Product Overview – SAX-Z-M Spectrum Analyzer Extension Modules for Anritsu SA

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General Operating Practices and Recommendations

General Guidelines

- Read all instructions and information in this manual before connecting an Extension Module to its power supply or external equipment. 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.

Safety Guidelines

- VDI accepts no liability for damage or injury resulting from or caused by:
    - Improper use, disassembly or use for other purposes than for which the product 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.
- Use of any attachments and accessories not authorized by VDI or that do not meet VDI's specifications may void a 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.
- A 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.
- Applying liquids (other than the TexWipe wipes / cloths used for cleaning) can cause lasting damage to the module.
- Power inputs to the RF Input and LO Input ports of Extension Modules are noted on labels on every Extension Module. These values provide optimal performance. Irreversible damage can result if input power exceeds stated damage threshold.

Waveguide Test Port and RF Cable 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.
- Torque coaxial connections to 90cNm. Avoid sharp bends in cables.
- Inspect waveguide flanges for damage or debris prior to making connections.
- Torque waveguide screws in the range of 20-50cNm when making waveguide flange connections. 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.

General Operating Practices and Recommendations

- VDI Extension Modules are intended to be used in typical laboratory conditions.
- 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.
- Do not connect or disconnect power cables while the Extender Module is turned on.

Spectrum Analyzer Extension Modules for Anritsu Analyzers

VDI SAX-Z-M Modules are used to extend the performance of modern Anritsu spectrum and signal analyzers in the frequency range of 26 GHz to 330 GHz in frequency bands from WR-28 (26-40 GHz) to WR-3.4 (220-330 GHz). These modules use VDI's proprietary mixer technology, which achieves low-conversion loss and exceptional sensitivity. Standard features include direct extension of spectrum analyzers and block down-conversion for broadband signal analysis.

SAX-Z-M Operating Modes

The SAX-Z-M modules can be used in various configurations: Spectrum Analyzer Extension, Block Down-conversion, and Block Up-conversion.

Spectrum Analyzer Extension Mode extends the frequency capability of a modern commercial microwave spectrum analyzer. The internal local oscillator of the spectrum analyzer is used to drive the extension module, allowing use of the spectrum analyzer's data processing to determine the signal's spectrum across the entire waveguide band. This is similar to the function of traditional external mixers, but with greatly improved performance.

Block Down-Conversion Mode converts a block of signal spectrum within the input band of the extension module to a lower frequency, where it can be coupled into the RF port of an analyzer, or processed by other means. In this case, an external synthesizer is used as the LO source for the mixer. By varying the LO frequency, the frequency of the down-converted signal spectrum can be adjusted. The instantaneous bandwidth of the down-converted spectral block can be quite large, as shown in the data tables on Page 10. Block down-conversion maintains the spectral quality of the signal.

SAX-Z-M Module Product Specifications

The specifications listed in the table below are for standard configurations. For different configurations and options, please see specifications in the “Available Configurations and Options” section.

Part Number	RF Frequency Band (GHz)	RF Power Limits (Compression / Damage, typ.)	Intrinsic Mixer Conversion Loss (dB, typ.)*	High Freq. IF Output, Stop Frequency (GHz, typ.)	High / Low LO Input Port Harmonic Factors
WR28SAX-Z-M	26-40	-4 / 6	9	4	2 / 4
WR19SAX-Z-M	40-60	-10 / 0	9	6	2 / 8
WR15SAX-Z-M	50-75	-10 / 0	10	7.5	4 / 8
WR12SAX-Z-M	60-90	-10 / 0	10	9	6 / 12
WR10SAX-Z-M	75-110	-10 / 0	10	11	6 / 12
WR8.0SAX-Z-M	90-140	-10 / 0	10	14	4 / 16
WR6.5SAX-Z-M	110-170	-10 / 0	10	17	6 / 18
WR5.1SAX-Z-M	140-220	-10 / 0	11	22	6 / 24
WR4.3SAX-Z-M	170-260	-10 / 0	11	26	9 / 27
WR3.4SAX-Z-M	220-330	-10 / 0	12	40	12 / 36

*Intrinsic Mixer Conversion loss is measured from the RF Test Port to Mixer IF Port at 322.5 MHz before any IF amplification. Mixer IF Port cannot be accessed by user. VDI includes a Conversion Loss Table compatible with the Anritsu MS2850A or similar analyzer. The measurements to generate the Conversion Loss Table is taken at IF = 1.875 GHz at both RF>LO and LO>RF.

Specification Notes:

*Conversion loss increases at a rate of about ~1.5-2dB/10 GHz up to the specified maximum IF.

*All models include a ~50kHz-40 GHz IF amplifier with ~12dB gain. Noise Figure of IF Amplifier degrades significantly below ~50 MHz.

SAX-Z-M Module General Specifications

The specifications listed in the table below are for standard configurations. For different configurations and options, please see specifications in the “Available Configurations and Options” section.

Description		Specification	Connector
LO Input Port	Low Frequency (Typical / Damage)	10 dBm ± 3dB / 18 dBm	2.92mm (f)
	Maximum, Test Set Controller (7.6 MHz)	0 dB ± 3dB / 6 dBm	2.92mm (f)
Low Freq. IF Output Port	WR-28 to WR-3.4 (Typical)	~50kHz-2.5GHz	2.92mm(f)
High Freq. IF Output Port	Start Frequency (Typical)	~50kHz	2.92mm(f)
	Stop Frequency	See Product Specifications Table	
Test Port	Standard VDI Waveguide Flange	WR-15 to WR-3.4	UG-387/UM
		WR-28 to WR-19	UG-599/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	-
Enclosure Dimensions	Typical (Length x Width x Height, inches), WR-28 to WM-250	6.00” x 3.50” x 1.50”	-
Maximum Weight		2 lbs. (0.90 kg.)	-

Specifications for Alternative Configurations and Options

-UP and -UP40 Options (Block Up-Conversion Options)

Block Up-Conversion Mode up-converts a block of IF signals in the microwave/millimeter-wave band to generate a block of RF signals for transmission. Similar to the down-conversion mode, an external synthesizer is used to drive the module and sets the output frequency. The output signal block is generated in both the upper and lower sidebands of the effective LO frequency at the mixer. Optional output filters are available to eliminate one of these sidebands. Also, amplifiers are available to boost the output power in many of the lower frequency bands.

Notes:

- At the RF output port, two sidebands will be generated and RF frequencies can be calculated by using the following relationships: $RF_{lower} = n*LO - IF$ and $RF_{upper} = n*LO + IF$.
- External filters can be used to reject the undesired sideband. Contact VDI for more information.
- External amplifiers can be used to increase the RF output power. Contact VDI for more information. (Bias ports on front panel are used to supply appropriate bias voltage to VDI amplifiers).
- The input LO frequency should be greater than the maximum IF frequency used, in order to prevent harmonics of the LO signal to fall within the desired block of signals.
- If possible, the high frequency LO input port should be used to reduce spurious signals in the RF Output at the test port.

