Application Note

Direct Connect Millimeter Wave Frequency Extension Modules for Keysight's Dual Source PNA / PNA-X Series Network Analyzer.

Introduction

Extending Keysight's PNA / PNA-X vector network analyzers beyond their internal operating frequency range with OML millimeter wave frequency extension modules is well documented when using the millimeter-wave controller, N5261/62A. This paper describes an alternate direct-connect procedure that involves directly connecting OML modules to the front panel of the Keysight PNA-X (i.e., effectively bypassing the N526xA millimeter-wave controller). Using this alternative setup, S-parameter measurements are possible for S_{11}, S_{21}, S_{12} and S_{22}.

Requirements to function without the millimeter-wave controller are,

1. Either a 2 or 4 Port Dual Source PNA / PNA-X
2. Option 080 (Frequency Offset) installed
3. Additional Keysight information about banded solutions is available here: http://na.support.keysight.com/pna/help/latest/IFAccess/mmWave_Measurement_w_No_Test_Set.htm
4. Keysight mm-wave macro download: http://na.support.keysight.com/pna/apps/mmwave_setup.msi

An external power supply is necessary for energizing the two OML frequency extension modules. OML offers a standalone power supply (contact OML for more details); otherwise, the following power supplies can satisfy the DC requirements:

- +12VDC, 7A, DC power supply (E3632A) or
- two external +12VDC, 3A, DC power supplies (E3615A, HP6284A)
- or a single dual +12VDC, 3A, DC power supply (HP6253A)

OML millimeter wave frequency extension modules are simply "plug n' play" after configuring the PNA / PNA-X for millimeter wave measurement.

Hardware Connection

Connect PNA / PNA-X, OML millimeter wave frequency extension modules and DC power supply as shown in Figure 1.

Note: RF and LO cables must be phase stable RF cables.

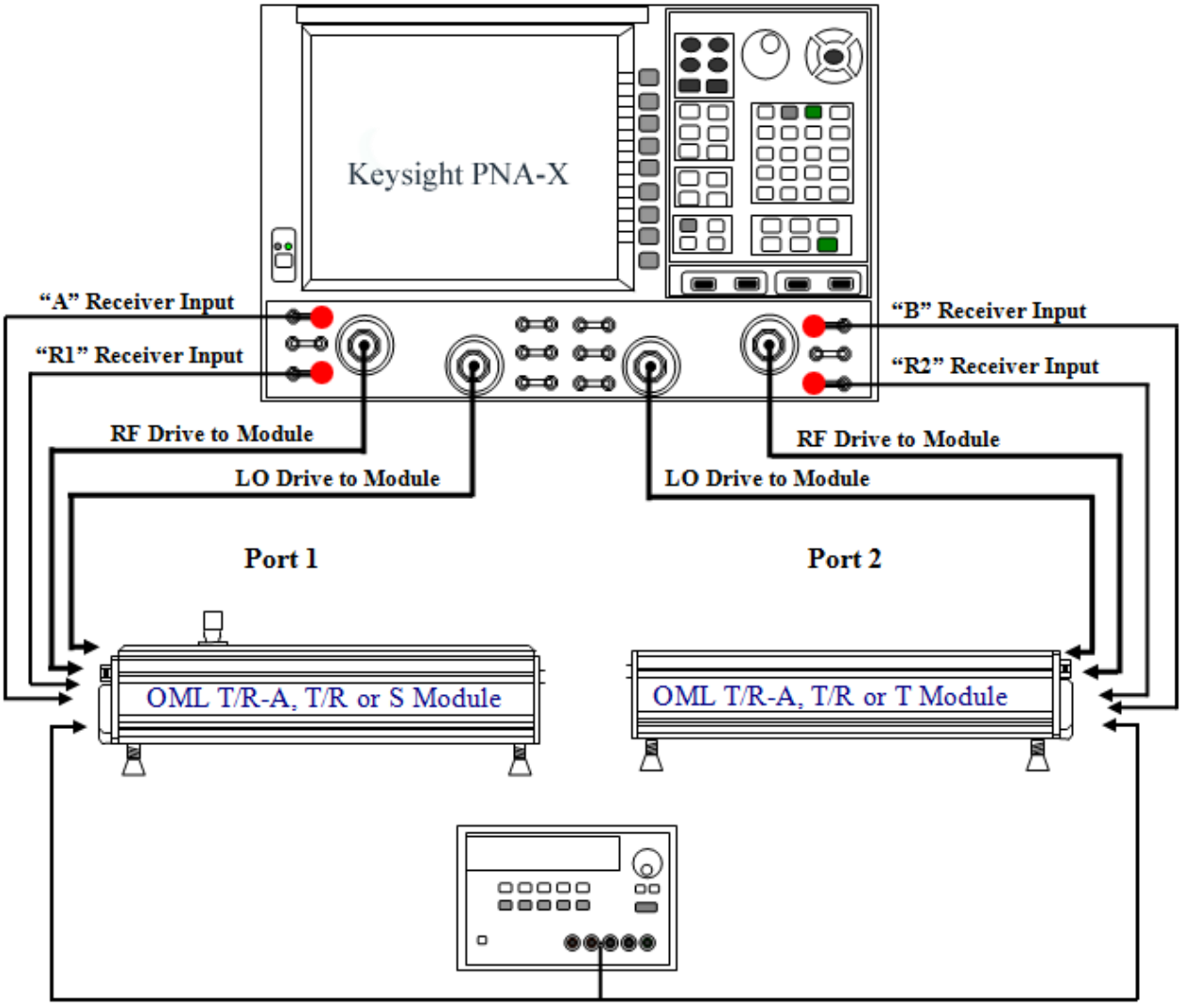


Figure 1 – PNA / PNA-X and OML module connection without millimeter-wave controller

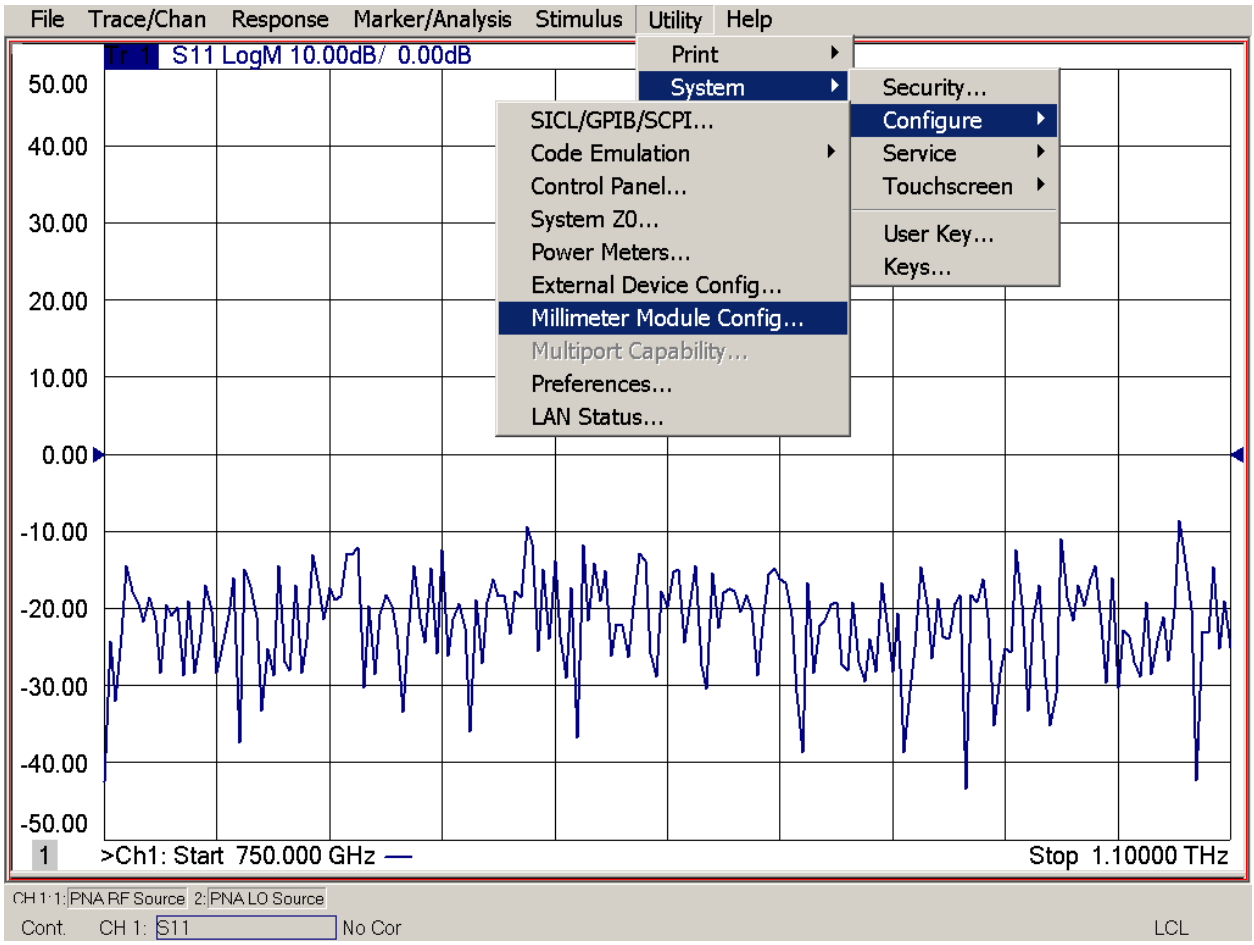
Instrumentation Configuration

In the following description, a PNA-X with firmware version A09.10.05 is used for the screen displays captured in this procedure. Different firmware version may have slightly different displays.

