BGA7210

700 MHz to 3800 MHz high linearity variable gain amplifier

Rev. 5 — 20 January 2017 Product data sheet

1. Product profile

1.1 General description

The BGA7210 MMIC is, also known as the BTS6001A, an extremely linear Variable Gain Amplifier (VGA), operating from 0.7 GHz to 3.8 GHz. The maximum gain is 30 dB. It has an attenuation range of 31.5 dB. At its minimum attenuation setting it has a maximum output power of 21 dBm, an $IP3_O$ of 39 dBm and a noise figure of 6.5 dB.

The current consumption can be optimized per attenuation setting allowing for optimized overall system performance. The current consumption and attenuation level are controlled through a Serial Peripheral Interface (SPI). The current can be reduced to 120 mA. Optimal linearity performance is obtained at 185 mA. The BGA7210 has a fast switching power-down pin to further reduce current consumption during idle time.

The BGA7210 has been designed and qualified for the severe mission profile of cellular base stations, but its outstanding RF performance and interfacing flexibility make it suitable for a wide variety of applications.

The BGA7210 is housed in a 32 pins 5 mm × 5 mm leadless HVQFN32 package.

1.2 Features and benefits

- Operating frequency range from 0.7 GHz to 3.8 GHz
- High gain of 30 dB
- High $IP3_O$ of 39 dBm
- Attenuation range of 31.5 dB with 0.5 dB step (6 bit)
- Maximum output power of 21 dBm
- Noise figure of 6.5 dB at maximum gain
- ESD protection on all pins (HBM 4 kV; CDM 2 kV)
- Fast switching power-save mode
- Moisture sensitivity level 1
- Compliant to Directive 2002/95/EC, regarding Restriction of Hazardous Substances (RoHS)

1.3 Applications

- IF and RF applications
- WiMAX and cellular base stations
- Cable modem termination systems
- Temperature compensation circuits

1.4 Quick reference data

Table 1. Quick reference data

4.75 V ≤ V_{SUP} ≤ 5.25 V; –40 °C ≤ T_{amb} ≤ +85 °C; maximum current; input and output is terminated with 50 Ω; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{SUP}	supply voltage		[1]	4.75	5.0	5.25	V
$I_{CC(tot)}$	total supply current	maximum current		160	195	230	mA
		optimized current	[2]	-	185	-	mA
		minimum current		-	120	-	mA
		power-down current		-	15	-	mA
T_{amb}	ambient temperature			–40	+25	+85	°C
G_p	power gain	minimum attenuation					
		700 MHz ≤ f ≤ 1400 MHz		26	30	33	dB
		1400 MHz ≤ f ≤ 1700 MHz		26	29.5	33	dB
		1700 MHz ≤ f ≤ 2200 MHz		26	29	33	dB
		2200 MHz ≤ f ≤ 2800 MHz		25	28	31	dB
		3400 MHz ≤ f ≤ 3800 MHz		22	26	30	dB
α_{range}	attenuation range	700 MHz ≤ f ≤ 2200 MHz		28	31.5	35	dB
		2200 MHz ≤ f ≤ 2800 MHz		27	30.5	34	dB
		3400 MHz ≤ f ≤ 3800 MHz		26	29.5	33	dB
NF	noise figure	minimum attenuation					
		700 MHz ≤ f ≤ 2200 MHz		-	6.5	8.5	dB
		2200 MHz ≤ f ≤ 2800 MHz		-	7	9	dB
		3400 MHz ≤ f ≤ 3800 MHz		-	8	10	dB
		maximum attenuation					
		700 MHz ≤ f ≤ 2200 MHz		-	27.5	30.5	dB
		2200 MHz ≤ f ≤ 2800 MHz		-	28	31	dB
		3400 MHz ≤ f ≤ 3800 MHz		-	28.5	32	dB
$IP3_O$	output third-order intercept point	minimum attenuation	[3]				
		700 MHz ≤ f ≤ 1400 MHz		34	39	-	dBm
		1400 MHz ≤ f ≤ 1700 MHz		32	37	-	dBm
		1700 MHz ≤ f ≤ 2200 MHz		30	35	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz		28	34	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz; C_{sh} = 0.68 pF	[4]	30	35	-	dBm
		3400 MHz ≤ f ≤ 3800 MHz		24	30	-	dBm
		maximum attenuation	[3]				
		700 MHz ≤ f ≤ 1400 MHz		-	35	-	dBm
		1400 MHz ≤ f ≤ 1700 MHz		-	33	-	dBm
		1700 MHz ≤ f ≤ 2200 MHz		-	31	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz		-	30	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz; C_{sh} = 0.68 pF	[4]	-	30	-	dBm
		3400 MHz ≤ f ≤ 3800 MHz		-	25	-	dBm

Table 1. Quick reference data *...continued*

4.75 V ≤ V_{SUP} ≤ 5.25 V; −40 °C ≤ T_{amb} ≤ +85 °C; maximum current; input and output is terminated with 50 Ω; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$P_{L(1dB)}$	output power at 1 dB gain compression	minimum attenuation				
		700 MHz ≤ f ≤ 2800 MHz	18	21	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz; C_{sh} = 0.68 pF [4]	20	23	-	dBm
		3400 MHz ≤ f ≤ 3800 MHz	16	19	-	dBm

[1] Supply voltage on pins RF_OUT, V_{CC2}, V_{DDA}, V_{CC1} and V_{DDD}.

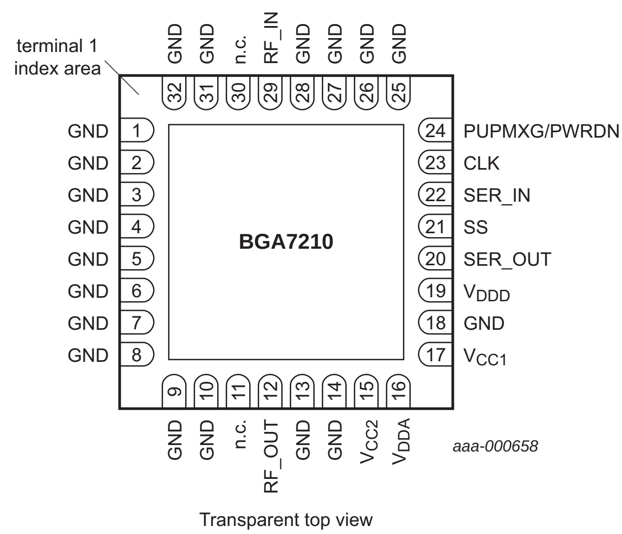
[2] See Section 9.2.

[3] P_i = −23 dBm per tone; Δf = 10 MHz.

[4] See Section 11.

2. Pinning information

2.1 Pinning



Transparent top view

Fig 1. Pin configuration

2.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
GND	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 18, 25, 26, 27, 28, 31, 32	Ground
n.c.	11, 30	not connected
RF_OUT	12	RF output and supply to amplifier 2
V_{CC2}	15	Supply voltage to amplifier 2
V_{DDA}	16	Analog supply voltage to DSA

Table 2. Pin description *…continued*

Symbol	Pin	Description
V_{CC1}	17	Supply voltage to amplifier 1
V_{DDD}	19	Digital supply voltage to digital controller
SER_OUT	20	SPI data output
SS	21	SPI slave select (0 = select; 1 = deselect)
SER_IN	22	SPI data input
CLK	23	SPI clock input
PUPMXG/PWRDN	24	Power-up gain attenuation / power down
RF_IN	29	RF input

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BGA7210	HVQFN32	plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; body 5 × 5 × 0.85 mm	SOT617-3

4. Marking

Table 4. Marking

Type number	Marking code
BGA7210	7210

5. Limiting values

Table 5. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{SUP}	supply voltage		[1]	–0.6	+8	V
V_I	input voltage		[2]	–0.6	+8	V
V_O	output voltage		[3]	–0.6	+8	V
I_I	input current		[4]	–20	+20	mA
I_O	output current		[5]	–20	+20	mA
P_{RFIN}	power on pin RF_IN			-	30	dBm
T_{stg}	storage temperature			–65	+150	°C
T_j	junction temperature			-	150	°C
V_{ESD}	electrostatic discharge voltage	Human Body Model (HBM); According to JEDEC standard 22-A114E		-	4	kV
		Charged Device Model (CDM); According to JEDEC standard 22-C101B		-	2	kV

[1] Absolute maximum DC voltage on pins RF_OUT, V_{CC2}, V_{DDA}, V_{CC1}, V_{DDD} and RF_IN.

