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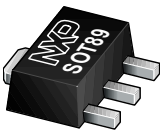


BGA7024

400 MHz to 2700 MHz 0.25 W high linearity silicon amplifier

Rev. 3 — 11 June 2014 Product data sheet

1. Product profile

1.1 General description

The BGA7024 MMIC is a one-stage amplifier, available in a low-cost surface-mount package. It delivers 24 dBm output power at 1 dB gain compression and superior performance up to 2700 MHz.

1.2 Features and benefits

- 400 MHz to 2700 MHz frequency operating range
- 16 dB small signal gain at 2 GHz
- 24 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
- All pins ESD protected

1.3 Applications

- Broadband CPE/MoCA
- WLAN/ISM/RFID
- Wireless infrastructure (base station, repeater, point-to-point 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 Ω. Typical values at V_{CC} = 5 V; T_{case} = 25 °C; unless otherwise specified.

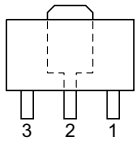
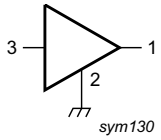
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{CC}	supply current		95	110	125	mA
f	frequency	[1]	400	-	2700	MHz
G_p	power gain	f = 2140 MHz	13.5	15	16.5	dB
$P_{L(1dB)}$	output power at 1 dB gain compression	f = 2140 MHz	24.0	25.5	-	dBm
$IP3_O$	output third-order intercept point	f = 2140 MHz [2]	35.0	38.5	-	dBm

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

[2] P_L = 11 dBm per tone; spacing = 1 MHz.

2. Pinning information

Table 2. Pinning

Pin	Description	Simplified outline	Graphic symbol
1	$V_{CC(RF)}$ [1]		
2	GND [2]		
3	RF_IN [1]		

[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
BGA7024	-	plastic surface-mounted package; exposed die pad for good heat transfer; 3 leads	SOT89

4. Functional diagram

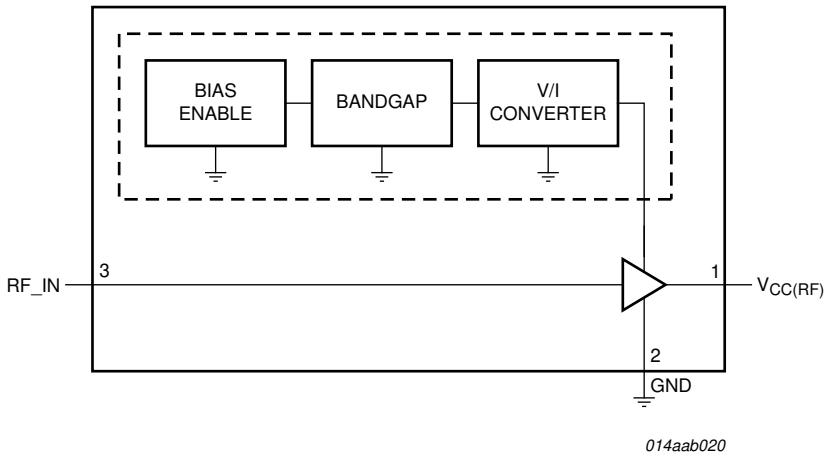


Fig 1. Functional diagram

5. Limiting values

Table 4. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{CC(RF)}$	RF supply voltage		-	5.7	V
$P_{i(RF)}$	RF input power		-	25	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

6. Thermal characteristics

Table 5. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-c)}$	thermal resistance from junction to case	[1][2]	25	K/W

[1] Case is ground solder pad.

[2] Thermal resistance measured using infrared measurement technique, device mounted on application board and placed in still air.

7. Static characteristics

Table 6. Characteristics

Input and output impedances matched to 50 Ω. Typical values at V_{CC} = 5 V; 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		95	110	125	mA

8. Dynamic characteristics

Table 7. Dynamic characteristics

Input and output impedances matched to 50 Ω. Typical values at V_{CC} = 5 V; T_{case} = 25 °C; see Section 12 "Application information"; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f	frequency	[1]	400	-	2700	MHz
G_p	power gain	f = 940 MHz	-	22	-	dB
		f = 1960 MHz	-	16	-	dB
		f = 2140 MHz	13.5	15	16.5	dB
		f = 2445 MHz	-	14	-	dB

Table 7. Dynamic characteristics *…continued*

Input and output impedances matched to 50 Ω. Typical values at V_{CC} = 5 V; T_{case} = 25 °C; see Section 12 "Application information"; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$P_{L(1dB)}$	output power at 1 dB gain compression	f = 940 MHz	-	24	-	dBm
		f = 1960 MHz	-	25.5	-	dBm
		f = 2140 MHz	24.0	25.5	-	dBm
		f = 2445 MHz	-	24.5	-	dBm
$IP3_O$	output third-order intercept point	f = 940 MHz [2]	-	37.5	-	dBm
		f = 1960 MHz [2]	-	38.0	-	dBm
		f = 2140 MHz [2]	35.0	38.0	-	dBm
		f = 2445 MHz [2]	-	37.5	-	dBm
NF	noise figure	f = 940 MHz [3]	-	2.9	-	dB
		f = 1960 MHz [3]	-	3.7	-	dB
		f = 2140 MHz [3]	-	3.7	-	dB
		f = 2445 MHz [3]	-	4.0	-	dB
RL_{in}	input return loss	f = 940 MHz	-	−9	-	dB
		f = 1960 MHz	-	−10	-	dB
		f = 2140 MHz	-	−10	-	dB
		f = 2445 MHz	-	−14	-	dB
RL_{out}	output return loss	f = 940 MHz	-	−29	-	dB
		f = 1960 MHz	-	−22	-	dB
		f = 2140 MHz	-	−29	-	dB
		f = 2445 MHz	-	−11	-	dB

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

[2] P_L = 11 dBm per tone; spacing = 1 MHz.

[3] Defined at $P_{i(RF)}$ = −40 dBm; small signal conditions.

