

# BGA7027

400 MHz to 2700 MHz 0.5 W high linearity silicon amplifier

Rev. 2 — 26 November 2010

Product data sheet

## 1. Product profile

### 1.1 General description

The BGA7027 MMIC is a one-stage amplifier, offered in a low-cost surface-mount package. It delivers 28 dBm output power at 1 dB gain compression and a superior performance up to 2700 MHz.

### 1.2 Features and benefits

- 400 MHz to 2700 MHz frequency operating range
- 11 dB small signal gain at 2 GHz
- 28 dBm output power at 1 dB gain compression
- Integrated active biasing
- External matching allows broad application optimization of the electrical performance
- 5 V single supply operation
- ESD protection at all pins

### 1.3 Applications

- Broadband CPE/MoCA
- WLAN/ISM/RFID
- Wireless infrastructure (base station, repeater, backhaul systems)
- Industrial applications
- E-metering
- Satellite Master Antenna TV (SMATV)

### 1.4 Quick reference data

**Table 1. Quick reference data**

Input and output impedances matched to 50  $\Omega$ . Typical values at:  $V_{CC} = 5$  V;  $T_{case} = 25$  °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f	frequency		[1] 400	-	2700	MHz
$G_p$	power gain	f = 2140 MHz	9.0	11.0	13.0	dB
$P_{L(1dB)}$	output power at 1 dB gain compression	f = 2140 MHz	26	28	-	dBm
IP3 <sub>O</sub>	output third-order intercept point	f = 2140 MHz	[2] 40.0	42.5	-	dBm

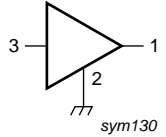
[1] Operation outside this range is possible but not guaranteed.

[2]  $P_L = 17$  dBm per tone; spacing = 1 MHz.



## 2. Pinning information

**Table 2. Pinning**

Pin	Description	Simplified outline	Graphic symbol
1	V <sub>CC(RF)</sub>	<a href="#">[1]</a>	
2	GND	<a href="#">[2]</a>	
3	RF_IN	<a href="#">[1]</a>	

[1] This pin is DC-coupled and requires an external DC-blocking capacitor.

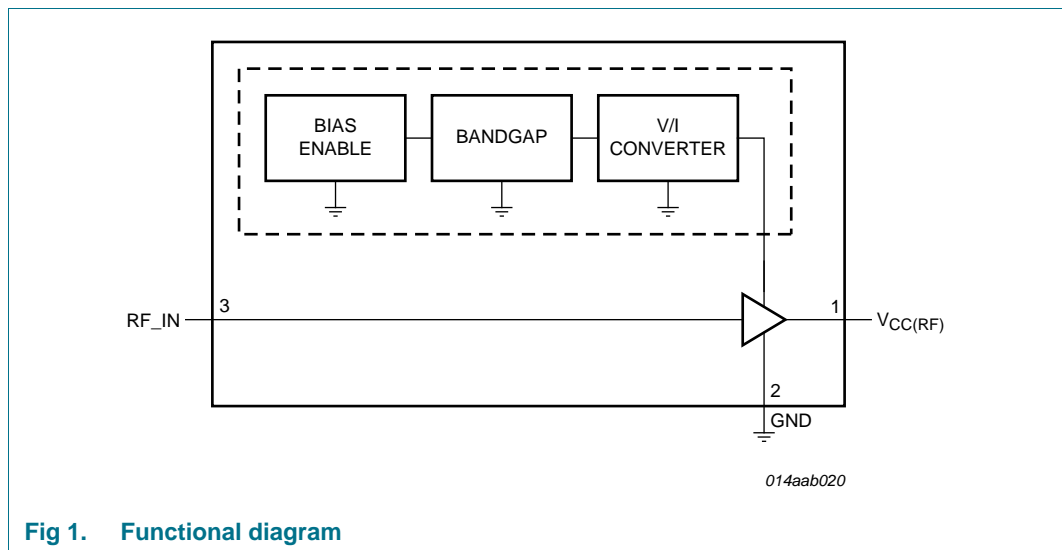
[2] The center metal base of the SOT89 also functions as heatsink for the power amplifier.

## 3. Ordering information

**Table 3. Ordering information**

Type number	Package		
	Name	Description	Version
BGA7027	-	plastic surface-mounted package; exposed die pad for good heat transfer; 3 leads	SOT89

## 4. Functional diagram



## 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		-	5.7	V
$P_{i(RF)}$	RF input power	$f = 2140$ MHz; switched	[1]	28	dBm
$T_{case}$	case temperature		-40	+85	°C
$T_j$	junction temperature		-	150	°C
$V_{ESD}$	electrostatic discharge voltage	Human Body Model (HBM); according to JEDEC standard 22-A114E	-	2000	V
		Charged Device Model (CDM); according to JEDEC standard 22-C101B	-	500	V

[1] Withstands switching between zero and maximum  $P_{i(RF)}$

## 6. Thermal characteristics

**Table 5. Thermal characteristics**

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-c)}$	thermal resistance from junction to case	$T_{case} = 85$ °C; $V_{CC} = 5$ V; $I_{CC} = 165$ mA	38	K/W

## 7. Static characteristics

**Table 6. Static characteristics**

Input and output impedances matched to 50  $\Omega$ . Typical values at  $T_{case} = 25$  °C, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC}$	supply voltage		-	5.0	-	V
$I_{CC}$	supply current	$V_{CC} = 5.0$ V	140	165	190	mA

## 8. Dynamic characteristics

**Table 7. Dynamic characteristics**

Input and output impedances matched to 50  $\Omega$ . Typical values at  $V_{CC} = 5$  V;  $T_{case} = 25$  °C, NXP application circuit; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f$	frequency		[1]	400	-	2700 MHz
$G_p$	power gain	$f = 940$ MHz	[2]	-	19.0	- dB
		$f = 1960$ MHz	[2]	-	11.5	- dB
		$f = 2140$ MHz	[2]	9.0	11.0	13.0

**Table 7. Dynamic characteristics ...continued**

Input and output impedances matched to 50  $\Omega$ . Typical values at  $V_{CC} = 5$  V;  $T_{case} = 25$  °C, NXP application circuit; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
P <sub>L(1dB)</sub>	output power at 1 dB gain compression	f = 940 MHz	-	29.0	-	dBm
		f = 1960 MHz	-	27.5	-	dBm
		f = 2140 MHz	26.0	28.0	-	dBm
IP <sub>3O</sub>	output third-order intercept point	f = 940 MHz [3]	-	41.5	-	dBm
		f = 1960 MHz [3]	-	43.0	-	dBm
		f = 2140 MHz [3]	40.0	42.5	-	dBm
NF	noise figure	f = 940 MHz	-	2.6	-	dB
		f = 1960 MHz	-	3.8	-	dB
		f = 2140 MHz	-	3.9	-	dB
RL <sub>in</sub>	input return loss	f = 940 MHz [2]	-	-16	-	dB
		f = 1960 MHz [2]	-	-8	-	dB
		f = 2140 MHz [2]	-	-8	-	dB
RL <sub>out</sub>	output return loss	f = 940 MHz [2]	-	-11	-	dB
		f = 1960 MHz [2]	-	-13	-	dB
		f = 2140 MHz [2]	-	-15	-	dB

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

[2] Defined at P<sub>i(RF)</sub> = -40 dBm; small signal conditions.

[3] P<sub>L</sub> = 17 dBm per tone; spacing = 1 MHz.

## 9. Scattering parameters

**Table 8. Scattering parameters, MMIC only**

$V_{CC} = 5$  V;  $I_{CC} = 165$  mA;  $T_{case} = 25$  °C.

f (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)
400	0.92	178	8.03	93	0.01	49	0.76	-176
500	0.92	176	6.55	89	0.01	53	0.75	-178
600	0.92	173	5.55	85	0.02	55	0.75	179
700	0.92	171	4.80	82	0.02	56	0.75	177
800	0.92	168	4.24	79	0.02	56	0.75	175
900	0.92	165	3.80	76	0.02	56	0.75	173
1000	0.92	162	3.46	72	0.03	55	0.76	170
1100	0.92	160	3.14	69	0.03	54	0.76	167
1200	0.92	157	2.85	66	0.03	53	0.76	165
1300	0.92	154	2.61	63	0.03	52	0.76	163
1400	0.93	152	2.39	61	0.03	50	0.77	161
1500	0.93	150	2.20	58	0.03	49	0.78	160
1600	0.93	149	2.03	56	0.04	48	0.78	159
1700	0.93	148	1.88	54	0.04	47	0.79	157

**Table 8. Scattering parameters, MMIC only ...continued** $V_{CC} = 5\text{ V}$ ;  $I_{CC} = 165\text{ mA}$ ;  $T_{case} = 25\text{ }^{\circ}\text{C}$ .

