



# BIPOLAR ANALOG INTEGRATED CIRCUIT

# UPC3223TB

## 5 V, SILICON MMIC MEDIUM OUTPUT POWER AMPLIFIER

### DESCRIPTION

The  $\mu$ PC3223TB is a silicon monolithic IC designed as IF amplifier for DBS tuners. This IC is manufactured using our 30 GHz  $f_{max}$  UHS0 (Ultra High Speed Process) silicon bipolar process.

### FEATURES

- Wideband response :  $f_u = 3.2$  GHz TYP. @ 3 dB bandwidth
- Medium output power :  $P_{O(sat)} = +12.0$  dBm @  $f = 1.0$  GHz  
:  $P_{O(sat)} = +9.0$  dBm @  $f = 2.2$  GHz
- High linearity :  $P_{O(1\text{ dB})} = +6.5$  dBm @  $f = 1.0$  GHz  
:  $P_{O(1\text{ dB})} = +5.0$  dBm @  $f = 2.2$  GHz
- Power gain :  $G_P = 23.0$  dB TYP. @  $f = 1.0$  GHz  
:  $G_P = 23.0$  dB TYP. @  $f = 2.2$  GHz
- Supply voltage :  $V_{CC} = 4.5$  to  $5.5$  V
- Port impedance : input/output  $50 \Omega$

### APPLICATION

- IF amplifiers in DBS converters etc.

### ORDERING INFORMATION (Solder Contains Lead)

| Part Number       | Package              | Marking | Supplying Form   |
|-------------------|----------------------|---------|--|
| $\mu$ PC3223TB-E3 | 6-pin super minimold | C3J     | <ul style="list-style-type: none"><li>• Embossed tape 8 mm wide</li><li>• 1, 2, 3 pins face the perforation side of tape</li><li>• Qty 3 kpcs/reel</li></ul> |

### ORDERING INFORMATION (Pb-Free)

| Part Number         | Package              | Marking | Supplying Form   |
|---------------------|----------------------|---------|--|
| $\mu$ PC3223TB-E3-A | 6-pin super minimold | C3J     | <ul style="list-style-type: none"><li>• Embossed tape 8 mm wide</li><li>• 1, 2, 3 pins face the perforation side of tape</li><li>• Qty 3 kpcs/reel</li></ul> |

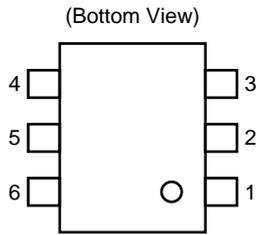
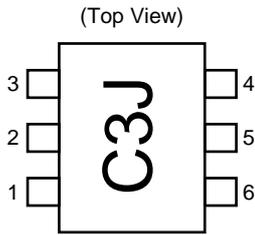
**Remark** To order evaluation samples, contact your nearby sales office.

Part number for sample order:  $\mu$ PC3223TB

**Caution** Observe precautions when handling because these devices are sensitive to electrostatic discharge.

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

**PIN CONNECTIONS**



| Pin No. | Pin Name        |
|---------|-----------------|
| 1       | INPUT           |
| 2       | GND             |
| 3       | GND             |
| 4       | OUTPUT          |
| 5       | GND             |
| 6       | V <sub>CC</sub> |

**PRODUCT LINE-UP OF 5 V-BIAS SILICON MMIC MEDIUM OUTPUT AMPLIFIER**  
 (T<sub>A</sub> = +25°C, f = 1 GHz, V<sub>CC</sub> = V<sub>out</sub> = 5.0 V, Z<sub>s</sub> = Z<sub>L</sub> = 50 Ω)

| Part No.  | f <sub>u</sub><br>(GHz) | P <sub>O(sat)</sub><br>(dBm) | G <sub>P</sub><br>(dB) | NF<br>(dB) | I <sub>CC</sub><br>(mA) | Package              | Marking |
|-----------|-------------------------|------------------------------|------------------------|------------|-------------------------|----------------------|---------|
| μPC2708TB | 2.9                     | +10.0                        | 15                     | 6.5        | 26                      | 6-pin super minimold | C1D     |
| μPC2709TB | 2.3                     | +11.5                        | 23                     | 5.0        | 25                      |                      | C1E     |
| μPC2710TB | 1.0                     | +13.5                        | 33                     | 3.5        | 22                      |                      | C1F     |
| μPC2776TB | 2.7                     | +8.5                         | 23                     | 6.0        | 25                      |                      | C2L     |
| μPC3223TB | 3.2                     | +12.0                        | 23                     | 4.5        | 19                      |                      | C3J     |

