BTS6303U

Wideband high linearity pre-driver amplifier 2.3 GHz - 4.2 GHz

Rev. 5 — 18 October 2022

Product data sheet

1 General description

The BTS6303U 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 4.2 GHz. It is housed in a 3 mm x 3 mm x 0.85 mm 16-terminal HVQFN package. The amplifier is ESD protected on all terminals.

2 Features and benefits

- High saturated output power $P_{o(sat)}$ = 28 dBm, at 3.5 GHz
- High power gain G_p = 37 dB
- High linearity performance ACLR = -40 dBc
- Programmable bias current (via external resistor)
- Fast switching to support TDD systems
- 5 V single supply, quiescent current 67 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

Unless otherwise specified, the following settings are used for measurements: f = 3.5 GHz; V_{CC} = 5 V; T_{amb} = 25 °C; input and output 50 Ω; R_{SET} = 10 kΩ.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{CC}	supply current	ON state, P_o = 15 dBm	-	94	116	mA
		ON state, quiescent	-	67	87	mA
		OFF state	-	1	-	mA
G_p	power gain	ON state, f = 3.5 GHz	35	37.9	41.2	dB
		OFF state	-	-50	-	dB
$P_{o(sat)}$	saturated output power	f = 3.5 GHz	-	28	-	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	-	-40	-	dBc

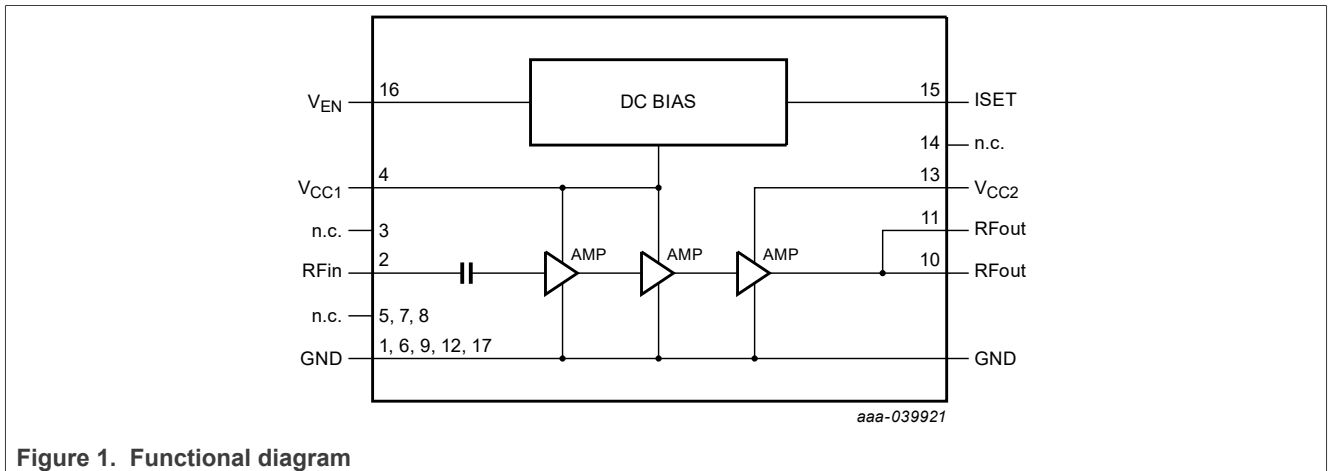## 5 Ordering information

Table 2. Ordering information

Type number	Orderable part number	Package			
		Name	Description		Version
BTS6303U	BTS6303UJ	HVQFN16	3 mm x 3 mm x 0.85 mm, 16 terminals no leads		SOT758-1