f (MHz)	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)
1800	0.94	147	1.75	63	0.04	47	0.80	157
1900	0.94	146	1.64	51	0.04	46	0.80	157
2000	0.94	146	1.53	50	0.04	46	0.80	157
2100	0.93	146	1.45	49	0.04	46	0.81	157
2200	0.93	147	1.39	49	0.05	46	0.81	157
2300	0.93	147	1.33	48	0.05	45	0.81	158
2400	0.92	147	1.29	48	0.05	45	0.80	159
2500	0.91	147	1.26	47	0.05	45	0.80	160
2600	0.91	148	1.24	46	0.06	45	0.80	160
2700	0.89	147	1.23	45	0.06	44	0.79	161

## 10. Reliability information

**Table 9. Reliability**

Life test	Conditions	Intrinsic failure rate
HTOL	according to JESD85; confidence level 60 %; $T_j = 55\text{ }^{\circ}\text{C}$ ; activation energy = 0.7 eV; acceleration factor determined according to the Arrhenius equation	4

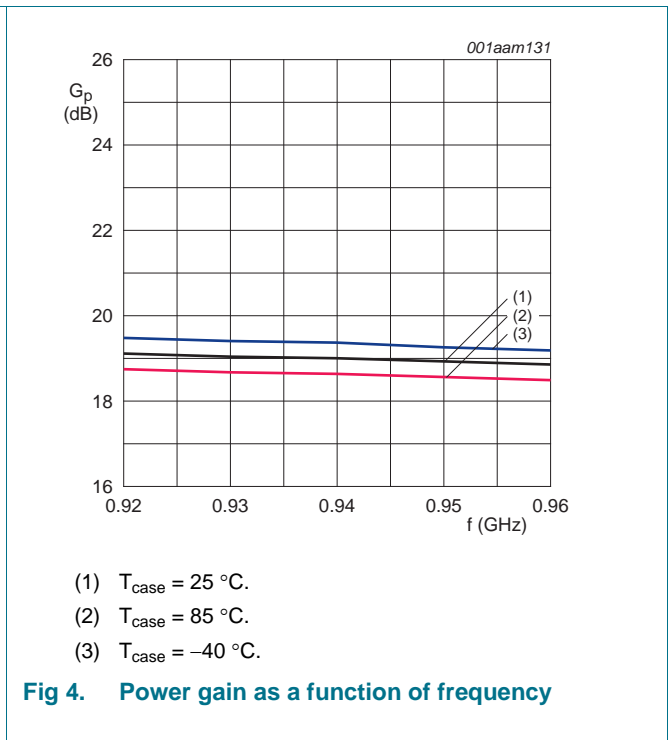
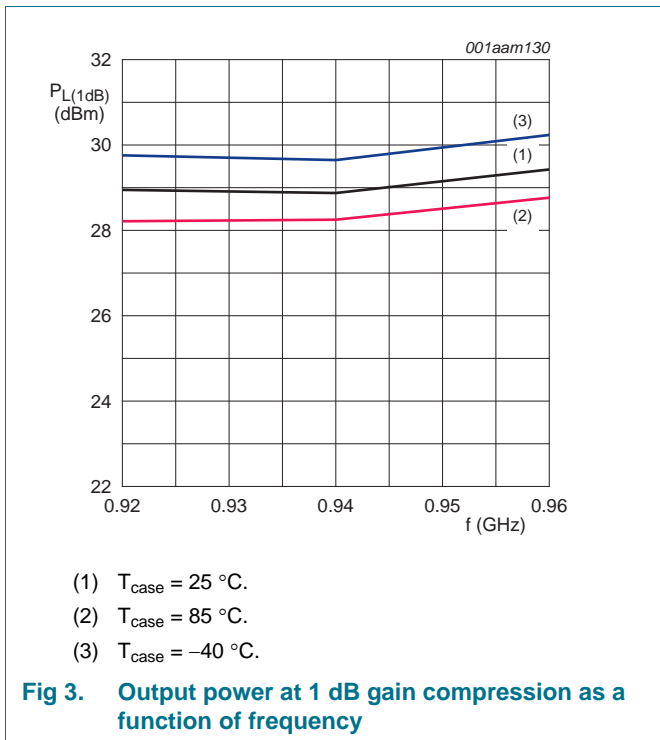
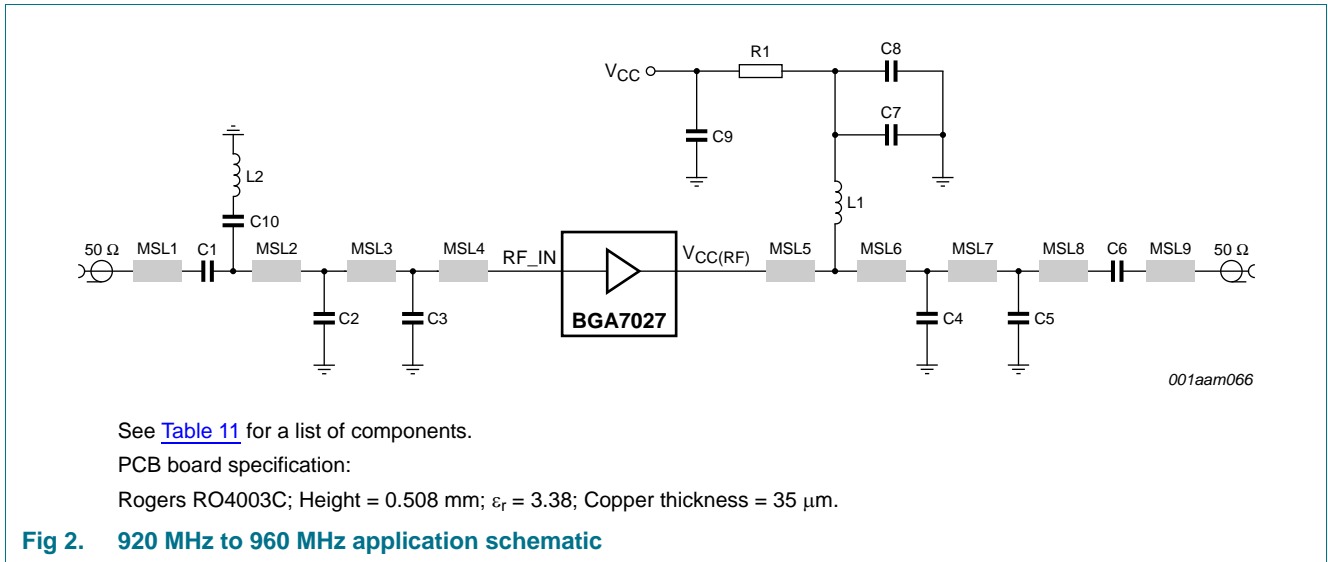
## 11. Moisture sensitivity

