NEC

Application Note

USAGE AND APPLICATION CHARACTERISTICS OF μPC2757, μPC2758, AND μPC8112, 3-V POWER SUPPLY, 1.9-GHz FREQUENCY DOWN-CONVERTER ICS FOR MOBILE COMMUNICATION

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[MEMO]

NESAT is the abbreviation for NEC Silicon Advanced Technology and a trademark of NEC Corporation.

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 wide as possible to minimize ground impedance (to prevent undesired oscillation).
All the ground pins must be connected together in a wide ground pattern to decrease impedance difference.
(3) Keep the track length of the ground pins as short as possible.
(4) The bypass capacitor should be attached to the V_{CC} pin.
(5) The DC cut capacitor must be each attached to the input and output pins.
(6) Refer to the data sheet of each product for the relevant cautions and electrical characteristics.
μPC2757T, μPC2758T Data Sheet (P10716E)
μPC8112T Data Sheet (P10764E)
μPC2757TB, μPC2758TB Data Sheet (P12771E)
μPC8112TB Data Sheet (P12808E)

Some of data sheets may be preliminary versions. However preliminary versions are not marked as such.

[MEMO]

1. INTRODUCTION

Japan's Personal Digital Cellular (PDC) service was started in 1995. Shortly after that, the service of Personal Handy Phone Systems (PHS) was also introduced to the market. As of December, 1998, 38,998,000 cellular subscribers and 5,981,000 PHS subscribers had signed up, accounting for 44,979,000 handsets in total and for 35.5 percent of the population.

In keeping with the trends of widespread use, the demand for handset downsizing has increased. To meet such downsizing demands, in addition to the frequency down-converter ICs μPC2757T, μPC2758T, and μPC8112T currently marketed as conventional products, NEC has developed and commercialized further miniaturized 6-pin mini mold types μPC2757TB, μPC2758TB, and μPC8112TB.

This application note describes the usage method and selected application examples of these ICs.

2. OVERVIEW OF PRODUCTS

2.1 Lineup by External Size

The μPC2757, μPC2758, and μPC8112 are high-frequency silicon monolithic ICs, which are developed as 1st frequency down-converter IC receivers for cellular and cordless telephones. In addition to the existing 6-pin mini mold package (size 2915), a 6-pin super mini mold (size 2012) is also available. Suffixes T and TB, which are appended in the part number represent packages and denote mini mold and super mini mold, respectively. In this lineup, one part number includes only one type of circuitry with the package size distinction made by the suffix T (conventional) or TB (shrink), which is the same rule employed for the up-converter series (but is not the case for the amplifier series). Since the chip layout and size are changed when the TB type is employed, impedance values between T and TB types differ slightly. Other electrical characteristics, however, are identical between the two types.

2.2 Lineup by Characteristics and IF Output Format

The lineup offers the option of choosing a product and its external circuitry according to the desired characteristics. The features of products taking the μPC2757 as the basis of comparison are shown below.

μPC2758: μPC2757 with higher gain and higher output intercept points μPC8112: μPC2757 with higher input intercept points, and an improved input conversion IM_3 level * Circuit current comparisons (from least to greatest current): μPC2757 < μPC8112 < μPC2758

Figure 2-1 shows internal block diagrams of these products.

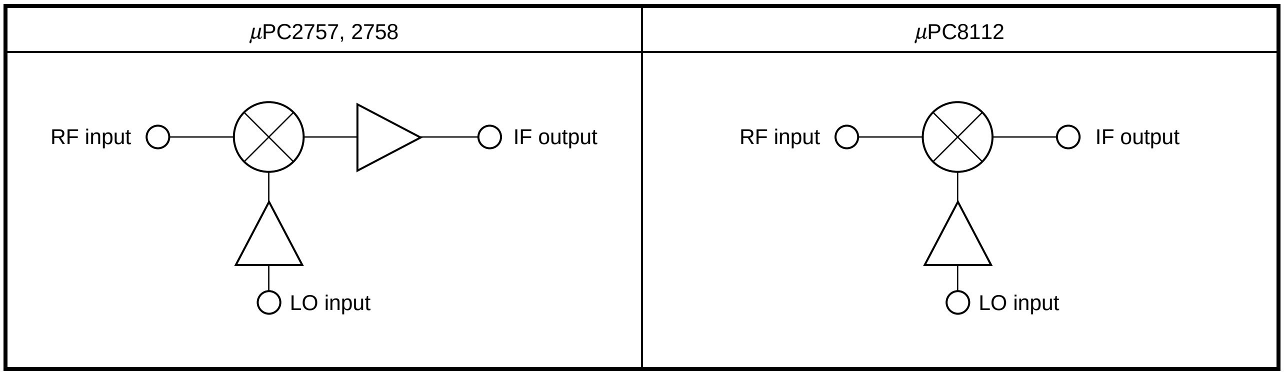
The μPC2757 has the same block configuration as the μPC2758, which includes an input mixer, LO amplifier, and IF output amplifier. The input mixer blocks in the μPC2758 have almost the same characteristics as the μPC2757. In the μPC2758, increasing the IF output amplifier's current raises the output intercept point while obtaining high gain. Concerning the intermodulation distortion characteristic, although the graphed plot for the input level and third-order intermodulation distortion (IM_3) level is weighted slightly toward the second-order level (2.7) when compared to the ordinary third-order plot, the IM_3 level is higher compared to the third-order plot, which is calculated from the crosspoint IP_3 using a logical expression.

The μPC8112 excludes an emitter-follower-type IF output amplifier; instead the mixer is designed as an open collector output. The mixer without the IF output amplifier has a larger circuit current. The circuit can be optimized in output return loss and input intercept points by externally matching the output impedance with the next connected device, which improves the IM_3 level for the relatively high input intercept point and input conversion. The IM_3 level is also improved by the intermodulation distortion characteristic of the output circuit, in which the input level and IM_3 level's graphed plot is closer to a third-order plot than the μPC2757 and μPC2758.

A double balanced mixer (DBM) and a high-isolation LO amplifier are used to prevent leakage, which effectively minimizes LO leakage to RF/IF ports and RF leakage to LO ports.

Table 2-1 shows the lineup of NEC frequency down-converter ICs and Figure 2-2 shows the package drawings. The lineup is developed and commercialized using NEC's own silicon bipolar process "NESAT III". For details of this process, refer to Pamphlet NESAT Process (Doc. No. P12647E).

Figure 2-1. Internal Block Diagrams



★ **Table 2-1. Lineup of Frequency Down-converter IC**

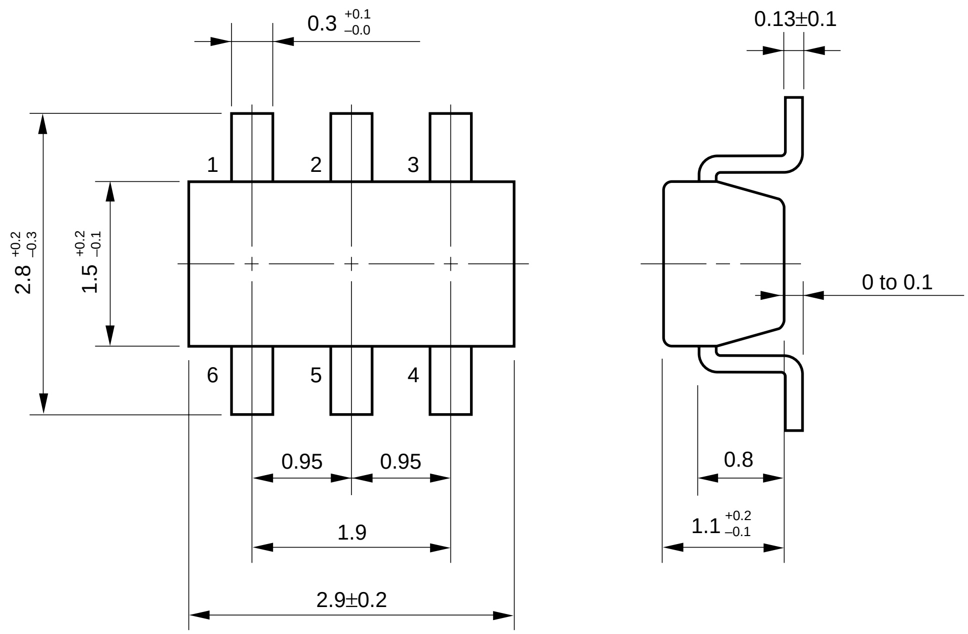
Item / Product	No RF I_{CC} (mA)	900 MHz SSB NF (dB)	1.5 GHz SSB NF (dB)	1.9 GHz SSB NF (dB)	900 MHz CG (dB)	1.5 GHz CG (dB)	1.9 GHz CG (dB)	900 MHz IIP_3 (dBm)	1.5 GHz IIP_3 (dBm)	1.9 GHz IIP_3 (dBm)
μPC2757T	5.6	10	10	13	15	15	13	–14	–14	–12
μPC2757TB										
μPC2758T	11	9	10	13	19	18	17	–13	–12	–11
μPC2758TB										
μPC8112T	8.5	9	11	11	15	13	13	–10	–9	–7
μPC8112TB										

Item / Product	900 MHz $P_{O\,(sat)}$ (dBm)	1.5 GHz $P_{O\,(sat)}$ (dBm)	1.9 GHz $P_{O\,(sat)}$ (dBm)	900 MHz RF_{lo} (dB)	1.5 GHz RF_{lo} (dB)	1.9 GHz RF_{lo} (dB)	IF Output Format	Package
μPC2757T	–3	–	–8	–	–	–	Emitter follower	6-pin mini mold
μPC2757TB								6-pin super mini mold
μPC2758T	1	–	–4	–	–	–		6-pin mini mold
μPC2758TB								6-pin super mini mold
μPC8112T	–2.5	–3	–3	–80	–57	–55	Open collector	6-pin mini mold
μPC8112TB								6-pin super mini mold

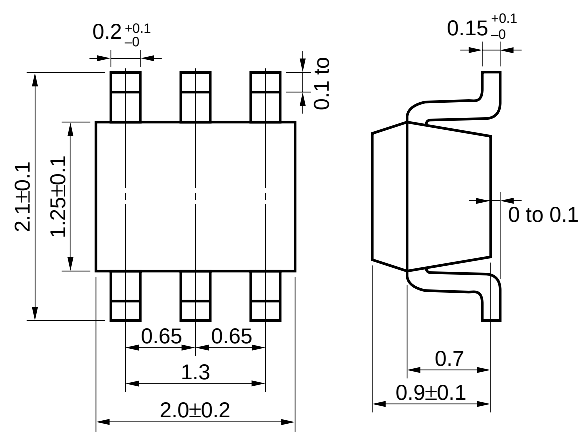
T_A = +25°C, V_{CC} = 3.0 V

Remark The typical value is used for each major characteristic.

★ **Figure 2-2. (a) 6-Pin Mini-Mold Package Drawing (Unit: mm)**



(b) 6-Pin Super Mini-Mold Package Drawing (Unit: mm)



3. MEASUREMENT AND CALCULATION OF MAIN CHARACTERISTICS

In this product series, the electrical characteristics are specified by the test circuit shown in the data sheets which RF input port and LO input port coupled to the signal generator with capacitor only. The purpose of these ratings is to set a common point of reference since the impedance at the input port is high in relation to 50 Ω and input conversion characteristics vary according to the external circuitry.

The main items to be measured are the input/output levels, conversion gain (CG), and third-order intermodulation distortion (IM_3). As a rating for various items, CG is a ratio of the RF input power (P_{RFin}) and the IF output's fundamental wave power (P_{IFin}), and IM_3 refers to the frequency relationship between the IF output's fundamental waves ($f_{IFout}1$, $f_{IFout}2$) and distorted wave (f_{IM3}) when there are two frequencies input to the RF input (for a detailed theoretical description, see the literature on high-frequency electronic circuits).

$$CG\ (dB) = P_{IFout} - P_{RFin}$$
$$f_{IM3}1\ (Hz) = 2 \times f_{IFout}1 - f_{IFout}2$$
$$f_{IM3}2\ (Hz) = 2 \times f_{IFout}2 - f_{IFout}1$$

These signal levels are obtained by measurements under certain frequency conditions. On the other hand, the third-order distortion intercept point (IP_3) is an extrapolated value from these measured characteristics. Therefore, IP_3 is a virtual point that is used to calculate a value when we could not measure item under noise level of a measuring instrument. Thus, there is an input level value (IIP_3) and an output level value (OIP_3). OIP_3 is intrinsically rated according to the IC's current efficiency due to D/U ratio of signals level appeared in output, while IIP_3 is established according to the relation between OIP_3 and CG. The relationships among these characteristics are graphed Figure 3-1. You should note that IIP_3 and OIP_3 are extrapolated values and are not actually measured values.

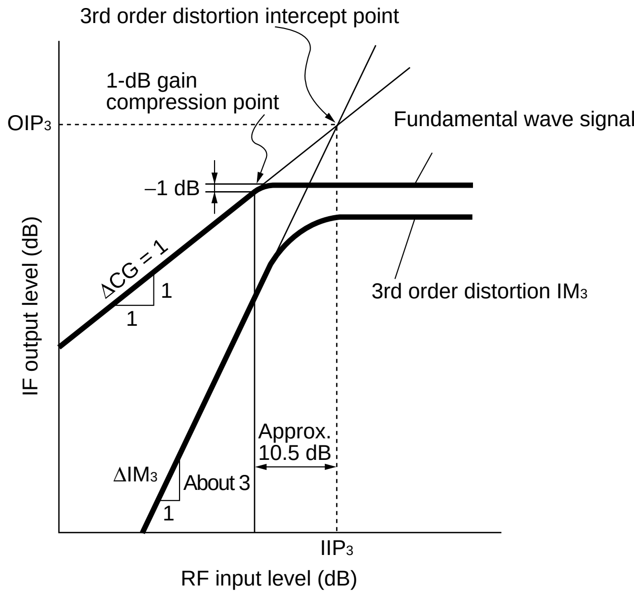
In particular, the gradient (ΔIM_3) for input to IM_3 has almost 3, but accurate value may deviate from 3.0. This is because, mathematically, ΔIM_3 is a third-order gradient, which deviate from the theoretical condition based on the internal chip, the mounted parasitic path, etc. Accordingly, you should calculate using actually measured values to describe accurate distortion behavior.

$$OIP_3 = \frac{\Delta IM_3 \times P_{IFout} - IM_3}{\Delta IM_3 - 1}\ (dBm)$$

$$IIP_3 = \frac{\Delta IM_3 \times P_{RFin} + CG - IM_3}{\Delta IM_3 - 1}\ (dBm)$$

(Where $OIP_3 = IIP_3 + CG$)

Figure 3-1. Conceptual Diagram of Input/Output Characteristics, Conversion Gain (CG), and 3rd Order Intermodulation Distortion (IM_3)



4. APPLICATION CIRCUITS AND CHARACTERISTICS

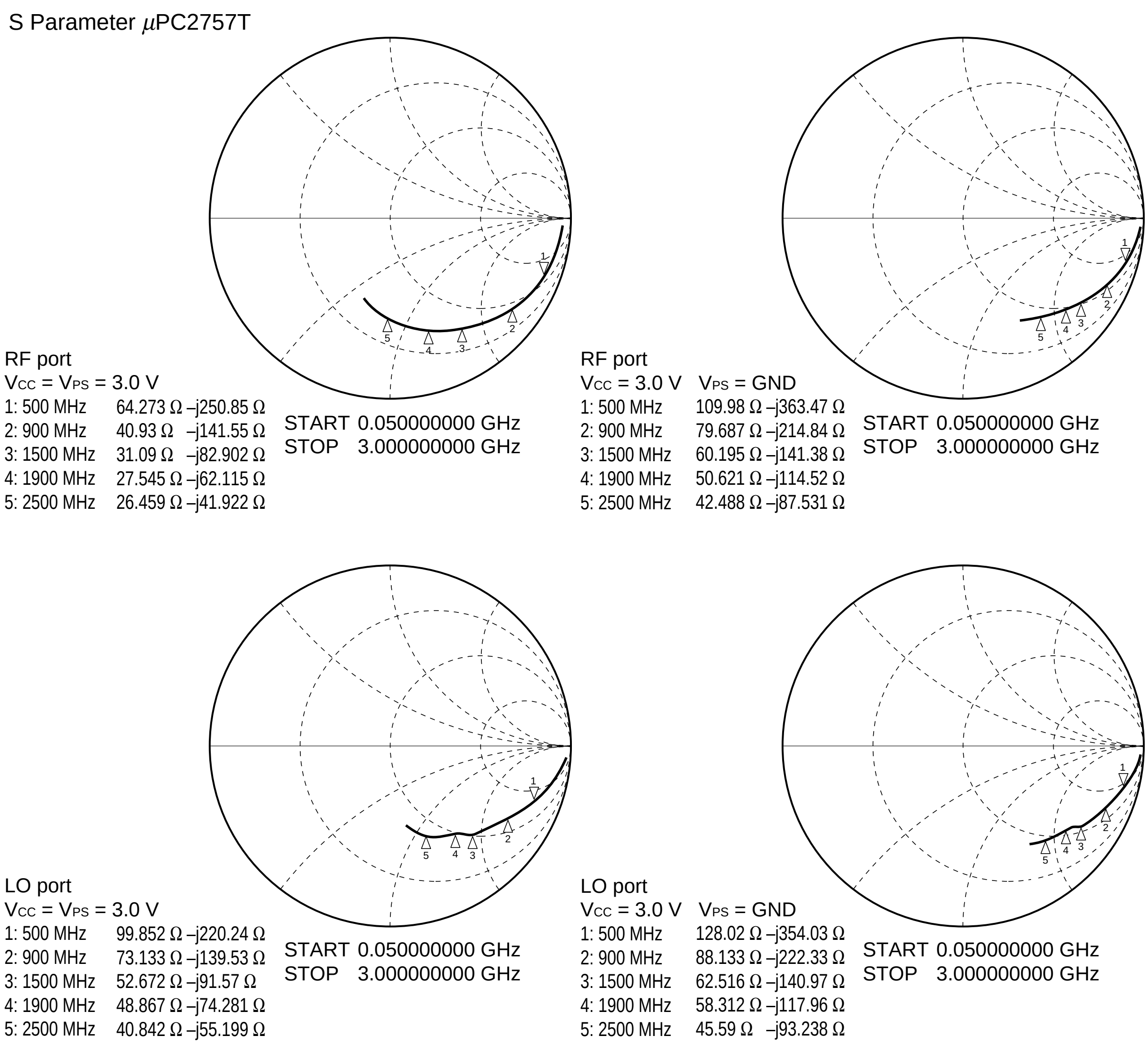
In this series, according to the measuring circuit in the data sheet, the electrical characteristics specified only by coupling the signal generator and capacitor are standardized for the RF input port and LO input port. For actual use, however, the external circuits connected to the input pins differ according to the application and required characteristics.

4.1 Input Pin Connections with Front Stage

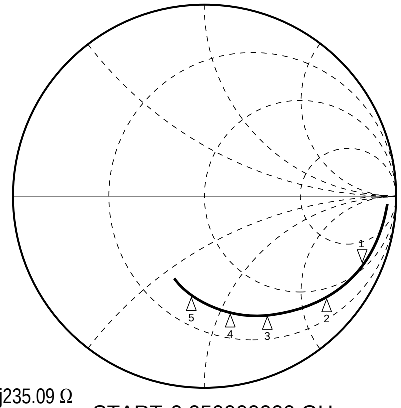
(1) Internal circuitry of input pins

In each product, each input pin is a base input of an NPN transistor, with high impedance in relation to 50 Ω for frequencies up to 1.9 GHz. Figure 4-1 shows Smith charts for the RF port and LO port in each product.

