μPC3221GV

5 V AGC AMPLIFIER + VIDEO AMPLIFIER

DESCRIPTION

The μPC3221GV is a silicon monolithic IC designed for use as AGC amplifier for digital CATV, cable modem systems. This IC consists of gain control amplifier and video amplifier.

The package is 8-pin SSOP 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, uniformity and reliability.

FEATURES

- Low distortion : IM_3 = 56 dBc TYP. @ single-ended output, V_{out} = 0.7 V_{p-p}/tone
- Low noise figure : NF = 4.2 dB TYP.
- Wide AGC dynamic range : GCR = 50 dB TYP. @ input prescribe
- On-chip video amplifier : V_{out} = 1.0 V_{p-p} TYP. @ single-ended output
- Supply voltage : V_{CC} = 5.0 V TYP.
- Packaged in 8-pin SSOP suitable for surface mounting

APPLICATION

- Digital CATV/Cable modem receivers

ORDERING INFORMATION

Part Number	Package	Supplying Form
μPC3221GV-E1-A	8-pin plastic SSOP (4.45 mm (175))	• Embossed tape 8 mm wide • Pin 1 indicates pull-out direction of tape • Qty 1 kpcs/reel

Remark To order evaluation samples, contact your nearby sales office.
Part number for sample order: μPC3221GV-A

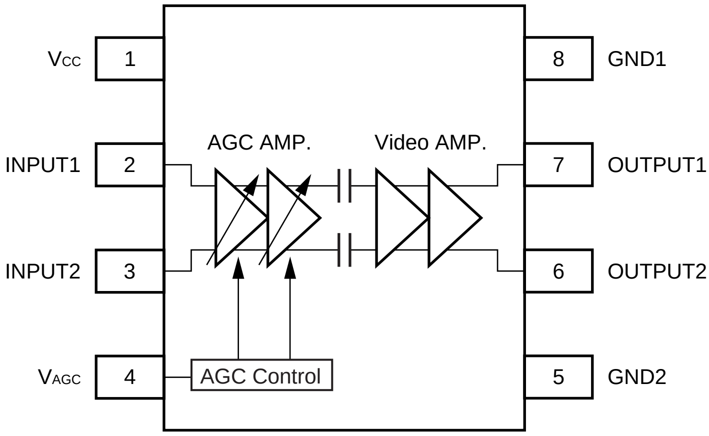
Caution Observe precautions when handling because these devices are sensitive to electrostatic discharge.

Document No. PU10171EJ03V0DS (3rd edition)

The mark ★ shows major revised points.

INTERNAL BLOCK DIAGRAM AND PIN CONNECTIONS

(Top View)

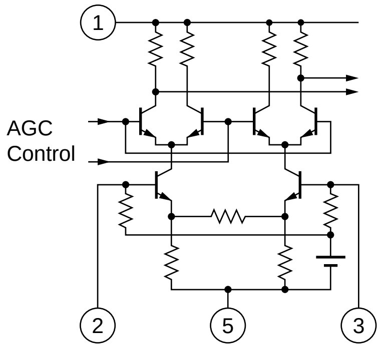
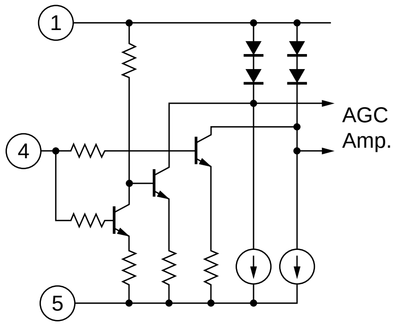
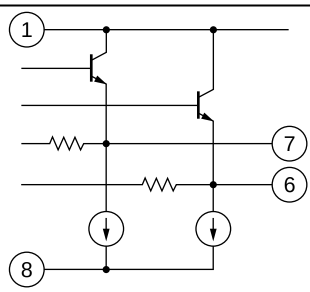


PRODUCT LINE-UP OF 5 V AGC AMPLIFIER

Part Number	I_{CC} (mA)	G_{MAX} (dB)	G_{MIN} (dB)	GCR (dB)	NF (dB)	IM_3 (dBc) Note	Package
μPC3217GV	23	53	0	53	6.5	50	8-pin SSOP (4.45 mm (175))
μPC3218GV	23	63	10	53	3.5	50	
μPC3219GV	36.5	42.5	0	42.5	9.0	58	
μPC3221GV	33	60	10	50	4.2	56	

Note f_1 = 44 MHz, f_2 = 45 MHz, V_{out} = 0.7 V_{p-p}/tone, single-ended output

PIN EXPLANATIONS

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V) Note	Function and Application	Internal Equivalent Circuit
1	V_{CC}	4.5 to 5.5	–	Power supply pin. This pin should be externally equipped with bypass capacitor to minimize ground impedance.	———
2	INPUT1	–	1.29	Signal input pins to AGC amplifier. This pin should be coupled with capacitor for DC cut.	
3	INPUT2	–	1.29		
4	V_{AGC}	0 to V_{CC}	–	Gain control pin. This pin's bias govern the AGC output level. Minimum Gain at V_{AGC} : 0 to 0.5 V Maximum Gain at V_{AGC} : 3 to 3.5 V Recommended to use AGC voltage with externally resister (example: 1 kΩ).	
5	GND2	0	–	Ground pin. This pin should be connected to system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible.	———
6	OUTPUT2	–	2.28	Signal output pins of video amplifier. This pin should be coupled with capacitor for DC cut.	
7	OUTPUT1	–	2.28		
8	GND1	0	–	Ground pin. This pin should be connected to system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible. All ground pins must be connected together with wide ground pattern to decrease impedance difference.	———

Note Pin voltage is measured at V_{CC} = 5.0 V.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Ratings	Unit
Supply Voltage	V_{CC}	T_A = +25°C	6.0	V
Gain Control Voltage Range	V_{AGC}	T_A = +25°C	0 to V_{CC}	V
Power Dissipation	P_D	T_A = +85°C **Note**	250	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	Test 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	–	3.5	V
Operating Frequency Range	f_{BW}		10	45	100	MHz

