

Fundamental Mixer (FM) Operational Manual



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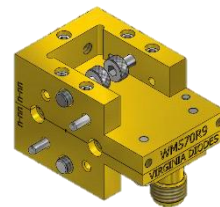
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FM General Overview, Safety and Operational Guidelines

Fundamental Mixers (FM)

Virginia Diodes offers fundamental mixers (FMs) 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 performance. VDI FMs offer full waveguide band coverage and are available from WR15 (50-75 GHz) to WR0.22 (3250-5000 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 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

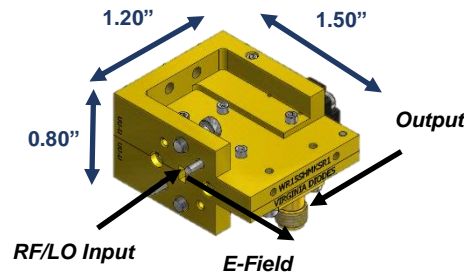
- Inspect waveguide flanges for debris prior to making connections.
- Making a connection with debris between the waveguide flanges can damage the waveguide interface and prevent repeatable connections.
- If debris is present, clean the flange with pre-dampened lint free wipes or swabs (e.g. TexWipe 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 does not recommend the use of liquid or paste for either thermal grounding of VDI components or for locking screws. Liquids/pastes wicking into the VDI component can damage the internal devices and worsen performance.

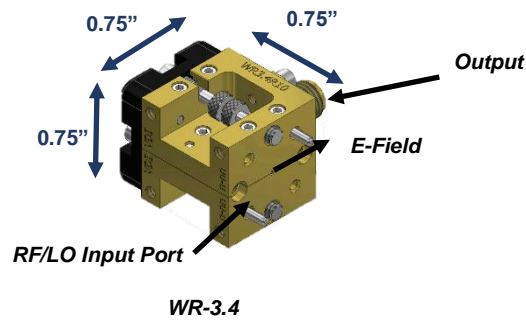
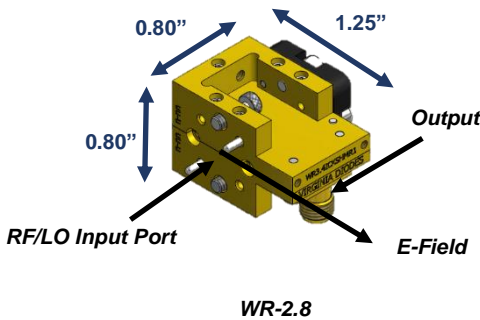
Low Frequency Fundamental Mixers (WR-15 to WR-10)

These mixers have a rectangular waveguide RF/LO input port. The drawings and corresponding dimensions are for a typical WR-15 fundamental mixers. The WR12FMs and WR10FMs have similar form factor to the WR15FMs.



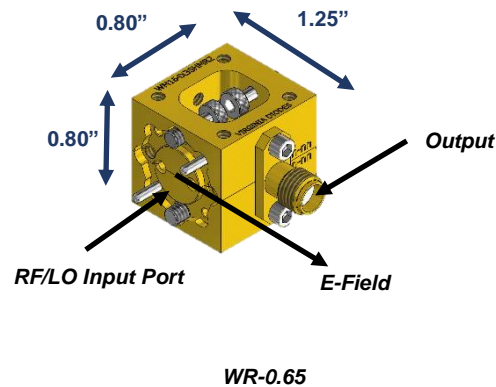
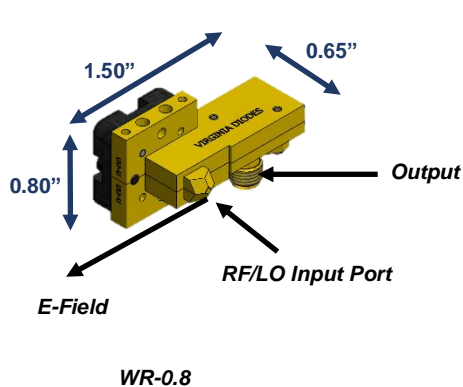
Middle Frequency Fundamental Mixers (WR-8.0 to WR-1.0)

These mixers have rectangular waveguide RF/LO input port. The drawing and corresponding dimensions are for a typical WR-2.8 and WR-3.4 fundamental mixer. Other FMs (WR-8.0 to WR-5.1 and WR-1.9 to WR-1.0) have similar configurations to the WR2.8FM, and WR-4.3 and WR-2.2 have a similar configuration to the WR3.4FM. Dimensions may be slightly different.



