

# Active Doubler

## 7.5 - 25.0 / 15.0 - 50.0 GHz



**XX1000-BD**  
Rev. V3

### Features

- Excellent Broadband Mixer Driver
- Single Ended Fed Doubler with Distributed Buffer Amplifier
- Excellent LO Driver for MACOM Receivers
- +15 dBm Output Drive
- 100% On-Wafer RF, DC and Output Power Testing
- 100% Visual Inspection to MIL-STD-883 Method 2010
- RoHS\* Compliant

### Applications

- Point-to-Point Radio
- Microwave
- LMDS
- SATCOM
- VSAT

### Description

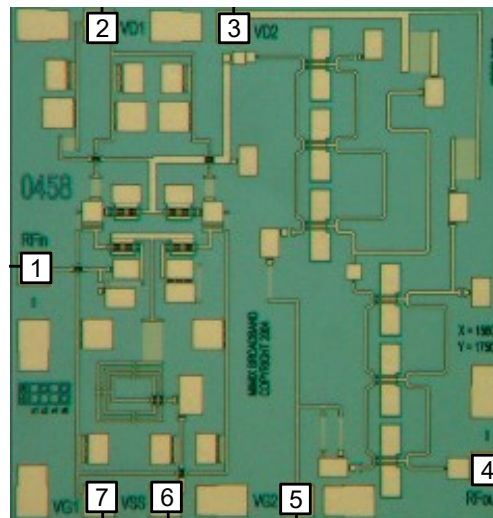
This single ended fed (no external balun required) 7.5 - 25.0 / 15.0 - 50.0 GHz GaAs MMIC doubler has a 15 dBm output drive and is an excellent LO doubler that can be used to drive fundamental mixer devices. It is also well suited to drive MACOMs' XR1002 receiver device.

This MMIC uses a GaAs pHEMT device model technology, and is based upon electron beam lithography to ensure high repeatability and uniformity. The chip has surface passivation to protect and provide a rugged part with backside via holes and gold metallization to allow either a conductive epoxy or eutectic solder die attach process.

### Ordering Information

| Part Number    | Package                 |
|----------------|-------------------------|
| XX1000-BD-000V | vacuum release gel paks |
| XX1000-BD-EV1  | evaluation board        |

### Chip Device Layout



### Pad Configuration<sup>1</sup>

| Pad | Function          | Description           |
|-----|-------------------|-----------------------|
| 1   | RF <sub>IN</sub>  | RF Input              |
| 2   | V <sub>D1</sub>   | Drain Voltage Stage 1 |
| 3   | V <sub>D2</sub>   | Drain Voltage Stage 2 |
| 4   | RF <sub>OUT</sub> | RF Output             |
| 5   | V <sub>G2</sub>   | Gate Voltage Stage 2  |
| 6   | V <sub>SS</sub>   | Source Supply Voltage |
| 7   | V <sub>G1</sub>   | Gate Voltage Stage 1  |

1. Backside metal is RF, DC and thermal ground.

\* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

**Electrical Specifications: Input Freq. = 7.5 - 25 GHz, T<sub>A</sub> = 25°C**

| Parameter  | Units | Min. | Typ. | Max. |
|--|-------|------|------|------|
| Output Frequency Range   | GHz   | 15   | —    | 50   |
| Input Return Loss  | dB    | —    | 12   | —    |
| Output Return Loss   | dB    | —    | 12   | —    |
| Harmonic Gain  | dB    | —    | 13   | —    |
| Fundamental Rejection  | dBc   | —    | 20   | —    |
| Saturated Output Power   | dBm   | —    | 15   | —    |
| RF Input Power   | dBm   | -10  | —    | +10  |
| Output Power at 0 dBm P <sub>IN</sub>  | dBm   | —    | 13   | —    |
| Drain Bias Voltage (V <sub>D1,2</sub> )  | VDC   | —    | 5.0  | 5.5  |
| Gate Bias Voltage (V <sub>G1</sub> )   | VDC   | -1.2 | -0.6 | +0.1 |
| Gate Bias Voltage (V <sub>G2</sub> )   | VDC   | -1.2 | 0.0  | +0.1 |
| Drain Current (I <sub>D1,2</sub> )<br>(V <sub>D</sub> = 5.0 V, V <sub>G1</sub> = -0.6 V, V <sub>G</sub> = 0 V Typical) | mA    | —    | 265  | 280  |
| Source Voltage (V <sub>SS</sub> )  | VDC   | -5.5 | -5.0 | -2.0 |
| Source Current (I <sub>SS</sub> )  | mA    | 25   | 50   | 60   |

