2020

VNA Extension Modules Operational Manual

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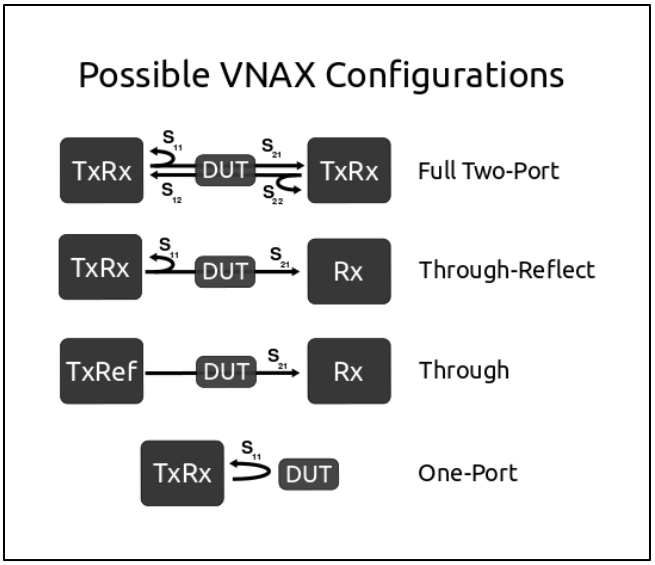
WR1.5 to WR0.65 Extension Modules shown with their power supplies

VNAX Configurations and Equipment Options

Vector Network Analyzer Extension Modules

VNA Extension Modules from Virginia Diodes deliver high performance network analyzer frequency extension into the THz range. Models cover 50 GHz to 1,500 GHz with products for additional bands in development. In addition to our full Transceiver (TxRx) modules, VDI also offers Transmit-Reference (TxRef) modules and Receive only (Rx) modules that deliver optimized performance for specific applications. These modules combine high test port power and exceptional dynamic range to deliver industry leading performance. They are compatible with most network analyzers and can be integrated into probe stations and antenna chambers. Power leveling and sweeping is also supported when used with our PM5 Power Meter. Available options and accessories include increased test port power (select bands), micrometer-driven attenuators (~0-30dB), increased cable length and calibration kits.



Available Formats and Configurations

Module Format	Module Details		
 **WR28 to WM570 (WR2.2)**	**PN: VNAX-TxRx-M** Available Options: -Attn, -5m	**PN: VNAX-TxRef-M** Available Options: -Attn, -5m	**PN: VNAX-Rx-M** Available Options: -HS, -5m
 **WM380 (WR1.5) to WM164 (WR0.65)**	**PN: VNAX-TxRx** Available Options: -Attn, -5m	**PN: VNAX-TxRef** Available Options: -Attn, -5m	**PN: VNAX-Rx** Available Options: -HS, -5m

Key to Available Options -- Contact VDI for details

-HS: Default option for Rx modules. Rx modules can be configured for high loss environments where maximum sensitivity is preferred. Rx modules will allow for both Rx and Rx-HS configurations.

-Attn: TxRx and TxRef modules up to WM380 (WR1.5) can include micrometer driven variable attenuators (~0-30dB adjustable range). The attenuators reduce TPP and DR as much as 8 dB in the WR3.4 and higher frequency bands, also adds ~2 inches to the length of the enclosure.

-5m: Modules configured for <24 GHz drive frequencies can be modified to accommodate cables up to 5 meters in length.

Modules with variable attenuators (WM380 to WM164)

Read all instructions and information in this product manual before connecting an Extension Module to its power supply or a VNA. Operational procedures must be followed for proper function. If you have questions, contact VDI before supplying power to or otherwise operating any VDI Extension Module.

VDI assumes the customer is familiar with microwave, millimeter wave and VDI products in general. The user is expected to understand all safety guidelines, health hazards and general advisories that may exist and are associated with the use of this product. VDI is not responsible for any human hazards that may exist or may occur while using this device.

RF Drive Limitations

Power inputs to the RF Input and LO Input ports of Extension Modules are noted on labels on every Extension Module See examples on Pages 6, 10 and 11; these values provide optimal performance. Irreversible damage can result if input power exceeds stated damage threshold.

Virginia Diodes, Inc. (VDI) accepts no liability for damage or injury resulting from or caused by:

- Improper use, disassembly or use for other purposes than those for which the Extension Module was designed;
- Use outside common safety, health or general advisories pertaining to microwave, millimeter wave and VDI products.
- Repairs carried out by persons other than VDI or its assigned agents;
- Tampering with or altering power cords or other cabling.

Test Port Care

- Do not remove the test ports; test ports must be connected with care for optimal RF calibration results.
- Replace dust caps when the system is idle.

Waveguide Inspection

- Inspect waveguide flanges prior to making connections.
- Extension module waveguide screws should be torqued in the range 20-50 cNm, greater torque can damage the interface.
- Making a connection with metal debris between the waveguide flanges can damage the waveguide interface and prevent repeatable connections.
- If debris is present, clean the flange with pre-dampened TexWipe wipes or swabs (e.g. Part Number TX1065).
- If these are not available, TexWipe cloths lightly dampened with ethanol may be used (e.g. Part Number TX604).
- Cover test ports with dust caps when the system is idle.

RF Cable Care

- Use a torque of 90 cNm when making coaxial connections. Avoid sharp bends in cables (RF, IF, LO, etc).

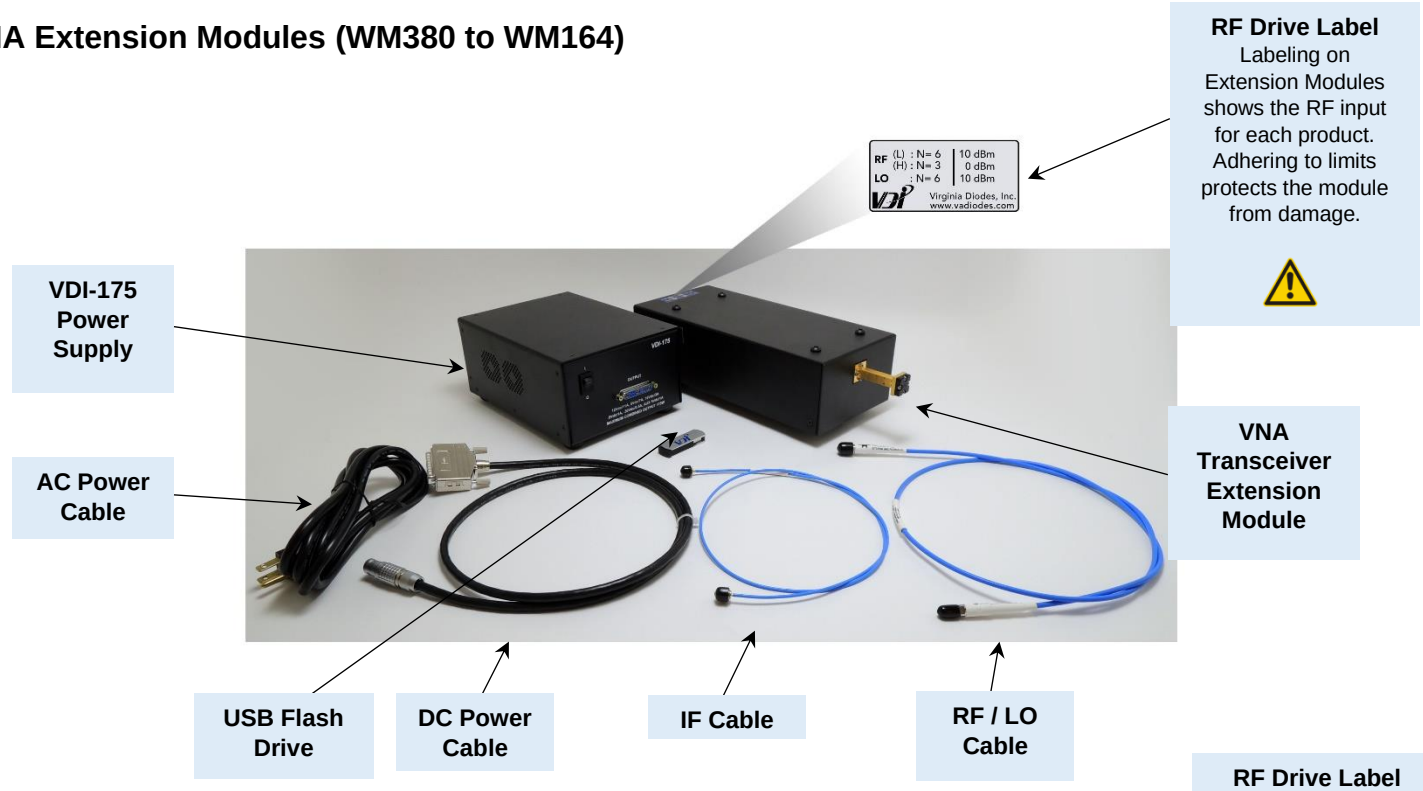
General Operating Practices and Recommendations

- VDI VNA Extension Modules are intended to be used in typical laboratory conditions.
- To set up VDI's VNA Extension Modules on a PNA/PNA-X front panel only, proceed to Page 26. For Millimeter-Wave Controller operation, proceed to Page 31.
- Use of any attachments and accessories not authorized by VDI or that do not meet VDI's specifications may void a VNA Extension Module's limited warranty and could pose a hazard to the operator, or cause lasting damage to the device.
- DC bias cables provided by VDI must be used. Alternative or replacement cables cannot be used unless the DC cables are adequately rated, properly grounded and authorized for use by VDI.
- Disassembling an Extender Module can cause lasting damage to components and pose a hazard to the operator.
- Applying liquids (other than the TexWipe wipes / cloths used for cleaning) can cause lasting damage to the module.
- Check with VDI before any measurement connection is attempted beyond those described in this manual or if it may exceed commonly accepted standards of practice.
- A VNA Extension Module is intended for use only with a power supply module or AC/DC converter supplied with the device by VDI. Use of other power supplies or converters could damage the device or injure the operator.
- Do not connect or disconnect power cables while the Extender Module is switched on.

Major Components and Accessories

VDI VNA Frequency Extension Modules utilize AC/DC power supplies/adapters, RF/LO/IF cables and software for VNA interface and operation. Equipment varies, as do RF input limits (see labels). Contact VDI with RF input limit or general operational questions before powering-up any module.

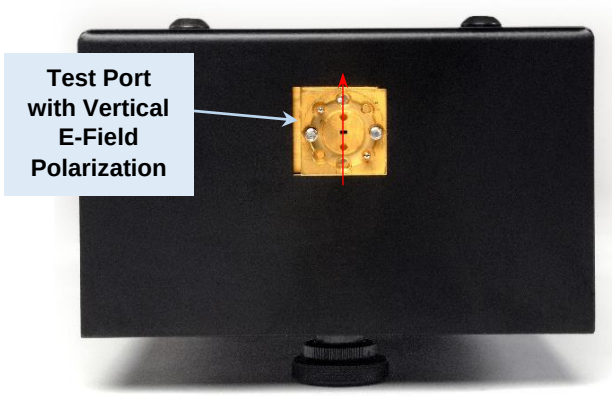
VNA Extension Modules (WM380 to WM164)



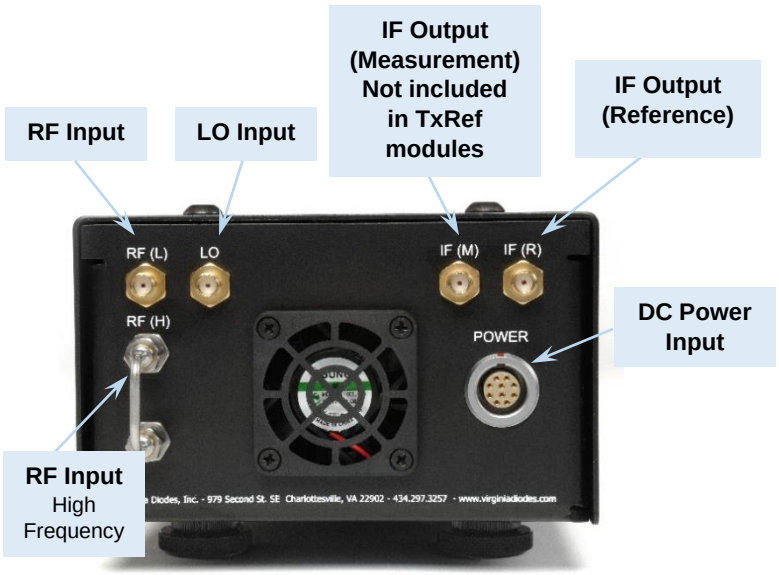
VNA Extension Modules (WR28 to WM570)

Module Details — Front and Rear Panel Connections

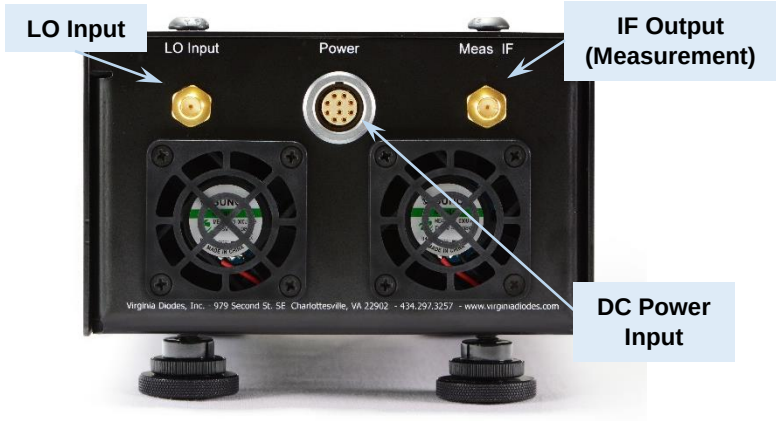
WM380 to WM164



Front Panel

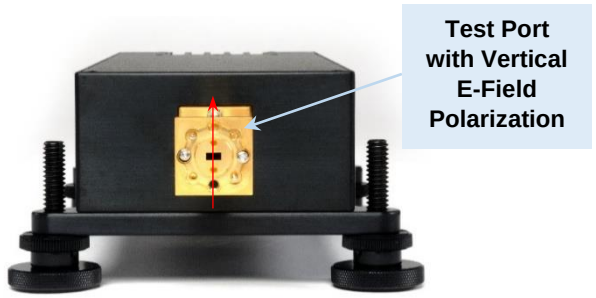


Rear Panel (TxRx, TxRef)

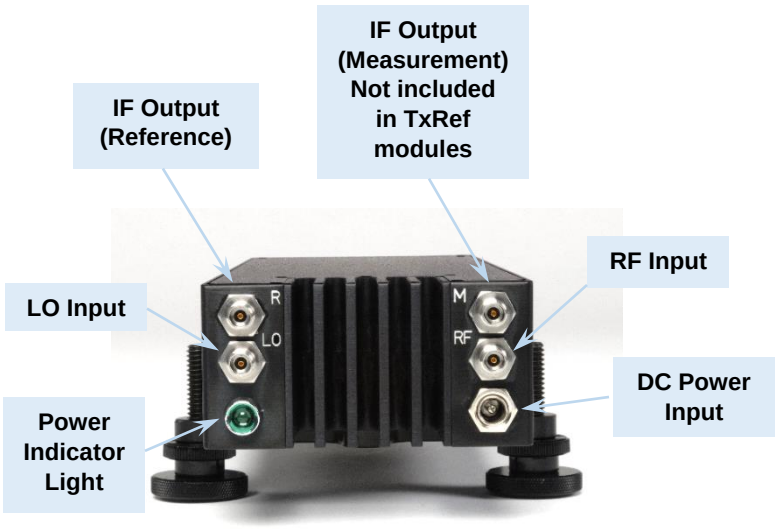


Rear Panel (Rx)

WR28 to WM570



Front Panel



Rear Panel (TxRx, TxRef)

Rear Panel (Rx)

Block Diagrams

The block diagrams presented on Pages 8 and 9 illustrate the different module configurations available; see configuration diagram on Page 4 for measurement details. Contact VDI with any configuration questions.

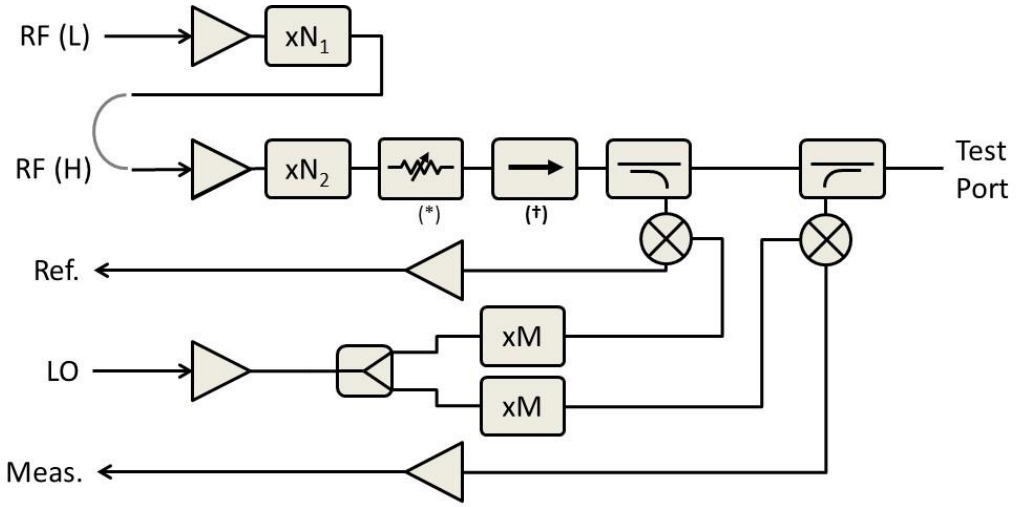


Figure 1: TxRx Block Diagram: WM380 to WM164
Typical major components in TxRx Extension Modules.
* Variable attenuator (optional) † Isolator (omitted for bands WR4.3 to WR1.0)

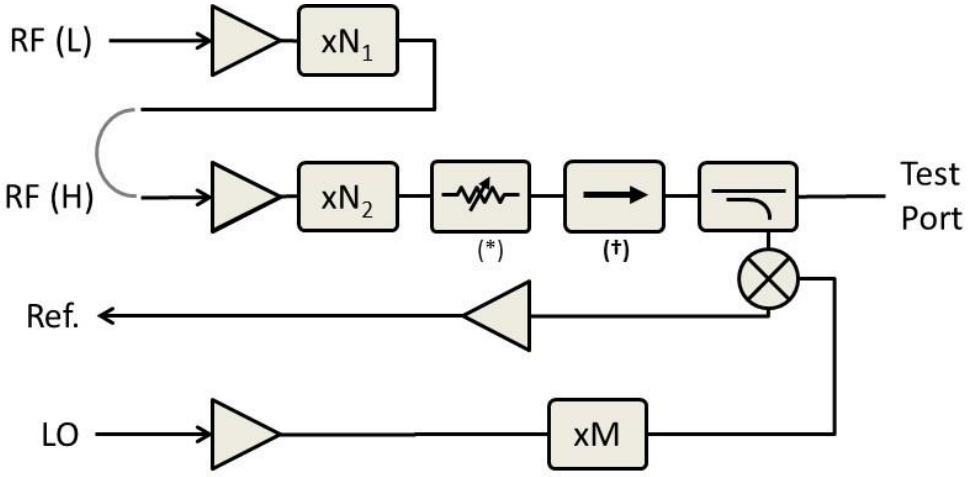


Figure 2: TxRef Block Diagram: WM380 to WM164
Typical major components in TxRef Extension Modules.
* Variable attenuator (optional) † Isolator (omitted for bands WR4.3 to WR1.0)

Block Diagrams

The block diagrams presented on Pages 8 and 9 illustrate the different module configurations available; see configuration diagram on Page 4 for measurement details. Contact VDI with any configuration questions.