9. Scattering parameters

Table 8. Scattering parameters at 5 V, MMIC only

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)
400	0.83	−178.9	14.03	112.7	0.01	35.5	0.53	−166.3
500	0.85	178.7	11.69	104.4	0.01	38.77	0.56	−168.9
600	0.85	176.4	9.93	98.19	0.02	41.13	0.57	−172.2
700	0.86	173.8	8.67	93.04	0.02	43.1	0.58	−174.8
800	0.86	171.1	7.68	88.54	0.02	44.34	0.58	−177.4
900	0.86	168.3	6.9	84.36	0.02	44.96	0.59	179.7
1000	0.86	165.4	6.29	80.24	0.02	45.07	0.60	176.7
1100	0.87	162.7	5.72	76.42	0.02	45	0.60	173.3
1200	0.88	159.9	5.23	72.83	0.02	44.54	0.60	170.9
1300	0.88	157.3	4.80	69.34	0.03	44.17	0.61	168.4

Table 8. Scattering parameters at 5 V, MMIC only *…continued*

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)
1400	0.89	154.8	4.43	66.17	0.03	43.58	0.61	166.4
1500	0.89	153	4.09	63.33	0.03	43.02	0.62	164.7
1600	0.89	151.3	3.80	60.8	0.03	42.67	0.63	163.1
1700	0.90	149.9	3.54	58.3	0.03	42.36	0.64	162.1
1800	0.90	148.7	3.30	56.13	0.03	41.89	0.65	161.2
1900	0.90	147.9	3.11	54.13	0.03	41.65	0.66	160.8
2000	0.91	147.5	2.93	52.63	0.03	41.7	0.66	160.5
2100	0.90	147	2.78	50.91	0.04	41.61	0.66	160.5
2200	0.90	146.9	2.65	49.5	0.04	41.59	0.67	160.9
2300	0.90	146.6	2.54	48.13	0.04	41.44	0.66	161.6
2400	0.90	146.5	2.46	46.88	0.04	41.61	0.66	161.7
2500	0.89	146.3	2.39	45.39	0.04	41.45	0.66	162.6
2600	0.88	146	2.34	43.93	0.05	41.13	0.65	162.8
2700	0.87	145.4	2.30	42.24	0.05	40.56	0.64	163.2

10. Reliability information

Table 9. Reliability

Life test	Conditions	Intrinsic failure rate
HTOL	according to JESD85; confidence level 60 %; T_j = 55 °C; activation energy = 0.7 eV; acceleration factor according to Arrhenius equation	4

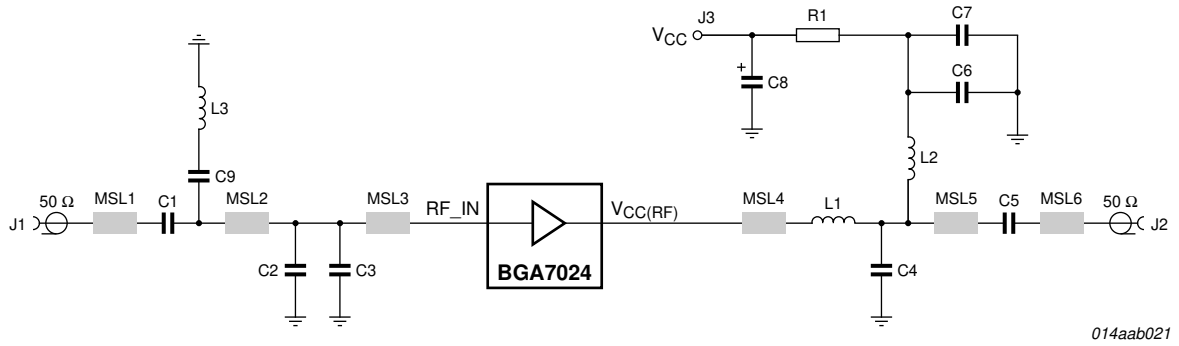
11. Moisture sensitivity

Table 10. Moisture sensitivity level

Test methodology	Class
JESD-22-A113	1

12. Application information

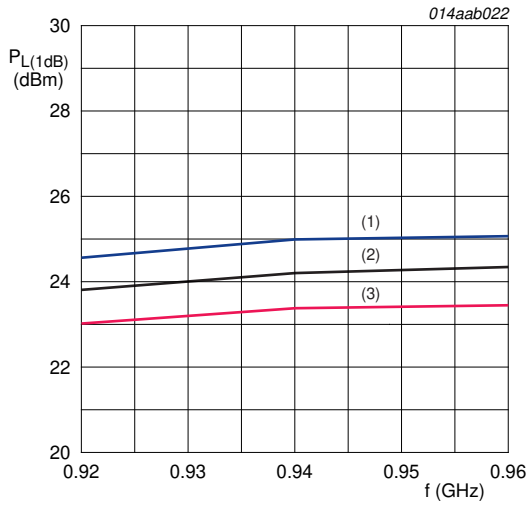
12.1 920 MHz to 960 MHz



See Table 11 for a list of components.

PCB specification: Rogers RO4003C; height = 0.508 mm; ε_r = 3.38; copper thickness = 35 μm.

Fig 2. 5 V application schematic; 920 MHz to 960 MHz

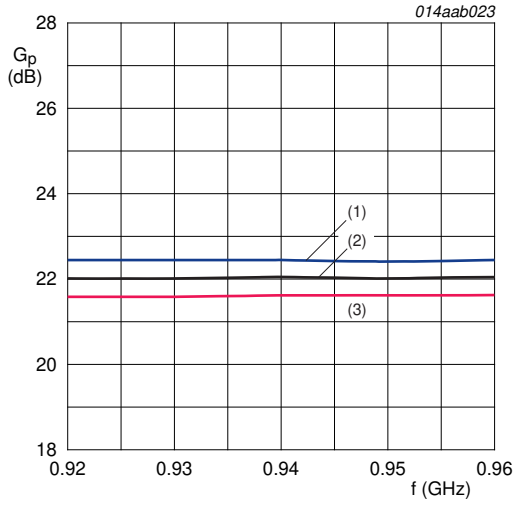


(1) T_{case} = −40 °C.

(2) T_{case} = 25 °C.

(3) T_{case} = 85 °C.

Fig 3. Output power at 1 dB gain compression as a function of frequency

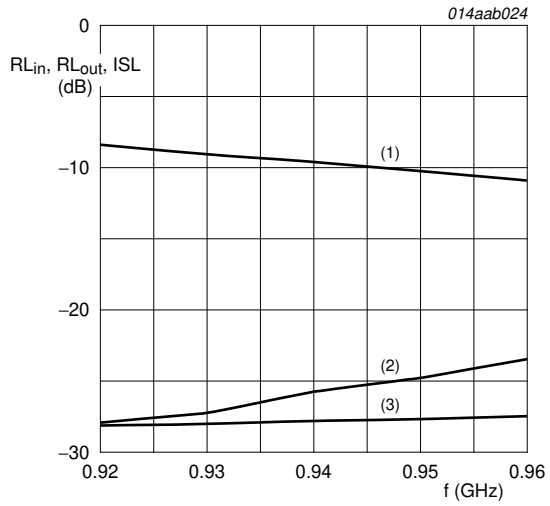


(1) T_{case} = −40 °C.

(2) T_{case} = 25 °C.

(3) T_{case} = 85 °C.

