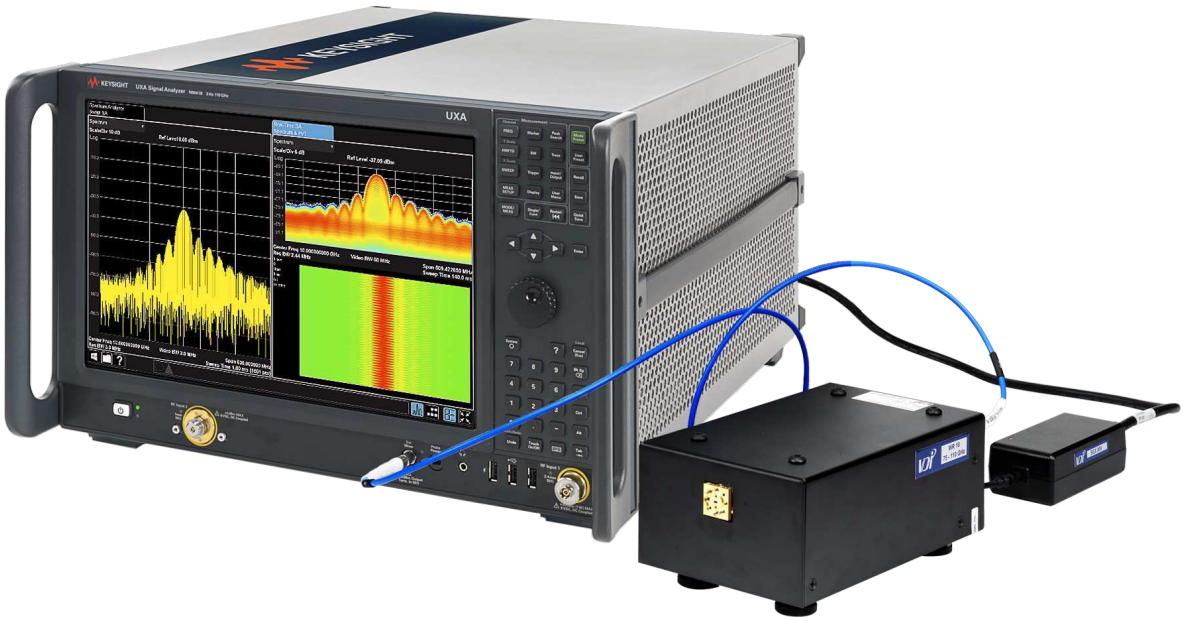
Keysight Technologies

Millimeter Wave Frequency Extenders

From Virginia Diodes Inc. for the
Keysight X-Series Signal Analyzers

Technical Overview



KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

The N9029AVxx signal analyzer frequency extension modules expand the measurement range of microwave signal analyzers up into the millimeter frequency range. They combine low conversion loss with excellent noise figure to provide the best possible sensitivity for measuring low-level signals.

Figure 1. The N9029AV03 frequency extender covers the WR3.4 band from 220 to 330 GHz.

The N9029AVxx modules can be used in two different operating modes, depending on the type of signals to be measured. In standard mode (see Figure 2), the LO signal comes from the signal analyzer, gets multiplied to a much higher frequency, and is mixed with the incoming millimeter signal entering the module from the waveguide input. The resulting 322.5 MHz IF signal is then routed back into the signal analyzer. A built-in diplexer enables both the LO and IF signals to share the same cable, allowing a single coaxial cable to provide the connection between the signal analyzer and the N9029AVxx frequency extender.

In this mode, the signal identification and image suppression features of the Keysight X-Series signal analyzers can be used to correctly identify the actual RF frequency and remove spurious signals. Amplitude readings on the signal analyzer can be corrected with the conversion loss table, which is stored on a USB memory stick included with each N9029AVxx module so that it can be easily downloaded into the signal analyzer's memory.

The standard mode is useful for general spectrum analysis and works best with stable CW or narrowband signals.

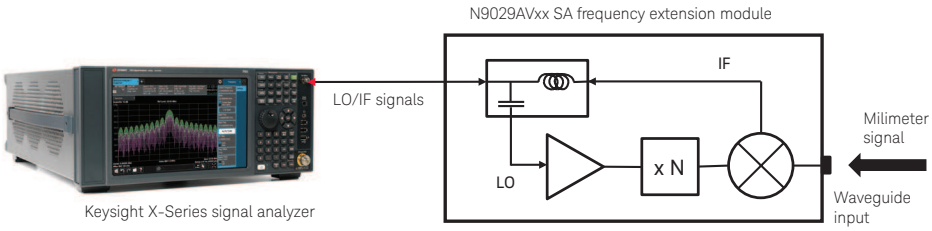


Figure 2. N9029AVxx signal analyzer frequency extension module operating in standard mode.

