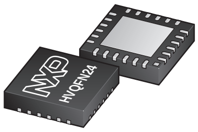

BGX7101

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

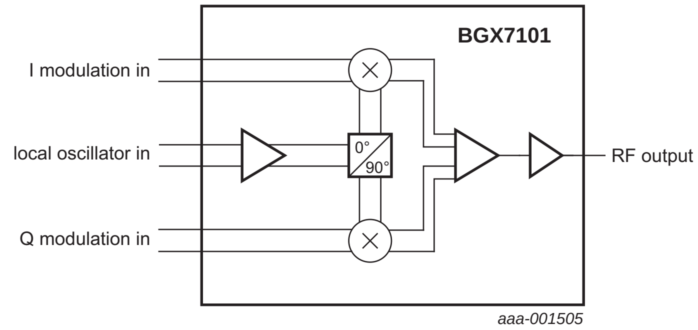

Fig 1. Functional block diagram

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”.

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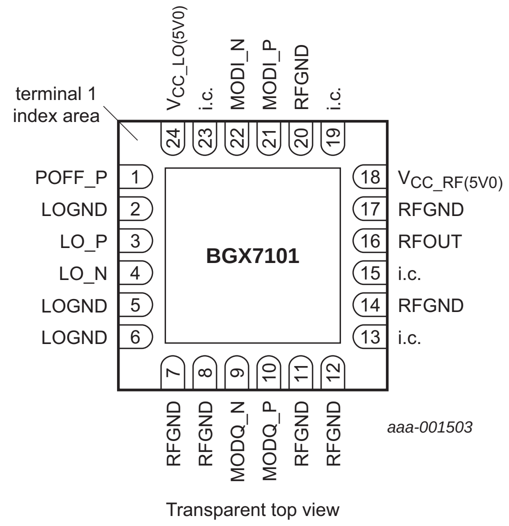

Fig 2. Pin configuration

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

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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.

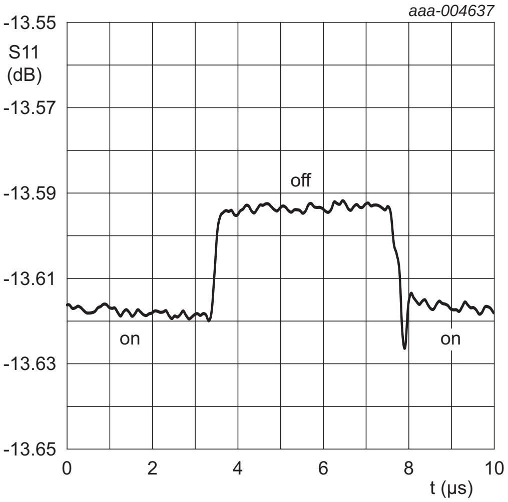

Fig 3. LO input return loss variation (S11_LO)

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

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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.

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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

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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

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[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

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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

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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.

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12. Application information

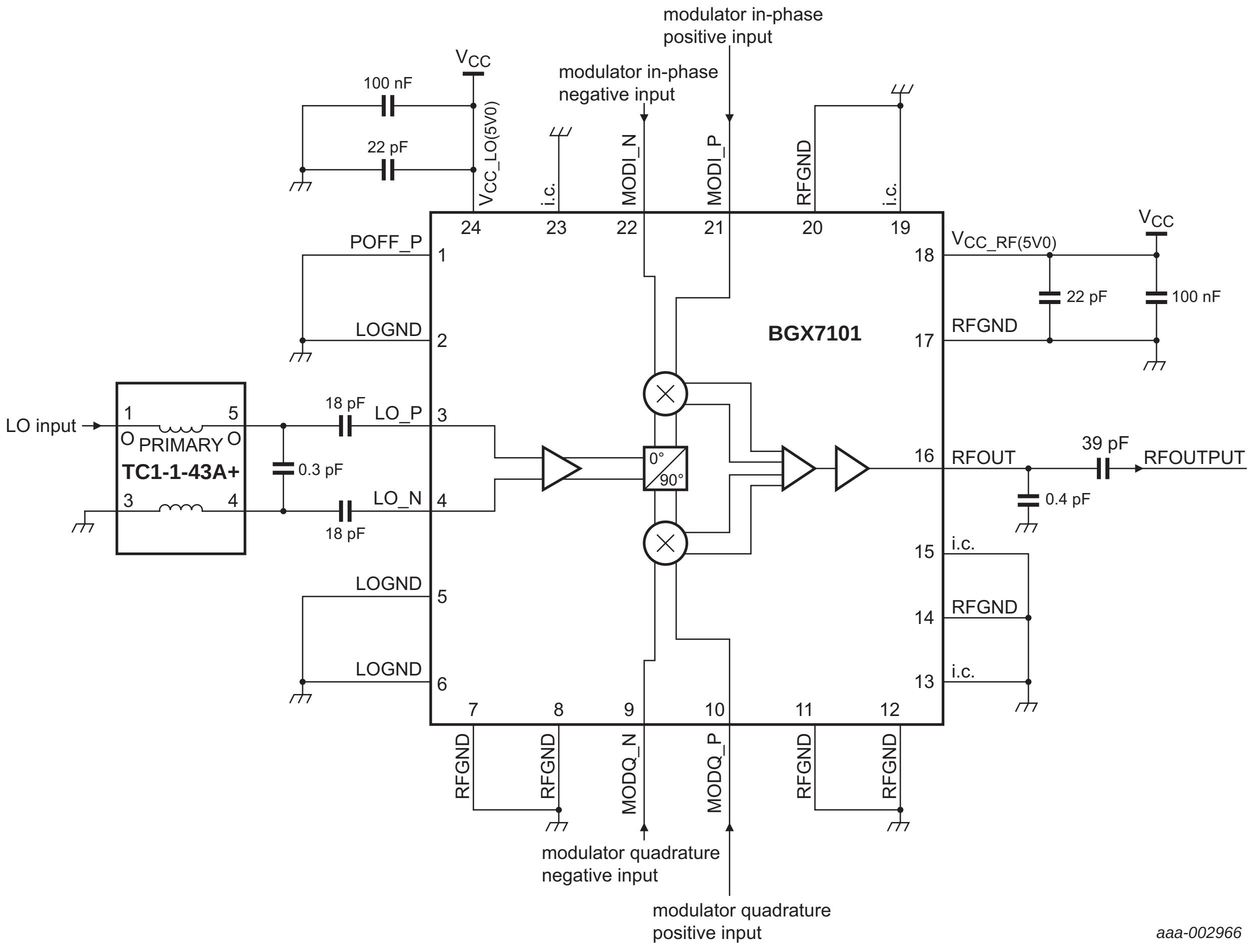


Fig 4. Typical wideband application diagram

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.

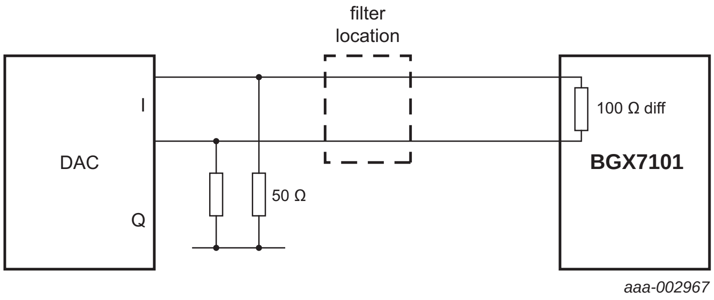


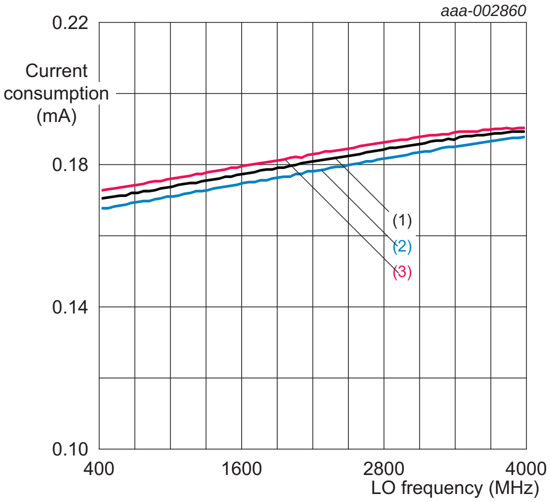
Fig 5. Typical interface

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.



