

# BGB707L7ESD

Wideband MMIC LNA with Integrated ESD Protection

## Data Sheet

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**BGB707L7ESD, Wideband MMIC LNA with Integrated ESD Protection**
**Revision History: 2012-11-09, Revision 3.3**

| Page | Subjects (changes since previous revision)   |
|------|--|
|      | This data sheet replaces the revision from 2010-06-30.<br>The product itself has not been changed and the device characteristics remain unchanged.<br>Only the product description and information available in the data sheet have been expanded and updated. |
|      |  |
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|      |  |

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## **1 Product Brief**

The BGB707L7ESD is a Silicon Germanium Carbon (SiGe:C) low noise amplifier MMIC with integrated ESD protection and active biasing. The device is as flexible as a discrete transistor and features high gain, reduced power consumption and very low distortion for a very wide range of applications.

The device is based on Infineon Technologies' cost effective SiGe:C technology and comes in a low profile TSLP-7-1 leadless green package.

## 2 Features

- High performance general purpose wideband MMIC LNA
- ESD protection integrated for all pins (3 kV for RF input vs. GND, 2 kV for all other pin combinations, HBM)
- Integrated active biasing circuit enables stable operating point against temperature- and processing-variations
- Excellent noise figure from Infineon's reliable high volume SiGe:C technology
- High gain and linearity at low current consumption
- Supply voltage: 1.8 V to 4.0 V
- Adjustable operating current 2.1 mA to 25 mA by external resistor
- Power-off function
- Very small and leadless package TSLP-7-1, 2.0 x 1.3 x 0.4 mm<sup>3</sup>
- Pb-free (RoHS compliant) and halogen-free package
- Qualification report according to AEC-Q101 available



### Applications

As Low Noise Amplifier (LNA) in

- Mobile, portable and fixed connectivity applications: WLAN 802.11a/b/g/n, WiMax 2.5/3.5/5 GHz, UWB, WiFi, Bluetooth
- Satellite communication systems: Navigation systems (GPS, Glonass), satellite radio (SDARs, DAB) and C-band LNB
- Multimedia applications such as mobile/portable TV, CATV, FM Radio
- 3G/4G UMTS/LTE mobile phone applications
- ISM applications like RKE, AMR and Zigbee

**Attention: ESD (Electrostatic discharge) sensitive device, observe handling precautions**

| Product Name | Package  | Marking |
|--------------|----------|---------|
| BGB707L7ESD  | TSLP-7-1 | AZ      |

### 3 Pin Configuration

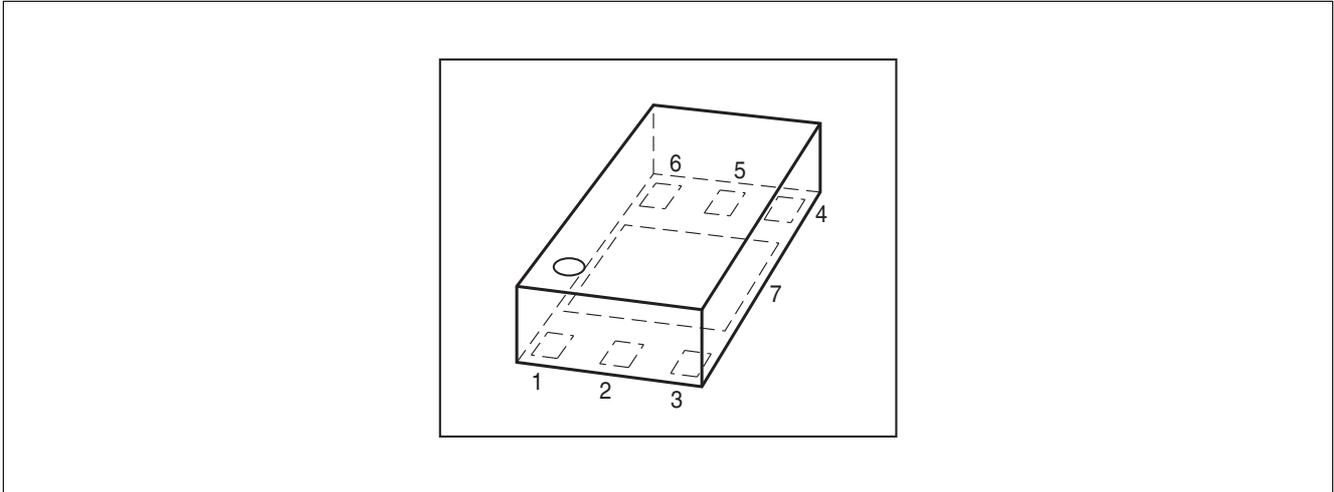


Figure 3-1 Pinning of BGB707L7ESD in TSLP-7-1

Table 3-1 Pinning Table

| Pin | Name       | Function               |
|-----|------------|------------------------|
| 1   | $V_{CC}$   | Supply voltage         |
| 2   | $V_{Bias}$ | Bias reference voltage |
| 3   | $RF_{in}$  | RF input               |
| 4   | $RF_{out}$ | RF output              |
| 5   | $V_{Ctrl}$ | On/Off control voltage |
| 6   | $Adj$      | Current adjustment pin |
| 7   | $GND$      | DC/RF GND              |

## 4 Functional Block Diagram

The functional block in **Figure 4-1** shows the principal schematic how the BGB707L7ESD is used in a circuit. The Power On/Off function is controlled by applying  $V_{Ctrl}$ . By using an external resistor  $R_{ext}$  the pre-set current of 2.1 mA (which is adjusted by the integrated biasing when  $R_{ext}$  is omitted) can be increased. Base- and collector voltages are applied to the respective pins  $RF_{in}$  and  $RF_{out}$  by external inductors  $L_B$  and  $L_C$ .

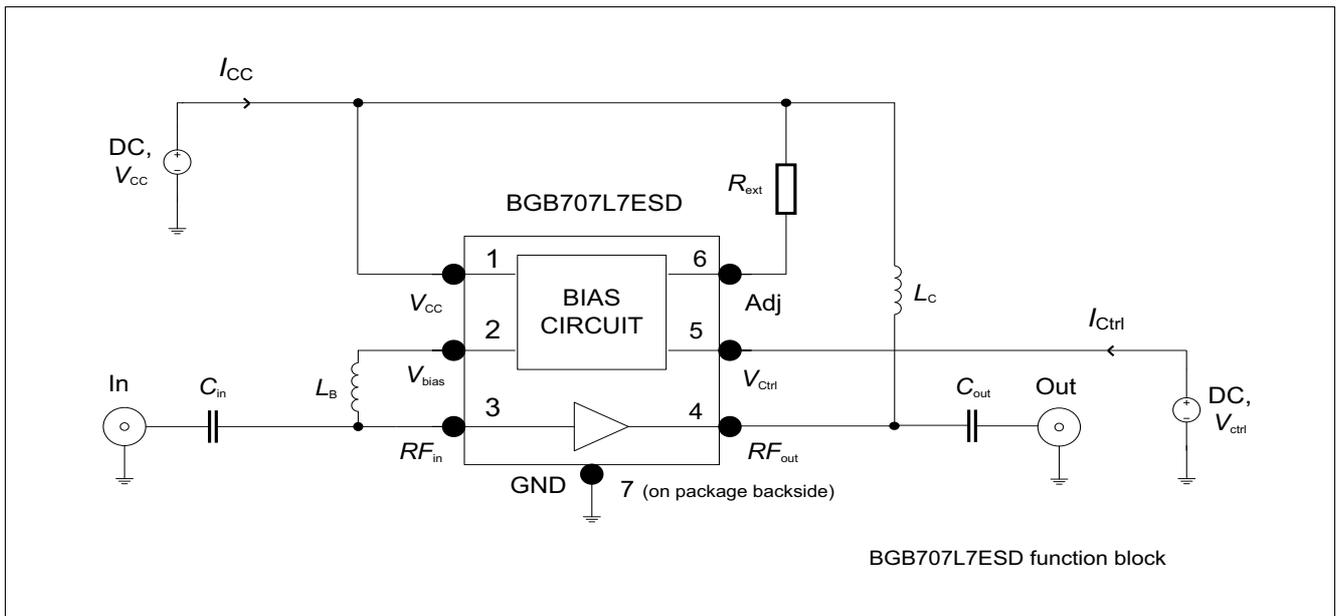


Figure 4-1 Functional Block Diagram

## 5 Maximum Ratings

**Table 5-1 Maximum Ratings at  $T_A = 25\text{ °C}$  (unless otherwise specified)**

| Parameter                             | Symbol     | Values |      |      | Unit | Note / Test Condition    |
|---------------------------------------|------------|--------|------|------|------|--------------------------|
|                                       |            | Min.   | Typ. | Max. |      |                          |
| Supply Voltage                        | $V_{CC}$   | –      | –    | 4.0  | V    | $T_A = 25\text{ °C}$     |
|                                       |            | –      | –    | 3.5  |      | $T_A = -55\text{ °C}$    |
| Supply Current at $V_{CC}$ pin        | $I_{CC}$   | –      | –    | 25   | mA   | –                        |
| DC Current at RF In pin               | $I_B$      | –      | –    | 2    | mA   | –                        |
| Voltage at Ctrl On/Off pin            | $V_{ctrl}$ | –      | –    | 4.0  | V    | –                        |
| Total Power Dissipation <sup>1)</sup> | $P_{tot}$  | –      | –    | 100  | mW   | $T_S \leq 112\text{ °C}$ |
| Junction Temperature                  | $T_J$      | –      | –    | 150  | °C   | –                        |
| Storage Temperature                   | $T_{Stg}$  | -55    | –    | 150  | °C   | –                        |

1)  $T_S$  is the soldering point temperature.  $T_S$  is measured at the GND pin (7) at the soldering point to the pcb

**Attention: Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.**

## 6 Thermal Characteristics

Table 6-1 Thermal Resistance

| Parameter                                | Symbol     | Values |      |      | Unit | Note / Test Condition |
|--|------------|--------|------|------|------|-----------------------|
|  |            | Min.   | Typ. | Max. |      |                       |
| Junction - Soldering Point <sup>1)</sup> | $R_{thJS}$ | –      | 375  | –    | K/W  | –                     |

1)For the definition of  $R_{thJS}$  please refer to Application Note AN077 (Thermal Resistance Calculation)