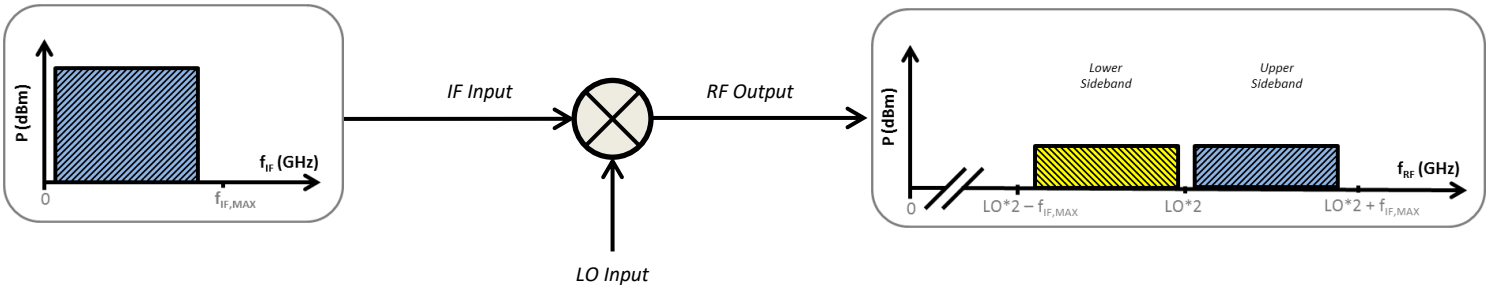
Part Number	SAX-Z-M-UP Specifications			
	IF Input Frequency (GHz, typ.)	IF Output Frequency (GHz, typ.)	IF Input Power (dBm, ~P0.1dB Compression / Damage, typ.)	Up-Conversion Loss (dB, typ., est.)
WR28SAX-Z-M-UP	1-4	~50kHz-4GHz	6 / 26	29
WR19SAX-Z-M-UP	1-6	~50kHz-6GHz	0 / 20	29
WR15SAX-Z-M-UP	1-7.5	~50kHz-7.5GHz	0 / 20	30
WR12SAX-Z-M-UP	1-9	~50kHz-9GHz	0 / 20	30
WR10SAX-Z-M-UP	1-11	~50kHz-11GHz	0 / 20	30
WR8.0SAX-Z-M-UP	1-14	~50kHz-14GHz	0 / 20	30
WR6.5SAX-Z-M-UP	1-17	~50kHz-17GHz	0 / 20	30
WR5.1SAX-Z-M-UP	1-20	~50kHz-20GHz	0 / 20	31
WR4.3SAX-Z-M-UP	1-20	~50kHz-20GHz	0 / 20	31
WR3.4SAX-Z-M-UP	1-20	~50kHz-20GHz	0 / 20	32

Part Number	SAX-Z-M-UP40 Specifications			
	IF Input Frequency (GHz, typ.)	IF Output Frequency (GHz, typ.)	IF Input Power (dBm, ~P0.1dB Compression / Damage, typ.)	Up-Conversion Loss (dB, typ., est.)
WR5.1SAX-Z-M-UP40	1-22	~50kHz-22GHz	0 / 20	31
WR4.3SAX-Z-M-UP40	1-26	~50kHz-26GHz	0 / 20	31
WR3.4SAX-Z-M-UP40	1-40	~50kHz-40GHz	0 / 20	32

Double Sideband Output

The SAX-Z-M-UPs can also be used to up-convert a block of IF signals to generate a block of millimeter-wave / THz signals for transmission from the RF port. The figure below shows how a VDI SAX-Z-M-UP up-converts a block of IF input signals. Due to the double sideband nature of the SAX-Z-M-UPs, two sidebands (upper and lower sidebands) are generated during the up-conversion process.

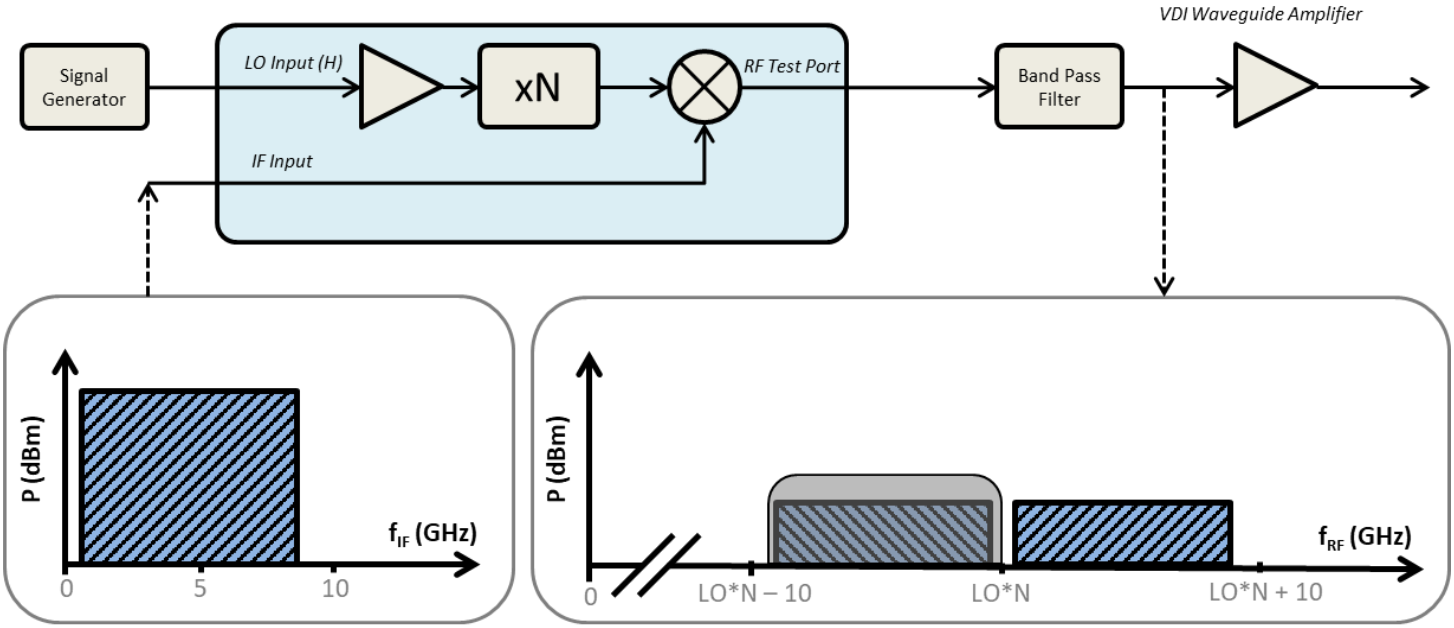
The lower sideband RF Output frequency can be calculated by: $f_{RF\text{-}lower} = N \bullet f_{LO} - f_{IF}$. The upper sideband RF Output frequency can be calculated by: $f_{RF\text{-}upper} = N \bullet f_{LO} + f_{IF}$, where N is the harmonic factor for the module. N=2 is shown in the figure below.



Block Up-Conversion with External BPF and Amplifier

VDI recommends using an external band pass filter and amplifier with the SAX-Z-M-UP in Up-Conversion Mode. See figure below.

BPFs may be preferred for certain applications to eliminate one sideband. VDI offers a range of filters for common wireless communication bands. Custom filters are also available upon request. VDI Amplifiers are broadband with high P1dB to provide high linear output power to overcome conversion and transmission losses. Please refer to the VDI BPF and Amplifier Product Manuals for more information.



-HS Option (High Sensitivity)

Most standard VDI SAX-Z-M Modules have a ~ -150dBm/Hz DANL (Displayed Average Noise Level) specification. For certain applications where improved sensitivity is required, VDI offers a High Sensitivity (-HS) option for improved DANL specification. The new DANL specification is listed in the table below. The IF bandwidth for down-conversion is limited to ~5 GHz with the -HS option. Contact VDI for more information.

Notes:

- Can be configured with -UP or -UP40 options. However, due to limited IF bandwidth of the -HS option, configuring -HS modules with -UP or -UP40 is not recommended.
- Review compression and damage levels of user Spectrum Analyzer prior to use. For large RF signal conditions, the user Spectrum Analyzer may reach its compression or damage levels while the SAX-Z-M-HS does not.

