DATA SHEET

CEL

BIPOLAR ANALOG INTEGRATED CIRCUIT
μPC8178TK

SILICON MMIC LOW CURRENT AMPLIFIER FOR MOBILE COMMUNICATIONS

DESCRIPTION

The μPC8178TK is a silicon monolithic integrated circuit designed as amplifier for mobile communications. This IC can realize low current consumption with external chip inductor which can not be realized on internal 50 Ω wide band matched IC. μPC8178TK adopts 6-pin lead-less minimold package using same chip as the conventional μPC8178TB in 6-pin super minimold.

TK suffix IC which is smaller package than TB suffix IC contributes to reduce mounting space by 50 %.

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

FEATURES

- Low current consumption : I_{CC} = 1.9 mA TYP. @ V_{CC} = 3.0 V
- Supply voltage : V_{CC} = 2.4 to 3.3 V
- Excellent isolation : ISL = 40 dB TYP. @ f = 1.0 GHz
  ISL = 41 dB TYP. @ f = 1.9 GHz
  ISL = 42 dB TYP. @ f = 2.4 GHz
- Power gain : G_P = 11.0 dB TYP. @ f = 1.0 GHz
  G_P = 11.0 dB TYP. @ f = 1.9 GHz
  G_P = 11.0 dB TYP. @ f = 2.4 GHz
- Gain 1 dB compression output power : $P_{O (1 dB)}$ = −5.5 dBm TYP. @ f = 1.0 GHz
  $P_{O (1 dB)}$ = −8.0 dBm TYP. @ f = 1.9 GHz
  $P_{O (1 dB)}$ = −8.0 dBm TYP. @ f = 2.4 GHz
- Operating frequency : 0.1 to 2.4 GHz (Output port LC matching)
- High-density surface mounting : 6-pin lead-less minimold package (1.5 × 1.3 × 0.55 mm)
- Light weight : 3 mg (Standard value)

APPLICAION

- Buffer amplifiers on 0.1 to 2.4 GHz mobile communications system

Caution Observe precautions when handling because these devices are sensitive to electrostatic discharge.

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The mark ★ shows major revised points.

★ ORDERING INFORMATION

Part Number	Order Number	Package	Marking	Supplying Form
μPC8178TK-E2	μPC8178TK-E2-A	6-pin lead-less minimold (1511) (Pb-Free) Note	6B	• Embossed tape 8 mm wide • Pin 1, 2, 3 face the perforation side of the tape • Qty 5 kpcs/reel

Note With regards to terminal solder (the solder contains lead) plated products (conventionally plated), contact your nearby sales office.

Remark To order evaluation samples, contact your nearby sales office.
Part number for sample order: μPC8178TK-A

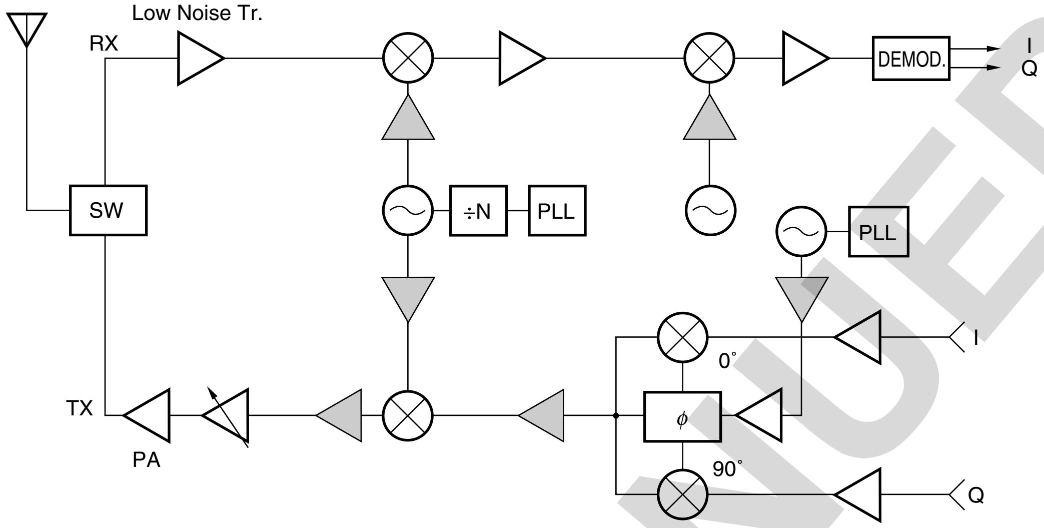
PRODUCT LINE-UP (T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω)

Parameter / Part No.	I_{CC} (mA)	1.0 GHz output port matching frequency			1.66 GHz output port matching frequency			1.9 GHz output port matching frequency			2.4 GHz output port matching frequency			Marking
		G_P (dB)	ISL (dB)	$P_{O(1dB)}$ (dBm)	G_P (dB)	ISL (dB)	$P_{O(1dB)}$ (dBm)	G_P (dB)	ISL (dB)	$P_{O(1dB)}$ (dBm)	G_P (dB)	ISL (dB)	$P_{O(1dB)}$ (dBm)	
μPC8178TB	1.9	11.0	39.0	–4.0	–	–	–	11.5	40.0	–7.0	11.5	38.0	–7.5	C3B
μPC8178TK	1.9	11.0	40.0	–5.5	–	–	–	11.0	41.0	–8.0	11.0	42.0	–8.0	6B
μPC8179TB	4.0	13.5	44.0	+3.0	–	–	–	15.5	42.0	+1.5	15.5	41.0	+1.0	C3C
μPC8128TB	2.8	12.5	39.0	–4.0	13.0	39.0	–4.0	13.0	37.0	–4.0	–	–	–	C2P
μPC8151TB	4.2	12.5	38.0	+2.5	15.0	36.0	+1.5	15.0	34.0	+0.5	–	–	–	C2U
μPC8152TB	5.6	23.0	40.0	–4.5	19.5	38.0	–8.5	17.5	35.0	–8.5	–	–	–	C2V

Remarks 1. Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail.
2. To know the associated product, please refer to each latest data sheet.

SYSTEM APPLICATION EXAMPLE

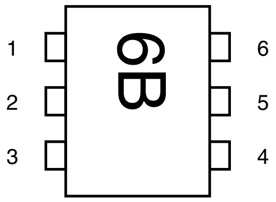
Location examples in digital cellular



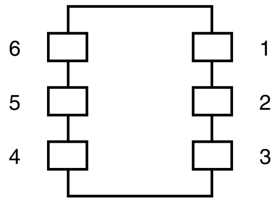
These ICs can be added to your system around △ parts, when you need more isolation or gain. The application herein, however, shows only examples, therefore the application can depend on your kit evaluation.

PIN CONNECTIONS

(Top View)

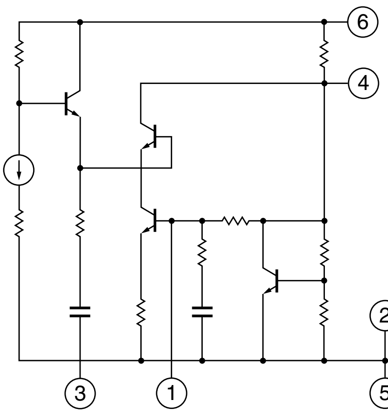


(Bottom View)



Pin No.	Pin Name
1	INPUT
2	GND
3	GND
4	OUTPUT
5	GND
6	V_{CC}

PIN EXPLANATION

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)[Note]	Function and Applications	Internal Equivalent Circuit
1	INPUT	–	0.90	Signal input pin. A internal matching circuit, configured with resisters, enables 50 Ω connection over a wide band. This pin must be coupled to signal source with capacitor for DC cut.	
2 3 5	GND	0	–	Ground pin. This pin should be connected to system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible. All the ground pins must be connected together with wide ground pattern to decrease impedance defference.	
4	OUTPUT	Voltage as same as V_{CC} through external inductor	–	Signal output pin. This pin is designed as collector output. Due to the high impedance output, this pin should be externally equipped with LC matching circuit to next stage. For L, a size 1 005 chip inductor can be chosen.	
6	V_{CC}	2.4 to 3.3	–	Power supply pin. This pin should be externally equipped with bypass capacitor to minimize its impedance.	

Note Pin voltage is measured at V_{CC} = 3.0 V.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Ratings	Unit
Supply Voltage	V_{CC}	T_A = +25°C, Pin 4, Pin 6	3.6	V
Circuit Current	I_{CC}	T_A = +25°C	15	mA
Power Dissipation	P_D	T_A = +85°C **Note**	232	mW
Operating Ambient Temperature	T_A		–40 to +85	°C
Storage Temperature	T_{stg}		–55 to +150	°C
Input Power	P_{in}	T_A = +25°C	+5	dBm

Note Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB

RECOMMENDED OPERATING RANGE

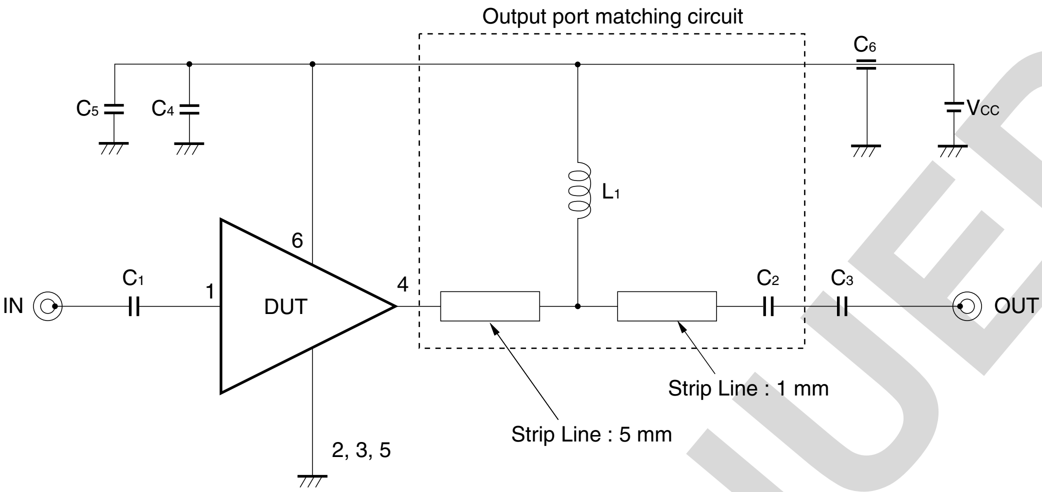
Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
Supply Voltage	V_{CC}	2.4	3.0	3.3	V	The same voltage should be applied to pin 4 and pin 6.
Operating Ambient Temperature	T_A	–40	+25	+85	°C	

ELECTRICAL CHARACTERISTICS
(Unless otherwise specified, T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω, at LC matched frequency)

