



# NEC's NPN SiGe RF IC IN A 8-PIN LEAD-LESS MINIMOLD

## UPA901TU

### FEATURES

- **OUTPUT POWER:**  
 $P_{out} = 19 \text{ dBm}$  @  $P_{in} = -3 \text{ dBm}$ ,  $V_{CE} = 3.6 \text{ V}$ ,  $f = 5.8 \text{ GHz}$
- **LOW POWER:**  
 $I_C = 90 \text{ mA}$  @  $P_{in} = -3 \text{ dBm}$ ,  $V_{CE} = 3.6 \text{ V}$ ,  $f = 5.8 \text{ GHz}$
- **SINGLE POWER SUPPLY OPERATION:**  
 $V_{CE} = 3.6 \text{ V}$
- **BUILT-IN BIAS CIRCUIT**
- **8-PIN LEAD-LESS MINIMOLD:**  
( $2.0 \times 2.2 \times 0.5 \text{ mm}$ )

### DESCRIPTION

NEC's UPA901TU is a silicon germanium HBT IC designed for the power amplifier of 5.8 GHz cordless phone and other 5.8 GHz applications. This IC consists of two stage amplifiers and has excellent performance, high efficiency, high gain, low power consumption.

NEC's UPA901TU is packaged in surface mount 8-pin lead-less minimold plastic package.

This device is fabricated with our SiGe HBT process UHS2-HV technology.

### APPLICATIONS

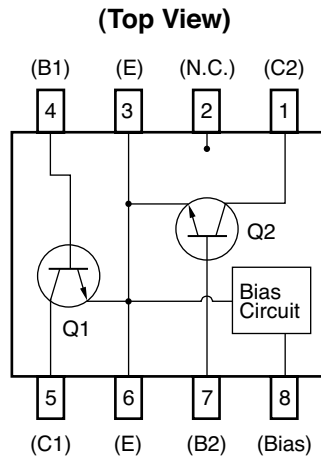
- 5.8 GHz Cordless Phones
- 5.8 GHz Band DSRC (Dedicated Short Range Communication) System
- 5 GHz Band Video Transmitter

### ORDERING INFORMATION

| PART NUMBER | ORDER NUMBER  | QUANTITY          | PACKAGE                               | MARKING | SUPPLYING FORM                                       |
|-------------|---------------|-------------------|---------------------------------------|---------|--|
| UPA901TU    | UPA901TU-A    | 50 pcs (Non reel) | 8-pin lead-less<br>minimold( Pb-Free) | A901    | • 8 mm wide embossed taping                          |
| UPA901TU-T3 | UPA901TU-T3-A | 5 kpcs/reel       |                                       |         | • Pin 1, Pin 8 face the perforation side of the tape |

**Remark** To order evaluation samples, contact your nearby sales office.  
The unit sample quantity is 50 pcs.

**PIN CONNECTIONS AND INTERNAL BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS** ( $T_A = +25^\circ\text{C}$ )

| PARAMETER                     | SYMBOL                    | RATINGS     | UNIT             |
|-------------------------------|---------------------------|-------------|------------------|
| Collector to Base Voltage     | $V_{CBO}$                 | 15          | V                |
| Collector to Emitter Voltage  | $V_{CEO}$                 | 4.5         | V                |
| Emitter to Base Voltage       | $V_{EBO}$                 | 2           | V                |
| Collector Current of Q1       | $I_{C1}$                  | 75          | mA               |
| Collector Current of Q2       | $I_{C2}$                  | 250         | mA               |
| Bias Current                  | $I_{BIAS}$                | 25          | mA               |
| Total Power Dissipation       | $P_{tot}$ <sup>Note</sup> | 410         | mW               |
| Junction Temperature          | $T_j$                     | 150         | $^\circ\text{C}$ |
| Storage Temperature           | $T_{stg}$                 | -65 to +150 | $^\circ\text{C}$ |
| Operating Ambient Temperature | $T_A$                     | -40 to +85  | $^\circ\text{C}$ |