VDI SAX-Z-M-HS Specifications					
Description	**WR28**	**WR19**	**WR15**	**WR12**	**WR10**
RF Frequency Band (GHz)	26-40	40-60	50-75	60-90	75-110
RF Power Limits (Compression / Damage, typ.) – Intrinsic Mixer*	-10 / 0	-10 / 0	-10 / 0	-10 / 0	-10 / 0
System Conversion Gain (dB, typ.)**	13	13	12	12	12
Max. IF Frequency (GHz, typ.)	5	5	5	5	5
Displayed Average Noise Level (dBm/Hz, typ., estimated)	-160	-160	-160	-160	-160
Description	**WR8.0**	**WR6.5**	**WR5.1**	**WR4.3**	**WR3.4**
RF Frequency Band (GHz)	90- 140	110-170	140-220	170-260	220-330
RF Power Limits (Compression / Damage, typ.) – Intrinsic Mixer*	-10 / 0	-10 / 0	-10 / 0	-10 / 0	-10 / 0
System Conversion Gain (dB, typ.)**	12	12	11	11	10
Max. IF Frequency (GHz, typ.)	5	5	5	5	5
Displayed Average Noise Level (dBm/Hz, typ., estimated)	-160	-160	-160	-160	-159 (est.)

*Intrinsic Mixer Compression / Damage specification does not include any IF amplification and other external equipment. Review compression and damage levels of user Spectrum Analyzer prior to use. For some large RF signal conditions, the user Spectrum Analyzer may reach its compression / damage levels while the SAX-Z-M-HS does not.
**System Conversion Gain includes Intrinsic Mixer Conversion Loss and IF Amplifier Gain (~22dB), in Configuration A. Specified at 322.5 MHz IF.

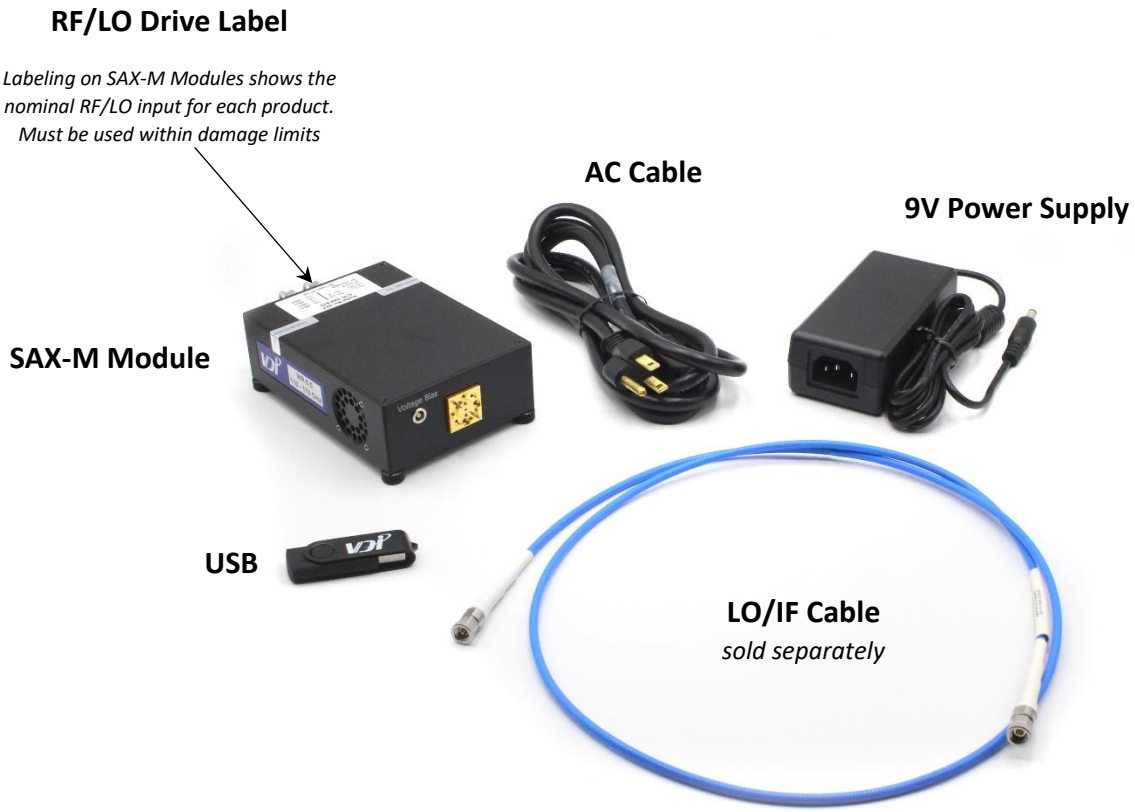
Available Configurations and Options

Part Number	*-UP*	*-UP40*	*-HS*
WR28SAX-Z-M	✓		✓
WR19SAX-Z-M	✓		✓
WR15SAX-Z-M	✓		✓
WR12SAX-Z-M	✓		✓
WR10SAX-Z-M	✓		✓
WR8.0SAX-Z-M	✓		✓
WR6.5SAX-Z-M	✓		✓
WR5.1SAX-Z-M	✓	✓	✓
WR4.3SAX-Z-M	✓	✓	✓
WR3.4SAX-Z-M	✓	✓	✓

Contact VDI for alternative configurations or options not listed above.

Product Overview and Accessories

VDI's Spectrum Analyzer Extension (SAX-Z-M) Modules and typical accessories are shown. The exact equipment delivered and especially the input limits (see labels) may vary. The module's input power limits are shown on the attached label and must be complied with to avoid damage and ensure optimal performance. Contact VDI with any questions before powering any module.



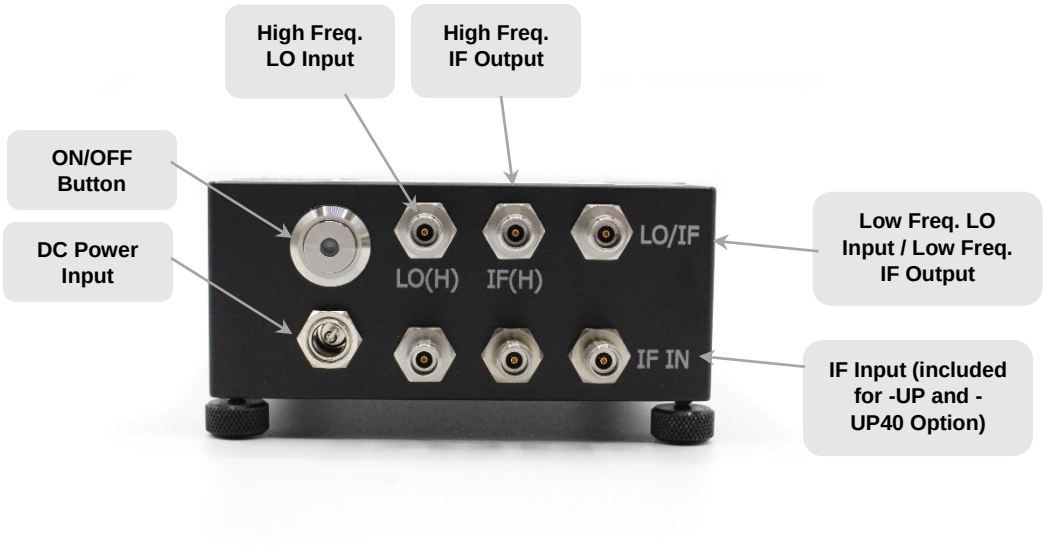
SAX-Z-M Module Ordering Notes

- Purchasing SAX-Z-M Modules assume that the SA is configured properly for frequency extension. SAX-Z-M Modules are compatible with an Anritsu MS2850A or similar modern Anritsu analyzer. For SAX Modules configured for other analyzers, please contact VDI.
- Options can be purchased later, but the SAX-Z-M Module must be returned to VDI for modification.
- Cable Sets are sold separately (see Cable Set section for more information).
- The 9V Power Supply is included with the purchase of a SAX-Z-M Module.

