

Broadband Frequency Tripler Operational Manual



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General Overview, Safety and Operational Guidelines

Broadband Frequency Triplers

Virginia Diodes, Inc. offers a broad range of millimeter-wave, passive frequency triplers based on planar GaAs Schottky diode technology. Frequency triplers can be used to extend the frequency coverage of microwave and millimeter-wave sources. VDI's broadband triplers have high efficiency across full waveguide bands without requiring any external DC bias. VDI offers broadband frequency triplers from WR-15 (50-75 GHz) to WR-0.34 (2200-3300 GHz). Custom frequency triplers that are optimized for specific applications may be 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.



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 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 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

- This manual applies to products shipping after March 24, 2020.
- 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.

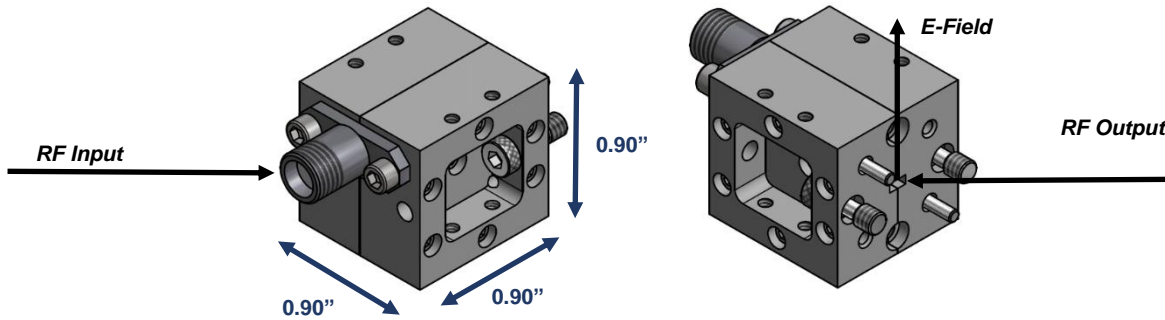
Required Operating Procedures

- DO NOT exceed maximum input power limits (see product datasheet).
- When attaching the tripler's output port to an active device, the input return loss of the active device must not exceed 0dB.

Failure to follow these required operating procedures may damage or destroy the device and will void the product warranty.

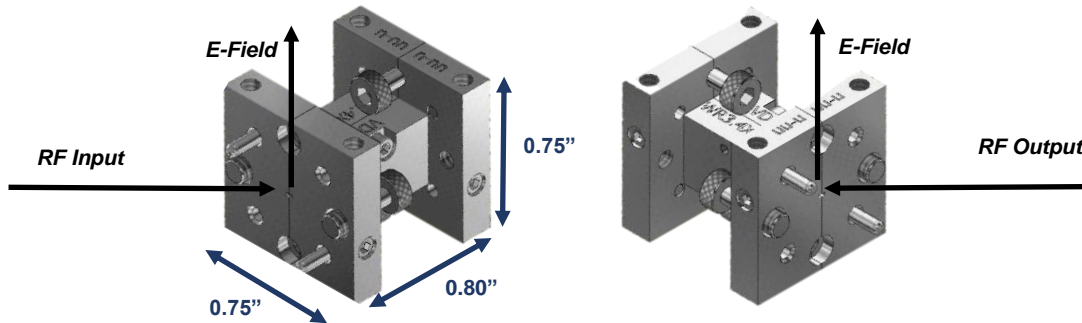
Low Frequency Broadband Frequency Triplers (WR-15 to WR-6.5)

These triplers will have a coaxial input port and a rectangular waveguide output port, with the exception of the WR-6.5 tripler, which has rectangular waveguide input and output ports. The drawing and corresponding dimensions are for a typical WR-12 frequency tripler. Other triplers (WR-15 to WR-6.5) will have similar configuration and dimensions.



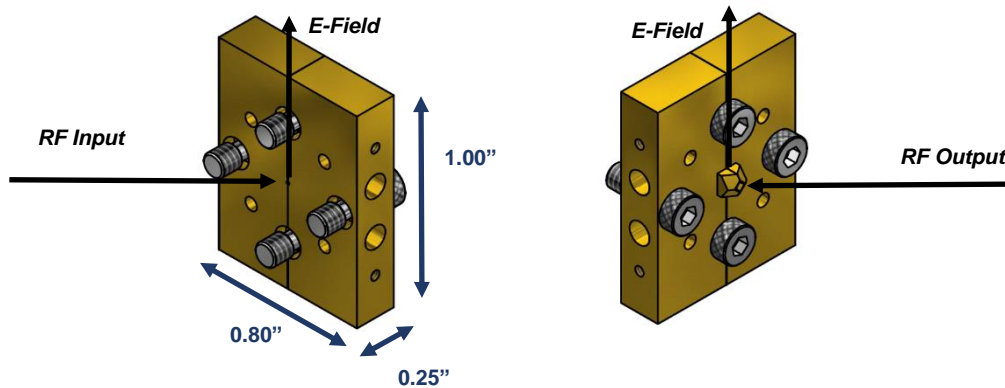
Middle Frequency Broadband Frequency Triplers (WR-5.1 to WR-1.5)

