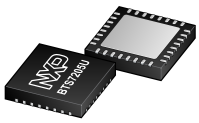


BTS7205U

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

Rev. 6 — 26 October 2021 **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 GHz; V_{CC} = 3.3 V, T_{case} = 50 ºC; input and output 50 Ω; 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 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 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 °C [2]	34	-	-	dBm
		applied on ANT pin, 10 seconds, T_{case} = 105 °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 °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

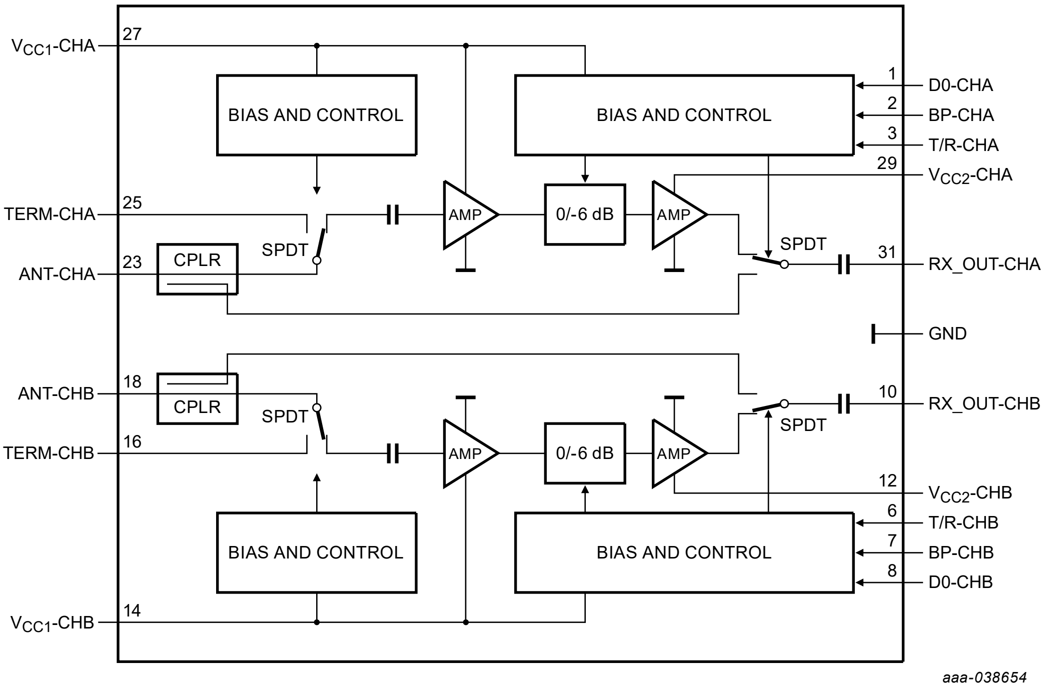


Figure 1. Functional diagram BTS7205U

8 Pinning information

8.1 Pin diagram

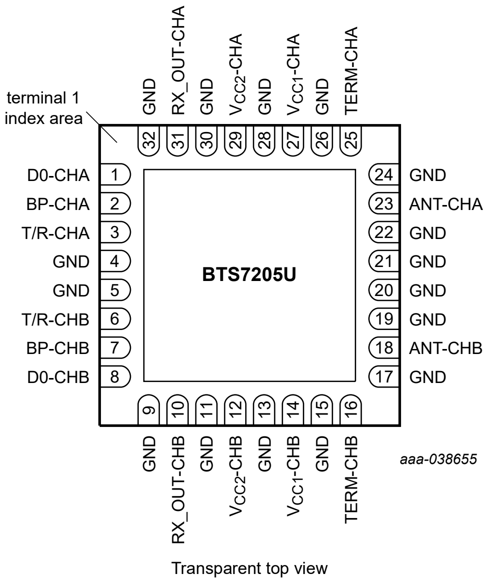


Figure 2. Pin configuration

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 GHz; V_{CC} = 3.3 V, T_{case} = 50 ºC; input and output 50 Ω; 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 GHz to 4.2 GHz, T_{case} = -40 °C to 105 °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 GHz to 4.2 GHz, T_{case} = -40 °C to 105 °C	-	-	1.7	dB
RL_i	input return loss	f = 3.3 GHz to 4.2 GHz	12	17	-	dB
RL_o	output return loss	f = 3.3 GHz to 4.2 GHz	12	17	-	dB
$RL_{align(RX\text{-}TX)}$	return loss alignment RX-TX	R_{TERM} = 50 Ω, f = 3.3 GHz to 4.2 GHz	12	-	-	dB
$\alpha_{isol(ch\text{-}ch)}$	isolation channel to channel	f = 3.3 GHz to 4.2 GHz [1]	40	42	-	dB
$G_{rel(f2/f0)}$	relative gain (G_{f2}/G_{f0})	f_0 = 3.3 GHz to 4.2 GHz, f_2 = 2 x f_0	-	-35	-25	dB
$G_{rel(f3/f0)}$	relative gain (G_{f3}/G_{f0})	f_0 = 3.3 GHz to 4.2 GHz, f_3 = 3 x f_0	-	-50	-45	dB
α_{2Ho}	output second harmonic level	P_o = 0 dBm	-	-56	-40	dBm
α_{3Ho}	output third harmonic level	P_o = 0 dBm	-	-69	-58	dBm
$IP3_o$	output third-order intercept point	2-tones at 10 MHz distance, P_i = -40 dBm each tone	20	23	-	dBm
