ERAVANT
FORMERLY SAGE MILLIMETER

VNA FREQUENCY EXTENDERS

COMPATIBILITY SUPPLEMENT: ANRITSU VECTORSTAR™ ME7838 SERIES

COMPATIBILITY SUPPLEMENT

CONTENTS

1. INTRODUCTION

Eravant's STO series of frequency extenders for Vector Network Analyzers (VNAs) are compatible with Anritsu ME7838 series two-port millimeter-wave test systems. This setup guide is applicable to test systems that include an Anritsu model MS4642A/B, MS4644A/B, MS4645A/B, or MS4647A/B VectorStar network analyzer and an Anritsu model 3739B/C Test Set.

Eravant's frequency extender models cover full waveguide bands from 50 to 330 GHz. A pair of Transmit/Receive (TX/RX) extenders provide simultaneous two-port, two-path measurement capability (S11, S12, S21 and S22). A single TX/RX extender can only measure S11 or S22.

Each TX/RX frequency extender provides one waveguide test port (Fig. 1.1). A frequency multiplier in the extender converts the Radio Frequency (RF) stimulus signal provided by the VNA to a higher frequency. A directional coupler samples the incident signal applied to the Device Under Test (DUT). Another directional coupler samples the reflected signal. The sampled signals are fed to a pair of internal mixers that convert the Reference and Measured signals to the Intermediate Frequency (IF) of the VNA. A Local Oscillator (LO) signal from the VNA is also multiplied by the frequency extender and applied to the down-converting mixers.

An optional level-setting attenuator controls the test signal power level. An optional amplifier increases the maximum test signal power. Both options are recommended, as they provide maximum versatility for a wide range of measurement applications.

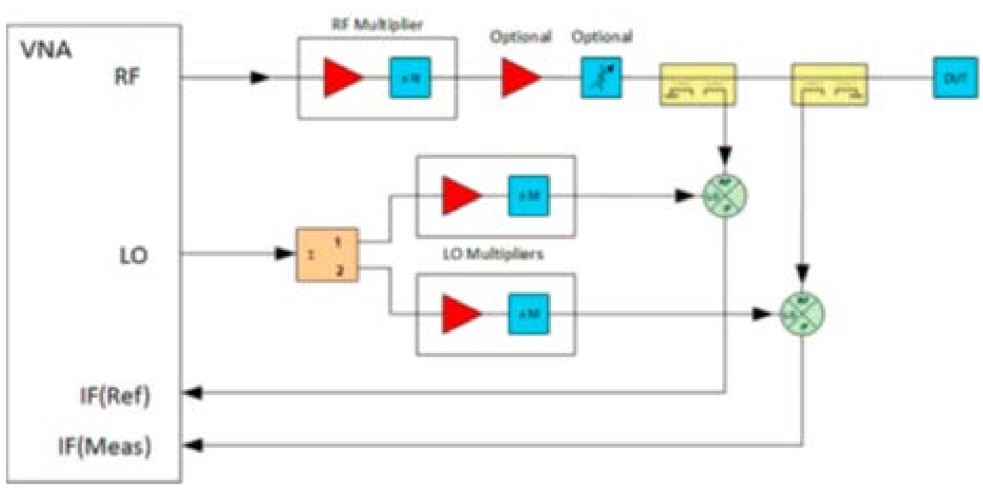

Fig. 1.1 – A single TX/RX frequency extender uses frequency multipliers to generate mm-wave test signals from lower frequency RF and LO signals provided by the VNA. Directional couplers sample the Reference and Measured signals. A pair of mixers down-convert the sampled signals to the IF of the VNA.