[2] Absolute maximum DC voltage on pins SS, SER_IN, CLK and PUPMXG/PWRDN.

[3] Absolute maximum DC voltage on pin SER_OUT.

[4] Absolute maximum DC current through pins SS, SER_IN, CLK and PUPMXG/PWRDN.

[5] Absolute maximum DC current through pin SER_OUT.

6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point	$T_{sp} \leq 85$ °C	[1]	16	K/W

[1] T_{sp} is the temperature at the solder point.

7. Static characteristics

Table 7. Static characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{SUP}	supply voltage		[1]	4.75	5.0	5.25	V
$I_{CC(tot)}$	total supply current	maximum		160	195	230	mA
		optimized current	[2]	-	185	-	mA
		minimum current		-	120	-	mA
		power-down current		-	15	-	mA
T_{amb}	ambient temperature			–40	+25	+85	°C
I_{CC}	supply current	on pin RF_OUT		-	85	-	mA
	supply current	on pin V_{CC2}		-	45	-	mA
	supply current	on pin V_{DDA}		-	5	-	mA
	supply current	on pin V_{CC1}		-	55	-	mA
	supply current	on pin V_{DDD}		-	5	-	mA
V_{IL}	LOW-level input voltage		[3]	–0.1	0	+0.8	V
V_{IH}	HIGH-level input voltage		[3]	2	3.3	V_{SUP} + 0.1	V
V_{OL}	LOW-level output voltage		[4]	–0.1	0	+0.8	V
V_{OH}	HIGH-level output voltage		[4]	2.5	3.3	3.4	V
I_{OL}	LOW-level output current		[4]	–15	-	0	mA
I_{OH}	HIGH-level output current		[4]	0	-	15	mA

[1] Supply voltage on pins RF_OUT, V_{CC2}, V_{DDA}, V_{CC1} and V_{DDD}.

[2] See Section 9.2.

[3] Digital input pins are: SS, SER_IN, CLK and PUPMXG/PWRDN.

[4] Digital output pin is: SER_OUT.

8. Dynamic characteristics

Table 8. Dynamic characteristics

4.75 V ≤ V_{SUP} ≤ 5.25 V; –40 °C ≤ T_{amb} ≤ +85 °C; maximum current; input and output terminated with 50 Ω, unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
G_p	power gain	minimum attenuation					
		700 MHz ≤ f ≤ 1400 MHz		26	30	33	dB
		1400 MHz ≤ f ≤ 1700 MHz		26	29.5	33	dB
		1700 MHz ≤ f ≤ 2200 MHz		26	29	33	dB
		2200 MHz ≤ f ≤ 2800 MHz		25	28	31	dB
		3400 MHz ≤ f ≤ 3800 MHz		22	26	30	dB
ΔG/ΔT	gain variation with temperature			–0.03	–0.006	0	dB/°C
$ΔG/ΔV_{SUP}$	gain variation with supply voltage			–0.2	-	+0.2	dB/V
$α_{range}$	attenuation range	700 MHz ≤ f ≤ 2200 MHz		28	31.5	35	dB
		2200 MHz ≤ f ≤ 2800 MHz		27	30.5	34	dB
		3400 MHz ≤ f ≤ 3800 MHz		26	29.5	33	dB
$α_{step}$	attenuation step	700 MHz ≤ f ≤ 2800 MHz		0	0.5	1	dB
		3400 MHz ≤ f ≤ 3800 MHz		0	0.5	1.2	dB
$ΔG_p$	power gain variation	700 MHz ≤ f ≤ 3800 MHz	[1]	–1.5	-	+1.5	dB
		700 MHz ≤ f ≤ 2200 MHz	[2]	$–(0.5 + 0.025 \times i_α)$	-	$+(0.5 + 0.025 \times i_α)$	dB
		2200 MHz ≤ f ≤ 2800 MHz	[2]	$–(0.3 + 0.025 \times i_α)$	-	$+(0.3 + 0.025 \times i_α)$	dB
		3400 MHz ≤ f ≤ 3800 MHz	[2]	$–(0.5 + 0.025 \times i_α)$	-	$+(0.5 + 0.025 \times i_α)$	dB
$G_{p(flat)}$	power gain flatness	700 MHz ≤ f ≤ 3800 MHz; per 200 MHz		-	-	1	dB
RL_{in}	input return loss	700 MHz ≤ f ≤ 3800 MHz		10	-	-	dB
RL_{out}	output return loss	700 MHz ≤ f ≤ 3800 MHz		7	-	-	dB
		2200 MHz ≤ f ≤ 2800 MHz; C_{sh} = 0.68 pF		10	-	-	dB
NF	noise figure	minimum attenuation					
		700 MHz ≤ f ≤ 2200 MHz		-	6.5	8.5	dB
		2200 MHz ≤ f ≤ 2800 MHz		-	7	9	dB
		3400 MHz ≤ f ≤ 3800 MHz		-	8	10	dB
		maximum attenuation					
		700 MHz ≤ f ≤ 2200 MHz		-	27.5	30.5	dB
		2200 MHz ≤ f ≤ 2800 MHz		-	28	31	dB
		3400 MHz ≤ f ≤ 3800 MHz		-	28.5	32	dB

Table 8. Dynamic characteristics *…continued*

4.75 V ≤ V_{SUP} ≤ 5.25 V; −40 °C ≤ T_{amb} ≤ +85 °C; maximum current; input and output terminated with 50 Ω, unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$IP3_O$	output third-order intercept point	minimum attenuation	[3]				
		700 MHz ≤ f ≤ 1400 MHz		34	39	-	dBm
		1400 MHz ≤ f ≤ 1700 MHz		32	37	-	dBm
		1700 MHz ≤ f ≤ 2200 MHz		30	35	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz		28	33	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz; C_{sh} = 0.68 pF	[4]	30	35	-	dBm
		3400 MHz ≤ f ≤ 3800 MHz		24	27	-	dBm
		maximum attenuation	[3]				
		700 MHz ≤ f ≤ 1400 MHz		-	35	-	dBm
		1400 MHz ≤ f ≤ 1700 MHz		-	33	-	dBm
		1700 MHz ≤ f ≤ 2200 MHz		-	31	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz		-	30	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz; C_{sh} = 0.68 pF	[4]	-	30	-	dBm
		3400 MHz ≤ f ≤ 3800 MHz		-	25	-	dBm
$P_{L(1dB)}$	output power at 1 dB gain compression	minimum attenuation					
		700 MHz ≤ f ≤ 2800 MHz		18	21	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz; C_{sh} = 0.68 pF	[4]	20	23	-	dBm
		3400 MHz ≤ f ≤ 3800 MHz		16	19	-	dBm
		maximum attenuation					
		700 MHz ≤ f ≤ 2800 MHz		-	20	-	dBm
		2200 MHz ≤ f ≤ 2800 MHz; C_{sh} = 0.68 pF	[4]	-	20	-	dBm
		3400 MHz ≤ f ≤ 3800 MHz		-	16	-	dBm
$t_{d(pd)}$	power-down delay time		[5]	-	100	-	ns
$t_{d(pu)}$	power-up delay time		[5]	-	5	-	µs
$t_{resp(\alpha)}$	attenuation response time		[5][6]	-	100	-	ns

[1] Normalized to maximum gain and attenuation.

[2] i_{α} specifies the decimal attenuation step, ranging from 0 to 63.

[3] P_i = −23 dBm per tone; Δf = 10 MHz.

[4] See Section 11.

[5] To within 0.1 dB of final gain state.

[6] After last SPI bit is clocked in.

9. Serial Peripheral Interface

9.1 Command word format

The Serial Peripheral Interface (SPI) operates in mode 0. This means that when the SPI is inactive the clock pin is logically LOW. When the SPI interface is active the data is clocked in at the rising edge of the clock pulse; data is clocked out at the negative edge. The control word length is 12 bits (see Figure 2), however the word length can be extended appropriately with trailing zeros (see Figure 3).