SAX-Z-M Module Details – Front and Rear Panel Connections

SAX-Z-M – Front Panel

**Voltage Bias Port (+9V) is compatible with external VDI amplifiers.*



SAX-Z-M – Rear Panel

Applies to all SAX-Z-M modules (IF and LO jumpers not shown). Damage limits listed above are subject to change.

SAX-Z-M Configurations

Configuration details for typical SAX-Z-M configurations are shown below. The photographs show proper LO and IF jumper and cable connections. Signal flow block diagrams are also provided. The multiplication factor N, for the LO input frequency, can be found on the Input Drive Label.

Configuration A: Spectrum Analyzer Extension

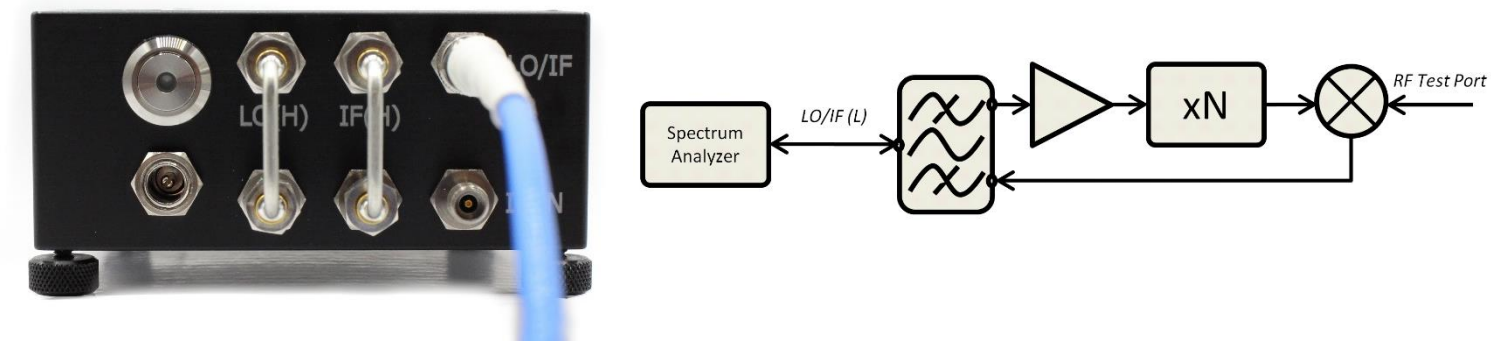


Figure 1: Spectrum Analyzer Extension
Proper configuration details for spectrum analyzer extension are shown.
The IF Input Port is not used.

Notes

- For this configuration, the VDI SAX-Z-M module is used in the same manner as a traditional external mixer.
- Therefore, the spectrum analyzer must have the external mixer option with an LO output signal that is consistent with the Low Frequency LO input requirements of the SAX-Z-M module. Refer to Spectrum Analyzer manual as needed.
- Signal Identification and/or Image Suppression may be used to reduce the number of spurious signals or unwanted sidebands.
- The number of points set on the Spectrum Analyzer may need to be adjusted to a larger value (10,000 points or more) to see all relevant signals.
- The 'ExternalMixerConversionLossTable' file is intended to be used with the Anritsu MS2850A or similar analyzer. The 'Conversion Loss' file provides conversion loss data for various SAX-Z-M configurations and not intended to be used to upload onto the analyzer. When using the VDI SAX-Z-M modules with other spectrum analyzers, please use the correct conversion loss data in a file format that is compatible with the spectrum analyzers.

Configuration B and C: Block Down-Conversion

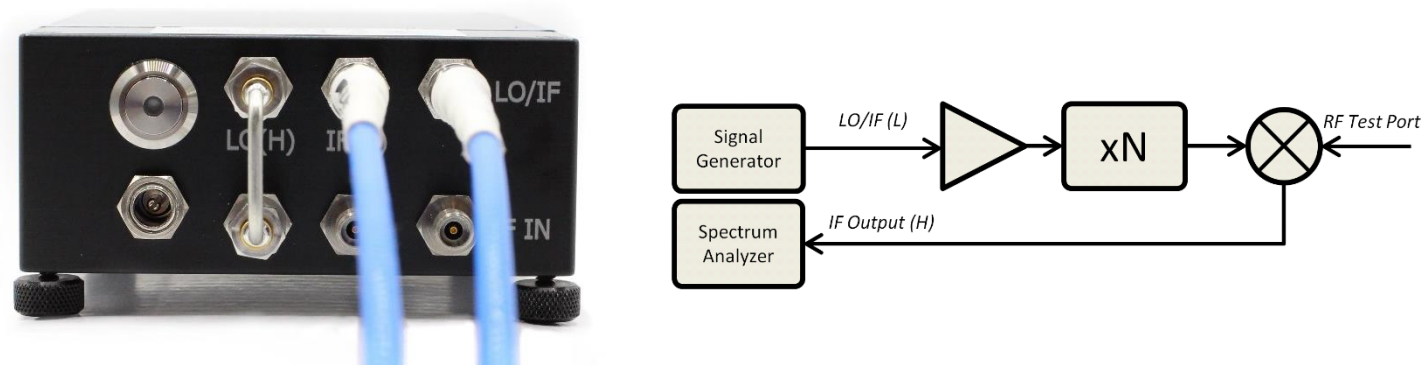


Figure 2: Block Down-Conversion – Low Frequency LO Input
Proper configuration details for down-conversion using the low frequency input port are shown. The IF Input Port is not used.

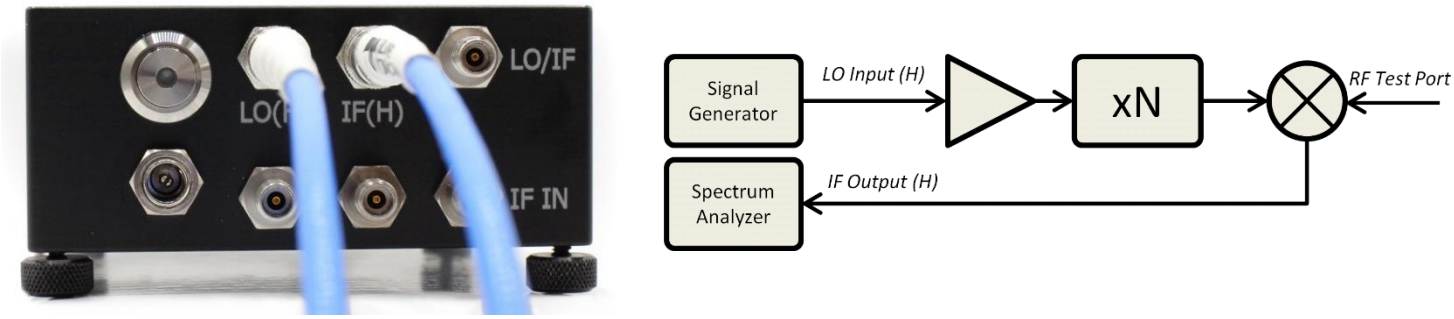


Figure 3: Block Down-Conversion – High Frequency LO Input
Proper configuration details for down-conversion using the high frequency input port are shown. The IF Input Port is not used.

Notes

- Attenuation between the SAX-Z-M module and customer spectrum analyzer (or similar instrument) may be necessary to avoid saturation or damage of the instrument. Refer to saturation and damage limits in manufacturer's operating manual.
- The input LO frequency should be greater than the maximum IF frequency used, in order to prevent regeneration of the LO signal in the IF Output.
- If possible, the high frequency LO input should be used to reduce spurious signals in the IF Output.
- VDI provides a CSV file on the USB drive that contains a table of conversion loss data from the RF Test Port to the IF Output (H), measured at an IF of 1.875 GHz.

