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# BGX7101

## Transmitter IQ modulator

**Rev. 5 — 25 January 2017** **Product data sheet**

## 1. General description

The BGX7101 is, also known as the BTS8001A, a device combines high performance, high linearity I and Q modulation paths for use in radio frequency up-conversion. It supports RF frequency outputs in the range from 400 MHz to 4000 MHz. The BGX7101 IQ modulator is performance independent of the IQ common mode voltage. The modulator provides a typical output power at 1 dB gain compression ($P_{L(1dB)}$) value of 12 dBm and a typical 27 dBm output third-order intercept point ($IP3_o$). Unadjusted sideband suppression and carrier feedthrough are 50 dBc and −45 dBm respectively. A hardware control pin provides a fast power-down/power-up mode functionality which allows significant power saving.

## 2. Features and benefits

- 400 MHz to 4000 MHz frequency operating range
- Stable performance across 0.25 V to 3.3 V common-mode voltage input
- Independent low-current power-down hardware control pin
- 12 dBm output −1 dB compression point
- 27 dBm output third-order intercept point (typical)
- Integrated active biasing
- Single 5 V supply
- 100 Ω differential IQ input impedance
- Matched 50 Ω single-ended RF output impedance
- ESD protection at all pins

## 3. Applications

- Mobile network infrastructure
- Microwave and broadband
- RF and IF applications
- Industrial applications

## 4. Device family

The BGX7101 operates in the RF frequency range of 400 MHz to 4000 MHz with modulation bandwidths up to 650 MHz.

# 5. Ordering information

**Table 1. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BGX7101HN | HVQFN24 | plastic thermal enhanced very thin quad flat package; no leads; 24 terminals; body 4 × 4 × 0.85 mm | SOT616-3 |

# 6. Functional diagram

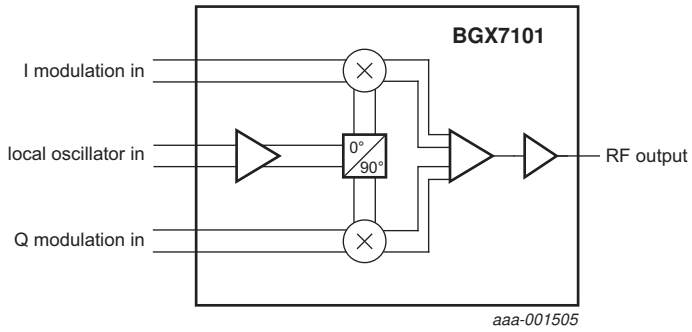



**Fig 1. Functional block diagram**

Differential I and Q baseband inputs are each fed to an associated upconverter mixer. The Local Oscillator (LO) carrier input is buffered and split into 0 degree and 90 degree signals. The in-phase signal is passed to the I mixer and the 90 degree phase-changed signal is passed to the Q mixer. The outputs of the mixers are summed to produce the resulting RF output signal.

# 7. Pinning information

## 7.1 Pinning

The BGX7101 device pinout is designed to allow easy interfacing when mounted on a Printed-Circuit Board (PCB). When viewing the device from above, the two differential IQ baseband input paths are at the top and bottom. The common LO input is at the left and the RF output at the right. Multiple power and ground pins allow for independent supply domains, improving isolation between blocks. A small package footprint is chosen to reduce bond-wire induced series inductance in the RF ports.

The input and output pin matching is described in Section 12 “Application information”.

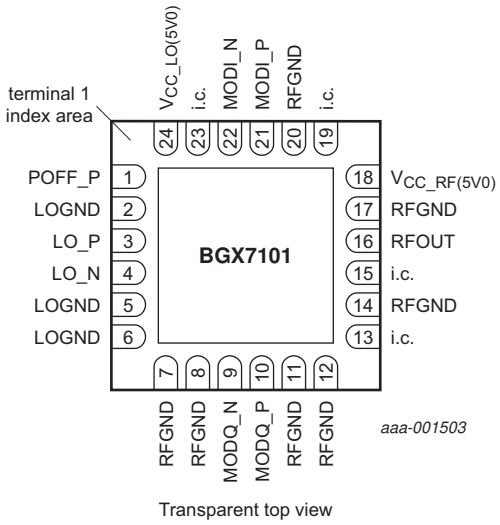



**Fig 2. Pin configuration**

## 7.2 Pin description

**Table 2. Pin description**

| Symbol | Pin | Type[1] | Description |
|---|---|---|---|
| POFF_P | 1 | I | active HIGH logic input to power-down modulator |
| LOGND | 2 | G | LO ground |
| LO_P | 3 | I | LO positive input[2] |
| LO_N | 4 | I | LO negative input[2] |
| LOGND | 5 | G | LO ground |
| LOGND | 6 | G | LO ground |
| RFGND | 7 | G | RF ground |
| RFGND | 8 | G | RF ground |
| MODQ_N | 9 | I | modulator quadrature negative input |
| MODQ_P | 10 | I | modulator quadrature positive input |
| RFGND | 11 | G | RF ground |
| RFGND | 12 | G | RF ground |
| i.c. | 13 | - | internally connected; to be tied to ground |
| RFGND | 14 | G | RF ground |
| i.c. | 15 | - | internally connected; to be tied to ground |
| RFOUT | 16 | O | modulator single-ended RF output[2] |
| RFGND | 17 | G | RF ground |
| $V_{CC\_RF(5V0)}$ | 18 | P | RF analog power supply 5 V |
| i.c. | 19 | - | internally connected; to be tied to ground |
| RFGND | 20 | G | RF ground |
| MODI_P | 21 | I | modulator in-phase positive input |
| MODI_N | 22 | I | modulator in-phase negative input |

**Table 2. Pin description** *…continued*

| Symbol | Pin | Type[1] | Description |
|---|---|---|---|
| i.c. | 23 | - | internally connected; to be tied to ground |
| $V_{CC\_LO(5V0)}$ | 24 | P | LO analog power supply 5 V |
| Exposed die pad | - | G | exposed die pad; must be connected to RF ground |

[1] G = ground; I = input; O = output; P = power.

[2] AC coupling required as shown in Figure 4 “Typical wideband application diagram”.

# 8. Functional description

## 8.1 General

Each IQ baseband input has a 100 Ω differential input impedance allowing straightforward matching, from the DAC output through the baseband filter. The device allows operation with IQ input common-mode voltages between 0.25 V and 3.3 V allowing direct connection to a broad family of DACs. The LO and RF ports provide broadband 50 Ω termination to RF source and loads.

The chip can be placed in inactive mode (see Section 8.2 “Shutdown control”).

## 8.2 Shutdown control

**Table 3. Shutdown control**

| Mode | Mode description | Functional description | POFF_P |
|---|---|---|---|
| Idle | modulator fully off; minimal supply current | shutdown enabled | > 1.5 V |
| Active | modulator active mode | shutdown disabled | < 0.5 V |

The modulator can be placed into inactive mode by the voltage level at power-up disable pin (pin 1, POFF_P). The time required to pass between active and low-current states is less than 1 μs.

The shutdown feature of IQ modulator during switching does not induce any unlock of the LO synthesizer in base station application thanks to the low impedance variation of the LO input.

The graph (see Figure 3) describes the impact on LO impedance variation during the switching time.

