



# Even Harmonic Mixer (EHM) Operational Manual



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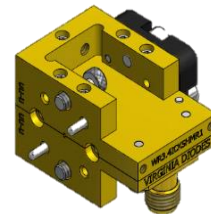
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# EHM General Overview, Safety and Operational Guidelines

## Even Harmonic Mixers (EHM)

Virginia Diodes offers even harmonic mixers (EHMs) for frequency down-conversion. These mixers are easy to use and well suited for millimeter-wave and terahertz applications. They also offer excellent conversion loss. VDI EHMs offer full waveguide band coverage and are available from WR15 (50-75 GHz) to WR2.2 (330-500 GHz). Higher frequency custom mixers are available upon request.



## Safety and Operational Guidelines



Read all instructions and information in this product manual before connecting the product to external equipment. Operational procedures must be followed for proper function. If you have questions, contact VDI before operating the product.



The internal components of every mixer can be damaged by Electro Static Discharge (ESD). Any operator using or handling the device should wear a grounded wrist strap specifically designed to guard against ESD. The work environment, including test benches, should also be properly grounded.



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

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

- Improper use, disassembly or use for purposes other than those for which the product was designed
- Use outside of 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.

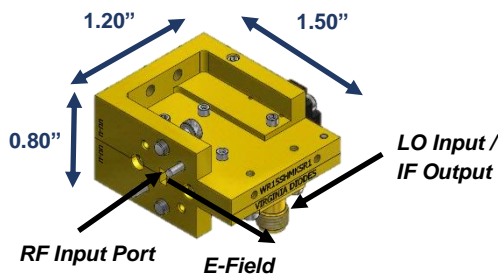
## Waveguide Inspection / Test Port Care

- Inspect waveguide flanges for debris prior to making connections.
- Making a connection with debris between the waveguide flanges can damage the waveguide interface and prevent repeatable connections.
- If debris is present, clean the flange with pre-dampened lint free wipes or swabs (e.g. TexWipe TX1065). If these are not available, lint free cloths lightly dampened with ethanol may be used (e.g. TexWipe TX604).
- When device is not in use, cover appropriate waveguide flanges with provided dust cap or protective waveguide tape.
- Waveguide screws should be torqued between 20-50 cNm; greater values can damage the interface.
- Use a torque of 90 cNm when making coaxial connections. Avoid sharp bends in cables.

## General Operating Practices and Recommendations

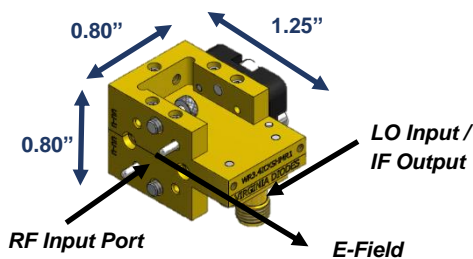
- Check with VDI before any use is attempted beyond those described in this manual, including uses that may exceed limitations stated here or commonly accepted standards of practice.

VDI EHMs have a rectangular waveguide RF input port. The LO input and the IF output share the same coaxial port. The LO input and IF output ports are separated by using a diplexer (see "Diplexer Configuration" section below). The drawings and corresponding dimensions are for a typical WR-10, WR-15 and WR-3.4 even harmonic mixer.



**WR-15**

WR-12 and WR-10 models expected to have similar dimensions

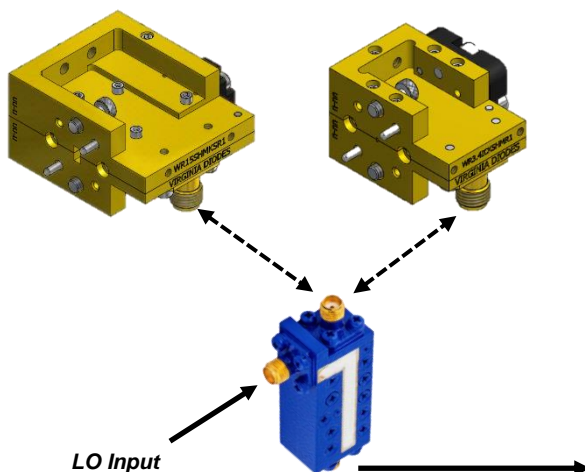


**WR-3.4**

WR-8.0 to WR-2.2 models expected to have similar dimensions

### Diplexer Configuration

VDI even harmonic mixers are typically shipped with a diplexer attached to the coaxial port, as indicated below. Diplexer model depends on the EHM model and the harmonic mixing factor the EHM is designed to operate at.



