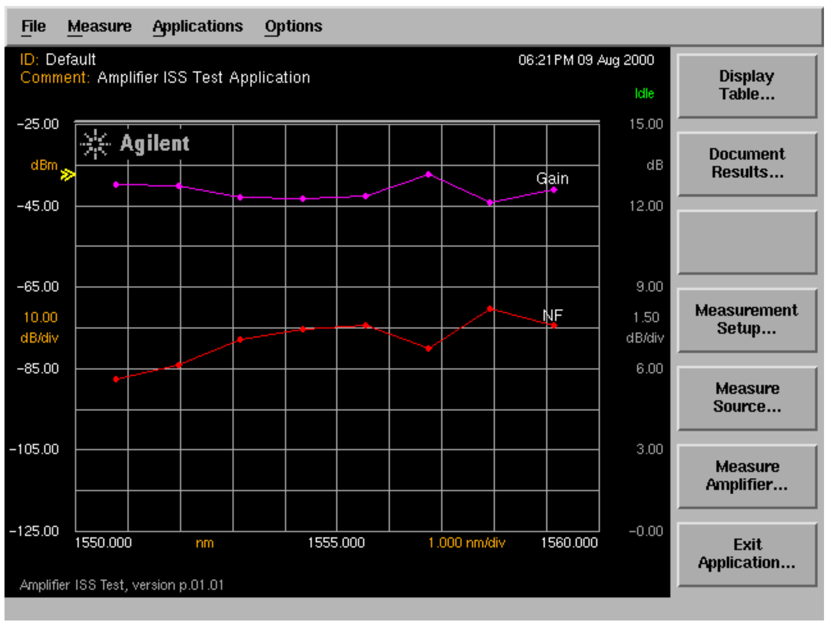
a An initial sweep is taken to set references, indicated by “Amplifier Initial Sweep...”.

b A second sweep measures the peak of the signal, indicated by “Amplifier Peak Sweep...”.

c A third sweep measures the noise level, indicated by “Amplifier Noise Sweep...”.

d After all the data is received, the application calculates the measurement results. The progress label reads “Calculating Results...”.

5 When the measurement is complete, the progress status label reads “Idle”.




Amplifier Measurement Results

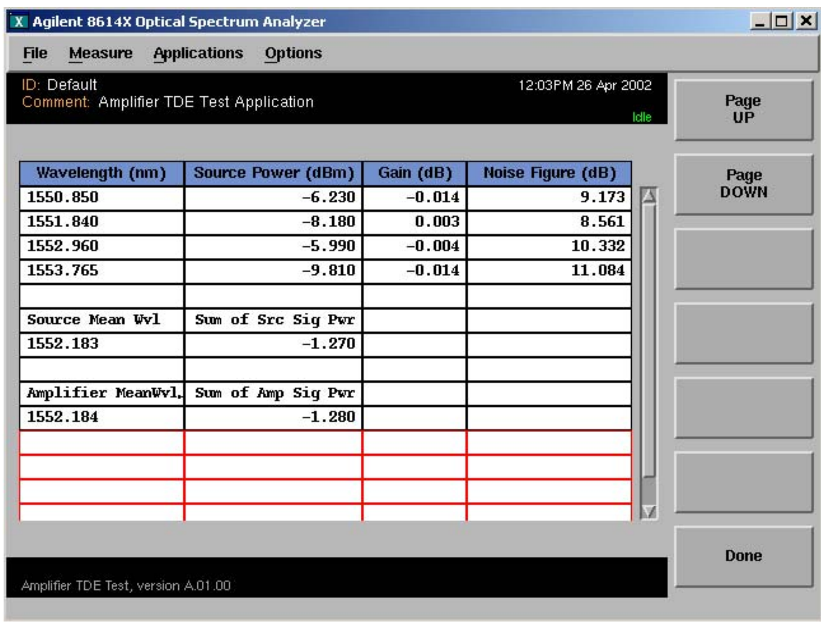
6 The measurement results will be displayed graphically. The points indicating the amplifier gain and noise figure are displayed relative to the dB scale on the right side of the graph. Negative noise figure values will not be displayed.

**NOTE**

If Continuous Amplifier Measurement mode is selected in the measurement setup dialog box, the measurement will continue to update the points on the display and in the Display Table at the end of each measurement.

## Viewing the Display Table

The DISPLAY TABLE... softkey is enabled when an amplifier measurement is complete and valid data is available. The results are displayed in a table similar to the one shown below. The Page Up and Page Down keys display previous and next pages of data if available.




When in continuous sweep mode the TDE Test application continues to sweep and update the tabular data at the end of each measurement.

At the end of the table, after all channels present have been measured, the table will display values of source mean wavelength, sum of source signal power, amplifier mean wavelength, and sum of amplifier signal power.

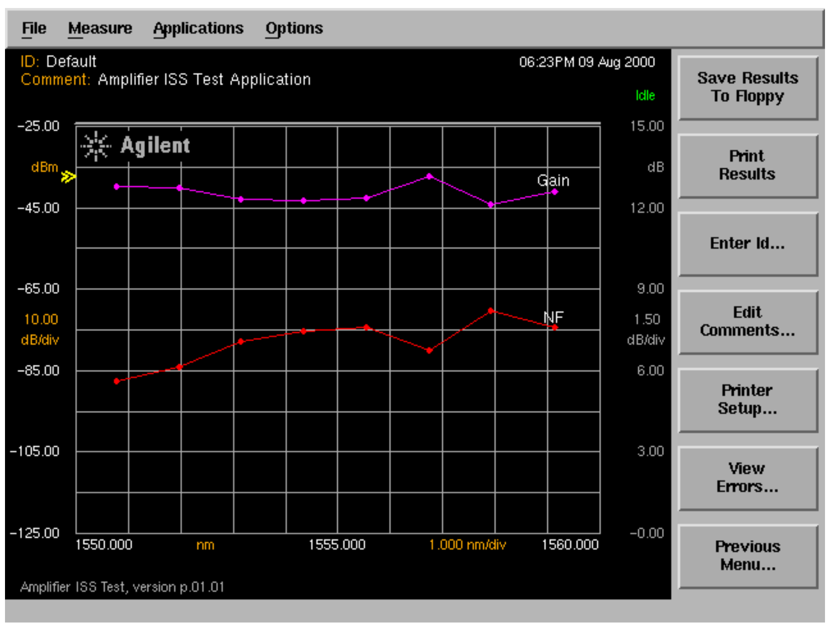
For a description of mathematical calculations refer to “Theory of Operation” on page 49.

## Documenting the Results

There are two ways to document results in the Amplifier Test application. You can either print them to a printer (specified under Printer Setup) or save them to a floppy disk.

After the source and amplifier measurements are complete and valid measurement data exists, the DOCUMENT RESULTS... softkey will be enabled.

Press DOCUMENT RESULTS... to display the Document Results selections.

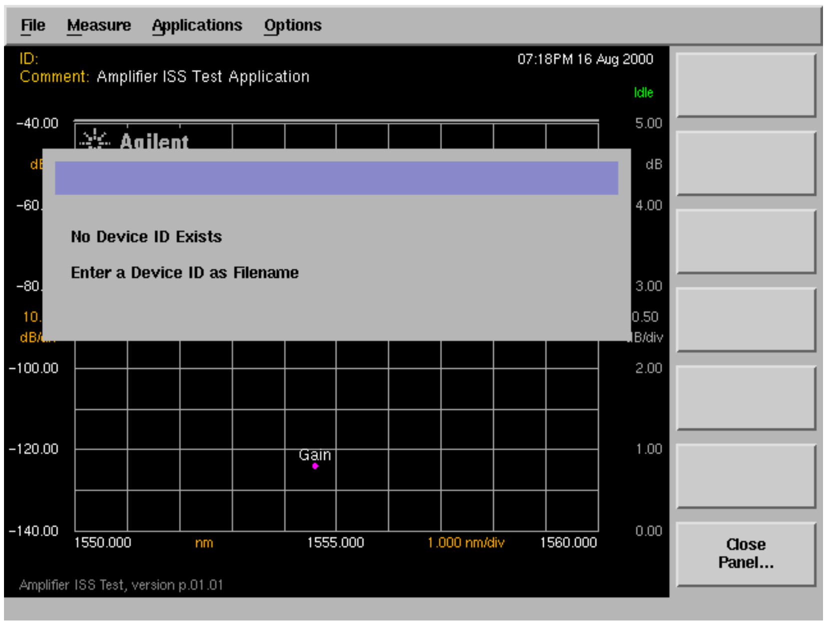



Document Results Menu

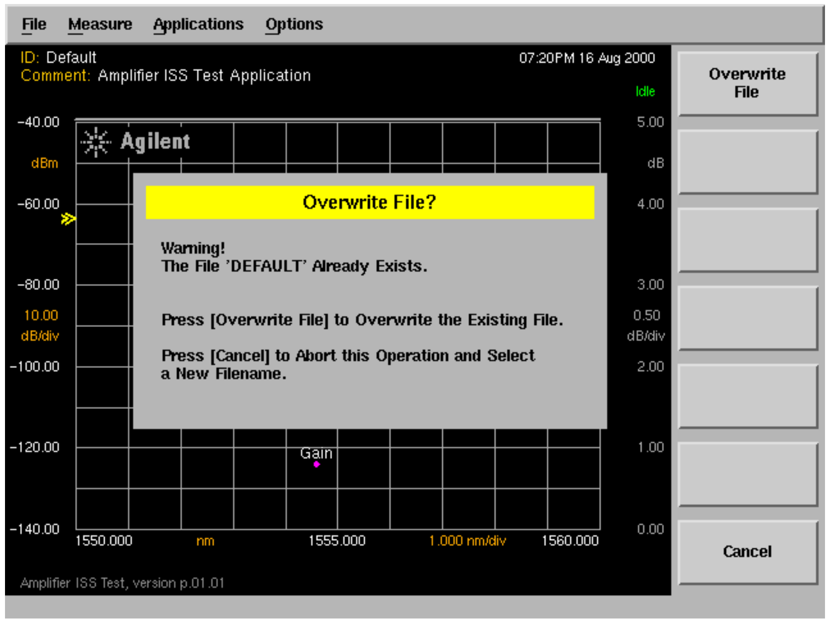
## Saving the results to a floppy disk

Press the SAVE RESULTS TO FLOPPY softkey to save the current results to a file on the floppy drive.

If a device ID has been entered, the name of the file is defaulted to the last 8 characters of the device ID.




If no ID exists, a message prompts you to "Enter a Device ID as Filename". Press CLOSE PANEL... to return to the Document Results menu and select ENTER ID... .



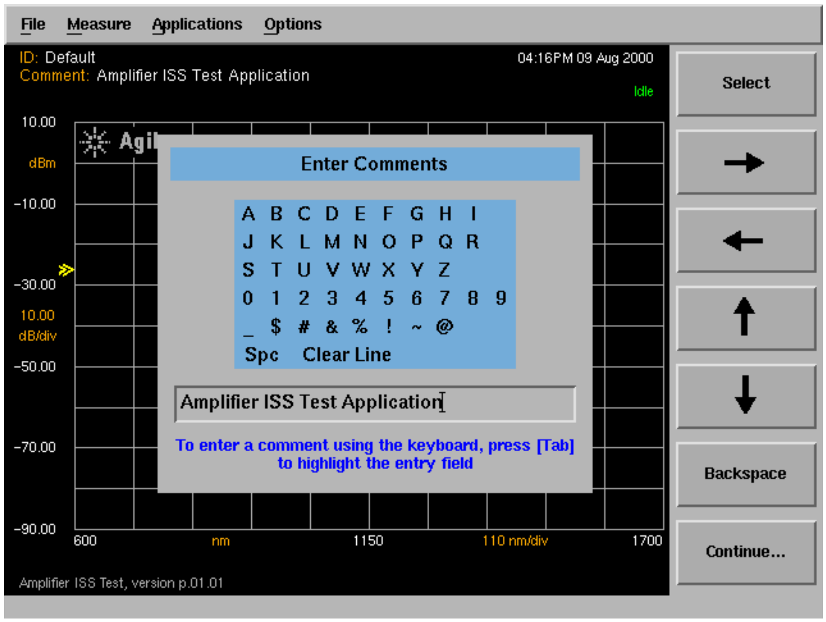

If the ID already exists, the warning "Overwrite File?" is displayed. Press OVERWRITE FILE to overwrite the existing file or CANCEL to return to the Enter ID screen.

A successful save operation is confirmed by a progress message displayed on the bottom left of the OSA display.

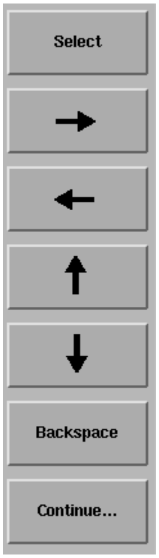
The current file is saved in ASCII (.csv) spreadsheet format. Graphics data is stored in Computer Graphics Metafile (.cgm) graphics format. This is a vector graphics format that describes pictures and graphical elements in geometric terms.

## Using the alphanumeric panel

Alphanumeric panels, such as the Device ID panel, allow you to enter identification and comment labels for the devices you test.




An example of an alphanumeric panel




**Select** selects the highlighted character.

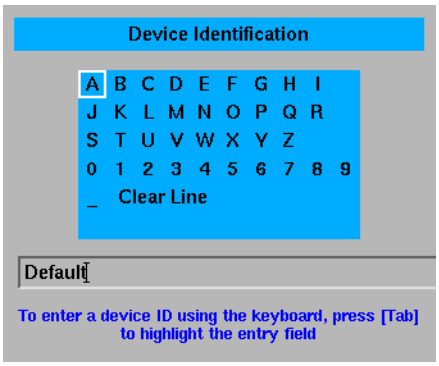
The **arrow** softkeys allow you to navigate from character to character in the dialog box.

**Backspace** removes a previously selected character.

**Continue** saves the current entry and returns you to the previous menu.

## To enter a device ID

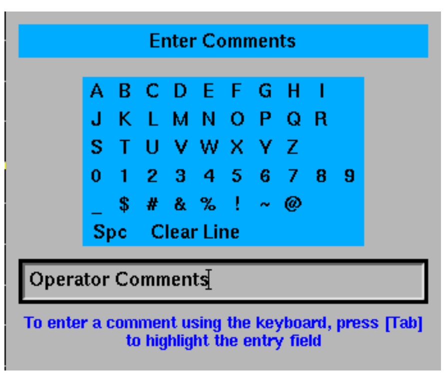
Press Enter ID... to access the Device Identification panel. Use the arrow and Select softkeys to enter the device ID. A maximum of 20 characters can be entered in this field.




Device Identification panel

## To enter comments

Press Enter Comments... to access the Enter Comments panel. Use the arrow and Select softkeys to enter a comment. A maximum of 50 characters can be entered in this field.




Enter Comments panel

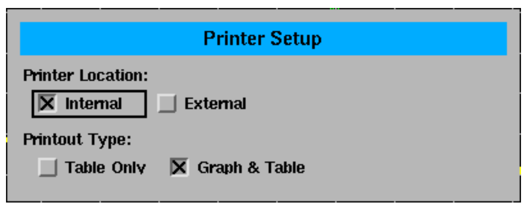
## Printing the results

1 Press PRINT RESULTS to print the results to the target printer.

The default setting is the internal printer and the default printout type is table only.

2 Press PRINTER SETUP... to access the Printer Setup dialog box.

3 Use the arrow and Select softkeys to select the target printer, and the printout type. This setting is reset when the front-panel PRESET key is pressed, otherwise the previous setting from the last time the application was started is retained.



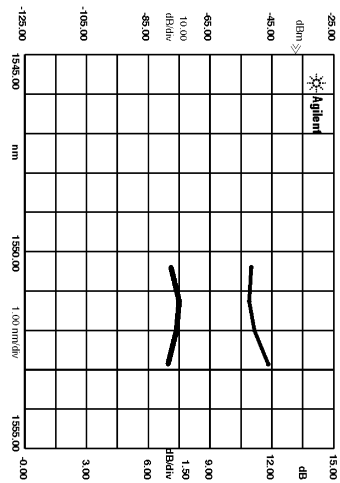

Printer Setup panel

The print operation is confirmed by a progress message displayed on the bottom left of the OSA display.

4 CLOSE PANEL... returns to the Document Results Menu.

The four possible print formats are shown in the following four figures:

3.0"




02:05PM 18 Aug 2000

DATA1

Amplifier ISS Test Application

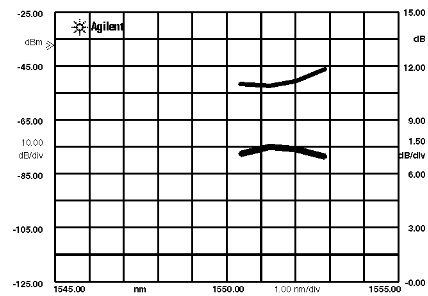
| | |
|---|---|
| Model# / Serial# | 86140A / pilot00052 |
| FW Rev / App Rev | p.01.67 p.01.01 / p.01.01 |
| Sens / Measured In | -69.55dBm / In Vacuum |

| Wavelength (nm) | Source Power (dBm) | Gain (dB) | Noise Figure (dB) |
|---|---|---|---|
| | | | |
| 1550.390 | -5.440 | 11.024 | 7.106 |
| 1551.260 | -5.800 | 10.874 | 7.532 |
| 1551.990 | -5.800 | 11.169 | 7.420 |
| 1552.830 | -5.980 | 11.810 | 6.946 |
| | | | |
| Source Mean Wvl | Sum of Src Sig Pwr | | |
| 1551.567 | 0.150 | | |
| | | | |
| Amplifier MeanWvl | Sum of Amp Sig Pwr | | |
| 1551.634 | 11.370 | | |
| | | | |
| | | | |
| | | | |
| | | | |

Graphics and Table, Internal Printer

8.5"

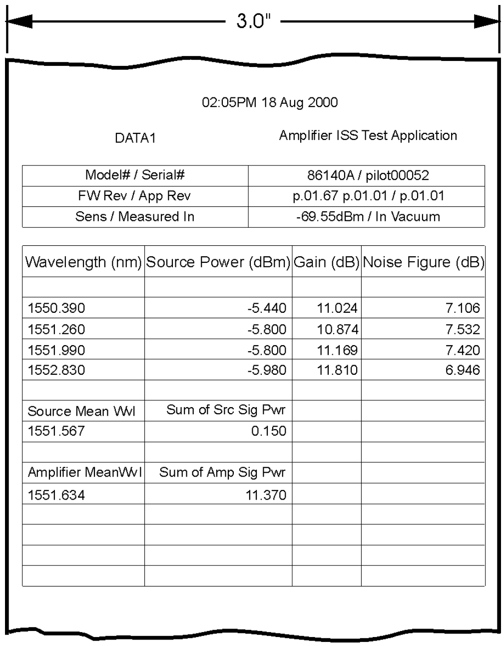
02:05PM 18 Aug 2000
DATA1
Amplifier ISS Test Application




| | |
|---|---|
| Model# / Serial# | 86140A / pilot00052 |
| FW Rev / App Rev | p.01.67 p.01.01 / p.01.01 |
| Sens / Measured In | -69.55dBm / In Vacuum |

| Wavelength (nm) | Source Power (dBm) | Gain (dB) | Noise Figure (dB) |
|---|---|---|---|
| | | | |
| 1550.390 | -5.440 | 11.024 | 7.106 |
| 1551.260 | -5.800 | 10.874 | 7.532 |
| 1551.990 | -5.800 | 11.169 | 7.420 |
| 1552.830 | -5.980 | 11.810 | 6.946 |
| | | | |
| Source Mean Wvl | Sum of Src Sig Pwr | | |
| 1551.567 | 0.150 | | |
| | | | |
| Amplifier MeanWvl | Sum of Amp Sig Pwr | | |
| 1551.634 | 11.370 | | |
| | | | |
| | | | |
| | | | |
| | | | |

Graphics and Table, External Printer




02:05PM 18 Aug 2000

DATA1 Amplifier ISS Test Application

| | |
|---|---|
| Model# / Serial# | 86140A / pilot00052 |
| FW Rev / App Rev | p.01.67 p.01.01 / p.01.01 |
| Sens / Measured In | -69.55dBm / In Vacuum |

| Wavelength (nm) | Source Power (dBm) | Gain (dB) | Noise Figure (dB) |
|---|---|---|---|
| | | | |
| 1550.390 | -5.440 | 11.024 | 7.106 |
| 1551.260 | -5.800 | 10.874 | 7.532 |
| 1551.990 | -5.800 | 11.169 | 7.420 |
| 1552.830 | -5.980 | 11.810 | 6.946 |
| | | | |
| Source Mean Wvl | Sum of Src Sig Pwr | | |
| 1551.567 | 0.150 | | |
| | | | |
| Amplifier MeanWvl | Sum of Amp Sig Pwr | | |
| 1551.634 | 11.370 | | |
| | | | |
| | | | |
| | | | |
| | | | |

Table Only, Internal Printer

8.5"

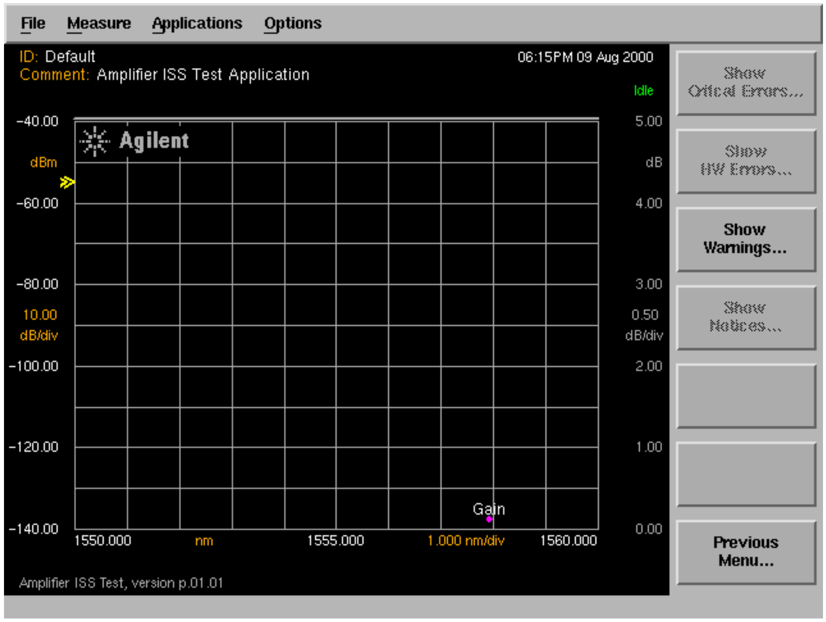
02:05PM 18 Aug 2000

| DATA1 | Amplifier ISS Test Application |
|---|---|
| Model# / Serial# | 86140A / pilot00052 |
| FW Rev / App Rev | p.01.67 p.01.01 / p.01.01 |
| Sens / Measured In | -69.55dBm / In Vacuum |

| Wavelength (nm) | Source Power (dBm) | Gain (dB) | Noise Figure (dB) |
|---|---|---|---|
| | | | |
| 1550.390 | -5.440 | 11.024 | 7.106 |
| 1551.260 | -5.800 | 10.874 | 7.532 |
| 1551.990 | -5.800 | 11.169 | 7.420 |
| 1552.830 | -5.980 | 11.810 | 6.946 |
| | | | |
| Source Mean Wvl | Sum of Src Sig Pwr | | |
| 1551.567 | 0.150 | | |
| | | | |
| Amplifier MeanWvl | Sum of Amp Sig Pwr | | |
| 1551.634 | 11.370 | | |
| | | | |
| | | | |
| | | | |
| | | | |

Table Only, External Printer

## Viewing Errors




Error Menu

Any errors generated in the course of the test or result documentation will generate error codes. These codes can be accessed by pressing the VIEW ERRORS... softkey. If any errors exist, the appropriate selection on the error menu will be enabled.

# Theory of Operation

## Interpolation Source Subtraction

The Amplifier Test application uses the Interpolation Source Subtraction (ISS) measurement technique to determine the noise figure of an amplifier. This method determines the amplified spontaneous emission (ASE) of the amplifier at the signal wavelength by measuring the noise power levels at wavelengths just above and below the signal and then interpolating to determine the noise level at the signal wavelength.

First, the spontaneous emission of the source is determined by measuring it's level at a specified offset (typically 1nm) above and below the signal wavelength and then taking the average of the measurements. This offset can be specified in the Measurement Setup dialog box, or calculated automatically using (0.5×RBW+0.5nm).

The same procedure is then used to determine the spontaneous emission at the output of the amplifier. The ASE and noise figure of the amplifier can then be determined using its calculated gain and these two spontaneous emission values.

### *Gain and Spontaneous Emission*

The purpose of an amplifier is to provide gain, which is defined as the ratio of output signal power to input signal power. These measured powers are actually the sum of the signal power and the small amount of spontaneous emission at the signal wavelength. This additional measured power can be a factor when high spontaneous emission levels are present.

### *Amplified Spontaneous Emission (ASE)*

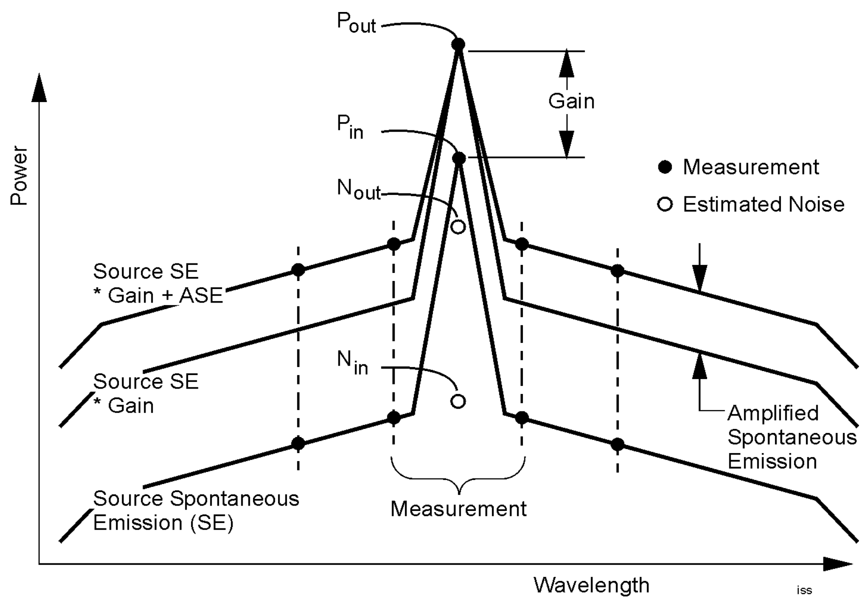
Ideally, an amplifier would amplify the input signal by it's gain and produce no additional output. However, amplifiers also produce ASE, which adds to the spontaneous emission of the source. This ASE is calculated as the difference between the output spontaneous emission power and the equivalent source spontaneous emission power measured at the amplifier output.

### *Interpolating Noise*

In order to correctly determine the noise figure, the ASE level must be determined at the signal wavelength. This cannot be directly measured because the ASE is masked by the signal power level. The ISS method uses filter characteristics of the OSA to reject the signal and measure the spontaneous emission levels at wavelengths near each signal.

To determine the noise level at the signal wavelength, several measurement sweeps are taken. The initial sweep adjusts the reference level to peak. The second sweep measures the power level and channel wavelength for each channel present, as well as the maximum noise value. The third and final sweep sets the reference level to the maximum noise level measured in the second sweep. It then measures the noise power for each channel by taking measurements above and below the channel wavelength at the predetermined offset value. These values are interpolated to determine the noise value at the channel wavelength. The linear interpolation method takes two measurements, one on each side of the channel. The noise at the channel wavelength is interpolated based on these two measurements.

The quadratic interpolation method takes four measurements, two on each side of the channel. This method approximates the curvature to account for curvature of the noise spectrum profile. In the vicinity of each channel, the noise generally assumes a Gaussian profile which can be modeled as a quadratic curve in dB. The noise at the channel wavelength is estimated based on the four measurements.




The noise figure of the amplifier is calculated from the measurements of the signal and ASE power levels using the following equations:

$$Gain = \frac{P_{out} - N_{out}}{P_{in} - N_{in}}$$

$$Gain(dB) = 10\log(Gain)$$

$$NoiseFactor \quad \frac{N_{out} - (N_{in}G)}{hvB_wG}\ \frac{1}{G}$$

$$NoiseFigure = 10\log(NoiseFactor)$$

Where:

- $P_{out}$ = amplifier output power
- $P_{in}$ = amplifier input power
- $N_{out}$ = interpolated output noise power
- $N_{in}$ = interpolated source noise power
- G = amplifier gain
- 1/G = the optional shot noise component
- $B_w$ = optical spectrum analyzer’s noise bandwidth in Hertz
- h = Plank’s constant ($6.626 \times 10^{-34}$ Watt seconds$^2$)
- v = signal frequency in Hertz

## Time Domain Extinction Technique

### *Erbium-Doped Fiber Recovery from Saturation*

The core of an optical amplifier, for wavelengths around 1550 nm, is a single-mode fiber doped with erbium. The erbium ions are shifted to higher energy levels by some pump lasers. The activated electrons remain in a meta stable level for some time. Without any signal at the amplifiers input, these electrons eventually fall down and emit some light randomly. However, if an input signal is applied, then the incoming wave stimulates the electrons to fall down and thus emit their energy coherently with the incoming wave. This is the main effect of the optical amplification. The amplification applies to randomly emitted photons as well, so the output spectrum of an optical amplifier consists of an amplified input spectrum (if applied) and the amplified spontaneous emission (ASE, which represents the noise from the amplifier.)

The more electrons used for stimulated emission, the fewer remain for random emission (and vice versa). Without an input signal, the ASE is much higher than with an input signal. Therefore, the ASE has to be measured when the amplifier is driven into saturation by an input signal.

The time domain extinction technique (TDE) takes advantage of the fact that the meta stable energy level of the erbium ion has a time constant of several hundreds of microseconds. Immediately after the input signal is turned off, the ASE power remains at the same level it was in the presence of the input signal. Then it starts to rise in an exponential fashion until it reaches the level of an undriven condition.

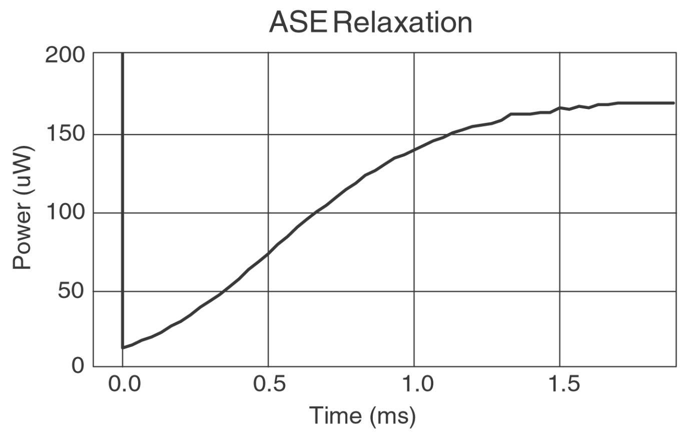



Figure 8   ASE time domain characteristics

The time characteristics can be tested using a laser source being modulated at a low frequency. Before the falling edge of the modulated laser, the amplifier noise (ASE) has stabilized at a saturated level. This power is the sum of the amplified input signal and the ASE which is very small due to the saturation of the amplifier. Immediately after the falling edge, the output signal consists of only ASE from the amplifier; that is, it does not contain the amplified signal any more, nor has it any sidemodes or spontaneous emission from the source. This fact allows accurate characterization of the ASE even at the wavelength of the saturating signal.

Because the power after the edge is up to a thousand times smaller than the power before, the measurement equipment must recover from the large signal in a very short time. The next figure shows typical recovery performance of the Agilent 8614XB family of optical spectrum analyzers. Within ten microseconds after the large signal has disappeared, the OSA can measure a 30 dB weaker signal with an accuracy of better than ±0.2 dB.

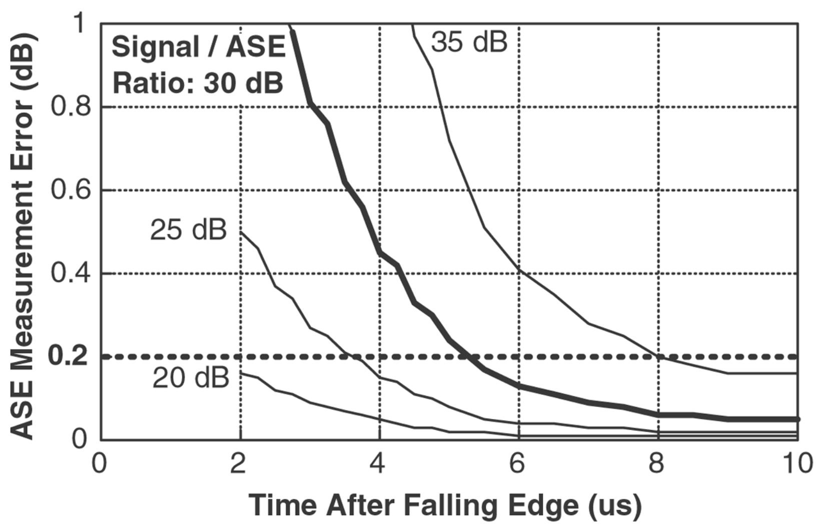



Figure 9 OSA recovery performance

# Amplifier Test Application Remote Commands

The Agilent 86140B Series Optical Spectrum Analyzer Programming Guide for the mainframe provides detailed information on remote programming of the instrument. Only commands unique to the Amplifier Test application are included in this section.

The Amplifier Test application remote command set is comprised of two types of commands:

***General Application support commands***

These are part of the base firmware and support applications in general. They allow you to get a list of installed applications, load / unload an application, and so on. These commands are grouped under:

- INSTrument Subsystem Commands

***Amplifier Test application specific commands***

These remote commands are specific to the Amplifier Test application and allow you to control the application remotely. They are grouped under the following subsystems:

- CALCulate Subsystem Commands
- FORMat Subsystem Commands
- INITiate Subsystem Commands
- SENSe Subsystem Commands

For more information, refer to the Remote Operation section in the Agilent 86140B Series Optical Spectrum Analyzer Programming Guide, or to the following book:

SCPI Consortium. *SCPI–Standard Commands for Programming Instruments, 1997*

## Command Conventions

Table 1

| Convention | Description |
|---|---|
| < > | Angle brackets indicate text strings entered by the developer. |
| [ ] | Square brackets indicate that the keyword DEFAULT can be used instead of a value or a variable for that parameter. Refer to the actual command description for the behavior when the DEFAULT keyword is used for a parameter. |
| \| | Indicates a choice of one element from a list. |
| { } | Braces indicate a group of constants to select from. Each constant is separated by the \| character. |
| name | Indicates the variable for which you provide a descriptive name. Any letter (Aa-Zz) followed by letters, digits (0-9) and underscore (_). Only the first 32 characters are significant. |
| spec_min | –infinity. The parameter *spec_min* cannot be a variable, only a constant or DEFAULT. |
| spec_max | +infinity. The parameter *spec_max* cannot be a variable, only a constant or DEFAULT. |
| from | Start wavelength or frequency of trace in nm (default) or THz. |
| to | Stop wavelength or frequency of trace in nm (default) or THz. |
| excursion | +excursion: means excursion dBs up (for example, from a pit).<br>-excursion: means excursion dBs down (for example, from a peak). |
| ref_pt | The reference point to be used for a measurement keyword. |

## CALCulate Subsystem Commands

The CALCulate subsystem performs post-acquisition data processing. The CALCulate subsystem operates on data acquired by a SENSe function.

### CALCulate:DATA:CPOWers?

Downloads the array of source channel powers measured. The data is returned in either an ASCII or binary form as determined by the FORMat:DATA command. The number of data points in this array is determined by the CALCulate:DATA:NCHannels? query.

### CALCulate:DATA:CGAin?

Downloads the array of channel gain values measured. The data is returned in either an ASCII or binary form as determined by the FORMat:DATA command. The number of data points in this array is determined by the CALCulate:DATA:NCHannels? query.

### CALCulate:DATA:CNF?

Downloads the array of channel noise figure values measured. The data is returned in either an ASCII or binary form as determined by the FORMat:DATA command. The number of data points in this array is determined by the CALCulate:DATA:NCHannels? query.

### CALCulate:DATA:CSTats?

Downloads the following statistics using a single query:

- Source mean wavelength
- Sum of source signal power
- Amplifier mean wavelength
- Sum of amplifier signal power

The data is returned in either an ASCII or binary form as determined by the FORMAT:DATA command.

### CALCulate:DATA:CWAVelengths?

Downloads the array of channel wavelengths measured. The data is returned in either an ASCII or binary form as determined by the FORMat:DATA command. The number of data points in this array is determined by the

CALCulate:DATA:NCHannels? query. The units are either nanometers or terahertz and can be changed using the CALCulate:DATA:TABLe:WAVe command.

---

**CALCulate:DATA:NCHannels?**

Queries the number of channels detected in the last measurement. The data is returned as an ASCII integer.

---

**CALCulate:DATA:TABLe:WAVe NM | THZ**

**CALCulate:DATA:TABLe:WAVe?**

Sets the wavelength units used for the tabular display and for the CALCulate:DATA:CWAVelengths remote query. Default units are NM.

The instrument x-axis display always displays wavelength in nanometers and is not affected by this command.

**Example**

```
CALC:DATA:TABL:WAV NM                    ! Assign table units to nm
```

---

**CALCulate:OFFSet:AMPLifier <numeric_value>**

**CALCulate:OFFSet:AMPLifier?**

Sets the trace level offset or power correction factor in dB for the amplifier path. The “dB” terminator is not required in the command.

**Example**

```
CALC:OFFS:AMPL 11                        ! Assign an amp offset
CALC:OFFS:AMPL?                          ! Read offset
```

**CALCulate:OFFSet:SOURce <numeric value>**

**CALCulate:OFFSet:SOURce?**

Sets the trace level offset or power correction factor in dB for the source path. The "dB" terminator is not required in the command.

| Example | | |
|---|---|---|
| | CALC:OFFS:SOUR 13 | ! Assign a source offset |
| | CALC:OFFS:SOUR? | ! Read offset |

**CALCulate:PEXCursion[:PEAK] <numeric_value>**

**CALCulate:PEXCursion[:PEAK]?**

Sets the peak excursion value for the marker search routines. The peak excursion value is used to determine whether or not a local maximum in the trace is to be considered a peak. To qualify as a peak, both sides of the local maximum must fall by at least the peak excursion value.

| Example | | |
|---|---|---|
| | CALC:PEX 5 | ! Assign peak excursion |
| | CALC:PEX? | ! Read peak excursion |

**CALCulate:THReshold <numeric_value> [DBM]**

**CALCulate:THReshold?**

Specifies the value for the peak search threshold. Peaks with amplitudes below this value will not be included in the channel count.

Units are DBM.

| Example | | |
|---|---|---|
| | CALC:THR -40 DBM | ! Assign a peak threshold |
| | CALC:THR? | ! Read peak threshold |

**CALCulate:SNOise [ON|OFF|0|1]**

**CALCulate:SNOise?**

Sets the shot noise term included/excluded in noise figure calculations. Default value is false. By default the shot noise term will not be added to the noise figure.

**Example**

```
CALC:SNO OFF        ! Turn off shot noise term
CALC:SNO?           ! Read shot noise
```

## CALibration Subsystem Commands

This subsystem has the function of performing system calibration.

### CALibration Alignment

Performs an automatic alignment of the instrument at the wavelength of the largest signal found in full span. This aligns the monochromator output with the photodetector for improved amplitude accuracy.

