

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# $\mu$ PC8163TB

## SILICON MMIC 2.0 GHz FREQUENCY UP-CONVERTER FOR CELLULAR TELEPHONE

### DESCRIPTION

The  $\mu$ PC8163TB is a silicon monolithic integrated circuit designed as frequency up-converter for cellular telephone transmitter stage. The  $\mu$ PC8163TB has improved intermodulation performance and smaller package.

The  $\mu$ PC8163TB is manufactured using NEC's 20 GHz fr NESAT™III silicon bipolar process. This process uses silicon nitride passivation film and gold electrodes. These materials can protect chip surface from external pollution and prevent corrosion/migration. Thus, this IC has excellent performance, uniformity and reliability.

### FEATURES

- Recommended operating frequency :  $f_{RFout} = 0.8 \text{ GHz to } 2.0 \text{ GHz}$ ,  $f_{iFin} = 50 \text{ MHz to } 300 \text{ MHz}$
- Supply voltage :  $V_{CC} = 2.7 \text{ to } 3.3 \text{ V}$
- High-density surface mounting : 6-pin super minimold package
- Higher  $IP_3$  :  $OIP_3 = +9.5 \text{ dBm @ } f_{RFout} = 830 \text{ MHz}$
- Minimized carrier leakage : Due to double balanced mixer

### APPLICATIONS

- Digital cellular phones

### ORDERING INFORMATION

Part Number	Package	Supplying Form
$\mu$ PC8163TB-E3	6-pin super minimold	Embossed tape 8 mm wide. Pin 1, 2, 3 face to tape perforation side. Qty 3 kp/reel

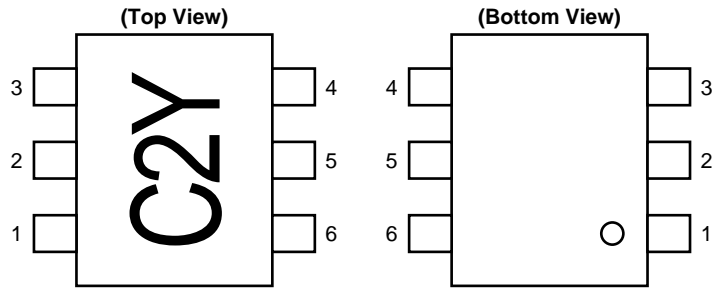
**Remark** To order evaluation samples, please contact your local NEC sales office.  
(Part number for sample order:  $\mu$ PC8163TB)

### Caution Electro-static sensitive device

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

**PIN CONNECTIONS**



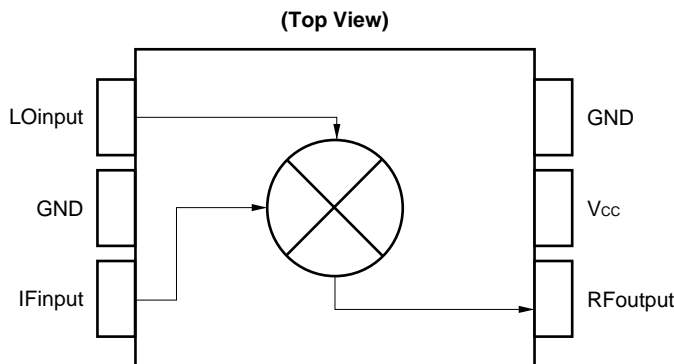
Pin No.	Pin Name
1	IFinput
2	GND
3	LOinput
4	GND
5	V <sub>CC</sub>
6	RFoutput

**SERIES PRODUCTS (T<sub>A</sub> = +25°C, V<sub>CC</sub> = V<sub>RFout</sub> = 3.0 V, Z<sub>L</sub> = Z<sub>S</sub> = 50 Ω)**

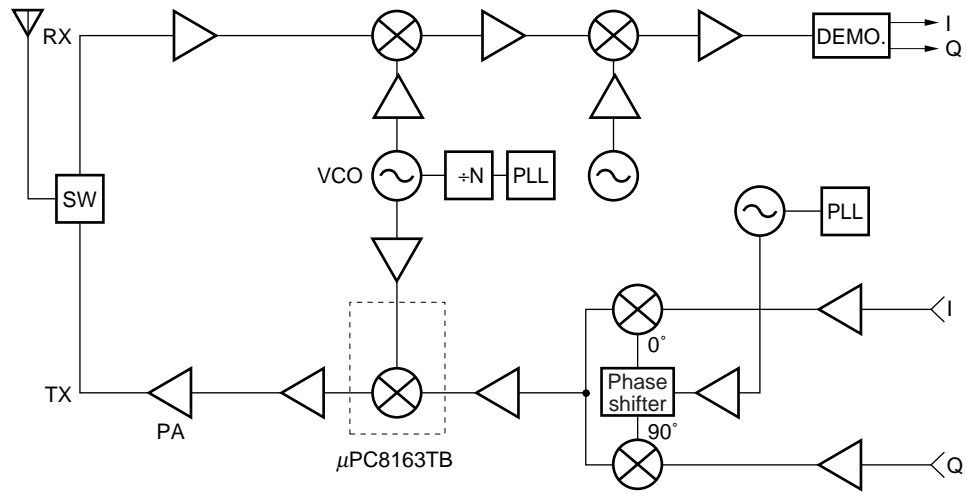
Type	Part No.	V <sub>CC</sub> (V)	I <sub>CC</sub> (mA)	CG1 (dB)	CG2 (dB)	P <sub>O(sat)</sub> 1 (dBm)	P <sub>O(sat)</sub> 2 (dBm)	OIP <sub>3</sub> 1 (dBm)	OIP <sub>3</sub> 2 (dBm)
High IP <sub>3</sub>	$\mu$ PC8106TB	2.7 to 5.5	9	9	7	-2	-4	+5.5	+2.0
Low Power Consumption	$\mu$ PC8109TB	2.7 to 5.5	5	6	4	-5.5	-7.5	+1.5	-1.0
Higher IP <sub>3</sub>	$\mu$ PC8163TB	2.7 to 3.3	16.5	9	5.5	0.5	-2	+9.5	+6.0

**Caution** The above table lists the typical performance of each model. See ELECTRICAL CHARACTERISTICS for the test conditions.