6 Marking

Table 3. Marking

Type number	Marking code
BTS6303U	33U

7 Functional diagram

Figure 1. Functional diagram
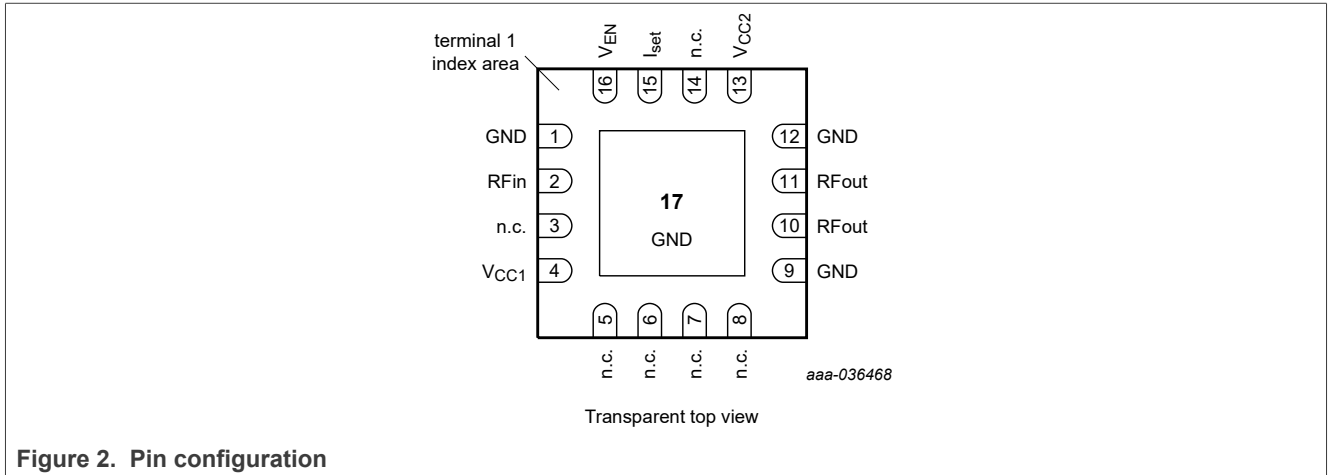
8 Pinning information

8.1 Pinning

Figure 2. Pin configuration

8.2 Pin description

Table 4. Pin description

Pin	Symbol	Description
1, 9, 12 and 17	GND	PCB ground
2	RFin	RF input
3	n.c.	PCB ground, or connect to RFin
5, 6, 7, 8 and 14	n.c. [1]	PCB ground
10 and 11	RFout	RF output; connect both to the same track
4	V_{CC1}	supply voltage
13	V_{CC2}	supply voltage
15	I_{set}	current set; connect to external resistor
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
$V_{I(set)}$	current set voltage		-0.3	4	V
$P_{i(RF)CW}$	continuous waveform RF input power	ON state, OFF state	-	10	dBm
T_{stg}	storage temperature		-50	150	°C
T_j	junction temperature		-	175	°C
MTTF	mean time to failure	at T_J = 165 °C	-	1.6E6	h
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		-	50	-	Ω
T_{case}	case temperature		-40	-	115	°C

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

12 Thermal characteristics

Table 8. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-case)}$	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.

