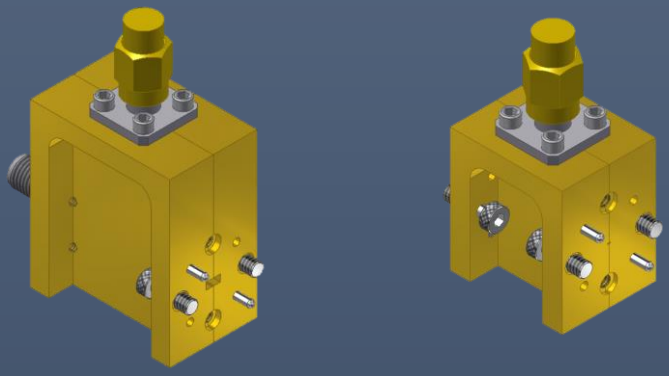
2016



Broadband Frequency Doubler Operational Manual

Virginia Diodes, Inc.

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Rev: 01 September 2016

Broadband Frequency Doublers

Virginia Diodes, Inc. offers a broad range of millimeter-wave, passive frequency doublers based on planar GaAs Schottky diode technology. Frequency doublers can be used to extend the frequency coverage of microwave and millimeter-wave sources. VDI broadband doublers have high efficiency across full waveguide bands. VDI offers broadband frequency doublers from WR-15 (50-75 GHz) to WR-1.9 (400-600 GHz). Custom frequency doublers 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

- This manual applies to products shipping after September 2016. Products shipped prior to September 2016 have individualized documentation.
- 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.

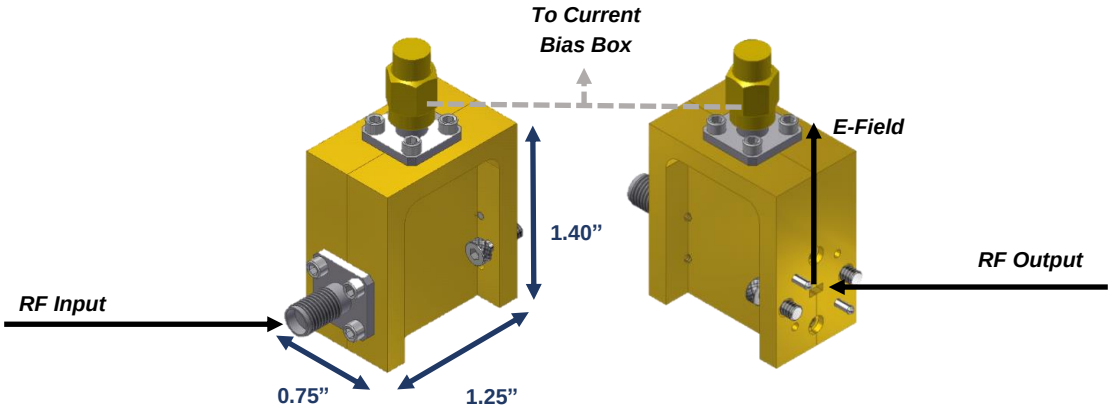
Required Operating Procedures

- 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 (See Page 5 and 6).
- DO NOT disconnect bias box from the device; doing so will expose the doubler to **possible ESD damage**.
- Apply voltage to current bias box prior to applying RF power to the device.
- When attaching the doubler'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.

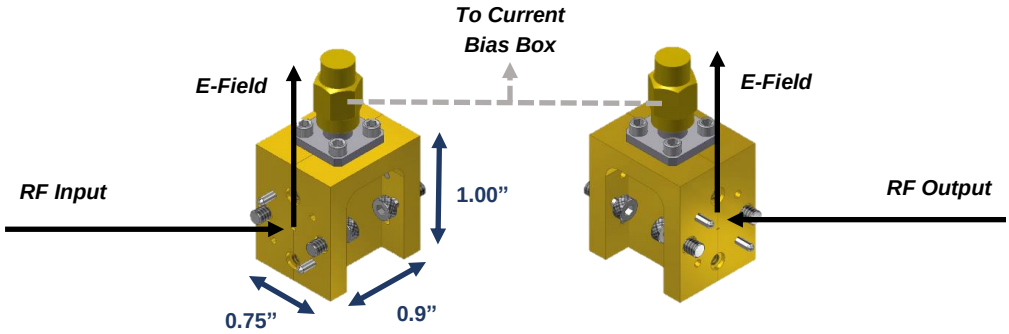
Low Frequency Broadband Frequency Doublers (WR-15 to WR-12)

These doublers will have a coaxial input port and a rectangular waveguide output port. The drawing and corresponding dimensions below are for a typical WR-15 frequency doubler. Other doublers (WR-15 to WR-12) will have similar configuration and dimensions.



