



# BGU7258

5 GHz ISM SiGe:C low-noise amplifier MMIC with bypass

Rev. 3 — 29 August 2018

Product data sheet

## 1 Product profile

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### 1.1 General description

The BGU7258 is a fully integrated MMIC Low Noise Amplifier (LNA) for wireless receiver applications in the 5 GHz to 6 GHz ISM band. Manufactured in NXP's high performance SiGe:C technology, the BGU7258 couples best-in-class gain, noise figure, linearity and efficiency with the process stability and ruggedness that are the hallmarks of SiGe technology. The BGU7258 features a robust temperature-compensated internal bias network and an integral bypass / shutdown feature that stabilizes the DC operating point over temperature and enables operation in the presence of high input signals, while minimizing current consumption in bypass (standby) mode. The 1.6 mm x 1.6 mm footprint coupled with only two external components, makes the circuit board implementation of the BGU7258 LNA the smallest IEEE 802.11ac LNA with bypass solution on the market, ideal for space sensitive applications.

### 1.2 Features and benefits

- Fully integrated, high performance LNA with built-in bypass
- Integrated DC blocking at RF input and RF output, with only two external components needed.
- Low 1.6 dB noise figure with 13 mA current consumption
- Low bypass current of 1  $\mu$ A (typical)
- Single supply 3.0 V to 3.6 V operation
- Integrated concurrent 2.4 GHz notch filter and temperature stabilized bias network
- High IP<sub>3i</sub> and low EVM
- High ESD protection of 2 kV (HBM) on all pins
- Small, 0.5 mm pitch, 1.6 x 1.6 x 0.5 mm QFN-style package, MSL 1 at 260 °C
- Compliant to Directive 2002/95/EC, regarding Restriction of Hazardous Substances (RoHS) following NXP's RHF-2006 indicator D (dark green)

### 1.3 Applications

- IEEE 802.11a/n/ac WiFi, WLAN
- Smartphones, tablets, net-books, and other portable computing devices
- Access points, routers, gateways
- Wireless video
- LTE advanced in unlicensed spectrum (LTE-U)
- General-purpose ISM applications



1.4 Quick reference data

Table 1. Quick reference data

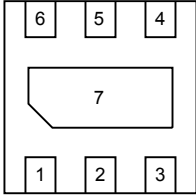
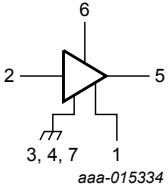
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 3.3\text{ V}$ ;  $Z_S = Z_L = 50\text{ }\Omega$ ;  $P_i = -30\text{ dBm}$ ;  $f = 5.5\text{ GHz}$  unless otherwise specified. All measurements done on application board (with a DC-decoupling capacitor of 4.7 nF placed close to  $V_{CC}$  [pin 6] and a 0.3 pF matching shunt capacitor at RF\_IN) with SMA connectors as reference plane.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
I <sub>CC</sub>	supply current	gain mode	-	13	-	mA	
		bypass mode	-	1	-	μA	
G <sub>p</sub>	power gain	gain mode					
		f = 5.1 GHz [1]	12	14	16	dB	
		f = 5.9 GHz [1]	11	13	15	dB	
		bypass mode					
		f = 5.1 GHz [1]	-	-7	-	dB	
		f = 5.9 GHz [1]	-	-7	-	dB	
P <sub>i(1dB)</sub>	input power at 1 dB gain compression	gain mode	-	-4	-	dBm	
NF	noise figure	gain mode	[1]	1.6	-	dB	

[1] Printed-Circuit Board (PCB) and connector losses excluded.

2 Pinning information

Table 2. Pinning

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	CTRL	gain control, switch between gain and bypass mode	 <p>Transparent top view</p>	 <p>aaa-015334</p>
2	RF_IN	RF in		
3	GND	ground		
4	GND	ground		
5	RF_OUT	RF out		
6	V <sub>CC</sub>	supply voltage		
7	GND	ground pad		

3 Ordering information

Table 3. Ordering information

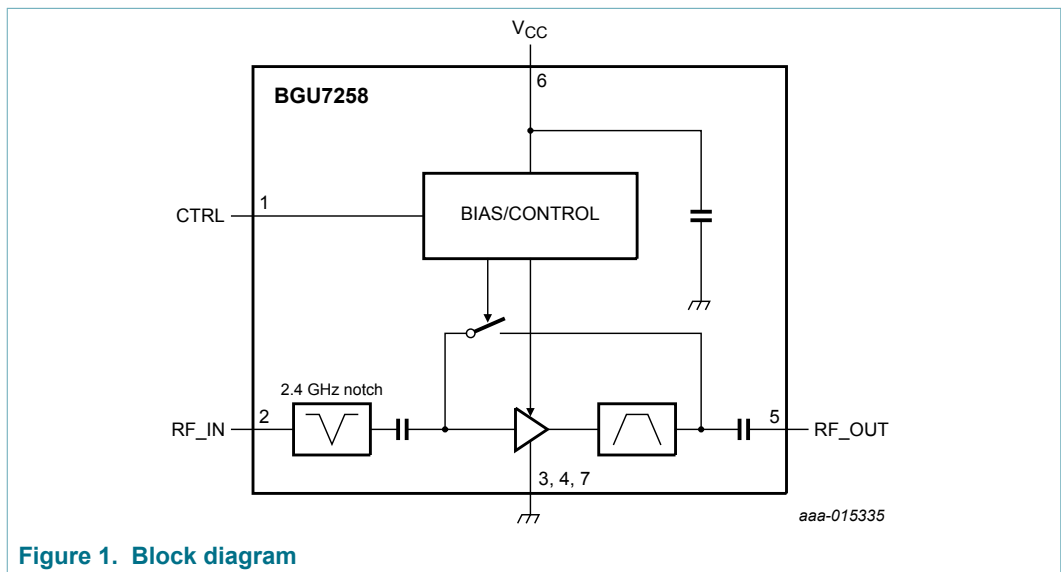
Type number	Package		Version
	Name	Description	
BGU7258	HXSON6	plastic thermal enhanced extremely thin small outline package; no leads; 6 terminals; body 1.6 x 1.6 x 0.5 mm	SOT1189-1
OM7870	-	5 GHz WLAN evaluation board	-

## 4 Marking

Table 4. Marking code

Type number	Marking
BGU7258	258

## 5 Block diagram



## 6 Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134). Absolute Maximum Ratings are given as limiting values of stress conditions during operation, that must not be exceeded under the worst case conditions.

Symbol	Parameter	Conditions		Min	Max	Unit
$V_{CC}$	supply voltage	RF input AC coupled	[1]	-0.5	+5.0	V
$V_{I(RF\_IN)}$	input voltage on pin RF_IN	DC	[1][2][3]	-0.5	+5.0	V
$V_{I(RF\_OUT)}$	input voltage on pin RF_OUT	DC	[1][2][3]	-0.5	+5.0	V
$V_{I(CTRL)}$	input voltage on pin CTRL		[1][2]	-0.5	+5.0	V
$T_{stg}$	storage temperature			-40	+150	°C
$T_j$	junction temperature			-	150	°C
$V_{ESD}$	electrostatic discharge voltage	Human Body Model (HBM); according to the joint JEDEC/ESDA standard JS-001-2012		-	±2	kV
		Charged Device Model (CDM); according to JEDEC standard JESD22-C101		-	±1	kV
$P_i$	input power	f = 5500 MHz; CW				
		gain mode; $V_{CC} = 3.3$ V	[1]	-	10	dBm
		bypass mode; $V_{CC} = 3.3$ V	[1]	-	10	dBm

[1] Stressed with pulses of 200 ms in duration in an application circuit as depicted in [Figure 34](#).

[2] Warning: due to internal ESD diode protection, the applied DC voltage should not exceed  $V_{CC} + 0.6$  V and should not exceed 5.0 V in order to avoid excess current.

[3] The RF input and RF output are AC-coupled through an internal DC blocking capacitor.

