# BGA736L16

## Tri-Band HSDPA LNA
## (2100, 1900/2100, 800/900 MHz)

RF & Protection Devices

Never stop thinking

**Edition 2008-07-03**

**Published by**
**Infineon Technologies AG**
**81726 München, Germany**

**BGA736L16**
**Revision History: 2008-07-03, V2.1**

| **Previous Version: 2008-02-27, V2.0** | |
|---|---|
| **Page** | **Subjects (major changes since last revision)** |
| 5, 6 | Updated HBM ESD protection |
| 11 | Added RF characteristics for UMTS band VIII |
| 13 | Added RF characteristics for UMTS band IV |
| 39 | Added application circuit schematic for UMTS bands I, IV and VIII |
| all | Updated values for high and mid gain currents |
| | |
| | |
| | |
| | |

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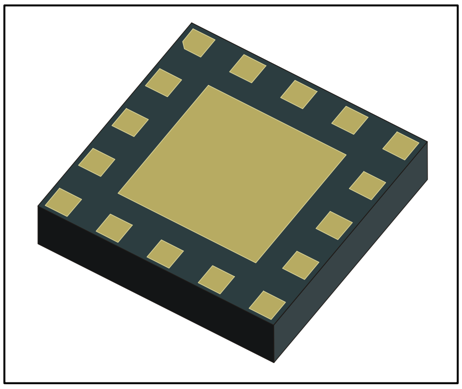
# 1 Description

The BGA736L16 is a highly flexible, tri-gain mode, and tri-band (2100, 1900/2100, 800/900 MHz) MMIC low noise amplifier for worldwide use. Based on Infineon's proprietary and cost-effective SiGe:C technology, the BGA736L16 features dynamic gain control, temperature stabilization, standby mode, and 2 kV ESD protection on-chip and matching off chip.
While two gain modes are common in W-CDMA systems, a third gain mode has been introduced to reduce the LNA gain just enough to pass adjacent channel tests without compromising on HSDPA performance. The 1900 MHz path can be converted into a 2100 MHz path and vice versa by optimizing the input matching and using an additional external output matching network. This document specifies device performance for the band combinations - UMTS bands I / II / V and UMTS bands I / IV / VIII.

**Features**
- Gain: 16 / 3 / -8 dB in high / mid / low gain mode
- Noise figure: 1.1 dB in high gain mode
- Supply current: 5.3 / 5.3 / 0.85 mA in high / mid / low gain modes
- Standby mode current consumption < 2 µA
- Outputs internally matched to 50 Ω
- 2 kV HBM ESD protection
- Low external component count
- Small leadless TSLP-16-1 package (2.3 x 2.3 x 0.39 mm)
- Pb-free (RoHS compliant) package

RoHS



**TSLP-16-1 package**

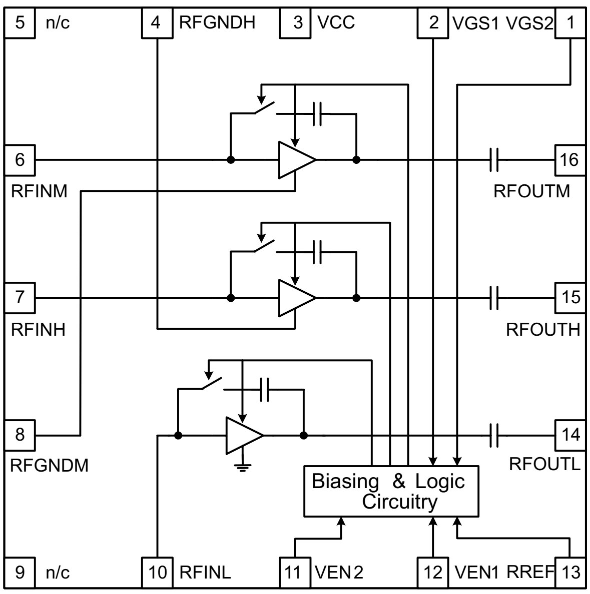



**Figure 1 Block diagram of triple-band LNA**

| Type | Package | Marking | Chip |
|---|---|---|---|
| BGA736L16 | PG-TSLP-16-1 | BGA736 | T1540 |

# 2 Electrical Characteristics

## 2.1 Absolute Maximum Ratings

**Table 1 Absolute Maximum Ratings**

| Parameter | Symbol | Values | | Unit | Note / Test Condition |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| Supply voltage | $V_{CC}$ | -0.3 | 3.6 | V | |
| Supply current | $I_{CC}$ | | 10 | mA | |
| Pin voltage | $V_{PIN}$ | -0.3 | $V_{CC}$ +0.3 | V | All pins except RF input pins |
| Pin voltage RF input pins | $V_{RFIN}$ | -0.3 | 0.9 | V | |
| RF input power | $P_{RFIN}$ | | 4 | dBm | |
| Junction temperature | $T_j$ | | 150 | °C | |
| Ambient temperature range | $T_A$ | -30 | 85 | °C | |
| Storage temperature range | $T_{STG}$ | -65 | 150 | °C | |

## 2.2 Thermal Resistance

**Table 2 Thermal Resistance**

| Parameter | Symbol | Value | Unit | Note / Test Conditions |
|---|---|---|---|---|
| Thermal resistance junction to soldering point | $R_{thJS}$ | $\leq$ 110 | K/W | |

## 2.3 ESD Integrity

**Table 3 ESD Integrity**

| Parameter | Symbol | Value | Unit | Note / Test Conditions |
|---|---|---|---|---|
| | | Typ. | | |
| ESD hardness HBM[1)] | $V_{ESD-HBM}$ | 2000 | V | All pins |

1) According to JESD22-A114

## 2.4 DC Characteristics

**Table 4 DC Characteristics, $T_A$ = 25 °C**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage | $V_{CC}$ | 2.7 | 2.8 | 3.0 | V | |
| Supply current high and mid gain mode<br>-30°C<br>25°C<br>85°C | $I_{CCHG}$<br>$I_{CCMG}$ | | <br><br>4.3<br>5.3<br>6.4 | | <br><br>mA<br>mA<br>mA | All bands<br>Supply current is proportional to absolute temperature |
| Supply current low gain mode | $I_{CCLG}$ | | 850 | | µA | All bands |
| Supply current standby mode | $I_{CCOFF}$ | | 0.1 | 2 | µA | |
| Logic level high | $V_{HI}$ | 1.5 | 2.8 | | V | VEN1 and VEN2 |
| Logic level low | $V_{LOW}$ | | 0.0 | 0.5 | V | |
| Logic currents VEN | $I_{ENL}$ | | 0.2 | | µA | VEN1 and VEN2 |
| | $I_{ENH}$ | | 10.0 | | µA | |
| Logic currents VGS | $I_{GSL}$ | | 0.1 | | µA | VGS |
| | $I_{GSH}$ | | 5.0 | | µA | |

## 2.5 Band Select / Gain Control Truth Table

**Table 5 Band Select Truth Table, $V_{CC}$ = 2.8 V**

| | High band | Mid band | Low band | Standby mode |
|---|---|---|---|---|
| VEN1 | H | H | L | L |
| VEN2 | H | L | H | L |

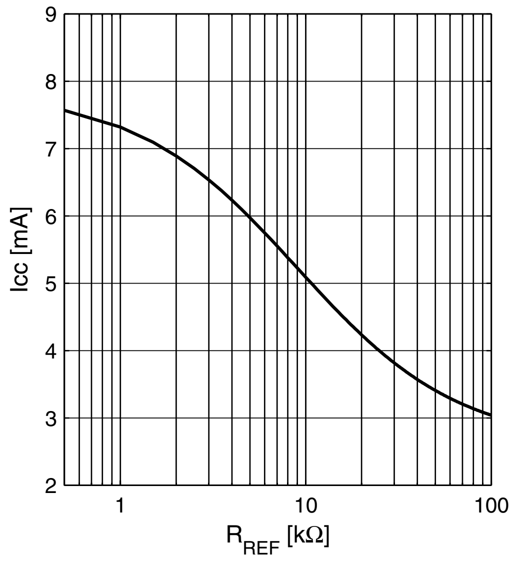
**Table 6 Gain Control Truth Table, $V_{CC}$ = 2.8 V**

| | High Gain | Mid Gain | Low Gain |
|---|---|---|---|
| VGS1 | H | H | L |
| VGS2 | L | H | L |

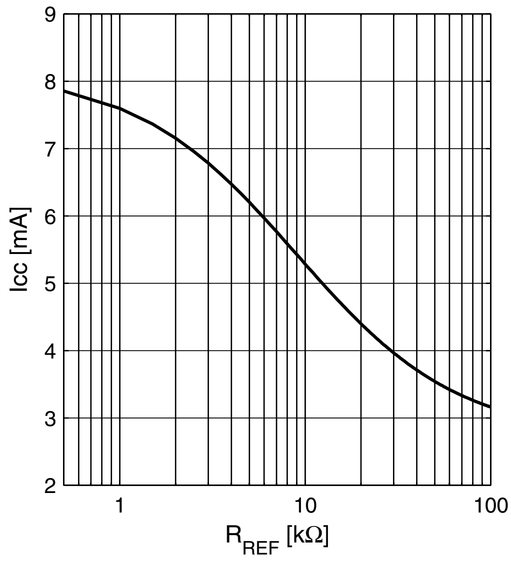
## 2.6 Supply current characteristics; $T_A$ = 25 °C

Supply current high / mid gain mode versus reference resistor $R_{REF}$ (see **Figure 2 on page 38** for reference resistor; low gain mode supply current is independent of reference resistor).

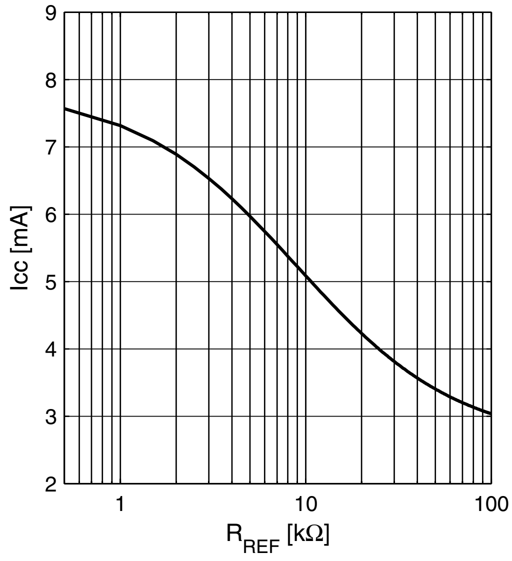
**Supply Current Highband** $I_{CC}$ = f ($R_{REF}$)
$V_{CC}$ = 2.8 V




**Supply Current Midband** $I_{CC}$ = f ($R_{REF}$)
$V_{CC}$ = 2.8 V



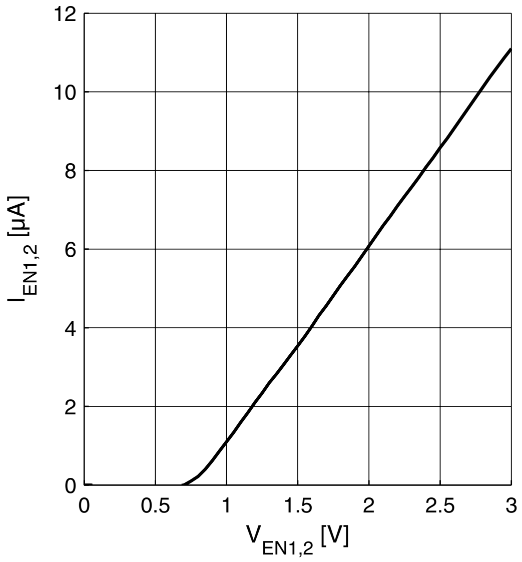

**Supply Current Lowband** $I_{CC}$ = f ($R_{REF}$)
$V_{CC}$ = 2.8 V



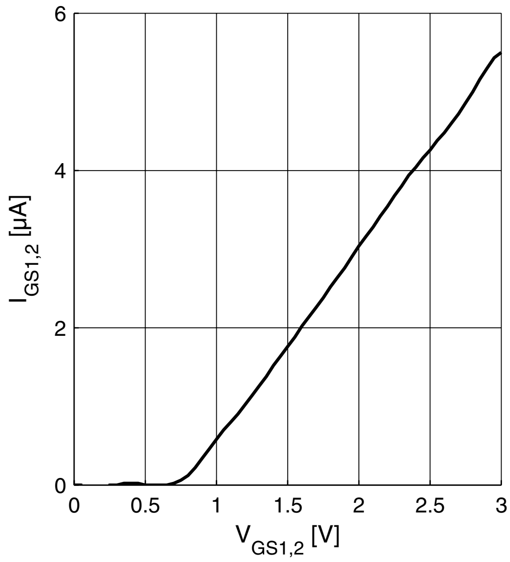
## 2.7 Logic Signal Characteristics; $T_A$ = 25 °C

Current consumption of logic inputs VEN1, VEN2, VGS1, VGS2

**Logic Currents** $I_{EN1,2}$ = f ($V_{EN1,2}$)
$V_{CC}$ = 2.8 V




**Logic Currents** $I_{GS1,2}$ = f ($V_{GS1,2}$)
$V_{CC}$ = 2.8 V




## 2.8 Switching Times

**Table 7 Typical switching times; $T_A$ = -30 ... 85 °C**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Settling time gainstep | $t_{GS}$ | | 1 | | µs | Switching from any gain mode to a different gain mode; all bands |
| Settling time bandselect | $t_{BS}$ | | 1.6 | | µs | Switching from any band to a different band; all gain modes |

## 2.9 Measured RF Characteristics Low Band

### 2.9.1 Measured RF Characteristics UMTS Band V

**Table 8 Typical Characteristics 800 MHz Band, $T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Pass band range | | 869 | | 894 | MHz | |
| Current consumption | $I_{CCHG}$ | | 5.20 | | mA | High gain mode |
| | $I_{CCMG}$ | | 5.20 | | mA | Mid gain mode |
| | $I_{CCLG}$ | | 0.85 | | mA | Low gain mode |
| Gain | $S_{21HG}$ | | 15.5 | | dB | High gain mode |
| | $S_{21MG}$ | | 3.0 | | dB | Mid gain mode |
| | $S_{21LG}$ | | -8.9 | | dB | Low gain mode |
| Reverse Isolation[1)] | $S_{12HG}$ | | -38 | | dB | High gain mode |
| | $S_{12MG}$ | | -40 | | dB | Mid gain mode |
| | $S_{12LG}$ | | -9 | | dB | Low gain mode |
| Noise figure | $NF_{HG}$ | | 1.1 | | dB | High gain mode |
| | $NF_{MG}$ | | 2.4 | | dB | Mid gain mode |
| | $NF_{LG}$ | | 9.0 | | dB | Low gain mode |
| Input return loss[1)] | $S_{11HG}$ | | -14 | | dB | 50 Ω, high gain mode |
| | $S_{11MG}$ | | -12 | | dB | 50 Ω, mid gain mode |
| | $S_{11LG}$ | | -10 | | dB | 50 Ω, low gain mode |
| Output return loss[1)] | $S_{22HG}$ | | -20 | | dB | 50 Ω, high gain mode |
| | $S_{22MG}$ | | -22 | | dB | 50 Ω, mid gain mode |
| | $S_{22LG}$ | | -18 | | dB | 50 Ω, low gain mode |
| Stability factor[2)] | $k$ | | >3.1 | | | DC to 10 GHz; all gain modes |
| Input compression point[1)] | $IP_{1dBHG}$ | | -11 | | dBm | High gain mode |
| | $IP_{1dBMG}$ | | -10 | | dBm | Mid gain mode |
| | $IP_{1dBLG}$ | | -12 | | dBm | Low gain mode |
| Inband IIP3[1)]<br>$f_1 - f_2$ = 1 MHz<br>$P_{f1} = P_{f2}$ = -25 dBm | $IIP3_{HG}$<br>$IIP3_{MG}$<br>$IIP3_{LG}$ | | -5<br>-5<br>-3 | | dBm | High gain mode<br>Mid gain mode<br>Low gain mode |

1) Verified by random sampling; not 100% RF tested
2) Not tested in production; guaranteed by device design

### 2.9.2 Measured RF Characteristics UMTS Band VIII

**Table 9 Typical Characteristics 900 MHz Band, $T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Pass band range | | 925 | | 960 | MHz | |
| Current consumption | $I_{CCHG}$ | | 5.20 | | mA | High gain mode |
| | $I_{CCMG}$ | | 5.20 | | mA | Mid gain mode |
| | $I_{CCLG}$ | | 0.85 | | mA | Low gain mode |
| Gain | $S_{21HG}$ | | 15.2 | | dB | High gain mode |
| | $S_{21MG}$ | | 2.8 | | dB | Mid gain mode |
| | $S_{21LG}$ | | -8.8 | | dB | Low gain mode |
| Reverse Isolation[1)] | $S_{12HG}$ | | -37 | | dB | High gain mode |
| | $S_{12MG}$ | | -39 | | dB | Mid gain mode |
| | $S_{12LG}$ | | -9 | | dB | Low gain mode |
| Noise figure | $NF_{HG}$ | | 1.2 | | dB | High gain mode |
| | $NF_{MG}$ | | 2.6 | | dB | Mid gain mode |
| | $NF_{LG}$ | | 9.0 | | dB | Low gain mode |
| Input return loss[1)] | $S_{11HG}$ | | -14 | | dB | 50 Ω, high gain mode |
| | $S_{11MG}$ | | -12 | | dB | 50 Ω, mid gain mode |
| | $S_{11LG}$ | | -11 | | dB | 50 Ω, low gain mode |
| Output return loss[1)] | $S_{22HG}$ | | -20 | | dB | 50 Ω, high gain mode |
| | $S_{22MG}$ | | -19 | | dB | 50 Ω, mid gain mode |
| | $S_{22LG}$ | | -19 | | dB | 50 Ω, low gain mode |
| Stability factor[2)] | $k$ | | >3.4 | | | DC to 10 GHz; all gain modes |
| Input compression point[1)] | $IP_{1dBHG}$ | | -9 | | dBm | High gain mode |
| | $IP_{1dBMG}$ | | -5 | | dBm | Mid gain mode |
| | $IP_{1dBLG}$ | | -11 | | dBm | Low gain mode |
| Inband IIP3[1)]<br>$f_1 - f_2$ = 1 MHz<br>$P_{f1} = P_{f2}$ = -25 dBm | $IIP3_{HG}$<br>$IIP3_{MG}$<br>$IIP3_{LG}$ | | -5<br>-5<br>-3 | | dBm | High gain mode<br>Mid gain mode<br>Low gain mode |

