DATA SHEET

NEC

BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC1678GV

5 V-BIAS, +17.5 dBm OUTPUT, 2.0 GHz WIDEBAND Si MMIC AMPLIFIER

★ **DESCRIPTION**

The μPC1678GV is a silicon monolithic integrated circuit designed as medium output power amplifier for high frequency system applications. Due to +17.5 dBm TYP. output at 2 GHz, this IC is recommendable for transmitter stage amplifier of L BAND wireless communication systems.

The μPC1678GV has shrink package and compatible pin connections and supply voltage to μPC1678G. So, in the case of decreasing your system size, μPC1678GV is suitable to replace from μPC1678G.

This IC is manufactured using NEC's 20 GHz f_T NESAT™IV silicon bipolar process. This process uses silicon nitride passivation film and gold electrodes. These materials can protect chip surface from external pollution and prevent corrosion/migration. Thus, this IC has excellent performance, uniformity and reliability.

FEATURES

- Supply voltage : V_{CC} = 4.5 to 5.5 V
- Saturated output power : $P_{O(sat)}$ = +17.5 dBm TYP. @ f = 500 MHz with external inductor
- Wideband response : f_u = 2.0 GHz TYP. @ 3 dB down below the gain at 0.1 GHz
- Power gain : G_P = 23 dB TYP. @ f = 500 MHz
- Isolation : ISL = 35 dB TYP. @ f = 500 MHz
- High-density surface mounting : 8-pin plastic SSOP package (3.0 × 3.2 × 1.8 mm)

APPLICATIONS

- PA driver for high frequency system.

ORDERING INFORMATION

Part Number	Package	Marking	Supplying Form
μPC1678GV-E1	8 pin plastic SSOP	1678	Embossed tape 8 mm wide. Pin 1 is in tape pull-out direction. Qty 1 kp/reel.

Remark To order evaluation samples, please contact your local NEC sales office.
(Part number for sample order: μPC1678GV)

Caution Electro-static sensitive devices

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.
Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

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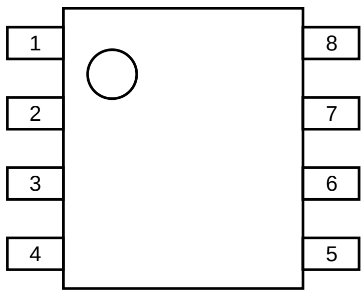
The mark ★ shows major revised points.

PIN CONNECTIONS

(Top Veiw)



Pin No.	Pin Name
1	INPUT
2	GND
3	GND
4	GND
5	OUTPUT
6	GND
7	GND
8	V_{CC}

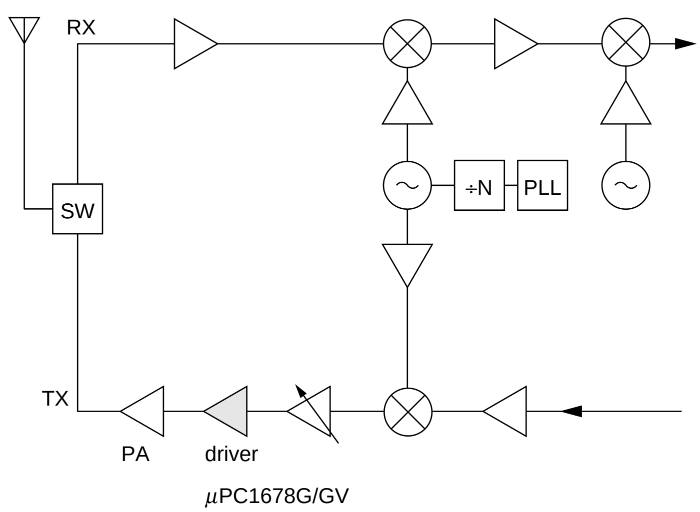
PRODUCT LINE-UP (T_A = +25 °C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)

Part Number	f_u (GHz)	$P_{O(sat)}$ (dBm)	G_P (dB)	NF (dB)	I_{CC} (mA)	Package
μPC1678G	2.0	+17.5	23	6.0	49	8-pin plastic SOP
μPC1678GV	2.0	+17.5	23	6.0	49	8-pin plastic SSOP

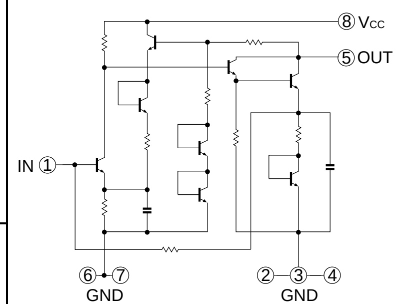
Remark Typical performance. Please refer to ELECTRICAL CHARACTERISTICS in detail.