		2-tones at 10 MHz distance, P_i = -40 dBm each tone, f_0 = 3.3 GHz to 4.2 GHz, T_{case} = -40 °C to 105 °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 °C to 105 °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 GHz to 4.2 GHz, T_{case} = -40 °C to 105 °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 GHz to 4.2 GHz, T_{case} = -40 °C to 105 °C	-	-	2.3	dB
RL_i	input return loss	f = 3.3 GHz to 4.2 GHz	12	17	-	dB
RL_o	output return loss	f = 3.3 GHz to 4.2 GHz	12	17	-	dB
$RL_{align(RX\text{-}TX)}$	return loss alignment RX-TX	R_{TERM} = 50 Ω, f = 3.3 GHz to 4.2 GHz	12	-	-	dB

Table 10. Characteristics*...continued*

f = 3.75 GHz; V_{CC} = 3.3 V, T_{case} = 50 ºC; input and output 50 Ω; unless otherwise specified.
Characteristics apply to each channel A and B separately.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$α_{isol(ch-ch)}$	isolation channel to channel	f = 3.3 GHz to 4.2 GHz [1]	40	42	-	dB
$G_{rel(f2/f0)}$	relative gain (G_{f2}/G_{f0})	f_0 = 3.3 GHz to 4.2 GHz, $f_2 = 2 \times f_0$	-	-35	-25	dB
$G_{rel(f3/f0)}$	relative gain (G_{f3}/G_{f0})	f_0 = 3.3 GHz to 4.2 GHz, $f_3 = 3 \times f_0$	-	-50	-45	dB
$α_{2Ho}$	output second harmonic level	P_o = 0 dBm	-	-56	-45	dBm
$α_{3Ho}$	output third harmonic level	P_o = 0 dBm	-	-65	-55	dBm
$IP3_o$	output third-order intercept point	2-tones at 10 MHz distance, P_i = -40 dBm each tone	20	22	-	dBm
		2-tones at 10 MHz distance, P_i = -40 dBm each tone, f_0 = 3.3 GHz to 4.2 GHz, T_{case} = -40 °C to 105 °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 °C to 105 °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 GHz to 4.2 GHz	12	22	-	dB
RL_o	output return loss	f = 3.3 GHz to 4.2 GHz	12	22	-	dB
$α_{isol(ANT-RX)}$	isolation between ANT to RX_OUT	f = 3.3 GHz to 4.2 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 °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 GHz to 4.2 GHz	12	25	-	dB
RL_o	output return loss	f = 3.3 GHz to 4.2 GHz	9	17	-	dB
Switching between modes						
$t_{sw(α)RX}$	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