These triplers will have rectangular waveguide input and output ports. The drawing and corresponding dimensions are for a typical WR-5.1 frequency tripler. Other triplers (WR-5.1 to WR-1.5) will have similar configuration and dimensions.



High Frequency Broadband Frequency Triplers (WR-1.2 to WR-0.34)

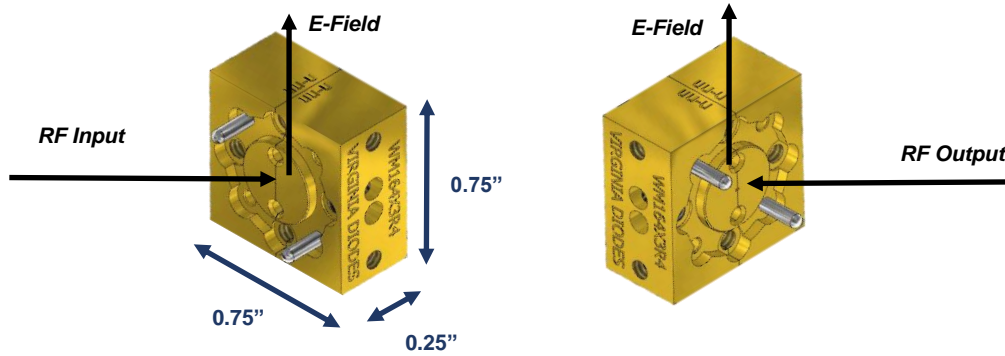
These triplers will have a rectangular waveguide input. The output port will be either a rectangular waveguide or an integrated horn antenna (~25dBi). The drawing and corresponding dimensions are for a typical WR-0.8 frequency tripler. Other triplers (WR-1.2 to WR-0.34) with the exception of WR-0.65 will have similar configuration and dimensions. WR-0.65 frequency tripler will be in the compact form factor. See below.



Product Overview – Continued

Compact High Frequency Broadband Frequency Triplers (WR-1.2 to WR-0.34)

VDI will transition the High Frequency Broadband Triplers to a compact form factor. These triplers will have a rectangular waveguide input and output flange. The drawing and corresponding dimensions are for a typical WM-164 (WR-0.65) frequency tripler. Currently, only the WM-164 (WR-0.65) frequency tripler is available in this form factor.



General Operating Procedure

RF input power must be applied to generate RF output power. The RF output frequency is exactly three times the RF input frequency.

Product Specifications

General Specifications for Broadband Frequency Triplers	
Description	Specification
Maximum Weight	~0.1 lbs.
Operating Temperature (Typical / Recommended)	25°C / 20-30°C†
Unwanted Harmonics (Typical)	-20dBc††

†VDI triplers are warrantied for room temperature operation. VDI can offer an enhanced warranty that extends the standard VDI warranty to cryogenic operation. Contact VDI for costs associated with the cryogenic warranty option.

††Unwanted harmonic performance assumes appropriate RF input power.

