



3 V, SILICON MMIC MEDIUM OUTPUT POWER AMPLIFIER FOR MOBILE COMMUNICATIONS

UPC8181TB

FEATURES

- **SUPPLY VOLTAGE:**
VCC = 2.7 to 3.3 V
- **CIRCUIT CURRENT:**
ICC = 23.0 mA TYP at VCC = 3.0 V
- **POWER GAIN:**
GP = 19.0 dB TYP at f = 0.9 GHz
GP = 21.0 dB TYP at f = 1.9 GHz
GP = 22.0 dB TYP at f = 2.4 GHz
- **MEDIUM OUTPUT POWER:**
PO(1dB) = +8.0 dBm TYP at f = 0.9 GHz
PO(1dB) = +7.0 dBm TYP at f = 1.9 GHz
PO(1dB) = +7.0 dBm TYP at f = 2.4 GHz
- **UPPER LIMIT OPERATING FREQUENCY:**
fu = 4.0 GHz TYP at 3 dB bandwidth (Standard value)
- **HIGH-DENSITY SURFACE MOUNTING:**
6-pin super minimold package (2.0 x 1.25 x 0.9 mm)

DESCRIPTION

NEC's UPC8181TB is a silicon Monolithic Microwave Integrated Circuit designed as an amplifier for mobile communications. This IC operates at 3 volts. The medium output power is suitable for RF-TX of mobile communication systems.

This IC is manufactured using NEC's 30 GHz f_{max} 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. This IC has excellent performance, uniformity, and reliability.

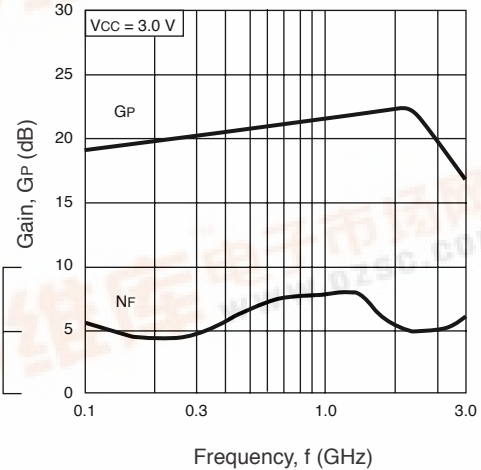
NEC's stringent quality assurance and test procedures ensure the highest reliability and performance.

ELECTRICAL CHARACTERISTICS

(TA = 25°C, VCC = VOUT = 3.0 V, Zs = ZL = 50Ω)

| PART NUMBER PACKAGE OUTLINE | | | UPC8181TB S06 | | |
|--------------------------------|---|-------|----------------------|----------------------|----------------------|
| SYMBOLS | PARAMETERS AND CONDITIONS | UNITS | MIN | TYP | MAX |
| ICC | Circuit Current (no signal) | mA | — | 23.0 | 30.0 |
| GP | Power Gain, f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz | dB | 16.0 18.0 19.0 | 19.0 21.0 22.0 | 22.0 24.0 25.0 |
| NF | Noise Figure, f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz | dB | — — — | 4.5 4.5 4.5 | 6.0 6.0 6.0 |
| fu | Upper Limit Operating Frequency, 3 dB down below from gain at f = 0.1 GHz | GHz | — | 4.0 | — |
| | Isolation, f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz | dB | 28.0 27.0 26.5 | 33.0 32.0 31.5 | — — — |

NOISE FIGURE, POWER GAIN vs. FREQUENCY



APPLICATIONS

- Buffer amplifiers for 1.9 GHz to 2.4 GHz mobile communication systems.

UPC8181TB

ELECTRICAL CHARACTERISTICS (cont.)

