

SILICON RFIC 2.5 GHz FREQUENCY UP-CONVERTER FOR WIRELESS TRANSCEIVER

UPC8172TB

FEATURES

- **RECOMMENDED OPERATING FREQUENCY:**
f_{RFout} = 0.8 to 2.5 GHz
- **SUPPLY VOLTAGE:**
V_{CC} = 2.7 to 3.3 V
- **HIGHER IP₃ AND CONVERSION GAIN:**
CG = 9.5 dB TYP
OIP₃ = +7.5 dBm TYP @ f_{RFout} = 0.9 GHz
- **HIGH-DENSITY SURFACE MOUNTING:**
6-pin super minimold package

DESCRIPTION

NEC's UPC8172TB is a silicon monolithic integrated circuit designed as a frequency up-converter for a wireless transceiver transmitter stage. This IC is manufactured using NEC's 30 GHz f_{max} UHS0 (Ultra High Speed Process) silicon bipolar process. This IC has the same circuit current as the conventional UPC8106TB, but operates at higher frequency, higher gain and lower distortion. Such performance and operation from a 3 volts supply makes this device ideal for mobile communications and wireless LAN applications.

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

ELECTRICAL CHARACTERISTICS

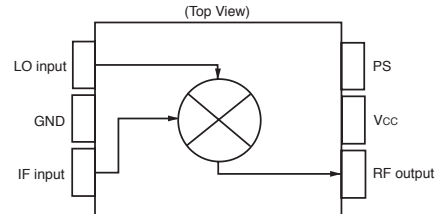
(T_A = 25°C, V_{CC} = V_{RFOUT} = 3.0 V, f_{iFin} = 240 MHz, P_{LOin} = -5 dBm, and V_{PS} ≥ 2.7 V unless otherwise specified))

| PART NUMBER PACKAGE OUTLINE | | | UPC8172TB S06 | | |
|--|---|--|------------------|------|------|
| SYMBOLS | PARAMETERS AND CONDITIONS ¹ | UNITS | MIN | TYP | MAX |
| I _{CC} | Circuit Current (no signal) | mA | 5.5 | 9.0 | 13.0 |
| I _{CC(PS)} | Circuit Current in Power Save Mode, V _{PS} = 0 V | μA | – | – | 2 |
| CG1 | Conversion Gain, | f _{RFout} = 0.9 GHz, P _{iFin} = -30 dBm | dB | 6.5 | 12.5 |
| CG2 | | f _{RFout} = 1.9 GHz, P _{iFin} = -30 dBm | dB | 5.5 | 11.5 |
| CG3 | | f _{RFout} = 2.4 GHz, P _{iFin} = -30 dBm | dB | 5.0 | 11.0 |
| P _{O(SAT)1} | Saturated RF Output Power, | f _{RFout} = 0.9 GHz, P _{iFin} = 0 dBm | dBm | -2.5 | – |
| P _{O(SAT)2} | | f _{RFout} = 1.9 GHz, P _{iFin} = 0 dBm | dBm | -3.5 | – |
| P _{O(SAT)3} | | f _{RFout} = 2.4 GHz, P _{iFin} = 0 dBm | dBm | -4.0 | – |
| Output Third-Order Distortion Intercept Point, | | | | | |
| OIP ₃₁ | f _{RFout} = 0.9 GHz | f _{iFin1} = 240 MHz | dBm | – | 7.5 |
| OIP ₃₂ | | | dBm | – | 6.0 |
| OIP ₃₃ | | | dBm | – | 4.0 |
| Input Third-Order Distortion Intercept Point, | | | | | |
| IIP ₃₁ | f _{RFout} = 0.9 GHz | f _{iFin1} = 240 MHz | dBm | – | -2.0 |
| IIP ₃₂ | | | dBm | – | -2.5 |
| IIP ₃₃ | | | dBm | – | -4.0 |
| SSB·NF1 | SSB Noise Figure, | f _{RFout} = 0.9 GHz, f _{iFin1} = 240 MHz | dB | – | 9.5 |
| SSB·NF2 | | f _{RFout} = 1.9 GHz, f _{iFin1} = 240 MHz | dB | – | 10.4 |
| SSB·NF3 | | f _{RFout} = 2.4 GHz, f _{iFin1} = 240 MHz | dB | – | 10.6 |
| TPS(rise) | Power Save Response Time | Rise Time, V _{PS} : GND' V _{CC} | μs | – | 1 |
| TPS(fall) | | Fall Time, V _{PS} : V _{CC} ' GND | μs | – | 1.5 |

Note:

1. f_{RFout} < f_{LOin} @ f_{RFout} = 0.9 GHz
f_{LOin} < f_{RFout} @ f_{RFout} = 1.9 GHz/2.4 GHz

BLOCK DIAGRAM



APPLICATIONS

- PCS1900 MHz
- 2.4 GHz band transmitter/receiver system (wireless LAN, etc.)

UPC8172TB

ABSOLUTE MAXIMUM RATINGS¹

(T_A = +25°C unless otherwise specified)

| SYMBOLS | PARAMETERS | UNITS | RATINGS |
|------------------|--------------------------------|-------|-------------|
| V _{CC} | Supply Voltage | V | 3.6 |
| V _{PS} | PS Pin Input Voltage | V | 3.6 |
| P _D | Power Dissipation ² | mW | 270 |
| T _A | Operating Ambient Temperature | °C | -40 to +85 |
| T _{STG} | Storage Temperature | °C | -55 to +150 |
| P _{IN} | Input Power | dBm | +10 |

Notes:

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

RECOMMENDED OPERATING CONDITIONS

| SYMBOLS | PARAMETERS | UNITS | MIN | TYP | MAX |
|--------------------|----------------------------------|-------|-----|-----|-----|
| V _{CC} | Supply Voltage ¹ | V | 2.7 | 3.0 | 3.3 |
| T _A | Operating Ambient Temperature | °C | -40 | +25 | +85 |
| P _{LOin} | Local Input Level ² | dBm | -10 | -5 | 0 |
| f _{RFout} | RF Output Frequency ³ | GHz | 0.8 | – | 2.5 |
| f _{iFin} | IF Input Frequency | MHz | 50 | – | 400 |

Note:

- Same voltage applied to pins 5 and 6.
- Z_s = 50 Ω (without matching).
- With external matching circuit.