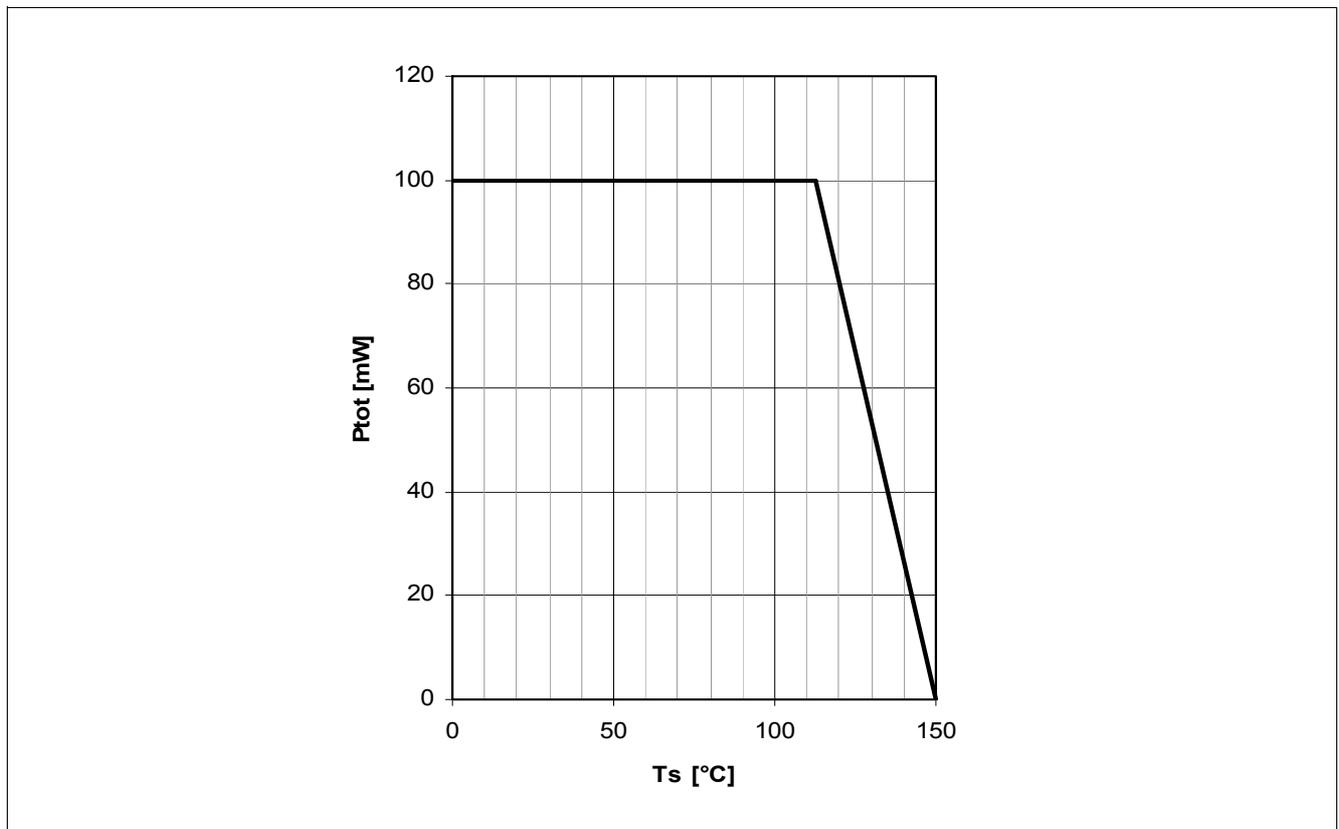


Figure 6-1 Total Power Dissipation  $P_{tot} = f(T_s)$

## 7 Operation Conditions

**Table 7-1 Operation Conditions**

| Parameter                           | Symbol     | Values |      |          | Unit | Note / Test Condition |
|-------------------------------------|------------|--------|------|----------|------|-----------------------|
|                                     |            | Min.   | Typ. | Max.     |      |                       |
| Supply Voltage                      | $V_{CC}$   | 1.8    | 3.0  | 4.0      | V    | –                     |
| Voltage Ctrl On/Off pin in On mode  | $V_{ctrl}$ | 1.2    | –    | $V_{CC}$ | V    | –                     |
| Voltage Ctrl On/Off pin in Off mode | $V_{ctrl}$ | -0.3   | –    | 0.3      | V    | –                     |

## 8 Electrical Characteristics

### 8.1 DC Characteristics

**Table 8-1 DC Characteristics at  $V_{CC} = 3\text{ V}$ ,  $T_A = 25\text{ °C}$** 

| Parameter                               | Symbol         | Values |      |      | Unit          | Note / Test Condition   |
|---|----------------|--------|------|------|---------------|---|
|   |                | Min.   | Typ. | Max. |               |   |
| Supply Current                          | $I_{CC}$       | –      | –    | –    | mA            | $V_{Ctrl} = 3\text{ V}$<br>$R_{ext} = \text{open}$<br>$R_{ext} = 12\text{ k}\Omega$<br>$R_{ext} = 4.7\text{ k}\Omega$<br>$R_{ext} = 2.4\text{ k}\Omega$<br>$R_{ext} = 1\text{ k}\Omega$ |
|   |                | 1.6    | 2.1  | 2.6  |               |   |
|   |                | –      | 3    | –    |               |   |
|   |                | –      | 4.2  | –    |               |   |
|   |                | –      | 6    | –    |               |   |
|   |                | –      | 10   | –    |               |   |
| Supply current in Off mode              | $I_{CC-off}$   | –      | –    | 6    | $\mu\text{A}$ | $V_{Ctrl} = 0\text{ V}$   |
| Current into $V_{Ctrl}$ pin in On mode  | $I_{Ctrl-on}$  | –      | 14   | 20   | $\mu\text{A}$ | $V_{Ctrl} = 3\text{ V}$   |
| Current into $V_{Ctrl}$ pin in Off mode | $I_{Ctrl-off}$ | –      | –    | 0.1  | $\mu\text{A}$ | $V_{Ctrl} = 0\text{ V}$   |

### 8.2 Typical DC Characteristic Curves

The measurement setup is an application circuit according to [Figure 4-1](#) using the integrated biasing.  $T_A = 25\text{ }^\circ\text{C}$  unless otherwise specified.

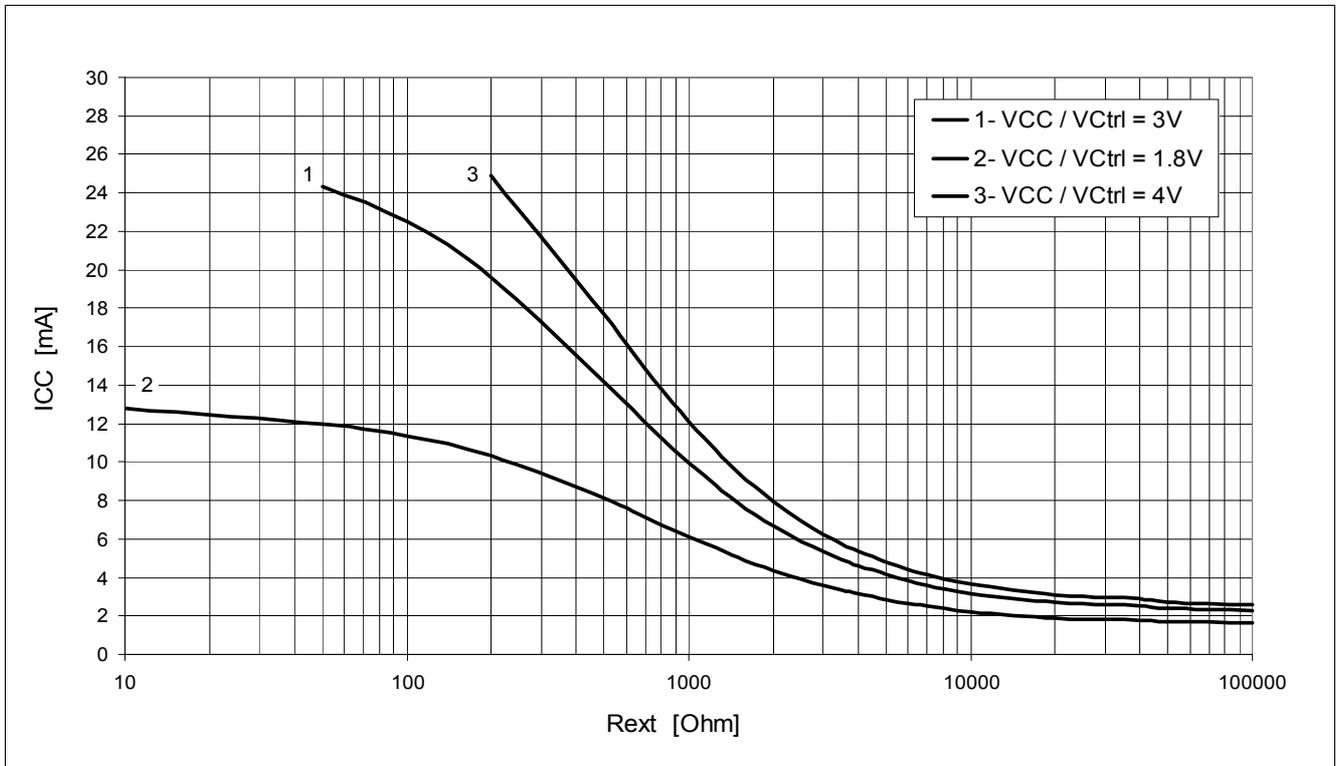


Figure 8-1  $I_{CC}$  as a Function of  $R_{ext}$ ,  $V_{CC}$  as Parameter

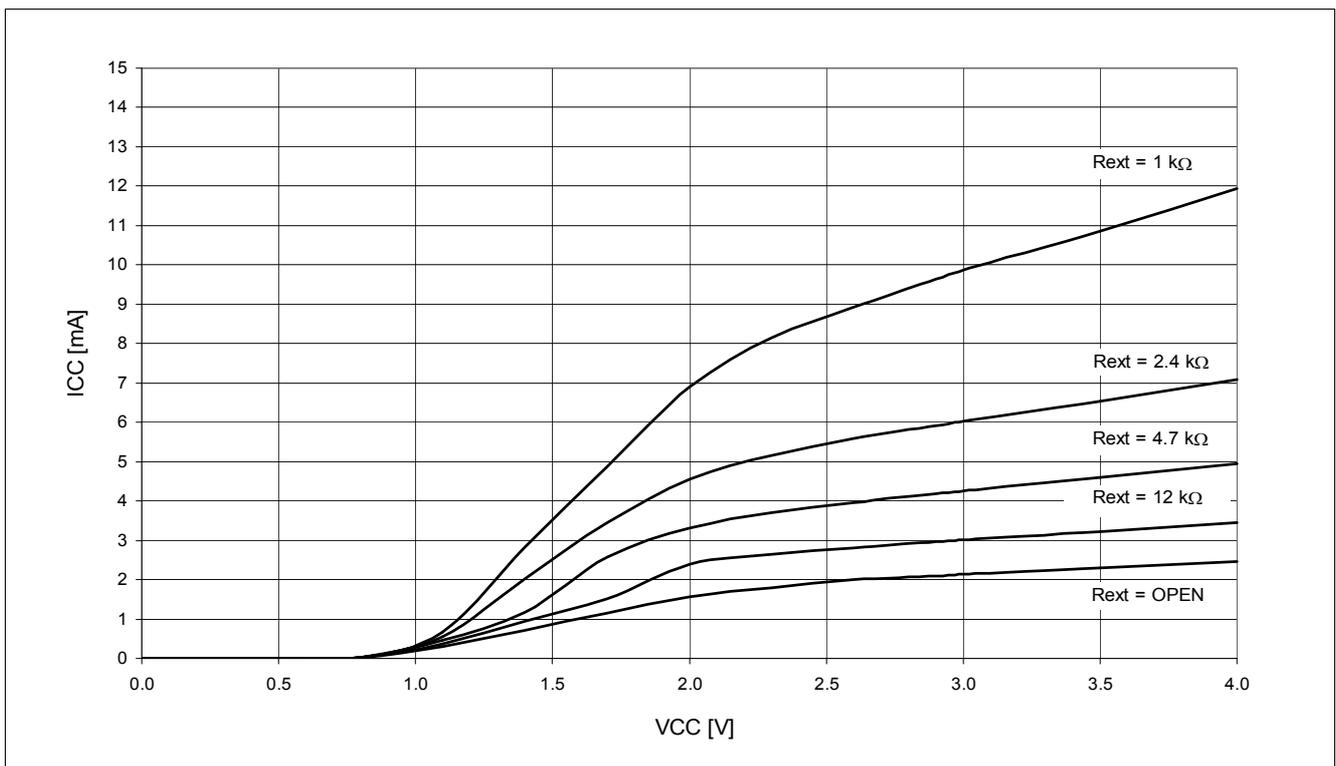


Figure 8-2  $I_{CC}$  as a Function of  $V_{CC}$ ,  $V_{Ctrl} = 3\text{ V}$ ,  $R_{ext}$  as Parameter

