Anritsu

MN4765A

O/E CALIBRATION MODULE

OPERATION MANUAL

P/N: 10410-00259
REVISION: A
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490 JARVIS DRIVE
MORGAN HILL, CA 95037-2809

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The Anritsu product(s) listed on the title page is (are) warranted against defects in materials and workmanship for one year from the date of shipment. Anritsu's obligation covers repairing or replacing products which prove to be defective during the warranty period. Buyers shall prepay transportation charges for equipment returned to Anritsu for warranty repairs. Obligation is limited to the original purchaser. Anritsu is not liable for consequential damages.

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UPDATES

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To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Company uses the following symbols to indicate safety-related information. For your own safety, please read the information carefully BEFORE operating the equipment.

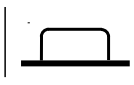
WARNING WARNING indicates a hazard. It calls attention to a procedure that could result in personal injury or loss of life if not performed properly. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

CAUTION CAUTION indicates a hazard. It calls attention to a procedure which, if not performed properly, could result in damage to or destruction of a component of the instrument. Do not proceed beyond a CAUTION note until the indicated conditions are fully understood and met.

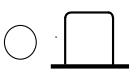
The instrument is marked with this symbol to indicate that it is necessary for the user to refer to the instructions in the operation manual.

Indicates ground.

Indicates alternating current.



Indicates power on switch setting.



Indicates power off switch setting.

WARNING

When supplying power to this test set, ***always*** use a three-wire power cable connected to a three-wire power line outlet. If power is supplied without grounding the equipment in this manner, there is a risk of receiving a severe or fatal electric shock.

WARNING

Before changing the fuse, ***always*** remove the power cord from the power outlet. There is the risk of receiving a fatal electric shock if the fuse is replaced with the power cord connected.

Always use a new fuse of the type and rating specified by the fuse markings on the rear panel of the instrument.

WARNING

There are no operator serviceable components inside. Refer servicing of the instrument to qualified service technicians.

To prevent the risk of electrical shock or damage to precision components, ***do not*** remove the equipment covers.

WARNING

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Table of Contents

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Chapter 1 General Information

Scope of This Manual

This manual provides general information, installation, and operating information for the Anritsu MN4765A O/E Calibration Module. Throughout this manual, the terms *MN4765A* and *O/E Calibration Module* will be used interchangeably to refer to the instrument. Manual organization is shown in the table of contents. Be sure to read this operation manual thoroughly before using the MN4765A.

Introduction

The MN4765A is a characterized 65 GHz O/E calibration module used to make broadband measurements. The module consists of a very fast and linear optical detector with circuitry to stabilize the temperature and bias voltage. It allows frequency domain measurements of optoelectronic components using the 37300C series Vector Network Analyzer (VNA).

Related Manuals

This manual provides operating instructions for the MN4765A O/E Calibration Module. Refer to the following manuals for detailed operating instructions and application notes when using the 37300C Vector Network Analyzer:

- Model 37XXXC Vector Network Analyzer Operation Manual, P/N: 10410-00226, Revision F or later
- E/O and O/E Measurements with the 37300C Series VNA Application Note, P/N: 11410-00311

Recommended Test Equipment

The following test equipment should be used with the MN4765A O/E Calibration Module:

- 37397C 65 GHz VNA
- MT9810A Optical Test Set (with DFB laser)
- Polarization Controller
- Broadband Modulator (for O/E measurements)
- Modulator Bias Controller
- Optical Patch Cord

MN4765A Features

- **Fast and Accurate Optoelectronic Measurements**
  The 37200C/37300C series VNAs, when calibrated using the MN4765A module, enable error-corrected Transfer Function, Group Delay, and Return Loss measurements of E/O and O/E components and subsystems.
- **National Institute of Standards and Technology Derived Characterization to 65 GHz**
  Magnitude and phase characterization is obtained using a primary standard characterized by NIST and held in the Anritsu Calibration Lab. The magnitude and phase data is provided on a diskette with the module.
- **Temperature Stable**
  The MN4765A is thermally stabilized to eliminate drift in photodiode performance over temperature.
- **Internal Biasing**
  Accurate bias voltage to the photodiode is maintained internally. An external, multi-country, AC adapter is included for easy operation.
- **High Linearity**
  Linear operating range to +6 dBm of optical input power for transfer function measurement uncertainties less than 2 dB up to 65 GHz.
- **High Responsivity**
  0.7 A/W (typical)

MN4765A Specifications

Table 1-1. *Environmental Specifications*

Operating Temperature:	18°C to 28°C
Storage Temperature:	–20°C to 70°C
Relative Humidity:	5% to 95%
EMC:	Conforms to the EMC Directive, 89/336/EEC per EN61326-1:1998
Emissions:	Class A, Group 1
Immunity:	EN61000-4-2/3/4/5/6/11

Table 1-2. *General Specifications*

Optical IN:	FC/APC
RF OUT:	V male
AC Adapter:	100 to 240V (50 to 60 Hz) input, +12 Vdc output
Power LED:	On when the AC adapter is plugged in and the internal photodiode is properly biased.
Operate LED:	On when the module's internal temperature has stabilized at an optimum temperature for accurate calibrations and measurements.
Dimensions:	33H x 51W x 127D mm (1.3H x 2.0W x 5.0D in.)

Table 1-3. *Performance Specifications*

Calibrated Frequency Range:	40 MHz to 65 GHz
Characterized Wavelength:	1550 nm ±20 nm
Linear Optical Input Power:	<6 dBm (linear operating range over which $\|S_{21}\|$ uncertainty is <0.25 dB)
Maximum Optical Input Power:	10 dBm
Electrical Return Loss:	<–8 dB (<50 GHz) <–5 dB (<65 GHz) typical
Operating Wavelength Range:	1480 nm to 1620 nm
DC Responsivity:	>0.55 A/W
Optical Return Loss:	<–24 dB