**Remark** Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail.

**PIN EXPLANATIONS**

| PIN No.     | Pin Name        | Applied Voltage (V)  | Pin Voltage (V)<br><small>Note</small> | Function and Applications   |
|-------------|-----------------|--|--|---|
| 1           | INPUT           | –  | 0.96                                   | Signal input pin.<br>A internal matching circuit, configured with resistors, enables 50 Ω connection over a wide band.<br>A multi-feedback circuits is designed to cancel the deviations of h <sub>FE</sub> and resistance.<br>This pin must be coupled to signal source with capacitor for DC cut. |
| 4           | OUTPUT          | Voltage as same as V <sub>CC</sub> through external inductor | –                                      | Signal output pin.<br>The inductor must be attached between V <sub>CC</sub> and output pins to supply current to the internal output transistors.   |
| 6           | V <sub>CC</sub> | 4.5 to 5.5   | –                                      | Power supply pin.<br>Witch biases the internal input transistor. This pin should be externally equipped with bypass capacitor to minimize its impedance.  |
| 2<br>3<br>5 | GND             | 0  | –                                      | Ground pin.<br>This pin should be connected to system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible.<br>All the ground pins must be connected together with wide ground pattern to decrease impedance difference.                                |

**Note** Pin Voltage is measured at V<sub>CC</sub> = 5.0 V

**ABSOLUTE MAXIMUM RATINGS**

| Parameter                     | Symbol    | Conditions                                | Ratings     | Unit               |
|-------------------------------|-----------|---|-------------|--------------------|
| Supply Voltage                | $V_{CC}$  | $T_A = +25^{\circ}\text{C}$ , Pin 4 and 6 | 6.0         | V                  |
| Total Circuit Current         | $I_{CC}$  | $T_A = +25^{\circ}\text{C}$               | 40          | mA                 |
| Power Dissipation             | $P_D$     | $T_A = +85^{\circ}\text{C}$ <b>Note</b>   | 270         | mW                 |
| Operating Ambient Temperature | $T_A$     |   | -40 to +85  | $^{\circ}\text{C}$ |
| Storage Temperature           | $T_{stg}$ |   | -55 to +150 | $^{\circ}\text{C}$ |
| Input Power                   | $P_{in}$  | $T_A = +25^{\circ}\text{C}$               | +10         | dBm                |

**Note** Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB

**RECOMMENDED OPERATING RANGE**

| Parameter                     | Symbol   | Conditions   | MIN. | TYP. | MAX. | Unit               |
|-------------------------------|----------|--|------|------|------|--------------------|
| Supply Voltage                | $V_{CC}$ | The same voltage should be applied to pin 4 and 6. | 4.5  | 5.0  | 5.5  | V                  |
| Operating Ambient Temperature | $T_A$    |  | -40  | +25  | +85  | $^{\circ}\text{C}$ |

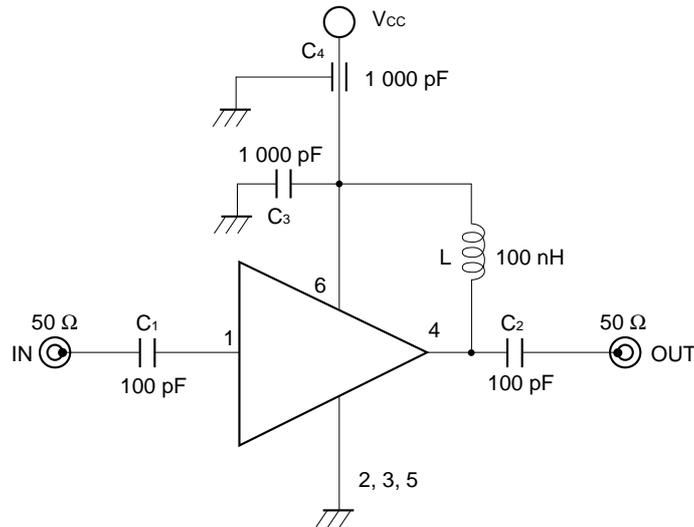
**ELECTRICAL CHARACTERISTICS ( $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = V_{out} = 5.0\text{ V}$ ,  $Z_S = Z_L = 50\ \Omega$ )**

