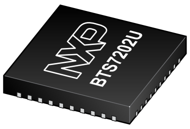


BTS7202U

3.3 GHz – 4.2 GHz RX Front-End Module

Rev. 5 — 5 September 2022 **Product data sheet**

1 General description

The BTS7202U is a dual channel Receiver Front-End Module (RX FEM) available in an HVQFN40 package. The BTS7202U is designed for 5G mMIMO Infrastructure applications. The BTS7202U includes two independent receive channels each with a low noise amplifier (LNA). The gain can be set to two different gain levels. Each channel also has a switch to route high-power TX signals to a termination load.

The device is matched to 50 Ω.

2 Features and benefits

- Operating frequency range 3.3 GHz – 4.2 GHz
- Two independently operating channels
- 500 mW power dissipation per channel
- High gain RX mode power gain 36.5 dB
- Low gain RX mode power gain 19 dB
- Typical Noise Figure 0.95 dB
- High TX power handling 44.5 dBm (10.5 dB PAPR)
- Single-ended input /output RF ports matched to 50 Ω
- Fast switching time between operation modes
- ESD protection on all pins
- HVQFN40 package 6 mm x 6 mm x 0.85 mm with 40 pins

3 Applications

- 5G mMIMO
- Wireless Infrastructure

4 Quick reference data

Table 1. Quick reference data

Unless otherwise specified, the following settings are used for measurements: f = 3.6 GHz; V_{CC} = 5 V, T_{case} = 25 ºC; input and output 50 Ω. 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		-	104	120	mA
G_p	power gain		35.5	36.5	40	dB
NF	noise figure		-	0.95	-	dB
$IP3_o$	output third-order intercept point	2-tones at 10 MHz distance, P_i = -40 dBm each tone	31.5	32.5	-	dBm
$P_{o(1dB)}$	output power at 1 dB gain compression		-	17	-	dBm
Low gain RX mode; signal from ANT to RX_OUT						
I_{CC}	supply current		-	49	60	mA
G_p	power gain		16.5	19	20.5	dB
NF	noise figure		-	1	-	dB
$IP3_o$	output third-order intercept point	2-tones at 10 MHz distance, P_i = -40 dBm each tone	29	30	-	dBm
$P_{o(1dB)}$	Output power at 1 dB gain compression		-	14.5	-	dBm
TX mode; signal from ANT to TERM						
I_{CC}	supply current		-	4	4.6	mA
$P_{i(AV)TX}$	Maximum average input power in TX mode [1]	applied on ANT pin, lifetime (10 yrs), T_{case} = 105 °C	-	40	42.5	dBm
		applied on ANT pin, 10 seconds, T_{case} = 105 °C [2]	-	43	44.5	dBm

[1] CP-OFDM with 10.5 dB PAPR, BW = 100 MHz, QPSK modulated, SCS = 60 kHz, fully allocated

[2] See limiting values table

5 Ordering information

Table 2. Ordering information

Type number	Orderable part number	Package		
		Name	Description	Version
BTS7202U	BTS7202UJ	HVQFN40	plastic thermal enhanced very thin quad flat package; no leads; 40 terminals; 0.5 mm pitch, 6 mm x 6 mm x 0.85 mm body	SOT618-6