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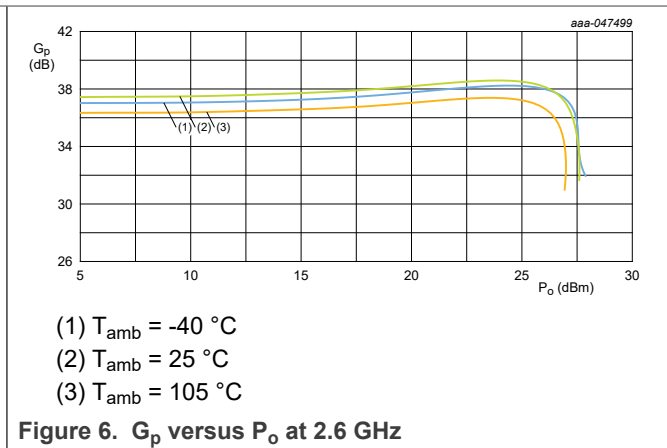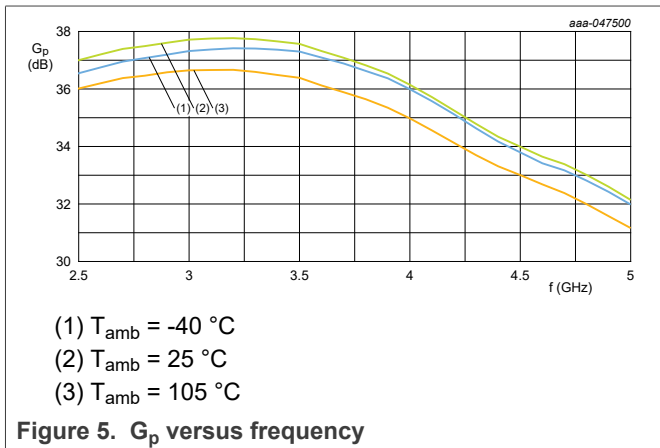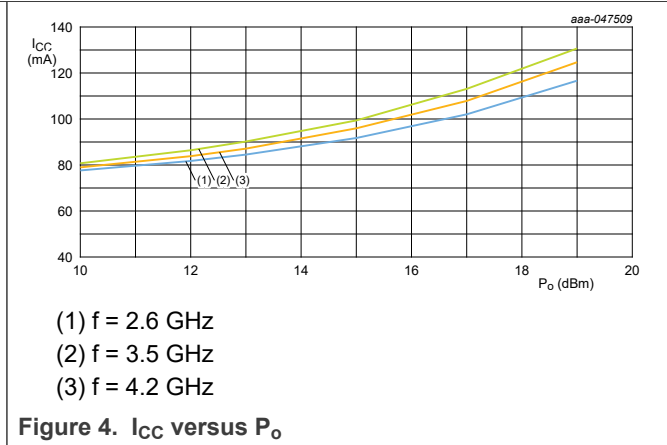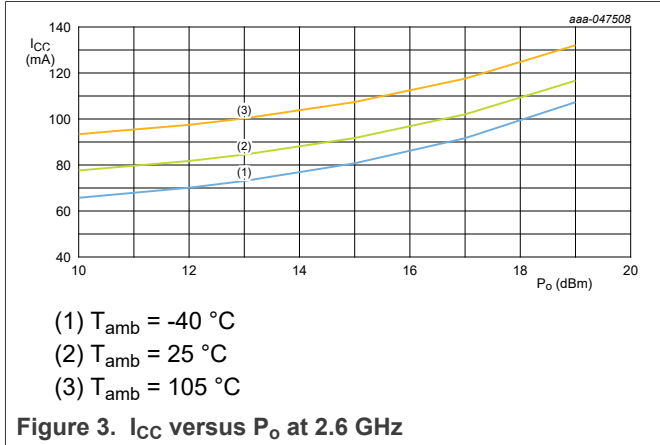**4 / 16**

13 Characteristics

Table 9. Characteristics

Unless otherwise specified, the following settings are used for measurements: f = 3.5 GHz; V_{CC} = 5 V; T_{amb} = 25 °C; input and output 50 Ω; R_{SET} = 10 kΩ; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{CC}	supply current	ON state, P_o = 15 dBm	-	94	116	mA
		ON state, quiescent	-	67	87	mA
		OFF state	-	1.1	-	mA
G_p	power gain	ON state				
		f = 2.6 GHz	34.3	36.3	39	dB
		f = 3.5 GHz	35	37.9	41.2	dB
		f = 4.2 GHz	32.2	34.6	39	dB
		OFF state	-	-50	-	dB
G_{flat}	gain flatness	f = 2.3 GHz to 2.7 GHz	-	0.9	-	dB
		f = 3.3 GHz to 3.8 GHz	-	0.9	-	dB
		f = 3.8 GHz to 4.2 GHz	-	1.6	-	dB
$t_{d(grp)}$	group delay time	f = 2.3 GHz to 2.7 GHz	-	0.3	-	ns
		f = 3.3 GHz to 3.8 GHz	-	0.3	-	ns
		f = 3.8 GHz to 4.2 GHz	-	0.3	-	ns
$P_{o(sat)}$	saturated output power	f = 2.6 GHz [1]	-	27.5	-	dBm
		f = 3.5 GHz [1]	-	28	-	dB
		f = 4.2 GHz [1]	-	26.9	-	dB
$P_{L(1dB)}$	output power at1 dB gain compression	f = 2.6 GHz	-	27.2	-	dBm
		f = 3.5 GHz	-	27.6	-	dBm
		f = 4.2 GHz	-	26.4	-	dBm
$IP3_o$	output third-order intercept point	2-tone; tone spacing = 100 MHz; P_o = 15 dBm	-	29.2	-	dBm
RL_i	input return loss		-	11.4	-	dB
RL_o	output return loss		-	10	-	dB
ISL_r	reverse isolation		-	49	-	dB
NF	noise figure	[2]	-	3.4	-	dB
$t_{s(pon)}$	power-on settling time	V_{EN} from LOW to HIGH to output power reaching 90 % of final power	-	0.12	-	µs
$t_{s(poff)}$	power-off settling time	V_{EN} from HIGH to LOW to output power reaching 10 % below initial power	-	0.06	-	µs
K	Rollett stability factor	1 MHz to 5 GHz	1	-	-	
ACLR	adjacent channel leakage ratio	CP-OFDM with 100 MHz channel BW, QPSK modulation, and 60 kHz SCS, fully allocated, P_o = 15 dBm	-	-40	-	dBc