**Note** Mounted on 20 × 20 × 0.8 mm (t) glass epoxy PCB (FR-4)

**THERMAL RESISTANCE** ( $T_A = +25^\circ\text{C}$ )

| PARAMETER                     | SYMBOL                         | TEST CONDITIONS | RATINGS | UNIT               |
|-------------------------------|--------------------------------|-----------------|---------|--------------------|
| Channel to Ambient Resistance | $R_{th(j-a1)}$ <sup>Note</sup> |                 | 150     | $^\circ\text{C/W}$ |
|                               | $R_{th(j-a2)}$                 | Free Air        | TBD     | $^\circ\text{C/W}$ |

**Note** Mounted on 20 × 20 × 0.8 mm (t) glass epoxy PCB (FR-4)

**RECOMMENDED OPERATING RANGE** (All Parameters)

| PARAMETER                    | SYMBOL      | MIN. | TYP. | MAX. | UNIT |
|------------------------------|-------------|------|------|------|------|
| Collector to Emitter Voltage | $V_{CE}$    | -    | 3.6  | 4.5  | V    |
| Total Current                | $I_{total}$ | -    | 90   | 300  | mA   |
| Input Power                  | $P_{in}$    | -    | -3   | +5   | dBm  |

**ELECTRICAL CHARACTERISTICS** ( $T_A = +25^\circ\text{C}$ )

**-DC CHARACTERISTICS-**

**(1) Q1**

| PARAMETER   | SYMBOL                       | TEST CONDITIONS   | MIN. | TYP. | MAX. | UNIT |
|---|------------------------------|---|------|------|------|------|
| Collector Cut-off Current                         | $I_{CBO}$                    | $V_{CB} = 5\text{ V}, I_E = 0\text{ mA}$                    | –    | –    | 60   | nA   |
| Emitter Cut-off Current                           | $I_{EBO}$                    | $V_{EB} = 1\text{ V}, I_C = 0\text{ mA}$                    | –    | –    | 120  | nA   |
| DC Current Gain                                   | $h_{FE}$ <small>Note</small> | $V_{CE} = 3\text{ V}, I_C = 6\text{ mA}$                    | 80   | 120  | 160  | –    |
| Current Ratio ( $I_{C(\text{set } 1)}/I_{BIAS}$ ) | CR1                          | $V_{CE} = 3.6\text{ V}, V_{BE} = V_{BIAS} = 0.865\text{ V}$ | 2    | 4.5  | 9    | –    |

