



## 5 V AGC AMPLIFIER + VIDEO AMPLIFIER

**DESCRIPTION**

The  $\mu$ PC3221GV 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 fr 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<sub>3</sub> = 56 dBc TYP. @ single-ended output, V<sub>out</sub> = 0.7 V<sub>p-p</sub>/tone
- Low noise figure : NF = 4.2 dB TYP.
- Wide AGC dynamic range : GCR = 50 dB TYP. @ input prescribe
- On-chip video amplifier : V<sub>out</sub> = 1.0 V<sub>p-p</sub> TYP. @ single-ended output
- Supply voltage : V<sub>CC</sub> = 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
$\mu$ PC3221GV-E1-A	8-pin plastic SSOP (4.45 mm (175))	<ul style="list-style-type: none"><li>• Embossed tape 8 mm wide</li><li>• Pin 1 indicates pull-out direction of tape</li><li>• Qty 1 kpcs/reel</li></ul>

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

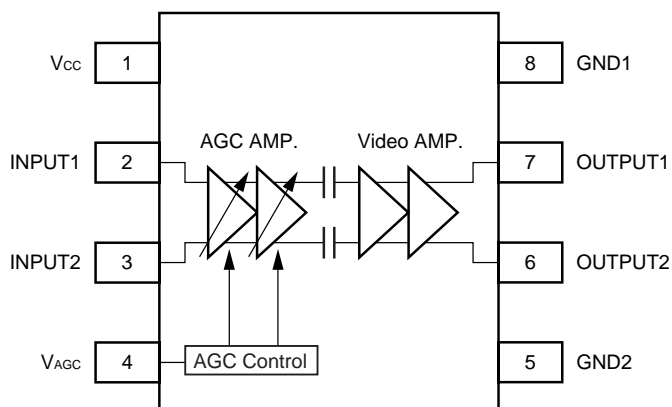
Part number for sample order:  $\mu$ PC3221GV-A

**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 CONNECTIONS**

**(Top View)**



**PRODUCT LINE-UP OF 5 V AGC AMPLIFIER**

Part Number	I <sub>cc</sub> (mA)	G <sub>MAX</sub> (dB)	G <sub>MIN</sub> (dB)	GCR (dB)	NF (dB)	IM <sub>3</sub> (dBc) <sup>Note</sup>	Package
$\mu$ PC3217GV	23	53	0	53	6.5	50	8-pin SSOP (4.45 mm (175))
$\mu$ PC3218GV	23	63	10	53	3.5	50	
$\mu$ PC3219GV	36.5	42.5	0	42.5	9.0	58	
$\mu$ PC3221GV	33	60	10	50	4.2	56	

**Note** f<sub>1</sub> = 44 MHz, f<sub>2</sub> = 45 MHz, V<sub>out</sub> = 0.7 V<sub>p-p</sub>/tone, single-ended output

**PIN EXPLANATIONS**

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V) <sup>Note</sup>	Function and Application	Internal Equivalent Circuit
1	V <sub>CC</sub>	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 <sub>AGC</sub>	0 to V <sub>CC</sub>	–	Gain control pin. This pin's bias govern the AGC output level.  Minimum Gain at V <sub>AGC</sub> : 0 to 0.5 V Maximum Gain at V <sub>AGC</sub> : 3 to 3.5 V Recommended to use AGC voltage with externally resistor (example: 1 k $\Omega$ ).	
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<sub>CC</sub> = 5.0 V.

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Test Conditions	Ratings	Unit
Supply Voltage	V <sub>CC</sub>	T <sub>A</sub> = +25°C	6.0	V
Gain Control Voltage Range	V <sub>AGC</sub>	T <sub>A</sub> = +25°C	0 to V <sub>CC</sub>	V
Power Dissipation	P <sub>D</sub>	T <sub>A</sub> = +85°C <b>Note</b>	250	mW
Operating Ambient Temperature	T <sub>A</sub>		-40 to +85	°C
Storage Temperature	T <sub>stg</sub>		-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 <sub>CC</sub>		4.5	5.0	5.5	V
Operating Ambient Temperature	T <sub>A</sub>	V <sub>CC</sub> = 4.5 to 5.5 V	-40	+25	+85	°C
Gain Control Voltage Range	V <sub>AGC</sub>		0	-	3.5	V
Operating Frequency Range	f <sub>ew</sub>		10	45	100	MHz

