Operation Manual

MN4765B
O/E Calibration Module

Anritsu

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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: O/E Calibration Module

Model Number: MN4765B

conforms to the requirement of:

EMC Directive:	2004/108/EC
Low Voltage Directive:	2006/95/EC

Electromagnetic Compatibility: EN 61326-1:2013

Emissions:	EN 55011:2009 +A1:2010 Group 1 Class A	
Immunity:	EN 61000-4-2:2009	4 kV CD, 8 kV AD
	EN 61000-4-3:2006 +A2:2010	3 V/m
	EN 61000-4-4:2004	0.5 kV S-L, 1 kV P-L
	EN 61000-4-5:2006	0.5 kV L-L, 1 kV L-E
	EN 61000-4-6: 2009	3 V
	EN 61000-4-11: 2004	100% @ 20 ms

Electrical Safety Requirement:

Product Safety: EN 61010-1:2010

Eric McLean, Corporate Quality Director

Morgan Hill, CA

19 FeB 2015
Date

European Contact: For Anritsu product CE information, contact Anritsu EMEA Limited, 200 Capability Green, Luton, Bedfordshire, LU1 3LU, England. (Telephone: +44 (0)1582 433200; Email: bert.francis@anritsu.com)

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NLNB - 201606

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 [Cr(VI)]	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷线路板 (PCA)	×	○	×	○	○	○
机壳、支架 (Chassis)	×	○	×	×	○	○
其他(电缆、风扇、连接器等) (Appended goods)	×	○	×	×	○	○

○：表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T 11364-2014 标准规定的限量要求以下。

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注) 生产日期标于产品序号的前四码(如 S/N 1628XXXX 为16 年第 28 周生产)。

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- A device marketed for use in an industrial application and is not intended for use in the home or residential area is classified as Class A. Class A equipment, commonly known as ISM (industrial, scientific, and medical) equipment, are for professional use in engineering and scientific applications commanding specialized training and good understanding of the English language. Products being sold in a commercial market for such applications have significantly less stringent emissions limits than Class B (residential) devices.

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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.

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Warning

Danger or Warning indicates a risk from a very hazardous condition or procedure that could result in light-to-severe injury or death, or loss related to equipment malfunction. Follow all safety precautions and procedures to minimize this risk.

Caution

Caution indicates a risk from a hazardous condition or procedure that could result in injury or loss related to equipment malfunction. Follow all safety precautions and procedures to minimize this risk.

Safety Symbols Used on Equipment and in Manuals

The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Ensure that you clearly understand the meanings of the symbols and take the necessary precautions *before* operating the equipment. Some or all of the following five symbols may or may not be used on all Anritsu equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.

This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.

This indicates a compulsory safety precaution. The required operation is indicated symbolically in or near the circle.

This indicates a warning or caution. The contents are indicated symbolically in or near the triangle.

This indicates a note. The contents are described in the box.

Warning

Always refer to the equipment manual when working near locations where the alert mark, shown on the left, is displayed. If equipment operation is conducted without heeding the advice in the manual, there is a risk of personal injury. In addition, the equipment performance may be reduced.

This alert mark is sometimes used with other marks and descriptions indicating other dangers.

Warning

When supplying power to this equipment, connect the accessory 3-pin power cord to a 3-pin grounded power outlet. If power is supplied without grounding the equipment, there is a risk of receiving a severe or fatal electric shock.

Warning

This equipment can not be repaired by the operator. Do not attempt to remove the equipment covers or to disassemble internal components. Only qualified service technicians with a knowledge of electrical fire and shock hazards should service this equipment. There are high-voltage parts in this equipment presenting a risk of severe injury or fatal electric shock to untrained personnel. In addition, there is a risk of damage to precision components.

Warning

Laser radiation may be present at fiber-optic cable connectors and ports. This laser radiation could present an ocular hazard from either direct viewing or by diffuse reflection. Do not view the emitted laser radiation directly or indirectly because permanent blindness may result.

