Application Note

NEC

USAGE AND APPLICATION OF SILICON MEDIUM-POWER HIGH-FREQUENCY AMPLIFIER MMIC

μPC1678G/1678GV/1679G
μPC2708T to 2710T
μPC2762T/2763T
μPC2771T/2776T

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[MEMO]

The information in this document will be updated without notice.

This document introduces general applications of the products in this series. The application circuits and circuit constants in this document are examples and not intended for use in actual mass production design. In addition, please take note that restrictions of the application circuit or standardization of the application circuit characteristics are not intended.

Especially, characteristics of high-frequency ICs change depending on the external components and mounting pattern. Therefore, the external circuit constants should be determined based on the required characteristics on your planned system referring to this document and characteristics should be checked before using these ICs.

The mark ★ shows major revised points.

[MEMO]

CONTENTS

Precautions for design-ins

(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} pin and output pin. 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.
(6) You should apply voltage to V_{CC} pin and output pin. You must not apply voltage to input pin nor regulate input pin voltage (e.g. direct DC pull-down).
(7) External components cannot modify the IC’s internal circuit feedback.

[MEMO]

1. INTRODUCTION

The application for high-frequency devices has recently grown to include not only TV/VCR tuners and cable TV converters but also DBS, cellular phones, pagers, and GPSs. In response to these diverse needs, NEC has developed an abundant line-up of high-frequency amplifier ICs.

This application note is intended to assist user in selecting the product that best suits their applications among NEC's line-up of silicon medium-power high-frequency amplifier ICs and as a reference for designing external circuits that unleash the products' characteristic.

See the data sheet of each product for the product ratings and specifications.

★ ## 2. PRODUCT LINE-UP

2.1 Characteristics

The part numbers of NEC's silicon medium-power high-frequency amplifier ICs are μPC1678/1679, μPC2708 to 2710, μPC2762/2763, and μPC2771/2776. Table 2-1 lists the characteristics of these products as measured with an NEC test circuit.

Table 2-1. Characteristics List of Silicon Medium-Power High-Frequency IC Data Sheet (T_A = +25°C, $V_{CC} = V_{out}$, $Z_S = Z_L$ = 50 Ω)

Part number (discrete part number)	V_{CC} (V)	f_u (GHz)	$P_{O(sat)}$ (dBm)	G_P (dB)	NF (dB)	I_{CC} (mA)	Package	Marking
μPC1678G	4.5 to 5.5	2.0	+17.5	23	6	49	8-pin plastic SOP (5.72 mm (225))	1678
μPC1678GV							8-pin plastic SSOP (4.45 mm (175))	
μPC1679G	4.5 to 5.5	1.8	+15.5	21.5	6	40	8-pin plastic SOP (5.72 mm (225))	1679
μPC2708T	4.5 to 5.5	2.9	+10.0	15	6.5	26	6-pin minimold	C1D
μPC2709T	4.5 to 5.5	2.6	+11.5	23	5	25	6-pin minimold	C1E
μPC2710T	4.5 to 5.5	1.2	+13.5	33	3.5	22	6-pin minimold	C1F
μPC2762T	2.7 to 3.3	2.9	+9.0	13	6.5	26.5	6-pin minimold	C1Z
μPC2763T	2.7 to 3.3	2.4	+11.0	20	5.5	27	6-pin minimold	C2A
μPC2771T	2.7 to 3.3	2.1	+12.5	21	6	36	6-pin minimold	C2H
μPC2776T	4.5 to 5.5	2.7	+8.5	23	6	25	6-pin minimold	C2L

Remark The above values are typical values for major characteristics.
Refer to the data sheet of each product for rating conditions.

The line-up features two power supply voltage ranges, 5 V and 3 V, and includes various power gains and output levels. 8-pin SOP, SSOP, and size 2915-size 6-pin minimold are available for packages. Figure 2-1 shows the package dimensions.

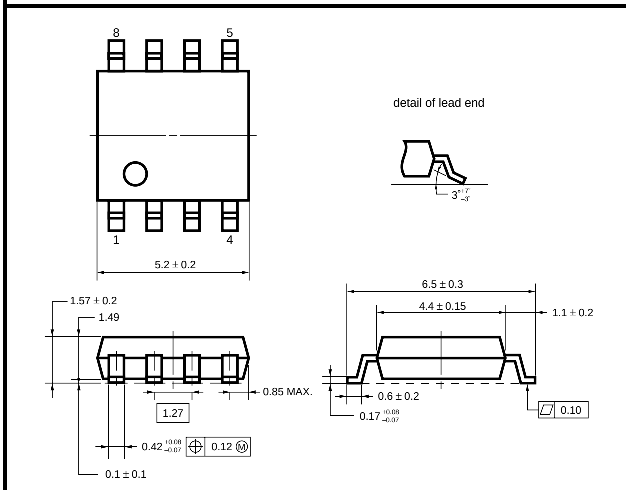
The part number is used for the marking in 8-pin packages but a three-character abbreviation is used for the marking in the 6-pin minimold package due to limited printing space. Each abbreviation corresponds to a product. Due to space limitation, the pin 1 mark is printed on the rear side in the minimold package. Figure 2-2 shows a marking example of the 6-pin minimold package.

The alphabetical characters suffixed to the part number (discrete part number) are the code that indicates the package. GV corresponds to 4.45 mm (175) SSOP, G to the conventional SOP, and T to the minimold. If two package codes exist for the same part number, such as the μPC1678, this means that the same product is available in two different packages. Since the marking is the same on both package types, the products should be distinguished by their package size.

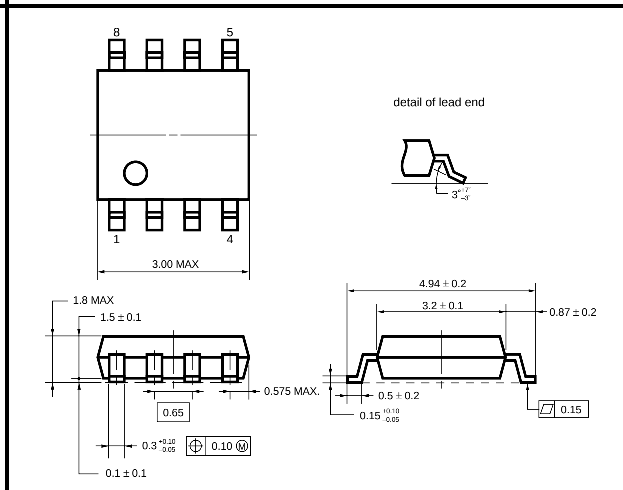
Taping is available as the supply medium for all products except DIP packages. Two taping codes are used according to the IC insertion orientation, ‘E1’ for SOP and SSOP and ‘E3’ for minimold. The order code should be “Discrete part number - taping code” (for example, μPC2776T-E3). For details, refer to the data sheet of each discrete part.

Figure 2-1. Package Drawings of Silicon Medium-Power High-Frequency Amplifier ICs

8-pin plastic SOP (5.72 mm (225))



8-pin plastic SSOP (4.45 mm (175))



6-pin minimold

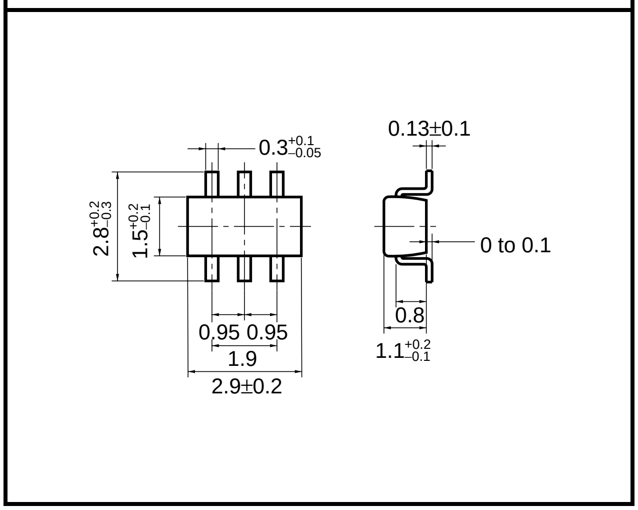
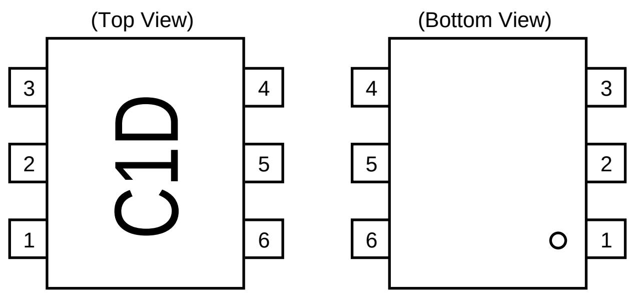


Figure 2-2. Marking Example



Remark The marking example in the above figure is that of the μPC2708T.

2.2 Test Circuit

The test circuit is shown in Figure 2-3. Note that the characteristics listed in the data sheets were obtained while the products were set to wide band and that different practical characteristics and conditions apply in the narrow band.

Measurement Method

Common conditions — Use feedthrough capacitor for the bypass capacitor

A network analyzer is used for the following parameters. (Voltage is applied to an output pin via Bias-T)

Power gain	S21 of IC after compensating for effect of input/output lines of jig
Isolation	S12 of IC after compensating for effect of input/output lines of jig
Input Return Loss	S11 of IC after compensating for effect of input/output lines of jig
Output Return Loss	S22 of IC after compensating for effect of input/output lines of jig

An NF meter is used for the following parameters.

Noise figure	NF including jig NF (Cable loss is compensated.)

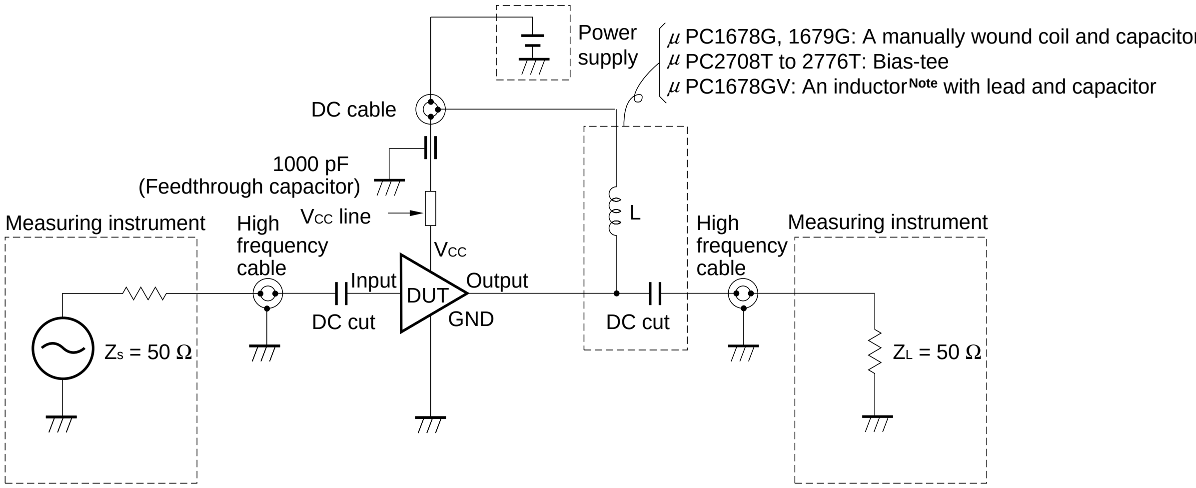
A signal generator and spectrum analyzer are used for the following items.