★ **Figure 4-1. Smith Charts of RF Port and LO Port (Input Ports)**

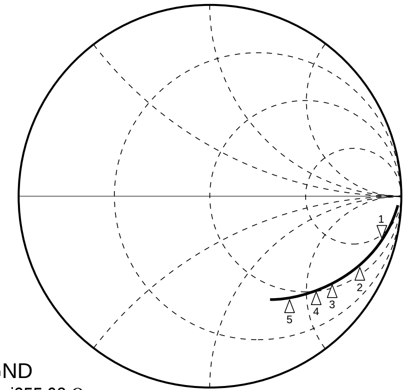


S Parameter μPC2758T



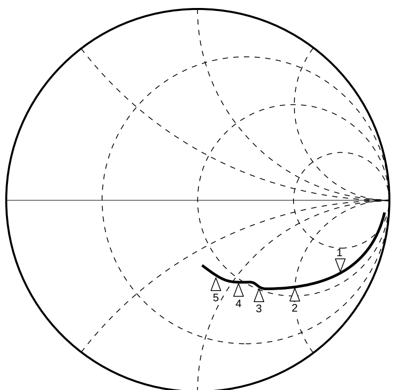
RF port
V_{CC} = V_{PS} = 3.0 V
1: 500 MHz 59.633 Ω –j235.09 Ω
2: 900 MHz 37.609 Ω –j131.38 Ω
3: 1500 MHz 29.121 Ω –j76.48 Ω
4: 1900 MHz 26.992 Ω –j56.742 Ω
5: 2500 MHz 26.697 Ω –j37.975 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz



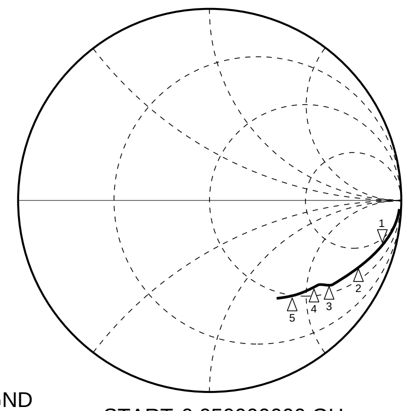
RF port
V_{CC} = 3.0 V V_{PS} = GND
1: 500 MHz 105.94 Ω –j355.98 Ω
2: 900 MHz 79.336 Ω –j214.39 Ω
3: 1500 MHz 61.398 Ω –j139.99 Ω
4: 1900 MHz 51.539 Ω –j113.45 Ω
5: 2500 MHz 42.875 Ω –j87.09 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz



LO port
V_{CC} = V_{PS} = 3.0 V
1: 500 MHz 69.883 Ω –j177.5 Ω
2: 900 MHz 59.047 Ω –j102.83 Ω
3: 1500 MHz 49.656 Ω –j67.445 Ω
4: 1900 MHz 46.871 Ω –53.65 Ω
5: 2500 MHz 42.143 Ω –j40.105 Ω

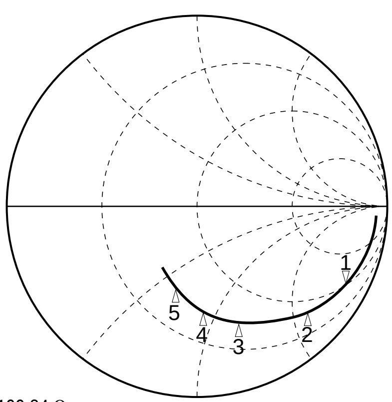
START 0.050000000 GHz
STOP 3.000000000 GHz



LO port
V_{CC} = 3.0 V V_{PS} = GND
1: 500 MHz 102.48 Ω –j330.11 Ω
2: 900 MHz 79.703 Ω –j199.25 Ω
3: 1500 MHz 60.961 Ω –j128.63 Ω
4: 1900 MHz 59.211 Ω –j107.32 Ω
5: 2500 MHz 48.105 Ω –j86.215 Ω

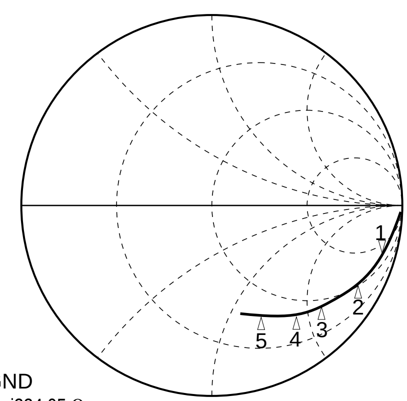
START 0.050000000 GHz
STOP 3.000000000 GHz

S Parameter μPC8112T



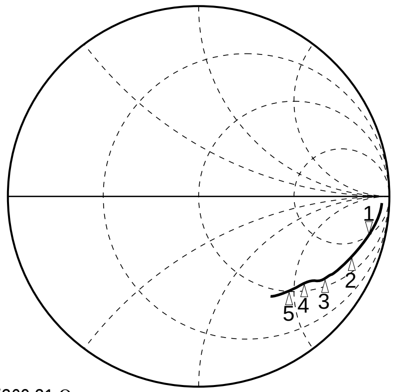
RF port
V_{CC} = V_{PS} = 3.0 V
1: 500 MHz 53.961 Ω –j199.84 Ω
2: 900 MHz 37.164 Ω –j110.75 Ω
3: 1500 MHz 30.703 Ω –j62.504 Ω
4: 1900 MHz 28.742 Ω –j45.379 Ω
5: 2500 MHz 29.257 Ω –j29.199 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz



RF port
V_{CC} = 3.0 V V_{PS} = GND
1: 500 MHz 70.25 Ω –j334.05 Ω
2: 900 MHz 53.289 Ω –j192.67 Ω
3: 1500 MHz 41.633 Ω –j117.89 Ω
4: 1900 MHz 36.133 Ω –j92.941 Ω
5: 2500 MHz 32.621 Ω –j66.703 Ω

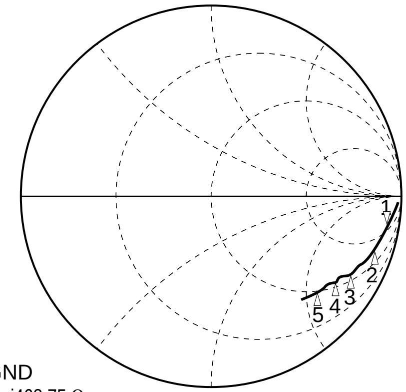
START 0.050000000 GHz
STOP 3.000000000 GHz



LO port
$V_{CC} = V_{PS}$ = 3.0 V

1: 500 MHz	147.34 Ω –j369.31 Ω
2: 900 MHz	90.164 Ω –j232.59 Ω
3: 1500 MHz	61.602 Ω –j144.84 Ω
4: 1900 MHz	59.125 Ω –j116.24 Ω
5: 2500 MHz	50.164 Ω –j94.008 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz

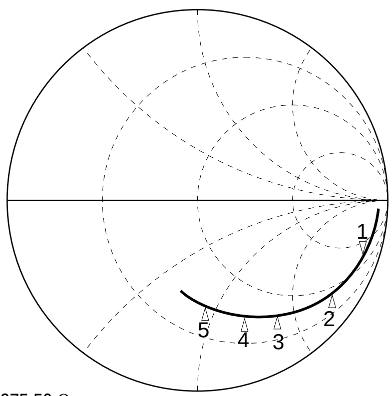


LO port
V_{CC} = 3.0 V V_{PS} = GND

1: 500 MHz	126.91 Ω –j468.75 Ω
2: 900 MHz	84.906 Ω –j278.58 Ω
3: 1500 MHz	58.266 Ω –j173.01 Ω
4: 1900 MHz	57.07 Ω –j140.45 Ω
5: 2500 MHz	47.453 Ω –j114.28 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz

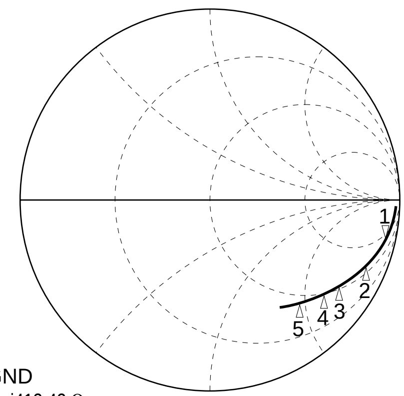
S Parameter μPC2757TB



RF port
$V_{CC} = V_{PS}$ = 3.0 V

1: 500 MHz	56.422 Ω –j275.59 Ω
2: 900 MHz	38.68 Ω –j152.71 Ω
3: 1500 MHz	31.699 Ω –j88.102 Ω
4: 1900 MHz	29.209 Ω –j65.926 Ω
5: 2500 MHz	29.209 Ω –j44.758 Ω

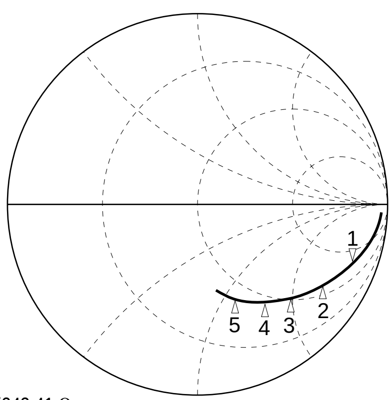
START 0.050000000 GHz
STOP 3.000000000 GHz



RF port
V_{CC} = 3.0 V V_{PS} = GND

1: 500 MHz	104.03 Ω –j413.42 Ω
2: 900 MHz	74.82 Ω –j243.06 Ω
3: 1500 MHz	59.266 Ω –j154.98 Ω
4: 1900 MHz	51.227 Ω –j124.55 Ω
5: 2500 MHz	43.996 Ω –j95.117 Ω

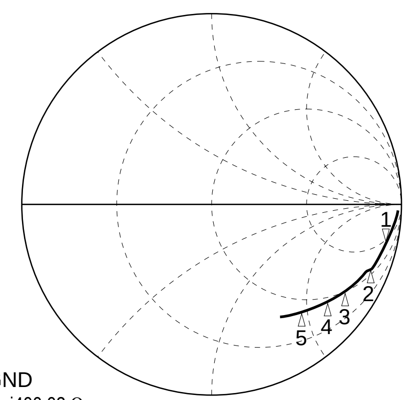
START 0.050000000 GHz
STOP 3.000000000 GHz



LO port
$V_{CC} = V_{PS}$ = 3.0 V

1: 500 MHz	90.969 Ω –j243.41 Ω
2: 900 MHz	67.828 Ω –j150.32 Ω
3: 1500 MHz	51.488 Ω –j97.273 Ω
4: 1900 MHz	44.621 Ω –j77.352 Ω
5: 2500 MHz	39.627 Ω –j56.738 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz

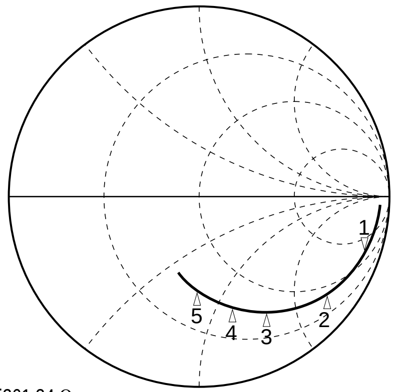


LO port
V_{CC} = 3.0 V V_{PS} = GND

1: 500 MHz	114.16 Ω –j400.03 Ω
2: 900 MHz	75.133 Ω –j242.73 Ω
3: 1500 MHz	53.516 Ω –j154.21 Ω
4: 1900 MHz	44.789 Ω –j124.74 Ω
5: 2500 MHz	37.004 Ω –j93.828 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz

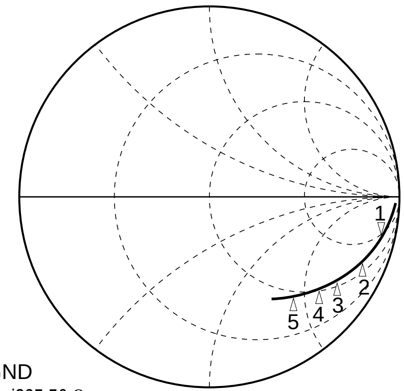
S Parameter μPC2758TB



RF port
$V_{CC} = V_{PS} = 3.0$ V

1: 500 MHz	63.312 Ω –j261.34 Ω
2: 900 MHz	40.227 Ω –j142.36 Ω
3: 1500 MHz	32.441 Ω –j79.68 Ω
4: 1900 MHz	31.107 Ω –j58.273 Ω
5: 2500 MHz	30.871 Ω –j39.08 Ω

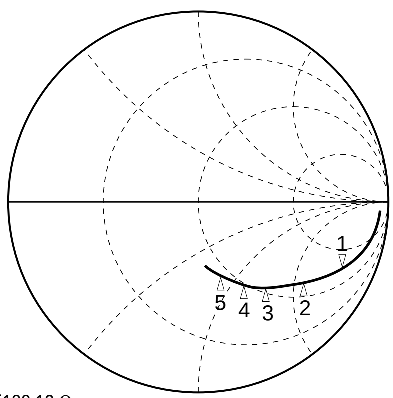
START 0.050000000 GHz
STOP 3.000000000 GHz



RF port
$V_{CC} = 3.0$ V V_{PS} = GND

1: 500 MHz	107.13 Ω –j395.56 Ω
2: 900 MHz	78.711 Ω –j234.41 Ω
3: 1500 MHz	61.922 Ω –j148.82 Ω
4: 1900 MHz	52.629 Ω –j119.55 Ω
5: 2500 MHz	44.766 Ω –j90.578 Ω

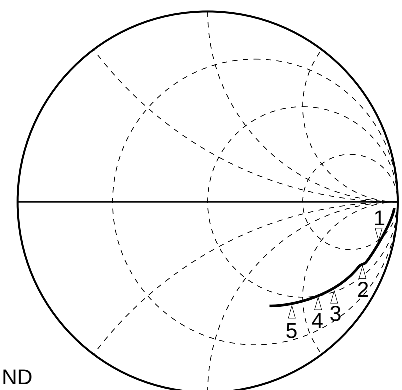
START 0.050000000 GHz
STOP 3.000000000 GHz



LO port
$V_{CC} = V_{PS} = 3.0$ V

1: 500 MHz	73.398 Ω –j188.13 Ω
2: 900 MHz	64.551 Ω –j112.66 Ω
3: 1500 MHz	53.133 Ω –j72.941 Ω
4: 1900 MHz	48.111 Ω –j57.307 Ω
5: 2500 MHz	44.541 Ω –j41.564 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz

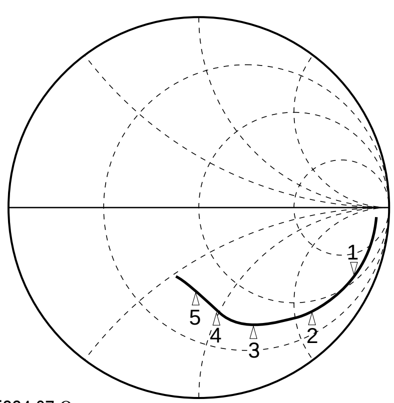


LO port
$V_{CC} = 3.0$ V V_{PS} = GND

1: 500 MHz	100.31 Ω –j374.75 Ω
2: 900 MHz	73.148 Ω –j223.07 Ω
3: 1500 MHz	57.719 Ω –j144.02 Ω
4: 1900 MHz	50.738 Ω –j119.52 Ω
5: 2500 MHz	41.836 Ω –j90.25 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz

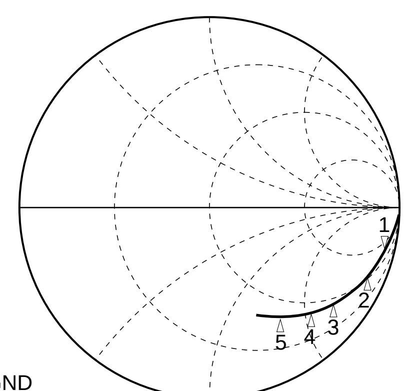
S Parameter μPC8112TB



RF port
$V_{CC} = V_{PS} = 3.0$ V

1: 500 MHz	62.711 Ω –j224.07 Ω
2: 900 MHz	48.977 Ω –j219.18 Ω
3: 1500 MHz	40.641 Ω –j129.94 Ω
4: 1900 MHz	37.422 Ω –j101.51 Ω
5: 2500 MHz	34.801 Ω –j74.141 Ω

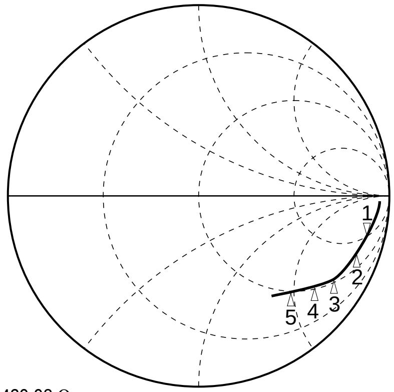
START 0.050000000 GHz
STOP 3.000000000 GHz

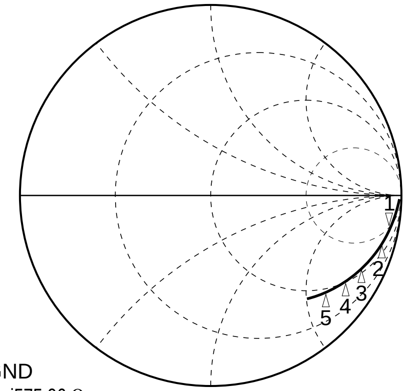


RF port
$V_{CC} = 3.0$ V V_{PS} = GND

1: 500 MHz	76.656 Ω –j421.67 Ω
2: 900 MHz	53.102 Ω –j234.55 Ω
3: 1500 MHz	44.844 Ω –j140.82 Ω
4: 1900 MHz	40.898 Ω –j109.73 Ω
5: 2500 MHz	38.063 Ω –j80.547 Ω

START 0.050000000 GHz
STOP 3.000000000 GHz





(2) External circuits

Since the RF filter that is used in the front stage of this IC features optimization of an attenuation by means of 50-Ω impedance of input and output, the impedance of the RF port in this IC should be adjusted to 50 Ω in an application. Examples of the RF filter S_{11} whose Z_L is 50 Ω and whose Z_L has moved from 50 Ω are shown in Figure 4-2. Based on the result shown in Figure 4-2, it is assumed that applications with Z_S = Z_L = 50 Ω is optimal.

Employ the following two methods to adjust impedance so that the RF input impedance of 50 Ω can be recognized when this IC is observed from the front stage.

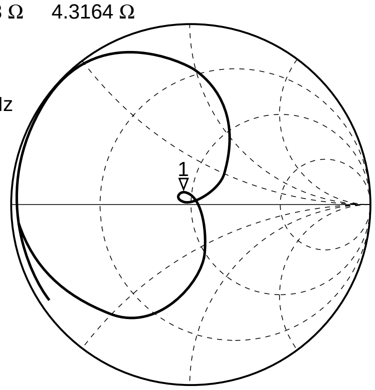
<1> Match with front stage output's impedance (parallel C, series L, and series C)

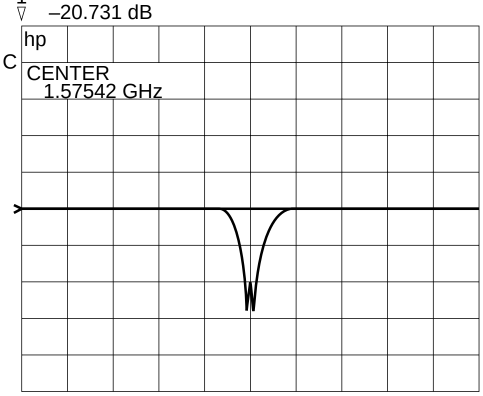
<2> 50-Ω termination with DC cut

Figure 4-3 shows external circuit configurations for these two methods.

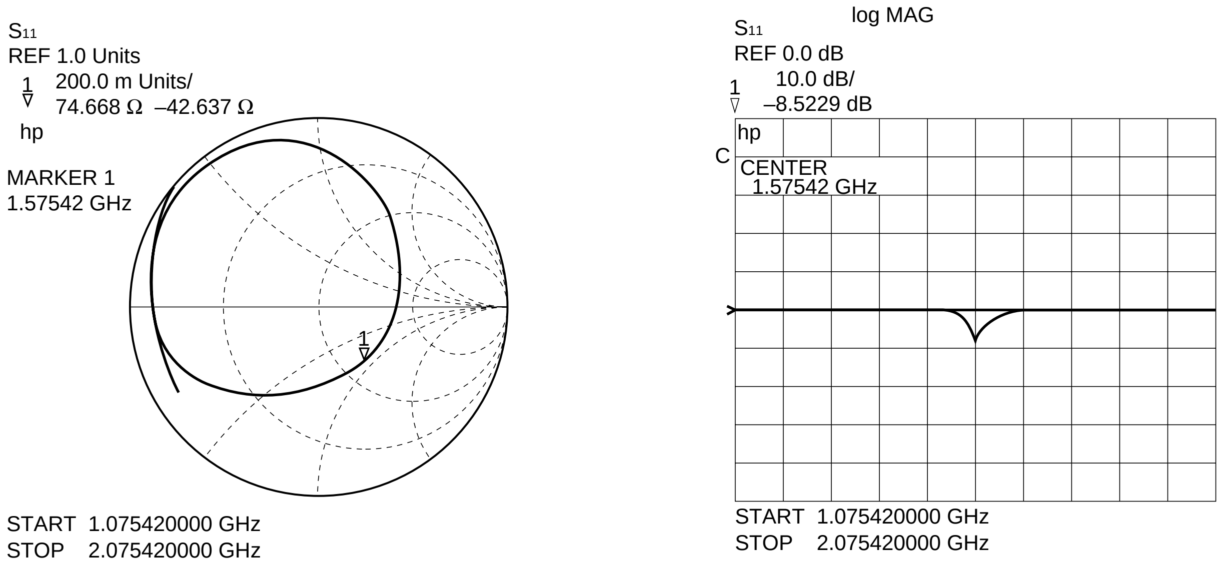
★ **Figure 4-2. Example of S_{11} of RF Filter**

(a) When Z_L = 50 Ω



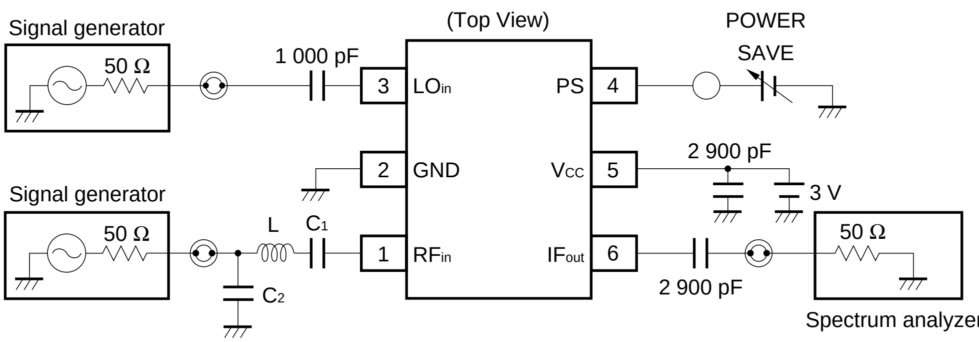


(b) When Z_L = 100 Ω



★ **Figure 4-3. Input Port External Circuit Example (Example of RF Input of μPC2757/58) (1/2)**

Measuring circuit <1> (Matches with front stage output impedance)



Measuring circuit <2> (50-Ω termination with DC cut and 50-Ω front stage output)

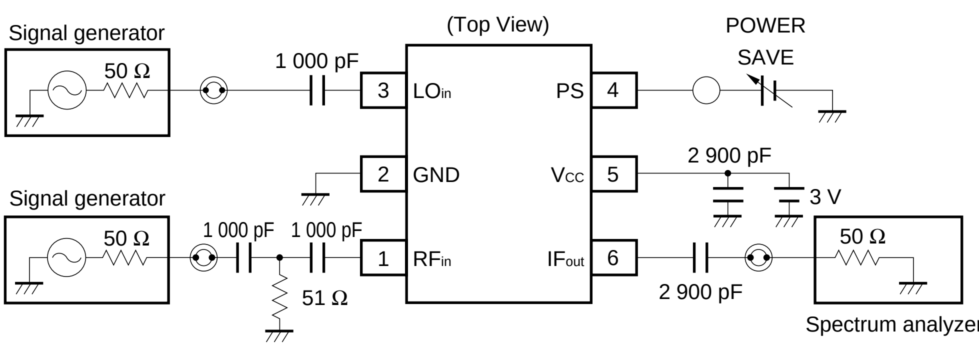
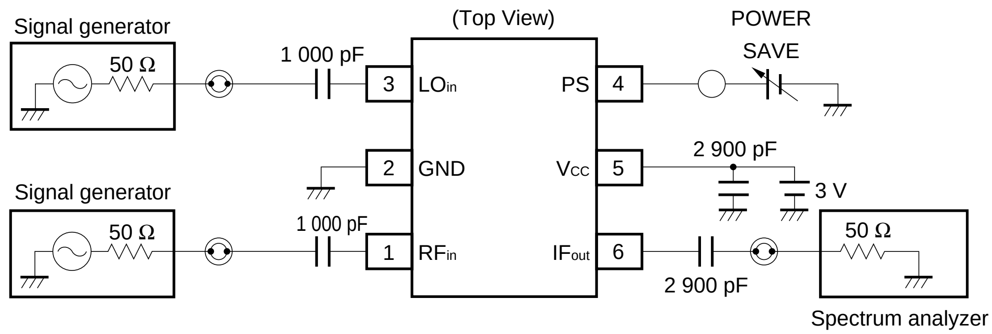


Figure 4-3. Input Port External Circuit Example (Example of RF Input of μPC2757/58) (2/2)

Measuring circuit (Measuring circuit of data sheet)



4.2 Output Pin Connection with Secondary Stage

(1) Internal circuitry of output circuit

The μPC2757 and μPC2758 have emitter-follower type IF outputs with low impedance in relation to 50 Ω. The μPC8112 has an open collector type output with high impedance in relation to 100 MHz to 300 MHz.

