To our customers,

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April 1st, 2010
Renesas Electronics Corporation

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RENESAS

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RENESAS

BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC2776TB

5 V, SUPER MINIMOLD SILICON MMIC MEDIUM OUTPUT POWER AMPLIFIER

DESCRIPTION

The μPC2776TB is a silicon monolithic integrated circuits designed as wideband amplifier. This amplifier has impedance near 50 Ω in HF band, so this IC suits to the system of HF to L band.

This IC is manufactured using NEC's 20 GHz f_T NESAT™ III 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
- Circuit current : I_{CC} = 25 mA TYP. @V_{CC} = 5.0 V
- Power gain : G_P = 23 dB TYP. @f = 1 GHz
- Medium output power : $P_{O(1\ dB)}$ = +6.5 dBm @f = 1 GHz
- Upper limit operating frequency : f_u = 2.7 GHz TYP. @3 dB bandwidth
- Port impedance : input/output 50 Ω
- High-density surface mounting : 6-pin super minimold package (2.0 × 1.25 × 0.9 mm)

APPLICATION

- Systems required wideband operation from HF to 2.0 GHz

ORDERING INFORMATION

Part Number	Package	Marking	Supplying Form
μPC2776TB-E3	6-pin super minimold	C2L	• Embossed tape 8 mm wide • 1, 2, 3 pins face the perforation side of the tape • Qty 3 kpcs/reel

Remark To order evaluation samples, please contact your local NEC sales office.
Part number for sample order: μPC2776TB

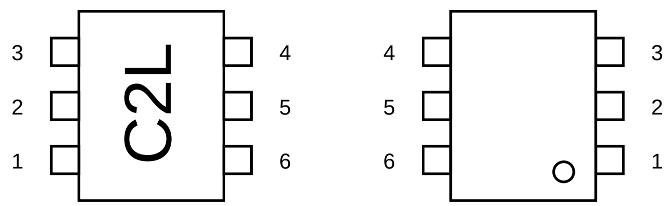
Caution Electro-static sensitive devices

Document No. P12680EJ3V0DS00 (3rd edition)
Date Published February 2001 N CP(K)
Printed in Japan

The mark ★ shows major revised points.

PIN CONNECTIONS

(Top View) (Bottom View)



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

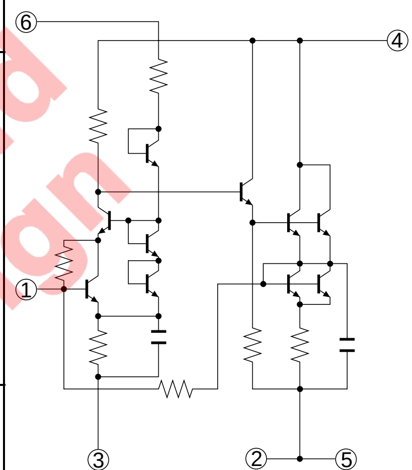
★ PRODUCT LINE-UP OF 5 V-BIAS SILICON MMIC MEDIUM OUTPUT POWER AMPLIFIER
(T_A = +25°C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)

Part No.	f_u (GHz)	$P_{O(1\,dB)}$ (dBm)	$P_{O(sat)}$ (dBm)	G_P (dB)	NF (dB)	I_{CC} (mA)	Package	Marking
μPC2776T	2.7	+6.5	+8.5	23	6.0 @f = 1 GHz	25	6-pin minimold	C2L
μPC2776TB							6-pin super minimold	
μPC2708T	2.9	–	+10.0	15	6.5 @f = 1 GHz	26	6-pin minimold	C1D
μPC2708TB							6-pin super minimold	
μPC2709T	2.3	+9.0	+11.5	23	5 @f = 1 GHz	25	6-pin minimold	C1E
μPC2709TB							6-pin super minimold	
μPC2710T	1.0	–	+13.5	33	3.5 @f = 0.5 GHz	22	6-pin minimold	C1F
μPC2710TB							6-pin super minimold	

Remark Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail.
To know the associated product, please refer to each latest data sheet.

