



BIPOLAR ANALOG INTEGRATED CIRCUIT

μ PC3220GR

LOW DISTORTION DOWN-CONVERTER IC FOR DIGITAL CATV

DESCRIPTION

The μ PC3220GR is a silicon monolithic IC designed for use as IF down-converter for digital CATV. This IC consists of AGC amplifier, mixer and video amplifier.

The package is 16-pin SSOP (Shrink Small Outline Package) suitable for surface mount.

This IC is manufactured using our 10 GHz f_T NESAT II AL silicon bipolar process.

This process uses silicon nitride passivation film. This material can protect chip surface from external pollution and prevent corrosion/migration. Thus, this IC has excellent performance, uniformly and reliability.

FEATURES

- Low distortion $IIP_3 = +1.0$ dBm TYP.
- Wide AGC dynamic range $GCR_{total} = 45.5$ dB TYP.
- On chip video amplifier
- Supply voltage : 5 V
- Packaged in 16-pin SSOP suitable for high-density surface mounting

APPLICATION

- Digital CATV receivers

ORDERING INFORMATION

Part Number	Order Number	Package	Marking	Supplying Form
μ PC3220GR-E1	μ PC3220GR-E1-A	16-pin plastic SSOP (5.72 mm (225)) (Pb-Free)	C3220	<ul style="list-style-type: none">• Embossed tape 12 mm wide• Pin 1 indicates pull-out direction of tape• Qty 2.5 kpcs/reel

Remark To order evaluation samples, contact your nearby sales office.

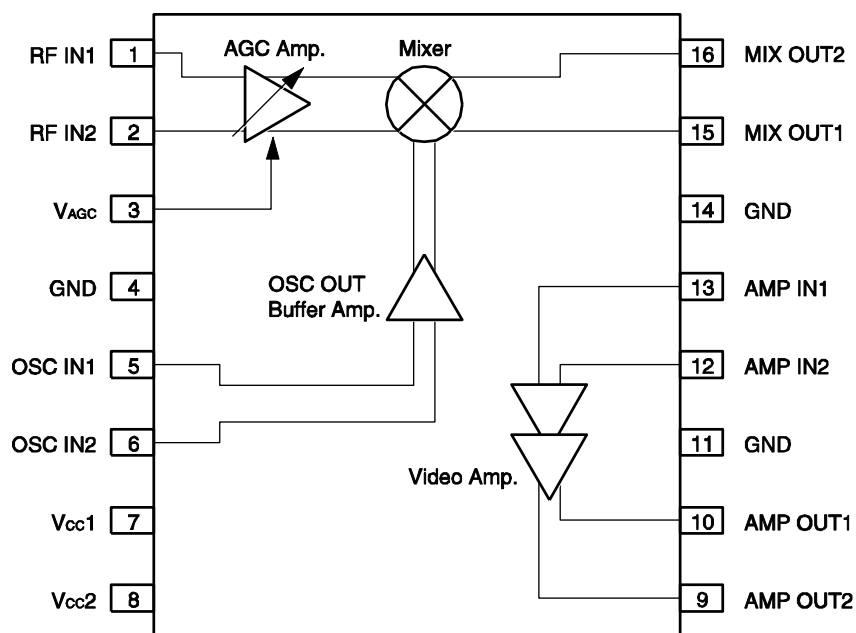
Part number for sample order: μ PC3220GR-A

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

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

INTERNAL BLOCK DIAGRAM AND PIN CONFIGURATION

(Top View)



PIN EXPLANATIONS

PIN No.	Symbol	Pin Voltage (V, TYP.)	Explanation	Equivalent Circuit
1	RF IN1	1.46	Input pin of IF signal. 1-pin is same phase and 2-pin is opposite phase at balance input. In case of single input, 1-pin or 2-pin should be grounded through capacitor (example 10 nF).	
2	RF IN2	1.46		
3	V _{AGC}	0 to 3.5	Automatic gain control pin. This pins bias govern the AGC output level. Minimum gain at V _{AGC} = 0 V Maximum gain at V _{AGC} = 3.5 V	
4	GND	0.0	Ground pin. Must be connected to the system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible.	
5	OSC IN1	2.6	Input pin of Oscillator signal. 5-pin is same phase and 6-pin is opposite phase at balance input. In case of single input, 5-pin or 6-pin should be grounded through capacitor (ex. 10 nF).	
6	OSC IN2	2.6		
7	V _{CC1}	5.0	Power supply pin of IF down convertor block. Must be connected bypass capacitor to minimize ground impedance.	
8	V _{CC2}	5.0	Power supply pin of video amplifier. Must be connected bypass capacitor to minimize ground impedance.	

PIN No.	Symbol	Pin Voltage (V, TYP.)	Explanation	Equivalent Circuit
9	AMP OUT2	2.5	Output pin of video amplifier. OUT1 and IN1 are same phase. OUT2 and IN2 are same phase.	
10	AMP OUT1	2.5		
11	GND	0.0	Ground pin. Must be connected to the system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible.	
12	AMP IN2	1.45	Signal input pin of video amplifier. This pin is high impedance.	
13	AMP IN1	1.45		
14	GND	0.0	Ground pin. Must be connected to the system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible.	
15	MIX OUT1	3.7	Output pin of mixer. This output pin features low-impedance because of its emitter-follower output port.	
16	MIX OUT2	3.7		

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V _{CC}	T _A = +25°C	6.0	V
Power Dissipation	P _D	T _A = +85°C Note	433	mW
Operating Ambient Temperature	T _A		–40 to +85	°C
Storage Temperature	T _{stg}		–55 to +150	°C

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

RECOMMENDED OPERATING RANGE

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply Voltage	V _{CC}		4.5	5.0	5.5	V
Operating Ambient Temperature	T _A	V _{CC} = 4.5 to 5.5 V	–40	+25	+85	°C
Gain Control Voltage Range	V _{AGC}		0	–	V _{CC}	V

ELECTRICAL CHARACTERISTICS ($T_A = +25^\circ\text{C}$, $V_{CC} = 5\text{ V}$)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
DC Characteristics						
Circuit Current 1 (Total Block)	I_{CC1}	No input signal, $V_{CC1} = V_{CC2} = 5\text{ V}$ Note 4	33.0	42.0	53.5	mA
Circuit Current 2 (AGC Amplifier Block + Mixer Block)	I_{CC2}	No input signal, $V_{CC1} = 5\text{ V}$ Note 4	15.0	20.0	25.5	mA
Circuit Current 3 (Video Amplifier Block)	I_{CC3}	No input signal, $V_{CC2} = 5\text{ V}$ Note 4	18.0	22.0	28.0	mA
AGC Voltage High Level	$V_{AGC(H)}$	@ Maximum gain Note 1	3.0	–	V_{CC}	V
AGC Voltage Low Level	$V_{AGC(L)}$	@ Minimum gain Note 1	0	–	0.5	V
RF Characteristics (AGC Amplifier Block + Mixer Block: $f_{RF} = 84\text{ MHz}$, $f_{LO} = 134\text{ MHz}$, $P_{LO} = -15\text{ dBm}$, $f_{IF} = 50\text{ MHz}$, $Z_S = 50\ \Omega$, $Z_L = 1\text{ k}\Omega$)						
RF Input Frequency Range	f_{RF}	$f_{IF} = 50\text{ MHz}$ constant Note 1	30	–	250	MHz
IF Output Frequency Range	f_{IF}	$f_{RF} = 84\text{ MHz}$ constant Note 1	0.1	–	150	MHz
Maximum Conversion Gain	CG_{MAX}	$V_{AGC} = 3.0\text{ V}$, $P_{in} = -50\text{ dBm}$ Note 1	30.5	33.0	35.5	dB
Minimum Conversion Gain	CG_{MIN}	$V_{AGC} = 0.5\text{ V}$, $P_{in} = -20\text{ dBm}$ Note 1	-18.0	-12.5	-3.5	dB
AGC Dynamic Range	GCR_{AGC}	$V_{AGC} = 0.5\text{ to }3.0\text{ V}$ Note 1	36.0	45.5	–	dB
Noise Figure	NF	DSB, $V_{AGC} = 3.0\text{ V}$ (@ Maximum gain) Note 2	–	7.0	8.5	dB
3rd Order Intermodulation Distortion	IM_3	$V_{out} = 0.236 V_{p-p} \times 2\text{ tone}$, (single-ended output), $P_{in} = -30\text{ dBm/tone}$ $f_{RF1} = 84\text{ MHz}$, $f_{RF2} = 85\text{ MHz}$ Note 1	24.0	26.5	–	dBc
RF Characteristics (Video Amplifier Block: $f = 50\text{ MHz}$, $Z_S = 50\ \Omega$, $Z_L = 1\text{ k}\Omega$)						
Differential Gain	G_{diff}	$P_{in} = -55\text{ dBm}$ Note 3	48.0	50.5	53.5	dB
Maximum Output Voltage 2	V_{oclip2}	$P_{in} = -25\text{ dBm}$ Note 3	2.95	3.70	–	V_{p-p}

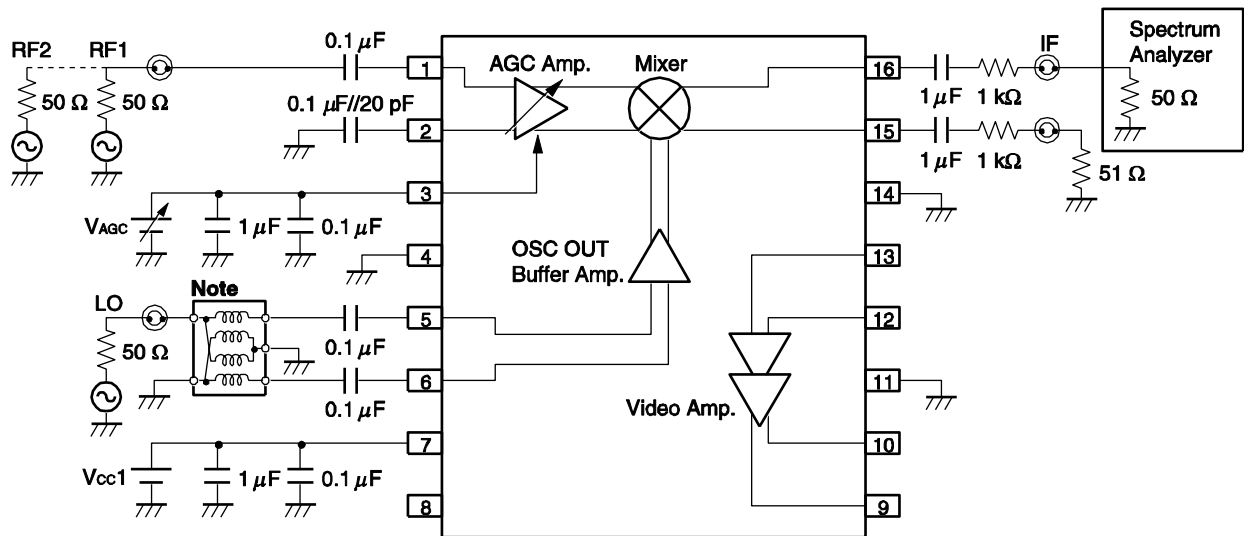
- Notes**
1. By measurement circuit 1
 2. By measurement circuit 2
 3. By measurement circuit 4
 4. By measurement circuit 6

STANDARD CHARACTERISTICS ($T_A = +25^\circ\text{C}$, $V_{CC} = 5\text{ V}$, $Z_S = 50\ \Omega$)

