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April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (<http://www.renesas.com>)

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BIPOLAR ANALOG INTEGRATED CIRCUIT
 μ PC3221GV

GENERAL PURPOSE 5 V 100 MHz AGC AMPLIFIER

DESCRIPTION

The μ 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 : $IM_3 = 56$ 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
μ PC3221GV-E1	8-pin plastic SSOP (4.45 mm (175))	<ul style="list-style-type: none"> • 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.

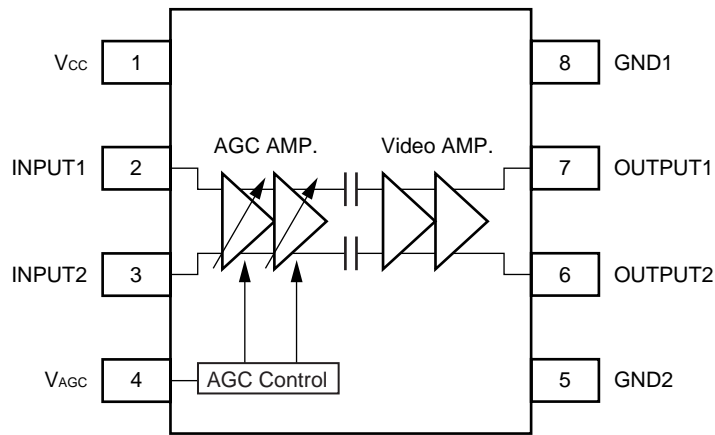
Part number for sample order: μ PC3221GV

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

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

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)	G _{CR} (dB)	NF (dB)	IM ₃ (dBc) ^{Note}	Package
μ PC3217GV	23	53	0	53	6.5	50	8-pin SSOP (4.45 mm (175))
μ PC3218GV	23	63	10	53	3.5	50	
μ PC3219GV	36.5	42.5	0	42.5	9.0	58	
μ PC3221GV	33	60	10	50	4.2	56	

Note f₁ = 44 MHz, f₂ = 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 resistor (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 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 _{MID1}	V _{AGC} = 2.2 V, P _{in} = –60 dBm Note 1	47.5	50.5	53.5	dB
Middle Voltage Gain 2	G _{MID2}	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 ₃₁	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 ₃₂	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 _{out1}) – G (@ P _{out2}) Note 1, 2	–0.5	0	+0.5	dB

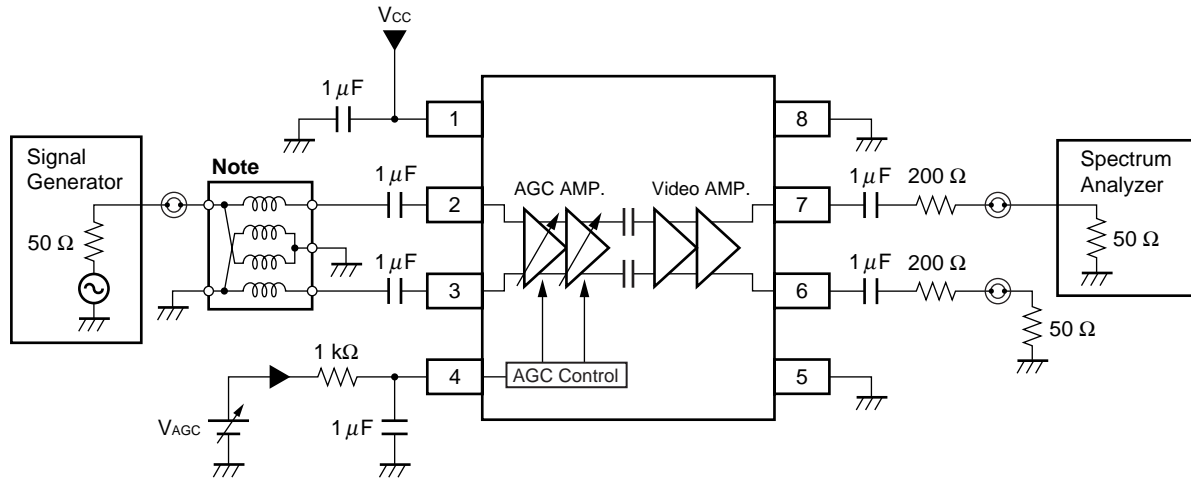
- Notes 1.** By measurement circuit 1
- 2.** By measurement circuit 2
- 3.** By measurement circuit 3

