

# BTS6403U

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

Rev. 7 — 9 May 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:  $f = 3.5\text{ GHz}$ ;  $V_{CC} = 5\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; input  $50\ \Omega$ , and output  $50\ \Omega$ .

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**

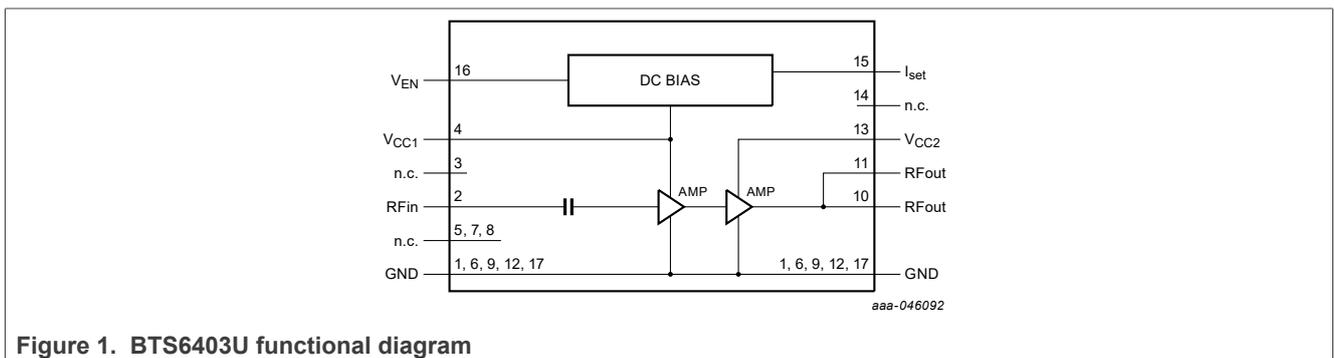
Type number	Orderable part number	Package		
		Name	Description	Version
BTS6403U	BTS6403UJ	HVQFN16	plastic thermal enhanced very thin quad flat package, no leads, 16 terminals, body 3 x 3 x 0.85 mm	SOT758-1

## 6 Marking

**Table 3. Marking**

Type number	Marking code
BTS6403U	43U

## 7 Functional diagram



## 8 Pinning information

### 8.1 Pin diagram

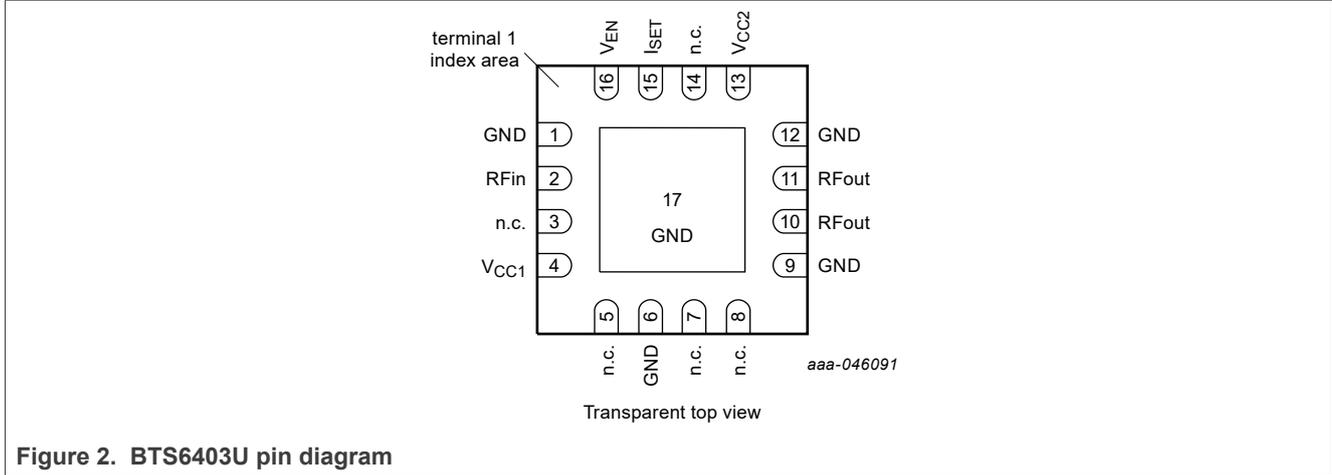


Figure 2. BTS6403U pin diagram

### 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		-50	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		120	°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
$R_{th(j-case)}$	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