| Parameter                          | Symbol               | Test Conditions                                   | MIN. | TYP.      | MAX. | Unit |
|------------------------------------|----------------------|---|------|-----------|------|------|
| Circuit Current                    | $I_{CC}$             | No input signal                                   | 15.0 | 19.0      | 24.0 | mA   |
| Power Gain                         | $G_P$                | $f = 1.0\text{ GHz}$ , $P_{in} = -30\text{ dBm}$  | 20.5 | 23.0      | 25.5 | dB   |
|                                    |                      | $f = 2.2\text{ GHz}$ , $P_{in} = -30\text{ dBm}$  | 20.0 | 23.0      | 26.0 |      |
| Saturated Output Power             | $P_{O(sat)}$         | $f = 1.0\text{ GHz}$ , $P_{in} = -5\text{ dBm}$   | +9.0 | +12.0     | -    | dBm  |
|                                    |                      | $f = 2.2\text{ GHz}$ , $P_{in} = -5\text{ dBm}$   | +6.0 | +9.0      | -    |      |
| Gain 1 dB Compression Output Power | $P_{O(1\text{ dB})}$ | $f = 1.0\text{ GHz}$                              | +4.5 | +6.5      | -    | dBm  |
|                                    |                      | $f = 2.2\text{ GHz}$                              | +3.0 | +5.0      | -    |      |
| Noise Figure                       | NF                   | $f = 1.0\text{ GHz}$                              | -    | 4.5       | 6.0  | dB   |
|                                    |                      | $f = 2.2\text{ GHz}$                              | -    | 4.0       | 5.5  |      |
| Upper Limit Operating Frequency    | $f_u$                | 3 dB down below flat gain at $f = 0.1\text{ GHz}$ | 2.8  | 3.2       | -    | GHz  |
| Isolation                          | ISL                  | $f = 1.0\text{ GHz}$ , $P_{in} = -30\text{ dBm}$  | 28.0 | 33.0      | -    | dB   |
|                                    |                      | $f = 2.2\text{ GHz}$ , $P_{in} = -30\text{ dBm}$  | 28.0 | 33.0      | -    |      |
| Input Return Loss                  | $RL_{in}$            | $f = 1.0\text{ GHz}$ , $P_{in} = -30\text{ dBm}$  | 9.0  | 12.0      | -    | dB   |
|                                    |                      | $f = 2.2\text{ GHz}$ , $P_{in} = -30\text{ dBm}$  | 12.0 | 17.5      | -    |      |
| Output Return Loss                 | $RL_{out}$           | $f = 1.0\text{ GHz}$ , $P_{in} = -30\text{ dBm}$  | 9.0  | 12.0      | -    | dB   |
|                                    |                      | $f = 2.2\text{ GHz}$ , $P_{in} = -30\text{ dBm}$  | 9.0  | 12.0      | -    |      |
| Gain Flatness                      | $\Delta G_P$         | $f = 0.1\text{ to }2.2\text{ GHz}$                | -    | $\pm 0.9$ | -    | dB   |

**OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY**  
**(T<sub>A</sub> = +25°C, V<sub>CC</sub> = V<sub>out</sub> = 5.0 V, Z<sub>s</sub> = Z<sub>L</sub> = 50 Ω)**

| Parameter              | Symbol           | Test Conditions | Reference Value | Unit |
|------------------------|------------------|-----------------|-----------------|------|
| Output Intercept Point | OIP <sub>3</sub> | f = 1.0 GHz     | +17.8           | dBm  |
|                        |                  | f = 2.2 GHz     | +14.8           |      |

**TEST CIRCUIT**



The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

**COMPONENTS OF TEST CIRCUIT FOR MEASURING ELECTRICAL CHARACTERISTICS**

|                                 | Type                   | Value    |
|---------------------------------|------------------------|----------|
| C <sub>1</sub> , C <sub>2</sub> | Chip Capacitor         | 100 pF   |
| C <sub>3</sub>                  | Chip Capacitor         | 1 000 pF |
| C <sub>4</sub>                  | Feed-through Capacitor | 1 000 pF |
| L                               | Chip Inductor          | 100 nH   |

**INDUCTOR FOR THE OUTPUT PIN**

The internal output transistor of this IC consumes 20 mA, to output medium power. To supply current for output transistor, connect an inductor between the Vcc pin (pin 6) and output pin (pin 4). Select large value inductance, as listed above.

The inductor has both DC and AC effects. In terms of DC, the inductor biases the output transistor with minimum voltage drop to output enable high level. In terms of AC, the inductor makes output-port impedance higher to get enough gain. In this case, large inductance and Q is suitable.

**CAPACITORS FOR THE Vcc, INPUT AND OUTPUT PINS**

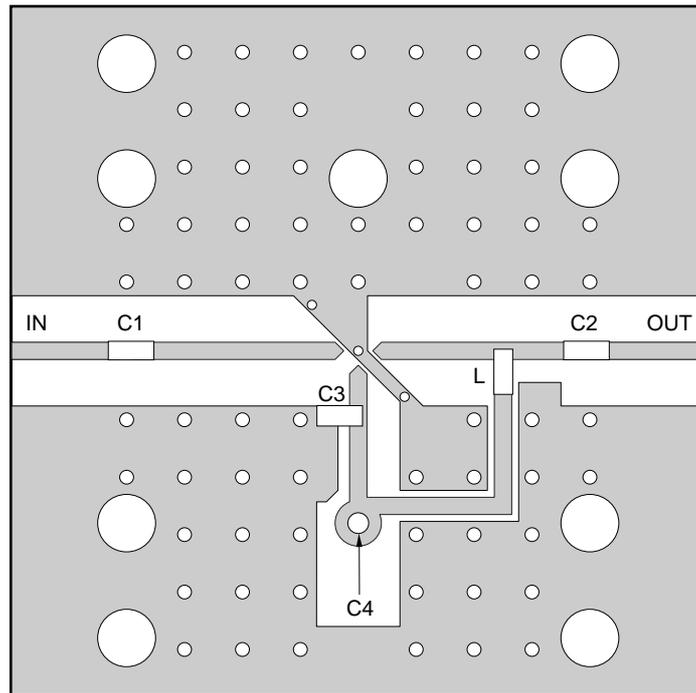
Capacitors of 1000 pF are recommendable as the bypass capacitor for the Vcc pin and the coupling capacitors for the input and output pins.