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

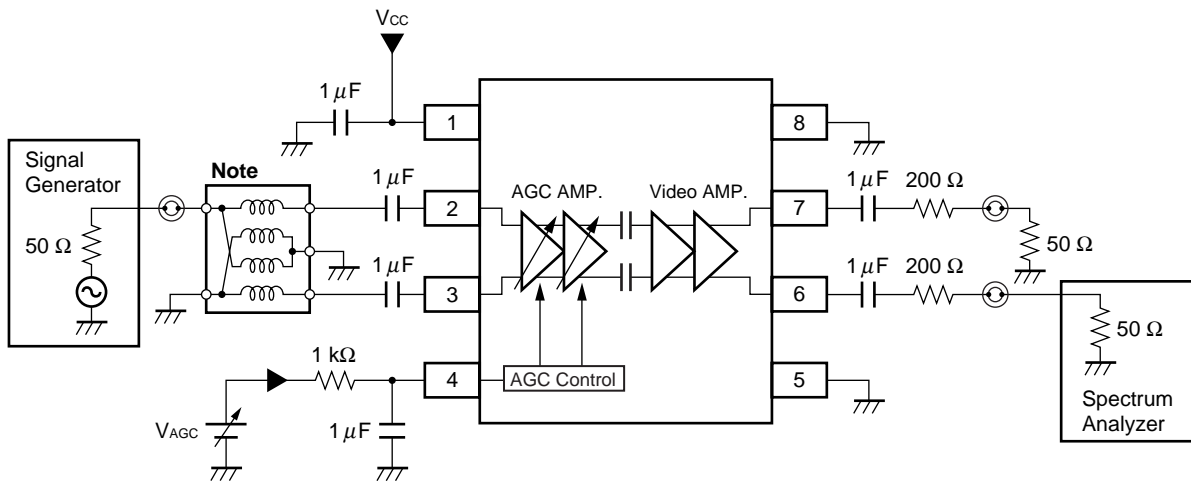
- Notes 1.** By measurement circuit 1
- 2.** By measurement circuit 3
- 3.** By measurement circuit 4

MEASUREMENT CIRCUIT 1



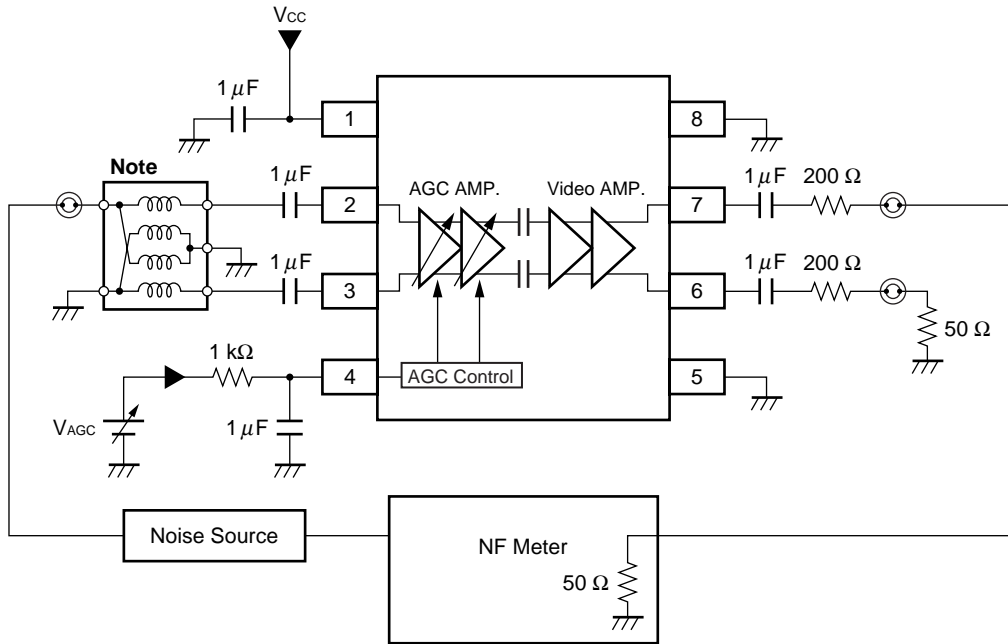
Note Balun Transformer: TOKO 617DB-1010 B4F (Double balanced type)

MEASUREMENT CIRCUIT 2



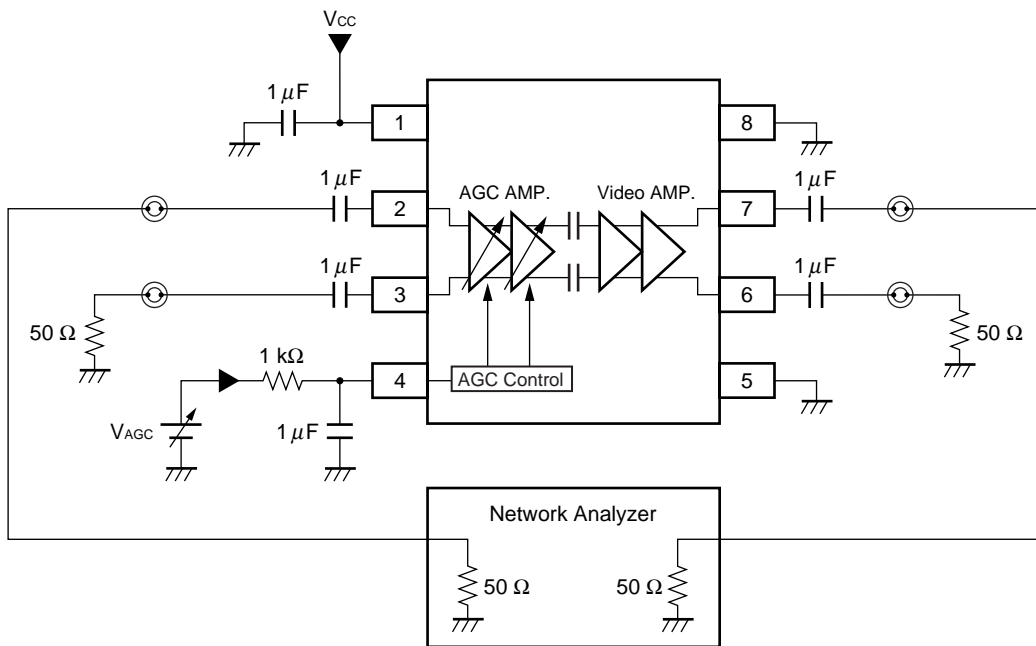
Note Balun Transformer: TOKO 617DB-1010 B4F (Double balanced type)