Fig 4. Power gain as a function of frequency



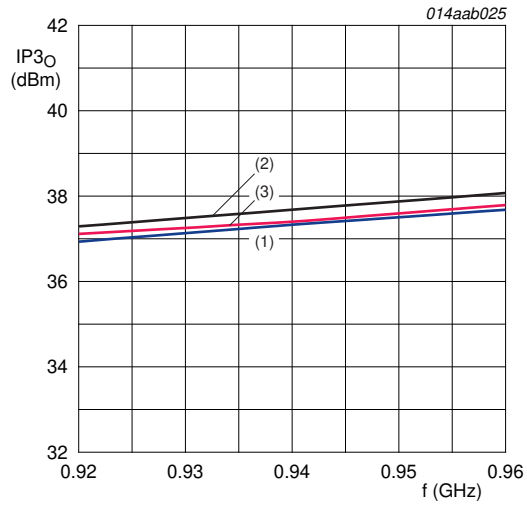
T_{case} = 25 °C.

(1) RL_{in}

(2) RL_{out}

(3) ISL

Fig 5. Input return loss, output return loss and isolation as a function of frequency

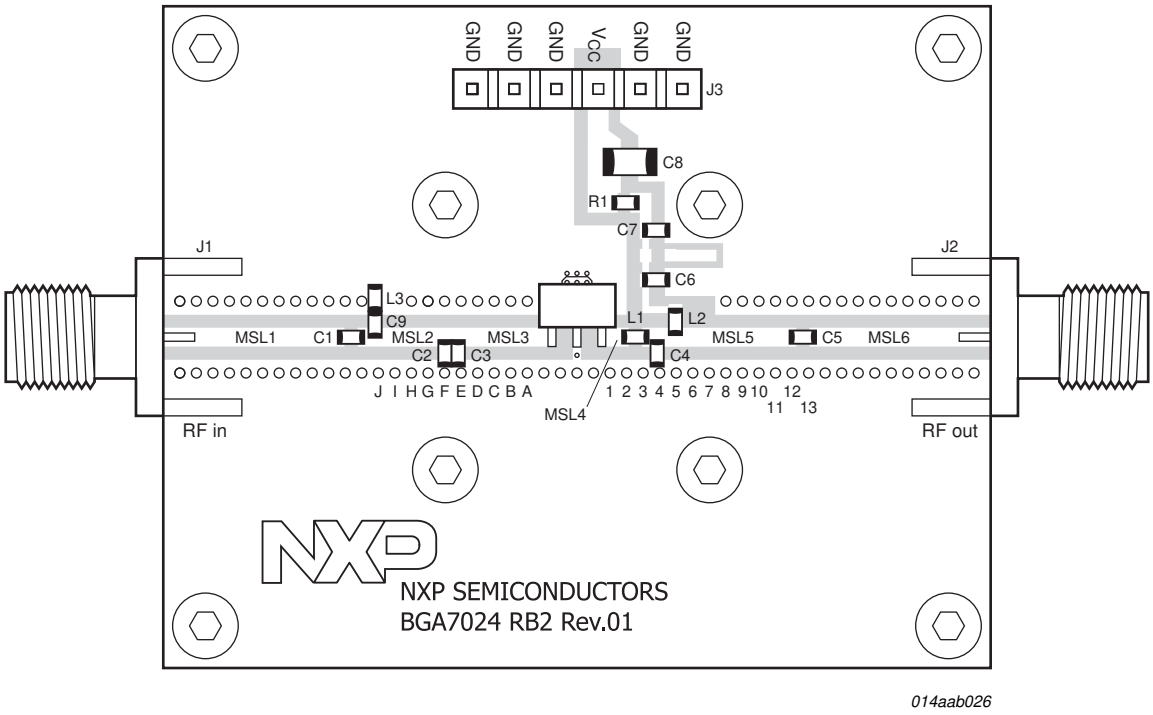


(1) T_{case} = −40 °C.

(2) T_{case} = 25 °C.

(3) T_{case} = 85 °C.

Fig 6. Output third-order intercept point as a function of frequency



See Table 11 for a list of components.

Fig 7. 5 V application reference board; 920 MHz to 960 MHz

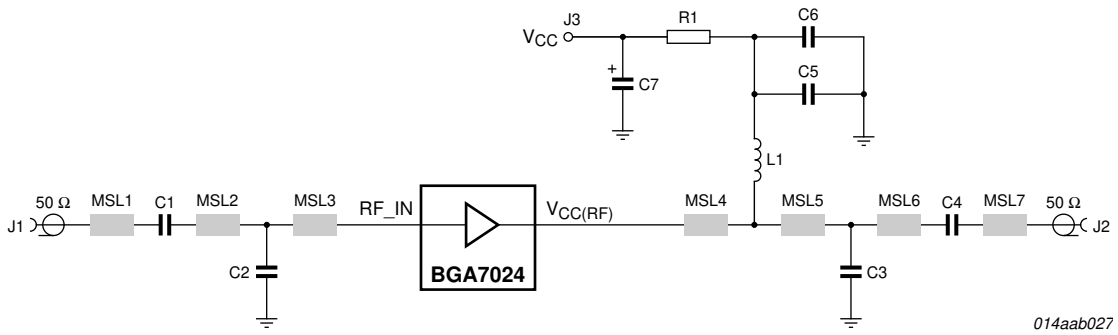
Table 11. 5 V application list of components; 920 MHz to 960 MHz

See Figure 2 and Figure 7 for component layout. PCB: Rogers RO4003C stack; height = 0.508 mm; copper plating thickness = 35 μm.

Component	Description	Value	Function	Remarks
C1, C5	capacitor	68 pF	DC blocking	Murata GRM1885C1H680JA01D
C2	capacitor	3.9 pF	input match	Murata GRM1885C1H3R9CZ01D
C3	capacitor	3.9 pF	input match	Murata GRM1885C1H3R9CZ01D
C4	capacitor	3.9 pF	output match	Murata GRM1885C1H3R9CZ01D
C6	capacitor	68 pF	RF decoupling	Murata GRM1885C1H680JA01D
C7	capacitor	100 nF	DC decoupling	AVX 0603YC104KAT2A
C8	capacitor	10 μF	DC decoupling	AVX 1206ZG106ZAT2A
C9	capacitor	68 nF	IMD suppression	Murata GRM1888R71H683KA93D
J1, J2	RF connector	SMA	-	Emerson Network Power 142-0701-841
J3	DC connector	6-pins	-	MOLEX
L1	inductor	4.7 nH	output match	Tyco Electronics 36501J4N7JTDG
L2	inductor	22 nH	DC feed	Tyco Electronics 36501J022JTDG
L3	inductor	33 nH	IMD suppression	Tyco Electronics 36501J033JTDG
MSL1[1]	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	input match	-
MSL2[1]	micro stripline	1.14 mm × 0.8 mm × 5.65 mm	input match	-
MSL3[1]	micro stripline	1.14 mm × 0.8 mm × 6.1 mm	input match	-
MSL4[1]	micro stripline	1.14 mm × 0.8 mm × 1.6 mm	output match	-
MSL5[1]	micro stripline	1.14 mm × 0.8 mm × 8.4 mm	output match	-
MSL6[1]	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	output match	-
R1	resistor	0 Ω	-	Multicomp MC 0.063W 0603 0R
PCB	-	RO4003C	-	-

[1] MSL1 to MSL6 dimensions specified as width × spacing × length.