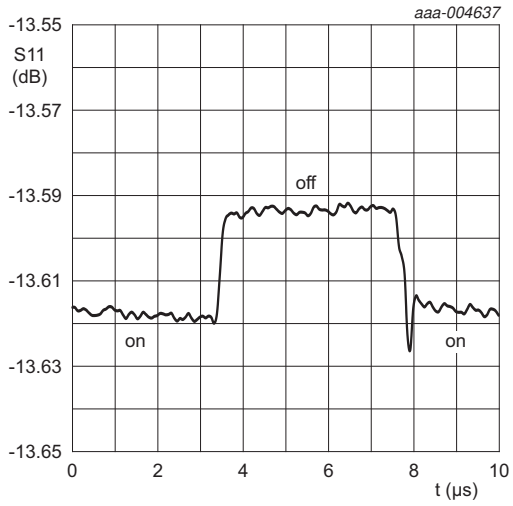



**Fig 3. LO input return loss variation (S11_LO)**

# 9. Limiting values

**Table 4. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | - | 5.5 | V |
| $P_{i(lo)}$ | local oscillator input power | | - | 16 | dBm |
| $P_{o(RF)}$ | RF output power | | - | 20 | dBm |
| $T_{mb}$ | mounting base temperature | | –40 | +85 | °C |
| $T_j$ | junction temperature | | - | +150 | °C |
| $T_{stg}$ | storage temperature | | –65 | +150 | °C |
| $V_{ESD}$ | electrostatic discharge voltage | EIA/JESD22-A114 (HBM) | –2500 | +2500 | V |
| | | EIA/JESD22-C101 (FCDM) | –650 | +650 | V |

**Table 4. Limiting values** *…continued*

*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| **Pin POFF_P** | | | | | |
| $V_i$ | input voltage | active HIGH logic input to power-down modulator | - | 3.5 | V |
| **Pins MODI_N, MODI_P, MODQ_N and MODQ_P** | | | | | |
| $V_i$ | input voltage | | 0 | 5 | V |
| $V_{ID}$ | differential input voltage | DC | −1 | +1 | V |

## 10. Thermal characteristics

**Table 5. Thermal characteristics**

| Symbol | Parameter | Conditions | Typ | Unit |
|---|---|---|---|---|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | | 10 | K/W |

## 11. Characteristics

**Table 6. Characteristics**

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | | 4.75 | 5 | 5.25 | V |
| $I_{CC(tot)}$ | total supply current | modulator in active mode | | | | | |
| | | $f_{lo}$ = 900 MHz | | - | 172 | - | mA |
| | | $f_{lo}$ = 2 GHz | | - | 180 | - | mA |
| | | $f_{lo}$ = 2.5 GHz | | - | 182 | - | mA |
| | | $f_{lo}$ = 3.5 GHz | | - | 188 | - | mA |
| | | modulator in inactive mode; $T_{mb}$ = 25 °C | | - | 6 | - | mA |
| $f_{lo}$ | local oscillator frequency | | [1] | 400 | - | 4000 | MHz |
| $P_{i(lo)}$ | local oscillator input power | | [1] | −9 | 0 | +6 | dBm |
| **Pins MODI_x and MODQ_x**[2] | | | | | | | |
| $V_{i(cm)}$ | common-mode input voltage | | | 0.25 | - | 3.3 | V |
| S22_RF | RF output return loss | | | - | 10 | - | dB |
| S11_LO | LO input return loss | | | - | 12 | - | dB |
| **MODI and MODQ**[3] | | | | | | | |
| $BW_{mod}$ | modulation bandwidth | gain fall off < 1 dB; $R_S$ = 50 Ω | | - | 650 | - | MHz |
| $R_{i(dif)}$ | differential input resistance | | | - | 100 | - | Ω |
| $C_{i(dif)}$ | differential input capacitance | | | - | 1.8 | - | pF |

[1] Operation outside this range is possible but parameters are not guaranteed.

[2] x = N or P.

[3] MODI = MODI_P − MODI_N and MODQ = MODQ_P − MODQ_N.

**Table 7. Characteristics at 750 MHz**

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $P_o$ | output power | 1 V (p-p) differential on MODI and MODQ[1] | | - | 4 | - | dBm |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | | - | 12 | - | dBm |
| $IP3_o$ | output third-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | | - | 28 | - | dBm |
| $IP2_o$ | output second-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | | - | 71 | - | dBm |
| $N_{flr(o)}$ | output noise floor | no modulation present | | - | −159 | - | dBm/Hz |
| | | modulation at MODI and MODQ[1]; $P_{o(RF)}$ = −10 dBm | | - | −158.5 | - | dBm/Hz |
| SBS | sideband suppression | unadjusted | | - | 63 | - | dBc |
| CF | carrier feedthrough | unadjusted | | - | −51 | - | dBm |
| $\alpha_{HD(bb)}$ | baseband harmonic distortion level | harmonic distortion at $f_{LO}$ + 2 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 76 | - | dBc |
| | | harmonic distortion at $f_{LO}$ + 3 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 89 | - | dBc |

[1] MODI = MODI_P − MODI_N and MODQ = MODQ_P − MODQ_N.

[2] Measurements done in supradyne mode.

**Table 8. Characteristics at 910 MHz**

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $P_o$ | output power | 1 V (p-p) differential on MODI and MODQ[1] | - | 4 | - | dBm |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | - | 12 | - | dBm |
| $IP3_o$ | output third-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | - | 28 | - | dBm |
| $IP2_o$ | output second-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | - | 75 | - | dBm |

**Table 8. Characteristics at 910 MHz** *…continued*

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $N_{flr(o)}$ | output noise floor | no modulation present | | - | −159 | - | dBm/Hz |
| | | modulation at MODI and MODQ[1]; $P_{o(RF)}$ = −10 dBm | | - | −158.5 | - | dBm/Hz |
| SBS | sideband suppression | unadjusted | | - | 49 | - | dBc |
| CF | carrier feedthrough | unadjusted | | - | −57 | - | dBm |
| $\alpha_{HD(bb)}$ | baseband harmonic distortion level | harmonic distortion at $f_{LO}$ + 2 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 77 | - | dBc |
| | | harmonic distortion at $f_{LO}$ + 3 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 92 | - | dBc |

[1] MODI = MODI_P − MODI_N and MODQ = MODQ_P − MODQ_N.

[2] Measurements done in supradyne mode.

**Table 9. Characteristics at 1.840 GHz**

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $P_o$ | output power | 1 V (p-p) differential on MODI and MODQ[1] | | - | 4 | - | dBm |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | | - | 12 | - | dBm |
| $IP3_o$ | output third-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | | - | 27 | - | dBm |
| $IP2_o$ | output second-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | | - | 71 | - | dBm |
| $N_{flr(o)}$ | output noise floor | no modulation present | | - | −158.5 | - | dBm/Hz |
| | | modulation at MODI and MODQ[1]; $P_{o(RF)}$ = −10 dBm | | - | −158 | - | dBm/Hz |
| SBS | sideband suppression | unadjusted | | - | 55 | - | dBc |
| CF | carrier feedthrough | unadjusted | | - | −50 | - | dBm |
| $\alpha_{HD(bb)}$ | baseband harmonic distortion level | harmonic distortion at $f_{LO}$ + 2 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 84 | - | dBc |
| | | harmonic distortion at $f_{LO}$ + 3 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 86 | - | dBc |

[1] MODI = MODI_P − MODI_N and MODQ = MODQ_P − MODQ_N.

[2] Measurements done in supradyne mode.

**Table 10. Characteristics at 1.960 GHz**

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $P_o$ | output power | 1 V (p-p) differential on MODI and MODQ[1] | | - | 4 | - | dBm |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | | - | 12 | - | dBm |
| $IP3_o$ | output third-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | | - | 27 | - | dBm |
| $IP2_o$ | output second-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | | - | 72 | - | dBm |
| $N_{flr(o)}$ | output noise floor | no modulation present | | - | −158.5 | - | dBm/Hz |
| | | modulation at MODI and MODQ[1]; $P_{o(RF)}$ = −10 dBm | | - | −158 | - | dBm/Hz |
| SBS | sideband suppression | unadjusted | | - | 57 | - | dBc |
| CF | carrier feedthrough | unadjusted | | - | −47 | - | dBm |
| $\alpha_{HD(bb)}$ | baseband harmonic distortion level | harmonic distortion at $f_{LO}$ + 2 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 72 | - | dBc |
| | | harmonic distortion at $f_{LO}$ + 3 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 86 | - | dBc |

[1] MODI = MODI_P − MODI_N and MODQ = MODQ_P − MODQ_N.

[2] Measurements done in supradyne mode.

**Table 11. Characteristics at 2.140 GHz**

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $P_o$ | output power | 1 V (p-p) differential on MODI and MODQ[1] | - | 4 | - | dBm |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | - | 12 | - | dBm |
| $IP3_o$ | output third-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | - | 27 | - | dBm |

**Table 11. Characteristics at 2.140 GHz** *…continued*

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $IP2_o$ | output second-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | | - | 75 | - | dBm |
| $N_{flr(o)}$ | output noise floor | no modulation present | | - | −158.5 | - | dBm/Hz |
| | | modulation at MODI and MODQ[1]; $P_{o(RF)}$ = −10 dBm | | - | −158 | - | dBm/Hz |
| SBS | sideband suppression | unadjusted | | - | 63 | - | dBc |
| CF | carrier feedthrough | unadjusted | | - | −45 | - | dBm |
| $\alpha_{HD(bb)}$ | baseband harmonic distortion level | harmonic distortion at $f_{LO}$ + 2 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 68 | - | dBc |
| | | harmonic distortion at $f_{LO}$ + 3 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 86 | - | dBc |

[1] MODI = MODI_P − MODI_N and MODQ = MODQ_P − MODQ_N.