MEASUREMENT CIRCUIT 3



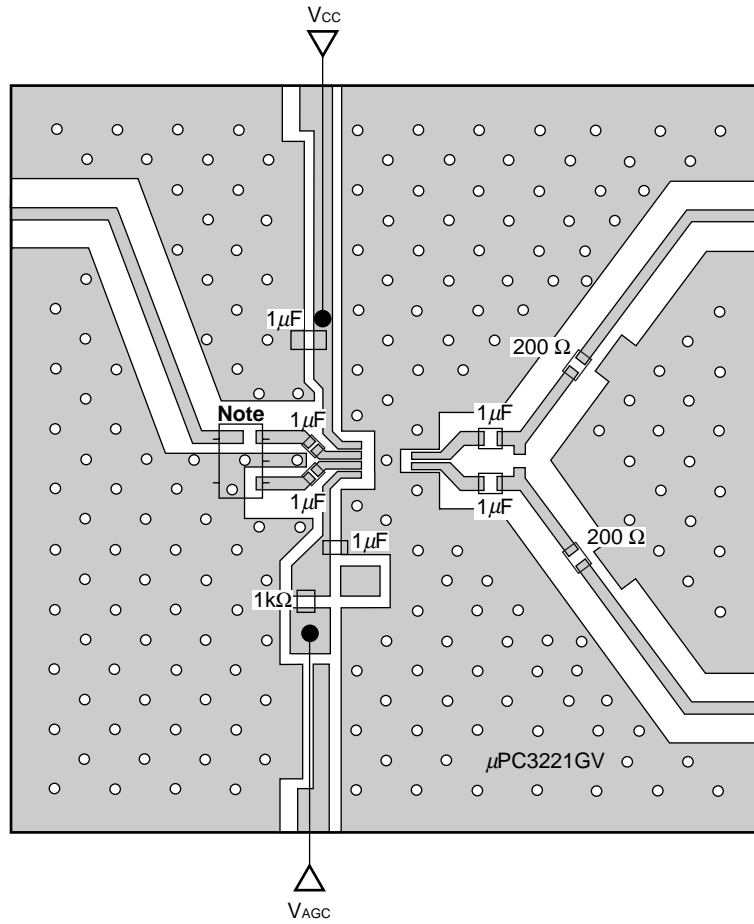
Note Balun Transformer: TOKO 617DB-1010 B4F (Double balanced type)

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)



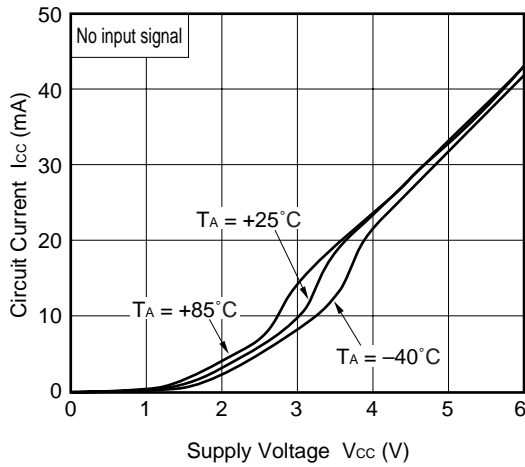
Note Balun Transformer

Remarks

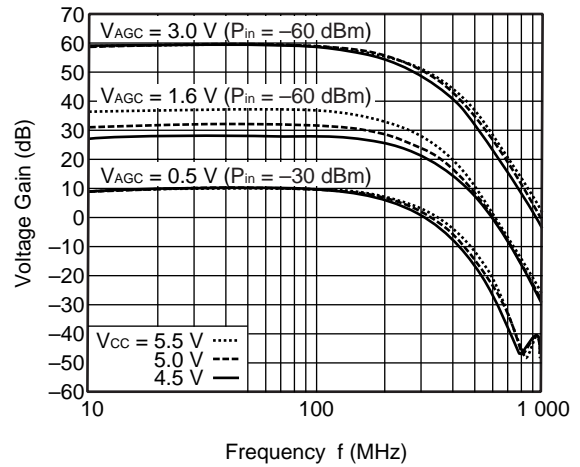
1. Back side: GND pattern
2. Solder plated on pattern
3. ○: Through hole

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

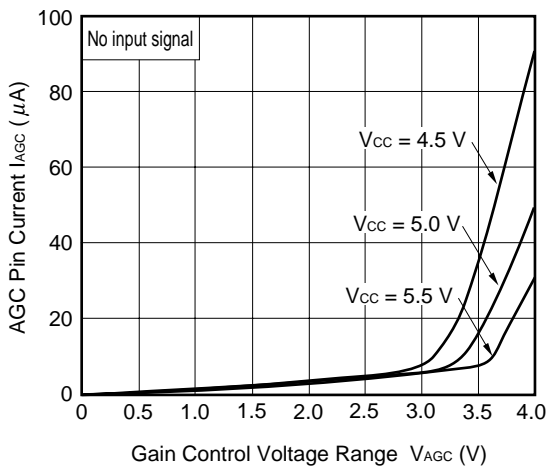
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