SERIES PRODUCTS¹ (T_A = +25°C, V_{CC} = V_{RFout} = 3.0 V, Z_S = Z_L = 50 Ω)

| Part Number | I _{CC} (mA) | f _{RFout} (GHz) | CG (dB) | | | OIP ₃ (dBm) | | |
|-------------|----------------------|--------------------------|--------------------------|-------------|-------------|--------------------------|-------------|-------------|
| | | | @RF 0.9 GHz ² | @RF 1.9 GHz | @RF 2.4 GHz | @RF 0.9 GHz ² | @RF 1.9 GHz | @RF 2.4 GHz |
| UPC8172TB | 9 | 0.8 to 2.5 | 9.5 | 8.5 | 8.0 | +7.5 | +6.0 | +4.0 |
| UPC8106TB | 9 | 0.4 to 2.0 | 9 | 7 | – | +5.5 | -1.0 | – |
| UPC8109TB | 5 | 0.4 to 2.0 | 6 | 4 | – | +1.5 | +2.0 | – |
| UPC8163TB | 16.5 | 0.8 to 2.0 | 9 | 5.5 | – | +9.5 | +6.0 | – |

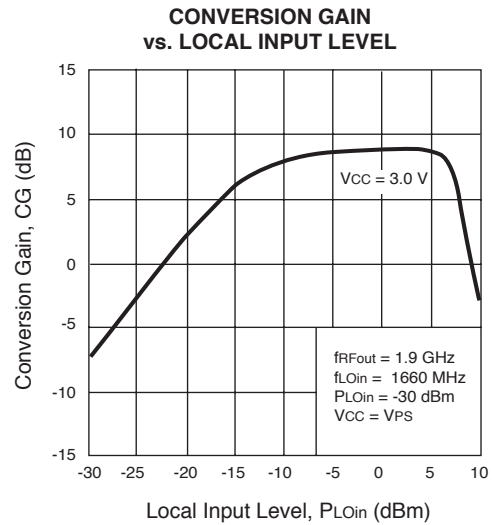
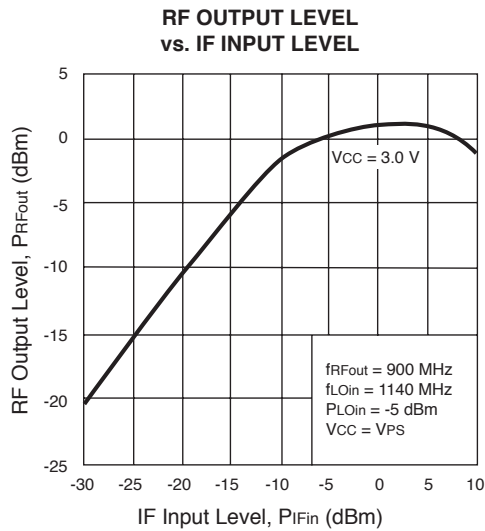
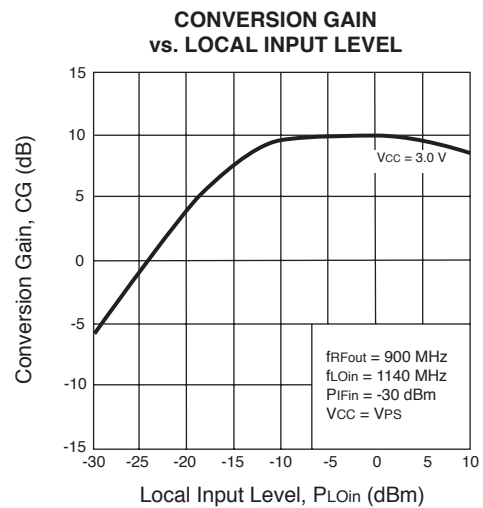
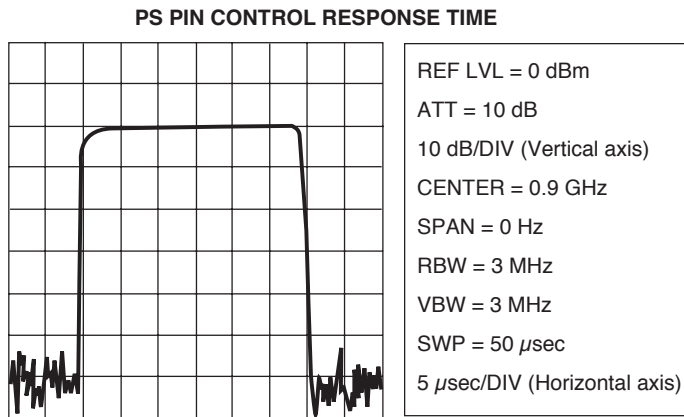
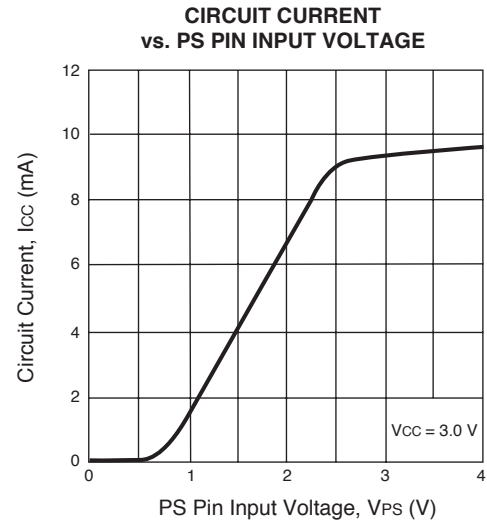
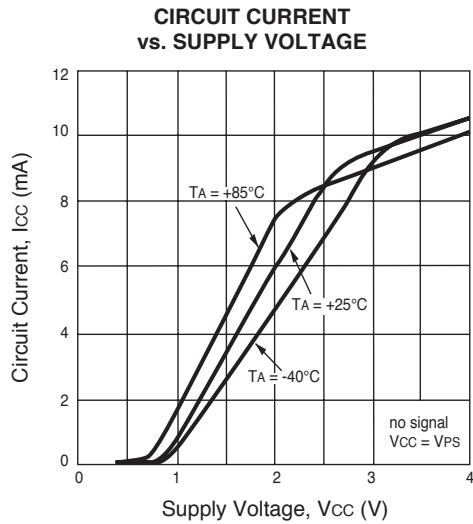
Notes:

