NEC

BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC8204TK

VARIABLE GAIN AMPLIFIER FOR TRANSMITTER AGC

DESCRIPTION

The μPC8204TK is a silicon monolithic integrated circuit designed as variable gain amplifier. The package is 6-pin lead-less minimold suitable for surface mount.

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

This IC is as same circuit current as conventional μPC8119T and μPC8120T, but operates at higher frequency and wider gain control range.

FEATURES

- Gain control range : GCR = 40 dB TYP. @ f = 1.9 GHz
  : GCR = 40 dB TYP. @ f = 2.4 GHz
- Maximum power gain : G_{PMAX} = 14.5 dB TYP. @ f = 1.9 GHz
  : G_{PMAX} = 14.0 dB TYP. @ f = 2.4 GHz
- Operating frequency : f_{in} = 0.8 to 2.5 GHz
- Supply voltage : V_{CC} = 2.7 to 3.3 V
- High-density surface mounting : 6-pin lead-less minimold package

APPLICATION

- 0.8 to 2.5 GHz transmitter/receiver system (PHS, WLAN and so on)

★ ORDERING INFORMATION

Part Number	Order Number	Package	Marking	Supplying Form
μPC8204TK-E2	μPC8204TK-E2-A	6-pin lead-less minimold (1511 PKG) (Pb-Free) Note	6E	• Embossed tape 8 mm wide • Pin 1, 6 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: μPC8204TK

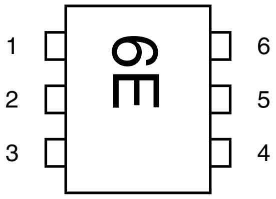
Caution Observe precautions when handling because these devices are sensitive to electrostatic discharge.

Document No. PU10408EJ02V0DS (2nd edition)
Date Published October 2005 CP(K)
Printed in Japan

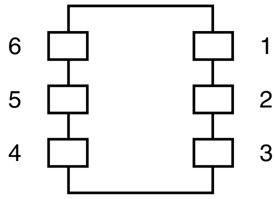
The mark ★ shows major revised points.

PIN CONNECTIONS

(Top View)



(Bottom View)



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

VARIABLE GAIN AMPLIFIER PRODUCT LINE-UP

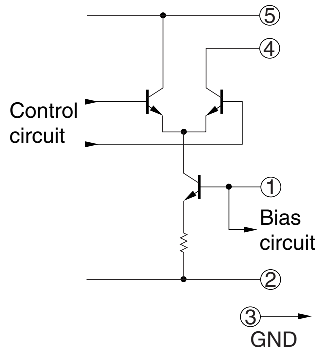
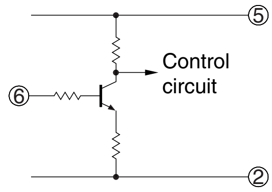
Parameter / Part No.	I_{CC} (mA)	0.95 GHz output port matching frequency			1.44 GHz output port matching frequency			1.9 GHz output port matching frequency			2.4 GHz output port matching frequency		
		G_{PMAX} (dB)	GCR (dB)	NF (dB)	G_{PMAX} (dB)	GCR (dB)	NF (dB)	G_{PMAX} (dB)	GCR (dB)	NF (dB)	G_{PMAX} (dB)	GCR (dB)	NF (dB)
μPC8204TK	11.5	–	–	–	–	–	–	14.5	40	7.5	14.0	40	7.5
μPC8119T	11.0	12.5	50	8.5	13.0	45	7.5	(12.5)	(22)	(7.2)	–	–	–
μPC8120T	11.0	13.0	50	9.0	13.5	45	7.5	(13.0)	(22)	(7.3)	–	–	–

Remarks 1. Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail. ( ): reference.

2. To know the associated product, please refer to each latest data sheet.

CONTENTS

1. PIN EXPLANATION

<table>
<tr><th>Pin No.</th><th>Pin Name</th><th>Applied Voltage (V)</th><th>Pin Voltage (V) Note</th><th>Function and Applications</th><th>Internal Equivalent Circuit</th></tr>
<tr><td>1</td><td>INPUT</td><td>–</td><td>1.2</td><td>RF input pin.
This pin should be coupled with capacitor (example 100 pF) for DC cut. Input return loss can be improved with external impedance matching circuit.</td><td rowspan="3">
</td></tr>
<tr><td>2
3</td><td>GND</td><td>0</td><td>–</td><td>Ground pin.
This pin should be connected to system ground with minimum inductance. Ground pa- ttern on the board should be formed as wide as possible. Ground pins must be connected together with wide ground pattern to decrease impedance difference.</td></tr>
<tr><td>4</td><td>OUTPUT</td><td>Voltage as same as V_{CC} through external inductor</td><td>–</td><td>RF output pin.
This pin is de-signed as open collector of high impedance. This pin must be externally equipped with matching circuits.</td></tr>
<tr><td>5</td><td>V_{CC}</td><td>2.7 to 3.3</td><td>–</td><td>Supply voltage pin.
This pin must be equipped with bypass capacitor (example 1 000 pF) to minimize its RF impedance.</td><td>———</td></tr>
<tr><td>6</td><td>V_{AGC}</td><td>0 to 3.3</td><td>–</td><td>Gain control pin.</td><td>
</td></tr>
</table>

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

2. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Ratings	Unit
Supply Voltage	V_{CC}	T_A = +25°C, Pin 4, 5	3.6	V
Total Circuit Current	I_{CC}	T_A = +25°C	30	mA
Gain Control Voltage	V_{AGC}	T_A = +25°C	3.6	V
Power Dissipation	P_D	T_A = +85°C **Note**	203	mW
Operating Ambient Temperature	T_A		–40 to +85	°C
Storage Temperature	T_{stg}		–55 to +150	°C
Input Power	P_{in}		+5	dBm

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

3. RECOMMENDED OPERATING RANGE

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
Supply Voltage	V_{CC}	2.7	3.0	3.3	V	Same voltage should be applied to pin 4 and pin 5.
Operating Ambient Temperature	T_A	–40	+25	+85	°C	
Operating Frequency	f_{in}	0.8	–	2.5	GHz	With external output-matching
Gain Control Voltage	V_{AGC}	0	–	3.3	V	

4. ELECTRICAL CHARACTERISTICS (T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω, external matched output port, unless otherwise specified)

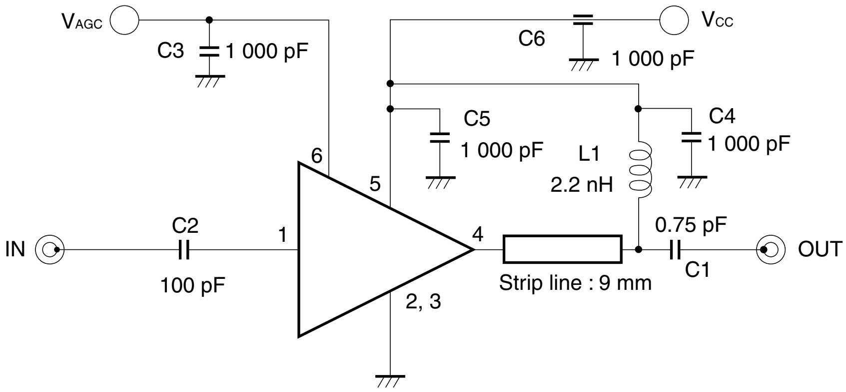
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I_{CC}	No signal	8.5	11.5	15.0	mA
Maximum Power Gain	G_{PMAX}	f = 1.9 GHz, P_{in} = –20 dBm	11.5	14.5	17.5	dB
		f = 2.4 GHz, P_{in} = –20 dBm	11.0	14.0	17.0	
Gain Control Range **Note**	GCR	f = 1.9 GHz, P_{in} = –20 dBm	35	40	–	dB
		f = 2.4 GHz, P_{in} = –20 dBm	35	40	–	
Gain 1 dB Compression Output Power	$P_{O\ (1\ dB)}$	f = 1.9 GHz, G_{PMAX}	+2.0	+5.0	–	dBm
		f = 2.4 GHz, G_{PMAX}	+2.0	+5.0	–	
Input Return Loss	RL_{in}	f = 1.9 GHz, G_{PMAX}	8	11	–	dB
		f = 2.4 GHz, G_{PMAX}	9	13	–	
Isolation	ISL	f = 1.9 GHz, G_{PMAX}	25	30	–	dB
		f = 2.4 GHz, G_{PMAX}	25	30	–	
Noise Figure	NF	f = 1.9 GHz, G_{PMAX}	–	7.5	10.0	dB
		f = 2.4 GHz, G_{PMAX}	–	7.5	10.0	

Note Gain control range GCR specification : GCR = G_{PMAX} – G_{PMIN} (dB)
Conditions G_{PMAX}@V_{AGC} = V_{CC}, G_{PMIN}@V_{AGC} = 0 V

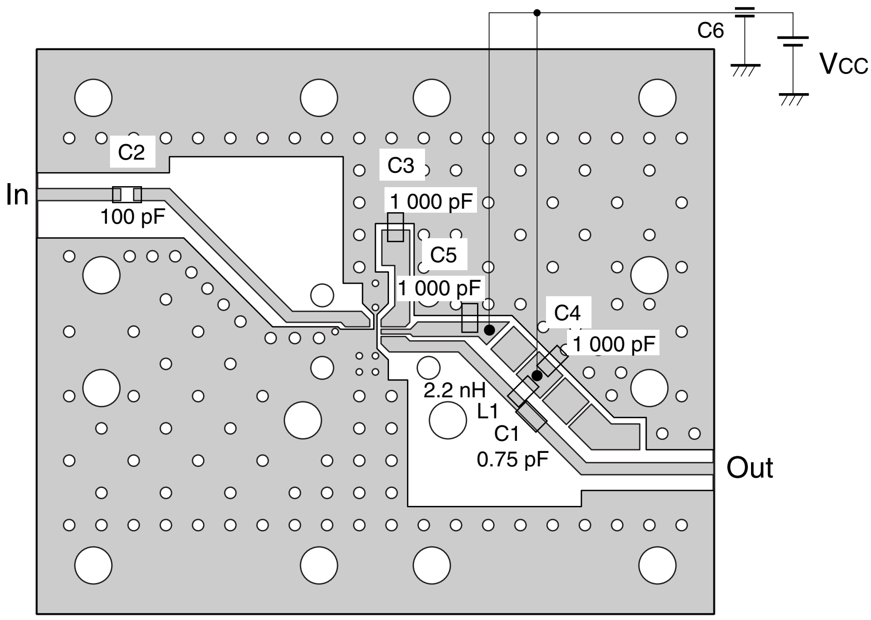
★ 5. TEST CIRCUITS

5. 1 f = 1.9 GHz

5. 1. 1 Test circuit 1



5. 1. 2 Illustration of the test circuit 1 assembled on evaluation board

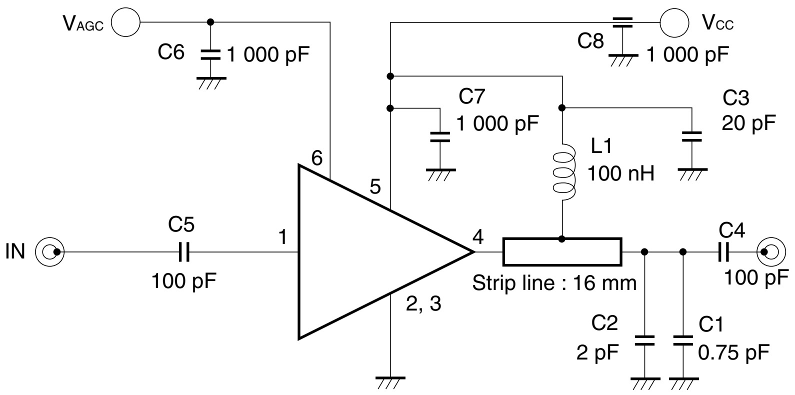


5. 1. 3 Component list

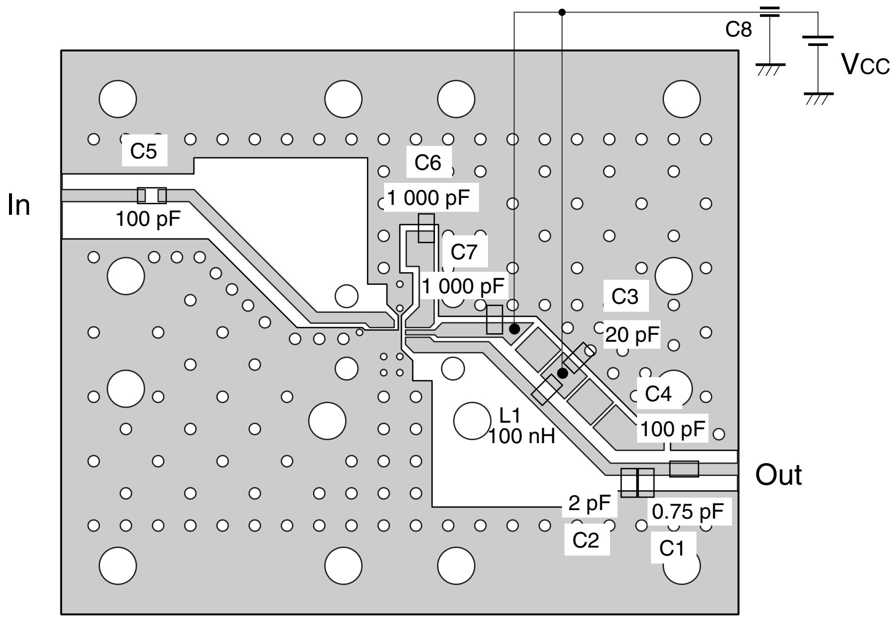
Symbol	Form	Rating	Part Number	Maker
C1	Chip Capacitor	0.75 pF	GRM39	Murata
C2	Chip Capacitor	100 pF	GRM39	Murata
C3, C4	Chip Capacitor	1 000 pF	GRM39	Murata
C5	Chip Capacitor	1 000 pF	GRM40	Murata
C6	Feed-through Capacitor	1 000 pF	DFT301-801X7R102S50	Murata
L1	Chip Inductor	2.2 nH	LL-2012	TOKO