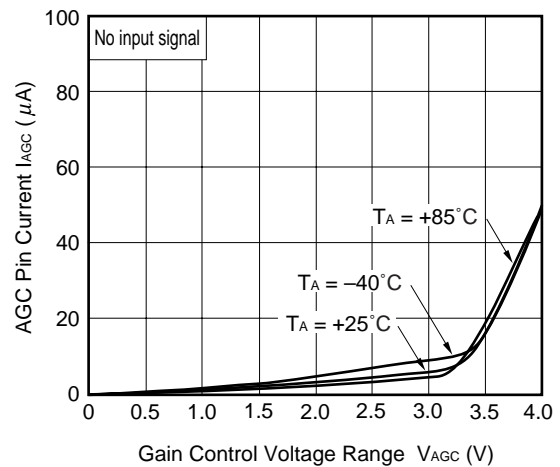
VOLTAGE GAIN vs. FREQUENCY



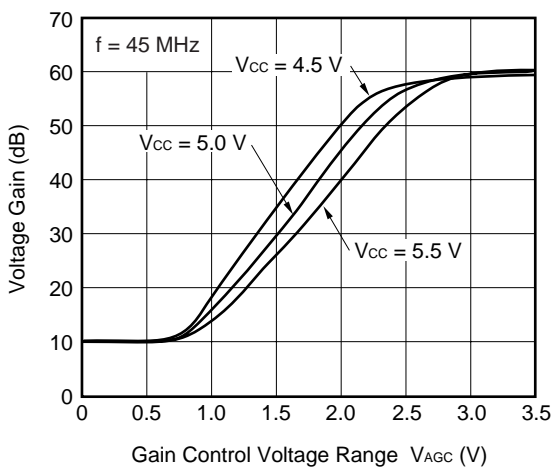
AGC PIN CURRENT vs. GAIN CONTROL VOLTAGE RANGE



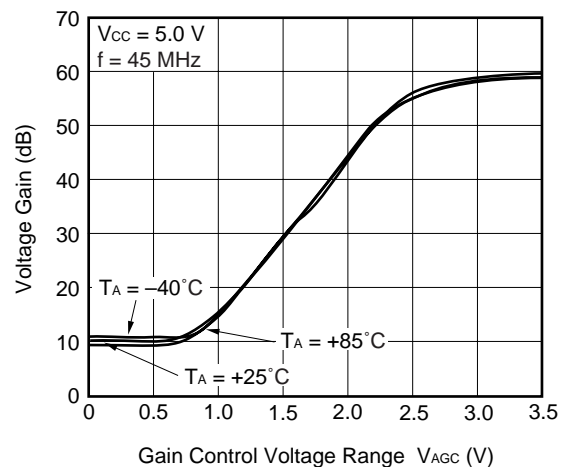
AGC PIN CURRENT vs. GAIN CONTROL VOLTAGE RANGE



VOLTAGE GAIN vs. GAIN CONTROL VOLTAGE RANGE

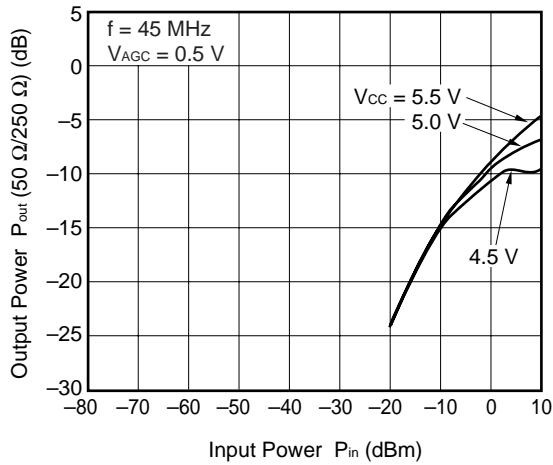


VOLTAGE GAIN vs. GAIN CONTROL VOLTAGE RANGE

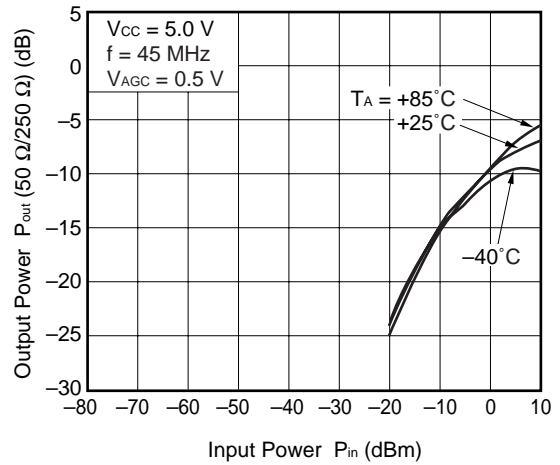


Remark The graphs indicate nominal characteristics.

