NEC

BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC8163TB

SILICON MMIC 2.0 GHz FREQUENCY UP-CONVERTER FOR CELLULAR TELEPHONE

DESCRIPTION

The μPC8163TB is a silicon monolithic integrated circuit designed as frequency up-converter for cellular telephone transmitter stage. The μPC8163TB has improved intermodulation performance and smaller package.

The μPC8163TB is manufactured using NEC's 20 GHz f_T NESAT™lll 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 to 2.0 GHz, f_{IFin} = 50 to 300 MHz
- Supply voltage : V_{CC} = 2.7 to 3.3 V
- High-density surface mounting : 6-pin super minimold package
- Higher IP_3 : OIP_3 = +9.5 dBm @ f_{RFout} = 830 MHz
- Minimized carrier leakage : Due to double balanced mixer

APPLICATION

- Digital cellular phones

ORDERING INFORMATION

Part Number	Package	Marking	Supplying Form
μPC8163TB-E3	6-pin super minimold	C2Y	Embossed tape 8 mm wide. Pin 1, 2, 3 face the tape perforation side. Qty 3 kpcs/reel

Remark To order evaluation samples, please contact your local NEC sales office (Part number for sample order: μPC8163TB).

Caution Electro-static sensitive devices

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The mark ★ shows major revised points.

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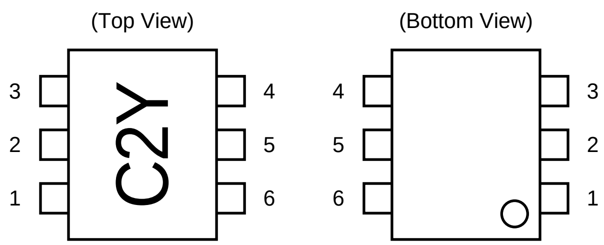
1. PIN CONNECTIONS



Pin No.	Pin Name
1	IFinput
2	GND
3	LOinput
4	GND
5	V_{CC}
6	RFoutput

★ ## 2. PRODUCT LINE-UP (T_A = +25°C, V_{CC} = V_{RFout} = 3.0 V, Z_S = Z_L = 50 Ω)

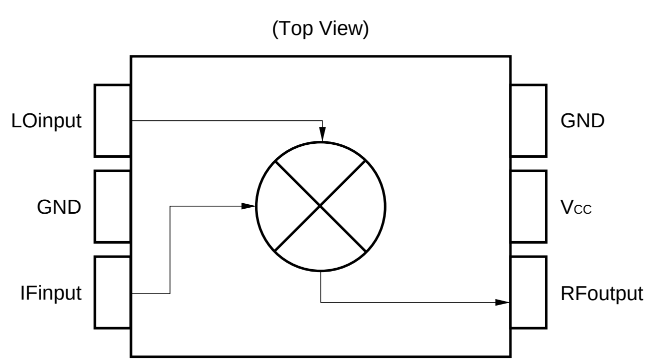
Part Number	I_{CC} (mA)	f_{RFout} (GHz)	CG (dB)		
			@RF 0.9 GHz[Note]	@RF 1.9 GHz	@RF 2.4 GHz
μPC8106TB	9	0.4 to 2.0	9	7	–
μPC8109TB	5	0.4 to.2.0	6	4	–
μPC8163TB	16.5	0.8 to 2.0	9	5.5	–
μPC8172TB	9	0.8 to 2.5	9.5	8.5	8.0
μPC8187TB	15	0.8 to 2.5	11	11	10

Part Number	$P_{O(sat)}$ (dBm)			OIP_3 (dBm)		
	@RF 0.9 GHz[Note]	@RF 1.9 GHz	@RF 2.4 GHz	@RF 0.9 GHz[Note]	@RF 1.9 GHz	@RF 2.4 GHz
μPC8106TB	–2	–4	–	+5.5	+2.0	–
μPC8109TB	–5.5	–7.5	–	+1.5	–1.0	–
μPC8163TB	+0.5	–2	–	+9.5	+6.0	–
μPC8172TB	+0.5	0	–0.5	+7.5	+6.0	+4.0
μPC8187TB	+4	+2.5	+1	+10	+10	+8.5

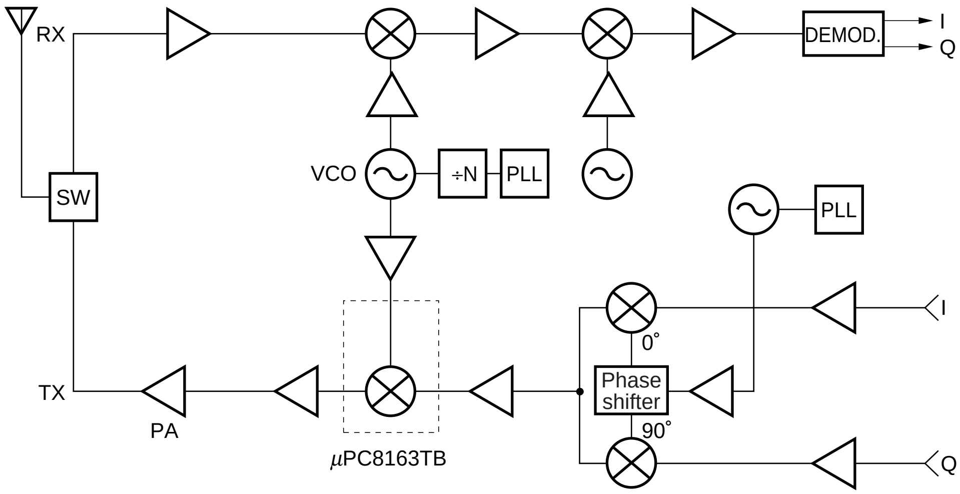
Note f_{RFout} = 0.83 GHz @ μPC8163TB and μPC8187TB

Remark Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail.
To know the associated product, please refer to each latest data sheet.

