

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# $\mu$ PC3206GR

### 50dB AGC AMP + VIDEO AMP

#### DESCRIPTION

The  $\mu$ PC3206GR is Silicon monolithic IC designed for Digital DBS and Digital CATV receivers. This IC consists of a two stage gain control amplifier and a wideband linear video amplifier.

This IC is packaged in 20-pin SSOP. Therefore, it can make RF block small.

#### FEATURES

- Broadband AGC dynamic range            50 dB (MIN.)
- Supply voltage                                5 V
- Packaged in 20-pin SSOP suitable for high-density surface mount

#### APPLICATIONS

- Digital DBS receiver
- STB of digital CATV

#### ORDERING INFORMATION

Part Number	Package	Supplying Form
$\mu$ PC3206GR-E1	20-pin plastic SSOP (225 mil)	Embossed tape 12 mm wide. Pin 1 indicates pull-out direction of tape. Qty 2.5 kp/reel.

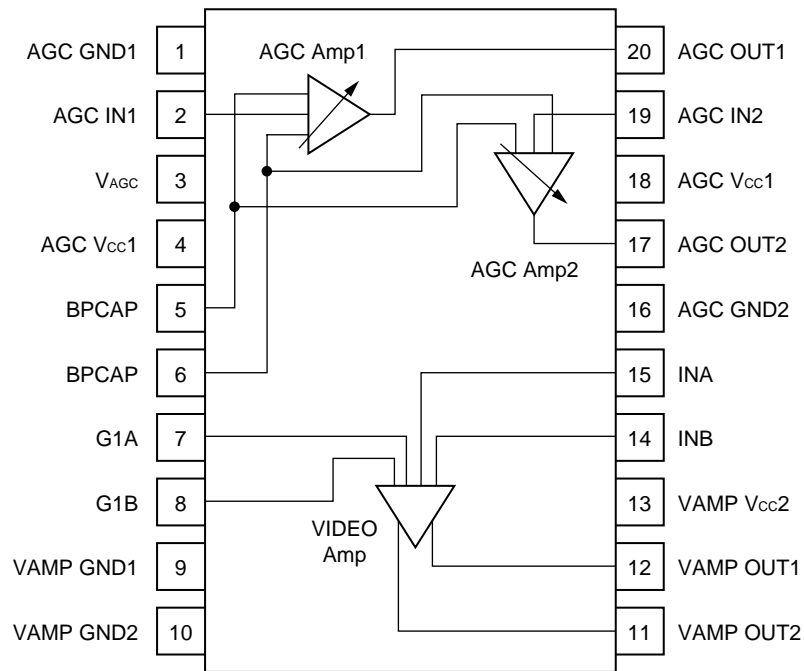
To order evaluation samples, please contact your local NEC office. (Part number for sample order :  $\mu$ PC3206GR)

**Caution** electro-static sensitive device

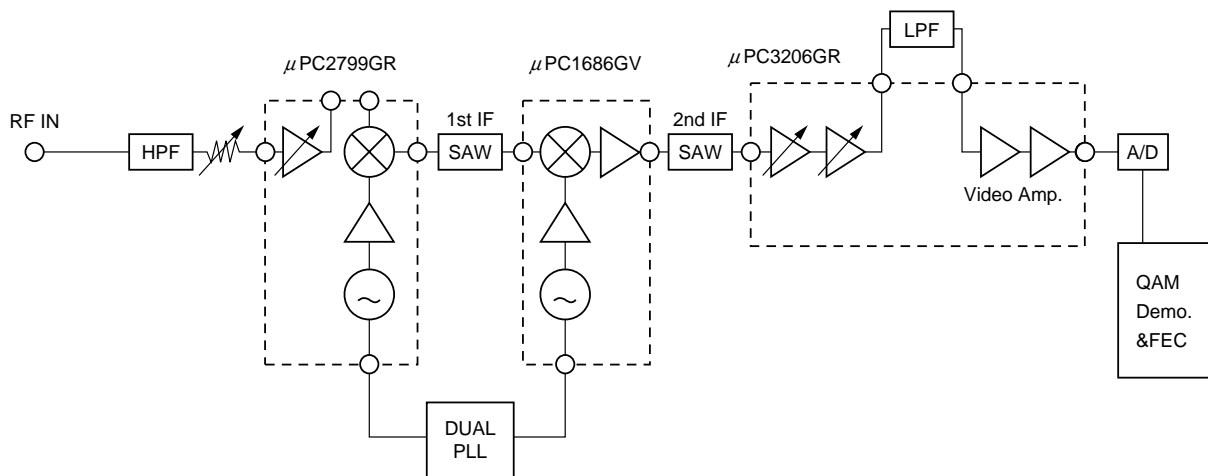
The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

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

**INTERNAL BLOCK DIAGRAM AND PIN CONFIGURATION (Top View)**



**TYPICAL APPLICATION**



PIN FUNCTIONS

Pin No.	Pin Name	Pin Voltage TYP.(V)	Function and Explanation	Equivalent Circuit
1	AGC GND1	0	Ground pin of AGC amplifier1. Form a ground pattern as wide as possible to maintain the minimum impedance.	
2	AGC IN 1 <small>Note 1</small>	1.02  1.02	Signal input pin to AGC amplifier.	
3	VAGC	0 to 5	Gain control pin. This pin's bias govern the AGC output level. Minimum gain at $V_{AGC} = 0\text{ V}$ Maximum gain at $V_{AGC} = 5\text{ V}$ Recommended to use by dividing AGC voltage with externally resistor (ex.100 kΩ).	
4	AGC Vcc1	5	Power supply pin of AGC amplifier1. Must be connected bypass capacitor to minimize ground impedance.	<p>Refer to Equivalent circuit of pin1 and pin2.</p>
5	BPCAP4 <small>Note 1</small>	2.61  2.61	Bypass pin of AGC amplifier1 and 2.	
6	BPCAP2 <small>Note 1</small>	2.84  2.49		
7	G1A <small>Note 2</small>	1.72  3.34	Gain control pin of video amplifier. Maximum gain at G1A – G1B = short. Minimum gain at G1A – G1B = open. Gain is able to adjust by inserting arbitrary resistor between 7pin and 8pin.	
8	G1B <small>Note 2</small>	1.72  3.34		
9	VAMP GND1	0	Ground pin of video amplifier. Form a ground pattern as wide as possible to maintain the minimum impedance.	
10	VAMP GND2	0		
11	VAMP OUT2 <small>Note 2</small>	2.52  4.92	Signal output pin of video amplifier. In case of $R_L = 1\text{ k}\Omega$ , single-end output voltage equal 2V <sub>P-P</sub> .	
12	VAMP OUT1 <small>Note 2</small>	2.52  4.92		

**Notes** 1. above :  $V_{AGC} = V_{CC1}$  below :  $V_{AGC} = 0\text{ V}$   
 2. above :  $V_{CC2} = 5\text{ V}$  below :  $V_{CC2} = 9\text{ V}$

Pin No.	Pin Name	Pin Voltage TYP.(V)	Function and Explanation	Equivalent Circuit
13	VAMP V <sub>cc2</sub>	5 to 9	Power supply pin of video amplifier. Must be connected bypass capacitor to minimize ground impedance.	
14	INB <sup>Note 2</sup>	2.49	Signal input pin to video amplifier.	
		4.13		
15	INA <sup>Note 2</sup>	2.49		
		4.13		
16	AGCGND2	0	Ground pin of AGC amplifier2. Form a ground pattern as wide as possible to maintain the minimum impedance.	
17	AGCOUT2 <sup>Note 1</sup>	1.69	Signal output pin of AGC amplifier2.	
		3.31		
18	AGC V <sub>cc1</sub>	5	Power supply pin of AGC amplifier2. Must be connected bypass capacitor to minimize ground impedance.	
19	AGC IN2 <sup>Note 1</sup>	1.01	Signal input pin of AGC amplifier2.	
		1.01		
20	AGCOUT1 <sup>Note 1</sup>	1.71	Signal output pin of AGC amplifier1.	
		3.35		

**Notes** 1. above : V<sub>AGC</sub> = V<sub>cc1</sub> below : V<sub>AGC</sub> = 0 V  
 2. above : V<sub>cc2</sub> = 5 V below : V<sub>cc2</sub> = 9 V

**ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25 °C unless otherwise specified)**

Parameter	Symbol	Conditions	Rating	Unit
Supply Voltage 1	V <sub>CC1</sub>	MIXER Block	6.0	V
Supply Voltage 2	V <sub>CC2</sub>	Video Amp Block	6.0	V
AGC Control Voltage	V <sub>AGC</sub>		6.0	V
Maximum Input Power	P <sub>in</sub> (MAX.)		+10	dBm
Power Dissipation	P <sub>D</sub>	T <sub>A</sub> = 85 °C <sup>Note</sup>	433	mW
Operating Ambient Temperature	T <sub>A</sub>		-40 to +85	°C
Storage Temperature	T <sub>stg</sub>		-55 to +150	°C

Parameter	Symbol	Conditions	Rating	Unit
Supply Voltage 1	V <sub>CC1</sub>	MIXER Block	6.0	V
Supply Voltage 2	V <sub>CC2</sub>	Video Amp Block	11.0	V
AGC Control Voltage	V <sub>AGC</sub>		6.0	V
Maximum Input Power	P <sub>in</sub> (MAX.)		+10	dBm
Power Dissipation	P <sub>D</sub>	T <sub>A</sub> = 75 °C <sup>Note</sup>	500	mW
Operating Ambient Temperature	T <sub>A</sub>		-40 to +75	°C
Storage Temperature	T <sub>stg</sub>		-55 to +150	°C

**Note** Mounted on 50 × 50 × 1.6 mm double epoxy glass board.

**RECOMMENDED OPERATING RANGE**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage 1	V <sub>CC1</sub>	4.5	5.0	5.5	V
Supply Voltage 2	V <sub>CC2</sub>	4.5	9.0	10.0	V
Operating Ambient Temperature 1 <sup>Note 1</sup>	T <sub>A1</sub>	-40	+25	+85	°C
Operating Ambient Temperature 2 <sup>Note 2</sup>	T <sub>A2</sub>	-40	+25	+75	°C

- Notes**
1. V<sub>CC1</sub> = V<sub>CC2</sub> = 4.5 to 5.5 V
  2. V<sub>CC1</sub> = 4.5 to 5.5 V, V<sub>CC2</sub> = 4.5 to 10 V

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C)**

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
AGC Amplifier Block (V <sub>cc1</sub> = 5 V, f <sub>in</sub> = 100 MHz, R <sub>L</sub> = 560 Ω)						
Circuit Current 1	I <sub>cc1</sub>	no input signal, V <sub>AGC</sub> = 5 V <b>Note 1</b>	11	16	22	mA
Circuit Current 2	I <sub>cc2</sub>	no input signal, V <sub>AGC</sub> = 0 V <b>Note 1</b>	15	22	32	mA
Bandwidth 1	BW1	Maximum gain (V <sub>AGC</sub> = 5 V), Pin = -60 dBm <b>Note 2, 3</b>	100	220	-	MHz
Bandwidth 2	BW2	Minimum gain (V <sub>AGC</sub> = 0 V), Pin = -15 dBm <b>Note 3</b>	500	-	-	MHz
Maximum Gain 1	G <sub>MAX1</sub>	Pin = -60 dBm, V <sub>AGC</sub> = 5 V <b>Note 3</b>	36	38.5	41	dB
Minimum Gain 1	G <sub>MIN2</sub>	Pin = -15 dBm, V <sub>AGC</sub> = 0 V <b>Note 3</b>	-	-28	-15	dB
Gain Control Range	GCR	Pin = -35 dBm, V <sub>AGC</sub> = 0 to 5V <b>Note 3</b>	50	-	-	dB
Maximum Output Power	P <sub>o (sat)</sub>	V <sub>AGC</sub> = 5 V, Pin = 0 dBm <b>Note 3</b>	0	2	-	dBm
Video Amplifier Block (V <sub>cc2</sub> = 9 V, f <sub>in</sub> = 100 MHz, R <sub>L</sub> = 1 kΩ)						
Circuit Current 3	I <sub>cc3</sub>	no input signal <b>Note 4</b>	16	24	34.5	mA
Differential Gain 1	G1	G1A-G1B pins:short <b>Note 5</b>	160	260	400	V/V
Differential Gain 2	G2	G1A-G1B pins:open <b>Note 5</b>	22	25	30	V/V
Video Amplifier Block (V <sub>cc2</sub> = 5 V, f <sub>in</sub> = 100 MHz, R <sub>L</sub> = 1 kΩ)						
Circuit Current 4	I <sub>cc4</sub>	no input signal <b>Note 4</b>	8	12.5	18	mA
Differential Gain 3	G3	G1A-G1B pins:short <b>Note 5</b>	80	140	230	V/V
Differential Gain 4	G4	G1A-G1B pins:open <b>Note 5</b>	16	22	30	V/V
Video Amplifier Block (V <sub>cc2</sub> = 5 V, 9 V Common, f <sub>in</sub> = 100 MHz, R <sub>L</sub> = 1 kΩ, single-ended)						
Bandwidth 1	BW <sub>G1</sub>	G1A-G1B pins:short <b>Note 2, 5</b>	-	100	-	MHz