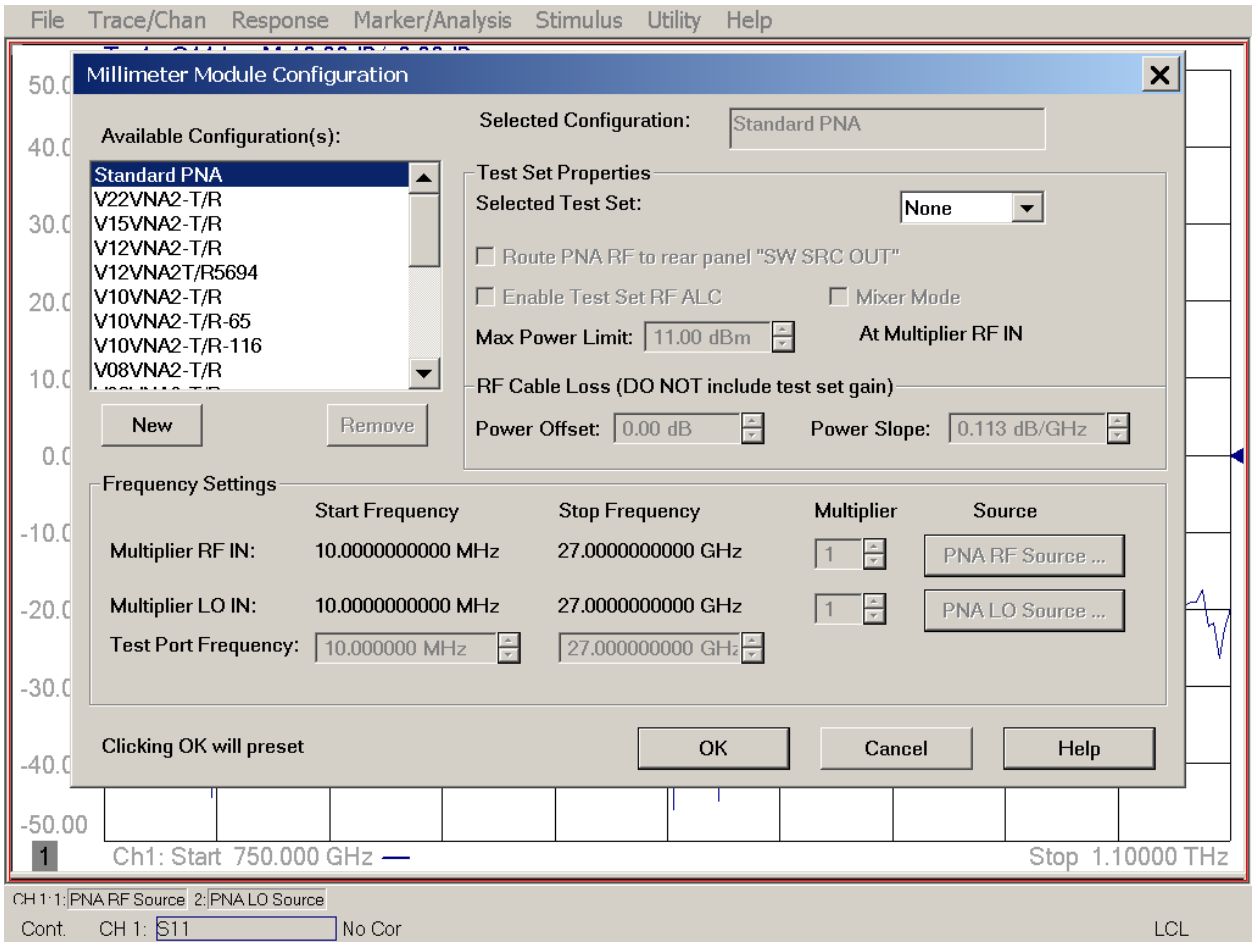
1. Configuring the PNA-X to "Standard PNA" mode

This initializes the PNA-X to run without the millimeter-wave controller.

1.1. It is always good practice to "**PRESET**" the PNA-X before changing configurations.
1.2. With mouse, select **"Utility"** from the **Pull Down Menu** and highlight **"System"**, **"Configure"** and select **"Millimeter Module Config…".**

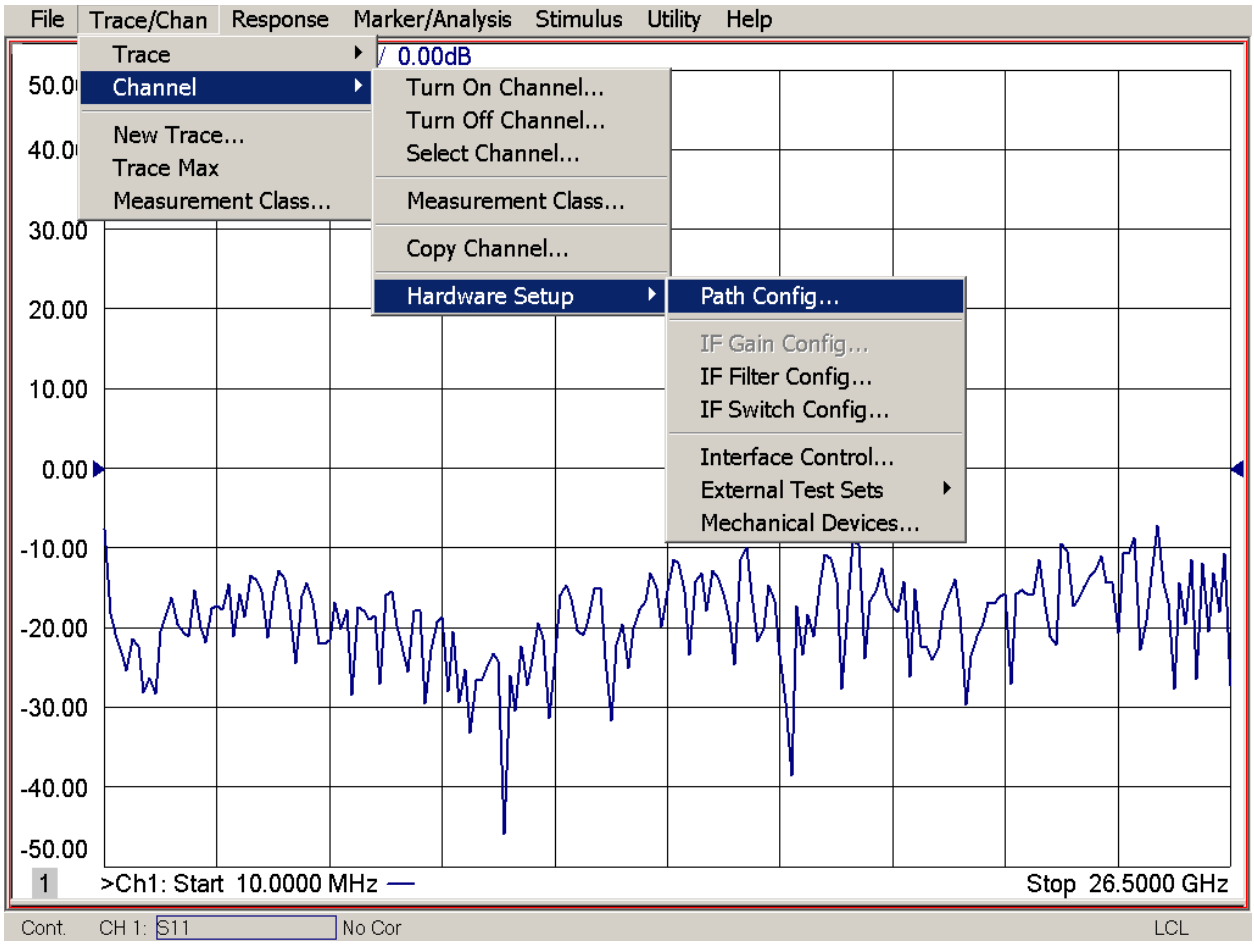


1.3. With mouse, select **"Standard PNA"** in **Available Configuration(s)** Table and click **"OK"** to accept the selection.



