CEL

NEC's LOW DISTORTION DOWN-CONVERTER IC FOR DIGITAL CATV

UPC3220GR

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 A 16-PIN SSOP SUITABLE FOR HIGH-DENSITY SURFACE MOUNTING**

APPLICATION

- **Digital CATV Receivers**

DESCRIPTION

NEC's UPC3220GR 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.

NEC's UPC3220GR is packaged in a 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.

ORDERING INFORMATION

PART NUMBER	ORDER NUMBER	PACKAGE	MARKING	SUPPLYING FORM
UPC3220GR-E1-A	UPC3220GR-E1-A	16-pin plastic SSOP (5.72 mm (225)) (Pb-Free) Note	C3220	• Embossed tape 12 mm wide • Pin 1 indicates pull-out direction of tape • Qty 2.5 kpcs/reel

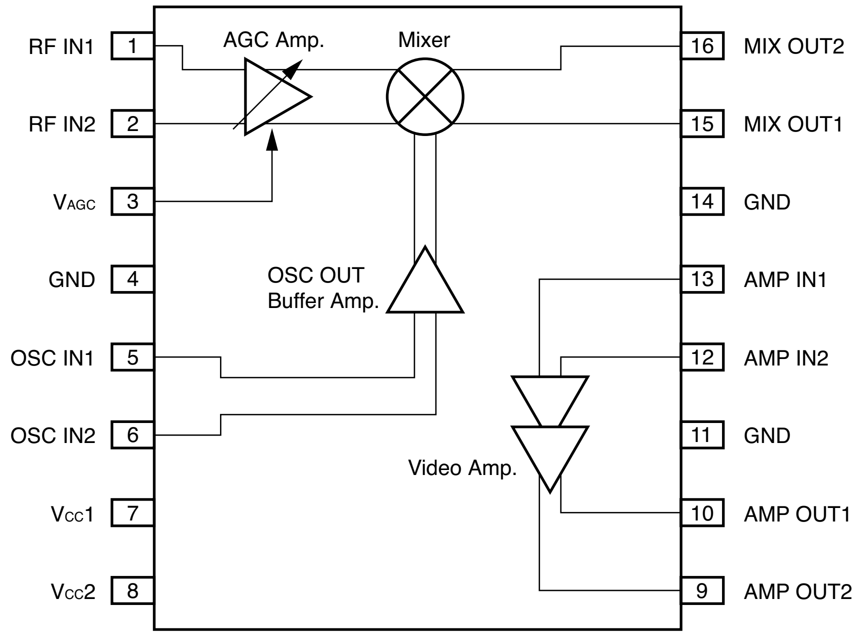
Note With regards to terminal solder (the solder contains lead) plated products (conventionally plated), contact your nearby sales office.

Remark To order evaluation samples, contact your nearby sales office.
Part number for sample order: μPC3220GR

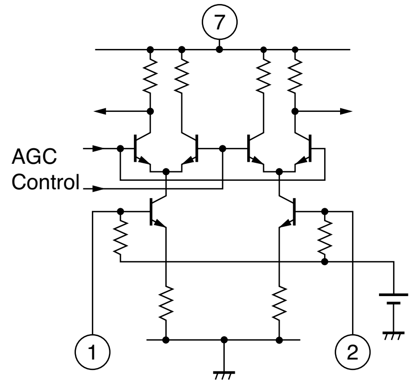
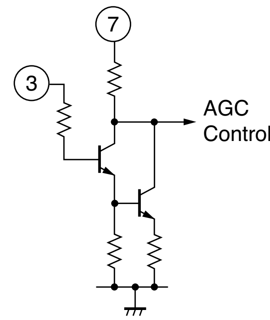
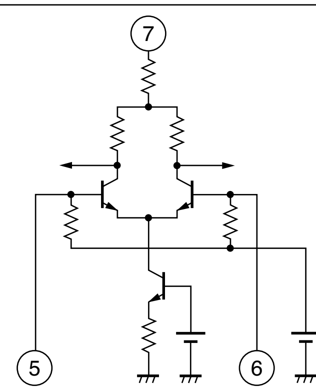
Caution Observe precautions when handling because these devices are sensitive to electrostatic discharge.

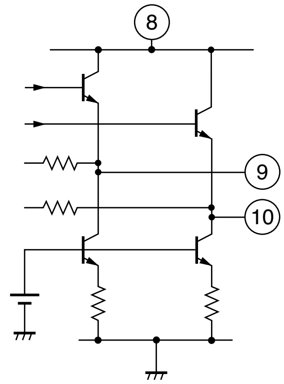
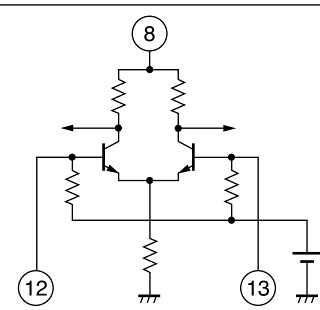
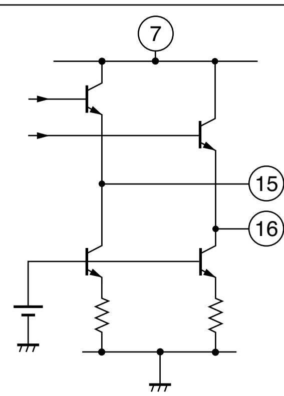
INTERNAL BLOCK DIAGRAM AND PIN CONFIGURATION

(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 x 50 x 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°C, V_{CC} = 5 V)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
DC Characteristics						
Circuit Current 1 (Total Block)	$I_{CC}1$	No input signal, $V_{CC}1$ = $V_{CC}2$ = 5 V **Note 4**	33.0	42.0	53.5	mA
Circuit Current 2 (AGC Amplifier Block + Mixer Block)	$I_{CC}2$	No input signal, $V_{CC}1$ = 5 V **Note 4**	15.0	20.0	25.5	mA
Circuit Current 3 (Video Amplifier Block)	$I_{CC}3$	No input signal, $V_{CC}2$ = 5 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 MHz, f_{LO} = 134 MHz, P_{LO} = –15 dBm, f_{IF} = 50 MHz, Z_S = 50 Ω, Z_L = 1 kΩ)						
RF Input Frequency Range	f_{RF}	f_{IF} = 50 MHz constant **Note 1**	30	–	250	MHz
IF Output Frequency Range	f_{IF}	f_{RF} = 84 MHz constant **Note 1**	0.1	–	150	MHz
Maximum Conversion Gain	CG_{MAX}	V_{AGC} = 3.0 V, P_{in} = –50 dBm **Note 1**	30.5	33.0	35.5	dB
Minimum Conversion Gain	CG_{MIN}	V_{AGC} = 0.5 V, P_{in} = –20 dBm **Note 1**	–18.0	–12.5	–3.5	dB
AGC Dynamic Range	GCR_{AGC}	V_{AGC} = 0.5 to 3.0 V **Note 1**	36.0	45.5	–	dB
Noise Figure	NF	DSB, V_{AGC} = 3.0 V (@ Maximum gain) **Note 2**	–	7.0	8.5	dB
3rd Order Intermodulaion Distortion	IM_3	V_{out} = 0.236 V_{p-p} × 2 tone, (single-ended output), P_{in} –30 dBm/tone f_{RF1} = 84 MHz, f_{RF2} = 85 MHz **Note 1**	24.0	26.5	–	dBc
RF Characteristics (Video Amplifier Block: f = 50 MHz, Z_S = 50 Ω, Z_L = 1 kΩ)						
Differential Gain	G_{diff}	P_{in} = –55 dBm **Note 3**	48.0	50.5	53.5	dB
Maximum Output Voltage 2	V_{oclip2}	P_{in} = –25 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

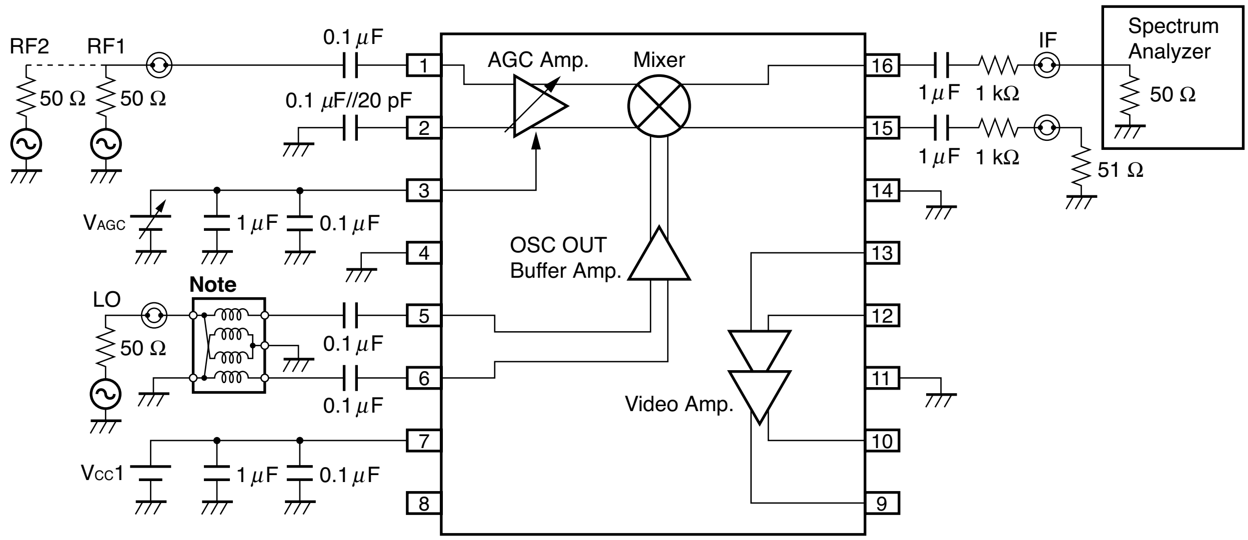
STANDARD CHARACTERISTICS (T_A = +25°C, V_{CC} = 5 V, Z_S = 50 Ω)

PARAMETER	SYMBOL	TEST CONDITIONS	REFERENCE VALUE	UNIT
AGC Amplifier Block + **Mixer Block** (f_{RF} = 84 MHz, f_{LO} = 134 MHz, P_{LO} = –15 dBm, f_{IF} = 50 MHz, Z_S = 50 Ω, Z_L = 1 kΩ)				
Input 3rd Order Distortion Intercept Point	IIP_3	V_{AGC} = 0.5 V (@ Minimum gain) f_{RF1} = 84 MHz, f_{RF2} = 85 MHz **Note 1**	+1.0	dBm
Maximum Output Voltage1	V_{oclip1}	V_{AGC} = 3.0 V, P_{in} = –20 dBm **Note 1**	0.65	V_{p-p}
RF IN Impedance	Z_{RFin}	V_{AGC} = 3.0 V, f = 84 MHz **Note 2**	440 – j1100	Ω
OSC IN Impedance	Z_{OSCin}	V_{AGC} = 3.0 V, f = 134 MHz **Note 2**	280 – j810	Ω
MIXER OUT Impedance	Z_{MIXout}	V_{AGC} = 3.0 V, f = 50 MHz **Note 2**	30.2 + j2.5	Ω
Video Amplifier Block (f = 50 MHz, Z_S = 50 Ω, Z_L = 1 kΩ)				
Frequency Range	f_{BW}	P_{in} = –55 dBm, G (f = 10 MHz) –1 dB **Note 3**	60	MHz
Input Impedance	Z_{AMPin}	f = 50 MHz **Note 4**	330 – j480	Ω
Output Impedance	Z_{AMPout}	f = 50 MHz **Note 4**	21.9 + j22.6	Ω
3rd Order Intermodulaion Distortion	IM_3	V_{out} = 0.7 V_{p-p} × 2 tone, f_{in1} = 49 MHz, f_{in2} = 50 MHz **Note 3**	55.0	dBc
Total Block (f_{RF} = 84 MHz, f_{LO} = 134 MHz, P_{LO} = –15 dBm, f_{IF} = 50 MHz, Z_S = 50 Ω, Z_L = 1 kΩ)				
Maximum Conversion Gain	CG_{MAX}	V_{AGC} = 3.0 V, P_{in} = –70 dBm **Note 5**	67.5	dB
Minimum Conversion Gain	CG_{MIN}	V_{AGC} = 0.5 V, P_{in} = –40 dBm **Note 5**	22.0	dB
Total Dynamic Range	GCR	V_{AGC} = 0.5 to 3.0 V **Note 5**	45.5	dB
Noise Figure	NF	DSB, V_{AGC} = 3.0 V (@ Maximum gain) **Note 6**	7.0	dB
Maximum Output Voltage	V_{oclip}	V_{AGC} = 3.0 V (@ Minimum gain) **Note 5**	3.7	V_{p-p}
Input 3rd Order Distortion Intercept Point	IIP_{3total}	V_{AGC} = 0.5 V (@ Minimum gain) f_{RF1} = 84 MHz, f_{RF2} = 85 MHz **Note 5**	+1.0	dBm
3rd Order Intermodulaion Distortion	IM_{3total}	V_{out} = 0.7 V_{p-p} × 2 tone, P_{in} –40 dBm/tone f_{RF1} = 84 MHz, f_{RF2} = 85 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

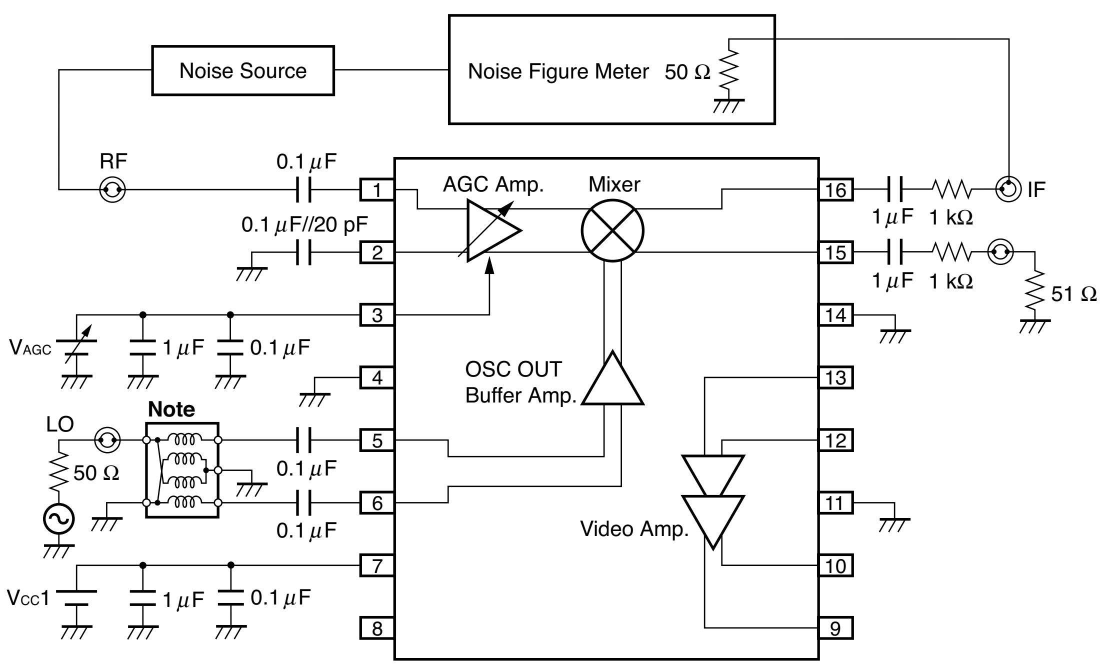
Remark The graphs indicate nominal characteristics.

