

BTS7205U

3.3 GHz - 4.2 GHz RX Analog Front-End Module with bypass

Rev. 7 — 7 June 2022

Product data sheet

1 General description

The BTS7205U is a dual channel Receiver Analog Front-End module (RX AFE) available in a leadframe HVQFN package.

The BTS7205U is designed for 5G mMIMO Infrastructure applications. The BTS7205U includes 2 independent receive channels with a low noise amplifier (LNA) with variable gain control. Each channel also has a switch for high-power TX signals. In addition, each channel has a separate TX signal bypass to RX output via a coupler.

The device is matched to 50 Ω and integrates harmonic and out-of-band filtering which minimizes the layout area in the application.

2 Features and benefits

- Operating frequency range 3.3 GHz - 4.2 GHz
- 170 mW power dissipation per channel
- RX power gain 36 dB
- RX power gain attenuation step 6 dB
- Typical Noise Figure 1.3 dB
- High TX power handling 37 dBm (9 dB PAPR)
- Single-ended input /output RF ports matched to 50 Ω
- Fast switching time between operation modes
- TX signal bypass via coupler to RX output
- ESD protection on all pins
- Leadframe HVQFN package 5.0 mm x 5.0 mm x 0.85 mm with 32 pins

3 Applications

- 5G mMIMO
- Wireless Infrastructure



4 Quick reference data

Table 1. Quick reference data

$f = 3.75 \text{ GHz}$; $V_{CC} = 3.3 \text{ V}$, $T_{case} = 50 \text{ }^\circ\text{C}$; input and output $50 \text{ } \Omega$; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
High gain RX mode; signal from ANT to RX_OUT						
I_{CC}	supply current		-	51	57	mA
G_p	power gain		34.5	36	37.5	dB
NF	noise figure		-	1.3	1.4	dB
$IP3_o$	output third-order intercept point	2-tones at 10 MHz distance, $P_i = -40 \text{ dBm}$ each tone	20	23	-	dBm
$P_{i(1dB)}$	input power at 1 dB gain compression		-25	-24	-	dBm
Low gain RX mode; signal from ANT to RX_OUT						
I_{CC}	supply current		-	51	57	mA
G_p	power gain		28.5	30	31.5	dB
α_{step}	attenuation step		5.3	6	6.4	dB
NF	noise figure		-	1.5	1.6	dB
$IP3_o$	output third-order intercept point	2-tones at 10 MHz distance, $P_i = -40 \text{ dBm}$ each tone	-	22	-	dBm
$P_{i(1dB)}$	input power at 1 dB gain compression		-19	-18	-	dBm
TX mode; signal from ANT to TERM						
I_{CC}	supply current		-	5.9	6.5	mA
$P_{i(AV)TX}$	maximum average input power in TX mode ^[1]	applied on ANT pin, 10 years, $T_{case(AV)} = 99 \text{ }^\circ\text{C}$ ^[2]	34	-	-	dBm
		applied on ANT pin, 10 seconds, $T_{case} = 105 \text{ }^\circ\text{C}$ ^[3]	37	-	-	dBm
TX bypass mode: Signal from ANT to RX_OUT via coupler						
G_p	power gain		-32	-29	-27.5	dB

[1] CP-OFDM with 9 dB PAPR, BW = 100 MHz, QPSK modulated, SCS = 60 kHz, fully allocated

[2] $T_{case(AV)}$ is an equivalent temperature that yields the same aging over life time as the expected temperature profile which includes temperatures up to $105 \text{ }^\circ\text{C}$

[3] See [Table 7](#)

5 Ordering information

Table 2. Ordering information

Type number	Orderable part number	Package		
		Name	Description	Version
BTS7205U	BTS7205UHP	HVQFN32	Plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; body 5.0 mm x 5.0 mm x 0.85 mm	SOT617-3

6 Marking

Table 3. Marking

Type number	Marking code
BTS7205U	7205U

7 Functional diagram

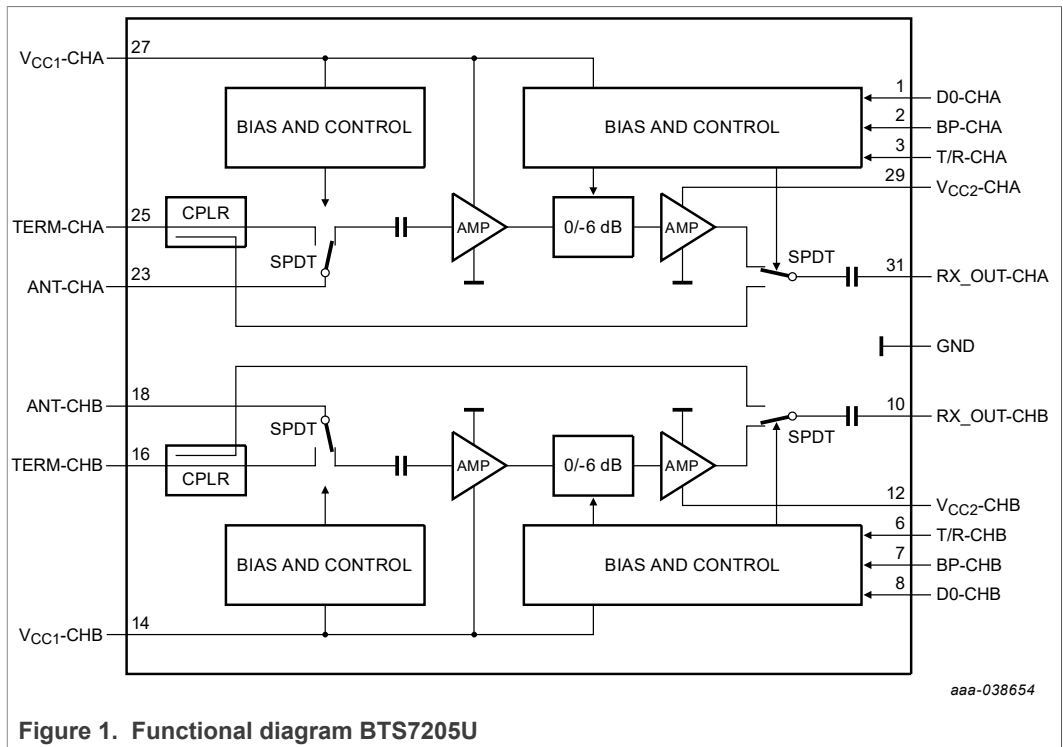
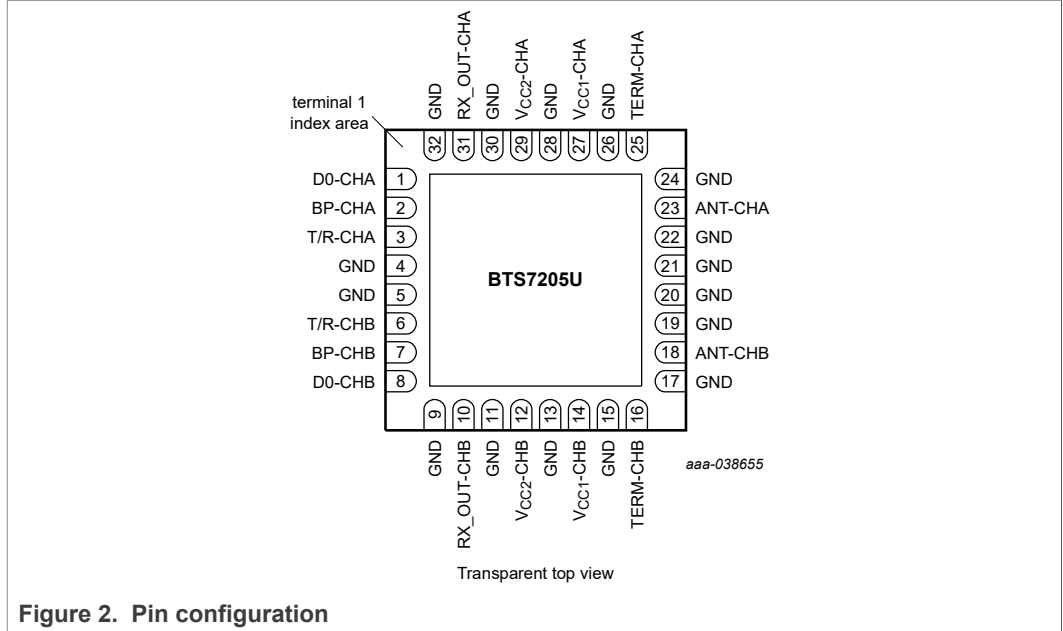