Caution

Electrostatic Discharge (ESD) can damage the highly sensitive circuits in the instrument. ESD is most likely to occur as test devices are being connected to, or disconnected from, the instrument's front and rear panel ports and connectors. You can protect the instrument and test devices by wearing a static-discharge wristband. Alternatively, you can ground yourself to discharge any static charge by touching the outer chassis of the grounded instrument before touching the instrument's front and rear panel ports and connectors. Avoid touching the test port center conductors unless you are properly grounded and have eliminated the possibility of static discharge.

Repair of damage that is found to be caused by electrostatic discharge is not covered under warranty.

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Chapter 1 — Overview

1-1 Introduction

The MN4765B is a characterized, unamplified photodiode module. It is used as an optical receiver with the Anritsu MS4640B, MS46122A, MS46322A and MS4652xB Series VNAs to perform highly accurate and stable optoelectronic measurements of both modulators (E/O) and photoreceivers (O/E). Bandwidth and wavelength coverage depends on the option selected when the module is ordered. The MN4765B allows error-corrected Transfer Function, Group Delay, and Return Loss measurements of optoelectronic components.

Throughout this manual, the terms MN4765B and O/E Calibration Module will be used interchangeably to refer to the MN4765B.

1-2 MN4765B 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 performing proper cleaning of the electrical and optical connectors is essential.

Characterization

The MN4765B module is serialized and comes with a characterization in relative magnitude and phase with a specified uncertainty from 70 kHz up to 110 GHz (depending on the option ordered). A copy of the characterization can be found on the USB memory device that ships with the module. If a replacement copy of the characterization is required, contact Anritsu Customer Service at: www.anritsu.com

Re-characterization

The MN4765B 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.

1-3 Anritsu VNA Related Manuals

VectorStar Vector Network Analyzers

Refer to the following documents for detailed operating instructions and application notes when using the MS4640B VectorStar VNA.

- MS4640B Series VNA Operation Manual – 10410-00317
- MS4640B Series VNA Measurement Guide – 10410-00318
- MS4640B Series VNA User Interface Reference Manual – 10410-00319
- Electrical-to-Optical and Optical-to-Electrical (E/O and O/E) Converter Measurements Application Note – 11410-00798

ShockLine Vector Network Analyzers

Refer to the following documents for detailed operating instructions and application notes when using the MS46122A, MS46322A, or MS4652xB, ShockLine VNA.

- MS46122A-MS46322A Series VNA Measurement Guide – 10410-00336
- MS4652xB Series VNA Measurement Guide – 10410-00753
- MS46121A-MS46122A-MS46322A Series VNA User Interface Reference Manual – 10410-00337
- MS4652xB Series VNA User Interface Reference Manual – 10410-00744
- Electrical-to-Optical and Optical-to-Electrical (E/O and O/E) Converter Measurements Application Note – 11410-00798

1-4 MN4765B Specifications

Refer to the MN4765B Technical Data Sheet – 11410-00843.

Chapter 2 — Installation

2-1 Introduction

This chapter provides installation instructions for the MN4765B O/E Calibration Module. It includes information on initial inspection, preparation for use, storage, and reshipment.

2-2 Unpacking and Initial Inspection

The MN4765B 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.

2-3 Contents

The MN4765B and all the necessary equipment to safely and correctly handle the calibration module. The items included are:

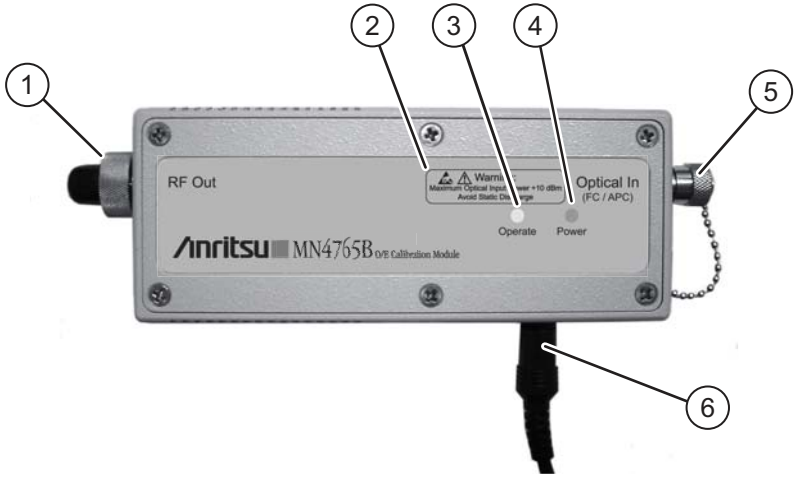
- MN4765B with user specified options
- AC adapter and power cord
- Calibration certificate
- USB memory device (containing a copy of the MN4765B calibration data)