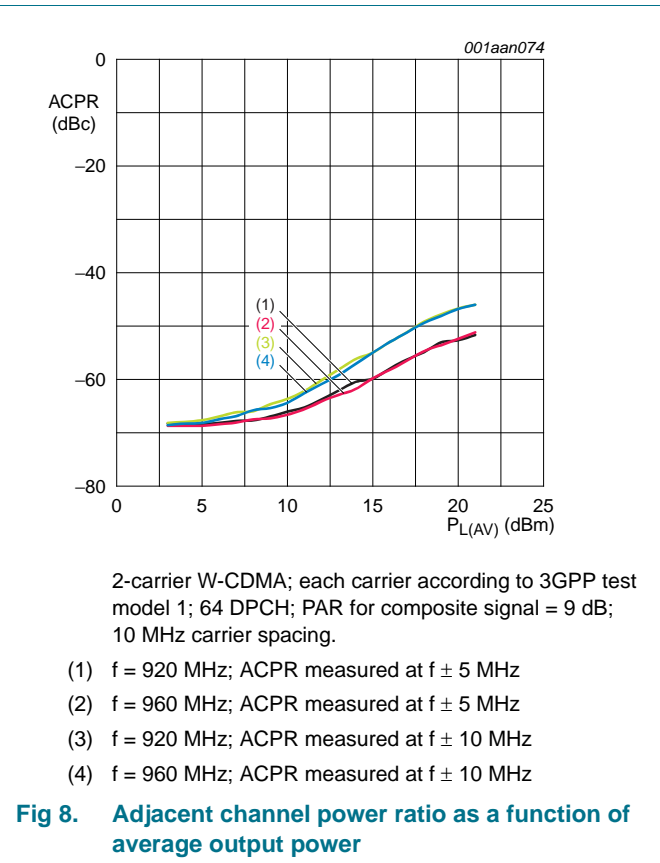
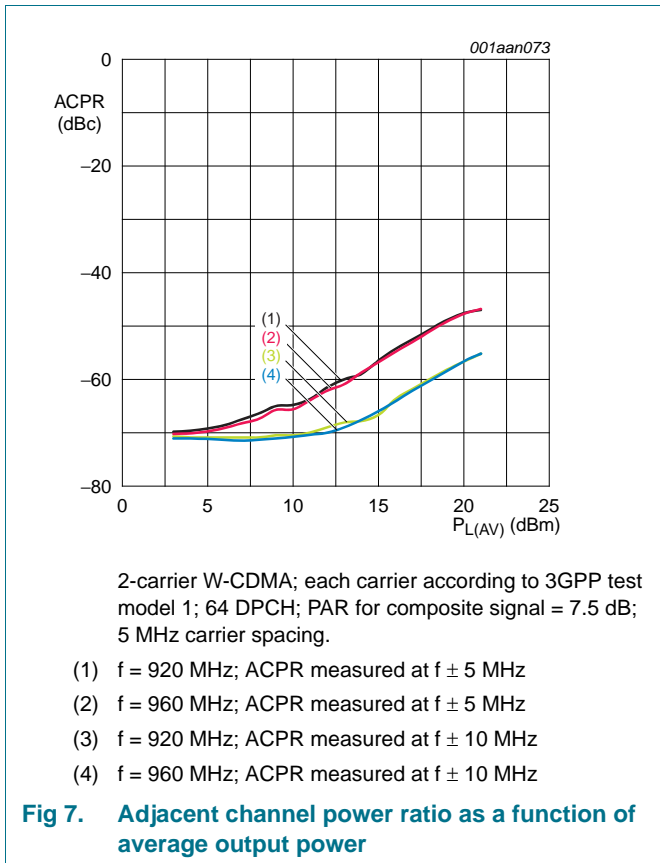
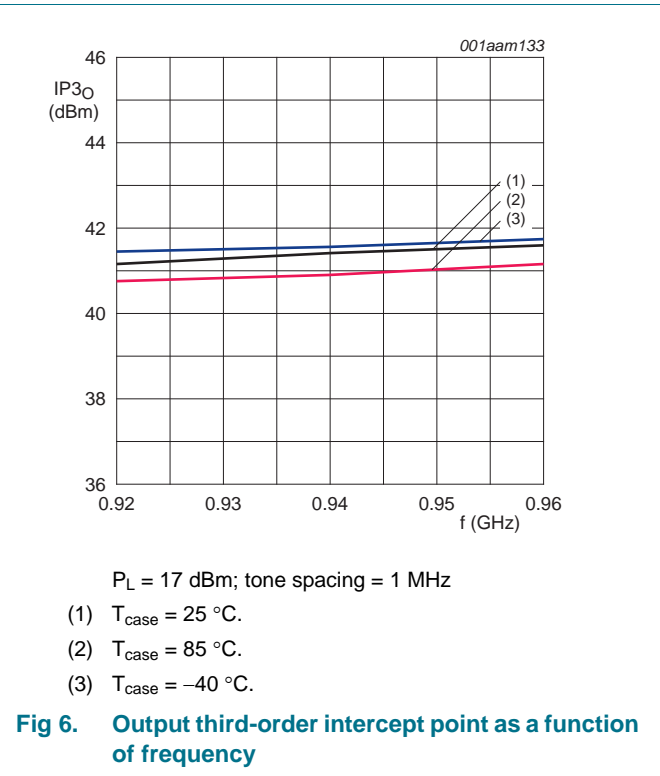
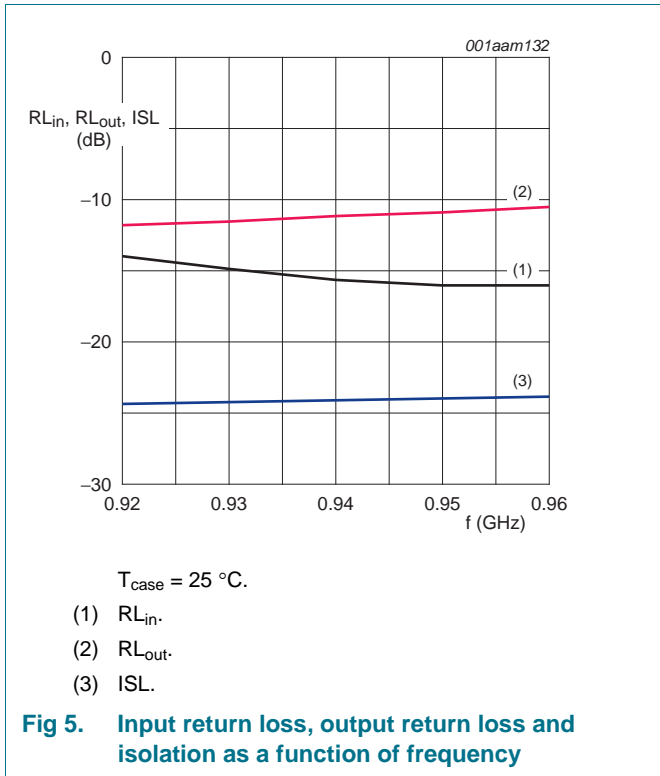
**Table 10. Moisture sensitivity level**

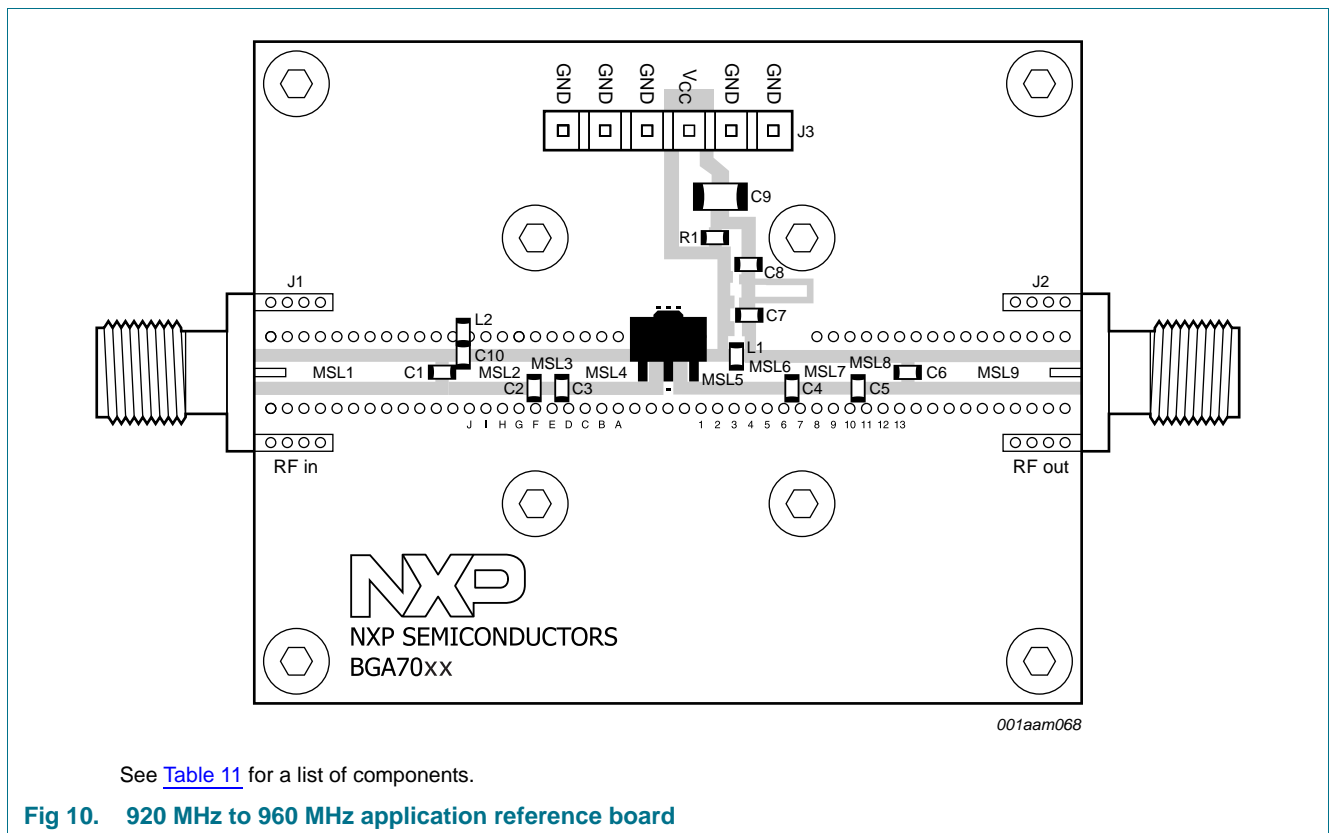
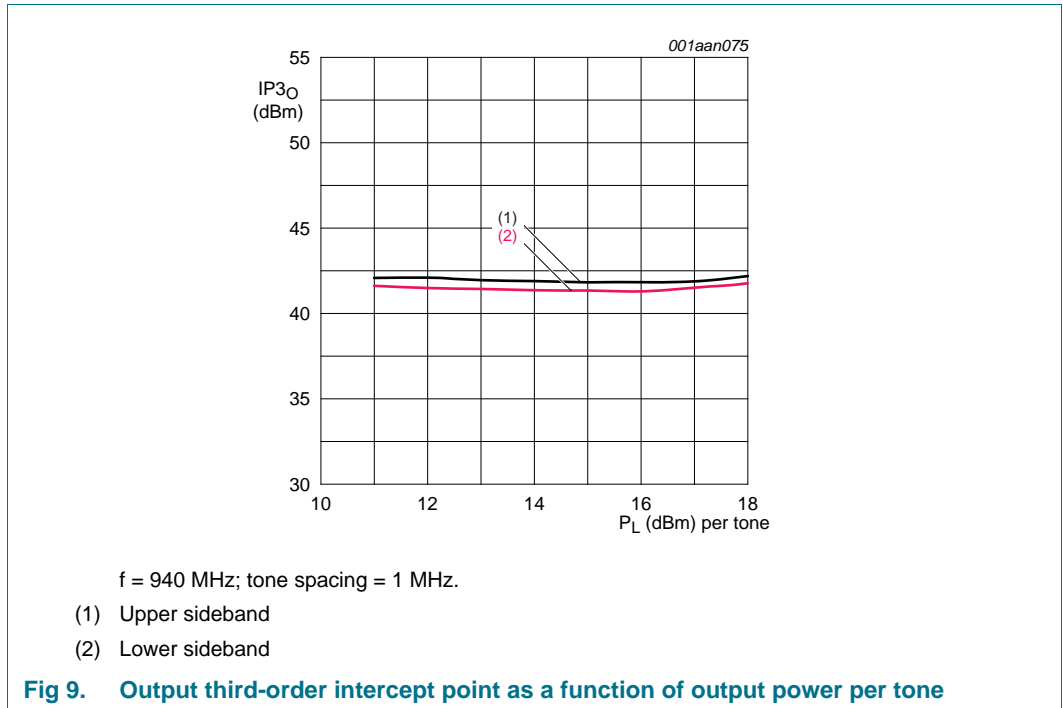
Test methodology	Class
JESD-22-A113	1

