NEC

Application Note

Usage and Applications of 6-Pin Super Mini-Mold Silicon Medium-Power High-Frequency Amplifier MMIC

μPC2708TB/2709TB/2710TB
μPC2762TB/2763TB
μPC2771TB/2776TB

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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.

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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) Apply voltage only to V_{CC} pin and output pin. Do 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.

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1. INTRODUCTION

The application for high-frequency devices has grown to include not only TV/VCR tuners and cable TV converters but also, more recently, DBS, cellular phones, pagers, and GPS. In addition, since the systems are shrinking in size, the ICs used must also become more compact.

NEC has been selling the silicon medium-power high-frequency amplifier ICs μPC2708 to 2710T, μPC2762/63T, and μPC2771/76T, which are 6-pin mini-mold products (size 2915). Now, a new lineup of 6-pin super mini-mold products, which are even smaller, has been released.

This application note introduce application characteristics for the 6-pin super mini-mold silicon medium-power high-frequency amplifier ICs.

See the data sheet for each product for details of the product's ratings, specifications, and use conditions.

2. PRODUCT LINEUP

2.1 Characteristics

Table 2-1 shows the lineup of silicon medium-power high-frequency amplifiers, which are the super mini-mold (size 2012) versions of the existing products, which employ package size 2915.

Table 2-1. 6-Pin Super Mini-Mold Silicon Medium-Power High-Frequency Amplifier MMIC Product Lineup (T_A = +25°C, V_{CC} = V_{out} = 5.0 V or 3.0 V, Z_L = Z_S = 50 Ω)

Part Number (discrete part number)	V_{CC} (V)	f_u (GHz)	$P_{O\ (1dB)}$ (dBm)	$P_{O\ (sat)}$ (dBm)	G_P (dB)	NF (dB)	I_{CC} (mA)	Marking
μPC2708TB	4.5 to 5.5	2.9	–	+10.0	15	6.5	26	C1D
μPC2709TB		2.3	+9.0	+11.5	23	5.0	25	C1E
μPC2710TB		1.0	–	+13.5	33	3.5	22	C1F
μPC2776TB		2.7	+6.5	+8.5	23	6.0	25	C2L
μPC2762TB	2.7 to 3.3	2.9	+8.0	+9.0	13	6.5	26.5	C1Z
μPC2763TB		2.7	+9.5	+11.0	20	5.5	27	C2A
μPC2771TB		2.2	+11.5	+12.5	21	6.0	36	C2H

Remark The above values are typical values for major characteristics. See each product's data sheet for detailed ratings, characteristic, etc.

The same part number is used for the product name. However, "TB" is assigned as the package code for the super mini-mold model, while "T" is assigned for the conventional mini-mold model. The same chip is used for products having the same part number, but the lead frame and package size have been changed to smaller one. Therefore, even though there may be a slight shift in the characteristics due to differences in the lead inductance or package capacitance, the characteristics obtained for the super mini-mold products are practically equivalent to those of the conventional mini-mold products since the same chips are used.

The super mini-mold product weighs approximately half as much as the mini-mold product. The weight of the mini-mold product is 13 mg, while the super mini-mold version is only 7 mg. The markings on the super mini-mold products use the same symbols as the conventional mini-mold products having the same part numbers, but the products can be distinguished by their package sizes. Figure 2-1 shows the external view of the 6-pin super mini-mold package, and Figure 2-2 shows the appearance of the product markings.

Since the theoretical descriptions for the 6-pin super mini-mold products and the 6-pin mini-mold products are the same because the same chips are used, refer to the **Application Note Usage and Application of Silicon Medium-Power High-Frequency Amplifier MMIC μPC1677 to 1679, μPC2708 to 2710, μPC2762/2763, μPC2771/2776 (Document No.: P12152E)** describing the 6-pin mini-mold products.

Figure 2-1. Package Drawing of the 6-Pin Super Mini-Mold Silicon Medium-Power High-Frequency Amplifier MMIC

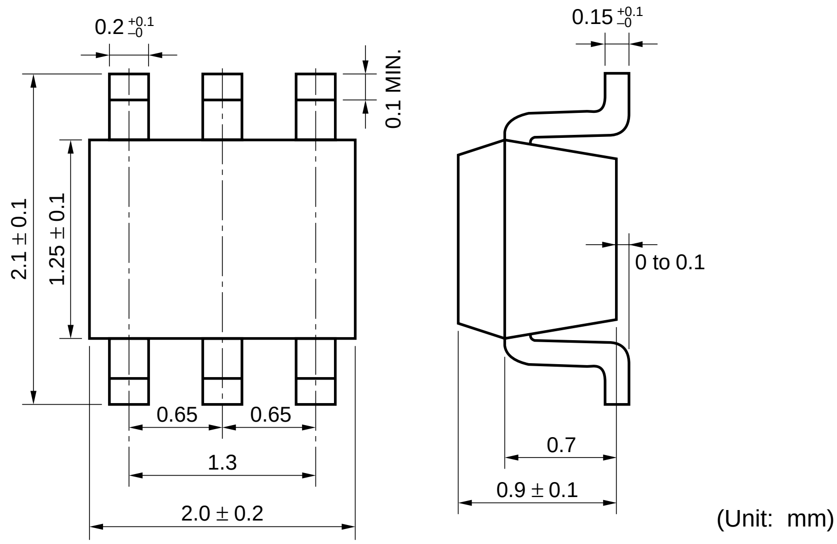
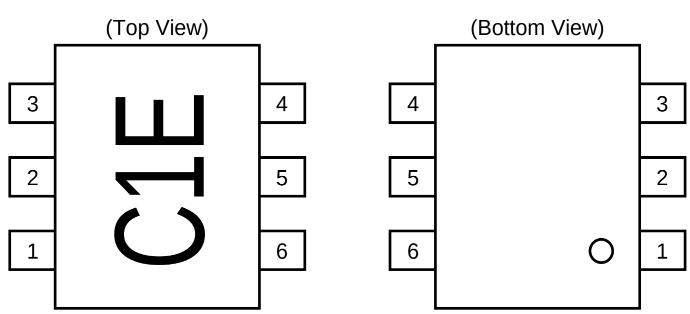


Figure 2-2. Marking Example

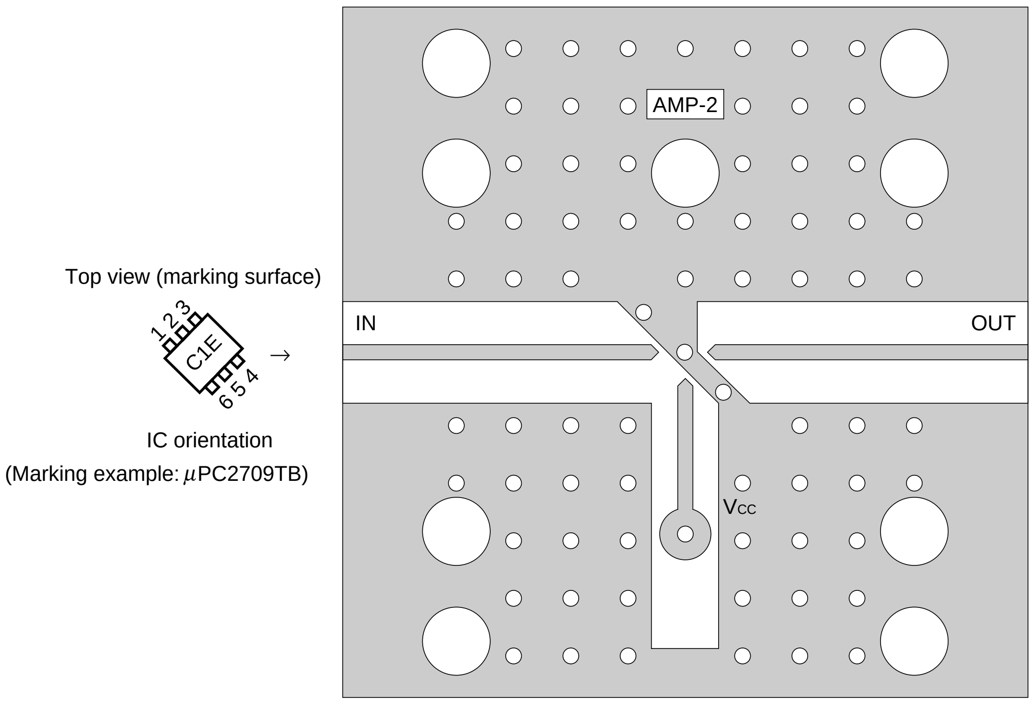


Remark The marking example shown in the above figure corresponds to μPC2709TB.

2.2 Test Circuit

The 6-pin super mini-mold products use the same test circuit, in which a bias-tee is used on the output side, as is used for the conventional 6-pin mini-mold products. Since the package width and pin pitch are smaller, the test board that is used has smaller mount pads. Figure 2-3 shows the layout of the test board AMP2, which is used for the 6-pin super mini-mold products.

Figure 2-3. 6-Pin Super Mini-Mold Common Test Board (AMP2)



Notes on printed board

- Board material... Loss can be reduced depending on the material of PCB. A polyamide double-sided PCB is used to maximize the performance of the IC itself.
- Back side .... Whole surface is ground pattern. Through holes keep the ground characteristics of the IC mounting side.
- Specifications.... AMP2 board dimensions: 30 × 30 × 0.4 (mm), with 35-μm thick copper patterning on both sides

3. APPLICATION CHARACTERISTIC EXAMPLE

The characteristics of the 6-pin super mini-mold products' test circuit, in which a bias-tee is used, are described in the data sheet. This document introduces the results of evaluating whether or not similar characteristics are obtained as were obtained for the conventional 6-pin mini-mold product, when configuring the application circuit on the AMP2 board using similar inductor parts. As the size of these super mini-mold products is smaller, they are expected to be increasingly used in cellular phones. Substantial evaluation data is provided of adjacent channel interference power when inputting PDC, PHS, or GSM modulated signals.

Figure 3-1 shows the application circuit configuration, and Table 3-1 summarizes specifications of the external inductors used for measurements of the application characteristic example.

Figure 3-1. Application Circuit Configuration

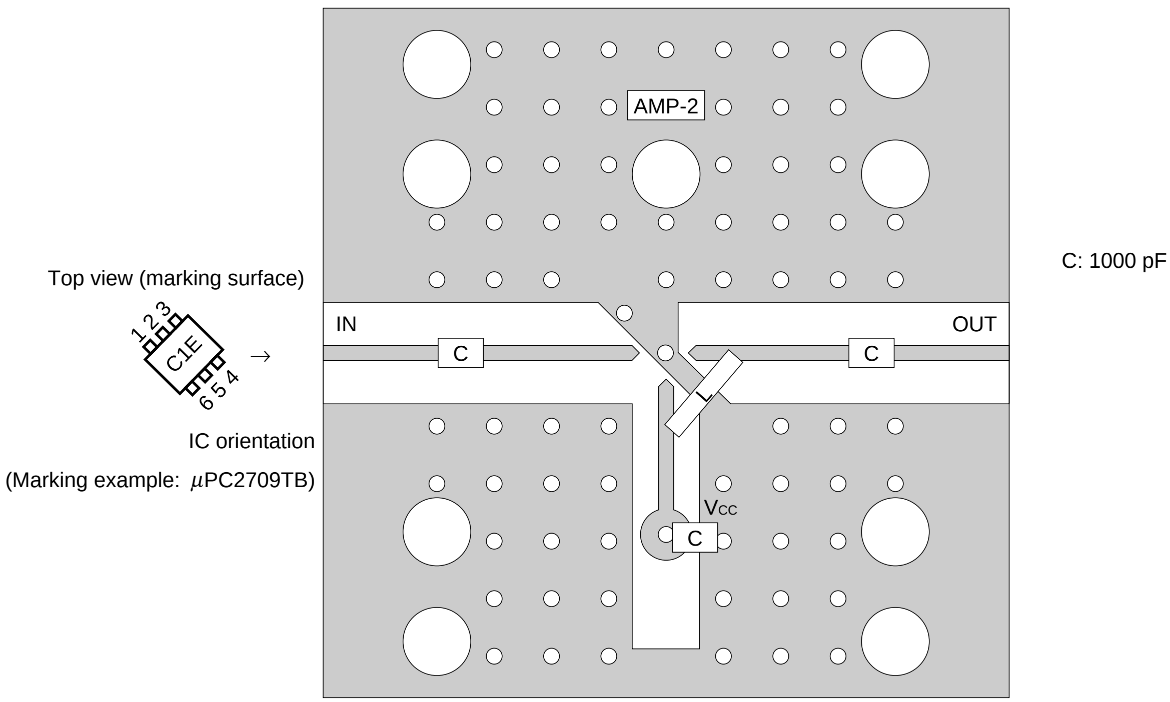


Table 3-1. Summary of Specifications of the External Inductors Used For Measurements of the Application Characteristic Example

Form	Manufacturer Name	Product Name	Inductance	Q	DC Resistance	Self-Resonance Frequency	Allowable Current
Wire-wound chip inductor	TOKO	FSLU2520-***	10-nH to 300-nH	15 to 30 MIN.	0.15 to 0.42 Ω	360 to 2300 MHz	380 to 790 mA

3.1 μPC2708TB, μPC2709TB, μPC2710TB

The external inductor values vs. gain frequency characteristics of the μPC2708TB, μPC2709TB, and μPC2710TB were measured using similar wire-wound chip inductors as were externally attached to the μPC2708T, μPC2709T, and μPC2710T. Figures 3-2, 3-3, and 3-4 show those characteristics. Since the μPC2708TB, μPC2709TB, and μPC2710TB have a circuit in which the output pin and the input-state/output-state peaking capacitance are linked, the peaking frequency is easily shifted to a higher frequency according to the external inductor value at the output pin. When a 10-nH inductor was used in this evaluation, a gain of approximately 22 dB was ensured at 2.7 GHz. Next, the 10-nH inductor was used to evaluate the characteristics of when these ICs are used in a frequency band of 1 GHz or more. Figures 3-5, 3-6, and 3-7 show those characteristics.