- Typical performance.
- f_{RFout} = 0.83 GHz @ UPC8163TB

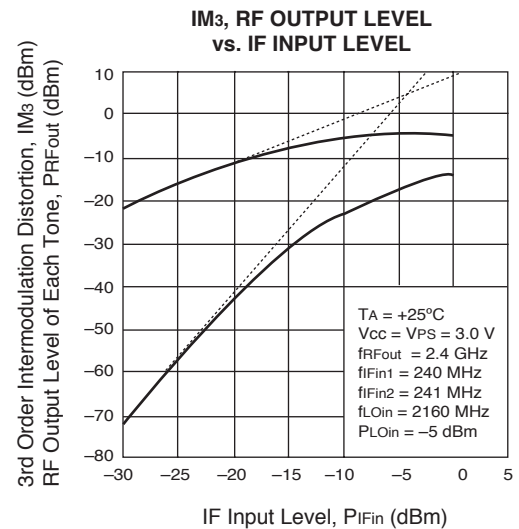
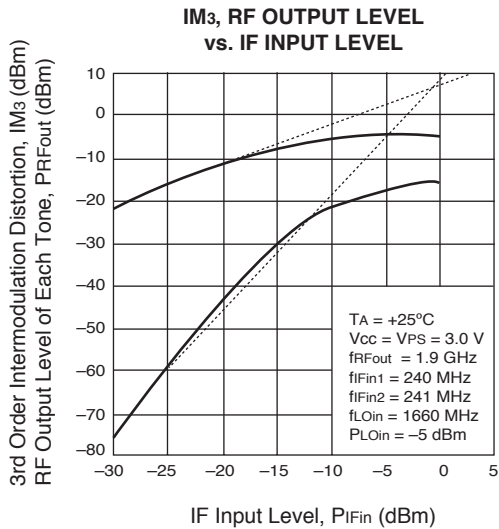
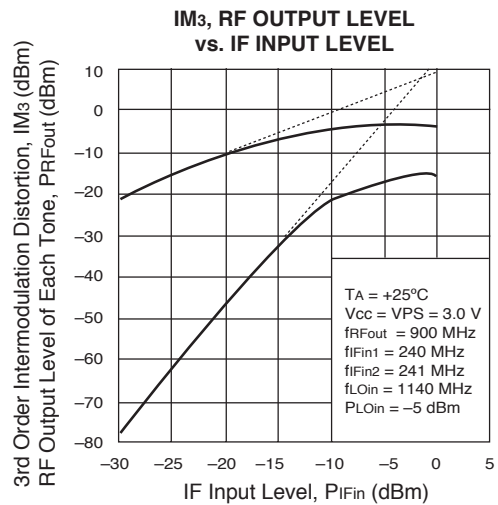
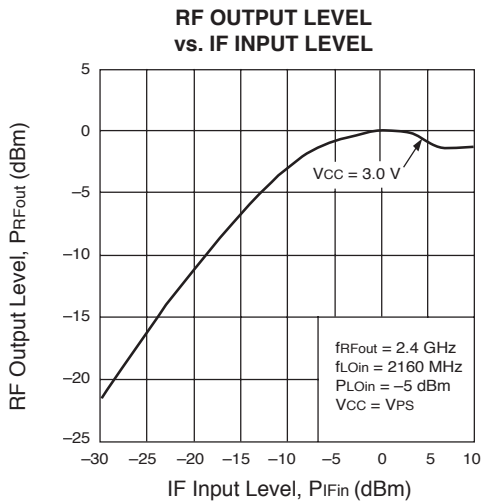
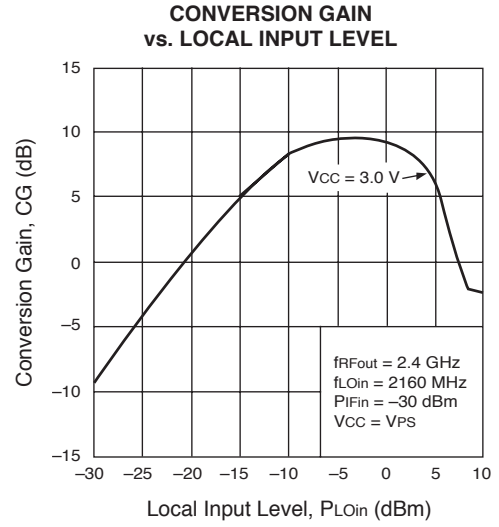
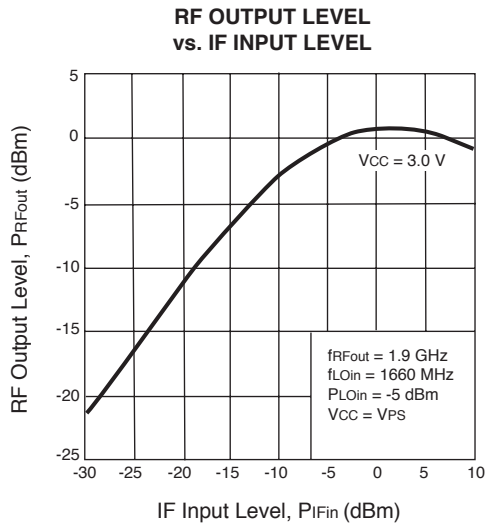
PIN FUNCTIONS (Voltage is measured at V_{CC} = V_{PS} = V_{RFOUT} = 3.0 V)