Configuration D: Block Up-Conversion (-UP and -UP40 Only)

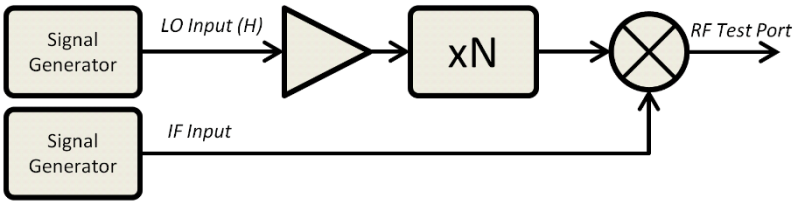
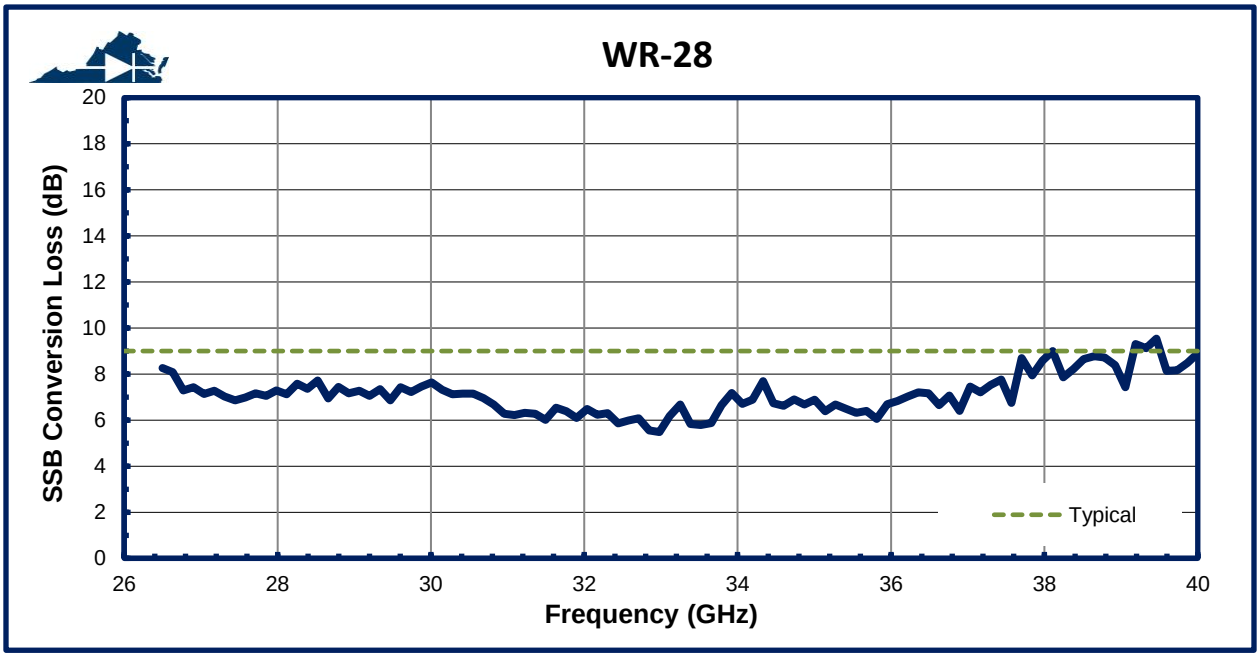


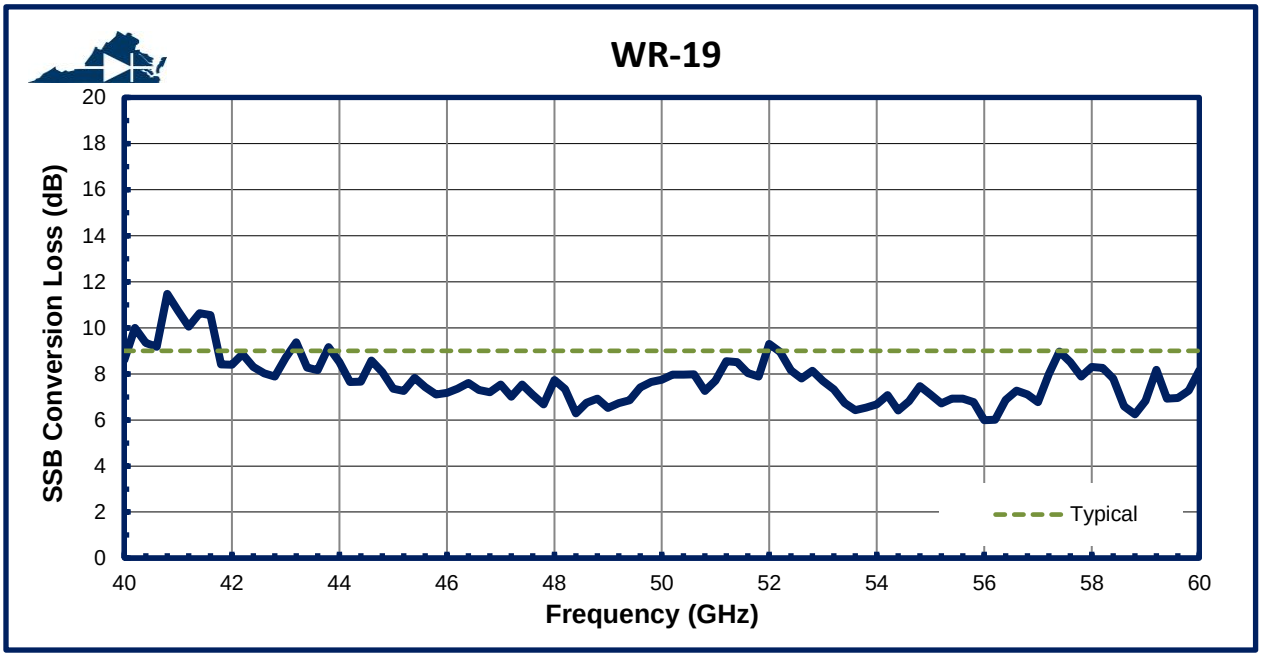
Figure 4: Block Up-Conversion
Proper configuration details for up-conversion are shown.
The IF Output (H) Port is not used.

See -UP and -U40 Option section for more information.