Caution The package size distinguishes between minimold and super minimold.

PIN EXPLANATION

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)Note	Function and Applications	Internal Equivalent Circuit
1	INPUT	–	1.03	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 source with capacitor for DC cut.	
2 3 5	GND	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 the ground pins must be connected together with wide ground pattern to decrease impedance difference.	
4	OUTPUT	Voltage as same as V_{CC} through external inductor	–	Signal output pin. The inductor must be attached between V_{CC} and output pins to supply current to the internal output transistors.	
6	V_{CC}	4.5 to 5.5	–	Power supply pin, which biases the internal input transistor. This pin should be externally equipped with bypass capacitor to minimize its impedance.	

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

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V_{CC}	T_A = +25°C, pin 4 and pin 6	6	V
Circuit Current	I_{CC}	T_A = +25°C	60	mA
★ Power Dissipation	P_D	Mounted on double-sided copper clad 50 × 50 × 1.6 mm epoxy glass PWB, T_A = +85°C	270	mW
Operating Ambient Temperature	T_A		–40 to +85	°C
Storage Temperature	T_{stg}		–55 to +150	°C
★ Input Power	P_{in}	T_A = +25°C	+10	dBm

RECOMMENDED OPERATING RANGE

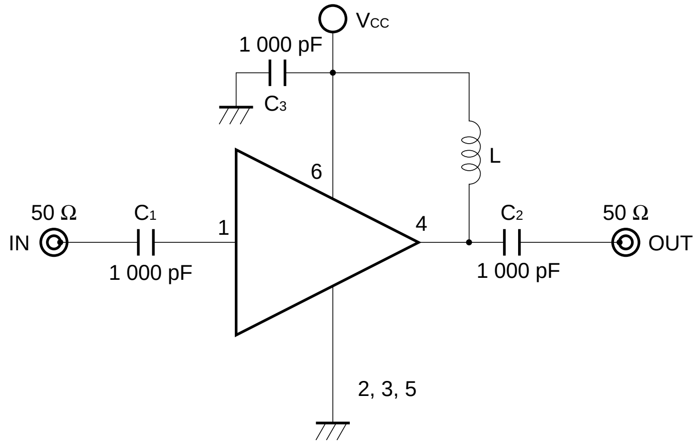
Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remark
Supply Voltage	V_{CC}	4.5	5.0	5.5	V	The same voltage should be applied to pin 4 and pin 6.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, T_A = +25 °C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I_{CC}	No signal	18	25	33	mA
Power Gain	G_P	f = 1 GHz	21	23	26	dB
Gain 1 dB Compression Output Power	$P_{O(1dB)}$	f = 1 GHz	+4.0	+6.5	–	dBm
Noise Figure	NF	f = 1 GHz	–	6.0	7.5	dB
Upper Limit Operating Frequency	f_u	3 dB down below from gain at f = 0.1 GHz	2.3	2.7	–	GHz
Isolation	ISL	f = 1 GHz	27	32	–	dB
Input Return Loss	RL_{in}	f = 1 GHz	4.5	7.5	–	dB
Output Return Loss	RL_{out}	f = 1 GHz	15	20	–	dB
★ Saturated Output Power	$P_{O(sat)}$	f = 1 GHz	–	+8.5	–	dBm
★ Gain Flatness	ΔG_P	f = 0.1 to 2.0 GHz	–	±1.0	–	dB

TEST CIRCUIT



COMPONENTS OF TEST CIRCUIT FOR MEASURING ELECTRICAL CHARACTERISTICS

	Type	Value
C_1, C_2	Bias Tee	1 000 pF
C_3	Capacitor	1 000 pF
L	Bias Tee	1 000 nH

EXAMPLE OF ACTUAL APPLICATION COMPONENTS

	Type	Value	Operating Frequency
C_1 to C_3	Chip capacitor	1 000 pF	100 MHz or higher
L	Chip inductor	300 nH	10 MHz or higher
		100 nH	100 MHz or higher
		10 nH	1.0 GHz or higher

INDUCTOR FOR THE OUTPUT PIN

The internal output transistor of this IC consumes 20 mA, to output medium power. To supply current for output transistor, connect an inductor between the Vcc pin (pin 6) and output pin (pin 4). Select large value inductance, as listed above.