[2] Measurements done in supradyne mode.

**Table 12. Characteristics at 2.650 GHz**

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $P_o$ | output power | 1 V (p-p) differential on MODI and MODQ[1] | - | 4 | - | dBm |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | - | 12 | - | dBm |
| $IP3_o$ | output third-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | - | 26 | - | dBm |
| $IP2_o$ | output second-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | - | 65 | - | dBm |
| $N_{flr(o)}$ | output noise floor | no modulation present | - | −158.5 | - | dBm/Hz |
| | | modulation at MODI and MODQ[1]; $P_{o(RF)}$ = −10 dBm | - | −158 | - | dBm/Hz |
| SBS | sideband suppression | unadjusted | - | 50 | - | dBc |

**Table 12. Characteristics at 2.650 GHz** *…continued*

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| CF | carrier feedthrough | unadjusted | | - | −45 | - | dBm |
| $\alpha_{HD(bb)}$ | baseband harmonic distortion level | harmonic distortion at $f_{LO}$ + 2 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 65 | - | dBc |
| | | harmonic distortion at $f_{LO}$ + 3 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 88 | - | dBc |

[1] MODI = MODI_P − MODI_N and MODQ = MODQ_P − MODQ_N.

[2] Measurements done in supradyne mode.

**Table 13. Characteristics at 3.650 GHz**

*Modulation source resistance per pin = 50 Ω; POFF_P connected to GND (shutdown disabled); $V_{CC}$ = 5 V; $T_{mb}$ range = −40 °C to +85 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz unless otherwise stated.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $P_o$ | output power | 1 V (p-p) differential on MODI and MODQ[1] | | - | 4 | - | dBm |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | | - | 12 | - | dBm |
| $IP3_o$ | output third-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | | - | 25 | - | dBm |
| $IP2_o$ | output second-order intercept point | IQ frequency 1 = 4.5 MHz; IQ frequency 2 = 5.5 MHz; output power per tone = −10 dBm | | - | 64 | - | dBm |
| $N_{flr(o)}$ | output noise floor | no modulation present | | - | −158 | - | dBm/Hz |
| | | modulation at MODI and MODQ[1]; $P_{o(RF)}$ = −10 dBm | | - | −158 | - | dBm/Hz |
| SBS | sideband suppression | unadjusted | | - | 57 | - | dBc |
| CF | carrier feedthrough | unadjusted | | - | −42 | - | dBm |
| $\alpha_{HD(bb)}$ | baseband harmonic distortion level | harmonic distortion at $f_{LO}$ + 2 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 64 | - | dBc |
| | | harmonic distortion at $f_{LO}$ + 3 × baseband frequency measured with 1 MHz tone at 1 V (p-p) differential | [2] | - | 80 | - | dBc |

[1] MODI = MODI_P − MODI_N and MODQ = MODQ_P − MODQ_N.

[2] Measurements done in supradyne mode.

# 12. Application information

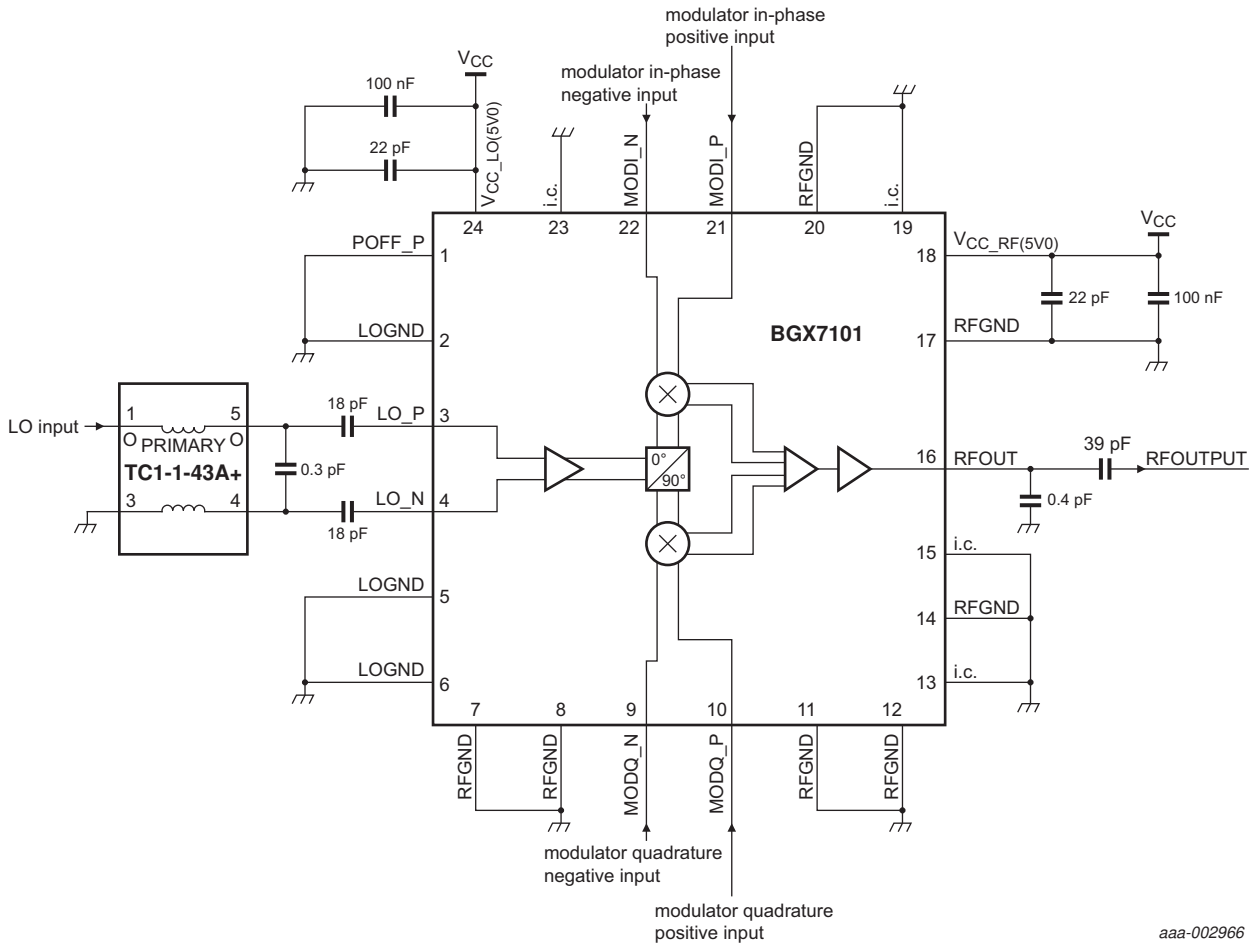



**Fig 4. Typical wideband application diagram**

Figure 4 shows a typical wideband (from 0.4 GHz to 4 GHz) application circuit. Refer to the application note for narrowband optimum component values.

## 12.1 External DAC interfacing

Nominal DAC single-ended output currents are between 0 mA to 20 mA. When driving into 25 Ω impedance, this creates 250 mV peak-single signal (1 V (p-p) differential). Half of the impedance is placed at the DAC outputs as 50 Ω load resistors, the other half is provided by the modulator itself. In this way, the differential filter can be properly terminated by 100 Ω at both ends.

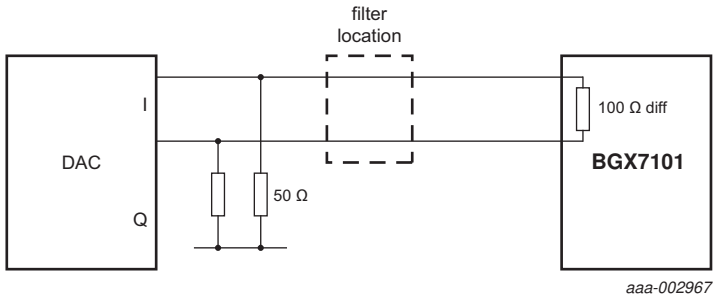


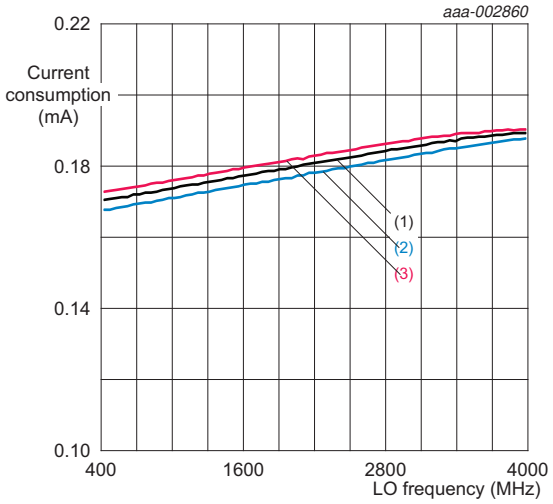

**Fig 5. Typical interface**

## 12.2 RF

Good RF port matching typically requires some reactive components to tune-out residual inductance or capacitance. As the LO inputs and RF output are internally DC biased, both pins need a series AC-coupling capacitor.

