

2.0-22.0 GHz GaAs MMIC Power Amplifier

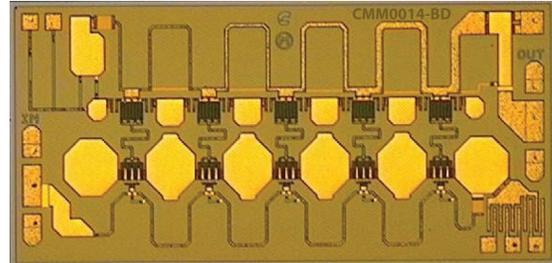
Features

- ✕ Ultra Wide Band Power Amplifier
- ✕ Compact Size/Self Bias Architecture
- ✕ 11.5 dB Small Signal Gain
- ✕ +24.0 dBm P1dB Compression Point
- ✕ +35.0 dBm Third Order Intercept
- ✕ 100% Visual Inspection to MIL-STD-883 Method 2010

General Description

Mimix Broadband's distributed 2.0-22.0 GHz GaAs MMIC power amplifier has a small signal gain of 11.5 dB with a +24.0 dBm P1dB output compression point. This MMIC uses Mimix Broadband's 0.3 μm 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. This device is well suited for Test Instrumentation, Military, Space, Microwave Point-to-Point Radio, SATCOM and VSAT applications.

Chip Device Layout



Absolute Maximum Ratings

| | |
|----------------------------|--------------------------------|
| Supply Voltage (Vd) | +9.0 VDC |
| Supply Current (Id1) | 350 mA |
| Input Power (Pin) | +20.0 dBm |
| Storage Temperature (Tstg) | -65 to +165 °C |
| Operating Temperature (Ta) | -55 to MTTF Graph ¹ |
| Channel Temperature (Tch) | MTTF Graph ¹ |

(1) Channel temperature affects a device's MTTF. It is recommended to keep channel temperature as low as possible for maximum life.

Electrical Characteristics (Ambient Temperature T = 25 °C)

| Parameter | Units | Min. | Typ. | Max. |
|---|-------|------|--------|------|
| Frequency Range (f) | GHz | 2.0 | - | 22.0 |
| Input Return Loss (S11) | dB | - | 15.0 | - |
| Output Return Loss (S22) | dB | - | 10.0 | - |
| Small Signal Gain (S21) | dB | - | 11.5 | - |
| Gain Flatness (ΔS21) | dB | - | +/-0.5 | - |
| Reverse Isolation (S12) | dB | - | 40.0 | - |
| Output Power for 1dB Compression (P1dB) | dBm | - | +24.0 | - |
| Output Third Order Intermods (OIP3) | dBm | - | +35.0 | - |
| Saturated Output Power (Psat) | dBm | - | +25.0 | - |
| Drain Bias Voltage (Vd) | VDC | - | +8.0 | +8.5 |
| Supply Current (Id) (Vd=8.0V Typical) | mA | - | 300 | 340 |

100% on-wafer DC testing and 100% RF wafer qualification. Wafer qualification includes sample testing from each quadrant with an 80% pass rate required.

