DATA SHEET

NEC

BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC2708TB

5 V, SUPER MINIMOLD SILICON MMIC MEDIUM OUTPUT POWER AMPLIFIER

DESCRIPTION

The μPC2708TB is a silicon monolithic integrated circuit designed as buffer amplifier for BS/CS tuners. This IC is packaged in super minimold package which is smaller than conventional minimold.

The μPC2708TB has compatible pin connections and performance to μPC2708T of conventional minimold version. So, in the case of reducing your system size, μPC2708TB is suitable to replace from μPC2708T.

This IC is manufactured using NEC's 20 GHz f_T NESAT™ lll 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

- High-density surface mounting : 6-pin super minimold package (2.0 × 1.25 × 0.9 mm)
- Wideband response : f_u = 2.9 GHz TYP. @ 3 dB bandwidth
- Medium output power : $P_{O(sat)}$ = +10 dBm TYP. @ f = 1 GHz with external inductor
- Supply voltage : V_{CC} = 4.5 to 5.5 V
- Power gain : G_P = 15 dB TYP. @ f = 1 GHz
- Port impedance : input/output 50 Ω

APPLICATIONS

- 1st IF amplifiers in BS/CS converters, etc.
- 1st IF stage buffer in BS/CS tuners, etc.

ORDERING INFORMATION

Part Number	Package	Marking	Supplying Form
μPC2708TB-E3	6-pin super minimold	C1D	Embossed tape 8 mm wide. 1, 2, 3 pins face the perforation side of the tape. Qty 3 kpcs/reel.

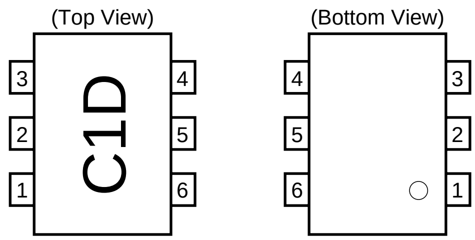
Remark To order evaluation samples, please contact your local NEC sales office (Part number for sample order: μPC2708TB).

Caution Electro-static sensitive devices

Document No. P13442EJ3V0DS00 (3rd edition)
Date Published November 2000 N CP(K)
Printed in Japan

The mark ★ shows major revised points.

PIN CONNECTIONS



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)

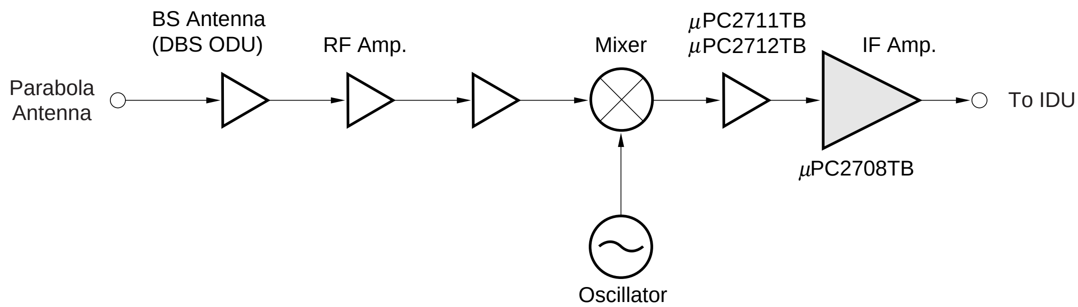
Part No.	f_u (GHz)	$P_{O(sat)}$ (dBm)	G_P (dB)	NF (dB)	I_{CC} (mA)	Package	Marking
μPC2708T	2.9	+10.0	15	6.5 @f = 1 GHz	26	6-pin minimold	C1D
μPC2708TB						6-pin super minimold	
μPC2709T	2.3	+11.5	23	5 @f = 1 GHz	25	6-pin minimold	C1E
μPC2709TB						6-pin super minimold	
μPC2710T	1.0	+13.5	33	3.5 @f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

