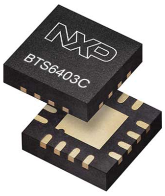
# BTS6403C

**Wideband high gain high linearity pre-driver amplifier 4.4 GHz - 5 GHz**

**Rev. 5 — 15 June 2023** **Product data sheet**




## 1 General description

The BTS6403C is a wideband, high linearity pre-driver amplifier for 5G massive MIMO infrastructure applications, with fast on-off switching to support TDD systems. The BTS6403C is designed to operate between 4.4 GHz and 5 GHz. The BTS6403C is housed in a 3 mm x 3 mm x 0.85 mm 16-terminal HVQFN16 package.

## 2 Features and benefits

- High saturated output power $P_{o(sat)}$ = 28 dBm
- High power-gain $G_p$ = 35.5 dB
- High linearity performance ACLR = -42 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

- 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 = 4.4 GHz; $V_{CC}$ = 5 V; $T_{amb}$ = 25 °C; input 50 Ω, and output 50 Ω; RSET = 10 kΩ*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CC}$ | supply current | ON state, $P_o$ = 15 dBm | - | 120 | 150 | mA |
| | | ON state, quiescent | - | 100 | 125 | mA |
| | | OFF state | - | 1.2 | 2.5 | mA |
| $G_p$ | power gain | On state | - | 35.5 | - | dB |
| | | OFF state | - | -49 | - | dB |
| $P_{o(sat)}$ | saturated output power | [1] | - | 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 | - | -42 | - | 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 |
| BTS6403C | BTS6403CJ | 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 |
|---|---|
| BTS6403C | 43C |

## 7 Functional diagram

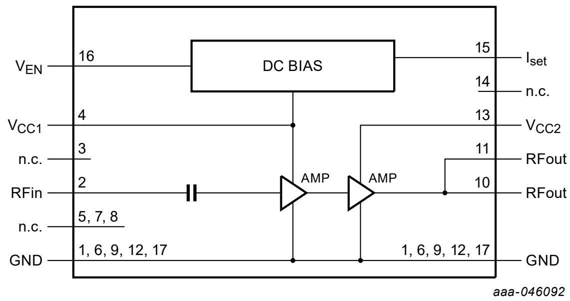



**Figure 1. BTS6403C functional diagram**

# 8 Pinning information

## 8.1 Pin diagram

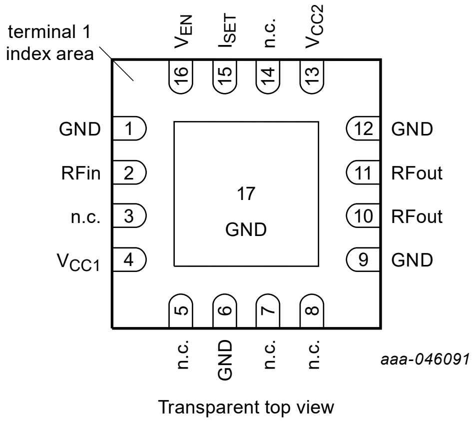



**Figure 2. BTS6403C pin diagram**

## 8.2 Pin description

**Table 4. Pin description**

| Pin | Symbol | Description |
|---|---|---|
| 1, 6, 9,12, and 17 | GND | PCB ground |
| 2 | $RF_{in}$ | RF input |
| 4 | $V_{CC1}$ | supply voltage |
| 3, 5, 7, 8 and 14 | n.c. [1] | not connected |
| 10 and 11 | $RF_{out}$ | RF output |
| 13 | $V_{CC2}$ | supply voltage |
| 15 | $I_{set}$ | Current set; connect to an 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 the application.