SYSTEM APPLICATION EXAMPLE

EXAMPLE OF PA driver in RF transmitter block



PIN EXPLANATION

Pin NO.	Pin Name	Applied Voltage (V)	Pin Voltage (V) Note	Functions and application	Internal equivalent circuit
1	INPUT	—	1.17	Signal input pin. A internal matching circuit, configured with resistors, enables 50 Ω connection over a wide band. A multi-feedback circuit is designed to cancel the deviations of h_{FE} and resistance. This pin must be coupled to signal sause with capacitor for DC cut.	 2, 3, 4, 6 and 7 are shorted by a lead frame.
5	OUTPUT	Voltage as same as V_{CC} through external inductor	—	Signal output pin. This output is designed as open collector of derlington transistors. Connect an inductor between this pin and V_{CC} pin to supply current to the internal output transistors. The inductor should be selected as high frequency use and small DC resistance.	
8	V_{CC}	4.5 to 5.5	—	Power supply pin. This pin should be externally equipped with bypass capacitor to minimize ground impedance.	
6 7	GND	0	—	Ground pins of internal input stage. Form a ground pattern as wide as possible to minimize ground impedance.	
2 3 4	GND	0	—	Ground pins of internal output stage. All the ground pins including pin 6 and pin 7 must be connected together with wide ground pattern to decrease impedance difference.	

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

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Rating	Unit
Supply Voltage	V_{CC}	T_A = +25 °C, Pin 5 and 8	6	V
Input Power	P_{in}	T_A = +25 °C	+10	dBm
Power Dissipation	P_D	Mounted on double sided copper clad 50 × 50 × 1.6 mm epoxy glass PWB (T_A = +85 °C)	330	mW
Operating Ambient Temperature	T_A		–45 to +85	°C
Storage Temperature	T_{stg}		–55 to +150	°C

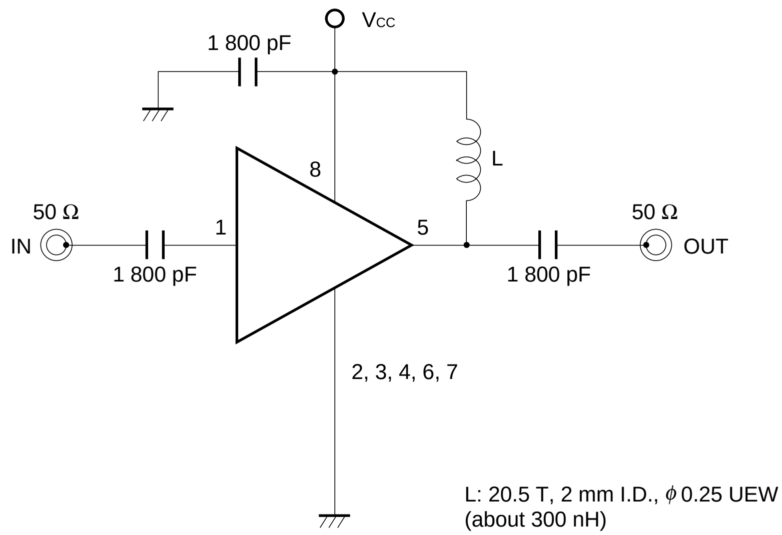
RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Notice
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	The same voltage should be applied to pin 5 and 8.
Operating Ambient Temperature	T_A	–45	+25	+85	°C	

ELECTRICAL CHARACTERISTICS (T_A = + 25 °C, $V_{CC} = V_{out}$ = 5.0 V, $Z_L = Z_S$ = 50 Ω)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I_{CC}	No signal	40	49	60	mA
Power Gain	G_P	f = 500 MHz	21	23	25	dB
Noise Figure	NF	f = 500 MHz	—	6.0	8.0	dB
Upper Limit Operating Frequency	f_u	3 dB down below from gain at f = 100 MHz	1.7	2.0	—	GHz
Isolation	ISL	f = 500 MHz	30	35	—	dB
Input Return Loss	RL_{in}	f = 500 MHz	11	14	—	dB
Output Return Loss	RL_{out}	f = 500 MHz	1	4	—	dB
Saturated Output Power Level	$P_{O(sat)}$	f = 500 MHz	+15.5	+17.5	—	dBm

TEST CIRCUIT



INDUCTOR FOR THE OUTPUT PIN

The internal output transistor of this IC consumes 30 mA, to output medium power. To supply current for output transistor, connect an inductor between the V_{CC} pin (pin 8) and output pin (pin 5).

