

Varactor Multiplier Operational Manual



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General Overview, Safety and Operational Guidelines

Varactor Frequency Multipliers

Virginia Diodes, Inc. offers a broad range of millimeter-wave, passive frequency multipliers based on planar GaAs Schottky diode technology. Frequency multipliers can be used to extend the frequency coverage of microwave and millimeter-wave sources. VDI varactor multipliers have high efficiency with approximately 4-14% 3dB bandwidth. VDI offers varactor multipliers from ~50 GHz to ~500 GHz. Custom frequency multipliers 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 other purposes 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

- 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.
- 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.

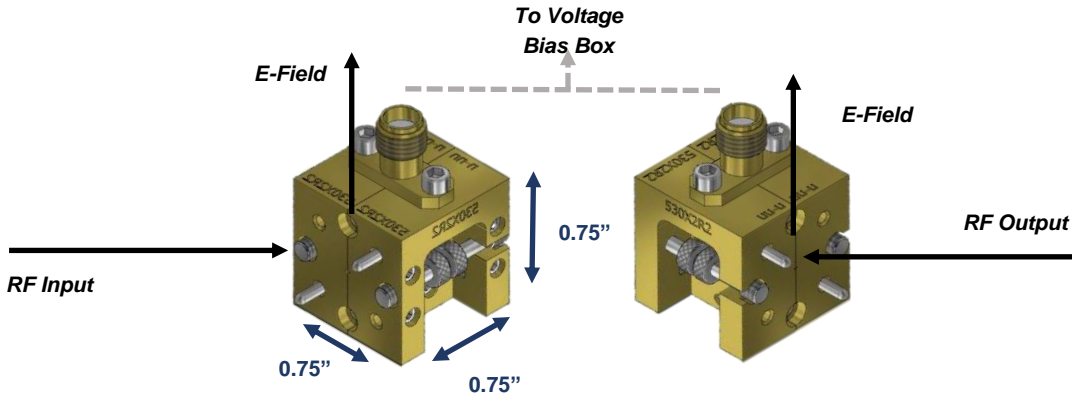
Required Operating Procedures

- The user and test bench should be grounded and protected against ESD.
- DO NOT exceed Bias Box Monitor Voltage and maximum RF input power limits.
- DO NOT disconnect bias box from the device; doing so will expose the multiplier to **possible ESD damage**.
- Apply voltage to voltage bias box prior to applying RF power to the device.
- DO NOT reflect more than 10% of the power back into the Varactor Multiplier output.
- VDI Varactor Multipliers do not have integrated input and output isolation, therefore isolators are recommended.

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

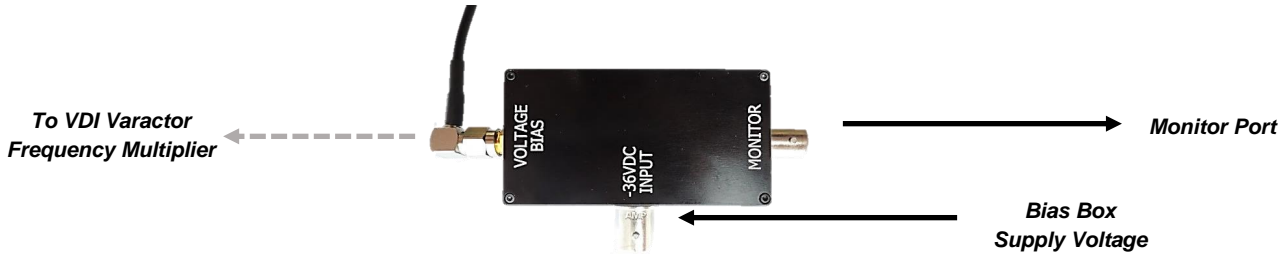
Varactor Multipliers

The drawing and corresponding dimensions below are for a typical D370 frequency doubler. The form factor for varactor doublers and triplers vary based on frequency and design. Contact VDI for 2D drawings of the latest varactor multiplier waveguide housings.



Voltage Bias Box

VDI varactor frequency multipliers require a voltage bias box for proper operation. A voltage bias box is included with every varactor frequency multiplier connected by a black SMA cable (~24 inches long). The bias box requires a customer supplied DC voltage ($-36V \pm 1V$). When the appropriate voltage is applied, the bias box supplies a fixed negative voltage bias to the device. The voltage bias value is configured at VDI for a specific RF input power specified by the customer.