1) Verified by random sampling; not 100% RF tested
2) Not tested in production; guaranteed by device design

## 2.10 Measured RF Characteristics Mid Band

### 2.10.1 Measured RF Characteristics UMTS Band II

**Table 10 Typical Characteristics 1900 MHz Band, $T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Pass band range | | 1930 | | 1990 | MHz | |
| Current consumption | $I_{CCHG}$ | | 5.30 | | mA | High gain mode |
| | $I_{CCMG}$ | | 5.30 | | mA | Mid gain mode |
| | $I_{CCLG}$ | | 0.85 | | mA | Low gain mode |
| Gain | $S_{21HG}$ | | 16.1 | | dB | High gain mode |
| | $S_{21MG}$ | | 2.7 | | dB | Mid gain mode |
| | $S_{21LG}$ | | -8.1 | | dB | Low gain mode |
| Reverse Isolation[1)] | $S_{12HG}$ | | -35 | | dB | High gain mode |
| | $S_{12MG}$ | | -36 | | dB | Mid gain mode |
| | $S_{12LG}$ | | -8 | | dB | Low gain mode |
| Noise figure | $NF_{HG}$ | | 1.0 | | dB | High gain mode |
| | $NF_{MG}$ | | 2.3 | | dB | Mid gain mode |
| | $NF_{LG}$ | | 7.8 | | dB | Low gain mode |
| Input return loss[1)] | $S_{11HG}$ | | -15 | | dB | 50 Ω, high gain mode |
| | $S_{11MG}$ | | -12 | | dB | 50 Ω, mid gain mode |
| | $S_{11LG}$ | | -11 | | dB | 50 Ω, low gain mode |
| Output return loss[1)] | $S_{22HG}$ | | -19 | | dB | 50 Ω, high gain mode |
| | $S_{22MG}$ | | -18 | | dB | 50 Ω, mid gain mode |
| | $S_{22LG}$ | | -18 | | dB | 50 Ω, low gain mode |
| Stability factor[2)] | $k$ | | >2.6 | | | DC to 10 GHz; all gain modes |
| Input compression point[1)] | $IP_{1dBHG}$ | | -13 | | dBm | High gain mode |
| | $IP_{1dBMG}$ | | -13 | | dBm | Mid gain mode |
| | $IP_{1dBLG}$ | | -7 | | dBm | Low gain mode |
| Inband IIP3[1)]<br>$f_1 - f_2$ = 1 MHz<br>$P_{f1} = P_{f2}$ = -26 dBm | $IIP3_{HG}$<br>$IIP3_{MG}$<br>$IIP3_{LG}$ | | -5<br>-6<br>2 | | dBm | High gain mode<br>Mid gain mode<br>Low gain mode |

1) Verified by random sampling; not 100% RF tested
2) Not tested in production; guaranteed by device design

## 2.10.2 Measured RF Characteristics UMTS Band IV

**Table 11 Typical Characteristics 2100 MHz Band, $T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Pass band range | | 2110 | | 2155 | MHz | |
| Current consumption | $I_{CCHG}$ | | 5.30 | | mA | High gain mode |
| | $I_{CCMG}$ | | 5.30 | | mA | Mid gain mode |
| | $I_{CCLG}$ | | 0.85 | | mA | Low gain mode |
| Gain | $S_{21HG}$ | | 15.3 | | dB | High gain mode |
| | $S_{21MG}$ | | 2.3 | | dB | Mid gain mode |
| | $S_{21LG}$ | | -7.5 | | dB | Low gain mode |
| Reverse Isolation[1)] | $S_{12HG}$ | | -34 | | dB | High gain mode |
| | $S_{12MG}$ | | -35 | | dB | Mid gain mode |
| | $S_{12LG}$ | | -8 | | dB | Low gain mode |
| Noise figure | $NF_{HG}$ | | 1.1 | | dB | High gain mode |
| | $NF_{MG}$ | | 2.7 | | dB | Mid gain mode |
| | $NF_{LG}$ | | 7.5 | | dB | Low gain mode |
| Input return loss[1)] | $S_{11HG}$ | | -19 | | dB | 50 Ω, high gain mode |
| | $S_{11MG}$ | | -14 | | dB | 50 Ω, mid gain mode |
| | $S_{11LG}$ | | -12 | | dB | 50 Ω, low gain mode |
| Output return loss[1)] | $S_{22HG}$ | | -18 | | dB | 50 Ω, high gain mode |
| | $S_{22MG}$ | | -17 | | dB | 50 Ω, mid gain mode |
| | $S_{22LG}$ | | -15 | | dB | 50 Ω, low gain mode |
| Stability factor[2)] | $k$ | | >2.6 | | | DC to 10 GHz; all gain modes |
| Input compression point[1)] | $IP_{1dBHG}$ | | -12 | | dBm | High gain mode |
| | $IP_{1dBMG}$ | | -12 | | dBm | Mid gain mode |
| | $IP_{1dBLG}$ | | -6 | | dBm | Low gain mode |
| Inband IIP3[1)]<br>$f_1 - f_2$ = 1 MHz<br>$P_{f1} = P_{f2}$ = -26 dBm | $IIP3_{HG}$<br>$IIP3_{MG}$<br>$IIP3_{LG}$ | | -5<br>-6<br>2 | | dBm | High gain mode<br>Mid gain mode<br>Low gain mode |

1) Verified by random sampling; not 100% RF tested
2) Not tested in production; guaranteed by device design

## 2.11 Measured RF Characteristics High Band

### 2.11.1 Measured RF Characteristics UMTS Band I

**Table 12 Typical Characteristics 2100 MHz Band, $T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ**

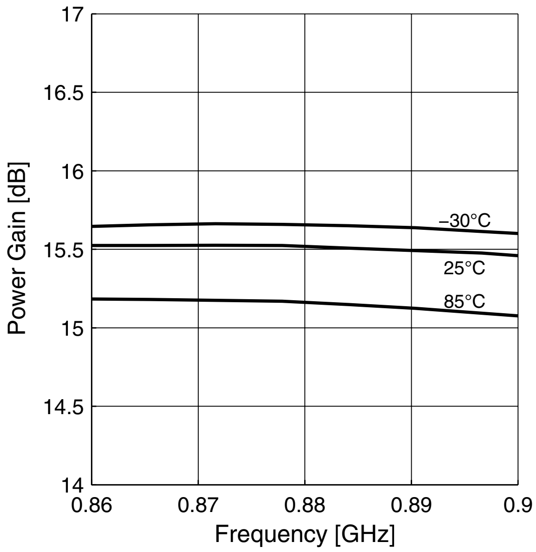
| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Pass band range | | 2110 | | 2170 | MHz | |
| Current consumption | $I_{CCHG}$ | | 5.30 | | mA | High gain mode |
| | $I_{CCMG}$ | | 5.30 | | mA | Mid gain mode |
| | $I_{CCLG}$ | | 0.85 | | mA | Low gain mode |
| Gain | $S_{21HG}$ | | 16.2 | | dB | High gain mode |
| | $S_{21MG}$ | | 2.3 | | dB | Mid gain mode |
| | $S_{21LG}$ | | -8.0 | | dB | Low gain mode |
| Reverse Isolation[1)] | $S_{12HG}$ | | -35 | | dB | High gain mode |
| | $S_{12MG}$ | | -36 | | dB | Mid gain mode |
| | $S_{12LG}$ | | -8 | | dB | Low gain mode |
| Noise figure | $NF_{HG}$ | | 1.0 | | dB | High gain mode |
| | $NF_{MG}$ | | 2.6 | | dB | Mid gain mode |
| | $NF_{LG}$ | | 7.9 | | dB | Low gain mode |
| Input return loss[1)] | $S_{11HG}$ | | -13 | | dB | 50 Ω, high gain mode |
| | $S_{11MG}$ | | -12 | | dB | 50 Ω, mid gain mode |
| | $S_{11LG}$ | | -10 | | dB | 50 Ω, low gain mode |
| Output return loss[1)] | $S_{22HG}$ | | -19 | | dB | 50 Ω, high gain mode |
| | $S_{22MG}$ | | -24 | | dB | 50 Ω, mid gain mode |
| | $S_{22LG}$ | | -14 | | dB | 50 Ω, low gain mode |
| Stability factor[2)] | $k$ | | >2.2 | | | DC to 10 GHz; all gain modes |
| Input compression point[1)] | $IP_{1dBHG}$ | | -13 | | dBm | High gain mode |
| | $IP_{1dBMG}$ | | -13 | | dBm | Mid gain mode |
| | $IP_{1dBLG}$ | | -7 | | dBm | Low gain mode |
| Inband IIP3[1)]<br>$f_1 - f_2$ = 1 MHz<br>$P_{f1} = P_{f2}$ = -27 dBm | $IIP3_{HG}$<br>$IIP3_{MG}$<br>$IIP3_{LG}$ | | -5<br>-5<br>2 | | dBm | High gain mode<br>Mid gain mode<br>Low gain mode |

1) Verified by random sampling; not 100% RF tested
2) Not tested in production; guaranteed by device design

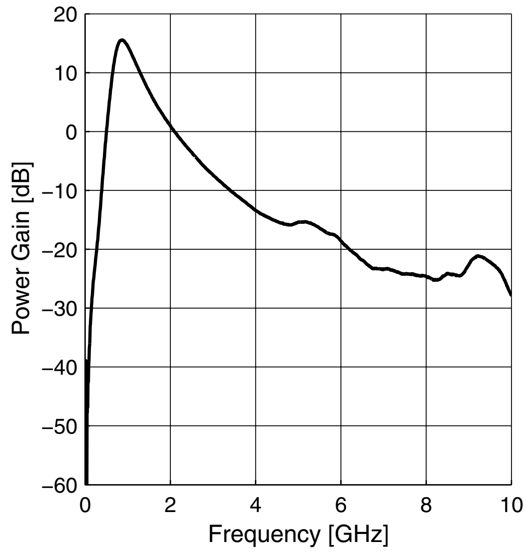
## 2.12 Measured Performance Low Band High Gain Mode vs. Frequency

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 0 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

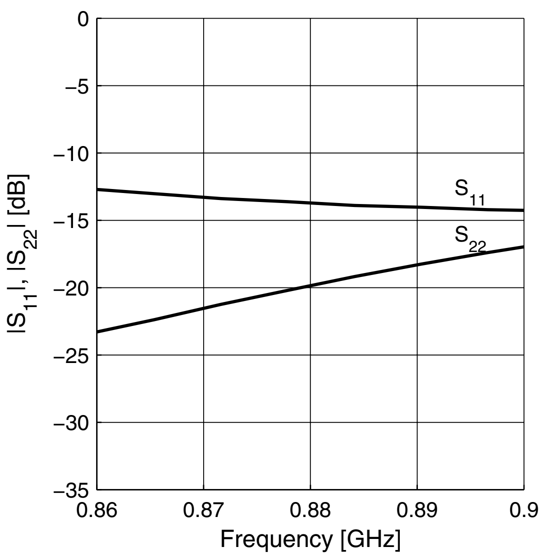
**Power Gain** $|S_{21}| = f(f)$



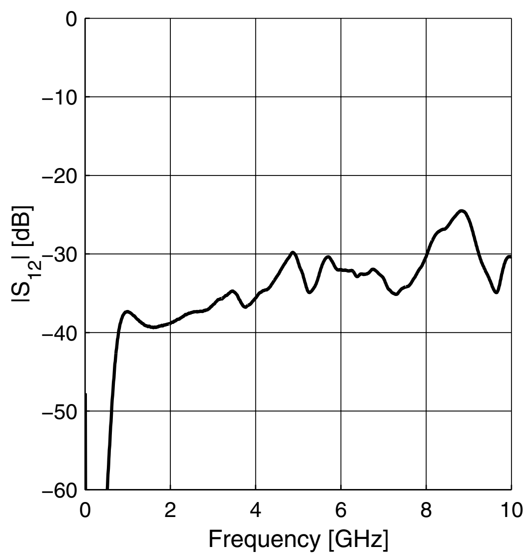

**Power Gain Wideband** $|S_{21}| = f(f)$



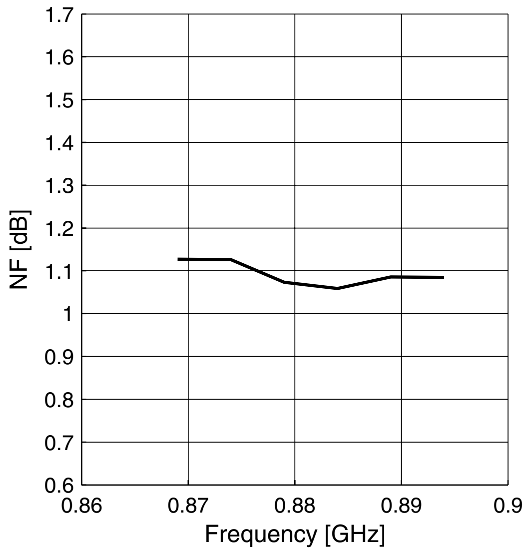

**Matching** $|S_{11}| = f(f)$, $|S_{22}| = f(f)$



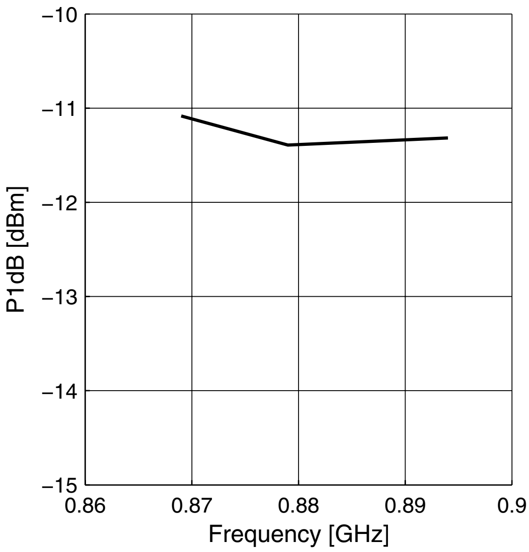

**Reverse Isolation** $|S_{12}| = f(f)$



**Noise Figure** $NF$ = f( $f$ )



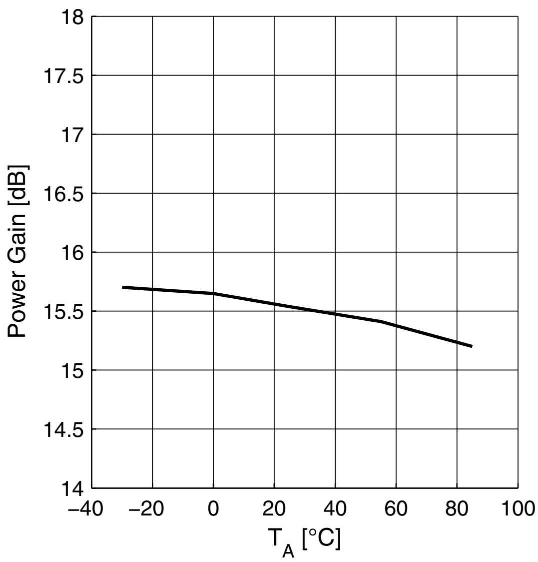

**Input Compression** $P_{1dB}$ = f( $f$ )



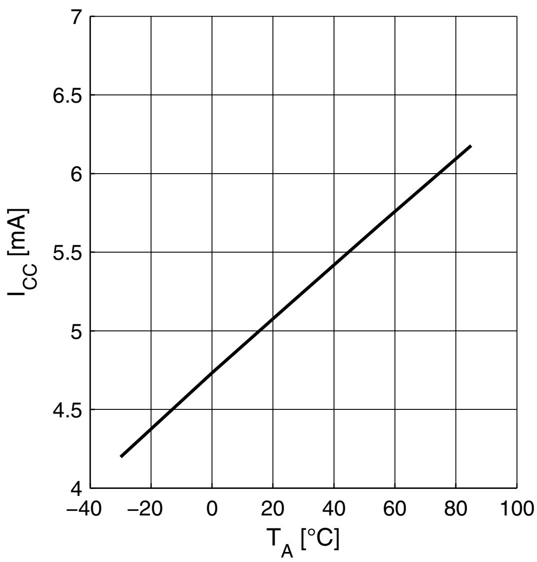

## 2.13 Measured Performance Low Band High Gain Mode vs. Temperature

$V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 0 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

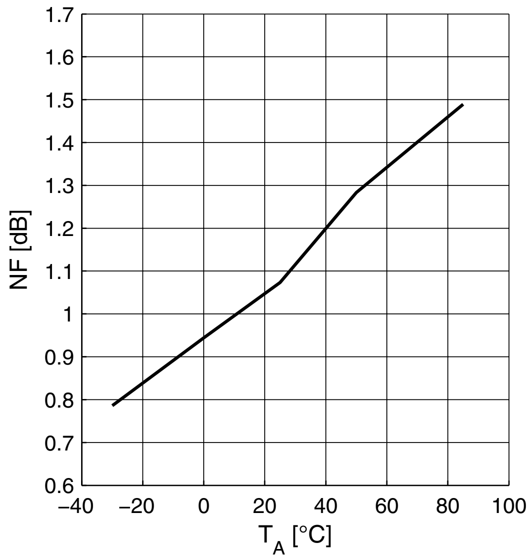
**Power Gain** $|S_{21}|$ = f($T_A$)



