



# SILICON RFIC LOW CURRENT AMPLIFIER FOR MOBILE COMMUNICATIONS

## UPC8178TB

### FEATURES

- **LOW CURRENT CONSUMPTION**  
 $I_{CC} = 1.9 \text{ mA TYP @ } V_{CC} = 3.0 \text{ V}$
- **SUPPLY VOLTAGE:**  
 $V_{CC} = 2.4 \text{ to } 3.3 \text{ V}$
- **EXCELLENT ISOLATION:**  
 $ISOL = 39 \text{ dB TYP @ } f = 1.0 \text{ GHz}$   
 $ISOL = 40 \text{ dB TYP @ } f = 1.9 \text{ GHz}$   
 $ISOL = 38 \text{ dB TYP @ } f = 2.4 \text{ GHz}$
- **POWER GAIN:**  
 $GP = 11.0 \text{ dB TYP @ } f = 1.0 \text{ GHz}$   
 $GP = 11.5 \text{ dB TYP @ } f = 1.9 \text{ GHz}$   
 $GP = 11.5 \text{ dB TYP @ } f = 2.4 \text{ GHz}$
- **OPERATING FREQUENCY:**  
 $0.1 \text{ to } 2.4 \text{ GHz}$  (Output port LC matching)
- **1 dB GAIN COMPRESSION OUTPUT POWER:**  
 $PO(1 \text{ dB}) = -4.0 \text{ dBm TYP @ } f = 1.0 \text{ GHz}$   
 $PO(1 \text{ dB}) = -7.0 \text{ dBm TYP @ } f = 1.9 \text{ GHz}$   
 $PO(1 \text{ dB}) = -7.5 \text{ dBm TYP @ } f = 2.4 \text{ GHz}$
- **HIGH-DENSITY SURFACE MOUNTING:**  
6-pin super minimold package ( $2.0 \times 1.25 \times 0.9 \text{ mm}$ )
- **LOW WEIGHT:**  
7 mg (Standard Value)

### APPLICATIONS

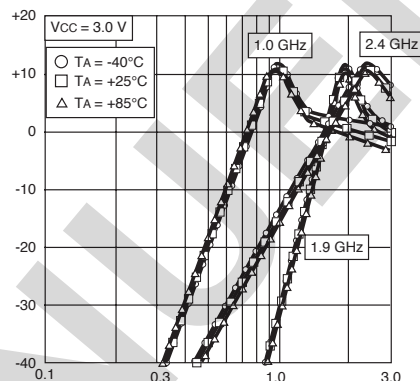
- Buffer Amplifiers on 0.1 to 2.4 GHz mobile communications system

### ELECTRICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$ ,  $V_{CC} = V_{OUT} = 3.0 \text{ V}$ ,  $Z_S = Z_L = 50 \Omega$ , at LC matched frequency unless otherwise specified))

| PART NUMBER<br>PACKAGE OUTLINE |                                        |             |             | UPC8178TB<br>S06 |       |      |      |
|--------------------------------|----------------------------------------|-------------|-------------|------------------|-------|------|------|
| SYMBOLS                        | PARAMETERS AND CONDITIONS <sup>1</sup> |             |             | UNITS            | MIN   | TYP  | MAX  |
| I <sub>CC</sub>                | Circuit Current (no signal)            |             |             | mA               | 1.4   | 1.9  | 2.4  |
| GP                             | Power Gain                             | f = 1.0 GHz |             | dB               | 9.0   | 11.0 | 13.0 |
|                                |                                        | f = 1.9 GHz |             | dB               | 9.0   | 11.5 | 13.5 |
|                                |                                        | f = 2.4 GHz |             | dB               | 9.0   | 11.5 | 13.5 |
| ISOL                           | Isolation                              | f = 1.0 GHz |             | dB               | 34    | 39   | —    |
|                                |                                        | f = 1.9 GHz |             | dB               | 35    | 40   | —    |
|                                |                                        | f = 2.4 GHz |             | dB               | 33    | 38   | —    |
| PO(1dB)                        | 1 dB Gain Compression Output Power     |             | f = 1.0 GHz | dBm              | -8.0  | -4.0 | —    |
|                                |                                        |             | f = 1.9 GHz | dBm              | -11.0 | -7.0 | —    |
|                                |                                        |             | f = 2.4 GHz | dBm              | -11.5 | -7.5 | —    |
| NF                             | Noise Figure                           | f = 1.0 GHz |             | dB               | —     | 5.5  | 7.0  |
|                                |                                        | f = 1.9 GHz |             | dB               | —     | 5.5  | 7.0  |
|                                |                                        | f = 2.4 GHz |             | dB               | —     | 5.5  | 7.0  |
| RLin                           | Input Return Loss                      | f = 1.0 GHz |             | dB               | 4     | 7    | —    |
|                                |                                        | f = 1.9 GHz |             | dB               | 5     | 8    | —    |
|                                |                                        | f = 2.4 GHz |             | dB               | 6.5   | 9.5  | —    |