**BLOCK DIAGRAM (FOR THE  $\mu$ PC8163TB)**



SYSTEM APPLICATION EXAMPLES (SCHEMATICS OF IC LOCATION IN THE SYSTEM)



**PIN EXPLANATION**

Pin No.	Pin Name	Applied Voltage V	Pin Voltage V <sup>Note</sup>	Function and Explanation	Equivalent Circuit
1	IFinput	—	1.2	This pin is IF input to double balanced mixer (DBM). The input is designed as high impedance. The circuit contributes to suppress spurious signal. Also this symmetrical circuit can keep specified performance insensitive to process-condition distribution. For above reason, double balanced mixer is adopted.	
2 4	GND	0	—	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 impedance.	
3	LOinput	—	2.1	Local input pin. Recommendable input level is -10 to 0 dBm.	
5	V <sub>CC</sub>	2.7 to 3.3	—	Supply voltage pin.	
6	RFoutput	Same bias as V <sub>CC</sub> through external inductor	—	This pin is RF output from DBM. This pin is designed as open collector. Due to the high impedance output, this pin should be externally equipped with LC matching circuit to next stage.	

**Note** Each pin voltage is measured with  $V_{CC} = V_{RFout} = 3.0\text{ V}$ .

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Test Conditions	Rating	Unit
Supply Voltage	V <sub>CC</sub>	T <sub>A</sub> = +25°C, Pin 5 and 6	3.6	V
Power Dissipation of Package	P <sub>D</sub>	Mounted on double-sided copperclad 50 × 50 × 1.6 mm epoxy glass PWB T <sub>A</sub> = +85°C	200	mW
Operating Ambient Temperature	T <sub>A</sub>		-40 to +85	°C
Storage Temperature	T <sub>stg</sub>		-55 to +150	°C
Maximum Input Power	P <sub>in</sub>		+10	dBm

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Supply Voltage	V <sub>CC</sub>	The same voltage should be applied to pin 5 and 6	2.7	3.0	3.3	V
Operating Ambient Temperature	T <sub>A</sub>		-40	+25	+85	°C
Local Input Level	P <sub>LOin</sub>	Z <sub>s</sub> = 50 Ω (without matching)	-10	-5	0	dBm
RF Output Frequency	f <sub>RFout</sub>	With external matching circuit	0.8	-	2.0	GHz
IF Input Frequency	f <sub>IFin</sub>		50	-	300	MHz

**ELECTRICAL CHARACTERISTICS**

(T<sub>A</sub> = +25°C, V<sub>CC</sub> = V<sub>RFout</sub> = 3.0 V, f<sub>IFin</sub> = 150 MHz, P<sub>LOin</sub> = -5 dBm)

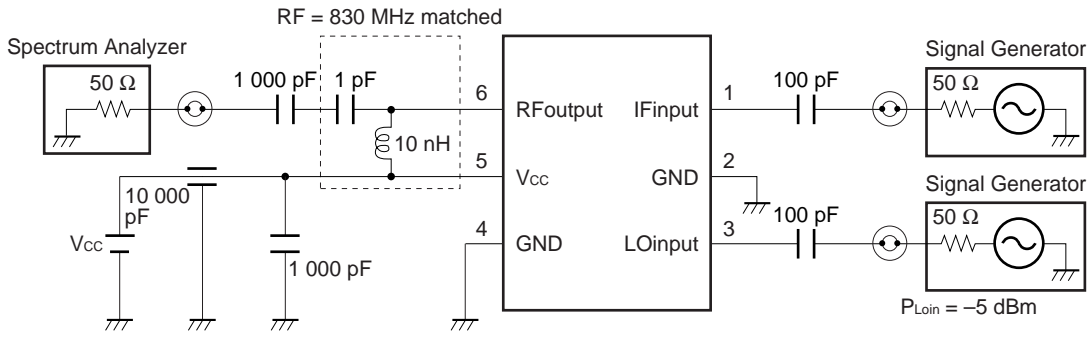
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I <sub>CC</sub>	No Signal	11.5	16.5	23	mA
Conversion Gain 1	CG1	f <sub>RFout</sub> = 830 MHz, P <sub>IFin</sub> = -20 dBm	6	9	12	dB
Conversion Gain 2	CG2	f <sub>RFout</sub> = 1.9 GHz, P <sub>IFin</sub> = -20 dBm	2.5	5.5	8.5	dB
Maximum RF Output Power 1	P <sub>O(sat) 1</sub>	f <sub>RFout</sub> = 830 MHz, P <sub>IFin</sub> = 0 dBm	-1.5	0.5	-	dBm
Maximum RF Output Power 2	P <sub>O(sat) 2</sub>	f <sub>RFout</sub> = 1.9 GHz, P <sub>IFin</sub> = 0 dBm	-4.5	-2	-	dBm

**OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY**

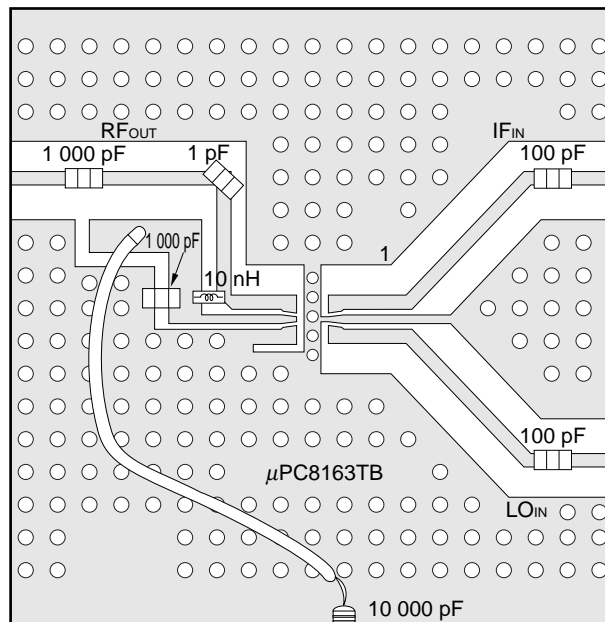
(T<sub>A</sub> = +25°C, V<sub>CC</sub> = V<sub>RFout</sub> = 3.0 V, P<sub>LOin</sub> = -5 dBm)