The inductor has both DC and AC effects. In terms of DC, the inductor biases the output transistor with minimum voltage drop to output enable high level. In terms of AC, the inductor make output-port impedance higher to get enough gain. In this case, large inductance and Q is suitable.

CAPACITORS FOR THE V_{CC}, INPUT AND OUTPUT PINS

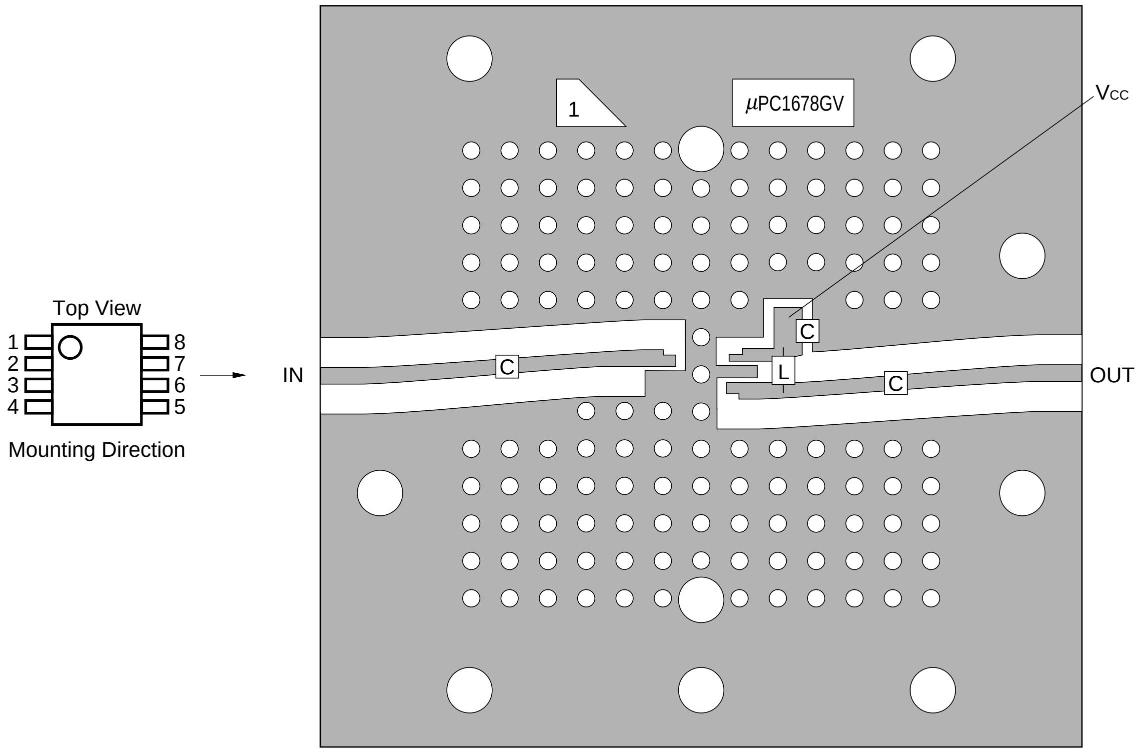
Capacitors of 1 800 pF are recommendable as the bypass capacitor for the V_{CC} pin and the coupling capacitors for the input and output pins.

The bypass capacitor connected to the V_{CC} pin is used to minimize ground impedance of V_{CC} pin. So, stable bias can be supplied against V_{CC} fluctuation.

The coupling capacitors, connected to the input and output pins, are used to cut the DC and minimize RF serial impedance. Their capacitance are therefore selected as lower impedance against a 50 Ω load. The capacitors thus perform as high pass filters, suppressing low frequencies to DC.

To obtain a flat gain from 100 MHz upwards, 1 800 pF capacitors are used in the test circuit. In the case of under 100 MHz operation, increase the value of coupling capacitor such as 10 000 pF. Because the coupling capacitors are determined by equation, $C = 1/(2\pi Rfc)$.