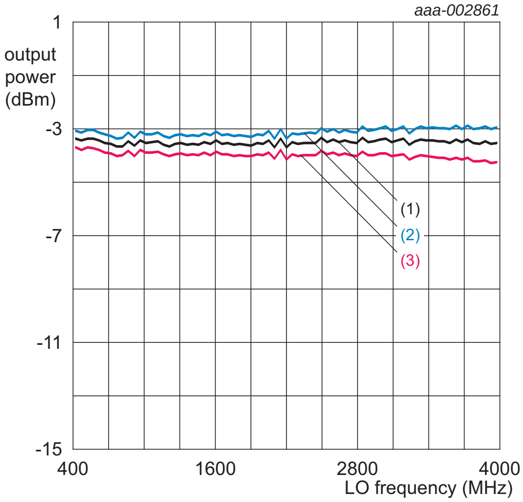
(1) T_{mb} = +25 °C.

(2) T_{mb} = −40 °C.

(3) T_{mb} = +85 °C.

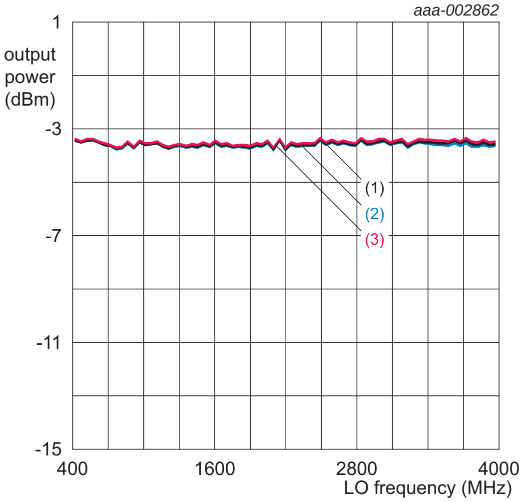
Fig 6. Current consumption versus f_{lo} and T_{mb}

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.



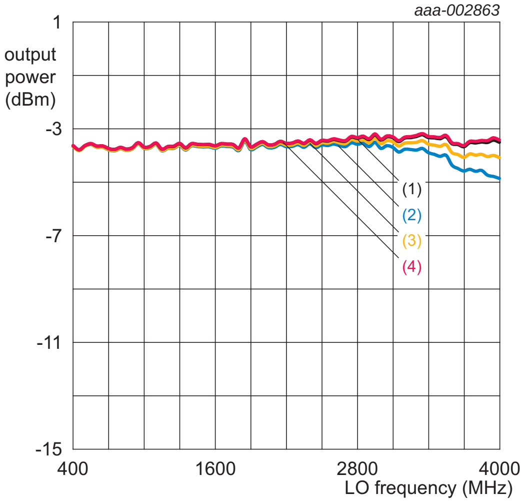
(1) T_{mb} = +25 °C.
(2) T_{mb} = −40 °C.
(3) T_{mb} = +85 °C.

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



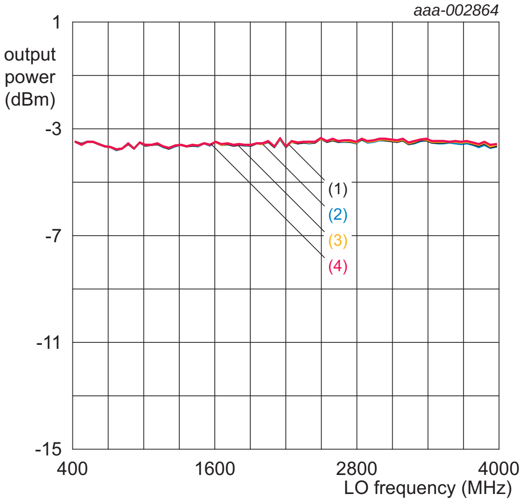
(1) V_{CC} = 5 V.
(2) V_{CC} = 4.75 V.
(3) V_{CC} = 5.25 V

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 $V_{i(cm)}$

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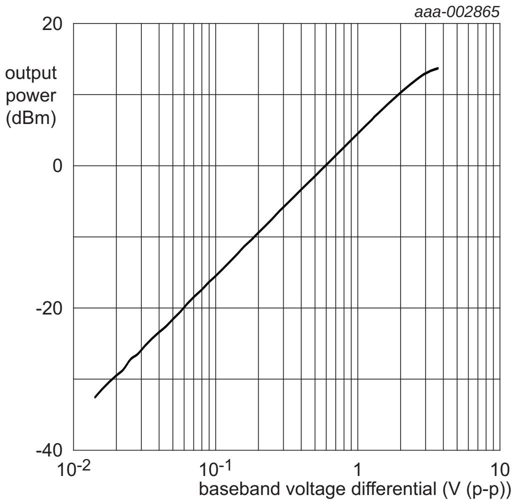

(1) f_{lo} = 2140 MHz.

Fig 11. P_o versus baseband voltage at 2140 MHz

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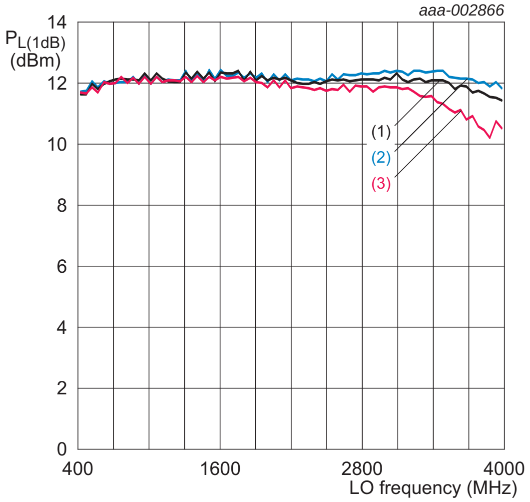
Parameters for the four following drawings: V_{CC} = 5 V; T_{mb} = 25 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz; IQ amplitude = 0.42 V (p-p) differential sine wave; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.

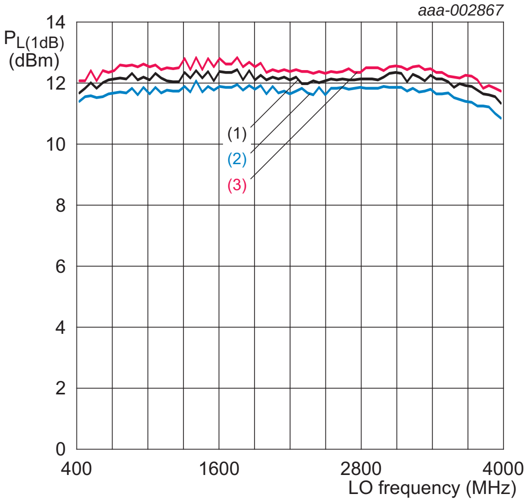


(1) T_{mb} = +25 °C.

(2) T_{mb} = −40 °C.

(3) T_{mb} = +85 °C.

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

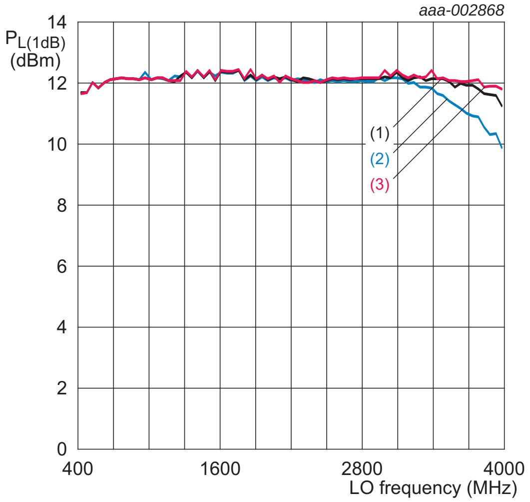


(1) V_{CC} = 5 V.

(2) V_{CC} = 4.75 V.

(3) V_{CC} = 5.25 V.

