

BIPOLAR ANALOG INTEGRATED CIRCUIT

μ PC8178TK

SILICON MMIC LOW CURRENT AMPLIFIER FOR MOBILE COMMUNICATIONS

DESCRIPTION

The μ PC8178TK is a silicon monolithic integrated circuit designed as amplifier for mobile communications. This IC can realize low current consumption with external chip inductor which can not be realized on internal 50 Ω wide band matched IC. μ PC8178TK adopts 6-pin lead-less minimold package using same chip as the conventional μ PC8178TB in 6-pin super minimold.

TK suffix IC which is smaller package than TB suffix IC contributes to reduce mounting space by 50 %.

This IC is manufactured using our 30 GHz f_{max} UHS0 (Ultra High Speed Process) silicon bipolar process.

FEATURES

- Low current consumption : $I_{CC} = 1.9$ mA TYP. @ $V_{CC} = 3.0$ V
- Supply voltage : $V_{CC} = 2.4$ to 3.3 V
- Excellent isolation : ISL = 40 dB TYP. @ $f = 1.0$ GHz
ISL = 41 dB TYP. @ $f = 1.9$ GHz
ISL = 42 dB TYP. @ $f = 2.4$ GHz
- Power gain : $G_P = 11.0$ dB TYP. @ $f = 1.0$ GHz
 $G_P = 11.0$ dB TYP. @ $f = 1.9$ GHz
 $G_P = 11.0$ dB TYP. @ $f = 2.4$ GHz
- Gain 1 dB compression output power : $P_{O(1\text{ dB})} = -5.5$ dBm TYP. @ $f = 1.0$ GHz
 $P_{O(1\text{ dB})} = -8.0$ dBm TYP. @ $f = 1.9$ GHz
 $P_{O(1\text{ dB})} = -8.0$ dBm TYP. @ $f = 2.4$ GHz
- Operating frequency : 0.1 to 2.4 GHz (Output port LC matching)
- High-density surface mounting : 6-pin lead-less minimold package (1.5 \times 1.3 \times 0.55 mm)
- Light weight : 3 mg (Standard value)

APPLICATION

- Buffer amplifiers on 0.1 to 2.4 GHz mobile communications system

Caution Observe precautions when handling because these devices are sensitive to electrostatic discharge.

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.
Not all devices/types available in every country. Please check with local NEC Compound Semiconductor Devices representative for availability and additional information.

★ ORDERING INFORMATION

| Part Number | Order Number | Package | Marking | Supplying Form |
|--------------|----------------|---|---------|---|
| μPC8178TK-E2 | μPC8178TK-E2-A | 6-pin lead-less minimold (1511) (Pb-Free) ^{Note} | 6B | <ul style="list-style-type: none"> • Embossed tape 8 mm wide • Pin 1, 2, 3 face the perforation side of the tape • Qty 5 kpcs/reel |

Note With regards to terminal solder (the solder contains lead) plated products (conventionally plated), contact your nearby sales office.

Remark To order evaluation samples, contact your nearby sales office.
Part number for sample order: μPC8178TK

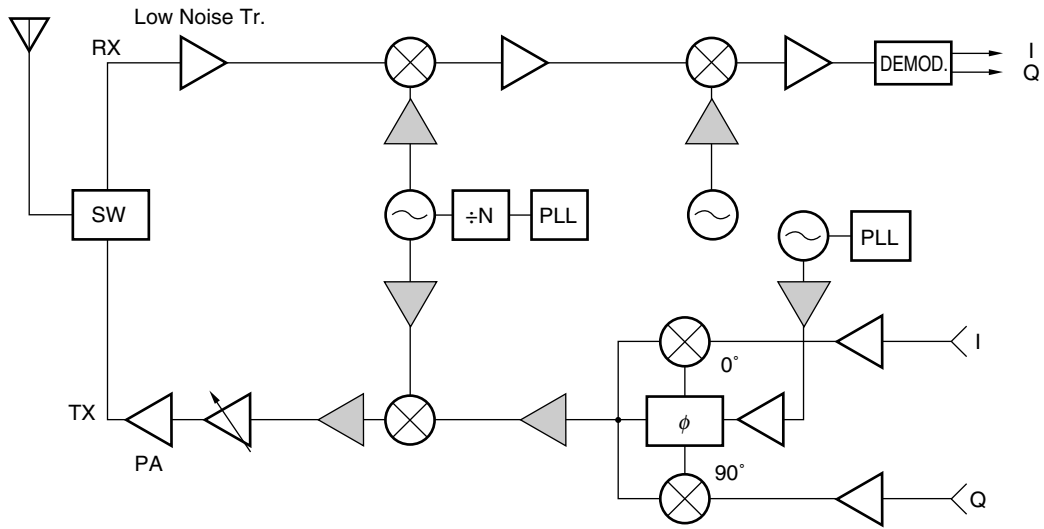
PRODUCT LINE-UP (T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_S = Z_L = 50 Ω)

| Parameter Part No. | I _{CC} (mA) | 1.0 GHz output port matching frequency | | | 1.66 GHz output port matching frequency | | | 1.9 GHz output port matching frequency | | | 2.4 GHz output port matching frequency | | | Marking |
|-----------------------|-------------------------|---|-------------|------------------------------|--|-------------|------------------------------|---|-------------|------------------------------|---|-------------|------------------------------|---------|
| | | G _P (dB) | ISL (dB) | P _{O(1dB)} (dBm) | G _P (dB) | ISL (dB) | P _{O(1dB)} (dBm) | G _P (dB) | ISL (dB) | P _{O(1dB)} (dBm) | G _P (dB) | ISL (dB) | P _{O(1dB)} (dBm) | |
| μPC8178TB | 1.9 | 11.0 | 39.0 | -4.0 | - | - | - | 11.5 | 40.0 | -7.0 | 11.5 | 38.0 | -7.5 | C3B |
| μPC8178TK | 1.9 | 11.0 | 40.0 | -5.5 | - | - | - | 11.0 | 41.0 | -8.0 | 11.0 | 42.0 | -8.0 | 6B |
| μPC8179TB | 4.0 | 13.5 | 44.0 | +3.0 | - | - | - | 15.5 | 42.0 | +1.5 | 15.5 | 41.0 | +1.0 | C3C |
| μPC8128TB | 2.8 | 12.5 | 39.0 | -4.0 | 13.0 | 39.0 | -4.0 | 13.0 | 37.0 | -4.0 | - | - | - | C2P |
| μPC8151TB | 4.2 | 12.5 | 38.0 | +2.5 | 15.0 | 36.0 | +1.5 | 15.0 | 34.0 | +0.5 | - | - | - | C2U |
| μPC8152TB | 5.6 | 23.0 | 40.0 | -4.5 | 19.5 | 38.0 | -8.5 | 17.5 | 35.0 | -8.5 | - | - | - | C2V |

Remarks 1. Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail.
2. To know the associated product, please refer to each latest data sheet.

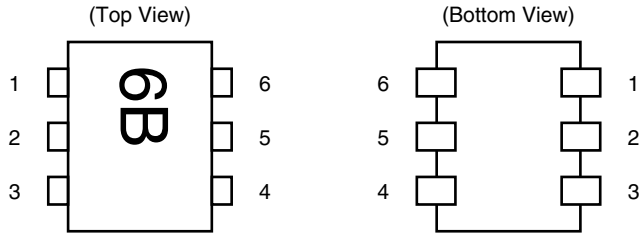
SYSTEM APPLICATION EXAMPLE

Location examples in digital cellular



These ICs can be added to your system around ▲ parts, when you need more isolation or gain. The application herein, however, shows only examples, therefore the application can depend on your kit evaluation.

PIN CONNECTIONS



| Pin No. | Pin Name |
|---------|-----------------|
| 1 | INPUT |
| 2 | GND |
| 3 | GND |
| 4 | OUTPUT |
| 5 | GND |
| 6 | V _{CC} |

PIN EXPLANATION

| Pin No. | Pin Name | Applied Voltage (V) | Pin Voltage (V) ^{Note} | Function and Applications | Internal Equivalent Circuit |
|-------------|-----------------|--|---------------------------------|--|-----------------------------|
| 1 | INPUT | – | 0.90 | Signal input pin. A internal matching circuit, configured with resistors, enables 50 Ω connection over a wide band. This pin must be coupled to signal source with capacitor for DC cut. | |
| 2 3 5 | GND | 0 | – | Ground pin. This pin should be connected to system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible. All the ground pins must be connected together with wide ground pattern to decrease impedance difference. | |
| 4 | OUTPUT | Voltage as same as V _{CC} through external inductor | – | Signal output pin. This pin is designed as collector output. Due to the high impedance output, this pin should be externally equipped with LC matching circuit to next stage. For L, a size 1 005 chip inductor can be chosen. | |
| 6 | V _{CC} | 2.4 to 3.3 | – | Power supply pin. This pin should be externally equipped with bypass capacitor to minimize its impedance. | |

Note Pin voltage is measured at V_{CC} = 3.0 V.

ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Test Conditions | Ratings | Unit |
|-------------------------------|------------------|--------------------------------------|-------------|------|
| Supply Voltage | V _{CC} | T _A = +25°C, Pin 4, Pin 6 | 3.6 | V |
| Circuit Current | I _{CC} | T _A = +25°C | 15 | mA |
| Power Dissipation | P _D | T _A = +85°C Note | 232 | mW |
| Operating Ambient Temperature | T _A | | -40 to +85 | °C |
| Storage Temperature | T _{stg} | | -55 to +150 | °C |
| Input Power | P _{in} | T _A = +25°C | +5 | dBm |

Note Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB

RECOMMENDED OPERATING RANGE

| Parameter | Symbol | MIN. | TYP. | MAX. | Unit | Remarks |
|-------------------------------|-----------------|------|------|------|------|--|
| Supply Voltage | V _{CC} | 2.4 | 3.0 | 3.3 | V | The same voltage should be applied to pin 4 and pin 6. |
| Operating Ambient Temperature | T _A | -40 | +25 | +85 | °C | |

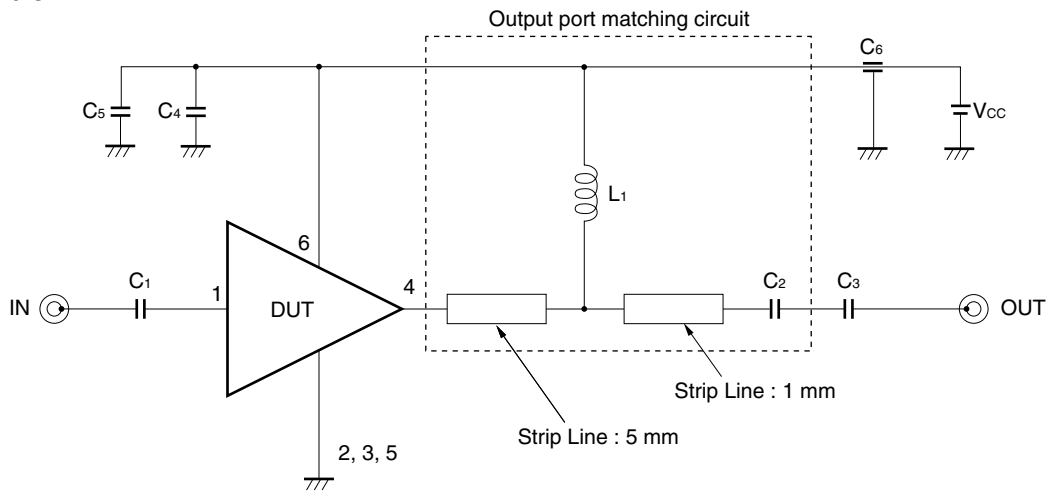
ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, T_A = +25°C, V_{CC} = V_{out} = 3.0 V, Z_s = Z_L = 50 Ω, at LC matched frequency)