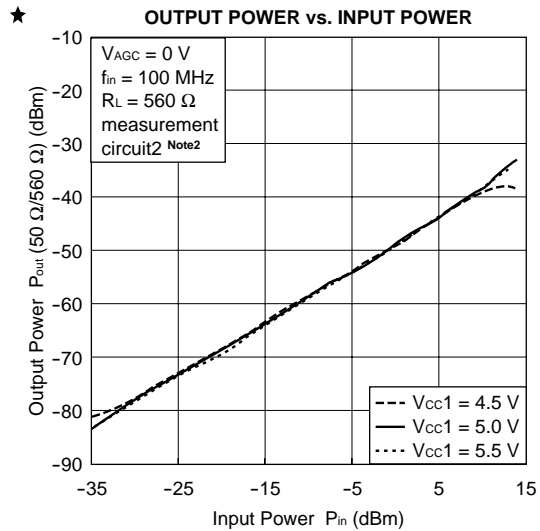
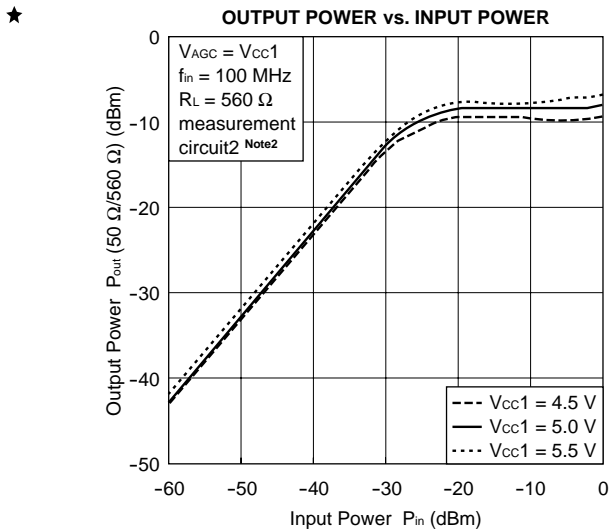
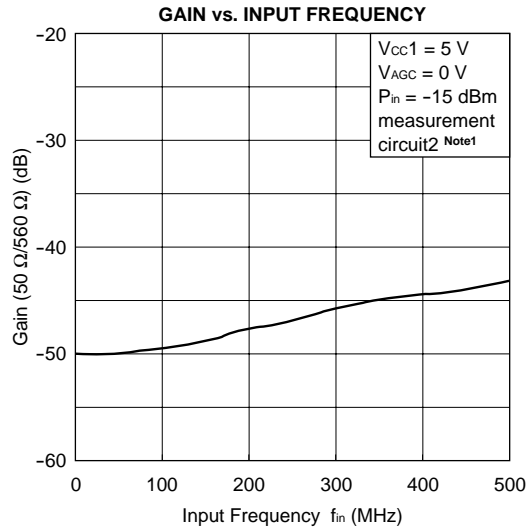
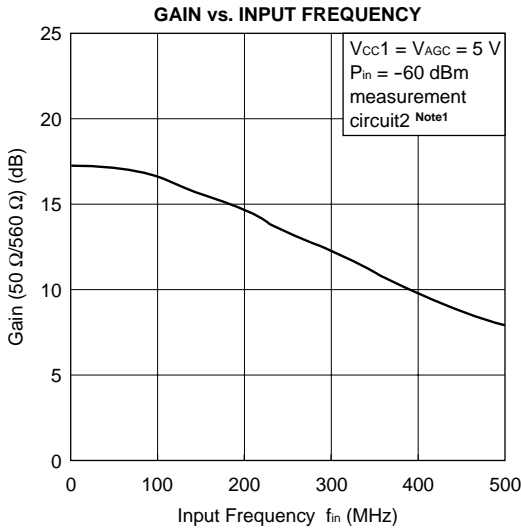
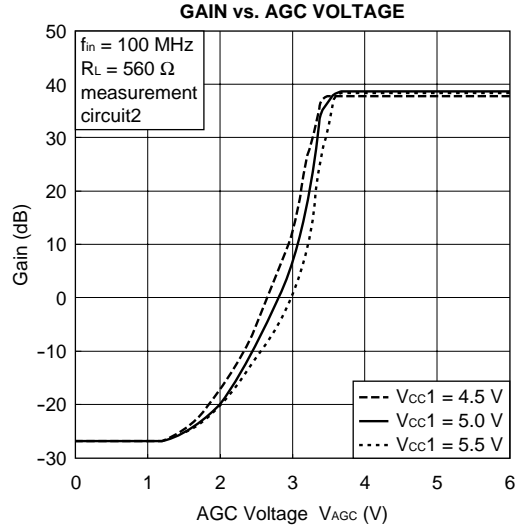
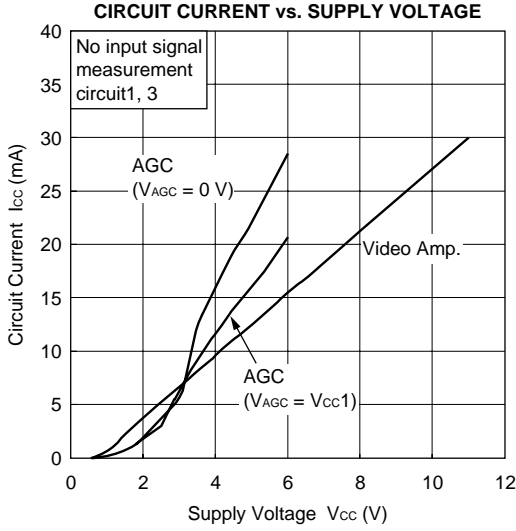
- Notes**
1. By measurement circuit 1
  2. -3 dB down from gain at 5 MHz
  3. By measurement circuit 2
  4. By measurement circuit 3
  5. By measurement circuit 4

**STANDARD CHARACTERISTICS (FOR REFERENCE) (T<sub>A</sub> = 25 °C)**

Parameter	Symbol	Test Conditions	Reference Values	Unit
AGC Amplifier Block (V <sub>cc1</sub> = 5 V, fin = 100 MHz, R <sub>L</sub> = 560 Ω)				
Noise Figure	NF	Maximum Gain (V <sub>AGC</sub> = 5 V) <b>Note 1</b>	5.5	dB
Output Intercept Point	OIP <sub>3</sub>	fin2 = 106 MHz, Maximum Gain (V <sub>AGC</sub> = 5 V) <b>Note 2</b>	+4.5	dBm
Video Amplifier Block (V <sub>cc2</sub> = 9 V, fin = 100 MHz, R <sub>L</sub> = 1 kΩ)				
Output Voltage	Vout	single-ended <b>Note 3</b>	2	V <sub>P-P</sub>
Single-end Gain 1	Avs1	G1A-G1B pins:short <b>Note 3</b>	130	V/V
Single-end Gain 2	Avs2	G1A-G1B pins:open <b>Note 3</b>	12	V/V
Input Intercept Point 1	IIP <sub>31</sub>	fin2 = 106 MHz, G1A-G1B pins:short <b>Note 3</b>	-16	dBm
Input Intercept Point 2	IIP <sub>32</sub>	fin2 = 106 MHz, G1A-G1B pins:open <b>Note 3</b>	4	dBm
Video Amplifier Block (V <sub>cc2</sub> = 5 V, fin = 100 MHz, R <sub>L</sub> = 1 kΩ)				
Single-end Gain 3	Avs3	G1A-G1B pins:short <b>Note 3</b>	70	V/V
Single-end Gain 4	Avs4	G1A-G1B pins:open <b>Note 3</b>	11	V/V
Input Intercept Point 3	IIP <sub>33</sub>	fin2 = 106 MHz, G1A-G1B pins:short <b>Note 3</b>	-15	dBm
Input Intercept Point 4	IIP <sub>34</sub>	fin2 = 106 MHz, G1A-G1B pins:open <b>Note 3</b>	2	dBm
Total Block (V <sub>cc1</sub> = 5 V, fin = 100 MHz, R <sub>L</sub> = 1 kΩ)				
Maximum Gain 2	G <sub>MAX2</sub>	V <sub>AGC</sub> = 5 V, V <sub>cc2</sub> = 5 V, G1A-G1B pins:short <b>Note 4</b>	76	dB
Maximum Gain 3	G <sub>MAX3</sub>	V <sub>AGC</sub> = 5 V, V <sub>cc2</sub> = 5 V, G1A-G1B pins:open <b>Note 4</b>	62	dB
Minimum Gain 2	G <sub>MIN2</sub>	V <sub>AGC</sub> = 0 V, V <sub>cc2</sub> = 5 V, G1A-G1B pins:short <b>Note 4</b>	10	dB
Maximum Gain 4	G <sub>MAX4</sub>	V <sub>AGC</sub> = 5 V, V <sub>cc2</sub> = 9 V, G1A-G1B pins:short <b>Note 4</b>	80	dB
Maximum Gain 5	G <sub>MAX5</sub>	V <sub>AGC</sub> = 5 V, V <sub>cc2</sub> = 9 V, G1A-G1B pins:open <b>Note 4</b>	63	dB
Minimum Gain 3	G <sub>MIN3</sub>	V <sub>AGC</sub> = 0 V, V <sub>cc2</sub> = 9 V, G1A-G1B pins:short <b>Note 4</b>	14	dB

- Notes**
1. By measurement circuit 5
  2. By measurement circuit 2
  3. By measurement circuit 4
  4. By measurement circuit 6

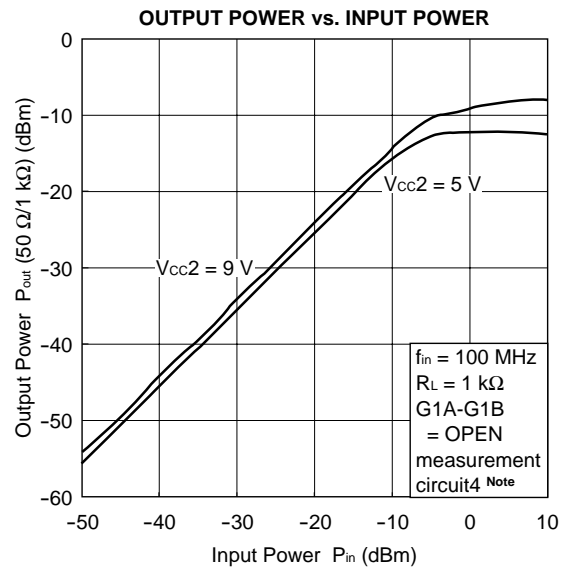
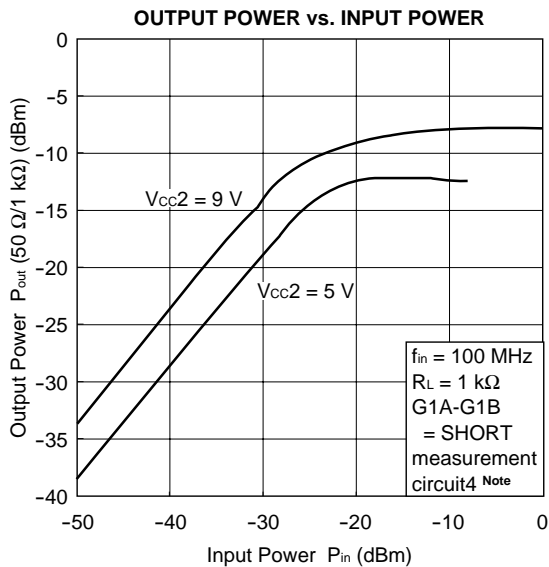
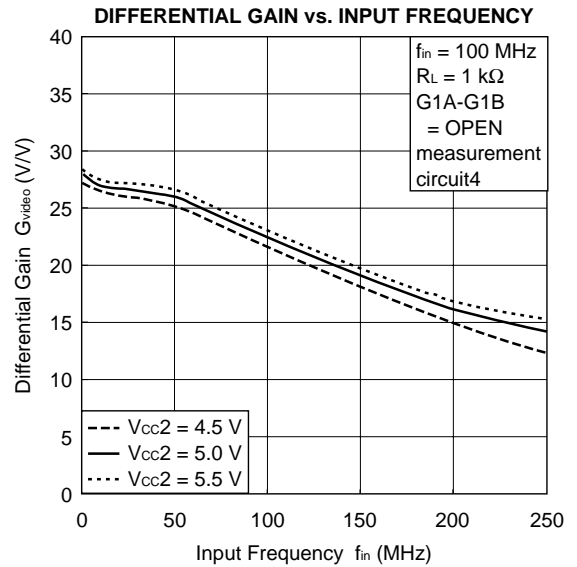
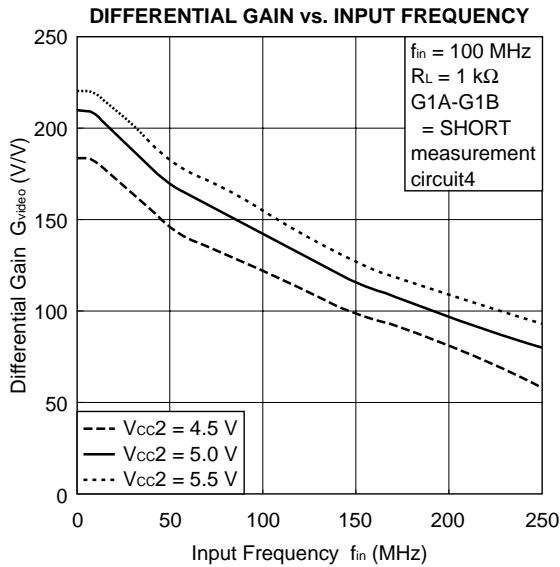
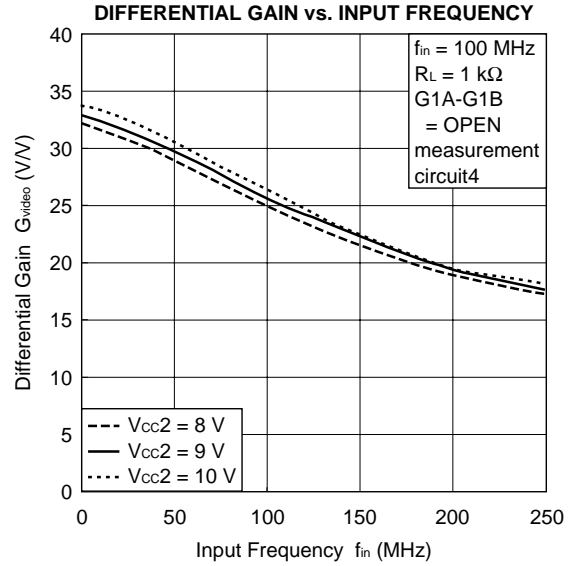
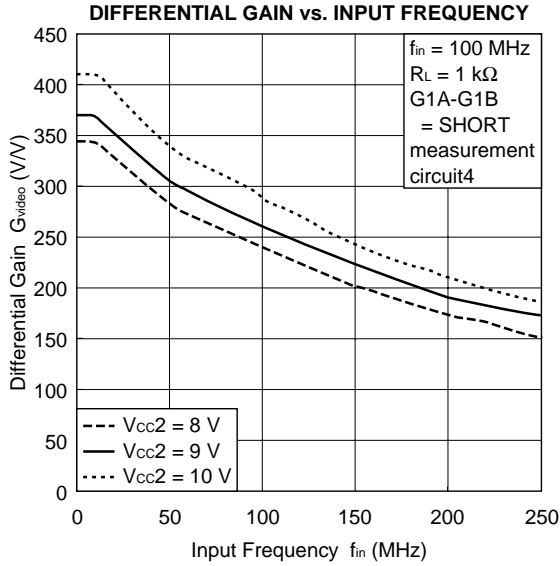
**TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C)**



