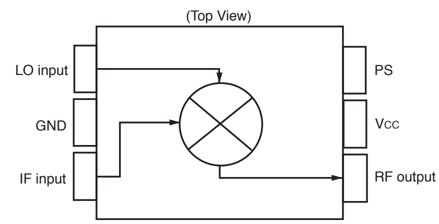
SILICON RFIC
2.5 GHz FREQUENCY UP-CONVERTER FOR WIRELESS TRANSCEIVER

UPC8172TB

FEATURES

- **RECOMMENDED OPERATING FREQUENCY:**
  f_{RFout} = 0.8 to 2.5 GHz
- **SUPPLY VOLTAGE:**
  V_{CC} = 2.7 to 3.3 V
- **HIGHER IP_3 AND CONVERSION GAIN:**
  CG = 9.5 dB TYP
  OIP_3 = +7.5 dBm TYP @ f_{RFout} = 0.9 GHz
- **HIGH-DENSITY SURFACE MOUNTING:**
  6-pin super minimold package

BLOCK DIAGRAM



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.

APPLICATIONS

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

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	9.5	12.5
CG2	Conversion Gain, f_{RFout} = 1.9 GHz, P_{IFin} = -30 dBm	dB	5.5	8.5	11.5
CG3	Conversion Gain, f_{RFout} = 2.4 GHz, P_{IFin} = -30 dBm	dB	5.0	8.0	11.0
$P_{O(SAT)1}$	Saturated RF Output Power, f_{RFout} = 0.9 GHz, P_{IFin} = 0 dBm	dBm	-2.5	0.5	–
$P_{O(SAT)2}$	Saturated RF Output Power, f_{RFout} = 1.9 GHz, P_{IFin} = 0 dBm	dBm	-3.5	0	–
$P_{O(SAT)3}$	Saturated RF Output Power, f_{RFout} = 2.4 GHz, P_{IFin} = 0 dBm	dBm	-4.0	-0.5	–
OIP_31	Output Third-Order Distortion Intercept Point, f_{RFout} = 0.9 GHz, $f_{IFin}1$ = 240 MHz, $f_{IFin}2$ = 241 MHz	dBm	–	7.5	–
OIP_32	Output Third-Order Distortion Intercept Point, f_{RFout} = 1.9 GHz, $f_{IFin}1$ = 240 MHz, $f_{IFin}2$ = 241 MHz	dBm	–	6.0	–
OIP_33	Output Third-Order Distortion Intercept Point, f_{RFout} = 2.4 GHz, $f_{IFin}1$ = 240 MHz, $f_{IFin}2$ = 241 MHz	dBm	–	4.0	–
IIP_31	Input Third-Order Distortion Intercept Point, f_{RFout} = 0.9 GHz, $f_{IFin}1$ = 240 MHz, $f_{IFin}2$ = 241 MHz	dBm	–	-2.0	–
IIP_32	Input Third-Order Distortion Intercept Point, f_{RFout} = 1.9 GHz, $f_{IFin}1$ = 240 MHz, $f_{IFin}2$ = 241 MHz	dBm	–	-2.5	–
IIP_33	Input Third-Order Distortion Intercept Point, f_{RFout} = 2.4 GHz, $f_{IFin}1$ = 240 MHz, $f_{IFin}2$ = 241 MHz	dBm	–	-4.0	–
SSB•NF1	SSB Noise Figure, f_{RFout} = 0.9 GHz, $f_{IFin}1$ = 240 MHz	dB	–	9.5	–
SSB•NF2	SSB Noise Figure, f_{RFout} = 1.9 GHz, $f_{IFin}1$ = 240 MHz	dB	–	10.4	–
SSB•NF3	SSB Noise Figure, f_{RFout} = 2.4 GHz, $f_{IFin}1$ = 240 MHz	dB	–	10.6	–
$T_{PS(rise)}$	Power Save Response Time, Rise Time, V_{PS}: GND → V_{CC}	μs	–	1	–
$T_{PS(fall)}$	Power Save Response Time, 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

ABSOLUTE MAXIMUM RATINGS[1]

(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:
1. Operation in excess of any one of these conditions may result in permanent damage.
2. 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

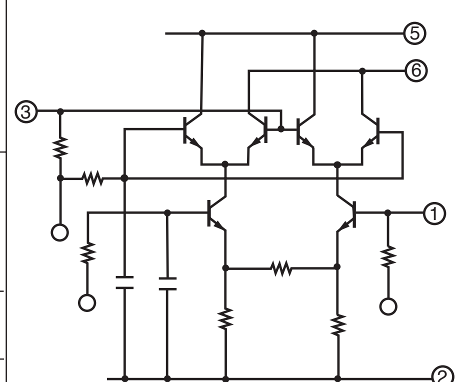
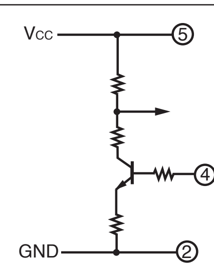
Note:
1. Same voltage applied to pins 5 and 6.
2. Z_S = 50 Ω (without matching).
3. With external matching circuit.