**ELECTRICAL CHARACTERISTICS**(T<sub>A</sub> = +25°C, V<sub>CC</sub> = 5 V, f = 45 MHz, Z<sub>s</sub> = 50 Ω, Z<sub>L</sub> = 250 Ω, single-ended output)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
DC Characteristics						
Circuit Current	I <sub>CC</sub>	No input signal <b>Note 1</b>	26	33	41	mA
AGC Pin Current	I <sub>AGC</sub>	No input signal, V <sub>AGC</sub> = 3.5 V <b>Note 1</b>	–	16	50	μA
AGC Voltage High Level	V <sub>AGC (H)</sub>	@ Maximum gain <b>Note 1</b>	3.0	–	3.5	V
AGC Voltage Low Level	V <sub>AGC (L)</sub>	@ Minimum gain <b>Note 1</b>	0	–	0.5	V
RF Characteristics						
Maximum Voltage Gain	G <sub>MAX</sub>	V <sub>AGC</sub> = 3.0 V, P <sub>in</sub> = –60 dBm <b>Note 1</b>	57	60	63	dB
Middle Voltage Gain 1	G <sub>MID1</sub>	V <sub>AGC</sub> = 2.2 V, P <sub>in</sub> = –60 dBm <b>Note 1</b>	47.5	50.5	53.5	dB
Middle Voltage Gain 2	G <sub>MID2</sub>	V <sub>AGC</sub> = 1.2 V, P <sub>in</sub> = –30 dBm <b>Note 1</b>	18	21	24	dB
Minimum Voltage Gain	G <sub>MIN</sub>	V <sub>AGC</sub> = 0.5 V, P <sub>in</sub> = –30 dBm <b>Note 1</b>	6	10	14	dB
Gain Control Range (input prescribe)	GCR <sub>in</sub>	V <sub>AGC</sub> = 0.5 to 3.0 V <b>Note 1</b>	43	50	–	dB
Gain Control Range (output prescribe)	GCR <sub>out</sub>	V <sub>out</sub> = 1.0 V <sub>p-p</sub> <b>Note 1</b>	36	40	–	dB
Gain Slope	G <sub>slope</sub>	Gain (@ V <sub>AGC</sub> = 2.2 V) – Gain (@ V <sub>AGC</sub> = 1.2 V) <b>Note 1</b>	26.5	29.5	32.5	dB/V
Maximum Output Voltage	V <sub>oclip</sub>	V <sub>AGC</sub> = 3.0 V (@ Maximum gain) <b>Note 1</b>	2.0	2.8	–	V <sub>p-p</sub>
Noise Figure	NF	V <sub>AGC</sub> = 3.0 V (@ Maximum gain) <b>Note 3</b>	–	4.2	5.7	dB
3rd Order Intermodulation Distortion 1	IM <sub>31</sub>	f <sub>1</sub> = 44 MHz, f <sub>2</sub> = 45 MHz, Z <sub>L</sub> = 250 Ω, P <sub>in</sub> = –30 dBm/tone, V <sub>out</sub> = 0.7 V <sub>p-p</sub> /tone (@ single-ended output) <b>Note 1</b>	43	47	–	dBc
3rd Order Intermodulation Distortion 2	IM <sub>32</sub>	f <sub>1</sub> = 44 MHz, f <sub>2</sub> = 45 MHz, Z <sub>L</sub> = 250 Ω, V <sub>AGC</sub> = 3.0 V (@ Maximum gain), V <sub>out</sub> = 0.7 V <sub>p-p</sub> /tone (@ single-ended output) <b>Note 1</b>	50	56	–	dBc
Gain Difference of OUTPUT1 and OUTPUT2	ΔG	V <sub>AGC</sub> = 3.0 V, P <sub>in</sub> = –60 dBm, ΔG = G (@ P <sub>out1</sub> ) – G (@ P <sub>out2</sub> ) <b>Note 1, 2</b>	–0.5	0	+0.5	dB

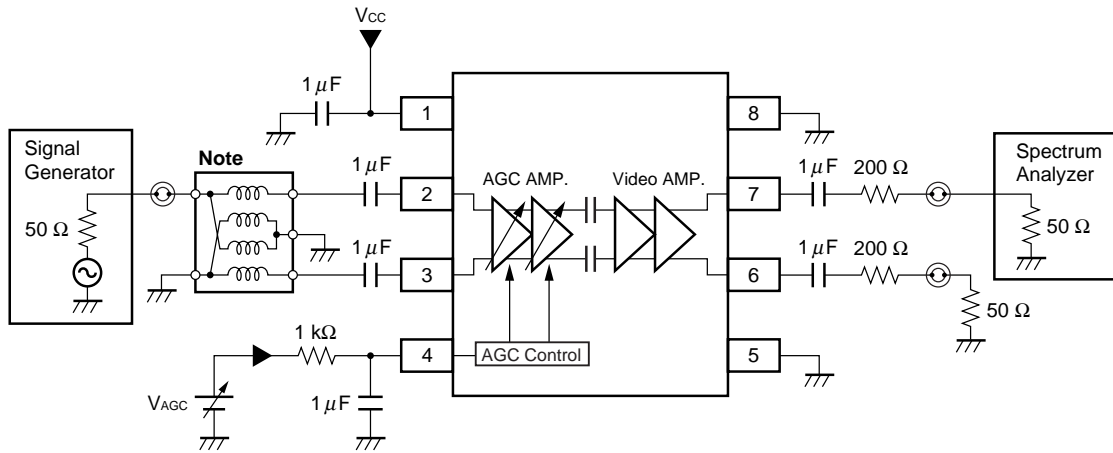
**Notes 1.** By measurement circuit 1**2.** By measurement circuit 2**3.** By measurement circuit 3

**STANDARD CHARACTERISTICS (T<sub>A</sub> = +25°C, V<sub>CC</sub> = 5 V, Z<sub>S</sub> = 50  $\Omega$ )**

Parameter	Symbol	Test Conditions	Reference Value	Unit
Noise Figure 2	NF2	Gain reduction = -10 dBm <b>Note 2</b>	6.0	dB
Noise Figure 3	NF3	Gain reduction = -20 dBm <b>Note 2</b>	9.5	dB
Output Voltage	V <sub>out</sub>	P <sub>in</sub> = -56 to -16 dBm <b>Note 1</b>	1.0	V <sub>p-p</sub>
Input Impedance	Z <sub>in</sub>	V <sub>AGC</sub> = 0.5 V, f = 45 MHz <b>Note 3</b>	0.9 k - j1.4 k	$\Omega$
Output Impedance	Z <sub>out</sub>	V <sub>AGC</sub> = 0.5 V, f = 45 MHz <b>Note 3</b>	9.0 + j1.9	$\Omega$
Input 3rd Order Distortion Intercept Point	IIP <sub>3</sub>	V <sub>AGC</sub> = 0.5 V (@ Minimum gain), f <sub>1</sub> = 44 MHz, f <sub>2</sub> = 45 MHz, Z <sub>L</sub> = 250 $\Omega$ (@ single-ended output) <b>Note 1</b>	+2.5	dBm