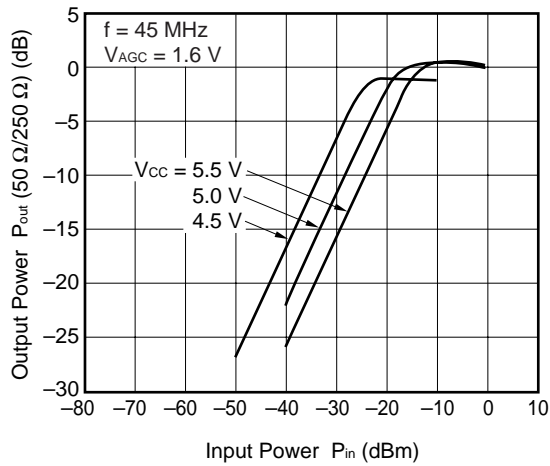
OUTPUT POWER vs. INPUT POWER



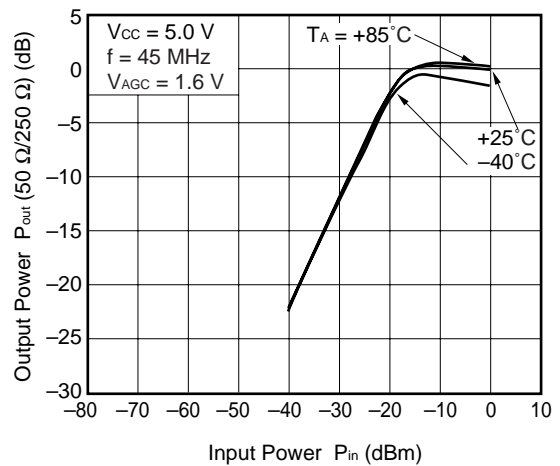
OUTPUT POWER vs. INPUT POWER



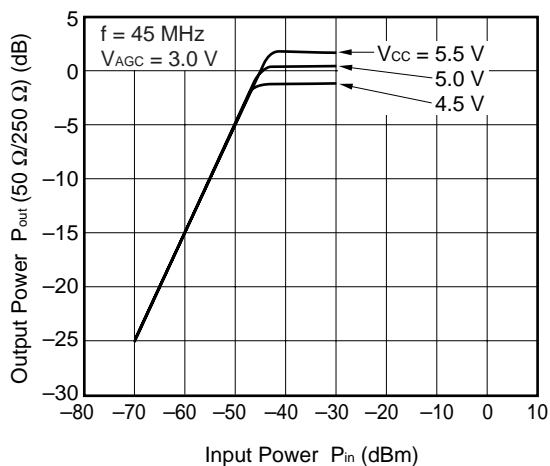
OUTPUT POWER vs. INPUT POWER



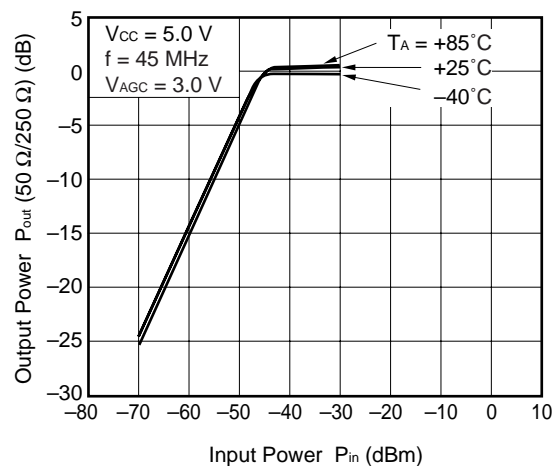
OUTPUT POWER vs. INPUT POWER



OUTPUT POWER vs. INPUT POWER

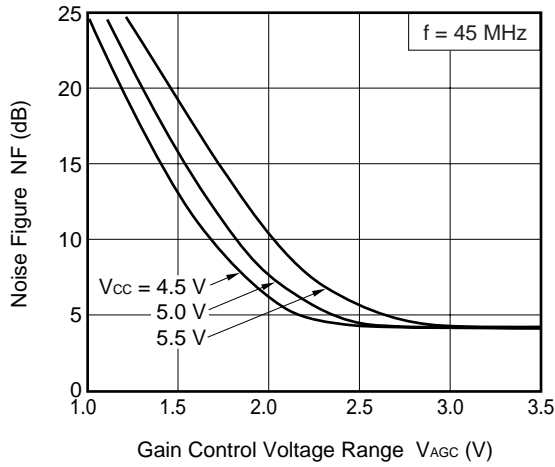


OUTPUT POWER vs. INPUT POWER

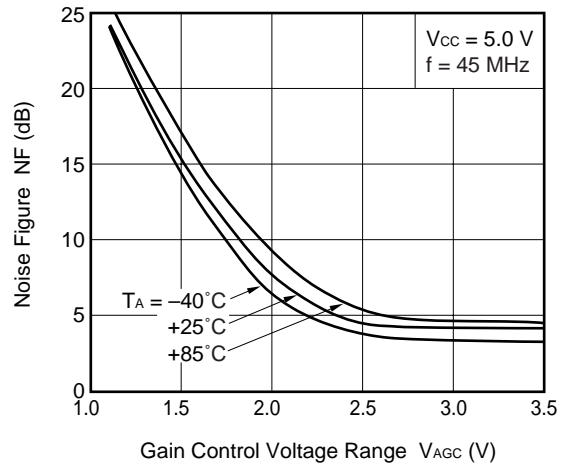


Remark The graphs indicate nominal characteristics.