6 Marking

Table 3. Marking

Type number	Marking code
BTS7202U	7202U

7 Functional diagram

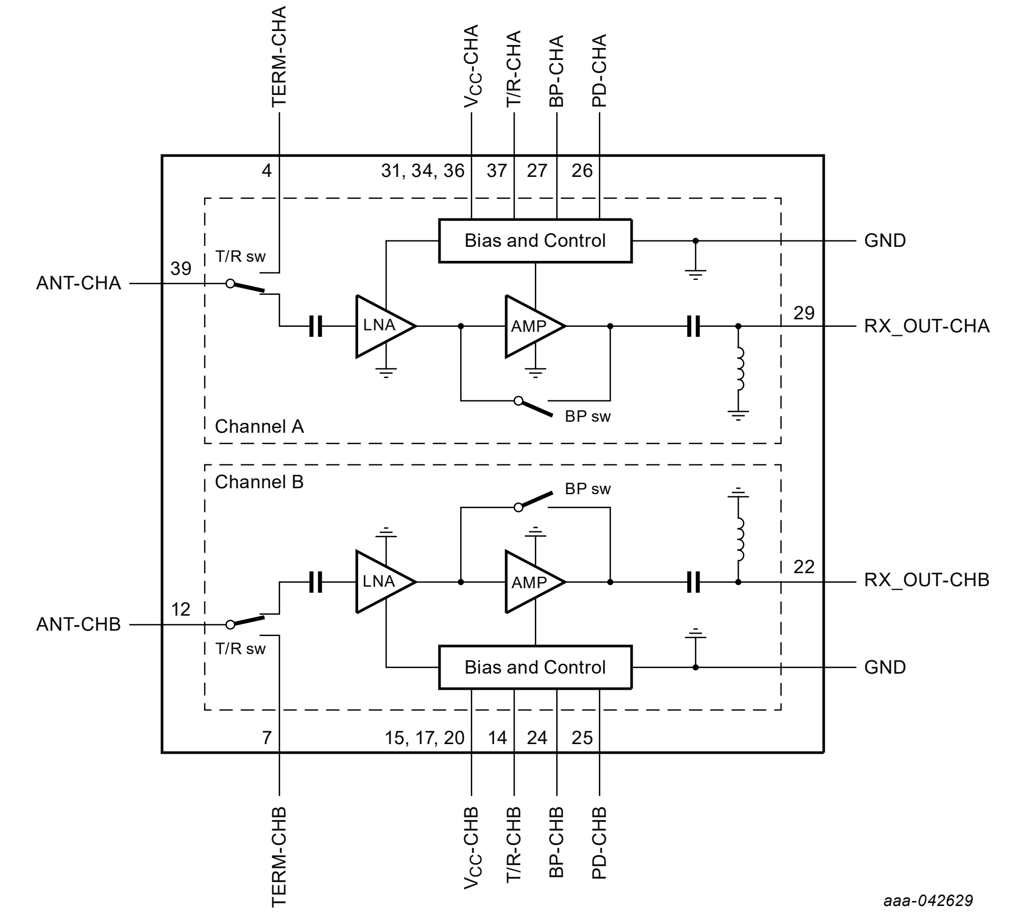


Figure 1. BTS7202U functional diagram

8 Pinning

8.1 Pin diagram

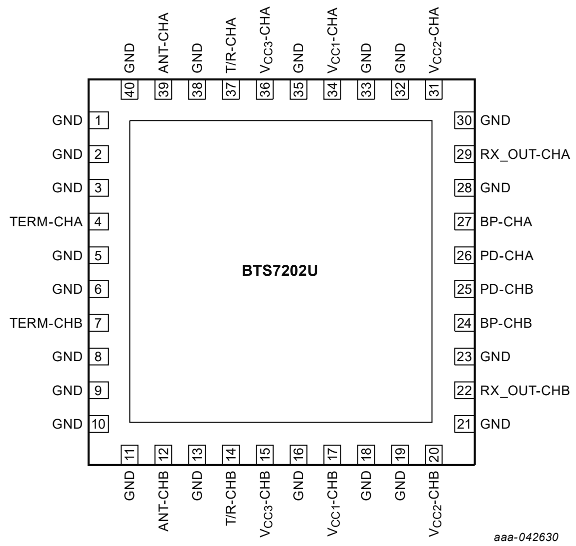


Figure 2. BTS7202U pin configuration

8.2 Pin description

Table 4. Pin description

Pin	Symbol	Description
1, 2, 3, 5, 6, 8, 9, 10, 11, 13, 16, 18, 19, 21, 23, 28, 30, 32, 33, 35, 38, 40	GND	Ground reference
4	TERM-CHA	Termination RF output for channel A (50 Ω, single ended)
7	TERM-CHB	Termination RF output for channel B (50 Ω, single ended)
12	ANT-CHB	RF input for channel B (50 Ω, single ended, DC at 0 V)
14	T/R-CHB	Select RX mode / TX mode for channel B
15, 17, 20	V_{CC}-CHB	Supply voltage for channel B
22	RX_OUT-CHB	RF output for channel B (50 Ω, single ended, DC at 0 V)
24	BP-CHB	Gain selection for channel B
25	PD-CHB	LNA disabling/enabling channel B
26	PD-CHA	LNA disabling/enabling channel A
27	BP-CHA	Gain selection for channel A
29	RX_OUT-CHA	RF output for channel A (50 Ω, single ended, DC at 0 V)
31, 34, 36	V_{CC}-CHA	Supply voltage for channel A
37	T/R-CHA	Select RX mode / TX mode for channel A
39	ANT-CHA	RF input 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	PD-CHA	BP-CHA	Mode of Operation
Low	Low	Low	High gain RX mode for channel A
Low	Low	High	Low gain RX mode for channel A
Low	High	Low/High	Isolation mode
High	Low	Low	Loopback High gain RX
High	Low	High	Loopback Low gain RX
High	High	Low/High	TX mode (LNAs off) for channel A

Table 6. Modes of operation for channel B

T/R-CHB	PD-CHB	BP-CHB	Mode of Operation
Low	Low	Low	High gain RX mode for channel B
Low	Low	High	Low gain RX mode for channel B
Low	High	Low/High	Isolation mode
High	Low	Low	Loopback High gain RX
High	Low	High	Loopback Low gain RX
High	High	Low/High	TX mode (LNAs off) 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
$V_{DC(ctrl\_pins)}$	DC voltage on control pins	applied on control pins T/R, PD, and BP	-0.3	3.6	V
$V_{DC(RF\_pins)}$	DC voltage on RF pins	applied on both ANT, and both TERM, RF pins	-	0	V
I_{CTRL}	control current		-	1	mA
$P_{i(AV)RX}$	average input power in RX mode [1]	applied on ANT pin, 10 seconds, T_{case} = 105 °C	-	30	dBm
$P_{i(AV)TX}$	average input power in TX mode [1]	applied on ANT pin, 10 seconds, T_{case} = 105 °C	-	44.5	dBm
T_{stg}	storage temperature		-50	150	°C
T_j	junction temperature	TX path, >1 x 10^6 h MTTF	-	150	°C
		RX path, >1 x 10^6 h MTTF	-	175	°C
$T_{case(func)}$	functional case temperature		-40	125	°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 10.5 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}, V_{CC2}, and V_{CC3} [1]	4.75	5	5.25	V
V_{IH}	HIGH-level input voltage	at pins T/R, PD, and BP	1.17	1.8	3.6	V
V_{IL}	LOW-level input voltage	at pins T/R, PD, and BP	0	-	0.63	V
T_{case}	case temperature	exposed die paddle at package bottom	-40	25	105	°C

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

12 Thermal characteristics

Table 9. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-case)}$	channel-junction to case thermal resistance [1]	TX mode	10	K/W
		RX mode	17	K/W

[1] for both channels operating

13 Characteristics

Table 10. Characteristics

Unless otherwise specified, the following settings are used for measurements: f = 3.6 GHz; V_{CC} = 5 V, T_{case} = 25 ºC; input and output 50 Ω. 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		-	104	120	mA
G_p	power gain		35.5	36.5	40	dB
G_{flat}	gain flatness	in 100 MHz band	-	0.35	-	dB
NF	noise figure		-	0.95	-	dB
RL_i	input return loss	f = 3.3 GHz to 4.2 GHz	-	25	-	dB
RL_o	output return loss	f = 3.3 GHz to 4.2 GHz	-	16	-	dB
$\alpha_{isol(ch-ch)}$	isolation channel to channel	f = 3.3 GHz to 4.2 GHz [1]	-	40	-	dB
$\alpha_{isol(ANT-TERM)}$	Isolation ANT to TERM	f = 3.3 GHz to 4.2 GHz	-	25	-	dB
$IP3_o$	output third-order intercept point	2-tones at 10 MHz distance, P_i = -40 dBm each tone	31.5	32.5	-	dBm
$P_{o(1dB)}$	output power at 1 dB gain compression		-	17	-	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		-	49	60	mA
G_p	power gain		16.5	19	20.5	dB
G_{flat}	gain flatness	in 100 MHz band	-	0.3	-	dB
NF	noise figure		-	1	-	dB
RL_i	input return loss	f = 3.3 GHz to 4.2 GHz	-	22	-	dB
RL_o	output return loss	f = 3.3 GHz to 4.2 GHz	-	12	-	dB
$\alpha_{isol(ch-ch)}$	isolation channel to channel	f = 3.3 GHz to 4.2 GHz [1]	-	58	-	dB
$\alpha_{isol(ANT-TERM)}$	Isolation ANT to TERM	f = 3.3 GHz to 4.2 GHz	-	25	-	dB
$IP3_o$	output third-order intercept point	2-tones at 10 MHz distance, P_i = -40 dBm each tone	29	30	-	dBm
$P_{o(1dB)}$	output power at 1 dB gain compression		-	14.5	-	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		-	4	4.6	mA
IL	Insertion Loss		-	0.5	-	dB
RL_i	input return loss ANT	f = 3.3 GHz to 4.2 GHz	-	19	-	dB
RL_o	output return loss TERM	f = 3.3 GHz to 4.2 GHz	-	19	-	dB

Table 10. Characteristics...*continued*

Unless otherwise specified, the following settings are used for measurements: f = 3.6 GHz; V_{CC} = 5 V, T_{case} = 25 ºC; input and output 50 Ω. Characteristics apply to each channel A and B separately.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\alpha_{isol(ANT-RX\_OUT)}$	isolation between ANT to RX_OUT	f = 3.3 GHz to 4.2 GHz, isolation mode	-	70	-	dB
		f = 3.3 GHz to 4.2 GHz, loopback High gain RX	-	10	-	dB
		f = 3.3 GHz to 4.2 GHz, loopback Low gain RX	-	30	-	dB
$P_{i(AV)TX}$	Maximum average input power in TX mode [2]	applied on ANT pin, lifetime (10 yrs), T_{case} = 105 °C	-	40	42.5	dBm
Switching between modes						
$t_{sw(\alpha)RX}$	switching time RX gain level		-	300	-	ns
$t_{sw(RX-TX)}$	switching from RX to TX	for the power transient at RX_OUT	-	360	-	ns
$t_{sw(TX-RX)}$	switching from TX to RX		-	500	-	ns