## 12. Application information

### 12.1 920 MHz to 960 MHz







See [Table 11](#) for a list of components.



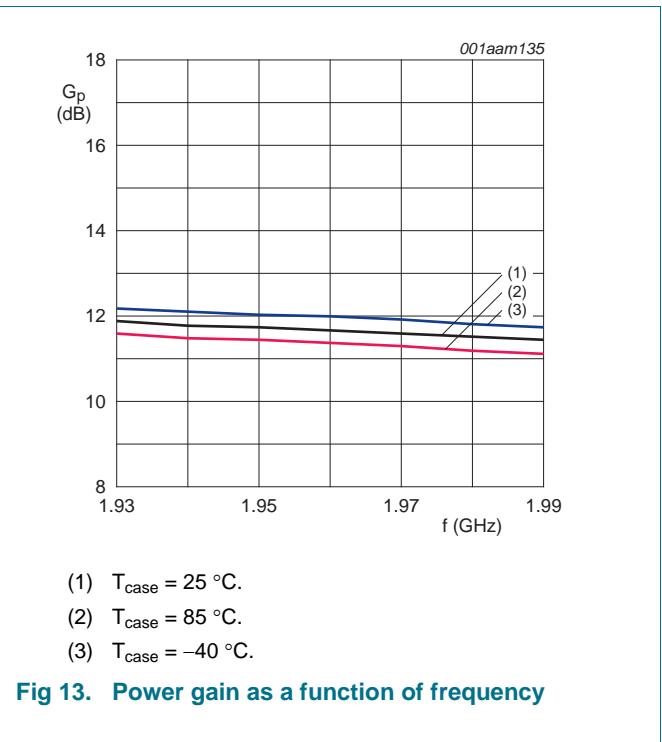
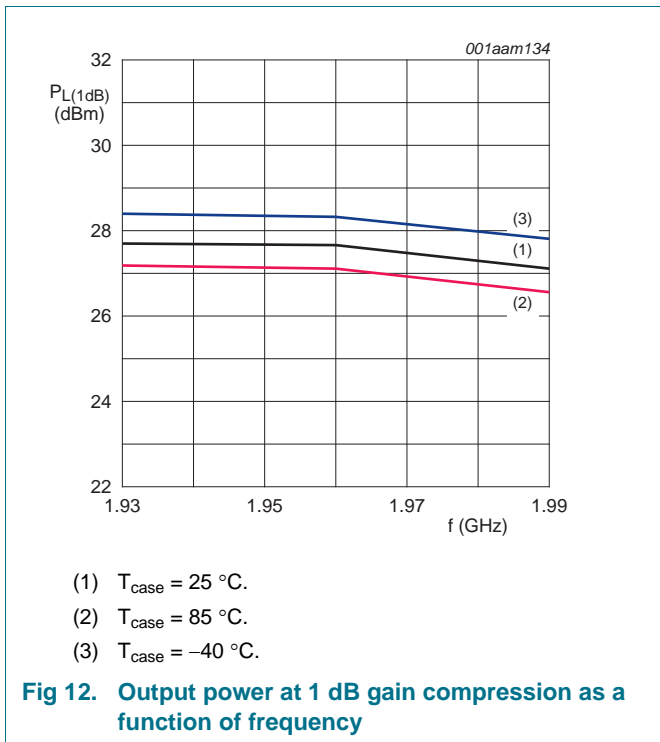
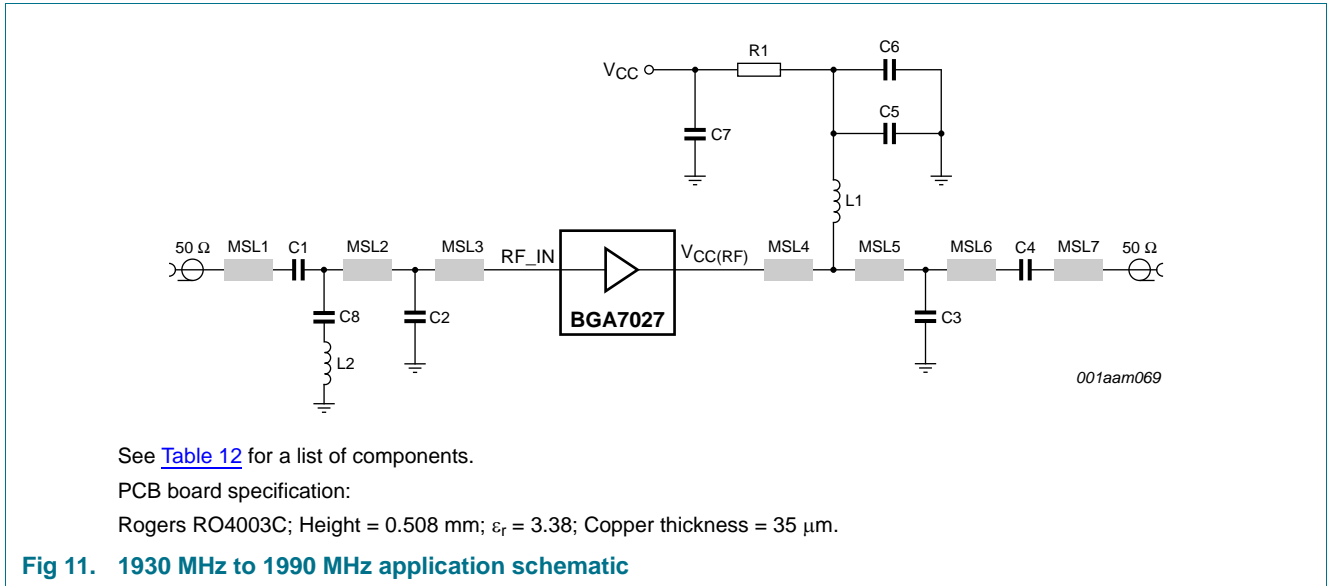
**Table 11. List of components of 920 MHz to 960 MHz**See [Figure 2](#) and [Figure 10](#) for component layout.Printed-Circuit Board (PCB): Rogers RO4003C stack; height = 0.508 mm; copper plating thickness = 35  $\mu$ m.