5. 2 f = 2.4 GHz

5. 2. 1 Test circuit 2



5. 2. 2 Illustration of the test circuit 2 assembled on evaluation board

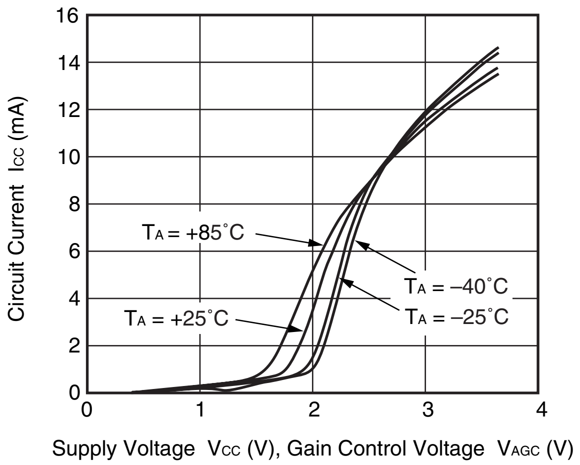


5. 2. 3 Component list

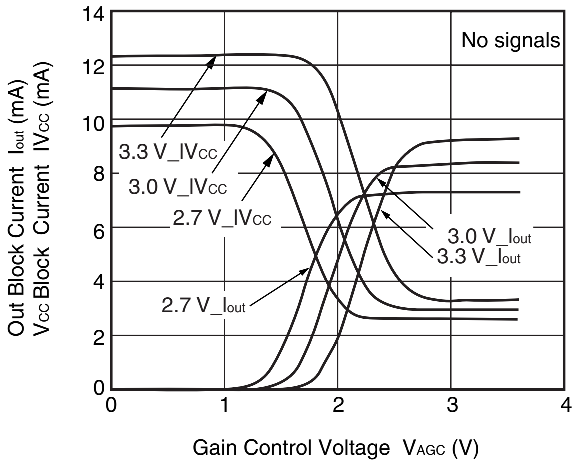
Symbol	Form	Rating	Part Number	Maker
C1	Chip Capacitor	0.75 pF	GRM39	Murata
C2	Chip Capacitor	2 pF	GRM39	Murata
C3	Chip Capacitor	20 pF	GRM39	Murata
C4, C5	Chip Capacitor	100 pF	GRM39	Murata
C6	Chip Capacitor	1 000 pF	GRM39	Murata
C7	Chip Capacitor	1 000 pF	GRM40	Murata
C8	Feed-through Capacitor	1 000 pF	DFT301-801X7R102S50	Murata
L1	Chip Inductor	100 nH	LL-1608	TOKO

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

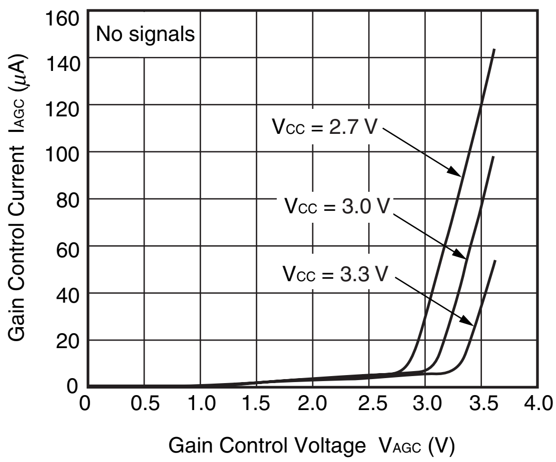
CIRCUIT CURRENT vs. SUPPLY VOLTAGE, GAIN CONTROL VOLTAGE



OUT BLOCK CURRENT AND VCC BLOCK CURRENT vs. GAIN CONTROL VOLTAGE



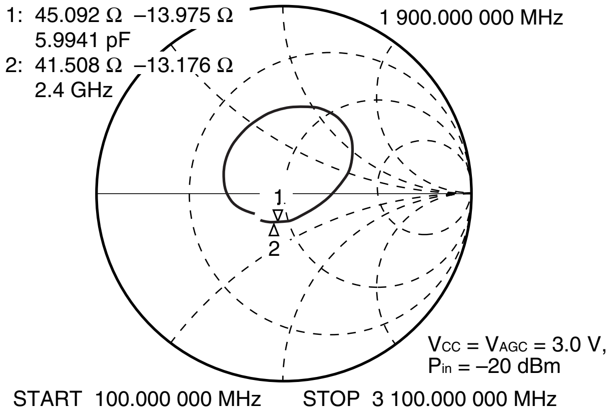
GAIN CONTROL CURRENT vs. GAIN CONTROL VOLTAGE



Remark The graphs indicate nominal characteristics.

6. 1 Inductor loading with external bias tee at output port

S11–FREQUENCY



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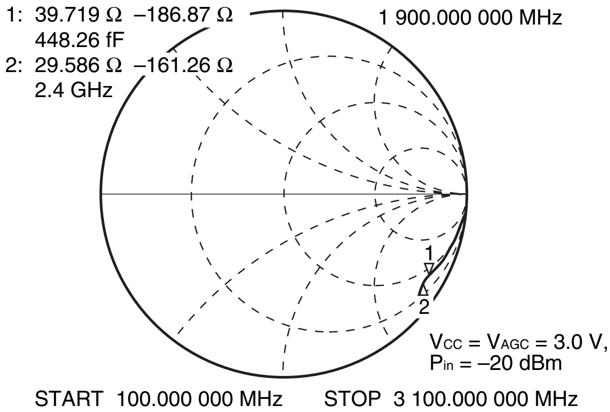

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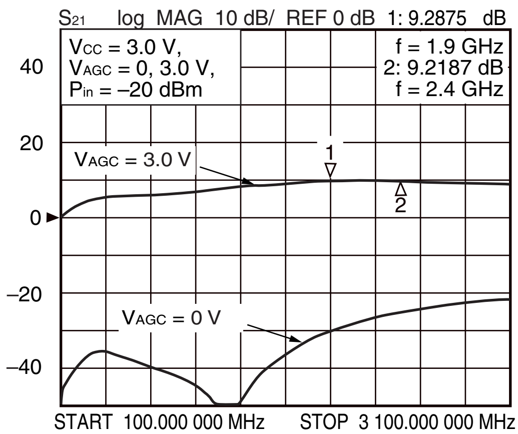

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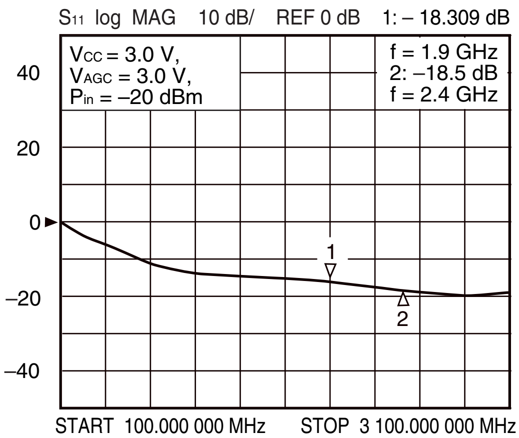

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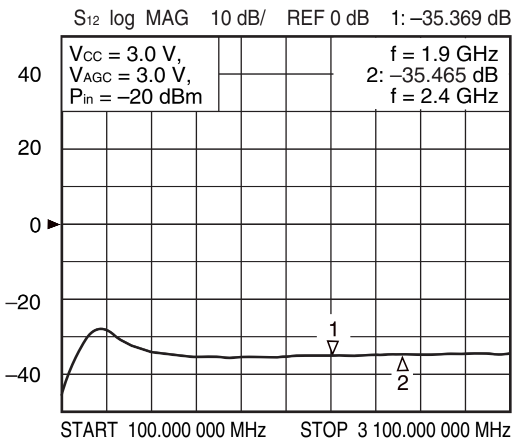

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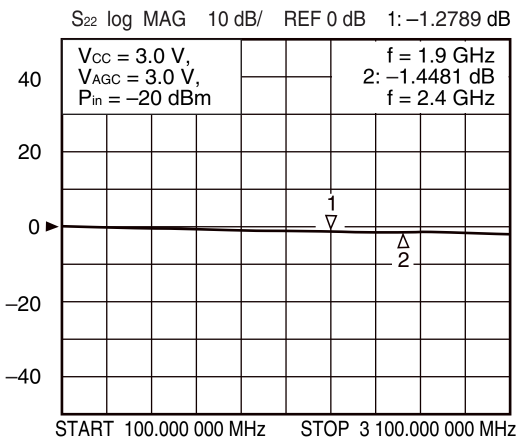
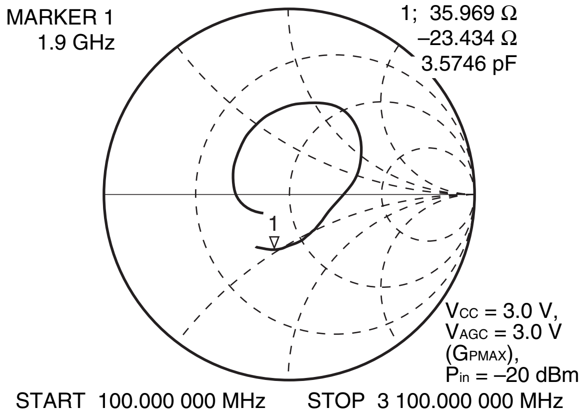


Remark The graphs indicate nominal characteristics.

6. 2 Output port matching at f = 1.9 GHz

S11–FREQUENCY



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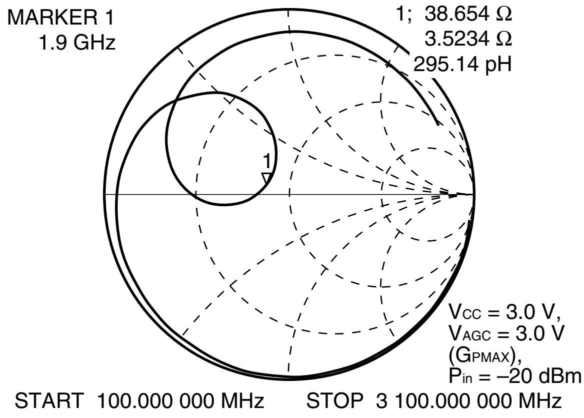

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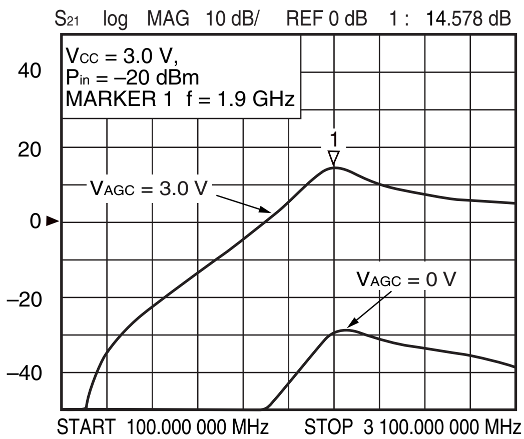

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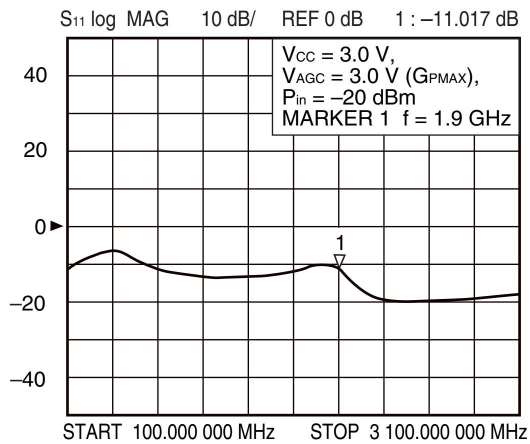

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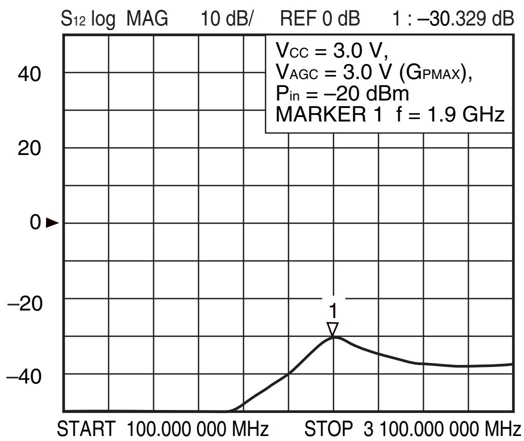