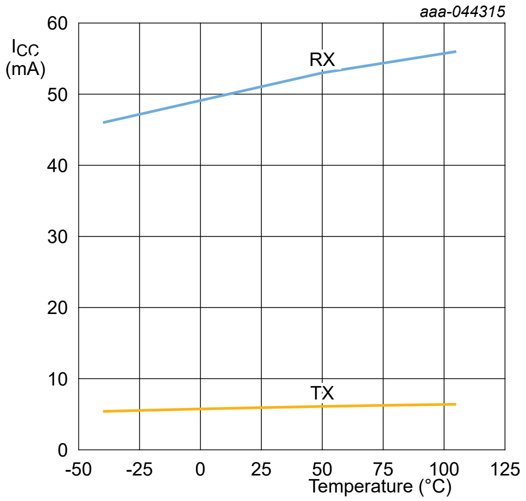


Figure 3. DC supply current versus temperature of a single channel

(1) = RX mode

(2) = TX/TXBP mode

14.2 High gain RX mode

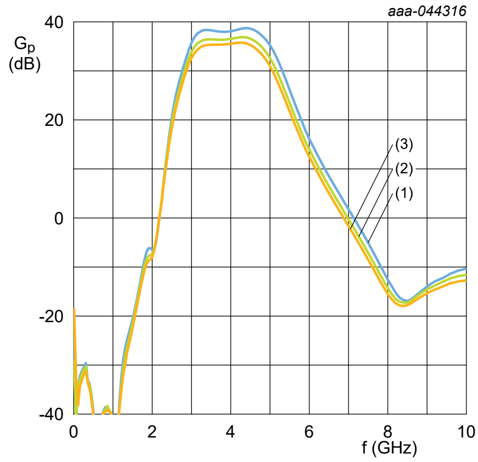


Figure 4. High gain RX mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

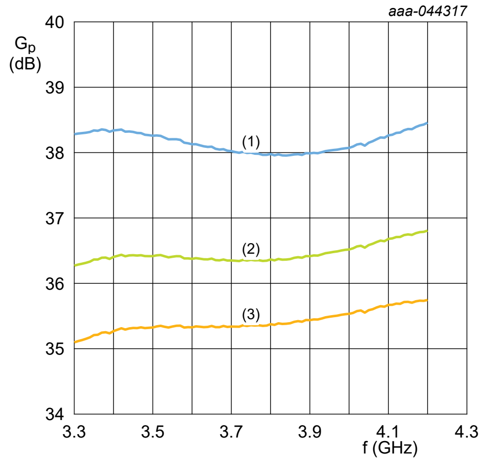


Figure 5. High gain RX mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

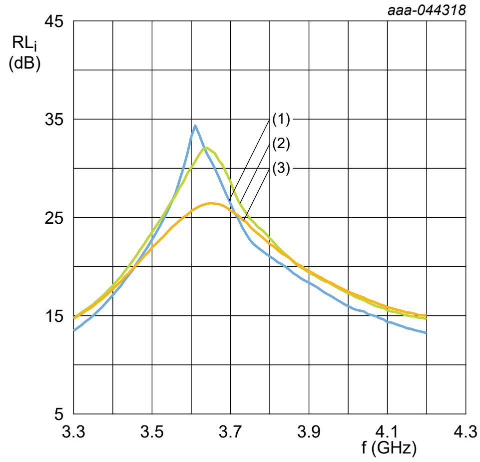


Figure 6. High gain RX mode, RL_i versus frequency over temperature

(1) T_{case} = -40 °C
(2) T_{case} = 50 °C
(3) T_{case} = 105 °C

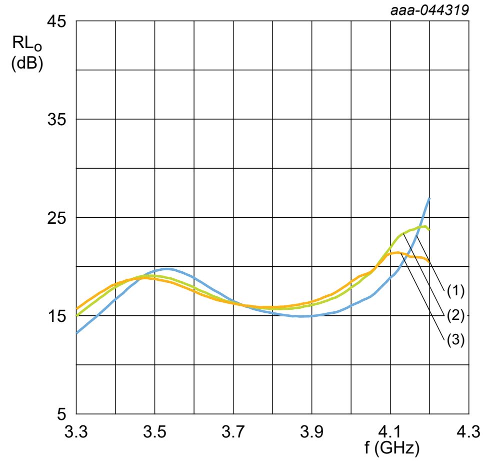


Figure 7. High gain RX mode, RL_o versus frequency over temperature

(1) T_{case} = -40 °C
(2) T_{case} = 50 °C
(3) T_{case} = 105 °C

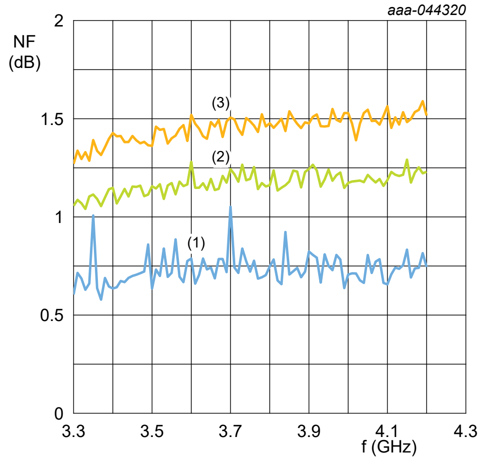


Figure 8. High gain RX mode, NF versus frequency over temperature

(1) T_{case} = -40 °C