Parameter	Symbol	Conditions	Data	Unit	
Input Third Order Distortion Intercept Point	IIP <sub>3 1</sub>	f <sub>IFin1</sub> = 150.0 MHz	f <sub>RFout</sub> = 830 MHz	0.5	dBm
	IIP <sub>3 2</sub>	f <sub>IFin2</sub> = 150.4 MHz	f <sub>RFout</sub> = 1.9 GHz	0.5	
Output Third-Order Distortion Intercept Point	OIP <sub>3 1</sub>	f <sub>IFin1</sub> = 150.0 MHz	f <sub>RFout</sub> = 830 MHz	+9.5	dBm
	OIP <sub>3 2</sub>	f <sub>IFin2</sub> = 150.4 MHz	f <sub>RFout</sub> = 1.9 GHz	+6.0	
SSB Noise Figure	SSB NF	f <sub>RFout</sub> = 830 MHz, f <sub>IFin</sub> = 150 MHz	12.5	dB	

**TEST CIRCUIT 1 (f<sub>RFout</sub> = 830 MHz)**



**ILLUSTRATION OF TEST CIRCUIT 1 ASSEMBLED ON EVALUATION BOARD**



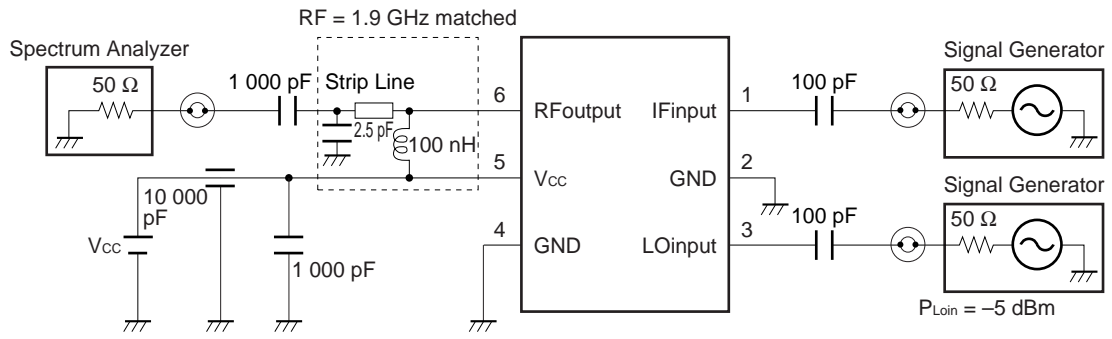
**EVALUATION BOARD CHARACTERS**

- (1) 35 μm thick double-sided copper clad 35 × 42 × 0.4 mm polyimide board
- (2) Back side: GND pattern
- (3) Solder plated patterns
- (4) ○: Through holes

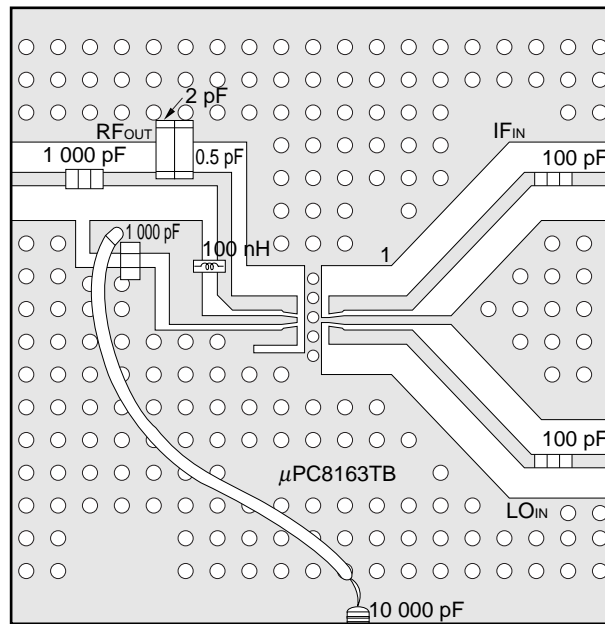
**ATTENTION** Test circuit or print pattern in this sheet is for testing IC characteristics.

In the case of actual system application, external circuits including print pattern and matching circuit constant of output port should be designed in accordance with IC's S parameters and environmental components.

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



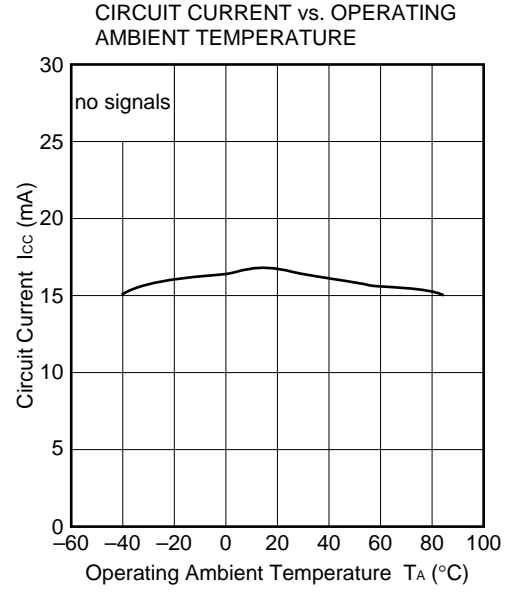
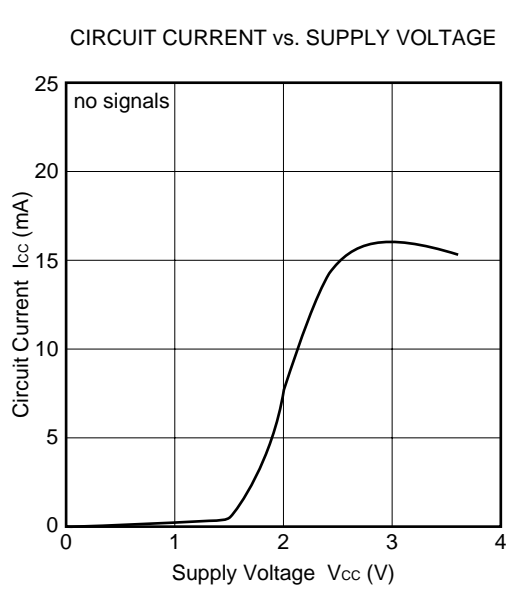
★ **ILLUSTRATION OF TEST CIRCUIT 2 ASSEMBLED ON EVALUATION BOARD**