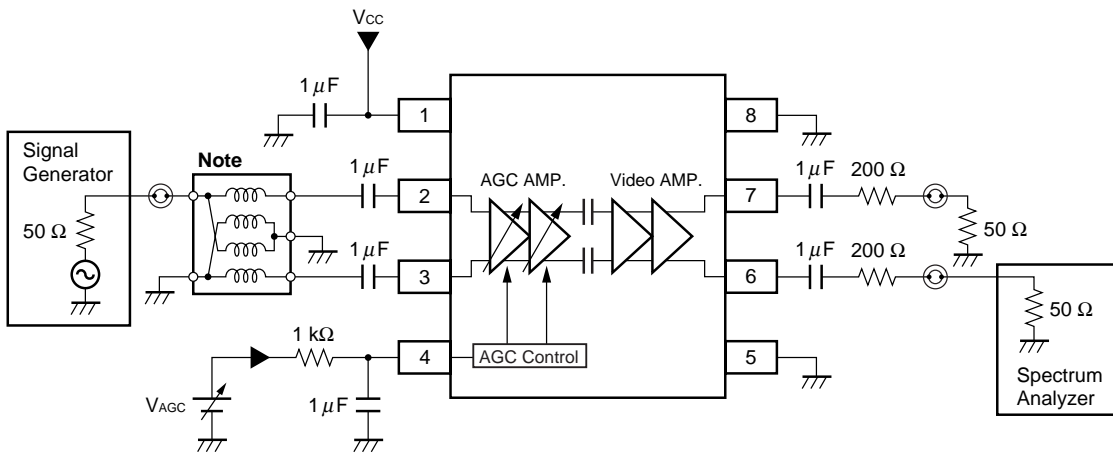
- Notes**
1. By measurement circuit 1
  2. By measurement circuit 3
  3. By measurement circuit 4

**MEASUREMENT CIRCUIT 1**



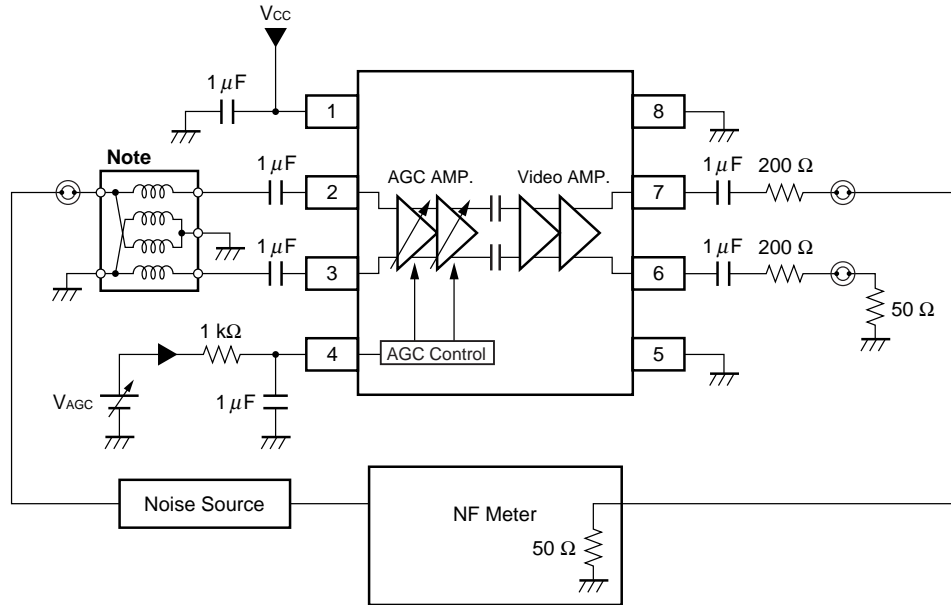
**Note** Balun Transformer: TOKO 617DB-1010 B4F (Double balanced type)

**MEASUREMENT CIRCUIT 2**



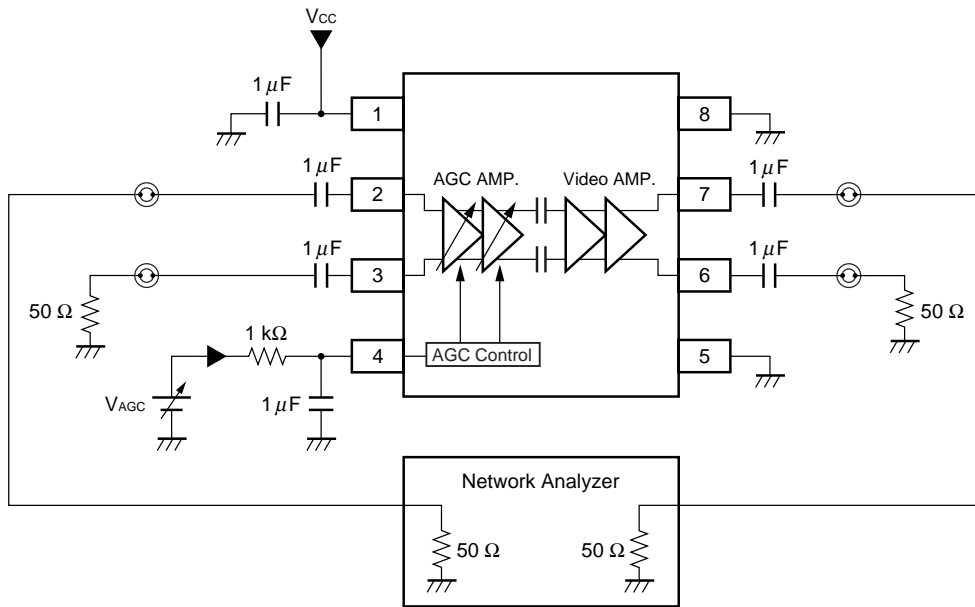
**Note** Balun Transformer: TOKO 617DB-1010 B4F (Double balanced type)