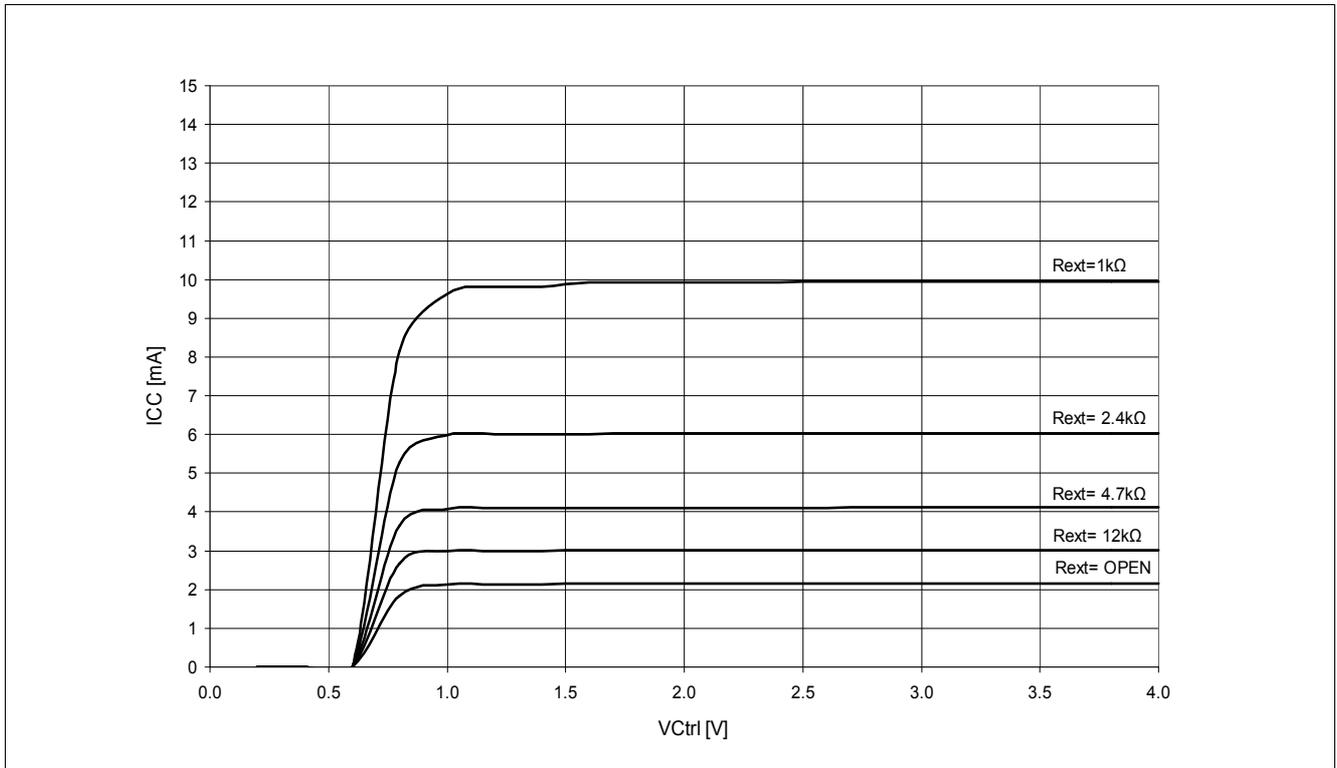


Figure 8-3  $I_{CC}$  as a Function of  $V_{Ctrl}$ ,  $V_{CC} = 3\text{ V}$ ,  $R_{ext}$  as Parameter

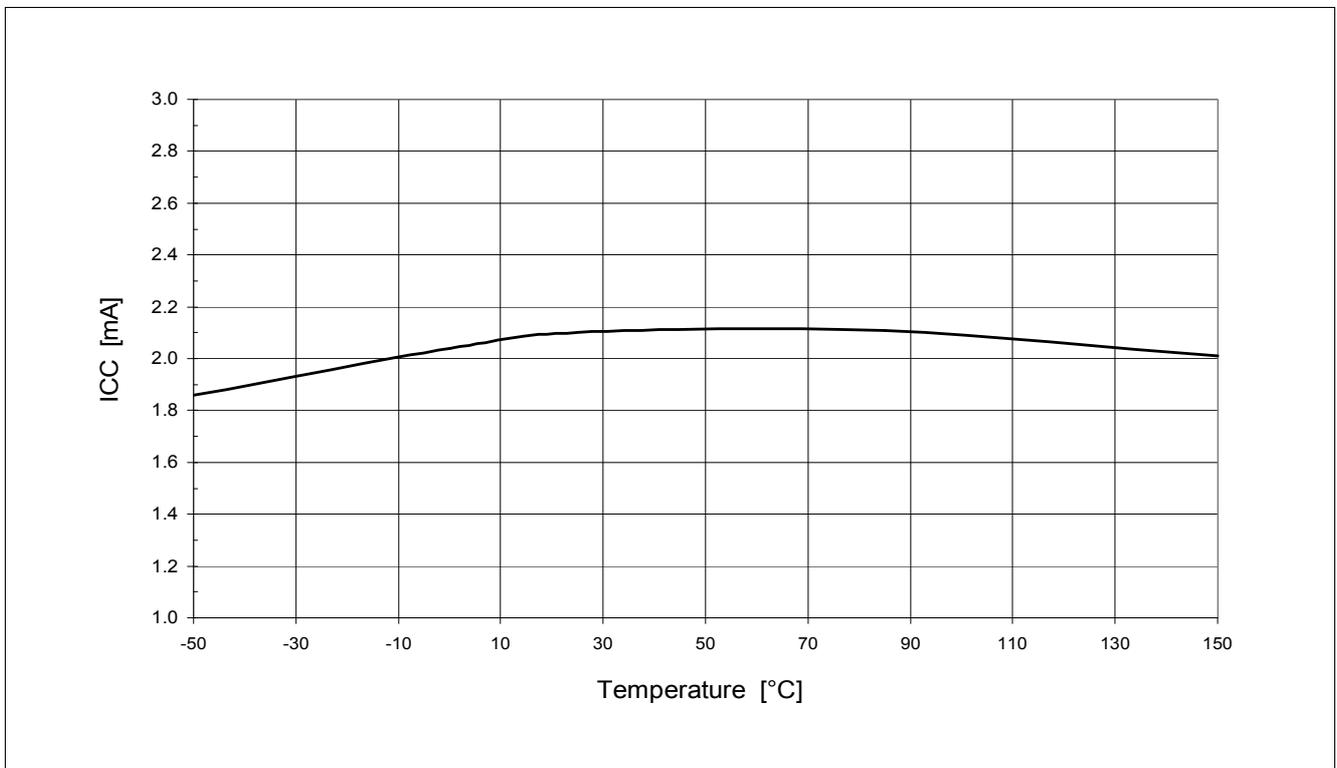


Figure 8-4  $I_{CC}$  as a Function of Temperature,  $V_{Ctrl} = V_{CC} = 3\text{ V}$ ,  $R_{ext} = \text{open}$

### 8.3 AC Characteristics

AC characteristics are described in two sub-chapters, first for 100 MHz FM Radio applications, then for higher frequencies in a 50  $\Omega$  environment.

#### 8.3.1 AC Characteristics in FM Radio Applications

Two BGB707L7ESD FM radio application notes are available on our website [www.infineon.com/BGB707](http://www.infineon.com/BGB707). Depending on the impedance of the used antenna, please consult AN177 for high-ohmic antennas and AN181 for 50  $\Omega$  antennas. In this chapter you find a summary of the electrical performance as described in these application notes in table form.

##### 8.3.1.1 High-Ohmic FM Radio Antenna

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 3.0\text{ V}$ ,  $I_{CC} = 3.0\text{ mA}$ ,  $V_{Ctrl} = 3.0\text{ V}$ ,  $f = 100\text{ MHz}$ ,  $R_{ext} = 12\text{ k}\Omega$

**Table 8-2 AC Characteristics in the FM Radio Application as Described in AN177**

| Parameter   | Symbol       | Values |                   |      | Unit | Note / Test Condition |
|---|--------------|--------|-------------------|------|------|-----------------------|
|   |              | Min.   | Typ.              | Max. |      |                       |
| Transducer Gain   | $ S_{21} ^2$ | –      | 12                | –    | dB   | –                     |
| Input Return Loss   | $RL_{IN}$    | –      | 0.5 <sup>1)</sup> | –    | dB   | –                     |
| Output Return Loss  | $RL_{OUT}$   | –      | 16                | –    | dB   | –                     |
| Noise Figure ( $Z_s = 50\ \Omega$ )                       | $NF$         | –      | 1.0               | –    | dB   | –                     |
| Input 1 dB Gain Compression Point <sup>2)</sup>           | $IP_{1dB}$   | –      | -5.5              | –    | dBm  | –                     |
| Input 3 <sup>rd</sup> Order Intercept Point <sup>3)</sup> | $IIP_3$      | –      | -12.5             | –    | dBm  | –                     |

1) LNA presents a high input impedance match over the 76-108 MHz FM radio band.

2)  $I_{CC}$  increases as RF input power level approaches  $IP_{1dB}$ .

3)  $IIP_3$  value depends on termination of all intermodulation frequency components. Termination used for the measurement is 50  $\Omega$  from 0.1 to 6 GHz.

##### 8.3.1.2 50 $\Omega$ FM Radio Antenna

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $I_{CC} = 4.2\text{ mA}$ ,  $V_{Ctrl} = 2.8\text{ V}$ ,  $f = 100\text{ MHz}$ ,  $R_{ext} = 4.7\text{ k}\Omega$

**Table 8-3 AC Characteristics in the FM Radio Application as Described in AN181**

| Parameter   | Symbol       | Values |      |      | Unit | Note / Test Condition |
|---|--------------|--------|------|------|------|-----------------------|
|   |              | Min.   | Typ. | Max. |      |                       |
| Transducer Gain   | $ S_{21} ^2$ | 13.5   | 15   | 16.5 | dB   | –                     |
| Input Return Loss   | $RL_{IN}$    | –      | 7.5  | –    | dB   | –                     |
| Output Return Loss  | $RL_{OUT}$   | –      | 14.5 | –    | dB   | –                     |
| Noise figure ( $Z_s = 50\ \Omega$ )                         | $NF$         | –      | 1.35 | 1.9  | dB   | –                     |
| Input 1 dB Gain Compression Point <sup>1) 2)</sup>          | $IP_{1dB}$   | –      | -10  | –    | dBm  | –                     |
| Input 3 <sup>rd</sup> Order Intercept Point <sup>2)3)</sup> | $IIP_3$      | -7.5   | -6   | –    | dBm  | –                     |

1)  $I_{CC}$  increases as RF input power level approaches  $IP_{1dB}$ .

2) Verified by random sampling

3)  $IIP_3$  value depends on termination of all intermodulation frequency components. Termination used for the measurement is 50  $\Omega$  from 0.1 to 6 GHz.

### 8.3.2 AC Characteristics in the SDMB Application

A technical report TR122 for LNA applications in the frequency range 2.3 GHz to 2.7 GHz is available on our web page [www.infineon.com/BGB707](http://www.infineon.com/BGB707). In this chapter you find a summary of the electrical performance for the SDMB application as described in technical report TR122 in table form.

**Table 8-4 AC Characteristics in the SDMB Application as Described in TR122,  $T_A = 25\text{ °C}$**

| Parameter                           | Symbol             | Values |      |      | Unit    | Note / Test Condition             |
|-------------------------------------|--------------------|--------|------|------|---------|-----------------------------------|
|                                     |                    | Min.   | Typ. | Max. |         |                                   |
| Frequency Range                     | $Freq$             | –      | 2.6  | –    | GHz     | –                                 |
| Supply Voltage                      | $V_{cc}$           | –      | 2.8  | –    | V       | –                                 |
| Bias Current                        | $I_{cc}$           | 4.4    | 5.6  | 6.8  | mA      | –                                 |
| Transducer Gain                     | $ S_{21} ^2$       | 13     | 15   | 17   | dB      | Power @ port1 = -30 dBm           |
| Transducer Gain (off mode)          | $ S_{21} ^2_{off}$ | –      | -18  | –    | dB      | –                                 |
| Noise Figure ( $Z_s = 50\ \Omega$ ) | $NF$               | –      | 1.15 | 1.5  | dB      | Including 0.1 dB Board losses     |
| Input Return Loss                   | $RL_{IN}$          | –      | 13.2 | –    | dB      | –                                 |
| Output Return Loss                  | $RL_{OUT}$         | –      | 12   | –    | dB      | –                                 |
| Reverse Isolation                   | $I_{REV}$          | –      | 27.8 | –    | dB      | Power @ port2 = -10 dBm           |
| Input P1dB                          | $IP_{1dB}$         | –      | -9.6 | –    | dBm     | –                                 |
| Output P1dB                         | $OP_{1dB}$         | –      | 4.4  | –    | dBm     | –                                 |
| Input IP3                           | $IIP_3$            | –      | -1.4 | –    | dBm     | Input power = -30 dBm             |
| Output IP3                          | $OIP_3$            | –      | 13.6 | –    | dBm     | –                                 |
| On Switching Time                   | $T_{on}$           | –      | 1.5  | –    | $\mu s$ | Measured with $C_2 = 1\text{ nF}$ |
| Off Switching Time                  | $T_{off}$          | –      | 4.2  | –    | $\mu s$ | –                                 |
| Stability                           | k                  | –      | >1   | –    |         | Stability measured up to 10 GHz   |

### 8.3.3 AC Characteristics in Test Fixture

For frequencies from 150 MHz to 10 GHz the measurement setup is a test fixture with Bias-T's in a 50 Ω system according to **Figure 8-5** at  $V_C = 3\text{ V}$ ,  $T_A = 25\text{ °C}$ . The collector current  $I_C$  is controlled by an external base voltage  $V_B$  applied at  $RF_{in}$  pin and not by the integrated biasing's reference voltage  $V_{Bias}$ .  $V_C$  controls the collector voltage at  $RF_{out}$  pin. This allows direct measurement of the amplifier performance as a function of bias conditions without passive components.