MEASUREMENT CIRCUIT 1



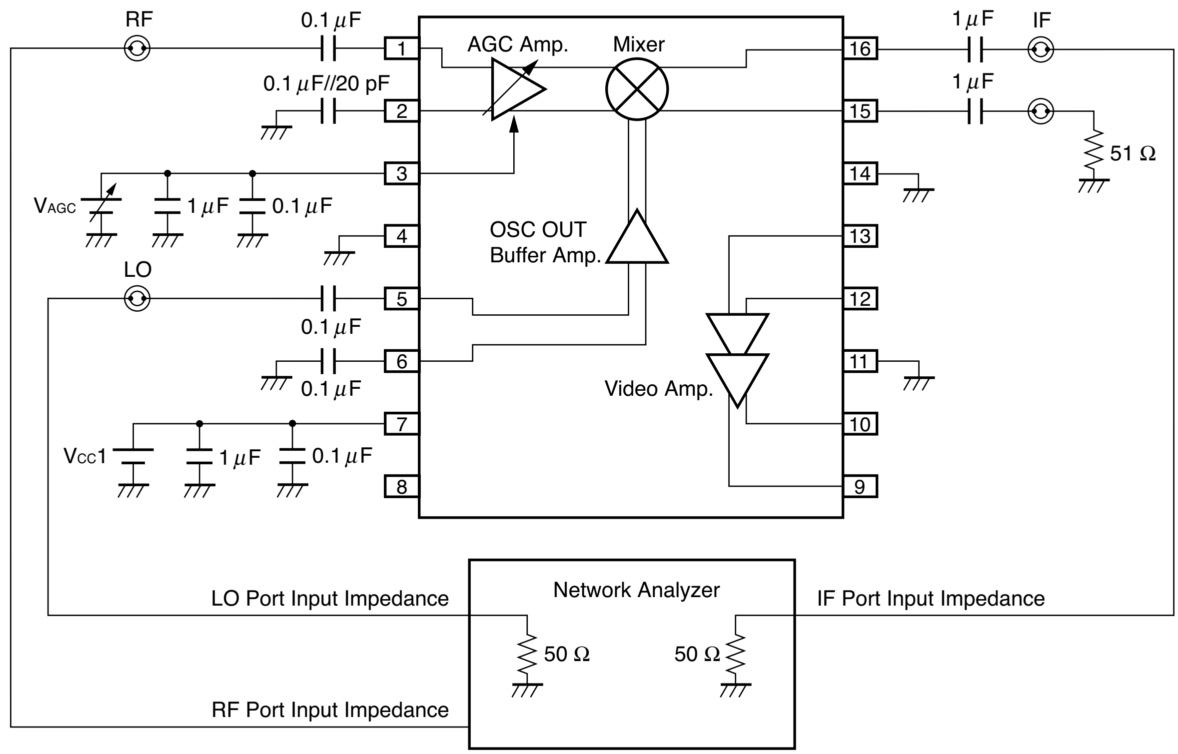
Note Balun Transformer : TOKO 617DB-1010 B4F (Double balanced type)

MEASUREMENT CIRCUIT 2

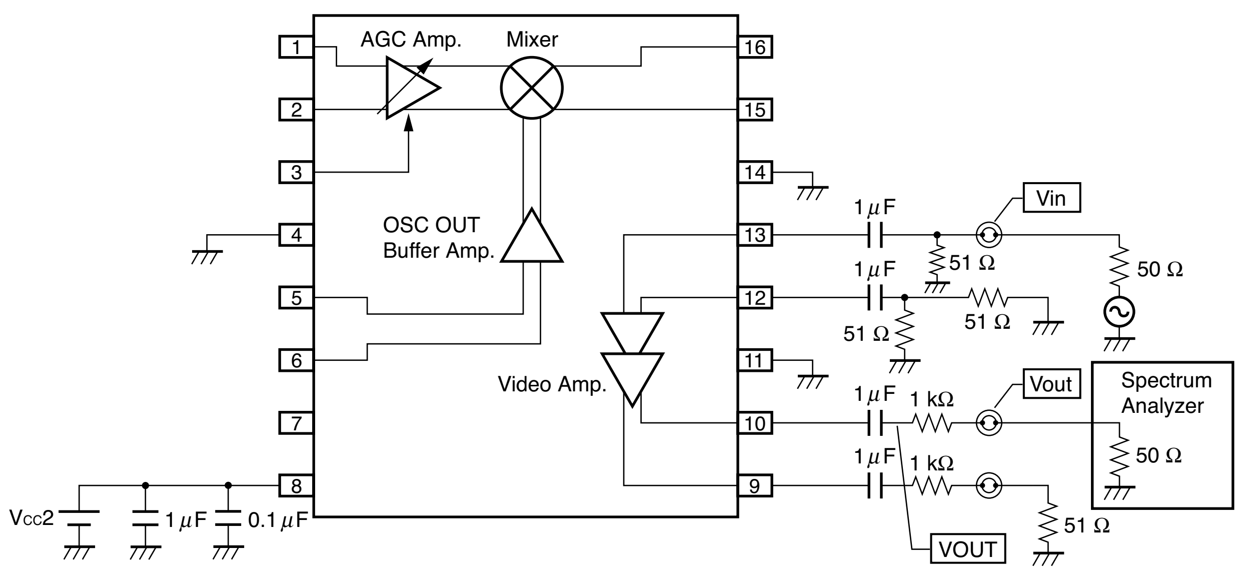


Note Balun Transformer : TOKO 617DB-1010 B4F (Double balanced type)

MEASUREMENT CIRCUIT 3



MEASUREMENT CIRCUIT 4

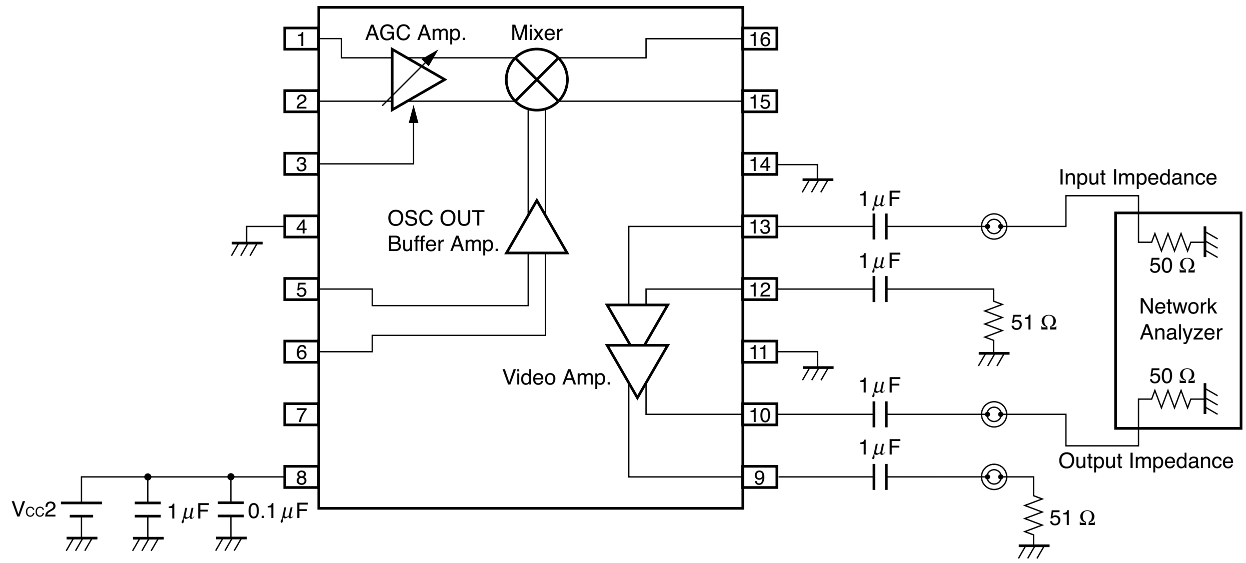


Remarks 1. Voltage Gain (Single Ended) = 20 log (VOUT/Vin) (dB)

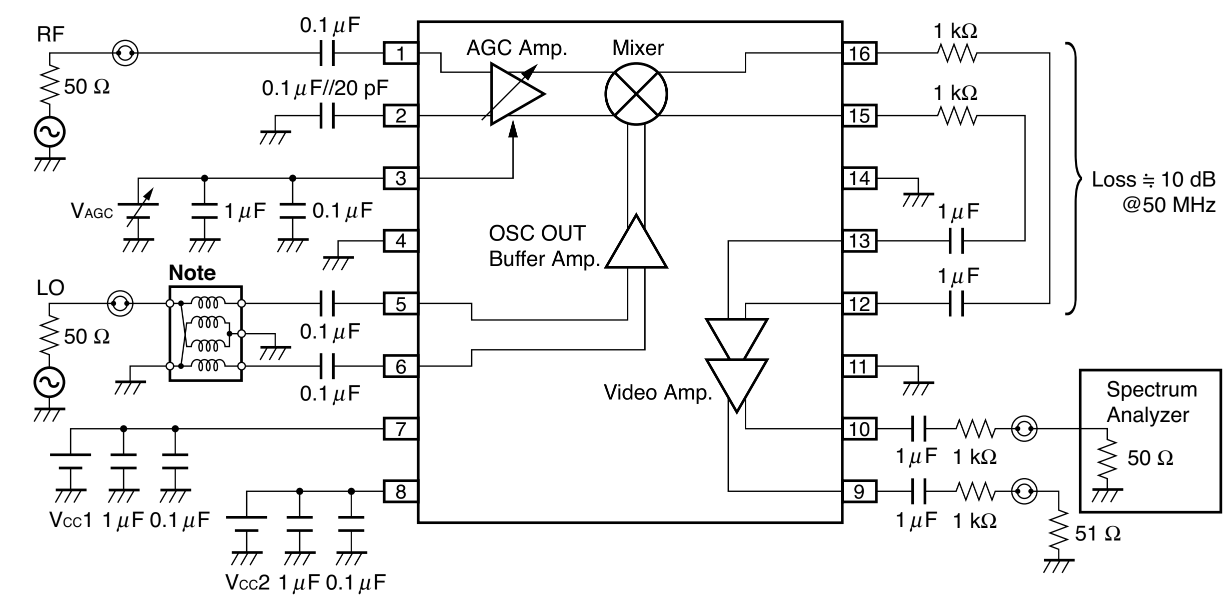
2. Differential Gain (Differential-out) = 20 log (2 × VOUT/Vin) (dB)