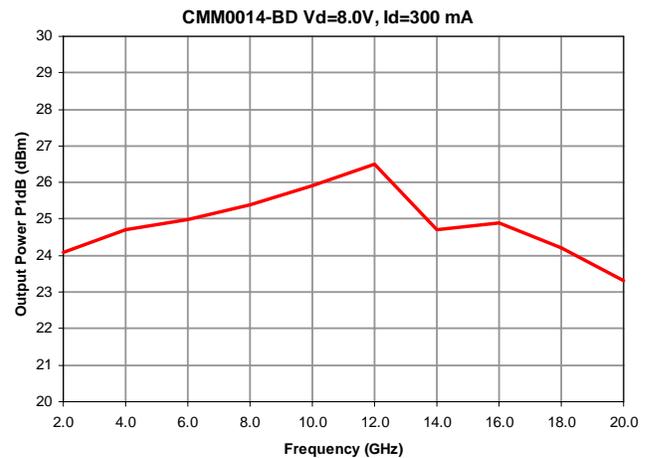
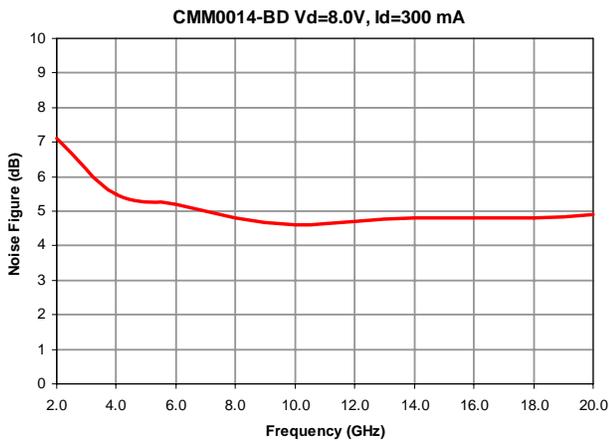
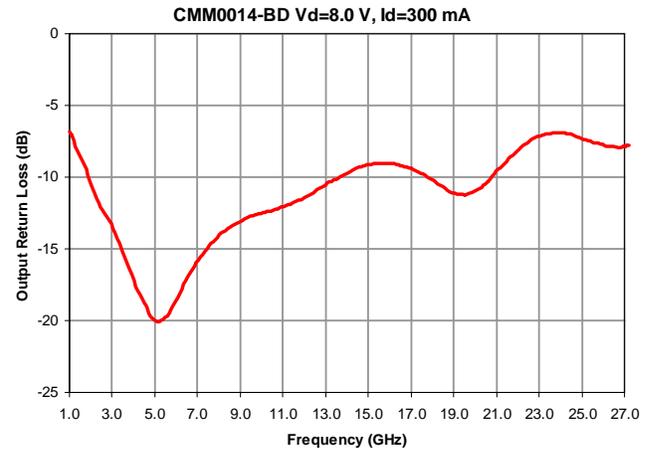
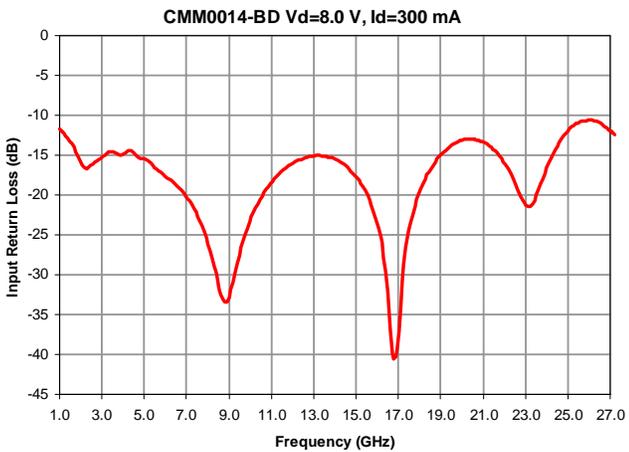
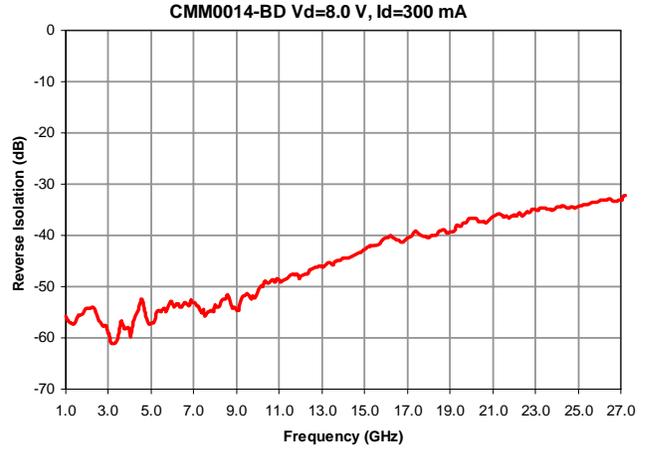