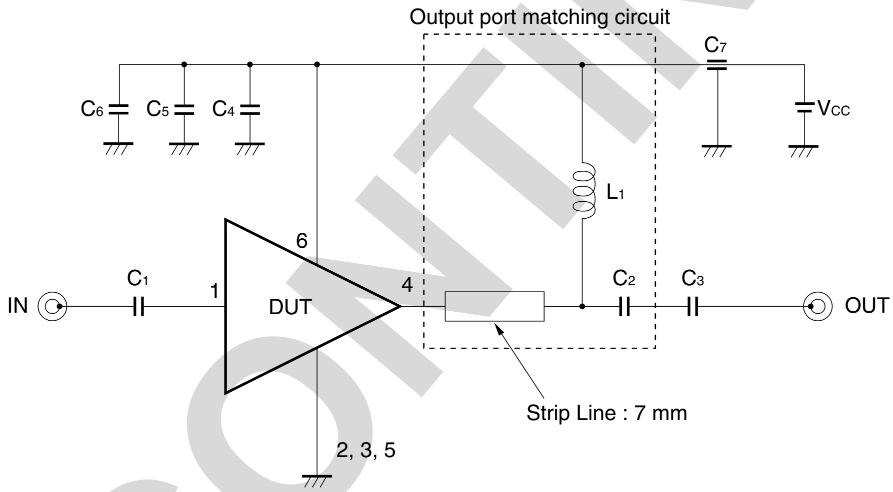
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I_{CC}	No signal	1.4	1.9	2.4	mA
Power Gain	G_P	f = 1.0 GHz, P_{in} = –30 dBm f = 1.9 GHz, P_{in} = –30 dBm f = 2.4 GHz, P_{in} = –30 dBm	9.0 9.0 9.0	11.0 11.0 11.0	13.0 13.5 13.5	dB
Isolation	ISL	f = 1.0 GHz, P_{in} = –30 dBm f = 1.9 GHz, P_{in} = –30 dBm f = 2.4 GHz, P_{in} = –30 dBm	35.0 36.0 37.0	40.0 41.0 42.0	– – –	dB
Gain 1 dB Compression Output Power	$P_{O(1\,dB)}$	f = 1.0 GHz f = 1.9 GHz f = 2.4 GHz	–8.0 –11.0 –11.5	–5.5 –8.0 –8.0	– – –	dBm
Noise Figure	NF	f = 1.0 GHz f = 1.9 GHz f = 2.4 GHz	– – –	5.5 5.5 5.5	7.0 7.0 7.0	dB
Input Return Loss	RL_{in}	f = 1.0 GHz, P_{in} = –30 dBm f = 1.9 GHz, P_{in} = –30 dBm f = 2.4 GHz, P_{in} = –30 dBm	4.0 5.0 6.5	7.0 8.0 9.5	– – –	dB

★ TEST CIRCUITS

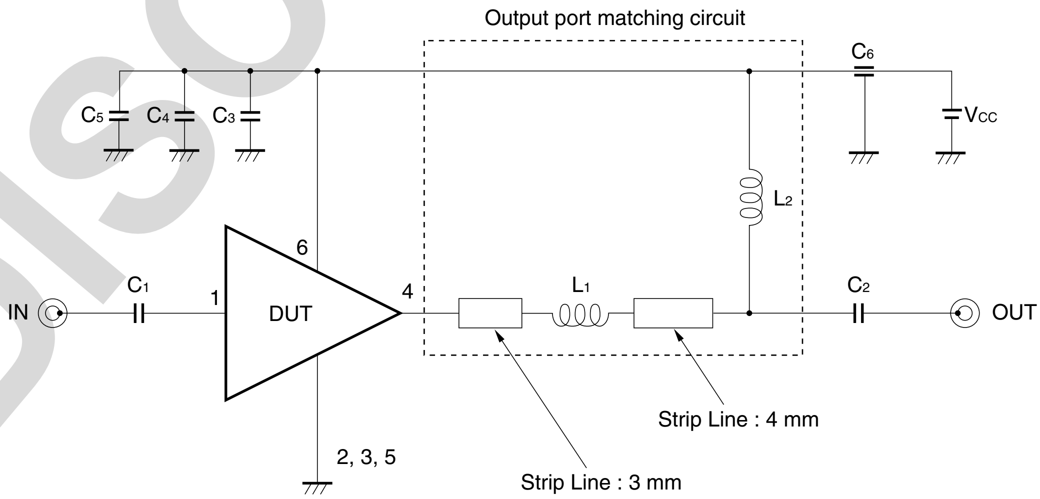
<1> f = 1.0 GHz



<2> f = 1.9 GHz

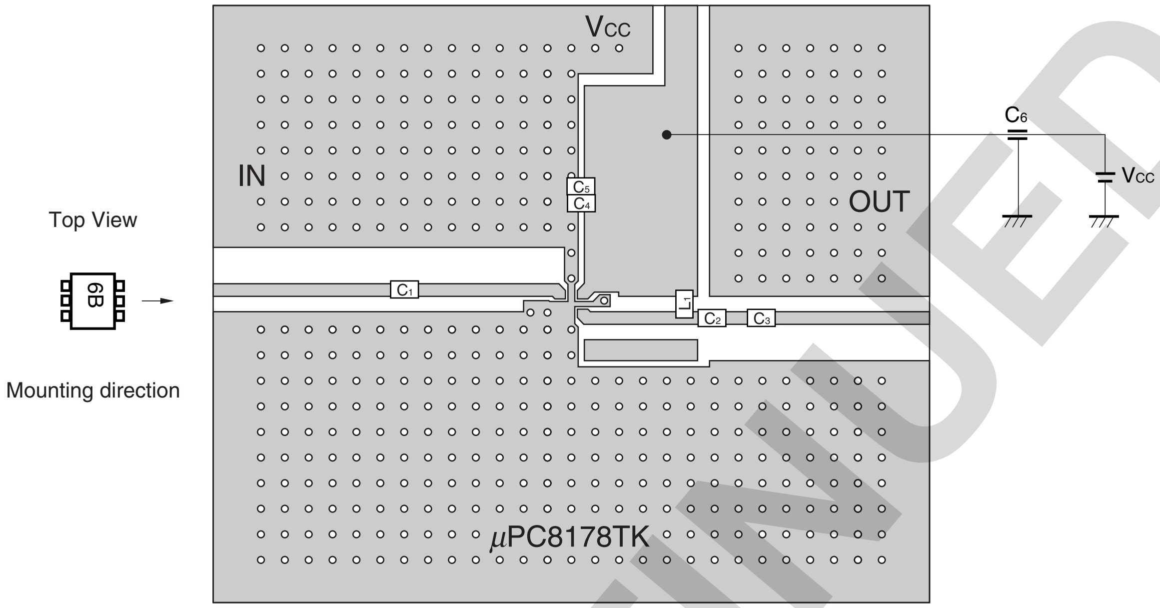


<3> f = 2.4 GHz



★ ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD

<1> f = 1.0 GHz

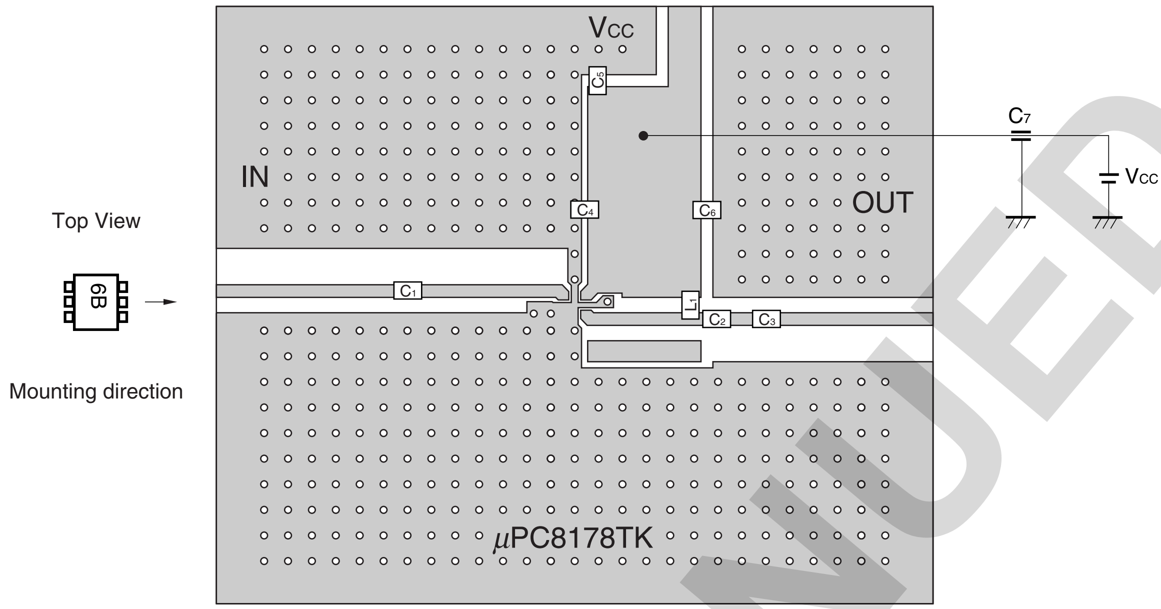


(∗1) 42 × 35 × 0.4 mm polyimide board, double-sided copper clad
(∗2) Back side: GND pattern
(∗3) Gold plated on pattern
(∗4) ○ : Through holes

COMPONENT LIST

Form	Symbol	Value	Type code	Maker
Chip capacitor	C_1, C_3	1 000 pF	GRM40CH102J50PT	murata
	C_2	0.75 pF	GRM39CKR75C50PT	murata
	C_4	20 pF	GRM39CH200J50PT	murata
	C_5	10 pF	GRM39CH100D50PT	murata
Feed-though Capacitor	C_6	1 000 pF	DFT301-801 × 7R102S50	murata
Chip inductor	L_1	12 nH	LL1608-FH12N	TOKO

<2> f = 1.9 GHz

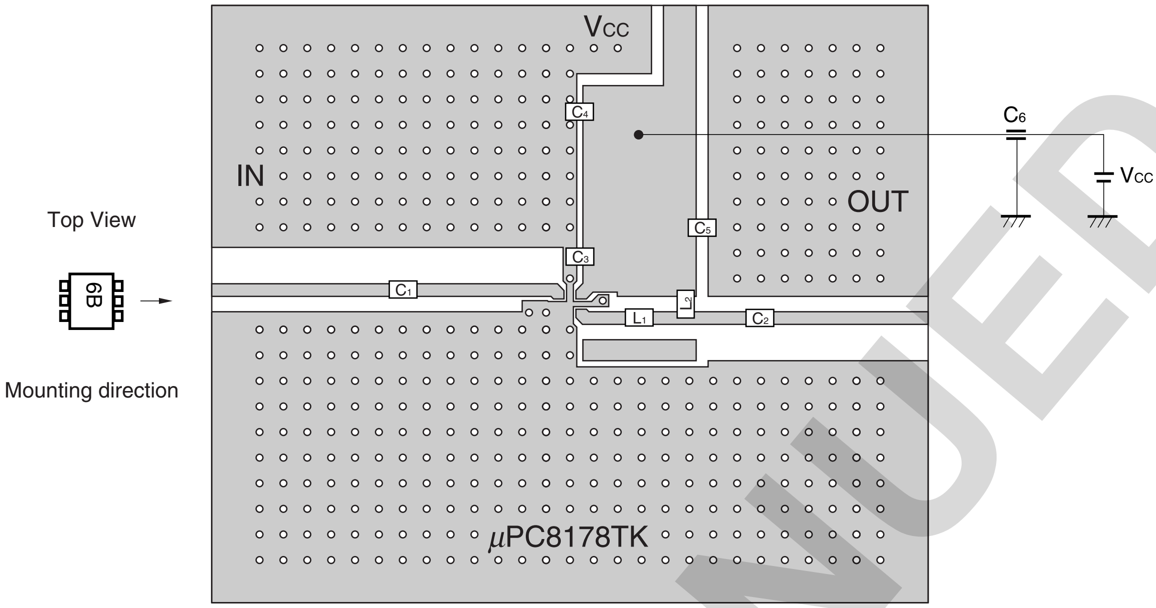


(∗1) 42 × 35 × 0.4 mm polyimide board, double-sided copper clad
(∗2) Back side: GND pattern
(∗3) Gold plated on pattern
(∗4) ○ : Through holes