High Frequency Broadband Frequency Doublers (WR-10 to WR-1.9)

These doublers will have rectangular waveguide input and output ports. The drawing and corresponding dimensions are for a typical WR-4.3 broadband frequency doubler. Other doublers (WR-10 to WR-1.9) will have similar configuration and dimensions.



Current Bias Box

VDI broadband frequency doublers require a bias box for proper operation. A current bias box is included with every broadband frequency doubler connected by a black SMA cable (~24 inches long). The bias box requires a customer supplied voltage (typically +12VDC). When the appropriate voltage is applied, the bias box supplies a fixed current bias to the device. The current bias value is generally optimized at VDI for a specific RF input power specified by the customer.

General Operating Procedure

Turn On: *The Bias Box Supply Voltage must be applied BEFORE applying the RF input power to the doubler. The voltage on the Monitor Port must not exceed the damage limit (See Page 6).*

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. The RF output frequency is exactly two times the RF input frequency.

Product Specifications

General Specifications for Broadband Frequency Doublers		
Description		**Specification**
Bias Box Supply Voltage	Voltage / Max Current Draw	+12 ± 0.1 VDC / 0.25A†
	Connector	BNC(f)
Monitor Port	Voltage Limit	See Figure 2
	Connector	BNC(f)
Maximum Weight	-	~0.1 lbs.
Operating Temperature	Typical / Recommended	25°C / 20-30°C††
Unwanted Harmonics (Typical)		-20dBc*

†VDI broadband doublers require bias. A current 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 doublers 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 Doublers						
VDI Part Number	**RF Output Frequency (GHz)**	**RF Output Flange†**	**RF Input Frequency (GHz)**	**RF Input Flange†**	**Typical Efficiency (%)††**	**RF Input Power Range (mW)***
WR15X2	50-75	WR-15	25-37.5	2.9mm(f)	9.0	250-1000
WR12X2	60-90	WR-12	30-45	2.4mm(f)	8.0	500-1000
WR10X2	75-110	WR-10	37.5-55	WR-21.0	9.0	250-500
WR8.0X2	90-140	WR-8.0	45-70	WR-15	9.0	50-200
WR6.5X2	110-170	WR-6.5	55-85	WR-12.2	8.0	50-200
WR5.1X2	140-220	WR-5.1	70-110	WR-10	7.5	20-50
WR4.3X2	170-260	WR-4.3	85-130	WR-8.6	6.0	20-50
WR3.4X2	220-330	WR-3.4	110-165	WR-6.5	6.0	20-50
WR2.8X2	260-400	WR-2.8	130-200	WR-5.1	4.0	10-35
WR2.2X2	325-500	WR-2.2	162.5-250	WR-4.6	3.0	5-20
WR1.9X2	400-600	WR-1.9	200-300	WR-3.8	2.5	10-30

†RF Flanges with 'WR' designation have UG-387/U-M flanges, with the exception of the WR-21.0, 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.

*Customer should specify available input power so multiplier bias can be optimized at VDI. The current bias is generally optimized for the intended input power during the production of the device.

Monitor Port on Current Bias Boxes

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 floating voltmeter. The bias box monitor voltage will be positive when no RF input power is applied. As RF input power increases, the voltage on the monitor port will eventually start to decrease and approach the negative limit.

Depending on the current 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 listed in the table below or the RF input power limit listed on Page 5. 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.