The Keysight Technologies, Inc. X-Series signal analyzers provide outstanding performance across a broad set of characteristics, such as dynamic range, displayed average noise level (DANL), distortion performance, phase noise, and measurement speed for frequencies up to 50 GHz. When paired with a new line of frequency extenders from Virginia Diodes Inc. (VDI), many of these capabilities are available up to 1.1 THz to meet the requirements of both established and emerging millimeter wave applications.

The N9029AVxx module can also be used as a wideband downconverter (see Figure 3). In this mode, a separate signal generator is used to provide a fixed LO signal, and a block of RF signals (both the upper and lower sidebands) are downconverted to IF and fed into the signal analyzer or oscilloscope RF input. This configuration provides an IF bandwidth of up to 20 GHz.

Block downconversion, in which spectral information is preserved, is very useful for signals that drift or for wideband communication signals. Like the standard mode, conversion loss can be applied to determine RF power. Spurious mixing products can be identified by varying the signal generator frequency slightly to determine the mixing order.

Figure 3. N9029AVxx signal analyzer frequency extension module operating in downconverter mode.

There is an optional capability available on some N9029AVxx frequency extender models, called Option UDC, which enables the unit to operate as either a wideband downconverter (see Figure 3) or an upconverter (see Figure 4). The conversion mode is determined by arranging the semi-rigid jumper cables on the rear panel of the N9029AVxx-UDC, as shown in Figures 5 through 8.

In upconverter mode, a baseband generator, such as the Keysight M8190A arbitrary waveform generator, can be used with the E8267D PSG vector signal generator to place a wide baseband signal on an IF carrier. The IF and LO inputs are up converted through the frequency extender, and mixing images are created at frequencies (F_{LO}*N-F_{IF}) and (F_{LO}*N+F_{IF}). Image rejection can be obtained at the up converter output by using externally-mounted bandpass waveguide filters that offer up to 100 dB of out-of-band rejection. Conversion loss data can be applied to determined RF output power. Spurious mixing products can be identified by varying the signal generator frequency slightly to determine the mixing order.

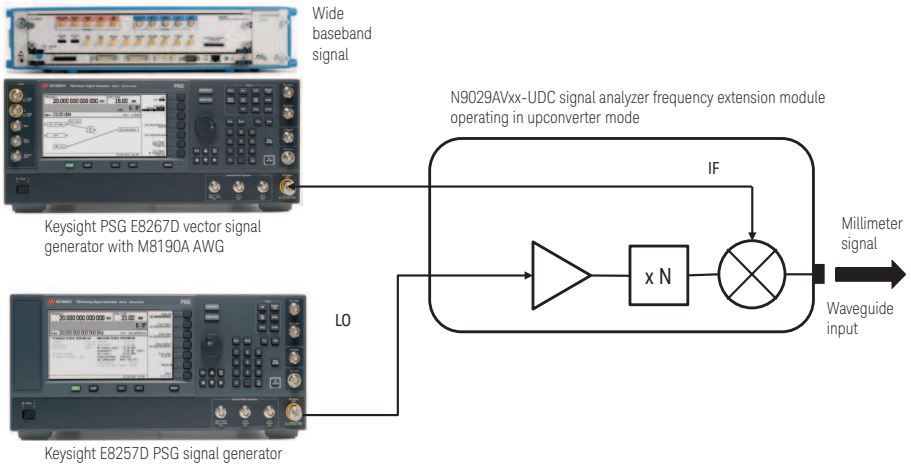


Figure 4. Upcoverter block diagram

Table 1. N9029AVxx-UDC configuration table

Configuration	LO connection	IF connection	Mode
A	Standard	Standard (Output)	Spectrum analyzer extension
B	Standard	High (Output)	Block downconversion
C	High	High (Output)	Block downconversion
D	High	IF (Input)	Block upconversion

Figure 5. N9029AVxx-UDC configuration A

Figure 6. N9029AVxx-UDC configuration B

Figure 7. N9029AVxx-UDC configuration C

Figure 8. N9029AVxx-UDC configuration D

Power supply requirements

Each N9029AVxx frequency extension module comes standard with an external 9 volt DC power supply.

Figure 9. The power supply is connected to the frequency extension module.