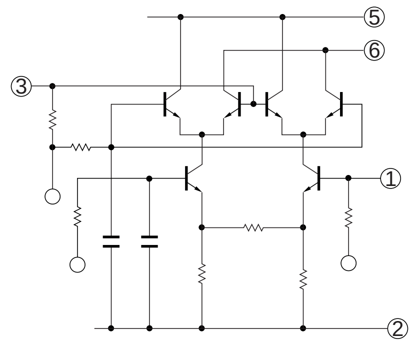
3. INTERNAL BLOCK DIAGRAM (for the μPC8163TB)



4. SYSTEM APPLICATION EXAMPLE (schematics of IC location in the system)



5. PIN EXPLANATION

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)Note	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	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 impedance.	
3	LOinput	—	2.1	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 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 at $V_{CC} = V_{RFout} = 3.0$ V.

6. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Rating	Unit
Supply Voltage	V_{CC}	T_A = +25°C, Pin 5 and 6	3.6	V
★ Package Power Dissipation	P_D	Mounted on double-sided copperclad 50 × 50 × 1.6 mm epoxy glass PWB T_A = +85°C	270	mW
Operating Ambient Temperature	T_A		–40 to +85	°C
Storage Temperature	T_{stg}		–55 to +150	°C
Maximum Input Power	P_{in}		+10	dBm

7. RECOMMENDED OPERATING RANGE

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
Supply Voltage	V_{CC}	2.7	3.0	3.3	V	The same voltage should be applied to pin 5 and 6
Operating Ambient Temperature	T_A	–40	+25	+85	°C	
Local Input Power	P_{LOin}	–10	–5	0	dBm	Z_S = 50 Ω (without matching)
RF Output Frequency	f_{RFout}	0.8	–	2.0	GHz	With external matching circuit
IF Input Frequency	f_{IFin}	50	–	300	MHz	

8. ELECTRICAL CHARACTERISTICS (T_A = +25°C, V_{CC} = V_{RFout} = 3.0 V, f_{IFin} = 150 MHz, P_{LOin} = –5 dBm)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I_{CC}	No input signal	11.5	16.5	23	mA
Conversion Gain 1	CG1	f_{RFout} = 830 MHz, P_{IFin} = –20 dBm	6	9	12	dB
Conversion Gain 2	CG2	f_{RFout} = 1.9 GHz, P_{IFin} = –20 dBm	2.5	5.5	8.5	dB
Saturated Output Power 1	$P_{O(sat)}$ 1	f_{RFout} = 830 MHz, P_{IFin} = 0 dBm	–1.5	+0.5	–	dBm
Saturated Output Power 2	$P_{O(sat)}$ 2	f_{RFout} = 1.9 GHz, P_{IFin} = 0 dBm	–4.5	–2	–	dBm

9. OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY (T_A = +25°C, V_{CC} = V_{RFout} = 3.0 V, P_{LOin} = –5 dBm)

Parameter	Symbol	Conditions		Reference Value	Unit
3rd Order Distortion Input Intercept Point	IIP_3 1	f_{IFin}1 = 150.0 MHz f_{IFin}2 = 150.4 MHz	f_{RFout} = 830 MHz	+0.5	dBm
	IIP_3 2		f_{RFout} = 1.9 GHz	+0.5	
3rd Order Distortion Output Intercept Point	OIP_3 1	f_{IFin}1 = 150.0 MHz f_{IFin}2 = 150.4 MHz	f_{RFout} = 830 MHz	+9.5	dBm
	OIP_3 2		f_{RFout} = 1.9 GHz	+6.0	
SSB Noise Figure	SSB • NF	f_{RFout} = 830 MHz, f_{IFin} = 150 MHz		12.5	dB

10. TEST CIRCUIT

10.1 Test Circuit 1 (f_{RFout} = 830 MHz)

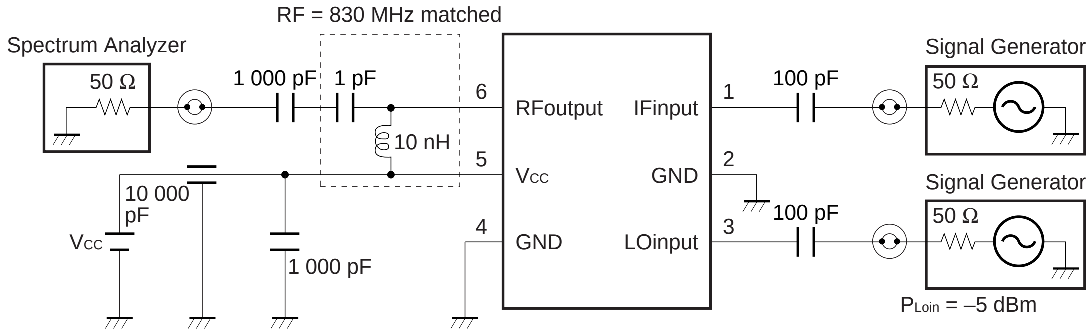
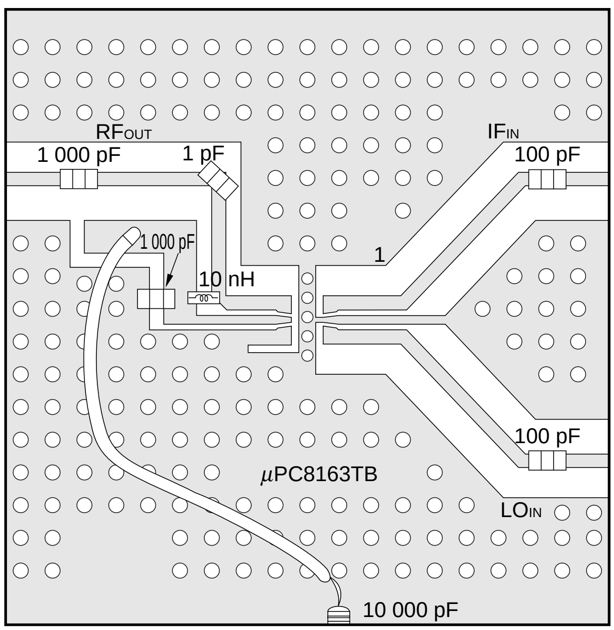