SERIES PRODUCTS[1] (T_A = +25°C, V_{CC} = V_{RFout} = 3.0 V, Z_S = Z_L = 50 Ω)

Part Number	Icc	f_{RFout}	CG (dB			OIP3 (dBm)		
	(mA)	(GHz)	@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:
1. Typical performance.
2. f_{RFout} = 0.83 GHz @ UPC8163TB

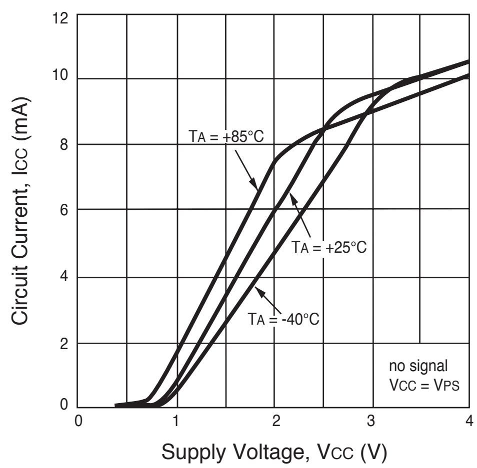
PIN FUNCTIONS (Voltage is measured at V_{CC} = V_{PS} = V_{RFOUT} = 3.0 V)

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	Vcc	2.7 to 3.3	—	Supply voltage pin.	
6	RFoutput	Same bias as Vcc 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	Vcc/GND		Power save control pin. Bias controls operate as follows: Pin Bias / Control: Vcc — Operation GND — Power Save	

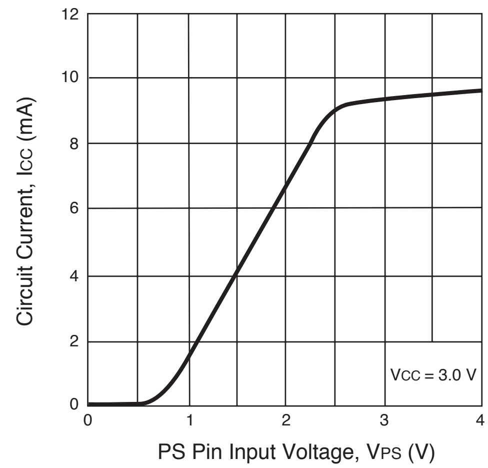
Pin Bias	Control
Vcc	Operation
GND	Power Save

TYPICAL PERFORMANCE CURVES (TA = 25°C)

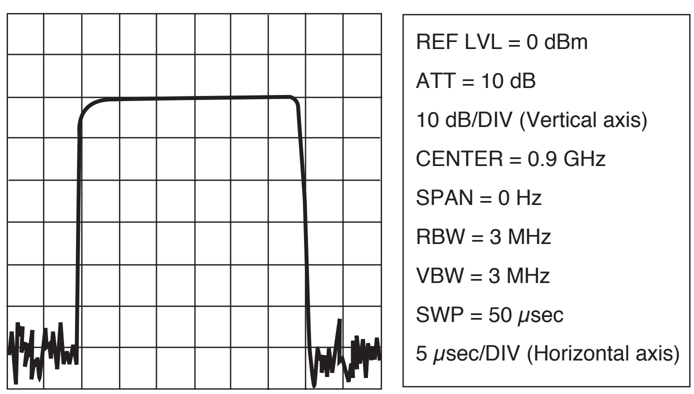
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



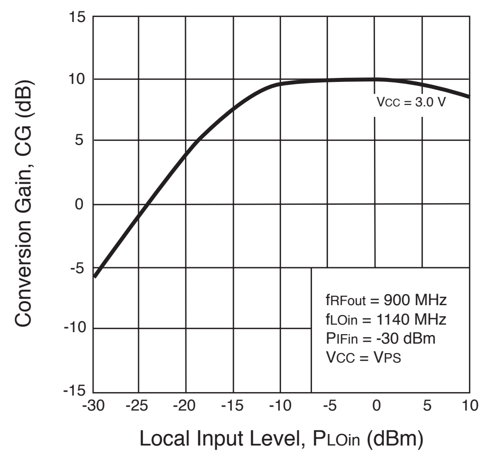
CIRCUIT CURRENT vs. PS PIN INPUT VOLTAGE