3. VOUT = Vout (Measured Value) × (1 050/50)

MEASUREMENT CIRCUIT 5

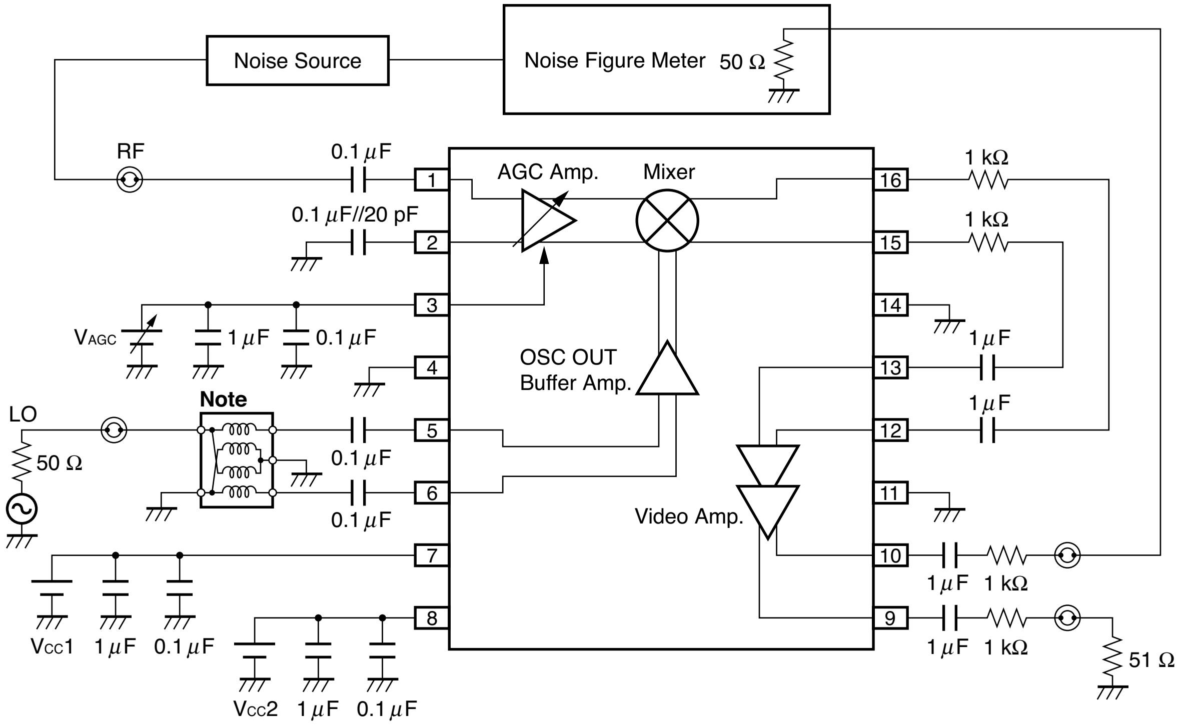


MEASUREMENT CIRCUIT 6



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

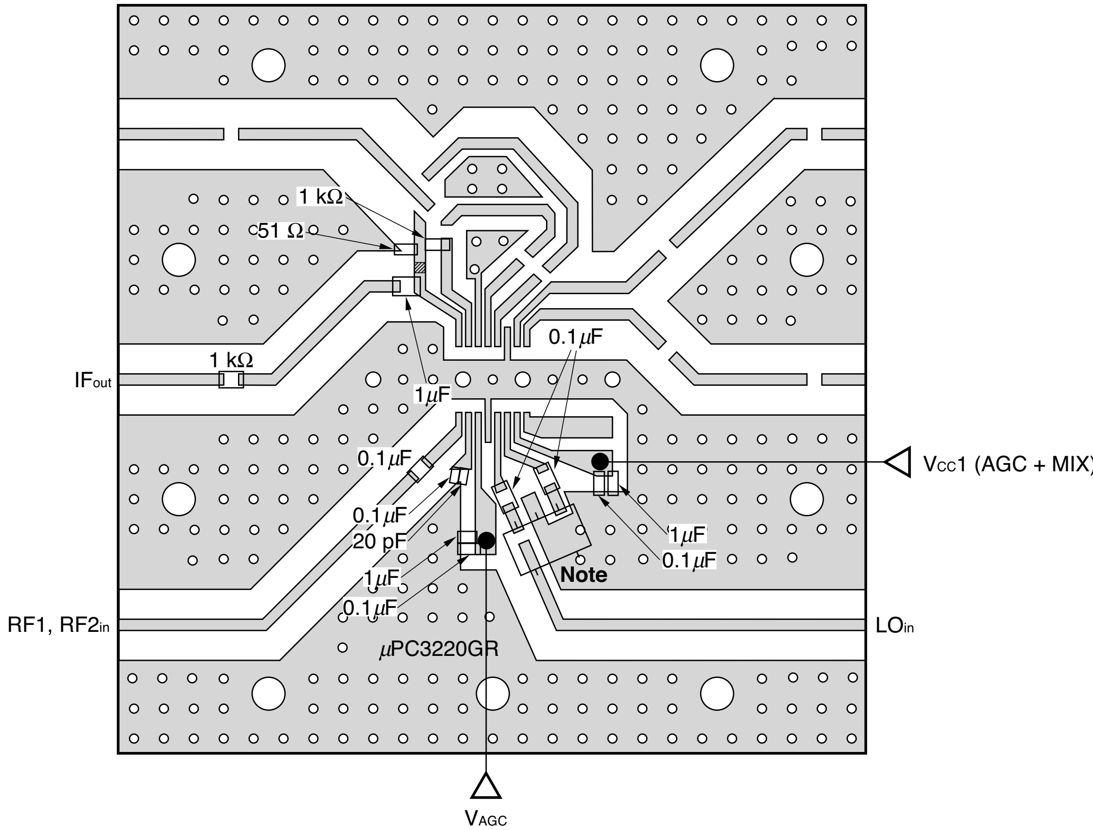
MEASUREMENT CIRCUIT 7



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

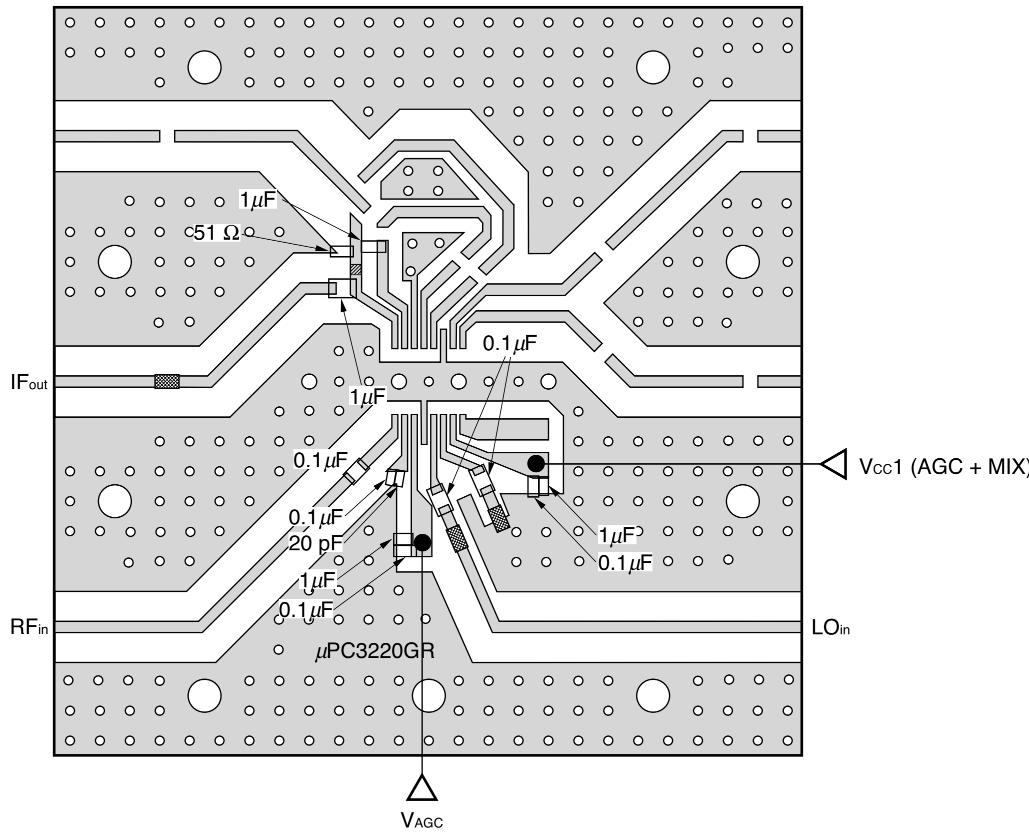


Note Balun Transformer

Remarks

1. Back side: GND pattern
2. Solder plated on pattern
3. ○◯ : Through hole
4. ▨ : Represents cutout

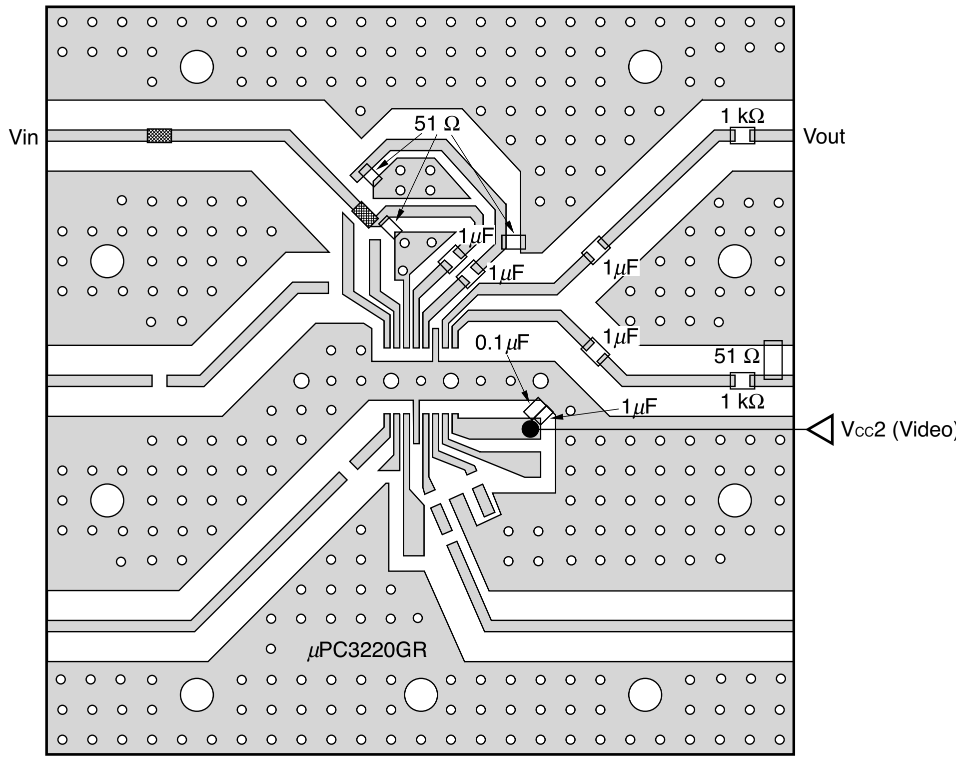
ILLUSTRATION OF THE MEASUREMENT CIRCUIT3 ASSEMBLED ON EVALUATION BOARD



Remarks

1. Back side: GND pattern
2. Solder plated on pattern
3. ○◯ : Through hole
4. ▨ : Represents cutout
5. ▩ : Represents short-circuit strip

