

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

Tel: 408-779-2698 Fax: 408-778-0491

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...".



300 Digital Drive Morgan Hill, CA USA 95037

Tel: 408-779-2698 Fax: 408-778-0491 www.omlinc.com

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

File	Trace/Chan Response	e Marker/Analysis	Stimulus Utility	Help			
50.0	Millimeter Module Confi	guration					x
40.0	Available Configuration(s	Sele	cted Configuration:	Standard P	PNA		
30.0 20.0 10.0	Standard PNA V22VNA2-T/R V15VNA2-T/R V12VNA2-T/R V12VNA2-T/R V10VNA2-T/R V10VNA2-T/R V10VNA2-T/R-65 V10VNA2-T/R-116 V08VNA2-T/R	Test Select Brown Max	Set Properties cted Test Set: oute PNA RF to rear pa nable Test Set RF ALC Power Limit: 11.00 d Cable Loss (DO NOT in	anel "SW SRI : Bm + nclude test se	Noni C OUT" I Mixer Moo At Multipl et gain)	e 🗨	
0.0	New	Remove Powe	er Offset: 0.00 dB	r Po	ower Slope:	0.113 dB/GHz	
	Frequency Settings		Сt Г		L. [1] = [] =	S	
-10.0	Multiplier RF IN: 1	0.00000000000 MHz	27.0000000000 G	Hz [1	iuitipiier 1 🚽	Source	
-20.0 -30.0	Multiplier LO IN: 1 Test Port Frequency:	0.000000000 MHz	27.000000000 G	Hz 1	×	PNA LO Source	4
-40.0 Clicking OK will preset OK Cancel Help							
-50.00 1	Ch1: Start 750.000	GHz —				Stop 1.10)000 THz
CH 1·1:PI Cont.	NA RF Source 2: PNA LO Source CH 1: S11	No Cor					LCL



Tel: 408-779-2698 Fax:

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...".





Tel: 408-779-2698 F

- 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...".





Tel: 408-779-2698 Fax:

- 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.





300 Digital Drive Morgan Hill, CA USA 95037

Tel: 408-779-2698 Fax: 4

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...".



Tel: 408-779-2698 Fax:

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.

File	Trace/Chan Response Marker/Analysis Stimulus Utility Help						
50.00	Tr 1 S11 LogM 10.00dB/ 0.00dB	Preset					
00.00							
40.00							
30.00							
00100	Macro Setup	×					
20.00	Macro Title: Macro executable: Macro runstring parameters						
10.00	Pulse C:\Program Files\Agilent\Network Analyzer\Appl AdaptorChar C:\Program Files\Agilent\Network Analyzer\Appl						
10.00							
0.00	Edit Macro Setup						
40.00	Define Macro						
-10.00	mm-wave settings Browse						
-20.00	Macro run string parameters						
-30.00							
-40.00	OK Cancel Help	User Preset on LOFE					
50.00							
1	Ch1: Start 10.0000 MHz — Stop 26.5000 GHz						
Cont.	CH 1: S11 No Cor	LCL					



Tel: 408-779-2698 Fax: 40

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".





Tel: 408-779-2698 Fax

- 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.

File Trace/Ch	nan Response Marker/Analysis Stimulus Utility Help					
Tr 1 S1	1 LogM 10.00dB/ 0.00dB	Preset				
40.00	🔆 mmWave Setup					
30.00 ———	Frequency Start Frequency Stop Frequency Multiplier					
20.00	Multiplier RF IN: 12.50000000 GHz → 18.33333333 GHz → (1) 6 → Multiplier I Q IN: 9.387500000 GHz → 13.762500000 GHz → (2) 8 →					
10.00	wwWave Freq.: 75.00000000 GHz + 110.00000000 GHz + (3)					
0.00	(4) IF Frequency: 100.000000 MHz → MmWave LO <mmwave (5)<br="" rf="">RF IN=mmWave Freq/RF Multiplier LO IN=(mmWave Freq+IF Freq)/LO Multiplier</mmwave>					
-10.00	Power Port Powers Coupled					
-20.00	Port1 Power 11.00 dBm ↔ Port2 Power 11.00 dBm ↔ (6)					
20.00						
40.00		User Preset				
-50.00		on OFF				
1 Ch1: Pri	mary Start 75.0000 GHz — Ston 110.000 GHz () * Macro i () mmwa () * mmwa	😼 🛐 10:48 AM				

OMLINC. 300 Digital Drive Morgan Hill, CA USA 95037

Tel: 408-779-2698 Fax: 408-778-0491

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



300 Digital Drive Morgan Hill, CA USA 95037