- Notes**
- Gain = (Gain at Spectrum Analyzer) + 20 log (560 Ω/50 Ω)
  - Output Power = (Output Power at Spectrum Analyzer) + 10 log (560 Ω/50 Ω)



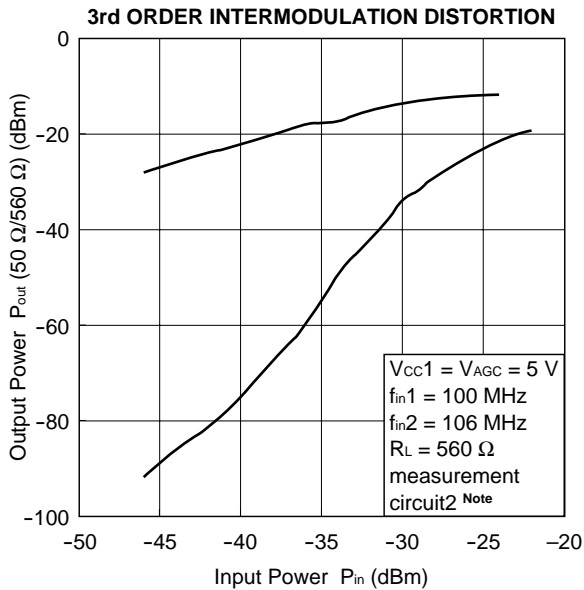
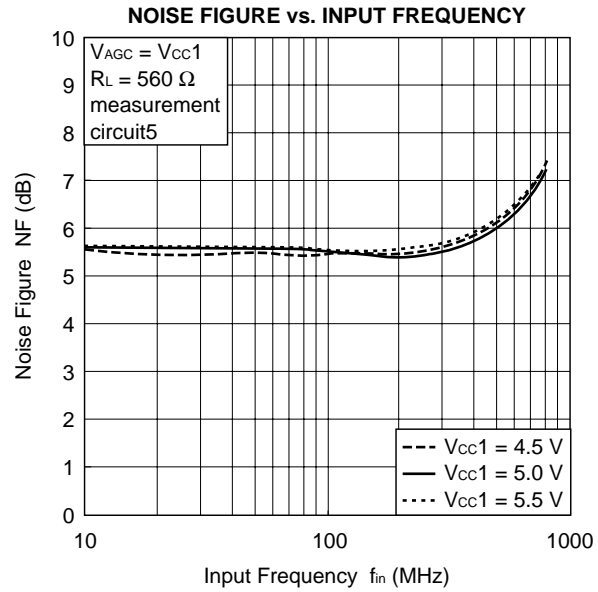
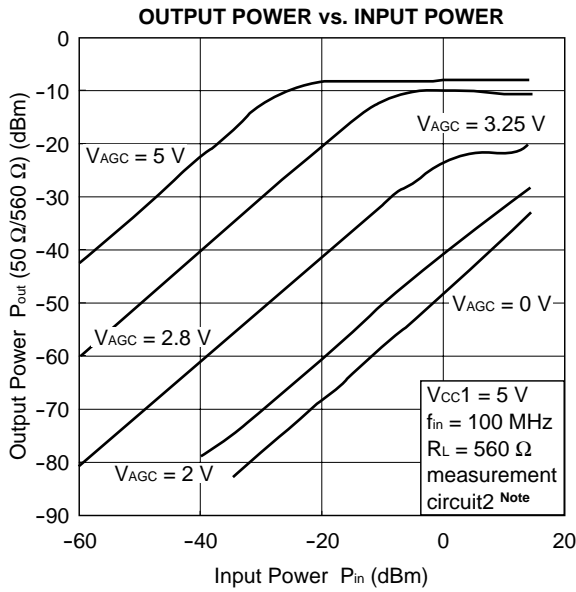
**TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C)**



**Note** Output Power = (Output Power at Spectrum Analyzer) + 10 log (1 k $\Omega$ /50  $\Omega$ )

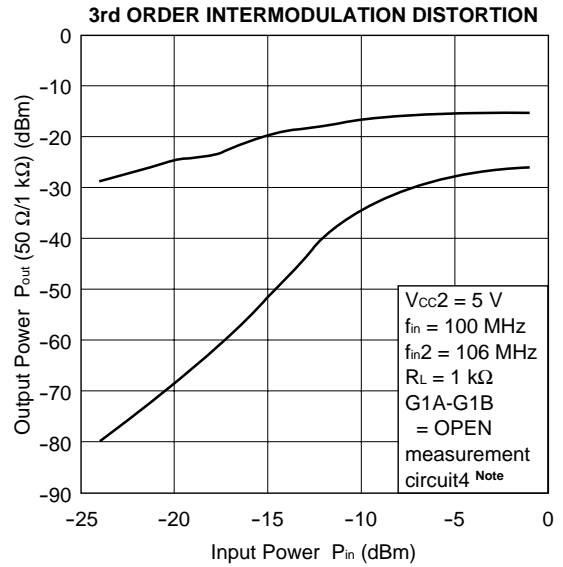
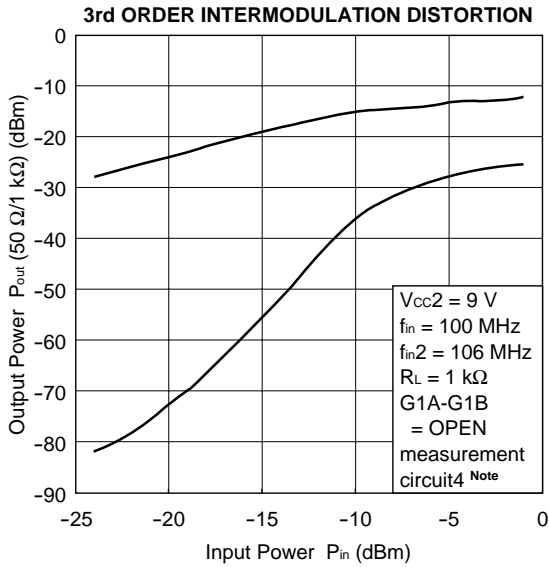
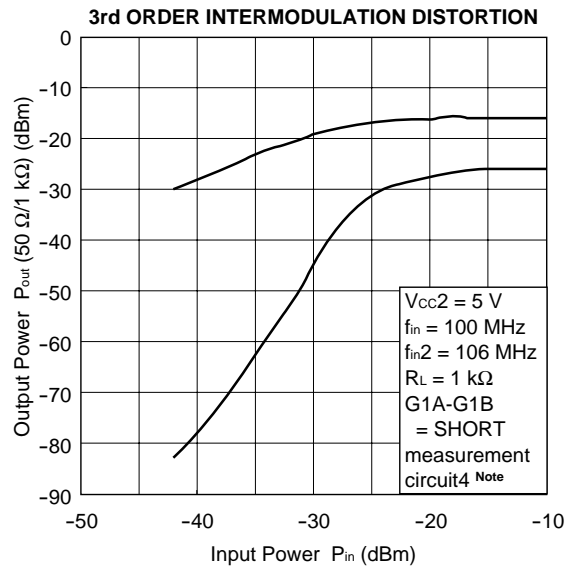
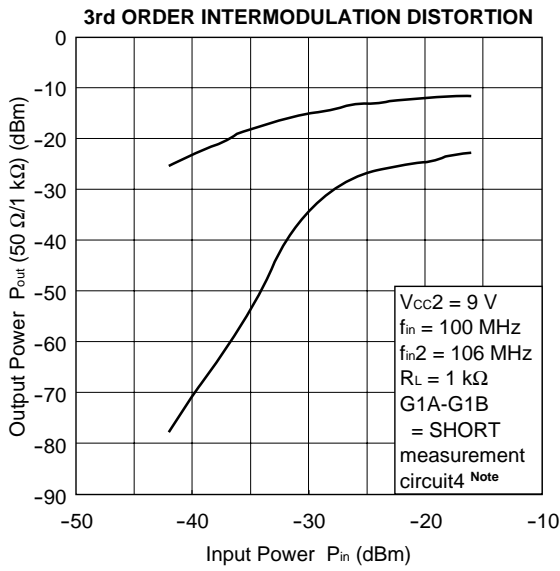
STANDARD CHARACTERISTICS (T<sub>A</sub> = 25 °C)

★



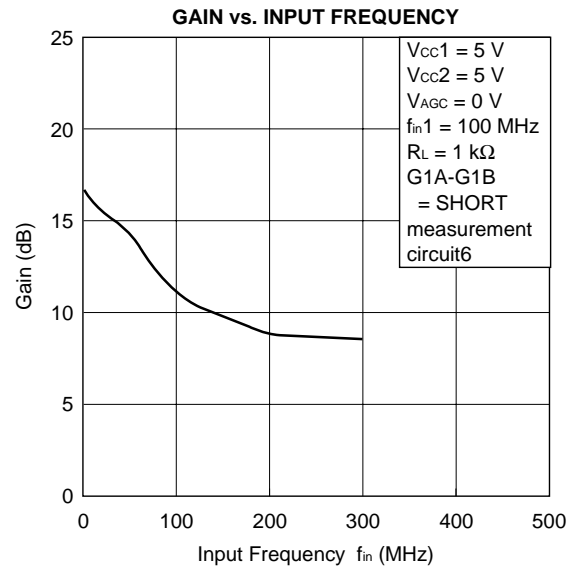
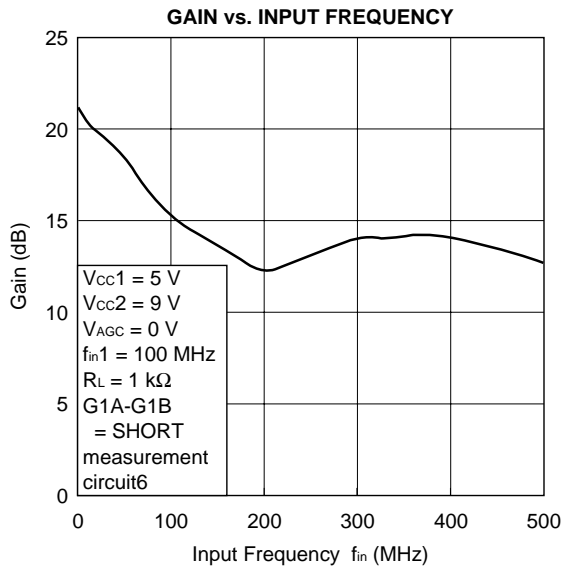
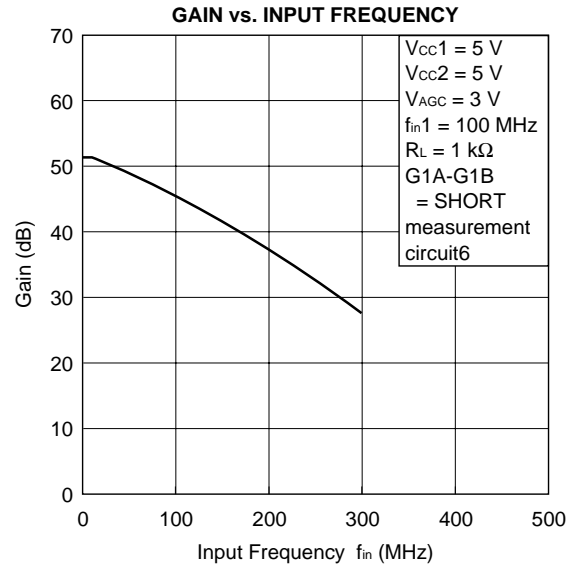
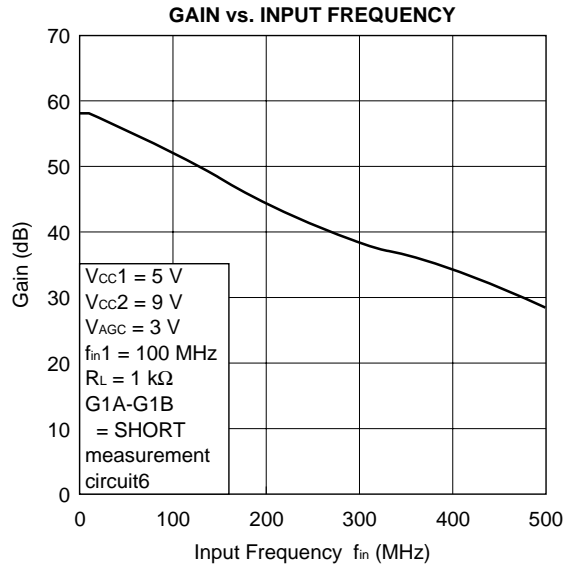
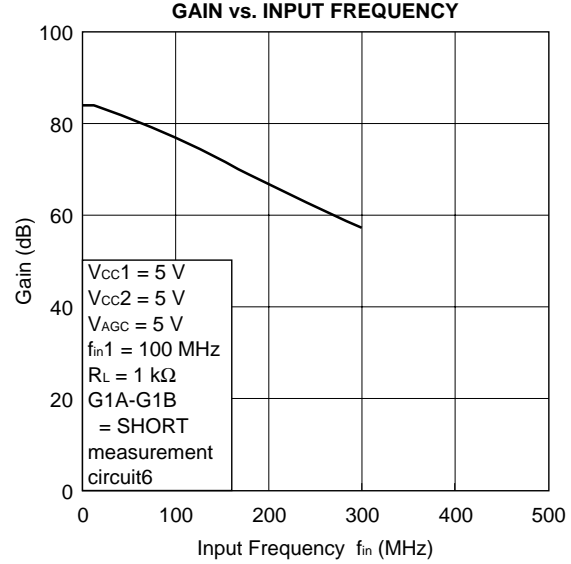
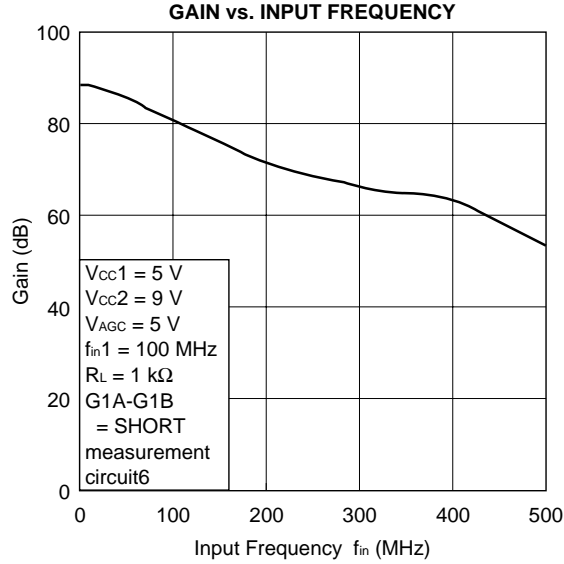
**Note** Output Power = (Output Power at Spectrum Analyzer) + 10 log (560  $\Omega$ /50  $\Omega$ )