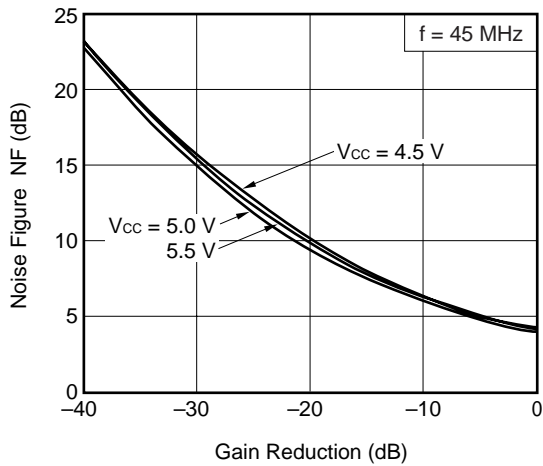
NOISE FIGURE vs. GAIN CONTROL VOLTAGE RANGE



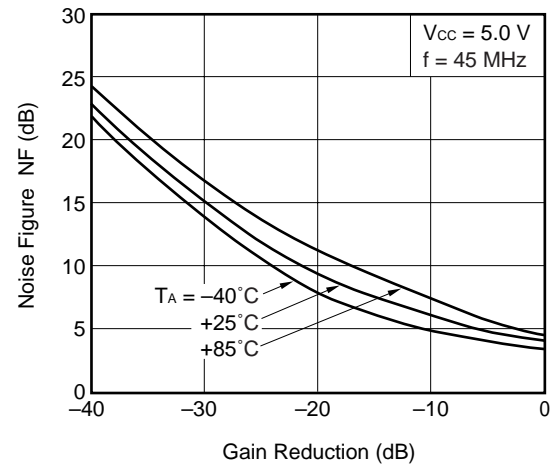
NOISE FIGURE vs. GAIN CONTROL VOLTAGE RANGE



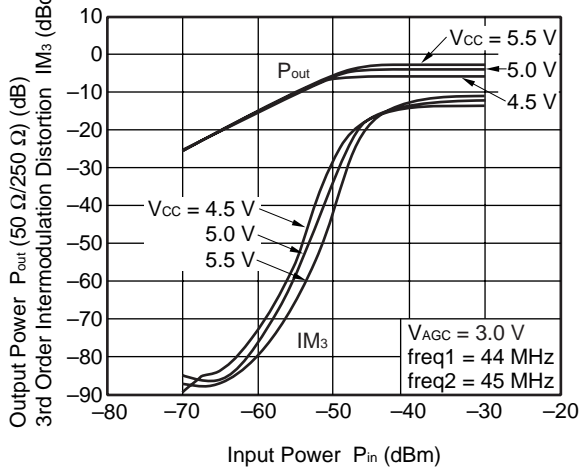
NOISE FIGURE vs. GAIN REDUCTION



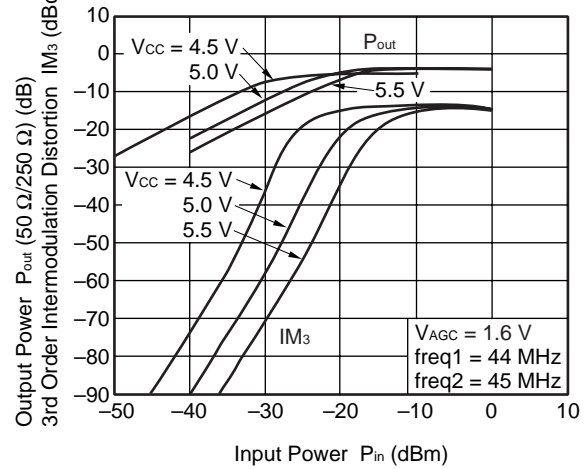
NOISE FIGURE vs. GAIN REDUCTION



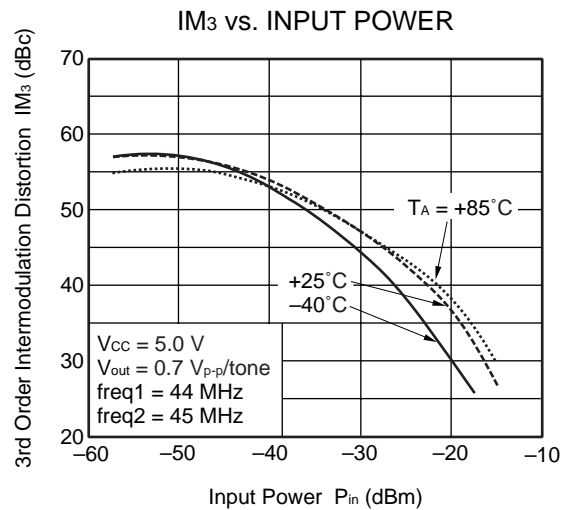