## 7 Thermal characteristics

**Table 6. Thermal characteristics**

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-case)}$	thermal resistance from junction to case		250	K/W

## 8 Static characteristics

Table 7. Static characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>CC</sub>	supply voltage	RF input, AC coupled	3.0	3.3	3.6	V
I <sub>CC</sub>	supply current	P <sub>i</sub> = -30 dBm				
		gain mode	-	13	-	mA
		bypass mode	-	1	-	μA
I <sub>I(CTRL)</sub>	input current on pin CTRL	gain mode	-	50	-	μA
T <sub>amb</sub>	ambient temperature		-40	+25	+85	°C

## 9 Dynamic characteristics

Table 8. Dynamic characteristics

T<sub>amb</sub> = 25 °C; V<sub>CC</sub> = 3.3 V; Z<sub>S</sub> = Z<sub>L</sub> = 50 Ω; P<sub>i</sub> = -30 dBm; f = 5.5 GHz unless otherwise specified. All measurements done on application board (with a DC-decoupling capacitor of 4.7 nF placed close to V<sub>CC</sub> [pin 6] and a 0.3 pF matching shunt capacitor at RF\_IN) with SMA connectors as reference plane.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
f	frequency		[1] 4900	-	5925	MHz	
G <sub>p</sub>	power gain	gain mode	[2]				
		f = 5.1 GHz		12	14	16	dB
		f = 5.9 GHz		11	13	15	dB
		bypass mode	[2]				
		f = 5.1 GHz		-	-7	-	dB
		f = 5.9 GHz		-	-7	dB	
RL <sub>in</sub>	input return loss	gain mode		-	17	-	dB
		bypass mode		-	10	-	dB
RL <sub>out</sub>	output return loss	gain mode		-	18	-	dB
		bypass mode		-	16	-	dB
ISL	isolation	gain mode		-	20	-	dB
G <sub>flat</sub>	gain flatness	bandwidth across 80 MHz channel					
		gain mode		-	±0.2	-	dB
		bypass mode		-	±0.2	-	dB
P <sub>I(1dB)</sub>	input power at 1 dB gain compression	gain mode		-	-4	-	dBm
IP <sub>3i</sub>	input third-order intercept point	two-tone; 5 MHz spacing					
		P <sub>i</sub> = -20 dBm; gain mode		-	8	-	dBm
		P <sub>i</sub> = -5 dBm; bypass mode		-	27	-	dBm
NF	noise figure	gain mode	[2]	-	1.6	-	dB
t <sub>sw(G)</sub>	gain switch time	V <sub>I(CTRL)</sub> = 0 V to 3.3 V					
		gain mode	[3]	-	150	-	ns

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
		bypass mode	[4] -	20	-	ns
K	Rollett stability factor	0 GHz ≤ f ≤ 20 GHz; gain mode	-	> 1	-	

- [1] ISM 5 GHz (in band).
- [2] Printed-Circuit Board (PCB) and connector losses excluded.
- [3] measured from 50 % of  $V_{I(CTRL)}$  control signal to 90 % of maximum RF output signal.
- [4] measured from 50 % of  $V_{I(CTRL)}$  control signal to 10 % of maximum RF output signal.

## 10 Gain control

**Table 9. Gain control (pin CTRL)**

$T_{amb} = 25\text{ °C}$ ;  $V_{CC} = 3.3\text{ V}$ .

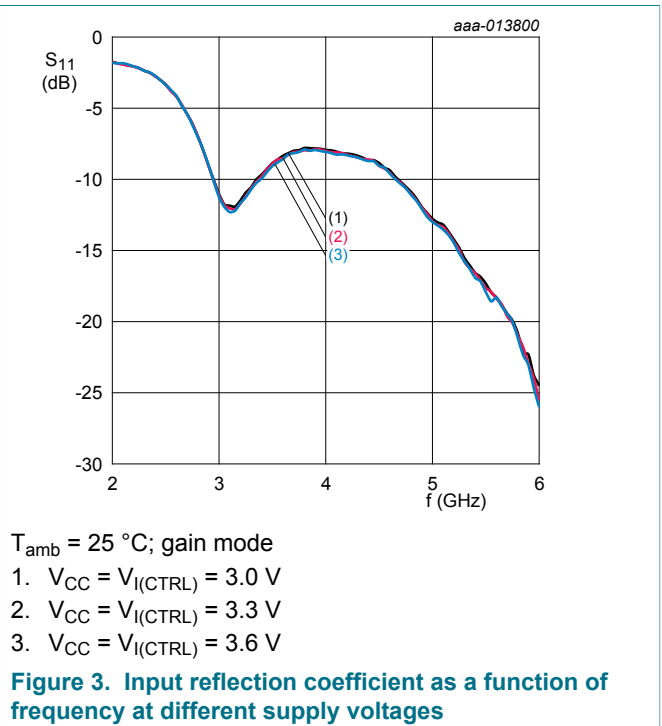
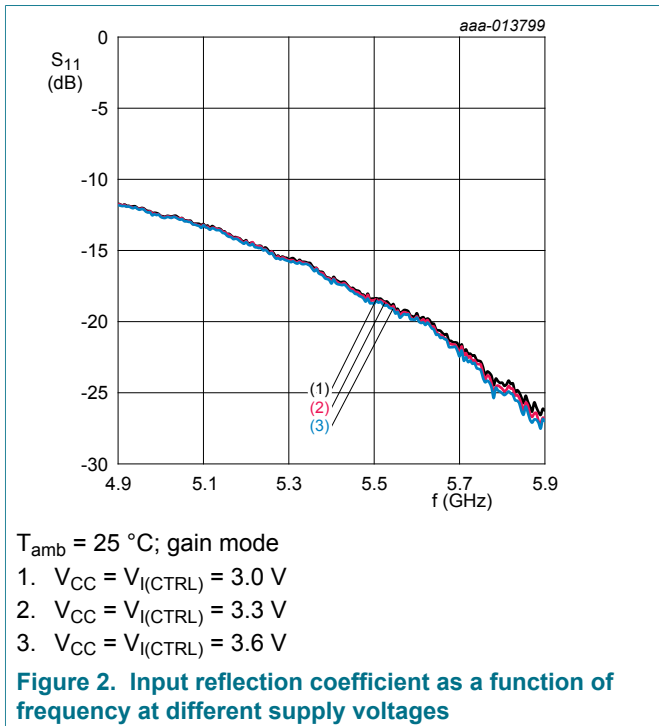
$V_{I(CTRL)}$ (V)	Mode
≤ 0.5	bypass
≤ 2.5	gain

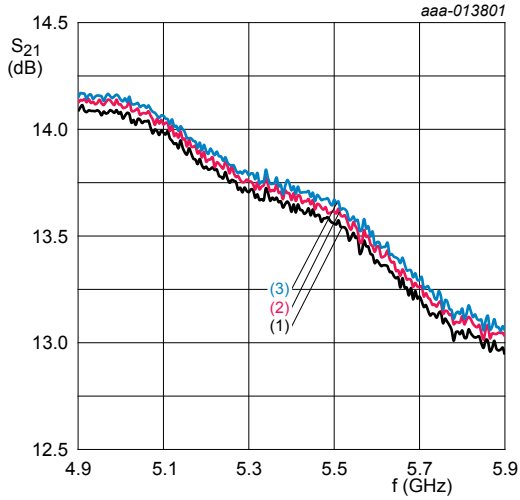
## 11 Application information

Please contact your local sales representative for more information. Application note AN11453 is available on the NXP website.

### 11.1 Graphs

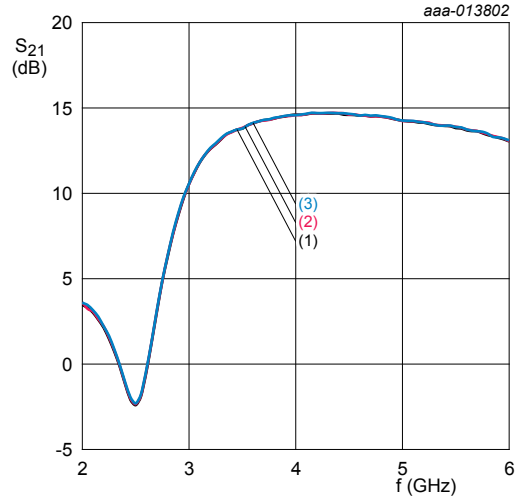
Typical performance measured on the application board.





