

# BGA2801

MMIC wideband amplifier

Rev. 2 — 29 October 2010

Product data sheet

## 1. Product profile

### 1.1 General description

Silicon Monolithic Microwave Integrated Circuit (MMIC) wideband amplifier with internal matching circuit in a 6-pin SOT363 plastic SMD package.

### 1.2 Features and benefits

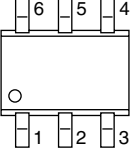
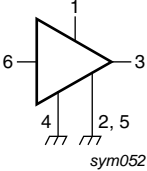
- Internally matched to  $50\ \Omega$
- A gain of 22.2 dB at 250 MHz increasing to 23.0 dB at 2150 MHz
- Output power at 1 dB gain compression = 2 dBm
- Supply current = 14.3 mA at a supply voltage of 3.3 V
- Reverse isolation > 29 dB up to 2 GHz
- Good linearity with low second order and third order products
- Noise figure = 4 dB at 950 MHz

### 1.3 Applications

- LNB IF amplifiers
- General purpose low noise wideband amplifier for frequencies between DC and 2.2 GHz

## 2. Pinning information

Table 1. Pinning

Pin	Description	Simplified outline	Graphic symbol
1	V <sub>CC</sub>		 sym052
2, 5	GND2		
3	RF_OUT		
4	GND1		
6	RF_IN		

## 3. Ordering information

Table 2. Ordering information

Type number	Package		Version
	Name	Description	
BGA2801	-	plastic surface-mounted package; 6 leads	SOT363



## 4. Marking

**Table 3. Marking**

Type number	Marking code	Description
BGA2801	*E8	* = - : made in Hong Kong * = p : made in Hong Kong * = W : made in China * = t : made in Malaysia

## 5. 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	RF input AC coupled	-0.5	3.6	V
$I_{CC}$	supply current		-	55	mA
$P_{tot}$	total power dissipation	$T_{sp} = 90\text{ °C}$	-	200	mW
$T_{stg}$	storage temperature		-40	+125	°C
$T_j$	junction temperature		-	125	°C
$P_{drive}$	drive power		-	-16.5	dBm

## 6. Thermal characteristics

**Table 5. Thermal characteristics**

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point	$P_{tot} = 200\text{ mW}$ ; $T_{sp} = 90\text{ °C}$	300	K/W

## 7. Characteristics

**Table 6. Characteristics**

$V_{CC} = 3.3\text{ V}$ ;  $Z_S = Z_L = 50\ \Omega$ ;  $P_i = -30\text{ dBm}$ ;  $T_{amb} = 25\text{ °C}$ ; measured on demo board; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC}$	supply voltage		3.0	3.3	3.6	V
$I_{CC}$	supply current		12.2	14.3	16.3	mA
$G_p$	power gain	$f = 250\text{ MHz}$	21.6	22.2	22.8	dB
		$f = 950\text{ MHz}$	21.7	22.4	23.1	dB
		$f = 2150\text{ MHz}$	21.5	23.0	24.4	dB
$RL_{in}$	input return loss	$f = 250\text{ MHz}$	15	17	19	dB
		$f = 950\text{ MHz}$	15	17	19	dB
		$f = 2150\text{ MHz}$	10	12	19	dB
$RL_{out}$	output return loss	$f = 250\text{ MHz}$	13	17	22	dB
		$f = 950\text{ MHz}$	14	15	16	dB
		$f = 2150\text{ MHz}$	10	12	15	dB

**Table 6. Characteristics ...continued** $V_{CC} = 3.3\text{ V}$ ;  $Z_S = Z_L = 50\ \Omega$ ;  $P_i = -30\text{ dBm}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ ; measured on demo board; unless otherwise specified.

