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SILICON RFIC LOW CURRENT AMPLIFIER FOR MOBILE COMMUNICATIONS

# UPC8179TB

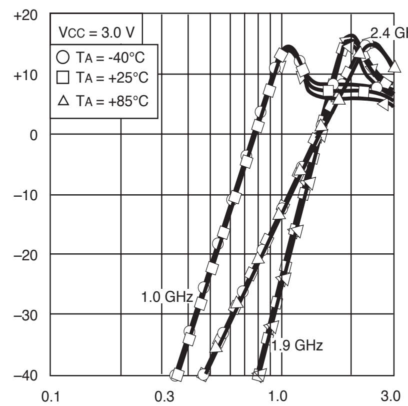
## FEATURES

- **HIGH DENSITY SURFACE MOUNTING:**
  6 Pin Super Minimold Package (2.0 x 1.25 x 0.9 mm)
- **SUPPLY VOLTAGE:**
  $V_{CC}$ = 2.4 to 3.3 V
- **HIGH EFFICIENCY:**
  $P_O(1dB)$ = +3.0 dBm TYP at f = 1.0 GHz
  $P_O(1dB)$ = +1.5 dBm TYP at f = 1.9 GHz
  $P_O(1dB)$ = +1.0 dBm TYP at f = 2.4 GHz
- **POWER GAIN:**
  $G_P$ = 13.5 dB TYP at f = 1.0 GHz
  $G_P$ = 15.5 dB TYP at f = 1.9 GHz
  $G_P$ = 15.5 dB TYP at f = 2.4 GHz
- **EXCELLENT ISOLATION:**
  ISL = 44 dB TYP at f = 1.0 GHz
  ISL = 42 dB TYP at f = 1.9 GHz
  ISL = 41 dB TYP at f = 2.4 GHz
- **LOW CURRENT CONSUMPTION:**
  $I_{CC}$ = 4.0 mA TYP AT VCC = 3.0 V
- **OPERATING FREQUENCY:**
  $I_{CC}$ = 4.0 mA TYP AT VCC = 3.0 V
- **LIGHT WEIGHT:**
  7 mg (standard Value)

## APPLICATIOIN

- Buffer amplifiers for 0.1 to 2.4 GHz mobile communications systems.

**POWER GAIN vs. FREQUENCY**




Output match for best performance at each frequency

## DESCRIPTION

NEC's UPC8179TB is a silicon monolithic integrated circuit designed as amplifier for mobile communications. This IC can realize low current consumption with external chip inductor which can be realized on internal 50Ω wideband matched IC. This low current amplifier uns on 3.0 V. This IC is manufactured using NEC's 30 GHz fMAX UHS0 (Ultra High Speed Process) silicon bipolar process. This process uses direct silicon nitride passivation film and gold electrodes. These materials can protect the chip surface from pollution and prevent corrosion/ migration. Thus this IC has exellent performance uniformity and reliability.

## ELECTRICAL CHARACTERISTICS,

(Unless otherwise specified, $T_A$ = +25°C, $V_{CC}$ = $V_{OUT}$ = 3.0 V, $Z_S$ = $Z_L$ = 50Ω, at LC matched Frequency)

| PART NUMBER<br>PACKAGE OUTLINE | | | | UPC8179TB<br>S06 | |
|---|---|---|---|---|---|
| SYMBOLS | PARAMETERS AND CONDITIONS | UNITS | MIN | TYP | MAX |
| $I_{CC}$ | Circuit Current (no input signal) | mA | 2.9 | 4.0 | 5.4 |
| GP | Power Gain, f = 1.0 GHz, $P_{IN}$ = -30 dBm<br>f = 1.9 GHz, $P_{IN}$ = -30 dBm<br>f = 2.4 GHz, $P_{IN}$ = -30 dBm | dB | 11.0<br>13.0<br>13.0 | 13.5<br>15.5<br>15.5 | 15.5<br>17.5<br>17.5 |
| ISOL | Isolation, f = 1.0 GHz, $P_{IN}$ = -30 dBm<br>f = 1.9 GHz, $P_{IN}$ = -30 dBm<br>f = 2.4 GHz, $P_{IN}$ = -30 dBm | dB | 39.0<br>37.0<br>36.0 | 44.0<br>42.0<br>41.0 | –<br>–<br>– |
| $P_{1dB}$ | Output Power at 1 dB gain compression, f = 1.0 GHz<br>f = 1.9 GHz<br>f = 2.4 GHz | dB | -0.5<br>-2.0<br>-3.0 | 3.0<br>1.5<br>1.0 | –<br>–<br>– |
| NF | Noise Figure, f = 1.0 GHz<br>f = 1.9 GHz<br>f = 2.4 GHz | dB | –<br>–<br>– | 5.0<br>5.0<br>5.0 | 6.5<br>6.5<br>6.5 |
| $RL_{IN}$ | Input Return Loss, (without matching circuit) f = 1.0 GHz, $P_{IN}$ = -30 dBm<br>f = 1.9 GHz, $P_{IN}$ = -30 dBm<br>f = 2.4 GHz, $P_{IN}$ = -30 dBm | dB | 4.0<br>4.0<br>6.0 | 7.0<br>7.0<br>9.0 | –<br>–<br>– |

## ABSOLUTE MAXIMUM RATINGS[1] ($T_A$ = 25°C)

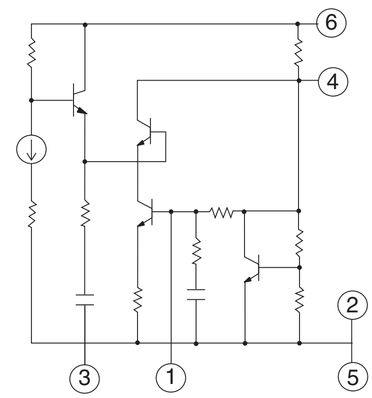
| SYMBOLS | PARAMETERS | UNITS | RATINGS |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage, Pins 4 & 6 | V | 3.6 |
| $I_{CC}$ | Circuit Current | mA | 15 |
| $P_D$ | Power Dissipation[2] | mW | 270 |
| $T_{OP}$ | Operating Temperature | °C | -40 to +85 |
| $T_{STG}$ | Storage Temperature | °C | -55 to +150 |
| $P_{IN}$ | Input Power | dBm | +5 |

Notes:
1. Operation in excess of any one of these parameters may result in permanent damage.
2. Mounted on a 50 x 50 x 1.6 mm epoxy glass PWB ($T_A$ = +85°C).