**Syntax** CAL:ALIG

**Related Key** Auto Align

## DISPlay Subsystem Commands

The DISPlay subsystem controls the selection and presentation of textual, graphical, and TRACe information.

### DISPlay[:WINDow]:DUT:COMMent<string>

Enters a new comment string for the device under test.

### DISPlay[:WINDow]:DUT:COMMent?

Returns the comment string for the device under test.

### DISPlay[:WINDow]:DUT[:ID]<string>

Enters a new identification string for the device under test.

**DISPlay[:WINDow]:DUT[:ID]?**

Returns the identification string for the device under test.

## FORMat Subsystem Commands

The FORMat subsystem sets a data format for transferring numeric and array information.

**FORMat[:DATA] REAL[32,64]|ASCII**

**FORMat[:DATA]?**

Specifies the format used during data transfer via GPIB. This command affects data transfers for the CALCulate[:DATA] subsystem.

The ASCII format is a comma-separated list of numbers.

The REAL format is a definite-length block of either 32-bit or 64-bit floating-point binary numbers. The definite-length block is defined by IEEE 488.2: a "#" character, followed by one digit (in ASCII) specifying the number of length bytes to follow, followed by the length (in ASCII), followed by length bytes of binary data. The binary data is a sequence of 8-byte floating point numbers, default to 64-bit and selectable to 32-bit.

## INITiate Subsystem Commands

The INITiate subsystem is used to control the initiation of the TRIGger subsystem.

**INITiate:IMMediate[:SEQuence [1|2]]**

Initiates the source measurement (sequence 1) or amplifier measurement (sequence 2) based on the sequence number. Default is sequence 2.

## INSTrument Subsystem Commands

The INSTrument subsystem provides a mechanism to identify and select logical instruments by either name or number. Arguments and responses are case sensitive.

**INSTrument:CATalog?**

**{Filter1,PowerMeter, OSA,PassiveComponent,WDM_AutoScan,Amp_ISS_Test, Amp_TDE_Test,<null>}**

Comma-separated list of strings representing the modes and applications supported in the instrument.

**INSTrument:CATalog:FULL?**

**{OSA,0,Filter1,1,PowerMeter,2,PassiveComponent,3,WDM_AutoScan,4,Amp_ISS_Test,5, Amp_TDE_Test,6}**

Comma-separated list of string-numeric pairs representing the modes and applications supported in the instrument.

**INSTrument:SELect <identifier> identifier - string**

**INSTrument:NSELect <numeric_value>**

**INSTrument:NSELect?**

Loads the application or instrument mode specified. Use the CATalog:FULL? command to obtain the number. Firmware revisions will add additional applications and the order may vary.

**Example**

```
INST:SEL ‘Amp_ISS_Test’        !Select amplifier interpolated source
                                 subtraction test
INST:NSEL5                     !Select amplifier test by number
INST:SEL?                      !Read ‘Amp_ISS_Test’

INST:SEL ‘Amp_TDE_Test’        !Select amplifier time domain extinction
                                 test
INST:NSEL6                     !Select amplifier test by number
INST:SEL?                      !Read ‘Amp_TDE_Test’
```

## SENSe Subsystem Commands

The SENSe setup commands control the specific settings of the device.

**SENSe:AVERage:COUNt <integer>**

**SENSe:AVERage:COUNt?**

Sets and queries the number of sweeps that will be averaged. Range is 1-1000. Command will also turn on trace averaging if it is not already on.

**Example**

```
SENS:AVER:COUN <INT>        ! Sets count for trace averaging
SENS:AVER:COUN?             ! Gets count for trace averaging
```

**SENSe:AVERage:[STATe] <ON|OFF|1|0>**

**SENSe:AVERage:[STATe]?**

Turns trace averaging on or off and queries trace averaging state.

**Example**

```
SENS:AVER[:STAT] <on|off.>  ! Turns trace averaging on/off
SENS:AVER[:STAT]            ! Gets trace averaging on/off
```

**SENSe:BANDwidth|BWIDth[:RESolution]: <numeric_value> [M|NM|UM|A]**

**SENSe:BANDwidth|BWIDth[:RESolution]?**

Sets the resolution bandwidth value to be used. Resolution bandwidth determines the instrument's ability to display two closely spaced signals as two distinct responses.

The resolution bandwidth can be set to one of the following values:

- **For 86140B Option 025, 86143B option 025, 86141B:**
  0.07 nm, 0.1 nm, 0.2 nm, 0.3 nm, 0.5 nm, 1 nm, 2 nm, 5 nm, 10 nm.
- **For 86140B, 86142B, 86143B, 86145B:**
  0.06 nm, 0.1 nm, 0.2 nm, 0.3 nm, 0.5 nm, 1 nm, 2 nm, 5 nm, 10 nm.
- **For 86144B, 86146B internal path:**
  0.06 nm, 0.07 nm, 0.1 nm, 0.14 nm, 0.2 nm, 0.33 nm, 0.5 nm, 1 nm, 2 nm, 5 nm, 10 nm.
- **For 86144B, 86146B external path:**

0.04 nm, 0.05 nm, 0.07 nm, 0.1 nm, 0.2 nm, 0.3 nm, 0.5 nm, 1 nm, 2 nm, 5 nm, 10 nm.

For the greatest measurement range and signal to noise ratio performance, a resolution bandwidth of 10 nm is recommended. Narrower bandwidths can be used if greater wavelength resolution is required.

**Example**

```
SENS:BWID .5 NM        ! Select a RBW for measurement
SENS:BWID?             ! Read bandwidth
```

---

**SENSe:BANDwidth|BWIDth: VIDeo <real>**

**SENSe:BANDwidth|BWIDth:VIDeo?**

Permits setting video bandwidth via remote interface with the SCPI command.

**Example**

```
SENS:BAND:VID <param>      ! Sets video bandwidth
SENS:BAND |BWID:VID ?      ! Gets video bandwidth
```

---

**SENSe:INTerpolation:METHod <LINear|QUADratic>**

**SENSe:INTerpolation:METHod?**

Allows selection and query of the interpolation method (linear or quadratic).

**Example**

```
SENS:INT:METH <LIN|QUAD>   ! Sets interpolation method, linear or 4
pt
                             quad
SENS:INT:METH?             ! Gets current interpolation
method
```

---

**SENSe:INTerpolation:OFFSet:VALue?**

**SENSe:INTerpolation:OFFSet:AUTO [ON|OFF|0|1]**

**SENSe:INTerpolation:OFFSet:AUTO?**

Specifies the noise measurement locations for interpolation. If auto is set to true, then the application will calculate the best offset value. Default units are NM.

**SENSe:[WAVelength:]STARt <numeric_value> [M|NM|UM|A|HZ|KHZ|MHZ|GHZ]**

**SENSe:[WAVelength:]STARt?**

Specifies the start wavelength for the Amplifier Test Application. Default units are NM.

**Example**

```
SENS:STAR 1500 NM        ! Select the start wavelength
SENS:STAR?               ! Read wavelength
```

**SENSe:[WAVelength:]STOP <numeric_value> [M|NM|UM|A|HZ|KHZ|MHZ|GHZ]**

**SENSe:[WAVelength:]STOP?**

Specifies the stop wavelength for the Amplifier Test application. Default units are NM.

**Example**

```
SENS:STOP 1540 NM        ! Select the stop wavelength
SENS:STOP?               ! Read wavelength
```

## TRIGger Subsystem Commands

**TRIGger[:SEQuence]:DELay:AUTO**

***For 86146B only***

Initiates a routine to automatically find the optimum trigger delay. TDE uses the source external trigger output to trigger the OSA to sample when the source is off. The OSA will measure the ASE associated with the amplifier.

**TRIGger[:SEQuence]:DELay<time>**

**TRIGger[:SEQuence]:DELay?**

***For 86146B only***

Sets the trigger delay used for the TDE measurement. TDE uses the source external trigger output to trigger the OSA to sample when the source is off. The OSA will measure the ASE associated with the amplifier.

# ISS Measurement Method Example Program

**Program**

```
10  !***************************** Select Amplifier ISS Test *****************************
20  !
30  ASSIGN @Osa TO 723;EOL CHR$(10) END                ! Use LF and EOI as command
terminators
40  !
50  OUTPUT @Osa;"inst:sel 'Amp_ISS_Test'"                ! Select Amp ISS test
60  !
70 !***************************** Measurement Setup **********************************
80 !
90  OUTPUT @Osa;"sens:int:meth quad"                     ! Select 4 pt quad int
100   !
110 !***************************** Measure the Source *********************************
120   !
130   INPUT "Connect source and press Enter to continue",A$
140   OUTPUT @Osa;"init:imm:seq 1"                       ! Take a source measurement
150   !
160 !***************************** Measure the Amplifier *******************************
170   !
180   INPUT "Connect amplifier and press Enter to continue",A$
190   OUTPUT @Osa;"init:imm:seq 2"                       ! Take an amplifier measurement
200   !
210 !***************************** Read the Results ************************************
220   !
230   OUTPUT @Osa;"calc:data:nch?"                       ! Find number of channels measured
240   ENTER @Osa;Nchannels
250   PRINT "Number of channels"
260   PRINT Nchannels
270   PRINT
280   !
290   ALLOCATE Datarray(1:Nchannels)
300   !
310   OUTPUT @Osa;"calc:data:cwav?"                      ! Read in the channel wavelengths
320   ENTER @Osa;Datarray(*)
330   PRINT "Channel wavelengths"
340   PRINT Datarray(*)
350   PRINT
360   !
370   OUTPUT @Osa;"calc:data:cpow?"                      ! Read in the channel powers
380   ENTER @Osa;Datarray(*)
390   PRINT "Channel powers"
400   PRINT Datarray(*)
410   PRINT
420   !
430   OUTPUT @Osa;"calc:data:cga?"                       ! Read in the channel gains
440   ENTER @Osa;Datarray(*)
```

```
450   PRINT "Channel gains"
460   PRINT Datarray(*)
470   PRINT
480   !
490   OUTPUT @Osa;"calc:data:cnf?"                  ! Read in the channel noise figures
500   ENTER @Osa;Datarray(*)
510   PRINT "Channel noise figures"
520   PRINT Datarray(*)
530   PRINT
540   !
550 !**************************** Read the Test Results ********************************
560   !
570   OUTPUT @Osa;"calc:data:cst?"                  ! Query statistics table Results
580   ENTER @Osa;Sourmwl;Sumsrcpwr;Ampmwl;Sumsamppwr
590   PRINT "Source Mean WL"
600   PRINT Sourmwl
610   PRINT
620   !
630   PRINT "Sum of Src Sig Pwr"
640   PRINT Sumsrcpwr
650   PRINT
660   !
670   PRINT "Amplifier Mean WL"
680   PRINT Ampmwl
690   PRINT
700   !
710   PRINT "Sum of Amp Sig Pwr"
720   PRINT Sumsamppwr
730   PRINT
740   !
750 !**************************** Exit the Application ********************************
760   !
770   OUTPUT @Osa;"*RST"                            ! Exit amplifier ISS application
780   LOCAL @Osa
790   END


==========================================================
Number of channels
+3

Channel wavelengths
+1.55385770E-006,+1.55485825E-006,+1.55594775E-006

Channel powers
-3.14317435E+000,-5.22143262E+000,-2.93054801E+000

Channel gains
+7.97910584E-003,-2.28063112E-003,-8.10500742E-003

Channel noise figures
+9.91000000E+037,+9.91000000E+037,+9.91000000E+037

Source Mean WL
+1.55492086E-006
```

Sum of Src Sig Pwr
1.12172171E+000

Amplifier Mean WL
+1.55491862E-006

Sum of Amp Sig Pwr
+1.12099868E+000

# TDE Measurement Method Example Program

**Program**

```
10 !****************************Select Amplifier TDE Test ******************************
20  !
30  ASSIGN @Osa TO 723;EOL CHR$(10) END              ! Use LF and EOI as command
terminators
40  !
50  OUTPUT @Osa;"inst:sel 'Amp_TDE_Test'"            ! Select Amp TDE test
60  !
70 !****************************Measurement Setup **********************************
80  !
90  !
100   OUTPUT @Osa;"sens:int:meth quad"               ! Select 4 pt quad int
110   !
120 !**************************** Measure the Source ********************************
130   !
140   INPUT "Connect source and press Enter to continue",A$
150   OUTPUT @Osa;"init:imm:seq 1"                   ! Take a source measurement
160   OUTPUT @Osa;"trig:seq:del:auto"                ! Determine trigger delay
170   !
180   !***** Measure the Amplifier ***************************************************
190   !
200   INPUT "Connect amplifier and press Enter to continue",A$
210   OUTPUT @Osa;"init:imm:seq 2"                   ! Take an amplifier measurement
220   !
230 !****************************Read the Results ***********************************
240   !
250   OUTPUT @Osa;"trig:seq:del?"                    ! Find trigger delay
260   ENTER @Osa;Trigdelay
270   PRINT "Trigger delay"
280   PRINT Trigdelay
290   PRINT
300   !
310   OUTPUT @Osa;"calc:data:nch?"                   ! Find number of channels measured
320   ENTER @Osa;Nchannels
330   PRINT "Number of channels"
340   PRINT Nchannels
350   PRINT
360   !
370   ALLOCATE Datarray(1:Nchannels)
380   !
390   OUTPUT @Osa;"calc:data:cwav?"                  ! Read in the channel wavelengths
400   ENTER @Osa;Datarray(*)
410   PRINT "Channel wavelengths"
420   PRINT Datarray(*)
430   PRINT
440   !
```

```
450   OUTPUT @Osa;"calc:data:cpow?"                 ! Read in the channel powers
460   ENTER @Osa;Datarray(*)
470   PRINT "Channel powers"
480   PRINT Datarray(*)
490   PRINT
500   !
510   OUTPUT @Osa;"calc:data:cga?"                  ! Read in the channel gains
520   ENTER @Osa;Datarray(*)
530   PRINT "Channel gains"
540   PRINT Datarray(*)
550   PRINT
560   !
570   OUTPUT @Osa;"calc:data:cnf?"                  ! Read in the channel noise figures
580   ENTER @Osa;Datarray(*)
590   PRINT "Channel noise figures"
600   PRINT Datarray(*)
610   PRINT
620   !
630 !***************************** Read the Test Results ********************************
640   !
650   OUTPUT @Osa;"calc:data:cst?"                  ! Query statistics table results
660   ENTER @Osa;Sourmwl;Sumsrcpwr;Ampmwl;Sumsamppwr
670   PRINT "Source Mean WL"
680   PRINT Sourmwl
690   PRINT
700   !
710   PRINT "Sum of Src Sig Pwr"
720   PRINT Sumsrcpwr
730   PRINT
740   !
750   PRINT "Amplifier Mean WL"
760   PRINT Ampmwl
770   PRINT
780   !
790   PRINT "Sum of Amp Sig Pwr"
800   PRINT Sumsamppwr
810   PRINT
820   !
830   !**************************** Exit the Application*********************************
840   !
850   OUTPUT @Osa;"*RST"                            ! Exit amplifier tde application
860   LOCAL @Osa
870   END

=============================================================
```

## Test Results

Trigger delay
+4.65435560E-006

Number of channels
+3

Channel wavelengths
+1.55385770E-006,+1.55485825E-006,+1.55596998E-006

Channel powers
-6.17120296E+000,-8.13289990E+000,-5.85822828E+000

Channel gains
+6.64604087E-003,+3.22791498E-002,-1.66935339E-002

Channel noise figures
+4.64523752E+000,+4.87264832E+000,+4.88462994E+000

Source Mean WL
+1.55492714E-006

Sum of Src Sig Pwr
-1.83947201E+000

Amplifier Mean WL
+1.55492862E-006

Sum of Amp Sig Pwr
-1.83601805E+000

# Source Test Application

# About the Application

The Source Test application is implemented in the Agilent 86140B series optical spectrum analyzer (OSA). All specifications and characteristics are derived from the 86140 series specifications.

The application quickly and accurately measures peak wavelength, power, full width at half maximum (FWHM) and other source characteristics for distributed feedback (DFB) lasers, Fabry-Perot (FP) lasers, and light emitting diodes (LEDs).

When the Source Test application is launched, the selected source test (DFB, FP, or LED) main softkey menu is displayed and changes are made to the standard OSA screen. The Marker Display panel is overlaid with the selected Source Test Results panel.

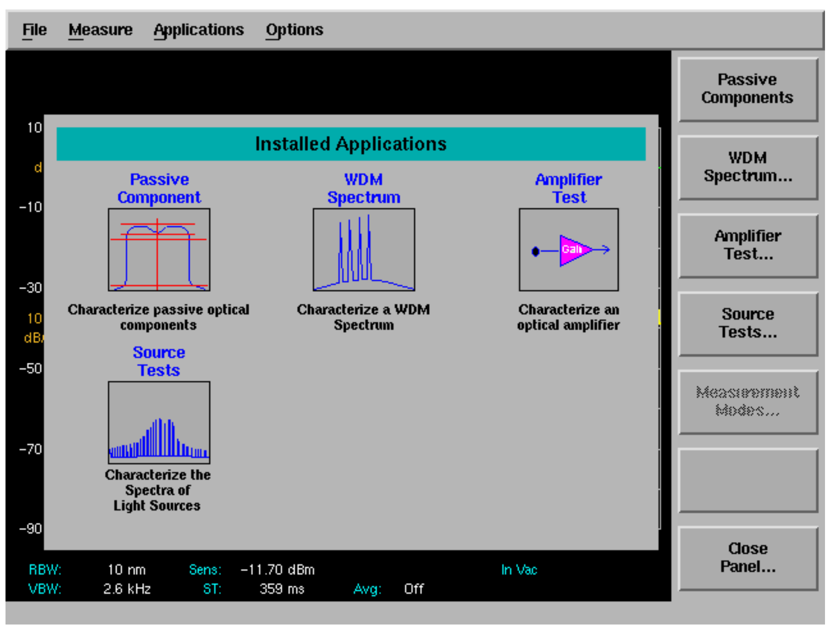
When in the Source Test application, all standard OSA functions are available. You may leave the Source Test menu by selecting any desired OSA function. Pressing the Appl's key will always bring you back to the source test menu. Pressing EXIT SOURCE TESTS will turn off source tests or pressing PRESET will reset the source test settings to their default values and turn off source tests.

# Performing Measurements

This section explains how to start and use the Source Test application. The application quickly and accurately measures peak wavelength, power, full width at half maximum (FWHM) and other source characteristics for distributed feedback (DFB) lasers, Fabry-Perot (FP) lasers, and light emitting diodes (LEDs).

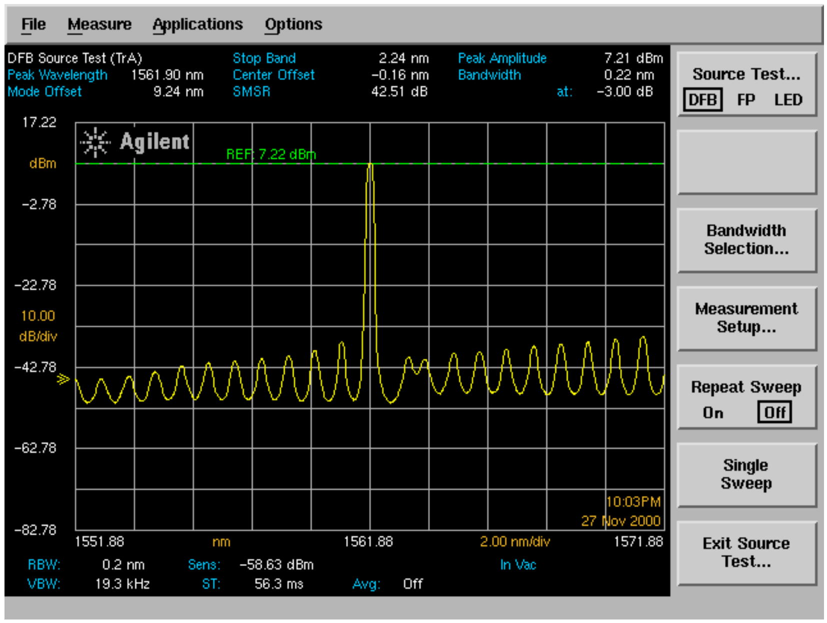
## Starting the Source Test Application

**1** Press the front-panel APPL'S key or, on the APPLICATIONS menu, select LAUNCH AN INSTALLED APPLICATION. The following screen is displayed:



Each installed application has an icon on the panel and a corresponding softkey.

**2** Press SOURCE TESTS to bring up the source test display, menu, and results panel shown below.




The Source Test results panel appears in the marker area at the top of the screen. Measurement results (attributes) for all source tests are displayed in this panel. The currently selected source test and trace names are displayed in the upper left corner of the results panel. Once a source test is initiated on a given trace, it remains associated with that trace even though another trace may be made active.

**Tip:** To change the selected source test trace, select the new trace (press TRACES > ACTIVE TRACE), switch to another source test momentarily using the Source Test softkey, and then reselect the original source test.

In addition to the source test results panel, the source test softkey menu is also displayed with the following softkeys:

**Source Test** is used to select the desired source test. The DFB source test is the default test.

**Bandwidth Selection** is active only during the DFB source test and allows you to change the vertical offset from the peak for the bandwidth measurement attribute.

**Measurement Setup** brings up the Source Test Measurement Setup Panel.

**Repeat Sweep** turns continuous sweep mode on or off.

**Single Sweep** initiates a single sweep or turns single sweep mode on.

**Exit Source Test** exits the application.

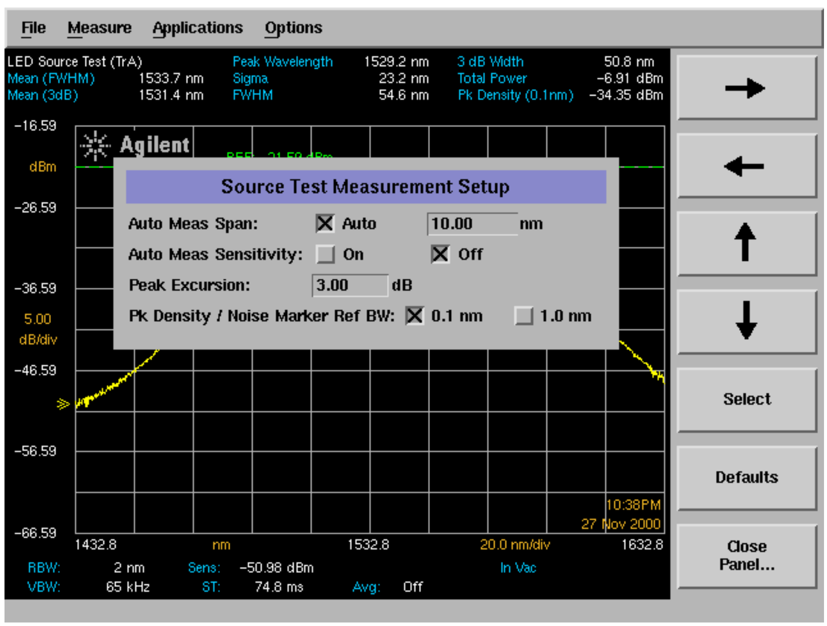
All normal OSA functionality is available while in the Source Test application. Simply select the desired function and press the APPL'S key when ready to return to the source test application.

## Setting Up a Measurement

Performing a source measurement is a two step process: First you must select the source test type for measurement (by pressing SOURCE TEST and selecting the desired test). Next, you can specify the parameters used for the measurement (by pressing Measurement Setup to access the Source Test Measurement Setup panel). The most common source measurement settings can be accessed via the setup panel. Remember that all standard OSA functions are also available while using the Source Test application.

**NOTE**

Changing any of the source test measurement settings will affect the corresponding settings in Auto Meas and Marker Setup Panels. These settings are grouped here for convenience.




**Auto Measure (Auto Meas) Span** selects the wavelength span for viewing the signal located by the auto measure function. If Auto is specified, the span is set wide enough to display most of the signal. If a particular span is desired, clear

Auto and enter the desired span in the nm text box. The recommended selection for Auto Meas Span is Auto for FP and LED source testing and the recommended setting for DFB source testing is 10 nm.

**Auto Meas Sensitivity** sets the sensitivity of the Auto Measure function so the resulting measurement has a minimal amount of noise. It is determined by finding the minimum in the measurement trace and comparing this value to the known sensitivity of the instrument at that wavelength. Sensitivity is then reduced until the signal is close to this minimum sensitivity or the sweep time becomes too long. This function is useful when viewing high dynamic range signals. The drawback to having this function on is that it generally requires a longer sweep time to get better sensitivity. The default selection is off. on is recommended for DFB lasers.

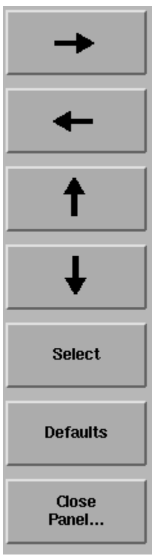
**Peak Excursion** (in dB) determines which side modes are included in the DFB source test measurements. To qualify as a peak, the peak's sides must rise and fall by at least the peak excursion. Setting the value too high may result in not identifying a peak. Setting the value too low may cause unwanted responses, including noise spikes, to be identified. The default value is 3 dB. Peak excursion is not used for the FP or LED source tests.

**Peak (Pk) Density / Noise Marker Reference (Ref) Bandwidth (BW) (0.1 nm or 1.0 nm)** determines whether the power spectral density is normalized to 0.1 nm or 1.0 nm. This setting is the same as the base OSA Noise Marker Reference Bandwidth. Default value is 0.1 nm.

### Navigating the Source Test Measurement Setup Window

The softkeys allow you to navigate through the measurement setup panel. The front-panel number keys, step keys, and knob on the OSA allow you to enter a numeric value in the highlighted field.

.




The **arrow** softkeys allow you to navigate from field to field in the panel. The highlighted parameter can be changed.

**Select** selects the highlighted parameter.

**Defaults** resets the parameters to their default condition.

**Close Panel...** saves the current setup and returns you to the previous menu.

# Characterizing DFB Lasers

The DFB source test performs a series of automatic measurements on distributed feedback lasers. All measurement results are displayed in the Source Test Results panel across the top of the screen.

**CAUTION** When you use improper cleaning and handling techniques, you risk expensive system repairs, damaged connectors, and compromised measurements. Clean all connectors properly before making connections. Refer to “Cleaning Connections for Accurate Measurements” on page 5-4.

## Measurement Attributes

The following is a list of attributes measured for the DFB laser source test. The measurement attributes are displayed across the top of the display at the end of the initial sweep. For Repeat Sweeps, the attributes are automatically updated at the end of each sweep. In Single Sweep mode, a sweep must be initiated in order for any setting changes to take effect and for the source test attributes to be updated.

**Peak wavelength** is the wavelength at which peak amplitude occurs. Peak wavelength is found by searching the trace from left to right across the wavelength span looking for the highest trace point.
**Mode Offset** is the wavelength separation (in nanometers) between the main spectral component and the next highest mode within the current trace span. Negative values indicate the next highest mode lies to the left of the main mode and positive values indicate the next highest mode lies to the right of the main mode.

**Stop Band** is the wavelength spacing between the upper and lower side modes adjacent to the main mode.

**NOTE** If peak excursion is set too high, the Stop Band measurement will display dash lines.

**Center Offset** indicates how well the main mode is centered in the stop band. This value is the difference between the wavelength of the main spectral component and the mean of the upper and lower stop band component wavelengths.

**NOTE** If peak excursion is set too high, the Center Offset measurement will display dashed lines.

**SMSR** (side mode suppression ratio) is the amplitude ratio (in dB) of the main spectral component and the largest side mode (not necessarily the first side mode) within the current trace. This is affected by both the wavelength span and the peak excursion.

**Peak Amplitude** is the power level of the laser's main spectral component.

**Bandwidth** is the bandwidth of the main spectral component of the DFB laser. Due to the narrow line width of most DFB lasers, the result of this measurement for an unmodulated laser is limited by the resolution bandwidth of the optical spectrum analyzer.

## To characterize a DFB laser

The following procedure is an example of a typical DFB laser measurement.

1 Press APPL'S > SOURCE TESTS > SOURCE TEST > SELECT DFB TEST to measure the distributed feedback laser's characteristics.

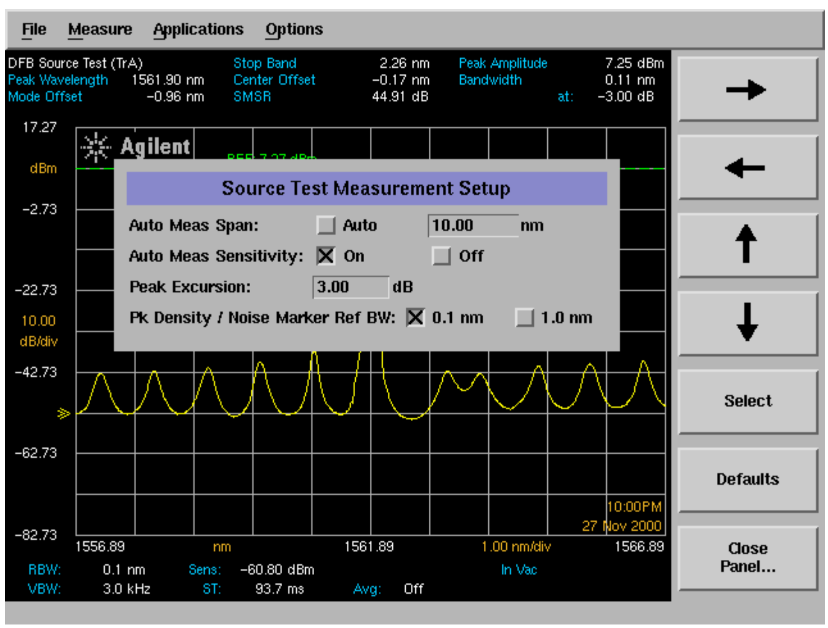
2 Press MEASUREMENT SETUP to open the Source Test Measurement Setup panel.

3 Clear the Auto Meas Span check box and enter a span of 10 nm or desired span.

4 Select ON for Auto Meas Sensitivity.

5 From the softkey menu, press CLOSE PANEL.

**Tip:** For turning the time and date on, press SYSTEM > MORE SYSTEM FUNCTIONS > SET TIME/DATE. Use the navigation keys to set the date, time, and time zone that are correct for your location. Press SET TIME/DATE when you are satisfied with your selections. The time and date will be included on the printout.



**6** Press AUTO MEAS to locate and display the laser's response automatically.

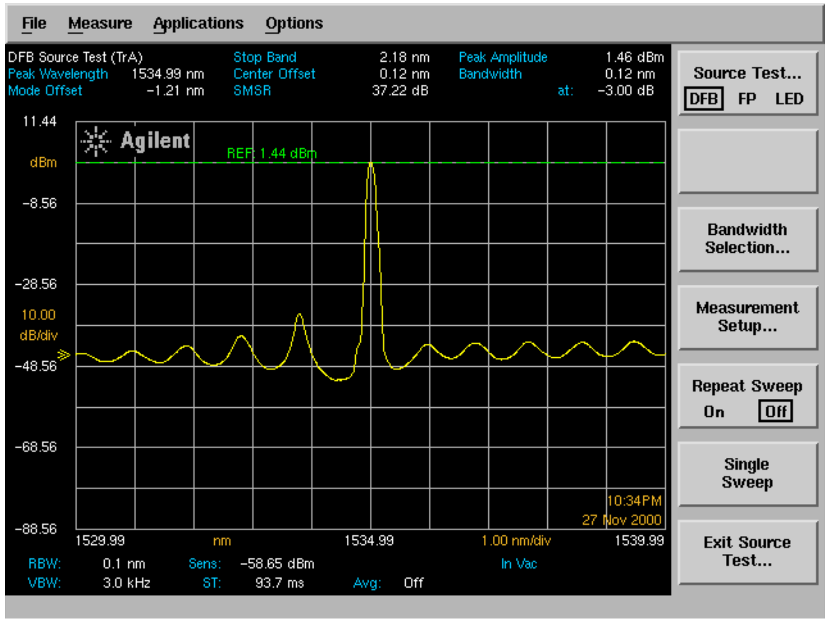
Auto Meas locates the largest signal in the full 600 nm to 1700 nm wavelength range, then reduces the span to display the signal properly. The reference level is set automatically to the signal's peak and the sensitivity is adjusted as needed.

The source tests provide the highest level of measurement automation possible thereby minimizing user interaction for batch source testing. For the first device under test (DUT), Auto Meas is used to locate and display the largest input signal, and automatically adjust all parameters (center wavelength, reference level, display span, and sensitivity) as required by the test. Auto Meas functionality is modified during the source tests to not turn the marker on at the end of the Auto Meas operation. Repeat Sweep may be disabled and Single Sweep may be selected to test subsequent devices.

At the end of the sweep, the Source Test Results panel (located at the top of the display) displays the measurement results. For Repeat Sweeps, the results are automatically updated at the end of each sweep. In Single Sweep mode, a sweep must be initiated in order for any setting changes to take effect and for the source test results to be updated.

**NOTE** When you change a DFB laser source, you need to ensure that the trace is centered on the screen. Press MARKERS > PEAK SEARCH > MARKER TO CENTER > MARKER TO REF LEVEL. Press APPL'S to return to the source test.

**7** Press PRINT to print the results to the target printer.




**Tip:** To select either the internal or an external printer as the target destination, press SYSTEM > PRINTER SETUP.

**8** To save the measurement and trace data, press SAVE/RECALL > SAVE MENU to open the Save Setup panel.

Select the desired Save options and then press CLOSE PANEL.

For more information on saving and printing results, refer to the *Agilent 86140B Series Optical Spectrum Analyzer User's Guide* section on Save/Recall and System menus.

**NOTE**

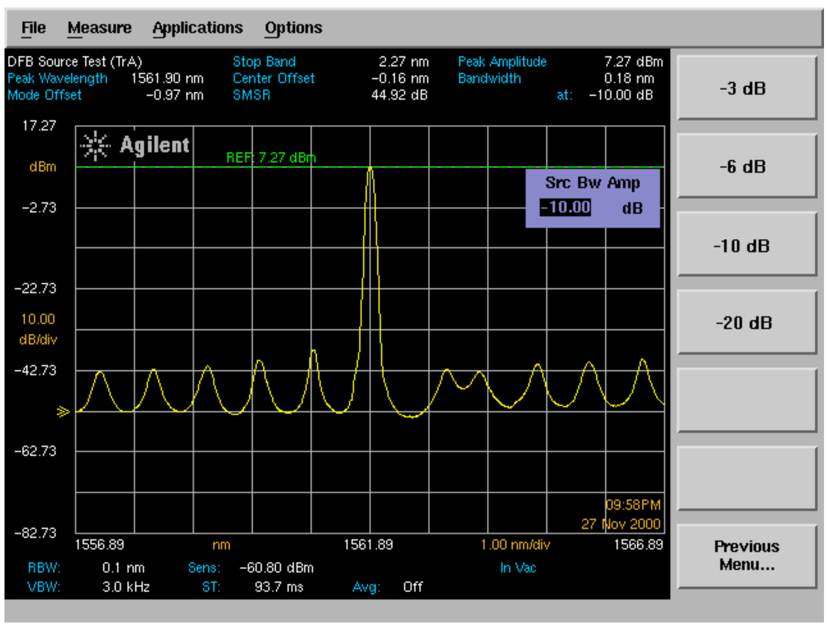
To properly characterize a DFB laser, the Sensitivity must be sufficient to resolve the DFB's side modes. Using Auto Meas with Auto Meas Sensitivity on ensures this. When not using Auto Meas, be sure to use a Sensitivity setting that is sufficient to resolve side modes of interest.

## DFB Laser Measurement Techniques

This section explains how to customize and use some of the OSA functions to assist you in accurately characterizing DFB lasers.

### Setting the desired vertical offset for bandwidth measurement

One of the DFB measurements is the bandwidth of the main spectral component. By default, the bandwidth is measured 3 dB below the peak wavelength. To change the bandwidth, press BANDWIDTH SELECTION...from the Source Test application's softkey menu. At the next sweep, bandwidth will be calculated using the new value.



The accuracy of the bandwidth measurement is affected by the following instrument settings:

- Wavelength span
- Trace length
- Resolution bandwidth

If the wavelength span is too wide (or the bandwidth is too narrow), there may not be enough trace points to calculate bandwidth accurately. Reducing the span increases the accuracy of the bandwidth calculated. Increasing the trace length also increases bandwidth accuracy.

Due to the narrow line width of most DFB lasers, the bandwidth measurement for an unmodulated laser is the chosen resolution bandwidth of the OSA. With modulation applied, lasers will chirp causing a spectral broadening. The resultant displayed waveform is the composite of the OSA's resolution bandwidth and the modulated laser's spectrum. When measuring the extent of chirp on the modulated laser, choose the narrowest resolution bandwidth available.

### Using peak excursion to determine side modes

**Peak Excursion** (in dB) determines which side modes are included in the measurements. To qualify as a peak, the peak's sides must rise and fall by at least the peak excursion. Setting the value too high may result in not identifying a peak. Setting the value too low may cause unwanted responses, including noise spikes, to be identified. The default value is 3 dB.

### Using line markers to determine side modes

When Line Markers are enabled and the Integrate Limit is on, the source test calculations are performed within the Line Marker limits. Note that Search Limit and Sweep Limit do not limit the source test calculation to within the Line Marker limits. The Line Marker limits may be adjusted to exclude modes from the source test calculations. The Line Marker limit range is shared with total power integration. Trace Integration need not be on to use source test with Line Marker limits. To use Line Marker limits:

1. Press MARKERS > MORE MARKER FUNCTIONS > LINE MARKER MENU.
2. Press WAVELENGTH LINE MKR 1 and WAVELENGTH LINE MKR 2 to adjust the Line Marker Limits.
3. Press ADVANCED LINE MKR FUNCTIONS > INTEGRATE LIMIT ON.
4. Press APPL'S to return to the Source Test.

# Characterizing Fabry-Perot Lasers

The FP source test performs a series of automatic measurements on Fabry-Perot lasers. All measurement results are displayed in the Source Test Results panel across the top of the screen.

**CAUTION** When you use improper cleaning and handling techniques, you risk expensive system repairs, damaged connectors, and compromised measurements. Clean all connectors properly before making connections. Refer to "Cleaning Connections for Accurate Measurements" on page 5-4.

## Measurement Attributes

The following is a list of attributes measured for the Fabry-Perot laser source test. The measurement attributes are displayed across the top of the display at the end of the initial sweep. For Repeat Sweeps, the attributes are automatically updated at the end of each sweep. In Single Sweep mode, a sweep must be initiated in order for any setting changes to take effect and for the source test attributes to be updated.

Measurement attributes are calculated using the entire set of trace points in order to provide more repeatable results. This is particularly useful for devices that exhibit significant levels of fluctuation in the distribution of optical energy among the spectral modes.