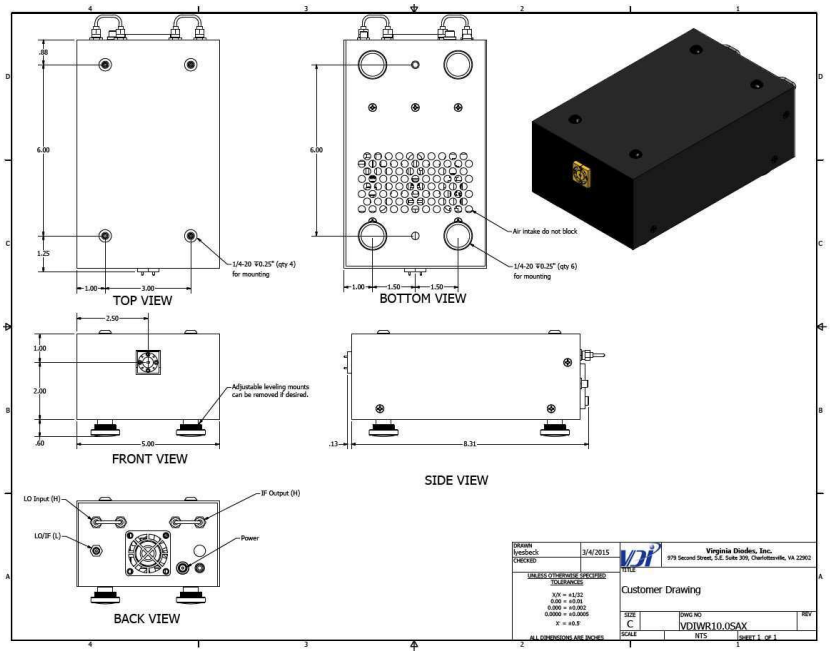


Figure 10. Outline drawing of VDI mm-wave extender

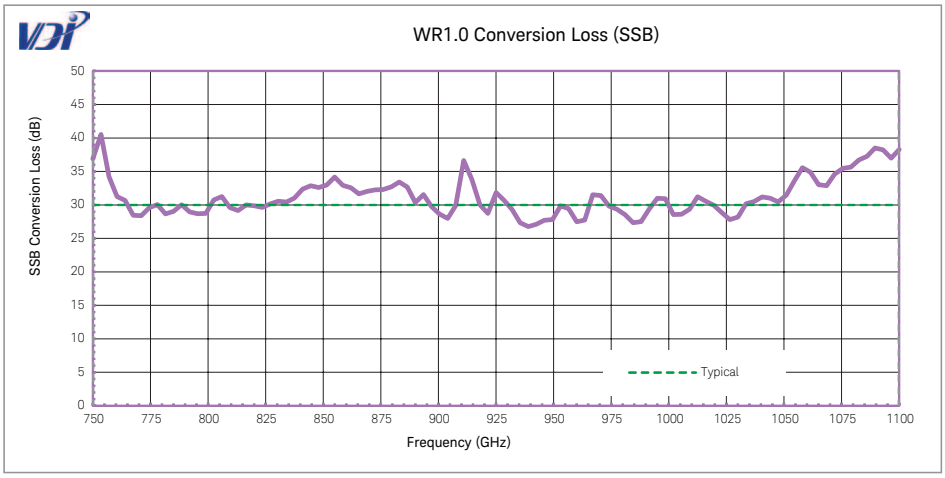


Figure 11. Measured intrinsic mixer conversion loss for the N9029AV01 (750 GHz to 1.1 THz) frequency extension module.

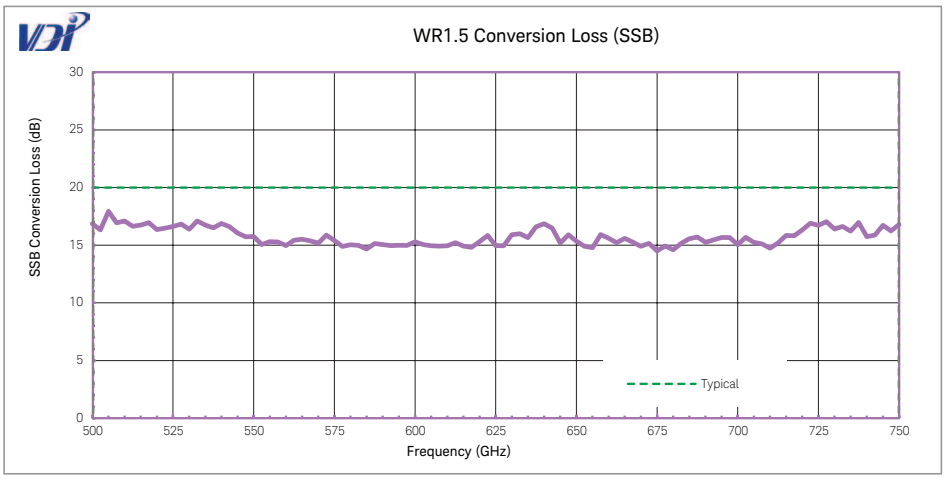


Figure 12. Measured intrinsic mixer conversion loss for the N9029AV1B (500 to 750 GHz) frequency extension module.