2. VECTORSTAR™ ME7838 SERIES 2-PORT MILLIMETER-WAVE VNA SYSTEMS

Anritsu's ME7838 two-port millimeter-wave test systems include a MS4642A/B, MS4644A/B, MS4645A/B, or MS4647A/B network analyzer and a 3739B/C Broadband Test Set (Fig. 2.1). The VNA must include the following options to work with a 3739 test set:

Option 007, (Receiver Offset for frequency-translated measurements)
Option 080, 081, 082, or 083 (Broadband / Millimeter Wave Interface)

The correct Broadband / Millimeter Wave Interface option depends on other VNA options selected. A common option, 082, is applicable when the VNA does not include options 070, 051, 061, or 062. For more information about VNA configurations that support various Broadband / Millimeter Wave Interfaces, consult with Anritsu Technical Support.

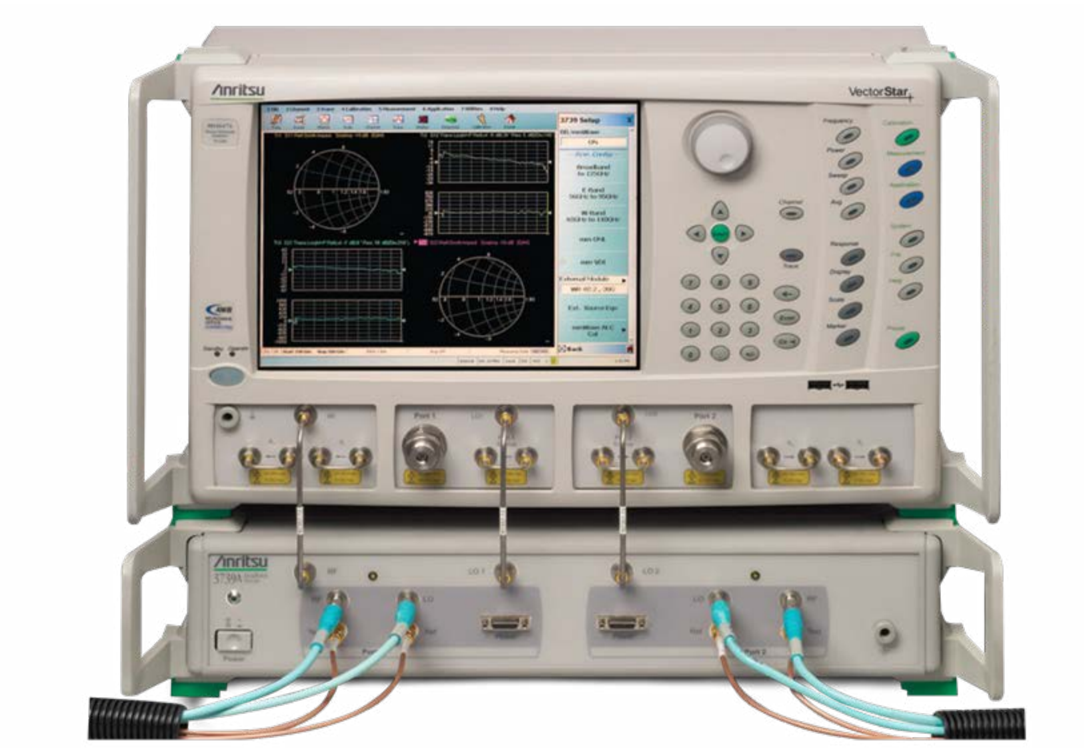

Fig. 2.1 – 2.1 – A typical Anritsu ME7838 banded millimeter-wave test system includes an MS464x VectorStarTM VNA and a 3739C Broadband Test Set.

3. ELECTRICAL CONNECTIONS

Refer to Anritsu document 10410-00293, Installation Guide for VectorStar™ ME7838 Series 2-Port Broadband/Banded Millimeter-Wave VNA System. This document provides detailed instructions for connecting the 3739B/C Broadband Test Set to an MS4640 Series VNA. Instrumentation-grade coaxial cables are required to connect the RF, LO, and IF ports of the STO frequency extenders to the 3739B/C Broadband Test Set (Fig. 3.1).