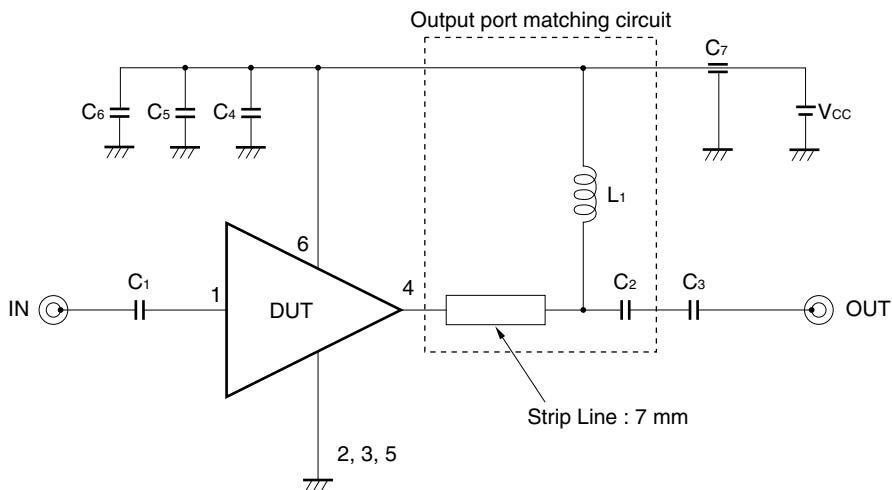
| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|------------------------------------|----------------------|--|------------------------|----------------------|----------------------|------|
| Circuit Current | I _{CC} | No signal | 1.4 | 1.9 | 2.4 | mA |
| Power Gain | G _P | f = 1.0 GHz, P _{in} = -30 dBm f = 1.9 GHz, P _{in} = -30 dBm f = 2.4 GHz, P _{in} = -30 dBm | 9.0 9.0 9.0 | 11.0 11.0 11.0 | 13.0 13.5 13.5 | dB |
| Isolation | ISL | f = 1.0 GHz, P _{in} = -30 dBm f = 1.9 GHz, P _{in} = -30 dBm f = 2.4 GHz, P _{in} = -30 dBm | 35.0 36.0 37.0 | 40.0 41.0 42.0 | - - - | dB |
| Gain 1 dB Compression Output Power | P _{O(1 dB)} | f = 1.0 GHz f = 1.9 GHz f = 2.4 GHz | -8.0 -11.0 -11.5 | -5.5 -8.0 -8.0 | - - - | dBm |
| Noise Figure | NF | f = 1.0 GHz f = 1.9 GHz f = 2.4 GHz | - - - | 5.5 5.5 5.5 | 7.0 7.0 7.0 | dB |
| Input Return Loss | RL _{in} | f = 1.0 GHz, P _{in} = -30 dBm f = 1.9 GHz, P _{in} = -30 dBm f = 2.4 GHz, P _{in} = -30 dBm | 4.0 5.0 6.5 | 7.0 8.0 9.5 | - - - | dB |

★ TEST CIRCUITS

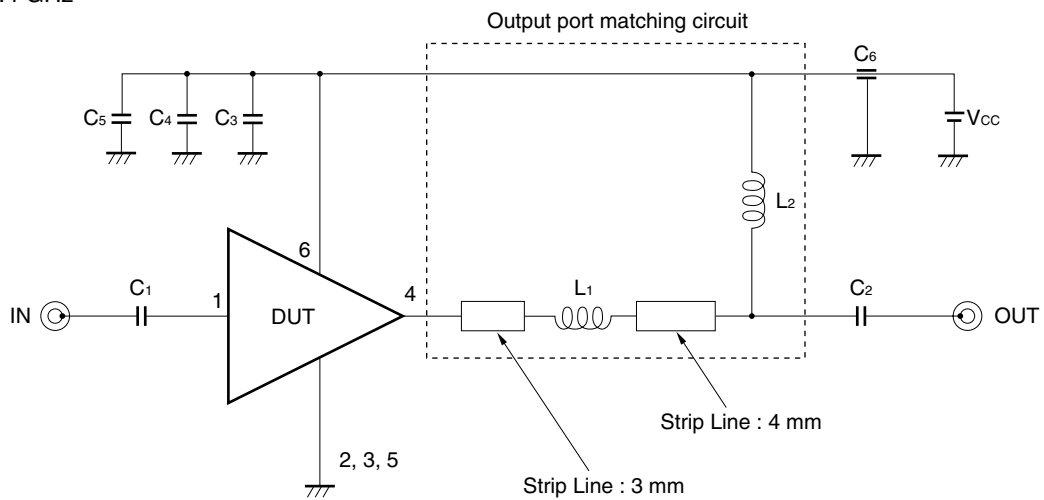
<1> f = 1.0 GHz



<2> f = 1.9 GHz

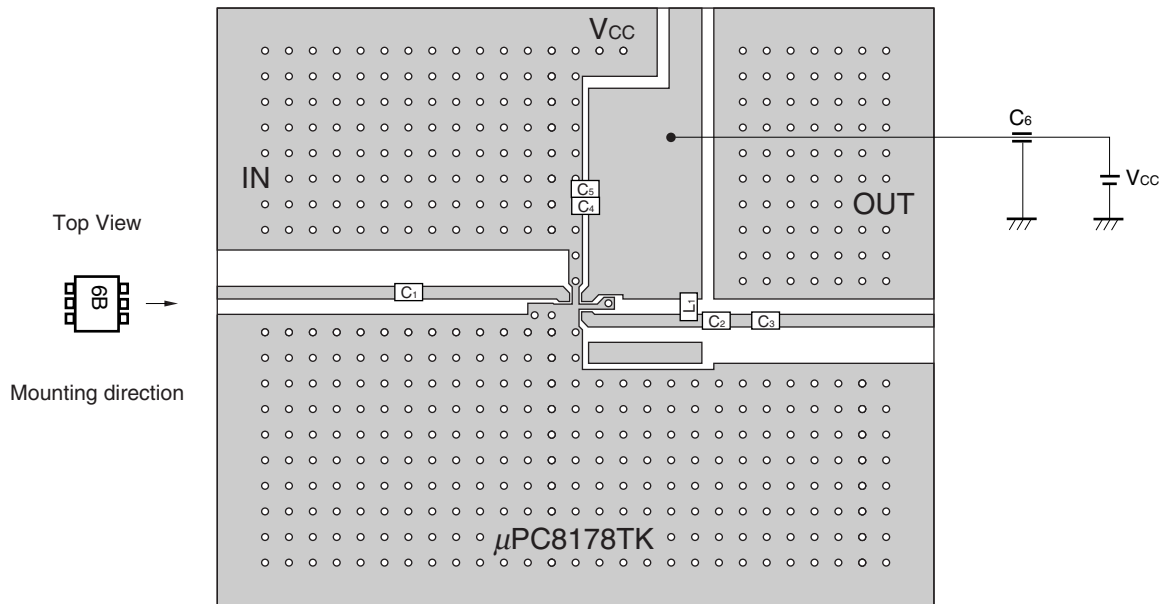


<3> f = 2.4 GHz



★ ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD

<1> f = 1.0 GHz

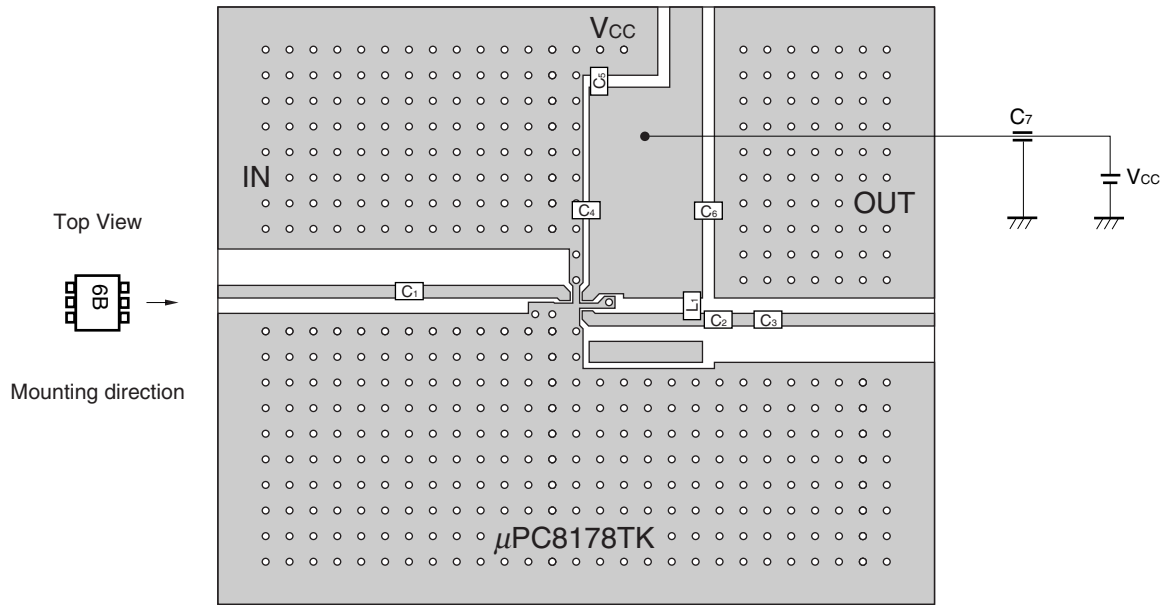


- (*1) 42 × 35 × 0.4 mm polyimide board, double-sided copper clad
- (*2) Back side: GND pattern
- (*3) Gold plated on pattern
- (*4) o : Through holes

COMPONENT LIST

| Form | Symbol | Value | Type code | Maker |
|------------------------|---------------------------------|----------|-----------------------|--------|
| Chip capacitor | C ₁ , C ₃ | 1 000 pF | GRM40CH102J50PT | murata |
| | C ₂ | 0.75 pF | GRM39CKR75C50PT | murata |
| | C ₄ | 20 pF | GRM39CH200J50PT | murata |
| | C ₅ | 10 pF | GRM39CH100D50PT | murata |
| Feed-through Capacitor | C ₆ | 1 000 pF | DFT301-801 × 7R102S50 | murata |
| Chip inductor | L ₁ | 12 nH | LL1608-FH12N | TOKO |