2-4 Preparation for Use

Preparation for use consists of familiarizing yourself with the MN4765B, cabling the calibration module to the Anritsu Vector Network Analyzer, and attaching the supplied AC adapter.

Note	Experience with an Anritsu Vector Network Analyzer is assumed. Refer to the operation manual and measurement guide supplied with the VNA for information and operating instructions with the Anritsu VNA. See "Anritsu VNA Related Manuals" on page 1-2.

The MN4765B's interfaces are outlined in Figure 2-1.



1	The RF Out connector is a male V connector on an MN4765B-0070/-0071/-0072, and a male W connector on an MN4765B-0110 with an easy to use coupling nut. Be sure to follow proper torquing instructions when making connections to the RF connector.
2	The Warning label indicates that the maximum optical input power to the MN4765B is 10 mW or 10 dBm. Exceeding this value will cause damage to the internal photodiode.
3	The yellow Operate LED indicates that the MN4765B has reached a stable temperature and that it is ready for operation. The recommended warm-up time is 5 minutes.

Figure 2-1. MN4765B O/E Calibration Module (1 of 2)

4	The green Power LED indicates that power is being delivered to the internal bias board and that the internal high-speed photodiode is properly biased. **Never** input light into the MN4765B when the green LED is off.
5	FC/APC optical input connector with protective dust cap. Attach an optical patch cord to this FC/APC connector to protect the MN4765B optical connector from repeated connections.
6	The MN4765B 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 MN4765B's top cover.

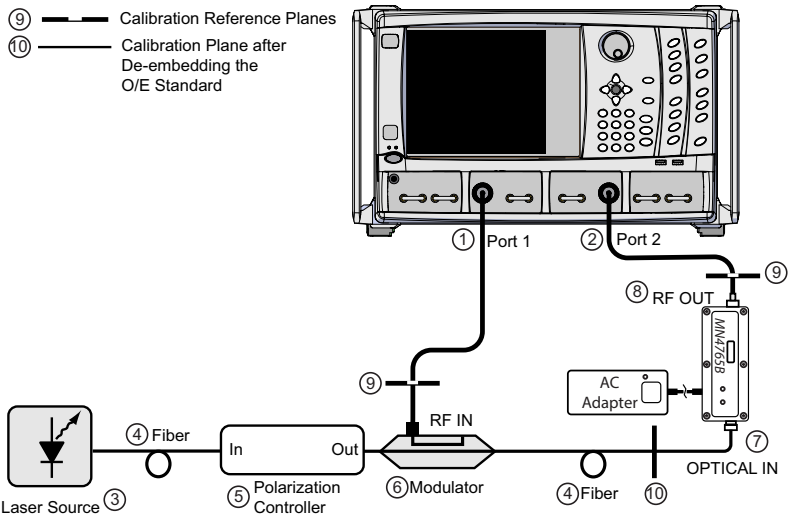
Figure 2-1. MN4765B O/E Calibration Module (2 of 2)

Power Requirements

The MN4765B AC power adapter accepts 100 VAC to 240 VAC, 50 Hz to 60 Hz, single-phase power. The calibration module is intended for Installation Category (Over Voltage Category) II.

MN4765B Measurement Setup

Connect the MN4765B Calibration Module to the Vector Network Analyzer. The example in Figure 2-2 on page 2-4 shows how to connect the MN4765B Calibration Module to an Anritsu VectorStar VNA. The connections to the VNA test ports are the same for the other Anritsu Vector Network Analyzers. With the MN4765B-0110 (110 GHz option), an ME7838X broadband system that incorporates an MS464xB VNA is required.