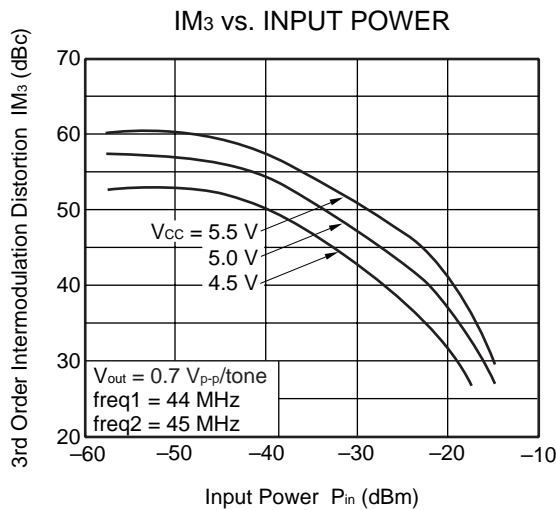
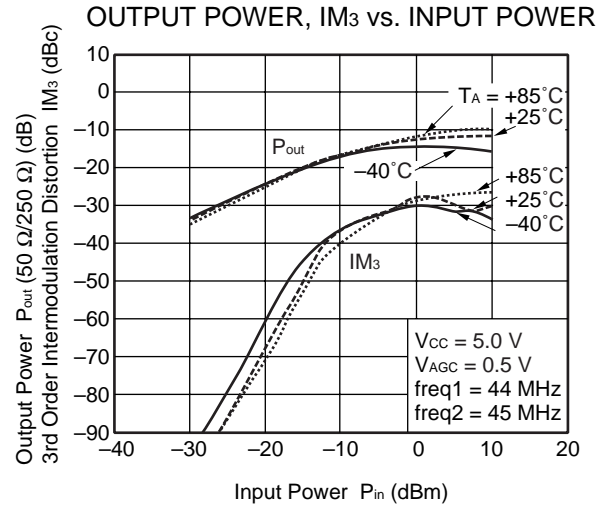
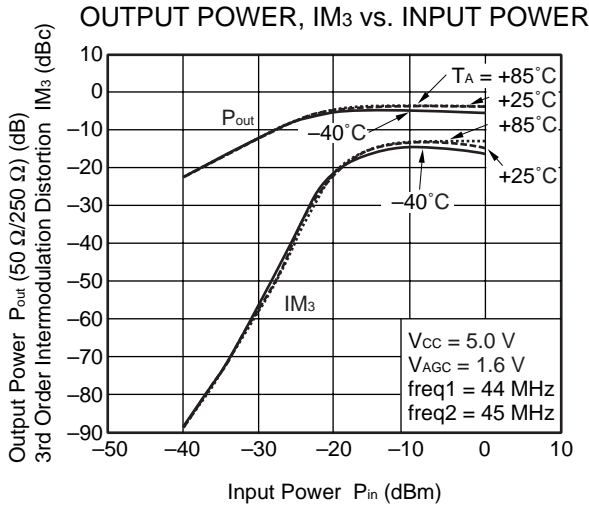
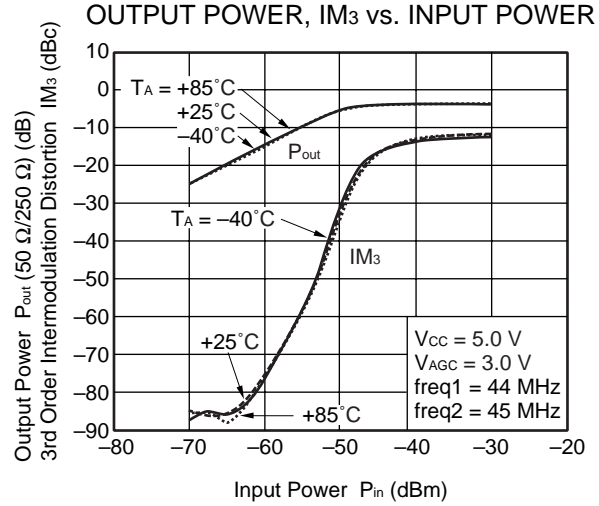
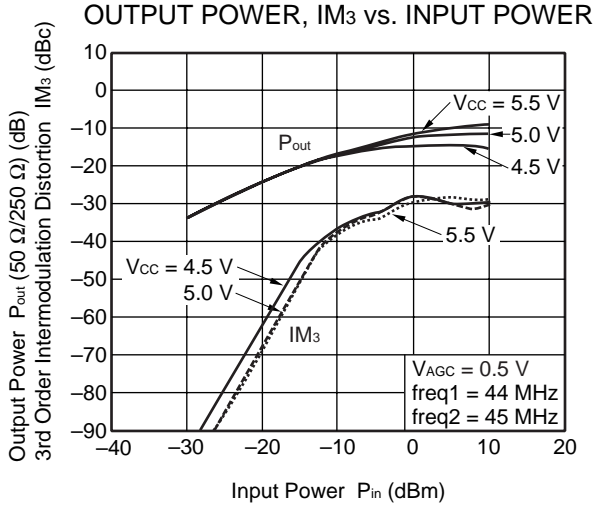
OUTPUT POWER, IM₃ vs. INPUT POWER



OUTPUT POWER, IM₃ vs. INPUT POWER



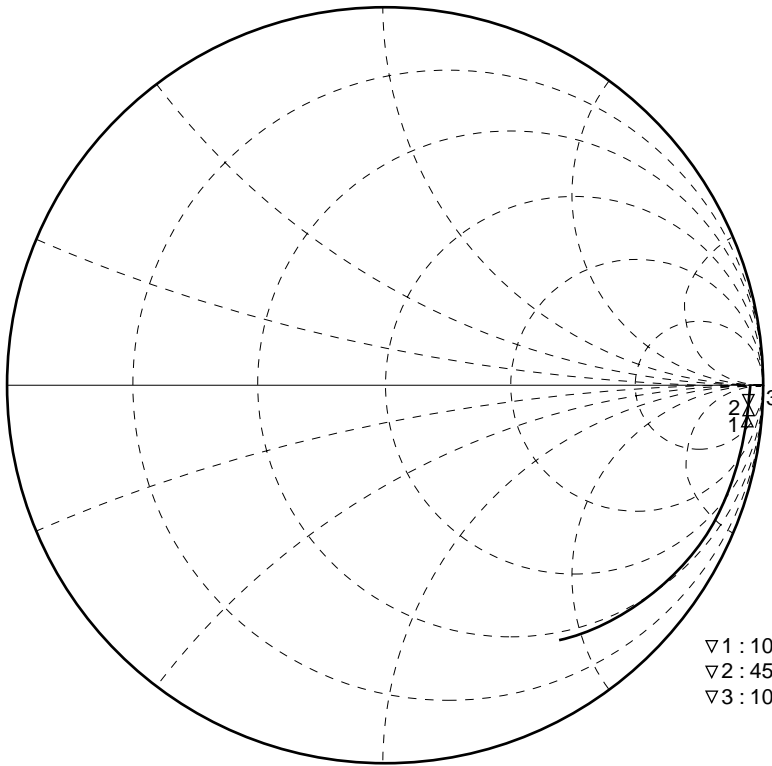
Remark The graphs indicate nominal characteristics.