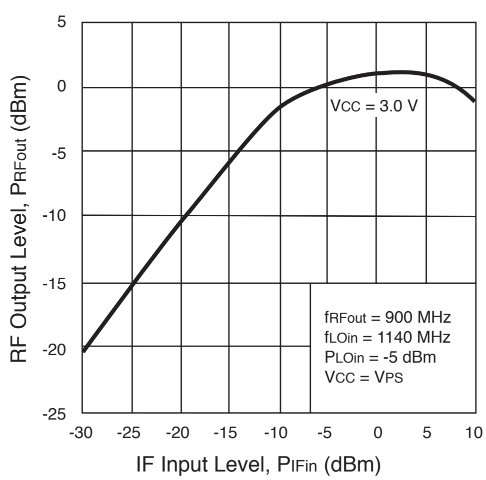
PS PIN CONTROL RESPONSE TIME



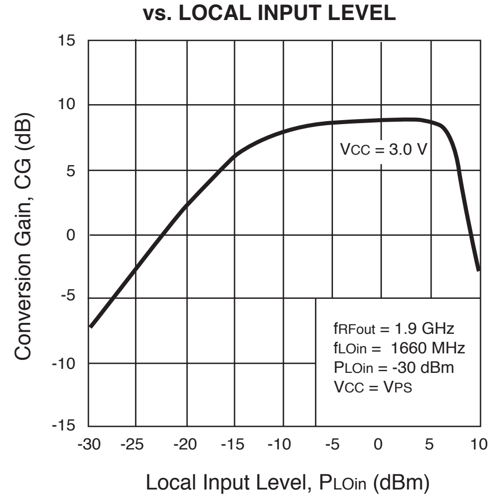
CONVERSION GAIN vs. LOCAL INPUT LEVEL



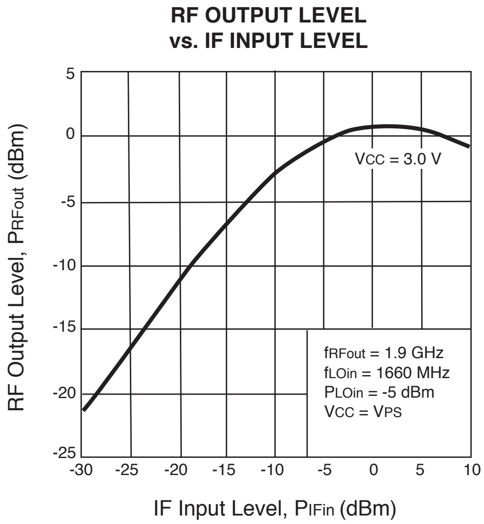
RF OUTPUT LEVEL vs. IF INPUT LEVEL

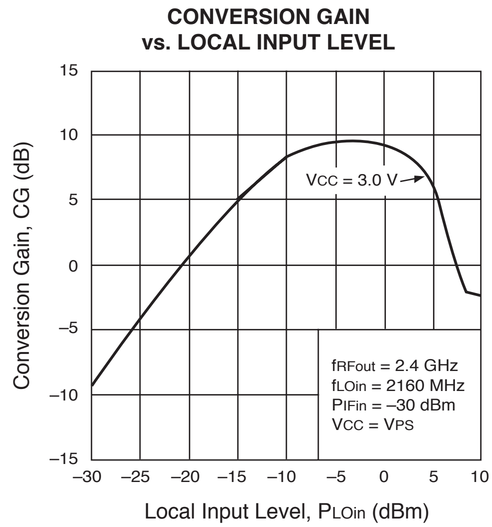


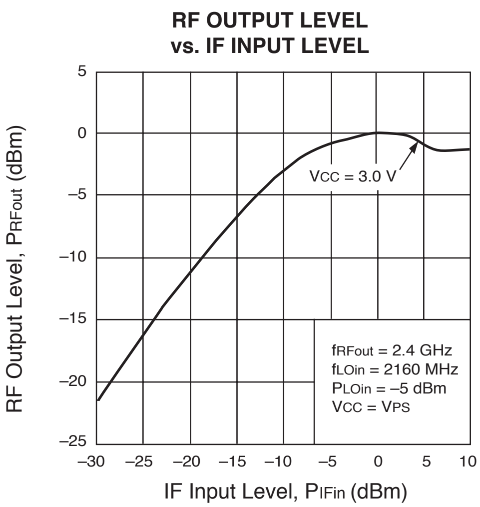
CONVERSION GAIN vs. LOCAL INPUT LEVEL

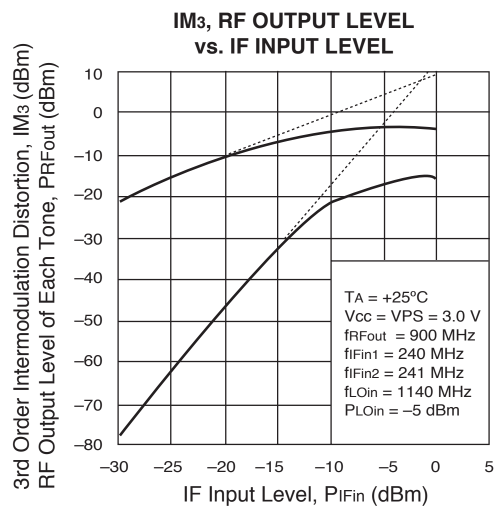


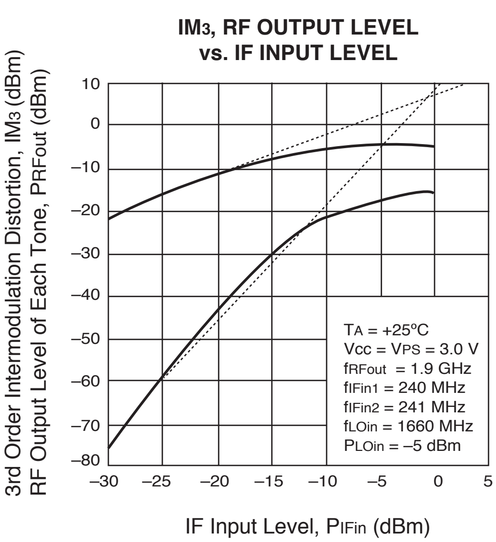
TYPICAL PERFORMANCE CURVES (TA = 25°C)