## 13. Test information

Parameters for the following drawings: $V_{CC}$ = 5 V; $T_{mb}$ = 25 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz; IQ amplitude = 0.42 V (p-p) differential sine wave; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.



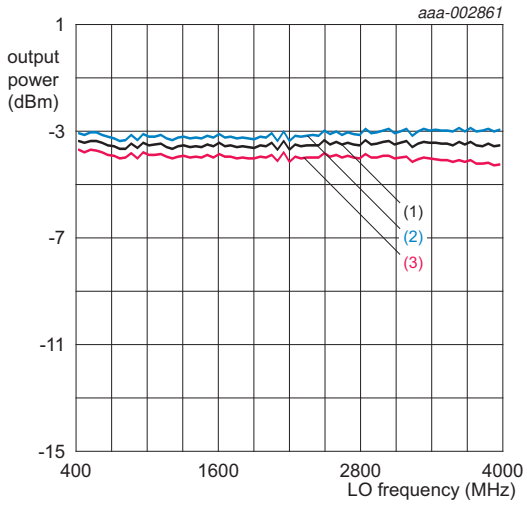

(1) $T_{mb}$ = +25 °C.

(2) $T_{mb}$ = −40 °C.

(3) $T_{mb}$ = +85 °C.

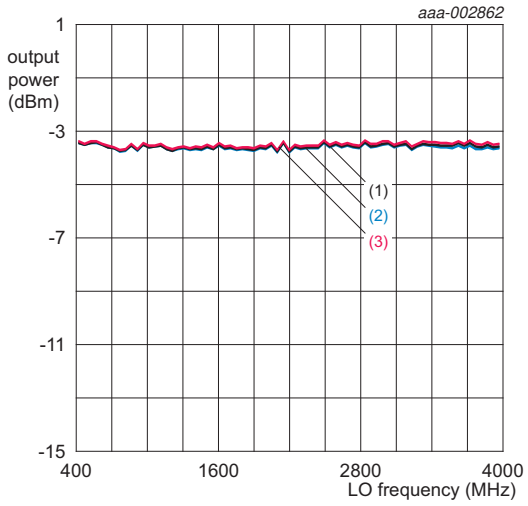
**Fig 6. Current consumption versus $f_{lo}$ and $T_{mb}$**

Parameters for the five following drawings: $V_{CC}$ = 5 V; $T_{mb}$ = 25 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz; IQ amplitude = 0.42 V (p-p) differential sine wave; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.



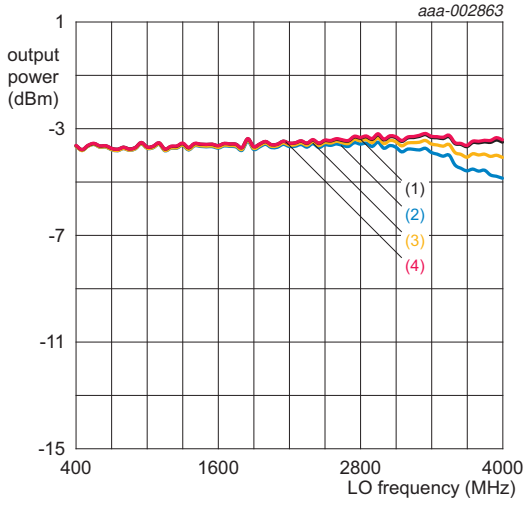

(1) $T_{mb}$ = +25 °C.
(2) $T_{mb}$ = −40 °C.
(3) $T_{mb}$ = +85 °C.

**Fig 7. $P_o$ versus $f_{lo}$ and $T_{mb}$**



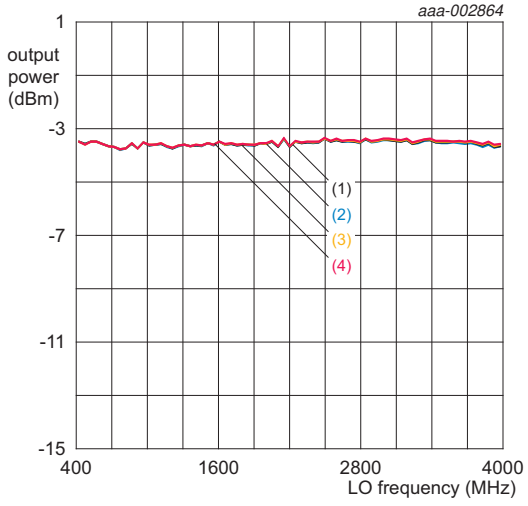

(1) $V_{CC}$ = 5 V.
(2) $V_{CC}$ = 4.75 V.
(3) $V_{CC}$ = 5.25 V

**Fig 8. $P_o$ versus $f_{lo}$ and $V_{CC}$**



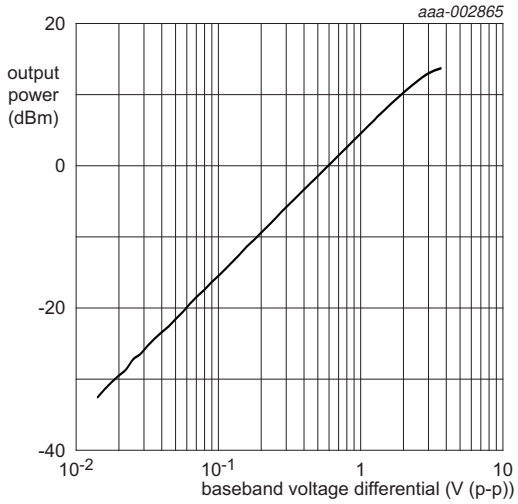

(1) $P_{i(lo)}$ = 0 dBm.
(2) $P_{i(lo)}$ = −9 dBm.
(3) $P_{i(lo)}$ = −6 dBm.
(4) $P_{i(lo)}$ = +6 dBm.

**Fig 9. $P_o$ versus $f_{lo}$ and $P_{i(lo)}$**




(1) $V_{i(cm)}$ = 0.5 V.
(2) $V_{i(cm)}$ = 0.25 V.
(3) $V_{i(cm)}$ = 1.5 V.
(4) $V_{i(cm)}$ = 2.5 V.

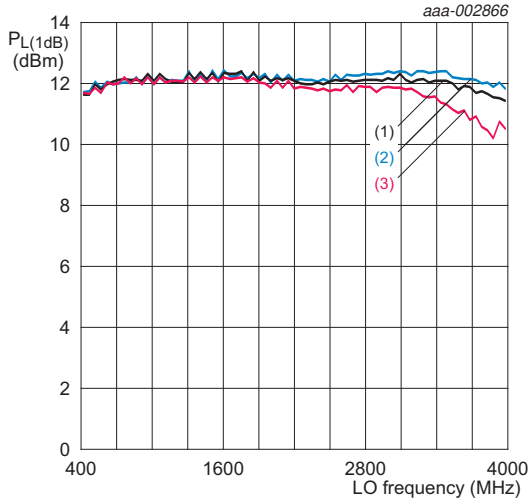
**Fig 10. $P_o$ versus $f_{lo}$ and $V_{i(cm)}$**




(1) $f_{lo}$ = 2140 MHz.