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

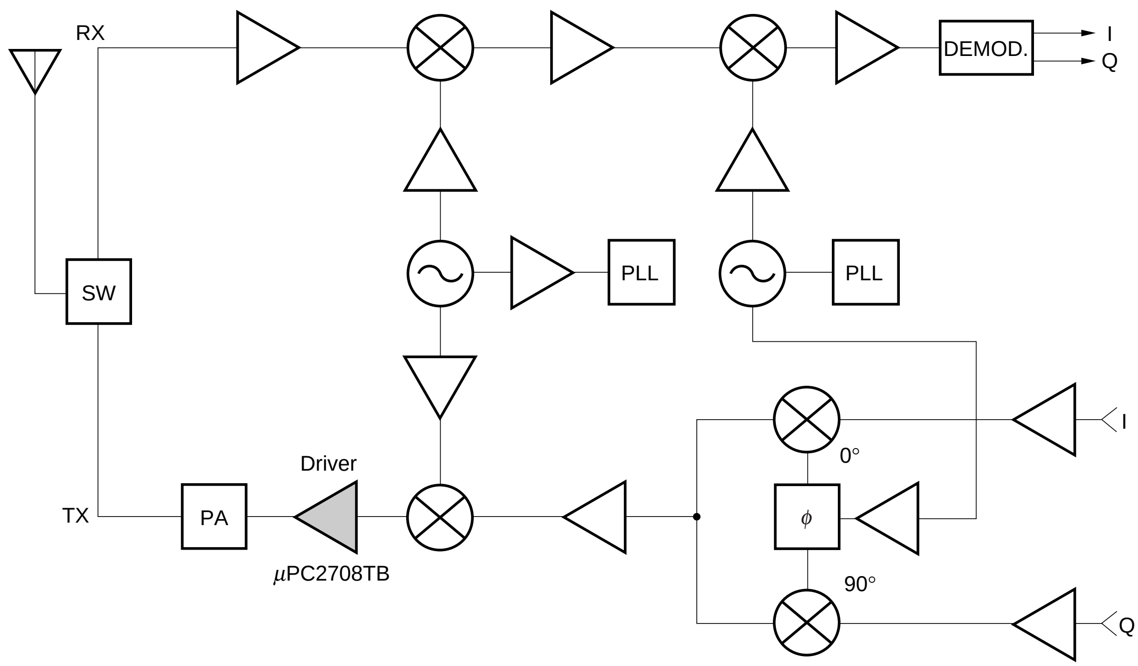
Caution The package size distinguishes between minimold and super minimold.

SYSTEM APPLICATION EXAMPLE

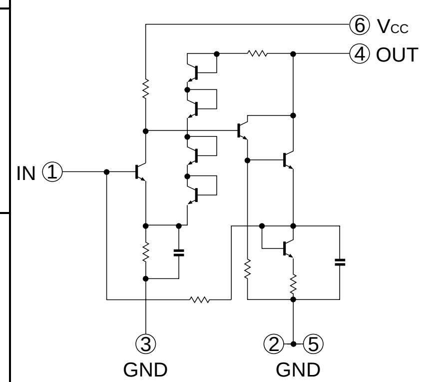
EXAMPLE OF DBS CONVERTERS



EXAMPLE OF 2.4 GHz BAND RECIEVER



PIN EXPLANATION

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)Note	Function and Applications	Internal Equivalent Circuit
1	INPUT	–	1.16	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.	
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.	
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.	

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 6	6	V
Total Circuit Current	I_{CC}	T_A = +25°C	60	mA
★ Power Dissipation	P_D	Mounted on doublesided 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

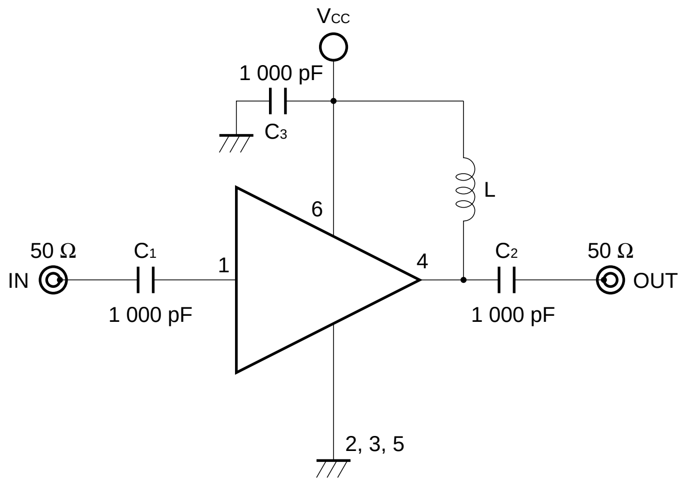
RECOMMENDED OPERATING RANGE

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 6.
Operating Ambient Temperature	T_A	–40	+25	+85	°C	