COMPONENT LIST

Form	Symbol	Value	Type code	Maker
Chip capacitor	C_1, C_3, C_5, C_6	1 000 pF	GRM40CH102J50PT	murata
	C_2	0.5 pF	GRM39CKR5C50PT	murata
	C_4	8 pF	GRM39CH080D50PT	murata
Feed-though Capacitor	C_7	1 000 pF	DFT301-801 × 7R102S50	murata
Chip inductor	L_1	2.7 nH	LL1608-FH2N7S	TOKO

<3> f = 2.4 GHz



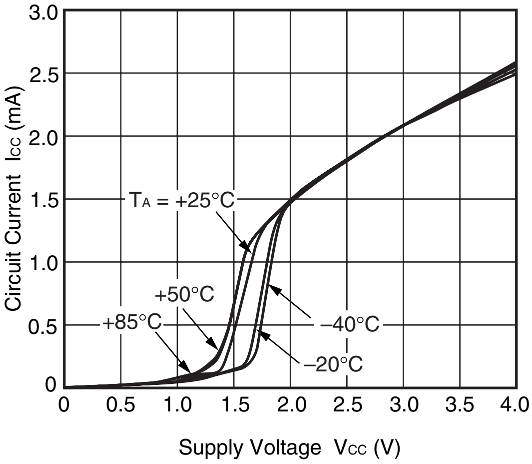
(∗1) 42 × 35 × 0.4 mm polyimide board, double-sided copper clad
(∗2) Back side: GND pattern
(∗3) Gold plated on pattern
(∗4) ○ : Through holes

COMPONENT LIST

Form	Symbol	Value	Type code	Maker
Chip capacitor	C_1, C_2, C_4, C_5	1 000 pF	GRM40CH102J50PT	murata
	C_3	10 pF	GRM39CH100D50PT	murata
Feed-though Capacitor	C_6	1 000 pF	DFT301-801 × 7R102S50	murata
Chip inductor	L_1	2.7 nH	LL1608-FH2N7S	TOKO
	L_2	1.8 nH	LL1608-FH1N8S	TOKO

★ **TYPICAL CHARACTERISTICS (T_A = +25°C, unless otherwise specified)**

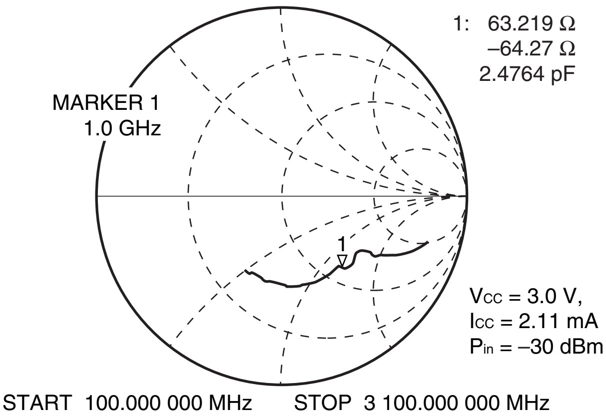
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



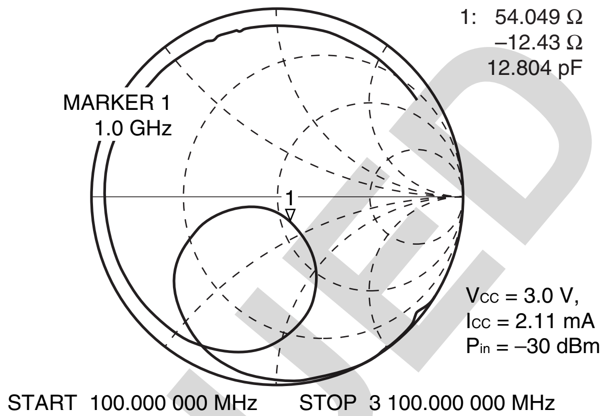
Remark The graph indicates nominal characteristics.

f = 1.0 GHz MATCHING

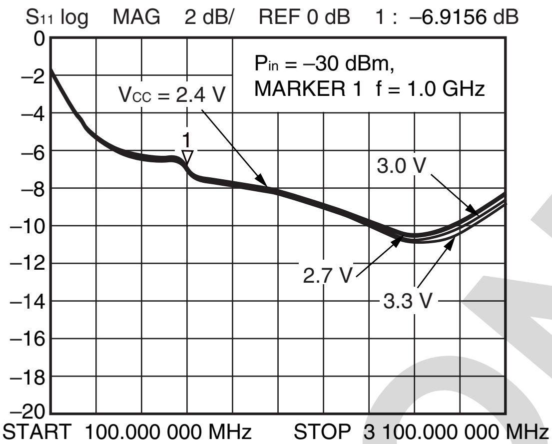
S_{11}-FREQUENCY



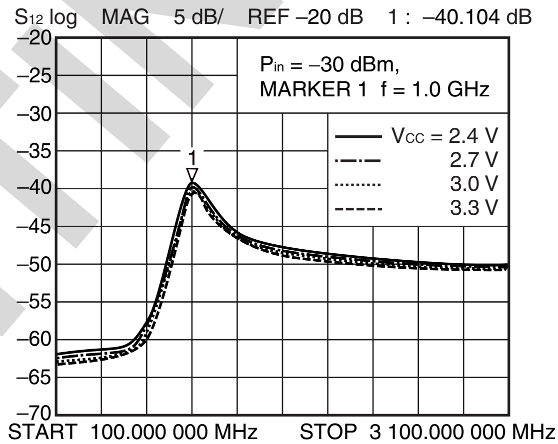
S_{22}-FREQUENCY



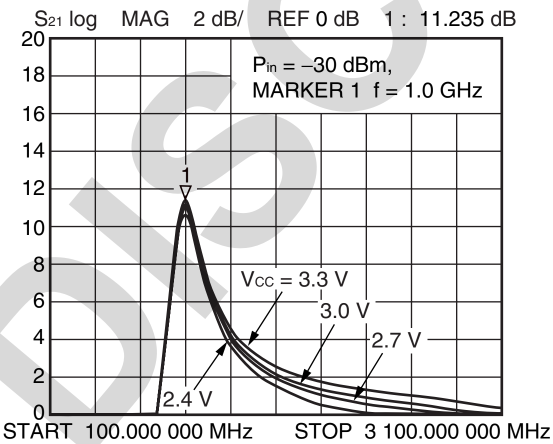
S_{11}-FREQUENCY



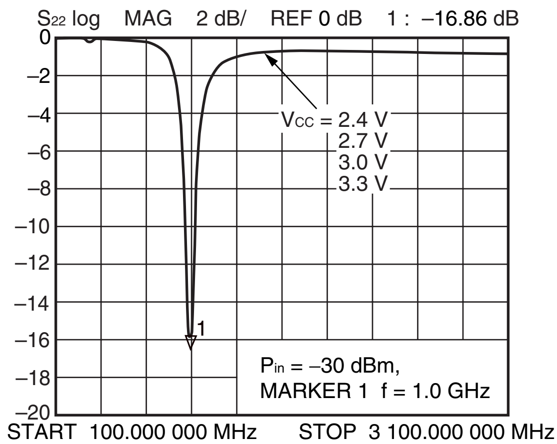
S_{12}-FREQUENCY



S_{21}-FREQUENCY

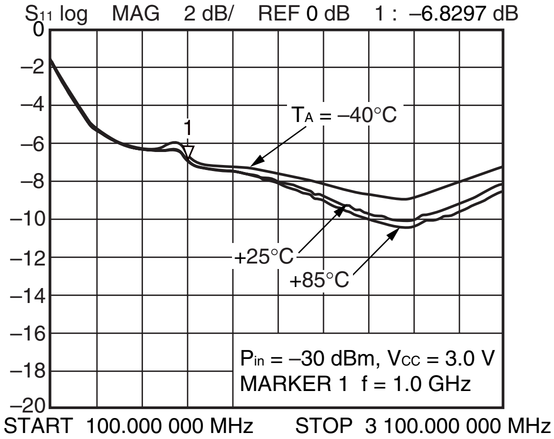


S_{22}-FREQUENCY



Remark The graphs indicate nominal characteristics.

S11-FREQUENCY



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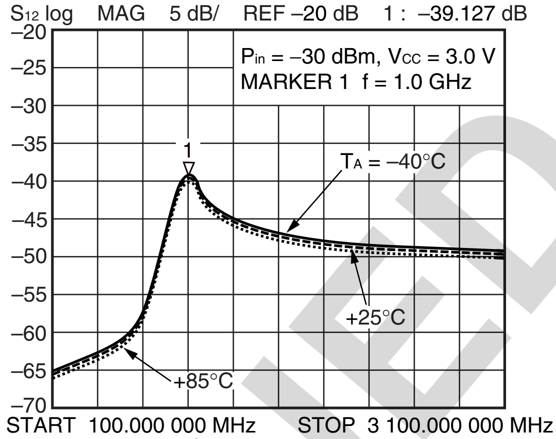

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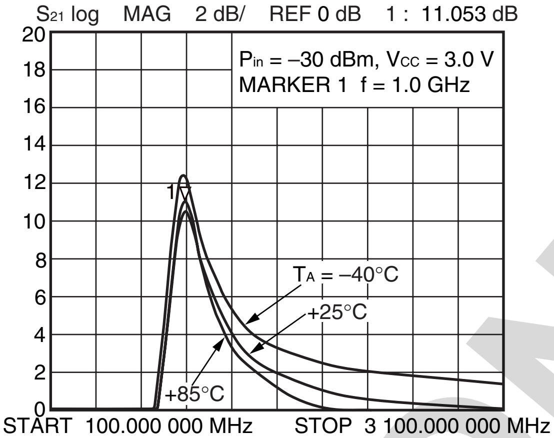