**Absolute Maximum Ratings<sup>2</sup>**

| Parameter  | Absolute Maximum    |
|--|---------------------|
| Drain Voltage (V <sub>D1</sub> , V <sub>D2</sub> ) | +6 V                |
| Source Voltage (V <sub>SS</sub> )                  | -6 V                |
| Drain Current (I <sub>D1</sub> +I <sub>D2</sub> )  | 320 mA              |
| Source Current (I <sub>SS</sub> )                  | 60 mA               |
| Gate Bias Voltage (V <sub>G1</sub> )               | +0.3 V              |
| Gate Bias Voltage (V <sub>G2</sub> )               | +0.1 V              |
| RF Input Power                                     | +12 dBm             |
| Storage Temperature                                | -65°C to +165°C     |
| Operating Temperature                              | -55°C to MTTF Table |
| Channel Temperature                                | MTTF Table          |

2. Channel temperature directly affects a device's MTTF. Channel temperature should be kept as low as possible to maximize lifetime.

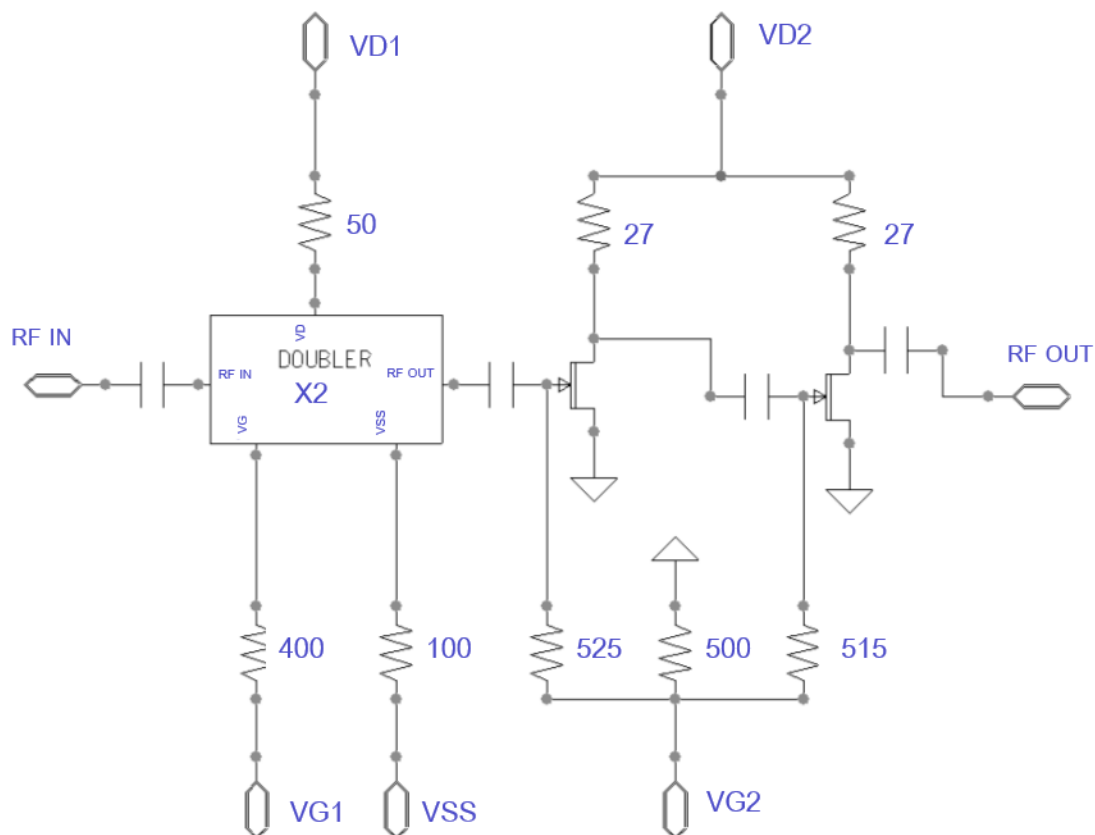
**Handling Procedures**

Please observe the following precautions to avoid damage:

**Static Sensitivity**

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these Class 2 devices.

