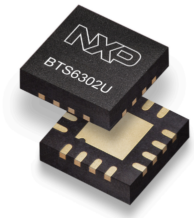


BTS6302U

Wideband high linearity pre-driver amplifier

Rev. 11 — 5 September 2022 **Product data sheet**

1 General description

The BTS6302U is a wideband, high linearity, pre-driver amplifier for 5G massive MIMO infrastructure applications, with fast on-off switching to support TDD systems. The amplifier is designed to operate between 2.3 GHz and 5 GHz. It is housed in a 3 mm × 3 mm × 0.85 mm 16-terminal HVQFN package.

The amplifier is ESD protected on all terminals.

2 Features and benefits

- High saturated output power $P_{o(sat)}$ = 27.9 dBm
- High power-gain G_p = 38 dB
- High linearity performance ACLR = -43 dBc
- Unconditionally stable
- Fast switching to support TDD systems
- 5 V single supply, quiescent current 68 mA
- Small 16-terminal leadless package 3 mm x 3 mm x 0.85 mm
- ESD protection on all terminals
- Moisture sensitivity level 1

3 Applications

- Wireless infrastructure 5G NR mMIMO
- High linearity pre-driver
- TDD systems

4 Quick reference data

Table 1. Quick reference data

f = 3.5 GHz; V_{CC} = 5 V; T_{amb} = 25 °C; input 100 Ω, and output 50 Ω; unless otherwise specified. Values under Min/Max in boldface font are guaranteed by test; Values in lightface font are based on simulation or characterization.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{CC}	supply current	ON state, P_o = 15 dBm	-	98	**120**	mA
		ON state, quiescent	-	68	**88**	mA
		OFF state	-	1	1.5	mA
G_p	power gain	ON state	**35.8**	38	**40.8**	dB
		OFF state	-	-60	-45	dB
$P_{o(sat)}$	saturated output power	[1]	27.7	27.9	-	dBm
ACLR	adjacent channel leakage ratio	CP-OFDM with 100 MHz channel BW, QPSK modulation, and 60 kHz SCS, fully allocated, P_o = 15 dBm	-	-43	-40	dBc

[1] Connector and Printed-Circuit Board (PCB) losses have been de-embedded, 3 dB gain compression

5 Ordering information

Table 2. Ordering information

Type number	Orderable part number	Package		
		Name	Description	Version
BTS6302U	BTS6302UJ	HVQFN16	3 mm × 3 mm × 0.85 mm, 16 terminals no leads	SOT758-1

6 Marking

Table 3. Marking

Type number	Marking code
BTS6302U	32U

7 Functional diagram

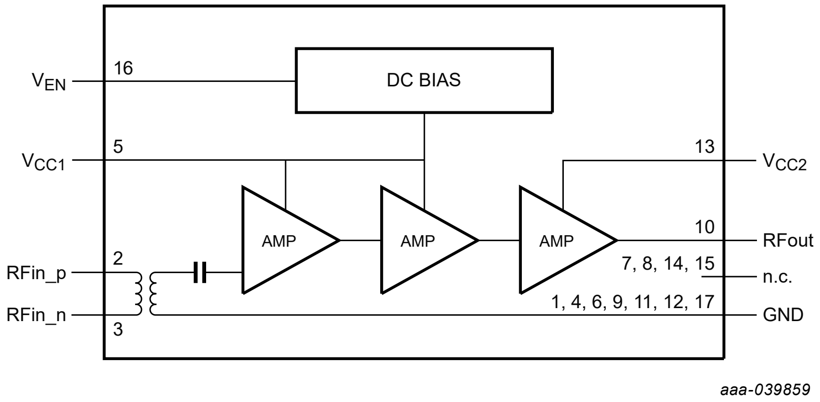


Figure 1. Functional drawing

8 Pinning information

8.1 Pinning

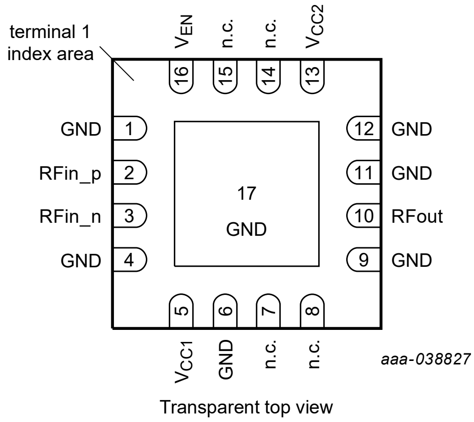


Figure 2. Pin configuration

8.2 Pin description

Table 4. Pin description

Pin	Symbol	Description
1, 4, 6, 9, 11, 12, and 17	GND	PCB ground
2	RFin_p	RF input
3	RFin_n	RF input
5	V_{CC1}	supply voltage
7, 8, 14, and 15	n.c. [1]	not connected
10	RFout	RF output
13	VCC2	supply voltage
16	V_{EN}	voltage enable; LOW = OFF state; HIGH = ON state