**Mean Wavelength** represents the center of mass of the trace points, normalized by the ratio of the trace point spacing and the resolution bandwidth. The power and wavelength of each trace point are used to calculate the mean (FWHM) wavelength.

$$\text{Mean Wavelength} = \sum_{i=1}^{n} \frac{P_i}{P_o}\left(\frac{\text{trace point spacing}}{\text{resolution bandwidth}}\right)\lambda_i$$

where:

$\lambda_i$ is the wavelength of a single trace point

$P_i$ is the power of a single trace point

$P_o$ is total power as defined below

**Peak Wavelength** is the wavelength of the laser's peak spectral component.

**Mode Spacing** (in nm) is the average wavelength spacing between the individual spectral components of the FP laser.

**Mode Spacing** (in GHz) is the average frequency between the individual spectral components of the FP laser.

**FWHM** (Full Width at Half Maximum) describes the spectral width of the half-power points of the FP laser, assuming a continuous, Gaussian power distribution. The half-power points are those where the power spectral density is one-half that of the peak amplitude of the computed Gaussian curve.

$$\text{FWHM} = 2.355\sigma$$

where:

$\sigma$ is sigma as defined below

**Peak Amplitude** is the power level of the peak spectral component of the FP laser.

**Total Power** is the summation of the power at each trace point, normalized by the ratio of the trace point spacing and the resolution bandwidth.

$$\text{Total Power} = \sum_{i=1}^{n} P_i\left(\frac{\text{trace point spacing}}{\text{resolution bandwidth}}\right)$$

where:

$P_i$ is the power of a single trace point

**Sigma** $(\sigma)$ is the rms value of the spectral width of the trace points based on a Gaussian distribution. The power and wavelength of each spectral component is used to calculate mean wavelength.

$$\text{sigma} = \sqrt{\sum_{i=1}^{n} \frac{P_i}{P_o}\left(\frac{\text{trace point spacing}}{\text{resolution bandwidth}}\right)(\lambda_i - \bar{\lambda})^2}$$

where:

$\bar{\lambda}$ is mean wavelength (FWHM) as defined above

$\lambda_i$ is the wavelength of a single trace point

$P_i$ is the power of a single trace point

$P_o$ is total power as defined above

## To characterize a Fabry-Perot laser

The following procedure is an example of a typical FP laser measurement.

1 Press APPL'S > SOURCE TESTS > SOURCE TEST > SELECT FP TEST to measure the Fabry-Perot laser's characteristics.

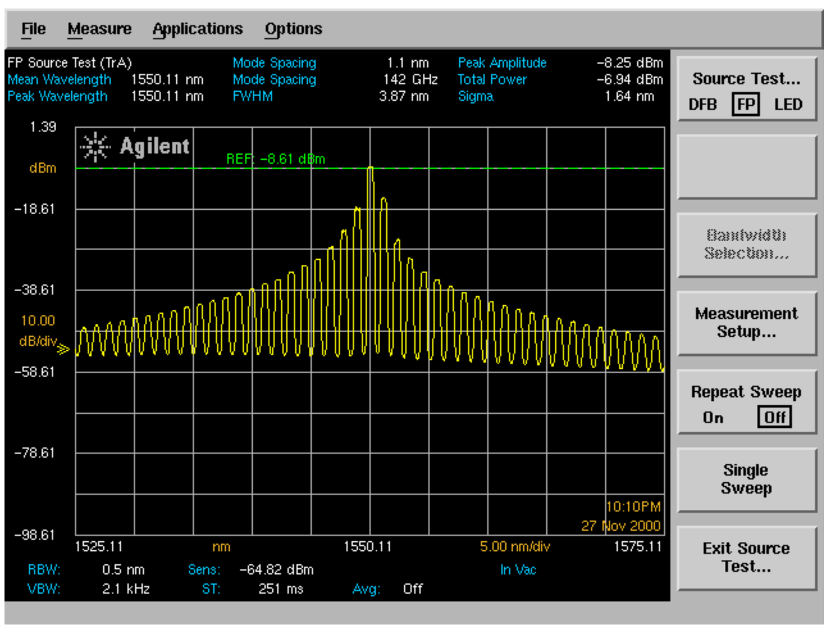
2 Press MEASURE SETUP to open the Source Test Measurement Setup panel.

3 Verify that Auto Meas Span is set to Auto.

4 Press SYSTEM > MORE SYSTEM FUNCTIONS > AUTO MEASURE SETUP to verify that Optimize Sensitivity is set to OFF.

5 From the softkey menu, press CLOSE PANEL.

**Tip:** For turning the time and date on, press SYSTEM > MORE SYSTEM FUNCTIONS > SET TIME/DATE. Use the navigation keys to set the date, time, and time zone that are correct for your location. Press SET TIME/DATE when you are satisfied with your selections. The time and date will be included on the printout.



**6** Press AUTO MEAS to locate and display the laser's response automatically.

Auto Meas locates the largest signal in the full 600 nm to 1700 nm wavelength range, then reduces the span to display the signal properly. The reference level is set automatically to the signal's peak.

**7** After Auto Meas, verify that the Sensitivity value (labeled "Sens" on the Settings panel located at the bottom of the OSA display) is at least *27 dB* below the current signal reference level. This helps assure that accurate FP measurement attributes are being displayed. If the sensitivity is not at least *27 dB* less than the reference level, adjust the Sensitivity (press AMPLITUDE > SENSITIVITY) to the desired level.

**Tip:** Sensitivity can be reduced (improving measurement quality) by either adjusting Sensitivity directly or by using Video Bandwidth (BANDWIDTH / SWEEP > VIDEO BW > MAN). Using Video Bandwidth has the advantage of minimizing sweep time and averaging laser modal noise.

The source tests provide the highest level of measurement automation possible thereby minimizing user interaction for batch source testing. For the first device under test (DUT), Auto Meas is used to locate and display the largest input signal, and automatically adjusts parameters (center wavelength, reference level, and display span) as required by the test. Auto Meas functionality is modified during source tests to not turn the marker on at the end of the Auto Meas operation. Normally, the Marker automatically marks the peak wavelength. Repeat Sweep may be disabled and Single Sweep may be selected to test subsequent devices.

At the end of the sweep, the Source Test Results panel (located at the top of the display) displays the measurement results. For Repeat Sweeps, the results are automatically updated at the end of each sweep. In Single Sweep mode, a sweep must be initiated in order for any setting changes to take effect and for the source test results to be updated.

**NOTE** When you change an FP laser source, you need to ensure that the trace is centered on the screen. Press MARKERS > PEAK SEARCH > MARKER TO CENTER > MARKER TO REF LEVEL. Press APPL'S to return to the source test.

**8** Press PRINT to print the results to the target printer.

**Tip:** To select either the internal or an external printer as the target destination, press SYSTEM > PRINTER SETUP.

**9** To save the measurement and trace data, press SAVE/RECALL > SAVE MENU to open the Save Setup panel.

Select the desired Save options and then press CLOSE PANEL.

For more information on saving and printing results, refer to the *Agilent 86140B Series Optical Spectrum Analyzer User's Guide* sections on Save/Recall and System menus.

## Fabry-Perot Laser Measurement Techniques

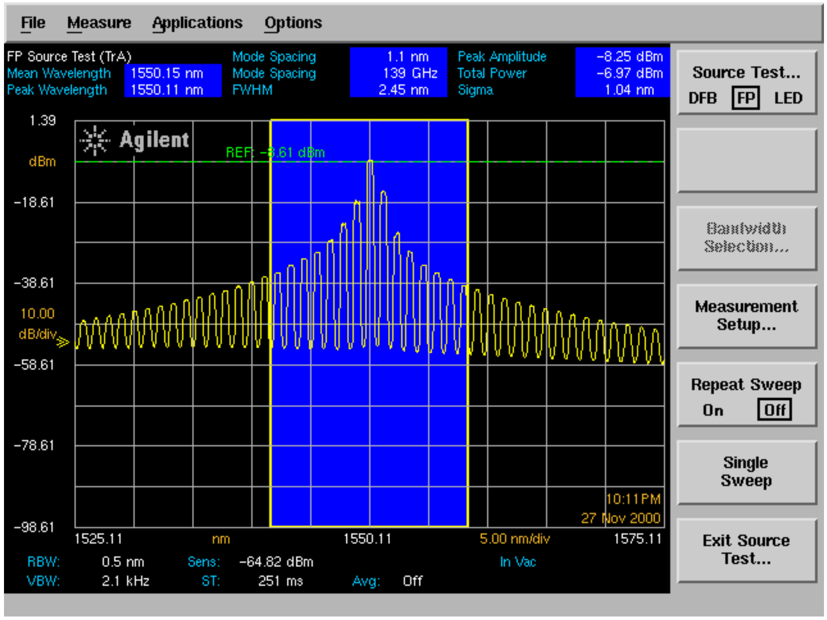
This section explains how to customize and use some of the OSA functions to assist you in accurately characterizing Fabry-Perot lasers.

### Using line markers to select spectral modes

When Line Markers are enabled and the Integrate Limit is on, the source test calculations are performed within the Line Marker limits. Note that Search Limit and Sweep Limit do not limit the source test calculation to within the Line Marker limits. The Line Marker limits may be adjusted to exclude modes from the source test calculations. The Line Marker limit range is shared with total power integration. Trace Integration need not be on to use source test with Line Marker limits. To use Line Marker limits:

1. Press MARKERS > MORE MARKER FUNCTIONS > LINE MARKER MENU.
2. Press WAVELENGTH LINE MKR 1 and WAVELENGTH LINE MKR 2 to adjust the Line Marker Limits.
3. Press ADVANCED LINE MKR FUNCTIONS > INTEGRATE LIMIT ON.

**4** Press APPL'S to return to the Source Test application.



# Characterizing LEDs

The LED source test performs a series of automatic measurements on light emitting diodes. All measurement results are displayed in the Source Test Results panel at the top of the screen. The LED measurement calculations compensate for the expected change in resolution bandwidth versus wavelength.

**CAUTION**

When you use improper cleaning and handling techniques, you risk expensive system repairs, damaged connectors, and compromised measurements. Clean all connectors properly before making connections. Refer to "Cleaning Connections for Accurate Measurements" on page 5-4.

## Measurement Attributes

The following is a list of attributes measured for the LED source test. The measurement attributes are displayed across the top of the display at the end of the initial sweep. For Repeat Sweeps, the attributes are automatically updated at the end of each sweep. In Single Sweep mode, a sweep must be initiated in order for any setting changes to take effect and for the source test attributes to be updated.

**Mean (FWHM)** represents the center of mass of the trace points, normalized by the ratio of the trace point spacing and the resolution bandwidth. The power and wavelength of each trace point are used to calculate the mean (FWHM) wavelength.

$$\text{Mean (FWHM)} = \sum_{i=1}^{n} \frac{P_i}{P_o} \left( \frac{\text{trace point spacing}}{\text{resolution bandwidth}} \right) \lambda_i$$

where:

$\lambda_i$ is the wavelength of a single trace point

$P_i$ is the power of a single trace point

$P_o$ is total power as defined below

**Mean (3dB)** is the average of the two wavelengths that are 3 dB (half-power) below the peak wavelength.

**Peak Wavelength** is the wavelength at which the peak of the LED spectrum occurs.

**Sigma** is the rms value of the spectral width of the LED based on a Gaussian distribution. The power and wavelength of each spectral component are used to calculate sigma.

$$\text{sigma} = \sqrt{\sum_{i=1}^{n} \frac{P_i}{P_o} \left( \frac{\text{trace point spacing}}{\text{resolution bandwidth}} \right) (\lambda_i - \bar{\lambda})^2}$$

where:

$\bar{\lambda}$ is mean wavelength (FWHM) as defined below

$\lambda_i$ is the wavelength of a single trace point

$P_i$ is the power of a single trace point

$P_o$ is total power as defined below

**FWHM (**Full Width at Half Maximum) describes the spectral width of the half-power (-3 dB) points of the LED, assuming a continuous, Gaussian power distribution. The half-power points are those where the power spectral density is one-half that of the peak amplitude of the computed Gaussian curve.

$$\text{FWHM} = 2.355\sigma$$

where:

$\sigma$ is sigma as defined above

**3 dB Width** describes the spectral width of the LED based on the separation of two wavelengths. Each wavelength has a power spectral density equal to one-half the peak power spectral density. The 3 dB width is determined by finding the peak of the LED spectrum, and dropping 3 dB on each side.

**Total Power** is the summation of the power at each trace point, normalized by the ratio of the trace point spacing and the resolution bandwidth. This normalization is required because the spectrum of the LED is continuous, rather than containing discrete spectral components (as a laser does).

$$\text{Total Power} = \sum_{i=1}^{n} P_i \left( \frac{\text{trace point spacing}}{\text{resolution bandwidth}} \right)$$

where:

$P_i$ is the power of a single trace point

**Pk Density (0.1 nm or 1.0 nm)** is the power spectral density (normalized to a 0.1 nm or 1.0 nm bandwidth) of the LED at the peak wavelength.

## To characterize an LED laser

The following procedure is an example of a typical LED laser measurement.

1 Press APPL'S > SOURCE TESTS > SOURCE TEST > SELECT LED TEST to measure the light emitting diode's characteristics.

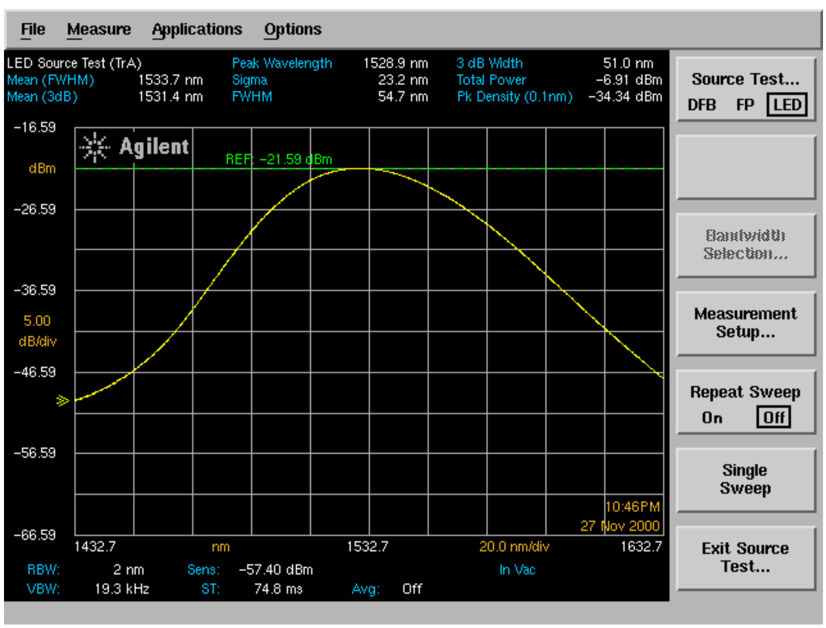
2 Press MEASURE SETUP to open the Source Test Measurement Setup panel.

3 Verify the Auto Meas Span is set to Auto.

4 Verify the Optimize Sensitivity is set to OFF.

5 From the softkey menu, press CLOSE PANEL.

**Tip:** For turning the time and date on, press SYSTEM > MORE SYSTEM FUNCTIONS > SET TIME/DATE. Use the navigation keys to set the date, time, and time zone that are correct for your location. Press SET TIME/DATE when you are satisfied with your selections. The time and date will be included on the printout.



**6** Press AUTO MEAS to locate and display the laser’s response automatically.

Auto Meas locates the largest signal in the full 600 nm to 1700 nm wavelength range, then reduces the span to display the signal properly. The reference level is set automatically to the signal’s peak and the sensitivity is adjusted as needed.

The source tests provide the highest level of measurement automation possible thereby minimizing user interaction for batch source testing. For the first device under test (DUT), Auto Meas is used to locate and display the largest input signal, and automatically adjust all parameters (center wavelength, reference level, and display span) as required by the test. Auto Meas functionality is modified during source tests to not turn the marker on at the end of the Auto Meas operation. Normally, the Marker automatically marks the peak wavelength. Repeat Sweep may be disabled and Single Sweep may be selected to test subsequent devices.

At the end of the sweep, the Source Test Results panel (located at the top of the display) displays the measurement results. For Repeat Sweeps, the results are automatically updated at the end of each sweep. In Single Sweep mode, a sweep must be initiated in order for any setting changes to take effect and for the source test results to be updated.

**NOTE** When you change an LED source, you need to ensure that the trace is centered on the screen. Press MARKERS > PEAK SEARCH > MARKER TO CENTER > MARKER TO REF LEVEL. Press APPL’S to return to the Source Test application.

**7** Press PRINT to print the results to the target printer.

**Tip**: To select either the internal or an external printer as the target destination, press SYSTEM > PRINTER SETUP.

**8** To save the measurement and trace data, press SAVE/RECALL > SAVE MENU to open the Save Setup panel.

Select the desired Save options and then press CLOSE PANEL.

For more information on saving and printing results, refer to the *Agilent 86140B Series Optical Spectrum Analyzer User’s Guide* sections on Save/Recall and System menus.

# LED Measurement Techniques

This section explains how to customize and use some of the OSA functions to assist you in accurately characterizing LEDs.

## Using line markers

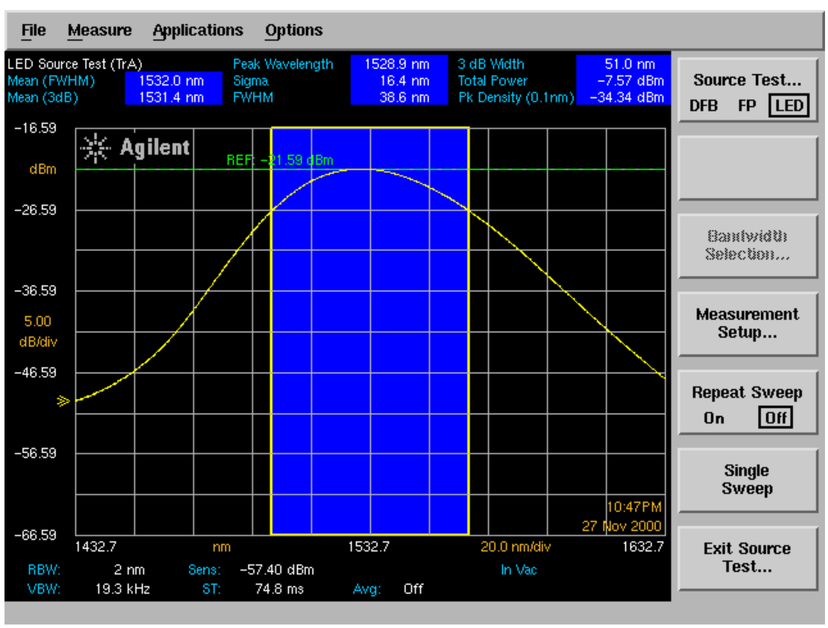
When Line Markers are enabled and the Integrate Limit is on, the source test calculations are performed within the Line Marker limits. Note that Search Limit and Sweep Limit do not limit the source test calculation to within the Line Marker limits. The Line Marker limits may be adjusted to include only the desired portion of the trace in the source test calculations. The Line Marker limit range is shared with total power integration. Trace Integration need not be on to use the source test with Line Marker limits. To use Line Marker limits:

1 Press MARKERS > MORE MARKER FUNCTIONS > LINE MARKER MENU.

2 Press WAVELENGTH LINE MKR 1 and WAVELENGTH LINE MKR 2 to adjust the Line Marker Limits.

3 Press ADVANCED LINE MKR FUNCTIONS > INTEGRATE LIMIT ON.

4 Press APPL'S to return to the Source Test application.



# Source Test Application Remote Commands

The CALC: section of the *Agilent 86140B Series Optical Spectrum Analyzer User's Guide* provides detailed information on remote programming of the instrument. Only commands unique to the Source Test application are included in this chapter with the following exceptions:

Center of Mass, Sigma, and FWHM calculations are supported via remote commands without entering the Source Test application. These commands are documented below and also in the Remote Operation chapter in the *Agilent 86140B Series Optical Spectrum Analyzer User's Guide*.

**NOTE**

Launching another OSA application remotely, such as Passive Component Test, will automatically disable any active source test. Initiating a source test from within another application is not supported.

## Command Conventions

Table 1

| Convention | Description |
|---|---|
| < > | Angle brackets indicate text strings entered by the developer. |
| [ ] | Square brackets indicate that the keyword DEFAULT can be used instead of a value or a variable for that parameter. Refer to the actual command description for the behavior when the DEFAULT keyword is used for a parameter. |
| \| | Indicates a choice of one element from a list. |
| { } | Braces indicate a group of constants to select from. Each constant is separated by the \| character. |
| name | Indicates the variable for which you provide a descriptive name. Any letter (Aa-Zz) followed by letters, digits (0-9) and underscore (_). Only the first 32 characters are significant. |
| spec_min | –infinity. The parameter *spec_min* cannot be a variable, only a constant or DEFAULT. |
| spec_max | +infinity. The parameter *spec_max* cannot be a variable, only a constant or DEFAULT. |
| from | Start wavelength or frequency of trace in nm (default) or THz. |
| to | Stop wavelength or frequency of trace in nm (default) or THz. |
| excursion | +excursion: means excursion dBs up (for example, from a pit).<br>-excursion: means excursion dBs down (for example, from a peak). |
| ref_pt | The reference point to be used for a measurement keyword. |

## CALCulate Subsystem Commands

The CALCulate subsystem performs post-acquisition data processing. The CALCulate subsystem operates on data acquired by a SENSe function.

Trace A corresponds to CALC 1, Trace B corresponds to CALC 2, and so on. Only one of each calculation (that is, Source Test, Center of Mass, or FWHM) may be on. For example, if FWHM is on for Trace A, turning FWHM on for Trace B will disable the FWHM for Trace A.

**CALCulate[1|2|3|4|5|6]:SOURce:TEST DFB | FP | LED | OFF**

**CALCulate[1|2|3|4|5|6]:SOURce:TEST?**

Initiates a source test measurement or disables the active suite. Only a single measurement suite may be on at a time (also operates exclusively with applications: Passive Component Test (PCT), Wavelength Division Multiplexing (WDM), and Amplifier Test applications). off disables all suites. Calculations are performed at the end of each sweep.

**CALCulate[1|2|3|4|5|6]:SOURce:[DATA]?**

Retrieves the results of the currently active source test measurement suite. The data is returned in either ASCII or binary form as determined by the FORMat:DATA command. Requesting results from a trace not selected in the CALCulate[1|2|3|4|5|6]:SOURce:TEST command returns a “Settings conflict” error.

Error values are indicated by returning the number: 9.91e+37. This value is defined by the SCPI standard to represent NaN (not a number). This indicates that the source test was unable to perform the particular measurement. Results will be returned in the order as shown below.

Table 2 Source Test Measurement Parameters

| Source Test | Measurement Parameter | Units |
|---|---|---|
| **DFB Test** | Peak Wavelength | Meters |
| | Mode Offset | Meters |
| | Stop Band | Meters |
| | Center Offset | Meters |
| | SMSR | dB |
| | Peak Amplitude | dBm |
| | Bandwidth | Meters |
| | Bandwidth Amplitude | dB |
| **FP Test** | Mean Wavelength | Meters |
| | Peak Wavelength | Meters |
| | Mode Spacing (M) | Meters |
| | Mode Spacing (Hz) | Hertz |
| | FWHM | Meters |
| | Peak Amplitude | dBm |
| | Total Power | dBm |
| | Sigma | Meters |
| **LED Test** | Mean (FWHM) Wavelength | Meters |
| | Mean Wavelength (3 dB down) | Meters |
| | Peak Wavelength | Meters |
| | Sigma | Meters |
| | FWHM | Meters |
| | Width at 3 dB down | Meters |
| | Total Power | dBm |
| | Peak Spectral Density (1.0 nm or 0.1 nm) depending on Noise Marker Reference Bandwidth | dBm |

**CALCulate:SOURce:FUNCtion:BWIDth | BANDwidth:NDB <numeric_value>**

**CALCulate:SOURce:FUNCtion:BWIDth | BANDwidth:NDB?**

Sets the desired vertical offset from the peak wavelength for the DFB source test bandwidth calculation. The default value is -3 dB. The parameter units are as specified in the UNIT:RATio command. This value can be set or queried anytime. The DFB source test does not need to be on. The new bandwidth value will be used on the next sweep. The offset value applies to all DFB source test bandwidth calculations.

**CALCulate[1|2|3|4|5|6]:CENTermass:STATe OFF | ON | 0 | 1**

Turns the Center of Mass (Mean Wavelength) calculation on. Trace A corresponds to CALC 1, Trace B corresponds to CALC 2, and so on. Only one Center of Mass calculation may be on. For instance, if Center of Mass is on for Trace A, turning Center of Mass on for Trace B will disable the Center of Mass calculation for Trace A. The data is returned in either ASCII or binary form as determined by the FORMat:DATA command.

The Center of Mass of the trace points is normalized by the ratio of the trace point spacing and the resolution bandwidth. The power and wavelength of each trace point are used to calculate the Center of Mass. The formula used is:

$$\text{Center of Mass} = \sum_{i=1}^{n} \frac{P_i}{P_o} \left( \frac{\text{trace point spacing}}{\text{resolution bandwidth}} \right) \lambda_i$$

where:

$\lambda_i$ is the wavelength of a single trace point

$P_i$ is the power of a single trace point

$P_o$ is total power as defined below

**Total Power** is the summation of the power at each trace point, normalized by the ratio of the trace point spacing and the resolution bandwidth. The formula used is:

$$\text{Total Power} = \sum_{i=1}^{n} P_i \left( \frac{\text{trace point spacing}}{\text{resolution bandwidth}} \right)$$

where:

$P_i$ is the power of a single trace point

### CALCulate[1|2|3|4|5|6]:CENTermass:[DATA]?

Returns the Center of Mass calculation results in meters. Trace A corresponds to CALC 1, Trace B corresponds to CALC 2, and so on. Corrections to all calculations are made for the slope and variation of the resolution bandwidth filter over the wavelength range of the trace. When CALCulate:TPOWer:IRANge is on, the calculation is performed over the upper and lower range limits. All calculations (that is, SOURce, CENTermass, FWHM, SIGMA, and TPOWer) share the same line marker limits. Sending this query when the CALCulate:CENTermass:STATe is off will generate a “Settings conflict” error. If the Center of Mass calculation cannot be performed, the number 9.91e+37 is returned. This value is defined by the SCPI standard to represent NaN (not a number).

### CALCulate[1|2|3|4|5|6]:FWHM:STATe OFF | ON | 0 | 1

Turns the Full Width Half Maximum (FWHM) calculation on. Trace A corresponds to CALC 1, Trace B corresponds to CALC 2, and so on. Only one of each calculation may be on. For instance if FWHM is on for Trace A, turning FWHM on for Trace B will disable the FWHM calculation for Trace A. The data is returned in either ASCII or binary form as determined by the FORMat:DATA command.

**FWHM (**Full Width at Half Maximum) describes the spectral width of the half-power (-3 dB) points of the trace, assuming a continuous, Gaussian power distribution. The half-power points are those where the power spectral density is one-half that of the peak amplitude. The formula used is:

$$\text{FWHM} = 2.355\sigma$$

where: $\sigma$ is sigma as defined in CALCulate:SIGMa

**CALCulate[1|2|3|4|5|6]:FWHM: [DATA]?**

Returns the FWHM calculation results in meters. Trace A corresponds to CALC 1, Trace B corresponds to CALC 2, and so on. Corrections to all calculations are made for the slope and variation of the resolution bandwidth filter over the wavelength range of the trace. When CALCulate:TPOWer:IRANge is on, the calculation is performed over the upper and lower range limits. All calculations (that is, SOURce, CENTermass, FWHM, SIGMA, and TPOWer) share the same line marker limits. Sending this query when the CALCulate:FWHM:STATe is off will generate a “Settings conflict” error. If the FWHM calculation cannot be performed, the number 9.91e+37 is returned. This value is defined by the SCPI standard to represent NaN (not a number).

**CALCulate[1|2|3|4|5|6]:SIGMa: [DATA]?**

Returns the sigma calculation results in meters.

**Sigma** is the rms value of the spectral width of the trace points based on a Gaussian distribution. The power and wavelength of each spectral component is used to calculate mean wavelength.

$$\text{sigma} = \sqrt{\sum_{i=1}^{n} \frac{P_i}{P_o}\left(\frac{\text{trace point spacing}}{\text{resolution bandwidth}}\right)(\lambda_i - \bar{\lambda})^2}$$

where:

$\bar{\lambda}$ is mean wavelength (Center of Mass) as defined in CALC:CENT

$\lambda_i$ is the wavelength of a single trace point

$P_i$ is the power of a single trace point

$P_o$ is total power as defined in CALC:CENT

CALCulate:FWHM:STATe must be on for this query. Trace A corresponds to CALC 1, Trace B corresponds to CALC 2, and so on. Corrections to all calculations are made for the slope and variation of the resolution bandwidth filter over the wavelength range of the trace. When CALCulate:TPOWer:IRANge is on, the calculation is performed over the upper and lower range limits. All five common calculation ranges (that is, SOURce, CENTermass, FWHM, SIGMA, and TPOWer) share the same limits. Sending a CALCulate:SIGMa? query when the CALCulate:FWHM:STATe is off will generate a "Settings conflict" error. If the Sigma calculation cannot be performed, the number 9.91e+37 is returned. This value is defined by the SCPI standard to represent NaN (not a number).

---

**CALCulate[1|2|3|4|5|6]:TPOWer:IRANge:LOWer <numeric_value>[M|UM|NM|A|HZ|KHZ|MHZ|GHZ|THZ]**

**CALCulate[1|2|3|4|5|6]:TPOWer:IRANge:LOWer?**

Sets the lower X-axis limit range for the TPOWer, SOURce, CENTermass, FWHM, and SIGMa calculations for all traces. Setting this value when the CALCulate:TPOWer:IRANge[:STATe] is off will automatically turn the CALCulate:TPOWer:IRANge[:STATe] on. The range used for the total power integration is the same range used for the marker search range, the trace mean range, and the wavelength range. Changing the range with this command will change all four ranges.

Default units for the parameter are meters. Sending the command when the instrument is in a zero span will generate a "Settings conflict" error.

---

**CALCulate[1|2|3|4|5|6]:TPOWer:IRANge:UPPer <numeric_value>[M|UM|NM|A|HZ|KHZ|MHZ|GHZ|THZ]**

**CALCulate[1|2|3|4|5|6]:TPOWer:IRANge:UPPer?**

Sets the upper X-axis limit range for the TPOWer, SOURce, CENTermass, FWHM, and SIGMa calculations for all traces. Setting this value when the CALCulate:TPOWer:IRANge[:STATe] is off will automatically turn the CALCulate:TPOWer:IRANge[:STATe] on. The range used for the total power calculation is the same range used for the marker search range, the trace mean range and the wavelength range. Changing the range with this command will change all four ranges.

Default units for the parameter are meters. Sending the command when the instrument is in a zero span will generate a “Settings conflict” error.

---

**CALCulate:MARKer:FUNCtion:NOISe:BWIDth|BANDwidth <numeric_value>**

**CALCulate:MARKer:FUNCtion:NOISe:BWIDth|BANDwidth?**

Sets the normalization bandwidth for the marker noise result query and the LED source test peak density calculation. The default units for the parameter are meters. There are only two allowable settings: 1.0 nm and 0.1 nm. Sending any value outside this range will generate a "Data out of range" error. Sending a value within this range will set the bandwidth to whichever of the two possible settings is closest to the specified value.

## CALibration Subsystem Commands

This subsystem has the function of performing system calibration.

### CALibration Alignment

Performs an automatic alignment of the instrument at the wavelength of the largest signal found in full span. This aligns the monochromator output with the photodetector for improved amplitude accuracy. Sending this command with a marker on screen will generate a Settings conflict error.

**Syntax** CAL:ALIG

**Related Key** Auto Align

## Equivalent Commands from the 71450 to the 86140B

The following table provides a list of the Agilent 71450 series commands and the SCPI equivalent commands for the Agilent 86140B series analyzers. The results are returned in the same order as Table 2 on page 2-34.

NOTE: For the 86140B series OSA, any space(s) or characters between a token (_) and the query (?) symbol are not supported. For example:

FP_ ? will not work on the 86140B series OSA, but will work for the 71450 series OSA. FP_? will work on the 86140B series OSA.

**NOTE** All legacy source test commands operate on the currently active trace.

Table 3 Equivalent Commands from the 71450 to the 86140B

| 71450 Series Command | 86140B Series Command | Description |
|---|---|---|
| **DFB Command** | | |
| DFB_ | CALCulate:SOURce:TEST DFB | Start DFB laser source test |
| DFB_? | CALCulate:SOURce:[DATA]? | Return DFB measurement suite results |
| DFB_B | Not supported | Turn stop band peaks view ON or OFF |
| DFB_C | Not supported | Turn SMSR view ON or OFF |
| DFB_O | Not supported, use CALCulate:SOURce:TEST OFF | Turn calculation ON or OFF |
| DFB_Q | CALCulate:SOURce:TEST OFF | Exit DFB laser source test |
| DFB_Z | DISP:WIND:TRAC:ALL:SCALE: AUTO:OPT prior to Auto Meas | Enable Sensitivity Optimization function |
| **FP Command** | | |
| FP_ | CALCulate:SOURce:TEST FP | Start FP laser source test |
| FP_? | CALCulate:SOURce:[DATA]? | Return FP measurement suite results |
| FP_B | Not supported | Turn peaks view ON or OFF |
| FP_C | Not supported | Turn distribution view ON or OFF |
| FP_G | Not supported | Select envelope distribution |
| FP_K | Default | Select Gaussian distribution |
| FP_L | Not supported | Select Lorenzian distribution |

| 71450 Series Command | 86140B Series Command | Description |
|---|---|---|
| FP_MKBW | Not supported | Set envelope bandwidth amplitude |
| FP_O | Not supported, use CALCulate:SOURce:TEST OFF | Turn calculation ON or OFF |
| FP_Q | CALCulate:SOURce:TEST OFF | Exit FP laser source test |
| FP_TH | Not supported | Set Peak Threshold |
| **LED Command** | | |
| LED_ | CALCulate:SOURce:TEST LED | Start LED laser source test |
| LED_? | CALCulate:SOURce:[DATA]? | Return LED measurement suite results |
| LED_B | Not supported | Turn integration window trace ON or OFF |
| LED_C | Not supported | Turn distribution view ON or OFF |
| LED_K | Default | Select Gaussian distribution |
| LED_L | Not supported | Select Lorenzian distribution |
| LED_O | Not supported, use CALCulate:SOURce:TEST OFF | Turn calculation ON or OFF |
| LED_Q | CALCulate:SOURce:TEST OFF | Exit LED laser source test |

## Sample Programs

The following are sample programs for the Source Test measurement, DFB, FP and LED remote control commands.