## Block Diagram & Schematics



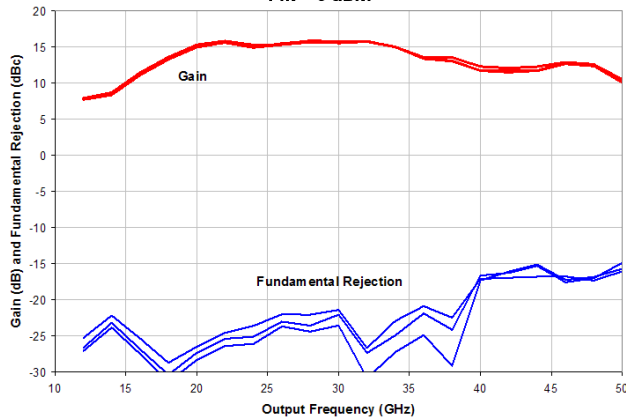
# Active Doubler 7.5 - 25.0 / 15.0 - 50.0 GHz



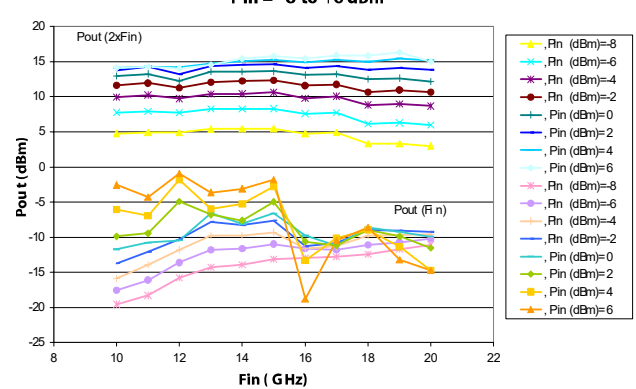
**XX1000-BD**  
Rev. V3

## Typical Performance Curves

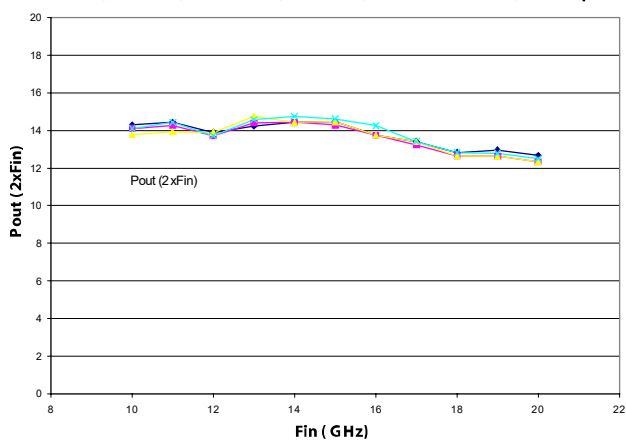
**Harmonic Gain and Fundamental Rejection vs Output Freq.**  
Pin = 0 dBm



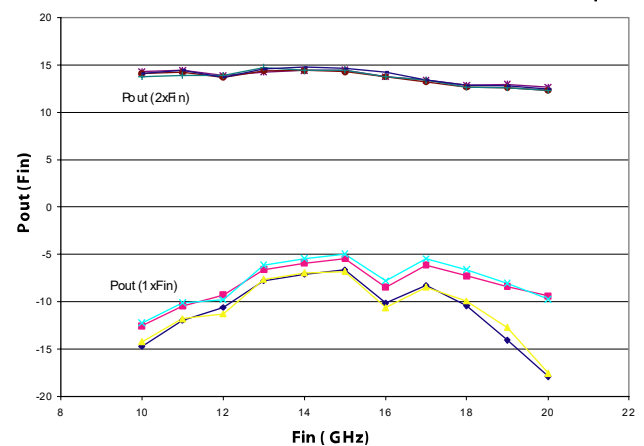
**XX1000-BD: Pout (2xFin) and Pout (Fin) vs. Fin (GHz)**  
Pin = -8 to +6 dBm