# 9 Functional description

**Table 5. Shutdown control**

| Ven | 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

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

**Table 6. Limiting values**

| 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 | | -50 | 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 | | - | 50 | - | Ω |
| $T_{case}$ | Case temperature | | -40 | | 120 | $^{o}$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 |
|---|---|---|---|---|
| $R_{th(j-case)}$ | 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: $V_{CC}$ = 5 V; $T_{amb}$ = 25 °C; input 50 Ω and output 50 Ω; RSET = 10 kΩ*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CC}$ | supply current | ON state, $P_o$ = 15 dBm, f = 4.4 GHz | - | 120 | 150 | mA |
| | | ON state, quiescent | - | 100 | 125 | mA |
| | | OFF state | - | 1.2 | 2.5 | mA |
| $G_p$ | power gain | ON state | | | | |
| | | f = 4.4 GHz | 33 | 35.5 | 38 | dB |
| | | f = 5 GHz | 31.5 | 34 | 36.5 | dB |
| | | OFF state | - | -49.0 | - | dB |
| $G_{flat}$ | gain flatness | f = 4.4 GHz to 4.6 GHz | - | 0.5 | - | dB |
| | | f = 4.6 GHz to 4.8 GHz | - | 0.6 | - | dB |
| | | f = 4.8 GHz to 5 GHz | - | 0.8 | - | dB |
| $t_{d(grp)}$ | group delay time | f = 4.4 GHz to 4.7 GHz | - | 0.4 | - | ns |
| | | f = 4.7 GHz to 5 GHz | - | 0.4 | - | ns |
| $P_{o(sat)}$ | saturated output power | f = 4.4 GHz [1] | - | 28.0 | - | dBm |
| | | f = 5 GHz [1] | - | 27.5 | - | dBm |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | f = 4.4 GHz | - | 27.5 | - | dBm |
| | | f = 5 GHz | - | 26.5 | - | dBm |
| $IP3_o$ | output third-order intercept point | 2-tone; tone spacing = 100 MHz; $P_o$ = 15 dBm, f = 4.4 GHz | - | 33 | - | dBm |
| $RL_i$ | input return loss | f = 4.4 GHz | 10 | 12 | - | dB |
| | | f = 5 GHz | 7 | 9 | - | dB |
| $RL_o$ | output return loss | f = 4.4 GHz | 10 | 15 | - | dB |
| | | f = 5 GHz | 10 | 21 | - | dB |
| $ISL_r$ | reverse isolation | | - | 50 | - | dB |
| NF | noise figure | f = 4.4 GHz [2] | - | 4.9 | - | dB |
| | | f = 5 GHz [2] | - | 5.1 | - | 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 | μs |

**Table 9. Characteristics**...*continued*

*Unless otherwise specified, the following settings are used for measurements: $V_{CC}$ = 5 V; $T_{amb}$ = 25 °C; input 50 Ω and output 50 Ω; RSET = 10 kΩ*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{s(poff)}$ | 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 | 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 dBm | - | -42.0 | - | 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

