



# BTS6403U

Wideband high gain high linearity pre-driver amplifier

2.3 GHz - 4.2 GHz

Rev. 3 — 31 January 2023

Product data sheet

## 1 General description

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The BTS6403U is a wideband, high gain, high linearity pre-driver amplifier for 5G massive MIMO infrastructure applications, with fast on-off switching to support TDD systems. The BTS6403U is designed to operate between 2.3 GHz and 4.2 GHz. The BTS6403U is housed in a 3 mm x 3 mm x 0.85 mm 16-terminal HVQFN16 package.

The amplifier is ESD protected on all terminals.

## 2 Features and benefits

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- High saturated output power  $P_{o(sat)} = 29.5$  dBm
- High power-gain  $G_p = 38.5$  dB
- High linearity performance ACLR = -45 dBc
- Unconditionally stable
- Fast switching to support TDD systems
- 5 V single supply, quiescent current 100 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

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- 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:  $f = 3.5 \text{ GHz}$ ;  $V_{CC} = 5 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ ; input  $50 \text{ } \Omega$ , and output  $50 \text{ } \Omega$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC}$	supply current	ON state, $P_o = 15 \text{ dBm}$	-	122	150	mA
		ON state, quiescent	-	100	125	mA
		OFF state	-	1.2	2.5	mA
$G_p$	power gain	On state	35	38.5	-	dB
		OFF state	-	-49	-	dB
$P_{o(sat)}$	saturated output power	[1]	26.5	29.5	-	dBm
ACLR	adjacent channel leakage ratio	CP-OFDM with 100 MHz channel BW, QPSK modulation, and 60 kHz SCS, fully allocated, $P_o = 15 \text{ dBm}$	-	-45	-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**

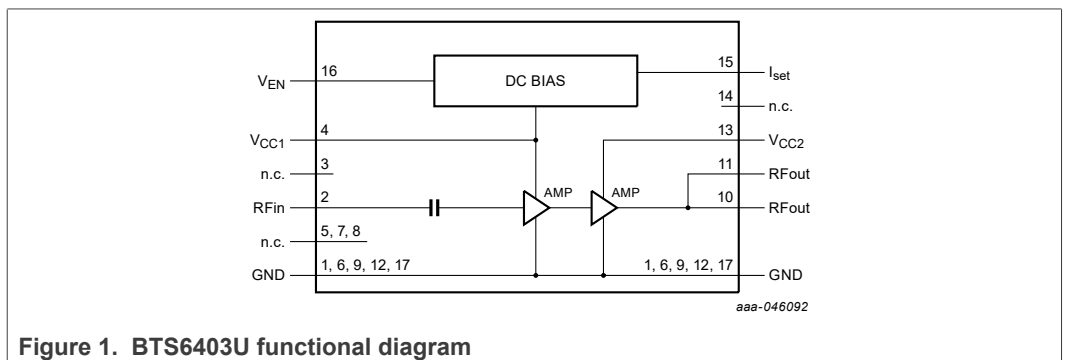
Type number	Orderable part number	Package		
		Name	Description	Version
BTS6403U	BTS6403UJ	HVQFN16	plastic thermal enhanced very thin quad flat package, no leads, 16 terminals, body 3 x 3 x 0.85 mm	SOT758-1