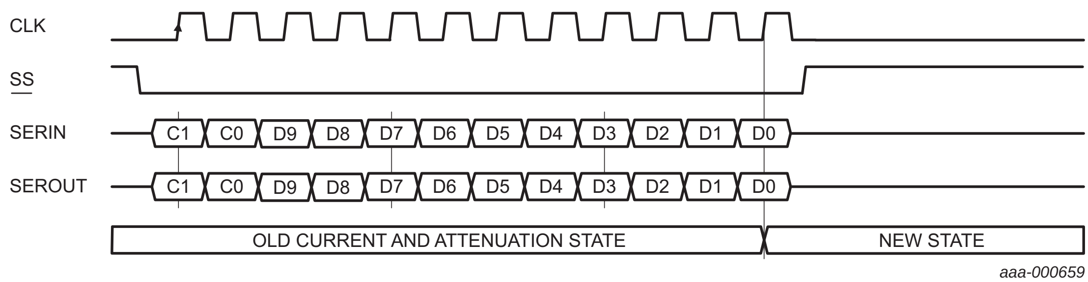


Fig 2. Timing diagram for 12-bit word

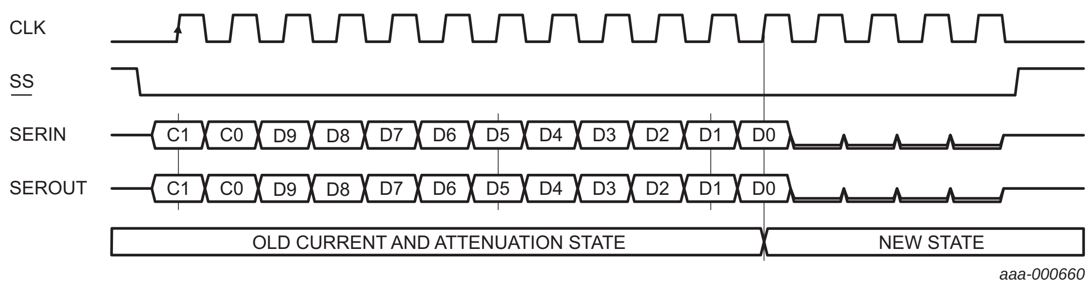


Fig 3. Timing diagram for 12-bit word length followed by four ignored trailing bits

The word written on the input (SER_IN) will be replicated on the output (SER_OUT)

9.2 Setting current and attenuation

The current and attenuation are set by bits D9 to D0 and are preceded by the command bits C0 and C1, which are always set to logic LOW, see Figure 4. If all bits are set to logic LOW (0x000) then current is at maximum and attenuation is at minimum; if all bits are set to logic HIGH (0x3FF) then current is at minimum and attenuation is at maximum.

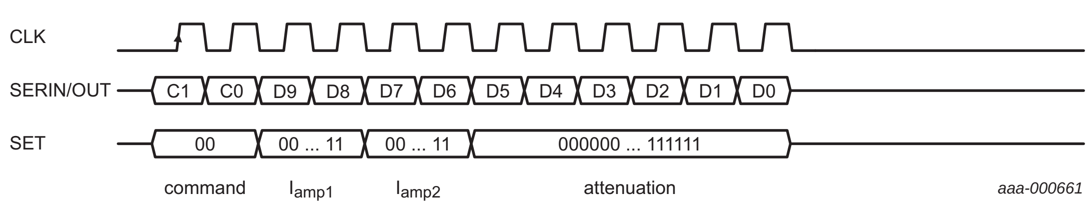


Fig 4. Command to set current of the first amplifier (D9, D8); second amplifier (D7, D6) and attenuation (D5, ... , D2)

Depending on the attenuation setting the current through the first amplifier and the second amplifier can be optimized, without compromising on linearity. At attenuations less than 9 dB the current in the first amplifier can be reduced with 10 mA; at attenuations equal or larger than 9 dB the current in the second amplifier can be reduced by 15 mA.

Table 9. Current first amplifier truth table

D9, D8	Current reduction (mA)
0x0	0
0x1	–10
0x2	–20
0x3	–30

Table 10. Current second amplifier truth table

D7, D6	Current reduction (mA)
0x0	0
0x1	–15
0x2	–30
0x3	–45

Table 11. Attenuation truth table; major states only

D5, D4, D3, D2, D1, D0	Attenuation (dB)
0x00	0
0x01	0.5
0x02	1
0x04	2
0x08	4
0x10	8
0x20	16
0x3F	31.5

9.3 SPI timing

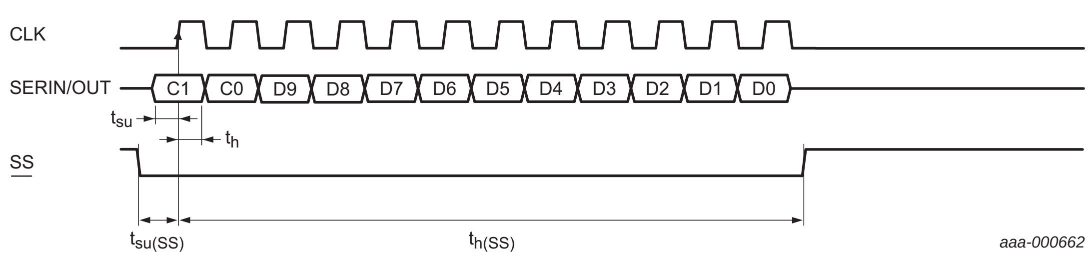


Fig 5. Timing diagram

Table 12. SPI timing

4.75 V ≤ V_{SUP} ≤ 5.25 V; –40 °C ≤ T_{amb} ≤ +85 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{SPI}	SPI frequency		0.1	-	20	MHz
t_{su}	set-up time		10	-	-	ns
t_h	hold time		10	-	-	ns
$t_{su(SS)}$	set-up time on pin SS		10	-	-	ns
$t_{h(SS)}$	hold time on pin SS		10 + 11 / f_{SPI}	-	-	ns

10. Power-up and power save

The PUPMXG/PWRDN pin determines the attenuation and currents at start-up of the chip (see Table 13). After start-up it can be used to power-down the device.

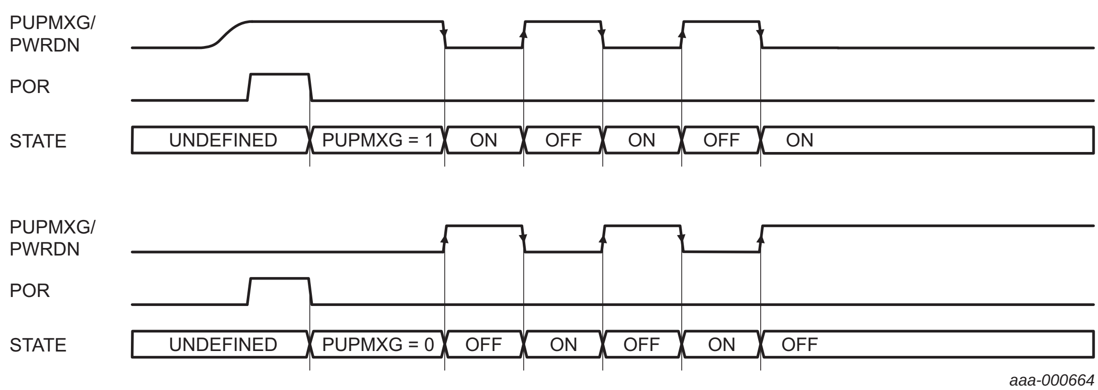


Fig 6. PUPMXG/PWRDN

Table 13. Power-up truth table

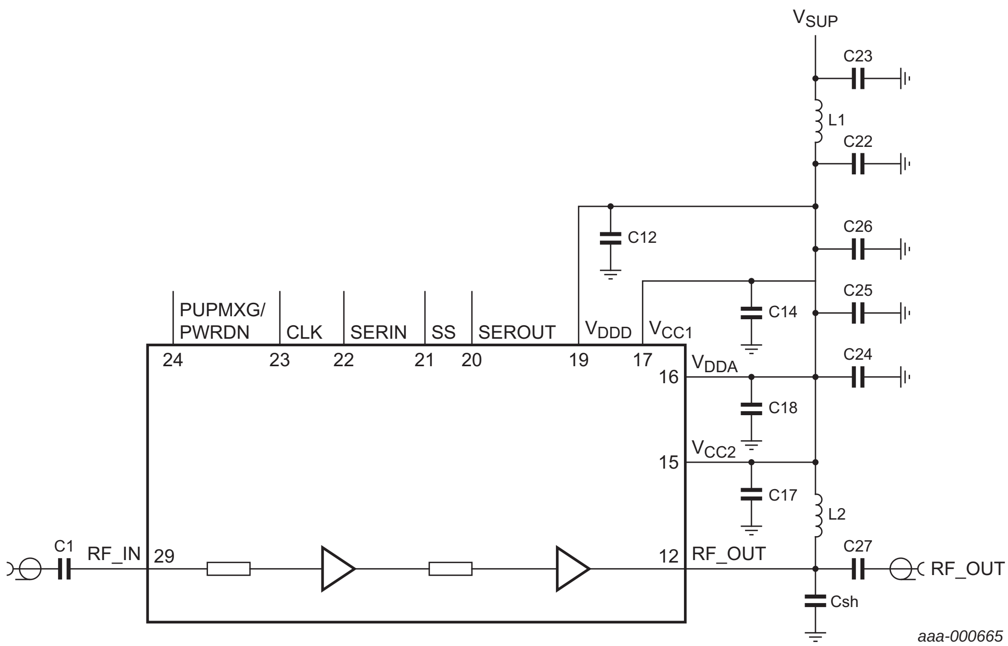
PUPMXG/PWRDN	Current (mA)	Attenuation (dB)
0	120	31.5
1	195	0