Input/Output power characteristics	These characteristics include jig-related effects, and frequency conditions that minimize jig influence should be set. The frequency conditions shall be set to obtain a wide band power gain. (Cable loss is compensated.)

A power supply and ampere meter are used for the following items.

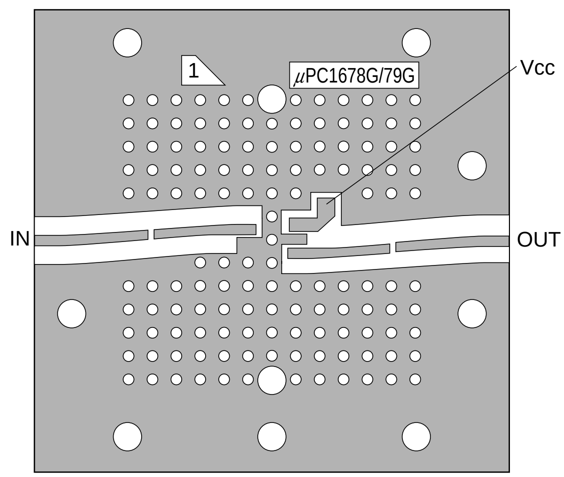
Circuit current	The output inductor is measured mainly via Bias-T and the inductor DC resistance is compensated.

Figure 2-3. Test Circuit

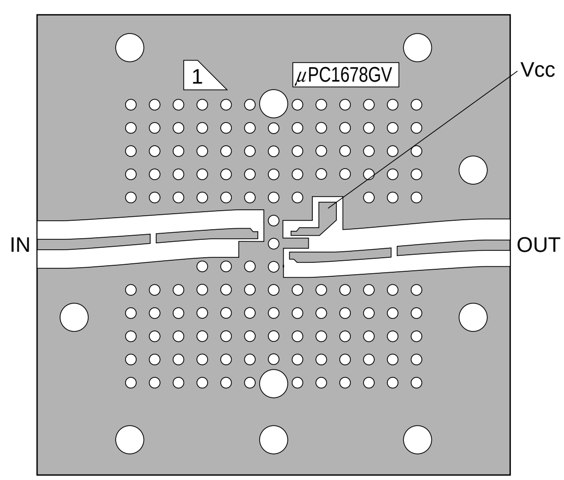


Note Refer to Table 4-1

Test Board for μPC1678G and 1679G

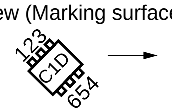


Test Board for μPC1678GV

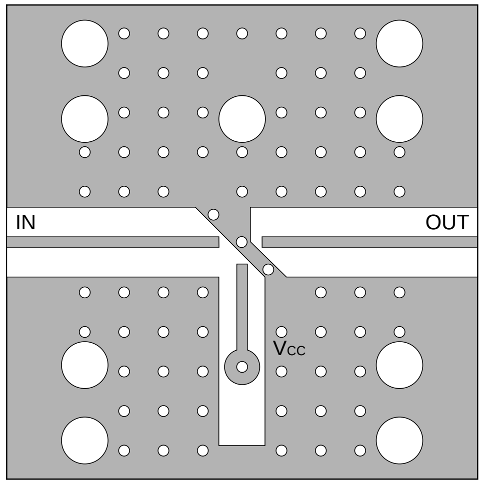


Test Board Common to 6-Pin Minimold (AMP1)

Top View (Marking surface)



IC orientation
Sample marking of μPC2708T



Part numbers
μPC2708T to 2710T
μPC2762T/2763T/2771T/2776T

Notes on printed boards

- Board material..... The following board materials are used to minimize board-related losses when measuring the intrinsic characteristics of ICs.
  μPC1678G, μPC1679G, μPC1678GV, AMP1: Polyimide double-sided copper-clad board
- Back side .... Whole surface is GND. Through holes keep the GND characteristics of the IC mounting side.
- Specifications...... μPC1678G, μPC1679G, μPC1678GV board dimensions:
  $50 \times 50 \times 0.4$ mm, 35 μm thick copper patterning on both sides
  AMP1 board dimensions:
  $30 \times 30 \times 0.4$ mm, 35 μm thick copper patterning on both sides

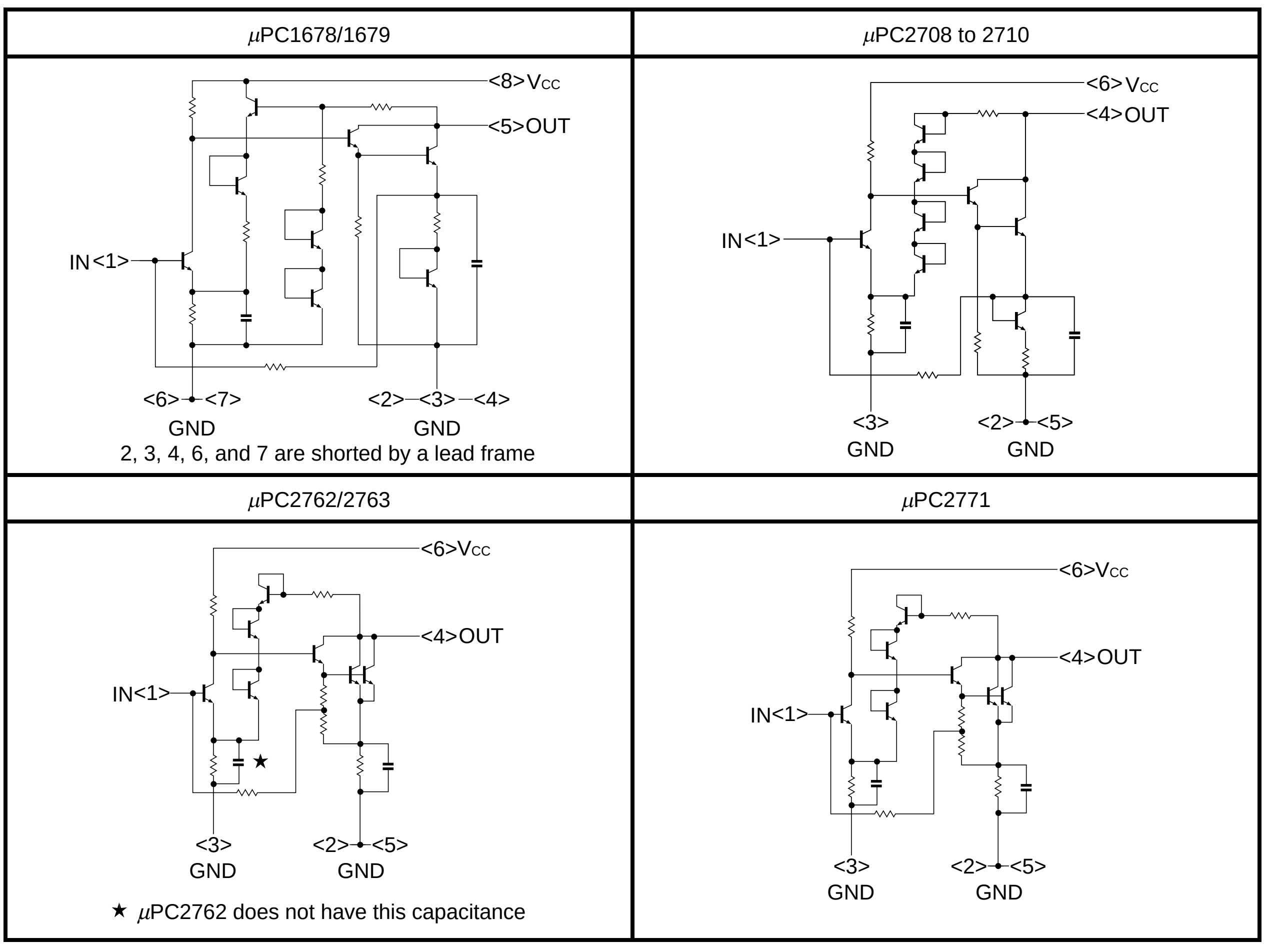
★ 3. THEORETICAL DESCRIPTION

3.1 Description of Internal Circuit

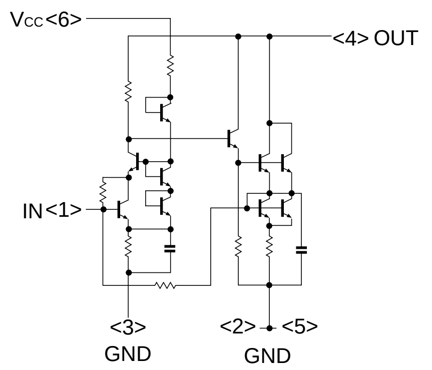
The products in this series incorporate 50 Ω matching circuits formed by resistors on the input side. A multiple negative feedback circuit is provided to offset the variations between h_{FE} and resistance. To obtain desired RF characteristics, a two-stage configuration is employed. Products in this series use the Darlington collector output type for the internal output stage. This output stage collector is ended as an output pin that enables current supply from this pin so that a medium output can be obtained.

For the test environment, Bias-T is mainly used to verify the characteristics in the wide band because the frequency characteristics are not affected. On the other hand, by using an inductor with the minimum required value, the gain in the high-frequency range increases by the amount that the gain in the low-frequency decreases and the band shifts to high-frequency. The gain change varies depending on the effect of the two-stage peaking capacitance that is connected to the internal equivalent circuit output port. The circuit constant differs depending on the product. However, the products can be classified into five types, μPC1678/1679, μPC2708 to 2710, μPC2762/2763/2771, and μPC2776, based on the internal circuit type. An internal equivalent circuit is shown in Figure 3-1.

Figure 3-1. Silicon Medium-Power Amplifier IC Internal Equivalent Circuit



μPC2776



3.2 External Circuit Description

The ICs in this series are designed to supply large current for an internal output stage transistor to obtain higher output. Therefore, RF characteristics are guaranteed by connecting an external element that offers no resistance to DC current and has high impedance in the high-frequency range. Bias-tee type test circuits are most commonly used to simplify testing and obtain reproducibility.

In actual use, you should externally connect an inductor between the output pin and V_{CC} pin. By using the external inductor, output port can keep the applied voltage and the impedance at used frequency without dropping both parameters. In addition, by using a wire-wound inductor with a self-resonance frequency close to the used frequency, the return loss on the output side may be improved.

For the electrical characteristics test circuit, a bias-tee of approximately 1000nH is used so that high impedance is maintained even in low frequency. If the impedance in the used frequency or above is kept high, the required gain can be obtained even if the inductance value is small. Therefore, the used frequency is allowed to be higher than the self-resonance frequency.