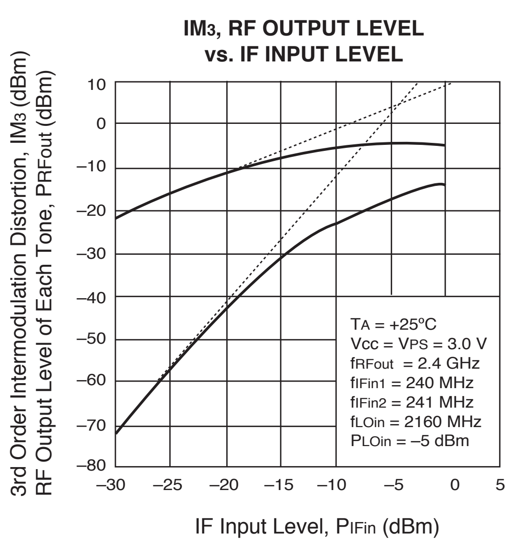






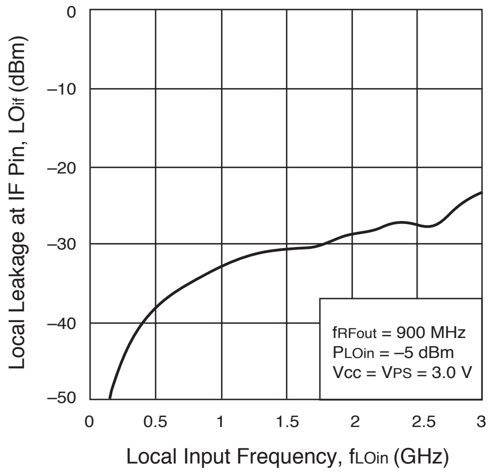




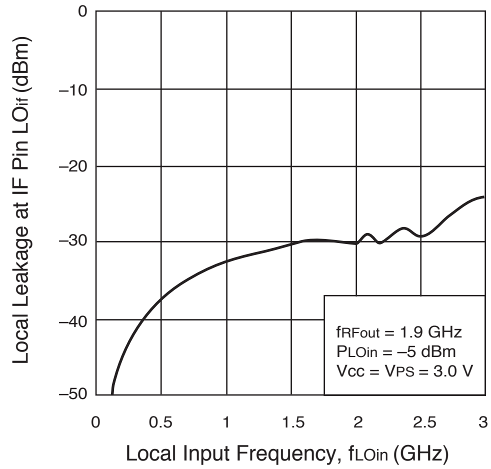


TYPICAL PERFORMANCE CURVES (TA = 25°C)

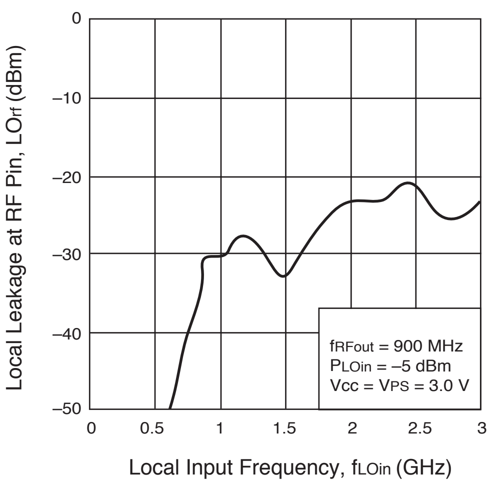
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT FREQUENCY



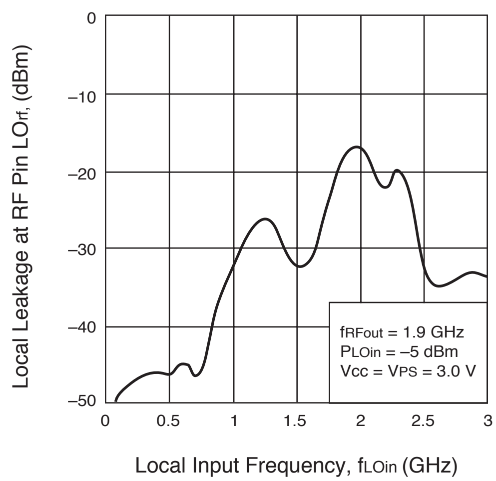
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT FREQUENCY



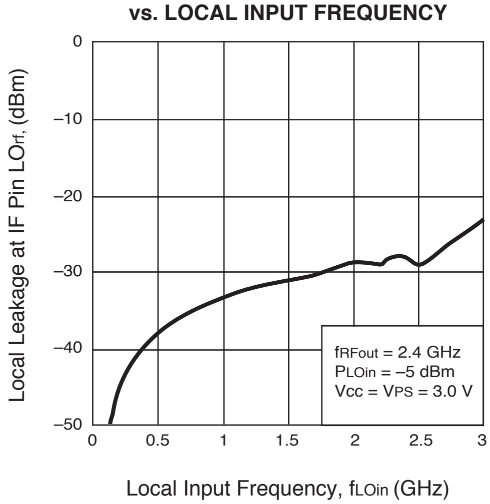
LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT FREQUENCY



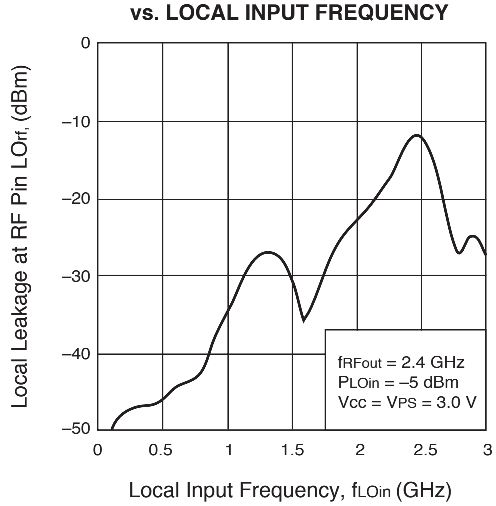
LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT FREQUENCY



LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT FREQUENCY

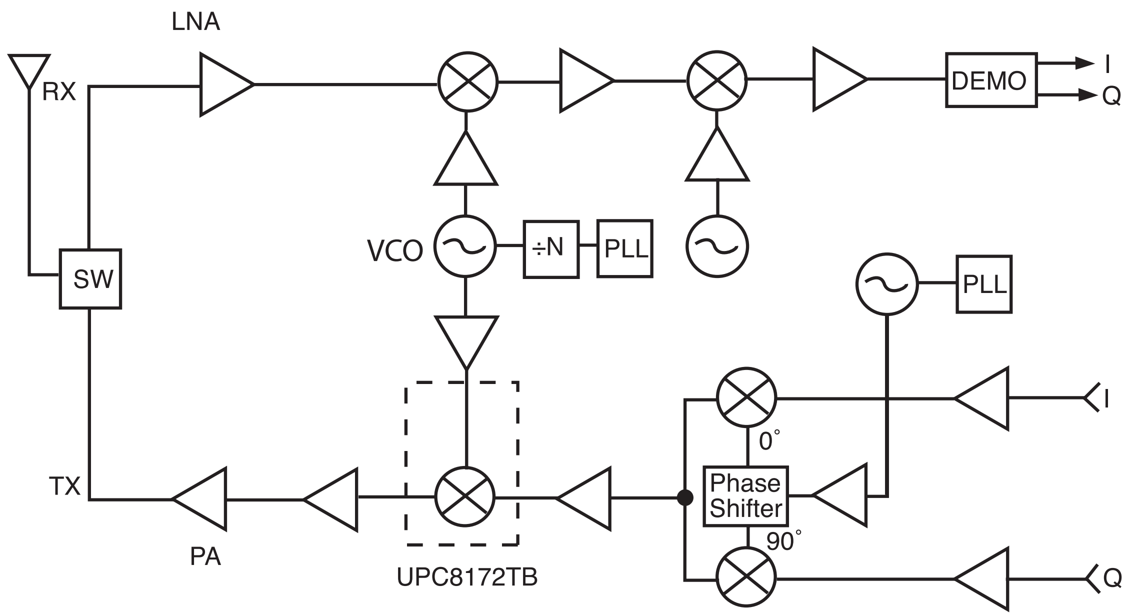


LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT FREQUENCY



SYSTEM APPLICATION EXAMPLE

Wireless Transceiver

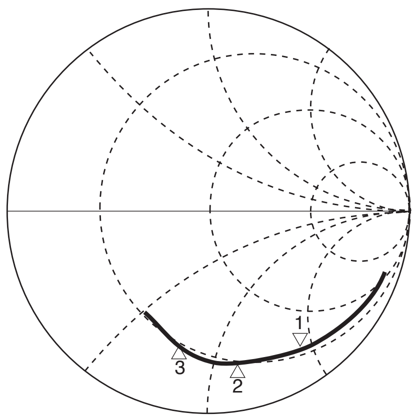


S-PARAMETERS FOR EACH PORT (V_{CC} = V_{PS} = V_{RFout} = 3.0 V)

(The paramters are monitored at DUT pins)

LO port

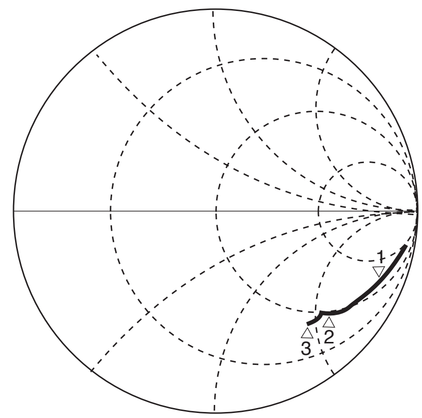
S_{11} Z
REF 1.0 Units
1 200.0 mUnits/
21.625 Ω -91.148 Ω
∇ *hp*
MARKER 1
1.15 GHz
MARKER 2
1.65 GHz
MARKER 3
2.15 GHz



START 0.400000000 GHz
STOP 2.500000000 GHz

RF port (without matching)

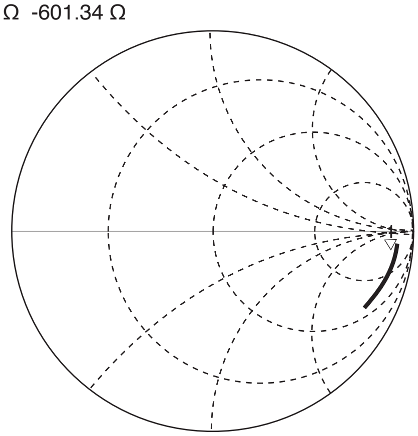
S_{22} Z
REF 1.0 Units
1 200.0 mUnits/
∇ 71.5 Ω -240.34 Ω
hp
MARKER 1
900 MHz
MARKER 2
1.9 GHz
MARKER 3
2.5 GHz