D-Series and T-Series Multipliers

D-Series: Multipliers with the prefix "D" indicates a narrowband, high efficiency frequency doubler

T-Series: Multipliers with the prefix "T" indicates a narrowband, high efficiency frequency tripler

General Operating Procedure

Turn On: The Bias Box Supply Voltage must be applied BEFORE applying the RF input power to the multiplier. The voltage on the Monitor Port must not exceed the damage limit (See individualized datasheets).

Turn Off: The RF input power must be turned off BEFORE turning off the Bias Box Supply Voltage. RF input power must be applied to generate RF output power.

Product Specifications

General Specifications for Varactor Multipliers		
Description		Specification
Bias Box Supply Voltage	Voltage / Max Current Draw	-36 ± 1 VDC / 0.1A [†]
	Connector	BNC(f)
Monitor Port	Voltage Limit	See Datasheet
	Connector	BNC(f)
Maximum Weight	-	~0.1 lbs.
Operating Temperature	Typical / Recommended	25°C / 20-30°C ^{††}
Unwanted Harmonics (Typical)		-20dBc [*]

[†]VDI varactor multipliers require bias. A voltage bias box is included with every multiplier (unless otherwise specified). Voltage specification may be subject to change. See label on bias box for exact supply voltage specifications.

^{††}VDI varactor multipliers are warranted 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.

Specifications for Varactor Doublers [*]						
VDI Part Number	RF Output Frequency (GHz) [†]	Peak Efficiency (%) ^{††}	Typical 3dB Bandwidth (%) ^{††}	RF Input Power Range (mW) ^{††}	Output Flange	Input Flange
D52-W	48-57	25	14	300-1950	WR-19 UG-383/U	2.9mm(f)
D52-N	48-58	32	8	300-1950	WR-19 UG-383/U	2.9mm(f)
D58	48-65	32	14	450-1800	WR-15 UG-385/U	2.9mm(f)
D62	51-67	33	14	400-1800	WR-15 UG-385/U	2.9mm(f)
D72	64-79	28-30	14	400-1500	WR-12 UG-387/U	2.9mm(f)
D84	73-90	28-30	14	250-1000	WR-10 UG-387/U-M	WR-22 UG-383/U
D90	86-96	30	10	200-900	WR-10 UG-387/U-M	WR-19 UG-383/U
D102	92-109	27	14	200-700	WR-10 UG-387/U-M	WR-19 UG-383/U
D108	92-124	30	10	250-1000	WR-8.0 UG-387/U-M	WR-15 UG-385/U
D110	104-118	25-30	8	200-900	WR-8.0 UG-387/U-M	WR-15 UG-385/U
D123	110-132	24-28	8	150-700	WR-6.5 UG-387/U-M	WR-15 UG-385/U
D153	135-157	24-28	8	150-650	WR-6.5 UG-387/U-M	WR-12 UG-387/U
D175	157-192	25-30	8	120-550	WR-5.1 UG-387/U-M	WR-10 UG-387/U-M
D210	195-228	25	8	100-500	WR-4.3 UG-387/U-M	WR-8.0 UG-387/U-M
D252	225-278	20-25	7	100-450	WR-3.4 UG-387/U-M	WR-6.5 UG-387/U-M
D315	280-338	18-23	6.5	120-220	WR-2.8 UG-387/U-M	WR-5.1 UG-387/U-M
D330	280-340	20-25	10	20-190	WR-2.8 UG-387/U-M	WR-5.1 UG-387/U-M
D370	330-420	18	6	15-110	WR-2.2 UG-387/U-M	WR-4.3 UG-387/U-M
D450	400-470	13	6	30-120	WR-2.2 UG-387/U-M	WR-4.3 UG-387/U-M
D530	440-590	9-13	5	10-80	WR-1.9 UG-387/U-M	WR-3.4 UG-387/U-M
D650	580-680	9-13	5	8-75	WM-380 UG-387/U-M	WR-3.4 UG-387/U-M

[†]The RF Output Frequency range indicates the range over which the multiplier can be tuned. The lower and upper limits indicate the minimum and maximum 3dB bandwidth limits of the multiplier respectively.