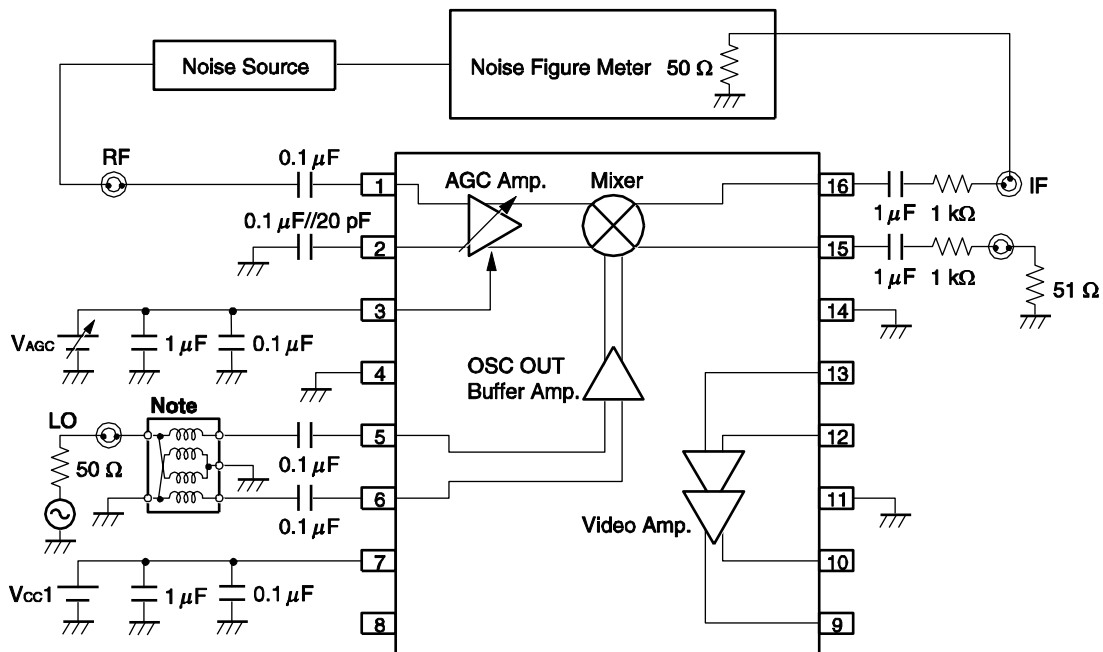
Parameter	Symbol	Test Conditions	Reference Value	Unit
AGC Amplifier Block + Mixer Block ($f_{RF} = 84\text{ MHz}$, $f_{LO} = 134\text{ MHz}$, $P_{LO} = -15\text{ dBm}$, $f_{IF} = 50\text{ MHz}$, $Z_S = 50\ \Omega$, $Z_L = 1\text{ k}\Omega$)				
Input 3rd Order Distortion Intercept Point	IIP ₃	$V_{AGC} = 0.5\text{ V}$ (@ Minimum gain) $f_{RF1} = 84\text{ MHz}$, $f_{RF2} = 85\text{ MHz}$ Note 1	+1.0	dBm
Maximum Output Voltage ¹	V_{oclip1}	$V_{AGC} = 3.0\text{ V}$, $P_{in} = -20\text{ dBm}$ Note 1	0.65	V_{p-p}
RF IN Impedance	Z_{RFin}	$V_{AGC} = 3.0\text{ V}$, $f = 84\text{ MHz}$ Note 2	$440 - j1100$	Ω
OSC IN Impedance	Z_{OSCin}	$V_{AGC} = 3.0\text{ V}$, $f = 134\text{ MHz}$ Note 2	$280 - j810$	Ω
MIXER OUT Impedance	Z_{MIXout}	$V_{AGC} = 3.0\text{ V}$, $f = 50\text{ MHz}$ Note 2	$30.2 + j2.5$	Ω
Video Amplifier Block ($f = 50\text{ MHz}$, $Z_S = 50\ \Omega$, $Z_L = 1\text{ k}\Omega$)				
Frequency Range	f_{BW}	$P_{in} = -55\text{ dBm}$, $G(f = 10\text{ MHz}) -1\text{ dB}$ Note 3	60	MHz
Input Impedance	Z_{AMPin}	$f = 50\text{ MHz}$ Note 4	$330 - j480$	Ω
Output Impedance	Z_{AMPout}	$f = 50\text{ MHz}$ Note 4	$21.9 + j22.6$	Ω
3rd Order Intermodulaion Distortion	IM ₃	$V_{out} = 0.7 V_{p-p} \times 2\text{ tone}$, $f_{in1} = 49\text{ MHz}$, $f_{in2} = 50\text{ MHz}$ Note 3	55.0	dBc
Total Block ($f_{RF} = 84\text{ MHz}$, $f_{LO} = 134\text{ MHz}$, $P_{LO} = -15\text{ dBm}$, $f_{IF} = 50\text{ MHz}$, $Z_S = 50\ \Omega$, $Z_L = 1\text{ k}\Omega$)				
Maximum Conversion Gain	CG _{MAX}	$V_{AGC} = 3.0\text{ V}$, $P_{in} = -70\text{ dBm}$ Note 5	67.5	dB
Minimum Conversion Gain	CG _{MIN}	$V_{AGC} = 0.5\text{ V}$, $P_{in} = -40\text{ dBm}$ Note 5	22.0	dB
Total Dynamic Range	GCR	$V_{AGC} = 0.5\text{ to }3.0\text{ V}$ Note 5	45.5	dB
Noise Figure	NF	DSB, $V_{AGC} = 3.0\text{ V}$ (@ Maximum gain) Note 6	7.0	dB
Maximum Output Voltage	V_{oclip}	$V_{AGC} = 3.0\text{ V}$ (@ Minimum gain) Note 5	3.7	V_{p-p}
Input 3rd Order Distortion Intercept Point	IIP _{3total}	$V_{AGC} = 0.5\text{ V}$ (@ Minimum gain) $f_{RF1} = 84\text{ MHz}$, $f_{RF2} = 85\text{ MHz}$ Note 5	+1.0	dBm
3rd Order Intermodulaion Distortion	IM _{3total}	$V_{out} = 0.7 V_{p-p} \times 2\text{ tone}$, $P_{in} -40\text{ dBm/tone}$ $f_{RF1} = 84\text{ MHz}$, $f_{RF2} = 85\text{ MHz}$ Note 5	51.0	dBc

- Notes**
1. By measurement circuit 1
 2. By measurement circuit 3
 3. By measurement circuit 4
 4. By measurement circuit 5
 5. By measurement circuit 6
 6. By measurement circuit 7

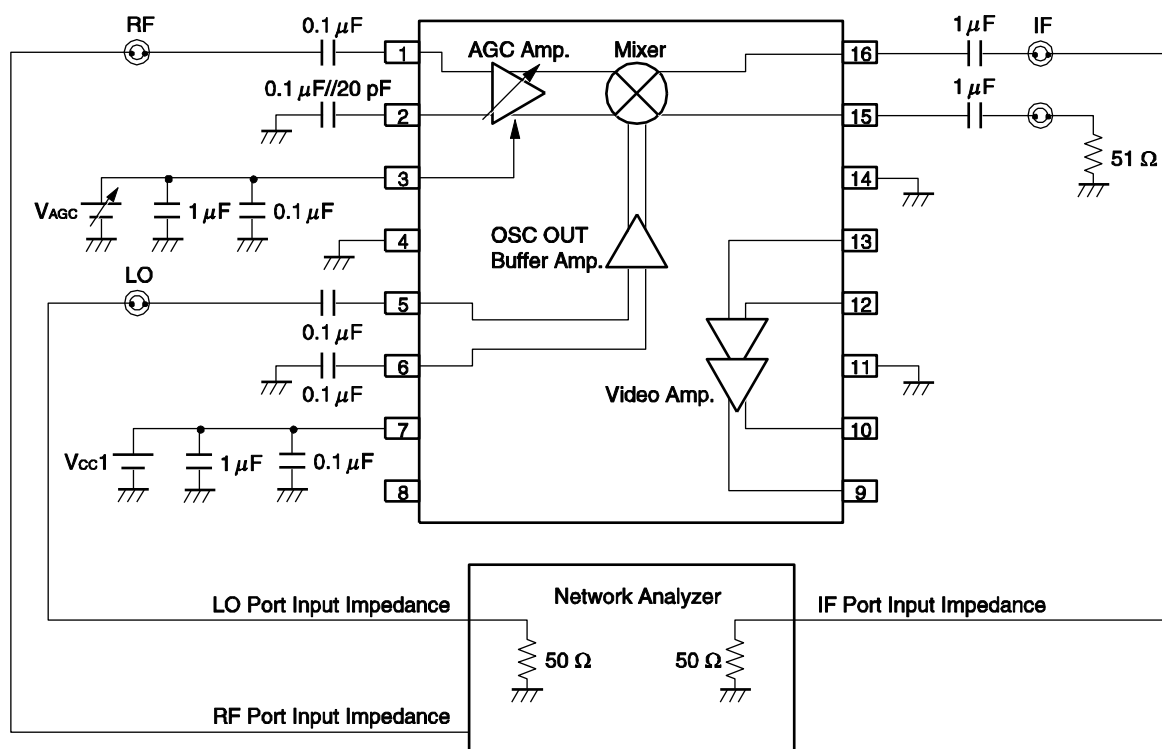
MEASUREMENT CIRCUIT 1



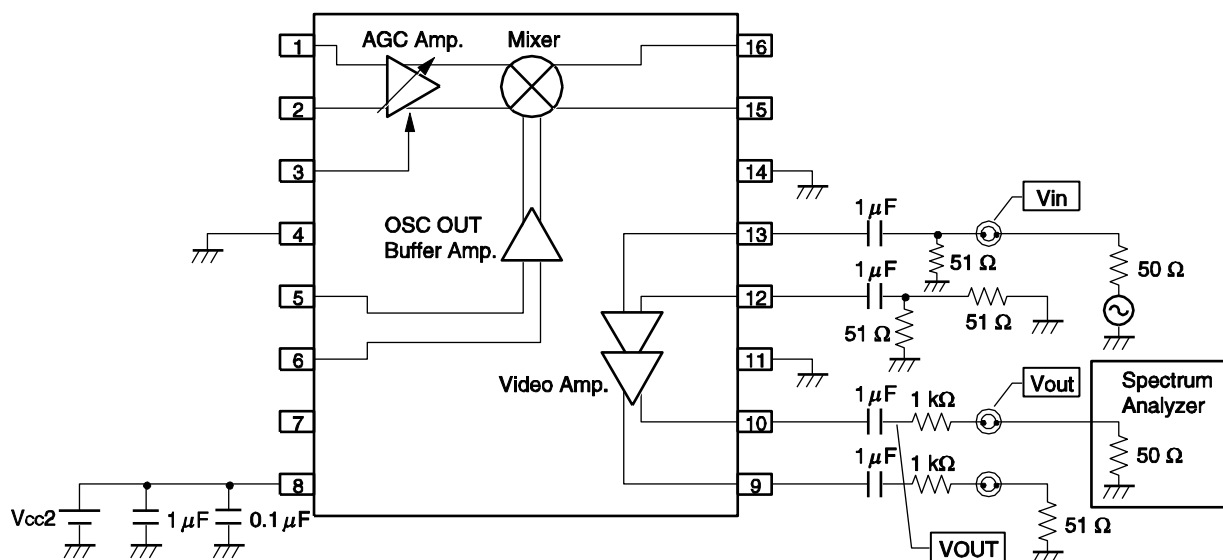
MEASUREMENT CIRCUIT 2



MEASUREMENT CIRCUIT 3

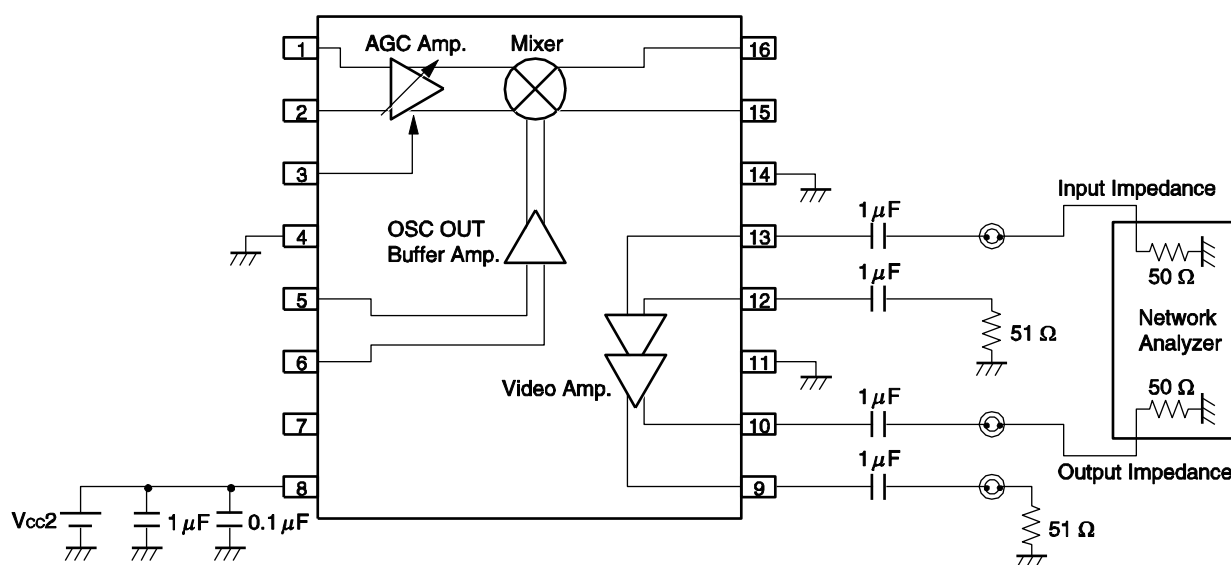


MEASUREMENT CIRCUIT 4

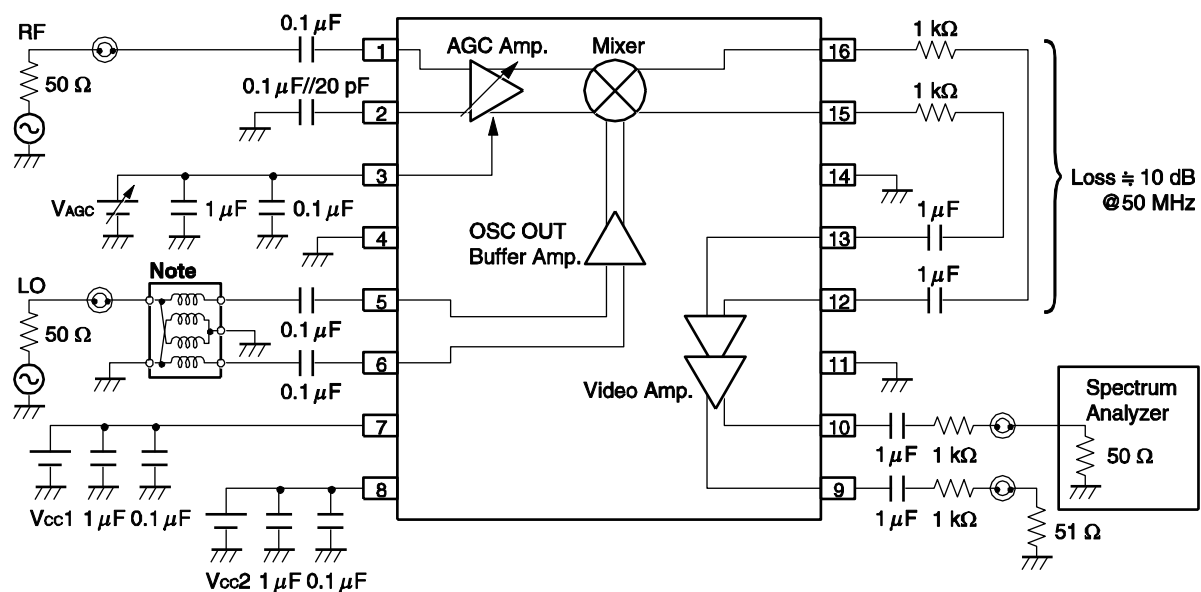


- Remarks**
1. Voltage Gain (Single Ended) = $20 \log (V_{OUT}/V_{in})$ (dB)
 2. Differential Gain (Differential-out) = $20 \log (2 \times V_{OUT}/V_{in})$ (dB)
 3. $V_{OUT} = V_{out} \text{ (Measured Value)} \times (1.050/50)$