**MEASUREMENT CIRCUIT 3**



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

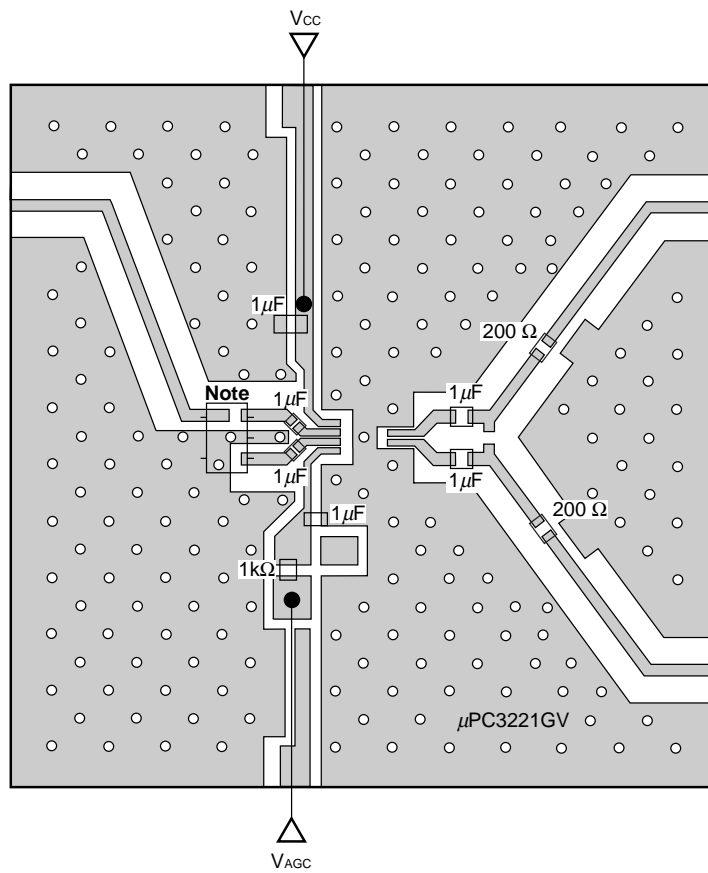
**MEASUREMENT CIRCUIT 4**



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)



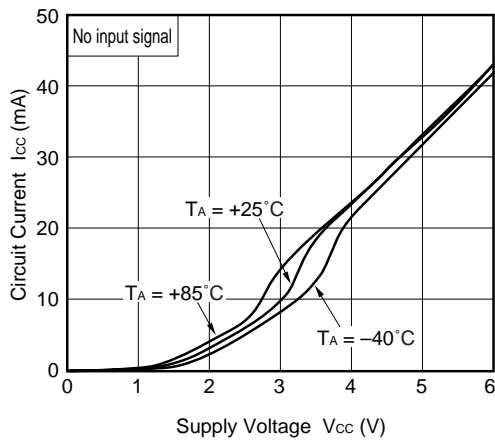
**Note** Balun Transformer

**Remarks**

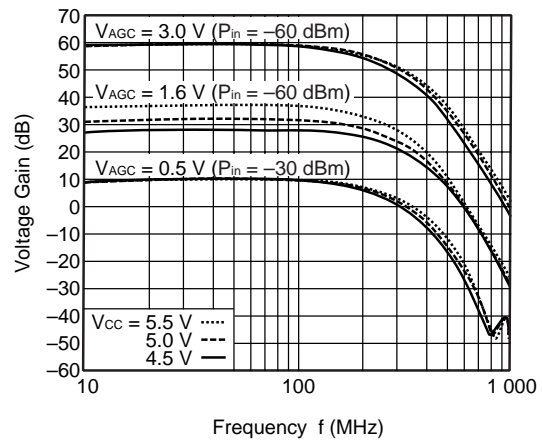
1. Back side: GND pattern
2. Solder plated on pattern
3. ○: Through hole

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

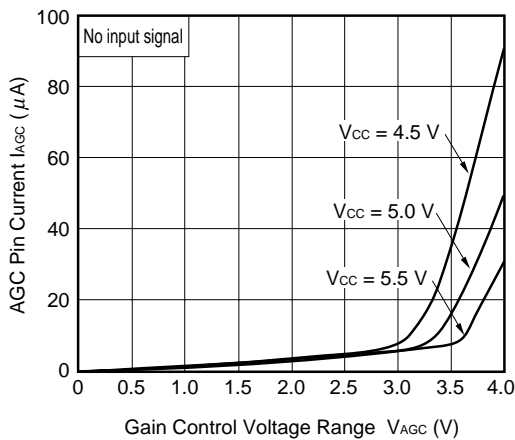
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