## 6 Marking

**Table 3. Marking**

Type number	Marking code
BTS6403U	43U

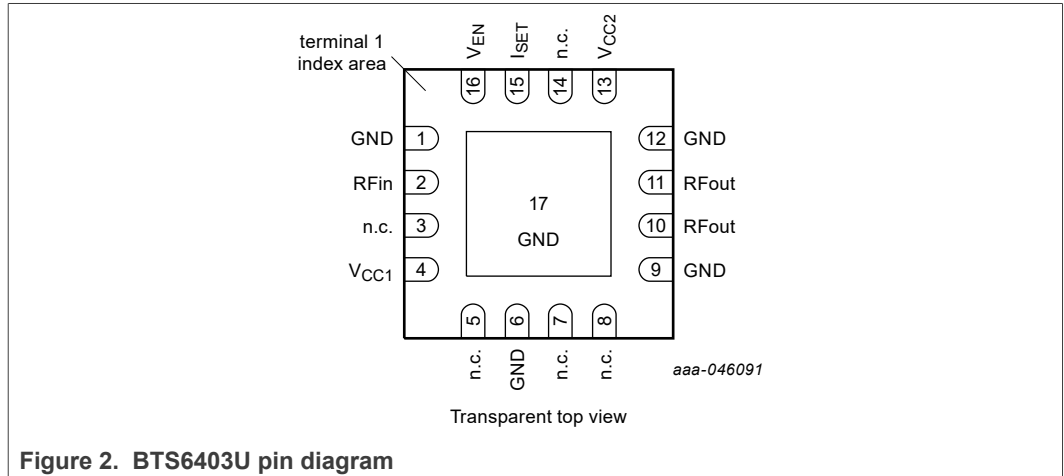
## 7 Functional diagram



**Figure 1. BTS6403U functional diagram**

## 8 Pinning information

### 8.1 Pin diagram



### 8.2 Pin description

Table 4. Pin description

Pin	Symbol	Description
1, 6, 9, 12, and 17	GND	PCB ground
2	RF <sub>in</sub>	RF input
4	V <sub>CC1</sub>	supply voltage
3, 5, 7, 8 and 14	n.c. <sup>[1]</sup>	not connected
10 and 11	RF <sub>out</sub>	RF output
13	V <sub>CC2</sub>	supply voltage
15	I <sub>set</sub>	Current set; connect to an external resistor
16	V <sub>EN</sub>	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 the application.

## 9 Functional description

**Table 5. Shutdown control**

V <sub>EN</sub>	voltage applied at pin V <sub>EN</sub> <sup>[1]</sup>	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<sub>EN</sub> can only be made HIGH, after supply voltage has been applied to pin V<sub>CC1</sub>.

## 10 Limiting values

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

**Table 6. Limiting values**

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>CC</sub>	supply voltage		-0.3	6	V
V <sub>EN</sub>	enable voltage		-0.3	4	V
P <sub>I(RF)CW</sub>	continuous waveform RF input power	ON state, OFF state	-	10	dBm
T <sub>stg</sub>	storage temperature		-40	150	°C
T <sub>j</sub>	junction temperature		-	175	°C
V <sub>ESD</sub>	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 <sub>CC</sub>	supply voltage	<sup>[1]</sup>	4.75	5	5.25	V
V <sub>IL</sub>	LOW-level input voltage		0	-	0.6	V
V <sub>IH</sub>	HIGH-level input voltage		1.2	-	3.6	V
V <sub>I(max)</sub>	maximum input voltage		-	-	3.6	V
Z <sub>0</sub>	characteristic impedance		-	50	-	Ω
T <sub>case</sub>	Case temperature		-40		115	°C

[1] Supply voltage at V<sub>CC1</sub> must be applied before, or at the same time as applying supply voltage to pin V<sub>CC2</sub>.

## 12 Thermal characteristics

**Table 8. Thermal characteristics**

Symbol	Parameter	Conditions	Typ	Unit
R <sub>th(j-case)</sub>	junction to case thermal resistance	<sup>[1]</sup> <sup>[2]</sup>	50	K/W

[1] case is ground solder pad

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

[2] thermal resistance determined with device mounted, and device bottom case kept at constant temperature