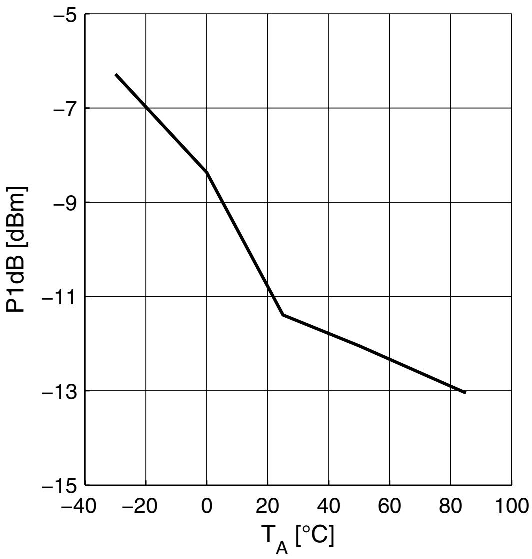

**Supply Current** $I_{CC}$ = f($T_A$)



**Noise Figure** $NF = f(T_A)$



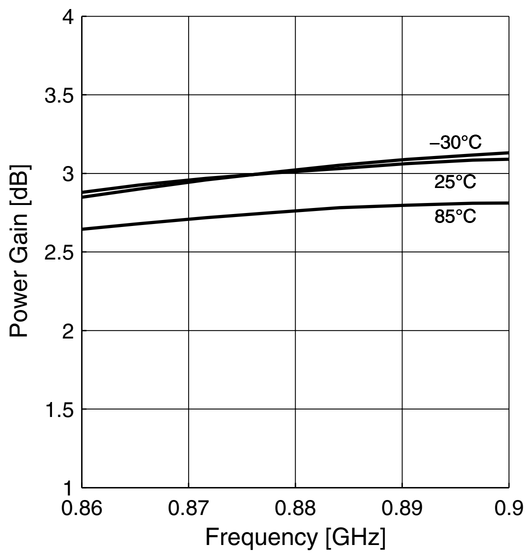

**Input Compression** $P_{1dB} = f(T_A)$



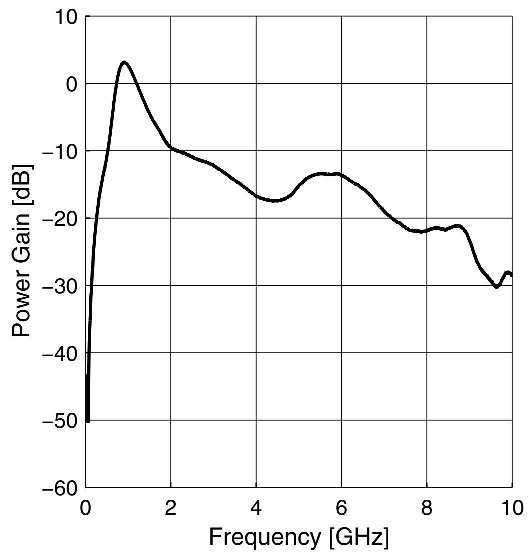

## 2.14 Measured Performance Low Band Mid Gain Mode vs. Frequency

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 2.8 V, $V_{EN1}$ = 0 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

**Power Gain** $|S_{21}| = f(f)$

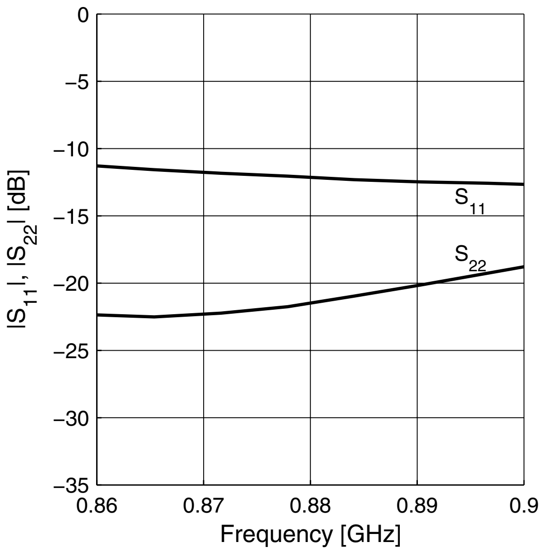



**Power Gain Wideband** $|S_{21}| = f(f)$

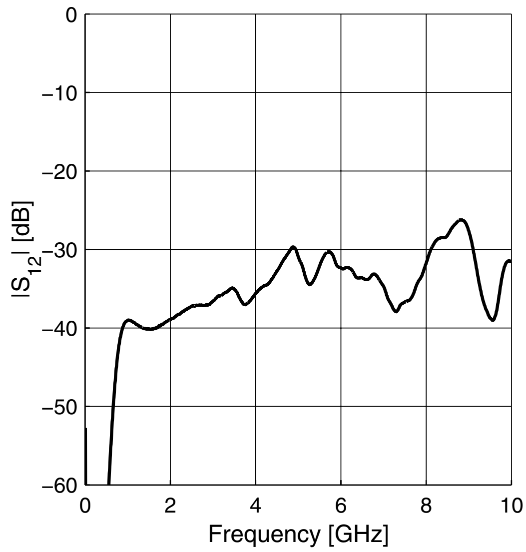


## Measured Performance Low Band Mid Gain Mode vs. Frequency

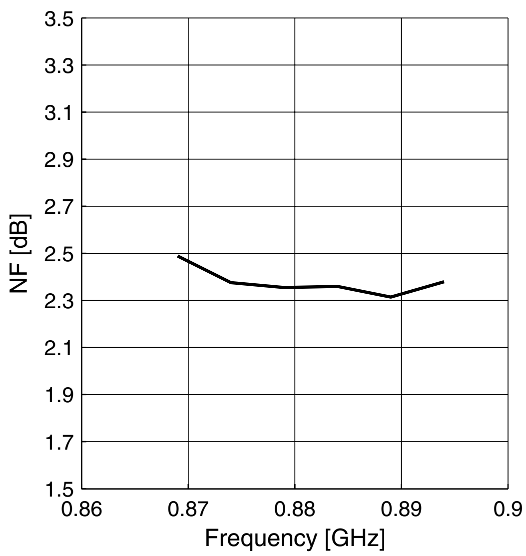
**Matching** $|S_{11}| = f(f)$, $|S_{22}| = f(f)$



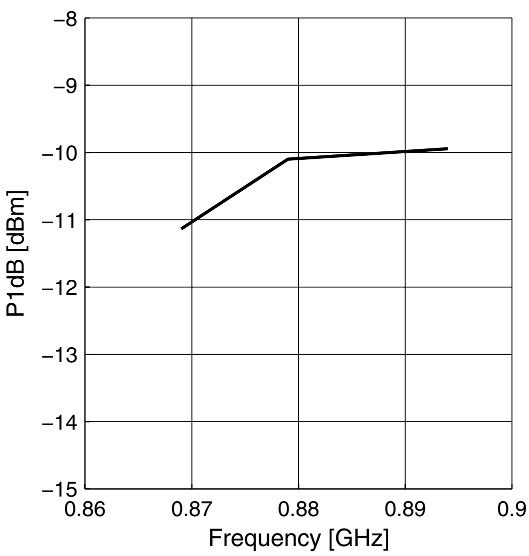

**Reverse Isolation** $|S_{12}| = f(f)$




**Noise Figure** $NF = f(f)$



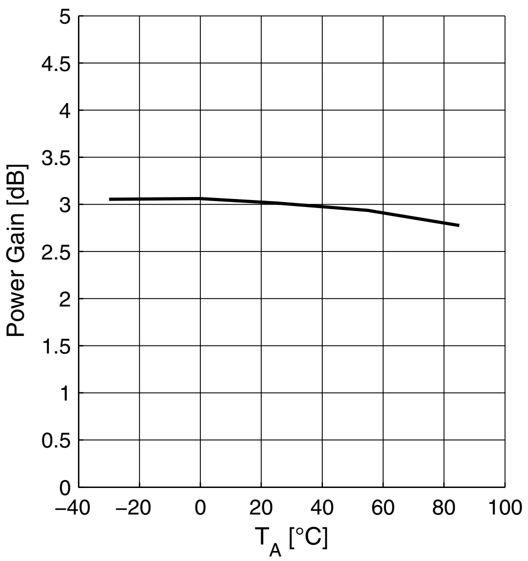

**Input Compression** $P_{1dB} = f(f)$



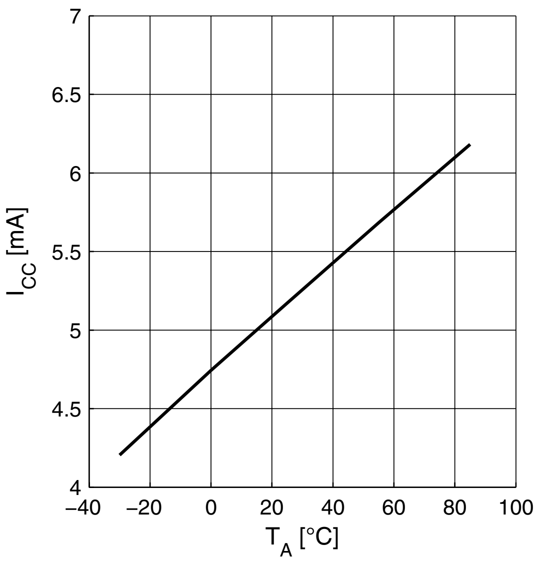
## 2.15 Measured Performance Low Band Mid Gain Mode vs. Temperature

$V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 2.8 V, $V_{EN1}$ = 0 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

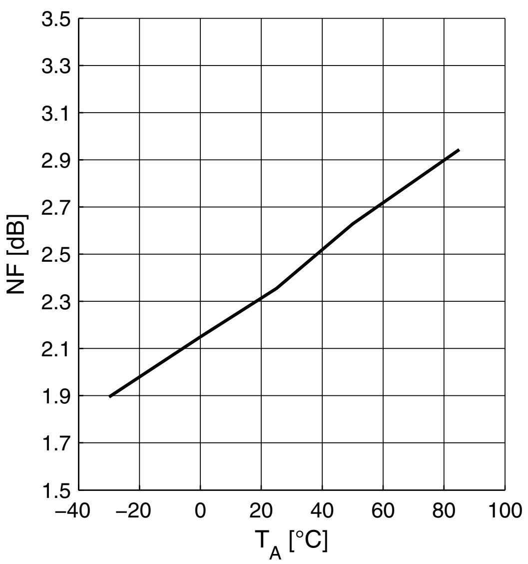
**Power Gain** $|S_{21}| = f(T_A)$



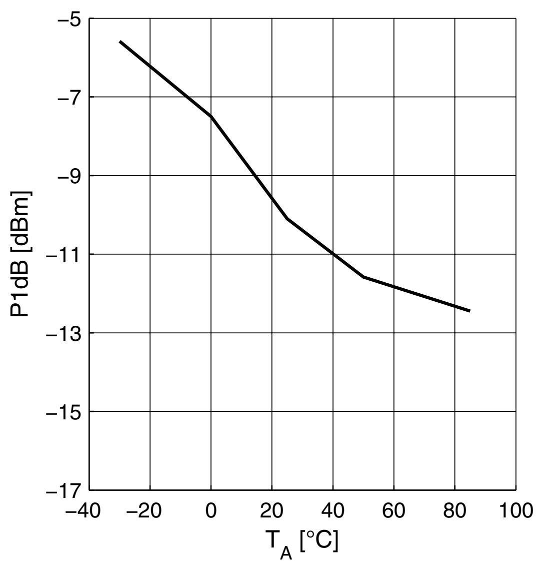

**Supply Current** $I_{CC} = f(T_A)$




**Noise Figure** $NF = f(T_A)$



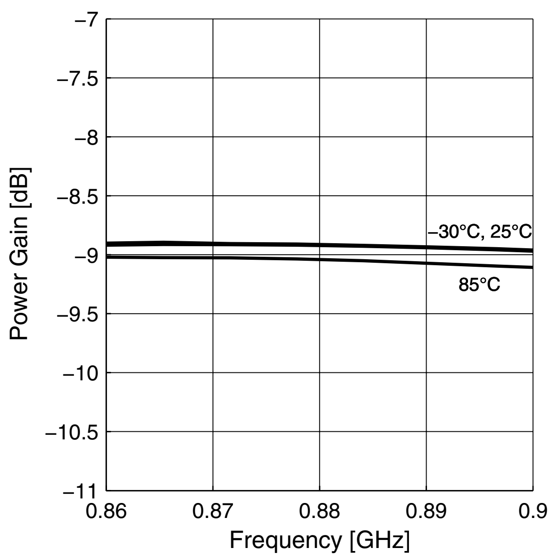

**Input Compression** $P_{1dB} = f(T_A)$



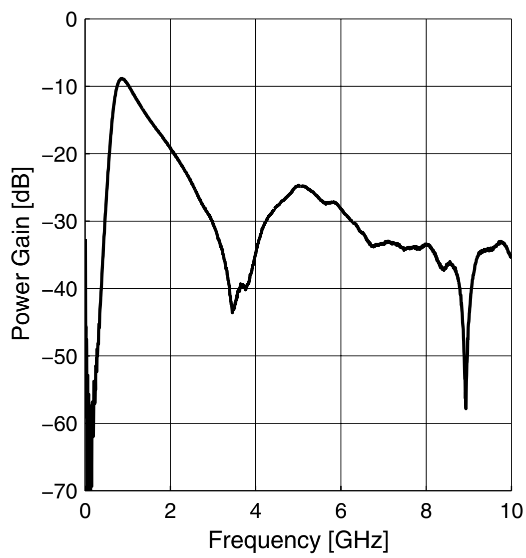
## 2.16 Measured Performance Low Band Low Gain Mode vs. Frequency

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{GS1}$ = 0 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 0 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

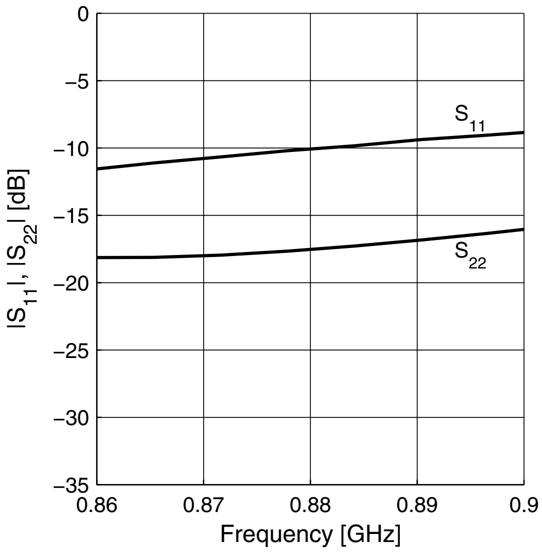
**Power Gain** $|S_{21}| = f(f)$



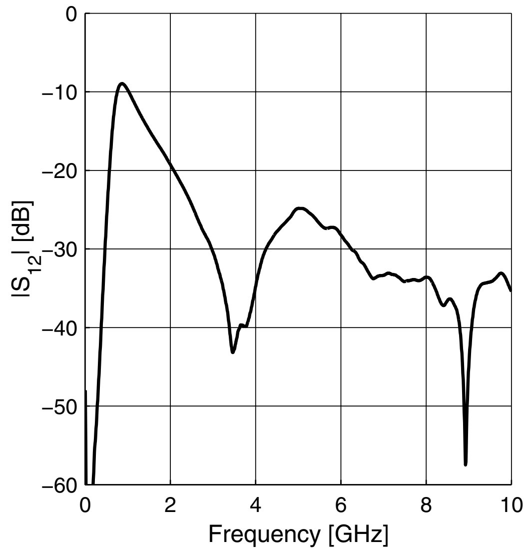

**Power Gain Wideband** $|S_{21}| = f(f)$



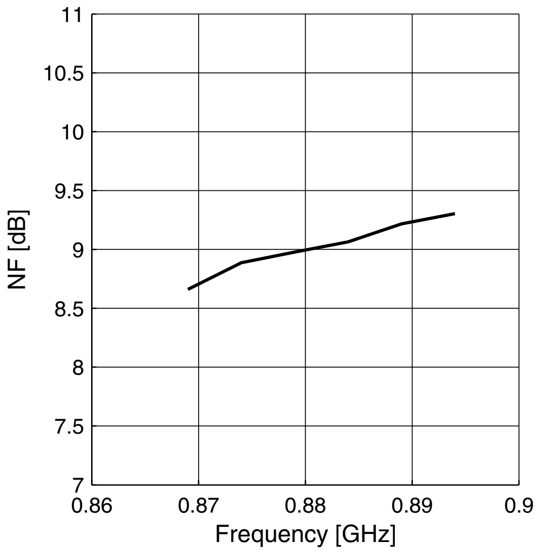

**Matching** $|S_{11}| = f(f)$, $|S_{22}| = f(f)$



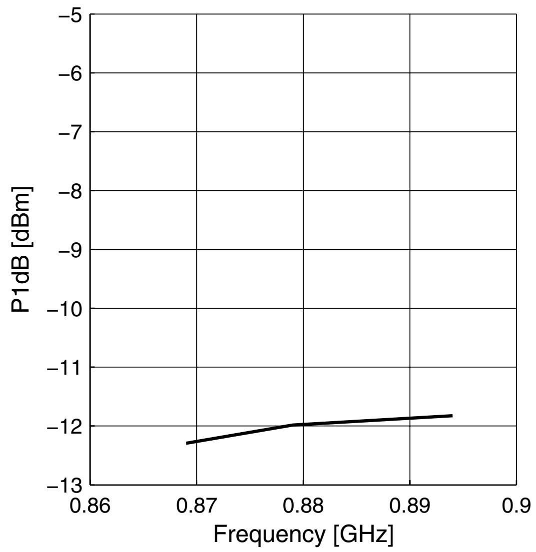

**Reverse Isolation** $|S_{12}| = f(f)$



**Noise Figure** $NF$ = f( $f$ )



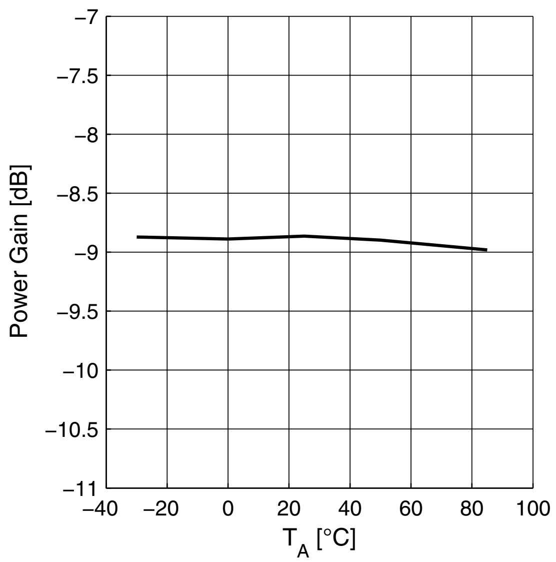

**Input Compression** $P_{1dB}$ = f( $f$ )



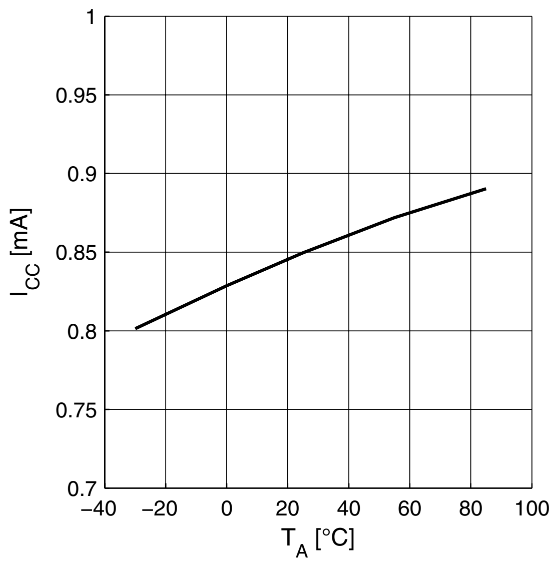

## 2.17 Measured Performance Low Band Low Gain Mode vs. Temperature

$V_{CC}$ = 2.8 V, $V_{GS1}$ = 0 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 0 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