ELECTRICAL CHARACTERISTICS
(T_A = +25°C, V_{CC} = 5 V, f = 45 MHz, Z_S = 50 Ω, Z_L = 250 Ω, single-ended output)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
DC Characteristics						
Circuit Current	I_{CC}	No input signal **Note 1**	26	33	41	mA
AGC Pin Current	I_{AGC}	No input signal, V_{AGC} = 3.5 V **Note 1**	–	16	50	μA
AGC Voltage High Level	$V_{AGC\ (H)}$	@ Maximum gain **Note 1**	3.0	–	3.5	V
AGC Voltage Low Level	$V_{AGC\ (L)}$	@ Minimum gain **Note 1**	0	–	0.5	V
RF Characteristics						
Maximum Voltage Gain	G_{MAX}	V_{AGC} = 3.0 V, P_{in} = –60 dBm **Note 1**	57	60	63	dB
Middle Voltage Gain 1	$G_{MID}1$	V_{AGC} = 2.2 V, P_{in} = –60 dBm **Note 1**	47.5	50.5	53.5	dB
Middle Voltage Gain 2	$G_{MID}2$	V_{AGC} = 1.2 V, P_{in} = –30 dBm **Note 1**	18	21	24	dB
Minimum Voltage Gain	G_{MIN}	V_{AGC} = 0.5 V, P_{in} = –30 dBm **Note 1**	6	10	14	dB
Gain Control Range (input prescribe)	GCR_{in}	V_{AGC} = 0.5 to 3.0 V **Note 1**	43	50	–	dB
Gain Control Range (output prescribe)	GCR_{out}	V_{out} = 1.0 V_{p-p} **Note 1**	36	40	–	dB
Gain Slope	G_{slope}	Gain (@ V_{AGC} = 2.2 V) – Gain (@ V_{AGC} = 1.2 V) **Note 1**	26.5	29.5	32.5	dB/V
Maximum Output Voltage	V_{oclip}	V_{AGC} = 3.0 V (@ Maximum gain) **Note 1**	2.0	2.8	–	V_{p-p}
Noise Figure	NF	V_{AGC} = 3.0 V (@ Maximum gain) **Note 3**	–	4.2	5.7	dB
3rd Order Intermodulation Distortion 1	$IM_3 1$	f_1 = 44 MHz, f_2 = 45 MHz, Z_L = 250 Ω, P_{in} = –30 dBm/tone, V_{out} = 0.7 V_{p-p}/tone (@ single-ended output) **Note 1**	43	47	–	dBc
3rd Order Intermodulation Distortion 2	$IM_3 2$	f_1 = 44 MHz, f_2 = 45 MHz, Z_L = 250 Ω, V_{AGC} = 3.0 V (@ Maximum gain), V_{out} = 0.7 V_{p-p}/tone (@ single-ended output) **Note 1**	50	56	–	dBc
Gain Difference of OUTPUT1 and OUTPUT2	ΔG	V_{AGC} = 3.0 V, P_{in} = –60 dBm, ΔG = G (@ $P_{out}1$) – G (@ $P_{out}2$) **Note 1, 2**	–0.5	0	+0.5	dB

Notes 1. By measurement circuit 1

2. By measurement circuit 2

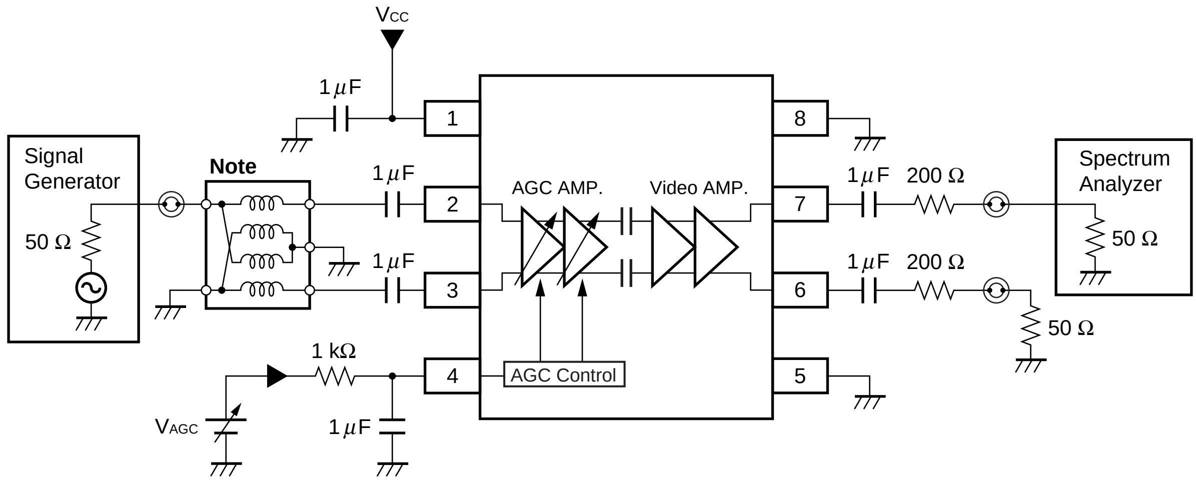
3. By measurement circuit 3

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

Parameter	Symbol	Test Conditions	Reference Value	Unit
Noise Figure 2	NF2	Gain reduction = –10 dBm **Note 2**	6.0	dB
Noise Figure 3	NF3	Gain reduction = –20 dBm **Note 2**	9.5	dB
Output Voltage	V_{out}	P_{in} = –56 to –16 dBm **Note 1**	1.0	V_{p-p}
Input Impedance	Z_{in}	V_{AGC} = 0.5 V, f = 45 MHz **Note 3**	0.9 k – j1.4 k	Ω
Output Impedance	Z_{out}	V_{AGC} = 0.5 V, f = 45 MHz **Note 3**	9.0 + j1.9	Ω
Input 3rd Order Distortion Intercept Point	IIP_3	V_{AGC} = 0.5 V (@ Minimum gain), f_1 = 44 MHz, f_2 = 45 MHz, Z_L = 250 Ω (@ single-ended output) **Note 1**	+2.5	dBm

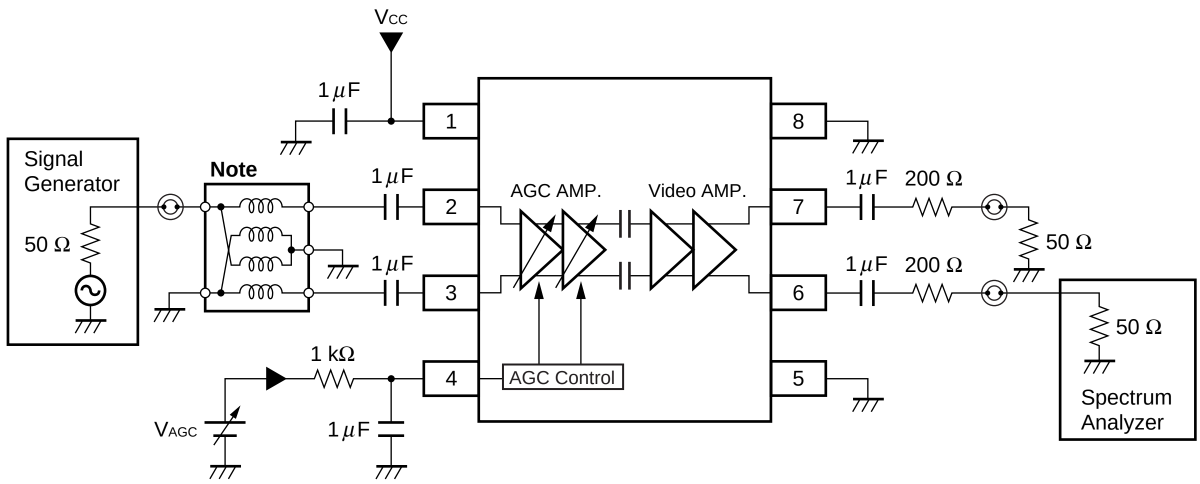
Notes 1. By measurement circuit 1
2. By measurement circuit 3
3. By measurement circuit 4