### 13 Characteristics

**Table 9. Characteristics**

Unless otherwise specified, the following settings are used for measurements:  $f = 3.5 \text{ GHz}$ ;  $V_{CC} = 5 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ ; input  $50 \text{ } \Omega$ , and output  $50 \text{ } \Omega$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC}$	supply current	ON state, $P_o = 15 \text{ dBm}$	-	122	150	mA
		ON state, quiescent	-	100	125	mA
		OFF state	-	1.2	2.5	mA
$G_p$	power gain	ON state				
		$f = 2.6 \text{ GHz}$	36.5	39.0	42.0	dB
		$f = 3.5 \text{ GHz}$	35.0	38.5	40.5	dB
		$f = 4.2 \text{ GHz}$	33.5	36.5	39.0	dB
		OFF state	-	-49.0	-	dB
$G_{flat}$	gain flatness	$f = 2.3 \text{ GHz to } 2.7 \text{ GHz}$	-	1.0	-	dB
		$f = 3.3 \text{ GHz to } 3.8 \text{ GHz}$	-	1.1	-	dB
		$f = 3.8 \text{ GHz to } 4.2 \text{ GHz}$	-	1.0	-	dB
$t_{d(grp)}$	group delay time	$f = 2.3 \text{ GHz to } 2.7 \text{ GHz}$	-	0.4	-	ns
		$f = 3.3 \text{ GHz to } 3.8 \text{ GHz}$	-	0.4	-	ns
		$f = 3.8 \text{ GHz to } 4.2 \text{ GHz}$	-	0.4	-	ns
$P_{o(sat)}$	saturated output power	$f = 2.6 \text{ GHz}$ [1]	-	29.0	-	dBm
		$f = 3.5 \text{ GHz}$ [1]	26.5	29.5	-	dBm
		$f = 4.2 \text{ GHz}$ [1]	-	28.5	-	dBm
$P_{L(1dB)}$	output power at 1 dB gain compression	$f = 2.6 \text{ GHz}$	-	28.0	-	dBm
		$f = 3.5 \text{ GHz}$	-	29.0	-	dBm
		$f = 4.2 \text{ GHz}$	-	28.0	-	dBm
$IP3_o$	output third-order intercept point	2-tone; tone spacing = 100 MHz; $P_o = 15 \text{ dBm}$	-	34.5	-	dBm
$RL_i$	input return loss	$f = 3.5 \text{ GHz}$	10.0	15.0	-	dB
$RL_o$	output return loss	$f = 3.5 \text{ GHz}$	10.0	21.0	-	dB
$ISL_r$	reverse isolation		-	57.0	-	dB
NF	noise figure	$f = 3.5 \text{ GHz}$ [2]	-	4.1		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	-	0.7	0.8	$\mu\text{s}$
$t_{s(poff)}$	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	$\mu\text{s}$
K	Rollett stability factor	1 MHz to 15 GHz	1.8	-	-	
ACLR	adjacent channel leakage ratio	CP-OFDM with 100 MHz channel BW, QPSK modulation, and 60 kHz SCS, fully allocated, $P_o = 15 \text{ dBm}$	-	-45.0	-40.0	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.