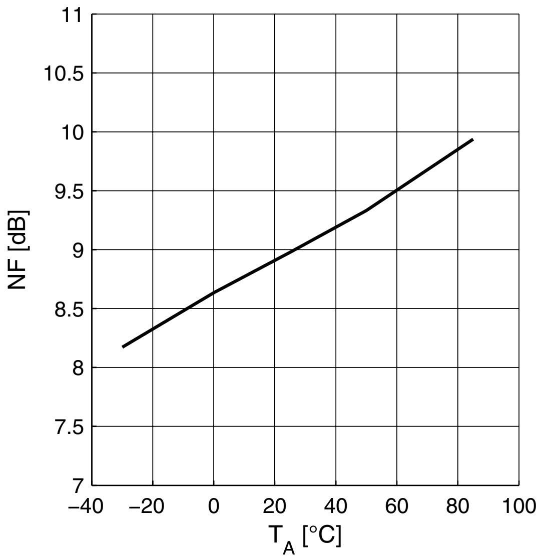
**Power Gain** $|S_{21}|$ = f ($T_A$)



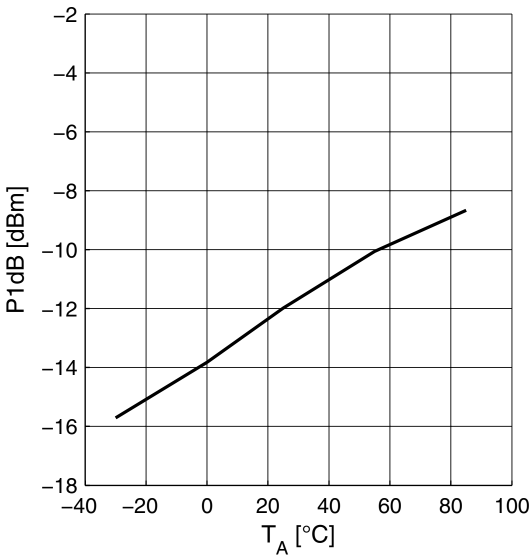

**Supply Current** $I_{CC}$ = f ($T_A$)



**Noise Figure** $NF$ = f($T_A$)



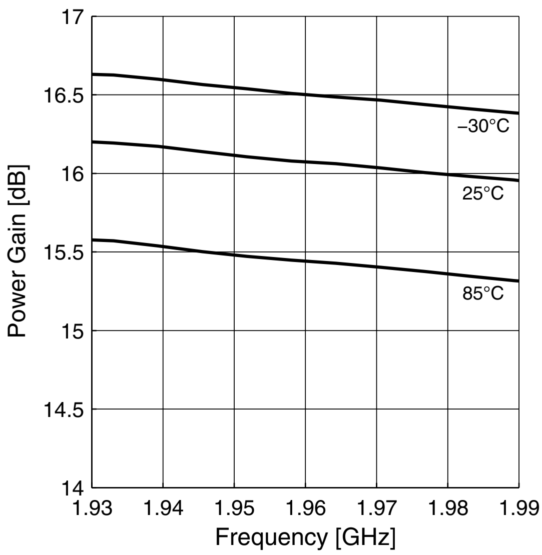

**Input Compression** $P_{1dB}$ = f($T_A$)



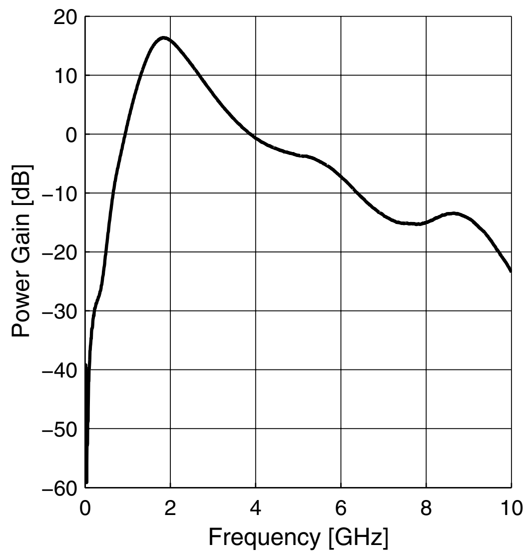

## 2.18 Measured Performance Mid Band High Gain Mode vs. Frequency

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 0 V, $R_{REF}$ = 8.2 kΩ

**Power Gain** $|S_{21}|$ = f( $f$ )

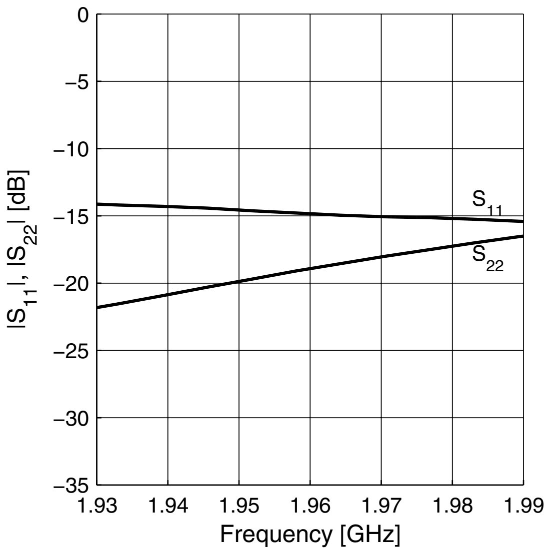



**Power Gain Wideband** $|S_{21}|$ = f( $f$ )

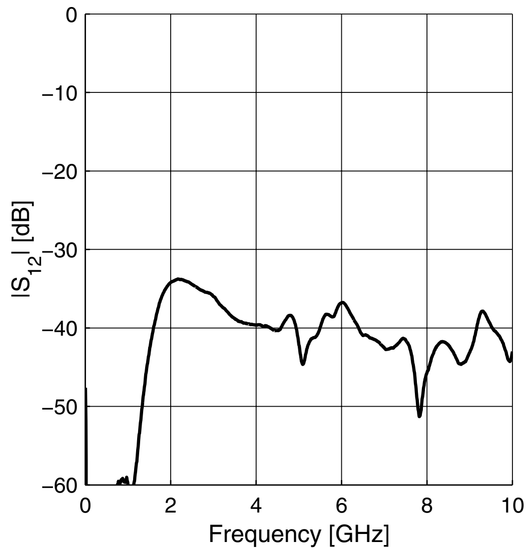


## Measured Performance Mid Band High Gain Mode vs. Frequency

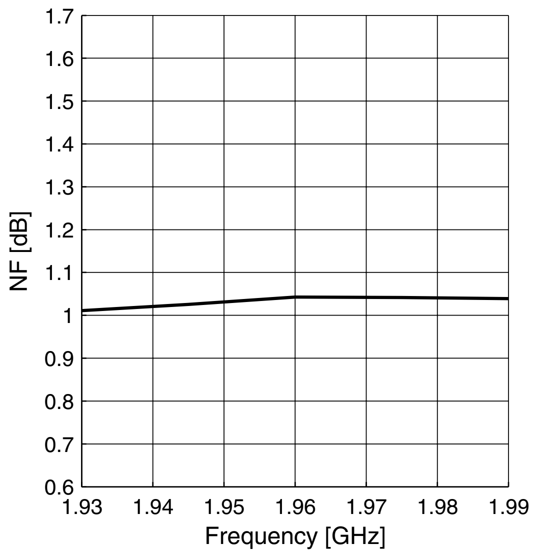
**Matching** $|S_{11}| = f(f)$, $|S_{22}| = f(f)$



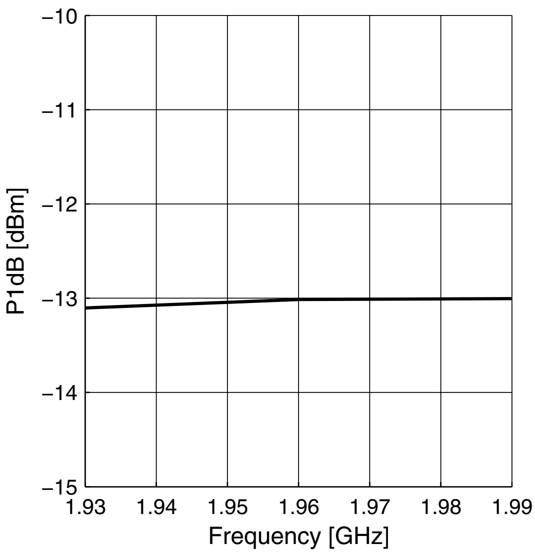

**Reverse Isolation** $|S_{12}| = f(f)$




**Noise Figure** $NF = f(f)$



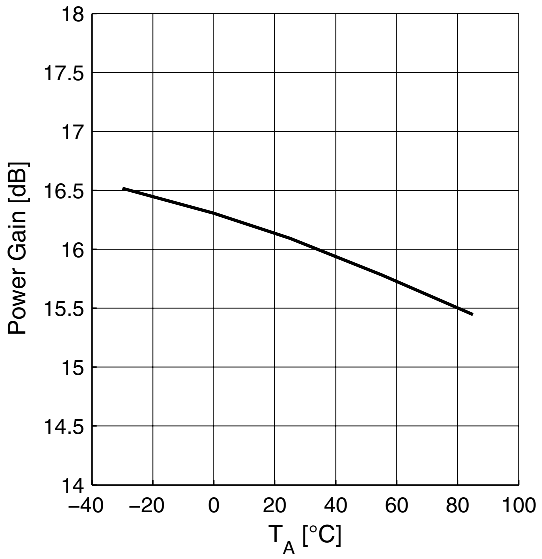

**Input Compression** $P_{1dB} = f(f)$



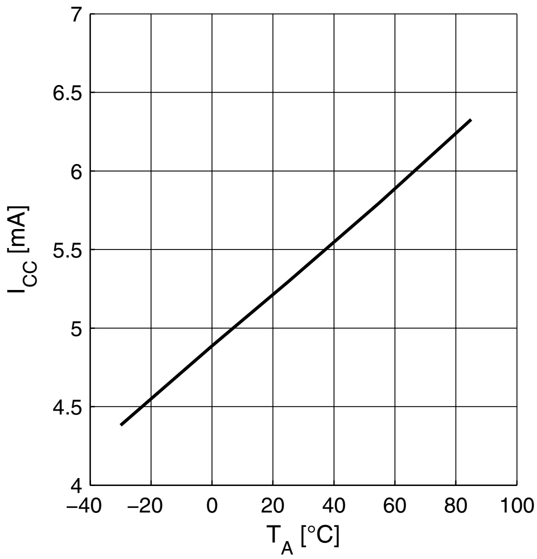
## 2.19 Measured Performance Mid Band High Gain Mode vs. Temperature

$V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 0 V, $R_{REF}$ = 8.2 kΩ

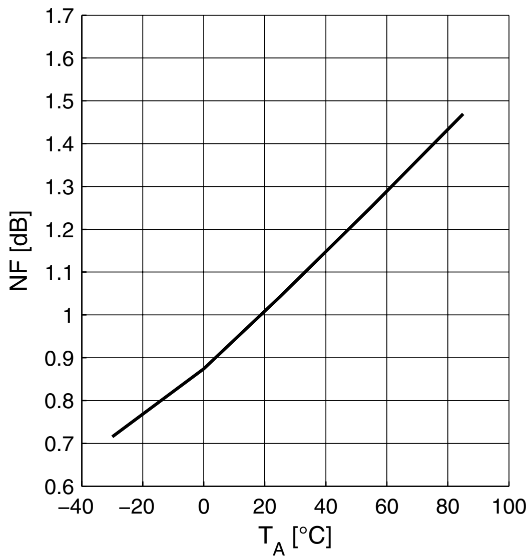
**Power Gain** $|S_{21}| = f(T_A)$



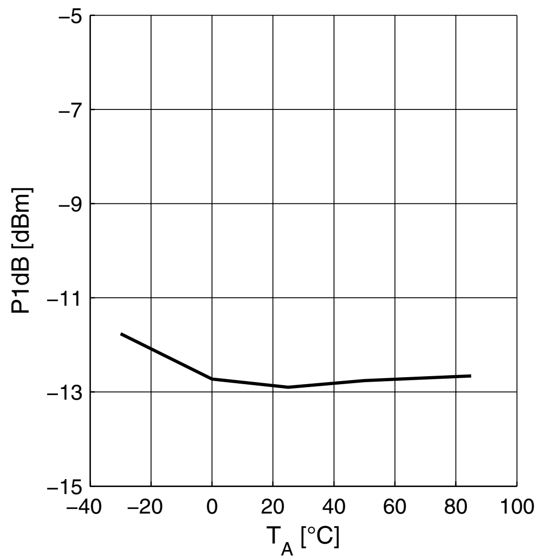

**Supply Current** $I_{CC} = f(T_A)$




**Noise Figure** $NF = f(T_A)$



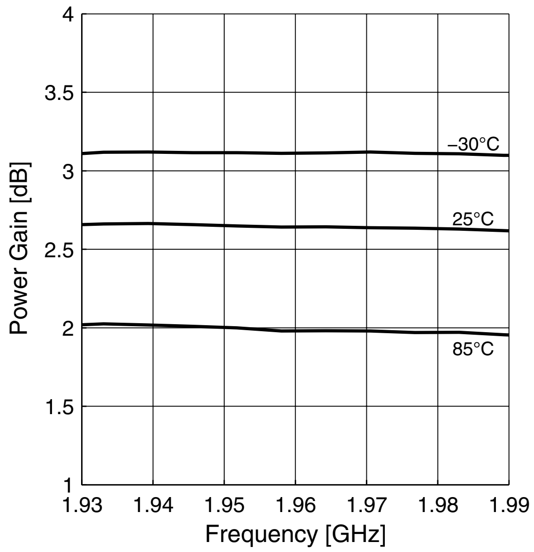

**Input Compression** $P_{1dB} = f(T_A)$



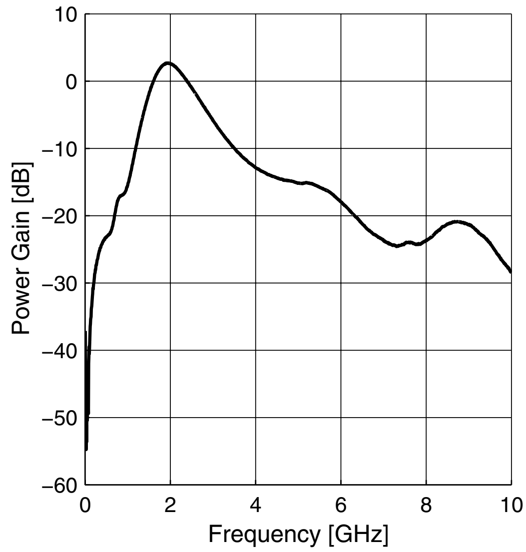
## 2.20 Measured Performance Mid Band Mid Gain Mode vs. Frequency

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 2.8 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 0 V, $R_{REF}$ = 8.2 kΩ