The following shows a calculation example for the used frequency f and inductance value L.

$$Z_{inductor} = 2\pi fL$$

$$Z_L = \frac{1}{\frac{1}{Z_{next}} + \frac{1}{Z_{inductor}}} = \frac{1}{\frac{1}{Z_{next}} + \frac{1}{2\pi fL}}$$

Here, the gain is rapidly decreased at the frequency where the $Z_{inductor}$ is smaller than the next stage impedance Z_{next} (50 Ω for example), and a large gain is obtained at the frequency where the $Z_{inductor}$ is larger than the next stage impedance. Accordingly, the relation between the used frequency and the minimum required inductor is as follows.

$$2\pi fL > 50 \quad (\text{when } Z_{next} = 50\ \Omega)$$

For example, the calculation of L such that L > 8 nH produces f > 1 GHz. Therefore, to obtain a flat gain for 1 GHz or higher, the inductance value must be larger than 8 nH.

Because band is limited by the input/output DC cut capacitor value, determine the capacitance value C based on the following calculation.

$$C = \frac{1}{2\pi \cdot Z \cdot f_C}$$

When using the IC in the low frequency band, C should be large value, and when using the IC in the high frequency band, C should be small value to secure the gain.

3.3 Temperature Condition

The maximum ratings of storage and operating temperatures of ICs are regulated in terms of ambient temperature. The package material is plastic so the thermal conductivity is lower than metal leads, and for this reason, the thermal resistance is defined by junction to ambient ($R_{th(j\text{-}A)}$), rather than case to ambient, which is meaningless in this case. Because the highly heat conductive metal leads (thermal resistance value between the junction and the lead is 30°C/W or smaller) are the determining factor with regard to thermal conductivity, the maximum junction temperature T_{jMAX} becomes equal to the maximum rating of the storage ambient temperature T_{STG} and the maximum ambient temperature T_{AMAX} becomes equal to the maximum value of the operating ambient temperature T_A (The storage temperature in this section means the non-biased temperature where the case temperature and ambient temperature are equal.). The relation between the power dissipation P_D and thermal resistance is as follows.

$$R_{th\ (j\text{-}A)} = \frac{T_{jMAX} - T_{AMAX}\ (°C)}{P_{D@}T_{AMAX}\ (W)}$$

The thermal resistance can be calculated since the maximum operating ambient temperature, maximum junction temperature, and power dissipation (at maximum operating ambient temperature) are defined based on the junction-to-ambient thermal resistance listed in the individual data sheet of each product.

The μPC1678G/GV have a large circuit current so that they experience temperature rise (heat production) due to IC current loss. This condition can be applied to the above expression. Taking the μPC1678G/GV as an example, the thermal resistance value becomes $R_{th\ (j\text{-}A)}$ = 180°C/W (when mounting IC on 50 × 50 × 1.6 mm double-sided epoxy glass copper-clad board). Because the circuit current is 60 mA MAX. when the small signal input at V_{CC} = 5.0 V:

$T_j = T_A + P_D \times R_{th\ (j\text{-}A)}$

$= T_A + 5.0\ (V) \times 0.060\ (A) \times 180\ (°C/W)$

$= T_A + 54\ (°C)$

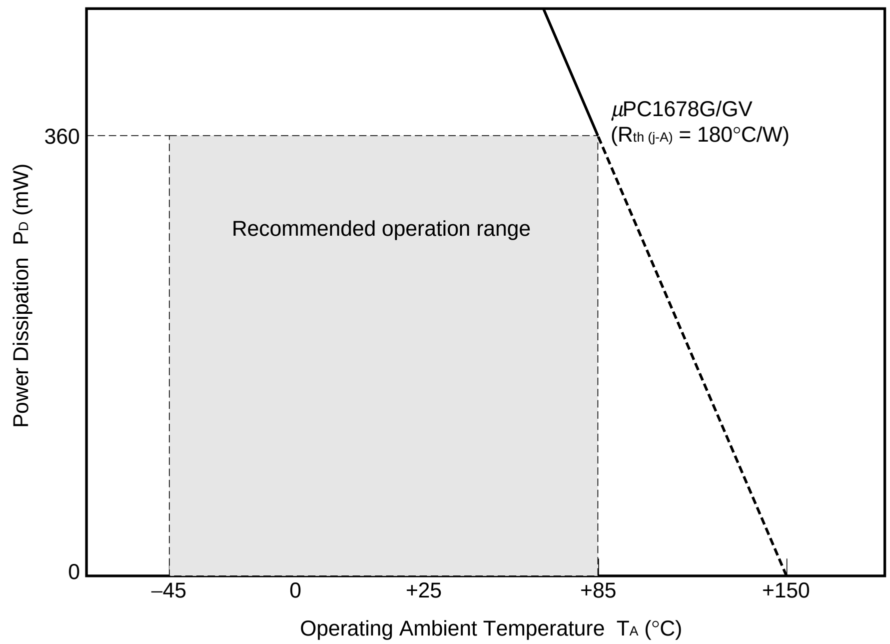
Since to $T_j \leq 150$ (°C),

$T_A + 54\ (°C) \leq 150\ (°C)$

$\therefore T_A \leq 96$ °C

Therefore, the operating ambient temperature, T_A = +85°C represents a margin of +11°C taking into account IC heating under these conditions.

Figure 3-2. μPC1678G/GV Power Dissipation vs. Ambient Temperature



★ 4. SAMPLE APPLICATION CHARACTERISTICS

Table 4-1 lists sample specifications and characteristics of inductors used for evaluation of application circuits. In this evaluation, evaluation boards with the same dimensions were used to test all the inductors within a product group (Table 4-2). The AMP1 board enables easy calibration using a network analyzer and S parameter measurement that is not affected by the jig input/output line because the input/output line is straight.

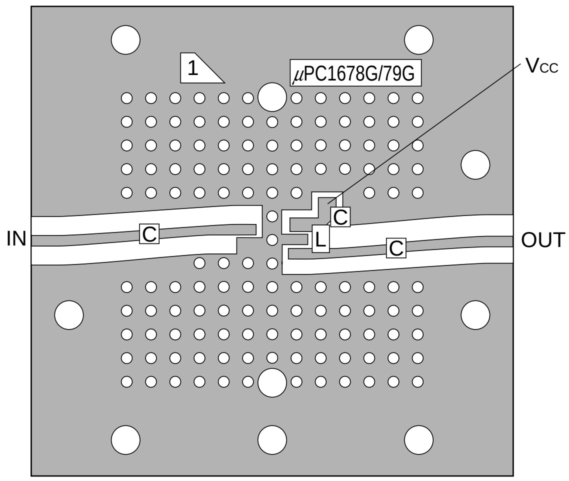
Table 4-1. Specifications of Inductors Used for Application Evaluation

Type	Manufacturer	Product	Inductance	Q	DC resistance	Self-resonance frequency	Permissible current
Wire-wound chip inductor	Murata Mfg. Co., Ltd.	LQN21A10NJ	10 nH	60 TYP.	0.25 Ω or less	100 MHz	770 mA
	TOKO INC.	FSLU2520-R10	100 nH	50 peak	0.21 Ω	730 MHz	540 mA
Axial lead inductor	Taiyo Uden Co., Ltd.	LA402 type	470 nH	35 to 40 MIN.	0.4 to 20 Ω MAX.	–	35 to 400 mA MAX.
Manually wound coil (Enameled wire)	Self made	Self made	50 nH to 1200 nH	–	–	–	–

Table 4-2. Evaluation Boards Used for Application Evaluation

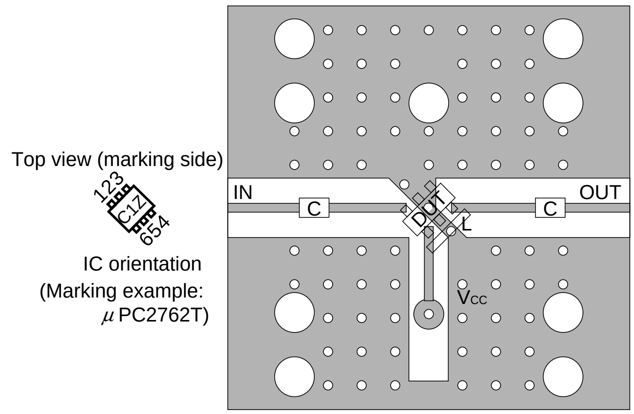
Evaluated part number	Evaluation board's name and figure
μPC1678G, μPC1679G	μPC1678G/79G evaluation board (Figure 4-1)
μPC2709T, μPC2776T, μPC2762/2763T, μPC2771T	6-pin minimold amplifier series common board AMP1 (Figure 4-2)

Figure 4-1. μPC1678G/79G Evaluation Board Mounting Example



L: Manually wound coil

Figure 4-2. Application Evaluation Circuit Board (AMP1) Mounting Example



L: LQN21A10NJ or FSLV2520-R10

Cautions 1. The listed inductors were used to evaluate the relation between inductor parameter and IC application characteristics, and are not recommended by NEC for actual use. For actual use, we recommended that you contact the inductor supplier referring to the specifications listed in Table 4-1 and evaluate your inductor before use.

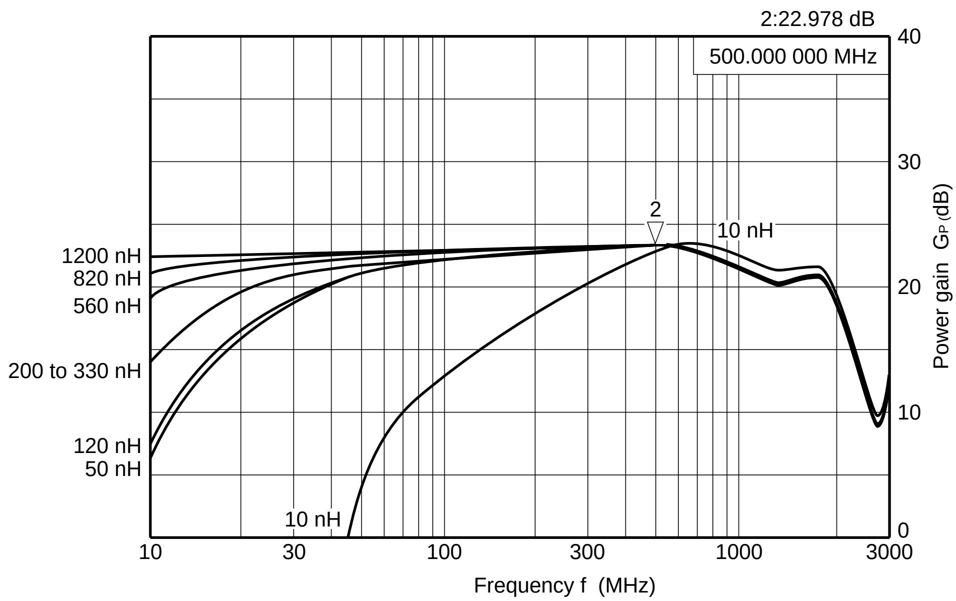
2. Since NEC calibrates the evaluation board pattern, NEC's evaluation characteristics do not reflect the effect of the pattern. Therefore, you should take into account the effect of the pattern in your actual application design.