[1] isolation RX_OUT-CHA to RX_OUT-CHB
[2] CP-OFDM with 10.5 dB PAPR, BW = 100 MHz, QPSK modulated, SCS = 60 kHz, fully allocated

14 Graphs

14.1 All modes

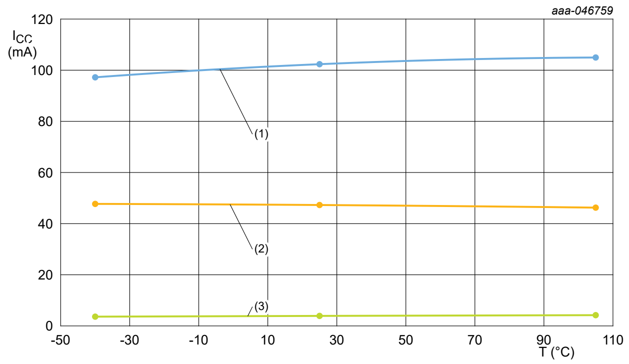


Figure 3. DC supply current versus temperature

(1) = High gain RX mode

(2) = Low gain RX mode

(3) = TX mode

14.2 High gain RX mode

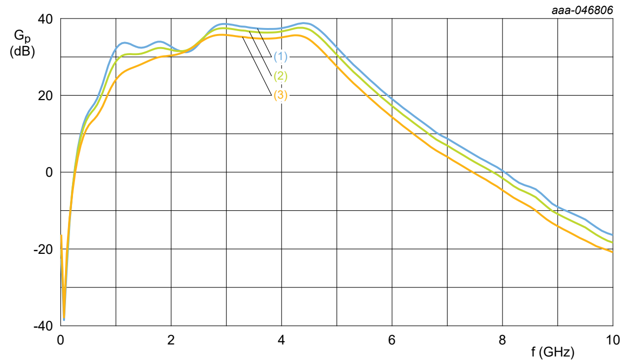


Figure 4. High gain RX mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

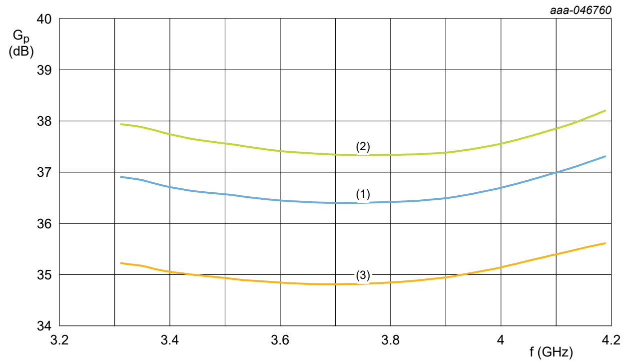


Figure 5. High gain RX mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

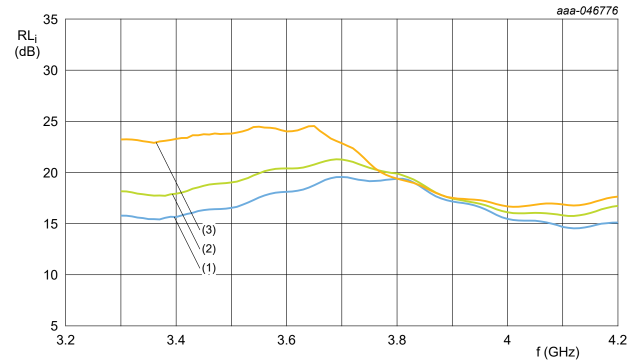


Figure 6. High gain RX mode, RL_i versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

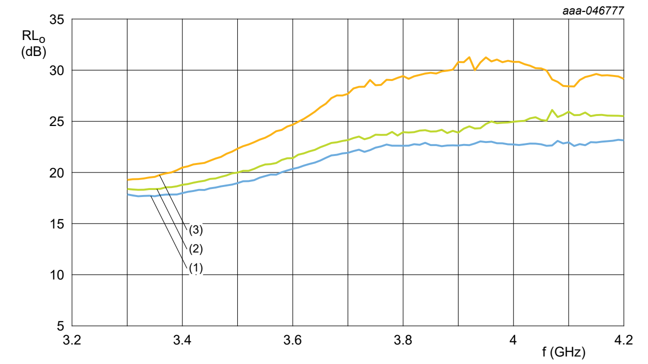


Figure 7. High gain RX mode, RL_o versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

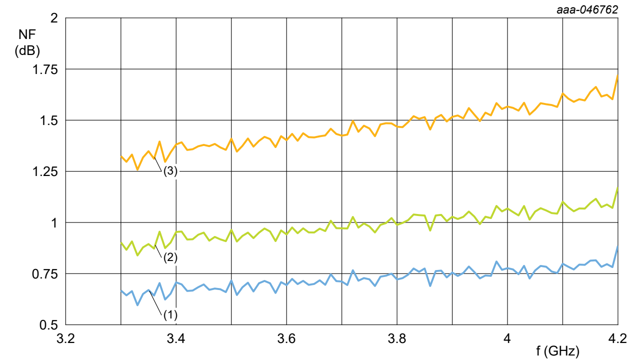


Figure 8. High gain RX mode, NF versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

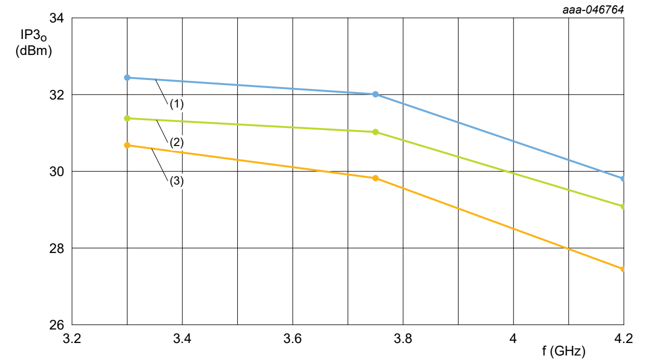


Figure 9. High gain RX mode, $IP3_o$ versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

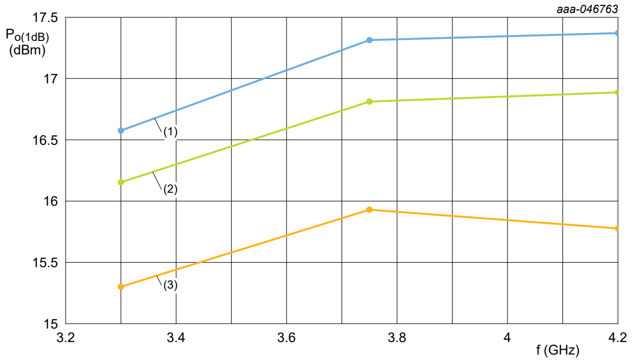


Figure 10. High gain RX mode, $P_{o(1dB)}$ versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