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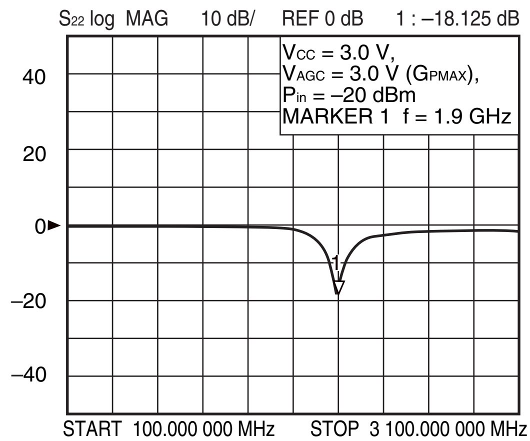

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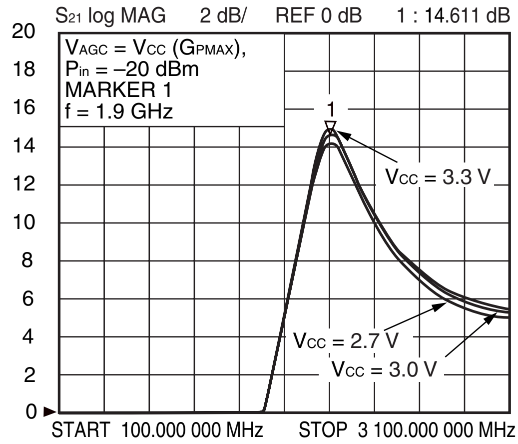

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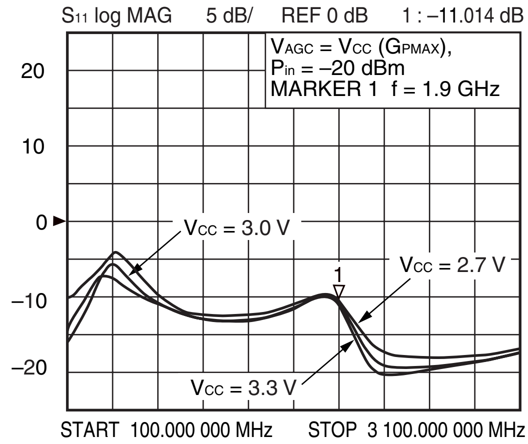

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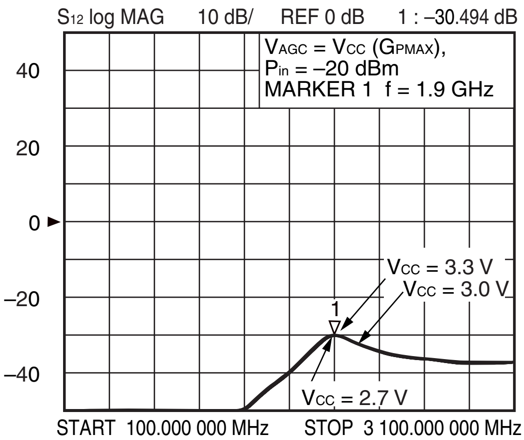

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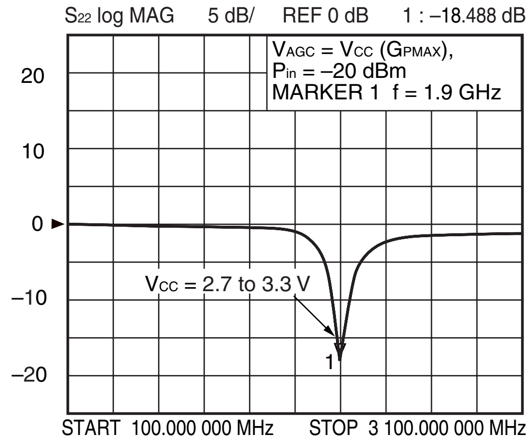

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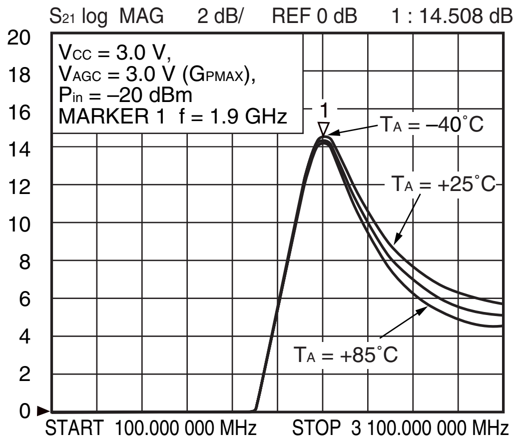

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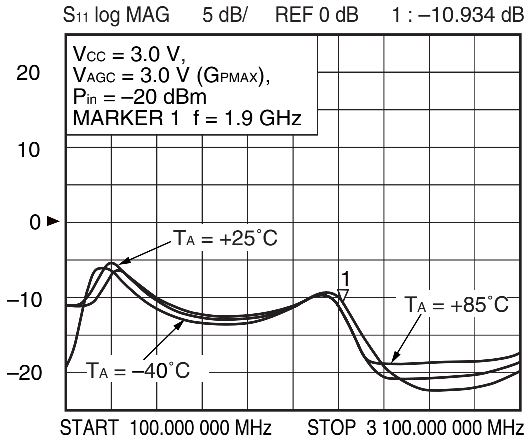

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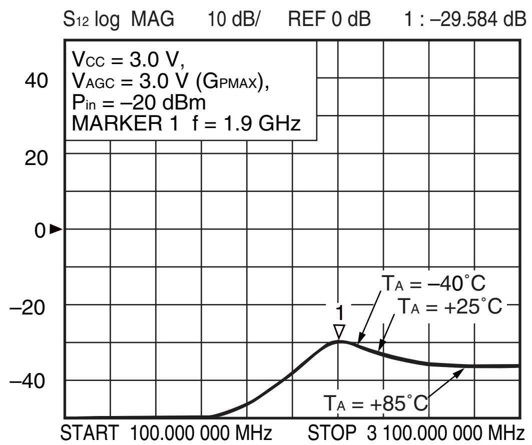

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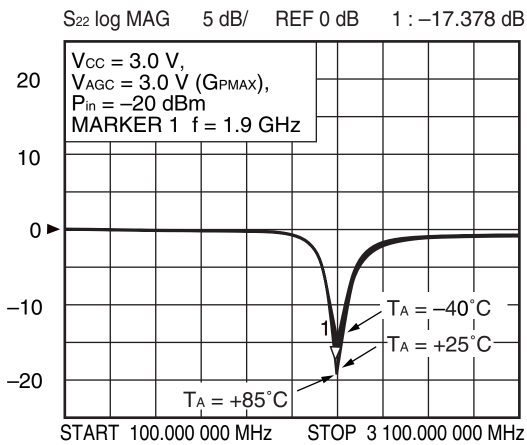

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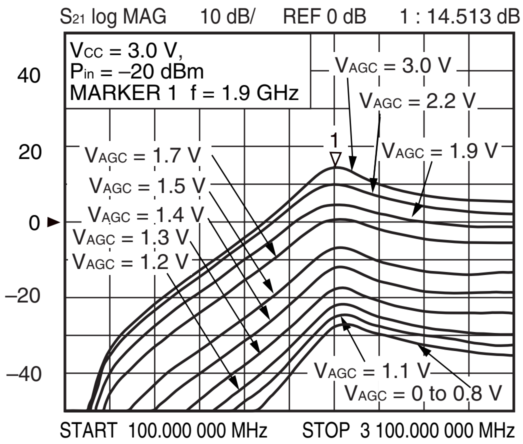

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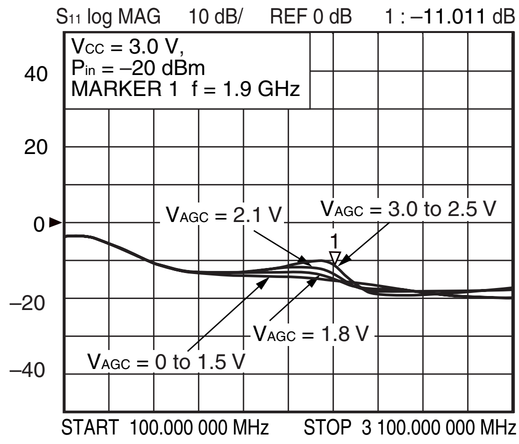

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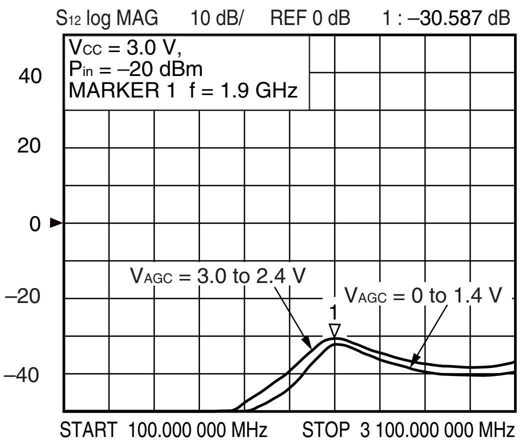

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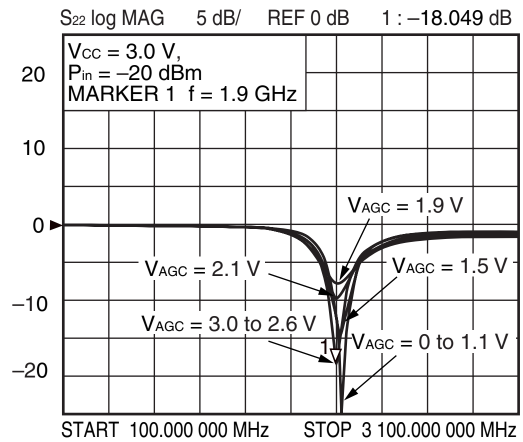

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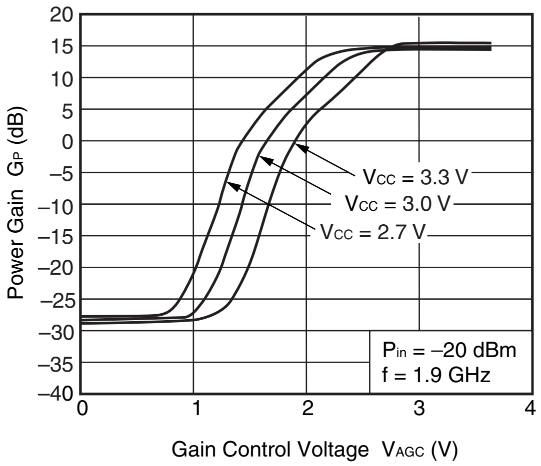
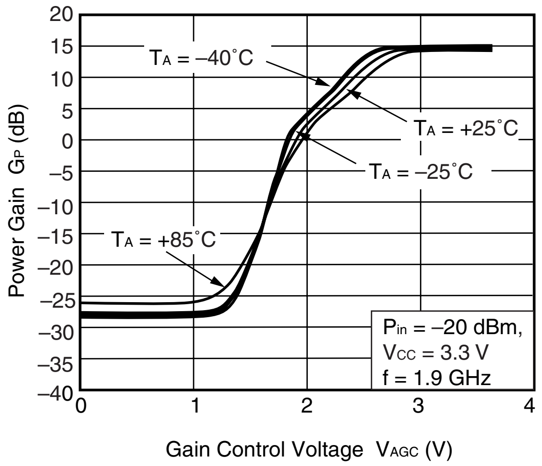
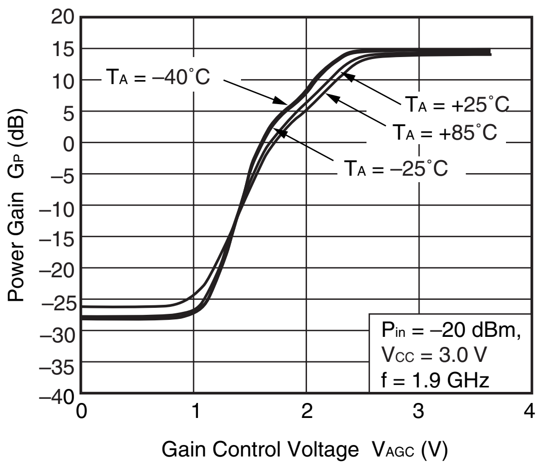
POWER GAIN vs. GAIN CONTROL VOLTAGE



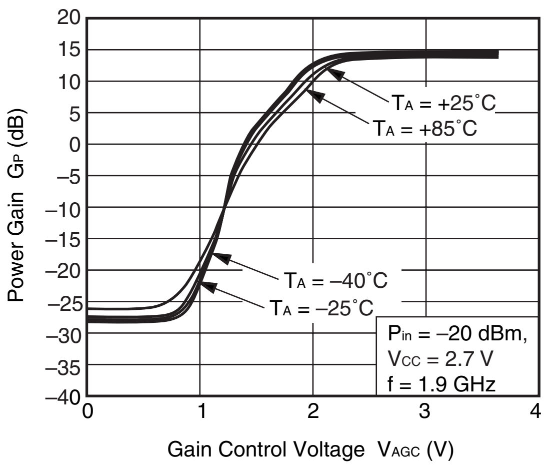
POWER GAIN vs. GAIN CONTROL VOLTAGE



POWER GAIN vs. GAIN CONTROL VOLTAGE

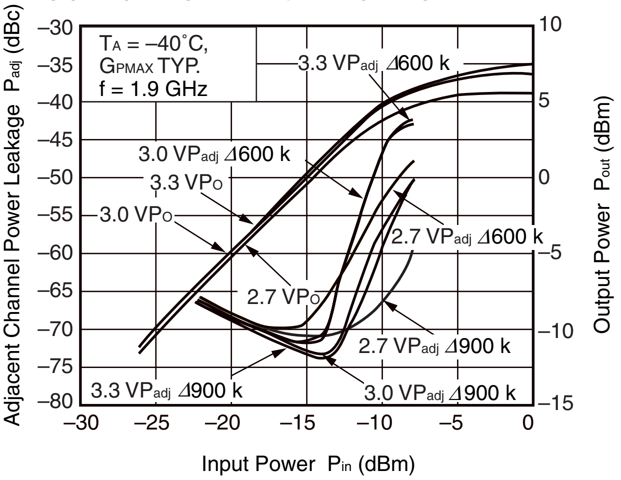


POWER GAIN vs. GAIN CONTROL VOLTAGE

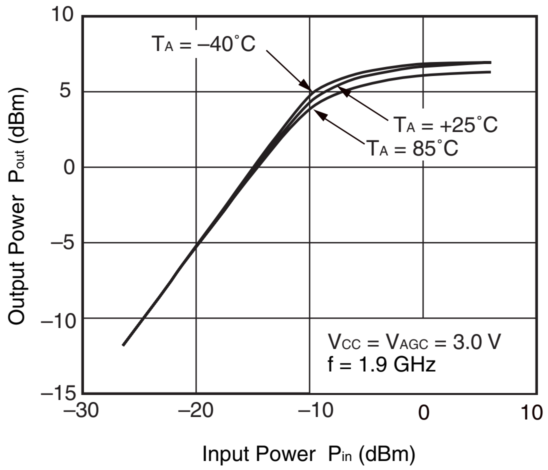


Remark The graphs indicate nominal characteristics.