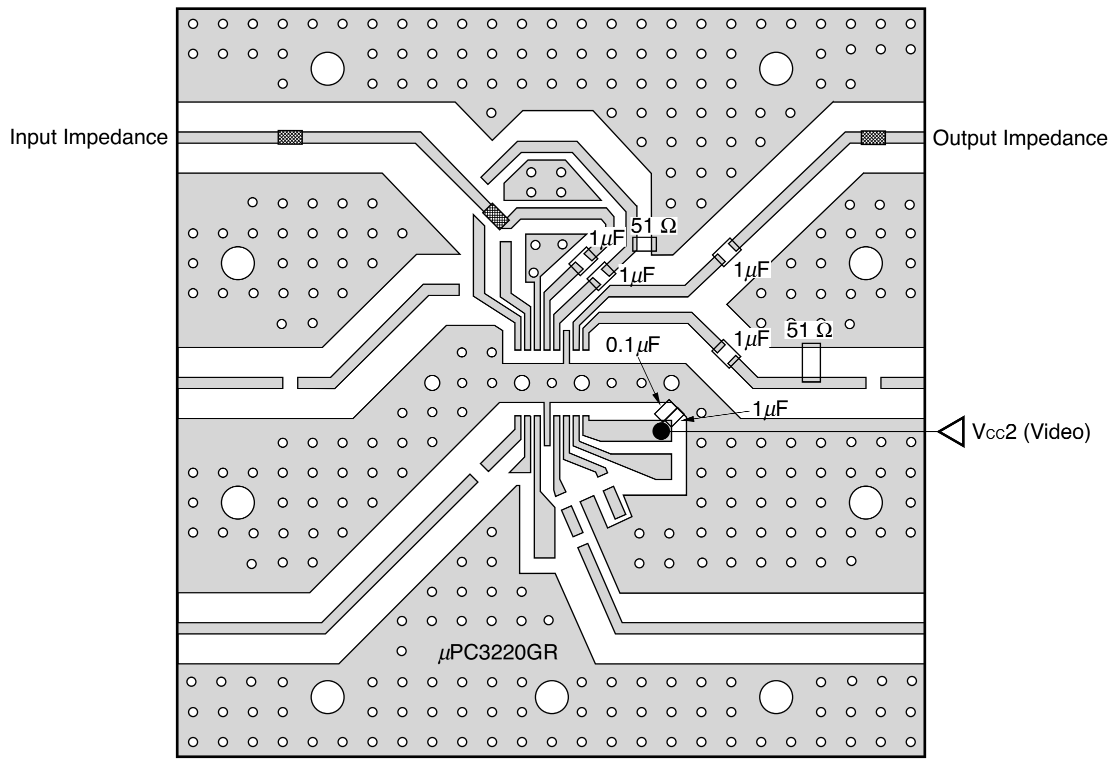
ILLUSTRATION OF THE MEASUREMENT CIRCUIT4 ASSEMBLED ON EVALUATION BOARD



Remarks

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

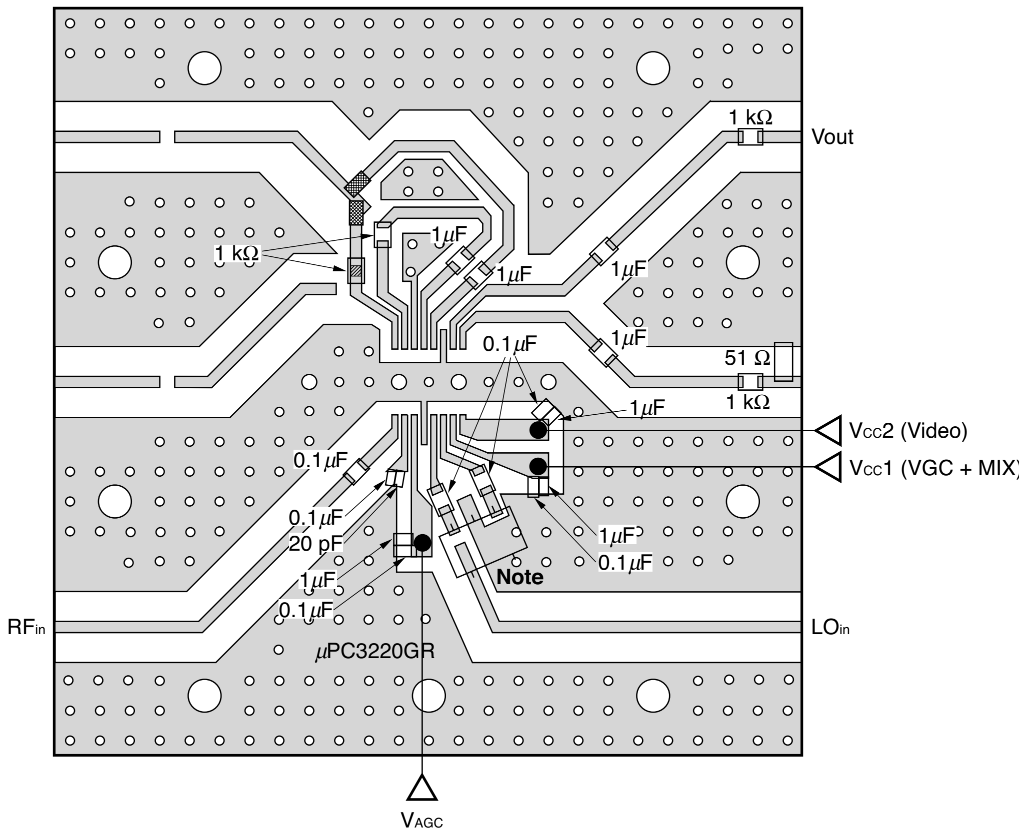
ILLUSTRATION OF THE MEASUREMENT CIRCUIT5 ASSEMBLED ON EVALUATION BOARD



Remarks

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

ILLUSTRATION OF THE MEASUREMENT CIRCUIT6, 7 ASSEMBLED ON EVALUATION BOARD



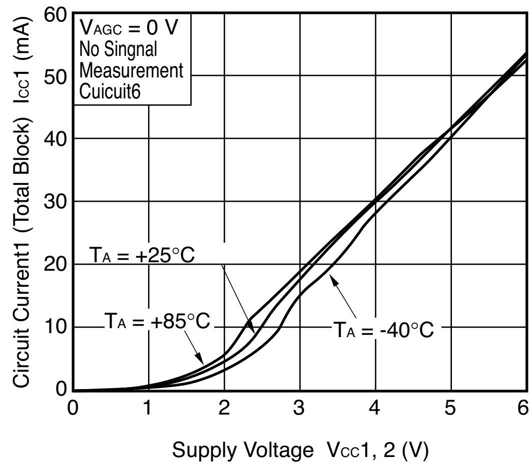
Note Balun Transformer

Remarks

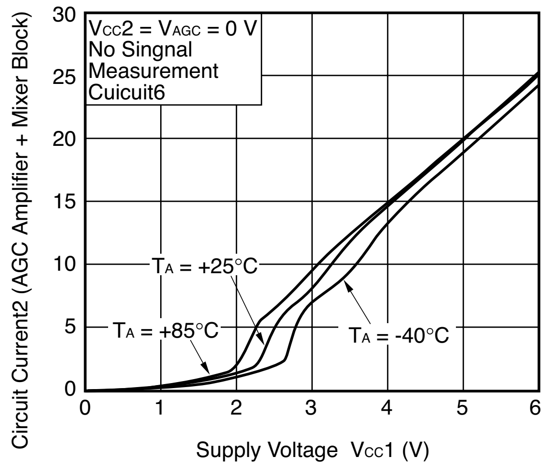
1. Back side: GND pattern
2. Solder plated on pattern
3. ○◯ : Through hole
4. ▨ : Represents cutout
5. ▩ : Represents short-circuit strip

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

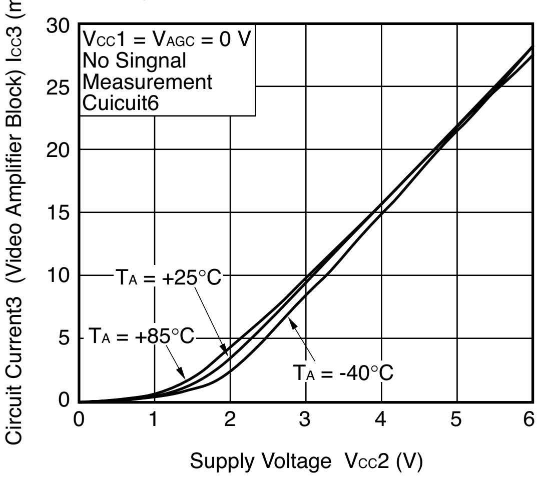
CIRCUIT CURRENT1 (TOTAL BLOCK) vs. SUPPLY VOLTAGE



CIRCUIT CURRENT2 (AGC AMPLIFIER + MIXER BLOCK) vs. SUPPLY VOLTAGE

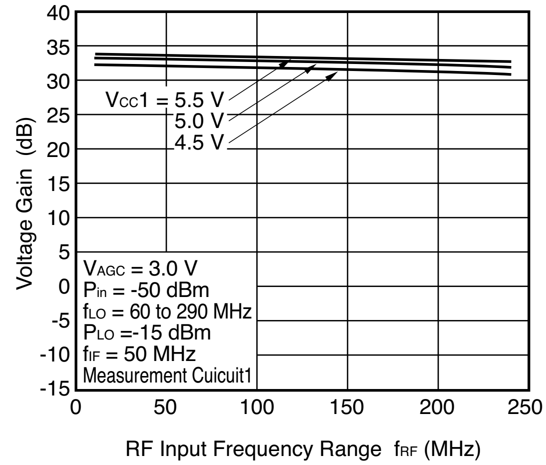


CIRCUIT CURRENT3 (VIDEO AMPLIFIER BLOCK) vs. SUPPLY VOLTAGE

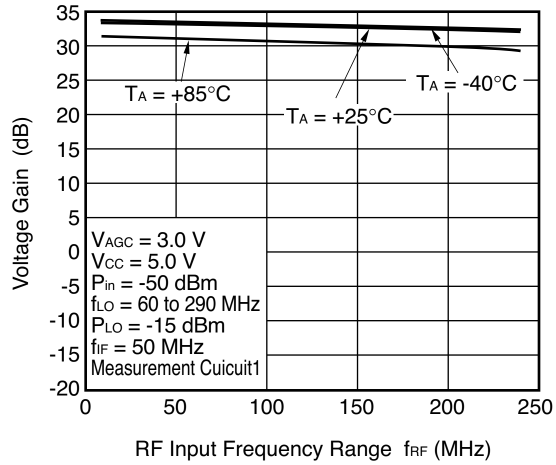


Remark The graphs indicate nominal characteristics.

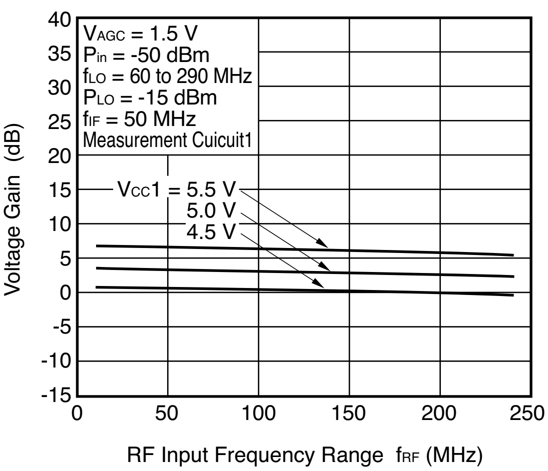
VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE



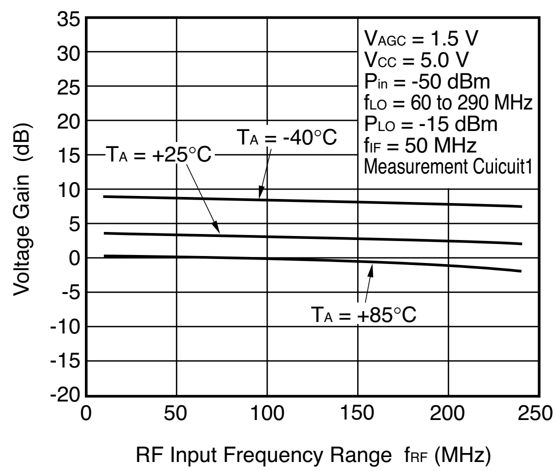
VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE



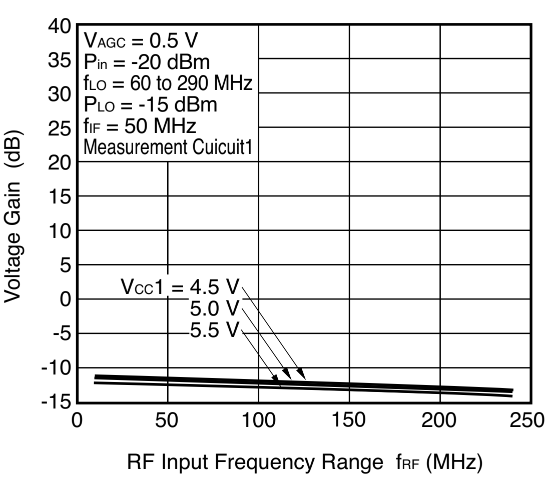
VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE



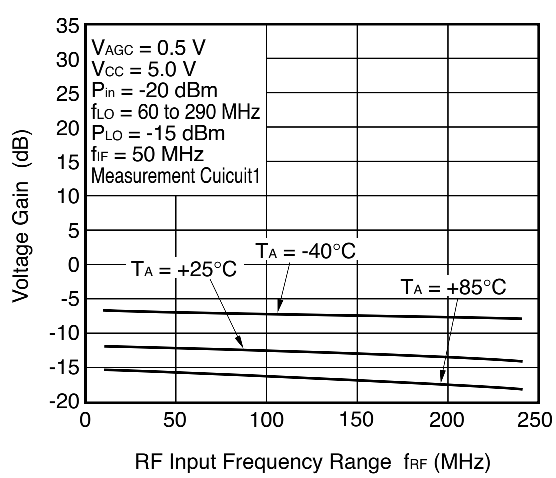
VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE



VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE

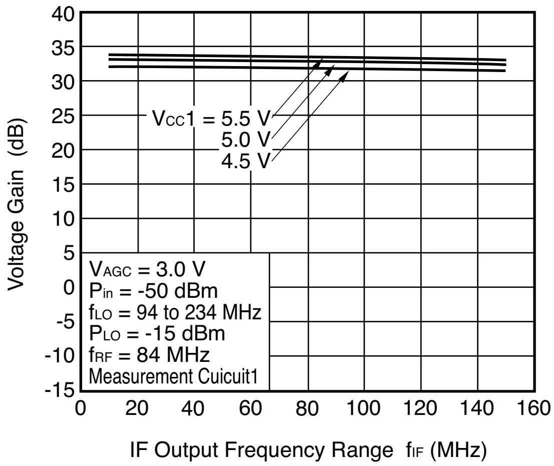


VOLTAGE GAIN vs.
RF INPUT FREQUENCY RANGE

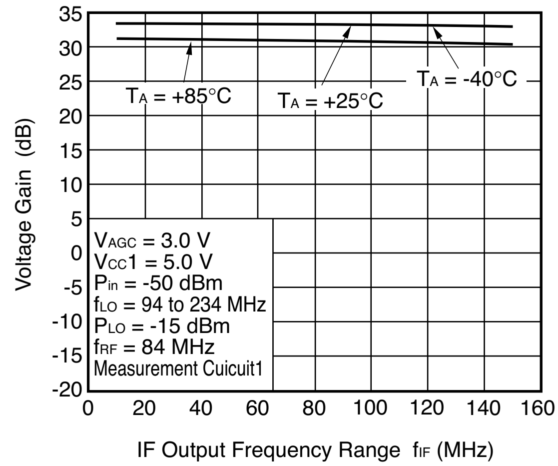


Remark The graphs indicate nominal characteristics.