The bypass capacitor connected to the Vcc pin is used to minimize ground impedance of Vcc pin. So, stable bias can be supplied against Vcc fluctuation.

The coupling capacitors, connected to the input and output pins, are used to cut the DC and minimize RF serial impedance. Their capacitances are therefore selected as lower impedance against a 50 Ω load. The capacitors thus perform as high pass filters, suppressing low frequencies to DC.

To obtain a flat gain from 100 MHz upwards, 1 000 pF capacitors are used in the test circuit. In the case of under 10 MHz operation, increase the value of coupling capacitor such as 10 000 pF. Because the coupling capacitors are determined by equation,  $C = 1/(2 \pi Rfc)$ .

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

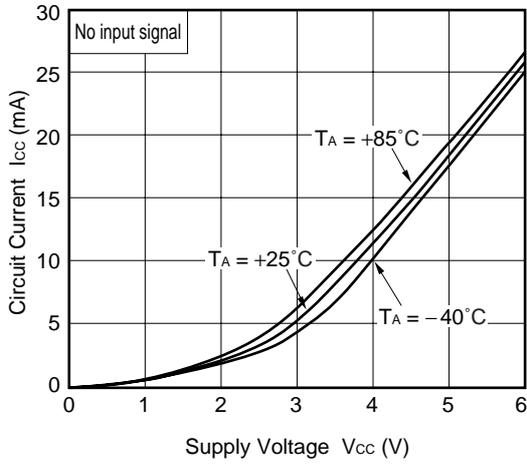
|                                 | Value    |
|---------------------------------|----------|
| C <sub>1</sub> , C <sub>2</sub> | 100 pF   |
| C <sub>3</sub> , C <sub>4</sub> | 1 000 pF |
| L                               | 100 nH   |

Notes

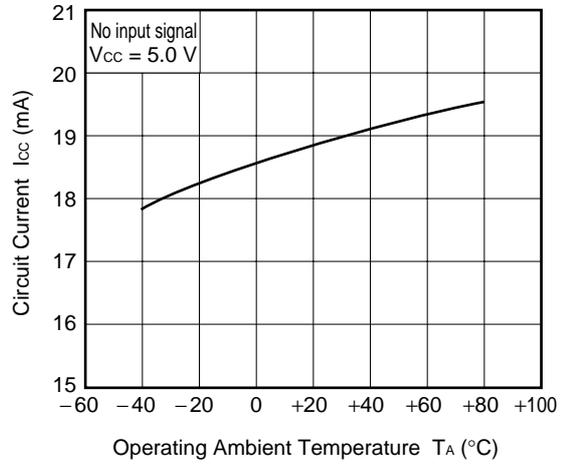
1. 30 × 30 × 0.4 mm double sided copper clad polyimide board.
2. Back side: GND pattern
3. Solder plated on pattern
4. ○: Through holes

**TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise specified)**

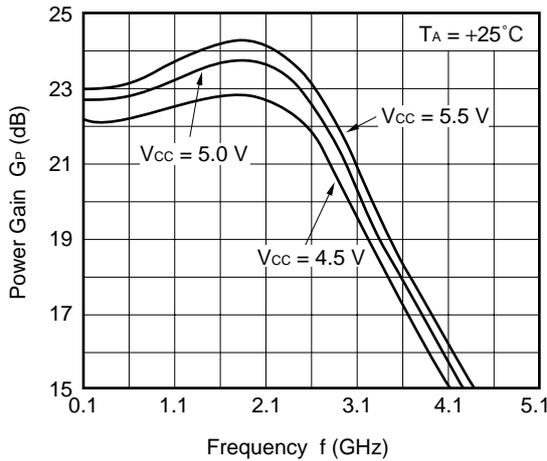
**CIRCUIT CURRENT vs. SUPPLY VOLTAGE**



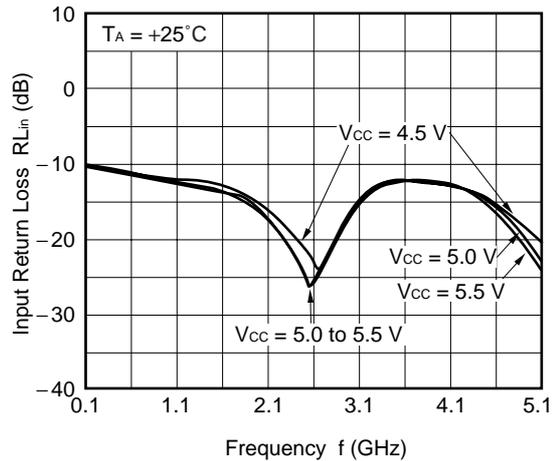
**CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE**