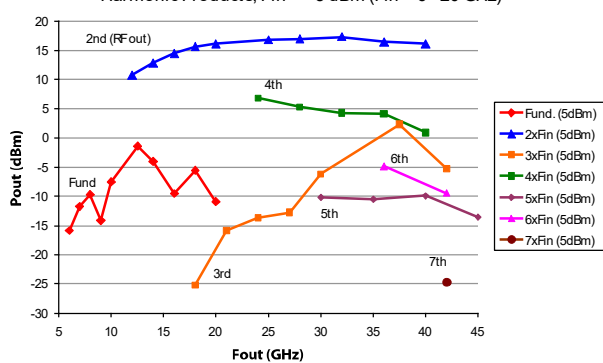
**XX1000-BD\_4\_samples: Pout (2xFin) vs. Fin (GHz)**  
Pin=0dBm, VD 1=5V, VG 1=-0.6V, VS S=-5V, VD 2=5V ~150mA, VG 2=open



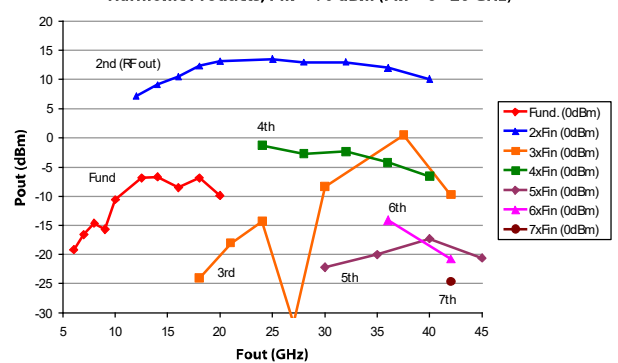
**XX1000-BD\_4\_samples: Pout (Fin) vs. Fin (GHz)**  
Pin=0dBm, VD 1=5V, VG 1=-0.6V, VS S=-5V, VD 2=5V ~150mA, VG 2=open



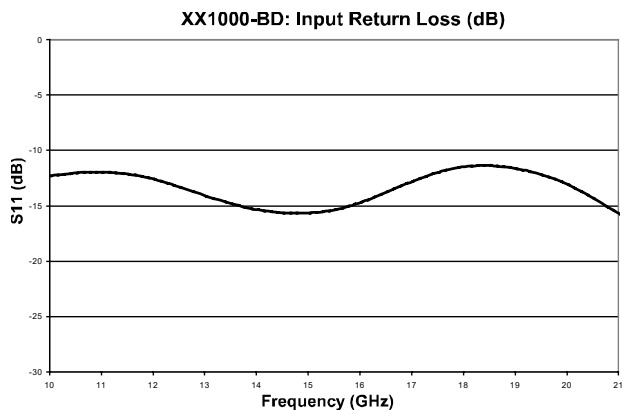
**Harmonic Products, Pin = +5 dBm (Fin = 6 - 20 GHz)**



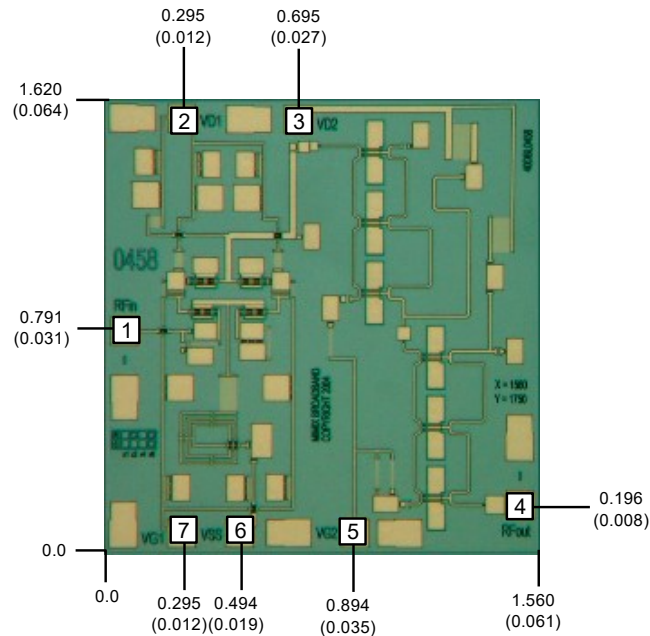
**Harmonic Products, Pin = +0 dBm (Fin = 6 - 20 GHz)**