<2> f = 1.9 GHz

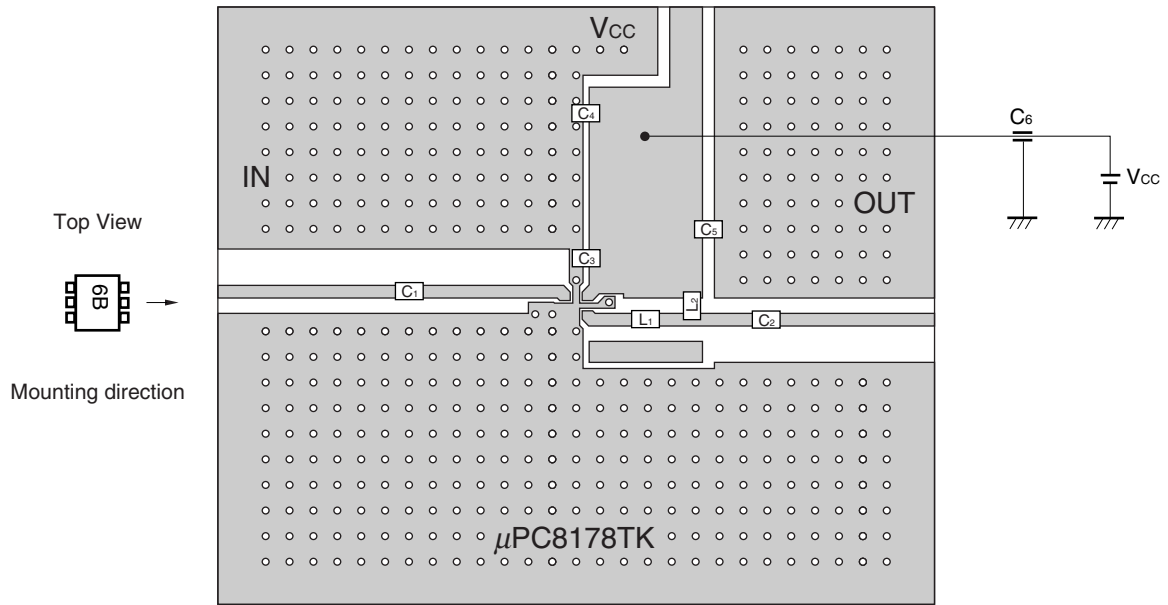


- (*1) 42 × 35 × 0.4 mm polyimide board, double-sided copper clad
- (*2) Back side: GND pattern
- (*3) Gold plated on pattern
- (*4) ○ : Through holes

COMPONENT LIST

| Form | Symbol | Value | Type code | Maker |
|------------------------|---|----------|-----------------------|--------|
| Chip capacitor | C ₁ , C ₃ , C ₅ , C ₆ | 1 000 pF | GRM40CH102J50PT | murata |
| | C ₂ | 0.5 pF | GRM39CKR5C50PT | murata |
| | C ₄ | 8 pF | GRM39CH080D50PT | murata |
| Feed-through Capacitor | C ₇ | 1 000 pF | DFT301-801 × 7R102S50 | murata |
| Chip inductor | L ₁ | 2.7 nH | LL1608-FH2N7S | TOKO |

<3> f = 2.4 GHz



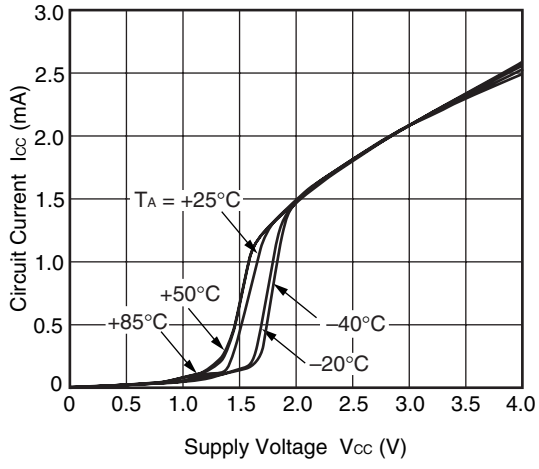
- (*1) 42 × 35 × 0.4 mm polyimide board, double-sided copper clad
- (*2) Back side: GND pattern
- (*3) Gold plated on pattern
- (*4) o : Through holes

COMPONENT LIST

| Form | Symbol | Value | Type code | Maker |
|------------------------|---|----------|-----------------------|--------|
| Chip capacitor | C ₁ , C ₂ , C ₄ , C ₅ | 1 000 pF | GRM40CH102J50PT | murata |
| | C ₃ | 10 pF | GRM39CH100D50PT | murata |
| Feed-through Capacitor | C ₆ | 1 000 pF | DFT301-801 × 7R102S50 | murata |
| Chip inductor | L ₁ | 2.7 nH | LL1608-FH2N7S | TOKO |
| | L ₂ | 1.8 nH | LL1608-FH1N8S | TOKO |

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

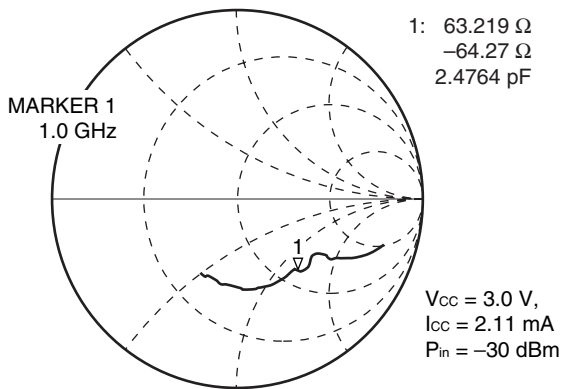
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



Remark The graph indicates nominal characteristics.

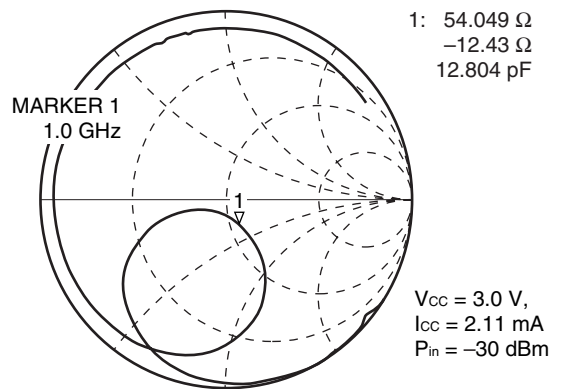
f = 1.0 GHz MATCHING

S₁₁-FREQUENCY



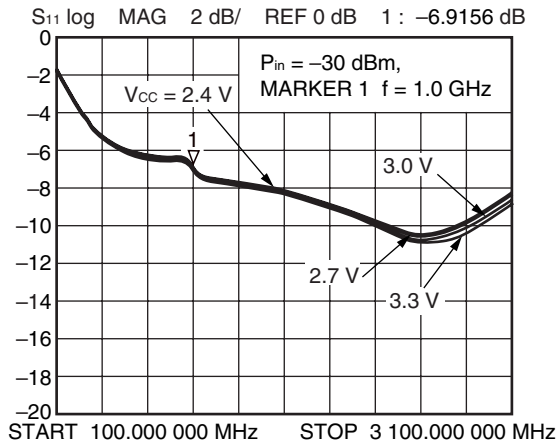
START 100.000 000 MHz STOP 3 100.000 000 MHz

S₂₂-FREQUENCY

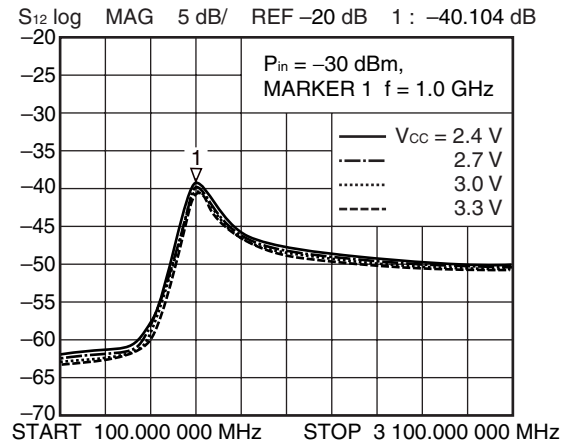


START 100.000 000 MHz STOP 3 100.000 000 MHz

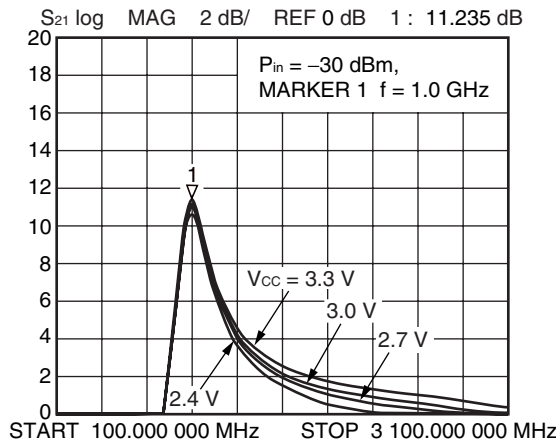
S₁₁-FREQUENCY



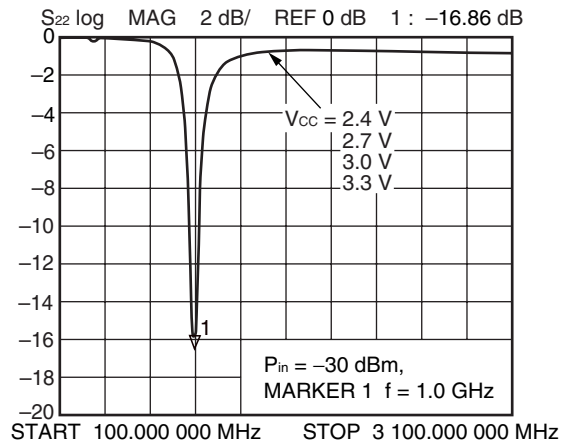
S₁₂-FREQUENCY



S₂₁-FREQUENCY

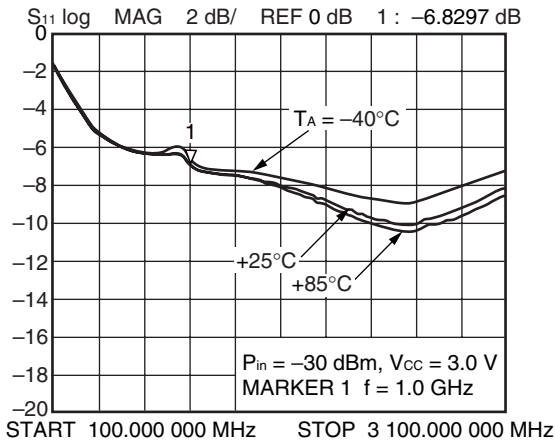


S₂₂-FREQUENCY

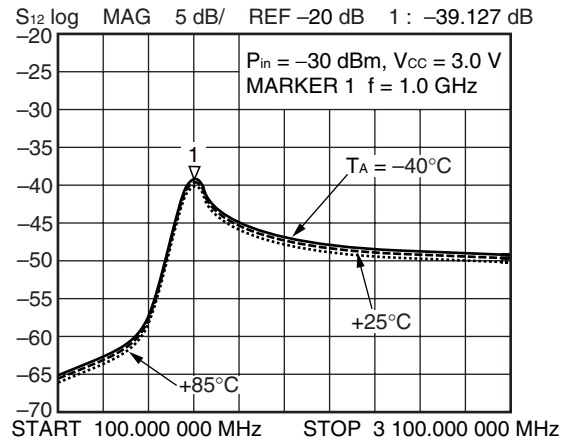


Remark The graphs indicate nominal characteristics.