11. Application information

11.1 Application board

A customer application board is available from NXP upon request. It includes USB interface circuitry and customer software to facilitate evaluation of the BGA7210.

The final application shall be terminated with 50 Ω and decoupled as depicted in Figure 7. The ground leads and exposed paddle should be connected directly to the ground plane. A sufficient number of via holes should be provided to connect the top and bottom ground planes in the final application board. Sufficient cooling should be provided that the temperature of the exposed die pad does not exceed 85 °C.



See Table 14 for list of components.

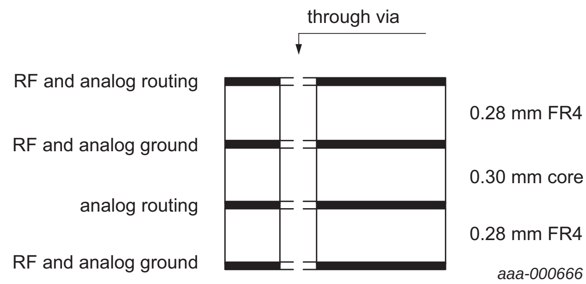
Fig 7. Schematic representation of the customer evaluation board

Table 14. List of components

See Figure 7 for schematics.

Component	Description	Value	Remarks
C1, C27	DC blocking capacitor	100 pF	Murata GRM
C12	decoupling capacitor	100 nF	close to pin 19
C14	decoupling capacitor	100 nF	close to pin 17
C17	decoupling capacitor	100 nF	close to pin 15
C18	decoupling capacitor	100 nF	close to pin 16
C22	optional decoupling capacitor	10 μF	part of optional ripple filter
C23	optional decoupling capacitor	10 μF	part of optional ripple filter
C24	decoupling capacitor	100 pF	
C25	decoupling capacitor	100 nF	
C26	decoupling capacitor	4.7 μF	
C_{sh}	optional matching capacitor to improve linearity at 2.2 GHz to 2.8 GHz	0.68 pF	Murata GRM; shall be located 5.5 mm from pin RF-OUT when using FR4 PCB described below.
L1	optional inductor	820 nH	part of optional ripple filter
L2	inductor	22 nH	Murata LQW 18

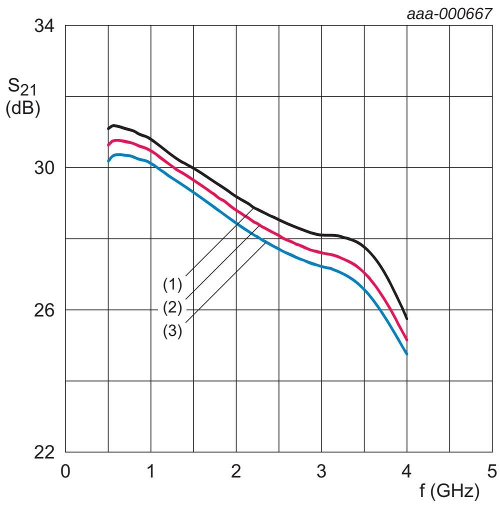
The recommended FR4 PCB layer stack is described in Figure 8. A 50 Ω coplanar grounded wave guide can be implemented by a 0.48 mm RF track and a clearance between the track and the ground planes of 1 mm on both sides.



ε_r = 4.5; interconnect 35 μm copper.

Fig 8. Printed-Circuit Board (PCB) layer stack

11.2 Characteristics



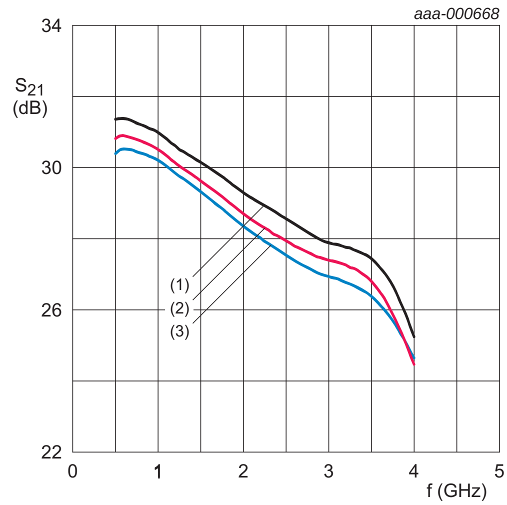
V_{SUP} = 5 V; maximum current setting.

(1) T_{amb} = −40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 9. Maximum power gain as a function of frequency; typical values



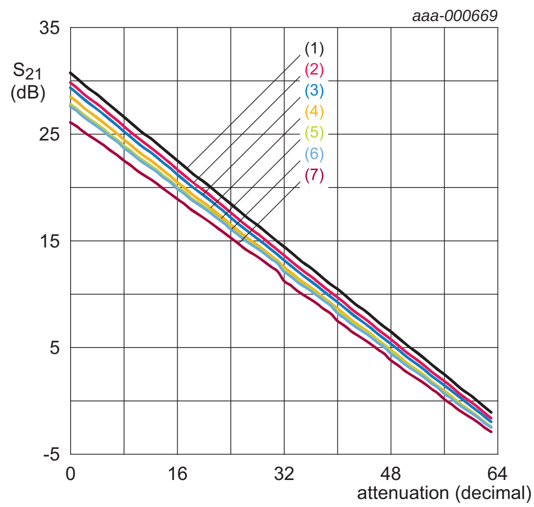
V_{SUP} = 5 V; maximum current setting and shunt capacitor (C_{sh}).

(1) T_{amb} = −40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 10. Maximum power gain with shunt capacitor as a function of frequency; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

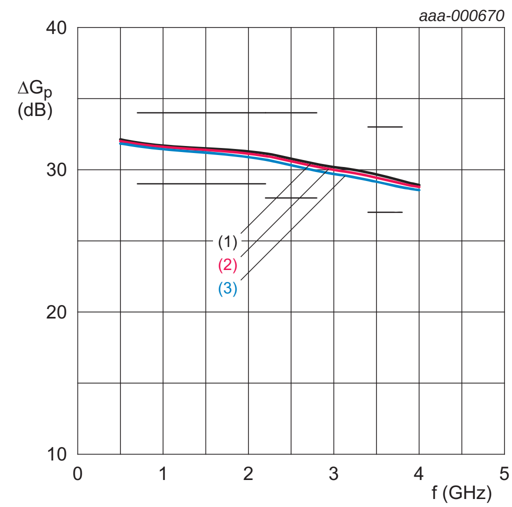
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 11. Power gain as a function of attenuation state; typical values



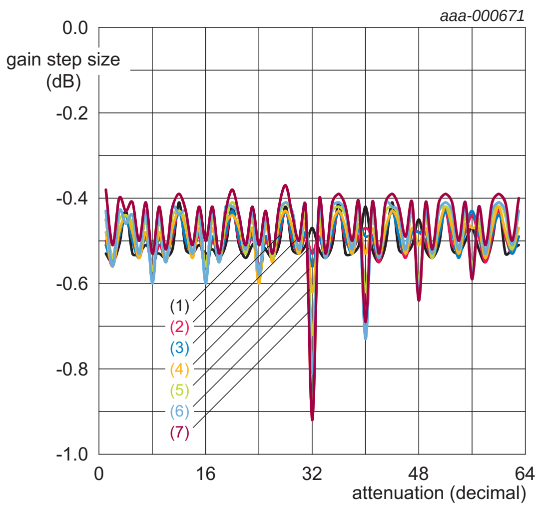
V_{SUP} = 5 V; maximum current setting.