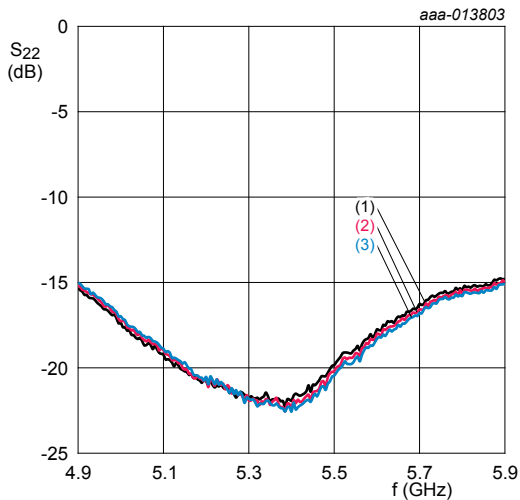
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; gain mode  
 1.  $V_{CC} = V_{I(CTRL)} = 3.0\text{ V}$   
 2.  $V_{CC} = V_{I(CTRL)} = 3.3\text{ V}$   
 3.  $V_{CC} = V_{I(CTRL)} = 3.6\text{ V}$

**Figure 4. Forward transmission coefficient as a function of frequency at different supply voltages**



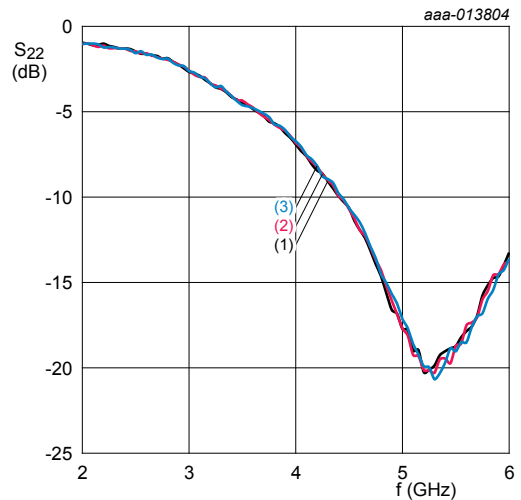
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; gain mode  
 1.  $V_{CC} = V_{I(CTRL)} = 3.0\text{ V}$   
 2.  $V_{CC} = V_{I(CTRL)} = 3.3\text{ V}$   
 3.  $V_{CC} = V_{I(CTRL)} = 3.6\text{ V}$

**Figure 5. Forward transmission coefficient as a function of frequency at different supply voltages**



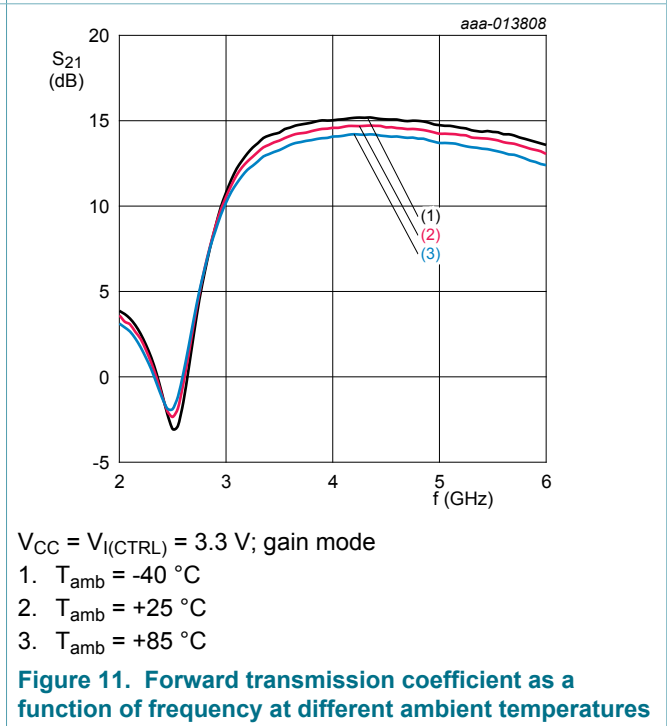
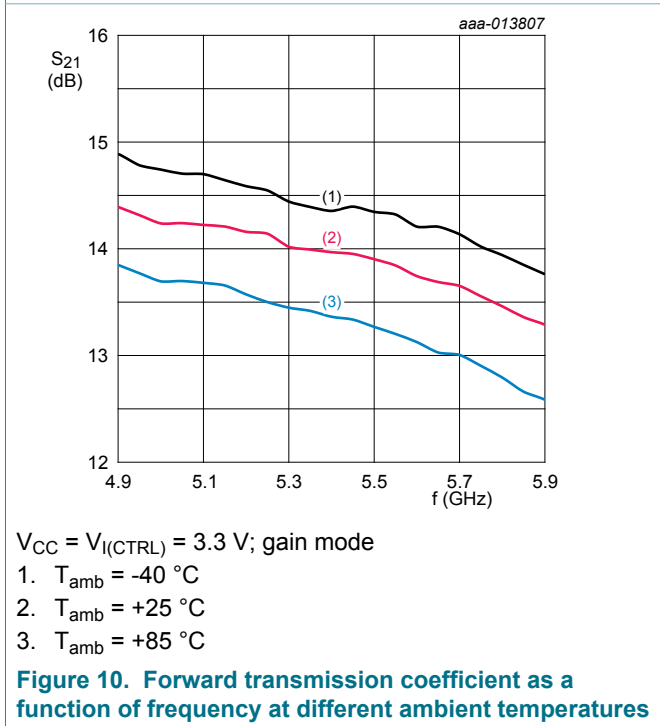
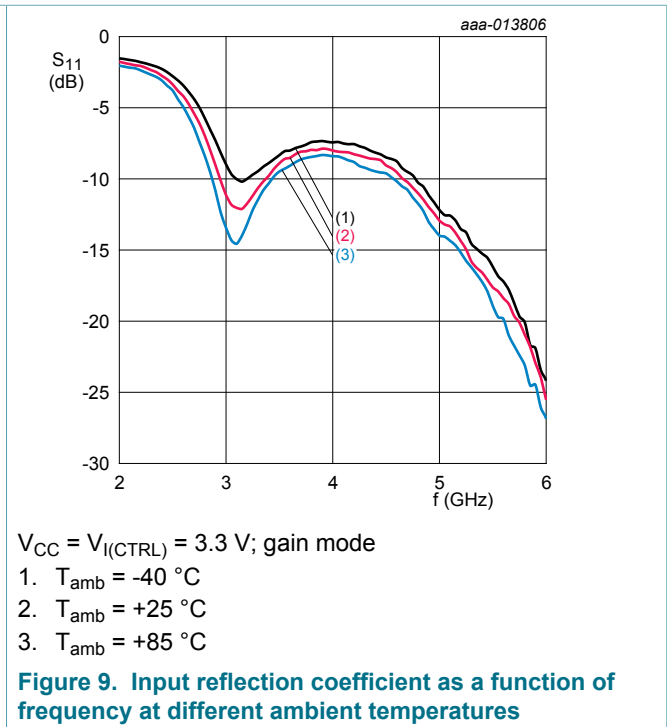
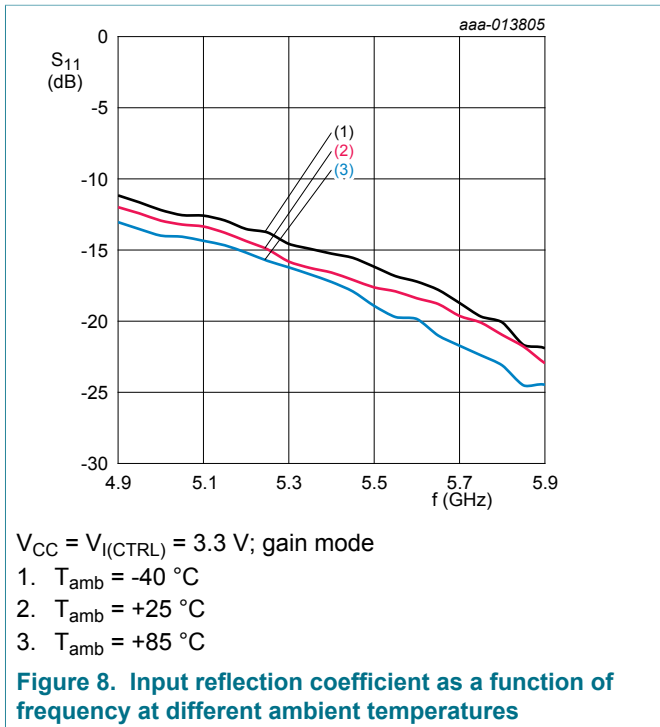
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; gain mode  
 1.  $V_{CC} = V_{I(CTRL)} = 3.0\text{ V}$   
 2.  $V_{CC} = V_{I(CTRL)} = 3.3\text{ V}$   
 3.  $V_{CC} = V_{I(CTRL)} = 3.6\text{ V}$