2. Setting the "Front Panel" Path Configuration

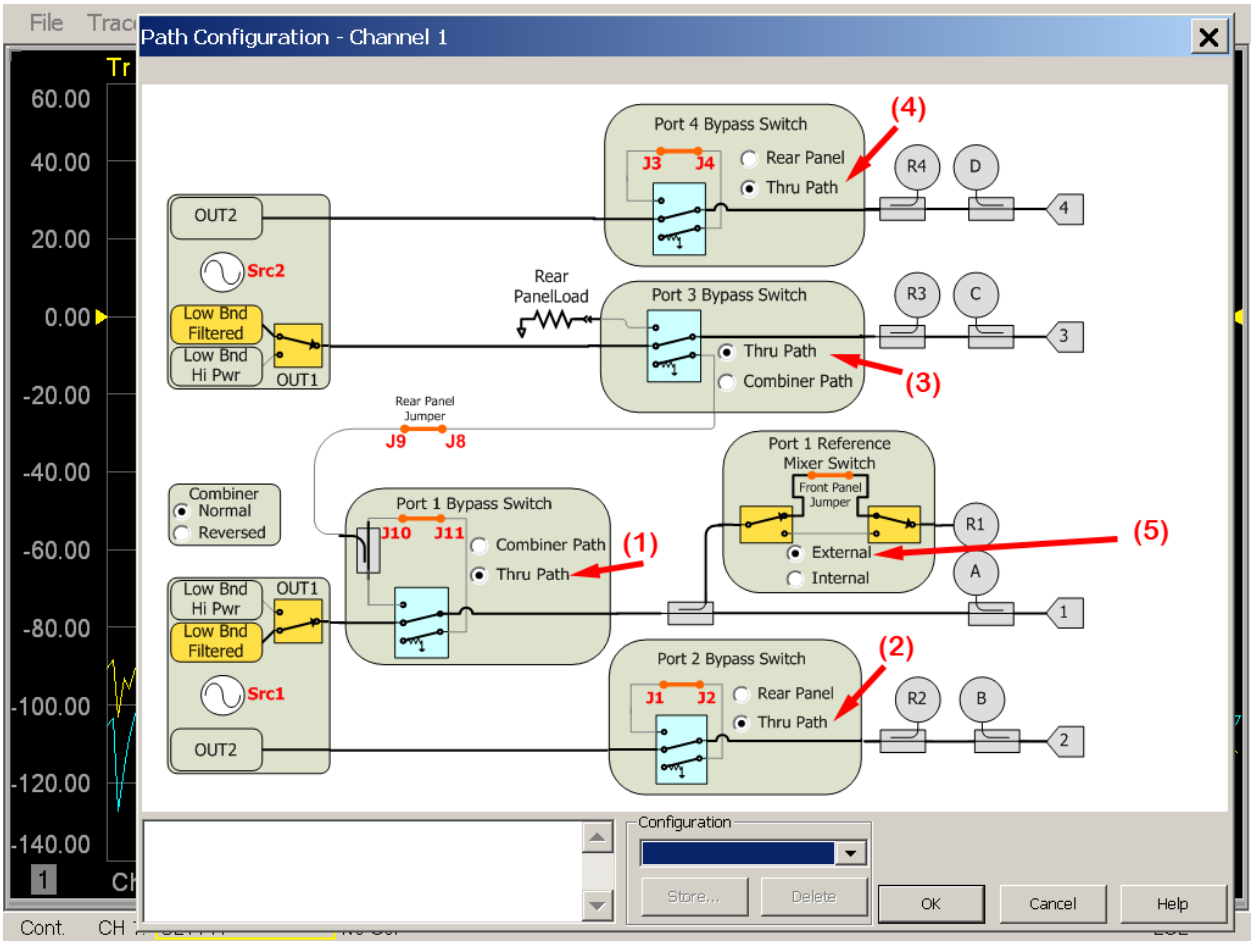
2.1. With mouse, select **"Trace/Chan"** from the **Pull Down Menu** and highlight **"Channel"**, **"Hardware Setup"** and select **"Path Config…"**.



2.2. Referring to the following **Path Configuration – Channel 1** Block Diagram, use the mouse to configure the paths according to the following checklist:

2.2.1. **Port 1 Bypass Switch,** select **"Thru Path"** **(1)**
2.2.2. **Port 2 Bypass Switch,** select **"Thru Path"** **(2)**
2.2.3. **Port 3 Bypass Switch,** select **"Thru Path"** **(3)**
2.2.4. **Port 4 Bypass Switch,** select **"Thru Path"** **(4)**
2.2.5. **Port 1 Reference Mixer Switch,** and select **"External"**. **(5)**

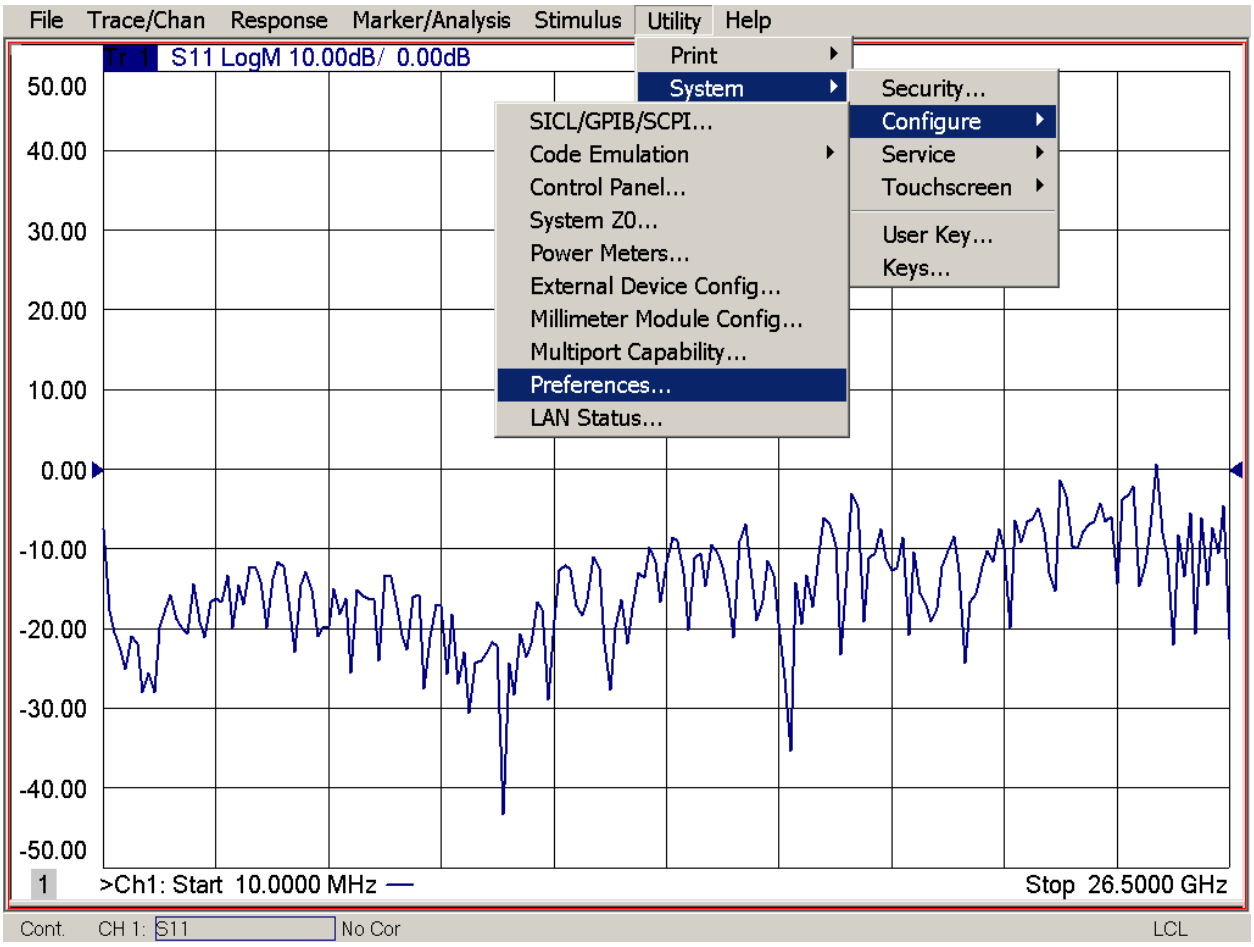
2.3. Click **"OK"** to accept the selection.