Figure 1. Functional diagram BTS7205U

8 Pinning information

8.1 Pin diagram



8.2 Pin description

Table 4.

Pin	Symbol	Description
1	D0-CHA	Select attenuation for channel A
2	BP-CHA	Bypass switch control for channel A
3	T/R-CHA	Select RX mode / TX mode for channel A
4, 5, 9, 11, 13, 15, 17, 19, 20, 21, 22, 24, 26, 28, 30, and 32	GND	Ground reference
6	T/R-CHB	Select RX mode / TX mode for channel B
7	BP-CHB	Bypass switch control for channel B
8	D0-CHB	Select attenuation for channel B
10	RX_OUT-CHB	RF output for channel B (50 Ω, single ended)
12, 14	V _{CC} -CHB	Supply voltage for channel B
16	TERM-CHB	Termination RF output for channel B (50 Ω, single ended, DC at 0 V)
18	ANT-CHB	RF input for channel B (50 Ω, single ended, DC at 0 V)
23	ANT-CHA	RF input for channel A (50 Ω, single ended, DC at 0 V)
25	TERM-CHA	Termination RF output for channel A (50 Ω, single ended, DC at 0 V)
27, 29	V _{CC} -CHA	Supply voltage for channel A
31	RX_OUT-CHA	RF output for channel A (50 Ω, single ended)
Die paddle	GND	Ground reference

9 Functional description

9.1 Modes of operation

Table 5. Modes of operation for channel A

T/R-CHA	BP-CHA	D0-CHA	Mode of Operation
Low	Low/High	Low	RX High gain mode for channel A
Low	Low/High	High	RX 6 dB reduced-gain mode for channel A
High	Low	Low/High	TX mode for channel A
High	High	Low/High	TX with bypass mode for channel A

Table 6. Modes of operation for channel B

T/R-CHB	BP-CHB	D0-CHB	Mode of Operation
Low	Low/High	Low	RX High gain mode for channel B
Low	Low/High	High	RX 6 dB reduced-gain mode for channel B
High	Low	Low/High	TX mode for channel B
High	High	Low/High	TX with bypass mode for channel B

10 Limiting values

Table 7. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
V _{CC}	supply voltage		-0.3	6	V
VDC _(ctrl_pins)	DC voltage on control pins	applied on control pins D0, BP, and T/R	-0.3	3.45	V
VDC _(RF_pins)	DC voltage on RF pins	applied on both ANT, and both TERM, RF pins	0	0	V
P _{I(AV)RX}	average input power in RX mode ^[1]	applied on ANT pin, 24 hours, T _{case} = 105 °C	-	11	dBm
P _{I(AV)TX}	average input power in TX mode ^[1]	applied on ANT pin, 10 seconds, T _{case} = 105 °C	37	39	dBm
T _{stg}	storage temperature		-40	150	°C
T _j	junction temperature		-	150	°C
V _{ESD}	electrostatic discharge voltage	Human Body Model (HBM) according to ANSI/ESDA/JEDEC standard JS-001	-2	2	kV
		Charged Device Model (CDM) according to ANSI/ESDA/JEDEC standard JS-002	-500	500	V

[1] CP-OFDM with 9 dB PAPR, BW = 100 MHz, QPSK modulated, SCS = 60 kHz, fully allocated

11 Recommended operating conditions

Table 8. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f _{oper}	operating frequency		3.3	-	4.2	GHz
Z ₀	characteristic impedance		-	50	-	Ω
V _{CC}	supply voltage	on pins V _{CC1} , and V _{CC2} ^[1]	3.15	3.3	3.45	V
V _{IH}	HIGH-level input voltage	at pins D0, BP, and T/R	1.2	1.8	2.5	V
V _{IL}	LOW-level input voltage	at pins D0, BP, and T/R	0	-	0.6	V
T _{case}	case temperature	exposed die paddle at package bottom	-40	50	105	°C

[1] channel A and channel B can be used independently

12 Thermal characteristics

Table 9. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
R _{th(j-case)}	channel-junction to case thermal resistance	TX mode	-	49	-	K/W
		RX mode	-	55	-	K/W

13 Characteristics

Table 10. Characteristics

$f = 3.75 \text{ GHz}$; $V_{CC} = 3.3 \text{ V}$, $T_{case} = 50 \text{ }^\circ\text{C}$; input and output $50 \text{ } \Omega$; unless otherwise specified.

Characteristics apply to each channel A and B separately.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
High gain RX mode; signal from ANT to RX_OUT						
I_{cc}	supply current		-	51	57	mA
G_p	power gain		34.5	36	37.5	dB
		$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $T_{case} = -40 \text{ }^\circ\text{C to } 105 \text{ }^\circ\text{C}$	33.5	-	39	dB
G_{flat}	gain flatness	in 200 MHz band	-	-	0.5	dB
NF	noise figure		-	1.3	1.4	dB
		$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $T_{case} = -40 \text{ }^\circ\text{C to } 105 \text{ }^\circ\text{C}$	-	-	1.7	dB
RL_i	input return loss	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	12	17	-	dB
RL_o	output return loss	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	12	17	-	dB
$RL_{align(RX-TX)}$	return loss alignment RX-TX	$R_{TERM} = 50 \text{ } \Omega$, $f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	12	-	-	dB
$\alpha_{isol(ch-ch)}$	isolation channel to channel	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$ ^[1]	40	42	-	dB
$G_{rel(f2/f0)}$	relative gain (G_{r2}/G_{f0})	$f_0 = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $f_2 = 2 \times f_0$	-	-35	-25	dB
$G_{rel(f3/f0)}$	relative gain (G_{r3}/G_{f0})	$f_0 = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $f_3 = 3 \times f_0$	-	-50	-45	dB
α_{2Ho}	output second harmonic level	$P_o = 0 \text{ dBm}$	-	-56	-40	dBm
α_{3Ho}	output third harmonic level	$P_o = 0 \text{ dBm}$	-	-69	-58	dBm
IP3 _o	output third-order intercept point	2-tones at 10 MHz distance, $P_i = -40 \text{ dBm}$ each tone	20	23	-	dBm
		2-tones at 10 MHz distance, $P_i = -40 \text{ dBm}$ each tone, $f_0 = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $T_{case} = -40 \text{ }^\circ\text{C to } 105 \text{ }^\circ\text{C}$	18	-	-	dBm
$P_{i(1dB)}$	input power at 1 dB gain compression		-25	-24	-	dBm
K	stability factor	1 MHz to 20 GHz, $T_{case} = -40 \text{ }^\circ\text{C to } 105 \text{ }^\circ\text{C}$	1	-	-	-
Low gain RX mode; signal from ANT to RX_OUT						
I_{cc}	supply current		-	51	57	mA
G_p	power gain		28.5	30	31.5	dB
		$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $T_{case} = -40 \text{ }^\circ\text{C to } 105 \text{ }^\circ\text{C}$	27.5	-	33	dB
α_{step}	attenuation step		5.3	6	6.4	dB
G_{flat}	gain flatness	in 200 MHz band	-	-	1.55	dB
NF	noise figure		-	1.5	1.6	dB
		$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $T_{case} = -40 \text{ }^\circ\text{C to } 105 \text{ }^\circ\text{C}$	-	-	2.3	dB
RL_i	input return loss	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	12	17	-	dB
RL_o	output return loss	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	12	17	-	dB
$RL_{align(RX-TX)}$	return loss alignment RX-TX	$R_{TERM} = 50 \text{ } \Omega$, $f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	12	-	-	dB