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

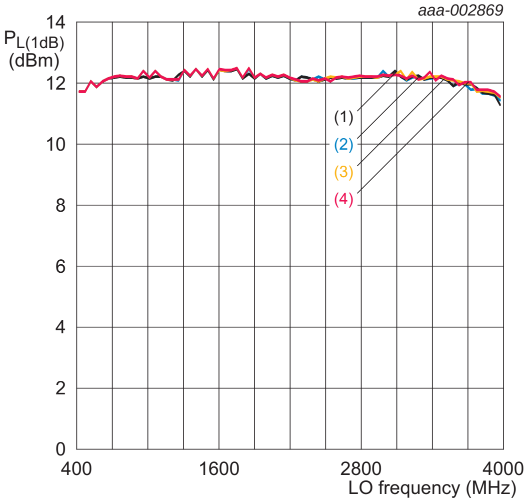


(1) $P_{i(lo)}$ = 0 dBm.

(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 $V_{i(cm)}$

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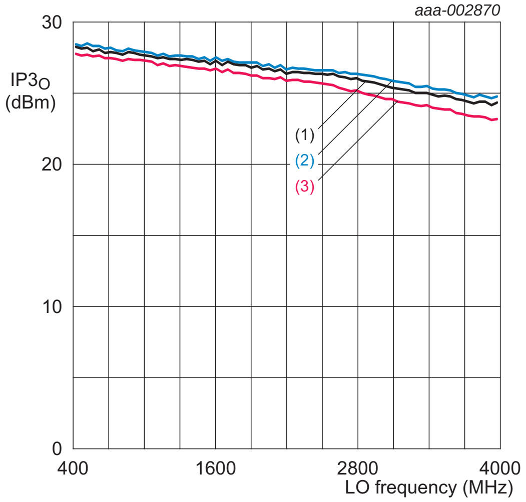
Parameters for the four following drawings: V_{CC} = 5 V; T_{mb} = 25 °C; $P_{i(lo)}$ = 0 dBm; two tones; tone 1: IQ frequency = 4.5 MHz and tone 2: IQ frequency = 5.5 MHz; P_o per tone = –10 dBm; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.

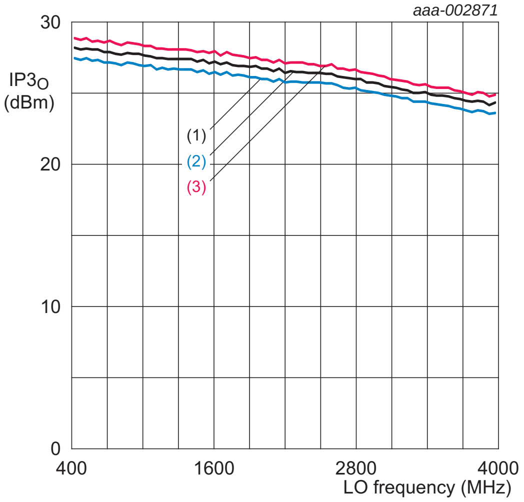


(1) T_{mb} = +25 °C.

(2) T_{mb} = –40 °C.

(3) T_{mb} = +85 °C.

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

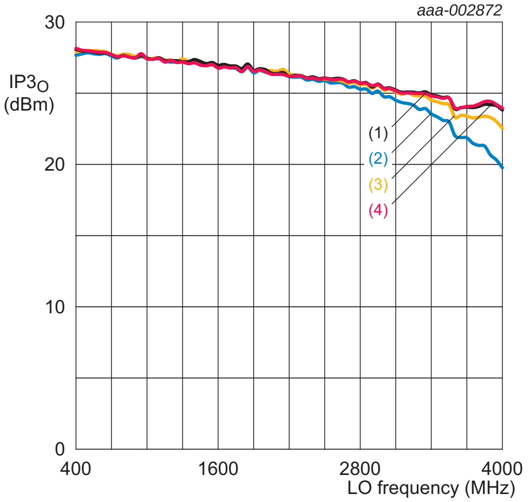


(1) V_{CC} = 5 V.

(2) V_{CC} = 4.75 V.

(3) V_{CC} = 5.25 V.

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



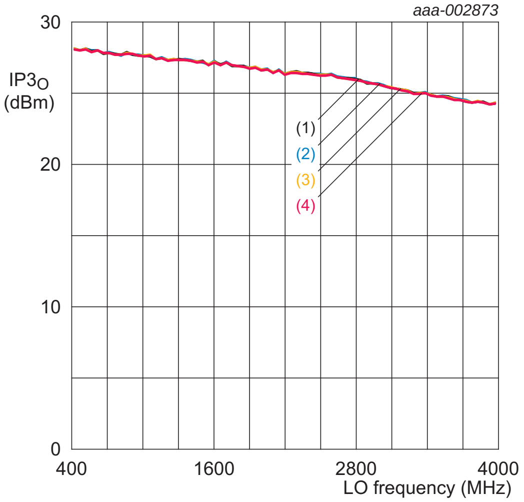
(1) $P_{i(lo)}$ = 0 dBm.

(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 $V_{i(cm)}$

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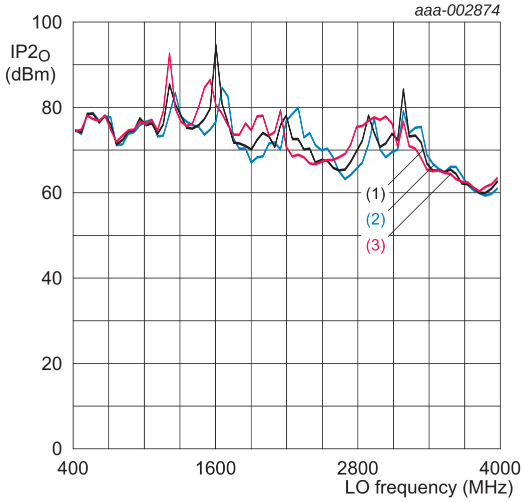
Parameters for the four following drawings: V_{CC} = 5 V; T_{mb} = 25 °C; $P_{i(lo)}$ = 0 dBm; two tones; tone 1: IQ frequency = 4.5 MHz and tone 2: IQ frequency = 5.5 MHz; P_o per tone = –10 dBm; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.

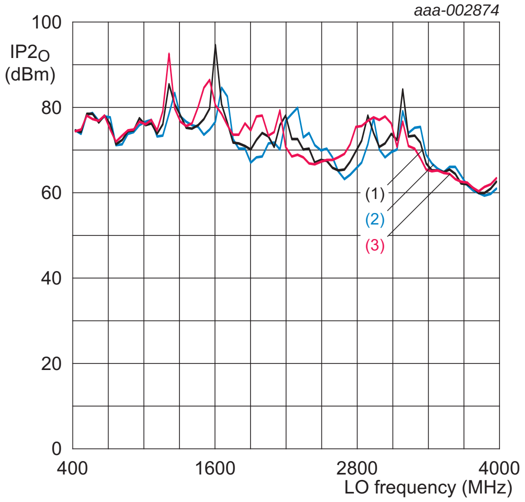


(1) T_{mb} = +25 °C.

(2) T_{mb} = –40 °C.

(3) T_{mb} = +85 °C.

Fig 20. IP2$_o$ versus f_{lo} and T_{mb}

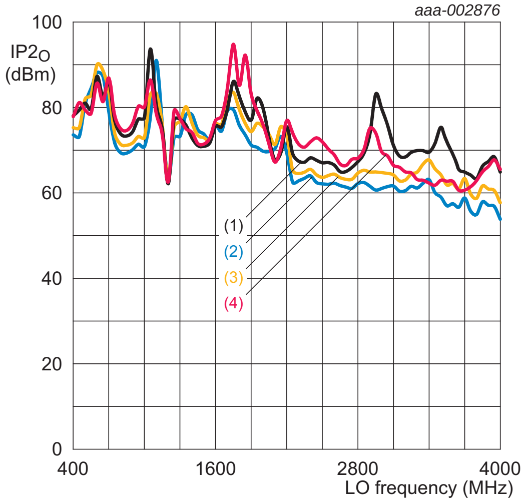


(1) V_{CC} = 5 V.

(2) V_{CC} = 4.75 V.

(3) V_{CC} = 5.25 V.

