User's Guide

# Agilent 86030A Lightwave Component Analyzer System

Agilent Technologies

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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.

❍ The OFF symbols are used to mark the positions of the instrument power line switch.

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This product has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

**WARNING** **If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.**

**WARNING** **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

# Contents

1



# Installation

# Installation

The instructions in this chapter show you how to install the 86030A 50 GHz LCA. For overseas sales, the product is shipped *without* an ac power connector. You should have a local electrician provide and install an ac connector that meets the standards for the region. Also, be sure to set all instruments to use the local line voltage.

**WARNING** **This system is a Safety Class I Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.**

**WARNING** **To prevent electric shock, disconnect the system from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.**

**WARNING** **HP/Agilent 86032A: No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

**WARNING** **HP/Agilent 86032A: For continued protection against fire hazard, replace line fuse only with same type and ratings. Use a 6.3A 250V fuse. The use of other fuses or materials is prohibited.**

**WARNING** **HP/Agilent 86032A and HP/Agilent 86030A: If the system and test set products are not used as specified, the protection provided by the equipment could be impaired. These products must be used in a normal condition (in which all means for protection are intact) only.**

**CAUTION** Do not load any software on the 86030A system computer.

**CAUTION** HP/Agilent 86032A and HP/Agilent 86030A: This system and test set are designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2, per IEC 1010 and 664 respectively.

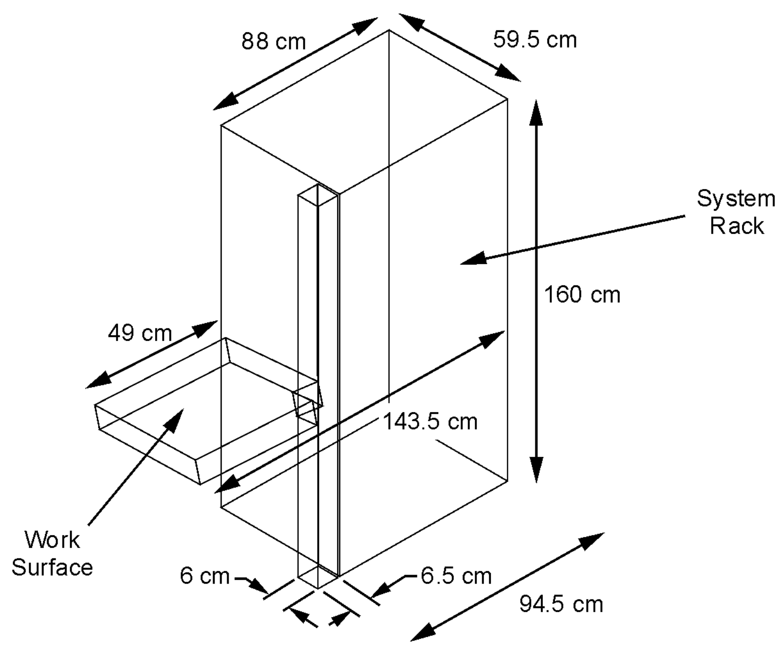
**CAUTION** HP/Agilent 86030A: Ventilation Requirements. When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product by 4°C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

**CAUTION** The warranty and calibration will be voided on systems where the individual instruments, including fiber-optic cables, RF cables, or GPIB cables are removed by the customer. The system should only be disassembled by an Agilent Customer Engineer. Instruments should not be swapped or removed by non-Agilent personnel.

# Step 1. Prepare the Site

Your site should accommodate the dimensions, weights, and power consumption limits shown in the following figure.

**WARNING** **This system weighs approximately 600 lbs (270 kg). To avoid injuries, use proper moving equipment and use extreme care when installing.**




**WARNING** **Install the system so the power cords are readily identifiable and are easily reached by the operator. The power cords are the disconnecting device. They disconnect the mains circuits from the mains supply**

**before other parts of the system. Alternately, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.**

**CAUTION** HP/Agilent 86030A and HP/Agilent 86032A: Install the system and test set according to the enclosure protection provided. This system and test set do not protect against the ingress of water. The system and test set protects against finger access to hazardous parts within the enclosure.

**CAUTION** Before switching on this system, make sure the line voltage selector switch on the HP/Agilent 86032A lightwave test set's rear panel is set to the voltage of the mains supply, that the correct fuse is installed, and that the supply voltage is in the specified range.

# Step 2. Install the Monitor Mount Assembly

1. Remove the black end cap from the top of the extrusion.
2. Slide the star knob onto the lower part of the extrusion and tighten.
3. Loosen the two black levers on the friction plate and slide it onto the extrusion.
4. Move the friction plate to the desired height and tighten the two black levers.
5. Loosen the star knob and raise it until it stops below the friction plate, then tighten the knob securely to prevent the friction plate, arm, and monitor mount assembly from falling.

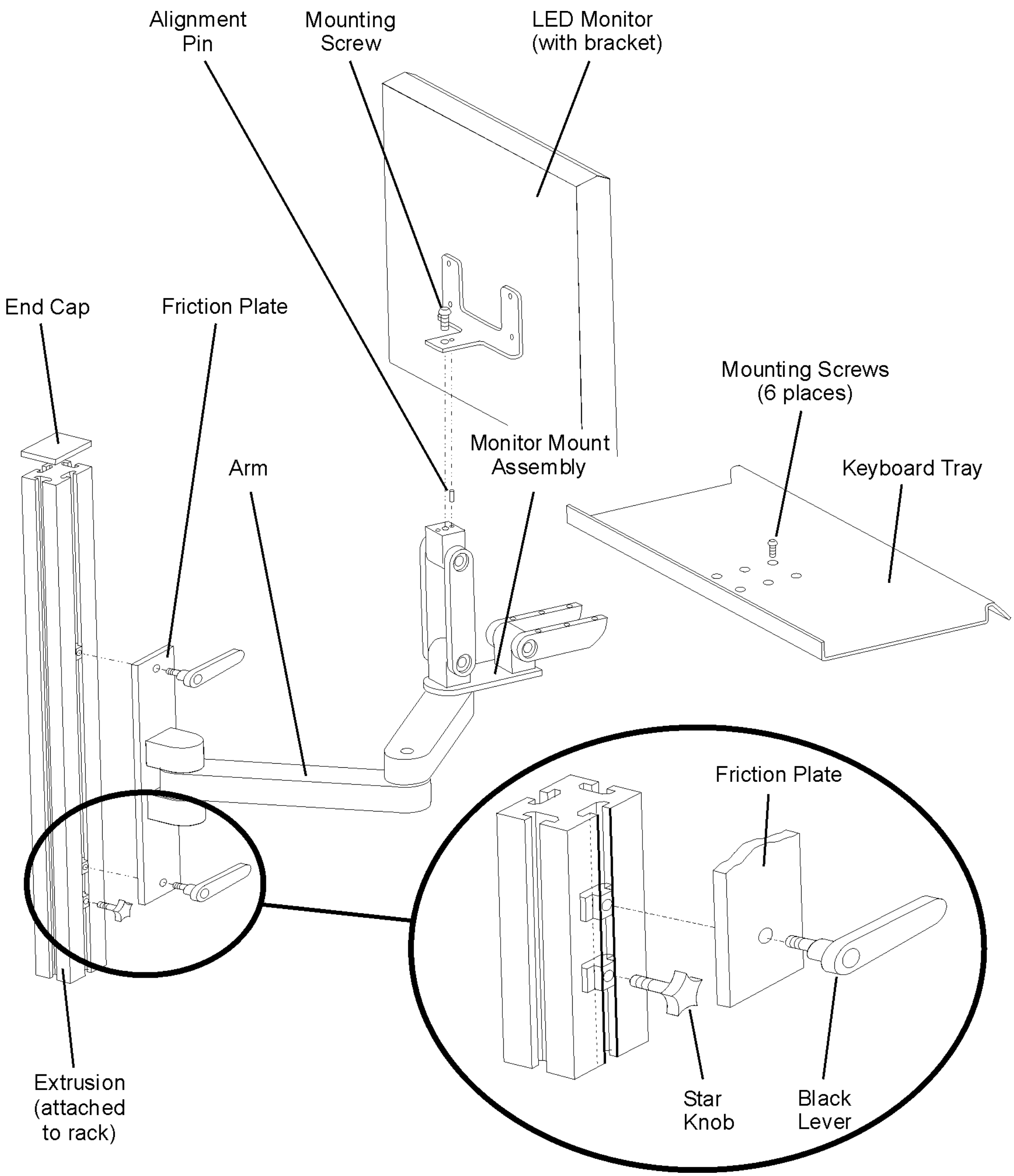
**WARNING** **If the star knob is not installed properly, the friction plate, arm, and monitor mount assembly may fall, causing injury to the user or damage to the monitor and mounting components.**

6. Attach the keyboard tray to the monitor mount assembly using the six provided mounting screws. Tighten with a 1/8” Allen wrench.
7. Attach the LCD monitor to the monitor mount assembly with the provided mounting screw. Tighten with a 7/32” Allen wrench. Make sure the monitor is properly oriented with the alignment pin, then tighten with a 7/32” Allen wrench.

**CAUTION** Tighten all hardware on the arm and monitor mount assembly as necessary to prevent the monitor and keyboard from tipping unexpectedly.

**CAUTION** Be careful when swinging the arm around in front of the system to avoid striking the 8510C and other system components.

8. Replace the black end cap on the extrusion.
9. Connect the monitor cables to the LCD monitor and secure the cables to the bottom of the arm using tie wraps.


Alignment Pin
Mounting Screw
LED Monitor (with bracket)
End Cap
Friction Plate
Mounting Screws (6 places)
Arm
Monitor Mount Assembly
Keyboard Tray
Friction Plate
Extrusion (attached to rack)
Star Knob
Black Lever

# Step 3. Install the Keyboard/Mouse Transmitter and the Work Surface

1. Slide the keyboard/mouse transmitter into the plastic holder on the bottom side of the work surface. Use the cable clamps on the bottom of the work surface to secure the cables.
2. Attach the work surface rails to the rack using a T-25 torx driver.
3. Slide the work surface over the rails and secure it using the hardware provided.
4. Route the transmitter cables through the rack and attach to the appropriate computer connectors using extension cables, if necessary.

   The Connect button on the transmitter should be towards the plastic holder.

# Step 4. Confirm Front and Rear Panel Connections

**1** Connect the jumper between the LASER OUTPUT and LASER INPUT on the 86032A front panel. Refer to Figure 1-1.

You must clean the connectors every time the jumper is connected. Refer to "Cleaning Connectors" on page 2-40.

**2** Confirm the cabling of the Agilent/HP 86030A system. Refer to Figure 1-2.

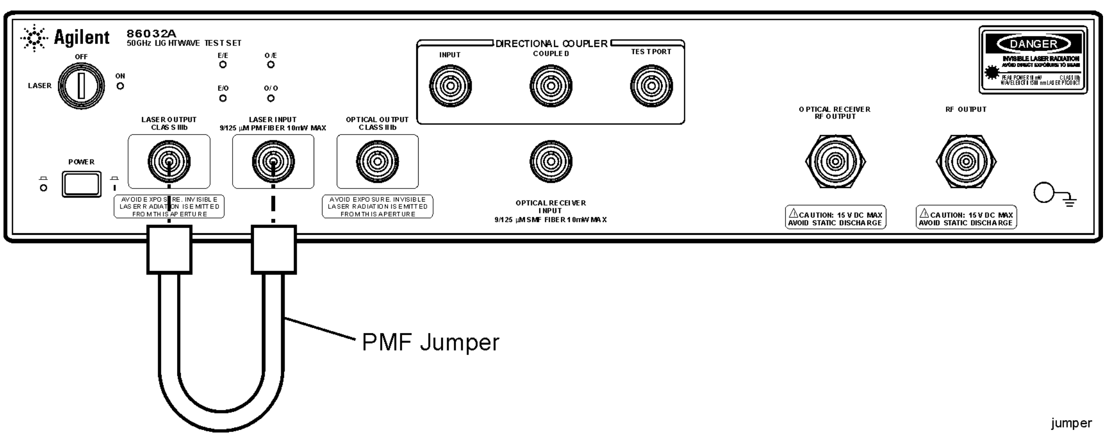



**Figure 1-1. Location of the PMF Jumper**

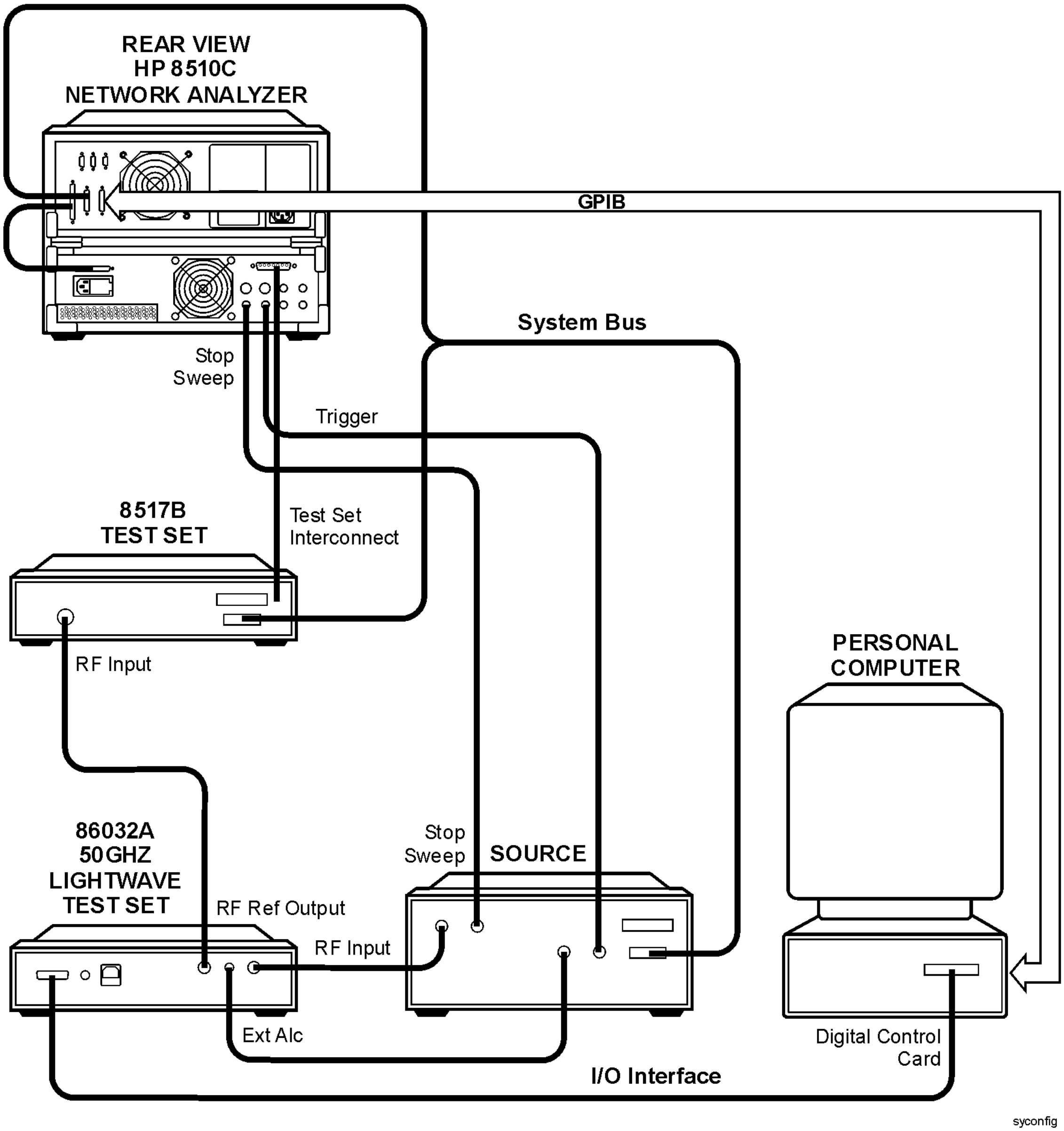



**Figure 1-2. Agilent 86030A Cabling Configuration**

# Step 5. Turn the System On

**1** Plug in the Power Distribution Units (PDU).

**2** Turn on the system, and allow it to warm up for two hours.

**3** When prompted for the password, enter Agilent.

**4** Make certain that the laser key is in the ON position.

**5** From the Windows **Start** menu on the 86030A computer, select **Programs**, **Agilent, 86030A Main** to open the software.

A splash screen will appear displaying the software title followed by the application screen shown in the following figure.

**NOTE** Do NOT attempt to close the analyzer application until the 86030A system status window says “System Ready.”


**6** Perform a system verification. Refer to “Lightwave Verification” on page 6-3.

# Step 6. Configure for Remote Operation

This step provides instructions for configuring and installing the 86030A controller software on a client PC, which is external to the analyzer system. This step is only necessary if you will be operating the 86030A remotely. For information on available commands and remote operation, refer to Chapter 4, "Remote Operation".

**Client PC Minimum Requirements**

- Windows NT 4.0 Service Pack 6
- LAN Card

## Configure the Client PC for a Private LAN Interface

These instructions assume that your computer already has a second network adapter (LAN card) and a TCP/IP protocol installed. The first LAN card must have a static IP to work on your public LAN in the presence of the second card.

1. On the client PC, click Start, Settings, Control Panel.
2. Double-click Network.
3. Select the Protocols tag and click Properties.
4. In the list displayed, select the type of LAN adapter card that you have installed in the client PC.
5. Click Adpater and select the second LAN card.
6. Click Specify, IP Address and enter the following settings.
   - For IP Address, enter 192.168.000.001
   - For Subnet Mask, enter 255.255.255.0
   - For Default Gateway: enter 192.168.000.001
7. Click Apply.

**NOTE** If you get an error at least twice, indicating the adapter card has an empty primary window address, click Yes.

8 For the TCP/IP Properties window, click OK.

9 On the Network window, click Close.

10 Restart the PC.

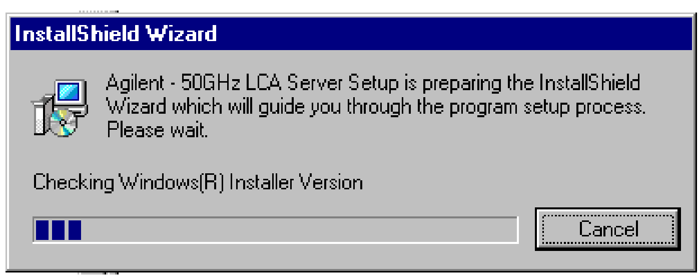
## Install the Controller Software

1 Insert the disk labled “Agilent 86030A Controller Software” into the client computer CDROM drive.

2 Locate the file “86030A_Inst.exe” on the disk.

3 Double-click the file to start the installation process.

4 The window below will appear, indicating the setup process has begun.




- If a window appears stating that the Windows installer is an older version, click OK to allow the setup to upgrade the installer. It may take a few moments for the Welcome screen to appear.
- Restart the computer after the installer is upgraded so the setup may continue.

5 When the InstallShield window appears, the installation process has begun. Click Next.

6 Enter the User Name and Organization, then click Next.

7 Select Complete setup, and click Next.

8 Click Install. The installation may take a few minutes.

9 Click Finish to complete the installation.

# Getting Started

# System Overview

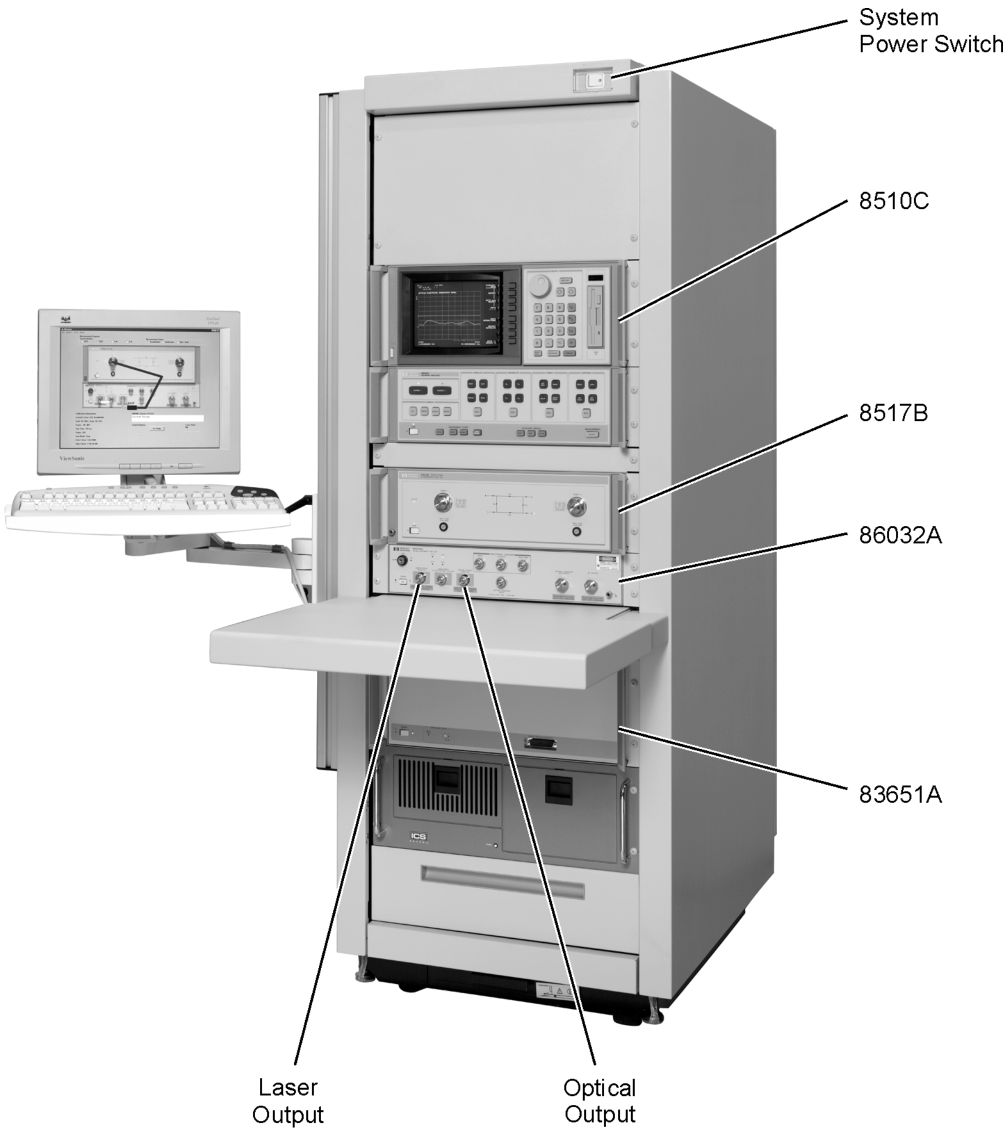
The Agilent 86030A 50 GHz lightwave component analyzer provides accurate and repeatable characterization of electro-optical, optical, and electrical components.

You can characterize components such as O/E photodiode receivers, E/O photodiodes, lightwave modulators, and other optical and electrical components used in 40 Gb/s lightwave systems.

The Agilent 86030A system consists of the following items:

- 85107B vector network analyzer system
- 86032A 50 GHz lightwave test set
- system software
- personal computer, serving as the system controller
- controller software for a client computer

**NOTE** You can control the 86030A directly using the system computer, or remotely using the controller software on a client computer.


System
Power Switch
8510C
8517B
86032A
83651A
Laser
Output
Optical
Output

### *Calibrated Measurements*

One of the key benefits of the 50 GHz lightwave component analyzer is its ability to perform calibrated measurements of optical components. The system contains an O/E receiver that has been factory calibrated in magnitude, and characterized in phase. The ability to make calibrated measurements assures accuracy, reliability, and confidence in the components being measured. Additionally, the laser source, optical modulator, and calibrated O/E receiver are temperature stabilized which also improves the accuracy and repeatability of measurements.

### *Verification Device*

A verification device is included with the N1012A Lightwave Verification Kit. The device is an O/E photodetector and includes associated amplitude and phase data. You can use this verification device at any time to verify the measurement integrity of your system. The 86030A system provides a guided verification routine that measures the verification device, and displays a graph of its response versus acceptable tolerances. The verification device allows you to periodically monitor system calibration, and detect when the optical test set needs to be recalibrated. You can also use the device to resolve uncertainty if unexpected results are obtained from a test device. This verification capability provides confidence in the measurement integrity of the system.

### *Measurement Software*

Guided measurement software provides an easy-to-use operator interface. It provides pictorial diagrams of interconnections for configuration, calibration, and measurements. On-screen prompts also guide you through the entire measurement process, from the calibration to the measurement.

### *Data Management*

Display, analysis, and archiving of data is easy and straightforward with the system. The measured data is displayed on the Agilent 8510C network analyzer. Full use of the analyzer's functions such as markers, data formats, and data scaling features are available. Data can be archived to disk in either ASCII text or Microsoft[1] Excel formats. The included Excel software allows data to be displayed and analyzed using standard Excel features and formats. Data connectivity to a local area network (LAN) is provided via a LAN card in the system's PC.

1. Microsoft and Excel are registered U.S. trademarks of Microsoft Corporation.

# System Accessories

The accessories described below may be shipped with your system.

**Table 2-1. System Accessories**

| Description | Agilent Model/Part Number |
|---|---|
| Verification Kit | N1012A |
| 86030A User's Guide | 86030-90023 |
| 2.4 mm 8510C Calibration Kit | 85056A |
| 2.4 mm Flexible Cables | 85133F |
| Controller (Client) Software CDROM | 86030-10004 |
| 86030A Operating System Software CDROM | 86030-10002 |
| 86032A Calibration Coefficients Floppy Disk | Unique to 86032A Test Set |
| Bias Network 0.045 - 50 GHz (2.4 mm)[a] | 11612B |

a. The bias network is not part of the 86030A shipment, yet it may be helpful when measuring modulators.

# Configuration Options

The standard Agilent/HP 86030A system is supplied with FC/PC optical connectors. If other optical connectors are desired, ordering one of the following connector options will replace the FC/PC connectors with the desired optical connectors.

**Table 2-2. Available Options for the 86030A System**

| Option Number | Description | Part Number |
|---|---|---|
| 011 | Diamond HMS-10 connector interface | 08154-61701 |
| 013 | DIN 47256 connector interface | 08154-61703 |
| 014 | ST optical connector interface | 08154-61704 |
| 017 | SC optical connector interface | 08154-61708 |
| 230 | 220-240 VAC operation | |

**WARNING** **During measurements, laser light emits from the front-panel OPTICAL OUTPUT connector and the LASER OUTPUT connector. This light originates from the system's laser source. Always keep these connectors covered when not in use.**

**NOTE** If you would like to change the optical connectors to a different type, you can order a quantity of seven of the replacement part number, shown above.

**CAUTION** The warranty and calibration will be voided on systems where the individual instruments are removed by the customer. The system should only be disassembled by a Agilent Technologies Customer Engineer. Instruments should not be replaced by non-Agilent Technologies personnel.

**Measurement accuracy—it's up to you!**

Fiber-optic connectors are easily damaged when connected to dirty or damaged cables and accessories. The 86030A's front-panel SOURCE OUTPUT and RECEIVER INPUT connectors, 86032A Laser Output and External Laser Input are no exception. When you use improper cleaning and handling techniques, you risk expensive instrument repairs, damaged cables, and compromised measurements. Before you connect any electrical cable to the 86030A, refer to "Electrostatic Discharge Information" on page 7-19.

# Front Panel Features

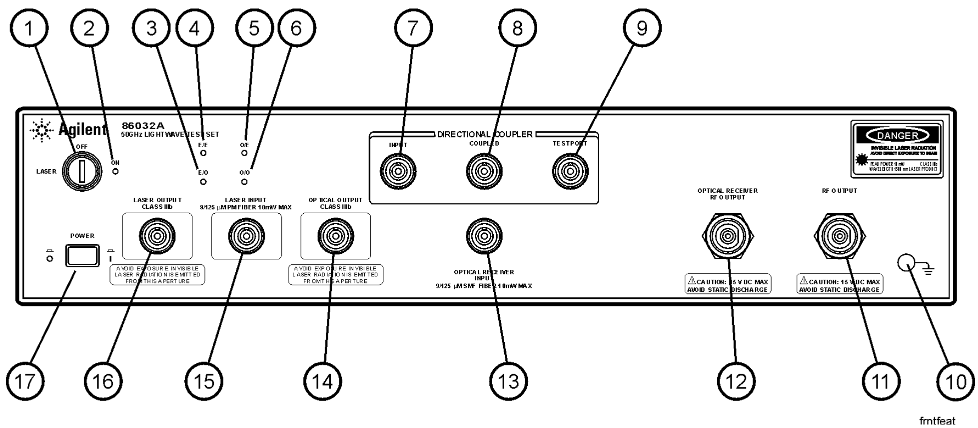



**Figure 2-3. 86032A Front Panel**

| | |
|---|---|
| 1. LASER Key | Turns the laser on and off. Note that the laser is not operational until it is activated by the 86030A software program. You can turn on the laser manually from the Diagnostic software. From the Windows Start menu, select Programs, Agilent Technologies 50 GHz LCA, 50 GHz Diagnostics. From the Laser menu, click Laser ON. Make sure the laser key on the 86032A is in the on position. |

**WARNING**

**Do NOT, under any circumstances, look into the optical output or any fiber/device attached to the output while the laser is in operation.** **Refer to "Laser Safety Considerations" on page 2-30.**

| | |
|---|---|
| 2. Laser LED | Indicates the state of the laser. When the LED is lit, the laser is on. Note that the laser is not operational until it is activated by the 86030A software program. You can turn on the laser manually from the Diagnostic software. From the Windows Start menu, select Programs, Agilent Technologies 50 GHz LCA, 50 GHz Diagnostics. From the Laser menu, click Laser ON. |
| 3. E/O LED | When on, indicates the internal measurement path is selected for an E/O (electrical-to-optical) device. |
| 4. E/E LED | When on, the internal measurement path is selected for an E/E (electrical-to-electrical) device. The test set is in a bypass mode for E/E device selection and the laser is shut down. The test set will need to be in the ON position for use in E/E mode. |
| 5. O/E LED | When on, the internal measurement path is selected for an (optical-to-electrical) O/E device. |
| 6. O/O LED | When on, the internal measurement path is selected for an (optical-to-optical) O/O device. |
| 7. DIRECTIONAL COUPLER INPUT | Input for the optical direction coupler. This port is usually connected to the OPTICAL OUTPUT. |
| 8. DIRECTIONAL COUPLER COUPLED | Port for the coupler output. This port is usually connected to the OPTICAL RECEIVER INPUT. |
| 9. DIRECTIONAL COUPLER TEST PORT | Coupler output port (transmission) or test port (reflection). |
| 10. Grounding Receptacle | Ground path that is provided to connect a static strap. |
| 11. RF OUTPUT | RF output that provides RF drive power for E/O devices. |
| 12. OPTICAL RECEIVER RF OUTPUT | Test set optical receiver output. |

| | |
|---|---|
| 13.OPTICAL RECEIVER INPUT | Test set optical receiver input. |
| 14. OPTICAL OUTPUT | Modulator output. |
| 15. LASER INPUT | External laser input. |
| 16. LASER OUTPUT | Output of internal laser. |
| 17. POWER Switch | Turns the instrument power on. |

**CAUTION** Use care in handling optical connectors. Damage to an optical test port connector can require a costly repair and lost productivity for the system. Keep optical cables connected to the test ports to protect the connectors from damage. Also, make sure to clean the connectors before each use. Refer to "Accurate Measurements" on page 2-33.

# Rear Panel Features

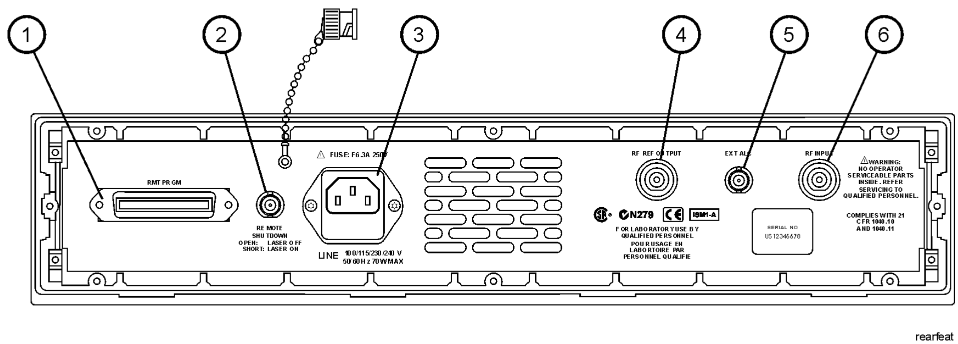



**Figure 2-4. 86032A Rear Panel**

| | |
|---|---|
| 1. Remote Programming Connector | Allows for remote control of the instrument's front panel via the 86030A software installed on the system PC. |
| 2. Laser Remote Shutdown | Turns the laser on or off. When the BNC short is connected, the laser is enabled. When removed, the laser is disabled. |
| 3. Line Module | This assembly houses the line cord connector. |
| 4. RF REF OUTPUT | RF output of the test set that is used to route the 8517B electrical test set for phase locking. |
| 5. EXT ALC | DC output from the leveling detector on the internal ALC circuit. This output is routed to the EXT ALC port of the network analyzer source. |
| 6. RF INPUT | RF input port from the source output of the network analyzer. |

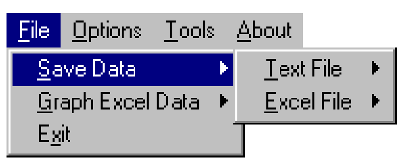
# Software Overview

The 86030A software sets up instrument states on the network analyzer and lightwave test set, and guides you through the measurement calibration and measurement procedures. The program combines the measurement calibration traces with the calibration data response of the lightwave receiver, and loads the result back into the network analyzer to provide calibrated lightwave measurements. You can save and view trace data using Microsoft Excel, and manually control the 86032A test set operation.

# File Menu


The File menu is used to save data as either an ASCII text file or an Excel worksheet. Using Graph Excel Data allows you to automatically view saved data in an Excel worksheet as tabular data, or as graphical data in log magnitude, phase or delay formats. The File menu is also used to exit the application.

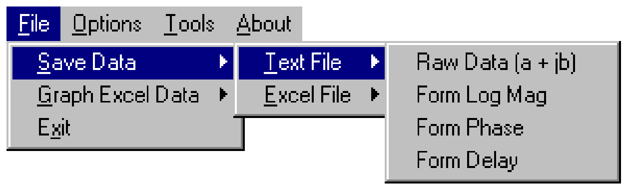
## Save Data




**Text File**

Text File allows you to save data as an ASCII text file in four different formats:

- Raw Data
- Log Magnitude
- Phase
- Delay

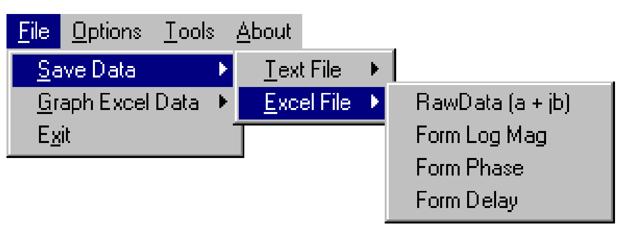



**Raw Data** saves trace data in a ASCII text format (.txt) known as a CITIFile (common instrumentation transfer and interchange file). The CITIFile format is useful when data will be exchanged with another network analyzer. The data file saves both real and imaginary pairs independent of the format of the active screen. However, any trace smoothing that was applied to the measurement will not be saved (that is, Smoothing On is activated from the 8510C Response menu).

**Formatted Data, Log Mag, Phase, Delay** saves trace data with any trace smoothing that was applied to the measurement (that is, Smoothing On is activated from the 8510C Response menu), but only retains the values of the format that was selected for saving (that is, Log Magnitude, Phase, or Delay).

## Excel File

Excel File allows you to save the trace display as a Microsoft Excel workbook (.xls extension). The Excel format is useful when you want to view or edit the data in an Excel spreadsheet.




**Raw Data** saves both real and imaginary pairs independent of the format of the active screen. This data can later be viewed in either Log Magnitude or Phase format from the File, Graph Excel Data menu. Any trace smoothing that was applied to the measurement will not be saved (that is, if Smoothing On is activated from the 8510C Response menu).

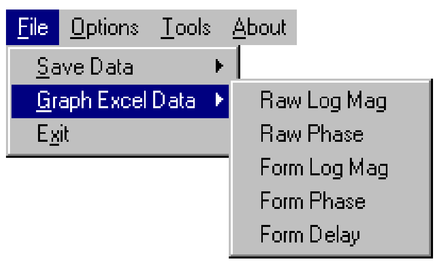
**Formatted Data** saves trace data and any trace smoothing that was applied to the measurement, but only viewed using the format that the data was originally saved (that is, Log Magnitude, Phase, or Delay).

**Log Mag** saves the log magnitude format. This is the standard Cartesian format used to display magnitude-only measurements of insertion loss, return loss, or absolute power in dB versus frequency.

**Phase** saves the phase of data versus frequency in a Cartesian format.

**Delay** saves the group delay format, with marker values given in seconds. Group delay is the measurement of signal transmission time through a test device. It is defined as the derivative of the phase characteristic with respect to frequency. Since the derivative is basically the instantaneous slope (or rate of change of phase with frequency), a perfectly linear phase shift results in a constant slope, and therefore a constant group delay.

## Graph Excel Data




**Raw Data**

Data allows you to view trace data in either Log Magnitude or Phase format. However, any trace smoothing that was applied to the measurement will not be captured. (that is, if Smoothing On was activated from the 8510C Response menu).

**Log Magnitude** displays the trace data in Cartesian format as logarithmic (dB) magnitude versus frequency.

**Phase** displays the trace data in Cartesian format as phase versus frequency.

**Formatted Data,**

Formatted Data allows you to view trace data in the format that it was saved (that is, Log Magnitude, Phase, or Delay) including any trace smoothing that was applied to the measurement

**Log Mag** displays the log magnitude format. This is the standard Cartesian format used to display magnitude-only measurements of insertion loss, return loss, or absolute power in dB versus frequency.

**Phase** displays the phase shift of data versus frequency in a Cartesian format.

**Delay** displays the group delay format, with marker values given in seconds. Group delay is the measurement of signal transmission time through a test device. It is defined as the derivative of the phase characteristic with respect to frequency. Since the derivative is basically the instantaneous slope (or rate of change of phase with frequency), a perfectly linear phase shift results in a constant slope, and therefore a constant group delay. See Figure 2-5.

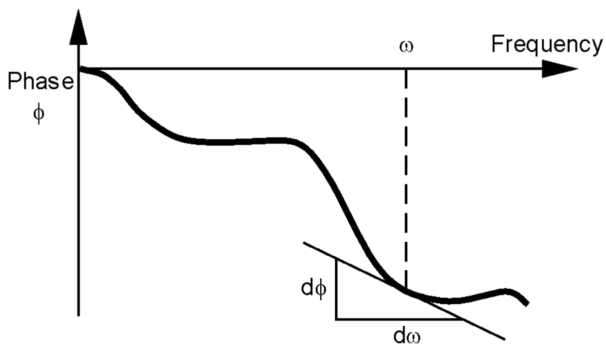



**Figure 2-5.**

Note, however, that the phase characteristic typically consists of both linear and higher order (deviations from linear) components. The linear component can be attributed to the electrical length of the test device, and represents the average signal transit time. The higher order components are interpreted as variations in transit time for different frequencies, and represent a source of signal distortion. See Figure 2-6.

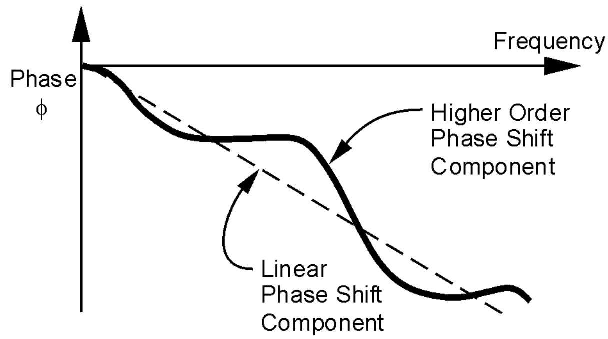



**Figure 2-6.**

$$Group\ Delay = \tau_g = \frac{-d\phi}{d\omega} \quad \begin{matrix} in\ Radians \\ in\ Radians \end{matrix} = \frac{-1}{360^\circ} \cdot \frac{d\phi}{df} \quad \begin{matrix} \phi\ in\ Degrees \\ f\ in\ Hz\ (\omega = 2\pi f) \end{matrix}$$

The analyzer computes group delay from the phase slope. Phase data is used to find the phase change, $\Delta\phi$, over a specified frequency aperture, $\Delta f$, to obtain an approximation for the rate of change of phase with frequency (Figure 2-7). This value, $\tau_g$, represents the group delay in seconds assuming linear phase change over $\Delta f$. It is important that $\Delta\phi$ be $\leq 180°$, or errors will result in the group delay data. These errors can be significant for long delay devices.

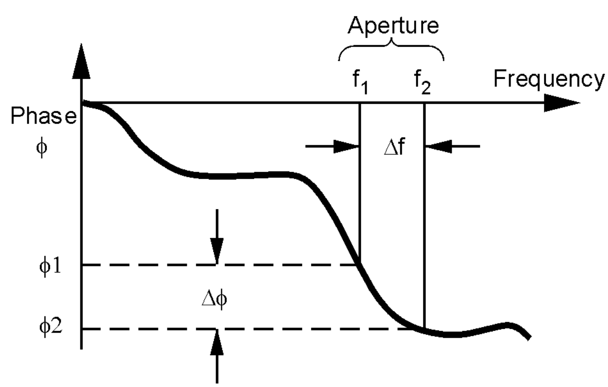



**Figure 2-7.**

When deviations from linear phase are present, changing the frequency step can result in different values for group delay. Note that in this case the computed slope varies as the aperture $\Delta f$ is increased (Figure 2-8). A wider aperture results in loss of the fine grain variations in group delay. This loss of detail is the reason that in any comparison of group delay data it is important to know the aperture used to make the measurement.

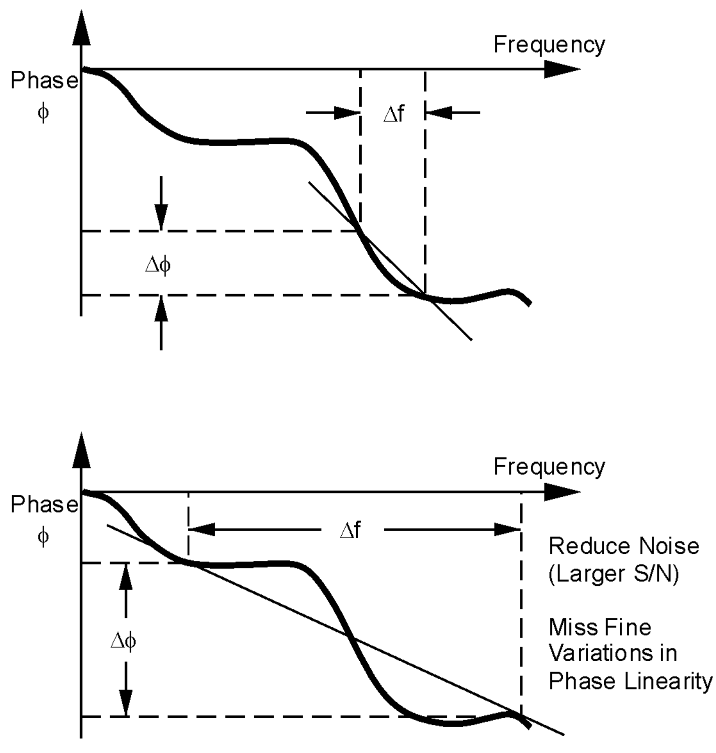


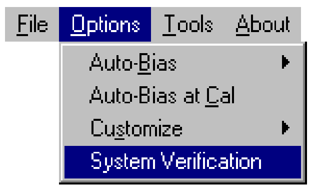

**Figure 2-8.**

In determining the group delay aperture, there is a trade-off between resolution of fine detail and rapid variations in group delay, which can look like a noisy trace. These rapid variations can be reduced by increasing the aperture, but this will tend to smooth out the fine detail. More detail will become visible as the aperture is decreased, but the variations will also increase, possibly to the point of obscuring the detail. A good practice is to use a smaller aperture to assure that small variations are not missed, then increase the aperture to smooth the trace.