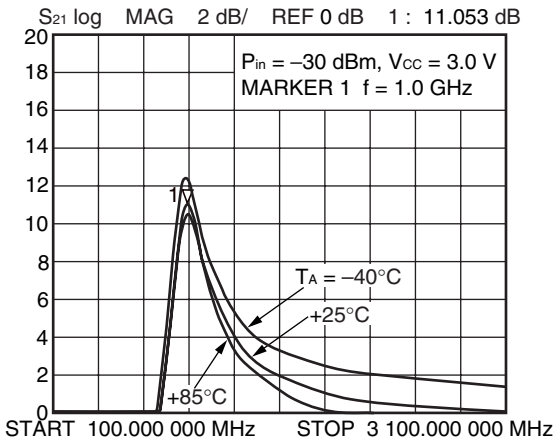
S₁₁-FREQUENCY



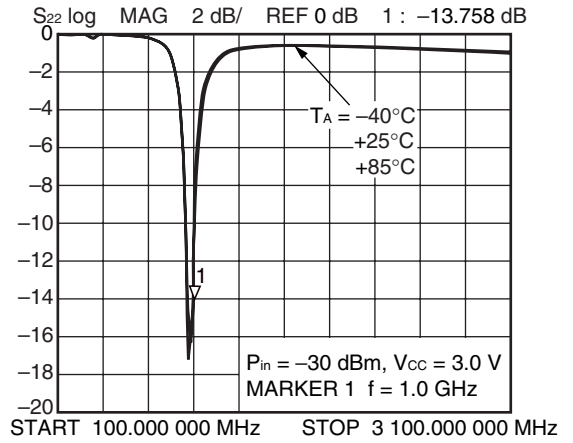
S₁₂-FREQUENCY



S₂₁-FREQUENCY

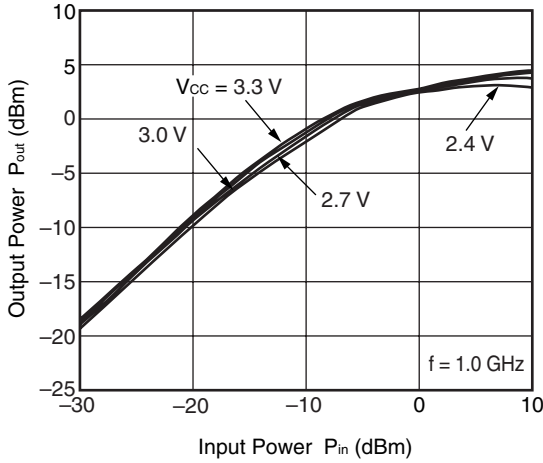


S₂₂-FREQUENCY

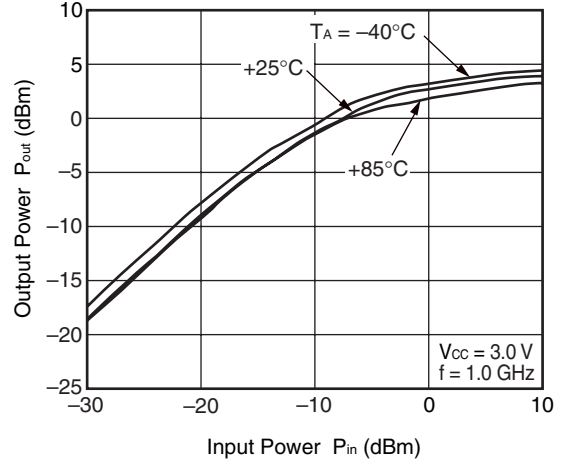


Remark The graphs indicate nominal characteristics.

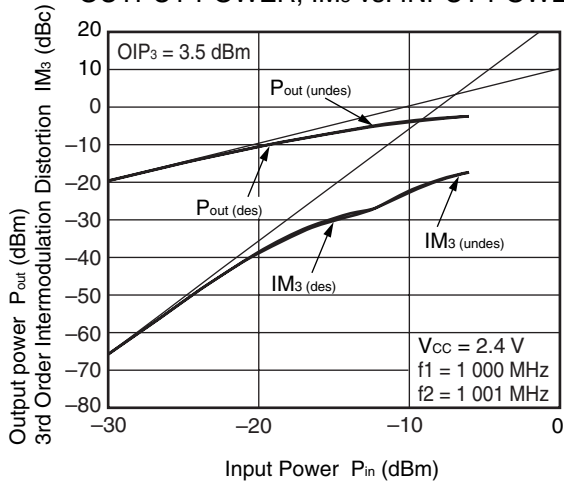
OUTPUT POWER vs. INPUT POWER



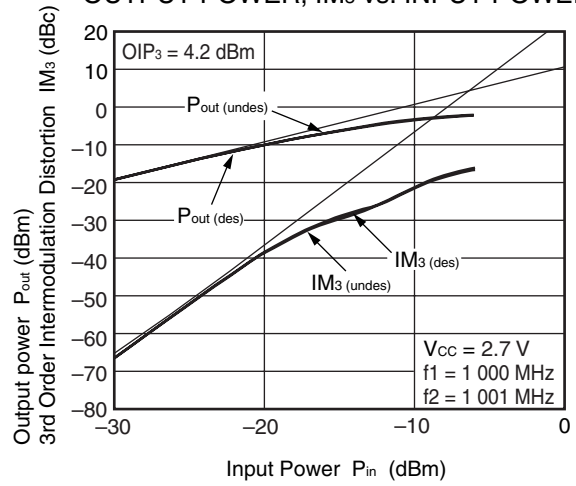
OUTPUT POWER vs. INPUT POWER



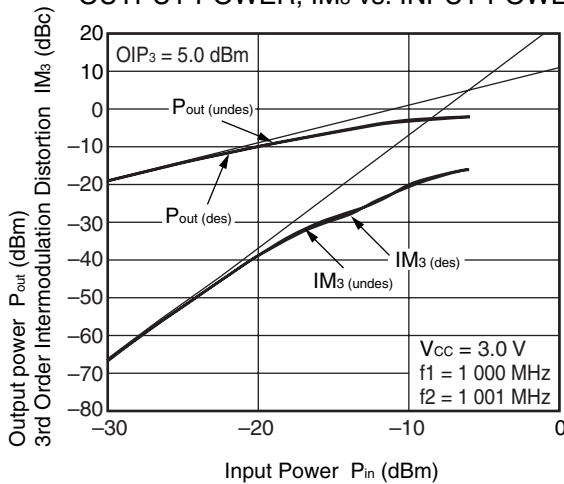
OUTPUT POWER, IM_3 vs. INPUT POWER



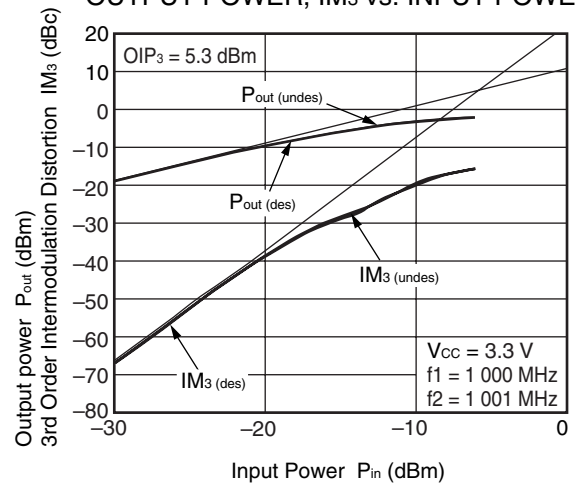
OUTPUT POWER, IM_3 vs. INPUT POWER



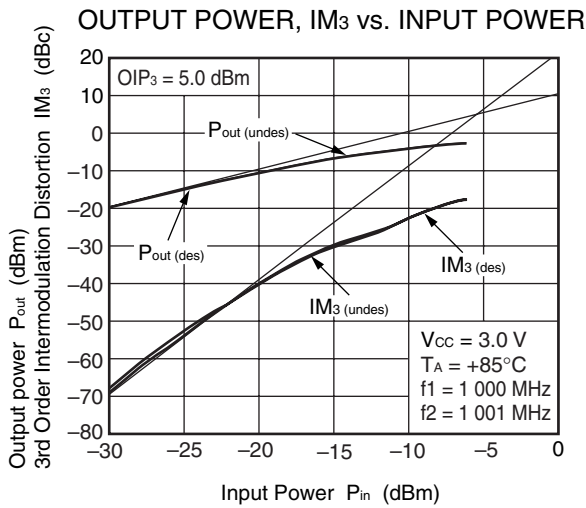
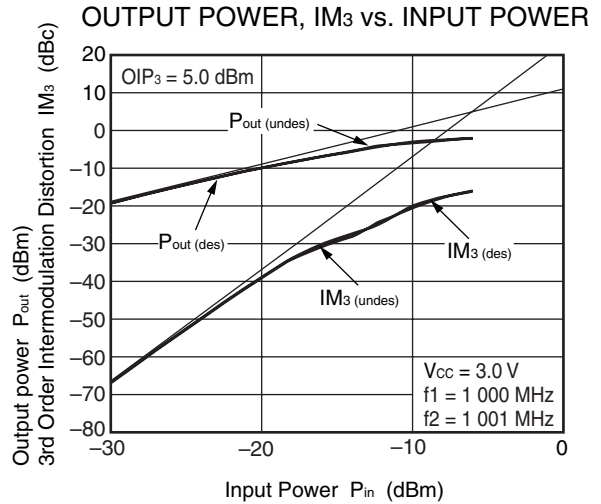
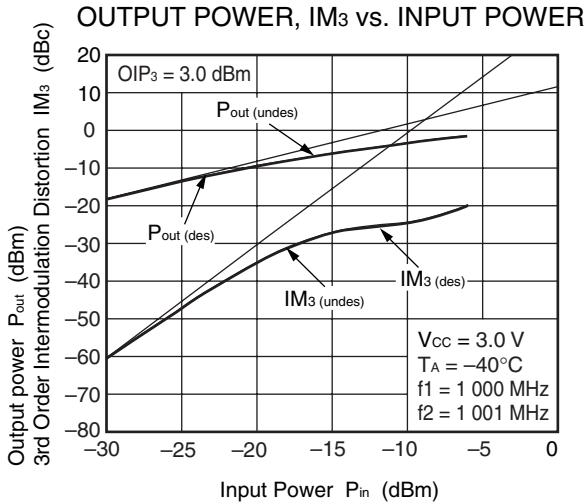
OUTPUT POWER, IM_3 vs. INPUT POWER



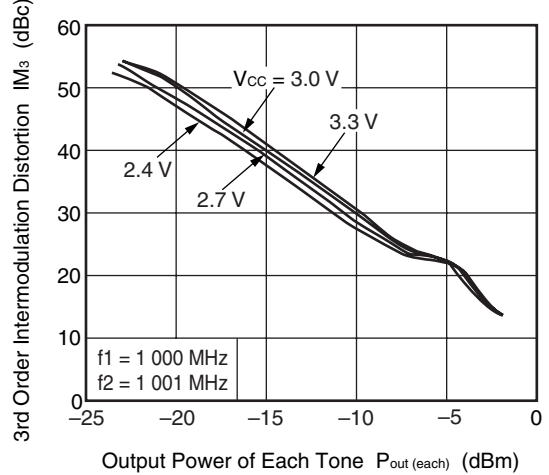
OUTPUT POWER, IM_3 vs. INPUT POWER



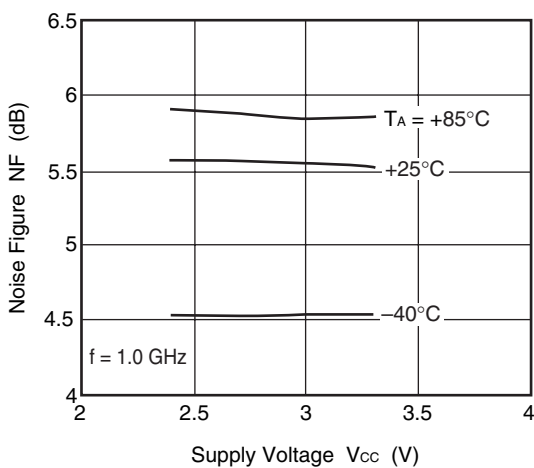
Remark The graphs indicate nominal characteristics.