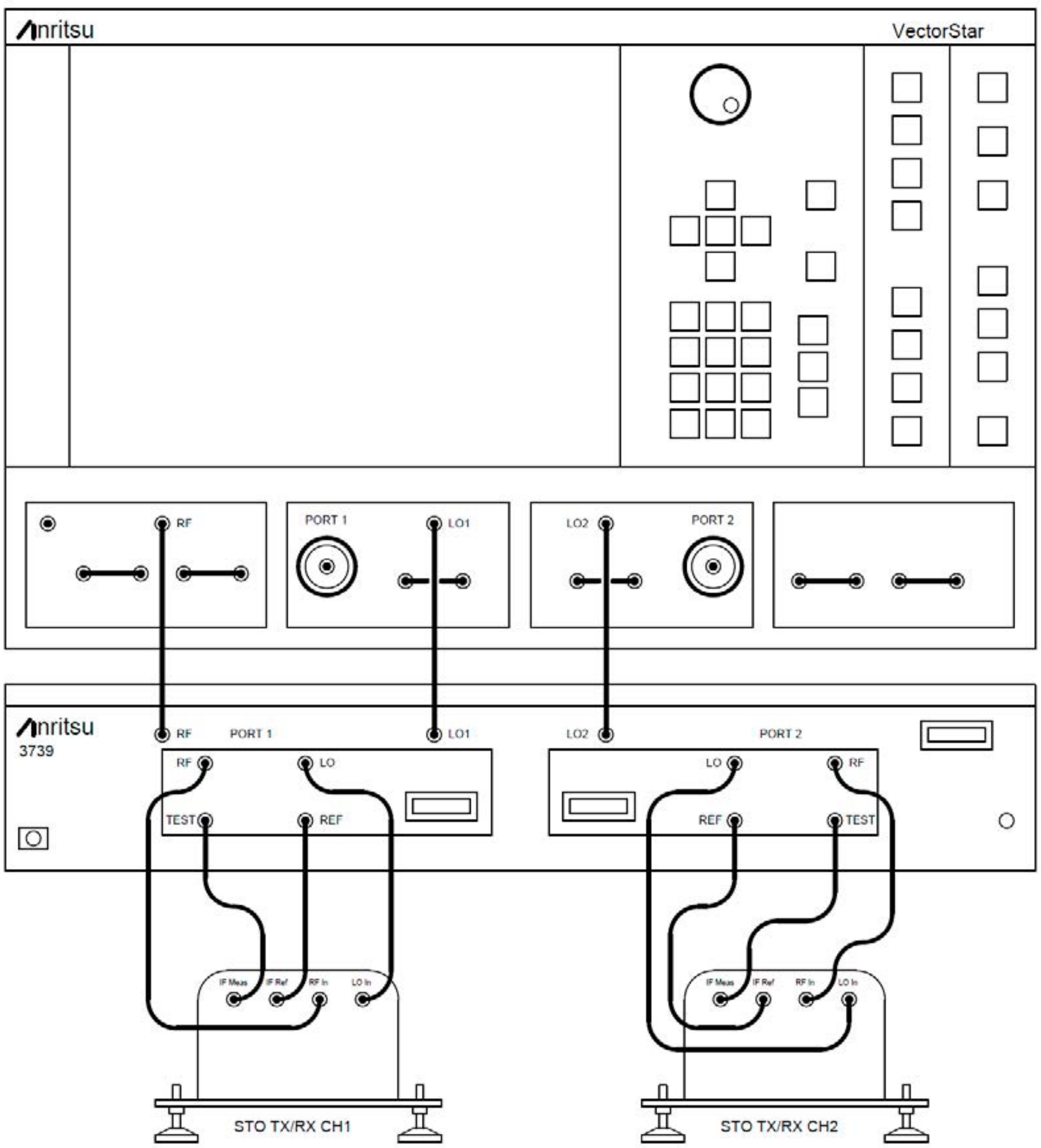

Fig. 3.1 – It may be necessary to insert attenuators in the LO signal paths to reduce power levels.