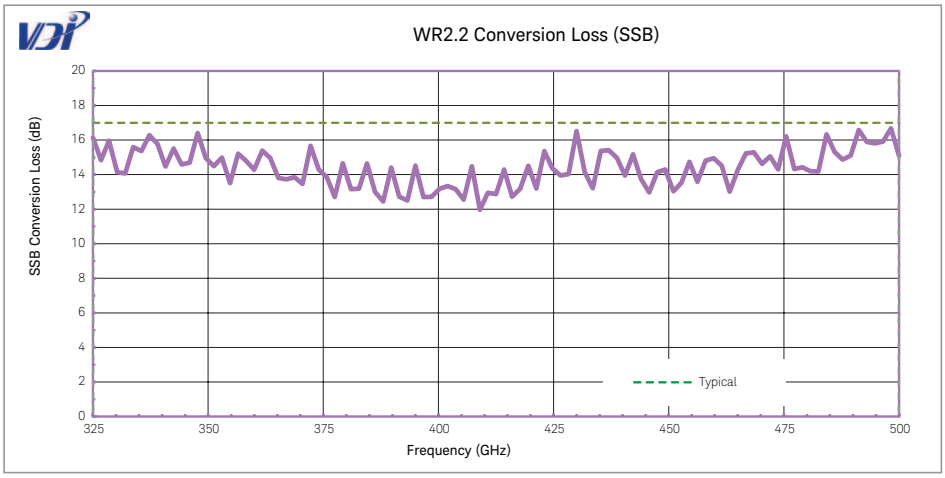


Figure 13. Measured intrinsic mixer conversion loss for the N9029AV02 (325 to 500 GHz) frequency extension module.

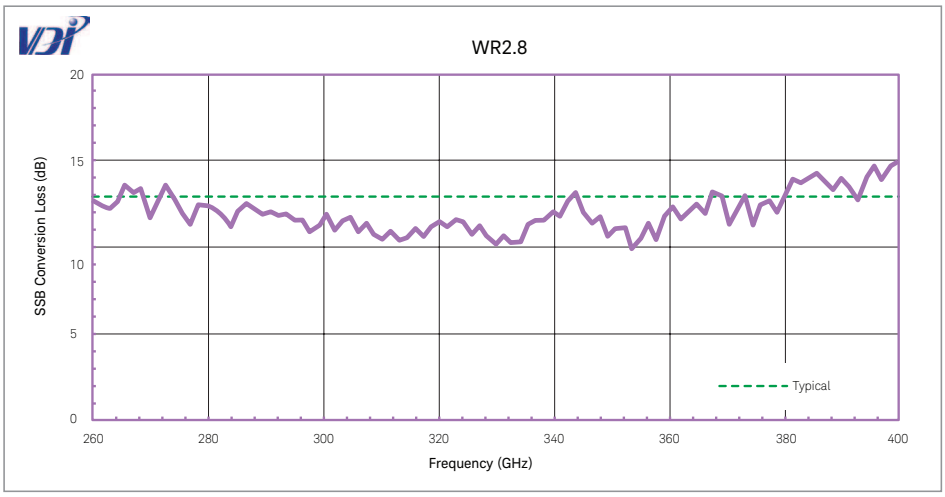


Figure 14. Measured intrinsic mixer conversion loss for the N902AV2B (260 to 400 GHz) frequency extension module.