# Exit

**Exit** closes the 86030A software application.

# Options Menu




The Options menu allows you to set and monitor system functions.

## Auto Bias

Auto Bias allows you to bias the modulator to operate at quadrature or at maximum optical power. Under typical circumstances the lightwave modulator is biased to operate at quadrature. Quadrature is the point where the slope of the optical power versus voltage is maximally positive. Refer to Figure 2-9.

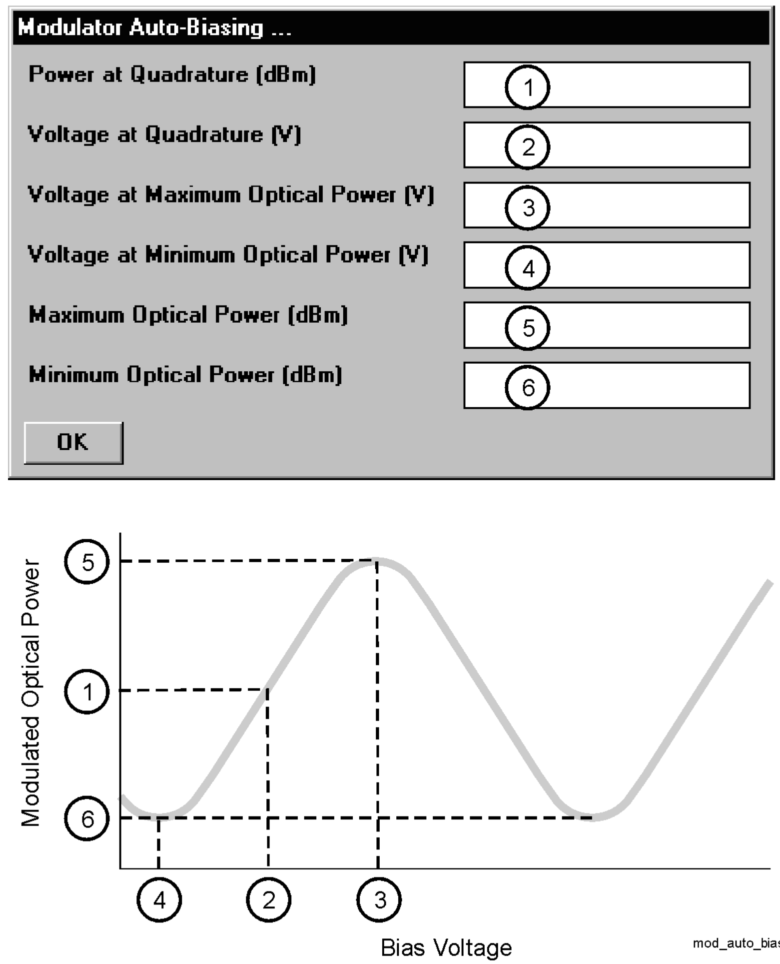



**Figure 2-9. Effect of Bias Voltage on Modulated Optical Power**

**Power at Quadrature (1)**

The point midway between the maximum and minimum optical power points, on the positive slope of the bias curve. The quadrature point allows maximum optical power variations versus modulation voltage.

**Voltage at Quadrature (2)**

The voltage where the optical power is at the quadrature point. The auto-biasing routine selects this voltage to bias the internal optical modulator.

**Voltage at Maximum Optical Power (3)**

The voltage at which the maximum output power occurs ($V_{max}$).

**Voltage at Minimum Optical Power (4)**

The voltage at which the minimum output power occurs ($V_{min}$).

**Maximum Optical Power (5)**

The maximum optical output power.

**Minimum Optical Power (6)**

The minimum optical output power.

## How to Determine if Auto Bias Values are Reasonable

The following formulas will help you to determine if the modulator auto bias settings are valid. Refer to Figure 2-9 on page 2-21

Voltage at Maximum Optical Power – Voltage at Minimum Optical Power should between 3 and 6 volts.

Voltage at Quadrature should be approximately $\frac{Vmax + Vmin}{2}$

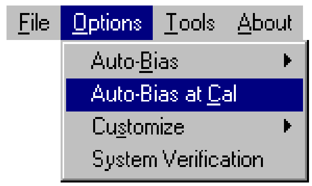
Maximum Optical Power should be > 3 dBm

Power at Quadrature should be > 0 dBm

**Tip**: You can set this value manually. From the Tools menu, click on Monitor Test Set. In the Modify Bias Voltage text box, enter the desired value and then click Set Modulator Bias Voltage to.

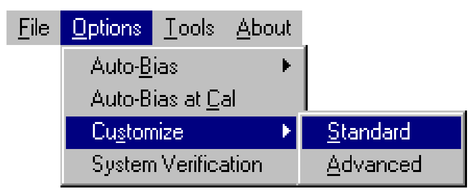
Refer to "Modulator Troubleshooting Tips" on page 7-16 for more information.

# Auto Bias At Cal




Auto Bias At Cal when selected, an auto bias is performed before each calibration. The auto bias is performed after you click either Resp Cal or Resp-Isol Cal.

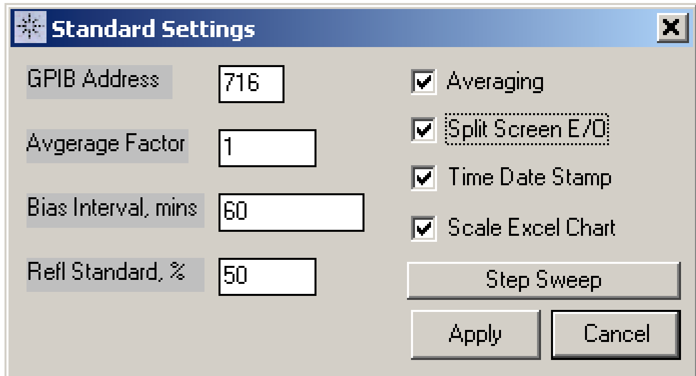
# Customize




Customize allows you to set and monitor certain parameters that affect the operation of the system.

**Standard**

The Standard Settings dialog box allows you to set and monitor certain parameters controlled by the network analyzer.




**GPIB Address** displays the current address setting for the analyzer. This value must correspond to the actual address on the 8510 GPIB address bus. Failure of these two numbers to match will prevent operation.

**Average Factor** is used to improve the sensitivity of the measurement. For the Step Mode of operation for each modulation frequency point, multiple data point samples (equal to the number of averages) are measured by the system, and averaged together to provide a single average value. Averaging multiple data points together reduces the effects of noise on the measurement. The improvement in sensitivity is equal to:

$$dB = 10\log_{10}(\text{number of averages})$$

Note the 8510C network analyzer only averages with powers of 2 (that is, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, and so on). Therefore, if an averaging factor of 500 is set on the analyzer, the analyzer will default to 256 averages.

**Bias Interval, mins** corresponds to the number of minutes before prompting you to perform another modulator auto bias.

**Refl Standard%** corresponds to the percent of reflection of the Reflection Standard used in the system. This is useful for O/O reflection modes.

**Averaging** when selected, the network analyzer will perform averaging at each data point.

**Split Screen E/O** when selected, the network analyzer displays both the bandwidth and reflection measurement on the display. *This function is only valid with an E/O Bandwidth and Reflection measurement.* Bandwidth is displayed on channel 1 and Reflection is displayed on channel 2. When this function is cleared, use the network analyzer front panel channel buttons to select between the two measurements.

**Time Date Stamp** when selected, the time and date stamp is applied to the trace on the network analyzer.

**Scale Excel Chart** when selected, the trace data saved from the network analyzer will be auto-scaled to fit into an Excel chart.

**Step Sweep/Ramp Sweep** toggles between step sweep and ramp sweep modes.

**Step Sweep** is a digital sweep beginning at the start frequency and ending at the stop frequency with the source phase locked and the data measured at a frequency interval determined by the number of points selected on the network analyzer (STIMULUS MENU, STEP). An up arrow on the trace identifies the data point just measured. The step mode is recommended when you need the best modulation frequency accuracy and repeatability.

Dwell time prior to measurement at each frequency point is controlled by the sweep time setting. Measurement time at each point is determined by the averaging factor.

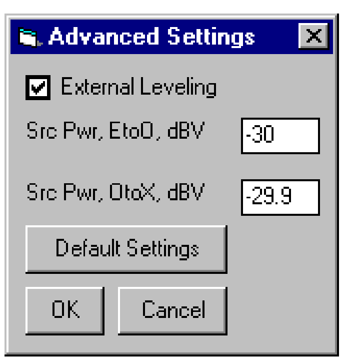
**NOTE**

System specifications are only warranted when using the Step Sweep mode of operation.

**Ramp Sweep** selects continuous linear analog sweeps beginning at the start frequency and ending at the stop frequency. The rate is determined by the sweep time, measuring data at frequency intervals set by the number of points. (8510 access, STIMULUS MENU, RAMP)

**Advanced**

The Advanced Settings dialog box allows changing of default power values.



**External Leveling** when checked, the system uses external leveling. When cleared, the system uses internal leveling. Normal system operation uses external leveling.

**Src Pwr, E to X, dBV** for E/O mode and E/ E mode, displays the 83651A external leveling source power.

**Src Pwr, O to X, dBV** for O/E mode and O/O mode, displays the 83651A external leveling source power.

**Default Settings** when selected, resets the source power to its factory default values.

### Setting the Power at the RF Output Port

The power at the 86030A RF output port is set at the factory for a nominal 0 dBm. You can change the RF output power level by following these steps:

1. Connect a power meter to the RF output port.
2. On the 8510, press **Span**, **0**, **Hz**, **Center Frequency**, **25, GHz**.
3. In the 86030A **Options** menu, click **Customize**, **Advanced**.
4. In the **Src Pwr**, **EtoO**, **dBV** box, enter the power value and click **OK**. Make the changes to the power level in small deviations from the default state.

**CAUTION** Do not exceed -3 to +5 dBm at the 8510 RF output port. Due to variations in amplifier gain, error messages may appear on the analyzer screen. Reduce or increase the power setting to remove the error messages.

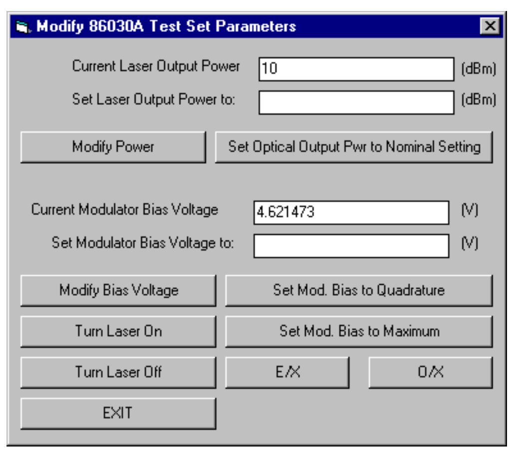
## System Verification

A System Verification performs a measurement on the verification device over the entire frequency range. The verification device is the 83440D Option 050 lightwave detector supplied in the N1012A verification kit. Once the verification is completed, the results are displayed in an Excel worksheet along with the error bars that were computed from the factory measurement of the verification device. For the system to pass the verification test, the verification device trace must fit within the error bars. A pass or fail indicator is displayed at the bottom of the worksheet. Refer to “Lightwave Verification” on page 6-3 for more information.

# Tools Menu


The Tools menu is used to monitor and modify 86032A test set parameters.

## Modify Test Set




**Curent Laser Output Power (dBm)** displays the value of the laser power coming from the LASER OUTPUT port of the test set.

**Set Laser Output Power to:(dBm),** when Modify Power is selected, the value will be updated to the value specified in this text box.

**Modify Power** sets the internal laser of the 86030A test set to the power specified in the Modify Power text box. This value will be used until you restart the 86030A software. Valid settings are from 0 dBm to 10 dBm.

**Set Optical Output Pwr to Nominal Setting** sets the laser to its factory default setting. When the software is started, the power always defaults back to the factory setting.

**Current Modulator Bias Voltage (V)** displays the value last applied to the internal modulator bias tee attached to the optical modulator.

**Set Modulator Bias Voltage to: (V)**, when Modify Bias Voltage is selected, the bias voltage will be updated to the value specified in this text box. The range is –10 to +10 volts.

**Modify Bias Voltage** sets the bias voltage to the value entered in the Set Modulator Bias Voltage text box.

**Turn Laser On** turns on the laser inside the 86032A test set. This command does not change the power of the laser. This function is useful in E/O mode when you may want to use the internal high power laser as a stimulus for testing optical modulators. The optical power is normally off in the E/O mode.

**Turn Laser Off** turns off the laser inside the 86032A test set. This command does not change power of the laser. If the laser is turned off and then turned back on again, the original power of the laser will be used.

**Set Mod. Bias to Quadrature** when clicked, performs an auto bias on the modulator and sets the modulator bias voltage to the midpoint of the modulated optical power curve. Biasing at quadrature maximizes the modulation response and minimizes distortion of the modulated signal.

The power of the laser is assumed to have been previously set. If the laser power is too low or if the laser is turned off, the auto bias routine will fail and display a message indicating that a bias point could not be found. For this command to function properly, the laser power should be left at its default setting or set to a reasonable power value (between 3 and 12 dBm) prior to performing this function.

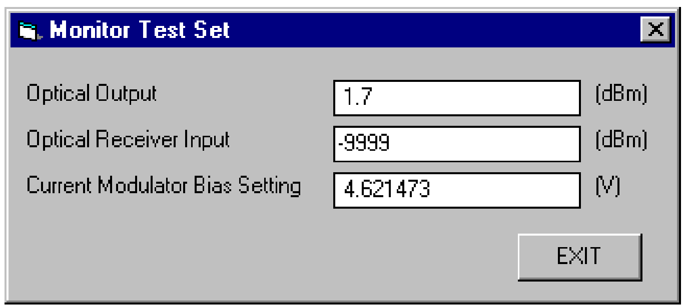
**Set Mod Bias to Maximum** when selected, performs an auto bias on the modulator and sets the modulator at maximum optical output power.

The power of the laser is assumed to have been previously set. If the laser power is too low or if the laser is turned off, the auto bias routine will fail and display a message indicating that a bias point could not be found. For this command to function properly, the laser power should be left to its default setting or set to a reasonable power value (between 3 and 12 dBm) prior to performing this function.

**E/X** when selected, puts the 86032A test set into electrical excitation mode. The RF signal coming into the optical test set will be routed out of the front panel connector marked “RF OUTPUT.” Therefore, the RF signal will not be routed to the optical modulator in the test set.

**O/X** when selected, puts the 86032A test set into optical excitation mode. The RF signal coming into the test set will be routed to the optical modulator, rather than out the front panel connector marked “RF OUTPUT.”

## Monitor Test Set




The Monitor Test Set dialog box is used to monitor and update the power and voltage levels of the 86032A test set.

**Optical Output Power (dBm)** displays the current optical power coming from the 86032A OPTICAL OUTPUT port.

**Optical Receiver Input (dBm)** displays the current optical power coming into the 86032A OPTICAL RECEIVER INPUT port.

**Current Modulator Bias Setting (V)** displays the current value of the 86032A bias voltage on the modulator.

# Laser Safety Considerations

**Laser Safety**

Laser radiation in the ultraviolet and far infrared parts of the spectrum can cause damage primarily to the cornea and lens of the eye. Laser radiation in the visible and near infrared regions of the spectrum can cause damage to the retina of the eye.

The CW laser sources use a laser from which the greatest dangers to exposure are:

1. To the eyes, where aqueous flare, cataract formation, and/or corneal burn are possible.
2. To the skin, where burning is possible.

**WARNING** **Do NOT, under any circumstances, look into the optical output or any fiber/device attached to the output while the laser is in operation.**

This system should be serviced only by authorized personnel.

Do not enable the laser unless fiber or an equivalent device is attached to the optical output connector.

**CAUTION** Use of controls or adjustments or performance of procedures other than those specified herein can result in hazardous radiation exposure.

**Laser Classifications**

United States-FDA Laser Class IIIb. The system is rated USFDA (United States Food and Drug Administration) Laser Class IIIb according to Part 1040, Performance Standards for Light Emitting Products, from the Center for Devices and Radiological Health.

International-IEC Laser Class 3B. The system is rated IEC (International Electrotechnical Commission) Laser Class 3B laser products according to Publication 825.

International-IEC 825. The system helps satisfy the International (IEC825) safety requirements with the use of a REMOTE SHUTDOWN and a KEY SWITCH.

## Laser Warning Labels

The 86030A is shipped with the following warning labels. For systems used outside of the USA, both laser aperture and laser warning labels will be included with the shipment (The labels are located in the same box as this manual). Place these labels directly over the USA laser warning and aperture labels.

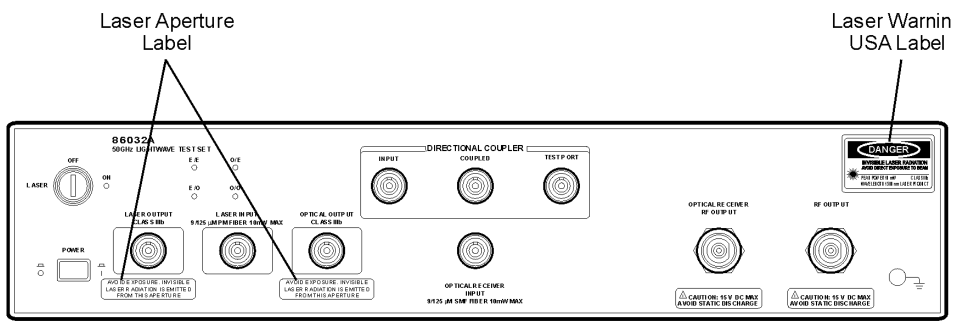



**Figure 2-10. Laser safety label locations**

## Electrical Safety

The electrical safety considerations are documented in the section "General Safety Considerations" on page iv. Familiarize yourself with the safety markings and instructions before operating this system.

## Service

Limited service may be performed on this system in accordance with information provided in Chapter 7, "Maintenance". For all other repairs the system must be returned to Agilent Technologies.

## Maintenance

On a daily basis, practice the techniques for proper connector use and care. Refer to the *Lightwave Connection Techniques for Better Measurements* booklet. If you should ever need to clean the cabinet, use a damp cloth only.

**CAUTION** Exposure to temperatures above 55°C may cause the front panel fiber to retract. In this case a matching compound can be used to temporarily improve return loss. However, the system should be returned to Agilent Technologies for repair.

**CAUTION** This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2, per IEC 1010 and 664 respectively.

**Learn proper connector care**

When you use improper cleaning and handling techniques, you risk expensive system repairs, damaged cables, and compromised measurements. Repair of damaged connectors due to improper use is not covered under warranty.

Clean all cables before applying to any connector. Refer to the *Lightwave Connections Techniques for Better Measurements* booklet.

# 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. The Figure 2-11 on page 2-34 shows the basic components of a typical connector.

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 specifica-

tions 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.

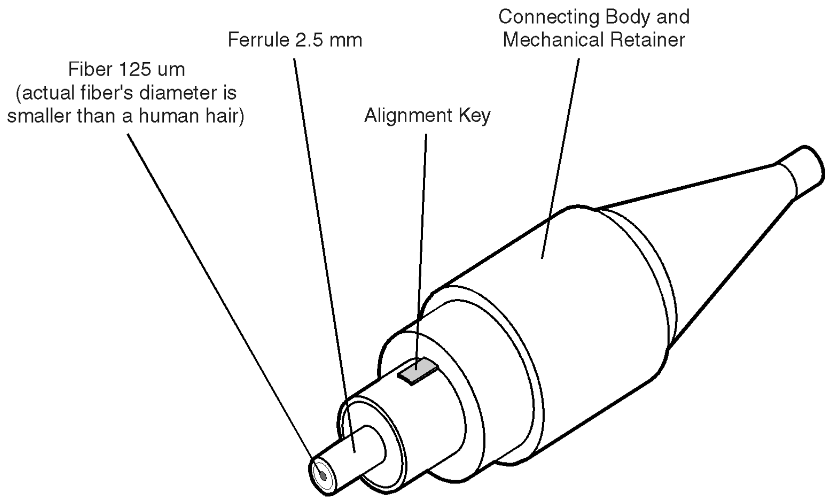



**Figure 2-11. Basic components of a connector.**

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 instruments typically use a connector such as the Diamond HMS-10, which has concentric tolerances within a few tenths of a micron. Agilent then uses a special universal adapter, which allows other cable types to mate with this precision connector. See Figure 2-12 on page 2-35.

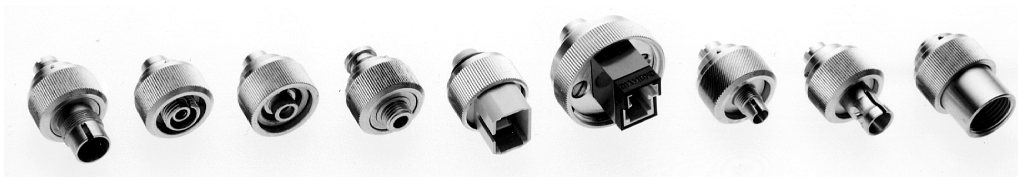


**Figure 2-12. Universal adapters**

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 2-13.

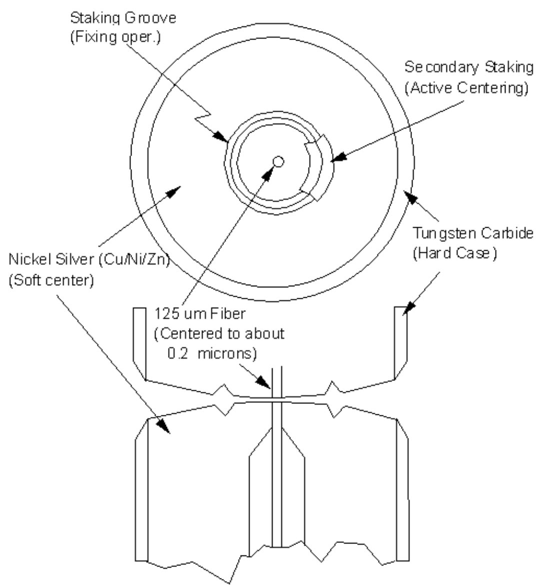



**Figure 2-13. Cross-section of the Diamond HMS-10 connector.**

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 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, bad measurements can be made without the user even being aware of a connector problem. Although microscopic examination and return loss measurements are the best way to ensure good connections, they are not always practical. An awareness of potential problems, along with good cleaning practices, can ensure that optimum connector performance is maintained. With glass-to-glass interfaces, it is clear that 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.

Figure 2-14 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 2-15 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 2-16 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 on one connector end can be transferred to another good connector that comes in contact with it.

The cure for these problems is disciplined connector care as described in the following list and in "Cleaning Connectors" on page 2-40.

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.

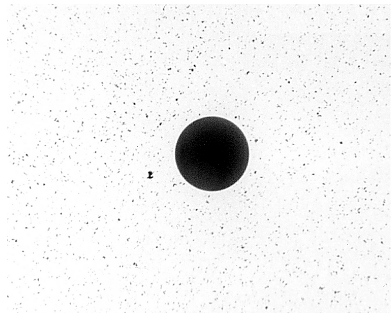


**Figure 2-14. Clean, problem-free fiber end and ferrule.**

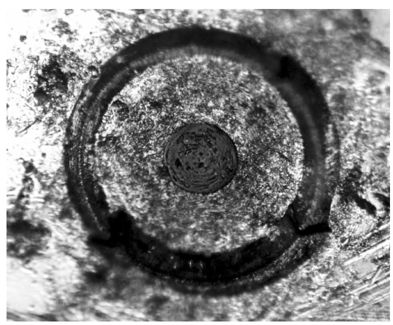


**Figure 2-15. Dirty fiber end and ferrule from poor cleaning.**

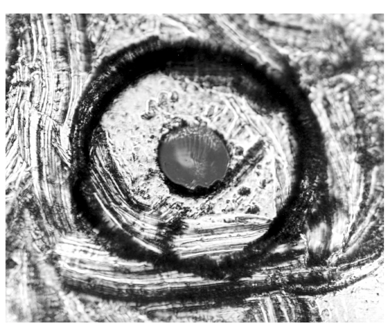


**Figure 2-16. Damage from improper cleaning.**

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.

### *To Test Insertion Loss*

Use an appropriate lightwave source and a compatible lightwave receiver to test insertion loss. Examples of test equipment configurations include the following equipment:

- 71450A or 71451A Optical Spectrum Analyzers with Option 002 built-in white light source.
- 8702 or 8703 Lightwave Component Analyzer system.
- 83420 Chromatic Dispersion Test Set with an 8510 Network Analyzer.
- 8153 Lightwave Multimeter with a source and power sensor module.

### *To Test Return Loss*

Use an appropriate lightwave source, lightwave receiver, and lightwave coupler to test return loss. Examples of test equipment configurations include the following equipment:

- Agilent 8703 Lightwave Component Analyzer.
- Agilent 8702 Lightwave Component Analyzer with the appropriate source, receiver, and lightwave coupler.
- Agilent 8504 Precision Reflectometer.
- Agilent 8153 Lightwave Multimeter with a source and power sensor module in

conjunction with a lightwave coupler.

- Agilent 81554SM Dual Source and Agilent 81534A Return Loss Module.

***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 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 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 2-3. Cleaning Accessories**

| Item | Agilent Part Number |
|---|---|
| Pure isopropyl alcohol | — |
| Cotton swabs | 8520-0023 |
| Small foam swabs | 9300-1223 |
| Compressed dust remover (non-residue) | 8500-5262 |

**Table 2-4. 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 |
| DIN dust cap | 5040-9364 |
| HMS10/Agilent dust cap | 5040-9361 |
| ST dust cap | 5040-9366 |

### *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.

## Caring for Electrical Connections

The following list includes the basic principles of microwave connector care. For more information on microwave connectors and connector care, consult the *Connector Care Manual*, part number 08510-90064.

***Handling and Storage***

- Keep connectors clean
- Extend sleeve or connector nut
- Use plastic endcaps during storage
- Do *not* touch mating plane surfaces
- Do *not* set connectors contact-end down

***Visual Inspection***

- Inspect all connectors carefully before every connection
- Look for metal particles, scratches, and dents
- Do *not* use damaged connectors

***Cleaning***

- Try cleaning with compressed air first
- Clean the connector threads
- Do *not* use abrasives
- Do *not* get liquid onto the plastic support beads

### *Making Connections*

- Align connectors carefully
- Make preliminary connection lightly
- To tighten, turn connector nut *only*
- Do *not* apply bending force to connection
- Do *not* overtighten preliminary connection
- Do *not* twist or screw in connectors
- Do *not* tighten past the “break” point of the torque wrench

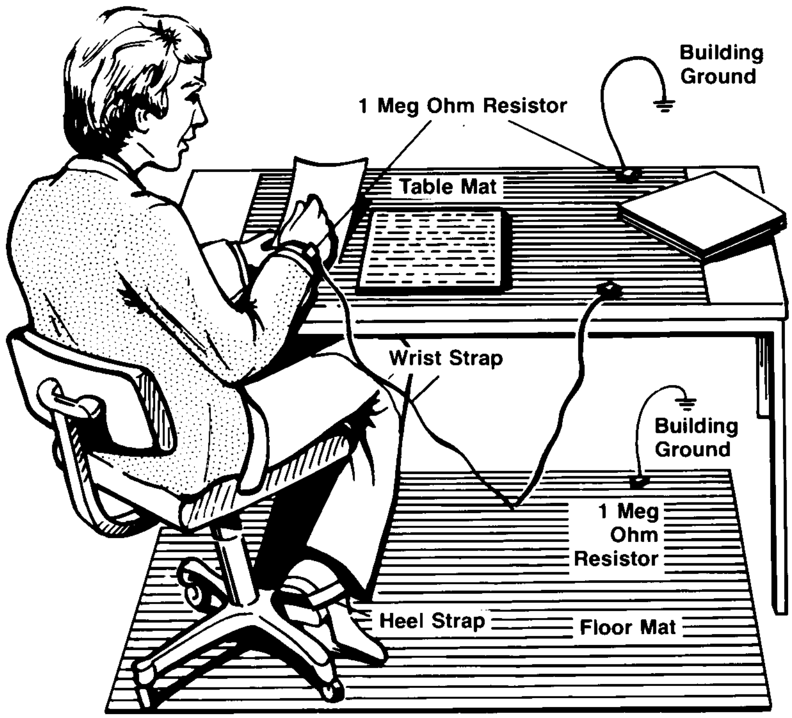
# Electrostatic Discharge Information

Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe work station. The following figure shows an example of a static-safe work station using two types of ESD protection:

- Conductive table-mat and wrist-strap combination.

**NOTE** For the 86030A 50 GHz LCA system, the static strap is attached to the 86032A front panel grounding receptacle. Refer to “Front Panel Features” on page 2-8.

- Conductive floor-mat and heel-strap combination.




Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone.

To ensure user safety, the static-safe accessories must provide at least 1 MΩ of isolation from ground. Refer to Table 17 on page 2-46 for information on ordering static-safe accessories.

**WARNING** **These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.**

## Reducing ESD Damage

The following suggestions may help reduce ESD damage that occurs during testing and servicing operations.

- Personnel should be grounded with a resistor-isolated wrist strap before removing any assembly from the unit.
- Be sure all instruments are properly earth-grounded to prevent a buildup of static charge.

**Table 17. Static-Safe Accessories**

| Agilent Part Number | Description |
|---|---|
| 9300-0797 | Set includes: 3M static control mat 0.6 m × 1.2 m (2 ft.× 4 ft.) and 4.6 cm (15 ft.) ground wire. (The wrist-strap and wrist-strap cord are not included. They must be ordered separately.) |
| 9300-0980 | Wrist-strap cord 1.5 m (5 ft.) |
| 9300-1383 | Wrist-strap, color black, stainless steel, without cord, has four adjustable links and a 7 mm post-type connection. |
| 9300-1169 | ESD heel-strap (reusable 6 to 12 months). |

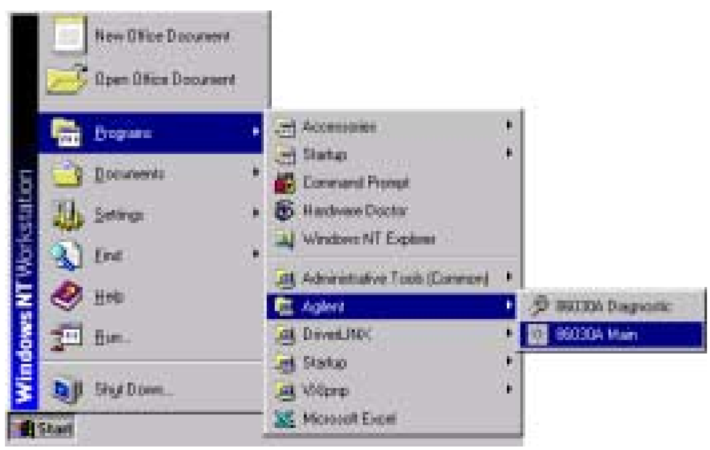
# Quick Start

This procedure steps you through the process of making your first measurement. The verification kit supplied with your system contains a photo detector, which we will use to make an optical-to electrical (O/E) bandwidth response measurement.

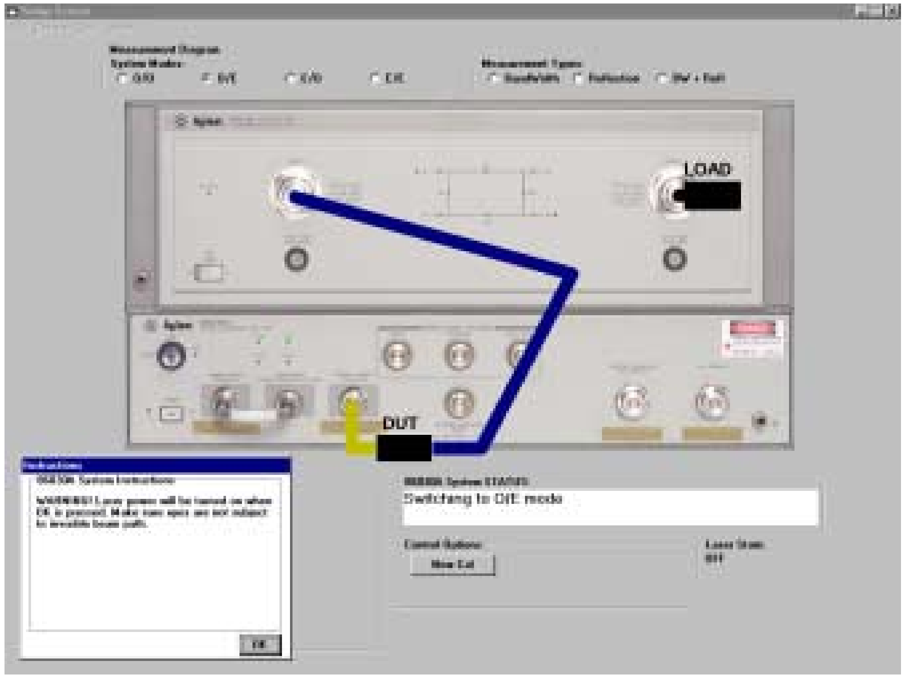
Photodiode responsivity (amps/watt) refers to how a change in optical power is converted to a change in output electrical current. As the frequency of modulation increases, eventually the receiver responsivity will rolloff. Thus, the device has a limited modulation bandwidth. The measurement of modulation bandwidth consists of stimulating the photodiode with a source of modulated light and measuring the output response current with an electrical receiver. The frequency of the modulation is swept to allow examination of the photodiode over a wide range of modulation frequencies.

1 From the Windows **Start** menu on the 86030A computer, select **Programs**, **Agilent, 86030A Main** to open the software.

**NOTE** Do NOT attempt to close the analyzer application until the 86030A system status window says “System Ready.”




2 Follow the instructions for the Laser power prompt, then press **OK**.

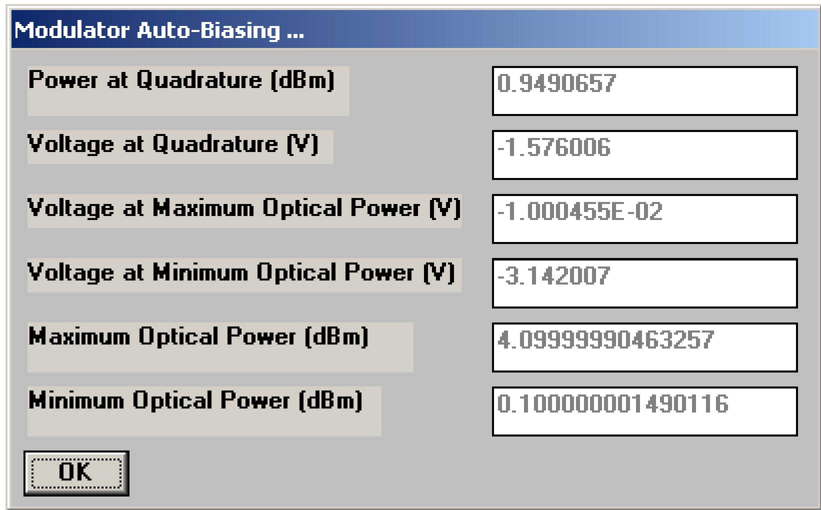



**3** When the software is first opened, a modulator auto-bias will automatically be performed, which takes approximately 2 minutes. The modulator is automatically biased to the optimum (quadrature) performance condition.

An auto-bias does not need to be performed before each individual measurement but should be performed for any of the following conditions:

- at least once every eight hours
- if the temperature has drifted more than 3°C from the user calibration temperature
- if the jumper between the 86032A LASER OUTPUT and LASER INPUT has been removed and replaced.

This routine takes approximately two minutes and the results will be displayed on the screen. Refer to “Auto Bias” on page 2-20.

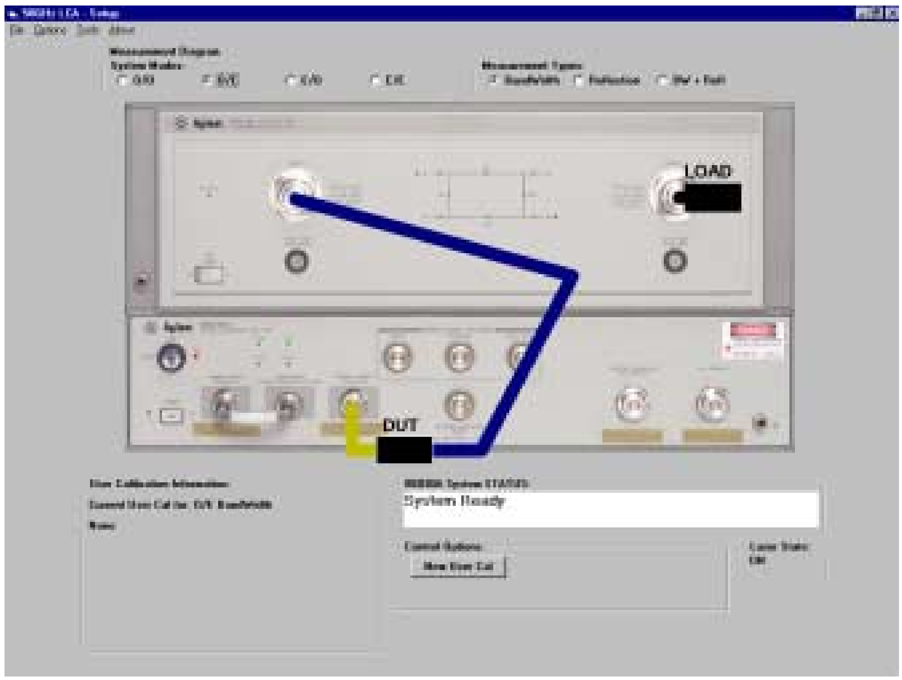



**4** When the auto bias is finished, click **OK** to close the Modulator Auto Bias window.

The system has finished setup procedures.

# Making an Optical to Electrical Measurement

**1** In the System Modes area, click on **O/E** (the default mode) to set up for an optical to electrical measurement.




**2** In the Measurement Types area, click on **BandWidth**.

**3** In the Control Options area, click on **To Setup**, **New User Cal.**

**4** The message, “Set 8510 to desired Start Frequency, Stop Frequency, and the Number of Points” appears. To do this:

**a** On the 8510 analyzer under the STIMULUS area, set the Start frequency and the Stop Frequency to the frequency range required for your measurement.

**b** From the STIMULUS MENU, select *NUMBER of POINTS*, then *801*.

**c** From the RESPONSE MENU, select AVERAGING ON and set to 128 points.

**5** Click **OK** in the application message box.

6 Follow the onscreen instructions to configure the test set for calibration, then press **OK**.

7 In the Control Options area, click on **Resp-Isol** to perform a response plus isolation calibration.

8 Follow the on-screen instructions for the Response portion of the calibration procedure.

9 Follow the on-screen instructions for the Isolation portion of the calibration procedure.

The system first takes an uncorrected measurement of the internal O/E converter in the 86032A test set. This raw data along with factory calibration data for the internal O/E are used to construct a calibration file for the system.

You can monitor the System Status area as the calibration is in progress. Once the calibration is completed, you can view the calibration results in the Calibration Information area.

You are now ready to make a bandwidth response measurement.

10 Follow the on-screen instructions for the measurement setup.

11 From the 8510 RESPONSE menu, adjust the scale to best fit the trace on the screen.

**a** Select *REF VALUE* and use the knob to center the trace around the display line.

**b** Select *SCALE* and decrease the dB/div to expand the trace across the display (approximately 2 dB/div).

**c** Repeat steps a and b to get the best view.

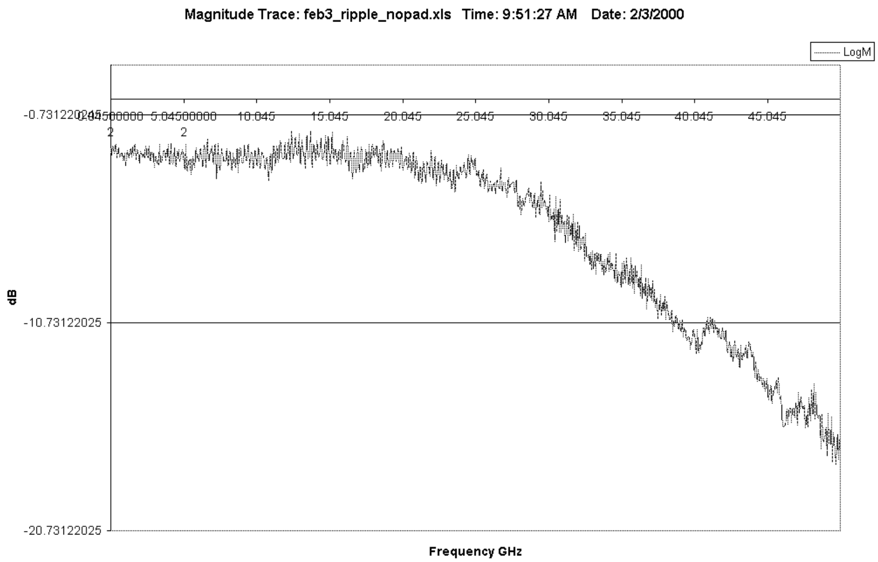
12 Select the RESPONSE MENU key, then SMOOTHING ON.

13 Save the trace data to an Excel file by selecting **File**, **Save Data**, **Excel File,** then, **Form Log Mag**.

14 In the Save to Excel dialog box, enter `quick_start` as the trace file name then click **OK**.

You can now view the trace by selecting **File, Graph Excel Data**, **Form Log Mag** and then **Open** the **Quick_Star**t file. Alternately, you can open a session of Excel and view or manipulate the trace file from there.

Or, you can further analyze the trace data by using the controls on the 8510C.


Magnitude Trace: feb3_ripple_nopad.xls Time: 9:51:27 AM Date: 2/3/2000
LogM
dB
-0.73122025
-10.73122025
-20.73122025
0.045000000 2
5.045000000 2
10.045
15.045
20.045
25.045
30.045
35.045
40.045
45.045
Frequency GHz

3



# Measurement Techniques

# The Calibrations

The 86030A software can perform many different types of calibrations depending on your device type and measurement needs. Following is a list of all of the available calibrations.

- **O/O**
  - Bandwidth Measurement
    - Response
    - Response/Isolation
  - Reflection Measurement
    - Response
    - Response/Isolation
- **O/E**
  - Bandwidth
    - Response
    - Response/Isolation
    - Response/Match
  - Reflection
    - Response
    - Response/Isolation
  - Bandwidth & Reflection
    - Response
    - Response/Isolation
- **E/O**
  - Bandwidth
    - Response
    - Response/Isolation
  - Reflection
    - Response
  - Bandwidth & Reflection
    - Response
    - Response/Isolation
  - Reflection Sensitivity
    - Response
- **E/E**

Use the 8510C for electrical calibrations and measurements.

**Table 3-1. Purpose and Use of Different Calibration Procedures**

| Calibration Procedure | Corresponding Measurement | Errors Removed | Standard Procedure |
|---|---|---|---|
| **Electrical** | | | |
| Response | Transmission or reflection measurement when the highest accuracy is not required. | Frequency response | Thru for transmission, open or short for reflection. |
| Response & Isolation | Transmission of high insertion loss devices or reflection of high return loss devices. Not as accurate as 1-port or 2-port calibration. | Frequency response plus isolation in transmission or directivity in reflection. | Same as response plus isolation std (load). |
| S11 1-port | Reflection of any one-port device or well terminated two-port device. | Directivity, source match, frequency response | Short, open, and load(s). |
| S22 1-port | Reflection of any one-port device or well terminated two-port device. | Directivity, source match, frequency response | Short, open, and load(s). |
| Full 2-port | Transmission or reflection measurements of highest accuracy for two-port devices. | Directivity, source match, load match, isolation, frequency response, each in forward and reverse directions. | Short, open, and load(s). Two loads needed for isolation. |
| **Optical (O, O/O)** | | | |
| Response | Transmission or reflection measurement when the highest accuracy is not required. | Frequency response | Optical thru for transmission, Fresnel or Reflector for reflection. |
| Response & Isolation | Transmission of high insertion loss devices or reflection of high return loss devices. | Frequency response, plus isolation in transmission or directivity in reflection. | Same as response plus disconnect cable or turn off laser. |
| **Optical (O/E)** | | | |
| Response | Transmission measurement | Frequency response | Optical and/or electrical thrus. |
| Response & Isolation | Transmission of high Insertion loss devices | Frequency response plus isolation | Same as Response plus disconnect cable or turn off laser. |
| Response & Match | Transmission measurement for devices with large electrical reflectivity. | Frequency response plus electrical mismatch | Same as Response plus short, opens, and loads. |

**Table 3-1. Purpose and Use of Different Calibration Procedures**

| Calibration Procedure | Corresponding Measurement | Errors Removed | Standard Procedure |
|---|---|---|---|
| **Optical (E/O)** | | | |
| Response | Transmission or reflection measurements. | Frequency response | Optical and /or electrical thrus for transmission, optical load for reflection sensitivity. |
| Response and Isolation | Transmission of high insertion loss devices. | Frequency response plus isolation | Same as response plus disconnect the cable or turn off the laser. |
| Note: If cables, connectors, or adapters are removed from the measurement setup that were used in the calibration, their effect must be accounted for by adding a port extension equivalent to the electrical length of the missing component(s). | | | |

### Measurement Error Correction for Devices with V Connectors (1.85 mm)

To accurately measure devices with V connectors (1.85 mm), adapt the 2.4 mm electrical cables that are part of the 86030A system, to a 1.85 mm connector. Then perform a measurement calibration on the 86030A system with an 85058 D (1.85 mm) calibration kit. This process will remove the effects of the small reflections from the 2.41/1.85 mm interface.