MEASUREMENT CIRCUIT 5

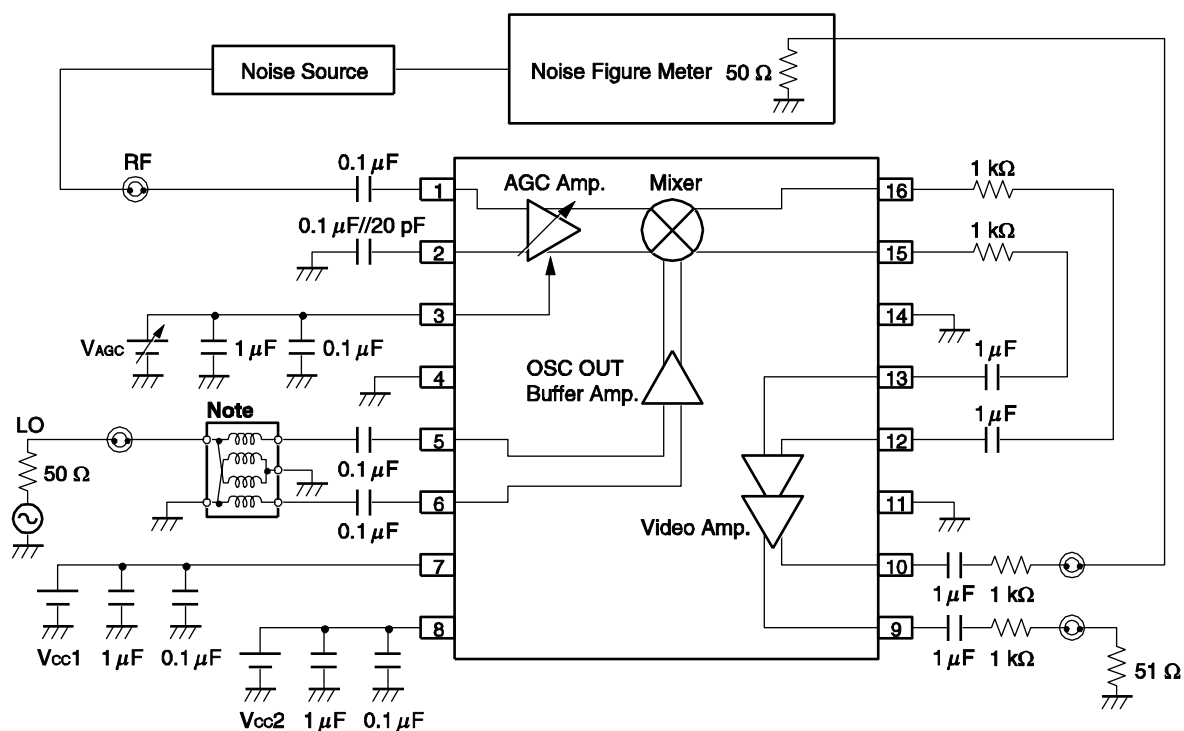


MEASUREMENT CIRCUIT 6



Note Balun Transformer : TOKO 617DB-1010 B4F (Double balanced type)

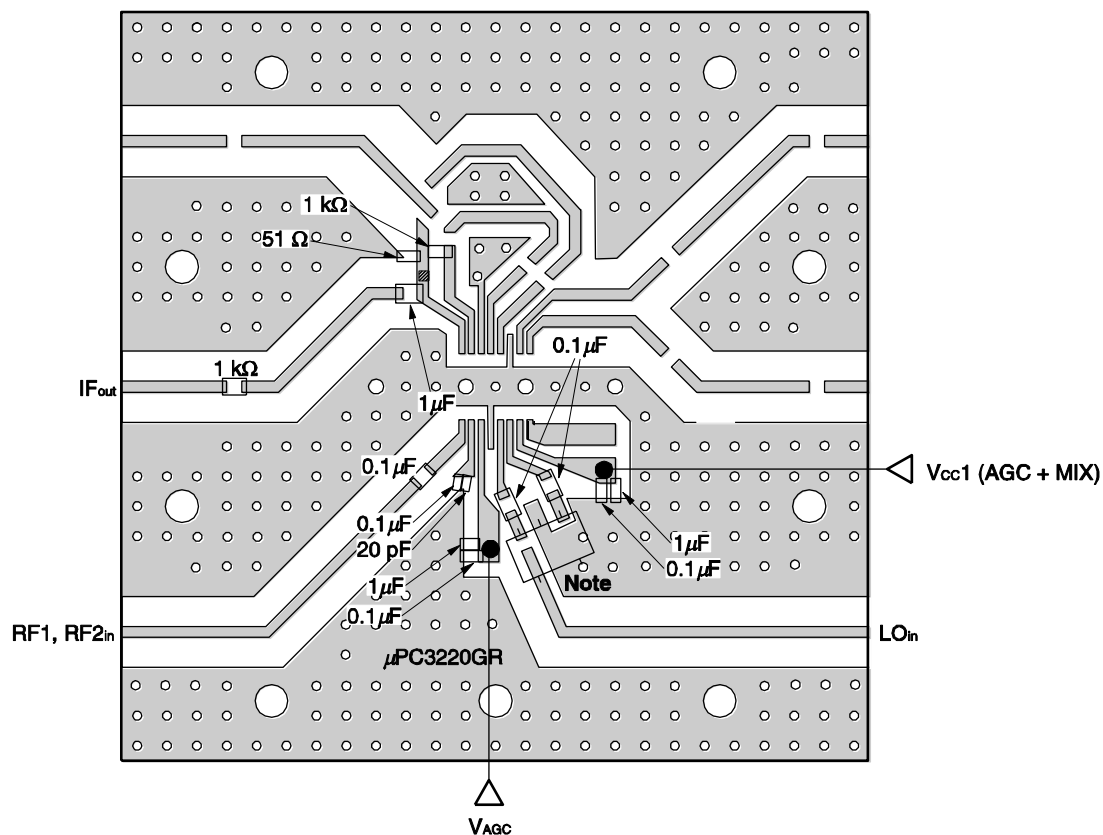
MEASUREMENT CIRCUIT 7



Note Balun Transformer : TOKO 617DB-1010 B4F (Double balanced type)

The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

ILLUSTRATION OF THE MEASUREMENT CIRCUIT1,2 ASSEMBLED ON EVALUATION BOARD

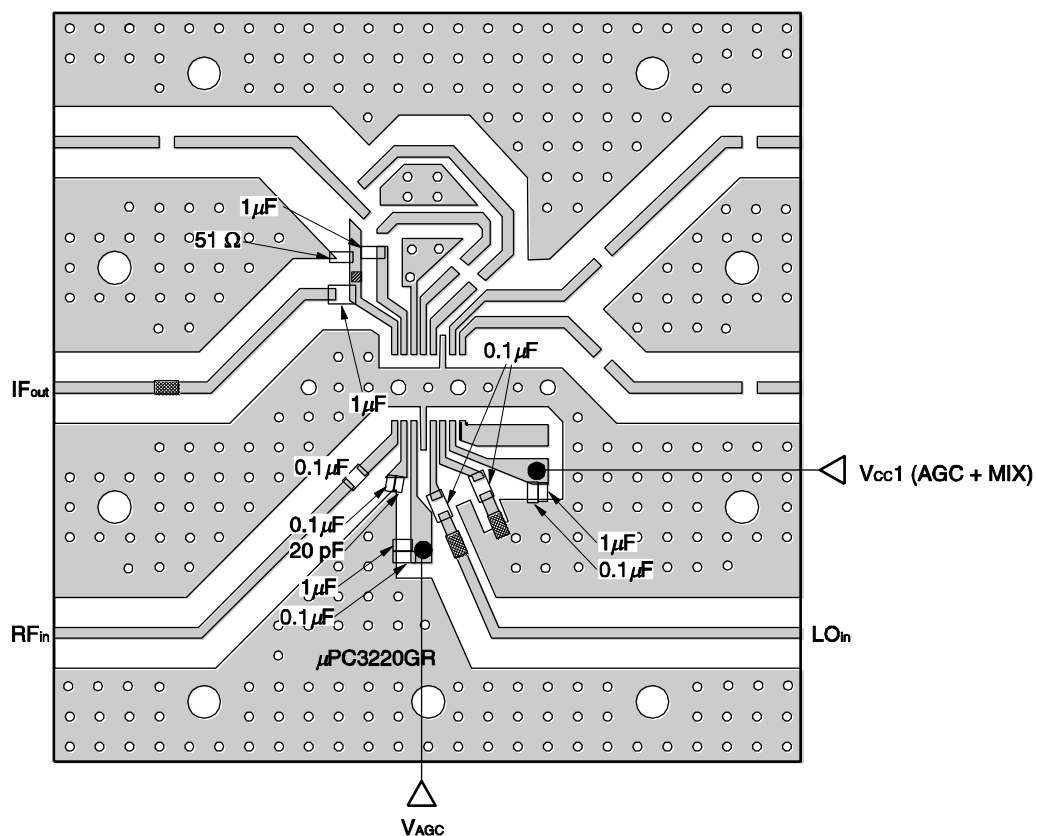


Note Balun Transformer

Remarks

1. Back side: GND pattern
2. Solder plated on pattern
3. \circ : Through hole
4. : Represents cutout

ILLUSTRATION OF THE MEASUREMENT CIRCUIT3 ASSEMBLED ON EVALUATION BOARD



Remarks



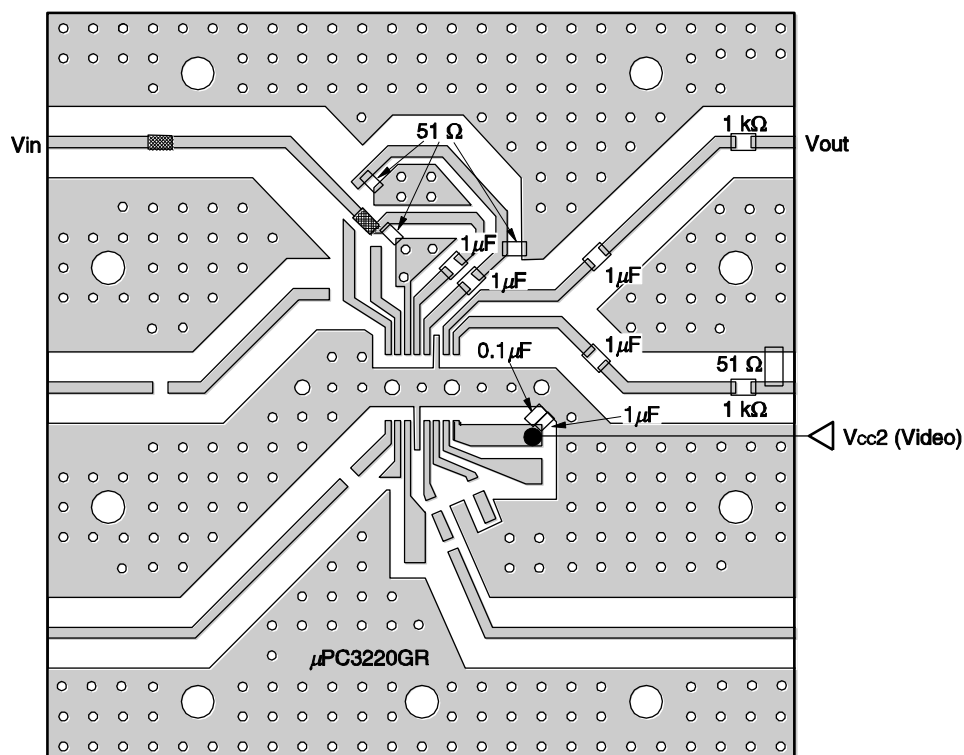
1. Back side: GND pattern
2. Solder plated on pattern
3. \circ : Through hole
4.  : Represents cutout
5.  : Represents short-circuit strip

ILLUSTRATION OF THE MEASUREMENT CIRCUIT4 ASSEMBLED ON EVALUATION BOARD



Remarks


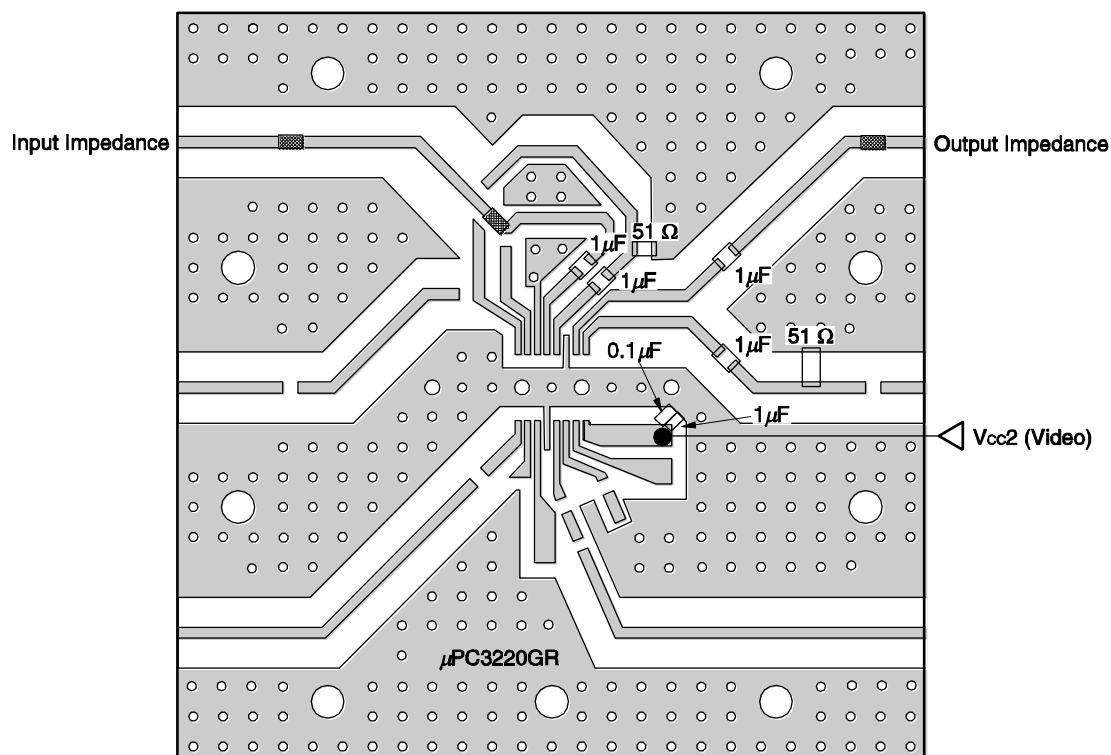
1. Back side: GND pattern
2. Solder plated on pattern
3. \circ : Through hole
4.  : Represents short-circuit strip