3.3 GHz - 4.2 GHz RX Analog Front-End Module with bypass

Table 10. Characteristics...continued

$f = 3.75 \text{ GHz}$; $V_{CC} = 3.3 \text{ V}$, $T_{case} = 50 \text{ }^\circ\text{C}$; input and output $50 \text{ } \Omega$; unless otherwise specified.

Characteristics apply to each channel A and B separately.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\alpha_{isol(ch-ch)}$	isolation channel to channel	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$ ^[1]	40	42	-	dB
$G_{rel(f_2/f_0)}$	relative gain (G_{f_2}/G_{f_0})	$f_0 = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $f_2 = 2 \times f_0$	-	-35	-25	dB
$G_{rel(f_3/f_0)}$	relative gain (G_{f_3}/G_{f_0})	$f_0 = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $f_3 = 3 \times f_0$	-	-50	-45	dB
α_{2Ho}	output second harmonic level	$P_o = 0 \text{ dBm}$	-	-56	-45	dBm
α_{3Ho}	output third harmonic level	$P_o = 0 \text{ dBm}$	-	-65	-55	dBm
IP_{3o}	output third-order intercept point	2-tones at 10 MHz distance, $P_1 = -40 \text{ dBm}$ each tone	20	22	-	dBm
		2-tones at 10 MHz distance, $P_1 = -40 \text{ dBm}$ each tone, $f_0 = 3.3 \text{ GHz to } 4.2 \text{ GHz}$, $T_{case} = -40 \text{ }^\circ\text{C to } 105 \text{ }^\circ\text{C}$	17	-	-	dBm
$P_{I(1dB)}$	input power at 1 dB gain compression		-19	-18	-	dBm
K	stability factor	1 MHz to 20 GHz, $T_{case} = -40 \text{ }^\circ\text{C to } 105 \text{ }^\circ\text{C}$	1	-	-	-
TX mode; signal from ANT to TERM						
I_{cc}	supply current		-	5.9	6.5	mA
IL	insertion loss	from ANT to TERM	-	0.55	0.6	dB
RL_i	input return loss	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	12	22	-	dB
RL_o	output return loss	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	12	22	-	dB
$\alpha_{isol(ANT-RX)}$	isolation between ANT to RX_OUT	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	55	-	-	dB
$P_{I(AV)TX}$	Maximum average input power in TX mode ^[2]	applied on ANT pin, lifetime (10 yrs), $T_{case(AV)} = 99 \text{ }^\circ\text{C}$ ^[3]	34	-	-	dBm
TX bypass mode: Signal from ANT to RX_OUT via coupler						
I_{CC}	supply current		-	5.9	6.5	mA
G_p	power gain		-32	-29	-27.5	dB
RL_i	input return loss	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	12	25	-	dB
RL_o	output return loss	$f = 3.3 \text{ GHz to } 4.2 \text{ GHz}$	9	17	-	dB
Switching between modes						
$t_{sw(\alpha)RX}$	switching time RX attenuation		-	-	100	ns
$t_{sw(RX-TX)}$	switching from RX to TX	for the power transient at RX_OUT	-	-	0.5	μs
$t_{sw(TX-RX)}$	switching from TX to RX		-	-	1	μs
$t_{sw(TX-bypass)}$	switching to TX bypass		-	-	1	μs

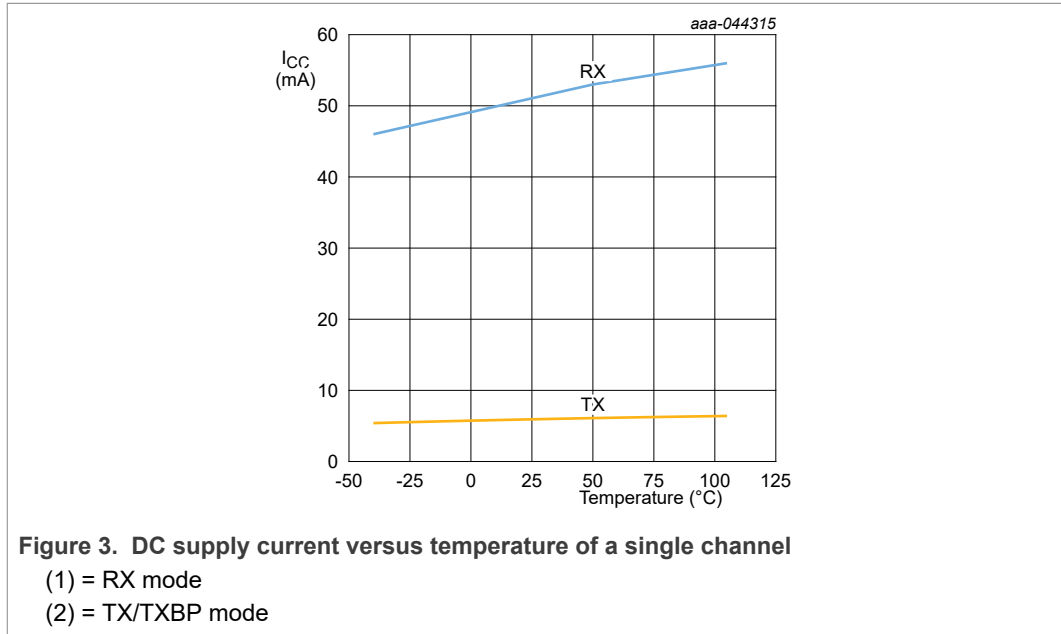
[1] G_p [ANT-CHA, RX_OUT-CHA] / G_p [ANT-CHB, RX_OUT-CHA]

[2] CP-OFDM with 9 dB PAPR, BW = 100 MHz, QPSK modulated, SCS = 60 kHz, fully allocated