# Saving and Reusing 86030A Calibration Sets

After you have performed a measurement calibration, the 86030A creates a calibration set that is applied to the measurement, reducing systematic errors. To save time with later measurements, you may want to use a previously created calibration set rather than creating a new set.

The 86030A uses the 8510 calibration set registers 1, 2, and 3 to create new calibration sets. If you perform another measurement calibration, the previous calibration set would be overwritten. Therefore, if you want to reuse a calibration set, you must move it out of calibration set registers 1-3 by doing one of the following:

- Move the calibration set to 8510 calibration set register 4, 5, 6, 7, or 8.
- Store the calibration set to a floppy disk.

Each calibration set is calculated based on a particular measurement state. Therefore, the error reduction and resulting measurement accuracy from a calibration is only valid if you use the same measurement settings that were used to create the calibration set.

There are also other variables that can affect measurement accuracy when you are reusing calibration sets:

- Differences in the ambient temperature between when you performed the measurement calibration and when you measured the device under test.
- Differences in the test port cables and accessories you used in the measurement calibration and in the device measurements.

## To Save and Reuse Calibration Sets

To save time, you may want to save and reuse a calibration set. Follow these general steps:

1. Either move the calibration set to 8510 calibration set registers (4-8) or store the set to a floppy disk.
2. Save the measurement settings as an instrument state.

**3** Reload and/or recall the calibration set and measurement settings.

### Move or Store a Calibration Set

**1** To move the calibration set from 8510 calibration set registers (1-3) to calibration set registers (4-8):

**a** Make sure the calibration set is enabled on the 8510 by pressing CAL, CORRECTION ON, and press CAL SET (1-3).

**b** Press CAL, MORE, MODIFY CALSET, FREQUENCY SUBSET, CREATE & SAVE, CAL SET (4-8).

**c** Repeat this step if you want to save more than one calibration set. For example, if you have performed a response and match calibration, there would be a calibration set in CAL SET 1 and CAL SET 2.

**2** To store a calibration set to a floppy disk:

**a** On the 8510, press DISC, STORE, CAL SET 1-8, and select the calibration set that you want to store. If you want to store all of the calibration sets, select CALSET ALL.

**b** Press STORE FILE.

### Save the Measurement Settings as an Instrument State

**3** Press SAVE, INST STATE (1-7) to save the measurement settings in an instrument state register.

**4** If you want to store the instrument state on a floppy disk, press DISC, STORE, INST STATE 1-8, then select the state that you want to store.

### Recall the Calibration Set and Measurement Settings

**5** To recall the measurement settings and the associated calibration set from the 8510 registers:

**a** Press RECALL, INST STATE 1-7 and select the instrument state you want to recall.

- **b** Press CAL, CAL SET and select the calibration state that you want to recall.

**6** To load the measurement settings and the associated calibration set files from a floppy disk and recall them to the 8510:

- **a** Press DISC, LOAD, INST STATE 1-8, then select the state that you want to load.
- **b** Press RECALL, INST STATE 1-7 and select the instrument state you want to recall.
- **c** Press DISK, LOAD, CAL SET 1-7 , then select the set that you want to load.
- **d** Press CAL, CAL SET 1-8 and select the calibration state that you want to re-call.

**NOTE** If you are recalling calibration sets for a response and match calibration, you must return the sets to CAL SET 1, and CAL SET 2. The analyzer will apply the calibration sets from those two registers for error correction of a response and match measurement.

# O/O Response and Isolation Bandwidth Calibration

The following procedure shows you how to make a response and isolation bandwidth calibration.

1 In the System Modes area in the Setup Screen, click on **O/O** to setup for an optical to optical measurement.

2 In the Measurement Types area, click on **BandWidth**.

3 In the Control Options area, click on **New User Cal**.

4 The message, “Set 8510 to desired Start Frequency, Stop Frequency, Averaging, and the Number of Points” appears. To do this:

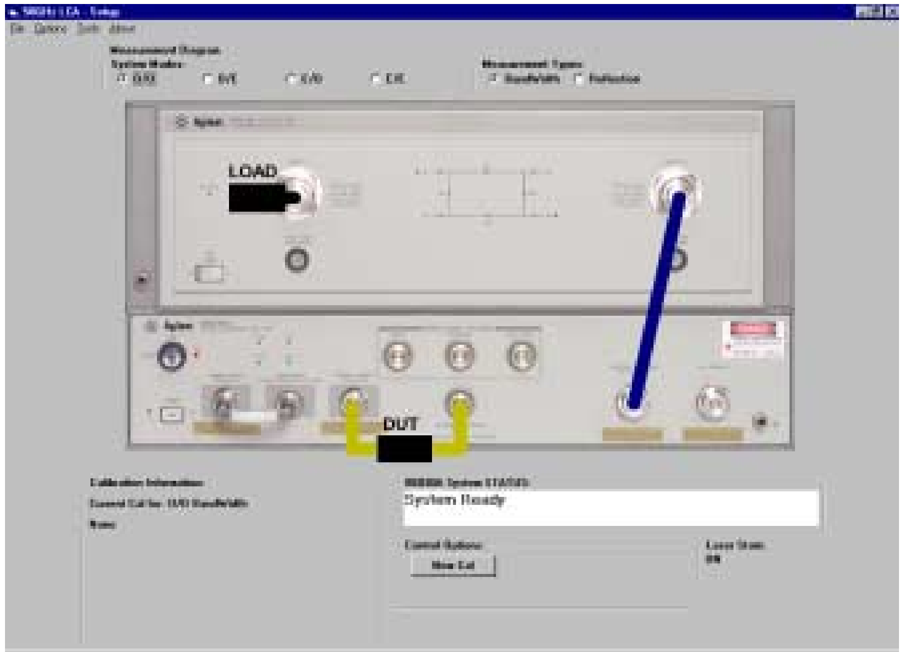
   **a** On the 8510 analyzer under the STIMULUS area, set the Start frequency and the Stop Frequency to the frequency range required for your measurement.

   **b** From the STIMULUS MENU, select *NUMBER of POINTS*, then select the number of data points, for example, 801 points.

   **c** From the RESPONSE MENU, select *AVERAGING ON/restart*, then enter the number of averages. For example, for 128 averages enter 128 x1.

5 In the Control Options area, click on **Resp-Isol** to perform a response plus isolation calibration.

6 Follow the on-screen instructions to complete the calibration procedure.


LOAD
DUT
System Ready

The figure below shows the results of an optical to optical measurement of a through line with 0 dB loss. The magnitude of the trace (that is, the vertical axis) is measured in dBo. For more information, refer to “O/O Display Scaling Calculations” on page 5-18.

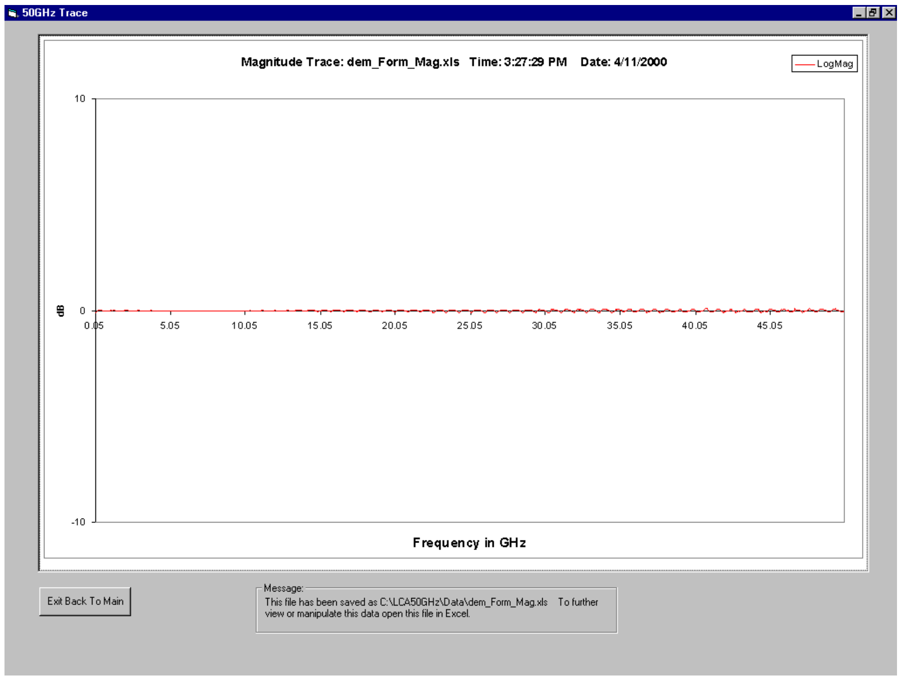



**Figure 3-1. Measurement results of a through line**

# O/E Response and Isolation Bandwidth Calibration

The following procedure shows you how to make an Optical to Electrical response and isolation bandwidth calibration.

1 In the System Modes area in the Setup Screen, click on **O/E** to setup for an optical to electrical measurement.

2 In the Measurement Types area, click on **BandWidth**.

3 In the Control Options area, click on **New User Cal**.

4 The message, “Set 8510 to desired Start Frequency, Stop Frequency, Averaging, and the Number of Points” appears. To do this:

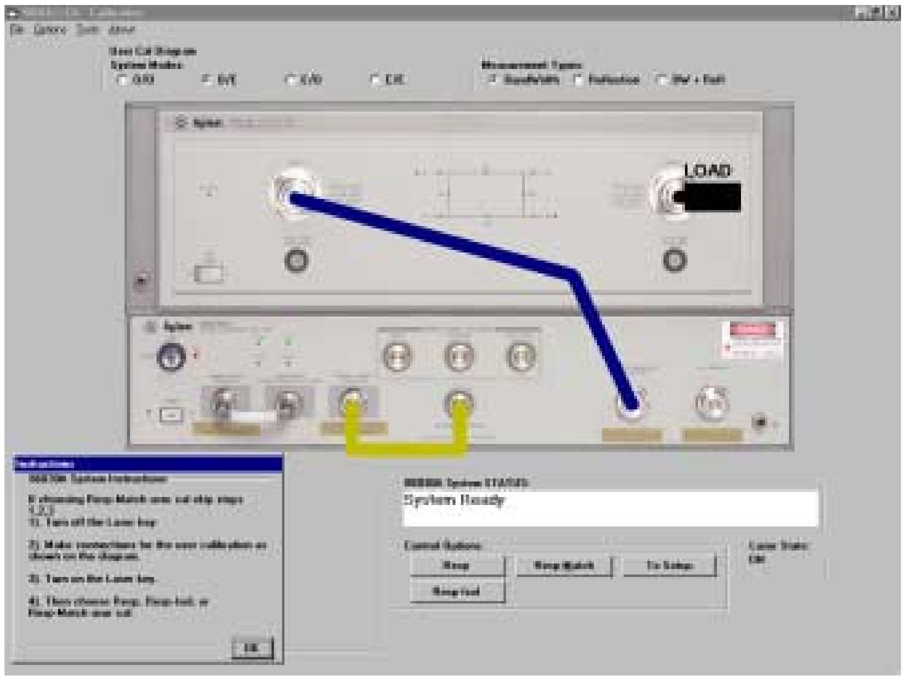
   **a** On the 8510 analyzer under the STIMULUS area, set the Start frequency and the Stop Frequency to the frequency range required for your measurement.

   **b** From the STIMULUS MENU, select *NUMBER of POINTS*, then select the number of data points, for example, 801 points.

   **c** From the RESPONSE MENU, select *AVERAGING ON/restart*, then enter the number of averages. For example, for 128 averages enter 128 x1.

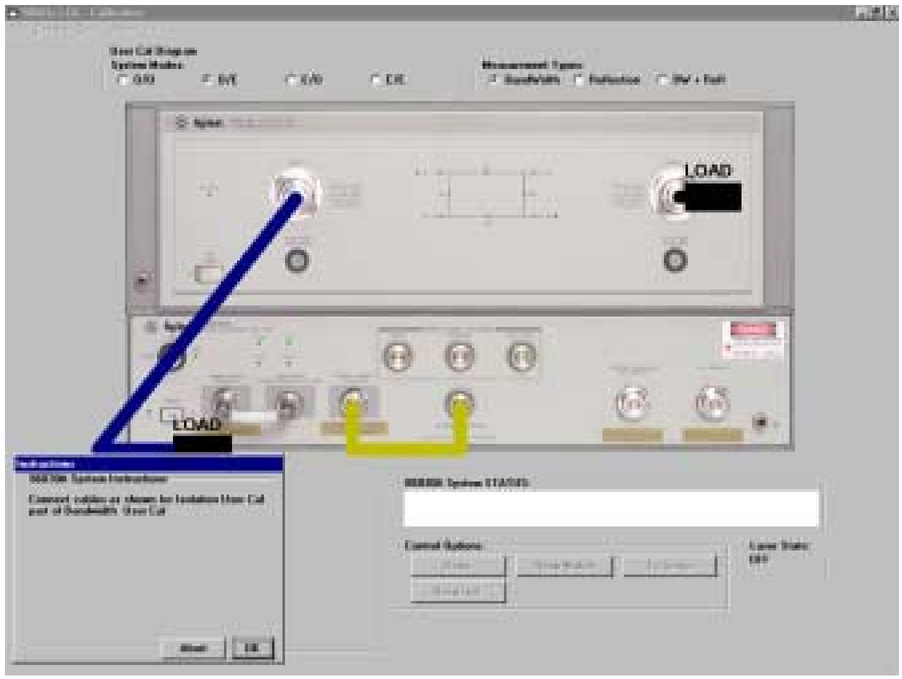
5 In the Control Options area, click on **Resp-Isol** to perform a response plus isolation calibration.

**6** Follow the on-screen instructions for the response portion of the calibration procedure. See figure below.



**7** Follow the on-screen instructions for the isolation portion of the calibration procedure.

See figure below.



# O/E Response and Match Bandwidth Calibration

The 86030A is capable of reducing the mismatch measurement uncertainty of a device under test by utilizing a response and match calibration. The advantage of a response and match calibration is that it compensates for the mismatch of the device under test, providing a more accurate calibration and measurement. Significant reduction of electrical mismatch error results.

For this calibration, you will need to use some of the accessories supplied in the 85056A 2.4 mm Calibration Kit.

The following procedure shows you how to make an Optical to Electrical response and match bandwidth calibration.

1 In the System Modes area in the Setup Screen, click on **O/E** to setup for an optical to electrical measurement.

2 In the Measurement Types area, click on **BandWidth**.

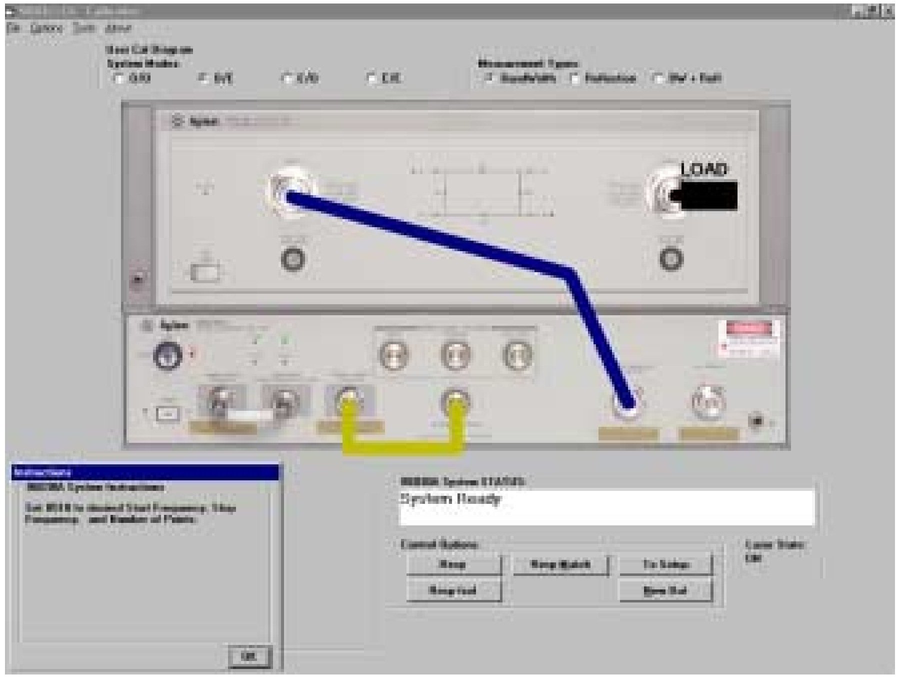
3 In the Control Options area, click on **New User Cal**.

4 The message, “Set 8510 to desired Start Frequency, Stop Frequency, Averaging, and the Number of Points” appears. To do this:

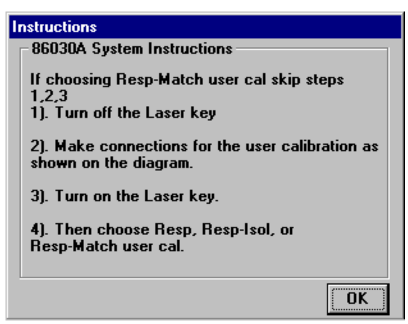
   **a** On the 8510 analyzer under the STIMULUS area, set the Start frequency and the Stop Frequency to the frequency range required for your measurement.

   **b** From the STIMULUS MENU, select *NUMBER of POINTS*, then select the number of data points, for example, 801 points.

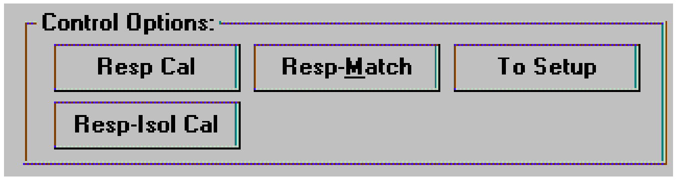
   **c** From the RESPONSE MENU, select *AVERAGING ON/restart*, then enter the number of averages. For example, for 128 averages enter 128 x1.




**5** When the following message appears, click **OK** to continue.

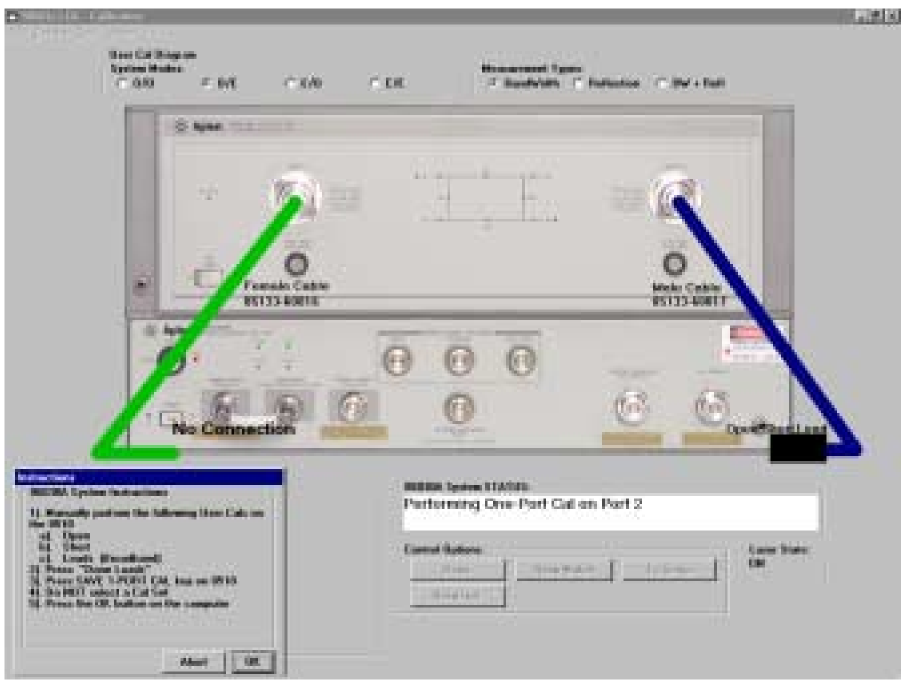



**6** In the Control Options area, click on **Resp-Match** to perform a response plus impedance match calibration.




## One-Port Calibration on Port 2

**7** Connect the equipment as shown on-screen, choosing an Open to connect to the end of the 8517B Port 2 cable.




**8** From the 8510C function keys, press *Open*.

Once a sweep of the trace is completed, the message *“Connect STD then press key to Measure”* appears, and you will notice that the Open function key on the 8510C is now underlined. This indicates that the Open portion of the calibration process is completed and you are ready to continue with a Short.

**9** Connect the equipment as shown on the screen, choosing a Short to connect to the end of the 8517B Port 1 cable.

**10** From the 8510C function keys, press *Short*.

Once a sweep of the trace is completed, the message *“Connect STD then press key to Measure”* appears, and you will notice that the Short function key on the 8510C is now underlined. This indicates that the Short portion of the calibration process is completed and you are ready to continue with a Load.

**11** Connect the equipment as shown onscreen, choosing a 50 ohm load to connect to the end of the 8517B Port 1 cable.

**12** From the 8510C function keys, press *Loads* then *Broadband*.

Once a sweep of the trace is completed, you will notice that the Broadband function key on the 8510C is now underlined. This indicates that the Load Broadband portion of the calibration process is completed.

**13** From the 8510C function keys, press *Done Loads*.

**14** From the 8510C function keys, press *Save 1-Port Cal*.

**NOTE** When the 8510C message “Select Calibration Set” appears, *do not* select a cal set to save. This completes the Port 2 portion of the match calibration.

**15** From the 86030A software, click **OK** to continue with the Port 1 portion of the match calibration.

## One-Port Calibration on Port 1

**16** Repeat Step 7 through Step 15 by attaching the Open, Short, and Load to the 8517B Port 2 instead of Port 1. Refer to Figure 3-2.

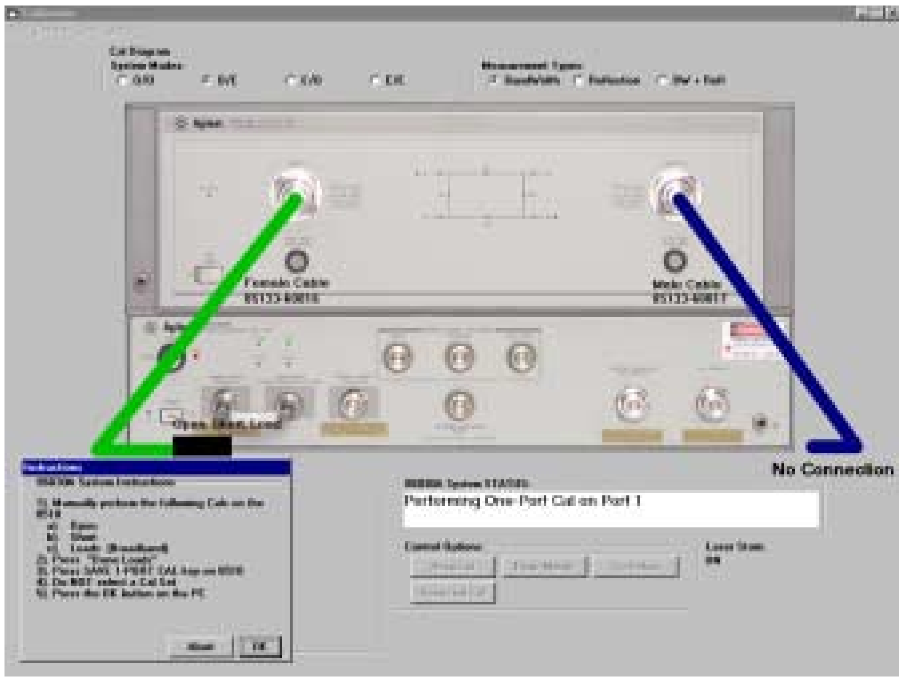



**Figure 3-2.**

## Measurement of Port 1 Reflectivity

**17** Connect the equipment as shown in Figure 3-3 then click **OK**.


**Figure 3-3.**

# Measurement of 86030A Internal O/E Response

**18** Connect the equipment as shown in Figure 3-4 then click **OK**.

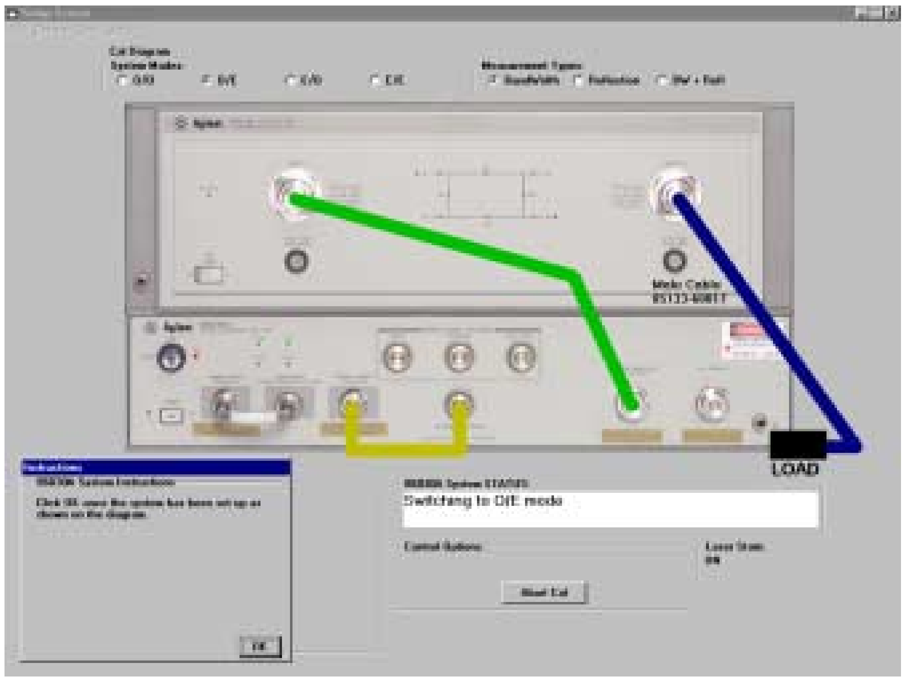



**Figure 3-4.**

# Measurement of Device Under Test

**19** Connect the equipment as shown in Figure 3-5 then click **OK**.

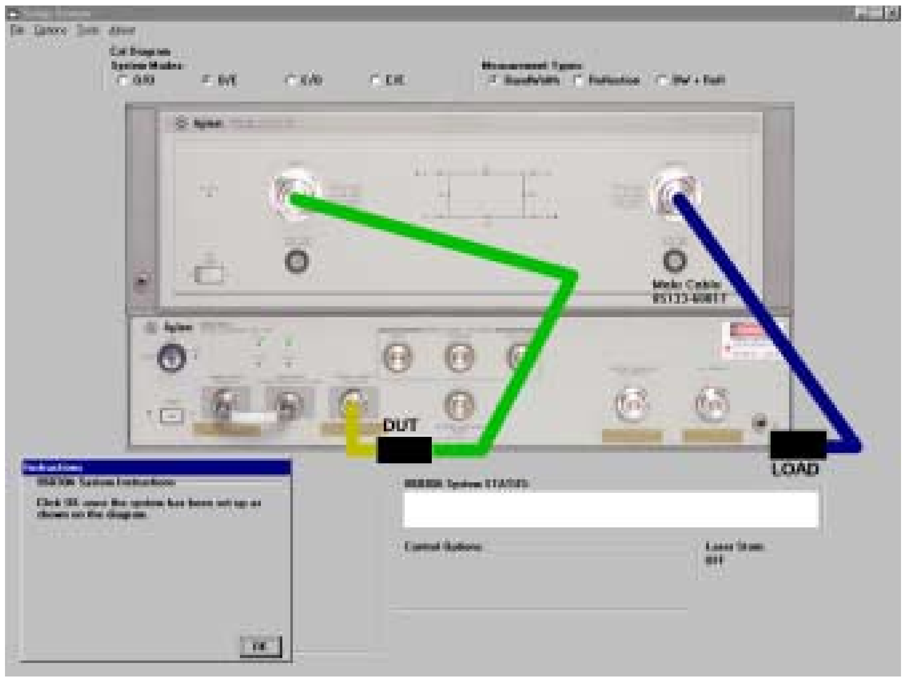



**Figure 3-5.**

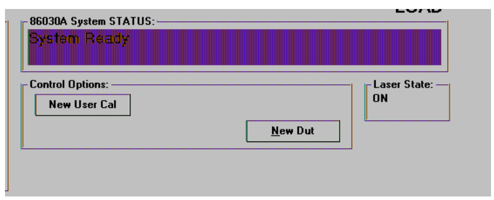
Once the calibration is completed, the results will be displayed in the User Calibration Information area.

# New Device Under Test (DUT)

The disadvantages of a response plus match calibration is that it is a more complicated and lengthy procedure and it is only valid for a particular DUT.

Using the New Dut function, in the Control Options area, repeats only the DUT reflectivity portion of the calibration. This greatly reduces the calibration time when a measurement of a new test device is desired, or if the electrical port match has changed.

The 86030A also provides a capability to mathematically reduce the effects of electrical mismatch. In order to do this, the DUT response information is modified using measurements of the electrical reflectivity of the DUT and the electrical reflectivity of the 86030A. Significant reduction of electrical mismatch error results.



# E/O Response and Isolation Bandwidth Calibration

The procedure below shows you how to make an Electrical to Optical response and isolation bandwidth calibration.

***E/O Measurement Considerations:***

- Modulator measurements require an external polarization controller connected in the test setup. However, the outputof the 86030A is keyed to the slow axis of PMF (polarization maintaining fiber), and if the modulator under test is similarly keyed and PMF is used from the laser output to the input of the modulator, the polarization controller may be eliminated. Otherwise setup the equipment as follows and shown in Figure 3-6 on page 3-26:
  - Connect the 86030A LASER OUTPUT to the polarization controller.
  - Connect the polarization controller to the modulator (DUT) input.
  - Connect the modulator (DUT) output to the 86030A OPTICAL RECEIVER INPUT.
  - Connect the 86030A RF OUTPUT through a bias tee (if needed) to the modulator (DUT) RF input.
  - Adjust the bias and the polarization controller for maximum output, as seen on the analyzer screen.
- Modulator measurement response is dependent on both the RF drive level and the amplitude of the signal at the modulator output. To make comparisons between modulators, both signal levels should be controlled.
  - Set the RF drive level and the optical power at the modulator (DUT) output to 1 mW.
  - The RF drive level to the modulator (DUT) should be ±0.5 mW across the band. If the drive varies more than ±0.5 mW, try shortening the RF cable or making a series of measurements over smaller ranges.

1. In the System Modes area in the Setup Screen, click on **E/O** to setup for an electrical to optical measurement.
2. In the Measurement Types area, click on **BandWidth**.
3. In the Control Options area, click on **New User Cal**.
4. The message, “Set 8510 to desired Start Frequency, Stop Frequency,

Averaging, and the Number of Points" appears. To do this:

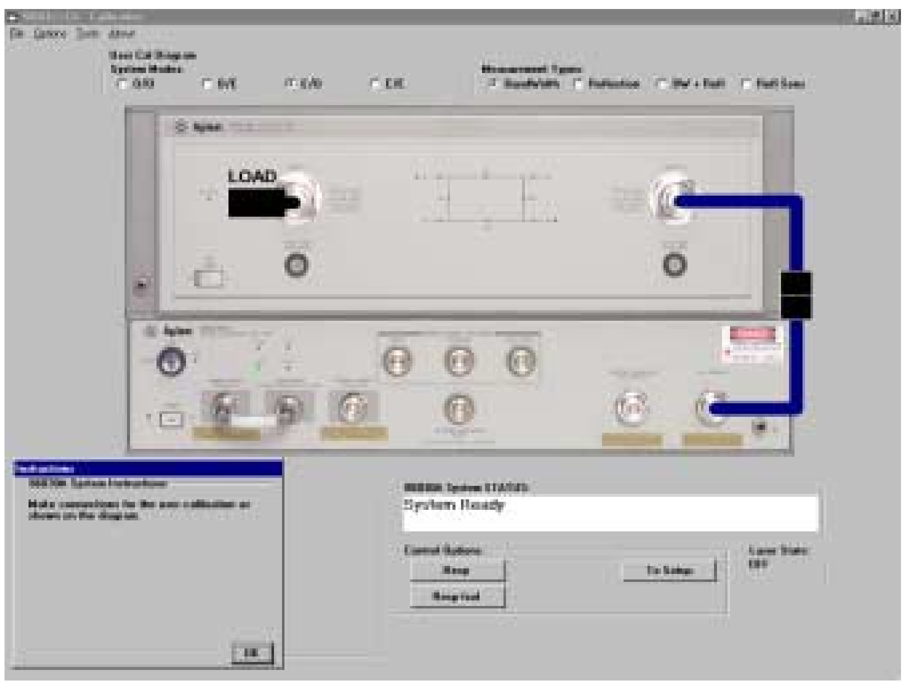
**a** On the 8510 analyzer under the STIMULUS area, set the Start frequency to and the Stop Frequency to the frequency range required for your measurement.

**b** From the STIMULUS MENU, select *NUMBER of POINTS*, then select the number of data points, for example, 801 points.

**c** From the RESPONSE MENU, select *AVERAGING ON/restart*, then enter the number of averages. For example, for 128 averages enter 128 x1.

**5** In the Control Options area, click on **Resp-Isol** to perform a response plus isolation calibration.

**6** Follow the on-screen instructions to perform the Response portion of the calibration procedure. See figure below.



**7** Follow the on-screen instructions to perform the Isolation portion of the calibration procedure. See figure below.

**8** The calibration is complete. Connect the E/O device under test. For example, the figure below shows the test setup for a modulator measurement.

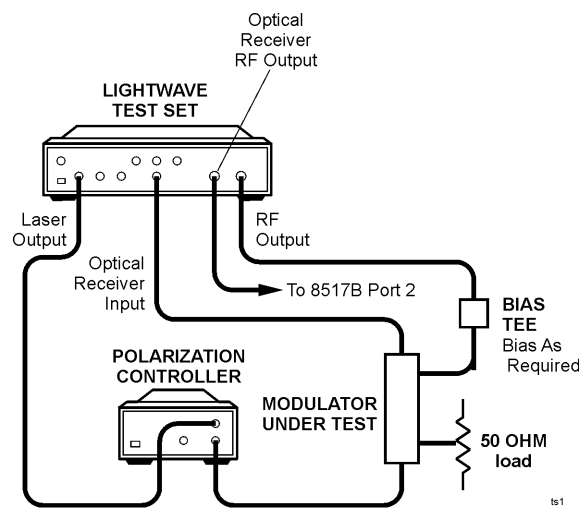
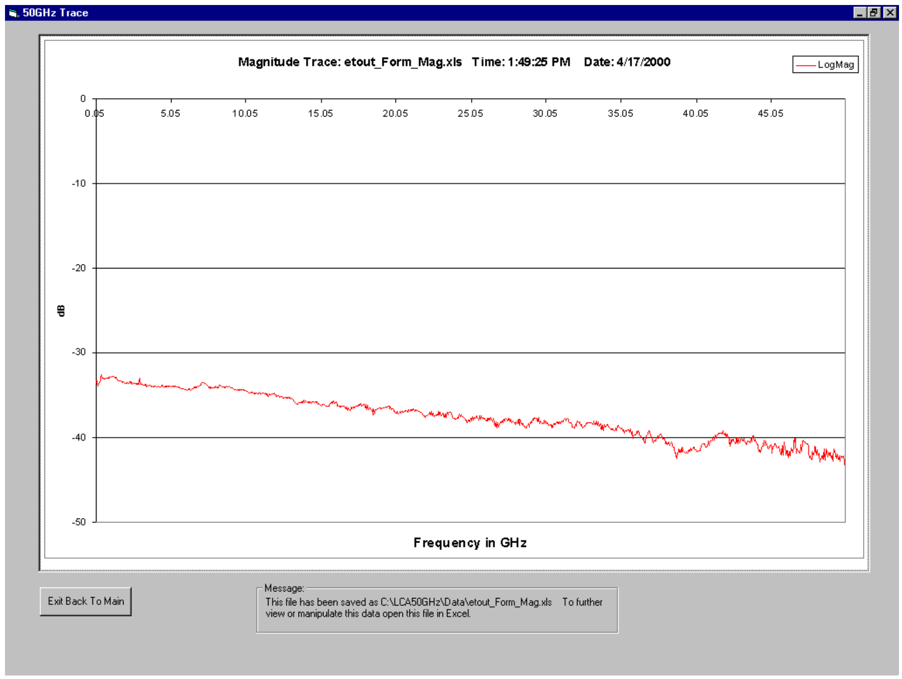



**Figure 3-6. Setup for a Modulator Measurement**

The figure below shows the results of a measurement of an external E/O modulator. The magnitude of the trace (that is, the vertical axis) is measured in dBe. For more information, refer to “E/O Display Scaling Calculations” on page 5-17.



# Agilent 86030A System Example Measurements

This section provides example measurements. These examples are not intended to cover all applications of the systems.

This section contains the following:

- Electrical mismatch ripple and its effects on measurements
- Optical reflection measurement between a splice and a cleave
- Bandwidth and reflection measurement of a lightwave source
- Magnitude response and deviation from linear phase for an optical receiver

**CAUTION** Costly replacement of an entire lightwave assembly will result from damage to an optical test port connector. Keep optical cables connected to the test ports to protect the connectors from damage.

**CAUTION** When you use improper cleaning and handling techniques, you risk expensive system repairs, damaged cables, and compromised measurements. Repair of damaged connectors due to improper use is not covered under warranty.

Clean all cables before applying to any connector. Refer to “Choosing the Right Connector” on page 2-33 and to “Cleaning Connectors” on page 2-40.

**WARNING** **Do NOT under any circumstances, look into the optical output of any fiber/device attached to the output while the laser is in operation. Refer to “Laser Safety Considerations” on page 2-30 for more information.**

# Electrical Mismatch Ripple and its Effects on Measurements

Mixmatch ripple is caused by a mismatch between the impedance of the device under test and the nominal 50 ohm input port on the 8517B test set. Depending on the phase of the desired (incident signal) and undesired signal (three times the path length of the reflected signal), the mismatch error signal either adds or subtracts to the magnitude of the desired signal. This phenomenon, called mismatch ripple, causes the trace to periodically deviate above and below the correct value. For devices that have high electrical reflectivity, the ripple is quite apparent. For devices that are well matched to 50 ohms, the mismatch ripple is much less visible.

Figure 3-7 will help to explain the effects of the trace ripple.

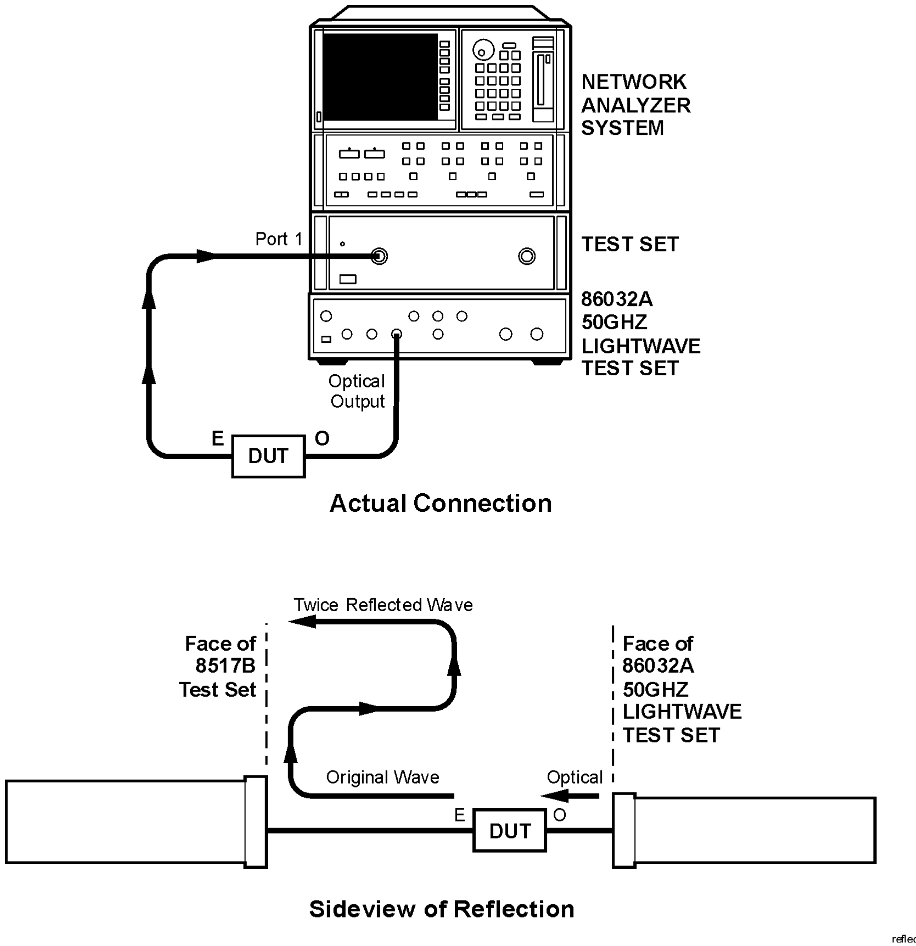



**Figure 3-7. Effects of Electrical Mismatch Ripple**

Spacing between successive peaks of this mismatch ripple is described by the equation:

$$ripple\ period\ Hz = \frac{Velocity\ in\ cable}{2 \cdot L_{cable}}$$

As an example, the 85133-60017 cable has a physical length of approximately 1 meter and a velocity of $2 \times 10^8 \frac{m}{s}$. In this case,

$$ripple\ period\ H_z = \frac{2 \times 10^8 \frac{m}{s}}{2 \cdot 1\ meter} = 1 \times 10^8, or\ 100\ MHz$$

For devices that have high reflectivity in the electrical port, the addition of a 6 dB attenuator on the electrical test port will substantially reduce the trace ripple. (A 6 dB attenuator is supplied in the verification kit.) However, there is a trade off of system sensitivity since the signal to noise floor will be reduced by 6 dB. Refer to “801 Data Points and No Attenuation Added” on page 3-35 and to “Ripple Measurement, 201 Points, with 6 dB Attenuator” on page 3-38.

The appearance of the trace ripple is also affected by the number of points selected for measurement.

When 801 points is used for a 50 GHz frequency span, there is approximately 62.5 MHz between data points. See Figure 3-8.

When 201 points is used for a 50 GHz frequency span, there is approximately 250 MHz between data points. Refer to “201 Data Points and 6 dB Attenuator” on page 3-38.

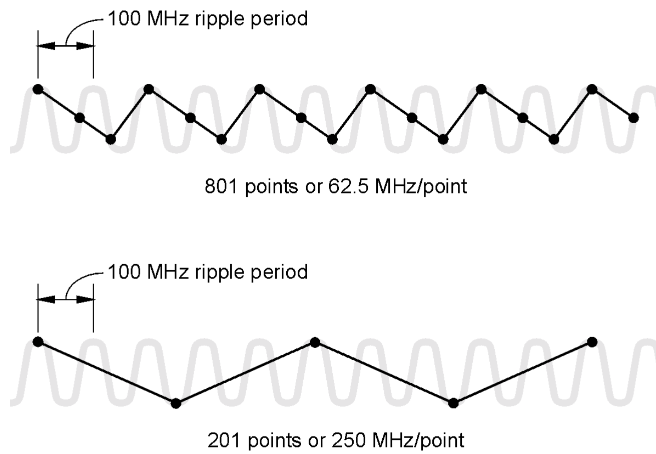



**Figure 3-8. The Number of Points for Measurement Effect Mismatch Ripple**

Compare the trace data taken with 201 points versus the trace data taken with 801 points. Notice that the 201 point trace has more of a sawtooth appearance. When fewer data points are taken, it affects your ability to discern the response of the device under test (DUT) from the effects of the ripple.