## 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 50  $\Omega$ , and output 50  $\Omega$ .

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC}$	supply current	ON state, $P_o = 15$ dBm	-	122	150	mA
		ON state, quiescent	-	100	125	mA
		OFF state	-	1.2	2.5	mA
$G_p$	power gain	ON state				
		$f = 2.6$ GHz	36.5	39.0	42.0	dB
		$f = 3.5$ GHz	35.0	38.5	40.5	dB
		$f = 4.2$ GHz	33.5	36.5	39.0	dB
		OFF state	-	-49.0	-	dB
$G_{flat}$	gain flatness	$f = 2.3$ GHz to 2.7 GHz	-	1.0	-	dB
		$f = 3.3$ GHz to 3.8 GHz	-	1.1	-	dB
		$f = 3.8$ GHz to 4.2 GHz	-	1.0	-	dB
$t_{d(grp)}$	group delay time	$f = 2.3$ GHz to 2.7 GHz	-	0.4	-	ns
		$f = 3.3$ GHz to 3.8 GHz	-	0.4	-	ns
		$f = 3.8$ GHz to 4.2 GHz	-	0.4	-	ns
$P_{o(sat)}$	saturated output power	$f = 2.6$ GHz [1]	-	29.0	-	dBm
		$f = 3.5$ GHz [1]	26.5	29.5	-	dBm
		$f = 4.2$ GHz [1]	-	28.5	-	dBm
$P_{L(1dB)}$	output power at 1 dB gain compression	$f = 2.6$ GHz	-	28.0	-	dBm
		$f = 3.5$ GHz	-	29.0	-	dBm
		$f = 4.2$ GHz	-	28.0	-	dBm
$IP3_o$	output third-order intercept point	2-tone; tone spacing = 100 MHz; $P_o = 15$ dBm	-	34.5	-	dBm
$RL_i$	input return loss	$f = 3.5$ GHz	10.0	15.0	-	dB
$RL_o$	output return loss	$f = 3.5$ GHz	10.0	21.0	-	dB
$ISL_r$	reverse isolation		-	57.0	-	dB
NF	noise figure	$f = 3.5$ 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	$\mu$ s

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

Table 9. Characteristics...continued

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
$t_{s(\text{poff})}$	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 Graphs

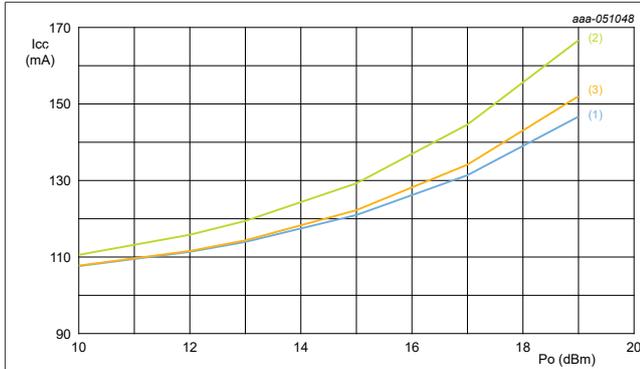


Figure 3.  $I_{CC}$  versus  $P_{out}$  over frequency at  $25 \text{ }^\circ\text{C}$   
 (1)  $f = 2.6 \text{ GHz}$   
 (2)  $f = 3.5 \text{ GHz}$   
 (3)  $f = 4.2 \text{ GHz}$