4.1 μPC1678G, μPC1679G

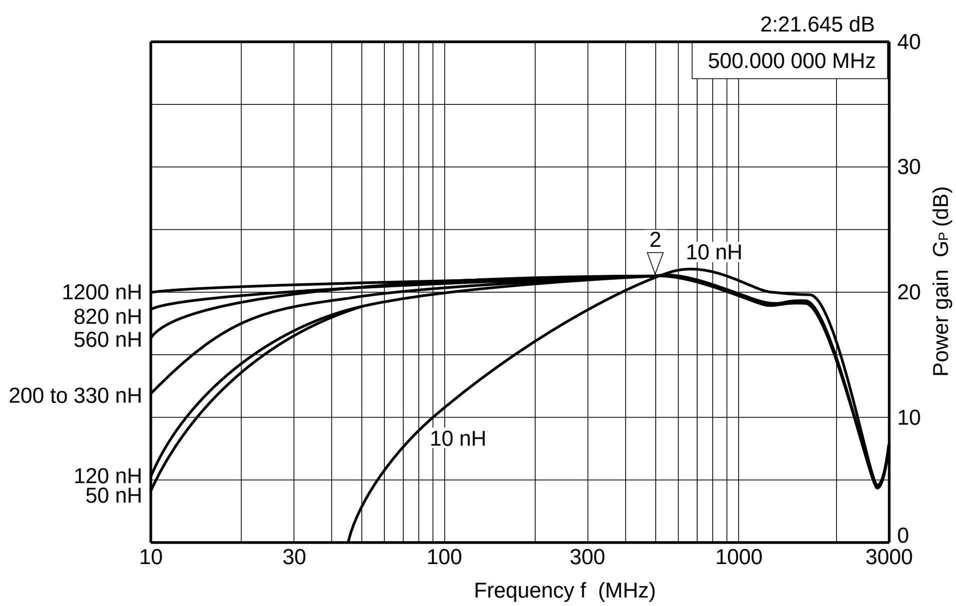
The gain vs. frequency characteristics of the μPC1678/1679 with various inductance values are measured using a manually wound coil. Figure 4-3 shows the measured characteristics. In the case of these ICs, the gain at low frequencies and high frequencies increases and wide band is achieved when the inductance value is increased, and the frequency band near the resonance frequency becomes narrow when the inductance value is decreased.

Figure 4-3. Power Gain vs. Frequency Characteristics of μPC1678G, μPC1679G for Various Inductance Values (Conditions : T_A = +25°C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)

(a) μPC1678G Power Gain vs. Frequency



(b) μPC1679G Power Gain vs. Frequency



4.2 μPC2709T

To judge the characteristics of the μPC2709T, it was compared with the μPC2776T, which has similar electric characteristics, using a 10 nH wire-wound type chip inductor (1 GHz self-resonance frequency). The results of the μPC2709T and μPC2776T are shown in Figures 4-4 and 4-5, respectively. The μPC2709T shows flat gain characteristics in the range from 1 GHz to 2.5 GHz. The μPC2776T shows a gain decline at 2.0 GHz and higher. This is because in the μPC2709T the peaking capacitances of the input/output stages are connected to the output pin and the peaking frequency tends to shift to high frequency due to the value of the inductor externally connected to the output pin whereas in the μPC2776T, the gain at high frequency is little affected because only the peaking capacitance is connected only to the output stage. Expressed a different way, the μPC2776T has smaller variations.

Figure 4-4. Frequency Characteristics of μPC2709T Using 10 nH Inductor
(Conditions: T_A = +25°C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)

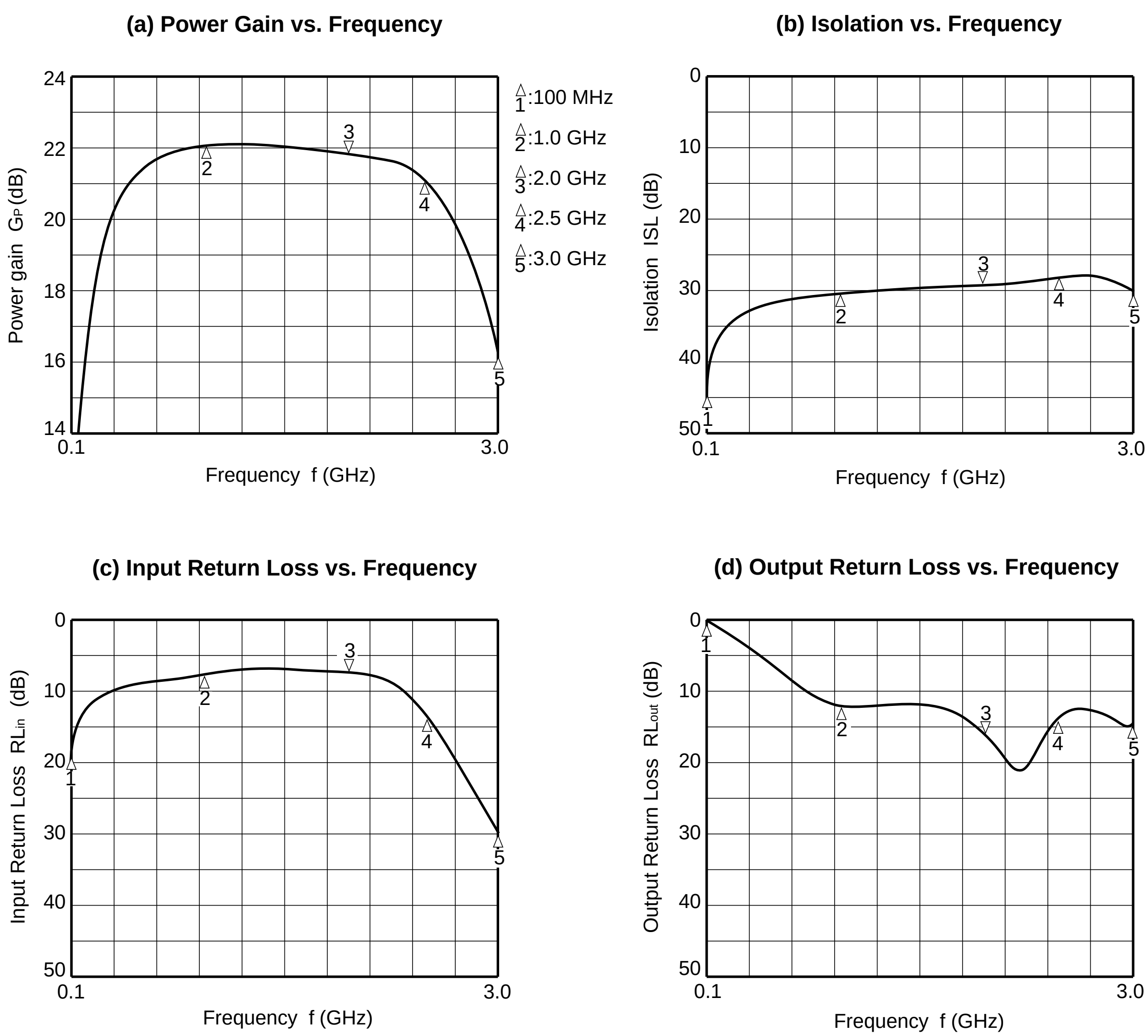
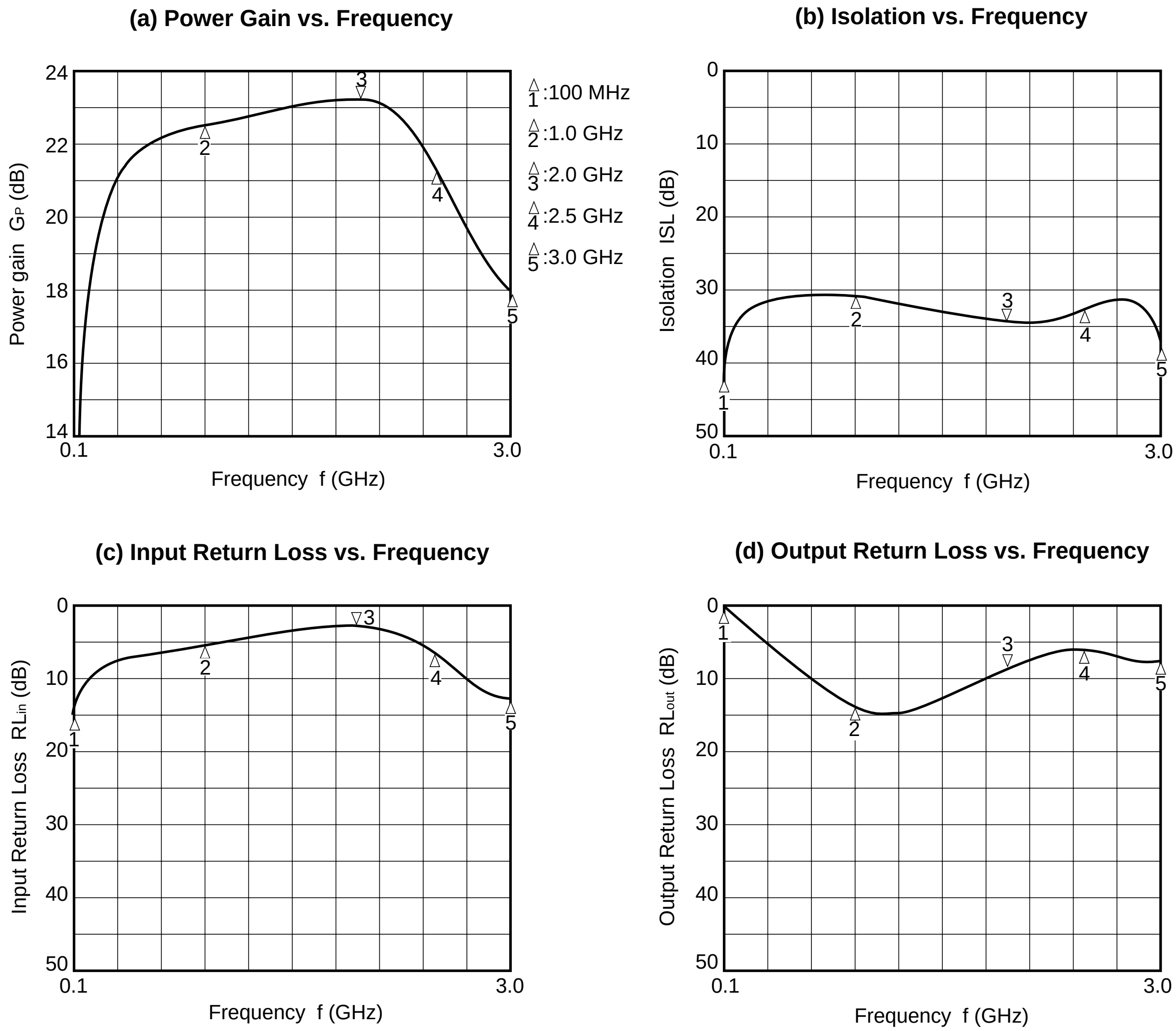