To demonstrate the effects of the system ripple, we will measure the 83440D lightwave detector supplied in the verification kit. The lightwave detector was selected for this example since it has high reflectivity (reflectivity ≈ 1) in the electrical port which will show the worst-case ripple.

# Ripple Measurement, 801 Points, No Attenuator

The first measurement example will use the maximum number of data points allowed by the network analyzer, but with no attenuation on the electrical port of the DUT.

## O/E Calibration

1 Connect a BNC 50 ohm load on Port 1 Bias on the 86032A rear panel.

   A BNC 50 ohm load can be found in the verification kit.

2 In the System Modes area, click on **O/E** to setup for an optical to electrical measurement.

3 In the Measurement Types area, click on **BandWidth**.

4 In the Control Options area, click on **New Cal**.

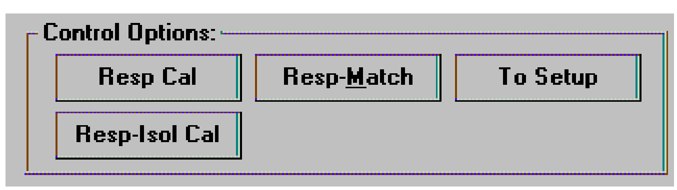
5 Follow the on-screen instructions to configure and perform the test set calibration.

6 The message, "Set 8510 to desired Start Frequency, Stop Frequency, and the Number of Points" appears. To do this:

   **a** On the 8510 analyzer under the STIMULUS area, set the Start frequency to 45 MHz and the Stop Frequency to 50 GHz.

   **b** From the STIMULUS MENU, select *NUMBER of POINTS*, then *801*.

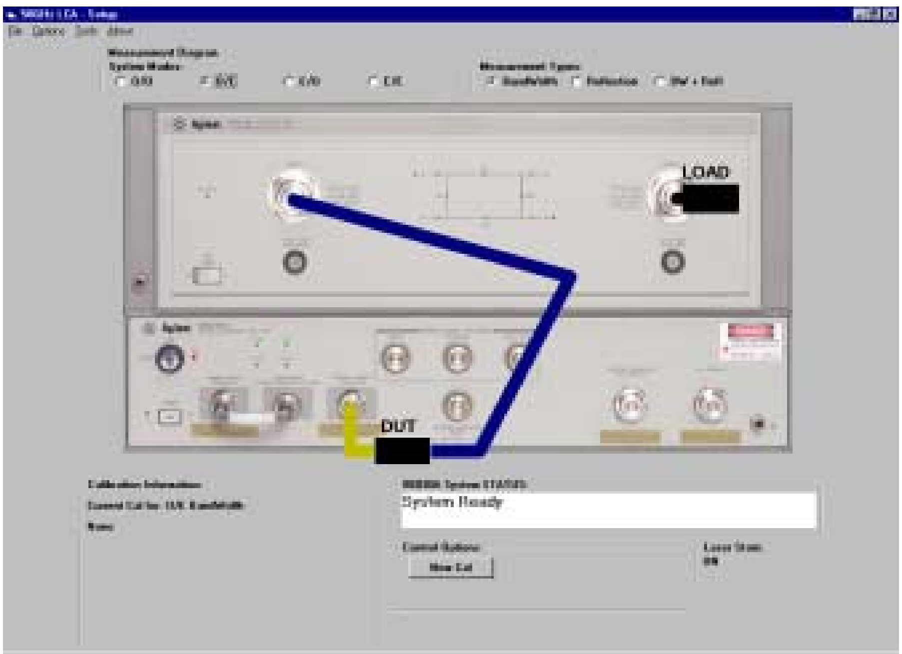
7 In the Control Options area, click on **Resp-Isol Cal**.



## Detector Response Measurement

**8** When the calibration is complete, connect the 83440D lightwave detector as shown. Remember to connect the 87421A power supply (found in the verification kit) to the DC bias port of the detector.

**NOTE** The 83440D Option 050 photodiode that is in the N1012A verification kit is internally terminated, and will not show as dramatic a change as the standard 83440D shown in this section.




**9** From the 8510 RESPONSE menu, adjust the scale to display the entire trace with the best sensitivity.

**a** Select *REF VALUE* and use the up and down arrow keys to center the trace around the display line.

**b** Select *SCALE* and decrease the dB/div to expand the trace across the display (approximately 2 dB/div).

**c** Repeat Step a and Step b to scale the trace across the display.

**d** Note the REF VALUE ___________ and SCALE ___________ as these settings will be used for the following comparison measurements.

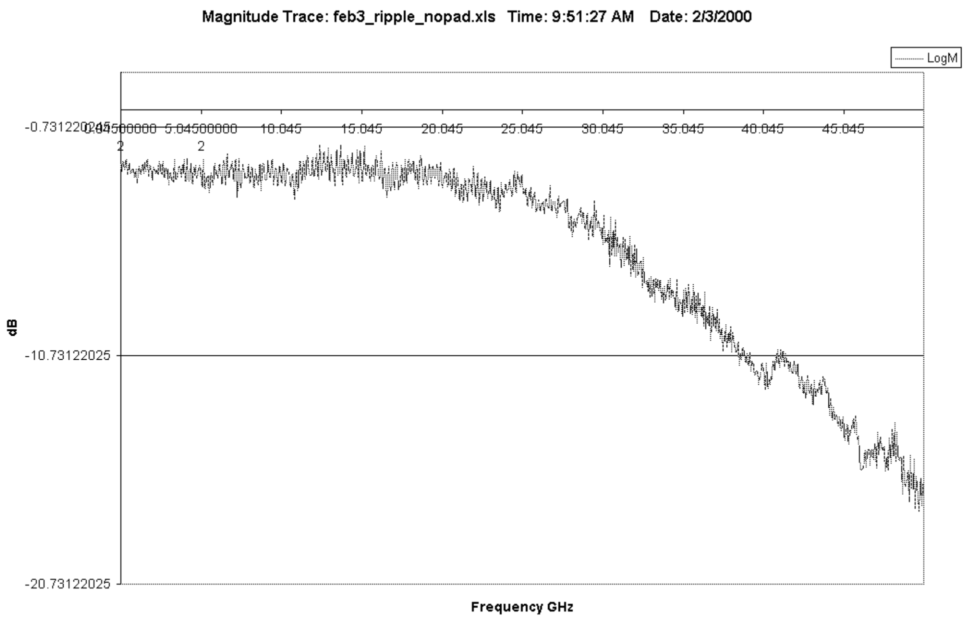



**Figure 3-9. 801 Data Points and No Attenuation Added**

**10** Save the trace data to an Excel file by selecting **File**, **Save Data**, **Excel File**, **Form Mag Log**.

**11** In the Save dialog box, enter the file name `ripple_801pts_nopad`.

Once the following measurement methods had been completed and the data saved, you can compare the results of the different measurement methods.

## Ripple Measurement, 801 Points, with 6 dB Attenuator

For devices that have a high reflectivity in their electrical port, adding an attenuator will reduce the effects of electrical mismatch ripple. However, you trade off system sensitivity for the reduced ripple since the signal to noise floor will be reduced by 6 dB.

1 Connect a 6 dB attenuator to the end of the 8517B Port 1 cable that connects to the electrical port of the 83340D lightwave detector.

The attenuator must be present for both the calibration and measurement procedures. Keep the attenuator and cable mated during the entire calibration and measurement procedure.

**NOTE**

The addition of the 6 dB attenuator to the test port cable causes this port to have a dc connection to ground. Insure that your DUT is compatible with having a dc path to ground.

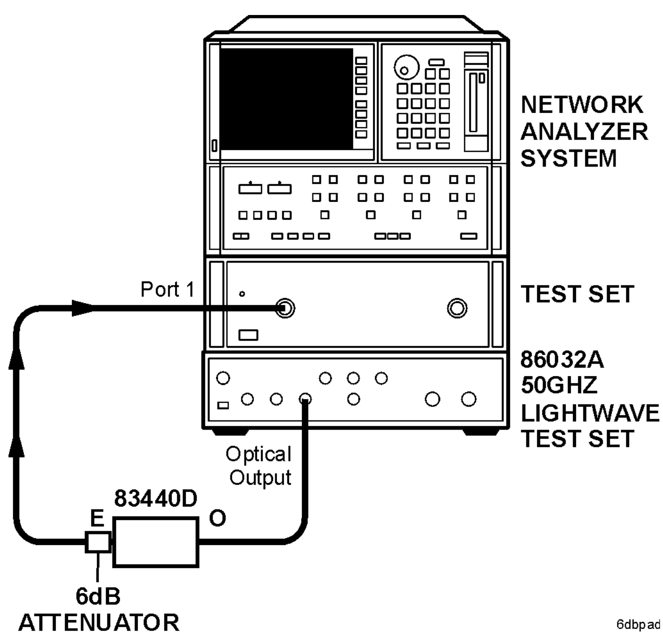



**Figure 3-10. O/E measurement with 6 dB attenuator**

**2** Repeat “O/E Calibration” on page 3-33.

**3** Repeat “Detector Response Measurement” on page 3-34. In Step 11, enter the file name ripple_801pts_6dbpad.

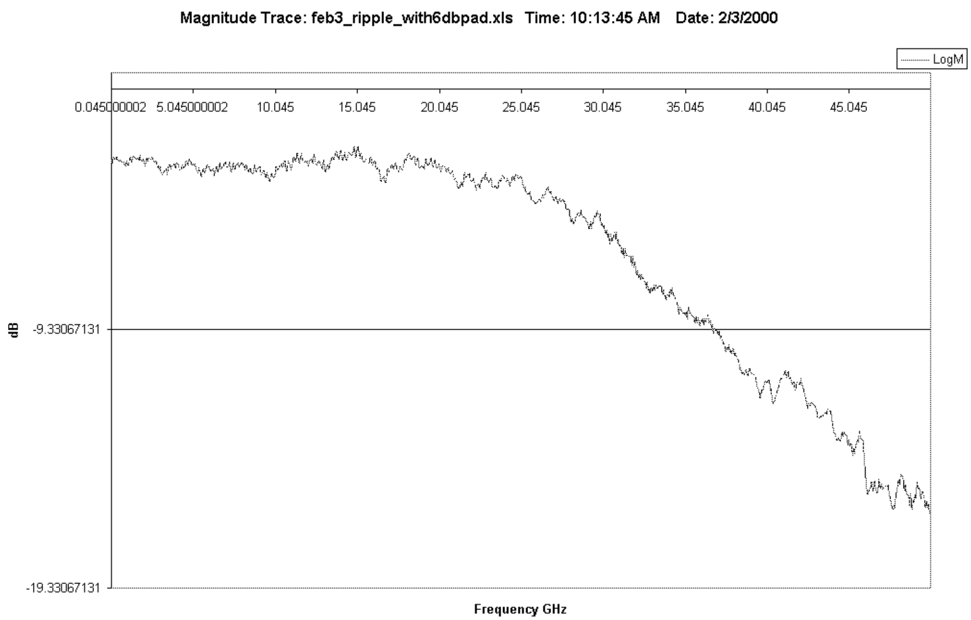



**Figure 3-11. 801 Data Points and 6 dB Attenuator**

# Ripple Measurement, 201 Points, with 6 dB Attenuator

The appearance of trace ripple is affected by the number of data points used for the measurement. When 201 point is selected for a 50 GHz span, there is approximately 250 MHz between data points. Thus, when viewing the trace data, it makes it difficult to discern the effects of the system ripple and the device characteristics.

1 Repeat "O/E Calibration" on page 3-33. In Step b of Step 6, select 201 points.

2 Repeat "Detector Response Measurement" on page 3-34. In Step 11, enter the file name ripple_201pts_6dbpad.

Compare the trace data taken with 201 points versus the trace data taken with 801 points. Notice that the 201 point trace has more of a sawtooth appearance. When fewer data points are taken, it affects your ability to discern the response of the device under test (DUT) from the effects of the ripple.

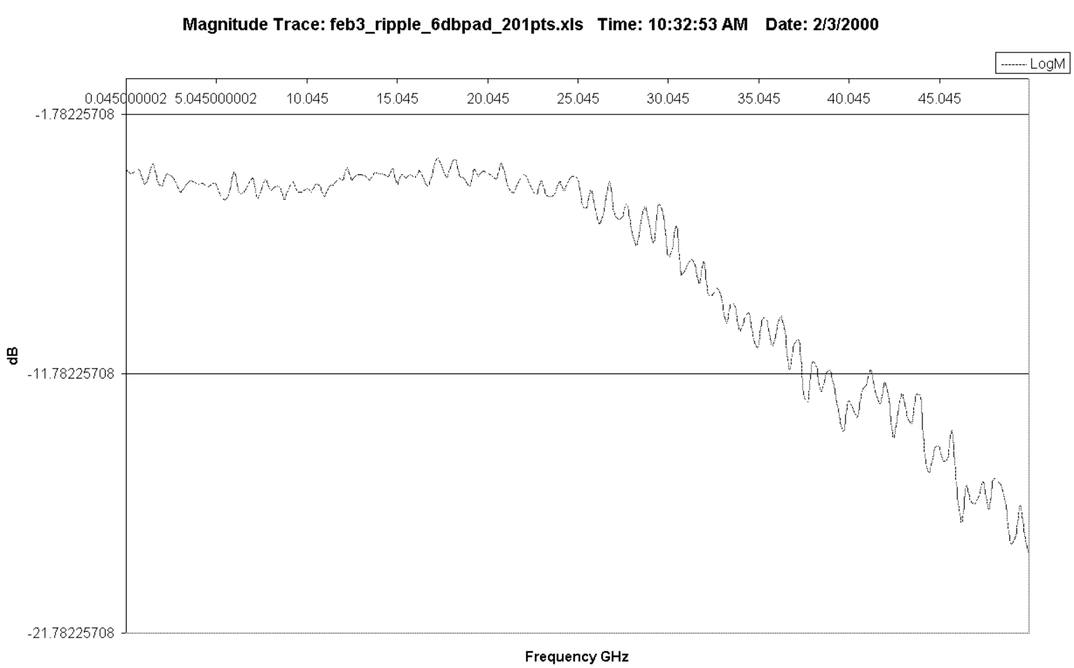



**Figure 3-12. 201 Data Points and 6 dB Attenuator**

## Ripple Measurement, 801 Points, Smoothing On, and 6 dB Attenuator

Turning Smoothing on can also help reduce trace ripple. Smoothing averages the points within the specified span. For this example, we will smooth the trace using 0.3% of the trace width. In this case, we have a 50 GHz trace width with each segment being 0.3% of 50 GHz or 150 MHz. If the DUT has features that do not vary significantly over a 150 MHz window, accurate measurements will be made. If this is not the case, then some distortion of the measurement will occur. Care should be taken when using this function, as important trace data may be masked by the effects of smoothing.

**1** Repeat “O/E Calibration” on page 3-33. In Step b of Step 6, select 801 points.

**2** Repeat “Detector Response Measurement” on page 3-34. In Step 9, select Smoothing On and set to 0.3% of span. In Step 11, enter the file name ripple_801pts_smoothingon_6dbpad.

## Use of Response and Match Calibration

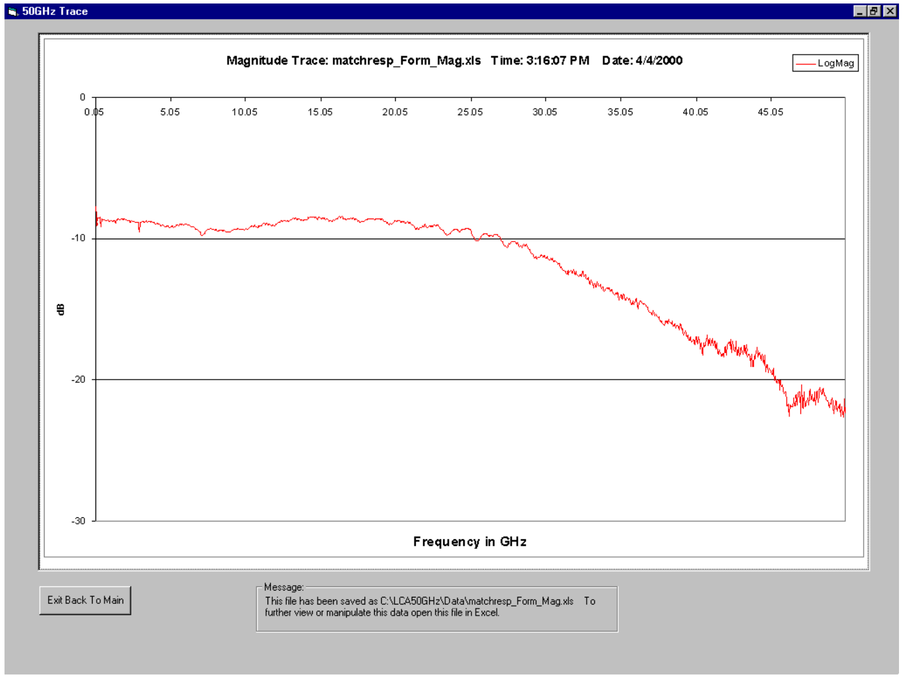
The 86030A also provides a capability to mathematically reduce the effects of electrical mismatch. In order to do this, the DUT response information is modified using measurements of the electrical reflectivity of the DUT and the electrical reflectivity of the 86030A. Significant reduction of electrical mismatch error results.

The disadvantage of a response plus match calibration is that it is a more complicated and lengthy procedure.

A response and match calibration is only valid for a particular DUT. If a measurement of a new DUT is desired, or if the electrical port match has changed, clicking on New DUT, in the Control Options area, will repeat the DUT reflectivity portion of the calibration.

**1** Perform a Response and Match calibration. Refer to “Follow the on-screen instructions for the isolation portion of the calibration procedure.” on page 3-13.

**2** Repeat “Detector Response Measurement” on page 3-34. In Step 11, enter the file name ripple_matchcal.


50GHz Trace
Magnitude Trace: matchresp_Form_Mag.xls Time: 3:16:07 PM Date: 4/4/2000
LogMag
0
-10
-20
-30
dB
0.05
5.05
10.05
15.05
20.05
25.05
30.05
35.05
40.05
45.05
Frequency in GHz
Exit Back To Main
Message:
This file has been saved as C:\LCA50GHz\Data\matchresp_Form_Mag.xls To further view or manipulate this data open this file in Excel.

# Magnitude Response and Deviation From Linear Phase of a Lightwave Receiver

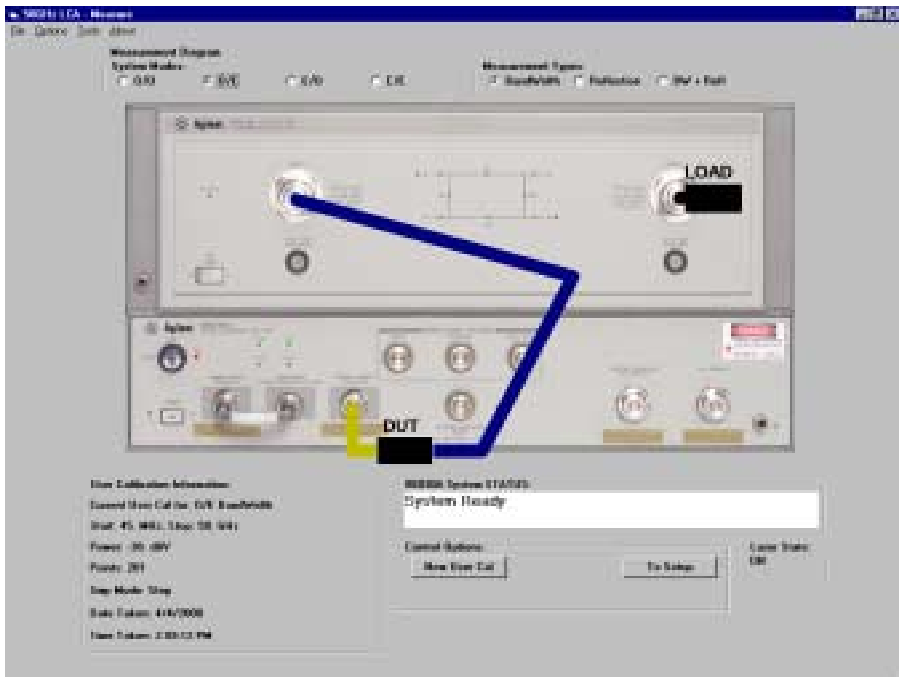
This example measures a lightwave receiver's transfer characteristics and deviation from linear phase. A receiver's transfer function is expressed in terms of receiver slope responsivity. This is the ratio of the RF current out to the intensity-modulated optical power in and is expressed in amp/watt or dB referenced to 1 A/W.

## Calibrating the system

**1** Perform an O/E Bandwidth calibration. Refer to "O/E Response and Isolation Bandwidth Calibration" on page 3-11.

## Connecting the device

**2** When the calibration is complete, connect the device as shown in the Measure window.



The 8510C displays the transfer characteristics of the lightwave receiver as shown in Figure 3-13. The measured device is an amplified photodiode receiver.

**3** To locate the maximum amplitude of the receiver, press, MARKER, *MORE,* then *MAXIMUM.*

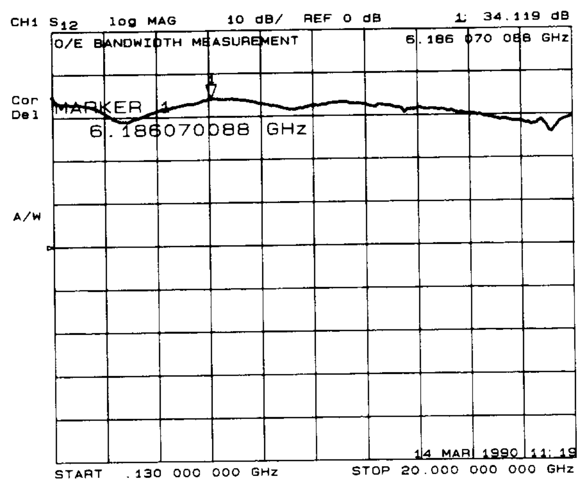



**Figure 3-13. Responsivity of a Photodiode Receiver**

## Measuring Deviation from Linear Phase

The analyzer can measure and display phase over the range of –180° to +180°. As phase changes beyond these values, a sharp 360° transition occurs in the displayed data. The electrical length effect can be removed to view the deviation from linear phase. To remove length effect, the analyzer mathematically implements a function similar to the mechanical “line stretchers” of earlier analyzers. This feature simulates a variable length of lossless transmission line. The simulation can be added to or removed from the analyzer’s internal reference port to compensate for the length of interconnecting cables, and so forth.

In this example, the electronic line stretcher measures the electrical delay of a photodiode receiver.

**1** In the RESPONSE area, press MENU, *ELECTRICAL DELAY*.

**2** Enter the delay time.

Pressing the *AUTO DELAY* function key on the 8510C will correctly perform a delay measurement if the device length is within the alias-free range of the measurement. The alias-free range is the range where you can correctly measure a response.

**3** To view the insertion phase response of the photodiode receiver, in the FORMAT area, press *PHASE.*

The modulation phase of the photodiode receiver is shown in Figure 3-14.

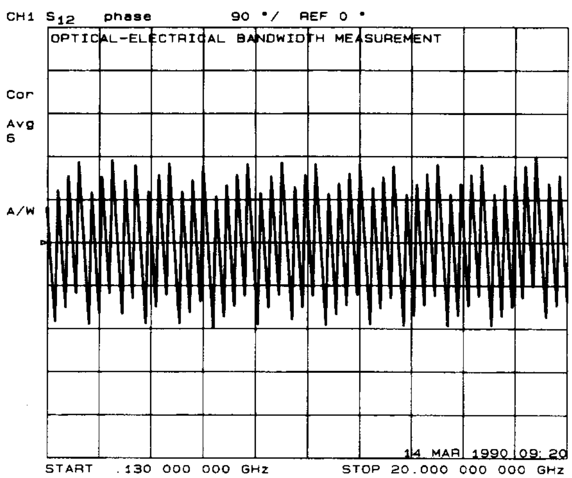



**Figure 3-14. Modulation Phase Response of a Photodiode Receiver**

The analyzer measures and displays phase over the range of –180° to +180°. As phase changes beyond these values, a sharp 360° transition occurs in the displayed data. The Δ measured between two adjacent frequency points must be <180°. If the phase is >180°, incorrect delay information may result. For example, the first set of frequency points shown in Figure 3-14 has a Δ = <180°. If the delta is < 180° between adjacent frequency points, the network analyzer will be successful in making group delay measurements on the DUT.

Figure 3-15 illustrates an example where the delta is > 180°. In this example there is a data point measuring –165° and the following data point measuring –5° (but on a different tooth of the sawtooth waveform). In order to compare the absolute phase difference between these two points, you must translate the –165° upward by 360° (one revolution on the cartesian scale). Resulting in a translated phase value of + 195°. The difference between the points can now be compared, 195° – –5° = 200°. Since the delta between points is > 180°, this situation will lead to erroneous values while making delay measurements.

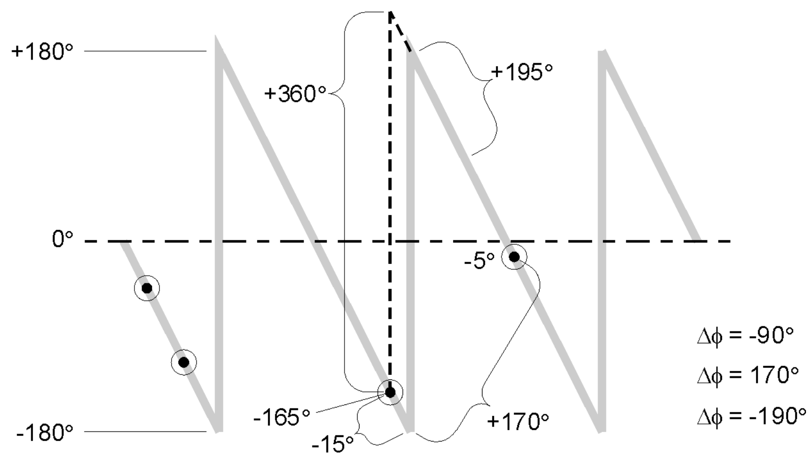



**Figure 3-15. Phase Samples**

To measure a correct phase response, the electrical delay must be within the alias free range.

**4** Calculate the alias-free range for the measurement parameters of the analyzer.

This range can be determined by:

$$AFR = \pm \frac{1}{2(\Delta f)}$$

$$\Delta f = \textit{frequency spacing between points}$$

$$\Delta f = \frac{\textit{start frequency} - \textit{stop frequency}}{\textit{number of points} - 1}$$

*For example, if:*

*start frequency = 130 MHz*

*stop frequency = 20 GHz*

*number of data points = 201*

*then:*

$$AFR = \pm\left[\frac{1}{\left(\frac{2(20\times10^{9} - 130\times10^{6})}{201 - 1}\right)}\right] = \pm 5\ ns$$

This means that the alias-free range is ±5 ns. Figure 3-16 shows a time domain response from an electrical delay of 8 ns with a ±5 ns alias free range. Notice the response repeats every 10 ns. The correct response is at 8 ns, but the auto delay function on the 8510C would give delay information of –3 ns since it is closest to zero.

If the electrical delay is set to the true value, the phase response is correct, but the time response is only correct in 1 alias free range around the delay time.

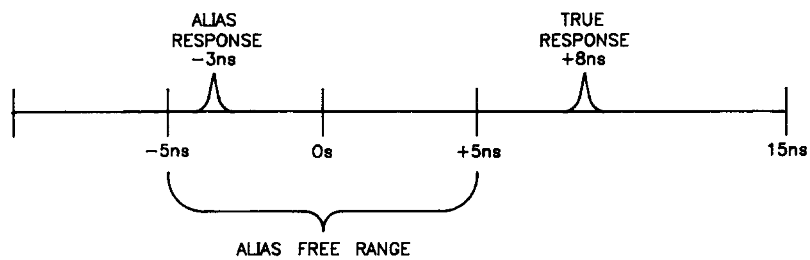



**Figure 3-16. Time Domain Response with the Alias Free Range**

## Alias Free Range

The number of data points may be increased to obtain an alias-free range larger than the electrical length of the device. If the number of data points is increased to 401, then the alias-free range is calculated as follows.

$$AFR = \pm\left[\frac{1}{\left(\frac{2(20\times10^{9} - 130\times10^{6})}{401 - 1}\right)}\right] = \pm 10\ ns$$

> **Note**
>
> The frequency span can also be made smaller to increase the alias-free range.

## Determining Electrical Length

Before a calibrated measurement is performed, a delay measurement may be taken with a small frequency span and compared to the calculated alias-free range. If the delay measurement result is longer than the alias-free range, the measurement parameters or electrical delay value needs to be changed.

**5** To narrow the span, in the STIMULUS area, press CENTER 2 [G/n] then SPAN 100 [M/u].

A new calibration can be done at this time. Without a calibration, the delay value may be off by ±5 ns.

> **Note**
>
> A frequency span of 100 MHz with 201 measurement points gives an alias-free range of 1 µs (approximately 300 meters). As the frequency span decreases, the alias-free range increases.

**6** To measure delay, in the RESPONSE MENU, press DELAY, then AUTO DELAY.

Read the value from the analyzer display.

**7** To remove delay measurement noise in the RESPONSE area, press MENU, *AVERAGING ON/RESTART*, then *SMOOTHING ON* 20 [x1].

Record the delay value________________.

**8** In the MENUS area, press DOMAIN, then *FREQUENCY*.

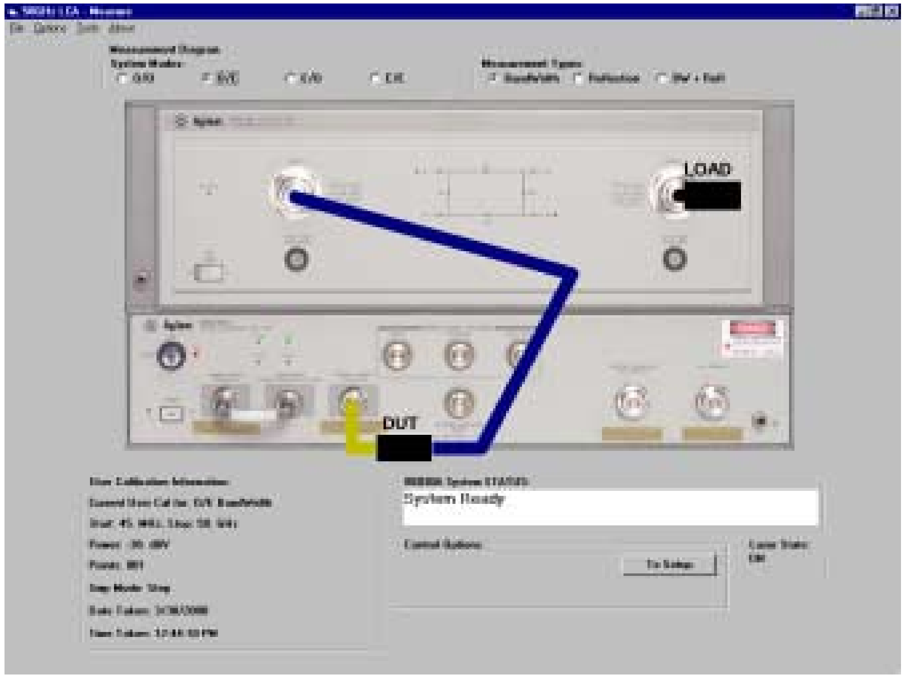
**9** To change the parameters back to the original setup, in the STIMULUS area, press START 130 [M/u], then STOP 20 [G/n].

**10** In the FORMAT area, press LOG MAG/.

When parameters are changed, another measurement calibration must be performed.

**11** Perform an O/E Bandwidth calibration.

**12** When the calibration is complete, connect the device between the optical and electrical test ports as shown on the Measure window.




**13** To measure the delay with the Auto Delay function, in the FORMAT area, press PHASE.

**14** In the RESPONSE area, press MENU, *AUTO DELAY,* then *ELECTRICAL DELAY*.

Notice the delay and phase information on the analyzer display.

If the electrical delay of the device is longer than the alias-free range, the Auto Delay function will not give the correct electrical delay, and the phase information will be offset by (difference of correct and incorrect delays) × (start frequency) × (360°).

Enter the electrical delay value recorded in Step 7.

**15** Turn the front panel knob to change the electrical length until the best flat line is achieved as shown in Figure 3-17.

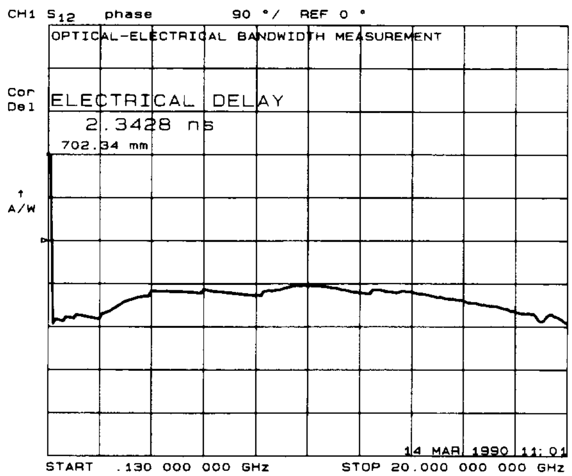



**Figure 3-17. Electrical Length Added**

**Note**

The drop in the trace at the beginning of the sweep in Figure 3-17 is because of a transition from +180° to –180°. The receiver measured is an inverting receiver. The phase of the output is inverted 180° from the input. To view the phase response that is out 180°, you may offset the phase reference.

**16** To offset the phase by 180°, in the RESPONSE area, press MENU then *PHASE OFFSET* 180 [x1].

Figure 3-18 shows the result of a phase offset.

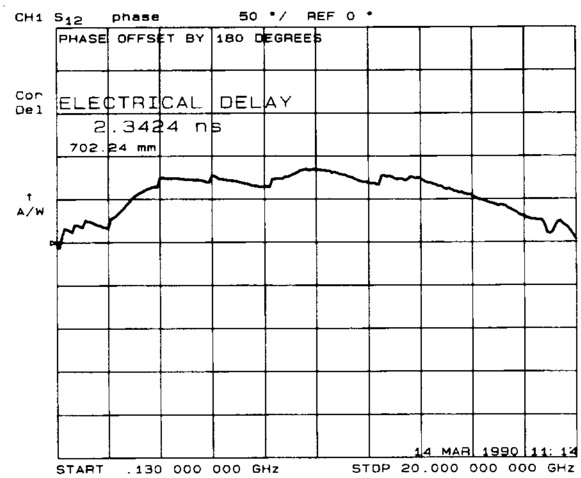


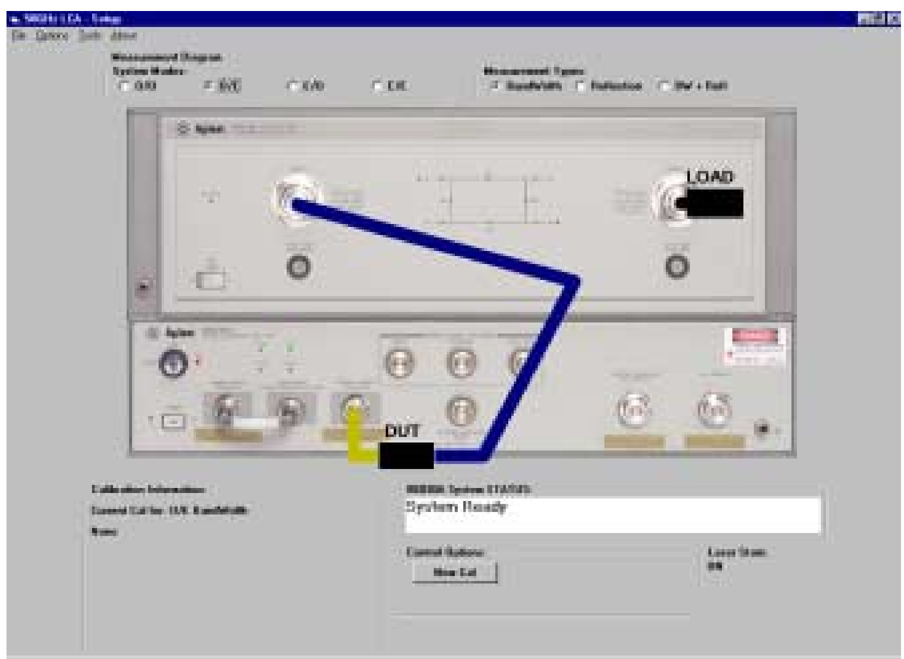

**Figure 3-18. Phase Offset by 180°**

# O/E RF Overload Detection Measurement

High-gain O/E converters may supply too much power to 8517B Port 1 inducing an RF overload condition. This may cause amplitude measurement errors to occur. The following procedure will help you to determine if any signals within the measured frequency range could cause an overload condition.

**1** Perform an O/E Response and Match calibration. Refer to "O/E Response and Isolation Bandwidth Calibration" on page 3-11.

**2** Connect the DUT as shown below and wait until an entire sweep of the trace has been taken.




**3** In the 8510C Menus area, press DISPLAY, *DATA and MEMORIES*, *DATA → MEMORY #* to store the active trace.

4 From the Display menu, press *MATH OPERATIONS*, and select *DIVIDE (/)* for the active memory register.

5 From the DISPLAY menu, press *MATH (/)* so that it is underlined.

This operation normalizes the memory to the data. This is useful for ratio comparisons between two traces, for example, measurements of gain or attenuation.

6 In the Response area, press SCALE and enter 1 X1 to set the magnitude scale to 1 dB per division.

7 From the 50 GHz LCA software, click on the **Tools** menu then **Modify Test Set**.

8 In the Modify Test Set dialog box, enter **9** dBm in the Set Laser Output Power box (that is, set the power to 1 dB lower than the value displayed in the Current Laser Output Power box) and then click **Modify Power**.

9 Monitor the change of the stored trace on the 8510C display. For the 1 dB decrease in optical power, you should see a 2 dB decrease in electrical power (that is, 2 divisions) across the entire trace. Any portion of the trace that doesn't drop by 2 dB indicates that there is an overload condition at that point.

10 If an overload condition is detected, you will need to reduce the input power to the point where a 1 dB optical change results in a 2 dB electrical change.

11 Once you have verified that an overload condition does not exist, set the Laser Output Power to the highest possible power without causing an overload condition.

# Remote Operation

# Chapter Overview

This chapter includes the following sections for describing the 86030A remote operation and showing you how you can use it to automate measurements on the lightwave component analyzer.

- 86030A Remote Operation Overview
- COM Fundamentals
- Getting a Handle to the Server Object
- Configure for DCOM Programming
- COM Data Types
- 86030A Remote Operation Tutorial
- 86030A Server API Overview
- List of Available Commands
- Description of Available Commands

The tutorial section contains information that show you how to do the following:

- Connect to the 86030A server
- Perform measurements
- Retrieve data
- Handle any errors

This chapter also introduces some COM fundamentals for the beginning COM programmer. Information on configuring DCOM to work with the 86030A and a client or controlling PC is also included. You can see most of the concepts described in this chapter by looking at the example program that comes with this system. The example program is on the client software CDROM and is installed on the client PC along with the 86030A client software. This documents gives the perspective of the Visual Basic programmer. All example code and references are to the Visual Basic development environment.

# 86030A Remote Operation Overview

The 86030A system includes a dedicated computer that contains the analyzer remote operation server. This server contains an API that allows you to operate the 86030A remotely, using your own computer and the programs that you have created. The graphic below shows the configuration for the 86030A system computer, your computer (client computer), and the connecting LAN. This configuration is used to isolate the 86030A from the your company's intranet. Refer to "Step 6. Configure for Remote Operation" on page 1-12 for more information.

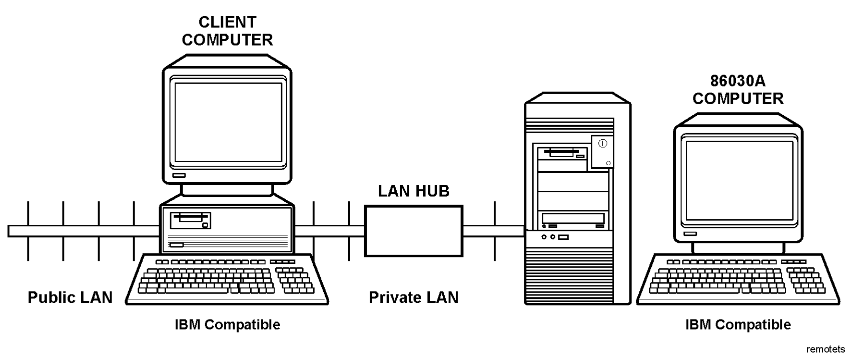



**Figure 4-1. Configuration for 86030A Remote Operation**

**NOTE**

A direct connection between the 86030A and private LAN requires a crosss-over cable. The preferred connection method uses a cross-over hub or LAN hub.

The 86030A software is designed as a standalone COM compliant automation server. Therefore, the terms "server" and "object" are used interchangeably in this chapter.

The 86030A server supports only Synchronous methods.  Each method of the server blocks until it has completed the command execution. That is, calls do not return until the server has finished executing the desired request.

At the end of this chapter there is a list of the available commands that you can use for creating programs to control the 86030A system and to perform measurement calibrations.

**NOTE**

It is always good practice to verify that the laser is on before making a measurement. See the gTestSetup command. If a program starts the LCA86030Amain application remotely, it is important to insure that there are no previous LCA86030Amain programs running on the server computer. Failure to end the 86030Amain program can lead to unreliable operation. If you are in doubt, use the NT task manager on the server computer to end all 86030Amain applications prior to running the remote program.

# COM Fundamentals

The following terms are disucssed in this section:

- Server Object
- Methods
- Properties
- Events

**NOTE** The information is this section is intended for an experienced SCPI programmer transitioning to COM programming. This is NOT a comprehensive tutorial on COM programming.

## Server Object

The 86030A system computer functions as a remote automation server. The server contains the 86030A measurement automation application structure of a single programmable object. All of the methods and properties discussed in this chapter are associated with this one server object.

In SCPI programming, you must first select a measurement before making any settings. With COM, you first get a handle to the object (server) and refer to that object in order to change or read settings on the 86030A system.

For more information on working with objects, see Getting a Handle to an Object.

The server IP settings come from the factory as follows:

| | |
|---|---|
| IP Address | 192.169.000.002 |
| Subnet Mask | 255.255.255.000 |
| Default Gateway | 192.168.000.001 |

## Methods

A method is an action that is performed on the 86030A system server object. In the following example, SysInit is a method that applies to the server (object). The SysInit method is shown to initialize the 86030A system.

```
Sub InitSystem()
serverSysInit
End Sub
```

## Properties

A property is an attribute of the server object, defining one of the object's characteristics such as start frequency, stop frequency, or number of points. To change the characteristics of the server object, you change the values of its properties. The server properties should be viewed as the 86030A measurement state.

To change the value of a property, follow the reference to 86030A server object with:

- a period (.)
- the property name
- an equal sign (=)
- the new property value

For example, the following statement sets the number of averages on the analyzer to 32 averages at each point.

```
sLCA.Averaging=32
```

You can also read the current value of a property. The following statement reads the current Averaging setting for the analyzer in to the variable intAverages.

```
IntAverages=sLCA.Averaging
```

Some properties cannot be set. Later in this chapter, there is a listing for each property that indicates if you can:

- Set and read the property (Write/Read)
- Only read the property (Read-only)

# Events

An event is an action recognized by the 86030A server object. In the Windows operating system, the applications respond to user-initiated events such as mouse moves and mouse clicks. A mouse click produces an event that the programmer can either ignore or handle by providing an appropriate subroutine like this:

```
Sub DoThis_onClick
Perform something
End Sub
```

If this subroutine were in your program and the mouse-click event occurred on your PC, it would generate a "Callback" to the client and interrupt whatever it was doing and handle the event.

The 86030A system supports the following single event.

**ERRHANDLER**

This event is used to notify you when an error has been encountered by the system. For example, if a method of the server is called and an error occurs while executing the method, the event ERRHANDLER is initiated which sends a message to the client (controlling) computer. For a definition of the ERRHANDLER event refer to "Public Event ERRHANDLER(strERROR As String, intErrorCode As enumStatus)" on page 4-94.