START 0.400000000 GHz
STOP 2.500000000 GHz

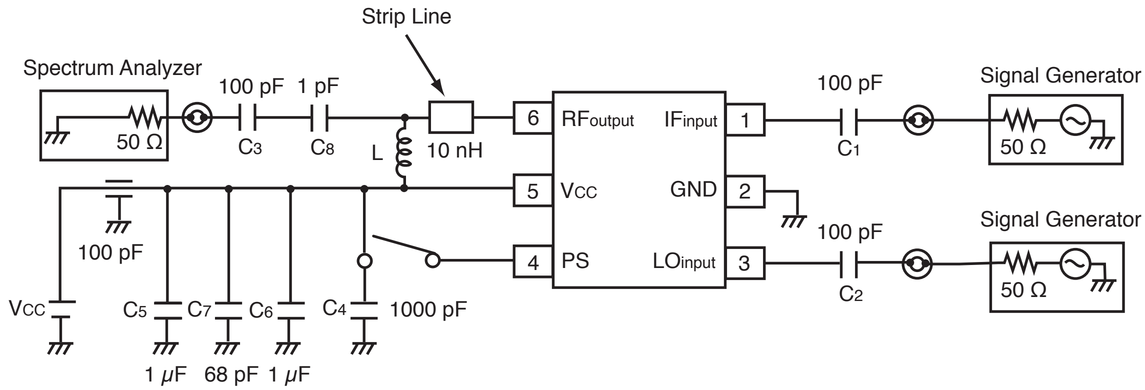
IF port

S_{11} Z
REF 1.0 Units
1 200.0 mUnits/
∇ 332.63 Ω -601.34 Ω
hp
MARKER 1
240.0 MHz

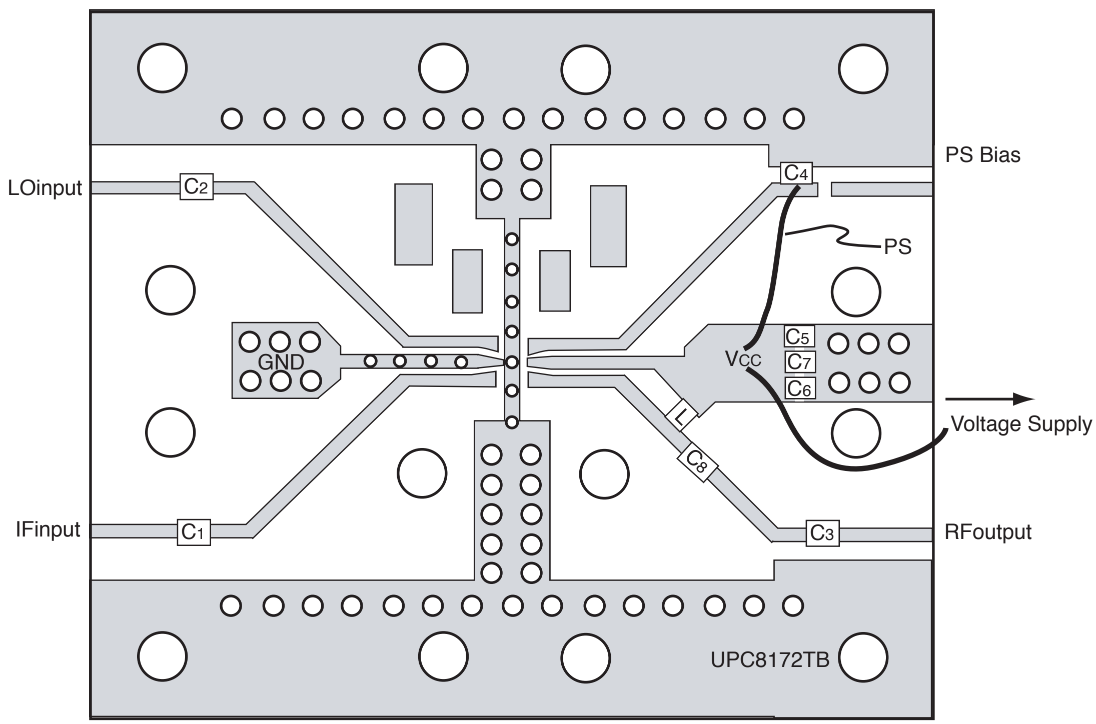


START 0.100000000 GHz
STOP 1.000000000 GHz

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



EXAMPLE OF TEST CIRCUIT 1 ASSEMBLED ON EVALUATION BOARD



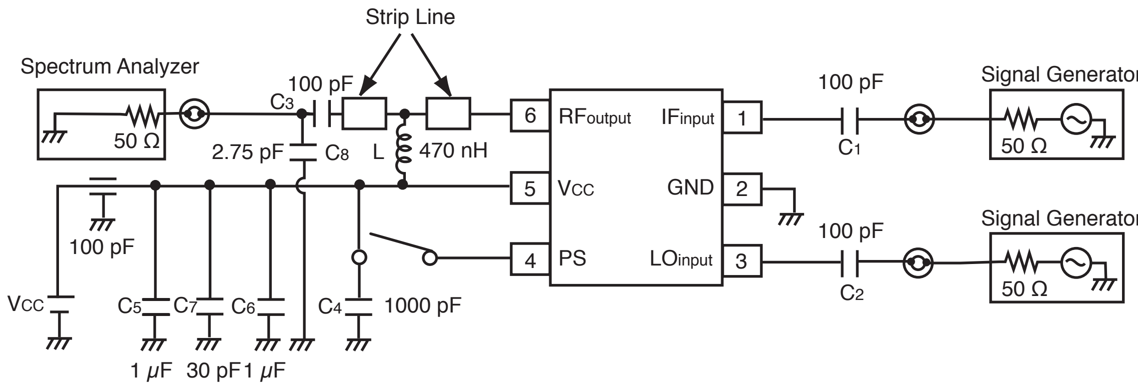
COMPONENT LIST

FORM	SYMBOL	VALUE
Chip Capacitor	C_1, C_2, C_3	100 pF
	C_4	1000 pF
	C_5, C_6	1 μF
	C_7	68 pF
	C_8	1 pF
Chip Inductor	L	10 nH[1]