**IF Output\***  
**EXTREMELY ESD Sensitive**

\*VDI provides an IF filter on the IF port of the diplexer for additional ESD protection. Filter may be removed to access full response of the diplexer IF port. User must follow ESD safe procedures.

Diplexer	LO Frequency (GHz)	IF Frequency (GHz)
ZDSS-3G4G-1+	4-20	DC-3
MD5	20-40	DC-12
MD6	15-26.5	DC-10
MD14	33-50	DC-15

Standard diplexer options are shown in the above table. Part numbers are subject to change. Alternative diplexers for non-standard harmonic mixing factors may be available upon request. Please contact VDI for more information.

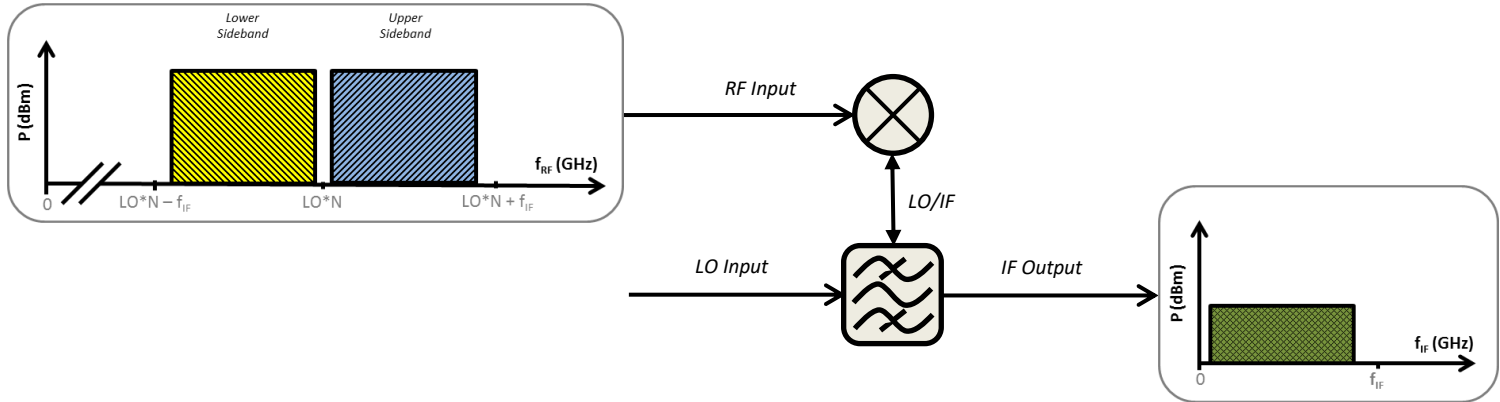
# Operating Procedures

VDI EHMs can be used to down-convert a block of millimeter-wave / THz signals to the IF band, where it can then be coupled into the RF port of an analyzer or processed by other means.

## Double Side Band Block Down-Conversion

Figure below shows how a VDI EHM down-converts a block of millimeter-wave signals. It is important to note that due to the double sideband nature of the EHMs, the mixer will convert both sidebands. The upper and lower sidebands will be down-converted to the same range of IF output frequencies.

For  $N^{\text{th}}$  harmonic mixing, the IF Output frequency can be calculated by:  $f_{\text{IF}} = |f_{\text{RF}} - N \cdot f_{\text{LO}}|$



## General Operating Procedure

**Turn On:** Apply appropriate LO power to the device then apply small signal RF input power.

**Turn Off:** Turn off small signal RF input power then turn off LO input power.

**LO Input:** The LO input frequency is  $\sim 1/N$  of the RF frequency, where  $N$  is an even harmonic. Maximum Available LO Frequency for each model is listed on Page 6. The user must adjust LO power at each frequency for optimal performance. DO NOT exceed damage limits listed on Page 6.