Product Specifications for Broadband Frequency Triplers						
VDI Part Number	RF Output Frequency (GHz)	RF Output Flange†	RF Input Frequency (GHz)	RF Input Flange†	Typical Efficiency (%)††	Input Power Options (Input Power Range / Damage Limit)**
WR15X3	50-75	WR-15	16.67-25	2.9mm(f)	3.5	HP (100-500mW / 625mW)
WR12X3	60-90	WR-12	20-30	2.9mm(f)	3.5	HP (75-400mW / 500mW)
WR10X3	75-110	WR-10	25-36.7	2.9mm(f)	3.5	MP (40-220mW / 275mW), HP (60-360mW / 450mW)
WR9.0X3	82-125	WR-9.0	27.3-41.7	2.9mm(f)	3.5	HP (60-250mW / 315mW)
WR8.0X3	90-140	WR-8.0	30-46.7	2.4mm(f)	3	MP (20-100mW, 120mW), HP (40-240mW / 300mW)
WR6.5X3	110-170	WR-6.5	36.7-56.7	WR-19.5	3	S (20-100mW / 120mW), HP (40-200mW / 250mW)
WR5.1X3	140-220	WR-5.1	46.7-73.3	WR-15.3	3	S (10-40mW / 50mW), HP (20-100mW / 120mW)
WR4.3X3	170-260	WR-4.3	56.7-86.7	WR-12.9	3	S (10-40mW / 50mW), HP (20-100mW / 120mW)
WR3.4X3	220-330	WR-3.4	73.3-110	WR-10.2	3	S (5-35mW / 45mW), HP (20-90mW / 110mW), UHP (30-160mW / 200mW)
WR2.8X3	260-400	WR-2.8	86.7-133.3	WR-8.4	3	S (5-35mW / 45mW), HP (20-90mW / 110mW), UHP (30-160mW / 200mW)
WR2.2X3	330-500	WR-2.2	110-166.7	WR-6.6	2	S (5-25mW / 30mW), HP (15-70mW / 90mW), UHP (20-150mW / 180mW)
WR1.9X3	400-600	WR-1.9	133.3-200	WR-5.7	1.5	S (5-25mW / 30mW), HP (15-65mW / 80mW), UHP (20-140mW / 175mW)
WR1.5X3	500-750	WR-1.5	166.7-250	WR-4.5	1.5	S (5-25mW / 30mW), HP (15-65mW / 80mW)
WR1.2X3	600-900	WR-1.2	200-300	WR-3.6	1	S (5-25mW / 30mW), HP (15-50mW / 60mW)
WR1.0X3	750-1100	WR-1.0	250-366.7	WR-3.0	0.5	S (5-25mW / 30mW), HP (15-50mW / 60mW)
WR0.8X3	900-1400	WR-0.8 Horn*	300-466.7	WR-2.4	0.2	S (5-25mW / 30mW)
WR0.65X3	1100-1700	WR-0.65	366.7-566.7	WR-1.9	0.2	LP (0.5-4.5mW / 5.5mW), S (5-25mW / 30mW)
WR0.51X3	1400-2200	WR-0.51 Horn*	466.7-733.3	WR-1.5	0.1	LP (0.5-3mW / 4mW)
WR0.34X3	2200-3300	WR-0.34 Horn*	733.3-1100	WR-1.0	0.05	LP (0.5-3mW / 4mW)

†RF

Flanges with 'WR' designation have UG-387/U-M flanges, with the exception of the WR-19, which has a UG-383/U flange.

††Efficiency assumes appropriate RF input power is applied to the device. Reduced efficiency is possible at band edges & upper and lower input power limits. Efficiency is defined as the RF output power, expressed as a percentage of the RF input power.

*Integrated Diagonal Horn antenna has a gain of ~25dBi specified at the center of the waveguide band. The gain changes as a function of frequency. See VDI Application Note: VDI Waveguide Feedhorn Specification (VDI-1001) for more information.