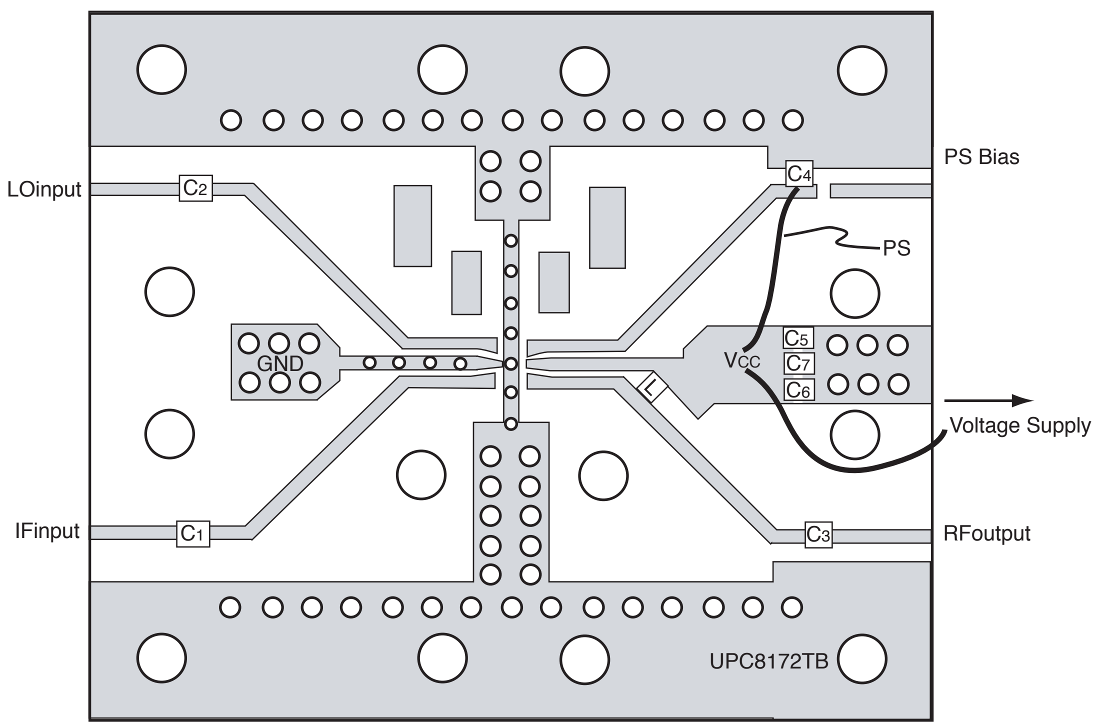
Note:
1. 10 nH: LL1608-FH10N (TOKO Co., Ltd.)

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

TEST CIRCUIT 2 (f_{RFout} = 1.9 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 μF
	C7	30 pF
	C8	2.75 pF
Chip Inductor	L	470 nH[1]

Note:

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

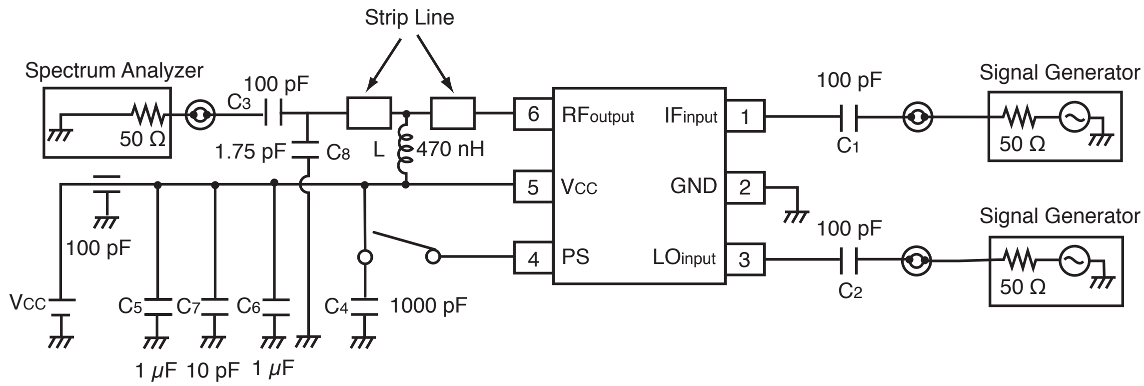
(*1) 35 x 42 x 0.4 mm polymide board, double-sided copper clad