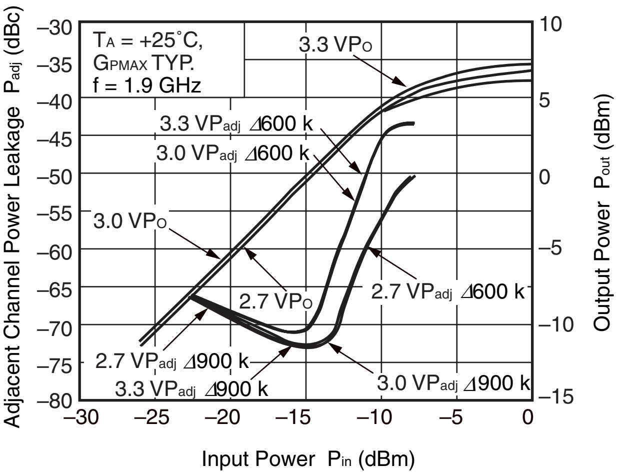
ADJACENT CHANNEL POWER LEAKAGE, OUTPUT POWER vs. INPUT POWER



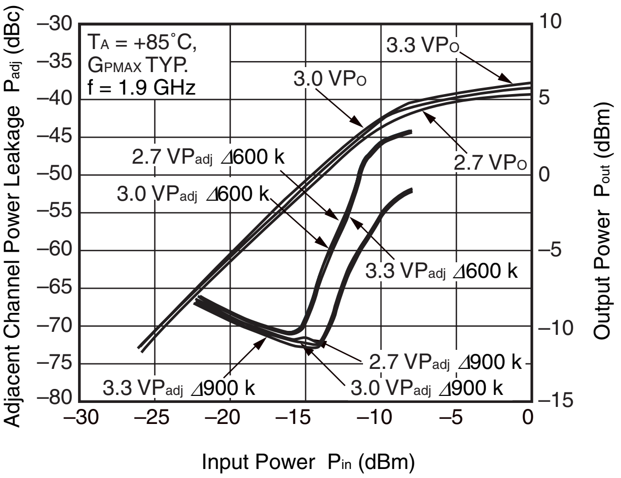
OUTPUT POWER vs. INPUT POWER



ADJACENT CHANNEL POWER LEAKAGE, OUTPUT POWER vs. INPUT POWER

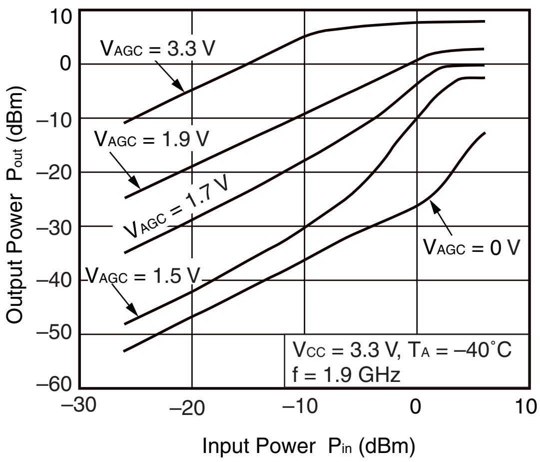


ADJACENT CHANNEL POWER LEAKAGE, OUTPUT POWER vs. INPUT POWER

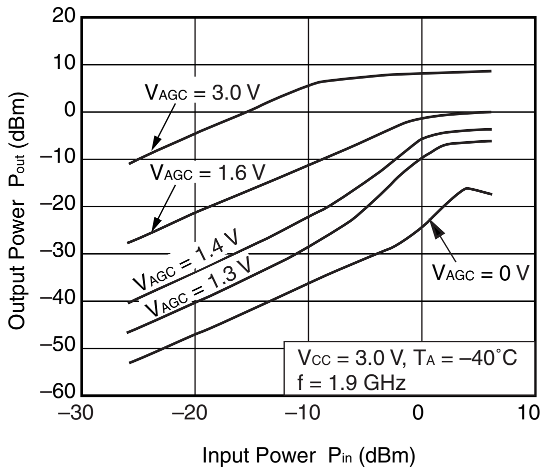


Remark The graphs indicate nominal characteristics.

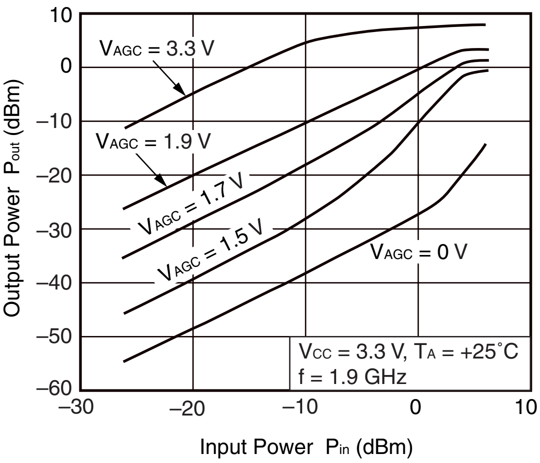
OUTPUT POWER vs. INPUT POWER



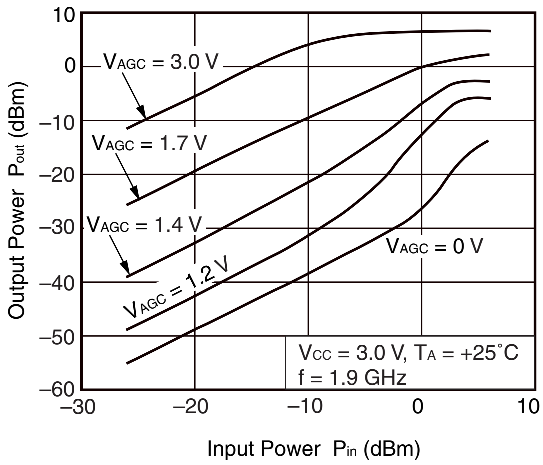
OUTPUT POWER vs. INPUT POWER



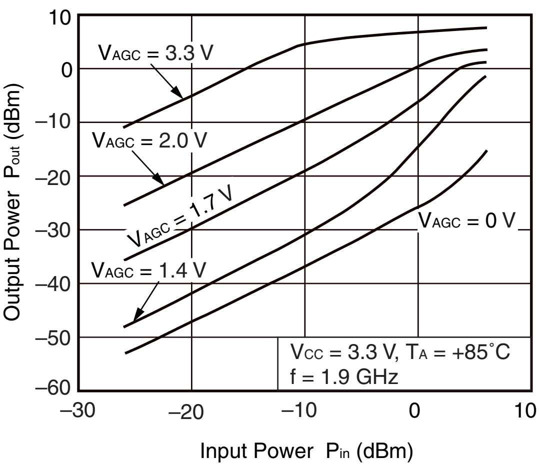
OUTPUT POWER vs. INPUT POWER



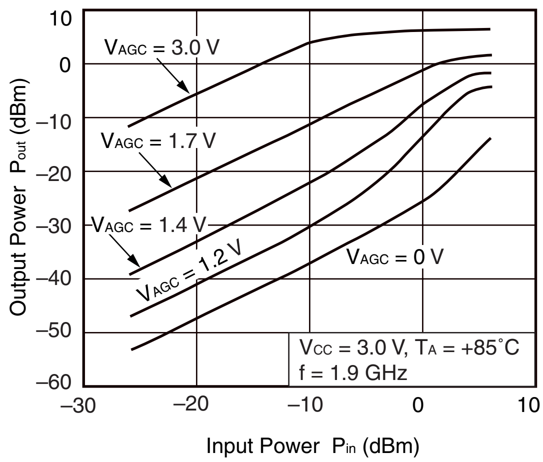
OUTPUT POWER vs. INPUT POWER



OUTPUT POWER vs. INPUT POWER

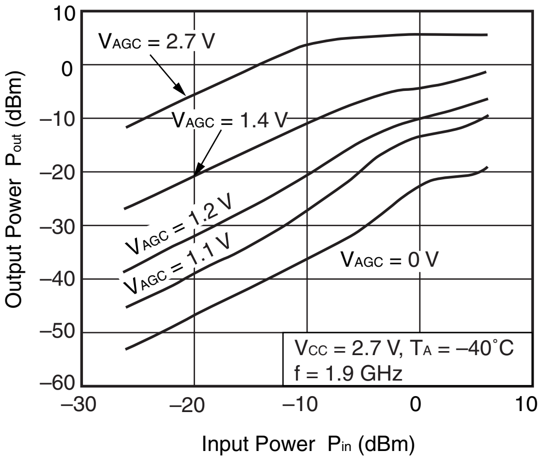


OUTPUT POWER vs. INPUT POWER

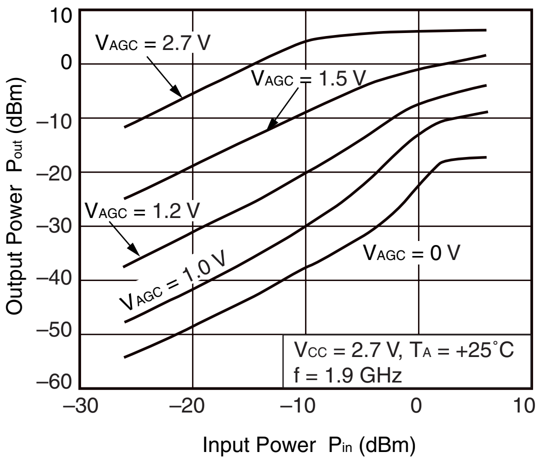


Remark The graphs indicate nominal characteristics.

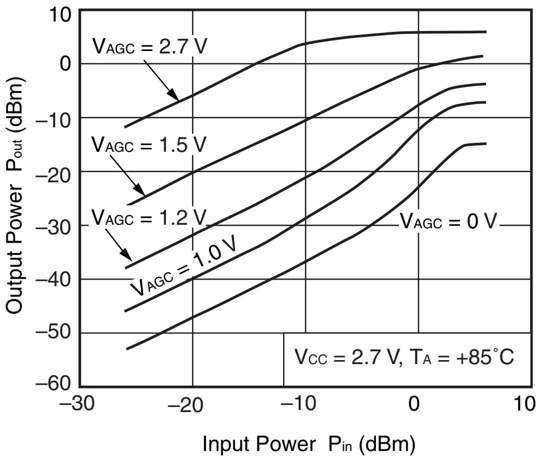
OUTPUT POWER vs. INPUT POWER



OUTPUT POWER vs. INPUT POWER

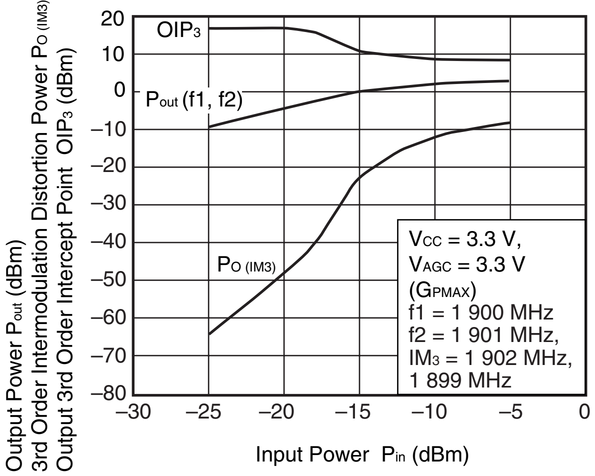


OUTPUT POWER vs. INPUT POWER

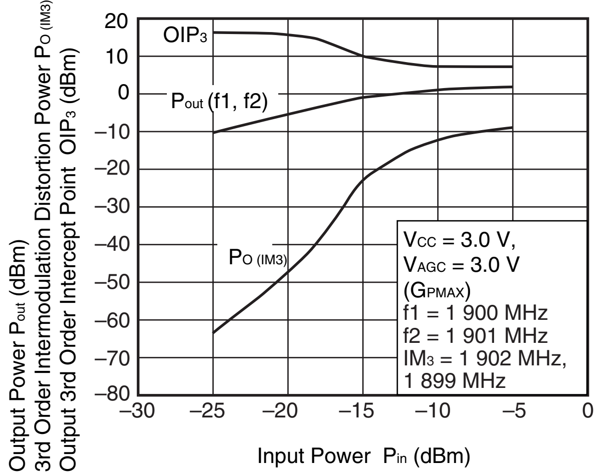


Remark The graphs indicate nominal characteristics.