Figure 3-2. μPC2708TB Power Gain vs. Frequency Characteristics External Inductor Value Dependencies (Conditions: T_A = +25°C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)

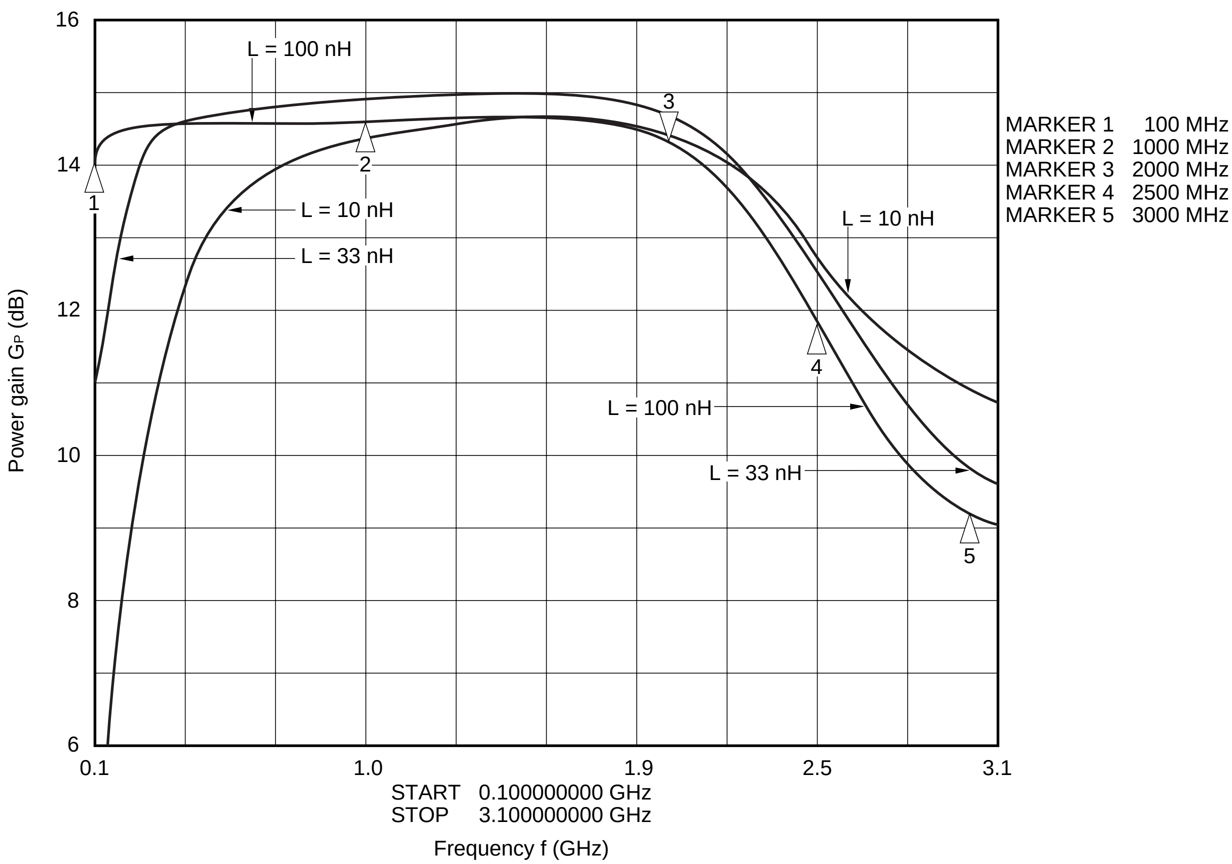


Figure 3-3. μPC2709TB Power Gain vs. Frequency Characteristic External Inductor Value Dependencies (Conditions: T_A = +25°C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)

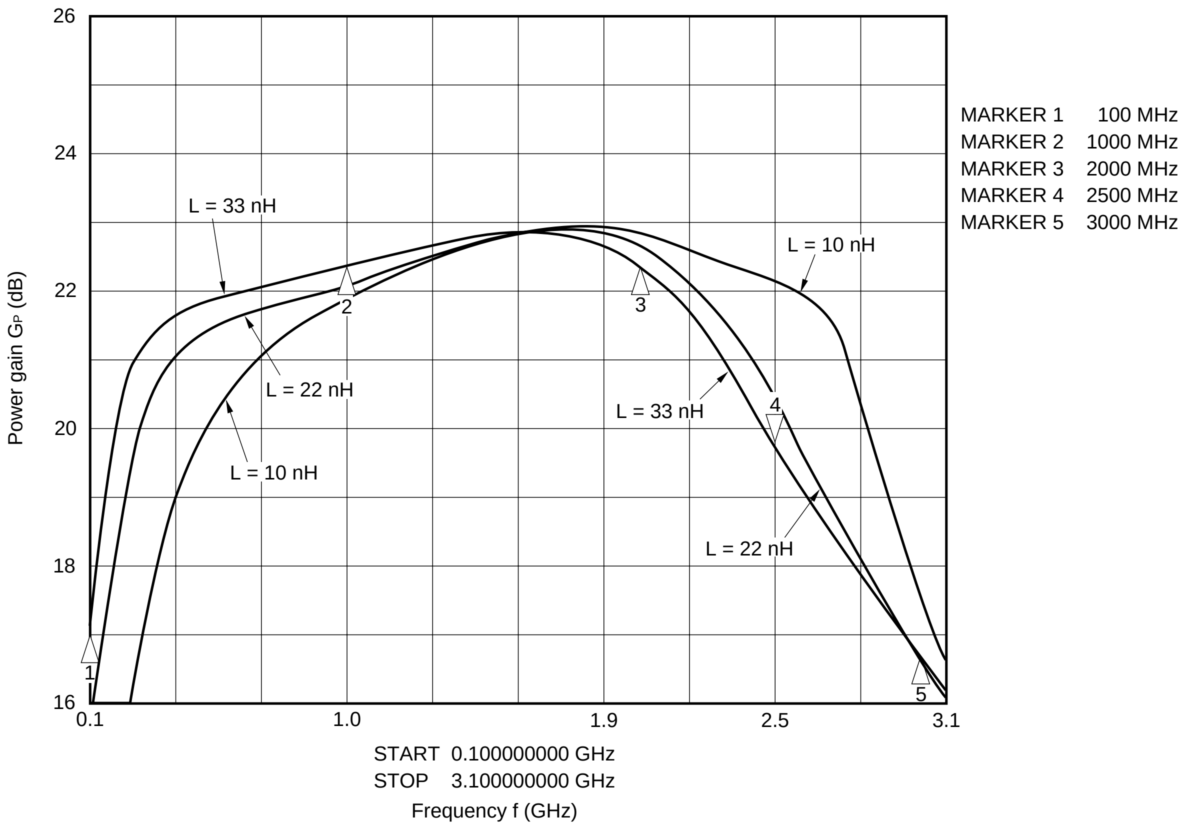


Figure 3-4. μPC2710TB Power Gain vs. Frequency Characteristics External Inductor Value Dependencies (Conditions: T_A = +25°C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)

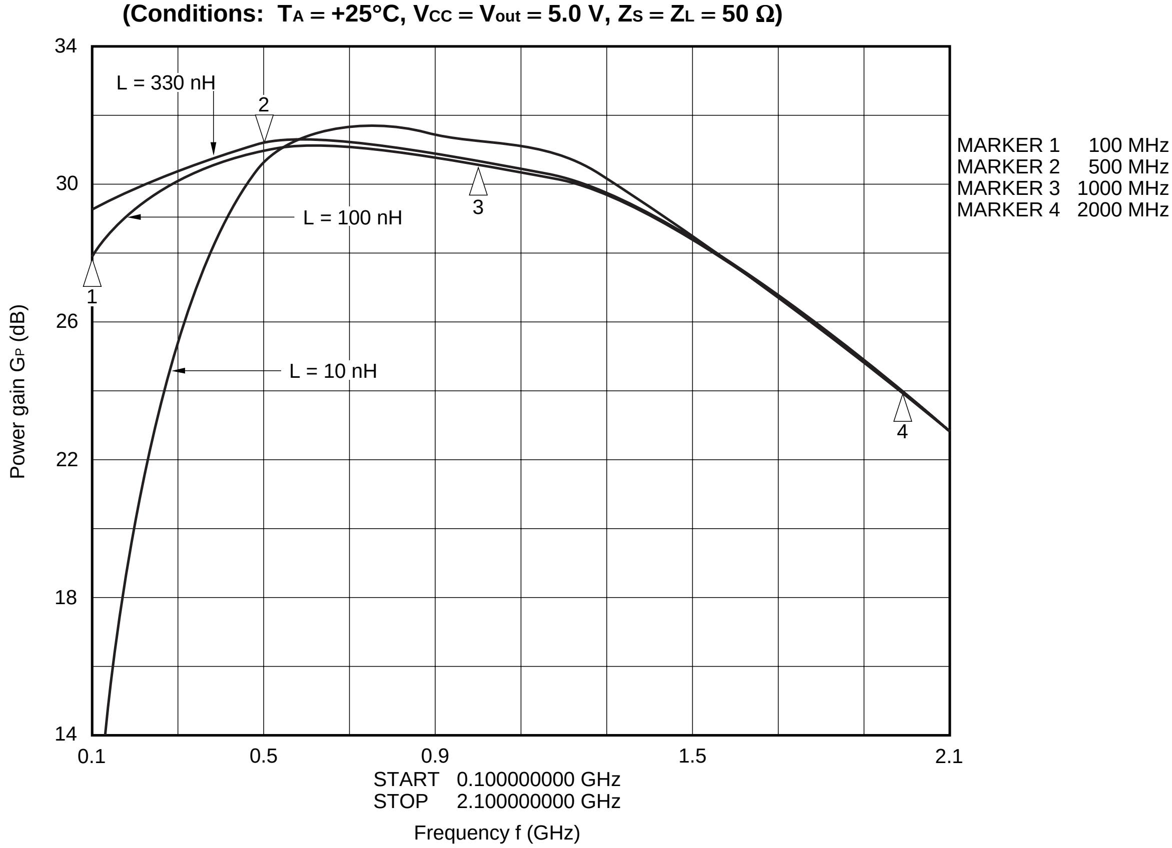


Figure 3-5. μPC2708TB Frequency Characteristics with 10-nH Inductor (1/2)
(Conditions: T_A = +25°C, V_{CC} = V_{out}, Z_S = Z_L = 50 Ω)

Output Power vs. Input Power

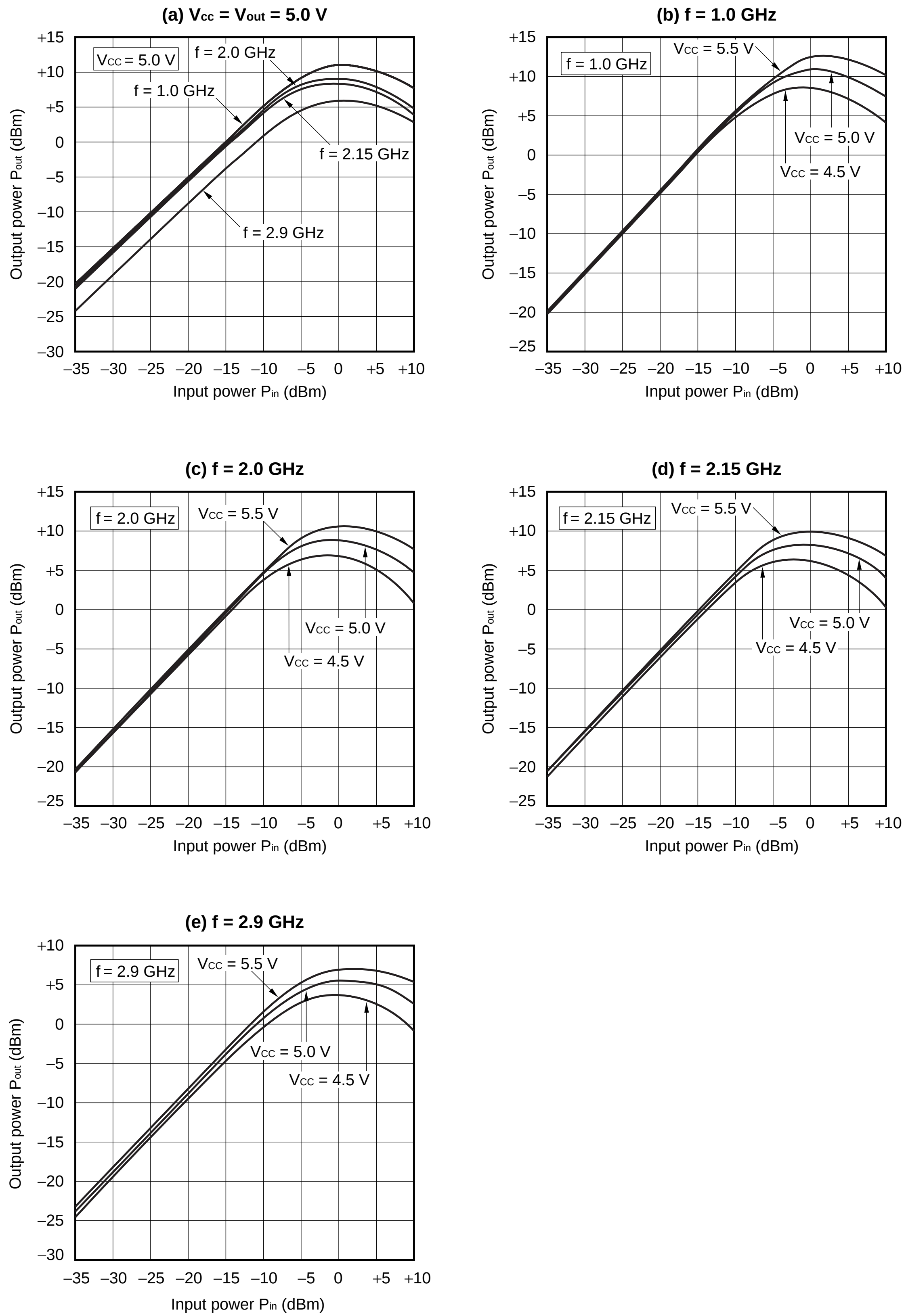


Figure 3-5. μPC2708TB Frequency Characteristics with 10-nH Inductor (2/2)
(Conditions: $T_A = +25°C$, $V_{CC} = V_{out}$, $Z_S = Z_L = 50\ \Omega$)

