PHYTRE

Innovative Transmission Tech

MN 4720 series

STD Light Source & Photonics Receiver

Quick User Guide

Please Keep this manual near the instrument

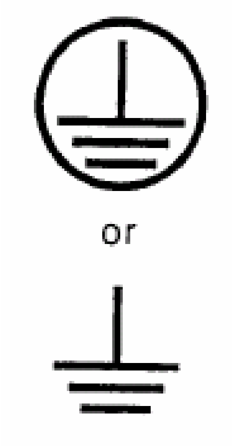
Contents

General safety

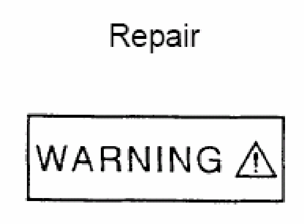
Safety Notification

WARING: Always refer to the operation manual when working near locations at which the alert mark, shown on the left, is attached. If the operation, etc., is performed without heeding the advice in the operation manual, there is a risk of personal injury. In addition, the equipment performance may be reduced.

Moreover, this alert mark is sometimes used with other marks and descriptions indicating other dangers.



WARING: When supplying power to this equipment, connect the accessory 3-pin power cord to a 3-pin grounded power outlet.
If a grounded 3-pin outlet is not available, use a conversion adapter and ground the green wire, or connect the frame ground on the rear panel of the equipment to ground. If power is supplied without grounding the equipment, there is a risk of receiving a severe or fatal electric shock.



WARING: 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 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 personal. In addition, there is a risk of damage to precision components.

Safety Caution

1. Before power off the Light source and Photodiode on MN4720 , the operation key must be turned off in advance to prevent the damage on the system.

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

3. Please make sure the environment is under following conditions before we start the measurement
   Power Requirement: 100 to 240V , 50~60Hz
   Warm up time : >30 min.
   Storage Temperature: 0℃ ~ 40℃
   Operation Temperature: 10℃ ~ 30℃

4. Laser Safety Information
   All laser sources listed above are classified as Class 1 according to IEC 60825-1 (2001).
   All laser sources comply with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50,

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Table of Contents

Chapter 1 General information

1.1 Description:

The Lightning/Scorpion Vector Network Analyzer solution facilitates the measurement of electrical-to-optical (E/O) and optical-to-electrical (O/E) transfer function in terms of bandwidth, flatness, and phase linearity (group delay). When measuring E/O devices, response of the characterized photodiode is de-embedded from the overall VNA measurement of the E/O, O/E back-to-back configuration. When measuring O/E devices, the photodiode is used to characterize an E/O standard, and the response is then de-embedded in a similar fashion. The de-embedding software is internal to Lightning and provides full on-screen direction, which simplifies calibration and improves measurement throughput.

Target Testing Components

☑ O/E (Photodiode)
- -PIN Diode
- -ROSA
- -Optical Receiver

☑ O/O Components
- - Passive component

☑ E/O Components
- -Laser Source
- -Modulator
- -TOSA

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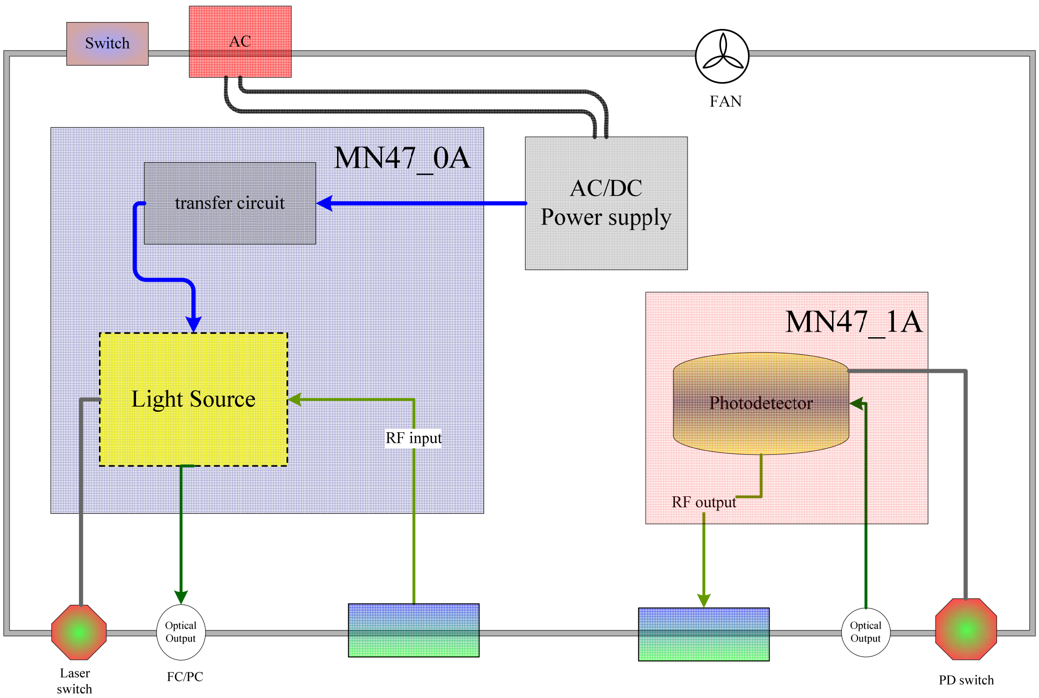
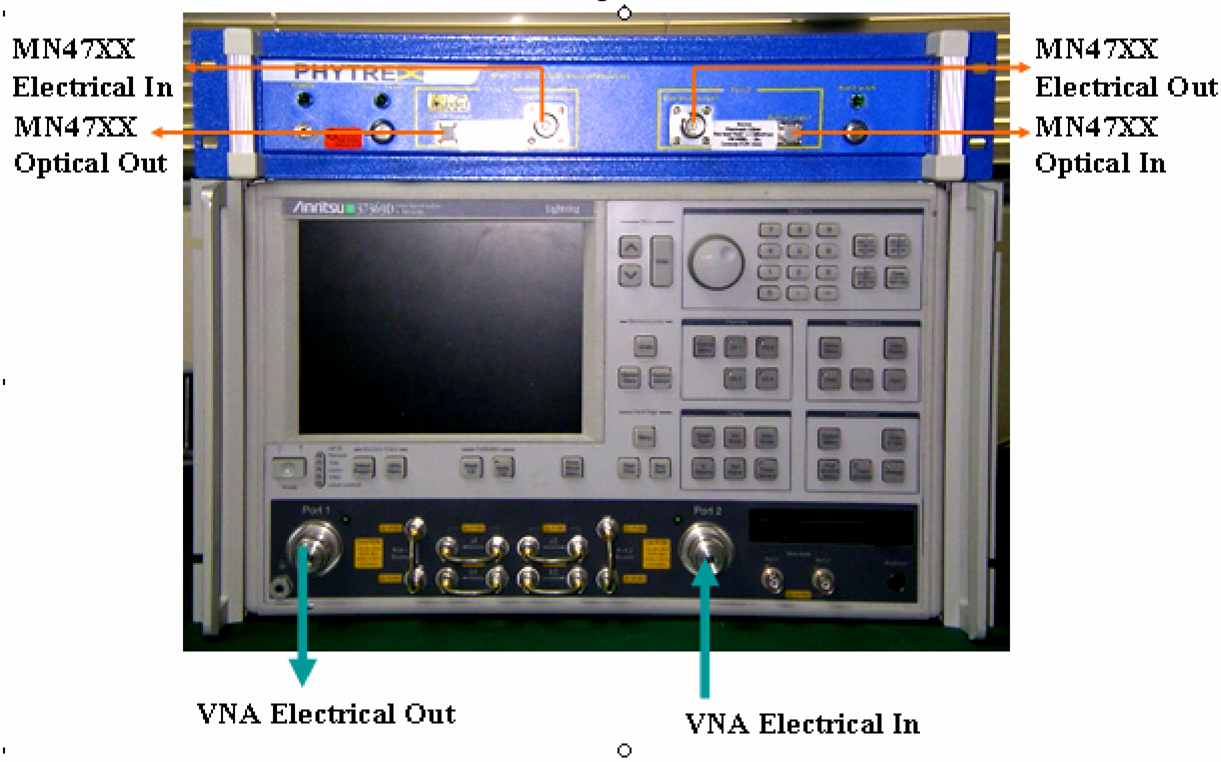
1.2 Features:

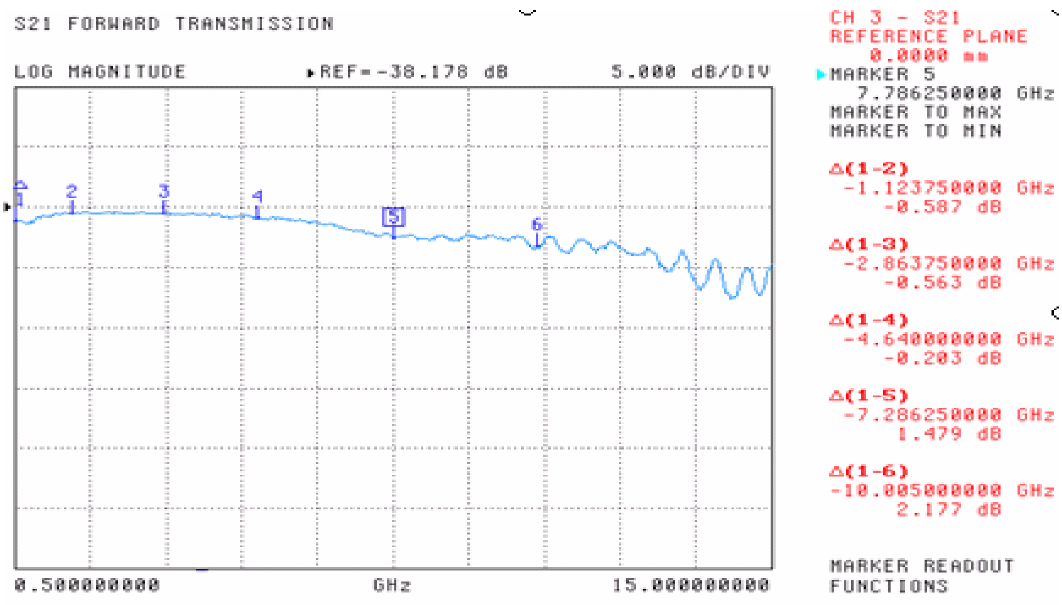
1. Wide bandwidth (up to 10Gbps) measurement
2. Optimize for Anritsu 37XXXC series and MS462X series VNA
3. Cooled Laser Diode for the stability of optical output power
4. Build-in External Modulator for better performance of S parameters
5. Standard Reference Receiver
   The photo-detector is calibrated with reference device traceable to standard Organization which provided high confidence measuring accuracy.
6. Light Source Wavelengths:
   1530 to 1570 nm …..Option MN4720 (Typical 1550nm)
   1290 to 1330 nm …..Option MN4721 (Typical 1310nm)
   850 nm……………. Option MN4722