^{††}The multiplier can be configured to operate at an RF input power level within the wide RF input power range specified above. However, the multiplier is expected to operate approximately ±1dB centered around the RF input power level specified, not exceeding the maximum or minimum RF input power range listed above. Different biases may be required to achieve optimal performance across the full input power range specified above. Efficiency and 3dB bandwidth may be reduced at low RF input power levels. **RF Input Power Damage Limit is expected to be approximately +2dB above the specified RF input power level specified, not exceeding the maximum RF input power listed above. See individualized datasheet for damage limit.**

^{*}This table is not a comprehensive list of all the varactor multipliers VDI offers. VDI may offer a different multiplier that is better suited for your application.

Product Specifications – Continued

Specifications for Varactor Triplers*						
VDI Part Number	RF Output Frequency (GHz) [†]	Peak Efficiency (%) ^{††}	Typical 3dB Bandwidth (%) ^{††}	RF Input Power Range (mW) ^{††}	Output Flange	Input Flange
T93	89-97	17-20	5	35-185	WR-10 UG-387/U-M	2.9mm(f)
T108	103-110	12-15	5	35-185	WR-8.0 UG-387/U-M	2.9mm(f)
T220	208-225	10-13	5	50-150	WR-4.0 UG-387/U-M	WR-12.8 UG-387/U-M
T228	223-233	10-12	5	75-170	WR-4.3 UG-387/U-M	WR-12.2 UG-387/U-M
T282	276-290	8-10	4	75-140	WR-3.4 UG-387/U-M	WR-10 UG-387/U-M
T321	305-335	7-9	4	20-55	WR-2.8 UG-387/U-M	WR-8.0 UG-387/U-M
T438	432-444	8-9	4	15-55	WR-2.0 UG-387/U-M	WR-6.5 UG-387/U-M

[†]The RF Output Frequency range indicates the range over which the multiplier can be tuned. The lower and upper limits indicate the minimum and maximum 3dB bandwidth limits of the multiplier respectively.

^{††}The multiplier can be configured to operate at an RF input power level within the wide RF input power range specified above. However, the multiplier is expected to operate approximately ± 1 dB centered around the RF input power level specified, not exceeding the maximum or minimum RF input power range listed above. Different biases may be required to achieve optimal performance across the full input power range specified above. Efficiency and 3dB bandwidth may be reduced at low RF input power levels. **RF Input Power Damage Limit is expected to be approximately +2dB above the specified RF input power level specified, not exceeding the maximum RF input power listed above. See individualized datasheet for damage limit.**

*This table is not a comprehensive list of all the varactor multipliers VDI offers. VDI may offer a different multiplier that is better suited for your application.

Monitor Port on Voltage Bias Boxes

VDI provides a Monitor Port on the Voltage Bias Box to allow the user to monitor the device to prevent damage. The voltage at the Monitor Port should be measured with a floating voltmeter. The bias box monitor voltage will be ~ 0 or negative when no RF input power is applied. As RF input power increases, the voltage on the monitor port will eventually start to increase and approach the positive limit.

Depending on the bias point, the Bias Box Monitor Voltage limit can be exceeded before the RF Input Power limit, or vice versa. **DO NOT** exceed the Monitor Port Limit and RF Input Power Damage Limit (see individualized datasheet). If the user is certain the input power will not cause the Monitor Port Limit to be exceeded, it is not necessary to use the Monitor Port.