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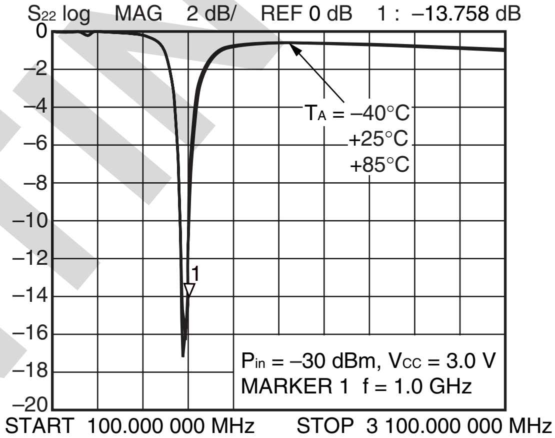
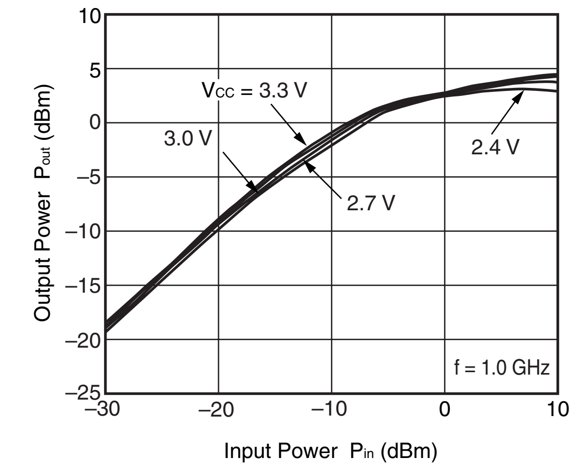
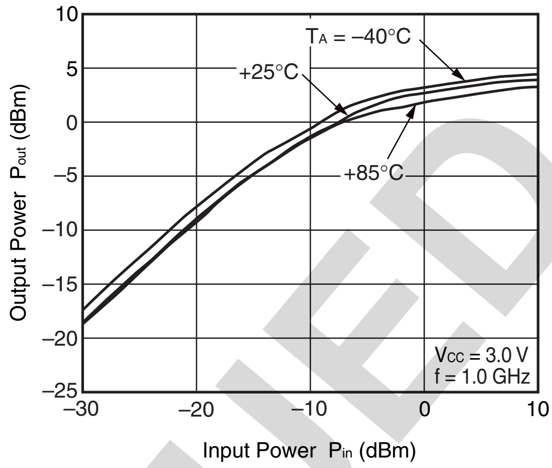


Remark The graphs indicate nominal characteristics.

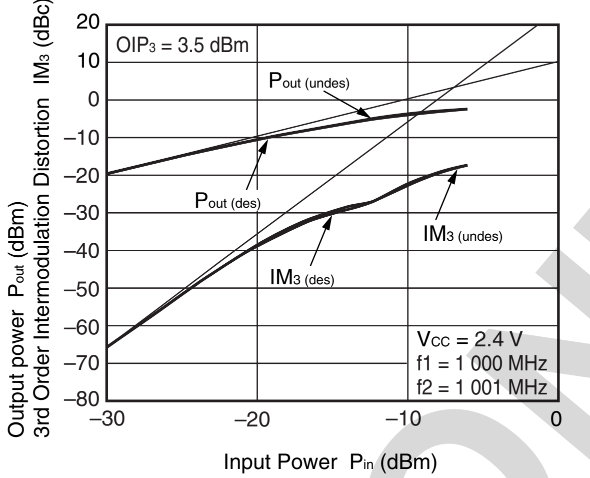
OUTPUT POWER vs. INPUT POWER



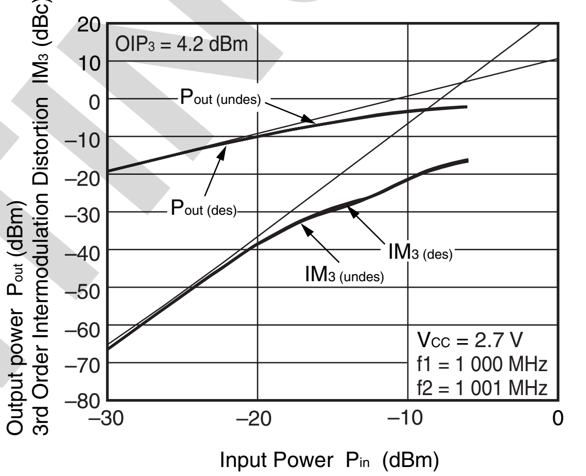
OUTPUT POWER vs. INPUT POWER



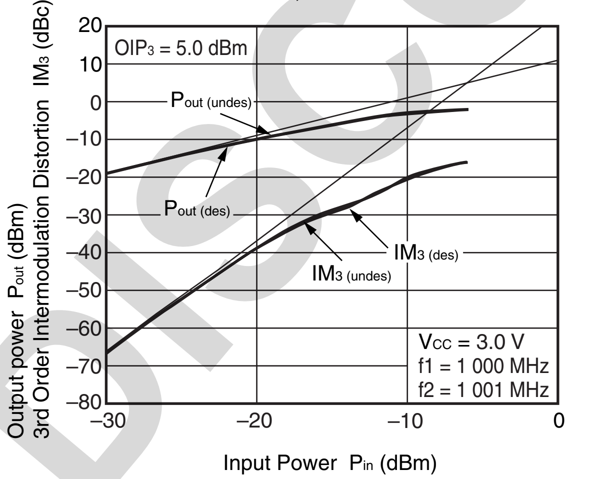
OUTPUT POWER, IM3 vs. INPUT POWER



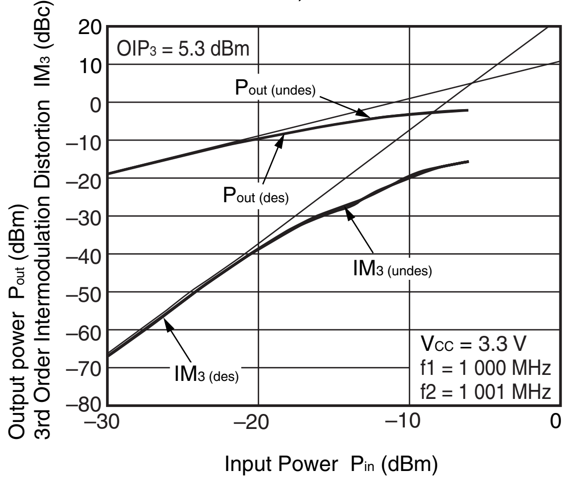
OUTPUT POWER, IM3 vs. INPUT POWER



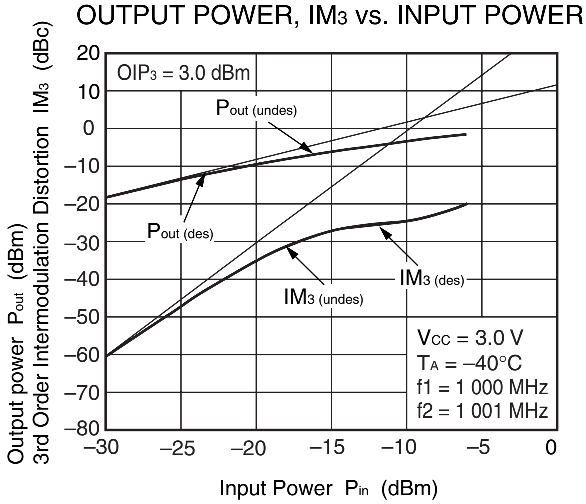
OUTPUT POWER, IM3 vs. INPUT POWER

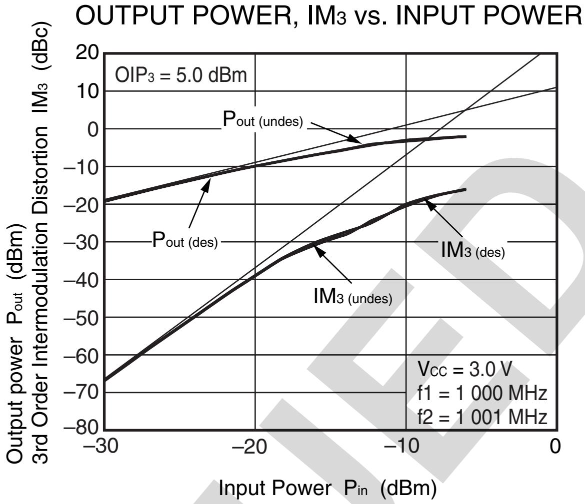


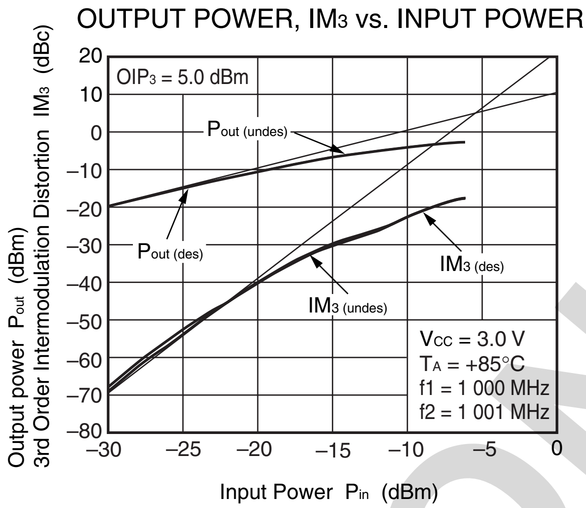
OUTPUT POWER, IM3 vs. INPUT POWER

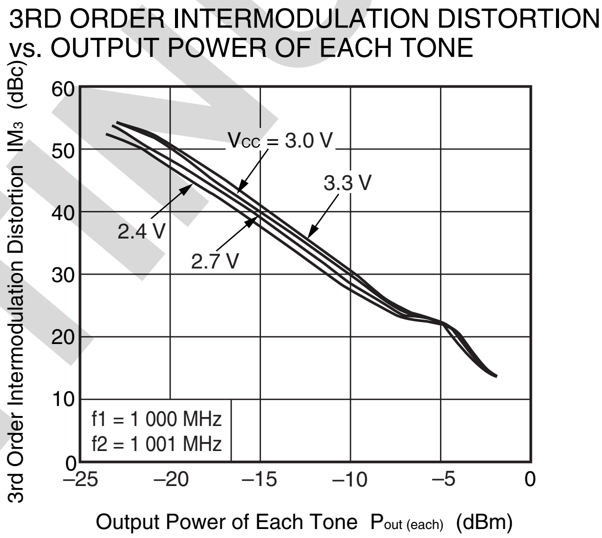


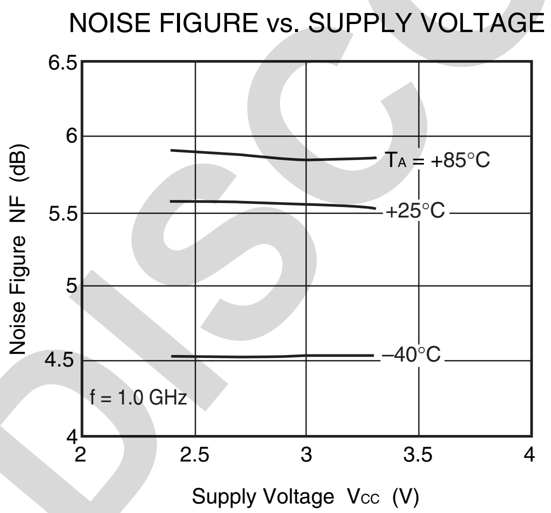
Remark The graphs indicate nominal characteristics.