## Typical Performance Curves (cont.)



## Mechanical Drawing



(Note: Engineering designator is 40DBL0458)

Units: millimeters (inches) Bond pad dimensions are shown to center of bond pad.  
Thickness: 0.110 +/- 0.010 (0.0043 +/- 0.0004), Backside is ground, Bond Pad/Backside Metallization: Gold  
All Bond Pads are 0.100 x 0.100 (0.004 x 0.004).  
Bond pad centers are approximately 0.109 (0.004) from the edge of the chip.  
Dicing tolerance: +/- 0.005 (+/- 0.0002). Approximate weight: 1.566 mg.

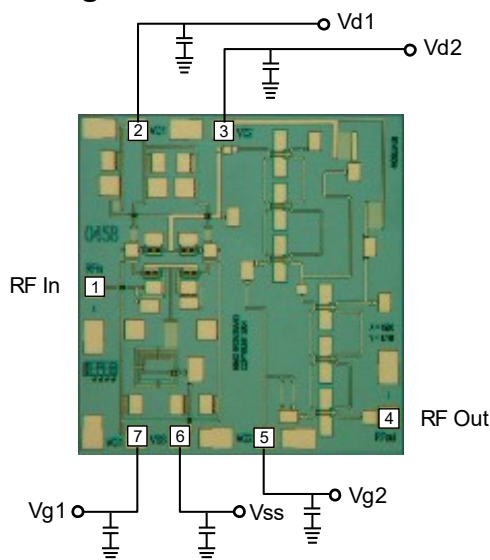
Bond Pad #1 (RF In)  
Bond Pad #2 (Vd1)

Bond Pad #3 (Vd2)  
Bond Pad #4 (RF Out)

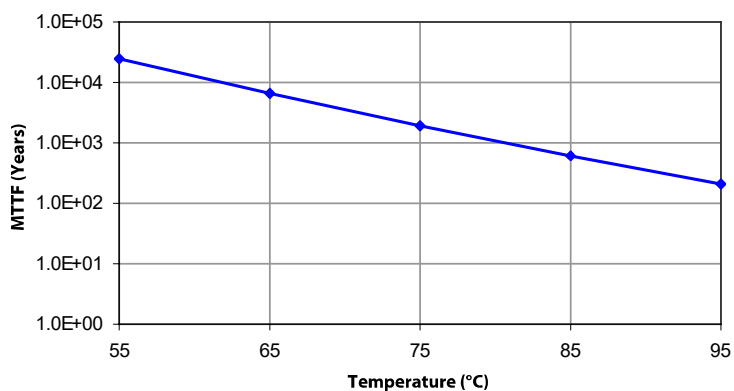
Bond Pad #5 (Vg2)  
Bond Pad #6 (Vss)

Bond Pad #7 (Vg1)

## Bias Arrangement



### MTTF vs. Back-plate Temperature (°C)



MTTF is calculated from accelerated life-time data of single devices and assumes isothermal back-plate.

Bias Conditions:  $V_{D1,2} = 5\text{ V}$ ,  $I_{D1,2} = 220\text{ mA}$ ,  $V_{SS} = -5\text{ V}$ ,  $I_{SS} = 50\text{ mA}$