(1) T_{amb} = −40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 12. Power gain range as a function of frequency; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

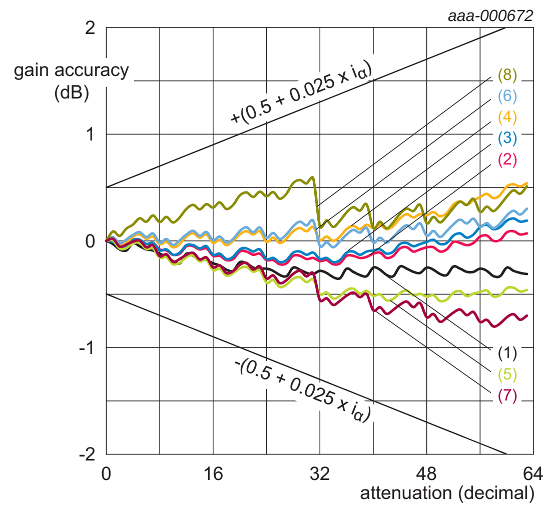
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 13. Gain step size as a function of attenuation state; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting.

(1) f = 0.7 GHz; α_{range} = 31.5 dB

(2) f = 1.4 GHz; α_{range} = 31.5 dB

(3) f = 1.7 GHz; α_{range} = 31.5 dB

(4) f = 2.2 GHz; α_{range} = 31.5 dB

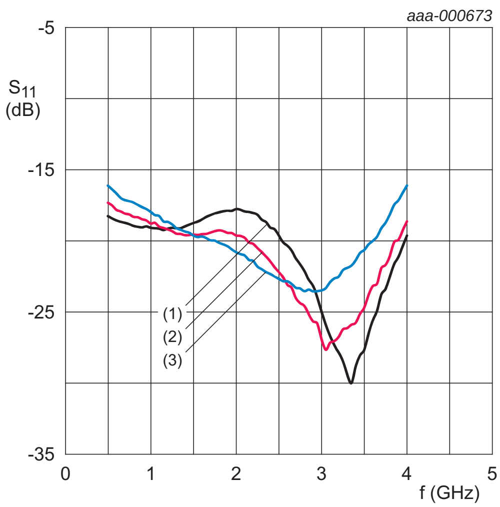
(5) f = 2.2 GHz; α_{range} = 30.5 dB

(6) f = 2.8 GHz; α_{range} = 30.5 dB

(7) f = 2.8 GHz; α_{range} = 29.5 dB

(8) f = 3.8 GHz; α_{range} = 29.5 dB

Fig 14. Power gain accuracy as a function of attenuation state; typical values



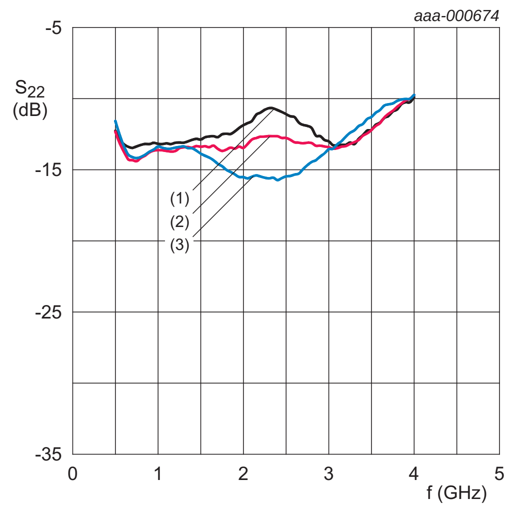
V_{SUP} = 5 V; maximum current setting; minimum attenuation.

(1) T_{amb} = −40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 15. Input return loss as a function of frequency; typical values



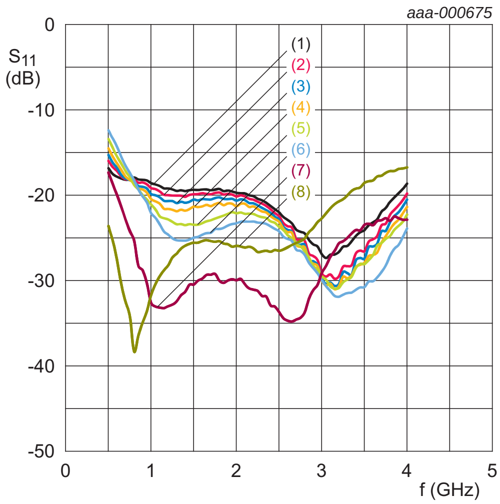
V_{SUP} = 5 V; maximum current setting; minimum attenuation.

(1) T_{amb} = −40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 16. Output return loss as a function of frequency; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting.

(1) attenuation = 0x00 (minimum)

(2) attenuation = 0x01

(3) attenuation = 0x02

(4) attenuation = 0x04

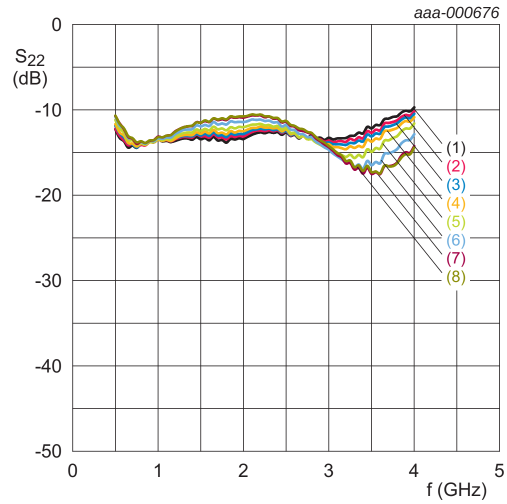
(5) attenuation = 0x08

(6) attenuation = 0x10

(7) attenuation = 0x20

(8) attenuation = 0x3F (maximum)

Fig 17. Input return loss as a function of frequency; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting.

(1) attenuation = 0x00 (minimum)

(2) attenuation = 0x01

(3) attenuation = 0x02

(4) attenuation = 0x04

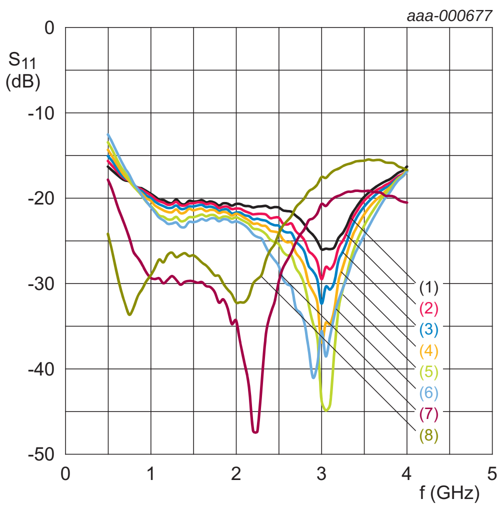
(5) attenuation = 0x08

(6) attenuation = 0x10

(7) attenuation = 0x20

(8) attenuation = 0x3F (maximum)

Fig 18. Output return loss as a function of frequency; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting and shunt capacitor (C_{sh}).

(1) attenuation = 0x00 (minimum)

(2) attenuation = 0x01

(3) attenuation = 0x02

(4) attenuation = 0x04

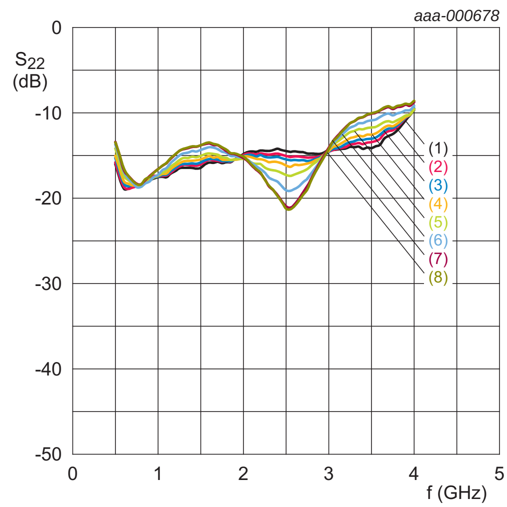
(5) attenuation = 0x08

(6) attenuation = 0x10

(7) attenuation = 0x20

(8) attenuation = 0x3F (maximum)

Fig 19. Input return loss with shunt capacitor as a function of frequency; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting and shunt capacitor (C_{sh}).