(2) T_{case} = 50 °C
(3) T_{case} = 105 °C

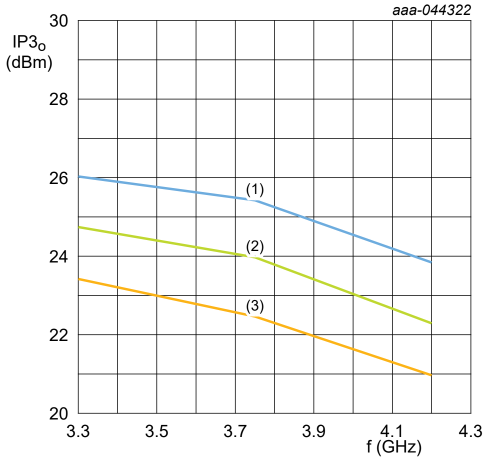


Figure 9. High gain RX mode, $IP3_o$ versus frequency over temperature

(1) T_{case} = -40 °C
(2) T_{case} = 50 °C
(3) T_{case} = 105 °C

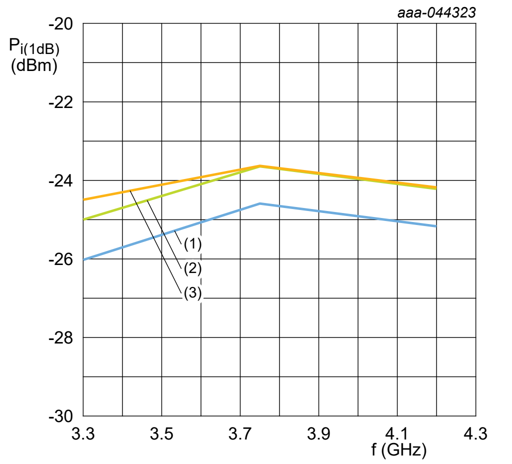


Figure 10. High gain RX mode, $P_{i(1dB)}$ versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

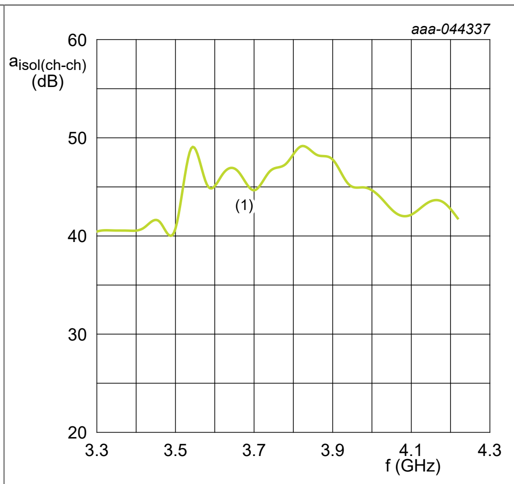


Figure 11. High gain RX mode, Channel Isolation versus frequency

(1) T_{case} = 50 °C

14.3 Low gain RX mode

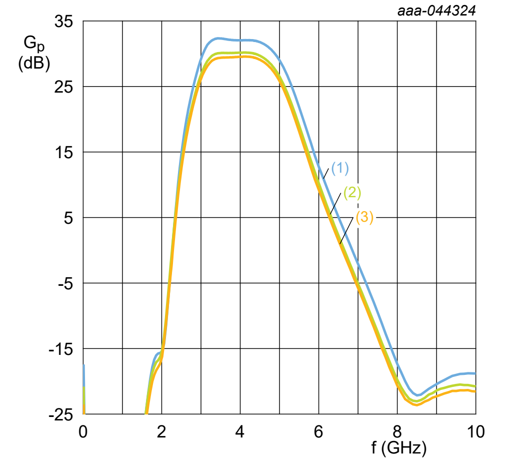


Figure 12. Low gain RX mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

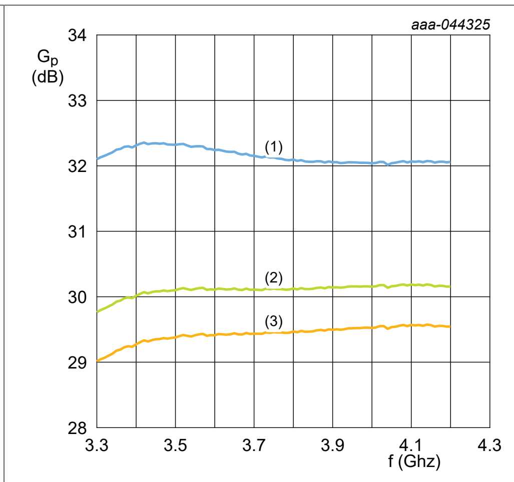


Figure 13. Low gain RX mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

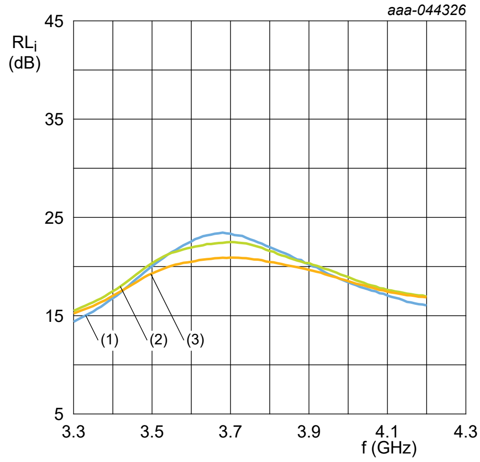


Figure 14. Low gain RX mode, RL_i versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