(TA = 25°C, VCC = VOUT = 3.0 V, ZS = ZL = 50Ω)

| PART NUMBER PACKAGE OUTLINE | | | UPC8181TB S06 | | |
|--------------------------------|--|-------|----------------------|----------------------|-------------|
| SYMBOLS | PARAMETERS AND CONDITIONS | UNITS | MIN | TYP | MAX |
| PO(1dB) | 1 dB Gain Compression Output Level, f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz | dBm | +5.5 +4.5 +4.5 | +8.0 +7.0 +7.0 | – – – |
| PO(SAT) | Saturated Output Power Level, f = 0.9 GHz, PIN = -5 dBm f = 1.9 GHz, PIN = -5 dBm f = 2.4 GHz, PIN = -5 dBm | dBm | – – – | +9.5 +9.0 +9.0 | – – – |
| RLin | Input Return Loss, f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz | dB | 4.5 7.5 8.0 | 7.5 10.5 11.0 | – – – |
| RLout | Output Return Loss, f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz | dB | 6.0 7.0 9.0 | 9.0 10.0 12.0 | – – – |

ABSOLUTE MAXIMUM RATINGS¹

| SYMBOLS | PARAMETERS | UNITS | RATINGS |
|---------|--------------------------------|-------|-------------|
| VCC | Supply Voltage ² | V | 3.6 |
| ICC | Total Circuit Current | mA | 60 |
| PD | Power Dissipation ³ | mW | 270 |
| TA | Operating Ambient Temperature | °C | -40 to +85 |
| TSTG | Storage Temperature | °C | -55 to +150 |
| PIN | Input Power ⁴ | dBm | +10 |

Notes:

- Operation in excess of any one of these conditions may result in permanent damage.
- TA = 25°C, pins 4 and 6.
- Mounted on a double-sided copper clad 50x50x1.6 mm epoxy glass PWB, TA = +85°C.
- TA = +25 °C

RECOMMENDED OPERATING CONDITIONS

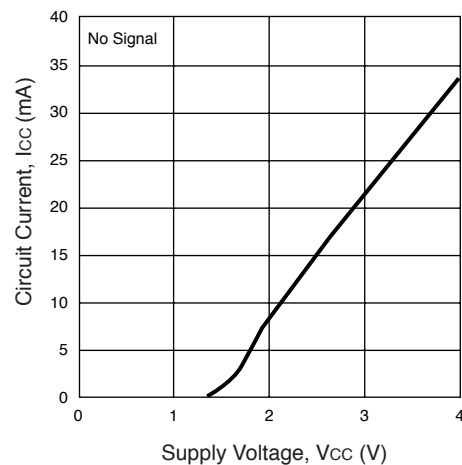
| SYMBOLS | PARAMETERS | UNITS | MIN | TYP | MAX |
|---------|-----------------------------|-------|-----|-----|-----|
| VCC | Supply Voltage ¹ | V | 2.7 | 3.0 | 3.3 |

Note:

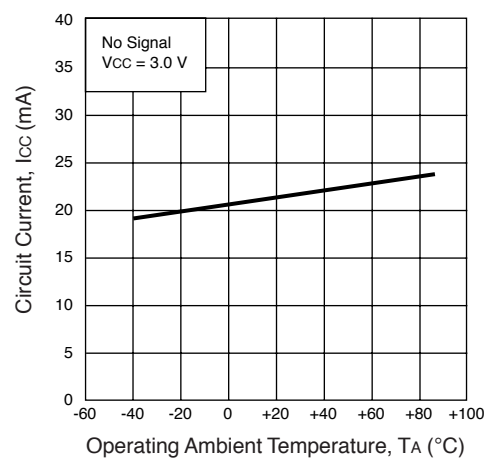
- Same voltage applied to pins 4 and 6

TYPICAL PERFORMANCE CURVES (Unless otherwise specified, TA = 25°C)

CIRCUIT CURRENT vs. SUPPLY VOLTAGE

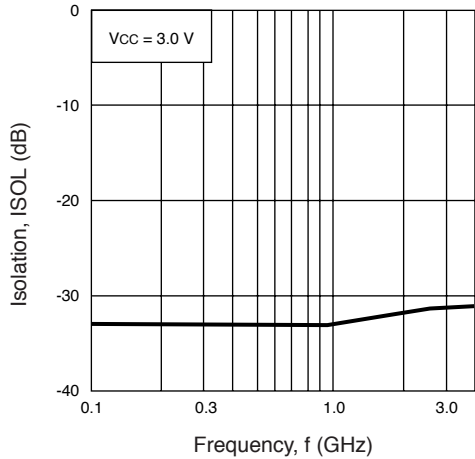


CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE

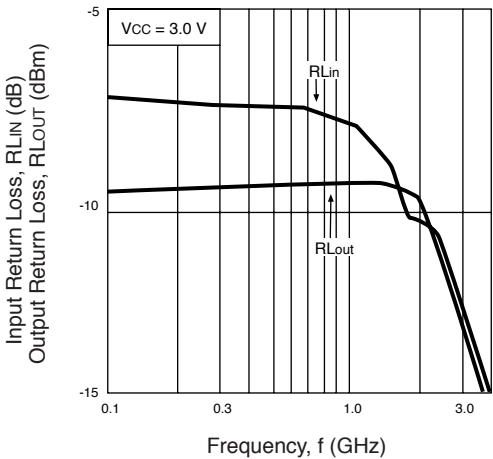


TYPICAL PERFORMANCE CURVES (Unless otherwise specified, $T_A = 25^\circ\text{C}$)