**Figure 6. Output reflection coefficient as a function of frequency at different supply voltages**

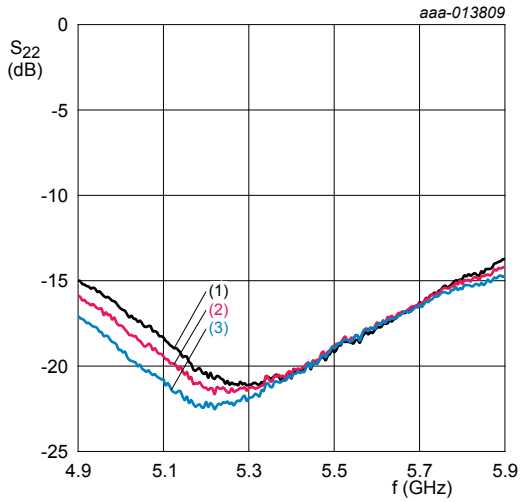


$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; gain mode  
 1.  $V_{CC} = V_{I(CTRL)} = 3.0\text{ V}$   
 2.  $V_{CC} = V_{I(CTRL)} = 3.3\text{ V}$   
 3.  $V_{CC} = V_{I(CTRL)} = 3.6\text{ V}$

**Figure 7. Output reflection coefficient as a function of frequency at different supply voltages**



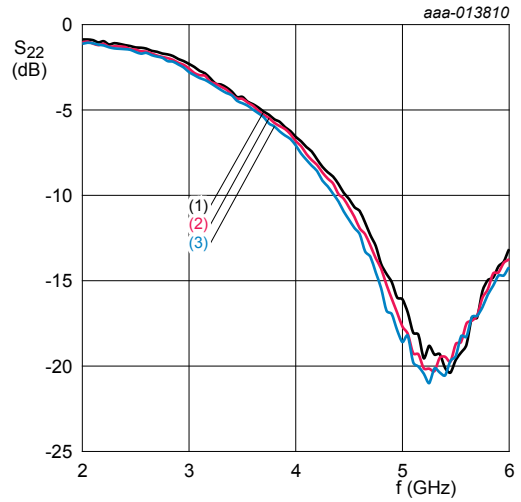




$V_{CC} = V_{I(CTRL)} = 3.3 \text{ V}$ ; gain mode

1.  $T_{amb} = -40 \text{ }^\circ\text{C}$
2.  $T_{amb} = +25 \text{ }^\circ\text{C}$
3.  $T_{amb} = +85 \text{ }^\circ\text{C}$

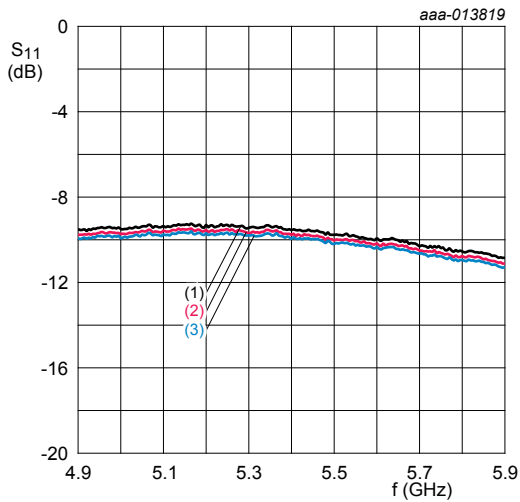
**Figure 12. Output reflection coefficient as a function of frequency at different ambient temperatures**



$V_{CC} = V_{I(CTRL)} = 3.3 \text{ V}$ ; gain mode

1.  $T_{amb} = -40 \text{ }^\circ\text{C}$
2.  $T_{amb} = +25 \text{ }^\circ\text{C}$
3.  $T_{amb} = +85 \text{ }^\circ\text{C}$

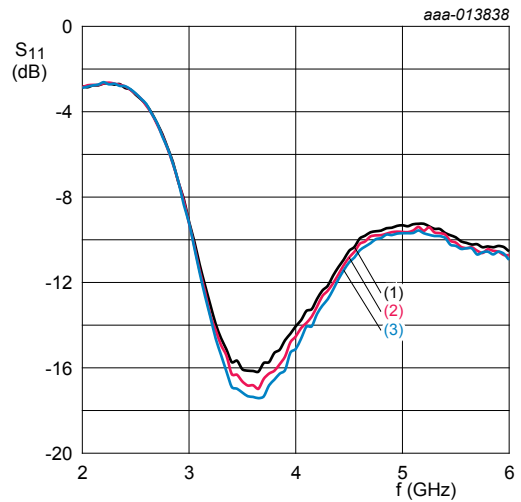
**Figure 13. Output reflection coefficient as a function of frequency at different ambient temperatures**



$T_{amb} = 25 \text{ }^\circ\text{C}$ ;  $V_{I(CTRL)} = 0 \text{ V}$ ; bypass mode

1.  $V_{CC} = 3.0 \text{ V}$
2.  $V_{CC} = 3.3 \text{ V}$
3.  $V_{CC} = 3.6 \text{ V}$

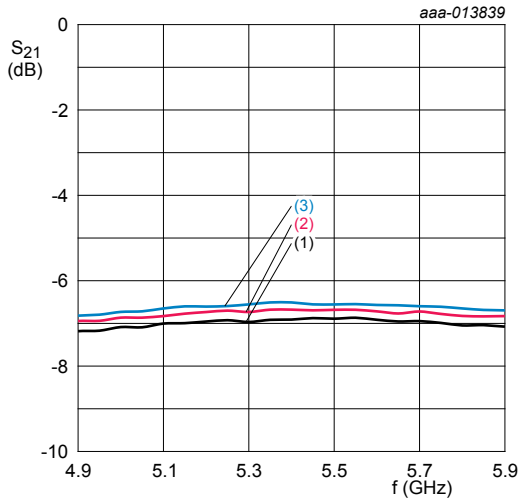
**Figure 14. Input reflection coefficient as a function of frequency at different supply voltages**



$T_{amb} = 25 \text{ }^\circ\text{C}$ ;  $V_{I(CTRL)} = 0 \text{ V}$ ; bypass mode

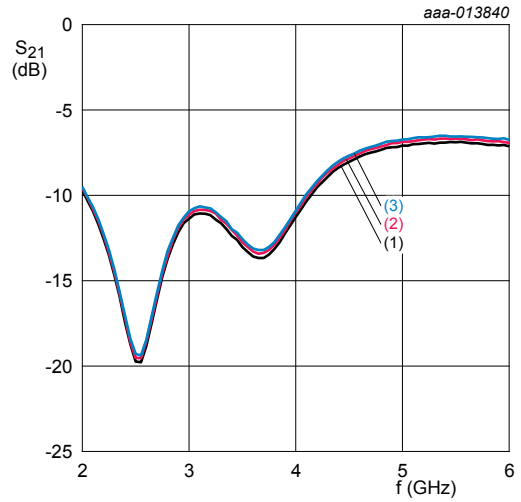
1.  $V_{CC} = 3.0 \text{ V}$
2.  $V_{CC} = 3.3 \text{ V}$
3.  $V_{CC} = 3.6 \text{ V}$

**Figure 15. Input reflection coefficient as a function of frequency at different supply voltages**



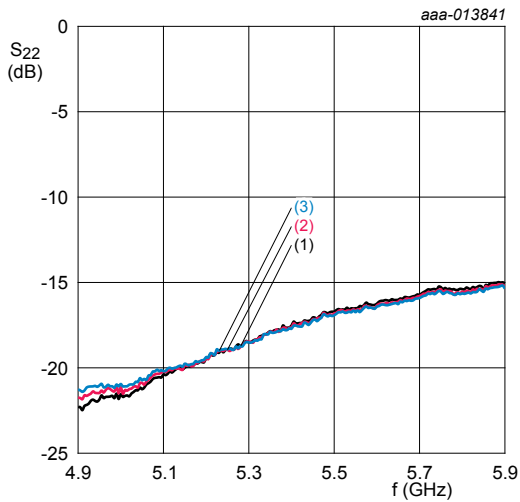
$T_{amb} = 25\text{ }^{\circ}\text{C}; V_{I(CTRL)} = 0\text{ V};$  bypass mode  
 1.  $V_{CC} = 3.0\text{ V}$   
 2.  $V_{CC} = 3.3\text{ V}$   
 3.  $V_{CC} = 3.6\text{ V}$