ILLUSTRATION OF THE MEASUREMENT CIRCUIT5 ASSEMBLED ON EVALUATION BOARD



Remarks


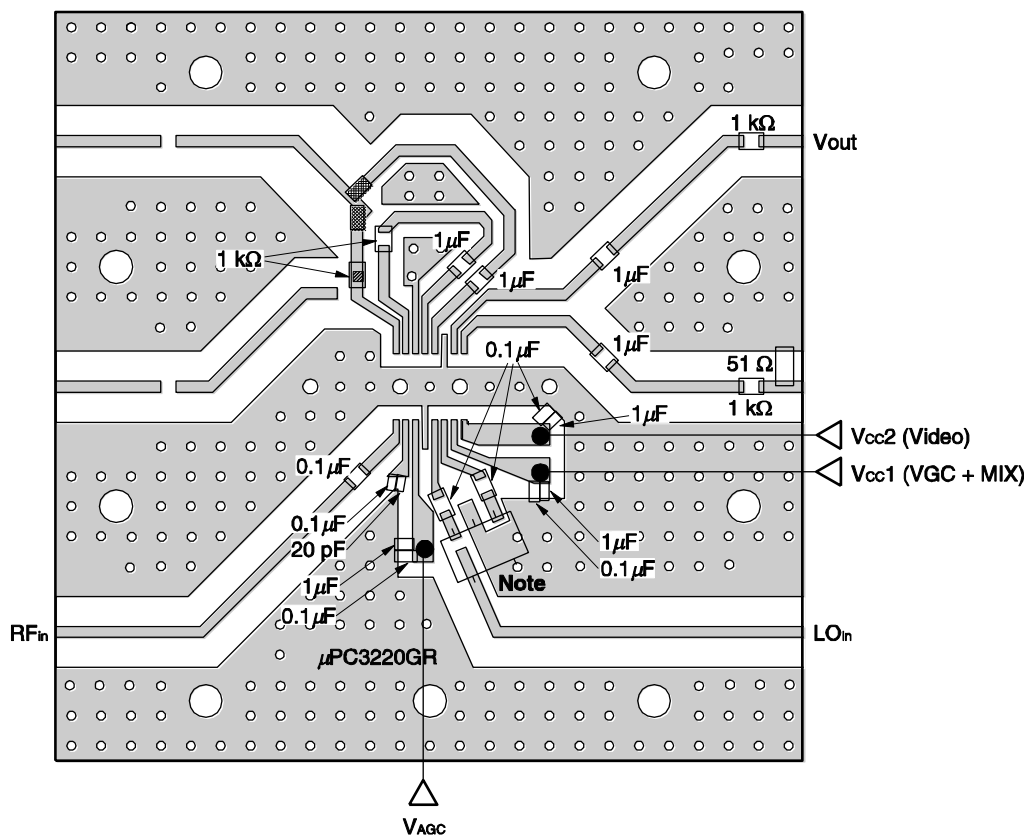


1. Back side: GND pattern
2. Solder plated on pattern
3. \circ : Through hole
4.  : Represents short-circuit strip

ILLUSTRATION OF THE MEASUREMENT CIRCUIT 6, 7 ASSEMBLED ON EVALUATION BOARD

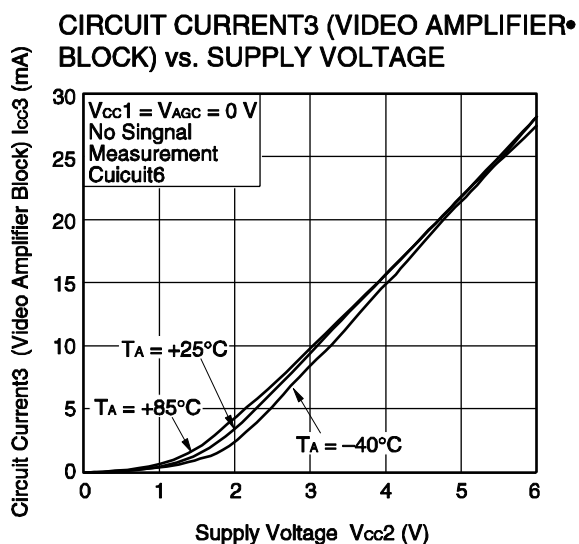
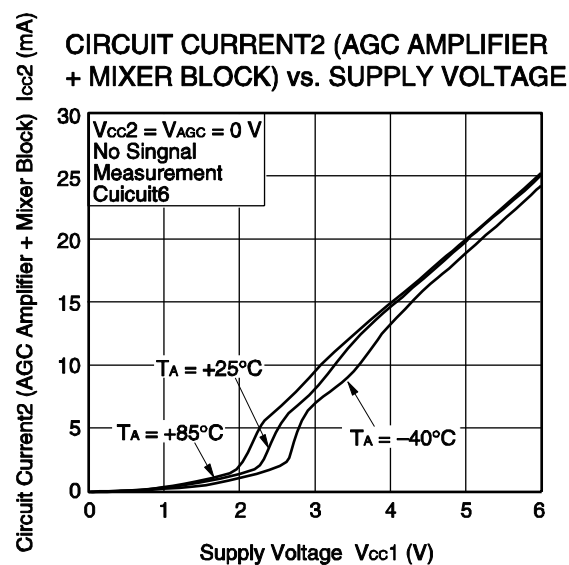
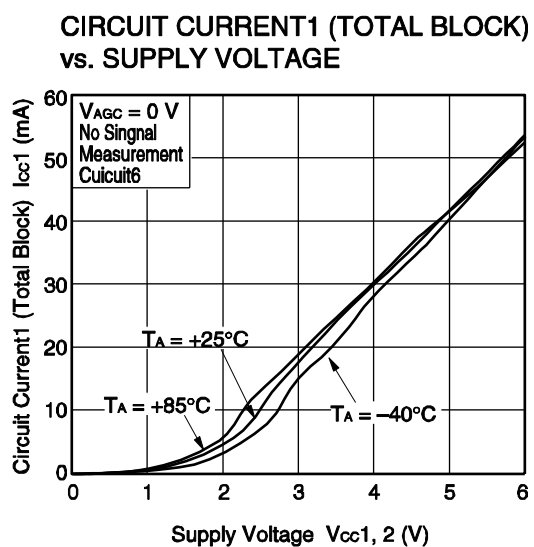


Note Balun Transformer

Remarks

1. Back side: GND pattern
2. Solder plated on pattern
3. \circ : Through hole
4.  : Represents cutout
5.  : Represents short-circuit strip

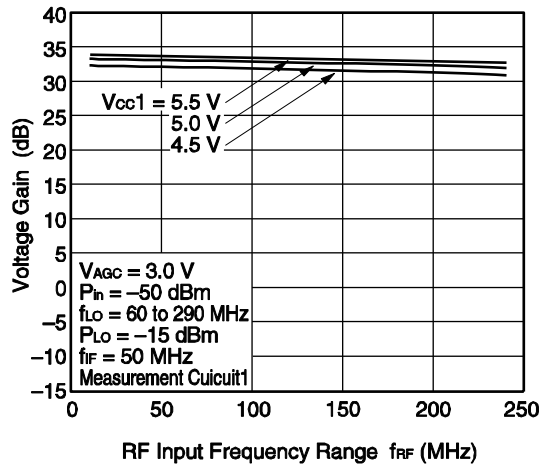
TYPICAL CHARACTERISTICS ($T_A = +25^\circ\text{C}$, unless otherwise specified)



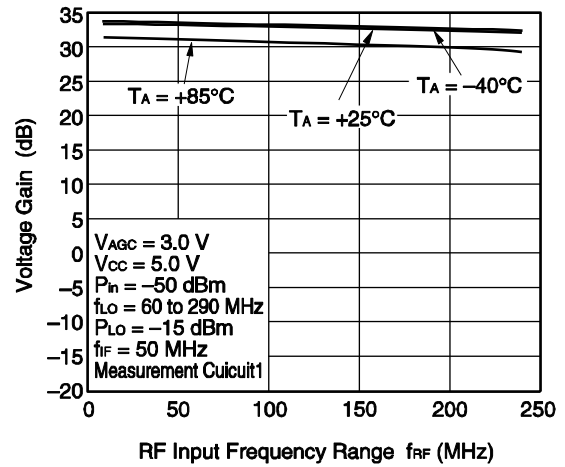
Remark The graphs indicate nominal characteristics.

–AGC Amplifier Block + Mixer Block–

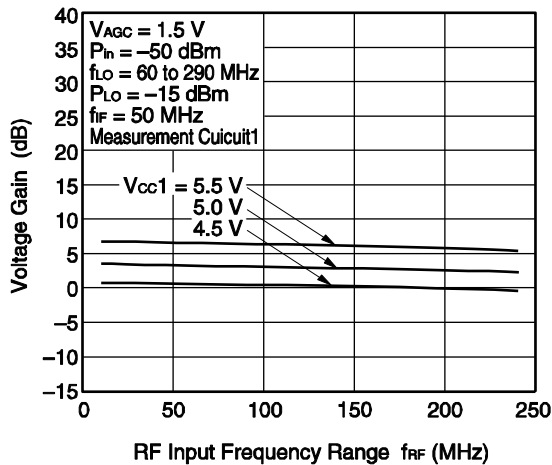
VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE



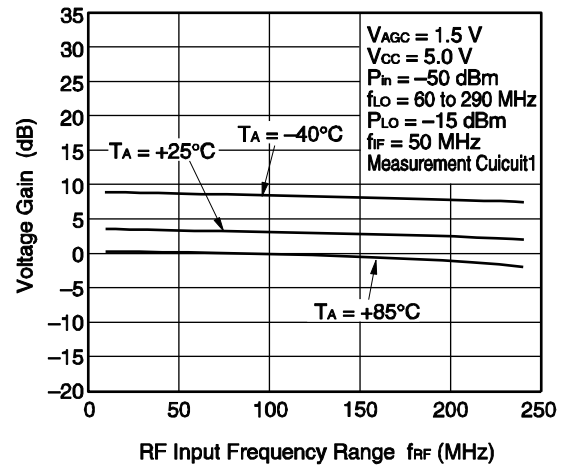
VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE



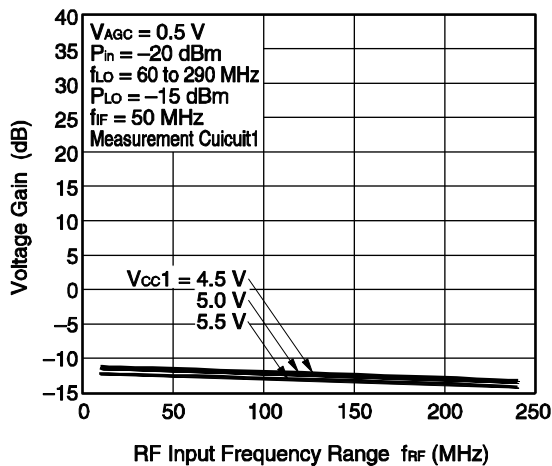
VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE



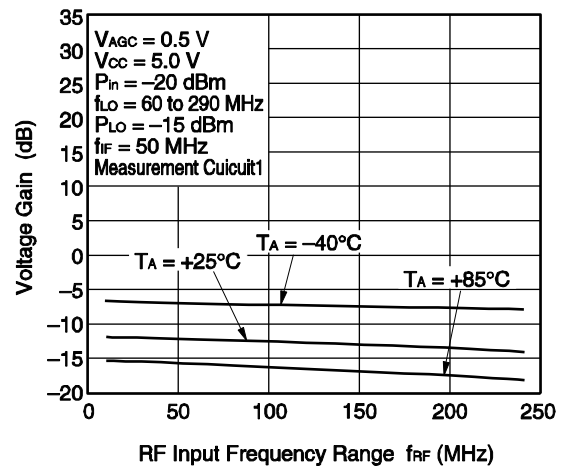
VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE



VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE

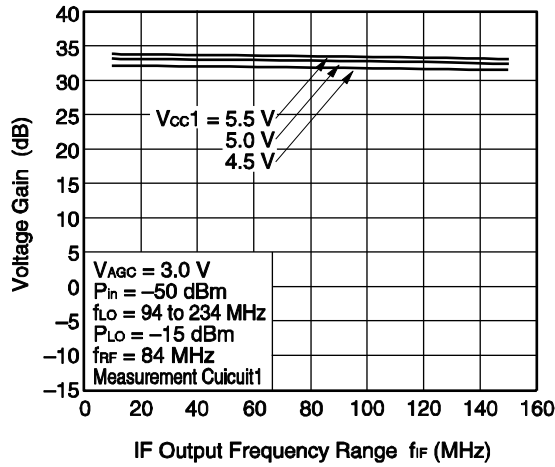


VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE

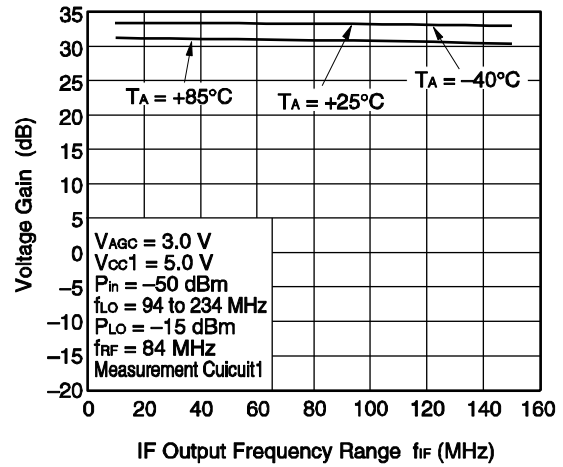


Remark The graphs indicate nominal characteristics.