High Frequency Fundamental Mixers (WR-0.8, WR-0.65, and WR-0.34)

The drawing and corresponding dimensions are for a typical WR0.8 and WR0.65 fundamental mixer.

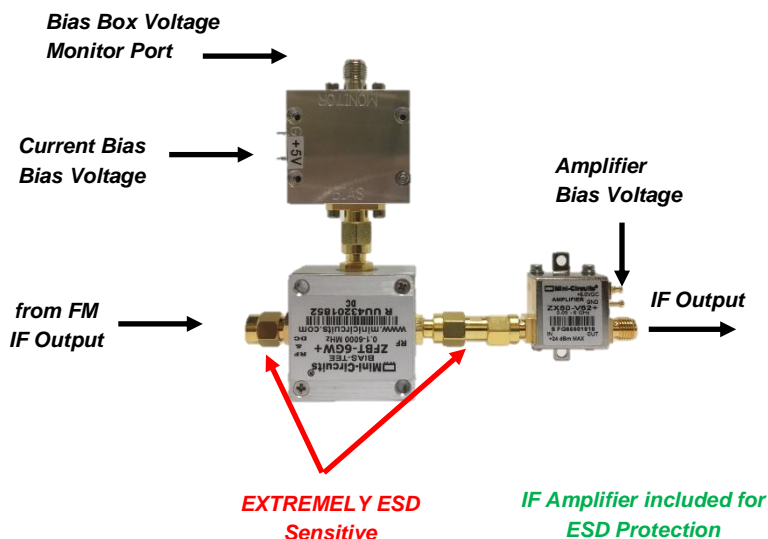


Configuration Details and General Operating Procedures

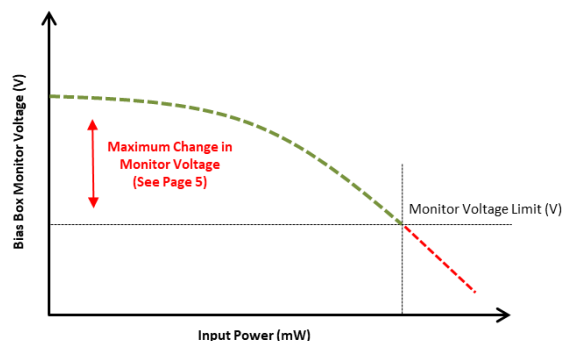
Current Bias Box, Bias-Tee and Amplifier Configuration

VDI fundamental mixers are typically shipped with a bias-tee, amplifier and current bias box attached to the coaxial port, as shown below. 6GHz bias-tee and amplifier is included with the standard FM configuration (see Figure 1a). 20 GHz and 40 GHz bias-tee & amplifier options are available for an additional cost. The current bias box and 6 GHz bias-tee are shown below.

VDI provides a monitor port on the Current Bias Box to allow the user to monitor the device to prevent damage. The voltage at the Monitor Port should be measured with a DC voltmeter. The bias box monitor voltage will be positive when no LO input power is applied. As LO input power increases, the voltage on the monitor port will eventually start to decrease. The maximum change in monitor voltage is specified on page 6. Figure 1b shows a simplified plot of the Bias Box monitor voltage as a function of input power.



(Figure 1a)



(Figure 1b)

General Operating Procedure

Turn On: Apply voltage bias to current bias box. Connect DC voltmeter to the Voltage Monitor Port on the current bias box. Apply LO and small signal RF input powers while monitoring the voltage output response from the Voltage Monitor Port. Do not exceed monitor voltage limits specified on page 6.

Turn Off: Turn off RF and LO input power. Turn off bias voltage to current bias box.

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

IF Output Port: The FM IF output port is extremely ESD sensitive. VDI provides an IF amplifier for ESD protection.

