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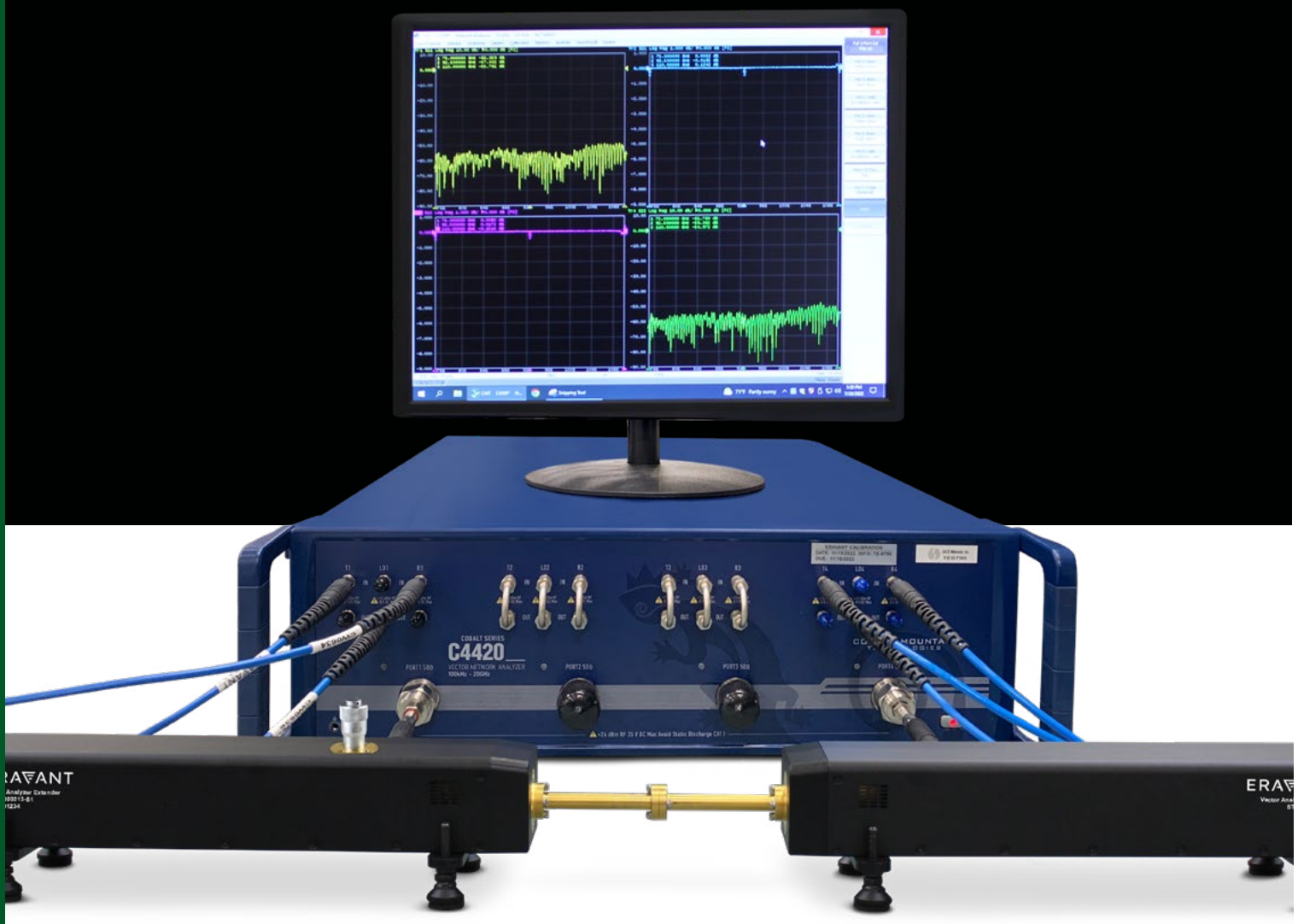
VNA FREQUENCY EXTENDERS

COMPATIBILITY SUPPLEMENT: COPPER MOUNTAIN TECHNOLOGIES COBALT SERIES C4409 & C4420



COMPATIBILITY SUPPLEMENT

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CONTENTS

1. INTRODUCTION

Eravant's STO series of frequency extenders for Vector Network Analyzers (VNAs) are compatible with Copper Mountain Technologies four-port Cobalt series instruments, model C4409 and C4420. This setup guide is directly applicable to a model C4420 four-port VNA model operating with a pair of TX/RX frequency extenders.