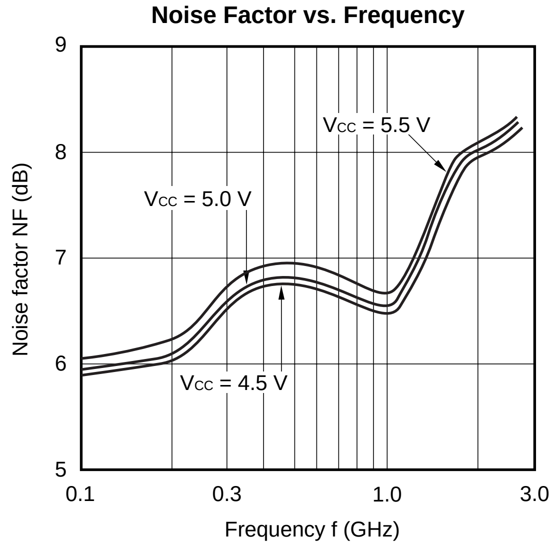


Figure 3-6. μPC2709TB Frequency Characteristics with 10-nH Inductor
(Conditions: T_A = +25°C, V_{CC} = V_{out}, Z_S = Z_L = 50 Ω)

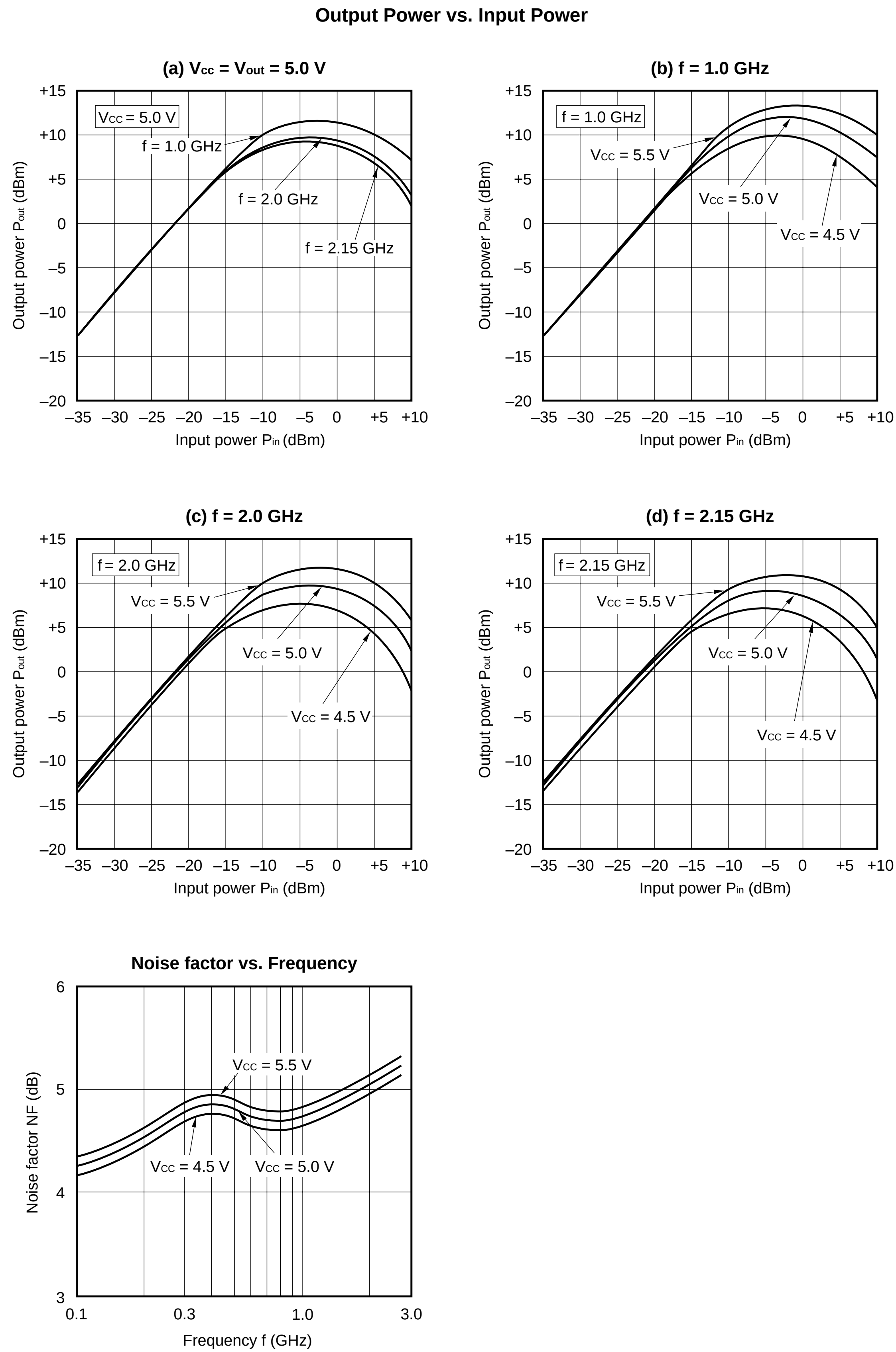
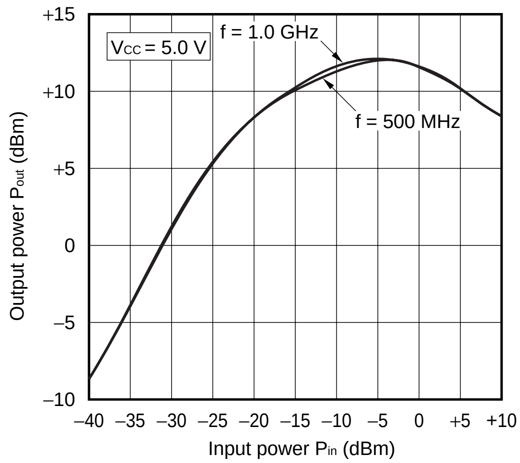


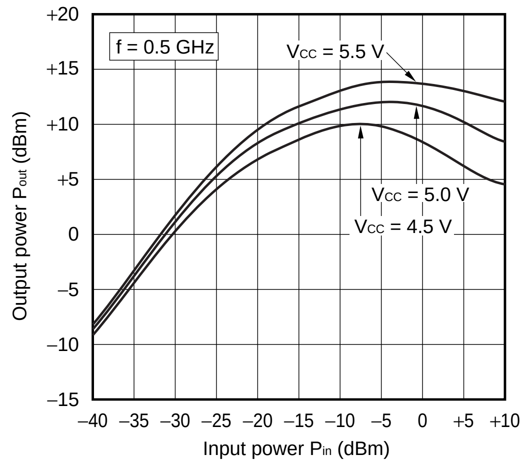
Figure 3-7. μPC2710TB Frequency Characteristics with 10-nH Inductor
(Conditions: T_A = +25°C, V_{CC} = V_{out}, Z_S = Z_L = 50 Ω)

Output Power vs. Input Power

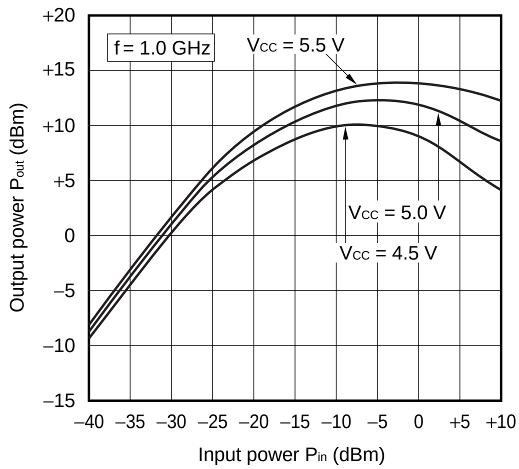
(a) V_{cc} = V_{out} = 5.0 V



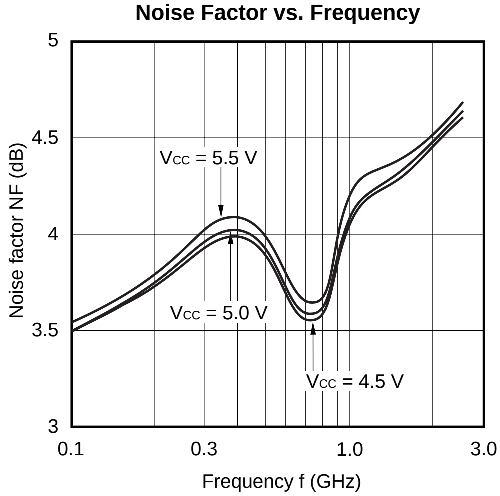
(b) f = 0.5 GHz



(c) f = 1.0 GHz



Noise Factor vs. Frequency



3.2 μPC2762TB, μPC2763TB, μPC2771TB

The external inductor values vs. gain frequency characteristics of the μPC2762TB, μPC2763TB, and μPC2771TB were measured using similar wire-wound chip inductors as were attached to the μPC2762T, μPC2763T, and μPC2771T. Figures 3-8, 3-9, and 3-10 show those characteristics.

For the μPC2762TB, reducing the inductor value increased the maximum gain, shifted the curve towards the higher frequency region, and narrowed the band in which the higher gain values occurred. For the μPC2763TB and μPC2771TB, although the gain did not vary when the inductor value changed, reducing the inductor value shifted the curve towards the higher frequency region. Next, as an application characteristic when these ICs are used in the transmission stage of a mobile communications device, the adjacent channel interference power was measured in an application circuit using a 300-nH inductor. The measurement conditions were applied using the PDC800M, PDC1.5G, PHS (1.9 GHz), and GSM900.

For the μPC2762TB, μPC2763TB, and μPC2771TB, the adjacent channel interference power in the linear region had a satisfactory value of –60 dBc or less with detuning at each frequency. Also, for the GSM900 conditions, even the adjacent channel interference power in the saturated region had a satisfactory value of –60 dBc or less with detuning at ±400 kHz. Figures 3-11, 3-12, and 3-13 show these characteristics.

Figure 3-8. μPC2762TB Power Gain vs. Frequency Characteristic External Inductor Value Dependencies (Conditions: T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω)

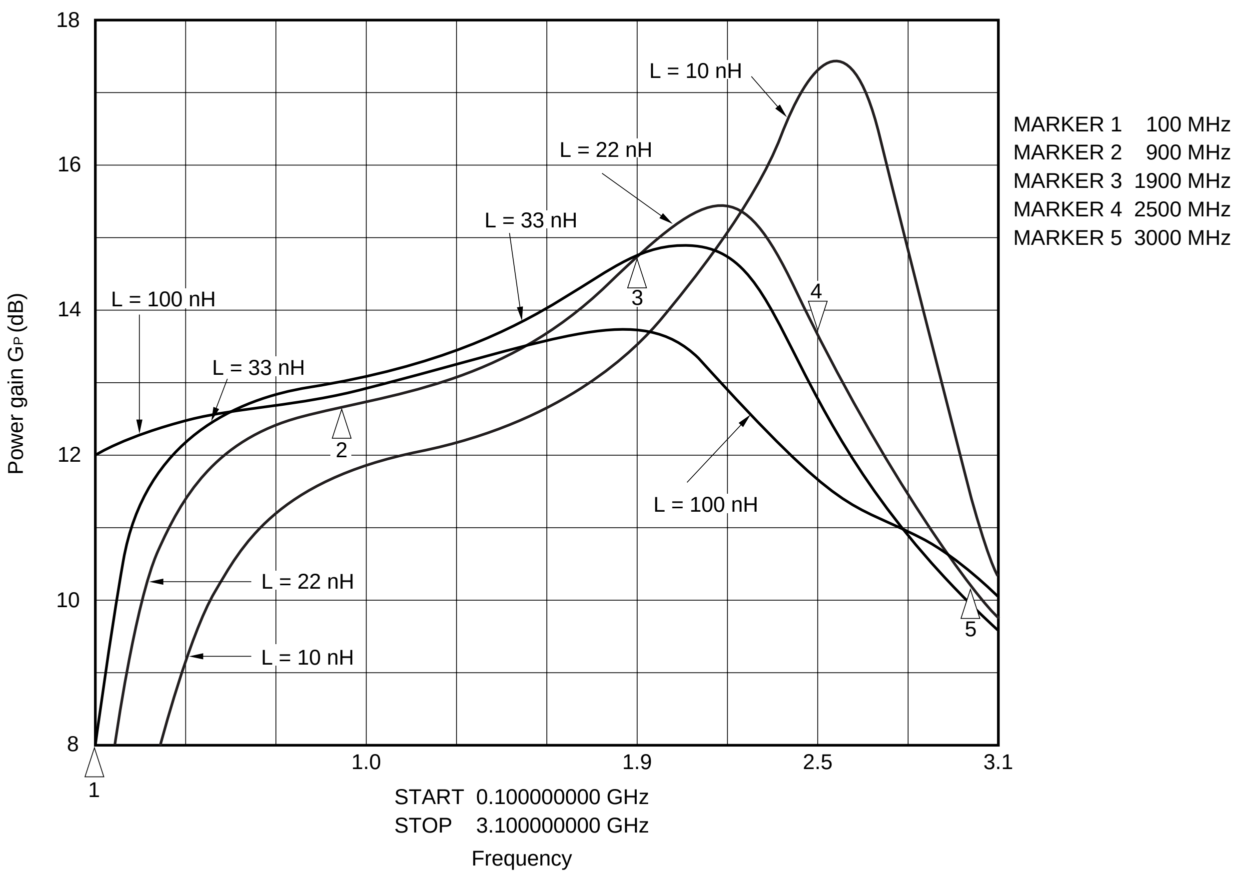


Figure 3-9. μPC2763TB Power Gain vs. Frequency Characteristic External Inductor Value Dependencies (Conditions: T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω)