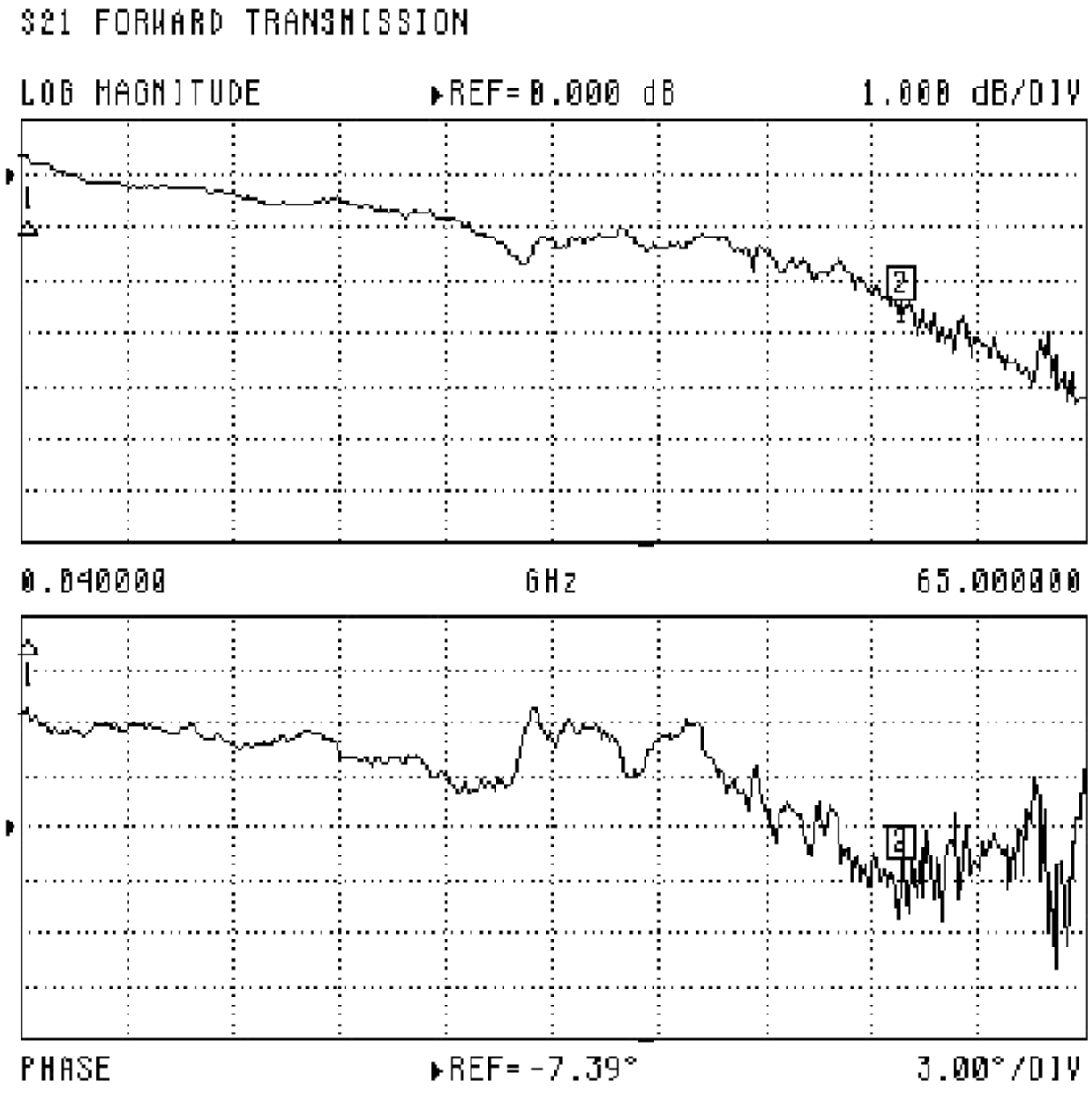

Figure 1-1. *Frequency Response of the MN4765A*

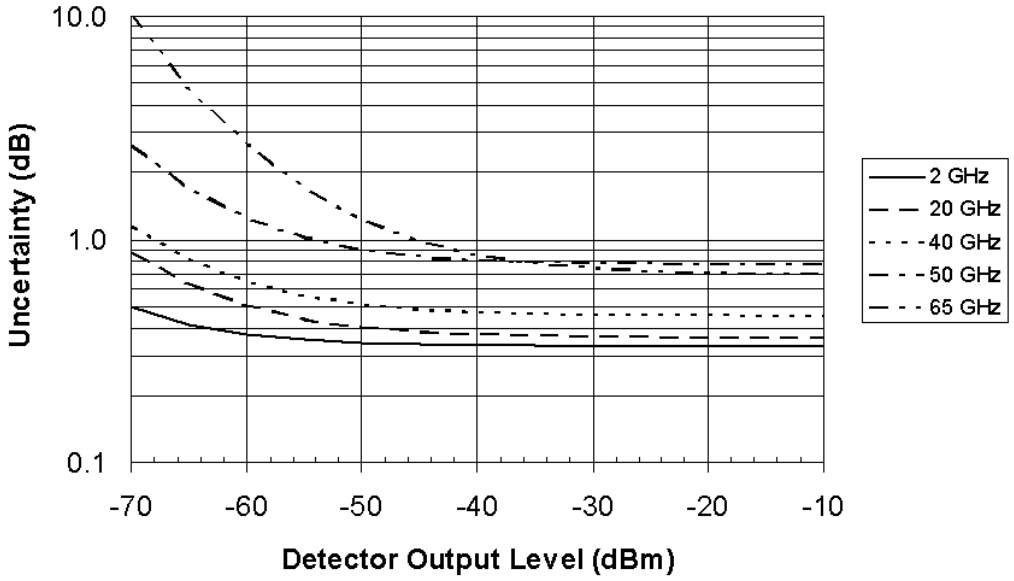

Figure 1-2. *O/E Characterization Uncertainty (Magnitude at 23°C ±3°C)*

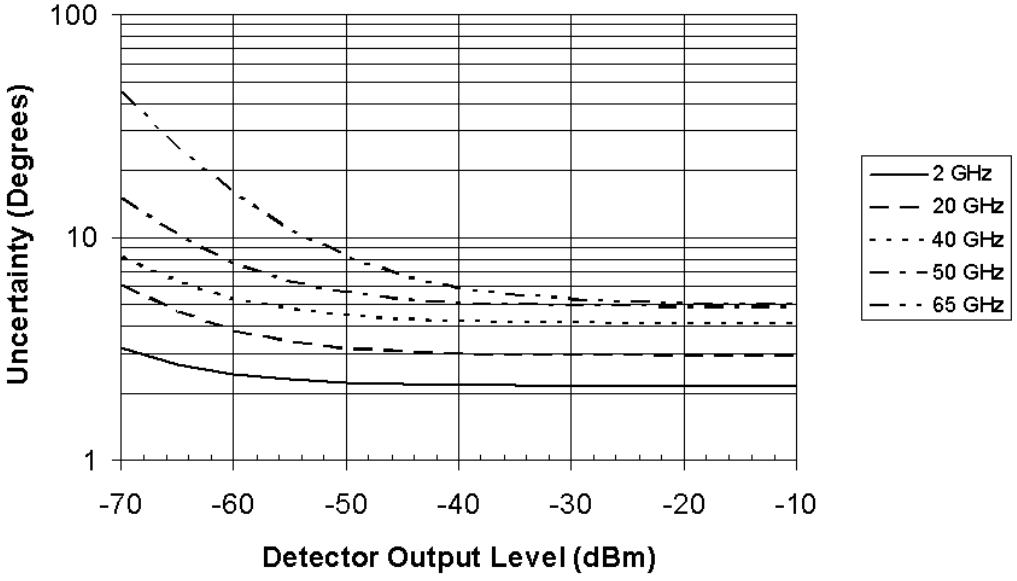

Figure 1-3. *O/E Characterization Uncertainty (Phase at 23°C ±3°C)*

MN4765A Characterization

The accuracy and longevity of any characterization depends on the ability to take care of the module, especially the connectors. Understanding the maximum rated specifications and general cleaning of the electrical and optical connectors is essential. These details will be covered later in this manual.