## RECOMMENDED OPERATING CONDITIONS

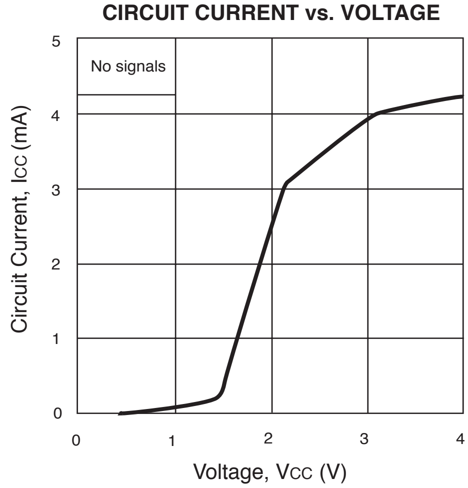
| SYMBOLS | PARAMETERS | UNITS | MIN | TYP | MAX |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | V | 2.7 | 3.0 | 3.3 |
| $T_A$ | Operating Ambient Temperature | °C | -40 | +25 | +85 |

## PIN FUNCTIONS

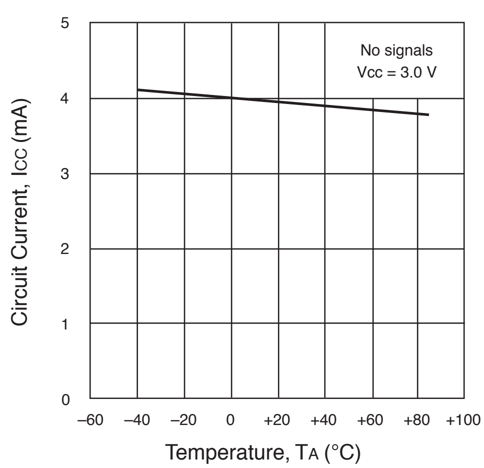
| Pin No. | Symbol | Pin Voltage | Description | Internal Equivalent Circuit |
|---|---|---|---|---|
| 1 | INPUT | 1.09 V | Signal Input Pin. A internal matching circuit, configured with resistors, enable 50 W connection over a wide band. This pin must be coupled to signal source with capacitor for DC cut. |   |
| 2<br>3<br>5 | GND | through external inductor | Ground pin. This pin should be connected to the system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible. All the ground pins must be connected together with wide ground pattern to decrease impedance difference. | |
| 4 | OUTPUT | Same as $V_{CC}$ voltage | Signal output pin. This pin is designed as collector output. Due to the high impedance output, this pin should be externally equipped with matching LC matching circuit to next stage. For L, a size 1005 chip inductor can be chosen. | |
| 6 | $V_{CC}$ | 2.4 to 3.3 | Power supply pin. This pin should be externally equipped with bypass capacitor to minimize its impedance. | |