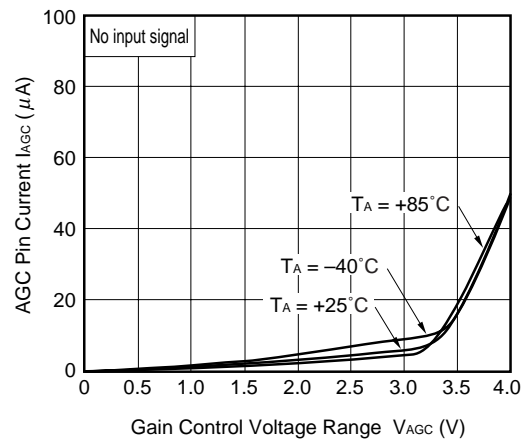
VOLTAGE GAIN vs. FREQUENCY



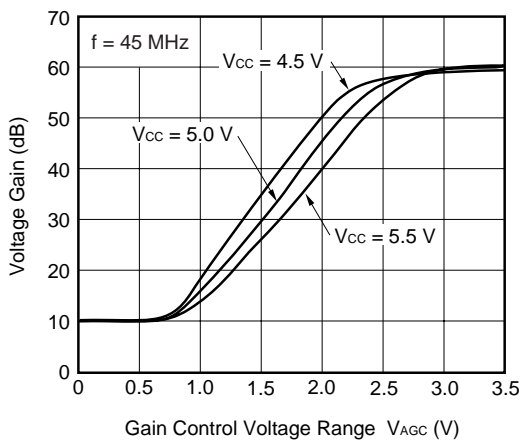
AGC PIN CURRENT vs. GAIN CONTROL VOLTAGE RANGE



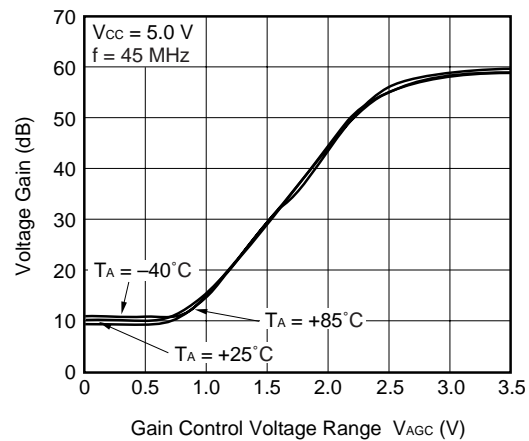
AGC PIN CURRENT vs. GAIN CONTROL VOLTAGE RANGE



VOLTAGE GAIN vs. GAIN CONTROL VOLTAGE RANGE

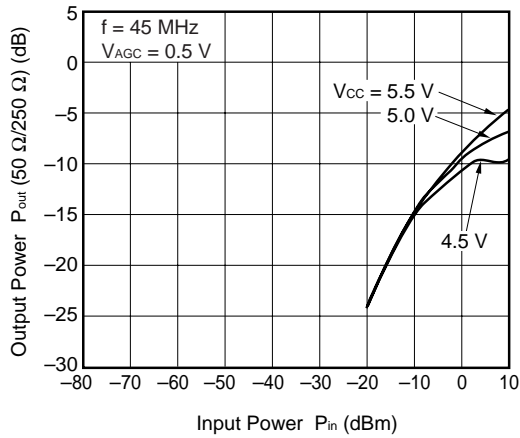


VOLTAGE GAIN vs. GAIN CONTROL VOLTAGE RANGE

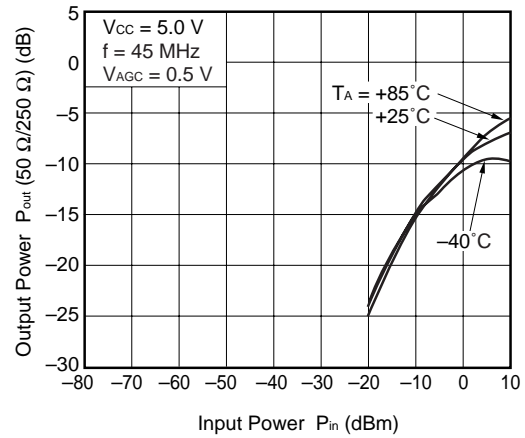


**Remark** The graphs indicate nominal characteristics.

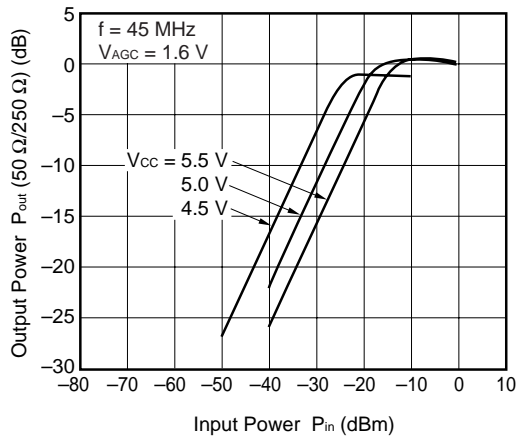