If you decide to use the COM event ERRHANDLER to get a callback, your program must do two things:

1. Subscribe to events.

   You must tell the application object that you are interested in receiving event callbacks. This process is called subscription.

   In Visual Basic, this is done by including "WithEvents" in the declaration statement. The declaration below dimensions an Application object (myLCA) and subscribes to the event(s) produced by the Application.

   ```
   Dim WithEvents myLCA as A86030_LCAServer.A86030Sync
   ```

2. Implement the Event Handler.

   In Visual Basic (VB), click on the object window (upper left pane). Find the Application object and check it. The event interface ERRHANDLER will appear in the upper right pane. As you click on the event, VB supplies the first line of code. You fill in the rest of the handler routine to service the event. The following is an example of an event handler subroutine responding to the ERRHANDLER event.

```
Private Sub myLCA_ERRHANDLER (strERROR As String, intEr-
rorCode As enumStatus)
‘ Programmers Code goes here to respond to any errors
End Sub
```

# Getting a Handle to the Server Object

The following topics are discussed in this section:

- What is a Handle
- Declaring an Object Variable
- Assigning an Object Variable

## What is a Handle

In SCPI programming you must first select a measurement before changing or reading settings. In COM programming the 86030A, you first get a handle to the server object and refer to that object to change or read its settings.

**NOTE** This process is also called "getting an instance of an object", and "returning an object." In this manual, "object" refers to the 86030A server, residing on the 86030A system computer.

There are two steps for getting a handle to the server object:

1 Declaring a variable as an object.

2 Assigning an object to the variable.

## Declaring a Variable As an Object

Use the Dim statement or one of the other declaration statements (Public, Private, or Static) to declare a variable. The type of variable that refers to an object must be a Variant, an Object, or a specific type of object. For example, all three of the following declarations are valid:

- **`Dim sLCA`**
- **`Dim sLCA As Object`**
- **`Dim sLCA As A86030_LCAServer.A86030Sync`**

**NOTE**

If you use a variable without first declaring it, the data type of the variable is Variant by default.

If you know the specific object type, you should declare the object variable as that object type. Declaring specific object types provides automatic type checking, faster code, and improved readability.

A reference to the 86030A automation server should look like one of the following:

- **`Dim sLCA As A86030_LCAServer.A86030Sync`**

or

- **`Public sLCA As A86030_LCAServer.A86030Sync`**

## Assigning an Object to a Variable

The only object to assign to a variable is the Application object (the 86030A Lightwave Component Analyzer). When assigning an object to a variable, use the Set keyword before the object variable that was previously declared. In the following example, "sLCA" is the variable we declared in the previous example. So we assign the current A86030_LCAServer Application to "sLCA."

Because the A86030_LCAServer object is the Application server, you must use the CreateObject keyword with the (classname, server name) parameters.

- classname for the analyzer object is always **`"A86030_LCAServer.A86030Sync"`**.
- server name corresponds to the name given to the PC in the 86030A system. By default this name is **`"XXXLWD"`**. Where **`"XXX"`** is a set of unique characters assigned at the factory.

For example, the following statements would create an instance of the Analyzer object.

```
Dim sLCA as A86030_LCAServer.A86030Sync
Set sLCA = CreateOb-
ject("A86030_LCAServer.A86030Sync","XXXLWD")
```

**NOTE**

These statements will start the 86030A application if it is not already running on your instrument.

Once you have created an object variable, you can refer to it exactly the same as you would refer to the corresponding object. You can set or return the properties of the object or use any of its methods. For example:

**`sLCA.SysStartUp`**

At this point the programmer is connected to the server that resides on the 86030A computer. By using the methods and properties of the server, the programmer can access the functionality of the 86030A system to perform calibrations and measurements.

Refer to "Overview of the 86030A Server API" on page 4-24 for a complete list of properties and methods supported by the 86030A server

# Configuring for DCOM Programming

The Distributed Component Object Model (DCOM) refers to accessing the analyzer application from a remote PC. The Component Object Model (COM) refers to accessing the analyzer application from the analyzer's system server. However, this last method of access is not supported for the 86030A LCA.

Before developing or running a DCOM program, you should first establish communication between your PC (client PC) and the 86030A system server. Then load the 86030A Client Software on the client PC and the 86030A type library is registered automatically.

**NOTE** Your programming environment may require you to set a reference to the type library on the client PC.

This section discusses the following topics on DCOM programming:

- Access Concepts
- Access Procedures

## Access Concepts

Agilent 86030A Lightwave Component Analyzers (LCA) are shipped from the factory such that Everyone has permission to launch and access the 86030A application via COM/DCOM. The term Everyone refers to a different range of users depending on whether the 86030A is a member of a Domain or Workgroup (it must be one or the other; not both).

**Workgroup**

A workgroup is established by the LCA administrator, declaring the workgroup name and declaring the LCA as a member of the workgroup. A workgroup does not require a network administrator to create it or control membership.

Everyone includes only those users who have been given logon accounts on the client PC.

By default, the LCA is configured as members of a workgroup named WORKGROUP.

**NOTE** For DCOM access, the user's log-on account name and password must match their PC logon account name and password EXACTLY.

**Domain** A domain is typically a large organizational group of computers. Network administrators maintain the domain and control which machines have membership in the domain.

Everyone includes those people who have membereship in the domain. In addition, those with logon accounts can also access the LCA.

In summary:

A Workgroup requires no maintainence, but allows DCOM access to only those users with a log-on account for the LCA.

A Domain requires an administrator, but all members of the domain are automatically allowed DCOM access to the LCA.

The next level of security is to allow only selected (not Everyone) domain and workgroup users DCOM Access and Launch capability of the analyzer.

## Access Procedures

**NOTE** Before performing this procedure, the user must first have a log-on account on the client PC.

This procedure is used for the following:

- Allowing only selected users remote (DCOM) Access and Launch capability to the analyzer. (Launch capability is starting the analyzer application if it is not already open.)
- Verifying you have DCOM accesss to the analyzer.

Perform the following steps for both Access and Launch capabilities:

1. On the LCA, click the Windows Start button.
2. Click Run.
3. In the Open box, type dcomcnfg.

4 Click OK.

5 In the Distributed COM Configuration Properties window, click on A86030_LCAServer in the Applications list.

6 Click Properties and select the Security tab.

**Access Capability**

The following steps configure the LCA to grant specific users DCOM access to the LCA application:

1 In the Agilent LCA Series Properties dialog box, click the Security tab.

2 Click Use custom access permissions, Edit.

3 In Registry Value Permissions, select Everyone.

4 Click Remove, Add.

5 In Add Users and Groups select the name(s) to have access to the LCA application.

6 Click Add, OK.

**Launch Permission**

The following steps configure the LCA to allow selected users to Launch (start) the LCA application:

1 Click Use custom launch permissions, Edit.

2 In Registry Value Permissions, select Everyone.

3 Click Remove, Add.

4 In Add Users and Groups select the name(s) to have access to the LCA application.

5 Click Add, OK.

6 In the Agilent LCA Series Properties dialog box, click the Identity tab.

7 Click The interactive user. This function allows access to the GUI interface.

# COM Data Types

The 86030A system server uses several data types to communicate with the client (customer) computer. Before using a variable, you should declare the variable as the type of data it will store. This will save memory and usually gain faster access. The following are the most common data types:

- Long Integer
- Single Precision (Real)
- Double Precision (Real)
- Boolean
- String
- Object
- Enumeration
- Variant

**Long**

Long integer variables are stored as signed 32-bit (4-byte) numbers ranging in value from -2,147,483,648 to 2,147,483,647.

**Double**

Double-precision floating-point variables are stored as IEEE 64-bit (8-byte) floating-point numbers ranging in value from -1.79769313486232E308 to -4.94065645841247E-324 for negative values and from 4.94065645841247E-324 to 1.79769313486232E308 for positive values.

**Single**

Single-precision floating-point variables are stored as IEEE 32-bit (4-byte) floating-point numbers, ranging in value from -3.402823E38 to -1.401298E-45 for negative values and from 1.401298E-45 to 3.402823E38 for positive values.

**Boolean**

Boolean variables are stored as 16-bit (2-byte) numbers, but they can only be True or False. Use the keywords True and False to assign one of the two states to Boolean variables.

When other numeric types are converted to Boolean values, 0 becomes False and all other values become True. When Boolean values are converted to other data types, False becomes 0 and True becomes -1.

**String**

String variables hold character information. A String variable can contain approximately 65,535 bytes (64K), is either fixed-length or variable-length, and contains one character per byte. Fixed-length strings are declared to be a specific length. Variable-length strings can be any length up to 64K, less a small amount of storage overhead.

**Object**

Object variables are stored as 32-bit (4-byte) addresses that refer to objects within the analyzer or within some other application. A variable declared as Object is one that can subsequently be assigned (using the Set statement) to refer to the actual analyzer object.

**Enumerations**

Enumerations (Enum) are a set of named constant values. They allow the programmer to refer to a constant value by name. For example:

```
Enum DaysOfWeek
Sunday = 0
Monday = 1
Tuesday = 2
Wednesday = 3
Thursday = 4
Friday = 5
Saturday = 6
End Enum
```

Given this set of enumerations, the programmer can then pass a constant value as follows:

```
SetTheDay(Monday)
```

rather than

`SetTheDay(1)`where the reader of the code has no idea what the value 1 refers to.

However, the analyzer returns a long integer, not the text.

```
Day = DaysofWeek(today) ‘Day=1
```

**Variant**

If you don't supply a data type, the variable is given the Variant data type. The Variant data type can represent many different data types in different situations.

The analyzer provides and receives Variant data in several instances because there a programming languages that cannot send or receive "typed" data. Variant data transfers at a slower rate than "typed" data.

# Tutorial Using 86030A Remote Operation

The example programs are a great place to start when you are learning to program the 86030A system. However, these programs are not warranted by Agilent Technologies and are intended to serve only as examples to aid you in learning the 86030A remote operation interface. The tutorial shows you how to do the following steps.

1. Connect to the 86030A server.
2. Initialize the server and the 86030A system.
3. Configure the 86030A system using the server.
4. Perform measurements using the remote operation interface.
5. Retrieve measurement data.
6. Check for any encountered errors.

The flow chart on the next page shows a suggested program sequence for operating the 86030A system remotely.

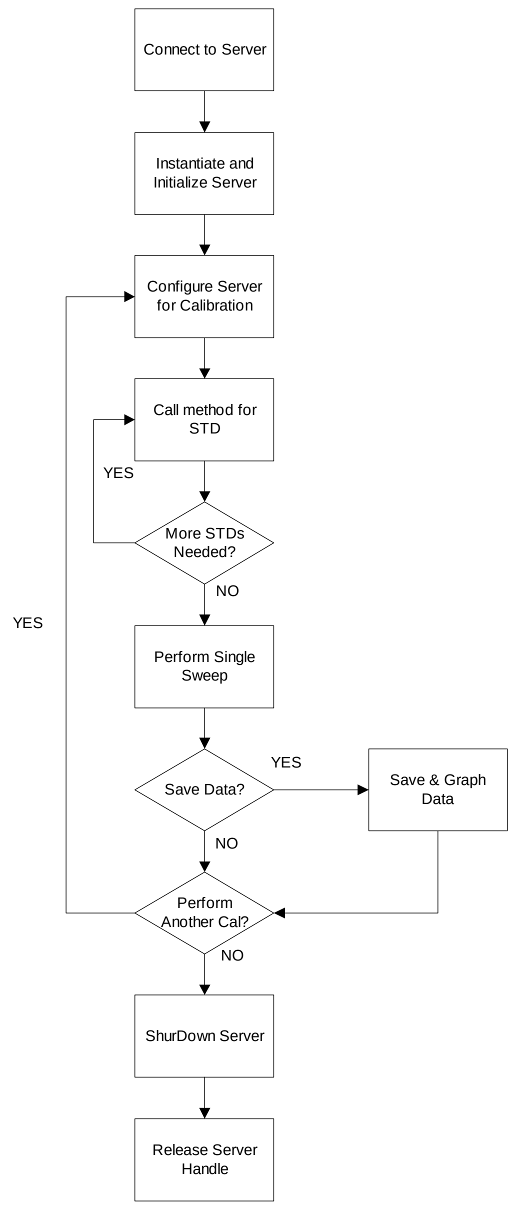



**Figure 4-2. Suggested Program Sequence**

## Step 1. Connect to the 86030A Server

The Visual Basic editor must be able to see the A86030_LCAServer.TLB file. This file contains the definition of the server interface.

1. To include this type library in your Visual Basic application, click Project, References, Browse.
2. Navigate to C:\Program Files\AgilentTechnologies\86030A and select the A86030_LCAServer.TLB file.
3. Declare and obtain a handle to the 86030A server. See "Getting a Handle to the Server Object" on page 4-9 for the details of how to connect to the server.

## Step 2. Instantiate and Initialize the 86030A Server

Initializing the server loads needed configuration information for placing the server, the optical test set, and the network analyzer into a known state. After the initialization, you can access the methods and properties of the 86030A server.

1. Execute the following statement so the server automatically establishes communication with the network analyzer.

```
Set sLCA=CreateOb-
ject("A86030_LCAServer.A86030Sync","XXXLWD")
```

2. Once a connection has been established execute the following statement to start the 86030A server.

```
sLCA.SysStartUp
```

3. Execute the SysInit method so the 86030A system is initialized. This should be the first method called after establishing a connection to the server. For example:

```
ErrorCode = server.SysInit
```

ErrorCode is a type integer and will be a 0 if the method was successful or a -1 if an error was encountered during the initialization. See "Events" on page 4-7 to see how errors are handled with the 86030A server.

The 86030A server is now initialized and contains the appropriate settings for the optical test set, and 8510. At this point you have full access to the functionality of the server. Also, the system is operating with a fully initialized and calibrated instrument.

**NOTE** The SysInit method can also be used to reset the instrument. This method places the system into a known state.

## Step 3. Configure the 86030A System Server for Calibration

Once you get a handle to the server object and initialize the server, you may want to make modifications to the 86030A current settings, or start a measurement calibration.

**1** Modify the measurement settings using properties.

You can use properties to modify the measurement settings. Refer to "System Properties" on page 4-25 for a list of the properties available for the 86030A.

For example, the following use of a property sets the averaging factor of the 8510 to 32 averages at each point.

```
server.Averaging = 32
```

**2** Set up a measurement state for a calibration using the "sSetupCal" method.

The main method for setting up a calibration is named **"sSetupCal"**. The following is an example call to this method. Refer to "List of Available Commands" on page 4-25 for more details on the measurement settings and the use of this method.

```
server.sSetupCal OE_BW_RESPONSE, POINTS401, 32,
45000000#, 50000000000#
```

- **OE_BW_REPONSE** is an enumerated value that selects an Optical to Electrical Bandwidth Response calibration.
- **POINTS401** is an enumerated value that selects 401 points on the 8510.
- **32** is the number of averages at each point.
- **45000000#** is a parameter for the start frequency.
- **50000000000#** is a parameter for the stop frequency.

Through the use of properties and methods the system is configured for the appropriate calibration. At this point the server is initialized and the 86030A system is configured for an O/E bandwidth response calibration.

### Step 4. Performing Measurements Using the Remote Operation Interface

Once the system has been configured for an appropriate calibration, a number of calibration standards must be measured as part of the calibration process.

The calibration standards must be measured in a specific order. Refer to "Calibration Methods" on page 4-41 for information on the correct sequence of standard measurements for each calibration type.

1 Determine the standards that must be measured for the measurement calibration type.

2 Determine the sequence in which the standards must be measured during the calibration process.

3 Make good connections for each of the calibration standard measurements.

4 Make a call to perform the standard measurement.

In the following example the O/E bandwidth response calibration has only one standard to measure.

```
ErrorCode =  server.OEBWRESP_STD1
```

The above call will cause the measurement of standard 1, which allows the 86030A system to reduce measurement errors. When the method returns ErrorCode it will either contain one of the following:

- **0** indicating success
- **-1** indicating failure

If a -1 is returned, the system status register can be queried to help determine the cause of the error. For example:

```
ErrorCode32 = server.SysStatusReg
```

The ErrorCode32 must be a 32 bit value or Long in Visual Basic. This code can be matched against the provided error codes to help determine the failure. The value in the system status register represents the last encountered error the system experienced.

More detailed errors can be obtained by using the ERRHANDLER event of the 86030A server. This event provides a detailed message and error code to help determine the encountered error.

To use this ERRHANDLER event you must create the handle to the server using WithEvents. For example:

```
Public WithEvents server As A86030_LCAServer.A86030Sync
```

You will also need to write an error handler to do something with the information that the server provides. For example:

```
Public Sub A86030_LCAServer_ERRHANDER (strerr as string,
interr as enumStatus)
'Your code goes here which takes the appropriate action
for the error that is encountered.
End Sub
```

## Step 5. Retrieve Measurement Data

There are methods that allow you to obtain measurement and calibration data from the 8510 using the 86030A remote operation. See "Data Methods" on page 4-34 to learn proper usage of these methods. The following code examples show different ways to obtain data.

- Obtaining measurement data:

```
Private Sub cmdGetMeasurementData_Click()
Dim Traces As Integer
Dim Points As Integer
Dim TraceData() As Single
server.GetTraceData LOGMAG_TYPE, Traces, Points, Trace-
Data
End Sub
```

**NOTE** The call to GetTraceData in the above example will return data from the 8510 into the array TraceData.

- Obtaining calibration data:

```
Private Sub cmdPlotCurrentCalibration_Click()
Dim Sets As Integer
Dim Points As Integer
Dim CalibrationData() As Single
server.GetCalibrationData Sets, Points, CalibrationData
End Sub
```

**NOTE** The call to GetCalibrationData in the above example will return data from the 8510 into the array CalibrationData.

This method allows you use the 86030A remote operation to download the correction coefficients from the 8510.

### Step 6. Check for Any Encountered Errors

You can use two different approaches to obtain error information remotely.

- In the first approach you can use the return values of methods and the system status register.
- In the second approach you can use the ERRHANDLER event provided by the server.

Almost all methods return a 0 or a -1 to indicate success or failure respectively. If the method was successful (returned 0), there is no reason to query the system status register. If a -1 was returned, then the system status register can provide information as to the reason for the error.

The second approach, using the ERRHANDLER event, provides the most information when an error is encountered. The handle to the 86030A server object must be declared WithEvents. Then an error handler must be written on the client or controlling computer to use this method of retrieving error information.

## Overview of the 86030A Server API

**System Properties** Use these properties to modify the current measurement settings on the 86030A.

**System Methods** Use these methods to initialize, verify, and shutdown the 86030A system.

**Data Methods** Use these methods to retrieve, save, and output measurement data.

**Network Analyzer Methods** Use these methods to control the network analyzer portion of the 86030A system.

**Calibration Methods** Use these methods to perform measurement calibrations. Along with each method that is associated with measuring a calibration standard, a graphic is included to show the connections that must be in place before the method is called.

**Testset Functions** Use these methods to control the lightwave test set portion of the 8603A system.

# List of Available Commands

### System Properties



### System Methods

### Data Methods



### Network Analyzer Methods



### Calibration Methods

### 86032A Testset Methods

# System Properties

### Averaging As Integer

Network Analyzer number of averages per measurement point.

### BiasInterval As Single

86032A testset modulator auto-bias interval in minutes.

5< = BiasInterval <= 9999. Default is 480minutes

### CouplerPower As Single [Read-only]

The power coming from the OPTICAL OUTPUT port on the optical test set (dBm).

### LaserPower As Single

The power coming from the LASER OUTPUT port on the optical test set (dBm). Range is -10 to + 10 dBm. Default is 10 dBm.

### MaxBiasVoltage As Single [Read-only]

86032A testset current modulator bias voltage required for maximum optical output power. This value is obtained during autobias, and is only valid after an autobias has been completed.

### Meas As Integer[Read-only]

86030A current measurement type.

- BANDWIDTH = 0
- REFLECTION = 1
- BW_N_REFL = 2
- REFL_SENS = 3
- RESPNMATCH = 4

### MinBiasVoltage As Single [Read-only]

86032A Testset current modulator bias voltage required for minimum optical output power. This value is obtained during autobias, and is only valid after an autobias has been completed.

### ModBias As Single

86032A Testset current modulator bias. Range is -9.9 volts to + 9.9 volts. This value is set by the 86030A system automatically after an autobias has been completed.

### Mode As Integer [Read-only]

86030A current system mode.

- OTOO = 0
- OTOE = 1
- ETOO = 2
- ETOE = 3

### NumberOfPoints As enumPointType

Network Analyzer number of points.

### QuadVoltage As Single[Read-only]

86032A testset current modulator quadrature voltage. This value is obtained during autobias, and is only valid after an autobias has been completed.

### ReceiverPower As Single[Read-only]

Optical power (dBm) at the OPTICAL RECEIVER INPUT port of the optical test set.

### ReflectSTD As Single

Optical reflection standard in percentage. Range is 0 to 100. This reflection standard is used during optical reflection calibrations.

### RunningLocal As Boolean

Enables (True) or disables (False) system running on instrument computer.

If RunningLocal is True, the system will turn on the instrument computer. If RunningLocal is False, the system will be in remote operation.

### SourcePowerEO As Single

Network Analyzer source power (dBm) for EO system mode.

-66 dBm < SourcePowerEO <= 20 dBm

### SourcePowerOE As Single

Network Analyzer source power (dBm) for OE and OO system mode.

-66 dBm < SourcePowerOE <= 20 dBm

### StartFrequency As Single

Start frequency of the network analyzer (Hz).

### StopFrequency As Single

Stop frequency of the network analyzer (Hz).

### SysStatusReg As enumStatus[Read-only]

Value of the System Status register. This value is the last error encountered by the system or the last action being executed. Once read it is cleared, its value is returned to 0 (SYSTEM_NORMAL).

# System Methods

```
Public Function SysStartUp() as Integer
```

**Description:** This function is called immediately after obtaining a handle to the server. This method starts the server application and brings up the Graphic User Interface (GUI). This method is always followed by a SysInit to run the interface remotely.

**NOTE** This method must be called to start the 86030A server.

```
Public Function SysInit() As Integer
```

**Description:** Initializes 86030A system.

**Pre-Conditions:** The system has not been initialized before. If it has then this function does nothing. Public Event StatusAvailable(Message As String).

**Post-Conditions:** The 86030A System is initialized. A 0 is returned once the system is initialized, a -1 is returned if an error was encountered in the process.

**Initialization:**

1. TestSet and software are placed into O/E bandwidth mode.
2. Network analyzer is initialized to work with the 86030A optical test set.
3. Autobias is performed for the first time.

```
Public Function SysShutDown() as Integer
```

**Description:** This function is called when user wishes to close and shut down the 86030 system. This function should be called directly before the handle to the server is released.

```
Public Sub SysVerifyStart() as Integer
```

**Description:** First function executed when performing a system verification. This function will initiate the system verification process. The following functions are needed to make up the complete verification process. Returns 0 if successful or -1 if error is encountered.

```
server:SysVerifyStart
server:OERESPMATCH_STD1
server:OERESPMATCH_STD2Open
server:OERESPMATCH_STD3Short
server:OERESPMATCH_STD4Load
server:OERESPMATCH_STD5Open
server:OERESPMATCH_STD6Short
server:OERESPMATCH_STD7Load
server:OERESPMATCH_STD8
server:OERESPMATCH_STD9
server:OERESPMATCH_STD10
boo|SystemPass=server.SysVerifyFinish
 If boo|SystemPass=True Then
MsgBox “System Passed”, vbOKOnly
Else
MsgBox “System Failed”, vbCritical
End If
```

```
Public Function SysVerifyFinish() As Boolean
```

**Description:** Last function called when performing a system verification.

**Return Value:** TRUE / FALSE Boolean value. TRUE indicates the system passed, and FALSE indicates the system failed.

# Data Methods

These methods are used for capturing, saving, and graphing measurement data.

```
Public Sub GTraceData (tracetype As enumTraceType, Traces As Integer, Points As Integer,
TraceData() As Single)
```

**Description:** This method is associated with the calibration that was previously performed. If a bandwidth and reflection calibration has been performed then both the bandwidth measurement and the reflection measurement will be returned in a multidimensional array. The reflection measurement will be returning in the following manner.

COMPLEX_TYPE

- Reflection
- TraceData(2,0 to Points - 1) contain all the real data points
- TraceData(3,0 to Points - 1) contain all the imaginary data points

Formatted Types(LOGMAG_TYPE, PHASE_TYPE, DELAY_TYPE)

- Bandwidth or Reflection
- TraceData(0, 0 to Points - 1) contain all the  data points
- TraceData(1, 0 to Points - 1) contain all 0s

The bandwidth portion of the measurement will be returned in array index 0 - 1.

```
Public Function SaveTraceText(strFilename As String, tracetype As enumTraceType) As Integer
```

**Description:** Saves the active trace from the 8510 into a text file.

**strFilename:** Absolute path where the file will be saved. For example:

StrFilename: “D:\LCA50GHz\Data\filename.xls”

**Tracetype:** Selects the trace type (COMPLEX_TYPE, LOGMAG_TYPE, PHASE_TYPE, DELAY_TYPE)

**NOTE** If a bandwidth and reflection calibration was the last calibration performed, the software assumes that both measurements are of interest. This method will append a "_BW" or "_RF" to the filename. Both files will appear in the D:\LCA50GHZ\Data directory as the following:
File1 = filename1_BW.xls
File2 = filename2_RF.xls

---

```
Public Function SaveTraceExcel(strFilename As String, tracetype As enumTraceType)As Integer
```

**Description:** Saves the active trace from the 8510 into an excel file.

**strFilename:** Absolute path where the file will be saved. For example:

StrFilename: "D:\LCA50GHz\Data\filename.xls"

**Tracetype:** Selects the trace type (COMPLEX_TYPE, LOGMAG_TYPE, PHASE_TYPE, DELAY_TYPE)

---

```
Public Function ExcelGraph(filenameExcel As String, tracetype As enumTraceType) As Integer
Syn
```

**Description:** Creates graph within existing excel file. This excel file must have already been saved using the method call SaveTraceExcel.

**filenameExcel:** Absolute path where the file will be saved. For example:

filenameExcel: "D:\LCA50GHz\Data\filename.xls"

**Tracetype:** Selects the trace type (COMPLEX_TYPE, LOGMAG_TYPE, PHASE_TYPE, DELAY_TYPE)

**NOTE** If a bandwidth and reflection calibration was the last calibration performed, the software assumes that both measurements are of interest. This method will append a "_BW" or "_RF" to the filename. Both files will appear in the D:\LCA50GHZ\Data directory as the following:
File1 = filename1_BW.xls
File2 = filename2_RF.xls

```
Public Function gResponse(arResponse() As Single, intmeas As Integer) As Integer
```

**Description:** This function returns an array through arResponse() containing the real and imaginary data for each point of measurement. An array dimensioned as arResponse (1 to 2 * Number of Points) as single should be passed to it. The data points are returned in arResponse(). The format for arResponse is odd indexes 1,3,5...contains real and even indexes 2,4,6...contain imaginary arResponse(1) and arResponse(2) make up a single data point.

intMeas: tells what type of measurement was performed either BANDWIDTH, REFLECTION, or BW_N_REFL.

```
Public Function gResponseLogMag(arResponse() As Single, intmeas As Integer) As Integer
```

**Description:** This function returns the Log Magnitude of the response displayed on the 8510. Only odd indexes of arResponse are of interest. All even indexes are 0. This function forces the 8510 into displaying Log Magnitude.

intMeas: is the type of measurement of interest.

```
Public Function gResponsePhase(arResponse() As Single, intmeas As Integer) As Integer
```

**Description:** This function returns the Phase of the response displayed on the 8510. Only odd indexes of arResponse are of interest. All even indexes are 0. This function forces the 8510 into displaying phase.

intMeas: is the type of measurement of interest.

```
Public Function gResponseDelay(arResponse() As Single, intmeas As Integer) As Integer
```

**Description:** This function returns the Delay of the response displayed on the 8510. Only odd indexes of arResponse are of interest. All even indexes are 0. This function forces the 8510 into displaying delay.

intMeas: is the type of measurement of interest.

```
 Public Function gCalibrationData(Sets As Integer, Points As Integer, CalibrationData() As
Single) As Integer
```

**Description:** This method returns the calibration array of the 8510. The contents are the calibration correction coefficients calculated during the last calibration. A valid calibration must have been performed before calling this method.

**Return Types:** CalibrationData(): multidimensional array of single. The dimension of the array is dependent on the type of calibration performed. If a response and isolation calibration was performed then the array will return both the response and isolation portions of the calibration. The returned array will be as follows.

- CalibrationData(0, 0 to Points - 1) = Real portion of isolation coefficients.
- CalibrationData(1, 0 to Points - 1) = Imaginary portion of isolation coefficients.
- CalibrationData(2, 0 to Points - 1) = Real portion of response coefficients.
- CalibrationData(3, 0 to Points - 1) = Imaginary portion of response coefficients.

If only a response calibration was performed then CalibrationData() will be as follows.

- CalibrationData(0, 0 to Points - 1) = Real portion of response coefficients.
- CalibrationData(1, 0 to Points - 1) = Imaginary portion of response coefficients.

**Sets:** This is an integer value specifying the dimension of the returned array. This value is a 1 for response calibrations, and a 2 for response and isolation calibrations.

**Points:** This is an integer value specifying the number of points for the returned calibration. This value is 0 if no valid calibration was available.

This function returns a 0 for success and a -1 for failure.

If a bandwidth and reflection calibration has been performed and both coefficients are desired. The methods sBandwidth and sReflection must be used to switch the system into the corresponding measurement mode and then to make the call to gCalibrationData.

For example:

```
Server.sBandwidth       'Puts system into bandwidth mode
Server.gCalibrationData(.....) 'Gets the calibration
data.
```

# Network Analyzer Methods

The following methods are used to setup the 8510C network analyzer.

```
Public Function Write8510(ByVal strgWriteBuffer As String)As Integer
```

**Description:** Performs a Pass-through to the Vector Network Analyzer (VNA). strgWrite-Buffer is a GPIB VNA compatible mneumonic, this command is passed to the VNA of the 86030A System.

```
Public Function Read8510()(StrgReadBuffer) As Integer
```

**Description:** Performs a Passthrough read to the VNA

**Pre-Conditions:** Active-Function on VNA specified.

**Post-Conditions:** Data is contained in string passed back.

```
Public Function sExternalLeveling(ByVal OnOff As Boolean)As Integer
```

**Description:** Causes the Source to be externally leveled. Leveling path goes through the testset if OnOff is TRUE. Otherwise Source of VNA uses internal leveling.

**Pre-Conditions:** None.

**Post-Conditions:** Leveling path is now through the testset (optical). If OnOff is TRUE. Otherwise source is using internal leveling.

```
Public Function sSweepTime(ByVal SwTime As Single)As Integer
```

**Description:** Sets the sweep time of VNA in milliseconds.

**Pre-Conditions:** None.

**Post-Conditions:** Sweep time of VNA set.

```
Public Function selectDefaultPowerSettings() As Integer
```

**Description:** Restores the default network analyzer power settings.

**Pre-Conditions:** None.

**Post-Conditions:** Default network analyzer power settings restored.

```
Public Function TakeCompleteSweep() As Integer
```

**Description:** Causes network analyzer to take a single complete sweep and then go to a hold state.

**Pre-Conditions:** None.

**Post-Conditions:** Network analyzer is stopped after taking a complete sweep.

```
Public Function ResumeContSweep() as Integer
```

**Description:** Causes network analyzer to resume sweeping.

**Pre-Conditions:** None.

**Post-Conditions:** Network analyzer is in sweep mode.

# Calibration Methods

The following methods enable you to setup and perform a calibration. Each calibration has a number of standards that need to be measured to properly calibrate the system. Standards can be called individually, but they must be in an expected order.

For example:

OEBWNRFRESPNISOL_STD1 is a method call that measures a single standard. The needed connections for this standard can be viewed in this document.

All calibration methods follow the naming convention shown.

- OE = Optical to Electrical measurement.
- BW = Bandwidth
- RF = Reflection
- BWNRF = Bandwidth and Reflection
- RESP = Response
- ISOL = Isolation
- Note: RESPNISOL = Response and Isolation
- STD1 = Standard 1

```
Public Function sSetupCal(ByVal CalType As enumStandards, ByVal Points As enumPointType, ByVal Average As Integer, ByVal Startf As Single, ByVal Stopf As Single) As Integer
```

**Description:** This is the Main Calibration Configuration Function Call, and is called before each new user calibration to setup the network analyzer and software to perform the calibration.

**Parameters:** CalType Valid: 0-17 Specifies Calibration Type - Valid values for this parameter are:

OO_BW_RESPONSE = 0
OO_BW_RESPNISOL = 1
OO_RF_RESPONSE = 2
OO_RF_RESPNISOL = 3
OE_BW_RESPONSE = 4
OE_BW_RESPNISOL = 5
OE_RF_RESPONSE = 6
OE_RF_RESPNISOL = 7
OE_BWNRF_RESPONSE = 8
OE_BWNRF_RESPNISOL = 9
OE_RESPNMATCH = 10
EO_BW_RESPONSE = 11
EO_BW_RESPNISOL = 12
EO_RF_RESPONSE = 13
EO_RF_RESPNISOL = 14
EO_BWNRF_RESPONS = 15
EO_BWNRF_RESPNISOL = 16
EO_REFSENSE = 17

**Power Valid:** -66dBm to 20dBm Format 32-bit single Between -66 and 20

**Points Valid:** Integer Valid values for parameter

POINTS51 = 51
POINTS101 = 101
POINTS201 = 201
POINTS401 = 401
POINTS801 = 801

**Average Valid:** Integers (0, 4096) network analyzer accepts only powers of 2: 0,1,2,4,..., 64,128,256,...1024

**Startf Valid:** 32-bit single < then 50GHz and > than 45MHz

**Stopf Valid:** 32-bit single < then 50GHz and > than 45MHz

```
Public Function gCalSetup(CalType As Integer, Power As Single, _ Points As Integer, Average
As Integer, Startf As Single, Stopf As Single) As Integer
```

**Description:** Returns the current calibration configuration.

**Pre-Conditions:** Software has been initialized previously.

**Post-Conditions:** Above values returned.

```
Public Function sBandwidth() As Integer
```

**Description:** This method switches the system to the bandwidth mode after the bandwidth and reflection calibration have been performed.

**Pre-Conditions:** A valid bandwidth and reflection calibration has been performed on the 86030A system.

**Post-Conditions:** The system will be in the bandwidth mode.

```
Public Function sReflection() As Integer
```

**Description:** This method switches the system to the reflection mode after and bandwidth and reflection calibration have been performed.

**Pre-Conditions:** A valid bandwidth and reflection calibration has been performed on the 86030A system.

**Post-Conditions:** The system will be in the reflection mode.

```
Public Function OOBWRESP_STD1() As Integer
```

**Description:** Performs the O/O standard 1 calibration for bandwidth response calibration.

**Pre-Conditions:** The connections in Figure 4-3 have been made on the instrument.

**Post-Conditions:** Standard for O/O bandwidth response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.


**Figure 4-3. Connections for O/O Bandwidth Response (Std1), and O/O Bandwidth Response and Isolation (Std1, Std2)**

---

```
Public Function OOBWRESPNISOL_STD1() As Integer
```

**Description:** Part of the optical-to-optical bandwidth response and isolation calibration. Measures the response calibration standard for the O/O bandwidth response and isolation.

**Pre-Conditions:** The connections in Figure 4-3 have been made on the instrument.

**Post-Conditions:** Response standard for O/O bandwidth response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

---

```
Public Function OOBWRESPNISOL_STD2() As Integer
```

**Description:** Part of the optical-to-optical bandwidth response and isolation calibration. Measures the isolation calibration standard for the O/O bandwidth response and isolation.

**Pre-Conditions:** OOBWRESPNISOL_STD1 have already been performed. The connections in Figure 4-3 on page 4-44 have been made on the instrument.

**Post-Conditions:** Standard for O/O bandwidth response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

Measurement Connections in Figure 4-4 are for a device under test, after performing an O/O bandwidth response and isolation calibration.

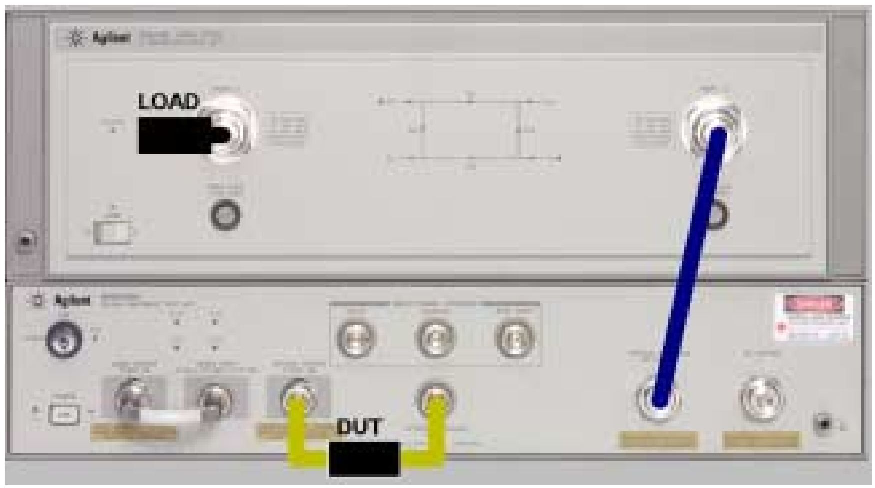



**Figure 4-4. Measurement Connections for a Device Under Test after an O/O Bandwidth Response and Isolation Calibration**

---

```
Public Function OORFRESP_STD1()As Integer
```

**Description:** Part of the optical-to-optical reflection response calibration. Measures the response calibration standard for O/O reflection.

**Pre-Conditions:** The connections in Figure 4-5 on page 4-46 have been made on the instrument.

**Post-Conditions:** Standard 1 for O/O reflection and response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

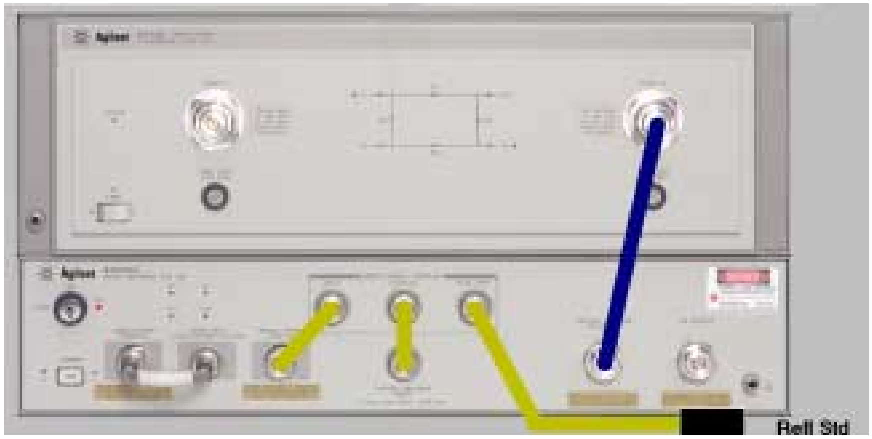



**Figure 4-5. Connections for O/O Reflection Response Calibration (Std1), and O/O Reflection Response Calibration (Std1, Std2)**

Measurement Connections in Figure 4-6 are for a device under test, after performing an O/O reflection response or O/O reflection response and isolation calibrations.


**Figure 4-6. Measurement Connections for a Device Under Test after an O/O Reflection Response Calibration**

---

`Public Function OORFRESPNISOL_STD1() As Integer`

**Description:** Part of the optical-to-optical reflection response and isolation calibration. Measures the response calibration standard for the O/O reflection response and isolation calibration.

**Pre-Conditions:** The connections in Figure 4-5 on page 4-46 have been made on the instrument.

**Post-Conditions:** Response standard for reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

---

`Public Function OORFRESPNISOL_STD2() As Integer`

**Description:** Part of the optical-to-optical reflection response and isolation calibration. Measures the isolation calibration standard for the O/O reflection response and isolation calibration.

**Pre-Conditions:** OORFRESPNISOL_STD1 has already been performed. The connections in Figure 4-5 on page 4-46 have been made on the instrument.

**Post-Conditions:** Standard 2 for O/O reflection response and isolation calibration has been performed.

Measurement Connections in Figure 4-7 on page 4-48 are for a device under test, after performing an O/O reflection response and isolation calibration.

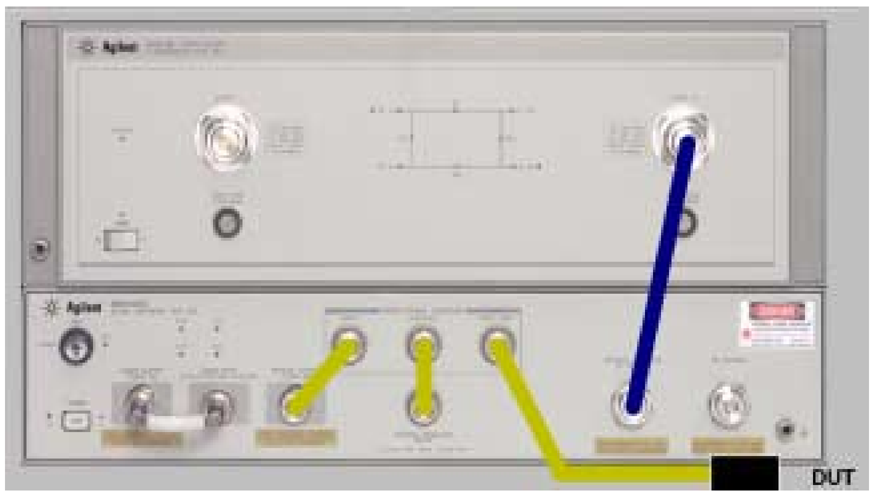



**Figure 4-7. Measurement Connections for a Device Under Test after an O/O Reflection Response and Isolation Calibration**

---

```
Public Function OEBWRESP_STD1() As Integer
```

**Description:** Measures the response calibration standard for O/E bandwidth response calibration.

**Pre-Conditions:** The connections in Figure 4-8 on page 4-49 have been made on the instrument.

**Post-Conditions:** Response standard for O/E bandwidth response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

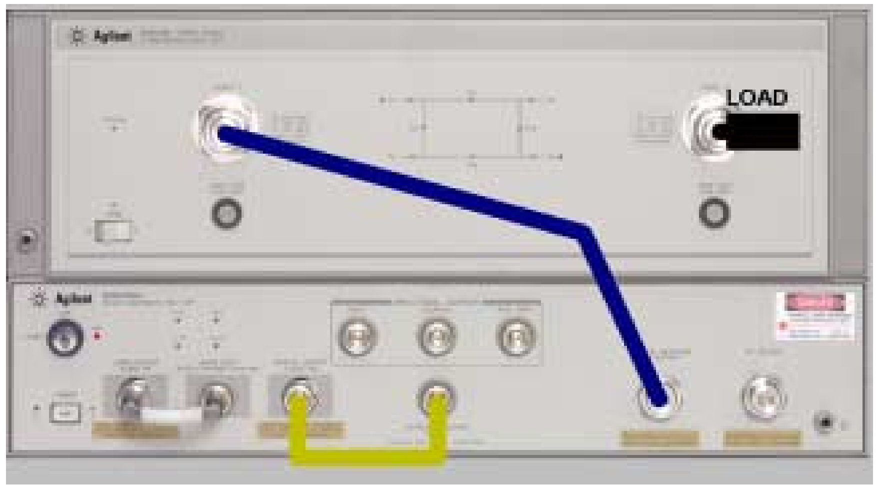



**Figure 4-8. Connections for O/E Bandwidth Response Calibration (Std1), and O/E Bandwidth Response & Isolation Calibration (Std1, Std2)**

Measurement Connections in Figure 4-9 on page 4-49 are for a device under test, after performing an O/E bandwidth response calibration.