[1] n.c. means that pin is not connected inside package, and may be left floating in application

9 Functional description

Table 5. Shutdown control

V_{en}	voltage applied at pin V_{en} [1]	State	Condition
LOW	$0 < V (V_{en}) < V_{IL(max)}$	OFF	bias active, amplifier not active
HIGH	$V_{IH(min)} < V (V_{en}) < V_{I(max)}$	ON	bias active, amplifier active

[1] V_{EN} can only be made HIGH, after supply voltage has been applied to pin V_{CC1}

10 Limiting values

Table 6. 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_{EN}	enable voltage		-0.3	4	V
$P_{i(RF)CW}$	continuous waveform RF input power	ON state, OFF state	-	10	dBm
T_{stg}	storage temperature		-40	150	°C
T_j	junction temperature		-	175	°C
V_{ESD}	electrostatic discharge voltage	Human Body Model (HBM) According to ANSI/ESDA/JEDEC standard JS-001	-	+/-2	kV
		Charged Device Model (CDM); According to ANSI/ESDA/JEDEC standard JS-002	-	+/-500	V

11 Recommended operating conditions

Table 7. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage	[1]	4.75	5	5.25	V
V_{IL}	LOW-level input voltage		0	-	0.6	V
V_{IH}	HIGH-level input voltage		1.2	-	3.6	V
$V_{I(max)}$	maximum input voltage		-	-	3.6	V
Z_0	characteristic impedance differential input		-	100	-	Ω
	characteristic impedance output		-	50	-	Ω
T_{case}	case temperature		-40	-	115	°C

[1] supply voltage at V_{CC1} must be applied before, or at the same time as applying supply voltage to pin V_{CC2}

12 Thermal characteristics

Table 8. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j\text{-}case)}$	junction to case thermal resistance	[1] [2]	50	K/W

[1] Case is ground solder pad.
[2] Thermal resistance determined with device mounted, and device bottom case kept at constant temperature.

13 Characteristics

Table 9. Characteristics

f = 3.5 GHz; V_{CC} = 5 V; T_{amb} = 25 °C; input 100 Ω, and output 50 Ω; unless otherwise specified. Values under Min/Max in boldface font are guaranteed by test; Values in lightface font are based on simulation or characterization.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{CC}	supply current	ON state, P_o = 15 dBm	-	98	**120**	mA
		ON state, quiescent	-	68	**88**	mA
		OFF state	-	1	1.5	mA
G_p	power gain	ON state, t_{amb} = -40 °C to 115 °C [1]				
		f = 2.6 GHz	35.7	38	40.6	dB
		f = 3.5 GHz	35.8	38	40.8	dB
		f = 4.2 GHz	33.8	36	38.6	dB
		OFF state	-	-60	-45	dB
G_{flat}	gain flatness	f = 2.3 GHz to 2.7 GHz	-	0.9	1	dB
		f = 3.3 GHz to 3.8 GHz	-	1	1.1	dB
		f = 3.8 GHz to 4.2 GHz	-	1.2	1.3	dB
$t_{d(grp)}$	group delay time	f = 2.3 GHz to 2.7 GHz	-	0.4	0.5	ns
		f = 3.3 GHz to 3.8 GHz	-	0.4	0.5	ns
		f = 3.8 GHz to 4.2 GHz	-	0.4	0.5	ns
$P_{o(sat)}$	saturated output power	f = 2.6 GHz [2]	28.1	28.3	-	dBm
		f = 3.5 GHz [2]	27.7	27.9	-	dBm
		f = 4.2 GHz [2]	26.5	26.7	-	dBm
$P_{L(1dB)}$	output power at1 dB gain compression	f = 2.6 GHz	27.8	28.1	-	dBm
		f = 3.5 GHz	27.3	27.6	-	dBm
		f = 4.2 GHz	26	26.3	-	dBm
$IP3_o$	output third-order intercept point	2-tone; tone spacing = 100 MHz; P_o = 15 dBm	27	33	-	dBm
CMRR	common mode rejection ratio		22	24	-	dB
RL_i	input return loss	f = 2.6 GHz	18	20	-	dB
		f = 3.5 GHz	9.5	10	-	dB
		f = 4.2 GHz	11	12	-	dB
RL_o	output return loss	f = 2.6 GHz	10	11	-	dB
		f = 3.5 GHz	10	11	-	dB
		f = 4.2 GHz	10	12	-	dB
ISL_r	reverse isolation		63	65	-	dB