ELECTRICAL CHARACTERISTICS (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 input Signal	20	26	33	mA
Power Gain	G_P	f = 1 GHz	13.0	15.0	18.5	dB
Saturated Output Power	$P_{O(sat)}$	f = 1 GHz, P_{in} = 0 dBm	+7.5	+10.0	–	dBm
Noise Figure	NF	f = 1 GHz	–	6.5	8.0	dB
Upper Limit Operating Frequency	f_u	3 dB down below flat gain at f = 0.1 GHz	2.7	2.9	–	GHz
Isolation	ISL	f = 1 GHz	18	23	–	dB
Input Return Loss	RL_{in}	f = 1 GHz	8	11	–	dB
Output Return Loss	RL_{out}	f = 1 GHz	16	20	–	dB
Gain Flatness	ΔG_P	f = 0.1 to 2.6 GHz	–	±0.8	–	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 ACTURAL 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 V_{CC} 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.

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

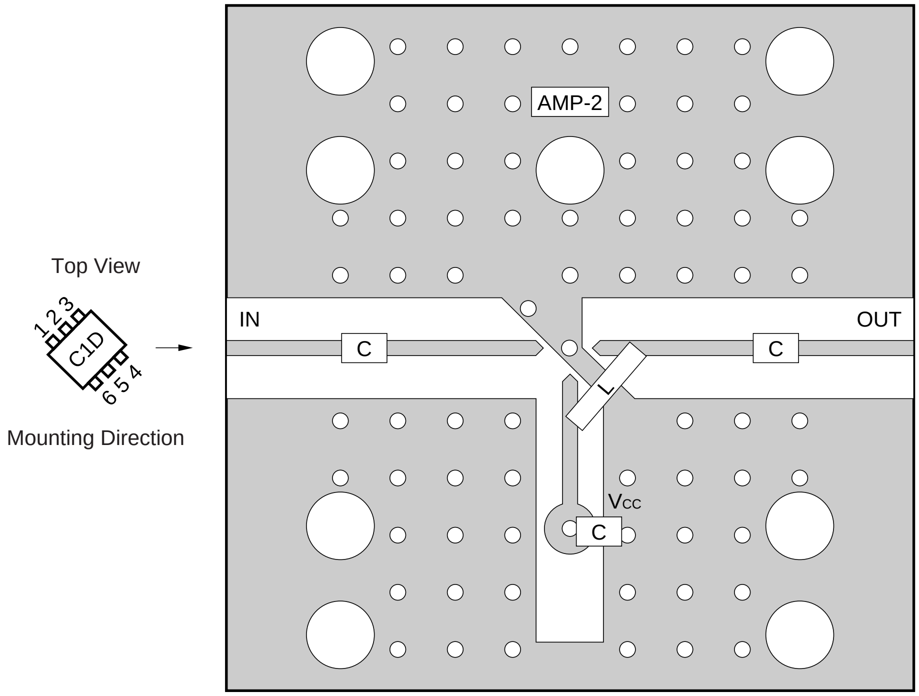
Capacitors of 1000 pF are recommendable as the bypass capacitor for the V_{CC} pin and the coupling capacitors for the input and output pins.