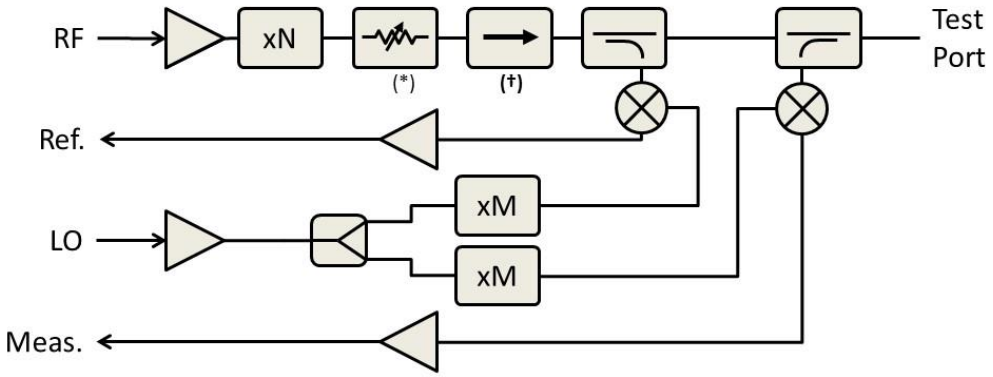


Figure 3: TxRx Block Diagram: WR28 to WM570
Typical major components in TxRx Extension Modules.
* Variable attenuator (optional) † Isolator (omitted for bands WR4.3 to WR1.0)

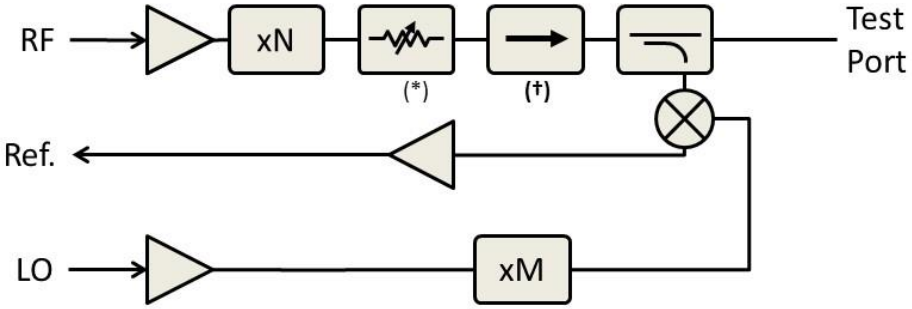


Figure 4: TxRef Block Diagram: WM380 to WM164
Typical major components in TxRef Extension Modules.
* Variable attenuator (optional) † Isolator (omitted for bands WR4.3 to WR1.0)

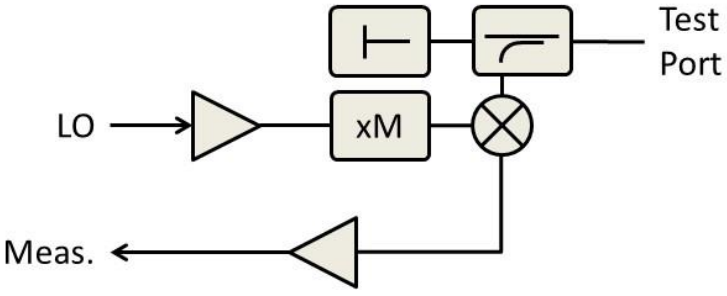


Figure 5: Rx Block Diagram: WM380 to WM164
Typical major components in a Receive Extension Module.

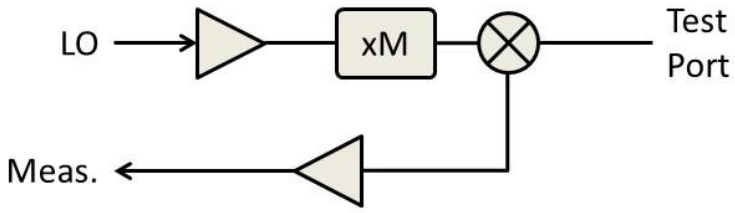


Figure 6: Rx-HS Block Diagram: WR28 to WM570
Typical major components in a Receive HS (High Sensitivity) Extension Module. This module is shipped with a fixed attenuator to allow for direct connection to a typical TxRx or TxRef module without damaging the module.

General Specifications

General Specifications VNA Extension Modules (WR28 to WR2.2)			
Description		**Specification**	**Connector**
RF Input	Typical / Damage, -20 Option (Default)	10 dBm ± 3dB / 16 dBm	2.9mm (f)
	Typical / Damage, -20 Option (Default) with -5M Option	2 dBm ± 3dB / 8 dBm	2.9mm (f)
	Typical / Damage, -40 Option	0 dBm ± 3dB / 6 dBm	2.9mm (f)
LO Input	Typical / Damage (Default)	10 dBm ± 3dB / 16 dBm	2.9mm (f)
	Typical / Damage, -5M Option	2 dBm ± 3dB / 8 dBm	2.9mm (f)
IF Outputs (Reference and Measurement)	Maximum, Direct Connection (279 MHz)	-9dBm	2.9mm (f)
	Maximum, Controller (7.6 MHz)	-27dBm	2.9mm (f)
Test Port	VDI Precision Flange	See Flange Diagram	UG-387/UM
Power Supply	AC Input	100-240VAC, <3.5A, 50-60Hz	U.S. or E.U.
	DC Output	9V / 4A	2.1mm I.D. x 5.5mm O.D. x 9.5mm (f)
Operating Temperature	Typical / Recommended	25°C / 20-30°C	-
Typical Enclosure Dimensions	TxRx & TxRef Module (in.), WR28 to WR19	9.5x3.0x1.5	-
	TxRx & TxRef Module (in.), WR15 to WR2.2	8.5x3.0x1.5	-
	TxRx & TxRef Module (in.), WR28 to WR19, -Atten Option	Contact VDI	-
	TxRx & TxRef Module (in.), WR15 to WR2.2, -Atten Option	8.5x3.0x1.5	-
	Rx Modules (in.)	3.75x3.0x1.5	-
Typical Weight	TxRx & TxRef Module (lbs.)	4	-
	Rx Modules (lbs.)	2	-

General Specifications VNA Extension Modules (WR1.5 to WR0.65)			
Description		**Specification**	**Connector**
RF Input	Standard Frequency Input (Typical / Damage)	10 dBm ± 3dB / 16 dBm	2.9mm (f)
	Standard Frequency Input (Typical / Damage), with -5M Option	2 dBm ± 3dB / 8 dBm	2.9mm (f)
	High Frequency Input (Typical / Damage)	0 dBm ± 3dB / 6 dBm	2.9mm (f)
LO Input	Typical / Damage (Default)	10 dBm ± 3dB / 16 dBm	2.9mm (f)
	Typical / Damage, -5M Option	2 dBm ± 3dB / 8 dBm	2.9mm (f)
IF Outputs (Reference and Measurement)	Maximum, Direct Connection (279 MHz)	-9dBm	2.9mm (f)
	Maximum, Controller (7.6 MHz)	-27dBm	2.9mm (f)
Test Port	VDI Precision Flange	See Flange Diagram	UG-387/UM
Power Supply (Sold Separately)	AC Input	100-240VAC, <3.5A, 50-60Hz	U.S. or E.U.
	DC Output	See VDI-175 Datasheet	See VDI-175 Datasheet
Operating Temperature	Typical / Recommended	25°C / 20-30°C	-
Typical Enclosure Dimensions	TxRx & TxRef Module (in.)	11x5x3	-
	Rx Modules (in.)	8x5x3	-
Typical Weight	TxRx & TxRef Module (lbs.)	9	-
	Rx Modules (lbs.)	4	-

VNA Extension Module Specifications

Waveguide Band (GHz)	Frequency Band (GHz)		Dynamic Range (BW=10Hz,dB)		Test Port Power (dBm, typ.)	Stability		Test Port Input Limit (estimate, dBm, damage) TxRx, TxRef †	Directivity (dB)
	Standard	Extended₸	Typical	Minimum		Magnitude (±dB)	Phase (±deg)		
WR28	26-40	-	120	110	13	0.15	2	33	30
WR19	40-60	-	120	105	13	0.15	2	31	30
WR15	50-75	47-77	120	110	13	0.15	2	30	30
WR12	60-90	55-95	120	110	13	0.15	2	30	30
WR12 (SE Option)	60-90	55-90	120	110	13	0.15	2	30	30
WR10	75-110	67-115	120	110	18	0.15	2	30	30
WR10 (SE Option)	75-110	67-110	120	110	-1	0.15	2	20	30
WR8.0	90-140	-	120	110	6	0.15	2	30	30
WR6.5	110-170	-	120	110	13	0.25	4	30	30
WR5.1	140-220	-	120	110	6	0.25	4	30	30
WR4.3	170-260	-	115	110	-2	0.3	4	28	30
WR3.4	220-330	-	115	105	1	0.3	6	26	30
WM710 (WR2.8)	260-400	-	100	80	-10	0.5	6	16	30
WM570 (WR2.2)	330-500	325-500	110	100	-3	0.5	6	10	30
WM380 (WR1.5)	500-750	-	100	80	-25	0.4	4	-3	30
WM250 (WR1.0)	750-1,100	-	65	45	-30	0.5	6	-3	30
WM164 (WR0.65)*	1,100-1,500	-	60	40	-45	1	20	-3	30

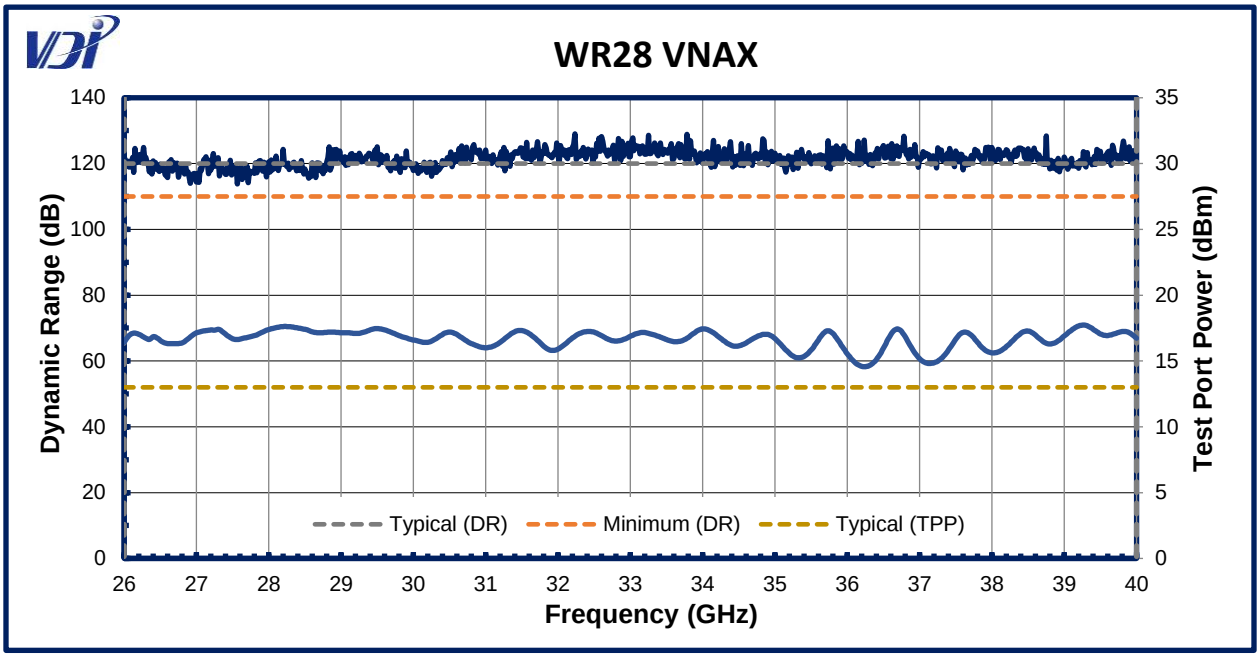
*WM164 (WR0.65) performance is specified for a TxRx-Rx configuration using external synthesizers. Performance of a TxRx-TxRx configuration is estimated to have a ~15dB degradation of dynamic range and may additionally require the use of a mmWave controller.
†Test Port Input Powers exceeding the peak Test Port Power of the TxRx or TxRef module will compress the module.

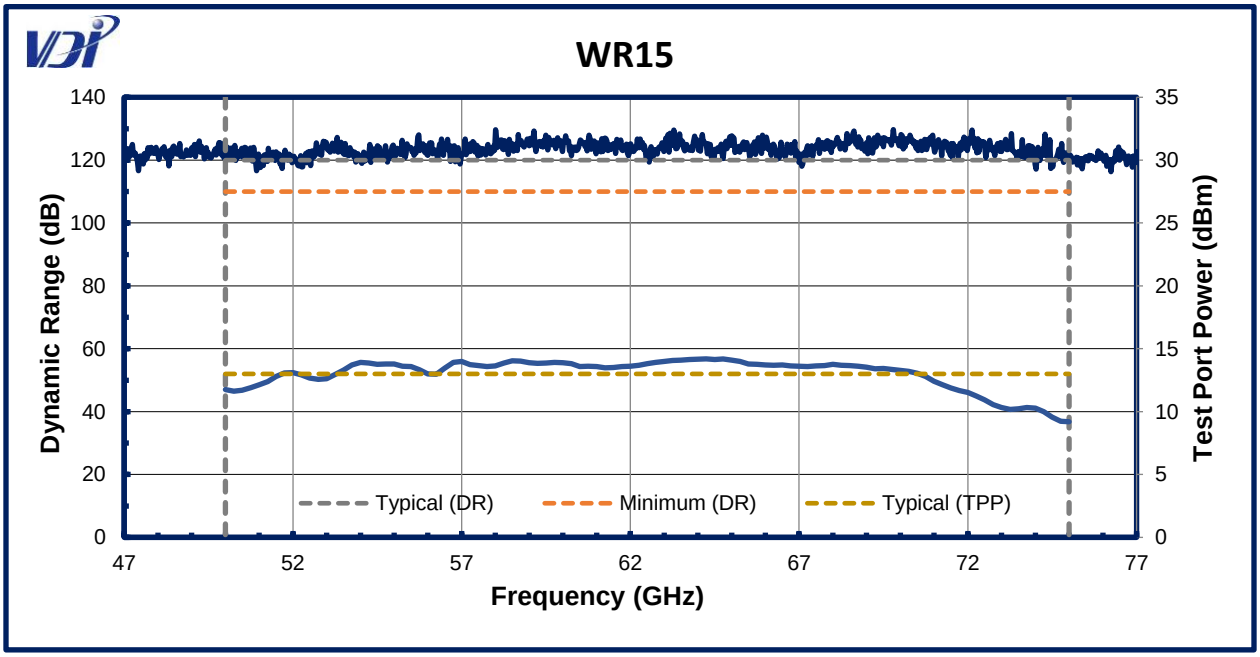
General Notes:
*Extension modules are compatible with all modern VNAs. Please consult with VDI to discuss VNA and module configurations that will yield the best performance of your application.

Specification Notes:
*Test Port Power is typical, reduced power is possible at band edges.
*Stability is specified for 1hr. after system warm-up, in stable environment with ideal cables.
*Specifications assume a through measurement with two TxRx heads.
*Specifications are measured on a Keysight PNA/PNAX with front panel connection at 25ºC typical.
*The dynamic range (RBW=10Hz) is measured by first connecting two TxRx modules together and normalizing the un-calibrated S21 & S12. The heads are then disconnected and terminated with a waveguide short. The rms of the measured S21 & S12 gives the system dynamic range.
*Typical Module Dimensions exclude test port (2" standard test port for all modules except WM250 (WR1.0), where a 1" test port is used).
₸Where noted, Extended Frequency Band applies; module performance within the standard band conforms to standard specifications while performance in the extended regions can be degraded as follows:
- The minimum and typical dynamic range is degraded by 10dB or less, compared to the specifications for the standard band.
- Typical test port power across the range is degraded by 5dB or less compared to the specifications for the standard band.

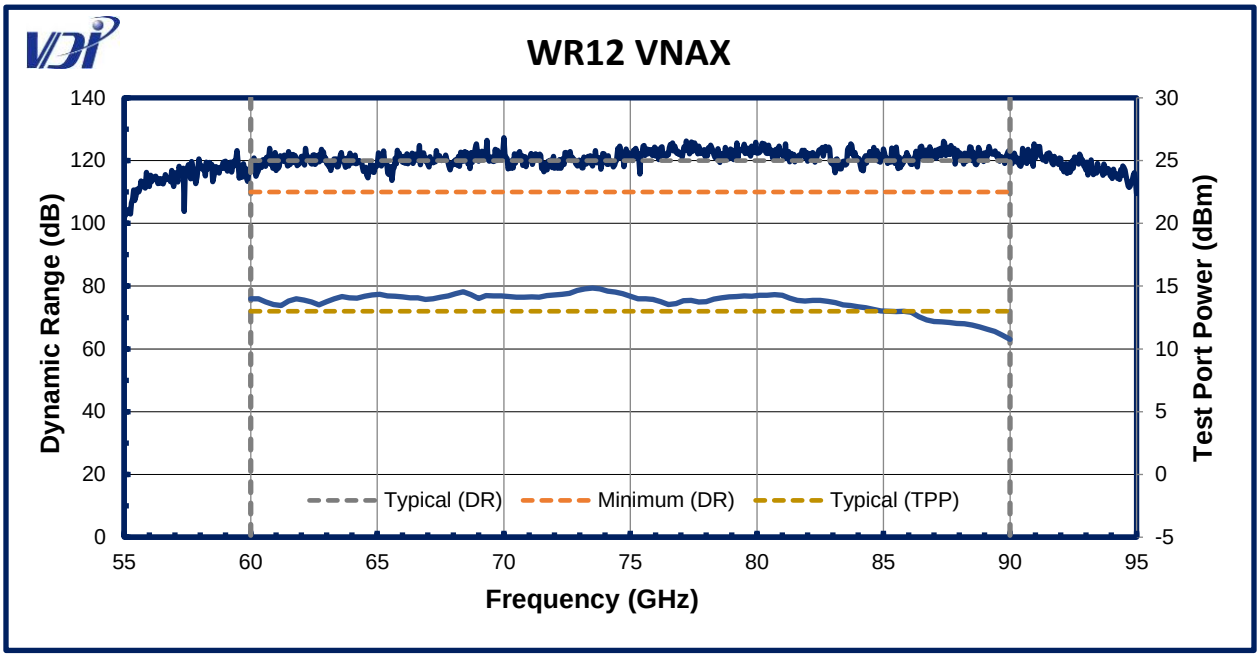
VNAX TxRx Performance

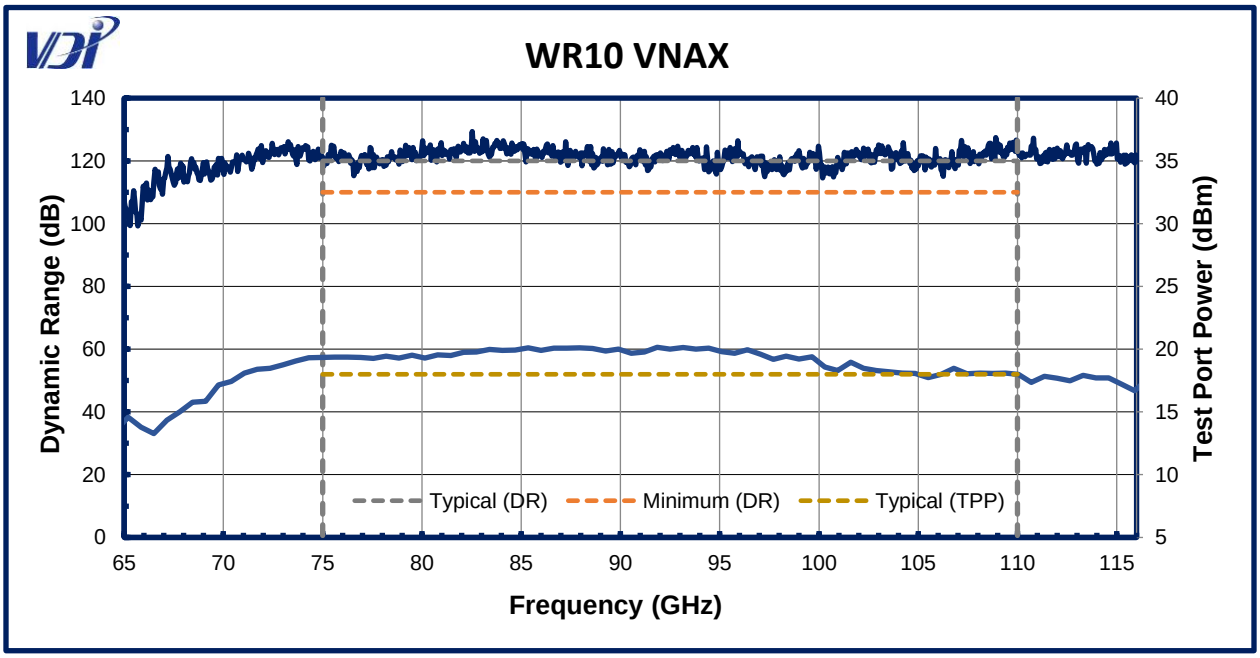
Typical System Dynamic Range and Test Port Power plots can be found on the following pages, starting with WR28 and ending with WR1.0 on page 17.