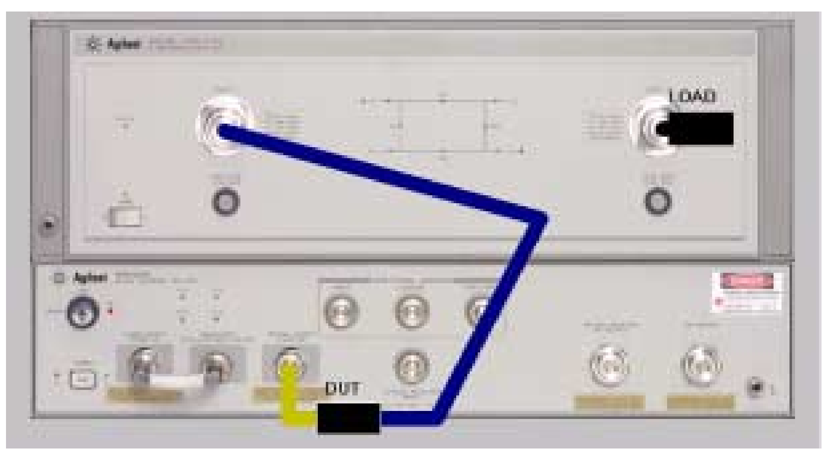



**Figure 4-9. Measurement Connections for a Device Under Test after an O/E Bandwidth Response Calibration**

---

```
Public Function OEBWRESPNISOL_STD1() As Integer
```

**Description:** Measures the isolation calibration standard for O/E response and isolation calibration.

**Pre-Conditions:** The connections in Figure 4-8 on page 4-49 have been made on the instrument.

**Post-Conditions:** Response standard for O/E bandwidth response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

---

```
Public Function OEBWRESPNISOL_STD2() As Integer
```

**Description:** Measures the isolation calibration standard for the O/E bandwidth response and isolation calibration.

**Pre-Conditions:** OEBWRESPNISOL_STD1 have already been performed. The connections in Figure 4-8 on page 4-49 have been made on the instrument.

**Post-Conditions:** Isolation standard for O/E bandwidth response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

Measurement Connections in Figure 4-10 on page 4-51 are for a device under test, after performing an O/E bandwidth response and isolation calibration.

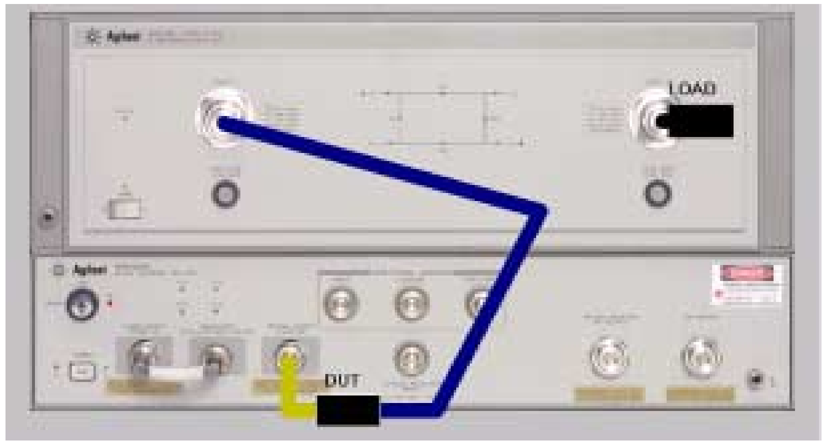



**Figure 4-10. Measurement Connections for a Device Under Test after an O/E Bandwidth Response and Isolation Calibration**

---

```
Public Function OERFRESP_STD1() As Integer
```

**Description:** Measures the response calibration standard for the O/E reflection response calibration.

**Pre-Conditions:** The connections in Figure 4-11 on page 4-52 have been made on the instrument.

**Post-Conditions:** Response standard for the O/E reflection response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

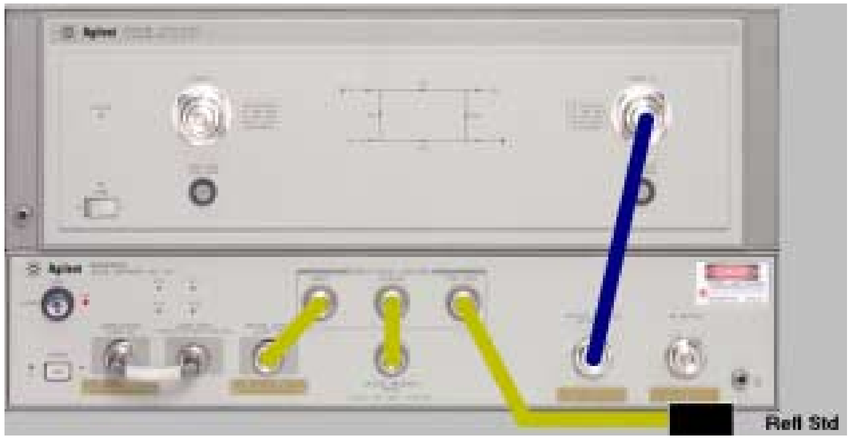



**Figure 4-11. Connections for O/E Reflection Response Calibration (Std1), and O/E Reflection Response and Isolation Calibration (Std1, Std2)**

Measurement Connections in Figure 4-12 on page 4-52 are for a device under test, after performing an O/E reflection and response calibration.


**Figure 4-12. Measurement Connections for a Device Under Test after an O/E Reflection Response Calibration or an O/E Reflection Response & Isolation Calibration**

```
Public Function OERFRESPNISOL_STD1() As Integer
```

**Description:** Measures the response calibration standard for the O/E reflection response and isolation calibration.

**Pre-Conditions:** The connections in Figure 4-11 on page 4-52 have been made on the instrument.

**Post-Conditions:** Response standard for O/E reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function OERFRESPNISOL_STD2()  As Integer
```

**Description:** Measures the isolation calibration standard for the O/E reflection response and isolation calibration.

**Pre-Conditions:** OERFRESPNISOL_STD1 has already been performed. The connections in Figure 4-11 on page 4-52 have been made on the instrument.

**Post-Conditions:** Isolation standard for the O/E reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

Measurement Connections in Figure 4-12 on page 4-52 are for a device under test, after performing an O/E reflection response and isolation calibration.

```
Public Function OEBWNRFRESP_STD1() As Boolean
```

**Description:** Measures the reflection response calibration standard for the O/E bandwidth reflection response calibration.

**Pre-Conditions:** The connections in Figure 4-13 have been made.

**Post-Conditions:** Reflector response standard for the O/E bandwidth reflection response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

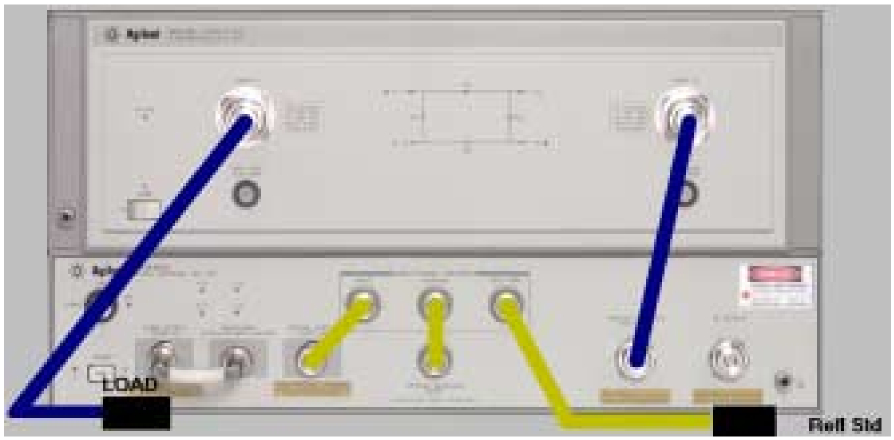



**Figure 4-13. Connections for O/E Bandwidth Reflection Response Calibration (Std1), and O/E Bandwidth Reflection Response & Isolation Calibration (Std1, Std2)**

---

```
Public Function OEBWNRFRESP_STD2() As Integer
```

**Description:** Measures the bandwidth response calibration standard for a O/E bandwidth and reflection response calibration.

**Pre-Conditions:** The connections in Figure 4-14 on page 4-55 have been made on the instrument.

**Post-Conditions:** Standard for bandwidth reflection response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

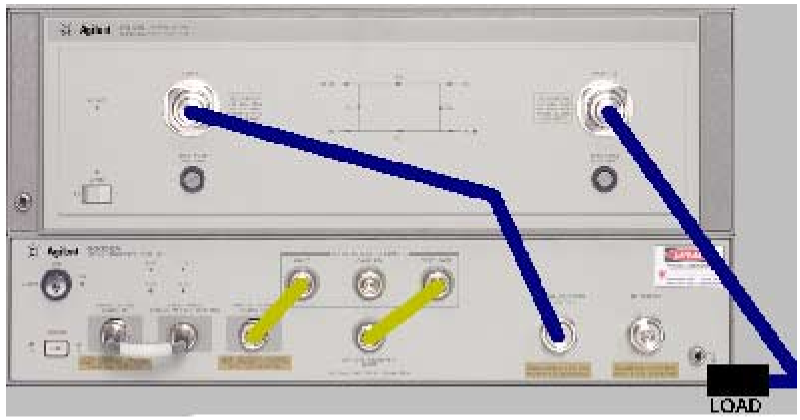



**Figure 4-14. Connections for O/E Bandwidth Reflection Response Calibration (Std2), and O/E Bandwidth Reflection Response & Isolation Calibration (Std3, Std4)**

Measurement Connections in Figure 4-15 on page 4-55 are for a device under test, after performing an O/E bandwidth reflection response calibration.

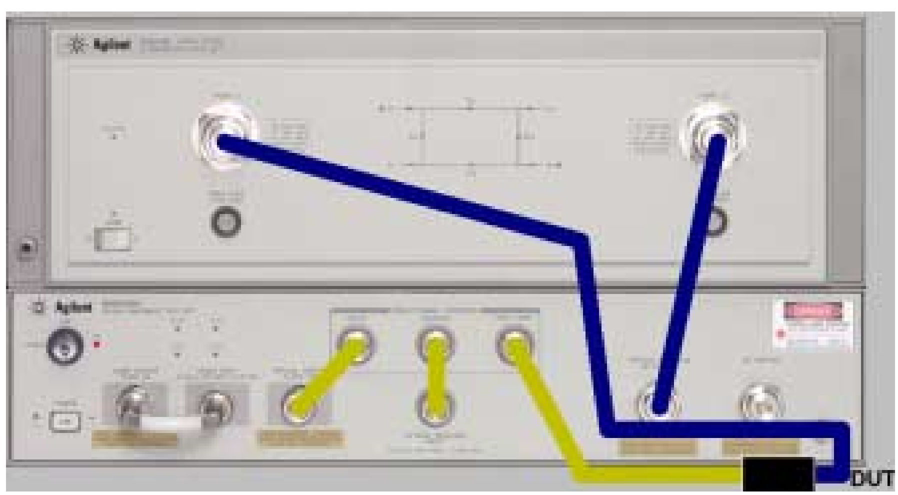



**Figure 4-15. Measurement Connections for a Device Under Test after an O/E Bandwidth Reflection Response Calibration or O/E Bandwidth Reflection Response & Isolation Calibration**

---

```
Public Function OEBWNRFRESPNISOL_STD1() As Integer
```

**Description:** Measures the reflection response calibration standard for O/E bandwidth and reflection response and isolation calibration.

**Pre-Conditions:** The connections in Figure 4-13 on page 4-54 have been made on the instrument.

**Post-Conditions:** Reflection response standard for theO/E bandwidth and reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

---

```
Public Function OEBWNRFRESPNISOL_STD2() As Integer
```

**Description:** Measures the reflection isolation calibration standard for an O/E bandwidth and reflection response and isolation calibration.

**Pre-Conditions:** OEBWNRFRESPNISOL_STD1 has already been performed. The connections in Figure 4-13 on page 4-54 have been made on the instrument.

**Post-Conditions:** Reflection isolation standard for an O/E bandwidth and reflection response and isolation calibration has been performed. Returns True if the calibration succeed and False if the calibration failed.

---

```
Public Function OEBWNRFRESPNISOL_STD3() As Integer
```

**Description:** Measures the bandwidth response calibration standard for an O/E bandwidth and reflection response and isolation calibration.

**Pre-Conditions:** OEBWNRFRESPNISOL_STD1 and OEBWNRFRESPNISOL_STD2 have already been performed. The connections in Figure 4-14 on page 4-55have been made on the instrument.

**Post-Conditions:** Bandwidth response standard for an O/E bandwidth and reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

---

```
Public Function OEBWNRFRESPNISOL_STD4() As Integer
```

**Description:** Measures the bandwidth isolation calibration standard for an O/E bandwidth and reflection response and isolation calibration.

**Pre-Conditions:** OEBWNRFRESPNISOL_STD1, OEBWNRFRESPNISOL_STD2 and OEBWNRFRESPNISOL_STD3 have already been performed. The connections in Figure 4-14 on page 4-55 have been made on the instrument.

**Post-Conditions:** Bandwidth response standard for an O/E bandwidth and reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

Measurement Connections in Figure 4-15 on page 4-55 are for a device under test, after performing an O/E bandwidth reflection response and isolation calibration.

---

```
Public Function OERESPNMATCH_STD1()  As Integer
```

**Description:** Measures calibration standard 1 for an O/E response and match calibration.

**Pre-Conditions:** The connections in Figure 4-16 on page 4-58 have been made on the instrument.

**Post-Conditions:** Standard 1 for an O/E response and match calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.


**Figure 4-16. Connections for O/E Response and Match Calibration (Std1, Std2, Std3, Std4)**

---

```
Public Function OERESPNMATCH_STD2Open()  As Integer
```

**Description:** Measures calibration standard 2 for an O/E response and match calibration.

**Pre-Conditions:** OERESPNMATCH_STD1 has been performed. The following connections in Figure 4-16 on page 4-58 have been made on the instrument.

**Post-Conditions:** Standard 2 for an O/E Response and Match calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

---

```
Public Function OERESPNMATCH_STD3Short()  As Integer
```

**Description:** Measures calibration standard 3 for an O/E response and match calibration.

**Pre-Conditions:** OERESPNMATCH_STD1 and OERESPNMATCH_STD2Open have been performed. The following connections in Figure 4-16 on page 4-58 have been made on the instrument.

**Post-Conditions:** Standard 3 for an O/E response and match calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function OERESPNMATCH_STD4Load()  As Integer
```

**Description:** Measures calibration standard 4 for an O/E response and match calibration.

**Pre-Conditions:** OERESPNMATCH_STD1, OERESPNMATCH_STD2Open and OERESPNMATCH_STD3Short have been performed. The following connections in Figure 4-16 on page 4-58 have been made on the instrument.

**Post-Conditions:** Standard 4 for an O/E response and match calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function OERESPNMATCH_STD5Open()  As Integer
```

**Description:** Measures calibration standard 5 for an O/E response and match calibration.

**Pre-Conditions:** OERESPNMATCH_STD1, OERESPNMATCH_STD2Open, OERESPNMATCH_STD3Short and OERESPNMATCH_STD4Load have been performed. The following connections in Figure 4-17 on page 4-60 have been made on the instrument.

**Post-Conditions:** Standard 5 for an O/E response and match calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function OERESPNMATCH_STD6Short()  As Integer
```

**Description:** Measures calibration standard 6 in an O/E response and match calibration.

**Pre-Conditions:** OERESPNMATCH_STD1, OERESPNMATCH_STD2Open, OERESPNMATCH_STD3Short, OERESPNMATCH_STD4Load and OERESPNMATCH_STD5Open have been performed. The following connections in Figure 4-17 on page 4-60 have been made on the instrument.

**Post-Conditions:** Standard 6 for an O/E response and match calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.


**Figure 4-17. Connections for O/E Response and Match Calibration (Std5, Std6, Std7)**

---

```
Public Function OERESPNMATCH_STD7Load () As Integer
```

**Description:** Measures calibration standard 7 in an O/E response and match calibration.

**Pre-Conditions:** OERESPNMATCH_STD1, OERESPNMATCH_STD2Open, OERESPNMATCH_STD3Short, OERESPNMATCH_STD4Load, OERESPNMATCH_STD5Open and OERESPNMATCH_STD6Short have been performed. The following connections in Figure 4-17 on page 4-60 have been made on the instrument.

**Post-Conditions:** Standard 7 for an O/E response and match calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function OERESPNMATCH_STD8 () As Integer
```

**Description:** Measures calibration standard 8 in an O/E response and match calibration.

**Pre-Conditions:** OERESPNMATCH_STD1, OERESPNMATCH_STD2Open, OERESPNMATCH_STD3Short, OERESPNMATCH_STD4Load, OERESPNMATCH_STD5Open, OERESPNMATCH_STD6Short and OERESPNMATCH_STD7Load have been performed. The following connections in Figure 4-18 have been made on the instrument.

**Post-Conditions:** Standard 8 for an O/E response and match calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

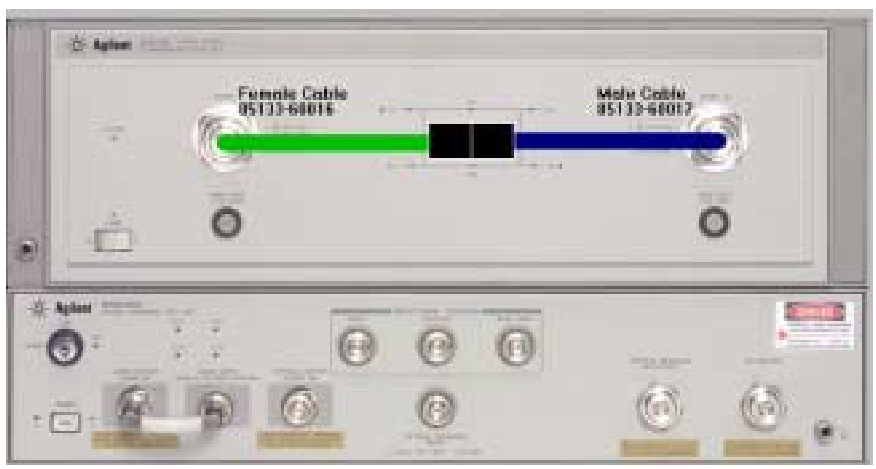



**Figure 4-18. Connections for O/E Response and Match Calibration (Std8)**

```
Public Function OERESPNMATCH_STD9 () As Integer
```

**Description:** Measures calibration standard 9 in an O/E response and match calibration.

**Pre-Conditions:** OERESPNMATCH_STD1, OERESPNMATCH_STD2Open, OERESPNMATCH_STD3Short, OERESPNMATCH_STD4Load, OERESPNMATCH_STD5Open, OERESPNMATCH_STD6Short, OERESPNMATCH_STD7Load and OERESPNMATCH_STD8 have been performed. The following connections in Figure 4-19 have been made on the instrument.

**Post-Conditions:** Standard 9 for an O/E response and match calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

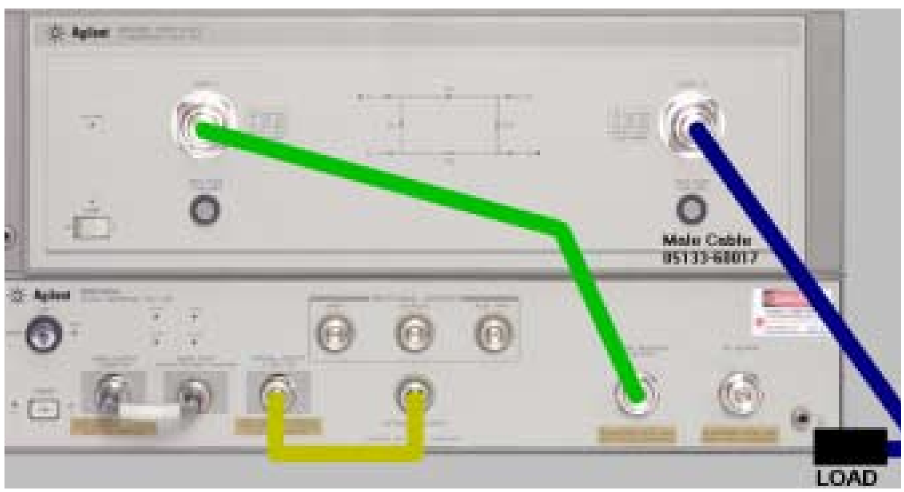



**Figure 4-19. Connections for O/E Response and Match Calibration (Std9)**

```
Public Function OERESPNMATCH_STD10 () As Integer
```

**Description:** Measures calibration standard 10 in an O/E response and match calibration.

**Pre-Conditions:** OERESPNMATCH_STD1, OERESPNMATCH_STD2Open, OERESPNMATCH_STD3Short, OERESPNMATCH_STD4Load, OERESPNMATCH_STD5Open, OERESPNMATCH_STD6Short, OERESPNMATCH_STD7Load, OERESPNMATCH_STD8 and OERESPNMATCH_STD9have been performed. The following connections in Figure 4-20 have been made on the instrument.

**Post-Conditions:** Standard 10 for an O/E response and match calibration has been performed.Returns 0 if the calibration succeeds and -1 if the calibration fails.

When standards 1 through 9 for the response calibration are successfully measured, calibration standard 10 may be called repeatedly to perform an calibration for a new device under test. When a different calibration or method is called, the first 1-9 standards must be called again for the calibration to be valid.

For example:

1. Measure calibration standards 1 through 9.
2. Connect a device under test, as shown in Figure 4-20.
3. Call the method OERESPNMATCH_STD10. When the calibration standard measurement is complete and the correction is up-loaded to the network analyzer, the corrected trace will be shown in the analyzer screen.
4. Call the method TakeCompleteTrace to verify that a complete sweep has been performed.
5. Save the trace data.
6. Connect a new device under test, as shown in Figure 4-20.
7. Again, call the method OERESPNMATCH_STD10. This measurement calibration will use the information from the previous calibration standards.

**NOTE** If no measurement settings are changed, you can use this approach to continually calibrate for new devices avoiding the measurements of calibration standards 1 through 9.

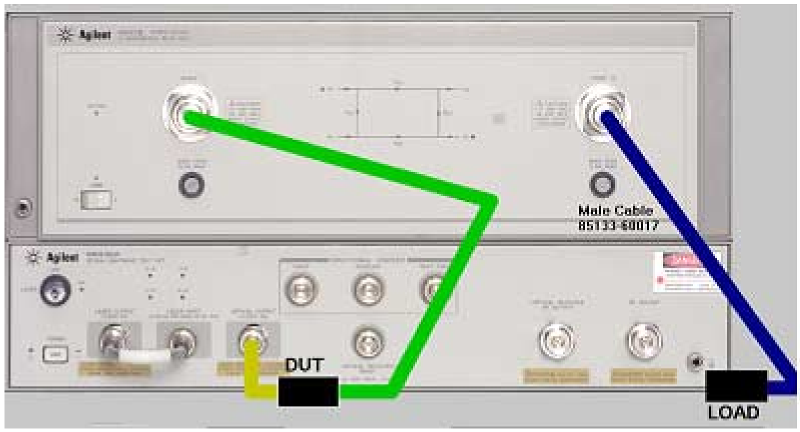



**Figure 4-20. Connections for O/E Response and Match Calibration (Std10), and a Device Under Test after an O/E Response and Match Calibration**

Measurement Connections in Figure 4-20 are for a device under test, after performing an O/E response and match calibration.

---

```
Public Function EOBWRESP_STD1() As Integer
```

**Description:** Measures the response standard for an E/O bandwidth response calibration.

**Pre-Conditions:** The following connections in Figure 4-21 on page 4-65 have been made on the instrument.

**Post-Conditions:** Response standard for an E/O bandwidth response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.


**Figure 4-21. Connections for E/O Bandwidth Response Calibration (Std1), and E/O Bandwidth Response & Isolation Calibration (Std1)**

Measurement Connections in Figure 4-22 are for a device under test, after performing an E/O bandwidth response calibration.


**Figure 4-22. Measurement Connections for a Device Under Test after an E/O Bandwidth Response Calibration or an E/O Bandwidth Response & Isolation Calibration**

```
Public Function EOBWRESPNISOL_STD1() As Integer
```

**Description:** Measures the response calibration standard for an E/O bandwidth response and isolation calibration.

**Pre-Conditions:** The following connections in Figure 4-21 on page 4-65 have been made on the instrument.

**Post-Conditions:** Response standard for an E/O bandwidth response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function EOBWRESPNISOL_STD2() As Integer
```

**Description:** Measures the isolation calibration standard for an E/O bandwidth response and isolation calibration.

**Pre-Conditions:** EOBWRESPNISOL_STD1 has been performed. The following connections in Figure Figure 4-23 on page 4-67 have been made on the instrument.

**Post-Conditions:** Isolation standard for an E/O bandwidth response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.


**Figure 4-23. Connections for E/O Bandwidth Response and Isolation Calibration (Std2), and E/O Bandwidth Reflection Response and Isolation Calibration (Std6)**

Measurement Connections in Figure 4-22 on page 4-65 are for a device under test, after performing an E/O bandwidth response and isolation.

---

```
Public Function EORFRESP_STD1() As Integer
```

**Description:** Measures the calibration standard 1 for an E/O reflection response calibration.

**Pre-Conditions:** The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 1 for an E/O reflection response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.


**Figure 4-24. Connections for E/O Reflection Response Calibration (Std1, Std2, Std3, Std4), and E/O Bandwidth Reflection Response Calibration (Std1, Std2, Std3, Std4), and E/O Bandwidth Reflection Response & Isolation Calibration (Std1, Std2, Std3, Std4)**

---

```
Public Function EORFRESP_STD2Open() As Integer
```

**Description:** Measures the calibration standard 2 for an E/O reflection response calibration.

**Pre-Conditions:** EORFRESP_STD1 has been performed. The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 2 for an E/O reflection response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

---

```
Public Function EORFRESP_STD3Short() As Integer
```

**Description:** Measures the calibration standard 3 for an E/O reflection response calibration.

**Pre-Conditions:** EORFRESP_STD1 and EORFRESP_STD2Open have been performed. The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 3 for an E/O reflection response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function EORFRESP_STD4Load() As Integer
```

**Description:** Measures the calibration standard 4 for an E/O reflection response calibration.

**Pre-Conditions:** EORFRESP_STD1, EORFRESP_STD2Open and EORFRESP_STD3Short have been performed. The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 4 for an E/O reflection response calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

Measurement Connections in Figure 4-25 are for a device under test, after performing an E/O reflection response calibration.


**Figure 4-25. Measurement Connections for a Device Under Test after an E/O Reflection Response Calibration**

```
Public Function EOBWNRFRESP_STD1() As Integer
```

**Description:** Measures calibration standard 1 for an E/O bandwidth and reflection response.

**Pre-Conditions:** The following connections in Figure 4-24 on page 4-68have been made on the instrument.

**Post-Conditions:** Standard 1 for an E/O bandwidth and reflection response calibration has been performed.

```
Public Function EOBWNRFRESP_STD2Open() As Integer
```

**Description:** Measures calibration standard 2 for an E/O bandwidth and reflection response.

**Pre-Conditions:** EOBWNRFRESP_STD1 has been performed. The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 2 for an E/O bandwidth and reflection response calibration has been performed.

```
Public Function EOBWNRFRESP_STD3Short() As Integer
```

**Description:** Measures calibration standard 3 for an E/O bandwidth and reflection response.

**Pre-Conditions:** EOBWNRFRESP_STD1 and EOBWNRFRESP_STD2Open have been performed. The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 3 for an E/O bandwidth and reflection response calibration has been performed.

---

```
Public Function EOBWNRFRESP_STD4Load() As Integer
```

**Description:** Measures calibration standard 4 for an E/O bandwidth reflection response.

**Pre-Conditions:** EOBWNRFRESP_STD1, EOBWNRFRESP_STD2Open and EOBWNRFRESP_STD3Short have been performed. The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 4 for an E/O bandwidth reflection response calibration has been performed.

---

```
Public Function EOBWNRFRESP_STD5() As Integer
```

**Description:** Measures bandwidth response calibration standard for an E/O bandwidth reflection response.

**Pre-Conditions:** EOBWNRFRESP_STD1, EOBWNRFRESP_STD2Open, BWNRFRESP_STD3Short and EOBWNRFRESP_STD4Load have been performed. The connections in Figure 4-26 on page 4-72 have been made on the instrument.

**Post-Conditions:** Bandwidth response standard for an bandwidth reflection response calibration has been performed.

**Figure 4-26. Connections for E/O Bandwidth Reflection Response Calibration (Std5), and E/O Bandwidth Reflection Response & Isolation Calibration (Std5)**

Measurement Connections in Figure 4-27 on page 4-72 are for a device under test, after performing an E/O bandwidth reflection response calibration.

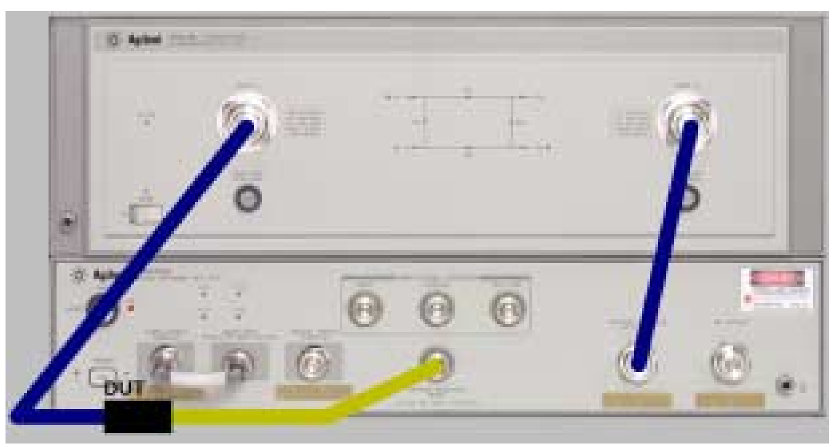



**Figure 4-27. Measurement Connections for a Device Under Test after an E/O Bandwidth Reflection Response Calibration**

```
Public Function EOBWNRFRESPNISOL_STD1() As Integer
```

**Description:** Measures calibration standard 1 for an E/O bandwidth reflection response and isolation calibration.

**Pre-Conditions:** The following connections in Figure 4-24 on page 4-68have been made on the instrument.

**Post-Conditions:** Standard 1 for an E/O bandwidth and reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function EOBWNRFRESPNISOL_STD2Open() As Integer
```

**Description:** Measures calibration standard 2 for an E/O bandwidth and reflection response and isolation calibration.

**Pre-Conditions:** EOBWNRFRESPNISOL_STD1 has been performed. The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 2 for an E/O bandwidth and reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function EOBWNRFRESPNISOL_STD3Short() As Integer
```

**Description:** Measures calibration standard 3 for an E/O bandwidth and reflection response and isolation calibration.

**Pre-Conditions:** EOBWNRFRESPNISOL_STD1 and EOBWNRFRESPNISOL_STD2Open have been performed. The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 3 for an E/O bandwidth and reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function EOBWNRFRESPNISOL_STD4Load() As Integer
```

**Description:** Measures calibration standard 4 for an E/O bandwidth and reflection response and isolation calibration.

**Pre-Conditions:** EOBWNRFRESPNISOL_STD1, EOBWNRFRESPNISOL_STD2Open and EOBWNRFRESPNISOL_STD3Short have been performed. The following connections in Figure 4-24 on page 4-68 have been made on the instrument.

**Post-Conditions:** Standard 4 for an E/O bandwidth and reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function EOBWNRFRESPNISOL_STD5() As Integer
```

**Description:** Measures bandwidth response calibration standard for an E/O bandwidth and reflection response and isolation calibration.

**Pre-Conditions:** EOBWNRFRESPNISOL_STD1, EOBWNRFRESPNISOL_STD2Open, EOBWNRFRESPNISOL_STD3Short and EOBWNRFRESPNISOL_STD4Load have been performed. The following connections in Figure 4-26 on page 4-72 have been made on the instrument.

**Post-Conditions:** Bandwidth response standard for an E/O bandwidth and reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

```
Public Function EOBWNRFRESPNISOL_STD6() As Integer
```

**Description:** Bandwidth isolation standard for an E/O bandwidth and reflection response and isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

**Pre-Conditions:** EOBWNRFRESPNISOL_STD1, EOBWNRFRESPNISOL_STD2Open, EOBWNRFRESPNISOL_STD3Short, EOBWNRFRESPNISOL_STD4Load and EOBWNRFRESPNISOL_STD5 have been performed. The following connections in Figure 4-23 on page 4-67 have been made on the instrument.

**Post-Conditions:** Standard for Bandwidth and Reflection Response and Isolation calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.

Measurement Connections in Figure 4-22 on page 4-65 are for a device under test, after performing an E/O bandwidth and reflection response and isolation calibration.

---

```
Public Function EOREFSENSE_STD1() As Integer
```

**Description:** Measures the reflection sensitivity calibration standard for an E/O reflection sensitivity calibration.

**Pre-Conditions:** The following connections in Figure 4-28 on page 4-76 have been made on the instrument.

**Post-Conditions:** Reflection sensitivity standard for an E/O reflection sensitivity calibration has been performed. Returns 0 if the calibration succeeds and -1 if the calibration fails.


**Figure 4-28. Connection for E/O Reflection Sensitivity Calibration (Std1)**

Measurement Connections in Figure 4-29 on page 4-76 are for a device under test, after performing an E/O reflection sensitivity calibration.


**Figure 4-29. Measurement Connections for a Device Under Test after an E/O Reflection Sensitivity Calibration**

# 86032A Testset Methods

The following methods are used to control the 86032A optical testset. These methods shouldn't normally be used.

```
 Public Function gTestSetSetup(lboolLaserON As Boolean, lsnglLaserPower As Single, lsnglM-
odBias As Single, lsnglReflectionSTD As Single, lsnglBiasInterval As Single, lintMode As
Integer, lsnglCouplerPower As Single, lsnglReceiverPower As Single, lsnglPowerLevel1 As Sin-
gle, lsnglPowerLevel2 As Single, lsnglPowerLevel3 As Single, lsnglPowerLevel4 As Sin-
gle,lsnglSourcePowerEO As Single, lsnglSourcePowerOE As Single) As Integer
```

**Description:** Returns the above 86032A testset values.

- boolLaserON: TRUE - Internal laser is enabled (turned on). FALSE - Internal laser is disabled (turned off) without modifying the power applied to the laser.
- sngllLaserPower: A 32-bit signed number (Single) representing internal laser output power in dBm. Range is -10 dBm to +10dBm.
- snglModBias: A 32-bit signed number (Single) representing the internal modulator bias voltage in volts. Range is - 10 to +10 volts.
- snglReflectionSTD: A 32-bit signed number (Single) representing the percent of reflection of the optical reflection standard used for optical reflection calibrations. Range is 0 to 100. 100 represents 100 % reflected power from the standard.
- snglBiasInterval: An integer representing the number of minutes between the internal modulator auto-biases.
- intMode: An integer value that determines which mode the optical testset is in.

  OTOO = 0 Optical To Optical

  OTOE = 1 Optical to Electrical

  ETOO = 2 Electrical to Optical

  ETOE = 3 Electrical to Electrical

**Pre-Conditions:** Optical test set has been initialized, either through the use of properties or by calling SysInit.

**Post-Conditions:** Above values are returned.

---

```
Public Function TurnLaserOn() as Integer
```

**Description:** Turns on the 86032A testset internal laser at the current defined laser power.

---

```
Public Function TurnLaserOff() as Integer
```

**Description:** Turns off the 86032A testset internal laser.

---

```
Public Function sBiasModAuto() as Integer
```

**Description:** Performs an auto-bias on the 86032A testset internal modulator.

---

```
Public Function sBiasModMax() as Integer
```

**Description:** Biases the 86032A testset internal modulator for max power output.

---

```
Public Function sModeOO() as Integer
```

**Description:** Puts the internal testset switch into optical mode.

**Pre-Conditions:** None.

**Post-Conditions:** test set is in optical mode.

---

```
Public Function sModeOE() as Integer
```

**Description:** Puts the internal testset switch into optical mode.

**Pre-Conditions:** None.

**Post-Conditions:** test set is in optical mode.

---

```
Public Function sModeEO() as Integer
```

**Description:** Puts the internal testset switch into electrical mode.

**Pre-Conditions:** None.

**Post-Conditions:** test set is in electrical mode.

---

```
Public Function sModeEE() as Integer
```

**Description:** Puts the internal testset switch into electrical mode.

**Pre-Conditions:** None.

**Post-Conditions:** test set is in electrical mode.

---

```
Public Function gVoltageLevels(Pwr1 As Single, Pwr2 As Single, Pwr3 As Single, Pwr4 As Single)
```

**Description:** Returns the 86032A testset power supply output voltages.

**Pre-Conditions:** None.

**Post-Conditions:** Values returned are those of the individual supply voltages within the optical testset.

# Enumerated Values

Many of the parameters to the Server's methods have been enumerated to easy in programming the 86030A. These enumerated values are listed below.

```
 Public Enum enumPointType
INVALID_POINTS = -1
POINTS51 = 51
POINTS101 = 101
POINTS201 = 201
POINTS401 = 401
POINTS801 = 801
MaxCalPoints = 801
End Enum
```

**Description:** Enumerates the valid number of points the system accepts for calibration.

```
 Public Enum enumTraceType
COMPLEX_TYPE = 0
LOGMAG_TYPE = 1
PHASE_TYPE = 2
DELAY_TYPE = 3
End Enum
```

**Description:** Enumerates the valid trace types.

```
 Public Enum enumStandards
OO_BW_RESPONSE = 0
OO_BW_RESPNISOL = 1
OO_RF_RESPONSE = 2
OO_RF_RESPNISOL = 3
OE_BW_RESPONSE = 4
OE_BW_RESPNISOL = 5
OE_RF_RESPONSE = 6
OE_RF_RESPNISOL = 7
OE_BWNRF_RESPONSE = 8
OE_BWNRF_RESPNISOL = 9
OE_RESPNMATCH = 10
EO_BW_RESPONSE = 11
EO_BW_RESPNISOL = 12
```

```
EO_RF_RESPONSE = 13
EO_RF_RESPNISOL = 14
EO_BWNRF_RESPONSE = 15
EO_BWNRF_RESPNISOL = 16
EO_REFSENSE = 17
End Enum
```

**Description:** Enumerates the valid calibrations for the system.

---

```
 Public Enum enumStatus
SYSTEM_NORMAL
SYSTEM_ERR_UNDEFINED End Enum
```

**Description:** These enumerated values provide information about system status or state. A definition for each follows below.

- SYSTEM_NORMAL indicates the system is functioning normally.
- SYSTEM_ERR_UNDEFINED indicates that an error has been encountered that is not defined.

# System Messages

**TestSet Errors**

ERR_AUTOBIAS_LASER_NOT_ON
ERR_RFLSTD_INVALID
ERR_BIAS_INTRVL_INVALID
ERR_INVALID_LASER_POWER
ERR_INVALID_BIAS_VOLTAGE
ERR_INVALID_MODE
ERR_POWER_COUPLER_NOT_SETTLED

**TestSet Actions**

SYS_TS_LASERON
SYS_TS_LASEROFF
SYS_TS_AUTOBIAS

**System Errors**

ERR_INVALID_CALIBRATION
ERR_MAINCONFIG_FILE_MISSING
ERR_INI_FILE_MISSING
ERR_CALIBRATION_FILE_MISSING
ERR_INIFILE_MISSING_VER
ERR_INI_TESTSET
ERR_LCA_DIRECTORY
ERR_MAIN_DIRECTORY
ERR_MAINCONFIG_FILE_MISSING
ERR_SYSTEM_ALREADY_RUNNING
ERR_SYSTEM_NOT_RUNNING
ERR_NOVALID_DATA
ERR_FILE_NOT_FOUND
ERR_CAL_STD_OUT_OF_SEQUENCY
ERR_CALIBRATION_STDS_MISSING

**System Actions**

SYS_INTIALIZING
SYS_INIT_GPIB
SYS_INIT_TESTSET
SYS_INIT_GETINIT_FILES
SYS_INIT_GUI
SYS_INIT_VNA
SYS_INIT_AUTOBIAS
SYS_SHUTDOWN
SYS_SHUTDOWN_GPIB
SYS_SHUTDOWN_CLNUP
SYS_VERIFY
SYS_VERIFY_FINISH

**Network Analyzer Errors**

ERR_UNDETERMINED_VNA
ERR_EO_PWR_INVALID
ERR_OE_PWR_INVALID
ERR_INVALID_START_FREQUENCY
ERR_INVALID_STOP_FREQUENCY
ERR_INVALID_NUM_POINTS
ERR_INVALID_AVERAGE

**Network Analyzer Actions**

SYS_WRITING_VNA_COMMAND
SYS_READING_VNA_RESPONSE
SYS_REQUESTING_CALDATA
SYS_RECEIVING_CALDATA
SYS_REQUESTING_TRACEDATA
SYS_RECEIVING_TRACEDATA

# Optical Test Set Error and Action Messages with Descriptions

### ERR_AUTOBIAS_LASER_NOT_ON

The intenal laser has been detected to be off. This is detected before and auto bias of the internal optical modulator is performed. This error can be reached if the laser is off, or if the laser power is too low. The laser can be turned off through software or through the use of the front panel key. The auto bias requires enough power to be present to auto bias the modulator.  The default laser power setting that is applied during initialization is guaranteed to provide enough power.

Status register value (hexidecimal): 80040201

### ERR_RFLSTD_INVALID

An invalid value has been applied for the reflection standard.

Status register value (hexidecimal): 80040202

### ERR_BIAS_INTRVL_INVALID

An invalid value has been applied for the bias interval.

Status register value (hexidecimal): 80040203

### ERR_INVALID_LASER_POWER

An invalid value has been applied for the laser power.

Status register value (hexidecimal): 80040204

### ERR_INVALID_BIAS_VOLTAGE

An invalid value has been applied for the bias voltage to the optical modulator.

Status register value (hexidecimal): 80040205

### ERR_INVALID_MODE

An invalid value has been applied for the mode of the system.

Status register value (hexidecimal): 80040206

### ERR_POWER_COUPLER_NOT_SETTLED

The value read from the intenal coupler that resides after the optical modulator is not stable. This can occur due to instability in the path from the laser to the coupler. A more common error is that the laser power is to low. Increase the laser power.

Status register value (hexidecimal): 80040207

### SYS_TS_LASERON

The system is in the progress of turning on the laser.

Status register value (hexidecimal): 8004021E

### SYS_TS_LASEROFF

The system is in the progress of turning off the laser.

Status register value (hexidecimal): 8004021F

### SYS_TS_AUTOBIAS

The system is in the progress of auto biasing the optical modulator.

Status register value (hexidecimal): 80040220

# System Error and Action Messages with Descriptions

### ERR_INVALID_CALIBRATION

A calibration has been invalided.

Status register value (hexidecimal): 80040265

### ERR_MAINCONFIG_FILE_MISSING

The main configuration (configMain.ini) file is missing.

Status register value (hexidecimal): 80040266

### ERR_INI_FILE_MISSING

The file config86030ASN.ini is missing.

Status register value (hexidecimal): 80040267

### ERR_CALIBRATION_FILE_MISSING

The systems calibration file (LWCxxxxx) is missing. Where xxxxx is the system service number.

Status register value (hexidecimal): 80040268

### ERR_INIFILE_MISSING_VER

The file ConfigVerDev.ini is missing.

Status register value (hexidecimal): 8004026E

### ERR_INI_TESTSET

The file testset configuration file (config86030Axxxxx.ini) is missing. Where xxxxx is the system service number.

Status register value (hexidecimal): 8004026F

### ERR_LCA_DIRECTORY

The directory D:\LCA50GHz is missing or corrupted.

Status register value (hexidecimal): 80040272

### ERR_MAIN_DIRECTORY

The directory C:\Program Files\Agilent\86030a is missing or corrupted.

Status register value (hexidecimal): 80040271

### ERR_MAINCONFIG_FILE_MISSING

The main configuration file ConfigMain.ini is missing from C:\Program Files\Agilent\86030a

Status register value (hexidecimal): 80040266

### ERR_SYSTEM_ALREADY_RUNNING

There has been an attempt to start the system when it is already running.

Status register value (hexidecimal): 80040273

### ERR_SYSTEM_NOT_RUNNING

There has been an attempt to call methods of the server before the method SysStartUp has been called.

Status register value (hexidecimal): 80040274

### ERR_NOVALID_DATA

Attempt to retrieve data that does not exist.

Status register value (hexidecimal): 8004026A

### ERR_FILE_NOT_FOUND

Attempt to access a file that does not exist.

Status register value (hexidecimal): 3EC

### ERR_CAL_STD_OUT_OF_SEQUENCY

One of the calibration standards has been called out of order.

Status register value (hexidecimal): 80040275

### ERR_CALIBRATION_STDS_MISSING

One of the calibration standards is missing. This error arises when the calibration method that was called does not complete successfully.

Status register value (hexidecimal): 8004026D

### SYS_INTIALIZING

System is in the progress of Initializing.

Status register value (hexidecimal): 80040282

### SYS_INIT_GPIB

System is in the progress of initializing GPIB communication to the 8510 network analyzer.

Status register value (hexidecimal): 80040283

### SYS_INIT_TESTSET

System is in the progress of initializing the optical test set.

Status register value (hexidecimal): 80040284

### SYS_INIT_GETINIT_FILES

System is in the progress of accessing initialization files.

Status register value (hexidecimal): 80040285

**SYS_INIT_GUI**

System is in the progress of initializing the GUI.

Status register value (hexidecimal): 80040286

**SYS_INIT_VNA**

System is in the progress of initializing the 8510 network analyzer.

Status register value (hexidecimal): 80040287

**SYS_INIT_AUTOBIAS**

System is in the progress of performing an initial auto bias.

Status register value (hexidecimal): 80040288

**SYS_SHUTDOWN**

System is in the progress of shutting down.

Status register value (hexidecimal): 80040289

**SYS_SHUTDOWN_GPIB**

System is in the progress of shutting down the GPIB communication drivers.

Status register value (hexidecimal): 8004028A

**SYS_SHUTDOWN_CLNUP**

System is in the progress of cleaning up system resources.

**SYS_VERIFY**

System is in the progress of performing a system verification.

Status register value (hexidecimal): 8004028C

## SYS_VERIFY_FINISH

System is in the progress of analyzing system verification data to determine system integrity.

Status register value (hexidecimal): 8004028D

# Network Analyzer Error and Action Messages with Descriptions

**ERR_UNDETERMINED_VNA**

An error has occurred within the 8510 network analyzer.

Status register value (hexidecimal): 800402C9

**ERR_EO_PWR_INVALID**

An invalid power has been specified for the 8510 source when the system is operating in electrical to optical mode.

Status register value (hexidecimal): 800402CA

**ERR_OE_PWR_INVALID**

An invalid power has been specified for the 8510 source when the system is operating in optical to electrical mode.

Status register value (hexidecimal): 800402CB

**ERR_INVALID_START_FREQUENCY**

An invalid start frequency has been specified for the 8510.

Status register value (hexidecimal): 800402CC

**ERR_INVALID_STOP_FREQUENCY**

An invalid stop frequency has been specified for the 8510.

Status register value (hexidecimal): 800402CE

### ERR_INVALID_NUM_POINTS

An invalid number of points has been specified for the 8510.

Status register value (hexidecimal): 800402CF

### ERR_INVALID_AVERAGE

An invalid number of averages has been specified for the 8510.

Status register value (hexidecimal): 800402D0

### SYS_WRITING_VNA_COMMAND

System is in the progress of writing a command to the 8510.

Status register value (hexidecimal): 800402E6

### SYS_READING_VNA_RESPONSE

System is in the progress of getting a resonse from the 8510.

Status register value (hexidecimal): 800402E7

### SYS_REQUESTING_CALDATA

System is in the process of requesting calibration data from the 8510.

Status register value (hexidecimal): 800402E8

### SYS_RECEIVING_CALDATA

System is downloading calibration data from the 8510.

Status register value (hexidecimal): 800402E9

### SYS_REQUESTING_TRACEDATA

System is in the process of requesting measurment data from the 8510.

Status register value (hexidecimal): 800402EA

## SYS_RECEIVING_TRACEDATA

System is in the process of receiving measurement data from the 8510.

Status register value (hexidecimal): 800402EB

# Error Codes and Error Handling

You can use two different approaches to obtain error information using the 86030A remote operation.

- In the first approach you can use the return values of methods and the system status register.
- In the second approach you can use the ERRHANDLER event provided by the server.

Almost all methods return a 0 or a -1 to indicate success or failure respectively. If the method was successful (returned a 0), there is no reason to query the system status register. If a -1 was returned, then the system status register can provide information as to the reason for the error. The system status register can take on the values of the enumStatus type. If the value of the status register is prefixed with an EER this represents the last error encountered while the method was executing. If the value of the status register is prefixed with an SYS this indicates the last action the server was performing when an error was encountered.

The second approach, using the ERRHANDLER event, provides more descriptive error information. The handle to the 86030A server object must be declared WithEvents. Then an error handler must be written on the client or controlling computer to use this method of retrieving error information. This handler returns both a string containing descripion, and an error code. The definition of the ERRHANDLER is repeated below.