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, 1000 pF capacitors are used in the test circuit. In the case of under 10 MHz operation, increase the value of coupling capacitor such as 10000 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

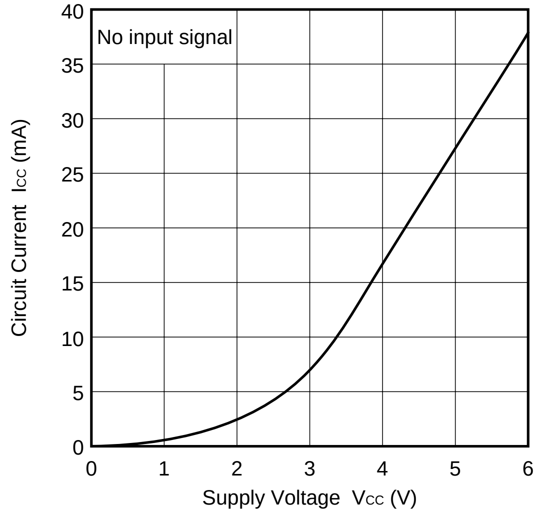
3. Solder plated on pattern

4. ○ ◯ : Through holes

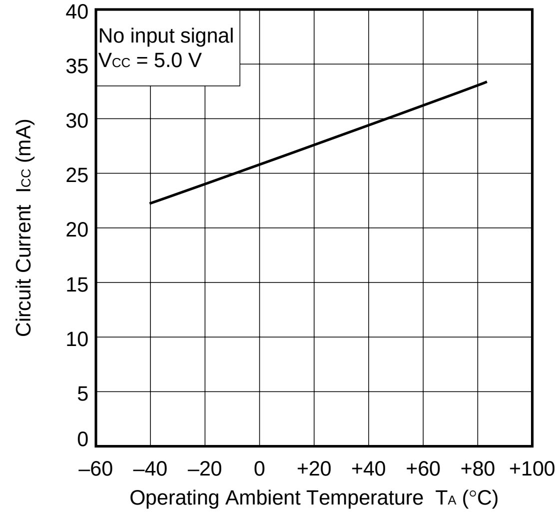
For more information on the use of this IC, refer to the following application note: **USAGE AND APPLICATION OF SILICON MEDIUM-POWER HIGH-FREQUENCY AMPLIFIER MMIC** (P12152E).

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

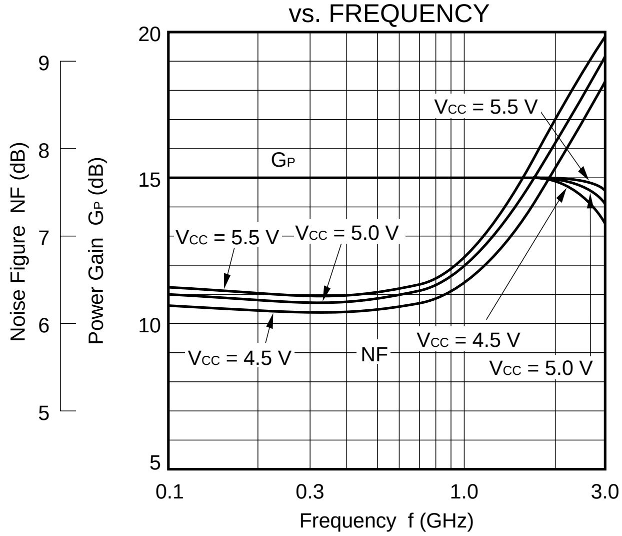
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



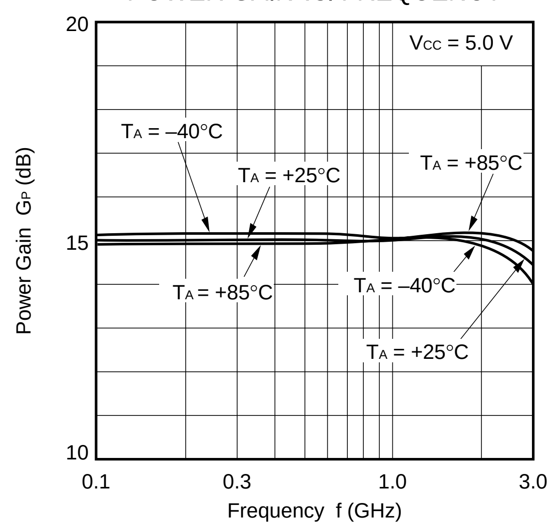
CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