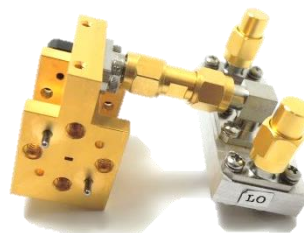
**IF Output Port (Extremely ESD Sensitive):** The IF output port is extremely ESD sensitive. DO NOT apply any DC biases or surges when connecting / disconnecting from IF port. Discharge static from cables before connecting to the device. DO NOT exceed damage limits listed on Page 6. Replace IF port with provided  $50\Omega$  termination when IF port is not in use.

**RF Input Port:** DO NOT exceed damage limits listed on Page 6.

Failure to follow these procedures may damage or destroy the device. The user is liable for repair costs of mixers damaged by ESD, and the use of stringent ESD precautions is recommended when making connections to VDI mixers.

# Product Specifications

General Specifications for Even Harmonic Mixers		
Description		Specification
RF Input Power	1dB Compression	~ -25 dBm
	Damage	0 dBm
LO Input Power	Recommended	7-11 dBm typical*
	Damage	13 dBm
LO/IF Port	-	2.9mm(f)†
Maximum Weight	-	~ 0.1 lbs.
Operating Temperature	Typical / Recommended	25°C / 20-30°C++



†EHMs without diplexers have 2.9mm(f) connectors for the LO/IF port. Connector types for LO and IF ports on diplexers depends on diplexer model (typically SMA or 2.9mm).

++VDI EHMs are warranted for room temperature operation. VDI can offer enhanced warranty that extends the standard VDI warranty to cryogenic operation. Contact VDI for costs associated with the cryogenic warranty option.

\*Defined at the LO input port of the diplexer.

Product Specifications for Even Harmonic Mixers				
VDI Part Number	RF Frequency (GHz)	Maximum Available LO Frequency (GHz)*	RF Flange†	Typical SSB Conversion Loss++
WR15EHM	50-75	10	WR-15	~20-25dB for 12 <sup>th</sup> harmonic mixing
WR12EHM	60-90	12	WR-12	~25-35dB for 8 <sup>th</sup> harmonic mixing
WR10EHM	75-110	15	WR-10.0	~20-25dB for 12 <sup>th</sup> harmonic mixing
WR8.0EHM	90-140	19	WR-8.0	~20-25dB for 12 <sup>th</sup> harmonic mixing
WR6.5EHM	110-170	24	WR-6.5	~23-28dB for 12 <sup>th</sup> harmonic mixing
WR5.1EHM	140-220	31	WR-5.1	~25-35dB for 16 <sup>th</sup> harmonic mixing
WR4.3EHM	170-260	36	WR-4.3	~25-35dB for 16 <sup>th</sup> harmonic mixing
WR3.4EHM	220-330	40	WR-3.4	~30-40dB for 18 <sup>th</sup> harmonic mixing
WR2.8EHM	260-400	40	WR-2.8	~30-40dB for 20 <sup>th</sup> harmonic mixing
WR2.2EHM	330-500	40	WR-2.2	~35-45dB for 16 <sup>th</sup> harmonic mixing

†All flanges are UG-387/U-M.

++SSB Conversion Loss performance is specified at ~279 MHz IF and assumes optimal RF and LO power coupled into the EHM.