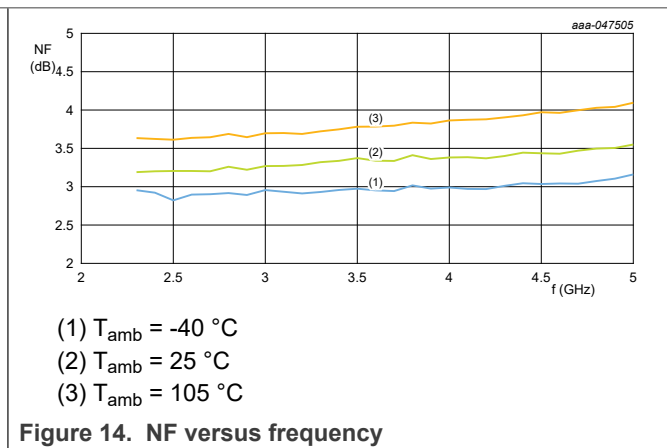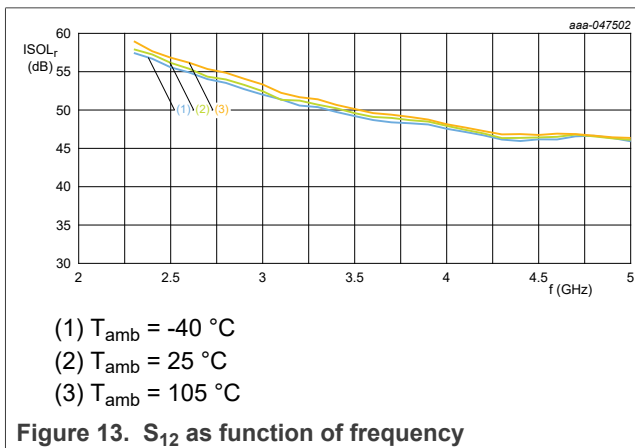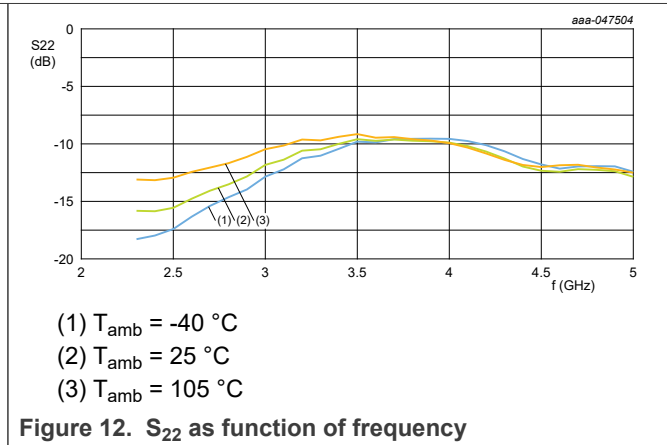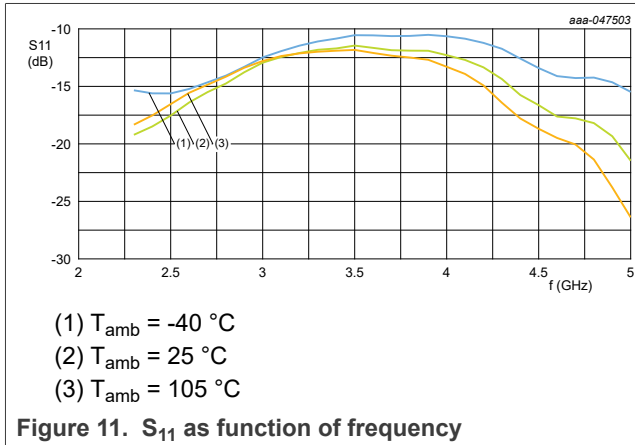[1] Connector and Printed-Circuit Board (PCB) losses have been de-embedded, 3 dB gain compression
[2] Connector and Printed-Circuit Board (PCB) losses have been de-embedded