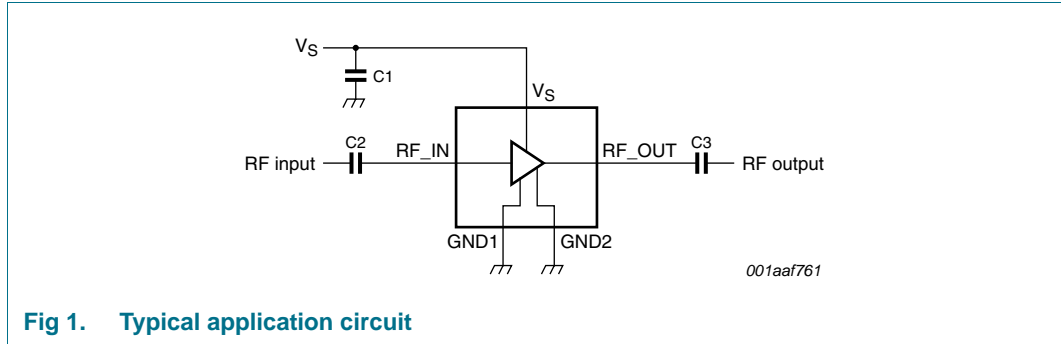
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
ISL	isolation	$f = 250\text{ MHz}$	58	78	99	dB
		$f = 950\text{ MHz}$	46	47	49	dB
		$f = 2150\text{ MHz}$	29	32	34	dB
NF	noise figure	$f = 250\text{ MHz}$	3.4	3.8	4.3	dB
		$f = 950\text{ MHz}$	3.4	3.8	4.3	dB
		$f = 2150\text{ MHz}$	3.5	3.9	4.4	dB
$B_{-3dB}$	-3 dB bandwidth	3 dB below gain at 1 GHz	2.5	2.8	3.1	GHz
K	Rollett stability factor	$f = 250\text{ MHz}$	252	308	363	
		$f = 950\text{ MHz}$	7	8	10	
		$f = 2150\text{ MHz}$	0.7	1.3	1.9	
$P_{L(sat)}$	saturated output power	$f = 250\text{ MHz}$	4	4	5	dBm
		$f = 950\text{ MHz}$	2	4	5	dBm
		$f = 2150\text{ MHz}$	1	2	3	dBm
$P_{L(1dB)}$	output power at 1 dB gain compression	$f = 250\text{ MHz}$	1	2	3	dBm
		$f = 950\text{ MHz}$	0	2	3	dBm
		$f = 2150\text{ MHz}$	-1	0	1	dBm
$IP3_I$	input third-order intercept point	$P_{drive} = -34\text{ dBm}$ (for each tone)				
		$f_1 = 250\text{ MHz}$ ; $f_2 = 251\text{ MHz}$	-10	-8	-6	dBm
		$f_1 = 950\text{ MHz}$ ; $f_2 = 951\text{ MHz}$	-11	-8	-6	dBm
$IP3_O$	output third-order intercept point	$P_{drive} = -34\text{ dBm}$ (for each tone)				
		$f_1 = 250\text{ MHz}$ ; $f_2 = 251\text{ MHz}$	12	14	16	dBm
		$f_1 = 950\text{ MHz}$ ; $f_2 = 951\text{ MHz}$	12	14	16	dBm
$P_{L(2H)}$	second harmonic output power	$P_{drive} = -31\text{ dBm}$				
		$f_{1H} = 250\text{ MHz}$ ; $f_{2H} = 500\text{ MHz}$	-62	-60	-58	dBm
		$f_{1H} = 950\text{ MHz}$ ; $f_{2H} = 1900\text{ MHz}$	-51	-50	-48	dBm
$\Delta IM2$	second-order intermodulation distance	$P_{drive} = -34\text{ dBm}$ (for each tone)				
		$f_1 = 250\text{ MHz}$ ; $f_2 = 251\text{ MHz}$	34	45	56	dBc
		$f_1 = 950\text{ MHz}$ ; $f_2 = 951\text{ MHz}$	27	39	50	dBc

## 8. Application information

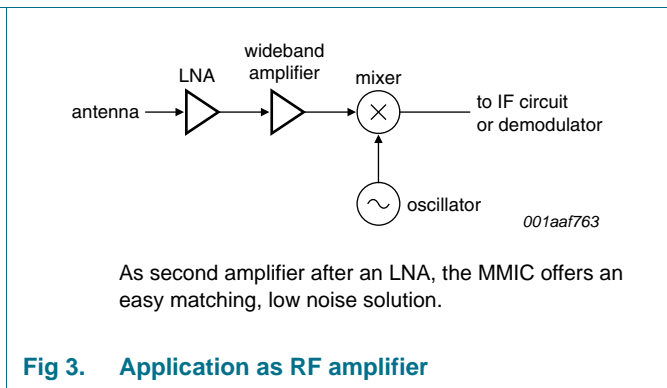
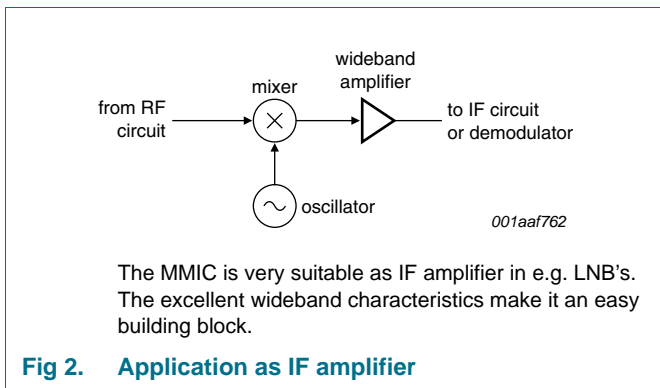
[Figure 1](#) shows a typical application circuit for the BGA2801 MMIC. The device is internally matched to  $50\ \Omega$ , and therefore does not need any external matching. The value of the input and output DC blocking capacitors C2 and C3 should not be more than 100 pF for applications above 100 MHz. However, when the device is operated below 100 MHz, the capacitor value should be increased.

The 22 nF supply decoupling capacitor C1 should be located as close as possible to the MMIC.

