



DATA SHEET

BIPOLAR ANALOG INTEGRATED CIRCUIT μ PC8187TB

SILICON MMIC HI-IP₃ FREQUENCY UP-CONVERTER FOR WIRELESS TRANSCEIVER

DESCRIPTION

The μ PC8187TB is a silicon monolithic integrated circuit designed as frequency up-converter for wireless transceiver. This IC is higher operating frequency, lower distortion and higher conversion gain than conventional μ PC8163TB.

This IC is manufactured using NEC's 30 GHz f_{\max} UHS0 (Ultra High Speed Process) silicon bipolar process.

FEATURES

- High output frequency : $f_{RFout} = 0.8$ to 2.5 GHz
- High-density surface mounting : 6-pin super minimold package
- Supply voltage : $V_{CC} = 2.7$ to 3.3 V
- Higher IP₃ : OIP₃ = +10 dBm @ $f_{RFout} = 1.9$ GHz

APPLICATION

- TDMA, PCS, CDMA etc.

ORDERING INFORMATION

Part Number	Package	Marking	Supplying Form
μ PC8187TB-E3-A	6-pin super minimold	C3G	<ul style="list-style-type: none">• 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 sales office.
(Part number for sample order: μ PC8187TB-A)

Caution Electro-static sensitive devices

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

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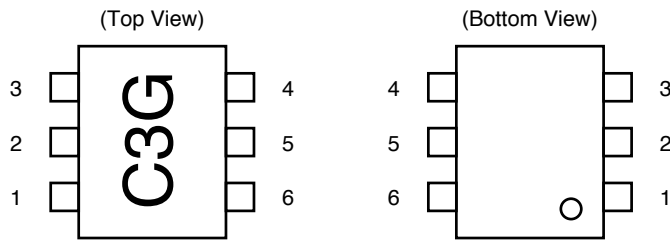
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1. PIN CONNECTIONS



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

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

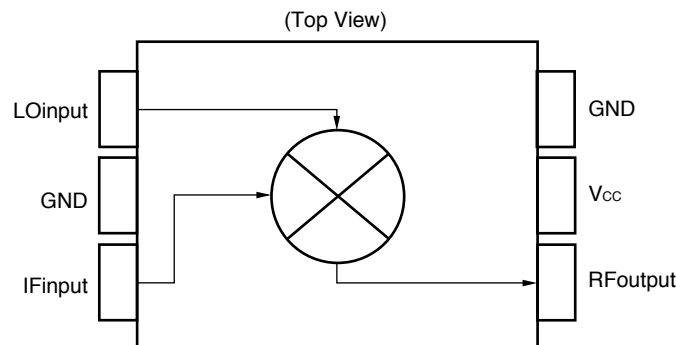
Part Number	I _{CC} (mA)	f _{RFout} (GHz)	CG (dB)		
			@RF 0.9 GHz ^{Note}	@RF 1.9 GHz	@RF 2.4 GHz
μPC8187TB	15	0.8 to 2.5	11	11	10
μPC8106TB	9	0.4 to 2.0	9	7	-
μPC8172TB	9	0.8 to 2.5	9.5	8.5	8.0
μPC8109TB	5	0.4 to 2.0	6	4	-
μPC8163TB	16.5	0.8 to 2.0	9	5.5	-

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
μPC8187TB	+4	+2.5	+1	+10	+10	+8.5
μPC8106TB	-2	-4	-	+5.5	+2.0	-
μPC8172TB	+0.5	0	-0.5	+7.5	+6.0	+4.0
μPC8109TB	-5.5	-7.5	-	+1.5	-1.0	-
μPC8163TB	+0.5	-2	-	+9.5	+6.0	-

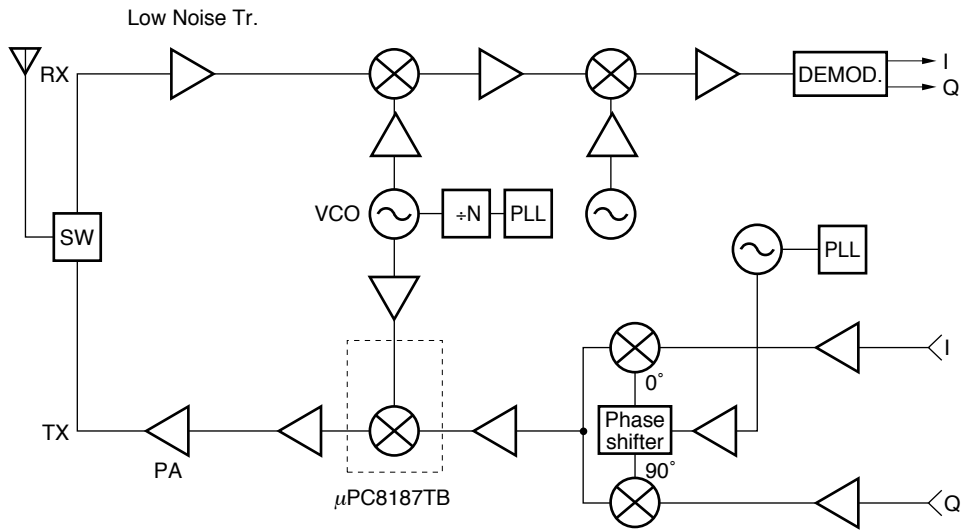
Note f_{RFout} = 0.83 GHz @ μPC8163TB and μPC8187TB

Remark Typical performance. Please refer to 8. ELECTRICAL CHARACTERISTICS in detail.
To know the associated product, please refer to each latest data sheet.

3. BLOCK DIAGRAM



4. SYSTEM APPLICATION EXAMPLES (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} = 2.8 V.

6. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Rating	Unit
Supply Voltage	V_{CC}	$T_A = +25^\circ\text{C}$	3.6	V
Power Dissipation	P_D	Mounted on double-side copperclad 50 × 50 × 1.6 mm epoxy glass PWB, $T_A = +85^\circ\text{C}$	270	mW
Operating Ambient Temperature	T_A		-40 to +85	$^\circ\text{C}$
Storage Temperature	T_{stg}		-55 to +150	$^\circ\text{C}$
Maximum Input Power	P_{in}		+10	dBm

7. RECOMMENDED OPERATING RANGE

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
Supply Voltage	V_{CC}	2.7	2.8	3.3	V	The same voltage should be applied to pin 5 and 6
Operating Ambient Temperature	T_A	-40	+25	+85	$^\circ\text{C}$	
Local Input Power	P_{LOin}	-10	-5	0	dBm	$Z_s = 50 \Omega$ (without matching)
RF Output Frequency	f_{RFout}	0.8	-	2.5	GHz	With external matching circuit
IF Input Frequency	f_{IFin}	50	-	400	MHz	

8. ELECTRICAL CHARACTERISTICS

($T_A = +25^\circ\text{C}$, $V_{CC} = V_{RFout} = 2.8 \text{ V}$, $f_{IFin} = 150 \text{ MHz}$, $P_{LOin} = -5 \text{ dBm}$)

Parameter	Symbol	Test Conditions ^{Note}	MIN.	TYP.	MAX.	Unit
Circuit Current	I_{CC}	No signal	11	15	19	mA
Conversion Gain	CG1	$f_{RFout} = 0.83 \text{ GHz}$, $P_{IFin} = -20 \text{ dBm}$	8	11	14	dB
	CG2	$f_{RFout} = 1.9 \text{ GHz}$, $P_{IFin} = -20 \text{ dBm}$	8	11	14	dB
	CG3	$f_{RFout} = 2.4 \text{ GHz}$, $P_{IFin} = -20 \text{ dBm}$	7	10	13	dB
Saturated Output Power	$P_{O(sat)1}$	$f_{RFout} = 0.83 \text{ GHz}$, $P_{IFin} = 0 \text{ dBm}$	+1.5	+4	-	dBm
	$P_{O(sat)2}$	$f_{RFout} = 1.9 \text{ GHz}$, $P_{IFin} = 0 \text{ dBm}$	0	+2.5	-	dBm
	$P_{O(sat)3}$	$f_{RFout} = 2.4 \text{ GHz}$, $P_{IFin} = 0 \text{ dBm}$	-1.5	+1	-	dBm

Note $f_{RFout} < f_{LOin}$ @ $f_{RFout} = 0.83 \text{ GHz}$

$f_{LOin} < f_{RFout}$ @ $f_{RFout} = 1.9 \text{ GHz}/2.4 \text{ GHz}$

9. OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY

(T_A = +25°C, V_{CC} = V_{RFout} = 2.8 V, P_{LOin} = -5 dBm)

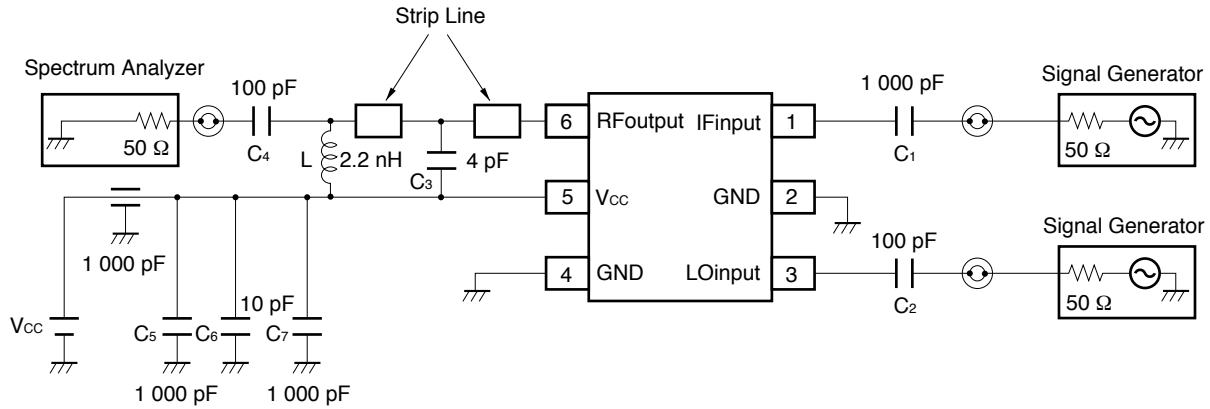
Parameter	Symbol	Test Conditions ^{Note}		Value	Unit
Output 3rd Order Distortion Intercept Point	OIP ₃₁	f _{RFout} = 0.83 GHz	f _{Fin1} = 150 MHz f _{Fin2} = 151 MHz	+10	dBm
	OIP ₃₂	f _{RFout} = 1.9 GHz		+10	dBm
	OIP ₃₃	f _{RFout} = 2.4 GHz		+8.5	dBm
Input 3rd Order Distortion Intercept Point	IIP ₃₁	f _{RFout} = 0.83 GHz	f _{Fin1} = 150 MHz f _{Fin2} = 151 MHz	-1.0	dBm
	IIP ₃₂	f _{RFout} = 1.9 GHz		-1.0	dBm
	IIP ₃₃	f _{RFout} = 2.4 GHz		-1.5	dBm
SSB Noise Figure	SSB•NF1	f _{RFout} = 0.83 GHz	f _{Fin} = 150 MHz	11	dB
	SSB•NF2	f _{RFout} = 1.9 GHz		12	dB
	SSB•NF3	f _{RFout} = 2.4 GHz		12.5	dB