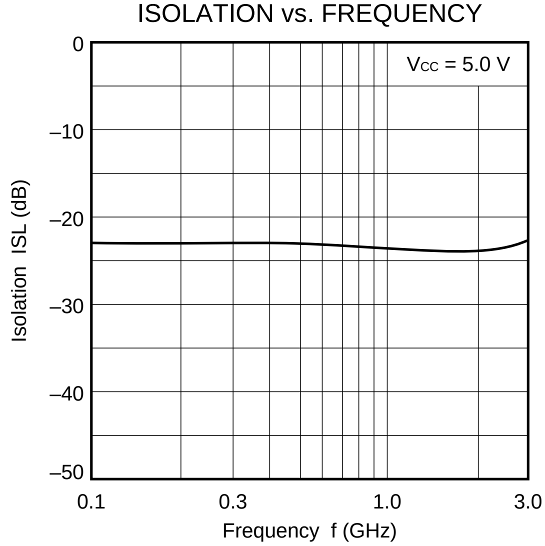
NOISE FIGURE, POWER GAIN vs. FREQUENCY



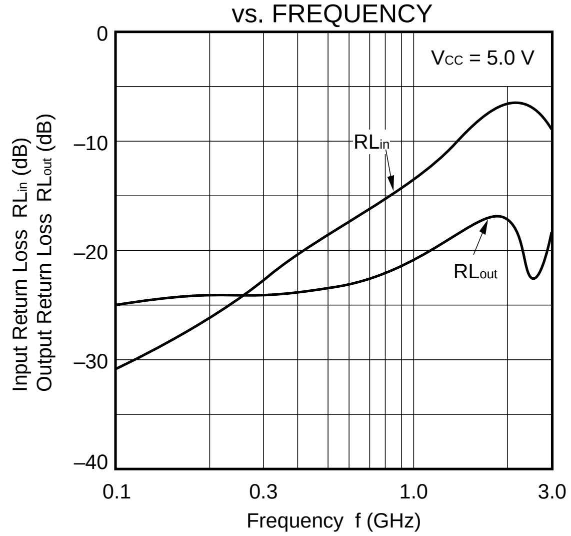
POWER GAIN vs. FREQUENCY



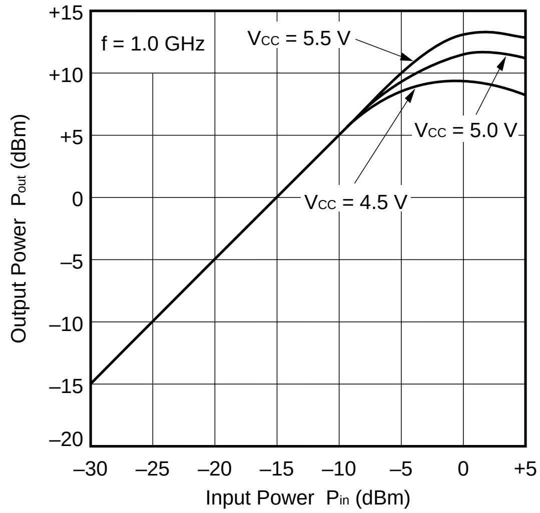
ISOLATION vs. FREQUENCY



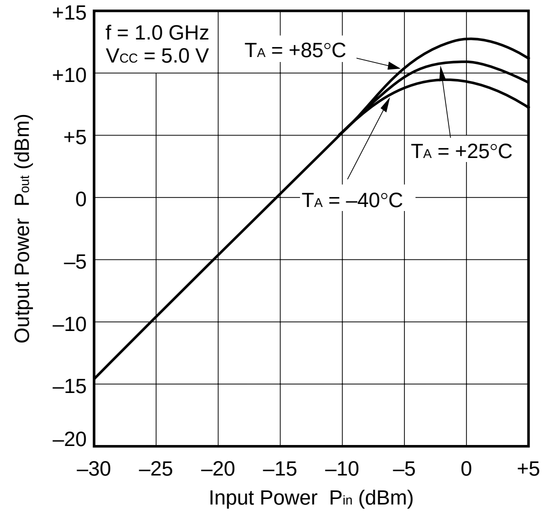
INPUT RETURN LOSS, OUTPUT RETURN LOSS vs. FREQUENCY



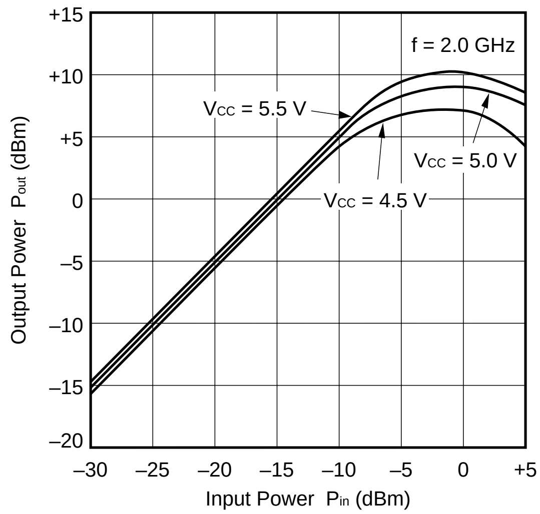