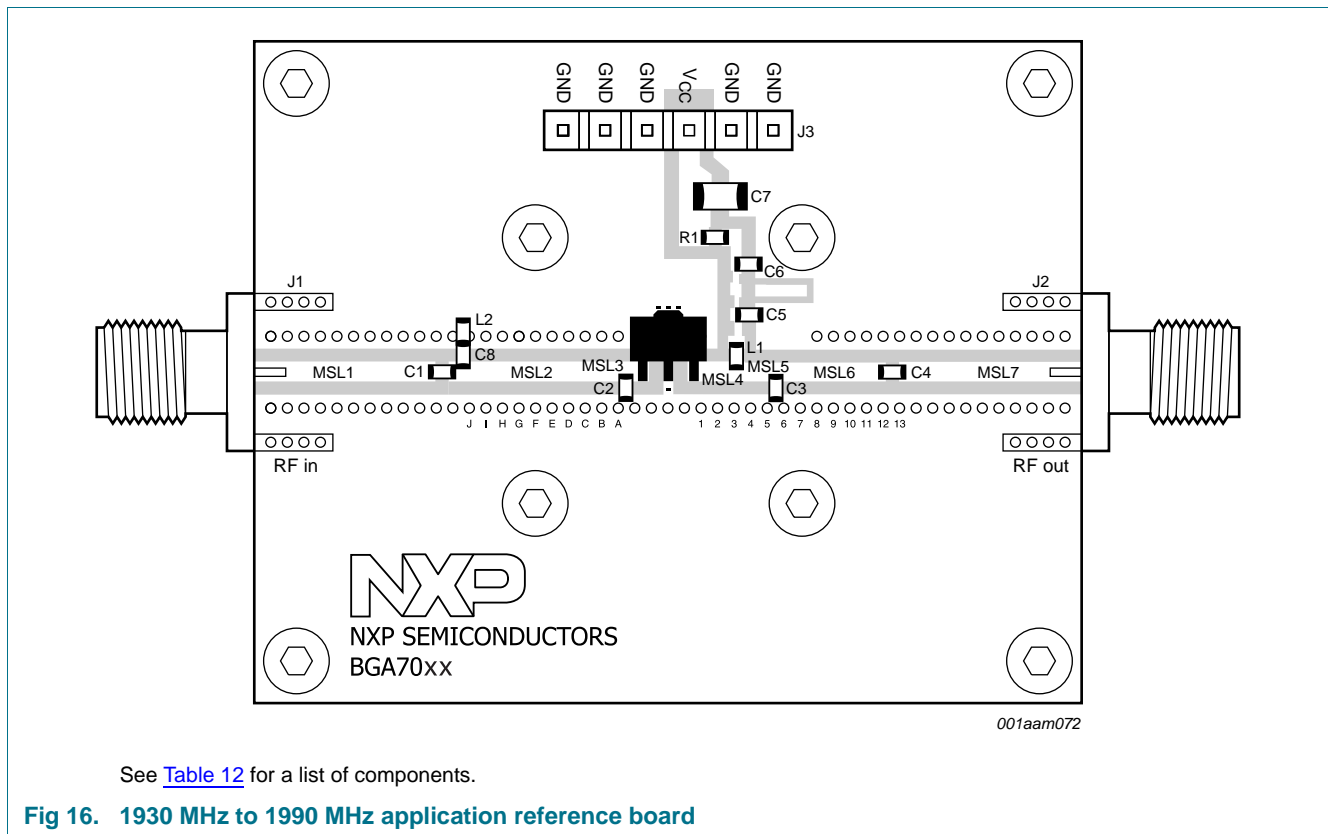
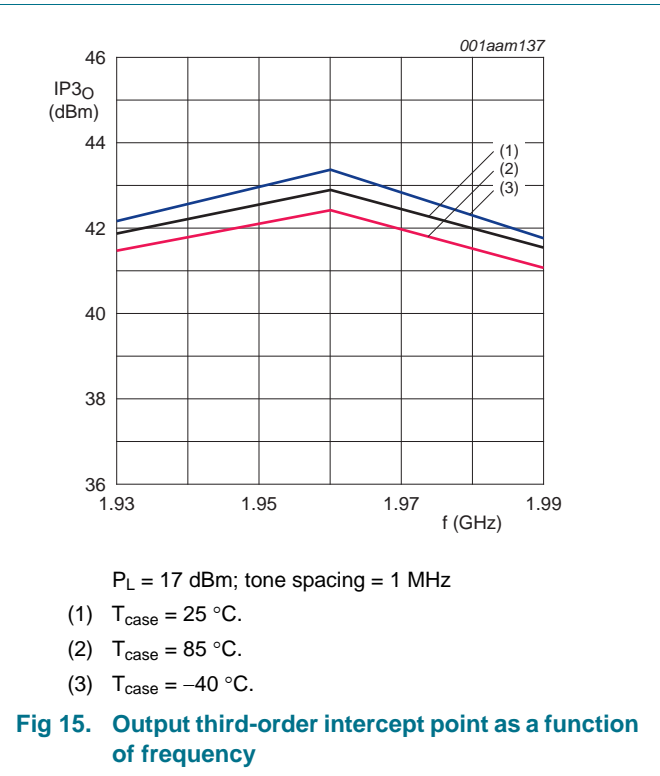
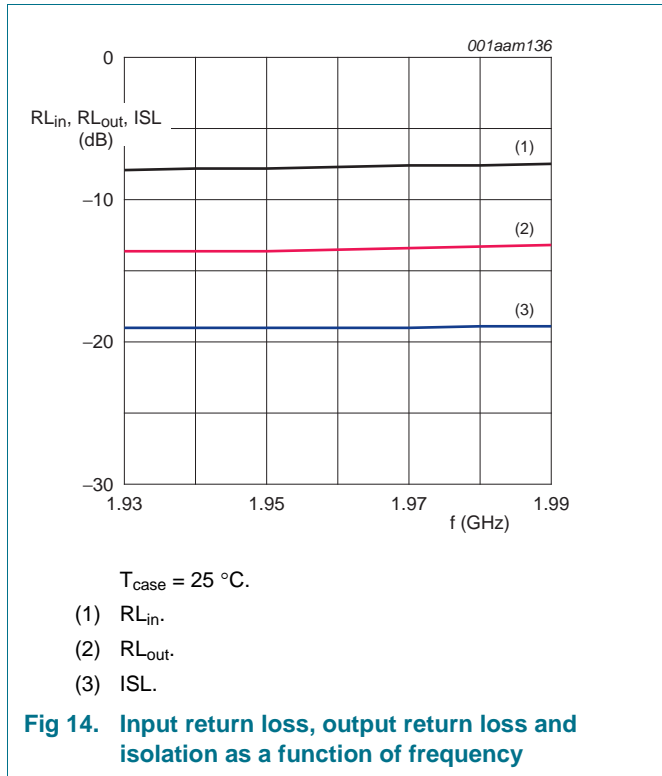
Component	Description	Value	Function	Remarks
C1, C6	capacitor	68 pF	DC blocking	Murata, GRM1885C1H680JA01D
C2	capacitor	5.6 pF	input match	Murata, GRM1885C1H5R6CZ01D
C3	capacitor	2.7 pF	input match	Murata, GRM1885C1H2R7CZ01D
C4	capacitor	1.0 pF	output match	Murata, GRM1885C1H1R0CZ01D
C5	capacitor	3.9 pF	output match	Murata, GRM1885C1H3R9CZ01D
C7	capacitor	68 pF	RF decoupling	Murata, GRM1885C1H680JA01D
C8	capacitor	100 nF	LF decoupling	AVX, 0603YC104KAT2A
C9	capacitor	10 $\mu$ F	LF decoupling	AVX, 1206ZG106ZAT2A
C10	capacitor	68 nF	IMD3 suppression	Murata, GRM1888R71H683KA93D
J1, J2	RF connector	SMA		Emerson Network Power, 142-0701-841
J3	DC connector	6 pins		MOLEX
L1	inductor	22 nH	DC Feed	Tyco Electronics, 36501J022JTDG
L2 <sup>[1]</sup>	inductor	33 nH	IMD3 suppression	Tyco Electronics, 36501J033JTDG
MSL1 <sup>[2]</sup>	micro stripline	1.14 mm $\times$ 0.8 mm $\times$ 10.95 mm	input match	
MSL2 <sup>[2]</sup>	micro stripline	1.14 mm $\times$ 0.8 mm $\times$ 4.3 mm	input match	
MSL3 <sup>[2]</sup>	micro stripline	1.14 mm $\times$ 0.8 mm $\times$ 1.7 mm	input match	
MSL4 <sup>[2]</sup>	micro stripline	1.14 mm $\times$ 0.8 mm $\times$ 4.8 mm	input match	
MSL5 <sup>[2]</sup>	micro stripline	1.14 mm $\times$ 0.8 mm $\times$ 2.7 mm	output match	
MSL6 <sup>[2]</sup>	micro stripline	1.14 mm $\times$ 0.8 mm $\times$ 3.2 mm	output match	
MSL7 <sup>[2]</sup>	micro stripline	1.14 mm $\times$ 0.8 mm $\times$ 4.0 mm	output match	
MSL8 <sup>[2]</sup>	micro stripline	1.14 mm $\times$ 0.8 mm $\times$ 1.6 mm	output match	
MSL9 <sup>[2]</sup>	micro stripline	1.14 mm $\times$ 0.8 mm $\times$ 10.95 mm	output match	
R1	resistor	0 $\Omega$		Multicomp, MC 0.063W 0603 0R

[1] Low Q inductor.

[2] MSL1 to MSL9 dimensions are specified as Width (W), Spacing (S) and Length (L).

12.2 1930 MHz to 1990 MHz





**Table 12. List of components of 1930 MHz to 1990 MHz**

See [Figure 11](#) and [Figure 16](#) for component layout.