Note f_{RFout} < f_{LOin} @ f_{RFout} = 0.83 GHz

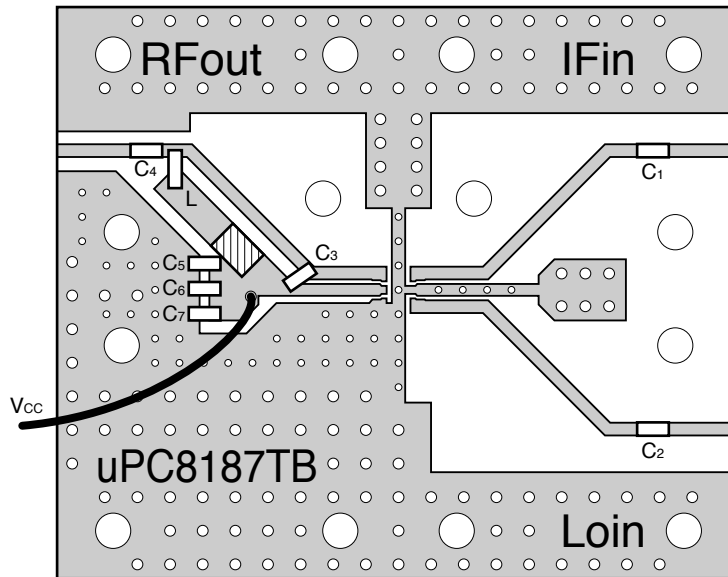
f_{LOin} < f_{RFout} @ f_{RFout} = 1.9 GHz/2.4 GHz

★ 10. TEST CIRCUITS

10.1 TEST CIRCUIT 1 ($f_{RFout} = 0.83 \text{ GHz}$)



EXAMPLE OF TEST CIRCUIT 1 ASSEMBLED ON EVALUATION BOARD



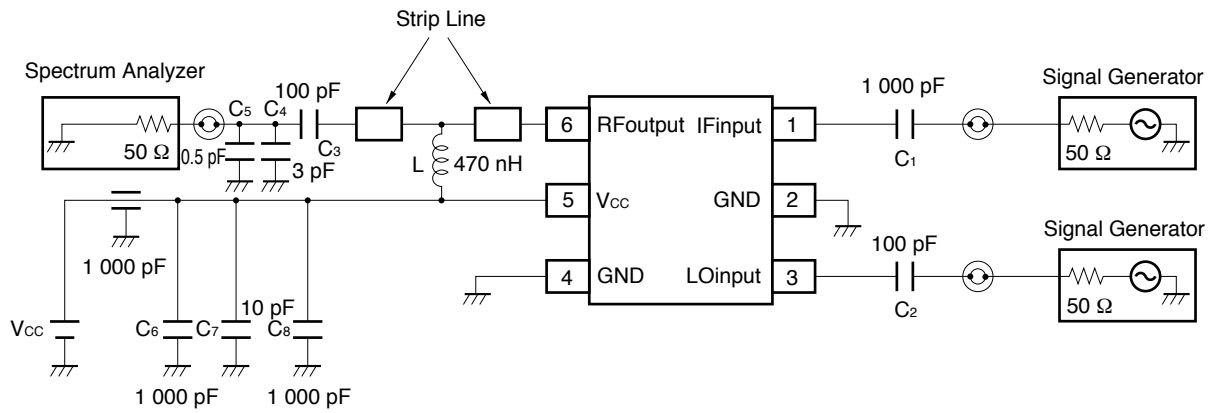
COMPONENT LIST

Form	Symbol	Value
Chip capacitor	C1, C5, C7	1 000 pF
	C2, C4	100 pF
	C6	10 pF
	C3	4 pF
Chip inductor	L	2.2 nH ^{Note}

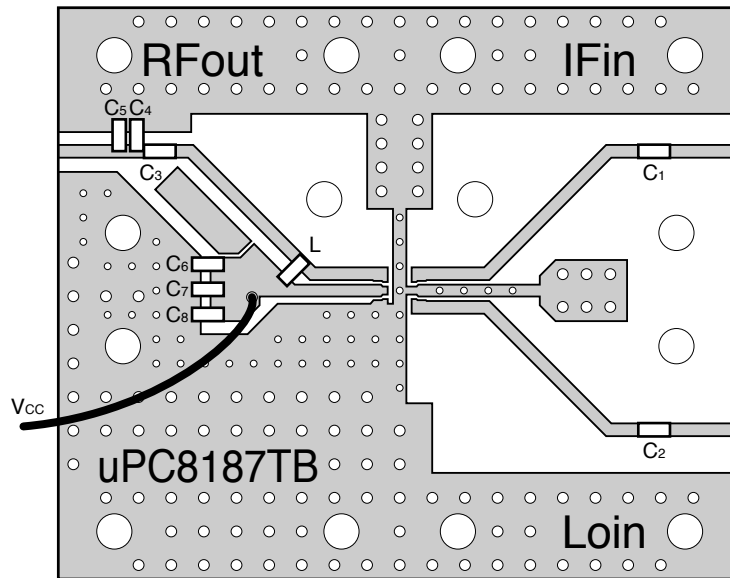
- (*1) 35 × 42 × 0.4 mm polyimide board, double-sided copper clad
- (*2) Ground pattern on rear of the board
- (*3) Solder plated patterns
- (*4) ○○○ : Through holes
- (*5) ▨ : Join patterns with electrical tape

Note 2.2 nH: LL1608-FH2N25 (TOKO Co., Ltd.)

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



EXAMPLE OF TEST CIRCUIT 2 ASSEMBLED ON EVALUATION BOARD



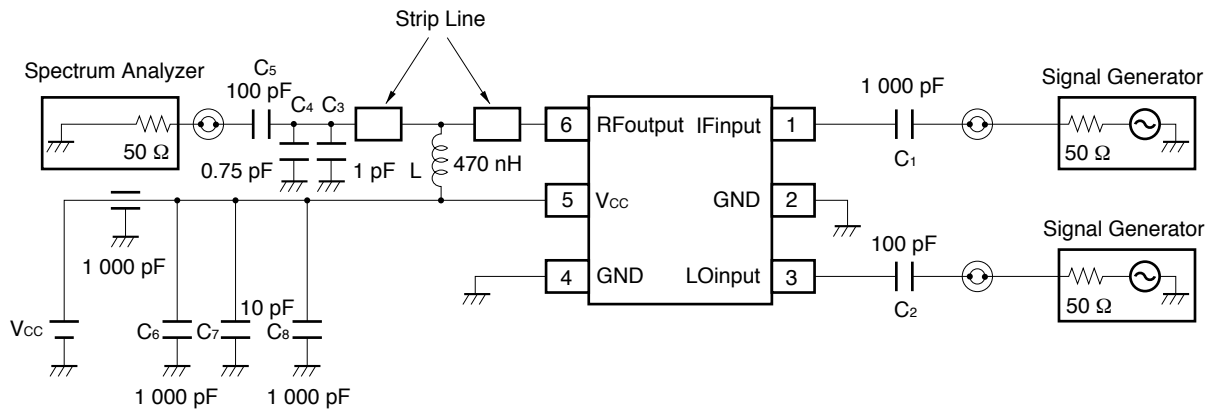
COMPONENT LIST

Form	Symbol	Value
Chip capacitor	C ₁ , C ₆ , C ₈	1 000 pF
	C ₂ , C ₃	100 pF
	C ₇	10 pF
	C ₄	3 pF
	C ₅	0.5 pF
Chip inductor	L	470 nH ^{Note}

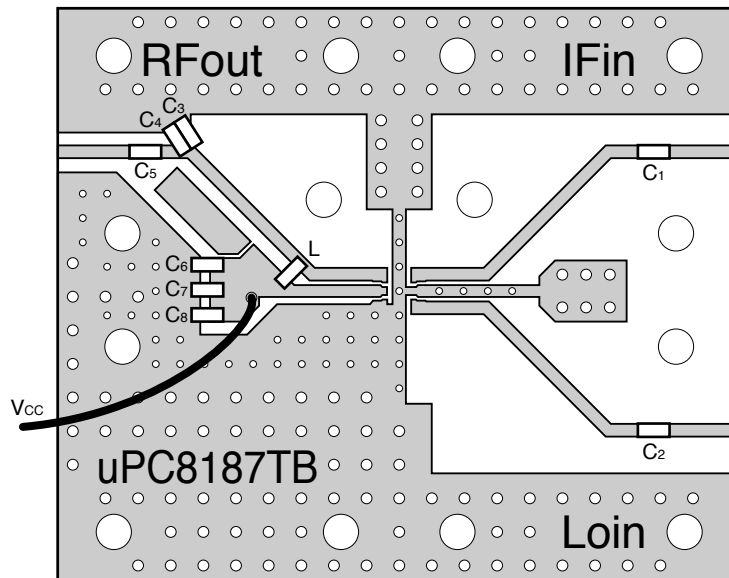
- (*1) 35 × 42 × 0.4 mm polyimide board, double-sided copper clad
- (*2) Ground pattern on rear of the board
- (*3) Solder plated patterns
- (*4) ○○○ : Through holes