Fig 21. IP2$_o$ versus f_{lo} and V_{CC}



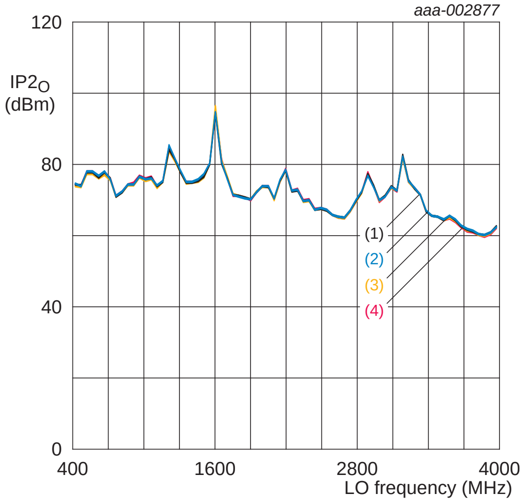
(1) $P_{i(lo)}$ = 0 dBm.

(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 $V_{i(cm)}$

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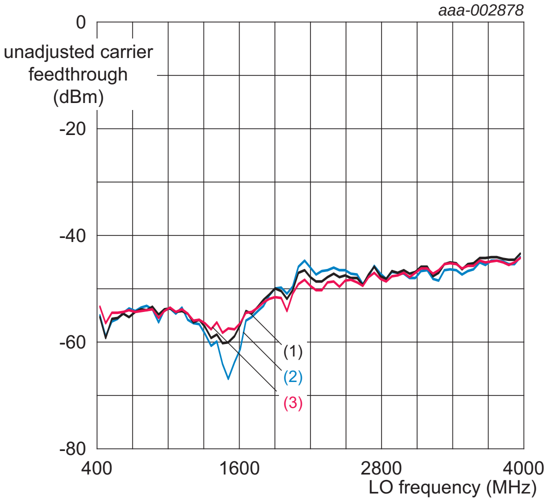
Parameters for the five following drawings: V_{CC} = 5 V; T_{mb} = 25 °C; $P_{i(lo)}$ = 0 dBm; IQ frequency = 5 MHz; IQ amplitude = 0.42 V (p-p) differential sine wave; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.

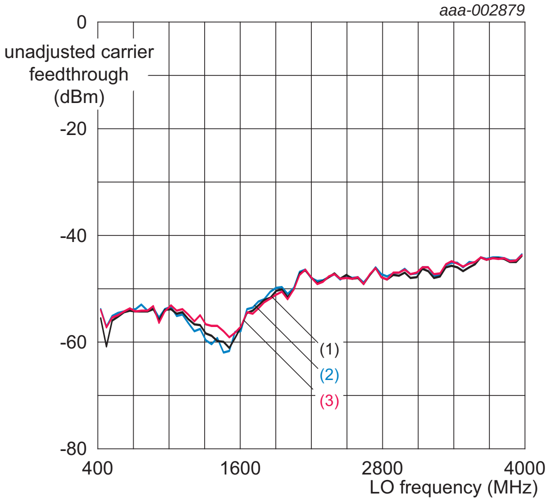


(1) T_{mb} = +25 °C.

(2) T_{mb} = −40 °C.

(3) T_{mb} = +85 °C.

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

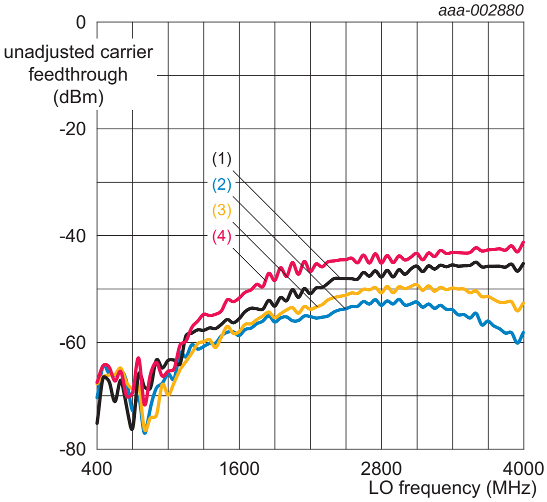


(1) V_{CC} = 5 V.

(2) V_{CC} = 4.75 V.

(3) V_{CC} = 5.25 V.

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



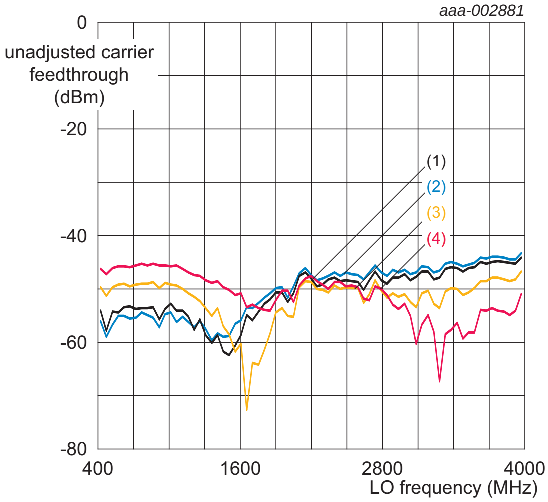
(1) $P_{i(lo)}$ = 0 dBm.

(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 $V_{i(cm)}$

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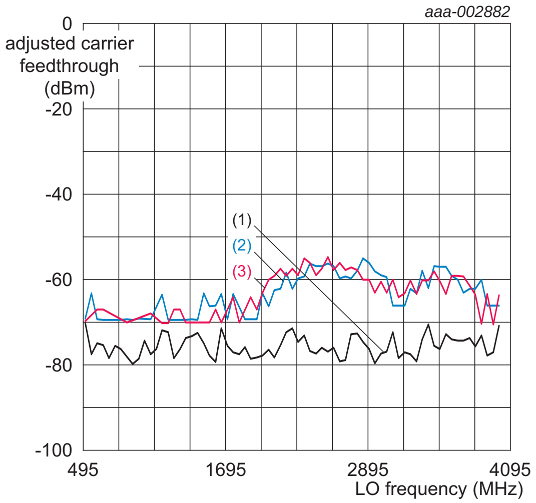


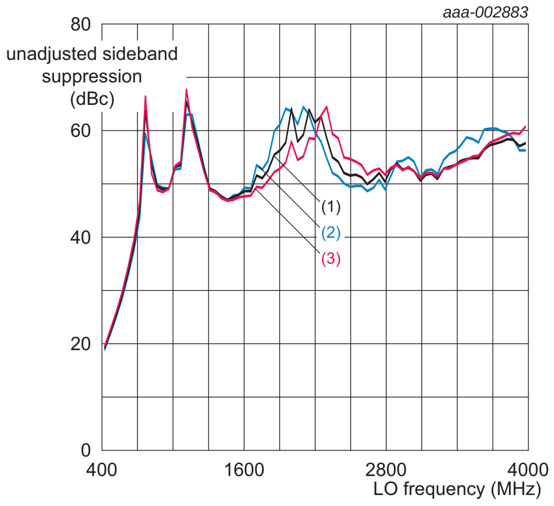
(1) T_{mb} = +25 °C.

(2) T_{mb} = –40 °C.

(3) T_{mb} = +85 °C.

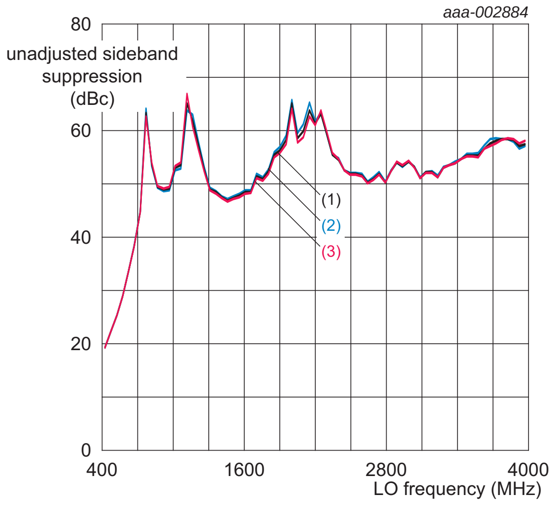
Fig 28. Adjusted CF versus f_{lo} and T_{mb} after nulling at 25 °C

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.