ILLUSTRATION OF TEST CIRCUIT 1 ASSEMBLED ON EVALUATION BOARD



EVALUATION BOARD CHARACTERS

(1) Double-sided copper clad 35 × 42 × 0.4 mm polyimide board

(2) Back side: GND pattern

(3) Solder plated patterns

(4) ∘○: Through holes

Caution 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.

10.2 Test Circuit 2 (f_{RFout} = 1.9 GHz)

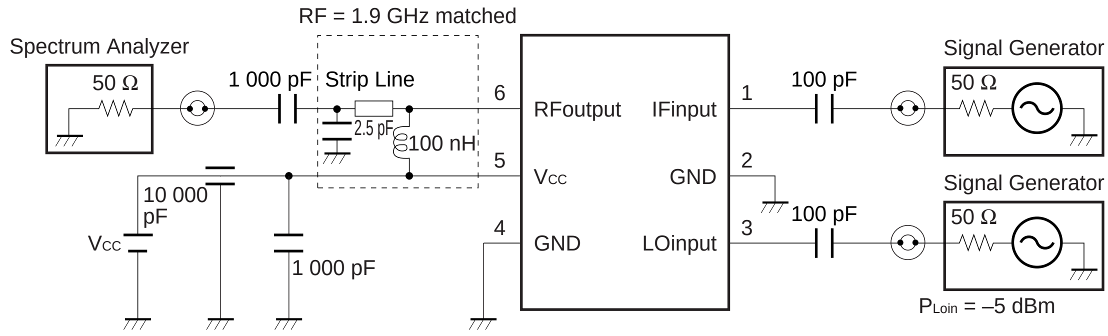
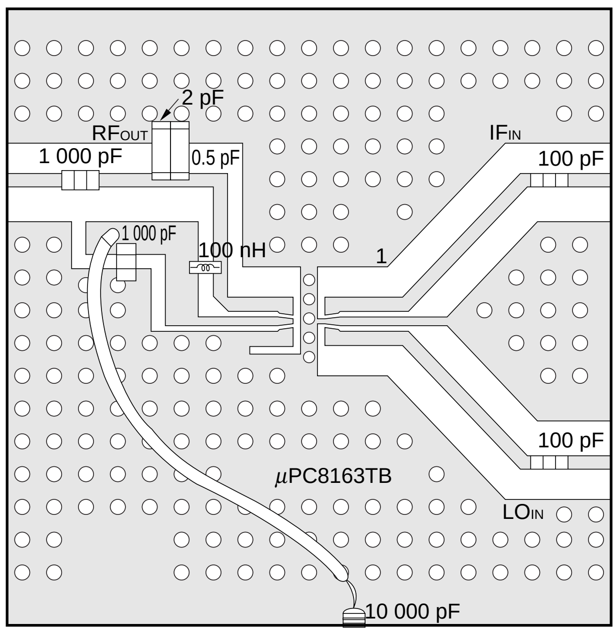