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



★ **COMPONENT LIST**

	Value
C	1 800 pF
L	300 nH

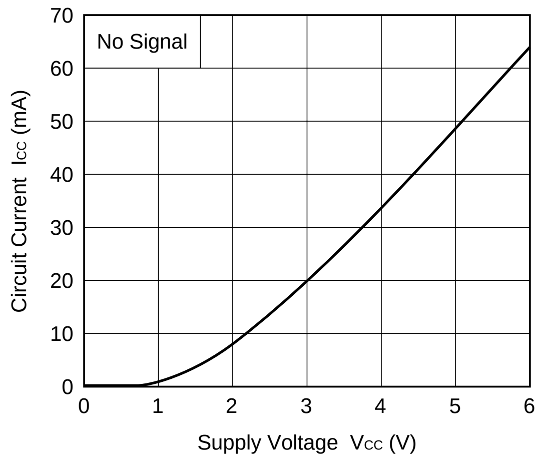
Notes

1. 50 × 50 × 0.4 mm double sided copper clad polyimide board.
2. Back side: GND pattern
3. Solder plated on pattern
4. o ◯ : Through holes

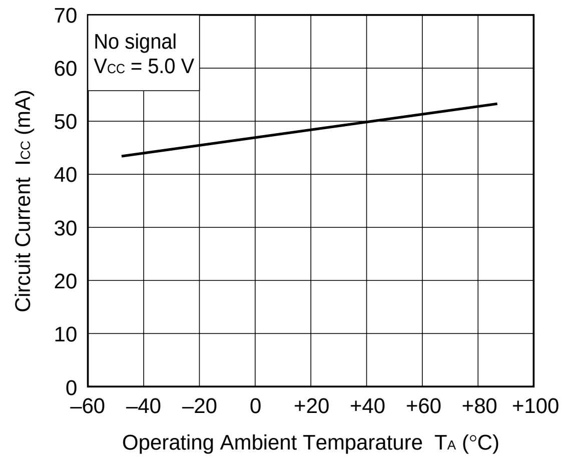
For more information on the use of this IC, refer to the following application note: USAGE AND APPLICATION OF SILICON MEDIUM-POWER HIGH-FREQUENCY AMPLIFIER MMIC (P12152E).

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

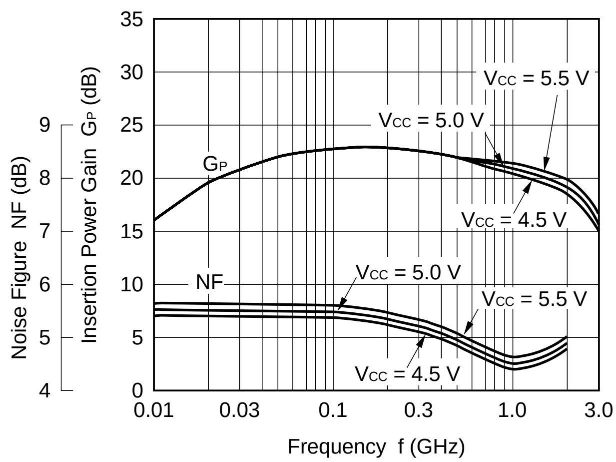
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