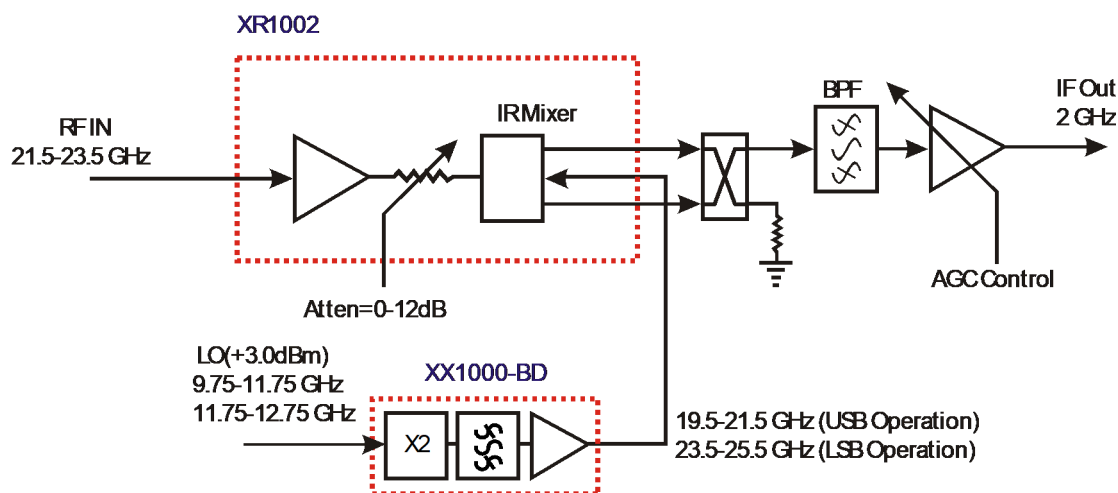
### App Note [1] Biasing -

It is recommended to separately bias each doubler stage with fixed voltages of  $V_{D1,2} = 5\text{ V}$ ,  $V_{SS} = -5\text{ V}$  and  $V_{G1} = -0.6\text{ V}$ . The typical DC currents are  $I_{D1} = 80\text{ mA}$ ,  $I_{D2} = 140\text{ mA}$  and  $I_{SS} = 50\text{ mA}$ .  $V_{G2}$  can be used for active control biasing of  $V_{D2}$ , or it can be left open and  $V_{D2}$  will self bias at approximately 140 mA. Maximum output power is achieved with  $V_{SS} = -5\text{ V}$  and  $I_{SS} = 50\text{ mA}$  but the device will operate with reduced bias to  $V_{SS} = -2\text{ V}$  and  $I_{SS} = 25\text{ mA}$ . It is also recommended to use active biasing on  $V_{D2}$  with  $V_{G2}$  to keep the currents constant as the RF power and temperature vary; this gives the most reproducible results. Depending on the supply voltage available and the power dissipation constraints, the bias circuit may be a single transistor or a low power operational amplifier, with a low value resistor in series with the drain supply used to sense the current. The gate of the pHEMT is controlled to maintain correct drain current and thus drain voltage. The typical gate voltage for  $V_{G2} = -0.1\text{ V}$ . Typically the gate is protected with silicon diodes to limit the applied voltage. Also, make sure to sequence the applied voltage to ensure negative gate bias is available before applying the positive drain supply.

### App Note [2] Bias Arrangement -

For individual stage bias (recommended for doubler applications) - Each DC pad ( $V_{D1,2}$ ,  $V_{SS}$  and  $V_{G1,2}$ ) needs to have DC bypass capacitance ( $\sim 100 - 200\text{ pF}$ ) as close to the device as possible. Additional DC bypass capacitance ( $\sim 0.01\text{ }\mu\text{F}$ ) is also recommended.

## Typical Application



MMIC based 18 - 34 GHz Double / Receiver Block Diagram  
(changing LO and IF frequencies as required allows the design to operate as high as 34 GHz.)



MACOM Technology Solutions Inc. ("MACOM"). All rights reserved.

These materials are provided in connection with MACOM's products as a service to its customers and may be used for informational purposes only. Except as provided in its Terms and Conditions of Sale or any separate agreement, MACOM assumes no liability or responsibility whatsoever, including for (i) errors or omissions in these materials; (ii) failure to update these materials; or (iii) conflicts or incompatibilities arising from future changes to specifications and product descriptions, which MACOM may make at any time, without notice. These materials grant no license, express or implied, to any intellectual property rights.

THESE MATERIALS ARE PROVIDED "AS IS" WITH NO WARRANTY OR LIABILITY, EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHT, ACCURACY OR COMPLETENESS, OR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHICH MAY RESULT FROM USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.

# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

MACOM:

[XX1000-BD-000V](#) [XX1000-QT-EV1](#)