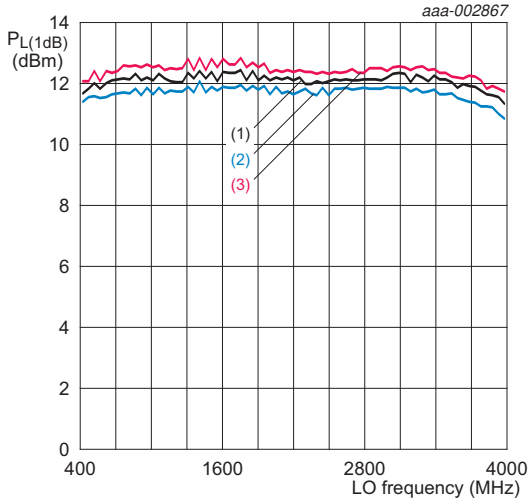
**Fig 11. $P_o$ versus baseband voltage at 2140 MHz**

Parameters for the four following drawings: $V_{CC}$ = 5 V; $T_{mb}$ = 25 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz; IQ amplitude = 0.42 V (p-p) differential sine wave; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.



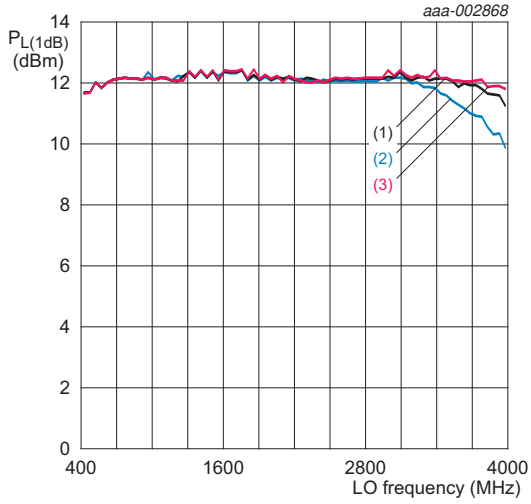

(1) $T_{mb}$ = +25 °C.
(2) $T_{mb}$ = −40 °C.
(3) $T_{mb}$ = +85 °C.

**Fig 12. $P_{L(1dB)}$ versus $f_{lo}$ and $T_{mb}$**



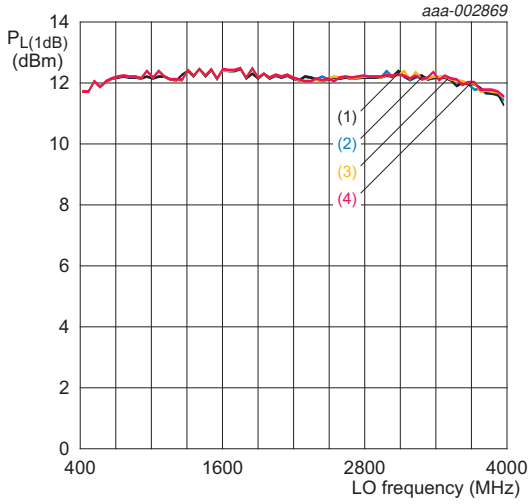

(1) $V_{CC}$ = 5 V.
(2) $V_{CC}$ = 4.75 V.
(3) $V_{CC}$ = 5.25 V.

**Fig 13. $P_{L(1dB)}$ versus $f_{lo}$ and $V_{CC}$**




(1) $P_{i(lo)}$ = 0 dBm.
(2) $P_{i(lo)}$ = −3 dBm.
(3) $P_{i(lo)}$ = +3 dBm.

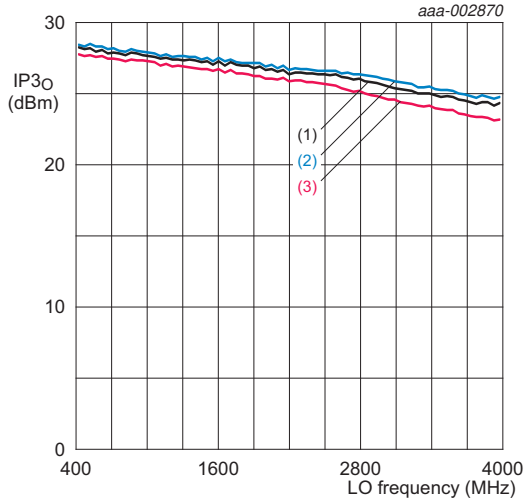
**Fig 14. $P_{L(1dB)}$ versus $f_{lo}$ and $P_{i(lo)}$**




(1) $V_{i(cm)}$ = 0.5 V.
(2) $V_{i(cm)}$ = 0.25 V.
(3) $V_{i(cm)}$ = 1.5 V.
(4) $V_{i(cm)}$ = 2.5 V.

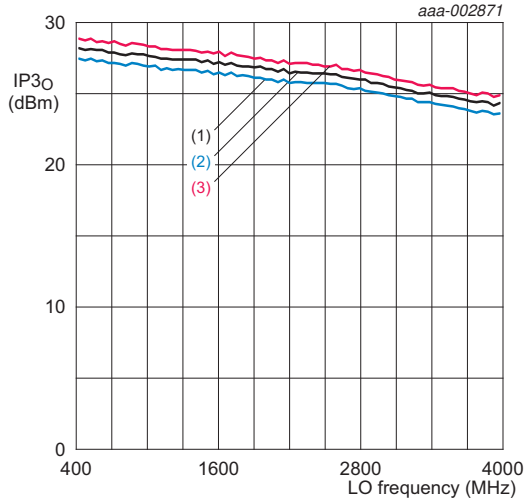
**Fig 15. $P_{L(1dB)}$ versus $f_{lo}$ and $V_{i(cm)}$**

Parameters for the four following drawings: $V_{CC}$ = 5 V; $T_{mb}$ = 25 °C; $P_{i(lo)}$ = 0 dBm; two tones; tone 1: IQ frequency = 4.5 MHz and tone 2: IQ frequency = 5.5 MHz; $P_o$ per tone = −10 dBm; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.



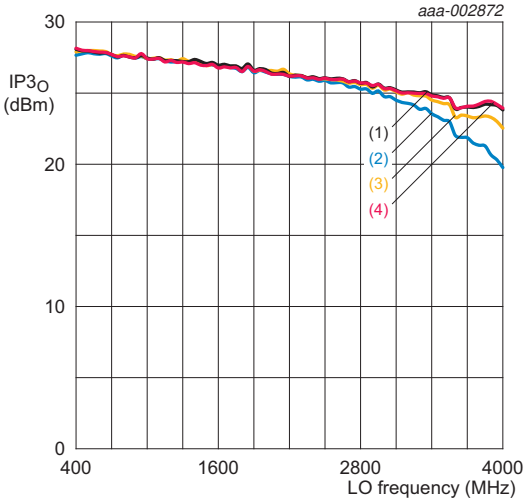

(1) $T_{mb}$ = +25 °C.
(2) $T_{mb}$ = −40 °C.
(3) $T_{mb}$ = +85 °C.

**Fig 16. $IP3_o$ versus $f_{lo}$ and $T_{mb}$**



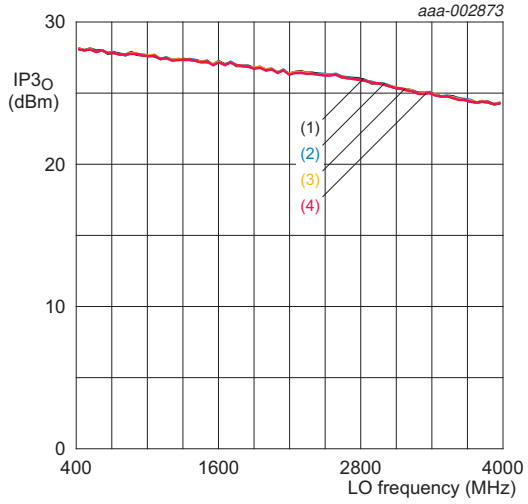

(1) $V_{CC}$ = 5 V.
(2) $V_{CC}$ = 4.75 V.
(3) $V_{CC}$ = 5.25 V.

**Fig 17. $IP3_o$ versus $f_{lo}$ and $V_{CC}$**




(1) $P_{i(lo)}$ = 0 dBm.
(2) $P_{i(lo)}$ = −9 dBm.
(3) $P_{i(lo)}$ = −6 dBm.
(4) $P_{i(lo)}$ = +6 dBm.