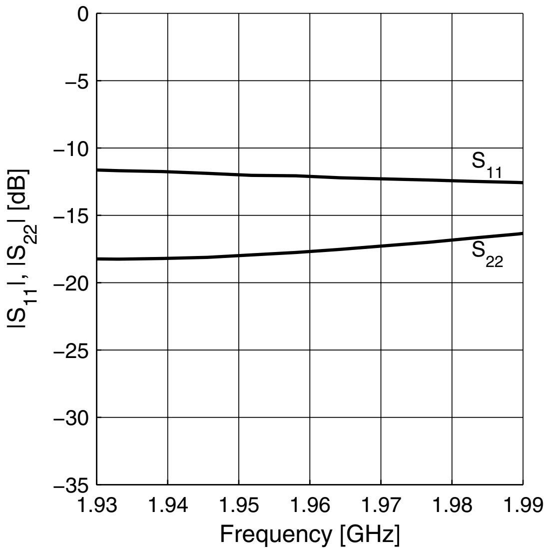
**Power Gain** $|S_{21}| = f(f)$



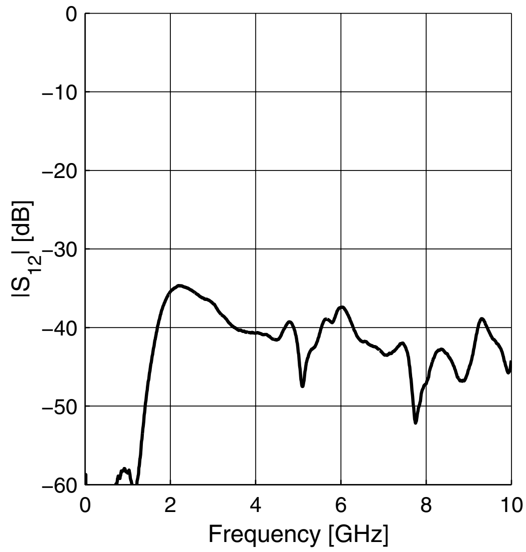

**Power Gain Wideband** $|S_{21}| = f(f)$



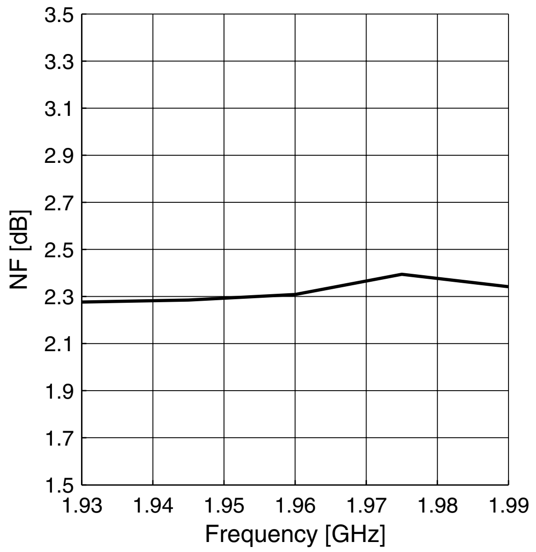

**Matching** $|S_{11}| = f(f)$, $|S_{22}| = f(f)$



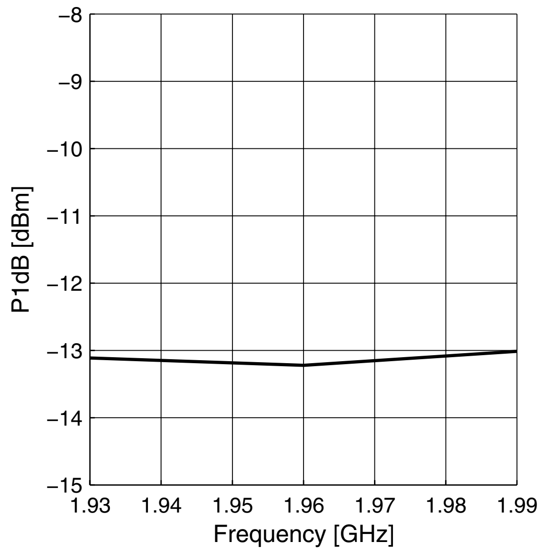

**Reverse Isolation** $|S_{12}| = f(f)$



**Noise Figure** $NF$ = f( $f$ )



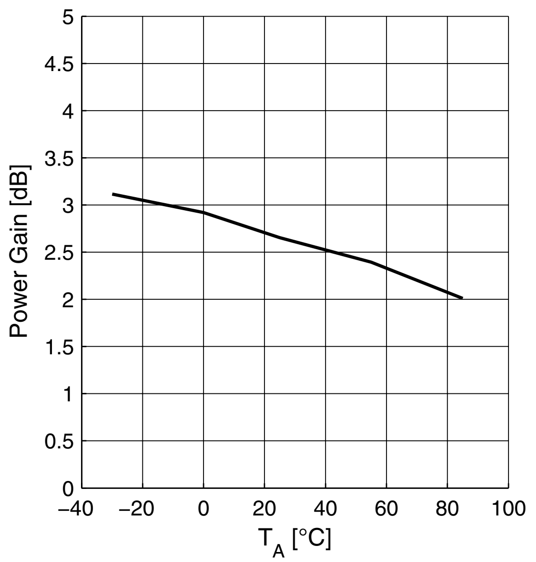

**Input Compression** $P_{1dB}$ = f( $f$ )



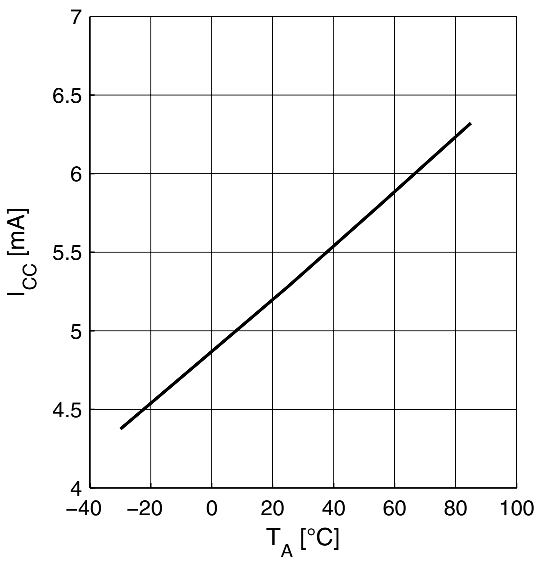

## 2.21 Measured Performance Mid Band Mid Gain Mode vs. Temperature

$V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 2.8 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 0 V, $R_{REF}$ = 8.2 kΩ

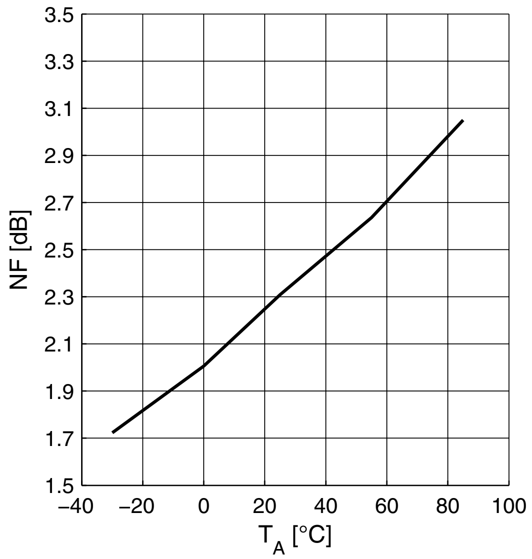
**Power Gain** $|S_{21}|$ = f($T_A$)



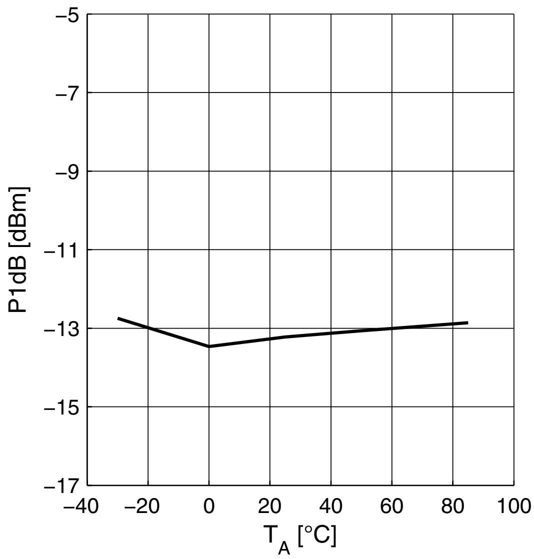

**Supply Current** $I_{CC}$ = f($T_A$)



**Noise Figure** $NF$ = f($T_A$)



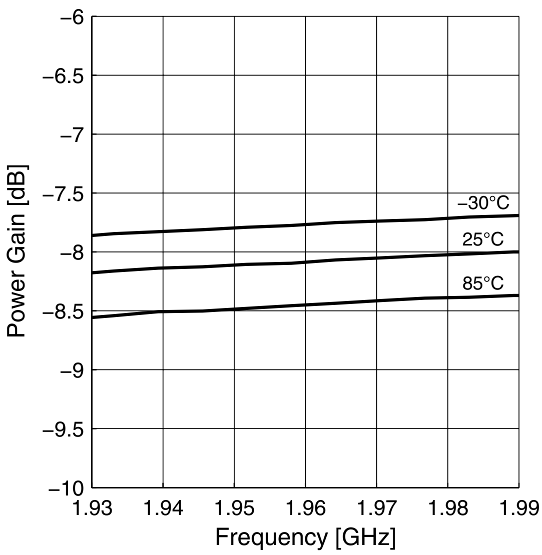

**Input Compression** $P_{1dB}$ = f($T_A$)



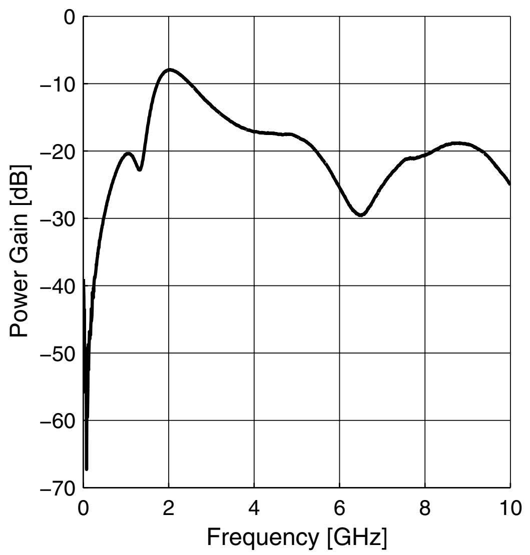

## 2.22 Measured Performance Mid Band Low Gain Mode vs. Frequency

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{GS1}$ = 0 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 0 V, $R_{REF}$ = 8.2 kΩ

**Power Gain** $|S_{21}|$ = f($f$)

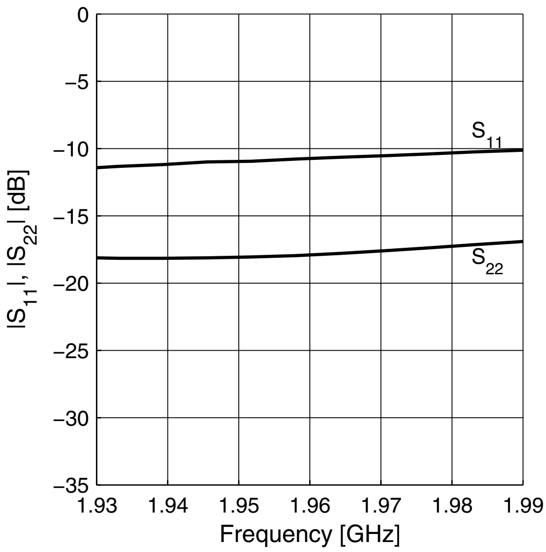



**Power Gain Wideband** $|S_{21}|$ = f($f$)

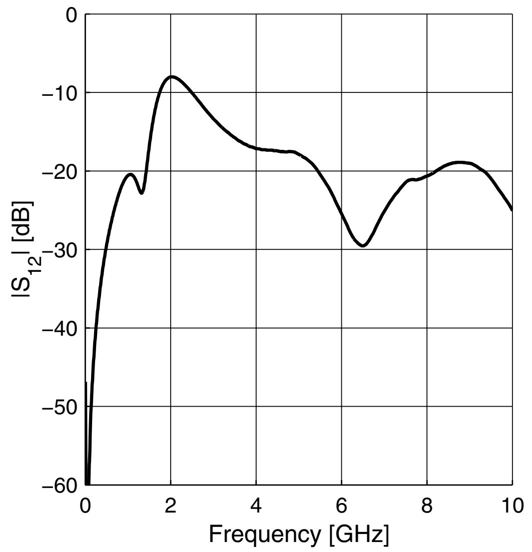


**Measured Performance Mid Band Low Gain Mode vs. Frequency**

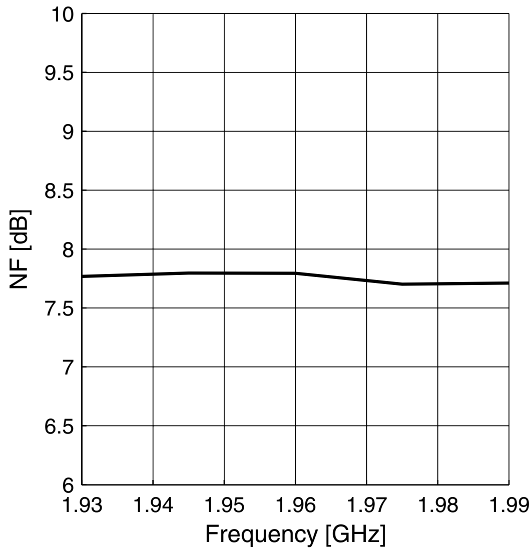
**Matching** $|S_{11}| = f(f)$, $|S_{22}| = f(f)$



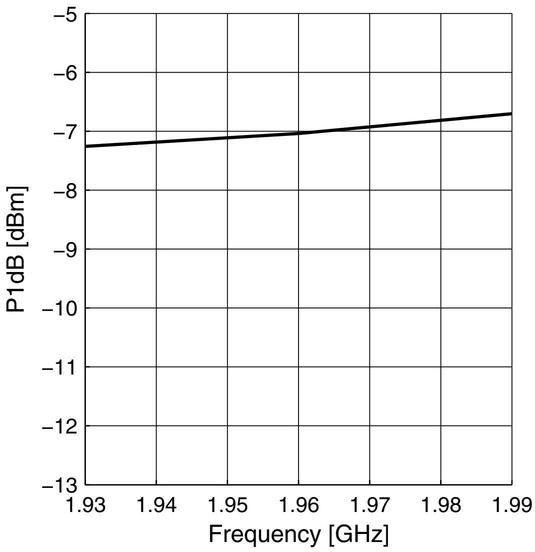

**Reverse Isolation** $|S_{12}| = f(f)$




**Noise Figure** $NF = f(f)$



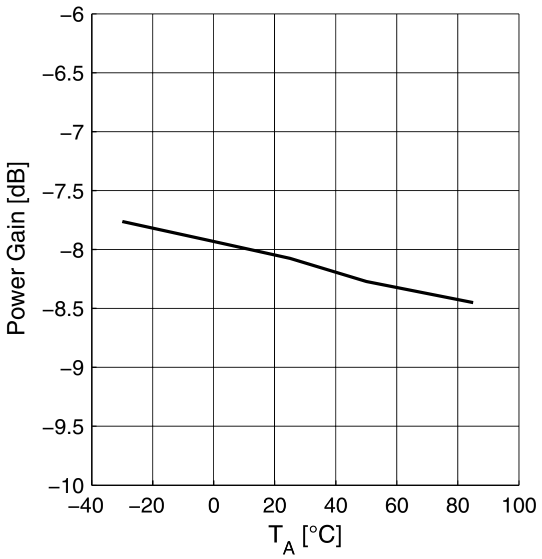

**Input Compression** $P_{1dB} = f(f)$



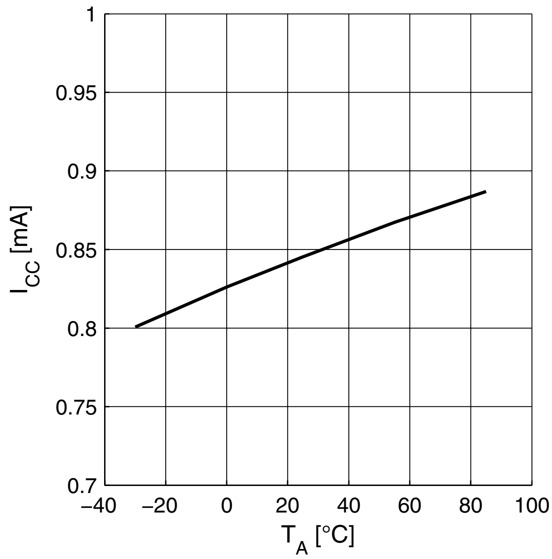
## 2.23 Measured Performance Mid Band Low Gain Mode vs. Temperature

$V_{CC}$ = 2.8 V, $V_{GS1}$ = 0 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 0 V, $R_{REF}$ = 8.2 kΩ

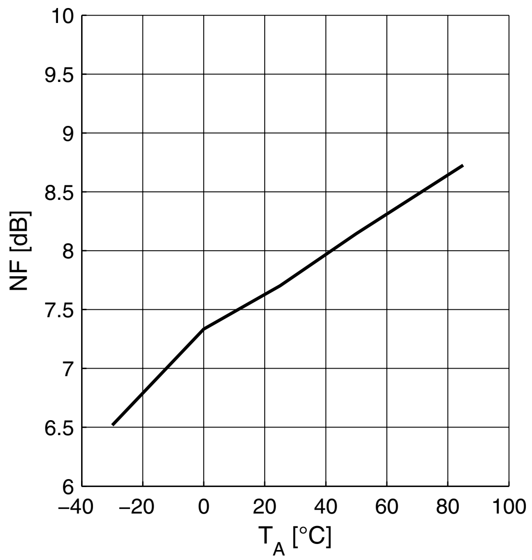
**Power Gain** $|S_{21}| = f(T_A)$



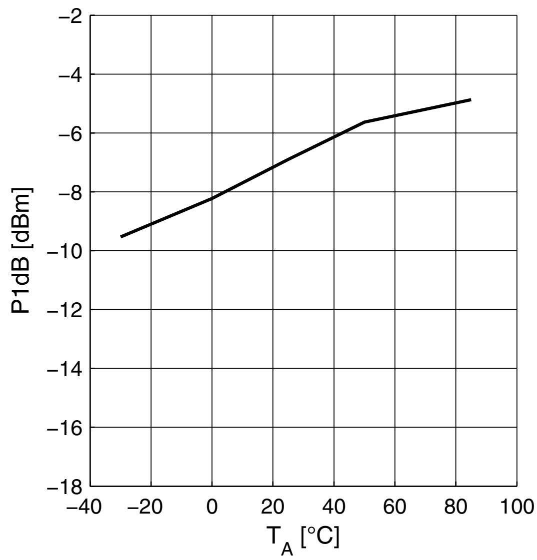

**Supply Current** $I_{CC} = f(T_A)$




**Noise Figure** $NF = f(T_A)$



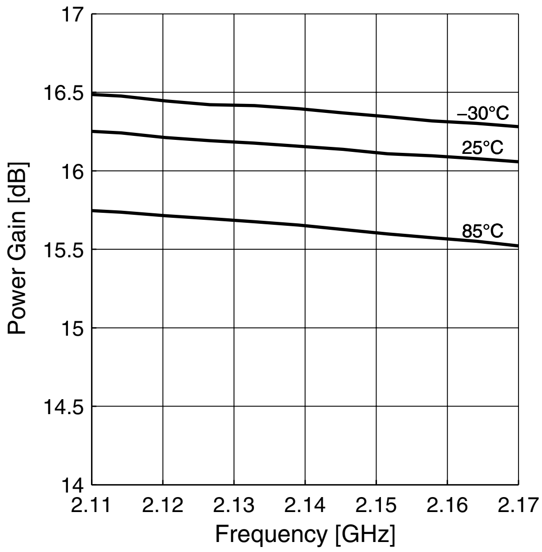

**Input Compression** $P_{1dB} = f(T_A)$



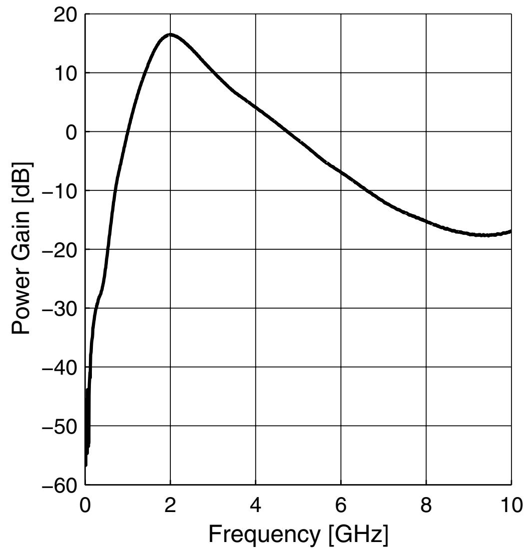
## 2.24 Measured Performance High Band High Gain Mode vs. Frequency