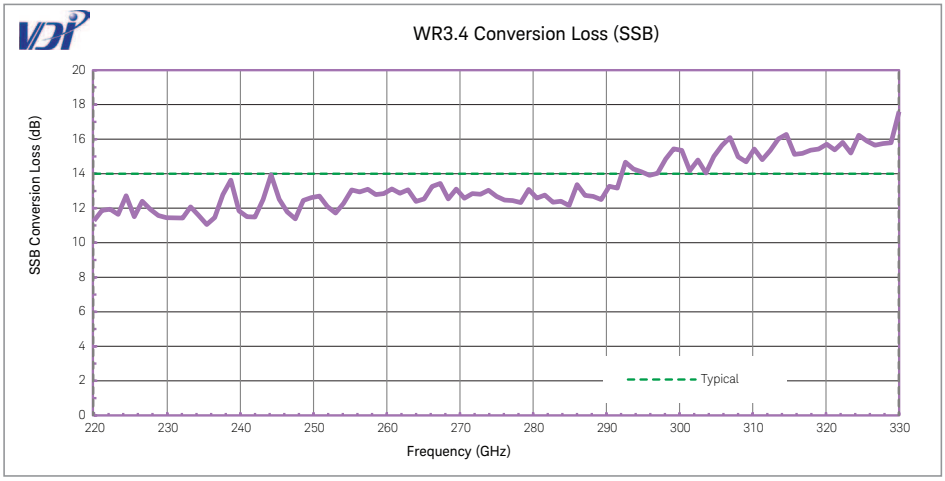


Figure 15. Measured intrinsic mixer conversion loss for the N9029AV03 (220 to 330 GHz) frequency extension module.

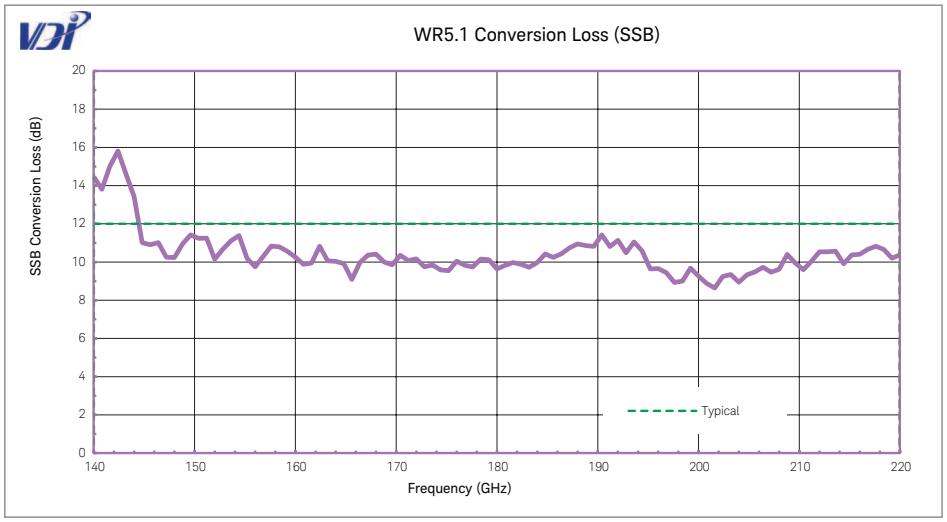


Figure 16. Measured intrinsic mixer conversion loss for the N9029AV05 (140 to 220 GHz) frequency extension module.

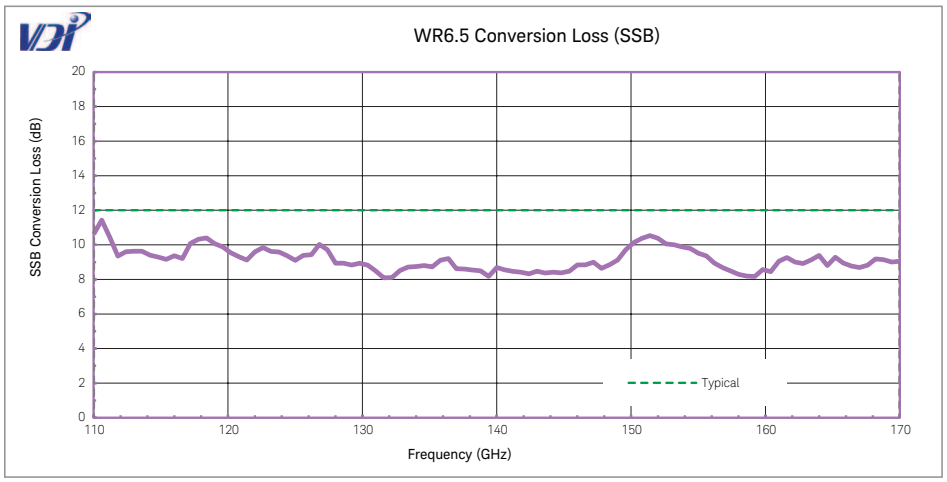


Figure 17. Measured intrinsic mixer conversion loss for the N9029AV06 (110 to 170 GHz) frequency extension module.