4. INSTRUMENT SETUP

The following instructions are general guidelines that supplement instructions contained in Anritsu document 10410-00293 Rev. H, Chapter 3 — ME7838A Initial System Checkout.

4.1 VNA Reset

Refer to 10410-00293H, Section 3-3, as a guide to reset the VNA to its factory-default configuration.

4.2 VNA Configuration

The configuration process depends on whether the VNA model is MS464xA or MS464xB.

4.2.1 VNA Configuration (MS464xA Series VNA)

Refer to 10410-00293H, Section 3-4 as guidance to configure the MS464xA Series VNA for Broadband / Banded operation. At the MAIN menu, select Application. The VNA should be pre-configured for Transmission and Reflection measurements. In the Receiver Configuration button group, select BB/mmWave (3739 Test Set). The Standard, Multiple Source, and BB/mmWave (3738 Test Set) buttons are deselected (Fig. 4.1).

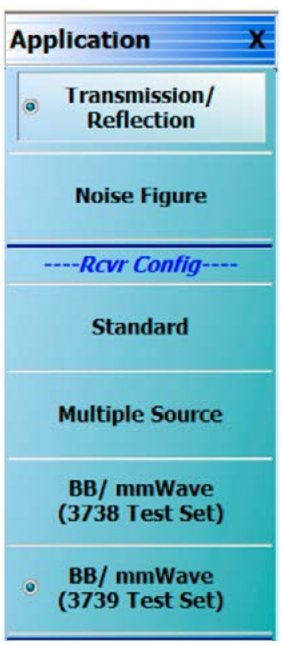

Fig. 4.1 – Select the 3739 Test Set

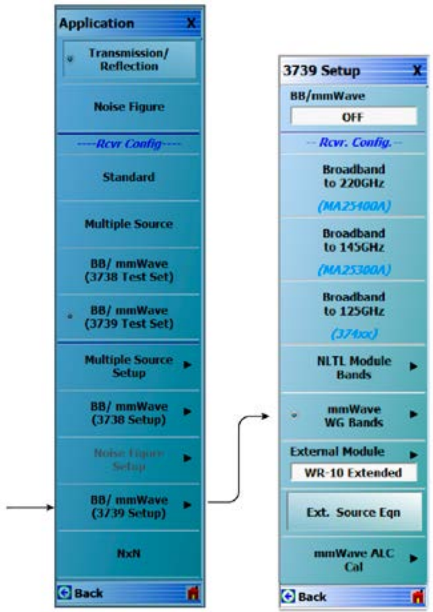

Fig. 4.2 – Select mmWave WG Bands

Navigate to the Application menu and select BB/mmWave (3739 Setup), mm-Wave WG Bands (Fig. 4.2).

From the OML series of banded waveguide bands, choose the appropriate frequency range (Fig. 4.3)

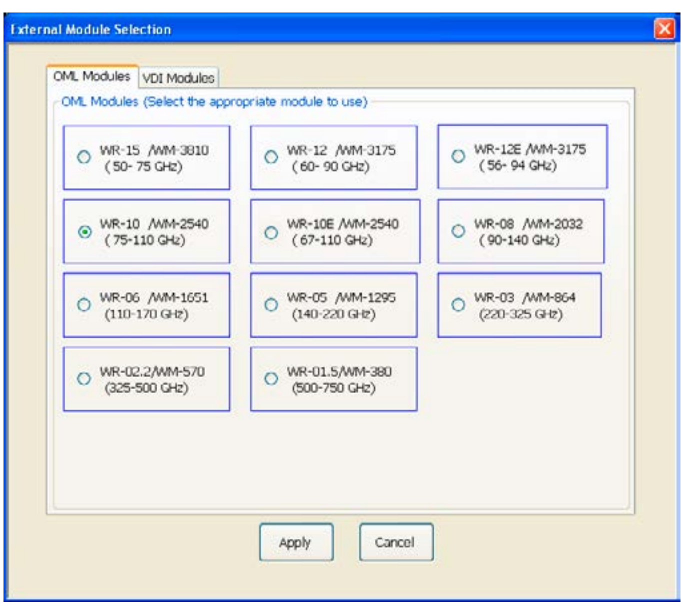

Fig. 4.3 – Select the appropriate frequency range from the list of OML modules.