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

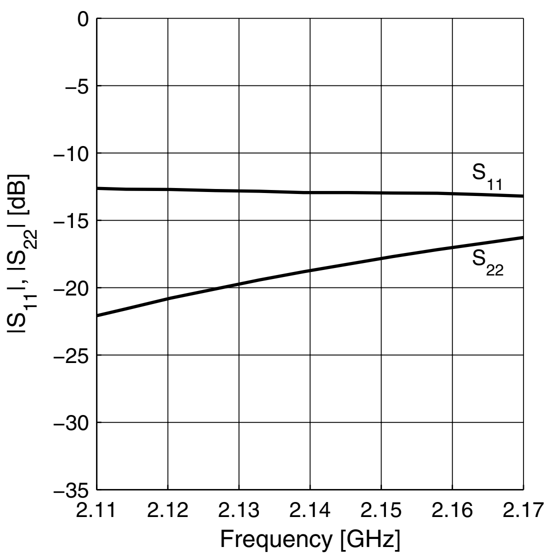
**Power Gain** $|S_{21}| = f(f)$



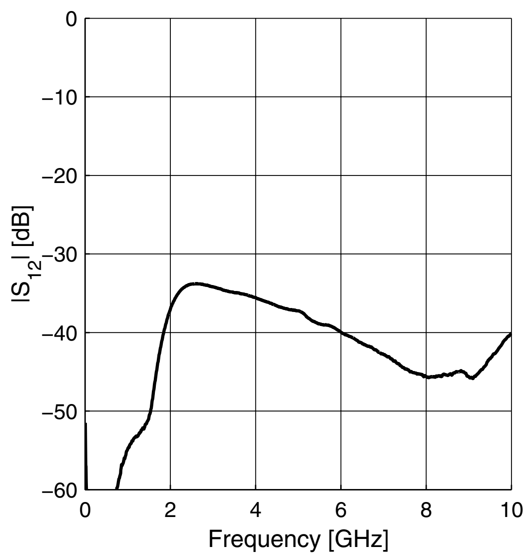

**Power Gain Wideband** $|S_{21}| = f(f)$



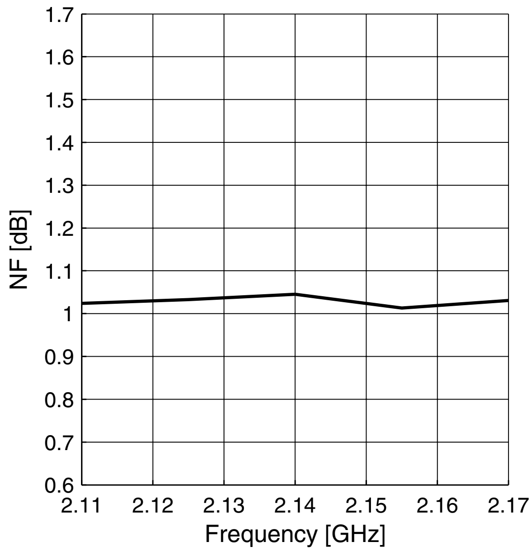

**Matching** $|S_{11}| = f(f)$, $|S_{22}| = f(f)$



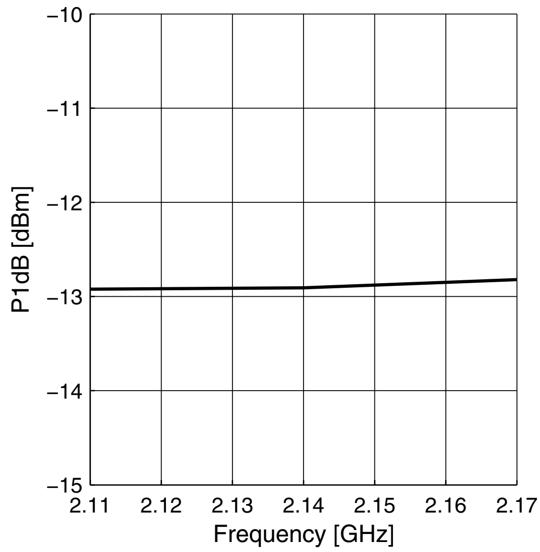

**Reverse Isolation** $|S_{12}| = f(f)$



**Noise Figure** $NF$ = f( $f$ )



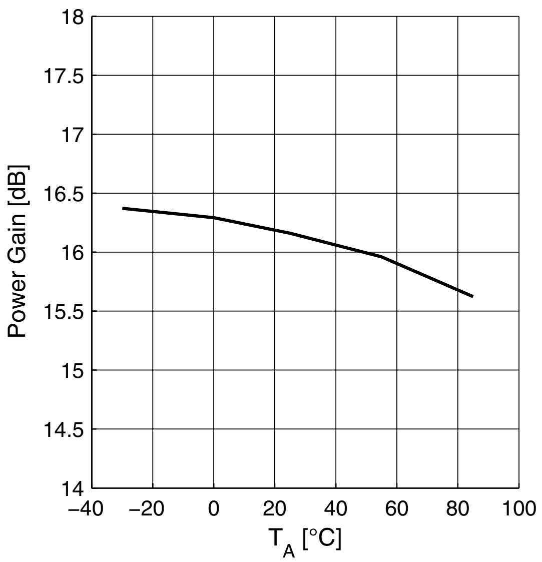

**Input Compression** $P_{1dB}$ = f( $f$ )



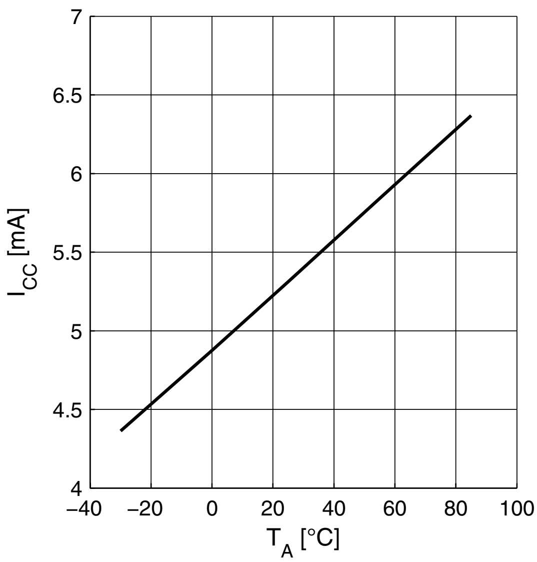

## 2.25 Measured Performance High Band High Gain Mode vs. Temperature

$V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

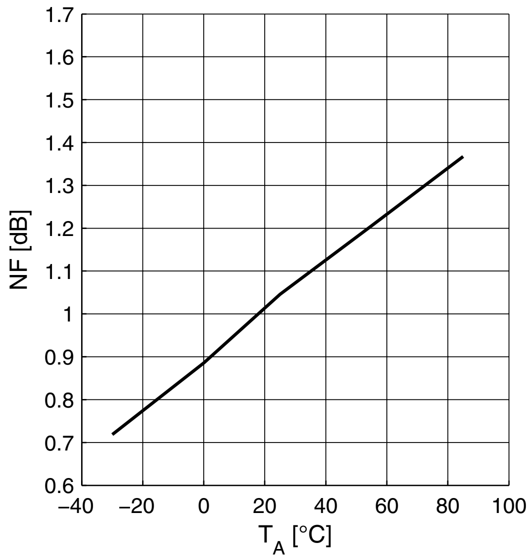
**Power Gain** $|S_{21}|$ = f( $T_A$ )



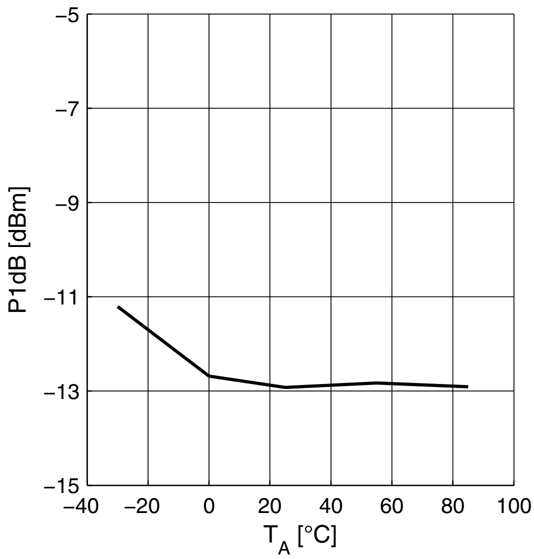

**Supply Current** $I_{CC}$ = f( $T_A$ )



**Noise Figure** $NF$ = f($T_A$)



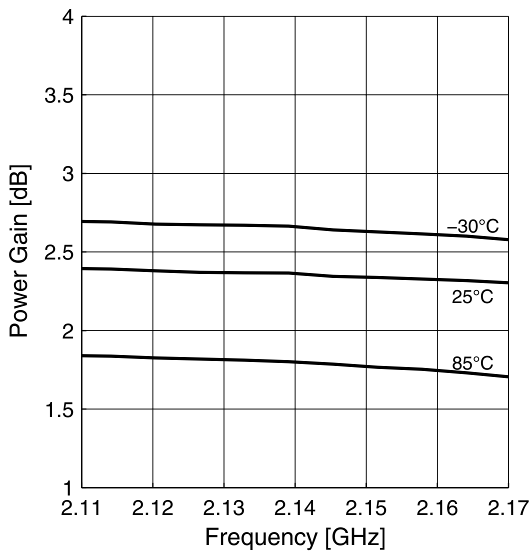

**Input Compression** $P_{1dB}$ = f($T_A$)



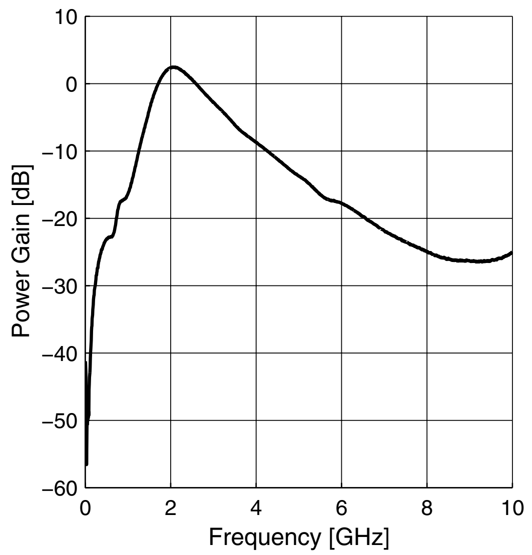

## 2.26 Measured Performance High Band Mid Gain Mode vs. Frequency

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 2.8 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

**Power Gain** $|S_{21}|$ = f($f$)

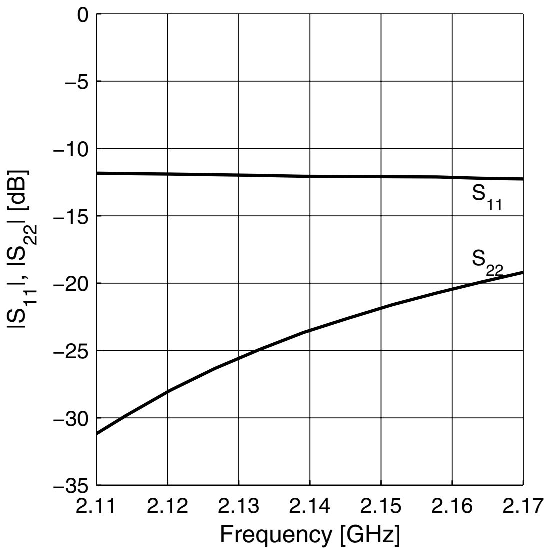



**Power Gain Wideband** $|S_{21}|$ = f($f$)

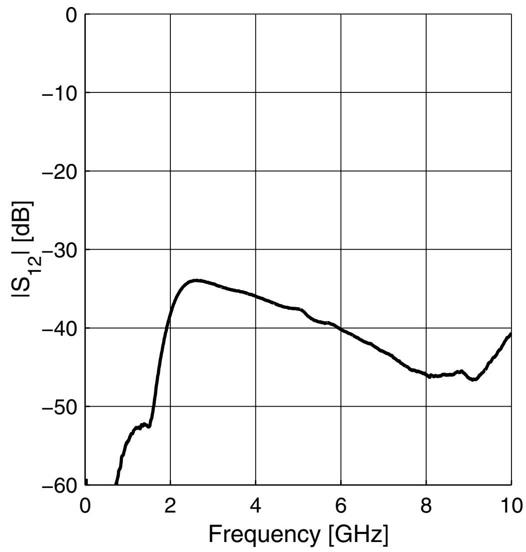


## Measured Performance High Band Mid Gain Mode vs. Frequency

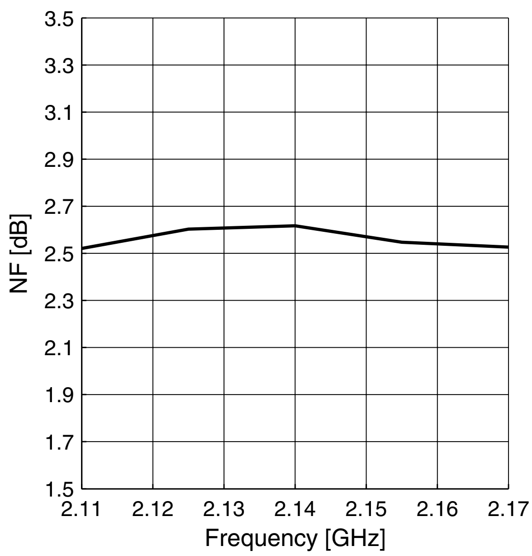
**Matching** $|S_{11}| = f(f)$, $|S_{22}| = f(f)$



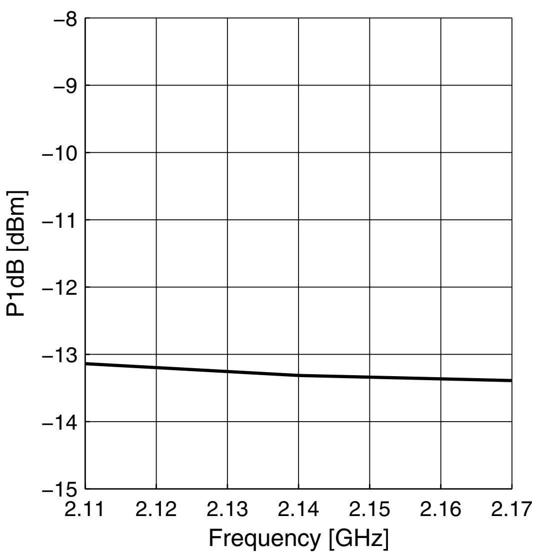

**Reverse Isolation** $|S_{12}| = f(f)$




**Noise Figure** $NF = f(f)$



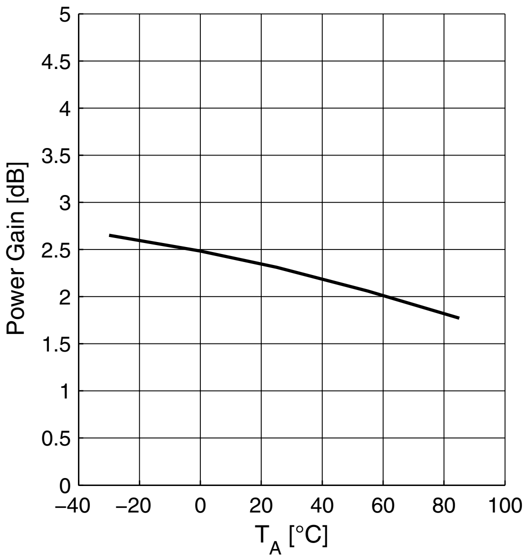

**Input Compression** $P_{1dB} = f(f)$



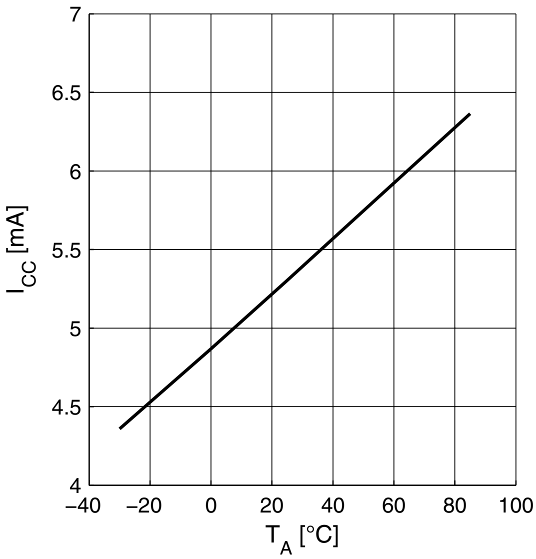
## 2.27 Measured Performance High Band Mid Gain Mode vs. Temperature

$V_{CC}$ = 2.8 V, $V_{GS1}$ = 2.8 V, $V_{GS2}$ = 2.8 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