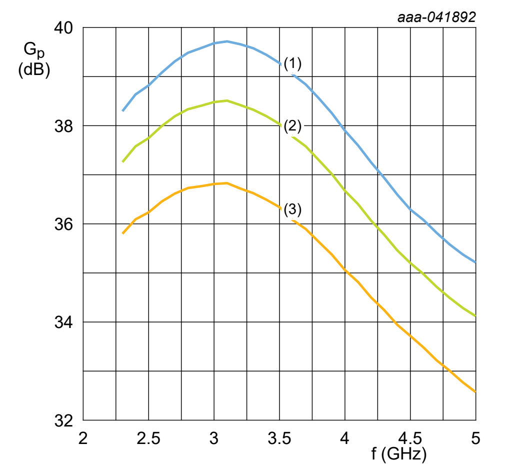
Table 9. Characteristics...*continued*

f = 3.5 GHz; V_{CC} = 5 V; T_{amb} = 25 °C; input 100 Ω, and output 50 Ω; unless otherwise specified. Values under Min/Max in boldface font are guaranteed by test; Values in lightface font are based on simulation or characterization.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
NF	noise figure	f = 2.6 GHz [3]	-	3.1	3.2	dB
		f = 3.5 GHz [3]	-	3.4	3.5	dB
		f = 4.2 GHz [3]	-	3.7	3.8	dB
$t_{s(pon)}$	power-on settling time	V_{EN} from LOW to HIGH to gain settled within 0.1 dB of final value and phase settled to within 1 degree of final value	-	0.8	0.9	µs
$t_{s(poff)}$	power-off settling time	V_{EN} from HIGH to LOW to gain settled to be < 5 % of gain in ON state	-	0.05	0.1	µs
K	Rollett stability factor	1 MHz to 15 GHz	5	-	-	
ACLR	adjacent channel leakage ratio	CP-OFDM with 100 MHz channel BW, QPSK modulation, and 60 kHz SCS, fully allocated, P_o = 15 dBm	-	-43	-40	dBc

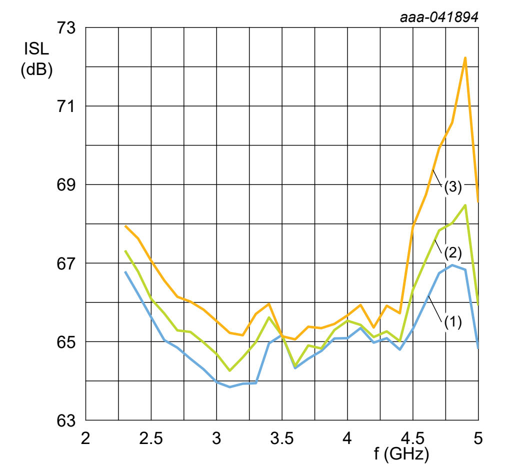
[1] These values are guaranteed by final test at t_{amb}
[2] Connector and Printed-Circuit Board (PCB) losses have been de-embedded, 3 dB gain compression
[3] Connector and Printed-Circuit Board (PCB) losses have been de-embedded

14 Graphs



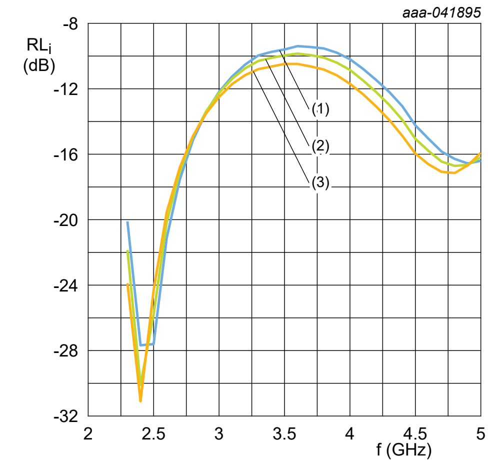
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 3. G_p versus frequency over temperature



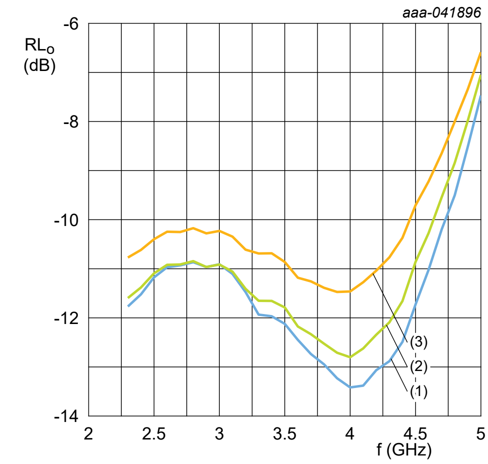
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 4. ISL_r versus frequency over temperature