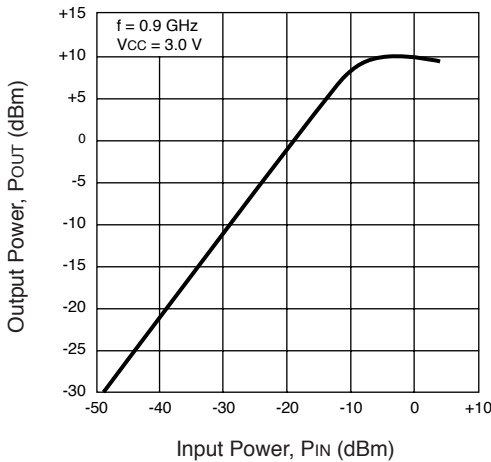
ISOLATION vs. FREQUENCY



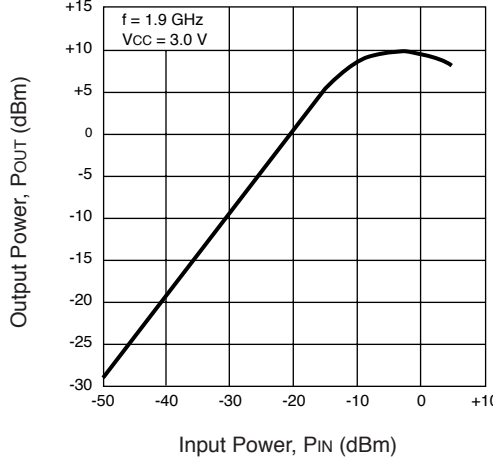
INPUT RETURN LOSS, OUTPUT RETURN LOSS vs. FREQUENCY



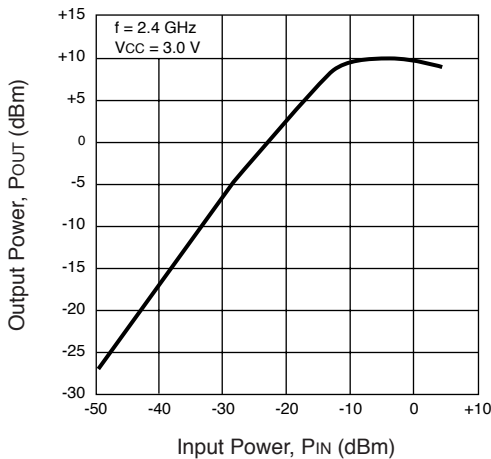
OUTPUT POWER vs. INPUT POWER



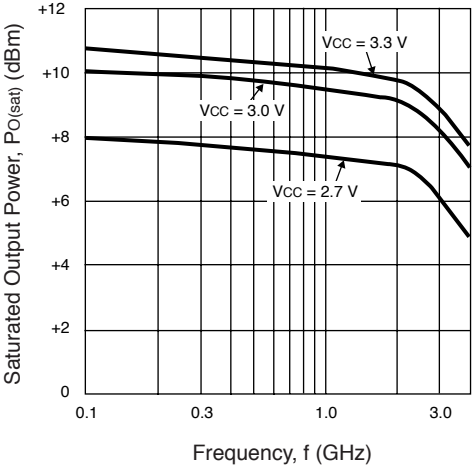
OUTPUT POWER vs. INPUT POWER



OUTPUT POWER vs. INPUT POWER

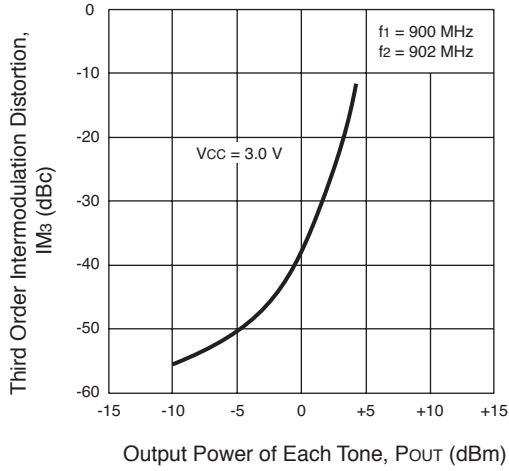


SATURATED OUTPUT POWER vs. FREQUENCY

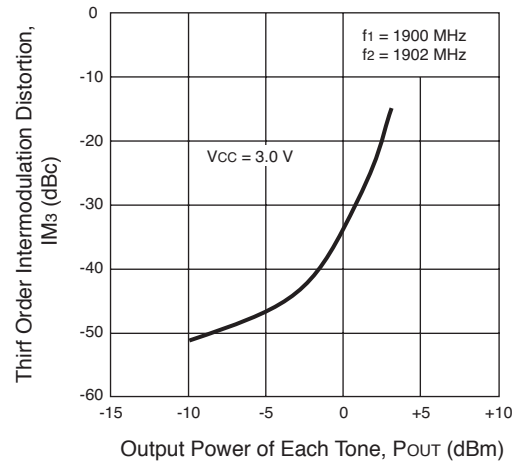


TYPICAL PERFORMANCE CURVES (Unless otherwise specified, $T_A = 25^\circ\text{C}$)

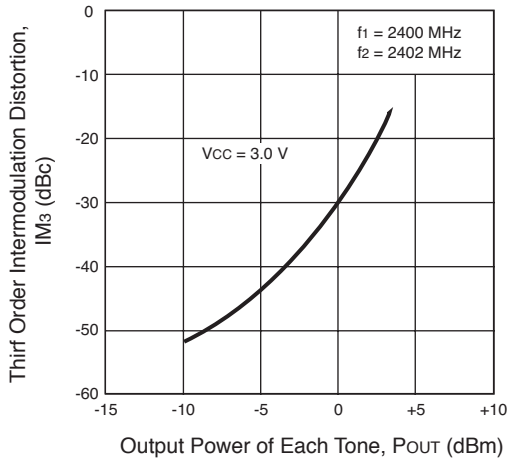
THIRD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE



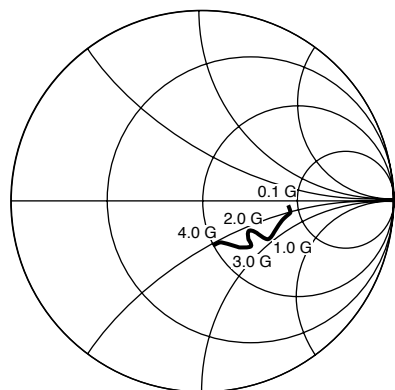
THIRD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE



THIRD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE

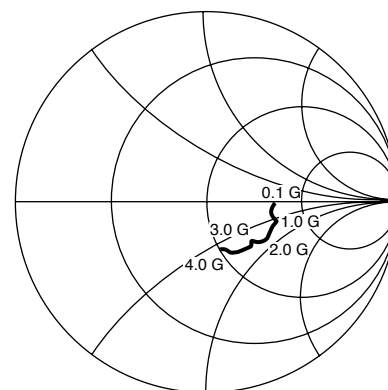


TYPICAL SCATTERING PARAMETERS (TA = 25°C)