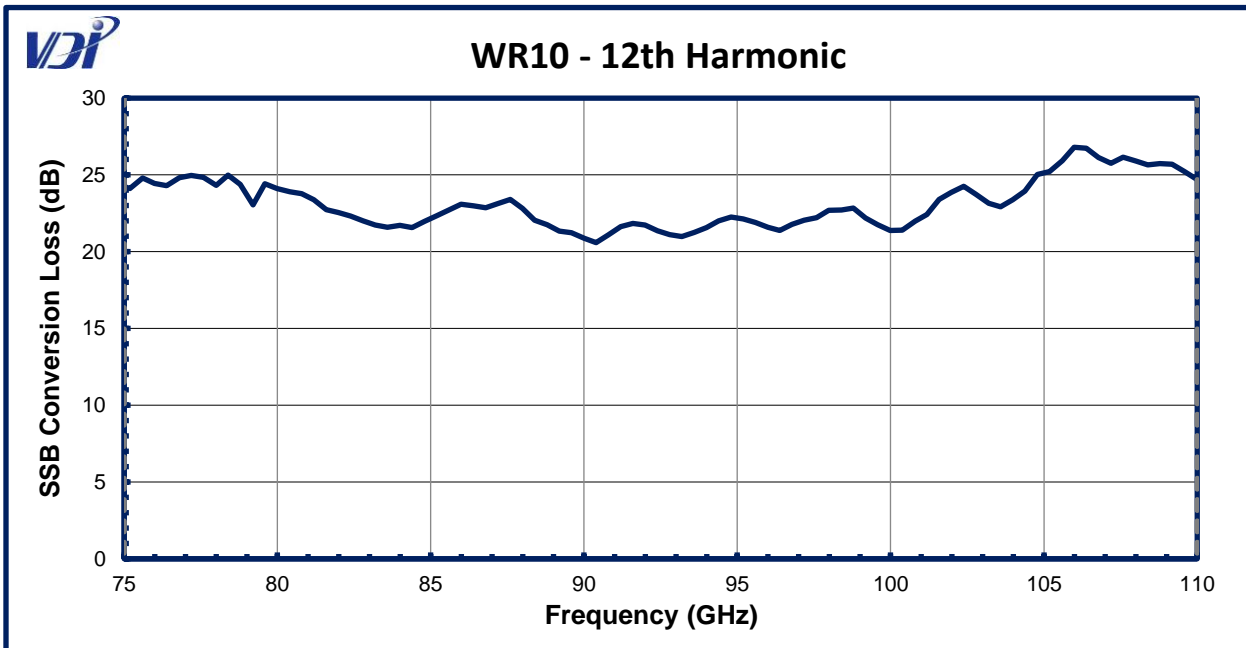
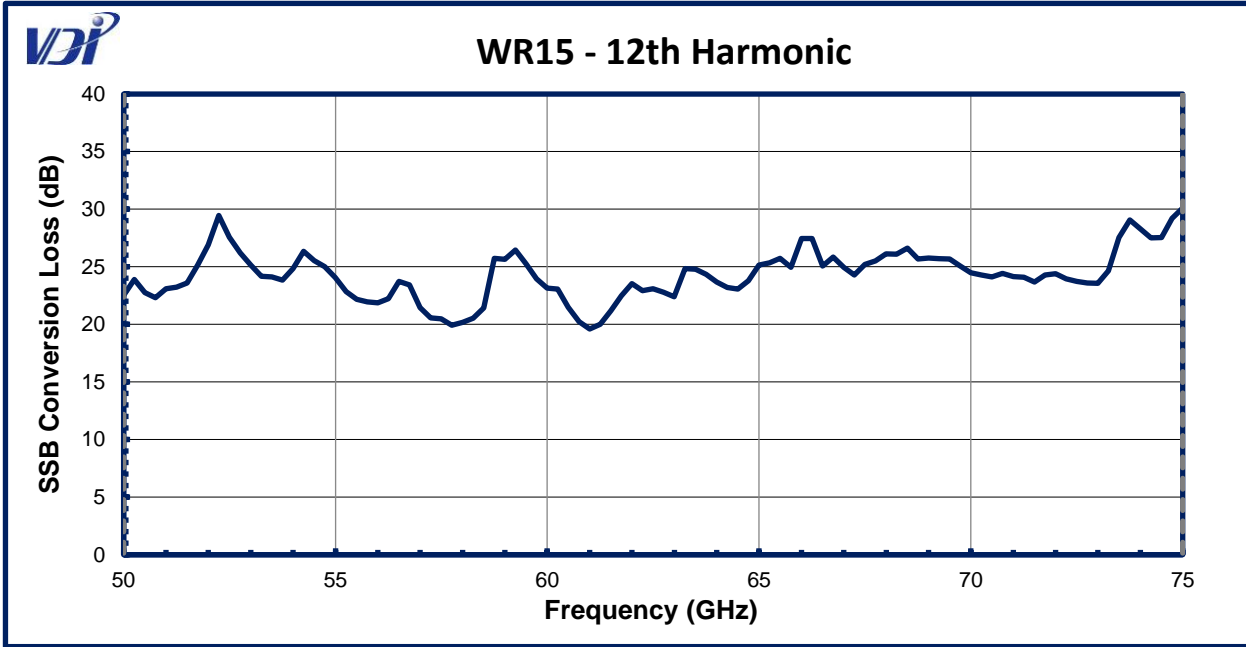
\*LO Input Frequency can be calculated by dividing the RF Input Frequency by the desired harmonic number. LO frequency cannot exceed Maximum Available LO Frequency specification.