MEASUREMENT CIRCUIT 1



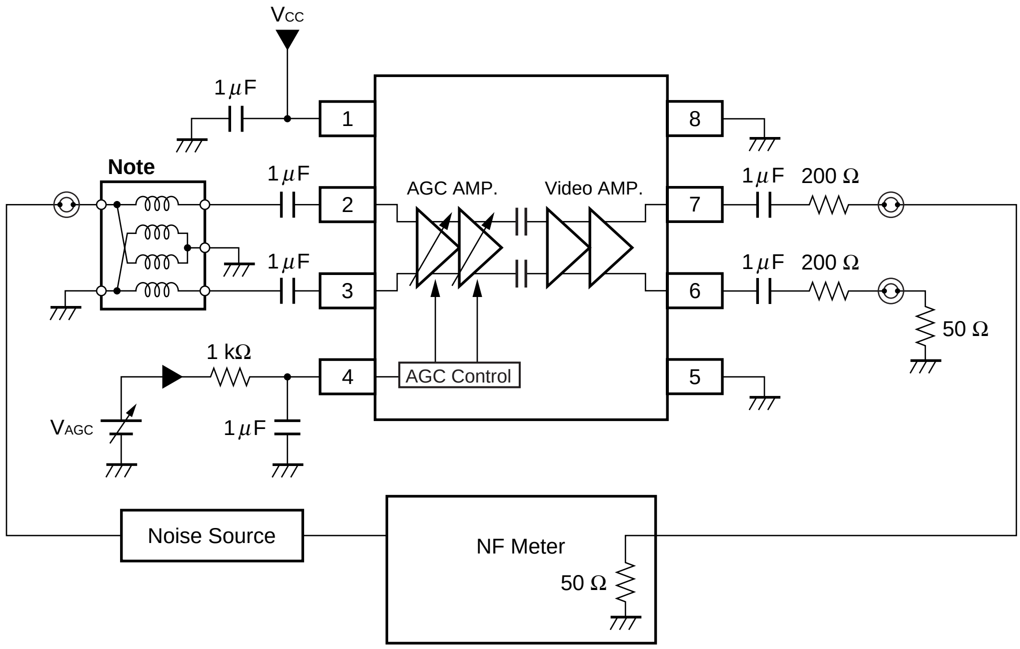
Note Balun Transformer: TOKO 617DB-1010 B4F (Double balanced type)

MEASUREMENT CIRCUIT 2



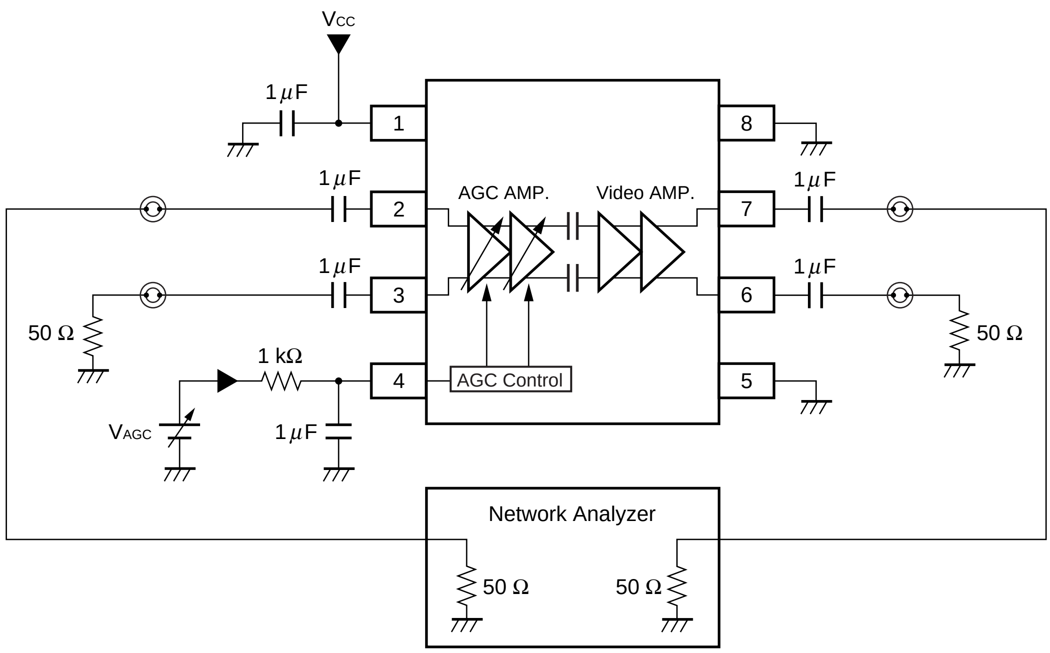
Note Balun Transformer: TOKO 617DB-1010 B4F (Double balanced type)

MEASUREMENT CIRCUIT 3



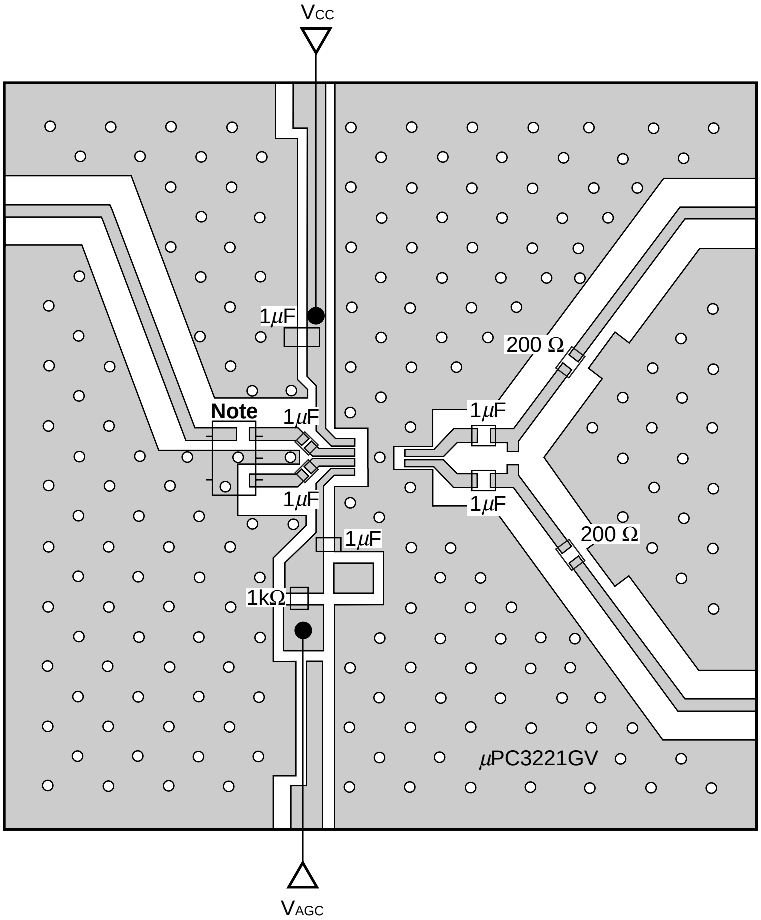
Note Balun Transformer: TOKO 617DB-1010 B4F (Double balanced type)