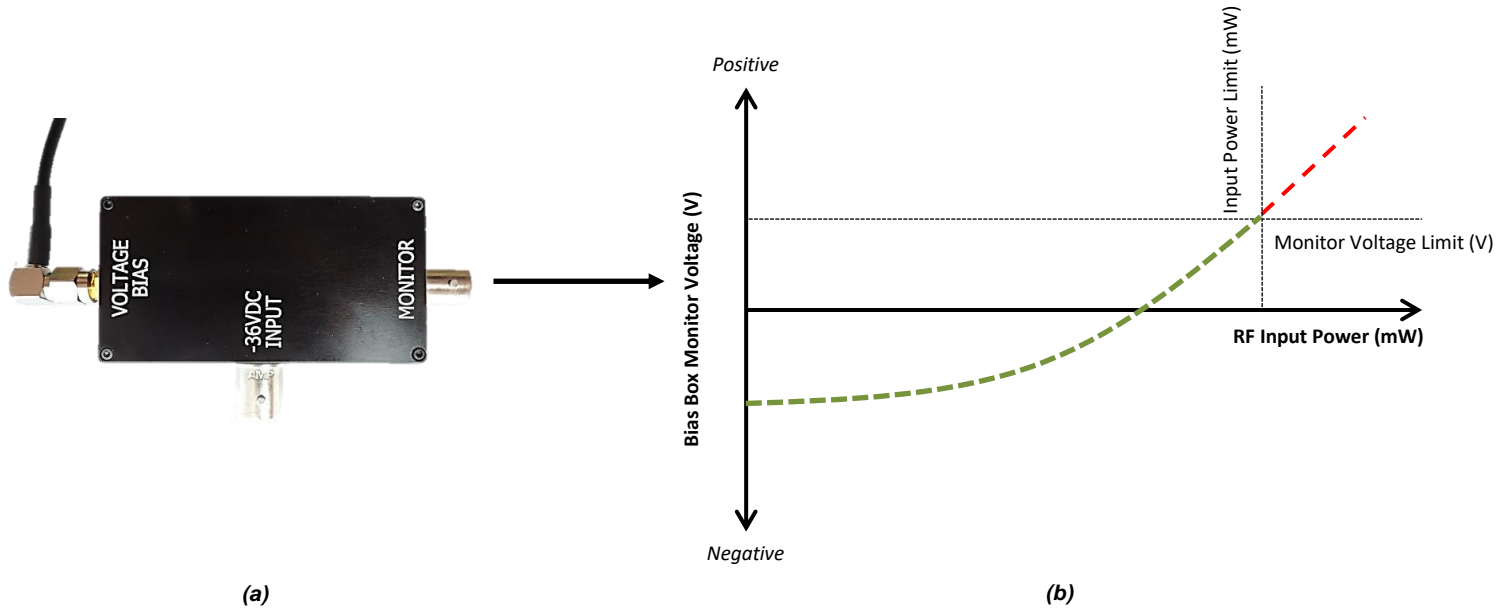
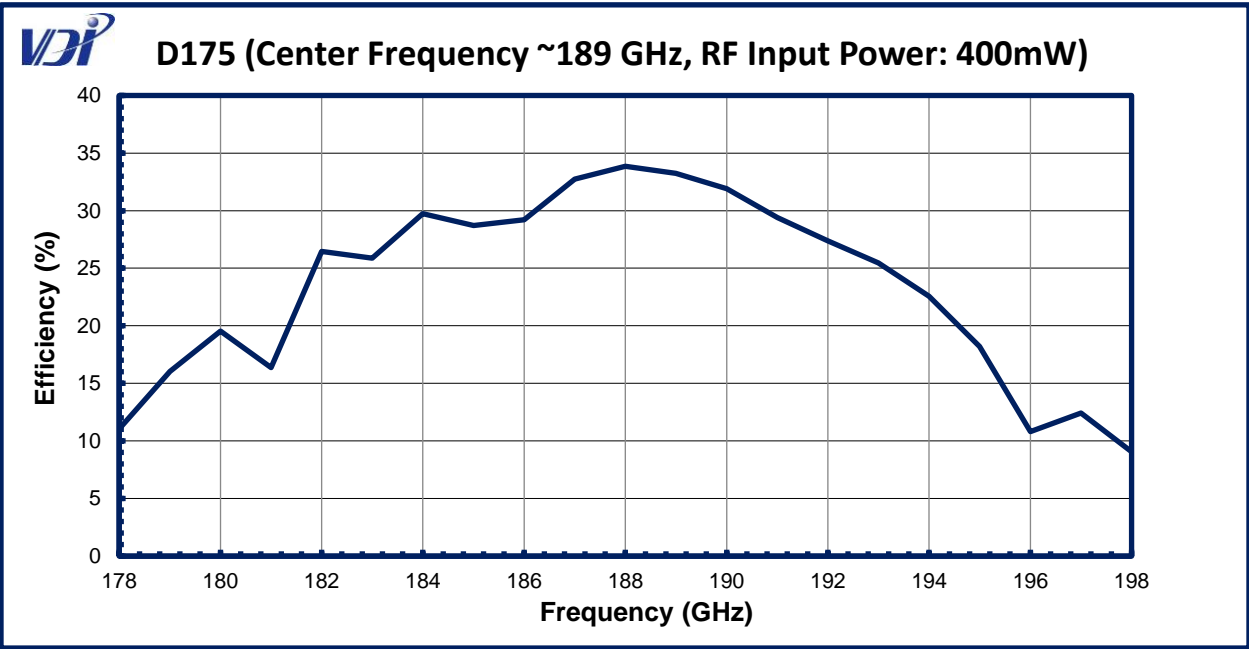