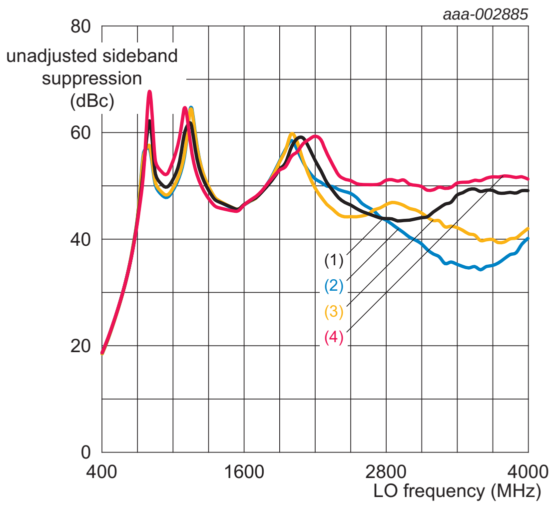
(1) T_{mb} = +25 °C.
(2) T_{mb} = −40 °C.
(3) T_{mb} = +85 °C.

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



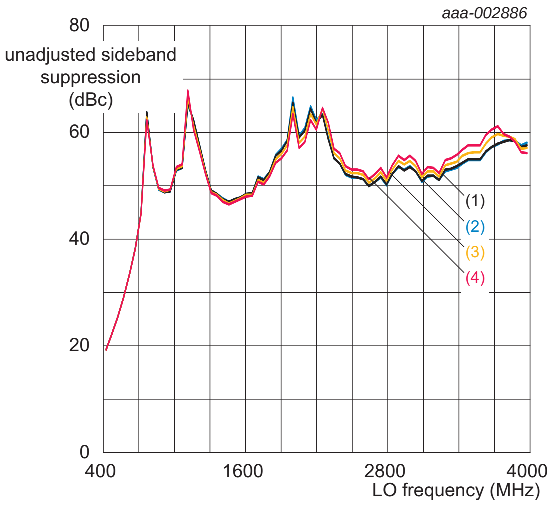
(1) V_{CC} = 5 V.
(2) V_{CC} = 4.75 V.
(3) V_{CC} = 5.25 V.

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 $V_{i(cm)}$

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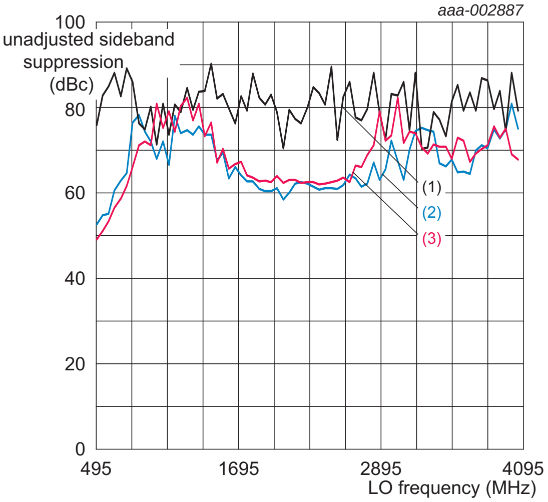

(1) T_{mb} = +25 °C.

(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

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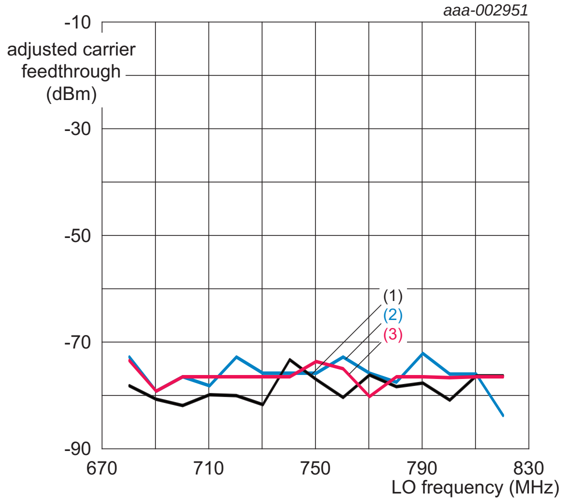
Parameters for the six following drawings: V_{CC} = 5 V; T_{mb} = 25 °C; LO = 0 dBm; IQ frequency = 5 MHz; IQ amplitude = 0.25 V (p-p) single-ended sine wave; $V_{i(cm)}$ = 0.5 V; broadband output match; unless otherwise specified.



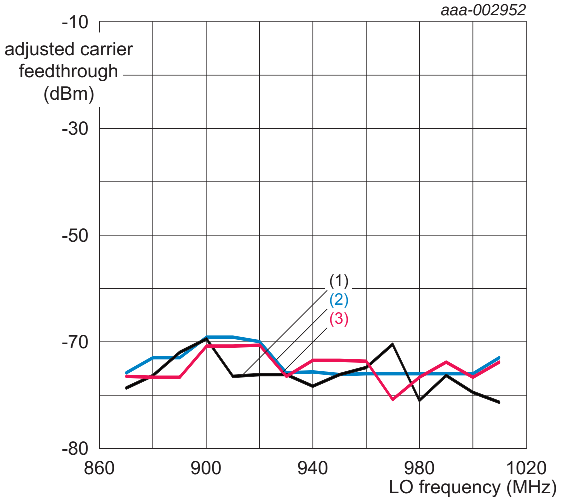
Adjusted at 750 MHz and after nulling T_{mb} at 25 °C

(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)



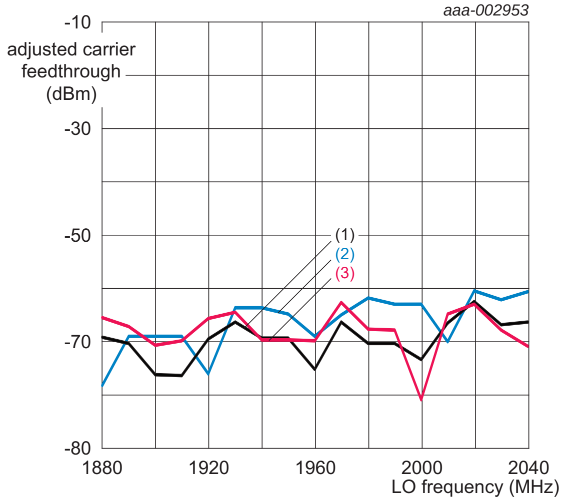
Adjusted at 942.5 MHz and after nulling T_{mb} at 25 °C

(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)



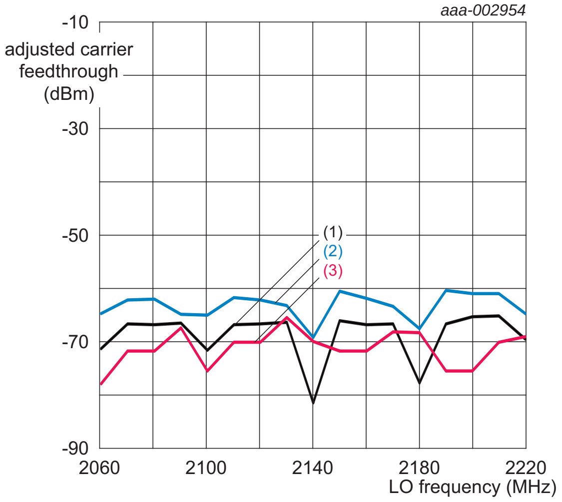
Adjusted at 1840 MHz and after nulling T_{mb} at 25 °C

(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)

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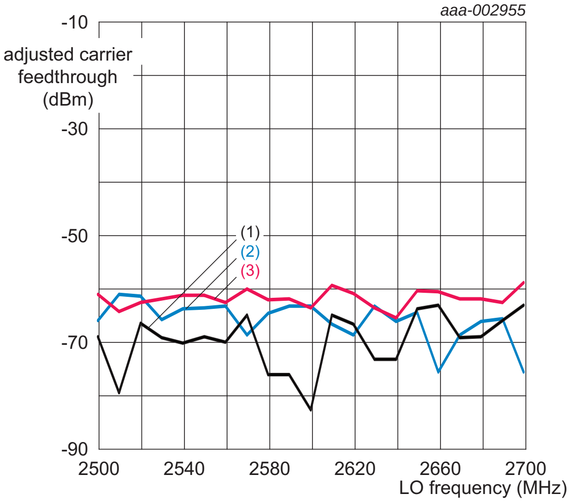