## General Notes:

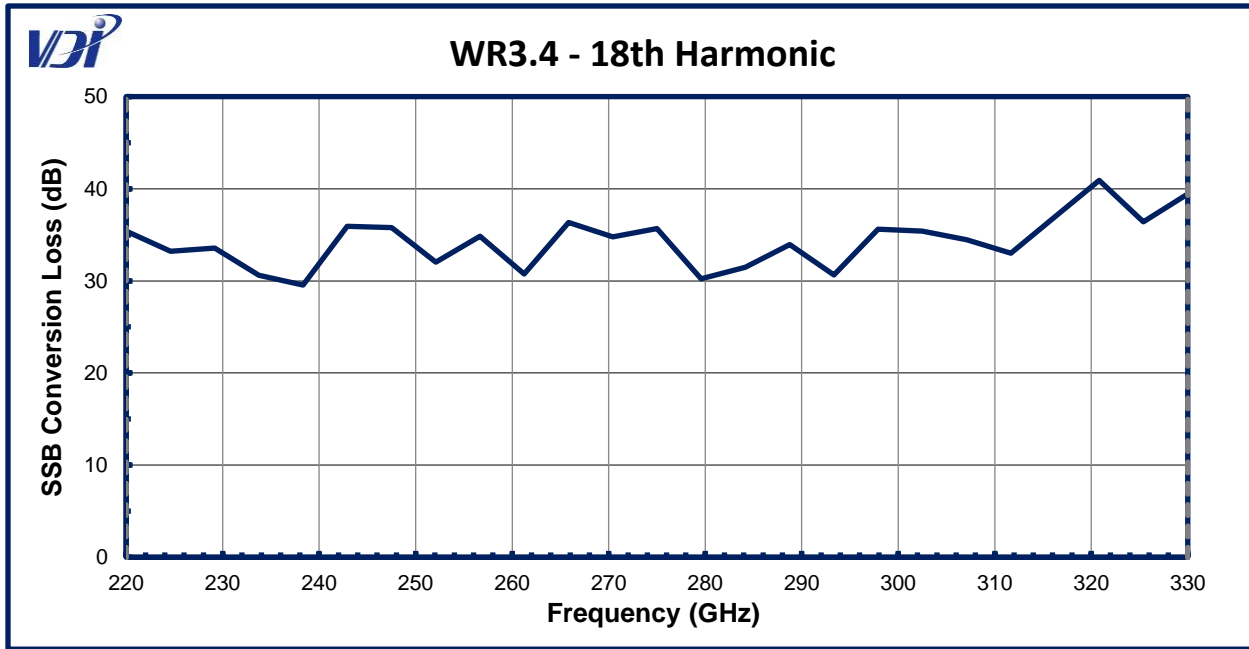
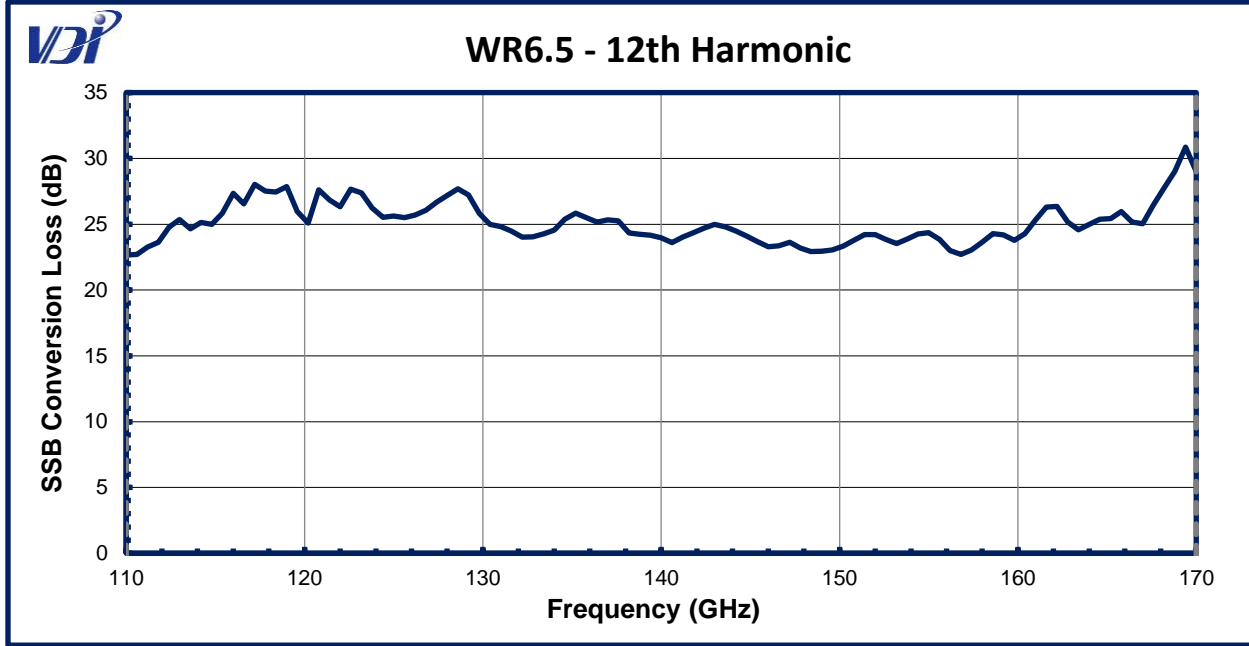
- VDI provides individualized SSB Conversion Loss at ~279 MHz IF for each component. Customized testing is available at additional cost. Contact VDI for more information.
- The required LO power for optimal performance varies across the frequency band. Performance specifications assume optimal RF and LO power coupled into the mixer
- Performance may be reduced near band edges.
- A ~100-3000 MHz high pass filter is included on the IF port of the diplexer for additional ESD protection. If required, the high pass filter can be removed to access the full IF frequency response of the diplexer IF port. Use extreme ESD caution when high pass filter is removed.
- Where available, an LO input isolator will smooth the required LO input power vs. frequency.