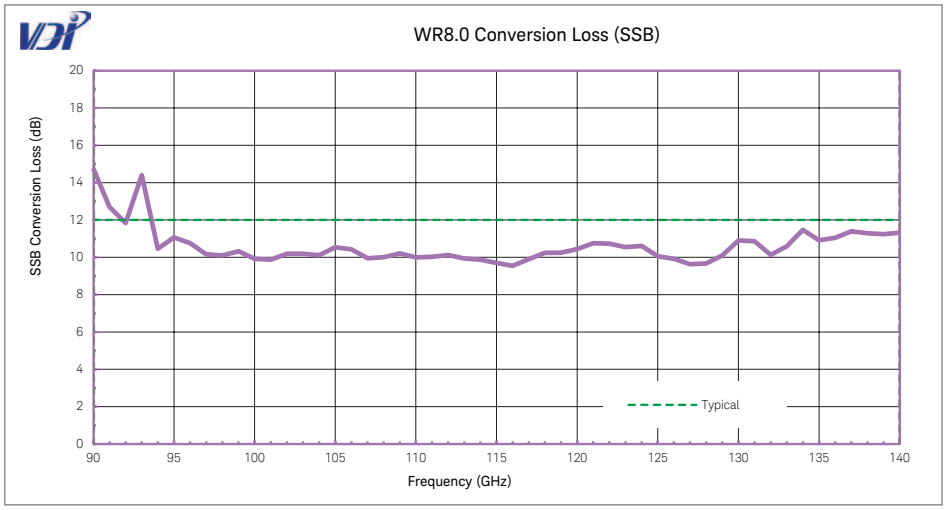


Figure 18. Measured intrinsic mixer conversion loss for the N9029AV08 (90 to 140 GHz) frequency extension module.

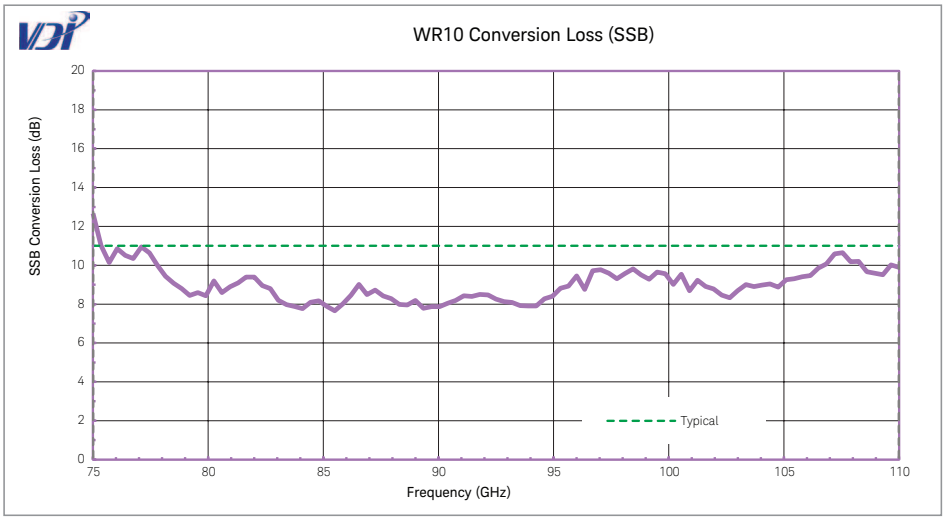


Figure 19. Measured intrinsic mixer conversion loss for the N9029AV10 (75 to 110 GHz) frequency extension module.

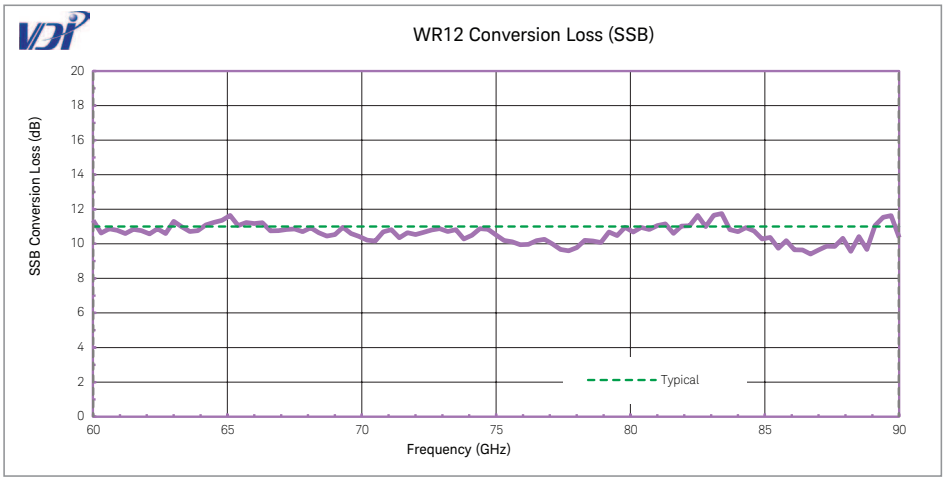


Figure 20. Measured intrinsic mixer conversion loss for the N9029AV12 (60 to 90 GHz) frequency extension.