1	VNA Port 1	6	Modulator
2	VNA Port 2	7	Optical In – MN4765B
3	Laser Source	8	RF Out – MN4765B
4	Fiber Cable	9	Calibration Reference Plane
5	Polarization Controller	10	Calibration Plane after De-embedding O/E Standard

Figure 2-2. MN4765B E/O Measurement Setup With a VectorStar VNA

1. Connect the MN4765B RF OUT port to Port 2 of the VNA (Other models of VNA can be used, but this will change the available frequency range).
2. Connect Port 1 of the MS4647B to the RF Input port of the modulator.
3. Connect the output port of the modulator to the Optical In port on the MN4765B.

Chapter 3 — Operation

3-1 Introduction

This chapter provides information on the operation of the MN4765B O/E Calibration Module. The illustrations provided of Vector Network Analyzer connections use the Anritsu VectorStar VNA. Other Anritsu VNAs use similar connections, but the resulting performance data will be slightly different.

3-2 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

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 MN4765B then converts the modulated optical signal back to an electrical signal that is measured by the VNA. 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 USB memory device along with the Anritsu MN4765B O/E Calibration Module. Once the response of the photodiode is removed, the S21 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.

Required Equipment

- Vector Network Analyzer MS4640B, MS46122A, MS46322A or MS4652xB models can be used, but the maximum frequency allowed will be limited by the frequency range of the VNA model. The MN4765B-0110 (110 GHz option) is typically used with a ME7838X broadband system.
- Polarization Controller (recommended)
- Laser light source with the appropriate wavelength for the user specified MN4765B option (i.e. 1550 nm for Options 70, 72 or 110; 1310 nm for Options 71 or 72)
- Broadband Modulator (for O/E measurements)
- Modulator Bias Controller
- Optical Patch Cord

Measurement Steps

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 for later recall.
2. Press the Measurement key and select O/E-E/O. From the E/O measurement window, shown in Figure 3-1 on page 3-3 select E/O Measurements. Follow the instructions to load the 12-term electrical calibration.
3. Load the s2p characterization file of the MN4765B. This removes the response of the photodiode that will be used for the E/O measurement.

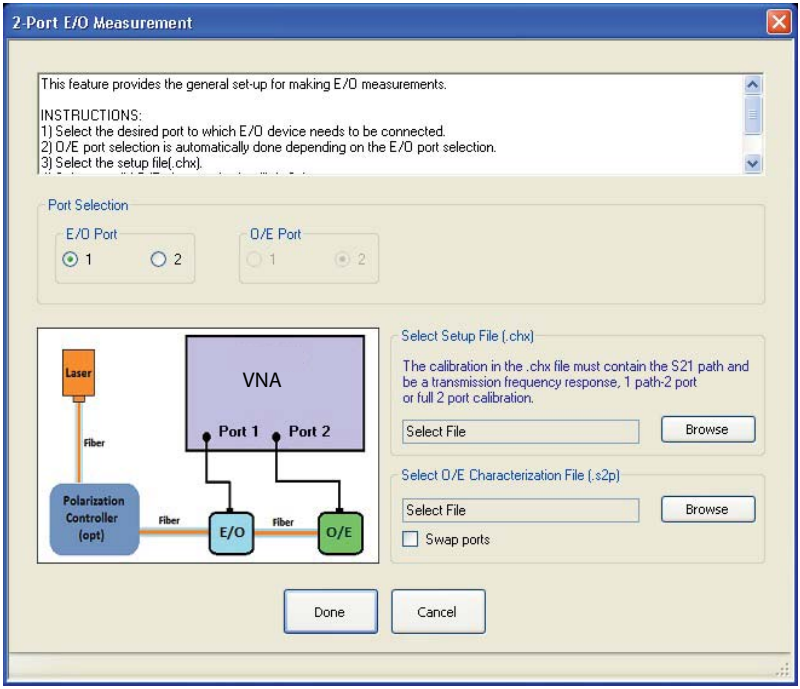


Figure 3-1. E/O Measurement Window

4. Connect the modulator DUT to the MN4765B photodiode in series as shown in Figure 2-2 on page 2-4.

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 using the Anritsu VectorStar VNA is shown in Figure 3-2.