Characterization

The MN4765A module is serialized and comes with a characterization in relative magnitude and phase with a specified uncertainty from 40 MHz up to 65 GHz. A copy of the characterization can be found on the 3.5-inch floppy disk that ships with the module. If a replacement copy of the characterization is required, contact Anritsu customer service.

Re-characterization

The MN4765A calibration certificate contains the recommended calibration interval. Any module outside of its calibration interval should be sent to Anritsu customer service for re-characterization. The Anritsu calibration lab will check the re-characterization against the original specifications.

Chapter 2 Installation

Introduction

This chapter provides installation instructions for the MN4765A O/E Calibration Module. It includes information on initial inspection, preparation for use, storage, and reshipment.

Unpacking and Initial Inspection

The MN4765A ships in two protective boxes, one external and one internal. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, retain until the contents of the shipment have been checked against the packing list and the module has been checked for mechanical and electrical operation.

If the shipment is incomplete or if the test set is damaged mechanically or electrically, notify your local sales representative or Anritsu Customer Service. If either the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as Anritsu. Keep the shipping materials for the carrier's inspection.

Contents

The external box holds the internal box plus a power cord to match the specific country code for utility outlets. The internal box contains the MN4765A and all the necessary equipment to safely and correctly handle the calibration module. The items included are:

- MN4765A
- AC Adapter and Power Cord
- Calibration Certificate
- 3.5-inch Diskette (copy of the MN4765A calibration data)
- Operation Manual

Preparation for Use

Preparation for use consists of familiarizing yourself with the MN4765A, cabling the calibration module to the 37397C Vector Network Analyzer, and attaching the supplied AC adapter.

NOTE

Experience with a 37397C Vector Network Analyzer is assumed. Refer to the operation manual supplied with the VNA for information and operating instructions for the 37397C.

The MN4765A's interfaces are outlined in Table 2-2 on the following page.

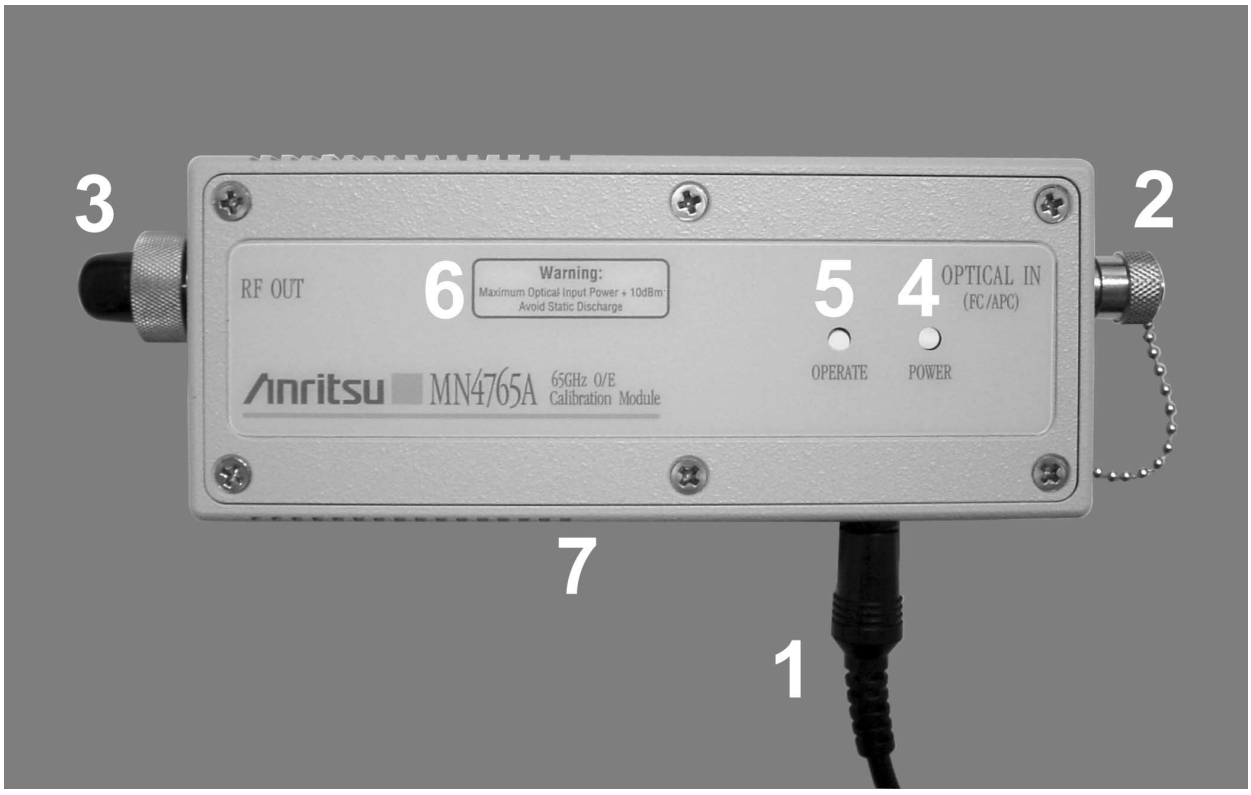

Figure 2-1. *MN4765A O/E Calibration Module*

Table 2-2. *MN4765A O/E Calibration Module Legend*

Index	Description
1	The MN4765A is powered by an AC adapter providing 12 V DC to an internal bias board. There is a green LED on the AC adapter to indicate power is connected. Do not confuse this green LED with the power LED located on the MN4765A's top cover.
2	FC/APC optical input connector with protective dust cap. Attach the optical patch cord to this FC/APC connector to protect the MN4765A optical connector from repeated connections.
3	The electrical output connector is a male V connector with an easy to use coupling nut. Be sure to follow proper torquing instructions when making connections to the RF connector.
4	The green POWER LED indicates that power is being delivered to the internal bias board. More importantly, it indicates that the internal high-speed photodiode is properly biased. Never input light into the MN4765A when the green LED is off.
5	The yellow OPERATE LED indicates that the MN4765A has reached a stable temperature and that it is ready for operation. The recommended warm-up time is 5 minutes.
6	The Warning label indicates that the maximum optical input power to the MN4765A is 10 mW or 10 dBm mean. Exceeding this value will cause damage to the internal photodiode.
7	The Calibration label indicates that the MN4765A is characterized by Anritsu's calibration lab. A copy of the characterization data is supplied on a 3.5-inch diskette. Please review the calibration certificate for service and calibration interval information.

WARNING

When supplying power to this calibration module, ***always*** use a three-wire power cable connected to a three-wire power line outlet. If power is supplied without grounding the equipment in this manner, there is a risk of receiving a severe or fatal electric shock.

Power Requirements

The MN4765A O/E Calibration Module accepts 85 to 240 Vac, 47 to 63 Hz, single-phase power. The calibration module is intended for Installation Category (Over Voltage Category) II.