**EVALUATION BOARD CHARACTERS**

- (1) 35  $\mu$ m thick double-sided copper clad 35 × 42 × 0.4 mm polyimide board
- (2) Back side: GND pattern
- (3) Solder plated patterns
- (4) o○: Through holes

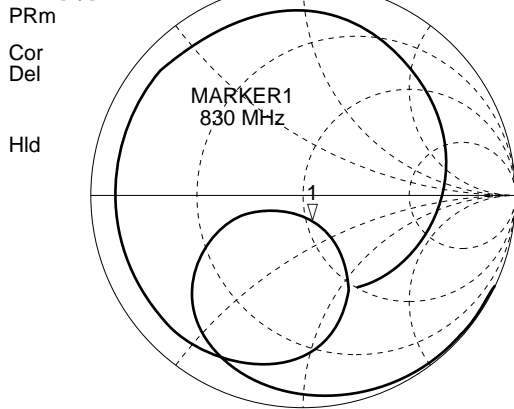
★ TYPICAL CHARACTERISTICS (T<sub>A</sub> = +25°C, unless otherwise specified V<sub>CC</sub> = V<sub>RFout</sub>)



★ S-PARAMETER FOR MATCHED RF OUTPUT (V<sub>CC</sub> = V<sub>RFout</sub> = 3.0 V) – with TEST CIRCUITS 1 and 2 – (monitored at RF connector on board)

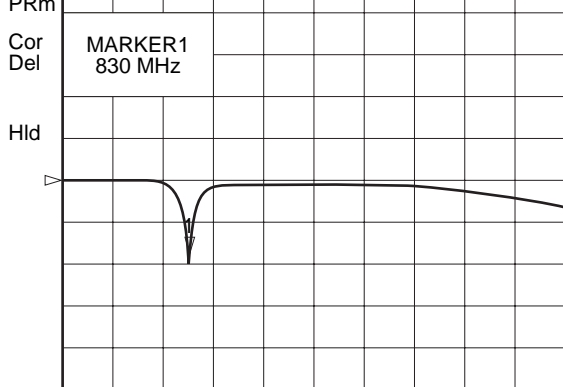
- RF output matched at 830 MHz

CH1 S<sub>11</sub> 1 U FS 1; 53.422 Ω -14.973 Ω 12.807 pF  
[hp] 830.000 000 MHz



START 100.000 000 MHz STOP 3 000.000 000 MHz

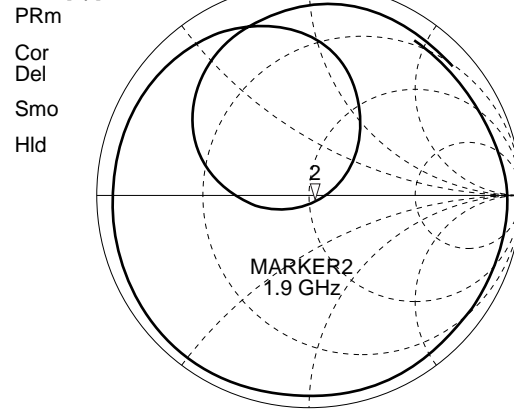
CH1 S<sub>11</sub> log MAG 10 dB/ REF 0 dB 1; -17.331 dB  
[hp] 830.000 000 MHz



START 100.000 000 MHz STOP 3 000.000 000 MHz

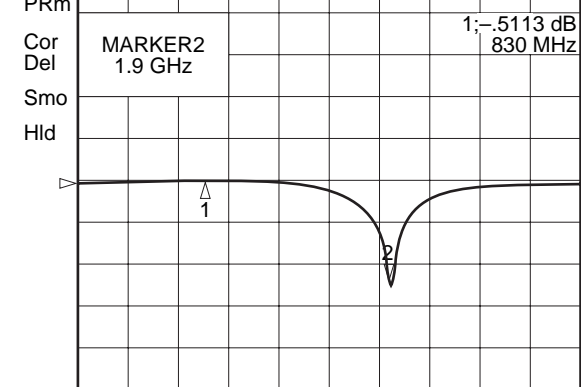
- RF output matched at 1.9 GHz

CH1 S<sub>11</sub> 1 U FS 2; 53.846 Ω -3.7441 Ω 22.373 pF  
[hp] 1 900.000 000 MHz



START 100.000 000 MHz STOP 3 000.000 000 MHz

CH1 S<sub>11</sub> log MAG 10 dB/ REF 0 dB 2; -24.741 dB  
[hp] 1 900.000 000 MHz