MEASUREMENT CIRCUIT 4



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

★ ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD (MEASUREMENT CIRCUIT 1)



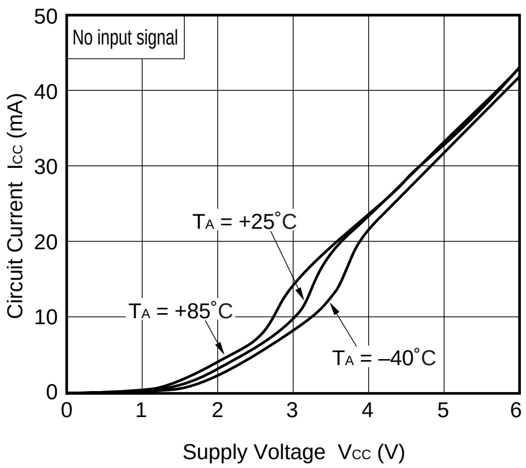
Note Balun Transformer

Remarks

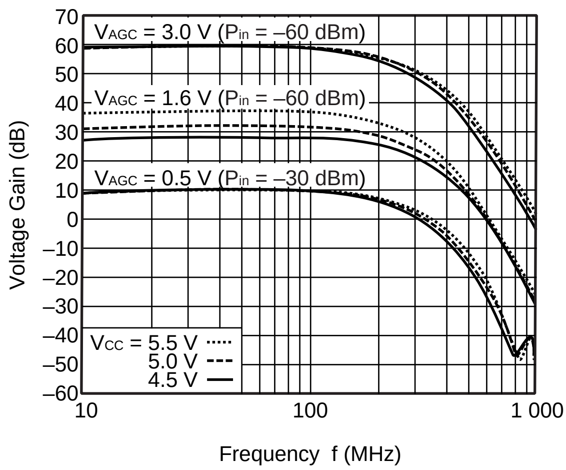
1. Back side: GND pattern
2. Solder plated on pattern
3. o : Through hole

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

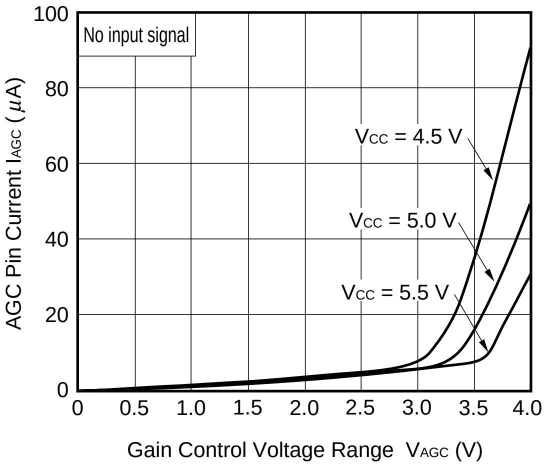
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