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.

For above reason, select an inductance of 100 Ω or over impedance in the operating frequency. The gain is a peak in the operating frequency band, and suppressed at lower frequencies.

The recommendable inductance can be chosen from example of actual application components list as shown above.

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

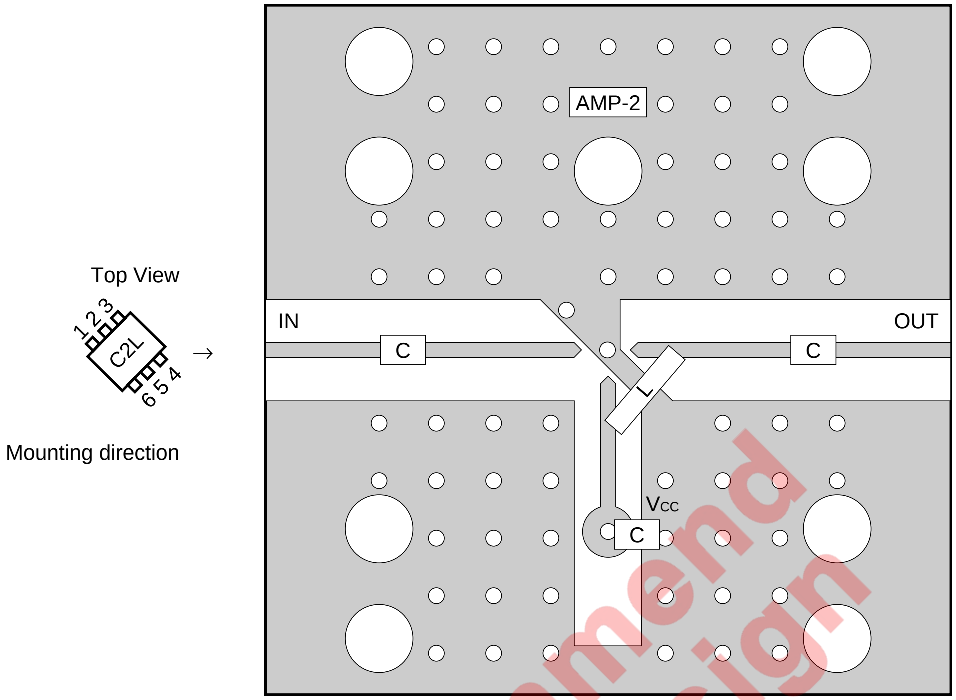
Capacitors of 1 000 pF are recommendable as the bypass capacitor for the Vcc pin and the coupling capacitors for the input and output pins.

The bypass capacitor connected to the Vcc pin is used to minimize ground impedance of Vcc pin. So, stable bias can be supplied against Vcc 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, 1 000 pF capacitors are used in the test circuit. In the case of under 10 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	1 000 pF
L	300 nH

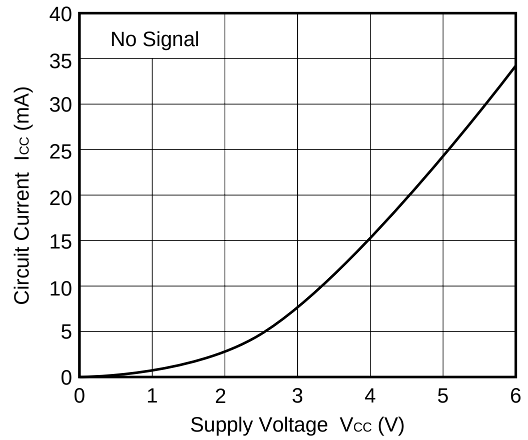
Notes

1. 30 × 30 × 0.4 mm double sided copper clad polyimide board.
2. Back side: GND pattern
3. Solder plated on pattern
4. ○ ◯ : Through holes