**Figure 16. Forward transmission coefficient as a function of frequency at different supply voltages**



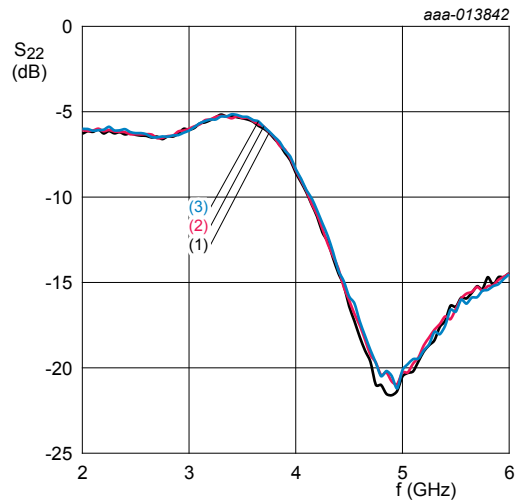
$T_{amb} = 25\text{ }^{\circ}\text{C}; V_{I(CTRL)} = 0\text{ V};$  bypass mode  
 1.  $V_{CC} = 3.0\text{ V}$   
 2.  $V_{CC} = 3.3\text{ V}$   
 3.  $V_{CC} = 3.6\text{ V}$

**Figure 17. Forward transmission coefficient as a function of frequency at different supply voltages**



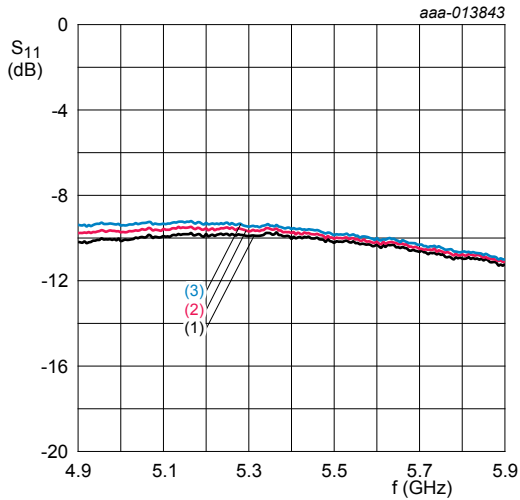
$T_{amb} = 25\text{ }^{\circ}\text{C}; V_{I(CTRL)} = 0\text{ V};$  bypass mode  
 1.  $V_{CC} = 3.0\text{ V}$   
 2.  $V_{CC} = 3.3\text{ V}$   
 3.  $V_{CC} = 3.6\text{ V}$

**Figure 18. Output reflection coefficient as a function of frequency at different supply voltages**



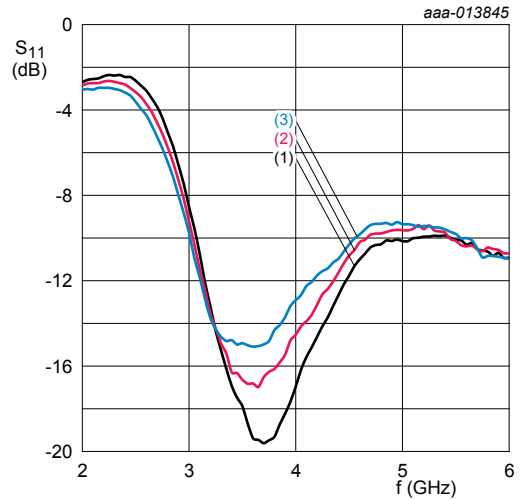
$T_{amb} = 25\text{ }^{\circ}\text{C}; V_{I(CTRL)} = 0\text{ V};$  bypass mode  
 1.  $V_{CC} = 3.0\text{ V}$   
 2.  $V_{CC} = 3.3\text{ V}$   
 3.  $V_{CC} = 3.6\text{ V}$

**Figure 19. Output reflection coefficient as a function of frequency at different supply voltages**



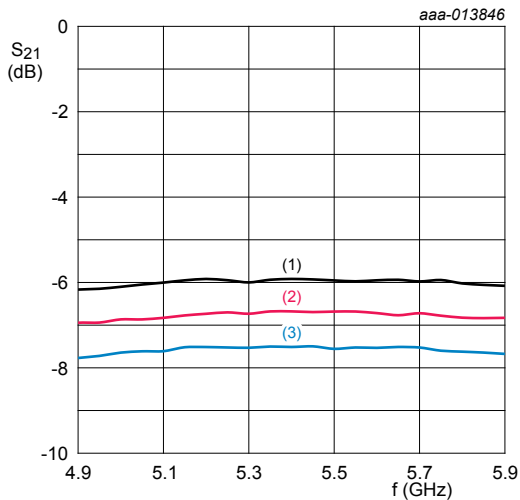
$V_{CC} = 3.3\text{ V}; V_{I(CTRL)} = 0\text{ V};$  bypass mode  
 1.  $T_{amb} = -40\text{ }^{\circ}\text{C}$   
 2.  $T_{amb} = +25\text{ }^{\circ}\text{C}$   
 3.  $T_{amb} = +85\text{ }^{\circ}\text{C}$

**Figure 20. Input reflection coefficient as a function of frequency at different ambient temperatures**



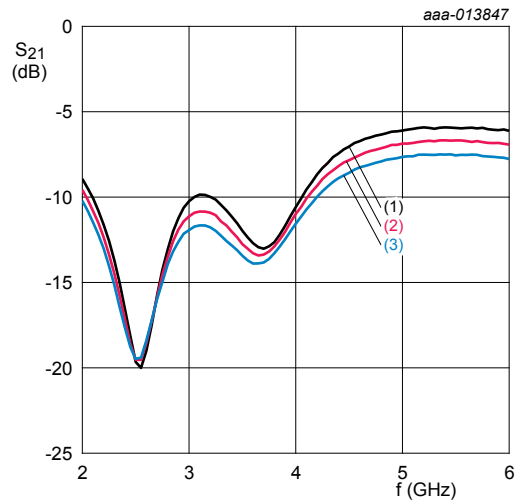
$V_{CC} = 3.3\text{ V}; V_{I(CTRL)} = 0\text{ V};$  bypass mode  
 1.  $T_{amb} = -40\text{ }^{\circ}\text{C}$   
 2.  $T_{amb} = +25\text{ }^{\circ}\text{C}$   
 3.  $T_{amb} = +85\text{ }^{\circ}\text{C}$

**Figure 21. Input reflection coefficient as a function of frequency at different ambient temperatures**



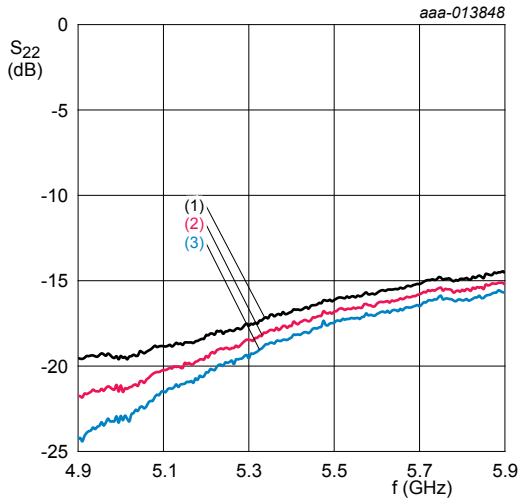
$V_{CC} = 3.3\text{ V}; V_{I(CTRL)} = 0\text{ V};$  bypass mode  
 1.  $T_{amb} = -40\text{ }^{\circ}\text{C}$   
 2.  $T_{amb} = +25\text{ }^{\circ}\text{C}$   
 3.  $T_{amb} = +85\text{ }^{\circ}\text{C}$