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

10.3 TEST CIRCUIT 3 (f_{R_{Fout}} = 2.4 GHz)



EXAMPLE OF TEST CIRCUIT 3 ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

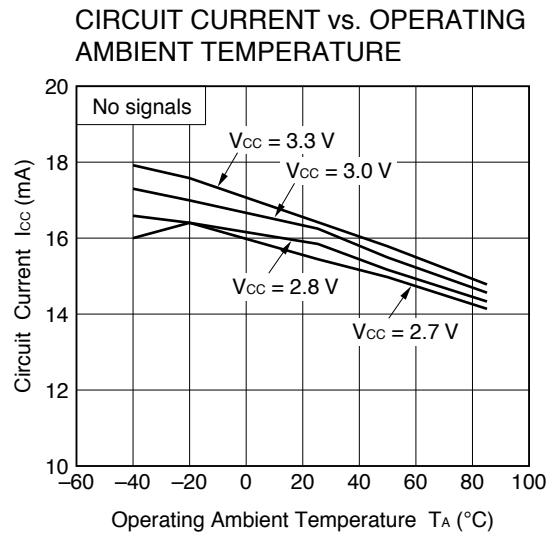
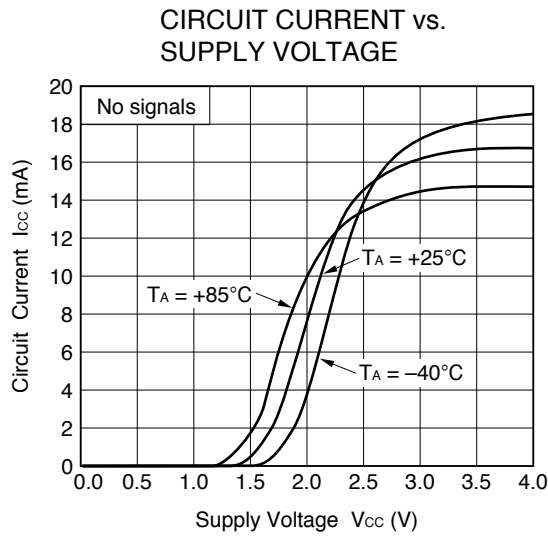
Form	Symbol	Value
Chip capacitor	C ₁ , C ₆ , C ₈	1 000 pF
	C ₂ , C ₅	100 pF
	C ₇	10 pF
	C ₃	1 pF
	C ₄	0.75 pF
Chip inductor	L	470 nH ^{Note}

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

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

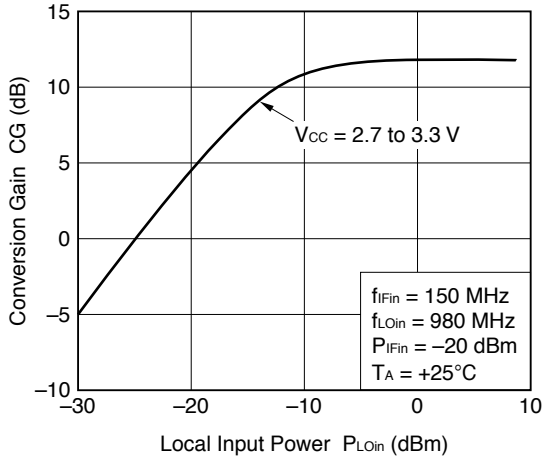
Caution The test circuits and board pattern on data sheet are for performance evaluation use only (They are not recommended circuits). In the case of actual design-in, matching circuit should be determined using S-parameter of desired frequency in accordance to actual mounting pattern.

★ 11. TYPICAL CHARACTERISTICS (Unless otherwise specified, $T_A = +25^\circ\text{C}$, $V_{CC} = V_{RFout}$)

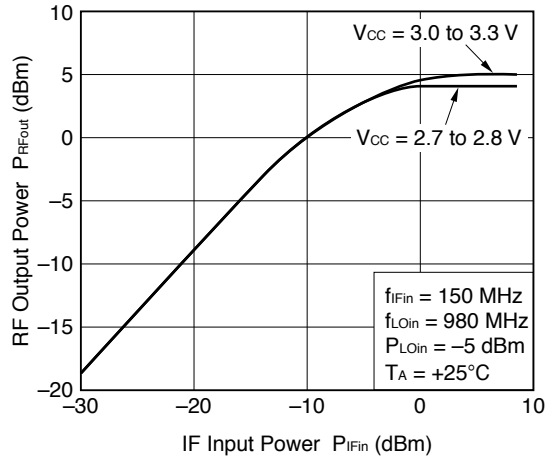


11.1 $f_{RFout} = 0.83$ GHz

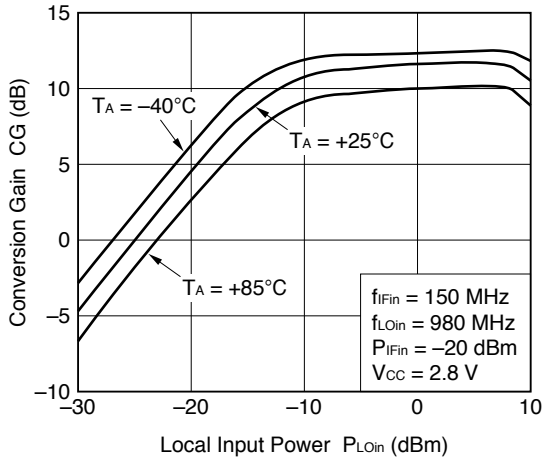
CONVERSION GAIN vs. LOCAL INPUT POWER



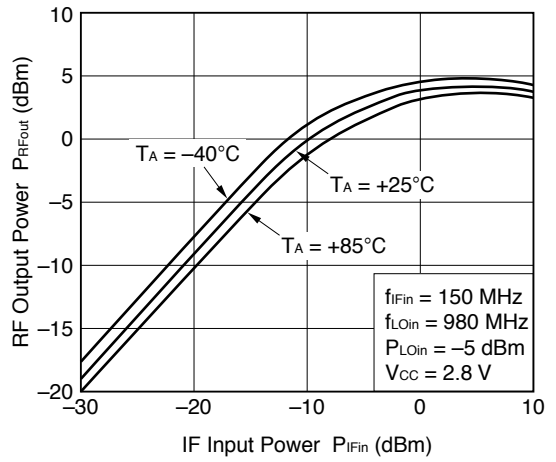
RF OUTPUT POWER vs. IF INPUT POWER

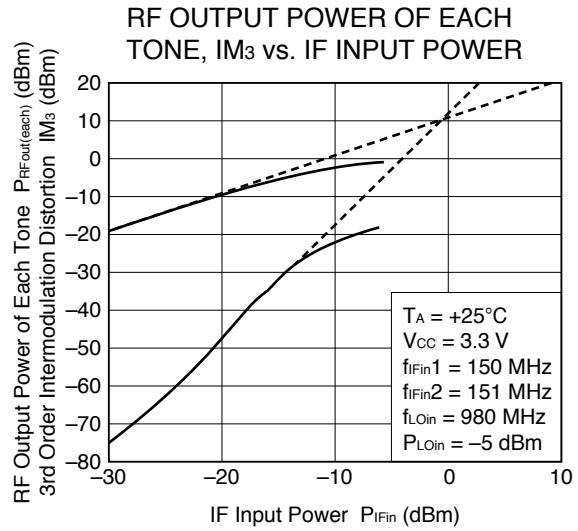
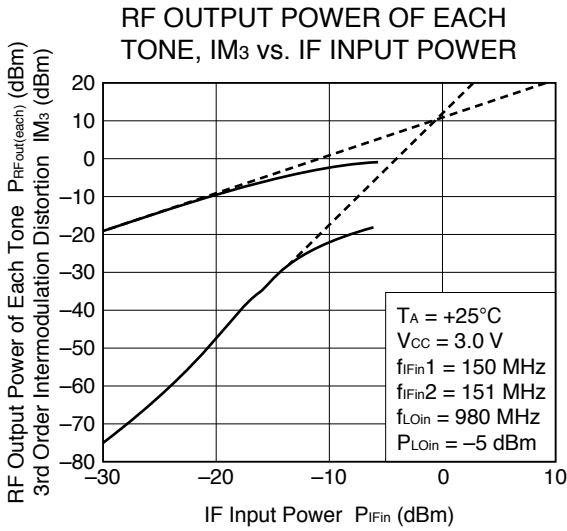
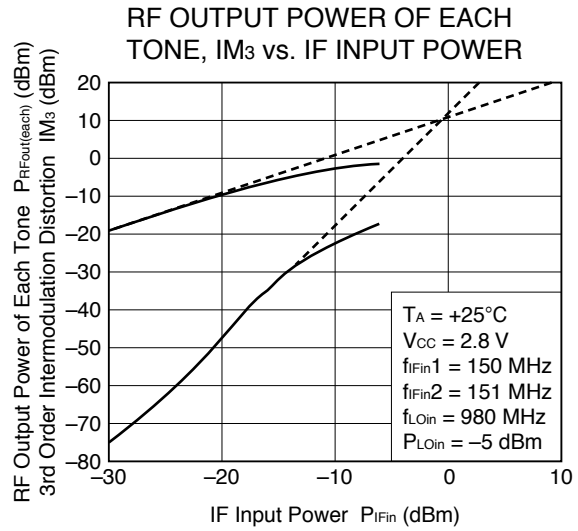
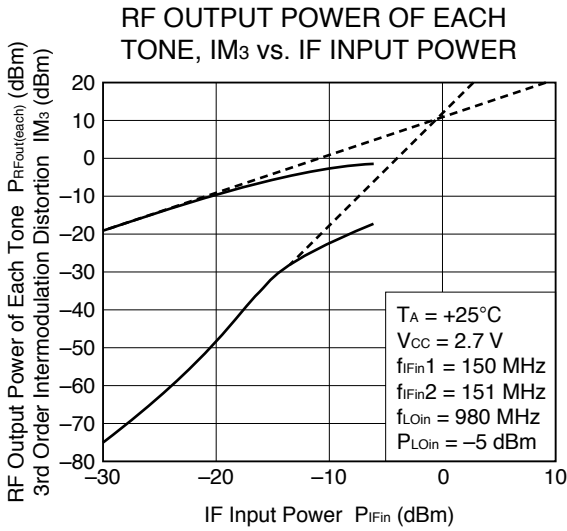