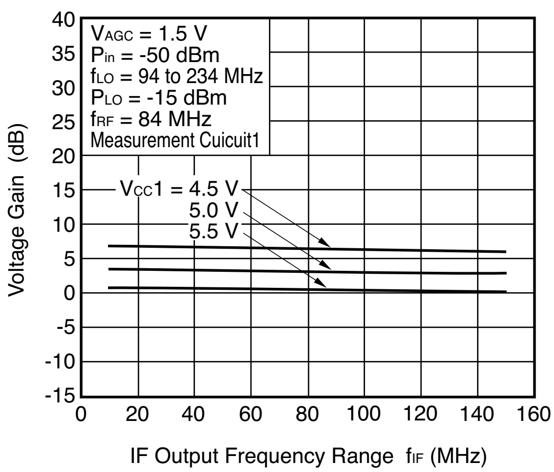
VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE



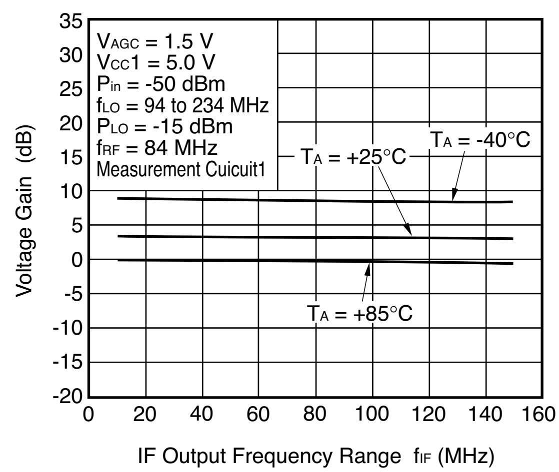
VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE



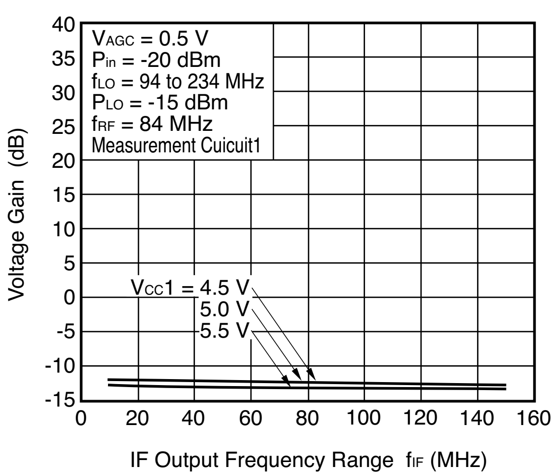
VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE



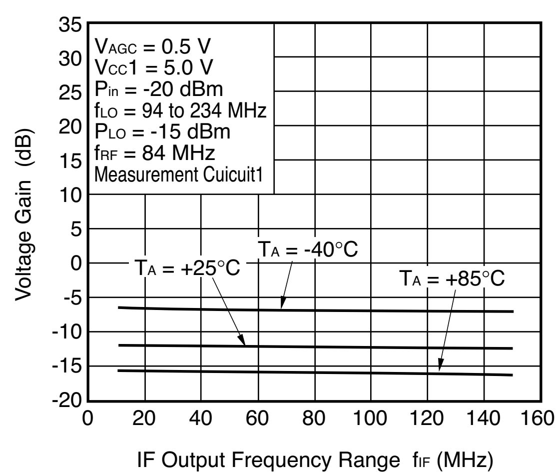
VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE



VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE

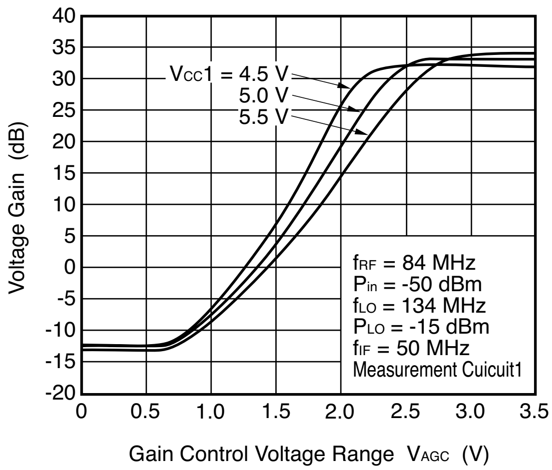


VOLTAGE GAIN vs.
IF OUTPUT FREQUENCY RANGE

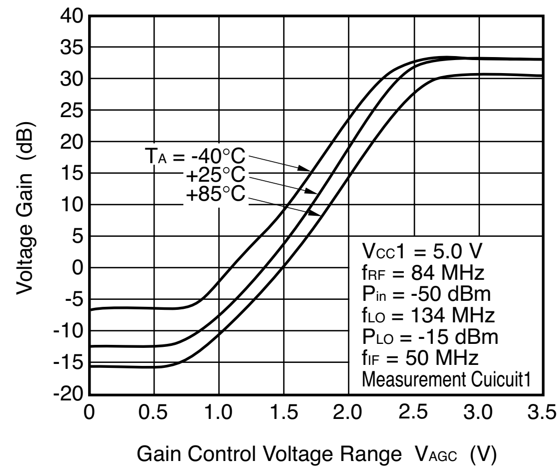


Remark The graphs indicate nominal characteristics.

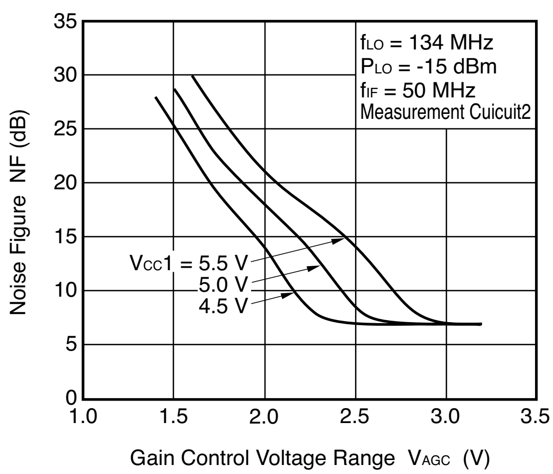
VOLTAGE GAIN vs.
GAIN CONTROL VOLTAGE RANGE



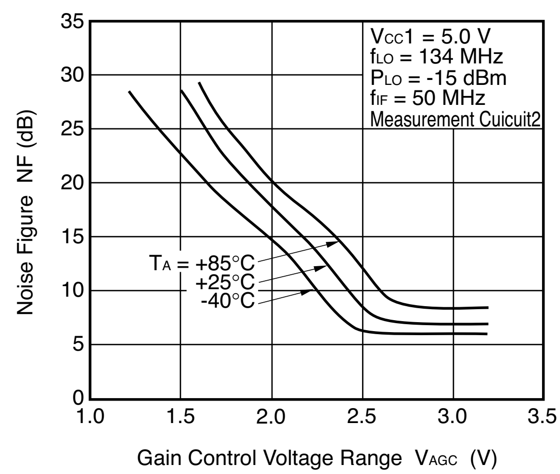
VOLTAGE GAIN vs.
GAIN CONTROL VOLTAGE RANGE



NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE

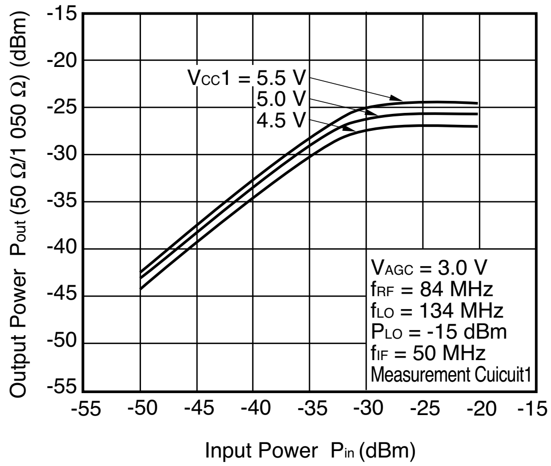


NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE

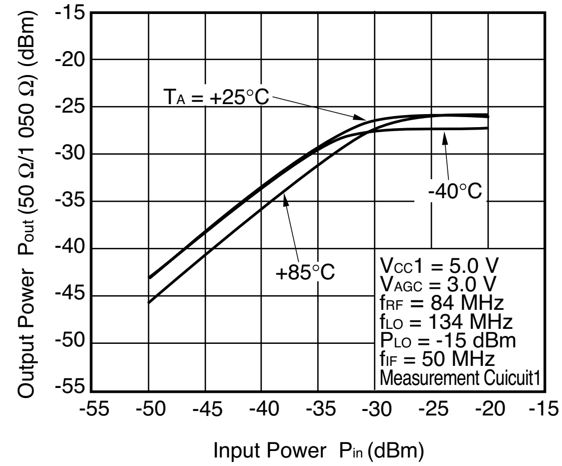


Remark The graphs indicate nominal characteristics.

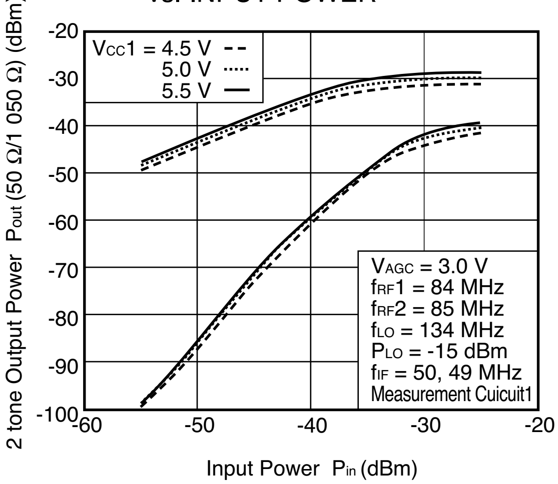
OUTPUT POWER vs. INPUT POWER



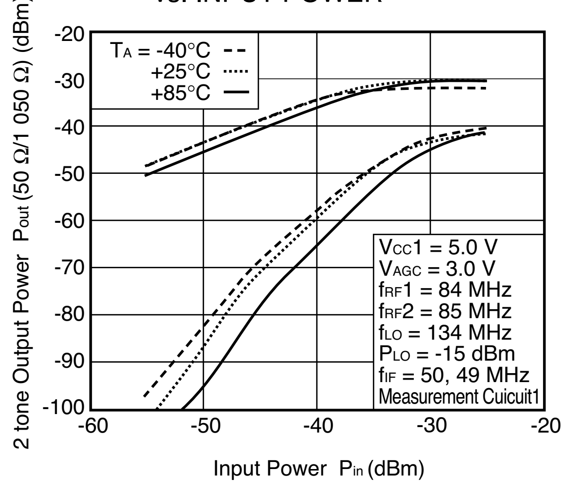
OUTPUT POWER vs. INPUT POWER



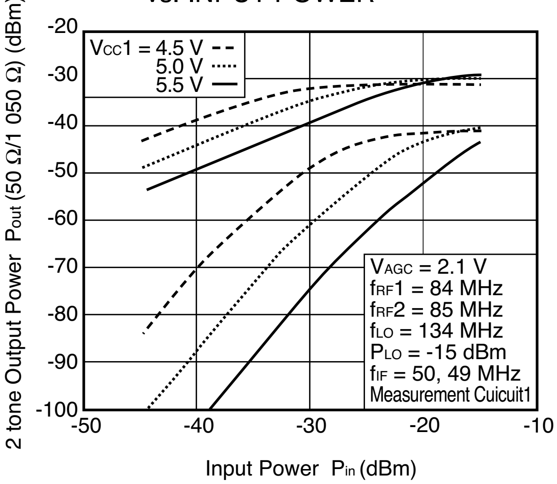
2 TONE OUTPUT POWER
vs. INPUT POWER



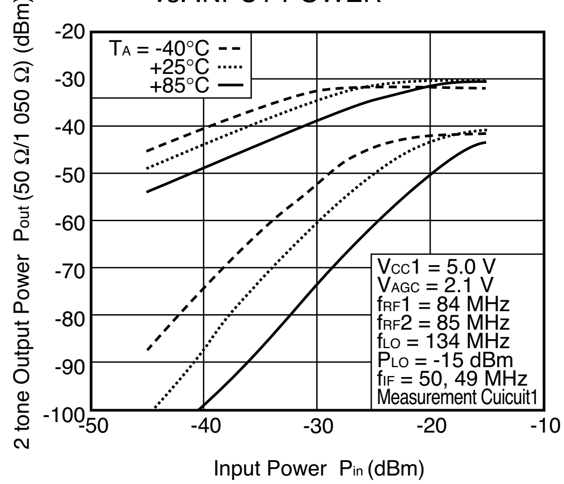
2 TONE OUTPUT POWER
vs. INPUT POWER



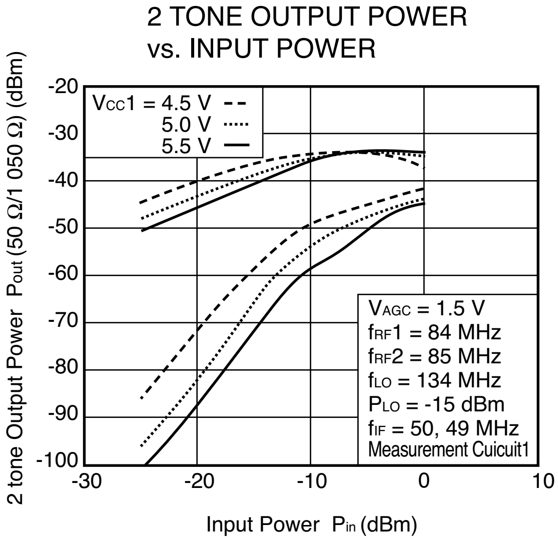
2 TONE OUTPUT POWER
vs. INPUT POWER

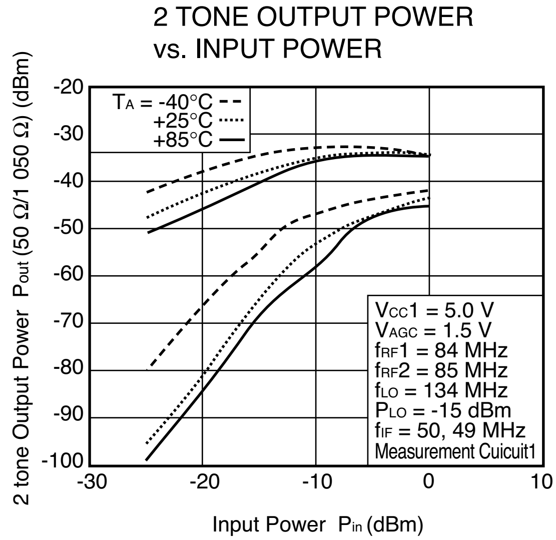


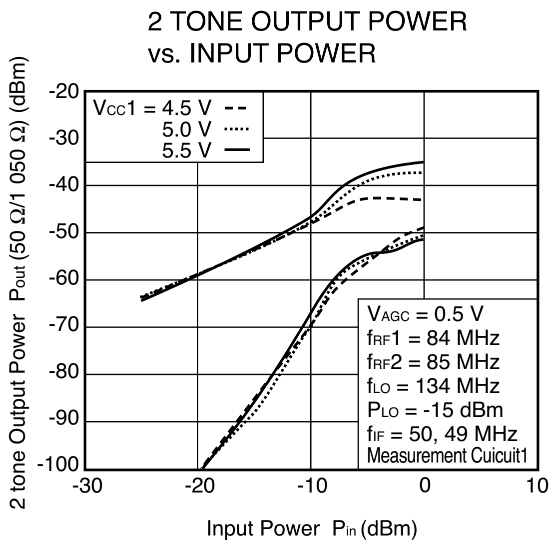
2 TONE OUTPUT POWER
vs. INPUT POWER

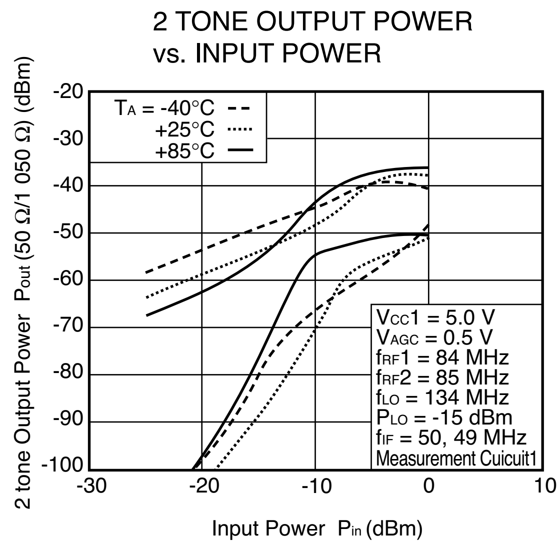


Remark The graphs indicate nominal characteristics.