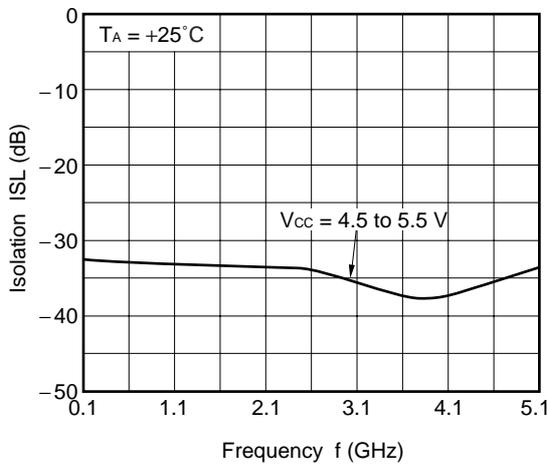
**POWER GAIN vs. FREQUENCY**



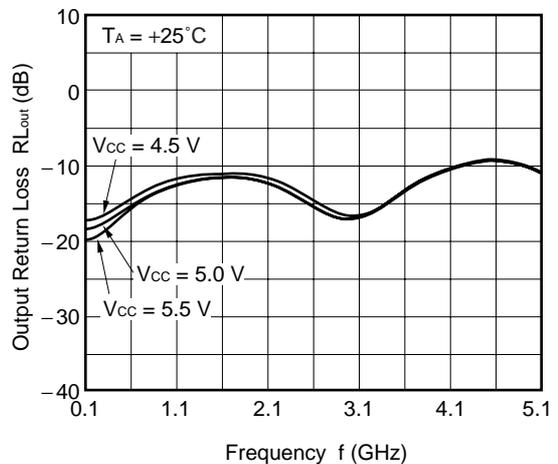
**INPUT RETURN LOSS vs. FREQUENCY**



**ISOLATION vs. FREQUENCY**

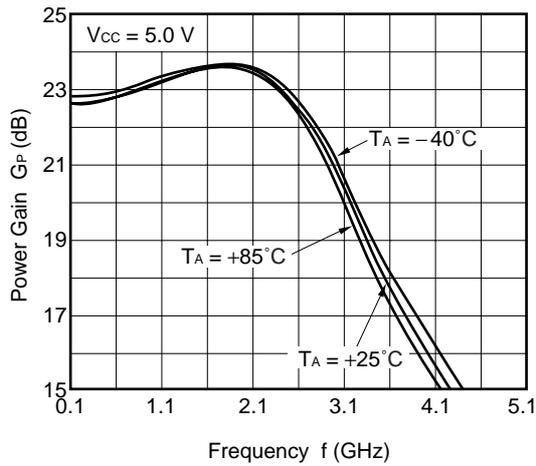


**OUTPUT RETURN LOSS vs. FREQUENCY**

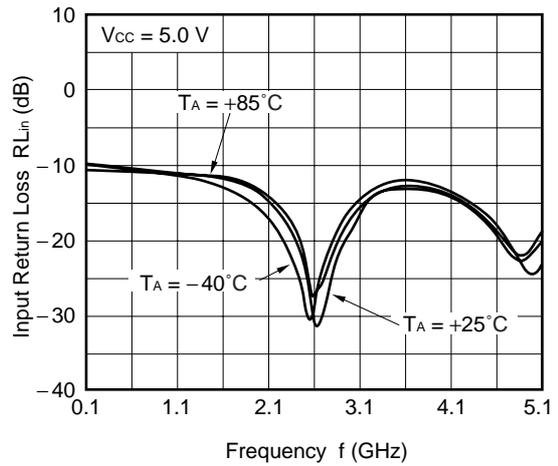


**Remark** The graphs indicate nominal characteristics.

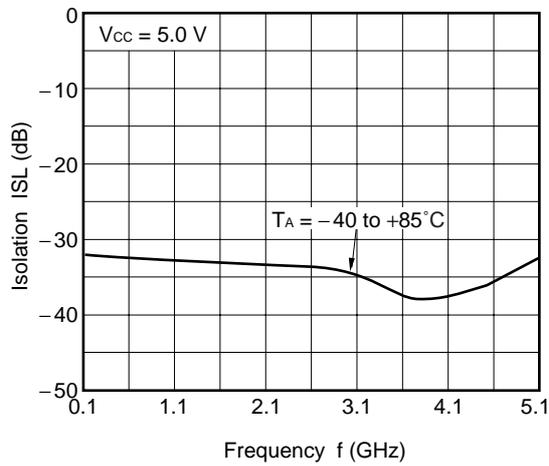