The following procedure provides the steps necessary to connect the MN4765A calibration module to the 37397C Vector Network Analyzer.

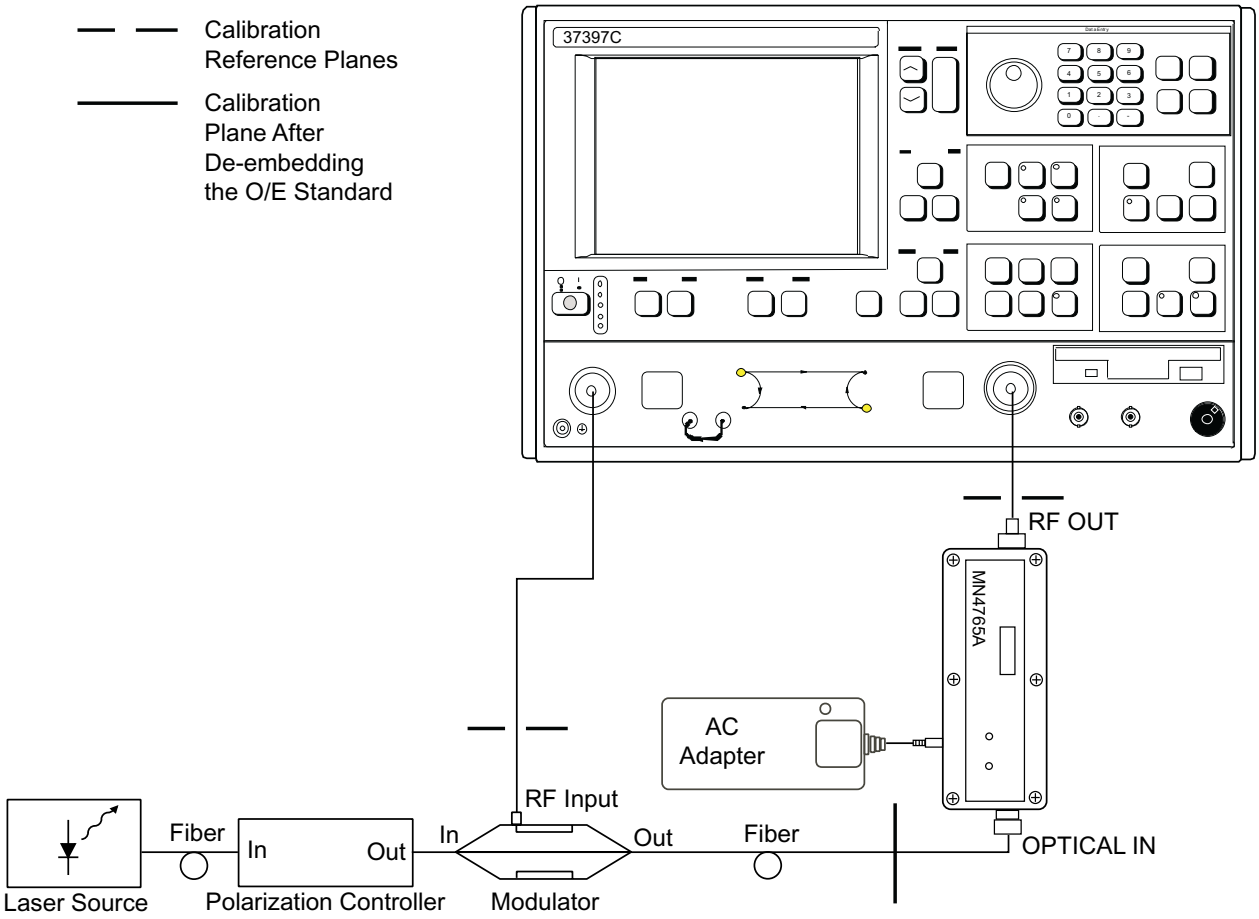

Figure 2-3. *MN4765A E/O Measurement Setup*

MN4765A Measurement Setup

Connect the MN4765A Calibration Module to the 37397C Vector Network Analyzer, shown in Figure 2-3, as follows:

Step 1. Connect the RF OUT port of the MN4765A to Port 2 of the 37397C.

Step 2. Connect Port 1 of the 37397C to the RF Input port of the modulator.

Step 3. Connect the output port of the modulator to the OPTICAL IN port on the MN4765A.

Step 4. Connect the output port of the laser source to the input port of the polarization controller

Step 5. Connect the optical output port of the polarization controller to the optical input port of the modulator.

Preparation For Storage/Shipment

The following paragraphs give instructions for preparing the MN4765A for storage or shipment.

Preparation for Storage

Preparing the MN4765A for storage consists of cleaning the unit, packing the inside of the storage container with moisture-absorbing desiccant crystals, and storing the unit in a temperature environment that is maintained between –20°C to +70°C (–4°F to +158°F).

Preparation for Shipment

To provide maximum protection against damage in transit, the MN4765A should be repackaged in the original shipping container in an ESD safe bag. If this container is no longer available and the unit is being returned to Anritsu for repair, advise Anritsu Customer Service and they will send a new shipping container free of charge.

Address the Container

If the instrument is being returned to Anritsu for service, mark the Anritsu address and your return address on the carton in one or more prominent locations. For international customers, use the address of your local representative found in the table at the back of this manual. For USA customers, use the Anritsu address shown below:

Anritsu Company
ATTN: Customer Service
490 Jarvis Drive
Morgan Hill, CA 95037-2809

Chapter 3 Operation

Introduction

This chapter provides information on the operation of the MN4765A O/E Calibration Module.

E/O Measurements

E/O converters modulate an electrical signal onto light to be sent over fiber links. The performance of modulators and optical transmitters is key to determining the maximum data rate achievable in an optical communication link. These devices are generally characterized in terms of:

- Modulation Bandwidth (transfer function or responsivity)
- Return Loss
- Phase Linearity
- Group Delay

Figure 3-1, on the following page, shows the general setup for making E/O measurements. The optical stimulus to the modulator is provided by an external laser source. The VNA supplies a swept microwave signal over the frequency range of interest to the modulator. The MN4765A then converts the modulated optical signal back to an electrical signal that is measured by the VNA.