**(2) Q2**

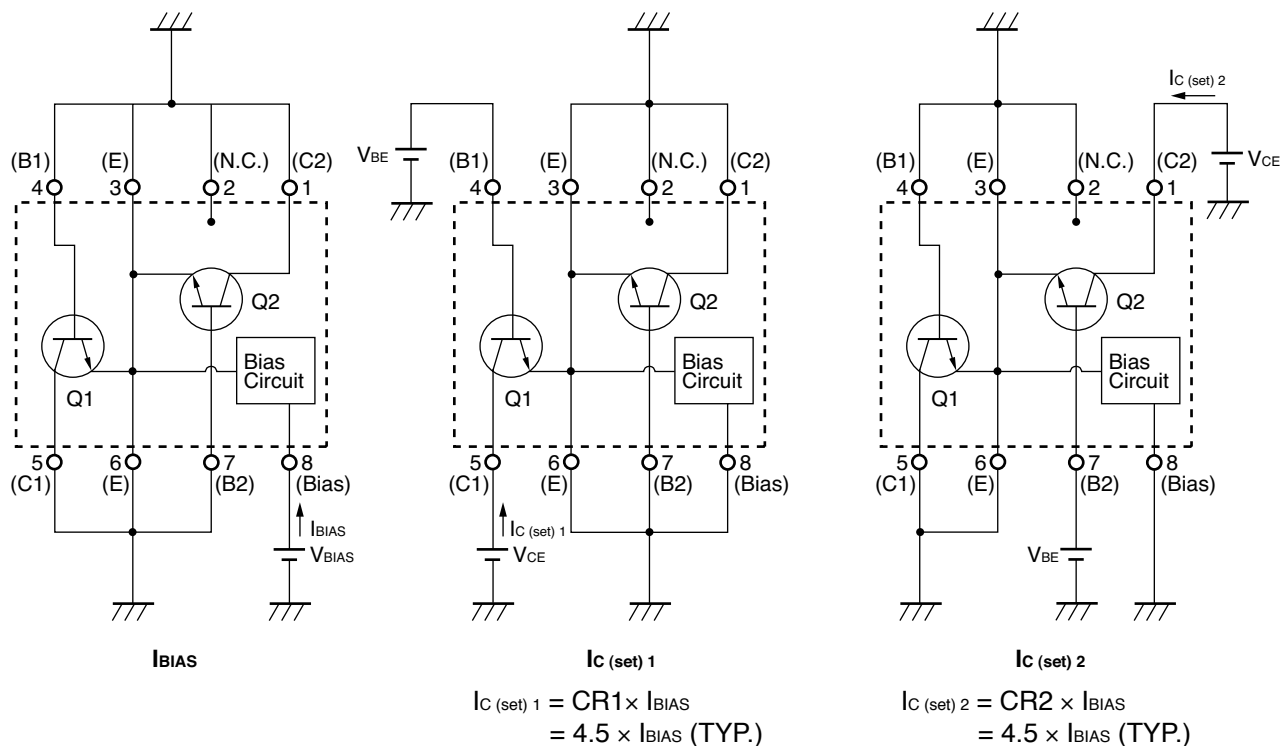
| PARAMETER   | SYMBOL                       | TEST CONDITIONS   | MIN. | TYP. | MAX. | UNIT |
|---|------------------------------|---|------|------|------|------|
| Collector Cut-off Current                         | $I_{CBO}$                    | $V_{CB} = 5\text{ V}, I_E = 0\text{ mA}$                    | –    | –    | 200  | nA   |
| Emitter Cut-off Current                           | $I_{EBO}$                    | $V_{EB} = 1\text{ V}, I_C = 0\text{ mA}$                    | –    | –    | 400  | nA   |
| DC Current Gain                                   | $h_{FE}$ <small>Note</small> | $V_{CE} = 3\text{ V}, I_C = 20\text{ mA}$                   | 80   | 120  | 160  | –    |
| Current Ratio ( $I_{C(\text{set } 2)}/I_{BIAS}$ ) | CR2                          | $V_{CE} = 3.6\text{ V}, V_{BE} = V_{BIAS} = 0.865\text{ V}$ | 8    | 10   | 13   | –    |

**(3) Bias Circuit**

| PARAMETER            | SYMBOL     | TEST CONDITIONS             | MIN. | TYP. | MAX. | UNIT |
|----------------------|------------|-----------------------------|------|------|------|------|
| Bias Circuit Current | $I_{BIAS}$ | $V_{BIAS} = 0.865\text{ V}$ | –    | 4    | –    | mA   |