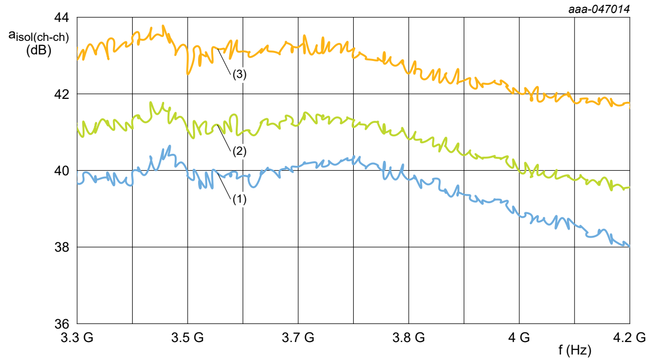


Figure 11. High gain RX mode, Channel Isolation versus frequency

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

14.3 Low gain RX mode

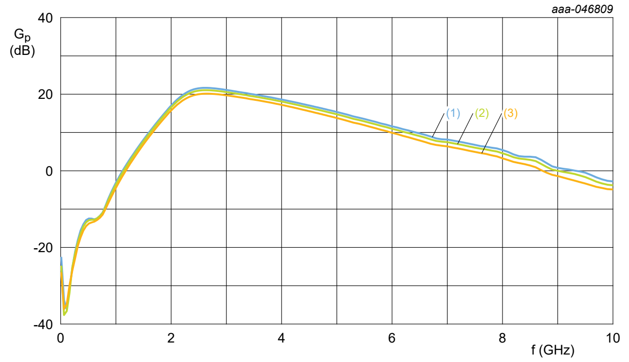


Figure 12. Low gain RX mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

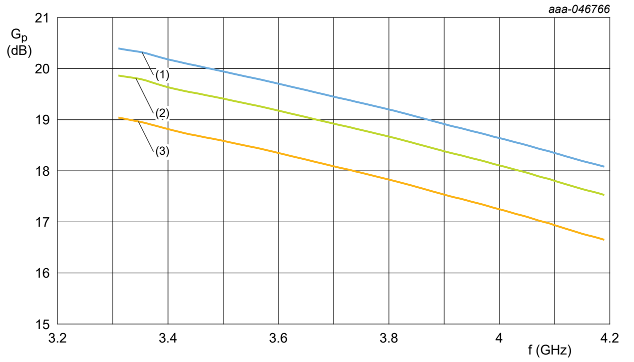


Figure 13. Low gain RX mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

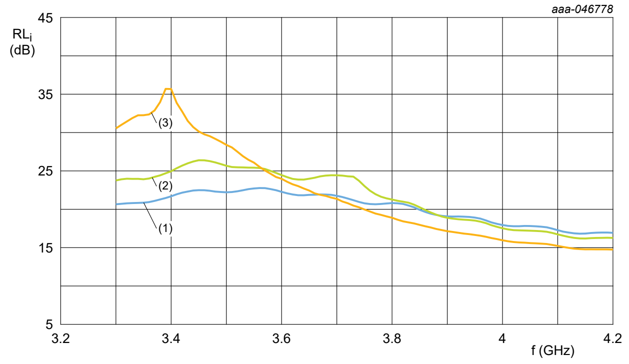


Figure 14. Low gain RX mode, RL_i versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

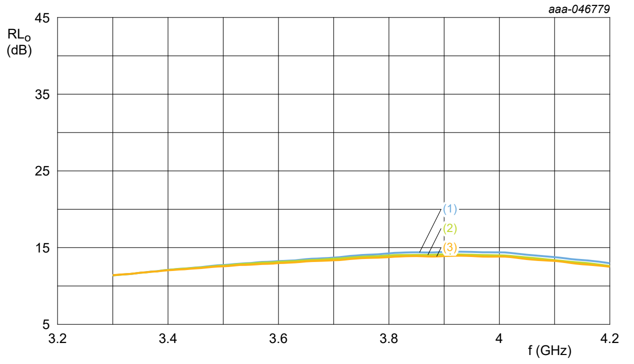


Figure 15. Low gain RX mode, RL_o versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

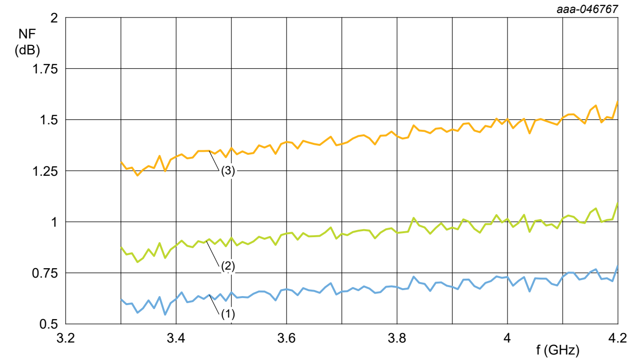


Figure 16. Low gain RX mode, NF versus frequency over temperature

(1) T_{case} = -40 °C
(2) T_{case} = 25 °C
(3) T_{case} = 105 °C

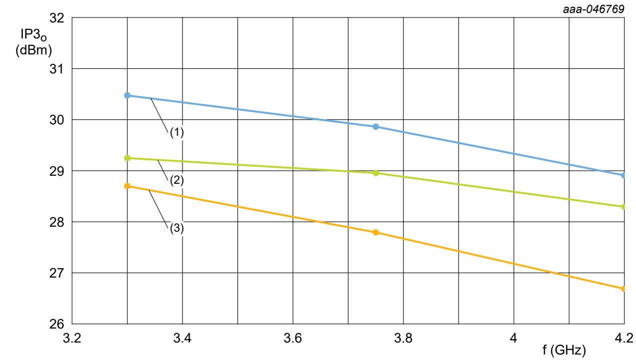


Figure 17. Low gain RX mode, $IP3_o$ versus frequency over temperature

(1) T_{case} = -40 °C
(2) T_{case} = 25 °C
(3) T_{case} = 105 °C

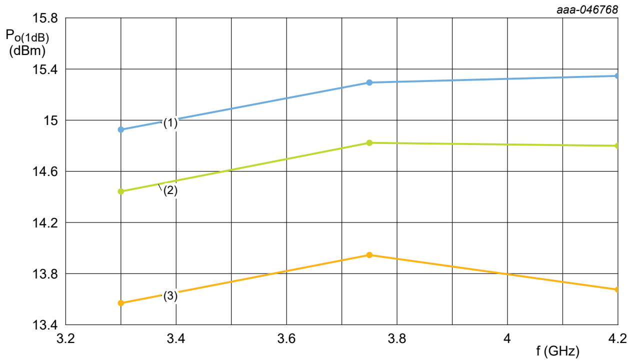


Figure 18. Low gain RX mode, Input $P_{o(1dB)}$ versus frequency over temperature