OUTPUT POWER vs. INPUT POWER



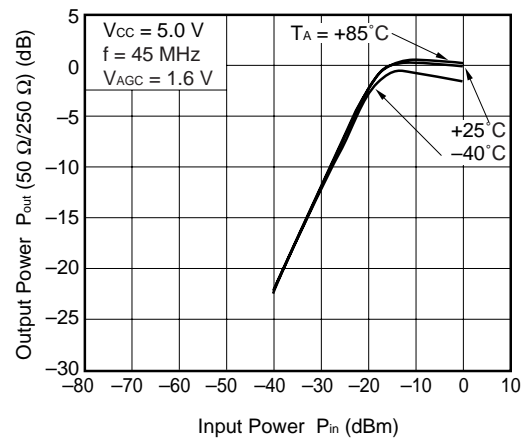
OUTPUT POWER vs. INPUT POWER



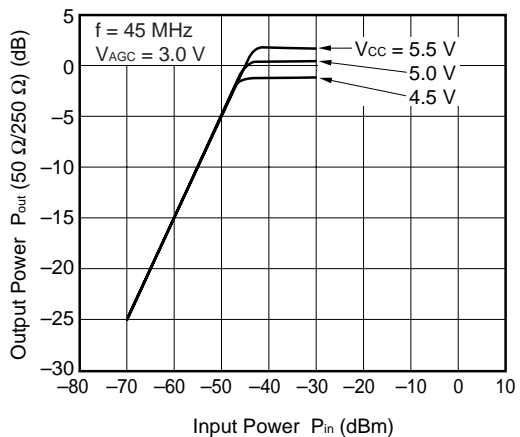
OUTPUT POWER vs. INPUT POWER



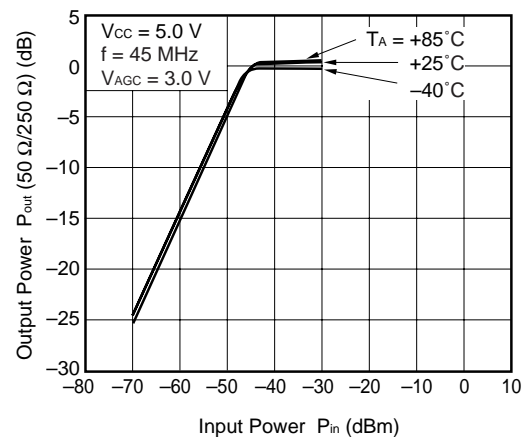
OUTPUT POWER vs. INPUT POWER



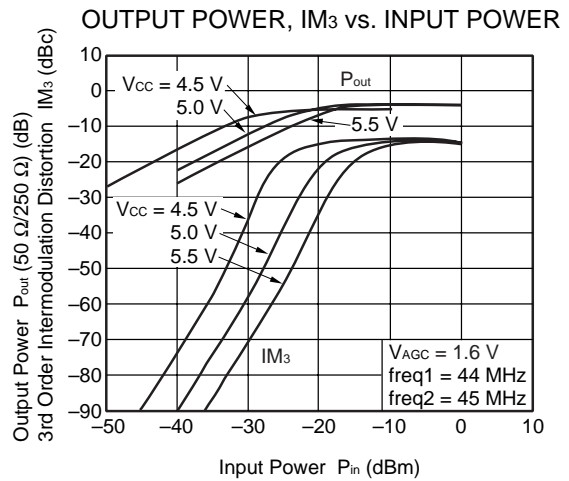
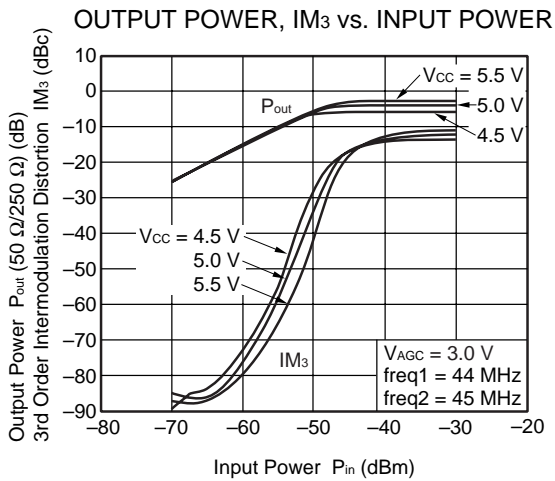
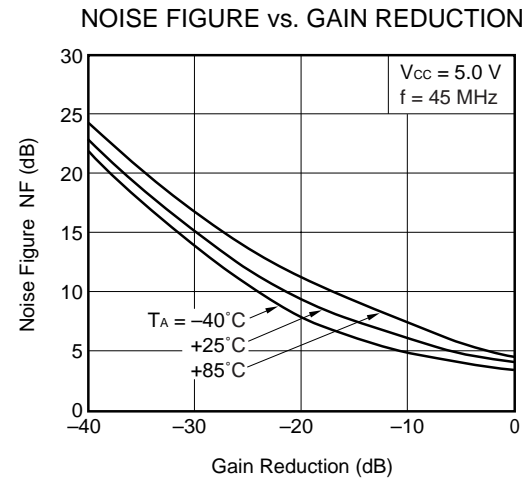
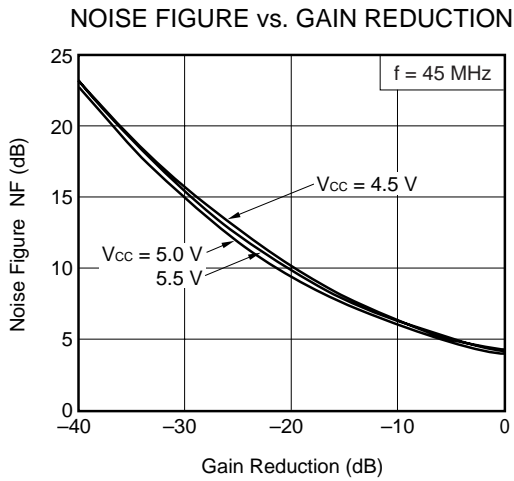
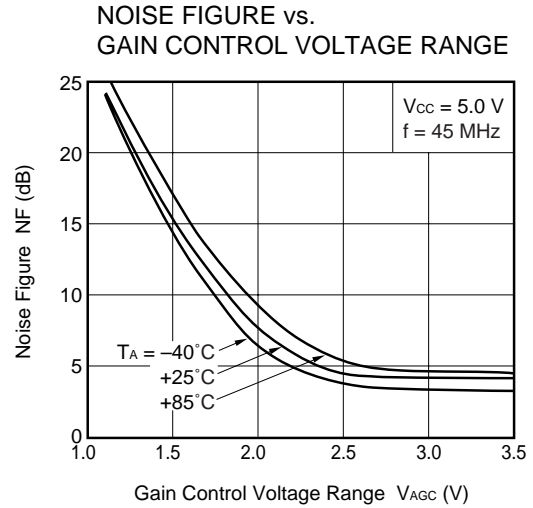
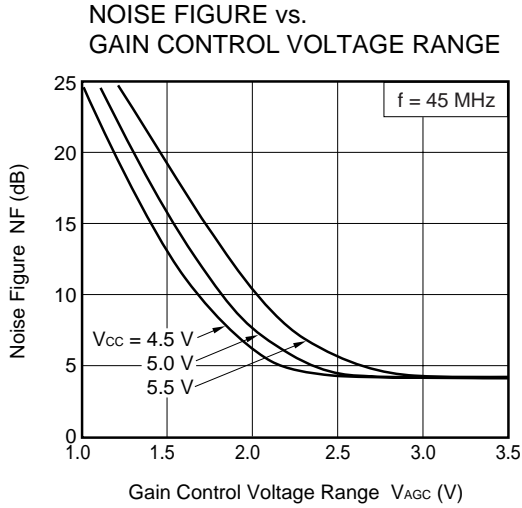
OUTPUT POWER vs. INPUT POWER