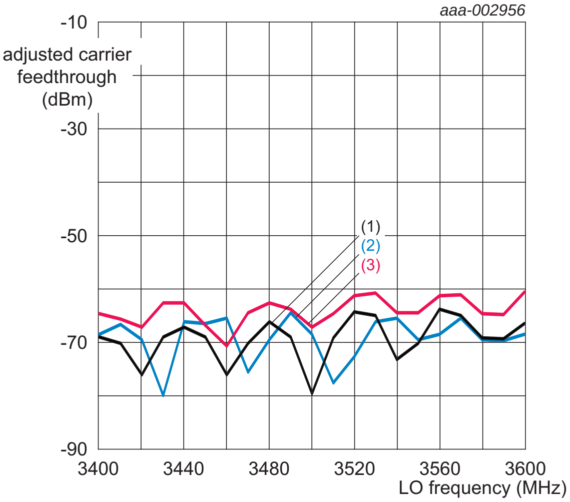
Adjusted at 2600 MHz and after nulling T_{mb} at 25 °C

(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

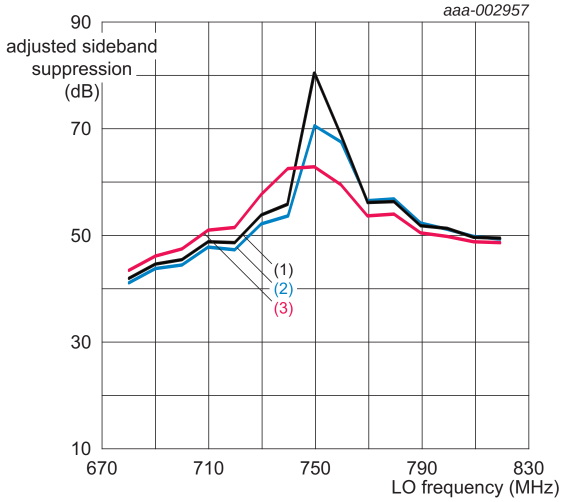
(1) T_{mb} = +25 °C.

(2) T_{mb} = –40 °C.

(3) T_{mb} = +85 °C.

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

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.



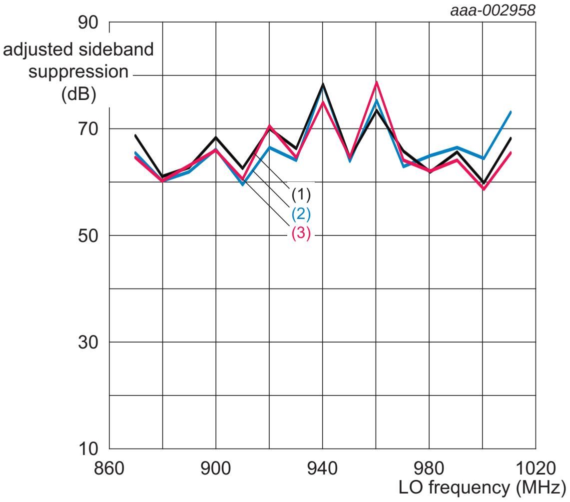
Adjusted at 750 MHz and after nulling T_{mb} at 25 °C

(1) T_{mb} = +25 °C.

(2) T_{mb} = –40 °C.

(3) T_{mb} = +85 °C.

Fig 40. Adjusted SBS versus f_{lo} and T_{mb} (750 LTE band)



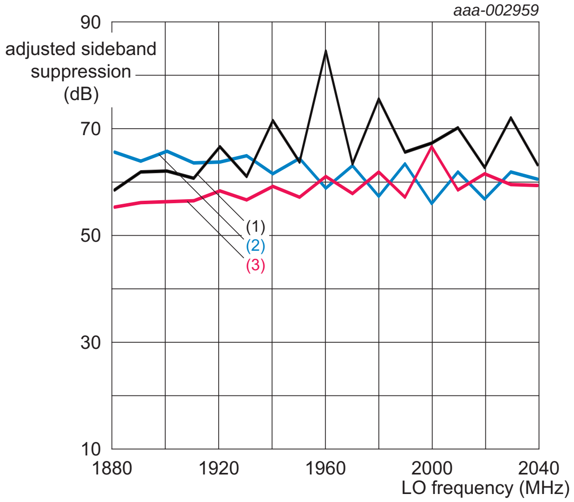
Adjusted at 942.5 MHz and after nulling T_{mb} at 25 °C

(1) T_{mb} = +25 °C.

(2) T_{mb} = –40 °C.

(3) T_{mb} = +85 °C.

Fig 41. Adjusted SBS versus f_{lo} and T_{mb} (GSM900 band)



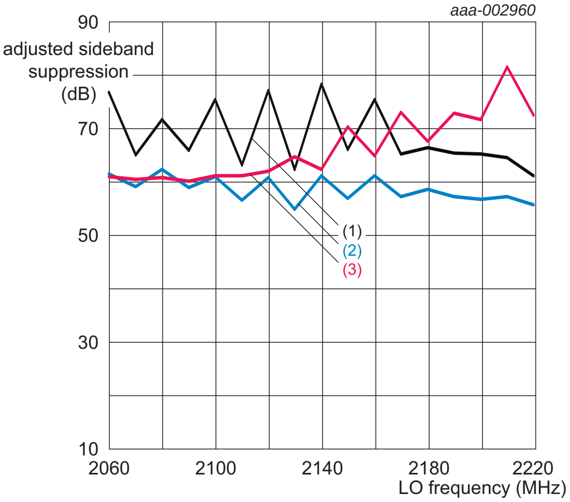
Adjusted at 1840 MHz and after nulling T_{mb} at 25 °C

(1) T_{mb} = +25 °C.

(2) T_{mb} = –40 °C.

(3) T_{mb} = +85 °C.

Fig 42. Adjusted SBS 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 43. Adjusted SBS versus f_{lo} and T_{mb} (UMTS band)

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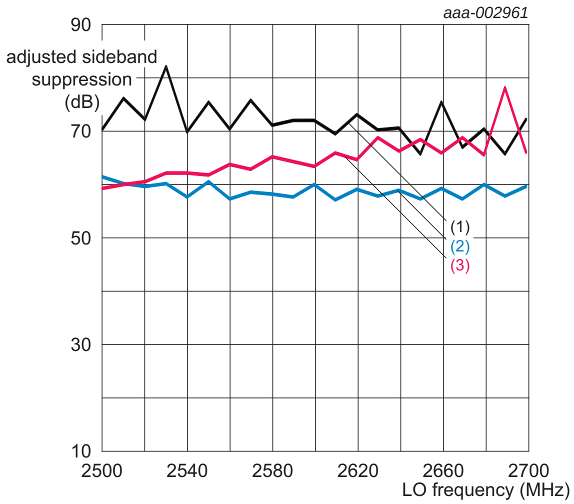


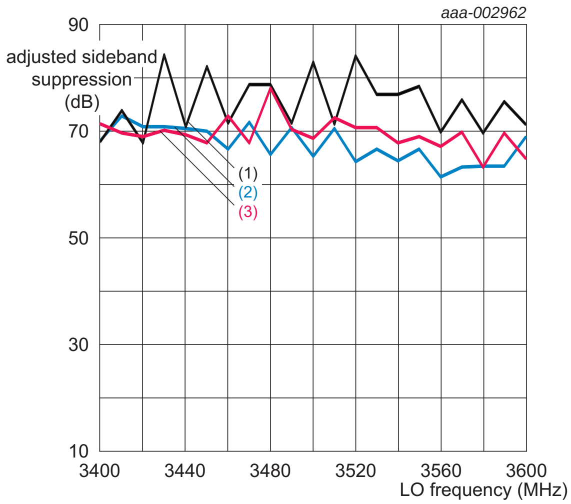
Adjusted at 2600 MHz and after nulling T_{mb} at 25 °C

(1) T_{mb} = +25 °C.

(2) T_{mb} = –40 °C.

(3) T_{mb} = +85 °C.