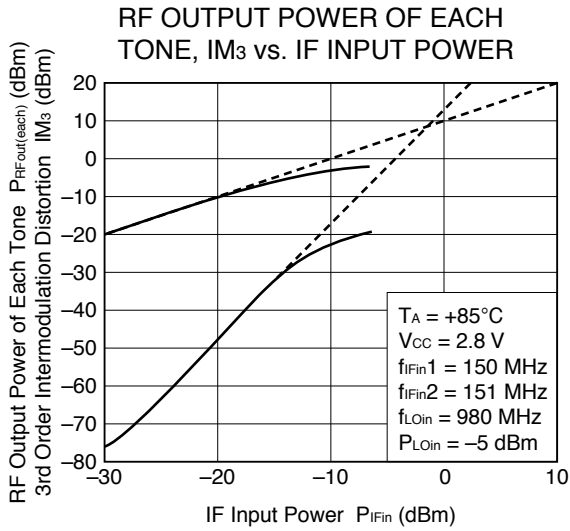
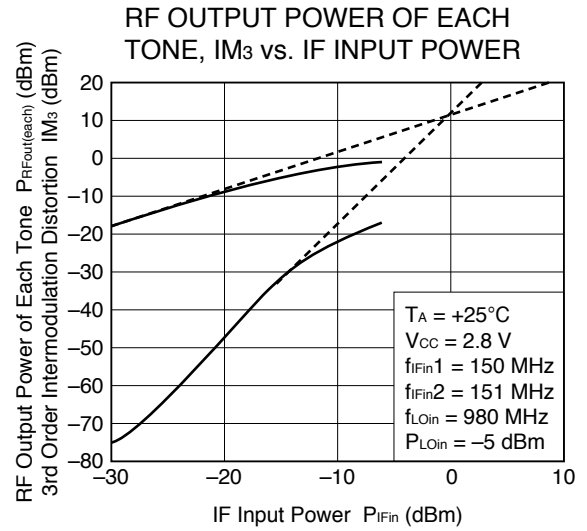
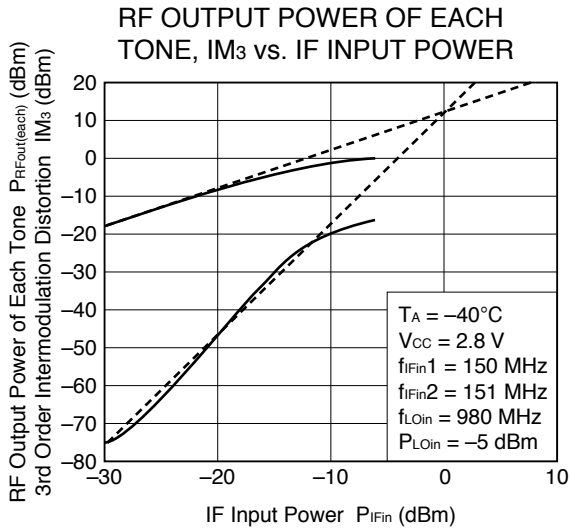
CONVERSION GAIN vs. LOCAL INPUT POWER



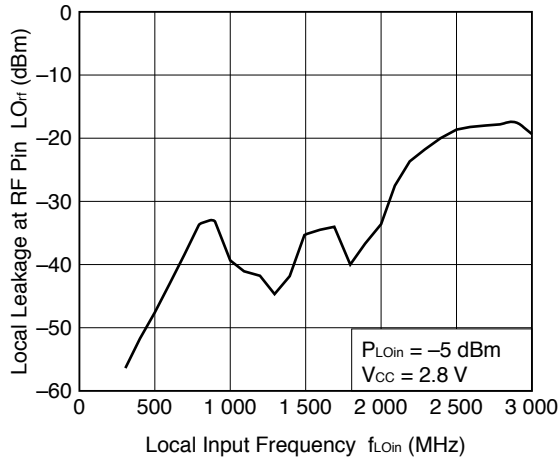
RF OUTPUT POWER vs. IF INPUT POWER



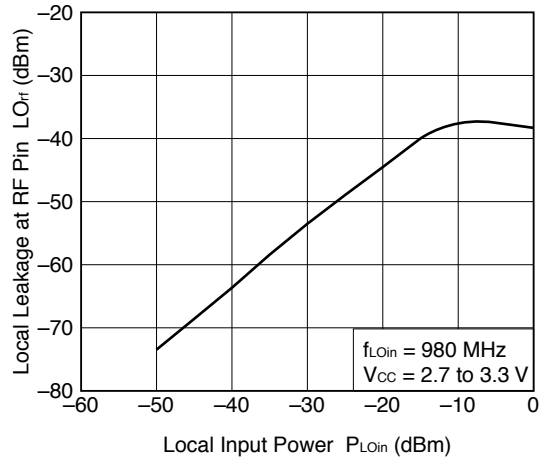




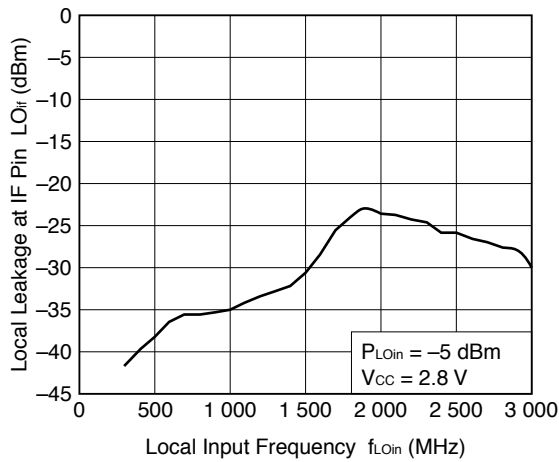
LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT FREQUENCY



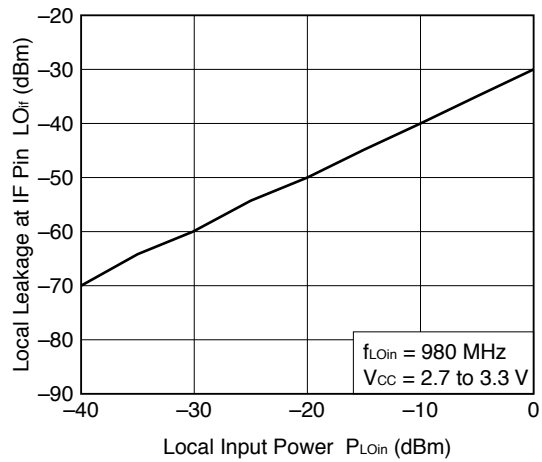
LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT POWER



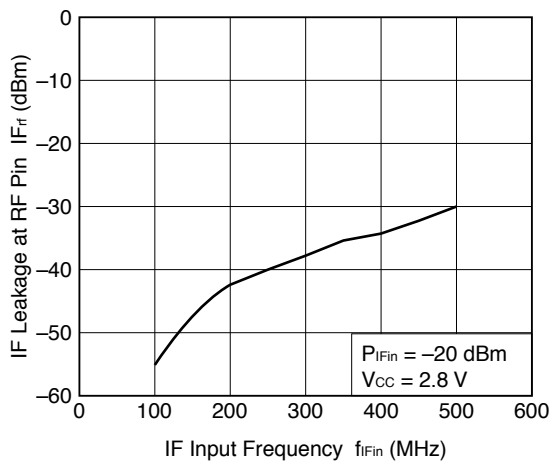
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT FREQUENCY



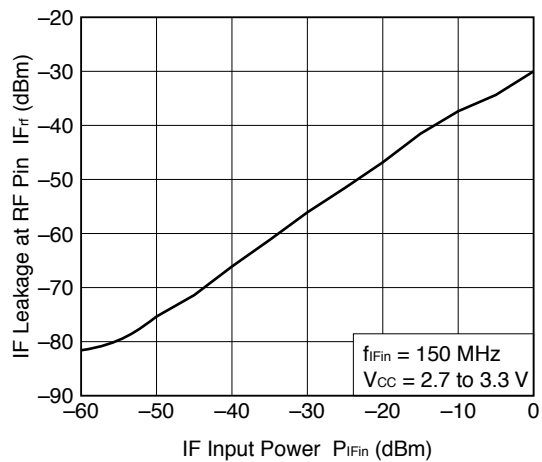
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT POWER