STANDARD CHARACTERISTICS (T<sub>A</sub> = 25 °C)

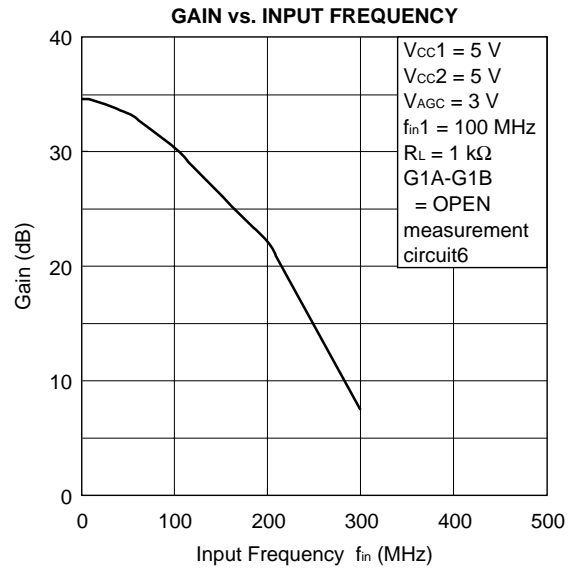
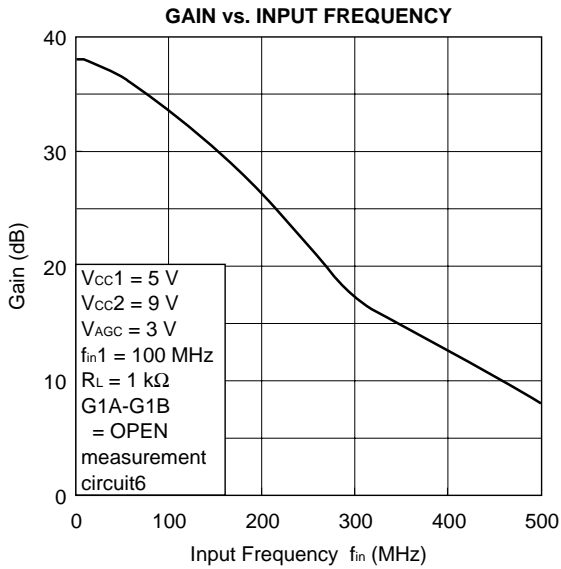
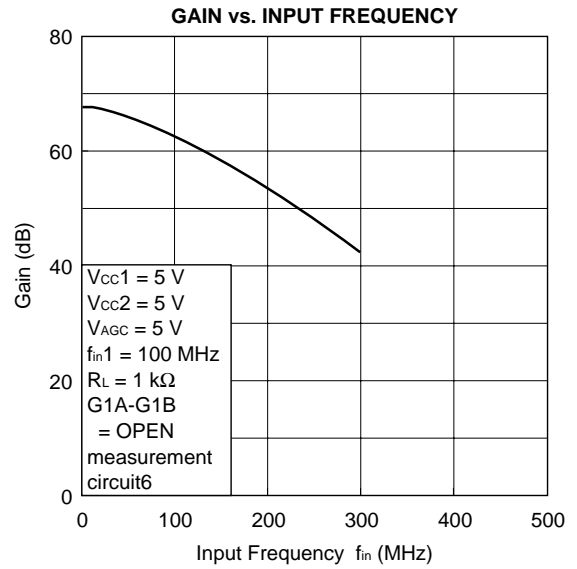
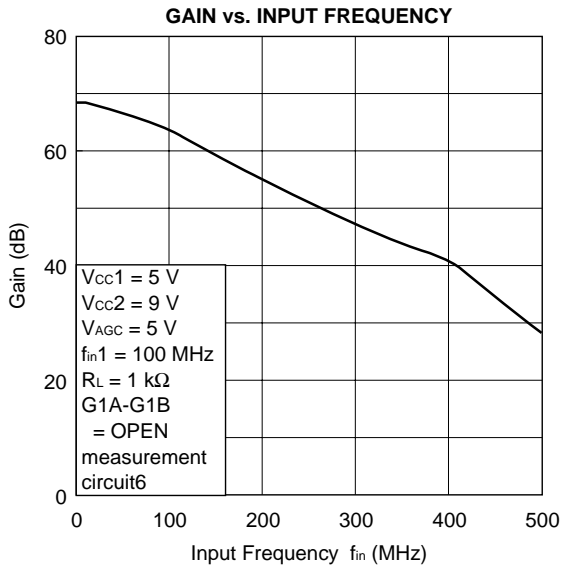


**Note** Output Power = (Output Power at Spectrum Analyzer) + 10 log (1 k $\Omega$ /50  $\Omega$ )

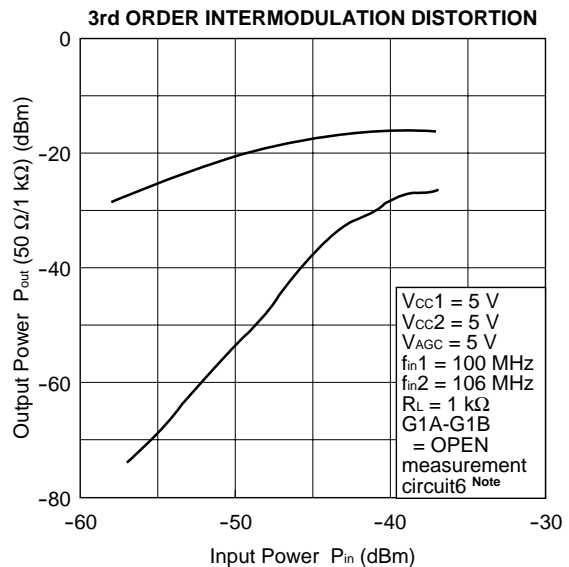
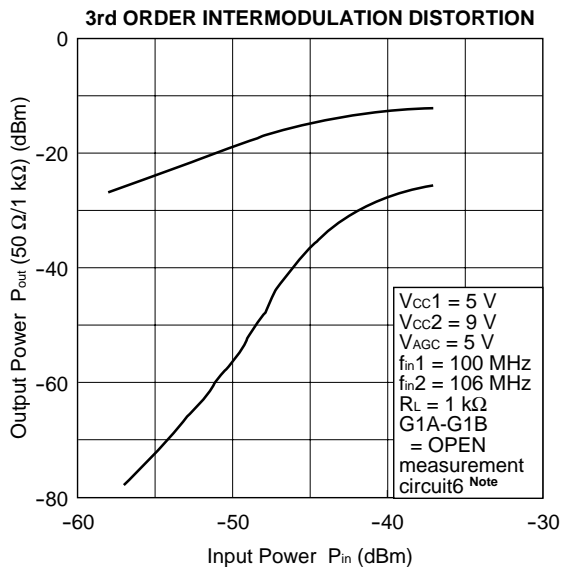
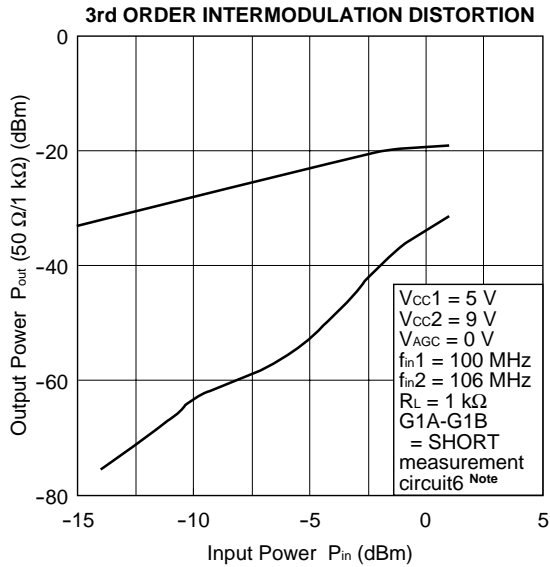
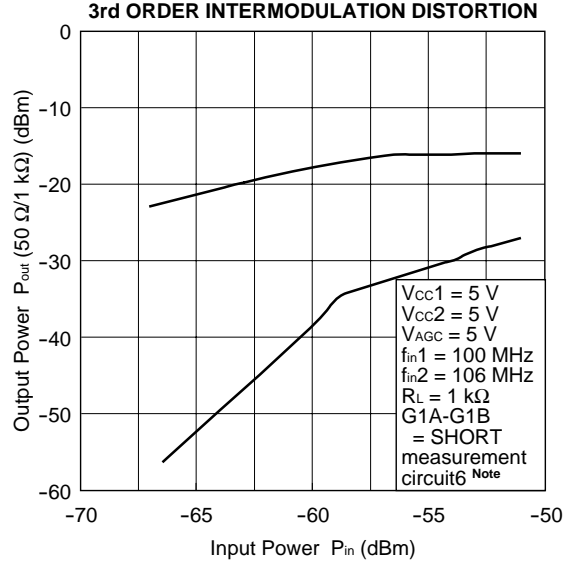
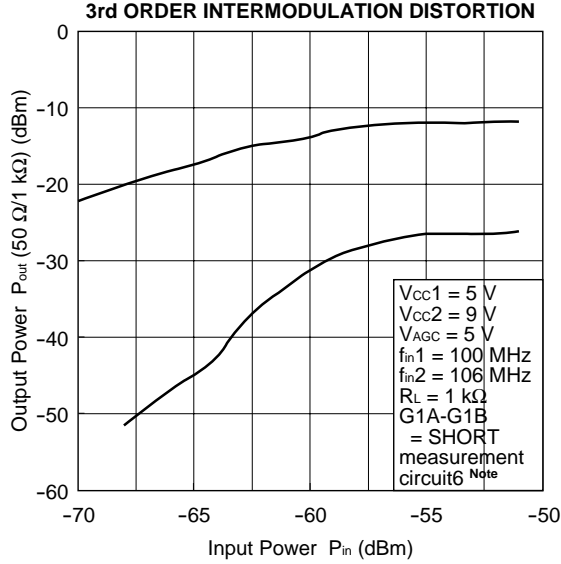
STANDARD CHARACTERISTICS (T<sub>A</sub> = 25 °C)



STANDARD CHARACTERISTICS (T<sub>A</sub> = 25 °C)