POWER GAIN vs. FREQUENCY



### DESCRIPTION

The UPC8178TB is a silicon monolithic integrated circuit designed as an amplifier for mobile communications. This IC can realize low current consumption with an external chip inductor which cannot be realized on an internal  $50 \Omega$  wideband matched IC. This low current amplifier operates on 3.0 V. This device is manufactured using NEC's 30 GHz  $f_{max}$  UHS0 (Ultra High Speed Process) silicon bipolar process which 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 excellent performance, uniformity and reliability.

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

ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

(TA = +25°C unless otherwise specified)

| SYMBOLS | PARAMETERS                     | UNITS | RATINGS     |
|---------|--------------------------------|-------|-------------|
| Vcc     | Supply Voltage <sup>2</sup>    | V     | 3.6         |
| Icc     | Circuit Current                | mA    | 15          |
| PD      | Power Dissipation <sup>3</sup> | mW    | 270         |
| TA      | Operating Ambient Temperature  | °C    | -40 to +85  |
| TSTG    | Storage Temperature            | °C    | -55 to +150 |
| PIN     | Input Power                    | dBm   | +5          |

Notes:

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

RECOMMENDED  
OPERATING CONDITIONS

| SYMBOLS | PARAMETERS                    | UNITS | MIN | TYP | MAX |
|---------|-------------------------------|-------|-----|-----|-----|
| Vcc     | Supply Voltage <sup>1</sup>   | V     | 2.4 | 3.0 | 3.3 |
| TA      | Operating Ambient Temperature | °C    | -40 | +25 | +85 |

Note:

- Same voltage applied to pins 4 and 6.

SERIES PRODUCTS<sup>1</sup> (TA = +25°C, VCC = Vout = 3.0 V, ZS = ZL = 50 Ω)