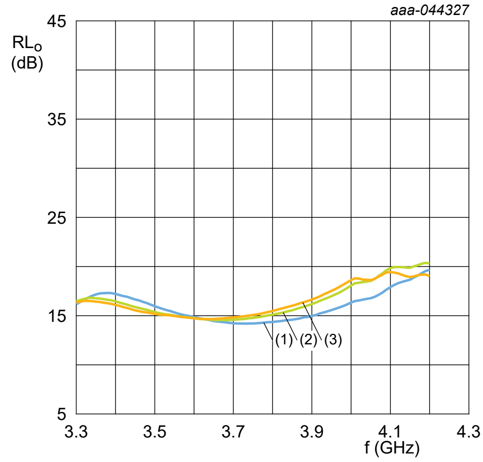


Figure 15. Low gain RX mode, RL_o versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

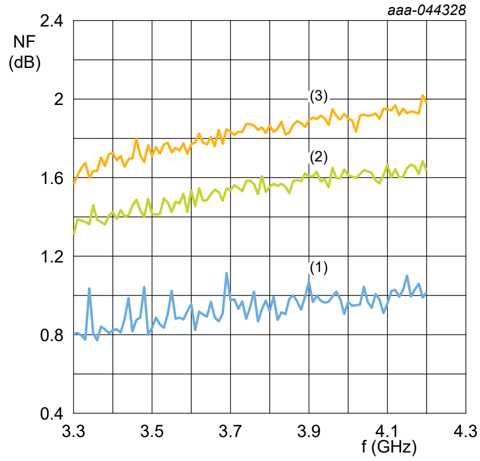


Figure 16. Low gain RX mode, NF versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

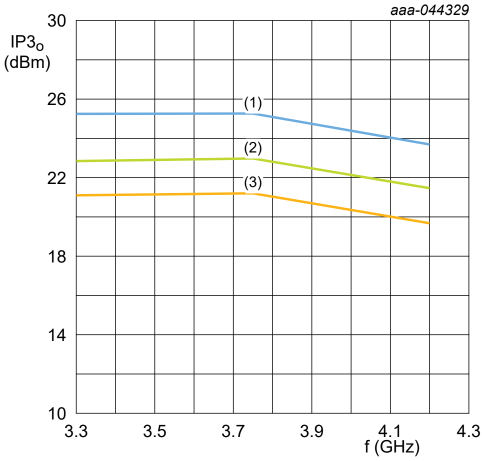


Figure 17. Low gain RX mode, $IP3_o$ versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

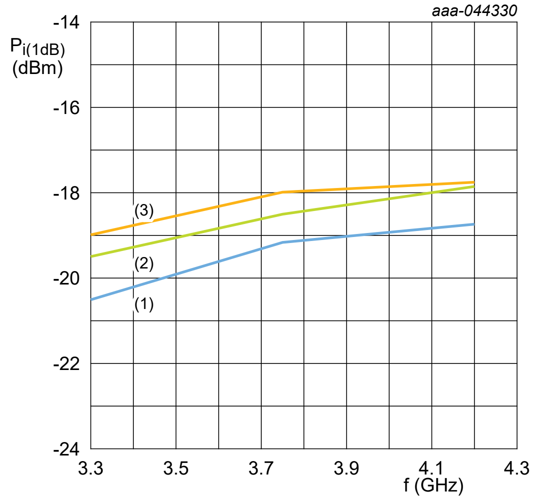


Figure 18. Low gain RX mode, Input $P_{i(1dB)}$ versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

14.4 TX mode

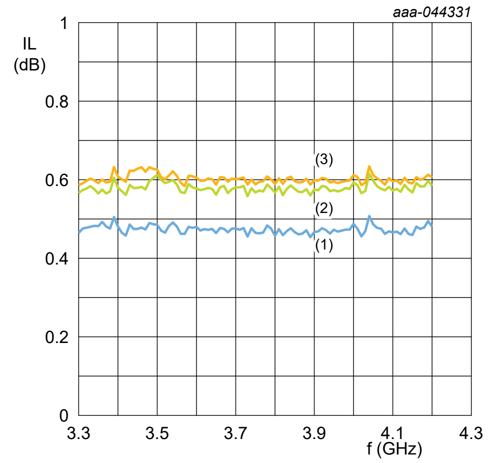


Figure 19. TX mode, α_{ins} versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

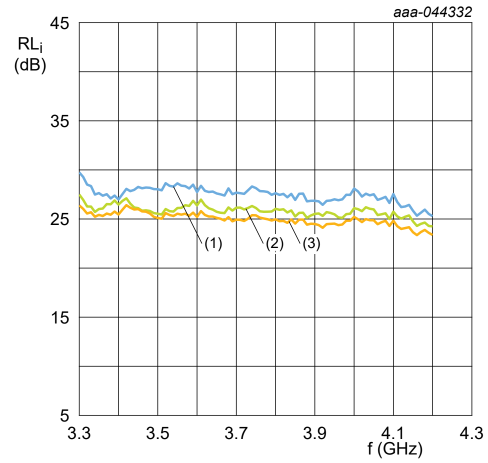


Figure 20. TX mode, RL_i versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