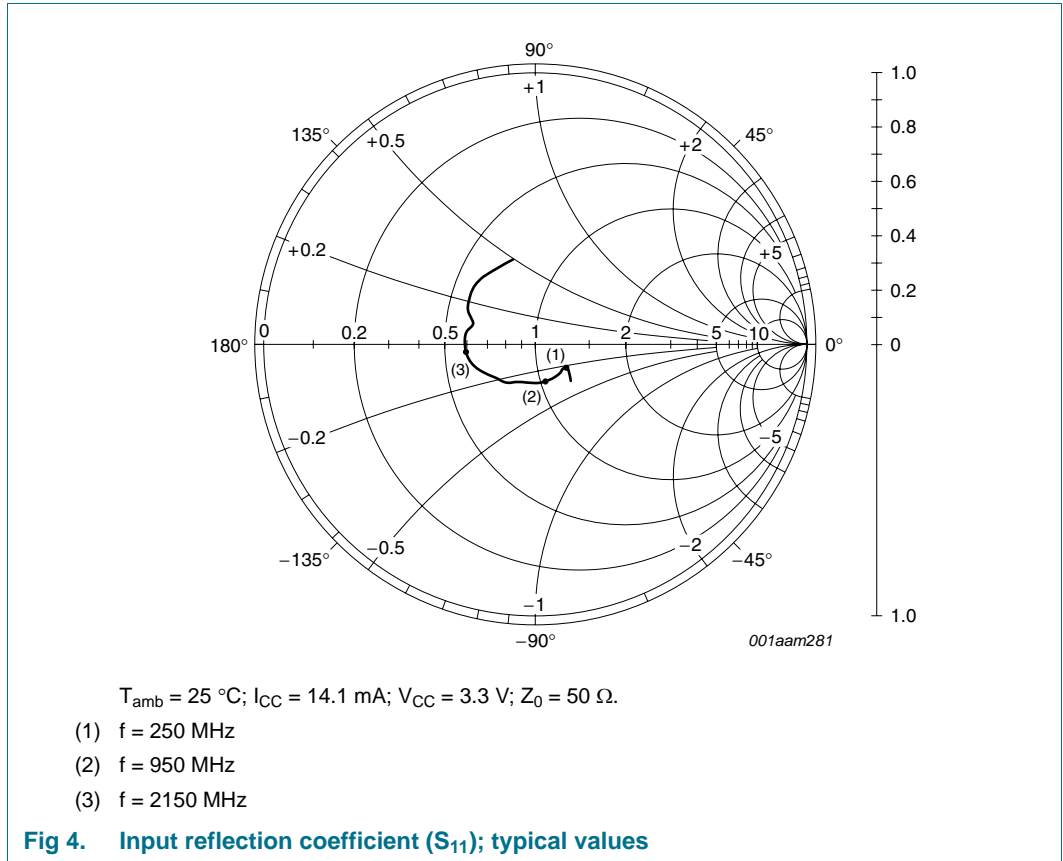
The PCB top ground plane, connected to pins 2, 4 and 5 must be as close as possible to the MMIC, preferably also below the MMIC. When using via holes, use multiple via holes as close as possible to the MMIC.