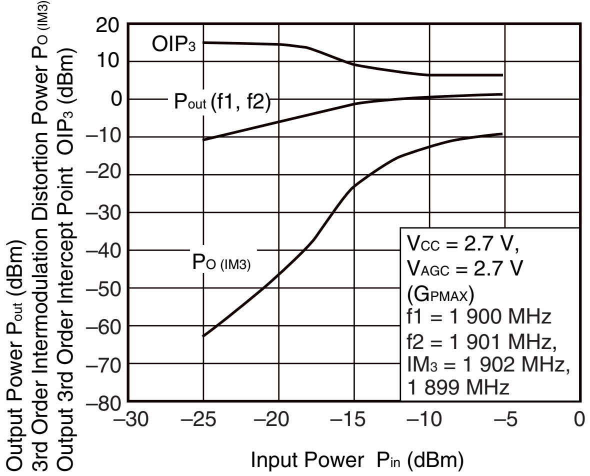
OUTPUT POWER, PO (IM3), OIP3 vs. INPUT POWER



OUTPUT POWER, PO (IM3), OIP3 vs. INPUT POWER

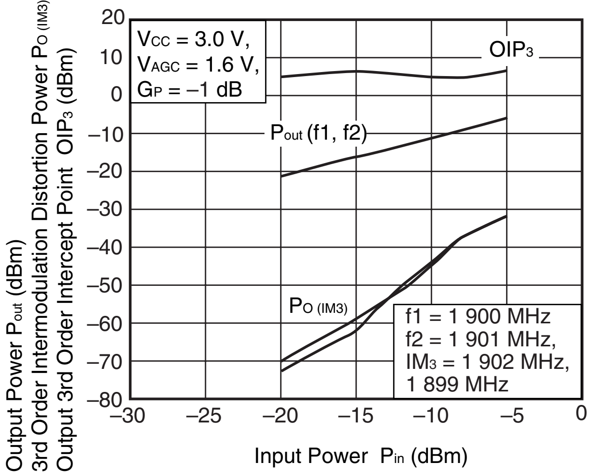


OUTPUT POWER, PO (IM3), OIP3 vs. INPUT POWER

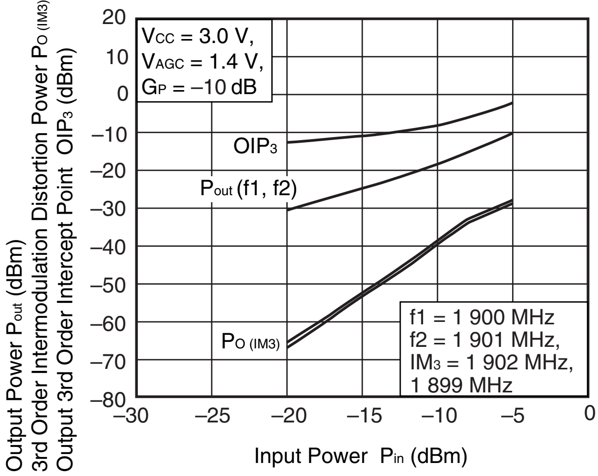


Remark The graphs indicate nominal characteristics.

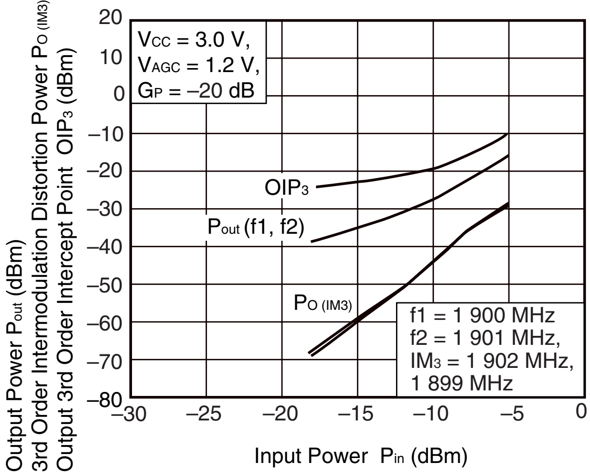
OUTPUT POWER, $P_{O\,(IM3)}$, OIP_3 vs. INPUT POWER



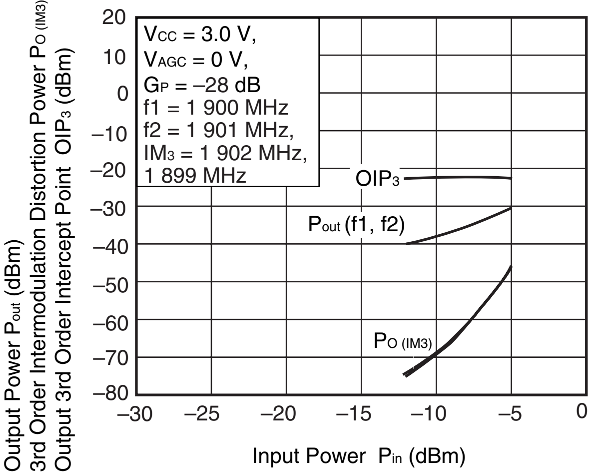
OUTPUT POWER, $P_{O\,(IM3)}$, OIP_3 vs. INPUT POWER



OUTPUT POWER, $P_{O\,(IM3)}$, OIP_3 vs. INPUT POWER

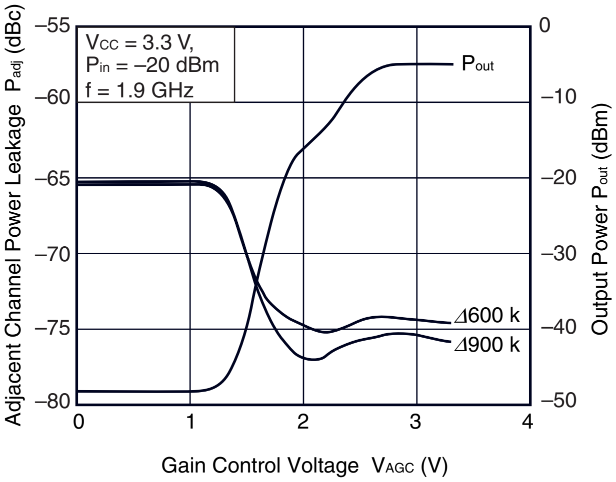


OUTPUT POWER, $P_{O\,(IM3)}$, OIP_3 vs. INPUT POWER

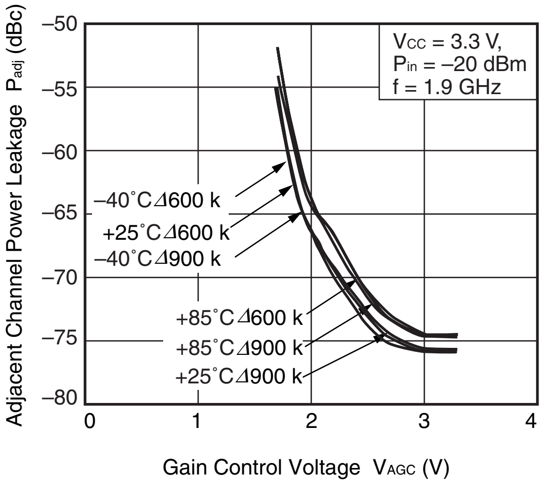


Remark The graphs indicate nominal characteristics.

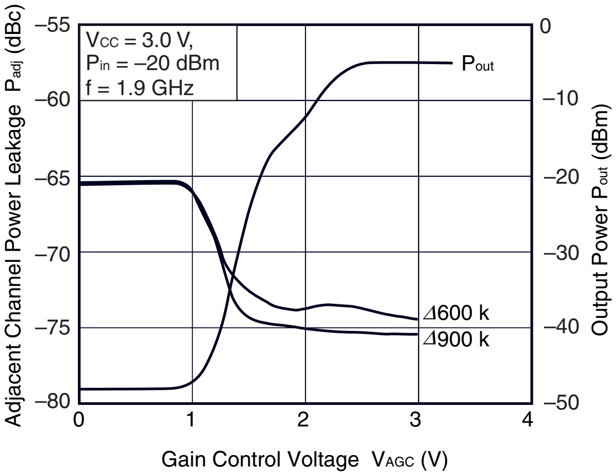
ADJACENT CHANNEL POWER LEAKAGE, OUTPUT POWER vs. GAIN CONTROL VOLTAGE



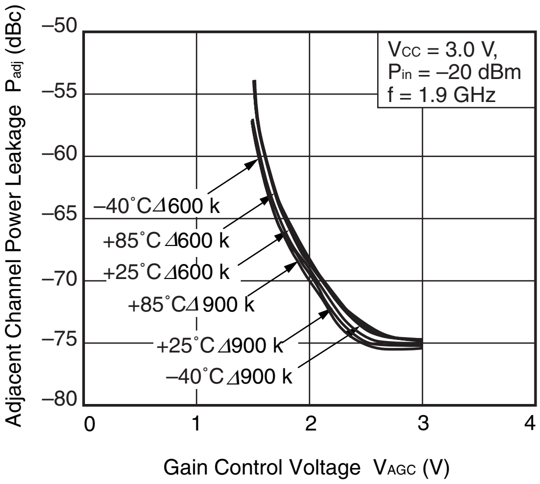
ADJACENT CHANNEL POWER LEAKAGE vs. GAIN CONTROL VOLTAGE



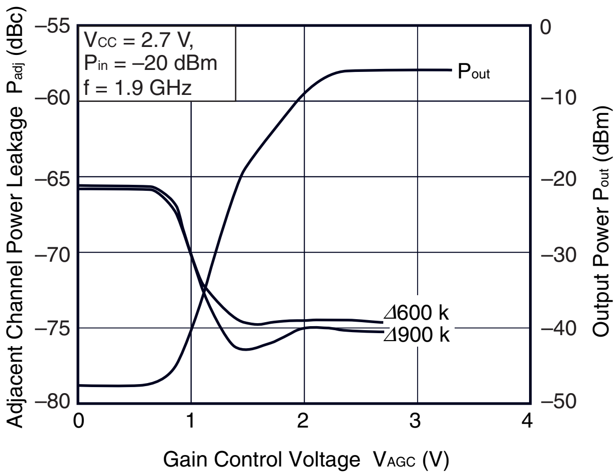
ADJACENT CHANNEL POWER LEAKAGE, OUTPUT POWER vs. GAIN CONTROL VOLTAGE



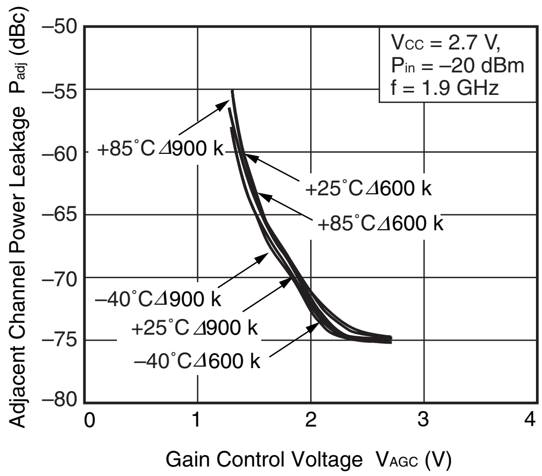
ADJACENT CHANNEL POWER LEAKAGE vs. GAIN CONTROL VOLTAGE



ADJACENT CHANNEL POWER LEAKAGE, OUTPUT POWER vs. GAIN CONTROL VOLTAGE

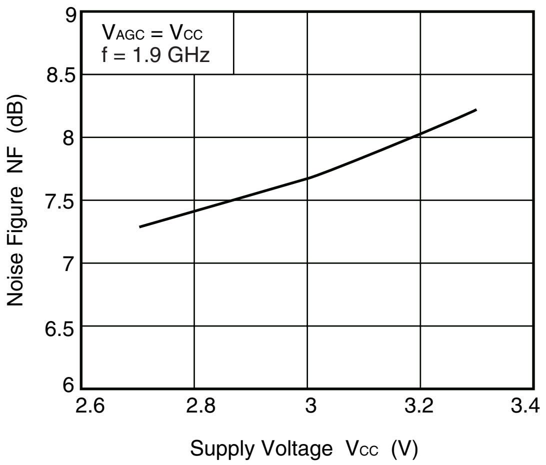


ADJACENT CHANNEL POWER LEAKAGE vs. GAIN CONTROL VOLTAGE

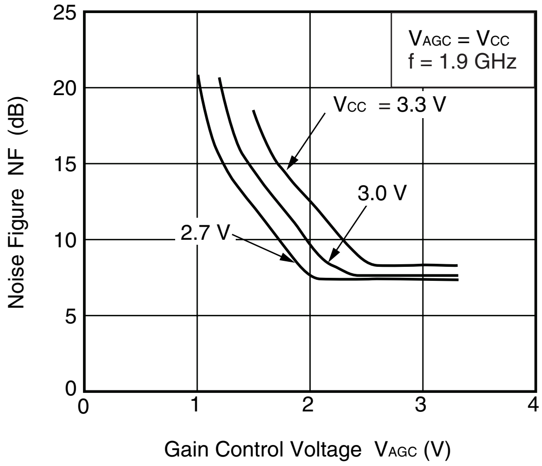


Remark The graphs indicate nominal characteristics.