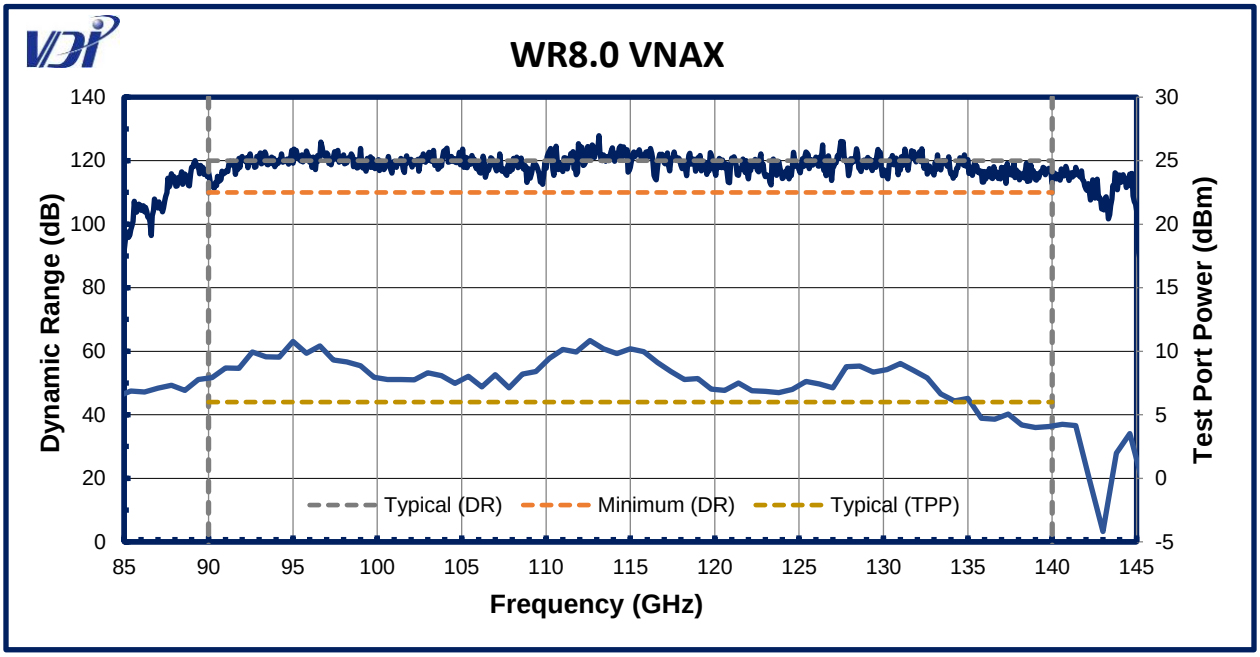


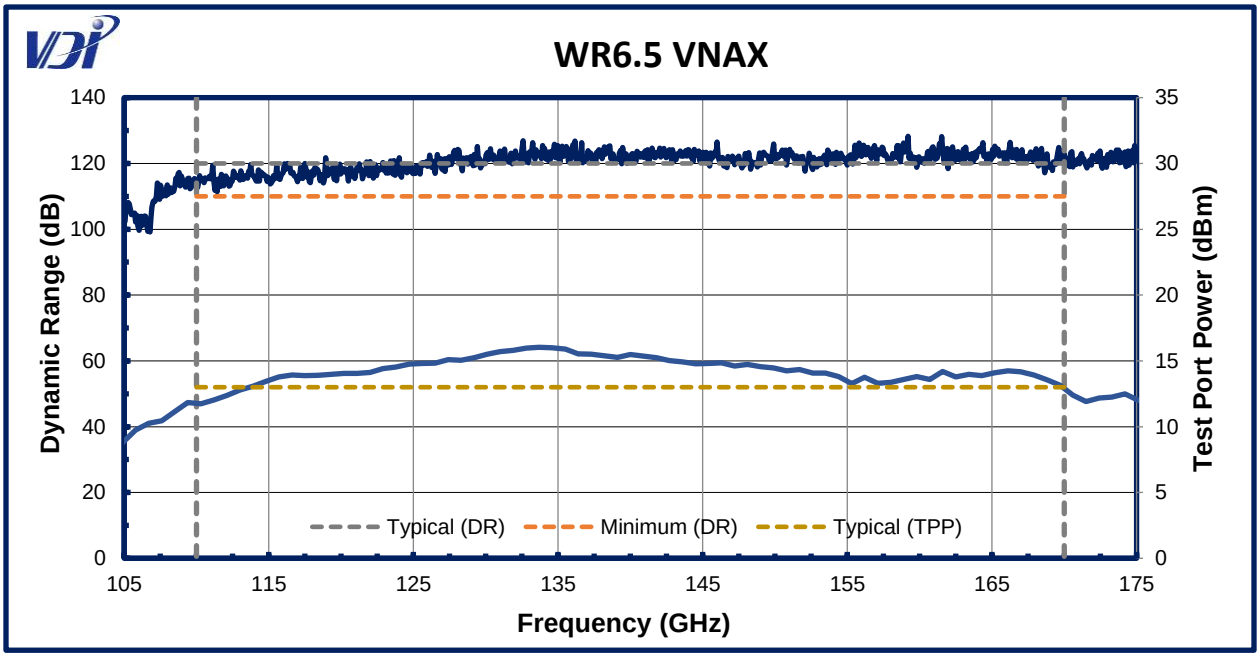
VNAX Performance — Continued



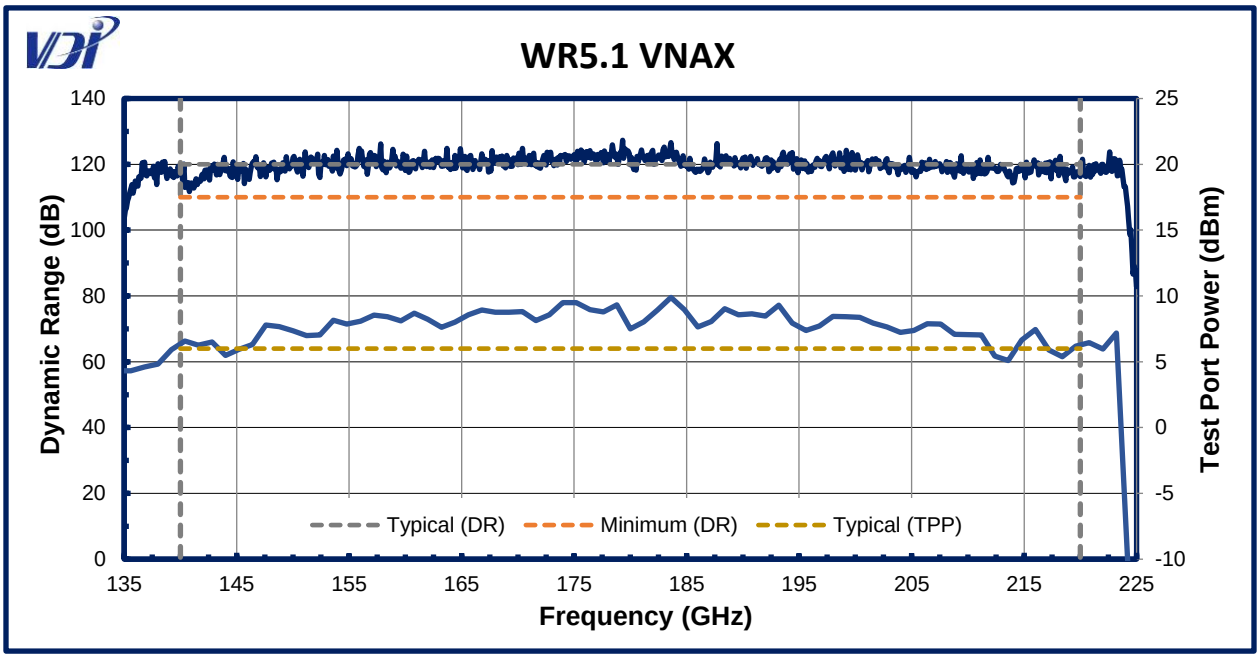


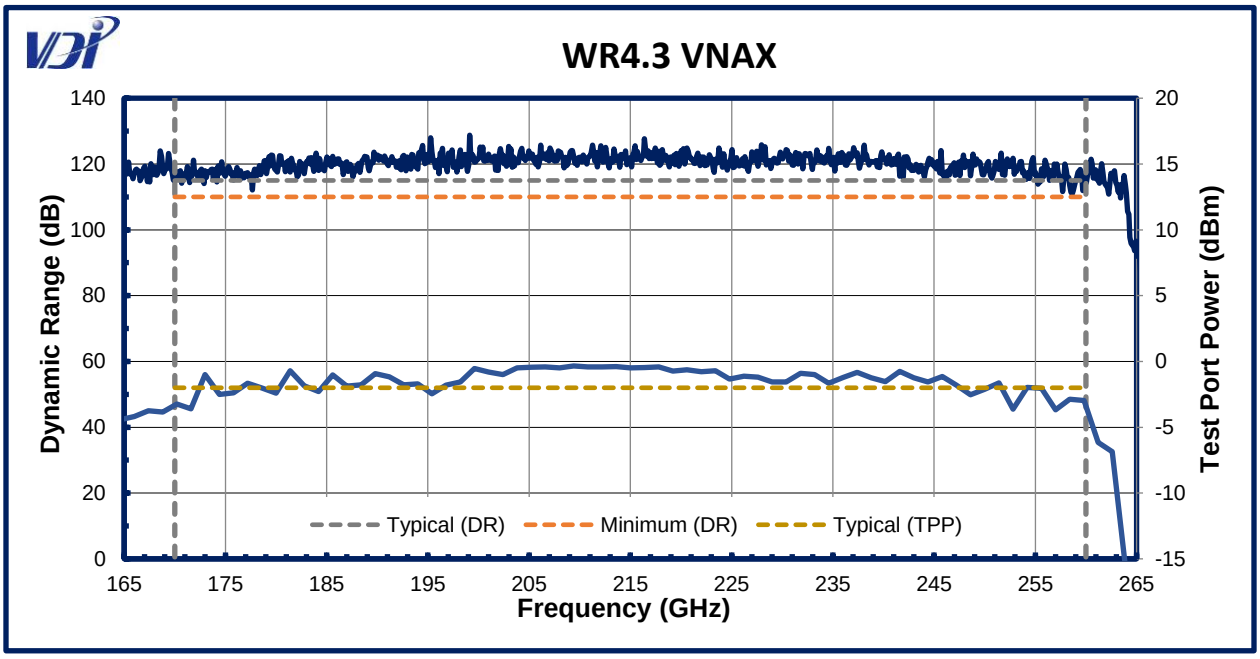
VNAX Performance — Continued



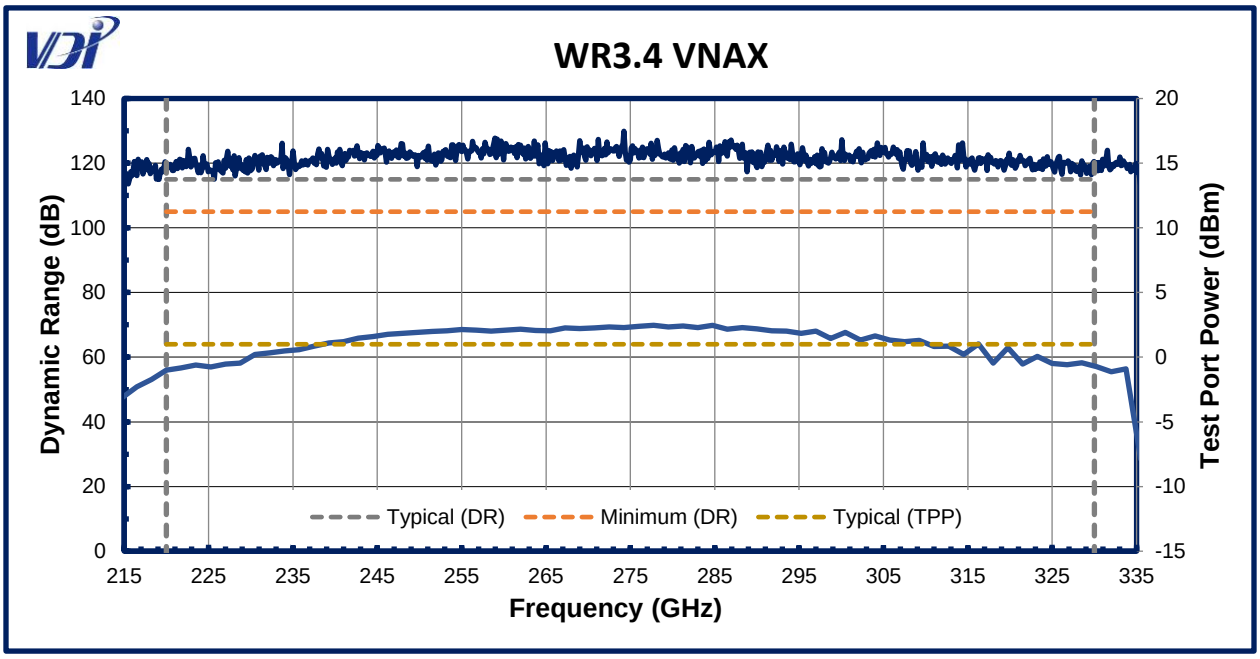


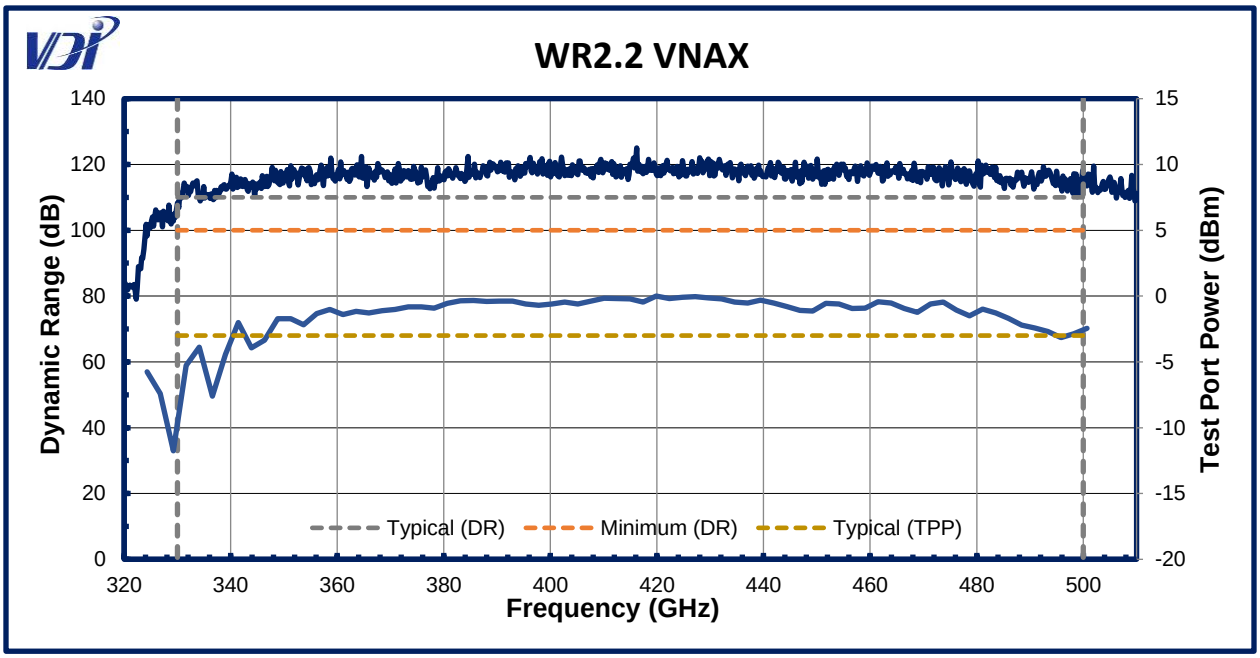
VNAX Performance — Continued



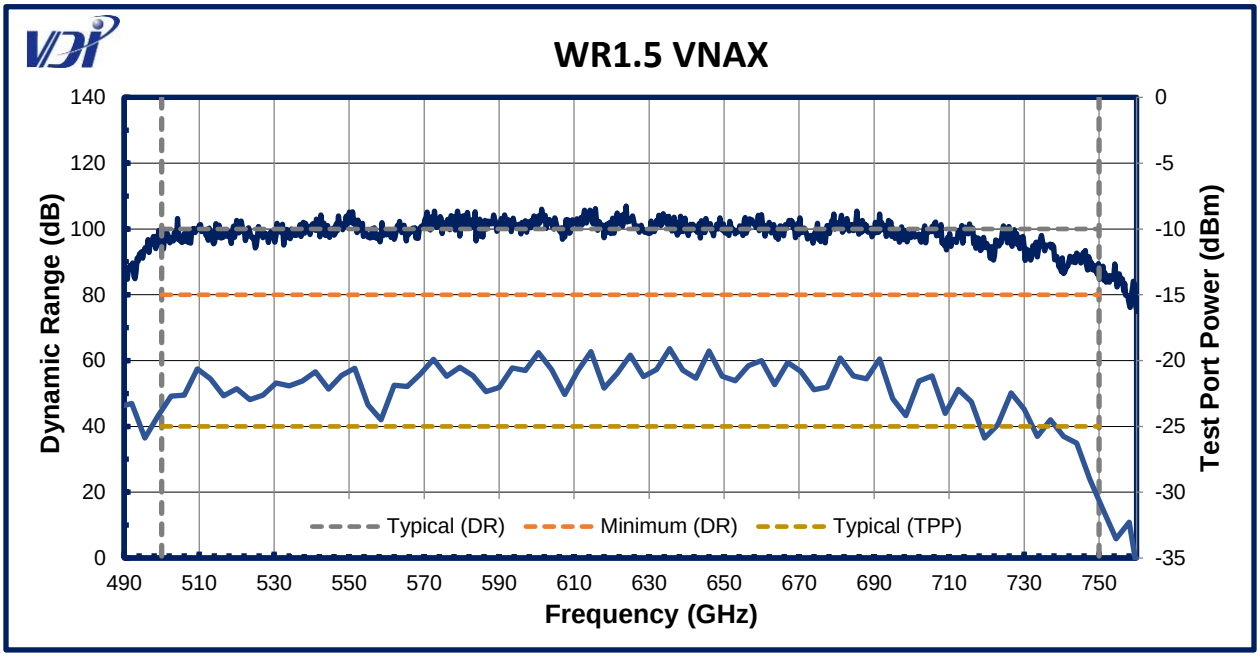


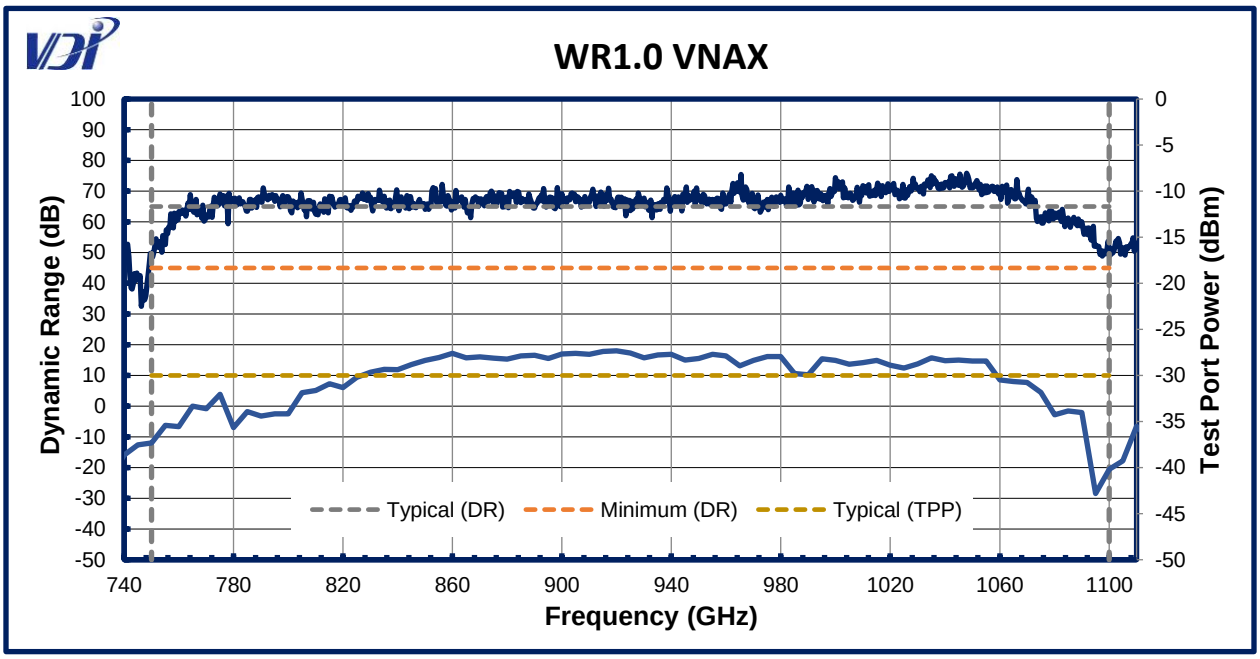
VNAX Performance — Continued





VNAX Performance — Final Performance Plot





Product Overview

VDI offers banded waveguide calibration kits for s-parameter calibration of our extension modules. Two different calibration techniques are offered dependent upon the frequency of operation: TRL (Through-Reflect-Line) calibrations for WR19 through WR3.4; SOLT (Short-Open-Load-Through) calibrations for WR2.8 through WR1.0. VDI also makes available both Type A (legacy) and Type B (current) versions of the calibration standards to support both QW (Quarter Wave Delay Shim) and QD (Quarter Wave Delay Short) standards. These standard versions are described here. For more VNA calibration theory information, please refer to Keysight's application note AN1287-3: "Network Analysis Basics - Applying Error Correction To Network Analyzer Measurements." For instructions to set up calibration kit definitions, refer to application note: "Specifying Calibration Standards and Kits for Keysight Vector Network Analyzers." Please contact VDI with any other questions regarding calibration procedures.