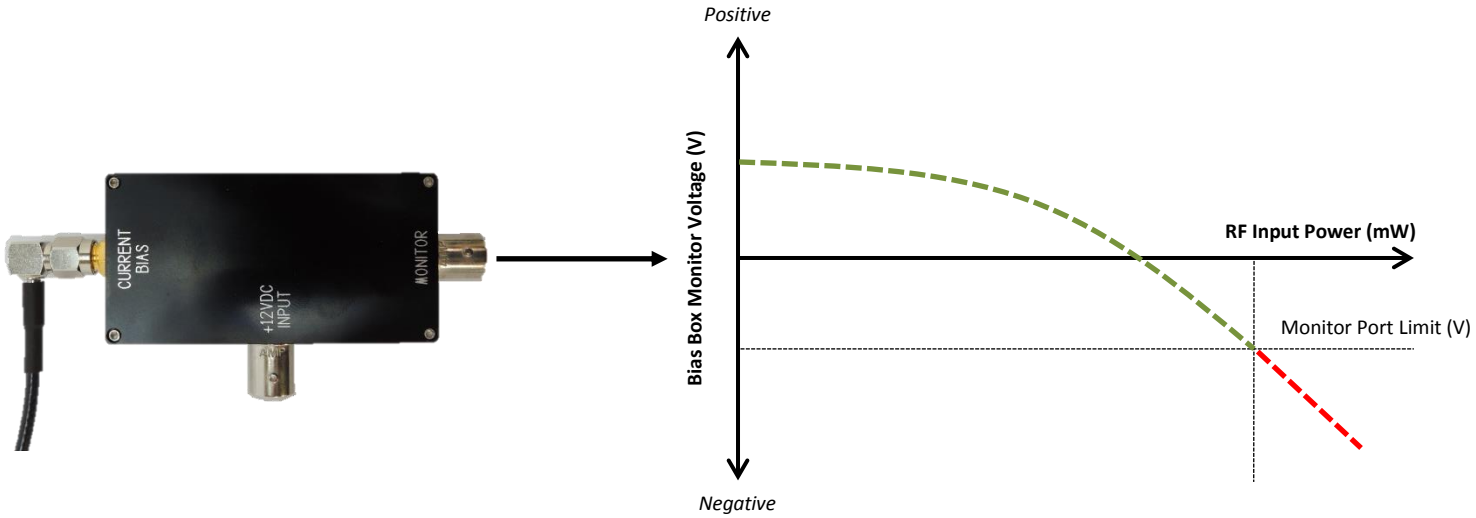


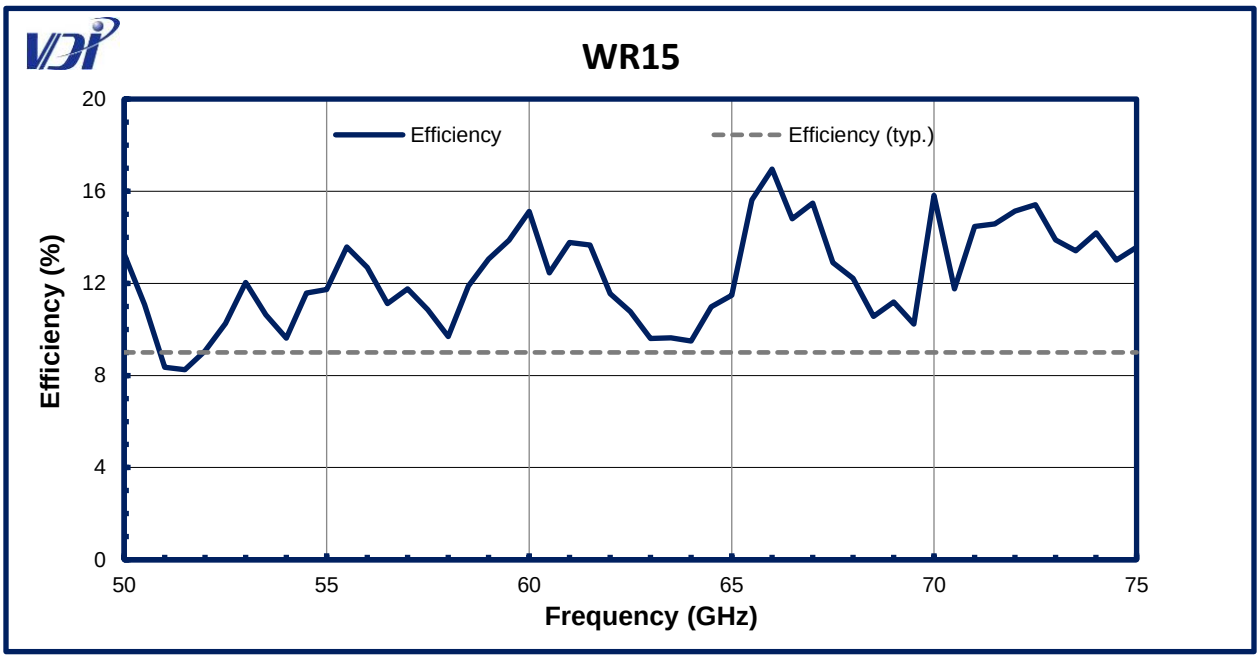
Figure 1: (a) Photograph of Current Bias Box is shown. (b) Plot of basic monitor port operation is shown. The exact shape of the plot is unique to each device.