## TYPICAL PERFORMANCE CURVES (Unless otherwise specified, $T_A$ = 25˚C)

**CIRCUIT CURRENT vs. VOLTAGE**

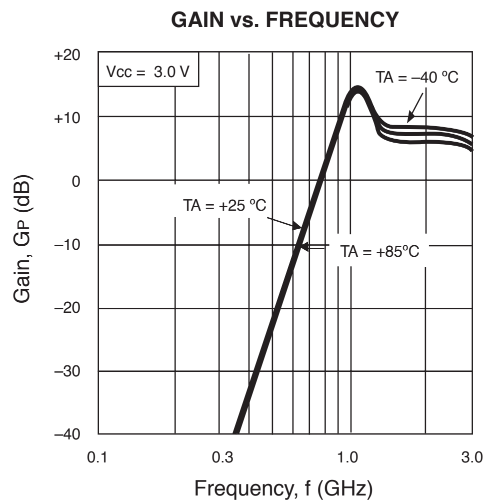


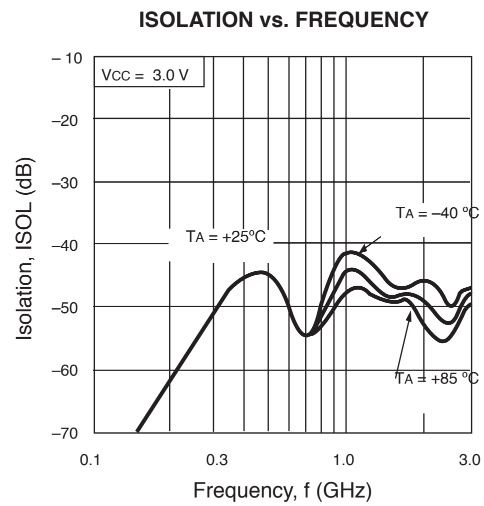

**CIRCUIT CURRENT vs. TEMPERATURE**

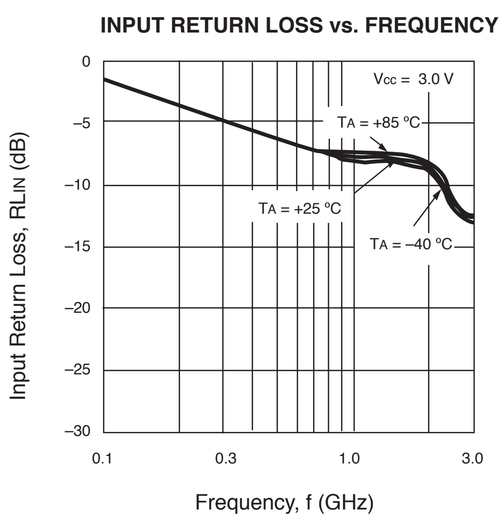


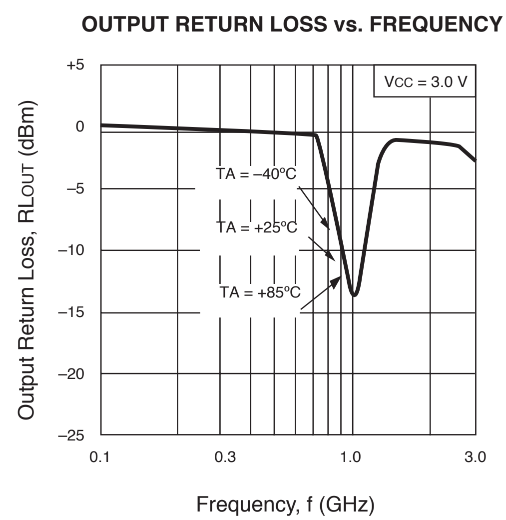
## TYPICAL PERFORMANCE CURVES (Unless otherwise specified, $T_A$ = 25˚C)