3. Setting the Calibration Preference

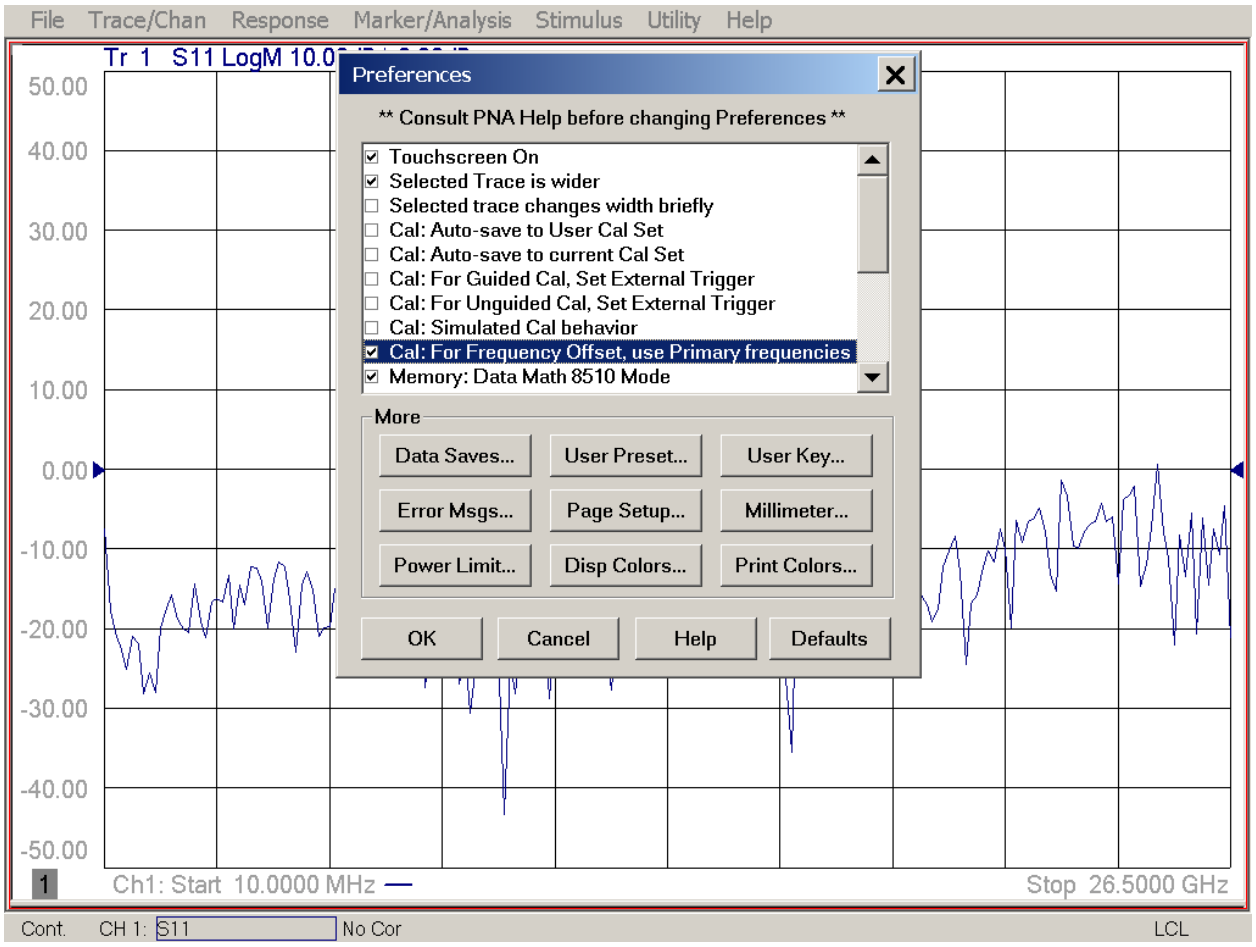
Frequency Offset Mode (FOM) primary frequency must be selected in order to calibrate the millimeter wave system.

3.1. With mouse, select **"Utility"** from the **Pull Down Menu** and highlight **"System"**, **"Configure"** and select **"Preference…"**.



3.2. With mouse, select **"Cal: For Frequency Offset, use Primary frequencies"** by click on the box adjacent to the **"Cal: For Frequency Offset, use Primary frequencies"** callout in **Preferences** selection dialog box.

3.3. Click **"OK"** to accept the selection.



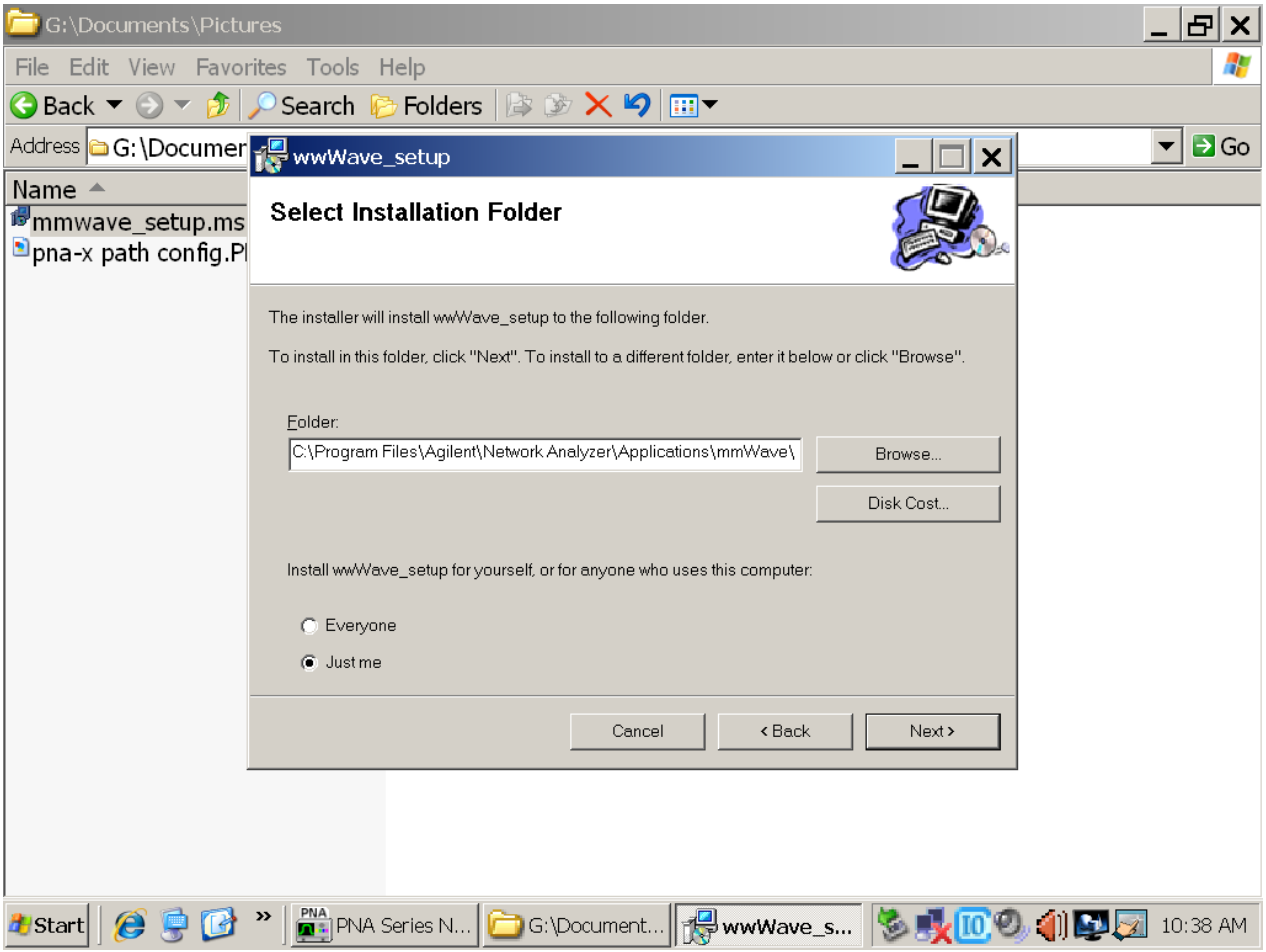
4. Keysight's Macro Streamlines Setup

Keysight has created a macro for use with the PNA-X that simplifies the interface with OML modules in terms of RF and LO multiplication factor and Receiver IF frequency. Download the macro from the following URL:
http://na.support.keysight.com/pna/apps/mmwave_setup.msi .