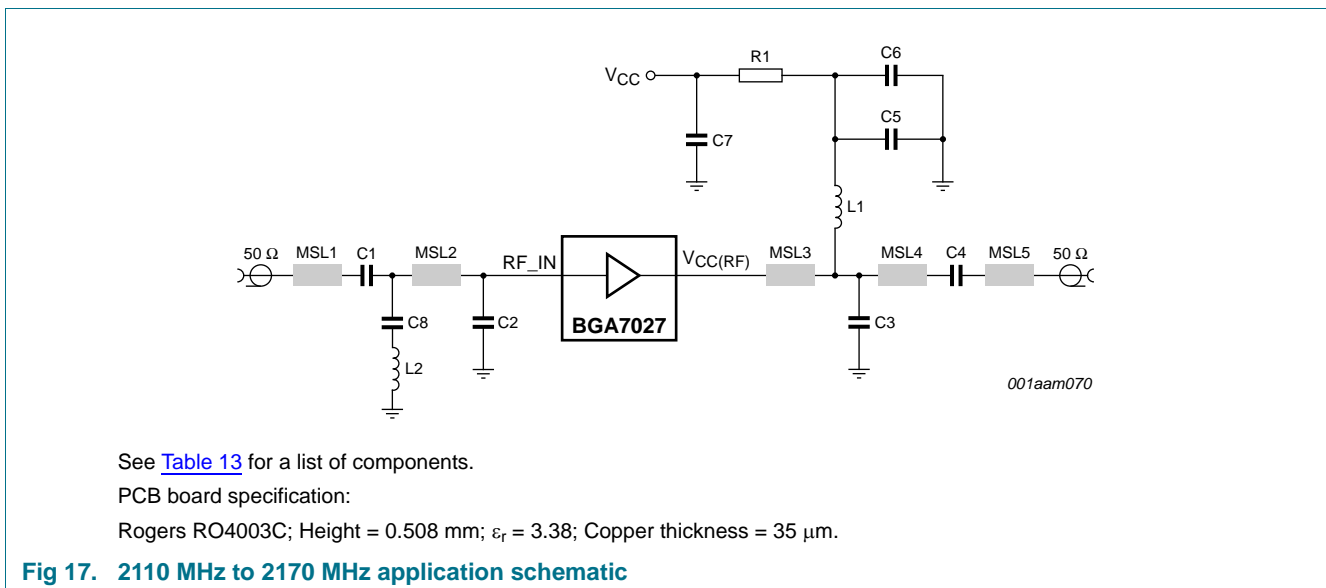
Printed-Circuit Board (PCB): Rogers RO4003C stack; height = 0.508 mm; copper plating thickness = 35 μm.

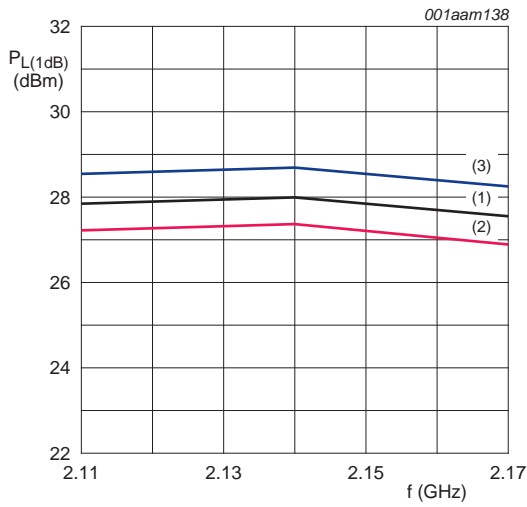
Component	Description	Value	Function	Remarks
C1, C4	capacitor	15 pF	DC blocking	Murata, GRM1885C1H150JA01D
C2	capacitor	2.4 pF	input match	Murata, GRM1885C1H2R4CZ01D
C3	capacitor	2.0 pF	output match	Murata, GRM1885C1H2R0CZ01D
C5	capacitor	15 pF	RF decoupling	Murata, GRM1885C1H150JA01D
C6	capacitor	100 nF	LF decoupling	AVX, 0603YC104KAT2A
C7	capacitor	10 μF	LF decoupling	AVX, 1206ZG106ZAT2A
C8	capacitor	68 nF	IMD3 suppression	Murata, GRM1888R71H683KA93D
J1, J2	RF connector	SMA		Emerson Network Power, 142-0701-841
J3	DC connector	6 pins		MOLEX
L1	inductor	22 nH	DC Feed	Tyco Electronics, 36501J022JTDG
L2 <sup>[1]</sup>	inductor	33 nH	IMD3 suppression	Tyco Electronics, 36501J033JTDG
MSL1 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	input match	
MSL2 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 10.6 mm	input match	
MSL3 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 1.0 mm	input match	
MSL4 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 2.7 mm	output match	
MSL5 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 2.0 mm	output match	
MSL6 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 6.8 mm	output match	
MSL7 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	output match	
R1	resistor	0 Ω		Multicomp. MC 0.063W 0603 0R

[1] Low Q inductor.

[2] MSL1 to MSL7 dimensions are specified as Width (W), Spacing (S) and Length (L).

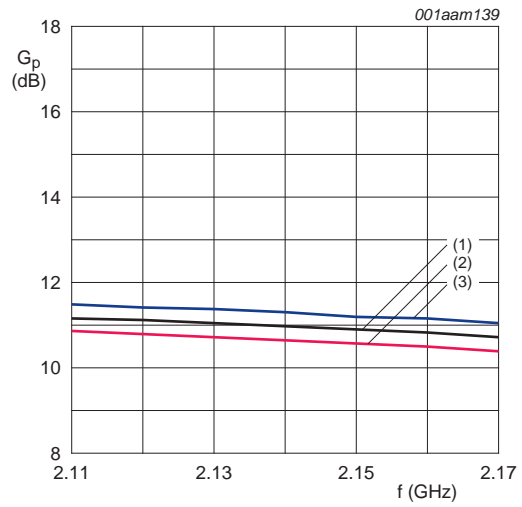
### 12.3 2110 MHz to 2170 MHz





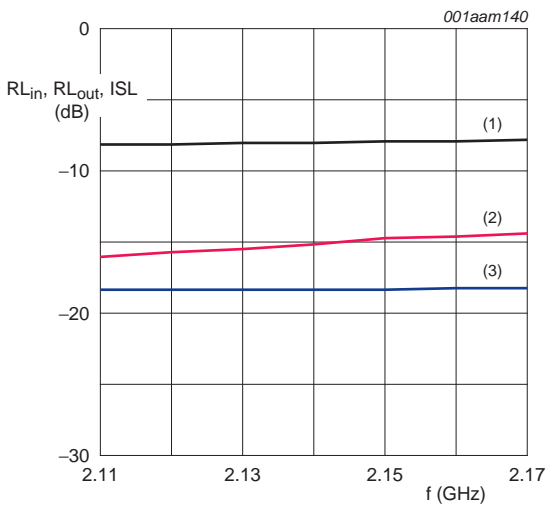
- (1)  $T_{case} = 25\text{ }^{\circ}\text{C}$ .
- (2)  $T_{case} = 85\text{ }^{\circ}\text{C}$ .
- (3)  $T_{case} = -40\text{ }^{\circ}\text{C}$ .

**Fig 18. Output power at 1 dB gain compression as a function of frequency**



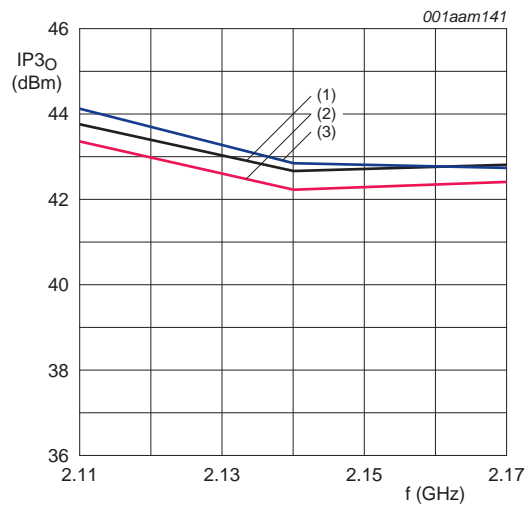
- (1)  $T_{case} = 25\text{ }^{\circ}\text{C}$ .
- (2)  $T_{case} = 85\text{ }^{\circ}\text{C}$ .
- (3)  $T_{case} = -40\text{ }^{\circ}\text{C}$ .