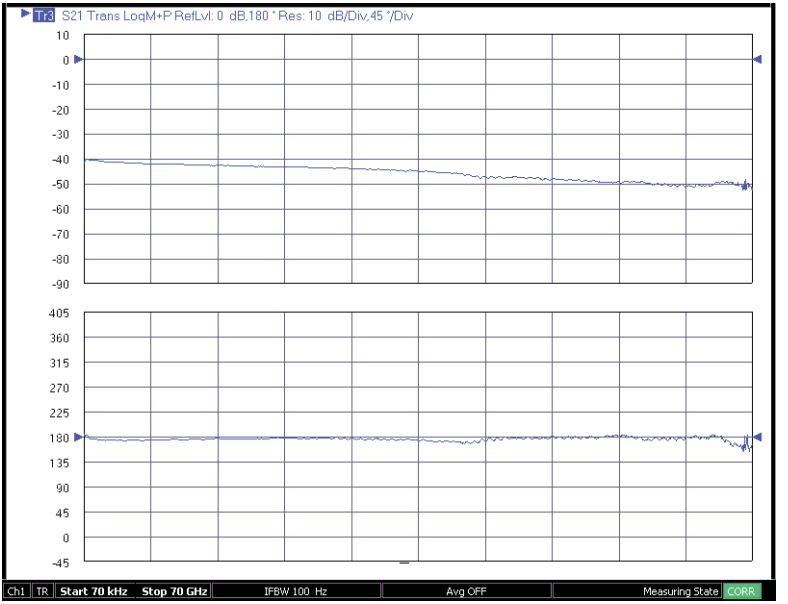


Figure 3-2. Transfer Function Measurement of a 40 Gb/s Modulator using the VectorStar VNA.

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. Phase is shown as part of Figure 3-2 but a separate phase graph type or a group delay graph type can also be selected.

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 Anritsu VNA's reference plane adjustment can be used to compensate for the phase change over frequency to display the variation from linear phase. By measuring S11, the electrical input impedance (for example, return loss of the modulator) can also be characterized. Analysis of the S11 data over distance, using the VNA's time domain function, can help in locating discontinuities and imperfections in the modulator.

3-3 O/E Measurements

The setup shown in Figure 2-2 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 MN4765B. See Appendix A for instructions on generating an s2p file.

Once the response of the modulator is removed, the S21 parameter displays the ratio of the output electrical signal to the input optical modulated signal. Transfer function measurements of the MN4765B using the Anritsu VectorStar VNA is shown in Figure 3-3 and Figure 3-4.