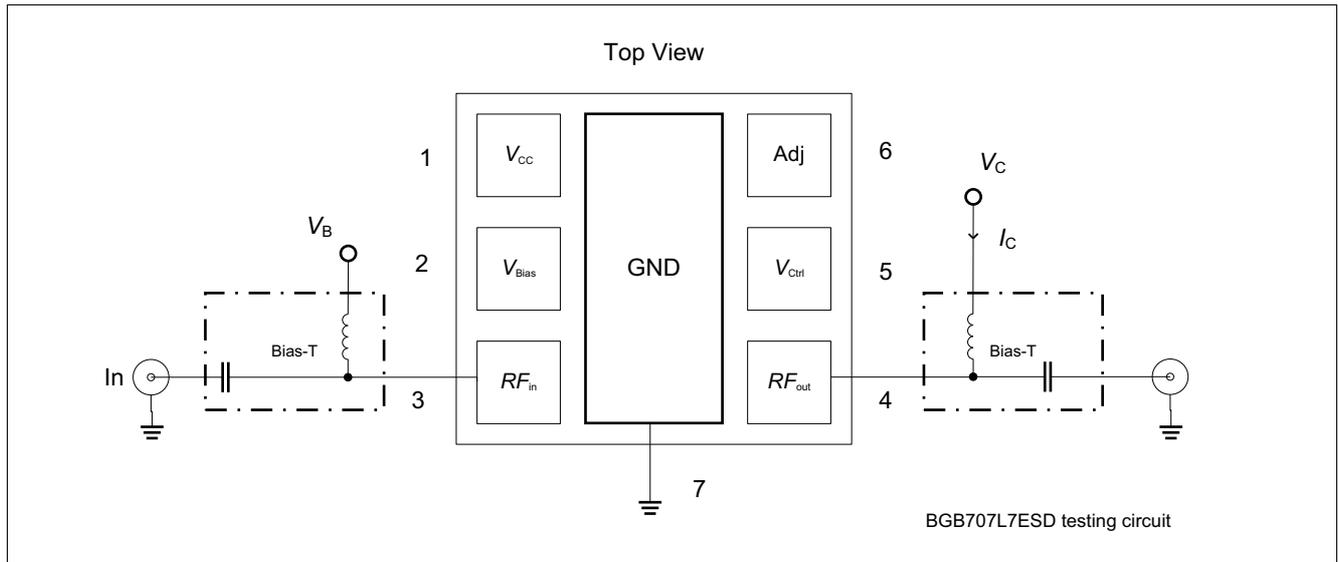


Figure 8-5 Testing Circuit for Frequencies from 150 MHz to 10 GHz

**Table 8-5 AC Characteristics  $V_C = 3\text{ V}, f = 150\text{ MHz}$** 

| Parameter                                   | Symbol            | Values |      |      | Unit | Note / Test Condition   |
|---|-------------------|--------|------|------|------|---|
|   |                   | Min.   | Typ. | Max. |      |   |
| Minimum Noise Figure                        | $NF_{\min}$       | –      | 0.4  | –    | dB   | $Z_S = Z_{\text{Sopt}}$   |
|   |                   | –      | 0.4  | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 0.5  | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 0.55 | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Transducer Gain                             | $ S_{21} ^2$      | –      | 17   | –    | dB   | $Z_S = Z_L = 50\ \Omega$  |
|   |                   | –      | 19   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 24   | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 27   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Maximum Power Gain                          | $G_{\text{ms}}$   | –      | 31.5 | –    | dB   | $Z_L = Z_{\text{Lopt}}, Z_S = Z_{\text{Sopt}}$                        |
|   |                   | –      | 33   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 35   | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 37   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Output 1 dB Compression Point <sup>1)</sup> | $OP_{1\text{dB}}$ | –      | 3.5  | –    | dBm  | $I_{\text{Cq}} = 2.1\text{ mA}, I_{\text{Ccomp}} = 11\text{ mA}^{2)}$ |
|   |                   | –      | 4    | –    |      | $I_{\text{Cq}} = 3\text{ mA}, I_{\text{Ccomp}} = 11\text{ mA}$        |
|   |                   | –      | 4.5  | –    |      | $I_{\text{Cq}} = 6\text{ mA}, I_{\text{Ccomp}} = 11\text{ mA}$        |
|   |                   | –      | 3    | –    |      | $I_{\text{Cq}} = 10\text{ mA}, I_{\text{Ccomp}} = 11\text{ mA}$       |
| Output 3rd Order Intercept Point            | $OIP_3$           | –      | 2    | –    | dBm  | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 6    | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 14.5 | –    |      | $I_C = 6\text{ mA}$   |
|   |                   | –      | 19.5 | –    |      | $I_C = 10\text{ mA}$  |

1)  $OP_{1\text{dB}}$  is the output compression point achieved in a  $50\ \Omega$  application circuit according to [Figure 4-1](#) using the integrated biasing.

2)  $I_{\text{Cq}}$  is the quiescent current at small input power levels.  $I_{\text{Cq}}$  increases up to  $I_{\text{Ccomp}}$  as RF input power approaches  $IP_{1\text{dB}}$ , cf. [Figure 8-12](#).

**Table 8-6 AC Characteristics  $V_C = 3\text{ V}, f = 450\text{ MHz}$** 

| Parameter                                   | Symbol            | Values |      |      | Unit | Note / Test Condition   |
|---|-------------------|--------|------|------|------|---|
|   |                   | Min.   | Typ. | Max. |      |   |
| Minimum Noise Figure                        | $NF_{\min}$       | –      | 0.45 | –    | dB   | $Z_S = Z_{\text{Sopt}}$   |
|   |                   | –      | 0.45 | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 0.5  | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 0.6  | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Transducer Gain                             | $ S_{21} ^2$      | –      | 17   | –    | dB   | $Z_S = Z_L = 50\ \Omega$  |
|   |                   | –      | 19   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 24   | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 27   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Maximum Power Gain                          | $G_{\text{ms}}$   | –      | 27   | –    | dB   | $Z_L = Z_{\text{Lopt}}, Z_S = Z_{\text{Sopt}}$                        |
|   |                   | –      | 28   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 30.5 | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 32   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Output 1 dB Compression Point <sup>1)</sup> | $OP_{1\text{dB}}$ | –      | 11.5 | –    | dBm  | $I_{\text{Cq}} = 2.1\text{ mA}, I_{\text{Ccomp}} = 11\text{ mA}^{2)}$ |
|   |                   | –      | 12   | –    |      | $I_{\text{Cq}} = 3\text{ mA}, I_{\text{Ccomp}} = 14\text{ mA}$        |
|   |                   | –      | 11.5 | –    |      | $I_{\text{Cq}} = 6\text{ mA}, I_{\text{Ccomp}} = 16\text{ mA}$        |
|   |                   | –      | 9.5  | –    |      | $I_{\text{Cq}} = 10\text{ mA}, I_{\text{Ccomp}} = 15\text{ mA}$       |
| Output 3rd Order Intercept Point            | $OIP_3$           | –      | 2    | –    | dBm  | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 5.5  | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 14   | –    |      | $I_C = 6\text{ mA}$   |
|   |                   | –      | 19.5 | –    |      | $I_C = 10\text{ mA}$  |

1)  $OP_{1\text{dB}}$  is the output compression point achieved in a  $50\ \Omega$  application circuit according to [Figure 4-1](#) using the integrated biasing.

2)  $I_{\text{Cq}}$  is the quiescent current at small input power levels.  $I_{\text{Cq}}$  increases up to  $I_{\text{Ccomp}}$  as RF input power approaches  $IP_{1\text{dB}}$ , cf. [Figure 8-12](#).

**Table 8-7 AC Characteristics  $V_C = 3\text{ V}, f = 900\text{ MHz}$** 

| Parameter                                   | Symbol            | Values |      |      | Unit | Note / Test Condition   |
|---|-------------------|--------|------|------|------|---|
|   |                   | Min.   | Typ. | Max. |      |   |
| Minimum Noise Figure                        | $NF_{\min}$       | –      | 0.55 | –    | dB   | $Z_S = Z_{\text{Sopt}}$   |
|   |                   | –      | 0.55 | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 0.6  | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 0.7  | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Transducer Gain                             | $ S_{21} ^2$      | –      | 17   | –    | dB   | $Z_S = Z_L = 50\ \Omega$  |
|   |                   | –      | 19   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 23.5 | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 26   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Maximum Power Gain                          | $G_{\text{ms}}$   | –      | 24   | –    | dB   | $Z_L = Z_{\text{Lopt}}, Z_S = Z_{\text{Sopt}}$                        |
|   |                   | –      | 25   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 27.5 | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 29   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Output 1 dB Compression Point <sup>1)</sup> | $OP_{1\text{dB}}$ | –      | 11   | –    | dBm  | $I_{\text{Cq}} = 2.1\text{ mA}, I_{\text{Ccomp}} = 13\text{ mA}^{2)}$ |
|   |                   | –      | 11   | –    |      | $I_{\text{Cq}} = 3\text{ mA}, I_{\text{Ccomp}} = 15\text{ mA}$        |
|   |                   | –      | 10   | –    |      | $I_{\text{Cq}} = 6\text{ mA}, I_{\text{Ccomp}} = 14\text{ mA}$        |
|   |                   | –      | 8.5  | –    |      | $I_{\text{Cq}} = 10\text{ mA}, I_{\text{Ccomp}} = 14\text{ mA}$       |
| Output 3rd Order Intercept Point            | $OIP_3$           | –      | 3.5  | –    | dBm  | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 8    | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 17   | –    |      | $I_C = 6\text{ mA}$   |
|   |                   | –      | 19.5 | –    |      | $I_C = 10\text{ mA}$  |

1)  $OP_{1\text{dB}}$  is the output compression point achieved in a  $50\ \Omega$  application circuit according to [Figure 4-1](#) using the integrated biasing.

2)  $I_{\text{Cq}}$  is the quiescent current at small input power levels.  $I_{\text{Cq}}$  increases up to  $I_{\text{Ccomp}}$  as RF input power approaches  $IP_{1\text{dB}}$ , cf. [Figure 8-12](#).

**Electrical Characteristics**
**Table 8-8 AC Characteristics  $V_C = 3\text{ V}$ ,  $f = 1.5\text{ GHz}$** 

| Parameter                                   | Symbol            | Values |      |      | Unit | Note / Test Condition   |
|---|-------------------|--------|------|------|------|---|
|   |                   | Min.   | Typ. | Max. |      |   |
| Minimum Noise Figure                        | $NF_{\min}$       | –      | 0.6  | –    | dB   | $Z_S = Z_{\text{Sopt}}$   |
|   |                   | –      | 0.6  | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 0.6  | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 0.7  | –    |      | $I_C = 10\text{ mA}$  |
| Transducer Gain                             | $ S_{21} ^2$      | –      | 16   | –    | dB   | $Z_S = Z_L = 50\ \Omega$  |
|   |                   | –      | 18.5 | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 22.5 | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 24.5 | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                                       |
| Maximum Power Gain                          | $G_{\text{ms}}$   | –      | 21.5 | –    | dB   | $Z_L = Z_{\text{Lopt}}$ , $Z_S = Z_{\text{Sopt}}$                                 |
|   |                   | –      | 23   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 25.5 | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 27   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                                       |
| Output 1 dB Compression Point <sup>1)</sup> | $OP_{1\text{dB}}$ | –      | 10.5 | –    | dBm  | $I_{\text{Cq}} = 2.1\text{ mA}$ , $I_{\text{Ccomp}} = 14\text{ mA}$ <sup>2)</sup> |
|   |                   | –      | 10   | –    |      | $I_{\text{Cq}} = 3\text{ mA}$ , $I_{\text{Ccomp}} = 16\text{ mA}$                 |
|   |                   | –      | 9    | –    |      | $I_{\text{Cq}} = 6\text{ mA}$ , $I_{\text{Ccomp}} = 15\text{ mA}$                 |
|   |                   | –      | 8    | –    |      | $I_{\text{Cq}} = 10\text{ mA}$ , $I_{\text{Ccomp}} = 15\text{ mA}$                |
| Output 3rd Order Intercept Point            | $OIP_3$           | –      | 3.5  | –    | dBm  | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 8    | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 17   | –    |      | $I_C = 6\text{ mA}$   |
|   |                   | –      | 19.5 | –    |      | $I_C = 10\text{ mA}$  |

1)  $OP_{1\text{dB}}$  is the output compression point achieved in a  $50\ \Omega$  application circuit according to [Figure 4-1](#) using the integrated biasing.