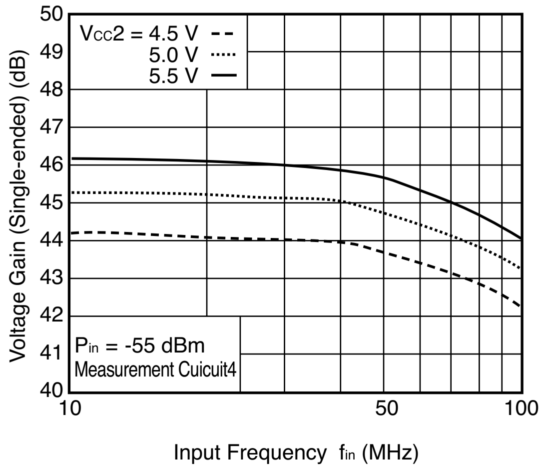




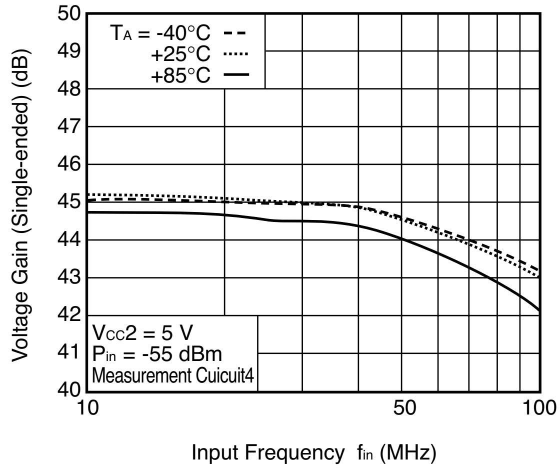
Remark The graphs indicate nominal characteristics.

–Video Amplifier Block–

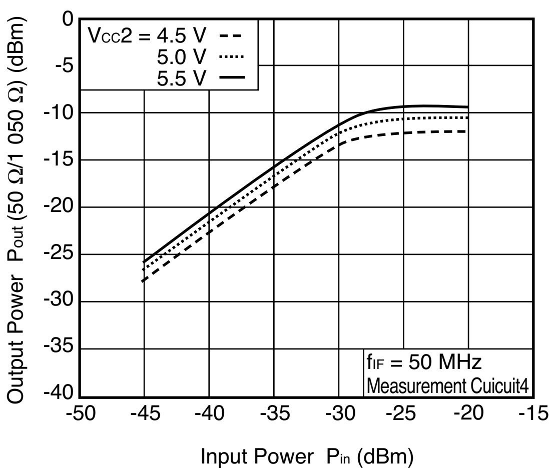
VOLTAGE GAIN (SINGLE-ENDED)
vs. INPUT FREQUENCY



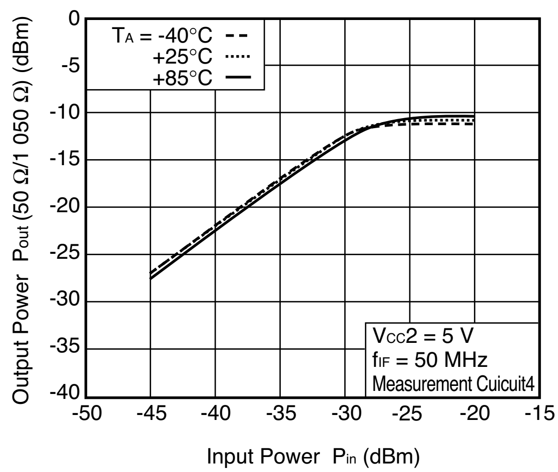
VOLTAGE GAIN (SINGLE-ENDED)
vs. INPUT FREQUENCY



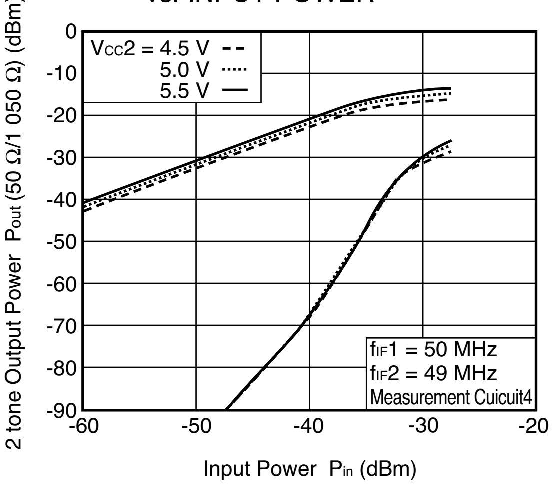
OUTPUT POWER vs. INPUT POWER



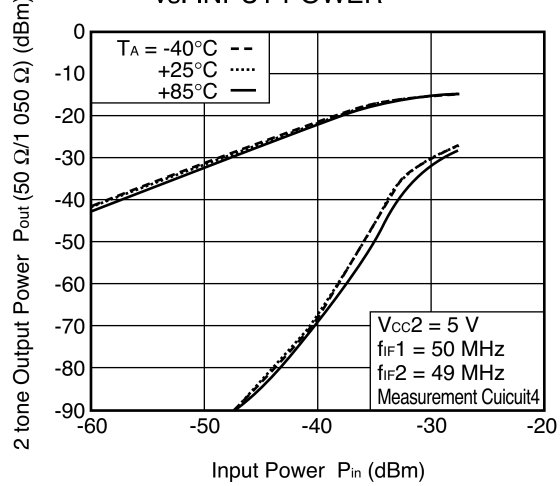
OUTPUT POWER vs. INPUT POWER



2 TONE OUTPUT POWER
vs. INPUT POWER



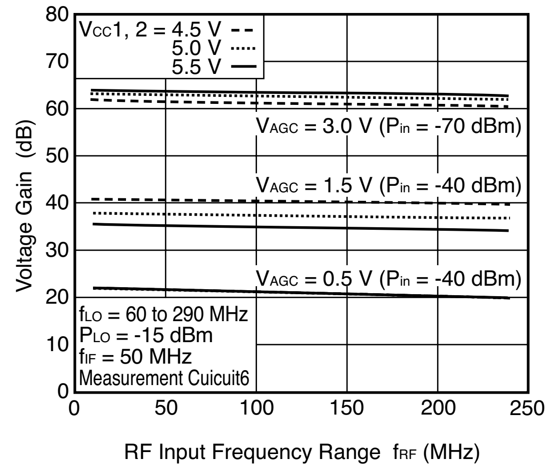
2 TONE OUTPUT POWER
vs. INPUT POWER



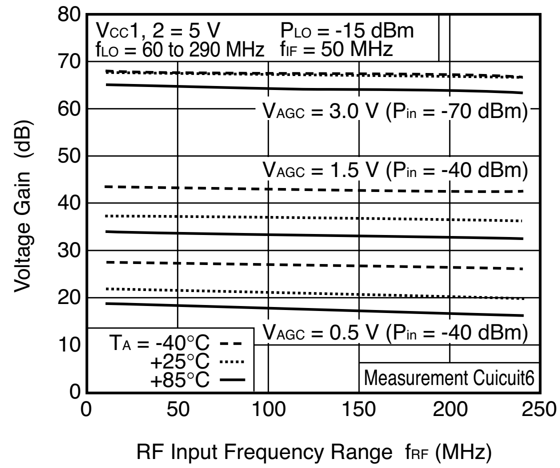
Remark The graphs indicate nominal characteristics.

–Total Block–

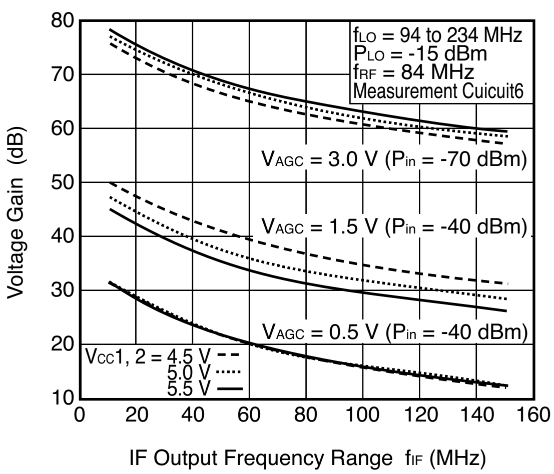
VOLTAGE GAIN
vs. RF INPUT FREQUENCY RANGE



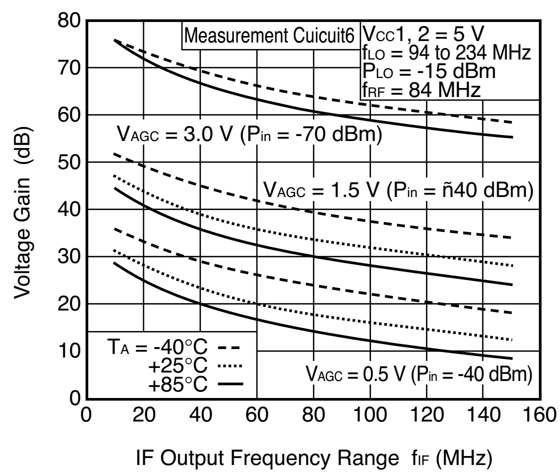
VOLTAGE GAIN
vs. RF INPUT FREQUENCY RANGE



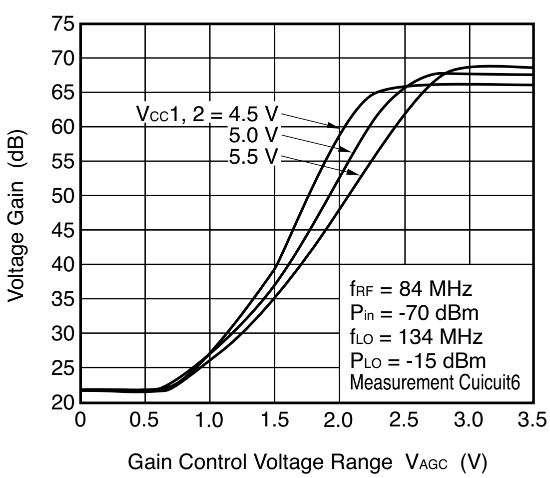
VOLTAGE GAIN
vs. IF OUTPUT FREQUENCY RANGE



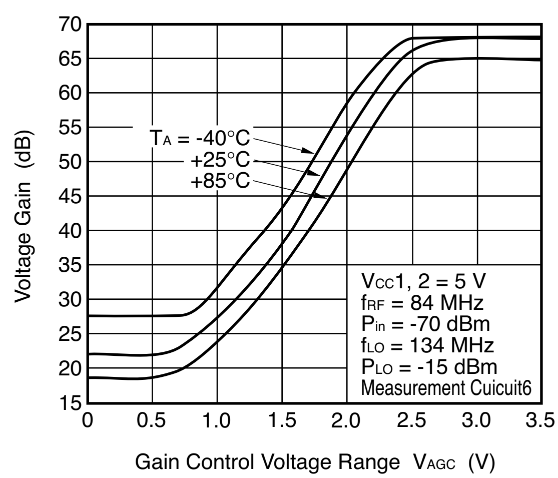
VOLTAGE GAIN
vs. IF OUTPUT FREQUENCY RANGE



VOLTAGE GAIN
vs. GAIN CONTROL VOLTAGE RANGE

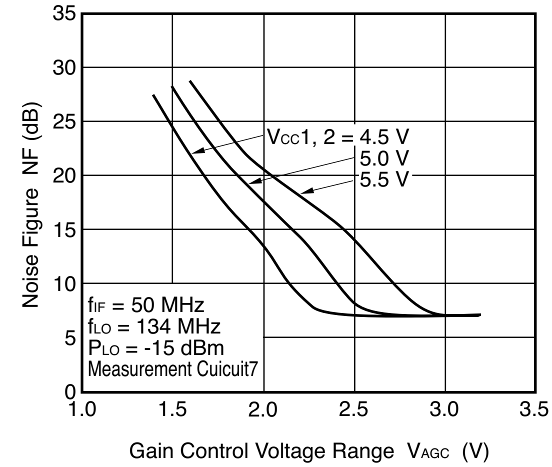


VOLTAGE GAIN
vs. GAIN CONTROL VOLTAGE RANGE

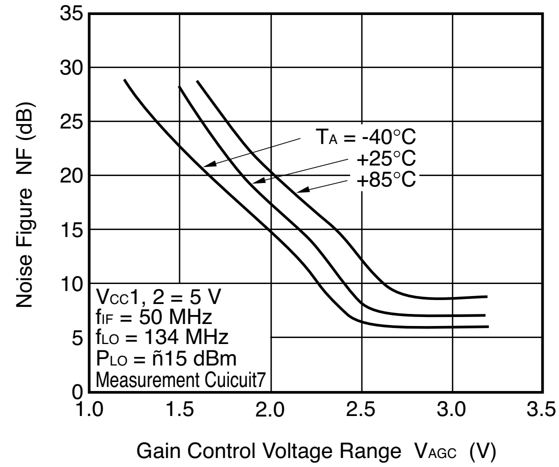


Remark The graphs indicate nominal characteristics.