(1) attenuation = 0x00 (minimum)

(2) attenuation = 0x01

(3) attenuation = 0x02

(4) attenuation = 0x04

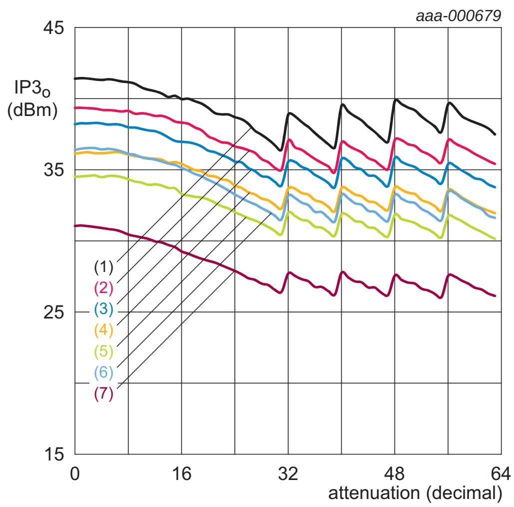
(5) attenuation = 0x08

(6) attenuation = 0x10

(7) attenuation = 0x20

(8) attenuation = 0x3F (maximum)

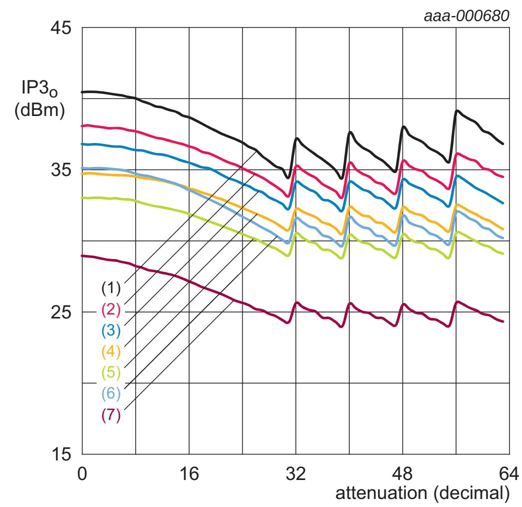
Fig 20. Output return loss with shunt capacitor as a function of frequency; typical values



V_{SUP} = 5 V; T_{amb} = −40 °C; maximum current setting.

(1) f = 0.7 GHz
(2) f = 1.4 GHz
(3) f = 1.7 GHz
(4) f = 2.2 GHz
(5) f = 2.8 GHz
(6) f = 2.8 GHz and C_{sh} used
(7) f = 3.8 GHz

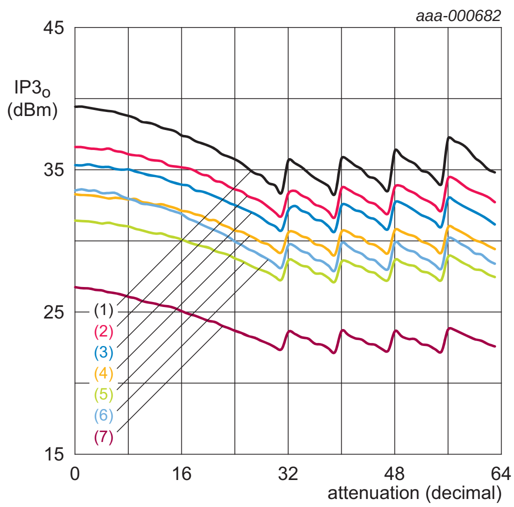
Fig 21. Output third-order intercept point as a function of attenuation state; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting.

(1) f = 0.7 GHz
(2) f = 1.4 GHz
(3) f = 1.7 GHz
(4) f = 2.2 GHz
(5) f = 2.8 GHz
(6) f = 2.8 GHz and C_{sh} used
(7) f = 3.8 GHz

Fig 22. Output third-order intercept point as a function of attenuation state; typical values



V_{SUP} = 5 V; T_{amb} = 85 °C; maximum current setting.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

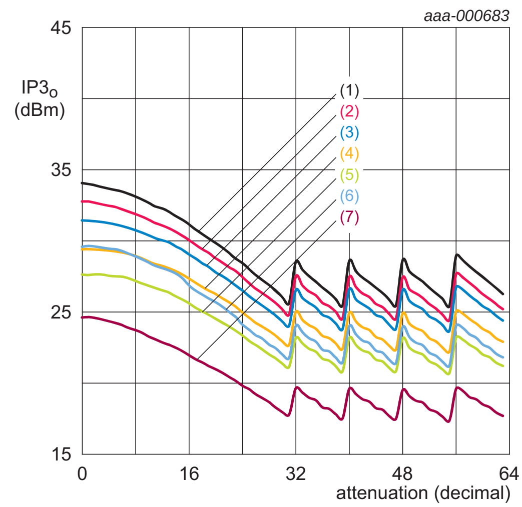
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 23. Output third-order intercept point as a function of attenuation state; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; minimal current setting.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

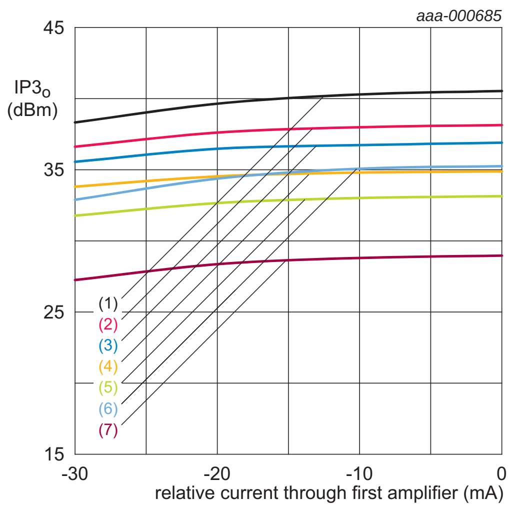
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 24. Output third-order intercept point as a function of attenuation state; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum gain; maximum current through second amplifier.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

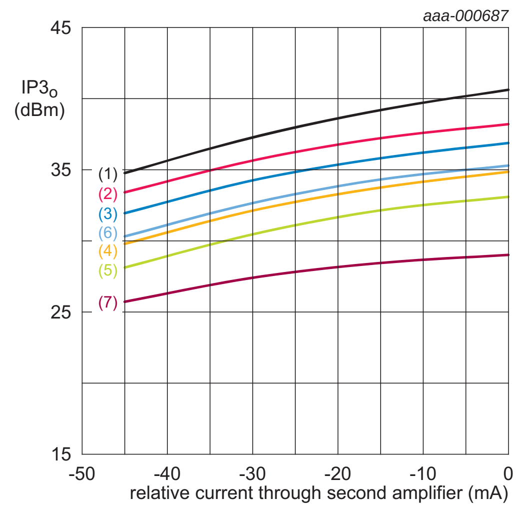
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 25. Output third-order intercept point as a function of relative current through first amplifier; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum gain; maximum current through first amplifier.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

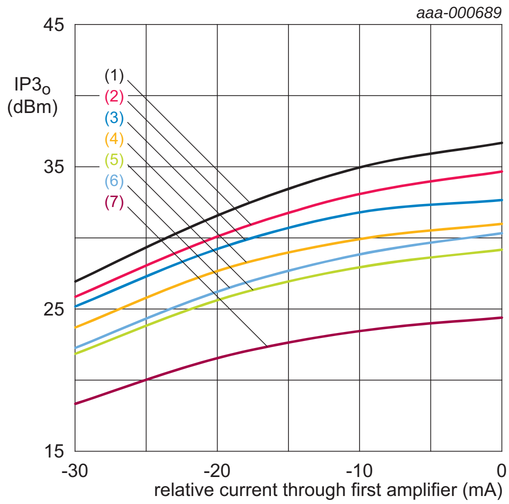
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 26. Output third-order intercept point as a function of relative current through second amplifier; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; minimum gain; maximum current through second amplifier.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