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



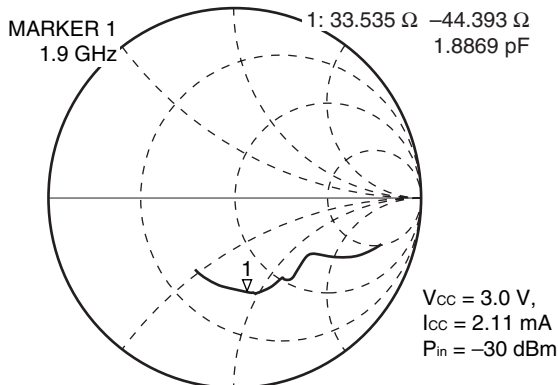
NOISE FIGURE vs. SUPPLY VOLTAGE



Remark The graphs indicate nominal characteristics.

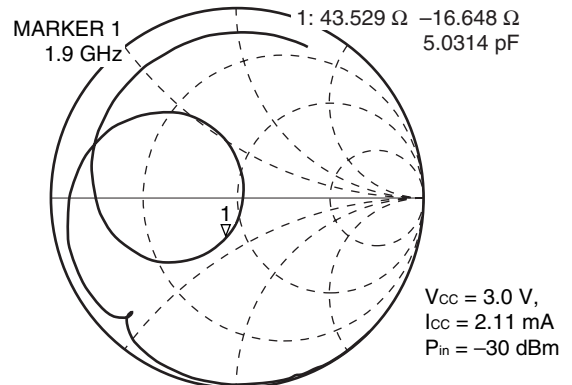
f = 1.9 GHz MATCHING

S₁₁-FREQUENCY



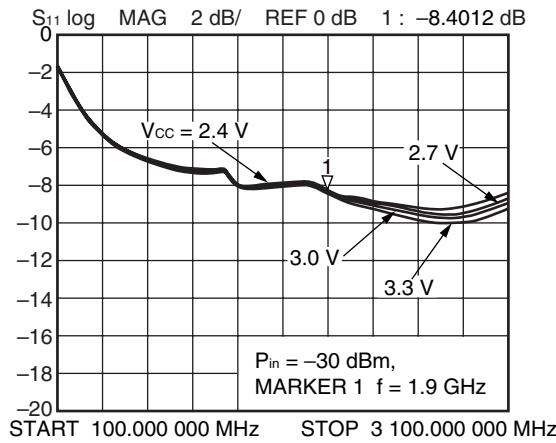
START 100.000 000 MHz STOP 3 100.000 000 MHz

S₂₂-FREQUENCY

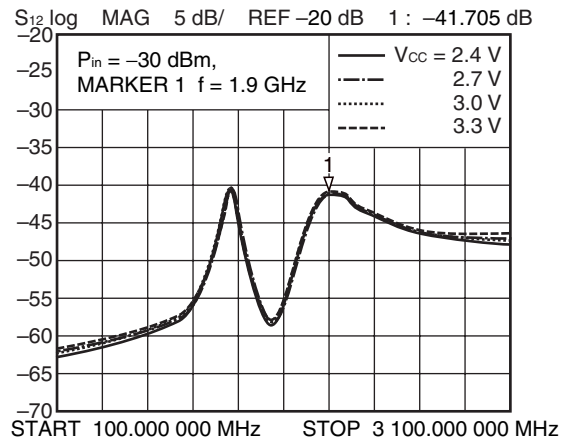


START 100.000 000 MHz STOP 3 100.000 000 MHz

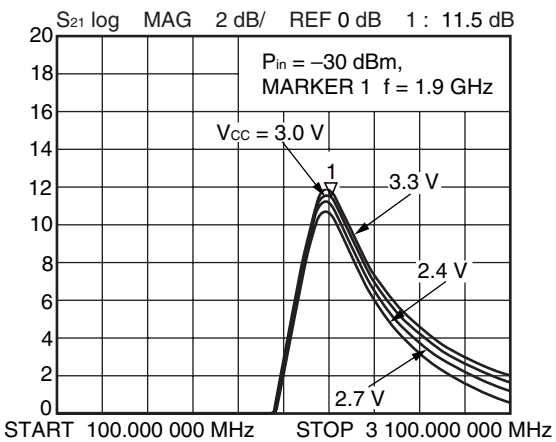
S₁₁-FREQUENCY



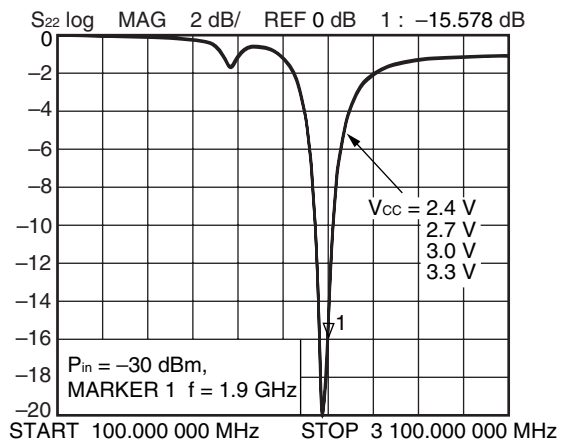
S₁₂-FREQUENCY



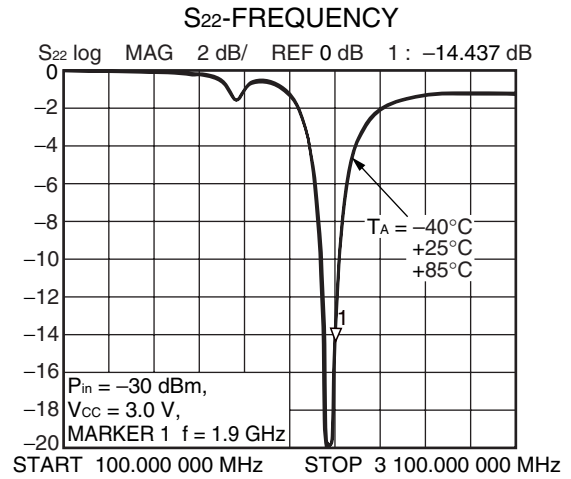
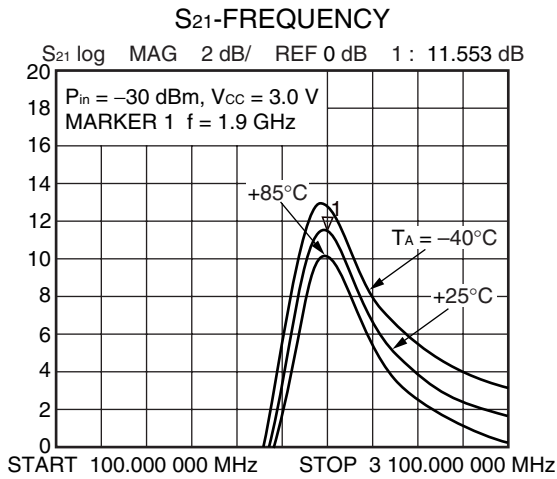
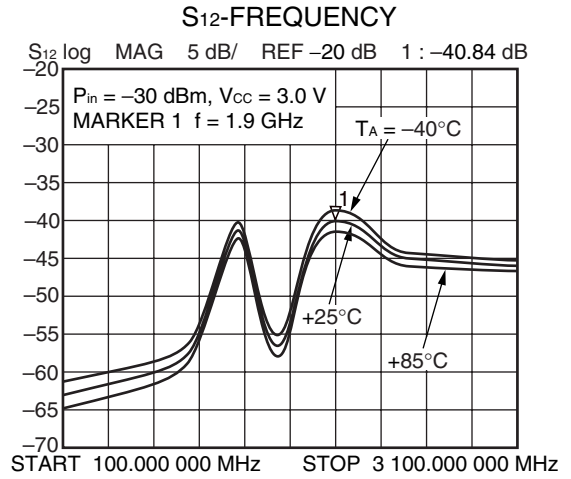
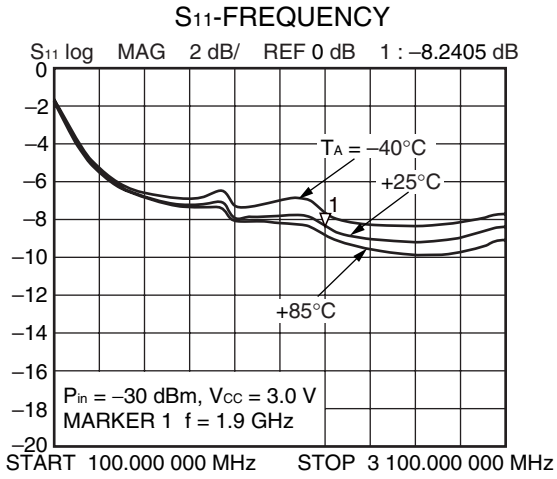
S₂₁-FREQUENCY



S₂₂-FREQUENCY

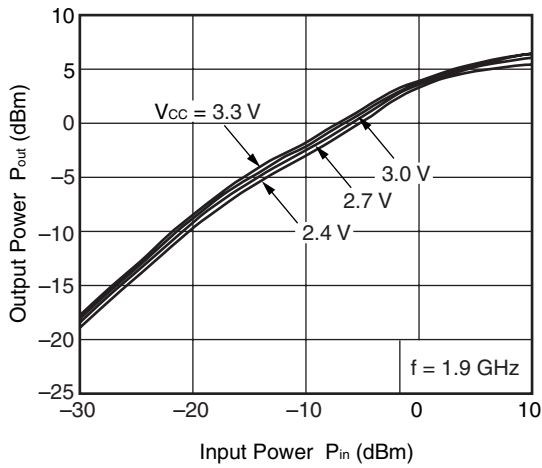


Remark The graphs indicate nominal characteristics.

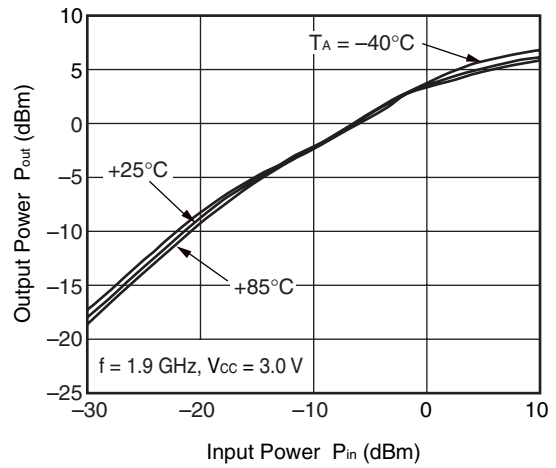


Remark The graphs indicate nominal characteristics.