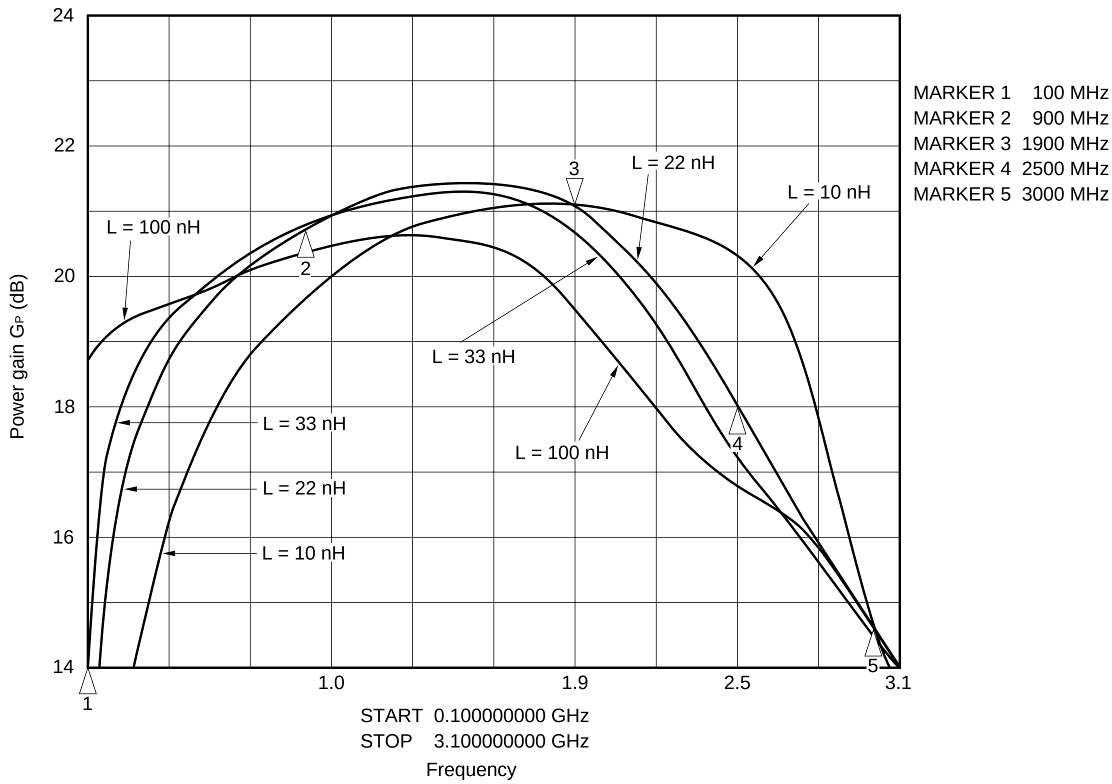


Figure 3-10. μPC2771TB Power Gain vs. Frequency Characteristic External Inductor Value Dependencies (Conditions: T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω)

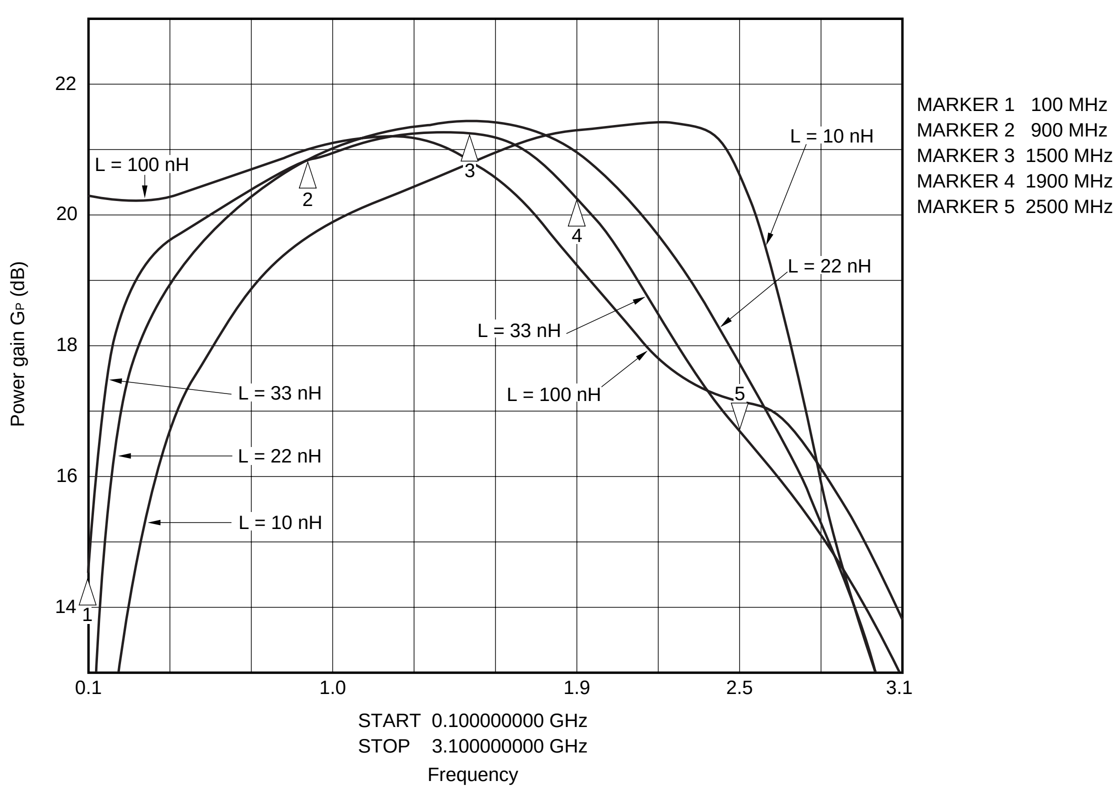
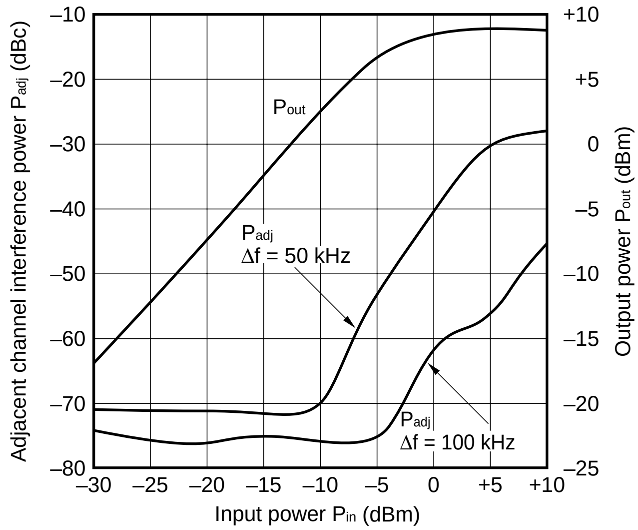


Figure 3-11. μPC2762TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (1/4)

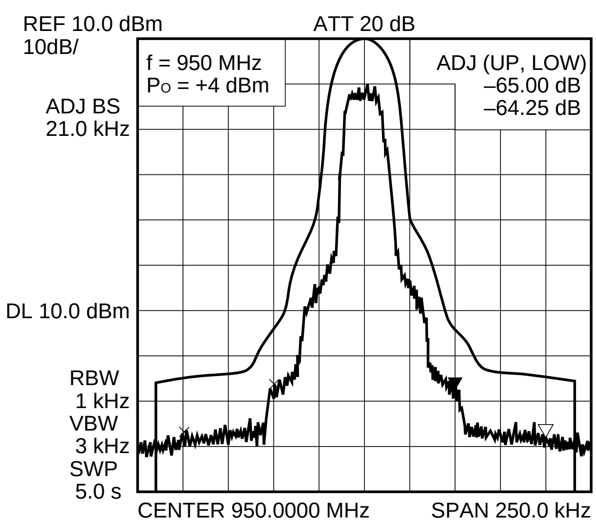
a) **Input frequency f_{in} = 950 MHz**

(Input wave conditions: π/4 QPSK modulated signal input, transmission rate 42 kbps, roll-off rate = 0.5, PN9 stage (pseudo-random pattern))

Adjacent channel interference power, Output power vs. Input power



Padj waveform (linear region)



Padj waveform (saturated region)

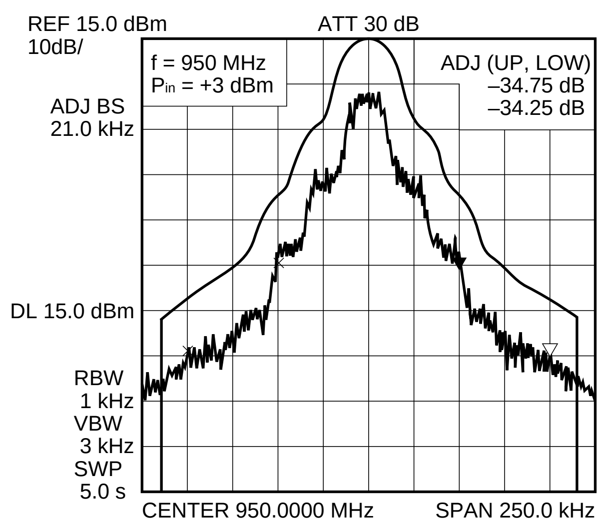
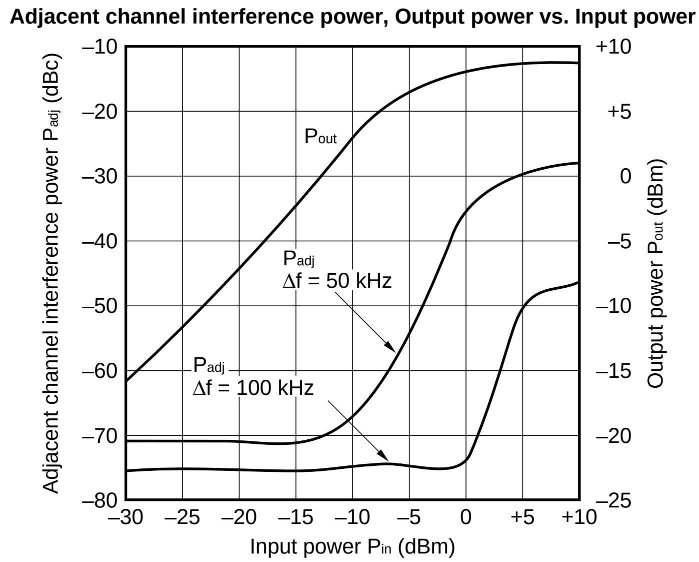
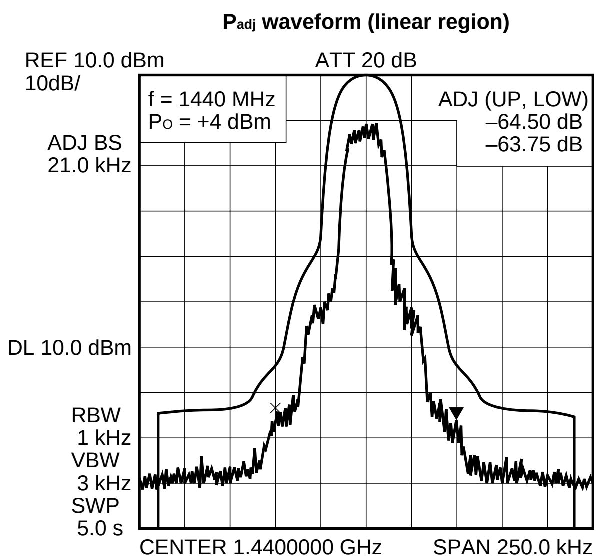


Figure 3-11. μPC2762TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (2/4)

b) Input frequency f_{in} = 1440 MHz
(Input wave conditions: π/4 QPSK modulated signal input, transmission rate 42 kbps, roll-off rate = 0.5, PN9 stage (pseudo-random pattern))





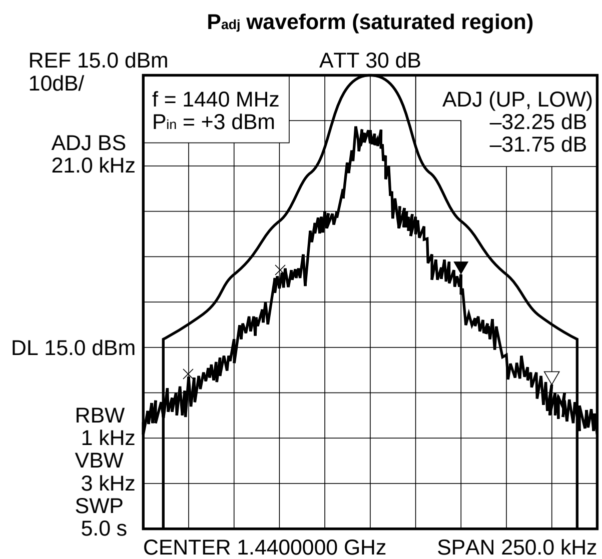
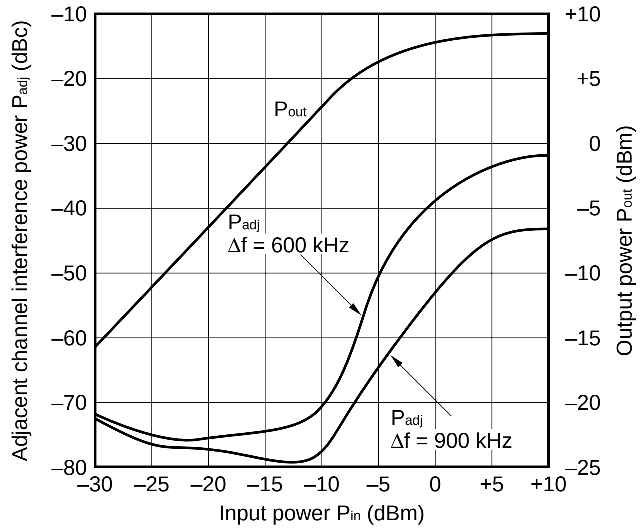


Figure 3-11. μPC2762TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (3/4)