ILLUSTRATION OF TEST CIRCUIT 2 ASSEMBLED ON EVALUATION BOARD



EVALUATION BOARD CHARACTERS

(1) Double-sided copper clad 35 × 42 × 0.4 mm polyimide board

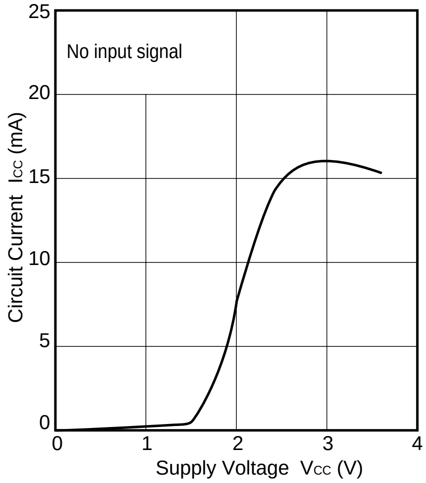
(2) Back side: GND pattern

(3) Solder plated patterns

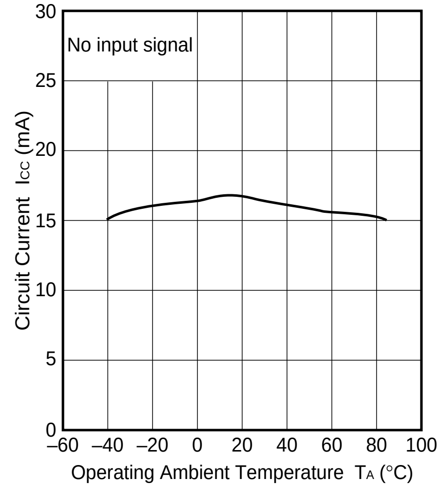
(4) ○O: Through holes

11. TYPICAL CHARACTERISTICS (T_A = +25°C, unless otherwise specified $V_{CC} = V_{RFout}$)

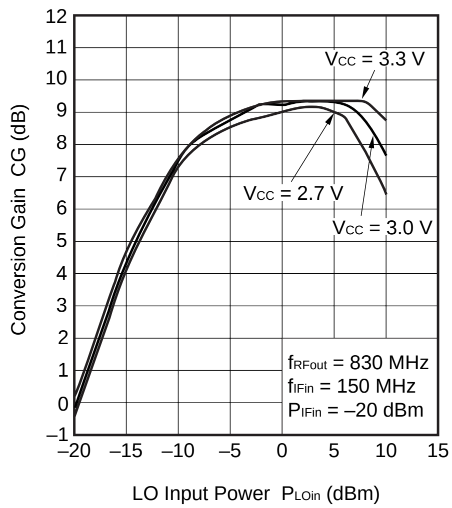
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



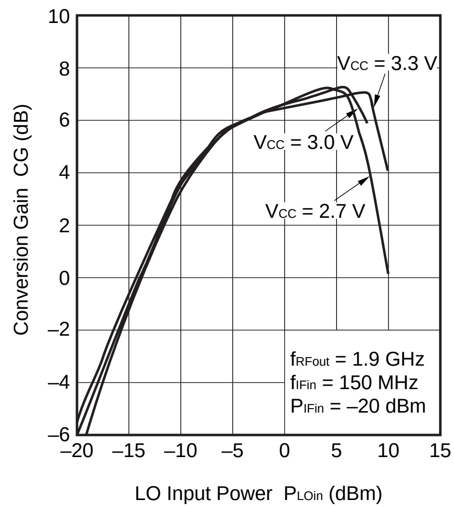
CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