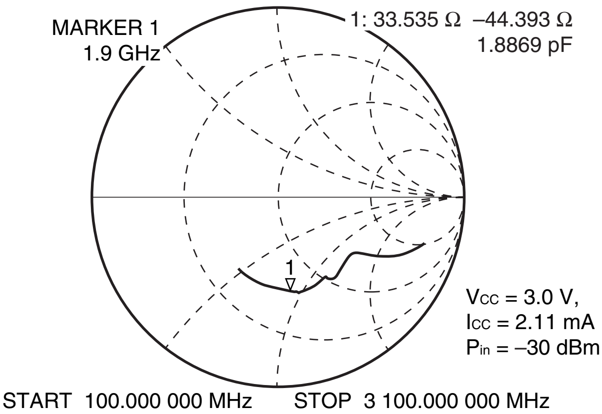




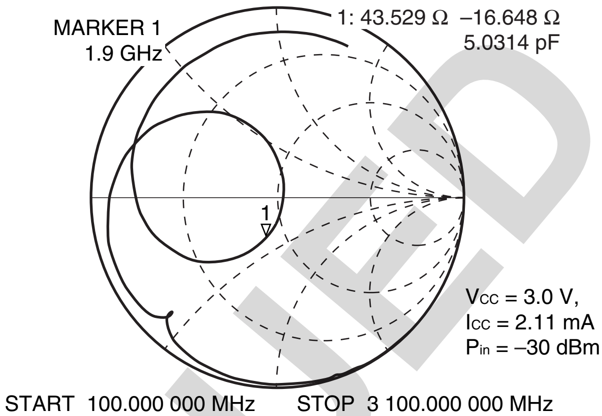
Remark The graphs indicate nominal characteristics.

f = 1.9 GHz MATCHING

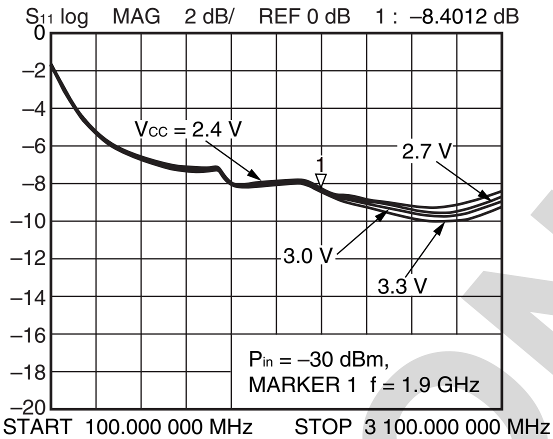
S11-FREQUENCY



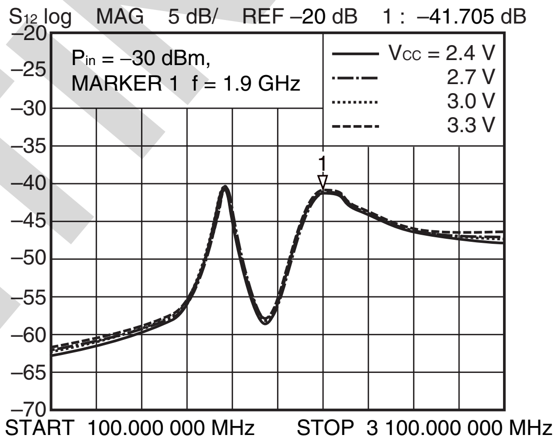
S22-FREQUENCY



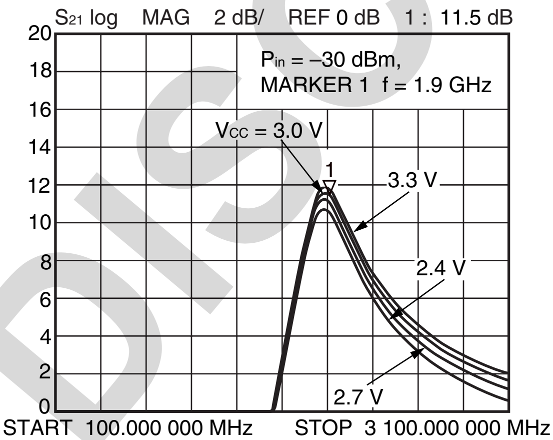
S11-FREQUENCY



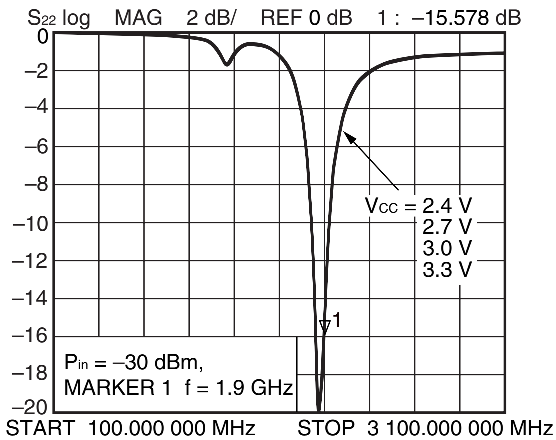
S12-FREQUENCY



S21-FREQUENCY

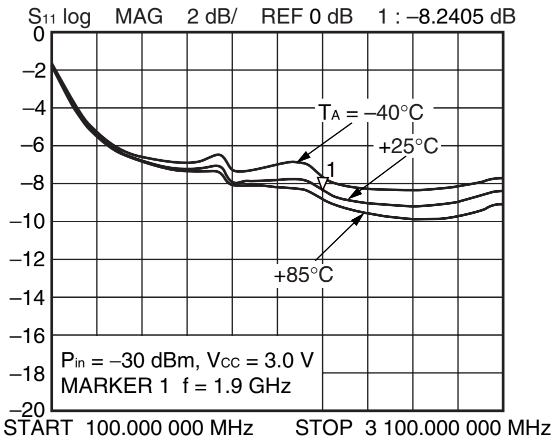


S22-FREQUENCY

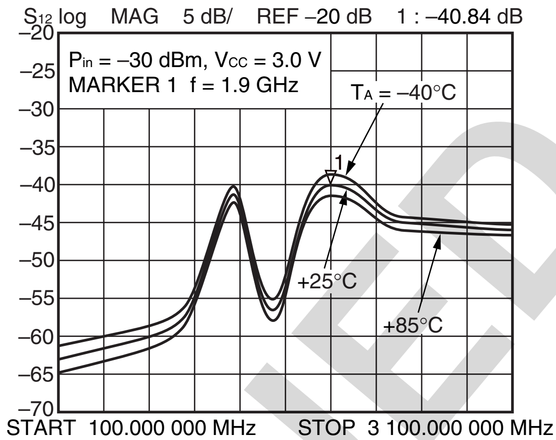


Remark The graphs indicate nominal characteristics.

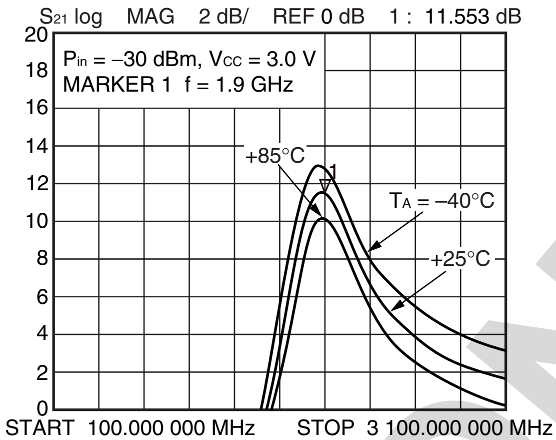
S11-FREQUENCY



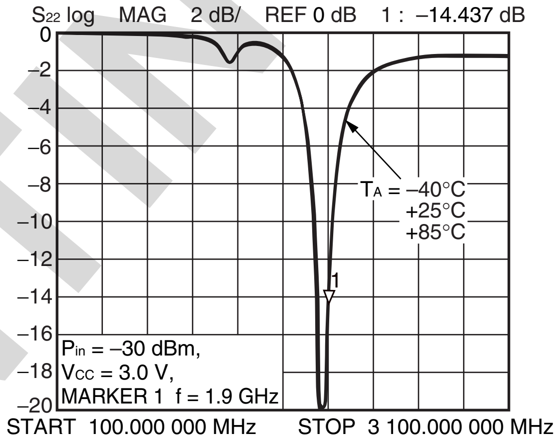
S12-FREQUENCY



S21-FREQUENCY

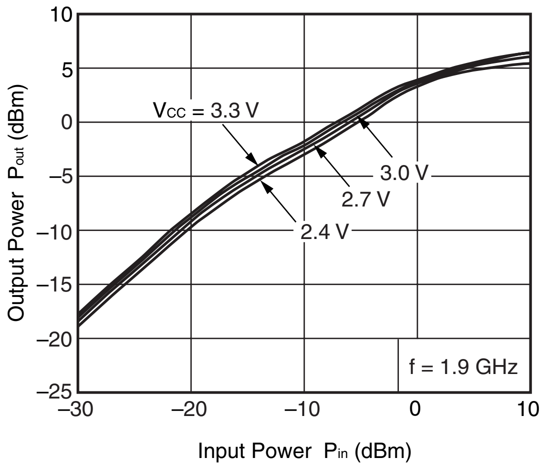


S22-FREQUENCY

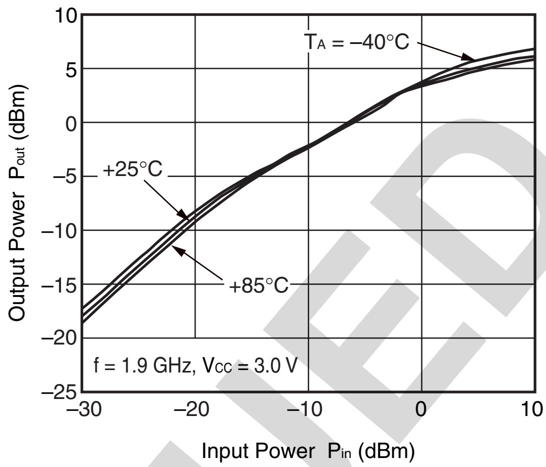


Remark The graphs indicate nominal characteristics.