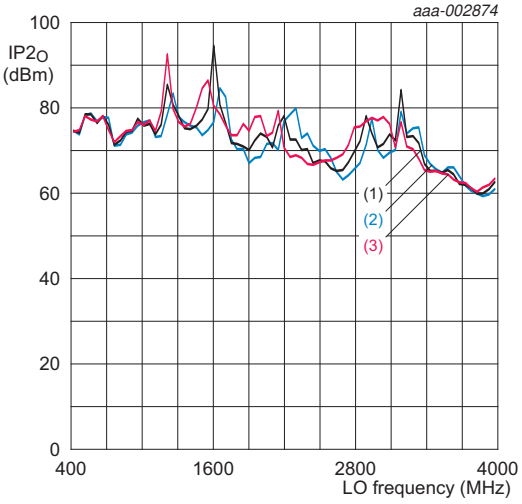
**Fig 18. $IP3_o$ versus $f_{lo}$ and $P_{i(lo)}$**




(1) $V_{i(cm)}$ = 0.5 V.
(2) $V_{i(cm)}$ = 0.25 V.
(3) $V_{i(cm)}$ = 1.5 V.
(4) $V_{i(cm)}$ = 2.5 V.

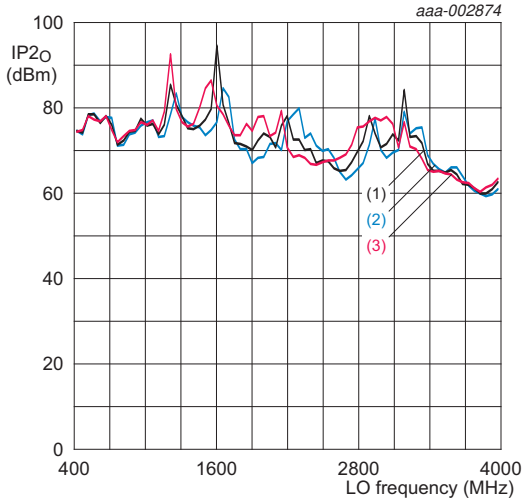
**Fig 19. $IP3_o$ versus $f_{lo}$ and $V_{i(cm)}$**

Parameters for the four following drawings: $V_{CC}$ = 5 V; $T_{mb}$ = 25 °C; $P_{i(lo)}$ = 0 dBm; two tones; tone 1: IQ frequency = 4.5 MHz and tone 2: IQ frequency = 5.5 MHz; $P_o$ per tone = −10 dBm; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.



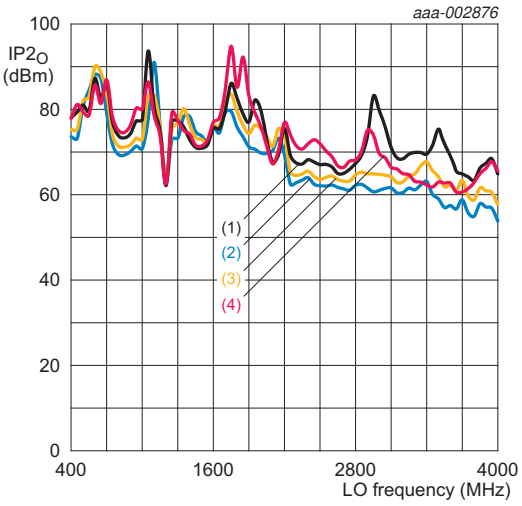

(1) $T_{mb}$ = +25 °C.
(2) $T_{mb}$ = −40 °C.
(3) $T_{mb}$ = +85 °C.

**Fig 20. $IP2_o$ versus $f_{lo}$ and $T_{mb}$**



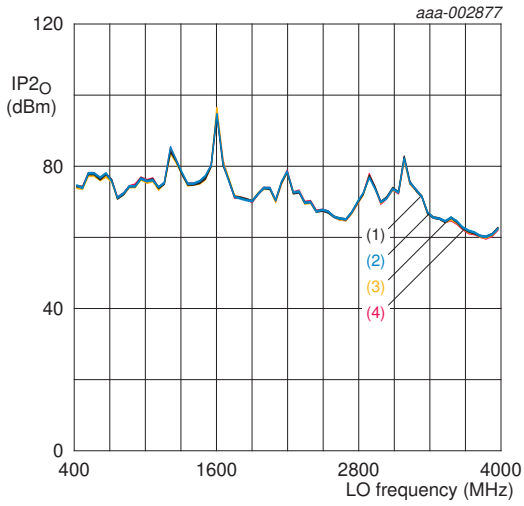

(1) $V_{CC}$ = 5 V.
(2) $V_{CC}$ = 4.75 V.
(3) $V_{CC}$ = 5.25 V.

**Fig 21. $IP2_o$ versus $f_{lo}$ and $V_{CC}$**




(1) $P_{i(lo)}$ = 0 dBm.
(2) $P_{i(lo)}$ = −9 dBm.
(3) $P_{i(lo)}$ = −6 dBm.
(4) $P_{i(lo)}$ = +6 dBm.

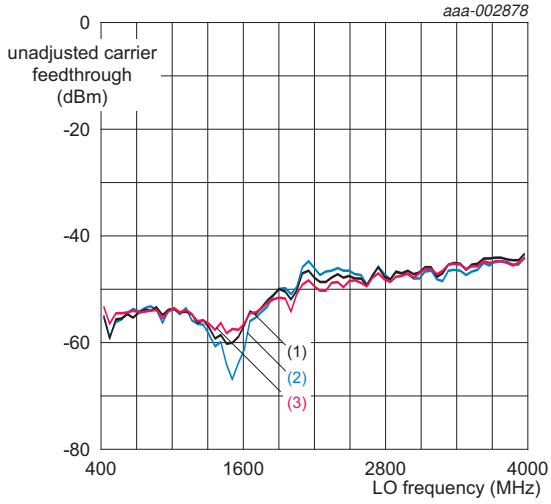
**Fig 22. $IP2_o$ versus $f_{lo}$ and $P_{i(lo)}$**




(1) $V_{i(cm)}$ = 0.5 V.
(2) $V_{i(cm)}$ = 0.25 V.
(3) $V_{i(cm)}$ = 1.5 V.
(4) $V_{i(cm)}$ = 2.5 V.

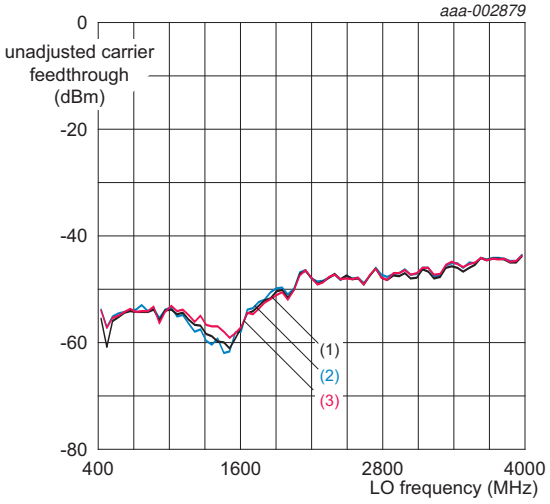
**Fig 23. $IP2_o$ versus $f_{lo}$ and $V_{i(cm)}$**

Parameters for the five following drawings: $V_{CC}$ = 5 V; $T_{mb}$ = 25 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz; IQ amplitude = 0.42 V (p-p) differential sine wave; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.



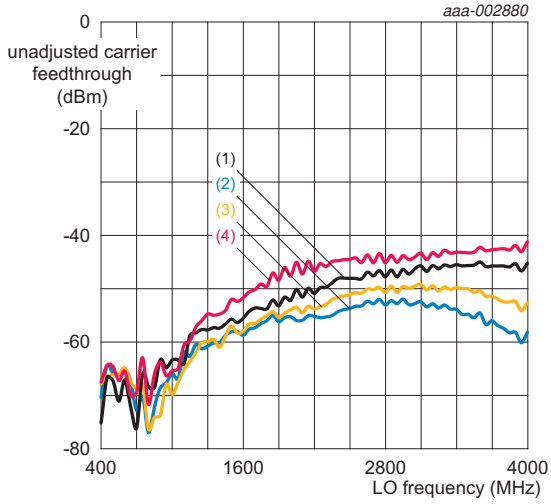

(1) $T_{mb}$ = +25 °C.
(2) $T_{mb}$ = −40 °C.
(3) $T_{mb}$ = +85 °C.