2)  $I_{\text{Cq}}$  is the quiescent current at small input power levels.  $I_{\text{Cq}}$  increases up to  $I_{\text{Ccomp}}$  as RF input power approaches  $IP_{1\text{dB}}$ , cf. [Figure 8-12](#).

Table 8-9 AC Characteristics  $V_C = 3\text{ V}, f = 1.9\text{ GHz}$ 

| Parameter                                   | Symbol            | Values |      |      | Unit | Note / Test Condition   |
|---|-------------------|--------|------|------|------|---|
|   |                   | Min.   | Typ. | Max. |      |   |
| Minimum Noise Figure                        | $NF_{\min}$       | –      | 0.6  | –    | dB   | $Z_S = Z_{\text{Sopt}}$   |
|   |                   | –      | 0.6  | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 0.6  | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 0.7  | –    |      | $I_C = 10\text{ mA}$  |
| Transducer Gain                             | $ S_{21} ^2$      | –      | 16   | –    | dB   | $Z_S = Z_L = 50\ \Omega$  |
|   |                   | –      | 18   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 21.5 | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 23   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Maximum Power Gain                          | $G_{\text{ms}}$   | –      | 21   | –    | dB   | $Z_L = Z_{\text{Lopt}}, Z_S = Z_{\text{Sopt}}$                        |
|   |                   | –      | 22   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 24   | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 26   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Output 1 dB Compression Point <sup>1)</sup> | $OP_{1\text{dB}}$ | –      | 10   | –    | dBm  | $I_{\text{Cq}} = 2.1\text{ mA}, I_{\text{Ccomp}} = 15\text{ mA}^{2)}$ |
|   |                   | –      | 10   | –    |      | $I_{\text{Cq}} = 3\text{ mA}, I_{\text{Ccomp}} = 16\text{ mA}$        |
|   |                   | –      | 8.5  | –    |      | $I_{\text{Cq}} = 6\text{ mA}, I_{\text{Ccomp}} = 14\text{ mA}$        |
|   |                   | –      | 8    | –    |      | $I_{\text{Cq}} = 10\text{ mA}, I_{\text{Ccomp}} = 14\text{ mA}$       |
| Output 3rd Order Intercept Point            | $OIP_3$           | –      | 3.5  | –    | dBm  | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 7.5  | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 17   | –    |      | $I_C = 6\text{ mA}$   |
|   |                   | –      | 19.5 | –    |      | $I_C = 10\text{ mA}$  |

1)  $OP_{1\text{dB}}$  is the output compression point achieved in a  $50\ \Omega$  application circuit according to [Figure 4-1](#) using the integrated biasing.

2)  $I_{\text{Cq}}$  is the quiescent current at small input power levels.  $I_{\text{Cq}}$  increases up to  $I_{\text{Ccomp}}$  as RF input power approaches  $IP_{1\text{dB}}$ , cf. [Figure 8-12](#).

Table 8-10 AC Characteristics  $V_C = 3\text{ V}, f = 2.4\text{ GHz}$ 

| Parameter                                   | Symbol            | Values |      |      | Unit | Note / Test Condition   |
|---|-------------------|--------|------|------|------|---|
|   |                   | Min.   | Typ. | Max. |      |   |
| Minimum Noise Figure                        | $NF_{\min}$       | –      | 0.65 | –    | dB   | $Z_S = Z_{\text{Sopt}}$   |
|   |                   | –      | 0.6  | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 0.6  | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 0.7  | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Transducer Gain                             | $ S_{21} ^2$      | –      | 15.5 | –    | dB   | $Z_S = Z_L = 50\ \Omega$  |
|   |                   | –      | 17   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 20   | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 21.5 | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Maximum Power Gain                          | $G_{\text{ms}}$   | –      | 20   | –    | dB   | $Z_L = Z_{\text{Lopt}}, Z_S = Z_{\text{Sopt}}$                        |
|   |                   | –      | 21   | –    |      | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 23   | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 25   | –    |      | $I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$                           |
| Output 1 dB Compression Point <sup>1)</sup> | $OP_{1\text{dB}}$ | –      | 10   | –    | dBm  | $I_{\text{Cq}} = 2.1\text{ mA}, I_{\text{Ccomp}} = 15\text{ mA}^{2)}$ |
|   |                   | –      | 10   | –    |      | $I_{\text{Cq}} = 3\text{ mA}, I_{\text{Ccomp}} = 16\text{ mA}$        |
|   |                   | –      | 9    | –    |      | $I_{\text{Cq}} = 6\text{ mA}, I_{\text{Ccomp}} = 14\text{ mA}$        |
|   |                   | –      | 8    | –    |      | $I_{\text{Cq}} = 10\text{ mA}, I_{\text{Ccomp}} = 14\text{ mA}$       |
| Output 3rd Order Intercept Point            | $OIP_3$           | –      | 4.5  | –    | dBm  | $I_C = 2.1\text{ mA}$   |
|   |                   | –      | 9    | –    |      | $I_C = 3\text{ mA}$   |
|   |                   | –      | 17.5 | –    |      | $I_C = 6\text{ mA}$   |
|   |                   | –      | 19.5 | –    |      | $I_C = 10\text{ mA}$  |

1)  $OP_{1\text{dB}}$  is the output compression point achieved in a  $50\ \Omega$  application circuit according to [Figure 4-1](#) using the integrated biasing.

2)  $I_{\text{Cq}}$  is the quiescent current at small input power levels.  $I_{\text{Cq}}$  increases up to  $I_{\text{Ccomp}}$  as RF input power approaches  $IP_{1\text{dB}}$ , cf. [Figure 8-12](#).

**Table 8-11 AC Characteristics  $V_C = 3\text{ V}, f = 3.5\text{ GHz}$** 

| Parameter                                   | Symbol            | Values |      |      | Unit | Note / Test Condition  |
|---|-------------------|--------|------|------|------|--|
|   |                   | Min.   | Typ. | Max. |      |  |
| Minimum Noise Figure                        | $NF_{\min}$       | –      | 0.8  | –    | dB   | $Z_S = Z_{\text{Sopt}}$<br>$I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$   |
|   |                   | –      | 0.75 | –    |      |  |
|   |                   | –      | 0.7  | –    |      |  |
|   |                   | –      | 0.75 | –    |      |  |
| Transducer Gain                             | $ S_{21} ^2$      | –      | 13.5 | –    | dB   | $Z_S = Z_L = 50\ \Omega$<br>$I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$  |
|   |                   | –      | 15.5 | –    |      |  |
|   |                   | –      | 18   | –    |      |  |
|   |                   | –      | 19   | –    |      |  |
| Maximum Power Gain                          | $G_{\text{ms}}$   | –      | 18.5 | –    | dB   | $Z_L = Z_{\text{Lopt}}, Z_S = Z_{\text{Sopt}}$<br>$I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$  |
|   |                   | –      | 20   | –    |      |  |
|   |                   | –      | 22   | –    |      |  |
|   |                   | –      | 23.5 | –    |      |  |
| Output 1 dB Compression Point <sup>1)</sup> | $OP_{1\text{dB}}$ | –      | 10   | –    | dBm  | $I_{\text{Cq}} = 2.1\text{ mA}, I_{\text{Ccomp}} = 16\text{ mA}^{2)}$<br>$I_{\text{Cq}} = 3\text{ mA}, I_{\text{Ccomp}} = 16\text{ mA}$<br>$I_{\text{Cq}} = 6\text{ mA}, I_{\text{Ccomp}} = 15\text{ mA}$<br>$I_{\text{Cq}} = 10\text{ mA}, I_{\text{Ccomp}} = 15\text{ mA}$ |
|   |                   | –      | 10   | –    |      |  |
|   |                   | –      | 9    | –    |      |  |
|   |                   | –      | 8    | –    |      |  |
| Output 3rd Order Intercept Point            | $OIP_3$           | –      | 5.5  | –    | dBm  | $I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$  |
|   |                   | –      | 12   | –    |      |  |
|   |                   | –      | 17.5 | –    |      |  |
|   |                   | –      | 19   | –    |      |  |

1)  $OP_{1\text{dB}}$  is the output compression point achieved in a  $50\ \Omega$  application circuit according to [Figure 4-1](#) using the integrated biasing.

2)  $I_{\text{Cq}}$  is the quiescent current at small input power levels.  $I_{\text{Cq}}$  increases up to  $I_{\text{Ccomp}}$  as RF input power approaches  $IP_{1\text{dB}}$ , cf. [Figure 8-12](#).

**Table 8-12 AC Characteristics  $V_C = 3\text{ V}$ ,  $f = 5.5\text{ GHz}$** 

| Parameter                                   | Symbol            | Values |      |      | Unit | Note / Test Condition  |
|---|-------------------|--------|------|------|------|--|
|   |                   | Min.   | Typ. | Max. |      |  |
| Minimum Noise Figure                        | $NF_{\min}$       | –      | 1.05 | –    | dB   | $Z_S = Z_{\text{Sopt}}$<br>$I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$   |
|   |                   | –      | 1    | –    |      |  |
|   |                   | –      | 0.9  | –    |      |  |
|   |                   | –      | 0.95 | –    |      |  |
| Transducer Gain                             | $ S_{21} ^2$      | –      | 11.5 | –    | dB   | $Z_S = Z_L = 50\ \Omega$<br>$I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$  |
|   |                   | –      | 13   | –    |      |  |
|   |                   | –      | 15   | –    |      |  |
|   |                   | –      | 15.5 | –    |      |  |
| Maximum Power Gain                          | $G_{\text{ms}}$   | –      | 17.5 | –    | dB   | $Z_L = Z_{\text{Lopt}}$ , $Z_S = Z_{\text{Sopt}}$<br>$I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$   |
|   |                   | –      | 18.5 | –    |      |  |
|   |                   | –      | 20   | –    |      |  |
|   |                   | –      | 19   | –    |      |  |
| Output 1 dB Compression Point <sup>1)</sup> | $OP_{1\text{dB}}$ | –      | 10.5 | –    | dBm  | $I_{\text{Cq}} = 2.1\text{ mA}$ , $I_{\text{Ccomp}} = 17\text{ mA}^{2)}$<br>$I_{\text{Cq}} = 3\text{ mA}$ , $I_{\text{Ccomp}} = 17\text{ mA}$<br>$I_{\text{Cq}} = 6\text{ mA}$ , $I_{\text{Ccomp}} = 15\text{ mA}$<br>$I_{\text{Cq}} = 10\text{ mA}$ , $I_{\text{Ccomp}} = 15\text{ mA}$ |
|   |                   | –      | 10   | –    |      |  |
|   |                   | –      | 9    | –    |      |  |
|   |                   | –      | 8    | –    |      |  |
| Output 3rd Order Intercept Point            | $OIP_3$           | –      | 6.5  | –    | dBm  | $I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$  |
|   |                   | –      | 12   | –    |      |  |
|   |                   | –      | 22   | –    |      |  |
|   |                   | –      | 21   | –    |      |  |

1)  $OP_{1\text{dB}}$  is the output compression point achieved in a  $50\ \Omega$  application circuit according to [Figure 4-1](#) using the integrated biasing.

2)  $I_{\text{Cq}}$  is the quiescent current at small input power levels.  $I_{\text{Cq}}$  increases up to  $I_{\text{Ccomp}}$  as RF input power approaches  $IP_{1\text{dB}}$ , cf. [Figure 8-12](#).