```
Public Event ERRHANDLER(strERROR As String, intErrorCode As enumStatus)
```

The variable strERROR contains a string that helps better identify and explain the cause of the error encountered. The variable intErrorCode returns one of the enumerated values defined in enumStatus. Together these values provide details to the cause of errors encountered.

# 5



# Theory of Operation

# System Operation

The lightwave test set is designed to operate with an 8510C microwave network analyzer system. Figure 5-1 shows a conceptual system block diagram. The 8510C network analyzer system consists of a microwave source, a reference receiver, and one or more measurement receivers. The microwave source is applied to the 86032A RF INPUT. The lightwave test set then provides a reference signal to the 8517B electrical test set, which provides a reference signal to the network analyzer. This reference signal is used for phase lock of the system.

The conceptual system block diagram shows an optical-to-optical (O/O) DUT (fiber) measurement configuration. The signal is routed from the OPTICAL OUTPUT through the fiber, demodulated by the test set's optical receiver, and then routed to the analyzer's measurement receiver. A similar configuration is used for electrical-to-optical (E/O) DUTs, except the device drive signal is the lightwave test set's RF OUTPUT. For O/E DUTs, the drive signal is from the OPTICAL OUTPUT and the DUT signal is routed to the analyzer's measurement receiver.

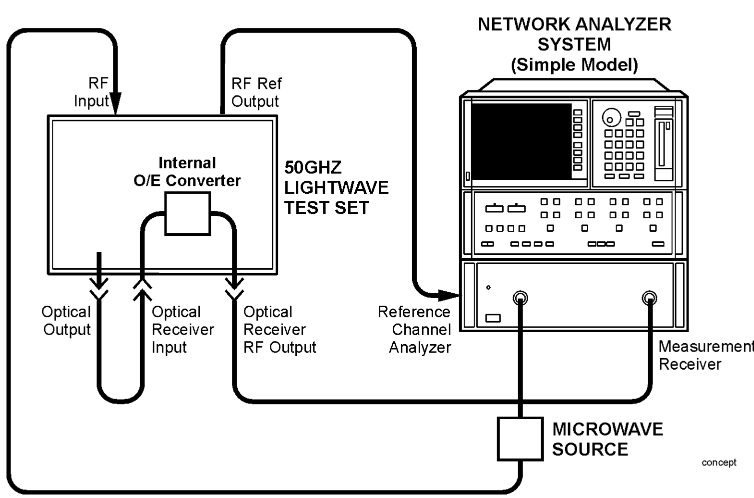



**Figure 5-1. Conceptual System Block Diagram**

# Lightwave Test Set Operation

The lightwave test set consists of four major functional blocks:

- Lightwave source deck (LSD)
- Amplified optical receiver
- Microwave modulation
- Printed circuit boards containing the internal amplifiers and other microcircuits

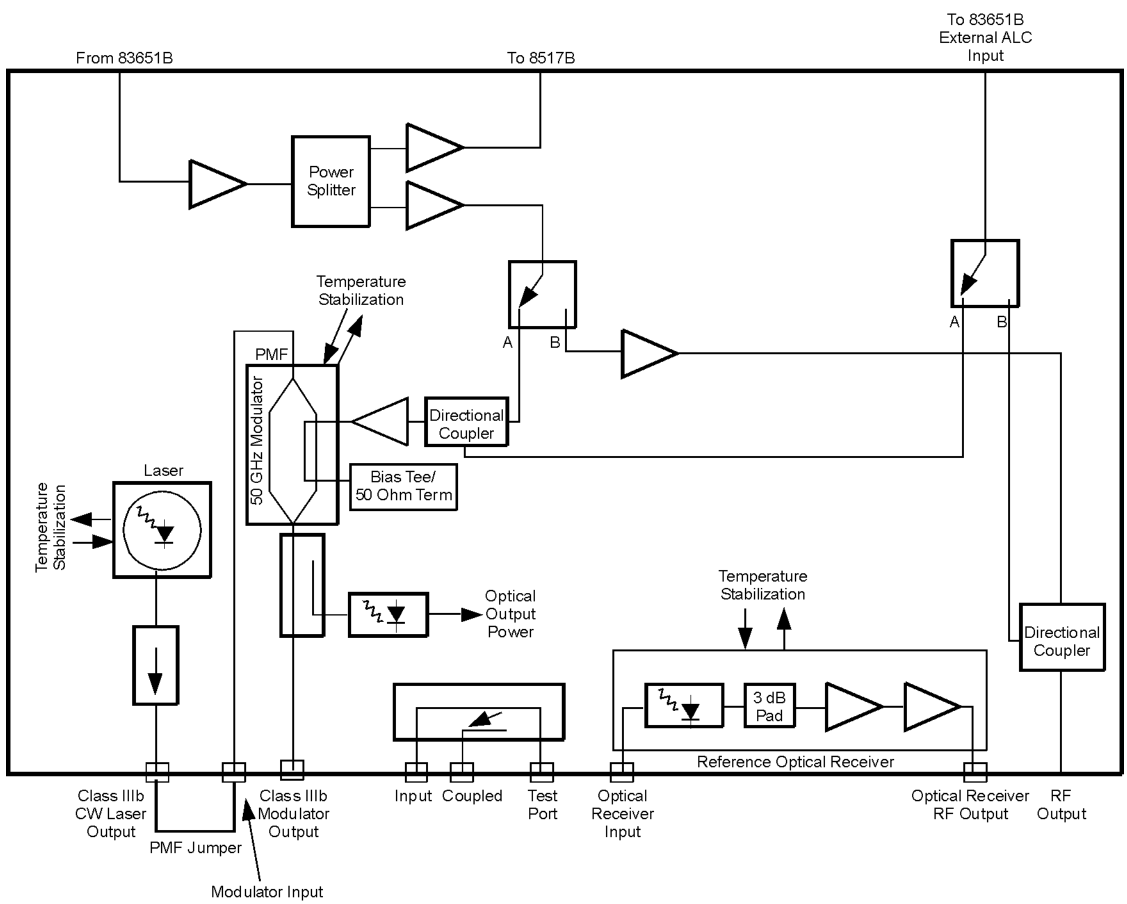



**Figure 5-2. 86032A Test Set Block Diagram**

## Lightwave Source Deck

The lightwave source deck converts RF energy into modulated laser light. The source of light is an unmodulated (CW) semiconductor distributed feedback laser (DFB) operating at approximately 1550 nm. The light is directed through a high-performance isolator (greater than 90 dB isolation) to prevent reflections from affecting the semiconductor laser.

A key component of the lightwave source deck is the lithium niobate ($LiNbO_3$) modulator. To work correctly, the modulator is biased with a fixed dc offset (quadrature voltage—half way between maximum and minimum optical intensity) that is supplied by the digital to analog converter. The modulator bias level is under PC control for optimal performance and to reduce unwanted effects such as source signal level drift.

After exiting the modulator, the laser light is routed to the front panel OPTICAL OUTPUT connector via a 5/95 coupler. The 5% arm of the optical coupler is used to monitor the average optical power that is delivered to the OPTICAL OUTPUT of the lightwave test set. Appropriate corrections are made to the modulator bias by the 86030A software to keep the modulator bias point at quadrature. The software initiates the modulator bias adjustment after every Mode Change to O/O and O/E. It can also be user initiated through the Auto Bias feature.

## Amplified Optical Receiver

The amplified optical receiver completes the lightwave path. This receiver consists of a high speed photodiode followed by RF amplification.

The lightwave receiver is the key component for the measurement calibration. A factory measurement of the magnitude and phase response of the lightwave receiver is saved on the hard drive of the PC and also on the supplied backup disk. This factory calibrated optical receiver becomes the standard for both optical-to-electrical and electrical-to-optical calibrations.

## Microwave Modulation

The 85107 RF network analyzer's microwave source is applied to the rear-panel RF INPUT connector of the lightwave test set. This signal is split internally. One path goes to the RF reference output connector for the lightwave test set used to phase lock the 85107 system. The other path from the splitter is routed to an RF switch. The RF switch is controlled by the 86030A software. Depending on the measurement mode selected by the user, the switch routes the signal to either the optical modulator (O/O and O/E modes), or to the RF OUTPUT port of the 86032A lightwave test set (E/O mode).

## Main Printed Circuit Board

The internal printed circuit (PC) board provides the correct drive voltages to the internal microcircuits.

## Drive Voltages

The power supply provides five voltages (+15V, –15V, +6V, +5V).

**Note**

The lightwave test set power switch will need to be in the ON state, even for electrical-to-electrical (E/E) measurements.

# Measurement Calibration

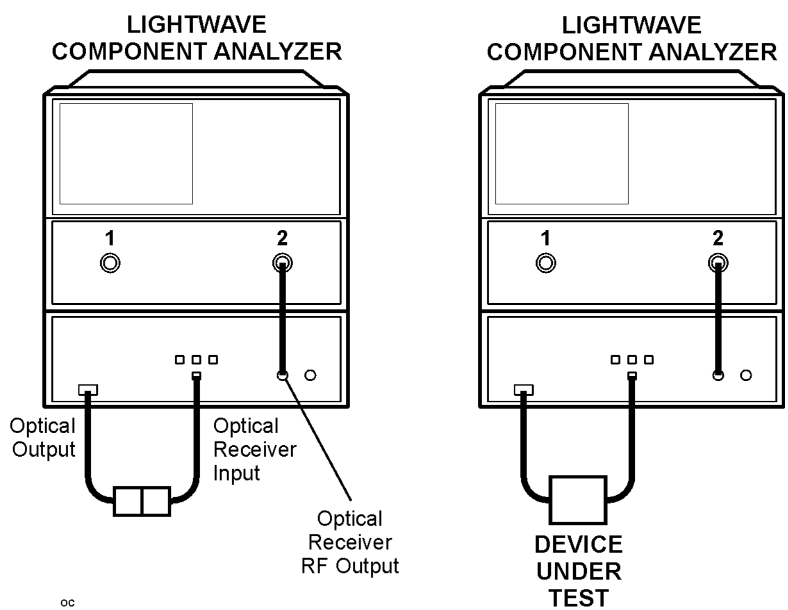
The lightwave test system provides calibrated measurements of lightwave components. The reference for an E/O (electrical to optical) and an O/E (optical to electrical) measurement is the lightwave photodiode receiver.

## Calibration Data

The response (magnitude and phase) of the lightwave receiver in your test set is measured at the factory and stored on a disk. This calibration data is combined with the user calibration measurement to provide accurate lightwave component analysis.

# O/O Measurement Calibration

A measurement calibration for an optical to optical device is a thru response calibration of an optical cable. The measurement of the optical device under test (DUT) is displayed relative to the thru line. When the device is measured, the response displayed is the device under test. The analyzer firmware performs the mathematical operations. The following figure shows the calibration measurement and device measurement configurations.




**Optical Configurations**

These are the equations for the calibration and device measurements:

$$\textit{calibration measurement} = (ES)(OS)(LWCABLE)(OR)(ER)$$
$$\textit{device measurement} = (ES)(OS)(DUT)(LWCABLE)(OR)(ER)$$

Therefore:

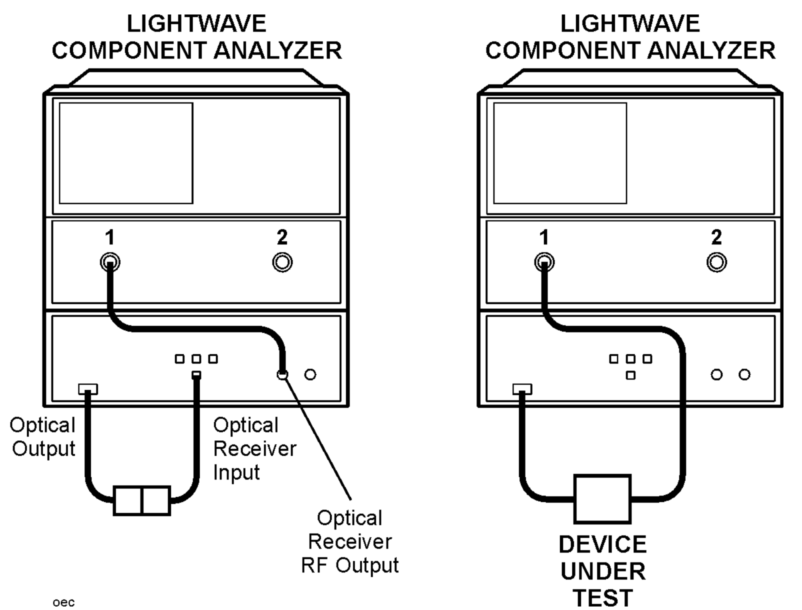
$$\textit{device measurement} / \textit{calibration measurement} =$$
$$\frac{(ES)(OS)(DUT)(LWCABLE)(OR)(ER)}{(ES)(OS)(LWCABLE)(OR)(ER)} = \textit{DUT response}$$

Where:

- ES = electrical source
- OS = optical source
- LWCABLE = lightwave cable
- OR = optical receiver
- ER = electrical receiver
- DUT = device under test
- ECABLE = electrical cable
- ORCAL = optical receiver calibration data

# O/E Measurement Calibration

A user measurement calibration for an optical to electrical device is combined with the calibration data stored on disk to provide accurate optical to electrical device characterizations. The following figure shows the calibration measurement and device measurement configurations.




**Optical to Electrical Configurations**

These are the equations for the calibration and device measurements:

$$\textit{calibration measurement} = (ES)(OS)(LWCABLE)(OR)(ECABLE)(ER)$$
$$\textit{device measurement} = (ES)(OS)(LWCABLE)(DUT)(ECABLE)(ER)$$

The calibration measurement is combined with the optical receiver response data (contained on disk) to form a calibration response.

Therefore:

$$\textit{device measurement} / \textit{calibration measurement} =$$
$$\frac{(ES)(OS)(DUT)(LWCABLE)(ECABLE)(ER)}{(ES)(OS)(LWCABLE)(OR)(ECABLE)(ER)(1/ORCAL)} = \textit{DUT response}$$

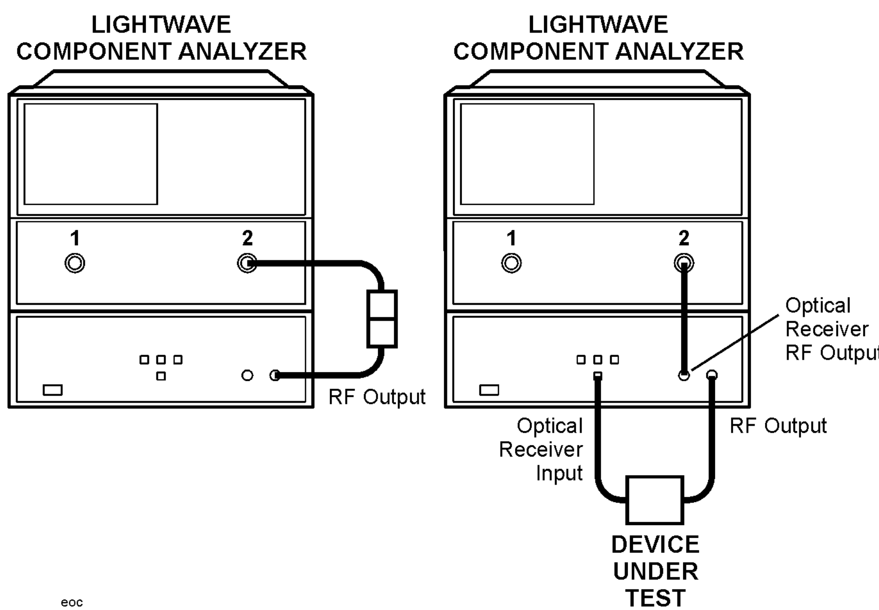
Where:

- ES = electrical source
- OS = optical source
- LWCABLE = lightwave cable
- OR = optical receiver
- ER = electrical receiver
- DUT = device under test
- ECABLE = electrical cable
- ORCAL = optical receiver calibration data

The optical receiver response calibration data (contained on disk) and the optical receiver response are ideally the same: $(OR)(1/(OR)) = 1$. Differences between these are reflected in the response uncertainty.

# E/O Measurement Calibration

The measurement calibration for an electrical to optical device is accomplished by measuring the microwave path from the lightwave test set to the network analyzer. The microwave response of the system is now known, and is combined with the lightwave test set optical receiver response to provide a complete response calibration. In the device measurement, the response calibration is subtracted from the full path measurement, leaving only the response of the DUT. The optical cable connected between the DUT and the lightwave receiver contributes to the DUT response. The following figure shows the calibration measurement and device measurement configurations.




**Electrical to Optical Configurations**

These are the equations for the calibration and device measurements:

$$calibration\ measurement = (ES)(ECABLE)(ER)$$

The calibration measurement is combined with the test set optical receiver response data in the analyzer to form a calibration response.

$$calibration\ response = (ES)(ECABLE)(ER)(ORCAL)$$
$$device\ measurement = (ES)(ECABLE)(DUT)(LWCABLE)(OR)(ER)$$

Therefore:

$$device\ measurement / calibration\ measurement =$$
$$\frac{(ES)(ECABLE)(DUT)(LWCABLE)(OR)(ER)}{(ES)(ECABLE)(ER)(ORCAL)} = (DUT)(LWCABLE)$$

Where:

- ES = electrical source
- OS =optical source
- LWCABLE = lightwave cable
- OR = optical receiver
- ER = electrical receiver
- DUT = device under test
- ECABLE = electrical cable
- ORCAL = optical receiver calibration data

A port extension should be added in order to mathematically remove the electrical length added by the lightwave cable. Lightwave cables less than 10 meters long have negligible frequency response.

## Port Extensions

The 8510C port extension is accessed from the CAL front panel key. To add a port extension and remove the effects of the lightwave cable in an E/O measurement, press:

CAL, *MORE*, *PORT EXTENSIONS 2*

Enter the delay time associated with the length of the lightwave cable that is connected between the E/O device and the lightwave receiver. Terminate the entry by pressing the G/n key on the analyzer.

For example: a 40 cm cable with an index of refraction of 1.46 has a delay of:

$$t = Ln/v = ((40\ cm)(1.46))/3 \times 10^{10}\ cm/s = 1.95\ ns$$

# Electrical Measurement Calibration

The measurement calibration for electrical devices does not involve the lightwave test set. Refer to the network analyzer documentation for information on performing microwave measurements and calibrations.

## Bias Voltage to the Modulator

Under typical circumstances, the lightwave modulator is biased to operate at quadrature. Quadrature is where the midpoint of the average optical power curve and the peak of the modulated optical power curve occur. Refer to Figure 5-3. This maximizes the modulation response and minimizes distortion of the modulated signal.

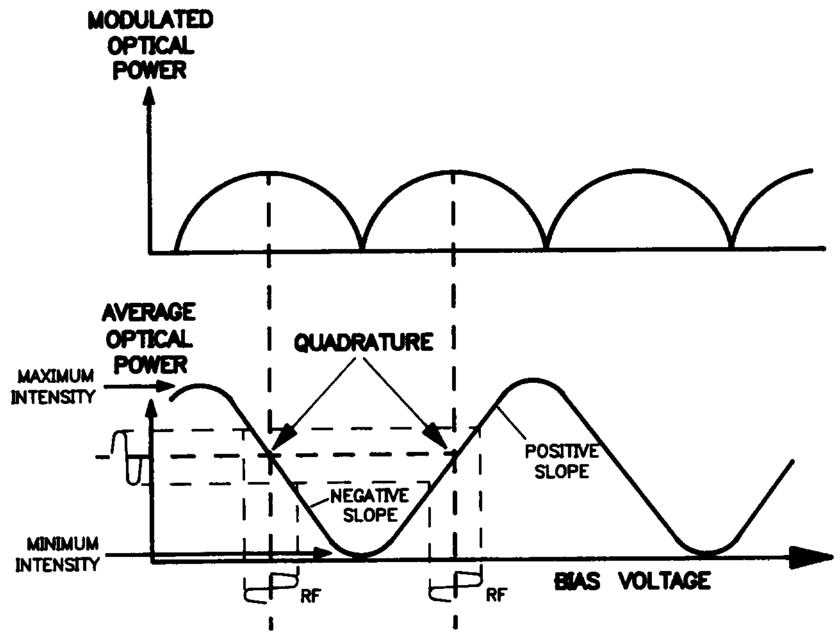



**Figure 5-3. The Effect of Bias Voltage on Average and Modulated Optical Power**

# O/E Display Scaling Calculations

The marker reads out the actual value in dB compared to 1 amp/watt responsivity. Suppose marker 1 has a value of 36 dB, indicating the gain of the receiver at a specific frequency. This corresponds to the responsivity (R) of the receiver in A/W, at the given frequency, that can be calculated as shown below.

*R (dB) = responsivity in dB at a given frequency compared to 1 A/W as read by the 86030A*

*R (A/W) = responsivity in units of amps/watt*

$$R(dB) = 20\log_{10}\frac{R(A/W)}{1(A/W)}$$

$$\frac{R(dB)}{20} = \log_{10}\frac{R(A/W)}{1(A/W)}$$

$$1(A/W) \times 10^{R(dB)/20} = \frac{R(A/W)}{1(A/W)} \times 1(A/W)$$

$$R(A/W) = 10^{R(dB)/20} \times 1(A/W)$$

*For example, if* $R(dB) = +36$ *dB, then:*

$$R = 10^{(36/20)} = 10^{1.8} = 63.1(A/W) = 63.1\frac{mA}{mW}$$

To read the result directly, in the FORMAT area press MENU, then *LINEAR MAGNITUDE*.

# E/O Display Scaling Calculations

The marker reads out the actual value in dB compared to 1 watt/amp responsivity. Suppose marker 1 has a value of –40 dB, indicating the efficiency of the transmitter at a specific frequency. (This is a typical value for a $LiNb0_3$ optical modulator.) This corresponds to the responsivity ($R_s$) of the transmitter in W/A, at the given frequency, that can be calculated as shown below.

*$R_s$ (dB) = responsivity in dB at a given frequency compared to 1 W/A as read by the 86030A*

*$R_s$ (W/A) = responsivity in units of watts/amp*

$$R_s(dB) = 20\log_{10}\frac{R_s(W/A)}{1(W/A)}$$

$$\frac{R_s(dB)}{20} = \log_{10}\frac{R_s(W/A)}{1(W/A)}$$

$$1(W/A)\times 10^{R_s(dB)/20} = \frac{R_s(W/A)}{1(W/A)}\times 1(W/A)$$

$$R_s(W/A) = 10^{R_s(dB)/20}\times 1(W/A)$$

*For example, if R(dB) = –40 dB, then:*

$$R = 10^{(-40/20)} = 10^{-2} = .01(W/A) = .01\frac{mW}{mA}$$

To read the result directly, in the FORMAT area press MENU, then *LINEAR MAGNITUDE*.

# O/O Display Scaling Calculations

The 0/0 mode scales the vertical axis using the formula:

$$Gain(dB) = 10\log\frac{p}{p_{ref}}$$

Thus, the gain is in optical dBs.

$P_{ref}$ is the power measured in the reference calibration trace. Optical through lines are most often used in the reference calibration.

To read the result directly, in the FORMAT area press MENU, then *LINEAR MAGNITUDE*.

6



# System Verification

# Introduction

In order to verify the system, it is necessary to perform the procedures described here. The recommended verification cycle is one year.

The system verification monitors the long-term stability and repeatability of the system hardware.

**Note**

Although this lightwave verification is a subset of the total process for verifying the system's conformance to specifications, this procedure can be used alone as a functional test and can be helpful in the following ways:

- It can be used at incoming inspection to check that no major degradation has occurred in the system during shipment.
- It provides a means to periodically monitor measurement stability.
- It can help isolate the cause of incorrect measurement results. (When the system passes the test, you will have confidence the system is operating correctly and any problem is in the setup or DUT.)

# Lightwave Verification

## Description

A verification device is included in the N1012A Verification Kit. It consists of a lightwave detector and it's associated amplitude and phase data. This verification device can be used at any time to verify the measurement integrity of your system. A guided verification routine is provided which measures the verification device, and displays a graph of its response versus acceptable tolerances. The verification device can be used periodically to monitor system calibration, and indicate when the optical test set needs to be recalibrated. It can also be used to resolve uncertainty if unexpected results are obtained from a test device. This verification capability provides confidence in the measurement integrity of the system. If the new data measured does not fall within these limits, refer to "If the Lightwave Verification Test Fails" on page 6-7.

## Procedure

1 Load the verification device data into the 86030A. The device data is on the floppy disk that is included in the verification kit.

   a Insert the N1012A verification device data disk into the floppy drive of the 86030A system computer.

   b From the Windows Desktop, double-click My Computer.

   c Double-click on the A: drive and then setup.bat.

2 Ensure that the following front panel connections are made:

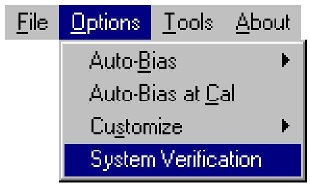
   - Connect LASER OUTPUT to LASER INPUT.
   - Connect OPTICAL OUTPUT to OPTICAL RECEIVER INPUT.
   - Connect OPTICAL RECEIVER RF OUTPUT to PORT 1 of the electrical test set.
   - Connect a 50-ohm termination to PORT 2 of the electrical test set.

3 On the 86032A test set, turn the laser key to the "ON" position.

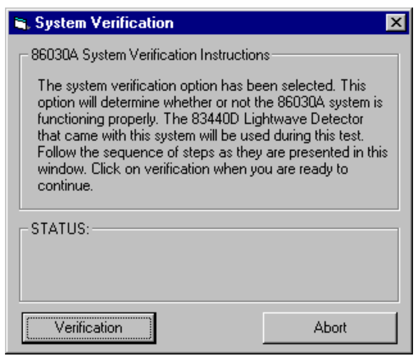
4 On the system computer desktop screen, double-click the 86030A system

software icon to start the system software.

5 In the **Options** menu, select **System Verification**.

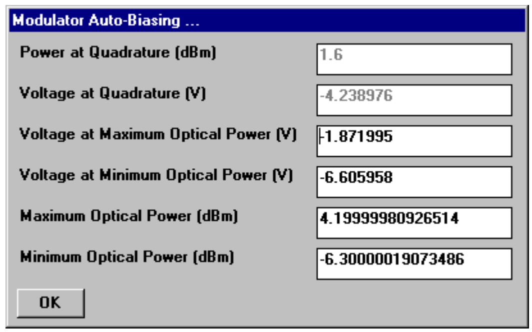



6 From the System Verification dialog box, click **Verification**.



**7** The System Verification procedure will start by performing an auto-bias routine.

**NOTE** Ensure that a BNC 50 ohm load is connected to the Port 1 bias tee on the 8517B rear panel.



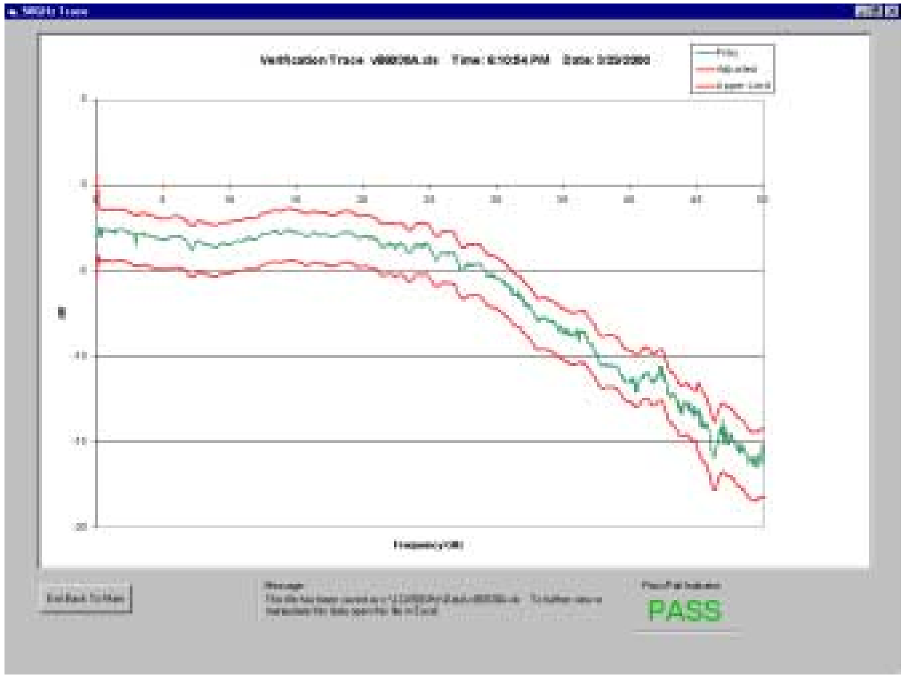

**8** Follow the on-screen instructions to perform an O/E response and isolation calibration.

**9** When the calibration procedure is complete, you will be prompted to connect the equipment as shown. The lightwave detector, that is included in the verification kit, is the DUT for the verification procedure. The DUT is powered by a power supply that is also included in the verification kit.

**NOTE** Be sure to connect the the dc bias port of the detector to the power supply. Also, be sure to connect the power supply to an AC power outlet.

**10** Once an entire sweep is displayed on the 8510C, click **OK** to continue.

**11** The verification process is completed. Click on **Finished** to save and view the verification results on an Excel worksheet.




**Example of Verification Test Results**

# If the Lightwave Verification Test Fails

**1** If any part of the test fails, measurement integrity is not confirmed. Proceed with the following checks.

**a** Clean all the optical and electrical connectors and make sure the connections are finger tight.

**b** Clean all the RF connectors and make sure the connections are made to the correct torque. Refer to “Accurate Measurements” on page 2-33.

**c** Run the lightwave verification test again.

**2** Check electrical connectors for damage, especially the center female pins.

**3** Check the flexible 2.4 mm cables for damage.

**4** If the test still fails, perform an autobias.

**a** Select Options, Autobias from the menu bar.

**b** Allow two hours for the modulator to stabilize, and then run the measurement stability test again.

**5** If the test still fails, reload the verification device data into the 86030A and run the verification test again. The device data is on the floppy disk that is part of the N1012A Verification Kit.

**6** If the test still fails, refer to Chapter 7, “Maintenance”.

# Maintenance

# Maintenance

This chapter shows you how to troubleshoot the system to the instrument level. To prevent voiding product warranty, do not remove any instrument covers. The Agilent 86032A test set is *not* customer serviceable. Do not open the Agilent 86030A covers for any reason.

**WARNING** **These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.**

**WARNING** **The opening of the system or removal of parts is likely to expose dangerous voltages. Disconnect the product from all voltage sources while it is being opened.**

**WARNING** **The power cord is connected to internal capacitors that may remain live for 5 seconds after disconnecting the plug from its power supply.**

**WARNING** **This is a Safety Class 1 Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intention interruption is prohibited.**

**WARNING** **To prevent electrical shock, disconnect the Agilent Technologies 86030A system from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean any instrument internally.**

**CAUTION** The warranty and calibration will be voided on systems where the individual instruments, including fiber-optic cables, RF cables, or GPIB cables are removed by the customer. The system should only be disassembled by an Agilent Technologies Customer Engineer. Instruments should not be swapped or removed by non-Agilent Technologies personnel.

# Troubleshooting

Troubleshooting consists of checking the setup and the connections. If a problem persists, contact Agilent Technologies.

**Check the Setup**

Plug in the system and listen for the sound of the fan. Even in standby (STBY) mode, the E/E LED should be on and the fan should run. Turn on the system. The O/O LED should turn on.

If either LED does not light or if the fan does not run, contact Agilent Technologies.

**WARNING**

**Do NOT, under any circumstances, look into the optical output or any fiber/device attached to the output while the laser is in operation. Refer to “Laser Safety Considerations” on page 2-30 for additional information.**

**CAUTION**

When you use improper cleaning and handling techniques, you risk expensive system repairs, damaged cables, and compromised measurements. Repair of damaged connectors due to improper use is not covered under warranty.

Clean all cables before applying to any connector. Refer to “Choosing the Right Connector” on page 2-33 and to “Inspecting Connectors” on page 2-36.

Use the key to turn on the laser. The laser LED should turn on. If not, check the REMOTE SHUTDOWN BNC connector on the rear panel. That connector must be shorted for the laser (and the front panel LED) to turn on. Connect the BNC short to the connector. If the laser LED does not turn on, contact Agilent Technologies. If the LED does turn on, continue.

If the setup has been changed or the optical power output seems low, you may have to check the optical connections.

Optical connections are a critical part of consistent measurements, as detailed in “Accurate Measurements” on page 2-33. Are all of the connections clean and properly made?

## To perform a quick check

Common troubleshooting skills can be used to locate many problems. The following steps are suggested for quickly narrowing down the problem.

1. Inquire about recent repairs or changes to the system. Often, this will help pinpoint current problems even if the system was operating correctly after the repair or change to the system.
2. Setup or reinstall the 86030A software to determine whether the problem is a hardware or a software problem. Refer to Chapter 1, “Installation”.

   Refer to Table 7-2 on page 7-6 for the correct addresses for the computer and the 86030A lightwave component analyzer system. If reinstalling the software does not solve the problem, the problem may not be a software error.
3. Check that all system components are wired correctly.
4. Remove, clean, and reinstall all optical connections.
5. Ensure that all cables are secure.
6. Check for a 50Ω load in the two bias ports of the 8517B electrical test set.

## To check the 8510C network analyzer

❒ Refer to the *8510C Onsite Service Guide* (Agilent part number 08510-90282) for 8510C troubleshooting procedures.

## To check the computer

❒ For problems with the personal computer that are unrelated to the rest of the 86030A, refer to the computer manual that was shipped with this system, or call your local IT department.

❒ If either the wireless keyboard or mouse are not responding, check the batteries.

❒ Troubleshoot the computer’s connection to the 86030A:

   a. Ensure that the GPIB and computer addresses are correct. The correct GPIB and I/O addresses for the computer and system are located in Table 7-2 on page 7-6 and Table 7-1 on page 7-6.

❒ Perform the following step:

**a** With a voltage meter, measure the voltage from the cable. It should be reading between 2 and 4 volts.

❒ If any of the following system failures occur, you can reinstall the 86030A computer operating system and applications:

- Windows operating system
- 86030A measurement application
- PC applications included on the 86030A system
- System diagnostic programs

### To Reinstall the 86030A System Software

1. Move any needed data that is on the 86030A computer hard drive to another storage media. This may include measurement setups as well as measurement data.
2. Insert the 86030A Operating System Software disk in the computer CDROM drive. This disk was included in the 86030A shipment.
3. Switch the 86030A system power off and then on. The installation program will automatically load. Follow the prompts that appear on the screen to complete the system software installation.
4. Refer to "After Repair" on page 7-26 for instructions on how to reinstall the calibration coefficient file and the verification device data file.

## To check the network

❒ Make sure the LAN cable is connected properly to the computer.

❒ Setup the computer LAN card according to the manufacturer's specifications.

❒ Disconnect the LAN cable, and test it using a LAN cable testing tool.

❒ Refer to the Windows NT documentation on networking the system. The Windows NT help system also contains a *Networking Troubleshooter* section which will guide you through the most common networking problems.

❒ Refer to your local IT department, or call the Agilent Test and Measurement Customer Support line at (800) 452-4844.

❒ Correct GPIB and I/O addresses for the computer and system are located in Table 7-2 on page 7-6 and Table 7-1 on page 7-6.

There are many types of inter-office LANs. Because of this, this manual can only give very basic troubleshooting information.

**Table 7-1. Computer I/O Addresses**

| Test Set Component | I/O Address |
|---|---|
| Modulation Bias DAC | &h300 |

**Table 7-2. GPIB Addresses**

| Instrument Name | GPIB Address |
|---|---|
| 86032A optical test set | 24 |
| 8510C network analyzer | 16 |
| 8517B electrical test set | 20 |
| 83651B synthesized sweeper | 19 |

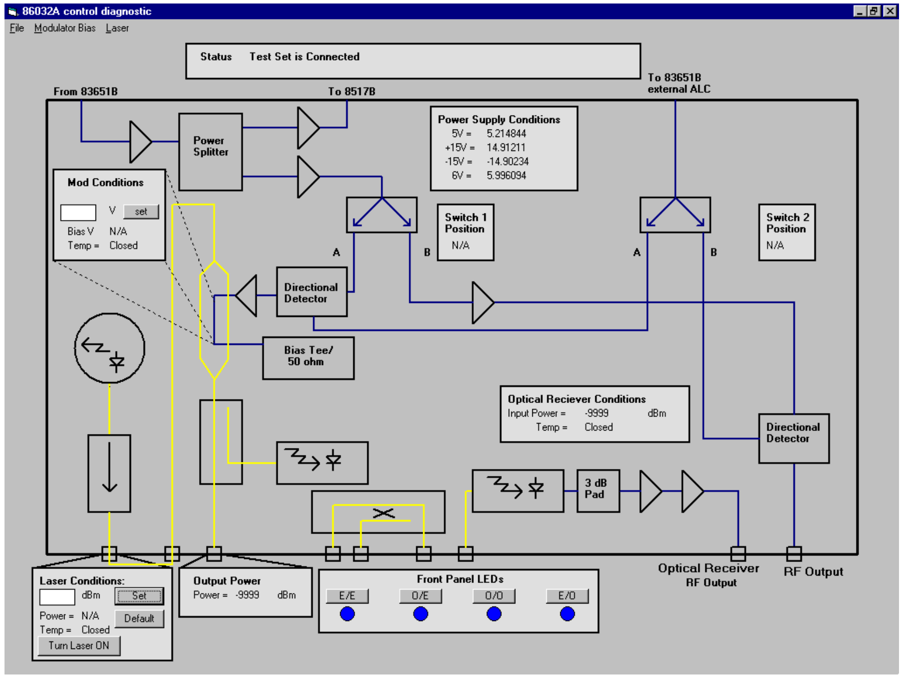
# 86032A Test Set Troubleshooting Diagnostics

Using the 50 GHz LCA Diagnostic software and an electrical power meter with an Agilent/HP 8487A power sensor (2.4 mm connector), you can do a thorough verification of the Agilent 86032A test set. The Diagnostic software will verify the functionality of the:

- laser
- modulator
- receiver
- RF paths

### To open the Diagnostic software

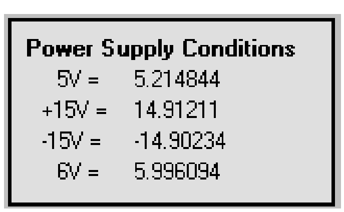
1 From the **Start** menu, click on **Programs**, **Agilent Technologies 50 GHz LCA**, **50 GHz LCA Diagnostic**.




## To verify power supply operation

The purpose of this test is to verify that the 86032A test set is properly connected to the system computer. Verification of the 86032A power supply functionality is also confirmed.

2 In the Power Supply Conditions area of the diagnostic software, the left column lists the power supplies used in the 86032A test set. The right column lists the actual value of these power supplies. Make sure that these values are close to the values in the left column.

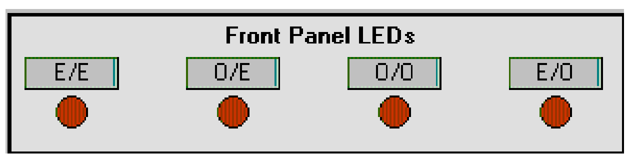


Tip: When the power supplies are functioning properly, the Status area will display "`Test Set is Connected`."


## To verify System Mode switching function

The purpose of this test is to verify that you can control the electrical switch inside the 86032A test set.

**3** In the Front Panel LEDs area of the diagnostic software, click on each of the four system modes in the following order: **E/E**, **O/E**, **E/O** then **O/O**.




**4** For each mode, you should hear a clicking noise from the 86032A test set indicating that the switch is working. Also, as each mode is selected, verify that the corresponding LED lights up on the test set front panel.

## To check laser conditions

The purpose of this test is to see if the internal DFB laser is producing the correct amount of output power.

**WARNING**

**Do NOT, under any circumstances, look into the optical output or any fiber/device attached to the output while the laser is in operation.**

**Refer to "Laser Safety Considerations" on page 2-30 for additional information.**

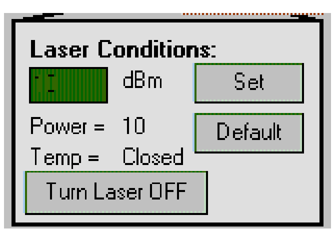
> **Note**
>
> To verify proper operation of the laser, the laser must be controlled via the 50 GHz Diagnostic software. Also, insure that a BNC short is connected to the Laser Remote Shutdown connector on the 86032A rear panel.

5 Select a fiber cable from the 86030A verification kit.

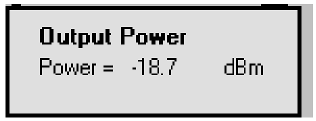
6 Clean and then connect the cable between the 86032A OPTICAL OUTPUT and the OPTICAL RECEIVER INPUT. Refer to "Cleaning Connectors" on page 2-40.

7 On the 86032A front panel, turn the Laser key to the ON position.

8 In the Laser Conditions area of the diagnostic software, click the Turn On Laser button. Verify that the 86032A LASER ON LED lights up.




9 In the Laser Conditions area, set the Laser Power to 10 dBm and observe the power as indicated in the Output Power area. There should be some indication of power.



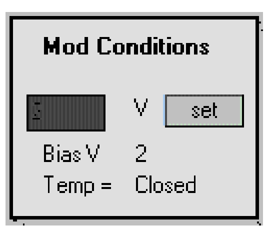

The actual power out is not a fixed value since the state of the modulator cannot be predicted. If the laser is not functioning, the power level will register –9999 or some other extremely low value.

## To check modulator conditions

The purpose of this test is to see if the electrical input voltage to the modulator can control the modulator loss.

**10** In the Front Panel LEDs area of the diagnostic software, click on **E/E** to remove the modulation from the lightwave path.

**11** In the Mod Conditions area, enter 1 Volt in the text box, and then press **Set**. Observe the Output Power level. Now, increase the voltage to 2V. There should be a noticeable change to the Output Power level. There is no way of determining if the power will increase or decrease because it is not known where 1 volt lies on the Modulator Bias Curve. See Figure 7-1 on page 7-12.




**12** In the 8510C STIMULUS area, select CENTER and enter 25 G (25 GHz), then select SPAN and enter 0 [x1] (0 Hz).

**13** From the Diagnostic software's **Modulator Bias** menu, select **Trace Out Mod Curve**.

Follow the on-screen instructions. It will take a few minutes to trace the output curve.

**14** To view the trace, open a session of Excel, then click **File**, **Open** to open *C:\LCA50GHZ\Data\Pwrcurve.*

This shows the output power versus applied voltage to the optical modulator. The voltage difference between the minimum and maximum power point is referred to as $V_\pi$. A typical value of $V_\pi$ is between 2.5 and 6 volts. The extinction ratio of the modulator is defined to be the ratio of the maximum power to the minimum power as expressed in dB. The typical value of extinction ratio is between 8 and 20 dB.

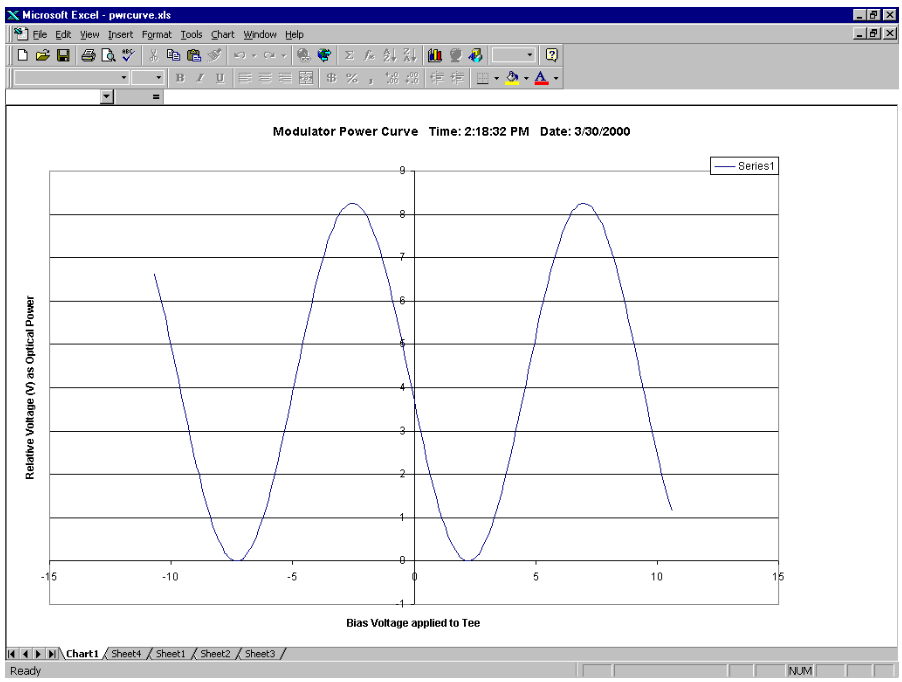
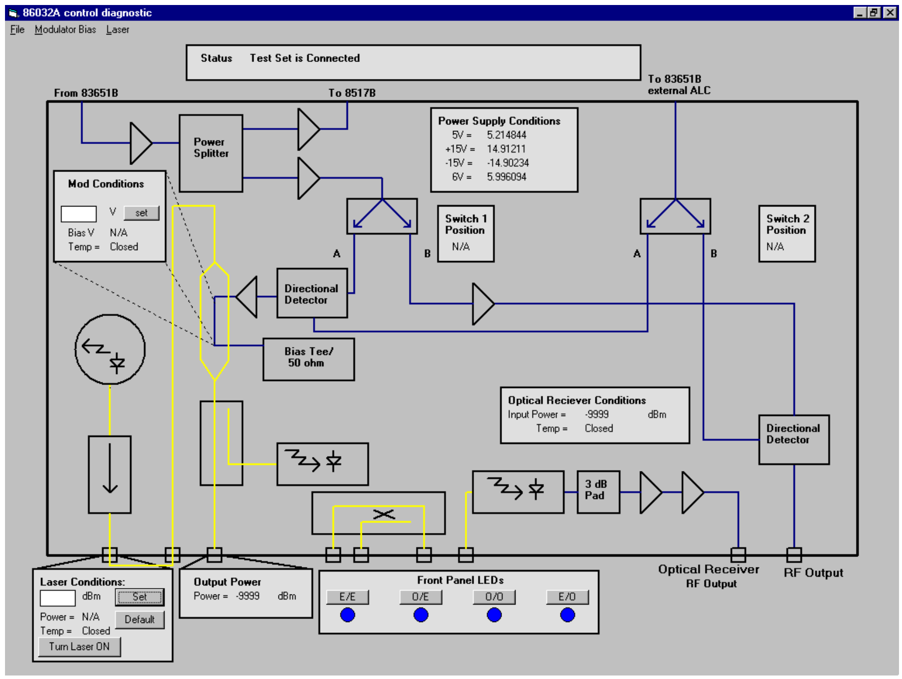



**Figure 7-1.**

## To verify the RF path integrity of the 86032A




This series of tests will check the RF path integrity for three different routes.

- Path A, *From 83651B* input to *To 8517B* output
- Path B, *From 83651B* input to *Optical Receiver RF Output*
- Path C, *From 83651B* input to *RF Output*

### Path A Test

The purpose of this test is to check Path A continuity.

**15** Connect an electrical power meter to the 86032A rear panel RF REF OUTPUT.

**16** In the 8510C STIMULUS area, select CENTER and enter 25 G (25 GHz), then select SPAN and enter 0 [x1] (0 Hz).

**17** From the 8510 STIMULUS MENU, select Power Menu, Power Source 1 and enter 0 [X1] (0 dBm).

**18** The power meter should read >5 dBm.

**Tip**: If the power is low, verify that the power out of the 83651A is 0 dBm. You can verify the power to 83651A by connecting the 8487A power sensor directly to the 83651A rear panel output.

**Path B Test**

The purpose of this test is to check Path B continuity.

**19** Connect the 8487A power sensor to the 86032A OPTICAL RECEIVER RF OUTPUT.

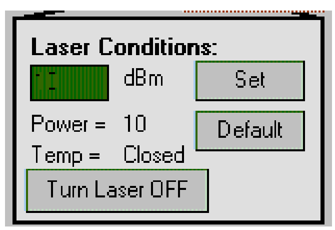
Ensure that a fiber cable is connected between the Optical Output and Receiver Input connectors on the front panel.

**Tip**: You will need a female-to female 2.4 adapter between the power sensor and the RF output, which you can find in the 85056A 2.4 mm calibration kit.

**20** From the Front Panel LEDs area, click on the O/E mode button.

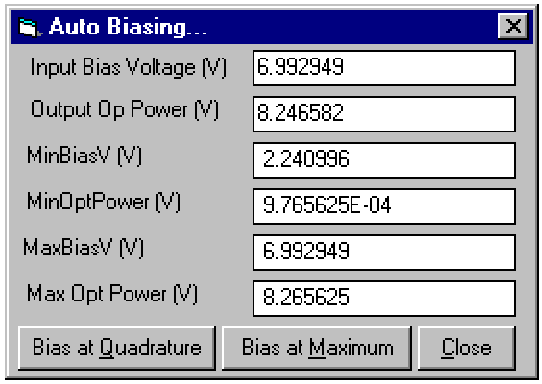
***Setting up the Laser Source Power***

**21** In the Laser Conditions area of the diagnostic software, enter **10** dBm in the text box, and then click **Set**.




***Setting Up the Modulator Bias Voltage***

**22** From the Diagnostic software main menu, select **Modulator Bias**, **Bias Modulator**.




**23** In the Auto Bias window, click **Bias at Quadrature**.

**24** Once the auto bias is completed, the power reading in the Output Power area and Optical Receiver Conditions area should be within 1 dB of each other.

This step verifies that there is a low loss connection between the Optical Output port and Optical Receiver Input port.

**25** Connect the power meter to the OPTICAL RECEIVER RF OUTPUT. The power meter should read > –20 dBm.

## Path C Test

The purpose of this test is to check Path C continuity.

**26** From the Diagnostic Front Panel LEDs area, click on **E/O**.

**27** Connect the 8487A power sensor to the 86032A RF OUTPUT.

**Tip**: You will need a female-to female 2.4 adapter between the power sensor and the RF output.

**28** In the 8510C STIMULUS area, select CENTER and enter 25 G (25 GHz), then select SPAN and enter 0 [x1] (0 Hz).

**29** The power meter should read ≥ –5 dBm.

**30** From the Diagnostic Front Panel LEDs area, click on O/O. The power meter reading should go to a very low value.

# Modulator Troubleshooting Tips

- If Maximum Optical Power is not greater than 3 dB, the problem could be one of the following.
  - Clean and reconnect the jumper cable that goes between the LASER OUTPUT to the LASER INPUT.