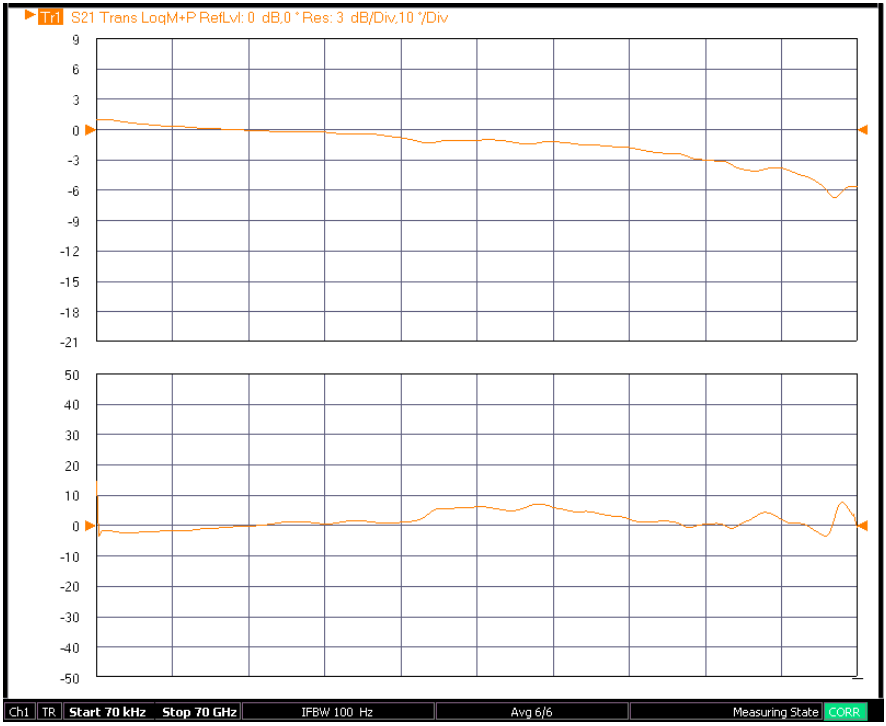


Figure 3-3. Transfer Function Measurement (Magnitude and Phase) of a MN4765B Module with Option 70 (MN4765B-0070) using the VectorStar VNA. Similar plots can be obtained using Option 71 or Option 72 modules.

The 3 dB bandwidth can be determined from the measurement using the Anritsu VectorStar VNA; approximately 53 GHz in the Option 70 example shown above in Figure 3-3 on page 3-7, and approximately 95 GHz in the Option 110 example shown in Figure 3-4 below.

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.

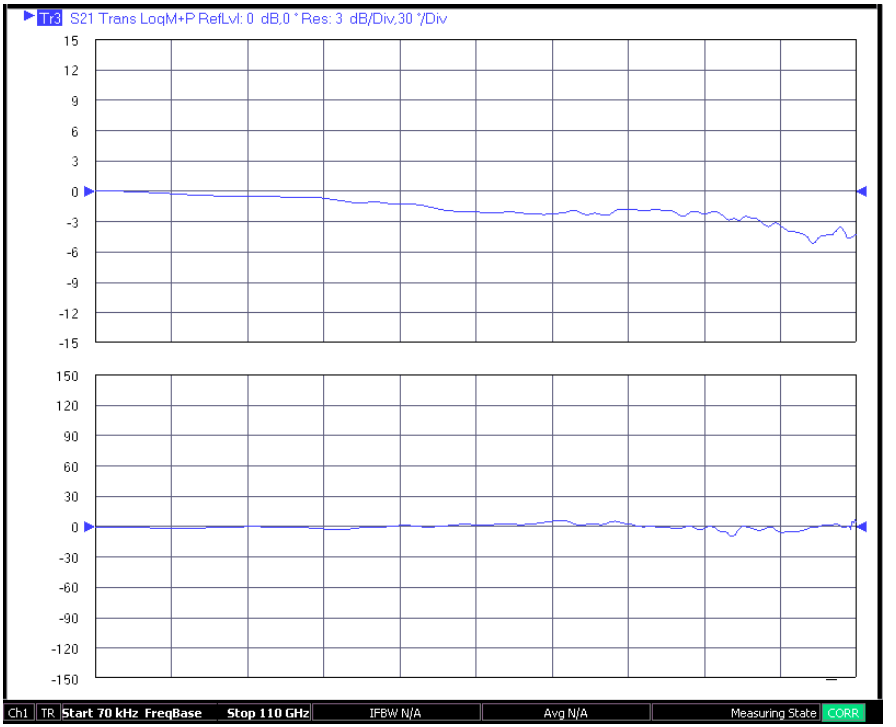


Figure 3-4. Transfer Function Measurement (Magnitude and Phase) of a MN4765B Module with Option 110 (MN4765B-0110) using the VectorStar VNA.

Required Equipment

Refer to the required E/O measurements equipment listed in Section "Required Equipment" on page 3-2.

Measurement Steps

1. Perform a 12-term calibration on the VNA over the frequency range of interest. Save the calibration for later recall.
2. Press the Measurement menu button on the VNA front panel. Select O/E-E/O, then press O/E Measurements.
3. Follow the instructions in the menu shown in Figure 3-5 to load the 12-term electrical calibration that was saved in Step 1.