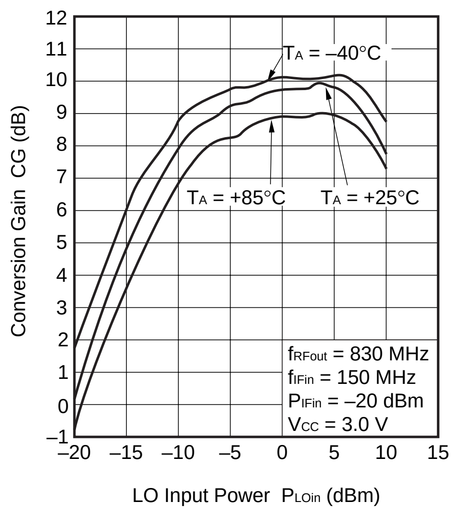
CONVERSION GAIN vs. LO INPUT POWER



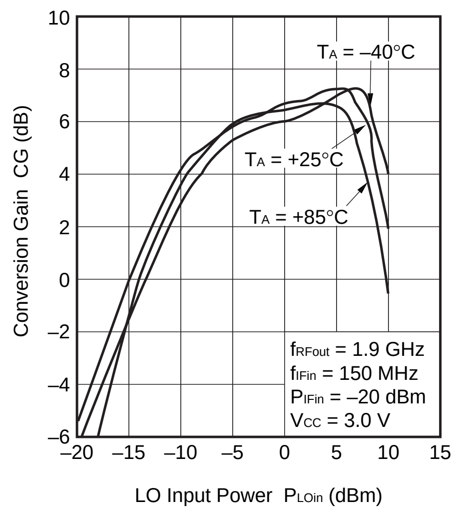
CONVERSION GAIN vs. LO INPUT POWER



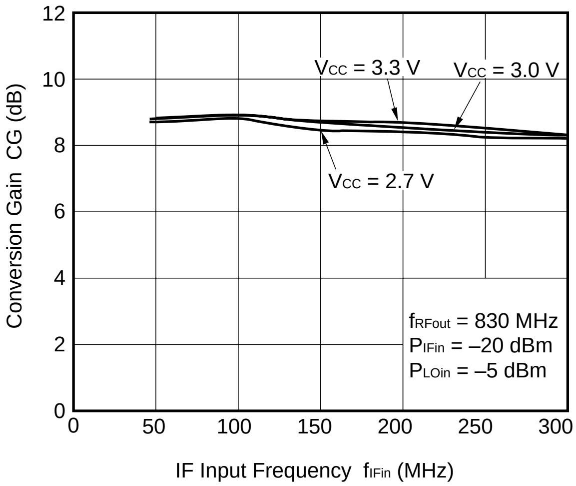
CONVERSION GAIN vs. LO INPUT POWER



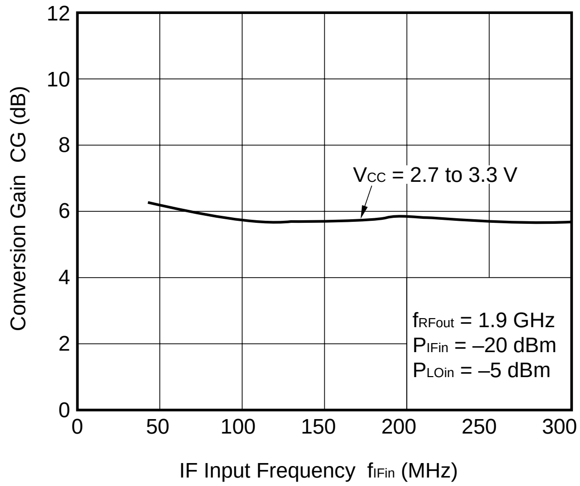
CONVERSION GAIN vs. LO INPUT POWER



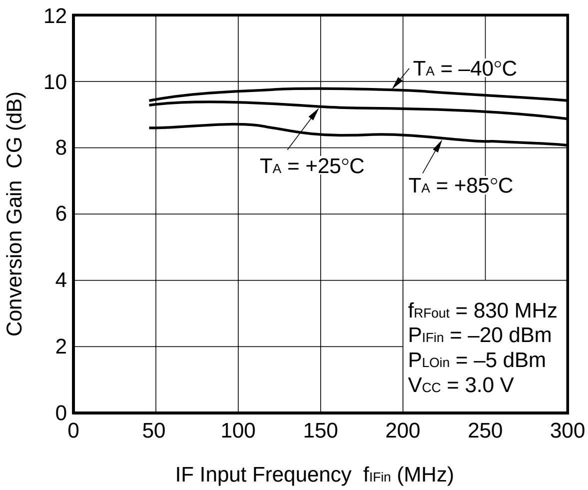
CONVERSION GAIN vs. IF INPUT FREQUENCY



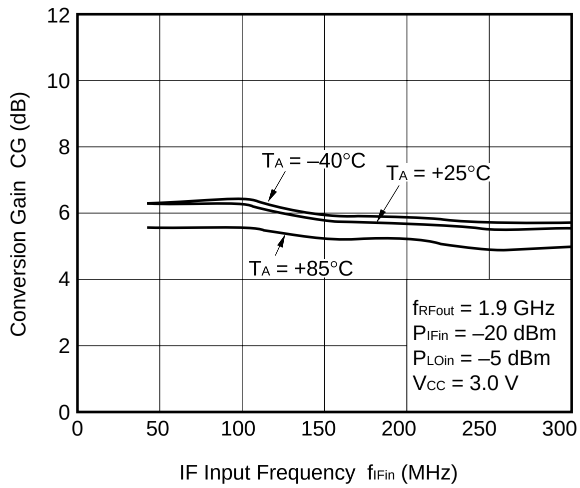
CONVERSION GAIN vs. IF INPUT FREQUENCY



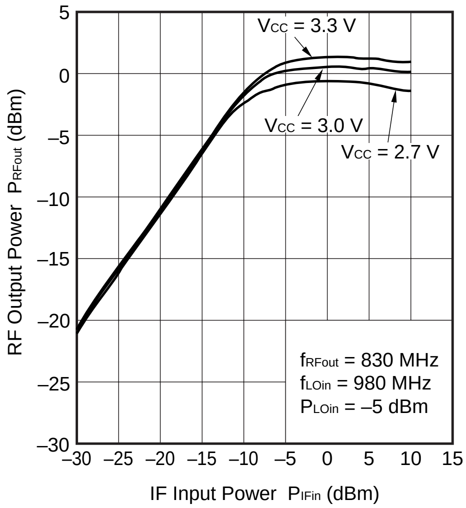
CONVERSION GAIN vs. IF INPUT FREQUENCY



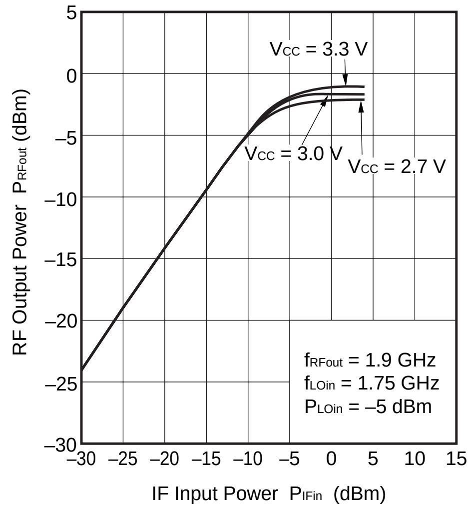
CONVERSION GAIN vs. IF INPUT FREQUENCY