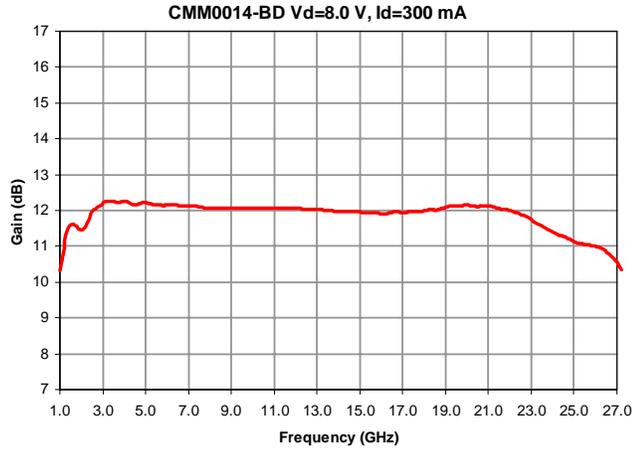
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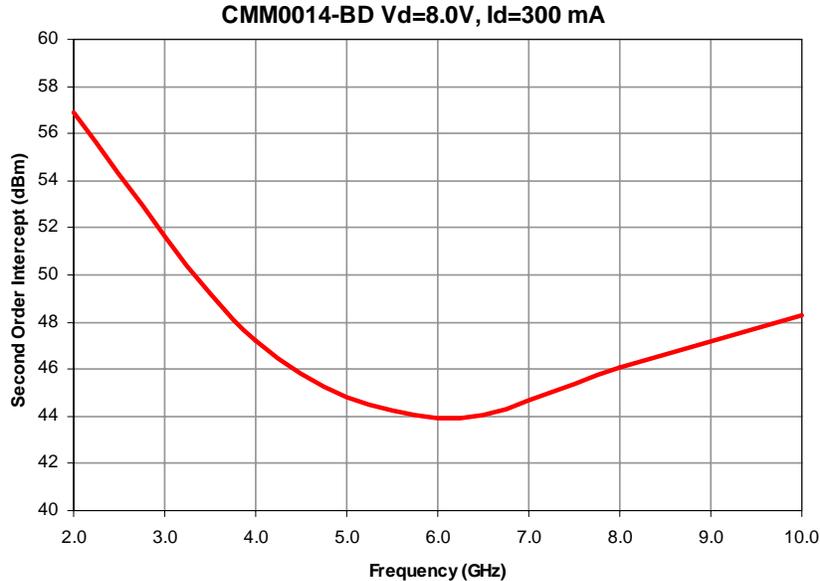
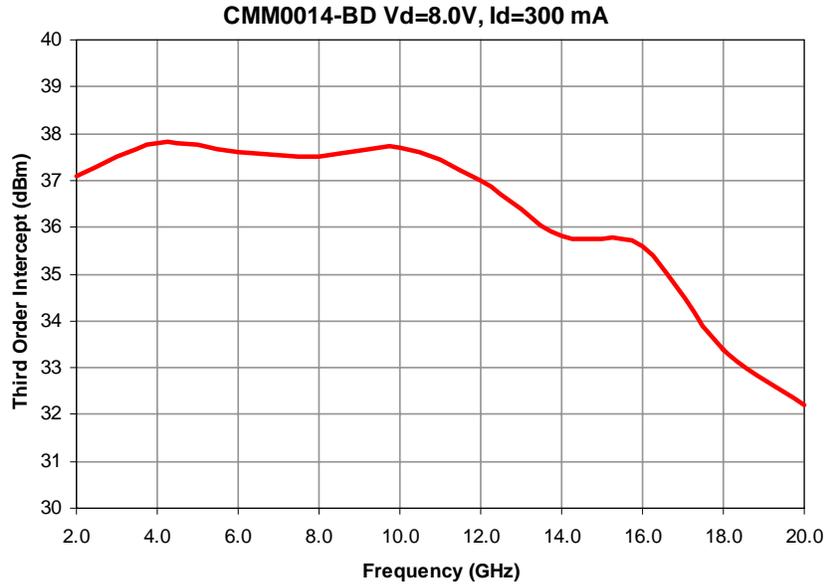
CMM0014-BD