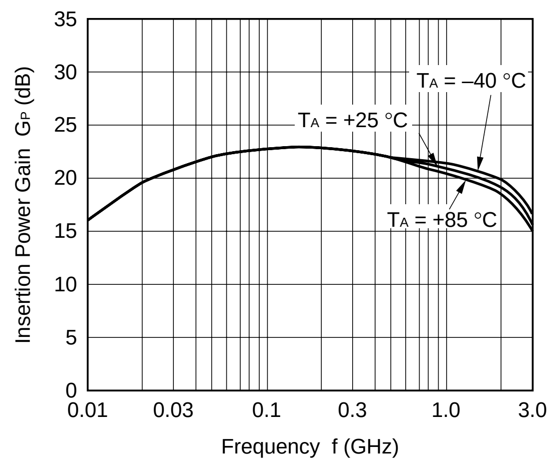
CIRCUIT CURRENT vs.
OPERATING AMBIENT TEMPERATURE



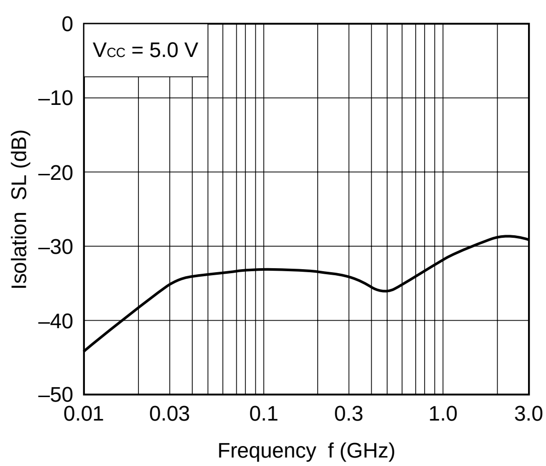
NOISE FIGURE, INSERTION POWER GAIN
vs. FREQUENCY



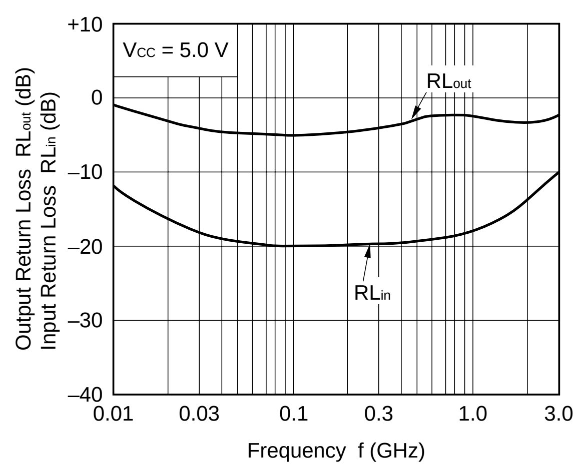
INSERTION POWER GAIN vs. FREQUENCY

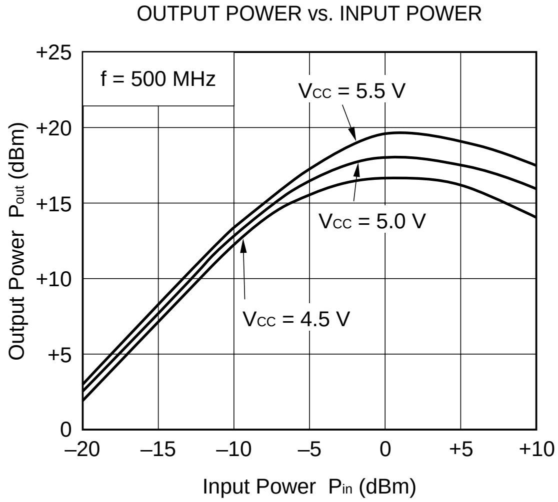


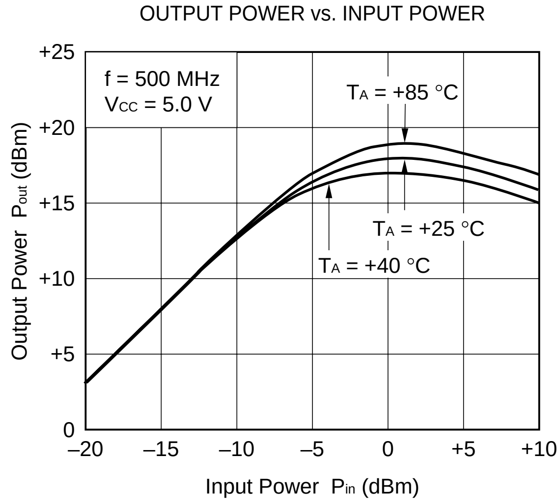
ISOLATION vs. FREQUENCY

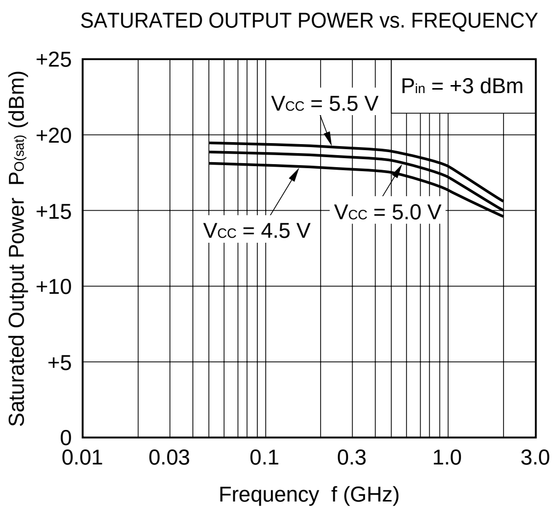


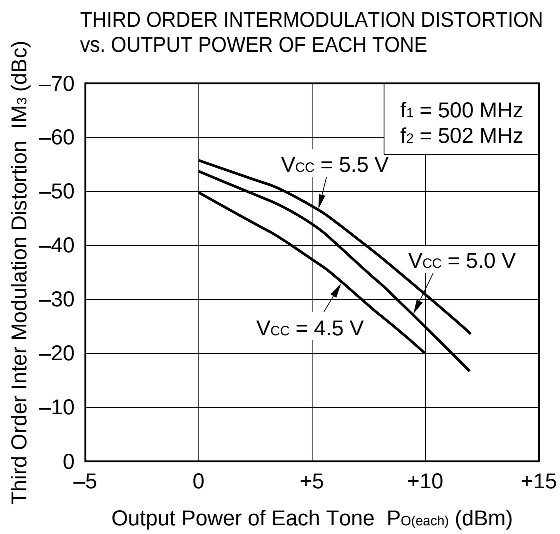
INPUT RETURN LOSS, OUTPUT RETURN LOSS
vs. FREQUENCY




OUTPUT POWER vs. INPUT POWER
f = 500 MHz
VCC = 5.5 V
VCC = 5.0 V
VCC = 4.5 V
Output Power Pout (dBm)
Input Power Pin (dBm)