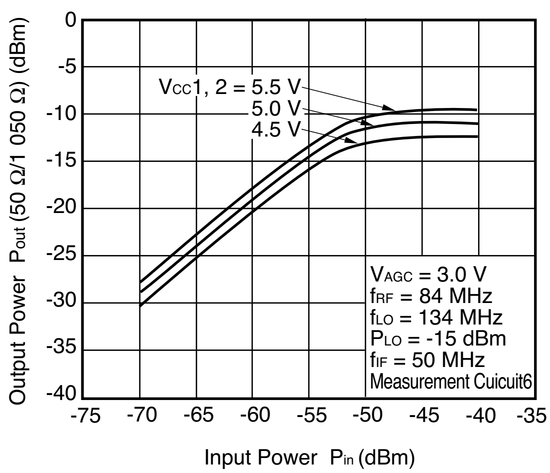
NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE



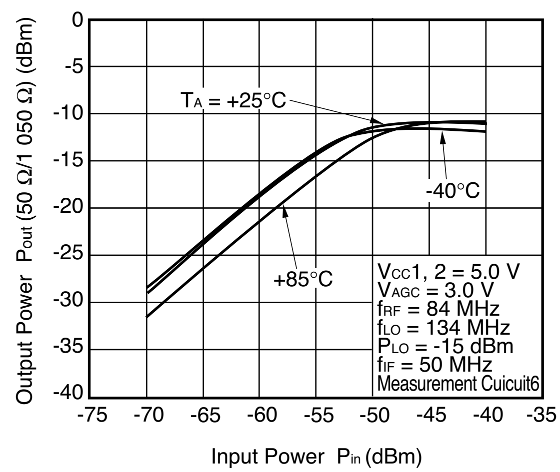
NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE



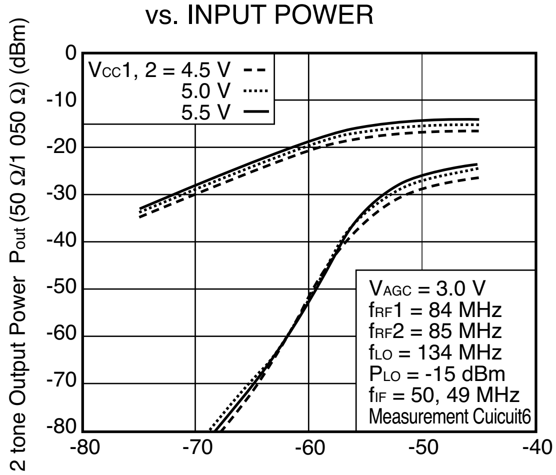
OUTPUT POWER vs. INPUT POWER



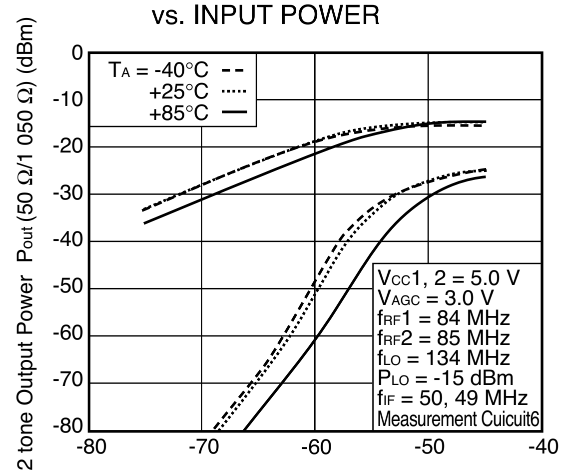
OUTPUT POWER vs. INPUT POWER



2 TONE OUTPUT POWER
vs. INPUT POWER

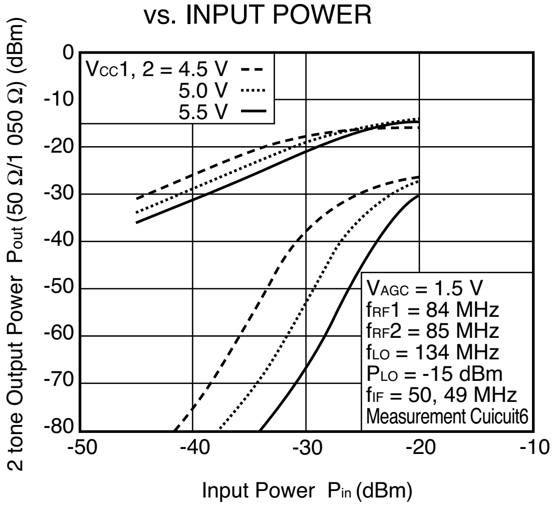


2 TONE OUTPUT POWER
vs. INPUT POWER

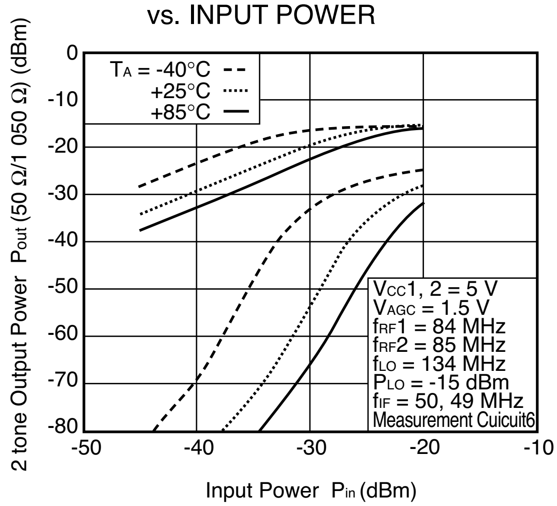


Remark The graphs indicate nominal characteristics.

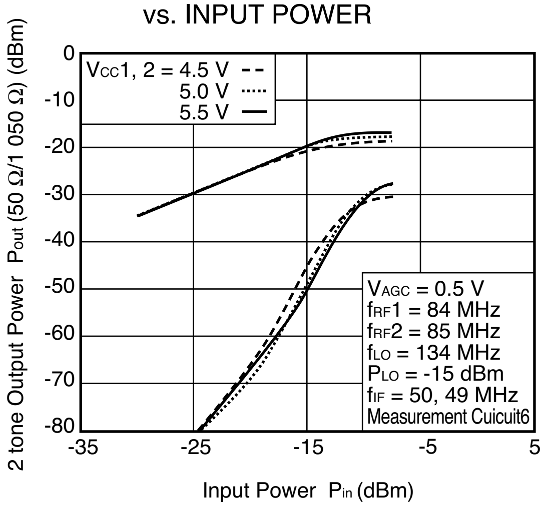
2 TONE OUTPUT POWER
vs. INPUT POWER



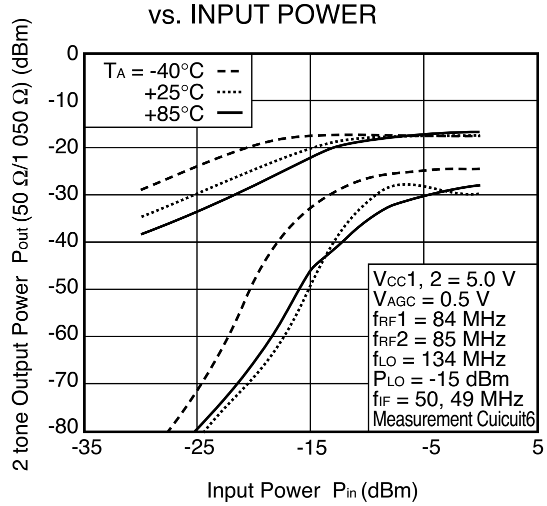
2 TONE OUTPUT POWER
vs. INPUT POWER



2 TONE OUTPUT POWER
vs. INPUT POWER

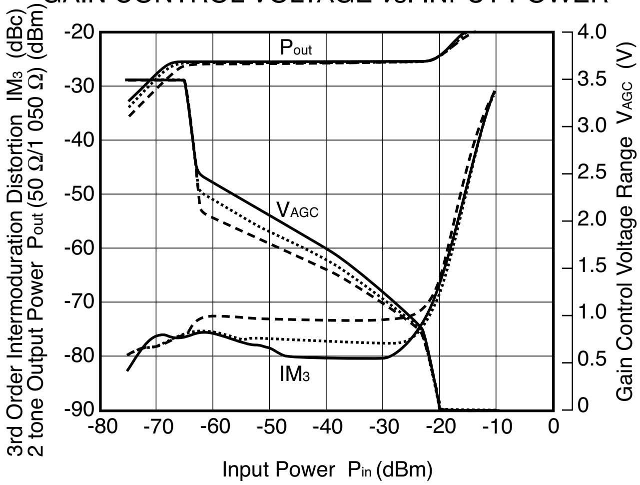


2 TONE OUTPUT POWER
vs. INPUT POWER



Remark The graphs indicate nominal characteristics.

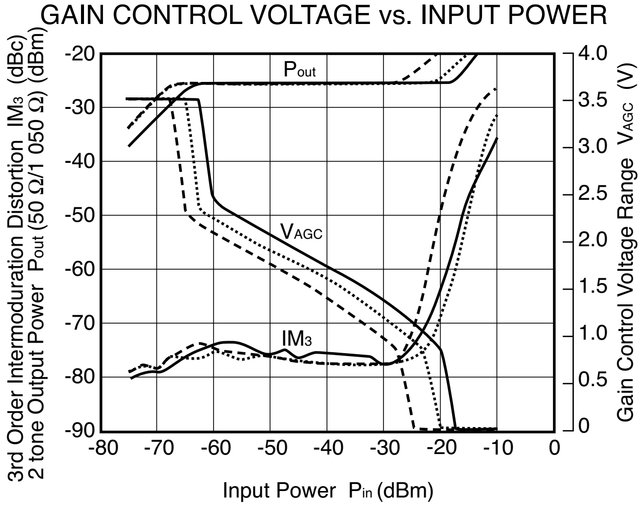
IM3, 2 TONE OUTPUT POWER,
GAIN CONTROL VOLTAGE vs. INPUT POWER



Vcc1, 2 = 4.5 V
5.0 V
5.5 V

Conditions
fRF1 = 84 MHz
fRF2 = 85 MHz
fLO = 134 MHz
PLO = -15 dBm
fIF = 50, 49 MHz
@Vout = 0.7 Vp-p/tone
Measurement Cuicuit6

IM3, 2 TONE OUTPUT POWER,
GAIN CONTROL VOLTAGE vs. INPUT POWER



TA = -40°C
+25°C
+85°C

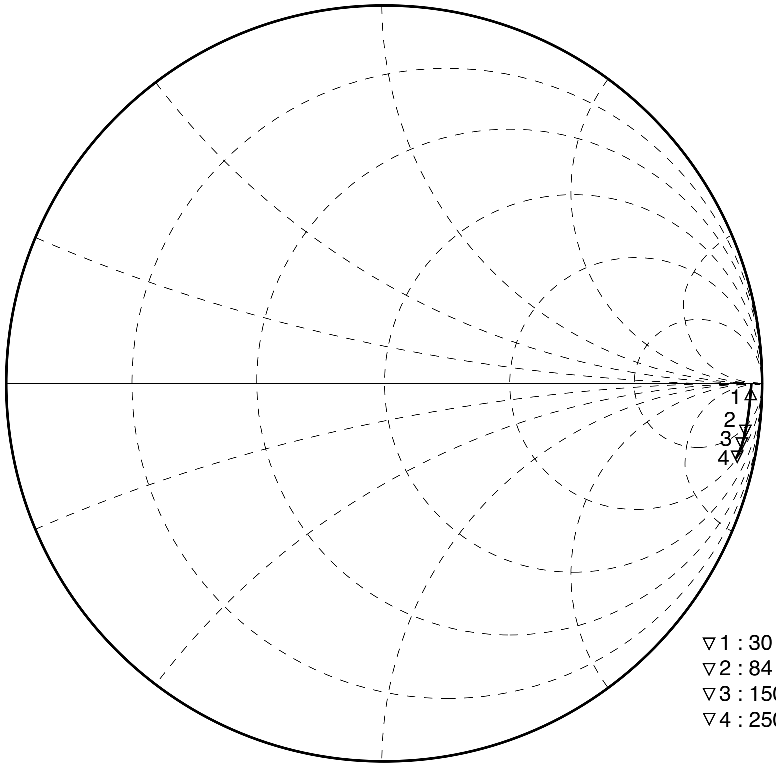
Conditions
fRF1 = 84 MHz
fRF2 = 85 MHz
fLO = 134 MHz
PLO = -15 dBm
fIF = 50, 49 MHz
@Vout = 0.7 Vp-p/tone
Measurement Cuicuit6

Remark The graphs indicate nominal characteristics.