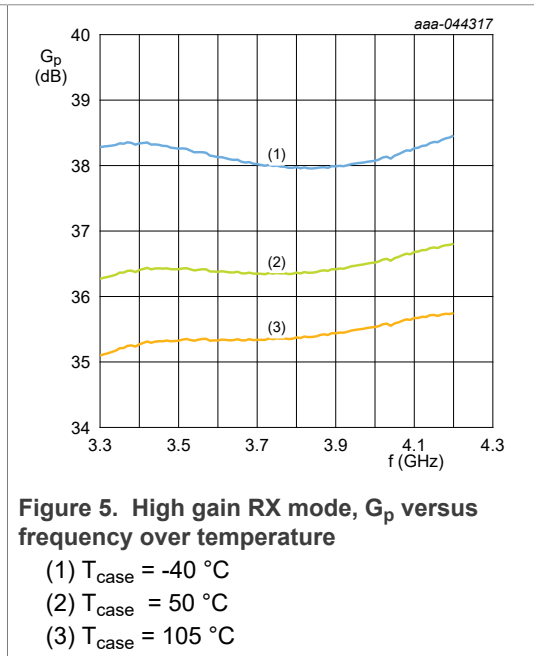
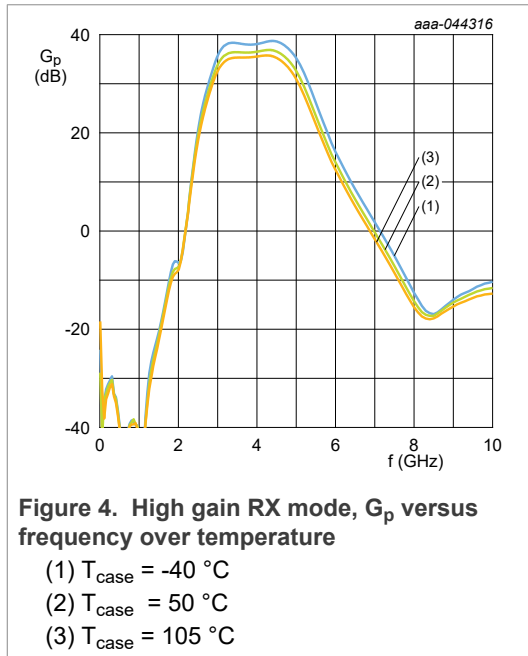
[3] $T_{case(AV)}$ is an equivalent temperature that yields the same aging over life time as the expected temperature profile which includes temperatures up to 105 °C

14 Graphs

14.1 All modes



14.2 High gain RX mode



3.3 GHz - 4.2 GHz RX Analog Front-End Module with bypass

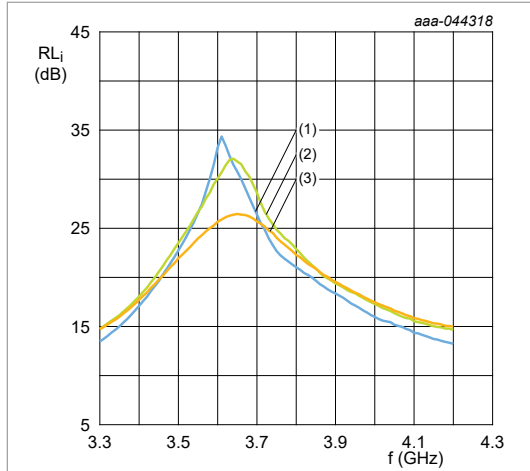


Figure 6. High gain RX mode, RL_i versus frequency over temperature
 (1) $T_{case} = -40\text{ °C}$
 (2) $T_{case} = 50\text{ °C}$
 (3) $T_{case} = 105\text{ °C}$

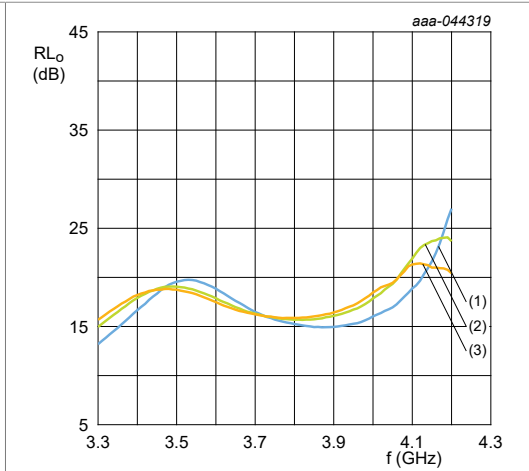


Figure 7. High gain RX mode, RL_o versus frequency over temperature
 (1) $T_{case} = -40\text{ °C}$
 (2) $T_{case} = 50\text{ °C}$
 (3) $T_{case} = 105\text{ °C}$

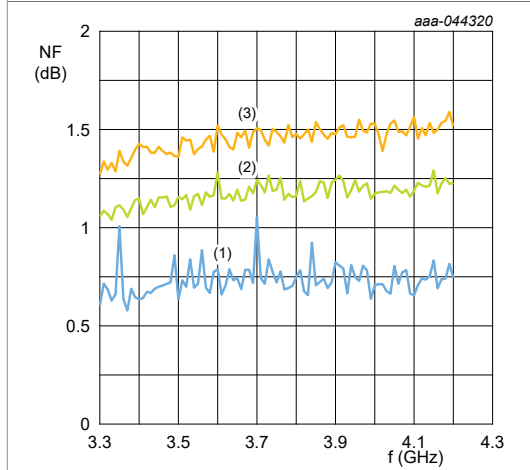


Figure 8. High gain RX mode, NF versus frequency over temperature
 (1) $T_{case} = -40\text{ °C}$
 (2) $T_{case} = 50\text{ °C}$
 (3) $T_{case} = 105\text{ °C}$