Power Amplifier Measurements



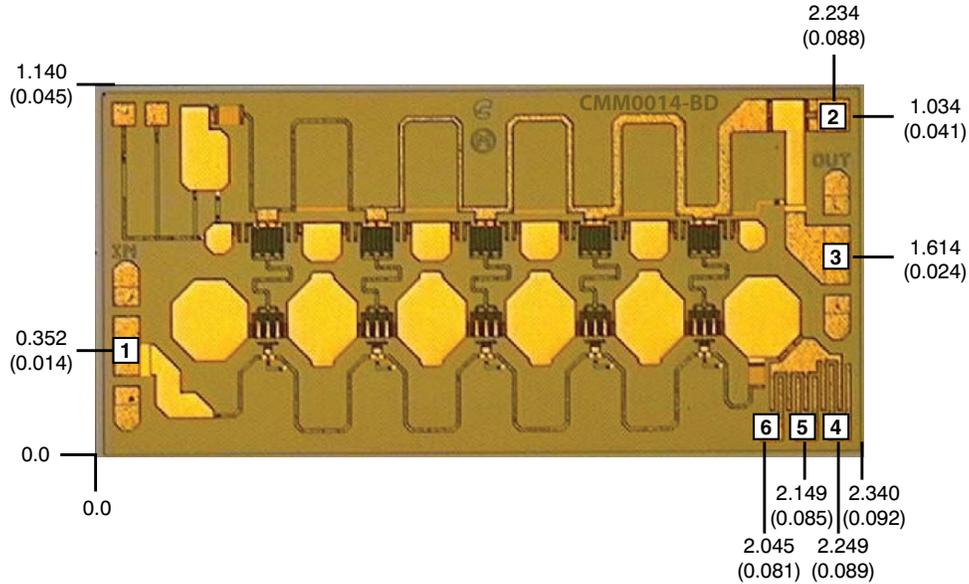
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Power Amplifier Measurements (cont.)



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Mechanical Drawing



(Note: Engineering designator is M380)

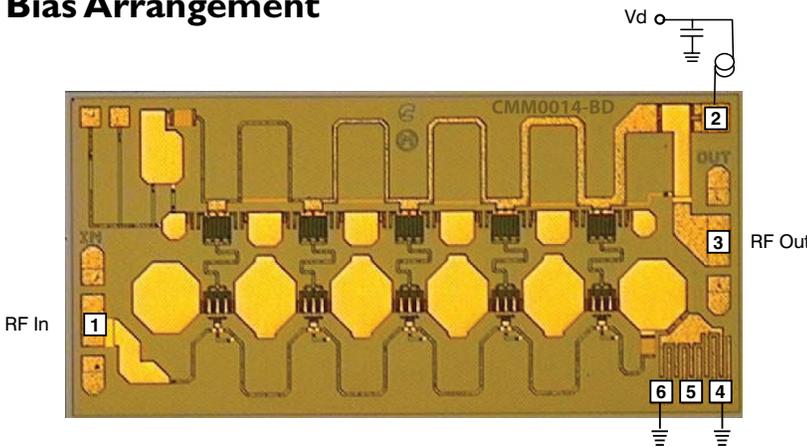
Units: millimeters (inches) Bond pad dimensions are shown to center of bond pad.
 Thickness: 0.110 +/- 0.010 (0.0043 +/- 0.0004), Backside is ground, Bond Pad/Backside Metallization: Gold
 All DC Bond Pads are 0.100 x 0.100 (0.004 x 0.004). All RF Bond Pads are 0.100 x 0.200 (0.004 x 0.008)
 Bond pad centers are approximately 0.109 (0.004) from the edge of the chip.
 Dicing tolerance: +/- 0.005 (+/- 0.0002). Approximate weight: 1.65 mg.