## 14 Application information

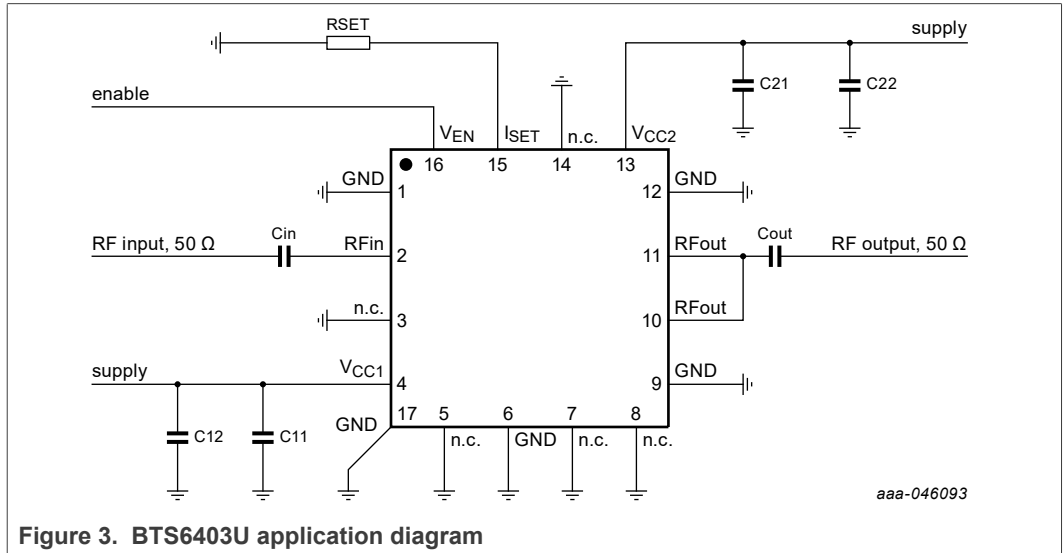


Figure 3. BTS6403U application diagram

Table 10. List of components

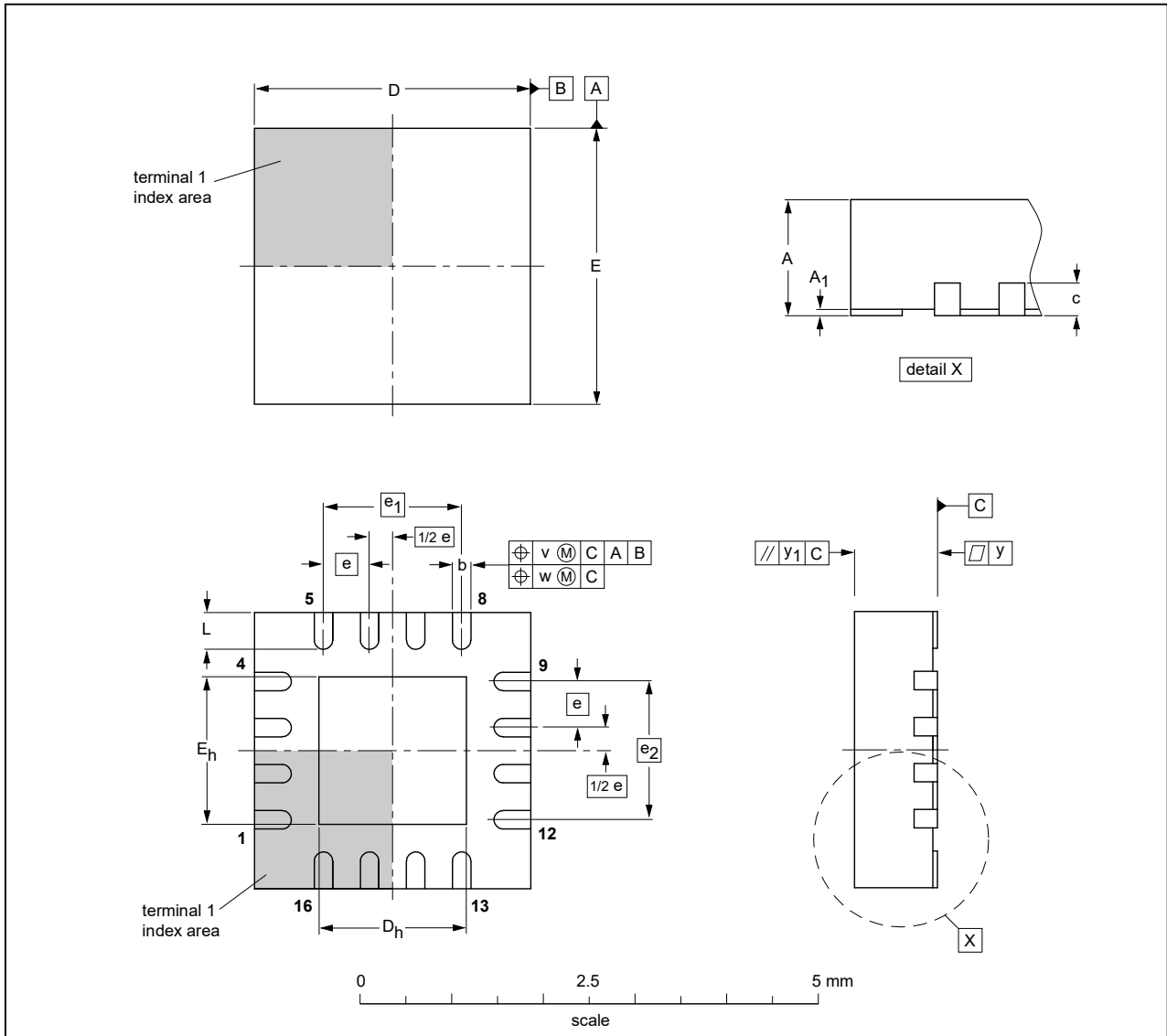
Component	Description	Value	Remarks
Cin	capacitor	18 pF	in a 50 Ω PCB track
Cout	capacitor	3.9 pF	in a 50 Ω PCB track
C11, and C21	capacitor	10 nF	recommended
C12, and C22 <sup>[1]</sup>	capacitor	10 μF	
RSET	resistor	10kΩ	default

[1] Placement of C12 and C22 is optional.

15 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 <sup>(1)</sup> max.	A <sub>1</sub>	b	c	D <sup>(1)</sup>	D <sub>h</sub>	E <sup>(1)</sup>	E <sub>h</sub>	e	e <sub>1</sub>	e <sub>2</sub>	L	v	w	y	y <sub>1</sub>
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