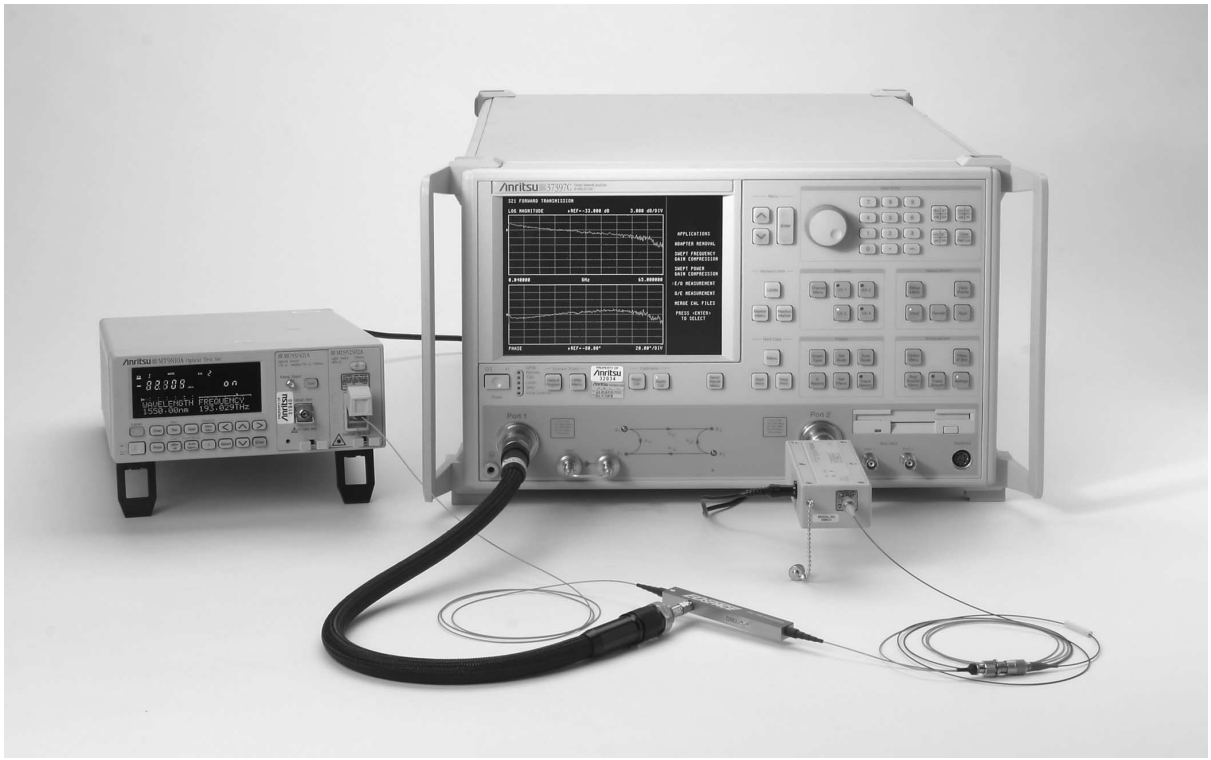

Figure 3-1. *MN4765A E/O Measurement Setup*

An electrical calibration is first performed on the VNA to remove the unwanted effects of the VNA, cables, and other components in the measurement path. The next step is to remove (de-embed) the photodiode's known response to reveal the performance of the E/O converter. The de-embedding of the photodiode response is performed using the VNA's internal E/O application menu. This process requires a characterization file for the photodiode in the s2p format. The characterization file is provided on a disk along with the Anritsu MN4756A O/E Calibration Module. Once the response of the photodiode is removed, the S_{21} measurement displays the modulator's transfer function (ratio of modulated optical output to the electrical input signal). The 3 dB bandwidth, phase linearity, and group delay of the modulator can be determined from this transfer function.

The following equipment is used for the measurement of a MN4765A O/E Calibration Module:

- 65 GHz Vector Network Analyzer (37397C)
- Optical Test Set (MT9810A)
- Polarization Controller (recommended)

Measurement Steps

Step 1. Perform a 12-term microwave calibration over the bandwidth of interest at the calibration reference planes to remove the response of the VNA and the cables from the measurement. Save the 12-term calibration to the hard disk or the floppy disk for later recall.

Step 2. Press the APPL key and select E/O MEASUREMENT. Under the E/O Application menu (Figure 3-2), follow the instructions to load the 12-term electrical calibration (from either the hard or floppy drive).

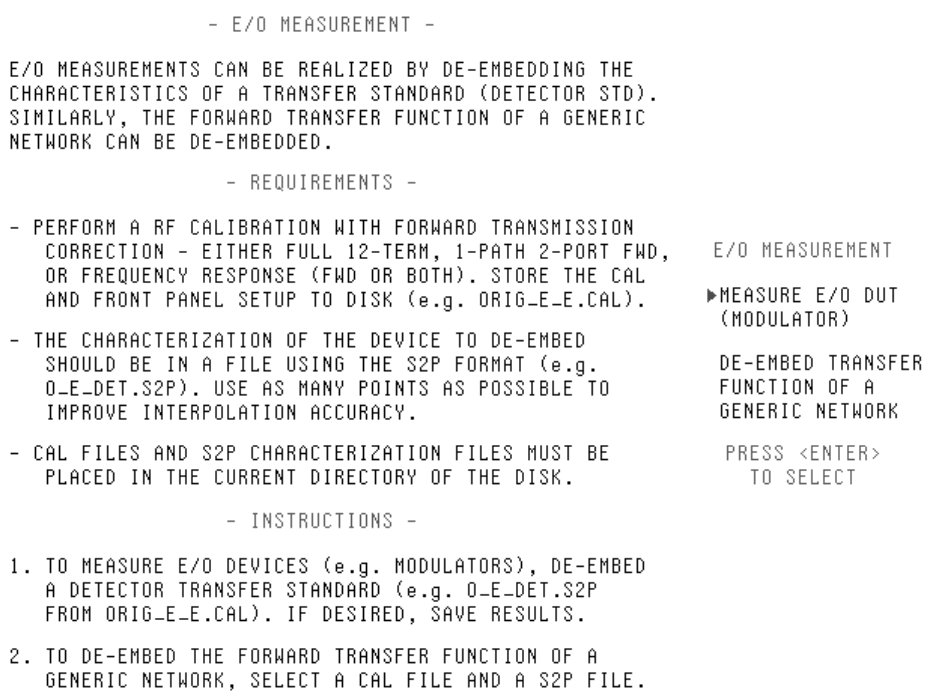

Figure 3-2. *E/O Measurement Instruction Menu*

Step 3. Load the s2p characterization file of the MN4765A. This removes the response of the photodiode that will be used for the E/O measurement.

Step 4. Connect the modulator DUT to the MN4765A photodiode in series as shown in Figure 2-3.

NOTE

To achieve the maximum signal level at the input of the photodiode, a polarization controller is recommended to adjust the polarization of the laser input to the modulator DUT. This improves the signal-to-noise ratio of the measurement.

Measurement Tips

Most E/O and O/E fiber optic components will exhibit some polarization dependence. Understanding the effects of polarization is essential to maximizing measurement efficiency. Stability is another important concern. Standard single mode fibers can alter polarization states simply by adding stress to the fiber.

The following tips can help enhance the measurements of E/O and O/E components:

- Measurement dynamic range can be maximized using a simple polarization controller before a polarization sensitive device. The VNA can be used to monitor the maximum RF output level as the polarization is adjusted.
- Polarization Maintaining Fiber (PMF) is an easy way to minimize polarization changes as a result of fiber turns and bends.

The transfer function measurement of a 40 Gb/s modulator is shown in Figure 3-3.