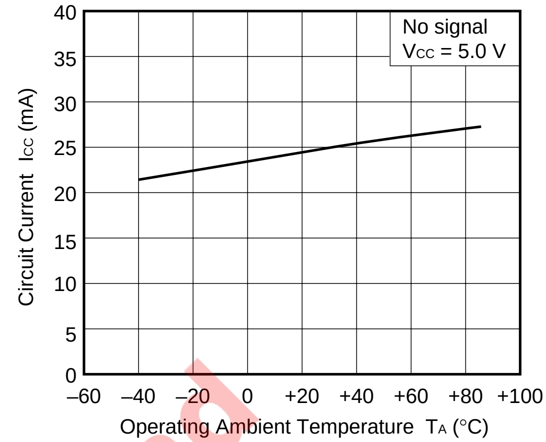
For more information on the use of this IC, refer to the following application note: **USAGE AND APPLICATIONS OF 6-PIN SUPER MINI-MOLD SILICON MEDIUM-POWER HIGH-FREQUENCY AMPLIFIER MMIC (P13252E).**

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

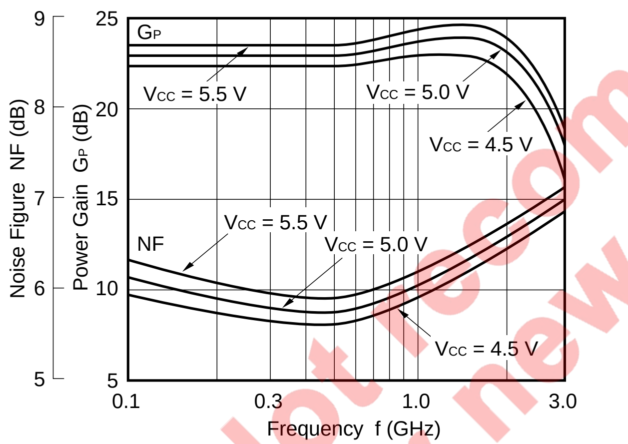
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



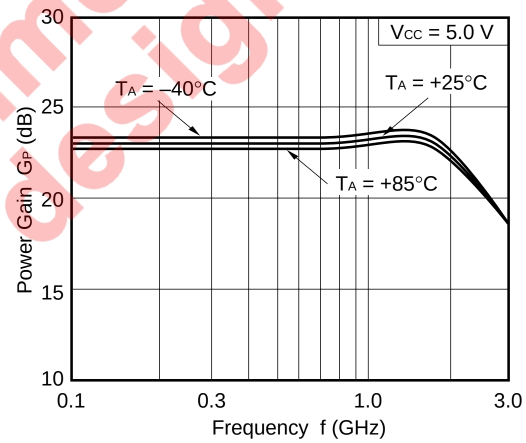
CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