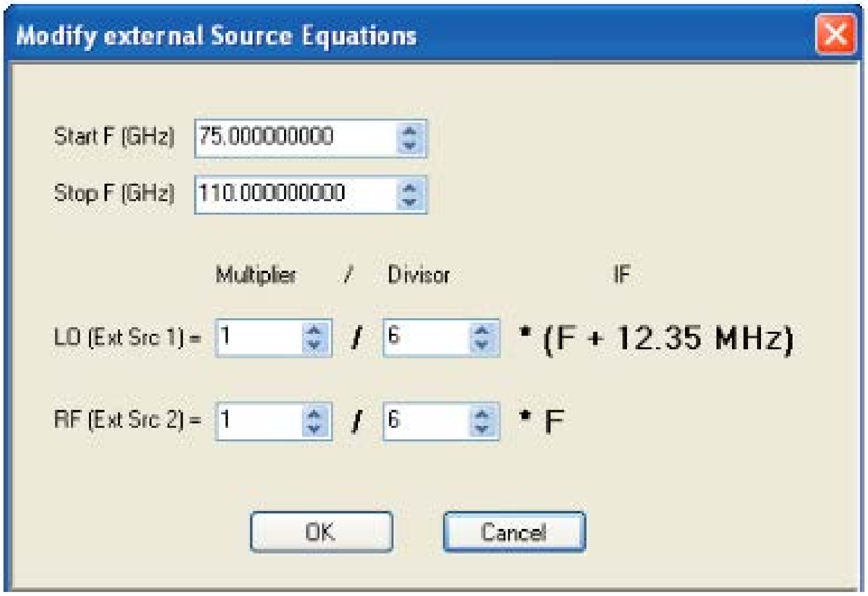

Fig. 4.4 – Edit equations for the RF and LO frequencies.

4.2.2 VNA Configuration (MS464xB Series VNA)

Refer to 10410-00293H, Section 3-4 as guidance to configure the MS464xB Series VNA for Broadband / Banded operation. At the MAIN menu, select Application. Select the Rcvr Config Button to open the Rcvr Config menu. Select the BB/mmWave (3739 Test Set) button. The Receiver Config button on the Application menu now shows 3739 Test Set is selected (Fig. 4.5).

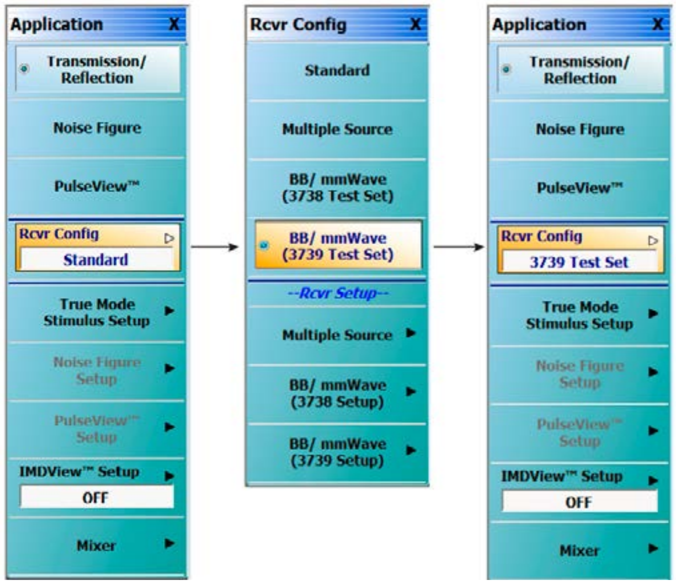

Fig. 4.5 – Select the 3739 Test Set from the Application menu.