Black Backing Plate: Unused ports are covered by a black backing plate. DO NOT tamper with the black backing plate.

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 Fundamental Mixers		
Description		Specification
RF Input Power	Compression (~P0.1dB)	~20dB below LO Input Power
	Damage	0 dBm
LO Input Power	Recommended	-15 to -5 dBm
	Damage	3 dBm
IF Port	-	See FM Options Table
Change in Monitor Voltage	Typical Range for Optimal Conversion*	50-150mV
	Maximum	See Table Below
Bias Voltage for Current Bias Box	-	+5V \pm 0.1V
Maximum Weight	-	~0.1 lbs.
Operating Temperature	Typical / Recommended	25°C / 20-30°C

*Mixer will work with less voltage change with reduced performance.

Product Specifications for Fundamental Mixers					
VDI Part Number††	RF / LO Frequency (GHz)	Maximum IF Frequency (GHz)*	RF/LO Flange	DSB Performance	
				Conversion Loss (dB, typ.)**	Maximum Change In Monitor Voltage (mV)†
WR15FM-XX	50-75	10	WR-15 UG-385/U	8	400
WR12FM-XX	60-90	12	WR-12 UG-387/U	8	400
WR10FM-XX	75-110	15	WR-10.0 UG-387/U-M	8	400
WR8.0FM-XX	90-140	19	WR-8.0 UG-387/U-M	8	400
WR6.5FM-XX	110-170	24	WR-6.5 UG-387/U-M	8	400
WR5.1FM-XX	140-220	31	WR-5.1 UG-387/U-M	9	400
WR4.3FM-XX	170-260	36	WR-4.3 UG-387/U-M	9	400
WR3.4FM-XX	220-330	40	WR-3.4 UG-387/U-M	10	400
WR2.8FM-XX	260-400	40	WR-2.8 UG-387/U-M	10	400
WR2.2FM-XX	330-500	40	WR-2.2 UG-387/U-M	11	400
WR1.9FM-XX	400-600	40	WR-1.9 UG-387/U-M	11	400
WR1.5FM-XX	500-750	40	WR-1.5 UG-387/U-M	15	400
WR1.2FM-XX	600-900	40	WR-1.2 UG-387/U-M	20	400
WR1.0FM-XX	750-1100	40	WR-1.0 UG-387/U-M	20	400
WR0.8FM-XX	900-1400	40	~25dBi Diagonal Horn	20	400
WR0.65FM-XX	1100-1700	40	WR-0.65 UG-387/U-M	20	400
WR0.34FM-XX	2300-3200	40	~25dBi Pyramidal Horn	25	250

*IF bandwidth may be limited by external components, such as the bias-tee and amplifier (see General Notes).

**VDI does not test conversion loss. For mixers up to WR1.0 and including WR0.65, VDI provides responsivity (change in monitor voltage / RF input power) data for each unit. For higher frequency FMs (WR0.8 and WR0.34), only I-V test and visual inspection will be completed prior to shipment. Additional testing may be available upon request at additional cost. Contact VDI for more information.

†Current Bias Box includes a Voltage Monitor Port. The change in the monitor voltage is related to the power delivered to the mixer. Exceeding the maximum limit will damage the mixer.

††XX is 06, 20 or 40, depending on the configuration. The 06, 20 and 40 options include a 6, 20 or 40 GHz Bias-Tee and Amplifier respectively, attached external to the FM housing. Contact VDI for costs to upgrade to 20 GHz or 40 GHz options.

General Notes:

- VDI's Fundamental Mixers are shipped with a current bias box and a bias-tee & amplifier with a bandwidth of 50MHz to 6 GHz. The 6 GHz bias-tee and amplifier can be replaced with a 20 GHz or 40 GHz bias-tee and amplifier for an additional cost.
- VDI Fundamental Mixers are single-ended, meaning that the RF and LO signals use the same input port, and thus an external combiner is required to combine these two signals.
- The current bias box is optimized for use as a mixer; contact VDI for instructions on how to improve performance in specific applications.
- Conversion Loss is specified for ~1 GHz IF and assumes optimal LO pump into mixer. Intrinsic mixer conversion loss increases as a function of IF, at a rate of about ~2dB per 10 GHz, up to the specified maximum IF.