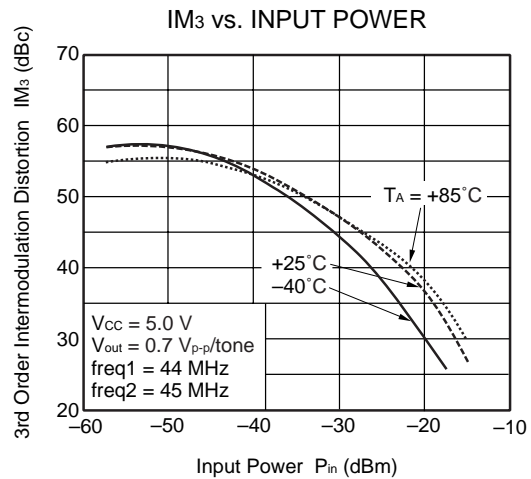
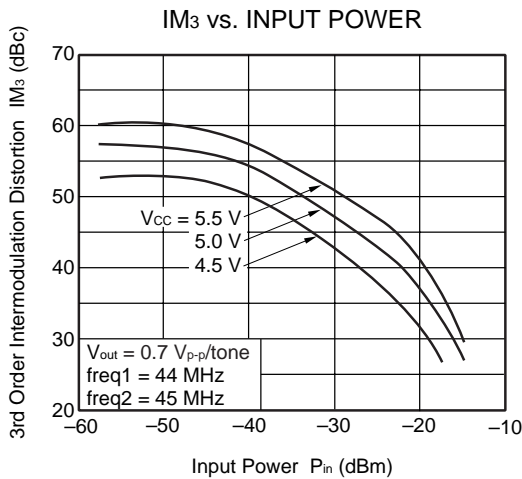
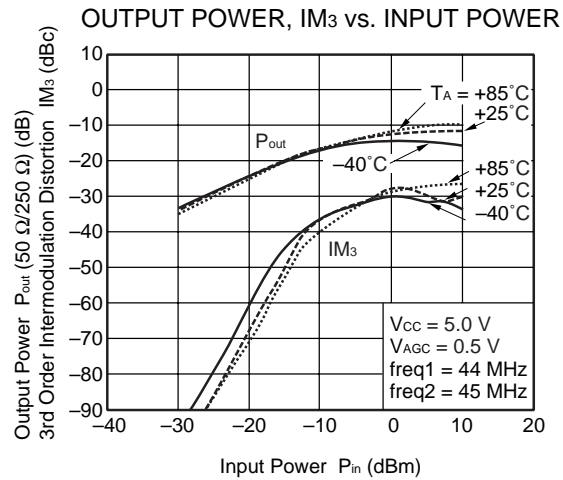
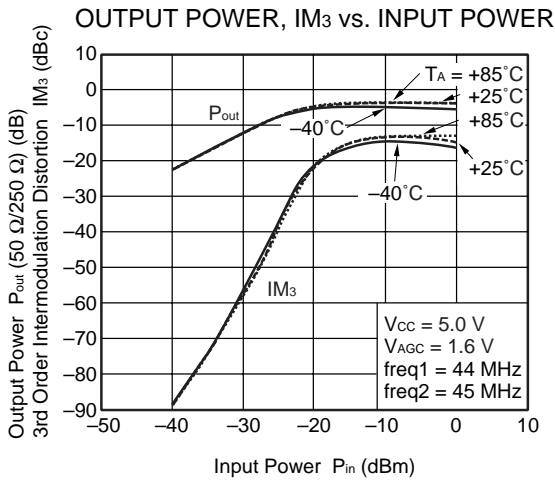
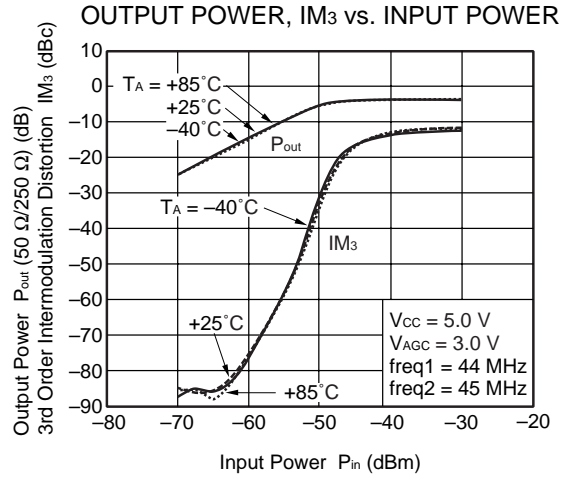
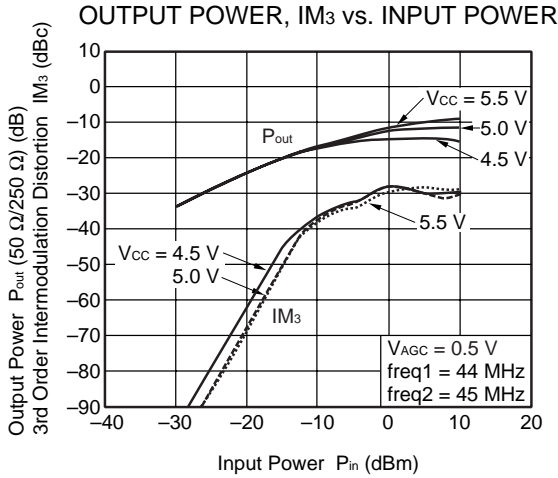
OUTPUT POWER vs. INPUT POWER