When the input impedance of an IF/SAW filter connected to the next stage is high (from 300 to 900 Ω), such as in digital mobile communications devices, the μPC8112 with its open-collector type output is suitable.

When connected to a 50-Ω impedance such as a buffer amplifier or LC filter, the μPC2757 and μPC2758 with their emitter-follower type IF outputs are suitable.

Although the above should be considered as selection criteria, you can select whichever method better suits your needs. Figure 4-4 shows an internal equivalent circuit of each product and Figure 4-5 shows an external circuit configuration.

Figure 4-4. Internal Equivalent Circuits

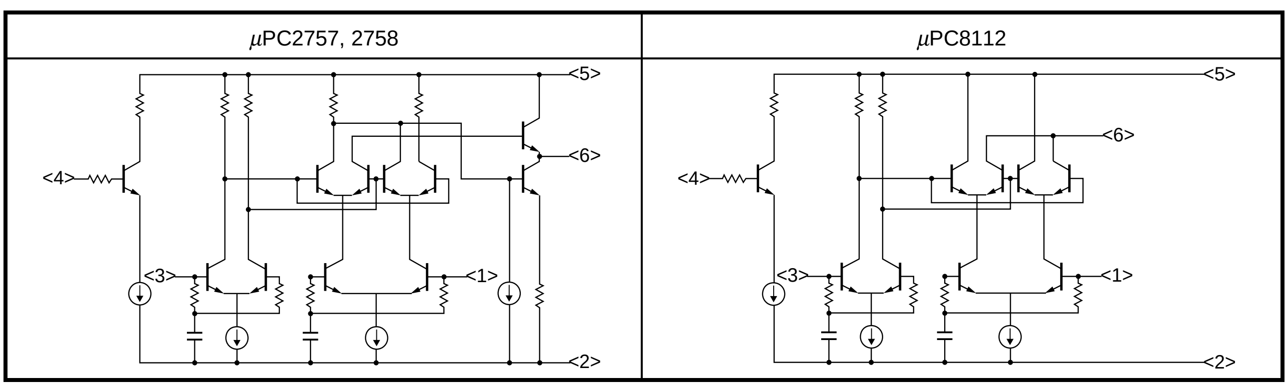
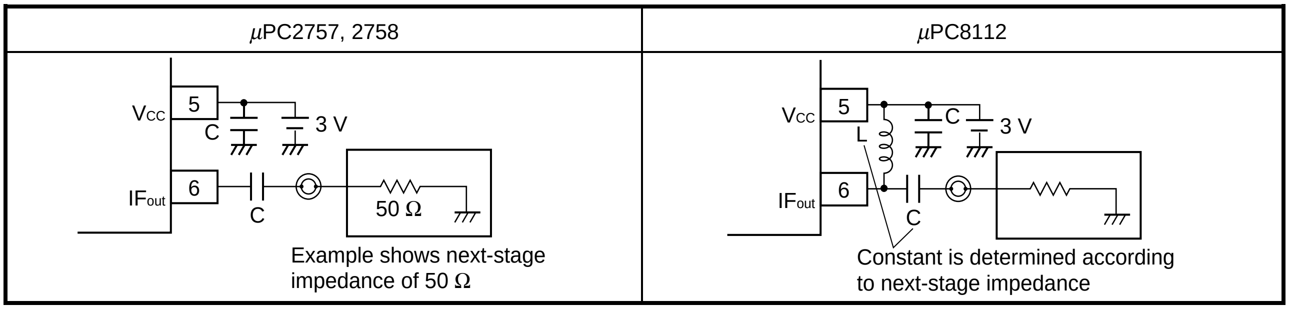


Figure 4-5. External Circuit Configurations for Output Ports



4.3 Description of Application Circuit Characteristics

(1) μPC2757 and μPC2758

Since only the input pins can determine the characteristics for these two product models, this section describes in detail the application characteristics that depend on the input pins' external connections.

Figures 4-6 and 4-7 show measurement results for three measurement conditions affecting the RF input pin: when using the matching method (<1>), when using the 50-Ω termination method (<2>), and when using the data sheet's test circuit. The output intercept point is almost the same no matter which measurement condition is used. However, the matching method's conversion gain value is 5 to 6 dB higher than the corresponding value in the data sheet characteristics and about 4 to 6 dB lower than when using the 50-Ω termination method. Also, variation of IM_3 in the input conversion is worsened when using the matching method (<1>) which multiplies only the IM_3 gradient (ΔIM_3) in relation to input and is improved when using the 50-Ω termination method (<2>).

This behavior occurs when the previous stage's characteristic impedance is 50 Ω (or a value close to 50 Ω), and the characteristics are thought to approximate the data sheet characteristics when there is high impedance.

In the RF input, we recommend using the matching method (<1>) when emphasizing conversion gain pin and we recommend using the 50-Ω termination method (<2>) when emphasizing input conversion distortion. The trade-offs are between improving VSWR and IIP_3 characteristics vs. lowering the CG and worsening the noise figure.

When using either method in the LO input pin, LO input level range of the CG flat or minimum noise figure shifts, so the method should be determined according to your LO input level.

(2) μPC8112

In the μPC8112, connecting an external matching circuit to the IF output pin can optimize the output return loss at the desired IF frequency to about –20 dB to obtain an IP_3 value for output conversion. A high-pass type circuit that includes parallel inductance and serial capacitance is used as the matching circuit configuration. Another objective is to apply a collector bias having the same potential as the V_{CC} to the internal transistors through the parallel inductor.

In this case, varying high-frequency characteristics depend on the circuit Q of the matching circuit. Even if the inductor's Q value is high, such as 60, the load Q is reduced and the desired frequency's output return loss becomes about –20 dB at 3.0 V, which is a gradual S_{22} in relation to the comparative frequency. Figures 4-8 and 4-9 show Smith charts and log MAGs of 100-MHz matching for the IF port. Even when the inductor's Q value is low (such as 20), if load Q becomes high, the desired frequency's output return loss becomes about –27 dB at 3.0 V, which means that the S_{22} is much sharper in the desired frequency and the CG is slightly (about 2 or 3 dB) higher compared to the data sheet's test circuit, which raises the IM_3 level proportionately.

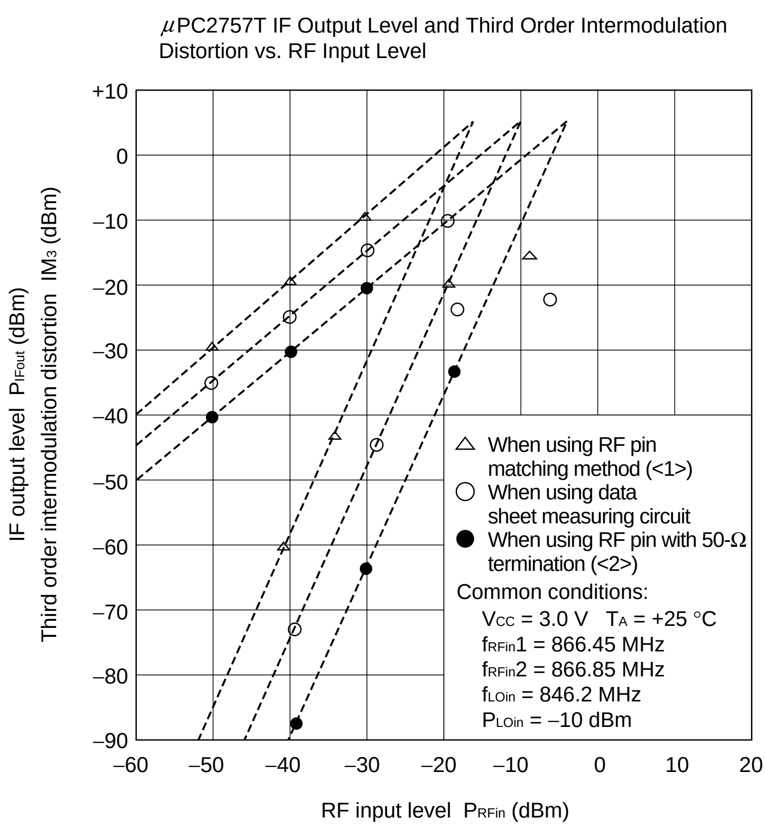
The output intercept point is mainly determined by the supply current from the output pin to the internal components. So, OIP3 is determined by the DC resistance of the inductor, neither Q value nor the load Q value. Consequently, inductor should select lower DC resistance value. The input conversion's IP_3 and IM_3 characteristics are determined by the output intercept point (which is itself determined using DC) and by the CG (which is itself determined using AC).

Any of the RF input pin's external circuit types can be determined based on whether the system's emphasis is on the CG or the input IP_3. Variation in characteristics according to the input pin's external components is similar in the μPC2757 and μPC2758. As an example of the S parameter for an RF input port with 50-Ω termination, refer to the Smith chart and log MAG chart shown in Figures 4-10 and 4-11. Thus, the VSWR can be improved by such an external connection.

These application circuits are implemented using RF-type external components and there is no change in the characteristics of DC-related items.

In the growing of systems such as digital mobile communications in which input conversion distortion is emphasized, this document shows data for each product model measured on circuits with RF 50-Ω termination as reference data for application circuit characteristics. Figures 4-12 and 4-13 show the corresponding performance curves and Tables 4-1 and 4-2 list the characteristics.

Figure 4-6. μPC2757T: Comparison of Characteristics from External Circuit Connection to RF Pin (Using Circuit from Figure 4-3)



★ **Figure 4-7. Comparison of Characteristics from External Circuit Connection to RF Pin (Super mini mold) (1/2)**

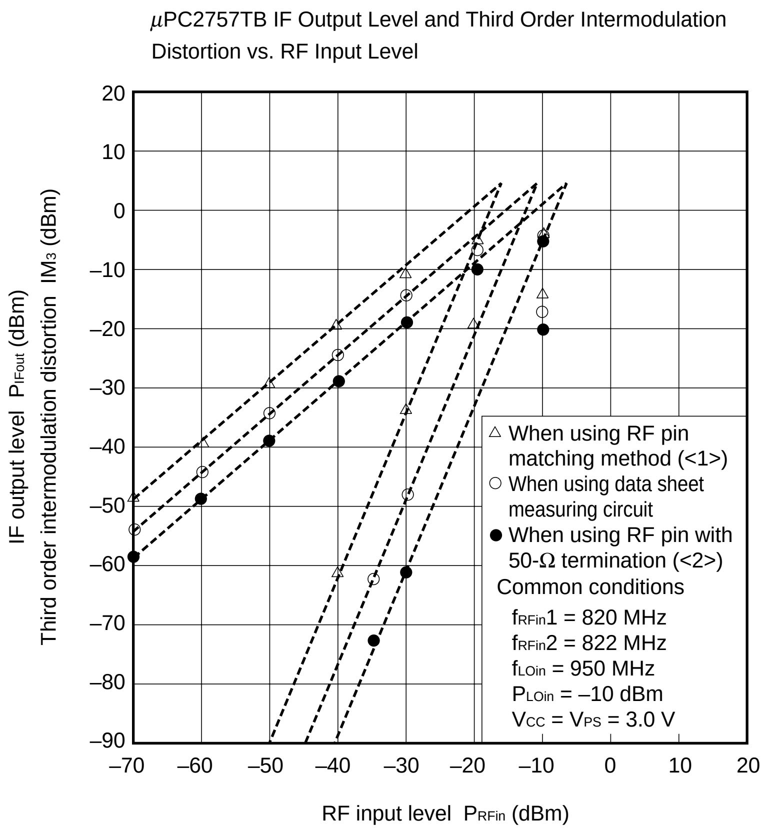
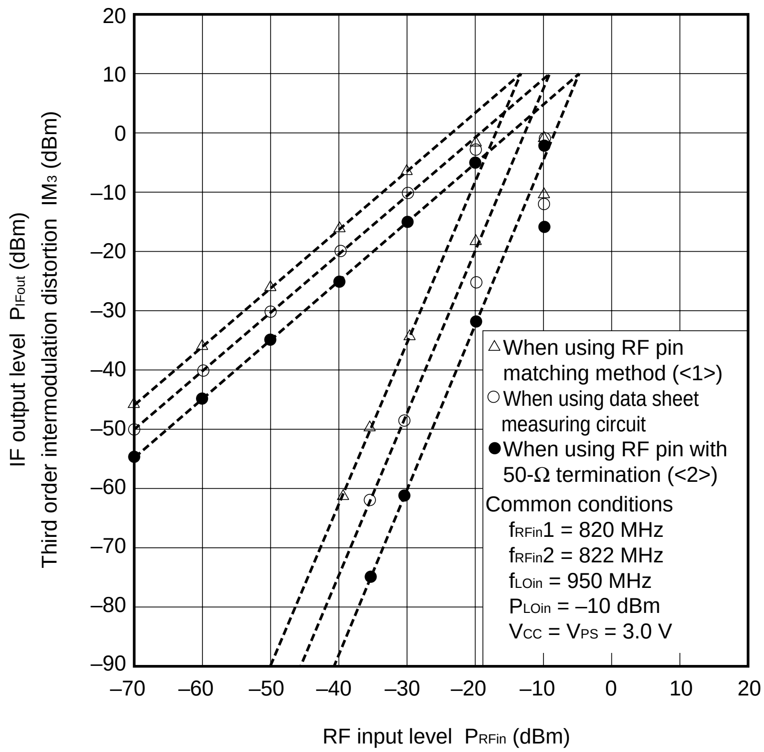


Figure 4-7. Comparison of Characteristics from External Circuit Connection to RF Pin (Super mini mold) (2/2)

μPC2758TB IF Output Level and Third Order Intermodulation Distortion vs. RF Input Level



μPC8112TB IF Output Level and Third Order Intermodulation Distortion vs. RF Input Level

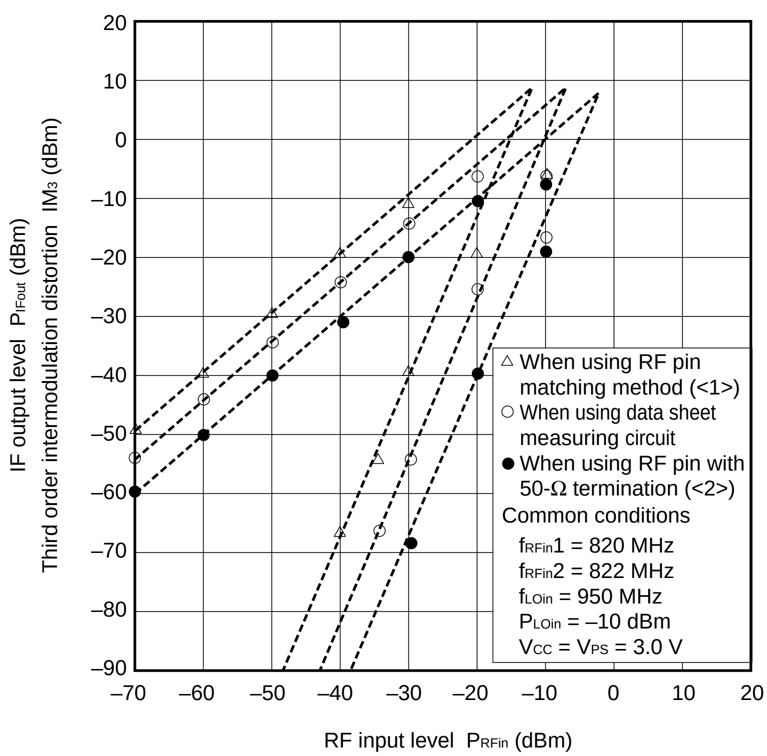
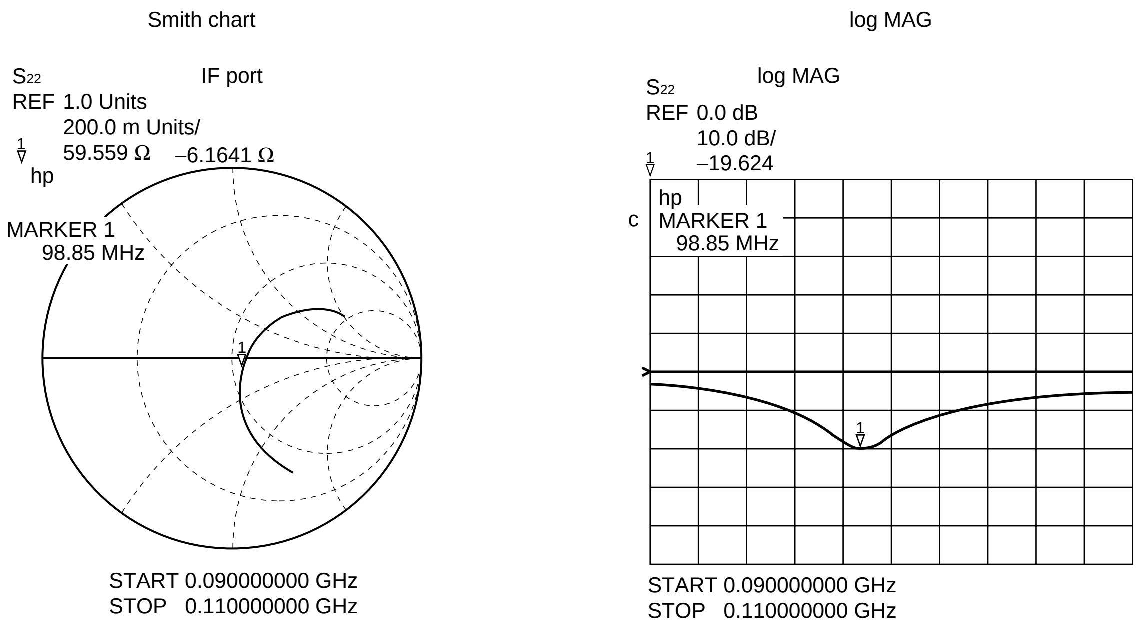


Figure 4-8. μPC8112T: 100-MHz Matching of IF Port



★ **Figure 4-9. μPC8112TB: 100-MHz Matching of IF Port**

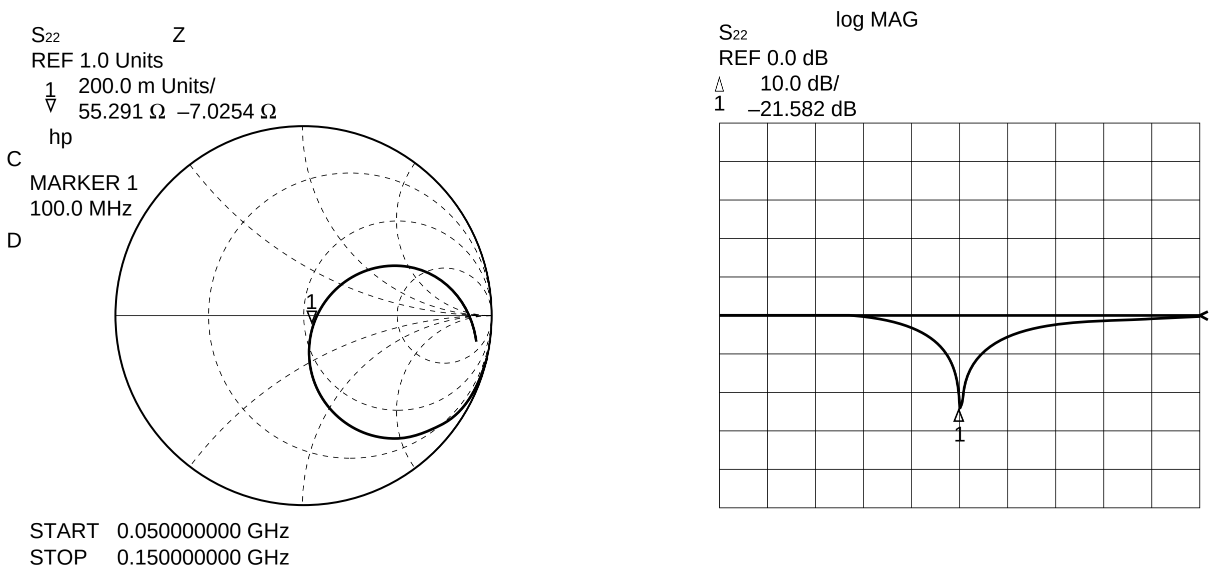
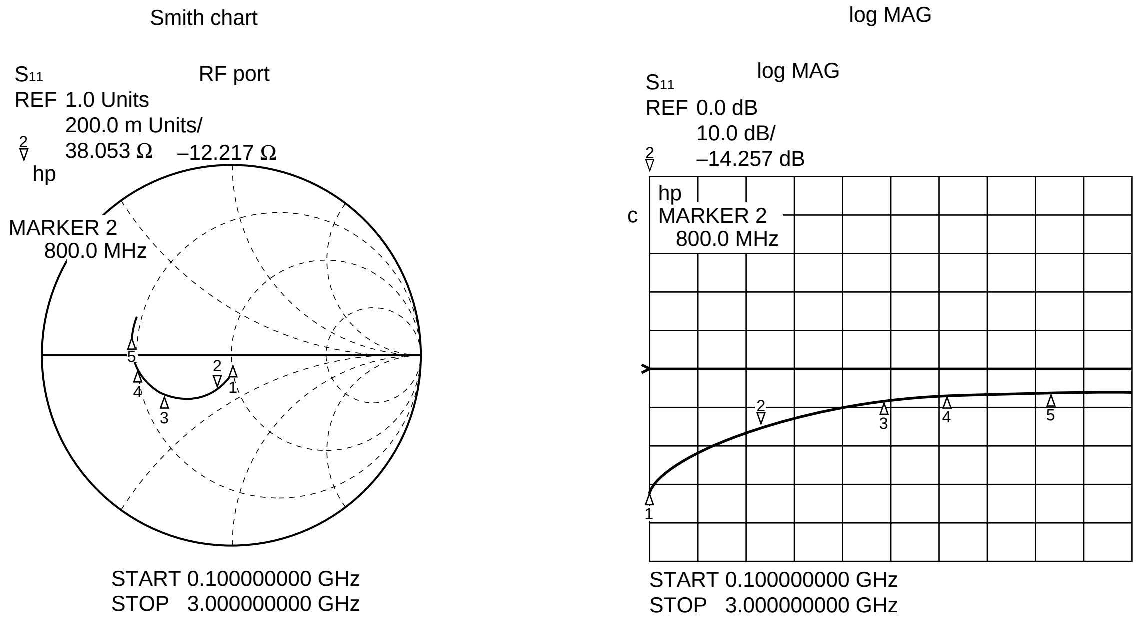