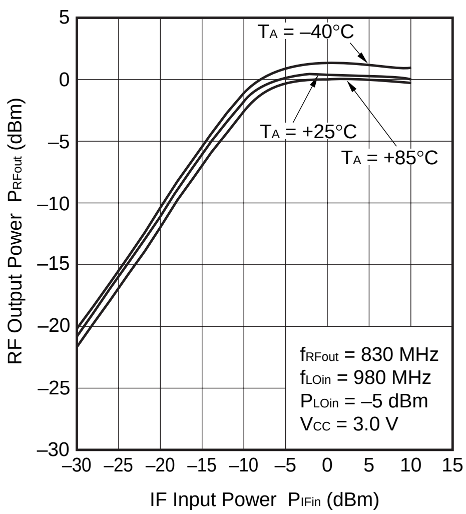
RF OUTPUT POWER vs. IF INPUT POWER



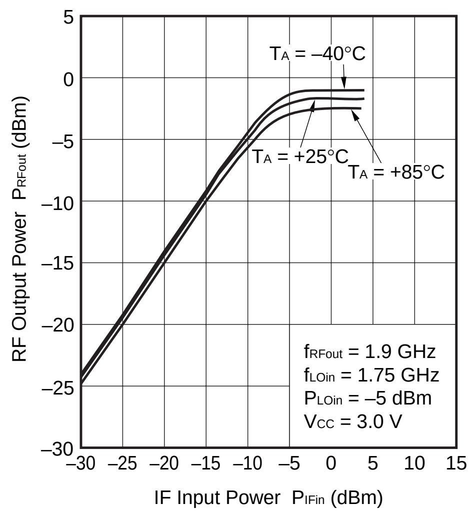
RF OUTPUT POWER vs. IF INPUT POWER



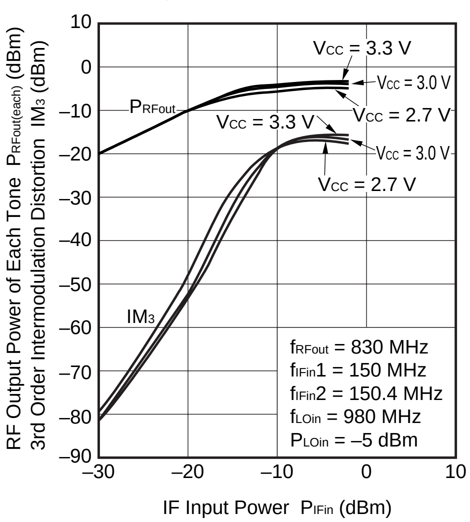
RF OUTPUT POWER vs. IF INPUT POWER



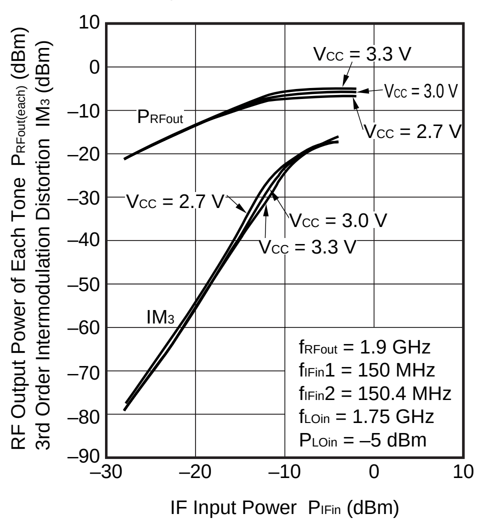
RF OUTPUT POWER vs. IF INPUT POWER



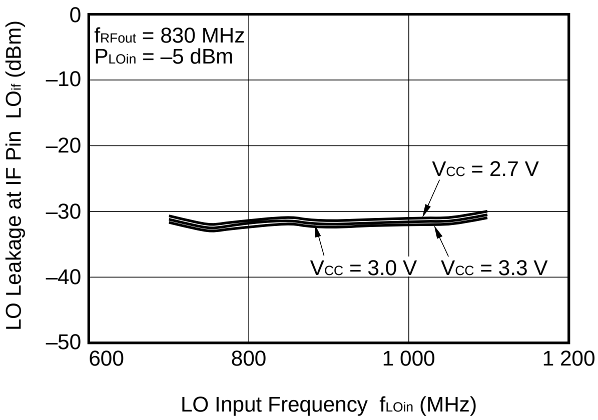
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



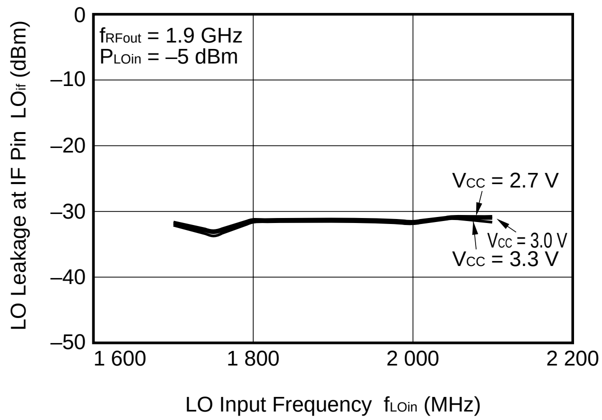
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



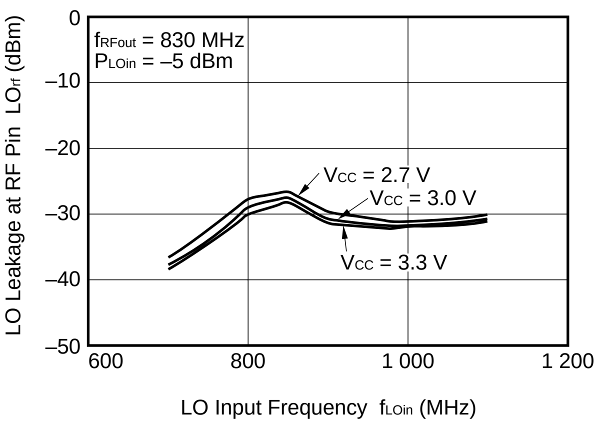
LO LEAKAGE AT IF PIN vs. LO INPUT FREQUENCY



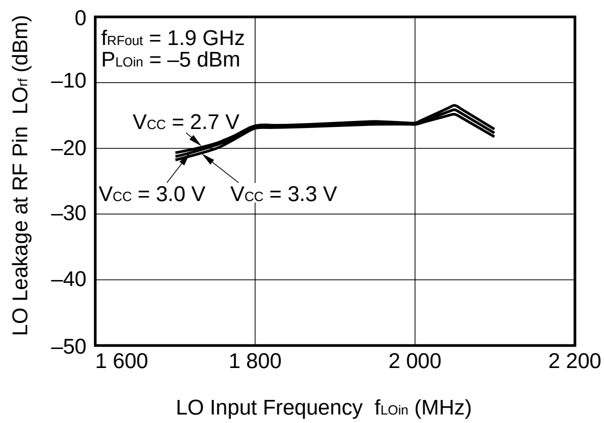
LO LEAKAGE AT IF PIN vs. LO INPUT FREQUENCY