1.3 System Block diagram and Photograph



Block diagram





Electric-Optic Modulator Frequency Response

Chapter 2 Measurement

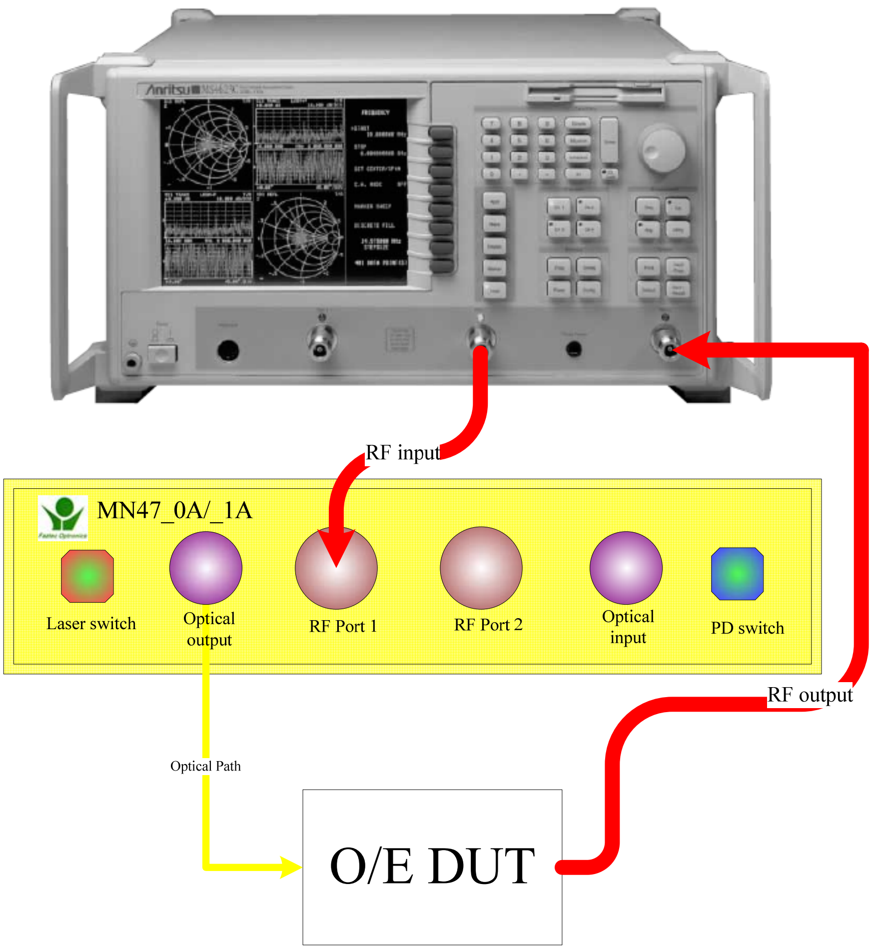
2.1 O/E measurement *(With 37300 series)*

2.1.1 Perform VNA 1 Path 2 ports Calibration

(Recommend calibration point= 401 points)

Please refer to MS462X series or 37300 series user manual.

2.1.2 Setup



O/E measurement setup

2.1.2 De-Embed S2P.file

This feature makes it possible to move the calibrated VNA error reference plane(s) to a different position by mathematically adding (embedding) or removing (de-embedding)certain structures from the measured data. Multiple networks can be cascaded on any unbalanced or balanced port so it is crucial that order of entry be kept in mind. Networks are entered starting at the DUT planes and working out toward the MS462xx. Two port networks are grouped together, as are four port networks, and the two port networks are placed closest to the DUT.

The following step illustrates how de-embedding is applied to a O/E device through Anritsu 37300C series VNA .

Step 1. Perform 1 path 2 ports calibration on the VNA over the frequency range of interest with reference planes at the modulator input and the photo-receiver DUT output.

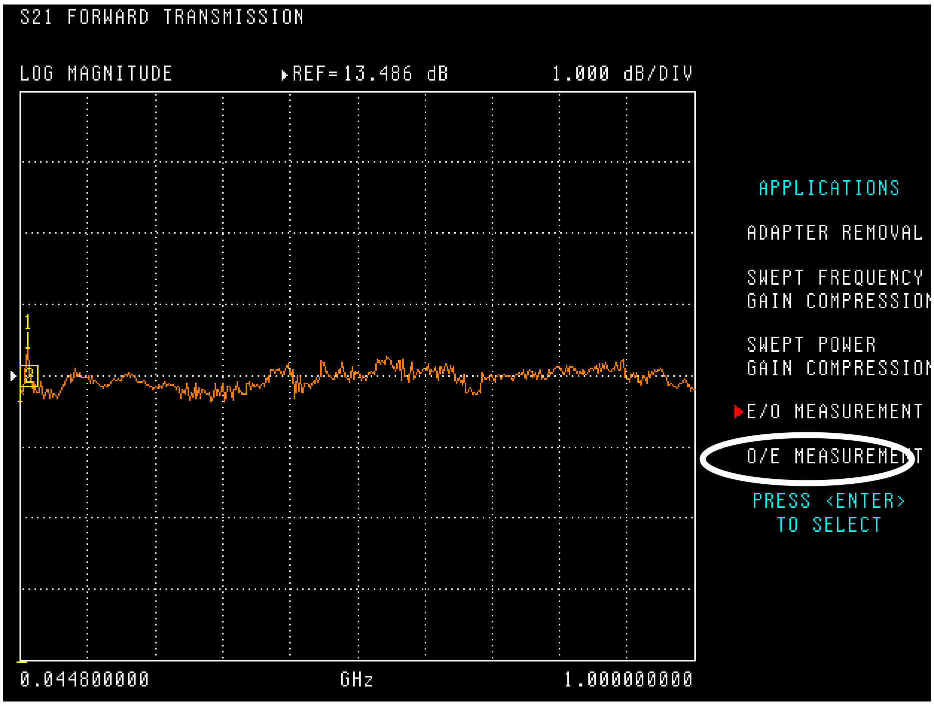
(Recommend calibration conditions: Start Frequencies= 44.8MH, Stop Frequencies= 1GHz,point= 401 points)

Step 2. Press **Save/Recall** to save the calibration data and location to the hard disk or a floppy disk.

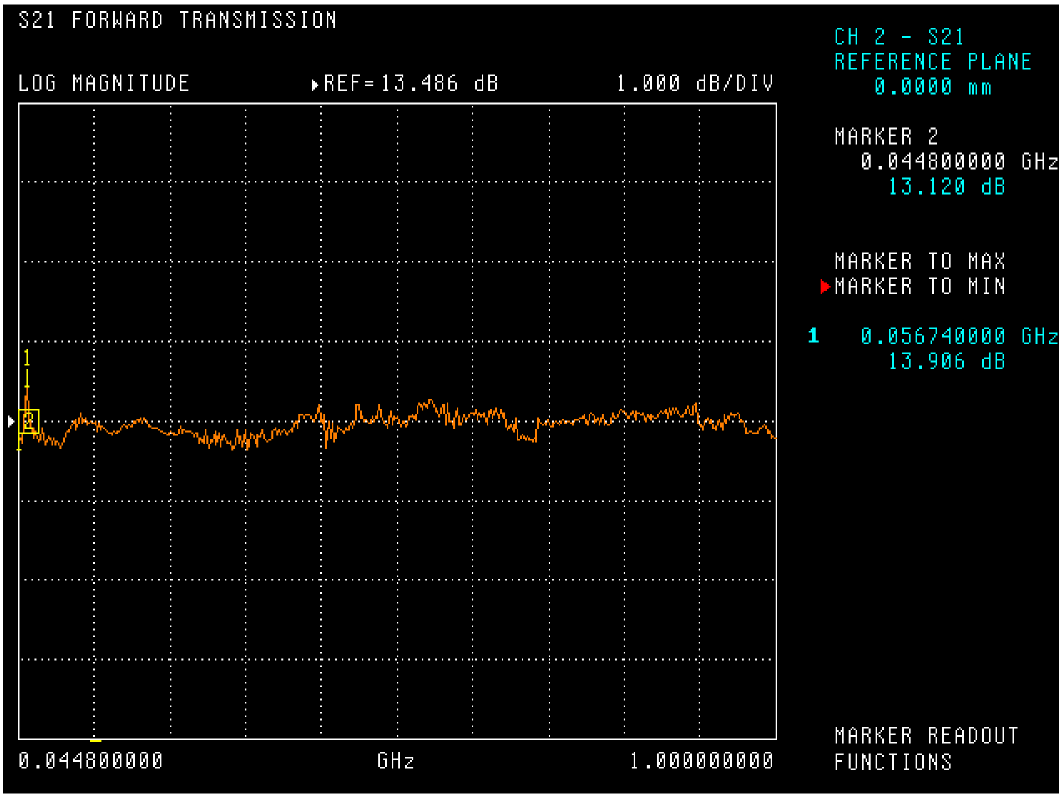
Step 3. Set the screen to display the S-Parameters that would be affected by embedding or de-embedding.

Step 4. Press **Application** on front panel button and set the O/E Measurement

Step 5. Select the "**De-embed O/E S2P (Detector STD)**" or "**Measurement O/E DUT (Detector)**"



Step 6. Load the Calibration data what we done at Step 1and Step 2
Step 7. Load the reference standard light source s2p file(EO1550.s2p)
Step 8. The de-embedding is performed immediately after file is read into VNA(either through hard disk or floppy drive)



2.2 Perform VNA 1 Path 2 ports Calibration (With MS462X series)

Please refer to MS462X series user manual.

(Recommend calibration conditions: Start Frequencies= 44.8MH, Stop Frequencies= 1GHz,point= 401 points)

The standard 2-port calibration for the MS4622 Vector Network Measurement System uses an Open, a Short, a Broadband and/or Sliding Load, and a through line connection to categorize the inherent errors in the measurement system. These errors include those caused by connectors as well as internal system errors such as RF leakage, IF leakage, and component interaction. For maximum accuracy, install the capacitive coefficients (for the open device) using the CALIBRATION COMPONENTS UTILITIES menu

Calibration Procedure

A detailed, step-by-step procedure for performing a Open-Short-Load calibration is given below.

Step 1. Press Appl (top left) then **TRANSMISSION AND REFLECTION**.

Step 2. Press Cal (bottom left) then PERFORM CAL 2-PORT CAL.

Pressing this key starts a linked set of soft-key choices that guide you through a measurement calibration.

Step 3. Observe the **CAL METHOD** and **LINE TYPE** soft-key options. If they read STANDARD and COAXIAL, respectively, go to step 5.

Step 4. Press the following soft keys in sequence:

CHANGE CAL METHOD AND LINE TYPE

CAL METHOD STANDARD

LINE TYPE COAXIAL

NEXT CAL STEP

Step 5. Press **NEXT CAL STEP** then **FULL 12-TERM or 1 Path 2 Ports.**

This soft key calibrates for the twelve error terms associated with a two-port calibration.

Step 6. Press **EXCLUDE ISOLATION**

This soft-key set lets you choose whether to include or exclude the error terms associated with leakage between measurement channels. For a normal calibration, you would choose to include these error terms.