IF LEAKAGE AT RF PIN vs. IF INPUT FREQUENCY

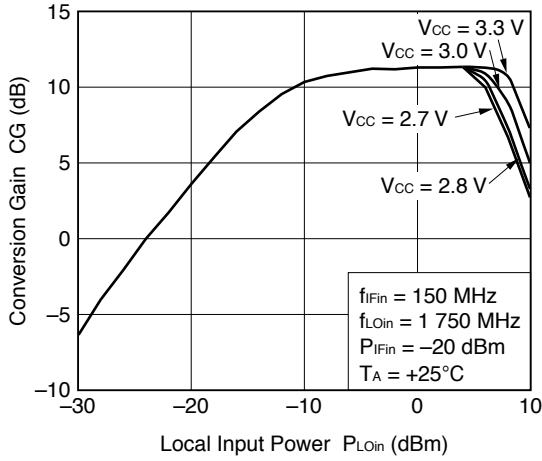


IF LEAKAGE AT RF PIN vs. IF INPUT POWER

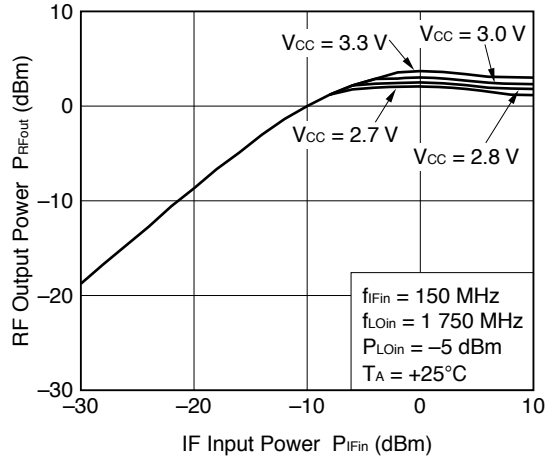


11.2 $f_{RFout} = 1.9$ GHz

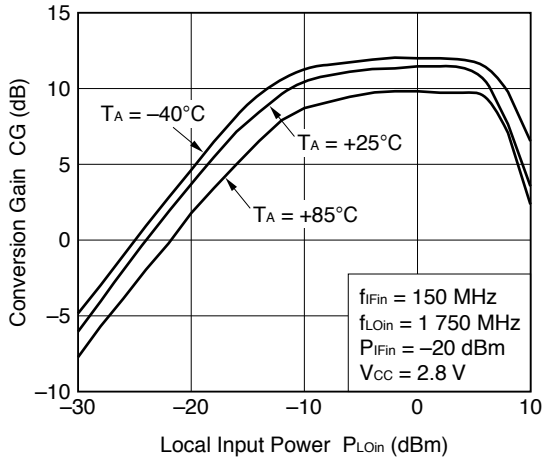
CONVERSION GAIN vs. LOCAL INPUT POWER



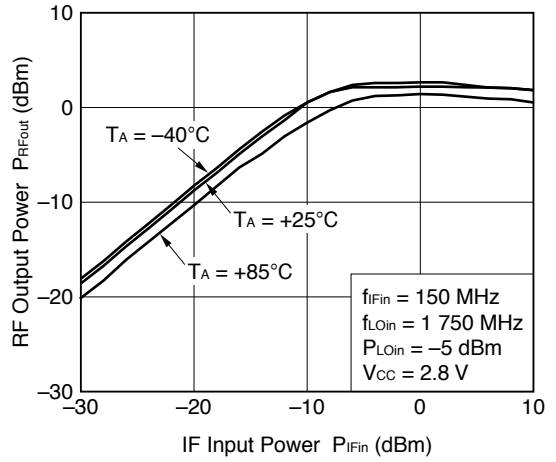
RF OUTPUT POWER vs. IF INPUT POWER



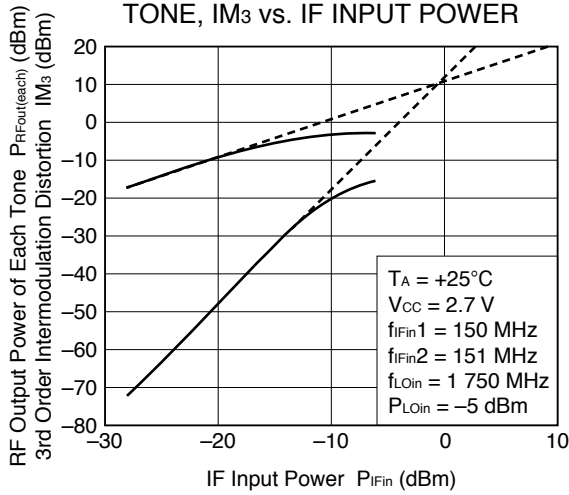
CONVERSION GAIN vs. LOCAL INPUT POWER



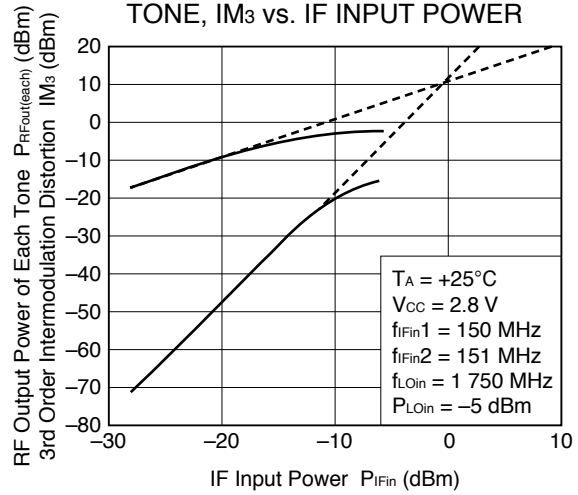
RF OUTPUT POWER vs. IF INPUT POWER



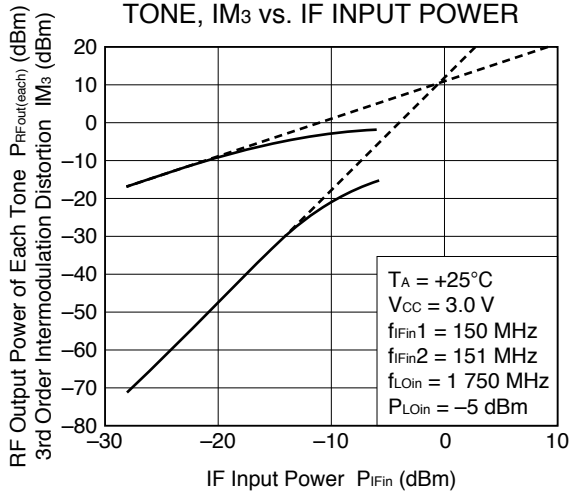
RF OUTPUT POWER OF EACH TONE, IM₃ vs. IF INPUT POWER



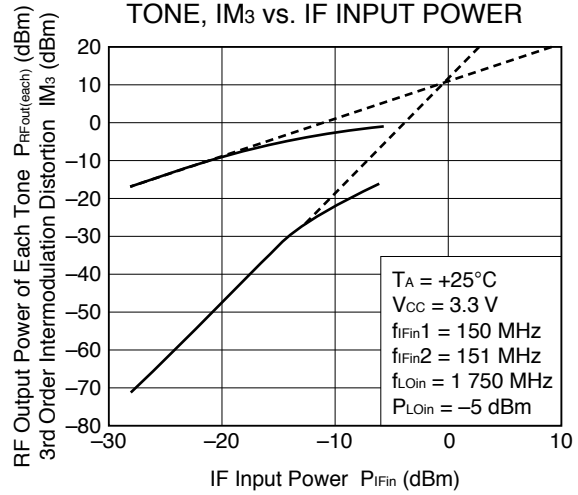
RF OUTPUT POWER OF EACH TONE, IM₃ vs. IF INPUT POWER

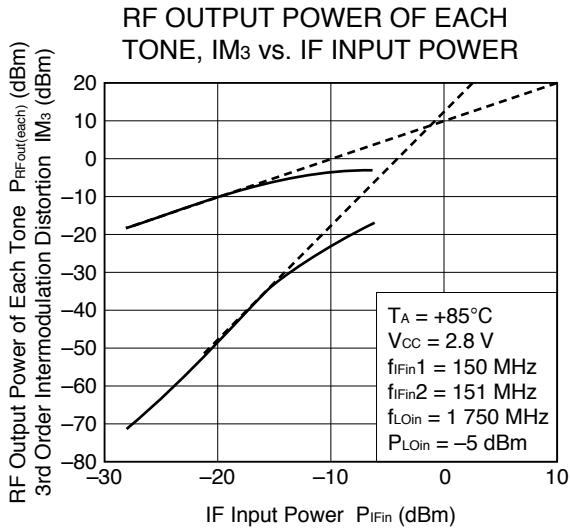
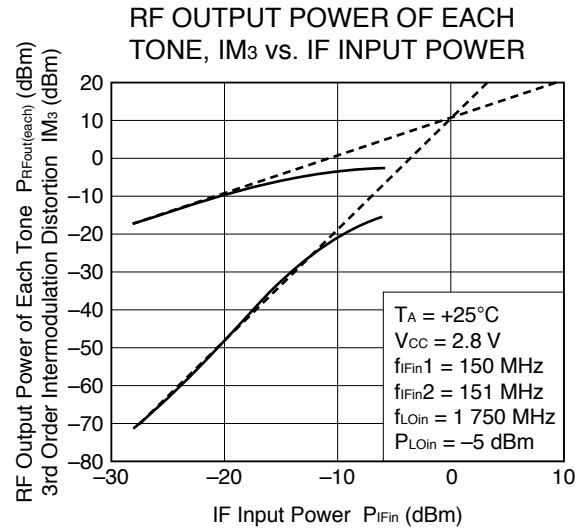
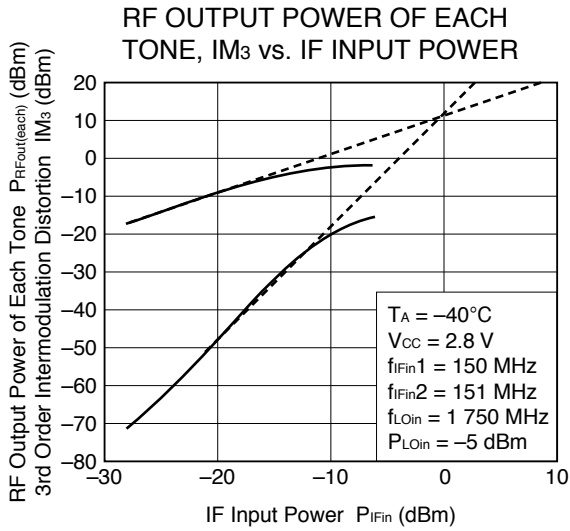


RF OUTPUT POWER OF EACH TONE, IM₃ vs. IF INPUT POWER

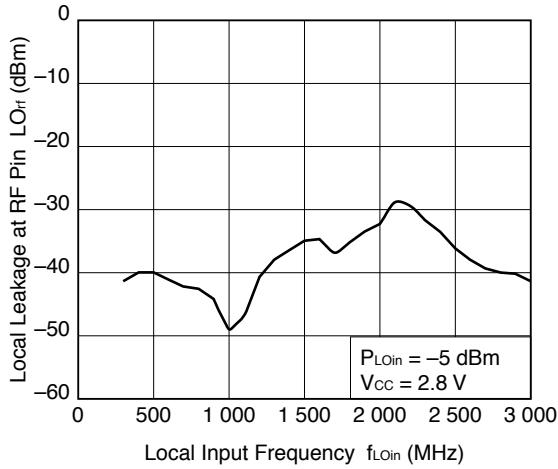


RF OUTPUT POWER OF EACH TONE, IM₃ vs. IF INPUT POWER

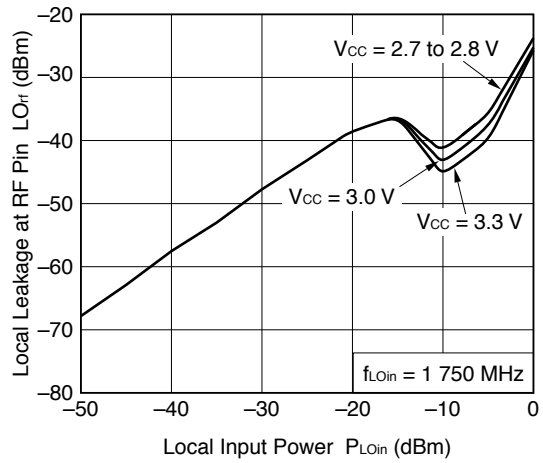




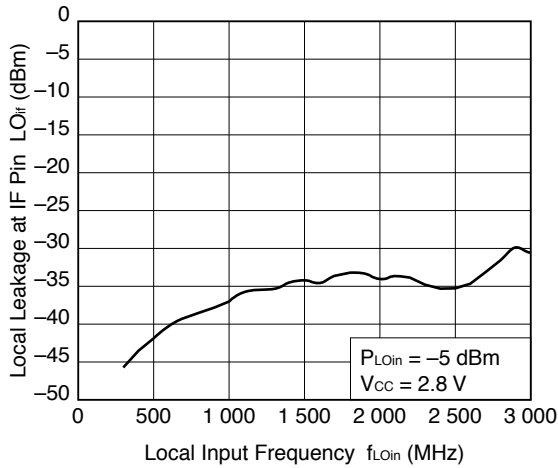
LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT FREQUENCY