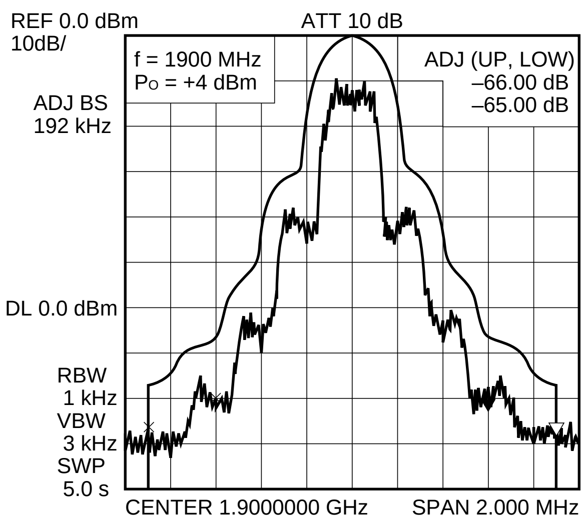
c) **Input frequency f_{in} = 1900 MHz**

(Input wave conditions: π/4 QPSK modulated signal input, transmission rate 384 kbps, roll-off rate = 0.5, PN9 stage (pseudo-random pattern))

Adjacent channel interference power, Output power vs. Input power



P_{adj} waveform (linear region)



P_{adj} waveform (saturated region)

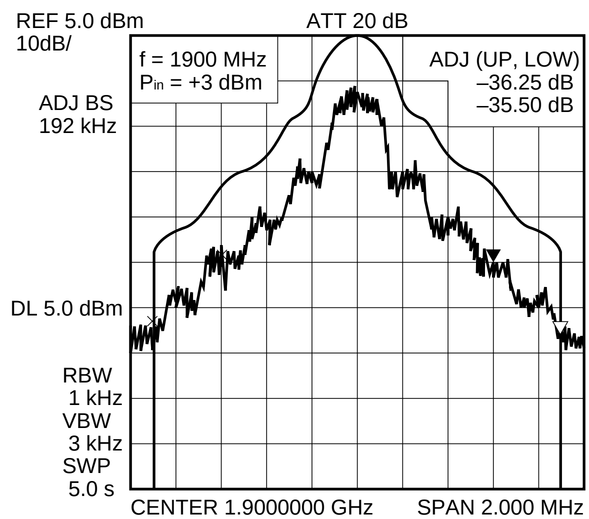
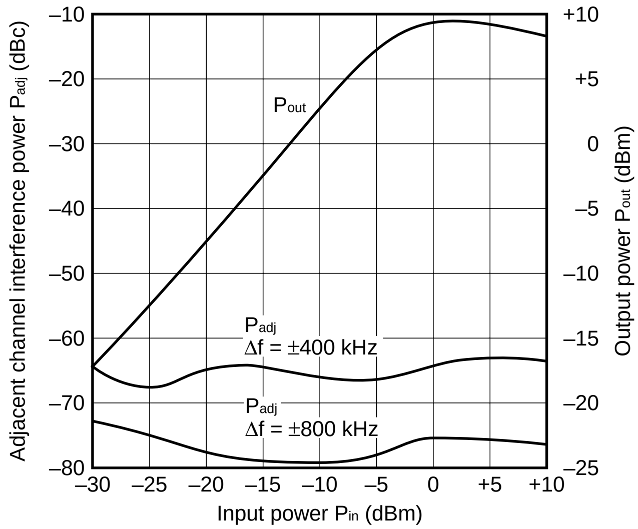


Figure 3-11. μPC2762TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (4/4)

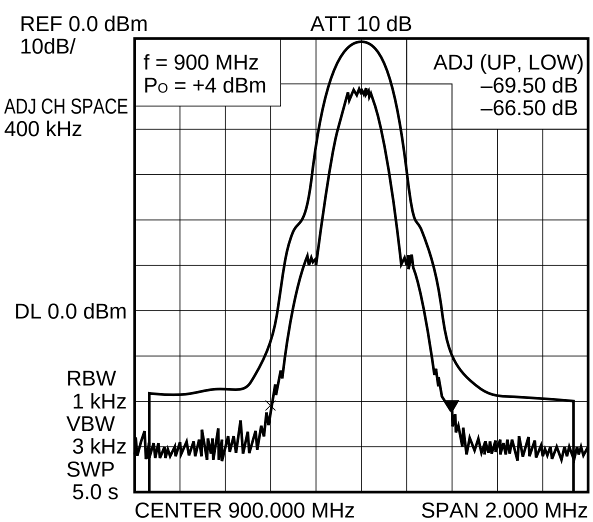
d) Input frequency f_{in} = 900 MHz

(Input wave conditions: GMSK modulated signal input, transmission rate 270.833 kbps, roll-off rate = 0.3, PN9 stage (pseudo-random pattern))

Adjacent channel interference power, Output power vs. Input power



Padj waveform (linear region)



Padj waveform (saturated region)

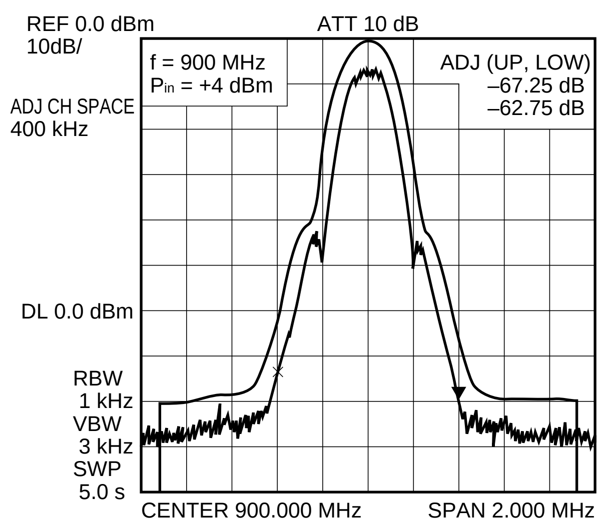
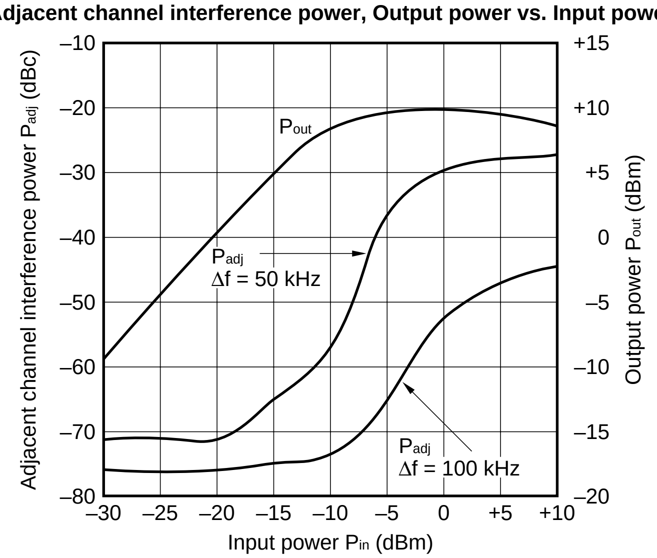
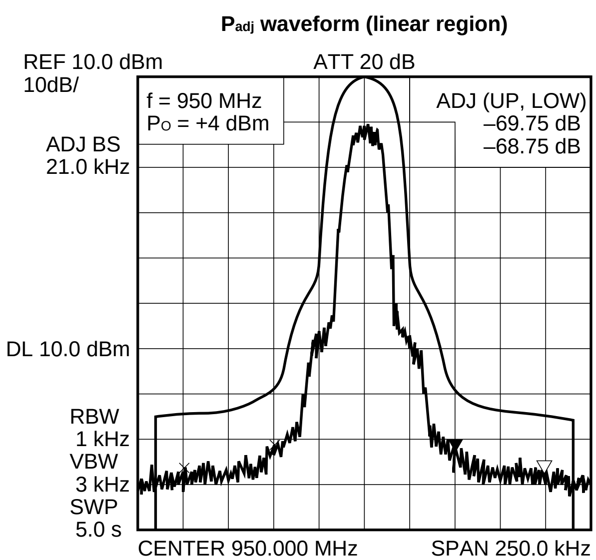


Figure 3-12. μPC2763TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (1/4)

a) **Input frequency f_{in} = 950 MHz**

(Input wave conditions: π/4 QPSK modulated signal input, transmission rate 42 kbps, roll-off rate = 0.5, PN9 stage (pseudo-random pattern))





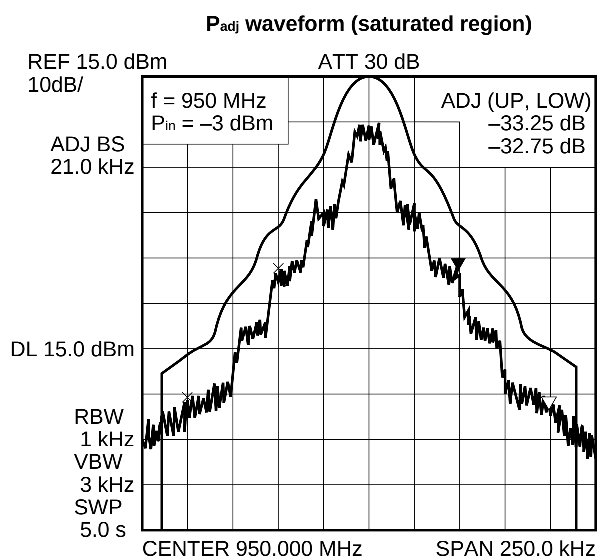
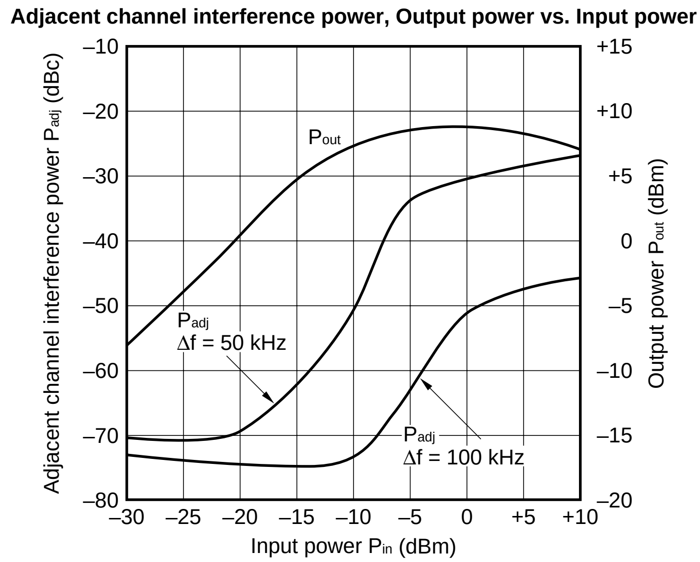
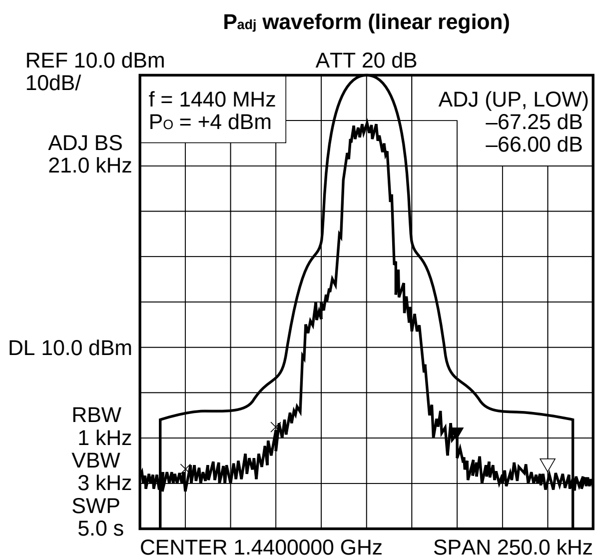


Figure 3-12. μPC2763TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (2/4)

b) Input frequency f_{in} = 1440 MHz

(Input wave conditions: π/4 QPSK modulated signal input, transmission rate 42 kbps, roll-off rate = 0.5, PN9 stage (pseudo-random pattern))





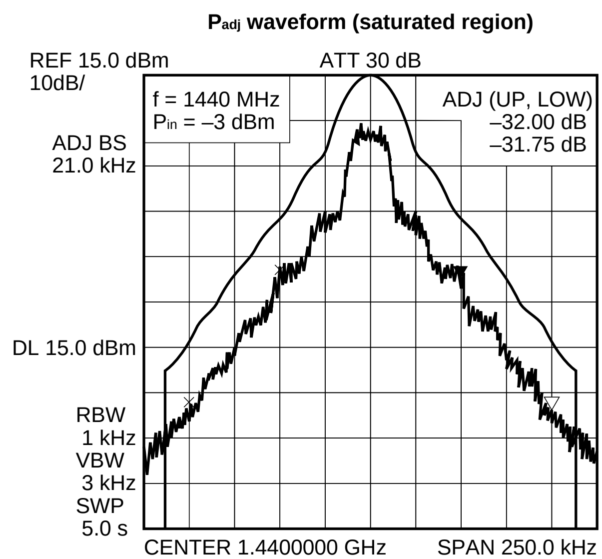
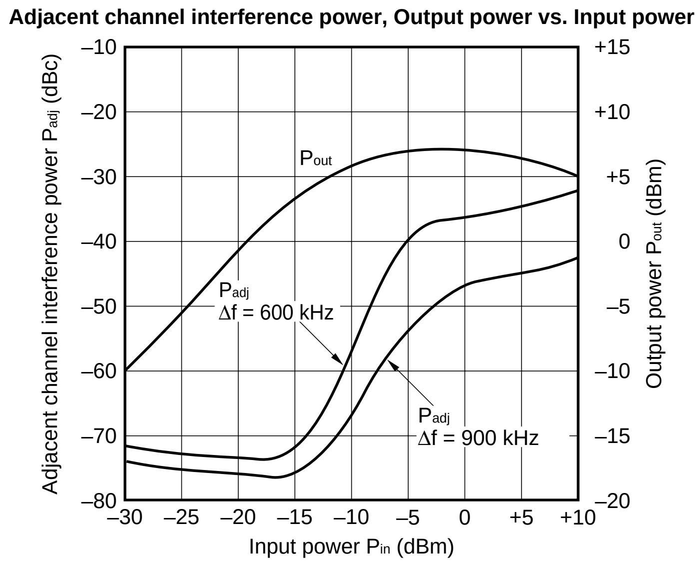
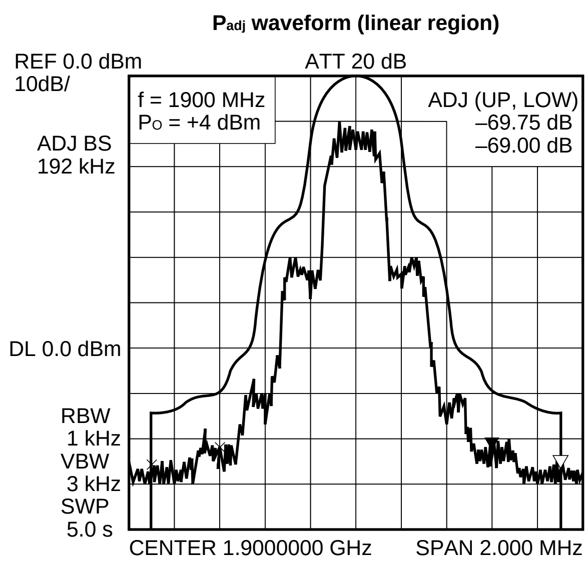