Product Specifications – Continued

Bias-Tee And Amplifier Options for FMs

FM Options					
FM Option (Part Number)††	Frequency Range	Gain (dB, typical)†	Bias Voltage	Input / Output Impedance**	Output Connector
WRX.xFM-06*	~50 MHz to 6 GHz	14	+5V (~80mA)	50 Ω	SMA(f)
WRX.xFM-20	~ 100 MHz to 20 GHz	12	+12V / -5V (~80mA)	50 Ω	2.9mm(f)
WRX.xFM-40	~50 MHz to 40 GHz	9	+5 V (~100mA)	50 Ω	2.9mm(f)

*Base Configuration

**Input and output impedance specified is for the bias-tee and amplifier only.

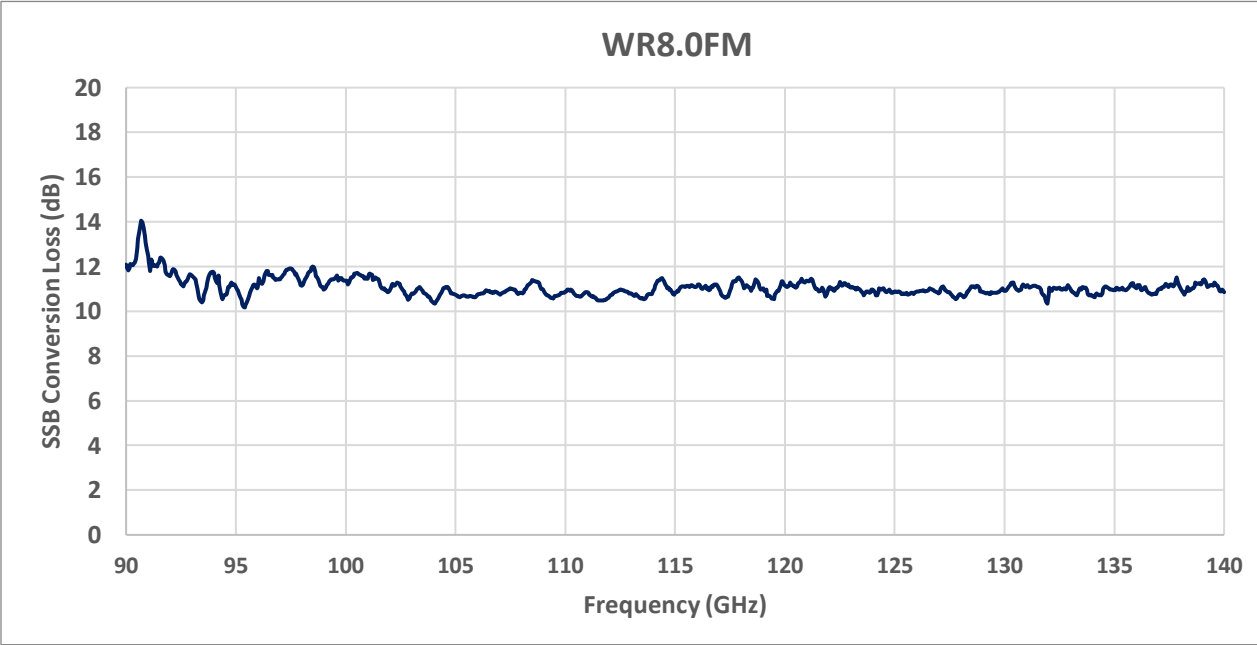
†Includes external bias-tee insertion loss and amplifier gain.

††X.x is the waveguide band (e.g. WR3.4FM-40 is a 220-330 GHz Fundamental Mixer with 40 GHz bias-tee and amplifier as specified above).

FM Single Side Band (SSB) Conversion Loss Performance

Typical SSB conversion loss data is shown below for approximately -7dBm LO input power, approximately -25dBm RF input power, and at 279 MHz IF. Conversion loss may be improved by optimizing the LO input power at every frequency.

VDI provides responsivity (change in monitor voltage / RF input power) data for each unit. Conversion loss testing may be available upon request at additional cost. Contact VDI for more information.



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:

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