Step 7. Press **NORMAL (1601 POINTS MAXIMUM).**

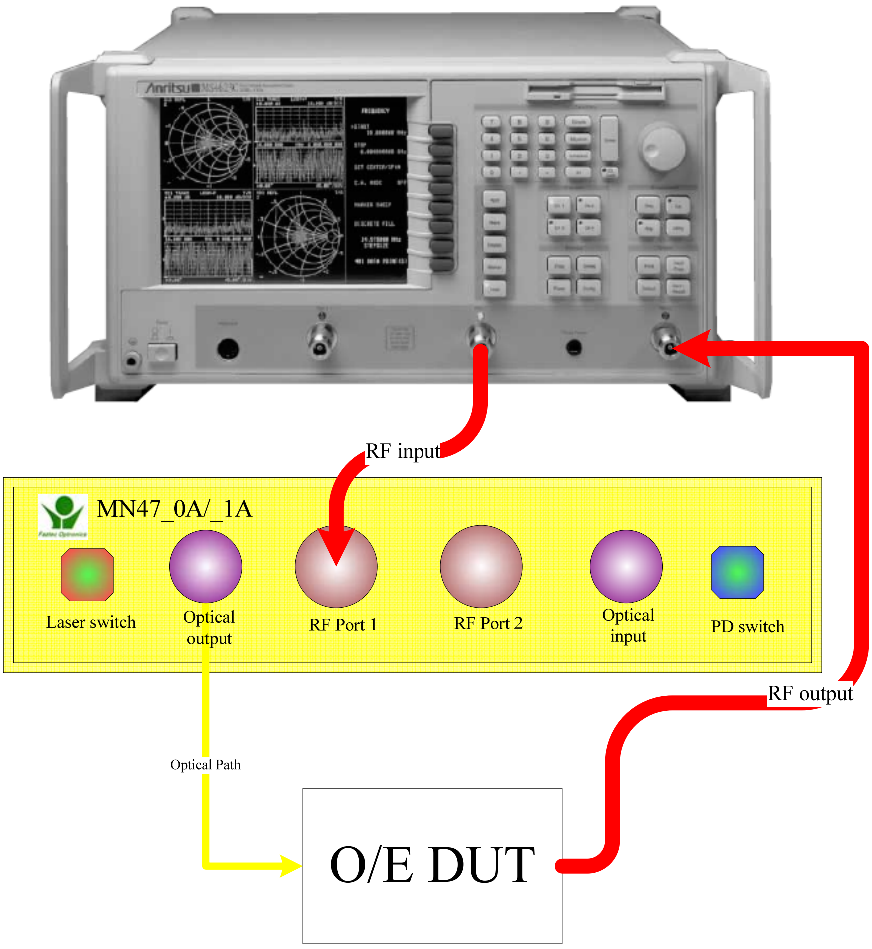
This soft-key set lets you select the number of frequency points at which calibration data is to be taken.

Step 8. Press **START**, then enter 44.8 MHz, using either the rotary knob or keypad and

terminator keys.
Step 9. Press **STOP**, then enter 1 GHz , using either the rotary knob or keypad and terminator keys.
The above 2 steps let you set your start and stop frequencies.
Step 10. Press **NEXT CAL STEP**.
In this soft-key set, current settings for all parameters appear in blue. If you do not need to make any changes, you would press the START CAL soft key. However, for this example, we will change them all.
Step 11. Press the following soft keys in sequence:
PORT 1 CONN
TYPE N (M)
PORT 2 CONN
TYPE N (F)
REFLECTION PAIRING
MIXED
Reflection Pairing lets you mix or match the Open and Short reflection devices in the Calibration Sequence menus. The MIXED choice lets you calibrate using first an Open on one port and a Short on the other, then a Short on one port and an Open on the other. Conversely, MATCHED lets you calibrate first using an Open on both ports then using a Short on both ports
Step 8. Press **START**, then enter 10 MHz, using either the rotary knob or keypad and terminator keys.
Step 9. Press **STOP**, then enter 3 GHz, using either the rotary knob or keypad and terminator keys.
The above 2 steps let you set your start and stop frequencies. For this example, press START, press 10 on keypad, and hit the M/_s/cm *terminator key. Perform like operations for STOP, except make entry read 3GHz.*
Step 10. Press **NEXT CAL STEP**.
In this soft-key set, current settings for all parameters appear in blue. If you do not need to make any changes, you would press the START CAL soft key. However, for this example, we will change them all.
Step 11. Press the following soft keys in sequence:
PORT 1 CONN
TYPE N (M)
PORT 2 CONN
TYPE N (F)
REFLECTION PAIRING
MIXED

Reflection Pairing lets you mix or match the Open and Short reflection devices in the Calibration Sequence menus. The MIXED choice lets you calibrate using first an Open on one port and a Short on the other, then a Short on one port and an Open on the other. Conversely, MATCHED lets you calibrate first using an Open on both ports then using a Short on both ports

2.2.1 Setup



O/E measurement setup

The following step illustrates how embedding and de-embedding is applied to a E/O device through Anritsu MS462X series VNA.

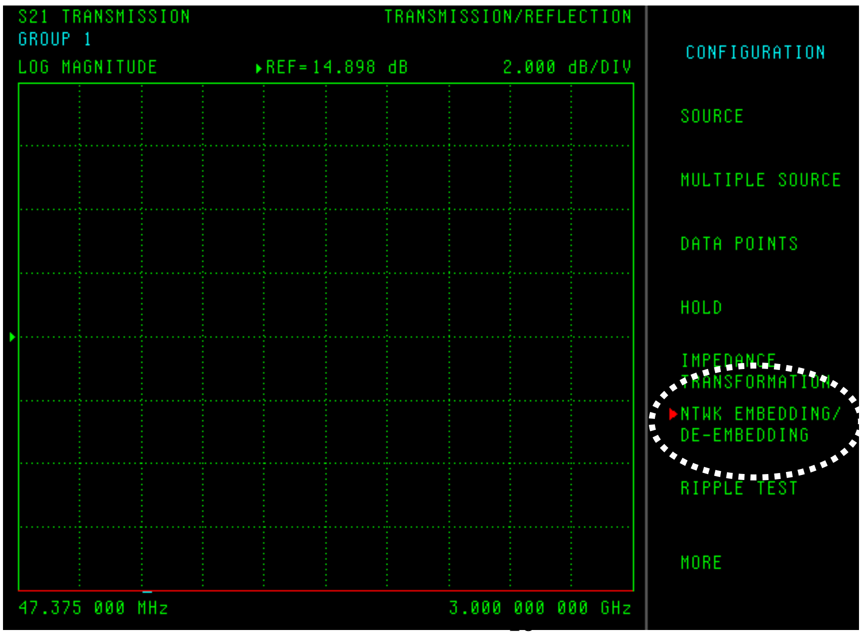
Step 1. Perform a 1 path 2 ports calibration on the VNA over the frequency range of interest with reference planes at the modulator input and the photo-receiver DUT output. **(Recommend calibration conditions: Start Frequencies= 44.8MH, Stop Frequencies= 1GHz,point= 401 points)**

Step 2. Press **Save/Recall** to save the calibration and set up to the hard disk or a floppy disk.

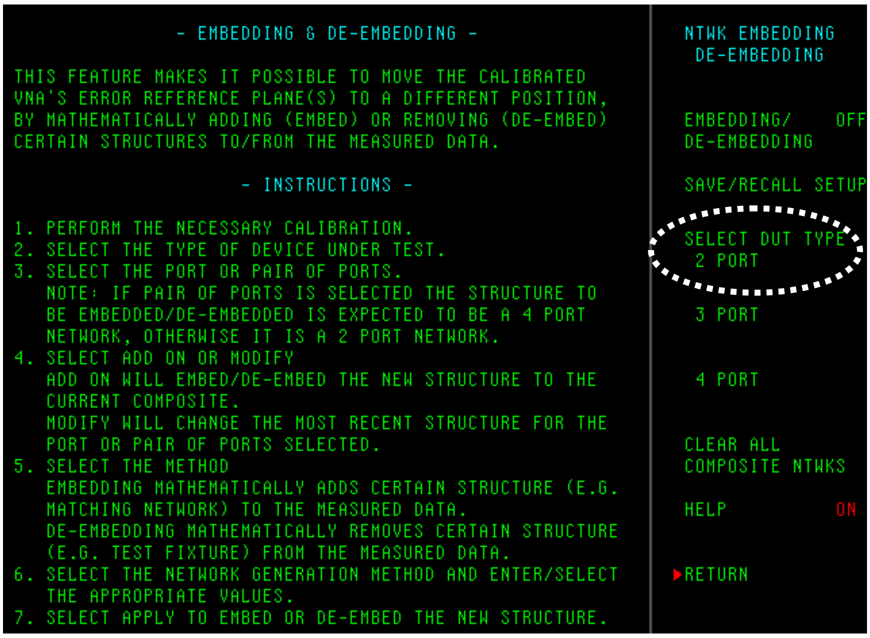
Step 3. Set the screen to display the S-Parameters that would be affected by embedding or de-embedding.

Step 4. Press the **Config** front panel key and the following menu softkeys to set E/O parameters for Port 1 of the DUT:

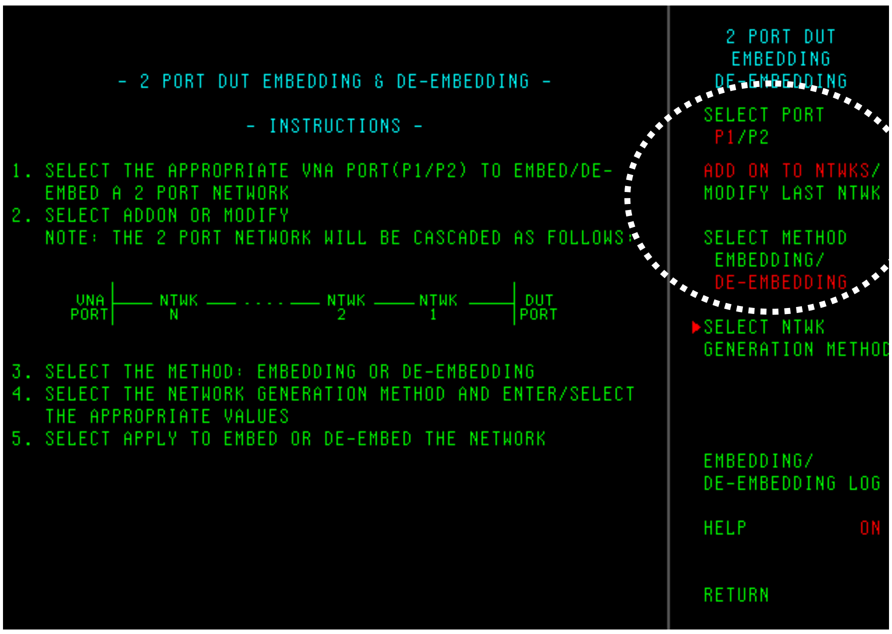
Step 5.Select **NTWK EMBEDDING/DE-EMBEDDING**