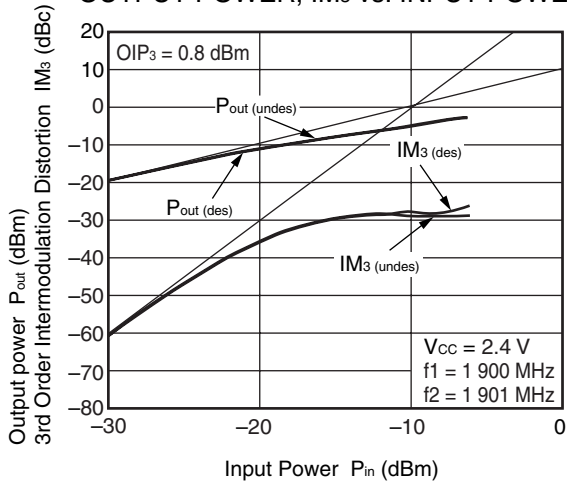
OUTPUT POWER vs. INPUT POWER



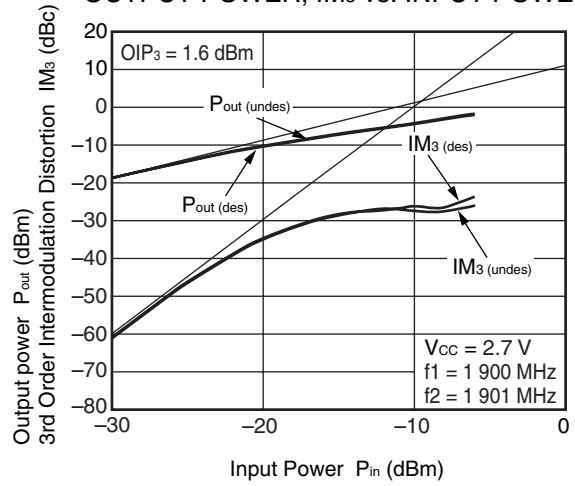
OUTPUT POWER vs. INPUT POWER



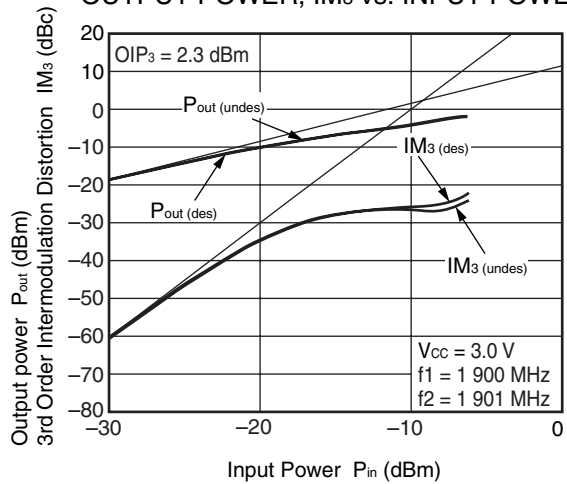
OUTPUT POWER, IM3 vs. INPUT POWER



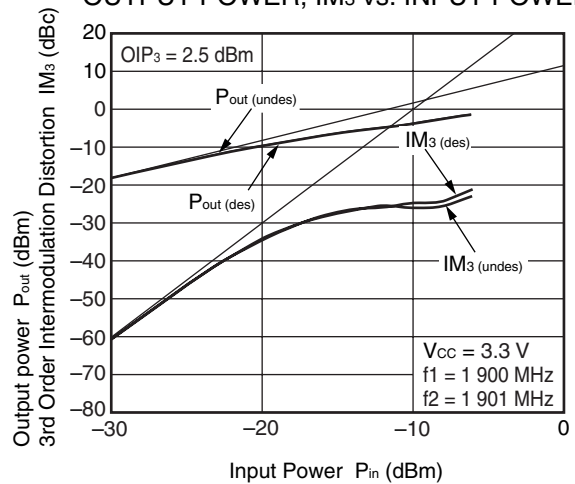
OUTPUT POWER, IM3 vs. INPUT POWER



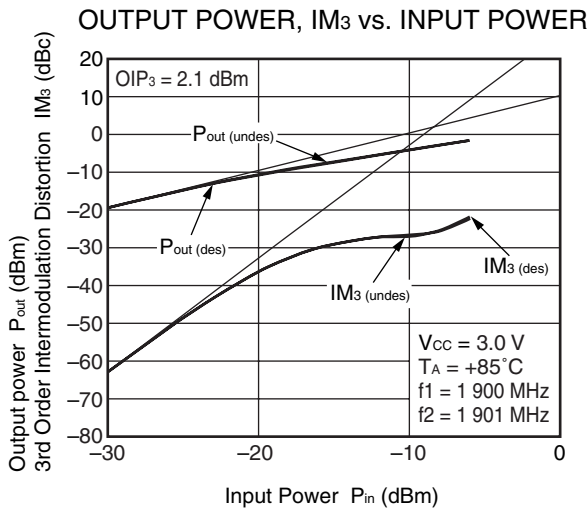
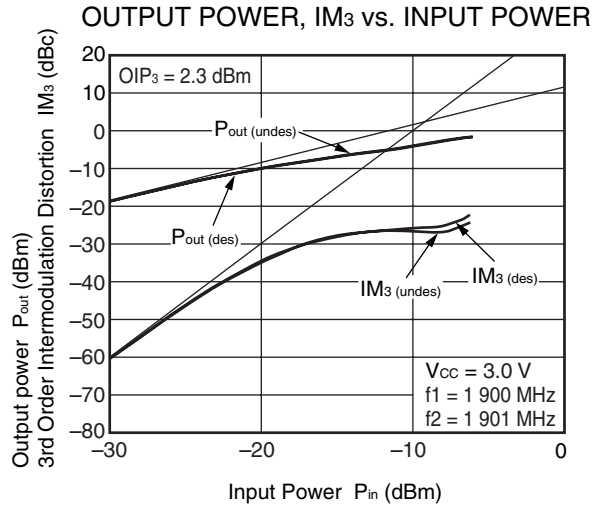
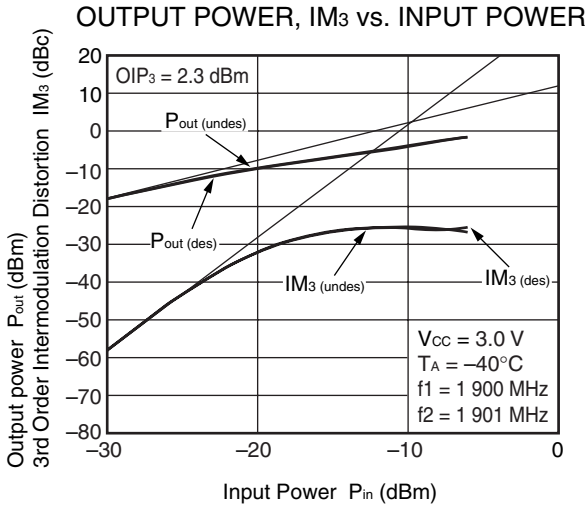
OUTPUT POWER, IM3 vs. INPUT POWER



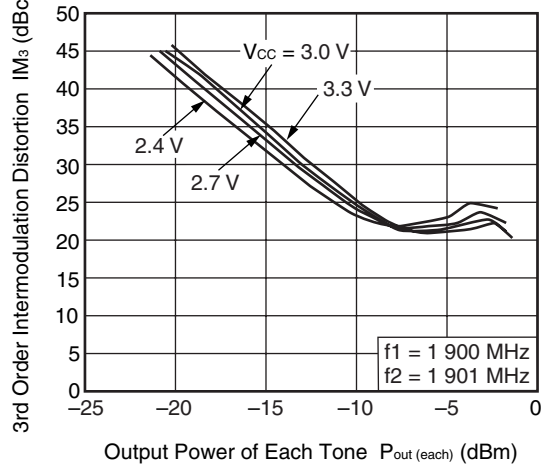
OUTPUT POWER, IM3 vs. INPUT POWER



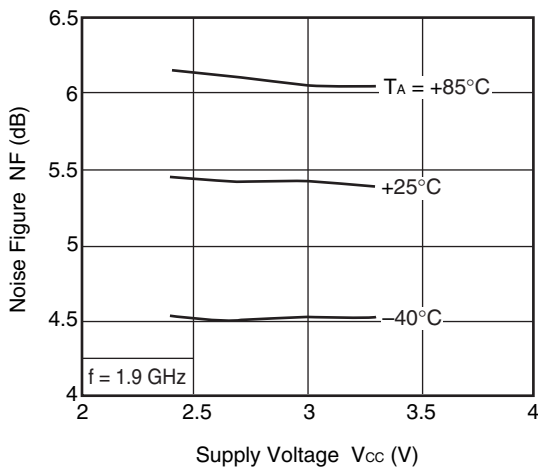
Remark The graphs indicate nominal characteristics.



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



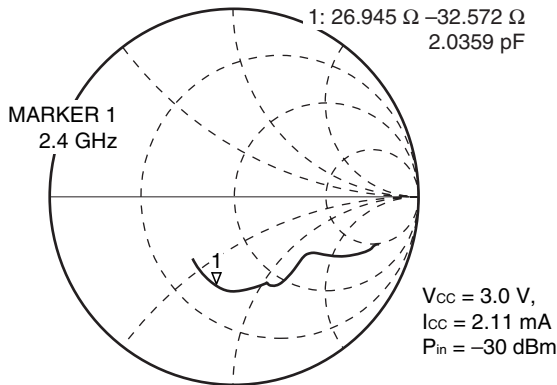
NOISE FIGURE vs. SUPPLY VOLTAGE



Remark The graphs indicate nominal characteristics.