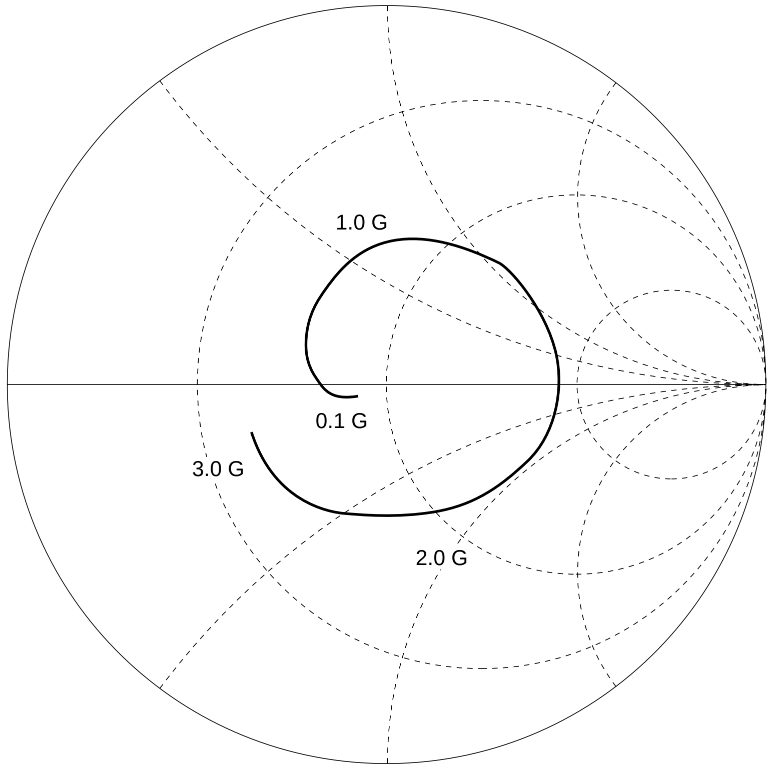

OUTPUT POWER vs. INPUT POWER
f = 500 MHz
VCC = 5.0 V
TA = +85 °C
TA = +25 °C
TA = +40 °C
Output Power Pout (dBm)
Input Power Pin (dBm)


SATURATED OUTPUT POWER vs. FREQUENCY
Pin = +3 dBm
VCC = 5.5 V
VCC = 5.0 V
VCC = 4.5 V
Saturated Output Power PO(sat) (dBm)
Frequency f (GHz)

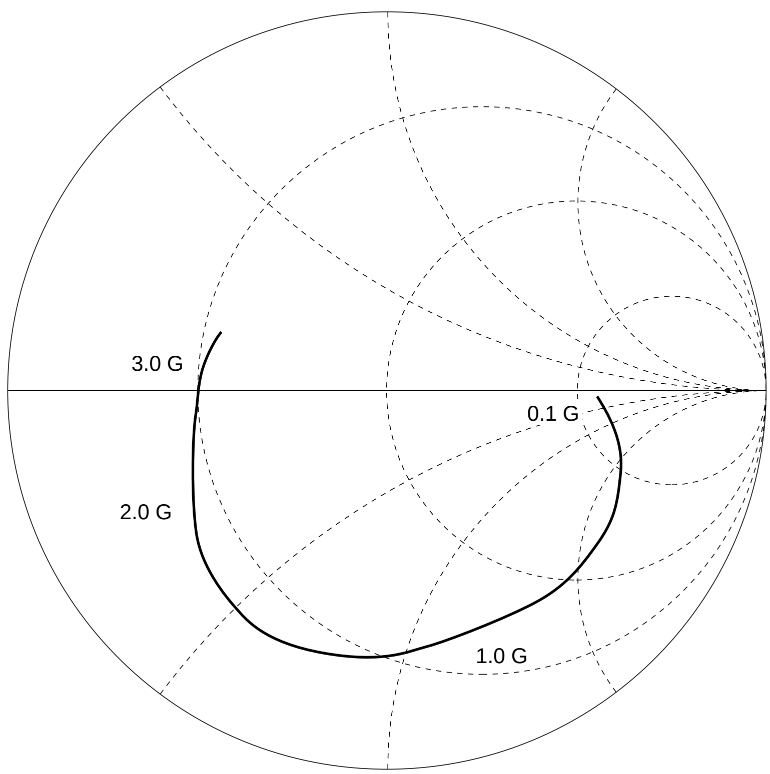

THIRD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE
f1 = 500 MHz
f2 = 502 MHz
VCC = 5.5 V
VCC = 5.0 V
VCC = 4.5 V
Third Order Inter Modulation Distortion IM3 (dBc)
Output Power of Each Tone PO(each) (dBm)