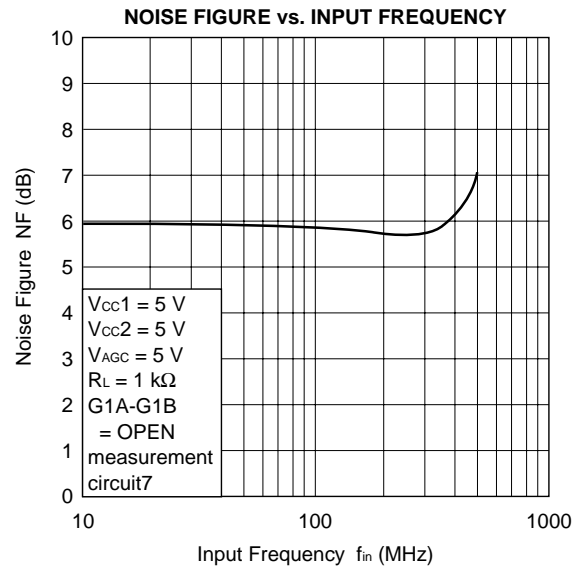
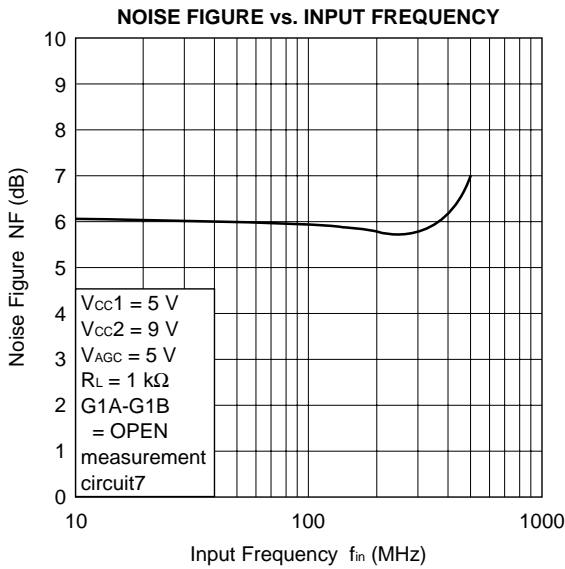
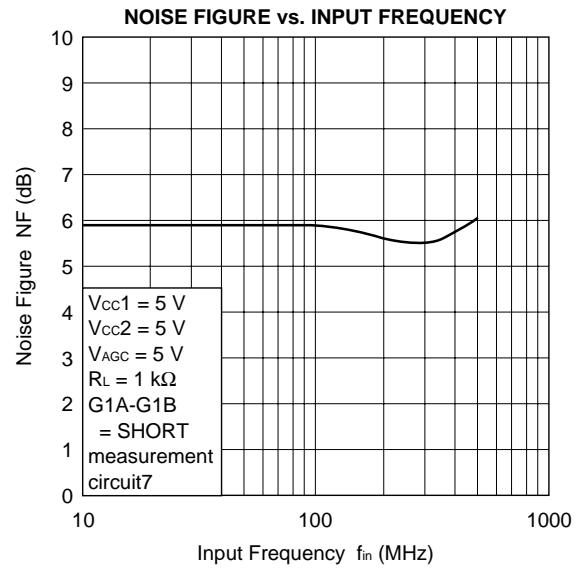
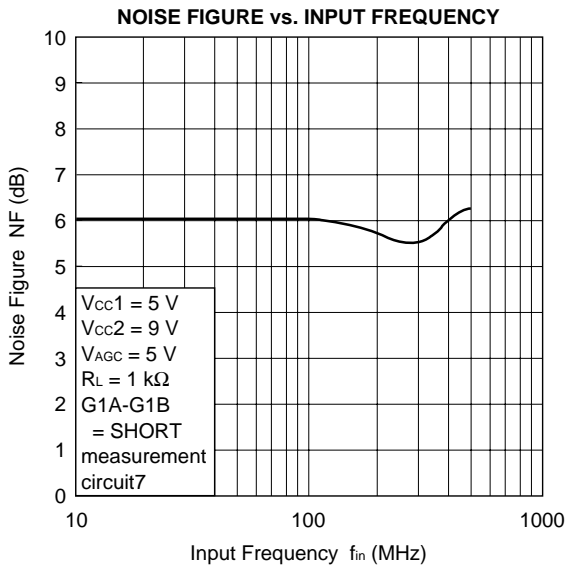


**STANDARD CHARACTERISTICS (T<sub>A</sub> = 25 °C)**

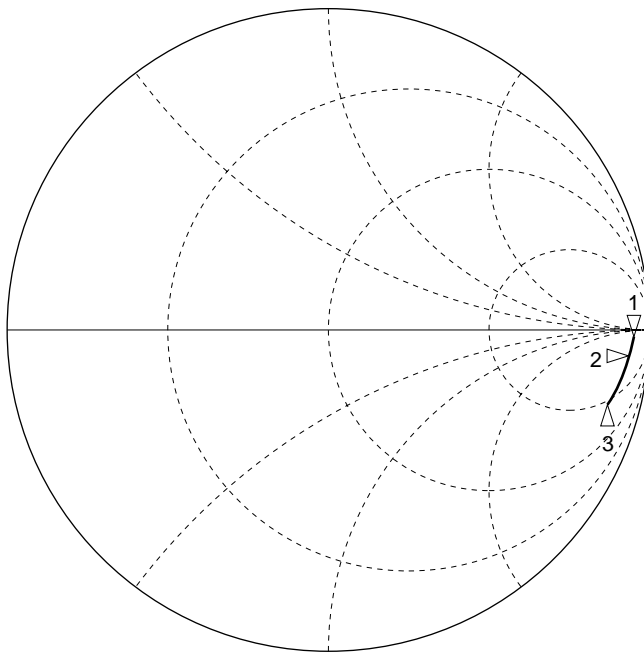


**Note** Output Power = (Output Power at Spectrum Analyzer) + 10 log (1 kΩ/50 Ω)

STANDARD CHARACTERISTICS (T<sub>A</sub> = 25 °C)



**INPUT IMPEDANCE (2 PIN)**

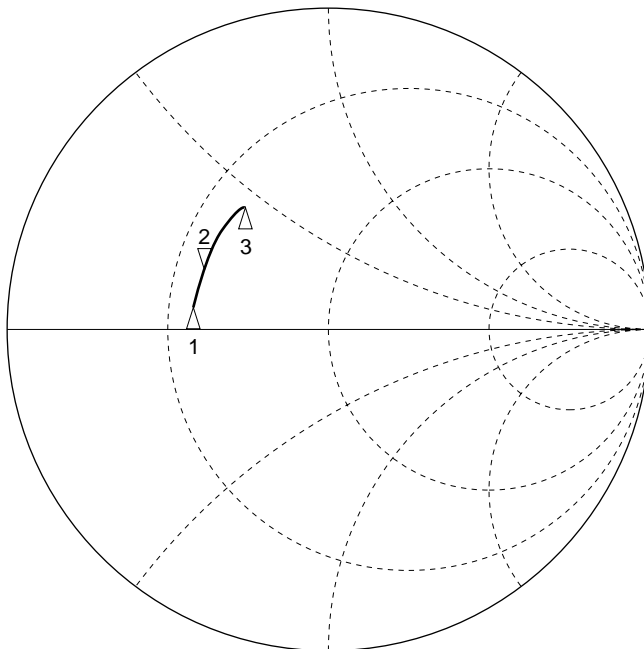


START 0.045000000 GHz  
 STOP 0.250000000 GHz

MARKER		Z <sub>in</sub>
1	45 MHz	938.4 Ω - j604.8 Ω
2	100 MHz	434.7 Ω - j573.8 Ω
3	250 MHz	122.5 Ω - j324.9 Ω

Conditions T<sub>A</sub> = 25°C  
 V<sub>cc1</sub> = 5 V

**OUTPUT IMPEDANCE (20 PIN)**



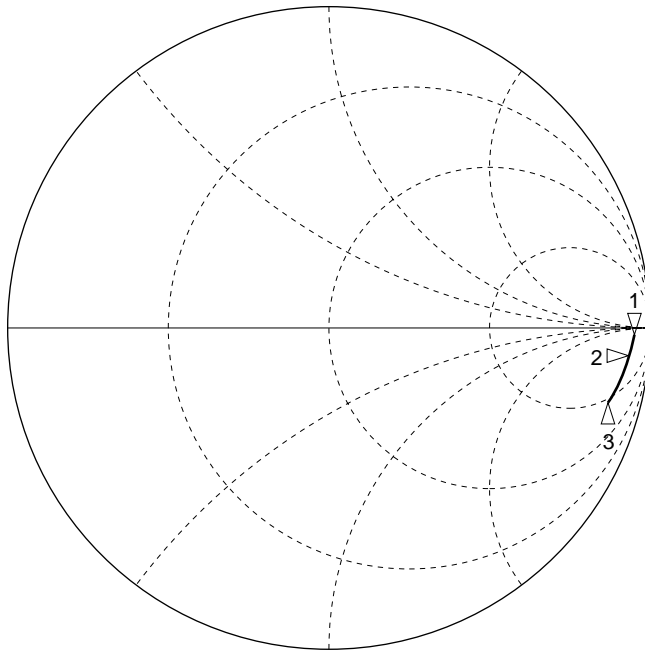
START 0.045000000 GHz  
 STOP 0.250000000 GHz

MARKER		Z <sub>out</sub>
1	45 MHz	19.86 Ω + 3.83 Ω
2	100 MHz	20.28 Ω + 9.26 Ω
3	250 MHz	22.28 Ω + 22.48 Ω

Conditions T<sub>A</sub> = 25°C  
 V<sub>cc1</sub> = 5 V



**INPUT IMPEDANCE (19 PIN)**

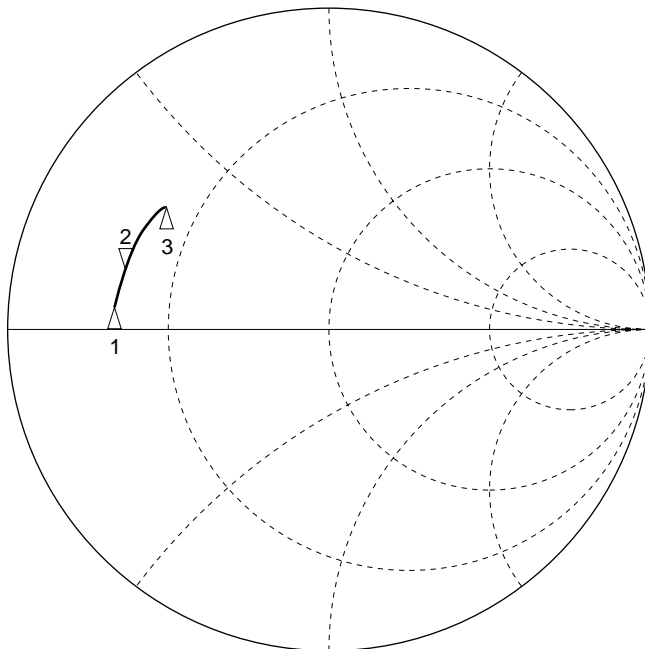


START 0.045000000 GHz  
STOP 0.250000000 GHz

MARKER		Z <sub>in</sub>
1	45 MHz	965.8 Ω - j601.2 Ω
2	100 MHz	446.6 Ω - j661.8 Ω
3	250 MHz	126.8 Ω - j312.4 Ω

Conditions T<sub>A</sub> = 25°C  
V<sub>cc1</sub> = 5 V

**OUTPUT IMPEDANCE (17 PIN)**



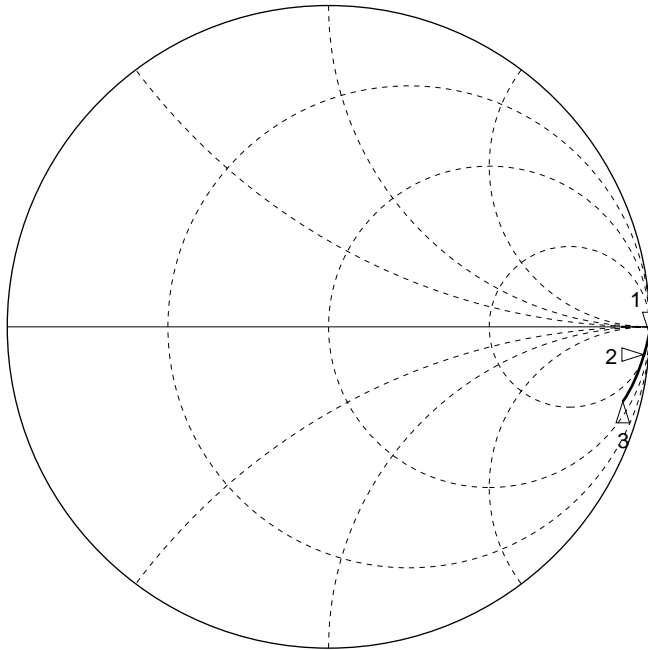
START 0.045000000 GHz  
STOP 0.250000000 GHz

MARKER		Z <sub>out</sub>
1	45 MHz	10.32 Ω + j2.88 Ω
2	100 MHz	10.86 Ω + j6.42 Ω
3	250 MHz	12.67 Ω + j15.39 Ω

Conditions T<sub>A</sub> = 25°C  
V<sub>cc1</sub> = 5 V

**INPUT IMPEDANCE (15 PIN)**

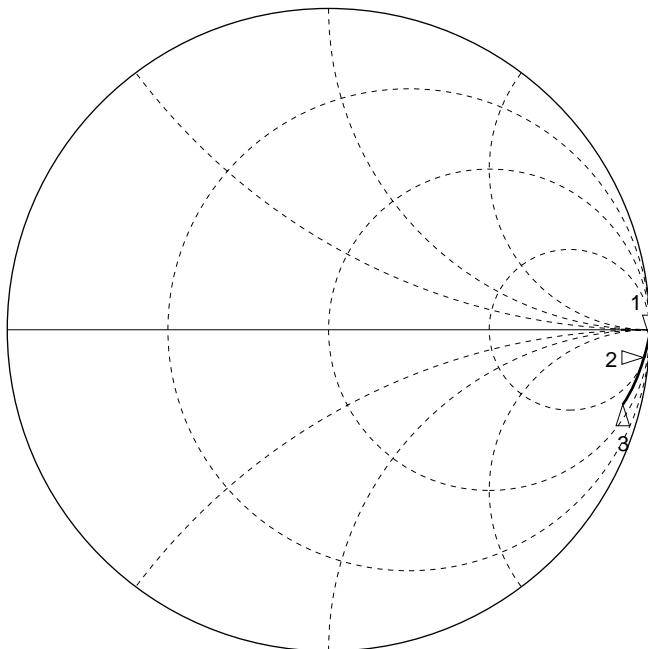
(i)  $T_A = 25^\circ\text{C}$ ,  $V_{CC2} = 5\text{ V}$