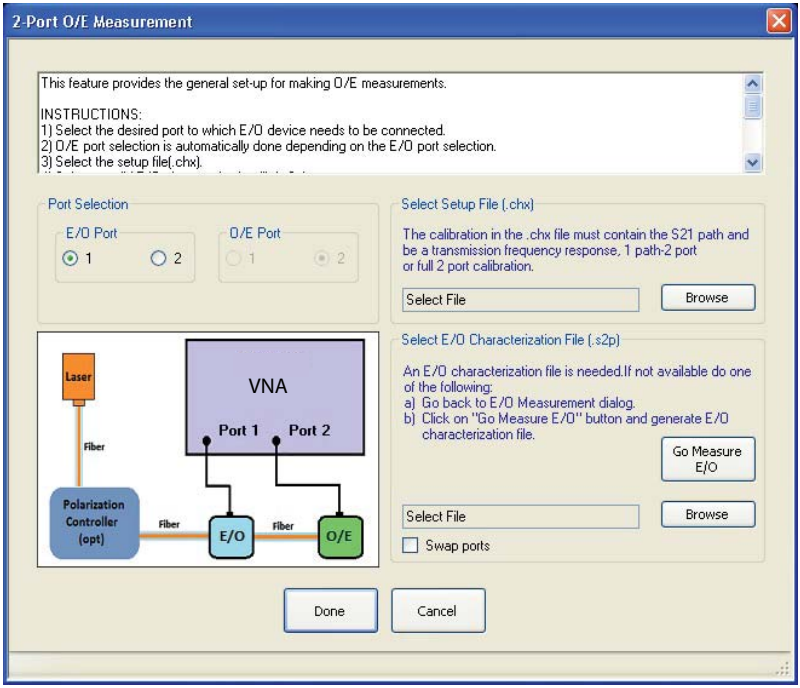


Figure 3-5. O/E Measurement Window

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 2-2 on page 2-4.

Appendix A — Supplemental Information

A-1 Characterization Files

The MN4765B 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:

1. Perform a 12-term calibration over the frequency range of interest. Save this calibration to a USB memory device.
2. Press the Measurement key on the front panel.
   - Select O/E-E/O | O/E Measurements.
   - When asked to load the original cal file, select the calibration that was saved in Step 1.
3. After loading the VNA calibration, load the s2p file for the MN4765B.
4. Connect the optical components together as shown in Figure 2-2 on page 2-4. Apply bias to the photodiode and to the modulator before turning on the laser.
5. Connect the AC adapter to the MN4765B. Ensure that the calibration module is powered up and that the yellow OPERATE LED is on.
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 averaging count, and lower the I.F. bandwidth.
   - At this point, the laser is on maximum power. The S21 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.
7. From the Display Menu, set the VNA to display Log Magnitude and Phase. From the Response menu select S21.
8. The screen should now display S21 (magnitude and phase) for the E/O modulator. The data can then be stored as an s2p file by selecting File, Save Data and by appropriately setting the file format and naming the file.

A-2 Optical Measurement Considerations

Laser Power and Bias Sequencing

Always make sure the MN4765B 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 MN4765B. 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.

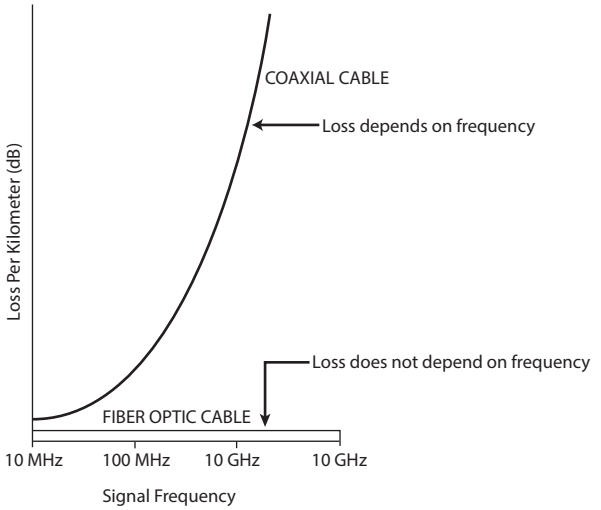


Figure A-1. Loss as a Function of Frequency for Coaxial and Fiber Optic Cables

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 of the Anritsu VNA providing 70 GHz is such that most commercial modulators will be well within their small signal regime with the VNA's drive level.

A DC power supply can be used in place of an MBC. However, the stability of the S21 measurement may be degraded due to drift in the modulator's bias point.

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