## Source Test measurements sample commands

```
10  ! Program to demonstrate the new commands for source measurements.
20  ! The center of mass and FWHM routines are used to measure LED source.
30  !
40  ! re-store "newcommands"
50  !
60  ASSIGN @Osa TO 723;EOL CHR$(12) END                    ! Set command terminator to LF & EOI
70  !
80  PRINTER IS "results.txt"
90  !
100  !   ***   Setup OSA for measurement   ***
110  !
120  OUTPUT @Osa;"*rst"                                    ! Preset OSA
130  !
140  OUTPUT @Osa;"sens:wav:star 1440nm"                    ! Set start wavelength
150  OUTPUT @Osa;"sens:wav:stop 1660nm"                    ! Set stop wavelength
160  !
170  OUTPUT @Osa;"disp:wind:trac:y1:scal:rlev -20.0dbm"    ! Set reference level
180  OUTPUT @Osa;"sens:pow:dc:rang:low -60dbm"             ! Set sensitivity required
190  OUTPUT @Osa;"sens:bwid:res 5nm"                       ! Set resolution bandwidth
200  !
210  OUTPUT @Osa;"calc:cent:stat on"                       !Enable center of mass measurement
220  OUTPUT @Osa;"calc:fwhm:stat on"                       ! Enable FWHM measurement
230  !
240  !   ***   Initiate measurement   ***
250  !
260  OUTPUT @Osa;"init:imm"                                ! Take sweep to update display
270  !
280  OUTPUT @Osa;"calc:cent?                               ! Request mean WL
290  ENTER @Osa;Meanwl
300  OUTPUT @Osa;"calc:fwhm?"                              ! Request FWHM
310  ENTER @Osa;Fwhm
320  OUTPUT @Osa;"calc:sigma?"                             ! Request sigma
330  ENTER @Osa;Sigma
340  !
350  !   ***   Print measurement results   ***
360  !
370  PRINT
380  PRINT "Command Measurement results"
390  PRINT
400  PRINT "Mean Wavelength (m)",Meanwl
410  PRINT "FWHM (m)",Fwhm
420  PRINT "Sigma (m)",Sigma
430  !
440  OUTPUT @Osa;"calc:cent:stat off"                      ! Turn off measurement
450  OUTPUT @Osa;"calc:Fwhm:stat off"                      ! Turn off measurement
460  !
470  LOCAL @Osa                                            ! Release OSA to local control
480  !
490  END
```

### *Command Measurement results*

Mean Wavelength (m)  1.55280884E-6

FWHM (m)   5.41096035E-8

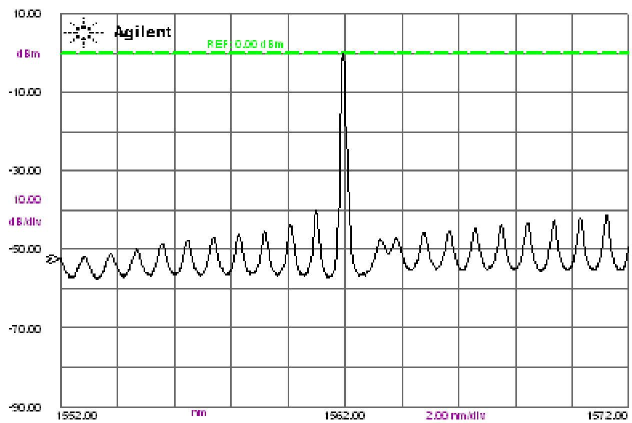
Sigma (m)  2.29764771E-8

## DFB Sample Remote Control Commands:

```
10   ! Program to demonstrate remote control of the source application.
20   ! The measurement is completed and the data returned.
30   !
40   ! re-store "DFBsource"
50   !
60   ASSIGN @Osa TO 723;EOL CHR$(12) END              ! Set command terminator to LF & EOI
70   !
80  ! PRINTER IS "results.txt"
90   !
100  !  ***   Setup OSA for measurement   ***
110  !
120  OUTPUT @Osa;"*rst"                               ! Preset OSA
130  OUTPUT @Osa;"calc:sour:test dfb"                 ! Select DFB source measurement
140  !
150  OUTPUT @Osa;"sens:wav:cent 1562nm"               ! Set center frequency and span
160  OUTPUT @Osa;"sens:wav:span 20nm"
                                                      ! for typical measurement
170  !
180  OUTPUT @Osa;"disp:wind:trac:y1:scal:rlev 0dbm"   ! Set reference level
190  OUTPUT @Osa;"sens:pow:dc:rang:low -60dbm"        ! Set sensitivity required
200  OUTPUT @Osa;"sens:bwid:res 0.1nm"                ! Set resolution bandwidth
210  !
220  OUTPUT @Osa;"calc:mark:pexc:peak 3.0db"          ! Set peak excursion
230  OUTPUT @Osa;"calc:sour:func:bwid:ndb -6.0db"     ! Set vertical offset for BW
240  !
250  !  ***   Initiate measurement   ***
260  !
270  OUTPUT @Osa;"init:imm"                           ! Take sweep to update display
280  !
290  OUTPUT @Osa;"calc:sour?"                         ! Request measurement data
300  ENTER @Osa;Peakwl,Moffs,Stopb,Coffs,Smsr,Peaka,Bw,Bwamp
310  !
320  !  ***   Print measurement results   ***
330  !
340  PRINT
350  PRINT "DFB Measurement results"
360  PRINT
370  PRINT "Peak Wavelength (m)",Peakwl
380  PRINT "Mode Offset (m)",Moffs
390  PRINT "Stop Band (m)",Stopb
400  PRINT "Center Offset",Coffs
410  PRINT "SMSR (dB)",Smsr
420  PRINT "Peak Amplitude (dBm)",Peaka
430  PRINT "Bandwidth (m)",Bw
440  PRINT "Bandwidth Amplitude (dB)",Bwamp
450  !
460  OUTPUT @Osa;"calc:sour:test off"                 ! Turn off source measurement
470  !
480  LOCAL @Osa                                       ! Release OSA to local control
490  !
500  END
```

## *DFB Measurement results*

Peak Wavelength (m)  1.56194E-6
Mode Offset (m)     -9.4E-10
Stop Band (m)       2.26E-9
Center Offset      -1.9E-10
SMSR (dB)  39.7615558
Peak Amplitude (dBm)-.538451274
Bandwidth (m)       1.4E-10
Bandwidth Amplitude (dB)      -6




| DFB Source Test (TrA) | |
|---|---|
| Peak Wavelength | 1561.94 nm |
| Mode Offset | -0.94 nm |
| Stop Band | 2.26 nm |
| Center Offset | -0.19 nm |
| SMSR | 39.76 dB |
| Peak Amplitude | -0.54 dBm |
| Bandwidth | 0.14 nm |
| at: | -6.00 dB |

RBW: 0.1 nm
VBW: 19.3 kHz
Sens: -60.00 dBm
ST: 89.9 ms
Avg: Off
In Vacuum

| Legend |
|---|
| A |

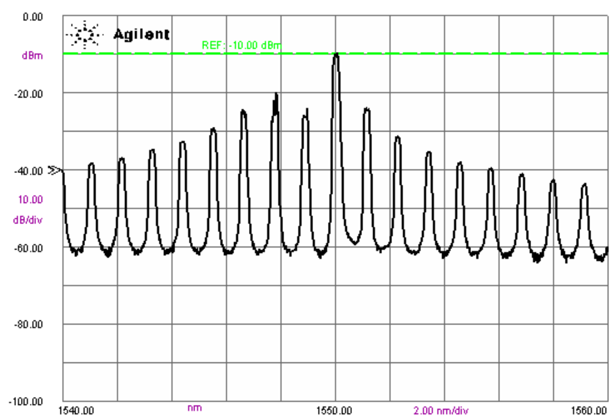
| | |
|---|---|
| Model Number | 86142A |
| Serial Number | US38380138 |
| Firmware Rev | p.01.86 p.01.01 |
| Auto Coupling | Off |
| Detection Mode | Peak |
| Trigger Delay | 10.0 us |
| Wavelength Offset | 0.000 nm |
| Trace A Offset | 0.00 dB |

## FP Sample Remote Control Commands

```
10   ! Program to demonstrate remote control of the source application.
20   ! The measurement is completed and the data returned.
30   !
40   ! re-store "FPsource"
50   !
60   ASSIGN @Osa TO 723;EOL CHR$(12) END              ! Set command terminator to LF & EOI
70
80   PRINTER IS "results.txt"
90   !
100  !  ***  Setup OSA for measurement  ***
110  !
120  OUTPUT @Osa;"*rst"                               ! Preset OSA
130  OUTPUT @Osa;"calc:sour:test fp"                  ! Select FP source measurement
140  !
150  OUTPUT @Osa;"sens:wav:star 1540nm"               ! Set start wavelength
160  OUTPUT @Osa;"sens:wav:stop 1560nm"               ! Set stop wavelength
170  !
180  OUTPUT @Osa;"disp:wind:trac:y1:scal:rlev -10.0dbm"! Set reference level
190  OUTPUT @Osa;"sens:pow:dc:rang:low -60dbm"        ! Set sensitivity required
200  OUTPUT @Osa;"sens:bwid:res 0.2nm"                ! Set resolution bandwidth
210  !
220  !  ***  Initiate measurement  ***
230  !
240  OUTPUT @Osa;"init:imm"                           ! Take sweep to update display
250  !
260  OUTPUT @Osa;"calc:sour?                          ! Request measurement data
270  ENTER @Osa;Meanwl,Peakwl,Modespm,Modesph,Fwhm,Peaka,Tpow,Sigma
280  !
290  !  ***  Print measurement results  ***
300  !
310  PRINT
320  PRINT "FP Measurement results"
330  PRINT
340  PRINT "Mean Wavelength (m)",Meanwl
350  PRINT "Peak Wavelength (m)",Peakwl
360  PRINT "Mode Spacing (m)",Modespm
370  PRINT "Mode Spacing (Hz)",Modesph
380  PRINT "FWHM (m)",Fwhm
390  PRINT "Peak Amplitude (dBm)",Peaka
400  PRINT "Total Power (dBm)",Tpow
410  PRINT "Sigma (m)",Sigma
420  !
430  OUTPUT @Osa;"calc:sour:test off"                 ! Turn off source measurement
440  !
450  LOCAL @Osa                                       ! Release OSA to local control
460  !
470  END
```

### *FP Measurement results*

Mean Wavelength (m) 1.54976934E-6
Peak Wavelength (m) 1.55002E-6
Mode Spacing (m) 1.13777778E-9
Mode Spacing (Hz) 1.42018207E+11
FWHM (m) 2.86935505E-9
3 dB Width (m) 0
Peak Amplitude (dBm)-9.93317222
Total Power (dBm) -9.12593026
Sigma (m) 1.21840979E-9




| FP Source Test (TrA) | |
|---|---|
| Mean Wavelength | 1549.77 nm |
| Peak Wavelength | 1550.02 nm |
| Mode Spacing | 1.1 nm |
| Mode Spacing | 142 GHz |
| FWHM | 2.87 nm |
| Peak Amplitude | -9.93 dBm |
| Total Power | -9.13 dBm |
| Sigma | 1.22 nm |

RBW: 0.2 nm    Sens: -60.00 dBm    In Vacuum
VBW: 19.3 kHz    ST: 56.3 ms    Avg: Off

Legend
A

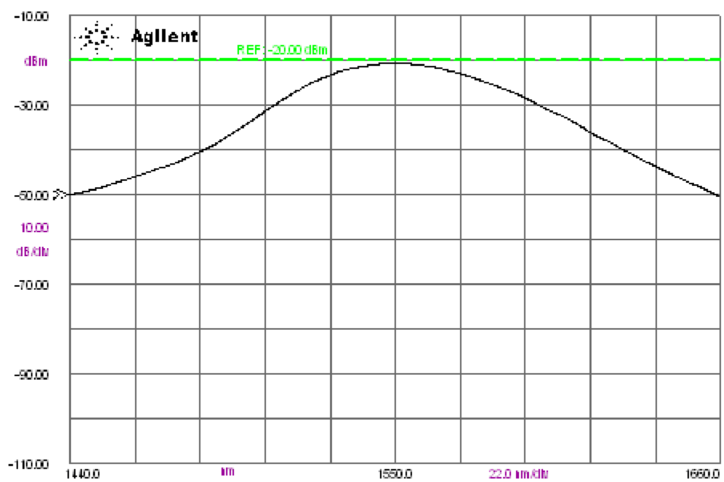
| Model Number | 86142A |
|---|---|
| Serial Number | US38380138 |
| Firmware Rev | p.01.86 p.01.01 |
| Auto Coupling | Off |
| Detection Mode | Peak |
| Trigger Delay | 10.0 us |
| Wavelength Offset | 0.000 nm |
| Trace A Offset | 0.00 dB |

## LED Sample Remote Control Commands

```
10  ! Program to demonstrate remote control of the source application.
20  ! The measurement is completed and the data returned.
30  !
40  ! re-store "LEDsource"
50  !
60  ASSIGN @Osa TO 723;EOL CHR$(12) END              ! Set command terminator to LF & EOI
70  !
80  PRINTER IS "results.txt"
90  !
100  !   ***   Setup OSA for measurement   ***
110  !
120  OUTPUT @Osa;"*rst"                              ! Preset OSA
130  OUTPUT @Osa;"calc:sour:test led"                ! Select LED source measurement
140  !
150  OUTPUT @Osa;"sens:wav:star 1440nm"              ! Set start wavelength
160  OUTPUT @Osa;"sens:wav:stop 1660nm"              ! Set stop wavelength
170  !
180  OUTPUT @Osa;"disp:wind:trac:y1:scal:rlev -20.0dbm" ! Set reference level
190  OUTPUT @Osa;"sens:pow:dc:rang:low -60dbm"       ! Set sensitivity required
200  OUTPUT @Osa;"sens:bwid:res 5nm"                 ! Set resolution bandwidth
210  OUTPUT @Osa;"calc:mark:func:nois:band 1nm"      ! Set noise reference to 1 nm
220  !
230  !   ***   Initiate measurement   ***
240  !
250  OUTPUT @Osa;"init:imm"                          ! Take sweep to update display
260  !
270  OUTPUT @Osa;"calc:sour?"                        ! Request measurement data
280  ENTER @Osa;Meanwlf,Meanwl,Peakwl,Sigma,Fwhm,Bwidth,Tpow,Peaksd
290  !
300  !   ***   Print measurement results   ***
310  !
320  PRINT
330  PRINT "LED Measurement results"
340  PRINT
350  PRINT "Mean (FWHM) Wavelength (m)",Meanwlf
360  PRINT "Mean Wavelength (m)",Meanwl
370  PRINT "Peak Wavelength (m)",Peakwl
380  PRINT "Sigma (m)",Sigma
390  PRINT "FWHM (m)",Fwhm
400  PRINT "3 dB Width (m)",Bwidth
410  PRINT "Total Power (dBm)",Tpow
420  PRINT "Peak Spectral Density (dBm)",Peaksd
430  !
440  OUTPUT @Osa;"calc:sour:test off"                ! Turn off source measurement
450  !
460  LOCAL @Osa                                      ! Release OSA to local control
470  !
480 END
```

### *LED Measurement results*

Mean (FWHM) Wavelength (m) 1.55273635E-6
Mean Wavelength (m) 1.55099E-6
Peak Wavelength (m) 1.55E-6
Sigma (m) 2.29537883E-8
FWHM (m) 5.40561714E-8
3 dB Width (m) 4.862E-8
Total Power (dBm) -10.333219
Peak Spectral Density (dBm) -27.5968118




| LED Source Test (TrA) | |
|---|---|
| Mean (FWHM) | 1552.7 nm |
| Mean (3dB) | 1551.0 nm |
| Peak Wavelength | 1550.0 nm |
| Sigma | 23.0 nm |
| FWHM | 54.1 nm |
| 3 dB Width | 48.6 nm |
| Total Power | -10.33 dBm |
| Pk Density (1nm) | -27.60 dBm |

RBW: 5 nm
VBW: 19.3 kHz
Sens: -60.00 dBm
ST: 83.2 ms
Avg: Off
In Vacuum

Legend
A

| Model Number | 86142A |
|---|---|
| Serial Number | US38380138 |
| Firmware Rev | p.01.86 p.01.01 |
| Auto Coupling | Off |
| Detection Mode | Peak |
| Trigger Delay | 10.0 us |
| Wavelength Offset | 0.000 nm |
| Trace A Offset | 0.00 dB |

3



# Passive Component Test Application

# About the Application

The Passive Component Test application simplifies the complex characterization and testing of passive components. The application includes guided setups to prompt you through the measurement procedure. When the setup is complete the application performs an automatic pass/fail check against your custom specifications.

The application can easily be customized for your particular devices by modifying the specification files using either a text editor or a Microsoft®[1] Excel spreadsheet template wizard. The template wizard can be downloaded from the web. For more information, refer to “Excel Template Wizard for the PCT Application” on page 3-23.

To perform a measurement, you must run a specification file. Specification files configure the settings of the instrument, describe measurements, and direct the printing or saving of the measurement results. Specification files can be stored and loaded from the internal memory of the optical spectrum analyzer, or imported from a disk.

Because specification sets are stored in the internal memory of the optical spectrum analyzer, you can easily switch between tests. Refer to “Designing Specification Sets” on page 3-22 to learn how to design your own specification files.

It is easy to learn how to design and write specification files. Anyone with a basic understanding of how to operate the optical spectrum analyzer can learn how to design specification sets in approximately one hour. This is a small investment considering the time you’ll save testing your devices.

Figure 1 and Figure 2 on page 3-4 show the measurement screen and the table of results displayed after a measurement has been taken.

1. Microsoft® is a U.S. registered trademark of Microsoft Corp.

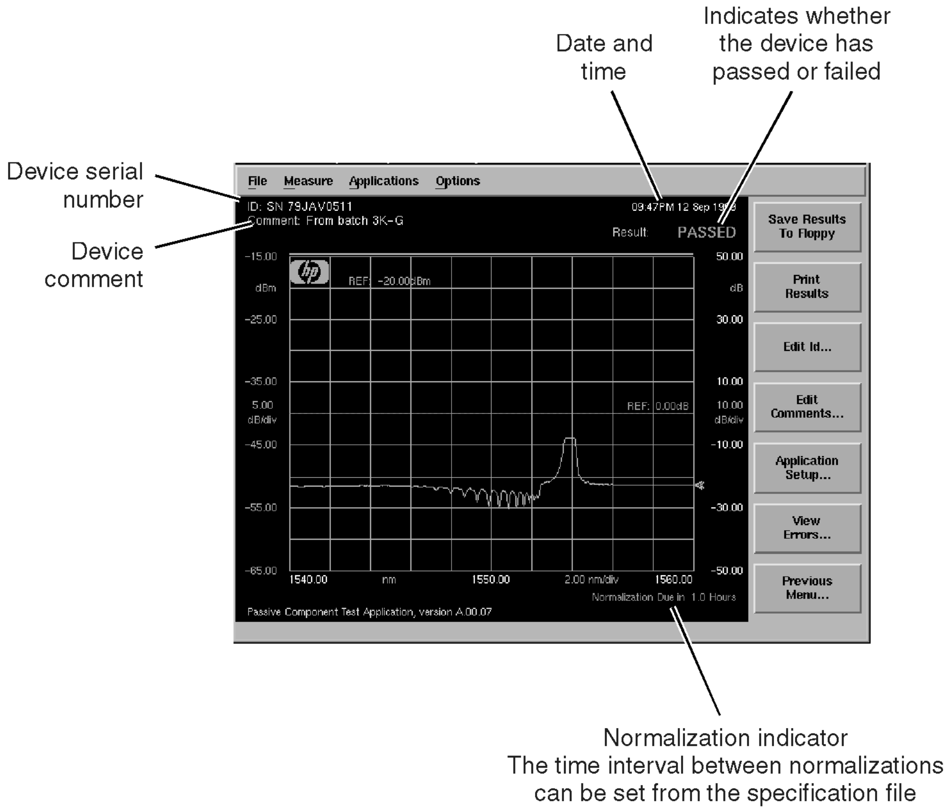



Figure 1 The Measurement screen

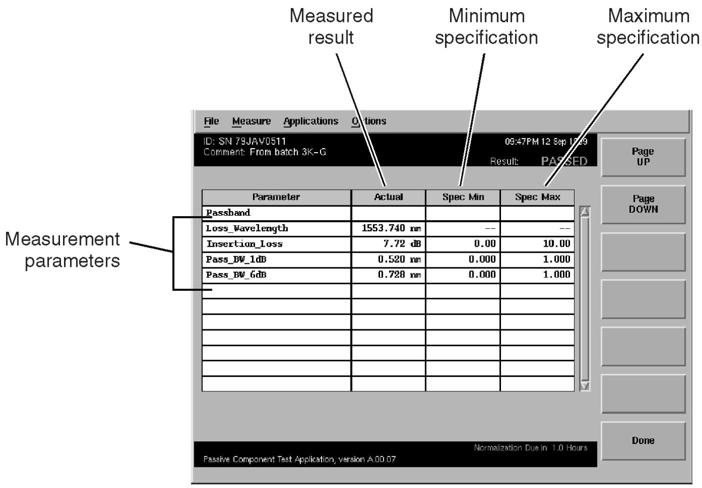
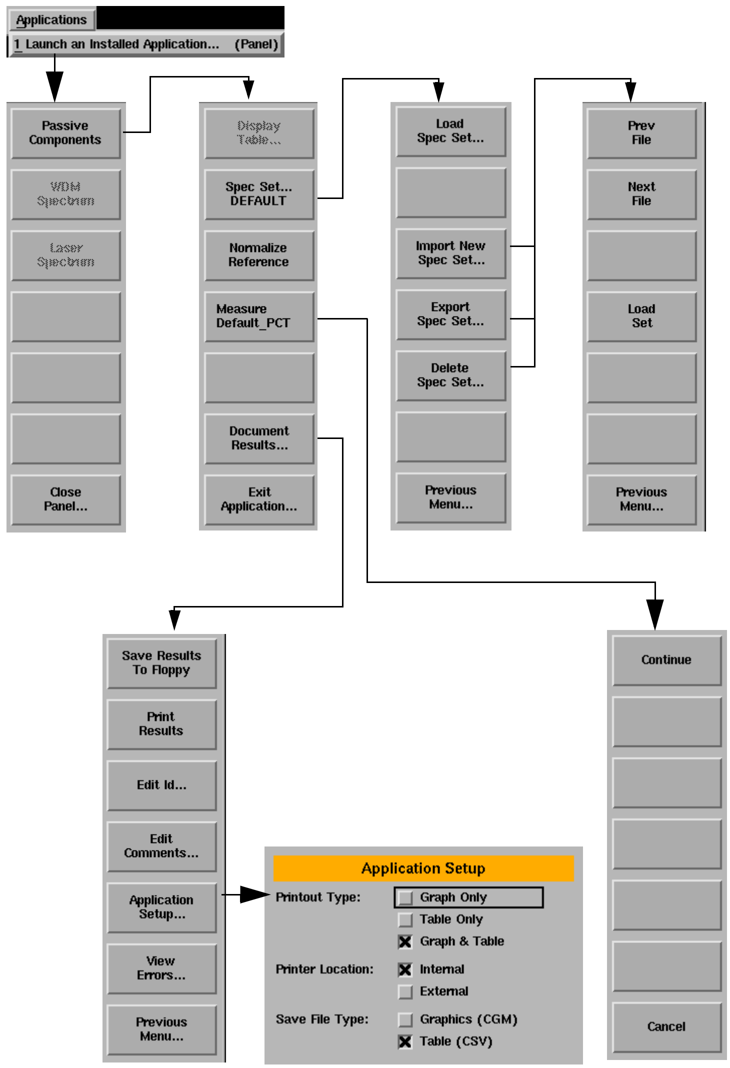



Figure 2 A table of results

## The Passive Component Test Menus




The application softkeys are accessed using the front-panel APPL'S key or the Applications menu, Launch an Installed Application selection on the menu bar.

# Performing Measurements

This section explains how to load and use the Passive Components Test application.

Measurements are performed using either the instrument’s internal broadband EELED or white-light source, or an external broadband source. You can test passive devices having any number of light paths, such as filters and couplers and WDM multiplexers.

To use the Passive Components Test application you must:

**1** Start the application, see “To start the Passive Components Test application” on page 3-7.

**2** Load a specification set from internal memory, see “To load an existing specification set” on page 3-11, or import a specification set from a floppy disk, see “To import a specification set” on page 3-9.

**3** Perform a normalization if required, see “To run the source normalization routines” on page 3-13. The application automatically detects whether normalization is required.

**4** Measure the device under test, see “To measure the device under test” on page 3-14.

You can then:

- Save the results, see “To save the results to floppy” on page 3-15.
- Print the results, see “To print the results” on page 3-15.
- View the results in a table, see “To display a table of the results” on page 3-16.

### To start the Passive Components Test application

1 Press the front-panel APPL'S key or the Applications menu Launch an Installed Application selection.

2 The following screen is displayed.

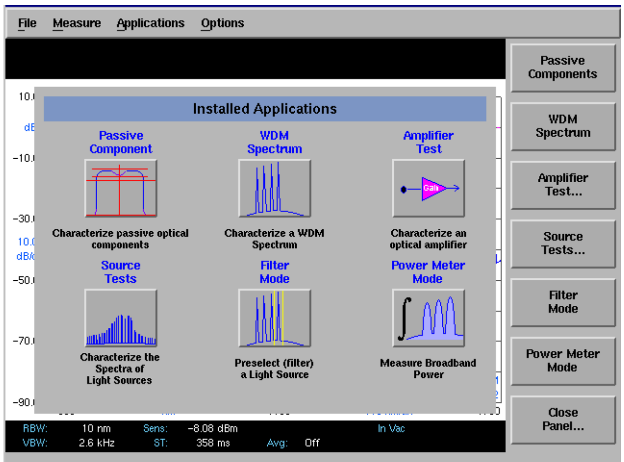



Figure 3 Applications Panel and Menu

The panel and the menu change whenever an application is installed or uninstalled. Each installed application has an icon on the panel and a corresponding softkey.

3 Press the PASSIVE COMPONENTS softkey. The loading of the application is indicated by the on-screen message, “Loading Passive Component Application, Please Wait...”. When the application is loaded, the name of the selected set appears on the SPEC SET.... softkey. The application is now ready for use.

The following functions assume the application is loaded.

## To select a specification set

1 Press the SPEC SET.... <SPEC SET> softkey.

You can now load an existing specification set, import a new specification set from a floppy disk, or delete an existing specification set from the internal memory of the OSA. If no specification sets are available, the default specification set is loaded.

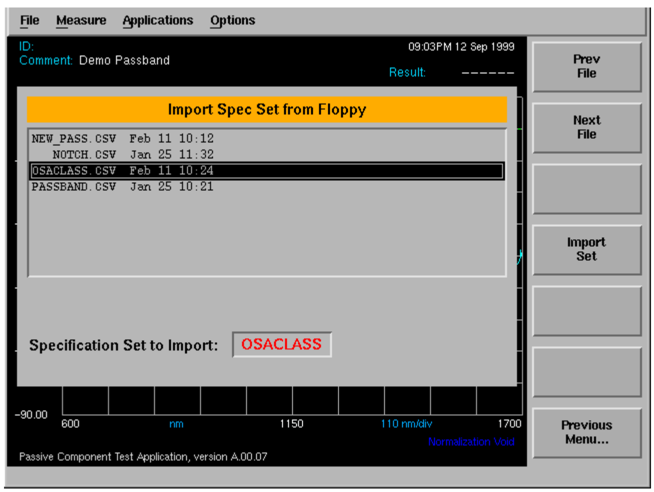
## To import a specification set

1 Insert the floppy disk containing the specification set into the internal floppy disk drive of the OSA.

2 Press the SPEC SET.... <SPEC SET> softkey.

**NOTE** Specification set file names must conform to the MS-DOS 8.3 file name convention, a maximum of 8 characters.

3 Press the IMPORT SPEC SET.... softkey.



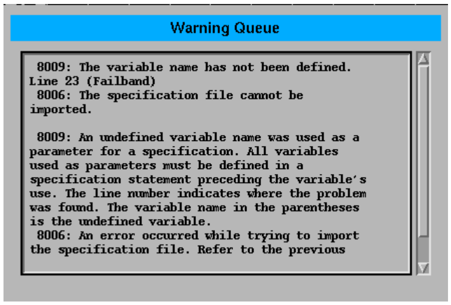

A list of the externally stored specification sets is displayed.

4 Use the navigation keys to select the desired specification set.

5 Press the IMPORT SET softkey.

The selected specification set is imported into the internal memory of the OSA. When a specification set is imported it is checked for errors and “compiled” before being copied into internal storage.

If errors are detected in the specification set being imported, the SHOW WARNINGS.... softkey appears. Press the SHOW WARNINGS.... softkey, then the PREV and NEXT softkeys to display a detailed description of the error.

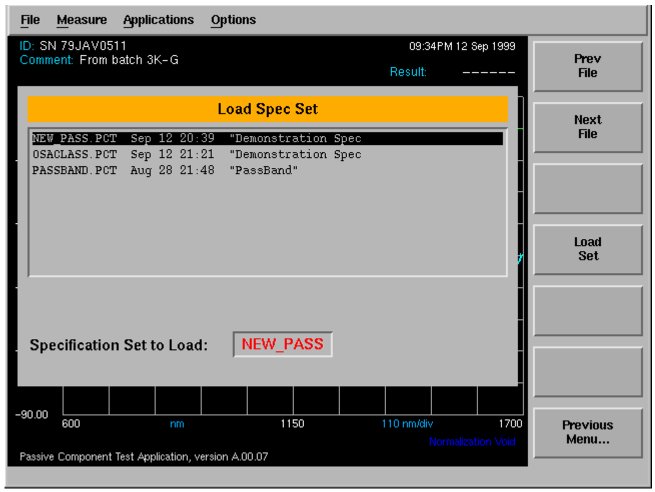



If no errors are detected, the file is automatically copied to internal memory, loaded, and the application returns to the previous menu.

## To load an existing specification set

1 Press the SPEC SET.... <SPEC SET> softkey.

2 Press the LOAD SPEC SET.... softkey.




A list of the internally stored specification sets is displayed. A specification set must be imported from a floppy disk into the internal memory of the OSA before it can be loaded. For information on importing specification sets, see “To import a specification set” on page 3-9.

If no specification sets have been previously imported, the Load Spec Set list will contain the Default specification set.

3 Use the navigation keys to select the desired specification set.

4 Press the LOAD SET softkey.

The currently selected specification set is loaded and you are returned to the previous softkey menu. While the specification set is being loaded, the message “Loading Spec Set <*spec set name*>, Please Wait...” is displayed.

## To export a specification set

1. Press the SPEC SET.... <SPEC SET> softkey.
2. Press the EXPORT SPEC SET.... softkey. A list of the internally stored specification sets is displayed.
3. Use the navigation keys to select the desired specification set and then press the EXPORT SET softkey. The CSV specification set file from internal memory is output to the floppy disk.

## To delete a specification set

1. Press the SPEC SET.... <SPEC SET> softkey.
2. Press the DELETE SPEC SET.... softkey. A list of the internally stored specification sets is displayed.
3. Use the navigation keys to select the specification set to be deleted and then press the DELETE SPEC SET softkey. The currently selected specification set is deleted from internal memory. After the file is deleted, the application returns to the previous menu.

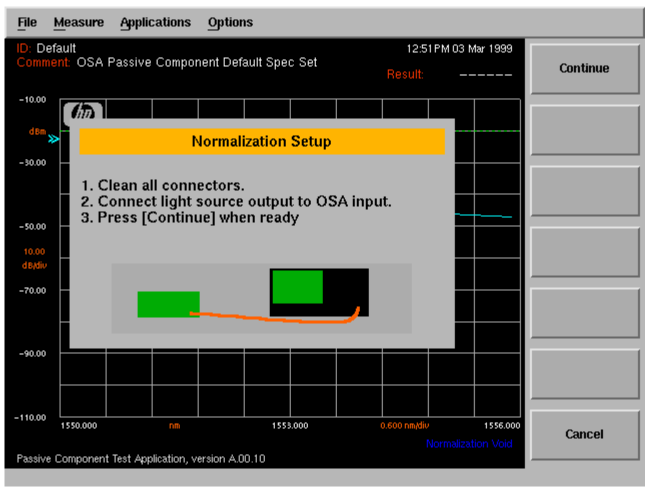
## To run the source normalization routines

**NOTE** The application will automatically detect if a normalization is required and will run the routine before the next measurement is made. The time interval between normalizations is specified in the specification set.

1 Load the desired specification set. See “To select a specification set” on page 3-8.

2 Press the PREVIOUS MENU softkey.

3 Press the NORMALIZE REFERENCE softkey.



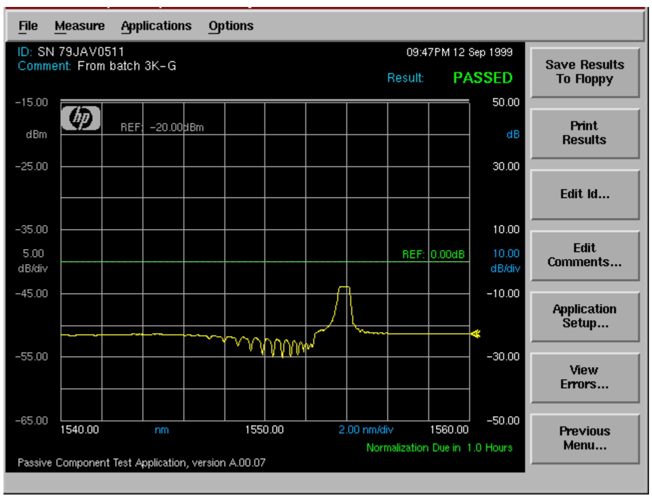

4 Follow the on-screen instructions to perform the source normalization.
After the source normalization is successfully completed, press Continue to return to the previous menu. The device under test can be measured. See “To measure the device under test” on page 3-14.

## To measure the device under test

1 Load the desired specification set. See “To select a specification set” on page 3-8.

2 Press the MEASURE <SPEC SET> softkey. The application will detect and automatically run the normalization routine if required. See “To run the source normalization routines” on page 3-13.

3 The measurement will automatically continue when the normalization routine is completed.




The results can now be viewed as a waveform, as shown in the figure, or in a table, see “To display a table of the results” on page 3-16. The data can also be saved, see “To save the results to floppy” on page 3-15, and printed, see “To print the results” on page 3-15.

### To save the results to floppy

The results can be saved automatically by using the STORE, AUTO keyword in the specification set, refer to “STORE, AUTO” on page 3-68.

To save the results manually after completing a measurement, press the DOCUMENT RESULTS softkey. Then press the SAVE RESULTS TO FLOPPY softkey. The results of the test are saved to the floppy disk. The data can be saved as either graphical data in CGM format or as tabular data in CSV. For information on selecting the type of data to be saved, see “To change the default application settings” on page 3-19.

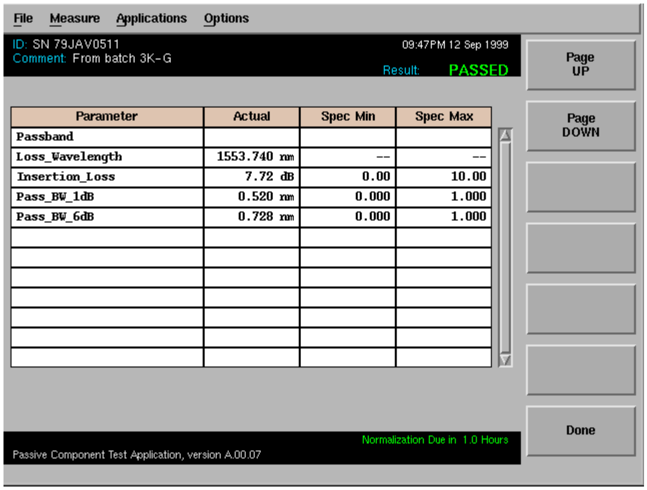
### To print the results

The results can be printed automatically by using the PRINT keyword in the specification set, refer to “PRINT” on page 3-66.

To print the results manually after completing a measurement, press the DOCUMENT RESULTS softkey. Then press the PRINT RESULTS softkey. The results can be printed out as a graph, a table, or as both on either the internal printer or on an external printer. See “To change the default application settings” on page 3-19 for information on making these selections.

## To display a table of the results

After a measurement has been completed, press the DISPLAY TABLE.... softkey.



## To edit the ID of the device under test

**NOTE** Based on the specification set selected, you are usually prompted for the Device ID and Comments at the beginning of the measurement. However, if you were not prompted, or you wish to edit the Device ID or Comment fields, the following procedure can be used.

1 After completing a measurement, press the DOCUMENT RESULTS.... softkey.

2 Press the EDIT ID.... softkey.

### *To enter the ID using the arrow keys*

1 Use the front-panel step keys (⇑ and ⇓) and the arrow softkeys (→ and ←) to highlight each letter of the ID string.

2 When the desired letter or function is selected, press the SELECT softkey.

3 Select the BACKSPACE softkey to delete individual letters.

4 When you finish entering the string, press the CONTINUE softkey.

### *To enter the ID using a trackball or mouse*

1 Use the pointing device to place the cursor on a letter of the filename. Click on the character to select it.

2 Click the BACKSPACE softkey to delete individual letters.

3 When you finish entering the string, click the CONTINUE softkey. The new device ID is displayed on-screen in the ID field.

**NOTE** The new Device ID is saved *only for the current session.* Each time a new device is measured, the comment and ID strings are reset to the values specified in the specification set.

## To edit the comments for the device under test

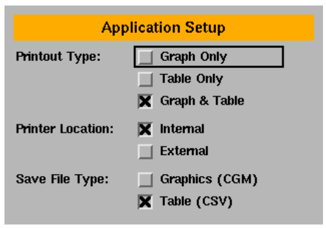
**NOTE** Based on the specification set selected, you are usually prompted for the Device ID and Comments at the beginning of the measurement. However, if you were not prompted, or you wish to edit the Device ID or Comment fields, the following procedure can be used.

1. After completing a measurement, press the DOCUMENT RESULTS.... softkey.
2. Press the EDIT COMMENTS.... softkey.
3. Use the navigation keys to enter your comments. See “To enter the ID using the arrow keys” on page 3-17 and To enter the ID using a trackball or mouse 17 for information on entering the comment string.
4. When you finish entering the string, click the CONTINUE softkey. The new comment is displayed on-screen in the Comment field.

**NOTE** The new comment is saved *only for the current session.* Each time a new device is measured, the comment and ID strings are reset to the values specified in the specification set.

## To change the default application settings

1. After completing a measurement, press the DOCUMENT RESULTS.... softkey.
2. Press the APPLICATION SETUP.... softkey.
3. Refer to To Fill In a Setup Panel 20 for information on changing and selecting items in the setup panel.




### Setup panel selections

***Printout Type***

The results can be printed out as a graph, a table, or as both.

***Printer Location***

Selects either the internal printer or an external printer as the print destination.

***Save File Type***

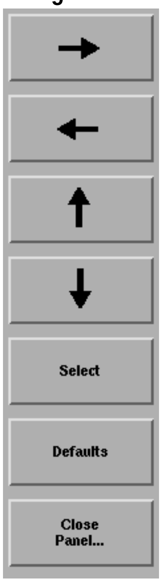
The data can be saved as either graphical data in CGM format or as tabular data in CSV.

## To Fill In a Setup Panel

Any of the instrument settings can be changed by using either the front-panel keys or the menu bar selections. Many of the menu selections and front-panel keys display a softkey panel. Settings in softkey panels are changed using the softkeys, data-entry keys, mouse, and trackball.

Setup panels allow you to adjust setup conditions which are not frequently changed.

### Using the softkeys




***The arrow softkeys***

Allows the user to navigate from field to field in the dialog box. The highlighted parameter can be changed.

***The Select softkey***

Selects or deselects the highlighted parameter.

***The Defaults softkey***

Resets the parameters to their default condition.

***Close Panel.... softkey***

Saves the current setup and returns the user to the previous menu.

***The front-panel number keys, step keys, and knob***

Allows the user to enter a numeric value in the highlighted field.

### To use the navigation softkeys

1. Use the arrow softkeys to highlight the settings on the setup panel.
2. Use the SELECT softkey to toggle the selection boxes on and off.
3. Enter values in the numeric fields using the front-panel knob or numeric entry pad.
4. To return the setup values to the instrument's preset settings, press the DEFAULTS softkey.
5. When you are satisfied with your selections, press the CLOSE PANEL.... softkey to enter your selections and close the setup panel.

# Designing Specification Sets

***What is a specification set?***

Specification sets are files that program the Passive Component Test application to perform a measurement. Each specification set defines one test. Specification sets are comma-separated-value (CSV) ASCII files that you can write using any text editor or spreadsheet program. The file name must comply with the MS-DOS 8.3 file name convention, a maximum of 8 characters, and the file name extension must be *.csv.*

***How can I write specification sets?***

You can use any ASCII editor to create your specification sets. Refer to “Using an ASCII Editor” on page 3-43 for more information.

You can also simplify the writing of specification sets by using an Excel template. Refer to “Excel Template Wizard for the PCT Application” on page 3-23 for more information.

If you use a spreadsheet program to develop your specification sets, configure the spreadsheet to automatically insert the commas for you when you save your file.

To learn the details about each specification set keyword, refer to “Specification Set Keywords” on page 3-57.

## Excel Template Wizard for the PCT Application

Writing specification sets can be simplified by using the Microsoft® Excel template. The Excel template wizard can be downloaded from the web at http://www.agilent.com. In the Quick Search box, type “pct wizard”. Click on “Agilent 86140A Series OSA Passive Component Test Application and then click on “Download pct wizard.exe”. The template features a pull-down menu and setup wizard to automate the generation of specification sets.

## Installing the PCT Wizard

The Microsoft® Excel spreadsheet wizard, *pct_wizard.xlt,* contains a powerful macro that prompts you for measurement statements and builds a valid specification set file for your measurement.

Before using the template for the first time, make a backup copy and store it in a safe place. When working with the template in Excel, use the SAVE CSV button to prevent writing over the original, unmodified template. To prevent modifying the original template, on the File menu do *not* select Save.

### *To download and install the wizard*

The PCT Wizard download is for Microsoft Windows systems only. To download the PCT Wizard:

**1** Create a folder *c:\osa\pct* on your local PC.

**2** On the web, go to http://www.agilent.com/comms/osa then click on:

Agilent 86140B Benchtop Standard Performance Optical Spectrum Analyzer
Application Notes and Technical Papers
Passive Component Test Application
Passive Component Test Application
pct_wizard.exe.

**3** Download and save the *pct_wizard.exe* to the *c:\osa\pct* directory. This is a self extracting archive.

**4** To extract the files, from Windows Explorer, double-click on *pct_wizard.exe*.

Four files are extracted:

Table 1

| | |
|---|---|
| readme.txt | A text file of the instructions shown on this web page. |
| pct_wizard.xlt | The Excel Wizard used to write specification sets. |
| pct_wizard.dll | The driver file required to run the PCT Wizard. |
| pct_help.pdf | Instructions for using the PCT Wizard and a brief tutorial. This file can be viewed and printed using Adobe Acrobat. If you do not have Adobe Acrobat Reader necessary for viewing PDF documentation, download your free Acrobat Reader now. (Button) |

5 Move the *pct_wizard.dll* to the *c:\windows\system* directory.

6 Make a backup copy of *pct_wizard.xlt* and store it in a safe place.

## To view the help file

**NOTE** You must have Adobe Acrobat reader installed.

- To view the help file and tutorial, from Windows Explorer, double click on *pct_help.pdf*.

## To start the PCT Wizard

**NOTE** You must have Microsoft Excel installed.

- To open Excel and start the Wizard, from Windows Explorer, double-click on *pct_wizard.xlt*.