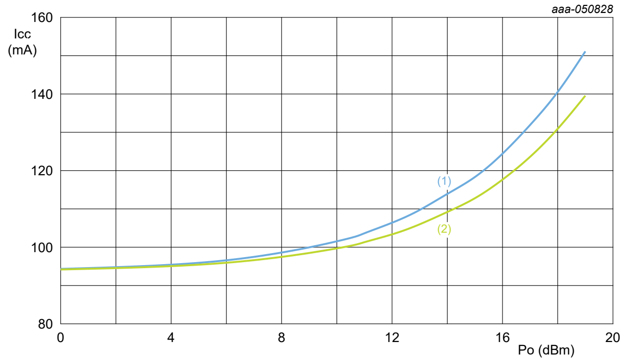



**Figure 3. $I_{cc}$ versus $P_{out}$ over frequency at 25 °C**

(1) f = 4.4 GHz
(2) f = 5 GHz

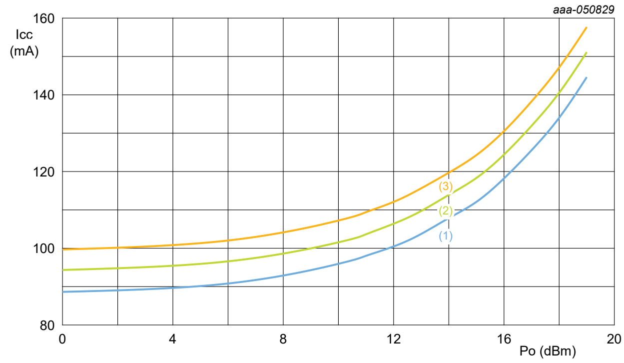



**Figure 4. $I_{cc}$ versus $P_{out}$ over temperature at 3.5 GHz**

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

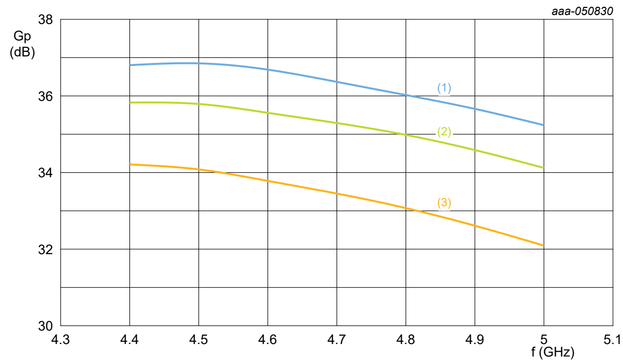



**Figure 5. Gain versus frequency over temperature**

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

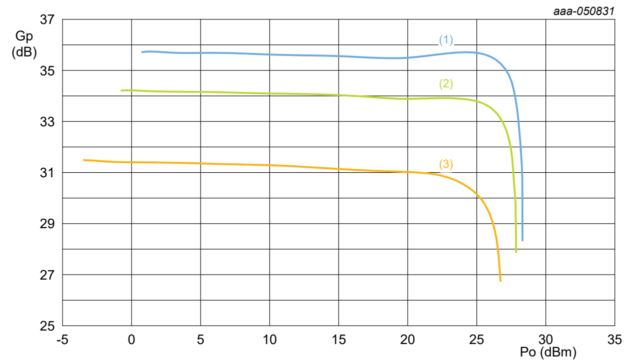



**Figure 6. Gain versus $P_{out}$ over temperature at 4.4 GHz**

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

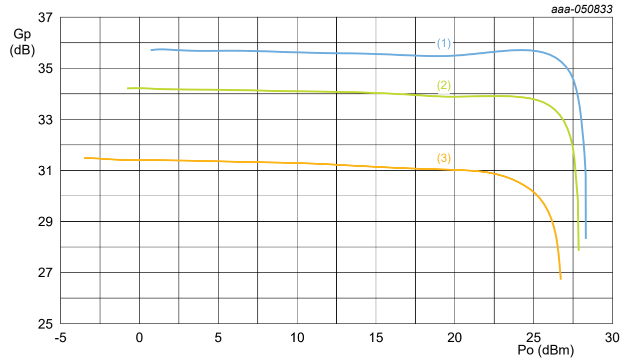



**Figure 7. Gain versus $P_{out}$ over temperature at 5 GHz**

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

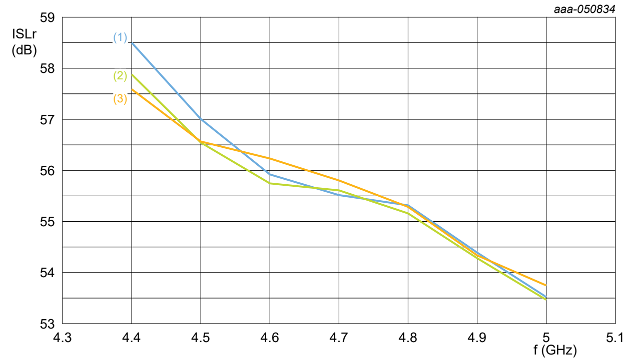



**Figure 8. Isolation versus frequency over temperature**

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

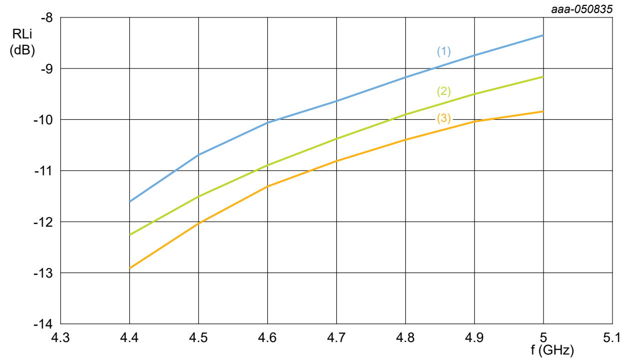