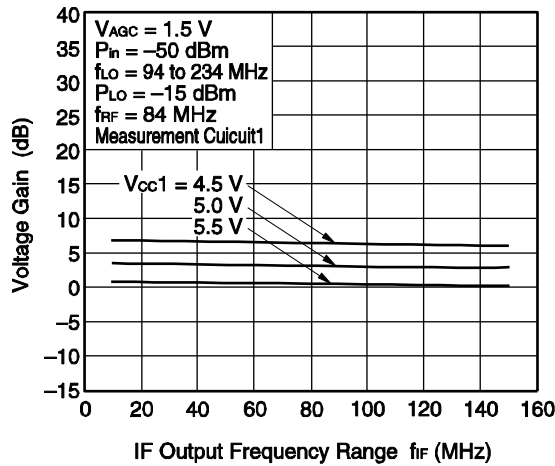
VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE



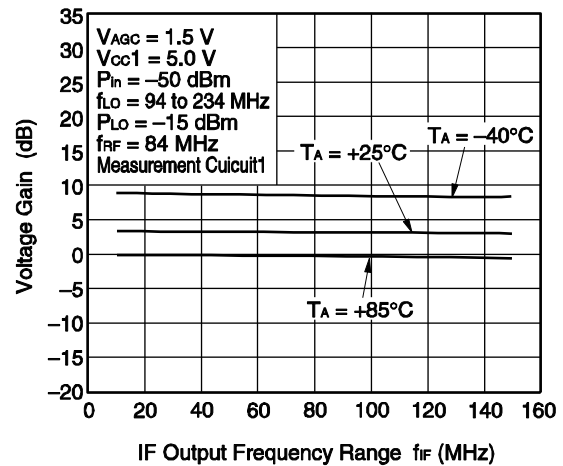
VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE



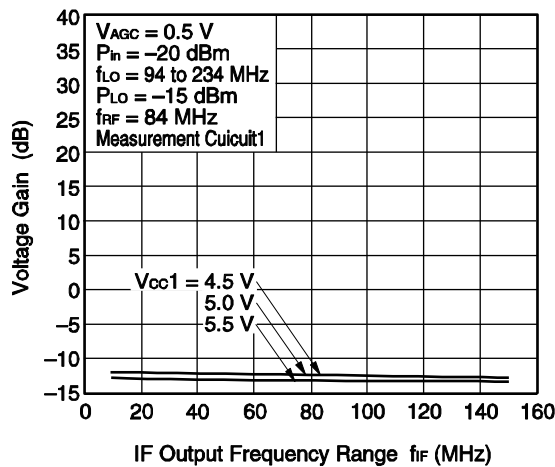
VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE



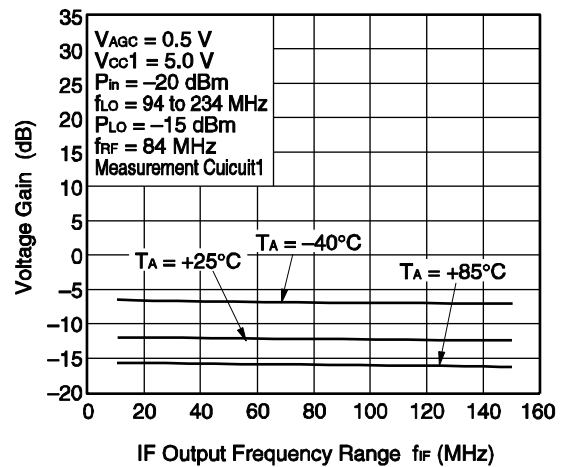
VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE



VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE

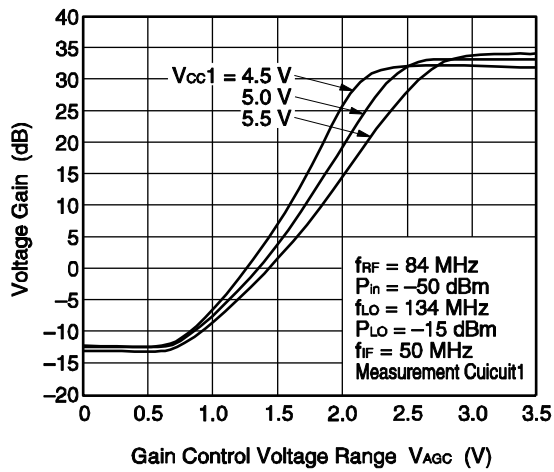


VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE

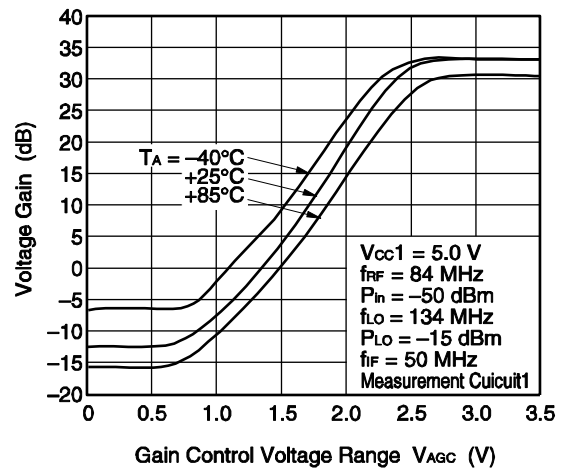


Remark The graphs indicate nominal characteristics.

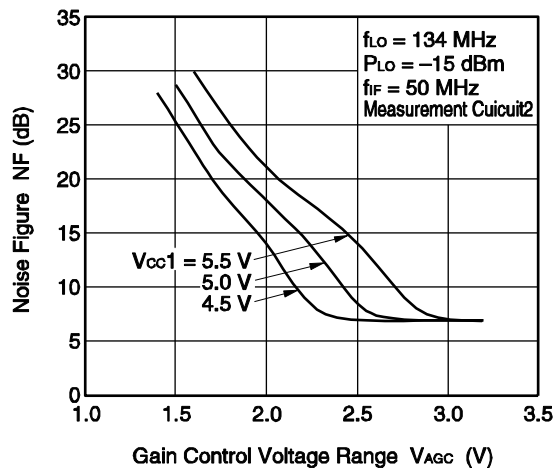
VOLTAGE GAIN vs.
GAIN CONTROL VOLTAGE RANGE



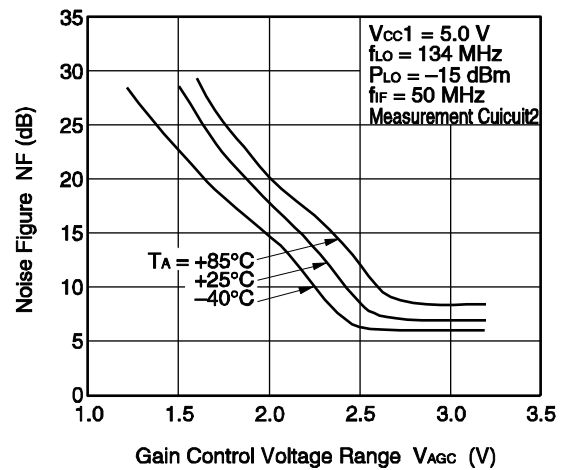
VOLTAGE GAIN vs.
GAIN CONTROL VOLTAGE RANGE



NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE

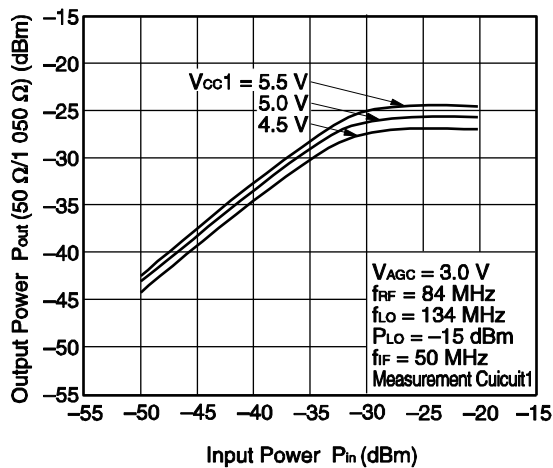


NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE

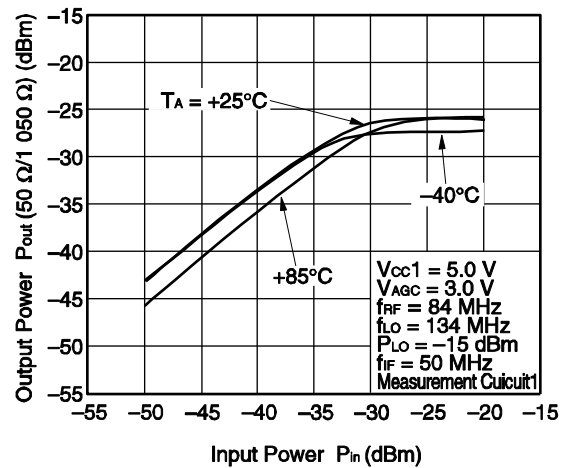


Remark The graphs indicate nominal characteristics.

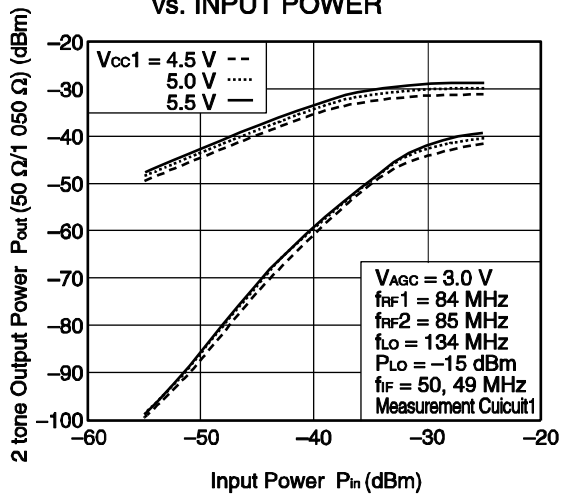
OUTPUT POWER vs. INPUT POWER



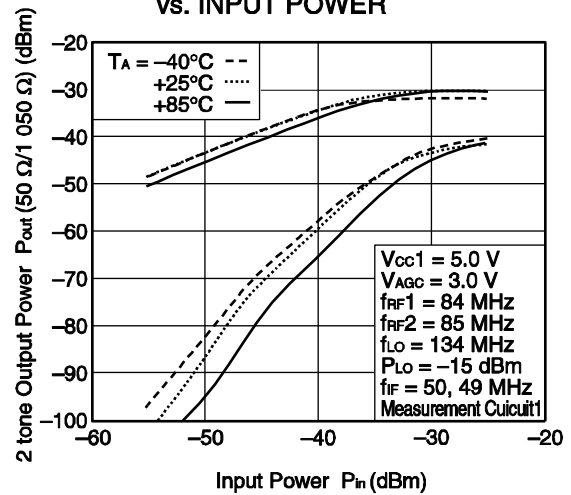
OUTPUT POWER vs. INPUT POWER



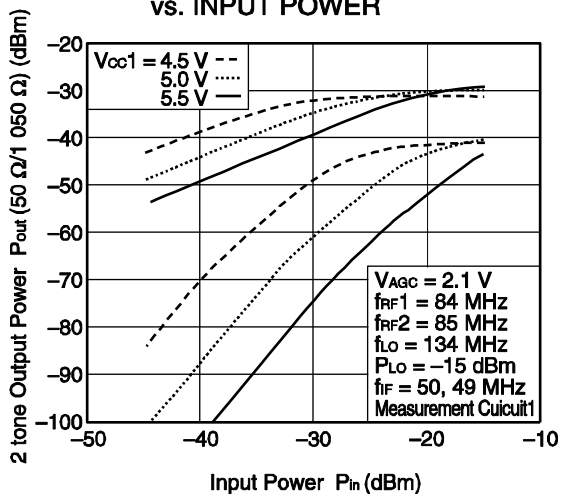
2 TONE OUTPUT POWER vs. INPUT POWER



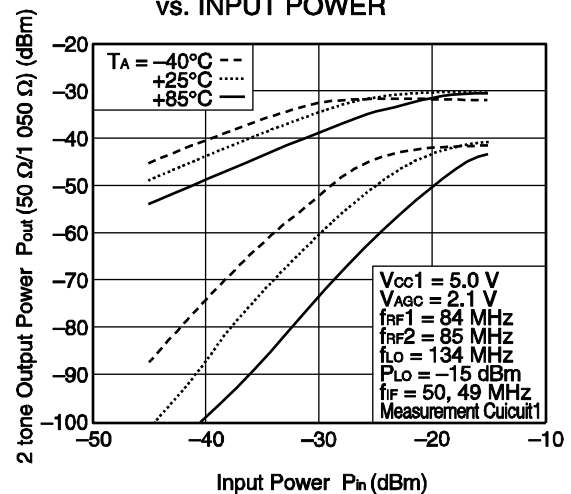
2 TONE OUTPUT POWER vs. INPUT POWER



2 TONE OUTPUT POWER vs. INPUT POWER

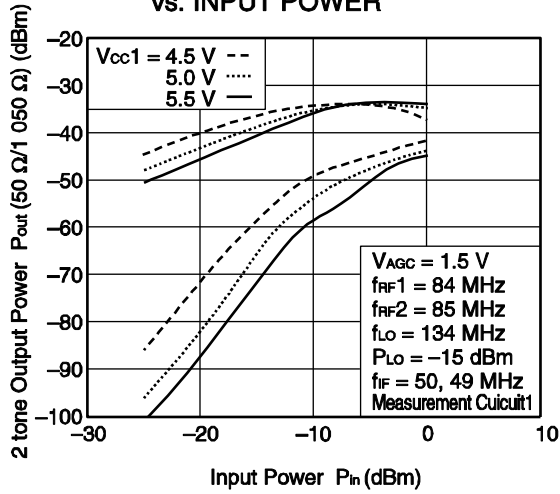


2 TONE OUTPUT POWER vs. INPUT POWER

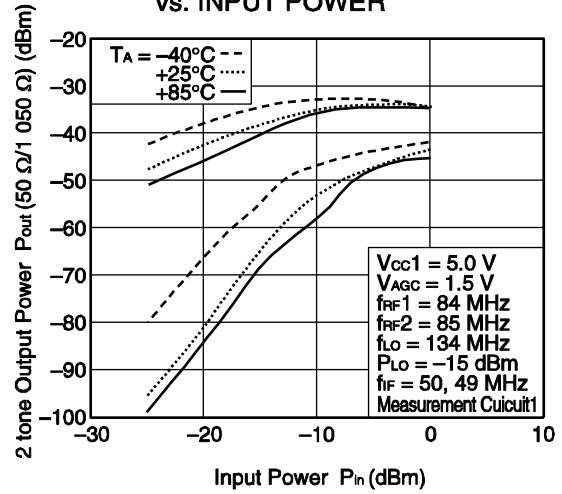


Remark The graphs indicate nominal characteristics.