NOISE FIGURE vs. SUPPLY VOLTAGE



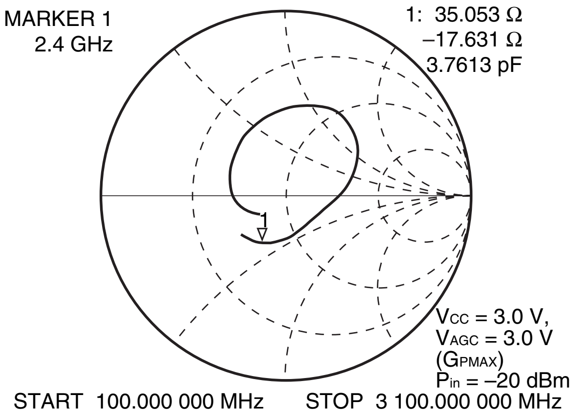
NOISE FIGURE vs.
GAIN CONTROL VOLTAGE



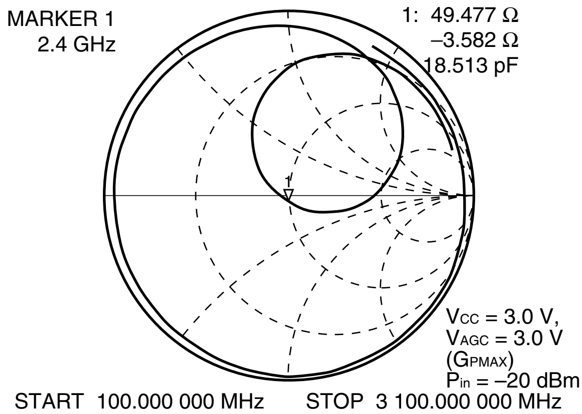
Remark The graphs indicate nominal characteristics.

6. 3 Output port matching at f = 2.4 GHz

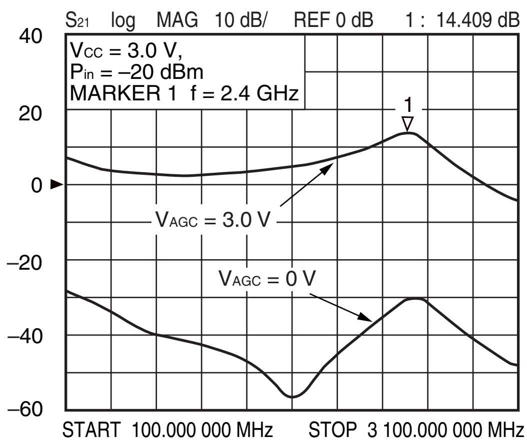
S11–FREQUENCY



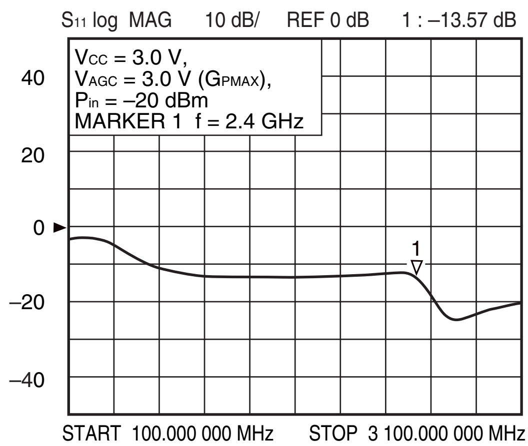
S22–FREQUENCY



S21–FREQUENCY



S11–FREQUENCY



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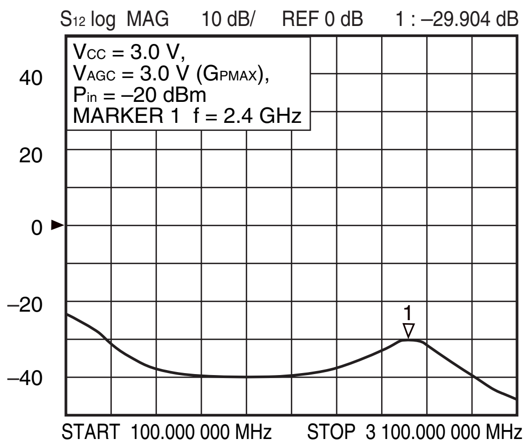

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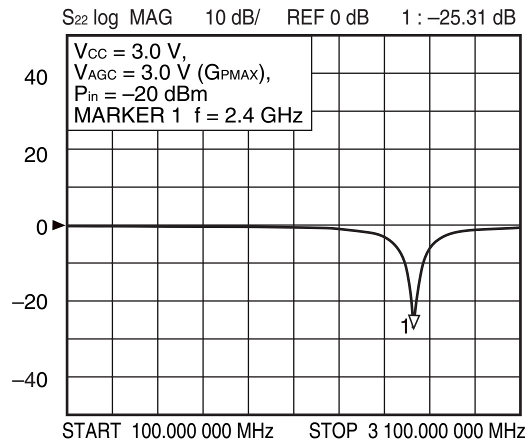
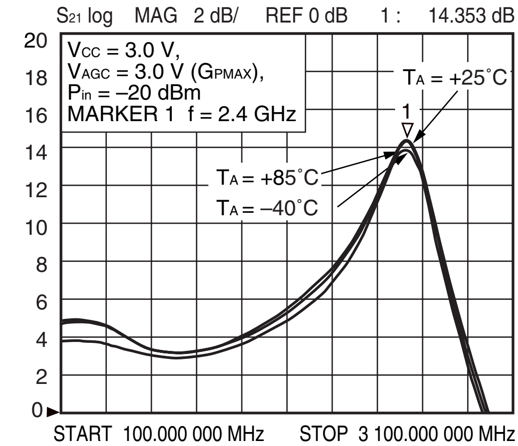


Remark The graphs indicate nominal characteristics.

S21–FREQUENCY



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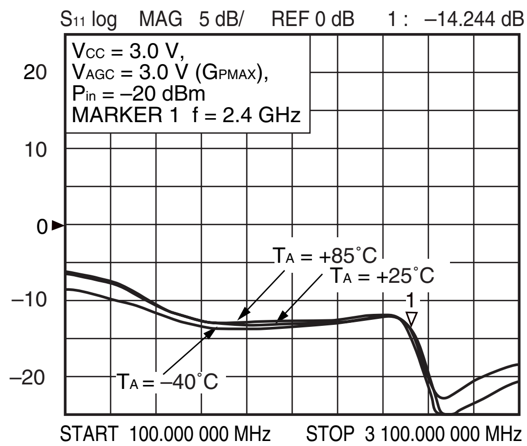

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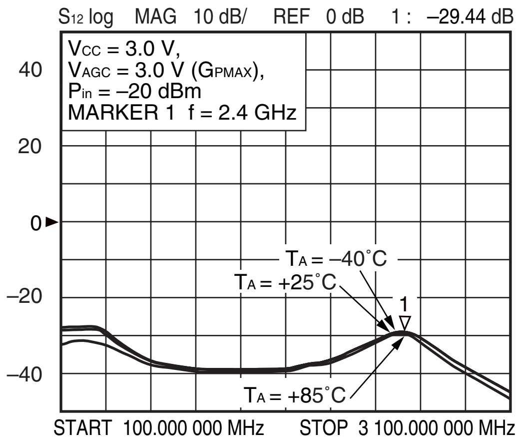
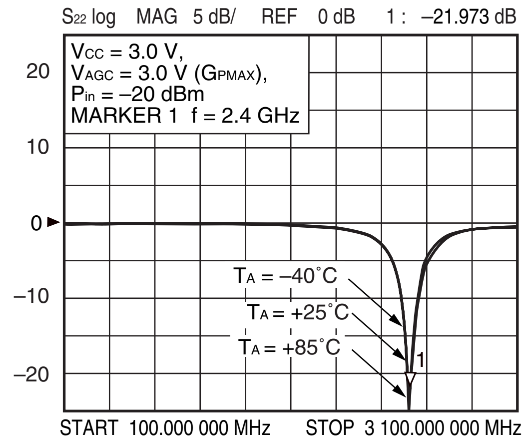
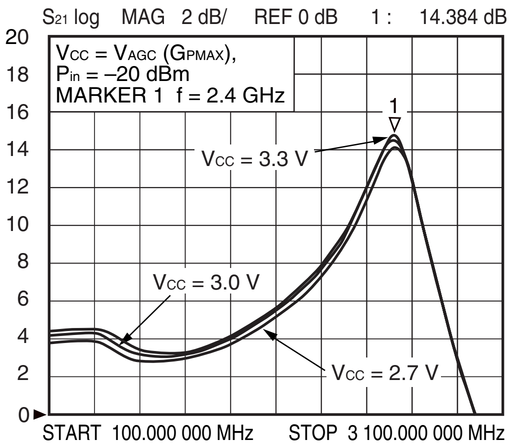


S22–FREQUENCY



Remark The graphs indicate nominal characteristics.

S21–FREQUENCY



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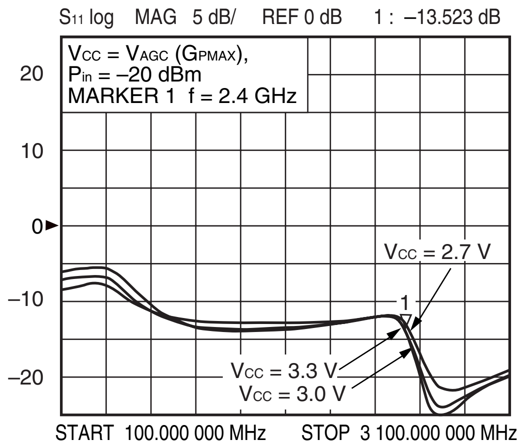

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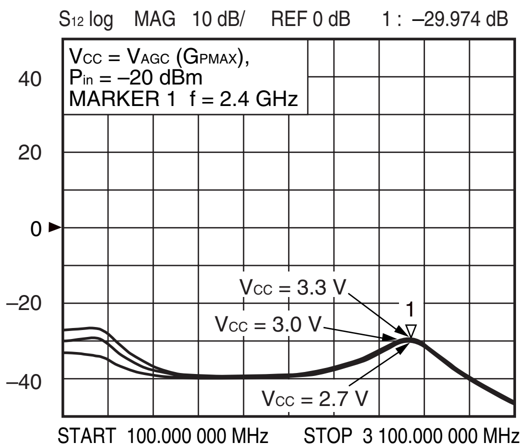

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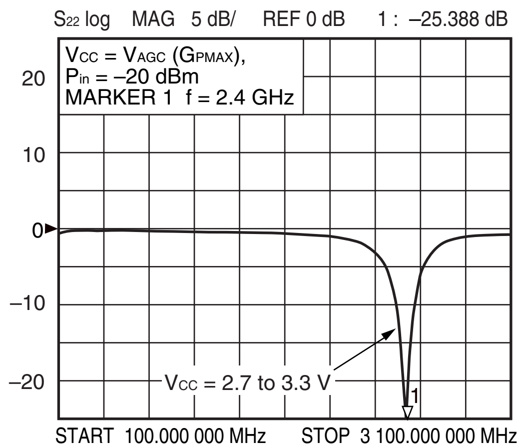
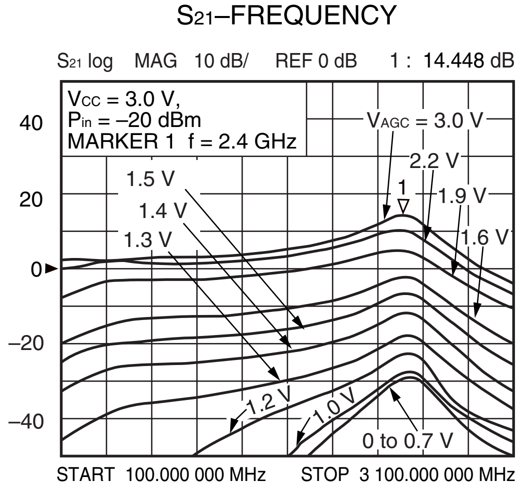
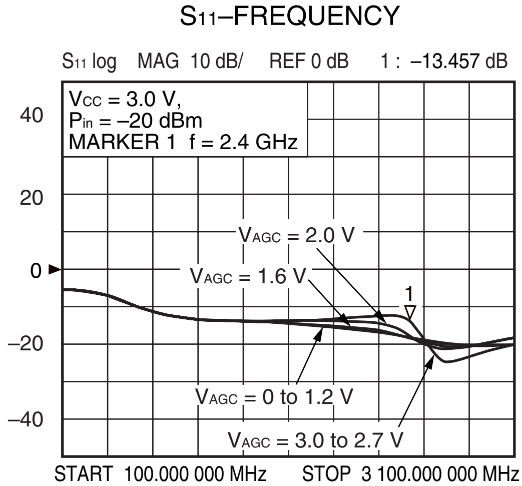
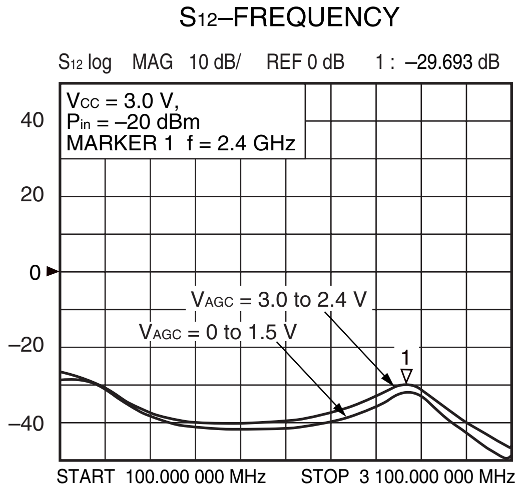
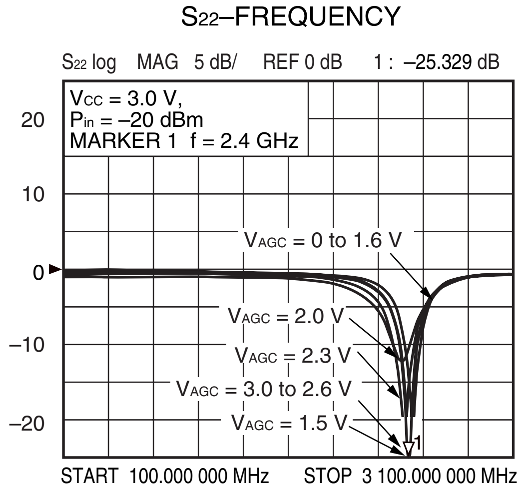


Remark The graphs indicate nominal characteristics.