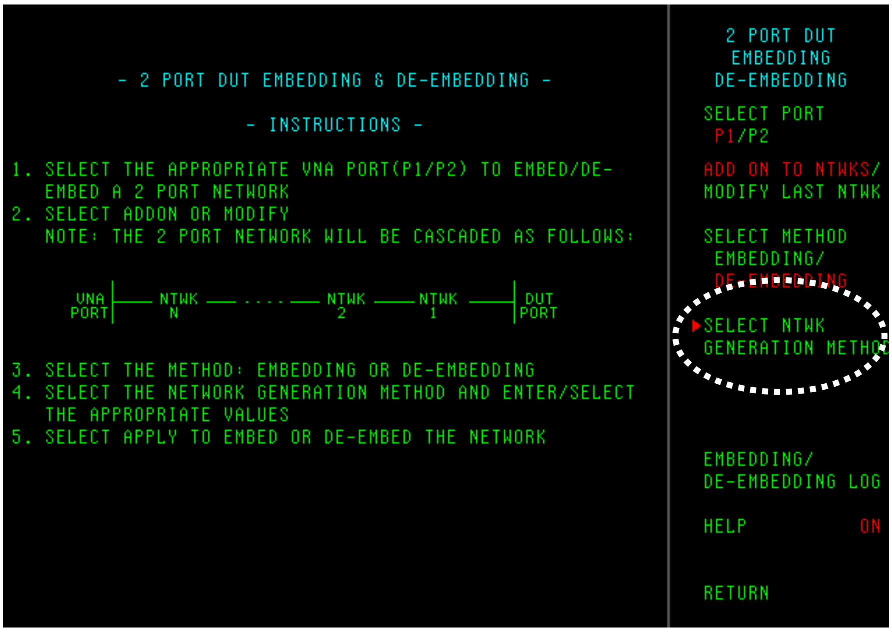
Step 6. **SELECT DUT TYPE = 2 PORT**



Step 7.Select **PORT P1, ADD ON TO NTWKS and DE-EMBEDDING**

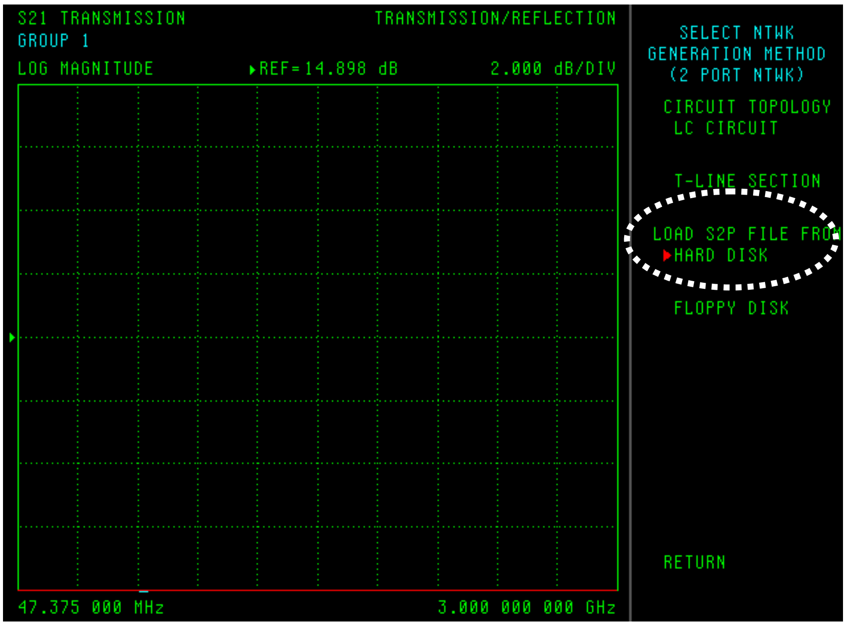


Step 8. **SELECT NTWK GENERATION METHOD**

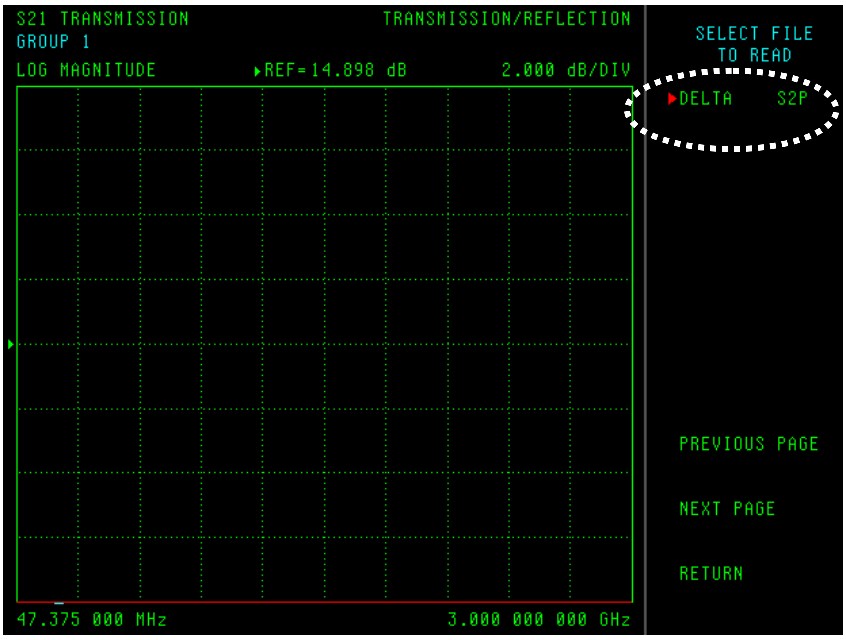


Step 9. Select **LOAD S2P FILE FROM HARD DISK Or FLOPY DISK**

(For O/E measuring, load E/O 1550)



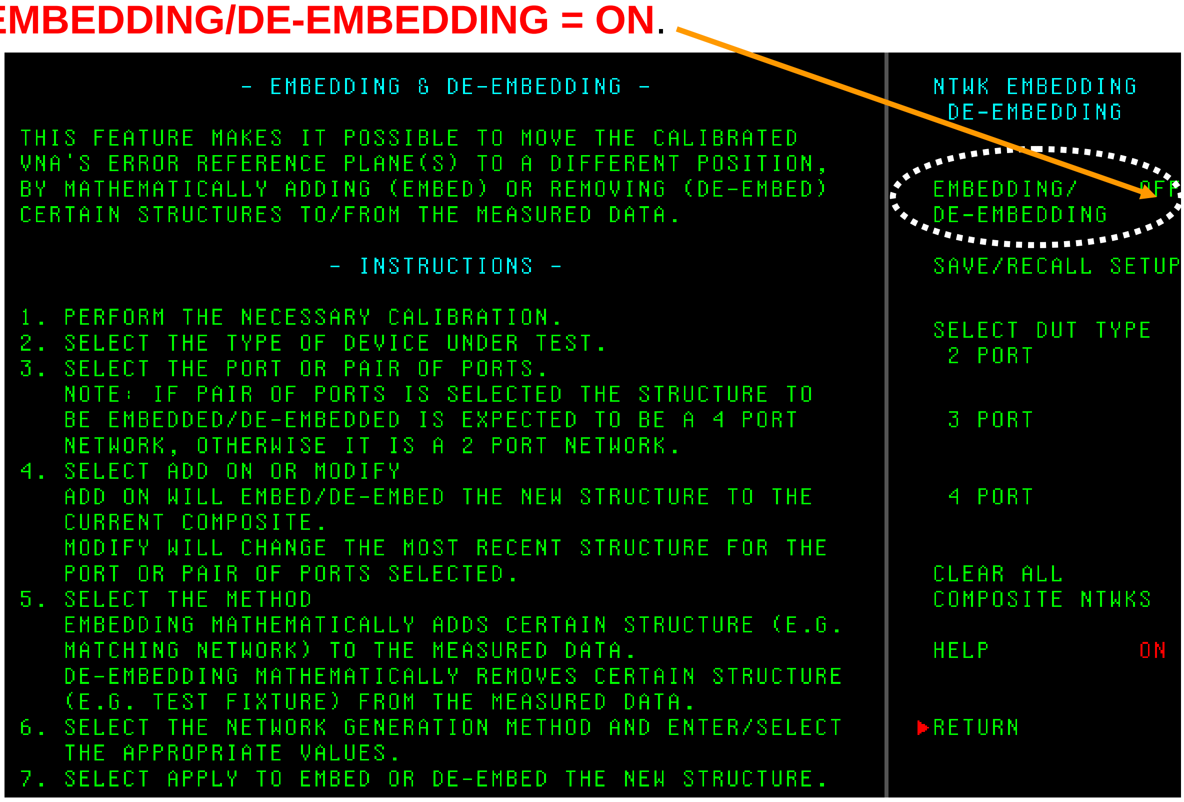
STEP 10. Select file to load. (For O/E measuring, load E/O 1550)

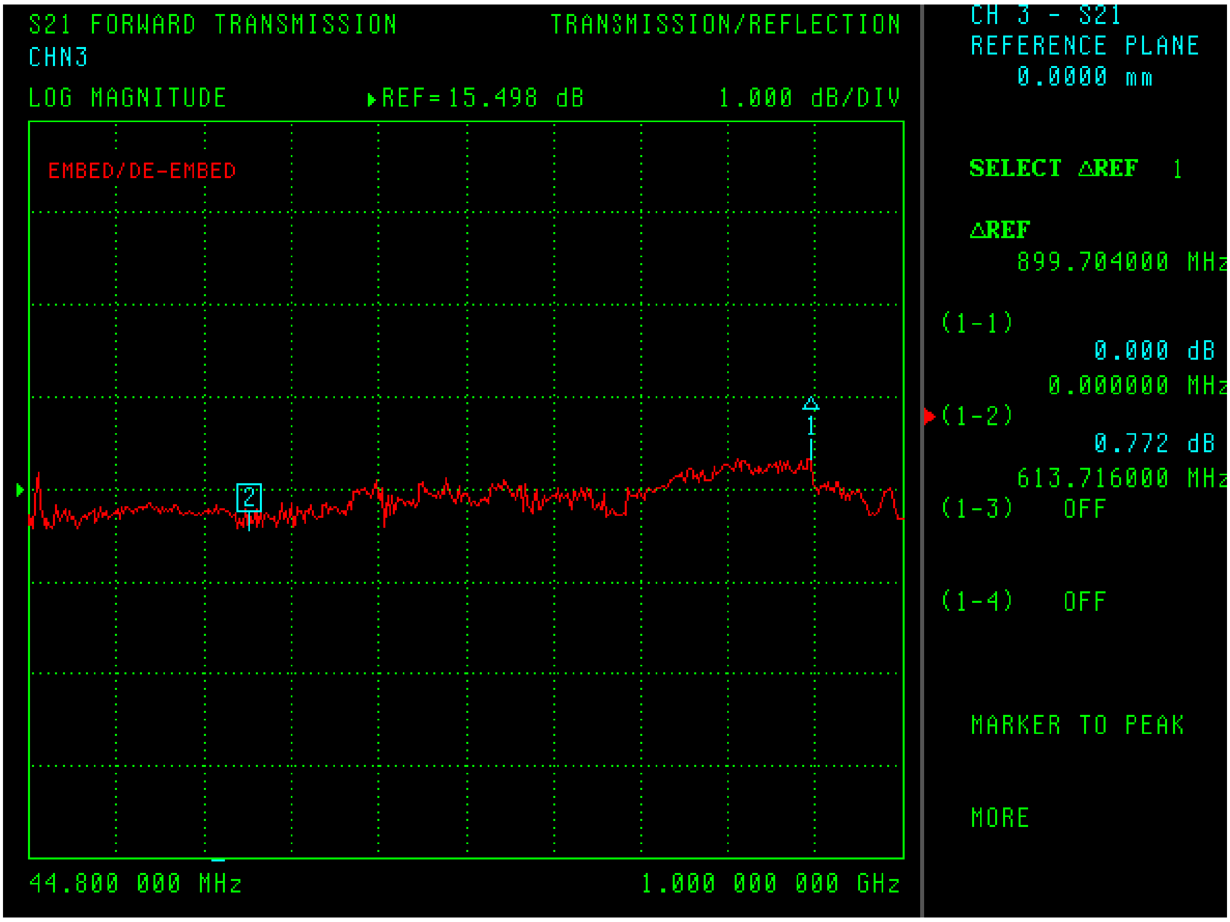


♦ **The file name is only the reference example for this manual, if you lost the reference *.s2p file, please contact Phytrex Service Engineer for help**

Step 11. Turn De-embedding ON

EMBEDDING/DE-EMBEDDING = ON.