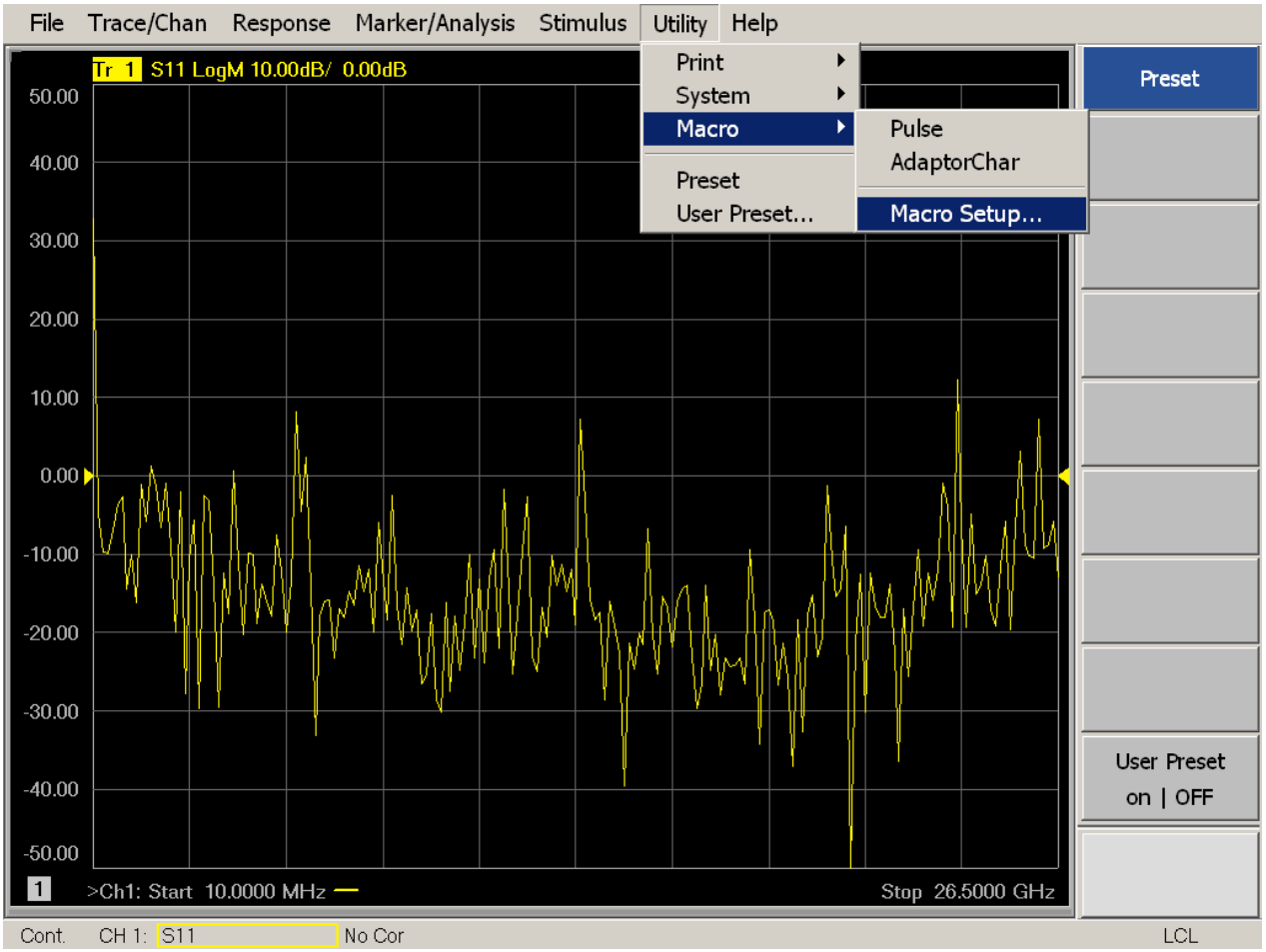
4.1. Copy the downloaded macro to USB memory stick and connect to front panel USB interface on PNA-X. Install the macro to the PNA-X by minimizing the PNA-X application (File/Minimize Application) and then navigating to the USB location and double-clicking on the mmwave_setup.msi macro. After clicking on "Next," the macro will attempt to install the macro (by default) on the PNA-X in the following location: C:\Program Files\Agilent\Network Analyzer\Applications\mmWave\. This location is important for macro setup within the PNA-X application.

4.2. Select "Next" and "Finish" to finalize macro installation to the hard drive.

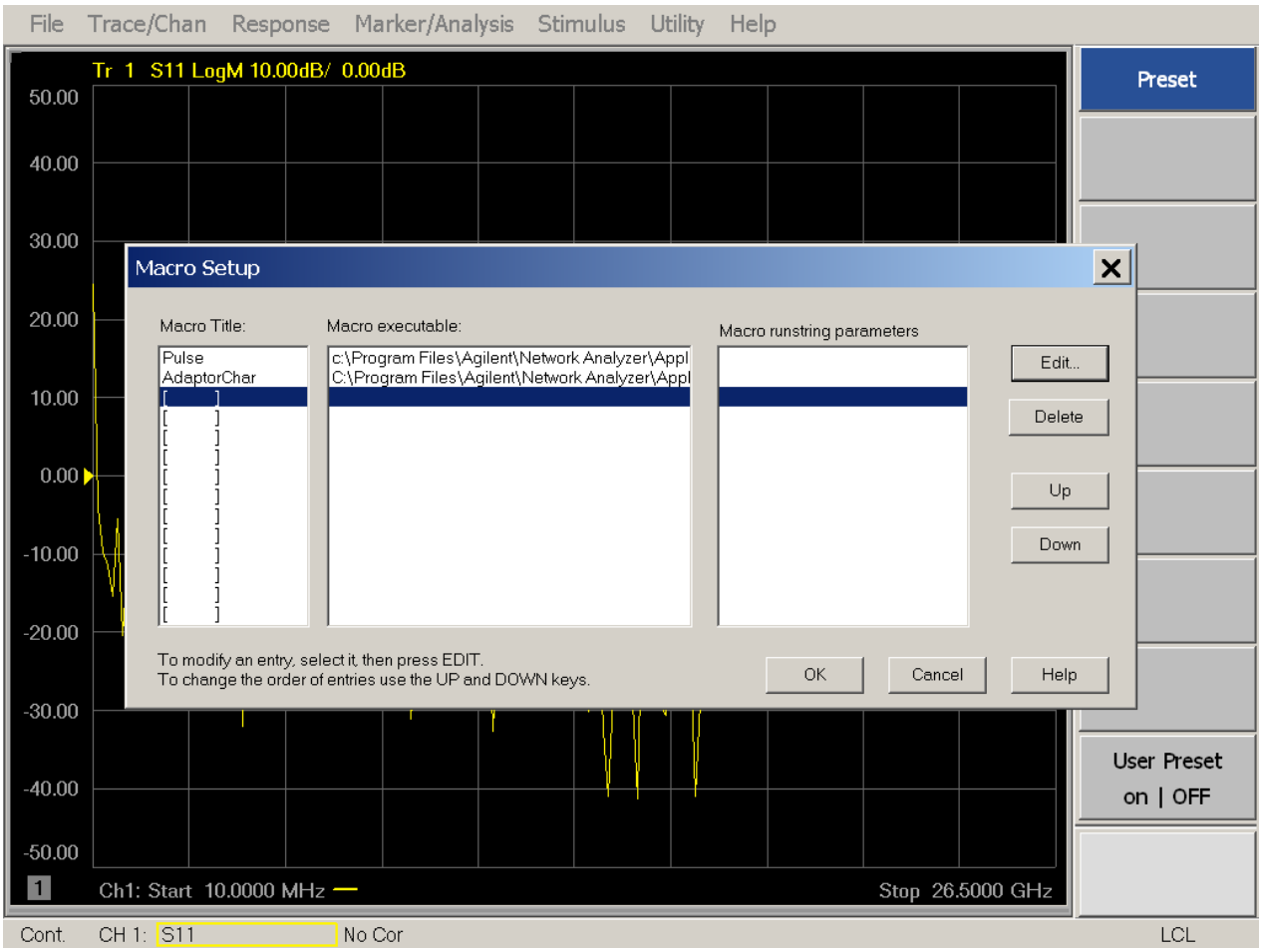
4.3. On the Windows toolbar, click on the "PNA Series Network Analyzer" to maximize the application and continue with the macro installation procedure.