MARKER		$Z_{in}$
1	45 MHz	$840.0\ \Omega - j2560\ \Omega$
2	100 MHz	$50.19\ \Omega - j1259\ \Omega$
3	250 MHz	$52.03\ \Omega - j475.6\ \Omega$

START 0.045000000 GHz  
STOP 0.250000000 GHz

(ii)  $T_A = 25^\circ\text{C}$ ,  $V_{CC2} = 9\text{ V}$

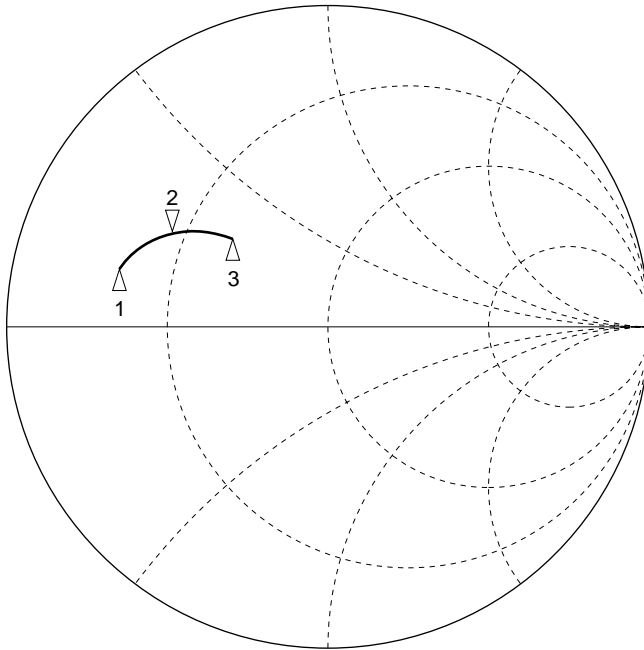


MARKER		$Z_{in}$
1	45 MHz	$478.3\ \Omega - j3091\ \Omega$
2	100 MHz	$106.13\ \Omega - j1368\ \Omega$
3	250 MHz	$55.11\ \Omega - j501.3\ \Omega$

START 0.045000000 GHz  
STOP 0.250000000 GHz

**OUTPUT IMPEDANCE (12 PIN)**

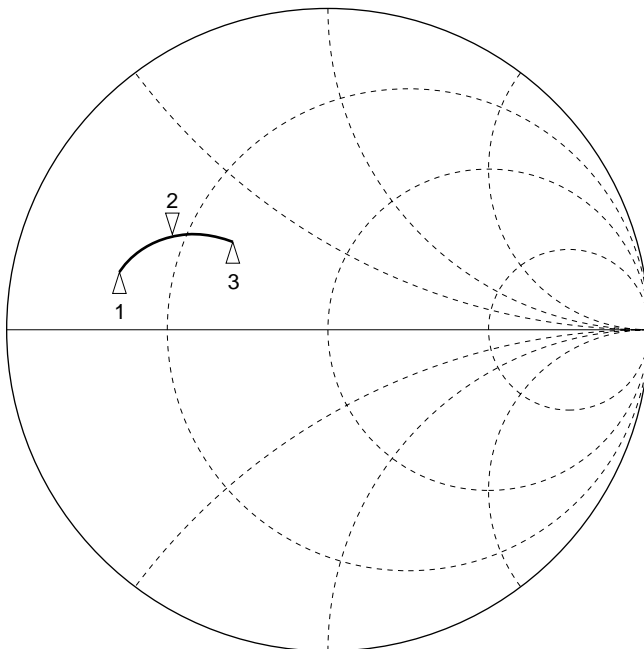
(i)  $T_A = 25^\circ\text{C}$ ,  $V_{cc2} = 5\text{ V}$ , 11 pin is grounded through  $50\ \Omega$  resistor.



START 0.045000000 GHz  
STOP 0.250000000 GHz

MARKER		$Z_{out}$
1	45 MHz	$9.88\ \Omega + j6.25\ \Omega$
2	100 MHz	$14.21\ \Omega + j11.78\ \Omega$
3	250 MHz	$23.64\ \Omega + j15.73\ \Omega$

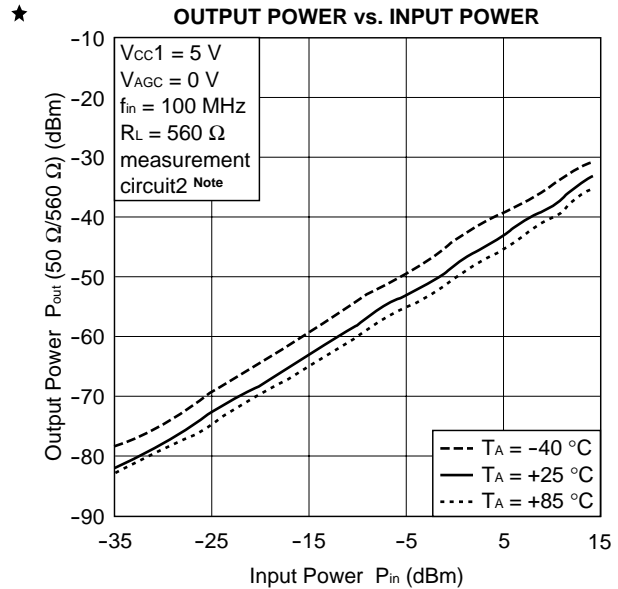
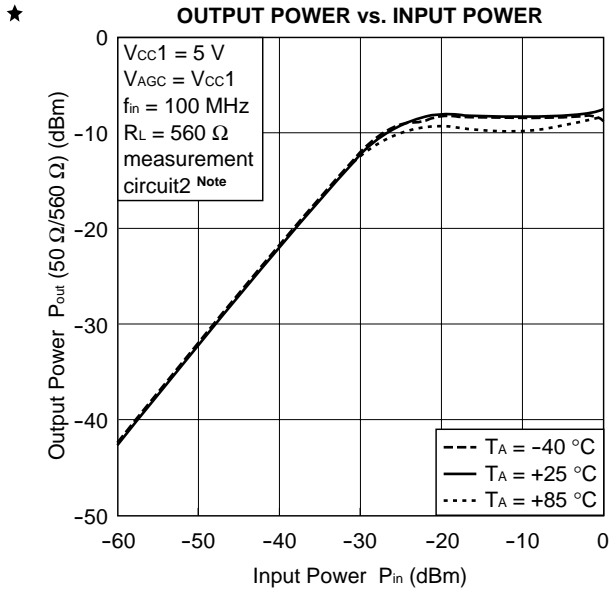
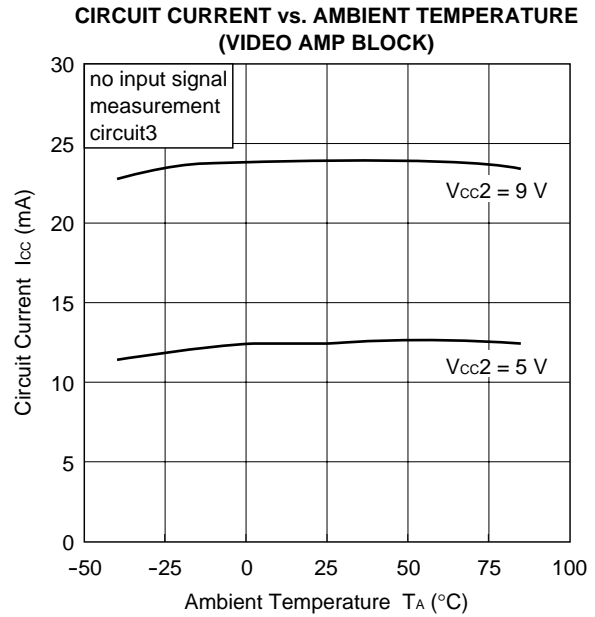
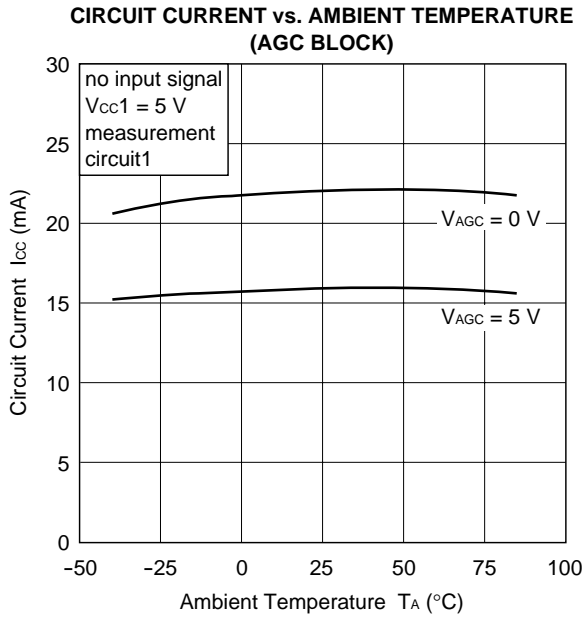
(ii)  $T_A = 25^\circ\text{C}$ ,  $V_{cc2} = 9\text{ V}$ , 11 pin is grounded through  $50\ \Omega$  resistor.



START 0.045000000 GHz  
STOP 0.250000000 GHz

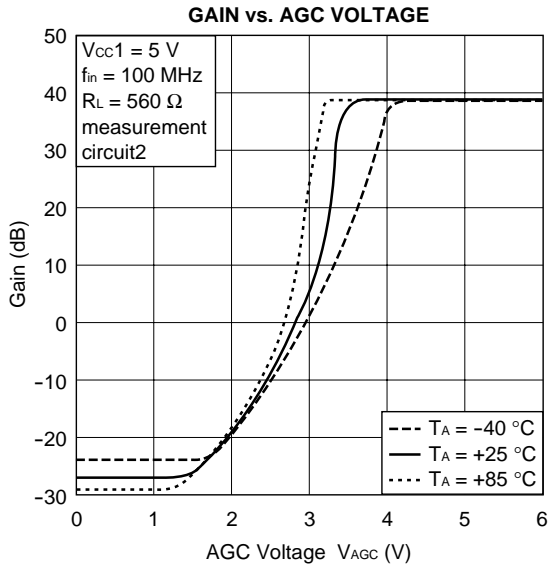
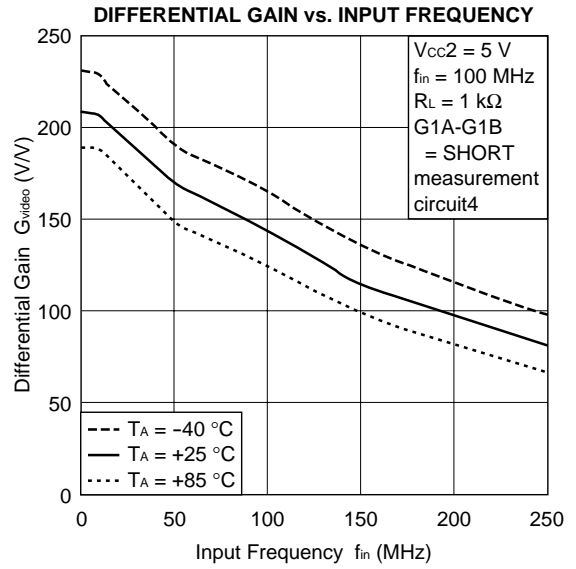
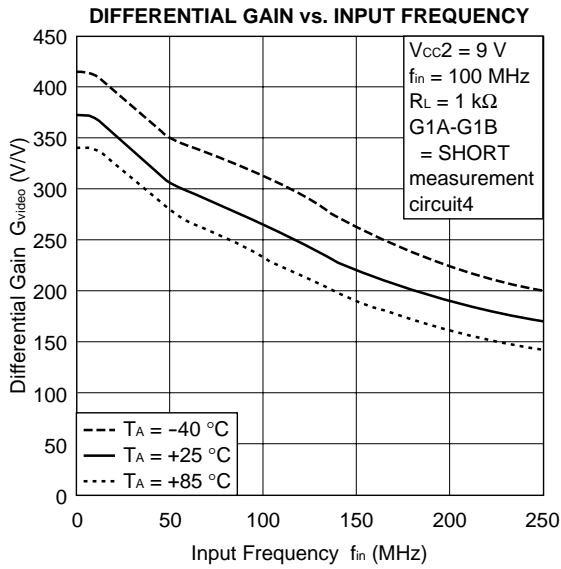
MARKER		$Z_{out}$
1	45 MHz	$7.36\ \Omega + j4.85\ \Omega$
2	100 MHz	$10.50\ \Omega + j9.58\ \Omega$
3	250 MHz	$19.37\ \Omega + j13.70\ \Omega$