Navigate to the Application menu and select Rcvr Config , BB/mmWave (3739 Setup), mmWave WG Bands , mm-OML (Fig. 4.6).

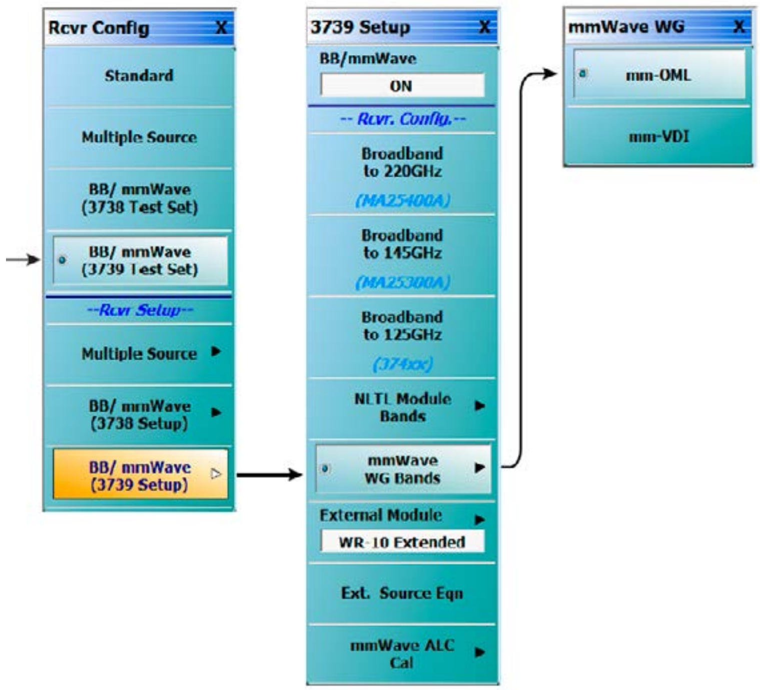

Fig. 4.6 – Select the OML series of mm-wave extender modules.

From the Application menu select Rcvr Config , BB/mmWave (3739 Setup) , External Module (Fig. 4.7). Select the applicable frequency band and click Apply.

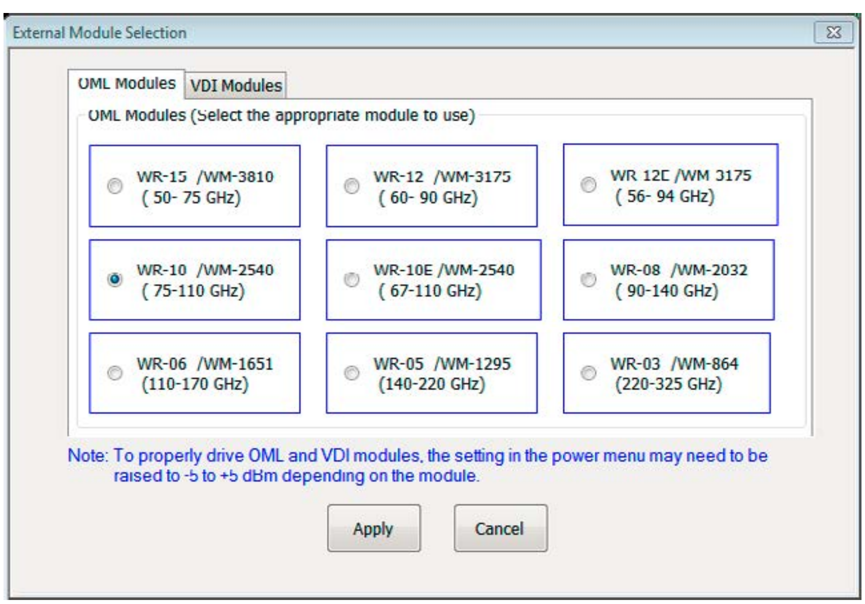

Fig. 4.7 – Select the applicable frequency band from the list of OML modules.