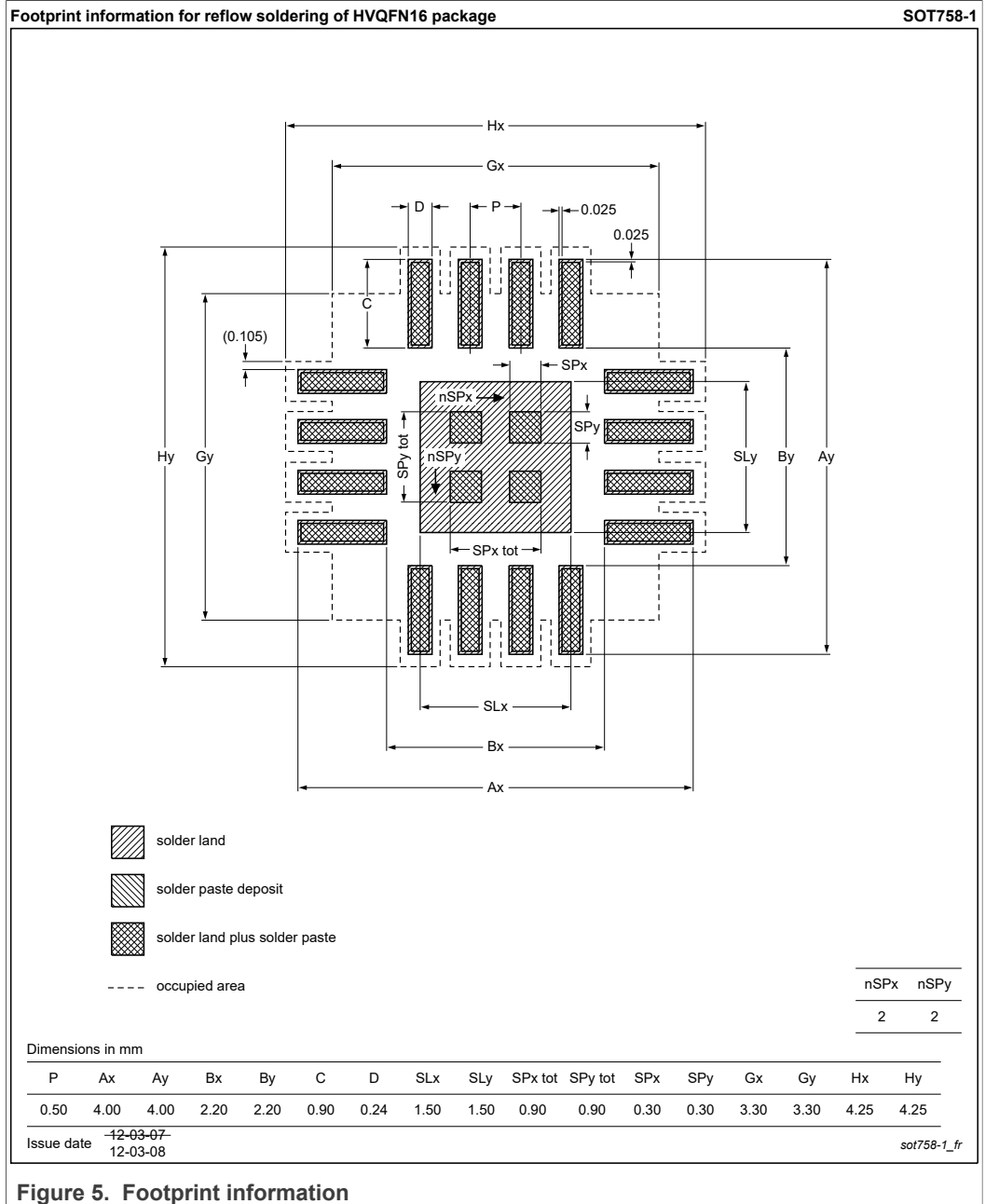
Note

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 4. Package outline SOT758-1 (HVQFN16)

**15.1 Footprint and solder information**



**Figure 5. Footprint information**

**16 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.



## 17 Abbreviations

Table 11. Abbreviations

Acronym	Description
5G NR	fifth 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

## 18 Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BTS6403U v.4	20230131	Product data sheet	-	BTS6403U v.3
	<ul style="list-style-type: none"> <li>Changed status from Company confidential to public</li> </ul>			
BTS6403U v.3	20230111	Product data sheet	-	BTS6403U v.2
modification	<ul style="list-style-type: none"> <li>updated table 1</li> <li>updated table 7</li> <li>updated table 9</li> <li>updated pin description, pin 3 is not connected and pin 6 is grounded</li> </ul>			
BTS6403U v.2	20220624	Preliminary data sheet	-	BTS6403U v.1
modification	<ul style="list-style-type: none"> <li>updated the drawings</li> <li>updated the value of some parameters</li> <li>changed the status to Preliminary</li> </ul>			
BTS6403U v.1	20220420	Objective data sheet	-	-

## 19 Legal information

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Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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.
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