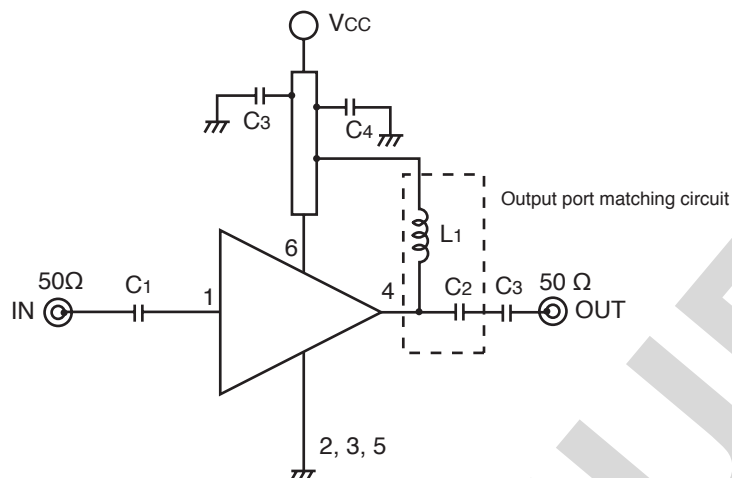
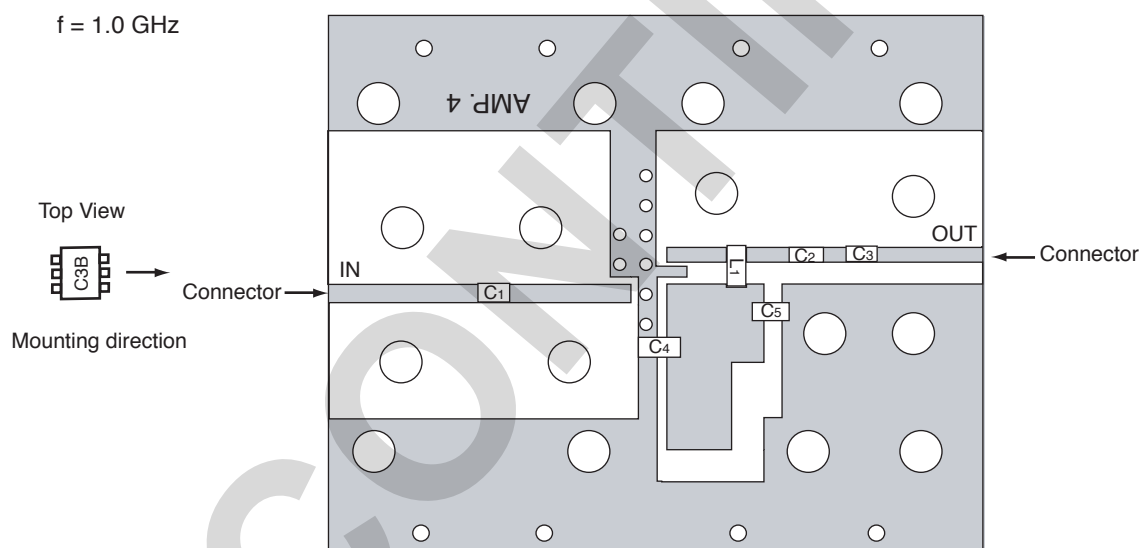
| Parameter<br><br>Part No. | Icc<br>(mA) | 1.0 GHz output port<br>matching frequency |              |                   | 1.66 GHz output port<br>matching frequency |              |                   | 1.9 GHz output port<br>matching frequency |              |                   | 2.4 GHz output port<br>matching frequency |              |                   | Marking |
|---------------------------|-------------|-------------------------------------------|--------------|-------------------|--------------------------------------------|--------------|-------------------|-------------------------------------------|--------------|-------------------|-------------------------------------------|--------------|-------------------|---------|
|                           |             | GP<br>(dB)                                | ISOL<br>(dB) | PO(1 dB)<br>(dBm) | GP<br>(dB)                                 | ISOL<br>(dB) | PO(1 dB)<br>(dBm) | GP<br>(dB)                                | ISOL<br>(dB) | PO(1 dB)<br>(dBm) | GP<br>(dB)                                | ISOL<br>(dB) | PO(1 dB)<br>(dBm) |         |
| UPC8178TB                 | 1.9         | 11                                        | 39           | -4.0              | —                                          | —            | —                 | 11.5                                      | 40           | -7.0              | 11.5                                      | 38           | -7.5              | C3B     |
| UPC8179TB                 | 4.0         | 13.5                                      | 44           | +3.0              | —                                          | —            | —                 | 15.5                                      | 42           | +1.5              | 15.5                                      | 41           | +1.0              | C3C     |
| UPC8128TB                 | 2.8         | 12.5                                      | 39           | -4.0              | 13                                         | 39           | -4.0              | 13                                        | 37           | -4.0              | —                                         | —            | —                 | C2P     |
| UPC8151TB                 | 4.2         | 12.5                                      | 38           | +2.5              | 15                                         | 36           | +1.5              | 15                                        | 34           | +0.5              | —                                         | —            | —                 | C2U     |
| UPC8152TB                 | 5.6         | 23                                        | 40           | -4.5              | 19.5                                       | 38           | -8.5              | 17.5                                      | 35           | -8.5              | —                                         | —            | —                 | C2V     |

Note:

- Typical performance.