POWER GAIN vs. FREQUENCY



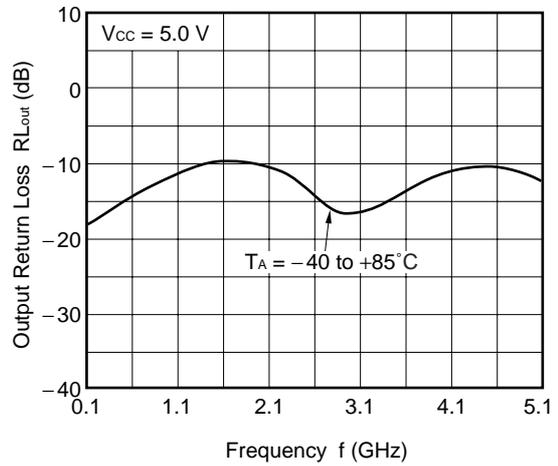
INPUT RETURN LOSS vs. FREQUENCY



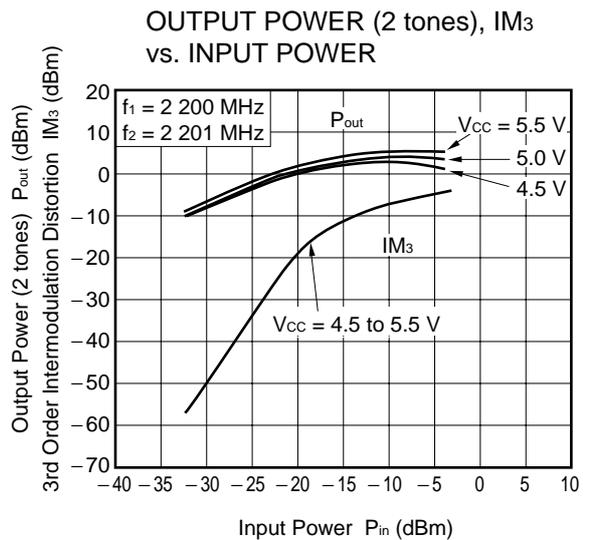
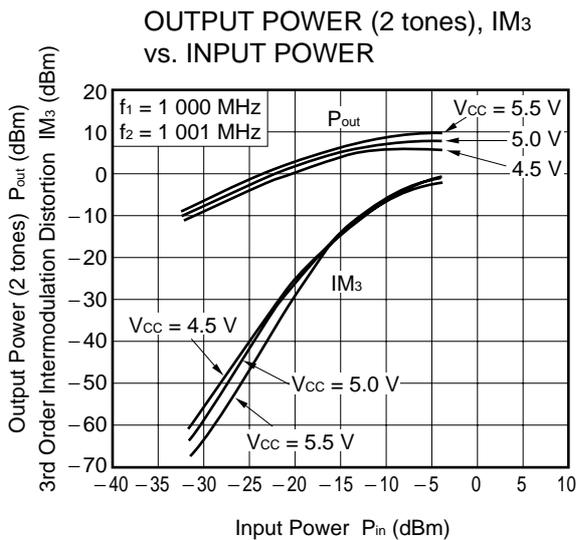
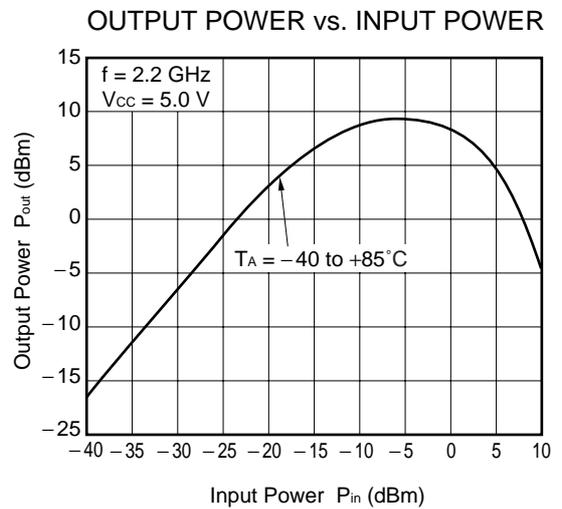
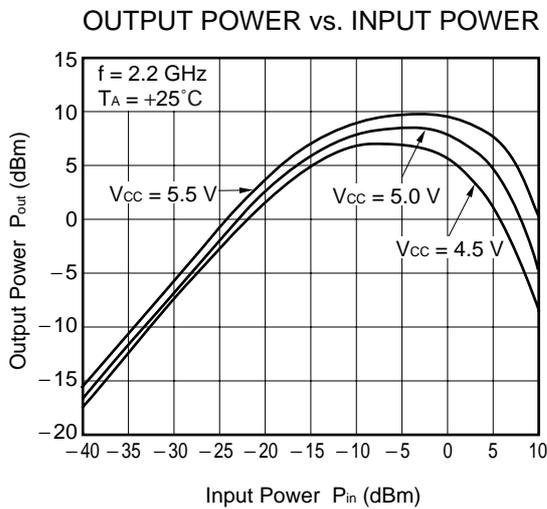
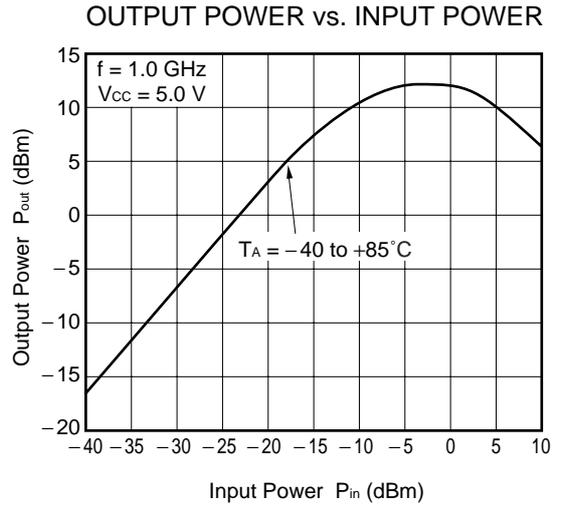
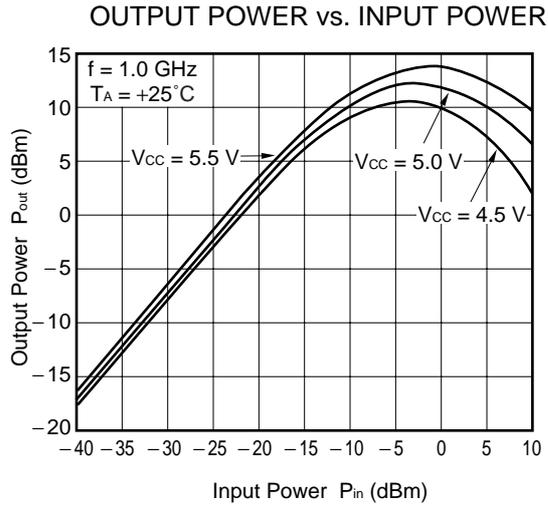
ISOLATION vs. FREQUENCY