Figure 3-12. μPC2763TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (3/4)

c) Input frequency f_{in} = 1900 MHz
(Input wave conditions: π/4 QPSK modulated signal input, transmission rate 384 kbps, roll-off rate = 0.5, PN9 stage (pseudo-random pattern))





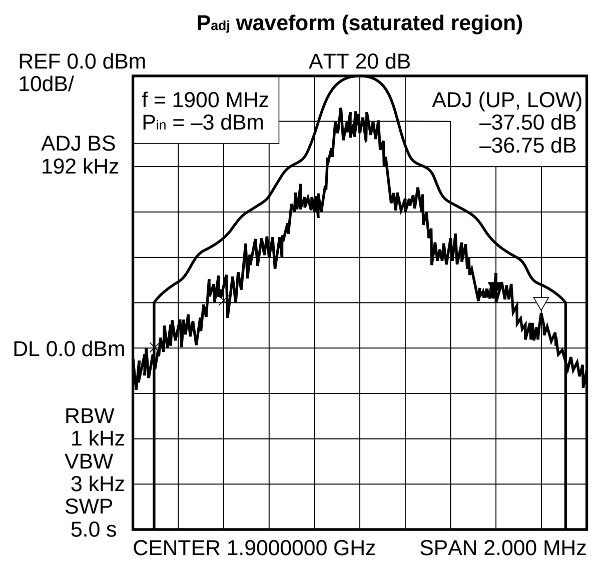
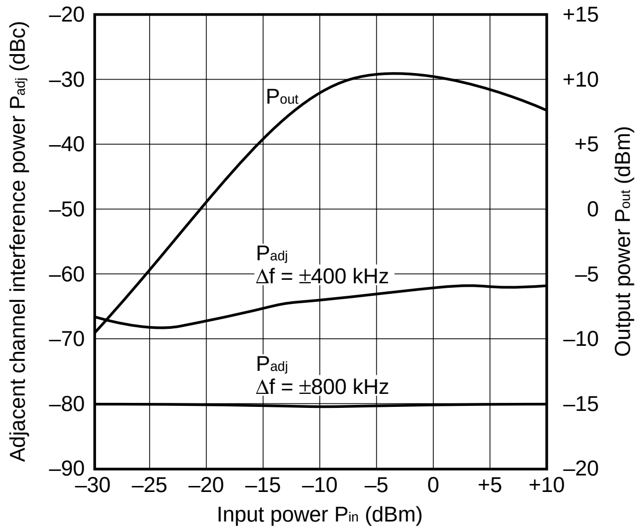


Figure 3-12. μPC2763TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (4/4)

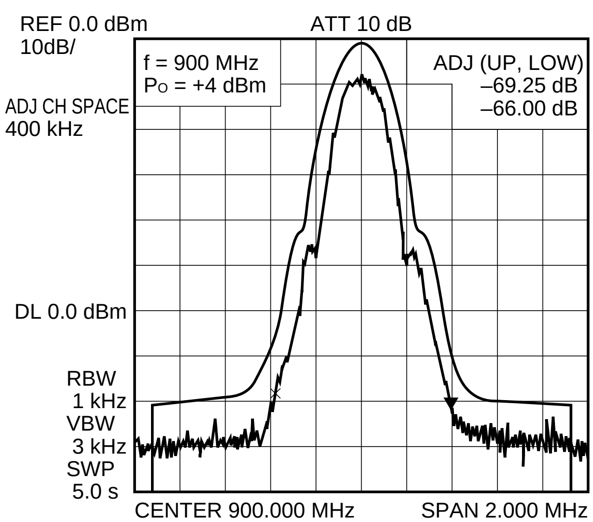
d) Input frequency f_{in} = 900 MHz

(Input wave conditions: GMSK modulated signal input, transmission rate 270.833 kbps, roll-off rate = 0.3, PN9 stage (pseudo-random pattern))

Adjacent channel interference power, Output power vs. Input power



P_{adj} waveform (linear region)



P_{adj} waveform (saturated region)

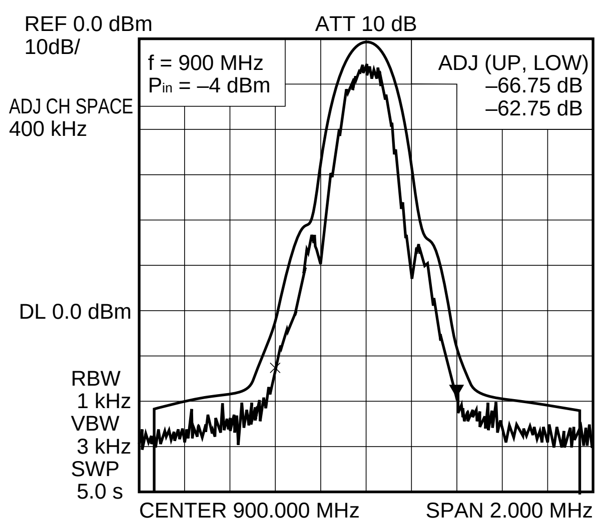
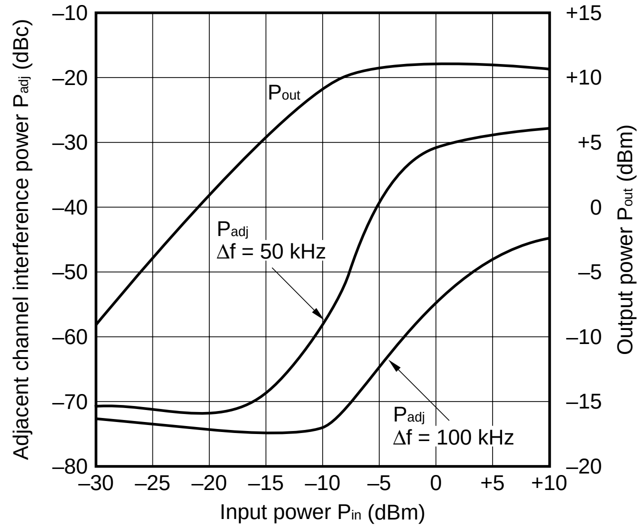


Figure 3-13. μPC2771TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (1/4)

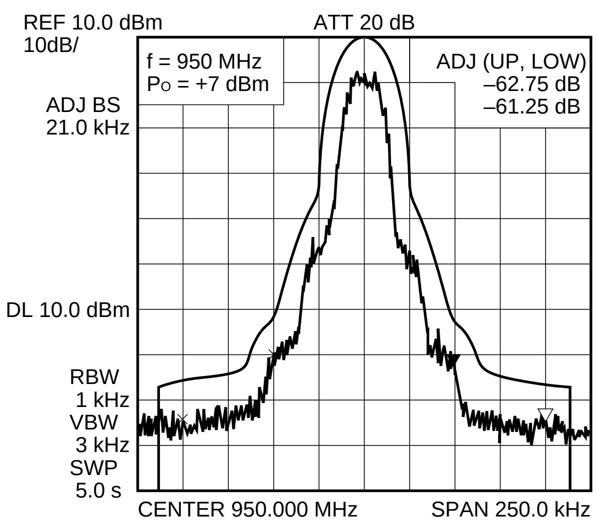
a) **Input frequency f_{in} = 950 MHz**

(Input wave conditions: π/4 QPSK modulated signal input, transmission rate 42 kbps, roll-off rate = 0.5, PN9 stage (pseudo-random pattern))

Adjacent channel interference power, Output power vs. Input power



Padj waveform (linear region)



Padj waveform (saturated region)

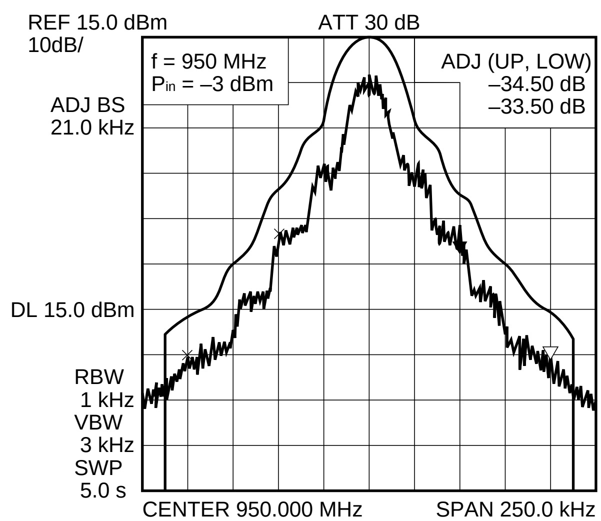
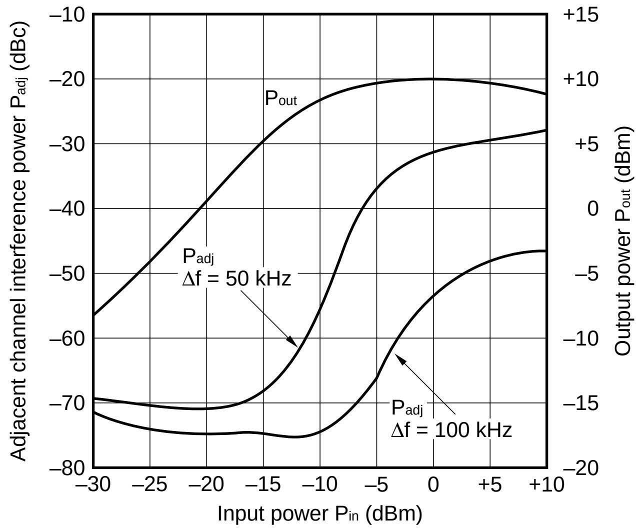


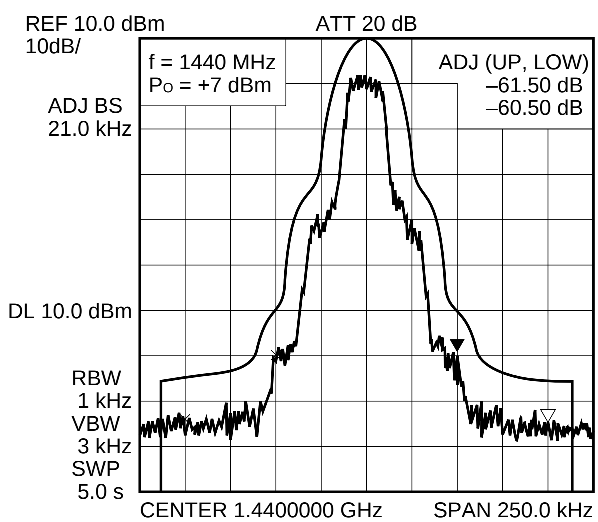
Figure 3-13. μPC2771TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (2/4)

b) Input frequency f_{in} = 1440 MHz
(Input wave conditions: π/4 QPSK modulated signal input, transmission rate 42 kbps, roll-off rate = 0.5, PN9 stage (pseudo-random pattern))

Adjacent channel interference power, Output power vs. Input power



Padj waveform (linear region)



Padj waveform (saturated region)

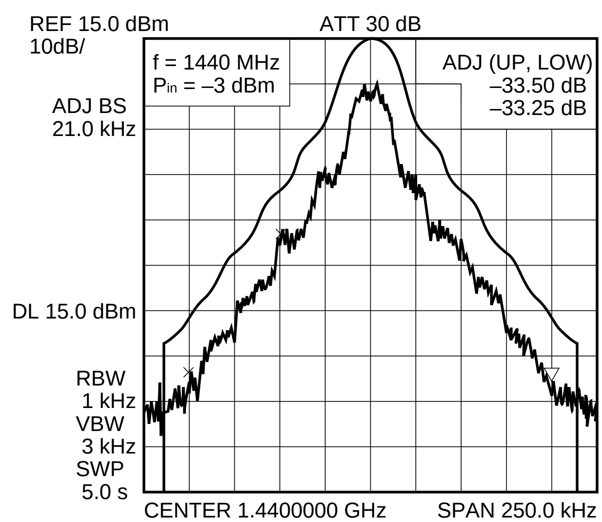
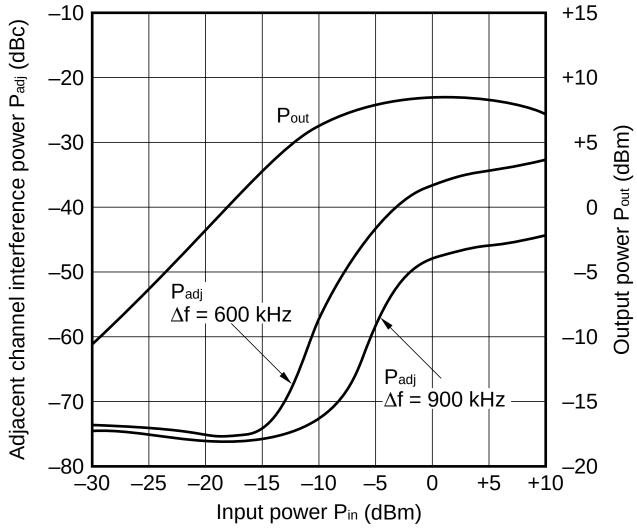