S21 FORWARD TRANSMISSION
TRANSMISSION/REFLECTION
CHN3
LOG MAGNITUDE
REF=15.498 dB
1.000 dB/DIV
EMBED/DE-EMBED
44.800 000 MHz
1.000 000 000 GHz
CH 3 - S21
REFERENCE PLANE
0.0000 mm
SELECT ΔREF 1
ΔREF
899.704000 MHz
(1-1)
0.000 dB
0.000000 MHz
(1-2)
0.772 dB
613.716000 MHz
(1-3) OFF
(1-4) OFF
MARKER TO PEAK
MORE

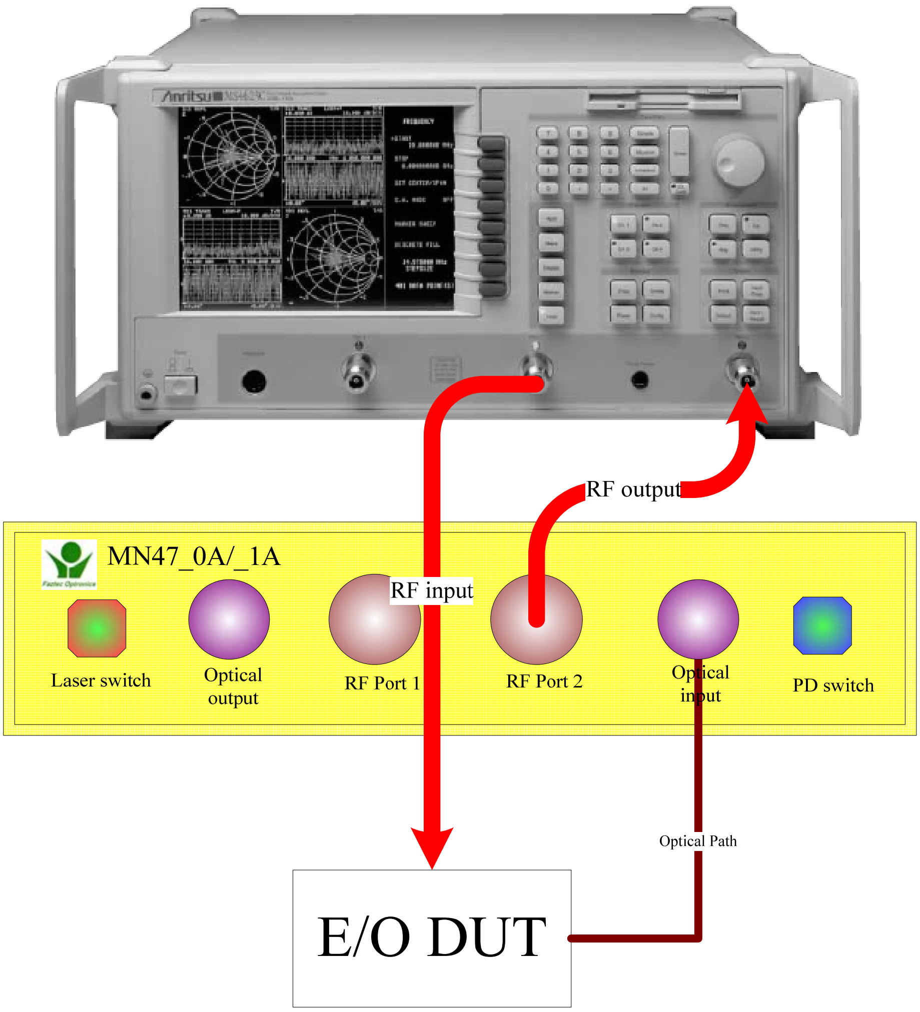
2.3 E/O measurement (With 37300 series)

2.3.1 Perform VNA 12-term (or 1 path 2 ports) Calibration

Please refer to 37300 series user manual.

(Recommend calibration conditions: Start Frequencies= 44.8MH, Stop Frequencies= 1GHz,point= 401 points)

2.3.2 Setup



E/O measurement setup

2.3.3 De-Embed S2P.file

This feature makes it possible to move the calibrated VNA error reference plane(s) to a different position by mathematically adding (embedding) or removing (de-embedding)certain structures from the measured data. Multiple networks can be cascaded on any unbalanced or balanced port so it is crucial that order of entry be kept in mind. Networks are entered starting at the DUT planes and working out toward the MS462xx. Two port networks are grouped together, as are four port networks, and the two port networks are placed closest to the DUT.

The following step illustrates how embedding and de-embedding is applied to a E/O device through Anritsu 37300 series VNA.

Step 1. Perform a 1 path 2 ports calibration on the VNA over the frequency range with reference planes at the modulator input and the photo-receiver DUT output.

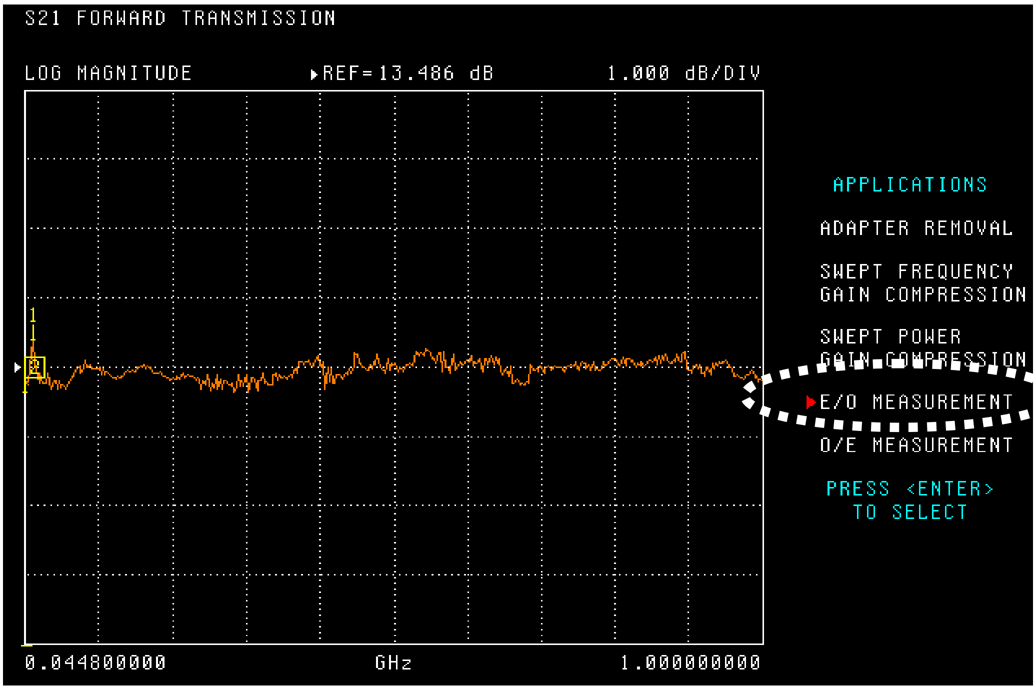
(Recommend calibration conditions: Start Frequencies= 44.8MH, Stop Frequencies= 1GHz,point= 401 points)

Step 2. Press **Save/Recall** to save the calibration result and location in hard disk or a floppy disk.

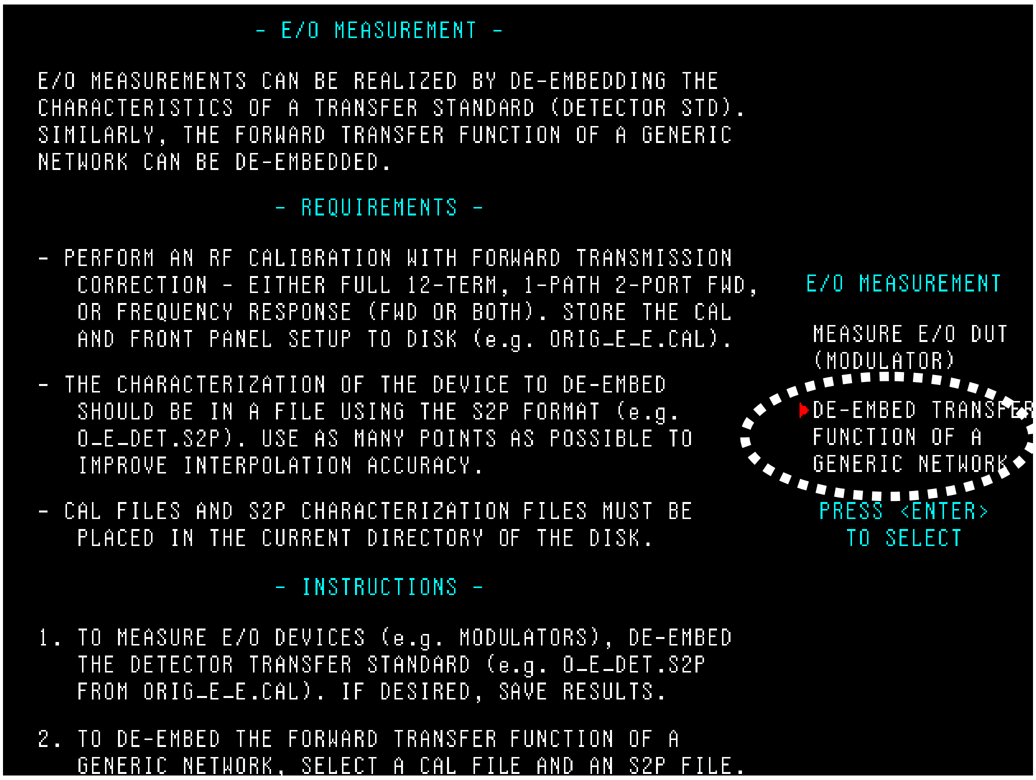
Step 3. Set the screen to display the S-Parameters that would be affected by embedding or de-embedding.

Step 4. Press **Application** on front panel button and set the E/O Measurement

Step 5. Select the “**Measure E/O DUT (Modulator)**” or “**De-embed Transfer Function of a generic Network**”