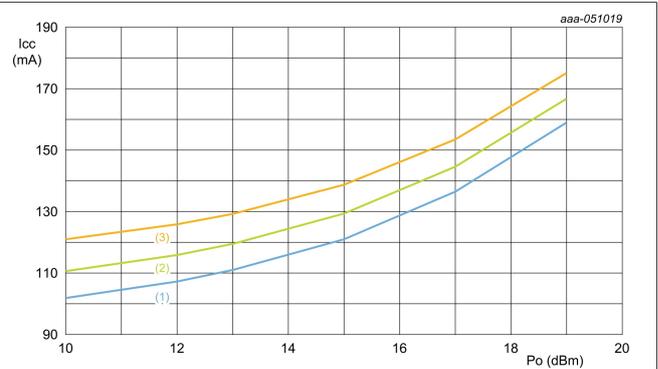


Figure 4.  $I_{CC}$  versus  $P_{out}$  over temperature at  $3.5 \text{ GHz}$   
 (1)  $T_{case} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{case} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{case} = 115 \text{ }^\circ\text{C}$

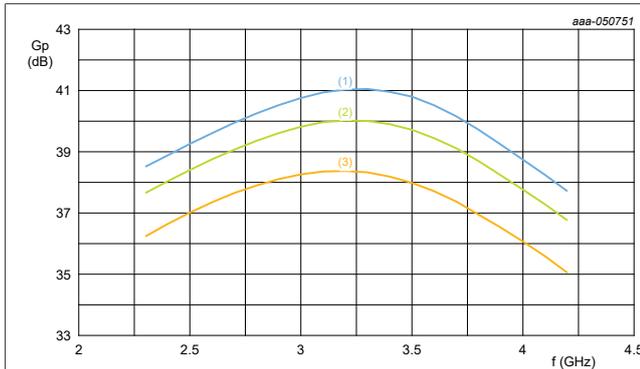


Figure 5. Gain versus frequency over temperature  
 (1)  $T_{case} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{case} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{case} = 115 \text{ }^\circ\text{C}$

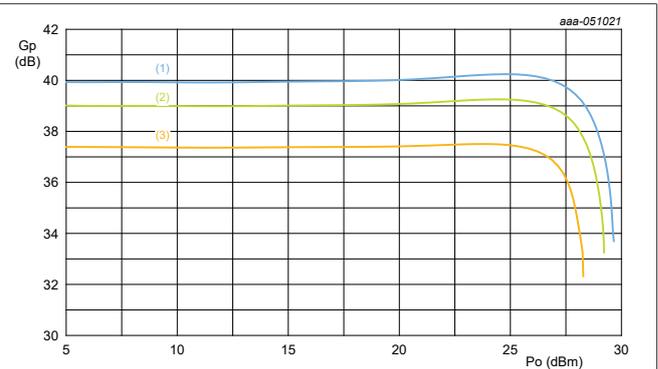
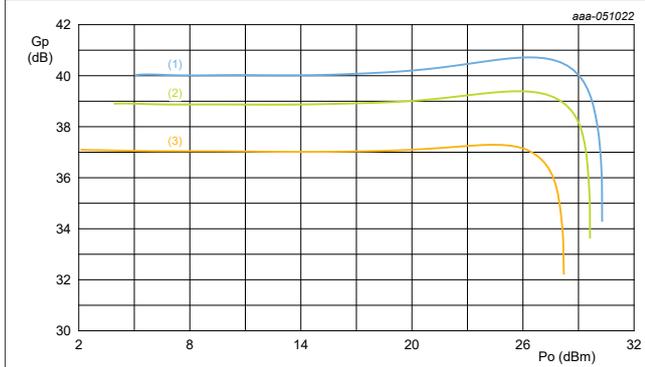
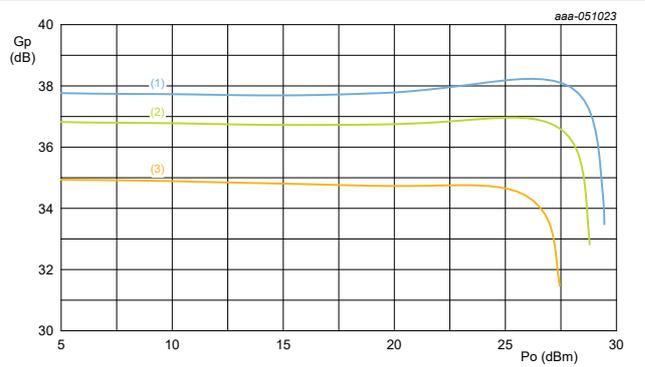