(1) T_{case} = -40 °C
(2) T_{case} = 25 °C
(3) T_{case} = 105 °C

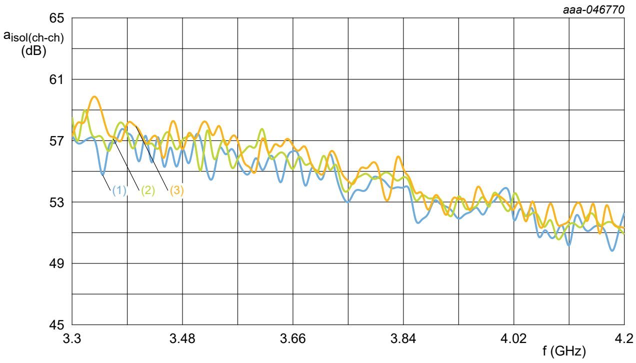


Figure 19. Low gain RX mode, Channel Isolation versus frequency

(1) T_{case} = -40 °C
(2) T_{case} = 25 °C
(3) T_{case} = 105 °C

14.4 TX mode

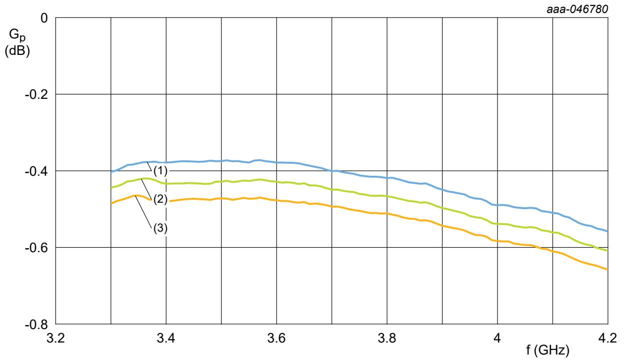


Figure 20. TX mode, G_p versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

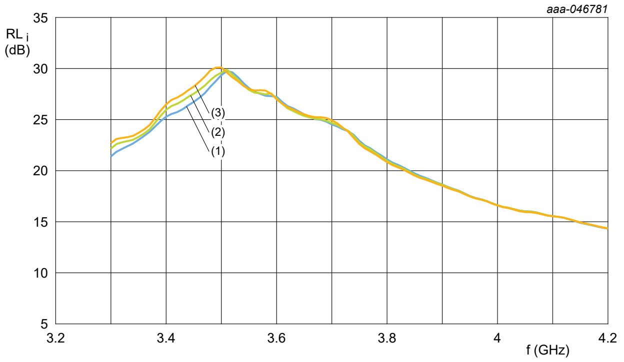


Figure 21. TX mode, RL_i versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

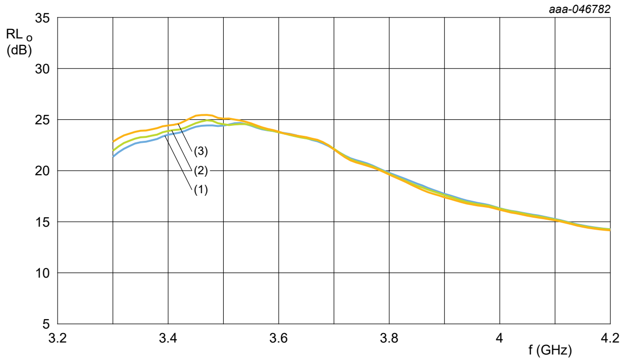


Figure 22. TX mode, RL_o versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

14.5 Loopback mode

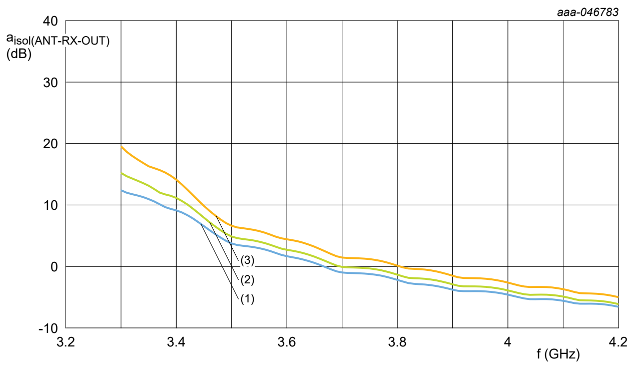


Figure 23. High gain Loopback mode, ANT to RX_OUT isolation versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

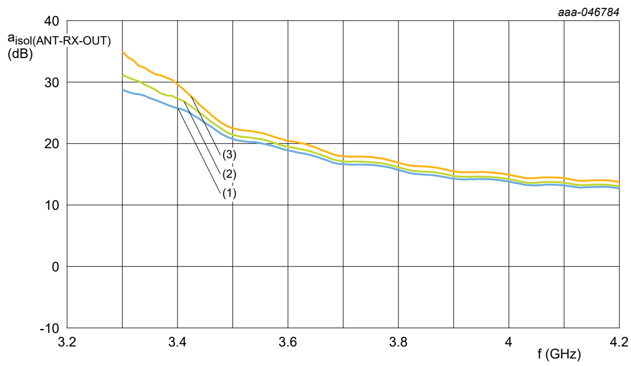


Figure 24. Low gain Loopback mode, ANT to RX_OUT isolation versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