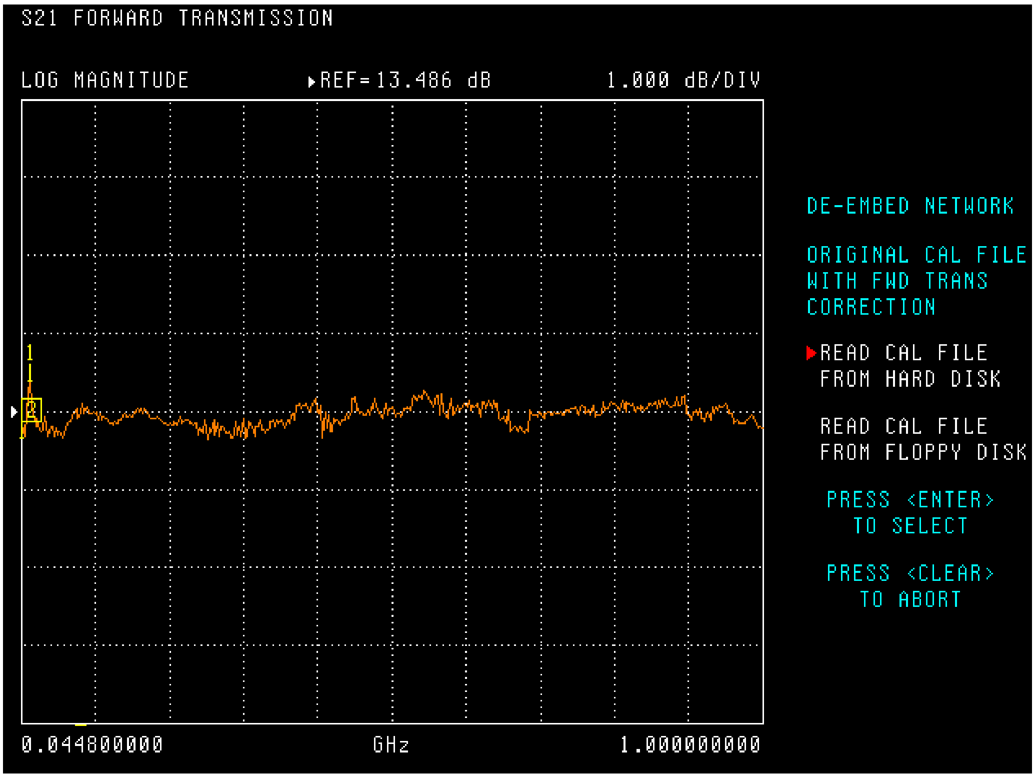


Step 4: Application menu on 37347

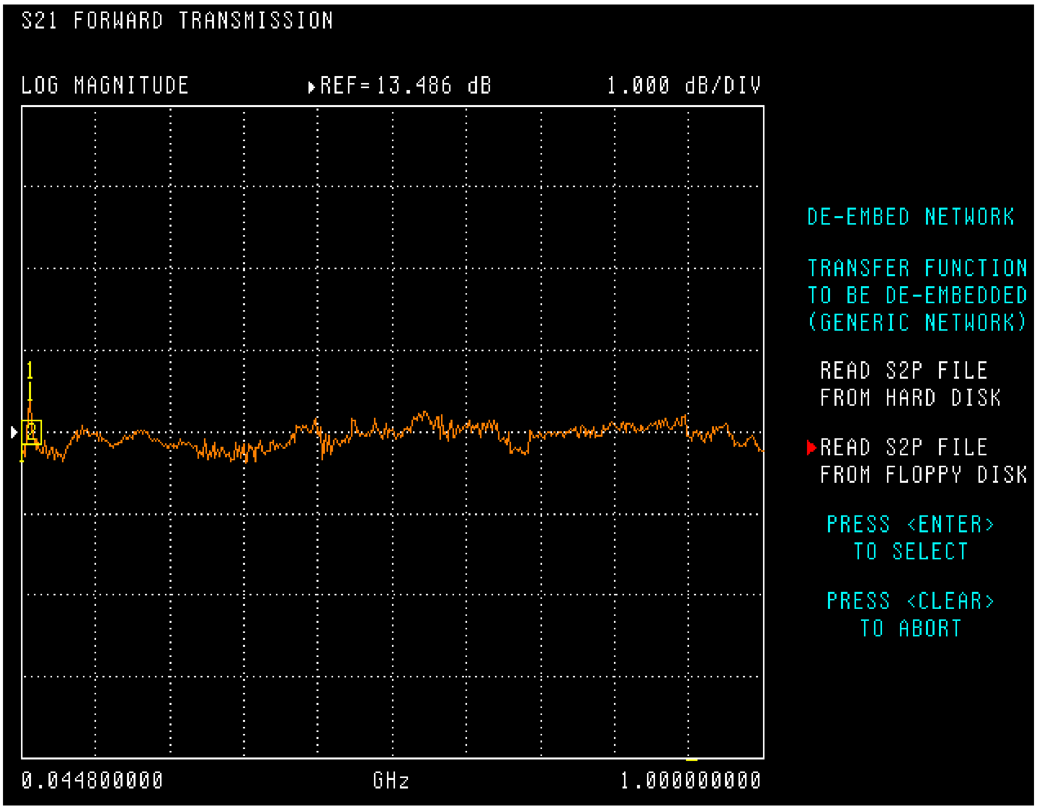


Step 5: E/O measurement instruction

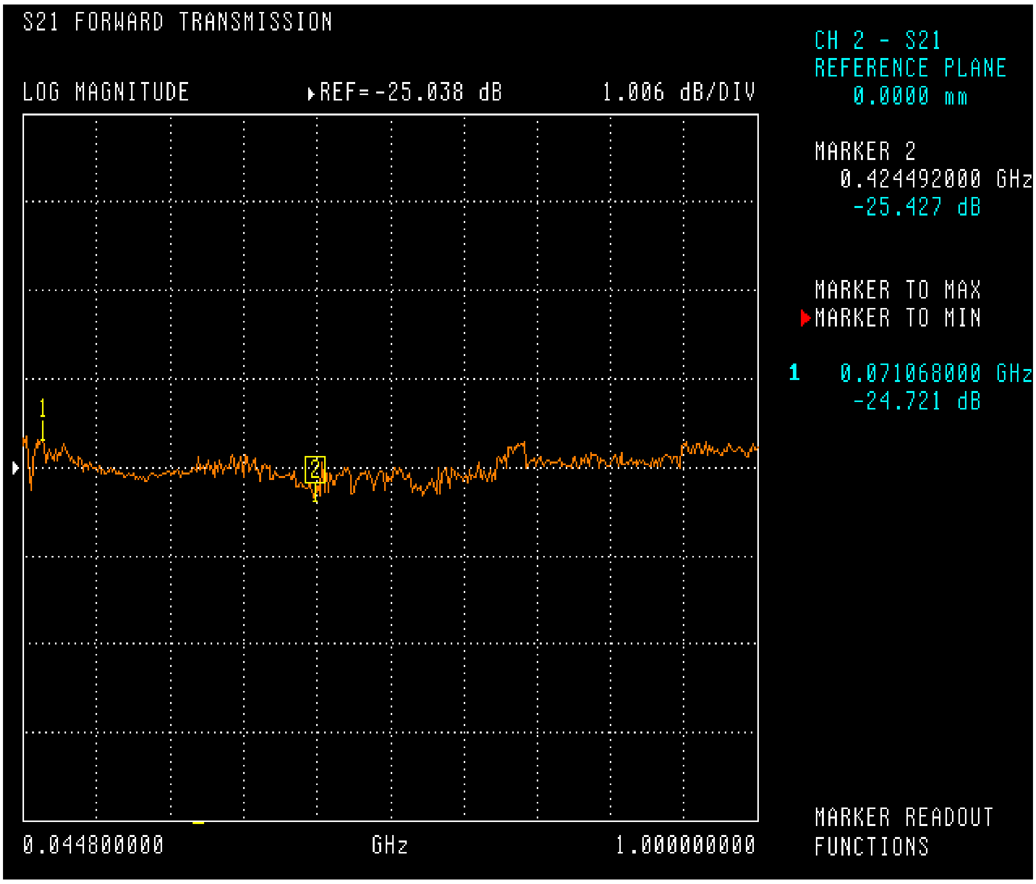
Step 6. Load the Calibration data what we done at Step 1and Step 2



Step 7. Load the reference standard photodiode s2p file(OE1550.s2p)



Step 8. The de-embedding is performed immediately after file is read into VNA(either through hard disk or floppy drive)

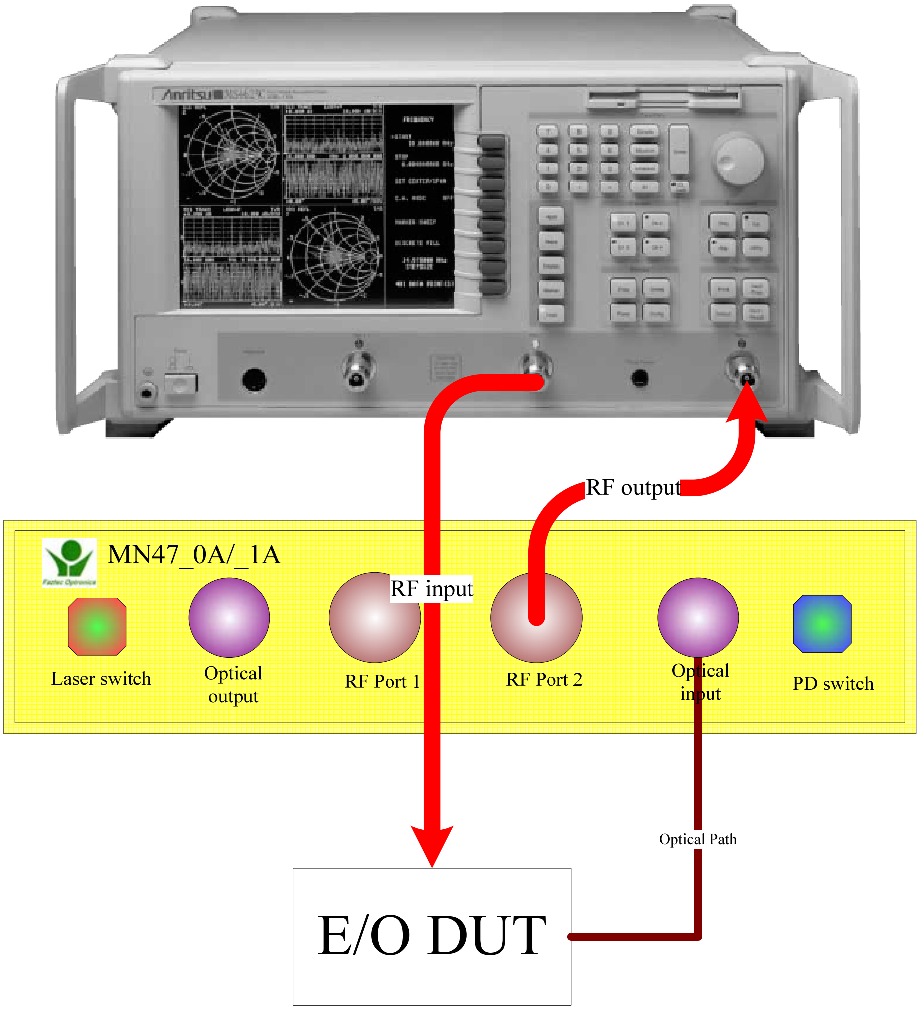


2.4 E/O measurement (With MS462X)

2.4.1 Perform VNA 1 Path 2 Ports Calibration

Please refer to MS462X series user manual. (or Refer Page 13,14,and 15)
(Recommend calibration conditions: Start Frequencies= 44.8MH, Stop Frequencies= 1GHz,point= 401 points)

2.4.2 Setup



E/O measurement setup

2.4.3 De-Embed S2P.file

This feature makes it possible to move the calibrated VNA error reference plane(s) to a different position by mathematically adding (embedding) or removing (de-embedding)certain structures from the measured data. Multiple networks can be cascaded on any unbalanced or balanced port so it is crucial that order of entry be kept in mind. Networks are entered starting at the DUT planes and working out toward the MS462xx. Two port networks are grouped together, as are four port networks, and the two port networks are placed closest to the DUT.

The following step illustrates how embedding and de-embedding is applied to a E/O device.

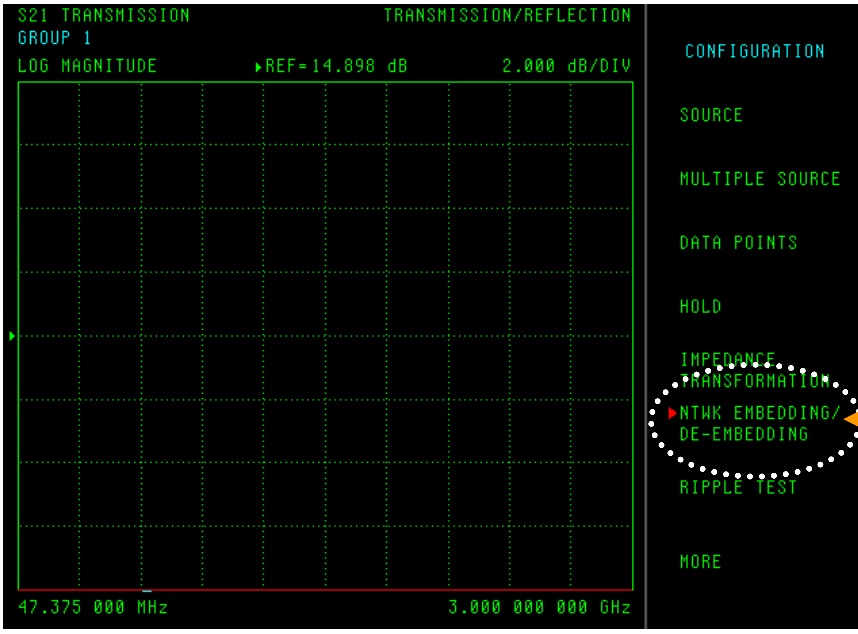
Step 1. Perform a 12-term (or 1path 2 ports) calibration on the VNA over the frequency range with reference planes at the modulator input and the photo-receiver DUT output.