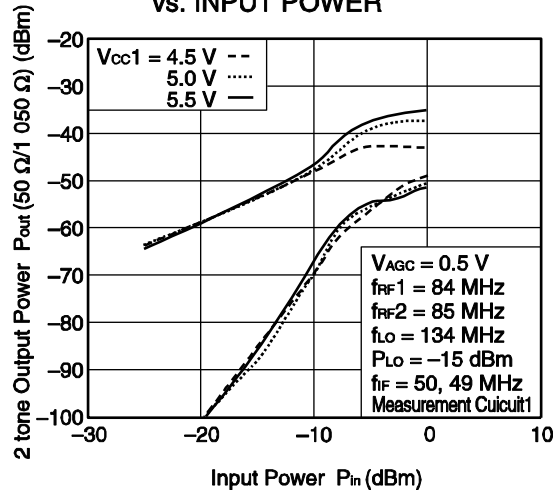
2 TONE OUTPUT POWER
vs. INPUT POWER



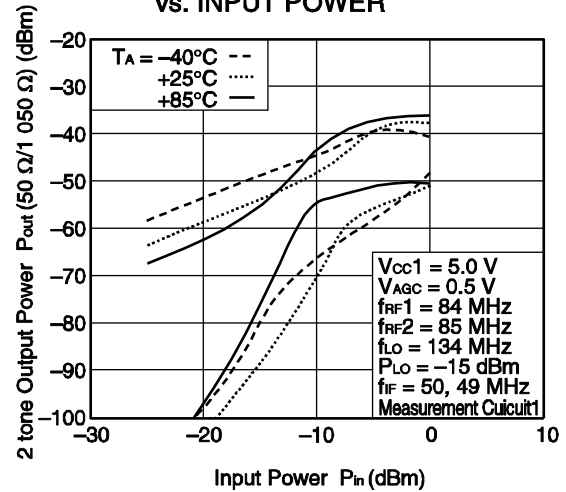
2 TONE OUTPUT POWER
vs. INPUT POWER



2 TONE OUTPUT POWER
vs. INPUT POWER



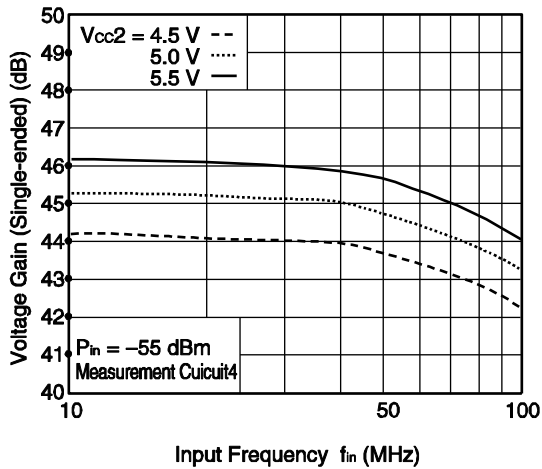
2 TONE OUTPUT POWER
vs. INPUT POWER



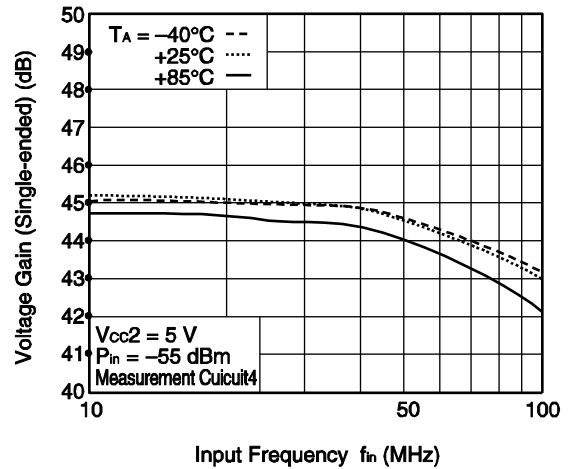
Remark The graphs indicate nominal characteristics.

–Video Amplifier Block–

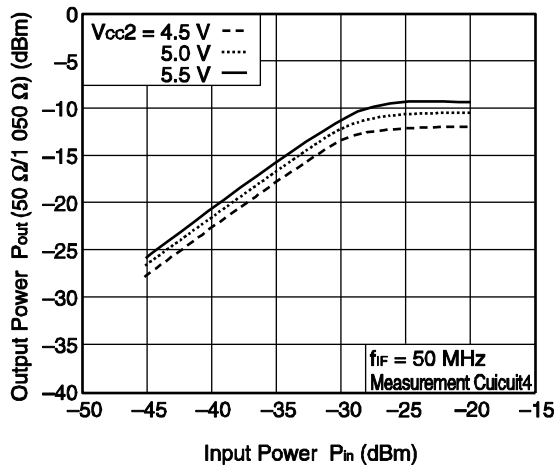
VOLTAGE GAIN (SINGLE-ENDED)
vs. INPUT FREQUENCY



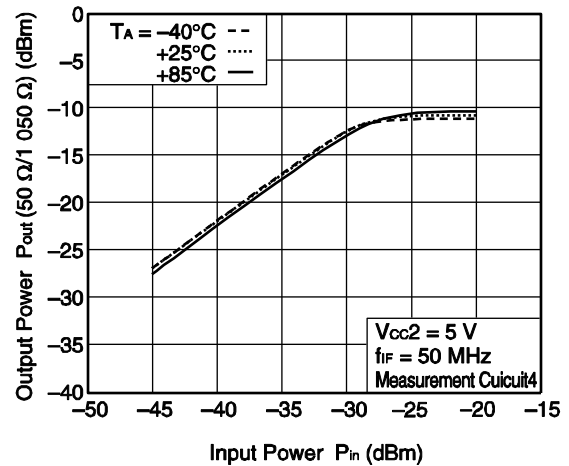
VOLTAGE GAIN (SINGLE-ENDED)
vs. INPUT FREQUENCY



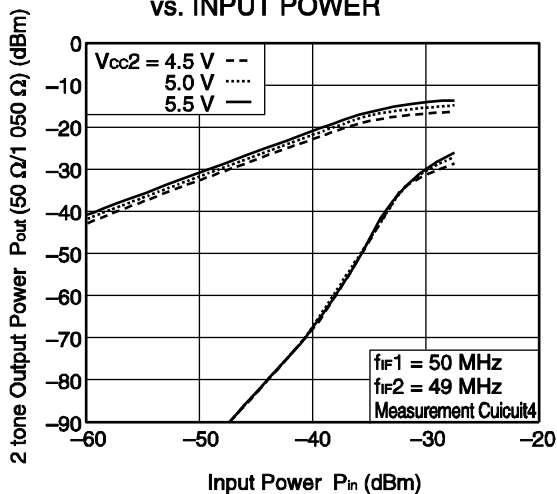
OUTPUT POWER vs. INPUT POWER



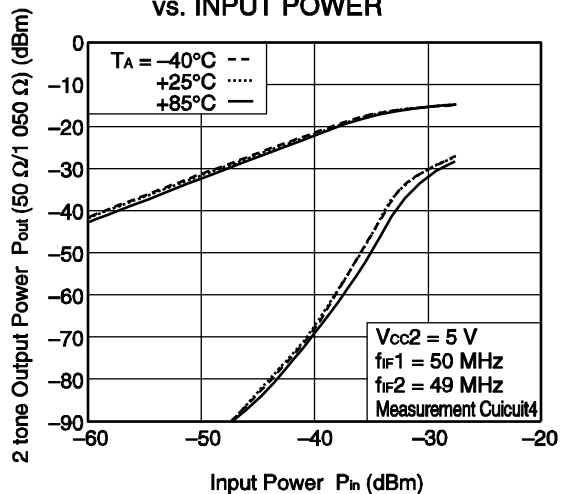
OUTPUT POWER vs. INPUT POWER



2 TONE OUTPUT POWER
vs. INPUT POWER



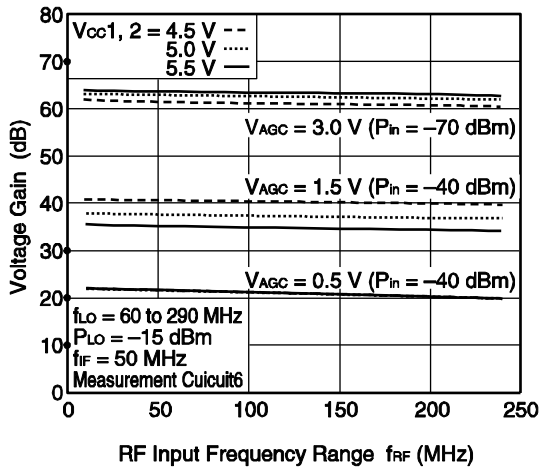
2 TONE OUTPUT POWER
vs. INPUT POWER



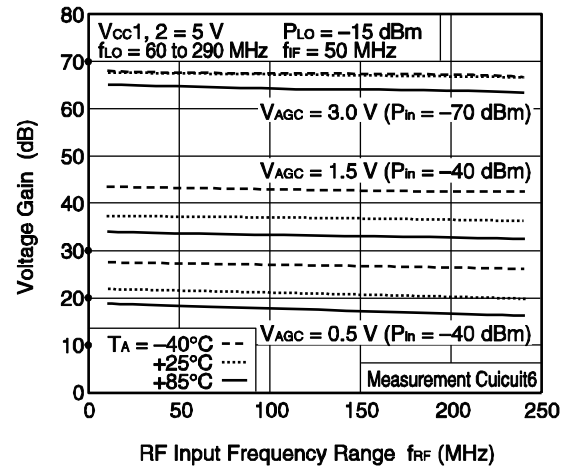
Remark The graphs indicate nominal characteristics.