Figure 6. Gain versus  $P_{out}$  over temperature at  $2.6 \text{ GHz}$   
 (1)  $T_{case} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{case} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{case} = 115 \text{ }^\circ\text{C}$

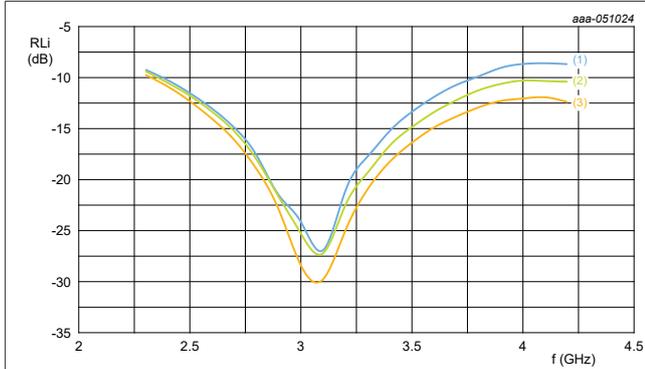
Wideband high gain high linearity pre-driver amplifier 2.3 GHz - 4.2 GHz



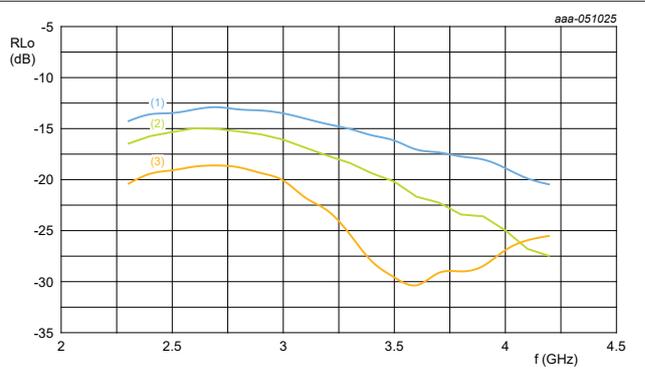
**Figure 7. Gain versus  $P_{out}$  over temperature at 3.5 GHz**  
 (1)  $T_{case} = -40\text{ }^{\circ}\text{C}$   
 (2)  $T_{case} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{case} = 115\text{ }^{\circ}\text{C}$



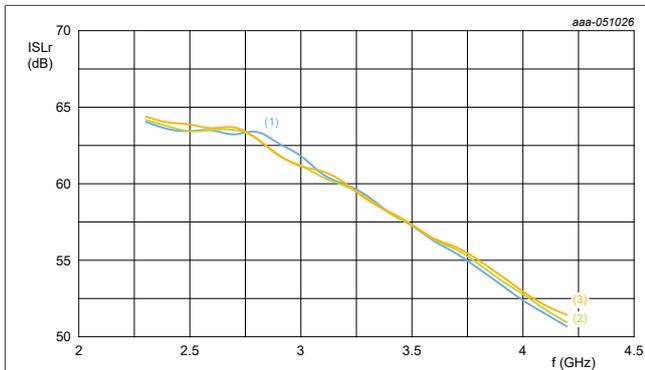
**Figure 8. Gain versus  $P_{out}$  over temperature at 4.2 GHz**  
 (1)  $T_{case} = -40\text{ }^{\circ}\text{C}$   
 (2)  $T_{case} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{case} = 115\text{ }^{\circ}\text{C}$



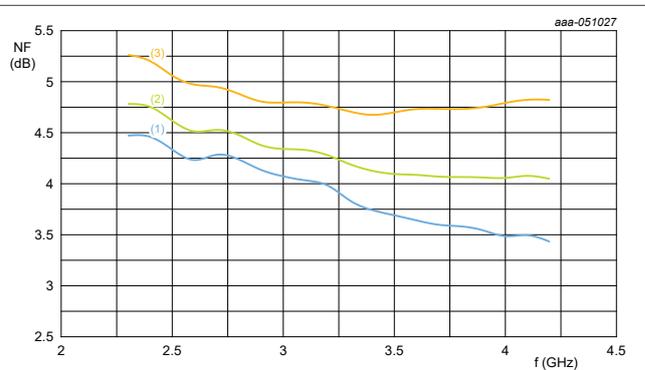
**Figure 9.  $S_{11}$  versus frequency over temperature**  
 (1)  $T_{case} = -40\text{ }^{\circ}\text{C}$   
 (2)  $T_{case} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{case} = 115\text{ }^{\circ}\text{C}$