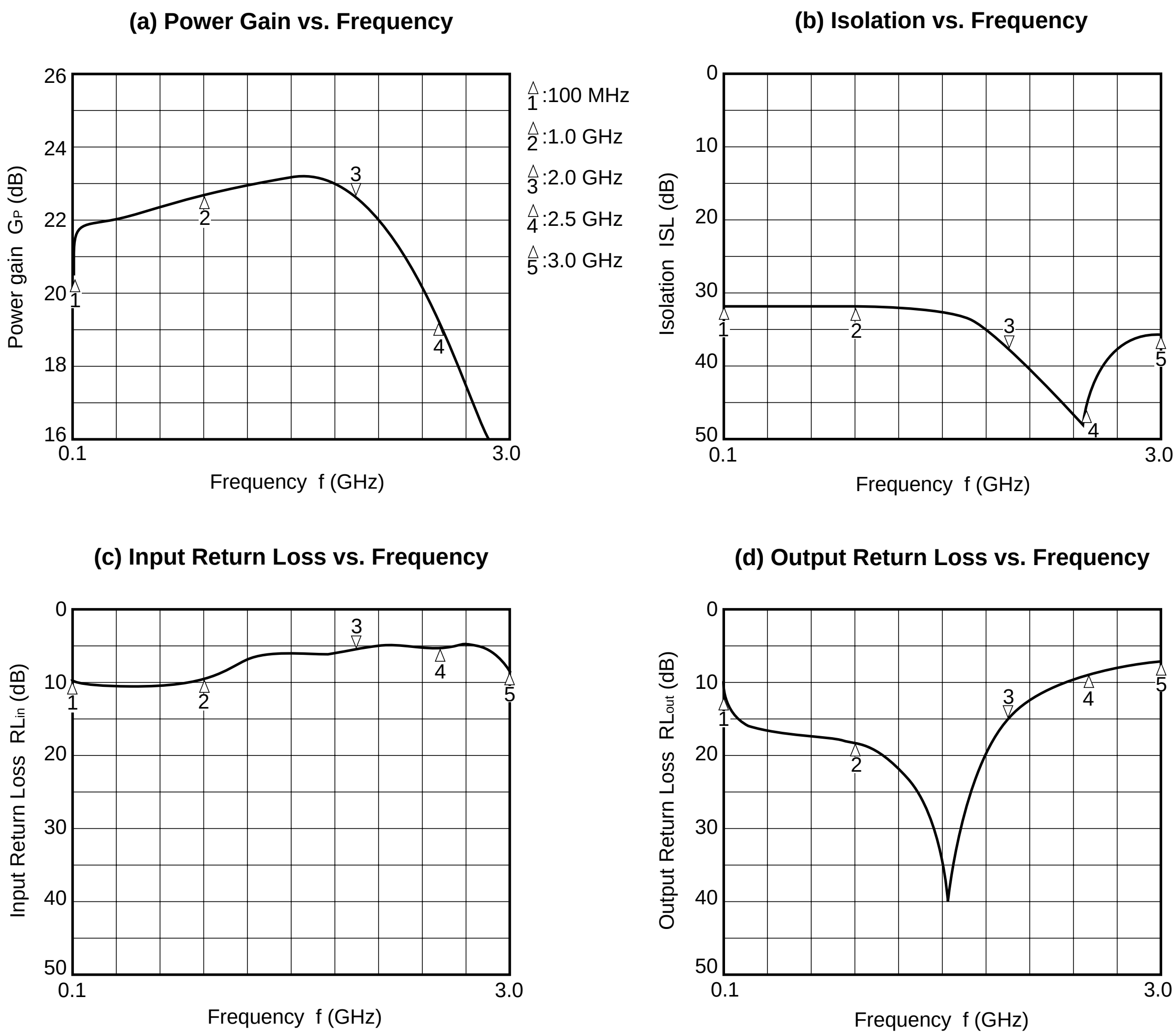
Figure 4-5. Frequency Characteristics of μPC2776T Using 10 nH Inductor
(Conditions: T_A = +25°C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)



4.3 μPC2776T

Based on the fact that the μPC2776T, high-frequency gain is not affected by an inductor, the μPC2776T was evaluated to obtain wide band characteristics from the VHF range to 2 GHz. A wire-wound chip inductor with the resonance frequency of 730 MHz and the inductance value of 100 nH was used to obtain a gain at 100 MHz or higher. The flat characteristics that were obtained are shown in Figure 4-6.

Figure 4-6. Frequency Characteristics of μPC2776T Using 100 nH Inductor (Conditions: T_A = +25°C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)



4.4 μPC2762T, μPC2763T

Given the fact that the μPC2762T/2763T have a wide 3 dB bandwidth, evaluation tests were tried to obtain the gain at 2 GHz or higher. A 10 nH wire-wound chip inductor (1 GHz self-resonance frequency) was used.

Figure 4-7. Frequency Characteristics of μPC2762T Using 10 nH Inductor
(Conditions: T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω)

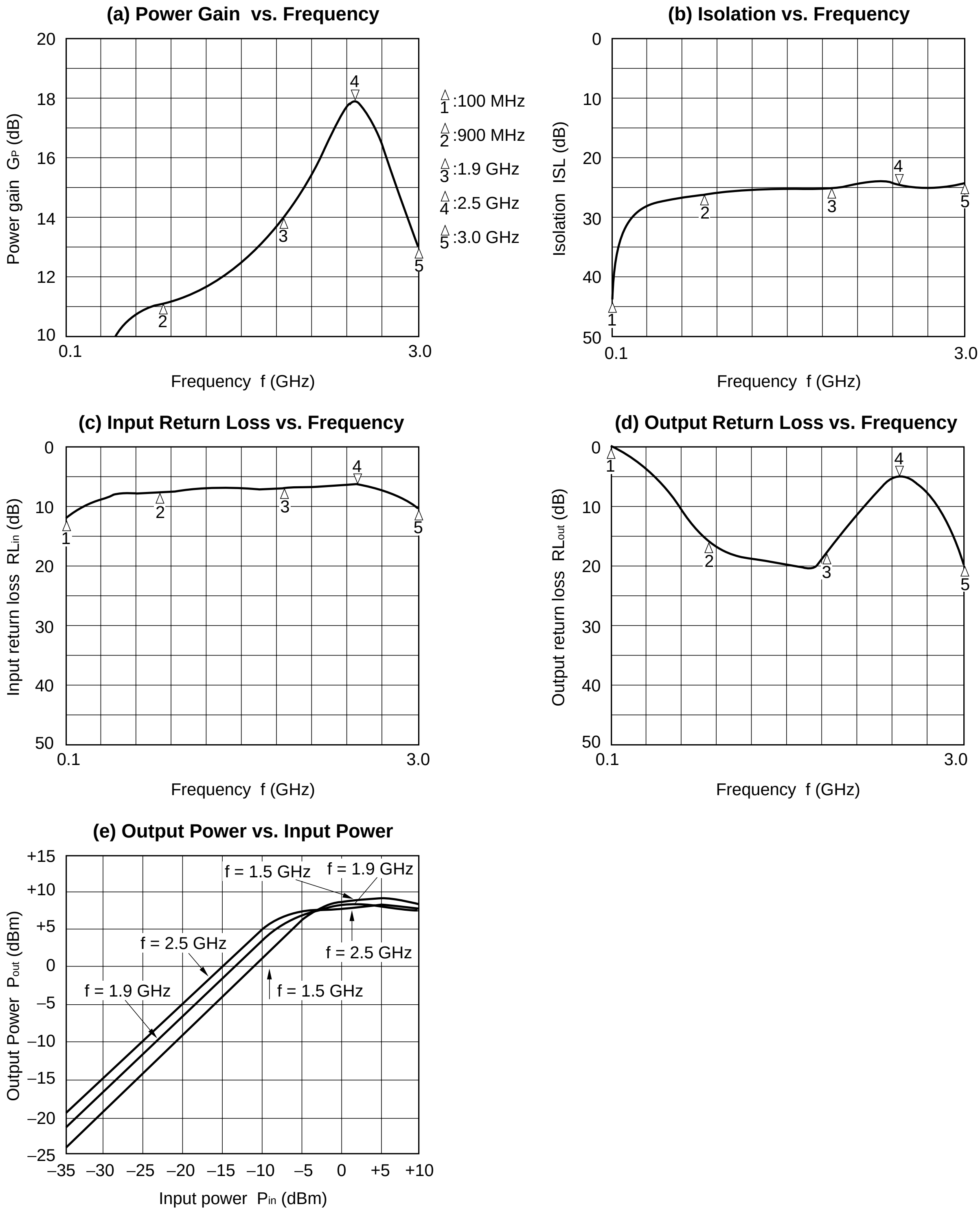
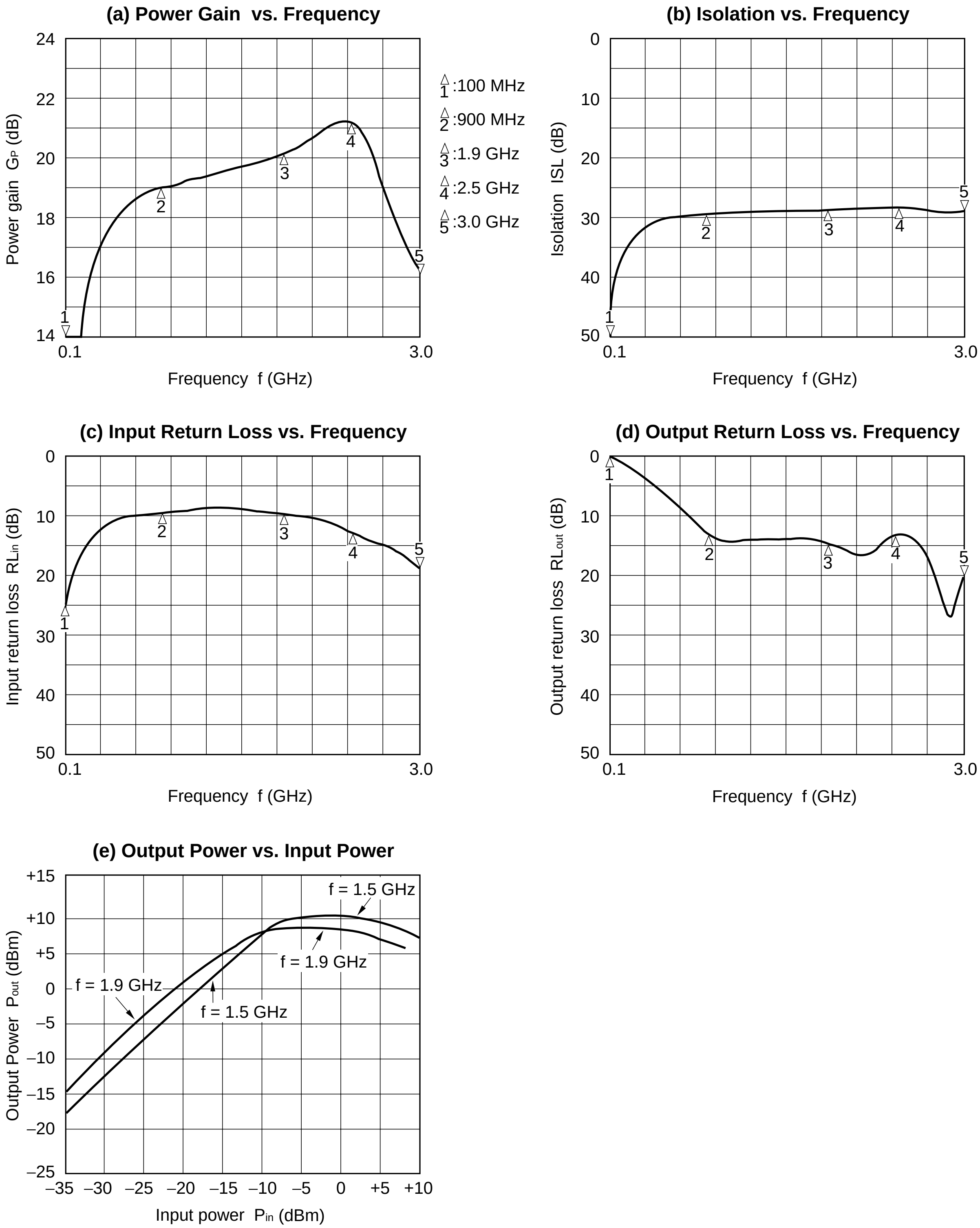