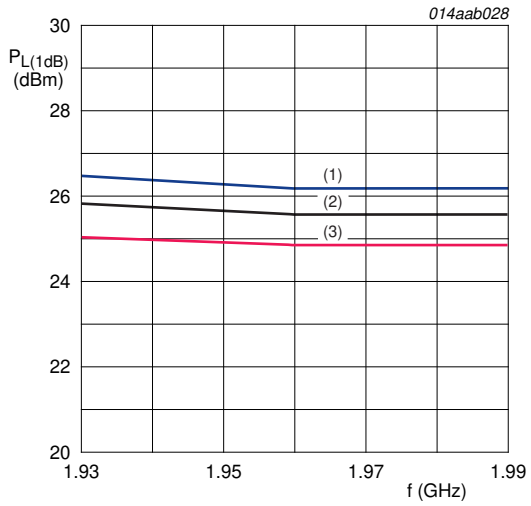
12.2 1930 MHz to 1990 MHz



See Table 12 for a list of components.

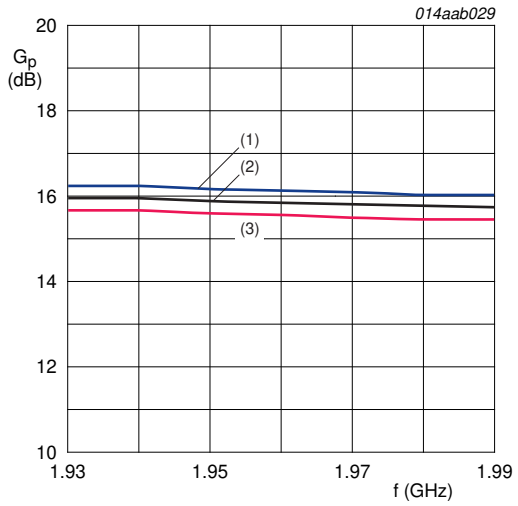
PCB specification: Rogers RO4003C; height = 0.508 mm; ε_r = 3.38; copper thickness = 35 μm.

Fig 8. 5 V application schematic; 1930 MHz to 1990 MHz



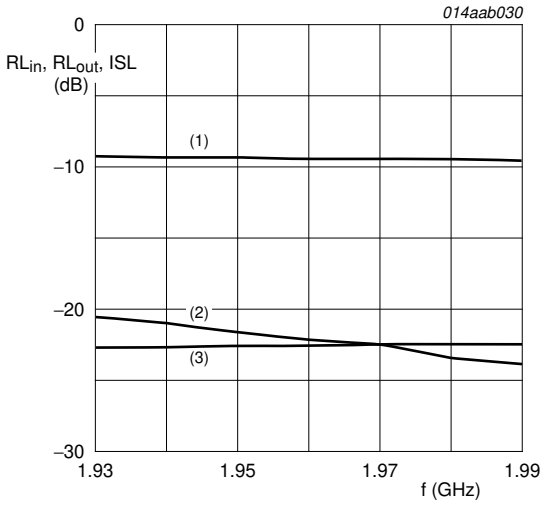
(1) T_{case} = −40 °C.
(2) T_{case} = 25 °C.
(3) T_{case} = 85 °C.

Fig 9. Output power at 1 dB gain compression as a function of frequency



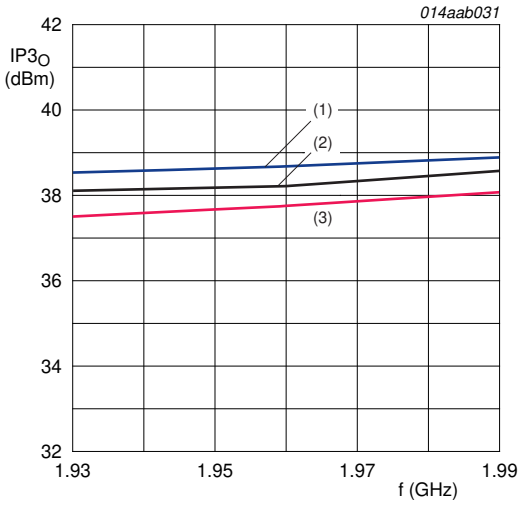
(1) T_{case} = −40 °C.
(2) T_{case} = 25 °C.
(3) T_{case} = 85 °C.

Fig 10. Power gain as a function of frequency



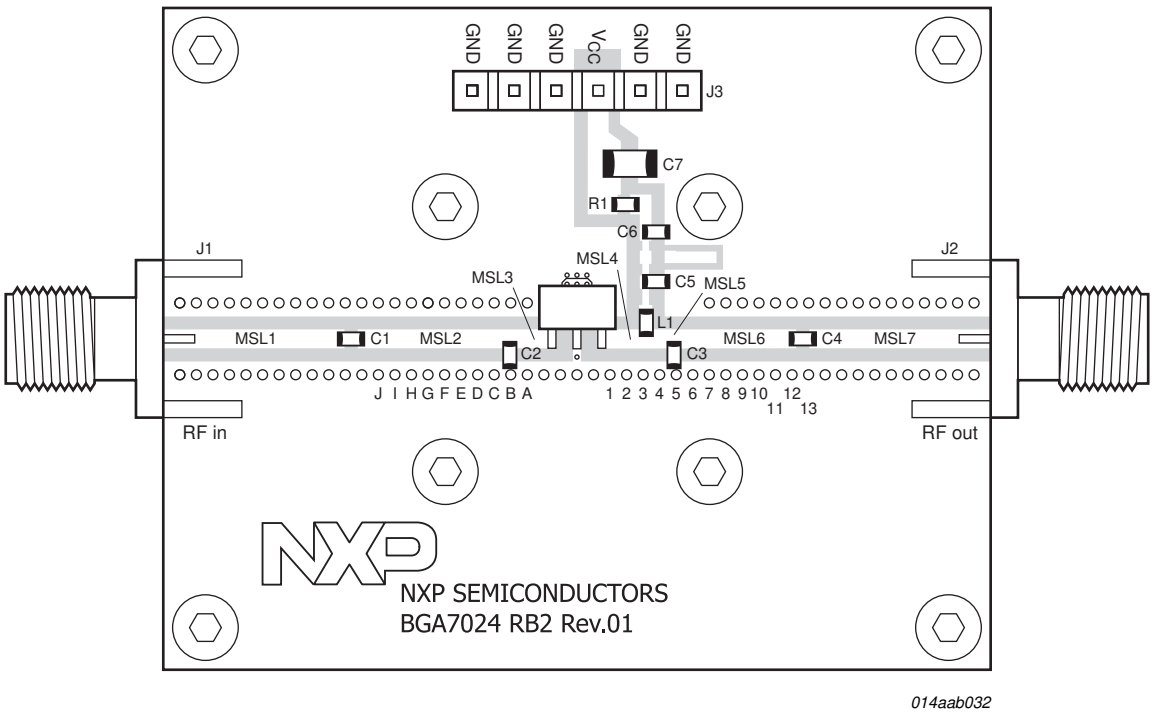
T_{case} = 25 °C.
(1) RL_{in}
(2) RL_{out}
(3) ISL

Fig 11. Input return loss, output return loss and isolation as a function of frequency



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

Fig 12. Output third-order intercept point as a function of frequency



See Table 12 for a list of components.