Eravant 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) without changing connections to the Device Under Test (DUT). A single TX/RX extender can measure both S11 and S22 by reversing the DUT orientation between measurements.

Each TX/RX frequency extender provides one waveguide test port (Fig. 1.1). Frequency multipliers in the extender convert the Radio Frequency (RF) stimulus signal provided by the VNA to a higher frequency. Directional couplers sample the incident signal applied to the DUT as well as 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.

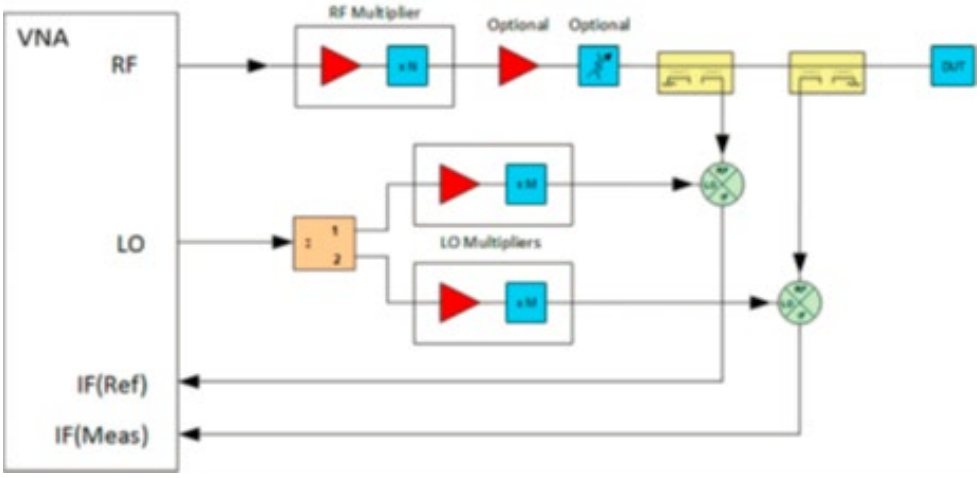

Fig. 1.1 – A single TX/RX frequency extender uses frequency multipliers to generate mm-wave test signals from lower frequency RF and LO signals provided by the VNA. Directional couplers sample the Reference and Measured signals. A pair of mixers down-convert the sampled signals to the IF of the VNA.

2. COBALT SERIES VNA COMPATIBILITY

The STO series of frequency extenders are compatible with Cobalt series VNAs that include independent LO signal sources (Fig. 2.1). Models C4409 and C4420 have four test ports with two RF sources and two LO sources. When two frequency extenders are used, Ports 1 and 4 are the active test ports.Fig. 2.1 – The STO series of VNA frequency extenders are compatible with Rohde & Schwarz ZVA series VNAs. Four test ports allow direct connections between the VNA and two frequency extenders.