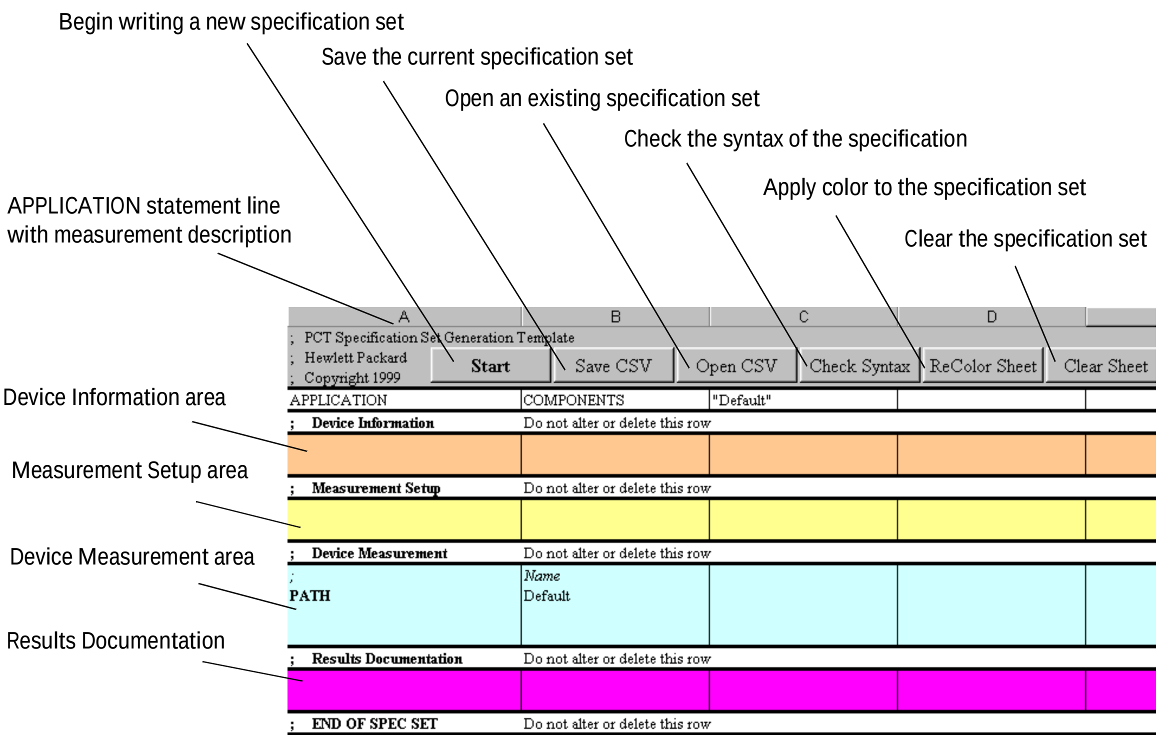
**NOTE** Never save your work from the file menu. This creates a modified template file which generates an improper specification set (CSV) file that will not run in the Passive Component Test application. **Always click the SAVE CSV button to save your specification set.**

## To remove the PCT Wizard from your PC

1 To remove all files and the PCT Wizard from your PC, delete the folder *c:\osa\pct* and all its contents.

2 Delete the file *pct_wizard.dll* from the *c:\windows\system* directory.

# The PCT Wizard at a Glance




The spreadsheet template

### *Device Information area*

This section is used to enter information about the device, such as the identification and comments. The ID and COMMENT statements allow you to specify the device you are testing and to label the test. Both of these values will be shown on the instrument screen. Each time a device is tested, the user can be prompted to enter the device's serial number.

### *Measurement Setup area*

This section is used to enter measurement setup information, such as the resolution, span, center wavelength and sensitivity. This area will contain the required NORMALIZE and SETUP keywords and the optional STIMULUS keyword to set up the optical spectrum analyzer for measurement.

The SETUP statement configures the settings of the optical spectrum analyzer. Only one SETUP statement should be used. The NORMALIZE keyword performs a trace normalization. The STIMULUS statement is used to specify the internal or external broadband light source of the instrument.

### *Device Measurement area*

This section is used to enter the test sequence and specification limits, such as, center wavelength and insertion loss. This area of the spreadsheet will contain the required PATH keyword, and the keywords and parameters for the chosen measurements.

For a full list of keywords and parameters, refer to “Specification Set Keywords” on page 3-57.

### *Results Documentation area*

Use this area to specify where and how the measurement results are stored and printed.

Use PRINT_SETUP to determine whether the summary is printed to the internal or external printer, and whether to print the results table or both the table and the graphics.

STORE_SETUP is used to determine what results information is saved to the floppy disk.

### To begin the specification set

Every specification set begins with a required APPLICATION statement which identifies the specification set with the Passive Component Test application. It also provides an identification string which is displayed when the file is cataloged. You must edit this string manually in cell C4.

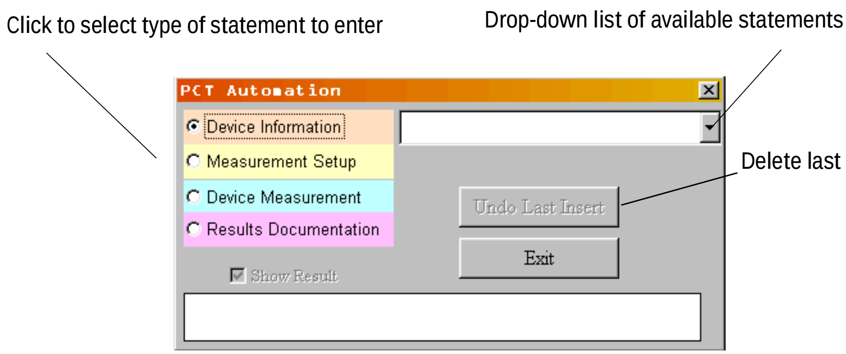
**NOTE** Do not modify or delete title rows, such as the “Device Information” row. If these rows are deleted, the PCT Wizard will not run properly.

After entering the identification string, you can create the specification set using the PCT Automation wizard.

All specification sets also require entries for SETUP, NORMALIZE, and PATH keywords. A default path is created whenever the CLEAR SHEET button is pressed. These will be entered using the wizard. Other keywords are optional. For a full list of keywords and parameters, refer to “Specification Set Keywords” on page 3-57.

## To Use the PCT Wizard

**1** Click the START button to display the PCT Automation dialog box.

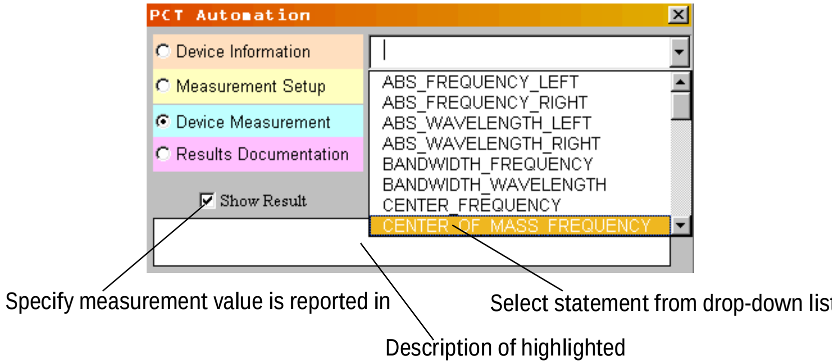



PCT Automation dialog box

**2** There are four types of specification set statements: Device Information, Measurement Setup, Device Measurement, and Results Documentation. For a complete description of these statements refer to Filling in the Device Information area 32, Filling in the Measurement Setup area 35, Filling in the Device Measurement area 37, Filling in the Results Documentation area 39, Specification Set Keywords 57.

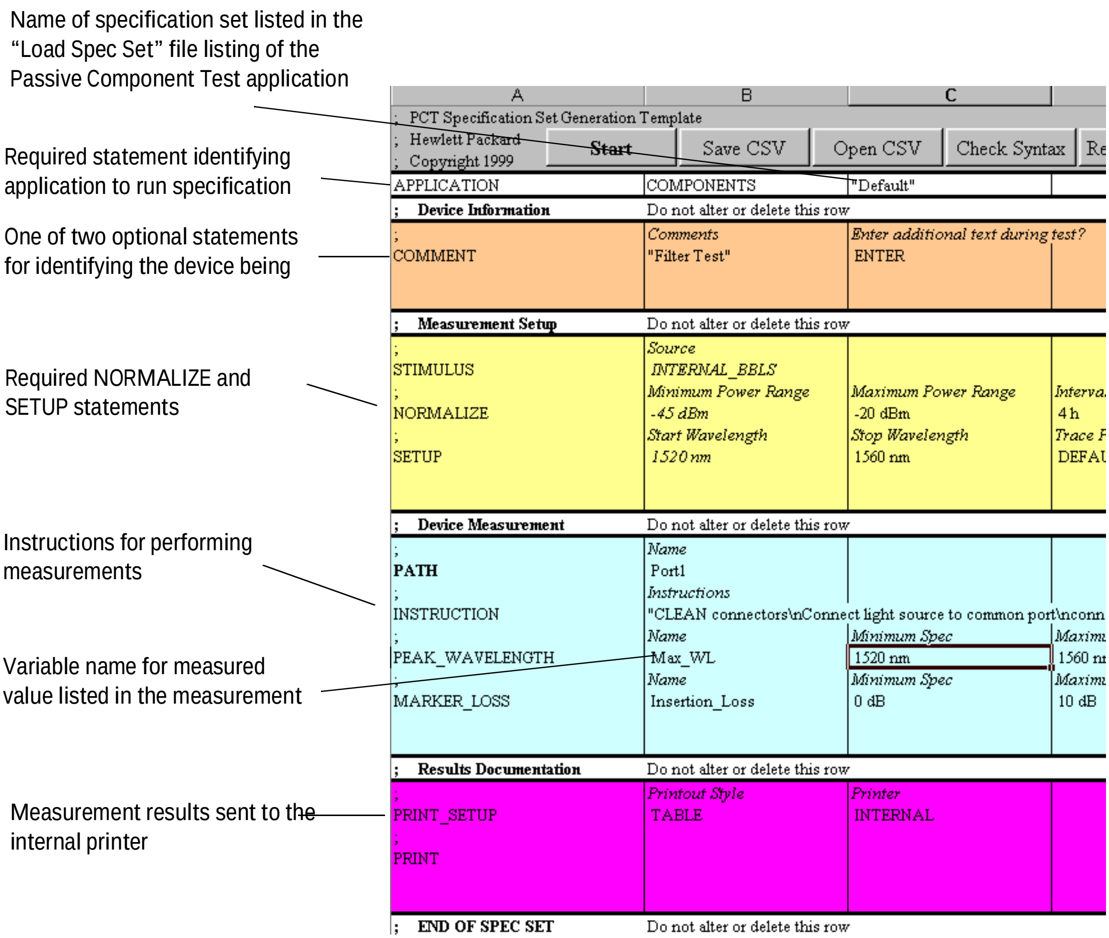
For each type of specification set statement, click the radio button next to the statement in the dialog box, then use the menu at the right to select a keyword. Enter the required information, then click OK to go on to the next item or to return to the first dialog box.

The UNDO LAST INSERT button allows you to delete the last entry made. If you need to modify any other entry, close the wizard and then edit the spreadsheet cell directly.




**3** When finished, click the EXIT button to close the PCT Automation dialog box. Any modifications necessary to the spreadsheet entries may be made directly to the spreadsheet cells after the dialog box is closed.

**4** To save the specification set, click the SAVE CVS button. On the File menu, do *not* select the Save command. If you do the specification set will *not* be saved properly.




Example of a specification set

# Tutorial

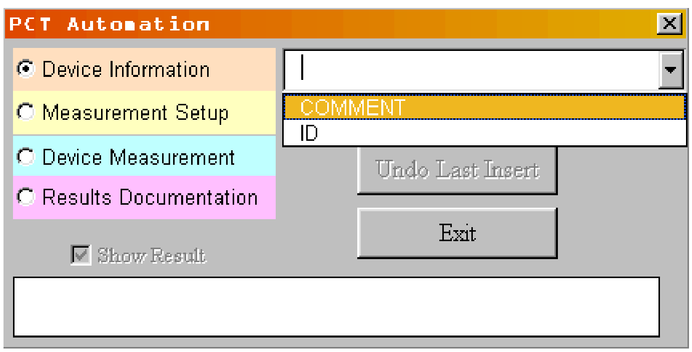
In this tutorial you will create a specification set for measuring the peak wavelength of a WDM filter. The passband of the filter is from 1540 nm to 1560 nm.

## To start the PCT Wizard

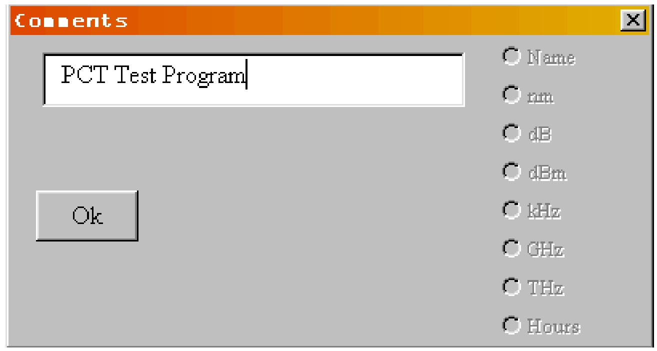
1. To open Excel and start the Wizard, from Windows Explorer, double-click on *pct_wizard.xlt*.
2. Click the START button.

## Filling in the Device Information area

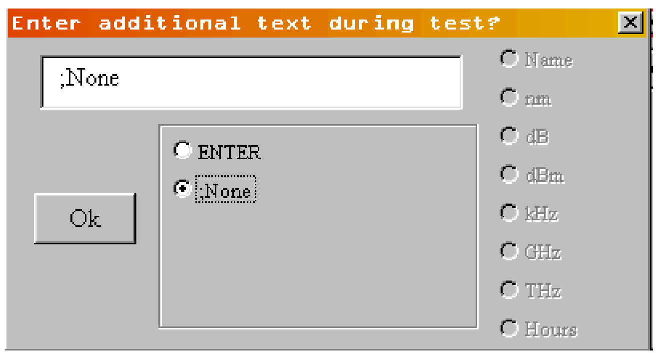
1. In the PCT Automation dialog box, click on the drop-down list and select COMMENT.



2 In the Comments dialog box text box, type PCT Test Program and then click OK.

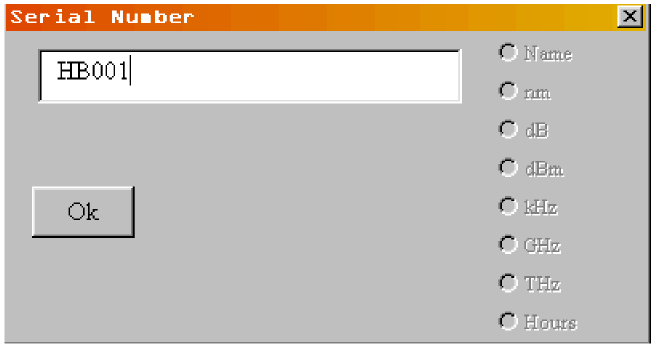



3 In the Enter Additional Text During Test? dialog box select the None option button and then click OK.

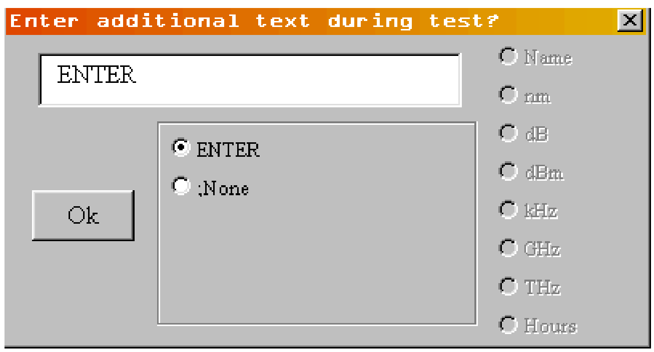



4 In the PCT Automation dialog box on the drop-down list select ID.

**5** In the Serial Number dialog box text box type, HB001 and click OK.




**6** In the Enter Additional Text During Test? dialog box, click OK to select the default text.



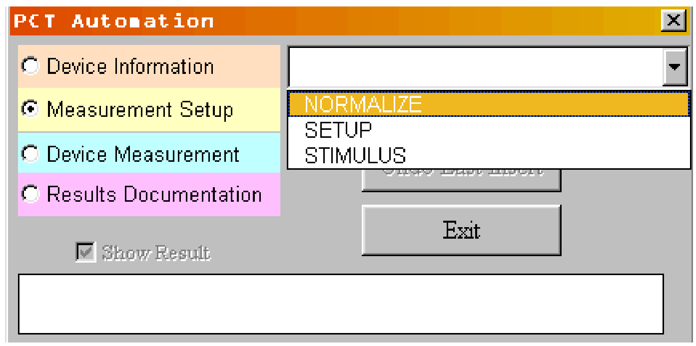

**NOTE** The default text of “ENTER” will cause the optical spectrum analyzer to prompt the user to input a device ID number

## Filling in the Measurement Setup area

### *To enter the normalize information*

**1** In the PCT Automation dialog box, select the Measurement Setup option button.

**2** In the PCT Automation dialog box select NORMALIZE on the drop-down list.




**3** In the Minimum Power Range dialog box enter -40 in the text box. Click OK.

**4** In the Maximum Power Range dialog box enter 0 in the text box. Click OK.

**5** To set the time between normalizations to two hours, in the Interval between normalizations dialog box enter 2. Click OK.

### *To enter the setup information*

**1** In the PCT Automation dialog box, select SETUP on the drop-down list.

**2** In the Start Wavelength dialog box, type 1540. Click OK.

**3** In the Stop Wavelength dialog box, type 1560. Click OK.

**4** In the Trace Points dialog box, type 1001. Click OK.

**5** In the Averages dialog box, type 1. Click OK.

**6** In the Resolution Bandwidth dialog box select the 0.1 nm option button. Click OK.

**7** In the Reference Level dialog box, type 0. Click OK.

**8** In the Scale (dB per division - optional) dialog box, type 10. Click OK.

**9** In the Sensitivity dialog box type, -85. Click OK.

**10** In the Video Bandwidth (3kHz max...) dialog box click OK to keep the DEFAULT text.

**11** In the PCT Automation dialog box select STIMULUS on the drop-down list.

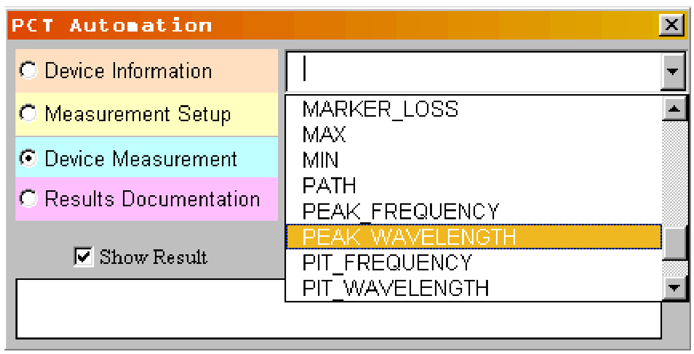
**12** In the Stimulus dialog box click OK to keep the INTERNAL_BBLS text.

## Filling in the Device Measurement area

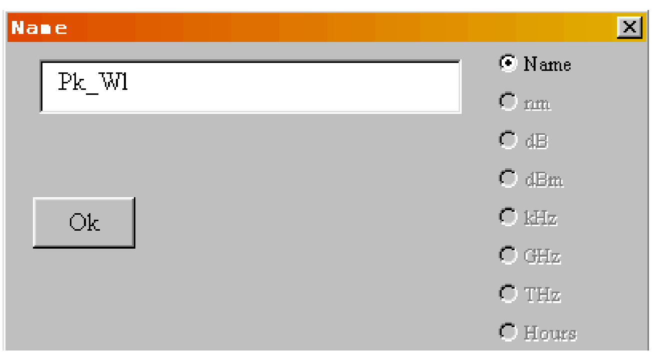
1 In the PCT Automation dialog box select the Device Measurement option button.

2 In the PCT Automation dialog box select PEAK_WAVELENGTH from the drop-down list.

**NOTE** Use the front-panel up and down arrow keys to cycle through the list of keywords and display a description of the highlighted keyword.




3 In the Name dialog box type Pk_Wl. Click OK.




**NOTE** The name you just entered, Pk_Wl, is now a variable name you can reference later.

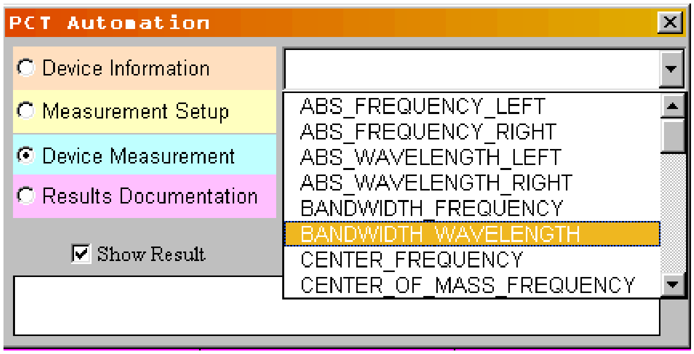
4 In the Minimum Spec dialog box, type 1545. Make sure the nm option button is selected. Click OK.

5 In the Maximum Spec dialog box, type 1555. Click OK.

**6** In the Search From dialog box, type 1540. Click OK.

**7** In the Search To dialog box, type 1560.Click OK.

**8** In the PCT Automation dialog box select BANDWIDTH_WAVELENGTH on the drop-down list.



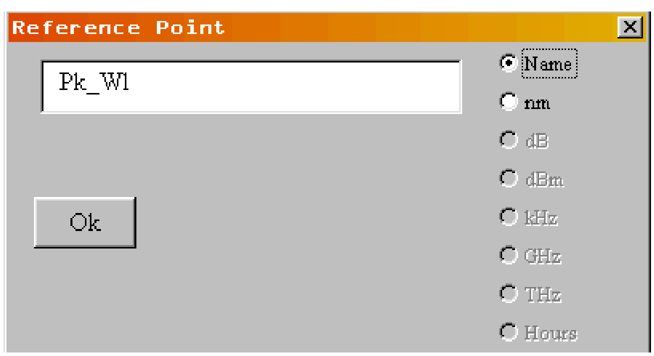

**9** In the Name dialog box type BW_3dB. Click OK.

**NOTE** The name you just entered, BW_3dB, is now a variable name you can reference later.

**10** In the Minimum Spec dialog box type 0.1. Click OK.

**11** In the Maximum Spec dialog box type 2. Click OK.

**12** In the Reference Point dialog box type, Pk_Wl. Select the Name option button. Click OK.



**NOTE**

This command uses the variable Pk_Wl you defined in Step 3 as its reference point. For this reason it is necessary to click on the Name bullet and not the nm option button. If an actual known wavelength value is entered, leave the nm option button selected.

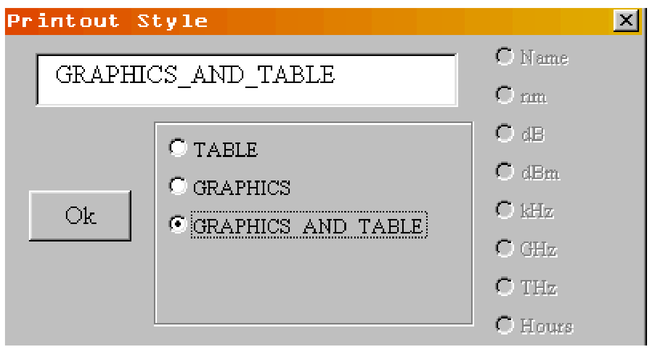
**13** In the Excursion dialog box, type -3. Click OK.

### Filling in the Results Documentation area

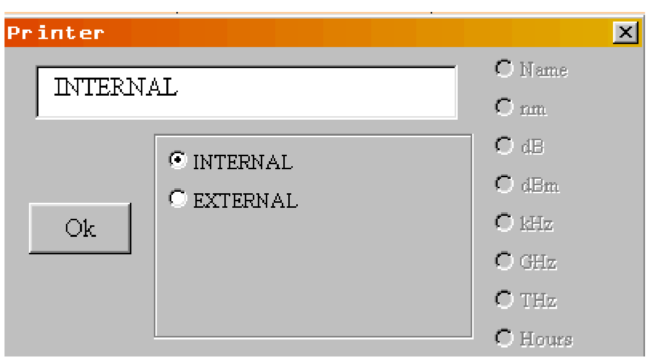
**1** In the PCT Automation dialog box select the Results Documentation option button.

**2** In the PCT Automation dialog box select PRINT_SETUP from the drop-down list.

**3** In the Printout Style dialog box select the GRAPHICS_AND_TABLE option button. Click Ok.




**4** In the Printer dialog box click OK to select the default text, INTERNAL.




**5** In the PCT Automation dialog box select PRINT on the drop-down list.

**6** In the PCT Automation dialog box, click on the Exit button

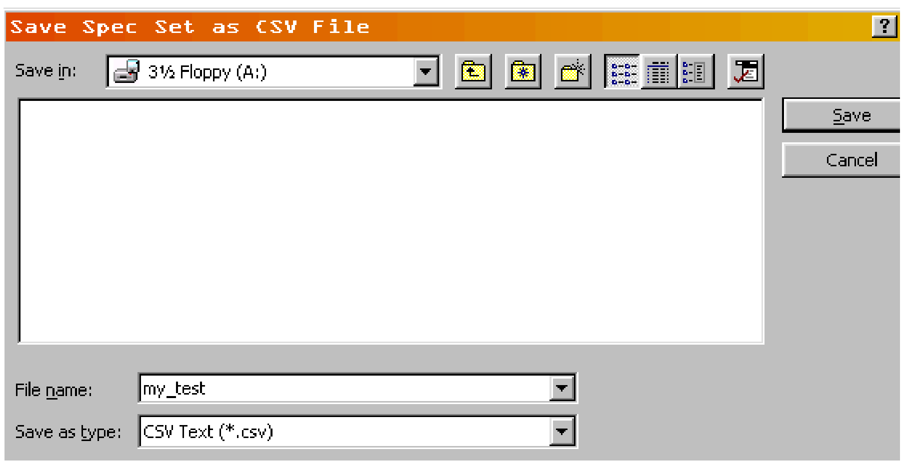
### Saving your specification set

1 Use the slide bar to go to the top of the template. Click on the SAVE CSV button.

**CAUTION**

**Always click the SAVE CSV button to save your specification set.** If you save your work from the File menu an Excel spreadsheet file ( **.xls*) will be saved. Although you can modify or change this spreadsheet file in the future.an Excel spreadsheet file will *not* run in the Passive Component Test application. To create a file that *will* run in the Passive Component Test application click on the SAVE CSV button.

2 Enter the file name and directory of your choice. Note that to port the specification set to the OSA it must be saved on a floppy disk in the root directory.




**CAUTION**

When you close the PCT template, Excel will ask you "Do you want to save the changes you made to 'PCT Template, v1.11'?" **Always answer "NO" to this question.** If you answer "YES" the original PCT Template will be changed. If you want to save your work as an Excel spreadsheet template enter a new filename, such as *my_test.xls.*

A picture of the completed specification sheet is shown on the following page.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ; PCT Specification Set Generation Template | | | | | | | | | |
| ; Hewlett Packard | Start | Save CSV | Open CSV | Check Syntax | ReColor Sheet | Clear Sheet | | | |
| ; Copyright 1999 | | | | | | | | | |
| APPLICATION | COMPONENTS | "Default" | | | | | | | |
| ; **Device Information** | Do not alter or delete this row | | | | | | | | |
| ; | *Comments* | *Enter additional text during test?* | | | | | | | |
| COMMENT | "PCT Test Program" | ;None | | | | | | | |
| ; | *Serial Number* | *Enter additional text during test?* | | | | | | | |
| ID | "HB001" | ENTER | | | | | | | |
| ; **Measurement Setup** | Do not alter or delete this row | | | | | | | | |
| ; | *Minimum Power Range* | *Maximum Power Range* | *Interval between normalizations* | | | | | | |
| NORMALIZE | -40 dBm | 0 dBm | 2 h | | | | | | |
| ; | *Start Wavelength* | *Stop Wavelength* | *Trace Points* | *Averages* | *Resolution Bandwidth* | *Reference Level* | *Scale (dB per Div* | *Sensitivity* | *Video Bandwidt* |
| SETUP | 1540 nm | 1560 nm | 1001 | 1 | 0.1 nm | 0 dBm | 10 dB | -85 dBm | DEFAULT |
| ; | *Source* | | | | | | | | |
| STIMULUS | INTERNAL_BBLS | | | | | | | | |
| ; **Device Measurement** | Do not alter or delete this row | | | | | | | | |
| ; | *Name* | | | | | | | | |
| **PATH** | Default | | | | | | | | |
| ; | *Name* | *Minimum Spec* | *Maximum Spec* | *Search From* | *Search To* | | | | |
| PEAK_WAVELENGTH | Pk_W1 | 1545 nm | 1555 nm | 1540 nm | 1560 nm | | | | |
| ; | *Name* | *Minimum Spec* | *Maximum Spec* | *Reference Point* | *Excursion* | | | | |
| BANDWIDTH_WAVELENGTH | BW_3dB | 0.1 nm | 2 nm | Pk_W1 | -3 dB | | | | |
| ; **Results Documentation** | Do not alter or delete this row | | | | | | | | |
| ; | *Printout Style* | *Printer* | | | | | | | |
| PRINT_SETUP | GRAPHICS_AND_TABLE | INTERNAL | | | | | | | |
| ; | | | | | | | | | |
| PRINT | | | | | | | | | |
| ; **END OF SPEC SET** | Do not alter or delete this row | | | | | | | | |

## Export Spec Set

Displays a list of internally stored specification sets. Use the navigation keys to select the desired specification set and then press the Export Set softkey. The comma-separated-value (CSV) specification set file from internal memory is output to the floppy disk.

**Key Path** Appl’s > Passive Components > Spec Set DEFAULT > Export Spec Set

**Related Functions** Load Spec Set, Import Spec Set, Delete Spec Set

**Remote Commands** MMEMory:SSET:DATA?<file_name>

## Import New Spec Set

Imports a specification set <file_name>, where <data_block> is a definite length block containing the specification set. Refer to the Agilent 86140B Series Measurement Applications User’s Guide (Part Number: 86140-90083)

**Key Path** Appl’s >Passive Components > Spec Set Default > Import New Spec Set

**Related Functions** Load Spec Set, Export Spec Set, Delete Spec Set

**Remote Commands** MMEMory:SSET:DATA <file_name>,<data_block>

## Load Spec Set

Loads an imported specification set as the current set of specs.

**Key Path** Appl’s > Passive Components > Load Spec Set

**Related Functions** Import New Spec Set, Export Spec Set, Delete Spec Set

**Remote Commands** MMEMory:SSET:LOAD<file_name>
MMEMory:SSET:LOAD?

## Using an ASCII Editor

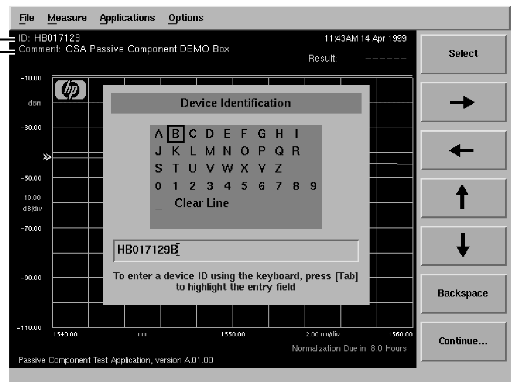
There are four types of specification set keywords: System Commands, Measurement Setup, Device Measurement, and Results Documentation. All specification sets require the APPLICATION, SETUP, NORMALIZE, and PATH keywords.

Every specification set begins with the APPLICATION keyword which identifies the specification set with the Passive Component Test application. It also provides a label that will be displayed when the specifications set is cataloged by the Passive Component Test application. Try to make the label descriptive of the test or device that you are measuring.

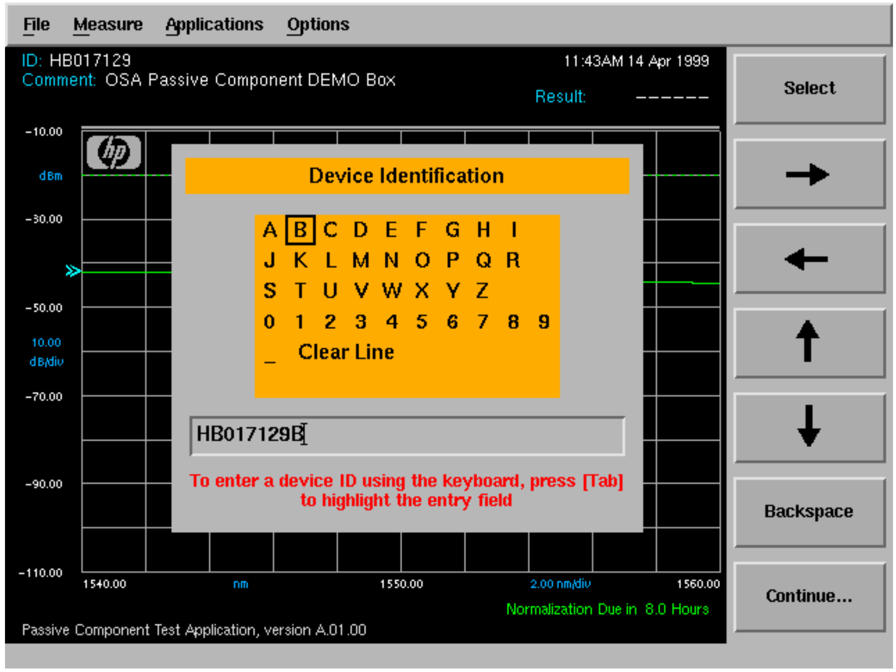
After the APPLICATION keyword, use the optional ID and COMMENT keywords to label the test and device being tested. The entered strings appear on the instrument’s display as shown in Example 3-2. Add the STIMULUS keyword to select the broadband light source. Next, use the SETUP and NORMALIZE keywords to configure the instrument’s settings and perform a trace normalization, see Example 5-4 on page 3-49.

Follow the PATH keyword with any keywords that are required for your measurement, followed by keywords to print or store the measurement results. Only one SETUP keyword should be used. If additional SETUP keywords are included, only the last keyword is used. Use the SWEEP and ZOOM commands to sweep a subset of the wavelength range and zoom to the screen.

```
 PCT Specification Set Generation Template
;  Hewlett Packard
;  Copyright 1999
APPLICATION          COMPONENTS          "Demonstration Spec Set"
;    Device Information   Do not alter or delete this row
;,                   Comments
COMMENT,             "OSA Passive Component DEMO Box"
;                    Serial Number       Additional text during test?
ID                   "HB017129"          ENTER
```




**Example 3-2.**




Keywords, such as PEAK_WAVELENGTH for example, must use all uppercase letters. Comments are preceded by a semicolon (;) character. Everything after a semicolon on a line is ignored. You can also insert blank lines to make your files easier to read. Keywords can be separated by either spaces or a comma (,) character. Notice that no flow control keywords, such as branching or looping, are provided.

***Measurement paths require a PATH keyword***

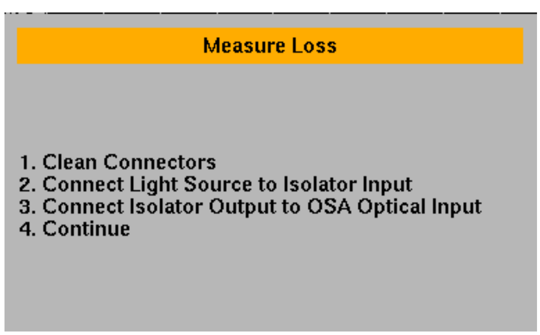
Include the PATH keyword before any group of measurement keywords listed for a specific measurement path. Devices with multiple paths, such as WDM multiplexers, require one PATH keyword for each path. Example 5-4 on page 3-49 has one PATH keyword. Example 3-3 on page 3-46 has two PATH keywords, one for device loss and one for device isolation. All measurement keywords between two PATH keywords apply to the first PATH keyword. Each PATH is measured in the order listed in the specification file. The *name* specified for each PATH appears in the final result table and on the MEASURE softkey.

| | | | | |
|---|---|---|---|---|
| ; Device Measurement | Do not alter or delete this row | | | |
| ; | Name | | | |
| PATH | Loss | | | |
| ; | Instructions | | | |
| INSTRUCTION | 1. Clean Connectors\n2. Connect Light Source to Isolator Input\n3. Connect Isolator Output to OSA Optical Input\n4. Continue | | | |
| ; | Name | Minimum Spec | Maximum Spec | Wavelength or frequency to measure power at |
| MARKER_LOSS | Insertion_Loss_1525 | DEFAULT | 4 dB | 1525 nm |
| ; | Name | Minimum Spec | Maximum Spec | Wavelength or frequency to measure power at |
| MARKER_LOSS | Insertion_Loss_1550 | DEFAULT | 4 dB | 1550 nm |
| ; | Name | Minimum Spec | Maximum Spec | Wavelength or frequency to measure power at |
| MARKER_LOSS | Insertion_Loss_1620 | DEFAULT | 5 dB | 1620 nm |
| ; | Start Wavelength (nm) | Stop Wavelength (nm) | Reference Level | Scale (dB per Div - optional) |
| ZOOM | 1525 nm | 1620 nm | 0 dB | 2 dB |
| | | | | |
| ; | Name | | | |
| PATH | Isolation | | | |
| ; | Instructions | | | |
| INSTRUCTION | 1. Clean Connectors\n2. Connect Light Source to Isolator Output\n3. Connect Isolator Input to OSA Optical Input\n4. Continue | | | |
| ; | Name | Minimum Spec | Maximum Spec | Wavelength or frequency to measure power at |
| MARKER_LOSS | Isolation_1525 | 20 dB | DEFAULT | 1525 nm |
| ; | Name | Minimum Spec | Maximum Spec | Wavelength or frequency to measure power at |
| MARKER_LOSS | Isolation_1550 | 35 dB | DEFAULT | 1550 nm |
| ; | Name | Minimum Spec | Maximum Spec | Wavelength or frequency to measure power at |
| MARKER_LOSS | Isolation_1620 | 25 dB | DEFAULT | 1620 nm |
| ; | Name | | | |
| ; | Start Wavelength (nm) | Stop Wavelength (nm) | Reference Level | Scale (dB per Div - optional) |
| ZOOM | 1525 nm | 1620 nm | -20 dB | 10 dB |

**Example 3-3.**

Notice the use of the INSTRUCTION keyword to convey instructions to the user. Each PATH can have one or more INSTRUCTION keywords. The dialog boxes are displayed in the order of the INSTRUCTION keywords. If no INSTRUCTION keyword is given for a particular PATH, a default instruction prompt is displayed. The measurement pauses until the CONTINUE softkey is clicked. In the displayed string, use the escape sequence *\n* to enter a newline character and force a line break.

Pressing the MEASURE DUT softkey brings up an instruction panel.




When the measurement is complete, the results can be viewed both graphically and in table form, as shown in Figure 4 and Figure 5.

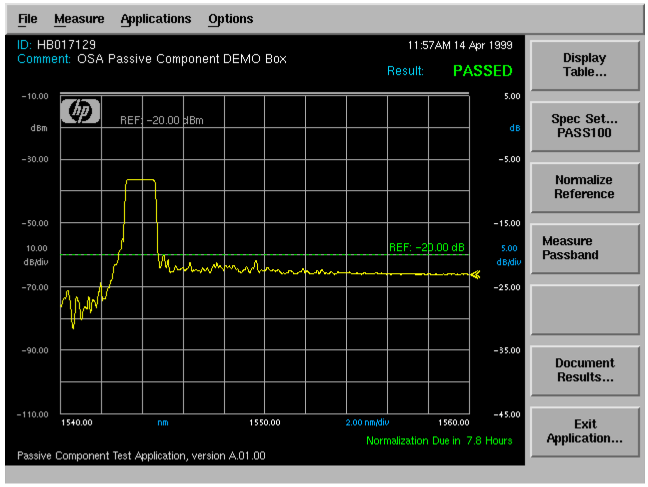
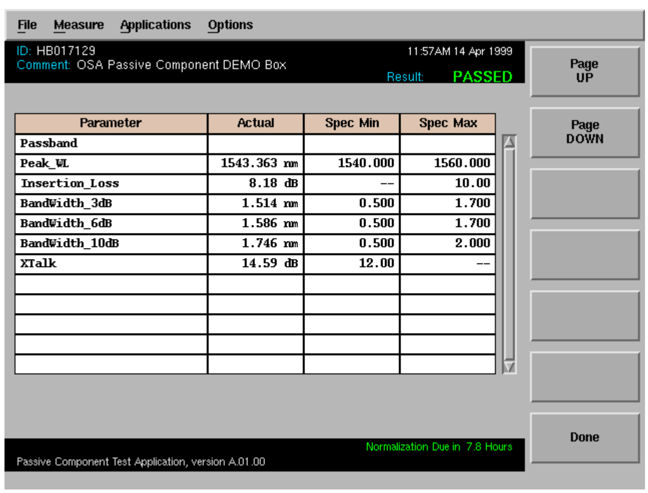



Figure 4 Measurement results displayed graphically.




| Parameter | Actual | Spec Min | Spec Max |
|---|---|---|---|
| Passband | | | |
| Peak_WL | 1543.363 nm | 1540.000 | 1560.000 |
| Insertion_Loss | 8.18 dB | -- | 10.00 |
| BandWidth_3dB | 1.514 nm | 0.500 | 1.700 |
| BandWidth_6dB | 1.586 nm | 0.500 | 1.700 |
| BandWidth_10dB | 1.746 nm | 0.500 | 2.000 |
| XTalk | 14.59 dB | 12.00 | -- |

Figure 5 Measurement results displayed in tabular format.