Fig 13. 5 V application reference board; 1930 MHz to 1990 MHz

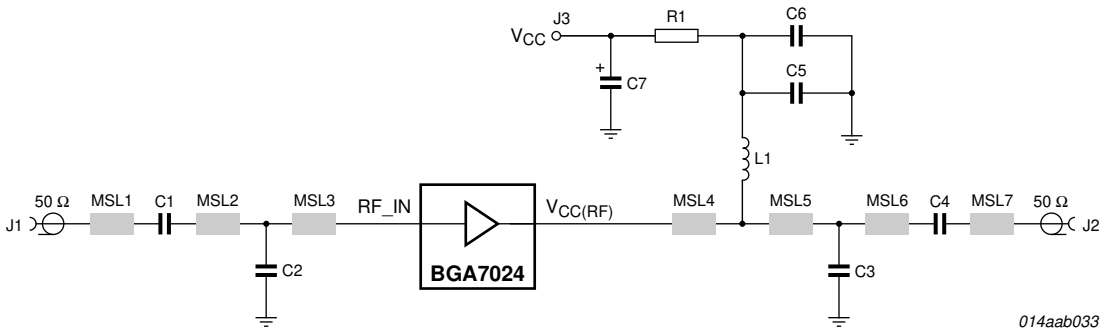
Table 12. 5 V application list of components; 1930 MHz to 1990 MHz

See Figure 8 and Figure 13 for component layout. 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	1.5 pF	output match	Murata GRM1885C1H1R5CZ01D
C5	capacitor	15 pF	RF decoupling	Murata GRM1885C1H150JA01D
C6	capacitor	100 nF	DC decoupling	AVX 0603YC104KAT2A
C7	capacitor	10 μF	DC decoupling	AVX 1206ZG106ZAT2A
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
MSL1[1]	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	input match	-
MSL2[1]	micro stripline	1.14 mm × 0.8 mm × 10.6 mm	input match	-
MSL3[1]	micro stripline	1.14 mm × 0.8 mm × 1.0 mm	input match	-
MSL4[1]	micro stripline	1.14 mm × 0.8 mm × 2.7 mm	output match	-
MSL5[1]	micro stripline	1.14 mm × 0.8 mm × 3.2 mm	output match	-
MSL6[1]	micro stripline	1.14 mm × 0.8 mm × 5.5 mm	output match	-
MSL7[1]	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	output match	-
R1	resistor	0 Ω	-	Multicomp MC 0.063W 0603 0R
PCB	-	RO4003C	-	-

[1] MSL1 to MSL7 dimensions specified as width × spacing × length.

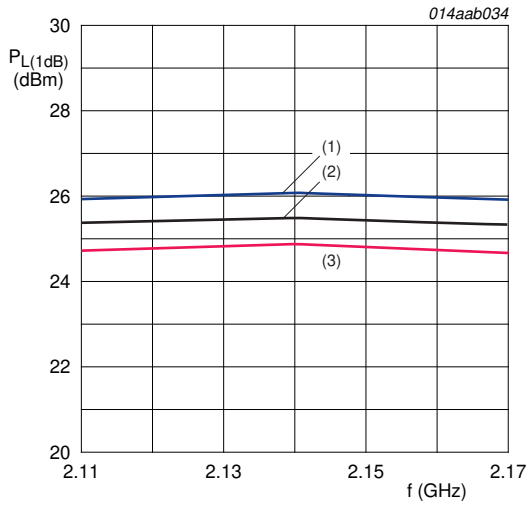
12.3 2110 MHz to 2170 MHz



See Table 13 for a list of components.

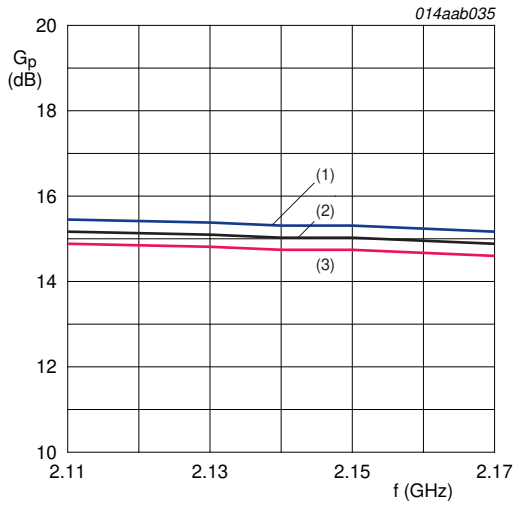
PCB specification: Rogers RO4003C; height = 0.508 mm; ε_r = 3.38; copper thickness = 35 μm.

Fig 14. 5 V application schematic; 2110 MHz to 2170 MHz



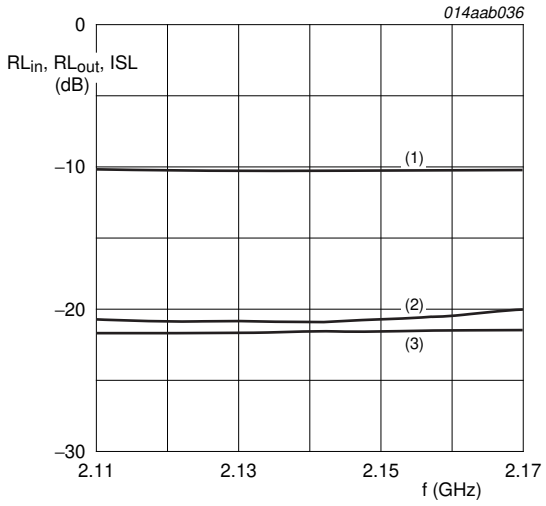
(1) T_{case} = −40 °C.
(2) T_{case} = 25 °C.
(3) T_{case} = 85 °C.

Fig 15. Output power at 1 dB gain compression as a function of frequency



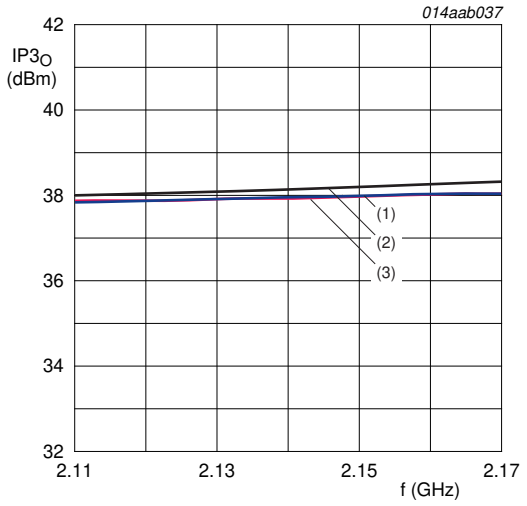
(1) T_{case} = −40 °C.
(2) T_{case} = 25 °C.
(3) T_{case} = 85 °C.