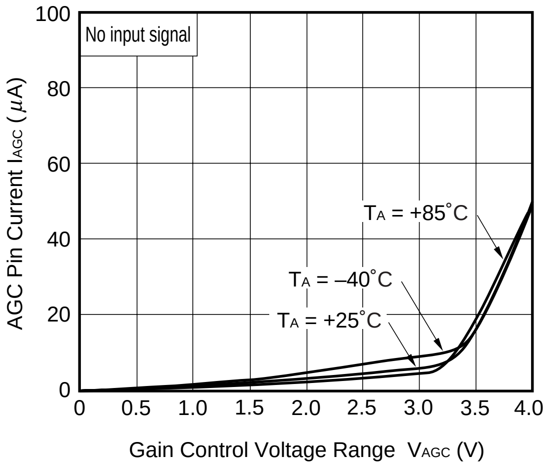
VOLTAGE GAIN vs. FREQUENCY



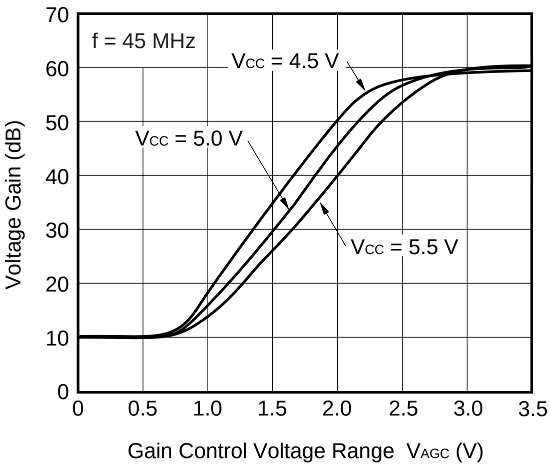
AGC PIN CURRENT vs.
GAIN CONTROL VOLTAGE RANGE



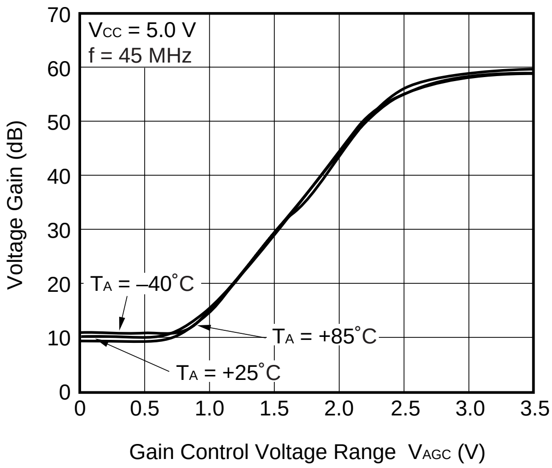
AGC PIN CURRENT vs.
GAIN CONTROL VOLTAGE RANGE



VOLTAGE GAIN vs.
GAIN CONTROL VOLTAGE RANGE

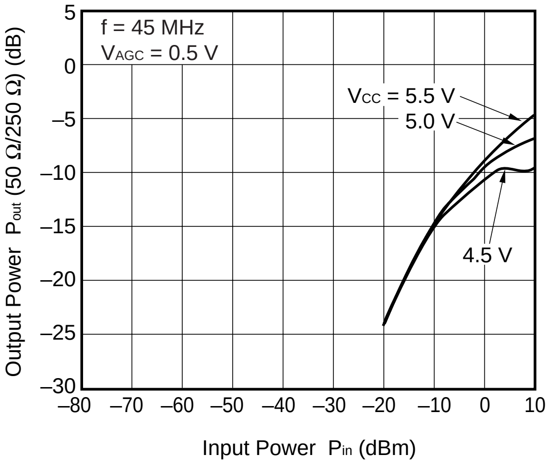


VOLTAGE GAIN vs.
GAIN CONTROL VOLTAGE RANGE

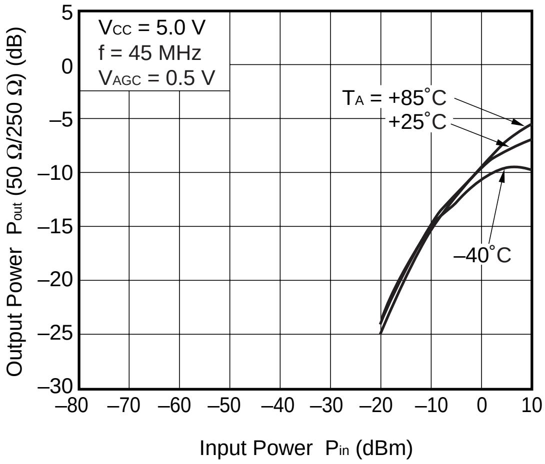


Remark The graphs indicate nominal characteristics.

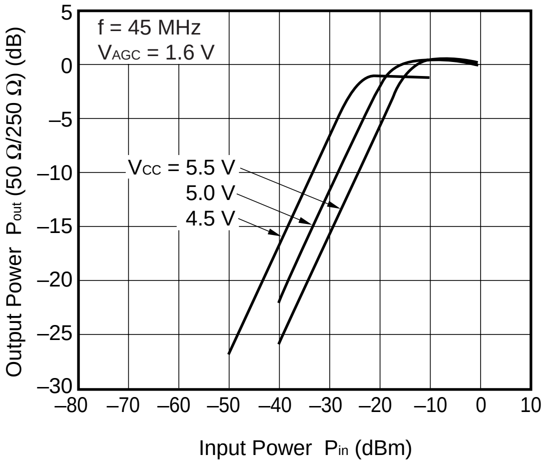
OUTPUT POWER vs. INPUT POWER



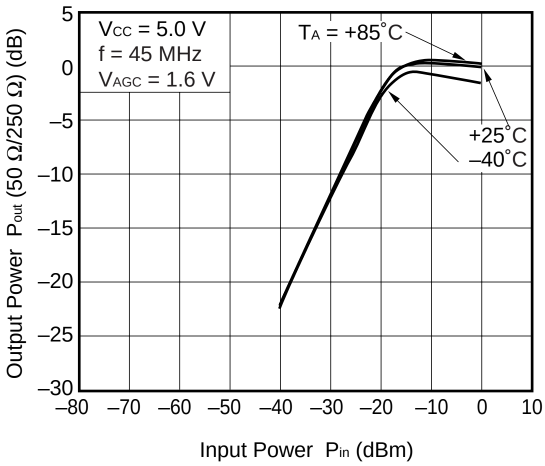
OUTPUT POWER vs. INPUT POWER



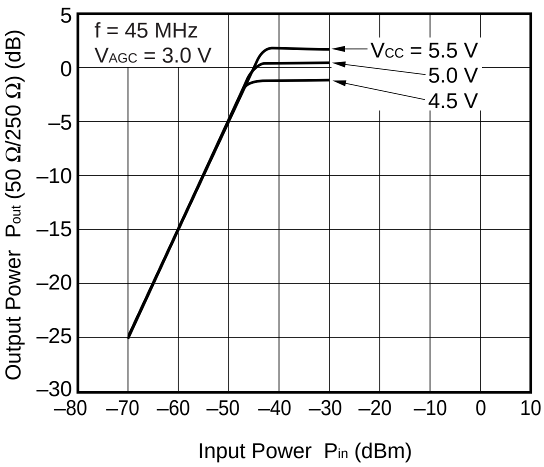
OUTPUT POWER vs. INPUT POWER



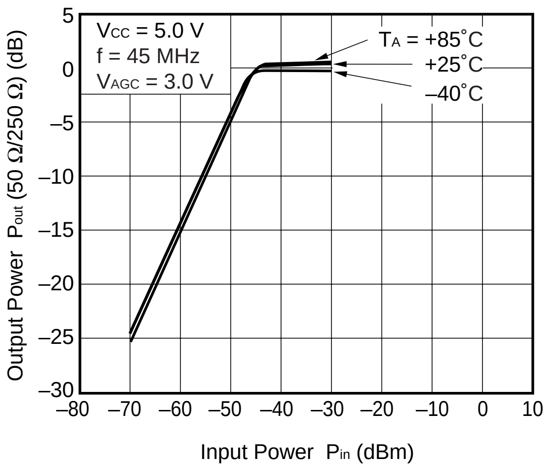
OUTPUT POWER vs. INPUT POWER



OUTPUT POWER vs. INPUT POWER

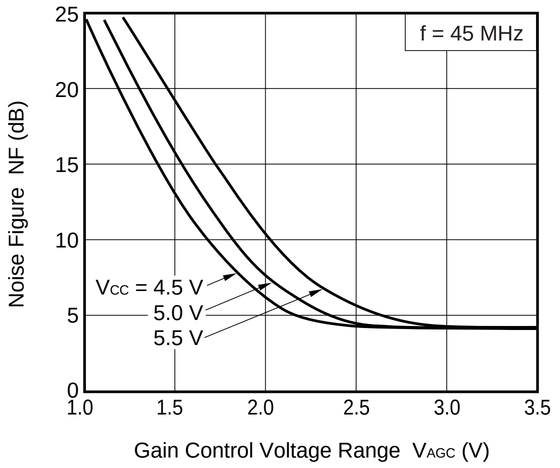


OUTPUT POWER vs. INPUT POWER

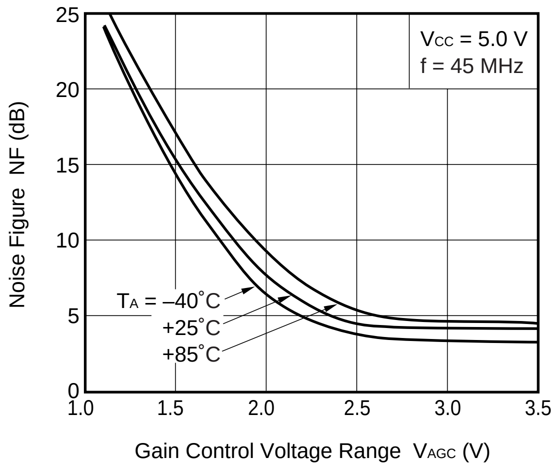


Remark The graphs indicate nominal characteristics.