–Total Block–

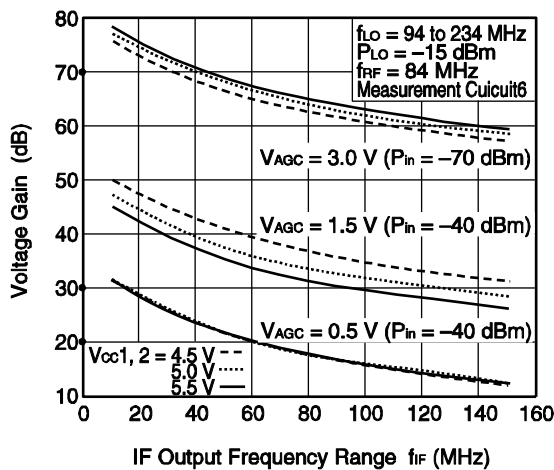
VOLTAGE GAIN
vs. RF INPUT FREQUENCY RANGE



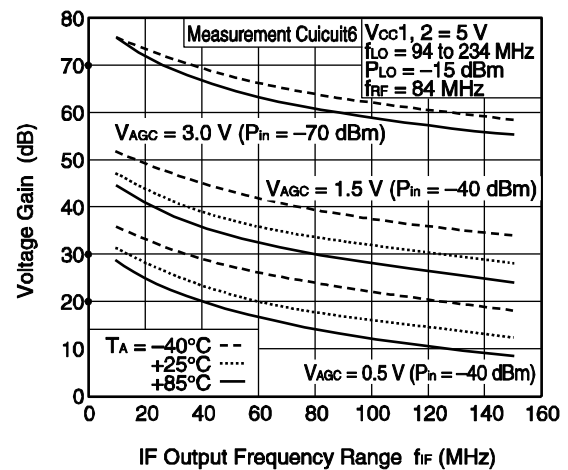
VOLTAGE GAIN
vs. RF INPUT FREQUENCY RANGE



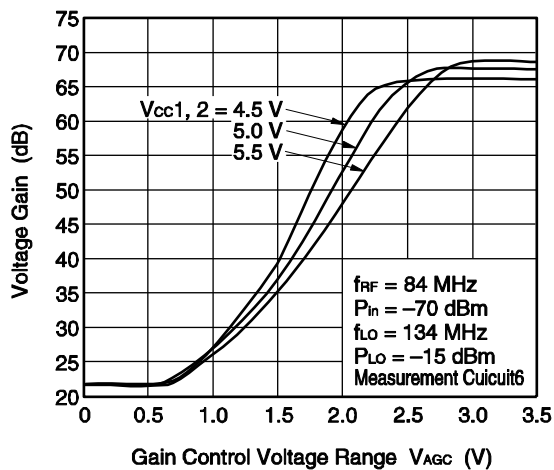
VOLTAGE GAIN
vs. IF OUTPUT FREQUENCY RANGE



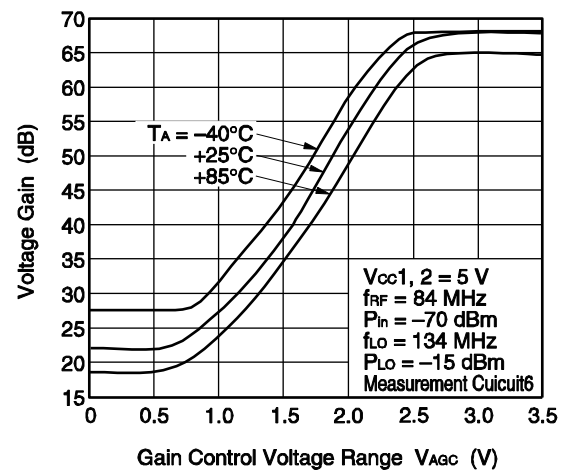
VOLTAGE GAIN
vs. IF OUTPUT FREQUENCY RANGE



VOLTAGE GAIN
vs. GAIN CONTROL VOLTAGE RANGE

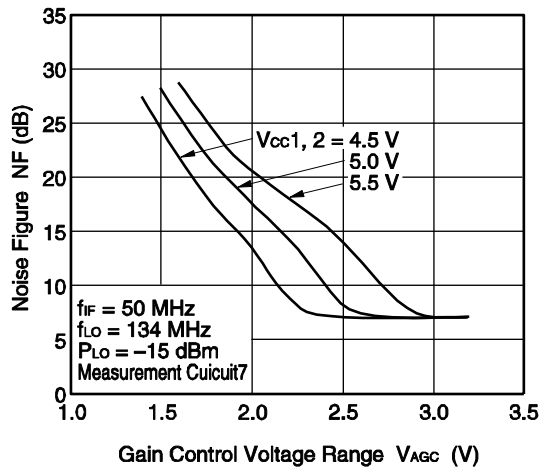


VOLTAGE GAIN
vs. GAIN CONTROL VOLTAGE RANGE

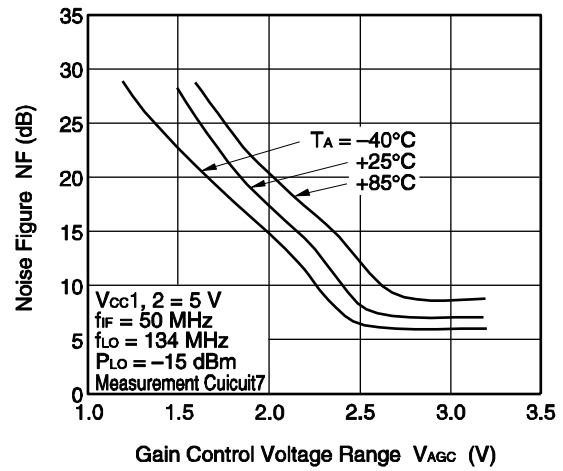


Remark The graphs indicate nominal characteristics.

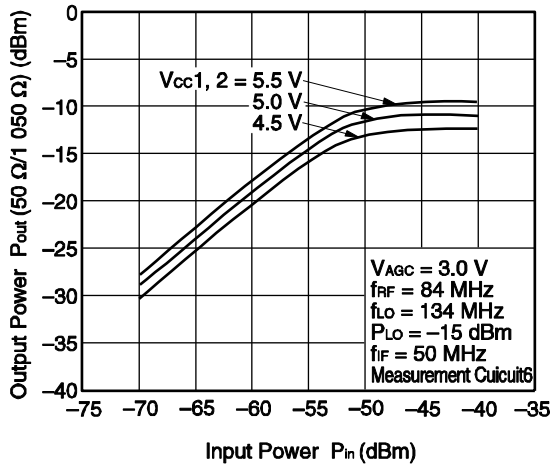
NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE



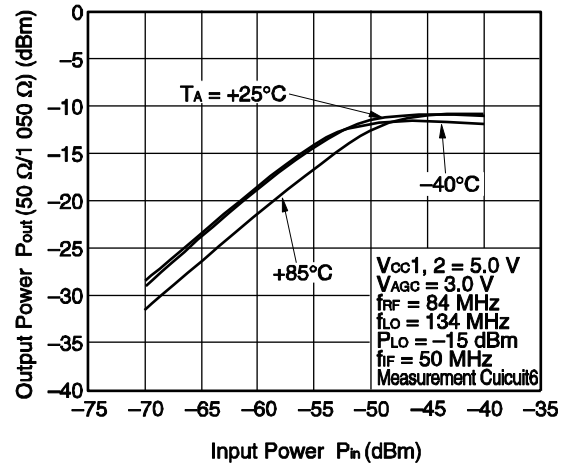
NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE



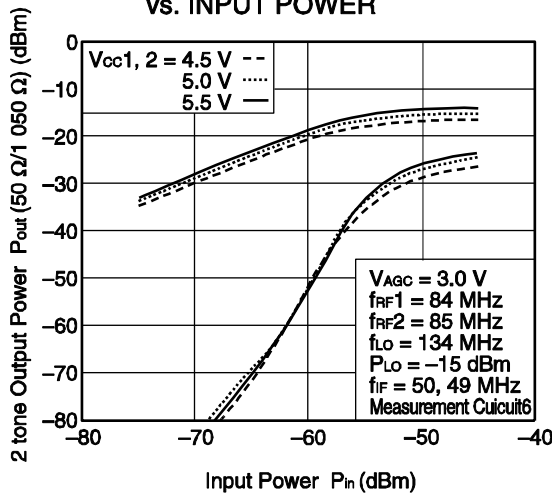
OUTPUT POWER vs. INPUT POWER



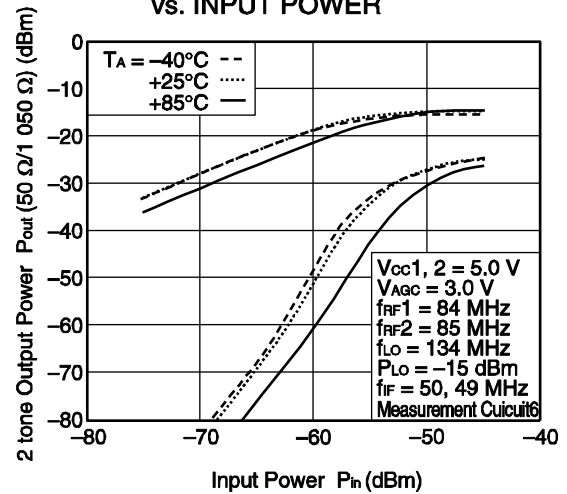
OUTPUT POWER vs. INPUT POWER



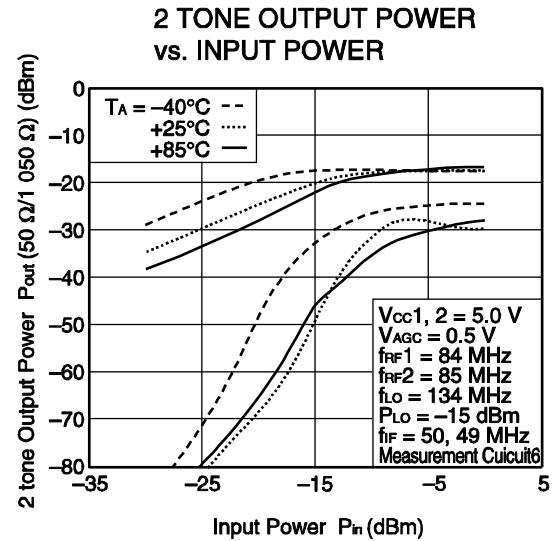
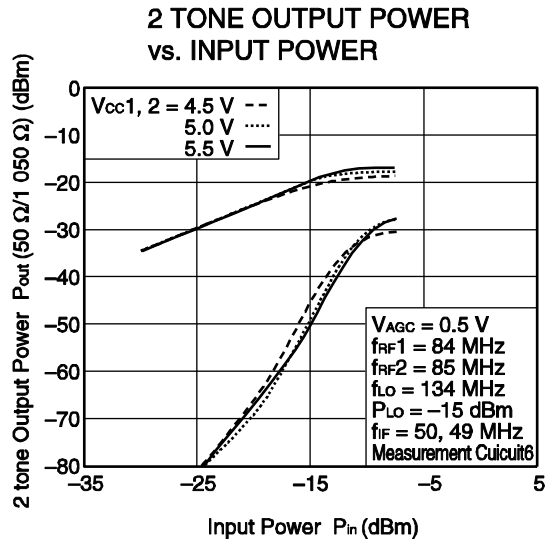
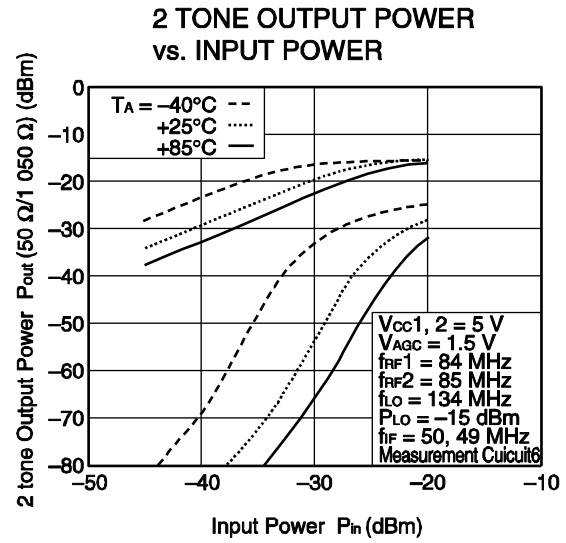
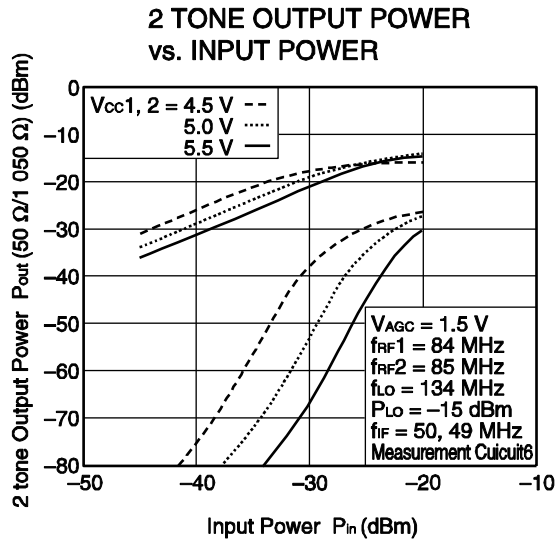
2 TONE OUTPUT POWER
vs. INPUT POWER



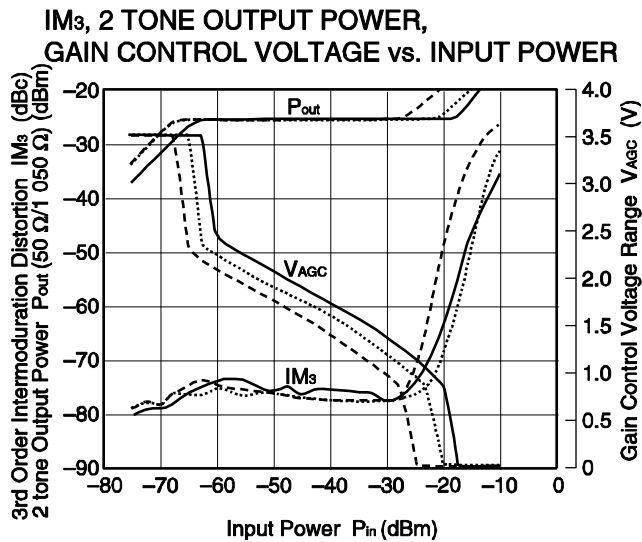
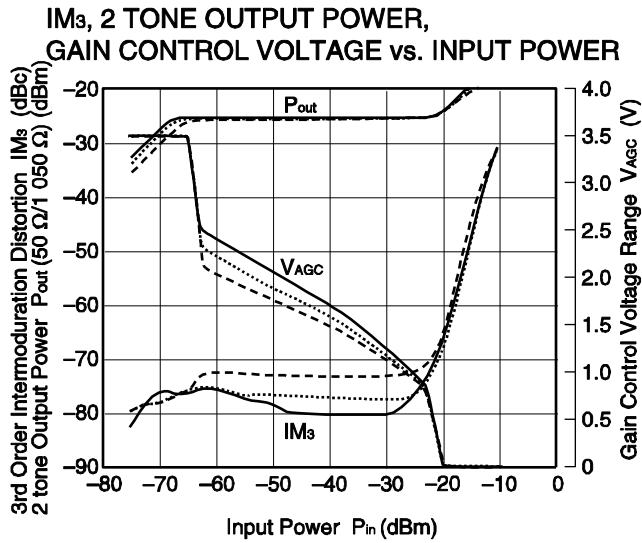
2 TONE OUTPUT POWER
vs. INPUT POWER



Remark The graphs indicate nominal characteristics.