**Note** Pulse measurement:  $PW \leq 350\ \mu\text{s}$ , Duty Cycle  $\leq 2\%$

**$I_{BIAS}$ ,  $I_{C(\text{set } 1)}$ ,  $I_{C(\text{set } 2)}$  MEASUREMENT CIRCUIT**



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

**ELECTRICAL CHARACTERISTICS** ( $T_A = +25^\circ\text{C}$ )**-RF CHARACTERISTICS-****(1) Q1**

| PARAMETER                         | SYMBOL        | TEST CONDITIONS  | MIN. | TYP. | MAX. | UNIT |
|-----------------------------------|---------------|--|------|------|------|------|
| Insertion Power Gain (Q1)         | $ S_{21e} ^2$ | $V_{CE} = 3.6\text{ V}$ , $I_C = 12\text{ mA}$ , $f = 5.8\text{ GHz}$                                      | 8.5  | 10.0 | 11.5 | dB   |
| Maximum Available Power Gain (Q1) | MAG1          | $V_{CE} = 3.6\text{ V}$ , $I_C = 12\text{ mA}$ , $f = 5.8\text{ GHz}$                                      | 13.5 | 15.0 | –    | dB   |
| Output Power (Q1)                 | $P_{out1}$    | $V_{CE} = 3.6\text{ V}$ , $I_{C(set)} = 12\text{ mA}$ ,<br>$f = 5.8\text{ GHz}$ , $P_{in} = -3\text{ dBm}$ | 10.2 | 11.2 | –    | dBm  |