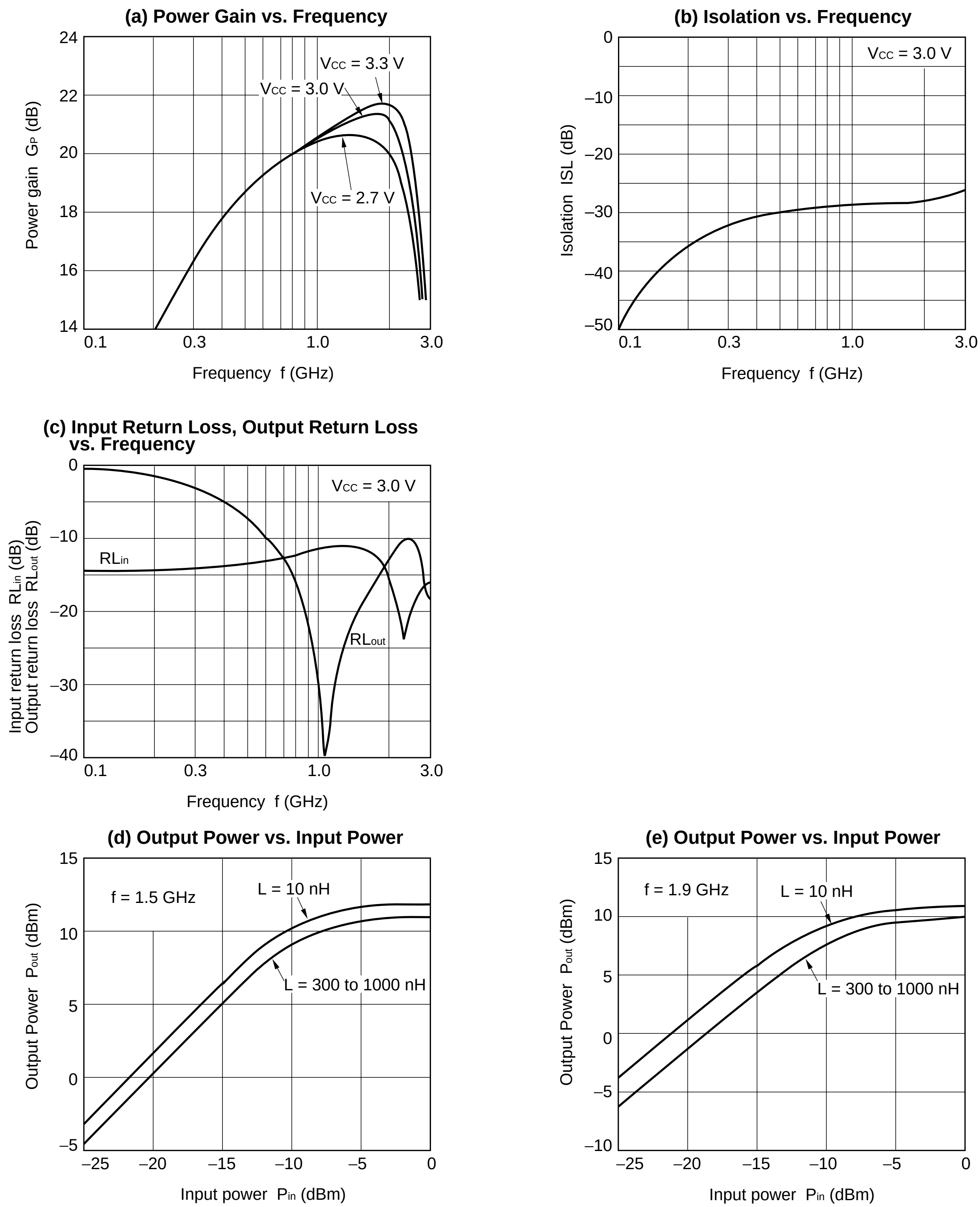
Figure 4-8. Frequency Characteristics of μPC2763T Using 10 nH Inductor
(Conditions: T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω)



4.5 μPC2771T

The μPC2771T has been evaluated to obtain characteristics in the range between 1.4 and 1.9 GHz. A 10 nH wire-wound chip inductor (1 GHz self-resonance frequency) was used. Under these test conditions, obtaining a gain in the range between 1.4 GHz and 1.9 GHz, the 1 dB gain compression point is raised by 1 dB.

Figure 4-9. Frequency Characteristics of μPC2771T Using 10 nH Inductor
(Conditions: T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω)



5. APPLICATIONS

Table 5-1 shows possible applications for NEC's silicon medium-power high-frequency amplifier ICs based on their characteristics.

Table 5-1. Medium-Power Amplifier IC Applications

Applications	Required Characteristics	Part Number
Transmission stage of transceivers or cellular-phone base stations	5 V, up to 1.0 GHz or 1.5 GHz	μPC1678G, μPC1678GV, μPC1679G, μPC2710T, μPC2776T
Transmission stage of cellular phones or portable transceivers	3 V, 0.8 GHz to 2 GHz	μPC2762T, μPC2763T, μPC2771T
Receiver stage of BS converters or BS tuner	5 V, 1 GHz to 2.215 GHz	μPC2708T, μPC2709T
Wireless LAN	3 V, 2.5 GHz bandwidth	μPC2762T, μPC2763T

6. SUMMARY

As explained in this application note, NEC's silicon medium-power high-frequency amplifier ICs can be useful characteristics by selecting adequate external circuit constants for the type of internal circuit and high-frequency characteristics of each IC.

7. AFTERWORD

NEC plans to develop products with higher output power and higher efficiency ASSP products.

REFERENCES

Silicon High-Frequency Wideband Amplifier MMIC Application Note (P11976E)
Data Sheets of each NEC silicon medium-power high-frequency amplifier IC

★ APPENDIX. S PARAMETER REFERENCE (T_A = +25°C)

μPC1678G

V_{CC} = V_{out} = 5.0 V, I_{CC} = 49 mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.078	−173.8	12.298	−4.0	0.023	−6.4	0.555	−3.2	1.40
200.0000	0.106	−179.1	12.891	−8.6	0.020	−7.3	0.593	−8.7	1.43
300.0000	0.140	166.3	13.625	−14.8	0.016	−4.7	0.630	−16.4	1.59
400.0000	0.176	150.2	14.453	−22.6	0.014	6.4	0.657	−25.3	1.53
500.0000	0.212	132.9	15.257	−31.5	0.014	23.1	0.673	−35.4	1.38
600.0000	0.246	115.5	15.663	−40.8	0.017	35.1	0.676	−45.1	1.05
700.0000	0.275	99.2	16.156	−51.3	0.020	41.0	0.669	−55.0	0.86
800.0000	0.304	83.2	16.291	−60.7	0.024	42.4	0.654	−64.0	0.71
900.0000	0.323	68.2	16.289	−71.0	0.027	41.8	0.627	−72.4	0.65
1000.0000	0.403	53.3	17.096	−80.2	0.030	47.1	0.660	−76.7	0.45
1100.0000	0.408	37.1	16.669	−90.7	0.036	43.0	0.646	−85.4	0.44
1200.0000	0.421	22.2	16.591	−100.7	0.036	41.3	0.639	−93.7	0.44
1300.0000	0.436	6.4	16.370	−111.2	0.041	36.5	0.660	−101.7	0.41
1400.0000	0.449	−8.4	16.056	−121.8	0.042	33.9	0.670	−109.8	0.40
1500.0000	0.463	−25.0	15.852	−131.6	0.045	28.3	0.690	−118.7	0.40
1600.0000	0.474	−41.5	15.332	−142.8	0.049	25.9	0.717	−127.0	0.41
1700.0000	0.472	−58.3	14.865	−154.2	0.048	22.1	0.734	−136.6	0.45
1800.0000	0.468	−76.1	14.169	−164.9	0.049	15.7	0.763	−146.9	0.48
1900.0000	0.457	−92.5	13.229	−176.8	0.048	13.7	0.783	−156.8	0.54
2000.0000	0.447	−109.6	12.144	172.6	0.048	8.1	0.806	−167.8	0.58
2100.0000	0.447	−126.4	10.947	162.7	0.049	4.0	0.830	−178.6	0.64
2200.0000	0.434	−142.6	9.853	153.4	0.047	−2.0	0.843	170.2	0.69
2300.0000	0.429	−158.5	8.796	146.3	0.044	−6.7	0.842	159.4	0.77
2400.0000	0.427	−173.0	7.894	139.7	0.040	−9.9	0.843	148.2	0.86
2500.0000	0.422	172.5	7.048	133.3	0.036	−12.5	0.825	137.4	0.99
2600.0000	0.419	158.3	6.363	128.8	0.027	−17.6	0.785	125.7	1.34
2700.0000	0.416	145.6	5.881	125.1	0.023	−17.2	0.744	117.2	1.71
2800.0000	0.400	136.1	5.387	121.3	0.018	4.5	0.701	109.7	2.34
2900.0000	0.402	126.2	5.223	116.2	0.018	11.0	0.681	103.0	2.53
3000.0000	0.406	118.1	5.030	113.5	0.020	28.2	0.645	96.5	2.45
3100.0000	0.397	109.8	4.675	107.3	0.022	35.3	0.616	90.7	2.47