**Additional power options may be available upon request. Contact VDI for more information.

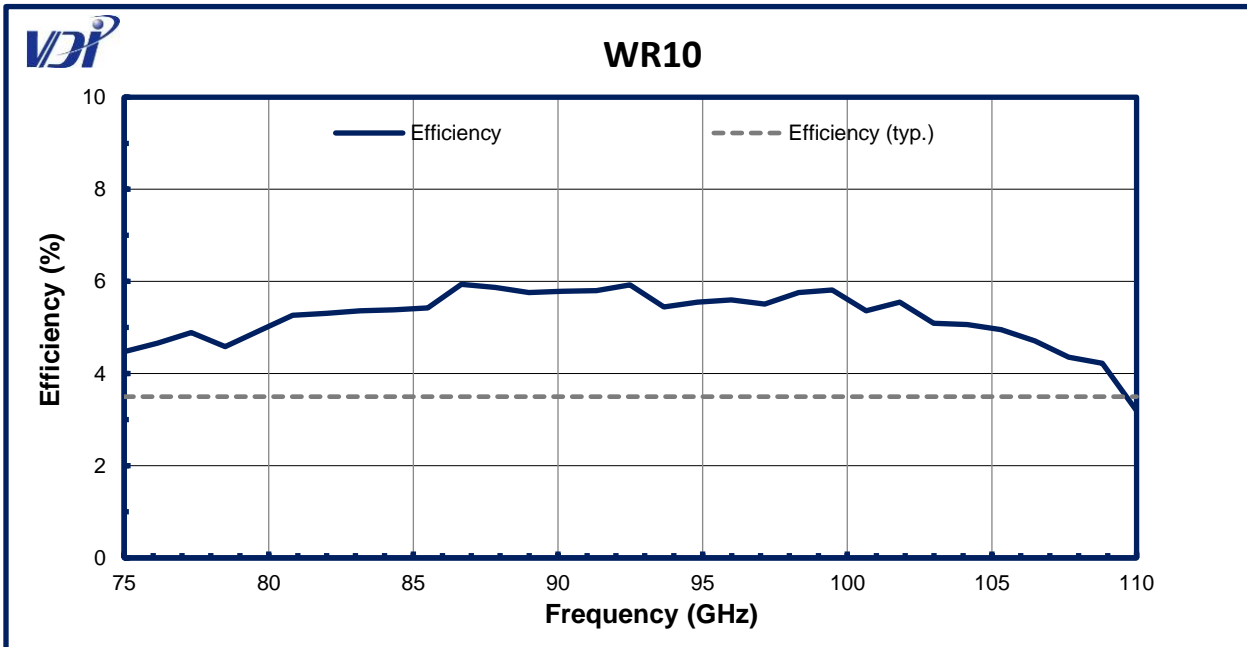
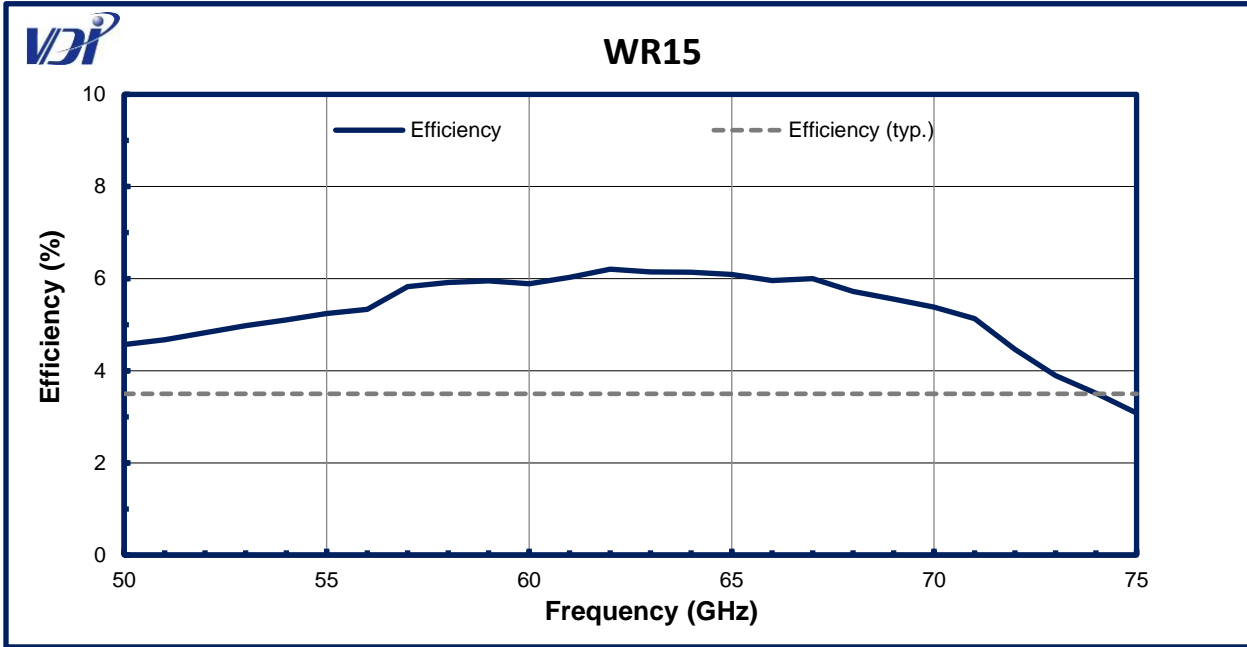
Part Number Format

Use "VDI Part Number" in above table with appropriate suffix for the desired input power option.