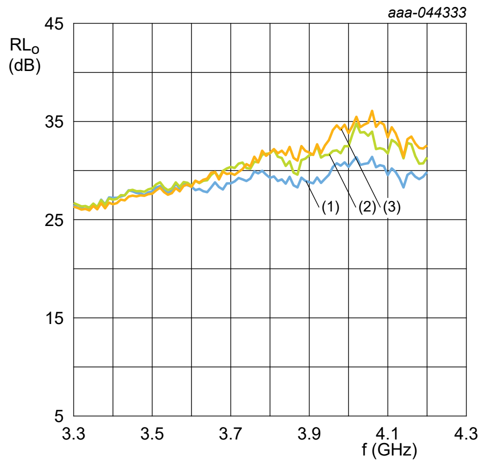


Figure 21. TX mode, RL_o versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

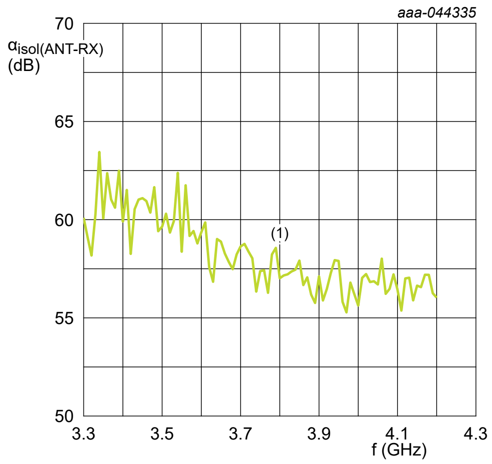


Figure 22. TX mode, ANT to RX_OUT isolation versus frequency

(1) T_{case} = 50 °C

14.5 TX bypass mode

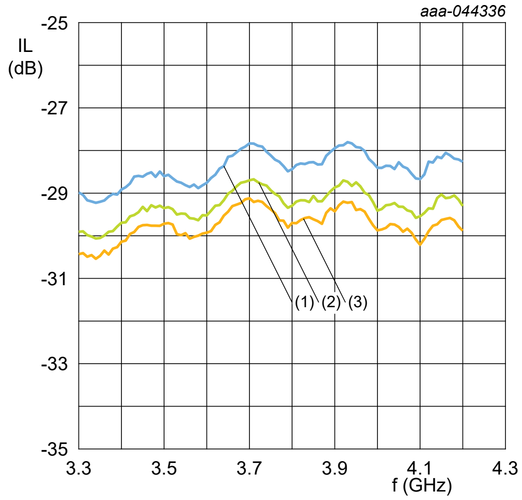


Figure 23. TX bypass mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 50 °C