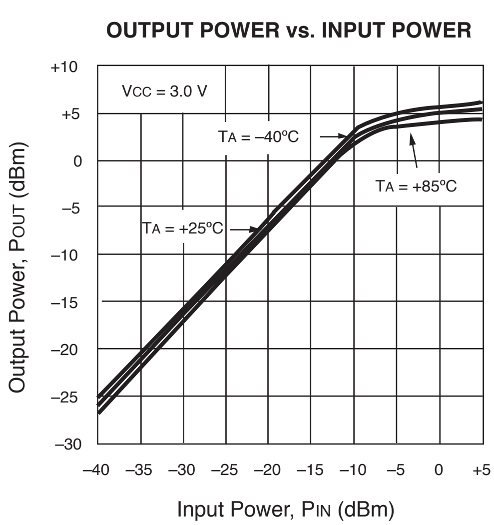
1.0 GHz Output Port Matching

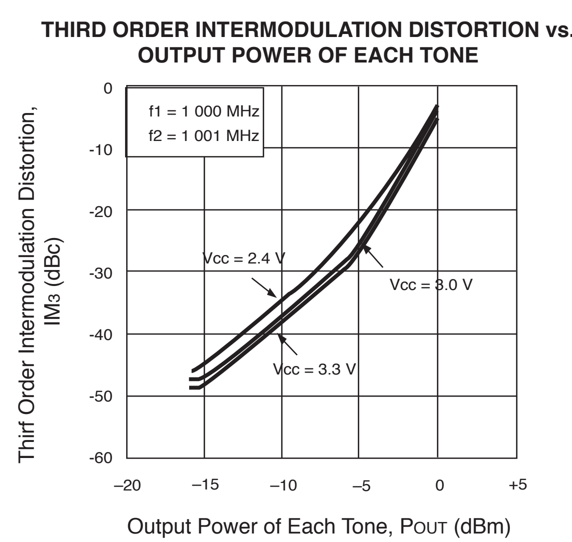


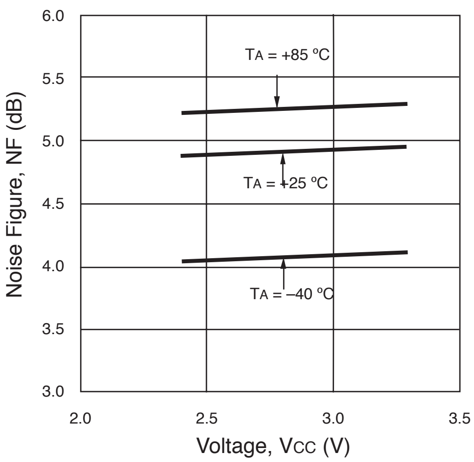



## TYPICAL PERFORMANCE CURVES (Unless otherwise specified, $T_A = 25^\circ C$)

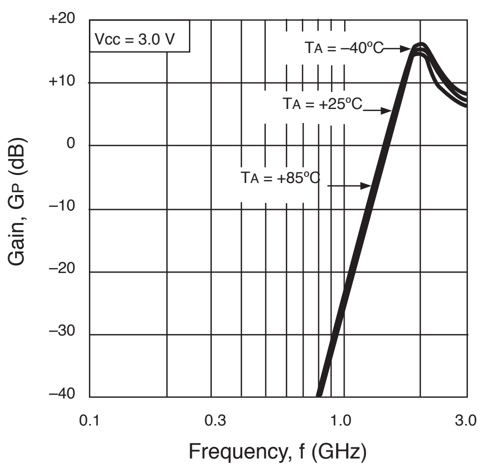
1.0 GHz Output Port Matching

**NOISE FIGURE vs. VOLTAGE**

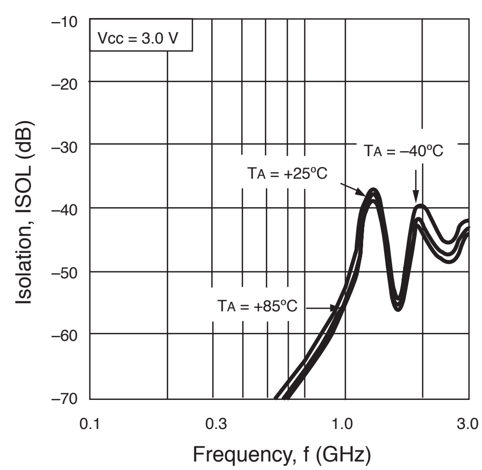



1.9 GHz Output Port Matching

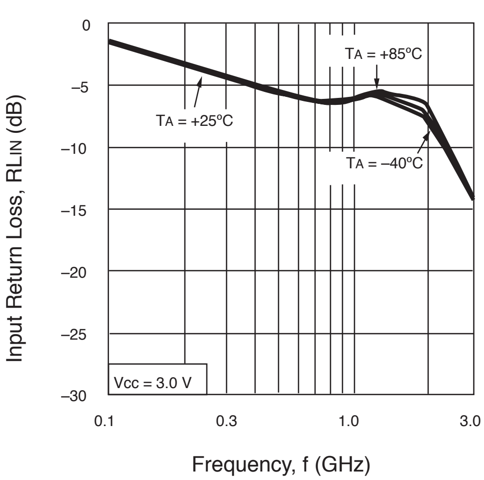
**GAIN vs. FREQUENCY**



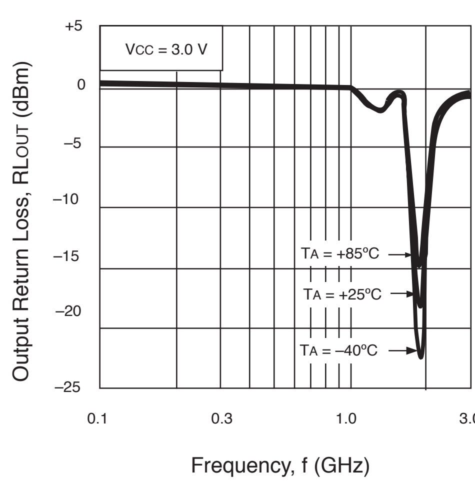