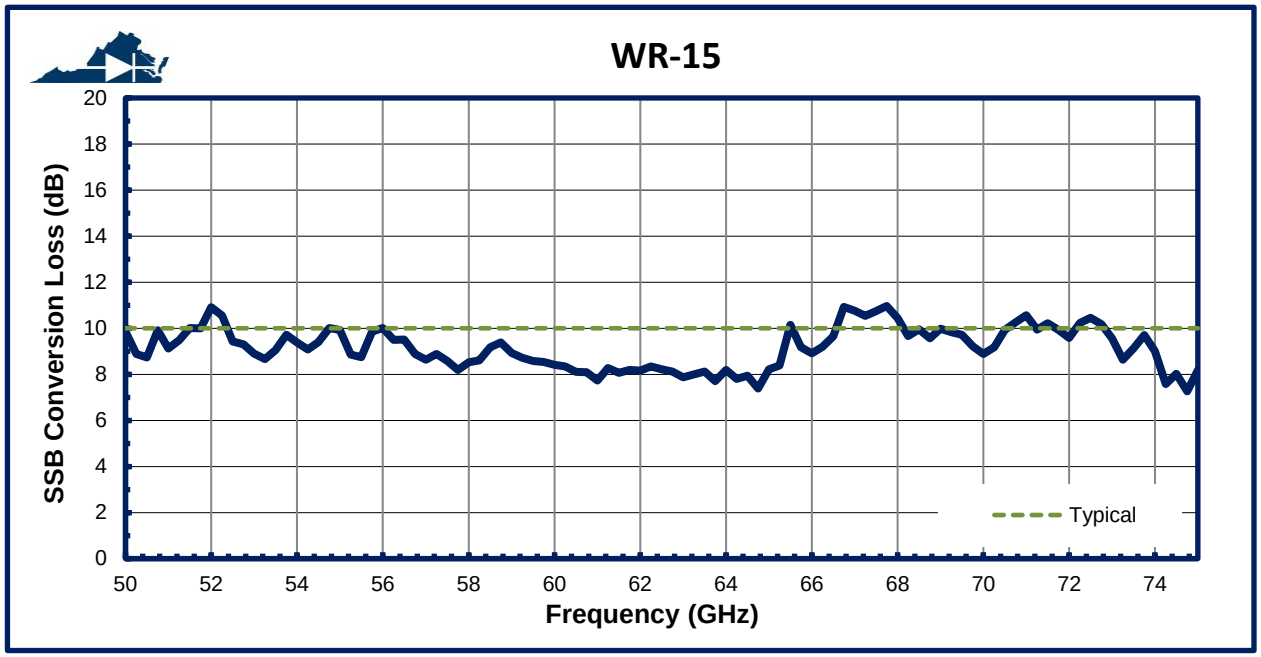
SAX Performance – Conversion Loss

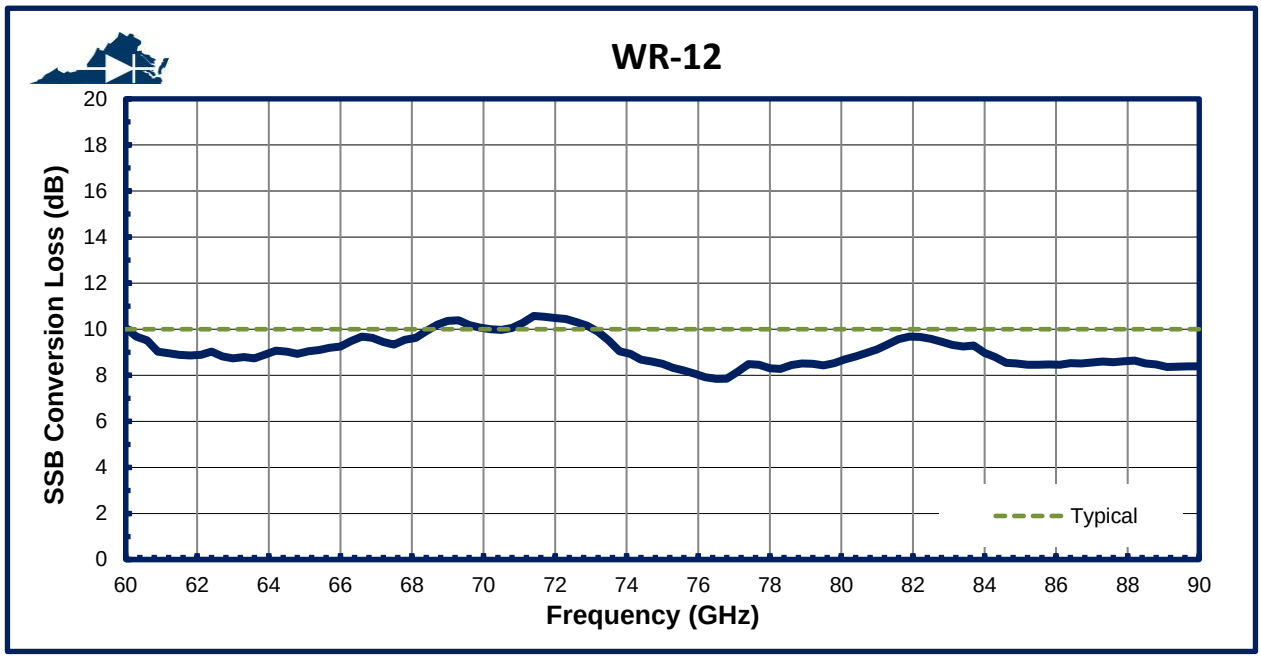
Typical Single Side Band (SSB) Intrinsic Mixer Conversion Loss plots are provided on the following pages. This is the conversion loss of the mixer before any IF amplification. Note, the user does not have direct access to the mixer, but this data is useful to understand the quality of the mixer