OUTPUT POWER vs. INPUT POWER



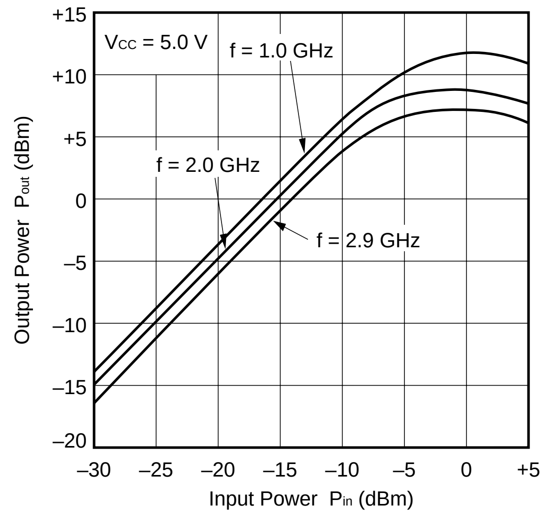
OUTPUT POWER vs. INPUT POWER



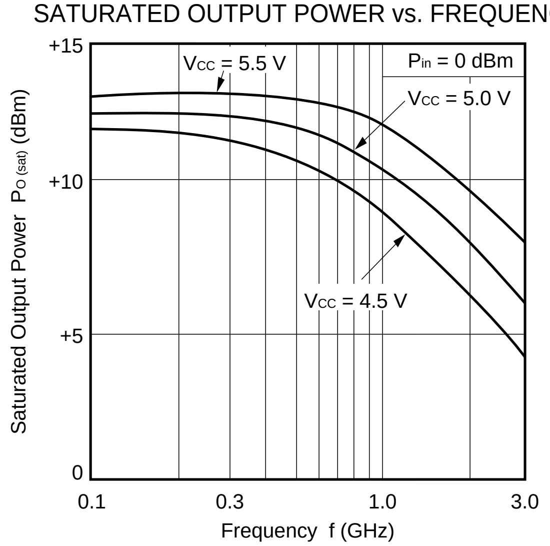
OUTPUT POWER vs. INPUT POWER



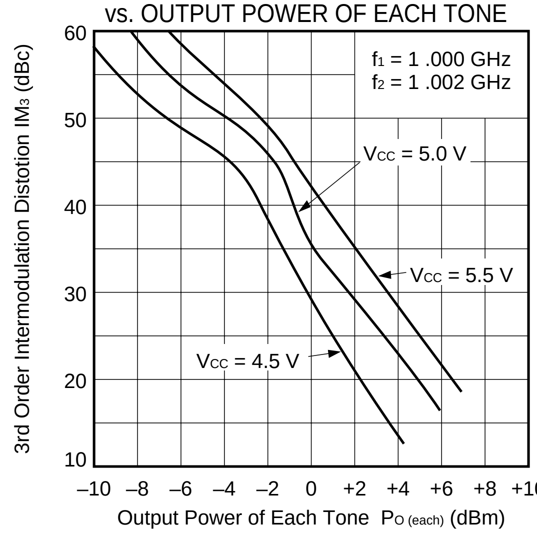
OUTPUT POWER vs. INPUT POWER



SATURATED OUTPUT POWER vs. FREQUENCY



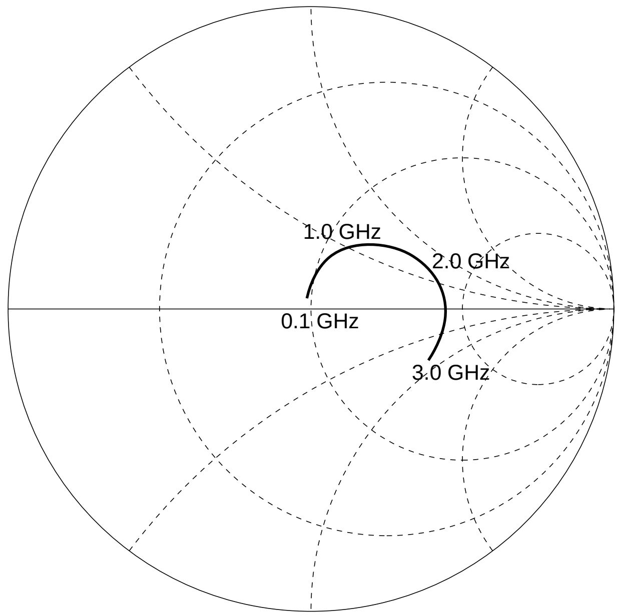