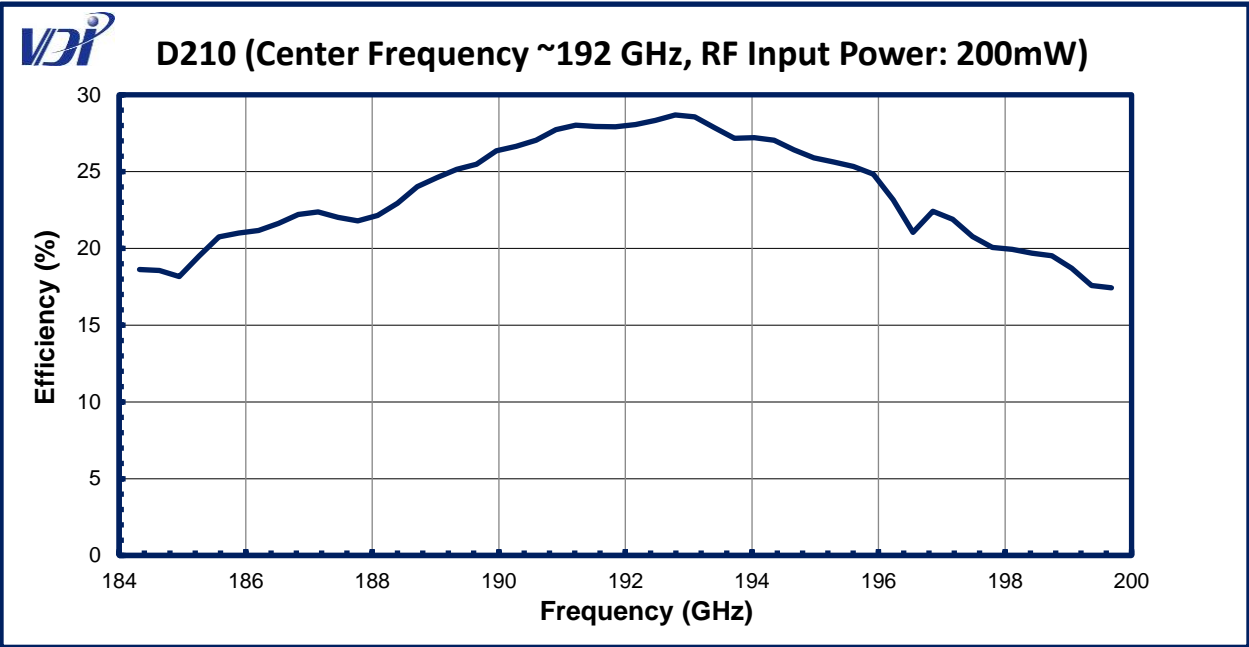