S11

Coordinates in Ohms
Frequency in GHz
Vcc = Vout = 3.0 V, Icc = 23



S22

Vcc = Vout = 3.0 V, Icc = 23.0 mA

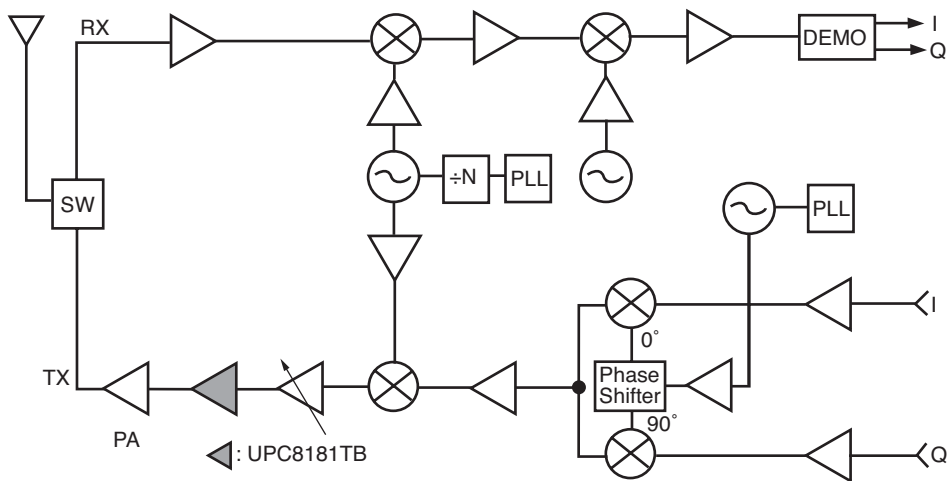
| FREQUENCY GHz | S11 | | S21 | | S12 | | S22 | | K |
|------------------|-------|-------|--------|--------|-------|------|-------|-------|------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | |
| 0.1 | 0.452 | -2.7 | 9.078 | -2.0 | 0.020 | 4.3 | 0.338 | -1.6 | 1.89 |
| 0.2 | 0.467 | -5.7 | 9.098 | -4.9 | 0.021 | 4.2 | 0.346 | -2.1 | 1.73 |
| 0.3 | 0.470 | -7.5 | 9.143 | -6.9 | 0.021 | 8.2 | 0.344 | -1.0 | 1.72 |
| 0.4 | 0.460 | -9.3 | 9.237 | -10.1 | 0.021 | 9.8 | 0.335 | -2.7 | 1.75 |
| 0.5 | 0.438 | -11.5 | 9.284 | -11.9 | 0.021 | 11.4 | 0.328 | -4.8 | 1.84 |
| 0.6 | 0.415 | -14.7 | 9.442 | -14.6 | 0.022 | 8.1 | 0.337 | -7.5 | 1.73 |
| 0.7 | 0.397 | -18.6 | 9.670 | -17.0 | 0.022 | 11.5 | 0.350 | -7.9 | 1.72 |
| 0.8 | 0.395 | -22.4 | 9.897 | -19.7 | 0.022 | 16.3 | 0.354 | -6.8 | 1.69 |
| 0.9 | 0.399 | -25.6 | 10.166 | -22.7 | 0.023 | 14.5 | 0.342 | -6.0 | 1.56 |
| 1.0 | 0.404 | -28.1 | 10.496 | -26.0 | 0.022 | 13.4 | 0.331 | -7.9 | 1.60 |
| 1.1 | 0.396 | -29.0 | 10.903 | -29.0 | 0.023 | 18.0 | 0.332 | -10.8 | 1.48 |
| 1.2 | 0.394 | -28.5 | 11.329 | -32.8 | 0.025 | 16.6 | 0.353 | -13.4 | 1.33 |
| 1.3 | 0.385 | -28.0 | 11.895 | -37.9 | 0.025 | 17.4 | 0.376 | -14.3 | 1.26 |
| 1.4 | 0.368 | -28.8 | 12.145 | -42.4 | 0.024 | 22.0 | 0.374 | -15.0 | 1.28 |
| 1.5 | 0.347 | -29.5 | 12.356 | -47.6 | 0.025 | 24.3 | 0.361 | -16.3 | 1.28 |
| 1.6 | 0.335 | -30.9 | 12.670 | -51.8 | 0.026 | 20.6 | 0.356 | -19.3 | 1.22 |
| 1.7 | 0.327 | -31.5 | 12.966 | -56.4 | 0.024 | 21.4 | 0.356 | -22.0 | 1.29 |
| 1.8 | 0.328 | -31.2 | 13.410 | -61.4 | 0.026 | 23.2 | 0.366 | -23.9 | 1.17 |