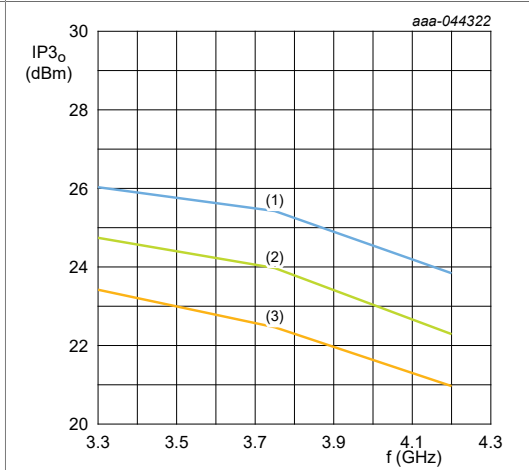
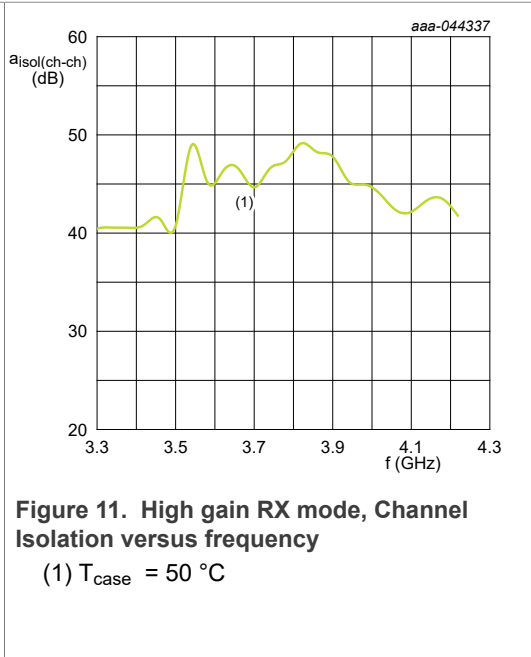
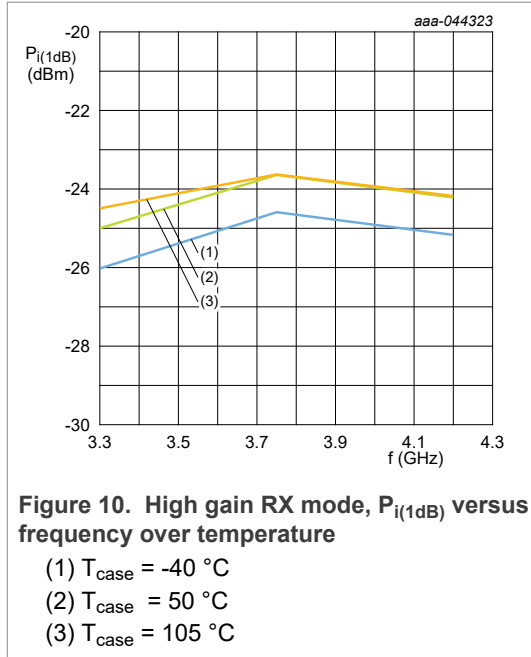
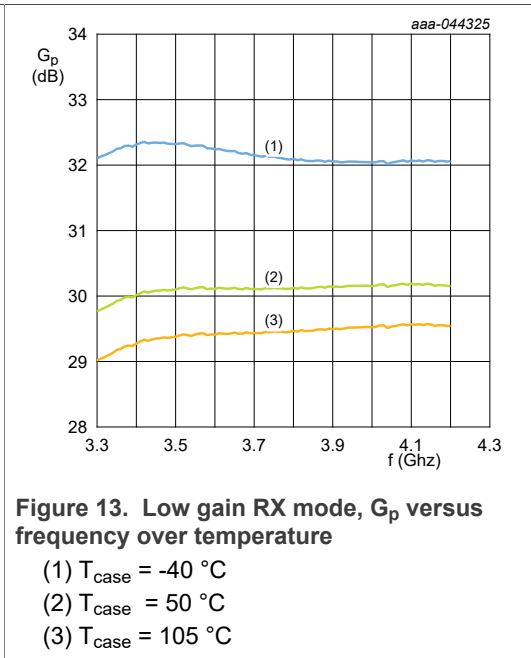
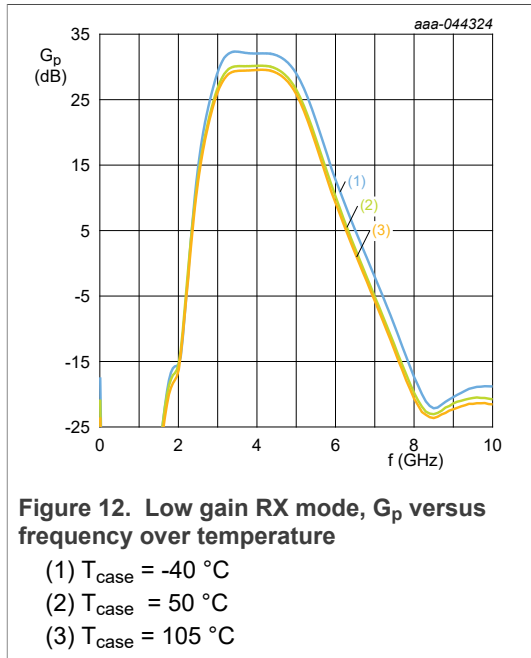


Figure 9. High gain RX mode, $IP3_o$ versus frequency over temperature
 (1) $T_{case} = -40\text{ °C}$
 (2) $T_{case} = 50\text{ °C}$
 (3) $T_{case} = 105\text{ °C}$

3.3 GHz - 4.2 GHz RX Analog Front-End Module with bypass



14.3 Low gain RX mode



3.3 GHz - 4.2 GHz RX Analog Front-End Module with bypass

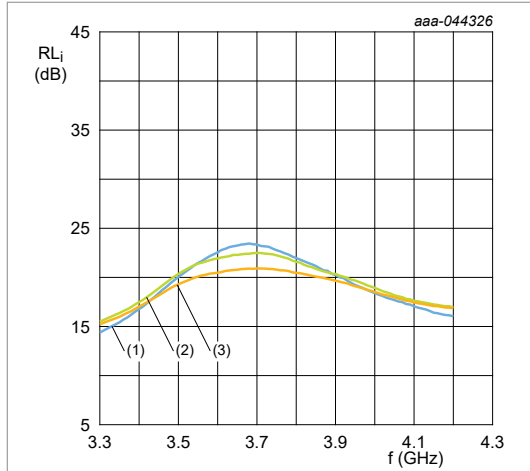


Figure 14. Low gain RX mode, RL_i versus frequency over temperature
 (1) $T_{case} = -40\text{ °C}$
 (2) $T_{case} = 50\text{ °C}$
 (3) $T_{case} = 105\text{ °C}$

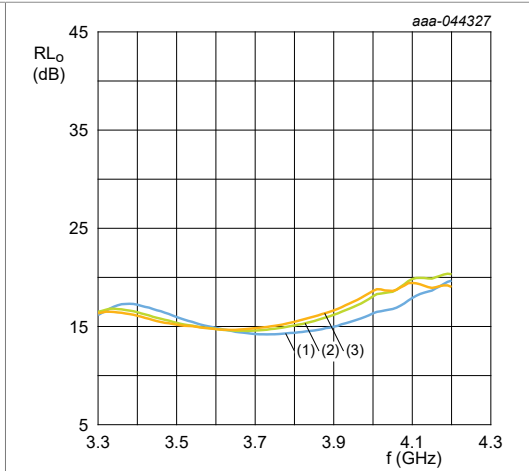


Figure 15. Low gain RX mode, RL_o versus frequency over temperature
 (1) $T_{case} = -40\text{ °C}$
 (2) $T_{case} = 50\text{ °C}$
 (3) $T_{case} = 105\text{ °C}$

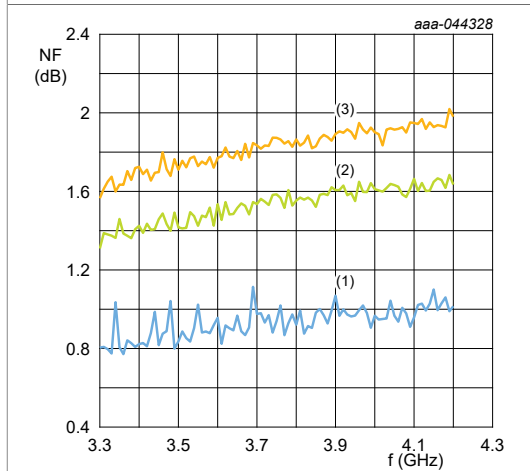


Figure 16. Low gain RX mode, NF versus frequency over temperature
 (1) $T_{case} = -40\text{ °C}$
 (2) $T_{case} = 50\text{ °C}$
 (3) $T_{case} = 105\text{ °C}$