## EHM Single Side Band (SSB) Conversion Loss Performance

Typical SSB conversion loss data is provided below. The LO input power was optimized across the frequency band. Additional data can be found on the [VDI website](#) or may be available upon request (technical@vadiodes.com). Measured conversion loss data will be shipped with each VDI EHM.

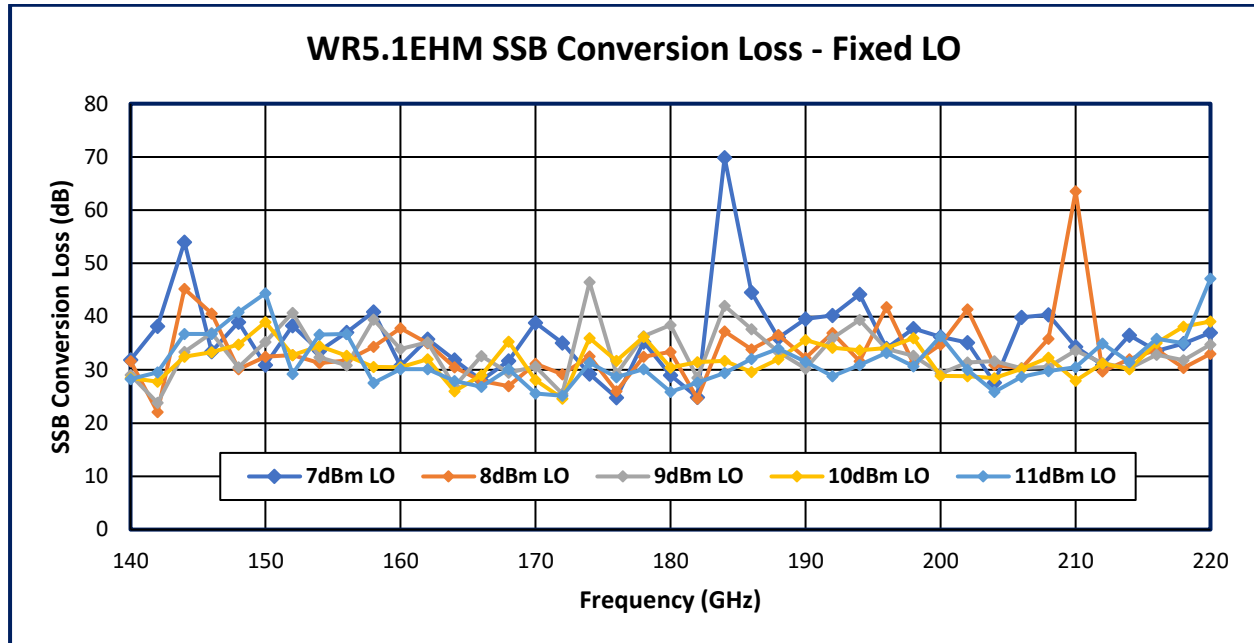


# EHM Performance – WR6.5 and WR3.4



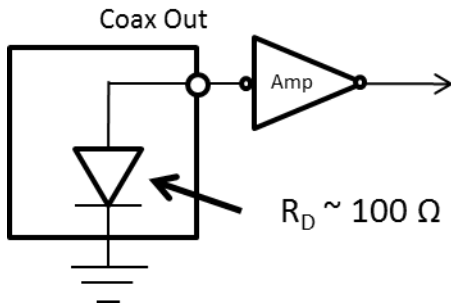


Typical SSB Conversion Loss of a WR5.1EHM is shown below for various LO input power levels. The plot is intended to be used as an example of how the performance can change due to changes in LO input power. The exact shape of the curves will vary. The performance is unique to the frequency band and specific serial number of the EHM.

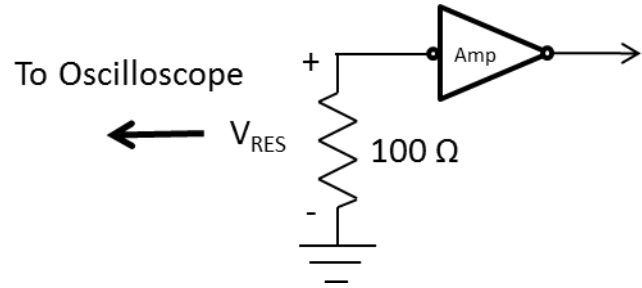


VDI EHMs are extremely ESD sensitive at their coaxial (IF) port. To add ESD protection, an IF amplifier is recommended. However, some IF amplifiers can exhibit DC bias or turn-on transients at the amplifier input, which can damage the VDI EHM. Even with AC coupling at the amplifier input, transients can occur when the amplifier bias is applied rapidly.

Before using an amplifier with a VDI mixer, it is recommended that bias or turn-on transients at the amplifier input be tested. Attach a 100  $\Omega$  resistor to the input of the amplifier. Monitor the resistor voltage on an oscilloscope as the amplifier bias is applied. The turn-on transient voltages across the resistor should be kept less than  $\sim 100\text{mV}$  for safe operation.



**VDI Mixer with External Amp**



**Turn-on Transient Testing**

# Addendum — Product Updates and Company Contacts

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 component operations, improve performance or add capabilities are always welcome.

## Contact VDI:

### Virginia Diodes, Inc.

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