Step 2. Press **Save/Recall** to save the calibration result and location in hard disk or a floppy disk.

Step 3. Set the screen to display the S-Parameters that would be affected by embedding or de-embedding.

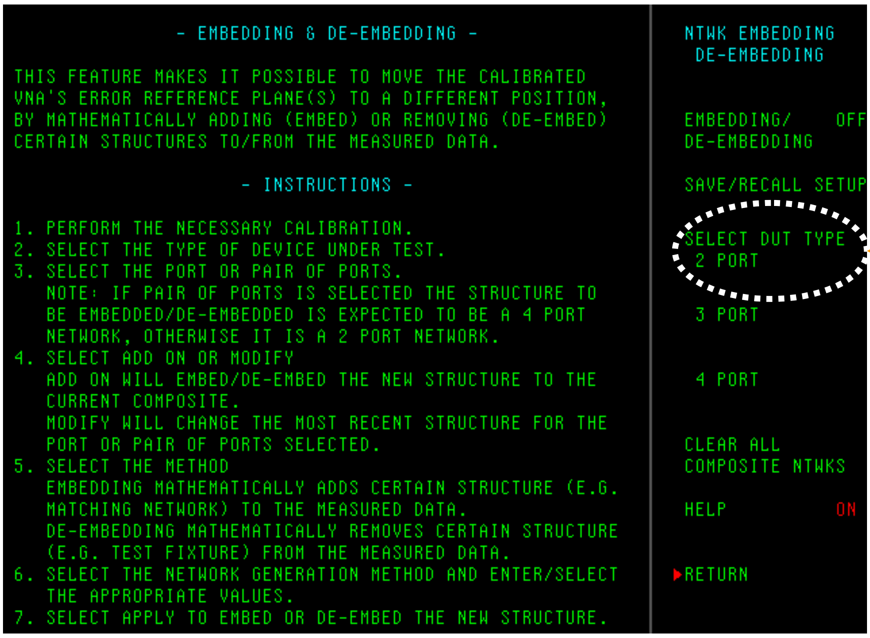
Step 4. Press the **Config** front panel key and the following menu soft keys to set E/O parameters for Port 2 of the DUT:

Step 5.Select NTWK EMBEDDING/DE-EMBEDDING



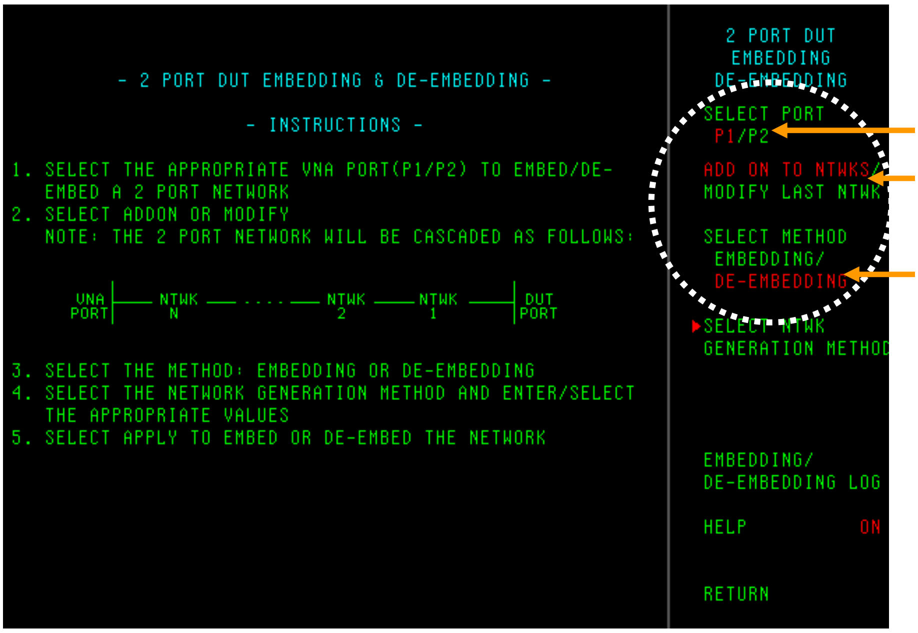
Select
NTWKS EMBEDDING/ DE-EMBEDDING

Step 6. SELECT DUT TYPE = 2 PORT



Select DUT TYPE
2 PORT

Step 7.Select **PORT 2**, ADD ON TO NTWKS and DE-EMBEDDING
(For E/O measurement , need to de-embedding Port2, please select Port 2)



Select **P2**

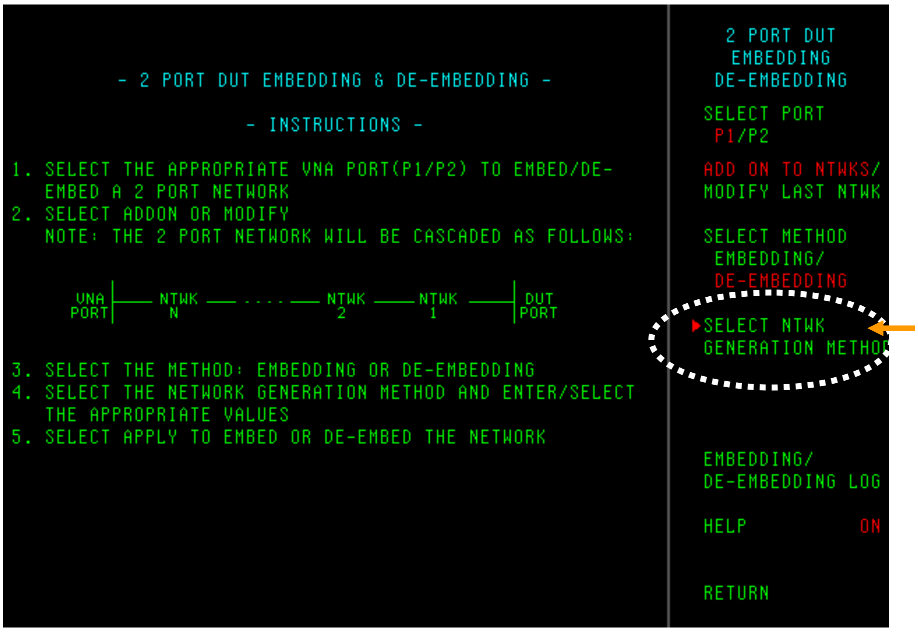
Select

ADD ON TO NTWKS

Select

DE-EMBEDDING

Step 8. Select NTWK GENERATION METHOD

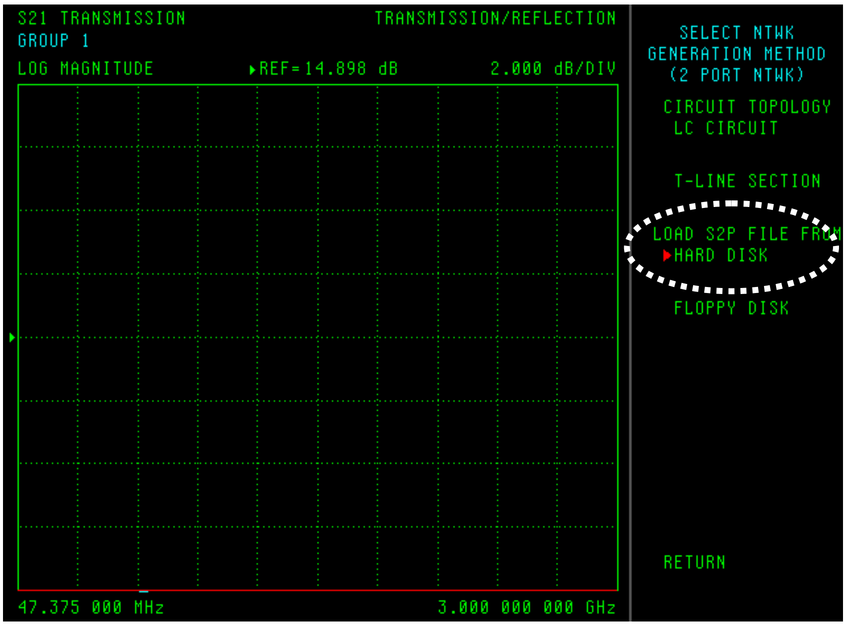


Select

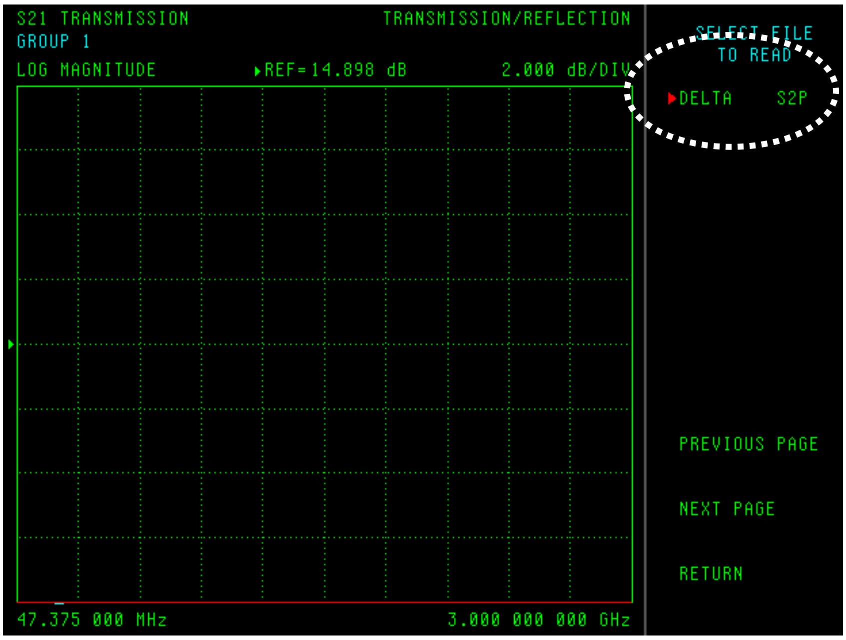
NTWK GERERATION

METHOD

Step 9. Select LOAD S2P FILE FROM HARD DISK Or FLOPPY DISK .