**Fig 19. Power gain as a function of frequency**



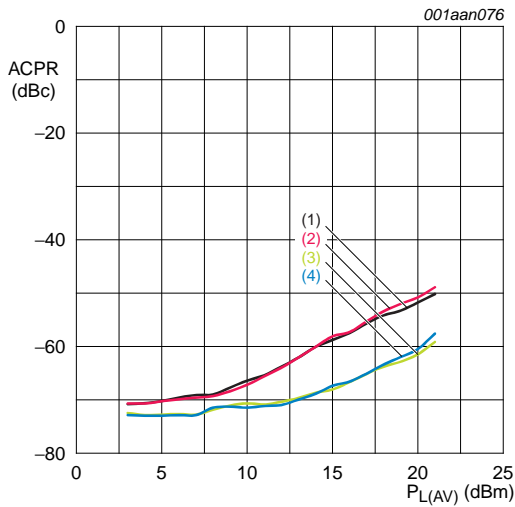
- $T_{case} = 25\text{ }^{\circ}\text{C}$ .
- (1)  $RL_{in}$ .
  - (2)  $RL_{out}$ .
  - (3) ISL.

**Fig 20. Input return loss, output return loss and isolation as a function of frequency**



- $P_L = 17\text{ dBm}$ ; tone spacing = 1 MHz
- (1)  $T_{case} = 25\text{ }^{\circ}\text{C}$ .
  - (2)  $T_{case} = 85\text{ }^{\circ}\text{C}$ .
  - (3)  $T_{case} = -40\text{ }^{\circ}\text{C}$ .

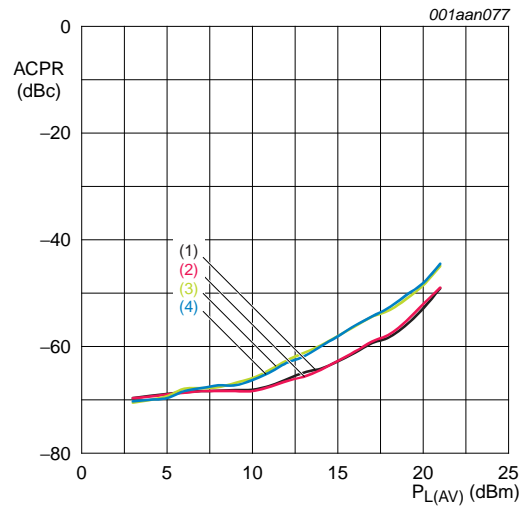
**Fig 21. Output third-order intercept point as a function of frequency**



2-carrier W-CDMA; each carrier according to 3GPP test model 1; 64 DPCH; PAR for composite signal = 7.5 dB; 5 MHz carrier spacing.

- (1)  $f = 2110$  MHz; ACPR measured at  $f \pm 5$  MHz
- (2)  $f = 2170$  MHz; ACPR measured at  $f \pm 5$  MHz
- (3)  $f = 2110$  MHz; ACPR measured at  $f \pm 10$  MHz
- (4)  $f = 2170$  MHz; ACPR measured at  $f \pm 10$  MHz

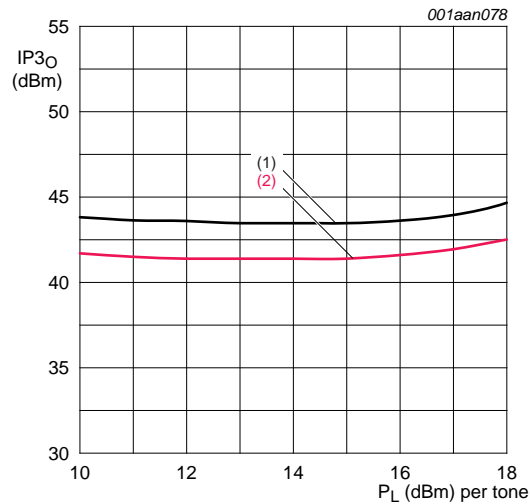
**Fig 22. Adjacent channel power ratio as a function of average output power**



2-carrier W-CDMA; each carrier according to 3GPP test model 1; 64 DPCH; PAR for composite signal = 9 dB; 10 MHz carrier spacing.

- (1)  $f = 2110$  MHz; ACPR measured at  $f \pm 5$  MHz
- (2)  $f = 2170$  MHz; ACPR measured at  $f \pm 5$  MHz
- (3)  $f = 2110$  MHz; ACPR measured at  $f \pm 10$  MHz
- (4)  $f = 2170$  MHz; ACPR measured at  $f \pm 10$  MHz

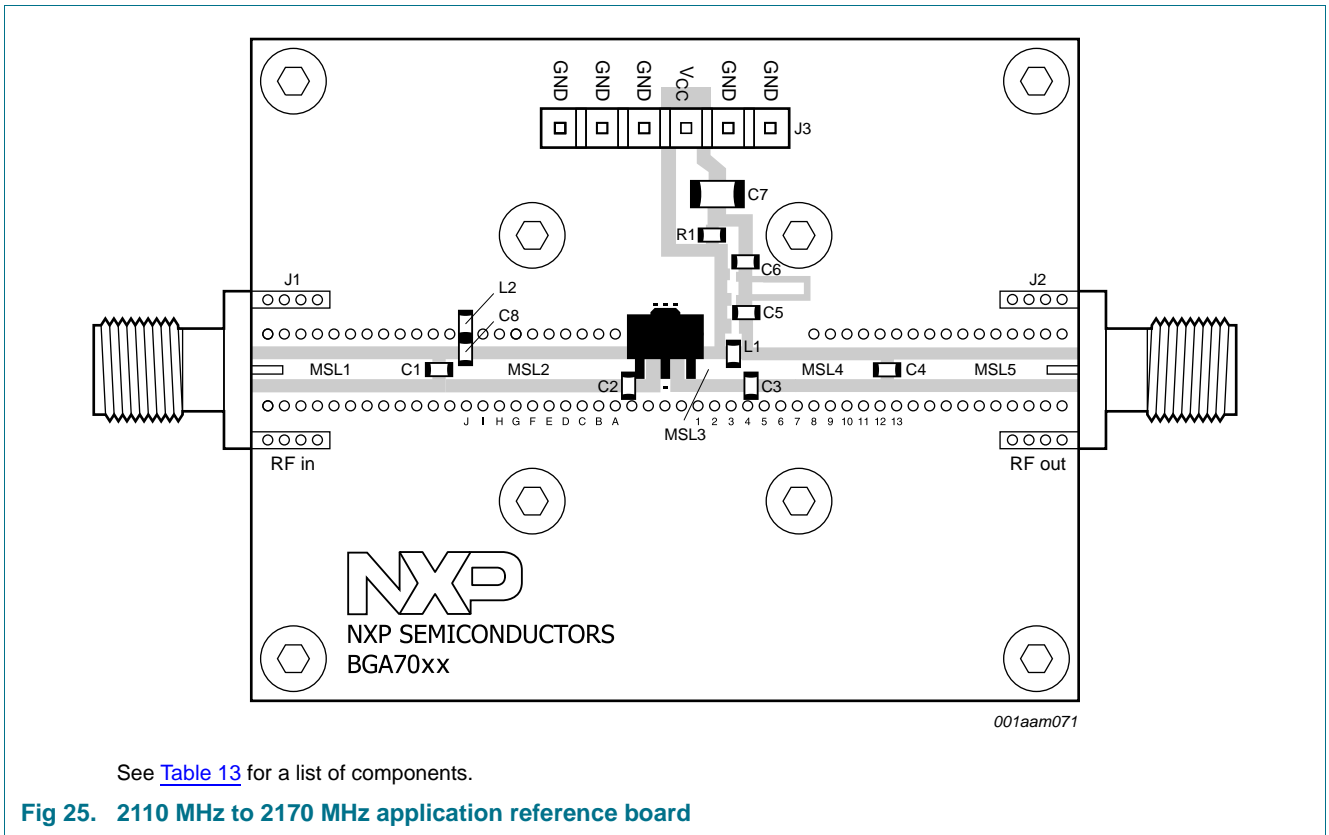
**Fig 23. Adjacent channel power ratio as a function of average output power**



$f = 2140$  MHz; tone spacing = 1 MHz.

- (1) Upper sideband
- (2) Lower sideband

**Fig 24. Output third-order intercept point as a function of output power per tone**



**Table 13. List of components of 2110 MHz to 2170 MHz**

See [Figure 17](#) and [Figure 25](#) for component layout.