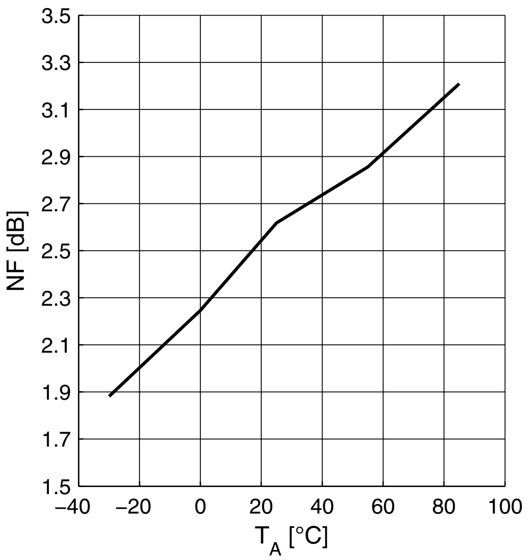
**Power Gain** $|S_{21}| = f(T_A)$



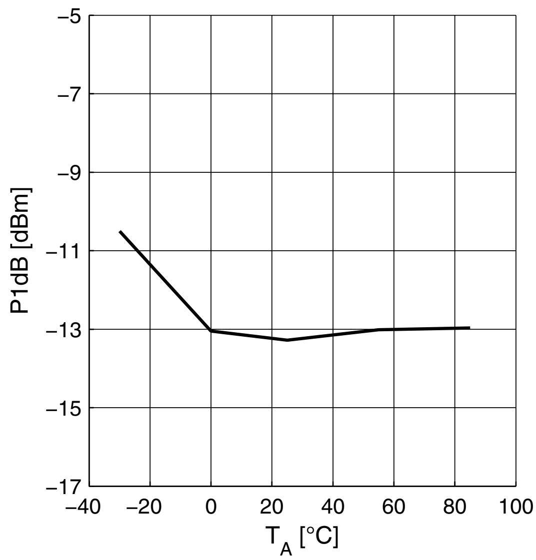

**Supply Current** $I_{CC} = f(T_A)$




**Noise Figure** $NF = f(T_A)$



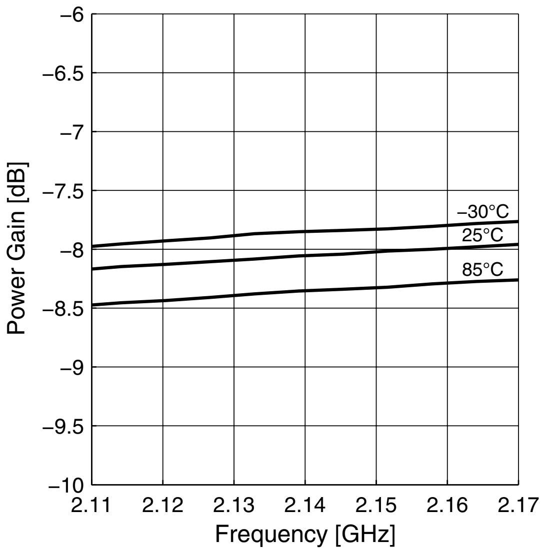

**Input Compression** $P_{1dB} = f(T_A)$



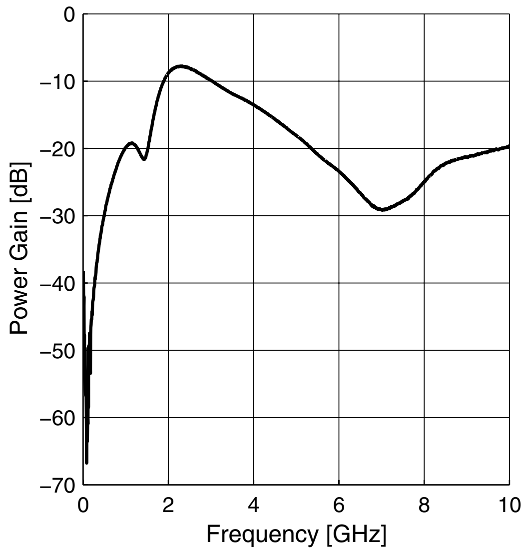
## 2.28 Measured Performance High Band Low Gain Mode vs. Frequency

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{GS1}$ = 0 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

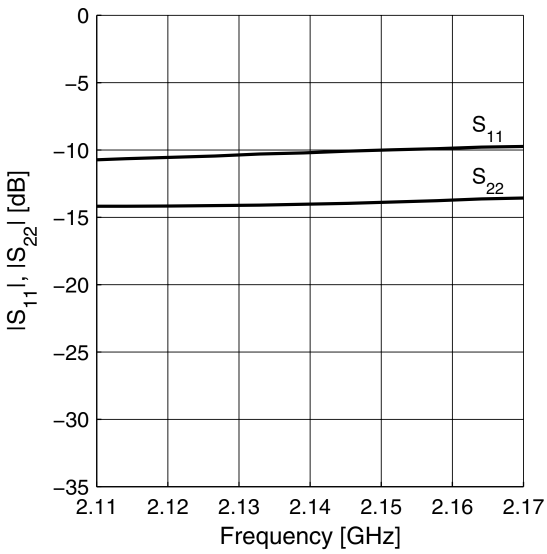
**Power Gain** $|S_{21}| = f(f)$



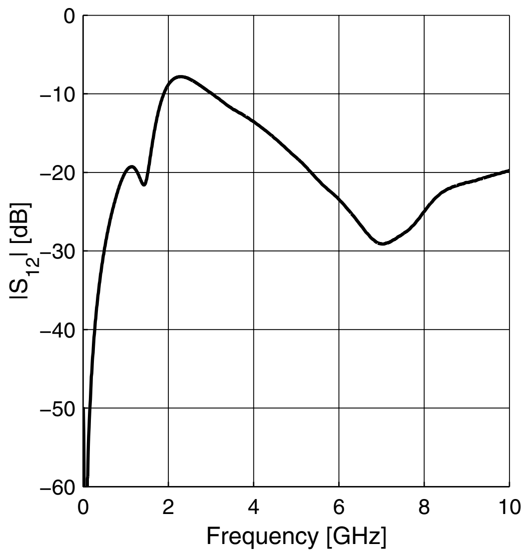

**Power Gain Wideband** $|S_{21}| = f(f)$



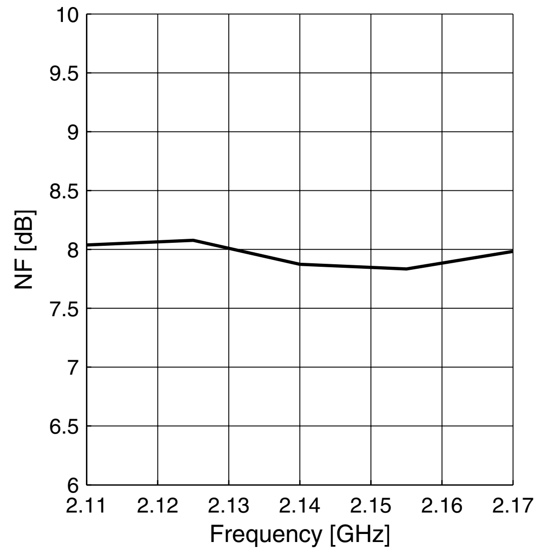

**Matching** $|S_{11}| = f(f)$, $|S_{22}| = f(f)$



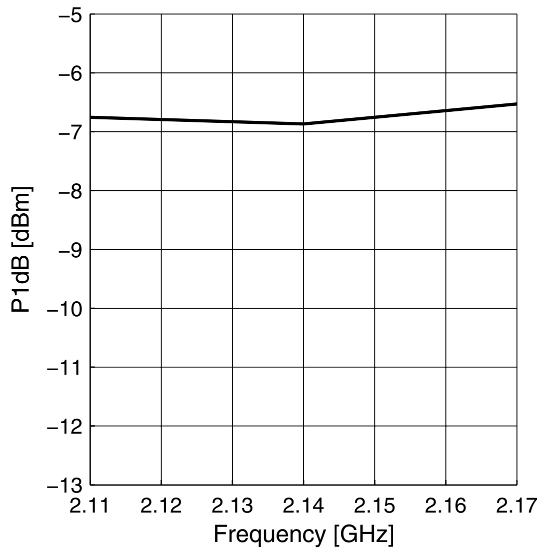

**Reverse Isolation** $|S_{12}| = f(f)$



**Noise Figure** $NF$ = f( $f$ )



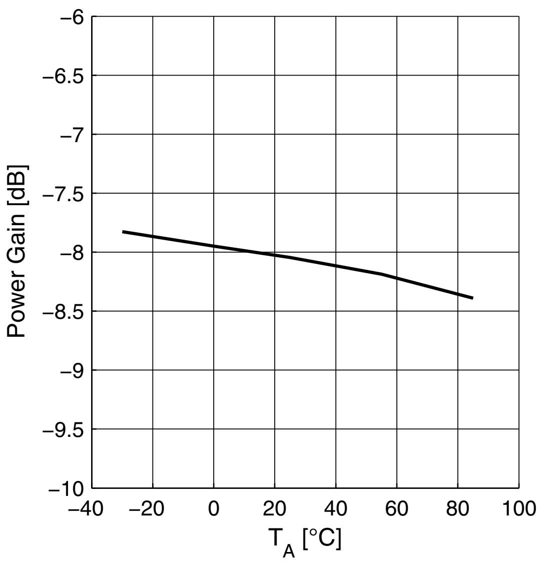

**Input Compression** $P_{1dB}$ = f( $f$ )



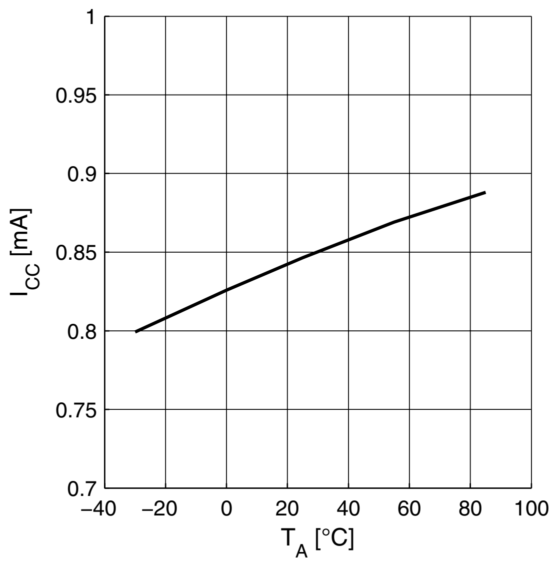

## 2.29 Measured Performance High Band Low Gain Mode vs. Temperature

$V_{CC}$ = 2.8 V, $V_{GS1}$ = 0 V, $V_{GS2}$ = 0 V, $V_{EN1}$ = 2.8 V, $V_{EN2}$ = 2.8 V, $R_{REF}$ = 8.2 kΩ

**Power Gain** $|S_{21}|$ = f($T_A$)

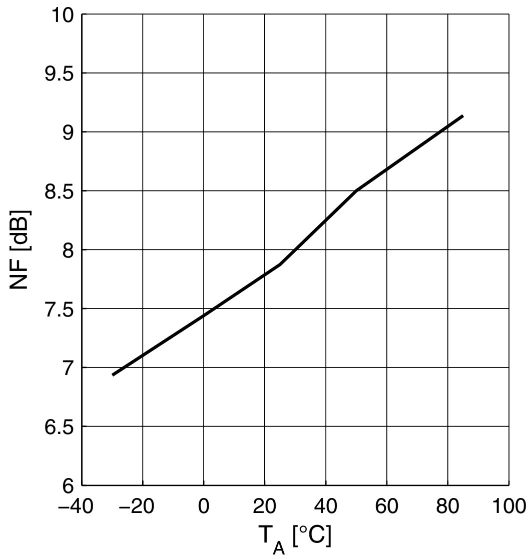



**Supply Current** $I_{CC}$ = f($T_A$)

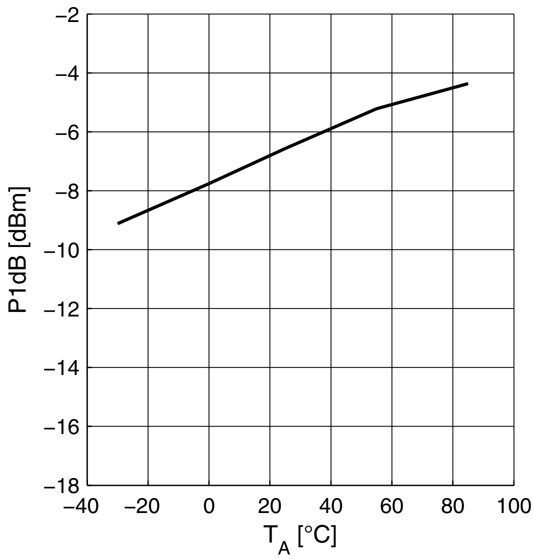


**Measured Performance High Band Low Gain Mode vs. Temperature**

**Noise Figure** $NF = f(T_A)$




**Input Compression** $P_{1dB} = f(T_A)$



# 3 Application Circuit and Block Diagram

## 3.1 UMTS bands I, II and V Application Circuit Schematic

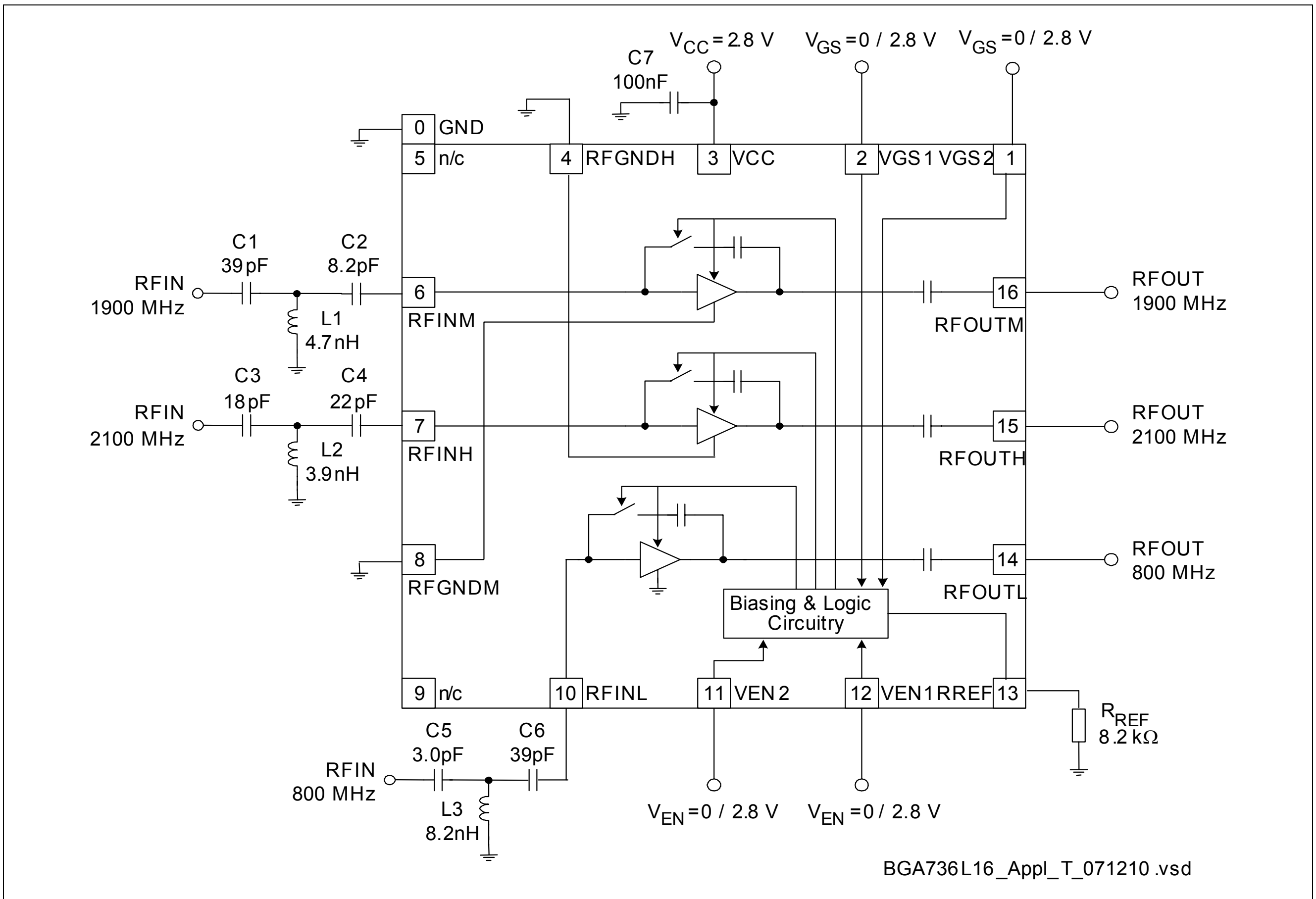



**Figure 2 Application circuit with chip outline (top view)**

*Note: Package paddle (Pin 0) has to be RF grounded.*

**Table 13 Parts List**

| Part Number | Part Type | Manufacturer | Size | Comment |
|---|---|---|---|---|
| L1...L3 | Chip inductor | Various | 0402 | Wirewound, Q ≈ 50 |
| C1...C7 | Chip capacitor | Various | 0402 | |
| $R_{REF}$ | Chip resistor | Various | 0402 | |