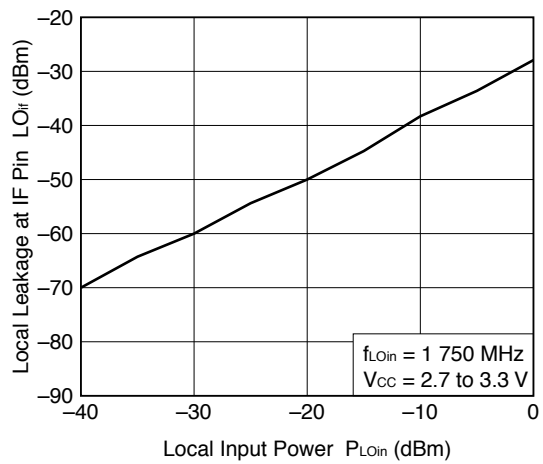
LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT POWER



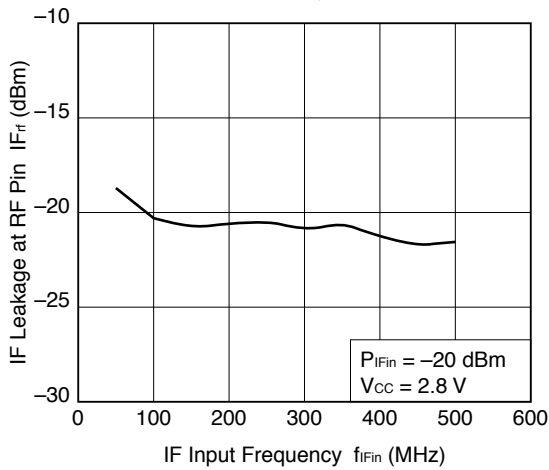
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT FREQUENCY



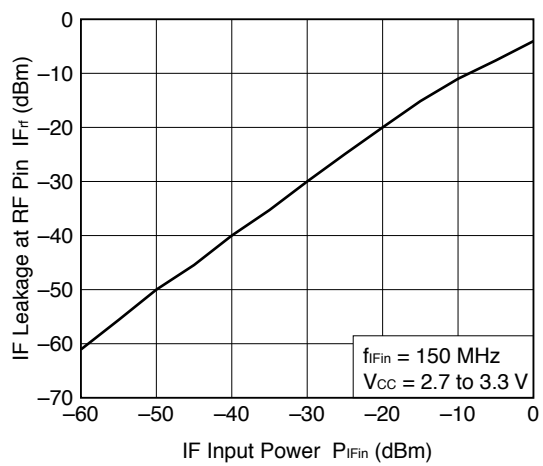
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT POWER



IF LEAKAGE AT RF PIN vs. IF INPUT FREQUENCY

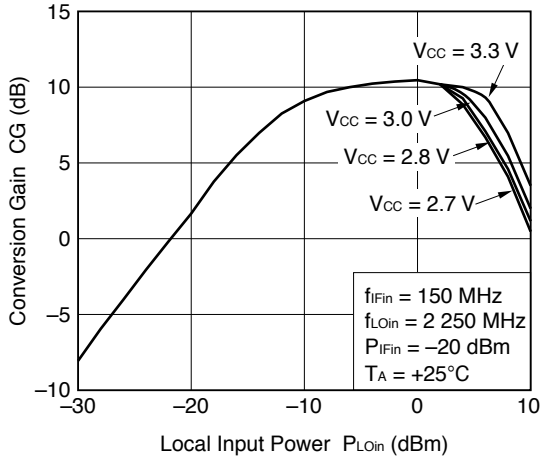


IF LEAKAGE AT RF PIN vs. IF INPUT POWER

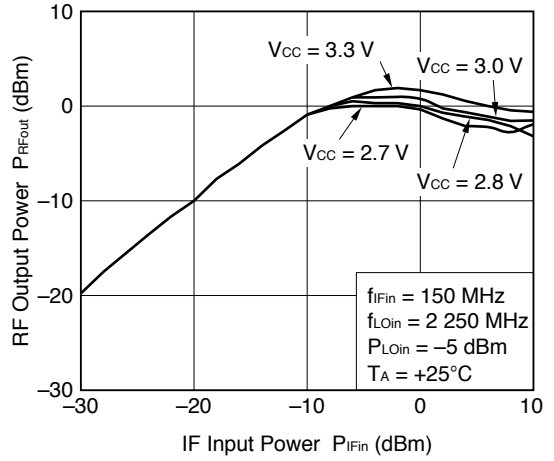


11.3 $f_{RFout} = 2.4$ GHz

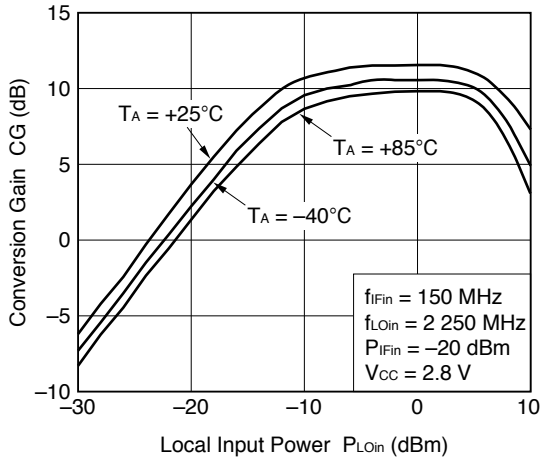
CONVERSION GAIN vs. LOCAL INPUT POWER



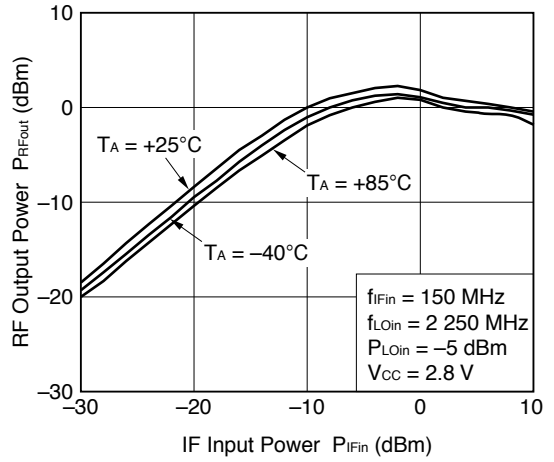
RF OUTPUT POWER vs. IF INPUT POWER

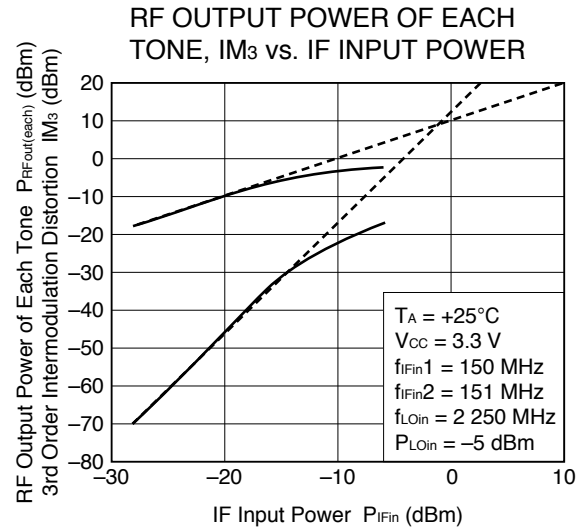
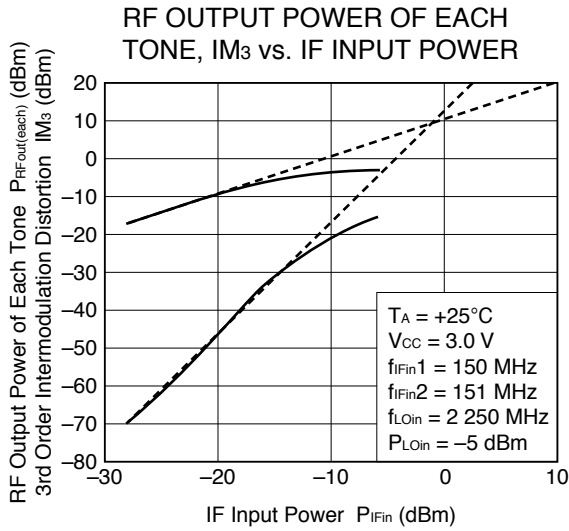
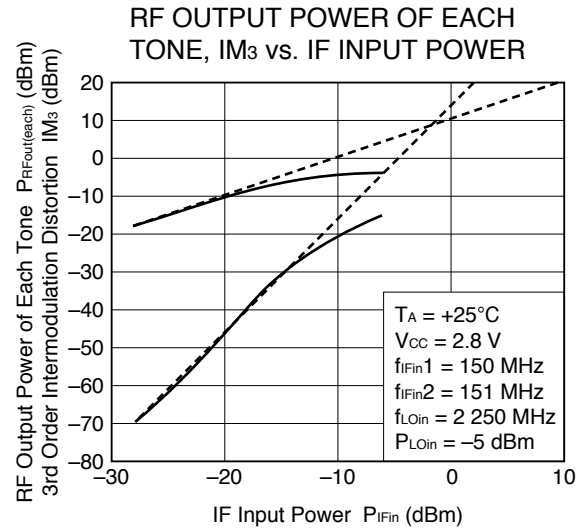
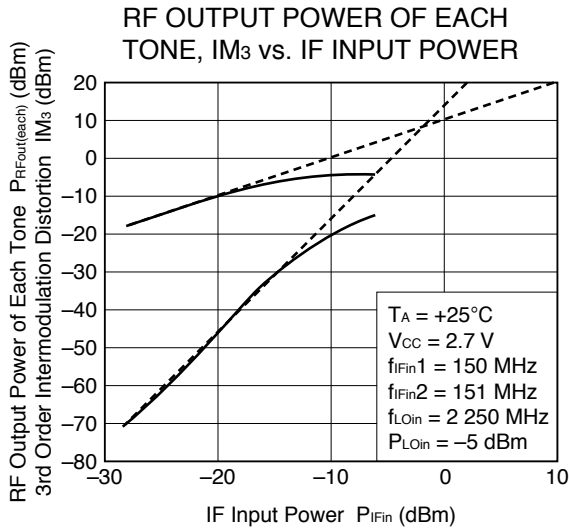