**Figure 10.  $S_{22}$  versus frequency over temperature**  
 (1)  $T_{case} = -40\text{ }^{\circ}\text{C}$   
 (2)  $T_{case} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{case} = 115\text{ }^{\circ}\text{C}$

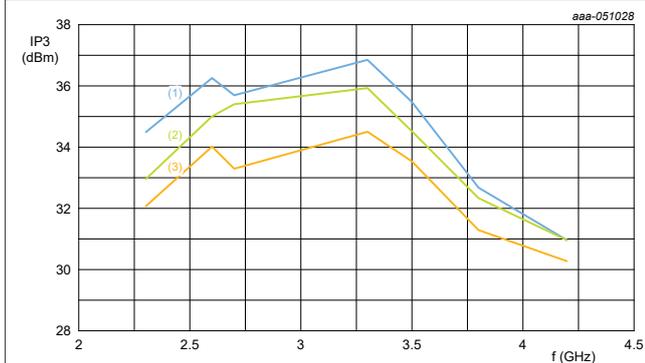


**Figure 11. Isolation versus frequency over temperature**  
 (1)  $T_{case} = -40\text{ }^{\circ}\text{C}$   
 (2)  $T_{case} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{case} = 115\text{ }^{\circ}\text{C}$

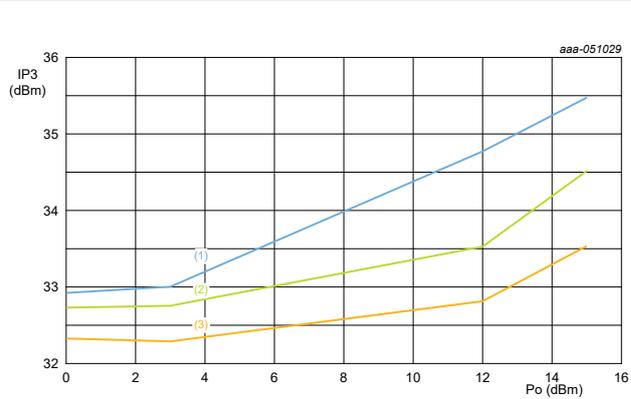


**Figure 12. NF versus frequency over temperature**  
 (1)  $T_{case} = -40\text{ }^{\circ}\text{C}$   
 (2)  $T_{case} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{case} = 115\text{ }^{\circ}\text{C}$

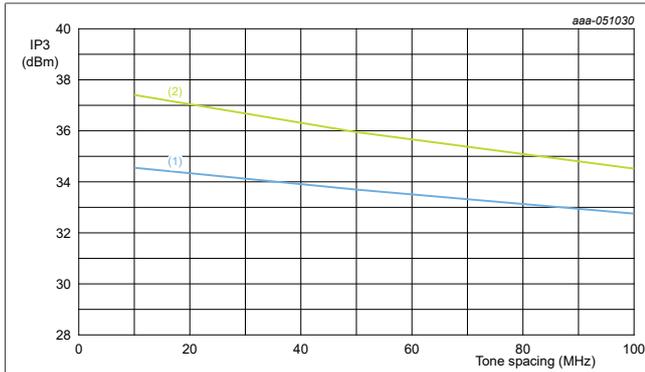
Wideband high gain high linearity pre-driver amplifier 2.3 GHz - 4.2 GHz



**Figure 13. IP3 versus frequency over temperature**  
 (1)  $T_{case} = -40\text{ °C}$   
 (2)  $T_{case} = 25\text{ °C}$   
 (3)  $T_{case} = 115\text{ °C}$



**Figure 14. IP3 versus  $P_{out}$  over temperature at 3.5 GHz**  
 (1)  $P_o = 3\text{ dBm}$   
 (2)  $P_o = 15\text{ dBm}$