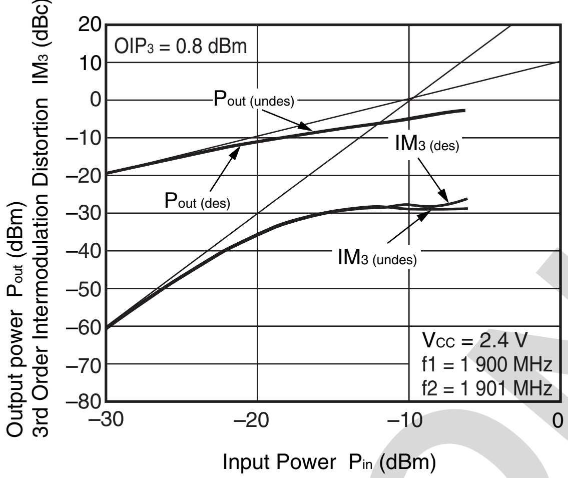
OUTPUT POWER vs. INPUT POWER



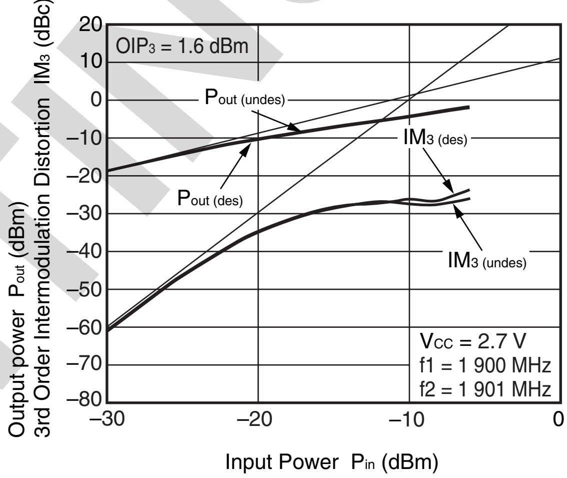
OUTPUT POWER vs. INPUT POWER



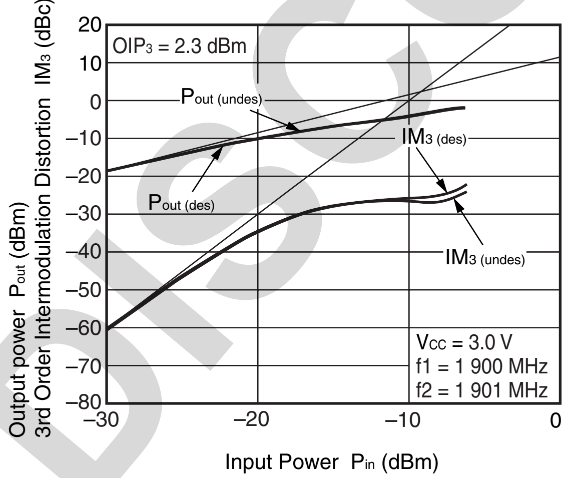
OUTPUT POWER, IM3 vs. INPUT POWER



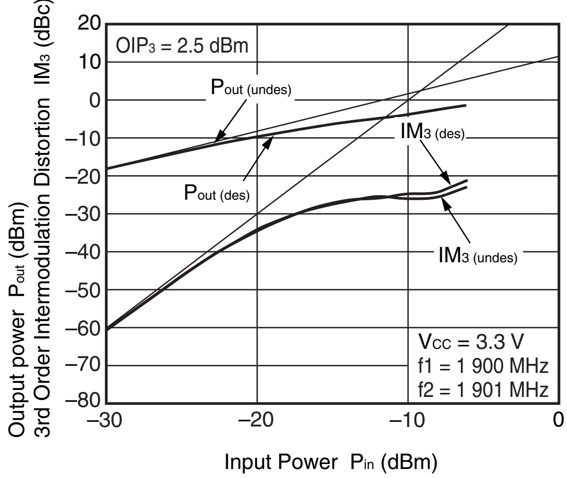
OUTPUT POWER, IM3 vs. INPUT POWER



OUTPUT POWER, IM3 vs. INPUT POWER

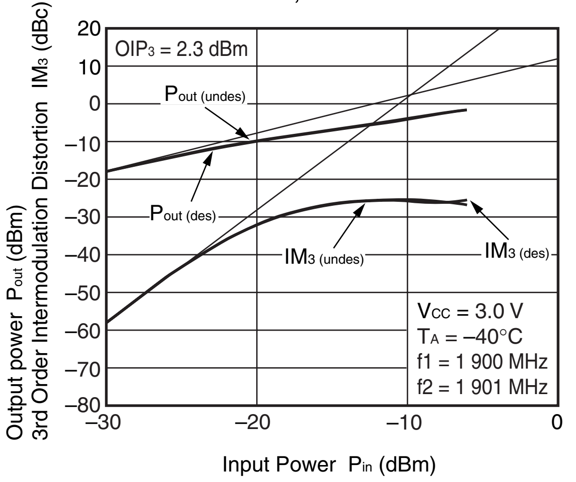


OUTPUT POWER, IM3 vs. INPUT POWER

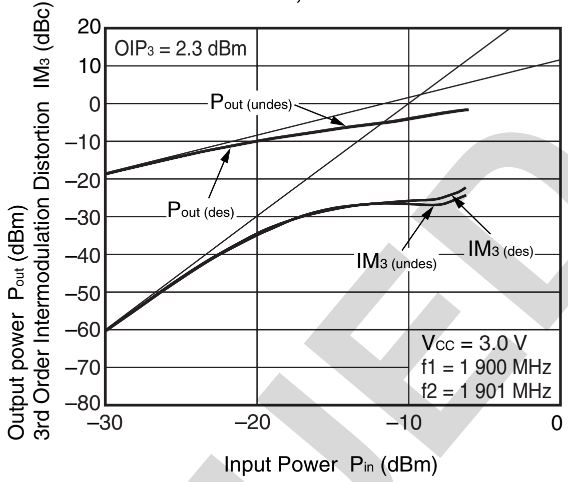


Remark The graphs indicate nominal characteristics.

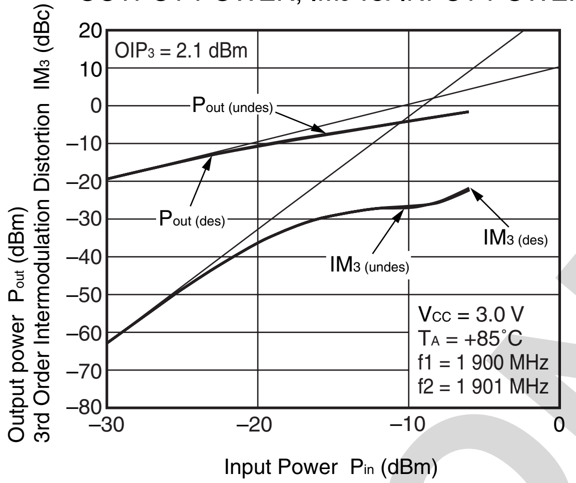
OUTPUT POWER, IM3 vs. INPUT POWER



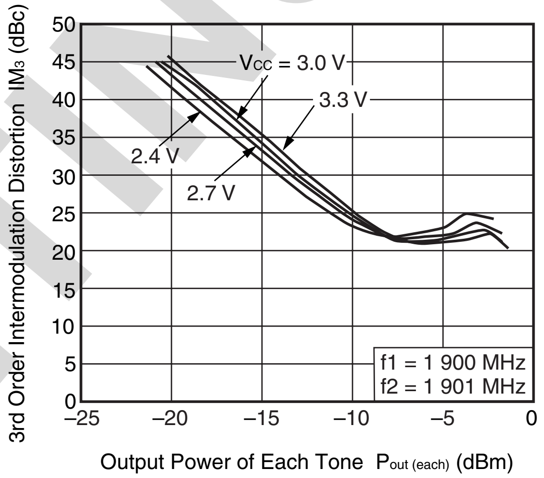
OUTPUT POWER, IM3 vs. INPUT POWER



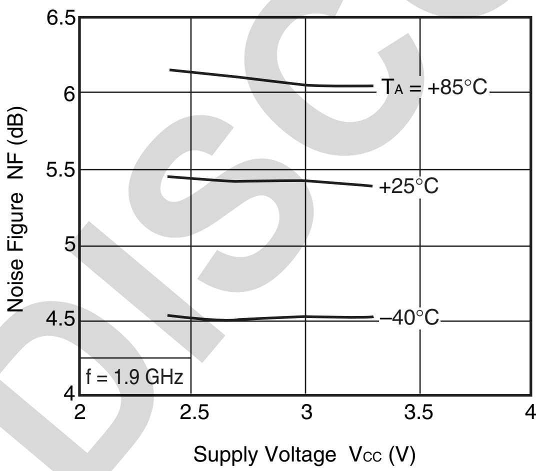
OUTPUT POWER, IM3 vs. INPUT POWER



3RD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE

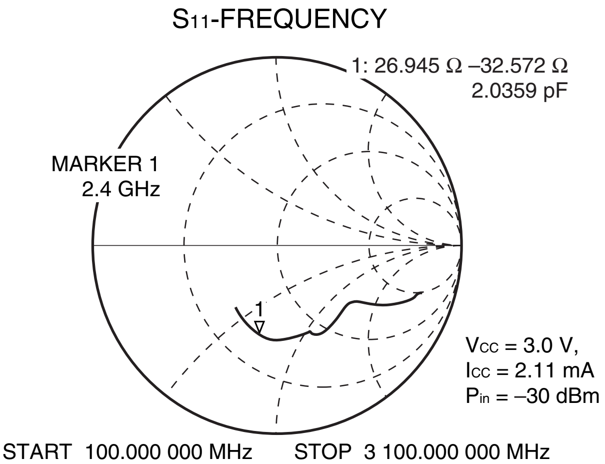


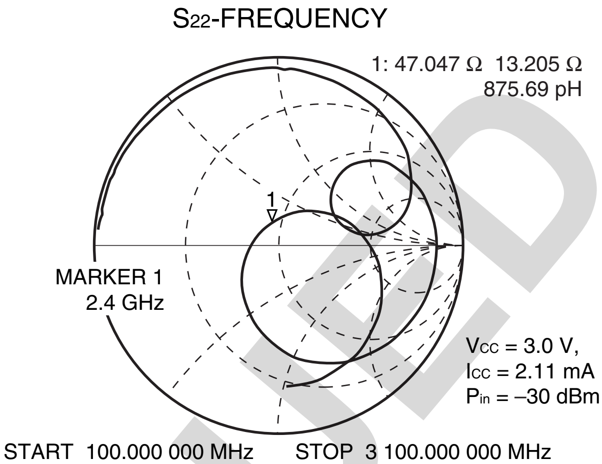
NOISE FIGURE vs. SUPPLY VOLTAGE

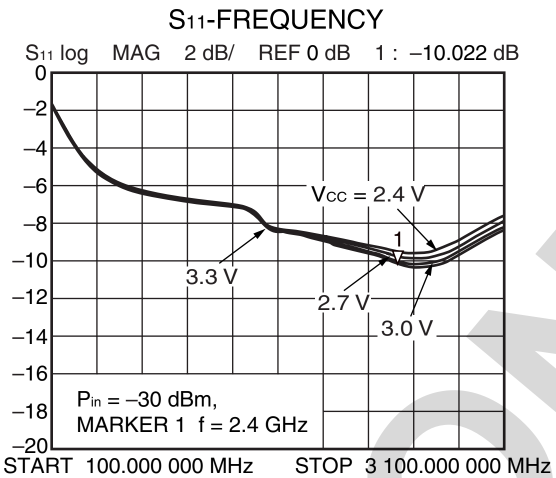


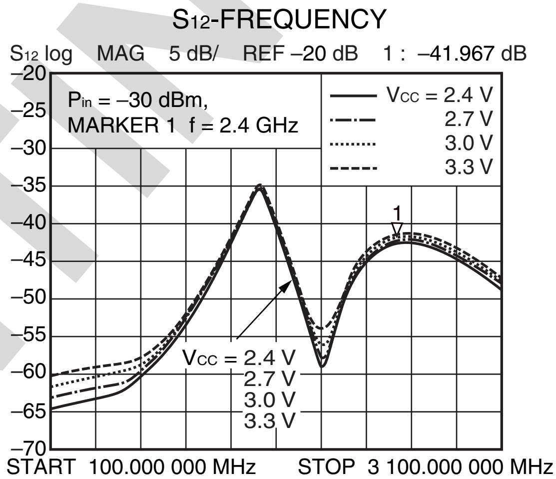
Remark The graphs indicate nominal characteristics.