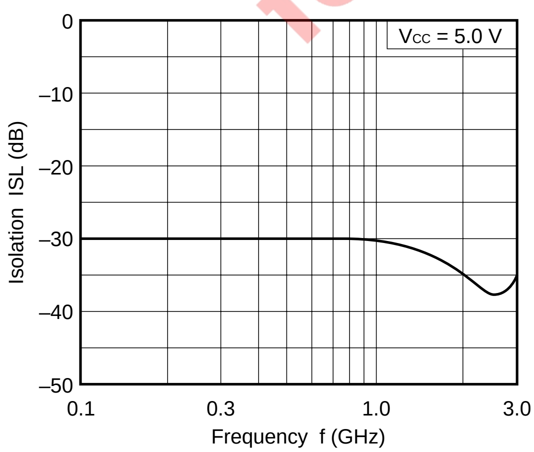
NOISE FIGURE, POWER GAIN vs. FREQUENCY



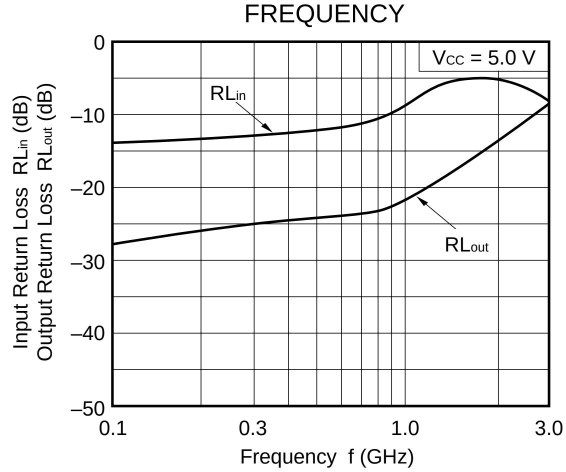
POWER GAIN vs. FREQUENCY



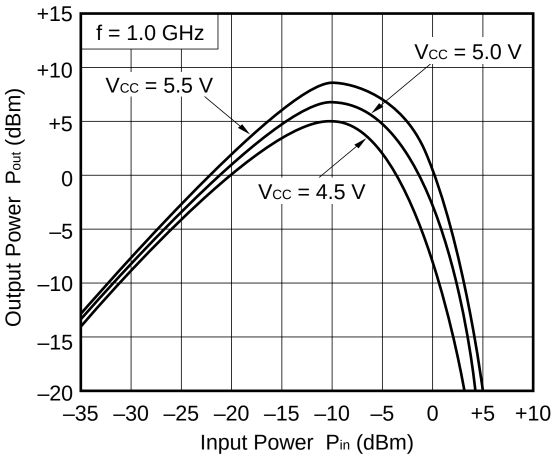
ISOLATION vs. FREQUENCY



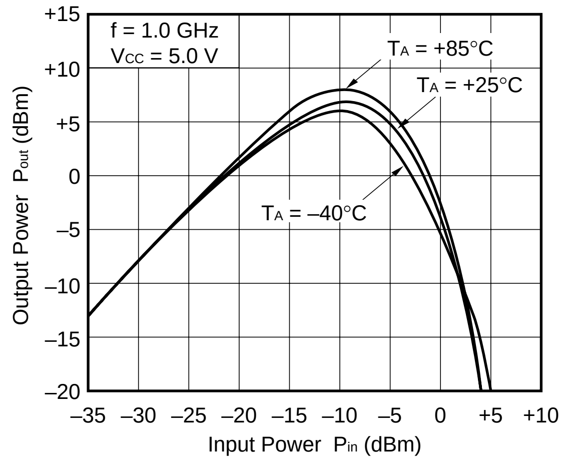
INPUT RETURN LOSS, OUTPUT RETURN LOSS vs. FREQUENCY