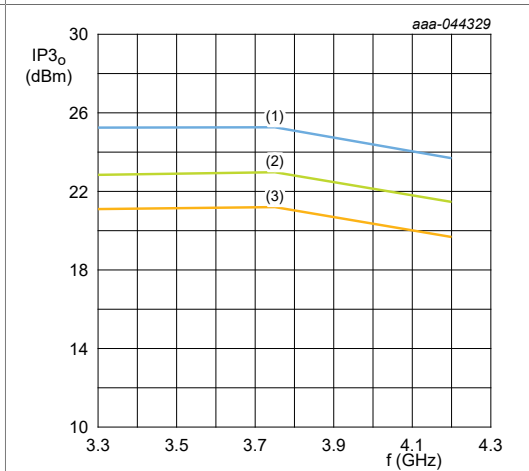
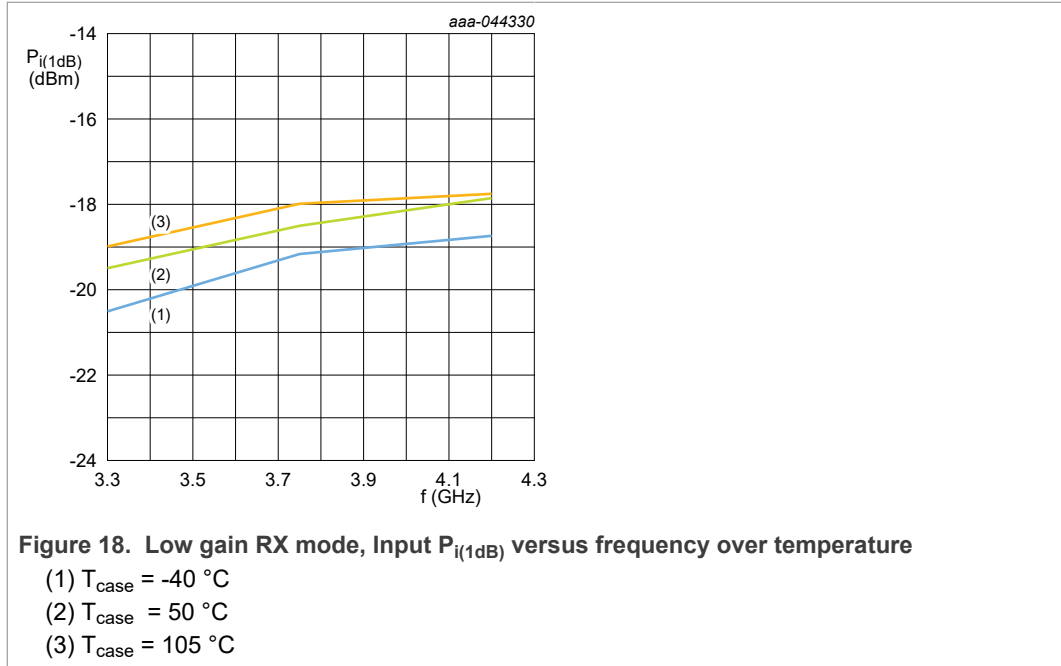
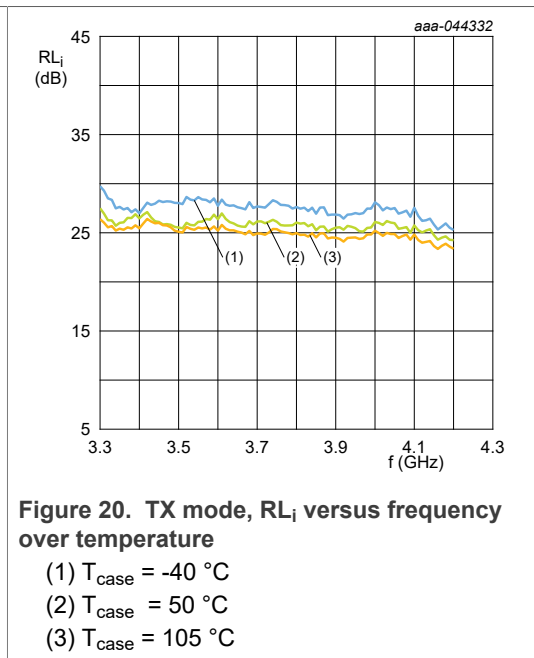
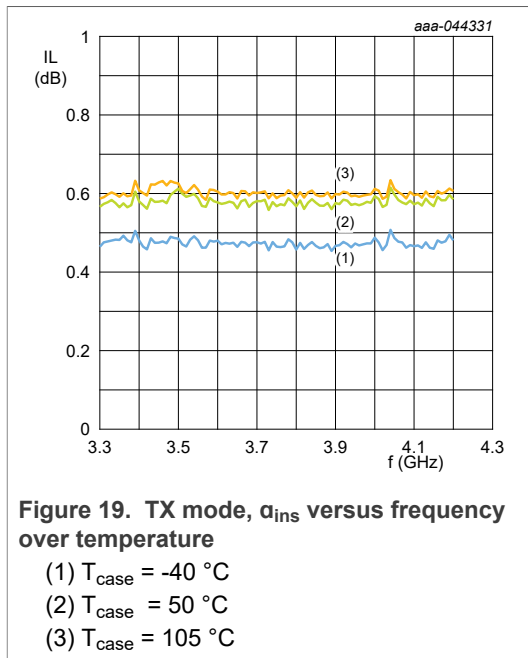


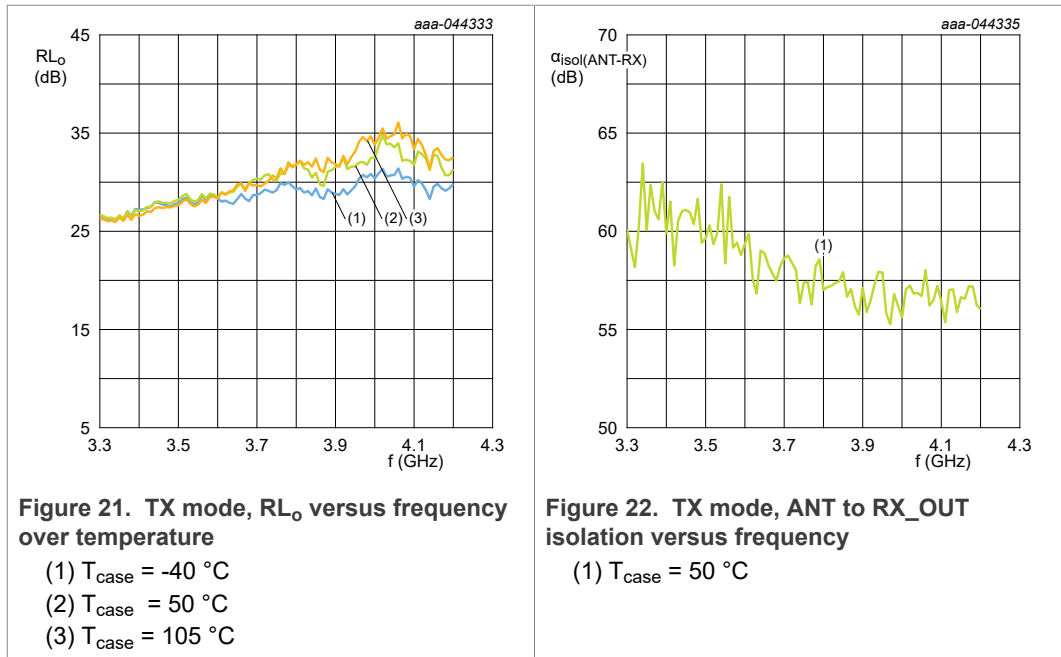
Figure 17. Low gain RX mode, $IP3_o$ versus frequency over temperature
 (1) $T_{case} = -40\text{ °C}$
 (2) $T_{case} = 50\text{ °C}$
 (3) $T_{case} = 105\text{ °C}$