| 1.9 | 0.327 | -29.4 | 13.722 | -66.8 | 0.027 | 27.5 | 0.367 | -25.6 | 1.11 |
| 2.0 | 0.325 | -29.4 | 14.151 | -72.3 | 0.026 | 24.6 | 0.369 | -28.5 | 1.11 |
| 2.1 | 0.316 | -28.5 | 14.412 | -78.1 | 0.028 | 26.4 | 0.363 | -31.7 | 1.05 |
| 2.2 | 0.295 | -29.4 | 14.747 | -84.1 | 0.027 | 26.5 | 0.361 | -35.4 | 1.08 |
| 2.3 | 0.288 | -30.8 | 15.144 | -90.3 | 0.029 | 27.5 | 0.359 | -37.1 | 1.02 |
| 2.4 | 0.291 | -34.1 | 15.463 | -97.4 | 0.029 | 27.1 | 0.346 | -39.0 | 1.01 |
| 2.5 | 0.303 | -38.3 | 15.264 | -104.6 | 0.029 | 27.7 | 0.323 | -40.6 | 1.04 |
| 2.6 | 0.317 | -41.1 | 15.137 | -112.6 | 0.028 | 25.5 | 0.303 | -43.1 | 1.09 |
| 2.7 | 0.335 | -41.3 | 14.774 | -119.8 | 0.029 | 25.5 | 0.294 | -43.9 | 1.07 |
| 2.8 | 0.349 | -41.0 | 14.176 | -127.7 | 0.031 | 25.0 | 0.299 | -43.0 | 1.03 |
| 2.9 | 0.347 | -39.4 | 13.710 | -133.7 | 0.029 | 32.9 | 0.304 | -41.3 | 1.09 |
| 3.0 | 0.345 | -43.2 | 12.808 | -139.8 | 0.029 | 24.8 | 0.317 | -44.9 | 1.15 |
| 3.1 | 0.341 | -45.4 | 12.313 | -146.0 | 0.031 | 28.9 | 0.325 | -46.7 | 1.13 |
| 3.2 | 0.331 | -47.9 | 11.587 | -149.3 | 0.029 | 31.6 | 0.318 | -48.7 | 1.25 |
| 3.3 | 0.323 | -49.8 | 11.003 | -154.5 | 0.031 | 31.2 | 0.315 | -52.1 | 1.27 |
| 3.4 | 0.311 | -52.1 | 10.638 | -157.7 | 0.031 | 29.5 | 0.307 | -56.1 | 1.32 |
| 3.5 | 0.302 | -52.6 | 10.228 | -162.0 | 0.029 | 32.5 | 0.302 | -60.0 | 1.44 |
| 3.6 | 0.289 | -54.9 | 9.985 | -166.5 | 0.030 | 31.4 | 0.303 | -63.7 | 1.47 |
| 3.7 | 0.266 | -56.5 | 9.543 | -170.1 | 0.030 | 39.6 | 0.301 | -65.1 | 1.54 |
| 3.8 | 0.253 | -61.5 | 9.184 | -174.5 | 0.031 | 34.1 | 0.294 | -67.5 | 1.55 |
| 3.9 | 0.238 | -65.6 | 8.816 | -177.7 | 0.030 | 36.2 | 0.275 | -68.8 | 1.71 |
| 4.0 | 0.238 | -70.7 | 8.488 | 178.2 | 0.032 | 38.9 | 0.270 | -71.0 | 1.70 |
| 4.1 | 0.244 | -74.0 | 8.186 | 174.3 | 0.032 | 37.0 | 0.266 | -75.1 | 1.75 |