| Collector Current (Q1)            | $I_{CC1}$     | $V_{CE} = 3.6\text{ V}$ , $I_{C(set)} = 12\text{ mA}$ ,<br>$f = 5.8\text{ GHz}$ , $P_{in} = -3\text{ dBm}$ | –    | 20   | –    | mA   |

**(2) Q2**

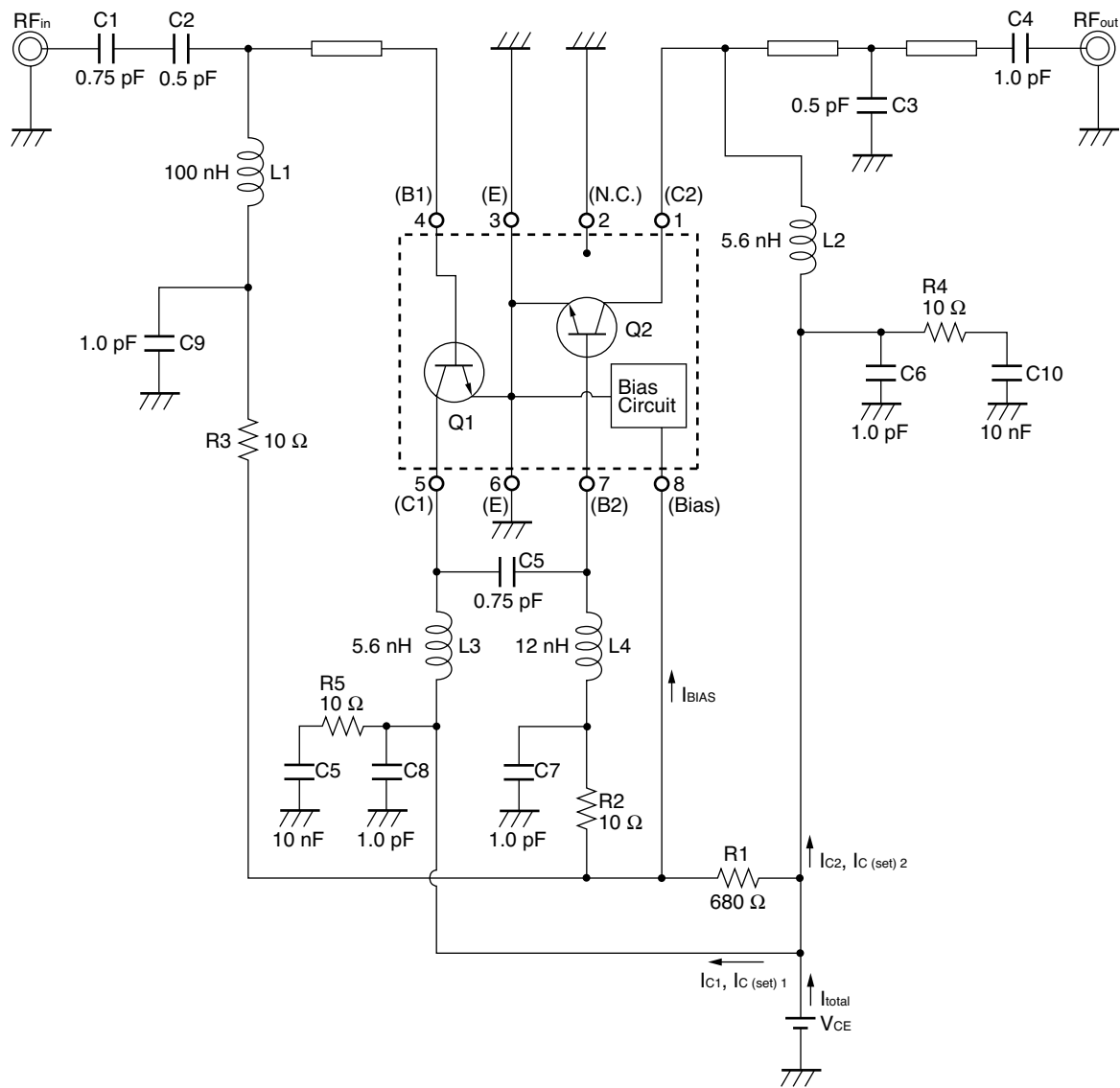
| PARAMETER                         | SYMBOL        | TEST CONDITIONS  | MIN. | TYP. | MAX. | UNIT |
|-----------------------------------|---------------|--|------|------|------|------|
| Insertion Power Gain (Q2)         | $ S_{21e} ^2$ | $V_{CE} = 3.6\text{ V}$ , $I_C = 40\text{ mA}$ , $f = 5.8\text{ GHz}$                                      | 2    | 3.5  | 5    | dB   |
| Maximum Available Power Gain (Q2) | MAG2          | $V_{CE} = 3.6\text{ V}$ , $I_C = 40\text{ mA}$ , $f = 5.8\text{ GHz}$                                      | 8.5  | 10.0 | 10.5 | dB   |
| Output Power (Q2)                 | $P_{out2}$    | $V_{CE} = 3.6\text{ V}$ , $I_{C(set)} = 40\text{ mA}$ ,<br>$f = 5.8\text{ GHz}$ , $P_{in} = 11\text{ dBm}$ | 17.5 | 19.0 | –    | dBm  |
| Collector Current (Q2)            | $I_{CC2}$     | $V_{CE} = 3.6\text{ V}$ , $I_{C(set)} = 40\text{ mA}$ ,<br>$f = 5.8\text{ GHz}$ , $P_{in} = 11\text{ dBm}$ | –    | 70   | –    | mA   |