Click on the External Source Equation button to edit the RF and LO frequency equations (Fig. 4.8).

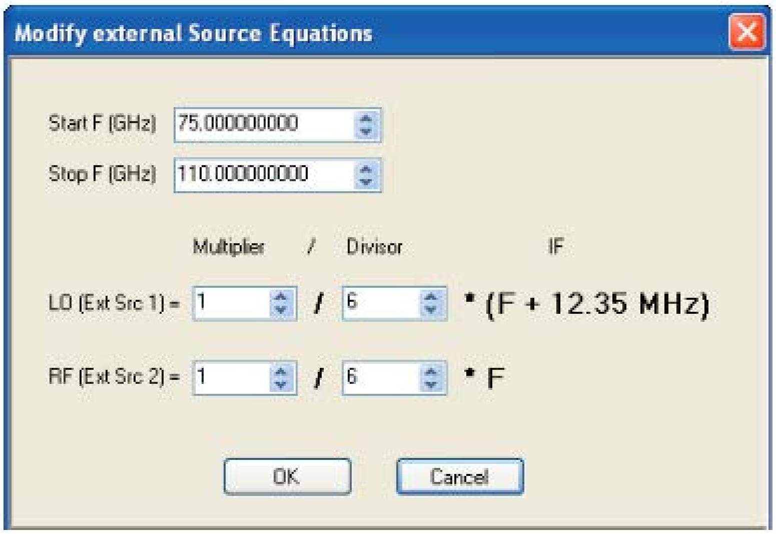

Fig. 4.8 – Edit equations for the RF and LO frequencies.

4.3 Intermediate Frequency

The frequency of the IF signal fed back to the 3739 test set is 12.35 MHz. This frequency is determined by the test system. It is not adjustable.

4.4 LO Signal Power Level

The nominal LO frequency range of the 3739C is 6 to 22 GHz. The test set is designed to provide a nominal LO power level of +10 dBm. This power level is set by a factory calibration that uses feedback from a level detector located inside the 3739C test set. The normal calibration delivers +12 dBm to the test set LO connector, so that the power delivered to the extender module is approximately +10 dBm for most frequency bands.

The LO signal amplitude can be reduced by inserting an attenuator into the signal path between the 3739C test set and the frequency extender. For a frequency extender that requires 0 dBm for the LO signal, a 10-dB attenuator is recommended. Prior to connecting the LO signal to the frequency extender, its power level should be verified using a calibrated spectrum analyzer or an RF power meter. The frequency span should be set to zero to obtain a continuous-wave, fixed-frequency test signal. The amplitude of the LO signal should be checked at multiple frequencies across the waveguide band.

It is possible to control the LO power level provided by the 3739 test set by adjusting its factory calibration. For more information about this option, consult with Anritsu technical support .

4.5 RF Signal Power Level

The nominal RF frequency range of the 3739C is 6 to 40 GHz. The RF power generated by the test set is determined by the Test Port power level at the VNA front panel connector, and the system gain of the 3739C test set. The RF output power generated by the 3739 test set is approximately 10 dB greater than the Test Port power level. **This approximation should be verified by measuring the actual RF power level using a calibrated spectrum analyzer or an RF power meter.**

The RF power level supplied to the frequency extender module is controlled by adjusting the Test Port power level on the VNA while factoring in 10 dB of gain provided by the 3739C test set. For a frequency extender that requires a nominal RF power level of 0 dBm, the Test Port power should be set to-10 dBm as a starting point. Prior to connecting the RF signal to the frequency extender, its power level should be verified using a calibrated spectrum analyzer or an RF power meter.

5. SYSTEM TESTS

The following instructions are guidelines for testing a single TX/RX frequency extender. It is recommended to test each TX/RX extender individually before testing them together.

Short-Circuit Termination

Terminate the waveguide test port with a short-circuit flange. The Short termination reflects all of the test signal power and maximizes the Measured IF signal returned to the VNA

System Power

Apply power to the VNA before powering the frequency extender. This ensures that the instrument has sufficient time to configure itself to operate correctly with the frequency extender. The user should verify that the instrument is correctly configured before applying power to the frequency extender.