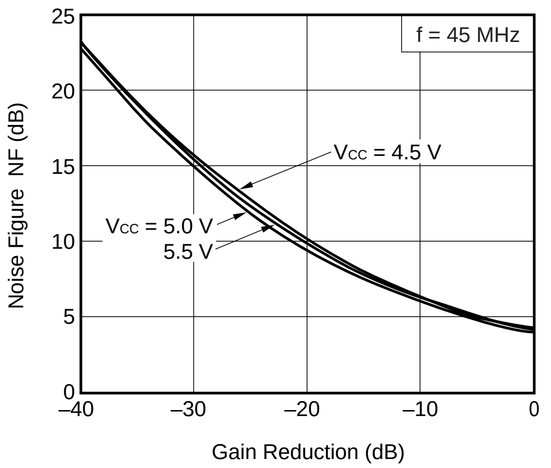
NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE



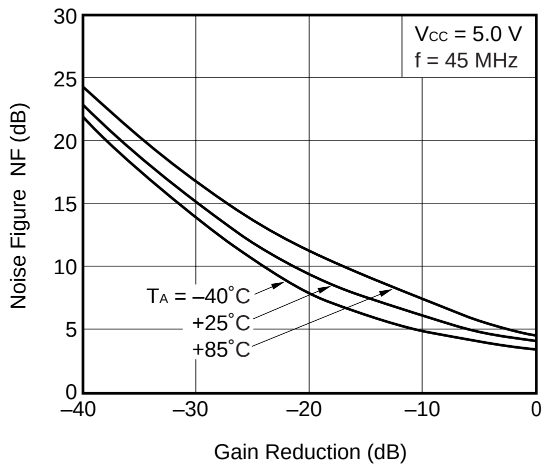
NOISE FIGURE vs.
GAIN CONTROL VOLTAGE RANGE