**Figure 15. IP3 versus tone spacing over  $P_{out}$**   
 (1)  $T_{case} = -40\text{ °C}$   
 (2)  $T_{case} = 25\text{ °C}$   
 (3)  $T_{case} = 115\text{ °C}$

### 15 Application information

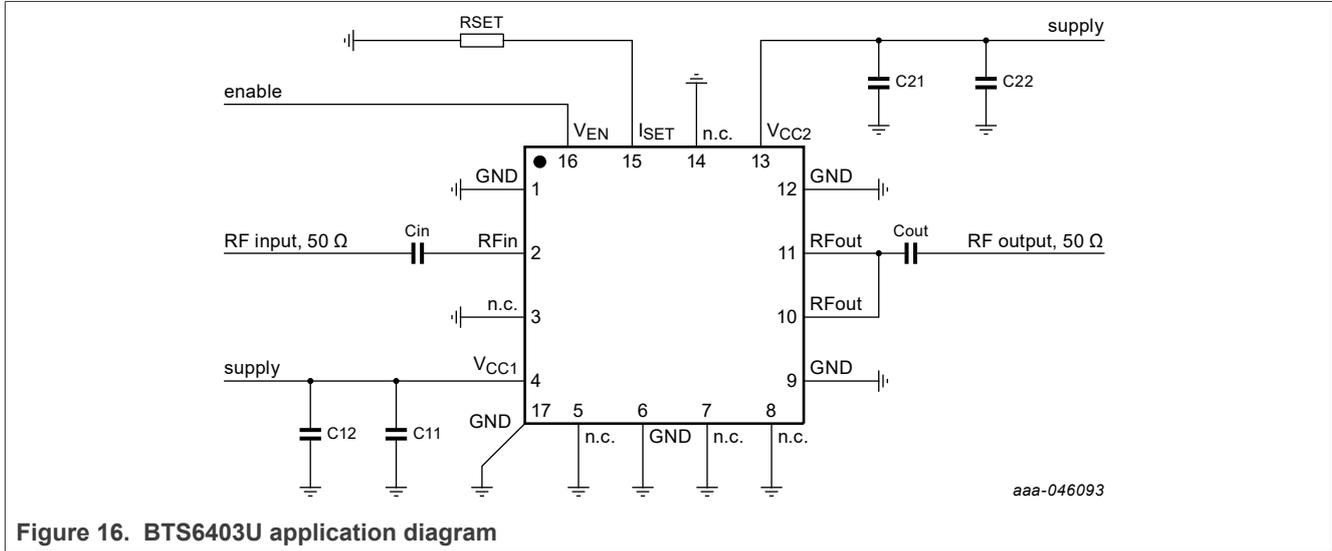


Figure 16. BTS6403U application diagram

Table 10. List of components

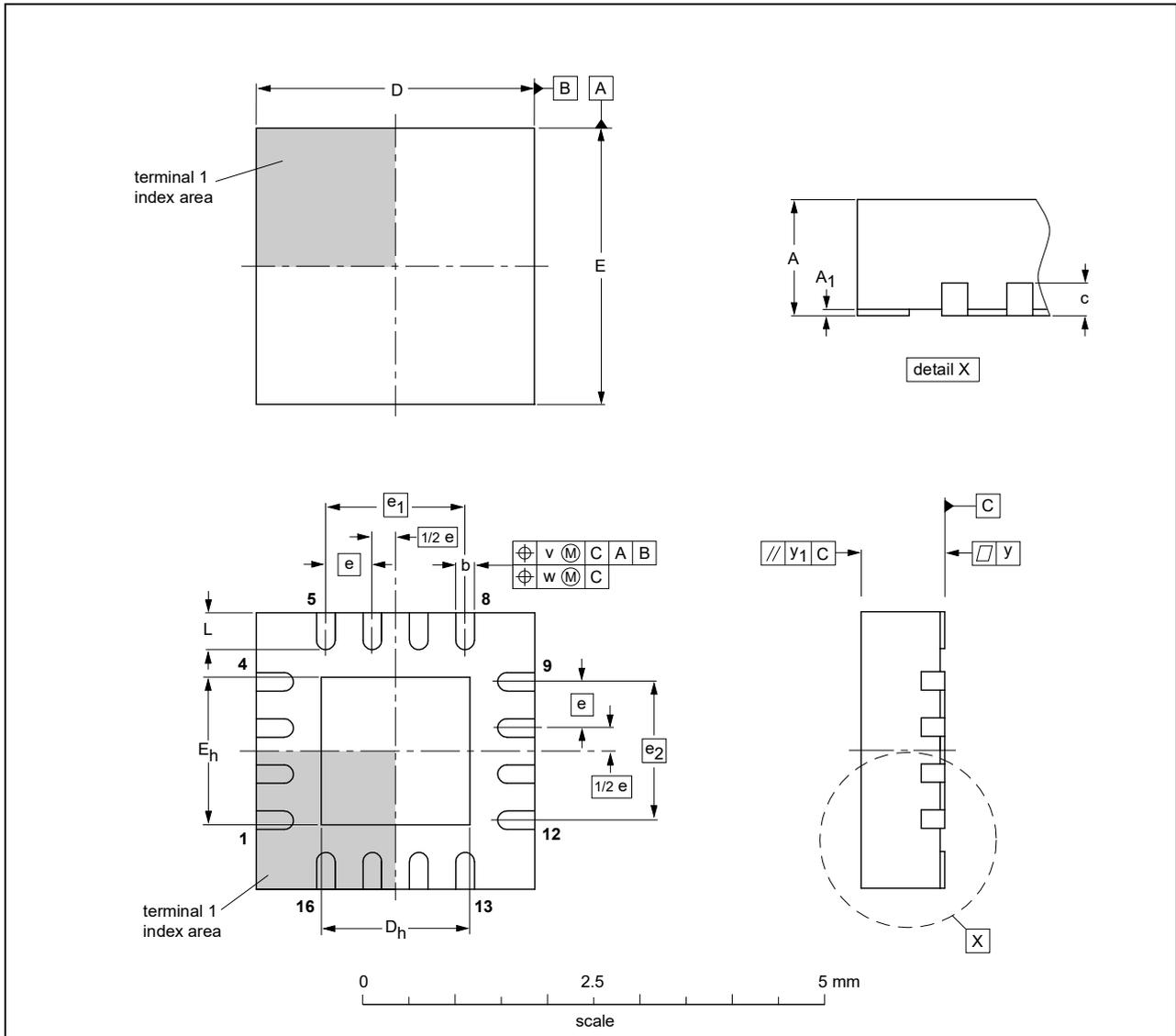
Component	Description	Value	Remarks
C <sub>in</sub>	capacitor	18 pF	in a 50 Ω PCB track
C <sub>out</sub>	capacitor	3.9 pF	in a 50 Ω PCB track
C <sub>11</sub> , and C <sub>21</sub>	capacitor	10 nF	recommended
C <sub>12</sub> , and C <sub>22</sub> <sup>[1]</sup>	capacitor	10 μF	
RSET	resistor	10kΩ	default

[1] Placement of C<sub>12</sub> and C<sub>22</sub> 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 <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