| Pin No. | Pin Name | Applied Voltage (V) | Pin Voltage (V) | Function and Explanation | Equivalent Circuit | | | | | | |
|-----------------|-----------------|--|-----------------|---|--------------------|---------|-----------------|-----------|-----|------------|--|
| 1 | IFinput | – | 1.4 | This pin is the IF input pin to the double balanced mixer (DBM). The input is designed as a high impedance. The circuit helps suppress spurious signals. Also this symmetrical circuit can keep specified performance insensitive to process-condition distribution. For that reason, a double balanced mixer is adopted. | | | | | | | |
| 2 | GND | GND | – | GND pin. Ground pattern on the board should be formed as wide as possible. Track length should be kept as short as possible to minimize ground inductance. | | | | | | | |
| 3 | LOinput | – | 2.3 | Local input pin. Recommendable input level is -10 to 0 dBm. | | | | | | | |
| 5 | V _{CC} | 2.7 to 3.3 | – | Supply voltage pin. | | | | | | | |
| 6 | RFoutput | Same bias as V _{CC} through external inductor | – | This pin is the RF output from the double balanced mixer. This pin is designed as an open collector. Due to the high impedance output, this pin should be externally equipped with an LC matching circuit to the next stage. | | | | | | | |
| 4 | PS | V _{CC} /GND | | Power save control pin. Bias controls operate as follows: <table border="1" style="margin: 10px auto;"> <thead> <tr> <th>Pin Bias</th> <th>Control</th> </tr> </thead> <tbody> <tr> <td>V_{CC}</td> <td>Operation</td> </tr> <tr> <td>GND</td> <td>Power Save</td> </tr> </tbody> </table> | Pin Bias | Control | V _{CC} | Operation | GND | Power Save | |
| Pin Bias | Control | | | | | | | | | | |
| V _{CC} | Operation | | | | | | | | | | |
| GND | Power Save | | | | | | | | | | |

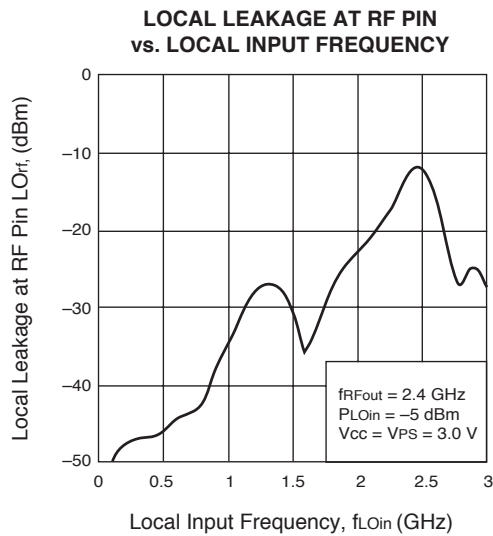
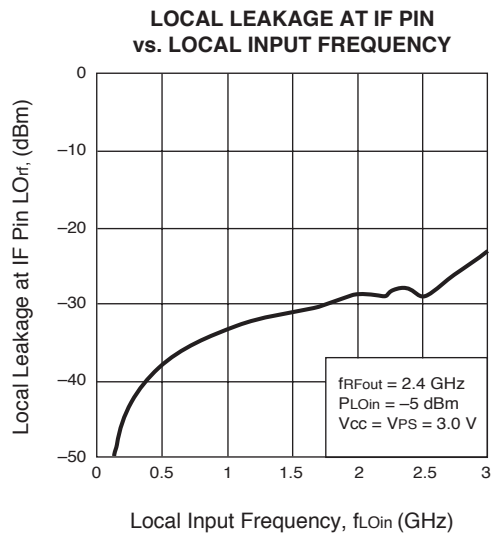
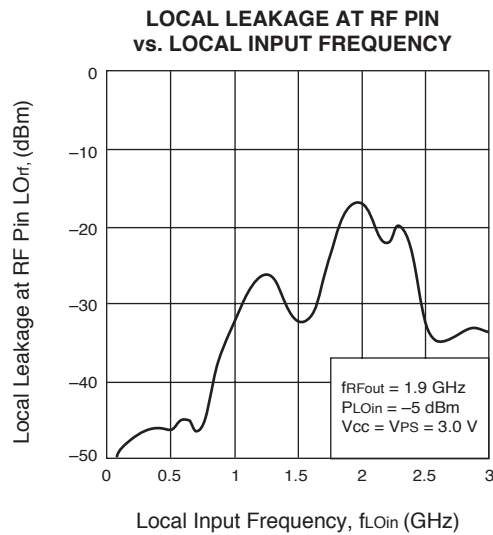
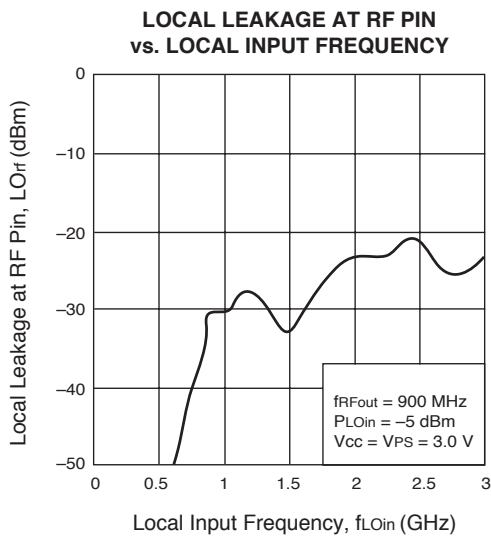
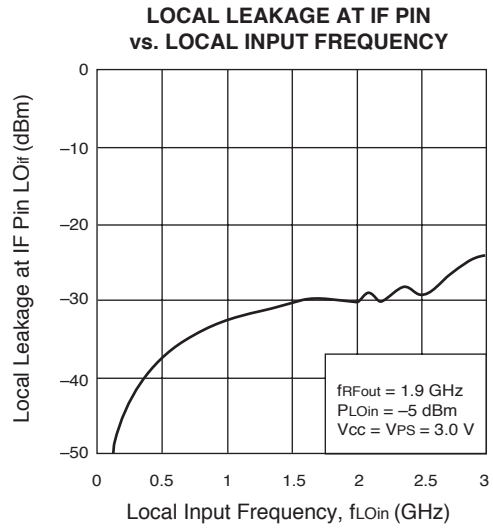
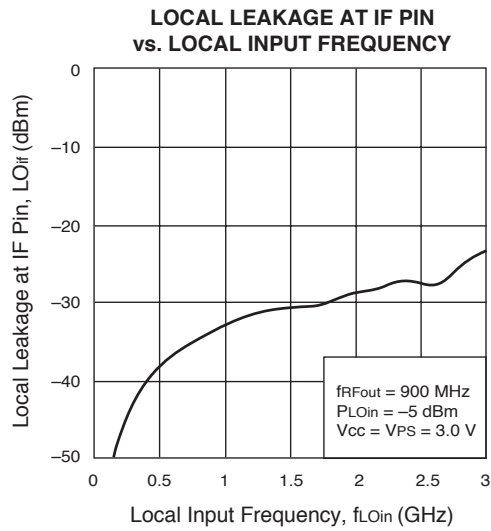
TYPICAL PERFORMANCE CURVES (TA = 25°C)