(*2) Ground pattern on rear of the board

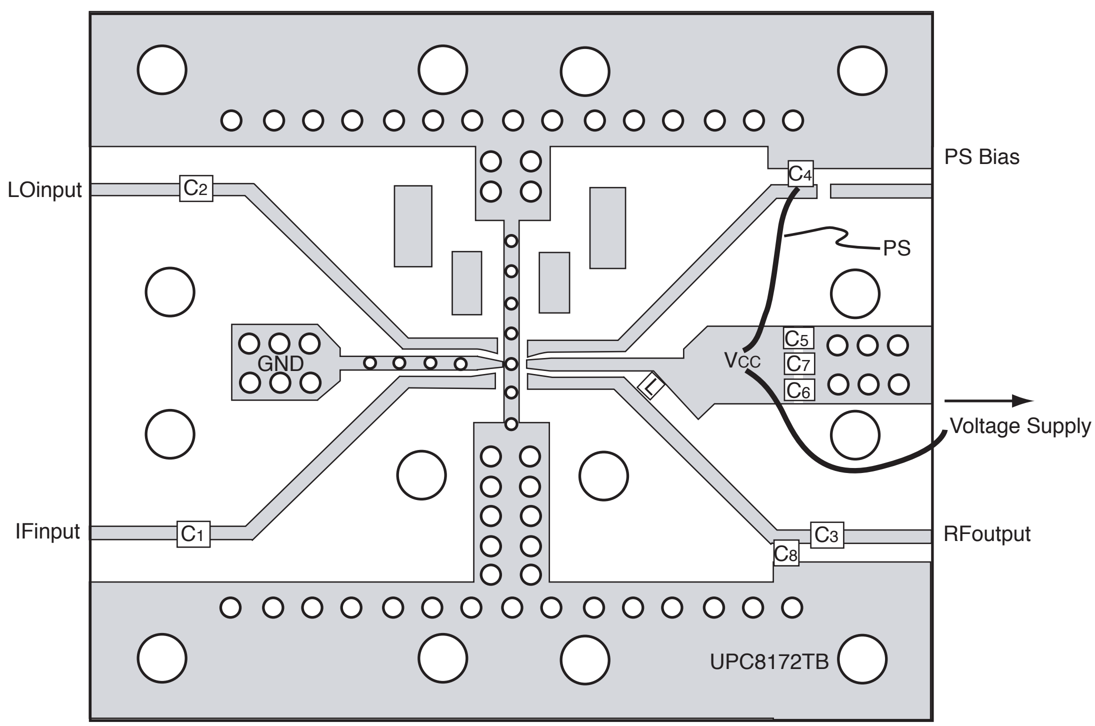
(*3) Solder plated patterns

(*4) ○○: Through holes

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



EXAMPLE OF TEST CIRCUIT 3 ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

FORM	SYMBOL	VALUE
Chip Capacitor	C_1, C_2, C_3	100 pF
	C_4	1000 pF
	C_5, C_6	1 μF
	C_7	10 pF
	C_8	1.75 pF
Chip Inductor	L	470 nH[1]

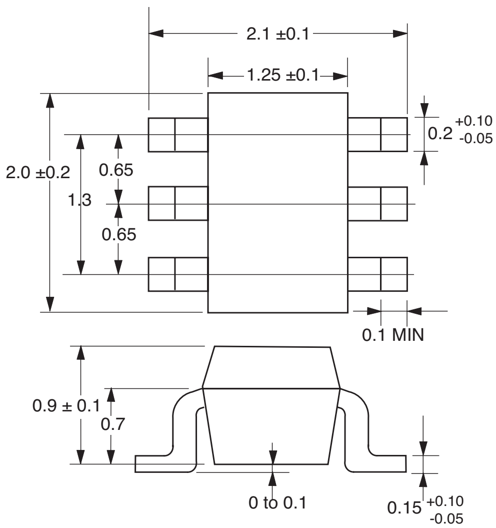
Note:

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

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

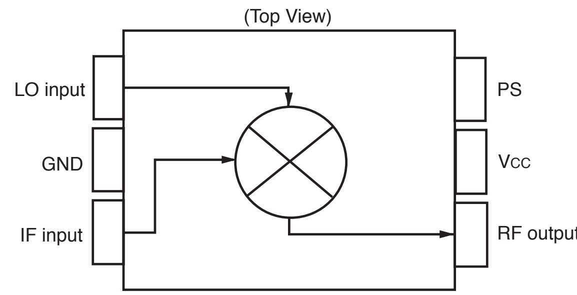
OUTLINE DIMENSIONS (Units in mm)

PACKAGE OUTLINE S06

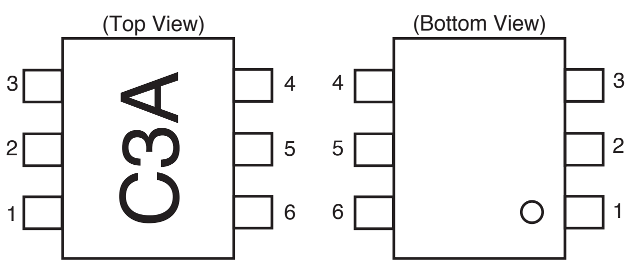


Note:
All dimensions are typical unless otherwise specified.

BLOCK DIAGRAM



PIN CONNECTIONS



PIN NO.	PIN NAME
1	IF_{input}
2	GND
3	LO_{input}
4	PS
5	V_{CC}
6	RF_{output}

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.

EXCLUSIVE NORTH AMERICAN AGENT FOR NEC RF, MICROWAVE & OPTOELECTRONIC SEMICONDUCTORS
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 06/14/2001

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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.

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