**Fig 24. Unadjusted CF versus $f_{lo}$ and $T_{mb}$**



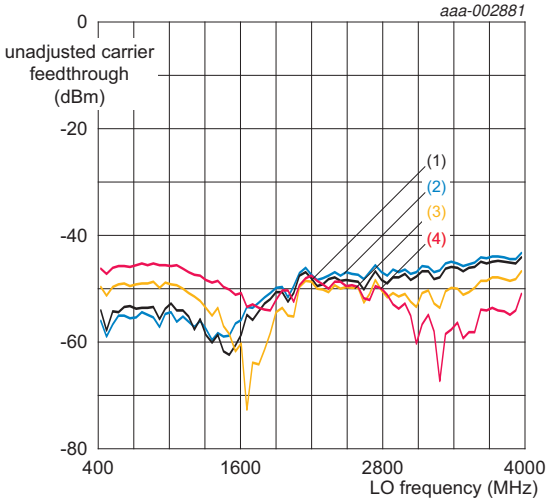

(1) $V_{CC}$ = 5 V.
(2) $V_{CC}$ = 4.75 V.
(3) $V_{CC}$ = 5.25 V.

**Fig 25. Unadjusted CF versus $f_{lo}$ and $V_{CC}$**



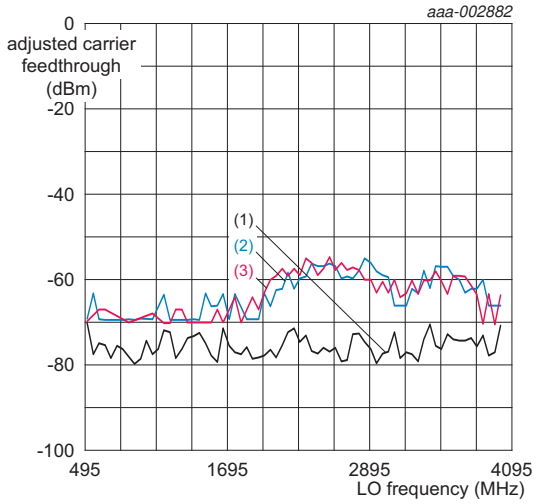

(1) $P_{i(lo)}$ = 0 dBm.
(2) $P_{i(lo)}$ = −9 dBm.
(3) $P_{i(lo)}$ = −6 dBm.
(4) $P_{i(lo)}$ = +6 dBm.

**Fig 26. Unadjusted CF versus $f_{lo}$ and $P_{i(lo)}$**




(1) $V_{i(cm)}$ = 0.5 V.
(2) $V_{i(cm)}$ = 0.25 V.
(3) $V_{i(cm)}$ = 1.5 V.
(4) $V_{i(cm)}$ = 2.5 V.

**Fig 27. Unadjusted CF versus $f_{lo}$ and $V_{i(cm)}$**



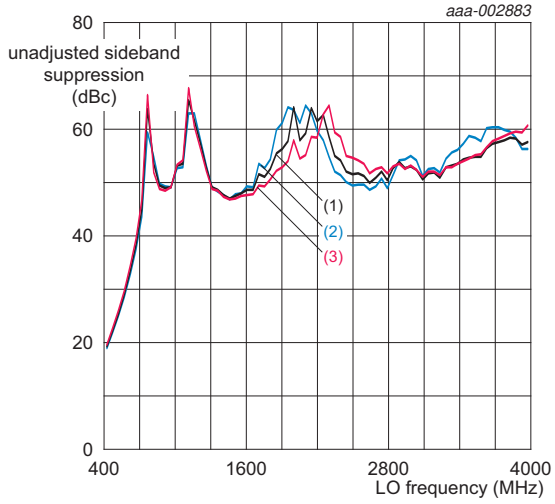

(1) $T_{mb}$ = +25 °C.

(2) $T_{mb}$ = −40 °C.

(3) $T_{mb}$ = +85 °C.

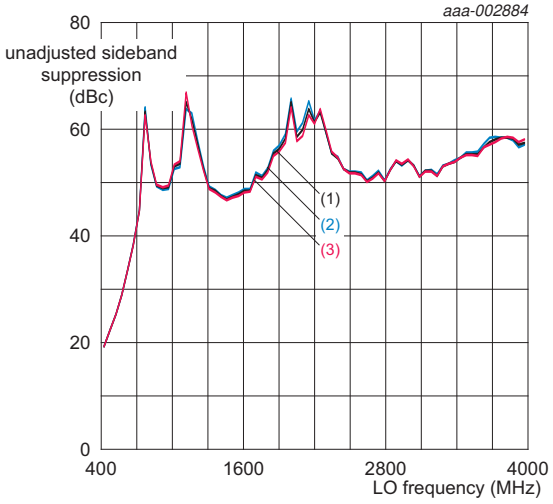
**Fig 28. Adjusted CF versus $f_{lo}$ and $T_{mb}$ after nulling at 25 °C**

Parameters for the five following drawings: $V_{CC}$ = 5 V; $T_{mb}$ = 25 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz; IQ amplitude = 0.42 V (p-p) differential sine wave; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.



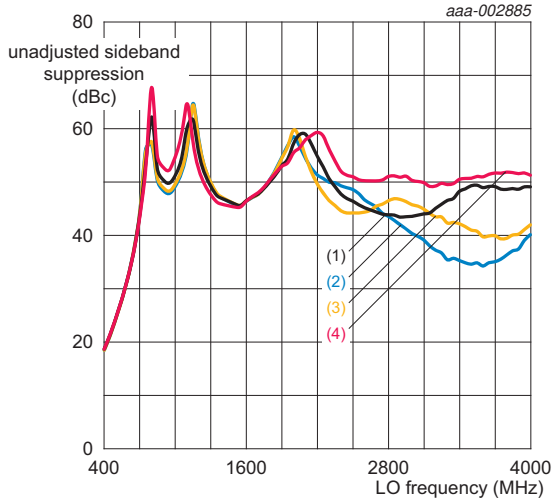

(1) $T_{mb}$ = +25 °C.
(2) $T_{mb}$ = −40 °C.
(3) $T_{mb}$ = +85 °C.

**Fig 29. Unadjusted SBS versus $f_{lo}$ and $T_{mb}$**



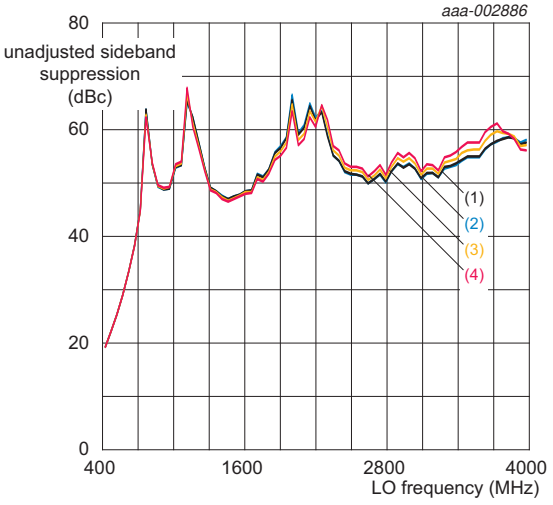

(1) $V_{CC}$ = 5 V.
(2) $V_{CC}$ = 4.75 V.
(3) $V_{CC}$ = 5.25 V.

**Fig 30. Unadjusted SBS versus $f_{lo}$ and $V_{CC}$**



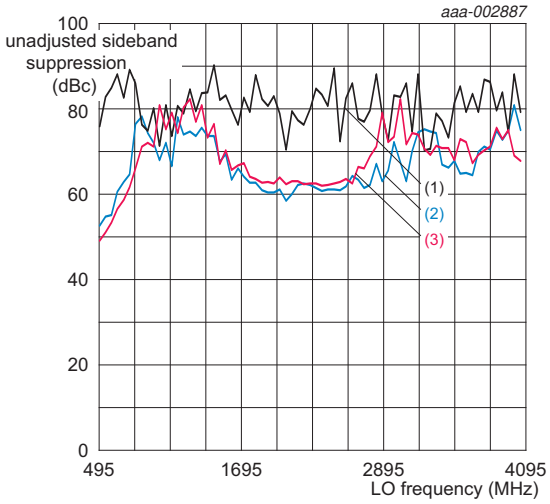

(1) $P_{i(lo)}$ = 0 dBm.
(2) $P_{i(lo)}$ = −9 dBm.
(3) $P_{i(lo)}$ = −6 dBm.
(4) $P_{i(lo)}$ = +6 dBm.

**Fig 31. Unadjusted SBS versus $f_{lo}$ and $P_{i(lo)}$**




(1) $V_{i(cm)}$ = 0.5 V.
(2) $V_{i(cm)}$ = 0.25 V.
(3) $V_{i(cm)}$ = 1.5 V.
(4) $V_{i(cm)}$ = 2.5 V.