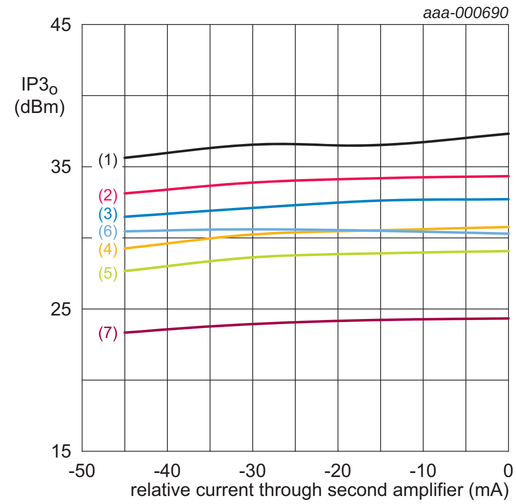
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 27. Output third-order intercept point as a function of relative current through first amplifier; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; minimum gain; maximum current through first amplifier.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

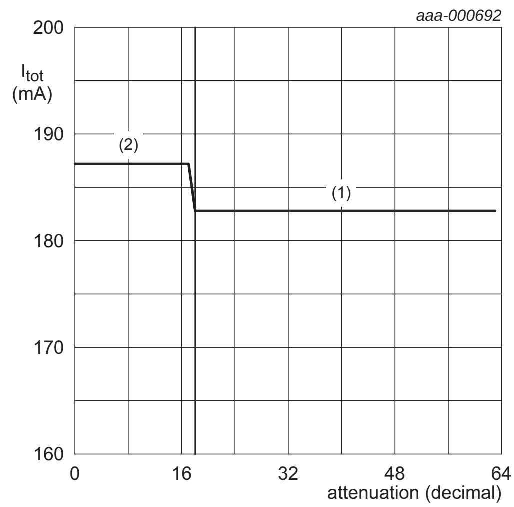
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 28. Output third-order intercept point as a function of relative current through second amplifier; typical values

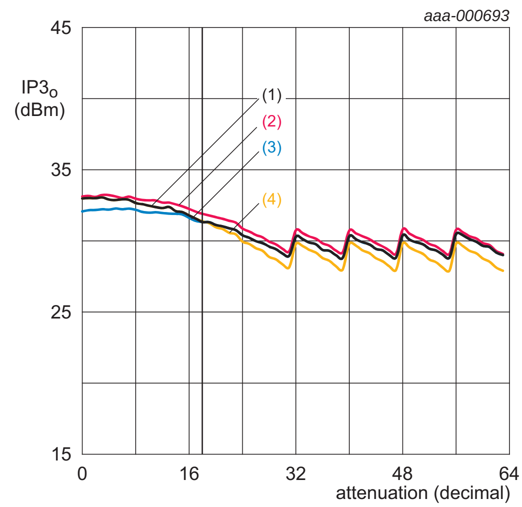


V_{SUP} = 5 V; T_{amb} = 25 °C.

(1) ΔI_{AMP1} / ΔI_{AMP2} = 0 mA / −15 mA

(2) ΔI_{AMP1} / ΔI_{AMP2} = −10 mA / 0 mA

Fig 29. Total current as a function of attenuation state optimized for $IP3_O$; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; f = 2.8 GHz.

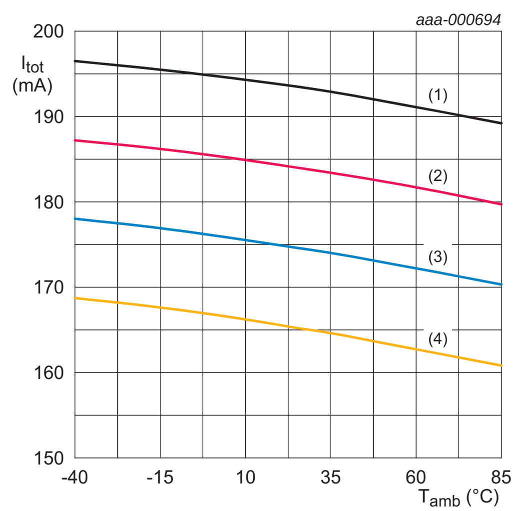
(1) ΔI_{AMP1} / ΔI_{AMP2} = I_{opt}

(2) ΔI_{AMP1} / ΔI_{AMP2} = 0 mA / 0 mA

(3) ΔI_{AMP1} / ΔI_{AMP2} = 0 mA / −15 mA

(4) ΔI_{AMP1} / ΔI_{AMP2} = −10 mA / 0 mA

Fig 30. Output third-order intercept point as a function of attenuation state; typical values



V_{SUP} = 5 V; maximum current through second amplifier.

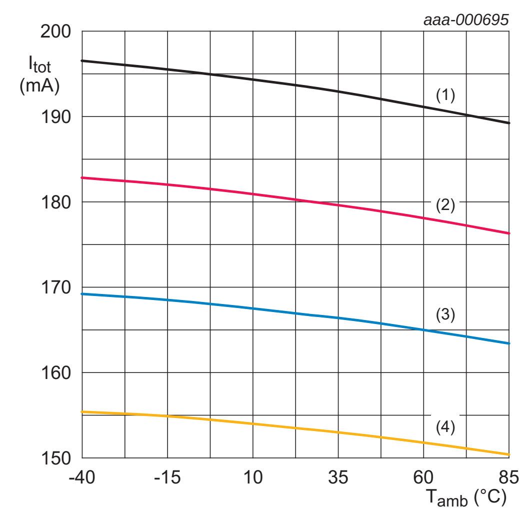
(1) I_{AMP1} = 0 mA

(2) I_{AMP1} = −10 mA

(3) I_{AMP1} = −20 mA

(4) I_{AMP1} = −30 mA

Fig 31. Total current as a function of ambient temperature; typical values



V_{SUP} = 5 V; maximum current through first amplifier.

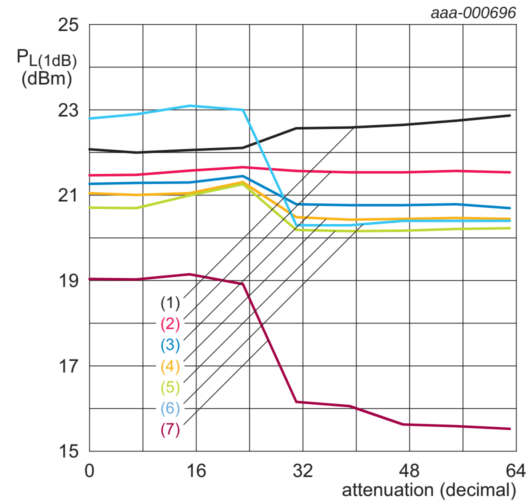
(1) I_{AMP2} = 0 mA

(2) I_{AMP2} = −10 mA

(3) I_{AMP2} = −20 mA

(4) I_{AMP2} = −30 mA

Fig 32. Total current as a function of ambient temperature; typical values



V_{SUP} = 5 V; T_{amb} = 85 °C; maximum current setting; attenuation states 0, 7, 15, 23, 31, 39, 47, 55 and 63 are depicted.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

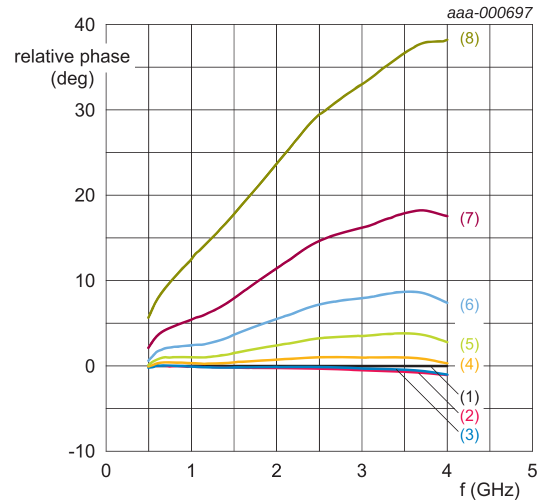
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 33. Output power at 1 dB gain compression as a function of attenuation state; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting.