TYPICAL PERFORMANCE CURVES (TA = 25°C)

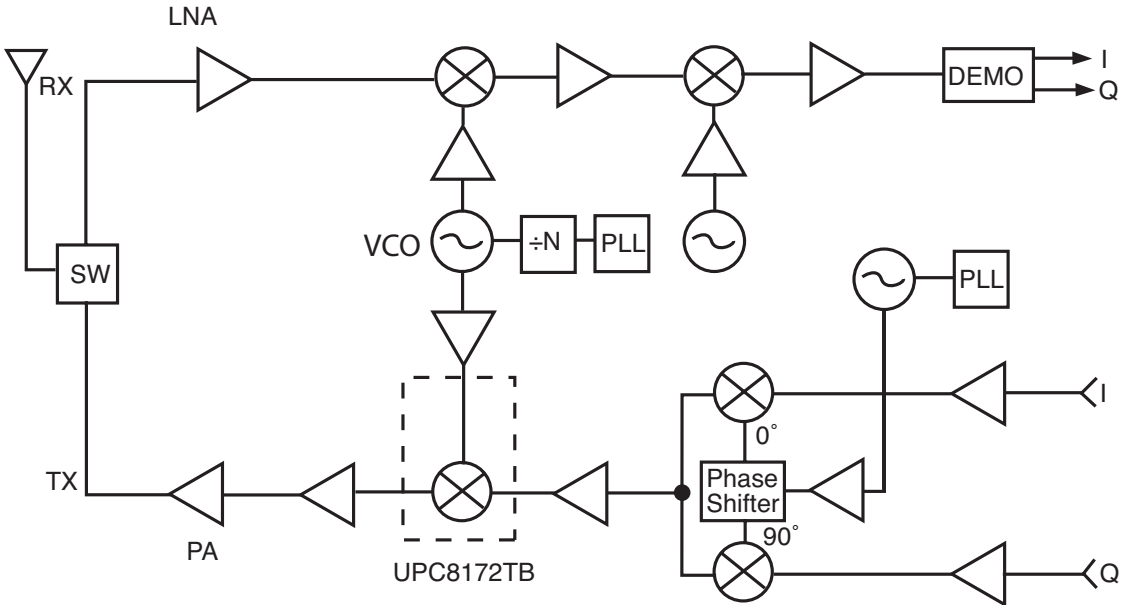


TYPICAL PERFORMANCE CURVES (TA = 25°C)



SYSTEM APPLICATION EXAMPLE

Wireless Transceiver

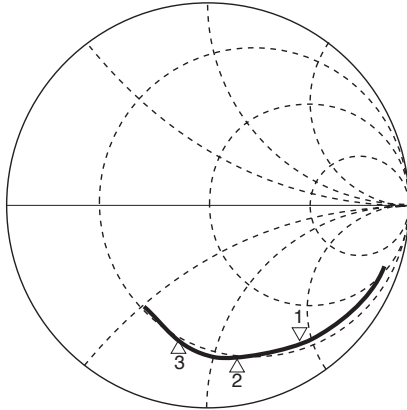


S-PARAMETERS FOR EACH PORT ($V_{CC} = V_{PS} = V_{RFout} = 3.0\text{ V}$)

(The paramters are monitored at DUT pins)

LO port

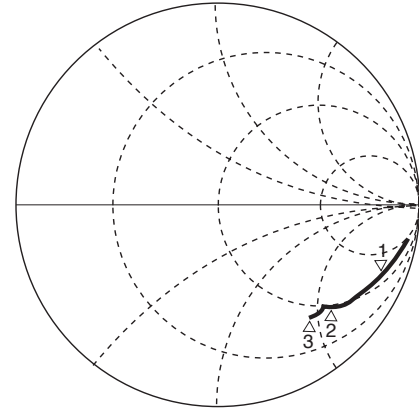
S11 Z
 REF 1.0 Units
 1 200.0 mUnits/
 21.625 Ω -91.148 Ω
 ∇ *hp*
 MARKER 1
 1.15 GHz
 MARKER 2
 1.65 GHz
 MARKER 3
 2.15 GHz



START 0.40000000 GHz
 STOP 2.50000000 GHz

RF port (without matching)

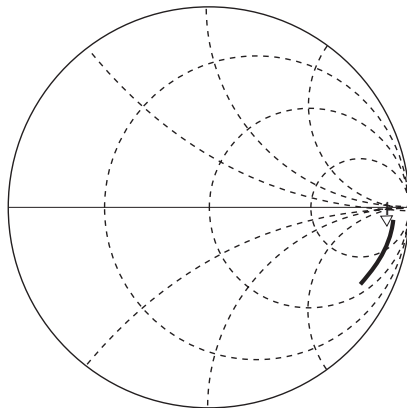
S22 Z
 REF 1.0 Units
 1 200.0 mUnits/
 71.5 Ω -240.34 Ω
 ∇ *hp*
 MARKER 1
 900 MHz
 MARKER 2
 1.9 GHz
 MARKER 3
 2.5 GHz