Figure 4-10. μPC8112T: 50-Ω Termination of RF Port



★ **Figure 4-11. μPC8112TB: 50-Ω Termination of RF Port**

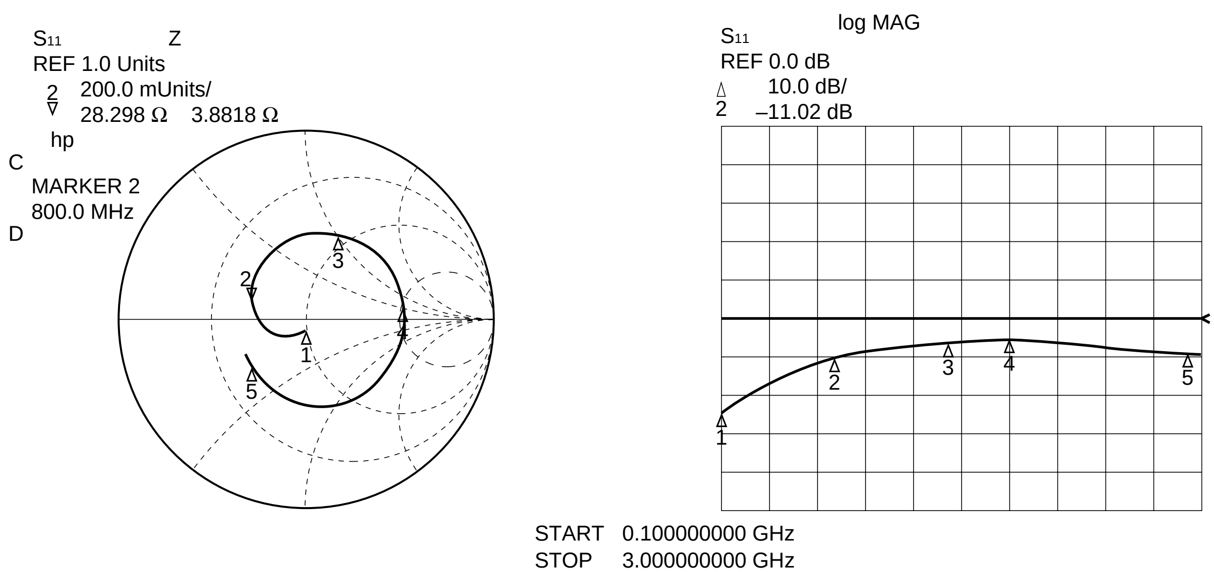


Table 4-1. Measured Characteristics using Application Circuit with 50-Ω termination of RF Port (mini mold)

(T_A = +25°C, V_{CC} = V_{PS} = 3.0 V, P_{LOin} = –10 dBm unless otherwise specified)

Item	Symbol	Condition	μPC2757T	μPC8112T	μPC2758T	Unit
Conversion gain	CG	f_{RFin} = 820 MHz, f_{IFout} = 130 MHz	10.5	11.5	13.8	dB
		f_{RFin} = 1489 MHz, f_{IFout} = 130 MHz	11.7	9.6	15.0	
		f_{RFin} = 1900 MHz, f_{IFout} = 240 MHz	11.7	9.5	15.0	
SSB noise figure	SSB • NF	f_{RFin} = 820 MHz, f_{IFout} = 130 MHz	14.1	14.6	13.1	dB
		f_{RFin} = 1489 MHz, f_{IFout} = 130 MHz	14.4	15.2	14.1	
		f_{RFin} = 1900 MHz, f_{IFout} = 240 MHz	13.8	14.7	13.1	
Third-order intermodulation distortion level (when P_{RFin} = –40 dBm)	IM_3	f_{RFin} = 820/822 MHz, f_{IFout} = 130 MHz	–90.0	–92.5	–88.1	dBm
		f_{RFin} = 1489/1491 MHz, f_{IFout} = 130 MHz	–87.5	–96.5	–87.5	
		f_{RFin} = 1900/1902 MHz, f_{IFout} = 240 MHz	–86.7	–94.2	–85.3	
Calculated value for input third-order distortion intercept point	IIP_3	f_{RFin} = 820/822 MHz, f_{IFout} = 130 MHz	–6.0	–5.5	–5.6	dBm
		f_{RFin} = 1489/1491 MHz, f_{IFout} = 130 MHz	–7.1	–4.3	–5.7	
		f_{RFin} = 1900/1902 MHz, f_{IFout} = 240 MHz	–7.6	–4.6	–6.9	
DUT's circuit current	I_{CC}	Without signal	5.3	7.4	8.9	mA

Cautions 1. (Above models)

- **Measurements of f_{RFin} = 820 MHz and f_{RFin} = 1489 MHz are upper local**
- **Measurement of f_{RFin} = 1900 MHz is lower local**
- **The measured value for IIP_3 (shown on the right side of the equation) is calculated based on the logical expression shown below. (ΔIM_3 is the IM_3 gradient when the measurement uses a P_{RFin} value from –40 dBm to –35 dBm. In this measurement, ΔIM_3 = 2.80).**

$$IIP_3 = \frac{\Delta IM_3 \times P_{RFin} + CG - IM_3}{\Delta IM_3 - 1} \text{ (dBm)}$$

- **This data should be used only as reference values, since the magnitude of VSWR improvement depends on the parasitic inductance and capacitance of the RF pattern into which external components inserted and the external components itself.**

2. (μPC8112T only)

- **LO input level P_{LOin} = –7 dBm only for f_{RFin} = 820 MHz (±10 MHz) case.**
- **While f_{IFout} = 130 MHz in other product models, in this product model f_{IFout} = 100 MHz (due to stricter measurement conditions similar to circuits in which characteristics are guaranteed in the data sheet)**

★ **Table 4-2. Measured Characteristics using Application Circuit with 50-Ω termination of RF Port (super mini mold)**

(T_A = +25°C, V_{CC} = V_{PS} = 3.0 V, P_{LOin} = –10 dBm unless otherwise specified)

Item	Symbol	Condition	μPC2757TB	μPC2758TB	μPC8112TB	Unit
Conversion gain	CG	f_{RFin} = 820 MHz, f_{IFout} = 130 MHz	10.3	14.3	15.0	dB
		f_{RFin} = 1489 MHz, f_{IFout} = 130 MHz	12.3	16.7	13.2	
		f_{RFin} = 1900 MHz, f_{IFout} = 240 MHz	12.2	16.2	10.0	
SSB noise figure	SSB • NF	f_{RFin} = 820 MHz, f_{IFout} = 130 MHz	14.0	13.9	13.2	dB
		f_{RFin} = 1489 MHz, f_{IFout} = 130 MHz	14.0	14.0	14.8	
		f_{RFin} = 1900 MHz, f_{IFout} = 240 MHz	13.9	13.7	14.5	
Third-order intermodulation distortion level (when P_{RFin} = –40 dBm)	IM_3	f_{RFin} = 820/822 MHz, f_{IFout} = 130 MHz	–90.9	–89.7	–94.8	dBm
		f_{RFin} = 1489/1491 MHz, f_{IFout} = 130 MHz	–88.8	–86.5	–96.2	
		f_{RFin} = 1900/1902 MHz, f_{IFout} = 240 MHz	–89.1	–86.7	–98.0	
Calculated value for input third-order distortion intercept point	IIP_3	f_{RFin} = 820/822 MHz, f_{IFout} = 130 MHz	–8.3	–5.5	–3.7	dBm
		f_{RFin} = 1489/1491 MHz, f_{IFout} = 130 MHz	–8.4	–6.0	–4.8	
		f_{RFin} = 1900/1902 MHz, f_{IFout} = 240 MHz	–5.7	–6.2	–6.7	
DUT's circuit current	I_{CC}	Without signal	5.6	10.7	8.5	mA

Cautions 1. (Above models)

- **Measurements of f_{RFin} = 820 MHz and f_{RFin} = 1489 MHz are upper local**
- **Measurement of f_{RFin} = 1900 MHz is lower local**
- **The measured value for IIP_3 (shown on the right side of the equation) is calculated based on the logical expression shown below.**

$$IIP_3 = \frac{\Delta IM_3 \times P_{RFin} + CG - IM_3}{\Delta IM_3 - 1} \text{ (dBm)}$$

- **This data should be used only as reference values, since the magnitude of VSWR improvement depends on the parasitic inductance and capacitance of the RF pattern into which external components inserted and the external components itself.**

2. (μPC8112TB only)

- **While f_{IFout} = 130 MHz in other product models, in this product model f_{IFout} = 100 MHz (due to stricter measurement conditions similar to circuits in which characteristics are guaranteed in the data sheet)**

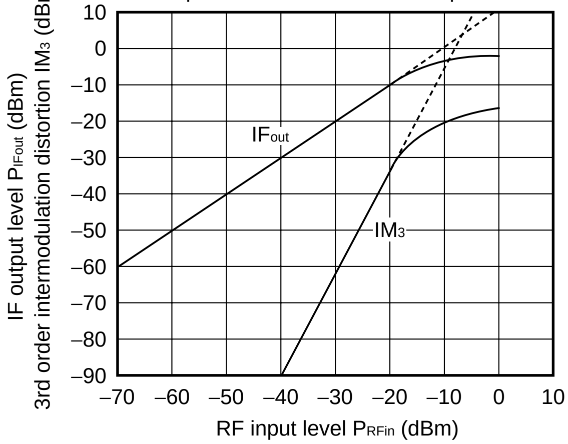
Figure 4-12. Application Circuit Characteristics of Mini-Mold Products (Using Circuit with RF 50-Ω Termination)

T_A = +25°C, V_{CC} = V_{PS} = 3.0 V (μPC8112T only: V_{CC} = V_{PS} = V_{IFout} = 3.0 V)

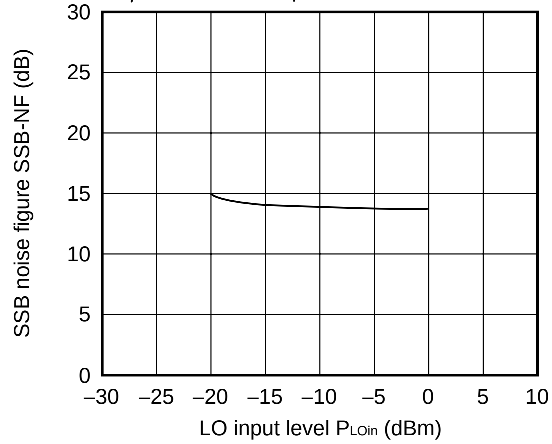
<1> $f_{RFin}1$ = 820 MHz, $f_{RFin}2$ = 822 MHz and, unless otherwise specified, f_{IFout} = 130 MHz, P_{LOin} = –10 dBm

μPC2757T

RF Input Level vs. IM3 and IF Output Level

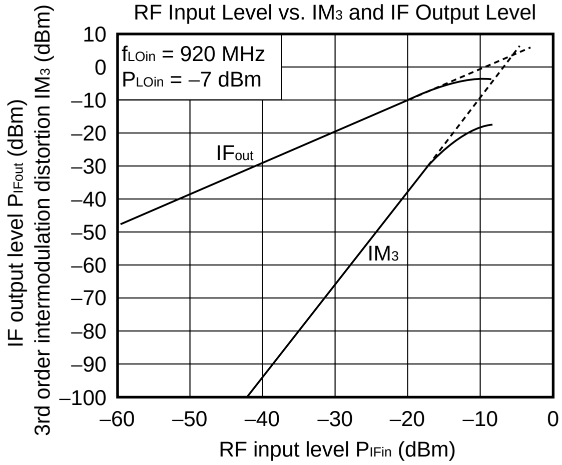


μPC2757T LO Input Level vs. SSB NF

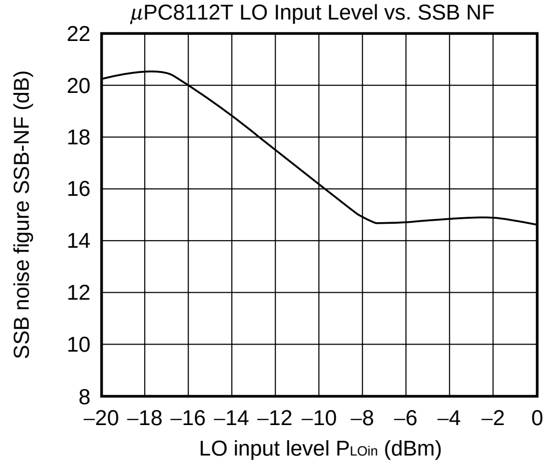


μPC8112T

RF Input Level vs. IM3 and IF Output Level

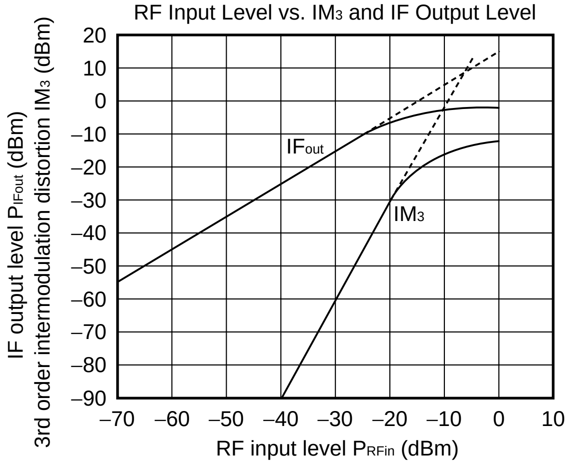


μPC8112T LO Input Level vs. SSB NF

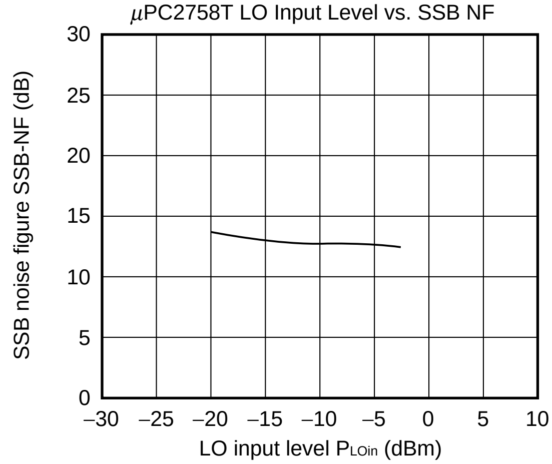


μPC2758T

RF Input Level vs. IM3 and IF Output Level

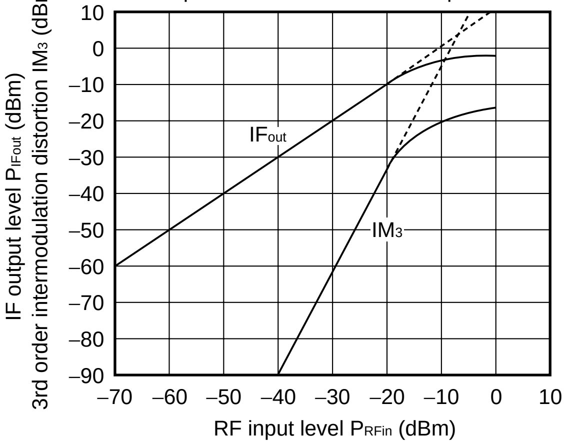


μPC2758T LO Input Level vs. SSB NF

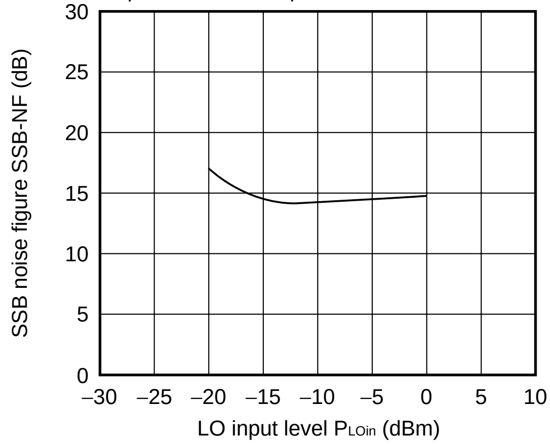


<2> $f_{RFin}1$ = 1489 MHz, $f_{RFin}2$ = 1491 MHz and, unless otherwise specified, f_{IFout} = 130 MHz, P_{LOin} = –10 dBm

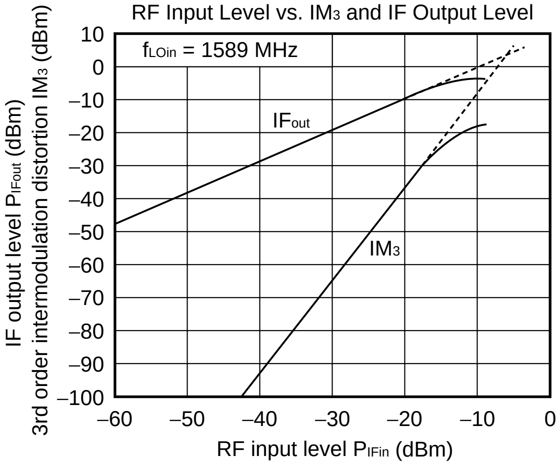
μPC2757T
RF Input Level vs. IM3 and IF Output Level



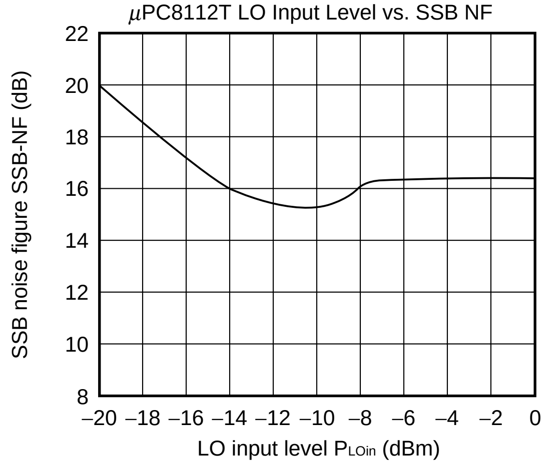
μPC2757T LO Input Level vs. SSB NF



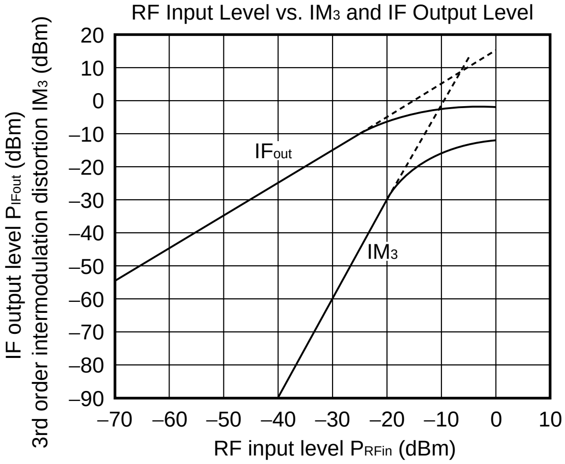
μPC8112T
RF Input Level vs. IM3 and IF Output Level



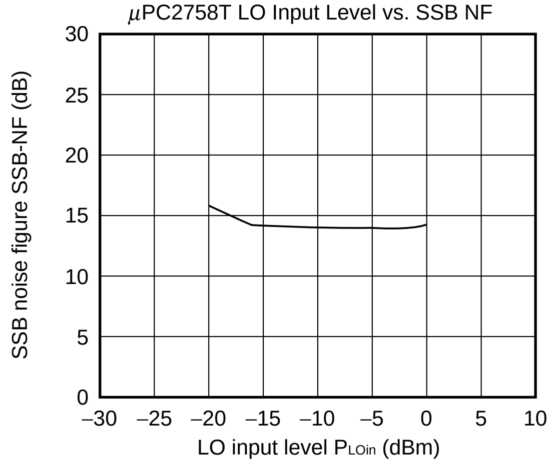
μPC8112T LO Input Level vs. SSB NF



μPC2758T
RF Input Level vs. IM3 and IF Output Level

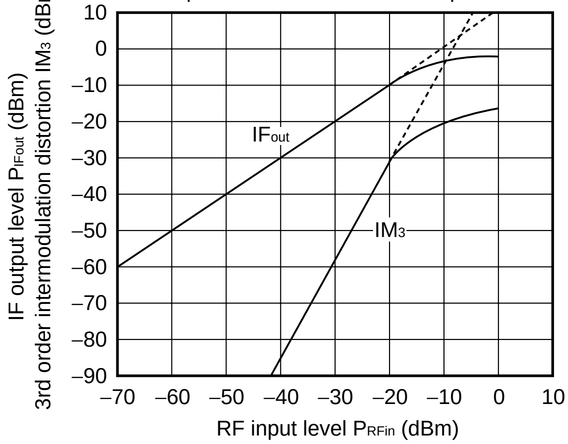


μPC2758T LO Input Level vs. SSB NF

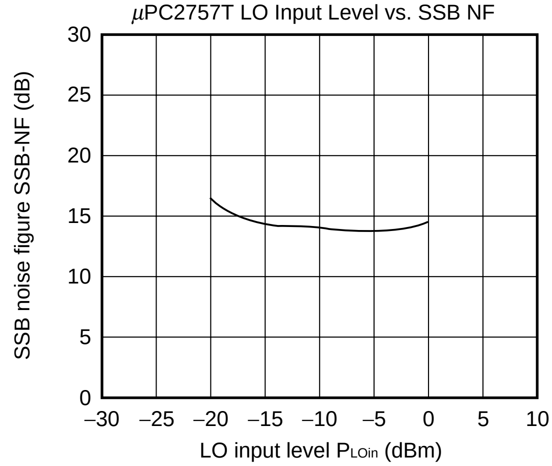


<3> $f_{RFin}1$ = 1900 MHz, $f_{RFin}2$ = 1902 MHz and f_{IFout} = 240 MHz, P_{LOin} = –10 dBm

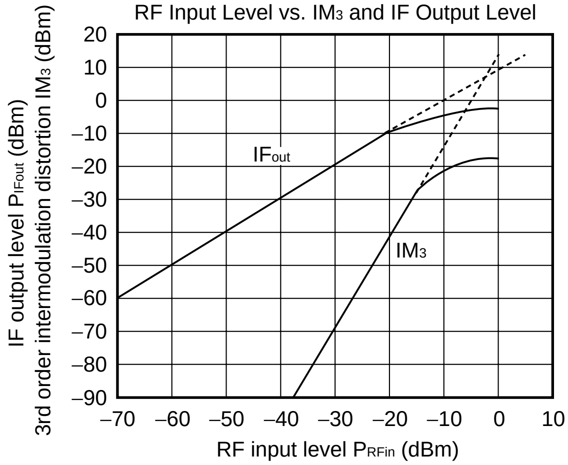
μPC2757T
RF Input Level vs. IM3 and IF Output Level