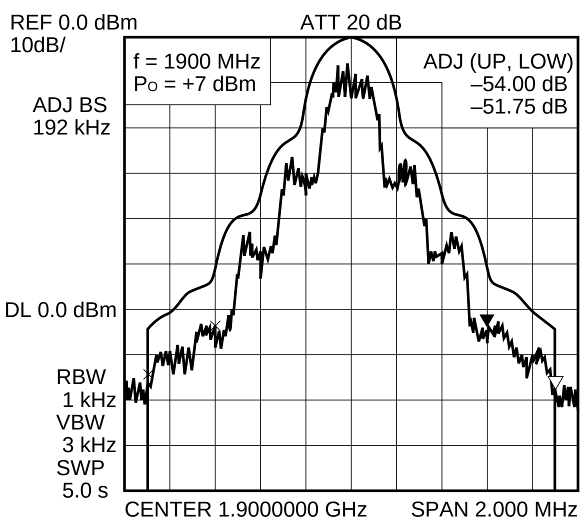
Figure 3-13. µPC2771TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (3/4)

c) Input frequency f_{in} = 1900 MHz
(Input wave conditions: π/4 QPSK modulated signal input, transmission rate 384 kbps, roll-off rate = 0.5, PN9 stage (pseudo-random pattern))

Adjacent channel interference power, Output power vs. Input power



Padj waveform (linear region)



Padj waveform (saturated region)

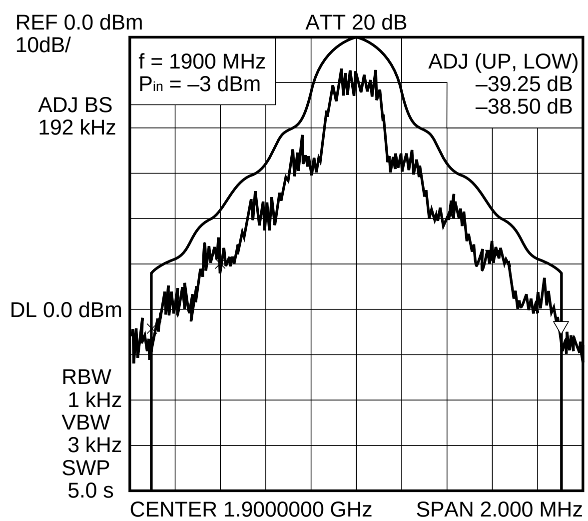
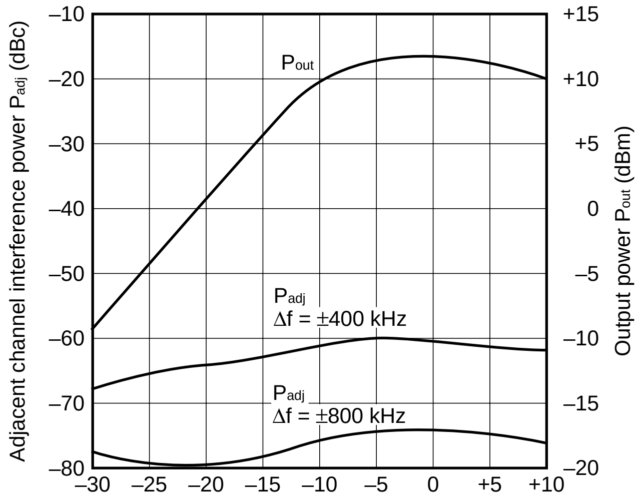


Figure 3-13. μPC2771TB Adjacent Channel Interference Power Characteristics with 300-nH Inductor (4/4)

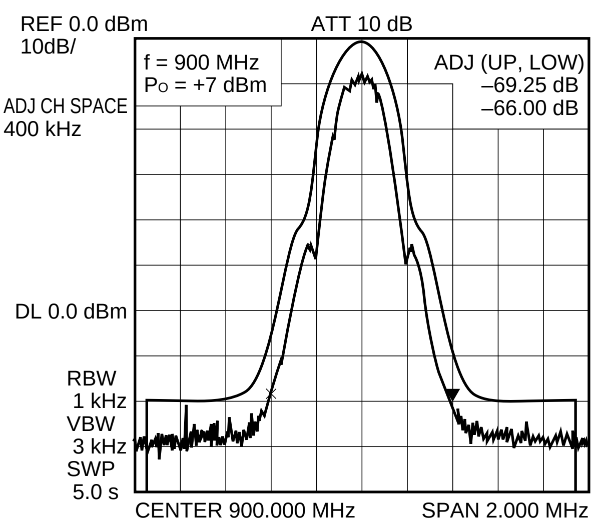
d) Input frequency f_{in} = 900 MHz

(Input wave conditions: GMSK modulated signal input, transmission rate 270.833 kbps, roll-off rate = 0.3, PN9 stage (pseudo-random pattern))

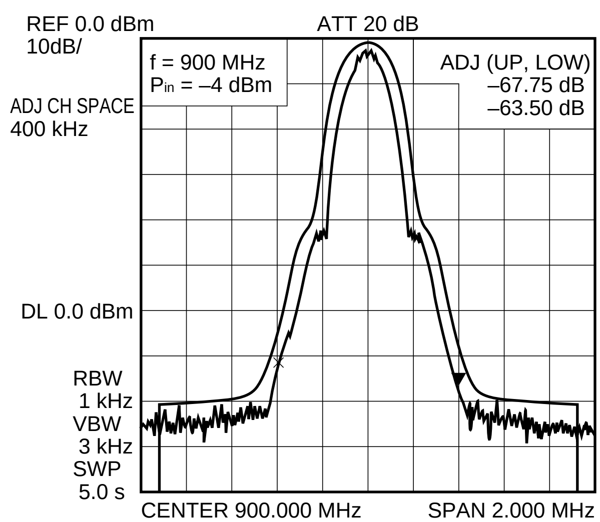
Adjacent channel interference power, Output power vs. Input power



Padj waveform (linear region)



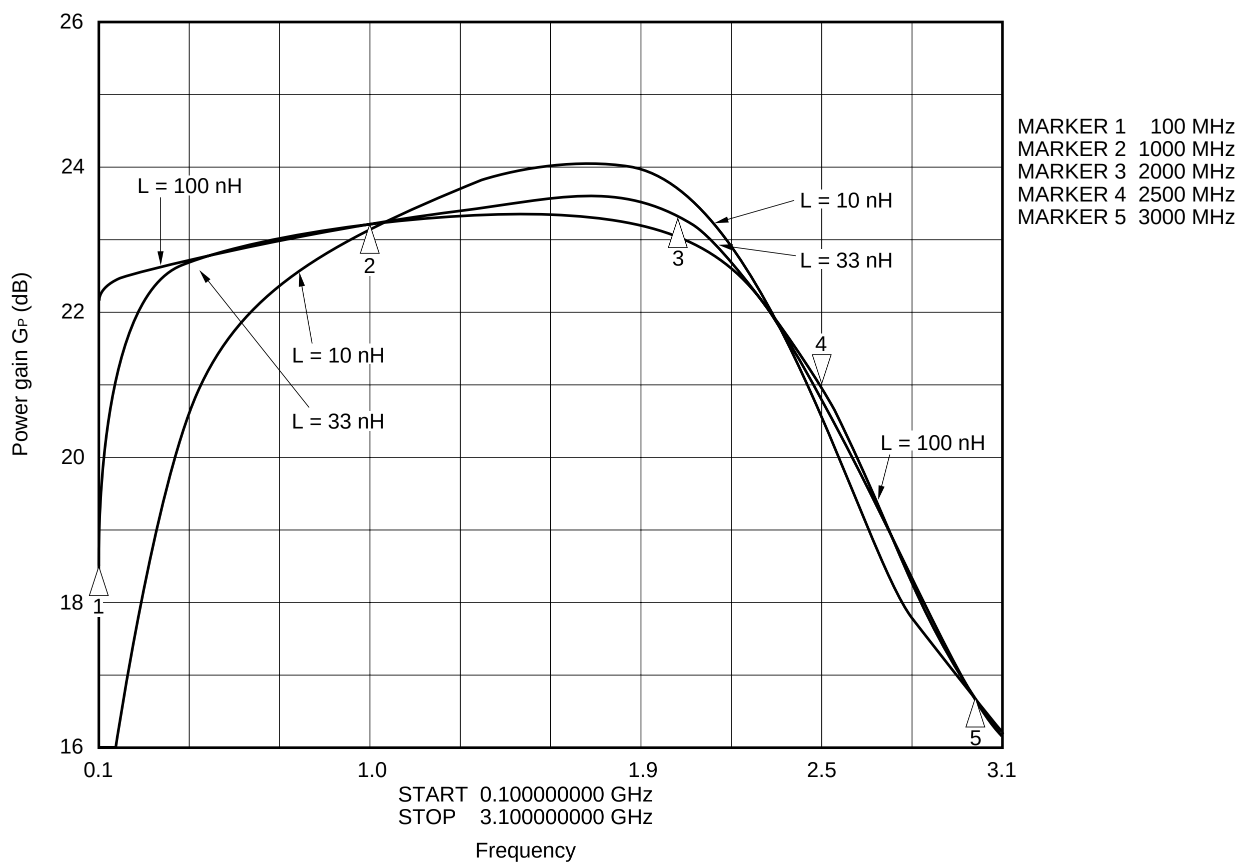
Padj waveform (saturated region)



3.3 μPC2776TB

The external inductor values and gain frequency characteristics of the μPC2776TB were measured using similar wire-wound chip inductors as were attached to the μPC2776T. Figure 3-14 shows those characteristics. Since the output-side characteristic impedance of the μPC2776TB below the VHF band is close to 50 Ω, using an external inductor value greater than or equal to 100 nH makes the μPC2776TB suitable for applications in the VHF band. Also, the curves in Figure 3-14 show that a wide area shift of frequencies cannot be achieved by reducing the inductor value as can be done for the μPC2709TB since an internal circuit insensitive to load variations is used for the μPC2776TB.

Figure 3-14. μPC2776TB Power Gain vs. Frequency Characteristic External Inductor Value Dependencies (Conditions: T_A = +25°C, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)



4. CONCLUSION

This application note introduced the application characteristics for the 6-pin super mini-molded μPC2708TB, μPC2709TB, μPC2710TB, μPC2762TB, μPC2763TB, μPC2771TB, and μPC2776TB and described how they differ from the conventional 6-pin mini-mold products. Readers can see that similar characteristics are obtained even though the external form has been reduced in size.

References

- Application Note Usage and Application of Silicon Medium-Power High-Frequency Amplifier MMIC μPC1677 to 1679, μPC2708 to 2710, μPC2762/2763, μPC2771/2776 (Document No. P12152E)
- Data sheet for each product
  μPC2708TB (Document No. P13442E)
  μPC2709TB (Document No. P12653E)
  μPC2710TB (Document No. P13443E)
  μPC2762TB/2763TB/2771TB (Document No. P12710E)
  μPC2776TB (Document No. P12680E)

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

μPC2708TB

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

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

μPC2709TB

V_{CC} = V_{out} = 5.0 V, I_{CC} = 26 mA

FREQUENCY	S11		S21		S12		S22		K
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG	
100.0000	0.227	0.2	13.698	–4.5	0.027	–1.0	0.196	0.9	1.37
200.0000	0.239	1.0	13.724	–9.6	0.027	3.1	0.207	2.2	1.36
300.0000	0.245	2.9	13.830	–14.5	0.026	4.7	0.212	4.1	1.38
400.0000	0.244	2.5	13.998	–19.9	0.027	7.8	0.223	3.4	1.32
500.0000	0.243	1.5	14.109	–25.0	0.026	9.8	0.234	2.1	1.33
600.0000	0.247	–1.5	14.246	–30.4	0.027	11.9	0.252	–0.4	1.26
700.0000	0.265	–3.2	14.538	–35.5	0.028	13.6	0.270	–2.3	1.20
800.0000	0.284	–3.6	14.703	–41.3	0.028	14.9	0.287	–4.6	1.15
900.0000	0.301	–3.3	15.051	–47.0	0.028	17.2	0.298	–7.4	1.10
1000.0000	0.305	–2.4	15.331	–53.5	0.029	18.8	0.309	–11.9	1.05
1100.0000	0.299	–3.2	15.605	–60.0	0.029	20.9	0.322	–17.1	1.04
1200.0000	0.300	–6.3	15.773	–66.7	0.029	22.5	0.336	–21.5	1.01
1300.0000	0.314	–10.3	16.152	–74.0	0.030	23.8	0.353	–24.8	0.95
1400.0000	0.328	–14.4	16.282	–81.0	0.030	26.1	0.353	–28.8	0.93
1500.0000	0.354	–17.3	16.337	–89.3	0.032	25.6	0.368	–35.5	0.86
1600.0000	0.359	–19.5	16.370	–96.5	0.031	26.8	0.370	–41.8	0.86
1700.0000	0.373	–22.1	16.256	–104.5	0.033	28.0	0.382	–46.9	0.81
1800.0000	0.371	–26.8	15.977	–112.7	0.032	29.3	0.381	–52.8	0.83
1900.0000	0.379	–31.1	15.529	–120.5	0.033	31.3	0.378	–57.8	0.83
2000.0000	0.386	–36.0	15.307	–128.1	0.034	31.0	0.373	–64.1	0.82
2100.0000	0.387	–39.5	14.745	–135.9	0.033	32.2	0.366	–70.8	0.85
2200.0000	0.374	–43.8	14.212	–143.7	0.033	30.5	0.363	–78.1	0.90
2300.0000	0.360	–48.7	13.633	–151.3	0.033	33.9	0.353	–83.0	0.94
2400.0000	0.339	–55.4	12.846	–158.7	0.032	35.5	0.331	–90.0	1.06
2500.0000	0.338	–62.0	11.990	–165.5	0.033	38.0	0.318	–95.6	1.11
2600.0000	0.334	–66.0	11.265	–172.1	0.033	39.1	0.304	–102.5	1.20
2700.0000	0.330	–69.0	10.560	–177.8	0.033	40.8	0.295	–108.3	1.25
2800.0000	0.311	–69.9	9.942	176.2	0.033	43.5	0.282	–113.7	1.36
2900.0000	0.291	–72.5	9.432	171.3	0.035	44.9	0.267	–118.6	1.40
3000.0000	0.258	–76.5	8.818	166.5	0.035	47.4	0.246	–125.1	1.55
3100.0000	0.240	–80.6	8.353	161.9	0.035	53.4	0.225	–131.2	1.64