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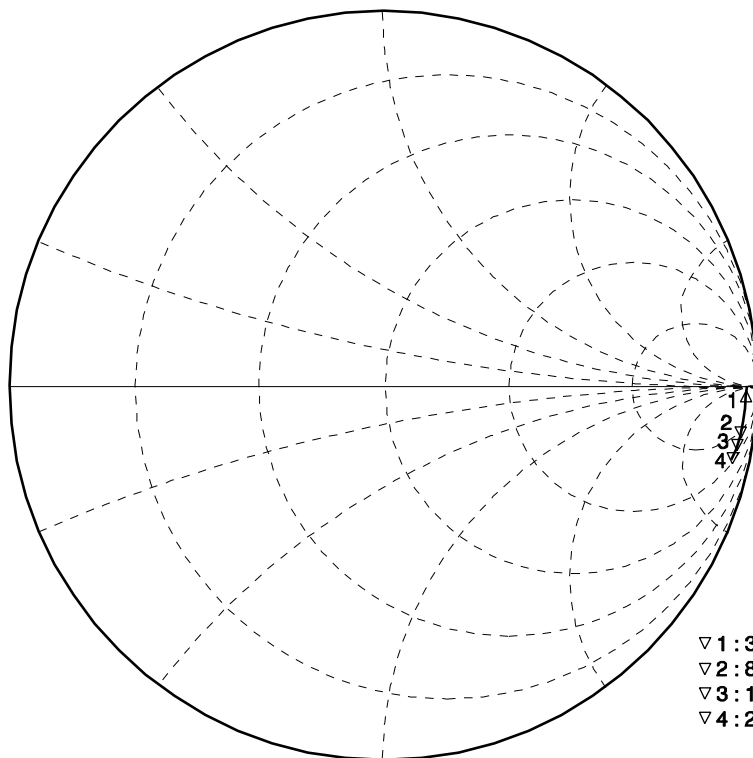


Remark The graphs indicate nominal characteristics.

S-PARAMETERS

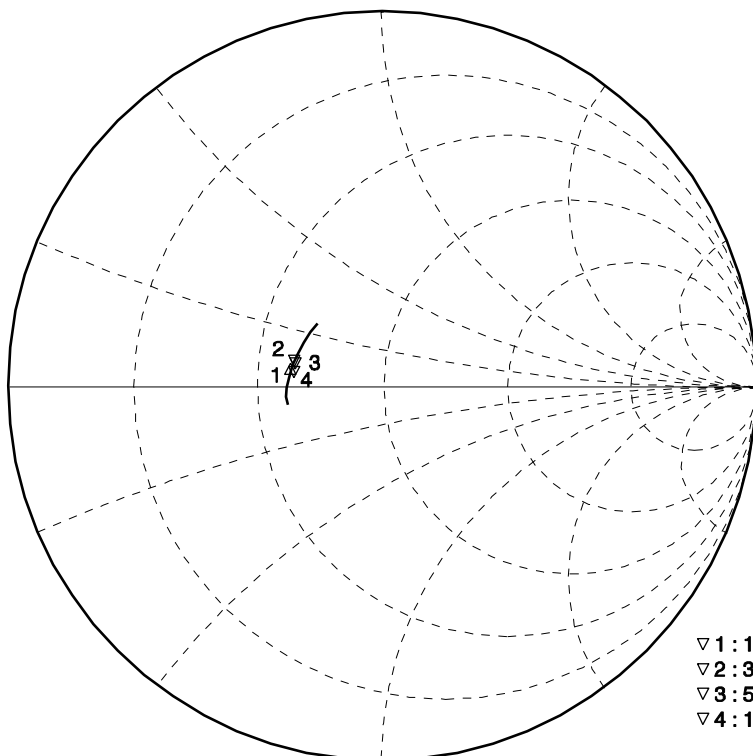
–AGC Amplifier Block + Mixer Block– ($V_{CC1} = 5.0\text{ V}$, $V_{AGC} = 3.0\text{ V}$, by measurement circuit 3)

MIXER RF Input Impedance



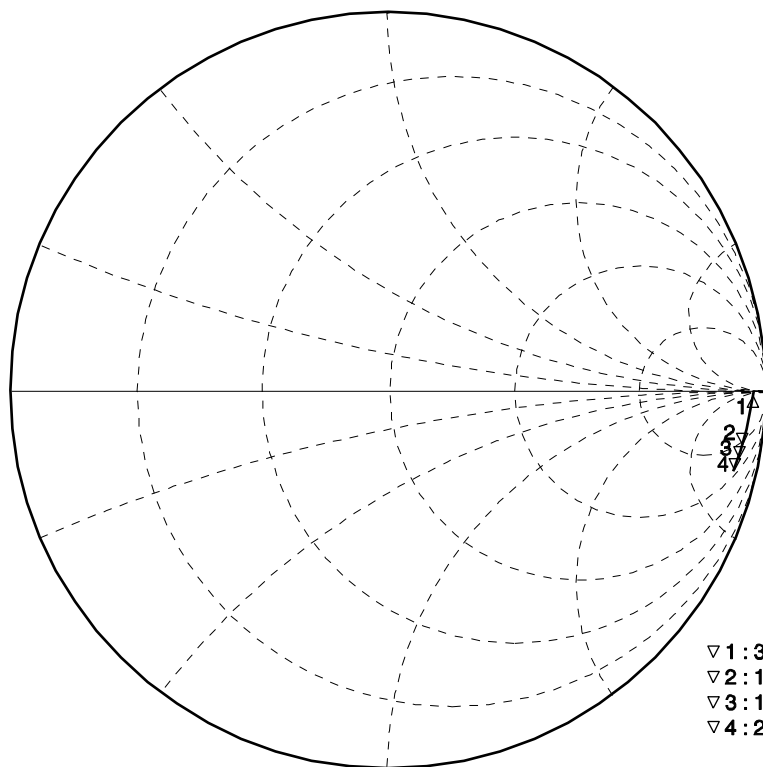
▽ 1 : 30 MHz•	1.830 k Ω •	–1.603 k Ω •	3.309 pF
▽ 2 : 84 MHz•	443.0 Ω •	–1.096 k Ω •	1.730 pF
▽ 3 : 150 MHz•	207.4 Ω •	–728.7 Ω •	1.456 pF
▽ 4 : 250 MHz•	109.7 Ω •	–454.1 Ω •	1.402 pF

MIXER IF Output Impedance



▽ 1 : 10 MHz•	29.48 Ω •	634.6 m Ω •	10.07 nH
▽ 2 : 36 MHz•	29.98 Ω •	1.908 Ω •	8.431 nH
▽ 3 : 50 MHz•	30.17 Ω •	2.476 Ω •	7.884 nH
▽ 4 : 100 MHz•	30.79 Ω •	4.171 Ω •	6.638 nH

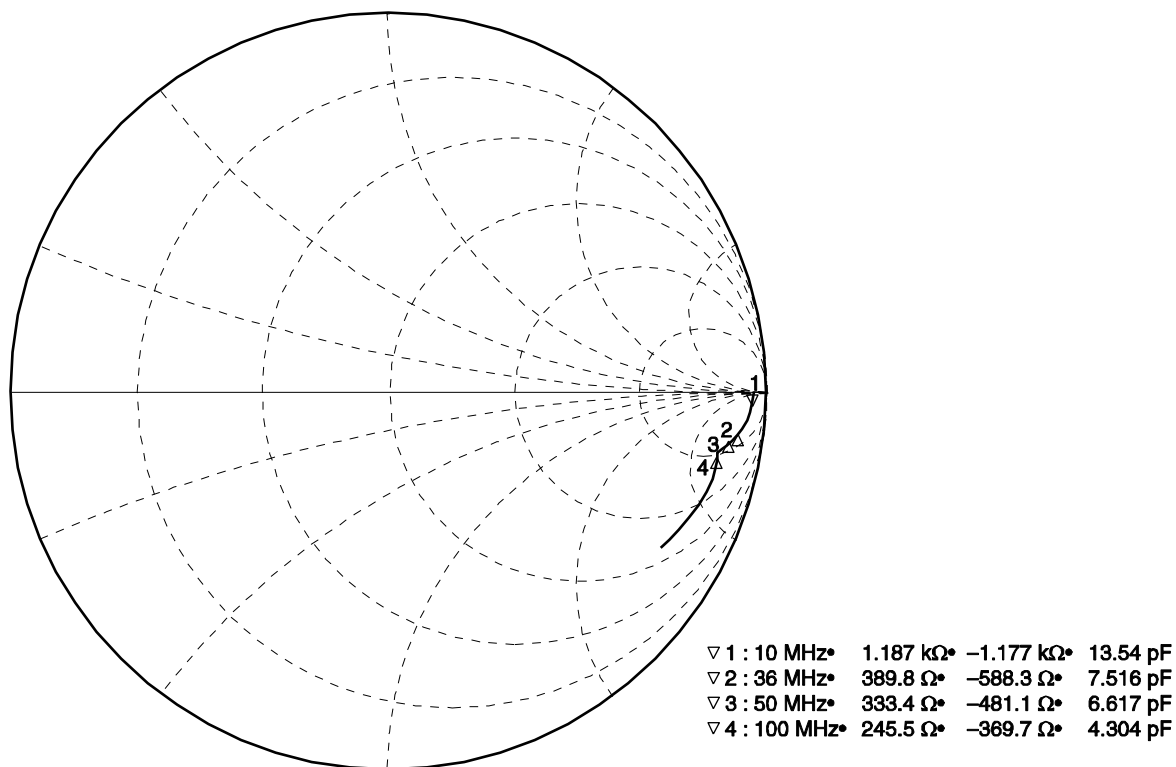
MIXER OSC Input Impedance



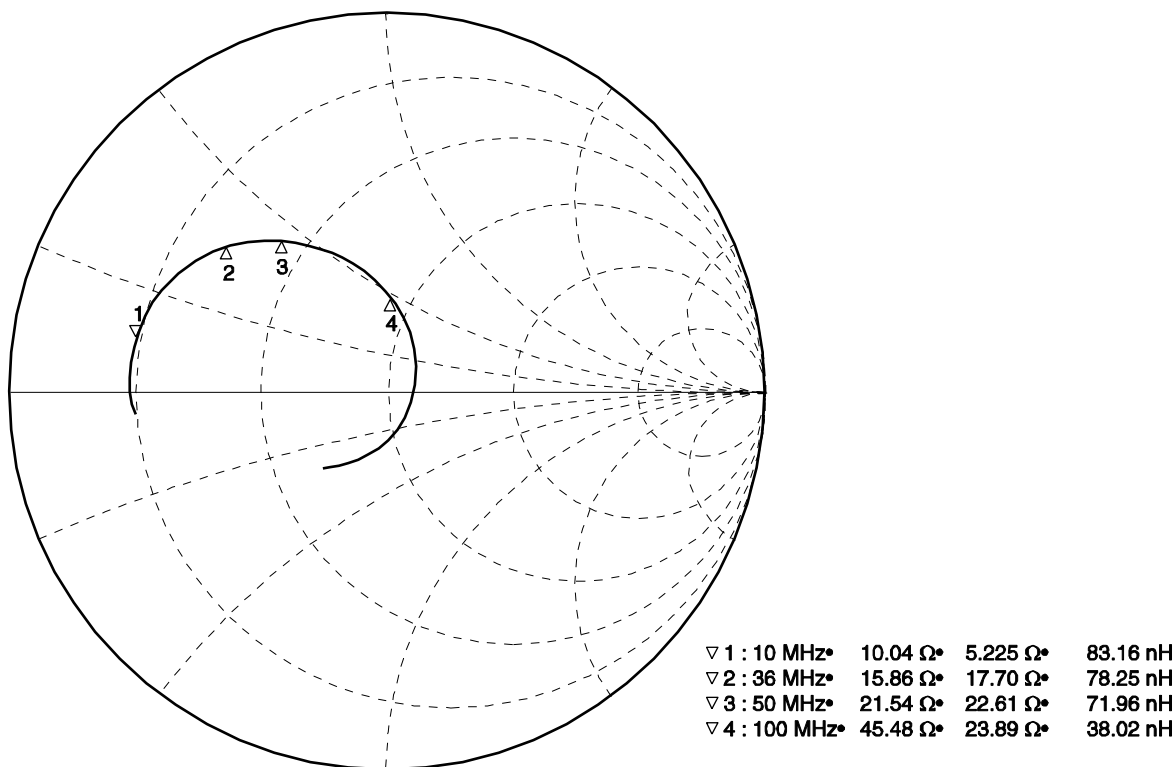
▽ 1 : 30 MHz•	1.820 kΩ•	-1.823 kΩ•	2.911 pF
▽ 2 : 100 MHz•	415.5 Ω•	-1.010 Ω•	1.575 pF
▽ 3 : 134 MHz•	284.6 Ω•	-813.1 Ω•	1.461 pF
▽ 4 : 250 MHz•	133.4 Ω•	-487.0 Ω•	1.307 pF

–Video Amplifier Block– ($V_{cc2} = 5.0\text{ V}$, by measurement circuit 5)

Video Amplifier Input Impedance

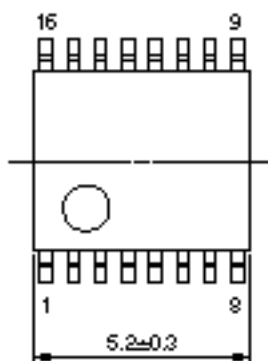


Video Amplifier Output Impedance

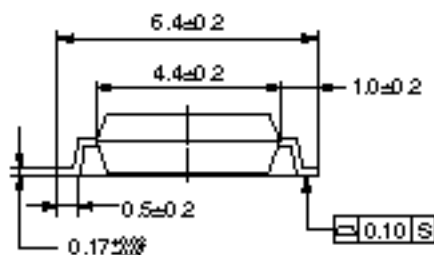
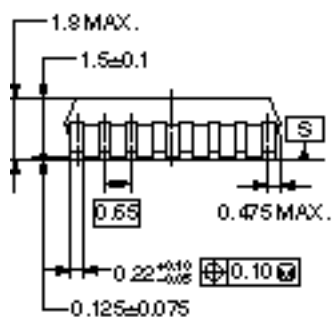


PACKAGE DIMENSIONS

16-PIN PLASTIC SSOP (5.72 mm (225)) (UNIT: mm)



detail of lead end



NOTES 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.

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

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

Mouser Electronics

Authorized Distributor

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[UPC2768GR-E1](#)