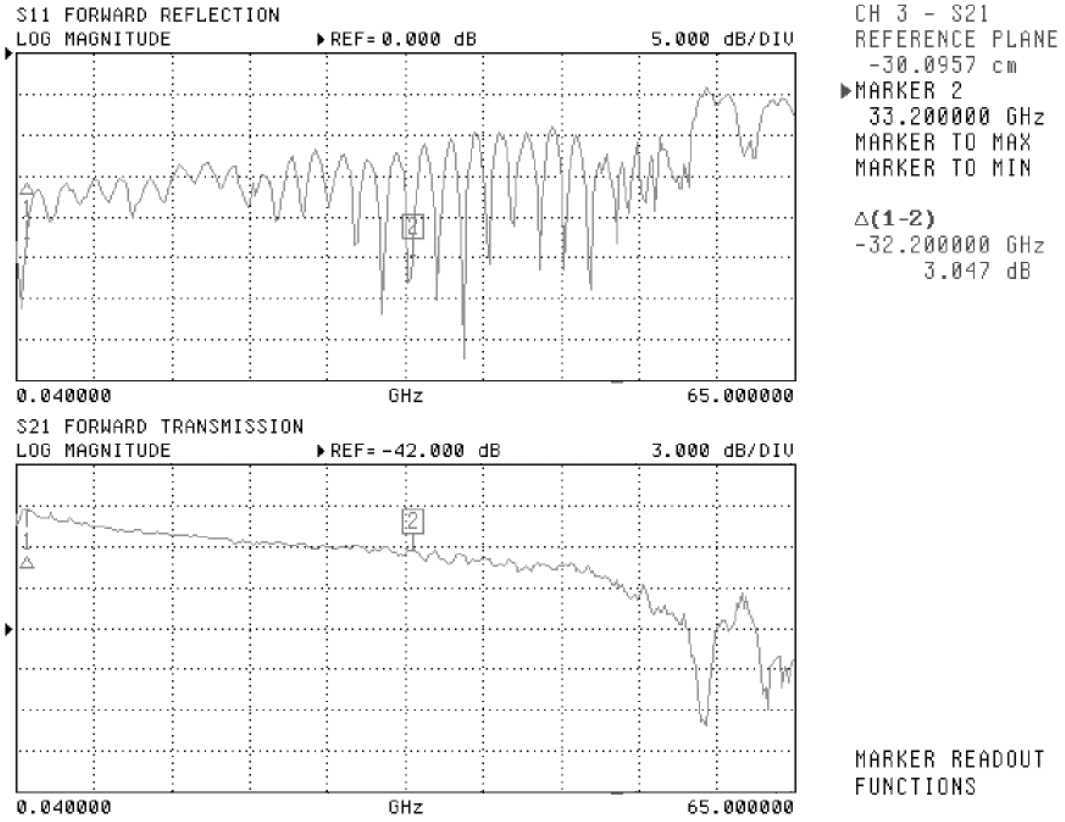

Figure 3-3. *Return Loss and Transfer Function Measurement of a 40 Gb/s Modulator.*

The bandwidth can be measured at the 3 dB roll off point in the modulator's response—approximately 32 GHz in this case.

Similarly, phase and group delay measurements of the modulator can also be made by selecting the appropriate graph type as shown in Figure 3-4 and Figure 3-5.

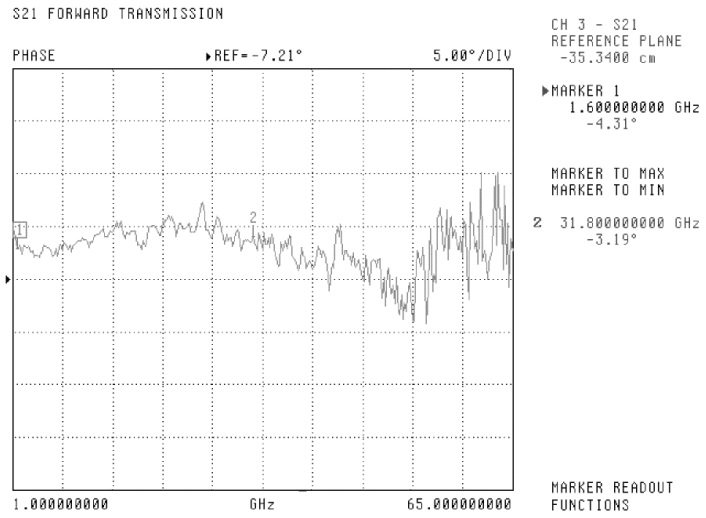

Figure 3-4. *Phase Linearity Measurement of a 40 Gb/s Modulator The reference plane was automatically adjusted using the REF PLANE menu to display the deviation from linear phase over the 65 GHz frequency range.*

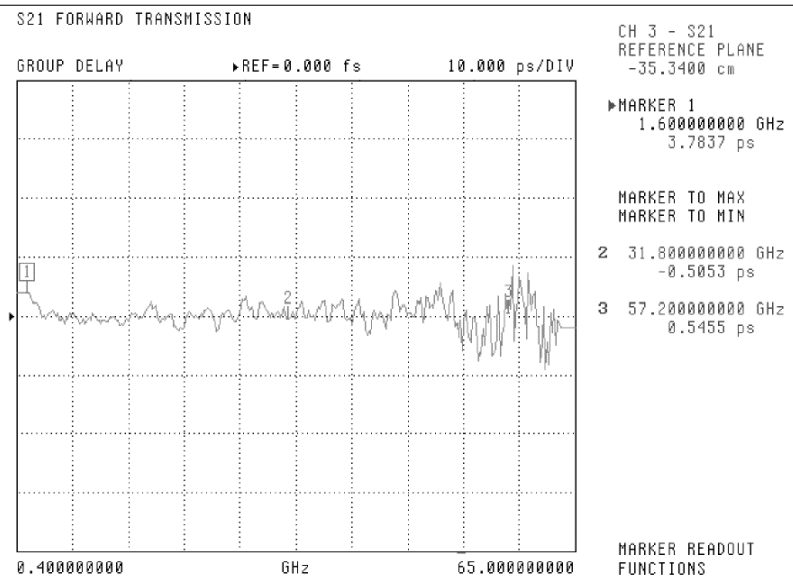

Figure 3-5. *Group Delay Measurement of a 40 Gb/s Modulator The frequency aperture (Δf) was set to 5% for this measurement.*

Phase measurements are generally comprised of multiple phase transitions due to the electrical length of the DUT. A representation of phase linearity through the device can be obtained by removing the fixed electrical length. The REF PLANE menu can be used to compensate for the phase change over frequency to display the variation from linear phase. By measuring S_{11}, the electrical input impedance (for example, return loss of the modulator) can also be characterized.

Analysis of the S_{11} data over distance, using the VNA's time domain function, can help in locating discontinuities and imperfections in the modulator.