Fig 44. Adjusted SBS 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 45. Adjusted SBS versus f_{lo} and T_{mb} (Wi MAX/LTE band)

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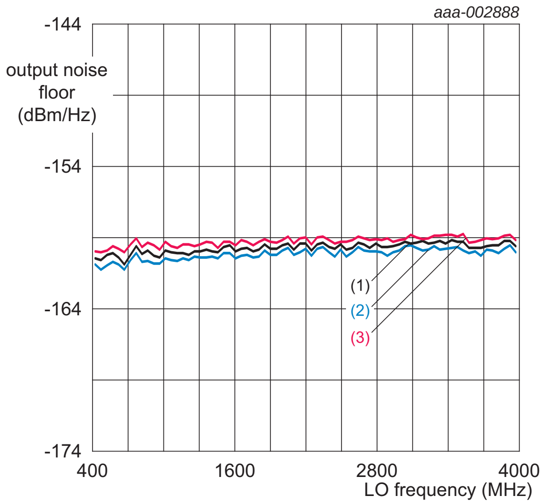
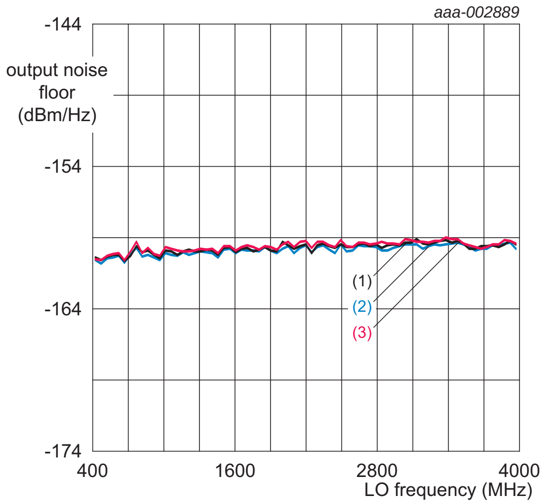
Parameters for the three following drawings: noise floor without baseband; V_{CC} = 5 V; T_{mb} = 25 °C; $P_{i(lo)}$ = 0 dBm; offset frequency = 20 MHz; input baseband ports terminated in 50 Ω; unless otherwise specified.



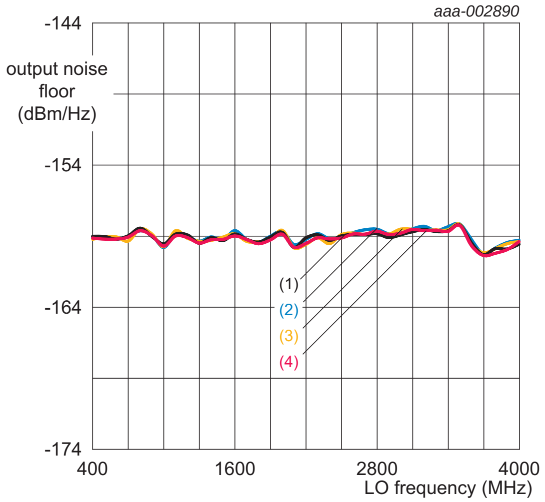
(1) T_{mb} = +25 °C.
(2) T_{mb} = −40 °C.
(3) T_{mb} = +85 °C.

Fig 46. $N_{flr(o)}$ versus f_{lo} and T_{mb}



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

Fig 47. $N_{flr(o)}$ 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 48. $N_{flr(o)}$ versus f_{lo} and $P_{i(lo)}$

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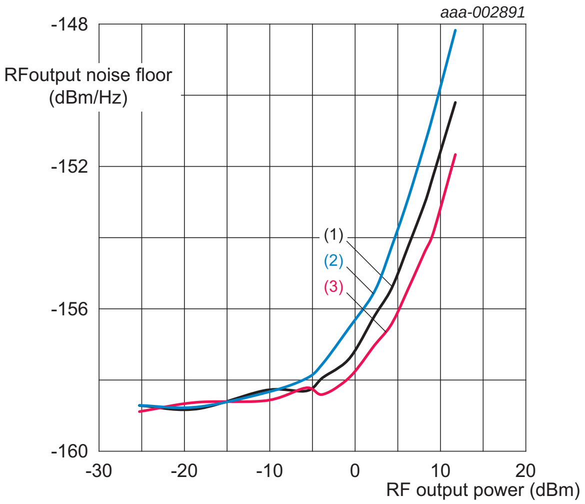
Parameters for the two following drawings: noise floor with baseband; V_{CC} = 5 V; T_{mb} = 25 °C; $P_{i(lo)}$ = 0 dBm; input baseband ports terminated on short circuit to ground for MODI_N, MODI_P and MODQ_N; DC signal on MODQ_P; unless otherwise specified.

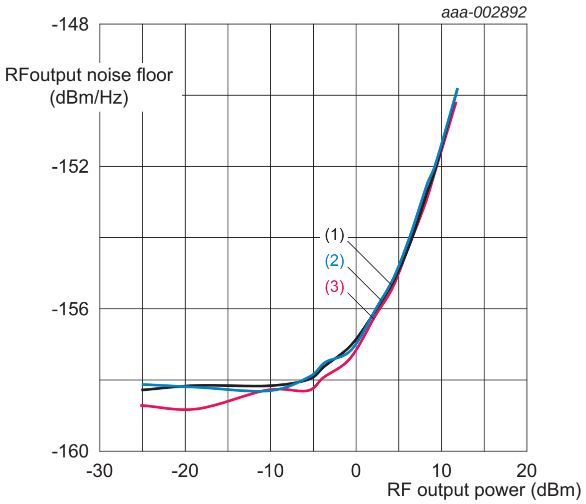


(1) $P_{i(lo)}$ = 0 dBm.

(2) $P_{i(lo)}$ = –3 dBm.

(3) $P_{i(lo)}$ = +3 dBm.

Fig 49. $N_{flr(o)}$ versus P_o at f_{RF} = 2140 MHz with 30 MHz offset



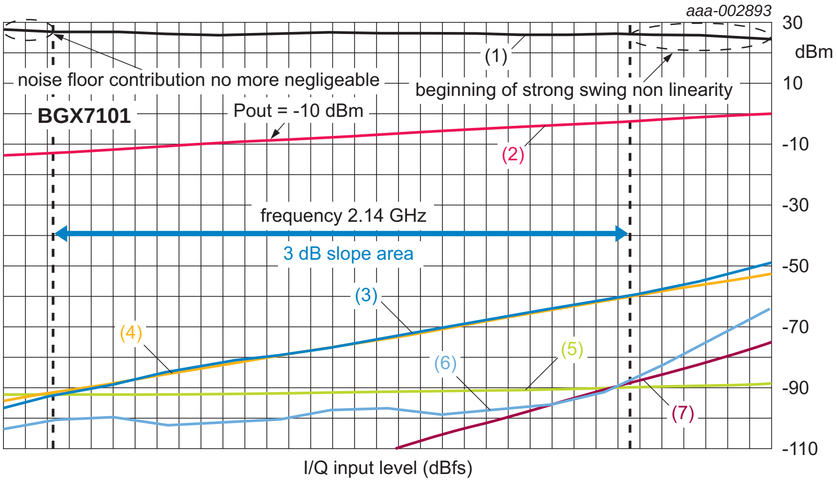
(1) RF = 1840 MHz.

(2) RF = 942.5 MHz.

(3) RF = 2140 MHz.

Fig 50. $N_{flr(o)}$ versus P_o at $P_{i(lo)}$ = 0 dBm

Parameters for the following drawing: T_{mb} = 25 °C; $P_{i(lo)}$ = 0 dBm; two tones for IM3, IM5, wanted and $IP3_o$; tone 1: IQ frequency = 4.5 MHz and tone 2: IQ frequency = 5.5 MHz; $V_{i(cm)}$ = 0.5 V; for noise floor measurement see preceding conditions; noise floor measurement has been integrated in 3.84 MHz bandwidth; unless otherwise specified.



(1) Measured $IP3_o$.

(2) Pout/Tone 1 dB step.

(3) Measured IM3.

(4) Trendline IM3.

(5) Noise floor in 3.84 MHz.

(6) Measured IM5.