**Fig 32. Unadjusted SBS versus $f_{lo}$ and $V_{i(cm)}$**



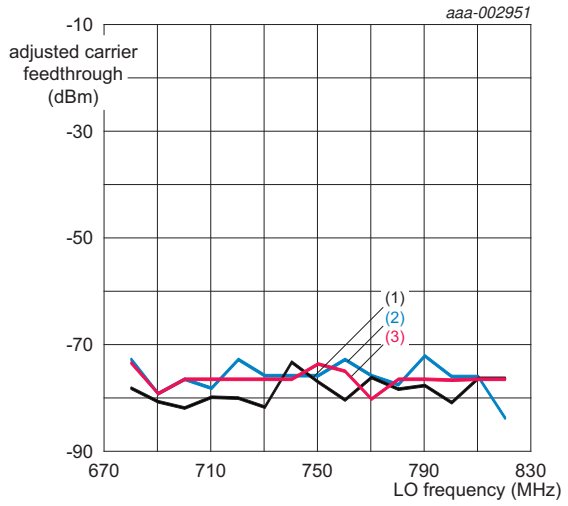

(1) $T_{mb}$ = +25 °C.

(2) $T_{mb}$ = −40 °C.

(3) $T_{mb}$ = +85 °C.

**Fig 33. Adjusted SBS versus $f_{lo}$ and $T_{mb}$ after nulling at 25 °C**

Parameters for the six following drawings: $V_{CC}$ = 5 V; $T_{mb}$ = 25 °C; LO = 0 dBm; IQ frequency = 5 MHz; IQ amplitude = 0.25 V (p-p) single-ended sine wave; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.



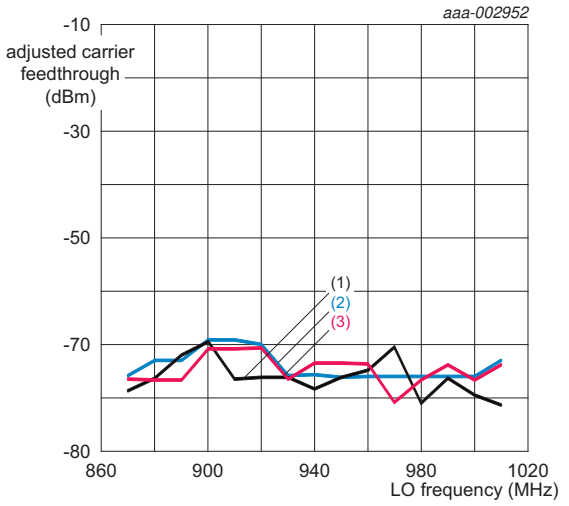

Adjusted at 750 MHz and after nulling $T_{mb}$ at 25 °C

(1) $T_{mb}$ = +25 °C.

(2) $T_{mb}$ = −40 °C.

(3) $T_{mb}$ = +85 °C.

**Fig 34. Adjusted CF versus $f_{lo}$ and $T_{mb}$ (750 LTE band)**



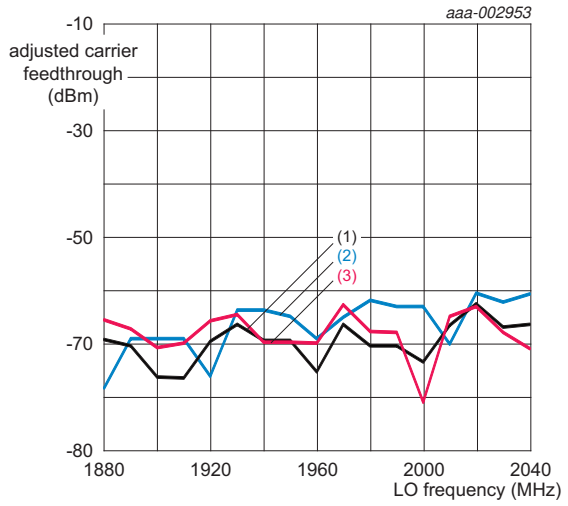

Adjusted at 942.5 MHz and after nulling $T_{mb}$ at 25 °C

(1) $T_{mb}$ = +25 °C.

(2) $T_{mb}$ = −40 °C.

(3) $T_{mb}$ = +85 °C.

**Fig 35. Adjusted CF versus $f_{lo}$ and $T_{mb}$ (GSM band)**



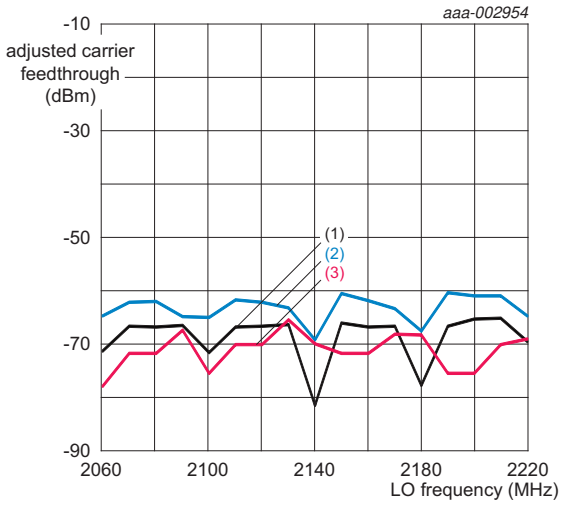

Adjusted at 1840 MHz and after nulling $T_{mb}$ at 25 °C

(1) $T_{mb}$ = +25 °C.

(2) $T_{mb}$ = −40 °C.

(3) $T_{mb}$ = +85 °C.

**Fig 36. Adjusted CF versus $f_{lo}$ and $T_{mb}$ (PCS band)**



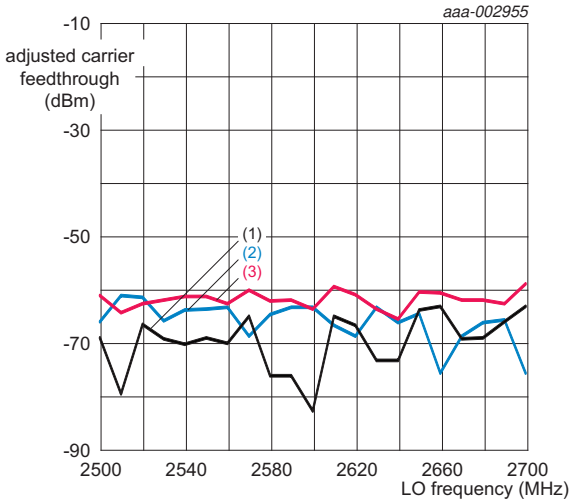

Adjusted at 2140 MHz and after nulling $T_{mb}$ at 25 °C

(1) $T_{mb}$ = +25 °C.

(2) $T_{mb}$ = −40 °C.

(3) $T_{mb}$ = +85 °C.

**Fig 37. Adjusted CF versus $f_{lo}$ and $T_{mb}$ (UMTS band)**



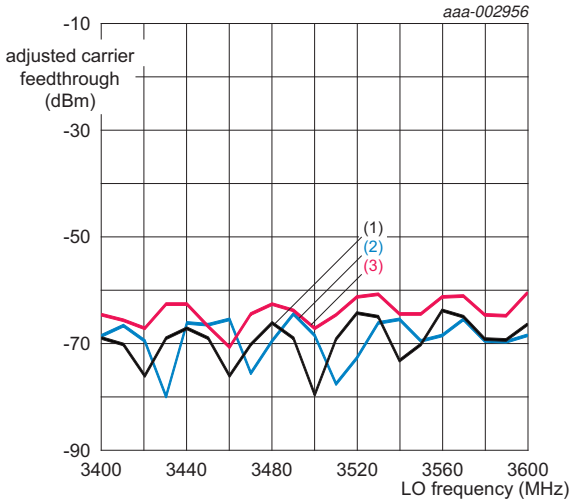

Adjusted at 2600 MHz and after nulling $T_{mb}$ at 25 °C

(1) $T_{mb}$ = +25 °C.

(2) $T_{mb}$ = −40 °C.

(3) $T_{mb}$ = +85 °C.

**Fig 38. Adjusted CF versus $f_{lo}$ and $T_{mb}$ (2.6 GHz LTE band)**




Adjusted at 3500 MHz and after nulling $T_{mb}$ at 25 °C

(1) $T_{mb}$ = +25 °C.

(2) $T_{mb}$ = −40 °C.

(3) $T_{mb}$ = +85 °C.

**Fig 39. Adjusted CF versus $f_{lo}$ and $T_{mb}$ (Wi MAX/LTE band)**