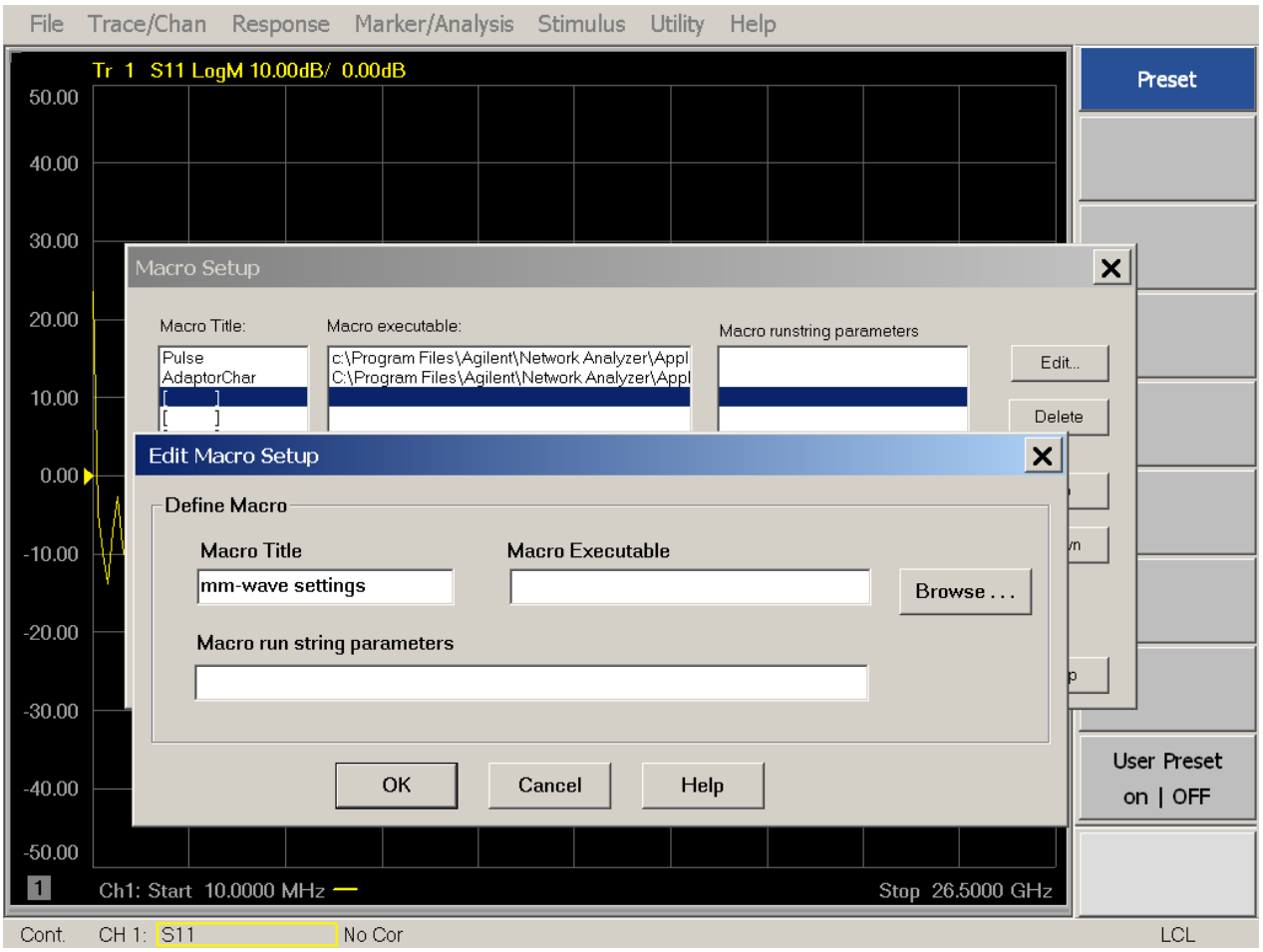
4.4. With mouse, select **“Utility”** from the **Pull Down Menu** and highlight **“Macro”**, and select **“Macro Setup…”**.



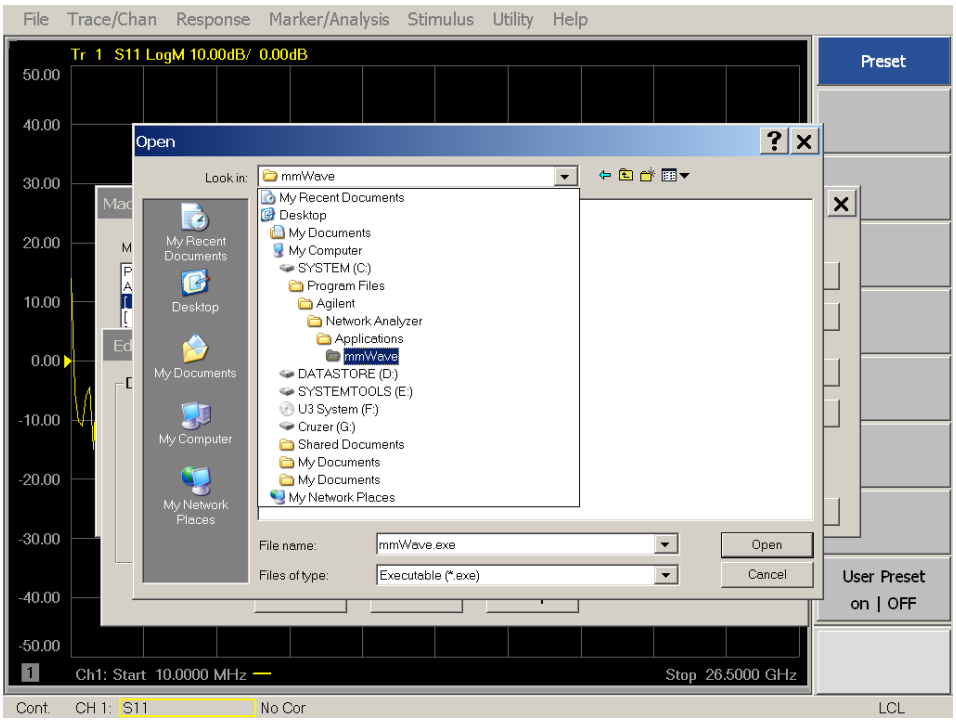
4.5. With mouse, highlight the next available row and select **"Edit"** to modify the information inside the **Edit Macro Setup** dialog box.

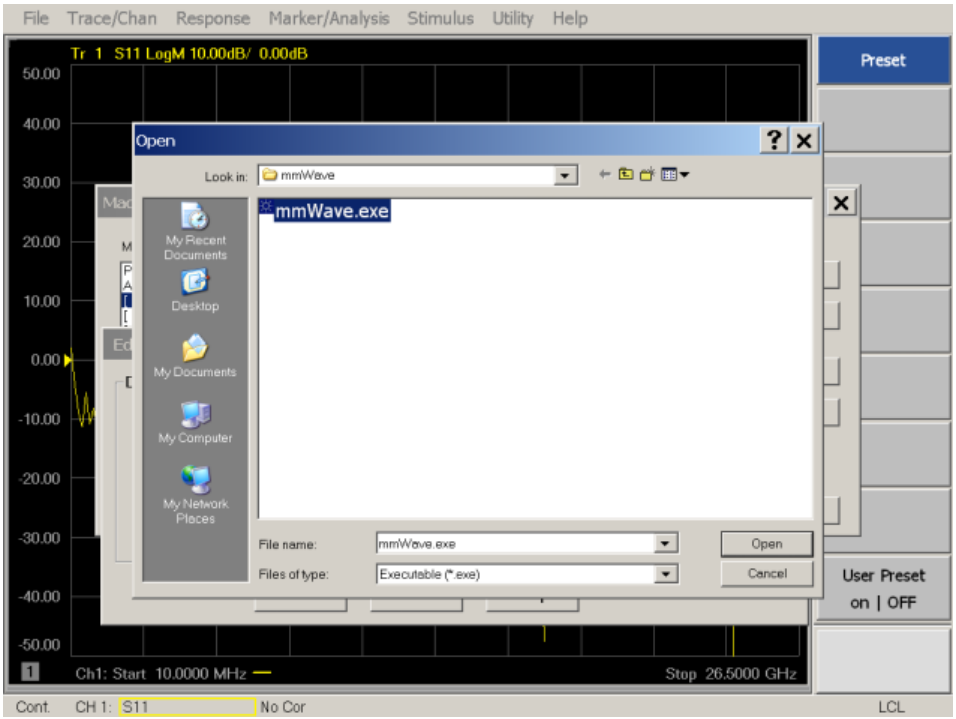


4.6. With mouse and keyboard, assign a Macro Title (e.g., mm-wave settings). This title will become viewable as a selection in the Macro pull down menu.
4.7. With mouse, click the **Browse…** key to navigate the hard drive to find the macro just copied to the hard drive.