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14 Graphs

(1) T_{amb} = -40 °C

(2) T_{amb} = 25 °C

(3) T_{amb} = 105 °C

Figure 3. I_{CC} versus P_o at 2.6 GHz

(1) f = 2.6 GHz

(2) f = 3.5 GHz

(3) f = 4.2 GHz

Figure 4. I_{CC} versus P_o

(1) T_{amb} = -40 °C

(2) T_{amb} = 25 °C

(3) T_{amb} = 105 °C

Figure 5. G_p versus frequency

(1) T_{amb} = -40 °C

(2) T_{amb} = 25 °C

(3) T_{amb} = 105 °C

Figure 6. G_p versus P_o at 2.6 GHz

(1) T_{amb} = -40 °C

(2) T_{amb} = 25 °C

(3) T_{amb} = 105 °C

Figure 7. G_p versus P_o at 3.5 GHz

(1) T_{amb} = -40 °C

(2) T_{amb} = 25 °C

(3) T_{amb} = 105 °C

Figure 8. G_p versus P_o at 4.2 GHz

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

Figure 9. $IP3_o$ versus frequency

(1) P_o = 12 dBm
(2) P_o = 15 dBm

Figure 10. $IP3_o$ versus Tone Spacing

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

Figure 11. S_{11} as function of frequency

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

Figure 12. S_{22} as function of frequency

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

Figure 13. S_{12} as function of frequency

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

Figure 14. NF versus frequency

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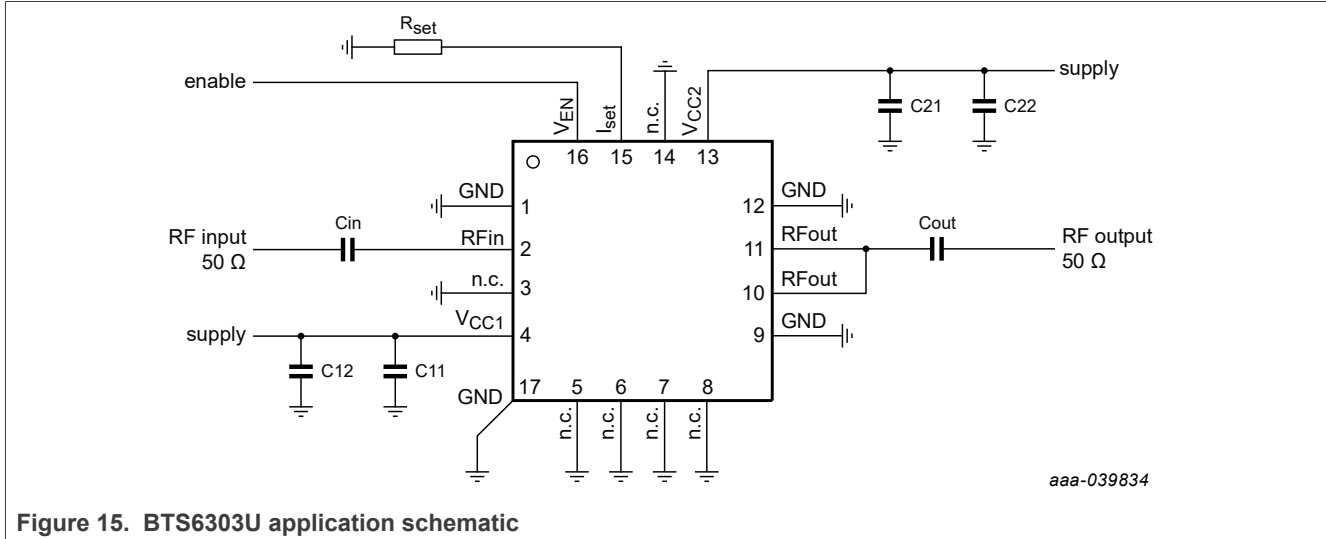## 15 Application information

Figure 15. BTS6303U application schematic

Table 10. List of components

See Figure 15 for schematics.