**Remark** The graphs indicate nominal characteristics.



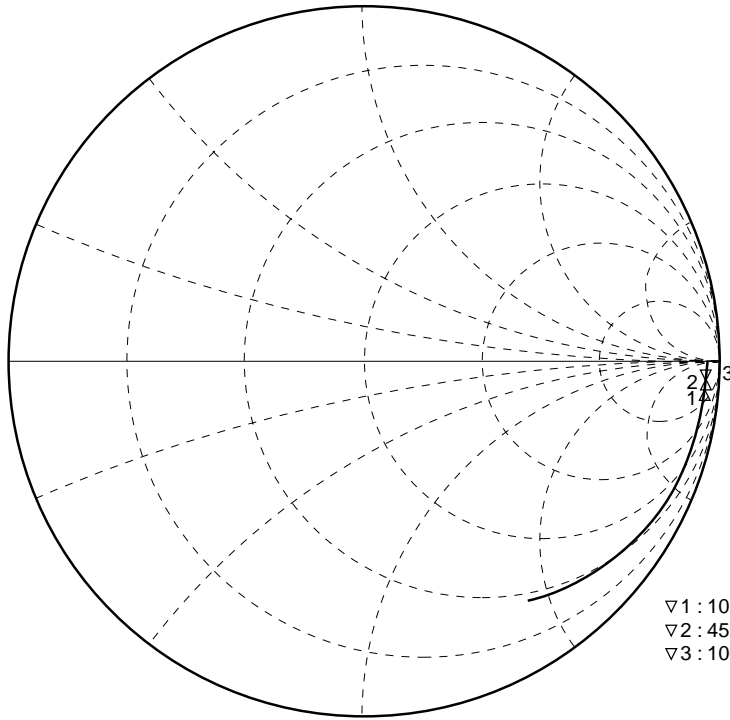
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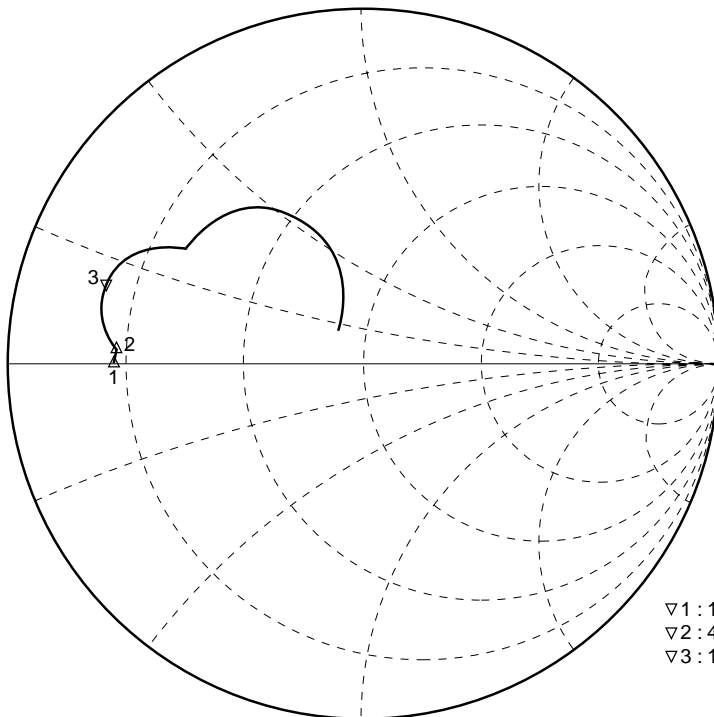
★ S-PARAMETERS (T<sub>A</sub> = +25°C, V<sub>CC</sub> = V<sub>AGC</sub> = 5.0 V)

S<sub>11</sub>-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

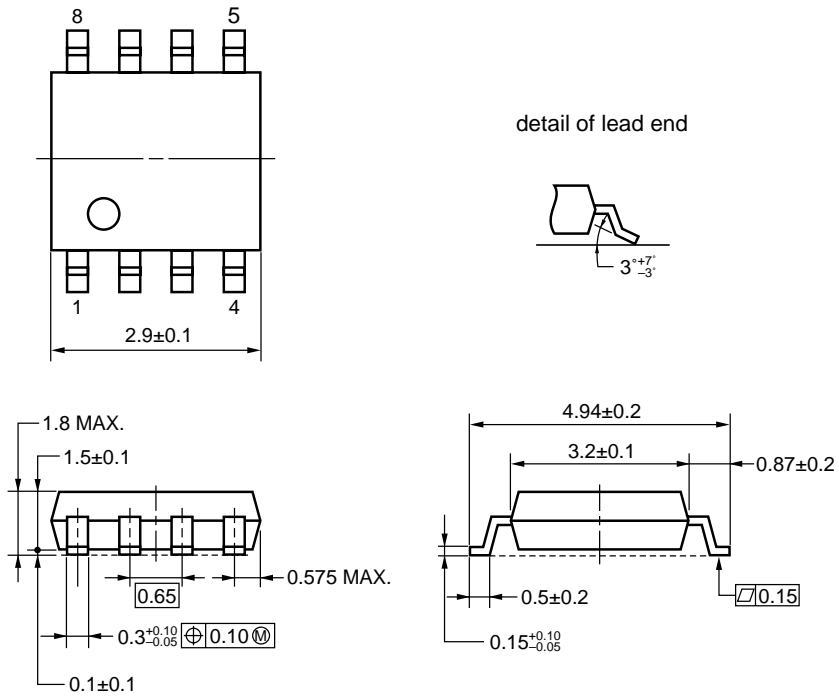
S<sub>22</sub>-FREQUENCY



▽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 Vcc 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
VPS	Peak temperature (package surface temperature) : 215°C or below Time at temperature of 200°C or higher : 25 to 40 seconds Preheating time at 120 to 150°C : 30 to 60 seconds Maximum number of reflow processes : 3 times Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	VP215
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).**



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Sales Division TEL: +81-44-435-1588 FAX: +81-44-435-1579

**NEC Compound Semiconductor Devices Hong Kong Limited**

E-mail: [ncsd-hk@elhk.nec.com.hk](mailto:ncsd-hk@elhk.nec.com.hk) (sales, technical and general)

Hong Kong Head Office TEL: +852-3107-7303 FAX: +852-3107-7309

Taipei Branch Office TEL: +886-2-8712-0478 FAX: +886-2-2545-3859

Korea Branch Office TEL: +82-2-558-2120 FAX: +82-2-558-5209

**NEC Electronics (Europe) GmbH** <http://www.ee.nec.de/>

TEL: +49-211-6503-0 FAX: +49-211-6503-1327

**California Eastern Laboratories, Inc.** <http://www.cel.com/>

TEL: +1-408-988-3500 FAX: +1-408-988-0279

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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.

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.