Electronic calibration kit definitions compatible with Keysight Network Analyzers are included with the calibration kits and can be downloaded from the VDI website (http://vadiodes.com/index.php/en/app-notes/downloads).

Notes on Calibration Kit Versions

There are two versions of the delay calibration standards (QW's and QD's) available in Type A (legacy) and Type B (current).

Care should be taken to identify your calibration kit version before downloading the electronic calibration kit definitions or using the delay lengths and other equipment supplied with your kit and illustrated on this page and the following pages. Identification can easily be achieved by examining the shape of the QW and QD calibration standards. (See the detailed description found on this page.) Higher frequency VNA Extension Modules (>260 GHz) could have one of two part numbers. For example: the 260-400 GHz band could be WR2.8 (legacy) or WM710 (current.) VDI recommends that Type A calibration kits be used with legacy modules and that Type B kits be used with current models.

Type A Standard (Legacy)	Type B Standard (Current)
 **QW (Quarter Wave Delay Shim)**	 **QW (Quarter Wave Delay Shim)**
 **QD (Quarter Wave Delay Short)**	 **QD (Quarter Wave Delay Short)**

QD Standard Mounting

The legacy version (Type A) of the QD standard utilizes a thick flange design that allows for direct mounting of the standard on the test port. Refer to the mechanical drawing in Appendix 9.

The current version (Type B) of the QD standard utilizes a slim design and therefore requires that the SC (Short Circuit) standard be used behind the QD to mount the standard on the test port. Care should be taken to insure that the delayed short side of the standard is facing the test port and that the polarization aligns with the test port.

Calibration Kit Component Care and Handling

Please remember that reasonable care must be used when handling the waveguide and shim components of each Calibration Kit. Contact VDI with questions or concerns.

Calibration Kits

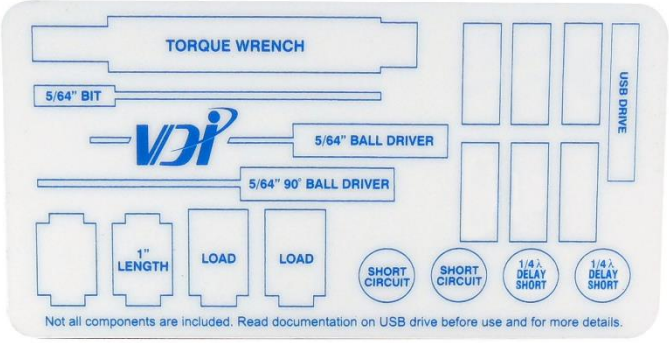


Figure 7: Type A SOLT Calibration Kit
Equipment typically supplied for Type A SOLT calibration is shown at the left. This kit's label (above) is modified to reflect typical contents.

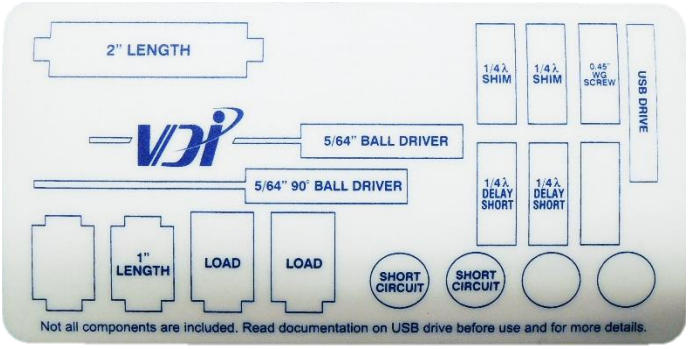


Figure 8: Type A / Type B TRL Calibration Kit
Equipment typically supplied for Type A and Type B TRL calibration is shown at the left. This kit's label (above) is modified to reflect typical contents.

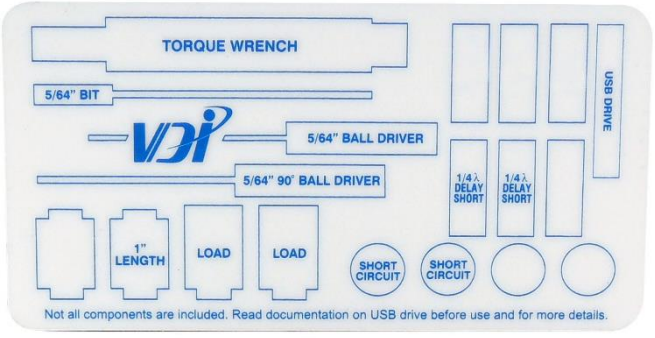


Figure 9: Type B SOLT Calibration Kit
Equipment typically supplied for Type B SOLT calibration is shown at the left. This kit's label (above) is modified to reflect typical contents.

Calibration Kit Specifications — Type A Kits

VNAX Calibration Kit Details—Type A Kits						
VDI Part Number	Description: Freq. Band (GHz)	Kit Type	Components List	Delay Length (one-way, in.±0.0002)	Cut-off Frequency (GHz)	Time Delay (one-way, ps)
WR1.0CK	750 - 1,100	SOLT	2SC, 2LD, 1SW(1”), 2QD	0.004	590.0	0.339
WR1.5CK	500 - 750	SOLT	2SC, 2LD, 1SW(1”), 2QD	0.006	393.3	0.509
WR2.2CK†	330 - 500	SOLT	2SC, 2LD, 1SW(1”), 2QD	0.010	268.2	0.848
WR2.8CK	260 - 400	SOLT	2SC, 2LD, 1SW(1”), 2QD	0.012	210.7	1.017
WR3.4CK	220 - 330	TRL	2SC, 2LD, 1SW(2”), 2QW	0.014	173.5	1.187
WR4.3CK	170 - 260	TRL	2SC, 2LD, 1SW(2”), 2QW	0.018	137.2	1.526
WR5.1CK	140 - 220	TRL	2SC, 2LD, 1SW(2”), 2QW	0.021	115.7	1.780
WR6.5CK	110 - 170	TRL	2SC, 2LD, 1SW(2”), 1QW	0.028	90.76	2.373
WR8.0CK	90 - 140	TRL	2SC, 2LD, 1SW(2”), 1QW	0.034	73.74	2.882
WR10CK†	75 - 110	TRL	2SC, 2LD, 1SW(2”), 1QW	0.042	59.00	3.560
WR12CK*†	60 - 90	TRL	2SC, 2LD, 1SW(2”), 1QW	0.050	48.36	4.238
WR15CK*†	50 - 75	TRL	2SC, 2LD, 1SW(2”), 1QW	0.063	39.86	5.339

*Includes 0.45” waveguide screws.

†Calibration kits operate over the extended frequency bands as described on Page 11

Key to Cal Kit Table Acronyms			
SOLT	Short-open-load-through calibration	**SW(1”)**	Straight Waveguide, one-inch
TRL	Through-reflect-line calibration	**SW(2”)**	Straight Waveguide, two-inch
SC	Short Circuit	**QW**	Quarter-Wave Shim
LD	Matched Load	**QD**	Quarter-Wave Delayed Short
All Calibration Kits include: A ball driver and Cal Kit definition file(s) on USB memory stick.			

Calibration Kit Specification Updates
Check our website for the latest Calibration Kit updates:
http://vadiodes.com/index.php/en/app-notes/downloads

Calibration Kit Specifications — Type B Kits

VNAX Calibration Kit Details—Type B Kits						
VDI Part Number	Description: Freq. Band (GHz)	Description: Kit Type	Description: Components List	Delay Length (one-way, in.±0.0002)	Cut-off Frequency (GHz)	Time Delay (one-way, ps)
WM250(WR1.0)CK	750 - 1,100	SOLT	2SC, 2LD, 1SW(1”), 2QD	0.0043	599.4	0.367
WM380(WR1.5)CK	500 - 750	SOLT	2SC, 2LD, 1SW(1”), 2QD	0.0063	394.3	0.534
WM570(WR2.2)CK†	330 - 500	SOLT	2SC, 2LD, 1SW(1”), 2QD	0.0094	262.9	0.801
WM710(WR2.8)CK	260 - 400	SOLT	2SC, 2LD, 1SW(1”), 2QD	0.0118	211.1	1.001
WR3.4CK	220 - 330	TRL	2SC, 2LD, 1SW(2”), 2QW	0.0142	173.4	1.201
WR4.3CK	170 - 260	TRL	2SC, 2LD, 1SW(2”), 2QW	0.0185	137.2	1.568
WR5.1CK	140 - 220	TRL	2SC, 2LD, 1SW(2”), 2QW	0.0220	115.7	1.869
WR6.5CK	110 - 170	TRL	2SC, 2LD, 1SW(2”), 1QW	0.0287	90.76	2.436
WR8.0CK	90 - 140	TRL	2SC, 2LD, 1SW(2”), 1QW	0.0346	73.74	2.936
WR10CK†	75 - 110	TRL	2SC, 2LD, 1SW(2”), 1QW	0.0425	59.00	3.604
WR12CK*†	60 - 90	TRL	2SC, 2LD, 1SW(2”), 1QW	0.0528	48.35	4.471
WR15CK*†	50 - 75	TRL	2SC, 2LD, 1SW(2”), 1QW	0.0630	39.86	5.339
WR19CK**	40 - 60	TRL	2SC, 2LD, 1SW(2”), 1QW	0.0776	31.41	6.576
WR28CK**	26 - 40	TRL	2SC, 2LD, 1SW(2”), 1QW	0.1177	21.10	9.973

*Includes 0.45” waveguide screws.
**WR28 and WR19 uses a UG-599/U-M flange. Therefore, the form factor of the calibration kit components will be different than those of other calibration kits.
†Calibration kits operate over the extended frequency bands as described on Page 11

Key to Cal Kit Table Acronyms			
SOLT	Short-open-load-through calibration	**SW(1”)**	Straight Waveguide, one-inch
TRL	Through-reflect-line calibration	**SW(2”)**	Straight Waveguide, two-inch
SC	Short Circuit	**QW**	Quarter-Wave Shim
LD	Matched Load	**QD**	Quarter-Wave Delayed Short
All Calibration Kits include: A ball driver and Cal Kit definition file(s) on USB memory stick.			

Calibration Kit Specification Updates
Check our website for the latest Calibration Kit updates:
http://vadiodes.com/index.php/en/app-notes/downloads

Extension Module Cable Sets from VDI

VDI offers a variety of cable sets to facilitate Extension Module operation. These cable sets complement various configurations described in this manual and also are designed to provide optimal performance with most contemporary network analyzers. Please contact VDI for additional details or assistance with ordering.

Cable Sets (CS) for VNA Extension modules			
	Module Configuration		
VNA Model / Length	TxRx	TxRef	Rx
Controller			
1.2m	CS-TST-TxRx-1.2	CS-TST-TxRef-1.2	CS-TST-Rx-1.2
5m	CS-TST-TxRx-5	CS-TST-TxRef-5	CS-TST-Rx-5
24 GHz and higher			
1.2m	CS-24-TxRx-1.2	CS-24-TxRef-1.2	CS-24-Rx-1.2
5m	CS-24-TxRx-5	CS-24-TxRef-5	CS-24-Rx-5
40 GHz and higher, for WR1.5 to WR0.65 modules using only Low-drive. Also, for all Mini-Modules.			
1.2m	CS-40-TxRx-1.2	CS-40-TxRef-1.2	CS-40-Rx-1.2
5m	CS-40-TxRx-5	CS-40-TxRef-5	CS-40-Rx-5
40 GHz and higher, WR1.5 to WR0.65 modules used with Low-Drive or High-Drive (adds HD RF cable)			
1.2m	CS-40-TxRx-HL-1.2	CS-40-TxRef-HL-1.2	-
Notes:			
TxRx = 2IF,LO,RF,Power; TxRef=IF,LO,RF,Power; Rx=IF,LO,Power. TxRx-HL and TxRef-HL cable sets (for high-drive and low-drive) includes an additional RF cable with a 2.4mm(m) connector.			
Cable connector type (VNA-side): Controller - IF-SMA(m), LO/RF-2.9mm(m); 24GHz & higher VNA - IF-SMA(m), LO/RF-2.9mm(f); 40GHz & higher VNA - IF-2.4mm(m), RF/LO - 2.4mm(f).			
Cable sets do not depend on the module's frequency band. Note: 5m cables are only used with VNAX modules with LO/RF frequencies <20 GHz.			
VDI modules must be configured for the proper cable length. The 5m option is required for longer cable configurations.			
Intermediate cable lengths are available by special order with longer delivery time; contact VDI for details.			

VDI presumes customers are familiar with VDI products, microwave/millimeter wave products in general and safe operation of such products. Standard VDI warranty terms apply; check warranty details at: http://vadiodes.com/index.php/en/documents?id=114:terms&catid=3. VDI offers these general guidelines; contact VDI with questions prior to operating any VDI Extension Module.

Setup Procedure: First Time PNA/PNA-X Front Panel Setup

The following procedure will set up the Keysight PNA/PNA-X family of Network Analyzers to work with VDI Extension Modules. The procedure only needs to be followed once on a particular PNA/PNA-X. If already completed on your PNA/PNA-X, skip to Page 26: 'Using VDI Extension Modules with Keysight PNA/PNA-X Systems.'

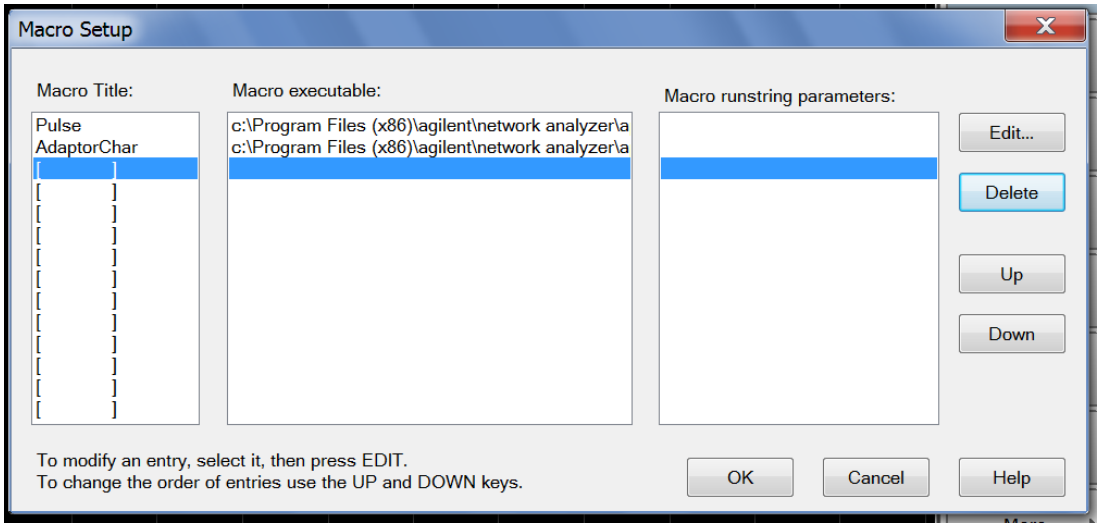
Update PNA/PNA-X Firmware

- VDI recommends installing the newest PNA/PNA-X firmware available.
- Exit the PNA/PNA-X Firmware [File] > [Exit].
- Obtain the most recent version of the firmware from Keysight at http://na.support.keysight.com/pna/firmware/firmware.html. Download the "Latest Production Release" for the appropriate PNA/PNA-X model.
- Once the firmware finishes downloading, right click on the firmware file and choose install.
- Restart the PNA/PNA-X and the new firmware will start automatically.

Load the Millimeter Wave Macro onto the PNA/PNA-X

The Millimeter Wave Macro simplifies Extension Module setup. The macro will be used to set the power levels and multiplication factors for inputs to the VDI Extension Modules. It is possible to do this setup manually through the [Stimulus] > [Frequency] > [Frequency Offset] window, but it is not recommended.

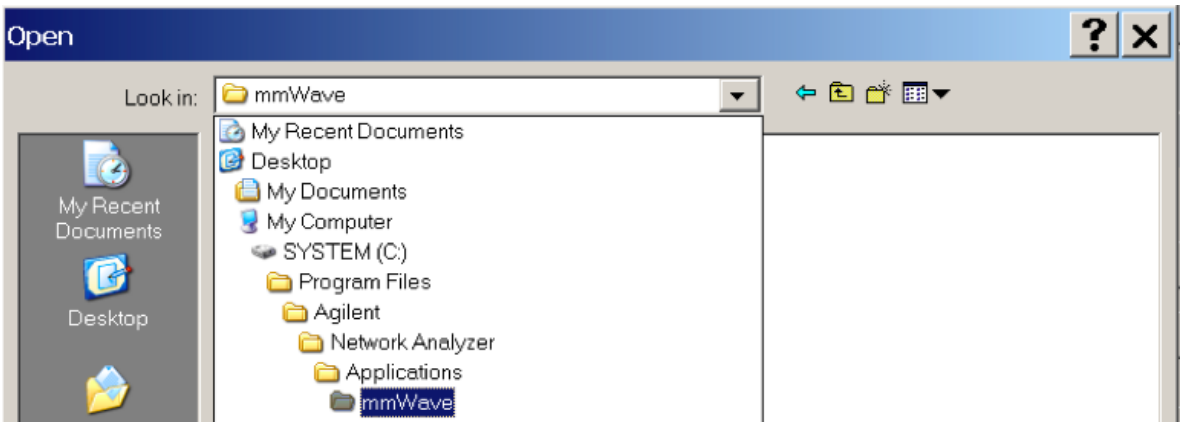
- Minimize the PNA/PNA-X Firmware [File] > [Minimize Application].
- Obtain the most recent version of the macro **"Direct Connect Millimeter Wave Macro"** from Keysight at http://na.support.keysight.com/pna/apps/applications.htm
- Right click on the downloaded "mmwave_setup.msi" file and choose install.
- Follow the on-screen instructions.
- Maximize the PNA/PNA-X Firmware.
- Navigate to [Utility] > [Macro] > [Macro Setup].
- Select an empty line and click [Edit…].



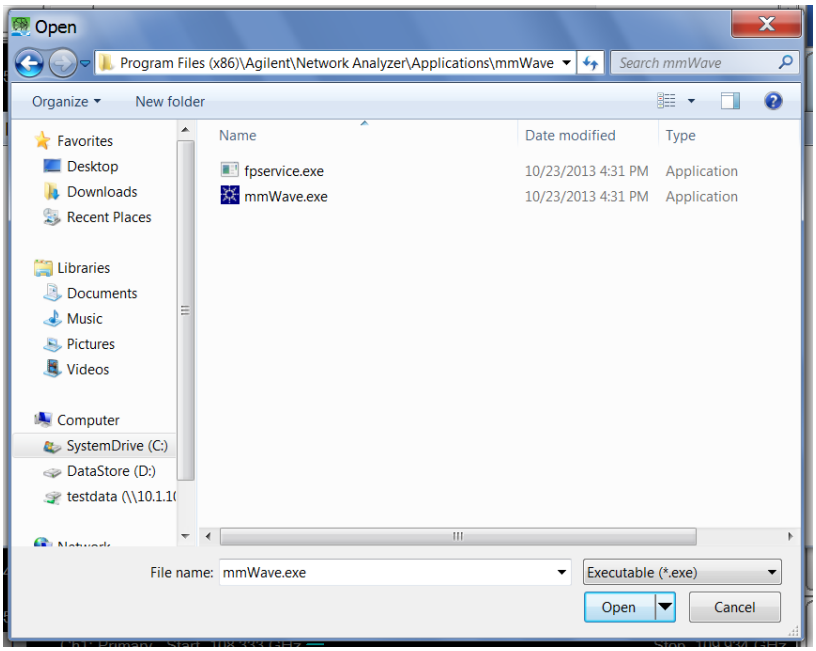
- In the 'Edit Macro Setup' window enter 'mmWave' as the 'Macro Title' and click [Browse...]