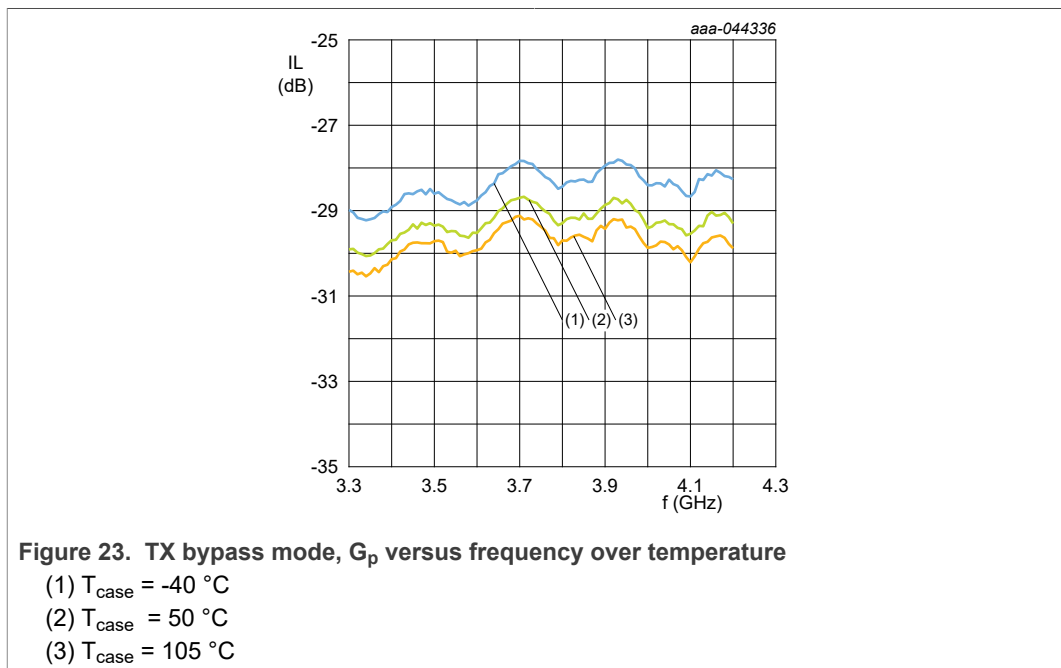
14.4 TX mode



3.3 GHz - 4.2 GHz RX Analog Front-End Module with bypass



14.5 TX bypass mode



15 Application information

Table 11. Application schematic

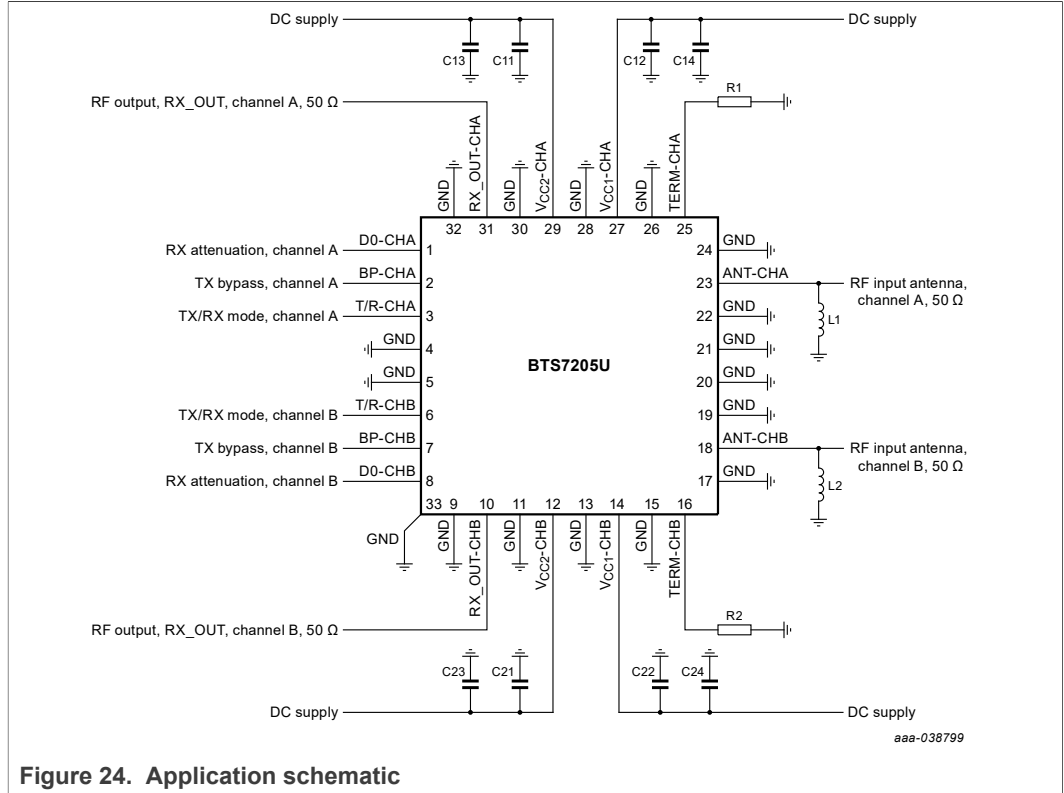


Figure 24. Application schematic

Table 12. List of components

Component	Description	Value	amount	Remarks
R1, and R2	load resistor	50 Ω, 50 W	2	must be able to withstand 34 dBm average power over lifetime
C11, C12, C21, and C22	capacitor	10 nF	4	as close as possible, less than 10 mm from IC
C13, C14, C23, and C24	capacitor	1 μF	4	as close as possible, less than 10 mm from IC
L1, and L2	inductor	120 nH	2	high-Q inductor, close to IC. Inductor is recommended to improve the switching time with a low ohmic connection at the ANT port.