OUTPUT RETURN LOSS vs. FREQUENCY



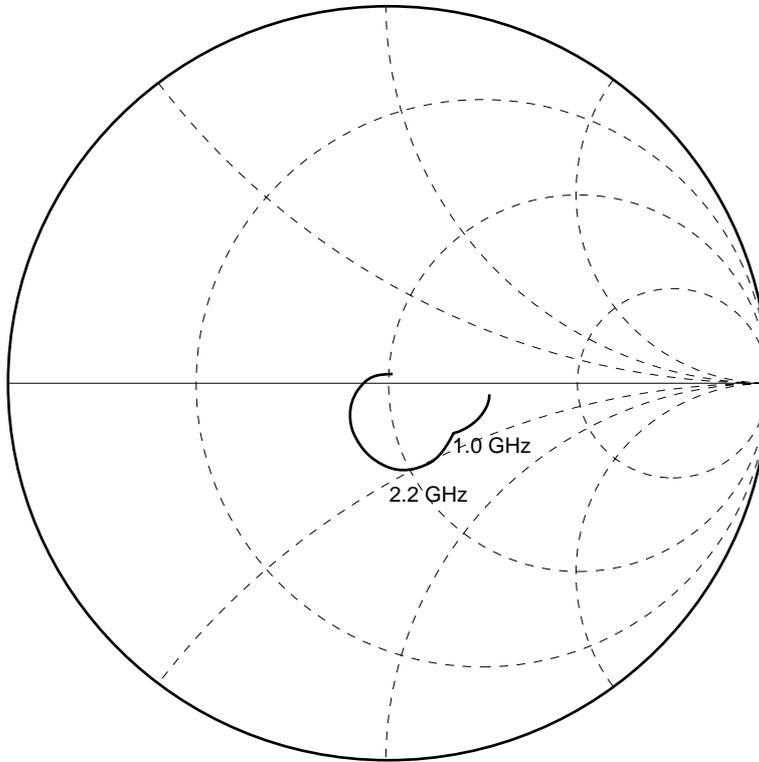
**Remark** The graphs indicate nominal characteristics.



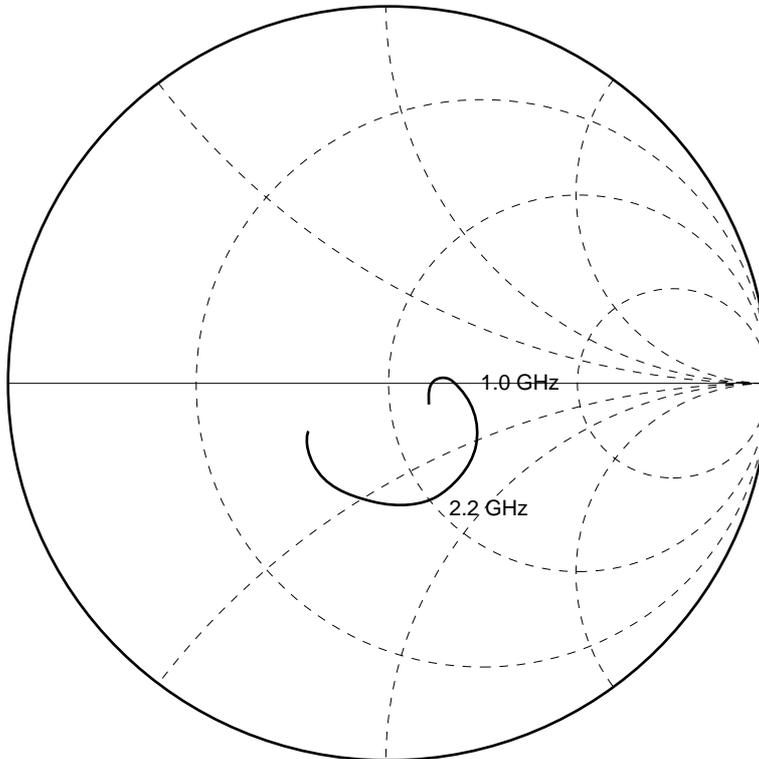
**Remark** The graphs indicate nominal characteristics.