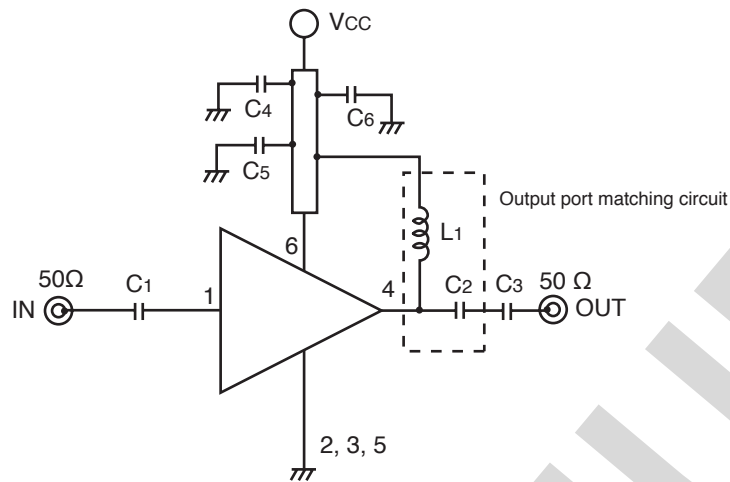
PIN FUNCTIONS (Pin Voltage is measured at Vcc = 3.0 V)

| Pin No.     | Pin Name | Applied Voltage (V)                           | Pin Voltage (V) | Function and Applications                                                                                                                                                                                                                                            | Internal Equivalent Circuit |
|-------------|----------|-----------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| 1           | Input    | —                                             | 0.91            | Signal input pin. An internal matching circuit, configured with resistors, enables a 50 Ω connection over a wide band. This pin must be coupled to the signal source with the capacitor for DC out.                                                                  |                             |
| 2<br>3<br>5 | GND      | 0                                             | —               | 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 a wide ground pattern to decrease impedance difference. |                             |
| 4           | Output   | Voltage same as Vcc through external inductor | —               | Signal output pin. This pin is designed as the collector output. Due to the high impedance output, this pin should be externally equipped with LC matching circuit to next stage. For L, a size 1005 chip inductor can be used.                                      |                             |
| 6           | Vcc      | 2.4 to 3.3                                    | —               | Power supply pin. This pin should be externally equipped with a bypass capacitor to minimize its impedance.                                                                                                                                                          |                             |

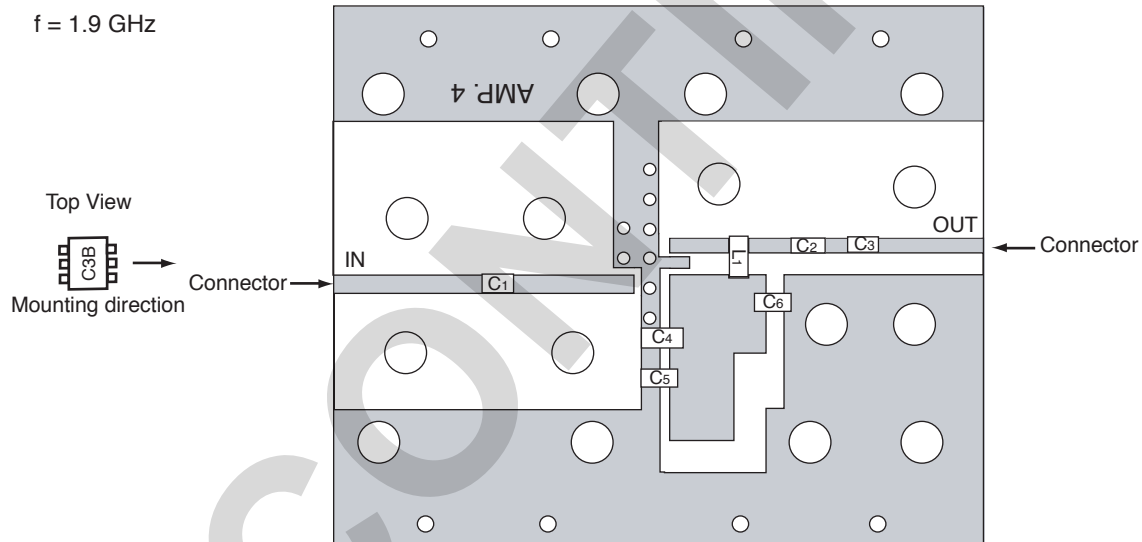
**TEST CIRCUIT 1** ( $f = 1.0 \text{ GHz}$ )**EXAMPLE OF TEST CIRCUIT 1 ASSEMBLED ON EVALUATION BOARD****COMPONENT LIST**

|            | 1.0 GHz Output Port Matching |
|------------|------------------------------|
| C1, C3, C5 | 1000 pF                      |
| C2         | 0.75 pF                      |
| C4         | 10 pF                        |
| L1         | 12 nH                        |