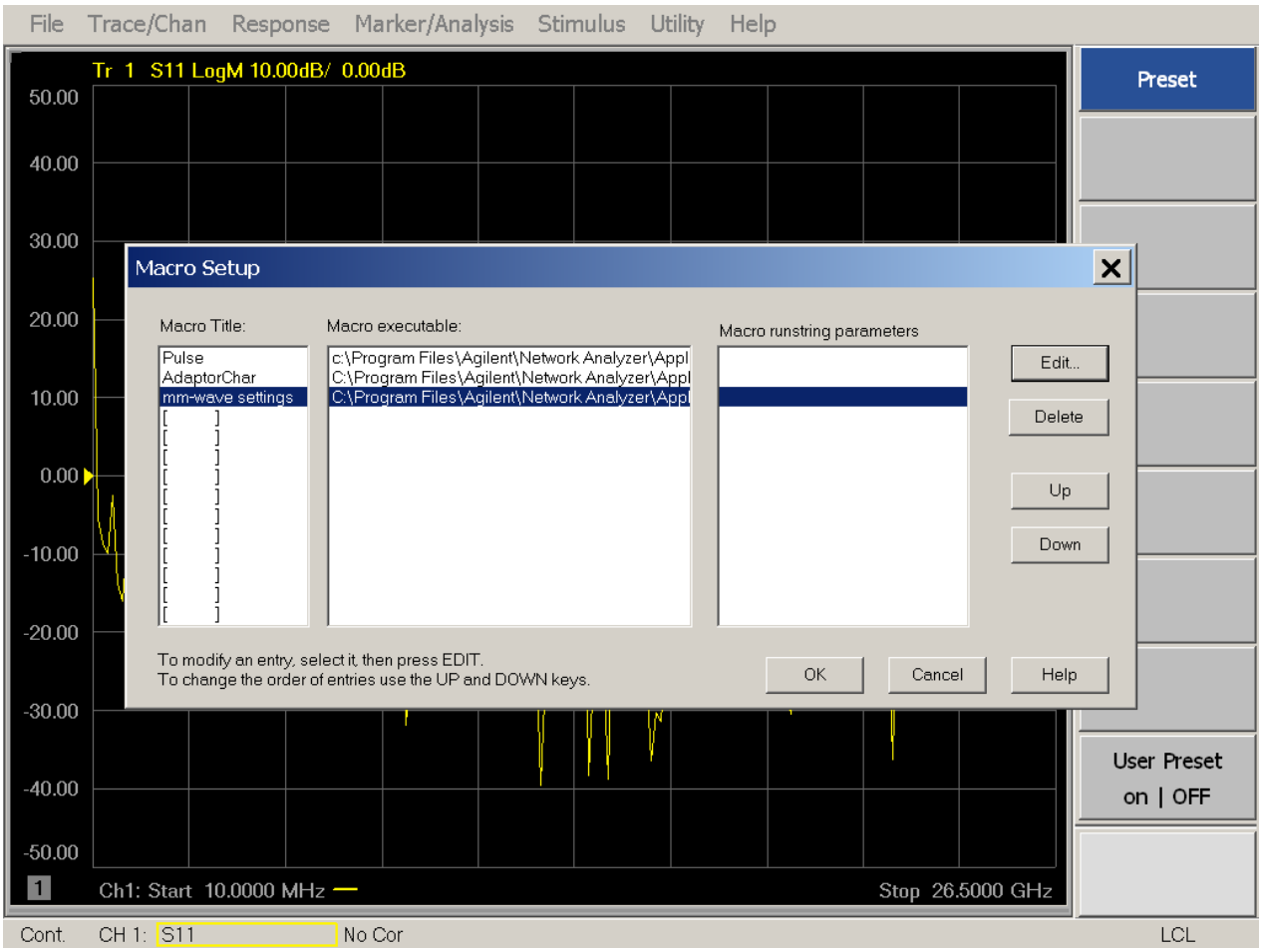


4.8. With mouse, navigate the hard drive to find the macro just copied to the hard drive. Select “mmWave.exe” and click on **Open** to assign the file to the macro definition.





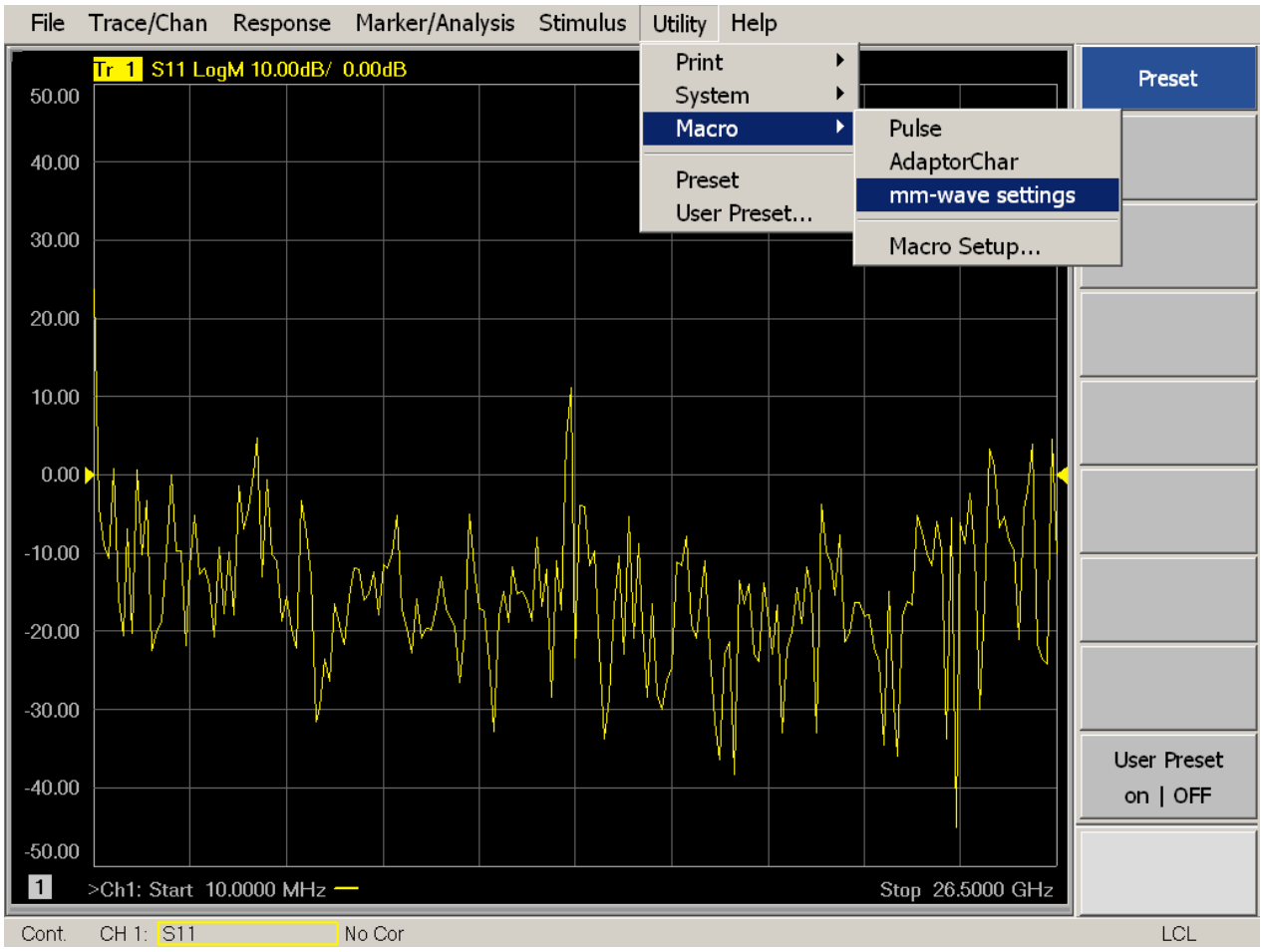
4.9. With mouse, click the **OK** key to finalize the macro setup. Once complete, the **Marco Setup** dialog box should look similar to the following screen capture.