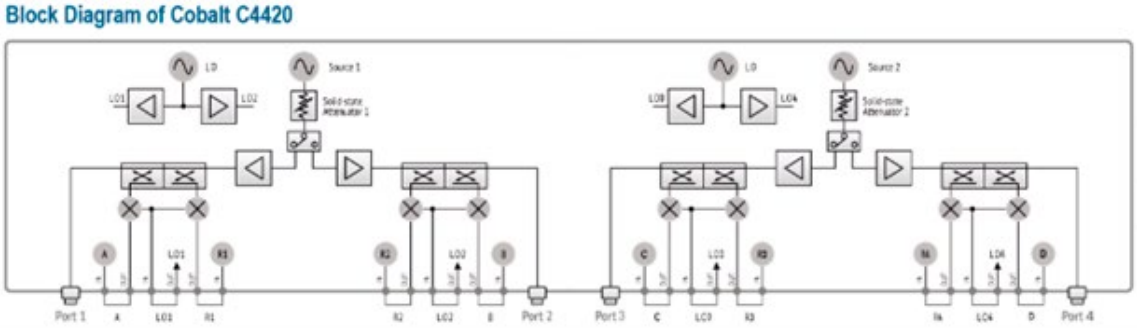

Fig. 2.1 – The STO series of VNA frequency extenders are compatible with four-port Cobalt series VNAs. The IF receiver channels and independent LO signals are accessible via front-panel coaxial connectors.

3. ELECTRICAL CONNECTIONS

Each TX/RX frequency extender is connected to a test port on a C4409 or C4420 VNA using four phase-stable coaxial cables (Fig. 3.1).

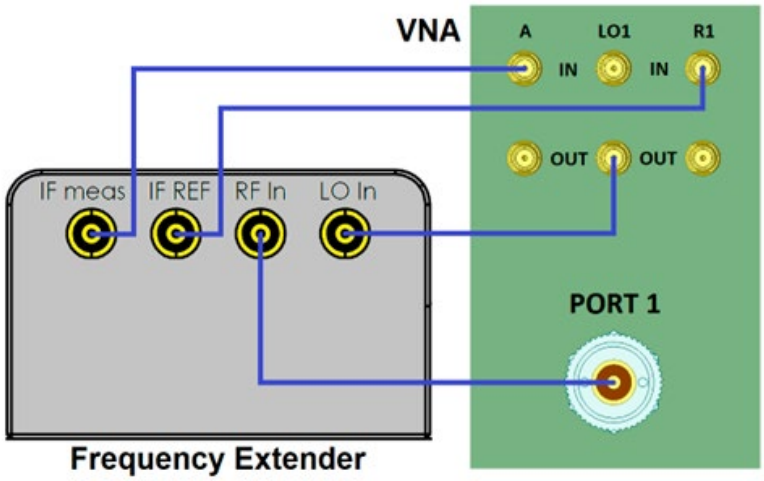

Fig. 3.1 – Each TX/RX frequency extender requires four instrumentation-grade coaxial cables to carry RF and LO signals to the extender and two IF signals back to the VNA.

4. INSTRUMENT SETUP

The following setup instructions are applicable to a model C4420 VNA with frequency extenders connected to Ports 1 and 4.

Configure the VNA to display S11, S14, S41 and S44.

Configure the VNA for operation with frequency extenders by clicking on the System button in the Menu Bar at the top of the user screen (Fig. 4.1). From the pull-down menus, select **Misc Setup, Frequency Extender.** Click on the **Custom** soft key.

A dialog box allows direct entry of the Start and Stop test frequencies, as well as the LO and RF multiplication factors and power levels (Fig. 4.2). These parameters are applied to all frequency extenders connected to the VNA. The RF and LO power levels should be equal to the nominal values specified for the frequency extenders, adjusted upward to compensate for cable losses.