**ISOLATION vs. FREQUENCY**




**INPUT RETURN LOSS vs. FREQUENCY**

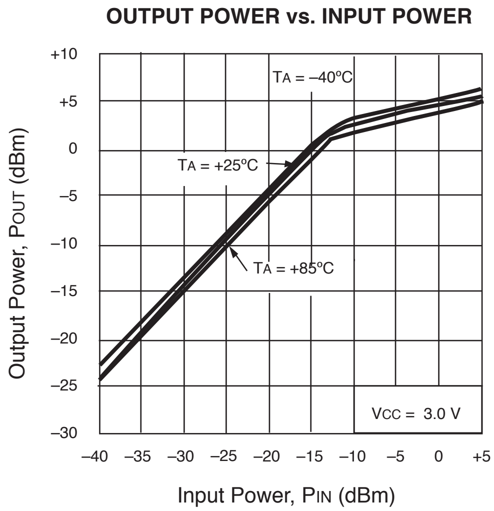


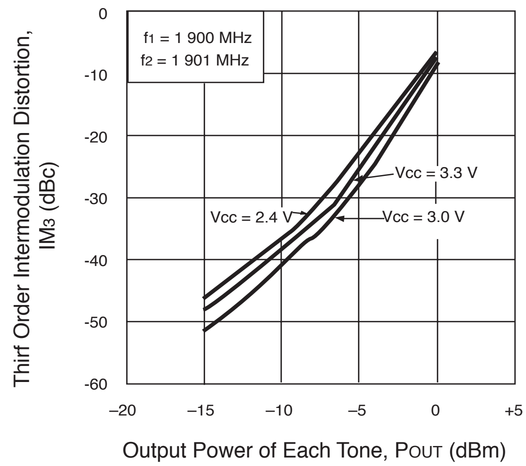

**OUTPUT RETURN LOSS vs. FREQUENCY**

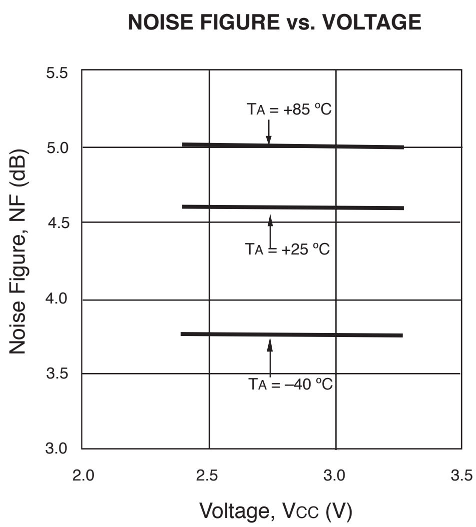


## TYPICAL PERFORMANCE CURVES (Unless otherwise specified, $T_A$ = 25˚C)

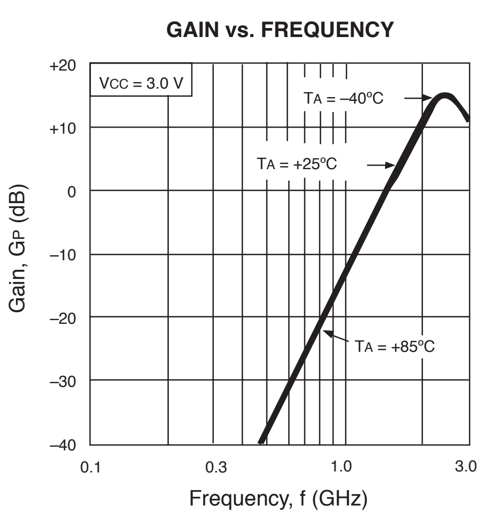
1.9 GHz Output Port Matching

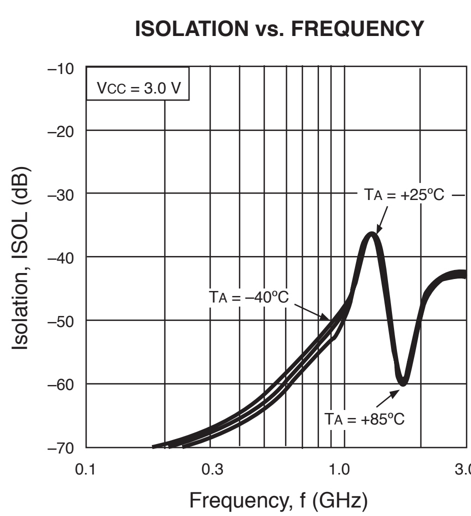



2.4 GHz Output Port Matching

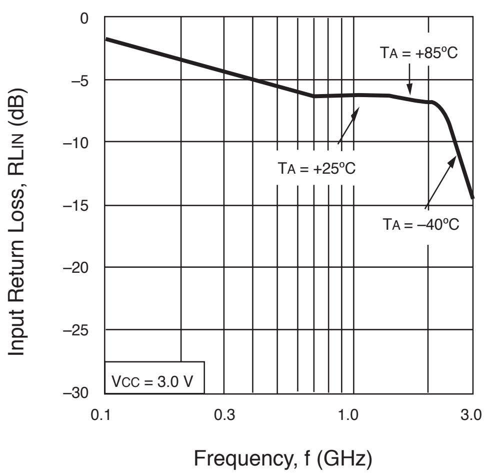


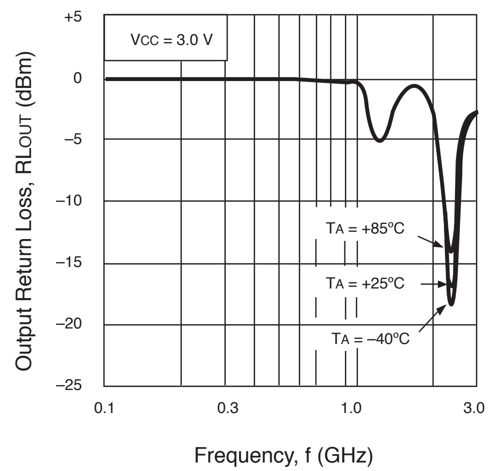
## TYPICAL PERFORMANCE CURVES (Unless otherwise specified, $T_A$ = 25˚C)