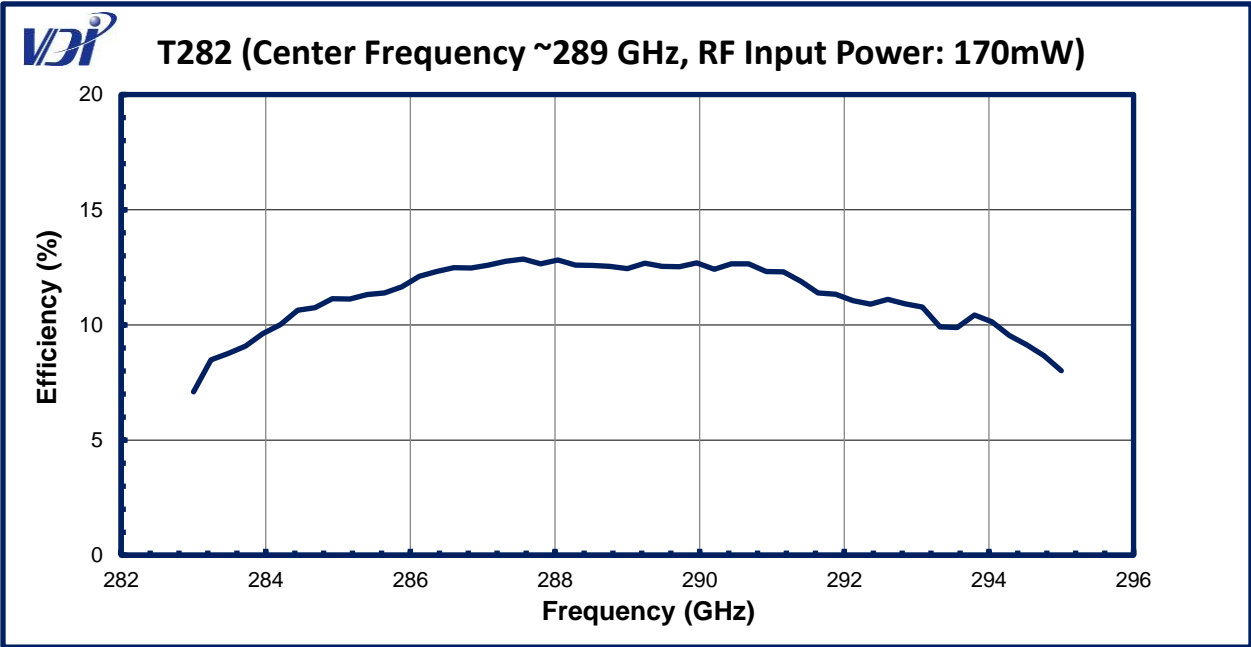
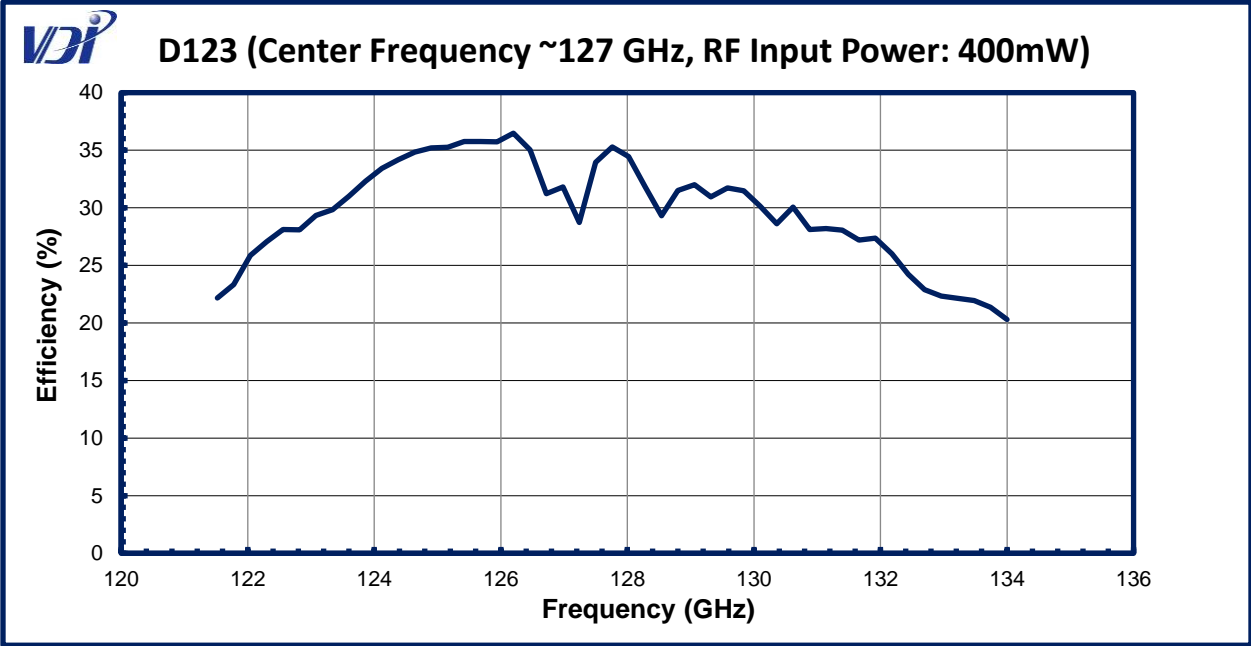
Figure 1: (a) Photograph of Voltage Bias Box is shown. (b) Plot of basic Monitor Port operation is shown. The exact shape of the plot is unique to each device.

Varactor Multiplier Performance

Sample efficiency data is provided on the following pages for various varactor frequency multipliers. Additional data may be available upon request (technical@vadiodes.com). Measured efficiency data is shipped with each VDI varactor frequency multiplier.



Performance – Examples



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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