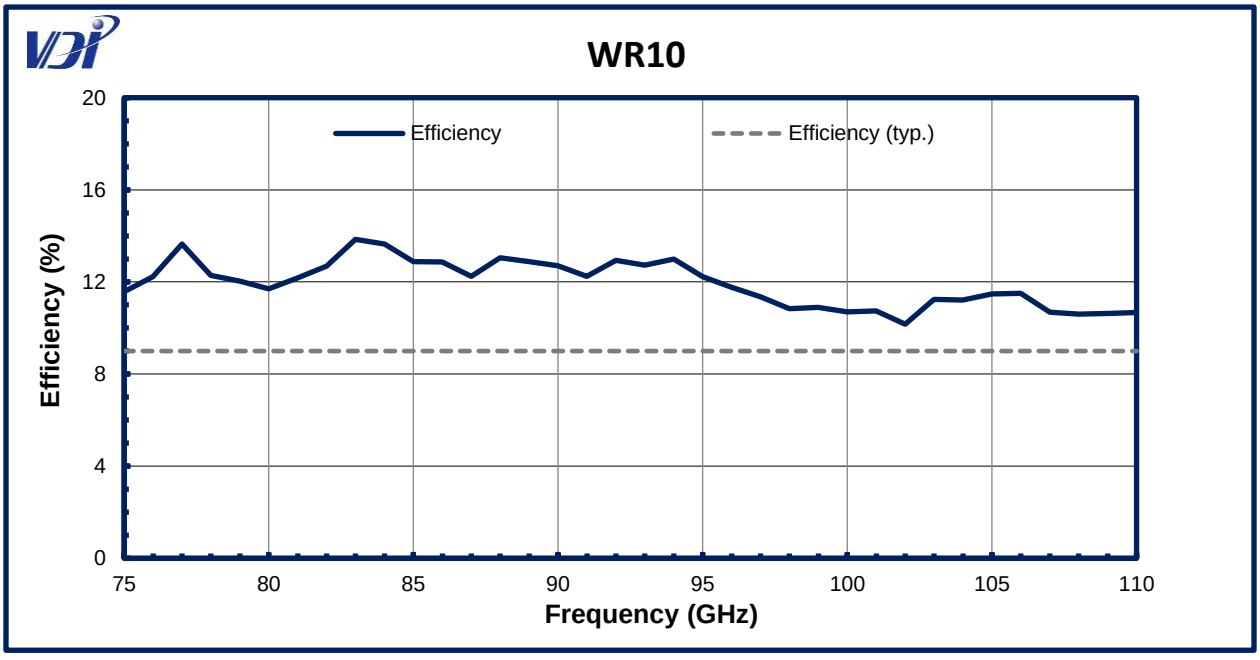
VDI Part Number	Bias Box Monitor Voltage Limit (V)
WR15X2	-4.50
WR12X2	-4.50
WR10X2	-3.00
WR8.0X2	-3.00
WR6.5X2	-2.50
WR5.1X2	-1.00
WR4.3X2	-1.25
WR3.4X2	-1.25
WR2.8X2	-0.75
WR2.2X2	-0.75
WR1.9X2	-0.75