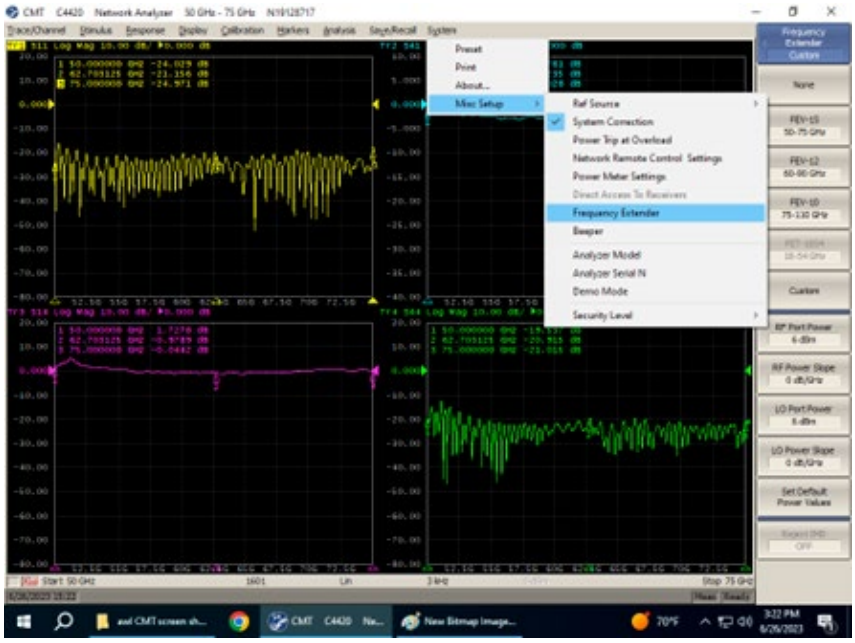

Fig. 4.1 – Frequency extender operation is enabled through the System pull-down menu tree. From the selection of available configurations, select Custom. Select None to restore normal VNA operation.

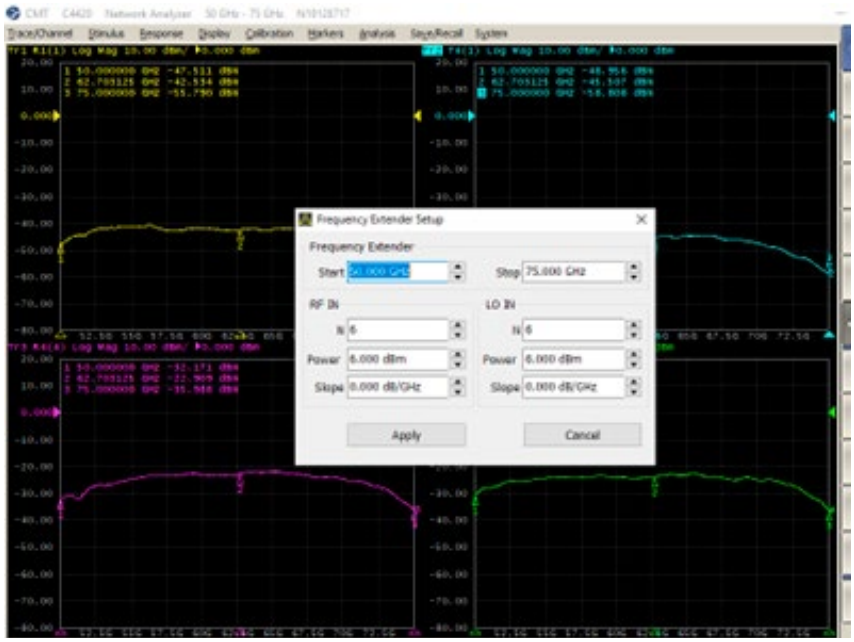

Fig. 4.2 – In addition to the Start and Stop test frequencies, the LO and RF multiplication factors and power levels are entered manually. These parameters are applied to all frequency extenders connected to the VNA.

When finished entering the values in the Frequency Extender Setup dialog box, press the Apply button. The instrument will restart with the new setup parameters activated.

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

Uncalibrated S11 or S22 Traces

Configure the PNA to display S11 (or S44) 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. Unusual features in the uncalibrated S11 trace may indicate loose connectors, damaged cables, or a configuration error.

Save the displayed trace to memory. Add the saved trace to 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.

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. When calibrating a waveguide VNA, the “Open” standard is typically a quarter-wave shim combined with a short-circuit flush termination.

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.

Repeat the above tests for all frequency extenders.

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 VNA measurement modes 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 does not change proportionally due to the nonlinear transfer function of the RF frequency multipliers. This effect can 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 can 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 chain 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 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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