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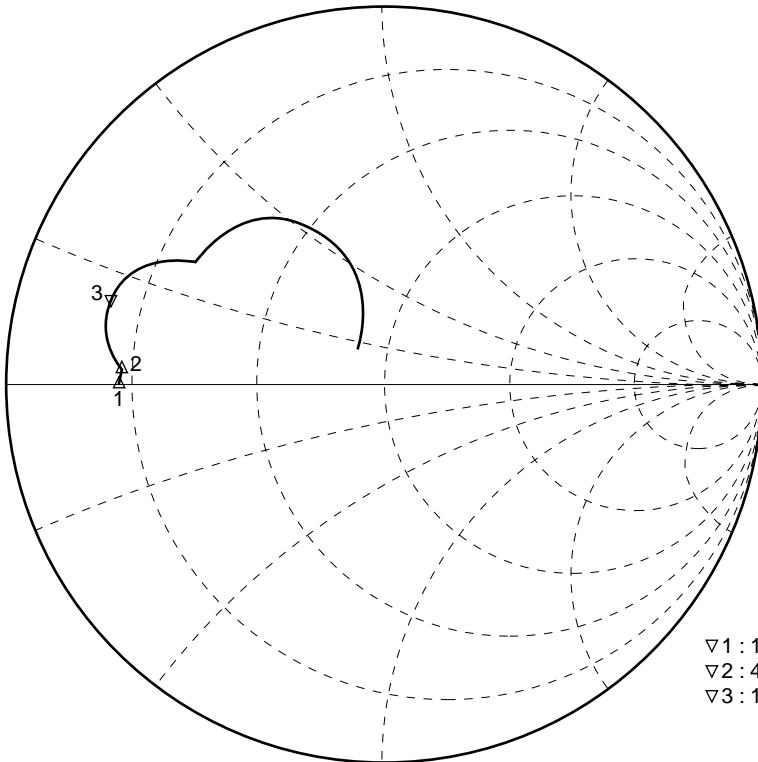
★ S-PARAMETERS ($T_A = +25^\circ\text{C}$, $V_{CC} = V_{AGC} = 5.0\text{ V}$)

S₁₁-FREQUENCY



▽1 : 10 MHz	2.889 k Ω	-1.059 k Ω	15.33 pF
▽2 : 45 MHz	864.1 Ω	-1.402 k Ω	2.524 pF
▽3 : 100 MHz	235.0 Ω	-806.9 Ω	1.973 pF

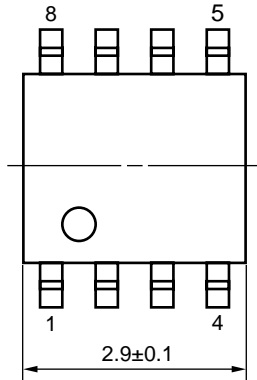
S₂₂-FREQUENCY



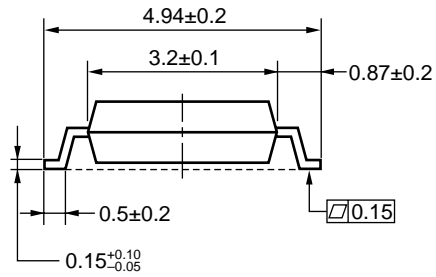
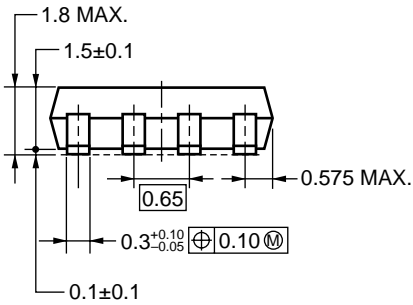
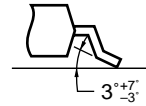
▽1 : 10 MHz	9.032 Ω	466.5 m Ω	7.335 nH
▽2 : 45 MHz	8.998 Ω	1.887 Ω	6.675 nH
▽3 : 100 MHz	7.266 Ω	6.750 Ω	10.74 nH

PACKAGE DIMENSIONS

8-PIN PLASTIC SSOP (4.45 mm (175)) (UNIT: mm)



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 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 ^{Note}	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

Note Excluding lead-free products

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

- **The information in this document is current as of July, 2004. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC's data sheets or data books, etc., for the most up-to-date specifications of NEC semiconductor products. Not all products and/or types are available in every country. Please check with an NEC sales representative for availability and additional information.**
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