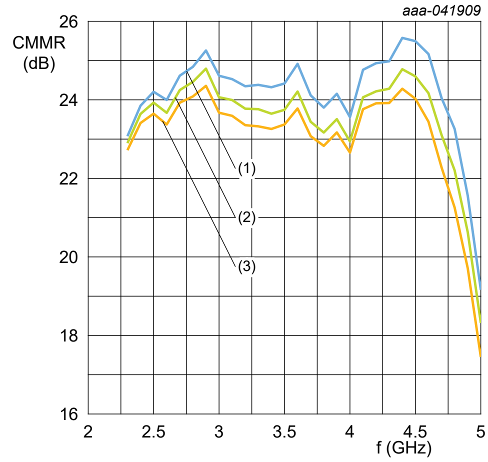
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 5. RL_i S11 versus frequency over temperature



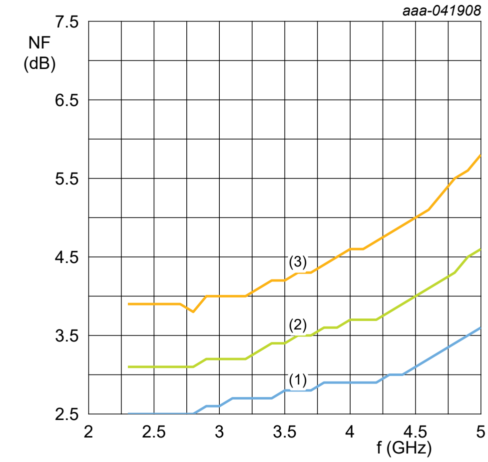
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 6. RL_o S22 versus frequency over temperature



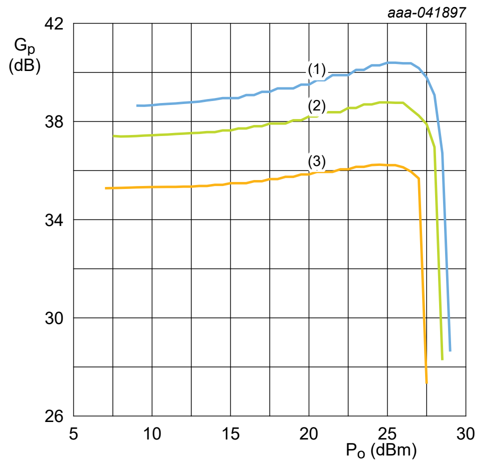
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 7. CMMR versus frequency over temperature



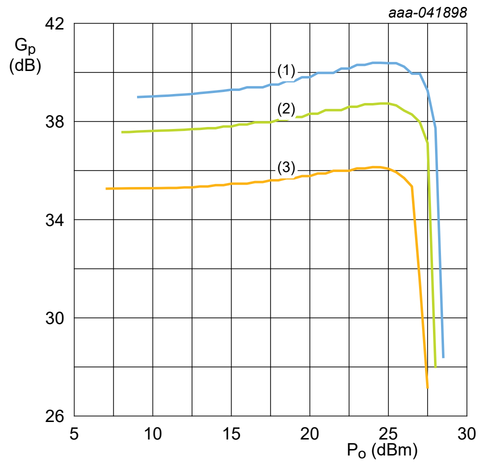
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 8. NF versus frequency over temperature



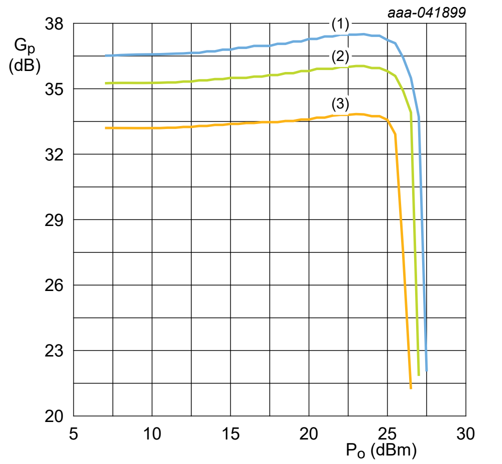
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 9. G_p versus P_o at 2.6 GHz over temperature