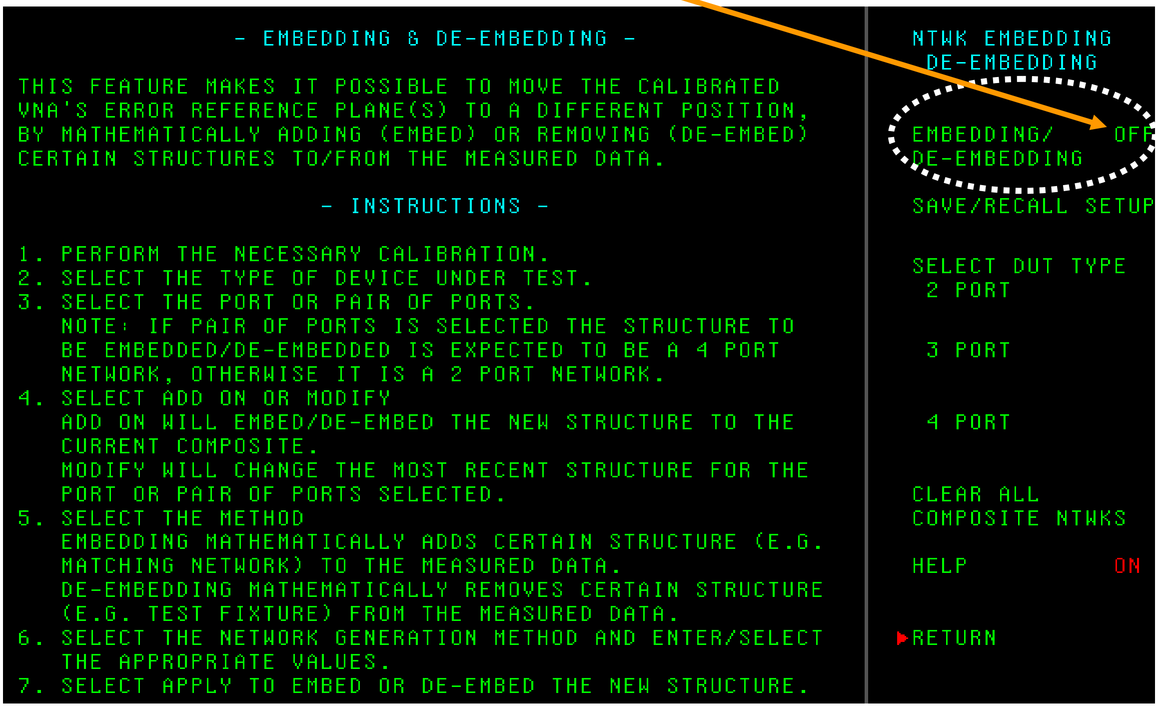
STEP 10. Select file to read.

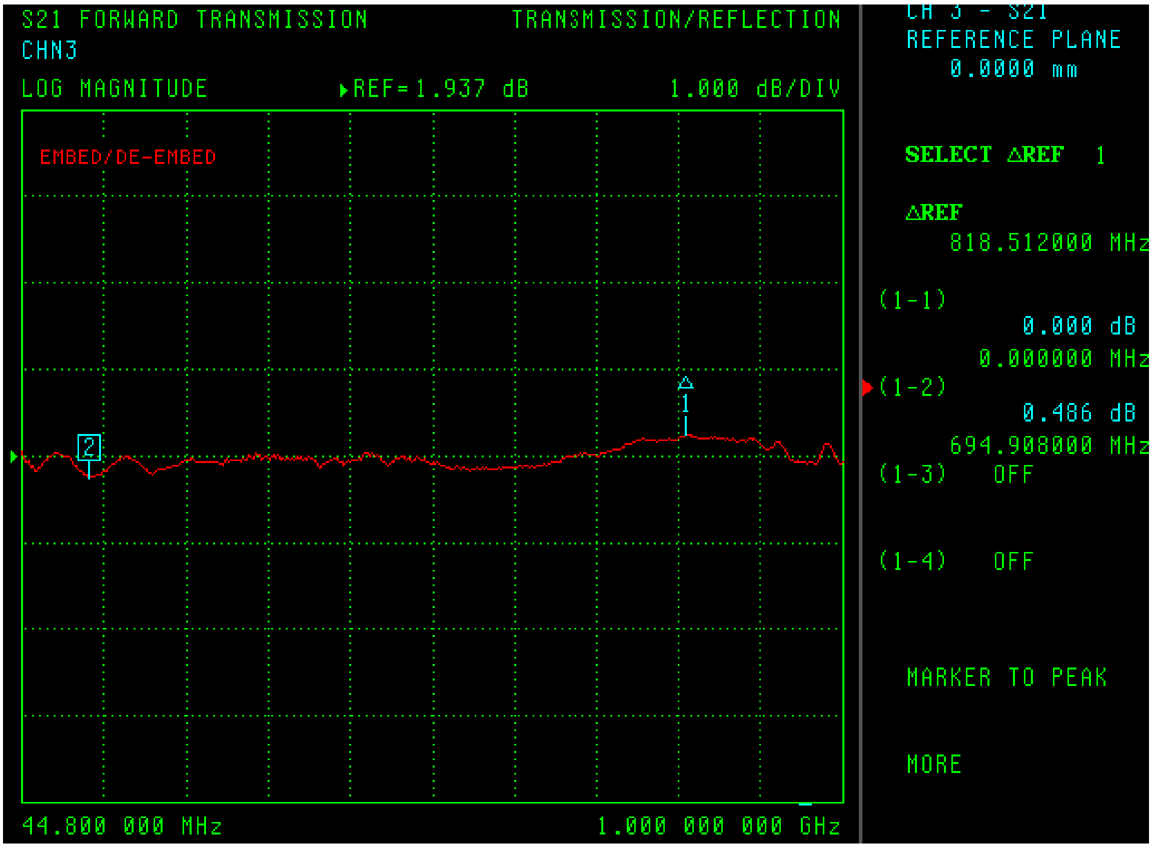


♦ The file name is only the reference example for this manual, if you lost the reference *.s2p file, please contact Phytrex Service Engineer for help

Step 11. Turn De-embedding ON

EMBEDDING/DE-EMBEDDING = ON





Chapter 3 Operation Quick Checkout Procedure

E/O Measurement

Step 1. Setup as test system . Be sure to clean the fiber before the connection .

Step 2. Power on the VNA and make the 1 path 2 ports calibration.
(see the operation manual of Anritsu 37300 series or MS 462X series)

Step 4. Power on the light source / photodiode (MN4720) and turn on the operation key for 20minutes.

Step 5. Progress the Embed/De-embed (or E/O Measurement) follow the instruction (Select Port 2 if you apply the MS462X series)

Step 6. Load the desire S2P file to de-embedded (OE1550.s2p)

Step 7. Measure the S21 parameter.

O/E Measurement

Step 1. Setup as test system . Be sure to clean the fiber before the connection

Step 2. Power on the VNA and make the 1 path 2 ports calibration.
(see the operation manual of Anritsu 37300 series or MS 462X series)

Step 4. Power on the light source / photodiode (MN4720) and turn on the operation key for 20minutes.

Step 5. Progress the Embed/De-embed (or O/E Measurement) follow the instruction (Select Port 1 if you apply MS462x series)

Step 6. Load the desire S2P file (EO1550.s2p) to de-embedded

Step 7. Measure the S21 parameter.

Appendix I: Measurement Uncertainty

Uncertainty in E/O and O/E Measurements

(For High Freq. Measuring Application)

In the measurements just described, the uncertainty can be broken into two categories

1) Uncertainty associated with the characterization of the available photodiode accessory
2) Uncertainty in the measurement with the DUT ,

Typically the user will purchase a characterized photodiode and receive a data file describing that device's transfer function. There is some uncertainty associated with that data based on the characterization technique. There are different levels of characterization possible. A direct characterization using such optical techniques as electro-optic sampling or the heterodyne method would be termed 1st tier. It is outside the scope of this note to go into detail on these characterization techniques. These characterization processes are time consuming and expensive so a typical user will not employ such a standard. A 2nd tier standard is characterized by a laboratory based on a 1st tier standard. It would be generated using a process similar to the O/E technique discussed previously but under carefully controlled conditions (bias, temperature, wavelength, etc.) using a 1st tier standard as the characterization device. The uncertainties for a 2nd tier standard will be used in later calculations. The uncertainty penalty in going to 2nd tier is typically small (on the order of 0.1 dB additional).

When measuring the DUT, there is an uncertainty associated just with the VNA measurement. Since the characterized photodiode response is then de-embedded, the characterization uncertainty must be combined with the VNA measurement uncertainty to obtain an overall value. In the case of an O/E measurement, there are actually two user measurements involved (one with a modulator and the characterized photodiode and one with that modulator and the DUT) so an additional uncertainty must also be included. Typically these uncertainties are all added on a root-sum-square basis since the measurements are assumed to be uncorrelated. Before proceeding to some uncertainty values, it may be useful to examine dependencies. On the VNA side, S21 uncertainty is typically quite low for medium power levels but will deviate at high signal levels (receiver compression, not an issue in these measurements) and at low signal levels (effects of the receiver noise floor). Thus the overall uncertainty will be a function of detector output signal level (getting worse as the signal level gets closer to the noise floor). Results can be improved by using higher RF drive levels (keeping all devices linear of course) and high optical power levels (same caveat). The RF match of

the modulator and photodiode will also influence uncertainties to some degree (at all signal levels) but the dependence is relatively weak as long as return loss is better than a few dB.

On the optical side, there is little high level signal dependence as long as the devices are linear. The characterized photodiodes are usually chosen to be very linear over wide power ranges to keep this from being an issue. The characterized detectors typically also have very weak wavelength dependencies; usually less than a few hundredths of a dB over 40 nm. When using a modulator as a transfer standard (as in an O/E measurement), however, it is important that the same wavelength be used in the different measurements with that modulator since much greater wavelength sensitivity exists in that component.

Specifications for the Anritsu 37397C 65 GHz VNA and 3654B V Calibration Kit were used to calculate VNA uncertainties at various frequencies. The use of different VNAs and/or calibration kits may result in slightly different values. Characterization uncertainties of the Anritsu 40 Gb/s photodiode were used for the standard part of the model. Optical system drift is included in the error model but it is assumed that all components are mechanically and thermally stable. Connector repeatability is also included in the model but all connectors are assumed to be in very good condition.

The results are shown with an independent variable of photodiode output power and plotted for both magnitude and phase for the two different types of measurements. Frequency is used as a parameter. Above this level, the dominant source of uncertainty passes from measurement signal-to-noise ratio to characterization uncertainty.

There is some frequency dependence for several reasons:

(1) Noise floor is higher at higher frequencies.

(2) The characterization uncertainty goes up with frequency.

(3) The basic VNA uncertainty (due to residual mismatch, etc.) goes up with frequency

Note: Refer from Anritsu Application Note **E/O and O/E measuring with Anritsu VNA**

Appendix II

Understand the *.S2P and related file formats*

The .s2p file format has generally been accepted by simulator and instrumentation manufacturers. The format is listed here primarily as a convenience. In all cases any white space separation is normally allowed but tab delimited is probably the most common. Usually no more than 4-5 significant figures are carried per field although there are exceptions. A header beginning with a # is required which specifies the frequency units (GHz, MHz,…), parameter type (S for S-parameters), format (MA for magnitude-angle, RI for real-imaginary, DB for log magnitude-angle), reference type (R for resistance), and reference impedance value (50 typically). Most simulators do not support the use of arbitrary impedance-referred S-parameters.

.s2p

GHz S MA R 50

(required header, frequency units, type of parameter, data format, term type and value)

Freq.	S11 (Mag),dB	S11 (Ang.),deg.	S21 (Mag),dB	S21 (Ang.),deg.	S12 (Mag),dB	S12 (Ang.),deg	S22 (Mag),dB	S22 (Ang.),deg.
5.81	0.975	75.8	0.218	-131	0.218	-131	0.975	-158

(freq S11 S21 S12 S22)

RI is also allowed as is dB for log-mag and phase

Note: Refer from Anritsu Application Note

APPENDIX III

Optical Transmitter and Receiver Specifications

Optical Transmitter	
Bandwidth	**44.8MHz to 1GHz**
Optical Connector	**Single Mode FC/PC**
Electrical Connector	**N Type**
Relative Intensity Noise (RIN)	**> 110dB/Hz**
Peak Wavelength	**1550nm ±20nm**
Average Optical Power	**-1~ +3dBm**
Optical Receiver	
Detect Wavelength Range	**1100 to 1600 nm**
Max. Input Power	**< +5dBm**
Measurement Range	**-7 dBm ~ +5 dBm**
Return Loss	**>20dB**
Optical Connector	**Single Mode FC/PC**
Electrical Connector	**N Type**

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