O/E Measurements

The setup shown in Figure 3-1 can also be applied to O/E measurements of a photodiode or photo-receiver DUT. Photodiodes demodulate the electrical signal from the optically modulated light in a fiber optic transmission network. An external laser source, used with a characterized modulator, provides the input to the O/E DUT. The response of the characterized modulator is de-embedded from the setup using the O/E application menu. The characterization file for the modulator can be generated using the MN4765A. See Appendix A for instructions on generating an s2p file.

Once the response of the modulator is removed, the S_{21} parameter displays the ratio of the output electrical signal to the input optical modulated signal. This is the DUT's transfer function (Figure 3-6).

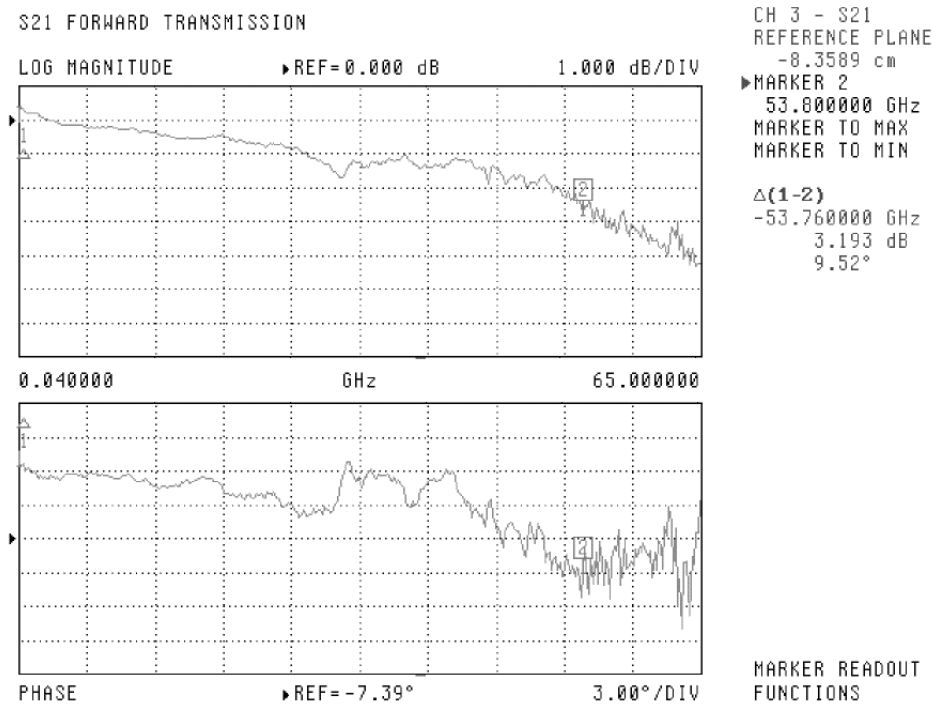

Figure 3-6. *Transfer Function Measurement (Magnitude and Phase) of a MN4765A Module.*

The 3 dB bandwidth can be determined from the measurement—approximately 53 GHz in this example. Phase linearity, group delay, and return loss of the O/E DUT can also be extracted from this measurement setup.

A characterized optical modulator is also required for an O/E measurement.

Measurement Steps

Step 1. Perform a 12-term calibration on the VNA over the frequency range of interest. Save the calibration for later recall.

Step 2. Press the APPL menu button on the VNA's front panel. Select O/E MEASUREMENT, then press MEASURE O/E DUT.

Step 3. Follow the instructions in the menu (Figure 3-7) to load the 12-term electrical calibration that was saved in Step 1.

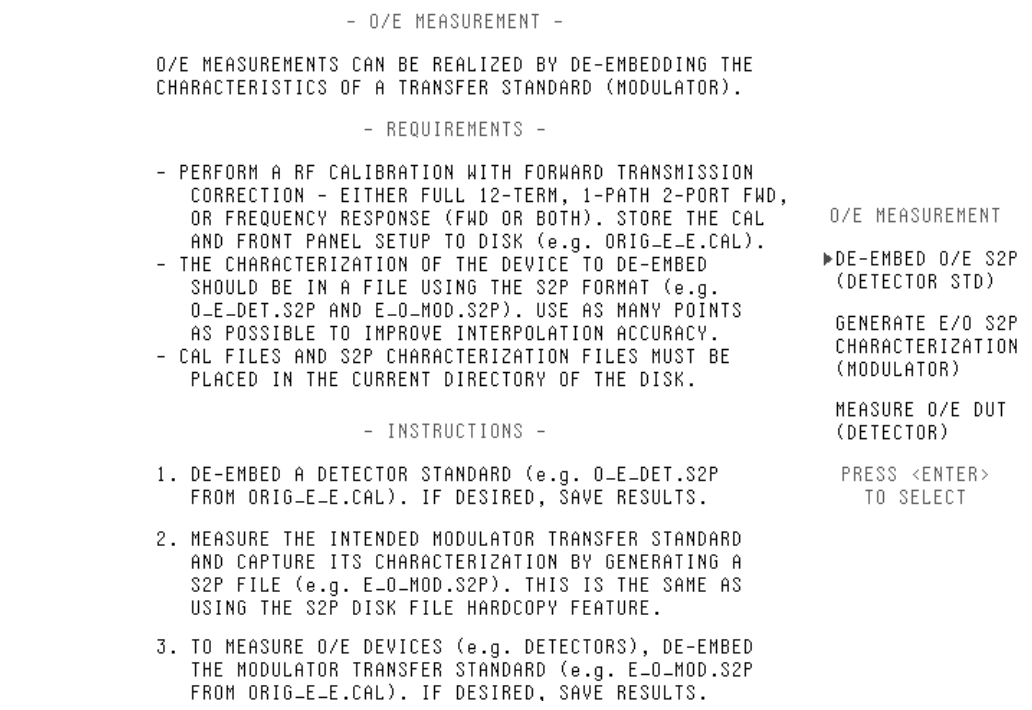

Figure 3-7. *O/E Measurement Instruction Menu*

Step 4. After entering the s2p file for the characterized modulator, the VNA is now calibrated and ready to make O/E measurements. Connect the characterized modulator and detector under test as shown in Figure 2-3 on page 2-5.

Appendix A
Supplemental Information

Characterization Files

The MN4765A O/E Calibration Module can be used to calibrate an E/O device, usually an external modulator, to be used in O/E measurements. The following calibration procedure guides you through an E/O calibration and produces an s2p file that represents the E/O standard:

Step 1. Perform a 12-term calibration over the frequency range of interest. Save this calibration to disk.

Step 2. Press the APPL key on the front panel and select O/E MEASUREMENT and DE-EMBED O/E S2P. When asked to load the original cal file, select the calibration that was saved in Step 1.

Step 3. After loading the VNA calibration, load the s2p file for the MN4765A.

Step 4. Connect the optical components together as shown in Figure 2-3 on page 2-5. Apply bias to the photodiode and to the modulator before turning on the laser.