S-PARAMETERS

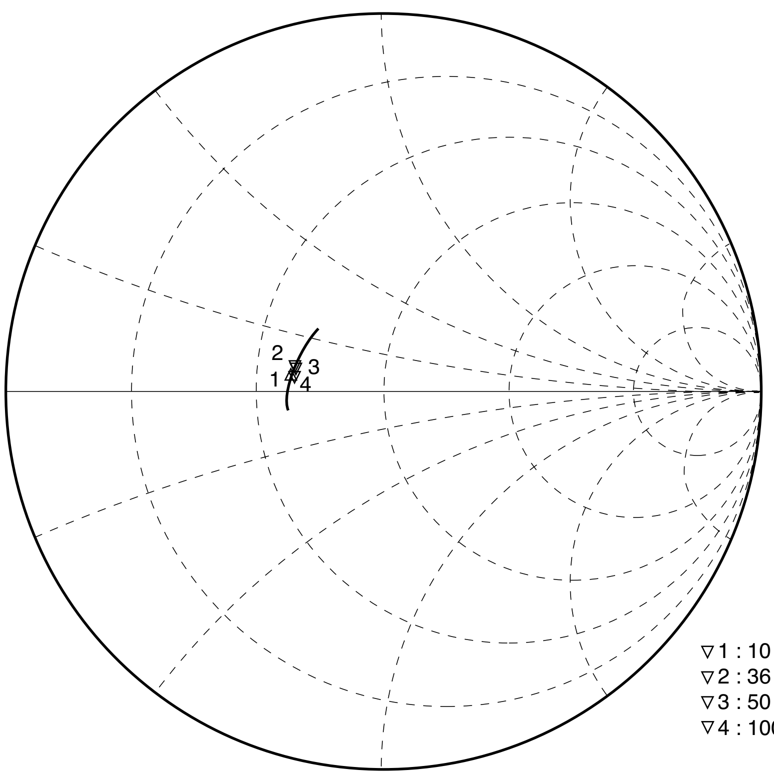
–AGC Amplifier Block + Mixer Block (Vcc1 = 5.0 V, VAGC = 3.0 V, by measurement circuit 3)

MIXER RF Input Impedance



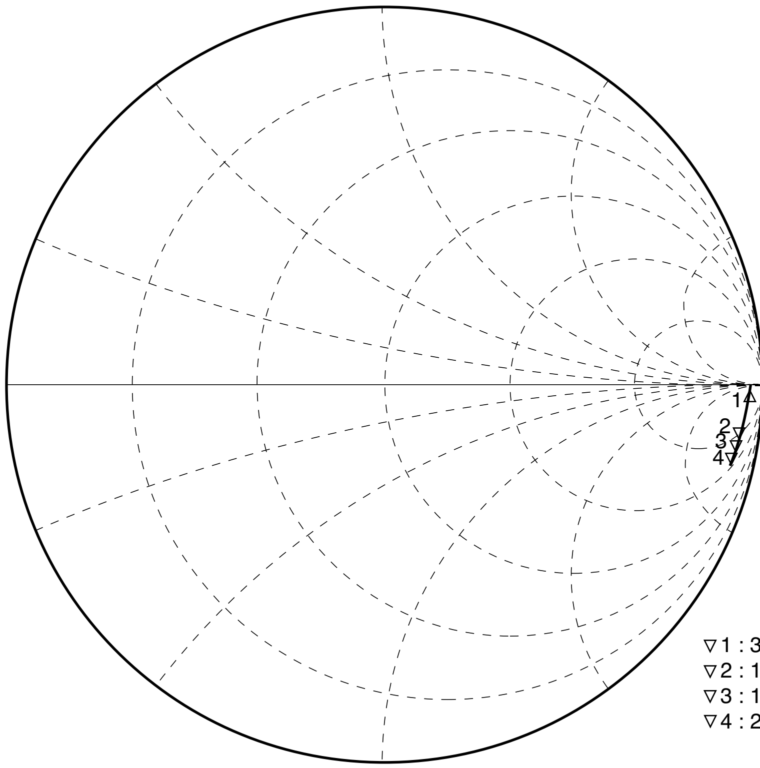
▽1 : 30 MHz	1.830 kΩ	-1.603 kΩ	3.309 pF
▽2 : 84 MHz	443.0 Ω	-1.096 kΩ	1.730 pF
▽3 : 150 MHz	207.4 Ω	-728.7 Ω	1.456 pF
▽4 : 250 MHz	109.7 Ω	-454.1 Ω	1.402 pF

MIXER RF Output Impedance



▽1 : 10 MHz	29.48 Ω	634.6 mΩ	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

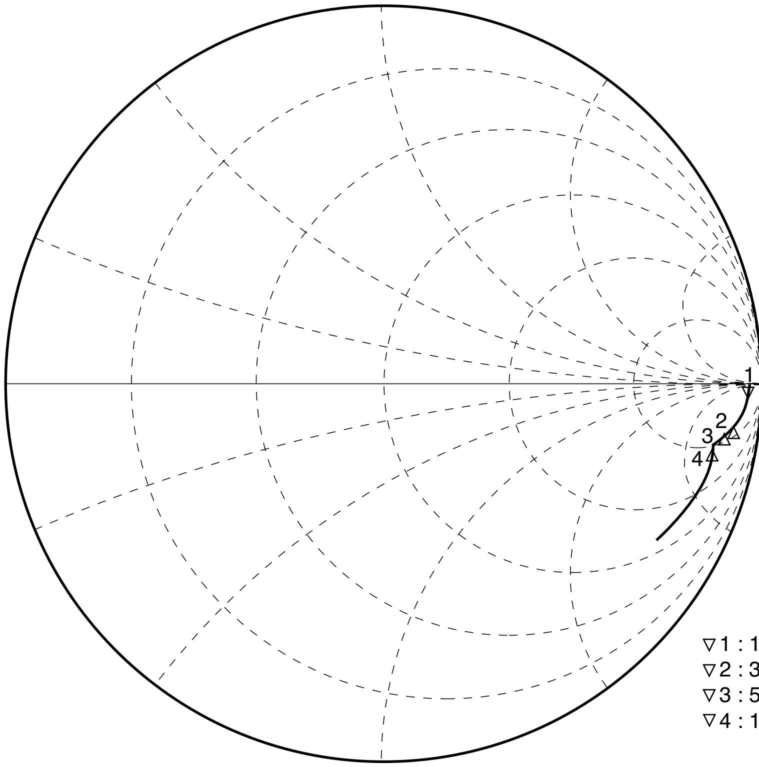
MIXER OSC Input Impedance



▽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

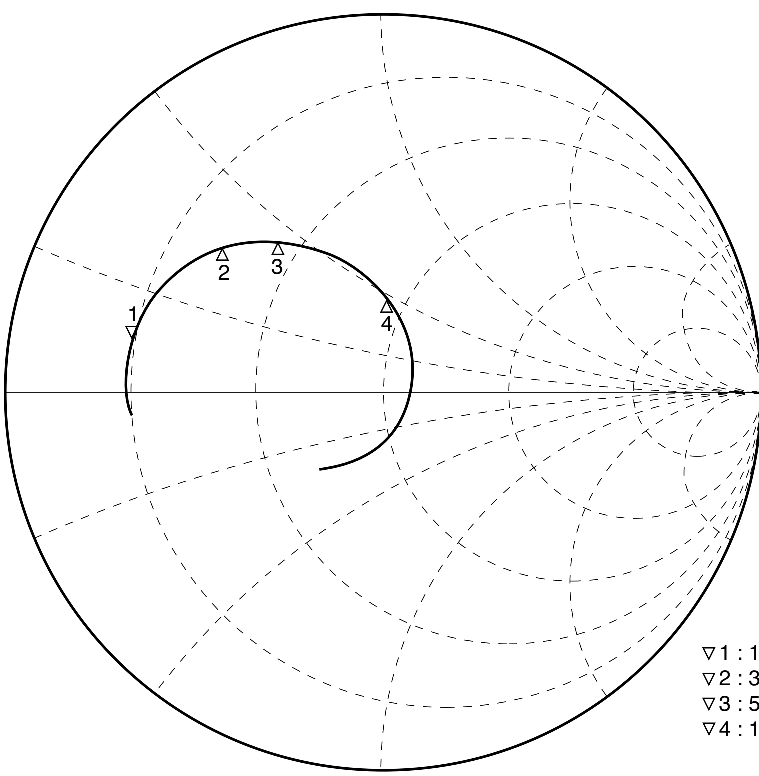
–Video Amplifier Block (Vcc2 = 5.0 V, by measurement circuit 5)

Video Amplifier Input Impedance



▽1 : 10 MHz	1.187 kΩ	-1.177 kΩ	13.54 pF
▽2 : 36 MHz	389.8 Ω	-588.3 Ω	7.516 pF
▽3 : 50 MHz	333.4 Ω	-481.1 Ω	6.617 pF
▽4 : 100 MHz	245.5 Ω	-369.7 Ω	4.304 pF

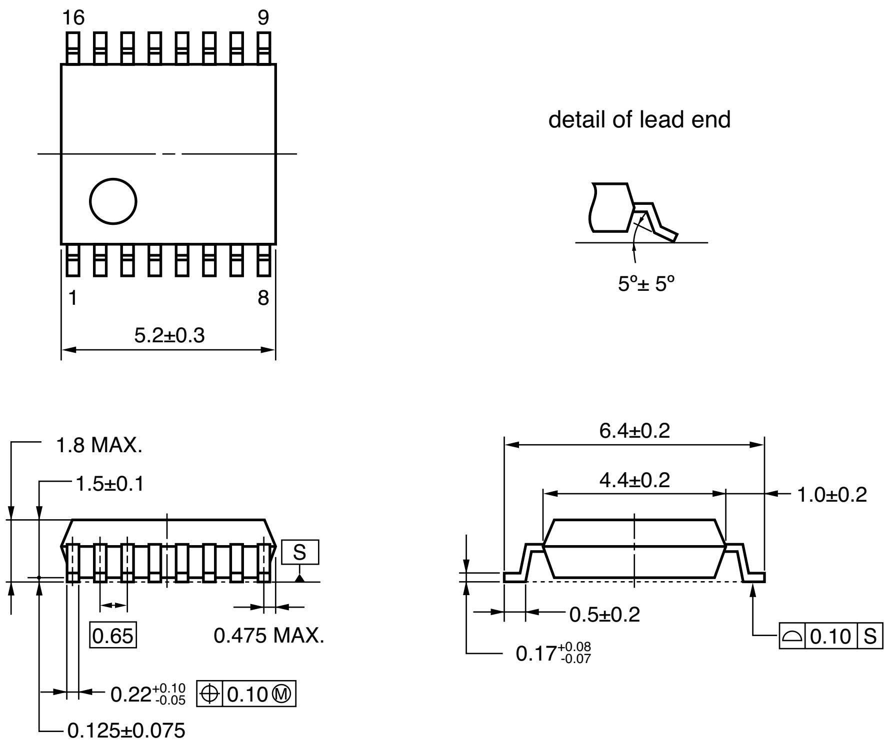
Video Amplifier Output Impedance



▽1 : 10 MHz	10.04 Ω	5.225 Ω	83.16 nH
▽2 : 36 MHz	15.86 Ω	17.70 Ω	78.25 nH
▽3 : 50 MHz	21.54 Ω	22.61 Ω	71.96 nH
▽4 : 100 MHz	45.48 Ω	23.89 Ω	38.02 nH

PACKAGE DIMENSIONS

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



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	IR260
	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	
Wave Soldering	Peak temperature (molten solder temperature)	: 260°C or below	WS260
	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	
Partial Heating	Peak temperature (pin temperature)	: 350°C or below	HS350
	Soldering time (per side of device)	: 3 seconds or less	
	Maximum chlorine content of rosin flux (% mass)	: 0.2%(Wt.) or below	

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

CEL California Eastern Laboratories, Your source for NEC RF, Microwave, Optoelectronic, and Fiber Optic Semiconductor Devices.
4590 Patrick Henry Drive • Santa Clara, CA 95054-1817 • (408) 988-3500 • FAX (408) 988-0279 • **www.cel.com**

CEL California Eastern Laboratories

4590 Patrick Henry Drive
Santa Clara, CA 95054-1817
Telephone: (408) 919-2500
Facsimile: (408) 988-0279

Subject: Compliance with EU Directives

CEL certifies, to its knowledge, that semiconductor and laser products detailed below are compliant with the requirements of European Union (EU) Directive 2002/95/EC Restriction on Use of Hazardous Substances in electrical and electronic equipment (RoHS) and the requirements of EU Directive 2003/11/EC Restriction on Penta and Octa BDE.

CEL Pb-free products have the same base part number with a suffix added. The suffix –A indicates that the device is Pb-free. The –AZ suffix is used to designate devices containing Pb which are exempted from the requirement of RoHS directive (*). In all cases the devices have Pb-free terminals. All devices with these suffixes meet the requirements of the RoHS directive.

This status is based on CEL's understanding of the EU Directives and knowledge of the materials that go into its products as of the date of disclosure of this information.

Restricted Substance per RoHS	Concentration Limit per RoHS (values are not yet fixed)	Concentration contained in CEL devices	
		-A	-AZ
Lead (Pb)	< 1000 PPM	Not Detected	(*)
Mercury	< 1000 PPM	Not Detected	
Cadmium	< 100 PPM	Not Detected	
Hexavalent Chromium	< 1000 PPM	Not Detected	
PBB	< 1000 PPM	Not Detected	
PBDE	< 1000 PPM	Not Detected	

If you should have any additional questions regarding our devices and compliance to environmental standards, please do not hesitate to contact your local representative.

Important Information and Disclaimer: Information provided by CEL on its website or in other communications concerning the substance content of its products represents knowledge and belief as of the date that it is provided. CEL bases its knowledge and belief on information provided by third parties and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. CEL has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. CEL and CEL suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.
In no event shall CEL's liability arising out of such information exceed the total purchase price of the CEL part(s) at issue sold by CEL to customer on an annual basis.
See CEL Terms and Conditions for additional clarification of warranties and liability.