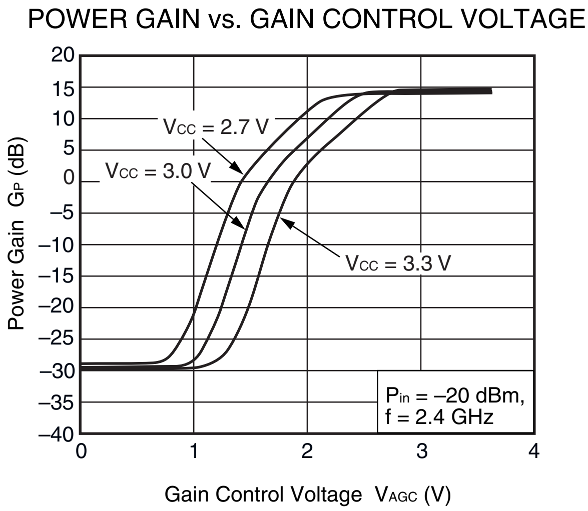


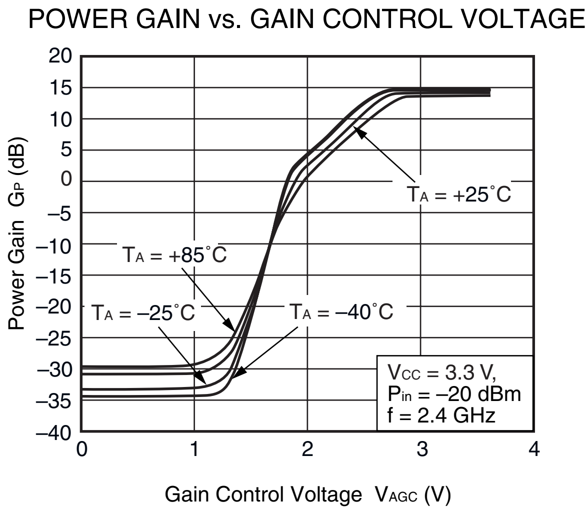


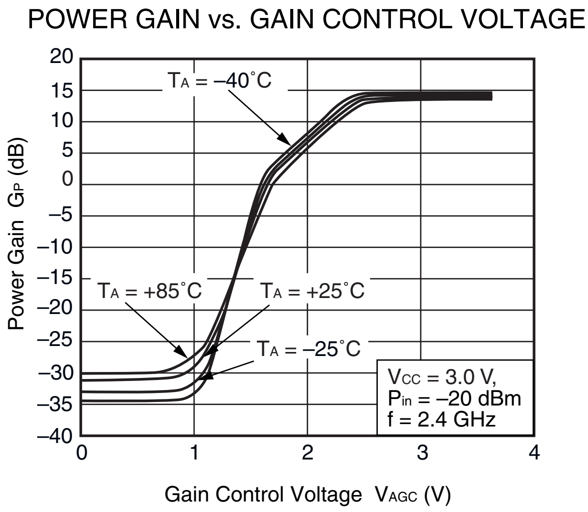


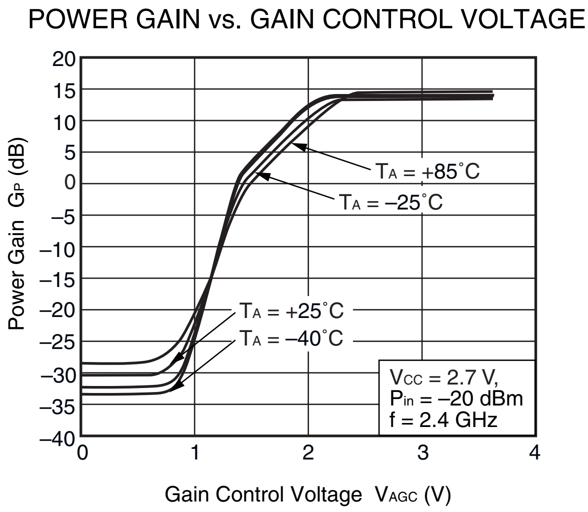


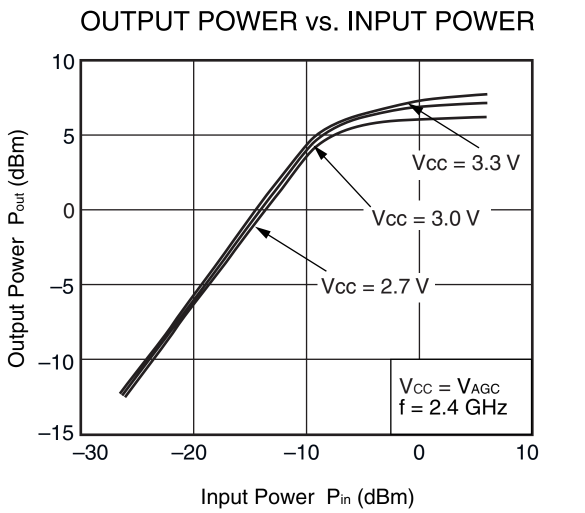
Remark The graphs indicate nominal characteristics.

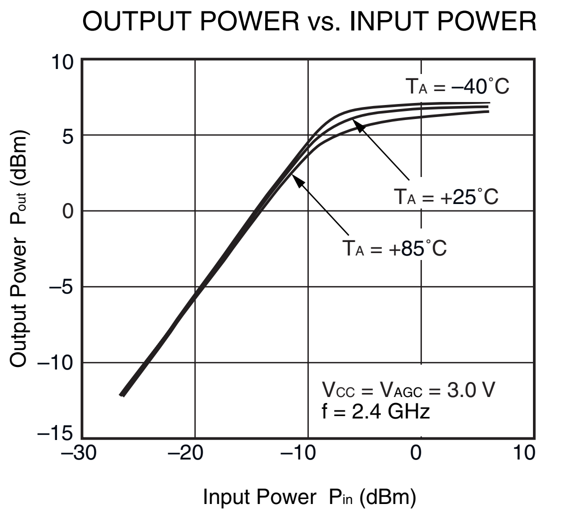






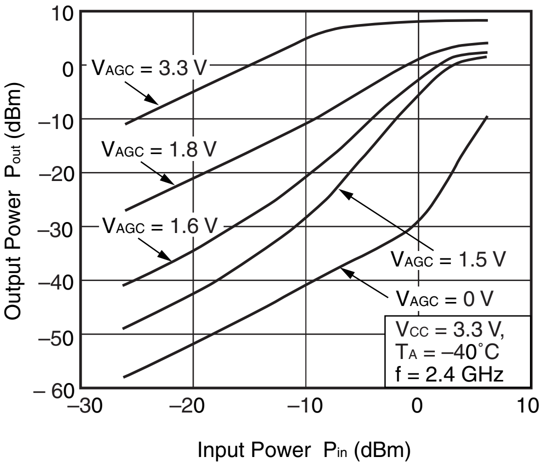




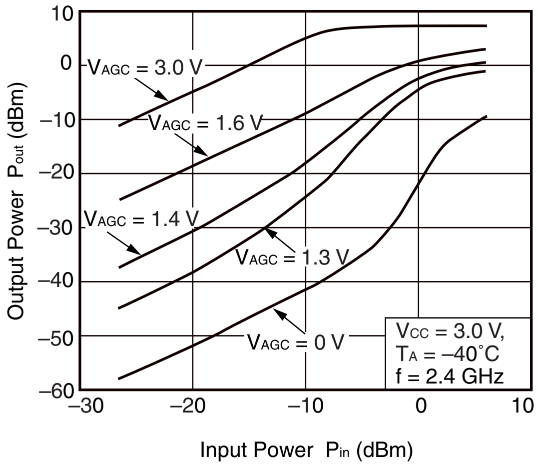


Remark The graphs indicate nominal characteristics.