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

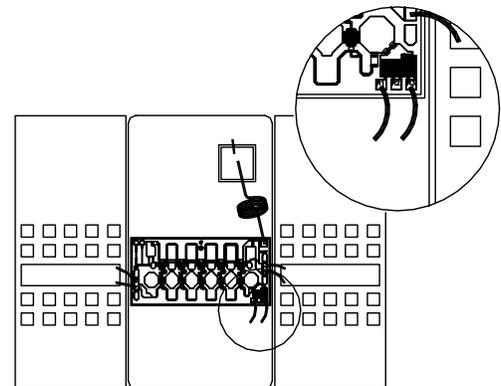
Bond Pad #3 (RF Out)
 Bond Pad #4 (Rs-1.2Ω)

Bond Pad #5 (Rs-2.1Ω)
 Bond Pad #6 (Rs-3.3Ω)

Bias Arrangement



Bypass Capacitors - See App Note [2]



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App Note [1] Biasing - As shown in the bonding diagram, this device operates using a self-biased architecture and only requires one drain bias. Bias is nominally $V_d=8V, I_d=300\text{ mA}$. For additional assistance in setting current via source resistor, see source resistance table below.

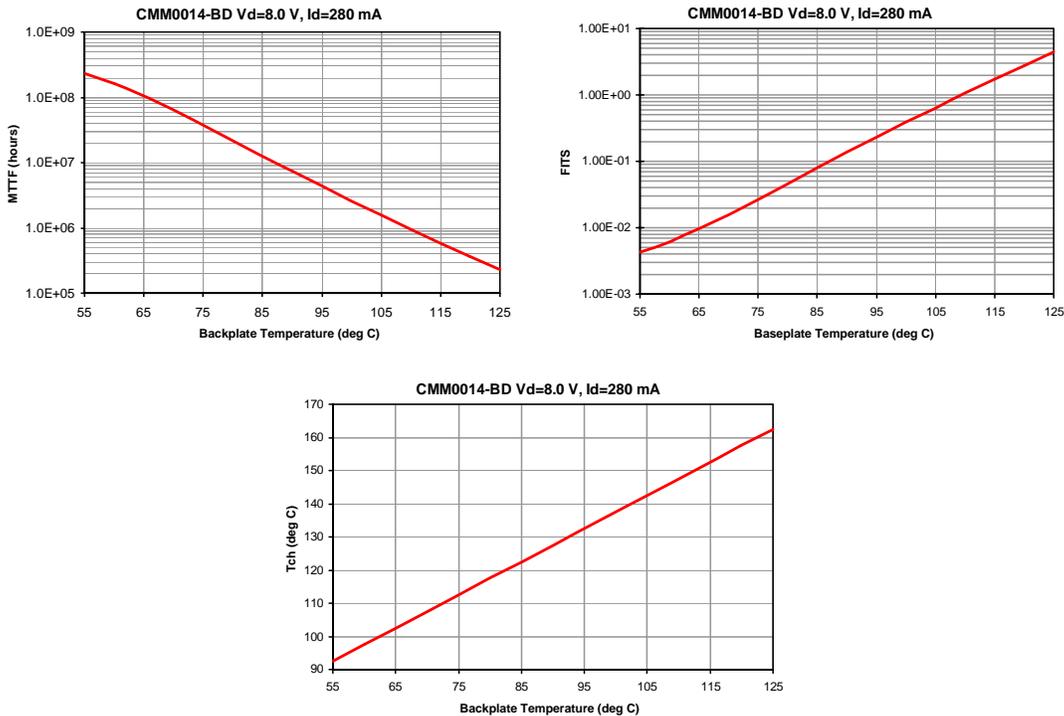
App Note [2] Bias Arrangement - Each DC pad (V_d) needs to have DC bypass capacitance ($\sim 100\text{-}200\text{ pF}$) as close to the device as possible. Additional DC bypass capacitance ($\sim 0.01\text{ }\mu\text{F}$) is also recommended. Additionally, to achieve the required broadband decoupling network a high-Q Drain bias inductor with high-Q bypass capacitor is needed. The proper network is necessary in order to bring Drain bias into the device with minimal impact on RF performance. The high-Q inductor is typically an air coil that can be purchased from an air coil manufacturer (Microwave Components or Piconics for example). The air coil needs to have minimum current handling capability, thus planned operating current needs to be defined and considered before defining actual air coil to be used. Mimix recommends 1.4 mil diameter gold wire and 4 turns as a starting point and may need to be optimized based on the actual application. Self-resonance of the bias inductor causes degradation in performance at both the low and high ends of the band. The self resonance is sensitive to spacing between turns and number of turns used. For example, the more turns in the Drain bias inductor the lower the self-resonant frequency of the inductor creating high end RF performance degradation. The opposite is true for a smaller number of turns.