Fig 16. Power gain as a function of frequency



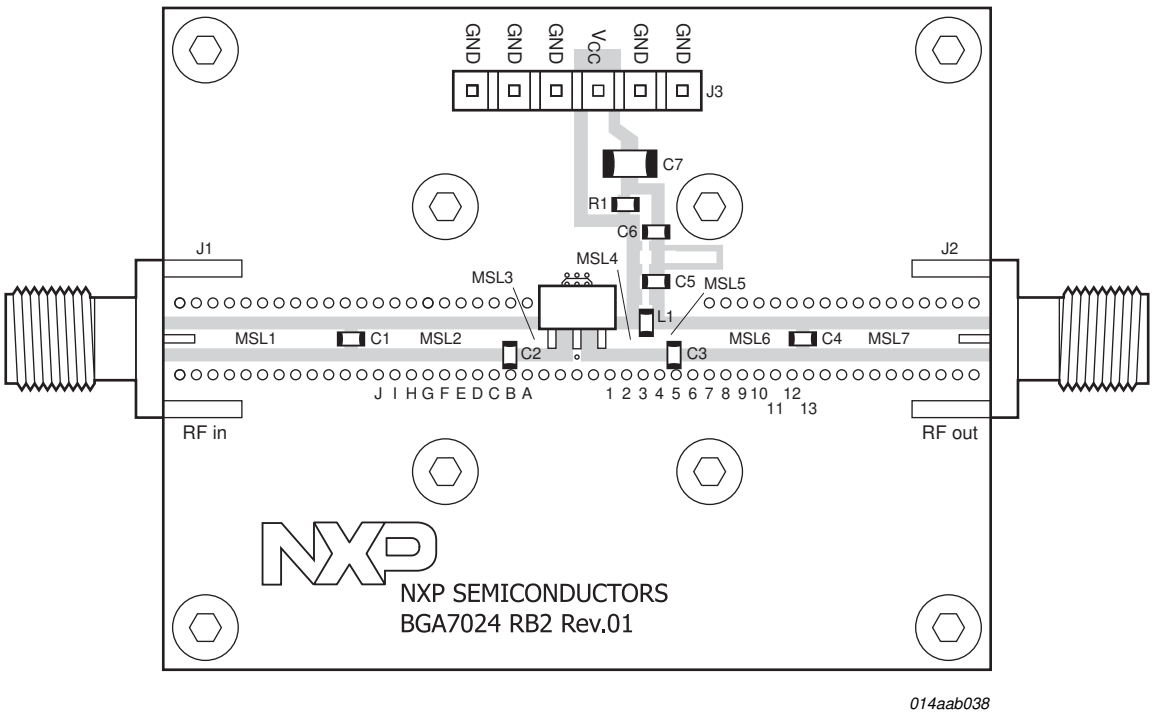
T_{case} = 25 °C.
(1) RL_{in}
(2) RL_{out}
(3) ISL

Fig 17. Input return loss, output return loss and isolation as a function of frequency



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

Fig 18. Output third-order intercept point as a function of frequency



See Table 13 for a list of components.

Fig 19. 5 V application reference board; 2110 MHz to 2170 MHz

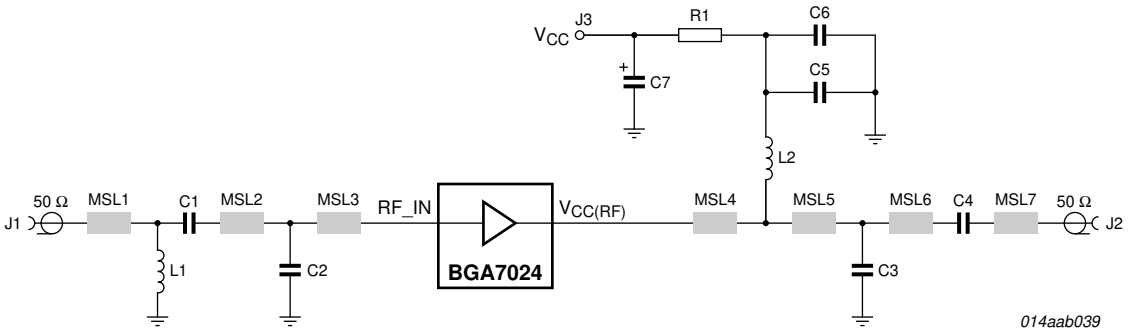
Table 13. 5 V application list of components; 2110 MHz to 2170 MHz

See Figure 14 and Figure 19 for component layout. 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	1.5 pF	output match	Murata GRM1885C1H1R5CZ01D
C5	capacitor	15 pF	RF decoupling	Murata GRM1885C1H150JA01D
C6	capacitor	100 nF	DC decoupling	AVX 0603YC104KAT2A
C7	capacitor	10 μF	DC decoupling	AVX 1206ZG106ZAT2A
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
MSL1[1]	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	input match	-
MSL2[1]	micro stripline	1.14 mm × 0.8 mm × 10.6 mm	input match	-
MSL3[1]	micro stripline	1.14 mm × 0.8 mm × 1.0 mm	input match	-
MSL4[1]	micro stripline	1.14 mm × 0.8 mm × 2.7 mm	output match	-
MSL5[1]	micro stripline	1.14 mm × 0.8 mm × 3.2 mm	output match	-
MSL6[1]	micro stripline	1.14 mm × 0.8 mm × 5.5 mm	output match	-
MSL7[1]	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	output match	-
R1	resistor	0 Ω	-	Multicomp MC 0.063W 0603 0R
PCB	-	RO4003C	-	-

[1] MSL1 to MSL7 dimensions specified as width × spacing × length.

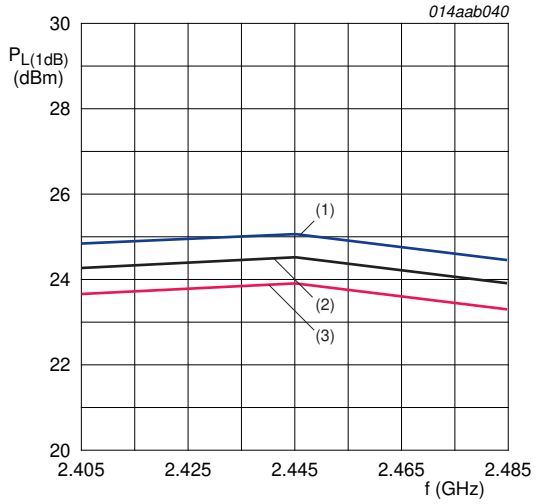
12.4 2405 MHz to 2485 MHz



See Table 14 for a list of components.