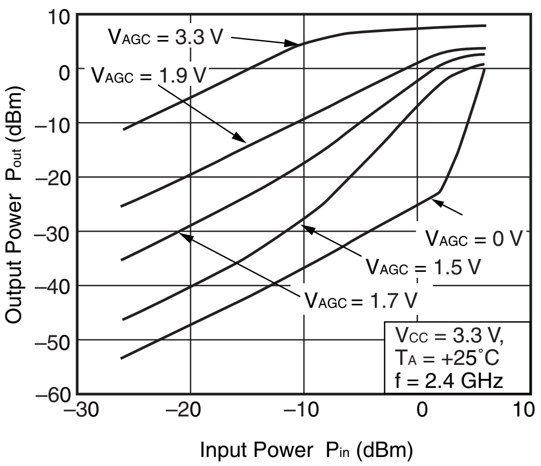
OUTPUT POWER vs. INPUT POWER



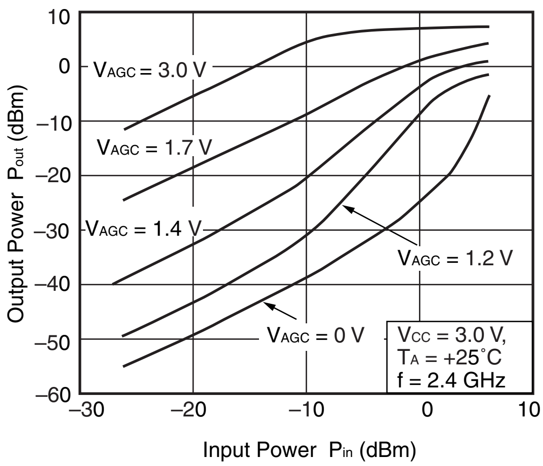
OUTPUT POWER vs. INPUT POWER



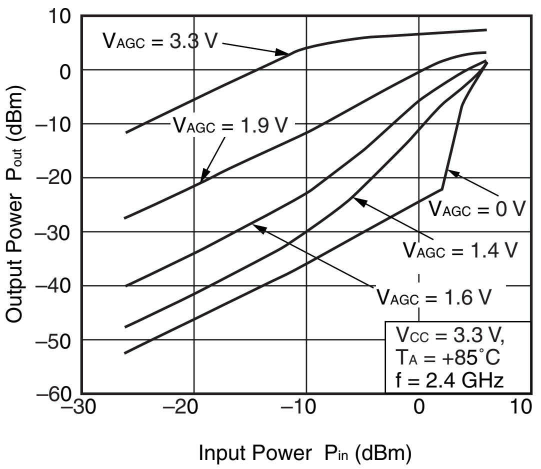
OUTPUT POWER vs. INPUT POWER



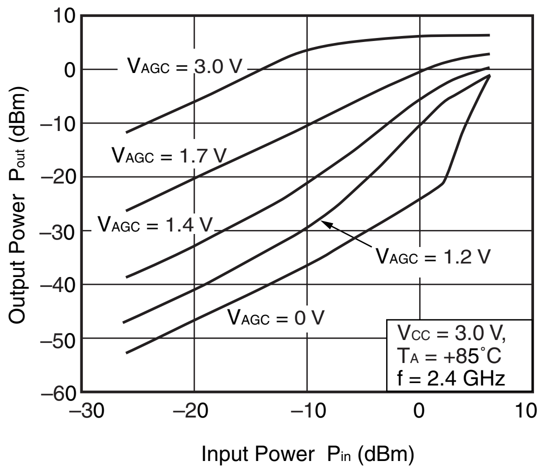
OUTPUT POWER vs. INPUT POWER



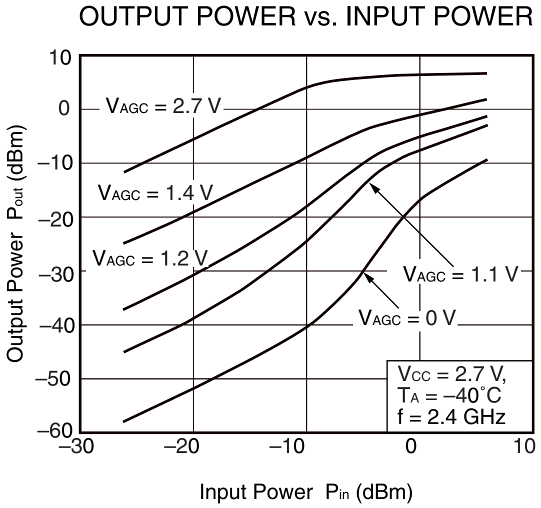
OUTPUT POWER vs. INPUT POWER

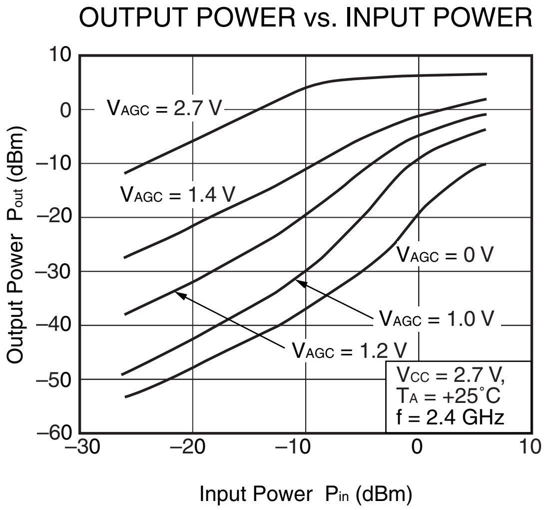


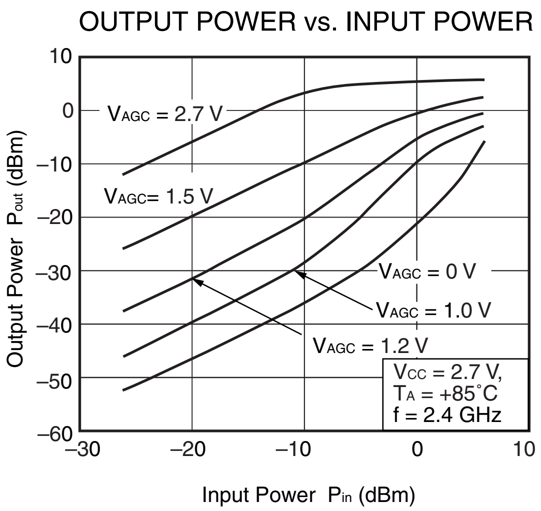
OUTPUT POWER vs. INPUT POWER



Remark The graphs indicate nominal characteristics.

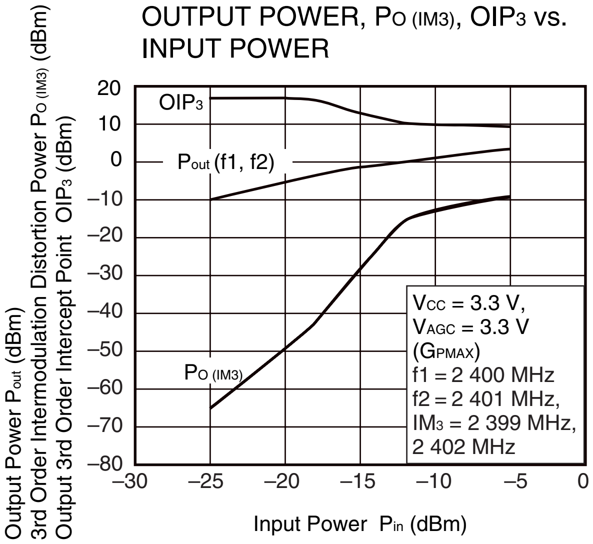




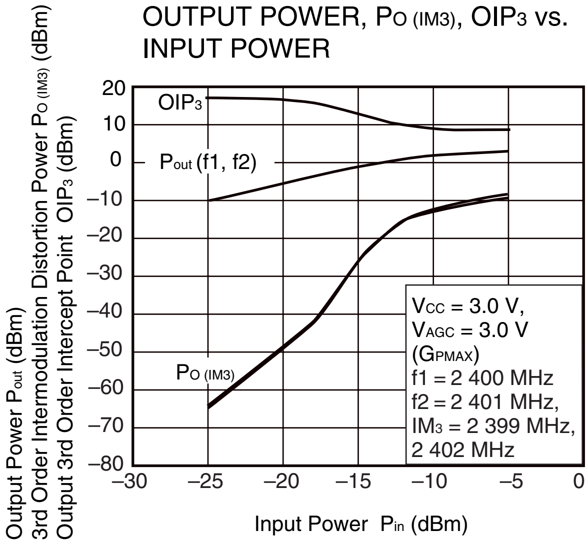


Remark The graphs indicate nominal characteristics.

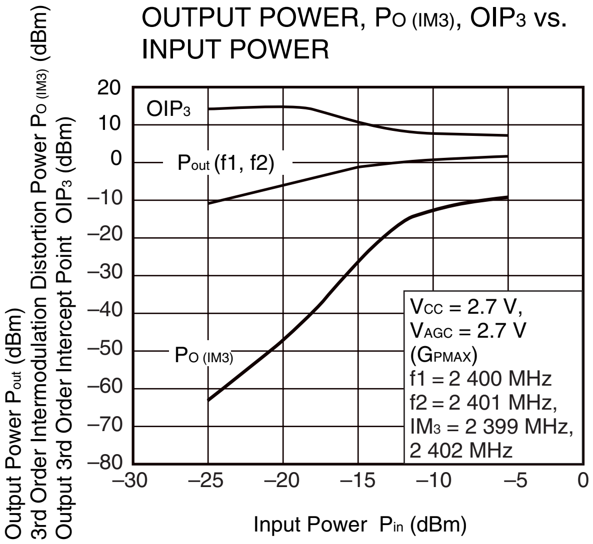
OUTPUT POWER, $P_{O\,(IM3)}$, OIP_3 vs. INPUT POWER



OUTPUT POWER, $P_{O\,(IM3)}$, OIP_3 vs. INPUT POWER

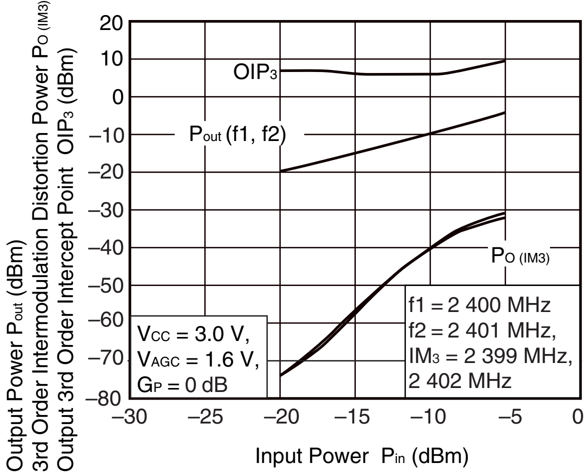


OUTPUT POWER, $P_{O\,(IM3)}$, OIP_3 vs. INPUT POWER

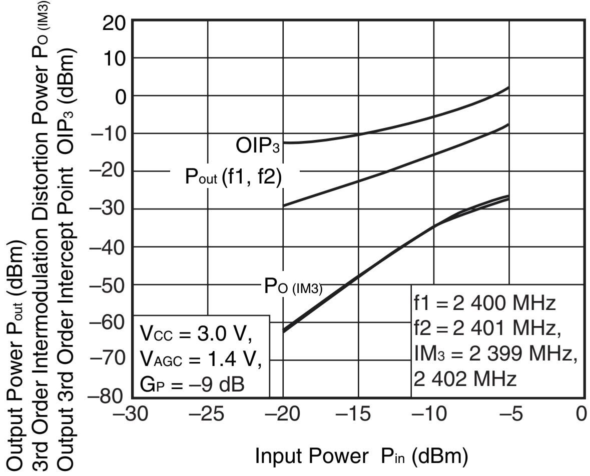


Remark The graphs indicate nominal characteristics.

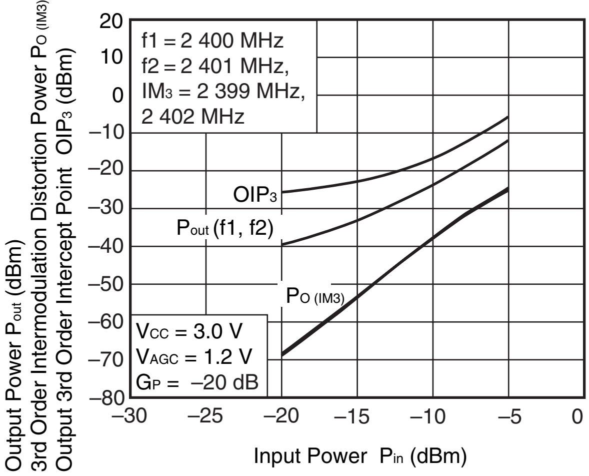
OUTPUT POWER, PO (IM3), OIP3 vs. INPUT POWER



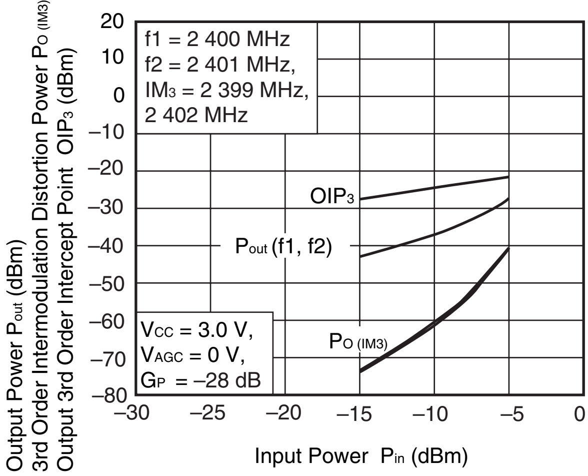
OUTPUT POWER, PO (IM3), OIP3 vs. INPUT POWER



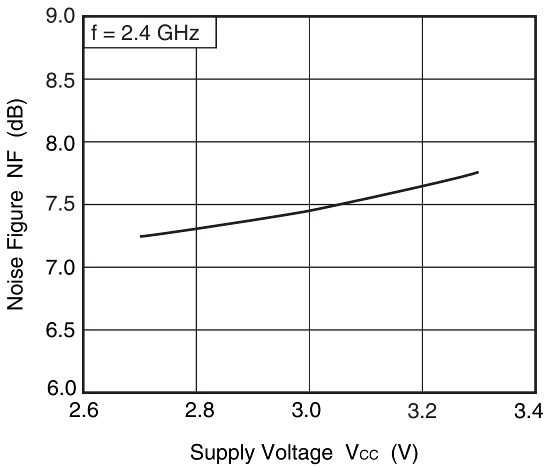
OUTPUT POWER, PO (IM3), OIP3 vs. INPUT POWER



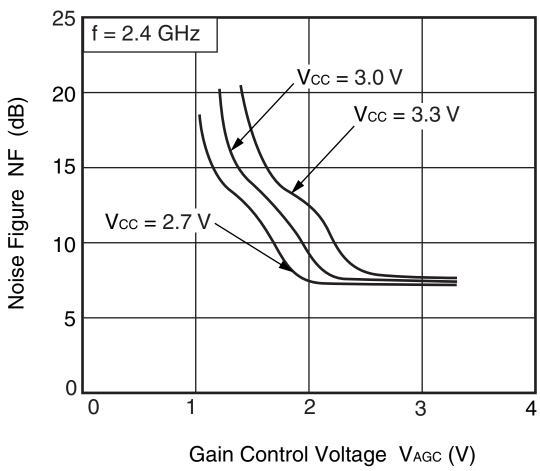
OUTPUT POWER, PO (IM3), OIP3 vs. INPUT POWER



NOISE FIGURE vs. SUPPLY VOLTAGE



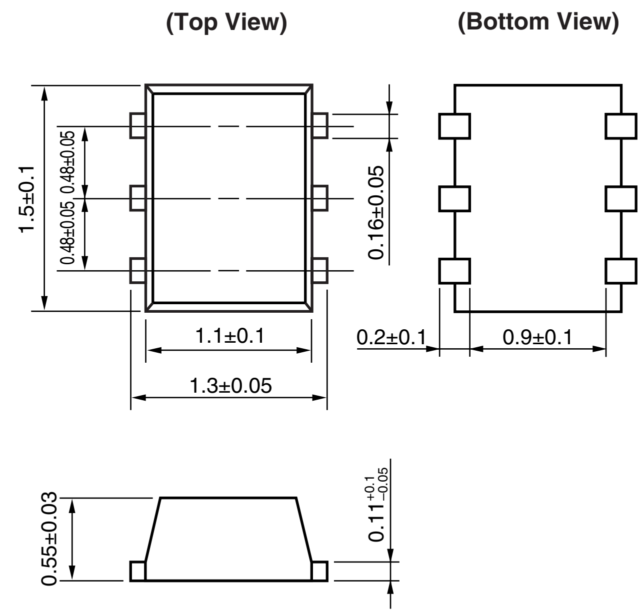
NOISE FIGURE vs. GAIN CONTROL VOLTAGE



Remark The graphs indicate nominal characteristics.

★ 7. PACKAGE DIMENSIONS

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



8. NOTES ON CORRECT USE

(1) Observe precautions for handling because of electro-static sensitive devices.
(2) Form a ground pattern as wide 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 the V_{CC} terminal.
(4) Impedance matching circuit must be each externally attached to input and output ports.
(5) The DC capacitor must be attached to input terminal.

★ 9. 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).

▶**For further information, please contact**

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