Uncalibrated S11 or S22 Response

Configure the VNA to display S11 (or S22) over the entire waveguide band. Display the uncalibrated S11 magnitude trace at 10 dB per division. The displayed trace should be continuous and not vary by more than ±10 dB across the waveguide band (Fig. 5.1). Unusual features in the uncalibrated S11 trace may indicate loose connectors, damaged cables, or a configuration error.

Save the displayed trace to memory. Combine the saved trace with the currently displayed (active) S11 trace. Flex the coaxial cables and observe any differences between the active and saved traces. Amplitude variations should be less than ±0.1 dB. If greater changes are observed, the coaxial cables may be damaged or they may be of insufficient quality.

Remove the short-circuit waveguide termination and replace it with a matched load. The active S11 trace should drop by at least 10 dB across the entire frequency band.

Remove the saved S11 trace from the display.

Fig. 5.1 – A display of uncalibrated S11 with a short-circuit waveguide termination connected to the test port should not vary by more than ±10 dB across the waveguide band.

One-Port Calibration

Perform a one-port calibration, following the VNA user instructions. An Open-Short-Match (OSM) or Short-Open-Load (SOL) calibration is sufficient. The “Open” standard in a waveguide calibration kit is often a quarter-wave shim combined with a short-circuit flush termination. Other lengths of offset shims combined with a short-circuit flange may be used as the “Open” and “Short” standards.

After completing the one-port calibration, connect a short-circuit flush termination to the frequency extender test port. The displayed magnitude of S11 should be approximately 0 dB and the displayed phase should be approximately 180 degrees across the entire frequency band.

Uncalibrated Transmission Responses

With two frequency extenders connected together, configure the VNA to display S21 (or S12) over the entire waveguide band. Display the uncalibrated S21 magnitude trace at 10 dB per division. The trace should be continuous and not vary by more than ±10 dB across the waveguide band (Fig. 5.2). Unusual features in the uncalibrated S11 trace may indicate loose connectors, damaged cables, or a configuration error.

Fig. 5.2 – A display of uncalibrated S21 with a short-circuit waveguide termination connected to the test port should not vary by more than ±10 dB across the waveguide band.

6. WORKING WITH TWO TX/RX FREQUENCY EXTENDERS

A pair of TX/RX frequency extenders provides full two-port measurement capability. After both TX/RX frequency extenders have been installed and tested, VNA operation is essentially the same as when no frequency extenders are installed. Exceptions may include the range of calibration methods that can be used. Some measurement modes such as gain compression or intermodulation may not be possible or may require careful interpretation of the test results.

Eravant frequency extenders require a limited range of amplitudes for the RF and LO signals provided by the VNA. This is because the frequency multipliers exhibit good conversion efficiency over a limited range of input power levels. If the RF input amplitude is varied, the frequency extender output power may not change proportionally due to the nonlinear transfer function of the RF frequency multiplier. This effect may skew the results of measurements that involve varying the test signal power level.

With most passive components, the frequency response does not depend on the test signal power level. For other devices such as amplifiers, modulators, and some passive components, control of the test signal power may be essential. If return loss measurements are not required, the test signal power level may be reduced by placing an attenuator between the frequency extender and the DUT.

Alternatively, the frequency extender on the input side of the DUT may be equipped with a level-setting attenuator to control the test signal power level. The attenuator is positioned between the RF frequency multiplier and the directional couplers. The attenuator adjusts the test signal power level without affecting the ratio between the Reference and Measured signals, preserving the system's ability to accurately measure the DUT's return loss.

The level-setting attenuator includes a micrometer head that enables precise and repeatable adjustments. Its numerical reading does not indicate the attenuation level. The attenuator is typically adjusted or calibrated using a waveguide power detector, or by monitoring signal levels at various points in the test system.

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