START 0.40000000 GHz
 STOP 2.50000000 GHz

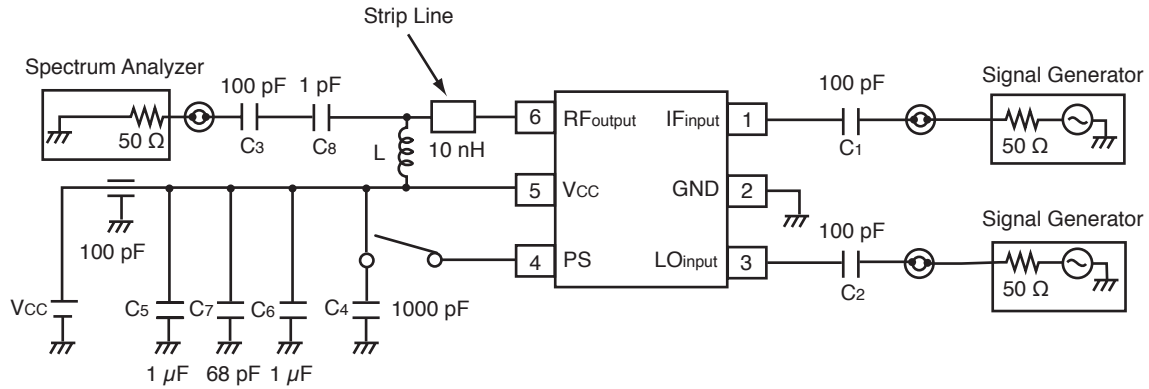
IF port

S11 Z
 REF 1.0 Units
 1 200.0 mUnits/
 332.63 Ω -601.34 Ω
 ∇ *hp*
 MARKER 1
 240.0 MHz

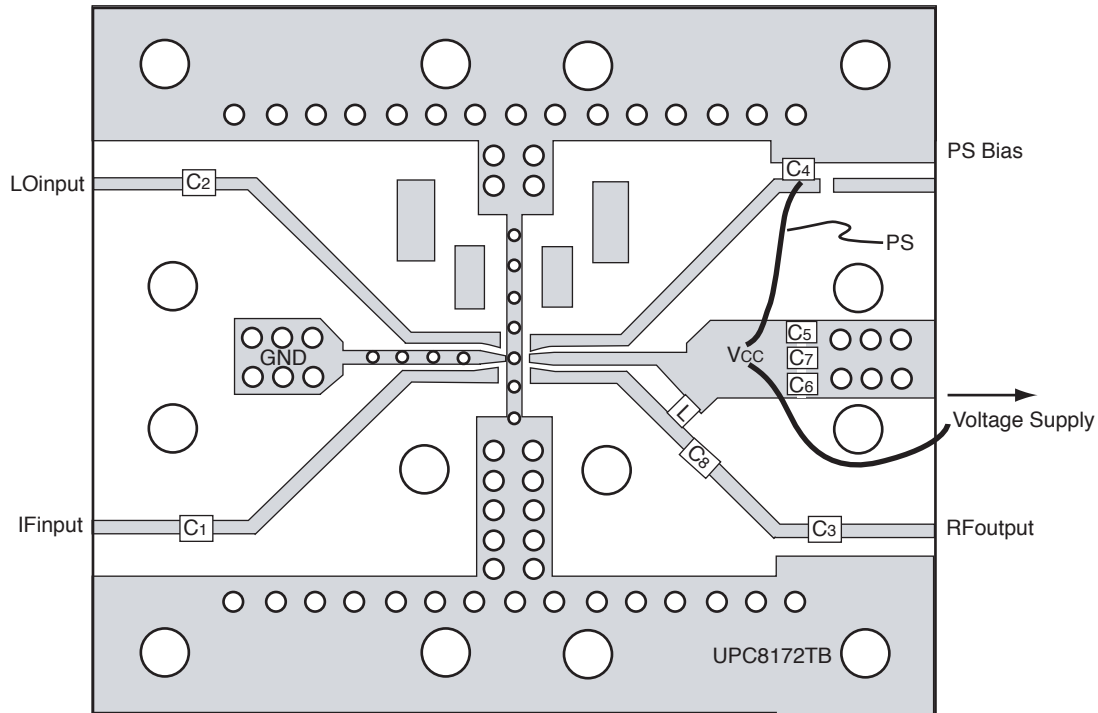


START 0.10000000 GHz
 STOP 1.00000000 GHz

TEST CIRCUIT 1 (f_{RFout} = 900 MHz)



EXAMPLE OF TEST CIRCUIT 1 ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

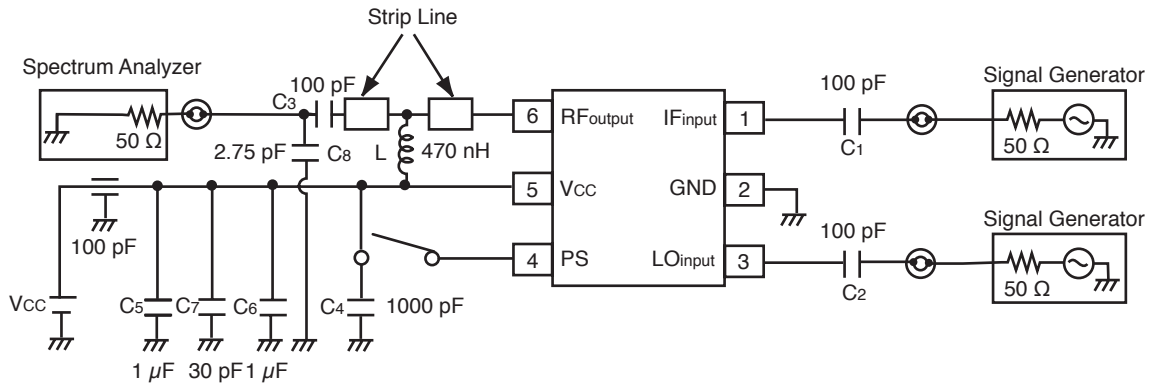
| FORM | SYMBOL | VALUE |
|----------------|---------------|---------|
| Chip Capacitor | C1, C2, C3 | 100 pF |
| | C4 | 1000 pF |
| | C5, C6 | 1 μF |
| | C7 | 68 pF |
| | C8 | 1 pF |
| | Chip Inductor | L |