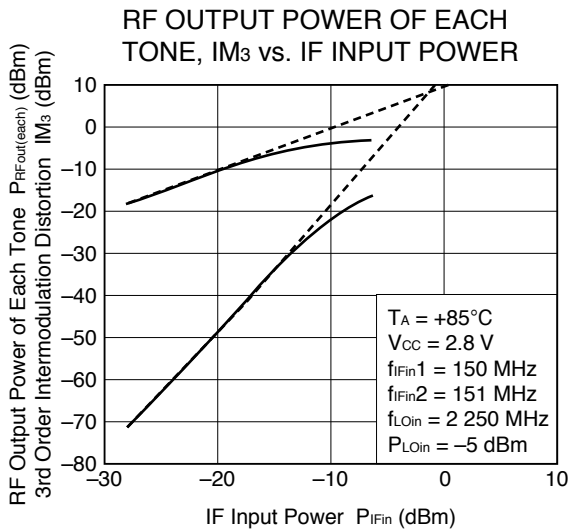
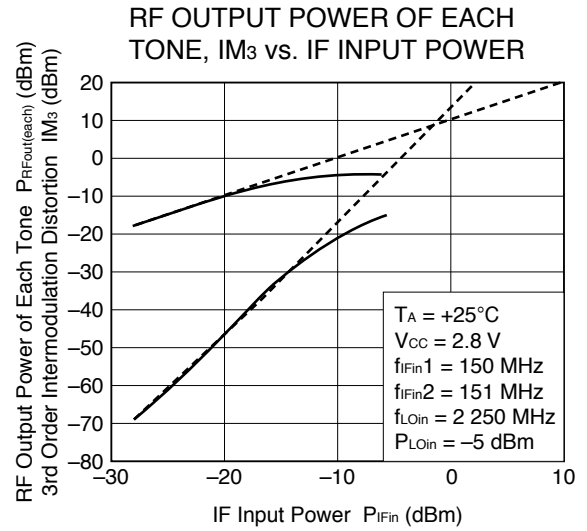
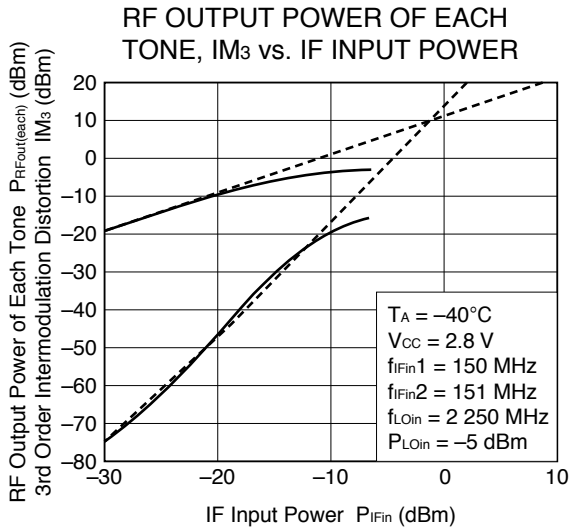
CONVERSION GAIN vs. LOCAL INPUT POWER



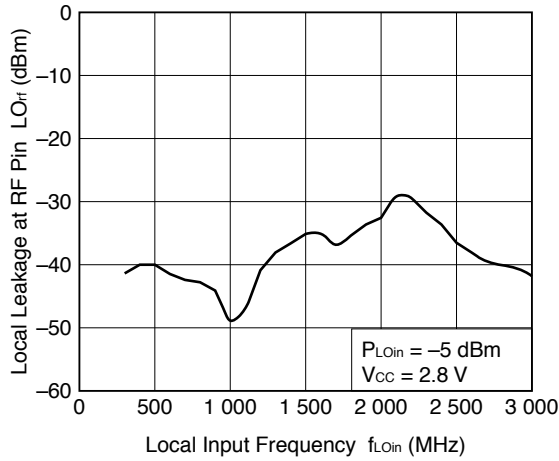
RF OUTPUT POWER vs. IF INPUT POWER



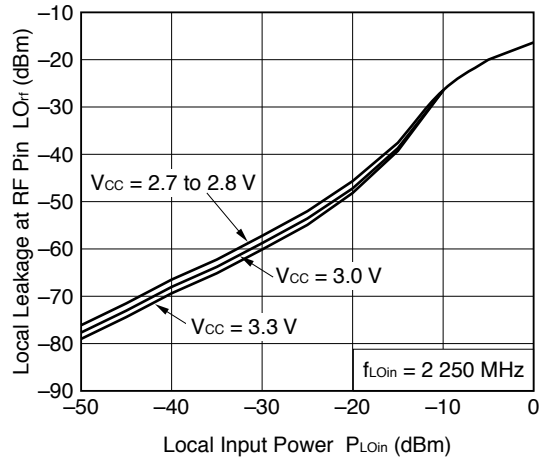




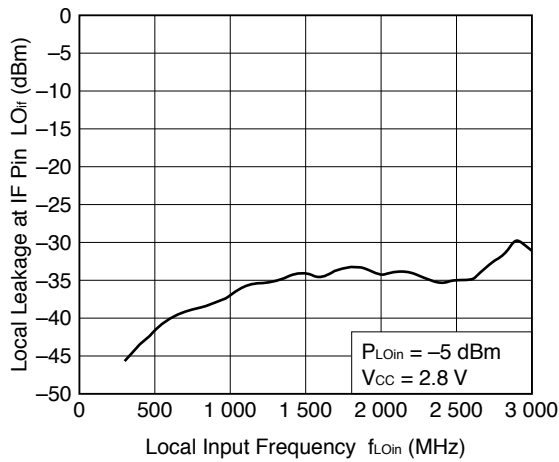
LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT FREQUENCY



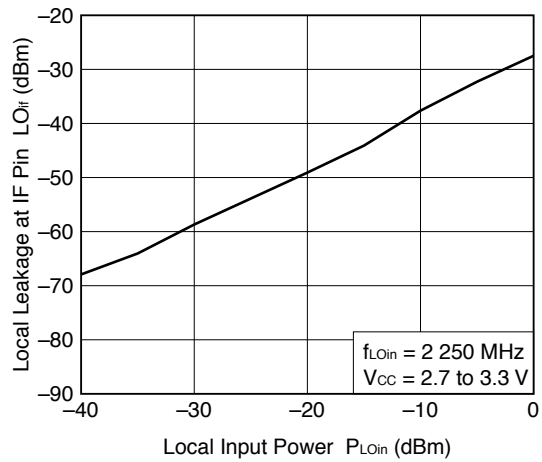
LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT POWER



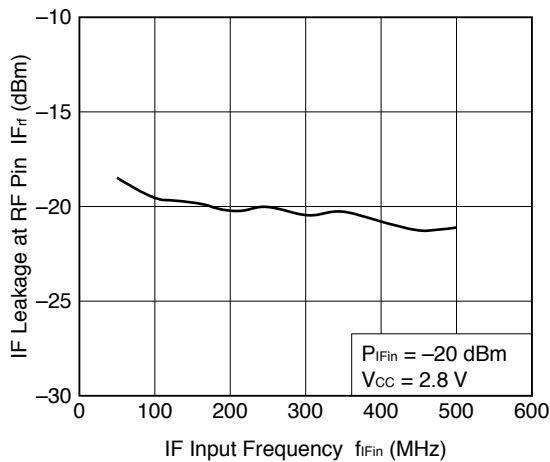
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT FREQUENCY



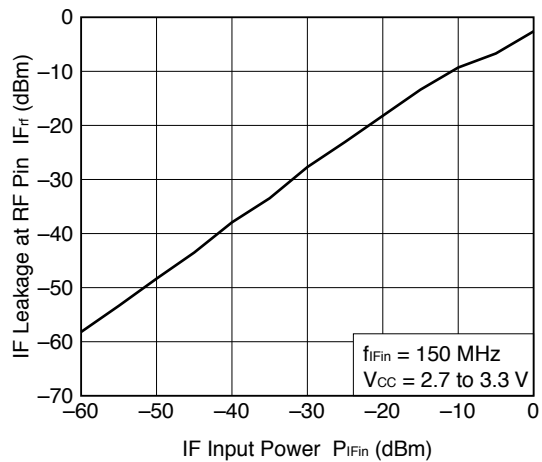
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT POWER



IF LEAKAGE AT RF PIN vs. IF INPUT FREQUENCY



IF LEAKAGE AT RF PIN vs. IF INPUT POWER

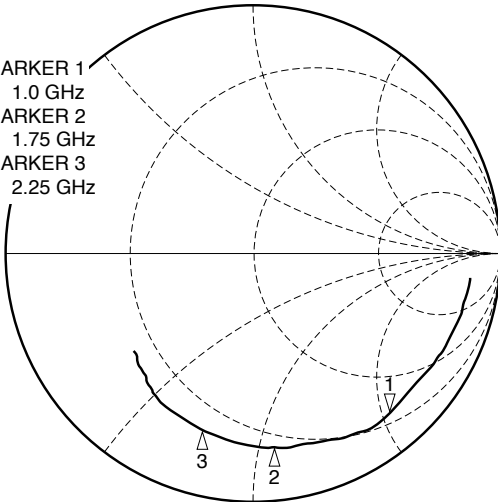


★ 12. S-PARAMETERS FOR EACH PORT ($V_{CC} = V_{RFout} = 2.8 V$)
 (The parameters are monitored at DUT pins)

LO port

S_{11} Z
 REF 1.0 Units
 1 200.0 mUnits/
 ∇_{hp} 22.762 Ω -104.25 Ω

MARKER 1
 1.0 GHz
 MARKER 2
 1.75 GHz
 MARKER 3
 2.25 GHz

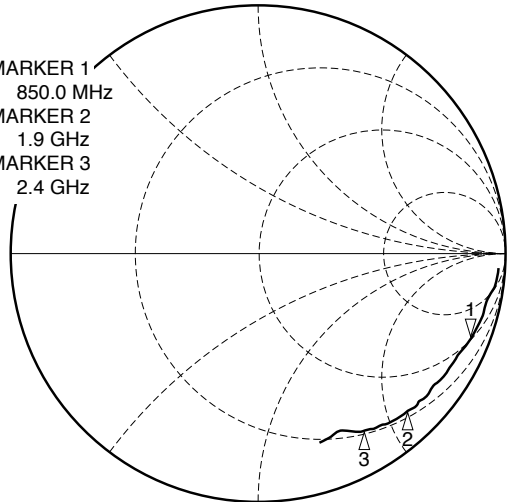


START 0.10000000 GHz
 STOP 3.10000000 GHz

RF port (without matching)