TEST CIRCUIT 2 (f = 1.9 GHz)



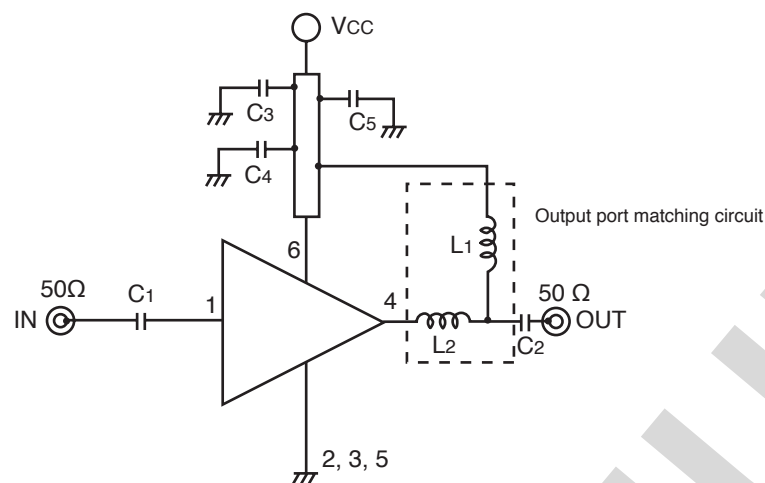
EXAMPLE OF TEST CIRCUIT 2 ASSEMBLED ON EVALUATION BOARD



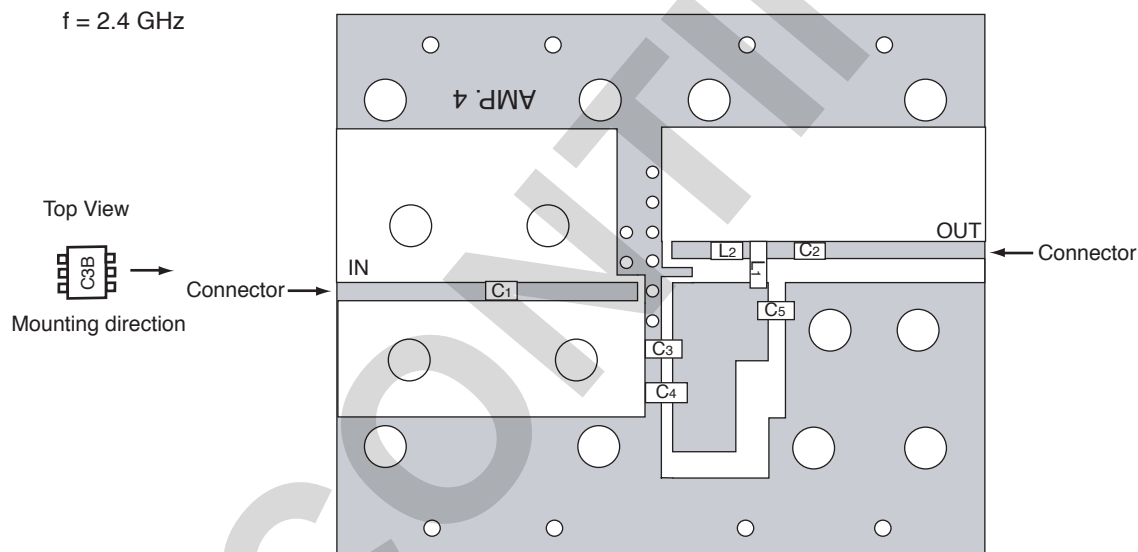
COMPONENT LIST

|                | 1.9 GHz Output Port Matching |
|----------------|------------------------------|
| C1, C3, C5, C6 | 1000 pF                      |
| C2             | 0.5 pF                       |
| C4             | 10 pF                        |
| L1             | 3.9 nH                       |