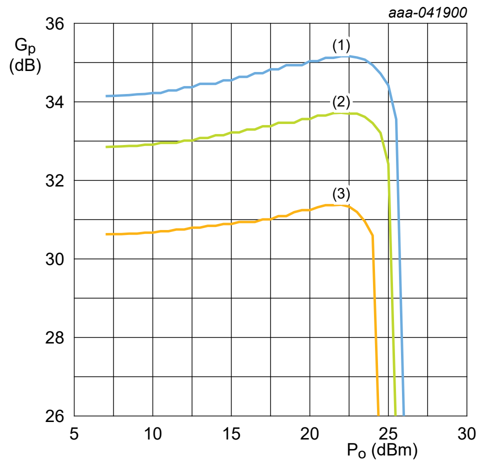
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 10. G_p versus P_o at 3.5 GHz over temperature



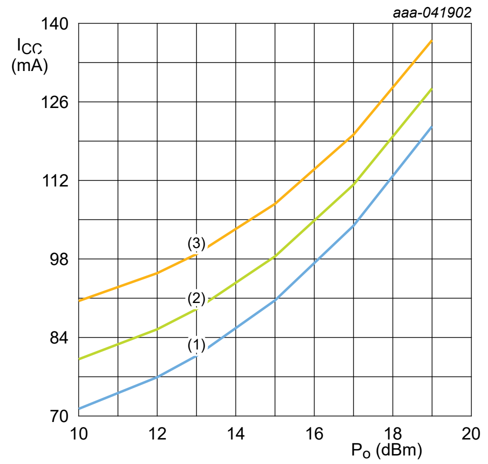
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 11. G_p versus P_0 at 4.2 GHz over temperature



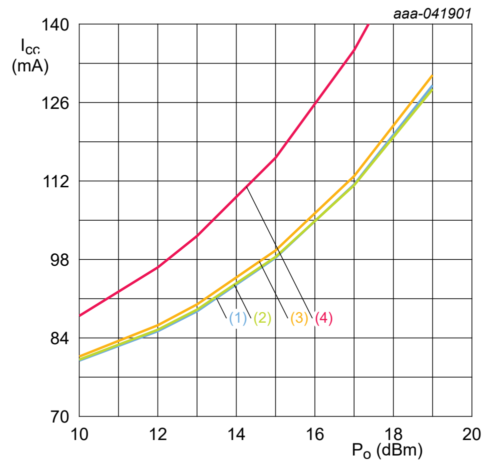
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 12. G_p versus P_0 at 5 GHz over temperature



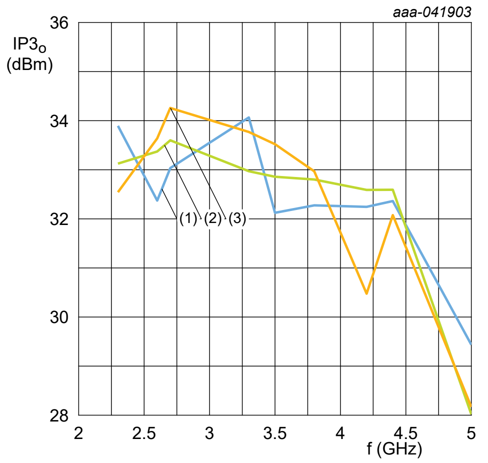
- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 13. I_{CC} versus P_o at 3.5 GHz over temperature



- (1) f = 2.6 GHz
- (2) f = 3.5 GHz
- (3) f = 4.2 GHz
- (4) f = 5 GHz

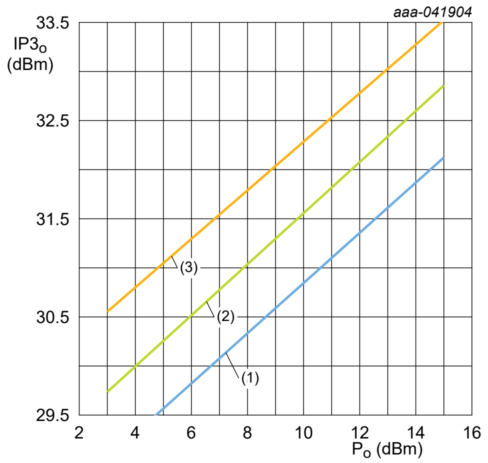
Figure 14. I_{CC} versus P_0 over frequency at 25 °C