CMM0014 - Source Resistance Table

| Left | Center | Corner | Net R |
|------|--------|--------|----------|
| 3.3 | 2.1 | 1.2 | |
| 0 | 0 | 0 | Infinity |
| 1 | 0 | 0 | 3.30 |
| 0 | 1 | 0 | 2.10 |
| 1 | 1 | 0 | 1.28 |
| 0 | 0 | 1 | 1.20 |
| 1 | 0 | 1 | 0.88 |
| 0 | 1 | 1 | 0.76 |
| 1 | 1 | 1 | 0.62 |

MTTF Graphs

These numbers were calculated based on accelerated life test information and thermal model analysis received from the fabricating foundry.



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Handling and Assembly Information

CAUTION! - Mimix Broadband MMIC Products contain gallium arsenide (GaAs) which can be hazardous to the human body and the environment. For safety, observe the following procedures:

- *Do not ingest.*
- *Do not alter the form of this product into a gas, powder, or liquid through burning, crushing, or chemical processing as these by-products are dangerous to the human body if inhaled, ingested, or swallowed.*
- *Observe government laws and company regulations when discarding this product. This product must be discarded in accordance with methods specified by applicable hazardous waste procedures.*

Life Support Policy - Mimix Broadband's products are not authorized for use as critical components in life support devices or systems without the express written approval of the President and General Counsel of Mimix Broadband. As used herein: (1) Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user. (2) A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ESD - Gallium Arsenide (GaAs) devices are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic containers, which should be opened in cleanroom conditions at an appropriately grounded anti-static workstation. Devices need careful handling using correctly designed collets, vacuum pickups or, with care, sharp tweezers.

Die Attachment - GaAs Products from Mimix Broadband are 0.100 mm (0.004") thick and have vias through to the backside to enable grounding to the circuit. Microstrip substrates should be brought as close to the die as possible. The mounting surface should be clean and flat. If using conductive epoxy, recommended epoxies are Tanaka TS3332LD, Die Mat DM6030HK or DM6030HK-Pt cured in a nitrogen atmosphere per manufacturer's cure schedule. Apply epoxy sparingly to avoid getting any on to the top surface of the die. An epoxy fillet should be visible around the total die periphery. For additional information please see the Mimix "Epoxy Specifications for Bare Die" application note. If eutectic mounting is preferred, then a fluxless gold-tin (AuSn) preform, approximately 0.001 thick, placed between the die and the attachment surface should be used. A die bonder that utilizes a heated collet and provides scrubbing action to ensure total wetting to prevent void formation in a nitrogen atmosphere is recommended. The gold-tin eutectic (80% Au 20% Sn) has a melting point of approximately 280 °C (Note: Gold Germanium should be avoided). The work station temperature should be 310 °C +/- 10 °C. Exposure to these extreme temperatures should be kept to minimum. The collet should be heated, and the die pre-heated to avoid excessive thermal shock. Avoidance of air bridges and force impact are critical during placement.

Wire Bonding - Windows in the surface passivation above the bond pads are provided to allow wire bonding to the die's gold bond pads. The recommended wire bonding procedure uses 0.076 mm x 0.013 mm (0.003" x 0.0005") 99.99% pure gold ribbon with 0.5-2% elongation to minimize RF port bond inductance. Gold 0.025 mm (0.001") diameter wedge or ball bonds are acceptable for DC Bias connections. Aluminum wire should be avoided. Thermo-compression bonding is recommended though thermosonic bonding may be used providing the ultrasonic content of the bond is minimized. Bond force, time and ultrasonics are all critical parameters. Bonds should be made from the bond pads on the die to the package or substrate. All bonds should be as short as possible.

| Part Number for Ordering | Description |
|--------------------------|---|
| CMM0014-BD-000V | RoHS compliant die packed in vacuum release gel packs |
| PB-CMM0014-BD-0000 | CMM0014-BD evaluation module |