### *Use variables to identify measured values*

The first parameter for most measurement keywords is a variable name. Variables are automatically initialized and allocated the first time that they are assigned a value by the application. Variables “hold” the measured value for the keyword. Variable values and names are displayed in the measurement results table. To prevent a variable from being displayed in the measurement results table, begin the corresponding keyword line with a pound sign (#) character.

The following PEAK_WAVELENGTH keyword defines the variable PEAK_WAVELENGTH. Notice that the MARKER_LEVEL keyword uses PEAK_WAVELENGTH, which is measured in the previous step, to define the wavelength for placing the marker.

```
PEAK_WAVELENGTH,Peak_wavelength,1545 nm,1555 nm,DEFAULT,DEFAULT
MARKER_LEVEL,Peak_power,-3 dB,3 dB,Peak_wavelength
```

Variable names can include both upper and lowercase letters but cannot include spaces; use the underscore character (_) instead. The first character of a variable must be a letter. Only the first 32 characters of the variable *name* are significant. For names to be considered different, the first 32 characters must not be identical.

***Results documentation area***

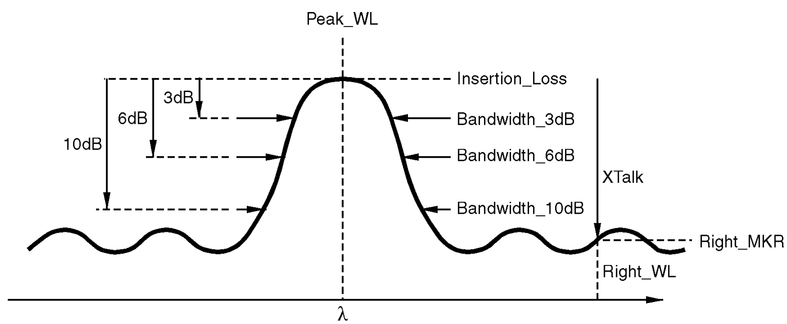
Use this area to specify where and how the measurement results are stored and printed.

Use PRINT_SETUP to determine whether the summary is printed to the internal or external printer and whether to print the results table or both the table and graphics.

STORE_SETUP is used in a similar way to determine what results information is saved to the floppy disk.

| | | | | | |
|---|---|---|---|---|---|
| ; PCT Specification Set Generation Template | | | | | |
| ; Hewlett Packard | | | | | |
| ; Copyright 1999 | | | | | |
| APPLICATION | COMPONENTS | Demonstration Spec Set | | | |
| ; Device Information | Do not alter or delete this row | | | | |
| ; | Comments | | | | |
| COMMENT | OSA Passive Component DEMO Box | | | | |
| ; | Serial Number | Additional text during test? | | | |
| ID | HB017129 | ENTER | | | |
| | | | | | |
| ; Measurement Setup | Do not alter or delete this row. | SETUP and CALIBRATE are mandatory keywords. | | | |
| ; | Minimum Power Range | Maximum Power Range | Interval between calibrations | | |
| NORMALIZE | -43 dBm | -33 dBm | 8 h | | |
| ; | Start Wavelength | Stop Wavelength | Trace Points (optional) | Averages (optional) | Resolution Bandwidth (optional) |
| SETUP | 1540 nm | 1560 nm | 1000 | 1 | 0.1 nm |
| ; | Source | | | | |
| STIMULUS | INTERNAL_BBLS | | | | |
| | | | | | |
| ; Device Measurement | Do not alter or delete this row | | | | |
| ; | Name | | | | |
| PATH | Passband | | | | |
| ; | Instructions | | | | |
| INSTRUCTION | 1. Clean Connectors\n2. Connect Light Source to Device Input\n3. Connect Passband to OSA Optical Input\n4. Continue | | | | |
| ; | Start Wavelength (nm) | Stop Wavelength (nm) | Reference Level (optional) | Scale (dB per Div - optional) | |
| ; | Name | Minimum Spec (Optional) | Maximum Spec (Optional) | From (Optional) | To (Optional) |
| PEAK_WAVELENGTH | Peak_WL | 1540 nm | 1560 nm | DEFAULT | DEFAULT |
| ; | Name | Minimum Spec (Optional) | Maximum Spec (Optional) | At (interpolate if location is not point) | |
| MARKER_LOSS | Insertion_Loss | DEFAULT | 10.0 dB | Peak_WL | |
| ; | Name | Minimum Spec (Optional) | Maximum Spec (Optional) | Reference Point | Excursion (Optional) |
| BANDWIDTH_WAVELENGTH | BandWidth_3dB | .5 nm | 1.7 nm | Peak_WL | -3 dB |
| ; | Name | Minimum Spec (Optional) | Maximum Spec (Optional) | Reference Point | Excursion (Optional) |
| BANDWIDTH_WAVELENGTH | BandWidth_6dB | .5 nm | 1.7 nm | Peak_WL | -6 dB |
| ; | Name | Minimum Spec (Optional) | Maximum Spec (Optional) | Reference Point | Excursion (Optional) |
| BANDWIDTH_WAVELENGTH | BandWidth_10dB | .5 nm | 2.0 nm | Peak_WL | -10 dB |
| ; | Name | Minimum Spec (Optional) | Maximum Spec (Optional) | At (interpolate if location is not point) | |
| #MARKER_LEVEL | Center_MKR | DEFAULT | DEFAULT | Peak_WL | |
| ; | Name | Minimum Spec (Optional) | Maximum Spec (Optional) | First Value | Second Value |
| #LIN_ADD | Right_WL | DEFAULT | DEFAULT | Peak_WL | 2 nm |
| ; | Name | Minimum Spec (Optional) | Maximum Spec (Optional) | At (interpolate if location is not point) | |
| #MARKER_LEVEL | Right_MKR | DEFAULT | DEFAULT | Right_WL | |
| ; | Name | Minimum Spec (Optional) | Maximum Spec (Optional) | First Value | Second Value |
| LOG_SUB | XTalk | 12 dB | DEFAULT | Center_MKR | Right_MKR |
| ; | Start Wavelength (nm) | Stop Wavelength (nm) | Reference Level (optional) | Scale (dB per Div - optional) | |
| ZOOM | 1540 nm | 1560 nm | -20 dB | 5 dB | |

**Example 5-4. Specification set for characterizing a WDM filter.**




Example 5-4 on page 3-49 shows a specification set written to characterize a WDM filter. The specification set measures the insertion loss, the 3 dB, 6 dB, and 10 dB bandwidths, the peak wavelength and the crosstalk.

Figure 6 shows the results summary table for a device measured using the specification set shown in Example 5-4. The device passes the specifications in this example.

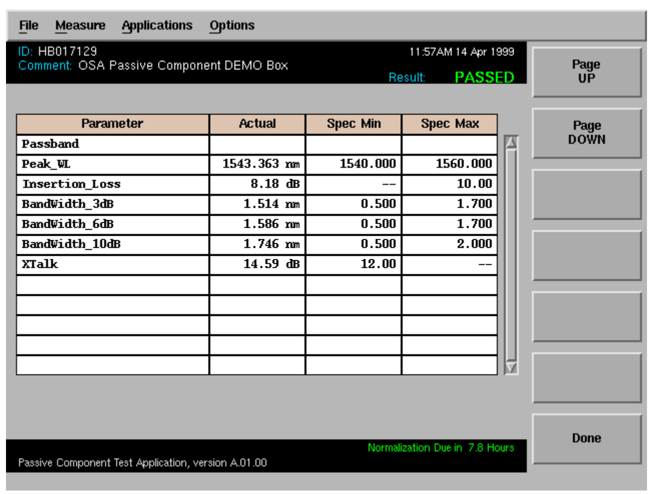



Figure 6 Results summary table for a WDM filter.

Example 6-5 on page 3-51 shows a specification set for characterizing an optical isolator. Note that it uses two paths, one for the insertion loss and one for the isolation.

```
;  PCT Specification Set Generation Template
;  Hewlett Packard
;  Copyright 1999
APPLICATION            COMPONENTS              Default
;    Device Information  Do not alter or delete this row
;                      Serial Number           Additional text during test?
ID                     A1234                   ENTER

;    Measurement Setup   Do not alter or delete this row
;                      Source
STIMULUS               INTERNAL_BBLS
;                      Start Wavelength        Stop Wavelength         Trace Points       Averages      Resolution Bandwidth     Reference Level
SETUP                  1525 nm                 1620 nm                 2001               1             2 nm                     -30 dBm
;                      Minimum Power Range     Maximum Power Range     Interval between normalizations
NORMALIZE              -45 dBm                 10 dBm                  8 h

;    Device Measurement  Do not alter or delete this row
;                      Name
PATH                   Loss
;                      Instructions
INSTRUCTION            1. Clean Connectors\n2. Connect Light Source to Isolator Input\n3. Connect Isolator Output to OSA Optical Input\n4. Continue
;                      Name                    Minimum Spec            Maximum Spec       Wavelength or frequency to measure power at
MARKER_LOSS            Insertion_Loss_1525     DEFAULT                 4 dB               1525 nm
;                      Name                    Minimum Spec            Maximum Spec       Wavelength or frequency to measure power at
MARKER_LOSS            Insertion_Loss_1550     DEFAULT                 4 dB               1550 nm
;                      Name                    Minimum Spec            Maximum Spec       Wavelength or frequency to measure power at
MARKER_LOSS            Insertion_Loss_1620     DEFAULT                 5 dB               1620 nm
;                      Start Wavelength (nm)   Stop Wavelength (nm)    Reference Level    Scale (dB per Div - optional)
ZOOM                   1525 nm                 1620 nm                 0 dB               2 dB

;                      Name
PATH                   Isolation
;                      Instructions
INSTRUCTION            1. Clean Connectors\n2. Connect Light Source to Isolator Output\n3. Connect Isolator Input to OSA Optical Input\n4. Continue
;                      Name                    Minimum Spec            Maximum Spec       Wavelength or frequency to measure power at
MARKER_LOSS            Isolation_1525          20 dB                   DEFAULT            1525 nm
;                      Name                    Minimum Spec            Maximum Spec       Wavelength or frequency to measure power at
MARKER_LOSS            Isolation_1550          35 dB                   DEFAULT            1550 nm
;                      Name                    Minimum Spec            Maximum Spec       Wavelength or frequency to measure power at
MARKER_LOSS            Isolation_1620          25 dB                   DEFAULT            1620 nm
;                      Name
;                      Start Wavelength (nm)   Stop Wavelength (nm)    Reference Level    Scale (dB per Div - optional)
ZOOM                   1525 nm                 1620 nm                 -20 dB             10 dB

;    Results Documentation  Do not alter or delete this row
;                      Printout Style          Printer
PRINT_SETUP            GRAPHICS_AND_TABLE      INTERNAL
;                      Store Type
STORE_SETUP            TABLE
;                      Store Name
STORE                  AUTO

;    END OF SPEC SET     Do not alter or delete this row
```

**Example 6-5. Specification set for characterizing an optical isolator.**

Figure 7 shows an example of the results summary table for an optical isolator characterized using the specification set shown in Example 6-5.

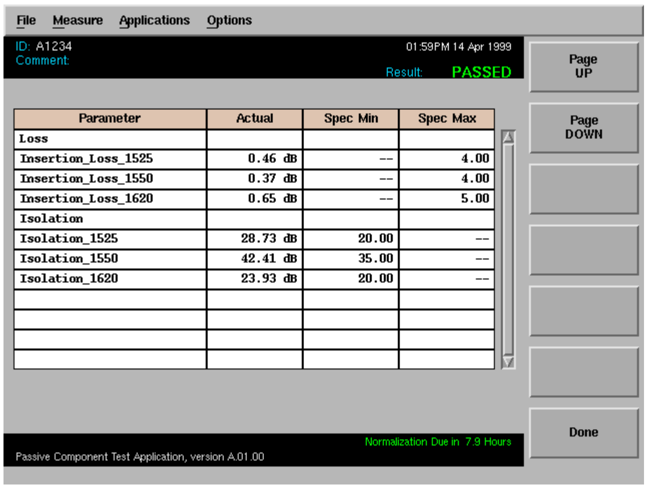
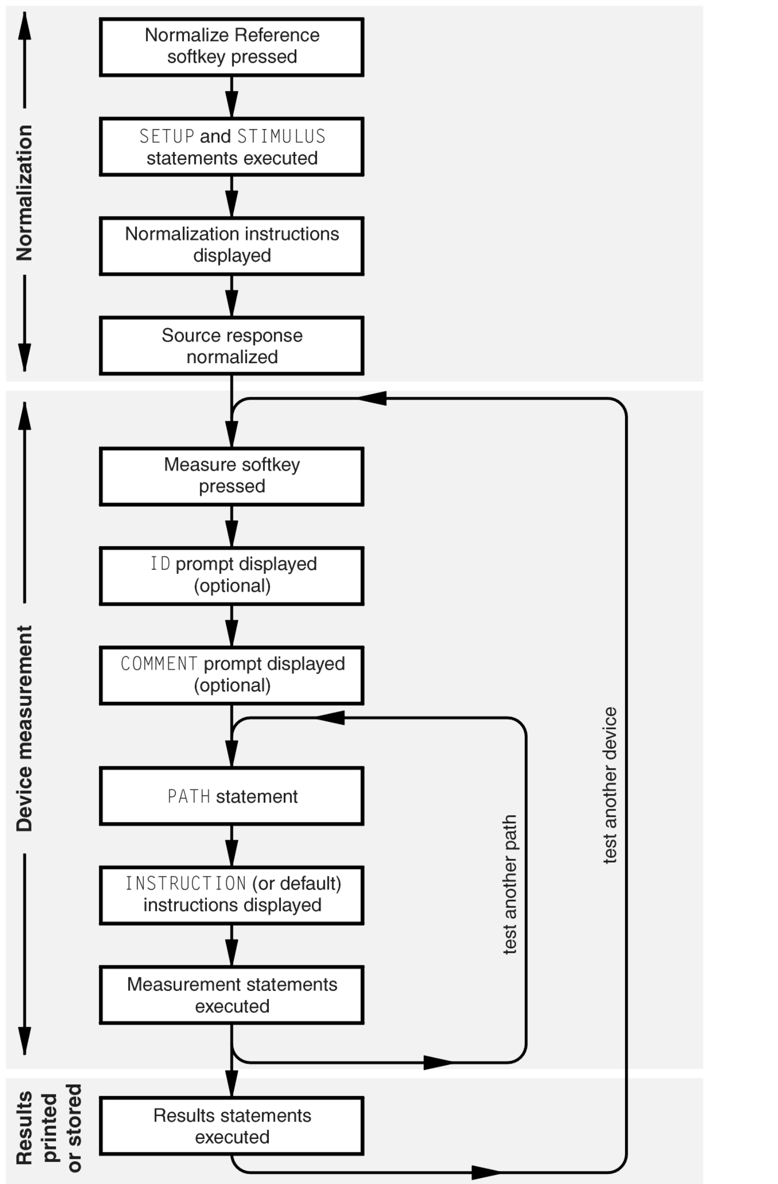



Figure 7 Measurement summary table for an isolator

# Specification Set Flowchart



## Quick List of Keywords

Table 6 List of Keywords (1 of 3)

| Command | Description |
|---|---|
| SYSTEM COMMANDS | |
| APPLICATION, COMPONENTS | Designates the specification set for use with the Passive Component Test application. Also identifies test in catalog. |
| COMMENT | Prints comment in comment section of the instrument's display. |
| ID | Prints an identification string in ID section of the instrument's display. |
| MEASUREMENT SETUP COMMANDS | |
| NORMALIZE | Specifies the minimum and maximum peak power range (in dBm) for the reference signal for a valid normalization. |
| SETUP | Configures the optical spectrum analyzer settings. |
| STIMULUS | Specifies the source that is used to take a reference trace as well as the actual measurement. |
| MEASUREMENT COMMANDS | |
| ABS_FREQUENCY_LEFT | Measures the absolute frequency of a trace point. |
| ABS_FREQUENCY_RIGHT | Measures the absolute frequency of a trace point. |
| ABS_WAVELENGTH_LEFT | Measures the absolute wavelength of a trace point. |
| ABS_WAVELENGTH_RIGHT | Measures the absolute wavelength of a trace point. |
| BANDWIDTH_FREQUENCY | Calculates the bandwidth (in THz). |
| BANDWIDTH_WAVELENGTH | Calculates the bandwidth (in nm). |
| CENTER_FREQUENCY | Locates the center frequency (THz). |
| CENTER_OF_MASS_FREQUENCY | Calculates the mean frequency (THz) representing the center of mass. |
| CENTER_OF_MASS_WAVELENGTH | Calculates the mean wavelength (nm) representing the center of mass. |
| CENTER_WAVELENGTH | Locates the center wavelength (nm). |
| DELTA_FREQUENCY_LEFT | Determines the frequency separation between a measurement point and reference point. |
| DELTA_FREQUENCY_RIGHT | Determines the frequency separation between a measurement point and reference point. |
| DELTA_WAVELENGTH_LEFT | Determines the wavelength separation between a measurement point and reference point. |

Table 6 List of Keywords (2 of 3)

| Command | Description |
|---|---|
| DELTA_WAVELENGTH_RIGHT | Determines the wavelength separation between a measurement point and reference point. |
| INSTRUCTION | Displays a prompt for the user for a measurement path. |
| LIN_ADD | Calculates the sum of two, or more, linear power, wavelength, frequency, or constant values. |
| LIN_AVG | Calculates the average of two or more values. |
| LIN_DIV | Calculates the ratio of two, or more, linear power, wavelength, frequency, or constant values. |
| LIN_MUL | Calculates the product of two, or more, linear power, wavelength, frequency, or constant values. |
| LIN_SUB | Calculates the difference between two, or more, linear power, wavelength, frequency, or constant values. |
| LOG_ADD | Calculates the sum of two, or more, logarithmic power, wavelength, frequency, or constant values. |
| LOG_SUB | Calculates the difference between two, or more, logarithmic power, wavelength, frequency, or constant values. |
| MARKER_LEVEL | Measures the power at the location specified. |
| MARKER_LOSS | Measures the power loss at the location specified referenced to the normalized response. |
| MAX | Calculates the maximum of two or more values. |
| MIN | Calculates the minimum of two or more values. |
| PATH | Specifies which set of measurement keywords should be grouped together and performed on the same trace measurement. |
| PEAK_FREQUENCY | Measures the frequency (THz) of the maximum power trace point in a wavelength range. |
| PEAK_WAVELENGTH | Measures the wavelength (nm) of the maximum power trace point in a wavelength range. |
| PIT_FREQUENCY | Measures the frequency (THz) of the minimum power trace point in a wavelength range. |
| PIT_WAVELENGTH | Measures the wavelength (nm) of the minimum power trace point in a wavelength range. |
| SWEEP | Specifies that the following data should be taken from a partial sweep. |
| ZOOM | Display the trace over the specified wavelength range on the screen. |
| RESULTS COMMANDS | |
| PRINT | Prints the measurement results with the settings defined in the PRINT_SETUP keyword. |
| PRINT_SETUP | Configures the hardcopy output of the measurement results. |

Table 6 List of Keywords (3 of 3)

| Command | Description |
|---|---|
| PRINT_SUMMARY | Prints the final summary of the results. |
| STORE,AUTO | Saves the measurement results as defined by the STORE_SETUP keyword. |
| STORE_SETUP | Configures the output of the measurement results that is stored on a disk in the front-panel disk drive. |

# Specification Set Keywords

Table 7

<table>
<tr><th>Convention</th><th>Description</th></tr>
<tr><td>< ></td><td>Angle brackets indicate text strings entered by the developer.</td></tr>
<tr><td>[ ]</td><td>Square brackets indicate that the keyword DEFAULT can be used instead of a value or a variable for that parameter. Refer to the actual command description for the behavior when the DEFAULT keyword is used for a parameter.</td></tr>
<tr><td>|</td><td>Indicates a choice of one element from a list.</td></tr>
<tr><td>{ }</td><td>Braces indicate a group of constants to select from. Each constant is separated by the | character.</td></tr>
<tr><td>name</td><td>Indicates the variable for which you provide a descriptive name. Any letter (Aa-Zz) followed by letters, digits (0-9) and underscore (_). Only the first 32 characters are significant.</td></tr>
<tr><td>spec_min</td><td>–infinity. The parameter spec_min cannot be a variable, only a constant or DEFAULT.</td></tr>
<tr><td>spec_max</td><td>+infinity. The parameter spec_max cannot be a variable, only a constant or DEFAULT.</td></tr>
<tr><td>from</td><td>Start wavelength or frequency of trace in nm (default) or THz.</td></tr>
<tr><td>to</td><td>Stop wavelength or frequency of trace in nm (default) or THz.</td></tr>
<tr><td>excursion</td><td>+excursion: means excursion dBs up (for example, from a pit).<br>-excursion: means excursion dBs down (for example, from a peak).</td></tr>
<tr><td>ref_pt</td><td>The reference point to be used for a measurement keyword.</td></tr>
</table>

ABS_FREQUENCY_LEFT, name, [*spec_min*], [*spec_max*], ref_pt, [excursion]

Measures the absolute frequency of a trace point and loads the value into the *name* variable. The value returned by this function is in THz. The point is located *excursion* dB away from the amplitude of the reference point (*ref_pt*). The search is made on frequencies higher than the reference. Arguments are *spec_min* and *spec_max*, which are absolute frequency values, or DEFAULT. The *ref_pt* can be a constant or a variable. To return the relative frequency, refer to the DELTA keywords. If no point on the trace meets the excursion criterion, the keyword is considered to have failed, and the left endpoint (highest frequency) of the trace is returned.

---

ABS_FREQUENCY_RIGHT, name, [*spec_min*], [*spec_max*], ref_pt, [excursion]

Measures the absolute frequency of a trace point and loads the value into the *name* variable. The value returned by this function is in THz. The point is located *excursion* dB away from the amplitude of the reference point (*ref_pt*). The search is made on frequencies lower than the reference. Arguments *spec_min* and *spec_max* are absolute frequency values or DEFAULT. The *ref_pt* can be a constant or a variable. To return the relative frequency, refer to the DELTA keywords. If no point on the trace meets the excursion criterion, the keyword is considered to have failed, and the right endpoint (lowest frequency) of the trace is returned.

---

ABS_WAVELENGTH_LEFT, name, [spec_min], [spec_max], ref_pt, [excursion]

Measures the absolute wavelength of a trace point and loads the value into the *name* variable. The value returned by this function is in nm. The point is located *excursion* dB away from the amplitude of the reference point (*ref_pt*). The search is made on wavelengths shorter than the reference. Arguments *spec_min* and *spec_max* are absolute wavelength values or DEFAULT. The *ref_pt* can be a constant or a variable. To return the relative wavelength, refer to the DELTA keywords. If no point on the trace meets the excursion criterion, the keyword is considered to have failed, and the left endpoint (shortest wavelength) of the trace is returned.

---

ABS_WAVELENGTH_RIGHT, name, [spec_min], [spec_max], ref_pt, [excursion]

Measures the absolute wavelength of a trace point and loads the value into the *name* variable. The value returned by this function is in nm. The point is located *excursion* dB away from the amplitude of the reference point (*ref_pt*). The search is made on wavelengths longer than the reference. Arguments *spec_min* and *spec_max* are absolute wavelength values or DEFAULT. The *ref_pt* can be a constant or a variable. To return the relative wavelength, refer to the DELTA keywords. If no point on the trace meets the excursion criterion, the keyword is considered to have failed, and the right endpoint (longest wavelength) of the trace is returned.

---

APPLICATION, COMPONENTS, “label string”

Designates the specification set for use with the Passive Component Test application. This keyword *must* be the first keyword in the specification set. The label string is used as a description when cataloging the imported specification sets in the instrument.

---

BANDWIDTH_FREQUENCY, name, [spec_min], [spec_max], ref_pt, [excursion]

Calculates the bandwidth (in THz) and loads the value into the *name* variable. The value returned by this function is in THz. The bandwidth is determined *excursion* dB to the left and to the right of the reference point. Negative excursion values specify a lower amplitude from the reference point, and positive excursion values specify a higher amplitude. If either the left or right trace point fails to meet the excursion criterion, the keyword is considered to have failed. If the left trace point fails, the left endpoint is used for the bandwidth calculation. If the right trace point fails, the right endpoint is used for the bandwidth calculation.

---

BANDWIDTH_WAVELENGTH, name, [spec_min], [spec_max], ref_pt, [excursion]

Calculates the bandwidth (in nm) and loads the value into the *name* variable. The value returned by this function is in nm. The bandwidth is determined *excursion* dB to the left and to the right of the reference point. Negative excursion values specify a lower amplitude from the reference point, and positive excursion values specify a higher amplitude. If either the left or right trace point fails to meet the excursion criterion, the keyword is considered to have failed. If the left trace point fails, the left endpoint is used for the bandwidth calculation. If the right trace point fails, the right endpoint is used for the bandwidth calculation.

CENTER_FREQUENCY, name, [spec_min], [spec_max], ref, [excursion]

Locates the center frequency (THz) and loads the value into the *name* variable. The value returned by this function is in THz. It represents the mean value of the two frequencies found *excursion* dB down (for negative excursion value) or up (for positive excursion value) to the left and right of the reference point. The reference parameter can be a variable or a constant. If either the left or right trace point fails to meet the excursion criterion, the keyword is considered to have failed. If the left trace point fails, the left endpoint is used for the bandwidth calculation. If the right trace point fails, the right endpoint is used for the bandwidth calculation.

CENTER_OF_MASS_FREQUENCY, name, [spec_min], [spec_max], [from], [to]

Calculates the mean frequency (THz) and loads the value into the *name* variable. The value returned by this function is in THz. The mean value represents the center of mass of the trace over the range *from–to*.

CENTER_OF_MASS_WAVELENGTH, name, [spec_min], [spec_max], [from], [to]

Calculates the mean wavelength (nm) and loads the value into the *name* variable. The value returned by this function is in nm. The mean value represents the center of mass of the trace over the range *from–to*.

CENTER_WAVELENGTH, name, [spec_min], [spec_max], ref, [excursion]

Locates the center wavelength (nm) and loads the value into the *name* variable. The value returned by this function is in nm. It represents the mean value of the two wavelengths found *excursion* dB down (for negative excursion value) or up (for positive excursion value) to the left and right of the reference point. The reference parameter can be a variable or a constant. If either the left or right trace point fails to meet the excursion criterion, the keyword is considered to have failed. If the left trace point fails, the left endpoint is used for the bandwidth calculation. If the right trace point fails, the right endpoint is used for the bandwidth calculation.

COMMENT, “<any text>”, ENTER

Allows the application user to enter a comment for the device being tested. The optional ENTER parameter causes a dialog box to appear before the measurement of the first path, prompting the operator to enter a comment. The maximum number of characters that can be displayed on the screen is 56.

DELTA_FREQUENCY_LEFT, name, [spec_min], [spec_max], ref_pt, [excursion]

Determines the frequency separation between a measurement point and reference point and loads the value into the *name* variable. The value returned by this function is in THz. The measurement point is located *excursion* dB away from the amplitude of the reference point (*ref_pt*). The search is made on frequencies higher than the reference. The value of the frequency returned is positive. Arguments *spec_min* and *spec_max* are absolute frequency values or DEFAULT. The *ref_pt* can be a constant or a variable. To return the absolute frequency, refer to the ABS keywords. If no point on the trace meets the excursion criterion, the keyword is considered to have failed, and the separation between the left endpoint of the trace and the reference point is returned.

DELTA_FREQUENCY_RIGHT, name, [spec_min], [spec_max], ref_pt, [excursion]

Determines the frequency separation between a measurement point and reference point and loads the value into the *name* variable. The value returned by this function is in THz. The measurement point is located *excursion* dB away from the amplitude of the reference point (*ref_pt*). The search is made on frequencies lower than the reference. The value of the frequency returned is negative. Arguments *spec_min* and *spec_max* are absolute frequency values or DEFAULT. The *ref_pt* can be a constant or a variable. To return the absolute frequency, refer to the ABS keywords. If no point on the trace meets the excursion criterion, the keyword is considered to have failed, and the right endpoint of the trace is returned.

DELTA_WAVELENGTH_LEFT, name, [spec_min], [spec_max], ref_pt, [excursion]

Determines the wavelength separation between a measurement point and reference point and loads the value into the *name* variable. The value returned by this function is in nm. The measurement point is located *excursion* dB away from the amplitude of the reference point (*ref_pt*). The search is made on wavelengths shorter than the reference. The value of the wavelength returned is negative. Arguments *spec_min* and *spec_max* are absolute wavelength values or DEFAULT. The *ref_pt* can be a constant or a variable. To return the absolute wavelength, refer to the ABS keywords. If no point on the trace meets the excursion criterion, the keyword is considered to have failed, and the left endpoint of the trace is returned.

DELTA_WAVELENGTH_RIGHT, name, [spec_min], [spec_max], ref_pt, [excursion]

Determines the wavelength separation between a measurement point and reference point and loads the value into the *name* variable. The value returned by this function is in nm. The measurement point is located *excursion* dB away from the amplitude of the reference point (*ref_pt*). The search is made on wavelengths longer than the reference. The value of the wavelength returned is positive. Arguments *spec_min* and *spec_max* are absolute wavelength values or DEFAULT. The *ref_pt* can be a constant or a variable. To return the absolute wavelength, refer to the ABS keywords. If no point on the trace meets the excursion criterion, the keyword is considered to have failed, and the left endpoint of the trace is returned.

ID, “<serial number>”, ENTER

Allows the application user to enter an identification number for the device being tested. The optional ENTER parameter causes a dialog box to appear before the measurement of the first path, prompting the operator to enter the identification number. The ID keyword is not required in a specification set.

INSTRUCTION, “<prompt string>”

Displays a prompt for the user in a dialog box. Each PATH can have one or more INSTRUCTION keywords. The dialog boxes are displayed in the order of the INSTRUCTION keywords. If no INSTRUCTION keyword is given for a particular PATH, a default instruction prompt is displayed. The measurement pauses until the CONTINUE softkey is clicked.

Use the escape sequence *\n* to enter a newline character and force a line break. Use the escape sequence *\”* to enter a double quote character.

LIN_ADD, name, [spec_min], [spec_max], value1, value2, ... , valueN

Calculates the sum of two or more linear power, wavelength, frequency, or constant values. The value returned by this function is in nm, THz, or dB, depending on the inputs. The sum is loaded into the *name* variable.

LIN_AVG, name, [spec_min], [spec_max], value1, value2, ... , valueN

Calculates the average of two or more values and loads the value into the *name* variable. The values are converted to linear and the linear average is calculated.

LIN_DIV, name, [spec_min], [spec_max], value1, value2, ... , valueN

Calculates the ratio of two or more linear power, wavelength, frequency, or constant values. The value returned by this function is in nm, THz, dB, or unitless, depending on the inputs. The ratio is loaded into the *name* variable.

LIN_MUL name, [spec_min], [spec_max], value1, value2, ... , valueN

Calculates the product of two or more linear power, wavelength, frequency, or constant values. The value returned by this function is in nm, GHz, or dB. The product is loaded into the *name* variable.

LIN_SUB, name, [spec_min], [spec_max], value1, value2, ... , valueN

Calculates the difference between two or more linear power, wavelength, frequency, or constant values. The value returned by this function is in nm, GHz, or dB. The difference is loaded into the *name* variable.

LOG_ADD, name, [spec_min], [spec_max], value1, value2, ... , valueN

Calculates the sum of two or more logarithmic power, wavelength, frequency, or constant values. The value returned by this function is in dB. The sum is loaded into the *name* variable.

LOG_SUB, name, [spec_min], [spec_max], value1, value2, ... , valueN

Calculates the difference between two or more logarithmic power, wavelength, frequency, or constant values. The value returned by this function is in dB. The difference is loaded into the *name* variable.

MARKER_LEVEL, name, [spec_min], [spec_max], ref_pt

Measures the power at the reference point specified and loads the value into the *name* variable. The value returned by this function is in dB. The power (dBm) or loss (dB) is dependent on the trace at a given wavelength. The *ref_pt* parameter can be a wavelength, frequency, or a previously defined *name*. Log interpolation of the power level is used if *ref_pt* doesn't fall exactly on a trace point.

MARKER_LOSS, name, [spec_min], [spec_max], ref_pt

Measures the power loss at the reference point specified, and loads the value into the *name* variable. Although the marker measures a negative decibel value, the returned value is positive to represent loss. The *ref_pt* parameter can be a wavelength, frequency, or a previously defined *name*. Log interpolation of the power level is used if *ref_pt* doesn't fall exactly on a trace point.

This keyword is provided as a convenience when measuring values, like insertion loss, which are typically specified with positive dB values but measured as negative dB values by the OSA.

MAX, name, [spec_min], [spec_max], value1, value2, .., valueN

Calculates the maximum of two or more values and loads the value into the *name* variable. All the values must have the same units. The *spec_min* and *spec_max* parameters must be either DEFAULT or constants with the same units as the values.

MIN, name, [spec_min], [spec_max], value1, value2,..., valueN

Calculates the minimum of two or more values and loads the value into the *name* variable. All the values must have the same units. The *spec_min* and *spec_max* parameters must be either DEFAULT or constants with the same units as the values.

NORMALIZE, [spec_min], [spec_max], [interval]

Specifies the minimum and maximum peak power range (in dBm) for the reference signal for a valid normalization. Failures cause the message "Normalization failed, clean connector and try again" to be displayed. All buttons except NORMALIZE REFERENCE are disabled. Pushing NORMALIZE REFERENCE starts the sequence again. Interval specifies the time interval between calibrations in hours. For example, 0.5h corresponds to 30 minutes. The maximum and DEFAULT value for the interval is 24 hours.

PATH, name

Specifies which set of measurement keywords should be grouped together and performed on the same trace measurement. The *name* specified for each PATH appears in the final result table and on the MEASURE softkey. For example, a coupler would require two PATH keywords, one for each arm of the coupler. Each PATH uses its own trace. All measurement keywords between two PATH keywords apply to the first PATH keyword. Each PATH is measured in the order listed in the specification file.

PEAK_FREQUENCY, name, [spec_min], [spec_max], [from], [to]

Measures the frequency (THz) of the maximum power trace point in a wavelength range. The units returned by this function are in THz. The measured value is placed in the *name* variable.

PEAK_WAVELENGTH, name, [spec_min], [spec_max], [from], [to]

Measures the wavelength (nm) of the maximum power trace point in a wavelength range. The units returned by this function are in nm. The measured value is placed in the *name* variable.

PIT_FREQUENCY, name, [spec_min], [spec_max], [from], [to]

Measures the frequency (THz) of the minimum power trace point in a wavelength range. The units returned by this function are in THz. The measured value is placed in the *name* variable.

PIT_WAVELENGTH, name, [spec_min], [spec_max], [from], [to]

Measures the wavelength (nm) of the minimum power trace point in a wavelength range. The units returned by this function are in nm. The measured value is placed in the *name* variable.

PRINT

Prints the results with the settings defined in the PRINT_SETUP keyword.

PRINT_SETUP, {TABLE | GRAPHICS | GRAPHICS_AND_TABLE}, {INTERNAL | EXTERNAL}

Configures the hardcopy output of the measurement results. Either the instrument’s internal printer or an external printer can be selected. As shown in the following table, the type of data printed is also selectable. Although application users can temporarily override these selections for the current measurement, when a new device is measured the print setup resets to the values defined by the PRINT_SETUP keyword.

Table 8

| Constant | Description |
|---|---|
| TABLE | Prints the measurement data in a table. |
| GRAPHICS | Prints the instrument’s display. |
| GRAPHICS_AND_TABLE | Prints the measurement data in a table along with the instrument’s display. |
| INTERNAL | Selects the instrument’s internal printer. |
| EXTERNAL | Selects an external printer. |

PRINT_SUMMARY

Prints the final summary of the results.

SETUP, start_wvl, stop_wvl, [pts], [avgs], [rbw], [ref_lvl], [scale], [sens], [vbw]

This required keyword configures the following optical spectrum analyzer settings:

start wavelength (nm)
stop wavelength (nm)
number of trace points
number of trace averages
resolution bandwidth (nm)
reference level (dBm)
amplitude scale (dB)
sensitivity (dBm)
video bandwidth (Hz)

The following line shows an example of this keyword:

SETUP 1500.00,nm,1600.00,nm,4001,1,0.10,nm,+10.00,dBm,10,dB,-90.0,dBm,100,Hz

These settings are always used when performing a normalization. PATH measurements also use these settings unless changed by the SWEEP keyword. If a parameter other than *avgs* is set to DEFAULT, the optical spectrum analyzer keeps its current setting. For the *avgs* parameter the DEFAULT keyword will set the value to 1. Otherwise, the SETUP keyword changes the setting to whatever is specified for a parameter. This behavior has the potential consequence of allowing the SWEEP keyword to change the sensitivity from the first normalization for subsequent normalizations.

For example, suppose that the instrument is currently at –70 dBm sensitivity and the SETUP keyword has DEFAULT for the sensitivity parameter. There is a SWEEP keyword with –80 dBm for sensitivity. This results in the first normalization being performed at –70 dBm sensitivity. After a path is measured which sets the instrument to –80 dBm sensitivity, subsequent normalizations will be made at –80 dBm.

There should be only one SETUP command in a specification set. Multiple SETUP commands generate a warning when the specification set is imported, but the specification set can still be imported. The settings of the last SETUP command will be the ones used by the specification set.

The start and stop wavelength values can only be constants. DEFAULT is not allowed for these values. All other parameter values must be either constants with units or the keyword DEFAULT. Variables are *not* allowed as parameters for this keyword.

STIMULUS, {INTERNAL_BBLS | EXTERNAL_BBLS}

Specifies the source that is used to take a reference trace, as well as the actual measurement.

Table 9

| Constant | Description |
| --- | --- |
| INTERNAL_BBLS | Selects the instrument's internal white-light or EELED broadband light source. |
| EXTERNAL_BBLS | Selects an external unmodulated broadband light source. |

STORE, AUTO

Saves the measurement results as defined by the STORE_SETUP keyword. A filename is automatically generated from the last 8 characters of the identification string entered using the ID keyword. The only legal characters for the filename are letters, numbers, and the underscore (_) character. If the ID string contains any other characters, those characters will be replaced with the underscore character. If a file already exists on the disk with the same filename, the file will be overwritten. There is no prompt for overwrite.