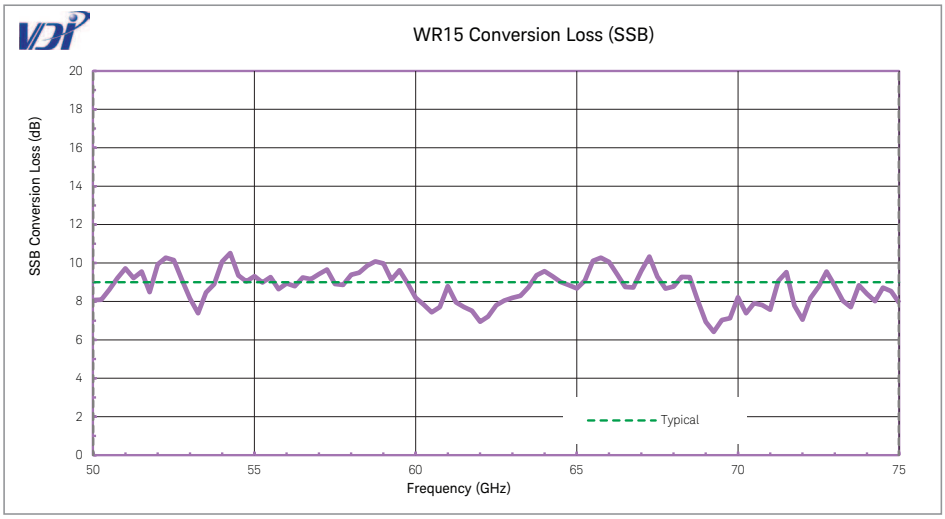


Figure 21. Measured intrinsic mixer conversion loss for the N9029AV15 (50-75 GHz) frequency extension module.

Table 2. Characteristics

Waveguide band	Frequency range (GHz)	LO input mode	Multiplication factors	LO input frequencies (GHz)	Intrinsic mixer conversion loss (dB) (Not including IF amplifier)	RF power limits: compression/ damage (dBm)	Displayed average noise level (dBm/Hz)
WR1.0	750 – 1,100	Standard	144	5.2 – 7.6	30	–20/–10	–135
		High	36	20.8 – 30.6			
WR1.5	500 – 750	Standard	72	6.9 – 10.4	18	–20/–10	–150
		High	18	27.8 – 41.7			
WR2.2	325 – 500	Standard	48	9.0 – 13.9	16	–20/–10	–150
		High	12	27.1 – 41.7			
WR2.8	260- 400	Standard	48	5.4 – 8.3	13	–10/0	–150
		High	12	21.7 – 33.3			
WR3.4	220 – 330	Standard	48	4.6 – 6.9	14	–20/–10	–150
		High	12	18.3 – 27.5			
WR4.3	220-330	Standard	36	4.72 – 7.22	11	–10/0	–150
		High	6	28.33 – 43.33			
WR5.1	140 – 220	Standard	24	5.8 – 9.2	11	–10/0	–150
		High	6	23.3 – 36.7			
WR6.5	110 – 170	Standard	24	4.6 – 7.1	10	–10/0	–150
		High	6	18.3 – 28.3			
WR8.0	90 – 140	Standard	12	7.5 – 11.7	10	–10/0	–150
		High	6	15.0 – 23.3			
WR10	75 – 110	Standard	12	6.3 – 9.2	10	–10/0	–150
		High	6	12.5 – 18.3			
WR12	60 – 90	Standard	12	5.0 – 7.5	10	–10/0	–150
		High	6	10.0 – 15.0			
WR15	50 – 75	Standard	12	4.17 – 6.25	9	–10/0	–150
		High	6	8.33 – 12.5			

Table 3. Specifications

Description		Specification	Connector
LO input level	Standard frequency (typical/damage)	10 dBm/16 dBm	2.92 mm (f)
	High frequency (typical/damage)	0 dBm/6 dBm	2.92 mm (f)
IF output frequency	Standard frequency	16 kHz to 2.5 GHz	2.92 mm (f)
	High frequency	16 kHz to < 20 GHz	2.92 mm (f)
RF input type	VDI precision flange		UG-387/UM
AC input	Power Supply Included	100-240 VAC, 3.5 A 50-60 Hz	NEMA 5-15P (U.S. & Canada)

Options and Accessories

Option ATN provides fixed waveguide attenuators that can be attached to the signal analyzer frequency extender input. These attenuators provide additional input protection from high-level signals that could possibly overload or damage the mixer. Option ATN attenuators are always recommended when attaching an E8257DVxx signal generator frequency extender to an N9029AVxx signal analyzer frequency extender.