16 Package outline

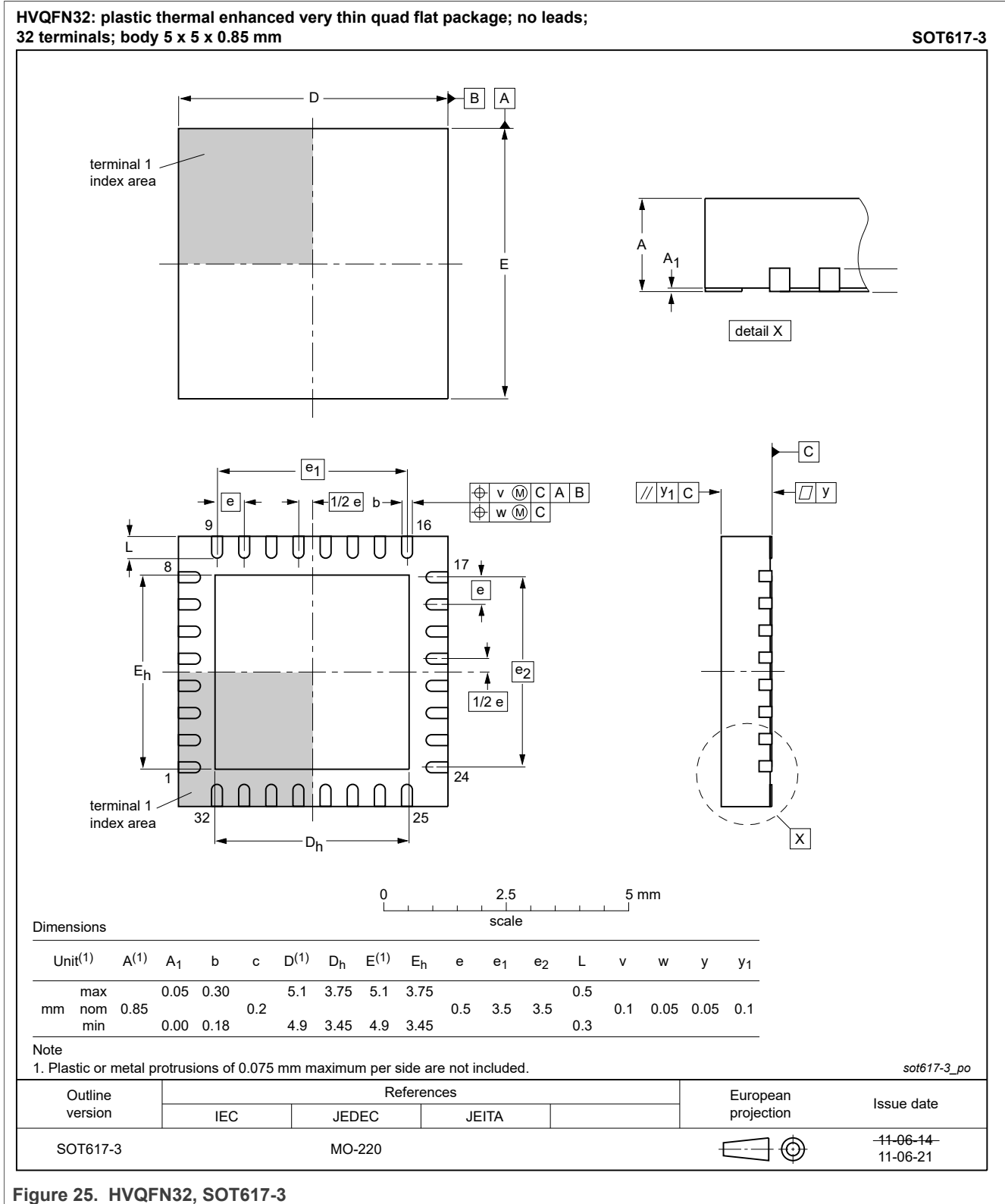


Figure 25. HVQFN32, SOT617-3

16.1 Footprint and solder information

NXP recommends by default to apply the soldering and footprint guidelines as are released in POD SOT617-3.

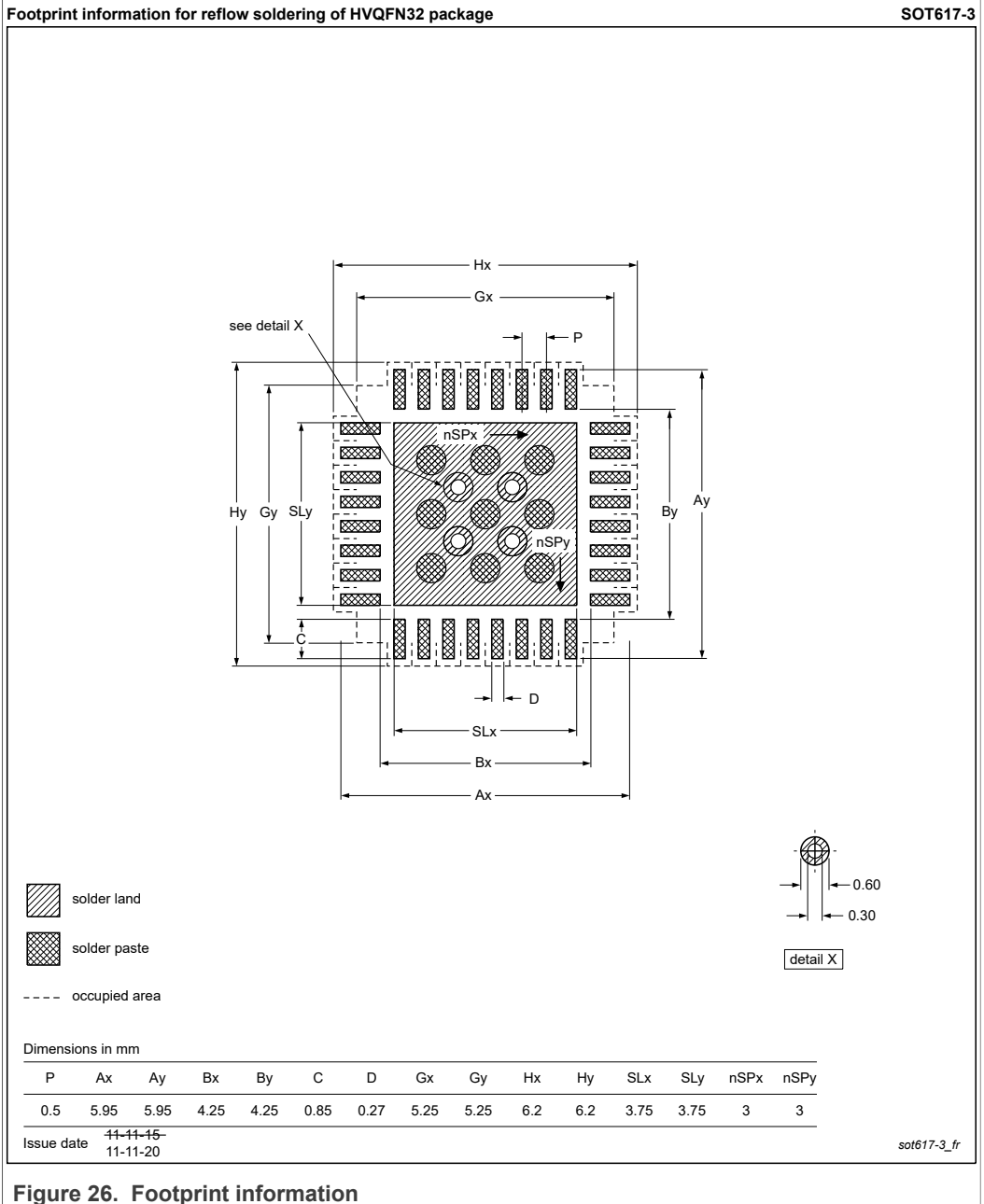


Figure 26. Footprint information

17 Handling information

CAUTION



This device is sensitive to ElectroStatic Discharge (ESD). Observe precautions for handling electrostatic sensitive devices. Such precautions are described in the *ANSI/ESD S20.20*, *IEC/ST 61340-5*, *JESD625-A* or equivalent standards.

18 Abbreviations

Table 13. Abbreviations

Acronym	Description
AMP	amplifier
ANT	antenna
BP	bypass
CPLR	coupler
CP-OFDM	cyclic prefix orthogonal frequency division multiplexing
D0	data line 0
ESD	electrostatic discharge
HVQFN	heat sink very thin quad flat no-leads
LNA	low noise amplifier
mMIMO	massive multiple-input multiple-output
PAPR	peak to average power ratio
QPSK	quadrature phase shift keying
SCS	sub carrier spacing
SPDT	single pull double throw
TERM	termination
T/R	transmit/receive mode

19 Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BTS7205U v.7	20220607	Product data sheet	202206005I	BTS7205U v.6
modification	<ul style="list-style-type: none"> corrected the Functional diagram 			
BTS7205U v.6	20211026	Product data sheet	-	BTS7205U v.5
modification	<ul style="list-style-type: none"> adapted some characteristic values added graphs changed status to Product data sheet added description on 120 nH coil 			
BTS7205U v.5	20211013	Objective data sheet	-	BTS7205U v.4

Table 14. Revision history...continued

Document ID	Release date	Data sheet status	Change notice	Supersedes
modification				
BTS7205U v.4	20210625	Objective data sheet	-	BTS7205U v.3
modification				
BTS7205U v.3	20210423	Objective data sheet	-	BTS7205U v.2.1
modification				
BTS7205U v.2.2	20210317	Objective data sheet	-	BTS7205U v.2.1
modification				
BTS7205U v.2.1	20210311	Objective data sheet	-	BTS7205U v.2
modification				
BTS7205U v.2	20200903	Objective data sheet	-	BTS7205U v.1
modification				
BTS7205U v.1	20200827	Objective data sheet	-	-

20 Legal information

20.1 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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