14.6 Isolation mode

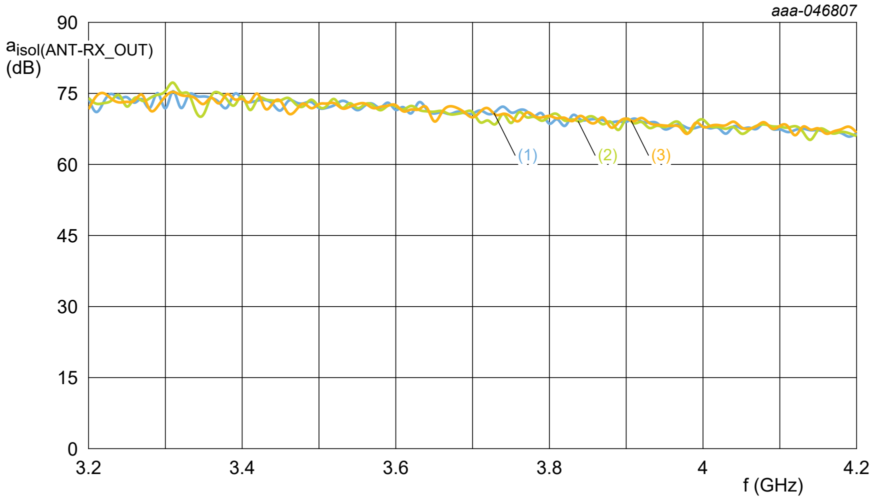


Figure 25. Isolation mode ANT to RX_OUT versus frequency over temperature

(1) T_{case} = -40 °C

(2) T_{case} = 25 °C

(3) T_{case} = 105 °C

15 Application information

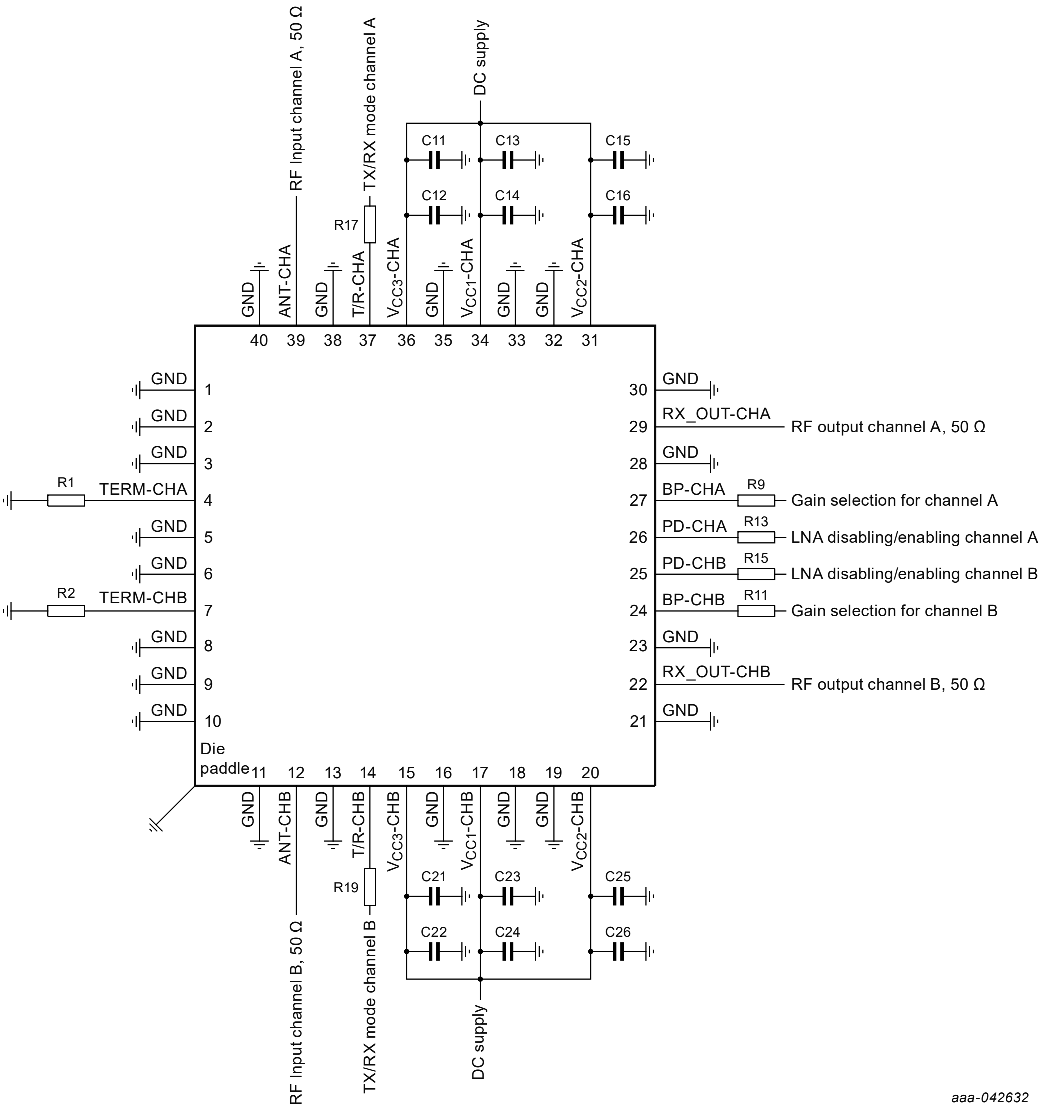


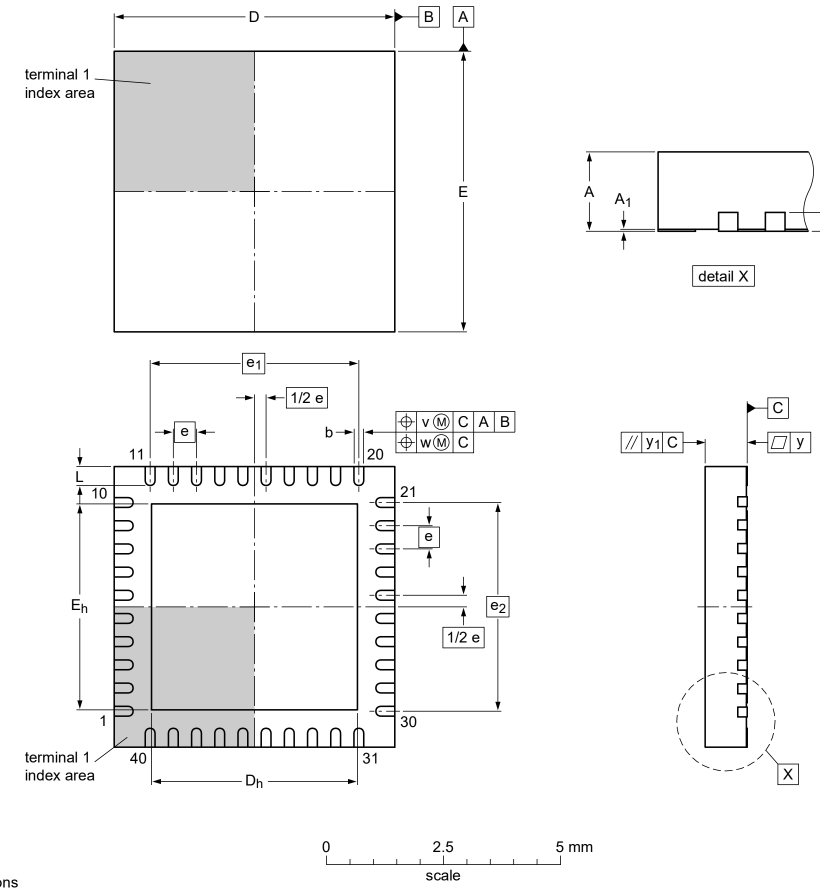
Figure 26. Application schematic BTS7202U

Table 11. List of components

Component	Description	Value	amount	Remarks
R1, and R2	load resistor	50 Ω, 50 W RMS	2	must be able to withstand 43 dBm average power over lifetime
R9, R11, R13, R15, R17, R19	resistor	2.7 KΩ	6	if the max I_{CTRL} capability is not exceeding 1mA, the resistor is optional
C11, C13, C15, C21, C23, and C25	capacitor	1 µF	6	as close as possible, less than 10 mm from IC
C12, C14, C16, C22, C24, and C26	capacitor	10 nF	6	as close as possible, less than 10 mm from IC

16 Package outline

HVQFN40: plastic thermal enhanced very thin quad flat package; no leads; 40 terminals; body 6 x 6 x 0.85 mm **SOT618-6**



Dimensions

Unit		$A^{(1)}$	A_1	b	c	$D^{(1)}$	D_h	$E^{(1)}$	E_h	e	e_1	e_2	L	v	w	y	y_1
	max	1.00	0.05	0.30		6.1	4.55	6.1	4.55				0.5				
mm	nom	0.85	0.02	0.21	0.2	6.0	4.40	6.0	4.40	0.5	4.5	4.5	0.4	0.1	0.05	0.05	0.1
	min	0.80	0.00	0.18		5.9	4.25	5.9	4.25				0.3				

Note

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

sot618-6_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT618-6		MO-220	- - -			~~09-02-23~~ 09-03-04

Figure 27. HVQFN40 SOT618-6

16.1 Footprint and solder information

NXP recommends by default to apply the soldering and footprint guidelines as are released in POD SOT618-6.