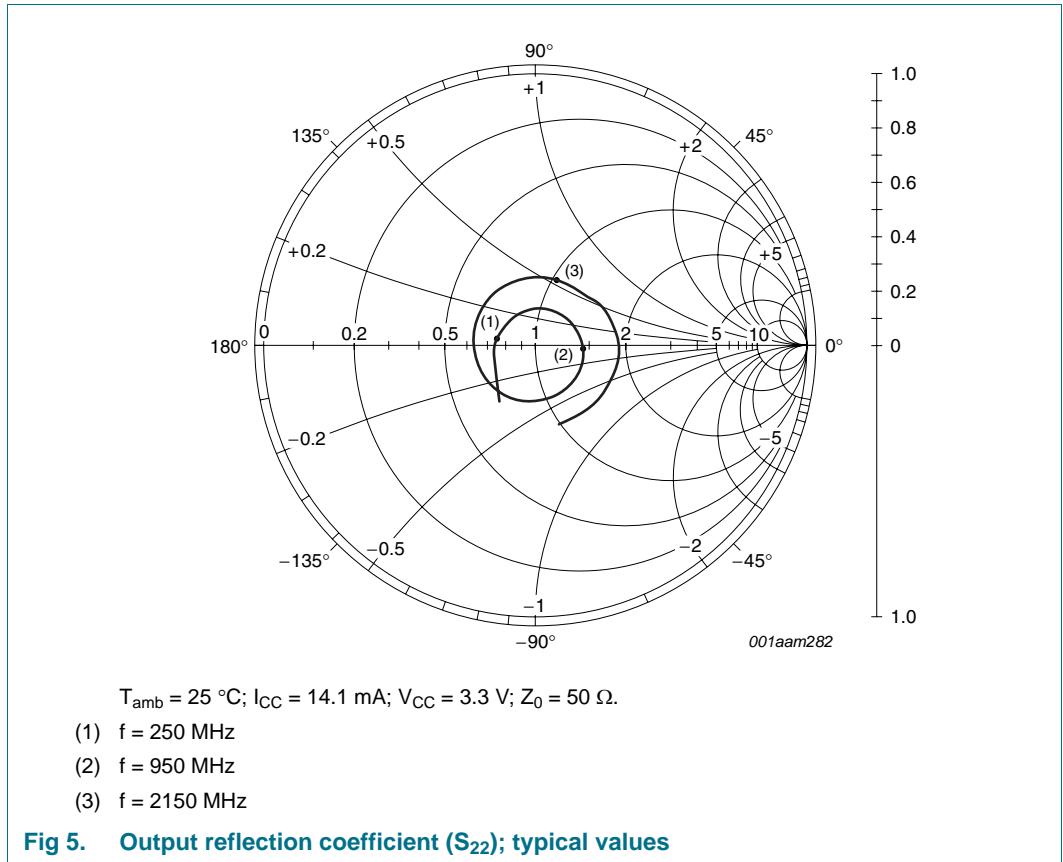


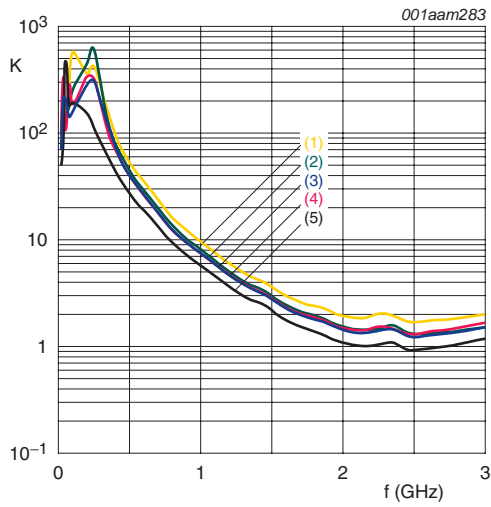
**8.1 Application examples**



**8.2 Graphs**



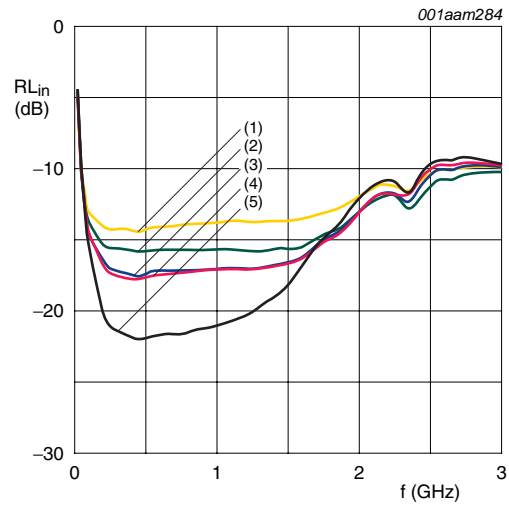




$P_{drive} = -40 \text{ dBm}; Z_0 = 50 \Omega.$

- (1)  $V_{CC} = 3.0 \text{ V}; T_{amb} = 85 \text{ }^\circ\text{C}; I_{CC} = 12.52 \text{ mA}$
- (2)  $V_{CC} = 3.0 \text{ V}; T_{amb} = -40 \text{ }^\circ\text{C}; I_{CC} = 12.67 \text{ mA}$
- (3)  $V_{CC} = 3.3 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}; I_{CC} = 14.08 \text{ mA}$
- (4)  $V_{CC} = 3.6 \text{ V}; T_{amb} = 85 \text{ }^\circ\text{C}; I_{CC} = 15.30 \text{ mA}$
- (5)  $V_{CC} = 3.6 \text{ V}; T_{amb} = -40 \text{ }^\circ\text{C}; I_{CC} = 16.51 \text{ mA}$

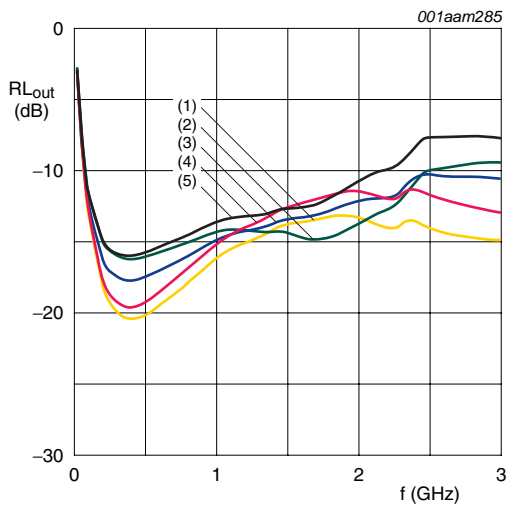
**Fig 6. Rollett stability factor as function of frequency; typical values**



$P_{drive} = -40 \text{ dBm}; Z_0 = 50 \Omega.$

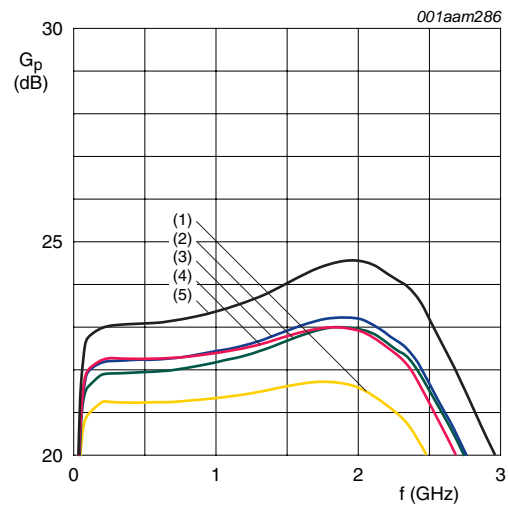
- (1)  $V_{CC} = 3.0 \text{ V}; T_{amb} = 85 \text{ }^\circ\text{C}; I_{CC} = 12.52 \text{ mA}$
- (2)  $V_{CC} = 3.0 \text{ V}; T_{amb} = -40 \text{ }^\circ\text{C}; I_{CC} = 12.67 \text{ mA}$
- (3)  $V_{CC} = 3.3 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}; I_{CC} = 14.08 \text{ mA}$
- (4)  $V_{CC} = 3.6 \text{ V}; T_{amb} = 85 \text{ }^\circ\text{C}; I_{CC} = 15.30 \text{ mA}$
- (5)  $V_{CC} = 3.6 \text{ V}; T_{amb} = -40 \text{ }^\circ\text{C}; I_{CC} = 16.51 \text{ mA}$