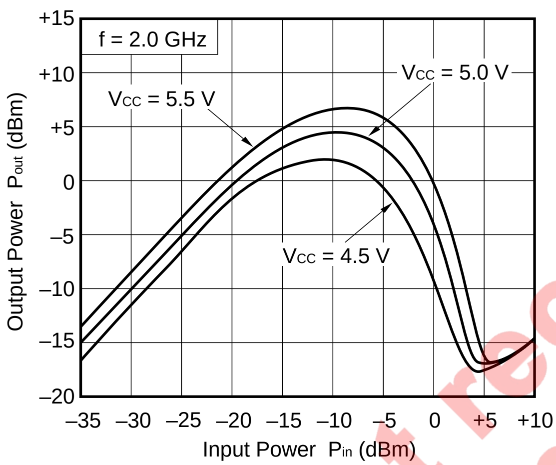
OUTPUT POWER vs. INPUT POWER



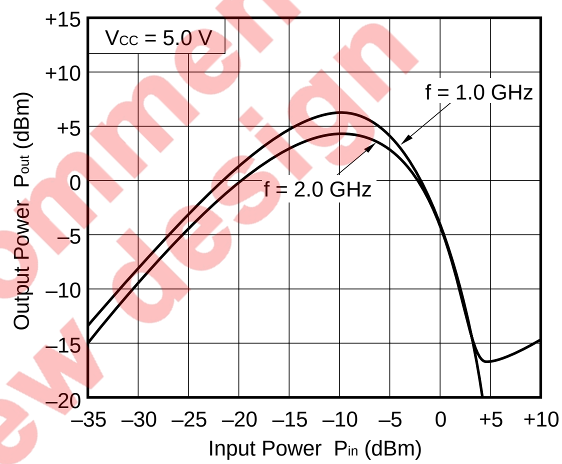
OUTPUT POWER vs. INPUT POWER



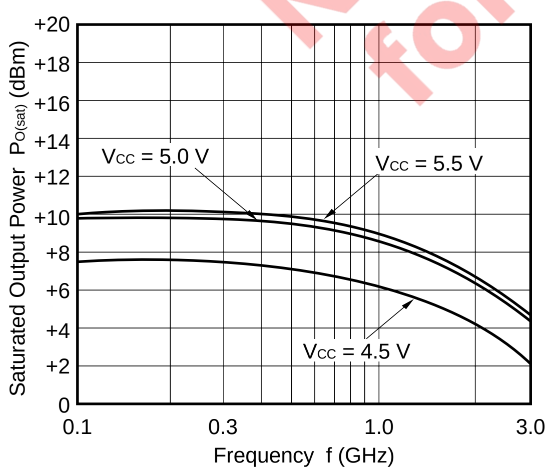
OUTPUT POWER vs. INPUT POWER



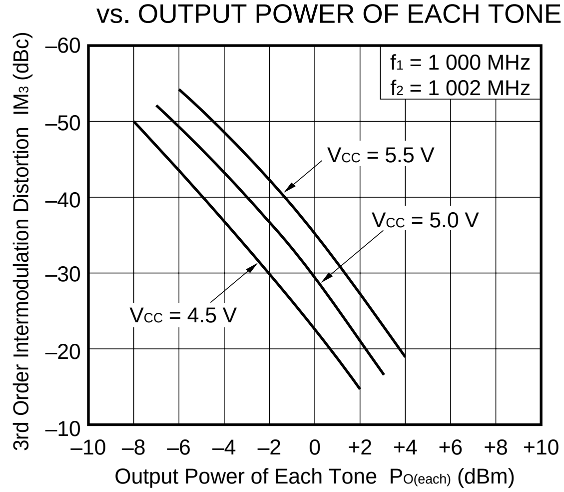
OUTPUT POWER vs. INPUT POWER



SATURATED OUTPUT POWER vs. FREQUENCY