2.4 GHz Output Port Matching

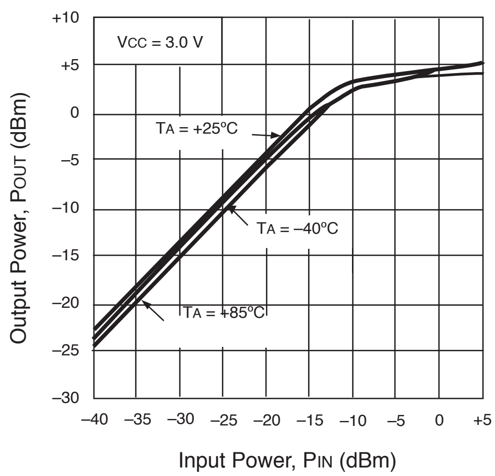
**INPUT RETURN LOSS vs. FREQUENCY**



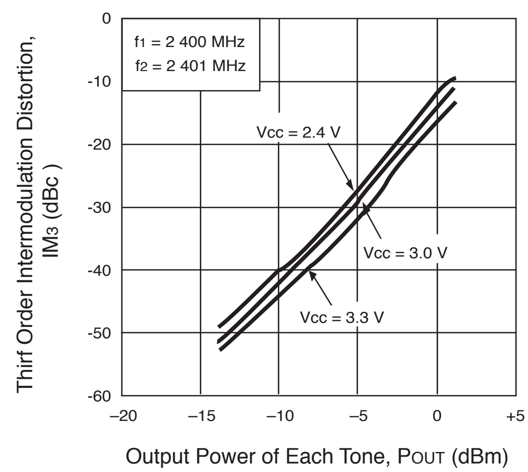

**OUTPUT RETURN LOSS vs. FREQUENCY**



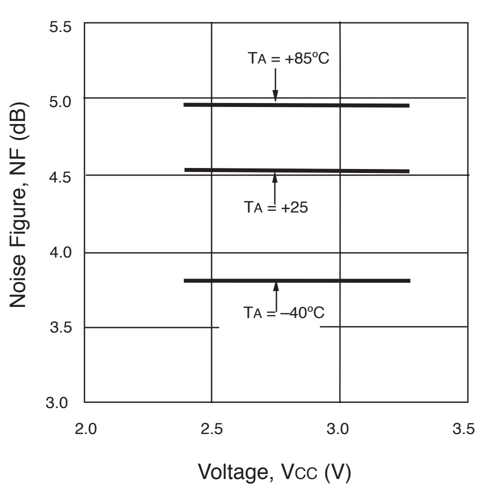

**OUTPUT POWER vs. INPUT POWER**



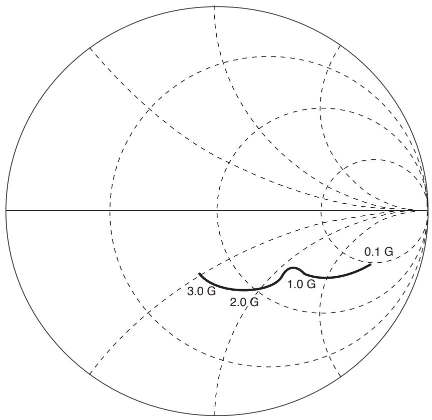

**THIRD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE**



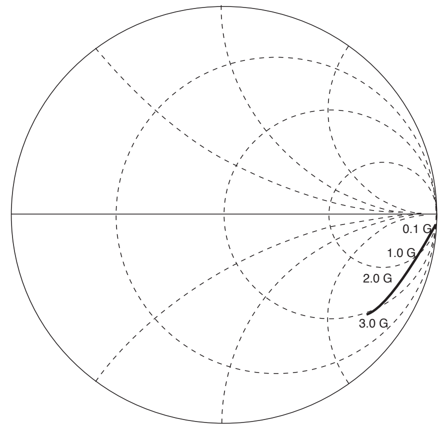

**NOISE FIGURE vs. VOLTAGE**



## TYPICAL SCATTERING PARAMETERS ($T_A = 25^\circ C$)




S11




S22

**Coordinates in Ohms**
**Frequency in GHz**
**$V_{CC} = V_{OUT} = 3.0$ V, $I_{CC} = 4.0$ mA**

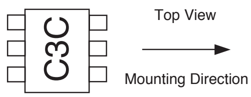
**$V_{CC} = V_{OUT} = 3.0$ V, $I_{CC} = 4.0$ mA**

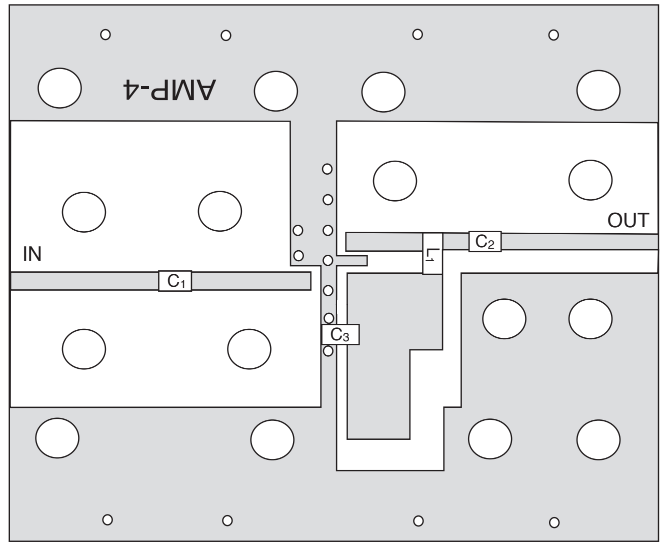
| FREQUENCY | S11 | | S21 | | S12 | | S22 | |
|---|---|---|---|---|---|---|---|---|
| GHz | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 0.1 | 0.824 | -17.1 | 1.181 | -177.7 | 0.002 | 108.8 | 0.996 | -2.4 |
| 0.2 | 0.692 | -25.9 | 1.181 | -172.4 | 0.003 | 64.7 | 0.986 | -4.0 |
| 0.3 | 0.594 | -29.2 | 1.247 | -167.4 | 0.004 | 51.3 | 0.980 | -5.8 |
| 0.4 | 0.533 | -30.7 | 1.370 | -164.1 | 0.005 | 55.8 | 0.965 | -7.5 |
| 0.5 | 0.499 | -31.1 | 1.514 | -162.4 | 0.005 | 60.6 | 0.958 | -8.6 |
| 0.6 | 0.474 | -32.0 | 1.677 | -162.9 | 0.006 | 46.6 | 0.950 | -10.1 |
| 0.7 | 0.460 | -32.7 | 1.885 | -163.8 | 0.006 | 42.9 | 0.941 | -11.2 |
| 0.8 | 0.450 | -34.0 | 2.050 | -166.3 | 0.006 | 45.9 | 0.935 | -12.4 |
| 0.9 | 0.441 | -35.6 | 2.237 | -169.2 | 0.005 | 42.1 | 0.929 | -13.8 |
| 1.0 | 0.438 | -37.7 | 2.460 | -173.1 | 0.007 | 34.0 | 0.918 | -14.9 |
| 1.1 | 0.431 | -39.8 | 2.627 | -177.3 | 0.007 | 46.9 | 0.914 | -16.0 |
| 1.2 | 0.426 | -42.0 | 2.772 | 178.4 | 0.005 | 27.7 | 0.903 | -17.0 |
| 1.3 | 0.427 | -44.8 | 2.965 | 173.2 | 0.005 | 40.2 | 0.895 | -18.3 |
| 1.4 | 0.417 | -48.1 | 3.123 | 168.0 | 0.004 | 24.4 | 0.891 | -19.5 |
| 1.5 | 0.413 | -50.6 | 3.199 | 161.8 | 0.006 | 45.5 | 0.884 | -20.4 |
| 1.6 | 0.408 | -54.6 | 3.351 | 156.8 | 0.005 | 44.6 | 0.877 | -21.1 |
| 1.7 | 0.398 | -57.6 | 3.345 | 151.2 | 0.003 | 42.4 | 0.867 | -22.1 |
| 1.8 | 0.387 | -61.6 | 3.103 | 145.5 | 0.005 | 44.6 | 0.877 | -21.1 |
| 1.9 | 0.380 | -64.9 | 3.361 | 140.9 | 0.005 | 59.5 | 0.859 | -24.4 |
| 2.0 | 0.366 | -69.1 | 3.375 | 136.3 | 0.004 | 45.4 | 0.852 | -25.1 |
| 2.1 | 0.352 | -72.1 | 3.350 | 132.3 | 0.003 | 58.3 | 0.846 | -25.9 |
| 2.2 | 0.341 | -75.6 | 3.304 | 127.9 | 0.003 | 73.9 | 0.847 | -26.4 |
| 2.3 | 0.330 | -79.4 | 3.347 | 124.8 | 0.006 | 81.1 | 0.839 | -27.4 |
| 2.4 | 0.320 | -82.4 | 3.325 | 121.2 | 0.006 | 98.3 | 0.839 | -28.2 |
| 2.5 | 0.304 | -85.6 | 3.275 | 117.3 | 0.006 | 100.5 | 0.838 | -29.1 |
| 2.6 | 0.296 | -88.2 | 3.284 | 113.7 | 0.004 | 114.6 | 0.834 | -29.7 |
| 2.7 | 0.285 | -91.7 | 3.283 | 111.0 | 0.005 | 104.8 | 0.830 | -30.6 |
| 2.8 | 0.272 | -94.3 | 3.224 | 106.5 | 0.005 | 114.1 | 0.831 | -31.4 |
| 2.9 | 0.267 | -96.9 | 3.333 | 104.3 | 0.008 | 127.8 | 0.837 | -32.0 |
| 3.0 | 0.256 | -99.5 | 3.251 | 101.1 | 0.009 | 126.3 | 0.831 | -33.4 |
| 3.1 | 0.248 | -101.9 | 3.381 | 96.0 | 0.008 | 134.1 | 0.833 | -34.0 |

## ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD

### COMPONENT LIST

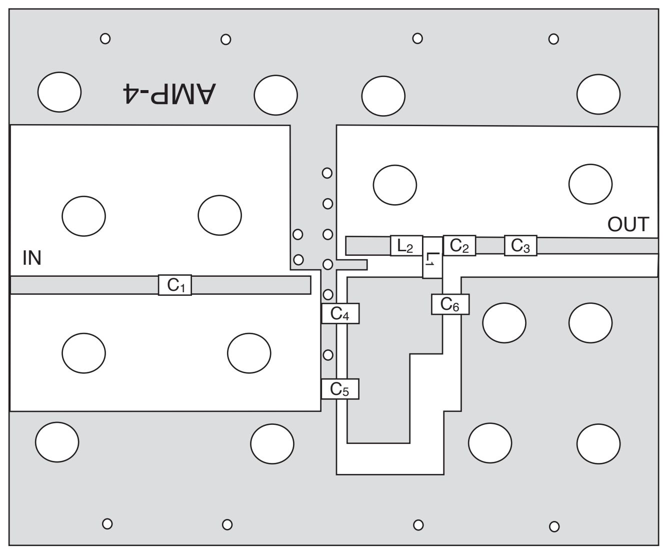
| | 1.0 GHz Output Port Matching |
|---|---|
| $C_1$ | 1000 pF |
| $C_2$ | 0.75 pF |
| $C_3$ | 10 pF |
| $L_1$ | 12 nH |



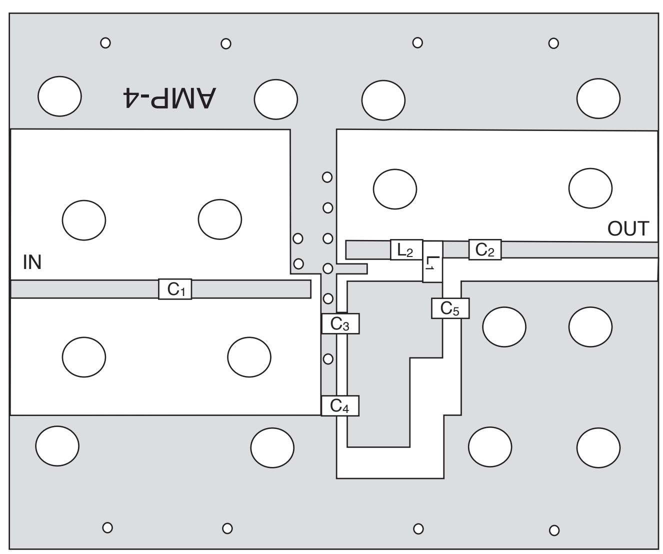

### COMPONENT LIST

| | 1.9GHz Output Port Matching |
|---|---|
| $C_1$, $C_3$, $C_5$, $C_6$ | 1000 pF |
| $C_2$ | 0.75 pF |
| $C_4$ | 10 pF |
| $L_1$ | 3.3 nH |



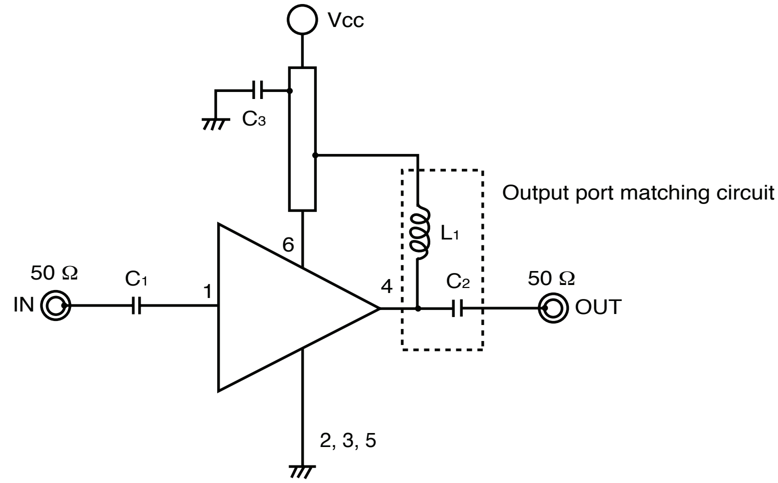

### COMPONENT LIST

| | 2.4 GHz Output Port Matching |
|---|---|
| $C_1$, $C_2$, $C_4$, $C_5$ | 1000 pF |
| $C_3$ | 10 pF |
| $L_1$ | 1.8 nH |
| $L_2$ | 2.7 nH |