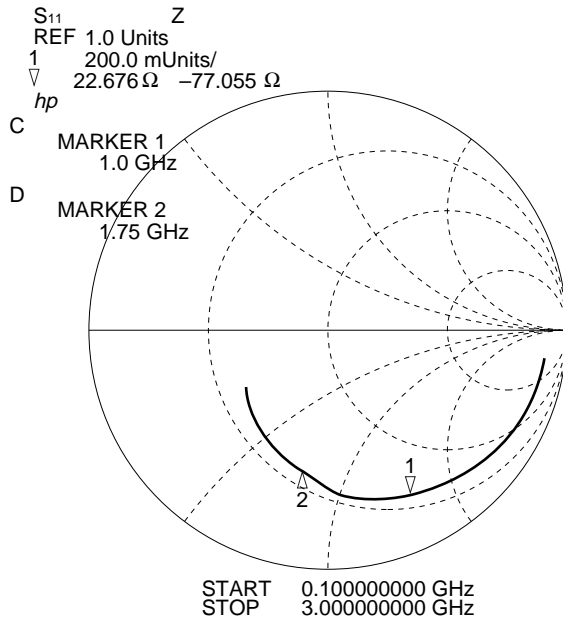


START 100.000 000 MHz STOP 3 000.000 000 MHz

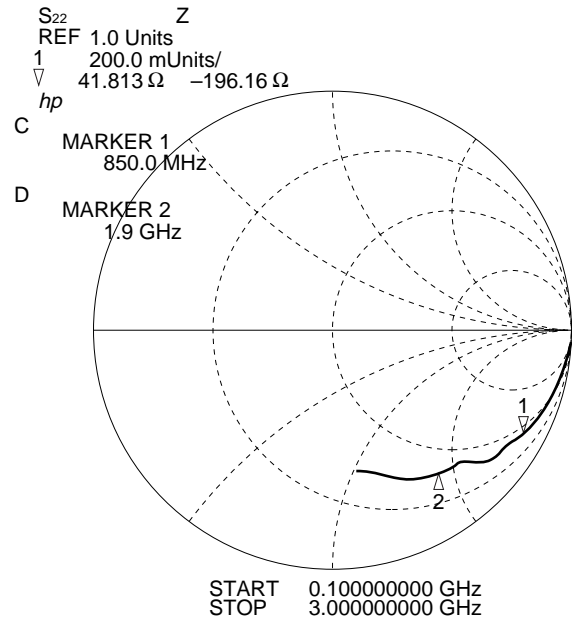


★ S-PARAMETERS FOR EACH PORT ( $V_{CC} = V_{RFout} = 3.0\text{ V}$ )

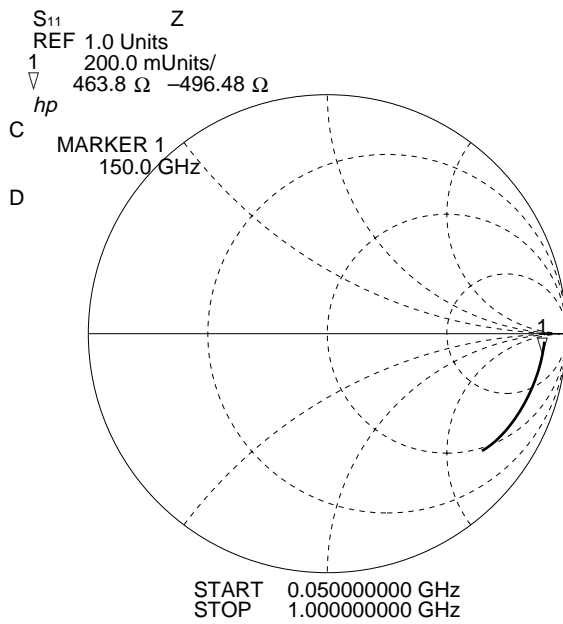
LO port



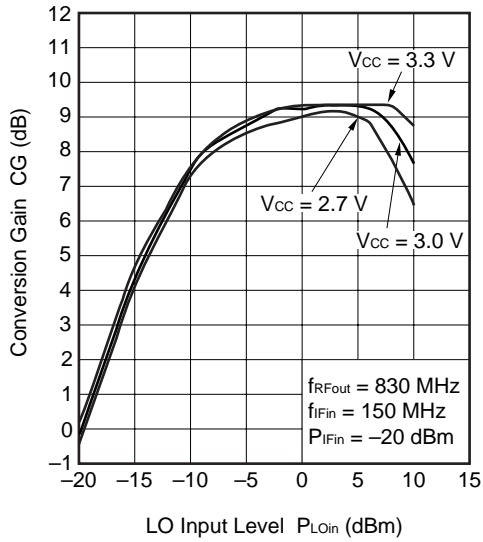
RF port (no matching)