3RD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE



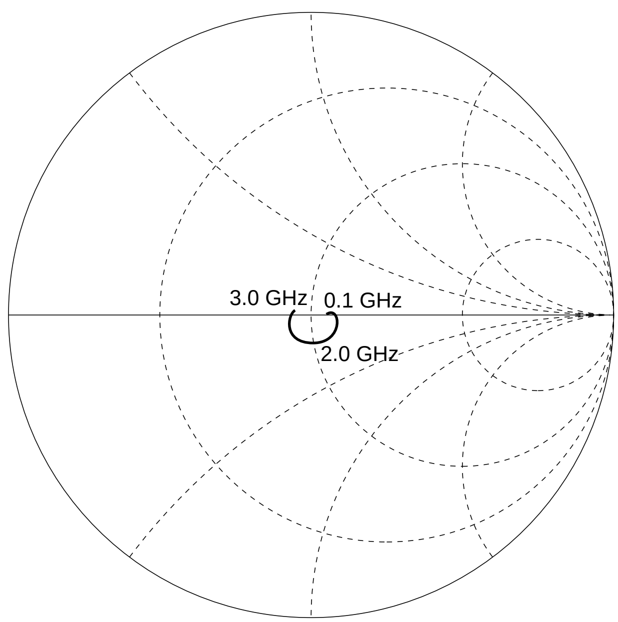
Remark The graphs indicate nominal characteristics.

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

S$_{11}$-FREQUENCY



S$_{22}$-FREQUENCY



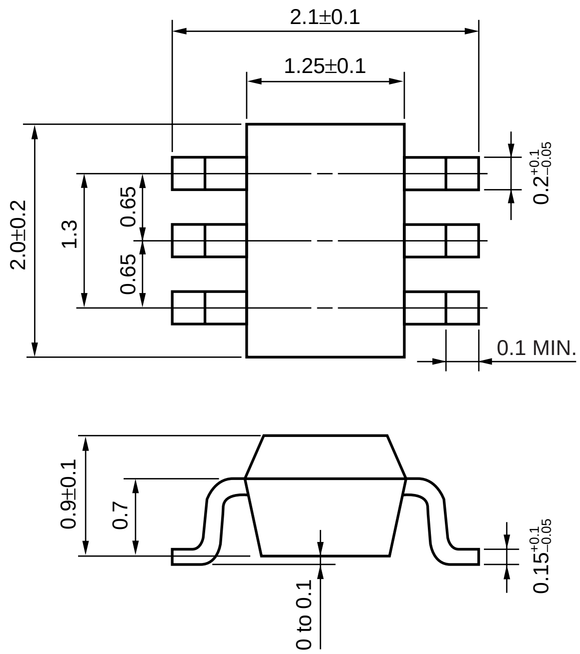
TYPICAL S-PARAMETER VALUES (T_A = +25°C)