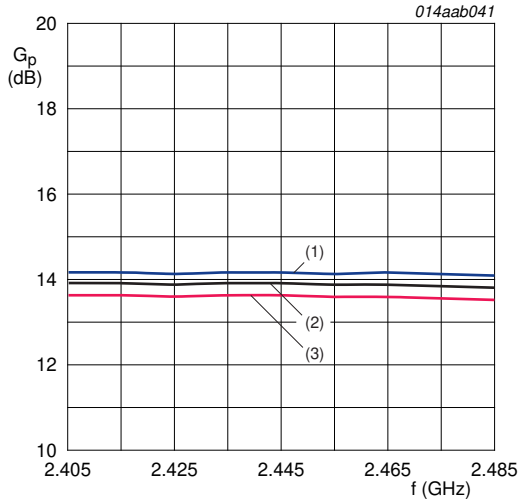
PCB specification: Rogers RO4003C; height = 0.508 mm; ε_r = 3.38; copper thickness = 35 μm.

Fig 20. 5 V application schematic; 2405 MHz to 2485 MHz



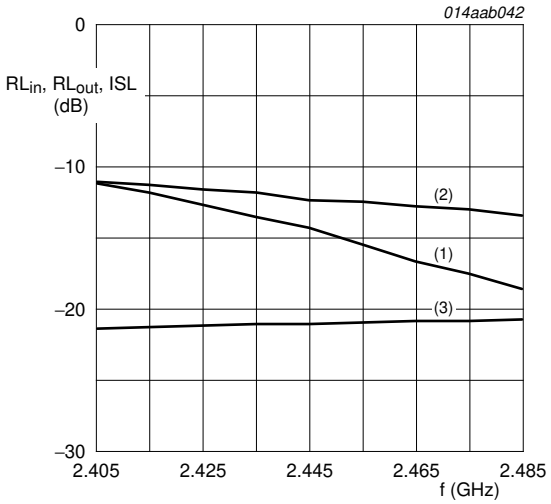
(1) T_{case} = −40 °C.
(2) T_{case} = 25 °C.
(3) T_{case} = 85 °C.

Fig 21. Output power at 1 dB gain compression as a function of frequency



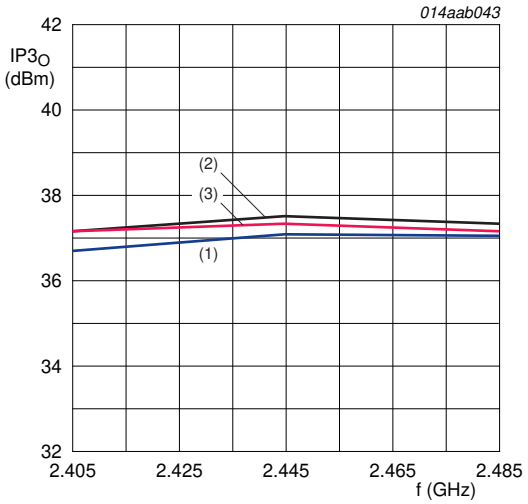
(1) T_{case} = −40 °C.
(2) T_{case} = 25 °C.
(3) T_{case} = 85 °C.

Fig 22. Power gain as a function of frequency



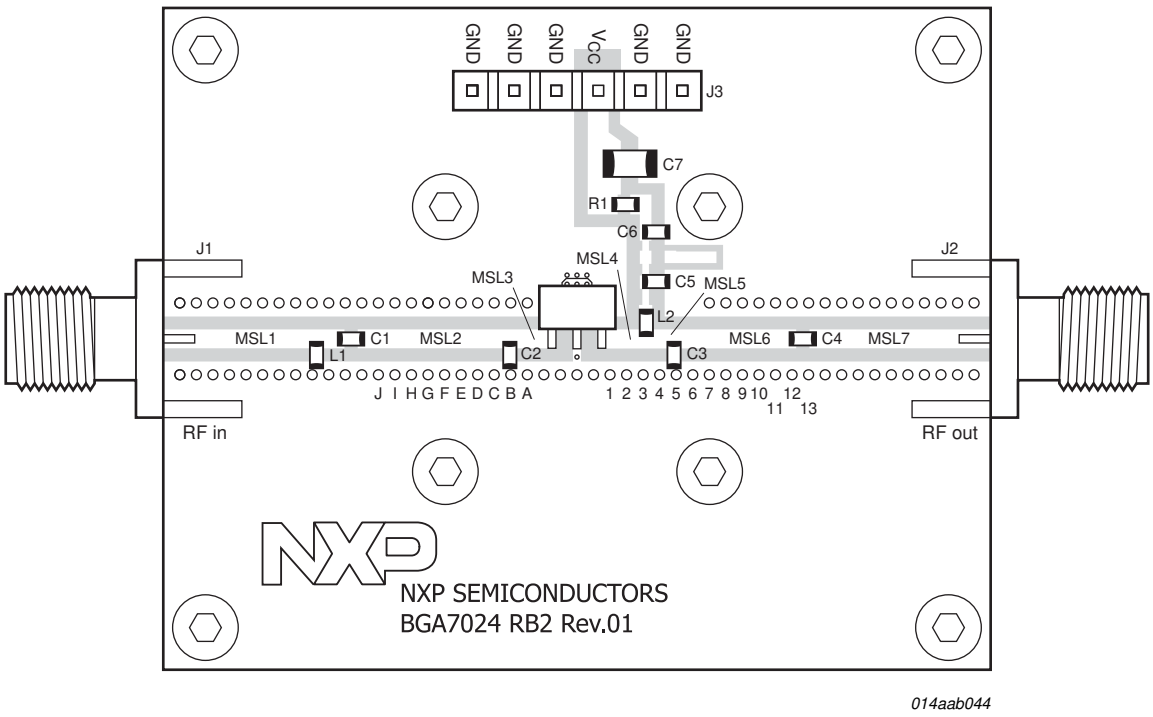
T_{case} = 25 °C.
(1) RL_{in}
(2) RL_{out}
(3) ISL

Fig 23. Input return loss, output return loss and isolation as a function of frequency



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

Fig 24. Output third-order intercept point as a function of frequency



See Table 14 for a list of components.