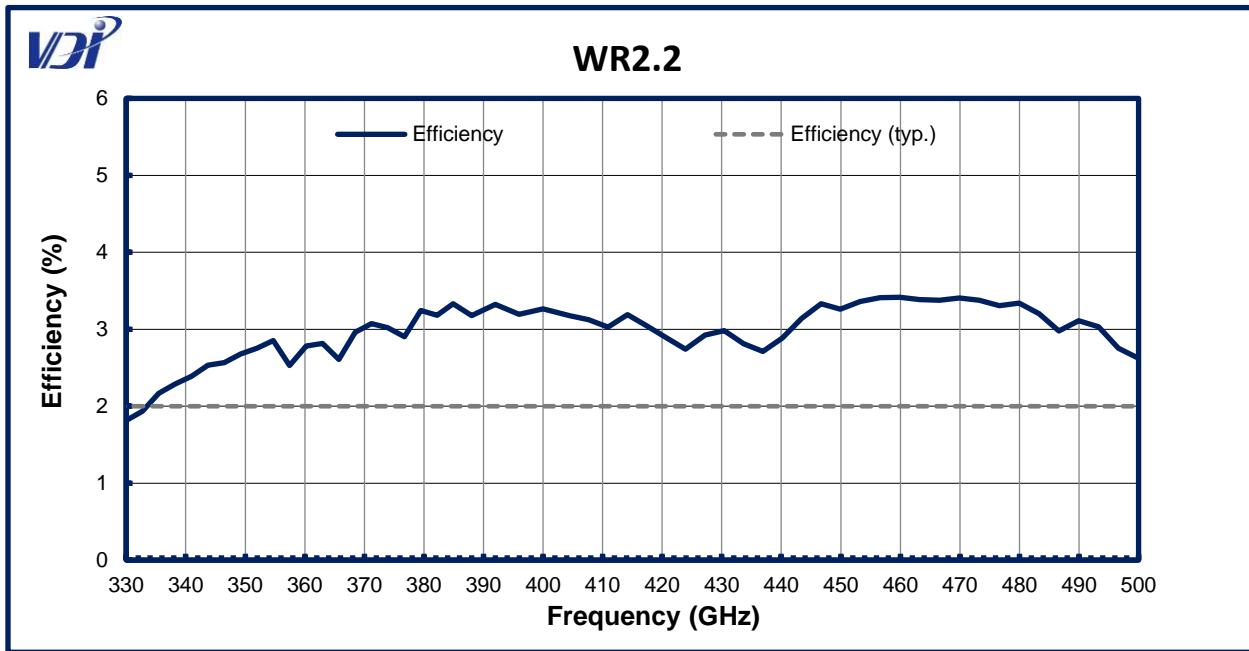
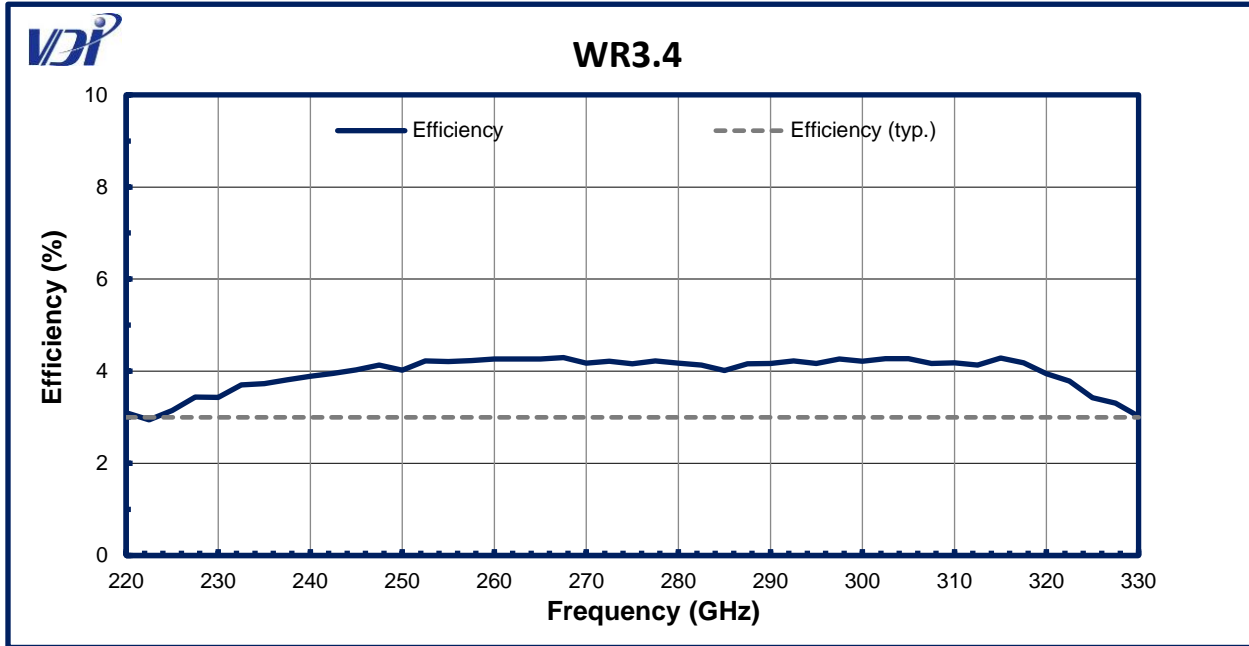
Example: WR2.2X3HP – VDI Frequency Tripler with output frequency of 325-500 GHz and RF input power range of 15-70mW.