Note:

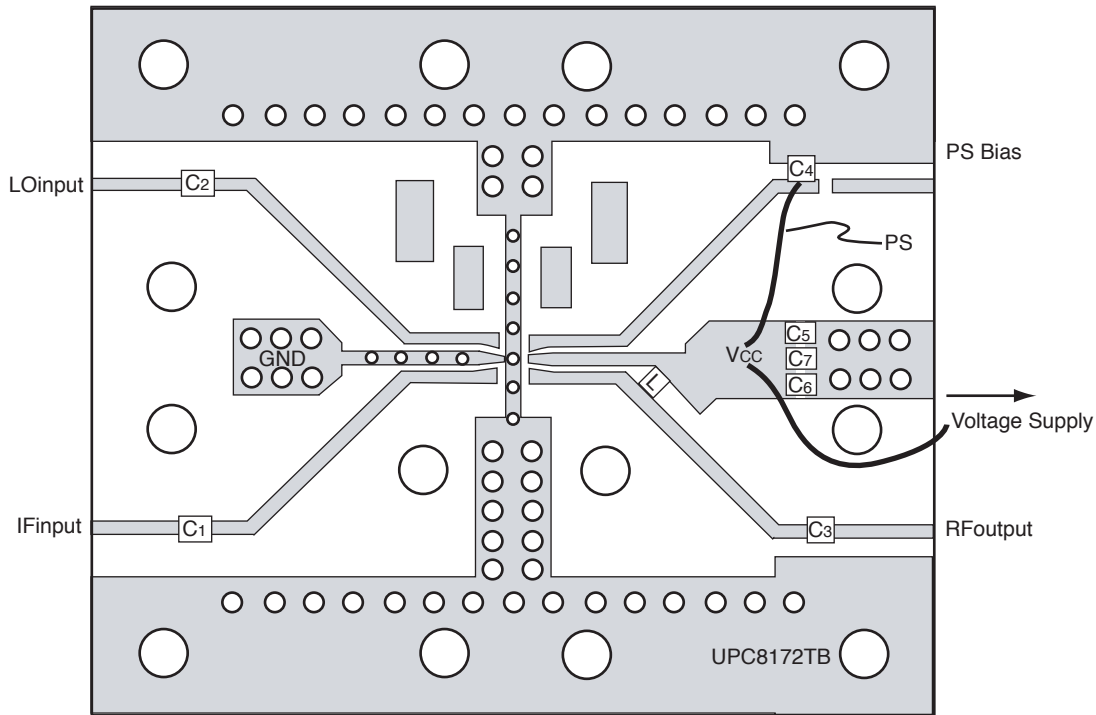
1. 10 nH: LL1608-FH10N (TOKO Co., Ltd.)

- (*1) 35x42x0.4 mm polyimide board, double-sided copper clad
- (*2) Ground pattern on rear of the board
- (*3) Solder plated patterns
- (*4) mmIII : Through holes

TEST CIRCUIT 2 ($f_{RFout} = 1.9\text{ GHz}$)



EXAMPLE OF TEST CIRCUIT 2 ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

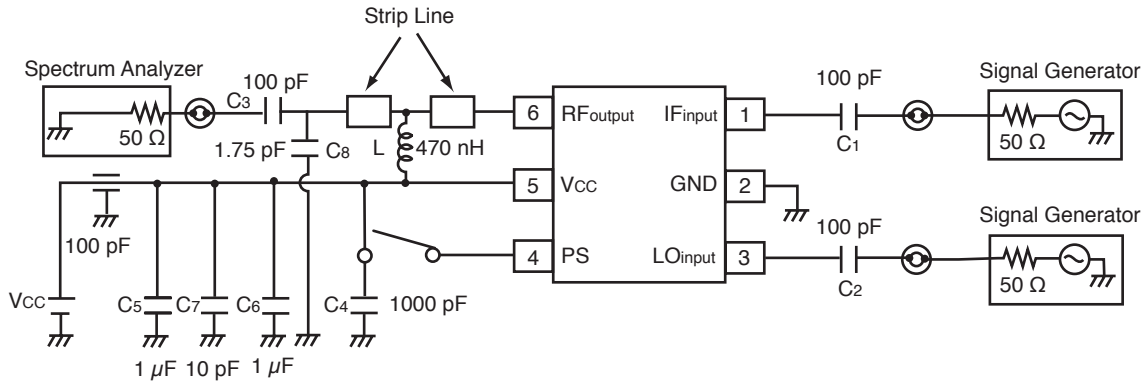
| FORM | SYMBOL | VALUE |
|----------------|------------|---------------------|
| Chip Capacitor | C1, C2, C3 | 100 pF |
| | C4 | 1000 pF |
| | C5, C6 | 1 μ F |
| | C7 | 30 pF |
| | C8 | 2.75 pF |
| Chip Inductor | L | 470 nH ¹ |

- (*1) 35 x 42 x 0.4 mm polyimide board, double-sided copper clad
- (*2) Ground pattern on rear of the board
- (*3) Solder plated patterns
- (*4) mmIII : Through holes