**Fig 7. Input return loss as function of frequency; typical values**



- $P_{drive} = -40\text{ dBm}; Z_0 = 50\ \Omega.$
- (1)  $V_{CC} = 3.0\text{ V}; T_{amb} = 85\text{ }^\circ\text{C}; I_{CC} = 12.52\text{ mA}$
  - (2)  $V_{CC} = 3.0\text{ V}; T_{amb} = -40\text{ }^\circ\text{C}; I_{CC} = 12.67\text{ mA}$
  - (3)  $V_{CC} = 3.3\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}; I_{CC} = 14.08\text{ mA}$
  - (4)  $V_{CC} = 3.6\text{ V}; T_{amb} = 85\text{ }^\circ\text{C}; I_{CC} = 15.30\text{ mA}$
  - (5)  $V_{CC} = 3.6\text{ V}; T_{amb} = -40\text{ }^\circ\text{C}; I_{CC} = 16.51\text{ mA}$

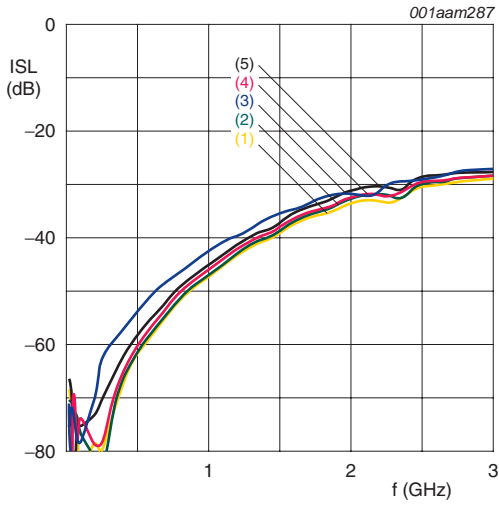
**Fig 8. Output return loss as function of frequency; typical values**



- $P_{drive} = -40\text{ dBm}; Z_0 = 50\ \Omega.$
- (1)  $V_{CC} = 3.0\text{ V}; T_{amb} = 85\text{ }^\circ\text{C}; I_{CC} = 12.52\text{ mA}$
  - (2)  $V_{CC} = 3.0\text{ V}; T_{amb} = -40\text{ }^\circ\text{C}; I_{CC} = 12.67\text{ mA}$
  - (3)  $V_{CC} = 3.3\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}; I_{CC} = 14.08\text{ mA}$
  - (4)  $V_{CC} = 3.6\text{ V}; T_{amb} = 85\text{ }^\circ\text{C}; I_{CC} = 15.30\text{ mA}$
  - (5)  $V_{CC} = 3.6\text{ V}; T_{amb} = -40\text{ }^\circ\text{C}; I_{CC} = 16.51\text{ mA}$

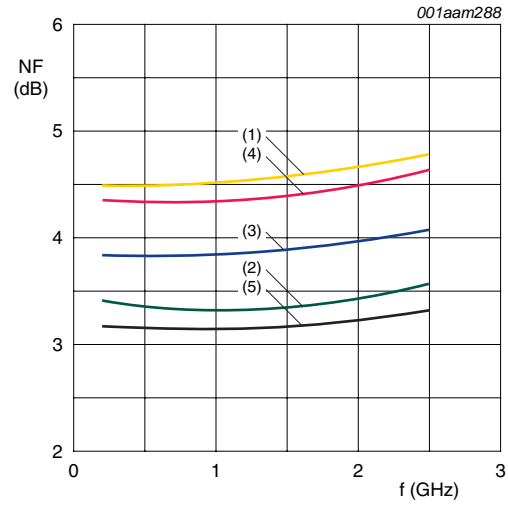
**Fig 9. Insertion power gain as function of frequency; typical values**





$P_{drive} = -40 \text{ dBm}; Z_0 = 50 \Omega.$   
 (1)  $V_{CC} = 3.0 \text{ V}; T_{amb} = 85 \text{ }^\circ\text{C}; I_{CC} = 12.52 \text{ mA}$   
 (2)  $V_{CC} = 3.0 \text{ V}; T_{amb} = -40 \text{ }^\circ\text{C}; I_{CC} = 12.67 \text{ mA}$   
 (3)  $V_{CC} = 3.3 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}; I_{CC} = 14.08 \text{ mA}$   
 (4)  $V_{CC} = 3.6 \text{ V}; T_{amb} = 85 \text{ }^\circ\text{C}; I_{CC} = 15.30 \text{ mA}$   
 (5)  $V_{CC} = 3.6 \text{ V}; T_{amb} = -40 \text{ }^\circ\text{C}; I_{CC} = 16.51 \text{ mA}$

**Fig 10. Isolation as function of frequency; typical values**



$Z_0 = 50 \Omega.$   
 (1)  $V_{CC} = 3.0 \text{ V}; T_{amb} = 85 \text{ }^\circ\text{C}; I_{CC} = 12.52 \text{ mA}$   
 (2)  $V_{CC} = 3.0 \text{ V}; T_{amb} = -40 \text{ }^\circ\text{C}; I_{CC} = 12.67 \text{ mA}$   
 (3)  $V_{CC} = 3.3 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}; I_{CC} = 14.08 \text{ mA}$   
 (4)  $V_{CC} = 3.6 \text{ V}; T_{amb} = 85 \text{ }^\circ\text{C}; I_{CC} = 15.30 \text{ mA}$   
 (5)  $V_{CC} = 3.6 \text{ V}; T_{amb} = -40 \text{ }^\circ\text{C}; I_{CC} = 16.51 \text{ mA}$

**Fig 11. Noise figure as function of frequency; typical values**

8.3 Tables

**Table 7. Supply current over temperature and supply voltages**

Typical values.