Fig 25. 5 V application reference board; 2405 MHz to 2485 MHz

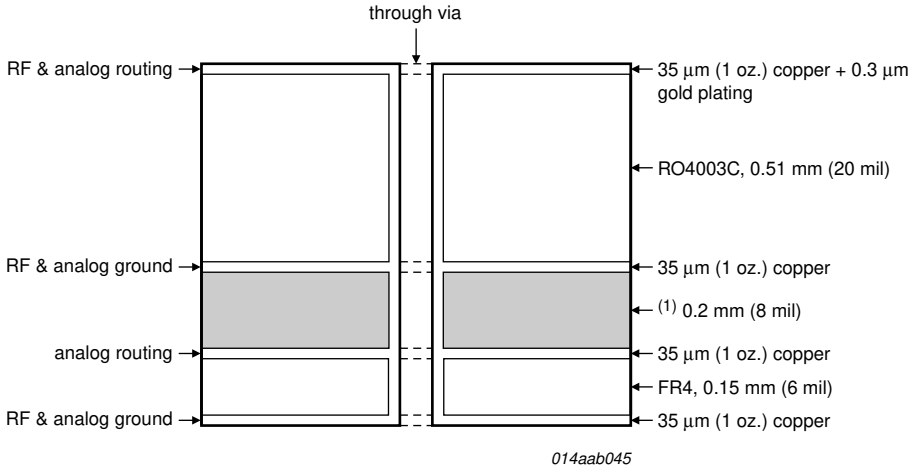
Table 14. 5 V application list of components; 2405 MHz to 2485 MHz

See Figure 20 and Figure 25 for component layout. 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	1.5 pF	input match	Murata GRM1885C1H1R5CZ01D
C3	capacitor	1.8 pF	output match	Murata GRM1885C1H1R8CZ01D
C5	capacitor	15 pF	RF decoupling	Murata GRM1885C1H150JA01D
C6	capacitor	100 nF	DC decoupling	AVX 0603YC104KAT2A
C7	capacitor	10 μF	DC decoupling	AVX 1206ZG106ZAT2A
J1, J2	RF connector	SMA	-	Emerson Network Power 142-0701-841
J3	DC connector	6-pins	-	MOLEX
L1	inductor	3.3 nH	input match	Tyco Electronics 36501J3N3JTDG
L2	inductor	22 nH	DC feed	Tyco Electronics 36501J022JTDG
MSL1[1]	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	input match	-
MSL2[1]	micro stripline	1.14 mm × 0.8 mm × 9.8 mm	input match	-
MSL3[1]	micro stripline	1.14 mm × 0.8 mm × 1.9 mm	output match	-
MSL4[1]	micro stripline	1.14 mm × 0.8 mm × 2.5 mm	output match	-
MSL5[1]	micro stripline	1.14 mm × 0.8 mm × 1.6 mm	output match	-
MSL6[1]	micro stripline	1.14 mm × 0.8 mm × 7.3 mm	output match	-
MSL7[1]	micro stripline	1.14 mm × 0.8 mm × 10.95 mm	output match	-
R1	resistor	0 Ω	-	Multicomp MC 0.063W 0603 0R
PCB	-	RO4003C	-	-

[1] MSL1 to MSL7 dimensions specified as width × spacing × length.

12.5 PCB stack

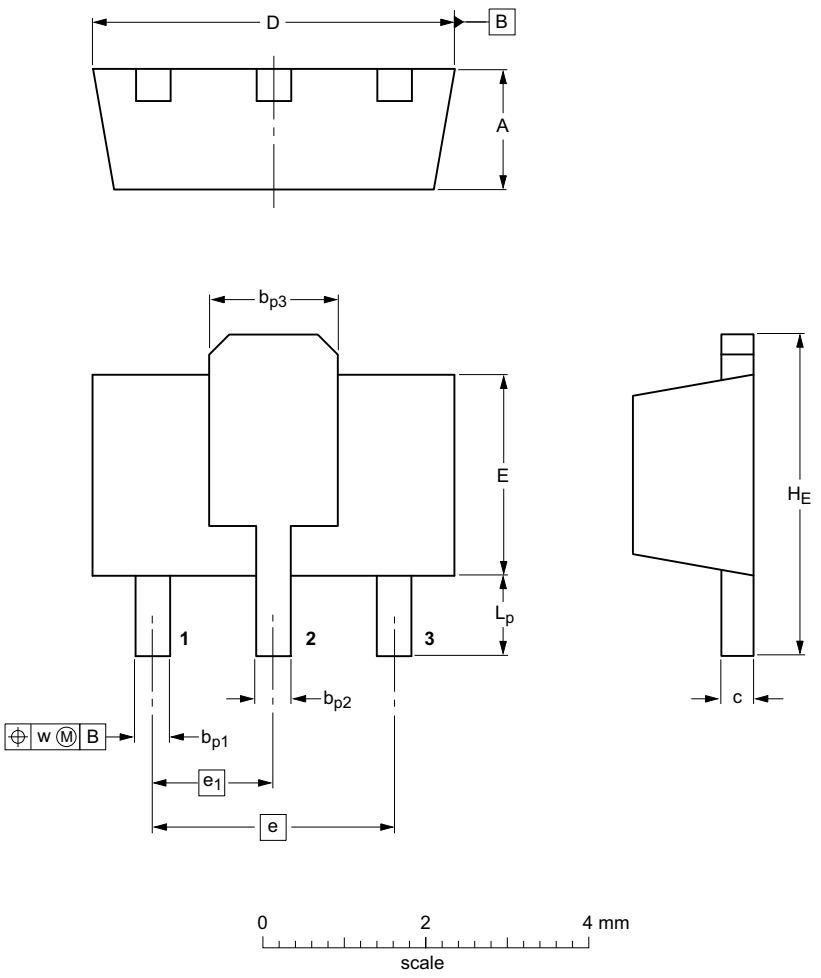


(1) Pre-impregnated.
RO4003C dielectric constant ε_r = 3.38.

Fig 26. PCB stack

13. Package outline

Plastic surface-mounted package; exposed die pad for good heat transfer; 3 leads **SOT89**



DIMENSIONS (mm are the original dimensions)

UNIT	A	b_{p1}	b_{p2}	b_{p3}	c	D	E	e	e_1	H_E	L_p	w
mm	1.6 1.4	0.48 0.35	0.53 0.40	1.8 1.4	0.44 0.23	4.6 4.4	2.6 2.4	3.0	1.5	4.25 3.75	1.2 0.8	0.13

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT89		TO-243	SC-62			~~06-03-16~~ 06-08-29

Fig 27. Package outline SOT89

14. Abbreviations

Table 15. Abbreviations

Acronym	Description
CPE	Customer-Premises Equipment
ESD	ElectroStatic Discharge
HTOL	High Temperature Operating Life
IR	InfraRed
ISM	Industrial, Scientific and Medical
MMIC	Monolithic Microwave Integrated Circuit
MoCA	Multimedia over Coax Alliance
PCB	Printed-Circuit Board
RFID	Radio Frequency IDentification
TX	Transmit
WLAN	Wireless Local Area Network

15. Revision history

Table 16. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGA7024 v.3	20140611	Product data sheet	-	BGA7024 v.2
Modifications:	• Table 5 on page 3: Thermal simulation results have been replaced by IR measurements results.			
BGA7024 v.2	20100830	Product data sheet	-	BGA7024 v.1
BGA7024	20100528	Product 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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