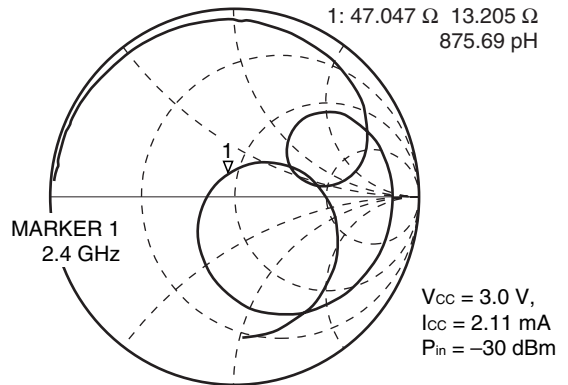
f = 2.4 GHz MATCHING

S₁₁-FREQUENCY



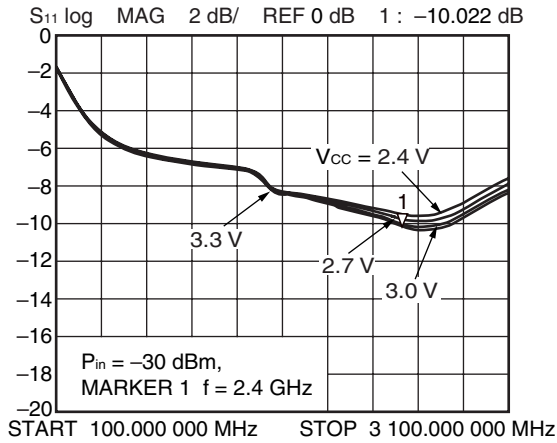
START 100.000 000 MHz STOP 3 100.000 000 MHz

S₂₂-FREQUENCY



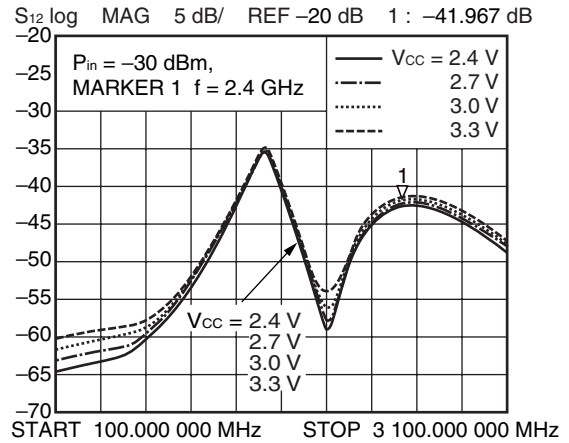
START 100.000 000 MHz STOP 3 100.000 000 MHz

S₁₁-FREQUENCY



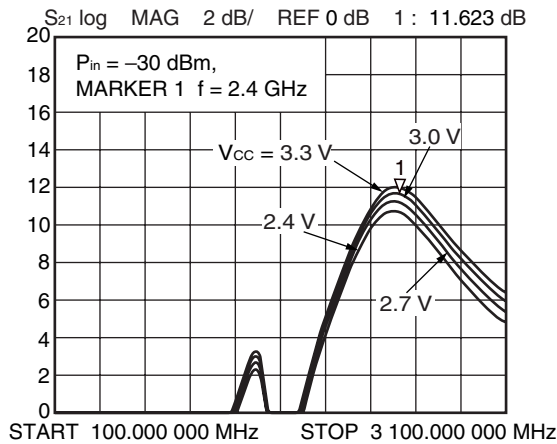
START 100.000 000 MHz STOP 3 100.000 000 MHz

S₁₂-FREQUENCY



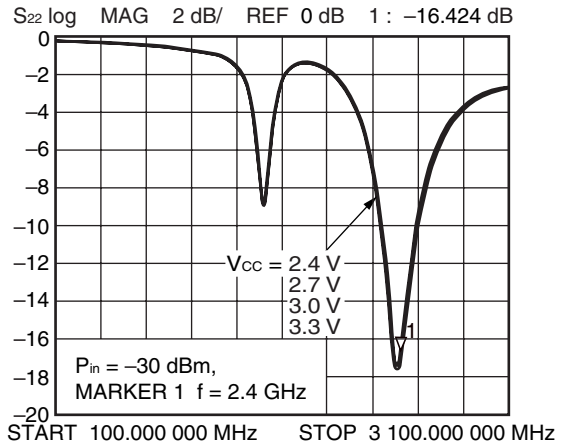
START 100.000 000 MHz STOP 3 100.000 000 MHz

S₂₁-FREQUENCY



START 100.000 000 MHz STOP 3 100.000 000 MHz

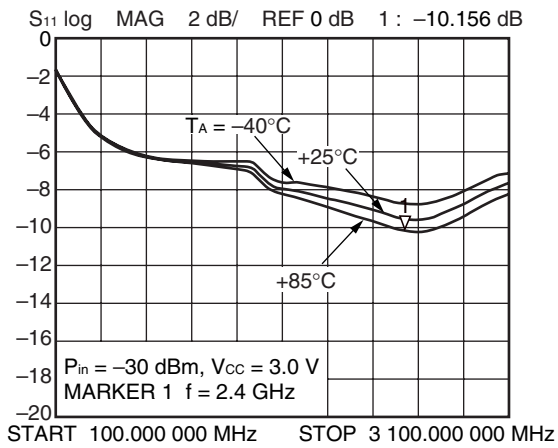
S₂₂-FREQUENCY



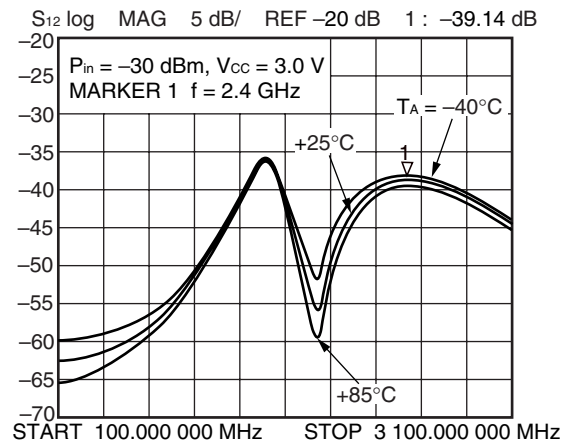
START 100.000 000 MHz STOP 3 100.000 000 MHz

Remark The graphs indicate nominal characteristics.

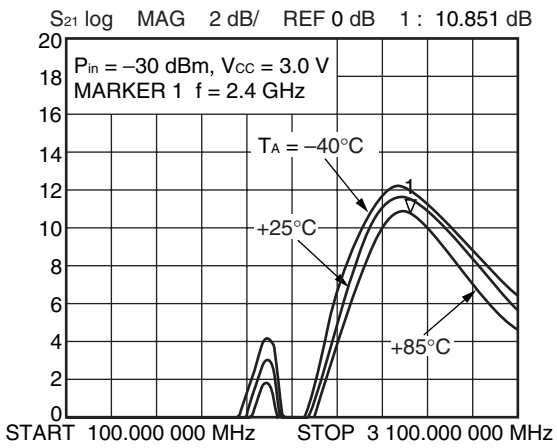
S11-FREQUENCY



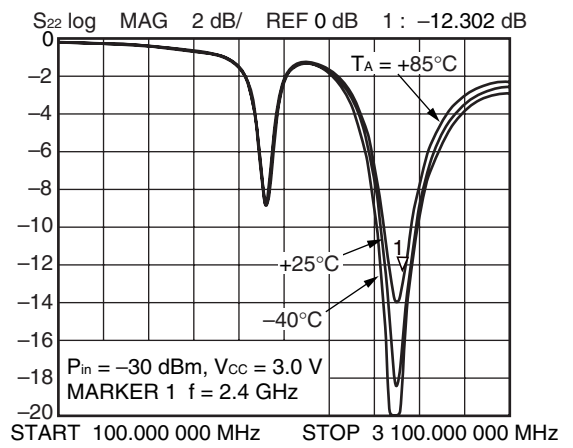
S12-FREQUENCY



S21-FREQUENCY

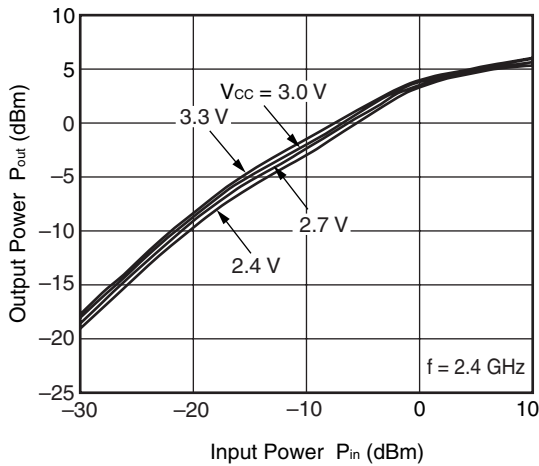


S22-FREQUENCY

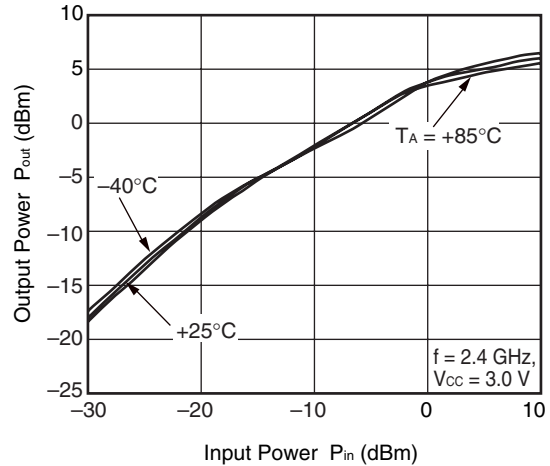


Remark The graphs indicate nominal characteristics.