$V_{CC} = V_{out} = 5.0$ 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

μPC1679G

$V_{CC} = V_{out} = 5.0$ V, $I_{CC} = 40$ mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.133	177.2	11.167	−4.7	0.024	−4.9	0.589	−3.9	1.40
200.0000	0.154	171.2	11.585	−9.8	0.022	−10.3	0.620	−9.7	1.41
300.0000	0.184	159.6	12.121	−16.1	0.018	−3.0	0.648	−17.3	1.51
400.0000	0.217	147.3	12.690	−23.9	0.015	4.9	0.669	−25.9	1.63
500.0000	0.247	132.4	13.210	−32.2	0.015	20.0	0.681	−35.1	1.42
600.0000	0.279	117.7	13.509	−40.9	0.017	35.5	0.680	−44.3	1.15
700.0000	0.307	102.8	13.902	−51.0	0.021	42.6	0.674	−53.6	0.88
800.0000	0.333	88.3	13.966	−59.8	0.026	44.8	0.659	−62.0	0.71
900.0000	0.342	76.4	13.895	−69.5	0.027	42.5	0.628	−70.6	0.72
1000.0000	0.412	60.4	14.401	−78.5	0.033	52.0	0.646	−75.4	0.48
1100.0000	0.419	46.1	14.244	−87.9	0.037	46.1	0.636	−83.6	0.46
1200.0000	0.434	31.7	14.249	−97.3	0.041	42.5	0.635	−90.1	0.43
1300.0000	0.450	18.1	14.096	−106.9	0.043	41.8	0.640	−97.8	0.41
1400.0000	0.461	3.2	13.945	−116.9	0.047	35.8	0.655	−105.0	0.39
1500.0000	0.481	−12.2	13.888	−125.9	0.051	34.1	0.664	−112.7	0.39
1600.0000	0.486	−27.2	13.645	−136.5	0.053	30.5	0.691	−120.6	0.39
1700.0000	0.487	−43.7	13.460	−147.3	0.053	27.3	0.707	−129.2	0.42
1800.0000	0.486	−61.2	13.043	−157.9	0.056	21.6	0.742	−138.5	0.44
1900.0000	0.479	−78.4	12.509	−170.0	0.058	17.7	0.771	−147.7	0.48
2000.0000	0.469	−95.6	11.678	179.0	0.057	13.6	0.794	−158.3	0.53
2100.0000	0.467	−113.5	10.720	168.4	0.057	9.9	0.819	−169.0	0.59
2200.0000	0.454	−130.9	9.763	158.2	0.056	3.5	0.840	179.9	0.63
2300.0000	0.450	−148.4	8.754	150.0	0.054	−1.4	0.846	168.7	0.71
2400.0000	0.449	−165.0	7.849	142.4	0.050	−6.4	0.852	157.1	0.78
2500.0000	0.443	179.3	7.022	135.4	0.045	−9.9	0.829	145.9	0.90
2600.0000	0.441	163.8	6.289	130.2	0.037	−13.3	0.790	133.6	1.11
2700.0000	0.430	149.9	5.800	126.1	0.029	−11.1	0.733	124.7	1.49
2800.0000	0.426	139.0	5.277	121.8	0.027	−1.1	0.697	117.2	1.75
2900.0000	0.429	128.2	5.108	116.7	0.027	6.1	0.672	110.0	1.84
3000.0000	0.432	118.6	4.894	114.0	0.025	15.9	0.635	103.2	2.02
3100.0000	0.419	110.7	4.541	107.4	0.028	31.2	0.598	98.0	2.05

μPC2708T

$V_{CC} = V_{out} = 5.0$ V, $I_{CC} = 24$ mA

FREQUENCY	S11		S21		S12		S22		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.040	−3.6	5.149	−3.2	0.073	0.2	0.132	−11.5	1.49
200.0000	0.063	30.7	5.185	−11.6	0.072	−1.3	0.138	−12.1	1.49
400.0000	0.112	47.5	5.195	−25.4	0.070	−4.2	0.140	−17.1	1.51
600.0000	0.162	49.6	5.205	−38.4	0.068	−5.9	0.144	−21.3	1.52
800.0000	0.211	45.7	5.215	−52.3	0.066	−6.6	0.150	−26.1	1.52
1000.0000	0.265	40.0	5.225	−64.4	0.064	−5.3	0.157	−31.0	1.52
1200.0000	0.319	32.0	5.233	−79.1	0.063	−5.3	0.165	−36.1	1.48
1400.0000	0.363	23.8	5.206	−94.2	0.061	−5.5	0.171	−43.7	1.48
1600.0000	0.404	15.3	5.149	−109.5	0.060	−4.9	0.176	−50.2	1.45
1800.0000	0.435	6.9	4.974	−125.6	0.060	−3.7	0.168	−57.3	1.46
2000.0000	0.460	−3.4	4.696	−141.1	0.060	−0.4	0.156	−62.5	1.49
2200.0000	0.456	−12.6	4.454	−156.6	0.060	−0.4	0.141	−60.3	1.58
2400.0000	0.442	−19.9	4.102	−172.5	0.060	−1.8	0.123	−61.6	1.74
2600.0000	0.422	−26.5	3.702	172.7	0.060	0.2	0.100	−61.5	1.95
2800.0000	0.396	−31.5	3.307	158.9	0.059	0.1	0.077	−61.6	2.26
3000.0000	0.365	−35.3	2.907	146.5	0.059	2.0	0.051	−56.7	2.62

μPC2709T

$V_{CC} = V_{out} = 5.0$ V, $I_{CC} = 30$ mA

FREQUENCY	S11		S21		S12		S22		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.258	−4.1	12.706	−3.7	0.022	7.5	0.234	−4.6	1.66
200.0000	0.261	−2.9	12.793	−12.2	0.024	3.1	0.240	−6.9	1.52
400.0000	0.271	−4.6	13.023	−27.0	0.025	6.5	0.260	−13.5	1.32
600.0000	0.275	−8.1	13.305	−41.3	0.026	10.5	0.288	−22.1	1.29
800.0000	0.278	−12.7	13.595	−57.4	0.026	11.0	0.312	−33.5	1.27
1000.0000	0.279	−15.2	13.816	−72.3	0.027	15.6	0.324	−43.4	1.20
1200.0000	0.276	−20.7	13.992	−90.3	0.027	17.7	0.332	−59.0	1.19
1400.0000	0.263	−25.6	13.750	−109.3	0.027	19.2	0.326	−75.1	1.22
1600.0000	0.246	−28.6	13.195	−128.3	0.028	20.6	0.302	−90.6	1.27
1800.0000	0.237	−31.7	12.254	−147.5	0.030	27.9	0.254	−106.8	1.33
2000.0000	0.222	−33.6	10.976	−166.1	0.031	33.2	0.198	−120.8	1.47
2200.0000	0.194	−33.1	9.664	177.5	0.033	35.8	0.143	−132.5	1.61
2400.0000	0.176	−26.8	8.392	162.0	0.034	38.5	0.089	−144.4	1.81
2500.0000	0.173	−23.2	7.771	154.8	0.035	39.2	0.065	−150.6	1.90

μPC2710T

$V_{CC} = V_{out} = 5.0$ V, $I_{CC} = 21$ mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.322	−0.3	37.668	−5.9	0.013	17.1	0.200	−11.7	1.06
200.0000	0.346	3.3	38.808	−17.0	0.012	19.8	0.208	−15.4	1.07
300.0000	0.383	2.1	40.192	−28.0	0.009	22.5	0.231	−23.5	1.21
400.0000	0.429	−1.7	41.567	−40.4	0.009	25.1	0.258	−34.2	1.10
500.0000	0.465	−9.4	42.130	−54.1	0.012	27.8	0.273	−47.2	0.86
600.0000	0.486	−17.8	42.282	−68.3	0.013	30.5	0.305	−60.9	0.79
700.0000	0.487	−27.2	41.075	−83.2	0.013	33.1	0.319	−77.8	0.82
800.0000	0.468	−36.5	39.129	−97.9	0.013	35.8	0.320	−96.2	0.89
900.0000	0.423	−44.5	35.399	−111.7	0.013	38.5	0.297	−115.4	1.04
1000.0000	0.392	−50.3	32.933	−123.4	0.014	41.2	0.260	−128.2	1.10
1100.0000	0.349	−56.6	30.025	−135.5	0.014	43.9	0.240	−142.2	1.22
1200.0000	0.301	−61.0	26.823	−146.8	0.015	46.6	0.216	−156.3	1.31
1300.0000	0.257	−63.2	23.836	−156.8	0.016	49.2	0.192	−169.7	1.40
1400.0000	0.217	−63.5	21.128	−165.9	0.016	51.6	0.173	176.0	1.56
1500.0000	0.184	−59.9	18.841	−174.2	0.017	54.5	0.155	162.3	1.65

μPC2762T
$V_{CC} = V_{out} = 3.0$ V, $I_{CC} = 29$ mA

FREQUENCY	S11		S21		S12		S22		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.365	−3.1	4.352	−14.3	0.039	−8.0	0.347	−6.8	2.20
200.0000	0.367	−5.3	4.333	−29.8	0.038	−18.5	0.345	−11.9	2.27
300.0000	0.371	−8.1	4.359	−44.2	0.038	−24.5	0.343	−15.9	2.29
400.0000	0.361	−9.9	4.327	−59.4	0.038	−32.7	0.334	−22.6	2.35
500.0000	0.359	−11.9	4.343	−73.1	0.040	−39.6	0.334	−29.0	2.29
600.0000	0.351	−14.0	4.445	−87.8	0.039	−50.4	0.359	−34.6	2.28
700.0000	0.350	−17.5	4.498	−102.1	0.041	−58.3	0.377	−37.0	2.19
800.0000	0.357	−20.0	4.630	−116.6	0.042	−67.5	0.369	−39.8	2.11
900.0000	0.371	−24.0	4.726	−131.8	0.042	−76.1	0.348	−43.6	2.10
1000.0000	0.405	−24.5	4.790	−147.5	0.043	−84.4	0.328	−48.6	2.05
1100.0000	0.421	−24.5	4.925	−161.9	0.045	−94.0	0.351	−52.5	1.90
1200.0000	0.454	−23.0	5.120	−177.7	0.047	−103.3	0.385	−55.7	1.70
1300.0000	0.462	−23.0	5.293	165.7	0.049	−113.6	0.397	−57.9	1.54
1400.0000	0.467	−24.7	5.350	148.3	0.048	−126.1	0.369	−63.8	1.51
1500.0000	0.457	−24.3	5.431	132.6	0.049	−133.5	0.342	−66.4	1.45
1600.0000	0.461	−25.0	5.529	116.2	0.049	−145.2	0.343	−72.7	1.36
1700.0000	0.459	−25.2	5.632	99.0	0.051	−153.6	0.341	−80.1	1.26
1800.0000	0.468	−25.7	5.646	82.5	0.050	−164.1	0.320	−86.2	1.26
1900.0000	0.485	−25.6	5.803	65.6	0.051	−172.7	0.286	−91.3	1.20
2000.0000	0.487	−26.8	5.921	48.0	0.054	177.1	0.265	−97.7	1.14
2100.0000	0.488	−25.9	5.993	29.9	0.055	167.8	0.238	−106.3	1.16
2200.0000	0.480	−26.7	6.027	11.0	0.057	157.1	0.206	−111.3	1.19
2300.0000	0.484	−29.5	5.967	−7.6	0.057	145.6	0.166	−118.0	1.25
2400.0000	0.473	−32.9	5.915	−26.4	0.056	137.3	0.109	−130.8	1.32
2500.0000	0.477	−37.4	5.766	−45.5	0.057	123.5	0.062	−164.2	1.33
2600.0000	0.470	−40.7	5.480	−64.5	0.059	115.2	0.031	127.3	1.36
2700.0000	0.471	−43.1	5.177	−81.9	0.061	104.9	0.037	43.5	1.37
2800.0000	0.469	−44.2	4.909	−98.6	0.060	94.5	0.079	7.1	1.43
2900.0000	0.468	−45.5	4.682	−115.3	0.061	87.8	0.105	−3.0	1.46
3000.0000	0.457	−45.8	4.465	−131.9	0.061	74.7	0.120	−6.4	1.52
3100.0000	0.425	−45.8	4.253	−148.2	0.065	64.2	0.107	−8.9	1.57