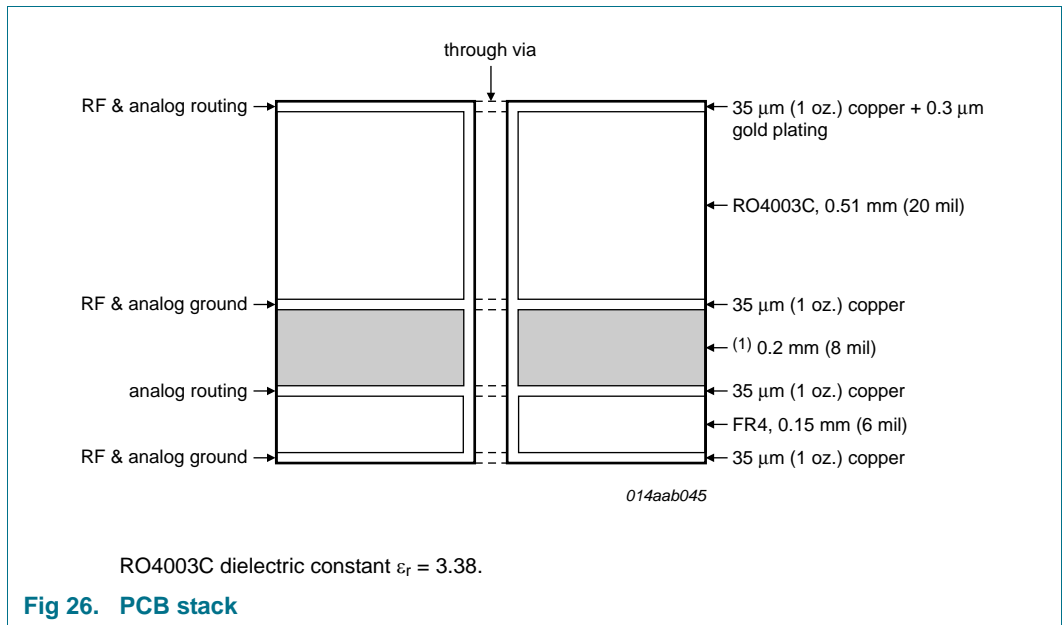
Printed-Circuit Board (PCB): Rogers RO4003C stack; height = 0.508 mm; copper plating thickness = 35 μm.

Component	Description	Value	Function	Remarks
C1, C4	capacitor	15 pF	DC blocking	Murata, GRM1885C1H150JA01D
C2	capacitor	2.2 pF	input match	Murata, GRM1885C1H2R2CZ01D
C3	capacitor	2.0 pF	output match	Murata, GRM1885C1H1R0CZ01D
C5	capacitor	15 pF	RF decoupling	Murata, GRM1885C1H150JA01D
C6	capacitor	100 nF	LF decoupling	AVX, 0603YC104KAT2A
C7	capacitor	10 μF	LF decoupling	AVX, 1206ZG106ZAT2A
C8	capacitor	68 nF	IMD3 suppression	Murata, GRM1888R71H683KA92D
J1, J2	RF connector	SMA		Emerson Network Power, 142-0701-841
J3	DC connector	6 pins		MOLEX
L1	inductor	22 nH	DC Feed	Tyco Electronics, 36501J022JTGD
L2 <sup>[1]</sup>	inductor	33 nH	IMD3 suppression	Tyco Electronics, 36501J033JTGD
MSL1 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	input match	
MSL2 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 11.3 mm	input match	
MSL3 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 3.2 mm	output match	
MSL4 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 8.0 mm	output match	
MSL5 <sup>[2]</sup>	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	output match	
R1	resistor	0 Ω		Multicomp, MC 0.063W 0603 0R

[1] Low Q inductor.

[2] MSL1 to MSL5 dimensions are specified as Width (W), Spacing (S) and Length (L).

### 12.4 PCB stack





### 13. Package outline

Plastic surface-mounted package; exposed die pad for good heat transfer; 3 leads

SOT89

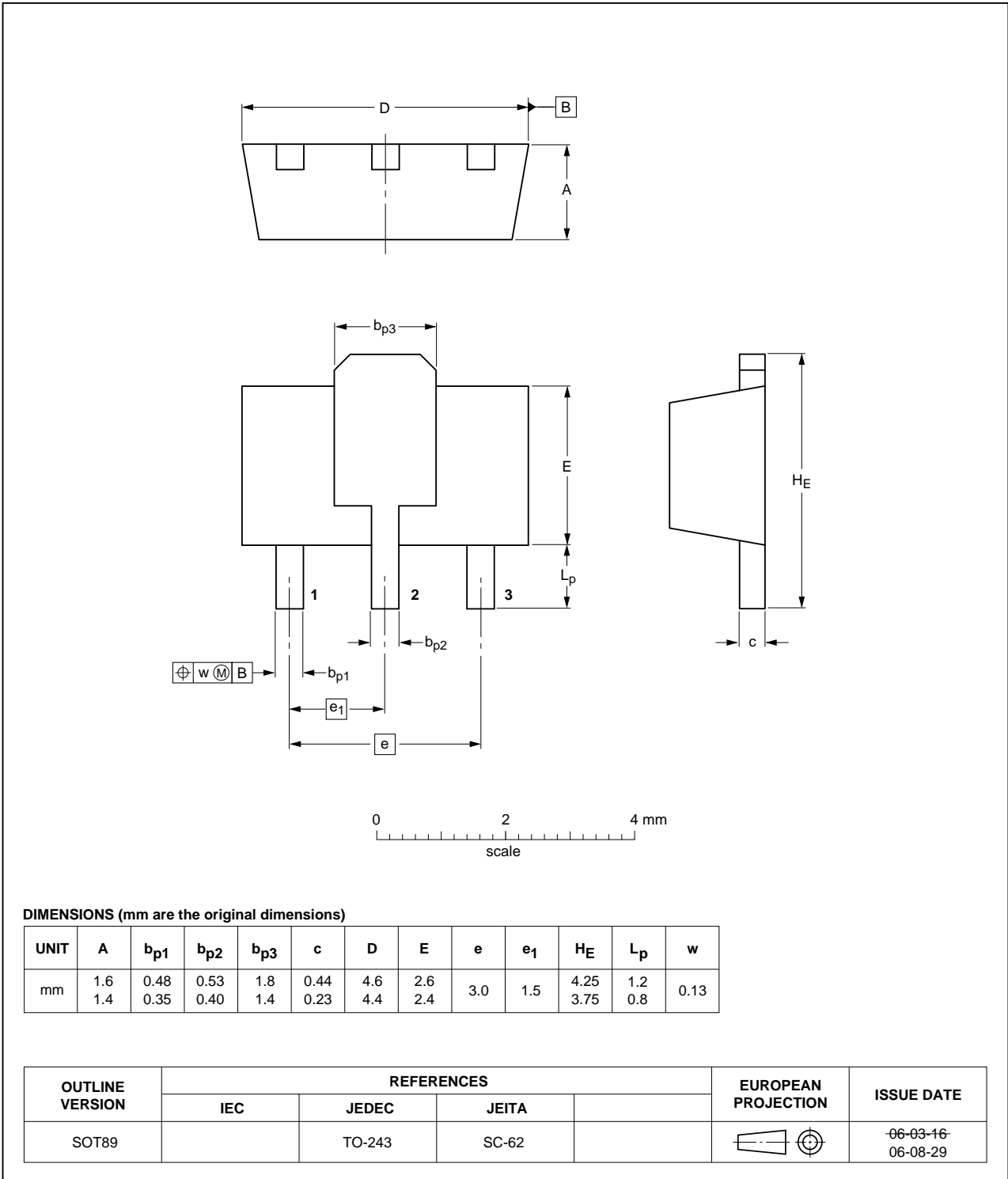


Fig 27. Package outline SOT89

## 14. Abbreviations

**Table 14. Abbreviations**

Acronym	Description
3GPP	3rd Generation Partnership Project
CPE	Customer-Premises Equipment
DPCH	Dedicated Physical CHannel
ESD	ElectroStatic Discharge
HTOL	High Temperature Operating Life
IMD3	3rd-order InterModulation Distortion
ISM	Industrial, Scientific and Medical
MMIC	Monolithic Microwave Integrated Circuit
MoCA	Multimedia over Coax Alliance
RFID	Radio Frequency IDentification
W-CDMA	Wideband Code Division Multiple Access
W-LAN	Wireless Local Area Network

## 15. Revision history

**Table 15. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGA7027 v.2	20101126	Product data sheet	-	BGA7027 v.1
Modifications:	<ul style="list-style-type: none"> <li>The status of this data sheet has been changed to Product data sheet</li> <li><a href="#">Table 1 on page 1</a>: some values have been changed</li> <li><a href="#">Table 1 on page 1</a>: some values have been added</li> <li><a href="#">Table 4 on page 3</a>: data for <math>P_{i(RF)}</math> have been added</li> <li><a href="#">Table 5 on page 3</a>: conditions have been changed</li> <li><a href="#">Table 7 on page 3</a>: some values have been changed</li> <li><a href="#">Table 7 on page 3</a>: some values have been added</li> <li><a href="#">Figure 7 on page 7</a>: figure has been added</li> <li><a href="#">Figure 8 on page 7</a>: figure has been added</li> <li><a href="#">Figure 9 on page 8</a>: figure has been added</li> <li><a href="#">Figure 22 on page 14</a>: figure has been added</li> <li><a href="#">Figure 23 on page 14</a>: figure has been added</li> <li><a href="#">Figure 24 on page 14</a>: figure has been added</li> </ul>			
BGA7027 v.1	20100811	Preliminary data sheet	-	-

## 16. Legal information

### 16.1 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".

[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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