(1) attenuation = 0x00 (minimum)

(2) attenuation = 0x01

(3) attenuation = 0x02

(4) attenuation = 0x04

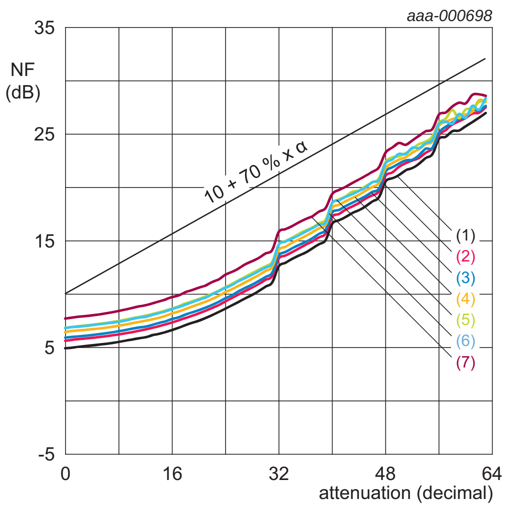
(5) attenuation = 0x08

(6) attenuation = 0x10

(7) attenuation = 0x20

(8) attenuation = 0x3F (maximum)

Fig 34. Relative phase as a function of frequency; typical values



V_{SUP} = 5 V; T_{amb} = 25 °C; maximum current setting.

(1) f = 0.7 GHz

(2) f = 1.4 GHz

(3) f = 1.7 GHz

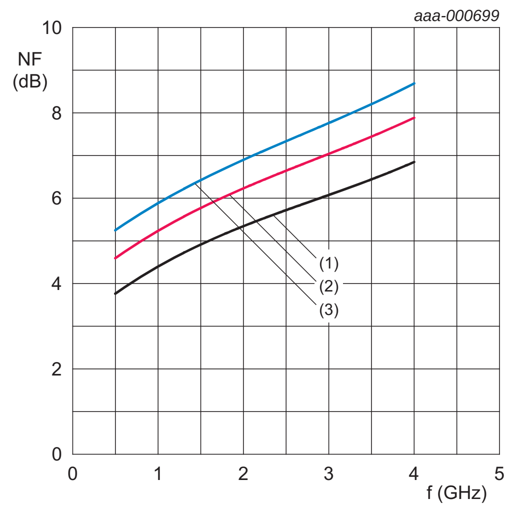
(4) f = 2.2 GHz

(5) f = 2.8 GHz

(6) f = 2.8 GHz and C_{sh} used

(7) f = 3.8 GHz

Fig 35. Noise figure as a function of attenuation state; typical values



V_{SUP} = 5 V; maximum gain and maximum current setting.

(1) T_{amb} = −40 °C

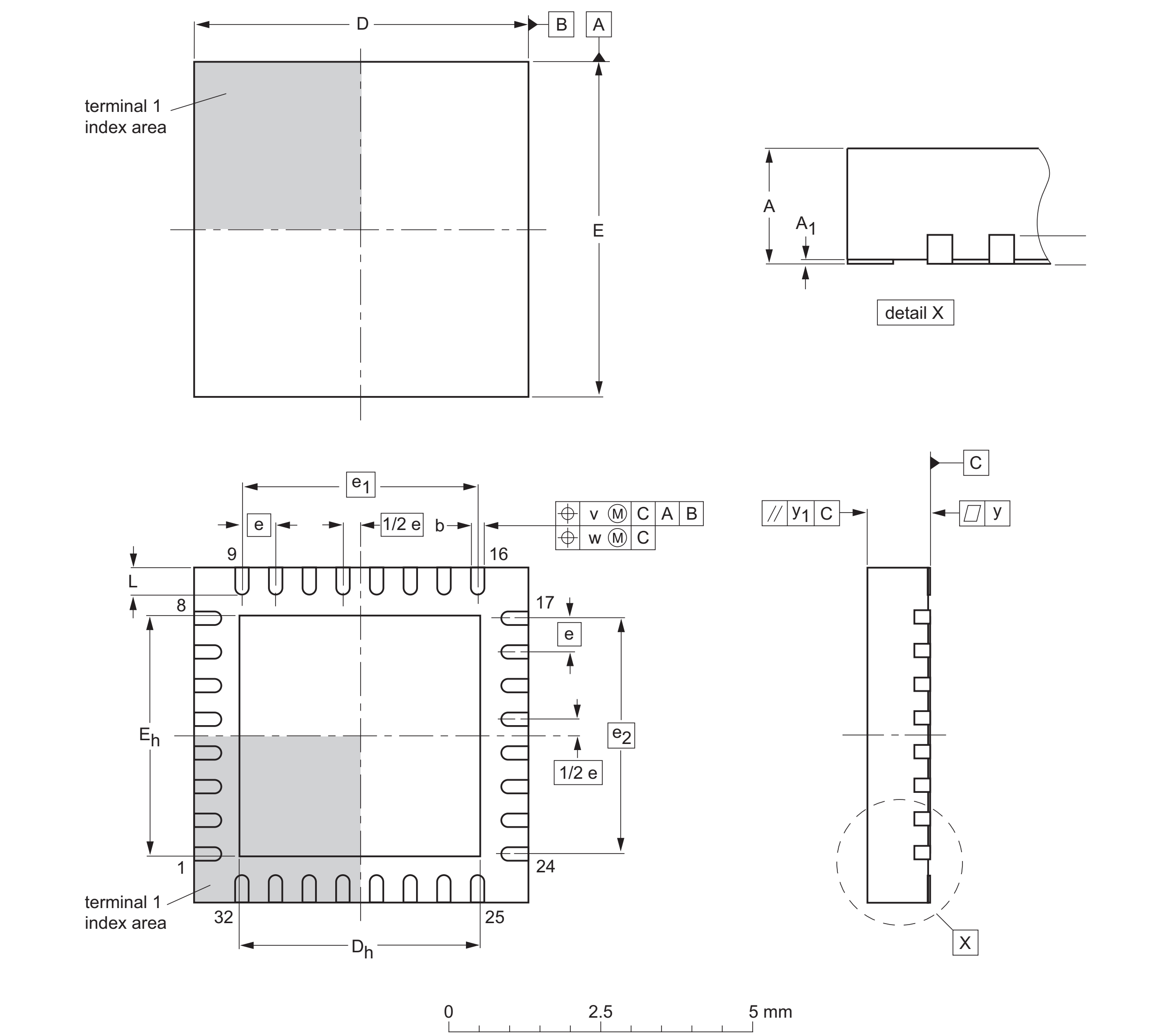
(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 36. Noise figure as a function of frequency; typical values

12. Package outline

HVQFN32: plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; body 5 x 5 x 0.85 mm **SOT617-3**



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
	max		0.05	0.30		5.1	3.75	5.1	3.75				0.5				
mm	nom	0.85			0.2					0.5	3.5	3.5		0.1	0.05	0.05	0.1
	min		0.00	0.18		4.9	3.45	4.9	3.45				0.3				

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

sot617-3_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT617-3		MO-220				~~11-06-14~~ 11-06-21

Fig 37. Package outline SOT617-3 (HVQFN32)

13. Packing information

The BGA7210 will be delivered in reel pack SMD 7”, 1500 pieces per reel.

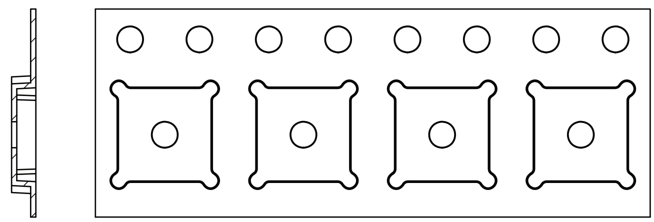


Fig 38. Carrier tape

14. Abbreviations

Table 15. Abbreviations

Acronym	Description
CDM	Charged Device Model
ESD	ElectroStatic Discharge
DSA	Digital Step Attenuator
HBM	Human Body Model
IF	Intermediate Frequency
MMIC	Monolithic Microwave Integrated Circuit
POR	Power-On Reset
RF	Radio Frequency
SPI	Serial Peripheral Interface
USB	Universal Serial Bus
WiMAX	Worldwide Interoperability for Microwave Access

15. Revision history

Table 16. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGA7210 v.5	20170120	Product data sheet	-	BGA7210 v.4
Modifications:	• Section 1: added BTS6001A according to our new naming convention			
BGA7210 v.4	20130128	Product data sheet	-	BGA7210 v.3
Modifications:	• Table 4: updated.			
BGA7210 v.3	20121224	Product data sheet	-	BGA7210 v.2
BGA7210 v.2	20120104	Product data sheet	-	BGA7210 v.1
BGA7210 v.1	20111213	Preliminary data sheet	-	-

16. Legal information

16.1 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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18. Contents

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Date of release: 20 January 2017
Document identifier: BGA7210