S-PARAMETERS ( $T_A = +25^\circ\text{C}$ ,  $V_{CC} = V_{out} = 5.0\text{ V}$ )

S<sub>11</sub>-FREQUENCY

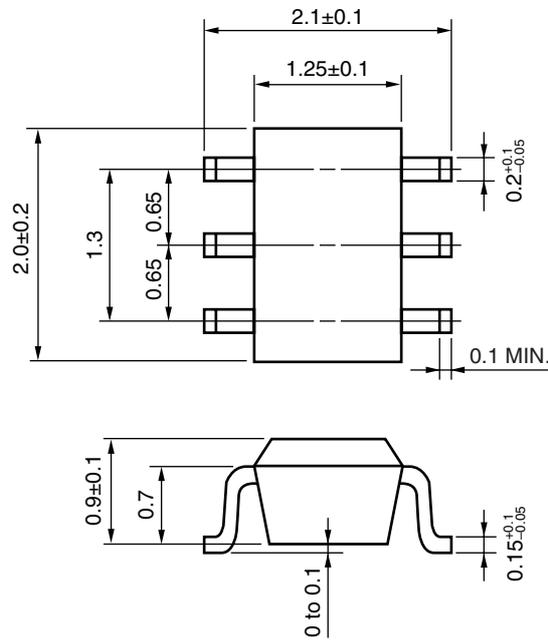


S<sub>22</sub>-FREQUENCY



PACKAGE DIMENSIONS

6-PIN SUPER MINIMOLD (UNIT: mm)



**NOTES ON CORRECT USE**

- (1) Observe precautions for handling because of electro-static sensitive devices.
- (2) Form a ground pattern as widely as possible to minimize ground impedance (to prevent undesired oscillation).  
All the ground pins must be connected together with wide ground pattern to decrease impedance difference.
- (3) The bypass capacitor should be attached to Vcc line.
- (4) The inductor must be attached between Vcc and output pins. The inductance value should be determined in accordance with desired frequency.
- (5) The DC cut capacitor must be each attached to input and output pin.

**RECOMMENDED SOLDERING CONDITIONS**

This product should be soldered and mounted under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your nearby sales office.

| Soldering Method | Soldering Conditions  | Condition Symbol |
|------------------|---|------------------|
| Infrared Reflow  | Peak temperature (package surface temperature) : 260°C or below<br>Time at peak temperature : 10 seconds or less<br>Time at temperature of 220°C or higher : 60 seconds or less<br>Preheating time at 120 to 180°C : 120±30 seconds<br>Maximum number of reflow processes : 3 times<br>Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below | IR260            |
| Wave Soldering   | Peak temperature (molten solder temperature) : 260°C or below<br>Time at peak temperature : 10 seconds or less<br>Preheating temperature (package surface temperature) : 120°C or below<br>Maximum number of flow processes : 1 time<br>Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below  | WS260            |
| Partial Heating  | Peak temperature (pin temperature) : 350°C or below<br>Soldering time (per side of device) : 3 seconds or less<br>Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below  | HS350            |

**Caution Do not use different soldering methods together (except for partial heating).**

Subject: Compliance with EU Directives

CEL certifies, to its knowledge, that semiconductor and laser products detailed below are compliant with the requirements of European Union (EU) Directive 2002/95/EC Restriction on Use of Hazardous Substances in electrical and electronic equipment (RoHS) and the requirements of EU Directive 2003/11/EC Restriction on Penta and Octa BDE.

CEL Pb-free products have the same base part number with a suffix added. The suffix –A indicates that the device is Pb-free. The –AZ suffix is used to designate devices containing Pb which are exempted from the requirement of RoHS directive (\*). In all cases the devices have Pb-free terminals. All devices with these suffixes meet the requirements of the RoHS directive.

This status is based on CEL’s understanding of the EU Directives and knowledge of the materials that go into its products as of the date of disclosure of this information.

| Restricted Substance per RoHS | Concentration Limit per RoHS (values are not yet fixed) | Concentration contained in CEL devices |     |
|-------------------------------|---|--|-----|
|                               |   | -A                                     | -AZ |
| Lead (Pb)                     | < 1000 PPM  | Not Detected                           | (*) |
| Mercury                       | < 1000 PPM  | Not Detected                           |     |
| Cadmium                       | < 100 PPM   | Not Detected                           |     |
| Hexavalent Chromium           | < 1000 PPM  | Not Detected                           |     |
| PBB                           | < 1000 PPM  | Not Detected                           |     |
| PBDE                          | < 1000 PPM  | Not Detected                           |     |

If you should have any additional questions regarding our devices and compliance to environmental standards, please do not hesitate to contact your local representative.

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