(7) Trendline IM5.

Fig 51. $IP3_o$, wanted, IM3, IM5 tone and noise floor

14. Marking

Table 14. Marking codes

Type number	Marking code
BGX7101HN	7101

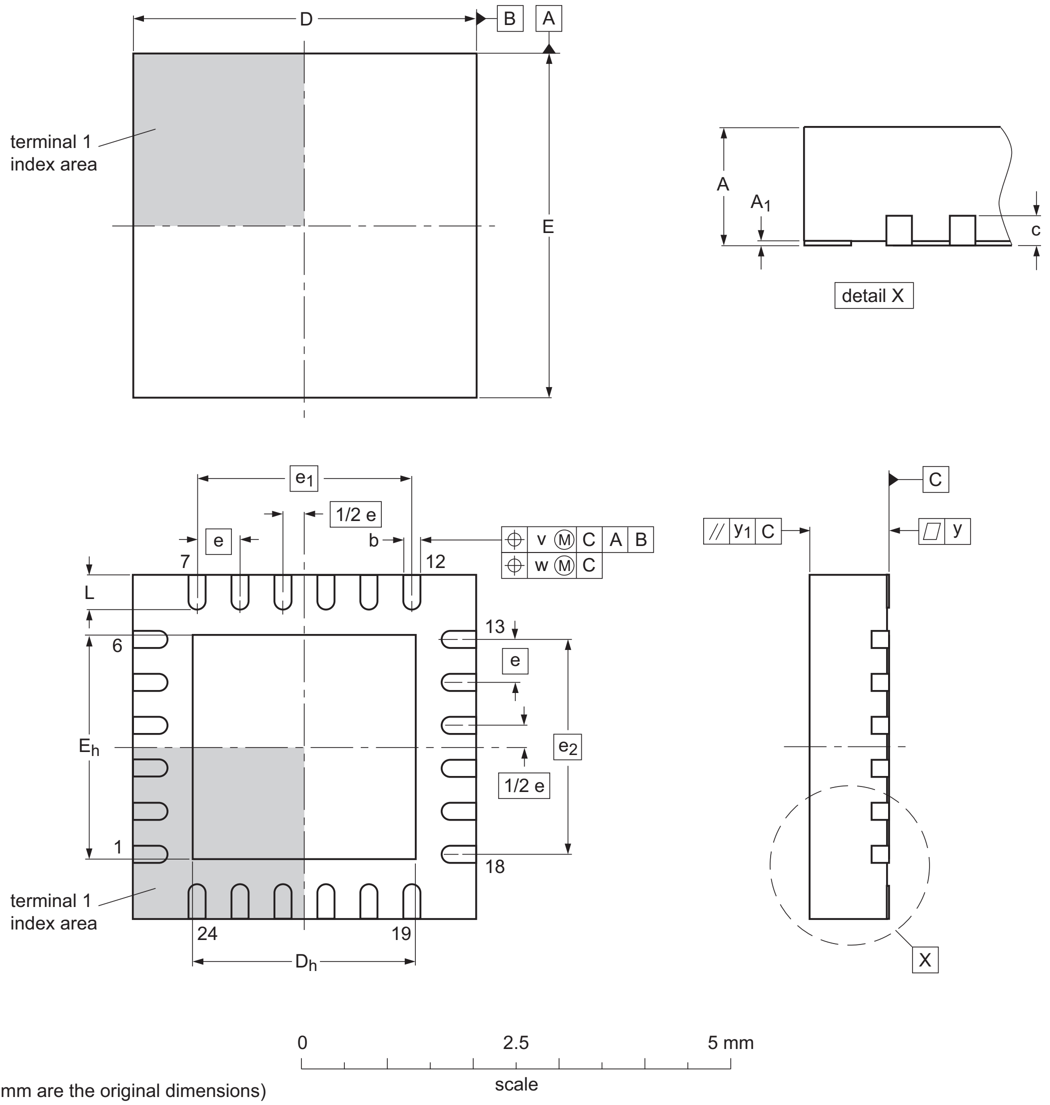
15. Package information

The BGX7101 uses an HVQFN 24-pin package with underside heat spreader ground.

16. Package outline

HVQFN24: plastic thermal enhanced very thin quad flat package; no leads; 24 terminals; body 4 x 4 x 0.85 mm

SOT616-3



Dimensions (mm are the original dimensions)

Unit$^{(1)}$		$A^{(1)}$	A_1	b	c	$D^{(1)}$	D_h	$E^{(1)}$	E_h	e	e_1	e_2	L	v	w	y	y_1
mm	max	1	0.05	0.30		4.1	2.75	4.1	2.75				0.5				
	nom				0.2					0.5	2.5	2.5		0.1	0.05	0.05	0.1
	min		0.00	0.18		3.9	2.45	3.9	2.45				0.3				

Note

1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

sot616-3_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT616-3		MO-220				~~16-02-17~~ 16-07-14

Fig 52. Package outline SOT616-3 (HVQFN24)

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17. Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 “Surface mount reflow soldering description”*.

17.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

17.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

17.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

17.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see Figure 53) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with Table 15 and 16

Table 15. SnPb eutectic process (from J-STD-020D)

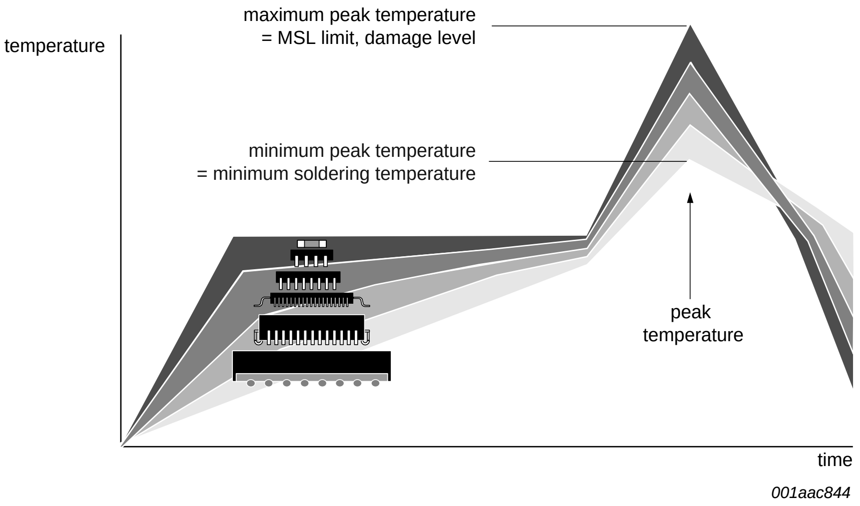
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm^3)	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

Table 16. Lead-free process (from J-STD-020D)

Package thickness (mm)	Package reflow temperature (°C)		
	Volume (mm^3)		
	< 350	350 to 2000	> 2000
< 1.6	260	260	260
1.6 to 2.5	260	250	245
> 2.5	250	245	245

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see Figure 53.



MSL: Moisture Sensitivity Level

Fig 53. Temperature profiles for large and small components

For further information on temperature profiles, refer to Application Note *AN10365 “Surface mount reflow soldering description”*.

18. Abbreviations

Table 17. Abbreviations

Acronym	Description
DAC	Digital-to-Analog Converter
DC	Direct Current
ESD	ElectroStatic Discharge
FCDM	Field-induced Charged-Device Model
HBM	Human Body Model
IF	Intermediate Frequency
LO	Local Oscillator
PCB	Printed-Circuit Board
RF	Radio Frequency
TDD	Time Division Duplex

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19. Revision history

Table 18. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGX7101 v.5	20170125	Product data sheet	-	BGX7101 v.4
Modifications:	• Section 1: added BTS8001A according to our new naming convention			
BGX7101 v.4	20130110	Product data sheet	-	BGX7101 v.3
Modifications:	• Table 7: updated • Table 8: updated • Table 9: updated • Table 10: updated • Table 11: updated • Table 12: updated • Table 13: updated			
BGX7101 v.3	20120903	Product data sheet	-	BGX7101 v.2
BGX7101 v.2	20120809	Product data sheet	-	BGX7101 v.1
BGX7101 v.1	20120425	Product data sheet	-	-

20. Legal information

20.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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