LO LEAKAGE AT RF PIN vs. LO INPUT FREQUENCY



LO LEAKGE AT RF PIN vs. LO INPUT FREQUENCY

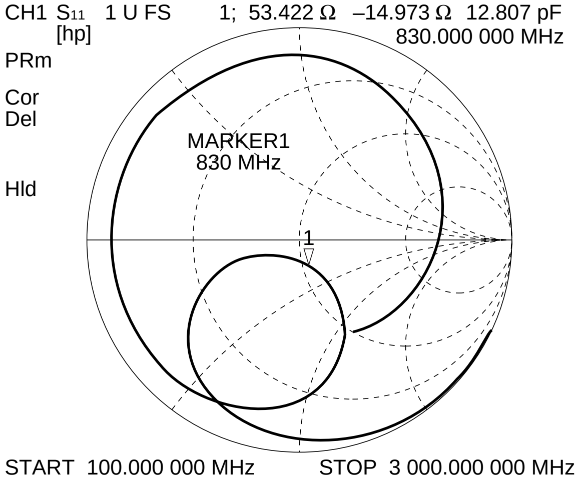


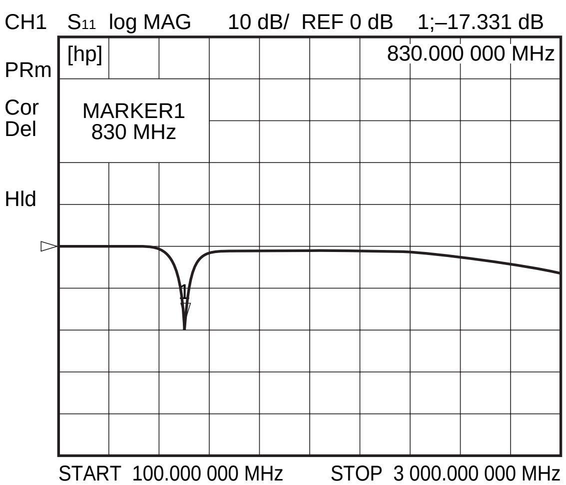
Remark The graphs indicate nominal characteristics.

12. S-PARAMETERS

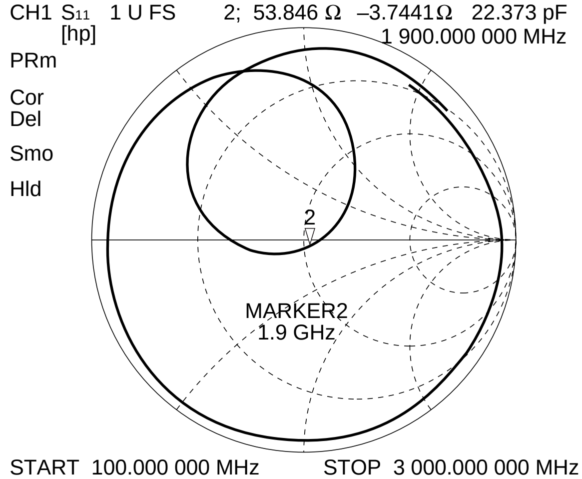
12.1 S-parameters for Matched RF Output ($V_{CC} = V_{RFout}$ = 3.0 V) – with test circuits 1 and 2 – (monitored at RF connector on board)