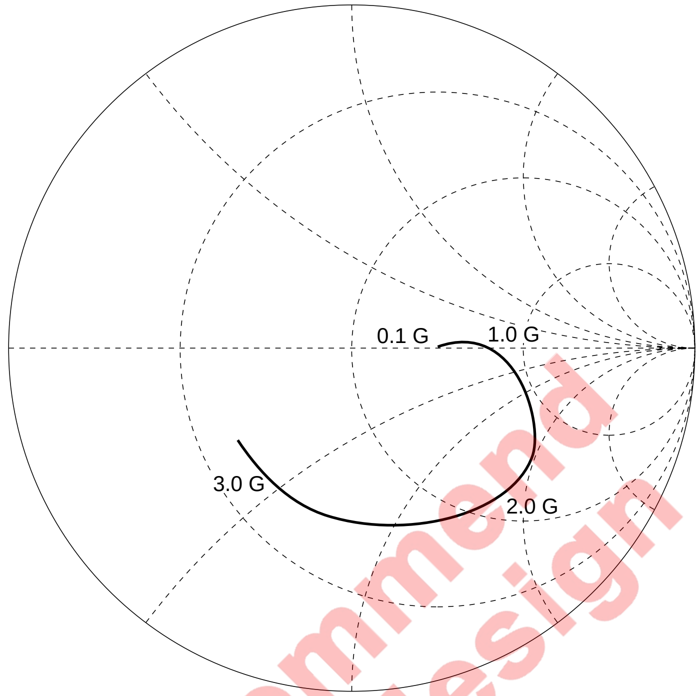


3RD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE

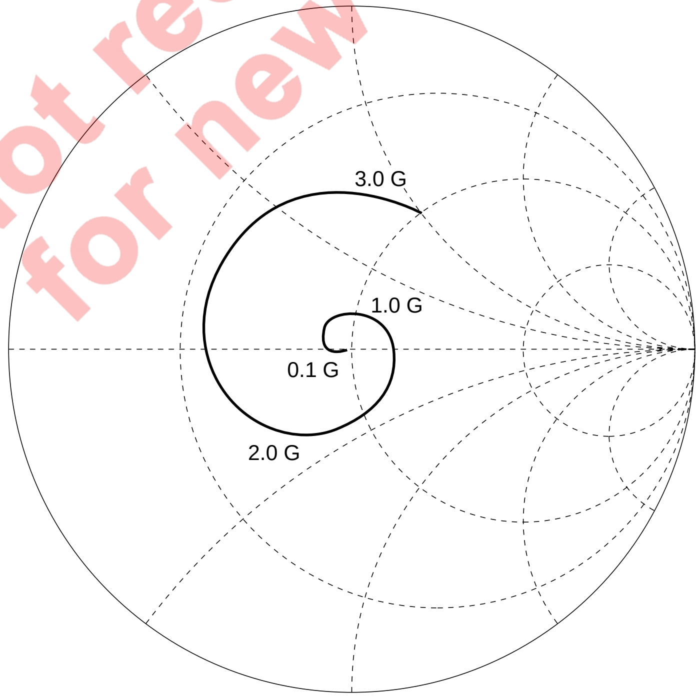


S-PARAMETERS (T$_A$ = +25°C, V$_{CC}$ = V$_{out}$ = 5.0 V)

S$_{11}$- FREQUENCY



S$_{22}$- FREQUENCY



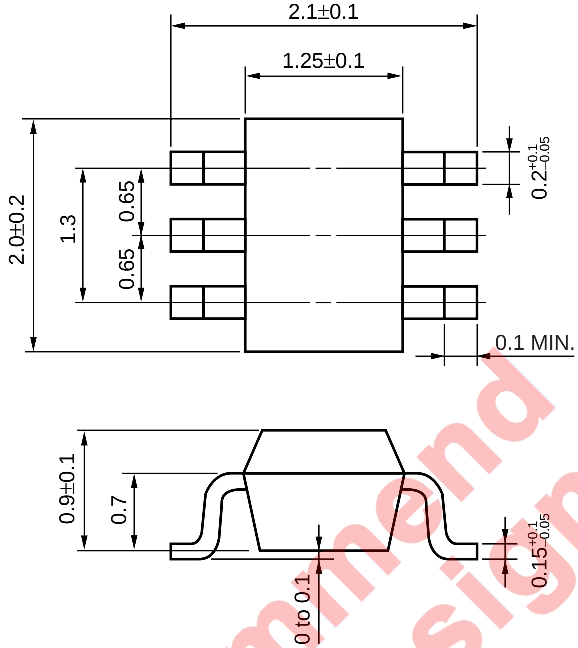
TYPICAL S-PARAMETER VALUES (T_A = +25°C)