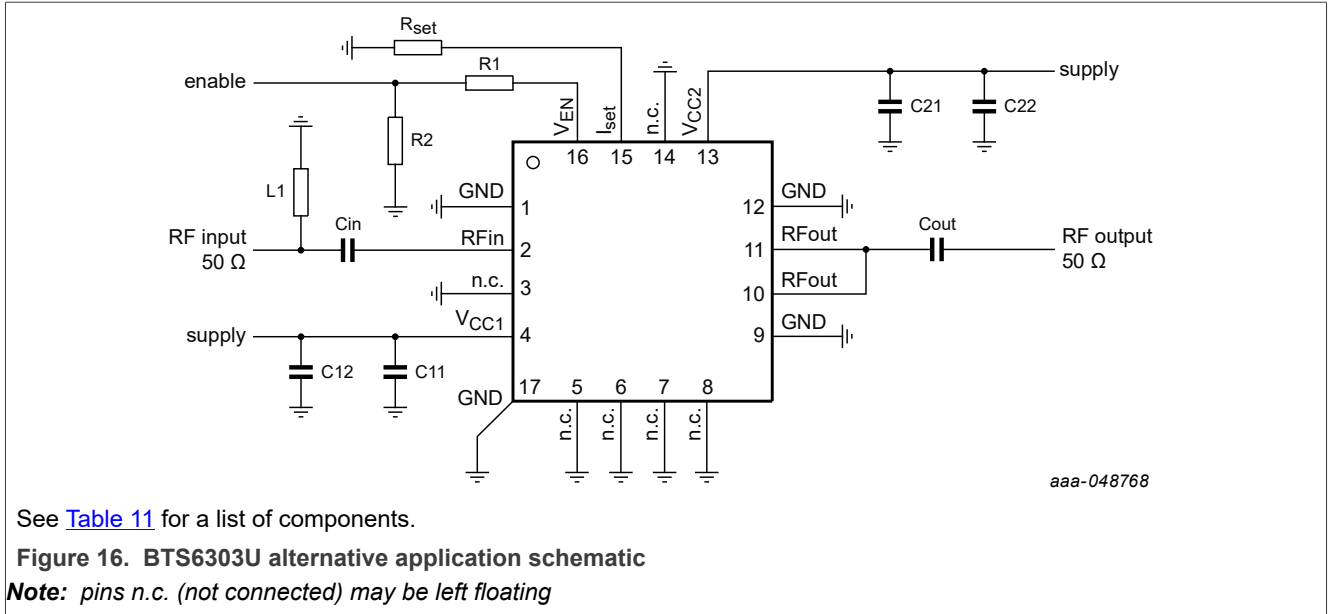| Component	Description	Value	Remarks
C_{in}	capacitor	3.3 pF	for DC blocking / matching
C_{out}	capacitor	18 pF	for DC blocking
C11, and C21	capacitor	10 nF	must be close (< 10 mm) to the IC
C12, and C22 [1]	capacitor	1 μF	must be close (< 10 mm) to the IC
RSET	resistor	10 KΩ	if lower resistor value is applied, a stability check is required

[1]   Optional

See Table 11 for a list of components.

Figure 16. BTS6303U alternative application schematic
Note: pins n.c. (not connected) may be left floating

Table 11. List of components
See *Figure 16* for schematics.

Component	Description	Value	Remarks
L1	inductor	3.3 nH	for optional matching / filtering
C_{in}	capacitor	3.3 pF	for DC blocking / matching
C_{out}	capacitor	18 pF	for DC blocking
C11, and C21	capacitor	10 nF	must be close (< 10 mm) to the IC
C12, and C22 [1]	capacitor	1 µF	must be close (< 10 mm) to the IC
RSET	resistor	10 KΩ	if lower resistor value is applied, a stability check is required
R1	resistor	5 KΩ	for EN pin protection
R2	resistor	100 KΩ	optional for EN pin protection