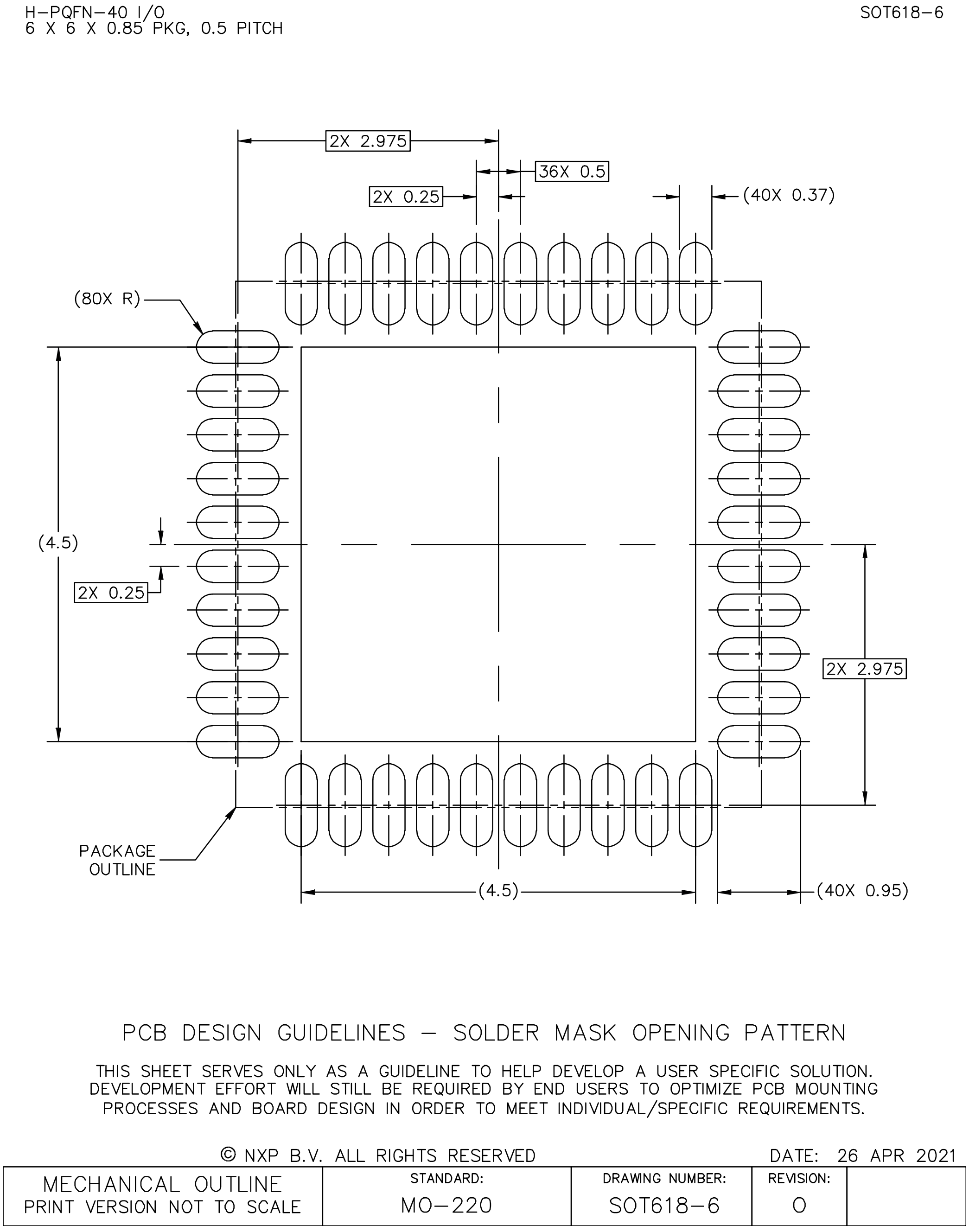


Figure 28. HVQFN40 solder mask opening patterns

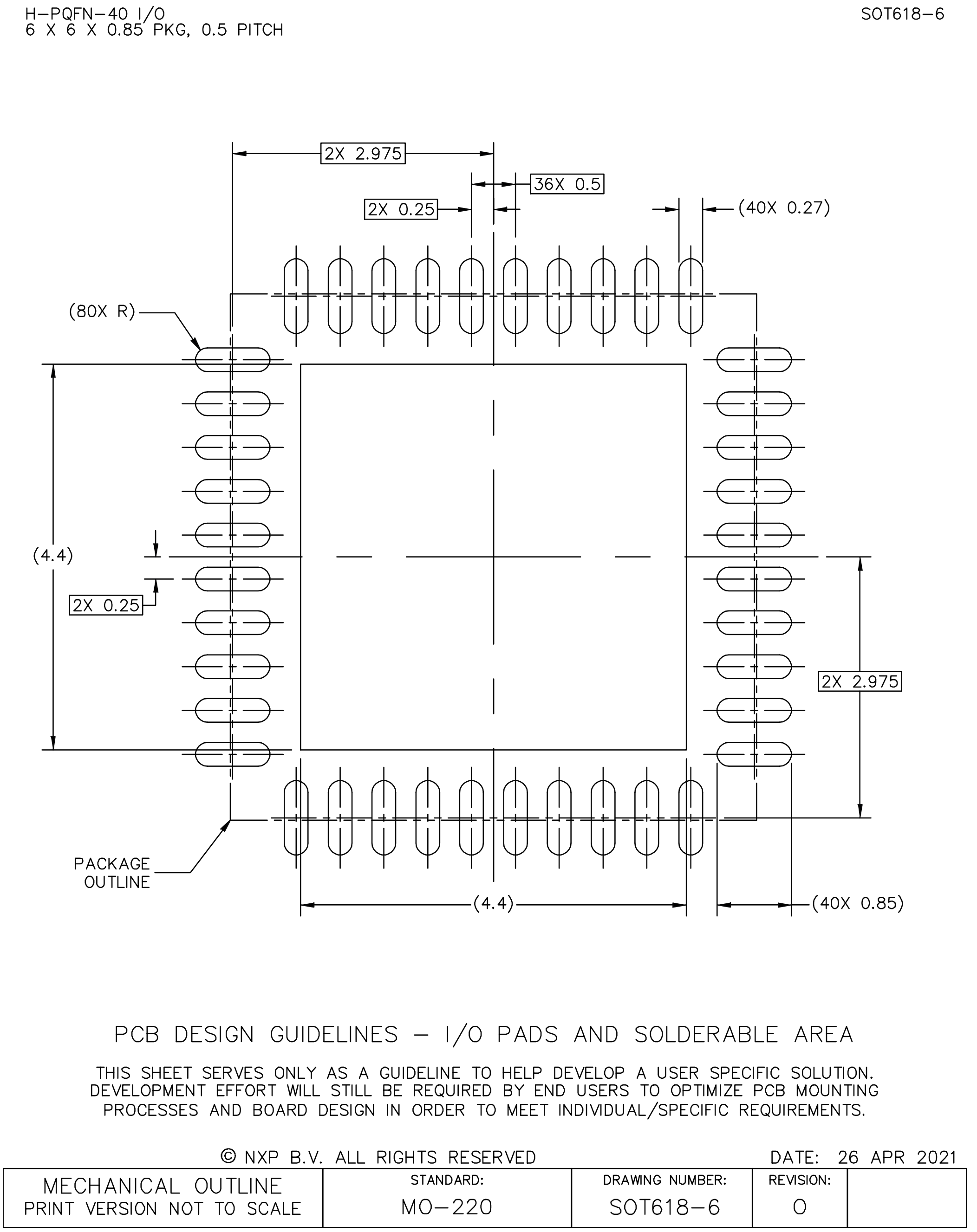
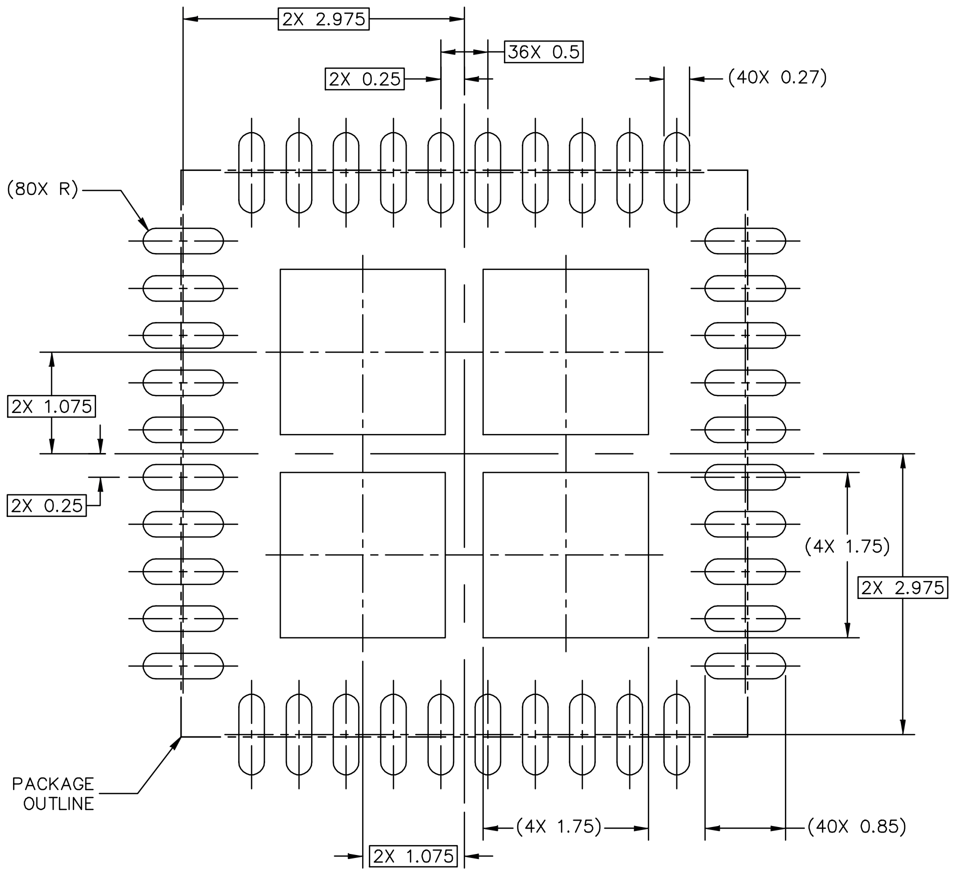


Figure 29. HVQFN40 I/O pads and solderable area

H–PQFN–40 I/O
6 X 6 X 0.85 PKG, 0.5 PITCH

SOT618–6



RECOMMENDED STENCIL THICKNESS 0.125

PCB DESIGN GUIDELINES – SOLDER PASTE STENCIL

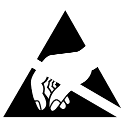
THIS SHEET SERVES ONLY AS A GUIDELINE TO HELP DEVELOP A USER SPECIFIC SOLUTION. DEVELOPMENT EFFORT WILL STILL BE REQUIRED BY END USERS TO OPTIMIZE PCB MOUNTING PROCESSES AND BOARD DESIGN IN ORDER TO MEET INDIVIDUAL/SPECIFIC REQUIREMENTS.

DATE: 26 APR 2021

MECHANICAL OUTLINE PRINT VERSION NOT TO SCALE	STANDARD: MO–220	DRAWING NUMBER: SOT618–6	REVISION: O	

Figure 30. HVQFN40 solder paste stencil

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 12. Abbreviations

Acronym	Description
ANT	antenna
BP	bypass
CP-OFDM	cyclic prefix orthogonal frequency division multiplexing
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
PD	power down
QPSK	quadrature phase shift keying
SCS	sub carrier spacing
TERM	termination
T/R	transmit/receive mode

19 Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BTS7202U v.5	20220905	Product data sheet	-	BTS7202U v.4
modification	• changed status to Product data sheet • added graphs to the data sheet • changed T_{case} to T_{amb} in the settings for the measurements • corrected the ground symbol in the functional diagram • corrected the application diagram • changed condition on channel to channel isolation, and added footnote			
BTS7202U v.4	20220509	Preliminary data sheet	-	BTS7202U v.3
modification	• changed minimum value of K factor • corrected the value of C12, C14, C16, C22, C24, and C26 to 10 nF			
BTS7202U v.3	20220425	Preliminary data sheet	-	BTS7202U v.2.1
modification	• adapted the value of several parameters and added some Min and or Max values • removed and added some conditions to different tables • changed the status to Preliminary data sheet			
BTS7202U v.2.1	20220114	Objective data sheet	-	BTS7202U v.2
modification	• adapted the value of several parameters • changed the condition on several Modes of operations			
BTS7202U v.2	20211223	Objective data sheet	-	BTS7202U v.1

Table 13. Revision history...*continued*

Document ID	Release date	Data sheet status	Change notice	Supersedes
modification	• adapted the value of several parameters • added marking information • added orderable part number			
BTS7202U v.1	20210625	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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