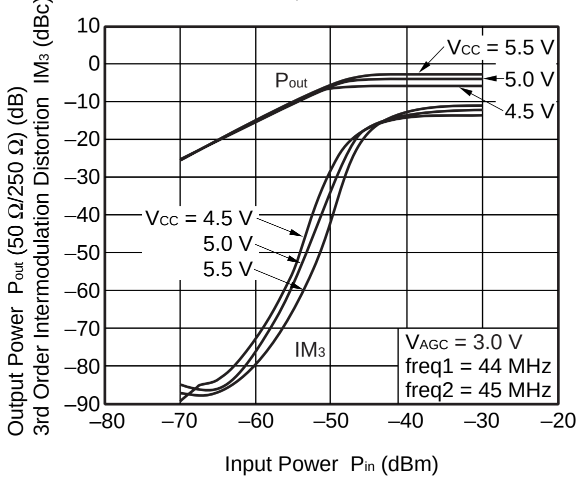
NOISE FIGURE vs. GAIN REDUCTION



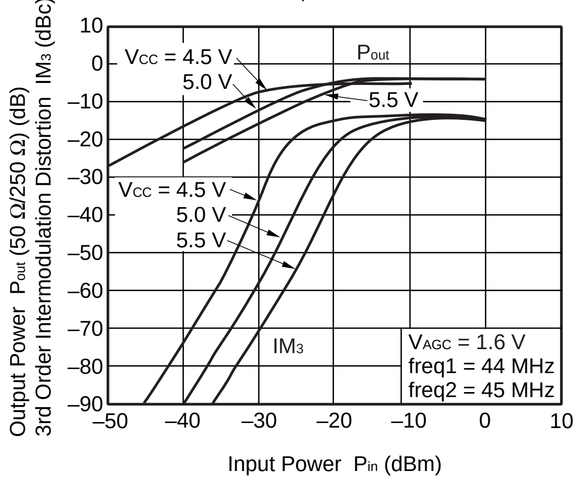
NOISE FIGURE vs. GAIN REDUCTION



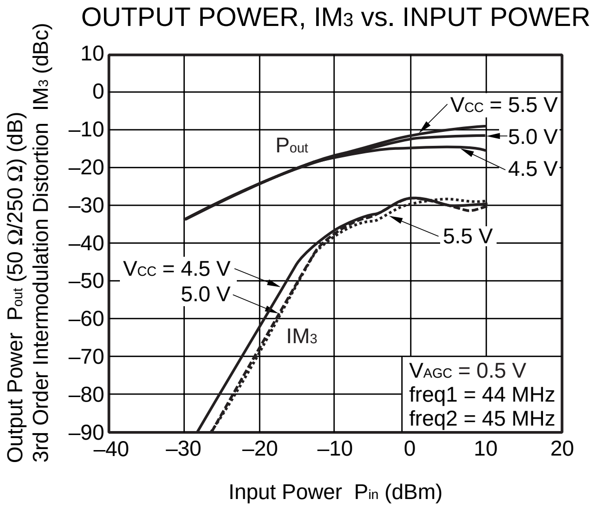
OUTPUT POWER, IM3 vs. INPUT POWER

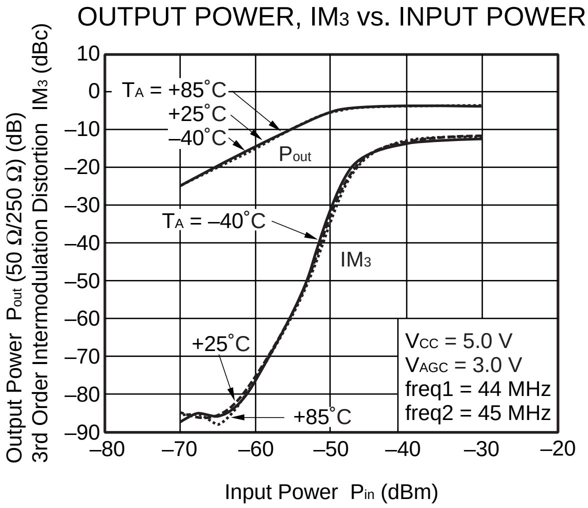


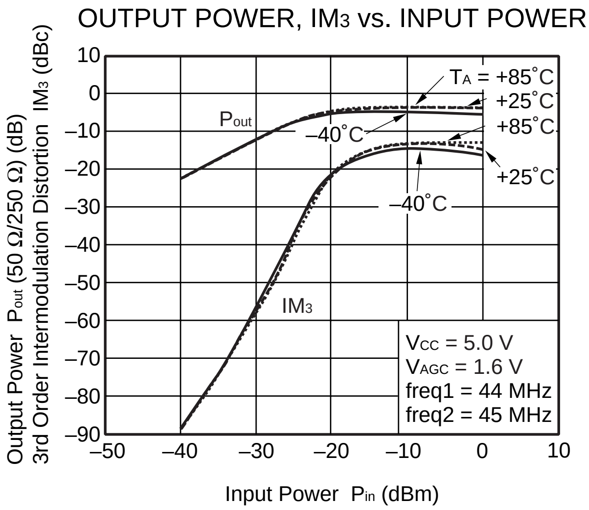
OUTPUT POWER, IM3 vs. INPUT POWER

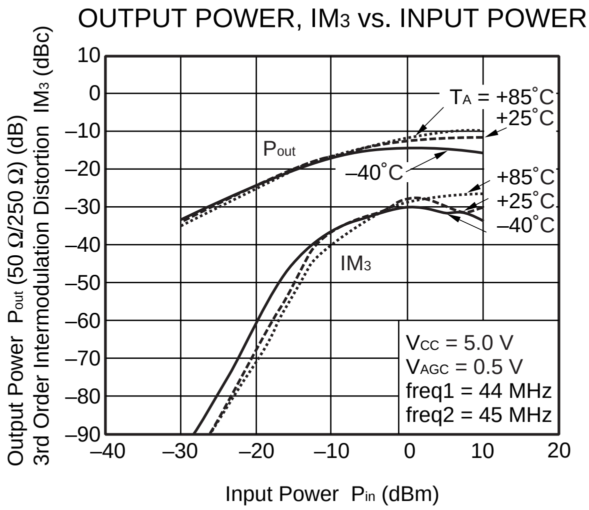


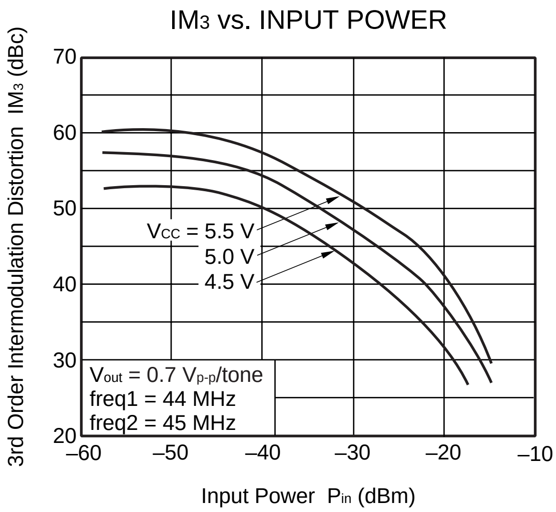
Remark The graphs indicate nominal characteristics.

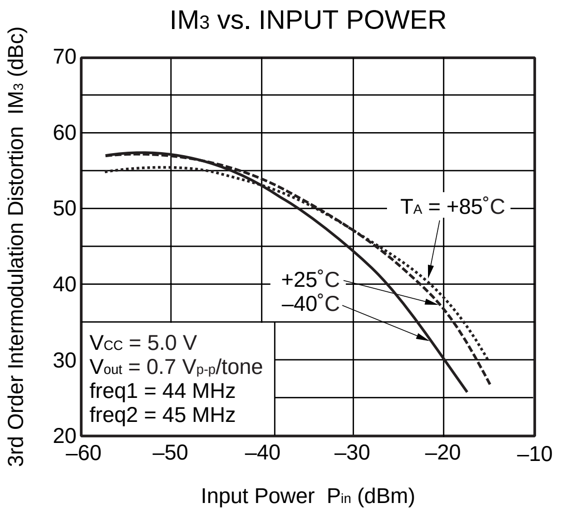








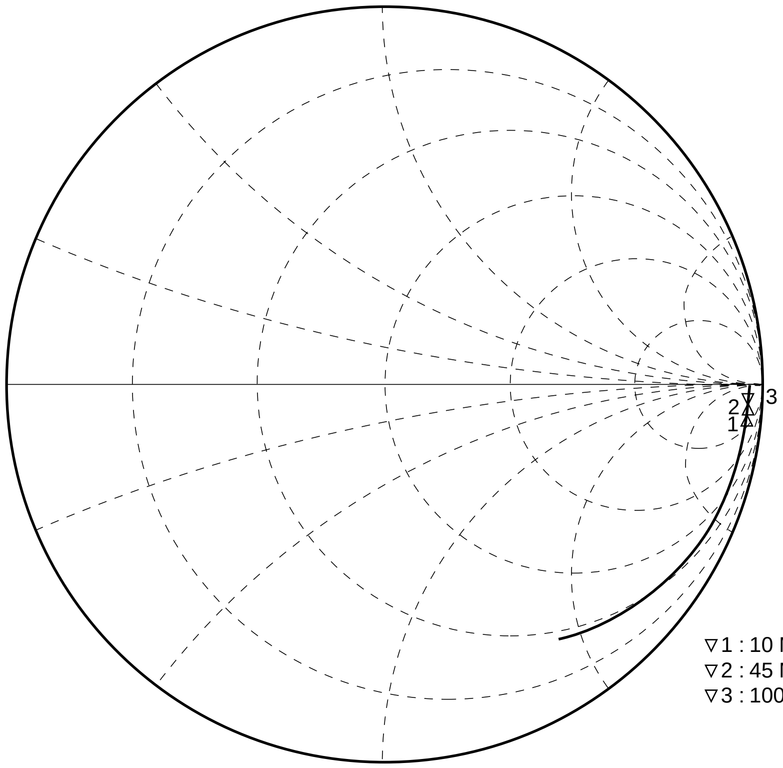




Remark The graphs indicate nominal characteristics.