V_{CC} = V_{out} = 5.0 V, I_{CC} = 27 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.226	2.8	13.844	–5.9	0.029	–1.5	0.032	–177.4	1.39
200.0000	0.240	6.4	13.862	–12.5	0.029	0.3	0.024	–171.9	1.39
300.0000	0.254	10.4	13.942	–18.6	0.028	3.2	0.030	–176.3	1.40
400.0000	0.267	11.4	14.123	–25.2	0.029	4.8	0.031	–167.6	1.36
500.0000	0.285	11.1	14.267	–31.8	0.029	7.2	0.037	–167.3	1.33
600.0000	0.308	8.5	14.423	–38.6	0.029	9.3	0.038	–159.3	1.28
700.0000	0.345	6.1	14.670	–45.5	0.030	10.7	0.040	–160.7	1.22
800.0000	0.386	3.9	14.864	–52.8	0.030	11.0	0.043	–161.9	1.18
900.0000	0.425	1.4	15.210	–60.1	0.031	11.9	0.055	–169.0	1.12
1000.0000	0.449	–1.5	15.455	–68.4	0.030	11.8	0.072	–169.1	1.10
1100.0000	0.466	–6.1	15.564	–76.6	0.030	10.6	0.084	–169.1	1.08
1200.0000	0.478	–12.0	15.550	–84.9	0.030	11.7	0.093	–173.6	1.07
1300.0000	0.507	–17.7	15.622	–93.1	0.030	13.4	0.094	177.9	1.05
1400.0000	0.533	–24.7	15.577	–101.3	0.029	13.2	0.114	167.0	1.05
1500.0000	0.564	–30.3	15.527	–110.6	0.029	13.5	0.130	164.1	1.02
1600.0000	0.568	–36.4	15.285	–119.0	0.027	11.3	0.154	158.0	1.07
1700.0000	0.576	–42.0	14.960	–127.8	0.026	12.6	0.167	152.6	1.09
1800.0000	0.571	–48.5	14.570	–136.4	0.024	14.8	0.179	143.0	1.18
1900.0000	0.570	–54.5	14.026	–144.7	0.023	15.8	0.194	135.2	1.27
2000.0000	0.569	–59.7	13.715	–151.7	0.022	18.2	0.212	128.1	1.35
2100.0000	0.564	–64.2	13.283	–159.8	0.020	23.5	0.228	121.6	1.48
2200.0000	0.548	–69.6	12.926	–167.5	0.018	27.1	0.240	115.9	1.66
2300.0000	0.535	–75.5	12.515	–174.8	0.018	36.3	0.251	108.1	1.75
2400.0000	0.516	–81.8	12.093	177.9	0.016	41.9	0.268	102.4	2.01
2500.0000	0.515	–87.0	11.498	170.1	0.017	53.3	0.279	96.0	1.99
2600.0000	0.508	–90.9	11.136	163.1	0.015	64.3	0.296	90.8	2.22
2700.0000	0.503	–94.8	10.511	156.6	0.015	67.9	0.306	86.7	2.29
2800.0000	0.489	–97.6	10.126	148.3	0.018	85.0	0.315	79.2	2.00
2900.0000	0.471	–101.3	9.850	143.2	0.019	93.7	0.330	73.0	1.96
3000.0000	0.457	–106.7	9.242	135.5	0.022	100.0	0.343	67.0	1.81
3100.0000	0.455	–111.3	9.065	128.9	0.026	108.0	0.357	60.7	1.53

★ **PACKAGE DIMENSIONS**

6-PIN SUPER MINIMOLD (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 the V_{CC} pin.
(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 attached to input pin and output pin.

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

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)**.

[MEMO]

[MEMO]

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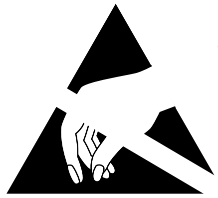

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