★ **S-PARAMETER (T$_A$ = +25 °C, V$_{CC}$ = V$_{out}$ = 5.0 V)**

S$_{11}$-FREQUENCY



S$_{22}$-FREQUENCY



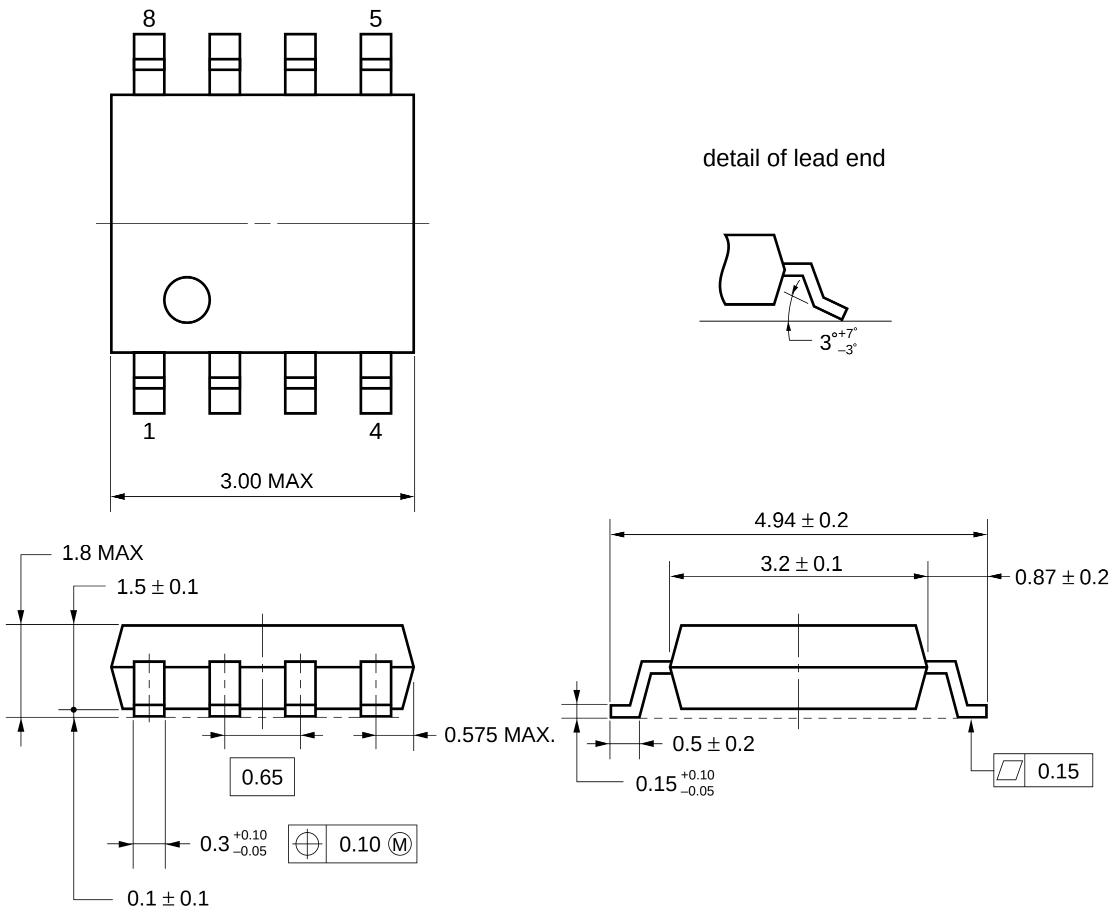
★ TYPICAL S-PARAMETER VALUES (T_A = +25 °C)