(3) T_{case} = 105 °C

15 Application information

Table 11. Application schematic

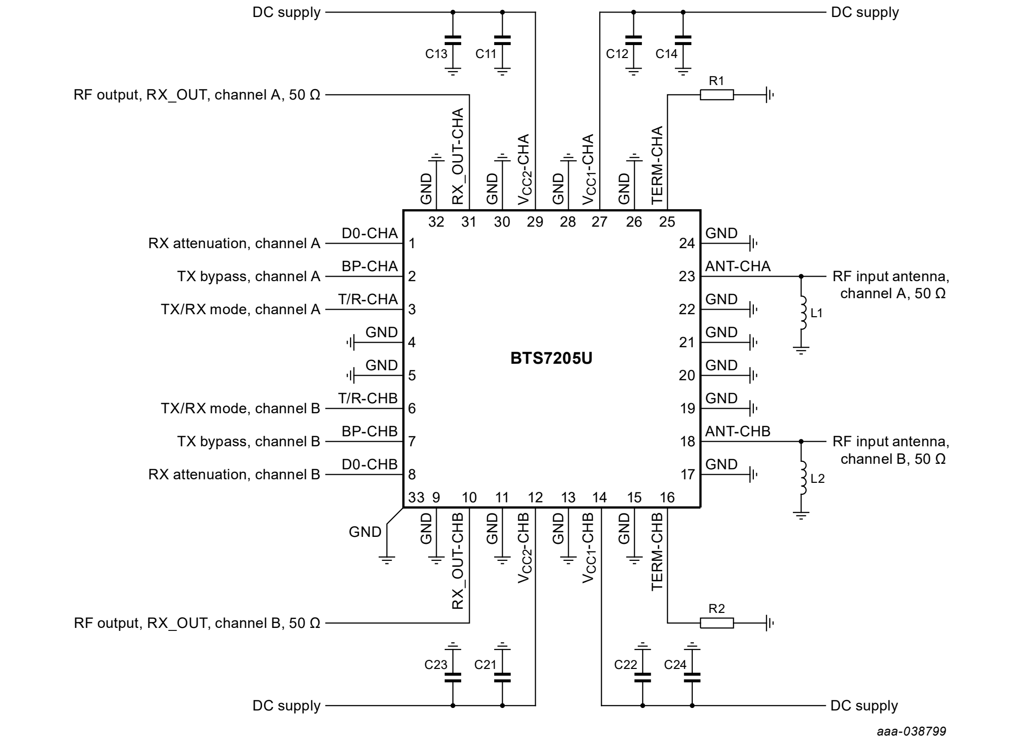


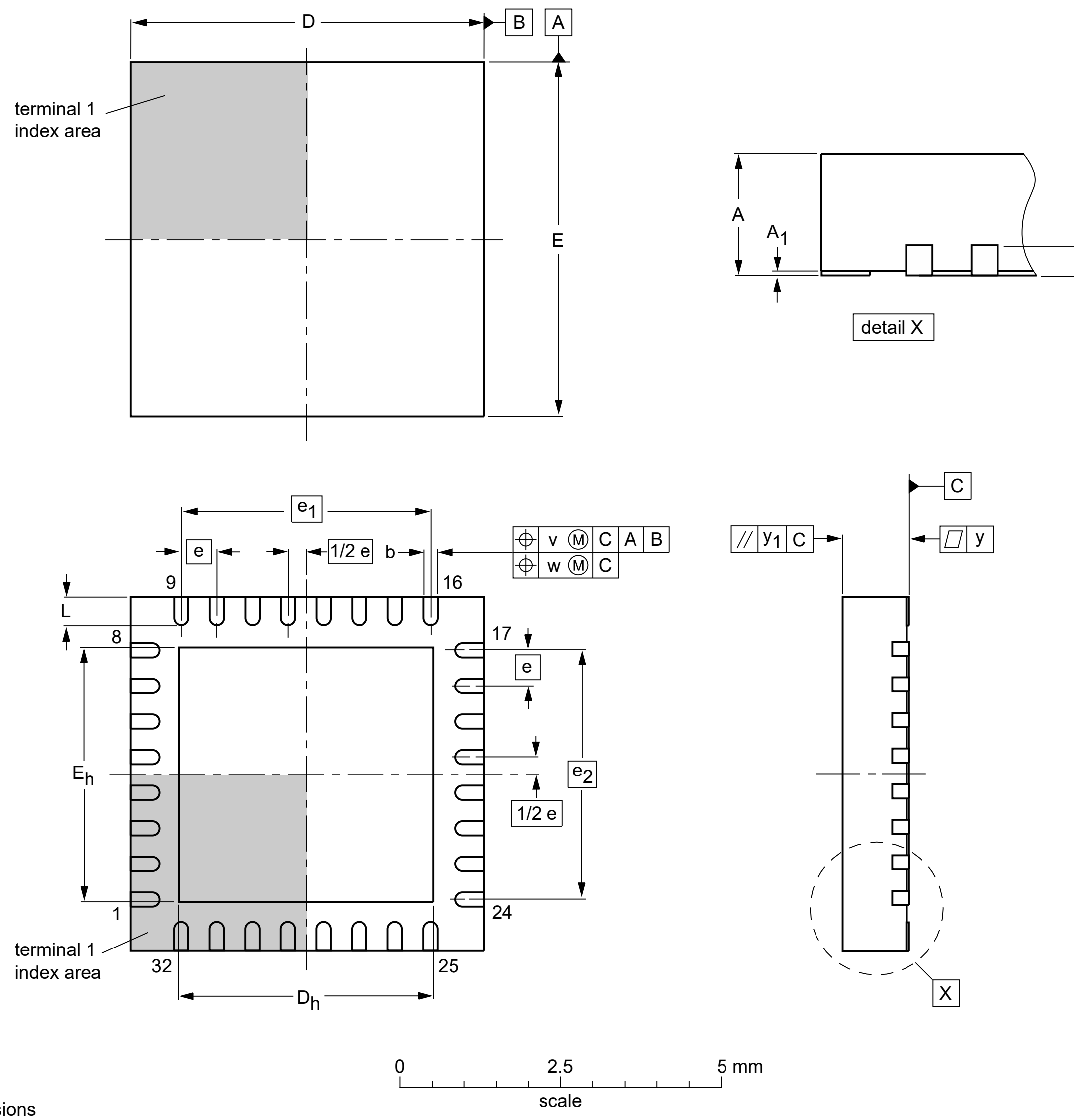
Figure 24. Application schematic

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

HVQFN32: plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; body 5 x 5 x 0.85 mm **SOT617-3**



Dimensions

Unit(1)		A(1)	A_1	b	c	D(1)	D_h	E(1)	E_h	e	e_1	e_2	L	v	w	y	y_1
mm	max		0.05	0.30		5.1	3.75	5.1	3.75				0.5				
	nom	0.85			0.2					0.5	3.5	3.5		0.1	0.05	0.05	0.1
	min		0.00	0.18		4.9	3.45	4.9	3.45				0.3				