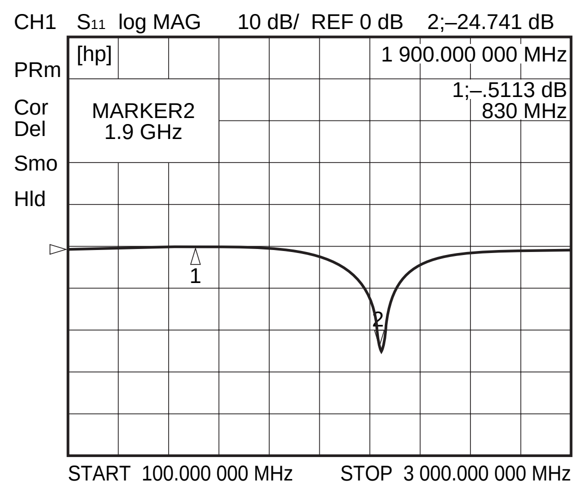
- RF output matched at 830 MHz





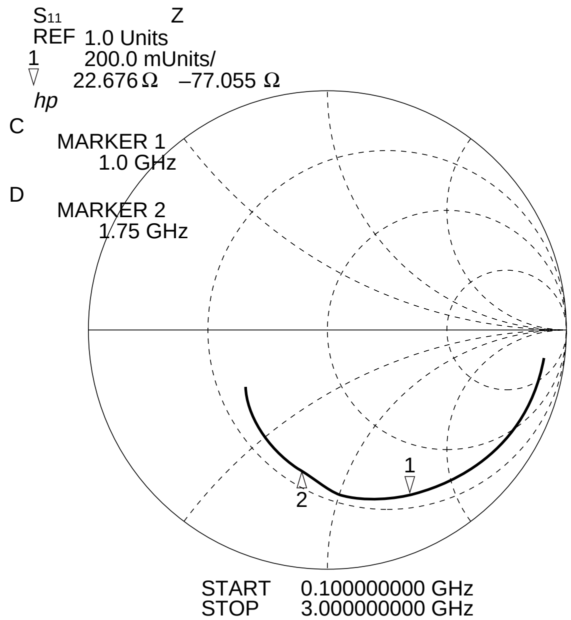
- RF output matched at 1.9 GHz



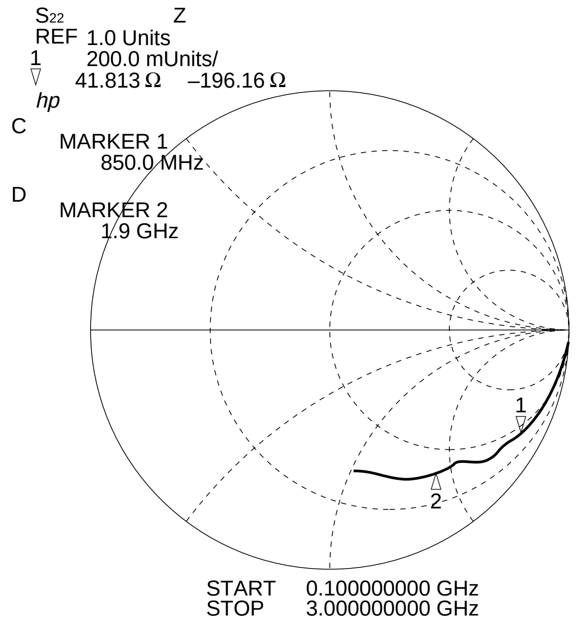


12.2 S-parameters for Each Port (V_{CC} = V_{RFout} = 3.0 V)

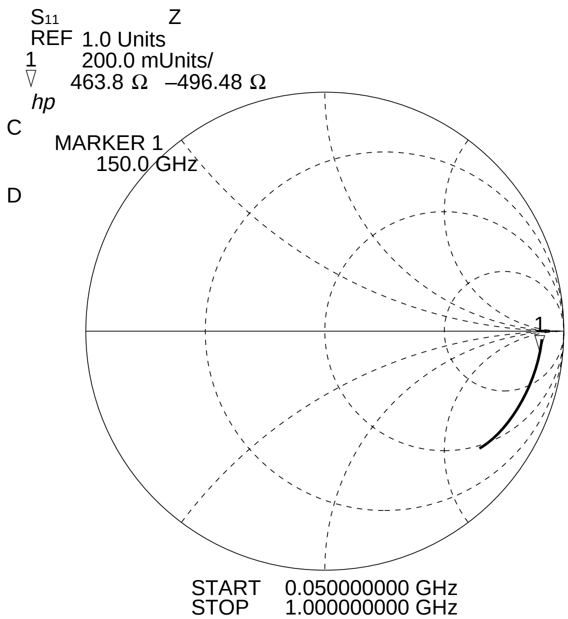
LO port



RF port (no matching)

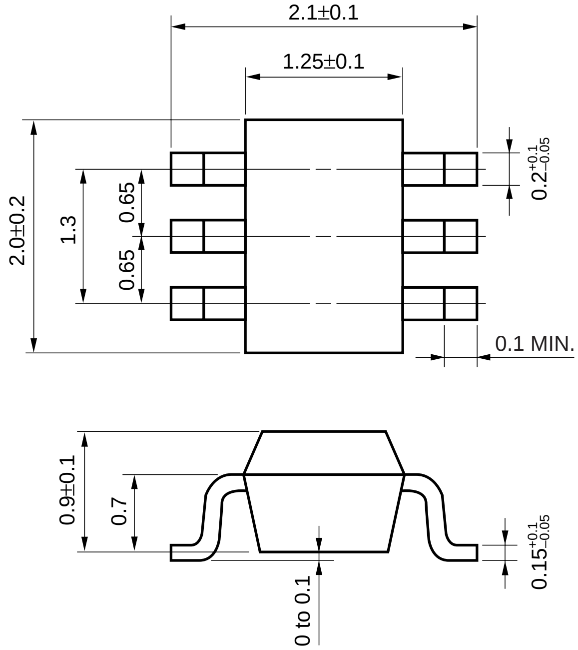


IF port



★ 13. PACKAGE DIMENSIONS

6-PIN SUPER MINIMOLD (UNIT: mm)



14. NOTE ON CORRECT USE

(1) Observe precautions for handling because of electrostatic sensitive devices.
(2) Form a ground pattern as widely as possible to minimize 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 V_{CC} pin.

15. 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[Note]	IR35-00-3
VPS	Package peak temperature: 215°C or below Time: 40 seconds or less (at 200°C) Count: 3, Exposure limit: None[Note]	VP15-00-3
Wave Soldering	Soldering bath temperature: 260°C or below Time: 10 seconds or less Count: 1, Exposure limit: None[Note]	WS60-00-1
Partial Heating	Pin temperature: 300°C Time: 3 seconds or less (per side of device) Exposure limit: None[Note]	–

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

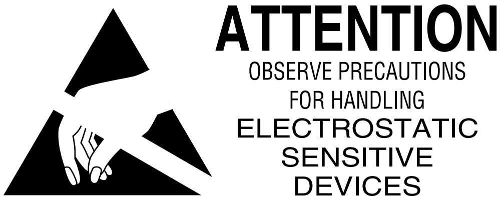
Caution Do not use different soldering methods together (except for partial heating).

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

[MEMO]

[MEMO]

[MEMO]



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