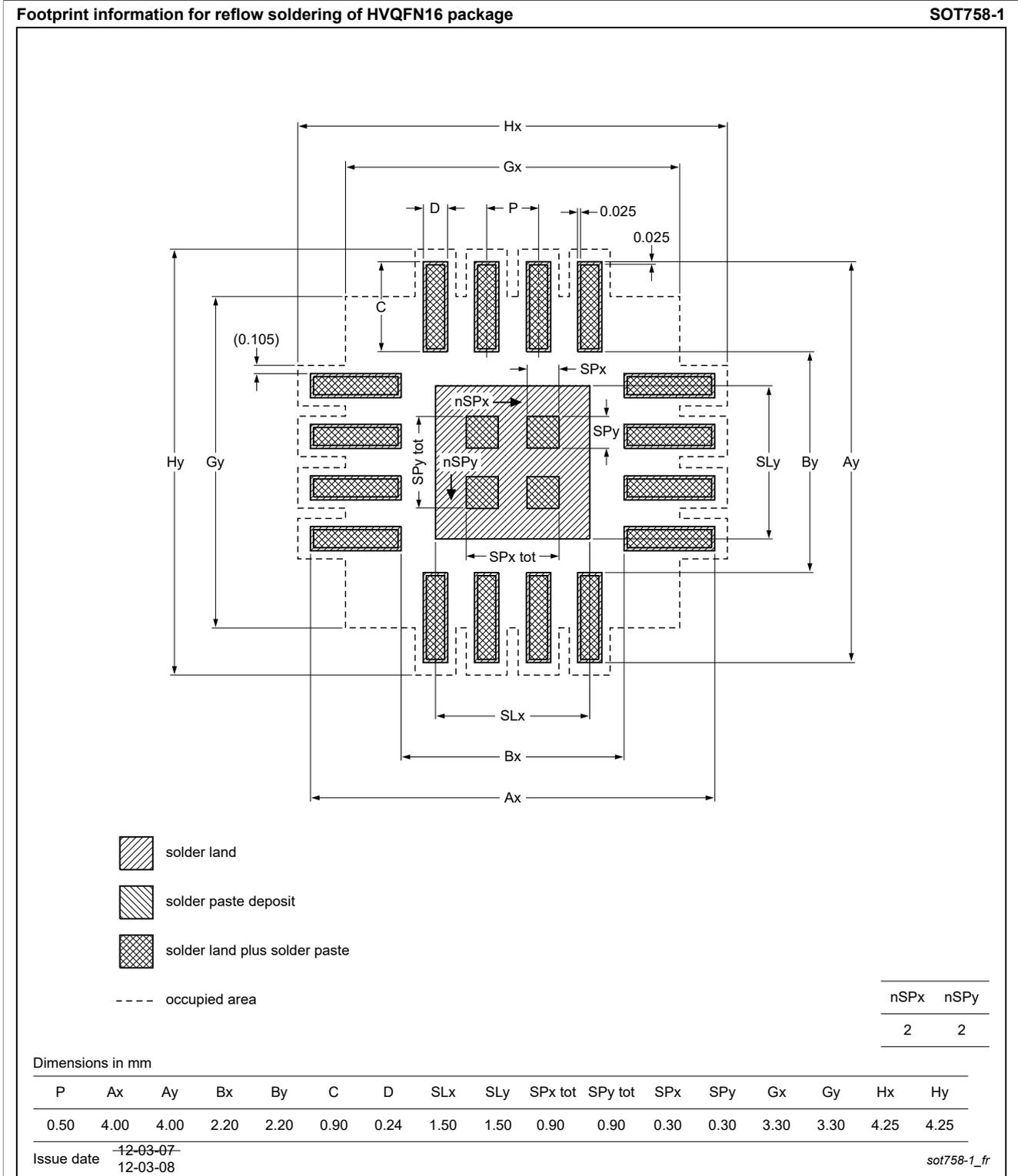
**Note**

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 17. Package outline SOT758-1 (HVQFN16)**

**16.1 Footprint and solder information**



**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 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

## 19 Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BTS6403U v.7	20230509	Product data sheet	-	BTS6403U v.6
		<ul style="list-style-type: none"> <li>changed max case temperature from 115°C to 120°C</li> </ul>		
BTS6403U v.6	20230329	Product data sheet	-	BTS6403U v.5
modification		<ul style="list-style-type: none"> <li>added graph topic</li> </ul>		
BTS6403U v.5	20230315	Product data sheet	-	BTS6403U v.4
modification		<ul style="list-style-type: none"> <li>updated min valeu storage temparture</li> </ul>		
BTS6403U v.4	20230131	Product data sheet	-	BTS6403U v.3
modification		<ul style="list-style-type: none"> <li>changed from company confidential to public</li> </ul>		
BTS6403U v.3	20230111	Product data sheet	-	BTS6403U v.2

## 20 Legal information

### 20.1 Data sheet status

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

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Date of release: 9 May 2023  
Document identifier: BTS6403U\_datasheet\_pg\_2022408