Symbol	Parameter	Conditions	T <sub>amb</sub> (°C)			Unit
			-40	25	85	
I <sub>CC</sub>	supply current	V <sub>CC</sub> = 3.0 V	12.67	12.24	12.52	mA
		V <sub>CC</sub> = 3.3 V	14.85	14.08	14.27	mA
		V <sub>CC</sub> = 3.6 V	16.51	15.65	15.30	mA

**Table 8. Second harmonic output power over temperature and supply voltages**

Typical values.

Symbol	Parameter	Conditions	T <sub>amb</sub> (°C)			Unit
			-40	25	85	
P <sub>L(2H)</sub>	second harmonic output power	f = 250 MHz; P <sub>drive</sub> = -33 dBm				
		V <sub>CC</sub> = 3.0 V	-53	-58	-59	dBm
		V <sub>CC</sub> = 3.3 V	-56	-60	-59	dBm
		V <sub>CC</sub> = 3.6 V	-58	-60	-59	dBm
		f = 950 MHz; P <sub>drive</sub> = -33 dBm				
		V <sub>CC</sub> = 3.0 V	-46	-50	-54	dBm
		V <sub>CC</sub> = 3.3 V	-47	-50	-53	dBm
		V <sub>CC</sub> = 3.6 V	-47	-49	-52	dBm

**Table 9. Input power at 1 dB gain compression over temperature and supply voltages**  
*Typical values.*

Symbol	Parameter	Conditions	T <sub>amb</sub> (°C)			Unit
			-40	25	85	
P <sub>i(1dB)</sub>	input power at 1 dB gain compression	f = 250 MHz				
		V <sub>CC</sub> = 3.0 V	-20	-20	-20	dBm
		V <sub>CC</sub> = 3.3 V	-20	-19	-19	dBm
		V <sub>CC</sub> = 3.6 V	-19	-19	-19	dBm
		f = 950 MHz				
		V <sub>CC</sub> = 3.0 V	-20	-20	-20	dBm
		V <sub>CC</sub> = 3.3 V	-20	-20	-20	dBm
		V <sub>CC</sub> = 3.6 V	-19	-19	-19	dBm
		f = 2150 MHz				
		V <sub>CC</sub> = 3.0 V	-22	-22	-22	dBm
		V <sub>CC</sub> = 3.3 V	-21	-21	-22	dBm
		V <sub>CC</sub> = 3.6 V	-21	-21	-22	dBm

**Table 10. Output power at 1 dB gain compression over temperature and supply voltages**  
*Typical values.*

Symbol	Parameter	Conditions	T <sub>amb</sub> (°C)			Unit
			-40	25	85	
P <sub>L(1dB)</sub>	output power at 1 dB gain compression	f = 250 MHz				
		V <sub>CC</sub> = 3.0 V	1	1	0	dBm
		V <sub>CC</sub> = 3.3 V	2	2	1	dBm
		V <sub>CC</sub> = 3.6 V	3	3	2	dBm
		f = 950 MHz				
		V <sub>CC</sub> = 3.0 V	1	0	0	dBm
		V <sub>CC</sub> = 3.3 V	2	2	1	dBm
		V <sub>CC</sub> = 3.6 V	3	3	2	dBm
		f = 2150 MHz				
		V <sub>CC</sub> = 3.0 V	0	-1	-2	dBm
		V <sub>CC</sub> = 3.3 V	1	0	-1	dBm
		V <sub>CC</sub> = 3.6 V	2	1	0	dBm

**Table 11. Saturated output power over temperature and supply voltages**  
*Typical values.*

Symbol	Parameter	Conditions	T <sub>amb</sub> (°C)			Unit
			-40	25	85	
P <sub>L(sat)</sub>	saturated output power	f = 250 MHz				
		V <sub>CC</sub> = 3.0 V	3	3	3	dBm
		V <sub>CC</sub> = 3.3 V	4	4	4	dBm
		V <sub>CC</sub> = 3.6 V	5	5	5	dBm
		f = 950 MHz				
		V <sub>CC</sub> = 3.0 V	3	3	2	dBm
		V <sub>CC</sub> = 3.3 V	4	4	3	dBm
		V <sub>CC</sub> = 3.6 V	5	5	4	dBm
		f = 2150 MHz				
		V <sub>CC</sub> = 3.0 V	2	1	0	dBm
		V <sub>CC</sub> = 3.3 V	3	2	1	dBm
		V <sub>CC</sub> = 3.6 V	4	3	1	dBm

**Table 12. Second-order intermodulation distance over temperature and supply voltages**  
*Typical values.*

Symbol	Parameter	Conditions	T <sub>amb</sub> (°C)			Unit
			-40	25	85	
ΔIM2	second-order intermodulation distance	f <sub>1</sub> = 250 MHz; f <sub>2</sub> = 251 MHz; P <sub>drive</sub> = -36 dBm				
		V <sub>CC</sub> = 3.0 V	48	48	42	dBc
		V <sub>CC</sub> = 3.3 V	52	45	41	dBc
		V <sub>CC</sub> = 3.6 V	49	44	41	dBc
		f <sub>1</sub> = 950 MHz; f <sub>2</sub> = 951 MHz; P <sub>drive</sub> = -36 dBm				
		V <sub>CC</sub> = 3.0 V	38	38	36	dBc
		V <sub>CC</sub> = 3.3 V	40	39	37	dBc
		V <sub>CC</sub> = 3.6 V	41	39	37	dBc