Broadband Frequency Tripler Performance

Typical efficiency data is provided on the following pages for various broadband frequency triplers. Additional data can be found on the [VDI website](http://www.vadiodes.com) or may be available upon request (technical@vadiodes.com). Measured efficiency data is shipped with each VDI broadband frequency tripler.



Performance – WR3.4 and WR2.2



Efficiency vs. RF Input Power

This graph shows measured data for a specific WR-10 frequency tripler at ~90 GHz. As the RF input power is increased, the efficiency will start to increase until the efficiency achieves a maximum value. Beyond this point, the efficiency reduces as the tripler begins to saturate.

The general shape of the curve is consistent with all VDI's broadband frequency triplers. However, the scale depends on the specific tripler design, the operating frequency and other operating conditions, for example temperature and impedance matching with the source and load.

Efficiency versus power data can be supplied for all shipped triplers at an additional cost.

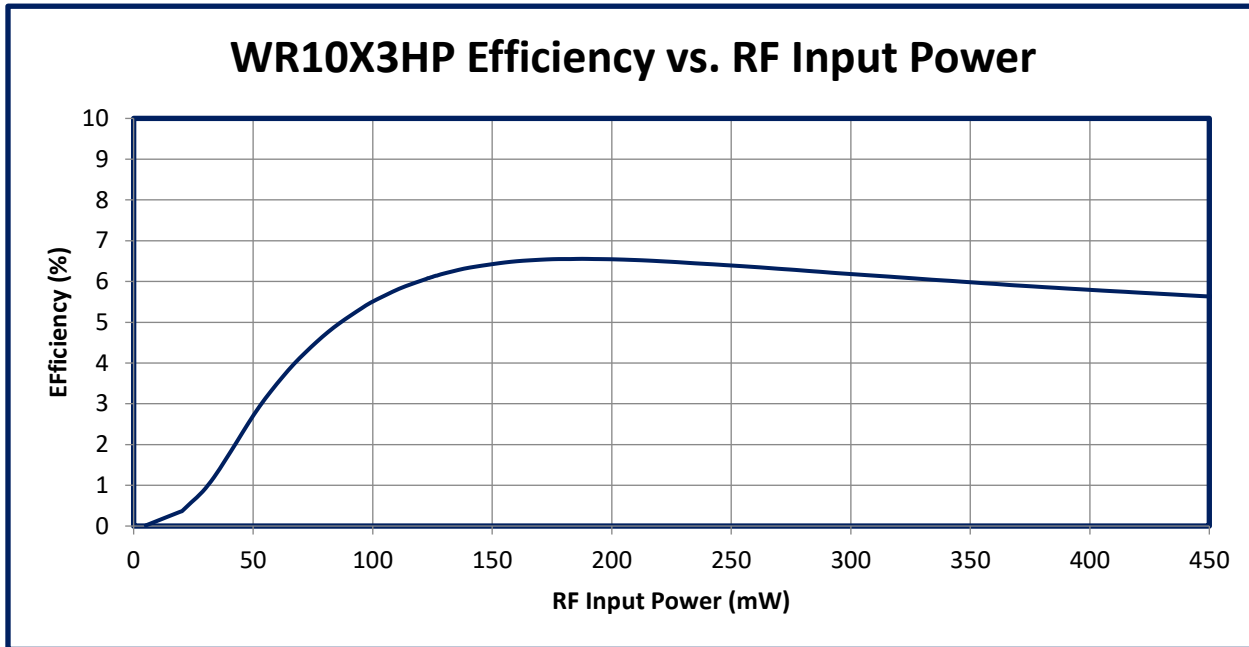


Figure 1: Efficiency vs. RF Input Power

The performance (efficiency vs. RF input power) is shown for a sample WR10X3HP at ~90 GHz.

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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