TEST CIRCUIT 3 (f = 2.4 GHz)



EXAMPLE OF TEST CIRCUIT 3 ASSEMBLED ON EVALUATION BOARD

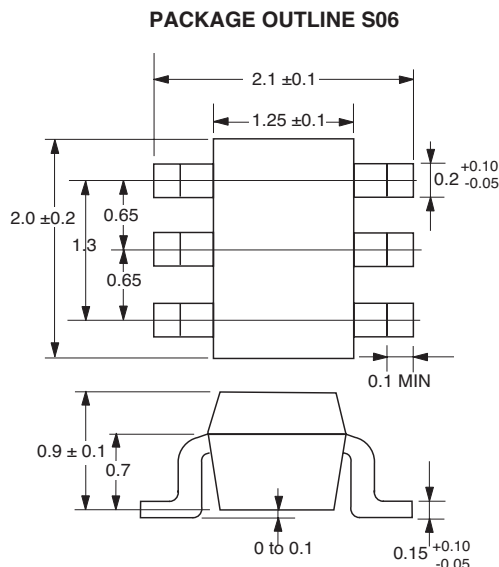


COMPONENT LIST

|                | 2.4 GHz Output Port Matching |
|----------------|------------------------------|
| C1, C3, C4, C5 | 1000 pF                      |
| C3             | 10 pF                        |
| L1             | 1.8 nH                       |
| L2             | 2.7 nH                       |

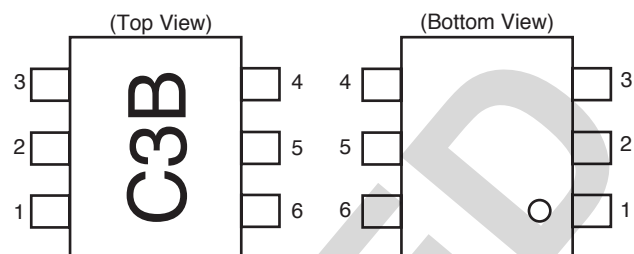
- NOTES:
1. 42 x 35 x 0.4 mm double sided copper clad polyimide board.
  2. Solder plated on pattern.
  3. Back side: GND pattern.
  4. ○ Through holes.

## OUTLINE DIMENSIONS (Units in mm)



Note:  
All dimensions are typical unless otherwise specified.

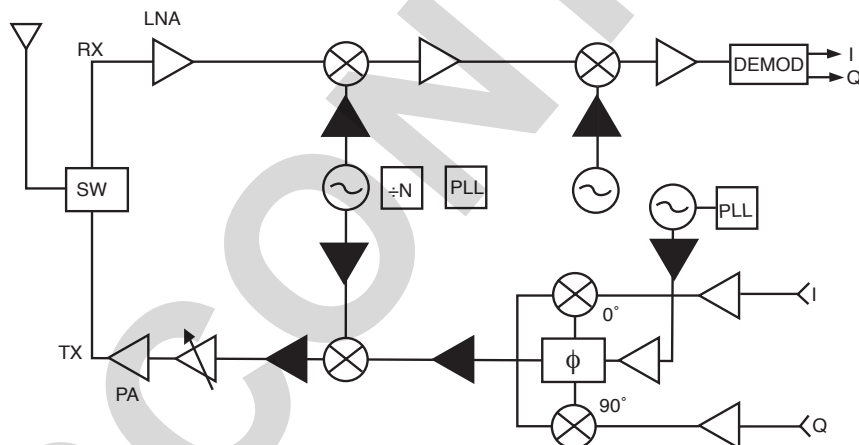
## PIN CONNECTIONS



| PIN NO. | PIN NAME |
|---------|----------|
| 1       | Input    |
| 2       | GND      |
| 3       | GND      |
| 4       | Output   |
| 5       | GND      |
| 6       | Vcc      |

## SYSTEM APPLICATION EXAMPLE

### Location examples in digital cellular



## ORDERING INFORMATION

| Part Number    | Quantity     |
|----------------|--------------|
| UPC8178TB-E3-A | 3 K pcs/reel |

### 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.

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

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06/20/2001

Subject: Compliance with EU Directives

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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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