**Table 8-13 AC Characteristics  $V_C = 3\text{ V}, f = 10\text{ GHz}$** 

| Parameter                                   | Symbol            | Values |      |      | Unit | Note / Test Condition  |
|---|-------------------|--------|------|------|------|--|
|   |                   | Min.   | Typ. | Max. |      |  |
| Minimum Noise Figure                        | $NF_{\min}$       | –      | 2    | –    | dB   | $Z_S = Z_{\text{Sopt}}$<br>$I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$   |
|   |                   | –      | 1.8  | –    |      |  |
|   |                   | –      | 1.5  | –    |      |  |
|   |                   | –      | 1.5  | –    |      |  |
| Transducer Gain                             | $ S_{21} ^2$      | –      | 5.5  | –    | dB   | $Z_S = Z_L = 50\ \Omega$<br>$I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$  |
|   |                   | –      | 7    | –    |      |  |
|   |                   | –      | 9    | –    |      |  |
|   |                   | –      | 10   | –    |      |  |
| Maximum Power Gain                          | $G_{\text{ms}}$   | –      | 14.5 | –    | dB   | $Z_L = Z_{\text{Lopt}}, Z_S = Z_{\text{Sopt}}$<br>$I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$  |
|   |                   | –      | 15   | –    |      |  |
|   |                   | –      | 15.5 | –    |      |  |
|   |                   | –      | 15.5 | –    |      |  |
| Output 1 dB Compression Point <sup>1)</sup> | $OP_{1\text{dB}}$ | –      | 6    | –    | dBm  | $I_{\text{Cq}} = 2.1\text{ mA}, I_{\text{Ccomp}} = 16\text{ mA}^{2)}$<br>$I_{\text{Cq}} = 3\text{ mA}, I_{\text{Ccomp}} = 16\text{ mA}$<br>$I_{\text{Cq}} = 6\text{ mA}, I_{\text{Ccomp}} = 15\text{ mA}$<br>$I_{\text{Cq}} = 10\text{ mA}, I_{\text{Ccomp}} = 15\text{ mA}$ |
|   |                   | –      | 6    | –    |      |  |
|   |                   | –      | 4    | –    |      |  |
|   |                   | –      | 4    | –    |      |  |
| Output 3rd Order Intercept Point            | $OIP_3$           | –      | 2.5  | –    | dBm  | $I_C = 2.1\text{ mA}$<br>$I_C = 3\text{ mA}$<br>$I_C = 6\text{ mA}$<br>$I_C = 10\text{ mA}$  |
|   |                   | –      | 7    | –    |      |  |
|   |                   | –      | 19.5 | –    |      |  |
|   |                   | –      | 18   | –    |      |  |

1)  $OP_{1\text{dB}}$  is the output compression point achieved in a  $50\ \Omega$  application circuit according to [Figure 4-1](#) using the integrated biasing.

2)  $I_{\text{Cq}}$  is the quiescent current at small input power levels.  $I_{\text{Cq}}$  increases up to  $I_{\text{Ccomp}}$  as RF input power approaches  $IP_{1\text{dB}}$ , cf. [Figure 8-11](#).

### 8.3.4 Typical AC Characteristic Curves

The measurement setup is the same as described in Figure 8-5 except for Figure 8-12 where compression is measured in a 50 Ω application circuit according to Figure 4-1 using the integrated biasing,  $V_C = 3\text{ V}$ ,  $T_A = 25\text{ °C}$ .