**Figure 22. Forward transmission coefficient as a function of frequency at different ambient temperatures**



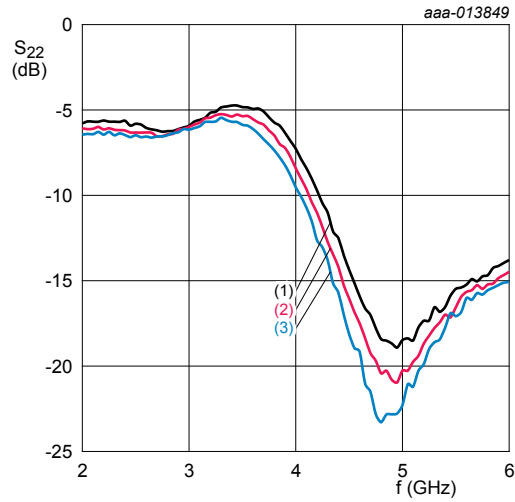
$V_{CC} = 3.3\text{ V}; V_{I(CTRL)} = 0\text{ V};$  bypass mode  
 1.  $T_{amb} = -40\text{ }^{\circ}\text{C}$   
 2.  $T_{amb} = +25\text{ }^{\circ}\text{C}$   
 3.  $T_{amb} = +85\text{ }^{\circ}\text{C}$

**Figure 23. Forward transmission coefficient as a function of frequency at different ambient temperatures**



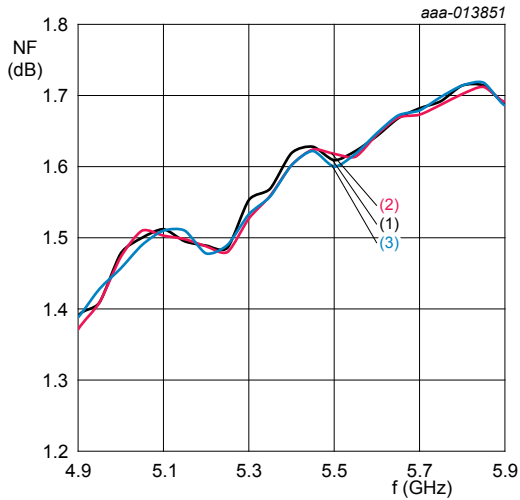
$V_{CC} = 3.3 \text{ V}; V_{I(CTRL)} = 0 \text{ V};$  bypass mode  
 1.  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 2.  $T_{amb} = +25 \text{ }^\circ\text{C}$   
 3.  $T_{amb} = +85 \text{ }^\circ\text{C}$

**Figure 24. Output reflection coefficient as a function of frequency at different ambient temperatures**



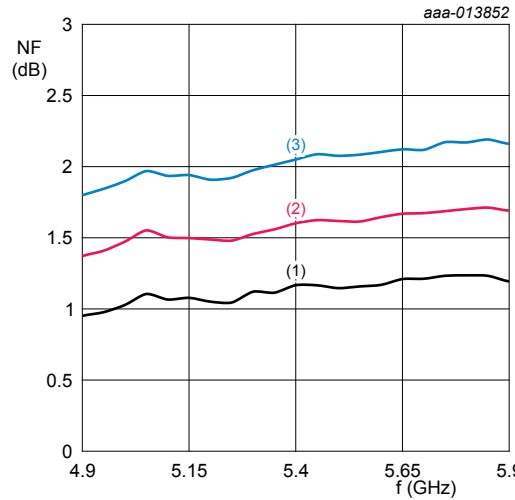
$V_{CC} = 3.3 \text{ V}; V_{I(CTRL)} = 0 \text{ V};$  bypass mode  
 1.  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 2.  $T_{amb} = +25 \text{ }^\circ\text{C}$   
 3.  $T_{amb} = +85 \text{ }^\circ\text{C}$

**Figure 25. Output reflection coefficient as a function of frequency at different ambient temperatures**



$T_{amb} = 25 \text{ }^\circ\text{C};$  gain mode  
 1.  $V_{CC} = V_{I(CTRL)} = 3.0 \text{ V}$   
 2.  $V_{CC} = V_{I(CTRL)} = 3.3 \text{ V}$   
 3.  $V_{CC} = V_{I(CTRL)} = 3.6 \text{ V}$

**Figure 26. Noise figure as a function of frequency at different supply voltages**



$V_{CC} = V_{I(CTRL)} = 3.3 \text{ V};$  gain mode  
 1.  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 2.  $T_{amb} = +25 \text{ }^\circ\text{C}$   
 3.  $T_{amb} = +85 \text{ }^\circ\text{C}$

**Figure 27. Noise figure as a function of frequency at different ambient temperatures**

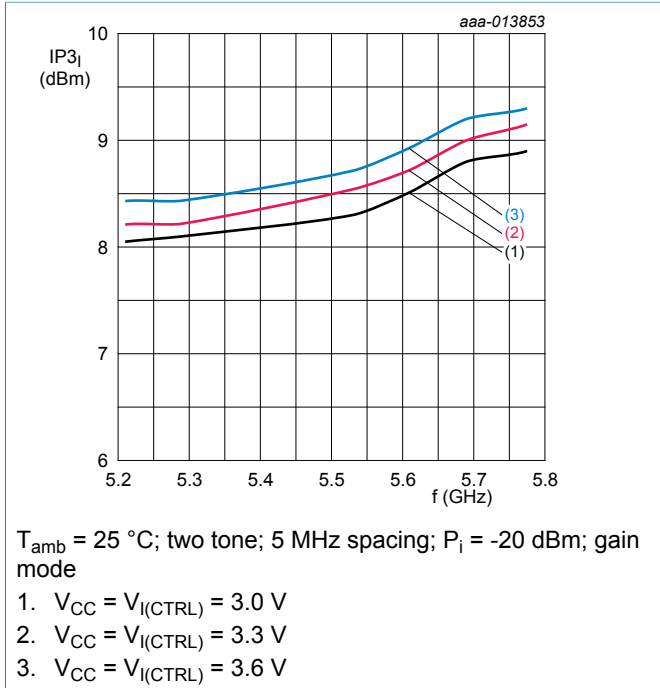


Figure 28. Input third-order intercept point as a function of frequency at different supply voltages

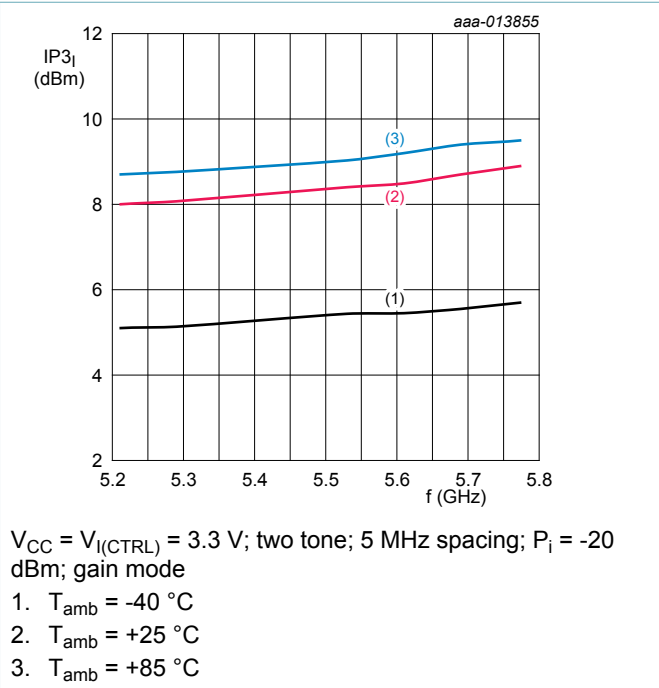


Figure 29. Input third-order intercept point as a function of frequency at different ambient temperatures