S_{22} Z
 REF 1.0 Units
 1 200.0 mUnits/
 ∇_{hp} 51.172 Ω -252.0 Ω

MARKER 1
 850.0 MHz
 MARKER 2
 1.9 GHz
 MARKER 3
 2.4 GHz

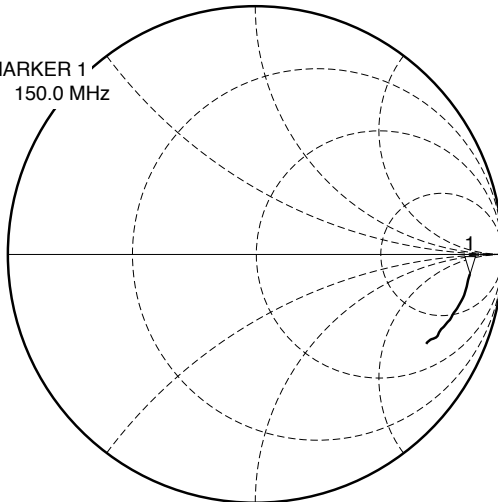


START 0.10000000 GHz
 STOP 3.10000000 GHz

IF port

S_{11} Z
 REF 1.0 Units
 1 200.0 mUnits/
 ∇_{hp} 518.97 Ω -321.09 Ω

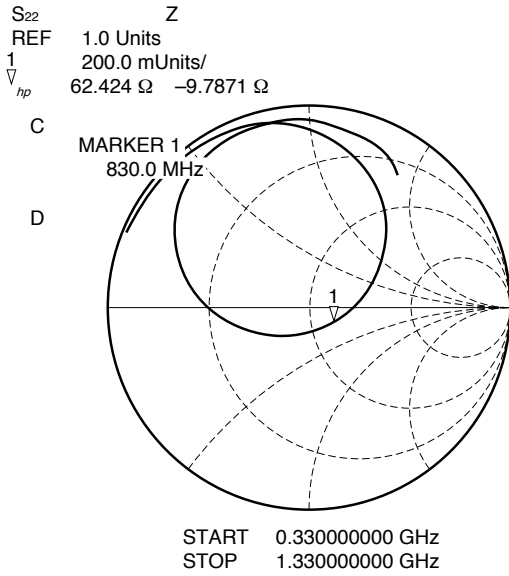
MARKER 1
 150.0 MHz



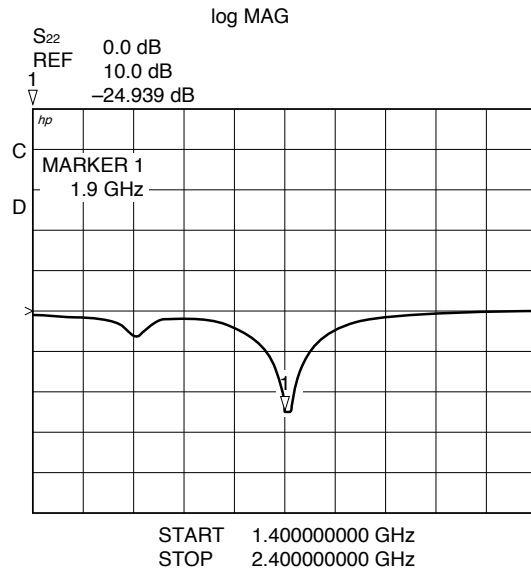
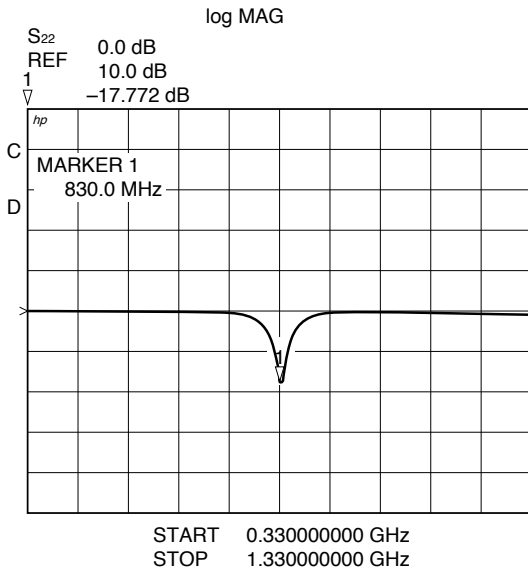
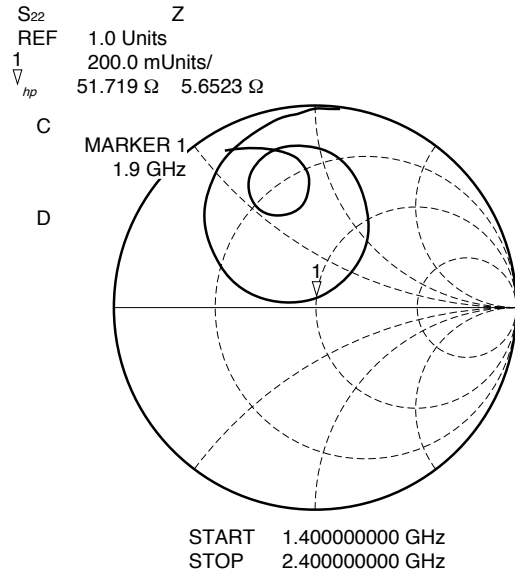
START 0.10000000 GHz
 STOP 1.00000000 GHz

★ 13. S-PARAMETERS FOR MATCHED RF OUTPUT ($V_{CC} = V_{RFout} = 2.8 V$)
 – ON EVALUATION BOARD – (S_{22} data are monitored at RF connector on board)

0.83 GHz (matched in test circuit 1)

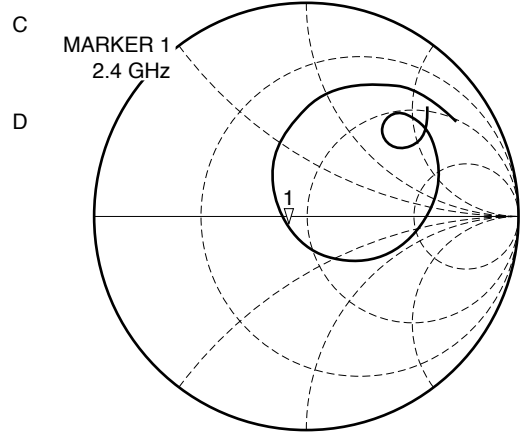


1.9 GHz (matched in test circuit 2)



2.4 GHz (matched in test circuit 3)

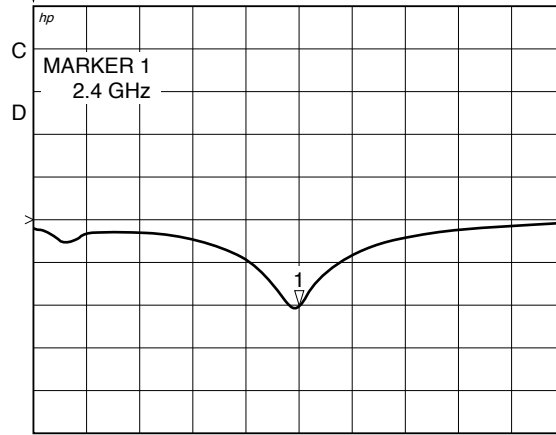
S₂₂ Z
 REF 1.0 Units
 1 200.0 mUnits/
 hp 41.41 Ω -3.2695 Ω



START 1.900000000 GHz
 STOP 2.900000000 GHz

log MAG

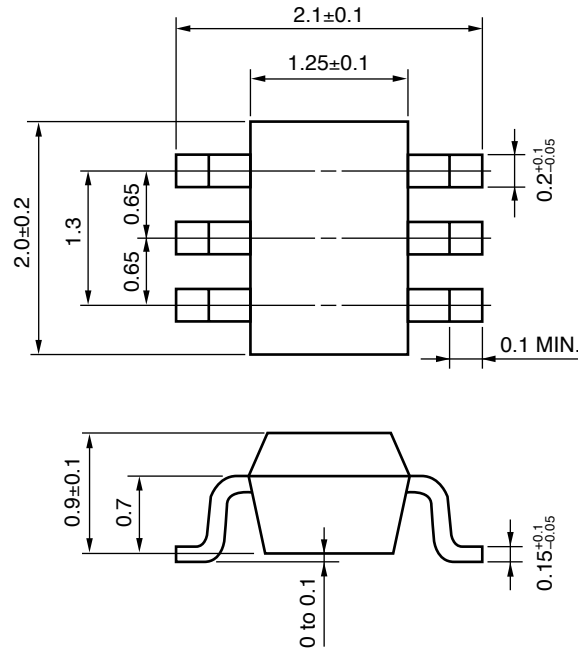
S₂₂ 0.0 dB
 REF 10.0 dB
 1 -20.203 dB
 hp



START 1.900000000 GHz
 STOP 2.900000000 GHz

14. PACKAGE DIMENSIONS

6-PIN SUPER MINIMOLD (UNIT: mm)



15. NOTE ON CORRECT USE

- (1) Observe precautions for handling because of electrostatic sensitive devices.
- (2) Form a ground pattern as wide as possible to minimize ground impedance (to prevent undesired oscillation).
- (3) Connect a bypass capacitor to the V_{CC} pin.
- (4) Connect a matching circuit to the RF output pin.
- (5) The DC cut capacitor must be each attached to the input and output pins.

16. RECOMMENDED SOLDERING CONDITIONS

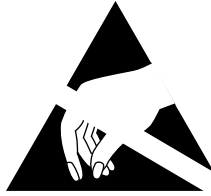
This product should be soldered under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your NEC sales representative.

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)**.



ATTENTION

OBSERVE PRECAUTIONS
FOR HANDLING
ELECTROSTATIC
SENSITIVE
DEVICES

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 - "Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)
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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	

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