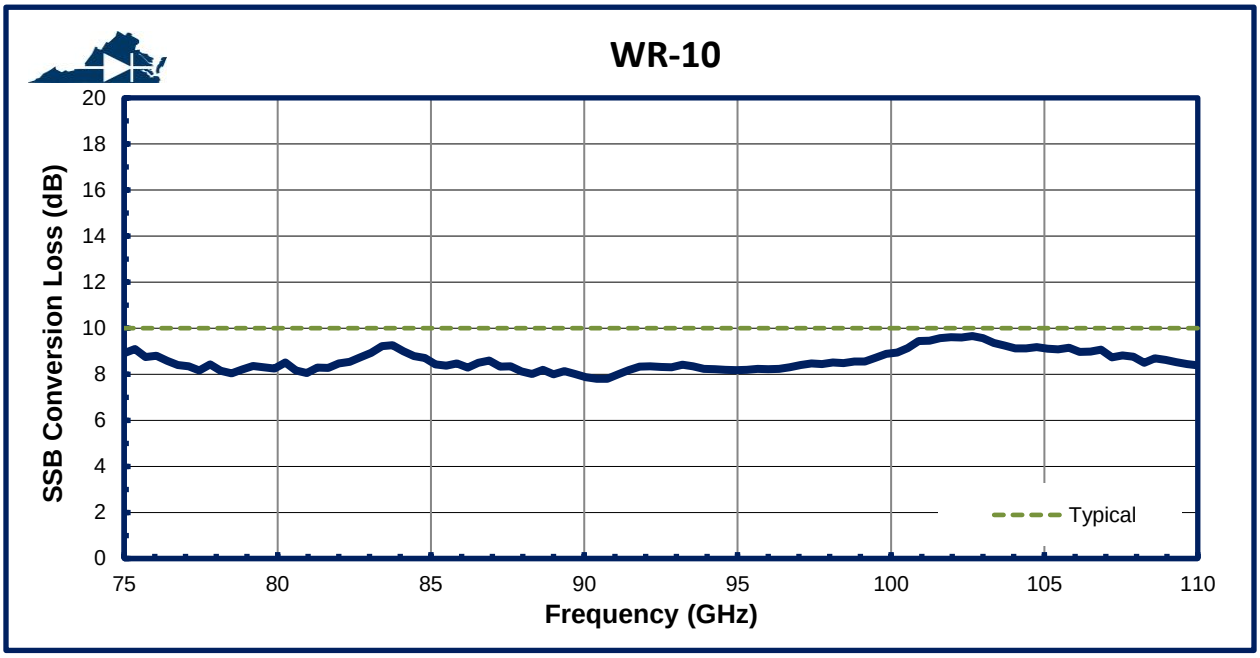


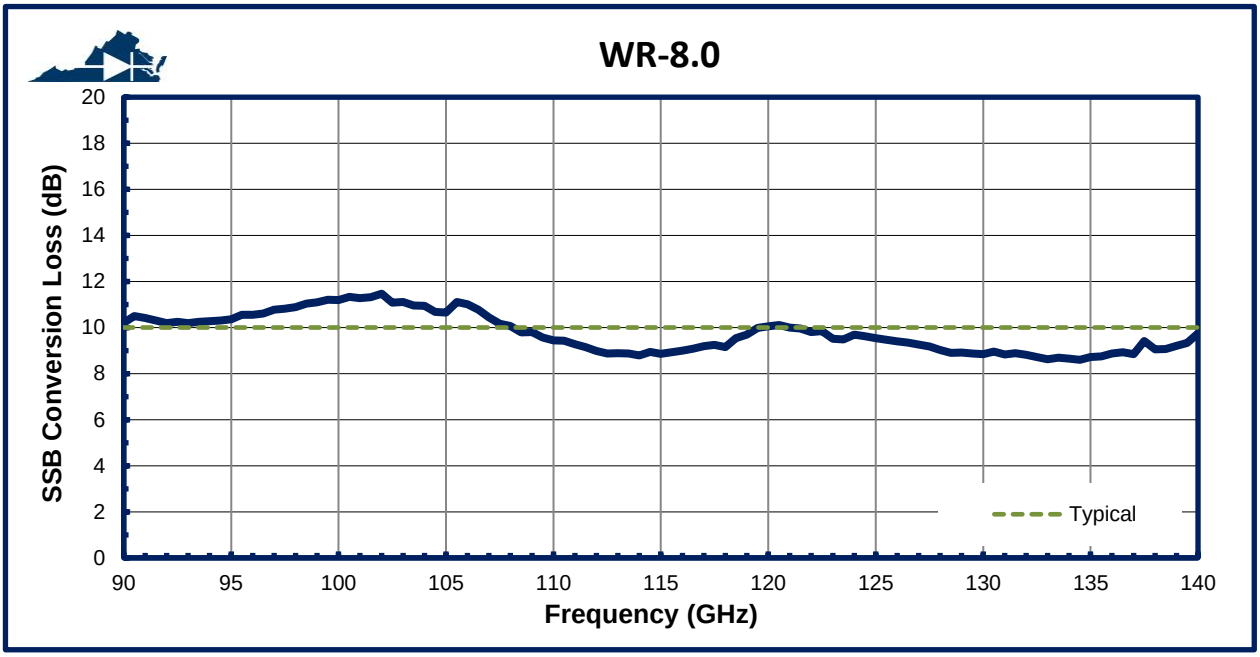
SAX-Z-M Performance – continued



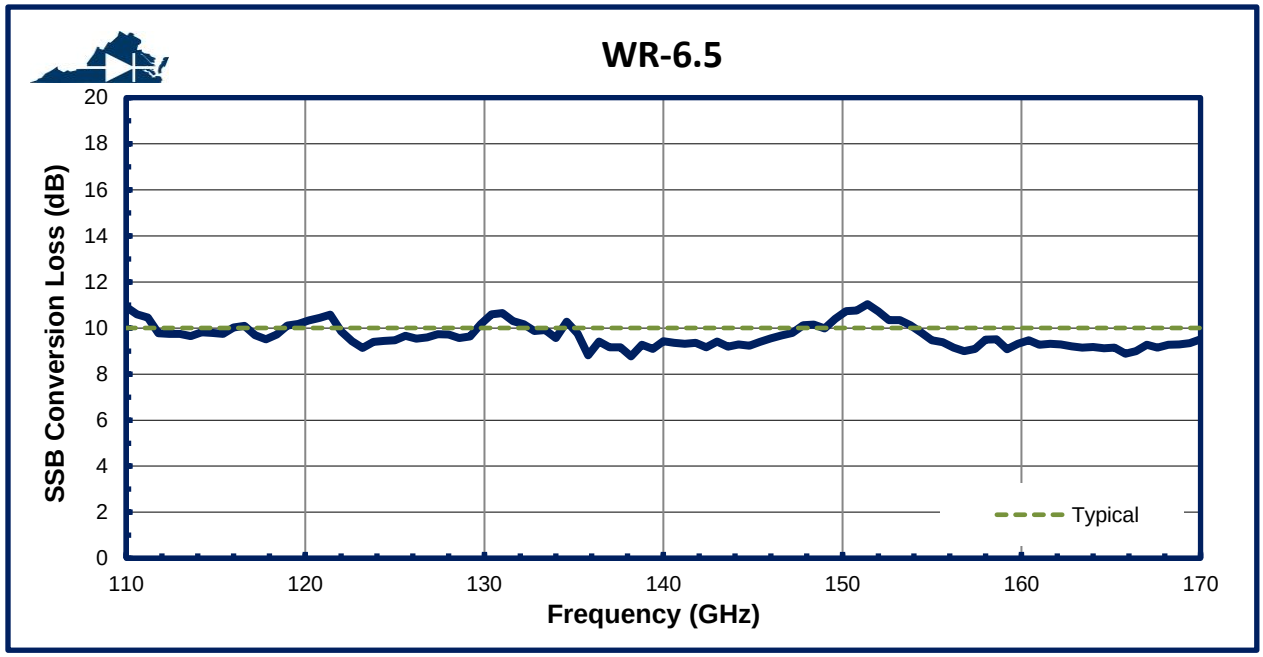


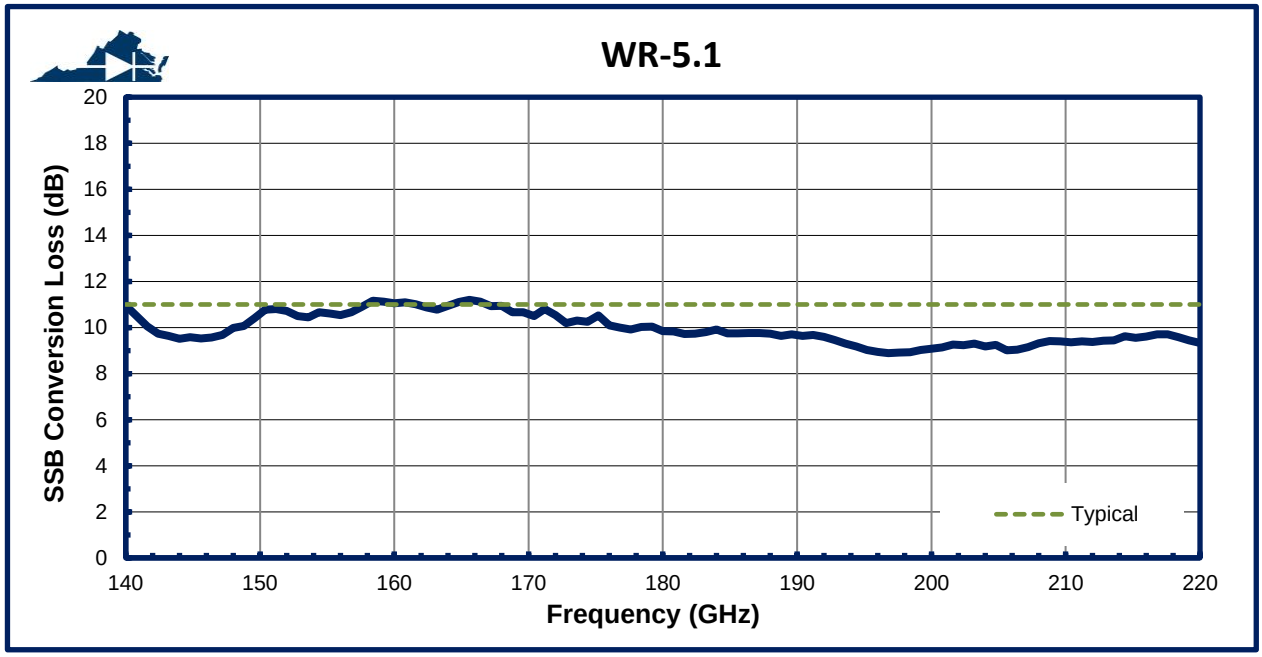
SAX-Z-M Performance – continued



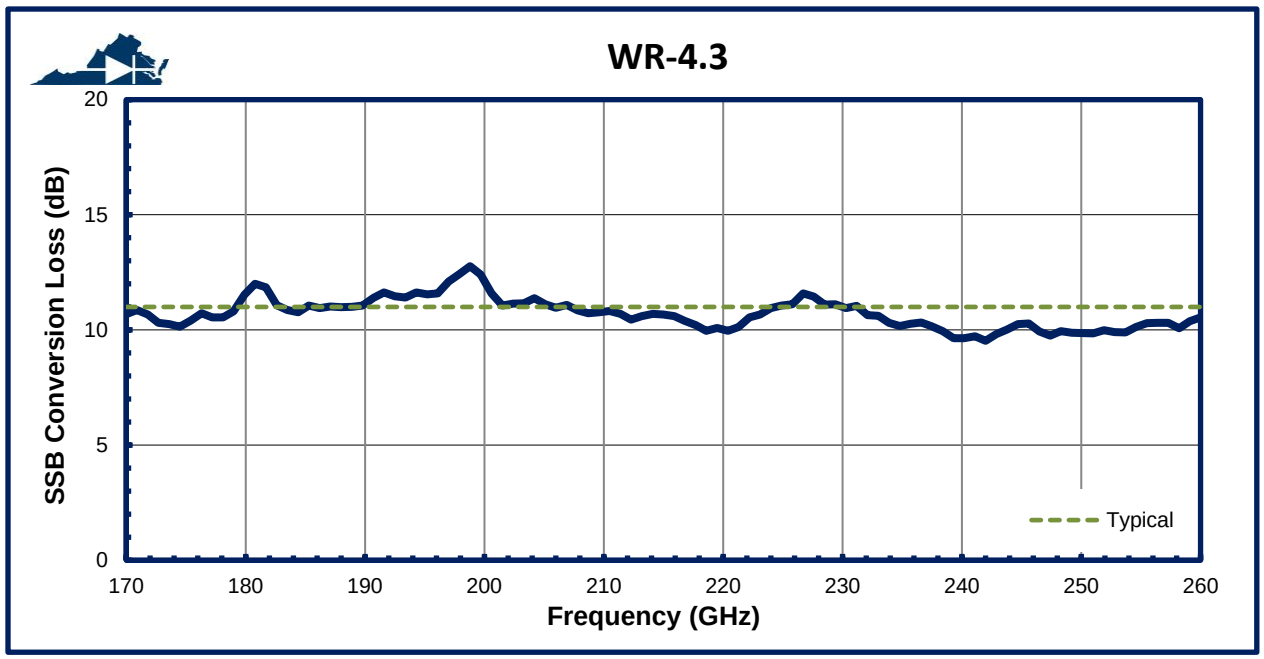


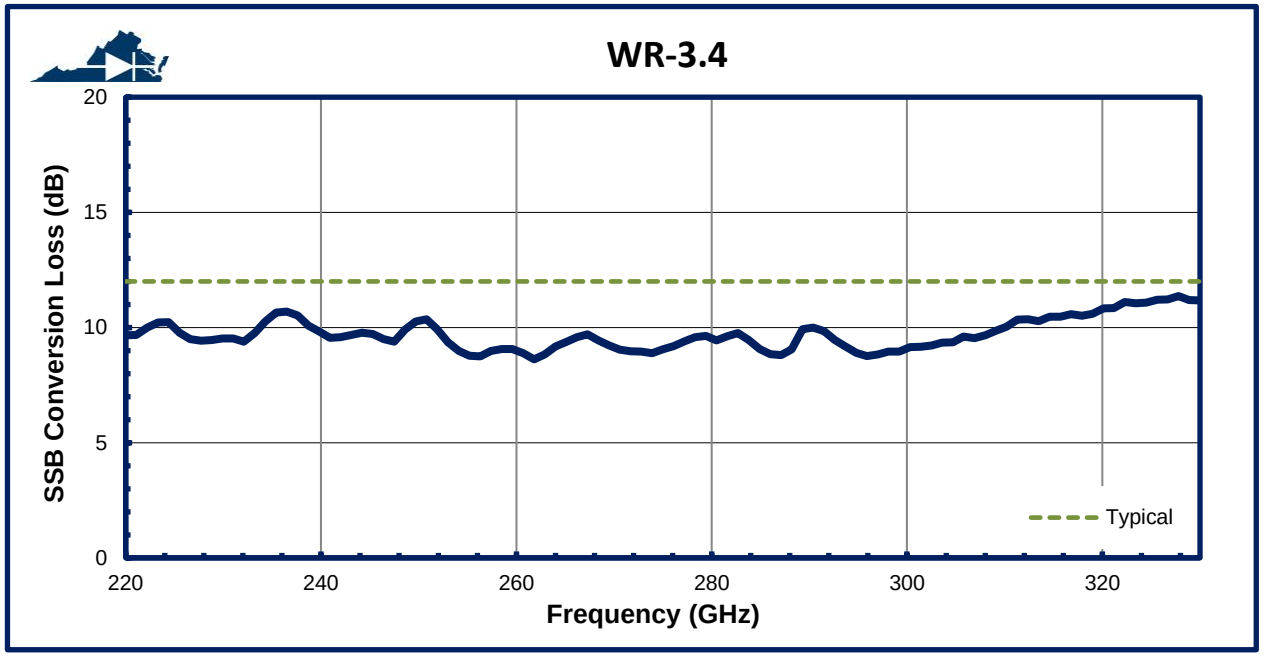
SAX-Z-M Performance – continued