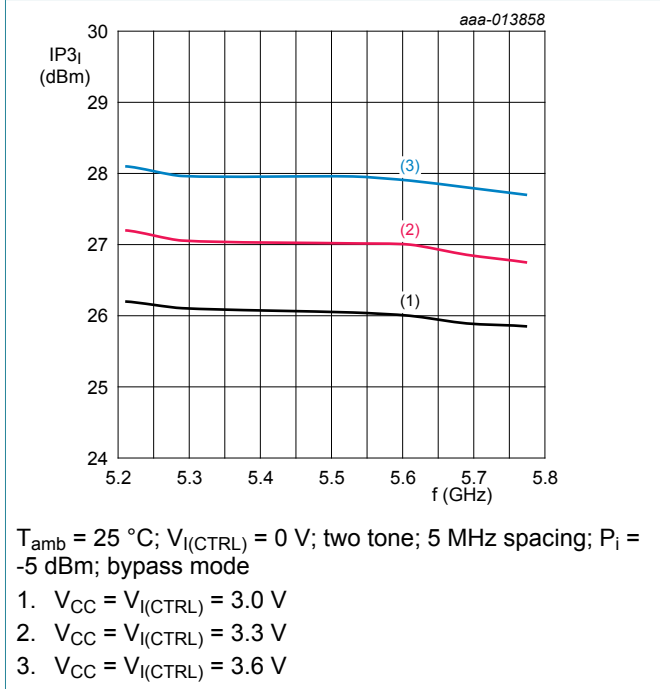


Figure 30. Input third-order intercept point as a function of frequency at different supply voltages

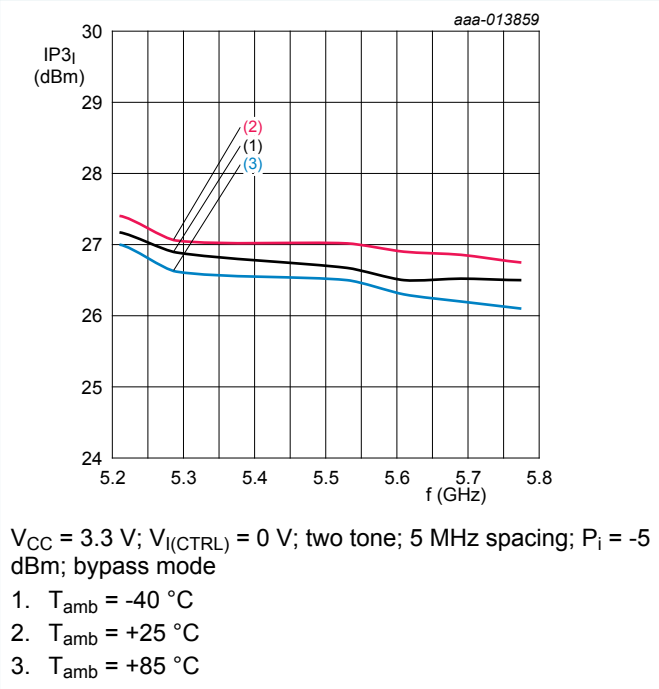
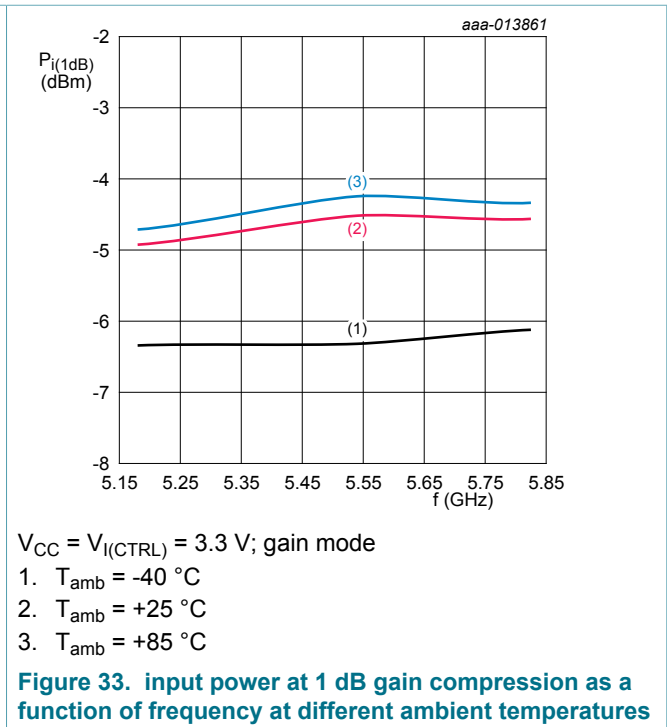
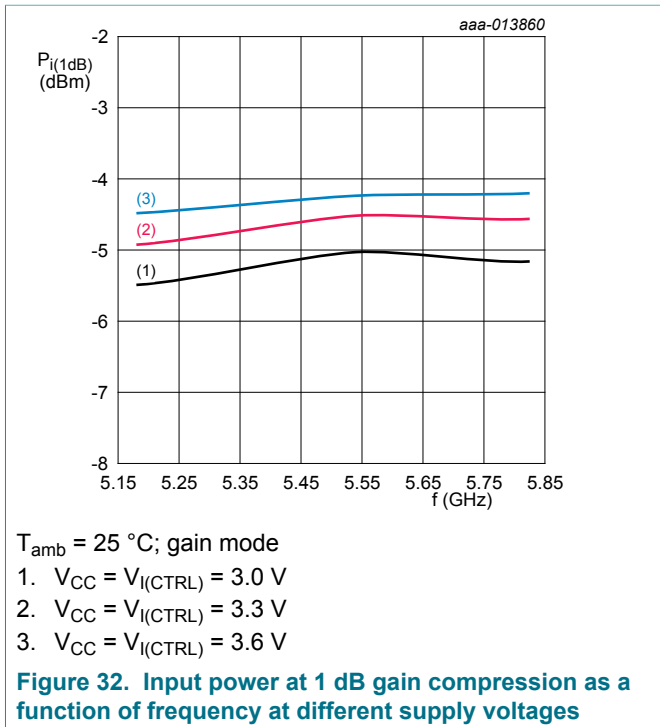
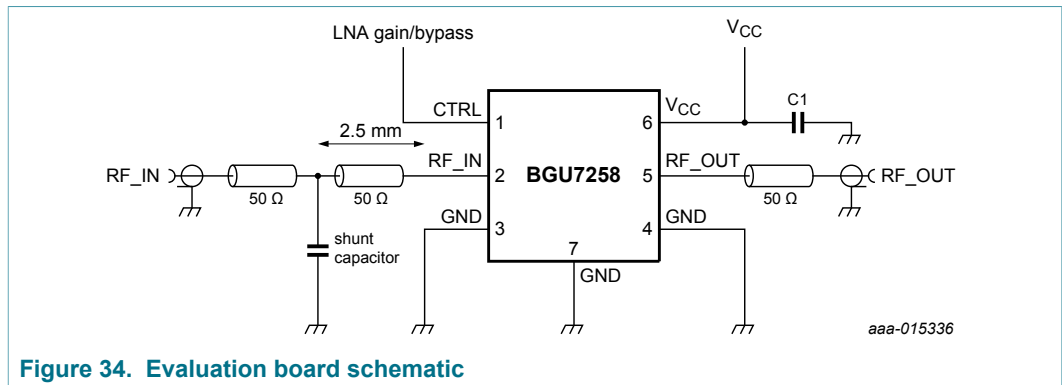


Figure 31. Input third-order intercept point as a function of frequency at different ambient temperatures



## 11.2 Application circuit

In [Figure 34](#) the application diagram as supplied on the evaluation board is given.



Note that in [Figure 34](#) the schematic for the BGU7258 evaluation board is shown using only two external components. A DC-decoupling capacitor placed close to  $V_{CC}$  (pin 6) and a matching shunt capacitor at  $RF\_IN$ .

The BGU7258 can also be used without the matching capacitor at  $RF\_IN$ . However, in this case the gain will be 0.5 dB lower, the noise figure 0.1 dB higher and the input return loss less than 10 dB (approximately 8 dB) over the whole 5 GHz ISM band (5 GHz to 6 GHz).

**Table 10. List of components**

See [Figure 34](#) for evaluation board schematic.

Preferred vendors different from the ones listed can be chosen, but be aware that the performance could be affected.