**(3) Q1 + Q2, 2 stage Amplifiers**

| PARAMETER               | SYMBOL      | TEST CONDITIONS  | MIN. | TYP. | MAX. | UNIT |
|-------------------------|-------------|--|------|------|------|------|
| Output Power (Q1 + Q2)  | $P_{out}$   | $V_{CE} = 3.6\text{ V}$ , $R_{BIAS} = 680\ \Omega$ ,<br>$f = 5.8\text{ GHz}$ , $P_{in} = -3\text{ dBm}$<br><b>Note</b> | 17.5 | 19.0 | –    | dBm  |
| Total Current (Q1 + Q2) | $I_{total}$ | $V_{CE} = 3.6\text{ V}$ , $R_{BIAS} = 680\ \Omega$ ,<br>$f = 5.8\text{ GHz}$ , $P_{in} = -3\text{ dBm}$<br><b>Note</b> | –    | 90   | –    | mA   |

**Note** by MEASUREMENT CIRCUIT 1

MEASUREMENT CIRCUIT 1

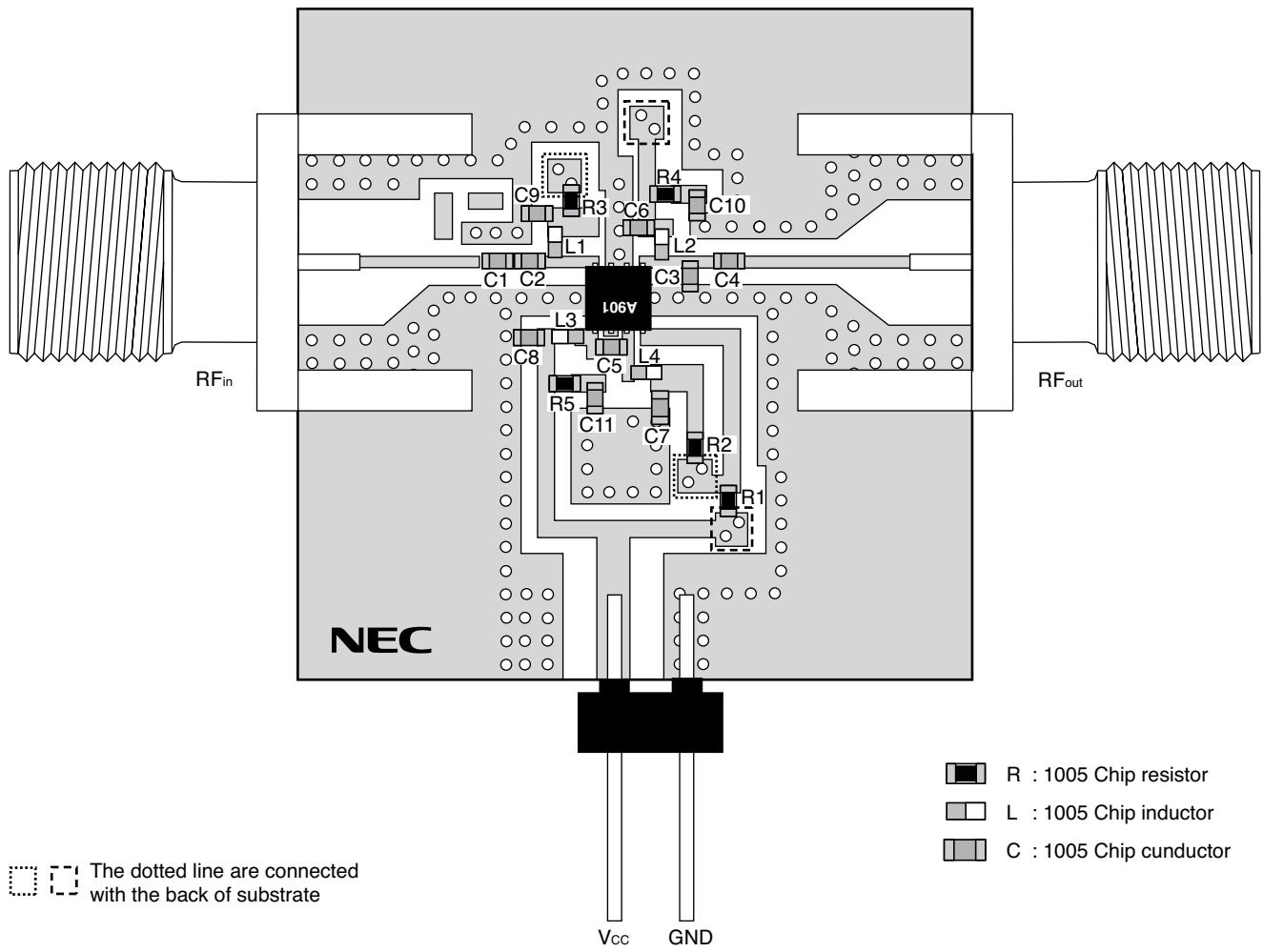


$$I_{C (set) 1} = CR1 \times I_{BIAS} = 4.5 \times I_{BIAS} \text{ (TYP.)}$$

$$I_{C (set) 2} = CR2 \times I_{BIAS} = 4.5 \times I_{BIAS} \text{ (TYP.)}$$

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

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