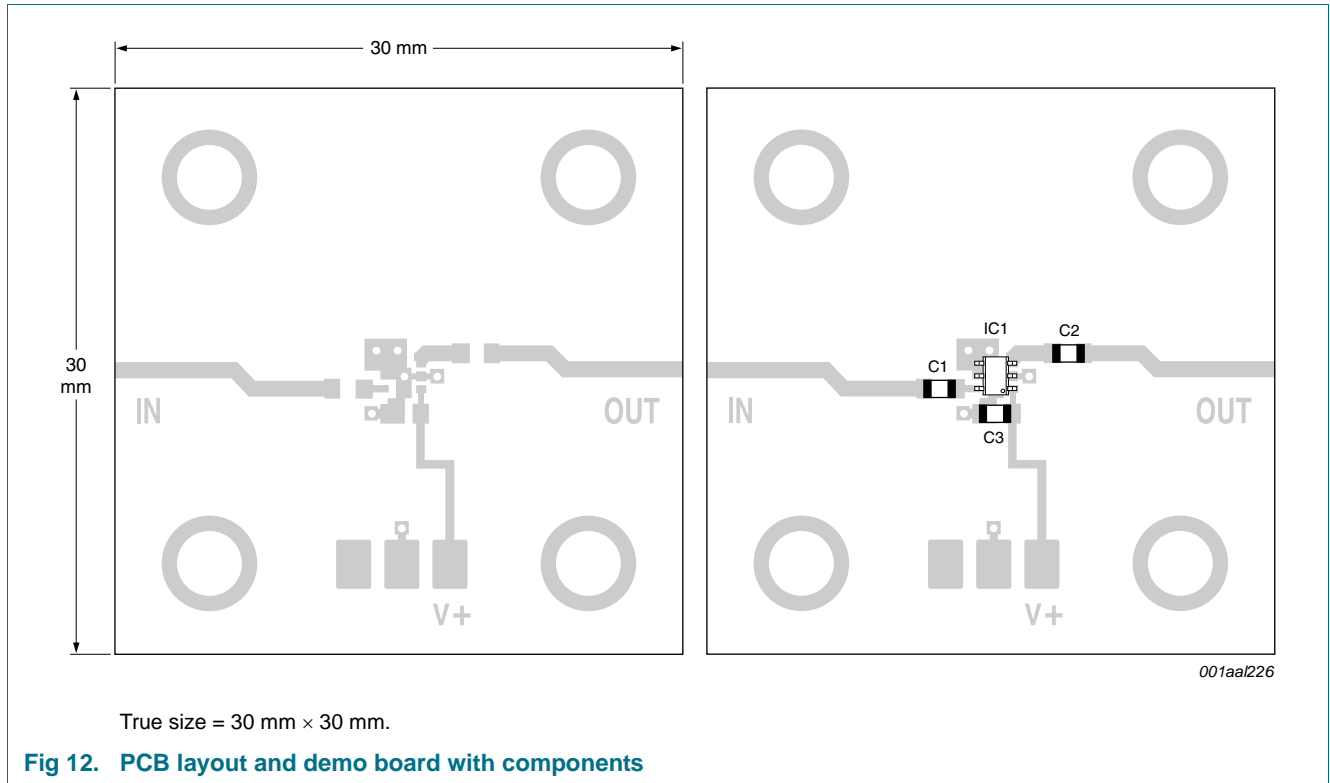
**Table 13. Output third-order intercept point over temperature and supply voltages**  
*Typical values.*

Symbol	Parameter	Conditions	T <sub>amb</sub> (°C)			Unit	
			-40	25	85		
IP <sub>3O</sub>	output third-order intercept point	f <sub>1</sub> = 250 MHz; f <sub>2</sub> = 251 MHz; P <sub>drive</sub> = -36 dBm	V <sub>CC</sub> = 3.0 V	13	13	12	dBm
			V <sub>CC</sub> = 3.3 V	15	14	14	dBm
			V <sub>CC</sub> = 3.6 V	16	15	14	dBm
		f <sub>1</sub> = 950 MHz; f <sub>2</sub> = 951 MHz; P <sub>drive</sub> = -36 dBm	V <sub>CC</sub> = 3.0 V	13	12	12	dBm
			V <sub>CC</sub> = 3.3 V	15	14	13	dBm
			V <sub>CC</sub> = 3.6 V	16	15	14	dBm
		f <sub>1</sub> = 2150 MHz; f <sub>2</sub> = 2151 MHz; P <sub>drive</sub> = -36 dBm	V <sub>CC</sub> = 3.0 V	9	8	7	dBm
			V <sub>CC</sub> = 3.3 V	11	9	8	dBm
			V <sub>CC</sub> = 3.6 V	12	10	8	dBm