Loading Millimeter Wave Macro for PNA/PNA-X

- Navigate to **C:\Program Files\Keysight\Network Analyzer\Applications\mmWave**



- Select **mmWave.exe** and click [Open].

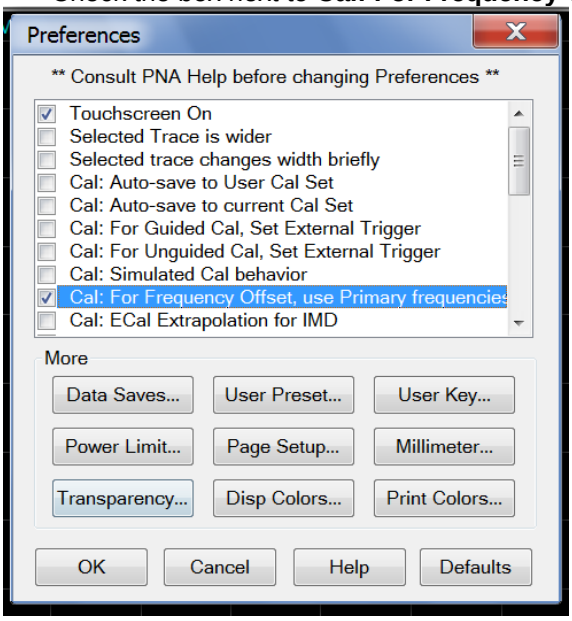


- Click [OK] twice to return to the instrument home screen

Calibration Kit Files

Set the PNA/PNA-X Preferences

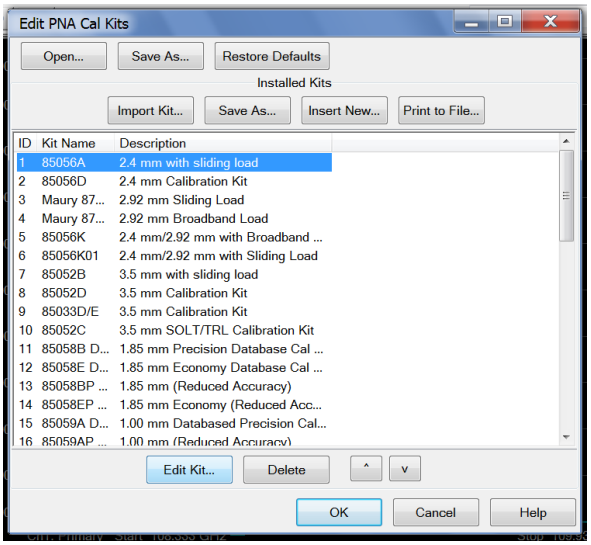
- Navigate to [Utility] > [System] > [Configure] > [Preferences].
- Check the box next to **Cal: For Frequency Offset, use Primary Frequencies**



- Click [OK]

Load Calibration Kit Files

- Minimize the PNA/PNA-X Firmware [File] > [Minimize Application].
- Obtain the most recent version of the calibration kit file from VDI at http://www.vadiodes.com/index.php/en/app-notes/downloads
- Unzip the calibration kit files.
- Maximize the PNA/PNA-X Firmware.
- Navigate to [Response] > [Cal] > [Cal Kit…].
- In the **Edit PNA Cal Kits** window that opens, click [Import Kit].



- Navigate to the unzipped calibration kit files and select the relevant file(s).
- Click [OK].
- End of procedure.

Using VDI Extension Modules with Keysight PNA/PNA-X Systems

The following procedures describe hardware and software setups using VDI Extension Modules with Keysight's PNA/PNA-X front panel. This section assumes that this particular PNA/PNA-X has been initialized by following the instructions in Appendix 4, Page 23: 'Setup Procedure: First Time PNA/PNA-X Front Panel Setup.'

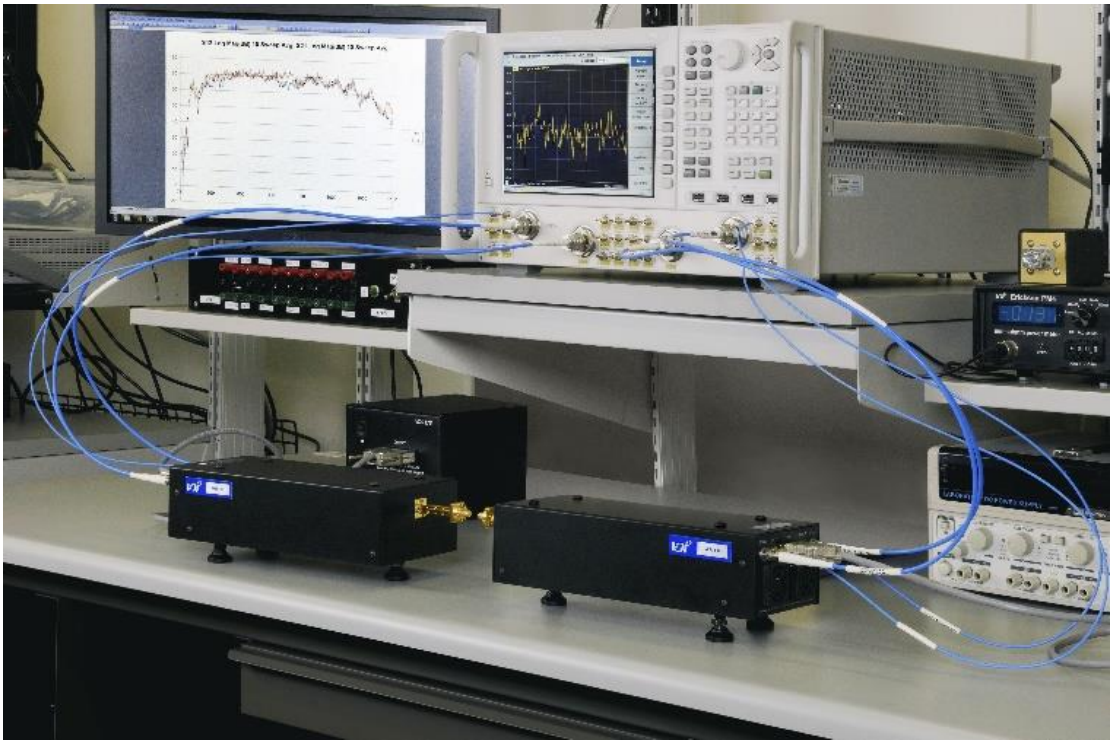
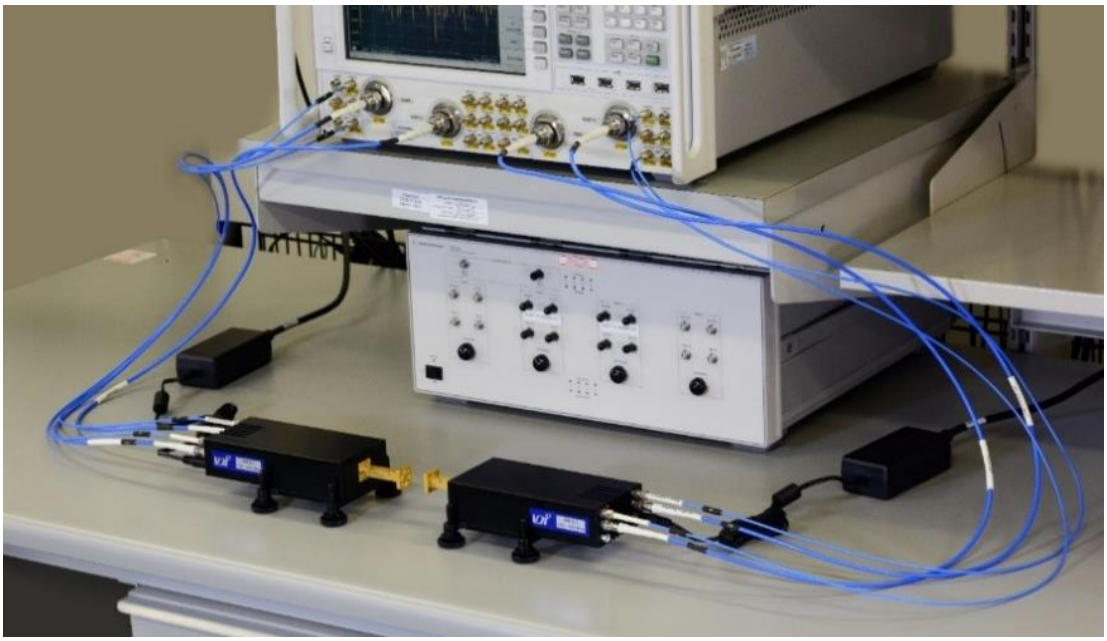


Figure 10:
Mechanical setup using VDI's Extension Modules connected for front panel operation.



Hardware Setup and Connections with VDI Extension Modules

- Place the Extension Modules on a flat surface and use the adjustable feet to align and level the test ports. When leveled properly the waveguide flanges will slide together with minimal resistance.

- For best system stability install in an area with stable conditions (temperature, humidity and airflow.)

- The adjustable feet can be removed and the six 1/4-20 threaded holes (3 per module) can be used to mount the Extension Modules. Do not allow screws to penetrate further than 0.25" into the Extension Modules.

- The bolts in the lid can be removed and the eight 1/4-20 threaded holes (4 per module) can be used to mount the Extension Modules. Do not allow screws to penetrate further than 0.25" into the Extension Modules.

Do not block or impede airflow into the air vents on the bottom or rear of the Extension Modules.

RF/LO/IF Cable Connections

- [Preset] the PNA/PNA-X
- Remove the jumpers attached to A, R1, B, R2 receivers on the front panel of the PNA/PNA-X.
- The [SOURCE OUT – CPLR THRU] jumpers must remain connected for front panel operation.
- Connect cables marked “IF” from [Ref. IF] and [Meas. IF] on the back of the first Extension Module to [RCVR R1 IN] and [RCVR A IN] respectively on the front panel of the PNA/PNA-X. See images below.

Figure 11:
Rear panel cables from the first Extension Module lead from its [Ref IF] cable connector to [RCVR R1 IN] on the analyzer’s front panel, and from the module’s [Meas. IF] cable connector to the analyzer’s [RCVR A IN] connection.

- Repeat this procedure for the second Extension Module, connecting [Ref. IF] and [Meas. IF] to [RCVR R2 IN] and [RCVR B IN] respectively. See images below.

Figure 12:
Rear panel cables from the second Extension Module lead from its [Ref IF] cable connector to [RCVR R2 IN] on the analyzer’s front panel, and from the module’s [Meas. IF] cable connector to the analyzer’s [RCVR B IN] connection.

RF/LO/IF Cable Connections

Connect cables marked “RF/LO” from [RF Input] and [LO Input] on the back of the first Extension Module to [Port 1] and [Port 3] respectively on the front panel of the PNA/PNA-X. See images below.

Figure 13:
Rear panel cables from the first Extension Module lead from its [RF Input] cable connector to [Port 1] on the analyzer’s front panel, while from the module’s [LO Input] cable is connected to the analyzer’s [Port 3] connection.

- Repeat this procedure for the second Extension Module, connecting [RF Input] and [LO Input] to [Port 2] and [Port 4] respectively. See images below.

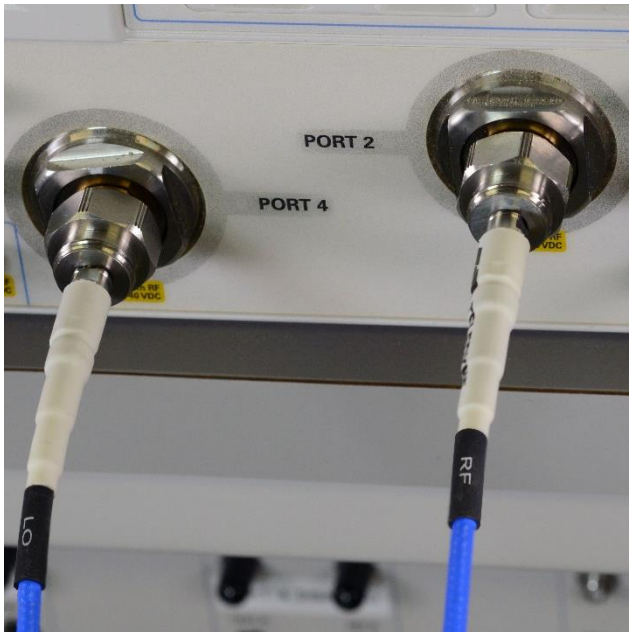


Figure 14:
Rear panel cables from the second Extension Module lead from its [RF Input] cable connector to [Port 2] on the analyzer’s front panel, while from the module’s [LO Input] cable is connected to the analyzer’s [Port 4] connection.

Connecting two VDI Extender Modules (WR28 to WR2.2) to a PNA/PNA-X network analyzer follows the same process as described on Pages 26 and 27 utilizing WR1.5 to WR0.65 Extension Modules. See Page 7 for rear panel Extension Module comparison images. Please contact VDI if you have questions about cable and port connectivity.

Powering the Extension Modules

Power Connections — WM380 (WR1.5) to WM164 (WR0.65)

- Once software is loaded, toggle the switch on the front of the VDI-175 power supplies to the ‘OFF’ (down) position;
- Plug both VDI-175’s into the AC power outlet using the included AC power cables;
- Connect each VDI-175 to one Extension Module using the included DC power cables;
- Toggle the power switch on the front of each VDI-175 power supply to the ‘ON’ (up) position;
- Contact VDI if you have power supply questions.

Power Connections — WR28 to WM570 (WR2.2)

- Once software is loaded and with the Extension Module not connected to its AC/DC power converter, connect cables from Extension Module to network analyzer as illustrated in previous pages;
- Connect the DC output power cord from the AC/DC power converter module into the port marked ‘Power’ at the rear of the Extension module;
- Connect the power converter to a 110-120V AC power outlet;
- Contact VDI if you have power supply questions.

WR1.5 to WR0.65 Module power connection port

WR1.5 to WR0.65 Modules shown with their power supplies

WR28 to WR2.2 Module power connection port

WR28 to WR2.2 Modules shown with their power supplies

Initial Navigation

- Navigate to [System] > [Configure] > [Millimeter Module Config…]
- Make sure “Standard PNA” is selected and click “OK”.

Load State File

- If no state file has previously been stored for these Extension Modules, skip to ‘Frequency Offset Mode Initialization’ on this page.
- Otherwise, navigate to [File] > [Recall…] and choose the previously saved state file.
- Skip to Appendix 6, Page 36.

Frequency Offset Mode Initialization

- Navigate to [Utility] > [Macro] > [mmWave].
- Enter **Start Frequency** and **Stop Frequency**. These correspond to the operational frequency band of the modules.
- Enter **Multiplier RF IN** and **Multiplier LO IN**. These values are fixed by VDI hardware and correspond to **Multiplier RF** and **Multiplier LO** on labels found on every Extension Module. (See illustrations below.)
- Enter **279 MHz** for the **IF Frequency**.
- Check the box labeled **mmWave LO<mmWave RF**.
- Uncheck the box labeled **Port Powers Coupled**.
- Enter **Port1 Power** and **Port2 Power.** These correspond to **VNA Output Power RF** according to the RF Drive Label, plus any cable dependent loss—See Appendix 8, Page 44.
- Enter **LO1 Power** and **LO2 Power.** These correspond to **VNA Output Power LO** according to the input power listed in the label, plus any cable dependent loss—See Appendix 8, Page 44.
- Click [Calculate], then click [Apply], then click [OK].

Figure 15:
Refer to ‘RF Drive Labels’ on your Extension Modules when entering values during mmWave Setup including input power and frequency multiplication factors, plus any cable-dependent loss (see Appendix 8 for cable loss data). Labels shown above are only samples; every Extension Module has input levels tailored to it; adhere to levels found on your Extension Modules’ labels.

Save State File

- Toggle RF Power ‘OFF’;
- Navigate to [File] > [Save As]. Choose a save location and filename and save as a ‘type **.sta**’ file;
- Loading this file at a later date will recall the Frequency Offset Settings as well as IF Bandwidth, Number of Points, Displayed Traces, etc.;
- Appendix 6, Page 36 ‘Operators Check—Wave Quantities, Dynamic Range and Subset Tests’ offers more test information;
- End of procedure.

First Time Setup with a Millimeter Wave Controller

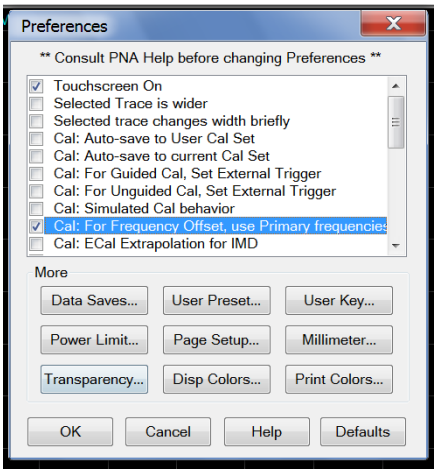
The Millimeter-Wave Controller provides the interface between a maximum of four millimeter-wave test head modules and a PNA/PNA-X series network analyzer. The following procedure will set up the Keysight PNA/PNA-X family of Network Analyzers to work with the VDI Extension Modules via a Millimeter-Wave Controller. The procedure only needs to be followed once on a particular PNA/PNA-X. If already completed on this PNA/PNA-X, go to Page 33: 'Millimeter-Wave Controller Hardware & Software Setup.'

Update PNA/PNA-X Firmware

- VDI recommends installing the newest PNA/PNA-X firmware; to do so, exit the PNA/PNA-X Firmware [File] > [Exit].
- Obtain the most recent version of the firmware from Keysight at: http://na.support.keysight.com/pna/firmware/firmware.html. Download the "Latest Production Release" for the appropriate PNA/PNA-X model.
- Once the firmware finishes downloading, right-click on the firmware file and choose [Install].
- Restart the PNA/PNA-X and the new firmware will start automatically.

Set PNA/PNA-X Preferences

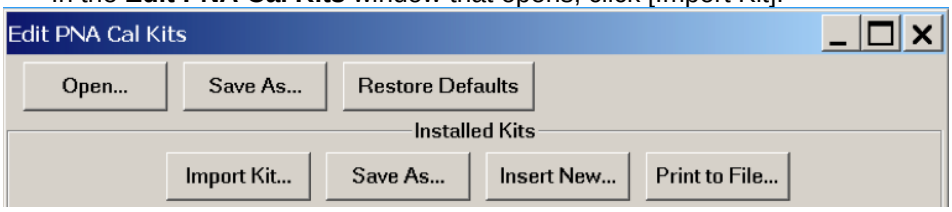
- Navigate to [Utility] > [System] > [Configure] > [Preferences].
- Check the box next to **Cal: For Frequency Offset, use Primary Frequencies**



- Click [OK].

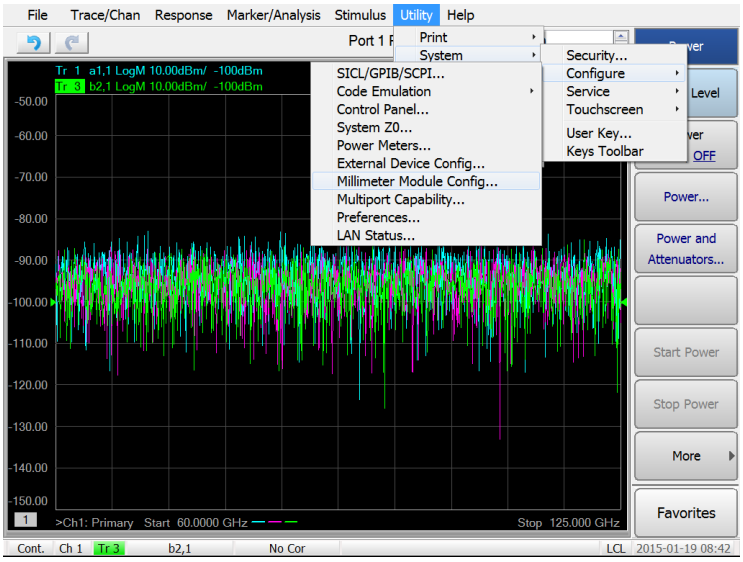
Load Calibration Kit Files

- Minimize the PNA/PNA-X Firmware [File] > [Minimize Application].
- Obtain the most recent version of the calibration kit file from VDI at: http://www.vadiodes.com/index.php/en/app-notes/downloads
- Unzip the calibration kit files.
- Maximize the PNA/PNA-X Firmware.
- Navigate to [Response] > [Cal] > [Cal Kit…].
- In the **Edit PNA Cal Kits** window that opens, click [Import Kit].