UPC8181TB

PIN FUNCTIONS (Pin Voltage is measured at $V_{CC} = 3.0\text{ V}$)

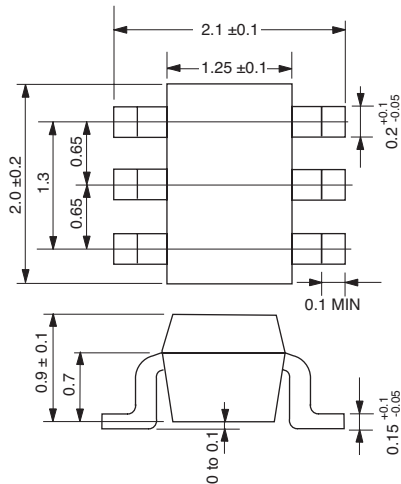
| Pin No. | Pin Name | Applied Voltage | Pin Voltage | Description | Equivalent Circuit |
|-------------|----------|---|-------------|---|--------------------|
| 1 | INPUT | — | 0.99 | Signal input pin. An internal matching circuit, configured with resistors, enables $50\ \Omega$ connection over a wide band. A multi-feedback circuit is designed to cancel the deviations of h_{FE} and resistance. This pin must be coupled to signal source with capacitor for DC cut. | |
| 2 3 5 | GND | 0 | — | GND 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 | Voltage as same as V_{CC} through external inductor | — | Signal output pin. The inductor must be attached between V_{CC} and output pins to supply current to the internal output transistors. | |
| 6 | V_{CC} | 2.7 to 3.3 | — | Power supply pin, which biases the internal input transistor. This pin should be externally equipped with bypass capacitor to minimize its impedance. | |