Figure 2: Table of Bias Box Monitor Voltage Limits

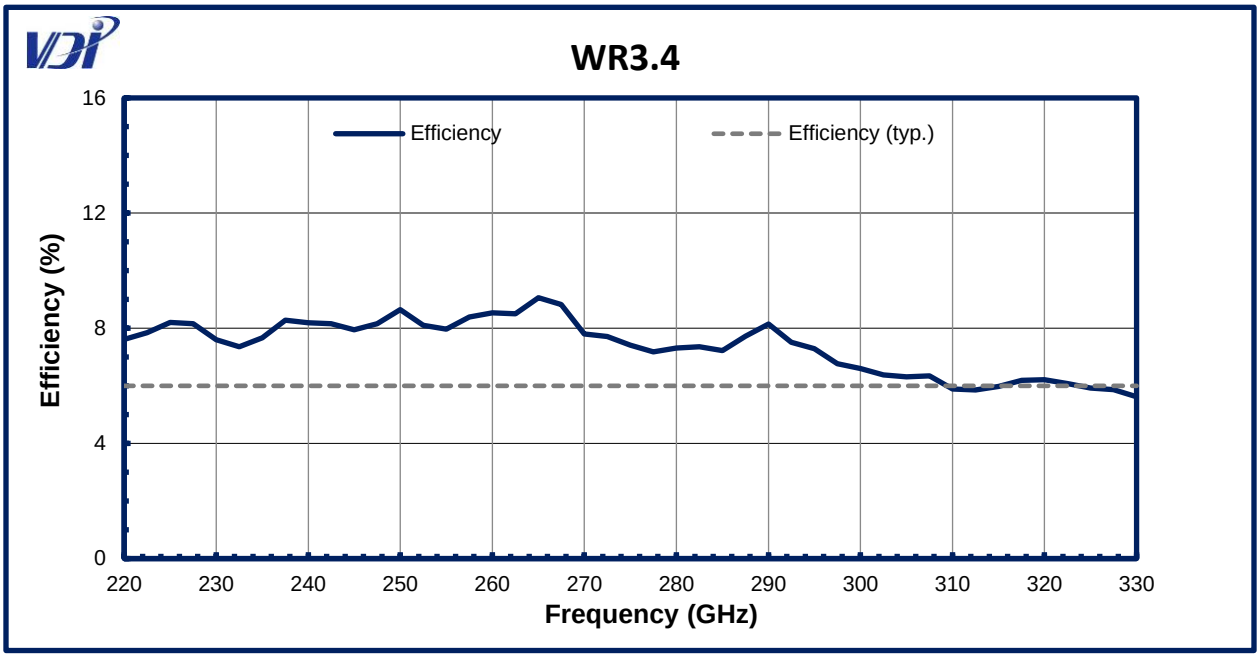
Broadband Frequency Doubler Performance

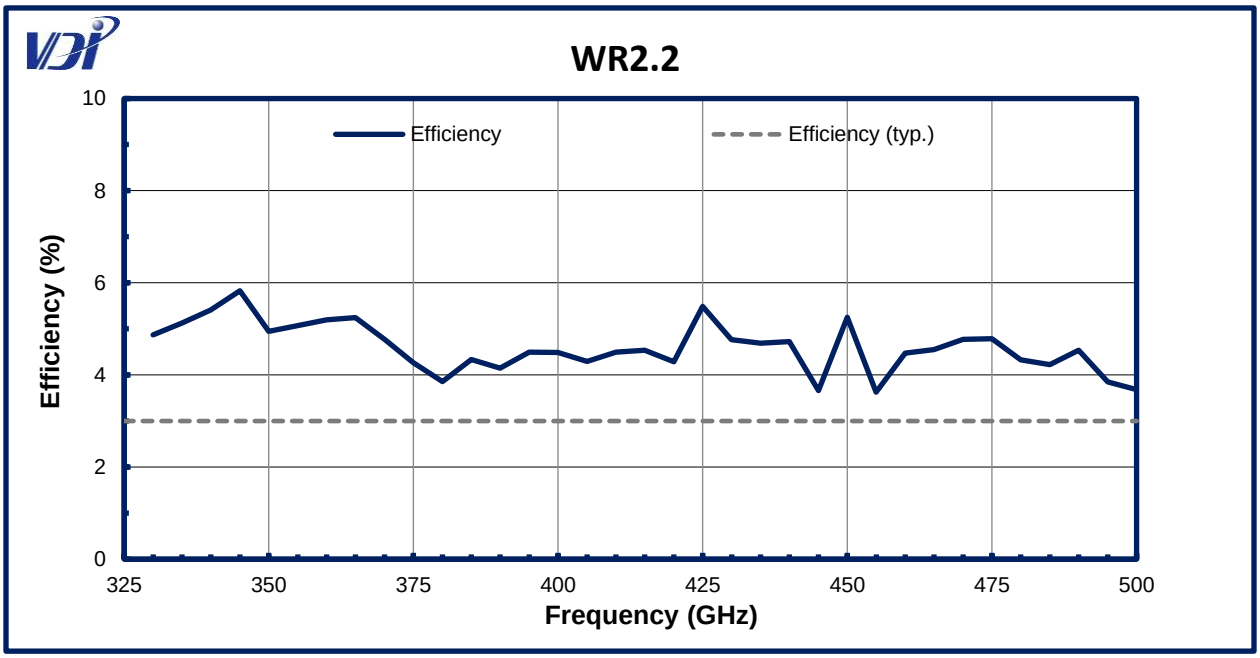
Typical efficiency data is provided on the following pages for various broadband frequency doublers. Additional data can be found on the VDI website or may be available upon request (technical@vadiodes.com). Measured efficiency data is shipped with each VDI broadband frequency doubler.





Performance – WR3.4 and WR2.2





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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