Step 5. Connect the AC adaptor to the MN4765A. Ensure that the calibration module is powered up and that the yellow OPERATE LED is illuminated.

Step 6. Turn the laser ON and adjust the polarization to achieve the maximum signal level. To enhance the response and reduce the signal-to-noise ratio, increase the laser's power and the VNA's averaging count, and lower the I.F. bandwidth.

At this point, the laser is on maximum power. The S_{21} parameter should show an E/O response over the entire frequency range of the calibration. The next steps will generate the modulator's s2p file.

Step 7. On the VNA, press: APPL | O/E MEASUREMENT | GENERATE E/O S2P | AUTOSCALE.

Step 8. The screen should now display S_{21} (magnitude and phase) for the E/O modulator. The data can then be stored as an s2p file by selecting STORE E/O S2P and by appropriately naming the file.

Optical Measurement Considerations

Laser Power and Bias Sequencing

Always make sure the MN4765A is biased properly before turning the laser on.

Optical Fiber Lengths

The measurement setup will typically require optical fibers to interconnect optical components with different connectors. For example, a modulator with an FC/PC connector at the output will require an optical patch cord to adapt to the FC/APC connector on the input of the MN4765A.

Optical fibers have negligible frequency dependent loss over the modulation bandwidths discussed here (Figure A-1). Thus, adding short lengths of optical patch cords to the setup does not affect the accuracy of transfer function measurements.

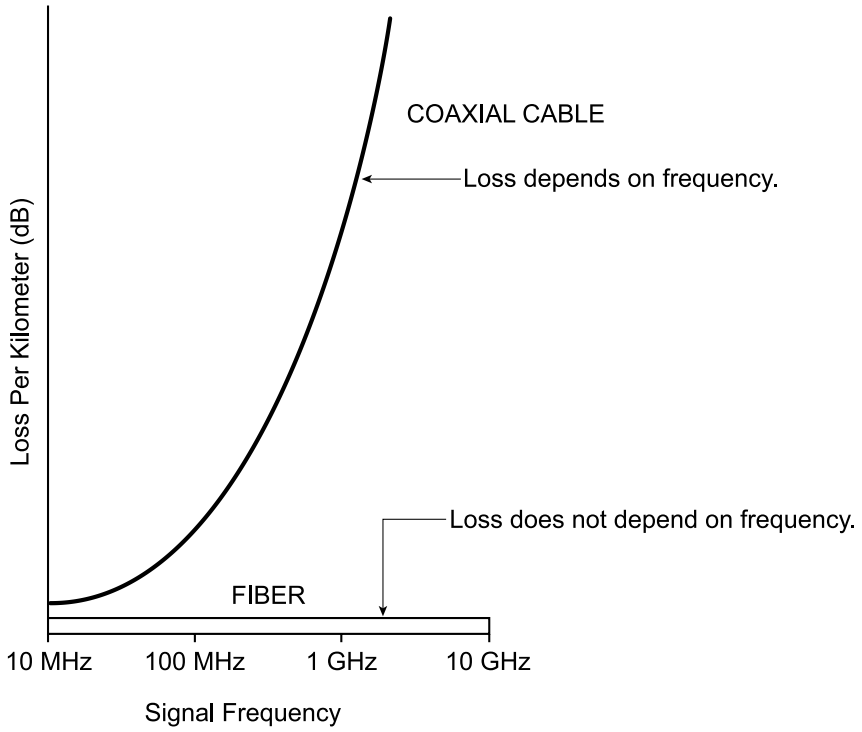

Figure A-1. *Loss as a Function of Frequency for Coaxial and Fiber Optic Cables*

Modulator Bias Control

Lithium Niobate modulators are generally biased using a modulator bias controller (MBC) to control the operating point of the modulator. When biased in quadrature, the input RF signal linearly modulates the optical carrier. Note that when an MBC is applied, it must be designed for small signal operation. The default power from the Port 1 test port is –7 dBm for the 65 GHz VNA (37397C). This results in a modulation depth of <10% (for most commercially available modulators).

A DC power supply can be used in place of an MBC. However, the stability of the S_{21} measurement may be degraded due to drift in the modulator's bias point.

DECLARATION OF CONFORMITY

Manufacturer's Name: ANRITSU COMPANY

Manufacturer's Address: Microwave Measurements Division
490 Jarvis Drive
Morgan Hill, CA 95037-2809
USA

declares that the product specified below:

Product Name: 65GHz O/E Calibration Module

Model Number: MN4765A

conforms to the requirement of:

EMC Directive 89/336/EEC as amended by Council Directive 92/31/EEC & 93/68/EEC
Low Voltage Directive 73/23/EEC as amended by Council directive 93/68/EEC

Electromagnetic Interference:

Emissions: CISPR 11:1990/EN55011:1991 Group 1 Class A
EN61000-3-2: 1995 Class A
EN61000-3-3: 1995

Immunity: EN 61000-4-2:1995/EN50082-1:1997 - 4kV CD, 8kV AD
EN 61000-4-3:1997/EN50082-1:1997 - 3V/m
EN 61000-4-4:1995/EN50082-1:1997 - 0.5kV SL, 1kV PL
EN 61000-4-5:1995/EN50082-1:1997 - 1kV L-L, 2kV L-E
EN 61000-4-6:1994/EN61326: 1998 – 3V
EN 61000-4-11:1994/EN61326: 1998 – 100% @ 20msec

Electrical Safety Requirement:

Product Safety: The Product Complies when used with Company supplied Power Supply (tested to EN 60950)

Director of Corporate Quality

Morgan Hill, CA

29-OCT-03
Date

European Contact: For Anritsu product EMC & LVD information, contact Anritsu LTD, Rutherford Close, Stevenage Herts, SG1 2EF UK, (FAX 44-1438-740202)

Appendix B Connector Care

Introduction

It is important to establish proper cleaning procedures when connecting fiber optic devices together. Fiber optic cores are made of glass and can easily be scratched or chipped if care is not taken.

The optical connector found on the MN4765A is an FC/APC connector. APC (Angled Physical Contact) is chosen to help minimize back-reflection. DFB lasers require large amounts of isolation to function properly. The optical return loss from a common PC connector can be as large as –30 dB or higher, depending upon the polish and cleanliness of the connector.

Connector Care

The following tips help ensure the quality of the optical connections:

- Always clean connectors after every connection.
- Use a fiber optic scope often to ensure there are no defects on the connector end face that can cause damage to other connectors.
- Use insertable patch cords for expensive devices that require many connections.
- Always use a cloth that is free of fiberglass to clean the connectors. If necessary, use alcohol to remove stubborn dirt and oil. Thoroughly remove any alcohol residue before reconnecting.
- Avoid using any oils for connecting two cables together. Oils are messy and very difficult to clean up.
- Optical connectors do not need torque. Some connections are better when the two fibers are barely touching. Tightening the connector too much will result in higher insertion loss, more reflection, and in some cases damage to the connector.
- Always observe proper mating to APC connectors. Connecting an APC connector to a PC connector will result in damage to the connectors.

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