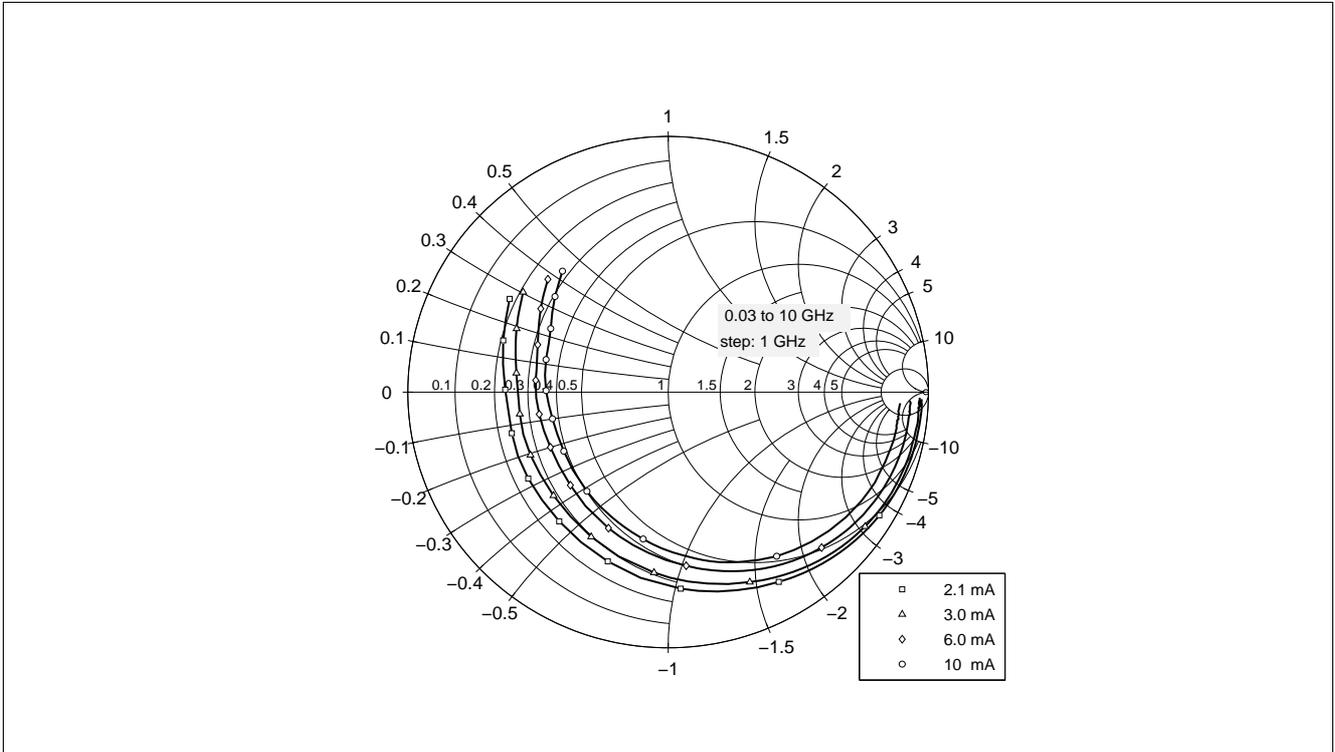


Figure 8-6  $S_{11}$  as a Function of Frequency,  $I_C$  as Parameter

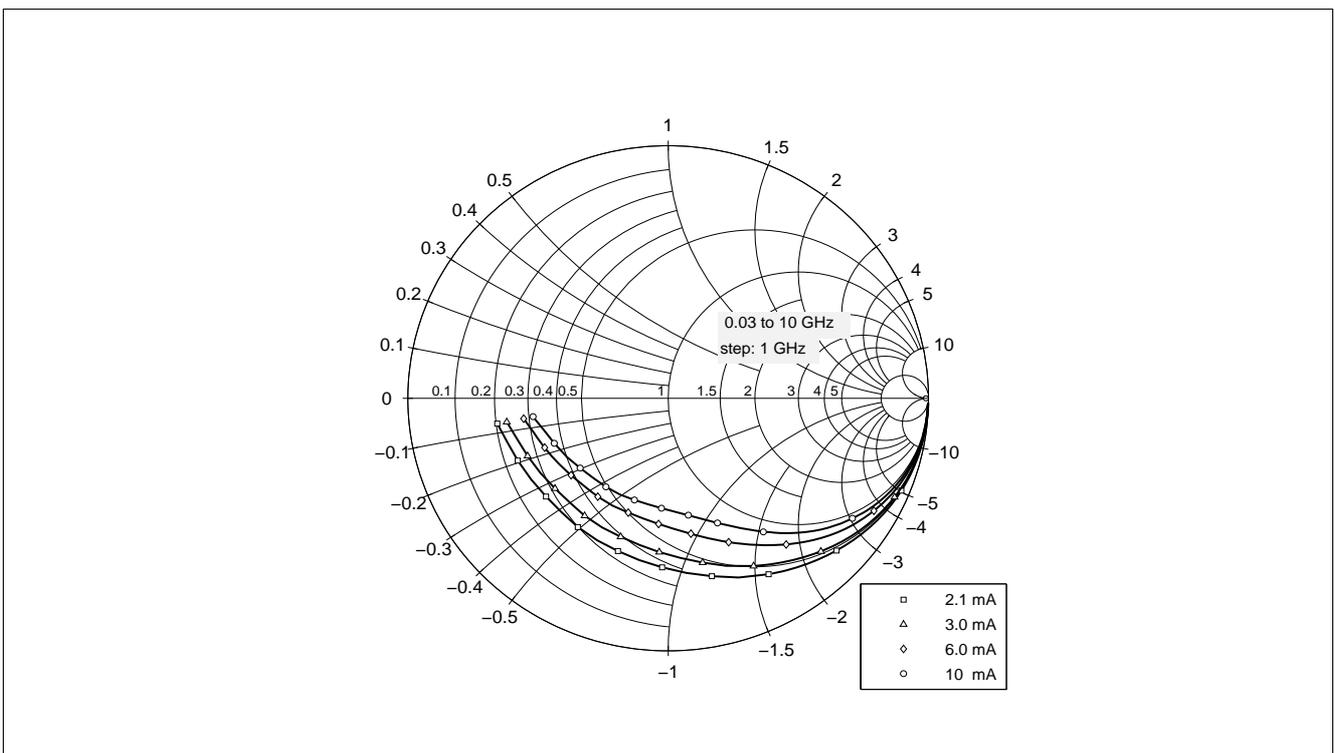


Figure 8-7  $S_{22}$  as a Function of Frequency,  $I_C$  as Parameter

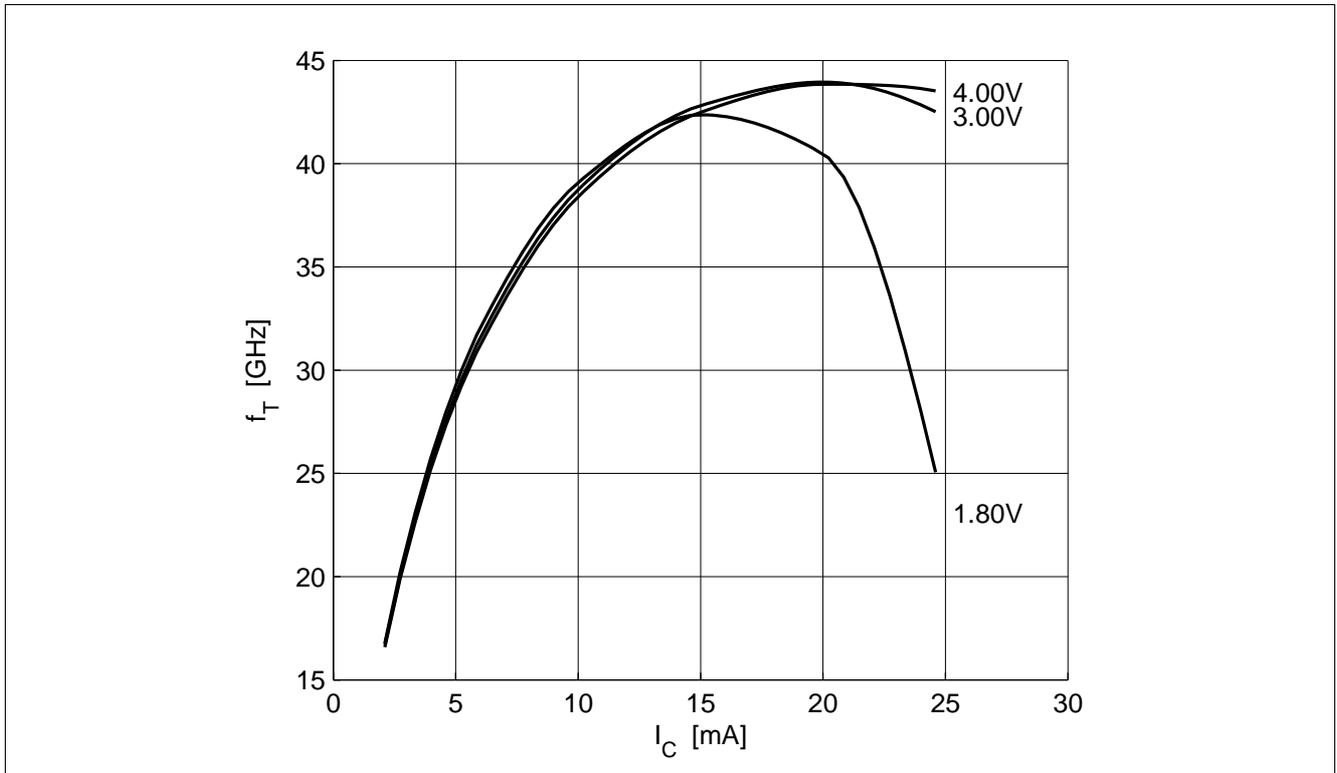


Figure 8-8 Transition Frequency as a Function of  $I_C$ ,  $V_C$  as Parameter

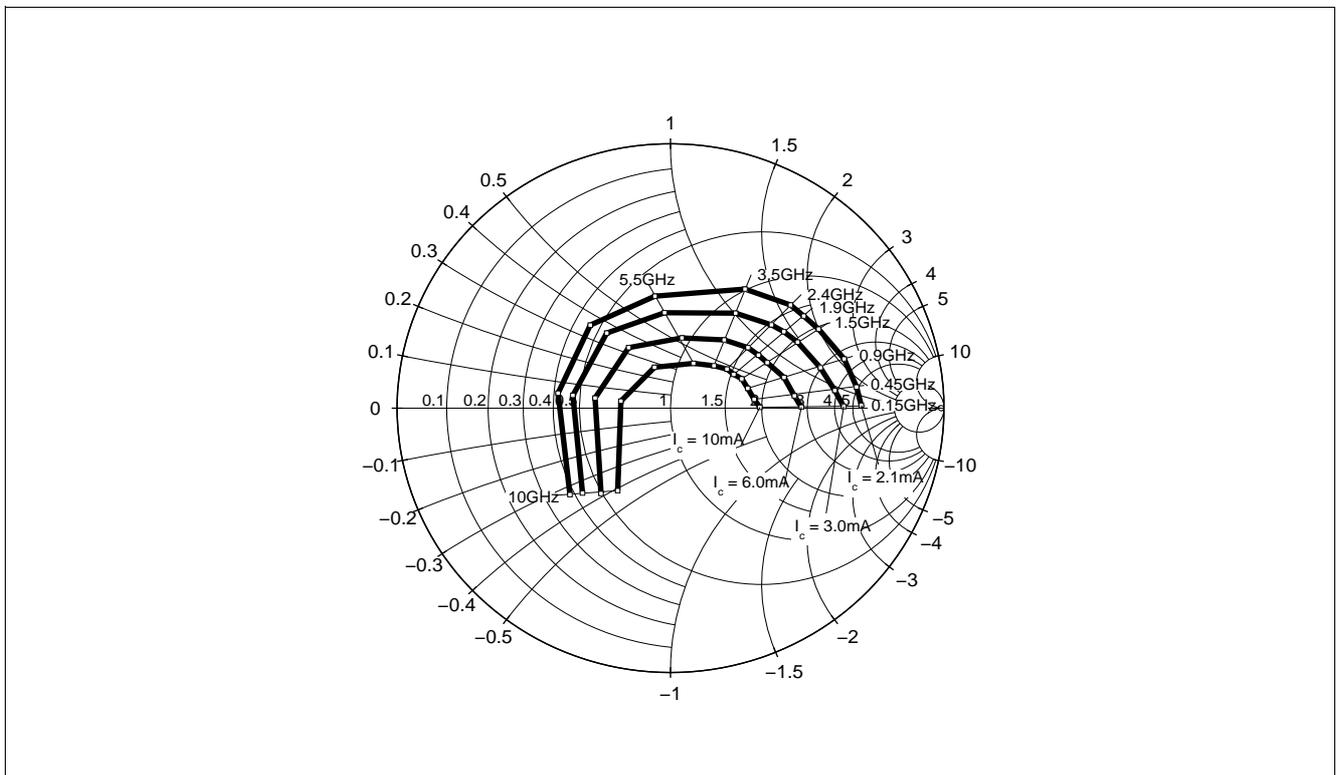


Figure 8-9 Optimum Source Impedance for Minimum  $NF$  as a Function of Frequency,  $I_C$  as Parameter