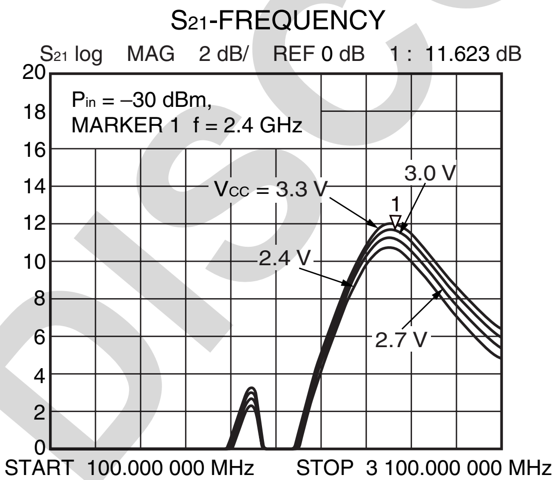
f = 2.4 GHz MATCHING

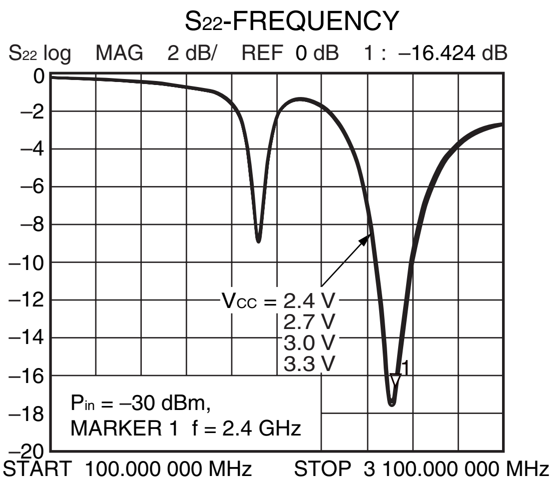






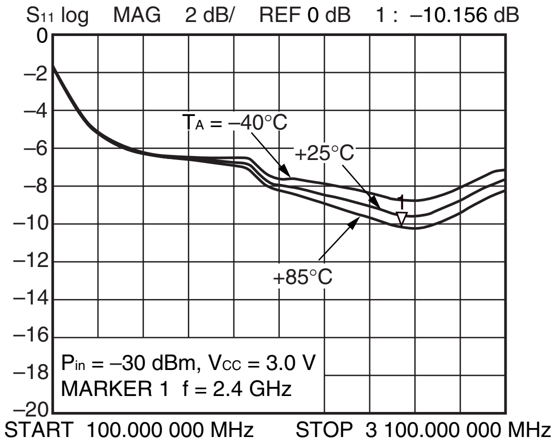




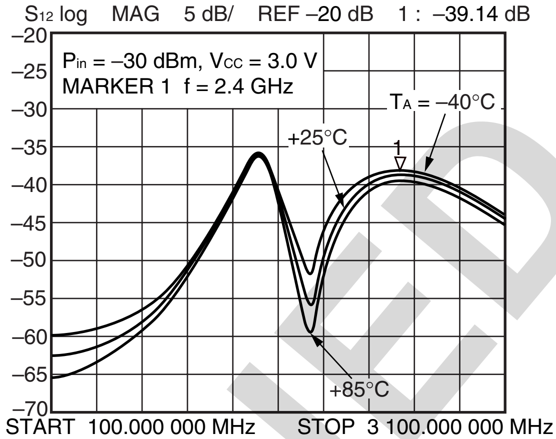


Remark The graphs indicate nominal characteristics.

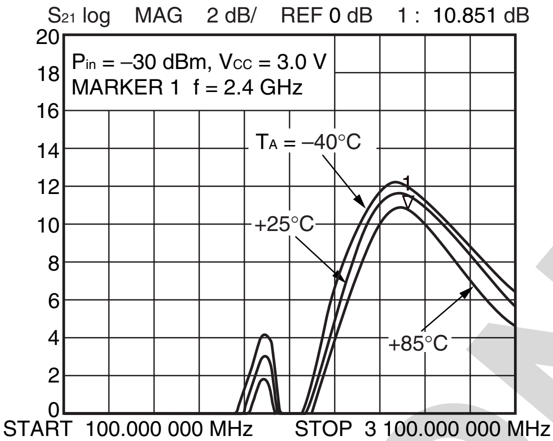
S11-FREQUENCY



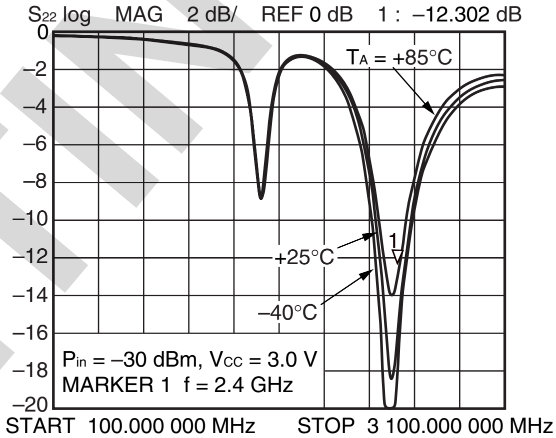
S12-FREQUENCY



S21-FREQUENCY

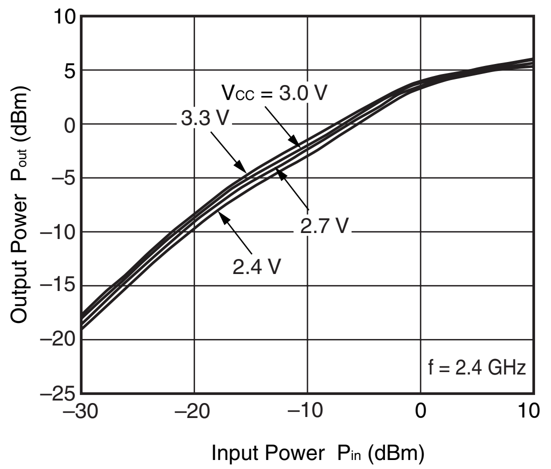


S22-FREQUENCY

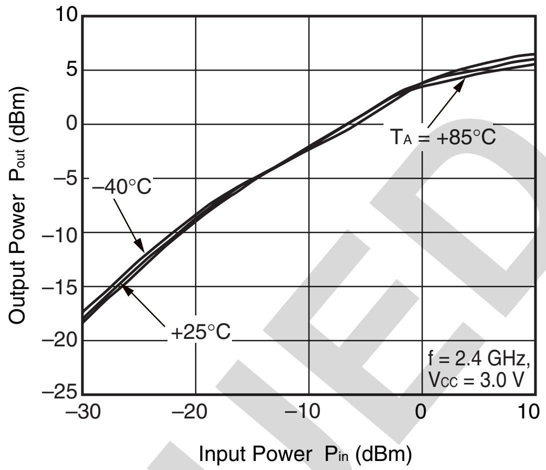


Remark The graphs indicate nominal characteristics.