Remarks

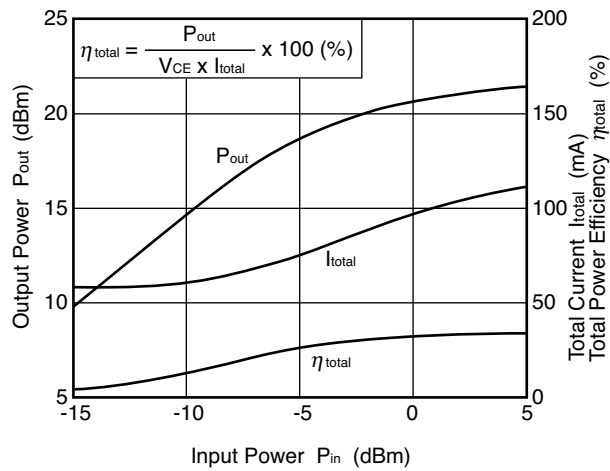
1. Substrate : 20 × 20 × 0.8 (t) mm FR-4 (4 Layer, each thickness 0.2 mm), copper thickness 18 μm, gold flash plating
2. Back side : GND pattern
3. o : Through hole

USING THE NEC EVALUATION BOARD

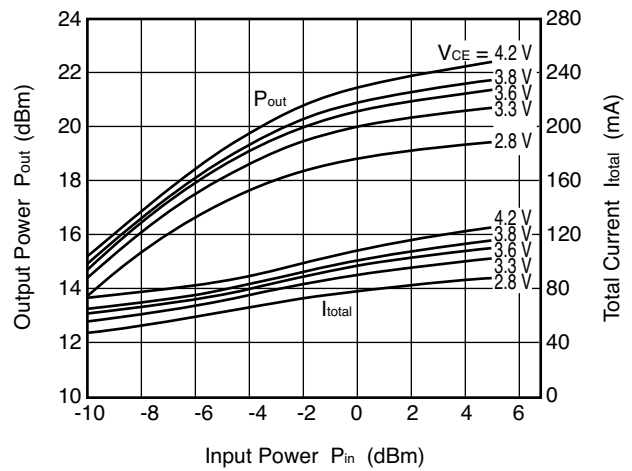
| SYMBOL | VALUES  | SYMBOL | VALUES  |
|--------|---------|--------|---------|
| R1     | 680 Ω   | C2     | 0.5 pF  |
| R2     | 10 Ω    | C3     | 0.5 pF  |
| R3     | 10 Ω    | C4     | 1.0 pF  |
| R4     | 10 Ω    | C5     | 0.75 pF |
| R5     | 10 Ω    | C6     | 1.0 pF  |
| L1     | 100 nH  | C7     | 1.0 pF  |
| L2     | 5.6 nH  | C8     | 1.0 pF  |
| L3     | 5.6 nH  | C9     | 1.0 pF  |
| L4     | 12 nH   | C10    | 10 nF   |
| C1     | 0.75 pF | C11    | 10 nF   |

**TYPICAL CHARACTERISTICS** ( $T_A = +25^\circ\text{C}$ ,  $V_{CE} = 3.6\text{ V}$ ,  $R_{BIAS} = 680\ \Omega$ ,  $f = 5.8\text{ GHz}$ , unless otherwise specified)