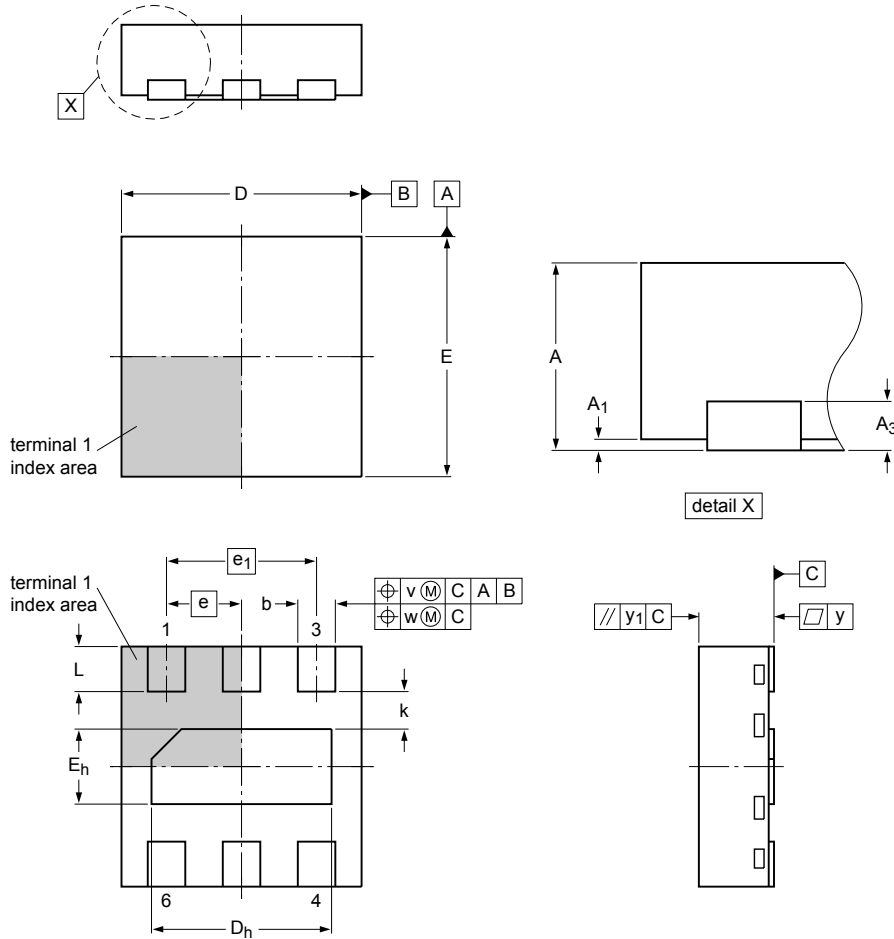
Component	Description	Value	Remarks
C1	capacitor	4.7 nF	Murata GRM155 series
shunt capacitor	capacitor	0.3 pF	Murata GJM155 series
RF_IN, RF_OUT	SMA connector	-	Emerson Network Power
V <sub>CC</sub> , LNA gain/bypass	3-pin connector	-	Molex

For more details or information see application note [AN11453](#).

12 Package outline

HXSON6: plastic, thermal enhanced extremely thin small outline package; no leads;  
6 terminals; body 1.6 x 1.6 x 0.5 mm

SOT1189-1



Dimensions

Unit <sup>(1)</sup>	A	A <sub>1</sub>	A <sub>3</sub>	b	D	D <sub>h</sub>	E	E <sub>h</sub>	e	e <sub>1</sub>	k	L	v	w	y	y <sub>1</sub>
max	0.50	0.05		0.30	1.7	1.3	1.7	0.6				0.35				
nom	0.48		0.127	0.25	1.6	1.2	1.6	0.5	0.5	1		0.30	0.1	0.05	0.05	0.05
min	0.46	0.00		0.20	1.5	1.1	1.5	0.4			0.2	0.25				

Note

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

sot1189-1\_po

Outline version	References			European projection	Issue date
	IEC	JEDEC	JEITA		
SOT1189-1	---	---	---		10-10-11 18-08-14

Figure 35. Package outline SOT1189-1 (HXSON6)



### 13 Soldering

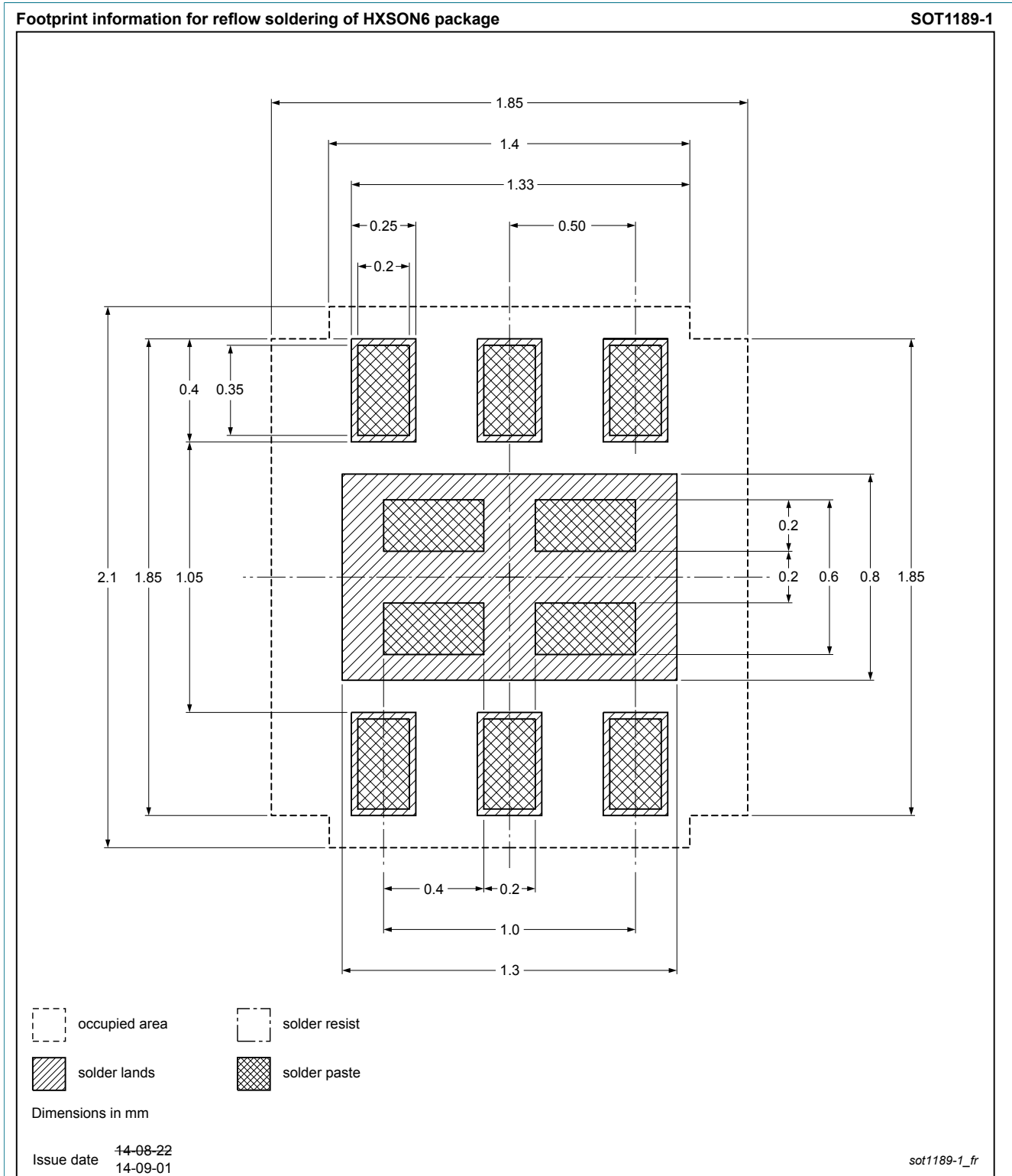


Figure 36. Reflow soldering footprint

## 14 Abbreviations

Table 11. Abbreviations

Acronym	Description
CW	continuous wave
ESD	electrostatic discharge
EVM	error vector magnitude
HBM	human body model
IEEE	institute of electrical and electronics engineers
ISM	industrial scientific medical
LTE	long-term evolution
LTE-U	long-term evolution unlicensed
MMIC	monolithic microwave-integrated circuit
MSL	moisture sensitivity level
RHF	RoHS halogen free
QFN	quad-flat no-leads
SiGe:C	silicon germanium carbon
SMA	sub miniature-version A
WLAN	wireless local area network

## 15 Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGU7258 v.3	20180829	Product data sheet	-	BGU7258 v.2
Modifications:	Package outline changed			
BGU7258 v.2	20141030	Product data sheet	-	BGU7258 v.1
Modifications:	• The status of this document has been changed to Product data sheet.			
BGU7258 v.1	20141023	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.

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

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