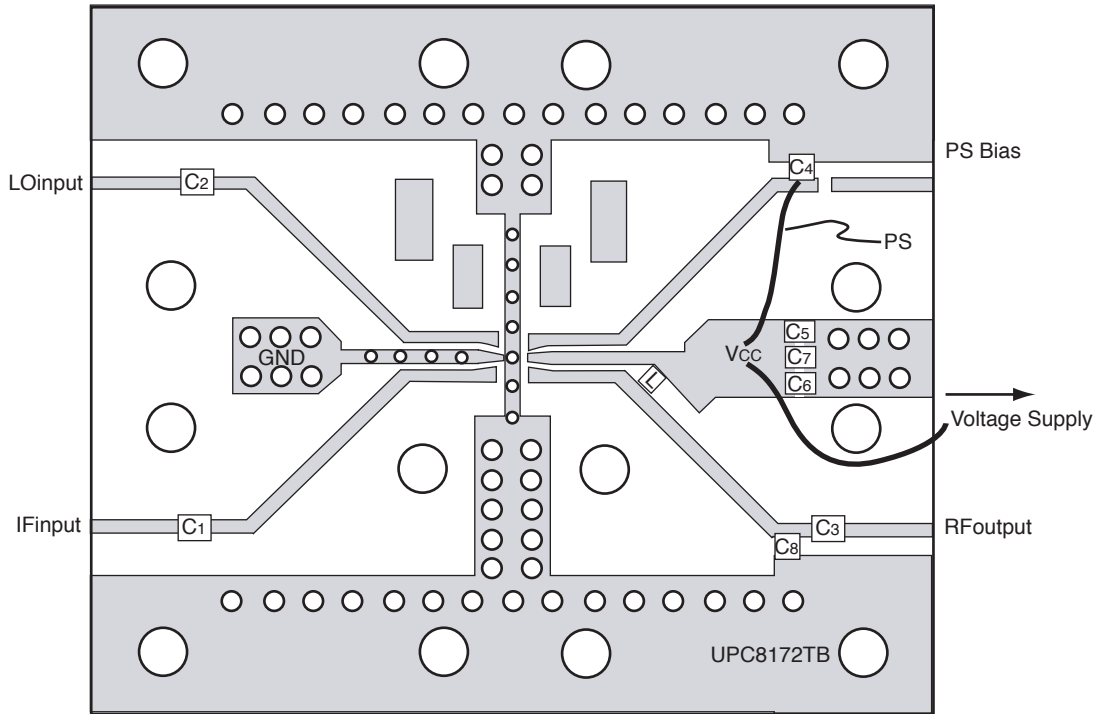
Note:

1. 470 nH: LL2012-FR47 (TOKO Co., Ltd.)

TEST CIRCUIT 3 ($f_{RFout} = 2.4 \text{ GHz}$)



EXAMPLE OF TEST CIRCUIT 3 ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

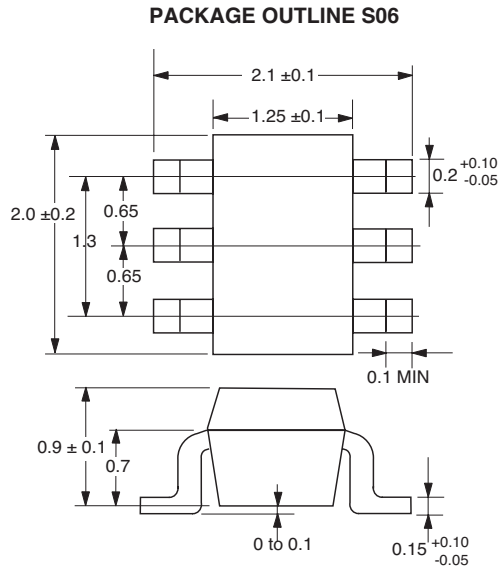
| FORM | SYMBOL | VALUE |
|----------------|---------------|---------|
| Chip Capacitor | C1, C2, C3 | 100 pF |
| | C4 | 1000 pF |
| | C5, C6 | 1 μF |
| | C7 | 10 pF |
| | C8 | 1.75 pF |
| | Chip Inductor | L |

- (*1) 35 x 42 x 0.4 mm polyimide board, double-sided copper clad
- (*2) Ground pattern on rear of the board
- (*3) Solder plated patterns
- (*4) mm∅: Through holes

Note:

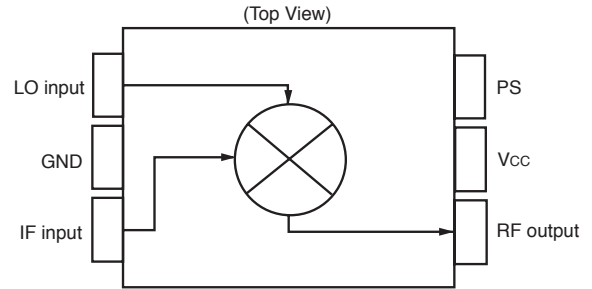
1. 470 nH: LL2012-FR47 (TOKO Co., Ltd.)

OUTLINE DIMENSIONS (Units in mm)

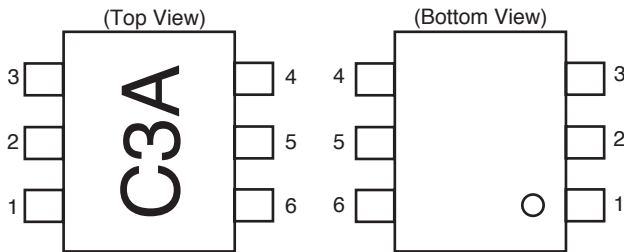


Note:
 All dimensions are typical unless otherwise specified.

BLOCK DIAGRAM



PIN CONNECTIONS



| PIN NO. | PIN NAME |
|---------|----------|
| 1 | IFinput |
| 2 | GND |
| 3 | LOinput |
| 4 | PS |
| 5 | Vcc |
| 6 | RFoutput |

ORDERING INFORMATION

| Part Number | Quantity |
|----------------|--------------|
| UPC8172TB-E3-A | 3 K pcs/reel |

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

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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DATA SUBJECT TO CHANGE WITHOUT NOTICE

06/14/2001

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 | |

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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