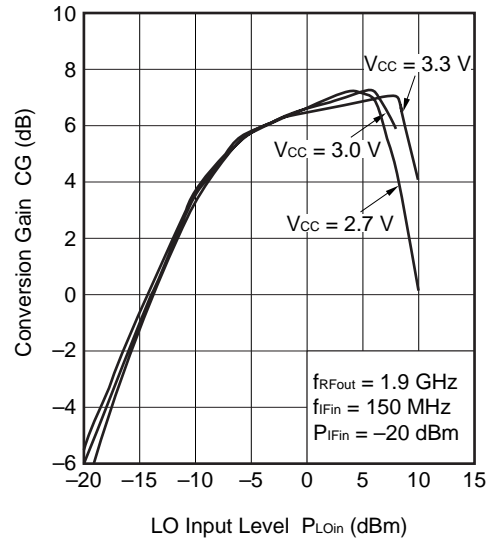
IF port



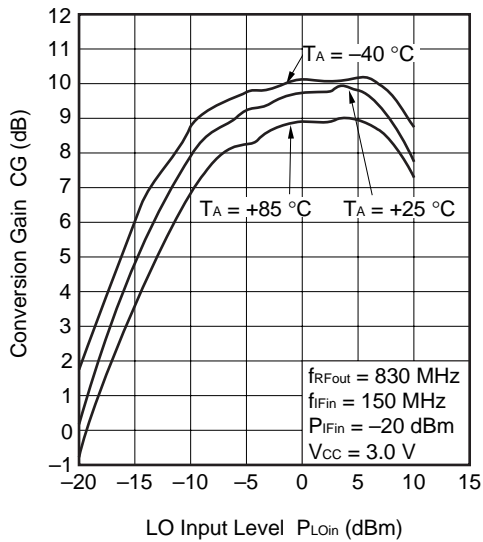
CONVERSION GAIN vs. LO INPUT LEVEL



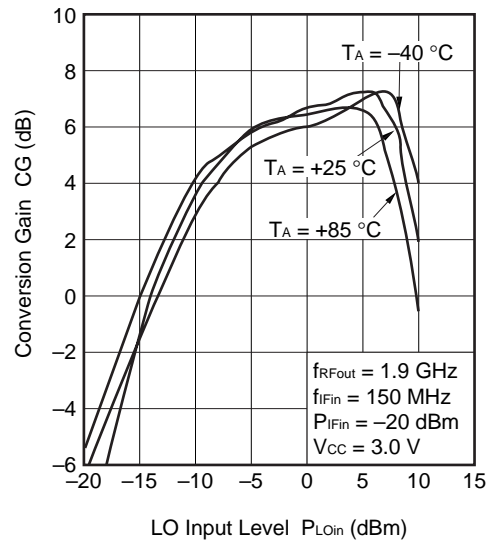
CONVERSION GAIN vs. LO INPUT LEVEL

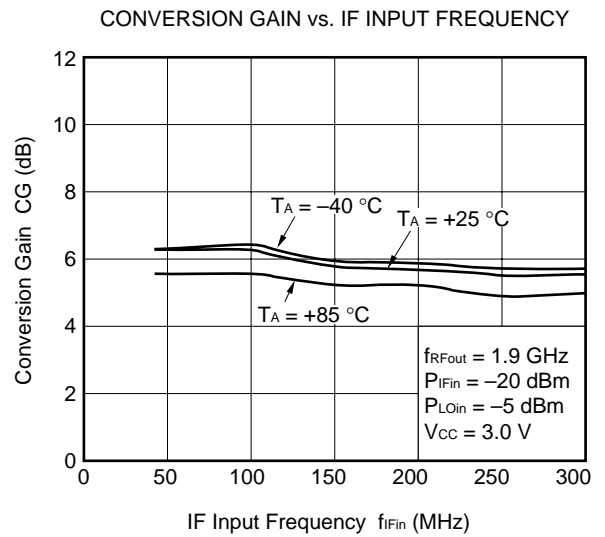
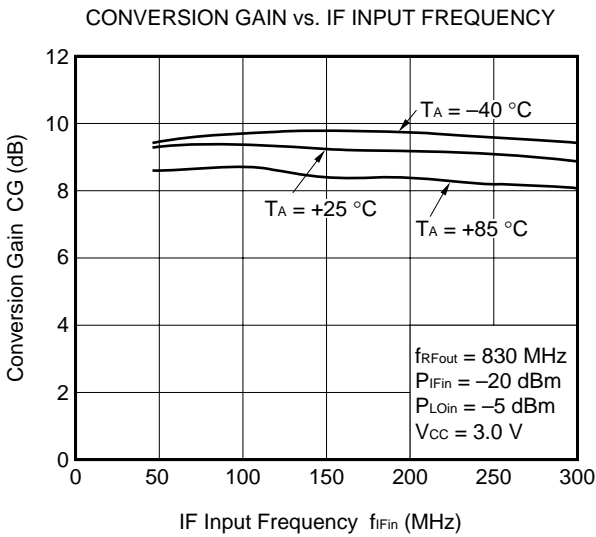
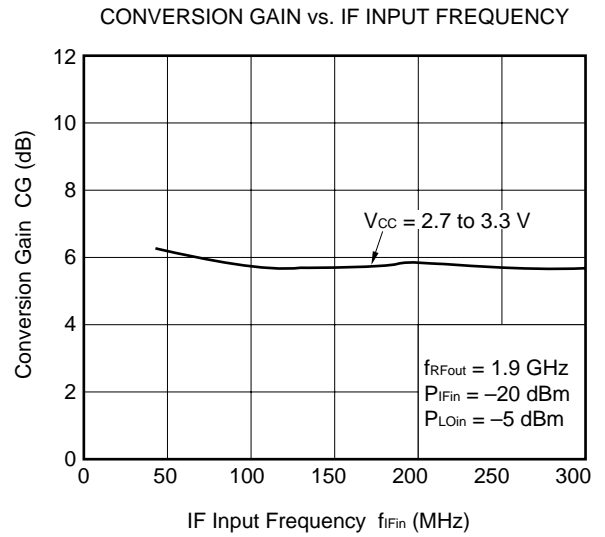
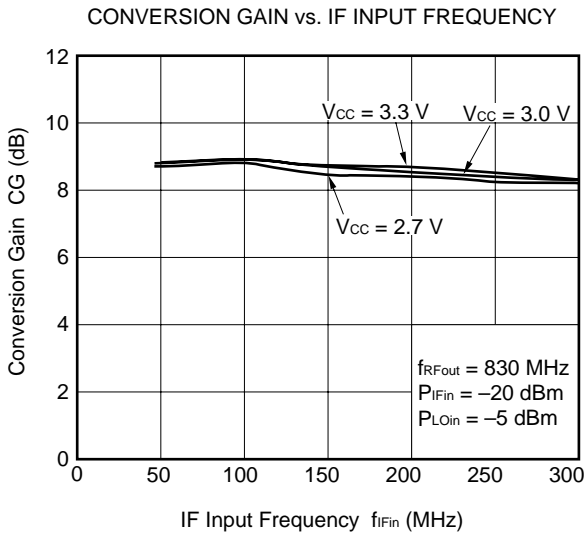