APPLICATION EXAMPLE (Digital Cellular Telephone)



OUTLINE DIMENSIONS (Units in mm)

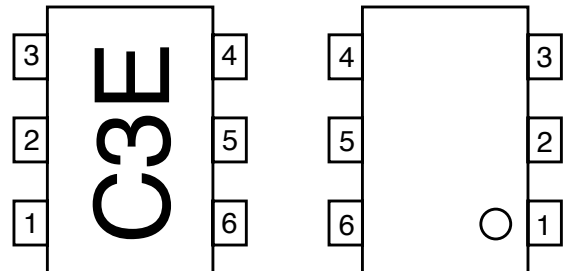
6-PIN SUPER MINIMOLD



LEAD CONNECTIONS

(Top View)

(Bottom View)



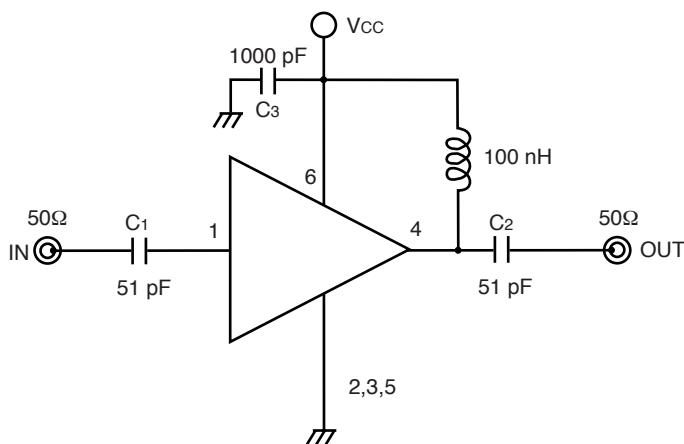
1. INPUT
2. GND
3. GND
4. OUTPUT
5. GND
6. Vcc

ORDERING INFORMATION

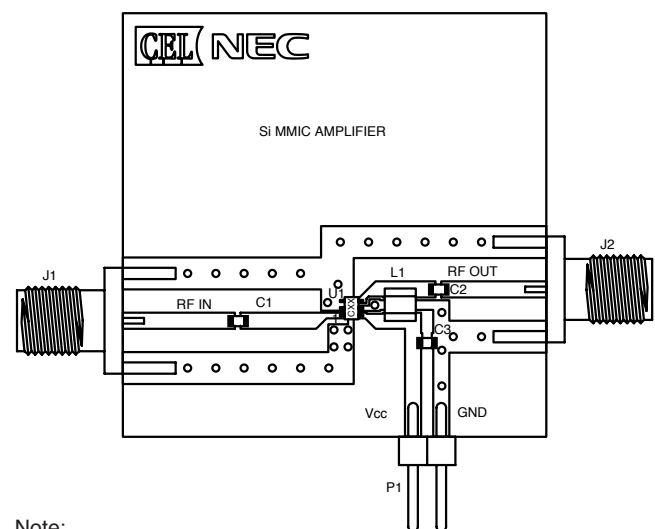
| PART NUMBER | PACKAGE | QUANTITY |
|----------------|----------------------|------------|
| UPC8181TB-E3-A | 6-pin super minimold | 3kpcs/Reel |

Note: Embossed tape 8 mm wide. Pins 1,2,3 face tape perforation side.

TEST CIRCUIT



APPLICATION BOARD



Note:

1. double sided copper clad GETEK board (H = .028, $\epsilon_r = 4.2$.)
2. Back side: GND pattern.
3. Solder plated on patterns.
4. o O : Through holes.

Life Support Applications

These NEC products are not intended for use in life support devices, appliances, or systems where the malfunction of these products can reasonably be expected to result in personal injury. The customers of CEL using or selling these products for use in such applications do so at their own risk and agree to fully indemnify CEL for all damages resulting from such improper use or sale.

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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 | |

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