tone spacing = 100 MHz, P_o = 15 dBm, V_{CC} = 5 V

- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

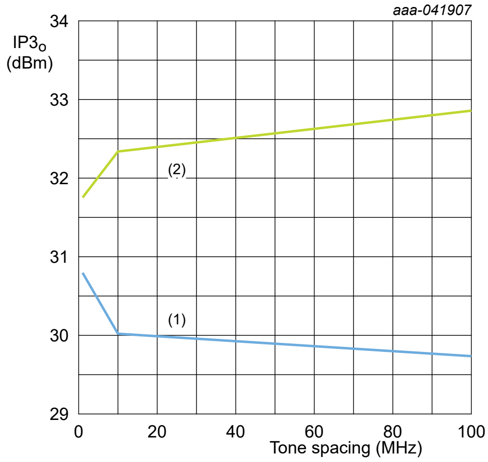
Figure 15. $IP3_o$ versus frequency over temperature



tone spacing = 100 MHz, V_{CC} = 5 V

- (1) T_{amb} = -40 °C
- (2) T_{amb} = 25 °C
- (3) T_{amb} = 115 °C

Figure 16. $IP3_o$ versus P_o over temperature

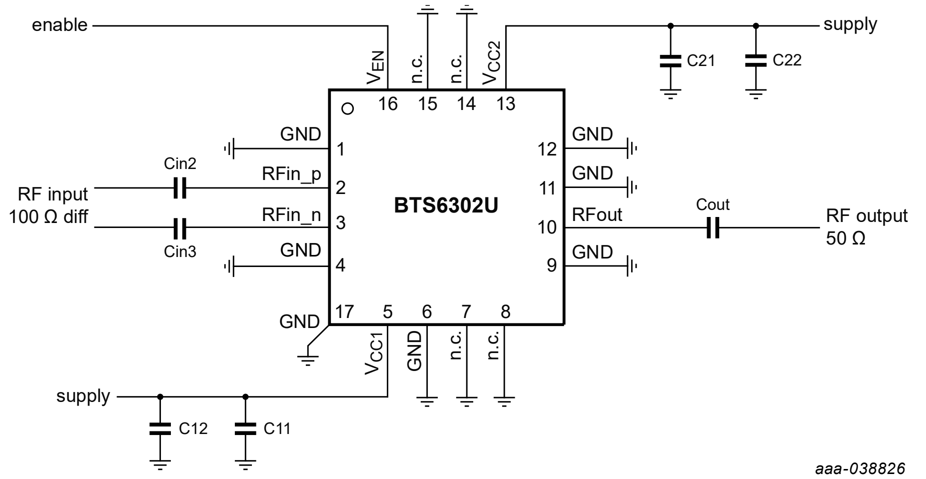


f = 3.5 GHz, V_{CC} = 5 V, T_{amb} = 25 °C

- (1) P_o = 3 dBm
- (2) P_o = 15 dBm

Figure 17. $IP3_o$ versus Tone spacing over P_o

15 Application information



See Table 10 for a list of components.

Figure 18. Schematic of application board

Note: *pins n.c. (not connected) may be left floating*

Table 10. List of components

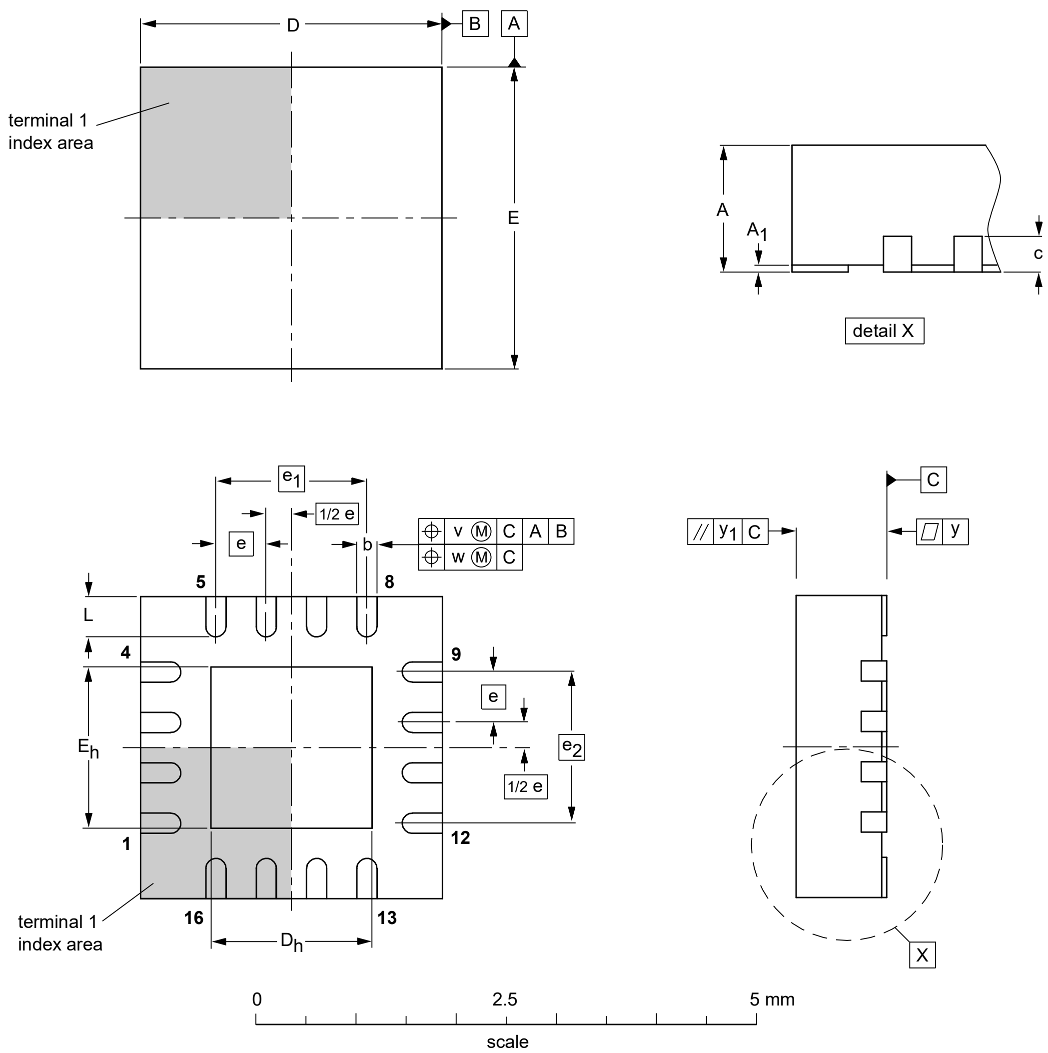
See Figure 18 for schematics.