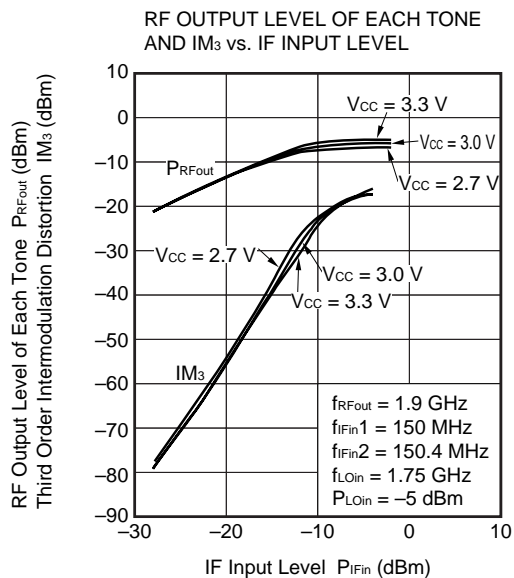
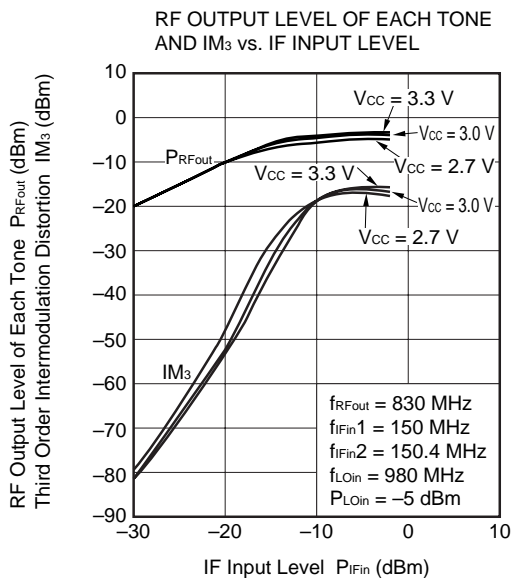
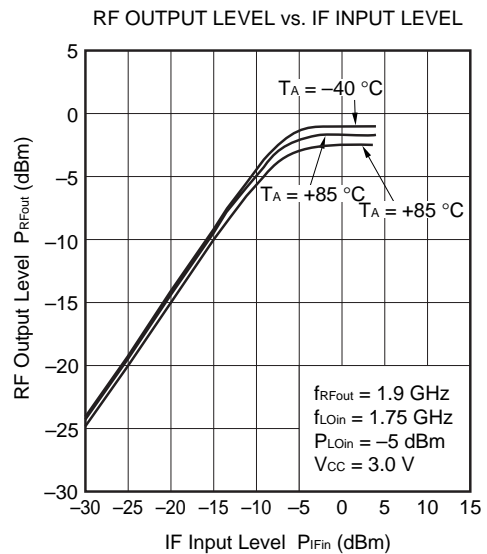
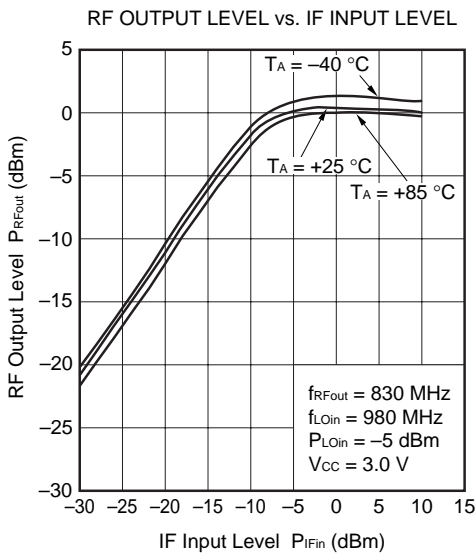
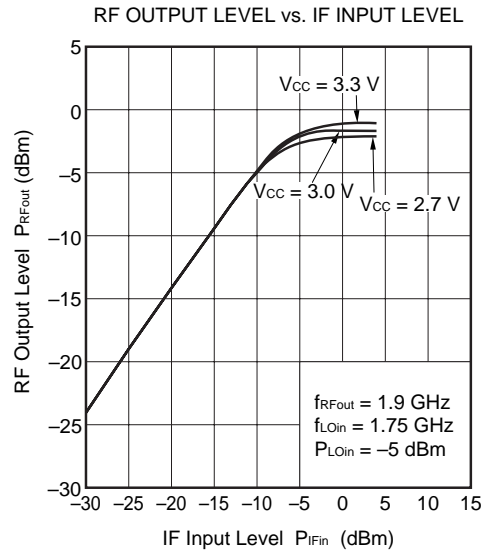
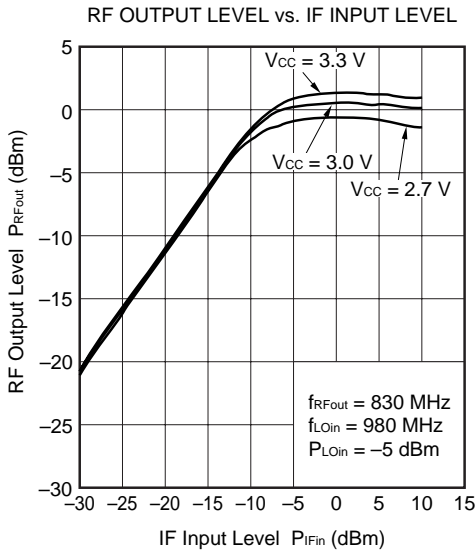
CONVERSION GAIN vs. LO INPUT LEVEL