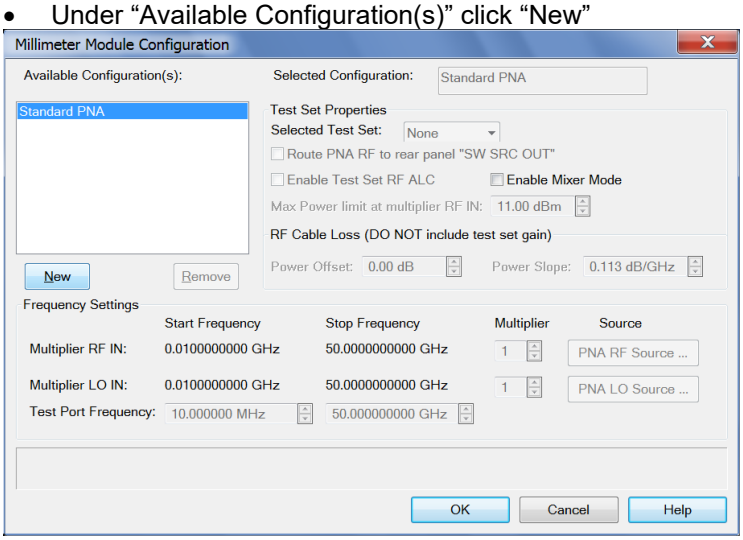


- Navigate to the unzipped calibration kit files and select the relevant file(s).
- Click [OK].

Navigate to [Utility] > [System] > [Configure] > [Millimeter Module Config…]



- Under “Available Configuration(s)” click “New”



- Enter a configuration name in the “Selected Configuration” text box.
- In the “Selected Test Set” menu, choose your Millimeter-Wave Controller model from the drop-down list.
- Toggle the “Enable Test Set RF ALC” on.
- Enter the RF and LO multipliers as specified in the Extension Module labels. See Page 6 for location information.
- Enter the start and stop frequencies according to the operational frequency band of the modules.
- Click OK to apply configuration. The Millimeter-Wave Controller will preset the PNA/PNA-X.
- For more information about the Millimeter Module Configuration Window, refer to: N5261A and N5262A Millimeter Head Controller User’s Guide
- End of procedure.

It is important for operators to ensure that power input to VDI Extension Modules does not exceed recommended power levels by more than 6 dB; recommended levels can be found on every module’s labeling. Power input levels of 6 dB (or greater) than recommended amounts can cause non-optimal performance and possibly result in lasting damage, depending upon how far recommended levels are exceeded.

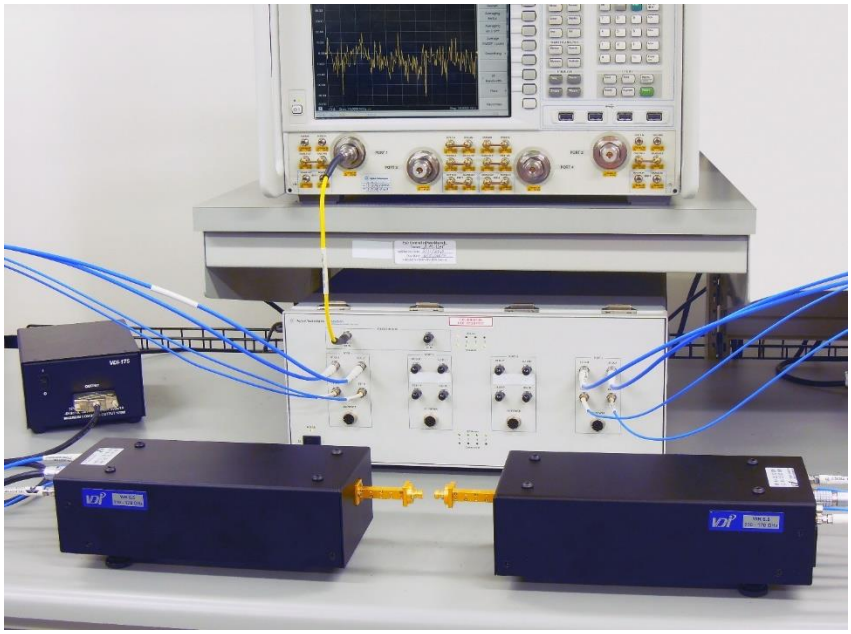


Figure 16:
Typical VDI bench setup showing Extension Modules connected for millimeter wave controller operation.

Millimeter Wave Controller Hardware and Software Setup

The following procedure describes the hardware and software setup of VDI Extension Modules using the Keysight Millimeter-Wave Controller. This section assumes that this particular Millimeter-Wave Controller has been initialized by following the instructions in Appendix 5, Page 31: 'First Time Millimeter-Wave Controller Setup.'

Mechanical Setup

In order to collect data using the Millimeter-Wave Controller and analyze it on a PNA/PNA-X, the RF, LO, and IF connections must be routed properly between the two Extension Modules and the Controller. The setup below references the specific case of routing the RF through the front, and all other connections through the rear panels, for an N5262A Millimeter-Wave Controller (option 700) interfacing with a PNA-X. Refer to: N5261A and N5262A Millimeter Head Controller User's Guide for connection guides for your specific model Controller and options.

- Place the Extension Modules on a flat surface and use the adjustable feet to align and level the test ports. When leveled properly the waveguide flanges will slide together with minimal resistance.
- For best system stability install in a location with constant temperature and minimal airflow.
- The adjustable feet can be removed and the six 1/4-20 threaded holes can be used to mount the Extension Modules. Do not allow screws to protrude further than 0.25" into the Extension Modules.
- The bolts in the lid can be removed and the eight 1/4-20 threaded holes (4 per module) can be used to mount the Extension Modules. Do not allow screws to penetrate further than 0.25" into the Extension Modules.

Do not block or impede airflow into the air vents on the bottom or rear of the Extension Modules.

RF / LO / IF Cable Connections

- Connect a jumper cable between the PNA/PNA-X Port 1 and the Millimeter-Wave Controller SRC1 RF IN as shown in Photo A.
- RF Out, LO Out, Test IF and Ref IF cables are shown correctly connected in Photos B & D.
- Ensure that both SRC RF IN ports are attached via jumper to the SRC RF OUT ports on the rear panel of the Millimeter-Wave Controller as shown in Photo C.
- Connect cables marked “IF” from [Ref. IF] and [Meas. IF] on the back of each Extension Module to [REF IF] and [TEST IF] respectively on the Millimeter-Wave Controller.
- Connect cables marked “RF” and “LO” from [RF Input] and [LO Input] on the back of each Extension Module to [RF OUT] and [LO OUT] respectively on the Millimeter-Wave Controller.

Photo A

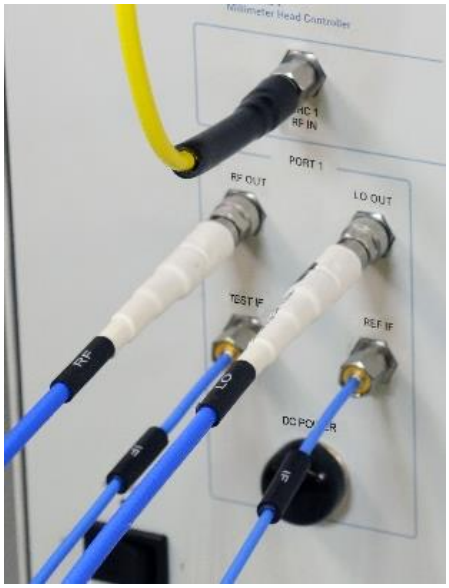


Photo B

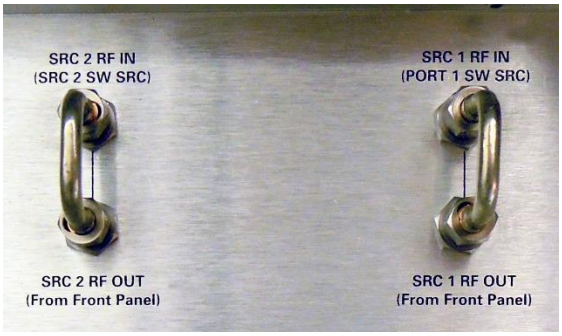


Photo C

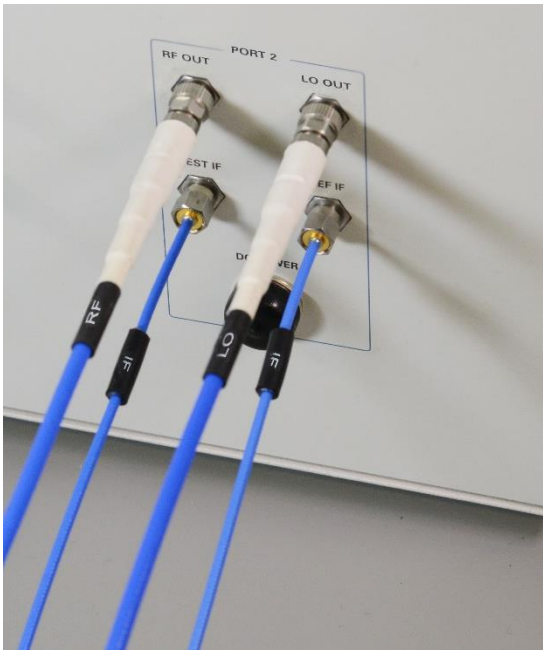


Photo D

Power Connections with Extension Modules

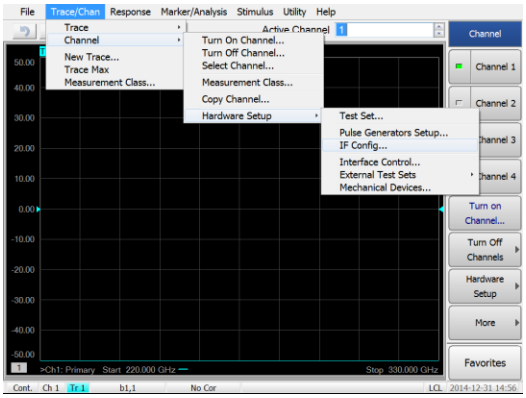
- Once software is loaded, toggle the switch on the front of the VDI-175 power supplies to the 'OFF' (down) position;
- Plug both VDI-175's into the AC power outlet using the included AC power cables;
- Connect each VDI-175 to one Extension Module using the included DC power cables;
- Toggle the power switch on the front of each VDI-175 power supply to the 'ON' (up) position;
- WR28 to WR2.2 Extension Modules connect to their power source in a similar fashion as WR1.5 to WR0.65 Extension Modules, except the VDI-175 is replaced with a universal AC/DC converter. See Page 29 for details.
- Contact VDI if you have power supply questions.

Load Configuration File

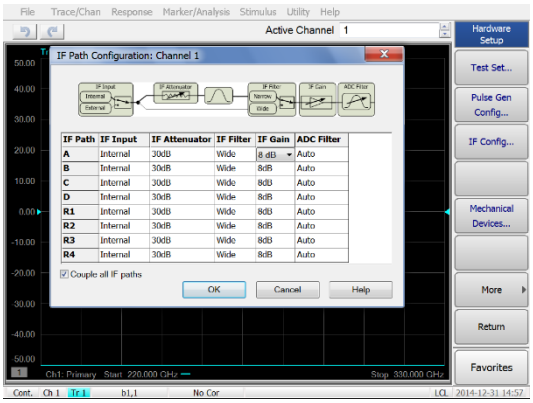
- Navigate to [Utility] > [System] > [Configure] > [Millimeter Module Config…]
- Under "Available Configuration(s):" select a pre-saved configuration state and click 'OK' to preset the PNA/PNA-X and Controller.
- If no configuration state has been created for these Extension Modules, skip to Page 32: 'Millimeter Module Configuration.'

IF Gain Configuration

- Navigate to [Trace/Chan] > [Channel] > [Hardware Setup] > [IF Config…]



- Select [8dB] from the dropdown list and toggle the "Couple all IF paths" checkbox
- Click 'OK'
- End of procedure.



This operator's check section is designed to provide a high degree of confidence that the Extension Modules and PNA/PNA-X are performing properly. The following tests should be performed any time you wish to reaffirm that the system is working well or to test following any time you have made modification to basic test scenarios. This operator's check does not verify performance to all specifications.

Check Wave Quantities

- Navigate to [Stimulus] > [Sweep] > [Number of Points]. Set this to 1201.
- Navigate to [Response] > [Avg] > [IF Bandwidth]. Set this to 1kHz.
- Add traces **[A,1] [B,2] [R1,1]** and **[R2,2]**.
- Terminate the waveguide test ports of the two Extension Modules with Short Circuits.
- Turn on the VDI-175 Power Supplies; or plug in the AC/DC converter if using WR28 to WR2.2 Extension Modules.
- Turn on PNA/PNA-X RF Power.
- Compare the traces on screen to the sample performance plot provided below. The shapes of the curves should be similar if the system is working properly.
    - All four traces should be of similar shape and level.
    - Peak levels should be between 0 dB and 15 dB.
    - Traces should reasonably flat and not have substantial dropouts or edge effects.
- VDI recommends saving wave quantity traces as a reference of system performance.

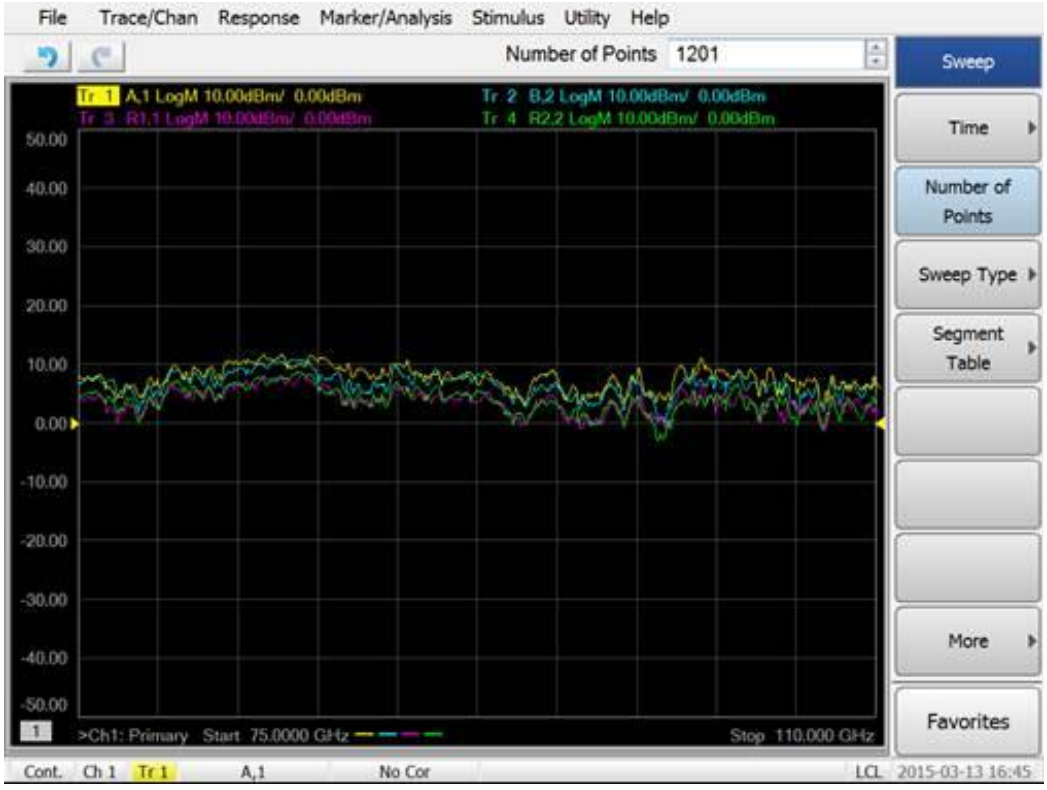


Figure 17:
Typical Wave Quantity data check results from a WR10 system (dB). Measurement was made using the procedure described above. Actual wave quantities will vary depending on VNAX and PNA/PNA-X models. For the N5222 units, the reference receiver traces display ~10dB lower than other PNA/PNA-X models.

Dynamic Range Check

This test should be performed any time you wish to reaffirm confidence in system operation. This operator's check does not verify performance to all specifications.

Check Dynamic Range

- Navigate to [Stimulus] > [Sweep] > [Number of Points]. Set this to 1201.
- Navigate to [Response] > [Avg] > [IF Bandwidth]. Set this to 10Hz.
- Add traces for S-parameters corresponding to chosen source ports.
- Add traces **[S12]** and **[S21]**.
- Connect the waveguide test ports of the two Extension Modules directly together.
- Turn on the VDI-175 Power Supplies; or plug in the AC/DC converter if using WR28 to WR2.2 Extension Modules.
- Turn on PNA/PNA-X RF Power.
- After one sweep completes, [Marker/Analysis] > [Memory] > [Normalize] on both traces. The resulting graph on screen should be flat at 0dB.
- Disconnect the waveguide test ports of the Extension Modules and terminate them with Short Circuits.
- Compare the traces on screen to the Dynamic Range data provided in Appendix 1. Note that the data shown in Appendix 1 is a ten sweep RMS average; the data shown on your screen will have larger amplitude variation, but same average level.
- The example of typical single sweep dynamic range for WR10 modules is shown below in Figure 18—yours should be similar if the system is working properly.
- End of procedure.

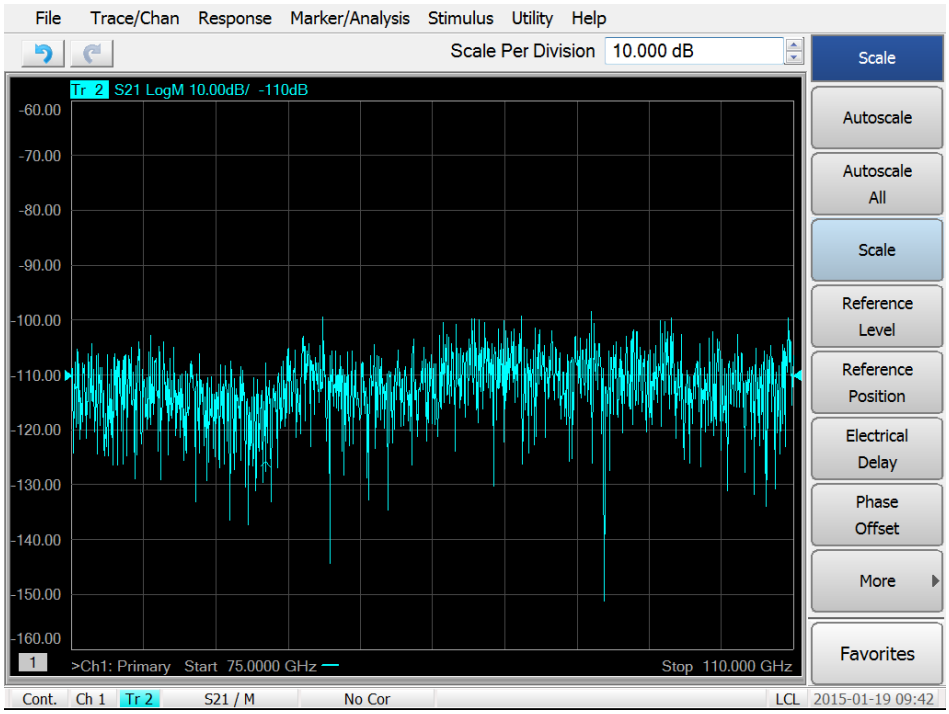


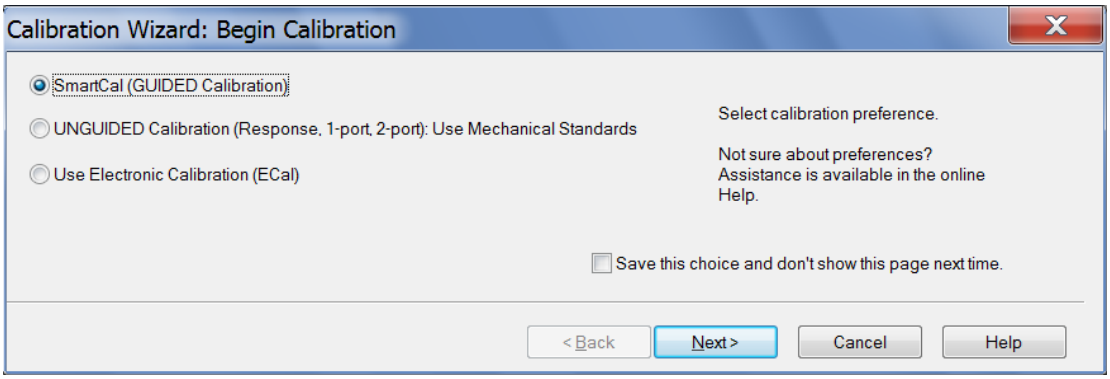
Figure 18:
Typical Single Sweep Dynamic Range data from a WR10 system (dB). Measurement made using procedure described above.