Component	Description	Value	Remarks
Cin2, and Cin3	capacitor	18 pF	in a 50 Ω PCB track
C_{out}	capacitor	3.9 pF	in a 50 Ω PCB track
C11, and C21	capacitor	10 nF	recommended
C12, and C22 [1]	capacitor	1 µF	

[1] placement of C12 and C22 is optional

16 Package outline

HVQFN16: plastic thermal enhanced very thin quad flat package; no leads; 16 terminals; body 3 x 3 x 0.85 mm **SOT758-1**



DIMENSIONS (mm are the original dimensions)

UNIT	$A^{(1)}$ max.	A_1	b	c	$D^{(1)}$	D_h	$E^{(1)}$	E_h	e	e_1	e_2	L	v	w	y	y_1
mm	1	0.05 0.00	0.30 0.18	0.2	3.1 2.9	1.75 1.45	3.1 2.9	1.75 1.45	0.5	1.5	1.5	0.5 0.3	0.1	0.05	0.05	0.1

Note

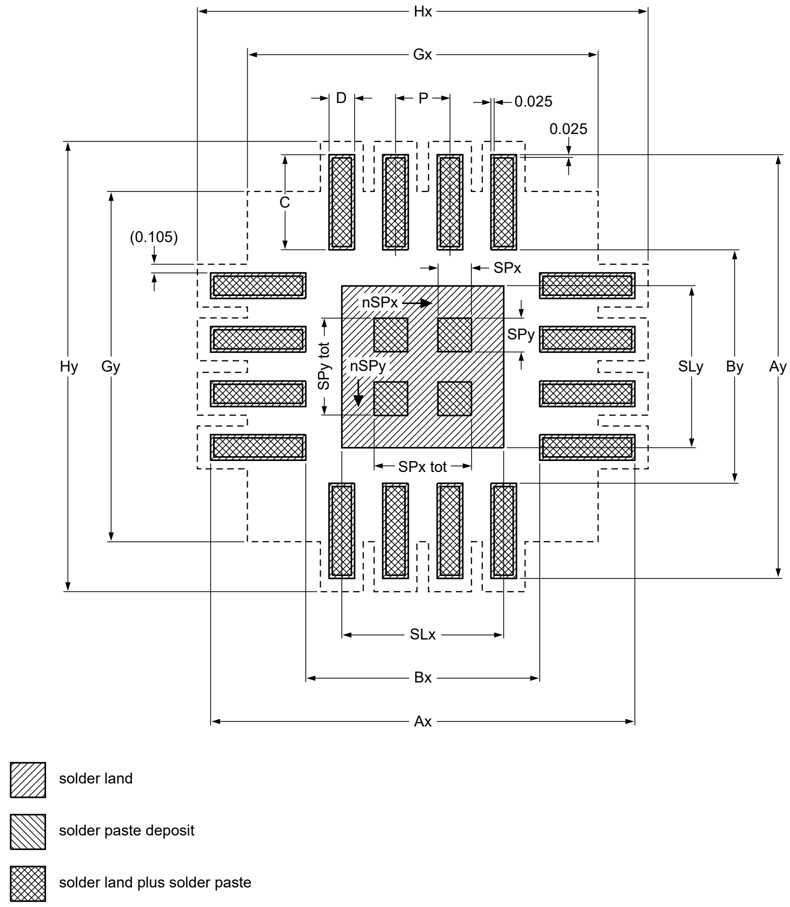
1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT758-1	- - -	MO-220	- - -			~~02-03-25~~ 02-10-21