μPC2763T

$V_{CC} = V_{out} = 3.0$ V, $I_{CC} = 26$ mA

FREQUENCY	S11		S21		S12		S22		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.0000	0.209	−0.0	10.116	−6.0	0.023	2.4	0.391	−6.2	1.76
200.0000	0.210	−0.8	10.149	−11.7	0.023	6.4	0.389	−12.3	1.74
300.0000	0.216	−1.8	10.186	−17.7	0.023	9.6	0.388	−18.2	1.75
400.0000	0.220	−3.2	10.292	−23.6	0.024	13.1	0.386	−24.1	1.70
500.0000	0.226	−5.1	10.366	−29.5	0.025	17.1	0.388	−30.0	1.60
600.0000	0.232	−6.9	10.467	−35.7	0.026	20.9	0.389	−36.3	1.56
700.0000	0.239	−9.6	10.635	−42.2	0.027	23.0	0.396	−42.3	1.46
800.0000	0.248	−12.3	10.717	−48.8	0.029	25.9	0.402	−48.5	1.35
900.0000	0.255	−15.9	10.900	−55.7	0.028	27.3	0.404	−55.4	1.36
1000.0000	0.262	−19.8	11.004	−63.2	0.030	27.7	0.408	−62.5	1.28
1100.0000	0.266	−24.0	11.168	−70.1	0.032	28.5	0.412	−70.0	1.20
1200.0000	0.273	−28.2	11.173	−77.7	0.033	29.7	0.416	−77.3	1.17
1300.0000	0.276	−33.7	11.318	−86.3	0.033	27.8	0.421	−85.3	1.15
1400.0000	0.280	−38.8	11.221	−94.0	0.034	29.2	0.423	−93.1	1.14
1500.0000	0.280	−44.8	11.134	−103.0	0.034	28.9	0.425	−101.7	1.14
1600.0000	0.280	−51.2	10.878	−111.4	0.034	29.7	0.420	−110.2	1.18
1700.0000	0.276	−57.7	10.512	−119.5	0.035	30.4	0.418	−118.5	1.21
1800.0000	0.269	−64.7	10.207	−127.4	0.035	32.1	0.415	−126.7	1.27
1900.0000	0.260	−71.3	9.747	−135.2	0.035	32.7	0.413	−135.6	1.33
2000.0000	0.251	−78.4	9.378	−142.6	0.035	33.4	0.408	−144.1	1.39
2100.0000	0.238	−85.6	8.962	−149.6	0.036	35.1	0.400	−153.1	1.45
2200.0000	0.224	−92.5	8.551	−157.0	0.035	35.9	0.391	−162.0	1.56
2300.0000	0.210	−99.7	8.135	−163.5	0.036	38.2	0.382	−171.1	1.60
2400.0000	0.196	−107.4	7.739	−170.2	0.035	40.2	0.373	−179.6	1.72
2500.0000	0.182	−114.5	7.349	−176.3	0.037	41.5	0.357	171.8	1.76
2600.0000	0.167	−121.4	6.980	177.4	0.038	44.0	0.343	163.1	1.81
2700.0000	0.152	−127.4	6.678	171.2	0.039	45.4	0.322	154.9	1.85
2800.0000	0.140	−131.9	6.309	165.3	0.039	46.7	0.298	148.1	1.97
2900.0000	0.134	−140.3	5.918	159.2	0.039	47.6	0.284	142.4	2.08
3000.0000	0.120	−148.7	5.675	153.9	0.041	48.8	0.271	137.1	2.10

μPC2771T

$V_{CC} = V_{out} = 3.0$ V, $I_{CC} = 36$ mA

FREQUENCY	S11		S21		S12		S22	
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
100.0000	0.148	109.2	10.732	−11.3	0.031	3.7	0.334	−6.9
200.0000	0.098	110.8	10.644	−15.4	0.025	2.2	0.320	−11.9
300.0000	0.082	107.6	10.739	−22.0	0.025	8.7	0.317	−17.0
400.0000	0.083	86.8	10.898	−28.9	0.025	0.7	0.323	−23.2
500.0000	0.088	68.9	11.011	−35.7	0.025	22.9	0.326	−31.2
600.0000	0.095	53.0	11.119	−43.5	0.022	17.1	0.337	−38.8
700.0000	0.114	38.9	11.246	−51.5	0.030	22.9	0.352	−46.0
800.0000	0.129	33.4	11.330	−59.1	0.034	10.3	0.355	−53.4
900.0000	0.163	23.1	11.526	−67.4	0.033	29.2	0.360	−64.2
1000.0000	0.178	16.2	11.500	−76.8	0.030	17.6	0.367	−71.1
1100.0000	0.192	11.3	11.537	−85.9	0.031	24.7	0.376	−79.8
1200.0000	0.207	5.5	11.403	−94.3	0.040	8.8	0.386	−89.0
1300.0000	0.211	1.9	11.176	−104.0	0.033	12.9	0.394	−97.8
1400.0000	0.217	−5.4	10.936	−113.4	0.031	21.2	0.395	−107.2
1500.0000	0.203	−11.0	10.587	−122.7	0.037	23.0	0.403	−115.9
1600.0000	0.196	−18.5	10.162	−132.0	0.033	16.6	0.407	−125.1
1700.0000	0.189	−24.0	9.784	−140.5	0.041	14.9	0.410	−132.4
1800.0000	0.170	−31.2	9.339	−148.9	0.039	10.2	0.404	−139.3
1900.0000	0.144	−38.4	8.836	−156.9	0.035	15.0	0.401	−147.0
2000.0000	0.137	−47.5	8.418	−164.5	0.036	20.7	0.392	−156.0
2100.0000	0.109	−56.6	7.877	−172.7	0.034	30.0	0.384	−162.9
2200.0000	0.088	−65.7	7.604	−179.8	0.038	21.3	0.384	−172.5
2300.0000	0.079	−70.9	7.214	172.4	0.045	33.4	0.377	−179.5
2400.0000	0.062	−77.9	6.743	164.6	0.039	19.6	0.359	170.2
2500.0000	0.047	−94.9	6.420	157.7	0.041	23.9	0.351	162.3
2600.0000	0.030	−102.0	6.044	151.1	0.046	28.6	0.331	153.5
2700.0000	0.018	−114.9	5.654	144.2	0.043	40.0	0.318	144.4
2800.0000	0.015	162.0	5.315	137.4	0.046	25.1	0.302	138.0
2900.0000	0.022	111.1	4.959	130.9	0.043	34.1	0.295	131.1
3000.0000	0.037	87.9	4.669	124.4	0.048	35.2	0.262	125.2

μPC2776T

$V_{CC} = V_{out} = 5.0$ V, $I_{CC} = 28$ mA

FREQUENCY	S11		S21		S12		S22		K
MHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	
100.000	0.218	−1.2	14.389	−16.1	0.030	−10.4	0.048	−157.8	1.33
200.000	0.223	1.7	14.257	−33.9	0.029	−24.1	0.045	−148.4	1.34
300.000	0.241	−0.5	14.347	−50.2	0.029	−29.3	0.046	−134.9	1.33
400.000	0.245	1.9	14.369	−67.4	0.029	−40.4	0.069	−131.1	1.32
500.000	0.259	2.0	14.491	−83.4	0.029	−49.3	0.094	−125.0	1.29
600.000	0.270	2.5	14.879	−101.0	0.030	−58.0	0.119	−116.5	1.23
700.000	0.291	−3.1	14.948	−117.9	0.030	−69.5	0.125	−113.1	1.22
800.000	0.322	−7.8	15.268	−135.5	0.029	−78.6	0.131	−127.6	1.19
900.000	0.350	−14.3	15.461	−153.1	0.029	−91.9	0.139	−144.5	1.18
1000.000	0.408	−18.0	15.585	−171.7	0.029	−103.2	0.139	−153.9	1.14
1100.000	0.451	−19.0	15.913	170.9	0.028	−112.4	0.141	−144.1	1.14
1200.000	0.521	−20.7	16.312	151.8	0.029	−121.3	0.145	−137.8	1.07
1300.000	0.557	−24.3	16.461	132.3	0.031	−135.5	0.146	−147.0	1.00
1400.000	0.571	−29.2	16.163	112.5	0.027	−144.7	0.158	−165.7	1.05
1500.000	0.573	−32.7	16.013	93.7	0.027	−155.5	0.183	176.6	1.06
1600.000	0.587	−37.7	15.734	74.7	0.025	−166.4	0.197	167.1	1.07
1700.000	0.588	−42.2	15.347	55.4	0.023	179.0	0.196	158.8	1.11
1800.000	0.604	−46.9	14.647	36.7	0.021	171.7	0.198	149.6	1.17
1900.000	0.609	−50.8	14.289	19.0	0.019	162.9	0.232	140.7	1.21
2000.000	0.599	−55.3	14.000	1.0	0.019	151.6	0.255	133.2	1.24
2100.000	0.584	−58.6	13.601	−18.1	0.016	142.7	0.280	125.8	1.41
2200.000	0.561	−64.2	13.010	−37.6	0.015	135.6	0.289	115.4	1.62
2300.000	0.544	−71.1	12.289	−55.5	0.011	127.9	0.304	109.6	2.21
2400.000	0.519	−78.3	11.716	−73.3	0.009	130.4	0.348	105.6	2.90
2500.000	0.519	−84.6	11.183	−91.2	0.008	130.4	0.387	102.5	3.27
2600.000	0.509	−90.3	10.551	−108.9	0.008	145.6	0.418	98.5	3.64
2700.000	0.504	−97.0	10.005	−126.1	0.012	163.5	0.430	94.2	2.44
2800.000	0.472	−102.5	9.513	−142.9	0.016	153.3	0.448	87.7	1.92
2900.000	0.434	−107.5	9.070	−160.4	0.019	141.0	0.459	83.6	1.79
3000.000	0.381	−112.1	8.605	−177.3	0.020	129.3	0.474	82.2	1.80
3100.000	0.330	−117.8	8.196	165.9	0.021	122.9	0.478	82.1	1.96

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