TRL and SOLT Calibration Procedures

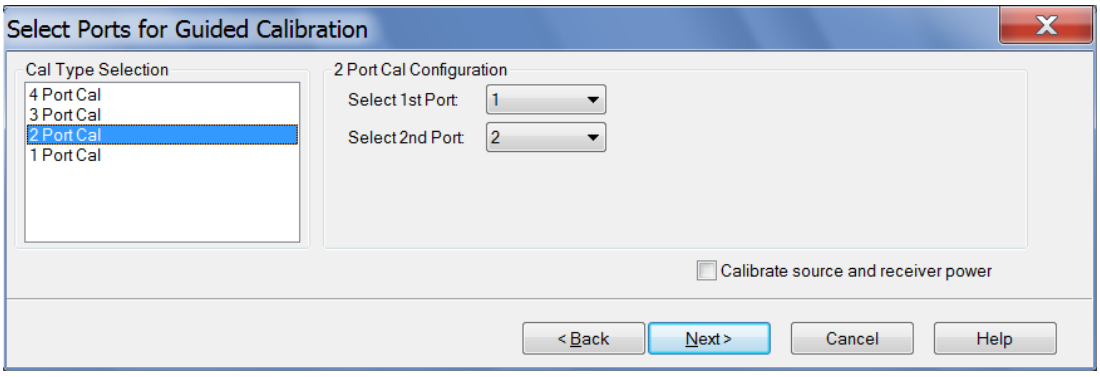
VDI Calibration Kits from WR15 through WR3.4 are designed for the TRL calibration procedure but can also be used to perform SOLT calibration. VDI Calibration Kits from WR2.8 through WR1.0 are designed for the SOLT calibration procedure. VDI Calibration Kits can also be used to perform a variety of other procedures; however these are not covered in this document.

The TRL Calibration Procedure

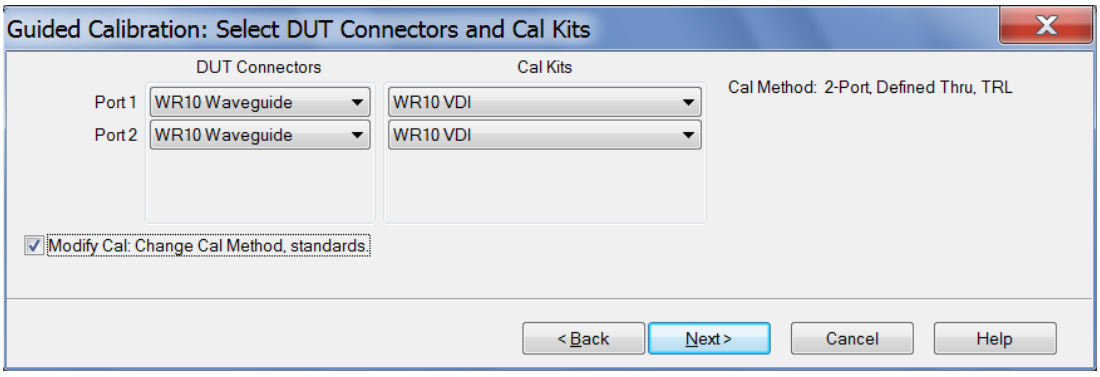
- VDI typically performs calibrated measurements using 1 kHz RBW and 1001 points. These values should be optimized based on the goals of the measurement.
- Navigate to [Response] > [Cal Wizard]
- Select the “SmartCal” bullet and click [Next >]



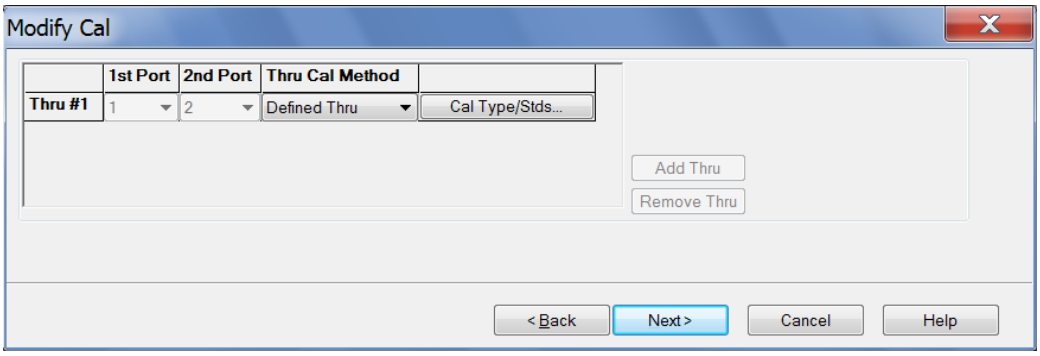
- Choose “2 Port Cal” with Ports 1 and 2 and click [Next >]



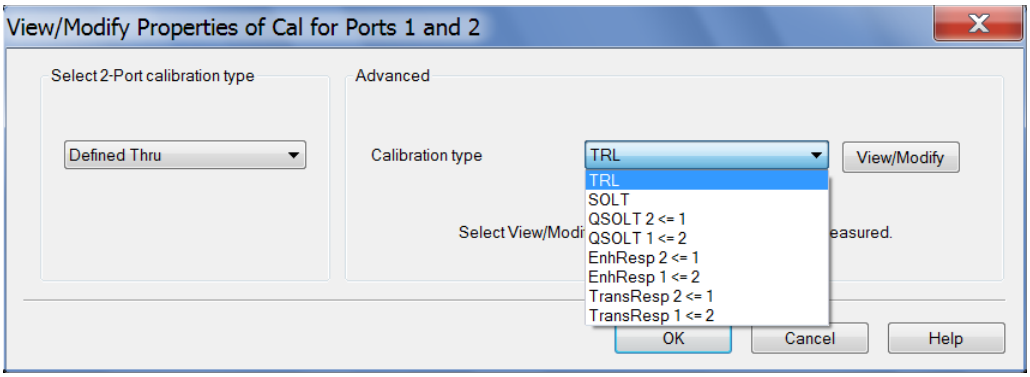
- Select the appropriate waveguide band and check “Modify Cal: Change Cal Method, standards” then click [Next >]



- Click [Cal Type/Stds…]



- Choose “TRL” from the “Calibration type” dropdown menu and click [OK]



- Click [Next >]
- Follow the on screen instructions and measure the calibration standards when prompted
- When the waveguide calibration procedure is complete, verify the calibration by connecting a straight waveguide between the two modules and measuring through parameters.
- End of procedure.

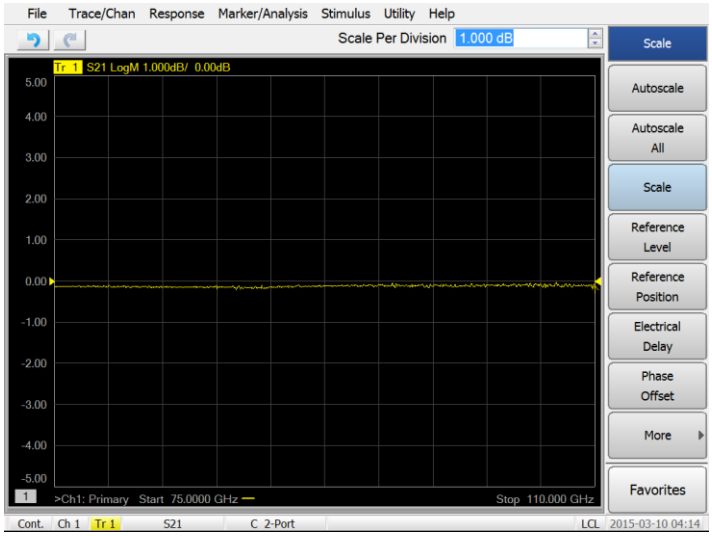
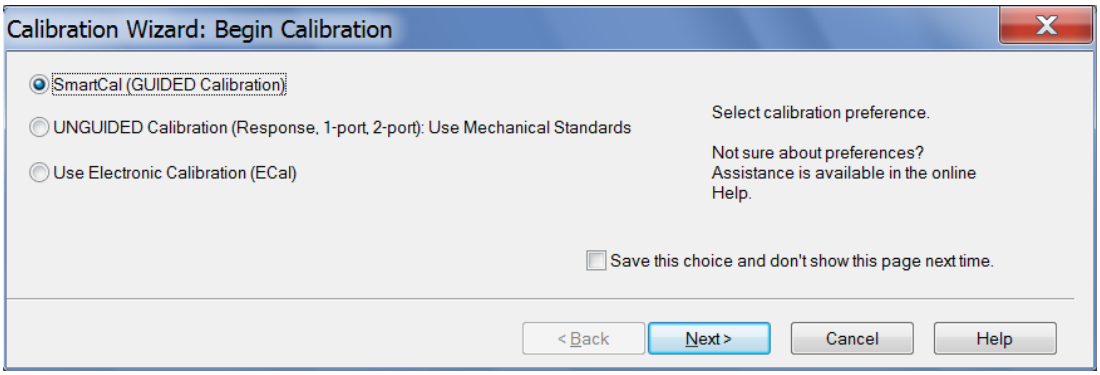


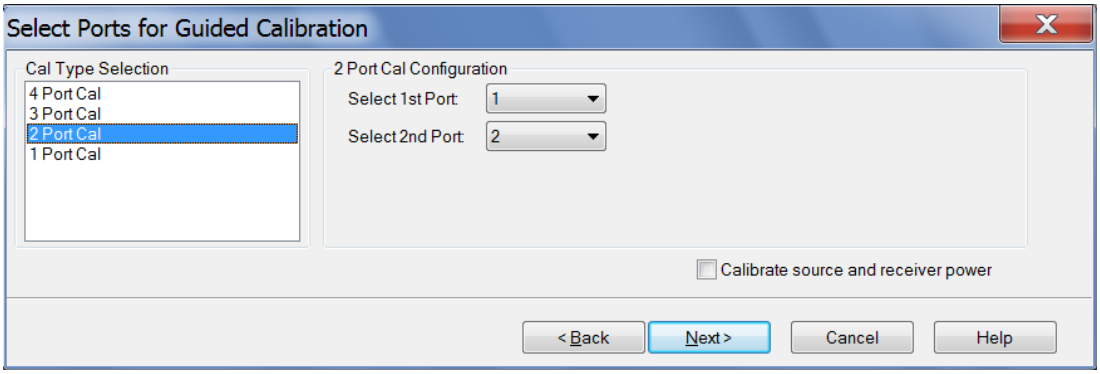
Figure 19:
S-Parameters for a 1” Straight Waveguide measured at WR10 (75-110 GHz) after a typical calibration.

The SOLT Procedure

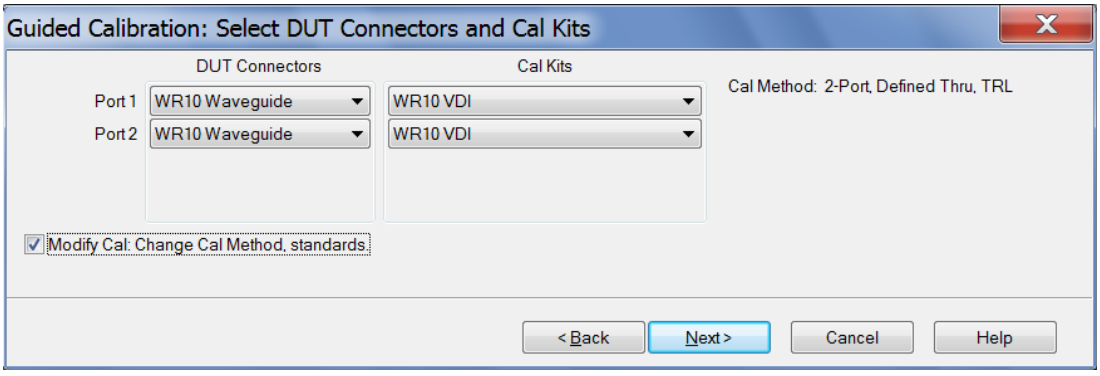
- VDI typically performs calibrated measurements using 1 kHz RBW and 1001 points. These values should be optimized based on the goals of the measurement.
- Navigate to [Response] > [Cal Wizard]
- Select the “SmartCal” bullet and click [Next >]



- Choose “2 Port Cal” with Ports 1 and 2 and click [Next >]

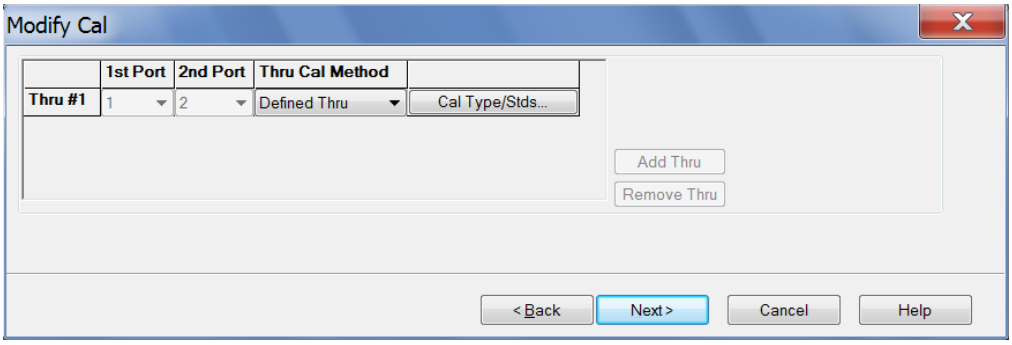


- Select the appropriate waveguide band and check “Modify Cal: Change Cal Method, standards” then click [Next >]

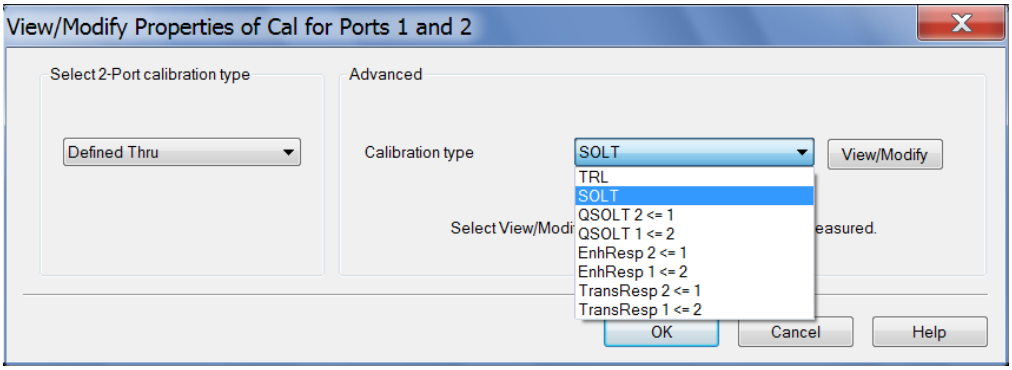


SOLT Calibration

- Click [Cal Type/Stds…]



- Choose “SOLT” from the “Calibration type” dropdown menu and click [OK]



- Click [Next >]
- Follow the on-screen instructions and measure the calibration standards when prompted
- When the calibration procedure is complete, verify the calibration by connecting a straight waveguide terminated with a short circuit to each module and measure the reflect parameters.
- End of procedure.

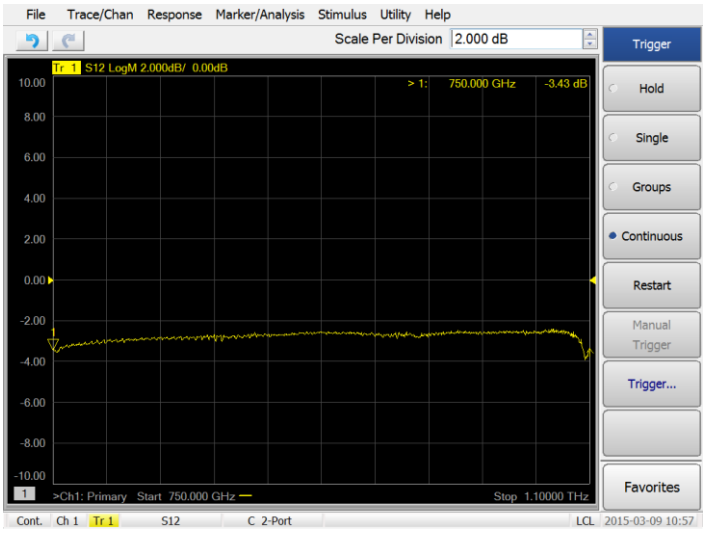


Figure 20:
S21 for a 1-inch straight waveguide measured at WR1.0 (750-1,100 GHz) after a typical calibration.

Saving Calibration States

After calibrating it is possible to save the calibration parameters. This file can later be loaded to provide a calibrated state and allow the user to quickly make measurements. Since the calibration is affected by cable motion, lab temperature, and system warm-up, results will not be as precise as a fresh calibration.

- Navigate to [File] > [Save As…]
- Choose a location and filename and save as type “.csa”
- End of procedure.

Setup Procedure

For first time setup of the VDI Extension Module, please refer to Appendix 4, Page 23.

Standard Operation

The high sensitivity system can be used in a manner similar to a standard system by affixing the included waveguide attenuator to the Rx module. It is possible to perform a waveguide calibration using the system in this configuration. This configuration is used by VDI to characterize performance of the Rx Module.

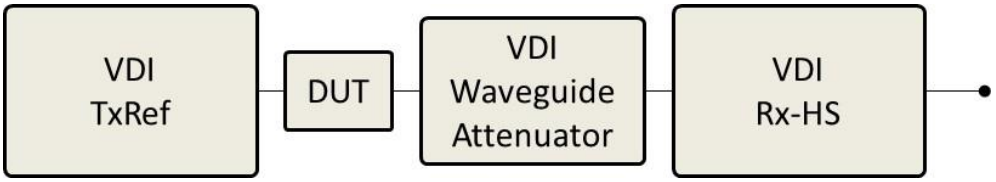


Figure 21:
Block diagram of the standard operation mode of a High Sensitivity Receiver.

Maximum Sensitivity Operation

To use the system for maximum sensitivity capability, the included waveguide attenuator should not be utilized in the test setup. Verify that the loss of DUT is high enough to avoid damage or saturation of the VDI Rx Module. For best results the output signal should be amplified, but should not exceed the saturation limit of the measurement device. Please contact VDI with any questions before configuring your Extension Module for high sensitivity operations.

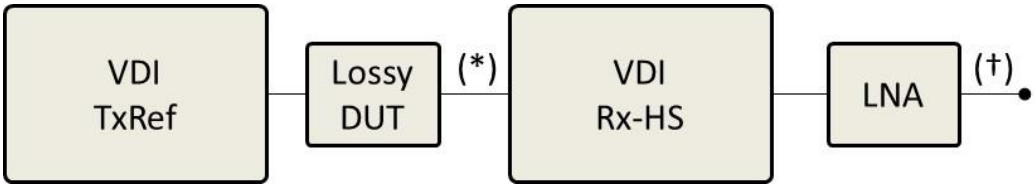


Figure 22:
Block diagram of Maximum Sensitivity Operation mode.
* See RF Drive Limit labels on the Rx Module.
† Amplify signal for maximum sensitivity.

VDI Extension Modules can be optimized for high loss DUTs such as antenna ranges and lossy wafer probes. This configuration takes advantage of the high sensitivity inherent in our receiver modules to allow for up to 150 dB of enhanced dynamic range, overcoming up to 30 dB of path loss in the measurement.