Figure 19. Package outline SOT758-1 (HVQFN16)

16.1 Footprint and solder information

Footprint information for reflow soldering of HVQFN16 package SOT758-1



nSPx	nSPy
2	2

Dimensions in mm

P	Ax	Ay	Bx	By	C	D	SLx	SLy	SPx tot	SPy tot	SPx	SPy	Gx	Gy	Hx	Hy
0.50	4.00	4.00	2.20	2.20	0.90	0.24	1.50	1.50	0.90	0.90	0.30	0.30	3.30	3.30	4.25	4.25

Issue date ~~12-03-07~~ 12-03-08

sot758-1_fr

Figure 20. 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 11. Abbreviations

Acronym	Description
5G NR	5th generation new radio
ACLR	adjacent channel leakage ratio
CP-OFDM	cyclic prefix orthogonal frequency division multiplexing
CMMR	common mode rejection ratio
ESD	electrostatic discharge
mMIMO	massive multiple-input multiple-output
PA	power amplifier
RF	radio frequency
TDD	time-division duplexing

19 Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BTS6302U v.11	20220905	Product data sheet	202209004I	BTS6302U v.10
modification	• changed the maximum value of T_J in the Limiting values table to 175 °C			
BTS6302U v.10	20211026	Product data sheet	-	BTS6302U v.9
modification	• Updated the Application diagram with a ground symbol at pin 15 • Changed Typical, and Maximum value at $t_{s(pon)}$ • added footnote to G_p in characteristics table • changed status to product data sheet			
BTS6302U v.9	20210610	Preliminary data sheet	-	BTS6302U v.8
modification	• corrected label on X-axis, and Y-axis on figure 13, and 16 graphics • changed min max values on some parameters			
BTS6302U v.8	20210423	Preliminary data sheet	-	BTS6302U v.7.1
modification	• added graphics • changed min max values on some parameters • changed status from Objective to Preliminary data sheet			
BTS6302U v.7.1	20210331	Objective data sheet	-	BTS6302U v.6.3
modification	• added Min/Max values to most parameters			
BTS6302U v.6.3	20210319	Objective data sheet	-	BTS6302U v.6.2
modification	• changed remark on C11, and C21 in List of components table to, recommended			
BTS6302U v.6.2	20210318	Objective data sheet	-	BTS6302U v.6.1
modification	• corrected the legend for graphic on NF versus frequency over temperature			
BTS6302U v.6.1	20210317	Objective data sheet	-	BTS6302U v.6
modification	• added graphic on NF versus frequency over temperature			
BTS6302U v.6	20210126	Objective data sheet	-	BTS6302U v.5

Table 12. Revision history*...continued*

Document ID	Release date	Data sheet status	Change notice	Supersedes
modification	• changed Typical values on some parameters • added and changed conditions on some parameters			
BTS6302U v.5	20210126	Objective data sheet	-	BTS6302U v.4.1
modification	• changed ESD value on CMD to +/- 500 V			
BTS6302U v.4.1	20201125	Objective data sheet	-	BTS6302U v.4
modification	• added official drawing of the Functional diagram			
BTS6302U v.4	20201120	Objective data sheet	-	BTS6302U v.3
modification	• removed R16, and C16 from application schematic • added condition 4.2 GHz to 5 GHz to G_{flat}, and $t_{d(grp)}$ • changed values on some characteristics			
BTS6302U v.3	20200925	Objective data sheet	-	BTS6302U v.2
modification	• removed gain mode 2 • changed T_{case} max to 115 °C • changed I_{CC}, ON state, P_o = 15 dBm from 92 mA to 100 mA, and ON state, quiescent from 78 mA to 90 mA			
BTS6302U v.2	20200917	Objective data sheet	-	BTS6302U v.1.1
modification	• changed description of pin 15 to n.c. • added footprint information			
BTS6302U v.1.1	20200901	Objective data sheet	-	BTS6302U v.1
modification	• added official pin layout, and application diagram			
BTS6302U v.1	20200814	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.

20.2 Definitions

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