  - From the Start menu, click on Agilent Technologies 50 GHz LCA, and then 50 GHz LCA Diagnostics. In the Diagnostics window, check the Laser Power Setting. The Laser Power should be approximately 10 dBm.
  - If the Voltage at Maximum Optical Power – Voltage at Minimum Optical Power is not between 3 and 6 volts, then try running a manual auto bias. From the Options menu, click on AutoBias, Quadrature.

# Agilent Technologies Support and Maintenance

On-site service by an Agilent Technologies customer engineer is available to ensure that your system uptime is maximized. You can order per-incident, contractual, or customized on-site system repair and on-site system calibration services. Just contact your local sales office, and give the operator the name of your company and the city where you're located. Then, ask to speak with a field sales engineer. If you're currently covered by a per-incident, contractual or customized program, contact your customer engineer through your local sales office to obtain on-site service.

**Note**

On-site repair and calibration are available for the 8510C network analyzer portion of the system in many parts of the world. In some areas, the PC also has on-site support. The 86032A lightwave test set must be returned to the factory for repair and calibration. Contact your local CE for more information. Refer to "Agilent Technologies Service Offices" on page 7-25.

### *Definition of On-site System Repair*

When you order one of Agilent's on-site system repair options, a customer engineer (CE) is assigned to your company. The CE becomes intimately acquainted with your environment and assumes personal responsibility for managing your system's maintenance program. Your CE will also perform preventive maintenance on a regular basis.

### *Definition of On-Site System Calibration*

When you order an on-site calibration agreement as part of your on-site system repair program, your assigned customer engineer (CE) will have calibrations on your system completed to the same level of quality that is applied to instruments that are returned to Agilent.

Calibration services for systems include the following:

- Calibration measurements traceable to national and international standards
- U.S. measurements traceable to the National Institute of Standards and Tech-

nology (NIST)

- Product performance compared to standards of known accuracy to ensure conformance with published specifications
- Calibration at Agilent-recommended intervals
- Complete data reports for all measured product performance
- Calibration certificate and sticker showing date of next scheduled calibration
- Calibration at no charge after a repair performed by Agilent on products covered under a calibration agreement or under Agilent Support Options

### *Other Test and Measurement Support Programs*

In addition to Hardware Support, the Test and Measurement division offers a wide range of other service and support programs.

- Software Support
- Application Consulting and Training
- Solution Engineering and Manufacturing Process Consulting

# Electrostatic Discharge Information

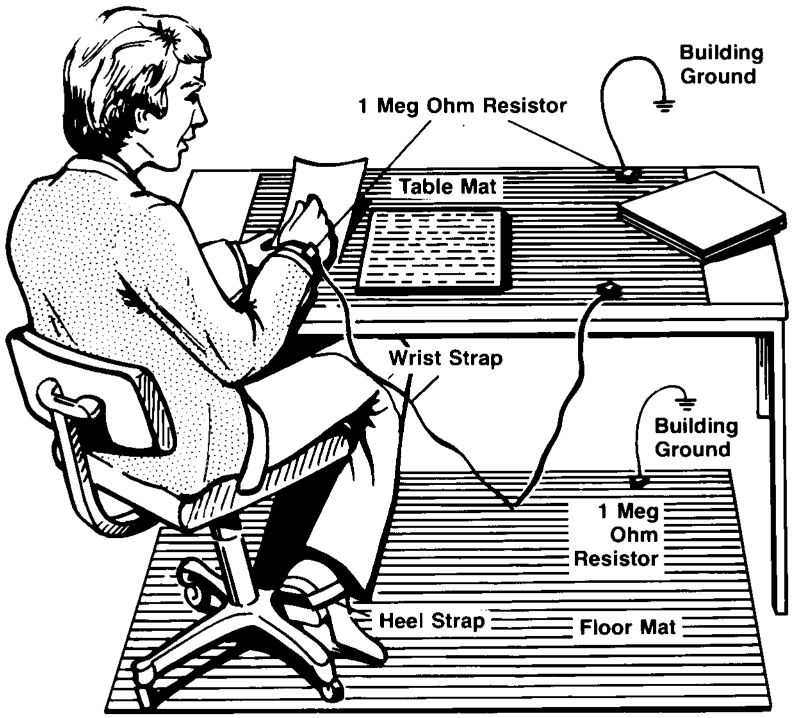
Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe work station. The following figure shows an example of a static-safe work station using two types of ESD protection:

- Conductive table-mat and wrist-strap combination.

**Note**

For the 86030A 50 GHz LCA system, the static strap is attached to the 86032A front panel grounding receptacle. Refer to “Front Panel Features” on page 2-8.

- Conductive floor-mat and heel-strap combination.




Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone.

To ensure user safety, the static-safe accessories must provide at least 1 MΩ of isolation from ground. Refer to Table 2 on page 7-21 for information on ordering static-safe accessories.

**WARNING** **These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.**

## Reducing ESD Damage

The following suggestions may help reduce ESD damage that occurs during testing and servicing operations.

- Personnel should be grounded with a resistor-isolated wrist strap before removing any assembly from the unit.
- Be sure all instruments are properly earth-grounded to prevent a buildup of static charge.

**Table 2. Static-Safe Accessories**

| Agilent Part Number | Description |
|---|---|
| 9300-0797 | Set includes: 3M static control mat 0.6 m × 1.2 m (2 ft.× 4 ft.) and 4.6 cm (15 ft.) ground wire. (The wrist-strap and wrist-strap cord are not included. They must be ordered separately.) |
| 9300-0980 | Wrist-strap cord 1.5 m (5 ft.) |
| 9300-1383 | Wrist-strap, color black, stainless steel, without cord, has four adjustable links and a 7 mm post-type connection. |
| 9300-1169 | ESD heel-strap (reusable 6 to 12 months). |

# Returning the System for Service

The instructions in this section show you how to properly return the instrument for repair or calibration. Always call the Agilent Instrument Support Center first to initiate service *before* returning your instrument to a service office. This ensures that the repair (or calibration) can be properly tracked and that your instrument will be returned to you as quickly as possible. Call this number regardless of where you are located. Refer to “Agilent Technologies Service Offices” on page 7-25 for a list of service offices.

Agilent Instrument Support Center. . . . . . . . . . . . . . . . . . . . . . .(800) 403-0801

If the instrument is still under warranty or is covered by an Agilent maintenance contract, it will be repaired under the terms of the warranty or contract (the warranty is at the front of this manual). If the instrument is no longer under warranty or is not covered by an Agilent maintenance plan, Agilent Technologies will notify you of the cost of the repair after examining the unit.

When an instrument is returned to a Agilent service office for servicing, it must be adequately packaged and have a complete description of the failure symptoms attached. When describing the failure, please be as specific as possible about the nature of the problem. Include copies of additional failure information (such as the instrument failure settings, data related to instrument failure, and error messages) along with the instrument being returned.

## Preparing the instrument for shipping

**1** Write a complete description of the failure and attach it to the instrument. Include any specific performance details related to the problem. The following information should be returned with the instrument.

- Type of service required.
- Date instrument was returned for repair.
- Description of the problem:
  - Whether problem is constant or intermittent.
  - Whether instrument is temperature-sensitive.
  - Whether instrument is vibration-sensitive.
  - Instrument settings required to reproduce the problem.
  - Performance data.
- Company name and return address.
- Name and phone number of technical contact person.
- Model number of returned instrument.
- Full serial number of returned instrument.
- List of any accessories returned with instrument.

**2** Cover all front or rear-panel connectors that were originally covered when you first received the instrument.

**CAUTION** Cover electrical connectors to protect sensitive components from electrostatic damage. Cover optical connectors to protect them from damage due to physical contact or dust.

**CAUTION** Instrument damage can result from using packaging materials other than the original materials. Never use styrene pellets as packaging material. They do not adequately cushion the instrument or prevent it from shifting in the carton. They may also cause instrument damage by generating static electricity.

**3** Pack the instrument in the original shipping containers. Original materials are available through any Agilent Technologies office. Or, use the following guidelines:

- Wrap the instrument in antistatic plastic to reduce the possibility of damage caused by electrostatic discharge.
- For instruments weighing less than 54 kg (120 lb.), use a double-walled, corrugated cardboard carton of 159 kg (350 lb.) test strength.
- The carton must be large enough to allow approximately 7 cm (3 inches) on

all sides of the instrument for packing material, and strong enough to accommodate the weight of the instrument.

- Surround the equipment with approximately 7 cm (3 inches) of packing material, to protect the instrument and prevent it from moving in the carton. If packing foam is not available, the best alternative is S.D-240 Air Cap™ from Sealed Air Corporation (Commerce, California 90001). Air Cap looks like a plastic sheet filled with air bubbles. Use the pink (antistatic) Air Cap™ to reduce static electricity. Wrapping the instrument several times in this material will protect the instrument and prevent it from moving in the carton.

**4** Seal the carton with strong nylon adhesive tape.

**5** Mark the carton “FRAGILE, HANDLE WITH CARE”.

**6** Retain copies of all shipping papers.

# Agilent Technologies Service Offices

Before returning an instrument for service, call the Agilent Technologies Instrument Support Center at (800) 403-0801, visit the Test and Measurement Web Sites by Country page at http://www.tm.agilent.com/tmo/country/English/index.html, or call one of the numbers listed below.

**Agilent Technologies Service Numbers**

| | |
|---|---|
| Austria | 01/25125-7171 |
| Belgium | 32-2-778.37.71 |
| Brazil | (11) 7297-8600 |
| China | 86 10 6261 3819 |
| Denmark | 45 99 12 88 |
| Finland | 358-10-855-2360 |
| France | 01.69.82.66.66 |
| Germany | 0180/524-6330 |
| India | 080-34 35788 |
| Italy | +39 02 9212 2701 |
| Ireland | 01 615 8222 |
| Japan | (81)-426-56-7832 |
| Korea | 82/2-3770-0419 |
| Mexico | (5) 258-4826 |
| Netherlands | 020-547 6463 |
| Norway | 22 73 57 59 |
| Russia | +7-095-797-3930 |
| Spain | (34/91) 631 1213 |
| Sweden | 08-5064 8700 |
| Switzerland | (01) 735 7200 |
| United Kingdom | 01 344 366666 |
| United States and Canada | (800) 403-0801 |

# After Repair

When you first received the 86030A LCA 50 GHz system, you also received a system calibration software disk as part of the shipment. The system software disk contains information that is unique to each 86032A test set. The 86030A system comes from the factory with this information loaded onto the system software disk. You will need to reinstall the system software disk for the following cases:

- If the 86032A test set has been returned to the factory for repair
- If the 86032A test set has been returned to the factory for calibration
- If the system controller (that is, personal computer) has been returned to the factory for repair

To perform the verification test, you will also need to reinstall the verification device data from the floppy disk that is included in the N1012A Verification Kit.

## To install the system calibration files

1. Insert the 86032A test set calibration coefficients files disk into the floppy drive of the 86030A system computer.
2. From the Windows Desktop, double-click My Computer.
3. Double-click on the A: drive and then setup.bat.

   Once the setup.bat file has been executed, the 86030A system is now ready for use.

## To install the verification device data files

1. Insert the N1012A disk into the floppy drive of the 86030A system computer.
2. From the Windows Desktop, double-click My Computer.
3. Double-click on the A: drive and then setup.bat.

# 8



# Specifications and Regulatory Information

# Specifications and Regulatory Information

This chapter lists specifications and characteristics of the 86030A. Specifications apply over the temperature range +20°C to +30°C after the system's temperature has been stabilized after two hours of continuous operation. The specifications are valid only for a temperature drift of less than ± 3°C from the user calibration temperature. A user calibration *must* be performed at least once every 8 hours.

**Specifications**

*Specifications* described warranted performance.

**Characteristics**

*Characteristics* provide useful, non warranted, information about the functions and performance of the system.

**Calibration cycle**

Agilent Technologies warrants instrument specifications over the recommended calibration interval. To maintain specifications, periodic recalibrations are necessary. We recommend that the 86030A be calibrated at an Agilent Technologies service facility every 12 months.

# General Specifications

**Table 8-1. General System Specifications**

| Measurement | Specification |
|---|---|
| Specified Temperature Range | 20 °C to 30 ° C |
| Operating Temperature Range | 5 °C to 40 °C |
| Storage Temperature | –40 °C to +75 °C |
| Power Dissipation | 1940 VA maximum |
| Supply Requirements | |
| Nominal Frequency Range | 47.5 to 66 Hz |
| Nominal Voltage | 100, 120, 220, 240 Vac, ±10% |
| Fuse Type and Rating for 86032A test set | 6.3A, 250V |
| System Weight | 250 kg/592 lbs. |
| System Rack Size | |
| Height | 1.6 meters |
| Width | 600 mm |
| Depth | 900 mm |

# Electrical Specifications

The electrical to electrical specifications are the same as for the 85107B with the following exceptions.

- The user does not have control of the RF power applied to the 8517B test set.
- In the Step mode, when the first point in the trace is in the 45 to 150 MHz range, the accuracy of the first point is significantly degraded.

  In the Ramp mode, accuracy of all measurements in the 45 MHz to 150 MHz range will be degraded.

The full performance of the 85107B can be obtained by reconnecting the 50 GHz source directly to the 8517B test set (bypassing the 86032A) using the cable supplied with the 8510C accessories.

Refer to the 85107B System manual for a complete listing of the specifications.

**Table 8-2. General Optical/Electrical Specifications**

| Measurement | Specification | Conditions |
|---|---|---|
| Modulation Frequency Range | 0.150 - 50 GHz | |
| Optical Source Center Wavelength | 1550 -1560 nm | DFB laser falls within these wavelength limits. |
| Optical Output Return Loss | > 30 dB | With factory new straight connectors. Improper connector care will degrade this specification. |
| Optical Input Return Loss | > 25 dB | With factory new straight connectors. Improper connector care will degrade this specification. |

**Table 8-2. General Optical/Electrical Specifications (Continued)**

| Measurement | Specification | Conditions |
|---|---|---|
| Average Optical Output Power: | | |
| Modulator at minimum loss | > 3 dBm | Modulator set at minimum insertion loss. |
| Modulator at quadrature | > 0 dBm | Modulator set at quadrature. Quadrature is the average of the minimum and maximum transmission state of the modulator. |
| Available power at Laser output port | > 8 dBm | This port has a polarization maintaining fiber (PMF) connected. |
| Nominal RF modulation power setting for E/O mode | 0 dBm | This is the default power that the system will use. This setting will assure that a 85107B receiver overload will not occur during the calibration process. Advanced users may increase the power level however, you will have to manually verify that receiver overload has not occurred. |
| Maximum available RF Modulation Power for E/O Mode | > 5 dBm | This is the power measured at the RF Output port of the 86032A test set. This value can be set manually from the 86030A program. From the Options menu, click Advanced, Customize, SRC Power E to O dBv and enter a new value. Note that you will need an electrical power meter to set this value as the 86030A software value is a relative number. |
| Maximum Operating Optical Input Power (to optical receiver input) | Do **not** exceed 4 mW (6 dBm) | Exceeding this value will cause measurement inaccuracies. |
| Maximum Optical Input Power to Optical Receiver (without damage) | Do **not** exceed 15 mW (11.8 dBm) | Power above this level can potentially damage the photodetector of the optical receiver. |

# Optical to Optical (O/O) Specifications

***Specification conditions:***

- Factory default laser power settings
- Factory default modulation power settings
- Setting of 512 averages on the 85107B
- Response and isolation calibration
- Greater than 20 dBe signal to noise ratio required for these specifications to be valid.
- Specifications are valid only for Step mode operation.

**Table 8-3. Optical to Optical Noise Floor**

| Frequency Range (GHz) | Noise Floor (dBo)[a] |
|---|---|
| 0.045 - 0.15 | < – 18 (Characteristic) |
| 0.15 - 0.2 | < – 24 |
| 0.2 - 0.3 | < – 27 |
| 0.3 - 0.5 | < – 30 |
| 0.5 - 10 | < – 33 |
| 10 - 20 | < – 30 |
| 20 - 30 | < – 27 |
| 30 - 40 | < – 22 |
| 40 - 50 | < – 18 |

[a] dB down from the 0 dBo loss reference $10\log\left(\frac{power}{optical\ thru\text{-}line\ power}\right)$.

# Optical to Electrical (O/E) Specifications

### *Relative Frequency Response*

Relative frequency response refers to the amount of error that accumulates when you compare the response of two or more frequency points. This would often be used in calculating the – 3 dB roll-off point of an optical modulator. A large error term for this measurement is dependent on the amount of electrical port reflectivity on the O/E device under test. Thus, relative frequency response is specified as a function of electrical port reflectivity. The electrical reflectivity of any O/E device can be measured using the E/E mode on the 86030A. The following relative frequency response tables are given for several values of O/E device under test electrical port reflectivity. If you do not know the electrical reflectivity, then you must use Table 8-6, “O/E Relative Frequency Response for the Electrical Port Reflection Coefficient < 1.0,” on page 8-9 as a conservative estimate. The electrical reflectivity of any O/E device can be measured using the E/E mode of the 86030A.

### *Specification Conditions*

- Factory default laser power settings
- Factory default modulation power settings
- Setting of 512 averages on the 85107B
- Response and isolation calibration
- Greater than 20 dBe signal to noise ratio required for these specifications to be valid.

Specifications are valid only for Step mode operation.

### Table 8-4. O/E Relative Frequency Response for the Electrical Port Reflection Coefficient < 0.25

| Frequency Range (GHz) | Relative Frequency Response (dBe) | Relative Frequency Response (dBe)[a] |
|---|---|---|
| 0.045 - 0.15 | ± 3.8 (Characteristic) | ± 3.8 (Characteristic) |
| 0.15 - 2 | ± 0.8 | ± 0.7 |
| 2 - 20 | ± 1.0 | ± 0.7 |
| 20 - 40 | ± 1.3 | ± 0.9 |
| 40 - 50 | ± 1.8 | ± 1.2 |

[a] With a 6 dB attenuator connected to the electrical receiving port of the 8517B test set. Refer to "O/E measurement with 6 dB attenuator" on page 3-36.

### Table 8-5. O/E Relative Frequency Response for the Electrical Port Reflection Coefficient < 0.5

| Frequency Range (GHz) | Relative Frequency Response (dBe) | Relative Frequency Response (dBe)[a] |
|---|---|---|
| 0.045 - 0.15 | ± 3.8 (Characteristic) | ± 3.8 (Characteristic) |
| 0.15 - 2 | ± 0.9 | ± 0.7 |
| 2 - 20 | ± 1.4 | ± 0.8 |
| 20 - 40 | ± 1.7 | ± 1.0 |
| 40 - 50 | ± 2.3 | ± 1.3 |

[a] With a 6 dB attenuator connected to the electrical receiving port of the 8517B test set. Refer to "O/E measurement with 6 dB attenuator" on page 3-36.

**Table 8-6. O/E Relative Frequency Response for the Electrical Port Reflection Coefficient < 1.0**

| Frequency Range (GHz) | Relative Frequency Response (dBe) | Relative Frequency Response (dBe)[a] |
|---|---|---|
| 0.045 - 0.15 | ± 3.8 (Characteristic) | ± 3.8 (Characteristic) |
| 0.15 - 2 | ± 1.2 | ± 0.8 |
| 2 - 20 | ± 2.0 | ± 1.0 |
| 20 - 40 | ± 2.4 | ± 1.2 |
| 40 - 50 | ± 3.2 | ± 1.6 |

[a] With a 6 dB attenuator connected to the electrical receiving port of the 8517B test set. Refer to “O/E measurement with 6 dB attenuator” on page 3-36.

### *Relative Frequency Response with Response and Match User Calibration*

#### *Specification Conditions*

- Factory default laser power settings
- Factory default modulation power settings
- Setting of 512 averages on the 85107B
- Any electrical port reflection coefficient
- Greater than 20 dBe signal to noise ratio required for these specifications to be valid.
- Specifications are valid only for Step mode operation.

**Table 8-7. O/E Relative Frequency Response for the Electrical Port Reflection Coefficient < 1.0 with Response and Match User Calibration**

| Frequency Range (GHz) | Relative Frequency Response (dBe) |
|---|---|
| 0.045 - 0.15 | ±3.8 (Characteristic) |
| 0.15 - 10 | ± 0.7 |
| 0.1 - 20 | ± 0.7 |
| 0.1 - 30 | ± 0.9 |
| 0.1 - 40 | ± 1.2 |

# O/E Absolute Noise Floor

***Specification Conditions***

- Factory default laser power settings
- Factory default modulation power settings
- Setting of 512 averages on the 85107B
- Response and isolation calibration
- The internal O/E converter is disconnected from the 8517B input after the user calibration process so that it is not contributing to the noise floor rise. O/E converters with very large responsivities will cause a noise floor rise. This noise floor specification is valid only for O/E converters with responsivities less than 2.0 amps/watt.
- Specifications are valid only for Step mode operation.

**Table 8-8. O/E Absolute Noise Floor**

| Frequency Range (GHz) | Noise Floor (dBe)[a] |
|---|---|
| 0.045 - 0.15 | – 40 (Characteristic) |
| 0.15 - 0.2 | – 50 |
| 0.2 - 0.3 | – 60 |
| 0.3 - 0.5 | – 62 |
| 0.5 - 10 | – 70 |
| 10 - 20 | – 62 |
| 20 - 30 | – 56 |
| 30 - 40 | – 47 |
| 40 - 50 | – 42 |

[a] dBe down from 1amp/watt = $20\log\left(\frac{DUT\ responsivity}{1\ amp/watt}\right)$

# Electrical to Optical (E/O) Specifications

Relative frequency response refers to the amount of error that accumulates when you compare the response of two or more frequency points. This would often be used in calculating the – 3 dB roll-off point of an optical modulator. A large error term for this measurement is dependent on the amount of electrical port reflectivity on the E/O device under test. Thus, relative frequency response is specified as a function of electrical port reflectivity. The electrical reflectivity of any E/O device can be measured using the E/E mode on the 86030A. The following relative frequency response tables are given for several values of E/O device under test electrical port reflectivity. If you do not know the electrical reflectivity, then you must use Table 8-11, "E/O Relative Frequency Response for the Electrical Port Reflection Coefficient < 1.0," on page 8-14 as a conservative estimate. The electrical reflectivity of any E/O device can be measured using the E/E mode of the 86030A.

### *Specification Characteristics*

- Factory default laser power settings
- Factory default modulation power settings
- Setting of 512 averages on the 85107B
- Response and isolation calibration
- 50 ohm termination on unused 8517B port
- Greater than 20 dBe signal to noise ratio required for these specifications to be valid.
- Specifications are valid only for Step mode operation.

**Table 8-9. E/O Relative Frequency Response for the Electrical Port Reflection Coefficient < 0.25**

| Frequency Range (GHz) | Relative Frequency Response (dBe) |
|---|---|
| 0.045 - 0.15 | ±2.2 (Characteristic) |
| 0.15 - 2 | ± 0.6 |
| 2 - 20 | ± 0.9 |
| 20 - 40 | ± 1.0 |
| 40 - 50 | ± 1.4 |

**Table 8-10. E/O Relative Frequency Response for the Electrical Port Reflection Coefficient < 0.5**

| Frequency Range (GHz) | Relative Frequency Response (dBe) |
|---|---|
| 0.045 - 0.15 | ±2.3 (Characteristic) |
| 0.15 - 2 | ± 0.8 |
| 2 - 20 | ± 1.3 |
| 20 - 40 | ± 1.5 |
| 40 - 50 | ± 2.1 |

**Table 8-11. E/O Relative Frequency Response for the Electrical Port Reflection Coefficient < 1.0**

| Frequency Range (GHz) | Relative Frequency Response (dBe) |
|---|---|
| 0.045 - 0.15 | ±2.8 (Characteristic) |
| 0.15 - 2 | ± 1.3 |
| 2 - 20 | ± 2.1 |
| 20 - 40 | ± 2.5 |
| 40 - 50 | ± 3.4 |

# E/O Absolute Noise Floor

### *Specification Conditions*

- Factory default laser power settings
- Factory default modulation power settings
- Setting of 512 averages on the 85107B
- Response and isolation calibration
- Specifications are valid only for Step mode operation.

**Table 8-12. Absolute Noise Floor**

| Frequency Range (GHz) | Noise Floor (dBe)[a] |
|---|---|
| 0.045 - 0.15 | – 50 (Characteristic) |
| 0.15 - 0.2 | – 55 |
| 0.2 - 0.3 | – 57 |
| 0.3 - 0.5 | – 60 |
| 0.5 - 10 | – 61 |
| 10 - 20 | – 58 |
| 20 - 30 | – 55 |
| 30 - 40 | – 53 |
| 40 - 50 | – 50 |

[a]dBe down from 1 watt/amp = $20\log\left(\frac{DUT\ responsivity}{1\,watt/amp}\right)$

# Characteristics

**Characteristics**

*Characteristics* provide useful, non warranted, information about the functions and performance of the system.

## Maximum Input Power into the 8510 Electrical Port

The following two tables indicate the maximum power the 8510 test port can tolerate before the system begins to overload and cause inaccurate measurements. For any reason, if an IF overload message appears on the 8510 display the input power must be reduced before continuing. Note that once an error message appears on the display, it does not go away until it is manually cleared using the 8510C Entry Off function. To check for an RF overload condition, refer to "O/E RF Overload Detection Measurement" on page 3-51.

**Table 8-13. Maximum Input Power into the 8517B Test Ports**

| Frequency Range (GHz) | Maximum Power (dBm) |
|---|---|
| 0.045 - 2.0 | + 18 |
| 2.0 - 20 | + 8 |
| 20 - 40 | + 4 |
| 40 - 50 | – 3 |

### *Typical Performance*

**Table 8-14. Optical Modulation Power from the 86032A Source Output[a]**

| Frequency Range (GHz) | Maximum Power (dBm) |
|---|---|
| 0.045 - 0.84 | 0 |
| 0.84 - 20 | – 3 |
| 20 - 40 | – 5 |
| 40 - 50 | – 10 |

[a]Typical Performance (this is not a specification)

# Optical to Electrical (O/E) Characteristics

### *O/E Absolute Frequency Response*

The relative frequency response specifications gave information that is helpful in determining parameters such as the –3 dB roll of point of a device under test, however, it did not address the issue of how accurate each frequency point was in terms of absolute response. The absolute frequency response accuracy addresses the absolute error that is present in a responsivity measurement at any particular modulation frequency.

### *Specification Conditions*

- Factory default laser power settings
- Factory default modulation power settings
- Setting of 512 averages on the 85107B
- Response and isolation calibration
- Greater than 20 dBe signal to noise ratio required for these specifications to be valid.
- Specifications are valid only for Step mode operation.

**Table 8-15. O/E Absolute Frequency Response Accuracy for the Electrical Port Reflection Coefficient < 0.25**

| Frequency Range (GHz) | Absolute Frequency Response (dBe) | Absolute Frequency Response (dBe)[a] |
|---|---|---|
| 0.045 - 0.15 | ±3.8 | ±3.8 |
| 0.15 - 2 | ± 1.3 | ± 1.2 |
| 2 - 20 | ± 1.5 | ± 1.2 |
| 20 - 40 | ± 1.8 | ± 1.4 |
| 40 - 50 | ± 2.3 | ± 1.7 |

[a] With a 6 dB attenuator connected to the electrical receiving port of the 8517B test set. Refer to “O/E measurement with 6 dB attenuator” on page 3-36.

**Table 8-16. O/E Absolute Frequency Response Accuracy for the Electrical Port Reflection Coefficient < 0.5**

| Frequency Range (GHz) | Absolute Frequency Response (dBe) | Absolute Frequency Response (dBe)[a] |
|---|---|---|
| 0.045 - 0.15 | ±3.8 | ±3.8 |
| 0.15 - 2 | ± 1.4 | ± 1.2 |
| 2 - 20 | ± 1.9 | ± 1.3 |
| 20 - 40 | ± 2.2 | ± 1.5 |
| 40 - 50 | ± 2.8 | ± 1.8 |

[a] With a 6 dB attenuator connected to the electrical receiving port of the 8517B test set. Refer to "O/E measurement with 6 dB attenuator" on page 3-36.

**Table 8-17. O/E Absolute Frequency Response Accuracy for the Electrical Port Reflection Coefficient < 1.0**

| Frequency Range (GHz) | Absolute Frequency Response (dBe) | Absolute Frequency Response (dBe)[a] |
|---|---|---|
| 0.045 - 0.15 | ±3.8 | ±3.8 |
| 0.15 - 2 | ± 1.7 | ± 1.3 |
| 2 - 20 | ± 2.5 | ± 1.5 |
| 20 - 40 | ± 2.9 | ± 1.7 |
| 40 - 50 | ± 3.7 | ± 2.1 |

[a] With a 6 dB attenuator connected to the electrical receiving port of the 8517B test set. Refer to "O/E measurement with 6 dB attenuator" on page 3-36.

### *Absolute Relative Frequency Response with Response and Match User Calibration*

#### *Specification Conditions*

- Factory default laser power settings
- Factory default modulation power settings
- Setting of 512 averages on the 85107B
- Any electrical port reflection coefficient
- Greater than 20 dBe signal to noise ratio required for these specifications to be valid.
- Specifications are valid only for Step mode operation.

**Table 8-18. O/E Absolute Frequency Response Accuracy for the Electrical Port Reflection Coefficient < 1.0 with Response and Match User Calibration**

| Frequency Range (GHz) | Absolute Frequency Response (dBe) |
|---|---|
| 0.045 - 0.15 | ±3.8 |
| 0.15 - 10 | ± 1.2 |
| 0.1 - 20 | ± 1.2 |
| 0.1 - 30 | ± 1.4 |
| 0.1 - 40 | ± 1.7 |

# Electrical to Optical (E/O) Characteristics

### *E/O Absolute Frequency Response*

The relative frequency response specifications gave information that is helpful in determining parameters such as the –3 dB roll of point of a device under test, however, it did not address the issue of how accurate each frequency point was in terms of absolute response. The absolute frequency response accuracy addresses the absolute error that is present in a responsivity measurement at any particular modulation frequency.

### *Specification Characteristics*

- Factory default laser power settings
- Factory default modulation power settings
- Setting of 512 averages on the 85107B
- Response and isolation calibration
- 50 ohm termination on unused 8517B port
- Greater than 20 dBe signal to noise ratio required for these specifications to be valid.
- Specifications are valid only for Step mode operation.

**Table 8-19. E/O Absolute Frequency Response for the Electrical Port Reflection Coefficient < 0.25**

| Frequency Range (GHz) | Absolute Frequency Response (dBe) |
|---|---|
| 0.045 - 0.15 | ± 2.6 |
| 0.15 - 2 | ± 1.1 |
| 2 - 20 | ± 1.4 |
| 20 - 40 | ± 1.5 |
| 40 - 50 | ± 1.9 |

**Table 8-20. E/O Absolute Frequency Response for the Electrical Port Reflection Coefficient < 0.5**

| Frequency Range (GHz) | Absolute Frequency Response (dBe) |
|---|---|
| 0.045 - 0.15 | ±2.8 |
| 0.15 - 2 | ± 1.3 |
| 2 - 20 | ± 1.8 |
| 20 - 40 | ± 2.0 |
| 40 - 50 | ± 2.6 |

**Table 8-21. E/O Absolute Frequency Response for the Electrical Port Reflection Coefficient < 1.0**

| Frequency Range (GHz) | Absolute Frequency Response (dBe) |
|---|---|
| 0.045 - 0.15 | ±3.3 |
| 0.15 - 2 | ± 1.8 |
| 2 - 20 | ± 2.6 |
| 20 - 40 | ± 3.0 |
| 40 - 50 | ± 3.9 |

# Test Set Monitoring Power Accuracy

The following characteristics relate to the accuracy of the test set monitoring capabilities. The test set monitoring functions are found under the Tools menu. Open the Modify Test Set dialog box to view the Current Laser Output Power, and Monitor Test Set dialog box to view the Optical Output Power and Optical Receiver Input Power.

**Table 8-22. Test Set Monitoring Power Accuracy**

| Test Set Power Settings | Characteristics | Power Range |
|---|---|---|
| Current Laser Output Power | ± 0.5 dB | 0 dBm to 10 dBm |
| Optical Output Power | ± 0.5 dB | – 10 dBm to 5 dBm |
| Optical Receiver Input Power | ± 0.5 dB | – 10 dBm to 5 dBm |

# Regulatory Information

- This product is classified as Class I according to 21 CFR 1040.10 and Class I according to IEC 60825-1.
- This product complies with 21 CFR 1040.10 and 21 CFR 1040.11.
- This is to declare that this system is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung -3.GSGV Deutschland).

### Notice for Germany: Noise Declaration

| Acoustic Noise Emission | Geraeuschemission |
|---|---|
| LpA < 70 dB | LpA < 70 dB |
| Operator position | am Arbeitsplatz |
| Normal position | normaler Betrieb |
| per ISO 7779 | nach DIN 45635 t.19 |

# Declaration of Conformity

## DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

**Manufacturer's Name:** Agilent Technologies, Inc.
**Manufacturer's Address:** 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

**Declares that the product:**

**Product Name:** Lightwave Component Analyzer System

**Model Number:** 86030A

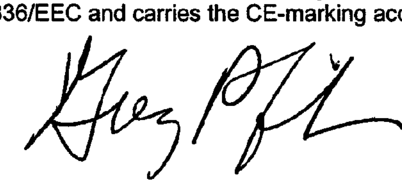
**Product Options:** This declaration covers all options of the above product.

**Is in conformity with:**

Safety: IEC 61010-1:1990 +A1:1992+A2:1995 / EN 61010-1:1994+A2:1995
CAN/CSA-C22.2 No. 1010.1-92
IEC 60825-1:1998
21CFR 1040.10 & 1040.11

EMC: CISPR 11:1990/EN 55011:1991 Group 1, Class A
IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995, 4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995, 3 V/m, 80-1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995, 0.5 kV sig. lines, 1 kV pow. lines
IEC 61000-4-5:1995 / EN 61000-4-5:1995, 0.5 kV l-l, 1 kV l-e
IEC 61000-4-6:1996 / EN 61000-4-6:1996, 3V 80% AM, power line
IEC 61000-4-11:1994 / EN 61000-4-11:1994, 100 %, 20 ms

**Supplementary Information:**
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.



Santa Rosa, CA, USA 25 Apr. 2000

Greg Pfeiffer/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or

# Index

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