## 3.2 UMTS bands I, IV and VIII Application Circuit Schematic

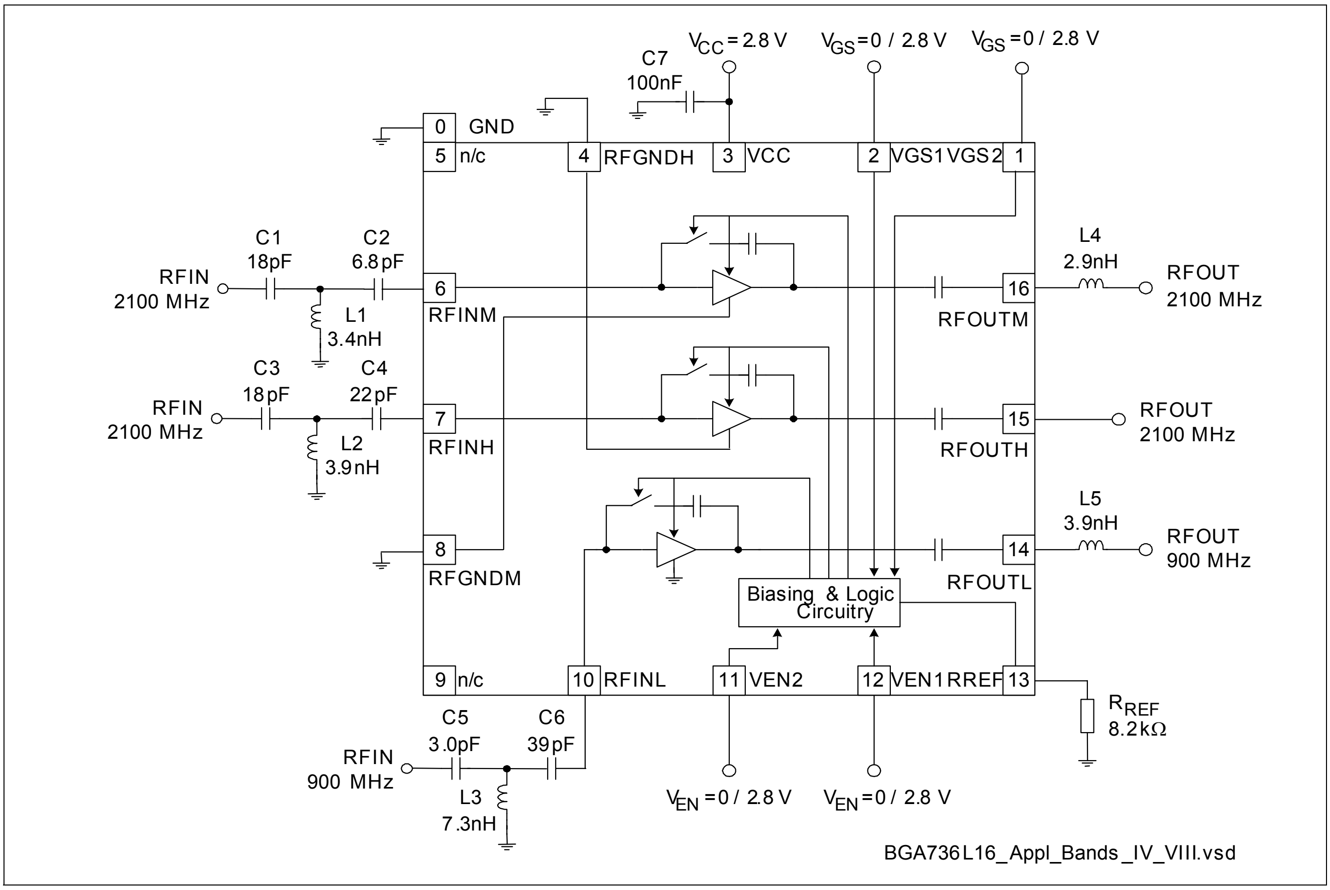



**Figure 3 Application circuit with chip outline (top view)**

*Note: Package paddle (Pin 0) has to be RF grounded.*

**Table 14 Parts List**

| Part Number | Part Type | Manufacturer | Size | Comment |
|---|---|---|---|---|
| L1...L5 | Chip inductor | Various | 0402 | Wirewound, Q ≈ 50 |
| C1...C7 | Chip capacitor | Various | 0402 | |
| $R_{REF}$ | Chip resistor | Various | 0402 | |

## 3.3 Pin Definition

**Table 15 Pin Definition and Function**

| Pin Number | Symbol | Function |
|---|---|---|
| 0 | GND | Ground connection for low band (800/900 MHz) LNA and control circuity (package paddle) |
| 1 | VGS2 | Gain step control |
| 2 | VGS1 | Gain step control |
| 3 | VCC | Supply voltage |
| 4 | RFGNDH | High band (2100 MHz) LNA RF ground |
| 5 | n/c | Not connected |
| 6 | RFINM | Mid band (1900/2100 MHz) LNA input |
| 7 | RFINH | High band (2100 MHz) LNA input |
| 8 | RFGNDM | Mid band (1900/2100 MHz) LNA RF ground |
| 9 | n/c | Not connected |
| 10 | RFINL | Low band (800/900 MHz) LNA input |
| 11 | VEN2 | Band select control |
| 12 | VEN1 | Band select control |
| 13 | RREF | Bias current reference resistor (high / mid gain mode) |
| 14 | RFOUTL | Low band (800/900 MHz) LNA output |
| 15 | RFOUTH | High band (2100 MHz) LNA output |
| 16 | RFOUTM | Mid band (1900/2100 MHz) LNA output |

## 3.4 Application Board

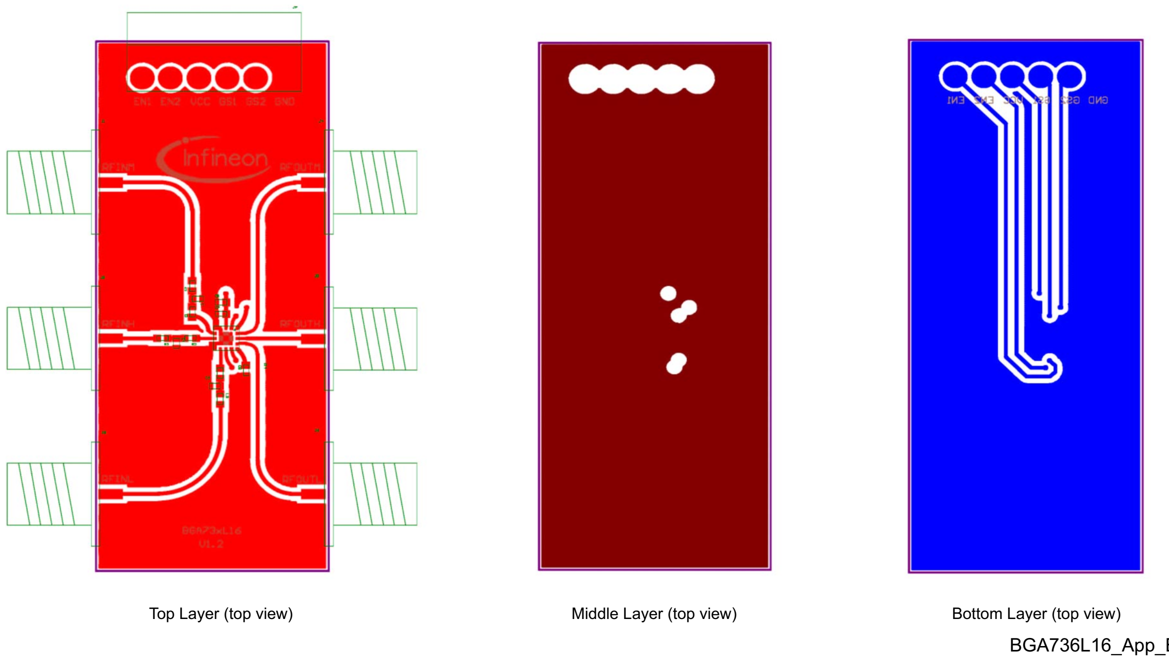



**Figure 4 Application board layout on 3-layer FR4. Top layer thickness: 0.2 mm, bottom layer thickness: 0.8 mm, 35 $\mu$m Cu metallization, gold plated. Board size: 20 x 50 mm**

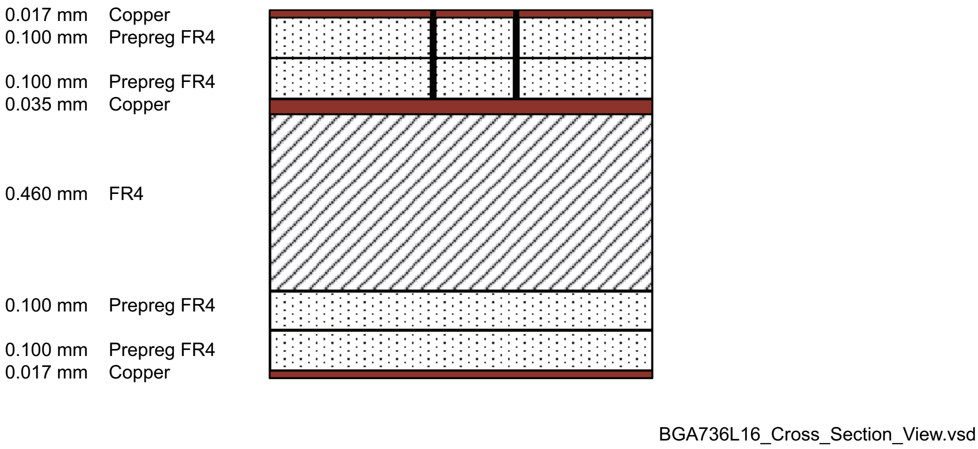



**Figure 5 Cross-section view of application board**

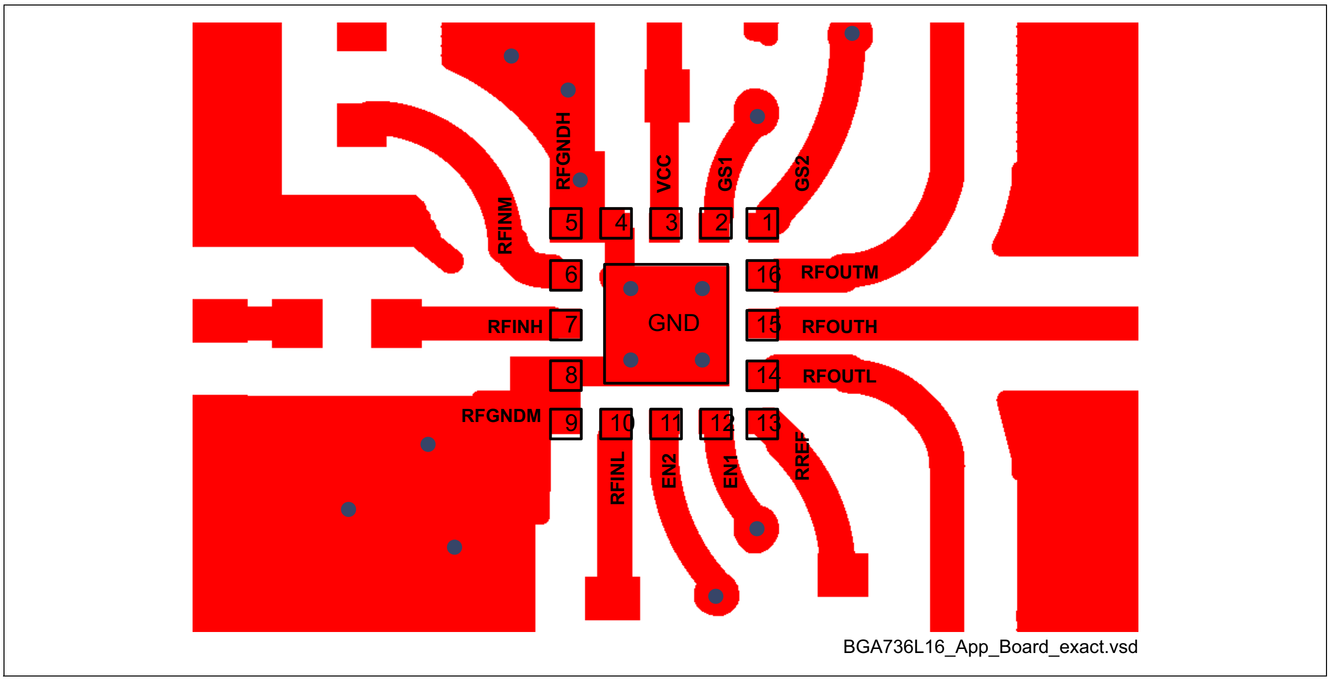



**Figure 6 Detail of application board layout**

*Note: In order to achieve the same performance as given in this datasheet please follow the suggested PCB-layout as closely as possible. The position of the GND vias is critical for RF performance.*

# 4 Physical Characteristics

## 4.1 Package Footprint

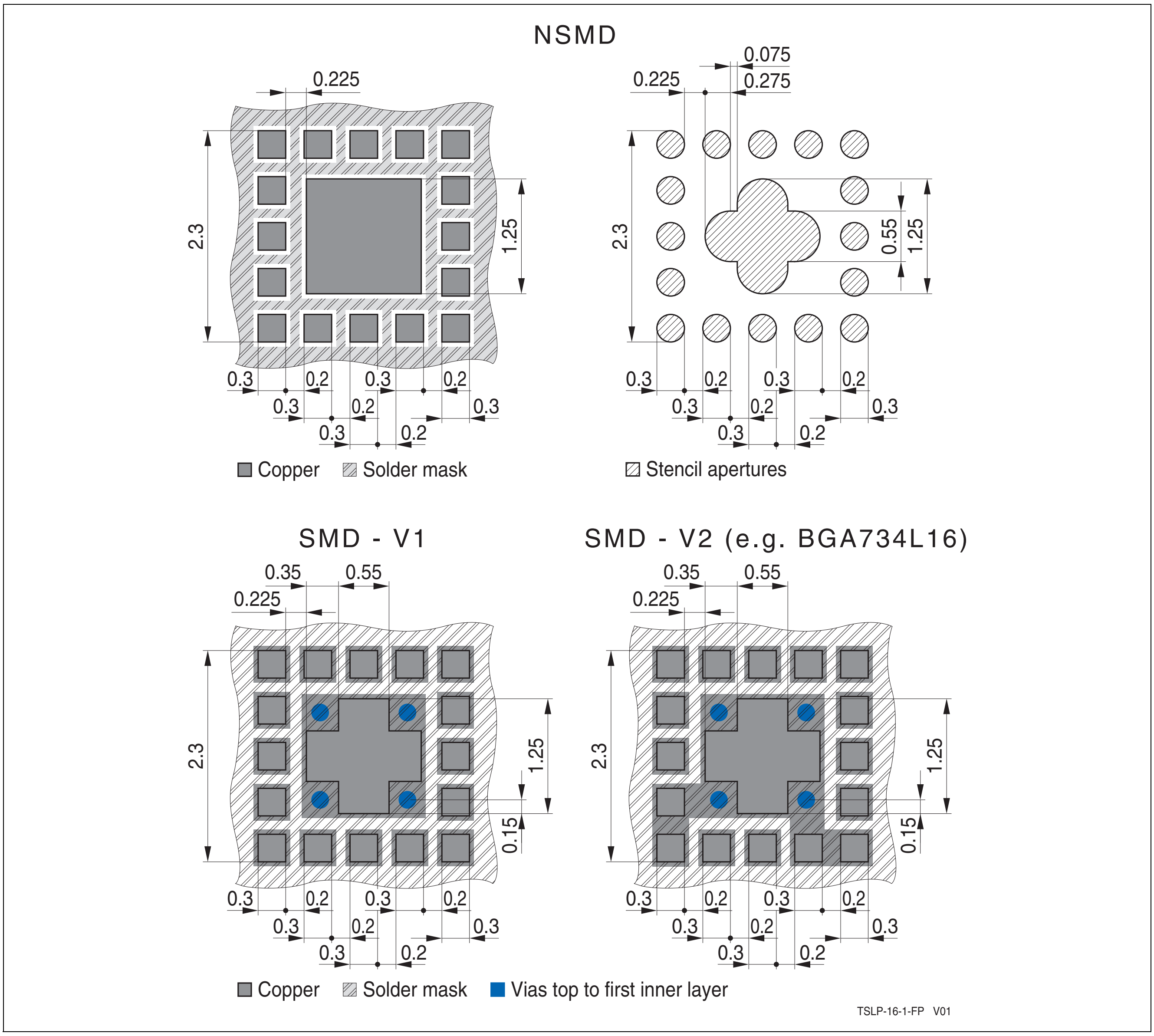



**Figure 7 Recommended footprint and stencil layout for the TSLP-16-1 package. SMD - V2 footprint is used on IFX application board**

## 4.2 Package Dimensions

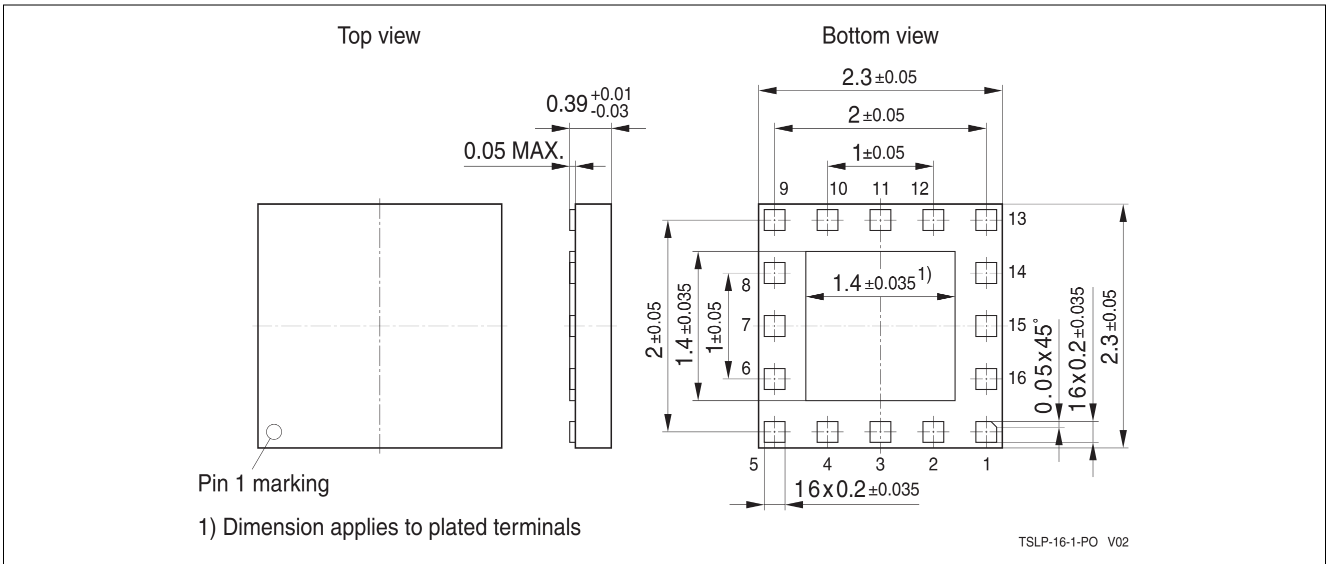



**Figure 8 Package outline (top, side and bottom view)**

w w w . i n f i n e o n . c o m

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