STORE_SETUP, {TABLE | GRAPHICS}

Configures the output of the measurement results that is stored on a disk in the front-panel disk drive. Although application users can temporarily override these selections for the current measurement, when a new device is measured, the storage setup resets to the values defined by the STORE_SETUP keyword. Use the STORE, AUTO keyword to actually store the data.

Table 10

| Constant | Description |
|---|---|
| TABLE | Stores the measurement data in a table, as well as all of the traces used for the measurements, in comma-separated-value (CSV) format. |
| GRAPHICS | Stores the measurement data in a CGM graphic file. |

SWEEP, start_wvl, stop_wvl, [avgs], [sens]

Specifies that the following data should be taken from a partial sweep. Normalization traces are always made using the conditions specified by SETUP. You can use this keyword to decrease measurement time by setting the instrument to sweep over a smaller wavelength range or with different trace averaging or sensitivity. The wavelength range specified here must fall within the one given in SETUP. In order to maintain integrity with the reference trace, the SWEEP function does *not* change the absolute wavelength position of trace points nor does it change the hardware reference level.

The start and stop wavelength values can only be constants. DEFAULT is not allowed for these values. All other parameter values must be either constants with units or the keyword DEFAULT for the optional parameters. Variables are not allowed as parameters for this keyword.

ZOOM, start_wvl, stop_wvl, [ref_lvl], [scale]

Displays the trace over the specified wavelength range on the screen. The zoom is performed after the path measurement is completed. If multiple ZOOM keywords are used for a PATH, only the last ZOOM keyword is used. Variables are not allowed as parameters for this keyword. The start and stop wavelength values can only be constants. DEFAULT is not allowed for these values. Reference level and scale values must be either constants with units or the keyword DEFAULT. DEFAULT reference level or the scale parameters specify that those settings will not change when zooming in the display.

# Passive Component Test Remote Commands

The *Agilent 86140B Series Optical Spectrum Analyzer User's Guide* for the mainframe provides detailed information on remote programming of the instrument. Only commands unique to the Passive Component Test application are included in this section.

***Passive Component Test application specific commands***

These remote commands are specific to the Passive Component Test application and allow you to control the application remotely. They are grouped under the following subsystems:

- CALCulate Subsystem Commands
- DISPlay Subsystem Commands
- FORMat Subsystem Commands
- HCOPy Subsystem Commands
- INITiate Subsystem Commands
- MMEMory Subsystem Commands
- SENSe Subsystem Commands
- TRACe Subsystem Commands

For more information, refer to the Remote Operation section in the *Agilent 86140B Series Optical Spectrum Analyzer User's Guide*, or to the following book:

SCPI Consortium. *SCPI–Standard Commands for Programming Instruments, 1997*

# Command Conventions

Table 11

<table>
<tr><th>Convention</th><th>Description</th></tr>
<tr><td>< ></td><td>Angle brackets indicate text strings entered by the developer.</td></tr>
<tr><td>[]</td><td>Square brackets indicate that the keyword DEFAULT can be used instead of a value or a variable for that parameter. Refer to the actual command description for the behavior when the DEFAULT keyword is used for a parameter.</td></tr>
<tr><td>|</td><td>Indicates a choice of one element from a list.</td></tr>
<tr><td>{}</td><td>Braces indicate a group of constants to select from. Each constant is separated by the | character.</td></tr>
<tr><td>name</td><td>Indicates the variable for which you provide a descriptive name. Any letter (Aa-Zz) followed by letters, digits (0-9) and underscore (_). Only the first 32 characters are significant.</td></tr>
<tr><td>spec_min</td><td>–infinity. The parameter spec_min cannot be a variable, only a constant or DEFAULT.</td></tr>
<tr><td>spec_max</td><td>+infinity. The parameter spec_max cannot be a variable, only a constant or DEFAULT.</td></tr>
<tr><td>from</td><td>Start wavelength or frequency of trace in nm (default) or THz.</td></tr>
<tr><td>to</td><td>Stop wavelength or frequency of trace in nm (default) or THz.</td></tr>
<tr><td>excursion</td><td>+excursion: means excursion dBs up (for example, from a pit).<br>-excursion: means excursion dBs down (for example, from a peak).</td></tr>
<tr><td>ref_pt</td><td>The reference point to be used for a measurement keyword.</td></tr>
</table>

## CALCulate Subsystem Commands

The CALCulate subsystem performs post-acquisition data processing. The CALCulate subsystem operates on data acquired by a SENSe function.

### CALCulate:DATA:GRAPh?

Returns the trace plot as an indefinite length block. After removing the #0 prefix and newline suffix, the data can be saved as a cgm format file.

### CALCulate:DATA:RESults?

Returns a comma separated list of measurement results. The results are returned in the order defined by the specification set file. The results are the same as the results table.

### CALCulate:DATA:TABLe?

Returns the measurement data in tabular format as an indefinite length block. The measurement data contains the table of results, instrument settings, and trace points. After removing the #0 prefix and newline suffix, the data can be saved as a csv format file.

### CALCulate:PATH[:NAME]?

Returns the name of the device path to be tested as defined in the specification set.

### CALCulate:PATH:RESult?

Returns the result of the device path measurement.

- -1 = No measurement made
- 0 = Device path failed specs
- 1 = Device path passed specs

## CALibration Subsystem Commands

This subsystem has the function of performing system calibration.

### CALibration Alignment

Performs an automatic alignment of the instrument at the wavelength of the largest signal found in full span. This aligns the monochromator output with the photodetector for improved amplitude accuracy. Sending this command with a marker on screen will generate a Settings conflict error.

**Syntax** CAL:ALIG

**Related Key** Auto Align

## DISPlay Subsystem Commands

The DISPlay subsystem controls the selection and presentation of textual, graphical, and TRACe information.

### DISPlay[:WINDow]:DUT:COMMent<string>

Enters a new comment string for the device under test.

### DISPlay[:WINDow]:DUT:COMMent?

Returns the comment string for the device under test.

### DISPlay[:WINDow]:DUT[:ID]<string>

Enters a new identification string for the device under test.

### DISPlay[:WINDow]:DUT[:ID]?

Returns the identification string for the device under test.

## FORMat Subsystem Commands

The FORMat subsystem sets a data format for transferring numeric and array information.

**FORMat[:DATA] REAL[64]|ASCII**

**FORMat[:DATA]?**

Specifies the trace data format used during data transfer via GPIB. This command effects data transfers for the CALCulate[:DATA] subsystem.

The ASCII format is a comma-separated list of numbers.

The REAL format is a definite-length block of 64-bit floating-point binary numbers. The definite-length block is defined by IEEE 488.2: a “#” character, followed by one digit (in ASCII) specifying the number of length bytes to follow, followed by the length (in ASCII), followed by length bytes of binary data. The binary data is a sequence of 8-byte, 64-bit floating point numbers.

## HCOPy Subsystem Commands

The HCOPy subsystem controls the setup of and printing to an external device.

**HCOPy:DESTination"SYSTem:COMMunicate:INTernal" | "SYSTem:COMMunicate:CENTronics"**

**HCOPy:DESTination?**

Selects the I/O port for hardcopy output. This effects subsequent use of the PRINT key and the HCOPy[:IMMediate] command.

**HCOPy:DEVice:MODE TABLe | GRAPh | ALL**

Determines the hardcopy output of the measurement results. The data can be printed as a table, a graph, or both.

**HCOPy:IMMediate**

Prints out the test results to the port defined by the HCOPy:DESTination command. The data printed is affected by the HCOPy:DEVice:MODE command.

## INITiate Subsystem Commands

The INITiate subsystem is used to control the initiation of the TRIGger subsystem.

**INITiate:IMMediate[:SEQuence [1|2]]**

Initiates the normalization routine (sequence 1) or the measurement routine (sequence 2) based on the sequence number. Measures only one path at a time.

**INITiate:ABORt**

Aborts the measurement of a device under test.

## INSTrument Subsystem Commands

The INSTrument subsystem provides a mechanism to identify and select logical instruments by either name or number. Arguments and responses are case sensitive.

**INSTrument:CATalog?**

**{OSA,PassiveComponent,WDM_AutoScan<null>}**

Comma-separated list of strings representing the Modes and Applications supported in the instrument.

**INSTrument:CATalog:FULL?**

**{OSA,0,PassiveComponent,1,WDM_AutoScan,2}**

Comma-separated list of string-numeric pairs representing the Modes and Applications supported in the instrument.

**INSTrument:SELect <identifier> identifier - string**

**INSTrument:NSELect <numeric_value>**

**INSTrument:NSELect?**

Loads the application or instrument mode specified.

**Example**

INSTrument:SELect ”WDM_AutoScan”

INSTrument:NSELect 2

## MMEMory Subsystem Commands

The MMEMory subsystem provides mass storage capabilities for instruments. The mass storage may be either internal or external to the instrument.

### MMEMory:SSET:CATalog?

Returns a comma separated list of imported specification sets from the instrument's internal memory.

### MMEMory:SSET:DATA<file_name>,<data_block>

### MMEMory:SSET:DATA? <file_name>

Imports a specification set <file_name>, where <data_block> is a definite length block containing the specification set. Refer to "Designing Specification Sets" on page 3-22 for additional designing information.

Returns a specification set file <file_name> as an indefinite length block. After removing the #0 prefix and newline suffix, the data can be saved as a csv format file.

### MMEMory:SSET:DELete<file_name>

Deletes a specification set from the instruments internal memory.

### MMEMory:SSET:LOAD<file_name>

### MMEMory:SSET:LOAD?

Loads an imported specification set as the current set of specs.

## SENSe Subsystem Commands

The SENSe setup commands control the specific settings of the device.

### [SENSe]:SWEep:POINts?

Returns the number of data points acquired during a sweep. This command is used in conjunction with the TRACe:POINts? query when downloading a trace.

## TRACe Subsystem Commands

A TRACe area is a named entity stored in instrument memory.

### TRACe[:DATA]?TRA|TRB|TRC|TRD|TRE|TRF

Returns the data points for the trace. The trace data format is determined by the FORMat subsystem.

# Sample Program

```
10  ! Program to demonstrate selecting a spec set
20  ! and then reading the results
30  !
40  ! The spec set for this program is example 3-15.
50  !
60  ! re-store “pctbfg”
70  !
80  ASSIGN @Osa TO 723;EOL CHR$(12) END                ! Set command terminator to LF & EOI
90  !
100 PRINTER IS “results.txt”
110 !
120 OUTPUT @Osa;”inst:sel ‘PassiveComponent’”          ! Loads PCT application
130 ! Note that a name must be in delimiters, ‘ or “
140 !
150 !
160 OUTPUT @Osa;”mmem:sset:load ‘PASS100’”             ! Load spec set from memory
170 !
180 OUTPUT @Osa;”disp:dut:comm ‘Remote measurement control’” ! Send comment line
190 OUTPUT @Osa;”disp:dut:comm?”
200 ENTER @Osa;Comment$
210 PRINT Comment$
220 !
230 OUTPUT @Osa;”disp:dut:id ‘DUT 12678’”              ! Send a new DUT ID
240 OUTPUT @Osa;”disp:dut:id?”
250 ENTER @Osa;Id$
260 PRINT Id$
270 !
280 PRINT “Make connections for normalization”
290 INPUT “Ready? Press Enter”,A$
300 OUTPUT @Osa;”init:imm:seq 1”                       ! Execute normalization routine
310 !
390 !
400 PRINT “Make connections for measurement”
410 INPUT “Ready? Press Enter”,A$
420 OUTPUT @Osa;”init:imm:seq 2”                       ! Execute measurement routine
430 !
```

```
440  OUTPUT @Osa;"calc:path:res?"              ! Query measurement results
450  ENTER @Osa;Results
460  IF Results=1 THEN 500                     ! Test for 1 as measurement passed
470  PRINT "Measurement failed ";Results
480  BEEP
490  STOP
500  PRINT "Measurement Passed"
510  !
520  !  ***  Read measurement table results  ***
530  !
540  OUTPUT @Osa;"calc:data:res?"              ! Read results column in table
550  ENTER @Osa;Peak_wl,Ins_loss,Bwidth_3db,Bwidth_6db,Bwidth_10db,Xtalk
560  !
570  PRINT "Peak Wavelength",Peak_wl
580  PRINT "Insertion Loss",Ins_loss
590  PRINT "3 dB Bandwidth",Bwidth_3db
600  PRINT "6 dB Bandwidth",Bwidth_6db
610  PRINT "10 dB Bandwidth",Bwidth_10db
620  PRINT "Cross talk",Xtalk
630  !
640  !  ***  Print out table  ***
650  !
660  OUTPUT @Osa;"hcop:dev:mode tabl"          ! Select table for printout
670  OUTPUT @Osa;"hcop:imm"                    ! print
680  !
700  END
```

Remote measurement

DUT 12678

Make connections for normalization

Make connections for measurement

Measurement Passed

Peak Wavelength    1553.794

Insertion Loss    8.47

3 dB Bandwidth    .585

6 dB Bandwidth    .703

10 dB Bandwidth    .891

Cross talk 21

| | |
|---|---|
| Model# / Serial# | 86142A / US38380189 |
| FW Rev / App Rev | P.03.00 |
| Sens / Measured in | -85.11 dBm / In Vacuum |

| Parameter | Actual | Spec Min | Spec Max |
|---|---|---|---|
| Passband | | | |
| Peak._WL | 1553.794 nm | 1540.00 | 1560.00 |
| Insertion_Loss | 8.47 dB | -- | 10.00 |
| BandWidth_3dB | 0.585 nm | 0.500 | 1.700 |
| BandWidth_6dB | 0.703 nm | 0.500 | 1.700 |
| BandWidth_10dB | 0.891 nm | 0.500 | 2.00 |
| XTalk | 21.00 dB | 12.00 | -- |

# 4



# WDM Channel Analysis Application

# About the Application

The WDM channel analysis application gives accurate wavelength, power and optical signal-to-noise ratio measurements. The results are displayed in an easy-to-read table. The WDM channel analysis application calculates the following attributes and display the results in the table:

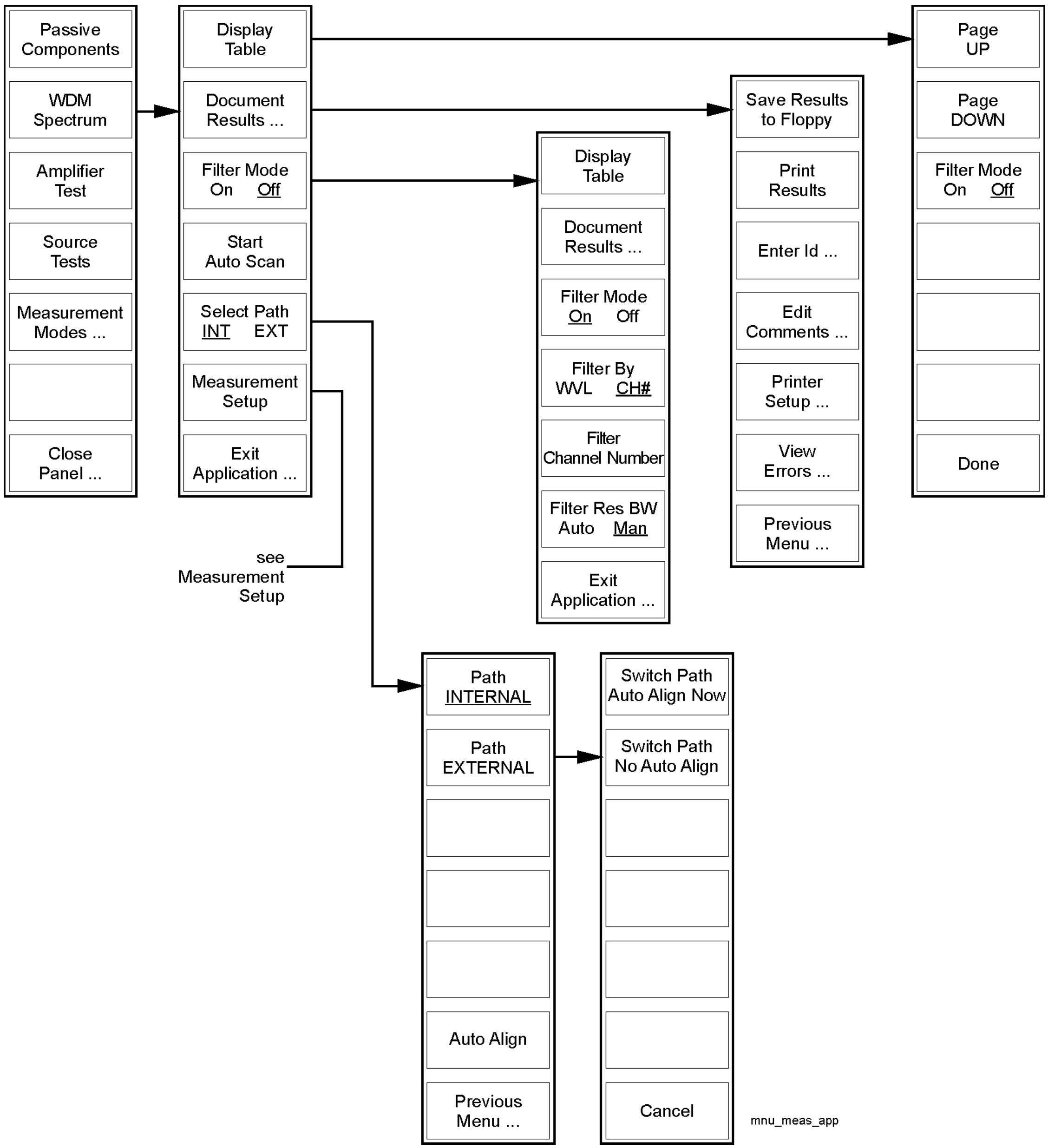
- Channel number for the channel with the maximum power
- Maximum channel power (dBm)
- Channel number for the channel with the minimum power
- Minimum channel power (dBm)
- Channel number for the channel with the maximum optical signal-to-noise ratio
- Maximum optical signal-to-noise ratio (dB)
- Channel number for the channel with the minimum optical signal-to-noise ratio
- Minimum optical signal-to-noise ratio (dB)
- Span tilt (dB/nm)
- Span tilt (dB)
- Peak-to-peak deviation, defined as:
  maximum channel power – minimum channel power

Using a noise sweep resolution bandwidth of 0.06 nm, the maximum wavelength span that can be measured is 75 nm. The maximum number of WDM channels that can be measured is 187.

The WDM channel analysis application uses a unique dual-sweep measurement technique. The first sweep uses a slightly broader filter to accurately measure signal power. The other sweep uses a very narrow band filter to measure the power density of the noise floor. The noise markers, which are corrected for filter shape, provide improved accuracy for the noise floor power density measurement which results in increased measurement accuracy of the optical signal-to-noise ratio.

This section provides a description of the user interface for this application. The behavior of the “Applications” menu of the OSA is also described.

# The Measurement Applications Menus



The application softkeys are accessed using the front-panel APPL'S key or the Applications menu, Launch an Installed Application selection on the menu bar.

# Performing Measurements

This section provides procedures for performing the following functions:



**Note**

The following functions assume the lightwave component analyzer is loaded.

## Starting the Application

This section explains how to start and use the WDM channel analysis application.

With the WDM channel analysis application you can test WDM sources, WDM multiplexers and other WDM components, such as filters and couplers.

To use the WDM channel analysis application you must:

**1** Start the application, refer to "To start the WDM channel analysis application" on page 4-7.

**2** Set up the measurement, refer to "To set up a measurement" on page 4-9.

**3** Measure the device under test.

You can then:

- View the results in a table, refer to "To display the results in a table" on page 4-16.
- Save the results, refer to "To save the results to floppy" on page 4-20.
- Print the results, refer to "To print the results" on page 4-21.

**4** Examine one channel or wavelength range in filter mode.

## To start the WDM channel analysis application

1 Press the front-panel APPL'S key or on the Applications menu select Launch an Installed Application.

2 The following screen is displayed.

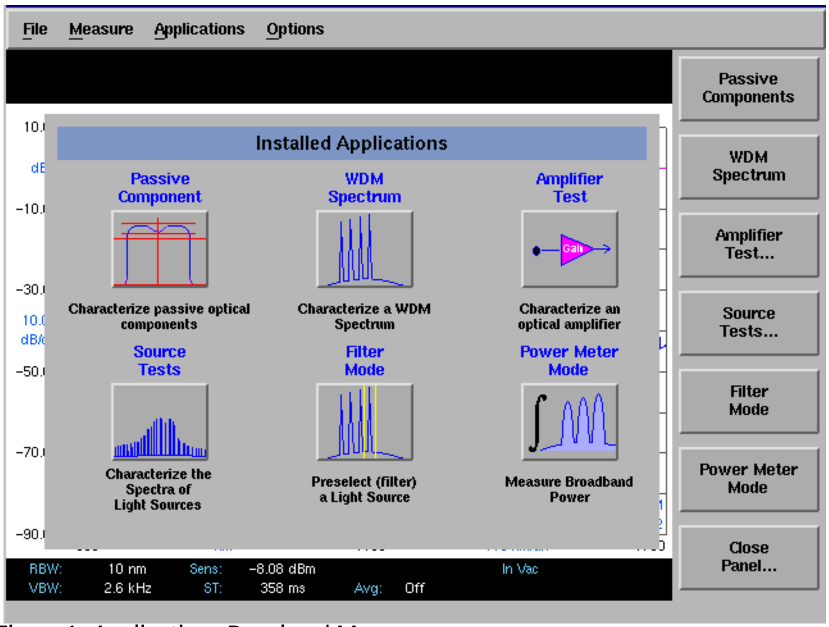


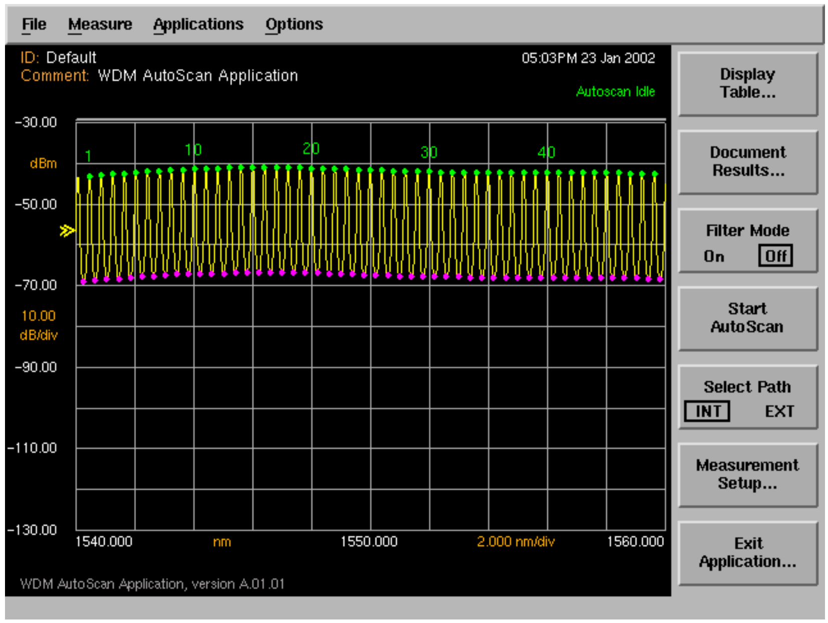

Figure 1 Applications Panel and Menu

The panel and the menu change whenever an application is installed or un-installed. Each installed application has an icon on the panel and a corresponding softkey.

3 Press the WDM SPECTRUM softkey to launch the channel analysis application.

## To perform an autoscan

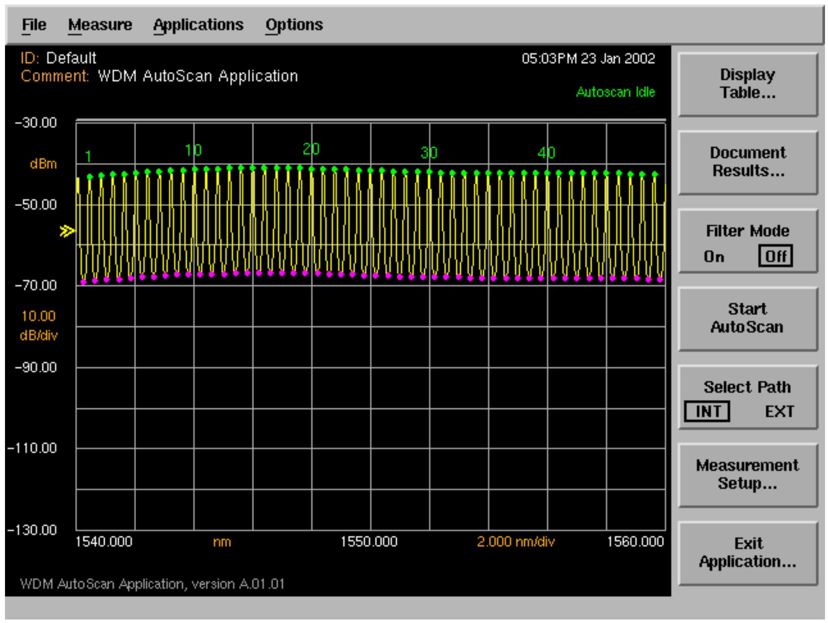
Press the START AUTOSCAN.... softkey.



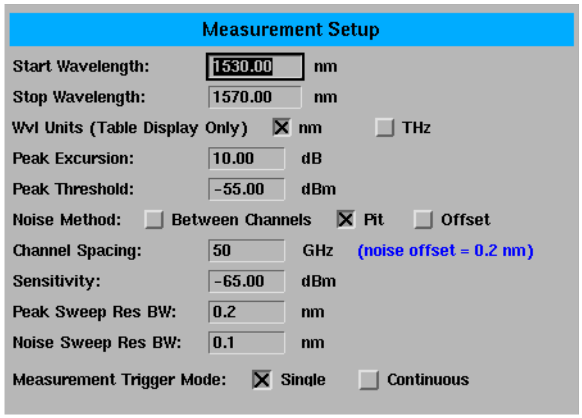

An automated channel scan is performed. The channel power, wavelength, optical signal-to-noise ratio, spectral gain tilt, and other statistics can be displayed either graphically or in a tabular format.

## To set up a measurement

Press the MEASUREMENT SETUP... softkey to open the Measurement setup menu and panel. This softkey is enabled whenever the system is not actively measuring.




The Measurement Setup panel opens.




WDM Measurement Setup panel

**Setup panel selections**

***Start Wavelength***

Default: 1530 nm

Sets the start wavelength for the Auto Scan function. Units are fixed in nm.

***Stop Wavelength***

Default: 1570 nm

Sets the stop wavelength for the Auto Scan function. Units are fixed in nm.

***Wavelength Units***

Default: nm

Selects the wavelength units, either nm or THz. These units are used in the display table only.

***Peak Excursion***

Default: 10 dB

Sets the peak excursion value in dB. This is the amount of amplitude the trace must rise and fall to considered a peak. Lower values lead to more signals being discerned, but if the peak excursion is set too low, peaks in the noise floor may be discerned as signals. If excursion is set too high, legitimate peaks may not be discerned as signals.

***Peak Threshold***

Default: -55 dBm

Sets the peak threshold value in dBm. Power levels below this threshold are not considered for peak search.

***Noise Method***

Default: Pit

Selects the noise method used: You can choose BETWEEN CHANNELS, PIT, or OFFSET.

When **Between Channels** is selected, the Noise marker is placed half-way between channels when making a noise power density measurement. The Noise power density used in the OSNR calculation is linearly interpolated between the noise marker to the left and to the right of the channel. *If the channel is the leftmost or rightmost channel in the measurement range, the noise would then be measured using the offset value for the side without an adjacent channel*.

When **Pit** is selected, the noise marker is placed at the lowest point between adjacent channels. The Noise power density used in the OSNR calculation is linearly interpolated between the noise marker to the left and to the right of the channel. *If a pit is not detected for the left and right side, the offset value specified for the noise measurement is used.*

When **Offset** is selected, the noise marker ‘noise offset’ is placed to the left and to the right of the channel when making a noise power density measurement. The Noise power density used in the OSNR calculation is linearly interpolated between the noise marker to the left and to the right of the channel. *The noise is always measured at the offset value specified*.

### *Channel Spacing*

Default: 100 GHz

Sets the channel spacing value in GHz. This value is the spacing between adjacent channels on the input signal. This value is used to calculate the noise offset value to use (noise offset = 1/2 channel spacing). The calculated noise offset value is displayed to the right of the channel spacing.

### *Sensitivity*

Default: –65 dBm

Sets31 the sensitivity value in dBm. Increasing sensitivity results in a more precise scan but increases the scan time.

### *Peak Sweep Res BW*

Default: 0.2 nm

Sets the resolution bandwidth value to be used during peak sweep. This determines the analyzer's ability to display two closely spaced signals as two distinct responses. Decreasing the resolution bandwidth provides a more detailed sweep but increases the scan time. The resolution bandwidth can be set to one of the following values: 0.07, 0.09, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 nm. For model 86142B, the minimum setting is 0.06 nm.

### *Noise Sweep Res BW*

Default: 0.1 nm

Sets the resolution bandwidth value to use during noise sweep. This determines the analyzer's ability to display two closely spaced signals as two distinct responses. Decreasing the resolution bandwidth provides a more detailed sweep but increases the scan time. The resolution bandwidth can be set to one of the following values: 0.06, 0.09, 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 nm. For model 86141B and 86140B Option 025, the minimum setting is 0.07 nm.

### *Measurement Trigger Mode*

Default: Single Trigger mode

Select either single or continuous trigger mode.

The navigation key operation is explained in To fill in a setup panel 25.

## To start a measurement

- Press the START AUTOSCAN softkey to start the measurement process.

A 2-sweep measurement is initiated. After the measurement is completed, the system either stops (Measurement Trigger Mode = Single), or initiates another 2-sweep measurement (Measurement Trigger Mode = Continuous).

During the measurement, the button label changes to STOP MEASUREMENT. Once the measurement is complete, the button label changes back to START AUTO SCAN.

## To stop a measurement

- Press STOP MEASUREMENT to stop a measurement in progress.

Selecting this softkey will stop the 2-sweep measurement cycle mid-sweep. Once the measurement is stopped, the button label changes to START AUTOSCAN.

## To select the external 9 µm fiber filter path

***For Agilent 86144B / 86146B only***

The 9µm external optical path is used to increase dynamic range and resolution bandwidth of the OSA.

1. Connect a 9 µm fiber between the Monochromator Output and the Photodetector Input.
2. Connect a light source to the Optical Input.
3. Press Select Path > Path External > Switch Path Auto Align Now.

An auto align is performed on the 9 µm filter path mode. This aligns the output of the monochromator with the photodetector input for improved amplitude accuracy.

Once Auto Align is completed, the OSA will return to the previous measurement state.

4. Press Start AutoScan to activate the external path and to update the measurement data.

**Tip**: If you want to proceed directly to using an external filter mode (Filter Mode On), then the step above is not required.

## To analyze a channel or wavelength

***For Agilent 86144B / 86146B only***

The Agilent 86144B and 86146B filter mode allows a single channel or wavelength from a dense wavelength division multiplex (DWDM) to be isolated and routed to another measurement instrument. The filtering is accurate and flexible. It has low polarization dependent loss (PDL), adjustable filter bandwidth, and a wide tuning range.

**1** Perform the procedure To select the external 9 μm fiber filter path 14.

The auto scan will identify and number the WDM channels. Using filter mode, you can easily filter out any of the channels by number, to the front panel Monochromator Output port.

**2** Press Filter Mode On Off so that On is underlined.

**3** Press Filter by WVL CH# to select the desired mode.

- **a** Select WVL > Filter Wavelength to tune to a particular wavelength for further analysis. For example, you can take the noise floor near a channel and route it to a DCA plug-in module.

A triangle marker will appear at the selected wavelength.

- **b** Select CH# > Filter Channel Number to select a particular channel to be filtered out and routed to a DCA plug-in module to measure the power, or a bit error rate tester to measure the Q factor.

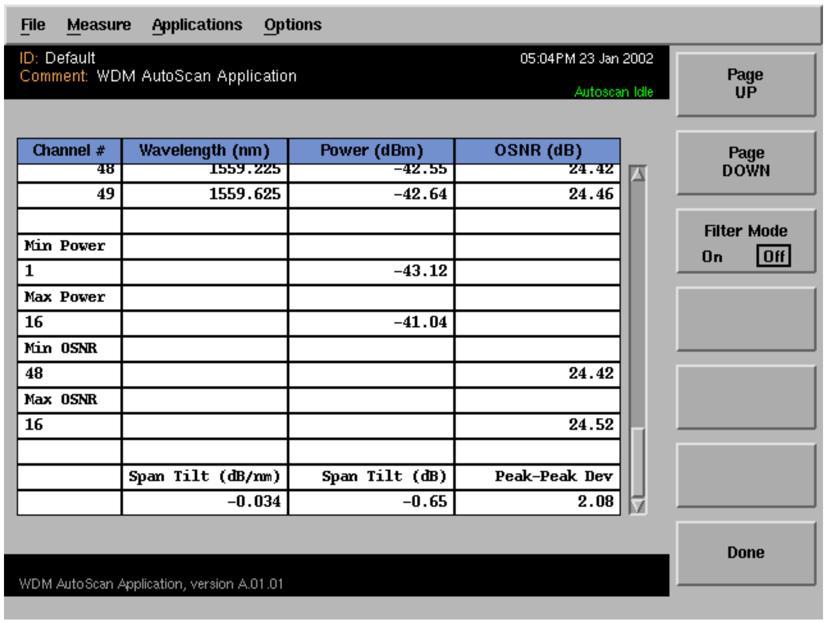
A triangle marker will appear at the selected channel.

**Note**

If the input signal is changing, you may periodically want to update your measurement. To do this, exit filter mode (Filter Mode Off) and then proceed in one of the two ways: 1. Connect the OSA Monochromator Output to the Photodetector Input and Press Start AutoScan. 2. Switch to the internal filter path (Filter Path Int) and press Start AutoScan.

## To display the results in a table

- Press the DISPLAY TABLE.... softkey. The results are displayed in a table similar to the one shown below.




| Channel # | Wavelength (nm) | Power (dBm) | OSNR (dB) |
|---|---|---|---|
| 48 | 1559.225 | -42.55 | 24.42 |
| 49 | 1559.625 | -42.64 | 24.46 |
| | | | |
| Min Power | | | |
| 1 | | -43.12 | |
| Max Power | | | |
| 16 | | -41.04 | |
| Min OSNR | | | |
| 48 | | | 24.42 |
| Max OSNR | | | |
| 16 | | | 24.52 |
| | | | |
| | Span Tilt (dB/nm) | Span Tilt (dB) | Peak-Peak Dev |
| | -0.034 | -0.65 | 2.08 |

| | |
|---|---|
| PAGE UP | display the previous page of results, if possible. |
| PAGE DOWN | display the next page of results, if possible. |
| DONE | exit the tabular display and return to the Auto Scan main menu. |

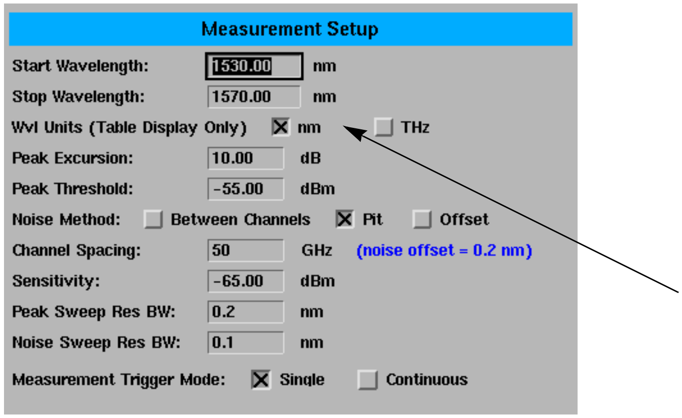
The WDM channel analysis application calculates the following statistics and display the results at the bottom of the table:

- Channel number for the channel with the maximum power
- Maximum channel power (dBm)
- Channel number for the channel with the minimum power
- Minimum channel power (dBm)
- Channel number for the channel with the maximum optical signal-to-noise ratio
- Maximum optical signal-to-noise ratio (dB)
- Channel number for the channel with the minimum optical signal-to-noise ratio
- Minimum optical signal-to-noise ratio (dB)
- Span tilt (dB / nm)
- Span tilt (dB)
- Peak-to-peak deviation, defined as:
  maximum channel power – minimum channel power

Using a noise sweep resolution bandwidth of 0.06 nm, the maximum wavelength span that can be measured is 75 nm. The maximum number of WDM channels that can be measured is 187.

## To change the wavelength units in the table

1 Press the MEASUREMENT SETUP.... softkey. The following window opens.




Measurement Setup panel

2 Select the desired units for the table. You can select either nanometers or terahertz.

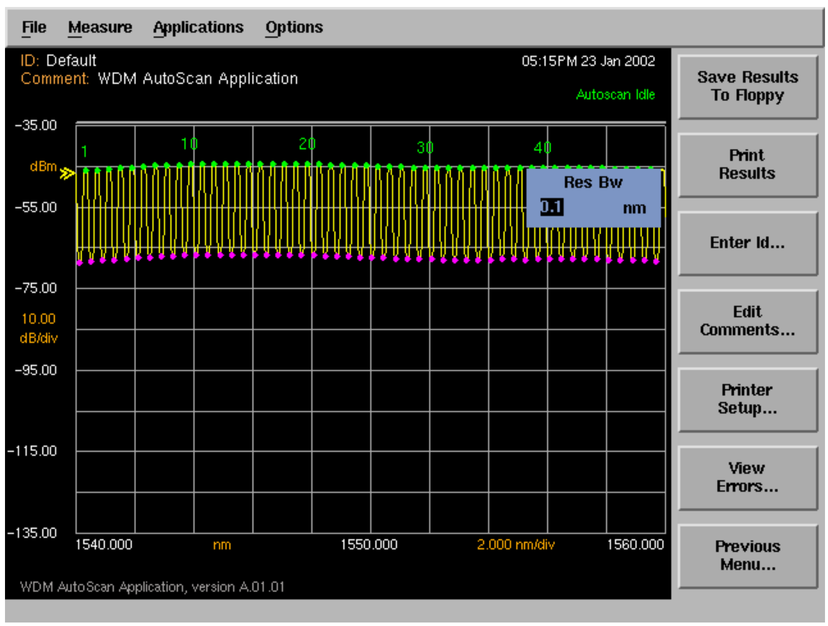
3 Press the CLOSE PANEL.... softkey when you are finished making your selections.

## To document measurement results

There are two ways to document results in the WDM Application. You can either print them to a printer (specified under printer setup) or you can save them to a floppy disk.

When the instrument is not sweeping, the DOCUMENT RESULTS... key of the WDM Application Main Menu is enabled.

- Press the DOCUMENT RESULTS... softkey. The following window opens.