In addition to the fixed attenuators, an external micrometer driven attenuator with 0 to 30 dB range is available: Option A30

Figure 22. Option ATN waveguide fixed attenuator

Table 4. Options ATN and UDC

Keysight model number	Option ATN attenuation value	Option UDC availability
N9029AV01	Contact factory	Yes
N9029AV1B	10 dB	Yes
N9029AV02	20 dB	Yes
N9029AV2B	20 dB	Yes
N9029AV03	30 dB	Yes
N9029AV05	20 dB	Yes
N9029AV06	20 dB	Yes
N9029AV08	30 dB	Yes
N9029AV10	30 dB	Yes
N9029AV12	30 dB	Yes
N9029AV15	40 dB	Yes

Table 5. Band pass filter options

Keysight model number	Band pass frequency	Waveguide size
N9029AV12-BF1	59.5 to 61.5 GHz	WR12
N9029AV12-BF2	71 to 76 GHz	WR12
N9029AV12-BF3	81 to 86 GHz	WR12
N9029AV12-BF4	76 to 81 GHz	WR12
N9029AV15-BF1	57.24 to 59.4 GHz	WR15
N9029AV15-BF2	59.4 to 61.56 GHz	WR15
N9029AV15-BF3	61.56 to 63.72 GHz	WR15
N9029AV15-BF4	63.72 to 65.88 GHz	WR15
N9029AV15-BF5	57.24 to 65.88 GHz	WR15

Table 6. Ordering information

Keysight model number	VDI part number	Frequency range (GHz)	Description
N9029AV01	WR1.0SAX	750 – 1,100	WR1.0 signal analyzer frequency extender
N9029AV1B	WR1.5SAX	500 – 750	WR1.5 signal analyzer frequency extender
N9029AV02	WR2.2SAX	325 – 500	WR2.2 signal analyzer frequency extender
N9029AV2B	WR2.8SAX	260 – 400	WR2.8 signal analyzer frequency extender
N9029AV03	WR3.4SAX	220 – 330	WR3.4 signal analyzer frequency extender
N9029AV05	WR5.1SAX	140 – 220	WR5.1 signal analyzer frequency extender
N9029AV06	WR6.5SAX	110 – 170	WR6.5 signal analyzer frequency extender
N9029AV08	WR8.0SAX	90 – 140	WR8.0 signal analyzer frequency extender
N9029AV10	WR10SAX	75 – 110	WR10 signal analyzer frequency extender
N9029AV12	WR12SAX	60 – 90	WR12 signal analyzer frequency extender
N9029AV15	WR15SAX	50 – 75	WR15 signal analyzer frequency extender

Option AMP provides waveguide amplification to the signal analyzer frequency extender input to overcome conversion loss and transmission loss. Option BF1 provides waveguide band pass filtering to the signal analyzer frequency extender input to filter one sideband and preserve signal modulation.

Horn antenna options provide free space coupling to the signal analyzer frequency extenders.

Table 7. Horn antenna options

Keysight model number	Frequency range
N9029AH15	50 to 75 GHz
N9029AH12	60 to 90 GHz
N9029AH10	75 to 110 GHz
N9029AH08	90 to 140 GHz
N9029AH05	140 to 220 GHz

Accessories included with each N9029AVxx signal analyzer frequency extender:

2.92 mm (m) to 2.92 mm (m) coaxial cable, 1.2 m length
USB memory stick with documentation and calibration data
9 volt DC power supply

Related Web Resources

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For more information on VDI's signal analyzer frequency extenders, visit:
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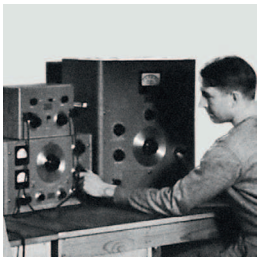

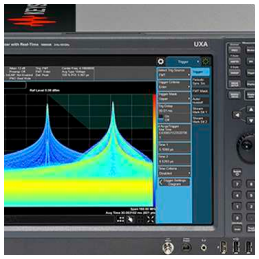

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