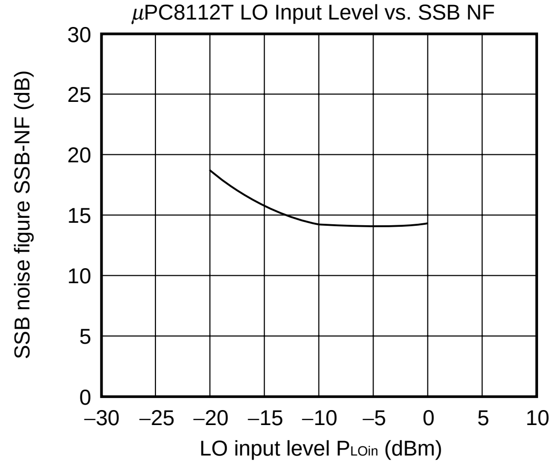
μPC2757T LO Input Level vs. SSB NF



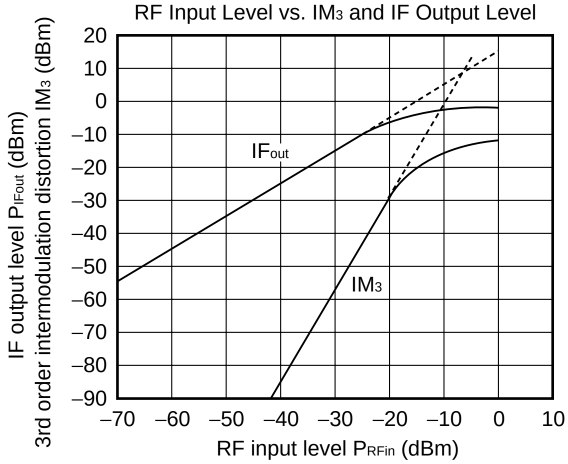
μPC8112T
RF Input Level vs. IM3 and IF Output Level



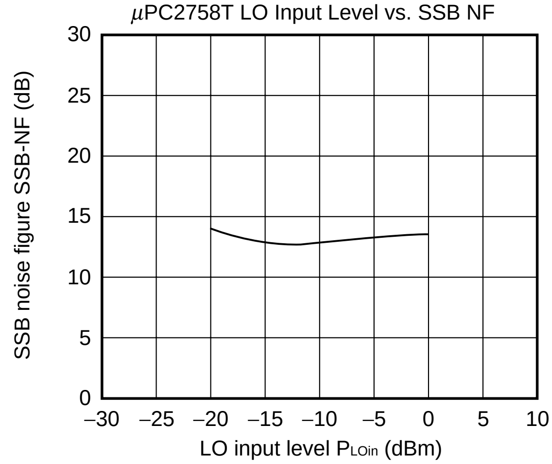
μPC8112T LO Input Level vs. SSB NF



μPC2758T
RF Input Level vs. IM3 and IF Output Level



μPC2758T LO Input Level vs. SSB NF



★

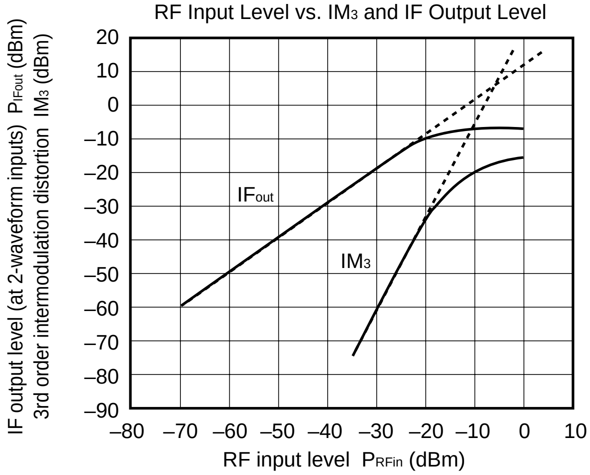
Figure 4-13. Application Circuit Characteristics of Super Mini-Mold Products (Using Circuit with RF 50-Ω Termination)

T_A = +25°C, V_{CC} = V_{PS} = 3.0 V (μPC8112TB only: V_{CC} = V_{PS} = V_{IFout} = 3.0 V)

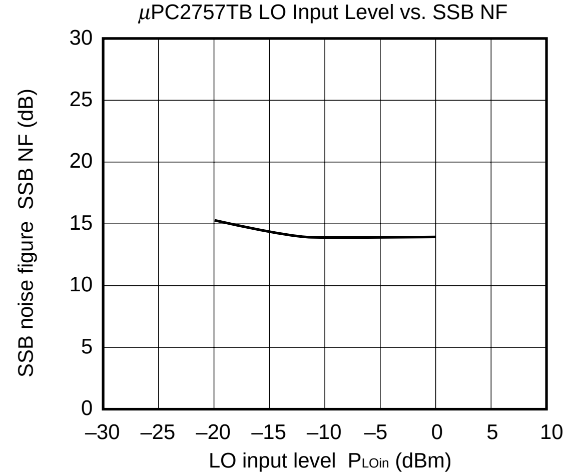
<1> $f_{RFin}1$ = 820 MHz, $f_{RFin}2$ = 822 MHz, P_{LOin} = –10 dBm, f_{IFout} = 130 MHz (μPC8112TB only: f_{IFout} = 100 MHz)

μPC2757TB

RF Input Level vs. IM3 and IF Output Level

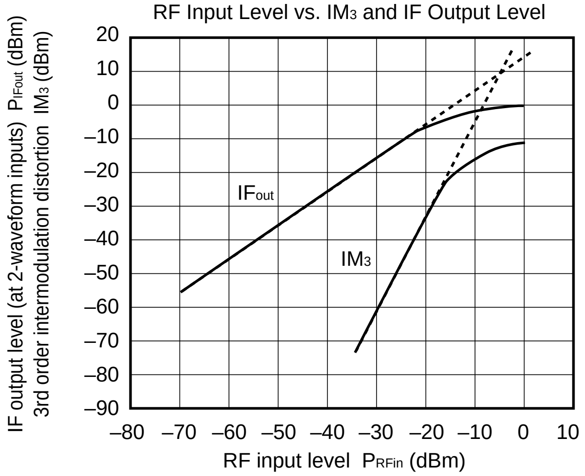


μPC2757TB LO Input Level vs. SSB NF

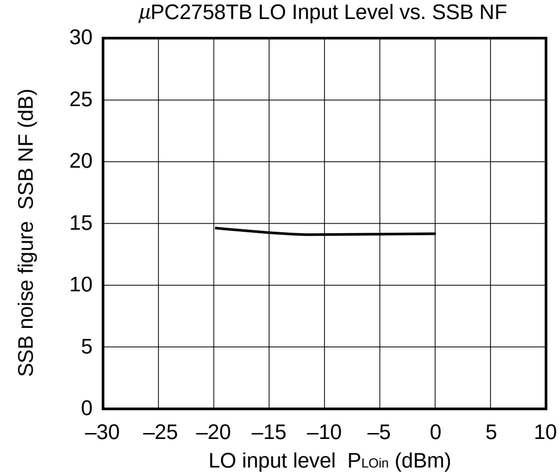


μPC2758TB

RF Input Level vs. IM3 and IF Output Level

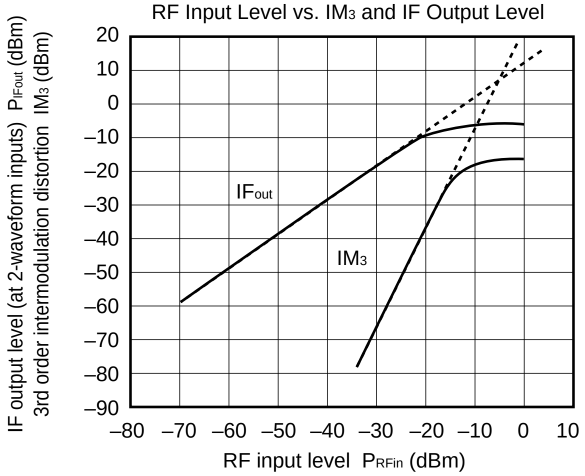


μPC2758TB LO Input Level vs. SSB NF

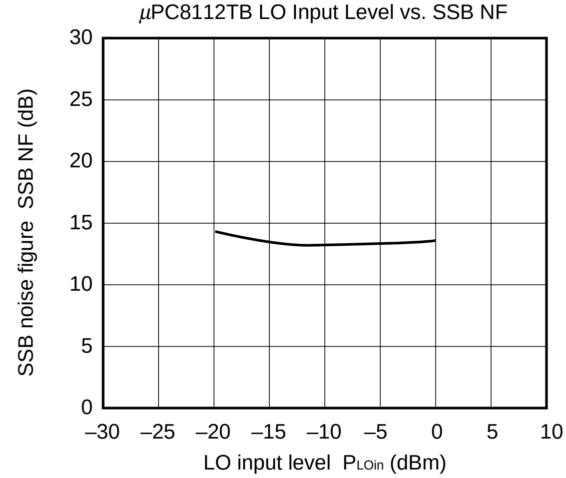


μPC8112TB

RF Input Level vs. IM3 and IF Output Level



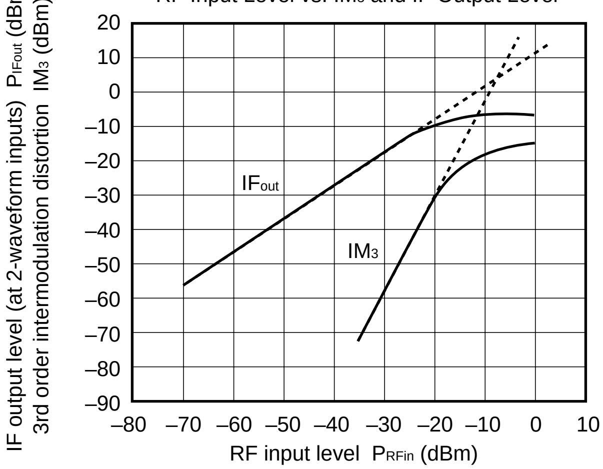
μPC8112TB LO Input Level vs. SSB NF



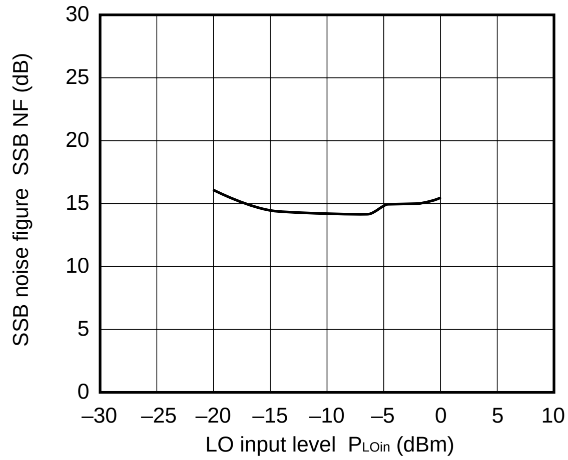
<2> $f_{RFin}1$ = 1489 MHz, $f_{RFin}2$ = 1491 MHz, P_{LOin} = –10 dBm, f_{IFout} = 130 MHz (μPC8112TB only: f_{IFout} = 100 MHz)

μPC2757TB

RF Input Level vs. IM3 and IF Output Level

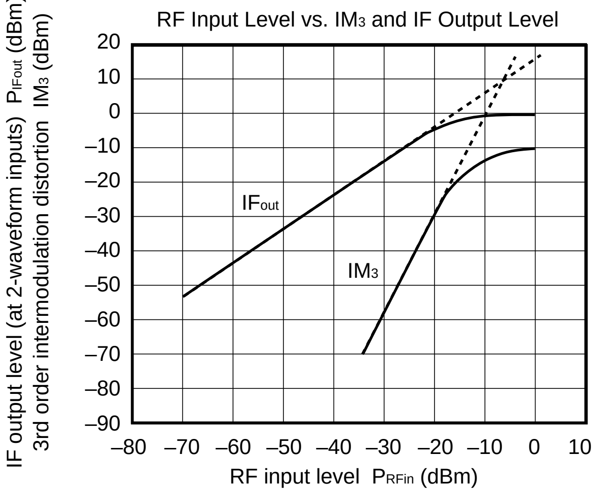


μPC2757TB LO Input Level vs. SSB NF

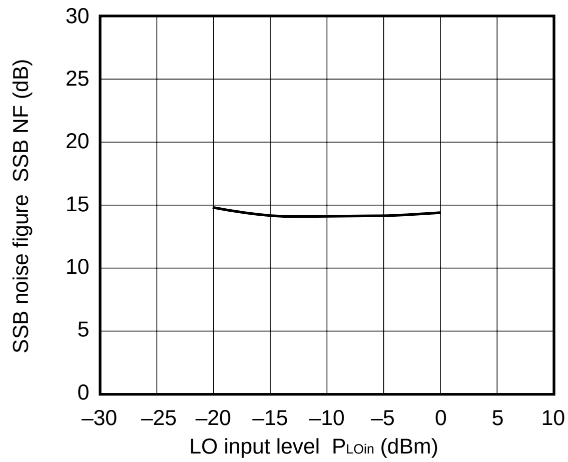


μPC2758TB

RF Input Level vs. IM3 and IF Output Level

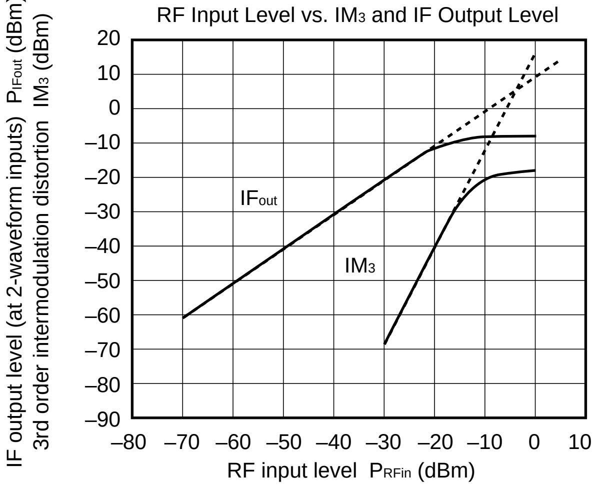


μPC2758TB LO Input Level vs. SSB NF

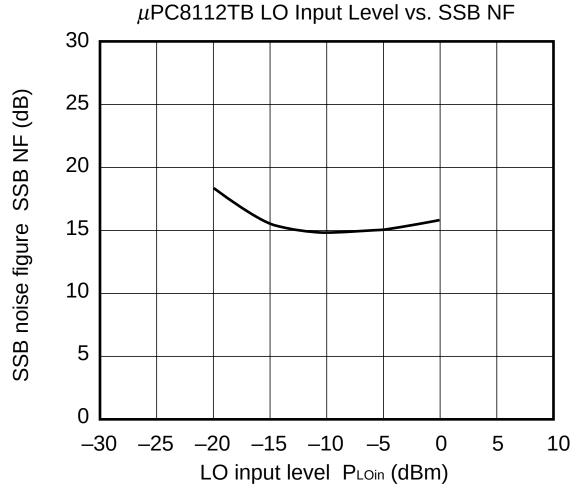


μPC8112TB

RF Input Level vs. IM3 and IF Output Level



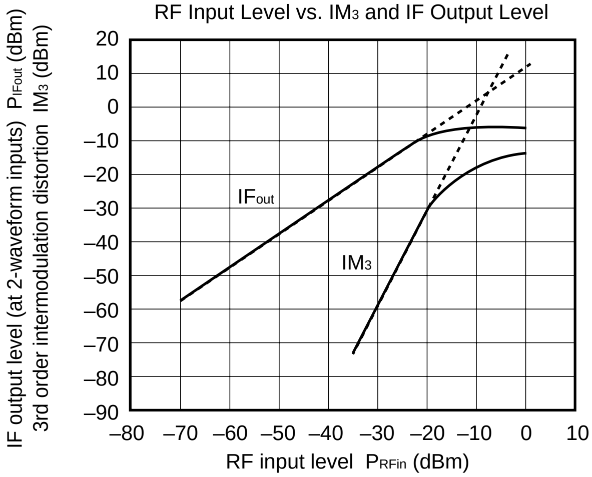
μPC8112TB LO Input Level vs. SSB NF



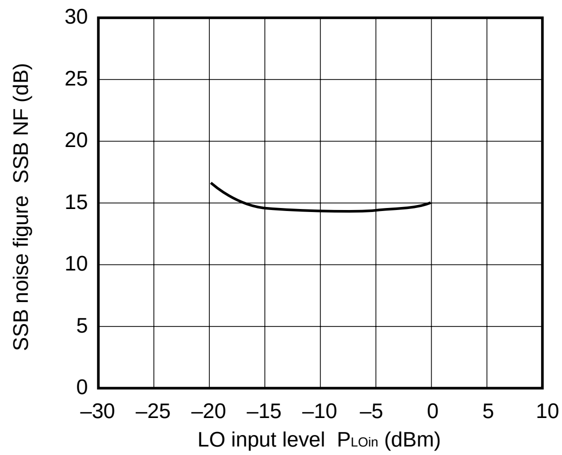
<3> $f_{RFin}1$ = 1900 MHz, $f_{RFin}2$ = 1902 MHz, P_{LOin} = –10 dBm, f_{IFout} = 240 MHz

μPC2757TB

RF Input Level vs. IM3 and IF Output Level

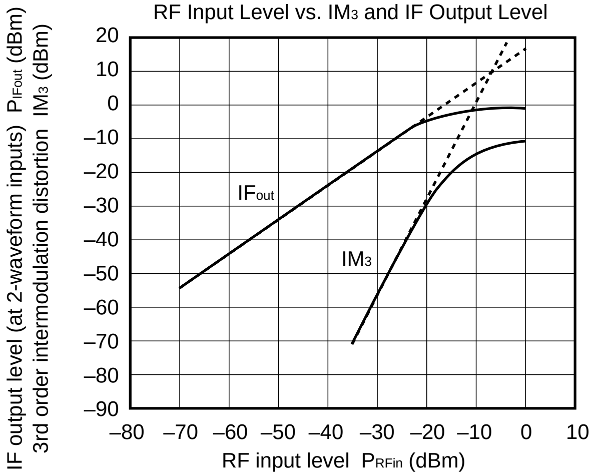


μPC2757TB LO Input Level vs. SSB NF

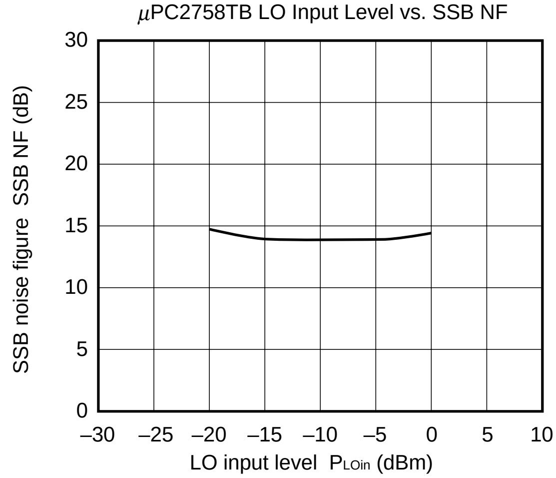


μPC2758TB

RF Input Level vs. IM3 and IF Output Level

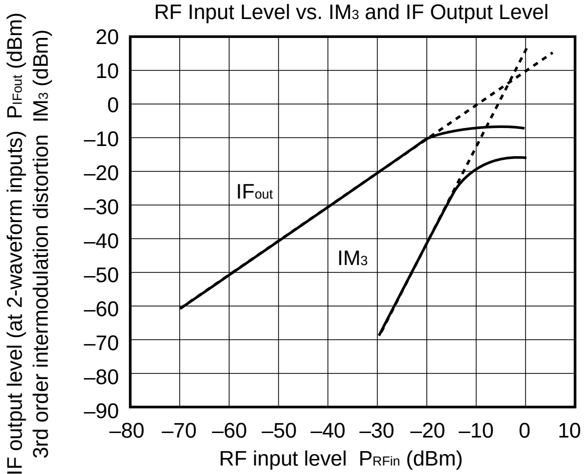


μPC2758TB LO Input Level vs. SSB NF



μPC8112TB

RF Input Level vs. IM3 and IF Output Level



μPC8112TB LO Input Level vs. SSB NF

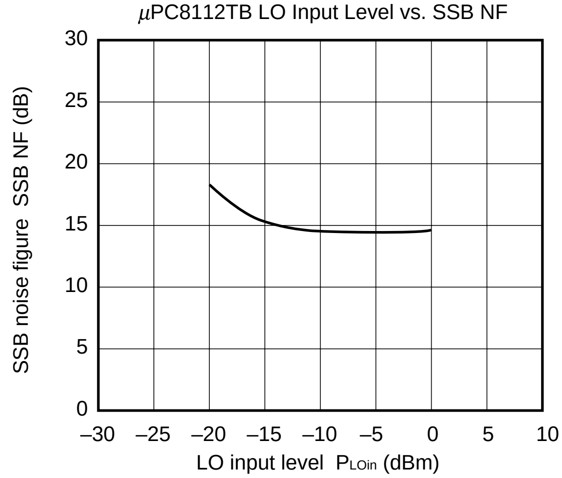
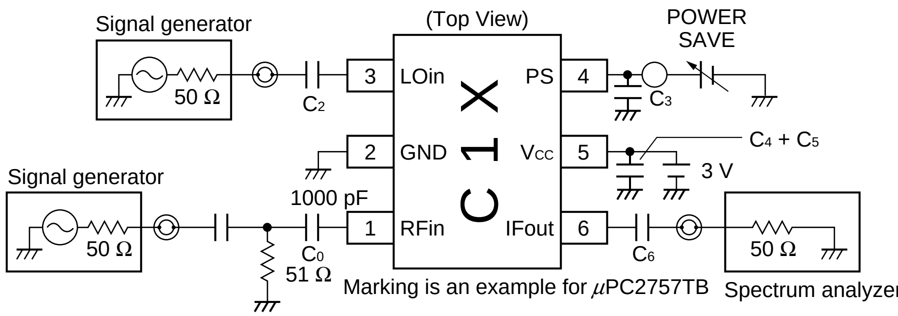
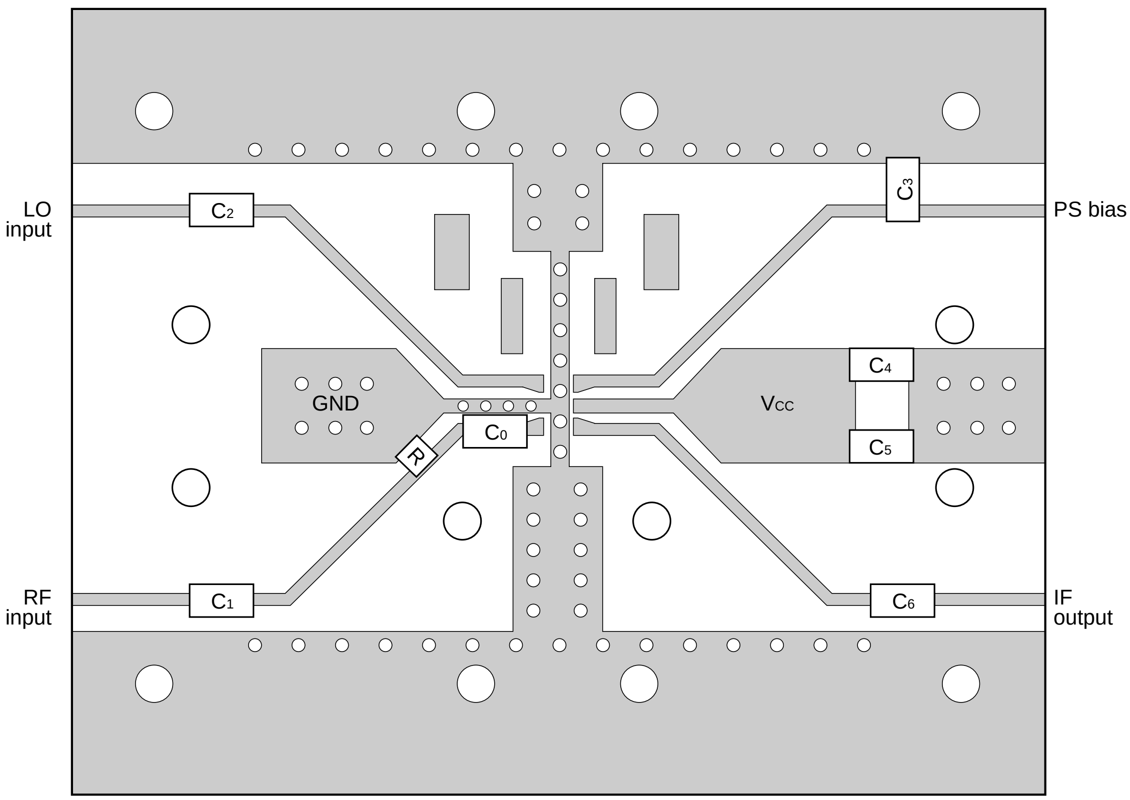