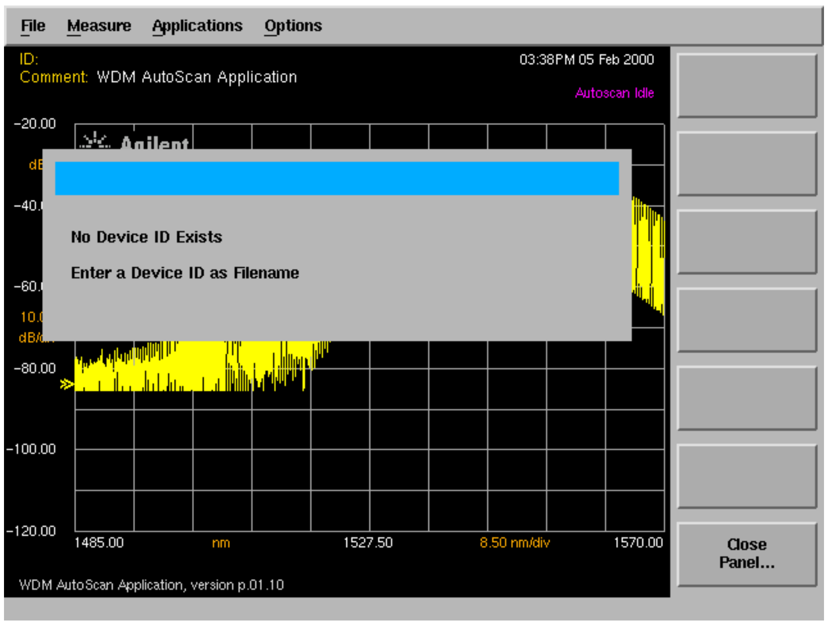



Document Results Menu

## To save the results to floppy

- Press the SAVE RESULTS TO FLOPPY softkey to save the current results to a file on the floppy drive.

The name of the file is defined as the last 8 characters of the ID. If no ID exists, a message prompts the user to "Enter a Device ID as filename". See "To enter a device ID" on page 4-22 for additional information.




Save Dialog Panel and Menu

If the ID already exists, the warning "Overwrite File?" is displayed.

The current file is saved in *.csv* spreadsheet format.

### To print the results

1 Press the PRINT RESULTS softkey to print the results to the target printer.

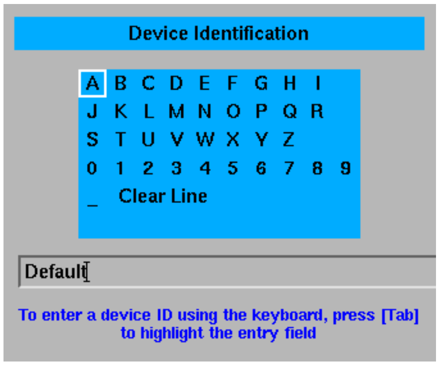
The target printer is as set by factory default, otherwise it retains the previous setting from the last time the application was started.

2 To change the target printer, press the PRINTER SETUP softkey.

3 The print operation is confirmed by a progress message displayed in the standard progress panel used in the base instrument.

## To enter a device ID

- Press the ENTER ID... softkey to access the Device Identification panel

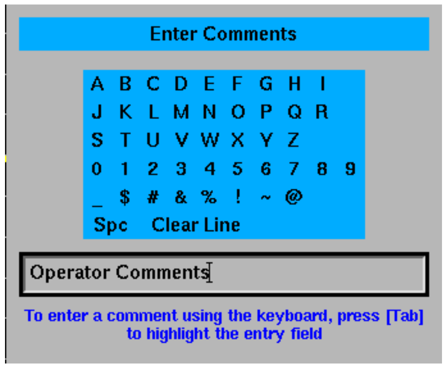



Device Identification panel

Entering characters and navigating this panel is explained in To use the alphanumeric panel softkeys 27.

## To enter comments

- Press the ENTER COMMENTS... softkey to access the Enter Comments panel.




Enter Comments panel

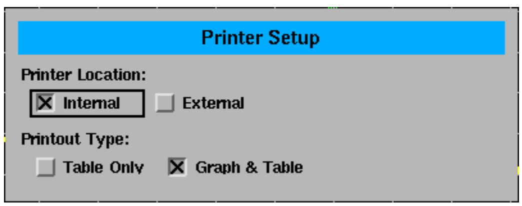
Entering characters and navigating this panel is explained in To use the alphanumeric panel softkeys 27.

## To set up the printer

1 Press the PRINTER SETUP softkey to access the Printer Setup panel.

The default setting is the internal printer and the default printout type is table only.

2 Use the check boxes to select the target printer, either external or internal, and the printout type. This setting is reset when the front-panel PRESET key is pressed, otherwise the previous setting from the last time the application was started is retained.




Printer Setup panel

Navigating and filling in the setup panel is explained in To fill in a setup panel 25.

PREVIOUS MENU... Returns to the Auto Scan Menu.

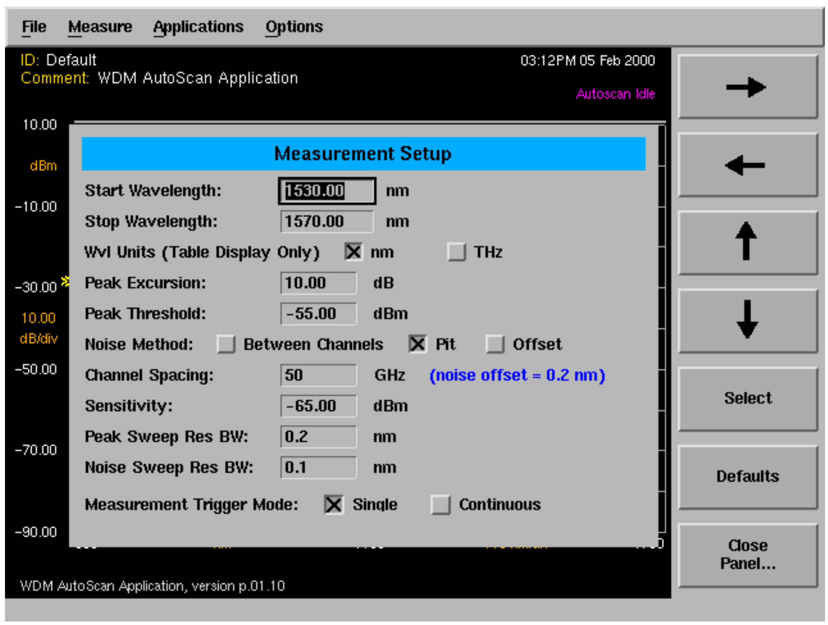
## To exit the application

- Press the EXIT APPLICATION softkey to exit the application.

# To fill in a setup panel

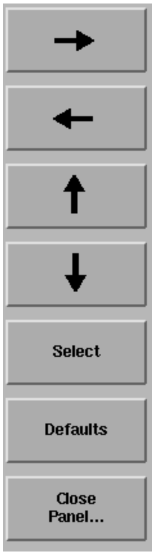
Any of the instrument settings can be changed by using either the front-panel keys or the menu bar selections. Many of the menu selections and front-panel keys display a softkey panel. Settings in softkey panels are changed using the softkeys, data-entry keys, mouse, and trackball.

Setup panels, such as the Measurement Setup panel, allow you to adjust setup conditions which are not frequently changed.




An example of a setup panel

**Using the softkeys**




***The arrow softkeys***

Allow you to navigate from field to field in the dialog box. The highlighted parameter can be changed.

***The Select softkey***

Selects or deselects the highlighted parameter.

***The Defaults softkey***

Resets the parameters to their default condition.

***Close Panel.... softkey***

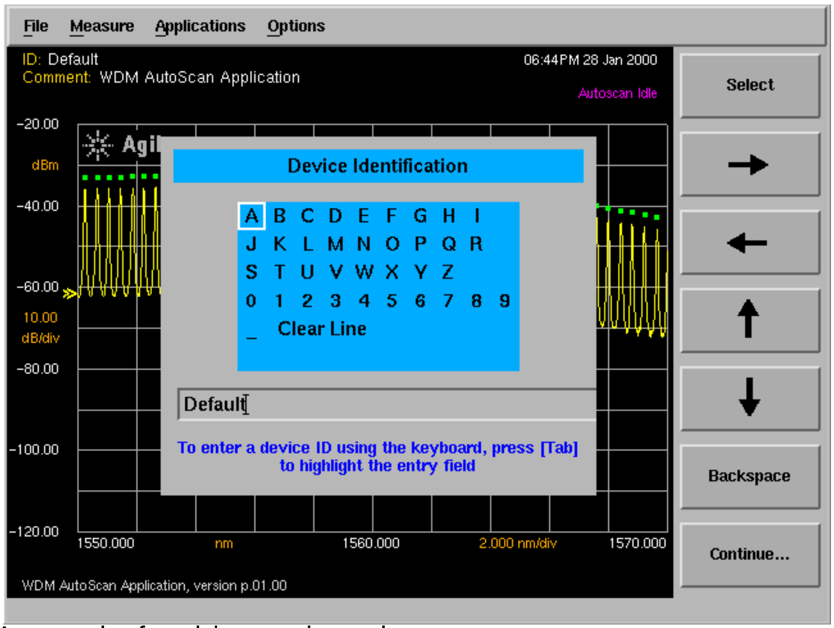
Saves the current setup and returns you to the previous menu.

***The front-panel number keys, step keys, and knob***

Allow you to enter a numeric value in the highlighted field.

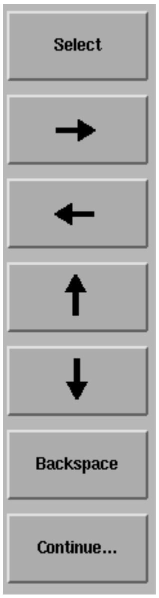
## To use the alphanumeric panel softkeys

Alphanumeric panels, such as the Device Identification panel, allow you to enter identification and comment labels for the devices you test.




An example of an alphanumeric panel

### Using the softkeys




***The Select softkey***

Selects the highlighted character.

***The arrow softkeys***

Allow you to navigate from character to character in the dialog box.

***The Backspace softkey***

Removes a previously selected character.

***Continue.... softkey***

Saves the current entry and returns you to the previous menu.

# WDM Channel Analysis Remote Commands

The *Agilent 86140B Series Optical Spectrum Analyzer Programming Guide* for the mainframe provides detailed information on remote programming of the instrument. Only commands unique to the lightwave component analyzer are included in this section.

The WDM channel analysis application remote command set is comprised of two types of commands:

***General Application support commands***

These are part of the base firmware and support applications in general. These commands allow the user to obtain a list of installed applications, load / unload an application, and so on.

***WDM channel analysis application specific commands***

These remote commands are specific to the WDM channel analysis application and allow you to control the WDM channel analysis application remotely. They are grouped under the following subsystems:

- CALCulate Subsystem Commands
- CALibration Subsystem Commands
- FORMat Subsystem Commands
- INITiate Subsystem Commands
- INPut Subsystem Commands
- ROUTe Subsystem Commands
- SENSe Subsystem Commands

For more information, refer to the Remote Operation section in the *Agilent 86140B Series Optical Spectrum Analyzer Programming Guide*, or to the following book:

SCPI Consortium. *SCPI–Standard Commands for Programming Instruments, 1997*

# Command Conventions

Table 1

<table>
<tr><th>Convention</th><th>Description</th></tr>
<tr><td>< ></td><td>Angle brackets indicate text strings entered by the developer.</td></tr>
<tr><td>[ ]</td><td>Square brackets indicate that the keyword DEFAULT can be used instead of a value or a variable for that parameter. Refer to the actual command description for the behavior when the DEFAULT keyword is used for a parameter.</td></tr>
<tr><td>|</td><td>Indicates a choice of one element from a list.</td></tr>
<tr><td>{ }</td><td>Braces indicate a group of constants to select from. Each constant is separated by the | character.</td></tr>
<tr><td>name</td><td>Indicates the variable for which you provide a descriptive name. Any letter (Aa-Zz) followed by letters, digits (0-9) and underscore (_). Only the first 32 characters are significant.</td></tr>
<tr><td>spec_min</td><td>–infinity. The parameter spec_min cannot be a variable, only a constant or DEFAULT.</td></tr>
<tr><td>spec_max</td><td>+infinity. The parameter spec_max cannot be a variable, only a constant or DEFAULT.</td></tr>
<tr><td>from</td><td>Start wavelength or frequency of trace in nm (default) or THz.</td></tr>
<tr><td>to</td><td>Stop wavelength or frequency of trace in nm (default) or THz.</td></tr>
<tr><td>excursion</td><td>+excursion: means excursion dBs up (for example, from a pit).<br>-excursion: means excursion dBs down (for example, from a peak).</td></tr>
<tr><td>ref_pt</td><td>The reference point to be used for a measurement keyword.</td></tr>
</table>

## CALCulate Subsystem Commands

The CALCulate subsystem performs post-acquisition data processing. The CALCulate subsystem operates on data acquired by a SENSe function. For more information, refer to page 4-1 of the *1997 SCPI Command Reference.*

### CALCulate:DATA:CPOWers?

This command allows the user to download the array of channel powers measured. The data is returned in either an ASCII or binary form as determined by the FORMat:DATA command. The number of data points in this array is determined by the CALCulate:DATA:NCHannels? query.

### CALCulate:DATA:CSNR?

This command allows the user to download the array of channel OSNR values measured. The data is returned in either an ASCII or binary form as determined by the FORMat:DATA command. The number of data points in this array is determined by the CALCulate:DATA:NCHannels? query.

### CALCulate:DATA:CSTats?

This command allows the user to download the following statistics using a single query:

- Channel number for the channel with the maximum power
- Maximum channel power (dBm)
- Channel number for the channel with the minimum power
- Minimum channel power (dBm)
- Channel number for the channel with the maximum optical signal-to-noise ratio
- Maximum optical signal-to-noise ratio (dB)
- Channel number for the channel with the minimum optical signal-to-noise ratio
- Minimum optical signal-to-noise ratio (dB)
- Span tilt (dB / nm)
- Span tilt (dB)
- Peak-to-peak deviation, defined as:
  maximum channel power – minimum channel power

Using a noise sweep resolution bandwidth of 0.06 nm, the maximum wavelength span that can be measured is 75 nm. The maximum number of WDM channels that can be measured is 187.

The data is returned in either an ASCII or binary form as determined by the FORMAT:DATA command.

### CALCulate:DATA:CWAVelengths?

This command allows the user to download the array of channel wavelengths measured. The data is returned in either an ASCII or binary form as determined by the FORMat:DATA command. The number of data points in this array is determined by the CALCulate:DATA:NCHannels? query. The units are either nanometers or terahertz and can be changed using the CALCulate:DATA:TABLe:WAVe command.

### CALCulate:DATA:NCHannels?

This command allows the user to query the number of channels detected in the last measurement. The data is returned as an ASCII integer.

**CALCulate:DATA:TABLe:WAVe NM|THZ**

**CALCulate:DATA:TABLe:WAVe?**

Sets the wavelength units used for the tabular display and for the CALCulate:DATA:CWAVelengths remote query. The instrument x-axis display always displays wavelength in nanometers and is not affected by this command.

**CALCulate:PEXCursion[:PEAK] <numeric_value>**

**CALCulate:PEXCursion[:PEAK]?**

Sets the peak excursion value for the marker search routines. The peak excursion value is used to determine whether or not a local maximum in the trace is to be considered a peak. To qualify as a peak, both sides of the local maximum must fall by at least the peak excursion value.

**CALCulate:THReshold <numeric_value> [W|MW|UW|DBM]**

**CALCulate:THReshold?**

Specifies the value for the peak search threshold. Peaks with amplitudes below this value will not be included in the channel count.

Default units are DBM.

## CALibration Subsystem Commands

This subsystem has the function of performing system calibration.

### CALibration Alignment

Performs an automatic alignment of the instrument at the wavelength of the largest signal found in full span. This aligns the monochromator output with the photodetector for improved amplitude accuracy. Sending this command with a marker on screen will generate a Settings conflict error.

**Syntax** CAL:ALIG

**Related Key** Auto Align

## DISPlay Subsystem Commands

The DISPlay subsystem controls the selection and presentation of textual, graphical, and TRACe information.

**DISPlay[:WINDow]:DUT:COMMent<string>**

Enters a new comment string for the device under test.

**DISPlay[:WINDow]:DUT:COMMent?**

Returns the comment string for the device under test.

**DISPlay[:WINDow]:DUT[:ID]<string>**

Enters a new identification string for the device under test.

**DISPlay[:WINDow]:DUT[:ID]?**

Returns the identification string for the device under test.

**DISPlay[:WINDow[1]]:TRACe:Y[:SCALe]:RLEVel <numeric_value>[W|MW|UW|DBM]**

**DISPlay[:WINDow[1]]:TRACe:Y[:SCALe]:RLEVel?**

Specifies the value of the reference level. Default units are DBM. Starting a measurement from the front panel sets the reference level automatically based on the maximum channel power. The reference level needs to be set manually when using the instrument remotely.

## FORMat Subsystem Commands

The FORMat subsystem sets a data format for transferring numeric and array information.

**FORMat[:DATA] REAL[32,64] | ASCII**

**FORMat[:DATA]?**

Specifies the trace data format used during data transfer via HP-IB. This command affects data transfers for the CALCulate[:DATA] subsystem. The ASCII format is a comma-separated list of numbers. The REAL format is a definite-length block of 64-bit floating-point binary numbers. The definite-length block is defined by IEEE 488.2: a "#" character, followed by one digit (in ASCII) specifying the number of length bytes to follow, followed by the length (in ASCII), followed by length bytes of binary data. The binary data is a sequence of 8-byte (64-bit) floating point numbers.

## INITiate Subsystem Commands

The INITiate subsystem is used to control the initiation of the TRIGger subsystem.

### INITiate:IMMediate

Initiates a new 2-sweep WDM measurement. This command is disabled when in when INPut:FILTer[STATe] is ON.

## INPut Subsystem Commands

The INPut subsystem is used to control the filter mode function. You must be in filter mode to use the INPut:FILTer commands.

**Note** The INPut subsystem commands are only available on the 86144B and 86146B.

**INPut:FILTer:BANDwidth|BWIDth[:RESolution] <value>[wvl units]**

**INPut:FILTer:BANDwidth|BWIDth[:RESolution]?**

Sets the resolution bandwidth of the filter. The query returns the filter's resolution bandwidth.

**INPut:FILTer:BANDwidth|RESolution|AUTOmatic <ON|OFF>**

**INPut:FILTer:BANDwidth|RESolution|AUTOmatic?**

Sets resolution bandwidth of the filter to automatic or manual mode. The query returns the automatic or manual status.

**INPut:CHANnel <channel number>**

Sets the filter to the wavelength of the specified channel. The channel number must be >0 and <=NUM_CHANNELS. There is no query associated with this command. Instead you should use INPut:FILTer:WAVelength?.

**INPut:FILTer[:STATe] <ON|OFF>**

**INPut:FILTer[:STATe]?**

Turns the filter mode on/off. If the external path has not been selected, a "Settings Conflict" error will be returned. IMITiate:IMMediate (sweeps) will be disabled while in filter mode.

The query returns the status of the filter mode. The query returns a 1 if the filter mode is on or returns a 0 if the filter mode is off.

**INPute:FILTerWAVelength <value>**

**INPute:FILTerWAVelength?**

Sets the filter to the specified wavelength. The query returns the wavelength where the filter is currently set.

# INSTrument Subsystem Commands

The INSTrument subsystem provides a mechanism to identify and select logical instruments by either name or number. Arguments and responses are case sensitive.

**INSTrument:CATalog?**

**{OSA,PassiveComponent,WDM_AutoScan<null>}**

Comma-separated list of strings representing the Modes and Applications supported in the instrument.

**INSTrument:CATalog:FULL?**

**{OSA,0,PassiveComponent,1,WDM_AutoScan,2}**

Comma-separated list of string-numeric pairs representing the Modes and Applications supported in the instrument.

**INSTrument:SELect <identifier> identifier - string**

**INSTrument:NSELect <numeric_value>**

**INSTrument:NSELect?**

Loads the application or instrument mode specified.

**Example**

INSTrument:SELect ”WDM_AutoScan”

INSTrument:NSELect 2

## ROUTe Subsystem Commands

The ROUTe subsystem provides a mechanism to select the internal 50 μm or external 9 μm path.

### ROUTe:PATH <INTernal|EXTernal>

### ROUTe:PATH?

***Available for the 86144B and 86146B only.***

Selects the internal 50 μm or external 9 μm path. This command is disabled when in filter mode. The query will return the current path.

## SENSe Subsystem Commands

The SENSe setup commands control the specific settings of the device.

**SENSe:BANDwidth|BWIDth[:RESolution]:NOISe <numeric_value> [M|NM|UM|A]**

**SENSe:BANDwidth|BWIDth[:RESolution]:NOISe?**

Specifies the resolution bandwidth value used for the ‘noise’ sweep in the 2-sweep measurement mode. Default units are m.

**SENSe:BANDwidth|BWIDth[:RESolution]:PEAK <numeric_value> [M|NM|UM|A]**

**SENSe:BANDwidth|BWIDth[:RESolution]:PEAK?**

Specifies the resolution bandwidth value used for the ‘peaks’ sweep in the 2-sweep measurement mode. Default units are m.

**SENSe:CHANnel:SPACing <numeric_value> [HZ|KHZ|MHZ|GHZ]**

**SENSe:CHANnel:SPACing?**

Specifies the value for channel spacing. Default units are GHz.

**SENSe:NOISe [PIT|FIXED|HD]**

**SENSe:NOISe?**

Specifies how the noise measurement locations are determined (pit, fixed offset, or half-distance between channels).

**SENSe:POWer[:DC]:RANGe:LOWer <numeric_value> [W|MW|UW|DBM]**

**SENSe:POWer[:DC]:RANGe:LOWer?**

Specifies the sensitivity value used for the WDM channel analysis application measurements. Default units are dBm.

**NOTE** The maximum value for sensitivity is +300 dBm. The minimum value is the value that causes the sweep time to become 1000 seconds, and is an attribute of each individual optical spectrum analyzer. The minimum value will always be less than the values for sensitivity shown in the Specifications section of the User's Guide

**SENSe:[WAVelength:]STARt <numeric_value> [M|NM|UM|A|HZ|KHZ|MHZ|GHZ]**

**SENSe:[WAVelength:]STARt?**

Specifies the start wavelength for the WDM channel analysis application. Default units are M.

**SENSe:[WAVelength:]STOP <numeric_value> [M|NM|UM|A|HZ|KHZ|MHZ|GHZ]**

**SENSe:[WAVelength:]STOP?**

Specifies the stop wavelength for the WDM channel analysis application. Default units are M.

5



# Customer Support

# Contacting Agilent

To learn more about your optical spectrum analyzer and other lightwave optical communication test solutions, visit our Internet web site. Before returning an instrument for service, call the Agilent Technologies Instrument Support Center at (800) 403-0801, or visit the Agilent Lightwave web site at www.agilent.com/find/assist. See “Agilent Technologies Service Offices” on page 5-3 for a list of service centers.

# Agilent Technologies Service Offices

Before returning an instrument for service, call the Agilent Technologies Instrument Support Center at (800) 403-0801, or call one of the numbers listed below.

Agilent Technologies Service Numbers

| | |
|---|---|
| Austria | (43 1) 25125-7000 |
| Belgium + Luxemburg | (02) 404.93.03 |
| Brazil | (55 11) 7297-3700 |
| Canada | 888-447-7378 |
| China | 800-810-0508 |
| France | 01.69.82.66.69 |
| Germany | 01805 24 6337 |
| Hong Kong | 800-93-3229 |
| India | 91-80-343-5755 |
| Ireland | 01205 4500 |
| Japan | 0120-32-0119 |
| Malaysia | 1-800-880-399 |
| Philippines | 1-800-1651-0135 |
| Singapore | 1-800-275-0880 |
| Spain | (34-91) 631 3300 |
| Sweden | (08) 506 487 00 |
| Switzerland | (+41 1) 735 9501 |
| Taiwan | 66 862 661 5900 |
| United Kingdom | 07004 123123 |
| United States | (800) 403-0801 |

# Cleaning Connections for Accurate Measurements

Today, advances in measurement capabilities make connectors and connection techniques more important than ever. Damage to the connectors on calibration and verification devices, test ports, cables, and other devices can degrade measurement accuracy and damage instruments. Replacing a damaged connector can cost thousands of dollars, not to mention lost time! This expense can be avoided by observing the simple precautions presented in this book. This book also contains a brief list of tips for caring for electrical connectors.

## Choosing the Right Connector

A critical but often overlooked factor in making a good lightwave measurement is the selection of the fiber-optic connector. The differences in connector types are mainly in the mechanical assembly that holds the ferrule in position against another identical ferrule. Connectors also vary in the polish, curve, and concentricity of the core within the cladding. Mating one style of cable to another requires an adapter. Agilent Technologies offers adapters for most instruments to allow testing with many different cables. Figure 1 on page 5-6 shows the basic components of a typical connectors.

The system tolerance for reflection and insertion loss must be known when selecting a connector from the wide variety of currently available connectors. Some items to consider when selecting a connector are:

- How much insertion loss can be allowed?
- Will the connector need to make multiple connections? Some connectors are better than others, and some are very poor for making repeated connections.
- What is the reflection tolerance? Can the system take reflection degradation?
- Is an instrument-grade connector with a precision core alignment required?
- Is repeatability tolerance for reflection and loss important? Do your specifications take repeatability uncertainty into account?
- Will a connector degrade the return loss too much, or will a fusion splice be required? For example, many DFB lasers cannot operate with reflections from connectors. Often as much as 90 dB isolation is needed.

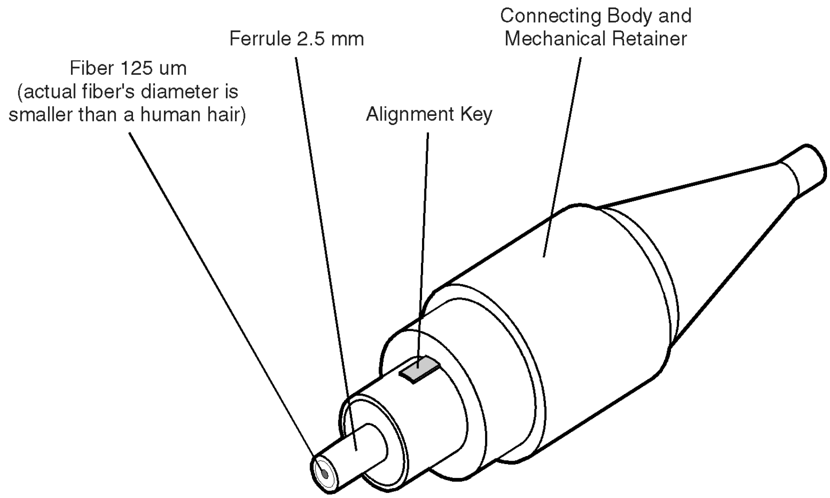



Figure 1 Basic components of a connector.

Over the last few years, the FC/PC style connector has emerged as the most popular connector for fiber-optic applications. While not the highest performing connector, it represents a good compromise between performance, reliability, and cost. If properly maintained and cleaned, this connector can withstand many repeated connections.

However, many instrument specifications require tighter tolerances than most connectors, including the FC/PC style, can deliver. These instruments cannot tolerate connectors with the large non-concentricities of the fiber common with ceramic style ferrules. When tighter alignment is required, Agilent Technologies instruments typically use a connector such as the Diamond HMS-10, which has concentric tolerances within a few tenths of a micron. Agilent Technologies then uses a special universal adapter, which allows other cable types to mate with this precision connector. See Figure 2.

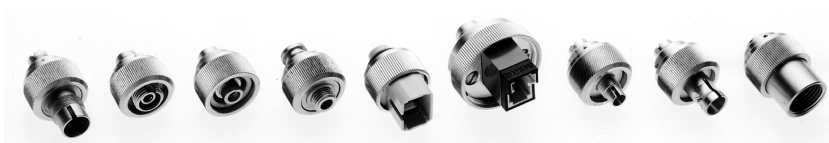


Figure 2 Universal adapters to Diamond HMS-10.

The HMS-10 encases the fiber within a soft nickel silver (Cu/Ni/Zn) center which is surrounded by a tough tungsten carbide casing, as shown in Figure 3.

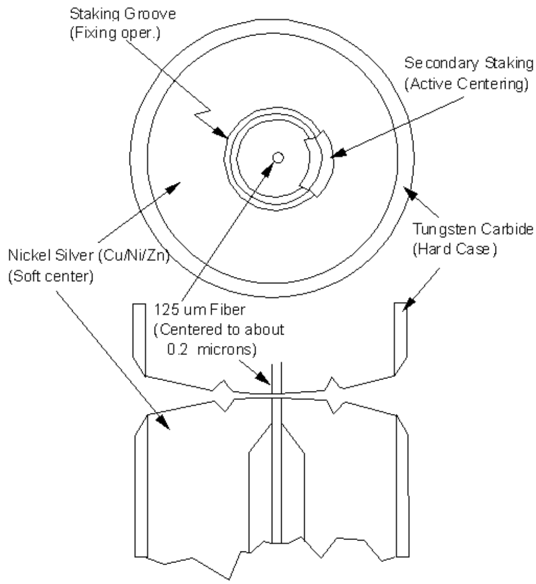



Figure 3 Cross-section of the Diamond HMS-10 connector.

The nickel silver allows an active centering process that permits the glass fiber to be moved to the desired position. This process first stakes the soft nickel silver to fix the fiber in a near-center location, then uses a post-active staking to shift the fiber into the desired position within 0.2 μm. This process, plus the keyed axis, allows very precise core-to-core alignments. This connector is found on most Agilent Technologies lightwave instruments.

The soft core, while allowing precise centering, is also the chief liability of the connector. The soft material is easily damaged. Care must be taken to minimize excessive scratching and wear. While minor wear is not a problem if the glass face is not affected, scratches or grit can cause the glass fiber to move out of alignment. Also, if unkeyed connectors are used, the nickel silver can be pushed onto the glass surface. Scratches, fiber movement, or glass contamination will cause loss of signal and increased reflections, resulting in poor return loss.

## Inspecting Connectors

Because fiber-optic connectors are susceptible to damage that is not immediately obvious to the naked eye, poor measurements result without the user being aware. Microscopic examination and return loss measurements are the best way to ensure good measurements. Good cleaning practices can help ensure that optimum connector performance is maintained. With glass-to-glass interfaces, any degradation of a ferrule or the end of the fiber, any stray particles, or finger oil can have a significant effect on connector performance. Where many repeat connections are required, use of a connector saver or patch cable is recommended.

Figure 4 shows the end of a clean fiber-optic cable. The dark circle in the center of the micrograph is the fiber's 125 μm core and cladding which carries the light. The surrounding area is the soft nickel-silver ferrule. Figure 5 shows a dirty fiber end from neglect or perhaps improper cleaning. Material is smeared and ground into the end of the fiber causing light scattering and poor reflection. Not only is the precision polish lost, but this action can grind off the glass face and destroy the connector.

Figure 6 shows physical damage to the glass fiber end caused by either repeated connections made without removing loose particles or using improper cleaning tools. When severe, the damage of one connector end can be transferred to another good connector end face that comes in contact with the damaged one. Periodic checks of fiber ends, and replacing connecting cables after many connections is a wise practice.

The cure for these problems is disciplined connector care as described in the following list and in Cleaning Connectors 12.

Use the following guidelines to achieve the best possible performance when making measurements on a fiber-optic system:

- Never use metal or sharp objects to clean a connector and never scrape the connector.
- Avoid matching gel and oils.

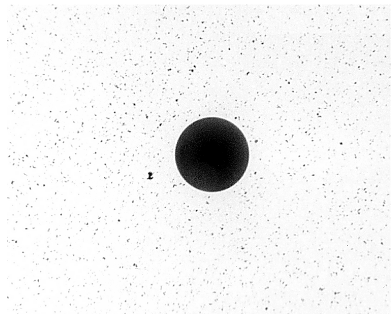


Figure 4 Clean, problem-free fiber end and ferrule.

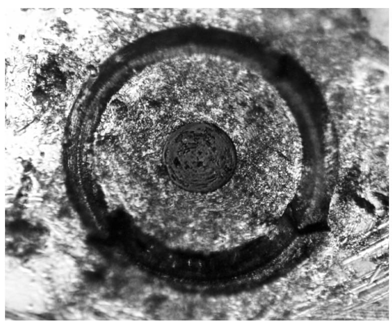


Figure 5 Dirty fiber end and ferrule from poor cleaning.

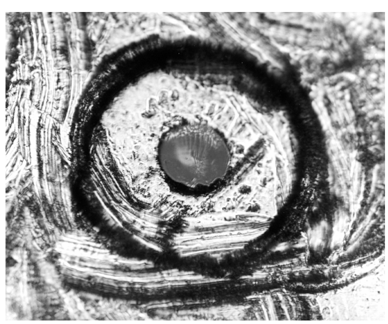


Figure 6 Damage from improper cleaning.

While these often work well on first insertion, they are great dirt magnets. The oil or gel grabs and holds grit that is then ground into the end of the fiber. Also, some early gels were designed for use with the FC, non-contacting connectors, using small glass spheres. When used with contacting connectors, these glass balls can scratch and pit the fiber. If an index matching gel or oil must be used, apply it to a freshly cleaned connector, make the measurement, and then immediately clean it off. Never use a gel for longer-term connections and never use it to improve a damaged connector. The gel can mask the extent of damage and continued use of a damaged fiber can transfer damage to the instrument.

- When inserting a fiber-optic cable into a connector, gently insert it in as straight a line as possible. Tipping and inserting at an angle can scrape material off the inside of the connector or even break the inside sleeve of connectors made with ceramic material.
- When inserting a fiber-optic connector into a connector, make sure that the fiber end does not touch the outside of the mating connector or adapter.
- Avoid over tightening connections.

Unlike common electrical connections, tighter is *not* better. The purpose of the connector is to bring two fiber ends together. Once they touch, tightening only causes a greater force to be applied to the delicate fibers. With connectors that have a convex fiber end, the end can be pushed off-axis resulting in misalignment and excessive return loss. Many measurements are actually improved by backing off the connector pressure. Also, if a piece of grit does happen to get by the cleaning procedure, the tighter connection is more likely to damage the glass. Tighten the connectors just until the two fibers touch.

- Keep connectors covered when not in use.
- Use fusion splices on the more permanent critical nodes. Choose the best connector possible. Replace connecting cables regularly. Frequently measure the return loss of the connector to check for degradation, and clean every connector, every time.

All connectors should be treated like the high-quality lens of a good camera. The weak link in instrument and system reliability is often the inappropriate use and care of the connector. Because current connectors are so easy to use, there tends to be reduced vigilance in connector care and cleaning. It takes only one missed cleaning for a piece of grit to permanently damage the glass and ruin the connector.

### *Measuring insertion loss and return loss*

Consistent measurements with your lightwave equipment are a good indication that you have good connections. Since return loss and insertion loss are key factors in determining optical connector performance they can be used to determine connector degradation. A smooth, polished fiber end should produce a good return-loss measurement. The quality of the polish establishes the difference between the “PC” (physical contact) and the “Super PC” connectors. Most connectors today are physical contact which make glass-to-glass connections, therefore it is critical that the area around the glass core be clean and free of scratches. Although the major area of a connector, excluding the glass, may show scratches and wear, if the glass has maintained its polished smoothness, the connector can still provide a good low level return loss connection.

If you test your cables and accessories for insertion loss and return loss upon receipt, and retain the measured data for comparison, you will be able to tell in the future if any degradation has occurred. Typical values are less than 0.5 dB of loss, and sometimes as little as 0.1 dB of loss with high performance connectors. Return loss is a measure of reflection: the less reflection the better (the larger the return loss, the smaller the reflection). The best physically contacting connectors have return losses better than 50 dB, although 30 to 40 dB is more common.

### *Visual inspection of fiber ends*

Visual inspection of fiber ends can be helpful. Contamination or imperfections on the cable end face can be detected as well as cracks or chips in the fiber itself. Use a microscope (100X to 200X magnification) to inspect the entire end face for contamination, raised metal, or dents in the metal as well as any other imperfections. Inspect the fiber for cracks and chips. Visible imperfections not touching the fiber core may not affect performance (unless the imperfections keep the fibers from contacting).

**WARNING**

**Always remove both ends of fiber-optic cables from any instrument, system, or device before visually inspecting the fiber ends. Disable all optical sources before disconnecting fiber-optic cables. Failure to do so may result in permanent injury to your eyes.**

## Cleaning Connectors

The procedures in this section provide the proper steps for cleaning fiber-optic cables and Agilent Technologies universal adapters. The initial cleaning, using the alcohol as a solvent, gently removes any grit and oil. If a caked-on layer of material is still present, (this can happen if the beryllium-copper sides of the ferrule retainer get scraped and deposited on the end of the fiber during insertion of the cable), a second cleaning should be performed. It is not uncommon for a cable or connector to require more than one cleaning.

**CAUTION**

Agilent Technologies strongly recommends that index matching compounds *not* be applied to their instruments and accessories. Some compounds, such as gels, may be difficult to remove and can contain damaging particulates. If you think the use of such compounds is necessary, refer to the compound manufacturer for information on application and cleaning procedures.

Table 1 Cleaning Accessories

| Item | Agilent Part Number |
|---|---|
| Cotton swabs | 8520-0023 |
| Small foam swabs | 9300-1223 |

Table 2 Dust Caps Provided with Lightwave Instruments

| Item | Agilent Part Number |
|---|---|
| Laser shutter cap | 08145-64521 |
| FC/PC dust cap | 08154-44102 |
| Biconic dust cap | 08154-44105 |

***To clean a non-lensed connector***

**CAUTION**

Do not use any type of foam swab to clean optical fiber ends. Foam swabs can leave filmy deposits on fiber ends that can degrade performance.

**1** Apply pure isopropyl alcohol to a clean lint-free cotton swab or lens paper.

Cotton swabs can be used as long as no cotton fibers remain on the fiber end after cleaning.

**2** Clean the ferrules and other parts of the connector while avoiding the end of the fiber.

**3** Apply isopropyl alcohol to a new clean lint-free cotton swab or lens paper.

**4** Clean the fiber end with the swab or lens paper.

Do *not* scrub during this initial cleaning because grit can be caught in the swab and become a gouging element.

**5** Immediately dry the fiber end with a clean, dry, lint-free cotton swab or lens paper.

**6** Blow across the connector end face from a distance of 6 to 8 inches using filtered, dry, compressed air. Aim the compressed air at a shallow angle to the fiber end face.

Nitrogen gas or compressed dust remover can also be used.

**CAUTION** Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

**7** As soon as the connector is dry, connect or cover it for later use.

If the performance, after the initial cleaning seems poor, try cleaning the connector again. Often a second cleaning will restore proper performance. The second cleaning should be more arduous with a scrubbing action.

***To clean an adapter***

The fiber-optic input and output connectors on many Agilent Technologies instruments employ a universal adapter such as those shown in the following picture. These adapters allow you to connect the instrument to different types of fiber-optic cables.

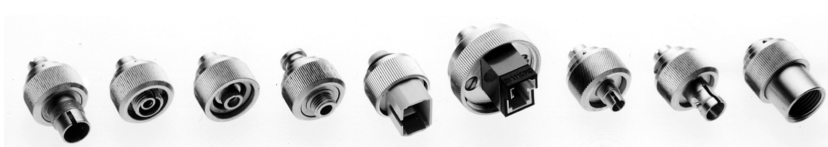


Figure 7 Universal adapters.

**1** Apply isopropyl alcohol to a clean foam swab.

Cotton swabs can be used as long as no cotton fibers remain after cleaning. The foam swabs listed in this section’s introduction are small enough to fit into adapters.

Although foam swabs can leave filmy deposits, these deposits are very thin, and the risk of other contamination buildup on the inside of adapters greatly outweighs the risk of contamination by foam swabs.

**2** Clean the adapter with the foam swab.

**3** Dry the inside of the adapter with a clean, dry, foam swab.

**4** Blow through the adapter using filtered, dry, compressed air.

Nitrogen gas or compressed dust remover can also be used. Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

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