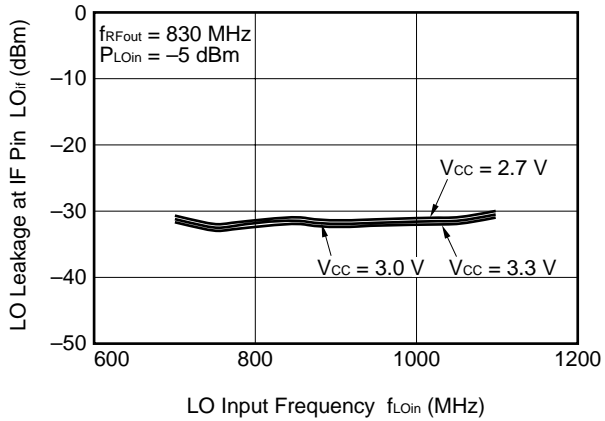
CONVERSION GAIN vs. LO INPUT LEVEL



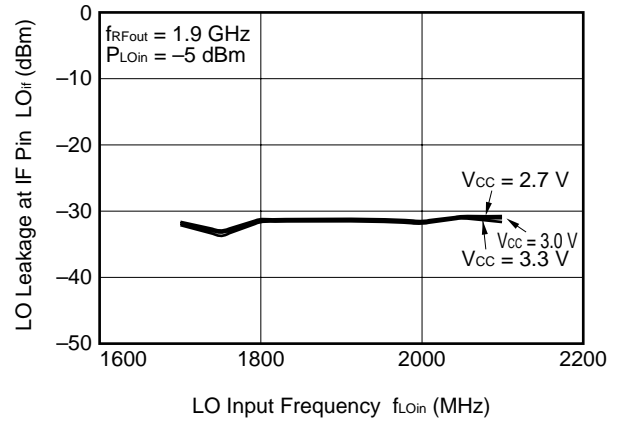




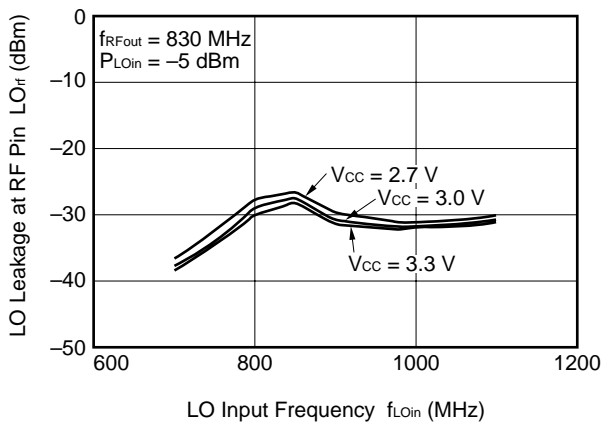
LO LEAKAGE AT IF PIN vs. LO INPUT FREQUENCY



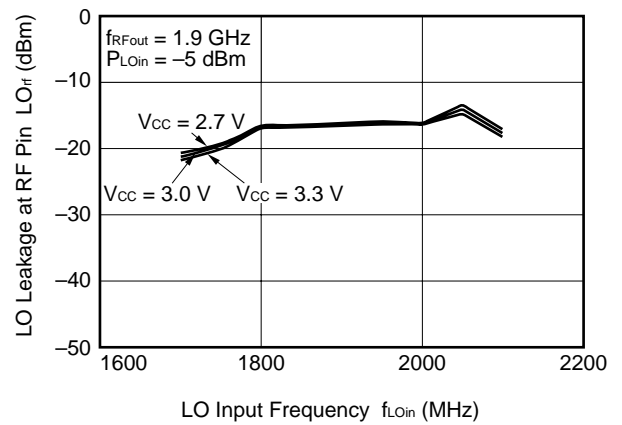
LO LEAKAGE AT IF PIN vs. LO INPUT FREQUENCY



LO LEAKAGE AT RF PIN vs. LO INPUT FREQUENCY

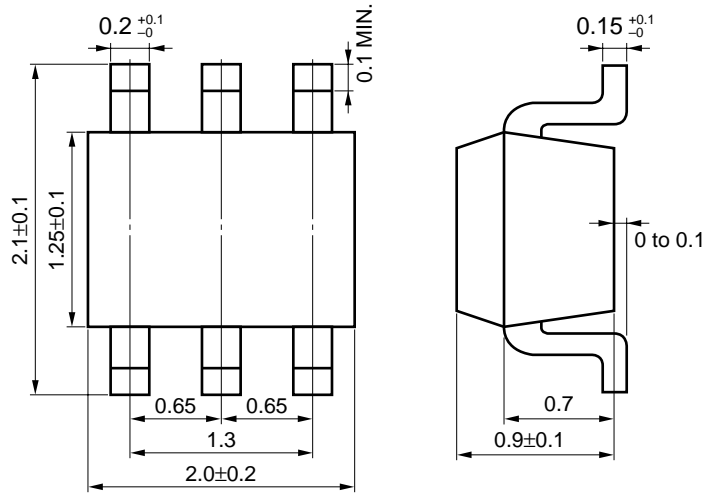


LO LEAKAGE AT RF PIN vs. LO INPUT FREQUENCY



PACKAGE DIMENSIONS

6 pin super minimold (Unit: mm)



**NOTE ON CORRECT USE**

- (1) Observe precautions for handling because of electrostatic sensitive devices.
- (2) Form a ground pattern as wide as possible to keep the minimum ground impedance (to prevent undesired oscillation).
- (3) Keep the track length of the ground pins as short as possible.
- (4) Connect a bypass capacitor (example: 1 000 pF) to the Vcc pin.

**RECOMMENDED SOLDERING CONDITIONS**

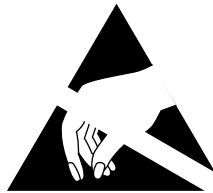
This product should be soldered under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your NEC sales representative.

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared Reflow	Package peak temperature: 235 °C or below Time: 30 seconds or less (at 210 °C) Count: 3, Exposure limit: None <sup>Note</sup>	IR35-00-3
VPS	Package peak temperature: 215 °C or below Time: 40 seconds or less (at 200 °C) Count: 3, Exposure limit: None <sup>Note</sup>	VP15-00-3
Wave Soldering	Soldering bath temperature: 260 °C or below Time: 10 seconds or less Count: 1, Exposure limit: None <sup>Note</sup>	WS60-00-1
Partial Heating	Pin temperature: 300 °C Time: 3 seconds or less (per side of device) Exposure limit: None <sup>Note</sup>	—

**Note** After opening the dry pack, keep it in a place below 25 °C and 65 % RH for the allowable storage period.

**Caution** Do not use different soldering methods together (except for partial heating).

For details of recommended soldering conditions for surface mounting, refer to information document SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL (C10535E).



## ATTENTION

OBSERVE PRECAUTIONS  
FOR HANDLING  
ELECTROSTATIC  
SENSITIVE  
DEVICES

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Specific: Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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