5. Use the Macro to Adjust Millimeter Wave Settings

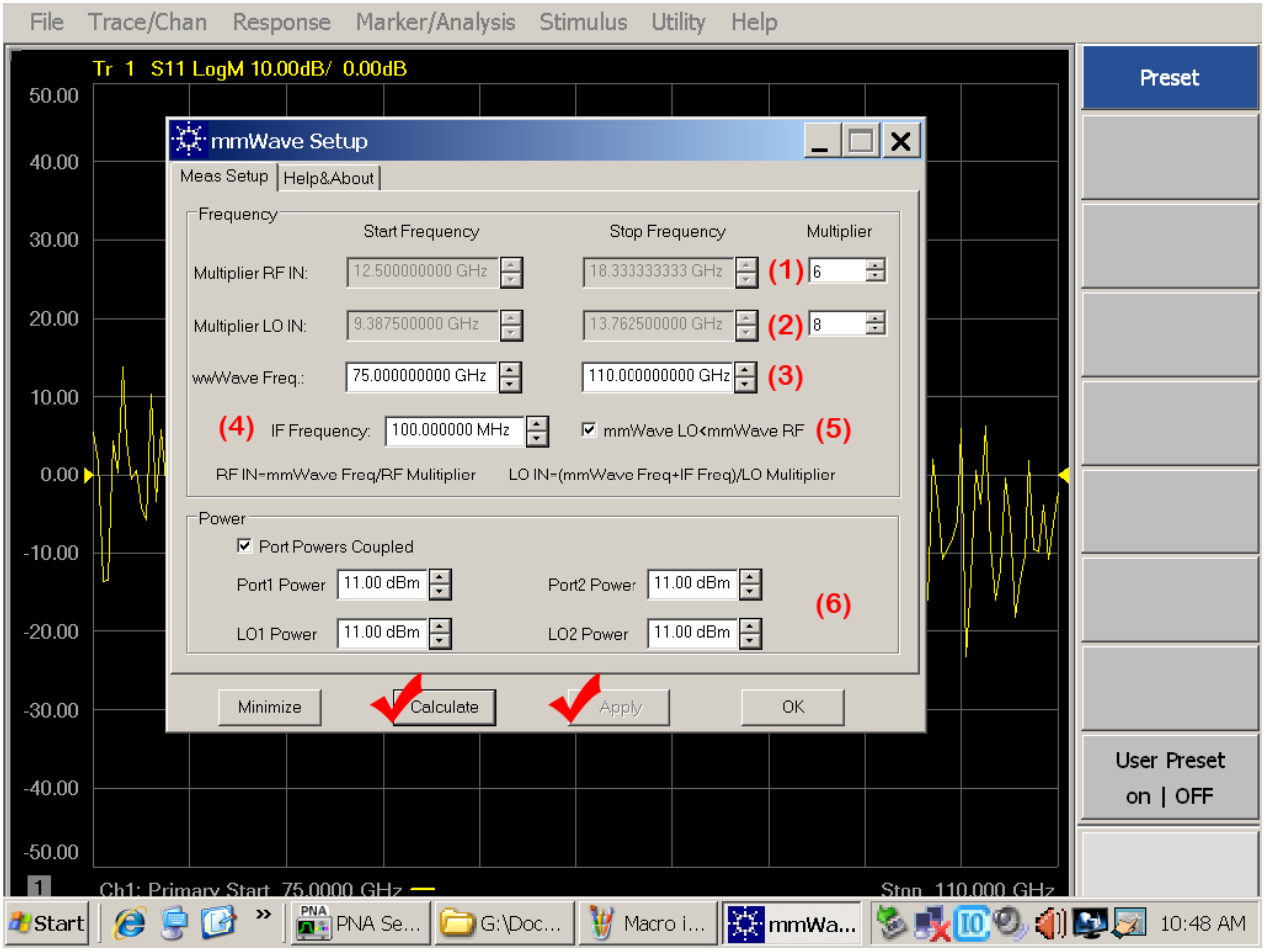
With macro installation complete, the macro execution simplifies the PNA-X interface with OML modules in terms of RF and LO multiplication factor and Receiver IF frequency.

5.1. With mouse, select **"Utility"** from the **Pull Down Menu** and highlight **"Macro"**, and select **"mm-wave settings"**.



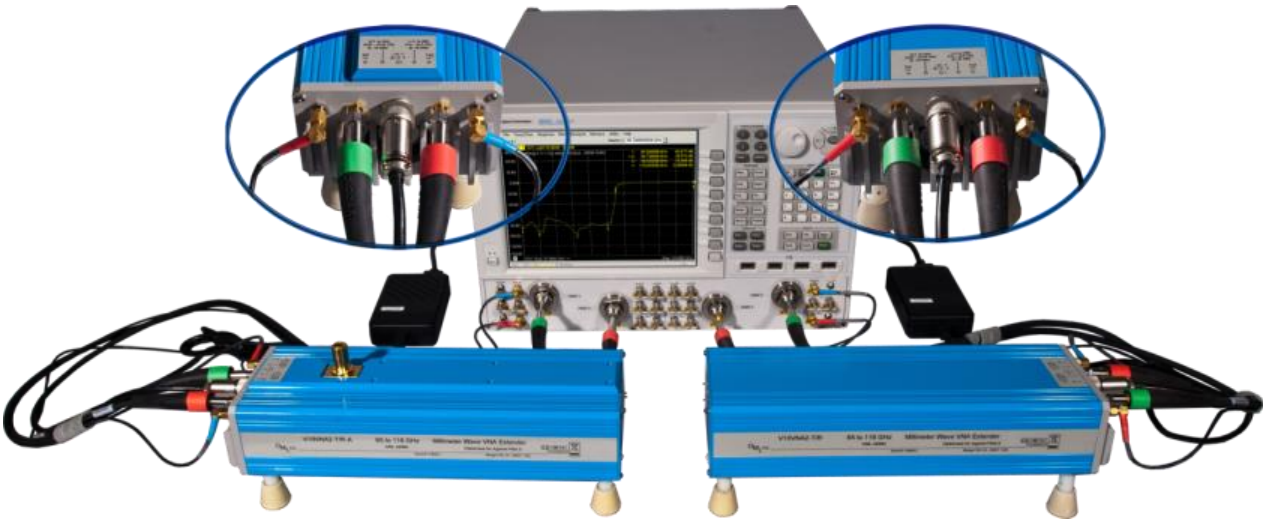
5.2. With mouse and keyboard, select the white cells in the **mmWave Setup** dialog box to configure OML modules for use with the PNA-X.

5.2.1. Input RF Multiplier **(1)**
5.2.2. Input LO Multiplier **(2)**
5.2.3. Input mmWave Start Frequency & Stop Frequency **(3)**
5.2.4. Input IF Frequency **(4)**
5.2.5. Check box to select mmWave LO < mmWave RF **(5)**
5.2.6. With Port Powers Coupled, input +11 dBm to satisfy OML's module input power prerequisite of +10 dBm (includes 1 dB cable loss compensation between PNA-X front panel and module) **(6)**
5.2.7. Press **Calculate** and then **Apply** to finalize settings.
5.2.8. Click **"OK"** to accept the selection.



6. Setup is Complete and System is Ready for Measurements

After running the mmWave setup macro, the overall system is now ready for measurements.



The following table summarizes the millimeter wave settings. Consult OML's brochure, datasheet, or module label as additional references for the multiplication factors.

Multipliers By Band	WR-15	WR-12	WR-10	WR-08	WR-06	WR-05	WR-03	WR-02.2
RF Multiplication Factor	X4	X6	X6	X8	X12	X12	X18	X30
LO Multiplication Factor	X5	X5	X8	X8	X10	X12	X18	X28
Start Frequency	50 GHz	60 GHz	75 GHz	90 GHz	110 GHz	140 GHz	220 GHz	325 GHz
Stop Frequency	75 GHz	90 GHz	110 GHz	140 GHz	170 GHz	220 GHz	325 GHz	500 GHz

Receiver IF Selection Note: Receiver offset frequency can be set between 10 MHz to 300 MHz. OML modules operating with PNA-X are typically optimized at IF = 7.6 MHz to coincide with the predetermined IF of the N526xA millimeter wave controller.

Measurement Tip: IF Bandwidth: uncheck, "Reduce IF bandwidth at Low Frequencies."