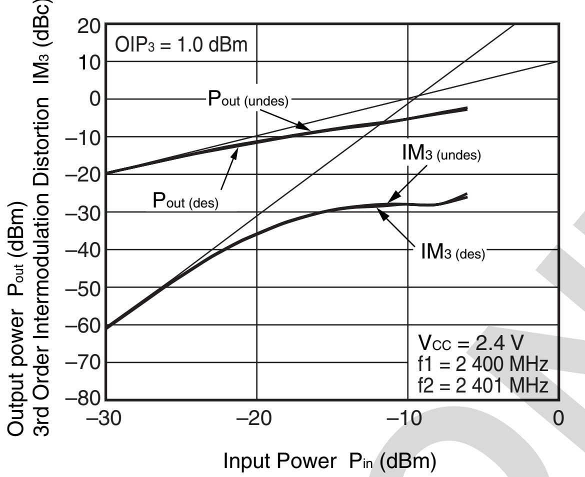
OUTPUT POWER vs. INPUT POWER



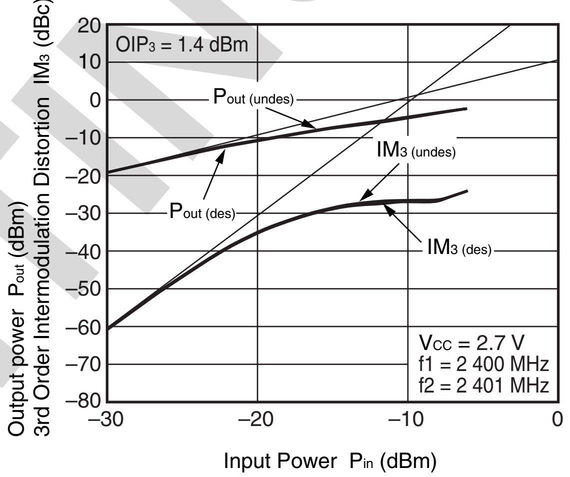
OUTPUT POWER vs. INPUT POWER



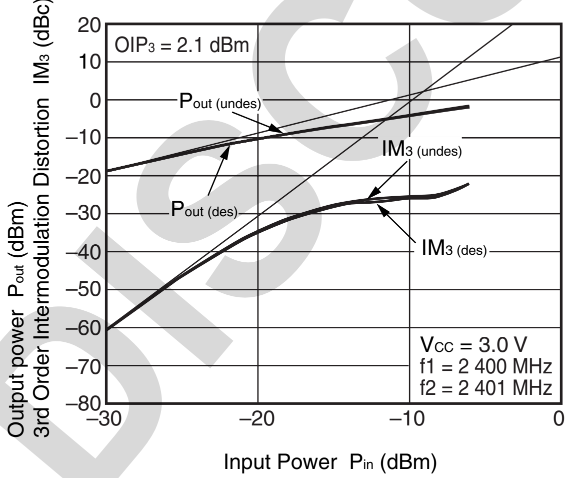
OUTPUT POWER, IM3 vs. INPUT POWER



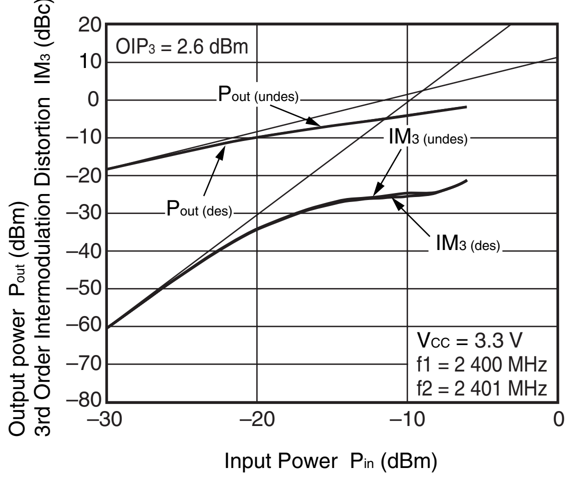
OUTPUT POWER, IM3 vs. INPUT POWER



OUTPUT POWER, IM3 vs. INPUT POWER

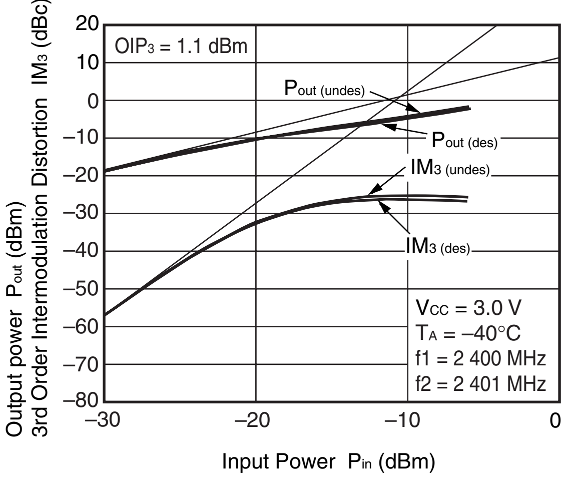


OUTPUT POWER, IM3 vs. INPUT POWER

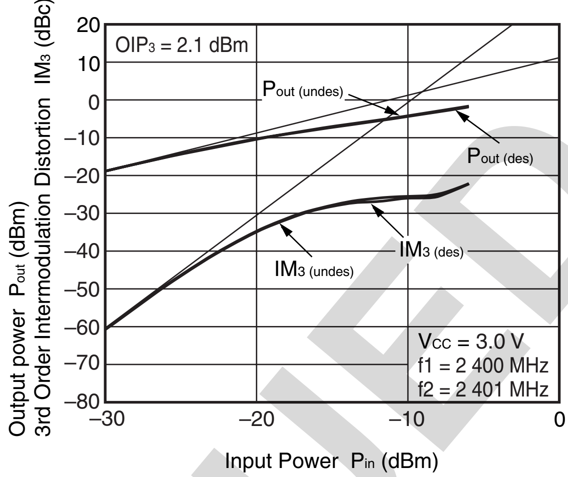


Remark The graphs indicate nominal characteristics.

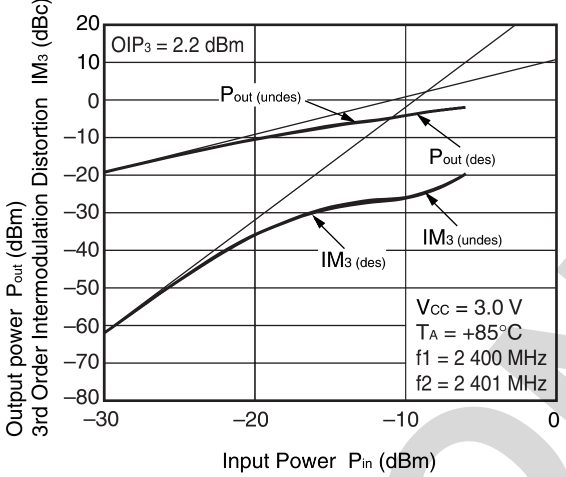
OUTPUT POWER, IM3 vs. INPUT POWER



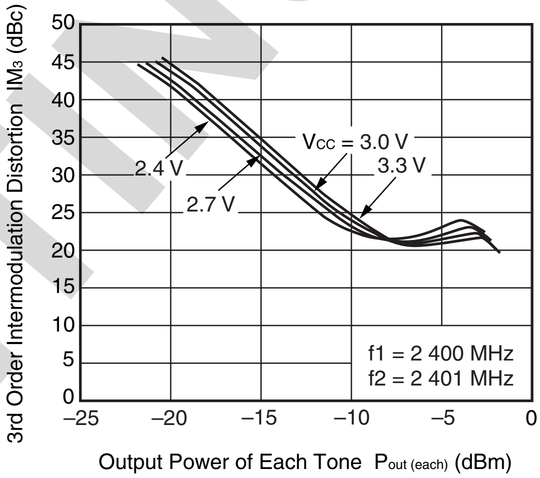
OUTPUT POWER, IM3 vs. INPUT POWER



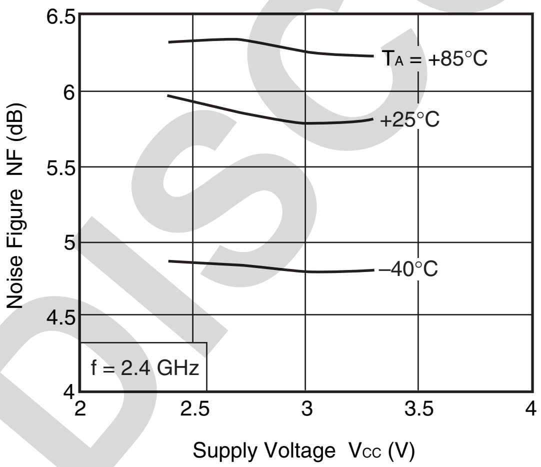
OUTPUT POWER, IM3 vs. INPUT POWER



3RD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE

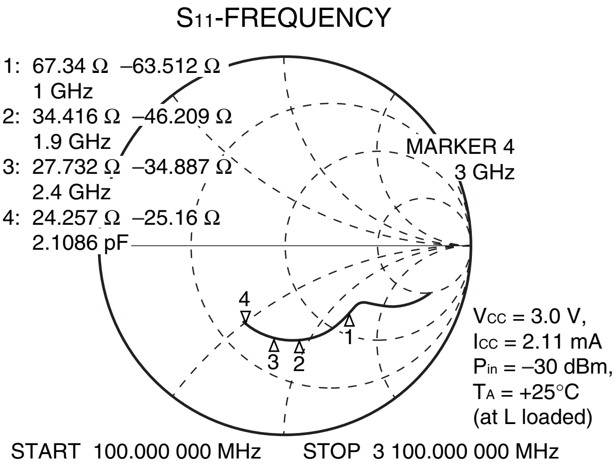


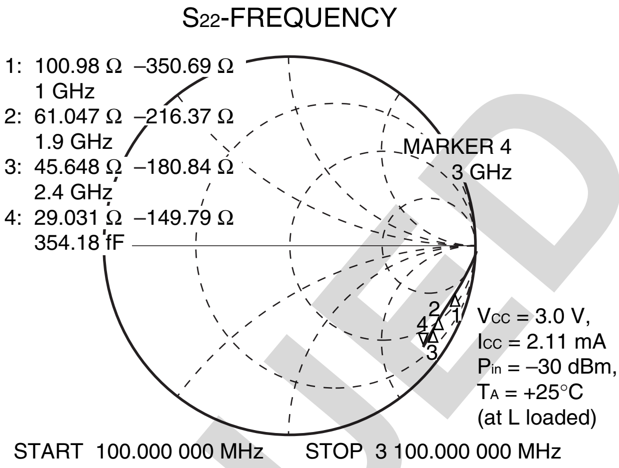
NOISE FIGURE vs. SUPPLY VOLTAGE



Remark The graphs indicate nominal characteristics.

f = 3.0 GHz MATCHING

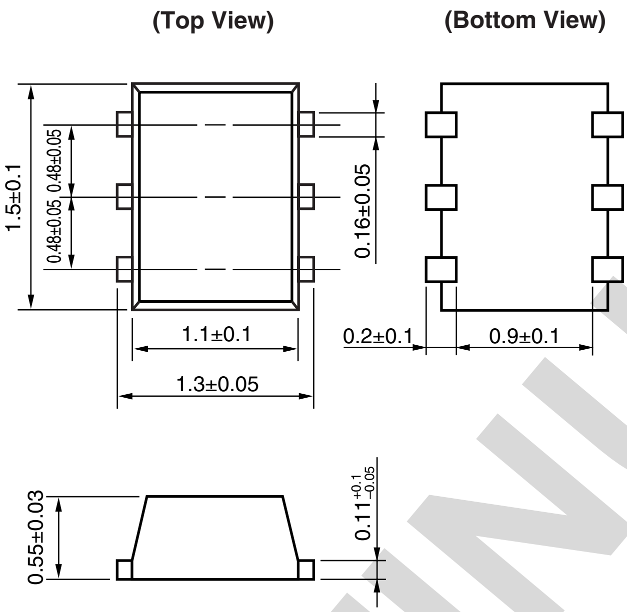




Remark The graphs indicate nominal characteristics.

★ PACKAGE DIMENSIONS

6-PIN LEAD-LESS MINIMOLD (1511) (UNIT: mm)



NOTE ON CORRECT USE

(1) Observe precautions for handling because of electro-static sensitive devices.
(2) Form a ground pattern as widely as possible to minimize ground impedance (to prevent undesired oscillation). All the ground pins must be connected together with wide ground pattern to decrease impedance difference.
(3) The bypass capacitor should be attached to V_{CC} line.
(4) The inductor (L) should be attached between output and V_{CC} pins. The L and series capacitor (C) values should be adjusted for applied frequency to match impedance to next stage.
(5) The DC capacitor must be attached to input pin.

★ RECOMMENDED SOLDERING CONDITIONS

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

Soldering Method	Soldering Conditions		Condition Symbol
Infrared Reflow	Peak temperature (package surface temperature) Time at peak temperature Time at temperature of 220°C or higher Preheating time at 120 to 180°C Maximum number of reflow processes Maximum chlorine content of rosin flux (% mass)	: 260°C or below : 10 seconds or less : 60 seconds or less : 120±30 seconds : 3 times : 0.2%(Wt.) or below	IR260
Wave Soldering	Peak temperature (molten solder temperature) Time at peak temperature Preheating temperature (package surface temperature) Maximum number of flow processes Maximum chlorine content of rosin flux (% mass)	: 260°C or below : 10 seconds or less : 120°C or below : 1 time : 0.2%(Wt.) or below	WS260
Partial Heating	Peak temperature (terminal temperature) Soldering time (per side of device) Maximum chlorine content of rosin flux (% mass)	: 350°C or below : 3 seconds or less : 0.2%(Wt.) or below	HS350

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

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