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

FREQUENCY	S11		S21		S12		S22		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.039	138.9	5.815	–4.8	0.077	–0.8	0.051	0.9	1.34
200.0000	0.053	119.7	5.822	–9.8	0.075	–1.5	0.048	1.4	1.36
300.0000	0.069	106.7	5.815	–14.3	0.074	–0.6	0.049	5.9	1.38
400.0000	0.088	97.2	5.813	–18.8	0.074	–0.5	0.054	8.9	1.36
500.0000	0.105	91.6	5.794	–23.8	0.072	–1.1	0.054	8.8	1.39
600.0000	0.123	84.9	5.823	–28.4	0.071	–0.6	0.056	10.4	1.40
700.0000	0.144	79.7	5.871	–33.0	0.070	0.1	0.060	11.5	1.40
800.0000	0.164	74.7	5.890	–38.2	0.071	0.5	0.065	11.6	1.37
900.0000	0.186	70.7	5.938	–42.8	0.073	2.3	0.072	11.1	1.34
1000.0000	0.205	66.1	5.960	–47.6	0.070	1.0	0.074	8.2	1.36
1100.0000	0.226	61.7	6.072	–52.7	0.069	3.3	0.075	9.4	1.34
1200.0000	0.245	57.7	6.097	–57.5	0.070	4.4	0.082	5.6	1.31
1300.0000	0.263	53.7	6.174	–63.0	0.067	2.5	0.085	0.6	1.33
1400.0000	0.286	48.6	6.275	–68.4	0.069	5.0	0.091	–4.6	1.28
1500.0000	0.308	44.3	6.371	–74.3	0.070	5.4	0.092	–8.2	1.24
1600.0000	0.328	40.7	6.419	–79.8	0.066	7.1	0.097	–12.6	1.26
1700.0000	0.344	36.2	6.470	–85.9	0.067	5.6	0.096	–19.6	1.23
1800.0000	0.364	31.0	6.555	–92.1	0.069	8.2	0.100	–23.9	1.18
1900.0000	0.382	26.0	6.542	–98.3	0.070	8.4	0.100	–32.0	1.15
2000.0000	0.395	21.2	6.570	–104.7	0.070	8.7	0.101	–38.9	1.13
2100.0000	0.405	16.8	6.528	–111.3	0.070	10.1	0.100	–47.2	1.12
2200.0000	0.417	11.8	6.527	–118.5	0.071	9.4	0.096	–57.2	1.09
2300.0000	0.427	6.6	6.438	–124.7	0.072	9.5	0.098	–66.1	1.09
2400.0000	0.431	2.2	6.336	–131.3	0.071	10.7	0.095	–76.5	1.09
2500.0000	0.431	–3.0	6.247	–138.1	0.072	12.8	0.098	–86.1	1.09
2600.0000	0.434	–8.2	6.127	–145.0	0.071	15.4	0.094	–99.9	1.10
2700.0000	0.423	–12.3	5.952	–151.7	0.071	14.5	0.088	–116.7	1.14
2800.0000	0.419	–17.1	5.816	–158.2	0.070	16.1	0.081	–134.4	1.18
2900.0000	0.408	–21.5	5.619	–165.0	0.073	15.3	0.074	–149.7	1.19
3000.0000	0.400	–26.2	5.354	–171.5	0.074	17.1	0.065	–170.3	1.24
3100.0000	0.386	–29.3	5.134	–177.4	0.075	17.1	0.053	172.8	1.28

★ 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 wide 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 attached to input 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 Time: 3 seconds or less (per side of device) Exposure limit: None[Note]	–

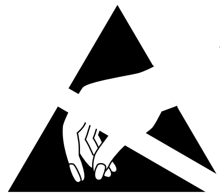
Note After opening the dry pack, keep it in a place below 25°C and 65% RH for the allowable storage period.

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]



ATTENTION
OBSERVE PRECAUTIONS
FOR HANDLING
ELECTROSTATIC
SENSITIVE
DEVICES

NESAT (NEC Silicon Advanced Technology) is a trademark of NEC Corporation.