Figure 4-14. Test Circuit of Application Circuit Characteristics

(a-1) μPC2757, 2758

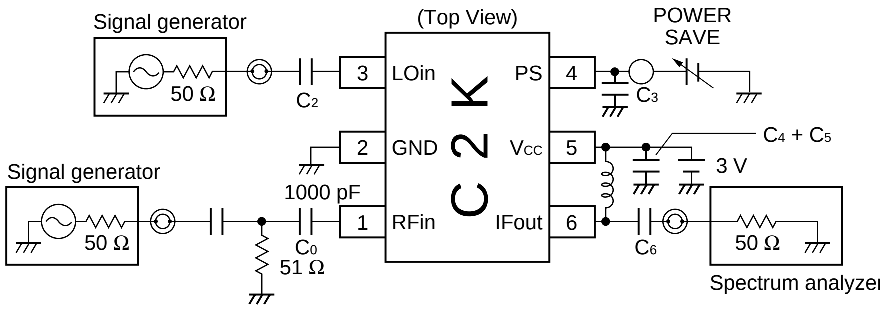


(a-2) PCB for μPC2757 and 2758

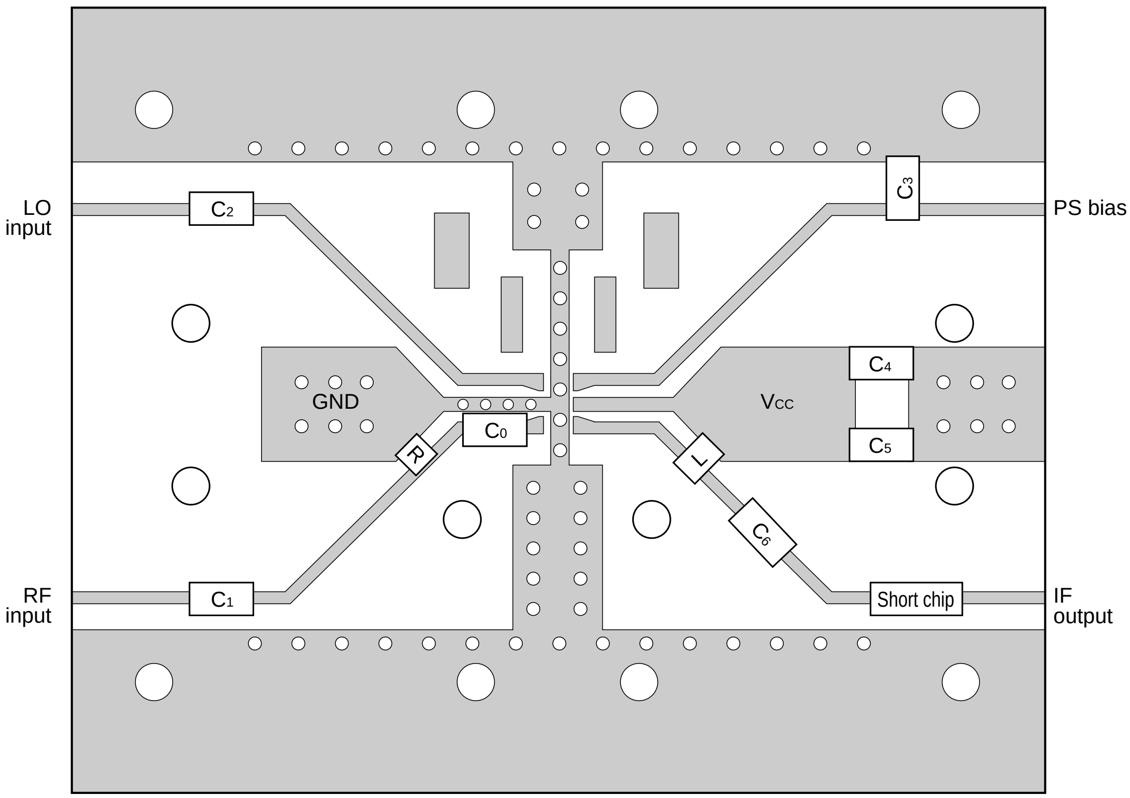


Caution The patterns of PCBs for mini-mold products (T) and super mini-mold products (TB) are same except for the intervals of the IC-pin setting blocks (The above diagram shows the super mini-mold PCB).

(b-1) μPC8112



(b-2) PCB for μPC8112



Caution The patterns of PCBs for mini-mold products (T) and super mini-mold products (TB) are same except for the intervals of the IC-pin setting blocks (The above diagram shows the super mini-mold PCB).

Notes concerning PCB

- NEC employs a polyimide double-sided PCB to reduce PCB-related loss and maximize the performance of the IC itself.
- The through holes ensure proper grounding.
- Specification PCB dimensions: 35 × 42 × 0.4 (mm), with 35-μm thick copper patterning on both sides
  Other specifications are the same as in the data sheets.

Parts Table

Mini-mold products

	μPC2757T, 2758T	μPC8112T	
		With IF 100-MHz matching[Note]	With IF 240-MHz matching[Note]
C_0 to C_5	MURATA GMR39: 1000 pF	MURATA GMR39: 1000 pF	MURATA GMR39: 1000 pF
L	None	MURATA LQH1NR33 Coil chip inductor: 330 nH	TOKO LL2012-F82N Multilayer chip inductor: 82 nH
C_6	MURATA GMR39: 3000 pF	MURATA GMR39: 5 pF	American Technical Ceramics: approximately 2 pF
R	MURATA: 51 Ω	MURATA: 51 Ω	MURATA: 51 Ω

★ **Super mini-mold products**

	μPC2757TB, 2758TB	μPC8112TB	
		With IF 100-MHz matching[Note]	With IF 240-MHz matching[Note]
C_0 to C_5	MURATA GMR39: 1000 pF	MURATA GMR39: 1000 pF	MURATA GMR39: 1000 pF
L	None	TDK NL252018-R33K Leadless inductor: 330 nH	TOKO LL2010-F100N Multilayer chip inductor: 100 nH
C_6	MURATA GMR39: 2700 pF, 200 pF	MURATA GMR39: 5 pF	MURATA GMR39: 2 pF
R	MURATA: 51 Ω	MURATA: 51 Ω	MURATA: 51 Ω

Note While the external circuitry (including the board pattern's parasitic parameters) matches (at 50 Ω) the IF port with the desired IF frequency, S_{22} is optimized as –20 dB. (In this test, a network analyzer was used to monitor the Smith chart and log MAG while the circuit was being adjusted. Any manufacturer's component can work when S_{22} is optimized to –20 dB.)

5. SYSTEM APPLICATION EXAMPLES

The following block diagrams are system examples of these ICs, based on our customer's actual design-in, the system's required characteristics, etc.

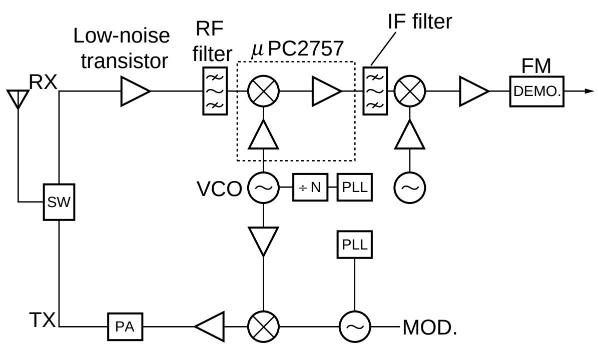
- Analog cellular or cordless telephone (CT1^{+}, etc.): μPC2757
- Digital cellular or cordless telephone (PDC, CT2, DECT, etc.): μPC2758
- Digital cellular or cordless mobile telephone (PHS, PDC, etc.): μPC8112

The above are just examples: selections can be based on your set's design specifications.

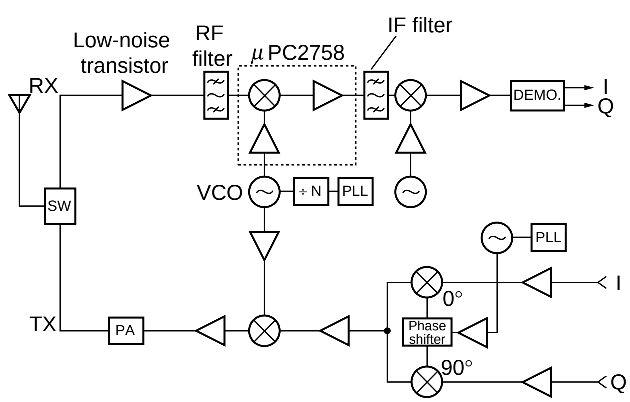
Figure 5-1 shows various block diagrams of these application systems.

Figure 5-1. System Block Diagrams

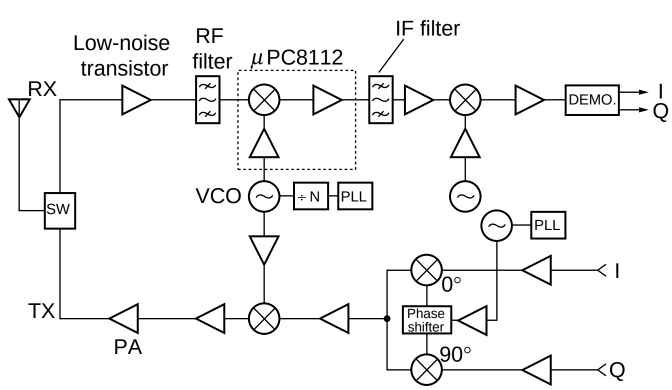
Example of analog cellular telephone



Example of digital cellular or cordless telephone



PHS



6. SUMMARY

Table 6-1. Input Pin External Circuits and Characteristics (All Three Product Models)

Pin	Relation to system	Type of external circuit	Differences vs. characteristic in data sheet	Emphasized characteristic
RF input pin	Analog systems, etc.	Matching	CG: approximately 5 dB higher IM_3: approximately 12 to 15 dB noisier	CG
	Digital cellular telephones, etc.	50-Ω termination	CG: 4 to 6 dB lower IM_3: 6 to 15 dB better	Intermodulation distortion at input level
LO input pin	When using a serial connection with the buffer amplifier output	Matching	Approximately -6 dB from the recommended P_{LOin} range	
	When using a serial connection with the filter	50-Ω termination	–	
	When using a parallel connection with the VCO output and buffer amplifier input	Capacitor coupling	–	

Remark As for buffer amplifier, μPC2745 and 2746 with 50-Ω input/output matching are hypothesized.

7. CONCLUSION

This application note has briefly described application circuit characteristics and selected examples for actual use of the μPC2757, μPC2758, and μPC8112, which are 3-V power supply, 1.9-GHz frequency down-converter ICs for cellular/cordless telephone and portable wireless communication devices. We hope that the application note will help you use this 6-pin mini-mold and super mini-mold type silicon MMICs.

★ ## APPENDIX. REFERENCE PARAMETERS

S parameters for each port

μPC2757T
$V_{CC} = V_{PS} = 3.0$ V, $T_A = +25$°C RF–IF

FREQUENCY MHz	RF port S_{11} MAG.	RF port S_{11} ANG.	LO port S_{11} MAG.	LO port S_{11} ANG.
50.0000	0.959	−2.3	0.968	−2.8
100.0000	0.950	−4.5	0.959	−5.3
150.0000	0.955	−6.8	0.951	−8.2
200.0000	0.948	−8.9	0.938	−10.3
250.0000	0.944	−11.1	0.923	−12.6
300.0000	0.939	−13.1	0.907	−14.8
350.0000	0.932	−15.5	0.894	−16.8
400.0000	0.920	−17.3	0.879	−18.5
450.0000	0.916	−19.2	0.864	−19.9
500.0000	0.910	−21.4	0.848	−21.4
550.0000	0.902	−23.4	0.835	−22.9
600.0000	0.893	−25.3	0.820	−24.5
650.0000	0.886	−27.2	0.811	−25.8
700.0000	0.879	−29.1	0.798	−27.0
750.0000	0.871	−30.9	0.787	−28.1
800.0000	0.862	−32.7	0.777	−29.4
850.0000	0.851	−34.5	0.771	−30.5
900.0000	0.846	−36.4	0.760	−32.0
950.0000	0.833	−38.3	0.749	−32.7
1000.0000	0.828	−40.0	0.742	−34.2
1050.0000	0.816	−42.0	0.733	−35.4
1100.0000	0.816	−43.8	0.730	−36.3
1150.0000	0.803	−45.7	0.718	−37.8
1200.0000	0.794	−47.1	0.712	−38.9
1250.0000	0.780	−49.2	0.705	−40.0
1300.0000	0.775	−51.0	0.695	−41.5
1350.0000	0.765	−52.4	0.690	−42.4
1400.0000	0.752	−54.2	0.682	−43.5
1450.0000	0.740	−55.9	0.675	−44.9
1500.0000	0.735	−57.3	0.668	−46.2
1550.0000	0.726	−59.2	0.655	−47.9
1600.0000	0.718	−60.5	0.637	−48.9
1650.0000	0.707	−62.7	0.627	−49.9
1700.0000	0.698	−64.6	0.618	−50.1
1750.0000	0.693	−66.1	0.613	−50.5
1800.0000	0.682	−67.6	0.611	−51.6
1850.0000	0.672	−69.4	0.607	−52.6
1900.0000	0.663	−71.4	0.602	−54.0
1950.0000	0.654	−72.7	0.596	−54.6
2000.0000	0.646	−74.7	0.592	−56.2
2050.0000	0.635	−76.4	0.586	−57.1
2100.0000	0.626	−78.1	0.581	−58.4
2150.0000	0.615	−79.7	0.575	−59.4
2200.0000	0.607	−81.7	0.565	−61.1
2250.0000	0.598	−83.1	0.560	−62.1
2300.0000	0.587	−84.8	0.556	−63.3
2350.0000	0.576	−86.4	0.550	−64.4
2400.0000	0.568	−88.1	0.540	−65.6
2450.0000	0.553	−90.0	0.536	−66.8
2500.0000	0.549	−91.4	0.526	−68.2
2550.0000	0.537	−92.9	0.522	−69.5
2600.0000	0.527	−94.2	0.512	−70.8
2650.0000	0.521	−96.0	0.503	−71.8
2700.0000	0.513	−97.4	0.500	−72.5
2750.0000	0.499	−99.4	0.490	−73.9
2800.0000	0.494	−100.8	0.487	−74.9
2850.0000	0.487	−102.3	0.475	−75.9
2900.0000	0.480	−103.8	0.468	−77.7
2950.0000	0.471	−105.8	0.464	−79.0
3000.0000	0.459	−107.2	0.457	−79.8

μPC2757T
$V_{CC} = 3.0$ V, V_{PS} = GND, $T_A = +25$°C

FREQUENCY MHz	RF port S_{11} MAG.	RF port S_{11} ANG.	LO port S_{11} MAG.	LO port S_{11} ANG.
50.0000	0.983	−1.7	0.981	−1.8
100.0000	0.977	−3.3	0.976	−3.6
150.0000	0.975	−4.9	0.969	−5.2
200.0000	0.969	−6.4	0.963	−6.6
250.0000	0.963	−8.0	0.956	−8.2
300.0000	0.957	−9.3	0.947	−9.6
350.0000	0.947	−10.9	0.936	−10.9
400.0000	0.939	−12.2	0.933	−12.1
450.0000	0.932	−13.2	0.922	−13.1
500.0000	0.927	−14.5	0.915	−14.4
550.0000	0.918	−15.9	0.909	−15.4
600.0000	0.910	−16.9	0.898	−16.5
650.0000	0.901	−17.9	0.891	−17.4
700.0000	0.899	−19.2	0.886	−18.5
750.0000	0.890	−20.1	0.878	−19.4
800.0000	0.879	−21.2	0.872	−20.2
850.0000	0.873	−22.2	0.866	−21.4
900.0000	0.865	−23.1	0.859	−22.5
950.0000	0.856	−24.1	0.852	−23.2
1000.0000	0.852	−25.2	0.846	−24.1
1050.0000	0.844	−26.3	0.842	−25.2
1100.0000	0.848	−26.8	0.835	−25.9
1150.0000	0.835	−28.0	0.831	−26.8
1200.0000	0.831	−28.9	0.823	−27.9
1250.0000	0.818	−29.9	0.819	−28.7
1300.0000	0.818	−31.0	0.808	−29.7
1350.0000	0.811	−31.4	0.805	−30.6
1400.0000	0.803	−32.5	0.798	−31.5
1450.0000	0.790	−33.1	0.794	−32.5
1500.0000	0.789	−33.9	0.785	−33.5
1550.0000	0.789	−34.7	0.775	−34.7
1600.0000	0.782	−35.5	0.762	−35.3
1650.0000	0.773	−36.6	0.752	−35.7
1700.0000	0.768	−37.9	0.748	−35.8
1750.0000	0.766	−38.3	0.746	−36.0
1800.0000	0.762	−39.0	0.746	−36.8
1850.0000	0.755	−40.1	0.743	−37.5
1900.0000	0.751	−41.0	0.738	−38.6
1950.0000	0.744	−41.5	0.736	−38.7
2000.0000	0.740	−43.1	0.729	−40.1
2050.0000	0.734	−43.6	0.730	−40.9
2100.0000	0.731	−44.6	0.725	−41.5
2150.0000	0.722	−45.4	0.723	−42.2
2200.0000	0.721	−46.7	0.718	−43.2
2250.0000	0.713	−47.3	0.715	−43.8
2300.0000	0.708	−48.0	0.715	−44.9
2350.0000	0.704	−49.2	0.710	−45.5
2400.0000	0.699	−49.8	0.707	−46.5
2450.0000	0.690	−51.1	0.704	−47.5
2500.0000	0.690	−51.7	0.697	−48.4
2550.0000	0.684	−52.7	0.690	−49.5
2600.0000	0.676	−53.5	0.690	−50.5
2650.0000	0.670	−54.4	0.683	−51.1
2700.0000	0.667	−55.1	0.680	−52.0
2750.0000	0.657	−56.1	0.671	−53.0
2800.0000	0.656	−57.2	0.672	−53.5
2850.0000	0.651	−57.9	0.661	−54.4
2900.0000	0.645	−58.8	0.657	−55.5
2950.0000	0.639	−59.9	0.654	−56.5
3000.0000	0.631	−60.7	0.650	−57.4

μPC2757T

$V_{CC} = V_{PS} = 3.0$, $T_A = +25°C$, IF S_{22}

FREQUENCY MHz	IF port S_{22} MAG.	ANG.
50.0000	0.371	173.7
60.0000	0.371	171.6
70.0000	0.371	169.4
80.0000	0.369	167.2
90.0000	0.369	165.0
100.0000	0.365	163.4
110.0000	0.365	161.3
120.0000	0.361	159.5
130.0000	0.360	157.5
140.0000	0.357	155.7
150.0000	0.353	154.0
160.0000	0.352	152.5
170.0000	0.348	150.7
180.0000	0.347	148.8
190.0000	0.342	147.1
200.0000	0.341	145.7
210.0000	0.337	144.1
220.0000	0.333	142.5
230.0000	0.333	141.3
240.0000	0.330	139.9
250.0000	0.326	138.1
260.0000	0.322	137.1
270.0000	0.319	135.2
280.0000	0.317	134.3
290.0000	0.315	132.7
300.0000	0.311	131.1

μPC2757T

$V_{CC} = 3.0$ V, V_{PS} = GND, $T_A = +25°C$, IF S_{22}

FERQUENCY MHz	IF port S_{22} MAG.	ANG.
50.0000	0.992	–1.9
60.0000	0.992	–1.9
70.0000	0.993	–2.5
80.0000	0.993	–2.6
90.0000	0.992	–3.1
100.0000	0.992	–3.6
110.0000	0.992	–4.0
120.0000	0.990	–4.2
130.0000	0.989	–4.7
140.0000	0.990	–4.9
150.0000	0.989	–5.4
160.0000	0.987	–5.7
170.0000	0.986	–6.0
180.0000	0.984	–6.4
190.0000	0.983	–6.6
200.0000	0.982	–7.1
210.0000	0.980	–7.3
220.0000	0.977	–7.7
230.0000	0.977	–8.0
240.0000	0.977	–8.3
250.0000	0.972	–8.5
260.0000	0.971	–8.6
270.0000	0.967	–9.1
280.0000	0.965	–9.3
290.0000	0.965	–9.6
300.0000	0.968	–9.8