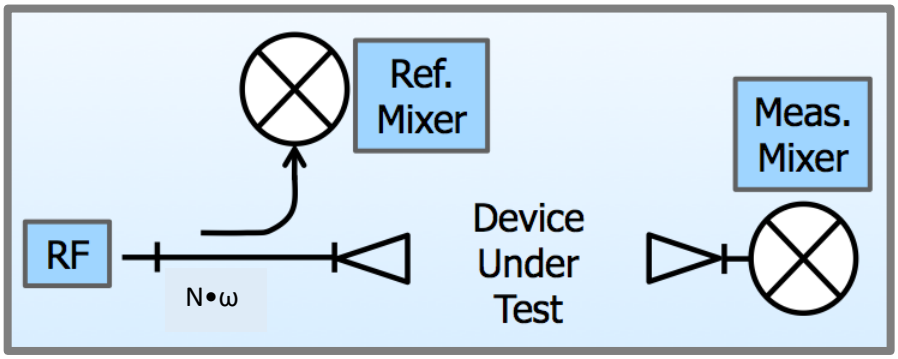


Figure 23:
A typical enhanced S21 configuration consists of one high power TxRef module on Port 1 and a high sensitivity Rx module (Rx-HS) on Port 2.

Technical Note: Measurement of dynamic range is often limited by receiver saturation, rather than transmitter power. For lossy samples, saturation is alleviated, allowing use of greater Tx power and/or higher Rx sensitivity.

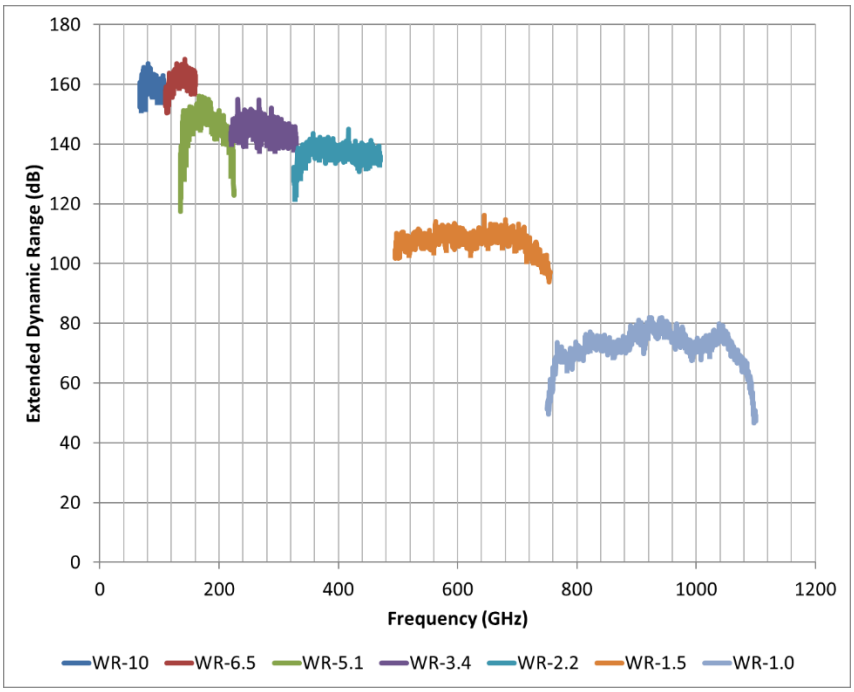


Figure 24:
The traces shown above depict characteristic enhanced dynamic range performance that can be achieved with VDI Extension Modules.

Cable Characterization

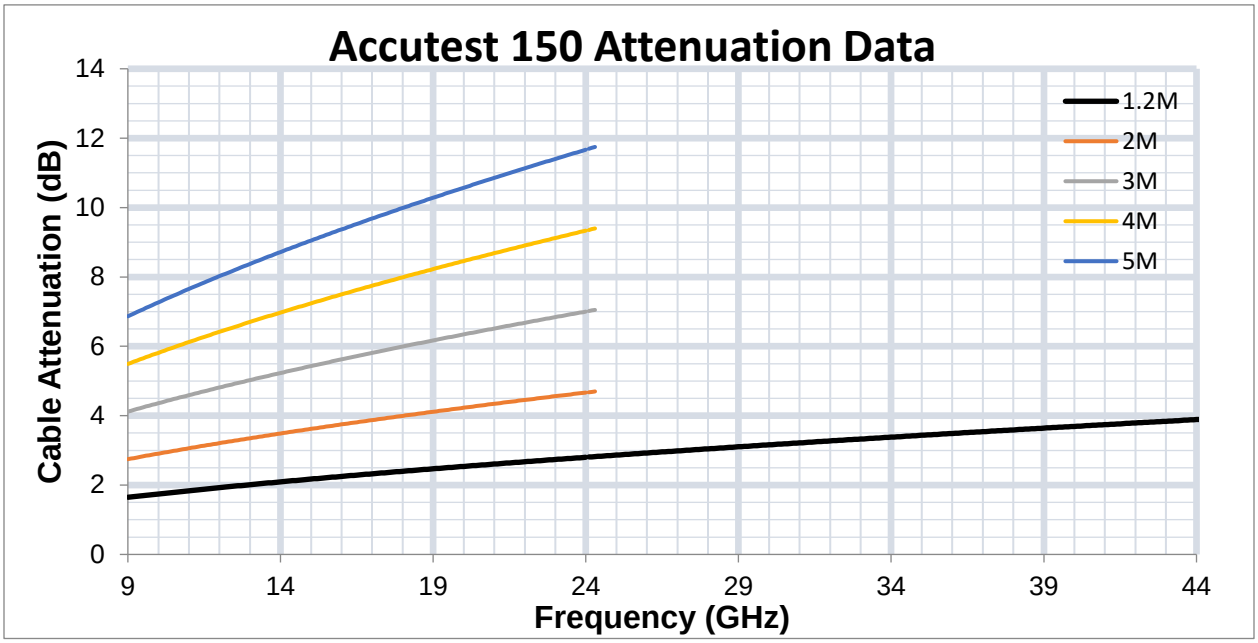
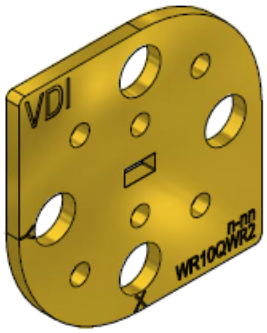
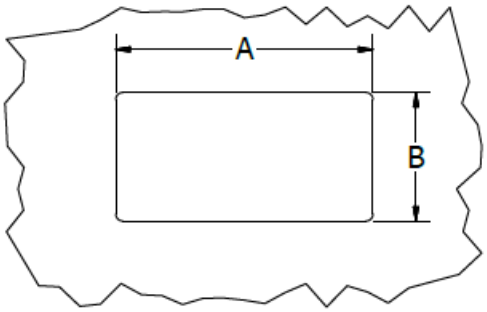


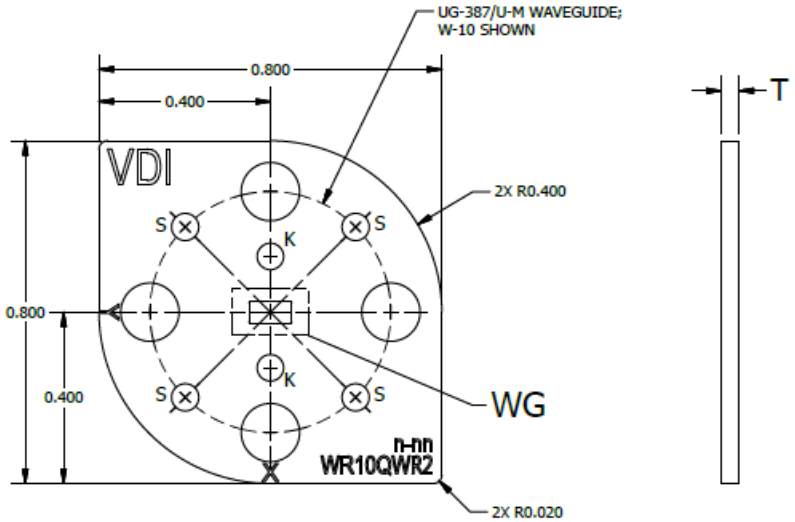
Figure 25:
Insertion Loss of Accutest 150 (RF/LO Cable) with respect to frequency. This chart can be used to calculate cable losses in your system.

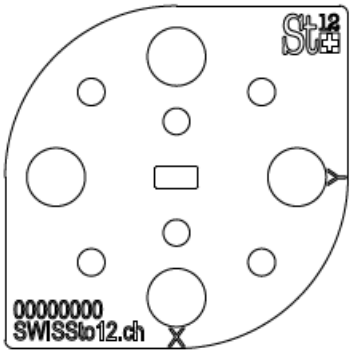




DETAIL WG - 6X SCALE

WAVEGUIDE TABLE			
DIMENSION	- A -	- B -	- T -
WR-15	0.1480 in	0.0740 in	0.0630 in
WR-12	0.1220 in	0.0610 in	0.0528 in
WR-10	0.1000 in	0.0500 in	0.0425 in
WR-8.0	0.0800 in	0.0400 in	0.0346 in
WR-6.5	0.0650 in	0.0325 in	0.0287 in
WR-5.1	0.0510 in	0.0255 in	0.0220 in
WR-4.3	0.0430 in	0.0215 in	0.0185 in
WR-3.4	0.0340 in	0.0170 in	0.0142 in
WM-710 (WR-2.8)	0.0280 in	0.0140 in	0.0118 in
WM-570 (WR-2.2)	0.0224 in	0.0112 in	0.0094 in
WM-470 (WR1.9)	0.0185 in	0.0093 in	0.0079 in
WM-380 (WR1.5)	0.0150 in	0.0075 in	0.0063 in
WM-310 (WR-1.2)	0.0122 in	0.0061 in	0.0051 in
WM-250 (WR-1.0)	0.0098 in	0.0049 in	0.0043 in
WM-200 (WR-0.8)	0.0079 in	0.0039 in	0.0035 in
WM-164 (WR-0.65)	0.0065 in	0.0032 in	0.0028 in
WM-130 (WR-0.51)	0.0051 in	0.0026 in	0.0024 in
WM-106 (WR-0.43)	0.0042 in	0.0021 in	0.0020 in
WM-86 (WR-0.34)	0.0034 in	0.0017 in	0.0016 in





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979 2nd ST. SE, SUITE 309
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www.virginiadiodes.com

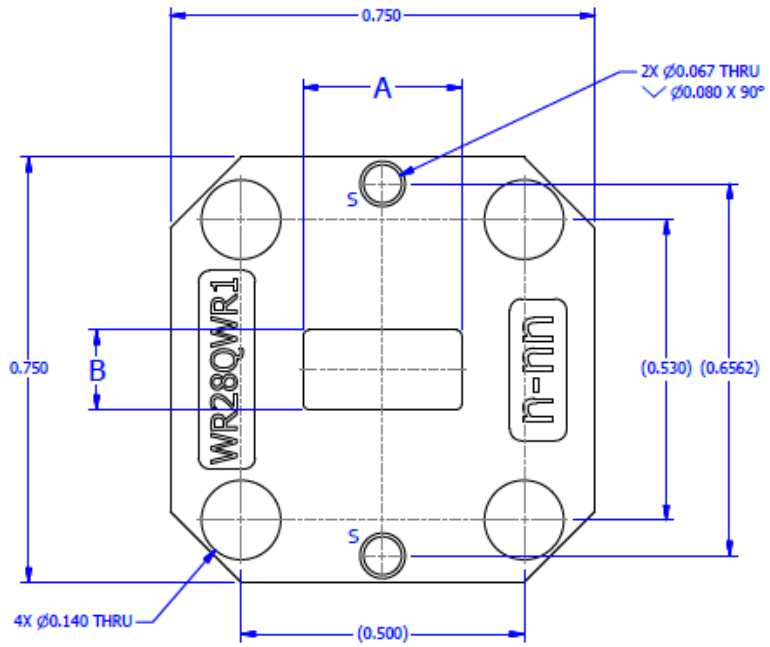
TITLE:	MATERIAL:		
PRECISION CALIBRATION SHIM (QW)		LAST REV. DATE: 7/28/2014	SHEET: 1 OF 1
MODEL #: WR-10QW		LAST REV.: R3V1	UNITS: INCH

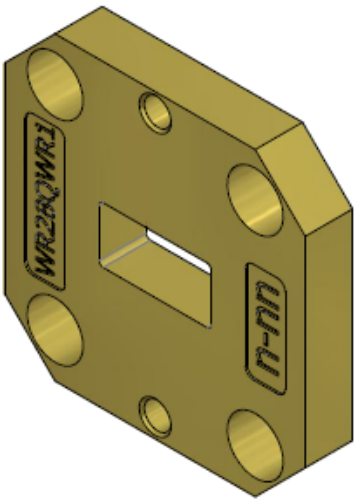
NOTE: SPECIFICATIONS AND CHARACTERISTICS ARE TYPICAL AND SUBJECT TO CHANGE AT ANY TIME.

Mechanical Drawing — Precision Calibration Shim (WR28 to WR19)

THE INFORMATION CONTAINED IN THIS DOCUMENT IS THE PROPRIETARY PROPERTY OF VIRGINIA DIODES, INC.

SHIM DIMENSION TABLE				
WAVEGUIDE	- A -	- B -	- T -	PART NUMBER MARKING
WR-28	0.2800	0.1400	0.1177	WR28QWR1
WR-22	0.2240	0.1120	0.0945	WR22QWR1
WR-19	0.1880	0.0940	0.0776	WR19QWR1





NOTE: SPECIFICATIONS AND CHARACTERISTICS ARE TYPICAL AND SUBJECT TO CHANGE AT ANY TIME.

TITLE: MILLED CALIBRATION SHIM WR-19, WR-22, & WR-28	MATERIAL: ALUMINUM ALLOY (MAY BE GOLD PLATED)	
	LAST REV. DATE: 5/10/2018	SHEET: 1 OF 1
MODEL #: WR28QW (SHOWN)	LAST REV.: R1V2	UNITS: INCH

Virginia Diodes, Inc.

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www.virginiadiodes.com

Mechanical Drawing — Precision Calibration Delay

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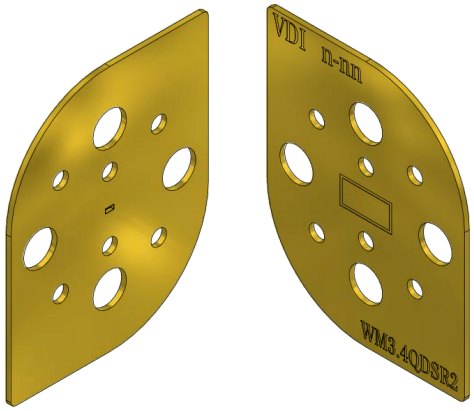
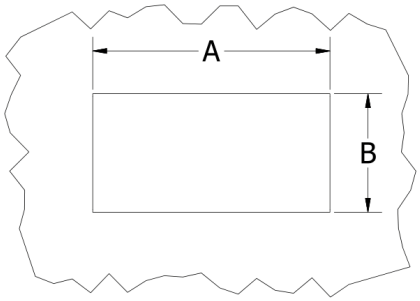
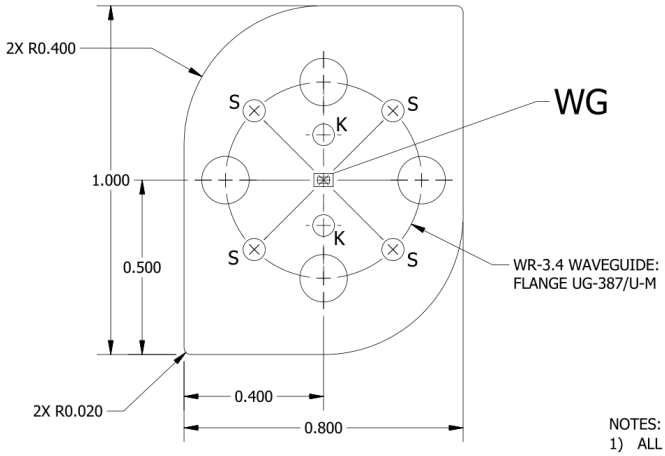
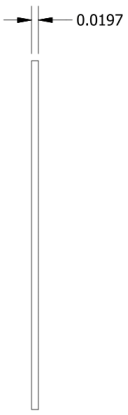


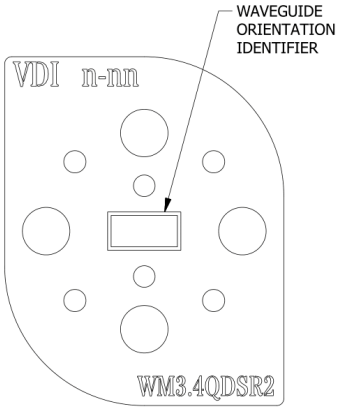


DETAIL WG - 20X SCALE

WAVEGUIDE TABLE			
DIMENSION	- A -	- B -	- D -
WR-3.4	0.0340 in	0.0170 in	0.0142 in
WM-710 (WR-2.8)	0.0280 in	0.0140 in	0.0118 in
WM-570 (WR-2.2)	0.0224 in	0.0112 in	0.0094 in
WM-470 (WR1.9)	0.0185 in	0.0093 in	0.0079 in
WM-380 (WR1.5)	0.0150 in	0.0075 in	0.0063 in
WM-310 (WR-1.2)	0.0122 in	0.0061 in	0.0051 in
WM-250 (WR-1.0)	0.0098 in	0.0049 in	0.0043 in
WM-200 (WR-0.8)	0.0079 in	0.0039 in	0.0035 in
WM-164 (WR-0.65)	0.0065 in	0.0032 in	0.0028 in
WM-130 (WR-0.51)	0.0051 in	0.0026 in	0.0024 in
WM-106 (WR-0.43)	0.0042 in	0.0021 in	0.0020 in
WM-86 (WR-0.34)	0.0034 in	0.0017 in	0.0016 in







NOTES:
1) ALL DIMENSIONS IN INCHES, UNLESS NOTED OTHERWISE.
2) WM-3.4QDS SHOWN (FOR REFERENCE ONLY).

NOTE: SPECIFICATIONS AND CHARACTERISTICS ARE TYPICAL AND SUBJECT TO CHANGE AT ANY TIME.

TITLE: PRECISION CALIBRATION DELAY (QDS)	MATERIAL: SEE P.O.	
	LAST REV. DATE: 7/21/2016	SHEET: 1 OF 1
MODEL #: WR3.4QDS (SHOWN)	LAST REV.: R2V3	UNITS: INCH

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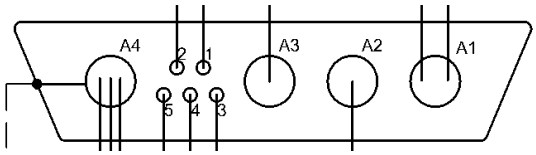
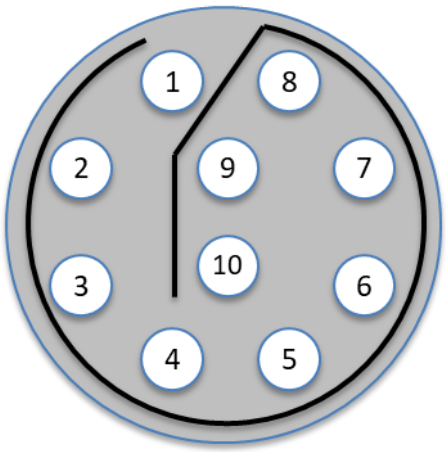
VDI-175 Power Supply Specifications



Parameter	Pin(s)	Specifications
DC Output	1	-5VDC/1A
	2	NC
	3	+5VDC/1A (Fan)
	4	GROUND (Fan)
	5, A4	GROUND
	A1	+12VDC/11A
	A2	+5VDC/7A
	A3	+15VDC/3A
Maximum Output Power	--	175W
AC Input	--	100-240VAC/ 3.5A
	--	50-60Hz

LEMO (10-Pin, 2B) Cable Specifications



Male LEMO Connector shown.

DB9-4 Pin	LEMO Pin	V_{DC} (V)	I_{DC} (A)
1	1	-5	1
2	2	NC	
A1	3	+12	11
A1	4		
A3	5	NC	
A4	6	GRND	-
A2	7	+5	7
3	8	+5 (Fan)	1
4	9	GRND (Fan)	-
5	10	GRND	-

Addendum — Product Updates and Company Contacts

Virginia Diodes' wide selection of Vector Network Analyzer (VNA) Extension Modules deliver industry-leading performance.

The Virginia Diodes staff of engineering and physical science professionals works to continually improve our products. We also depend upon feedback from colleagues and customers. Ideas to simplify Extension Module operations, improve performance or add capabilities are always welcome. Be certain that Virginia Diodes has your latest contact details including a phone number and an email address to receive update advisories.

Contact VDI:

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