[1] 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
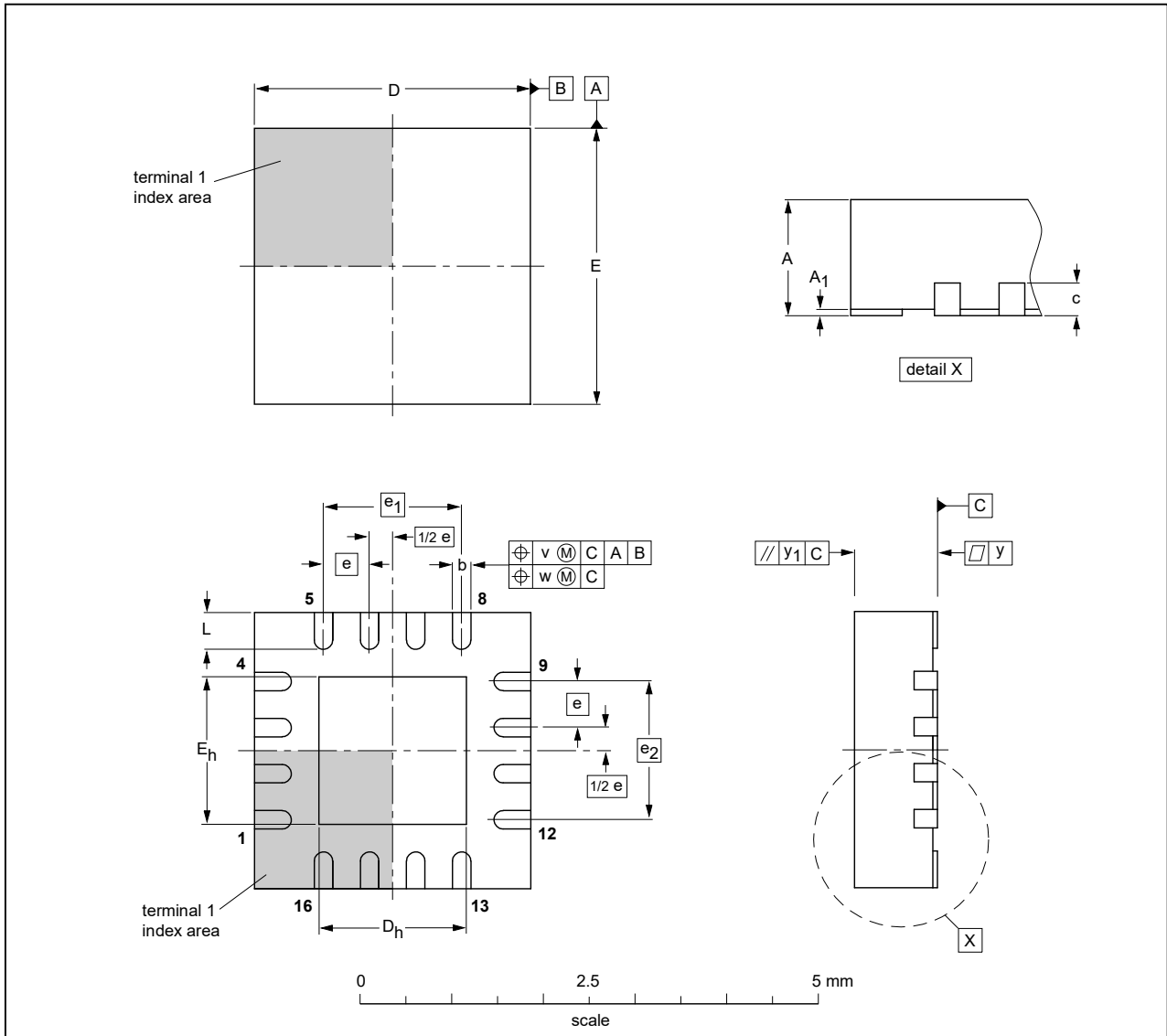
DIMENSIONS (mm are the original dimensions)