**THERMAL CHARACTERISTICS (FOR REFERENCE)**

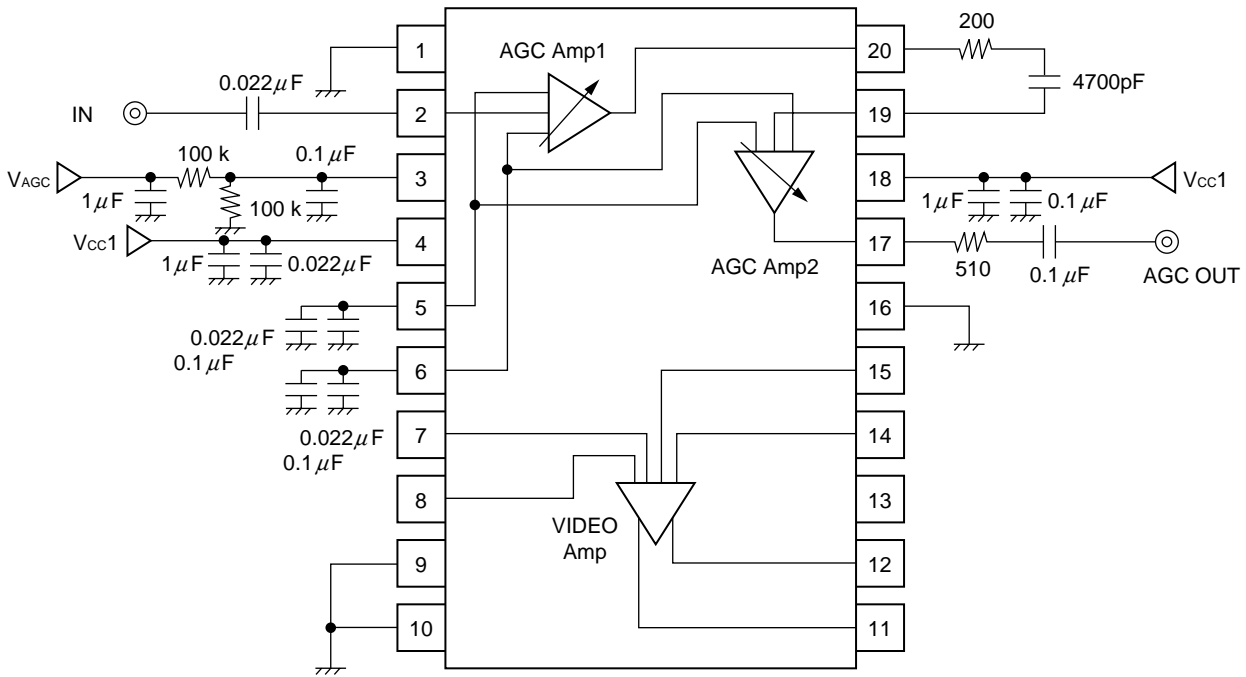


**Note** Output Power = (Output Power at Spectrum Analyzer) + 10 log (560 Ω/50 Ω)

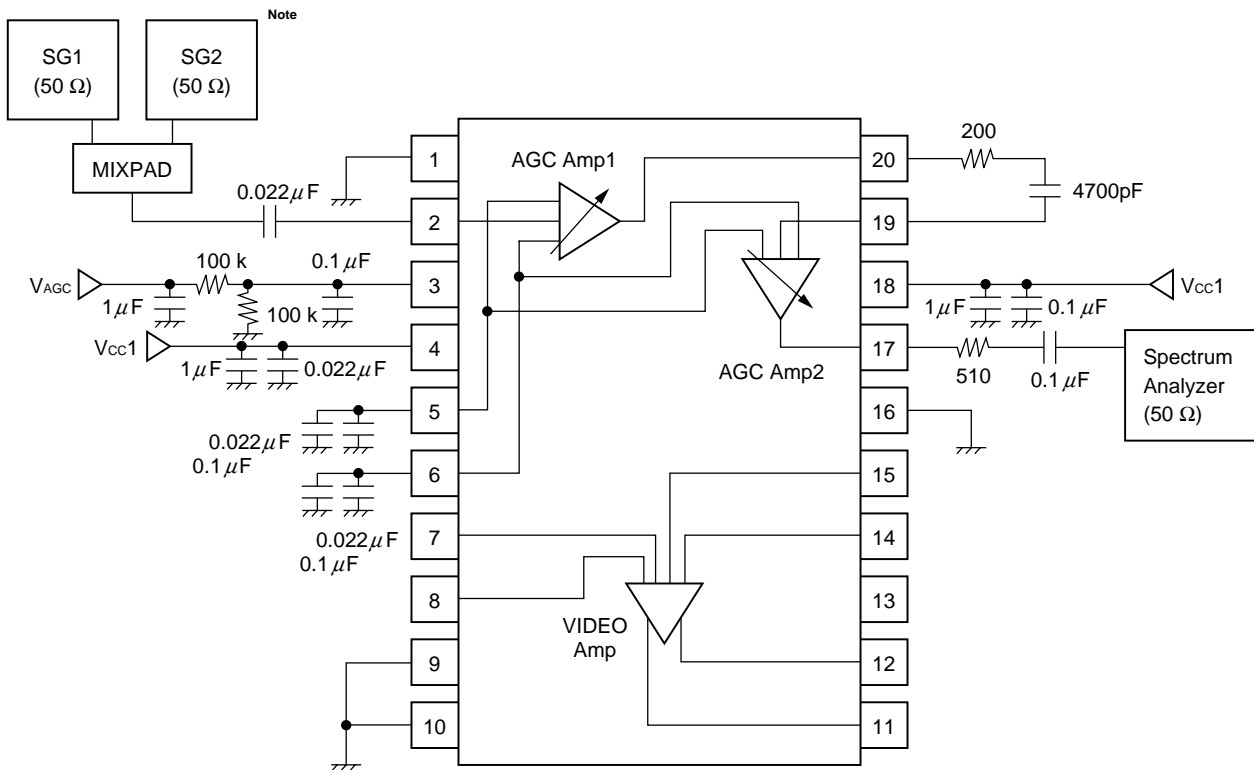
**THERMAL CHARACTERISTICS (FOR REFERENCE)**



MEASUREMENT CIRCUIT 1

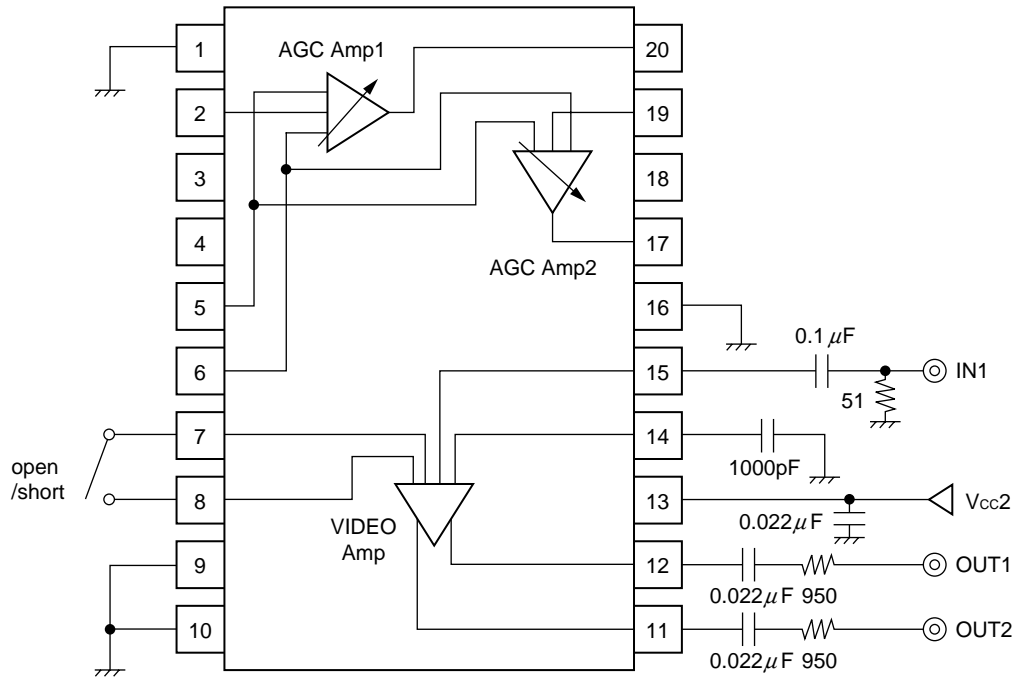


MEASUREMENT CIRCUIT 2

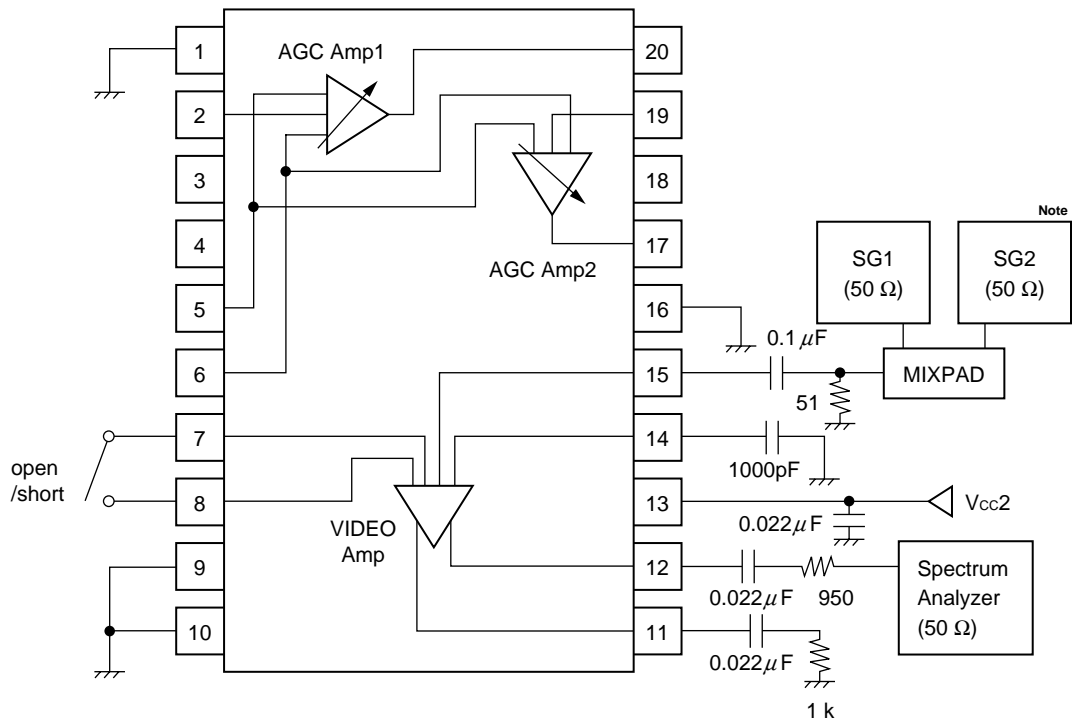


**Note** In the case of measurement of IM<sub>3</sub>

MEASUREMENT CIRCUIT 3

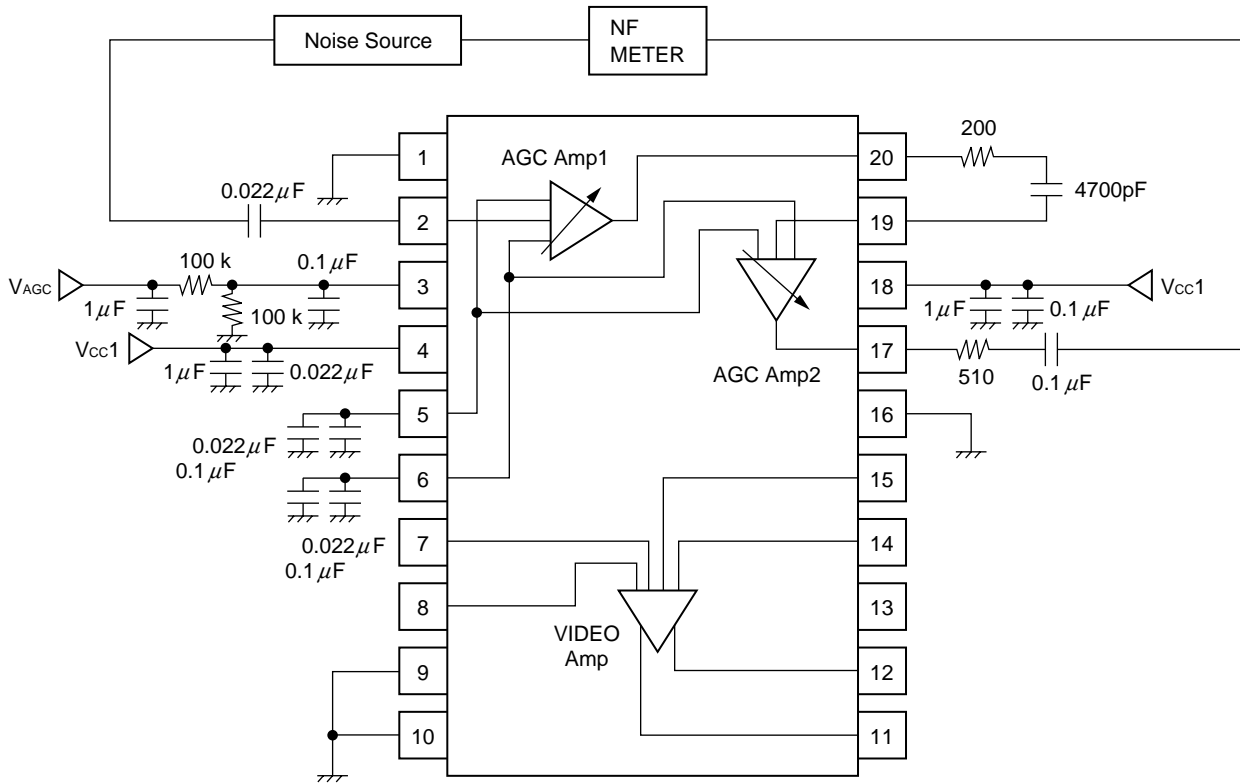


MEASUREMENT CIRCUIT 4

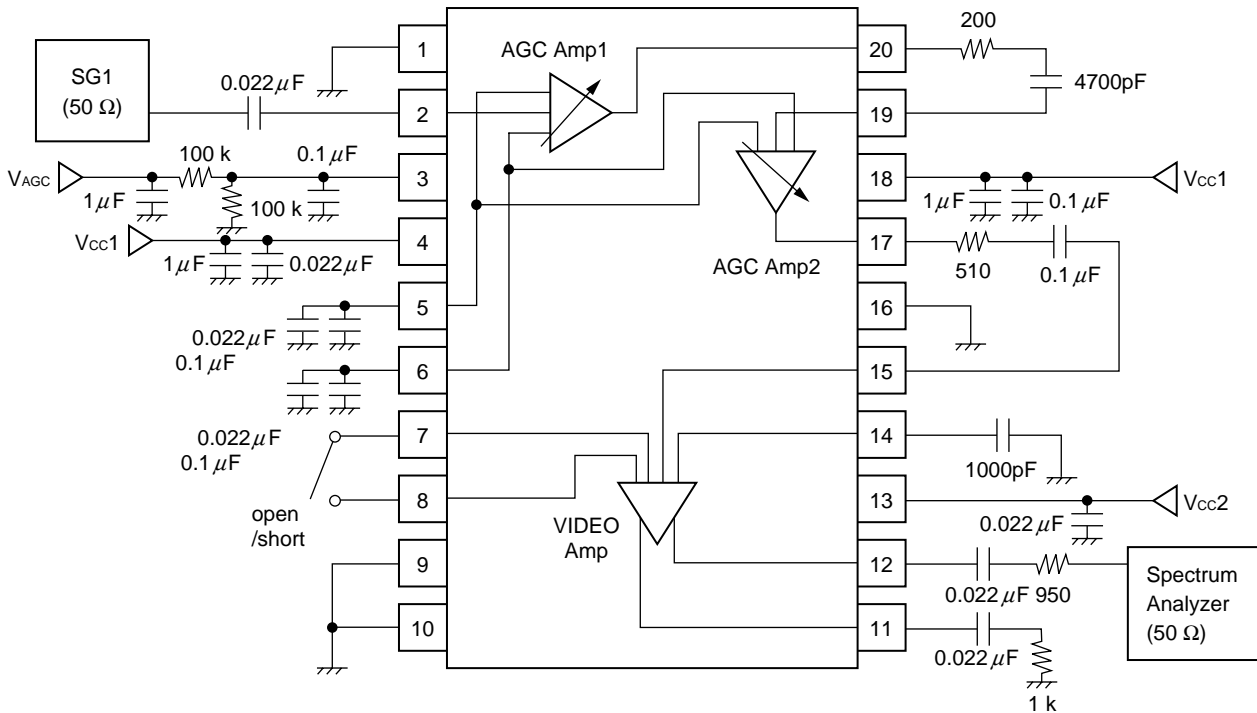


Note In the case of measurement of IM<sub>3</sub>

MEASUREMENT CIRCUIT 5



MEASUREMENT CIRCUIT 6





MEASUREMENT CIRCUIT 7

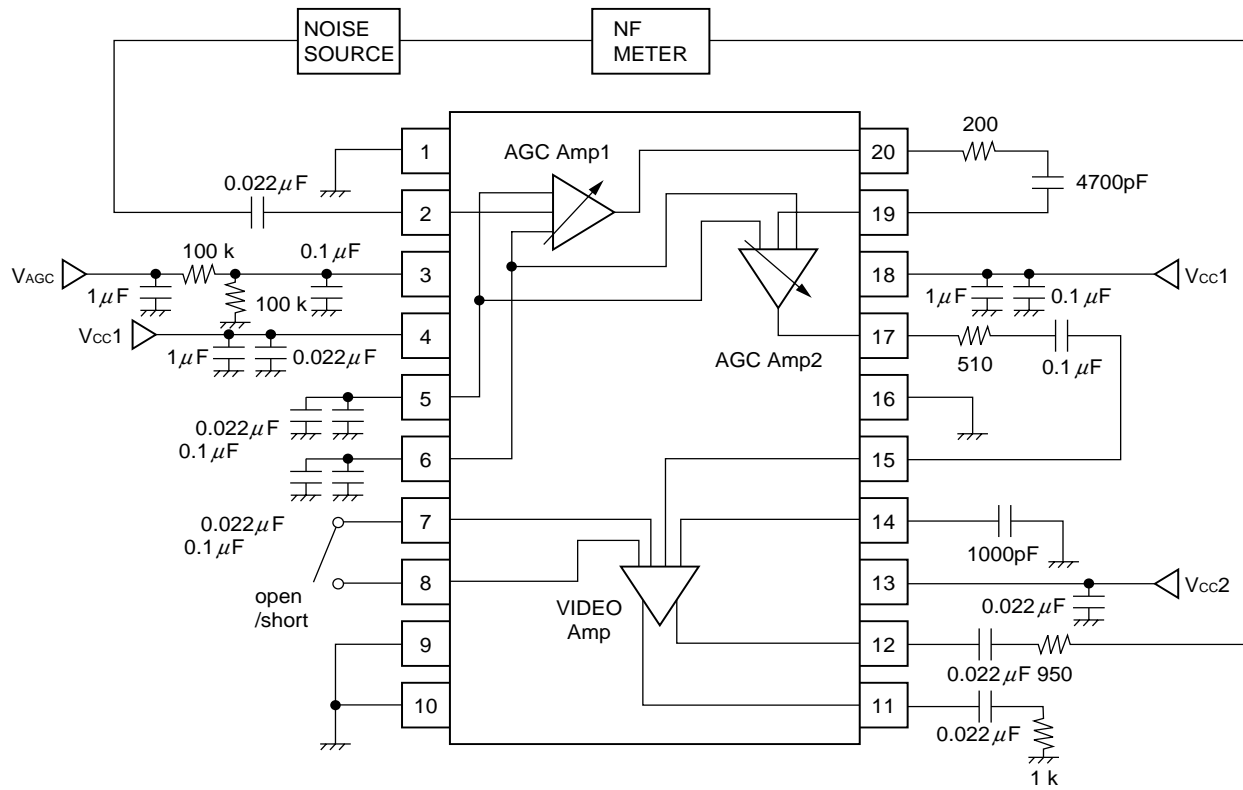
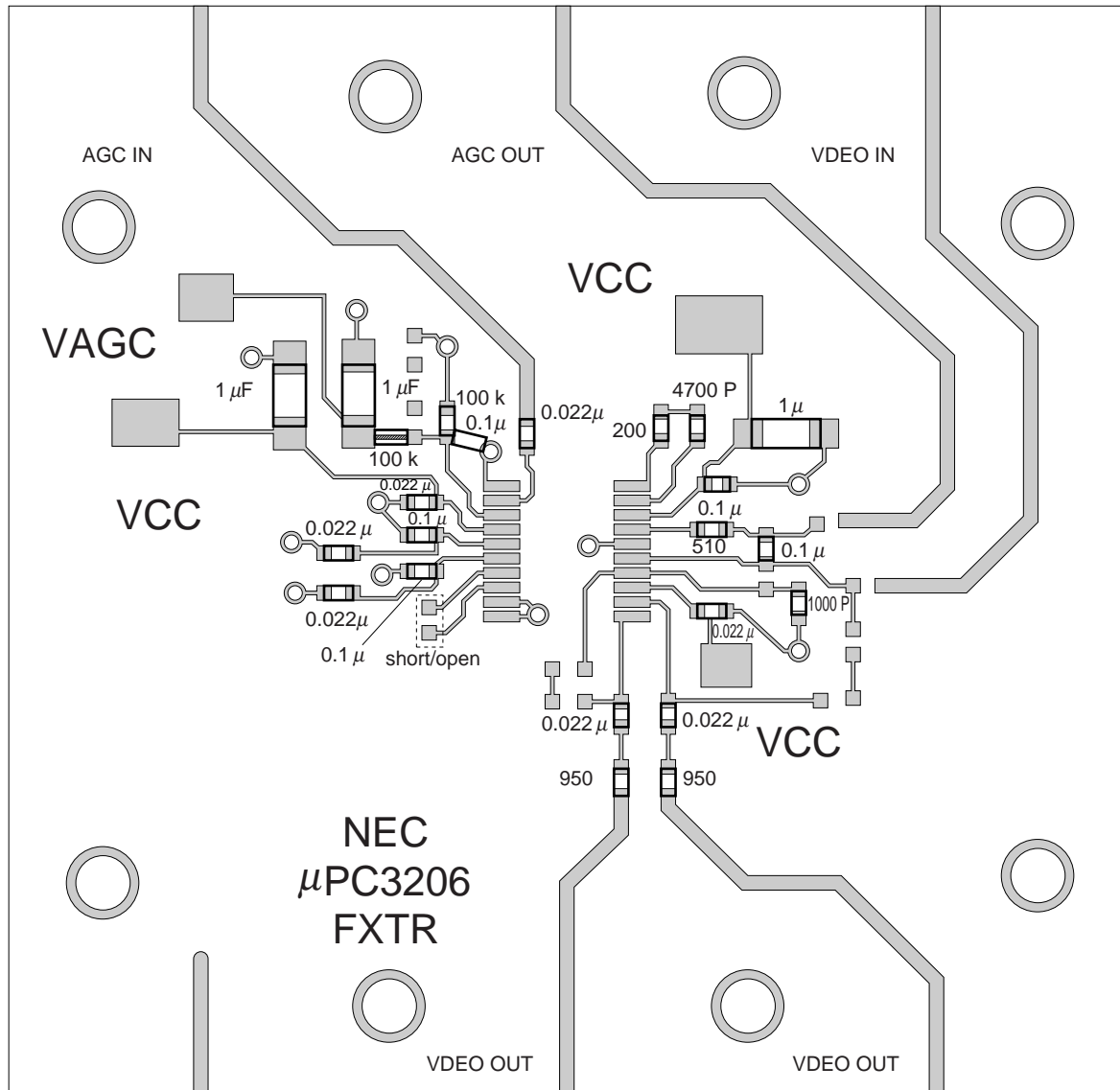


ILLUSTRATION OF THE EVALUATION BOARD FOR MEASUREMENT CIRCUIT6

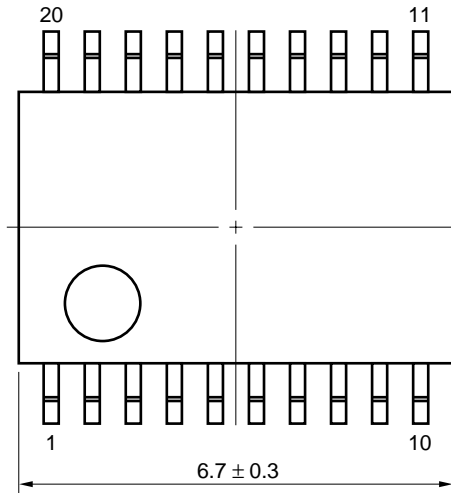


**Notes on evaluation board**

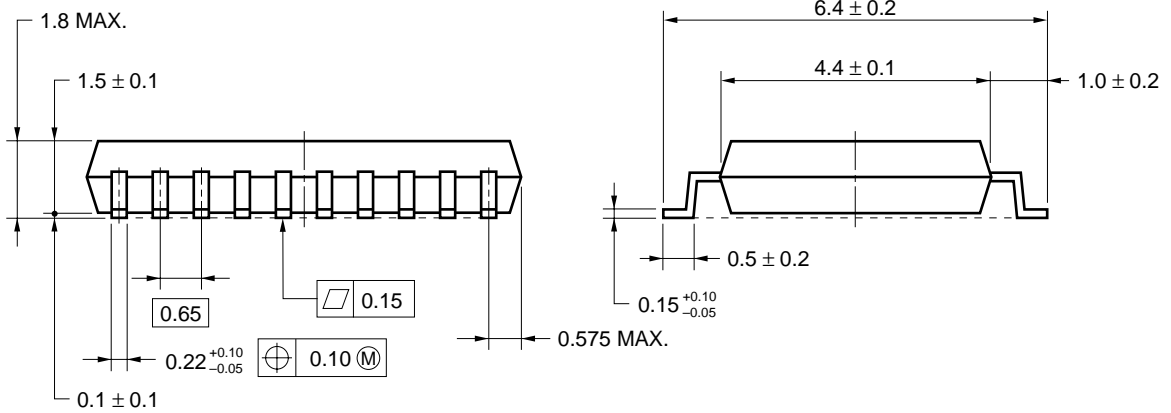
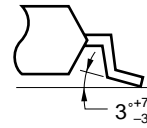
- (1) GND pattern on rear side
- (2) ○ ○: Through hole
- (3) ▨ ▨ ▨: represents cutout

PACKAGE DIMENSIONS

★ 20 PIN PLASTIC SSOP (225 mil) (UNIT: mm)



detail of lead end



**NOTE** Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.

**NOTE 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 undesires osillation).
- (3) Keep the track length of the ground pins as short as possible.
- (4) A low pass filter must be attached to Vcc line.
- (5) A matching circuit must be externally attached to output port.

**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 <sup>Note</sup> : None	IR35-00-3
VPS	Package peak temperature: 215°C or below Time: 40 seconds or less (at 200°C) Count: 3, Exposure limit <sup>Note</sup> : None	VP15-00-3
Partial Heating	Pin temperature: 300°C Time: 3 seconds or less (per side of device) Exposure limit <sup>Note</sup> : None	—

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

[MEMO]

[MEMO]

[MEMO]

- **The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.**
- No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Corporation. NEC Corporation assumes no responsibility for any errors which may appear in this document.
- NEC Corporation does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from use of a device described herein or any other liability arising from use of such device. No license, either express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Corporation or others.
- Descriptions of circuits, software, and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software, and information in the design of the customer's equipment shall be done under the full responsibility of the customer. NEC Corporation assumes no responsibility for any losses incurred by the customer or third parties arising from the use of these circuits, software, and information.
- While NEC Corporation has been making continuous effort to enhance the reliability of its semiconductor devices, the possibility of defects cannot be eliminated entirely. To minimize risks of damage or injury to persons or property arising from a defect in an NEC semiconductor device, customers must incorporate sufficient safety measures in its design, such as redundancy, fire-containment, and anti-failure features.
- NEC devices are classified into the following three quality grades:  
"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.
  - Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots
  - 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)
  - Specific: Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.