$V_{CC} = V_{out}$ = 5.0 V I_{CC} = 44 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.085	–163.8	12.206	–2.6	0.024	–5.0	0.558	–2.3	1.36
200.0000	0.118	–163.3	12.842	–6.0	0.020	–8.1	0.594	–6.6	1.43
300.0000	0.158	–170.9	13.766	–10.9	0.015	–2.4	0.637	–13.6	1.61
400.0000	0.184	176.0	14.731	–17.7	0.016	11.1	0.667	–21.3	1.39
500.0000	0.214	164.8	15.815	–25.1	0.014	26.3	0.692	–30.8	1.34
600.0000	0.243	152.4	16.598	–33.9	0.015	44.5	0.703	–40.2	1.13
700.0000	0.266	138.9	17.541	–43.2	0.019	51.4	0.701	–49.0	0.85
800.0000	0.293	125.2	18.057	–52.3	0.024	56.5	0.689	–57.0	0.69
900.0000	0.312	113.7	18.475	–62.2	0.027	58.1	0.670	–65.7	0.62
1000.0000	0.379	95.6	20.083	–71.9	0.031	61.7	0.686	–68.6	0.47
1100.0000	0.381	82.2	20.090	–82.8	0.035	58.6	0.685	–77.5	0.45
1200.0000	0.401	66.5	20.620	–94.0	0.038	56.0	0.688	–84.9	0.42
1300.0000	0.422	51.1	20.669	–106.8	0.042	55.1	0.702	–92.8	0.38
1400.0000	0.446	34.0	20.473	–119.6	0.046	52.6	0.713	–100.5	0.36
1500.0000	0.455	16.6	19.765	–132.5	0.048	48.4	0.717	–110.4	0.35
1600.0000	0.465	–0.5	18.759	–145.7	0.050	47.0	0.711	–119.0	0.36
1700.0000	0.444	–16.7	17.137	–157.7	0.049	44.9	0.684	–128.7	0.42
1800.0000	0.431	–33.5	15.512	–168.9	0.050	42.9	0.659	–137.4	0.48
1900.0000	0.397	–47.2	13.846	–178.7	0.048	43.5	0.616	–145.1	0.59
2000.0000	0.378	–59.2	12.398	172.4	0.048	45.8	0.574	–151.4	0.70
2100.0000	0.357	–70.5	11.060	164.9	0.048	45.3	0.540	–157.0	0.81
2200.0000	0.343	–80.7	9.918	157.8	0.048	47.4	0.510	–161.5	0.91
2300.0000	0.339	–89.4	8.927	151.7	0.049	47.4	0.489	–164.8	1.00
2400.0000	0.335	–98.9	8.107	146.2	0.051	46.1	0.483	–167.6	1.06
2500.0000	0.338	–107.2	7.388	140.6	0.050	46.2	0.475	–171.7	1.15
2600.0000	0.358	–115.5	6.772	135.4	0.055	46.8	0.475	–173.8	1.16
2700.0000	0.359	–125.3	6.267	131.0	0.051	48.1	0.463	–178.1	1.32
2800.0000	0.368	–133.9	5.807	125.4	0.054	49.4	0.482	179.5	1.33
2900.0000	0.372	–143.4	5.450	121.3	0.051	49.6	0.489	173.4	1.45
3000.0000	0.375	–152.7	5.018	116.0	0.050	53.6	0.475	166.3	1.62
3100.0000	0.372	–161.4	4.684	110.5	0.053	57.5	0.453	161.4	1.66

★ **PACKAGE DIMENSIONS**

8 PIN PLASTIC SSOP (UNIT : mm)



NOTE Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.

NOTE 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.
(4) The inductor must be attached between V_{CC} and output pins. The inductance value should be determined in accordance with desired frequency.
(5) The DC cut capacitor must be each attached to the input and output pins.

RECOMMENDED SOLDERING CONDITIONS

This product should be soldered under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your NEC sales representative.

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared Reflow	Package peak temperature: 235 °C or below Time: 30 seconds or less (at 210 °C) Count: 3, Exposure limit[Note]: None	IR35-00-3
VPS	Package peak temperature: 215 °C or below Time: 40 seconds or less (at 200 °C) Count: 3, Exposure limit[Note]: None	VP15-00-3
Wave Soldering	Soldering bath temperature: 260 °C or below Time: 10 seconds or less Count: 1, Exposure limit[Note]: None	WS60-00-1
Partial Heating	Pin temperature: 300 °C Time: 3 seconds or less (per side of device) Exposure limit[Note]: None	–

Note After opening the dry pack, keep it in a place below 25 °C and 65 % RH for the allowable storage period.

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

For details of recommended soldering conditions for surface mounting, refer to information document **SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL (C10535E)**.

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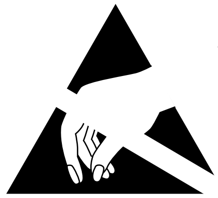

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ELECTROSTATIC
SENSITIVE
DEVICES

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