μPC2758T

$V_{CC} = V_{PS} = 3.0$, $T_A = +25°C$

FREQUENCY MHz	RF port S_{11} MAG.	RF port S_{11} ANG.	LO port S_{11} MAG.	LO port S_{11} ANG.
50.0000	0.955	−2.5	0.957	−3.3
100.0000	0.948	−4.9	0.953	−6.5
150.0000	0.948	−7.3	0.942	−9.5
200.0000	0.942	−9.4	0.932	−12.2
250.0000	0.936	−11.8	0.917	−15.1
300.0000	0.932	−13.8	0.901	−18.0
350.0000	0.925	−16.5	0.885	−20.7
400.0000	0.919	−18.2	0.870	−23.0
450.0000	0.914	−20.3	0.853	−25.3
500.0000	0.906	−22.6	0.833	−27.6
550.0000	0.897	−24.8	0.816	−29.9
600.0000	0.888	−26.8	0.794	−31.8
650.0000	0.881	−28.9	0.776	−33.9
700.0000	0.874	−30.9	0.759	−35.6
750.0000	0.869	−33.0	0.737	−37.4
800.0000	0.859	−35.1	0.723	−38.8
850.0000	0.848	−36.8	0.703	−40.3
900.0000	0.840	−38.8	0.691	−41.6
950.0000	0.828	−40.5	0.675	−43.0
1000.0000	0.824	−43.0	0.661	−44.5
1050.0000	0.810	−44.7	0.648	−45.6
1100.0000	0.809	−46.9	0.640	−46.5
1150.0000	0.793	−49.0	0.626	−47.8
1200.0000	0.782	−50.5	0.615	−48.8
1250.0000	0.768	−52.4	0.602	−49.9
1300.0000	0.760	−54.7	0.593	−51.2
1350.0000	0.749	−56.3	0.583	−52.5
1400.0000	0.741	−58.2	0.578	−53.7
1450.0000	0.725	−59.7	0.570	−54.7
1500.0000	0.718	−61.5	0.562	−56.2
1550.0000	0.711	−63.1	0.549	−57.8
1600.0000	0.700	−65.0	0.536	−59.2
1650.0000	0.689	−66.9	0.522	−60.6
1700.0000	0.679	−68.7	0.512	−60.6
1750.0000	0.671	−70.4	0.504	−61.3
1800.0000	0.663	−71.9	0.496	−62.2
1850.0000	0.651	−73.9	0.492	−63.0
1900.0000	0.642	−76.0	0.484	−64.5
1950.0000	0.628	−77.2	0.477	−65.1
2000.0000	0.623	−79.3	0.471	−66.5
2050.0000	0.609	−80.7	0.468	−67.5
2100.0000	0.599	−82.8	0.460	−68.9
2150.0000	0.587	−84.2	0.452	−69.7
2200.0000	0.580	−86.1	0.446	−71.0
2250.0000	0.569	−87.6	0.440	−71.8
2300.0000	0.558	−89.0	0.434	−73.6
2350.0000	0.548	−90.8	0.427	−74.2
2400.0000	0.539	−92.4	0.420	−75.5
2450.0000	0.525	−94.1	0.416	−76.5
2500.0000	0.522	−95.2	0.407	−78.1
2550.0000	0.512	−96.6	0.402	−79.5
2600.0000	0.503	−98.2	0.395	−80.6
2650.0000	0.495	−100.0	0.387	−81.9
2700.0000	0.484	−101.1	0.381	−82.6
2750.0000	0.476	−102.8	0.374	−83.8
2800.0000	0.472	−104.1	0.369	−84.7
2850.0000	0.467	−105.6	0.359	−85.9
2900.0000	0.459	−107.3	0.354	−87.6
2950.0000	0.452	−109.0	0.350	−88.6
3000.0000	0.442	−110.2	0.344	−89.6

μPC2758T

$V_{CC} = 3.0$ V, V_{PS} = GND, $T_A = +25°C$

FREQUENCY MHz	RF port S_{11} MAG.	RF port S_{11} ANG.	LO port S_{11} MAG.	LO port S_{11} ANG.
50.0000	0.984	−1.8	0.981	−1.9
100.0000	0.976	−3.3	0.978	−3.6
150.0000	0.975	−4.9	0.975	−5.3
200.0000	0.970	−6.3	0.969	−6.9
250.0000	0.962	−8.1	0.961	−8.6
300.0000	0.959	−9.5	0.953	−10.2
350.0000	0.946	−11.1	0.941	−11.8
400.0000	0.938	−12.2	0.937	−13.0
450.0000	0.930	−13.4	0.929	−14.3
500.0000	0.926	−14.9	0.920	−15.7
550.0000	0.918	−16.1	0.911	−16.9
600.0000	0.907	−17.2	0.899	−18.2
650.0000	0.901	−18.4	0.891	−19.3
700.0000	0.894	−19.5	0.885	−20.3
750.0000	0.889	−20.4	0.874	−21.6
800.0000	0.880	−21.6	0.865	−22.7
850.0000	0.873	−22.5	0.856	−23.6
900.0000	0.864	−23.5	0.848	−24.8
950.0000	0.856	−24.4	0.838	−25.6
1000.0000	0.850	−25.5	0.832	−26.7
1050.0000	0.841	−26.4	0.825	−27.6
1100.0000	0.848	−27.1	0.824	−28.3
1150.0000	0.833	−28.4	0.811	−29.5
1200.0000	0.828	−29.0	0.803	−30.4
1250.0000	0.816	−30.1	0.798	−31.1
1300.0000	0.812	−31.2	0.787	−32.3
1350.0000	0.806	−31.8	0.782	−33.2
1400.0000	0.796	−32.7	0.778	−34.1
1450.0000	0.788	−33.1	0.767	−34.9
1500.0000	0.785	−34.0	0.756	−36.2
1550.0000	0.783	−34.9	0.749	−37.3
1600.0000	0.774	−35.6	0.735	−38.0
1650.0000	0.771	−36.8	0.724	−38.4
1700.0000	0.765	−37.8	0.715	−38.7
1750.0000	0.762	−38.5	0.714	−38.3
1800.0000	0.756	−39.1	0.712	−39.0
1850.0000	0.752	−40.2	0.709	−39.8
1900.0000	0.747	−41.1	0.703	−40.4
1950.0000	0.738	−41.6	0.699	−40.9
2000.0000	0.737	−43.1	0.692	−41.9
2050.0000	0.728	−43.7	0.696	−42.4
2100.0000	0.726	−44.5	0.693	−43.5
2150.0000	0.720	−45.3	0.690	−44.1
2200.0000	0.714	−46.4	0.686	−45.1
2250.0000	0.709	−47.0	0.681	−45.9
2300.0000	0.704	−47.9	0.680	−46.8
2350.0000	0.699	−48.9	0.677	−47.3
2400.0000	0.696	−49.6	0.673	−48.6
2450.0000	0.687	−50.8	0.669	−49.3
2500.0000	0.685	−51.5	0.663	−50.1
2550.0000	0.678	−52.3	0.658	−51.3
2600.0000	0.673	−53.3	0.654	−52.0
2650.0000	0.667	−54.2	0.651	−53.0
2700.0000	0.661	−54.8	0.646	−53.4
2750.0000	0.653	−55.7	0.637	−54.5
2800.0000	0.651	−56.6	0.636	−54.8
2850.0000	0.647	−57.4	0.626	−55.8
2900.0000	0.642	−58.2	0.623	−57.0
2950.0000	0.635	−59.4	0.620	−57.7
3000.0000	0.629	−60.2	0.616	−58.5

μPC2758T

$V_{CC} = V_{PS} = 3.0$, $T_A = +25°C$

FREQUENCY MHz	IF port S_{22} MAG.	ANG.
50.0000	0.465	170.7
60.0000	0.463	167.8
70.0000	0.462	165.2
80.0000	0.456	162.4
90.0000	0.454	160.0
100.0000	0.450	157.6
110.0000	0.445	155.1
120.0000	0.440	153.1
130.0000	0.437	150.8
140.0000	0.430	148.3
150.0000	0.422	146.4
160.0000	0.418	144.2
170.0000	0.411	142.1
180.0000	0.406	139.9
190.0000	0.399	138.1
200.0000	0.394	135.9
210.0000	0.387	134.0
220.0000	0.382	132.0
230.0000	0.377	130.4
240.0000	0.371	128.9
250.0000	0.364	127.0
260.0000	0.360	125.5
270.0000	0.353	123.6
280.0000	0.347	122.0
290.0000	0.344	120.6
300.0000	0.338	119.1

μPC2758T

$V_{CC} = 3.0$ V, V_{PS} = GND, $T_A = +25°C$

FERQUENCY MHz	IF port S_{22} MAG.	ANG.
50.0000	0.993	–1.7
60.0000	0.995	–1.8
70.0000	0.991	–2.6
80.0000	0.990	–2.6
90.0000	0.994	–3.1
100.0000	0.992	–3.6
110.0000	0.990	–4.1
120.0000	0.991	–4.3
130.0000	0.986	–4.8
140.0000	0.990	–5.1
150.0000	0.990	–5.6
160.0000	0.987	–5.8
170.0000	0.985	–6.2
180.0000	0.984	–6.5
190.0000	0.983	–6.8
200.0000	0.980	–7.3
210.0000	0.980	–7.4
220.0000	0.977	–7.9
230.0000	0.977	–8.2
240.0000	0.975	–8.4
250.0000	0.970	–8.7
260.0000	0.972	–9.2
270.0000	0.969	–9.4
280.0000	0.965	–9.6
290.0000	0.963	–9.9
300.0000	0.963	–10.1

μPC8112T

$V_{CC} = V_{IFout} = V_{PS}$ = 3.0, V, T_A = +25°C

FREQUENCY MHz	RF port S_{11} MAG.	RF port S_{11} ANG.	LO port S_{11} MAG.	LO port S_{11} ANG.
50.0000	0.951	−3.0	0.970	−1.9
100.0000	0.946	−5.6	0.964	−3.3
150.0000	0.938	−8.3	0.959	−5.0
200.0000	0.939	−11.0	0.952	−6.3
250.0000	0.932	−13.6	0.944	−7.6
300.0000	0.922	−16.1	0.935	−8.8
350.0000	0.917	−19.2	0.929	−10.2
400.0000	0.906	−21.6	0.921	−11.3
450.0000	0.899	−24.1	0.915	−12.0
500.0000	0.886	−26.4	0.910	−13.3
550.0000	0.876	−28.7	0.905	−14.3
600.0000	0.868	−31.2	0.900	−15.3
650.0000	0.852	−33.6	0.895	−16.3
700.0000	0.837	−35.8	0.890	−17.4
750.0000	0.831	−38.0	0.883	−18.2
800.0000	0.815	−40.5	0.877	−19.3
850.0000	0.803	−42.4	0.873	−20.5
900.0000	0.791	−44.7	0.868	−21.2
950.0000	0.775	−47.1	0.865	−22.5
1000.0000	0.767	−49.1	0.855	−22.9
1050.0000	0.755	−51.2	0.856	−24.1
1100.0000	0.748	−53.4	0.851	−25.1
1150.0000	0.734	−55.4	0.837	−26.1
1200.0000	0.716	−57.3	0.835	−26.9
1250.0000	0.702	−59.5	0.828	−28.0
1300.0000	0.696	−61.5	0.820	−28.8
1350.0000	0.681	−63.7	0.815	−29.9
1400.0000	0.666	−65.9	0.804	−30.9
1450.0000	0.655	−67.4	0.803	−32.0
1500.0000	0.644	−69.2	0.795	−33.1
1550.0000	0.635	−71.3	0.784	−34.2
1600.0000	0.620	−73.3	0.775	−34.9
1650.0000	0.609	−75.3	0.762	−35.7
1700.0000	0.600	−76.9	0.752	−36.1
1750.0000	0.591	−79.2	0.748	−36.7
1800.0000	0.577	−80.9	0.742	−37.1
1850.0000	0.565	−83.1	0.736	−37.9
1900.0000	0.552	−85.0	0.732	−38.7
1950.0000	0.542	−87.0	0.724	−39.1
2000.0000	0.525	−88.9	0.717	−39.9
2050.0000	0.512	−90.8	0.716	−40.1
2100.0000	0.500	−92.2	0.711	−40.8
2150.0000	0.490	−93.6	0.708	−41.4
2200.0000	0.481	−95.1	0.704	−42.2
2250.0000	0.467	−96.7	0.703	−42.9
2300.0000	0.460	−98.5	0.699	−43.7
2350.0000	0.452	−99.7	0.693	−44.4
2400.0000	0.442	−101.1	0.690	−45.5
2450.0000	0.435	−102.9	0.691	−46.0
2500.0000	0.424	−104.9	0.686	−46.7
2550.0000	0.420	−105.8	0.678	−47.7
2600.0000	0.411	−107.3	0.673	−48.4
2650.0000	0.408	−109.0	0.673	−49.2
2700.0000	0.398	−111.1	0.662	−49.8
2750.0000	0.389	−112.6	0.658	−50.8
2800.0000	0.386	−114.1	0.655	−51.6
2850.0000	0.377	−116.3	0.650	−52.4
2900.0000	0.377	−117.5	0.644	−53.5
2950.0000	0.365	−118.8	0.638	−54.5
3000.0000	0.363	−120.6	0.635	−55.0

μPC8112T

$V_{CC} = V_{IFout}$ = 3.0V, V_{PS} = GND, T_A = +25°C

FREQUENCY MHz	RF port S_{11} MAG.	RF port S_{11} ANG.	LO port S_{11} MAG.	LO port S_{11} ANG.
50.0000	0.990	−1.5	0.986	−1.5
100.0000	0.986	−3.5	0.981	−2.6
150.0000	0.978	−5.3	0.981	−3.8
200.0000	0.980	−7.1	0.977	−5.1
250.0000	0.972	−8.7	0.971	−6.1
300.0000	0.967	−10.3	0.966	−7.2
350.0000	0.956	−12.3	0.961	−8.6
400.0000	0.950	−13.5	0.955	−9.3
450.0000	0.948	−15.0	0.955	−10.4
500.0000	0.940	−16.4	0.949	−11.3
550.0000	0.934	−17.8	0.943	−12.4
600.0000	0.929	−19.5	0.938	−13.2
650.0000	0.919	−20.6	0.934	−14.2
700.0000	0.910	−22.1	0.927	−15.4
750.0000	0.907	−23.3	0.924	−15.8
800.0000	0.897	−24.8	0.920	−16.9
850.0000	0.889	−25.9	0.917	−17.9
900.0000	0.884	−27.3	0.910	−18.5
950.0000	0.875	−28.5	0.908	−19.5
1000.0000	0.867	−30.0	0.898	−20.2
1050.0000	0.865	−31.4	0.897	−21.2
1100.0000	0.868	−32.5	0.901	−21.9
1150.0000	0.850	−33.7	0.884	−22.9
1200.0000	0.840	−35.0	0.883	−23.9
1250.0000	0.836	−36.0	0.878	−25.0
1300.0000	0.829	−37.5	0.871	−25.5
1350.0000	0.820	−38.9	0.865	−26.6
1400.0000	0.806	−40.1	0.957	−27.2
1450.0000	0.799	−41.1	0.859	−28.3
1500.0000	0.792	−41.9	0.850	−29.1
1550.0000	0.789	−43.2	0.839	−30.4
1600.0000	0.782	−44.3	0.829	−30.6
1650.0000	0.774	−45.8	0.818	−31.4
1700.0000	0.766	−46.7	0.811	−31.8
1750.0000	0.760	−47.9	0.809	−32.2
1800.0000	0.754	−49.0	0.803	−32.7
1850.0000	0.748	−50.2	0.802	−33.5
1900.0000	0.740	−51.4	0.800	−34.4
1950.0000	0.734	−52.6	0.787	−34.8
2000.0000	0.725	−53.8	0.780	−35.3
2050.0000	0.719	−55.0	0.779	−35.9
2100.0000	0.711	−56.1	0.776	−36.0
2150.0000	0.707	−57.1	0.775	−36.8
2200.0000	0.696	−58.2	0.772	−37.4
2250.0000	0.689	−59.4	0.772	−38.2
2300.0000	0.685	−60.7	0.770	−38.8
2350.0000	0.678	−61.7	0.768	−39.4
2400.0000	0.670	−62.9	0.766	−40.4
2450.0000	0.660	−64.3	0.765	−40.9
2500.0000	0.651	−65.5	0.760	−41.9
2550.0000	0.647	−66.2	0.757	−42.8
2600.0000	0.641	−67.5	0.750	−43.1
2650.0000	0.638	−68.7	0.753	−43.8
2700.0000	0.626	−69.8	0.742	−44.7
2750.0000	0.618	−71.1	0.741	−45.5
2800.0000	0.612	−72.4	0.736	−46.3
2850.0000	0.602	−73.6	0.734	−47.1
2900.0000	0.603	−74.6	0.728	−48.1
2950.0000	0.591	−75.6	0.726	−48.9
3000.0000	0.585	−76.7	0.723	−49.4

μPC8112T

$V_{CC} = V_{IFout} = V_{PS} = 3.0$, V, $T_A = +25°C$

FREQUENCY MHz	IF port S_{22} MAG	ANG
50.0000	0.994	–2.3
60.0000	0.993	–2.7
70.0000	0.994	–3.1
80.0000	0.990	–3.4
90.0000	0.993	–4.1
100.0000	0.993	–4.6
110.0000	0.992	–4.9
120.0000	0.989	–5.4
130.0000	0.988	–5.7
140.0000	0.988	–6.1
150.0000	0.988	–6.6
160.0000	0.984	–7.1
170.0000	0.985	–7.4
180.0000	0.983	–7.8
190.0000	0.982	–8.2
200.0000	0.981	–8.5
210.0000	0.977	–9.1
220.0000	0.978	–9.3
230.0000	0.977	–9.8
240.0000	0.978	–10.2
250.0000	0.974	–10.6
260.0000	0.971	–10.9
270.0000	0.977	–11.4
280.0000	0.968	–11.7
290.0000	0.969	–12.0
300.0000	0.965	–12.4

μPC8112T

$V_{CC} = V_{IFout} = 3.0V$, V_{PS} = GND, $T_A = +25°C$

FERQUENCY MHz	IF port S_{22} MAG	ANG
50.0000	0.997	–2.3
60.0000	0.997	–2.5
70.0000	0.998	–3.0
80.0000	0.991	–3.3
90.0000	0.999	–3.9
100.0000	0.996	–4.5
110.0000	0.994	–4.8
120.0000	0.993	–5.1
130.0000	0.993	–5.4
140.0000	0.988	–5.7
150.0000	0.989	–6.2
160.0000	0.987	–6.7
170.0000	0.987	–7.1
180.0000	0.986	–7.3
190.0000	0.985	–7.9
200.0000	0.982	–8.2
210.0000	0.979	–8.6
220.0000	0.981	–8.9
230.0000	0.979	–9.3
240.0000	0.978	–9.8
250.0000	0.974	–10.1
260.0000	0.974	–10.4
270.0000	0.971	–10.9
280.0000	0.967	–11.1
290.0000	0.972	–11.4
300.0000	0.967	–11.6

μPC2757TB

$V_{CC} = V_{PS} = 3.0$ V

FREQUENCY	RF port S11		LO port S11	
MHz	MAG.	ANG.	MAG.	ANG.
50.0000	0.965	−2.3	0.971	−2.3
100.0000	0.963	−4.0	0.965	−4.9
150.0000	0.963	−6.1	0.960	−7.1
200.0000	0.962	−8.0	0.952	−9.3
250.0000	0.956	−9.9	0.941	−11.5
300.0000	0.953	−12.1	0.929	−13.4
350.0000	0.950	−14.1	0.917	−15.5
400.0000	0.941	−15.9	0.904	−17.0
450.0000	0.938	−17.8	0.892	−18.9
500.0000	0.932	−19.8	0.878	−20.4
550.0000	0.924	−21.5	0.868	−22.1
600.0000	0.916	−23.6	0.854	−23.5
650.0000	0.909	−25.3	0.841	−24.7
700.0000	0.899	−27.2	0.829	−26.1
750.0000	0.897	−28.9	0.818	−27.7
800.0000	0.885	−30.9	0.811	−28.8
850.0000	0.876	−32.7	0.802	−30.1
900.0000	0.869	−34.5	0.790	−31.2
950.0000	0.863	−36.6	0.782	−32.6
1000.0000	0.858	−37.8	0.776	−33.6
1050.0000	0.841	−39.2	0.761	−35.0
1100.0000	0.841	−41.5	0.763	−35.9
1150.0000	0.822	−42.8	0.748	−37.4
1200.0000	0.813	−44.7	0.740	−38.3
1250.0000	0.798	−46.7	0.731	−39.9
1300.0000	0.786	−48.3	0.724	−41.0
1350.0000	0.774	−49.6	0.718	−41.7
1400.0000	0.766	−51.6	0.713	−43.5
1450.0000	0.757	−53.0	0.704	−44.1
1500.0000	0.749	−54.5	0.696	−45.5
1550.0000	0.742	−56.4	0.684	−46.4
1600.0000	0.729	−57.7	0.678	−47.7
1650.0000	0.718	−59.4	0.672	−48.8
1700.0000	0.711	−60.7	0.665	−50.2
1750.0000	0.699	−62.7	0.658	−51.2
1800.0000	0.686	−64.3	0.651	−52.2
1850.0000	0.678	−65.9	0.640	−53.6
1900.0000	0.666	−67.5	0.635	−54.7
1950.0000	0.654	−69.0	0.627	−55.8
2000.0000	0.646	−70.4	0.616	−56.9
2050.0000	0.635	−72.1	0.610	−58.3
2100.0000	0.625	−73.5	0.599	−59.1
2150.0000	0.614	−74.8	0.596	−60.4
2200.0000	0.609	−76.4	0.588	−61.5
2250.0000	0.594	−77.7	0.579	−62.7
2300.0000	0.582	−79.4	0.573	−63.6
2350.0000	0.582	−81.7	0.562	−64.4
2400.0000	0.571	−83.2	0.554	−66.1
2450.0000	0.559	−83.5	0.551	−66.9
2500.0000	0.546	−85.4	0.545	−68.3
2550.0000	0.537	−86.3	0.535	−69.3
2600.0000	0.528	−87.9	0.523	−70.1
2650.0000	0.516	−89.2	0.522	−71.5
2700.0000	0.519	−91.4	0.511	−72.0
2750.0000	0.507	−93.3	0.505	−73.3
2800.0000	0.506	−94.6	0.494	−74.3
2850.0000	0.493	−95.9	0.485	−75.0
2900.0000	0.483	−97.5	0.480	−76.2
2950.0000	0.478	−98.8	0.474	−77.4
3000.0000	0.471	−100.8	0.464	−79.0