SAX-Z-M Performance – continued





Cable Loss Characterization

AccuTest 150 Attenuation Data

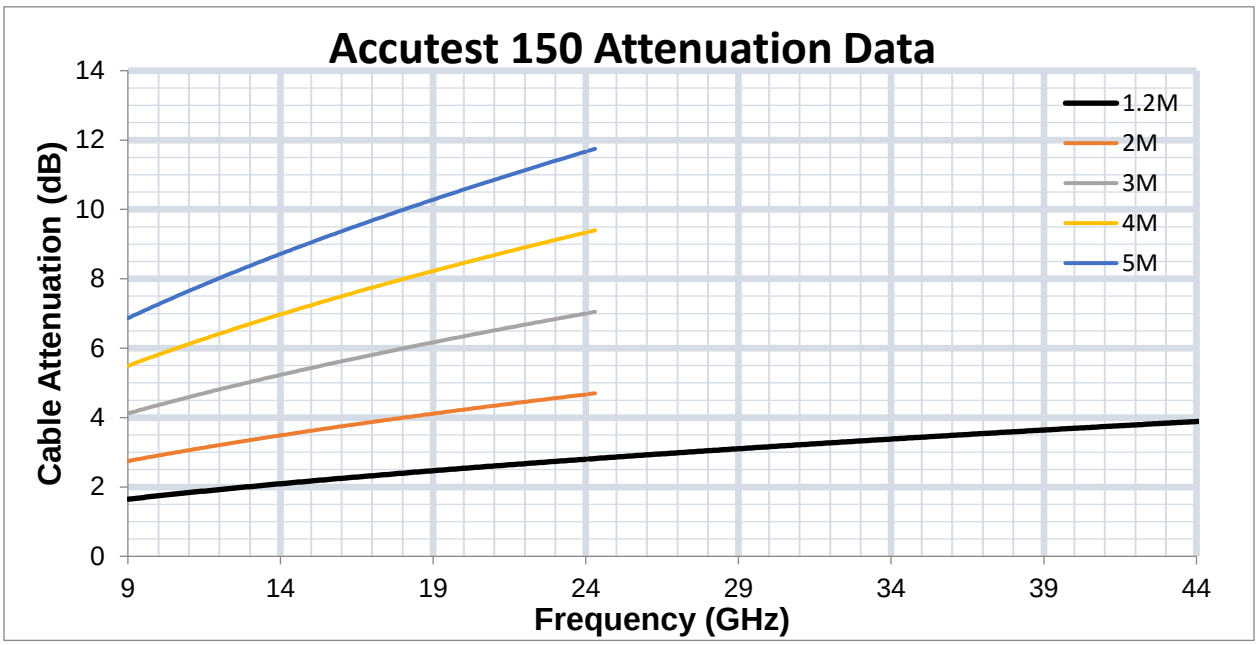


Figure 14: Insertion Loss of AccuTest 150 (RF/LO Cable) with respect to frequency. This chart can be used to calculate cable losses in your system.

Mechanical Drawings

Mechanical Drawing – This drawing applies to all SAX-Z-M modules.