**Table 14. -3 dB bandwidth over temperature and supply voltages**  
*Typical values.*

Symbol	Parameter	Conditions	T <sub>amb</sub> (°C)			Unit
			-40	25	85	
B <sub>-3dB</sub>	-3 dB bandwidth	V <sub>CC</sub> = 3.0 V	2.875	2.832	2.745	GHz
		V <sub>CC</sub> = 3.3 V	2.902	2.849	2.763	GHz
		V <sub>CC</sub> = 3.6 V	2.920	2.866	2.775	GHz

**9. Test information**



**Table 15. List of components used for the typical application**

Component	Description	Value	Dimensions
C1, C2	multilayer ceramic chip capacitor	100 pF	0603
C3	multilayer ceramic chip capacitor	22 nF	0603
IC1	BGA2801 MMIC		SOT363

10. Package outline

Plastic surface-mounted package; 6 leads

SOT363

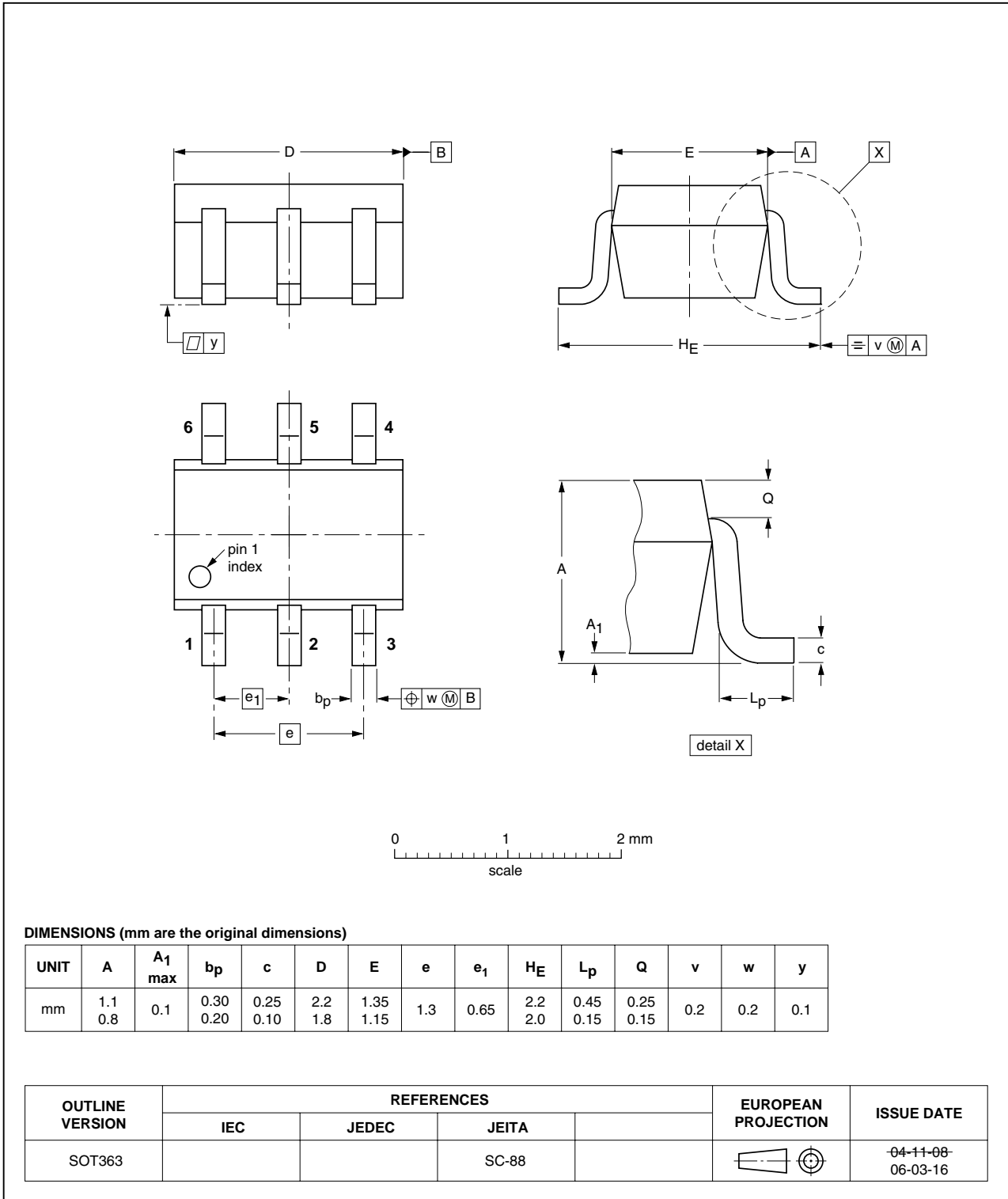


Fig 13. Package outline SOT363

## 11. Abbreviations

**Table 16. Abbreviations**

Acronym	Description
DC	Direct Current
IF	Intermediate Frequency
LNA	Low-Noise Amplifier
LNB	Low-Noise Block converter
PCB	Printed-Circuit Board
RF	Radio Frequency
SMD	Surface Mounted Device

## 12. Revision history

**Table 17. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGA2801 v.2	20101029	Product data sheet	-	BGA2801 v.1
Modifications	<ul style="list-style-type: none"><li>• <a href="#">Table 4 on page 2</a>: The minimum value for <math>V_{CC}</math> has been changed to <math>-0.5</math> V</li></ul>			
BGA2801 v.1	20100817	Product data sheet	-	-

## 13. Legal information

### 13.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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".

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