μPC2757TB

$V_{CC} = 3.0$ V, V_{PS} = GND

FREQUENCY	RF port S11		LO port S11	
MHz	MAG.	ANG.	MAG.	ANG.
50.0000	0.982	−1.7	0.981	−1.5
100.0000	0.979	−2.7	0.978	−3.1
150.0000	0.980	−4.2	0.978	−4.6
200.0000	0.974	−5.5	0.972	−5.9
250.0000	0.972	−6.8	0.966	−7.2
300.0000	0.966	−8.2	0.958	−8.5
350.0000	0.959	−9.5	0.950	−9.9
400.0000	0.956	−10.6	0.949	−11.0
450.0000	0.952	−11.8	0.943	−12.2
500.0000	0.946	−12.9	0.936	−13.2
550.0000	0.939	−14.0	0.933	−14.3
600.0000	0.931	−15.2	0.922	−15.4
650.0000	0.925	−16.3	0.920	−16.3
700.0000	0.920	−17.3	0.913	−17.4
750.0000	0.915	−18.4	0.903	−18.5
800.0000	0.906	−19.2	0.901	−19.4
850.0000	0.899	−20.6	0.899	−20.2
900.0000	0.893	−21.3	0.892	−21.4
950.0000	0.889	−22.5	0.887	−22.4
1000.0000	0.885	−23.0	0.881	−23.3
1050.0000	0.876	−24.1	0.872	−24.3
1100.0000	0.881	−24.9	0.883	−24.8
1150.0000	0.863	−25.7	0.865	−26.1
1200.0000	0.857	−26.8	0.859	−27.0
1250.0000	0.848	−28.0	0.856	−28.3
1300.0000	0.845	−28.7	0.850	−29.2
1350.0000	0.832	−29.5	0.848	−29.8
1400.0000	0.826	−30.4	0.842	−30.9
1450.0000	0.824	−30.8	0.835	−31.3
1500.0000	0.818	−31.8	0.834	−32.4
1550.0000	0.815	−32.4	0.823	−33.3
1600.0000	0.809	−33.4	0.819	−34.4
1650.0000	0.804	−34.4	0.816	−34.9
1700.0000	0.799	−35.0	0.811	−36.3
1750.0000	0.796	−36.1	0.804	−36.7
1800.0000	0.789	−36.8	0.805	−37.7
1850.0000	0.782	−37.7	0.800	−38.6
1900.0000	0.775	−38.3	0.798	−39.7
1950.0000	0.773	−39.1	0.793	−40.4
2000.0000	0.765	−40.0	0.783	−41.3
2050.0000	0.761	−40.8	0.785	−42.3
2100.0000	0.756	−41.6	0.777	−43.0
2150.0000	0.749	−42.4	0.773	−43.9
2200.0000	0.745	−43.3	0.763	−45.2
2250.0000	0.739	−44.1	0.762	−45.9
2300.0000	0.735	−45.0	0.759	−46.8
2350.0000	0.739	−46.3	0.755	−47.5
2400.0000	0.734	−47.1	0.748	−48.7
2450.0000	0.725	−47.5	0.744	−49.5
2500.0000	0.716	−48.5	0.740	−50.6
2550.0000	0.709	−49.3	0.733	−51.5
2600.0000	0.704	−50.2	0.726	−52.3
2650.0000	0.700	−50.8	0.725	−53.5
2700.0000	0.699	−51.9	0.719	−53.9
2750.0000	0.695	−53.2	0.712	−54.8
2800.0000	0.695	−54.0	0.704	−55.8
2850.0000	0.687	−54.6	0.698	−56.7
2900.0000	0.680	−55.8	0.696	−57.8
2950.0000	0.672	−56.7	0.686	−58.6
3000.0000	0.668	−57.5	0.681	−59.7

μPC2757TB

$V_{CC} = V_{PS} = 3.0$

FREQUENCY MHz	IF port S22 MAG.	ANG.
50.0000	0.477	174.6
60.0000	0.472	172.8
70.0000	0.471	170.9
80.0000	0.470	169.2
90.0000	0.466	167.5
100.0000	0.463	165.9
110.0000	0.462	164.3
120.0000	0.459	162.2
130.0000	0.456	161.0
140.0000	0.452	159.5
150.0000	0.448	158.0
160.0000	0.445	156.3
170.0000	0.442	155.1
180.0000	0.438	153.7
190.0000	0.435	152.5
200.0000	0.431	150.7
210.0000	0.426	149.5
220.0000	0.422	148.3
230.0000	0.417	146.9
240.0000	0.415	145.9
250.0000	0.410	144.7
260.0000	0.406	143.2
270.0000	0.401	142.2
280.0000	0.395	140.5
290.0000	0.391	139.9
300.0000	0.388	138.7

μPC2757TB

$V_{CC} = 3.0$ V, V_{PS} = GND

FERQUENCY MHz	IF port S22 MAG.	ANG.
50.0000	0.955	–1.5
60.0000	0.998	–1.9
70.0000	0.997	–2.3
80.0000	0.998	–2.8
90.0000	0.997	–2.9
100.0000	0.996	–3.2
110.0000	0.998	–3.6
120.0000	0.996	–4.1
130.0000	0.997	–4.4
140.0000	0.996	–4.7
150.0000	0.993	–5.0
160.0000	0.993	–5.3
170.0000	0.994	–5.6
180.0000	0.990	–5.8
190.0000	0.990	–6.1
200.0000	0.989	–6.3
210.0000	0.989	–6.7
220.0000	0.983	–7.1
230.0000	0.987	–7.3
240.0000	0.983	–7.5
250.0000	0.983	–7.8
260.0000	0.984	–7.9
270.0000	0.980	–8.5
280.0000	0.982	–8.7
290.0000	0.980	–8.9
300.0000	0.979	–9.3

μPC2758TB

$V_{CC} = V_{PS} = 3.0$

FREQUENCY	RF port S11		LO port S11	
MHz	MAG.	ANG.	MAG.	ANG.
50.0000	0.959	−2.0	0.959	−2.9
100.0000	0.958	−4.2	0.955	−6.4
150.0000	0.957	−6.4	0.948	−8.8
200.0000	0.953	−8.5	0.943	−11.3
250.0000	0.950	−10.6	0.930	−14.2
300.0000	0.943	−12.6	0.913	−16.8
350.0000	0.939	−14.7	0.899	−19.4
400.0000	0.930	−16.8	0.880	−21.8
450.0000	0.926	−18.7	0.862	−24.0
500.0000	0.919	−20.6	0.841	−26.1
550.0000	0.910	−22.6	0.823	−28.0
600.0000	0.901	−24.7	0.803	−29.8
650.0000	0.894	−26.5	0.786	−31.4
700.0000	0.884	−28.5	0.765	−32.8
750.0000	0.877	−30.4	0.751	−34.4
800.0000	0.868	−32.4	0.733	−35.3
850.0000	0.858	−34.3	0.722	−36.9
900.0000	0.848	−36.2	0.707	−38.1
950.0000	0.840	−38.2	0.689	−39.3
1000.0000	0.831	−40.1	0.680	−40.4
1050.0000	0.818	−42.0	0.672	−41.6
1100.0000	0.814	−43.8	0.667	−42.9
1150.0000	0.794	−45.9	0.651	−44.2
1200.0000	0.782	−47.8	0.637	−45.0
1250.0000	0.774	−49.4	0.625	−46.4
1300.0000	0.761	−51.3	0.617	−47.8
1350.0000	0.748	−53.4	0.605	−48.7
1400.0000	0.737	−55.1	0.599	−50.0
1450.0000	0.722	−56.7	0.588	−51.1
1500.0000	0.711	−58.3	0.578	−52.4
1550.0000	0.700	−60.1	0.572	−53.5
1600.0000	0.688	−62.0	0.560	−54.7
1650.0000	0.674	−63.8	0.551	−56.0
1700.0000	0.663	−65.5	0.541	−57.0
1750.0000	0.652	−67.3	0.533	−58.3
1800.0000	0.638	−68.8	0.522	−59.4
1850.0000	0.626	−70.4	0.517	−60.8
1900.0000	0.614	−72.3	0.505	−61.6
1950.0000	0.602	−73.7	0.497	−62.7
2000.0000	0.592	−75.4	0.486	−64.1
2050.0000	0.578	−77.1	0.475	−64.6
2100.0000	0.568	−78.6	0.467	−66.2
2150.0000	0.554	−80.0	0.460	−67.1
2200.0000	0.544	−81.7	0.456	−67.9
2250.0000	0.532	−82.9	0.443	−68.9
2300.0000	0.523	−84.3	0.436	−70.0
2350.0000	0.514	−85.8	0.427	−71.0
2400.0000	0.504	−87.2	0.420	−71.9
2450.0000	0.492	−88.7	0.414	−73.0
2500.0000	0.485	−90.2	0.406	−73.6
2550.0000	0.479	−91.5	0.398	−74.6
2600.0000	0.469	−93.1	0.395	−76.2
2650.0000	0.460	−94.9	0.382	−76.8
2700.0000	0.453	−96.5	0.380	−78.0
2750.0000	0.445	−98.1	0.371	−79.7
2800.0000	0.437	−99.6	0.362	−80.5
2850.0000	0.429	−101.9	0.356	−81.8
2900.0000	0.422	−103.1	0.347	−83.4
2950.0000	0.415	−104.9	0.341	−84.2
3000.0000	0.406	−106.3	0.336	−85.0

μPC2758TB

$V_{CC} = 3.0$ V, $V_{PS} = GND$

FREQUENCY	RF port S11		LO port S11	
MHz	MAG.	ANG.	MAG.	ANG.
50.0000	0.981	−1.5	0.983	−1.7
100.0000	0.980	−3.1	0.979	−3.0
150.0000	0.976	−4.6	0.974	−4.7
200.0000	0.973	−5.9	0.973	−6.1
250.0000	0.969	−7.3	0.970	−7.5
300.0000	0.963	−8.6	0.957	−8.9
350.0000	0.954	−10.0	0.953	−10.4
400.0000	0.952	−11.1	0.948	−11.3
450.0000	0.946	−12.2	0.944	−12.8
500.0000	0.939	−13.4	0.937	−14.0
550.0000	0.932	−14.6	0.931	−15.2
600.0000	0.923	−15.8	0.923	−16.3
650.0000	0.917	−16.7	0.917	−17.4
700.0000	0.911	−17.9	0.908	−18.7
750.0000	0.902	−18.8	0.903	−19.6
800.0000	0.897	−19.9	0.895	−20.5
850.0000	0.887	−21.0	0.891	−21.7
900.0000	0.881	−21.8	0.882	−22.9
950.0000	0.875	−22.7	0.872	−23.6
1000.0000	0.870	−23.7	0.865	−24.4
1050.0000	0.863	−24.8	0.861	−25.4
1100.0000	0.863	−25.4	0.868	−26.4
1150.0000	0.849	−26.7	0.851	−27.4
1200.0000	0.843	−27.5	0.840	−28.0
1250.0000	0.837	−28.3	0.834	−29.1
1300.0000	0.828	−29.0	0.829	−30.1
1350.0000	0.824	−30.1	0.824	−30.8
1400.0000	0.813	−31.0	0.818	−31.9
1450.0000	0.806	−31.4	0.808	−32.3
1500.0000	0.802	−32.4	0.804	−33.4
1550.0000	0.797	−33.2	0.800	−34.1
1600.0000	0.791	−33.9	0.790	−34.9
1650.0000	0.785	−35.0	0.788	−35.7
1700.0000	0.782	−35.7	0.782	−36.6
1750.0000	0.773	−36.7	0.774	−37.5
1800.0000	0.771	−37.5	0.769	−38.3
1850.0000	0.763	−38.3	0.769	−39.2
1900.0000	0.758	−39.2	0.763	−39.7
1950.0000	0.753	−39.8	0.759	−40.7
2000.0000	0.748	−41.0	0.753	−41.9
2050.0000	0.742	−41.9	0.749	−42.6
2100.0000	0.738	−42.7	0.742	−43.5
2150.0000	0.730	−43.7	0.737	−44.5
2200.0000	0.725	−44.5	0.738	−45.4
2250.0000	0.720	−45.3	0.731	−46.4
2300.0000	0.716	−46.0	0.724	−47.2
2350.0000	0.709	−47.0	0.719	−48.0
2400.0000	0.705	−47.8	0.713	−48.7
2450.0000	0.697	−48.7	0.710	−49.9
2500.0000	0.692	−49.5	0.703	−50.2
2550.0000	0.688	−50.3	0.693	−51.3
2600.0000	0.682	−51.2	0.695	−52.6
2650.0000	0.677	−52.2	0.684	−53.1
2700.0000	0.670	−53.0	0.680	−54.1
2750.0000	0.664	−53.8	0.671	−55.7
2800.0000	0.659	−54.7	0.664	−55.9
2850.0000	0.654	−55.5	0.662	−56.8
2900.0000	0.648	−56.5	0.654	−57.7
2950.0000	0.642	−57.4	0.653	−58.6
3000.0000	0.637	−58.2	0.645	−59.6

μPC2758TB

$V_{CC} = V_{PS} = 3.0$

FREQUENCY MHz	IF port S_{22} MAG.	ANG.
50.0000	0.575	172.8
60.0000	0.572	170.2
70.0000	0.568	168.0
80.0000	0.565	165.8
90.0000	0.560	163.9
100.0000	0.554	161.8
110.0000	0.547	159.8
120.0000	0.542	157.9
130.0000	0.536	156.0
140.0000	0.530	154.3
150.0000	0.523	152.6
160.0000	0.517	150.8
170.0000	0.510	149.1
180.0000	0.502	147.6
190.0000	0.495	146.0
200.0000	0.487	144.5
210.0000	0.480	143.1
220.0000	0.473	141.5
230.0000	0.465	140.1
240.0000	0.457	138.7
250.0000	0.450	137.4
260.0000	0.443	136.2
270.0000	0.435	134.9
280.0000	0.428	133.7
290.0000	0.422	132.5
300.0000	0.413	131.3

μPC2758TB

$V_{CC} = 3.0$ V, $V_{PS} = GND$

FERQUENCY MHz	IF port S_{22} MAG.	ANG.
50.0000	0.996	–1.7
60.0000	0.999	–2.1
70.0000	0.997	–2.3
80.0000	0.996	–2.6
90.0000	0.997	–3.0
100.0000	0.995	–3.5
110.0000	0.995	–3.6
120.0000	0.994	–4.0
130.0000	0.993	–4.3
140.0000	0.993	–4.7
150.0000	0.992	–5.0
160.0000	0.991	–5.3
170.0000	0.989	–5.6
180.0000	0.988	–5.9
190.0000	0.989	–6.2
200.0000	0.990	–6.5
210.0000	0.987	–6.7
220.0000	0.985	–7.2
230.0000	0.985	–7.5
240.0000	0.985	–7.7
250.0000	0.983	–8.0
260.0000	0.981	–8.3
270.0000	0.979	–8.5
280.0000	0.980	–9.0
290.0000	0.976	–9.1
300.0000	0.976	–9.4

μPC8112TB

$V_{CC} = V_{PS} = 3.0$ V

FREQUENCY MHz	RF port S11 MAG.	RF port S11 ANG.	LO port S11 MAG.	LO port S11 ANG.
50.0000	0.944	−2.8	0.965	−1.5
100.0000	0.935	−5.0	0.963	−2.7
150.0000	0.936	−7.4	0.959	−4.2
200.0000	0.936	−9.5	0.955	−5.3
250.0000	0.929	−12.0	0.946	−6.6
300.0000	0.919	−14.3	0.943	−7.5
350.0000	0.921	−16.7	0.933	−8.6
400.0000	0.910	−18.9	0.934	−9.5
450.0000	0.903	−21.1	0.930	−10.7
500.0000	0.896	−23.3	0.926	−11.6
550.0000	0.885	−25.7	0.922	−12.4
600.0000	0.874	−28.1	0.918	−13.5
650.0000	0.867	−30.3	0.912	−14.4
700.0000	0.855	−32.4	0.911	−15.4
750.0000	0.844	−34.7	0.904	−16.3
800.0000	0.833	−36.7	0.901	−17.4
850.0000	0.825	−38.9	0.898	−18.5
900.0000	0.809	−40.9	0.892	−19.5
950.0000	0.801	−43.0	0.883	−20.3
1000.0000	0.789	−44.9	0.883	−21.0
1050.0000	0.774	−47.0	0.875	−21.8
1100.0000	0.772	−48.9	0.881	−23.0
1150.0000	0.752	−50.8	0.867	−24.1
1200.0000	0.736	−52.9	0.860	−24.8
1250.0000	0.727	−54.6	0.855	−25.8
1300.0000	0.715	−56.8	0.847	−26.8
1350.0000	0.706	−58.6	0.840	−27.6
1400.0000	0.690	−60.8	0.841	−28.7
1450.0000	0.681	−62.7	0.834	−29.5
1500.0000	0.669	−64.7	0.827	−30.6
1550.0000	0.658	−66.4	0.820	−31.3
1600.0000	0.643	−68.4	0.816	−32.7
1650.0000	0.630	−71.1	0.803	−33.4
1700.0000	0.617	−73.2	0.798	−34.4
1750.0000	0.602	−75.3	0.790	−35.2
1800.0000	0.584	−77.3	0.782	−36.2
1850.0000	0.565	−78.7	0.771	−36.6
1900.0000	0.547	−80.2	0.763	−37.4
1950.0000	0.526	−81.6	0.757	−38.1
2000.0000	0.512	−82.5	0.749	−38.8
2050.0000	0.501	−83.5	0.745	−39.0
2100.0000	0.490	−84.8	0.739	−40.1
2150.0000	0.479	−85.4	0.733	−40.9
2200.0000	0.474	−86.7	0.727	−41.8
2250.0000	0.466	−87.7	0.724	−42.3
2300.0000	0.457	−88.8	0.720	−43.0
2350.0000	0.450	−89.9	0.715	−43.8
2400.0000	0.443	−91.1	0.710	−44.7
2450.0000	0.738	−92.3	0.703	−45.4
2500.0000	0.728	−93.1	0.698	−46.0
2550.0000	0.424	−94.6	0.690	−47.0
2600.0000	0.420	−96.0	0.682	−47.9
2650.0000	0.411	−97.5	0.677	−48.5
2700.0000	0.410	−98.9	0.671	−49.4
2750.0000	0.405	−99.9	0.666	−49.6
2800.0000	0.402	−101.8	0.664	−50.6
2850.0000	0.399	−103.3	0.650	−51.6
2900.0000	0.389	−105.5	0.651	−52.1
2950.0000	0.389	−106.1	0.641	−53.0
3000.0000	0.382	−108.6	0.636	−53.8

μPC8112TB

$V_{CC} = 3.0$ V, V_{PS} = GND

FREQUENCY MHz	RF port S11 MAG.	RF port S11 ANG.	LO port S11 MAG.	LO port S11 ANG.
50.0000	0.985	−1.5	0.976	−1.1
100.0000	0.985	−2.7	0.982	−2.0
150.0000	0.984	−4.1	0.979	−3.1
200.0000	0.984	−5.5	0.977	−3.9
250.0000	0.979	−6.8	0.974	−4.9
300.0000	0.971	−8.0	0.972	−5.8
350.0000	0.969	−9.4	0.965	−6.7
400.0000	0.969	−10.7	0.968	−7.5
450.0000	0.965	−11.9	0.965	−8.5
500.0000	0.961	−13.1	0.961	−9.5
550.0000	0.954	−14.5	0.960	−10.3
600.0000	0.950	−15.8	0.957	−11.1
650.0000	0.944	−17.0	0.949	−12.0
700.0000	0.941	−18.1	0.948	−12.8
750.0000	0.935	−19.5	0.943	−13.6
800.0000	0.927	−20.6	0.943	−14.6
850.0000	0.923	−21.7	0.936	−15.4
900.0000	0.913	−22.9	0.938	−16.2
950.0000	0.911	−24.4	0.928	−16.9
1000.0000	0.907	−25.2	0.928	−17.9
1050.0000	0.897	−26.3	0.923	−18.6
1100.0000	0.901	−27.3	0.930	−19.3
1150.0000	0.884	−28.7	0.914	−20.4
1200.0000	0.875	−29.9	0.906	−20.9
1250.0000	0.867	−30.8	0.904	−21.8
1300.0000	0.863	−32.2	0.903	−23.0
1350.0000	0.858	−33.4	0.896	−23.5
1400.0000	0.842	−34.5	0.896	−24.2
1450.0000	0.838	−35.1	0.891	−25.1
1500.0000	0.830	−36.2	0.885	−25.9
1550.0000	0.822	−37.1	0.879	−26.7
1600.0000	0.814	−38.1	0.878	−27.7
1650.0000	0.807	−39.6	0.865	−28.2
1700.0000	0.802	−40.1	0.865	−29.0
1750.0000	0.791	−41.6	0.855	−29.8
1800.0000	0.786	−42.6	0.854	−30.6
1850.0000	0.780	−43.4	0.845	−31.2
1900.0000	0.775	−44.5	0.838	−31.8
1950.0000	0.763	−45.5	0.834	−32.6
2000.0000	0.755	−46.4	0.831	−33.2
2050.0000	0.751	−47.3	0.829	−33.6
2100.0000	0.739	−48.7	0.827	−34.4
2150.0000	0.735	−49.2	0.718	−35.4
2200.0000	0.725	−50.5	0.817	−36.2
2250.0000	0.722	−51.2	0.812	−36.6
2300.0000	0.715	−52.4	0.809	−37.2
2350.0000	0.707	−53.0	0.804	−38.1
2400.0000	0.700	−54.3	0.803	−39.0
2450.0000	0.695	−55.2	0.795	−39.5
2500.0000	0.682	−56.0	0.793	−40.7
2550.0000	0.675	−56.9	0.785	−41.4
2600.0000	0.668	−58.1	0.778	−42.3
2650.0000	0.661	−59.1	0.773	−42.5
2700.0000	0.656	−60.3	0.771	−43.5
2750.0000	0.647	−61.0	0.766	−44.0
2800.0000	0.639	−61.8	0.764	−44.8
2850.0000	0.636	−63.0	0.752	−45.6
2900.0000	0.628	−63.8	0.752	−46.3
2950.0000	0.620	−64.9	0.746	−47.3
3000.0000	0.615	−65.9	0.741	−47.9

μPC8112TB

$V_{CC} = V_{PS} = 3.0$, V

FREQUENCY MHz	IF port S_{22} MAG.	ANG.
50.0000	0.995	–1.5
60.0000	0.993	–1.9
70.0000	0.995	–2.4
80.0000	0.992	–2.7
90.0000	0.993	–2.9
100.0000	0.994	–3.3
110.0000	0.990	–3.6
120.0000	0.989	–4.0
130.0000	0.990	–4.4
140.0000	0.991	–4.7
150.0000	0.990	–4.9
160.0000	0.991	–5.3
170.0000	0.988	–5.6
180.0000	0.988	–6.0
190.0000	0.984	–6.4
200.0000	0.988	–6.5
210.0000	0.984	–7.2
220.0000	0.984	–7.2
230.0000	0.981	–7.4
240.0000	0.983	–7.8
250.0000	0.982	–8.1
260.0000	0.981	–8.8
270.0000	0.979	–8.6
280.0000	0.978	–9.1
290.0000	0.977	–9.2
300.0000	0.978	–9.6

μPC8112TB

$V_{CC} = 3.0$ V, V_{PS} = GND

FERQUENCY MHz	IF port S_{22} MAG.	ANG.
50.0000	0.999	–1.5
60.0000	0.998	–1.9
70.0000	1.000	–2.3
80.0000	0.995	–2.6
90.0000	1.000	–2.8
100.0000	0.998	–3.2
110.0000	0.995	–3.5
120.0000	0.995	–4.0
130.0000	0.996	–4.3
140.0000	0.993	–4.6
150.0000	0.993	–4.7
160.0000	0.992	–5.0
170.0000	0.991	–5.4
180.0000	0.991	–5.8
190.0000	0.987	–5.9
200.0000	0.991	–6.3
210.0000	0.985	–6.8
220.0000	0.987	–6.8
230.0000	0.984	–7.0
240.0000	0.983	–7.5
250.0000	0.984	–7.7
260.0000	0.983	–8.2
270.0000	0.982	–8.3
280.0000	0.982	–8.6
290.0000	0.980	–8.7
300.0000	0.977	–8.9

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