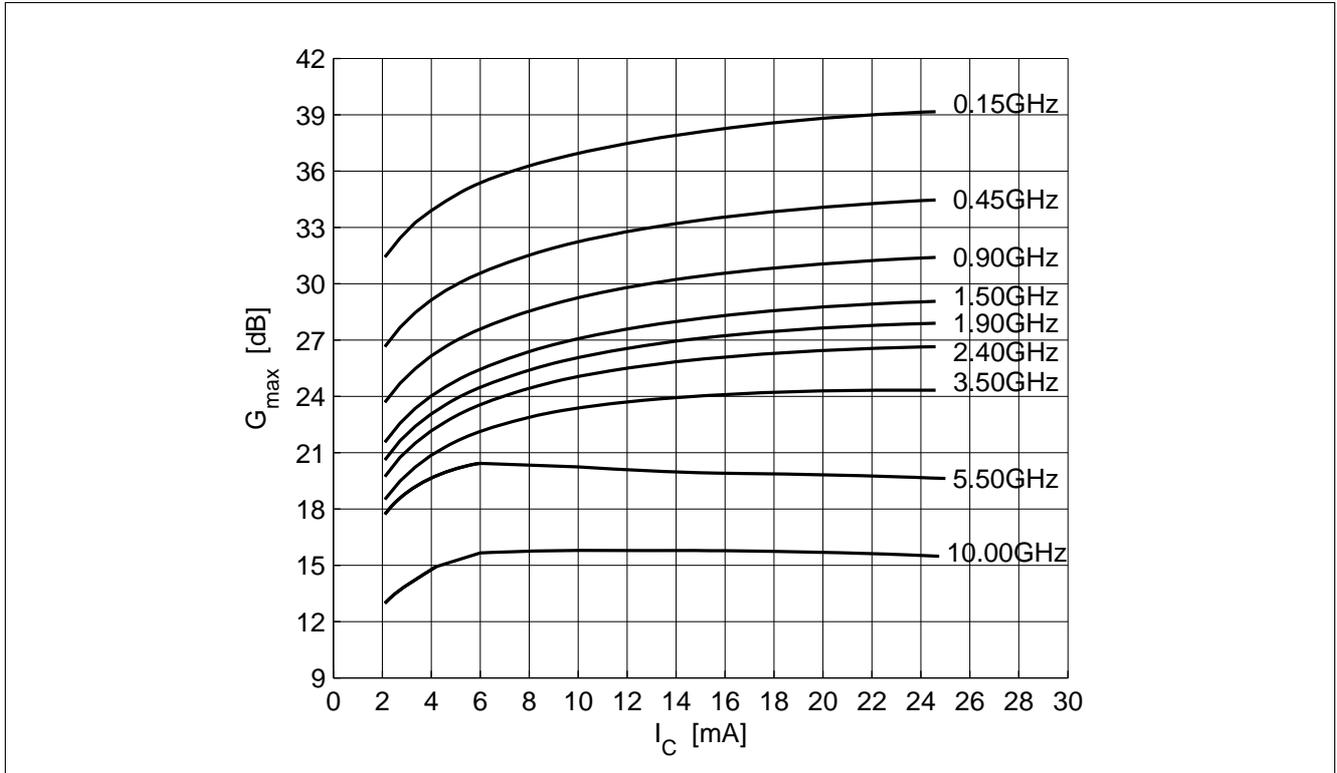


Figure 8-10 Maximum Power Gain as a Function of  $I_C$ , Frequency as Parameter

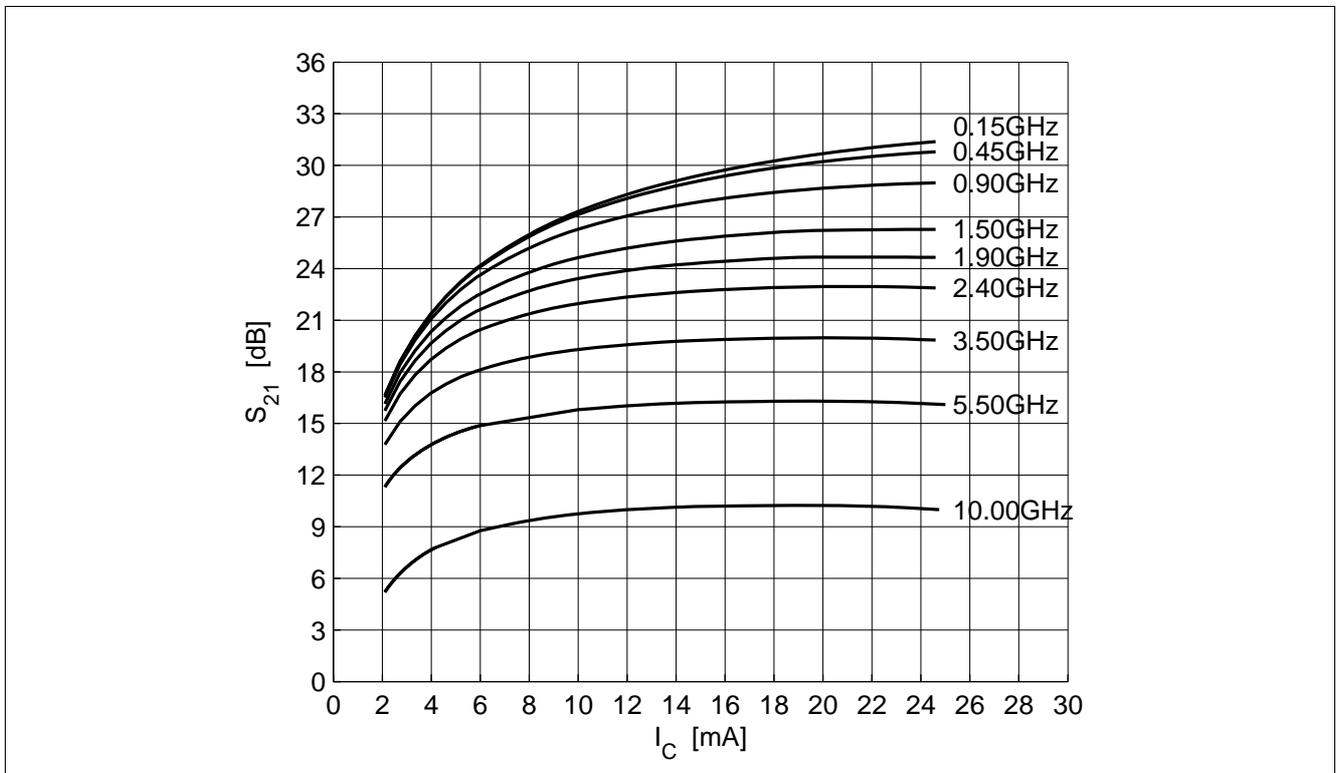


Figure 8-11 Power Gain as a Function of  $I_C$ , Frequency as Parameter

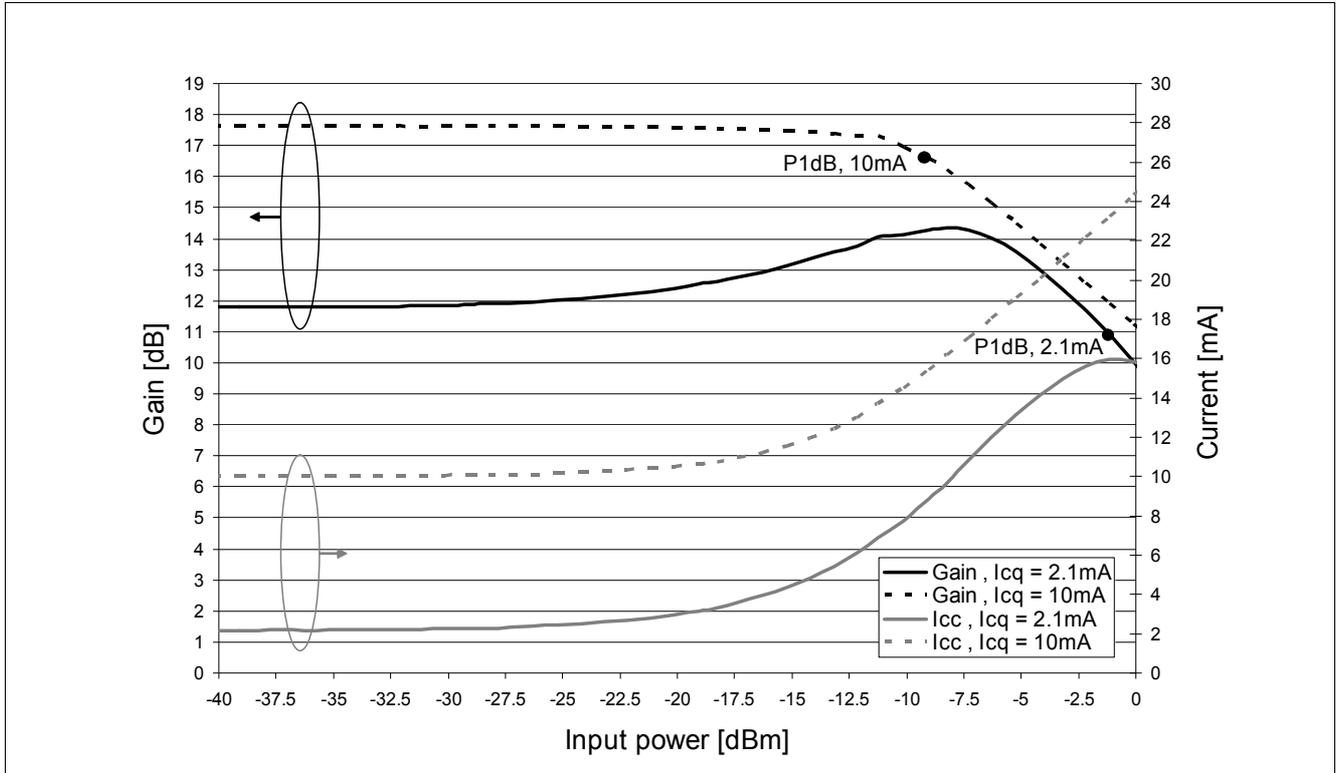


Figure 8-12 Power Gain and Total Supply Current as a Function of RF Input Power at 3.5 GHz

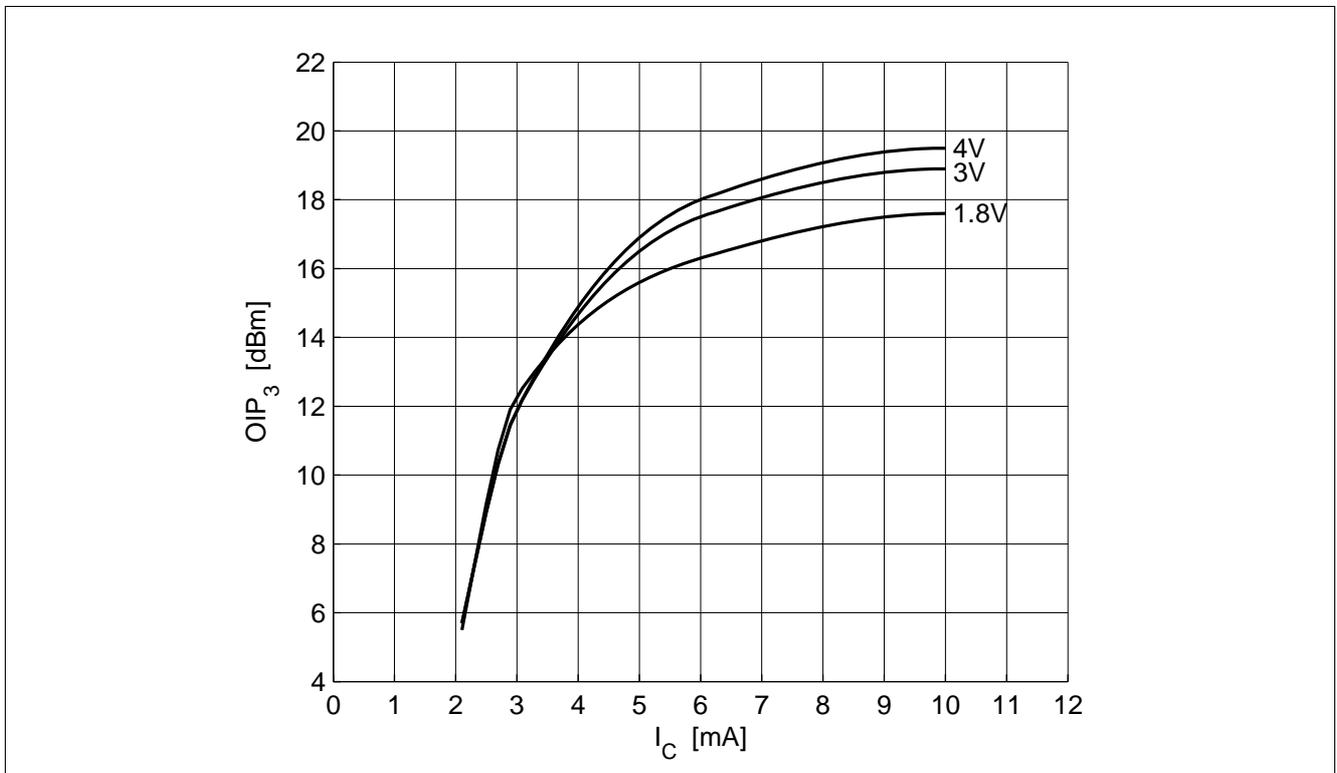


Figure 8-13 Output 3rd Order Intercept Point as a Function of  $I_C$  at 3.5 GHz,  $V_C$  as Parameter

## 9 Package Information

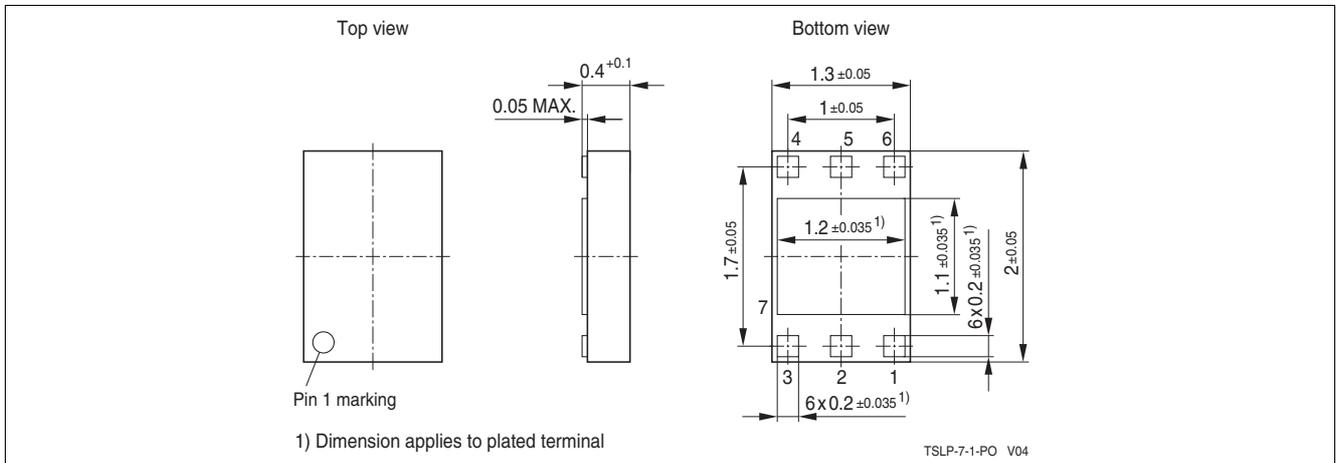


Figure 9-1 Package Outline TSLP-7-1

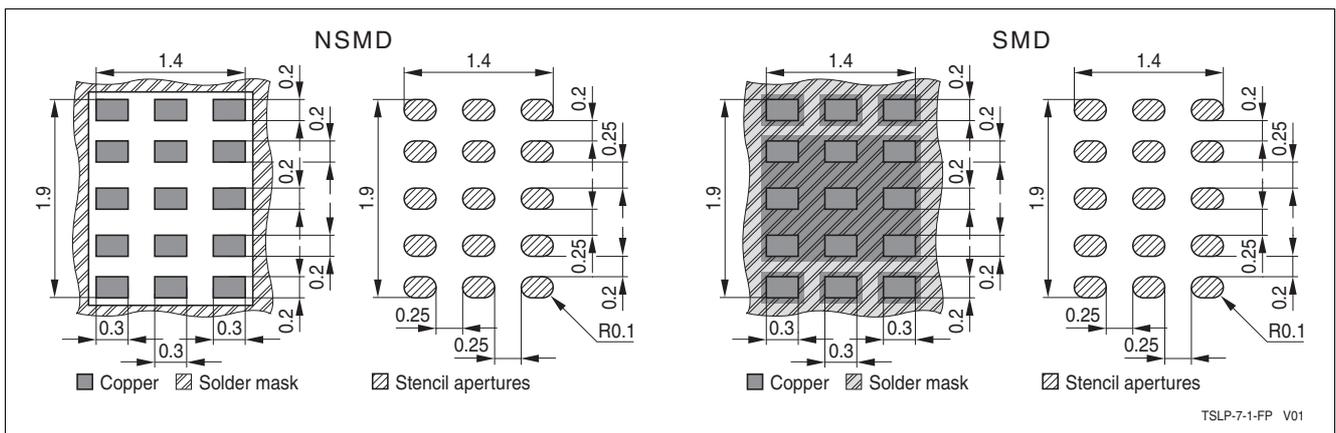


Figure 9-2 Footprint

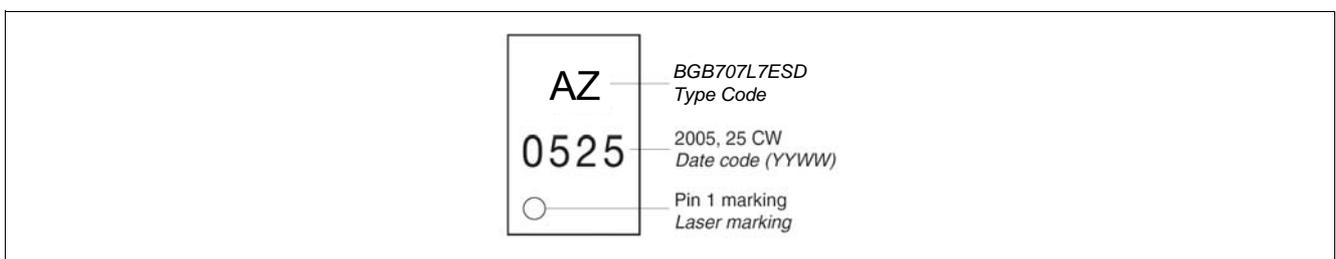


Figure 9-3 Marking Layout (top view)

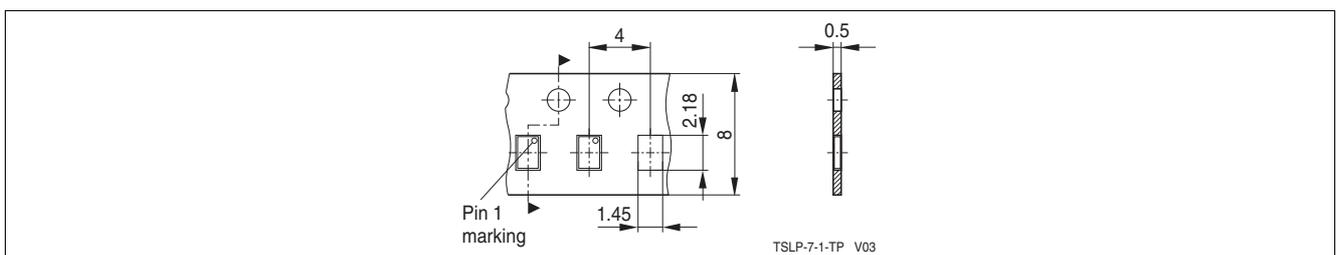


Figure 9-4 Tape Dimensions

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