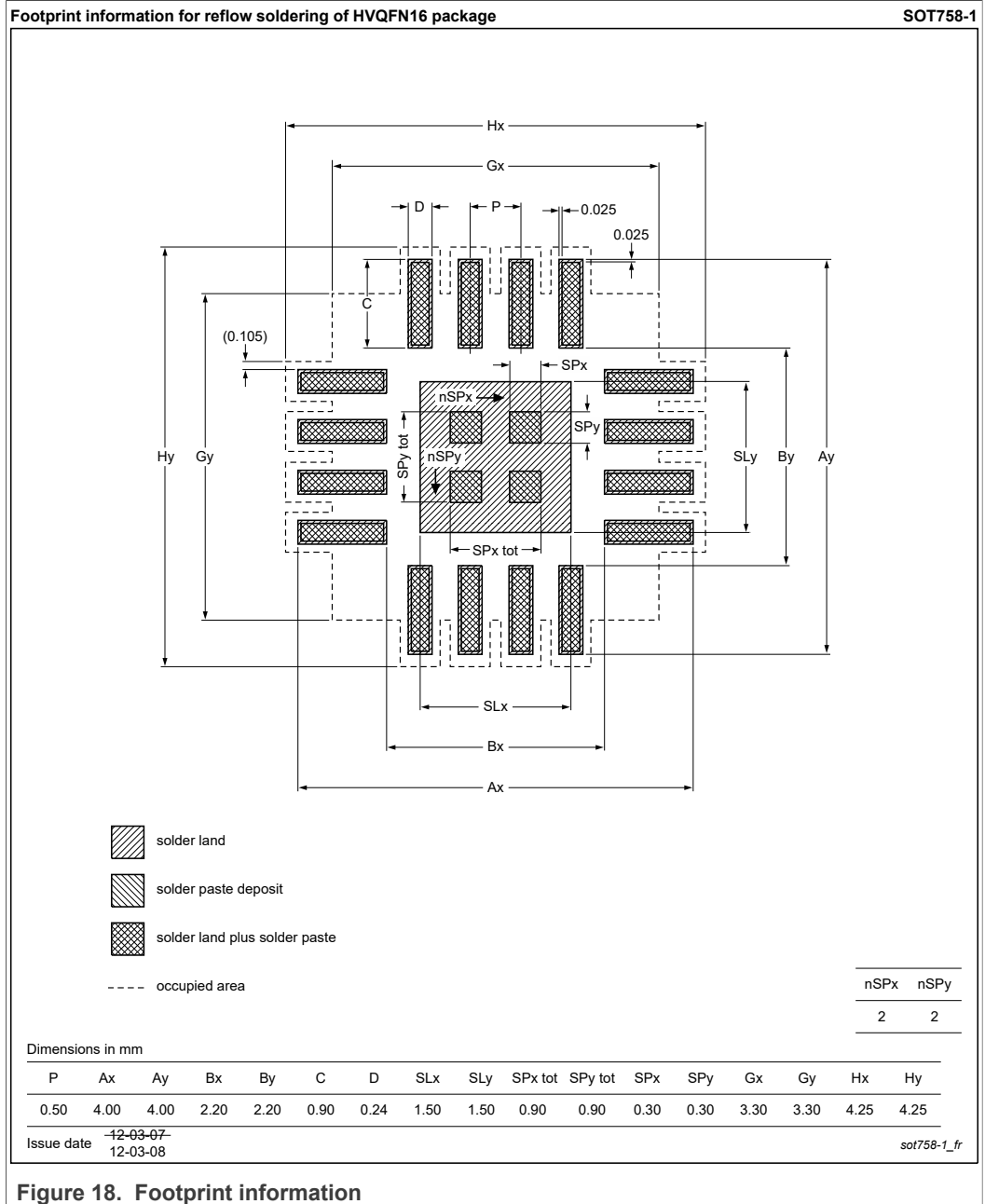| UNIT	A[1] max.	A₁	b	c	D[1]	Dₕ	E[1]	Eₕ	e	e₁	e₂	L	v	w	y	y₁
mm	1	0.05 0.00	0.30 0.18	0.2	3.1 2.9	1.75 1.45	3.1 2.9	1.75 1.45	0.5	1.5	1.5	0.5 0.3	0.1	0.05	0.05	0.1

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 17. 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 18. 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 12. Abbreviations

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

19 Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BTS6303U V.5	20221018	Product data sheet	-	BTS6303U V.4.1
modification	• added graphs • changed status to Product data sheet • changed security status to public (no security status on the pdf) • added MTTF to the Limiting values • updated values for power gain • added alternative application information			
BTS6303U V.4.1	20220411	Preliminary data sheet	-	BTS6303U V.4
modification	• Corrected the revision number on the first page. The number was not in line with the revision history			
BTS6303U V.4	20220411	Preliminary data sheet	-	BTS6303U V.3
modification	• changed values on several parameters			
BTS6303U V.3	20211110	Preliminary data sheet	-	BTS6303U V.2
modification	• changed status to Preliminary data sheet • changed value on several parameters			
BTS6303U V.2	20210326	Objective data sheet	-	BTS6303U V.1.2
modification	• changed Typical value on some characteristics • changed ESD value on CDM from +/-1 KV to +/-500 V • changed R$_{SET}$ to 10 KΩ • changed remarks on the capacitors in the List of components table • changed condition on K factor in the Characteristics table			
BTS6303U V.1.2	20201125	Objective data sheet	-	BTS6303U V.1.1
modification	• added official drawing of the Functional diagram			
BTS6303U V.1.1	20201120	Objective data sheet	-	BTS6303U V.1

Table 13. Revision history...*continued*

Document ID	Release date	Data sheet status	Change notice	Supersedes
modification	• changed values on some characteristics • added condition 3.8 GHz to 4.2 GHz to G_{flat}, and $t_{d(grp)}$			
BTS6303U V.1	20201118	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".
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