Note

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

sot617-3_po

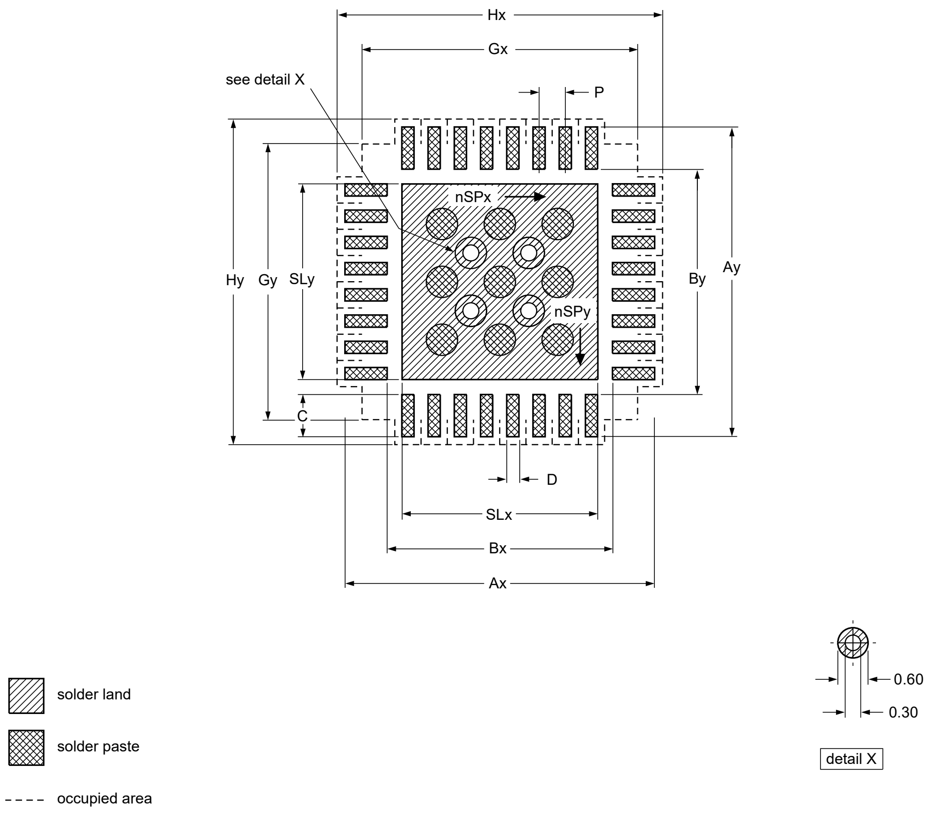
Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT617-3		MO-220				~~11-06-14~~ 11-06-21

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.

Footprint information for reflow soldering of HVQFN32 package **SOT617-3**



Dimensions in mm

P	Ax	Ay	Bx	By	C	D	Gx	Gy	Hx	Hy	SLx	SLy	nSPx	nSPy
0.5	5.95	5.95	4.25	4.25	0.85	0.27	5.25	5.25	6.2	6.2	3.75	3.75	3	3

Issue date ~~11-11-15~~ 11-11-20

sot617-3_fr

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.6	20211026	Product data sheet	-	BTS7205U v.5
modification	• 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	• changed footnote at $\alpha_{isol(ch-ch)}$ for both RX modes • added value for Thermal resistance • added parameter insertion loss to the TX mode characteristics table • corrected the orderable part number • added frequency setting to the Gp condition on both RX gain modes • changed values on some parameters			
BTS7205U v.4	20210625	Objective data sheet	-	BTS7205U v.3
modification	• updated the inductor value in the table List of components from 20 nH to 120 nH • added $P_{i(AV)TX}$ parameter to the TX Characteristics table • Corrected the Typical, and Maximum value on the RX I_{CC}			
BTS7205U v.3	20210423	Objective data sheet	-	BTS7205U v.2.1
modification	• changed some values on characteristics • removed condition on lifetime, and footnote on parameter $P_{i(AV)TX}$ at Limiting values			
BTS7205U v.2.2	20210317	Objective data sheet	-	BTS7205U v.2.1
modification	• changed T_{case} from 50 °C to 105 °C for $P_{i(AV)RX}$ at Limiting values • added footnote to parameter $P_{i(AV)TX}$ at Limiting values			
BTS7205U v.2.1	20210311	Objective data sheet	-	BTS7205U v.2
modification	• adapted the Modes of operation tables • removed and adapted Switching mode conditions • adapted the conditions on some parameters			
BTS7205U v.2	20200903	Objective data sheet	-	BTS7205U v.1
modification	• updated the list with parameters on characteristics • added extra conditions on some parameters • Added and changed some Min, Typ, and Max values • changed the remark on the R1, and R2 in the list of application components			
BTS7205U v.1	20200827	Objective data sheet	-	-

Contents

Date of release: 26 October 2021