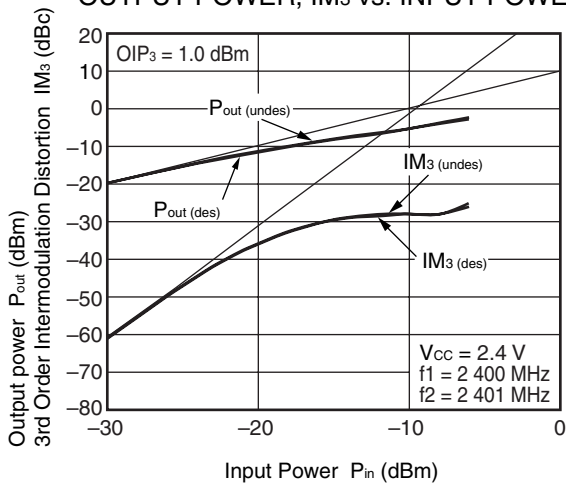
OUTPUT POWER vs. INPUT POWER



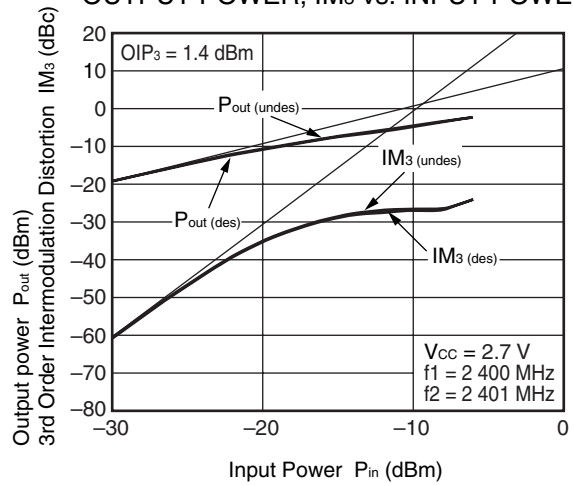
OUTPUT POWER vs. INPUT POWER



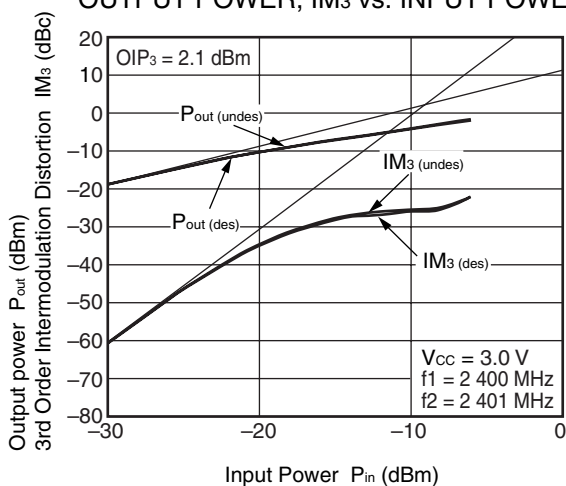
OUTPUT POWER, IM3 vs. INPUT POWER



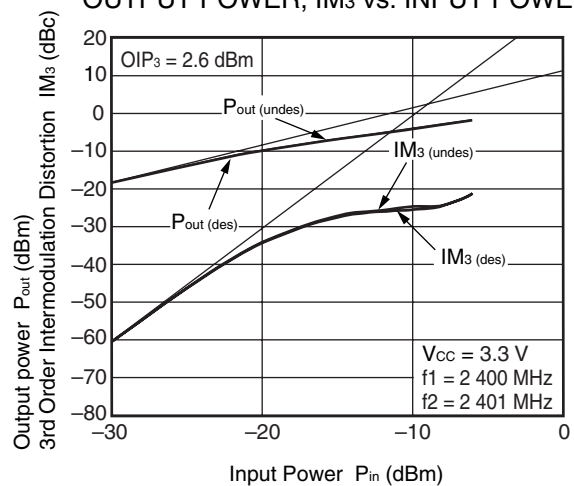
OUTPUT POWER, IM3 vs. INPUT POWER



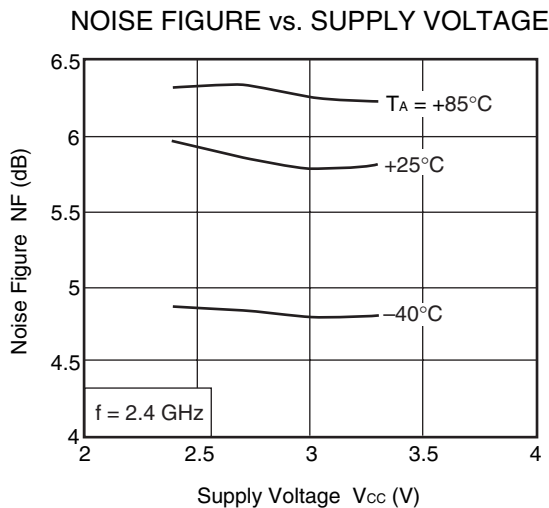
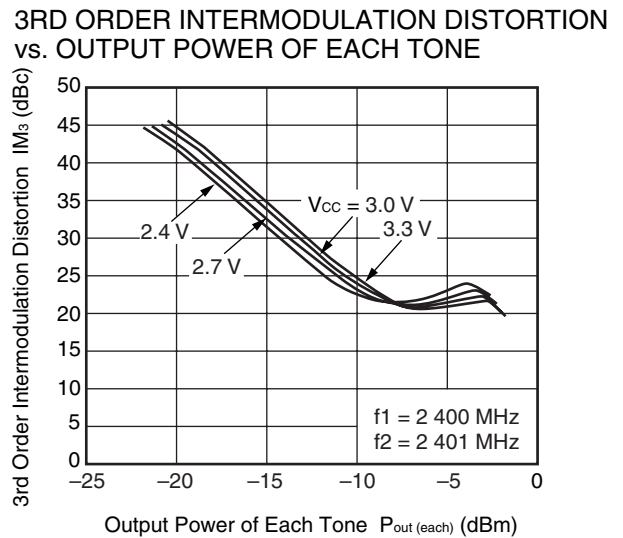
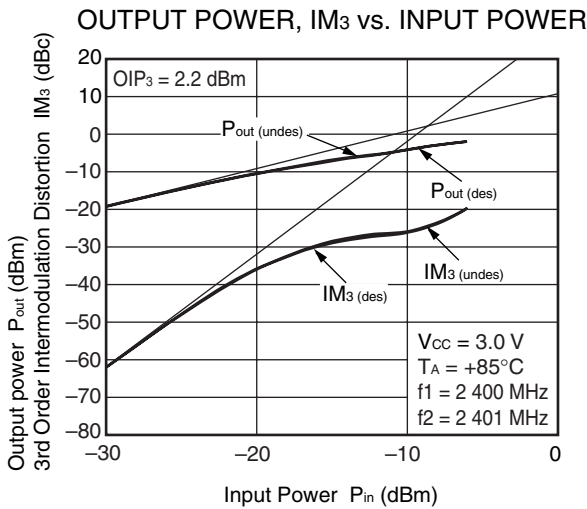
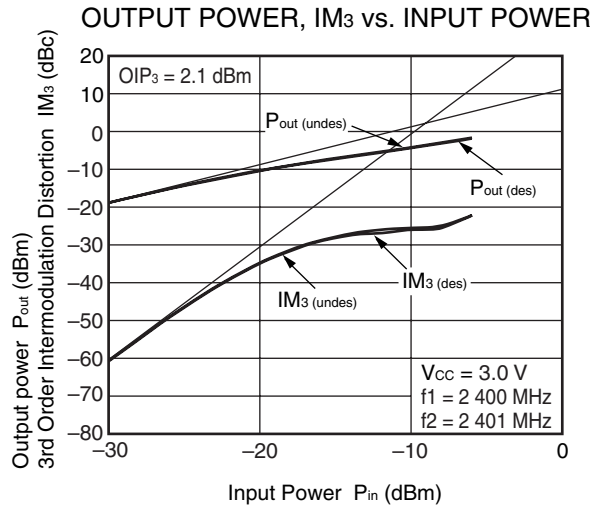
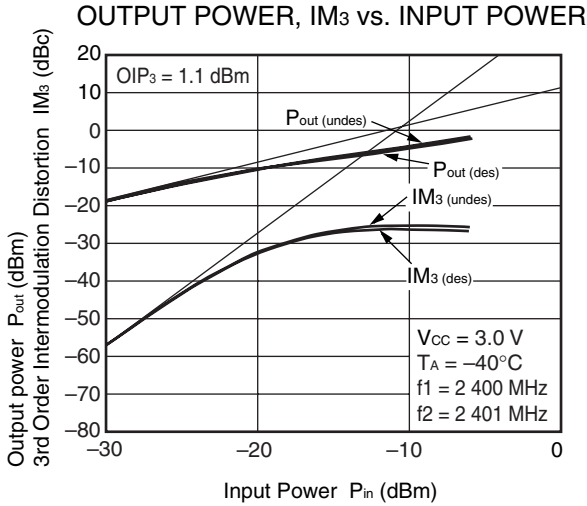
OUTPUT POWER, IM3 vs. INPUT POWER



OUTPUT POWER, IM3 vs. INPUT POWER



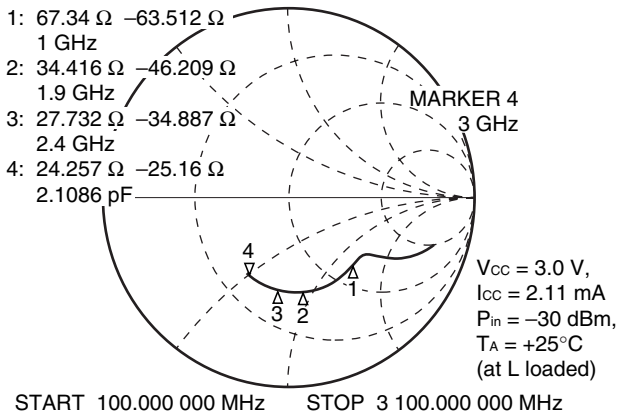
Remark The graphs indicate nominal characteristics.



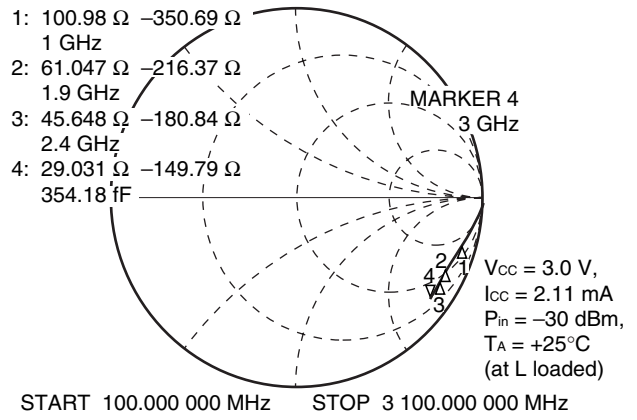
Remark The graphs indicate nominal characteristics.

f = 3.0 GHz MATCHING

S₁₁-FREQUENCY



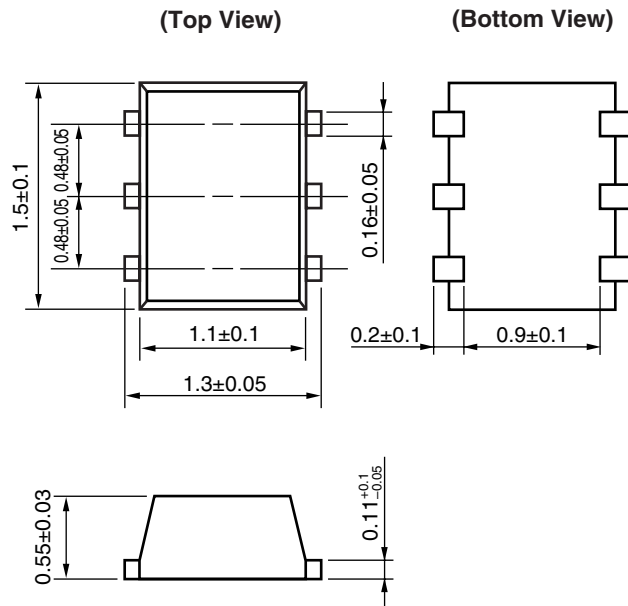
S₂₂-FREQUENCY



Remark The graphs indicate nominal characteristics.

★ PACKAGE DIMENSIONS

6-PIN LEAD-LESS MINIMOLD (1511) (UNIT: mm)



NOTE ON CORRECT USE

- (1) Observe precautions for handling because of electro-static sensitive devices.
- (2) Form a ground pattern as widely as possible to minimize ground impedance (to prevent undesired oscillation).
All the ground pins must be connected together with wide ground pattern to decrease impedance difference.
- (3) The bypass capacitor should be attached to Vcc line.
- (4) The inductor (L) should be attached between output and Vcc pins. The L and series capacitor (C) values should be adjusted for applied frequency to match impedance to next stage.
- (5) The DC capacitor must be attached to input pin.

★ **RECOMMENDED SOLDERING CONDITIONS**

This product should be soldered and mounted under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your nearby sales office.

| Soldering Method | Soldering Conditions | Condition Symbol |
|------------------|---|------------------|
| Infrared Reflow | Peak temperature (package surface temperature) : 260°C or below Time at peak temperature : 10 seconds or less Time at temperature of 220°C or higher : 60 seconds or less Preheating time at 120 to 180°C : 120±30 seconds Maximum number of reflow processes : 3 times Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below | IR260 |
| Wave Soldering | Peak temperature (molten solder temperature) : 260°C or below Time at peak temperature : 10 seconds or less Preheating temperature (package surface temperature) : 120°C or below Maximum number of flow processes : 1 time Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below | WS260 |
| Partial Heating | Peak temperature (terminal temperature) : 350°C or below Soldering time (per side of device) : 3 seconds or less Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below | HS350 |

Caution Do not use different soldering methods together (except for partial heating).

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 "Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)
 "Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.
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M8E 00.4-0110

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