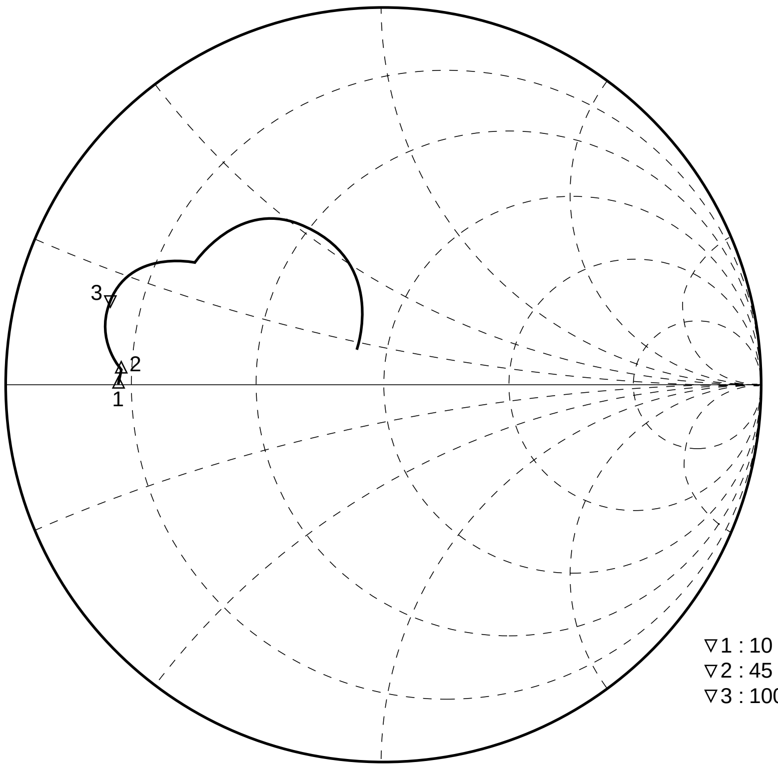
★ S-PARAMETERS (T_A = +25°C, V_{CC} = V_{AGC} = 5.0 V)

S_{11}–FREQUENCY



∇1 : 10 MHz	2.889 kΩ	–1.059 kΩ	15.33 pF
∇2 : 45 MHz	864.1 Ω	–1.402 kΩ	2.524 pF
∇3 : 100 MHz	235.0 Ω	–806.9 Ω	1.973 pF

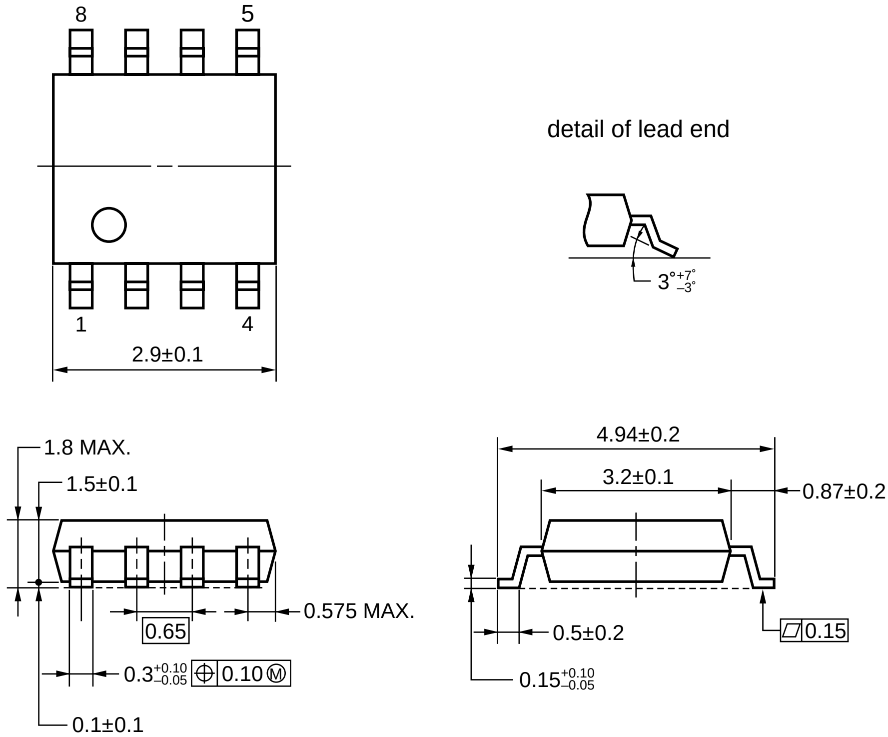
S_{22}–FREQUENCY



∇1 : 10 MHz	9.032 Ω	466.5 mΩ	7.335 nH
∇2 : 45 MHz	8.998 Ω	1.887 Ω	6.675 nH
∇3 : 100 MHz	7.266 Ω	6.750 Ω	10.74 nH

PACKAGE DIMENSIONS

8-PIN PLASTIC SSOP (4.45 mm (175)) (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) Time at peak temperature Time at temperature of 220°C or higher Preheating time at 120 to 180°C Maximum number of reflow processes Maximum chlorine content of rosin flux (% mass)	: 260°C or below : 10 seconds or less : 60 seconds or less : 120±30 seconds : 3 times : 0.2%(Wt.) or below	IR260
VPS	Peak temperature (package surface temperature) Time at temperature of 200°C or higher Preheating time at 120 to 150°C Maximum number of reflow processes Maximum chlorine content of rosin flux (% mass)	: 215°C or below : 25 to 40 seconds : 30 to 60 seconds : 3 times : 0.2%(Wt.) or below	VP215
Wave Soldering	Peak temperature (molten solder temperature) Time at peak temperature Preheating temperature (package surface temperature) Maximum number of flow processes Maximum chlorine content of rosin flux (% mass)	: 260°C or below : 10 seconds or less : 120°C or below : 1 time : 0.2%(Wt.) or below	WS260
Partial Heating	Peak temperature (pin temperature) Soldering time (per side of device) Maximum chlorine content of rosin flux (% mass)	: 350°C or below : 3 seconds or less : 0.2%(Wt.) or below	HS350

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

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  "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 and medical equipment for life support, etc.

  The quality grade of NEC semiconductor products is "Standard" unless otherwise expressly specified in NEC's data sheets or data books, etc. If customers wish to use NEC semiconductor products in applications not intended by NEC, they must contact an NEC sales representative in advance to determine NEC's willingness to support a given application.

  (Note)

  (1) "NEC" as used in this statement means NEC Corporation, NEC Compound Semiconductor Devices, Ltd. and also includes its majority-owned subsidiaries.

  (2) "NEC semiconductor products" means any semiconductor product developed or manufactured by or for NEC (as defined above).

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▶**For further information, please contact**

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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.

<table>
<tr><th>Restricted Substance per RoHS</th><th>Concentration Limit per RoHS (values are not yet fixed)</th><th colspan="2">Concentration contained in CEL devices</th></tr>
<tr><td rowspan="2">Lead (Pb)</td><td rowspan="2">< 1000 PPM</td><td>-A</td><td>-AZ</td></tr>
<tr><td>Not Detected</td><td>(*)</td></tr>
<tr><td>Mercury</td><td>< 1000 PPM</td><td colspan="2">Not Detected</td></tr>
<tr><td>Cadmium</td><td>< 100 PPM</td><td colspan="2">Not Detected</td></tr>
<tr><td>Hexavalent Chromium</td><td>< 1000 PPM</td><td colspan="2">Not Detected</td></tr>
<tr><td>PBB</td><td>< 1000 PPM</td><td colspan="2">Not Detected</td></tr>
<tr><td>PBDE</td><td>< 1000 PPM</td><td colspan="2">Not Detected</td></tr>
</table>

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.