μPC2710TB

$V_{CC} = V_{out} = 5.0$ V, $I_{CC} = 22$mA

FREQUENCY MHz	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG	K
100.0000	0.306	2.5	43.072	–8.4	0.012	15.2	0.156	2.7	1.08
200.0000	0.324	5.2	43.517	–17.1	0.010	10.7	0.164	2.1	1.17
300.0000	0.356	5.3	44.432	–26.5	0.010	20.2	0.185	0.3	1.10
400.0000	0.400	2.5	45.513	–36.9	0.012	26.9	0.225	–5.5	0.92
500.0000	0.439	–3.3	45.679	–48.1	0.012	27.0	0.255	–15.4	0.85
600.0000	0.469	–10.2	45.670	–59.7	0.013	31.3	0.283	–27.6	0.77
700.0000	0.481	–17.9	44.793	–71.8	0.014	34.9	0.301	–40.2	0.74
800.0000	0.488	–26.7	43.016	–84.3	0.014	27.9	0.312	–54.9	0.74
900.0000	0.479	–34.5	40.519	–96.0	0.013	26.6	0.316	–67.7	0.78
1000.0000	0.465	–41.2	37.946	–107.3	0.016	30.8	0.311	–79.5	0.79
1100.0000	0.448	–49.3	35.122	–117.9	0.016	26.6	0.307	–92.2	0.85
1200.0000	0.417	–54.9	32.108	–128.0	0.015	39.5	0.282	–104.6	0.99
1300.0000	0.387	–61.2	29.221	–137.0	0.015	39.7	0.270	–115.5	1.12
1400.0000	0.350	–65.2	26.656	–145.8	0.015	50.2	0.248	–127.0	1.27
1500.0000	0.316	–70.8	23.895	–153.9	0.013	50.8	0.236	–136.2	1.56
1600.0000	0.292	–74.0	21.576	–161.6	0.016	56.6	0.215	–145.3	1.49
1700.0000	0.256	–76.9	19.567	–168.1	0.015	69.0	0.200	–155.2	1.71
1800.0000	0.245	–80.5	17.743	–174.4	0.018	61.7	0.196	–162.5	1.59
1900.0000	0.215	–82.9	16.040	179.6	0.017	70.0	0.180	–173.4	1.88
2000.0000	0.201	–85.6	14.717	173.5	0.021	71.2	0.175	–178.1	1.71
2100.0000	0.177	–84.4	13.475	168.8	0.020	83.0	0.166	172.0	1.94
2200.0000	0.161	–88.8	12.327	163.1	0.021	76.7	0.171	167.7	1.99
2300.0000	0.145	–88.7	11.154	158.7	0.022	87.9	0.159	159.1	2.08
2400.0000	0.124	–90.3	10.262	154.4	0.023	81.4	0.164	154.0	2.15
2500.0000	0.113	–89.8	9.490	150.4	0.025	91.9	0.158	147.0	2.19
2600.0000	0.107	–91.9	8.793	146.4	0.028	88.7	0.166	141.8	2.06
2700.0000	0.091	–92.2	8.149	142.4	0.030	93.4	0.175	135.7	2.13
2800.0000	0.081	–94.9	7.652	138.9	0.031	92.1	0.183	131.6	2.13
2900.0000	0.067	–97.4	7.134	135.1	0.031	93.0	0.191	123.4	2.26
3000.0000	0.055	–103.8	6.726	131.5	0.039	88.3	0.200	118.9	1.97
3100.0000	0.039	–95.6	6.295	128.4	0.039	89.6	0.203	111.5	2.08

μPC2762TB

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

FREQUENCY MHz	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG	K
100.0000	0.338	–1.3	4.560	–3.4	0.039	1.0	0.310	–5.5	2.23
200.0000	0.346	–2.0	4.581	–7.6	0.039	2.7	0.311	–9.5	2.20
300.0000	0.348	–1.2	4.616	–11.3	0.039	6.8	0.302	–12.3	2.20
400.0000	0.340	–1.9	4.661	–15.8	0.040	8.1	0.296	–16.2	2.18
500.0000	0.329	–3.1	4.689	–19.5	0.040	11.6	0.290	–20.2	2.20
600.0000	0.324	–6.2	4.726	–23.6	0.041	13.7	0.292	–24.1	2.12
700.0000	0.341	–8.1	4.844	–27.4	0.042	15.8	0.291	–26.2	2.01
800.0000	0.359	–7.6	4.927	–31.5	0.043	18.1	0.292	–28.3	1.90
900.0000	0.378	–6.5	5.057	–35.8	0.044	19.3	0.284	–30.9	1.77
1000.0000	0.375	–5.1	5.179	–41.0	0.045	20.3	0.280	–35.3	1.72
1100.0000	0.363	–5.2	5.306	–45.9	0.047	22.1	0.285	–40.0	1.64
1200.0000	0.353	–6.7	5.400	–51.0	0.047	23.7	0.288	–43.4	1.62
1300.0000	0.357	–8.8	5.567	–56.5	0.048	26.1	0.288	–45.7	1.54
1400.0000	0.377	–11.7	5.706	–61.7	0.049	24.5	0.285	–47.9	1.44
1500.0000	0.402	–12.7	5.820	–68.0	0.052	26.7	0.282	–52.8	1.32
1600.0000	0.414	–13.2	5.987	–73.7	0.052	26.8	0.285	–58.1	1.27
1700.0000	0.426	–13.6	6.081	–80.1	0.055	29.0	0.288	–62.0	1.18
1800.0000	0.434	–16.1	6.182	–86.7	0.056	28.2	0.291	–66.1	1.14
1900.0000	0.448	–19.0	6.229	–93.2	0.057	28.5	0.286	–70.4	1.09
2000.0000	0.463	–21.7	6.328	–99.7	0.057	28.0	0.282	–76.2	1.07
2100.0000	0.483	–23.9	6.382	–106.7	0.058	28.5	0.282	–81.5	1.01
2200.0000	0.492	–25.8	6.431	–113.8	0.058	29.0	0.282	–86.9	0.99
2300.0000	0.492	–29.7	6.424	–121.2	0.060	30.1	0.278	–91.7	0.99
2400.0000	0.486	–34.6	6.329	–128.8	0.060	30.2	0.268	–98.4	1.01
2500.0000	0.489	–40.4	6.146	–136.1	0.062	31.1	0.260	–104.5	1.02
2600.0000	0.500	–44.6	5.997	–143.1	0.061	32.1	0.251	–111.3	1.05
2700.0000	0.511	–48.5	5.822	–149.9	0.064	31.4	0.248	–116.7	1.03
2800.0000	0.511	–50.4	5.693	–157.0	0.066	34.0	0.237	–121.5	1.04
2900.0000	0.494	–52.9	5.553	–163.0	0.065	33.8	0.222	–128.3	1.11
3000.0000	0.465	–55.9	5.334	–169.5	0.065	35.5	0.203	–134.5	1.20
3100.0000	0.441	–60.6	5.157	–175.5	0.066	35.5	0.189	–141.1	1.27

μPC2763TB

$V_{CC} = V_{out} = 3.0$ V, $I_{CC} = 28$ mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG	
100.0000	0.231	–1.4	10.210	–3.8	0.023	2.4	0.406	–4.1	1.68
200.0000	0.242	–0.2	10.305	–8.5	0.023	7.8	0.412	–7.5	1.66
300.0000	0.250	2.7	10.464	–12.9	0.024	9.3	0.407	–9.9	1.58
400.0000	0.245	2.8	10.655	–18.2	0.024	13.4	0.407	–13.9	1.55
500.0000	0.242	2.0	10.863	–22.8	0.026	16.1	0.405	–17.6	1.44
600.0000	0.241	–2.2	11.093	–28.1	0.027	19.9	0.414	–21.6	1.37
700.0000	0.263	–5.3	11.544	–33.2	0.028	22.3	0.419	–24.6	1.25
800.0000	0.291	–5.6	11.843	–39.0	0.029	22.5	0.424	–27.7	1.16
900.0000	0.316	–5.1	12.291	–45.1	0.029	23.9	0.424	–31.9	1.09
1000.0000	0.322	–4.0	12.676	–52.4	0.030	25.6	0.425	–37.1	1.02
1100.0000	0.318	–5.4	13.066	–59.8	0.031	24.1	0.438	–42.5	0.96
1200.0000	0.309	–9.0	13.311	–67.3	0.031	27.0	0.442	–47.8	0.96
1300.0000	0.322	–14.2	13.661	–75.8	0.033	28.8	0.441	–51.2	0.90
1400.0000	0.344	–20.6	13.845	–83.9	0.033	28.5	0.434	–56.0	0.87
1500.0000	0.371	–23.7	13.824	–93.0	0.035	30.1	0.435	–62.2	0.82
1600.0000	0.380	–27.5	13.890	–101.5	0.035	28.1	0.439	–68.9	0.80
1700.0000	0.388	–30.6	13.634	–110.5	0.036	29.2	0.439	–74.6	0.78
1800.0000	0.378	–36.4	13.236	–119.6	0.035	29.9	0.428	–81.3	0.84
1900.0000	0.378	–42.1	12.724	–127.9	0.035	30.9	0.411	–87.0	0.89
2000.0000	0.375	–46.6	12.290	–136.1	0.035	32.9	0.393	–93.4	0.94
2100.0000	0.369	–50.5	11.707	–144.0	0.035	33.0	0.385	–99.6	0.99
2200.0000	0.351	–53.8	11.130	–151.7	0.036	35.7	0.373	–104.9	1.06
2300.0000	0.331	–59.8	10.524	–159.1	0.036	36.8	0.359	–110.3	1.13
2400.0000	0.306	–66.4	9.824	–165.9	0.034	38.7	0.336	–117.5	1.31
2500.0000	0.300	–73.1	9.152	–172.3	0.035	40.1	0.321	–123.3	1.41
2600.0000	0.294	–75.8	8.583	–178.2	0.034	43.8	0.306	–129.4	1.55
2700.0000	0.290	–77.1	8.029	176.2	0.035	46.3	0.299	–133.9	1.58
2800.0000	0.270	–77.7	7.610	170.6	0.037	47.7	0.288	–138.6	1.63
2900.0000	0.248	–78.7	7.240	166.1	0.039	51.1	0.270	–143.6	1.67
3000.0000	0.219	–82.3	6.827	161.2	0.039	53.6	0.253	–150.1	1.79
3100.0000	0.198	–88.7	6.516	156.9	0.040	55.1	0.244	–156.2	1.88

μPC2771TB

$V_{CC} = V_{out} = 3.0$ V, $I_{CC} = 35$ mA

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}		K
MHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG	
100.0000	0.045	19.7	10.570	–4.7	0.028	0.8	0.327	–6.2	1.65
200.0000	0.057	37.0	10.638	–9.5	0.028	5.0	0.325	–11.5	1.63
300.0000	0.075	41.3	10.775	–14.1	0.029	8.6	0.323	–16.2	1.58
400.0000	0.090	43.3	11.004	–19.4	0.030	11.1	0.326	–20.9	1.49
500.0000	0.105	42.2	11.275	–24.4	0.030	14.9	0.331	–26.4	1.45
600.0000	0.118	40.2	11.586	–30.0	0.031	15.8	0.342	–32.0	1.37
700.0000	0.138	34.9	12.041	–35.9	0.031	19.8	0.350	–37.3	1.29
800.0000	0.163	32.5	12.367	–42.1	0.032	20.1	0.359	–42.8	1.20
900.0000	0.186	29.4	12.844	–48.8	0.032	23.2	0.361	–49.4	1.15
1000.0000	0.202	26.3	13.300	–56.6	0.032	23.9	0.371	–56.1	1.11
1100.0000	0.219	21.7	13.771	–64.6	0.033	24.9	0.389	–62.5	1.03
1200.0000	0.233	15.4	14.082	–73.5	0.033	26.6	0.400	–69.3	0.99
1300.0000	0.252	8.4	14.365	–83.2	0.036	28.8	0.405	–75.4	0.92
1400.0000	0.267	–0.1	14.336	–92.6	0.036	30.0	0.402	–83.6	0.91
1500.0000	0.285	–6.8	14.142	–102.4	0.036	32.0	0.406	–91.6	0.90
1600.0000	0.293	–13.9	13.929	–112.0	0.037	31.6	0.413	–99.3	0.89
1700.0000	0.304	–20.9	13.428	–121.6	0.039	32.5	0.414	–105.8	0.88
1800.0000	0.290	–28.1	12.722	–131.0	0.038	34.7	0.401	–113.7	0.96
1900.0000	0.285	–35.3	11.966	–139.6	0.038	36.1	0.387	–120.8	1.03
2000.0000	0.273	–41.8	11.232	–147.5	0.038	37.4	0.378	–127.6	1.09
2100.0000	0.267	–47.4	10.500	–154.8	0.039	39.1	0.366	–133.1	1.14
2200.0000	0.254	–51.6	9.815	–161.7	0.040	41.4	0.356	–138.0	1.20
2300.0000	0.237	–57.1	9.168	–168.0	0.041	43.7	0.342	–142.8	1.28
2400.0000	0.221	–61.1	8.570	–173.7	0.041	48.3	0.325	–148.3	1.37
2500.0000	0.212	–68.8	7.967	–179.7	0.042	48.3	0.322	–152.6	1.44
2600.0000	0.208	–72.2	7.507	174.9	0.043	50.8	0.314	–156.7	1.49
2700.0000	0.202	–74.1	7.004	170.0	0.045	53.7	0.309	–160.1	1.53
2800.0000	0.190	–76.3	6.667	164.7	0.047	54.2	0.303	–164.0	1.56
2900.0000	0.178	–76.7	6.336	160.7	0.051	57.7	0.292	–167.8	1.55
3000.0000	0.154	–82.3	6.003	155.6	0.051	56.5	0.287	–172.8	1.62
3100.0000	0.147	–88.0	5.772	151.3	0.054	59.3	0.279	–176.4	1.61

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

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

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