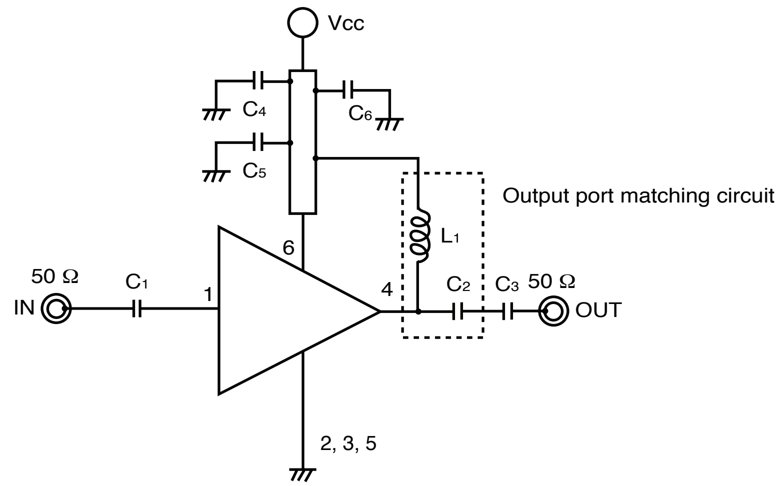


## TEST CIRCUITS

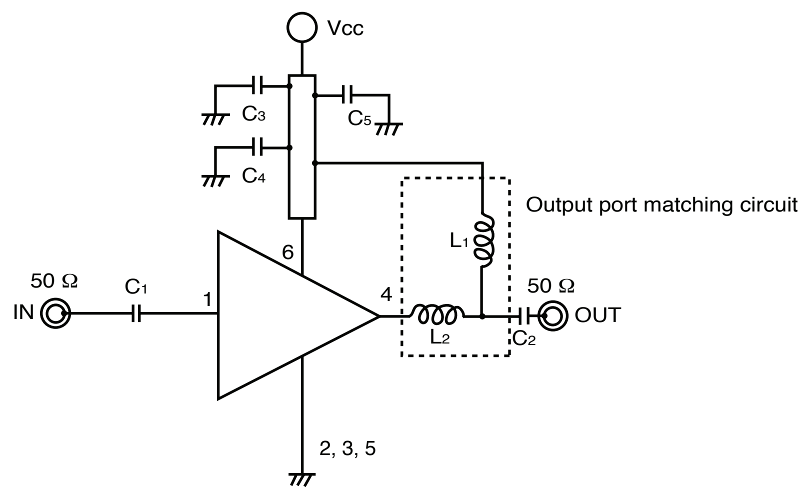
<1> f = 1.0 GHz



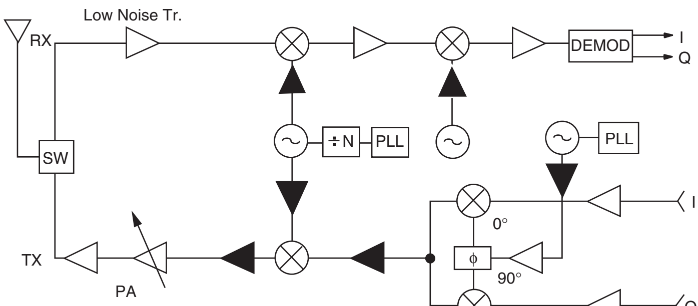

<2> f = 1.9 GHz




<3> f = 2.4 GHz

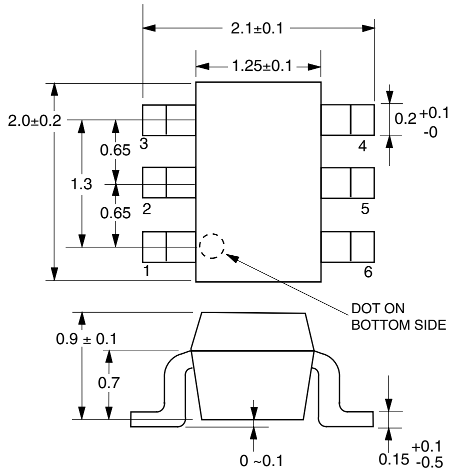


## SYSTEM APPLICATION EXAMPLE



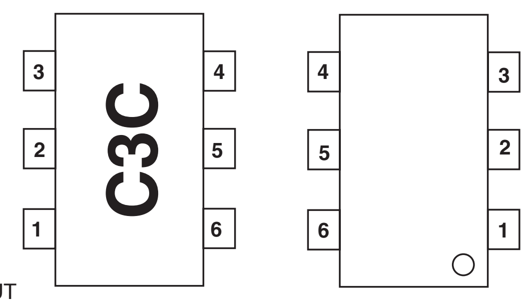

## OUTLINE DIMENSIONS (Units in mm)

**PACKAGE OUTLINE S06**




## LEAD CONNECTIONS

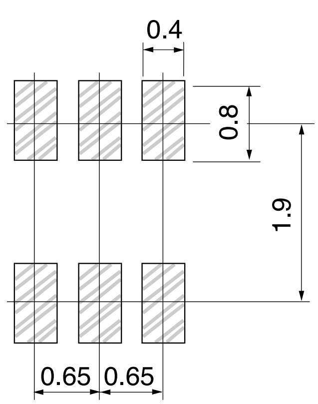
(Top View) (Bottom View)




1. INPUT
2. GND
3. GND
4. OUTPUT
5. GND
6. $V_{CC}$

## RECOMMENDED P.C.B. LAYOUT (Units in mm)

Note:
All dimensions are typical unless otherwise specified.




## ORDERING INFORMATION

| PART NUMBER | QTY |
|---|---|
| UPC8179TB-E3-A | 3K/Reel |

Note:

Embossed tape, 8 mm wide. Pins 1, 2, 3 are in tape pull-out direction.

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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.