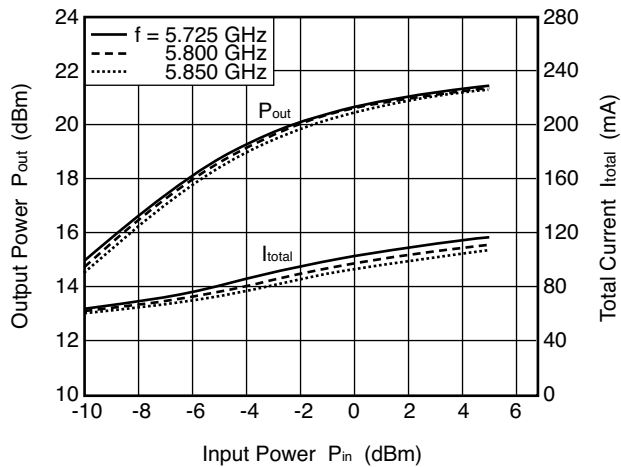
OUTPUT POWER, TOTAL CURRENT, TOTAL POWER EFFICIENCY vs. INPUT POWER



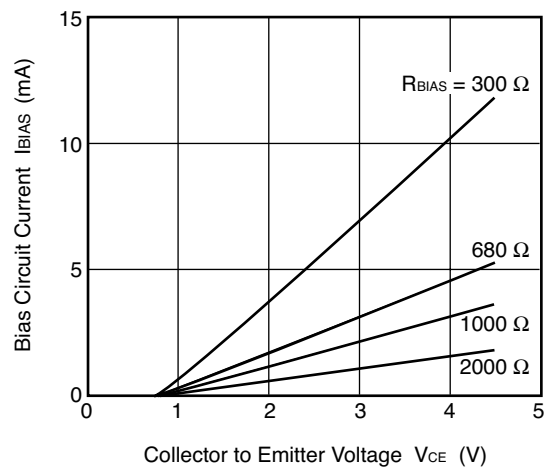
OUTPUT POWER, TOTAL CURRENT, vs. INPUT POWER



OUTPUT POWER, TOTAL CURRENT, vs. INPUT POWER



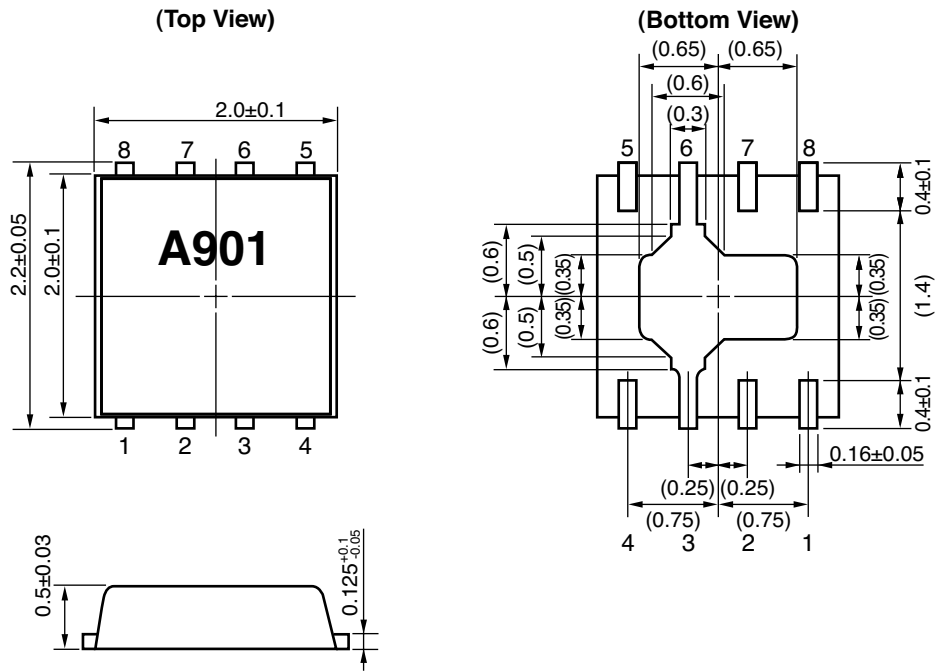
BIAS CIRCUIT CURRENT vs. COLLECTOR TO EMITTER VOLTAGE



**Remark** The graphs indicate nominal characteristics.

PACKAGE DIMENSIONS

8-PIN LEAD-LESS MINIMOLD (UNIT:mm)



Remark ( ) : Reference value

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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02/15/2005

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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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