**Figure 9. $RL_i$ $S_{11}$ over temperature**

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

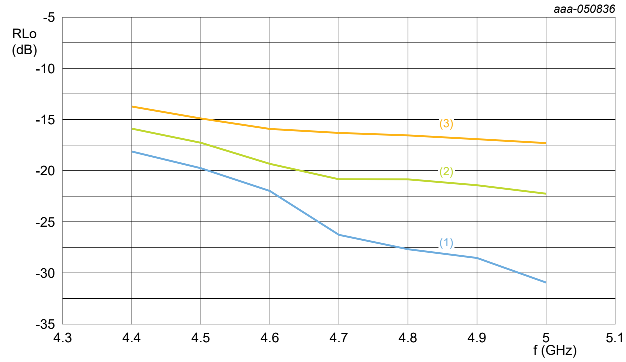



**Figure 10. $RL_o$ $S_{22}$ over temperature**

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

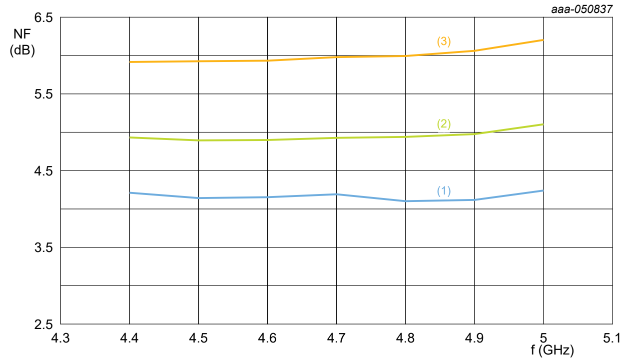



**Figure 11. NF versus frequency over temperature**

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

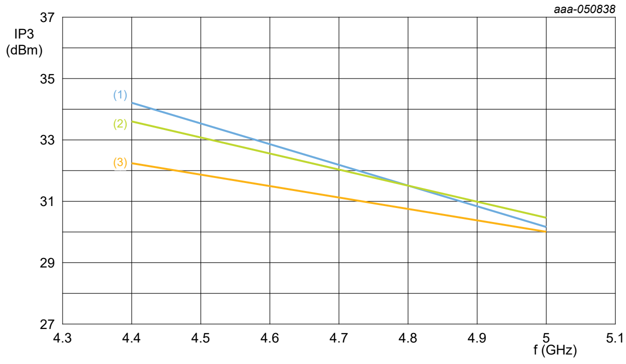



**Figure 12. IP3 versus frequency over temperature**

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

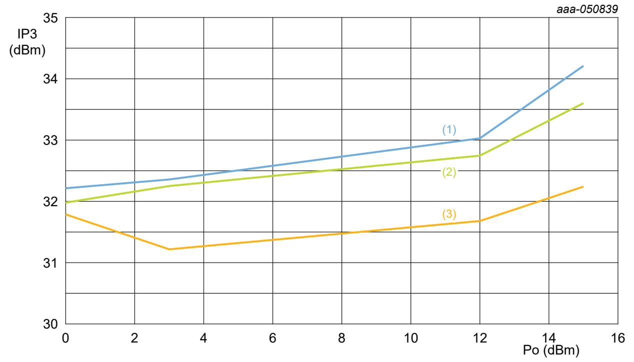



**Figure 13. IP3 versus $P_{out}$ over temperature at 4.4 GHz**

(1) $T_{case}$ = -40 °C

(2) $T_{case}$ = 25 °C

(3) $T_{case}$ = 115 °C

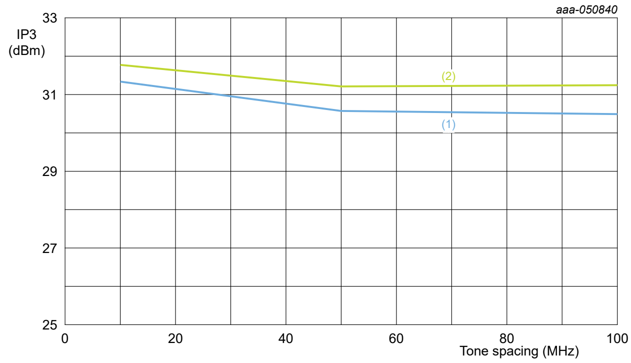



**Figure 14. IP3 versus tone spacing over $P_{out}$**

(1) $P_o$ = 3 dBm

(2) $p_0$ = 15 dBm

# 15 Application information

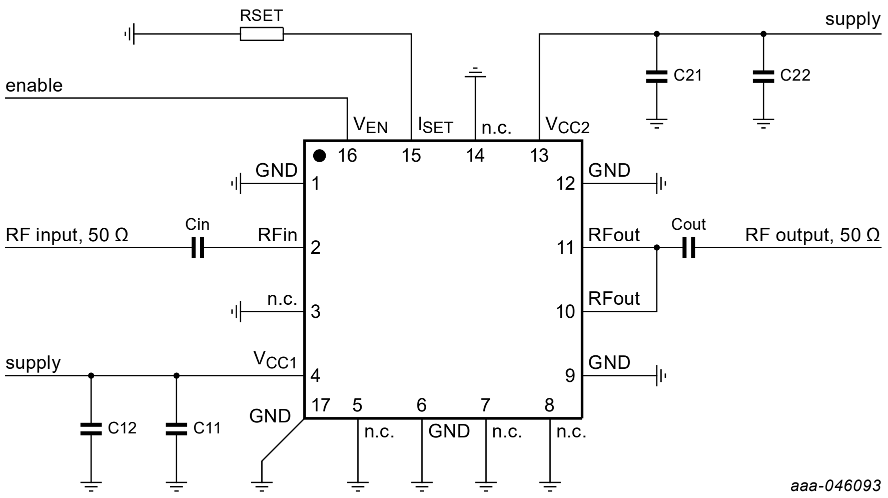


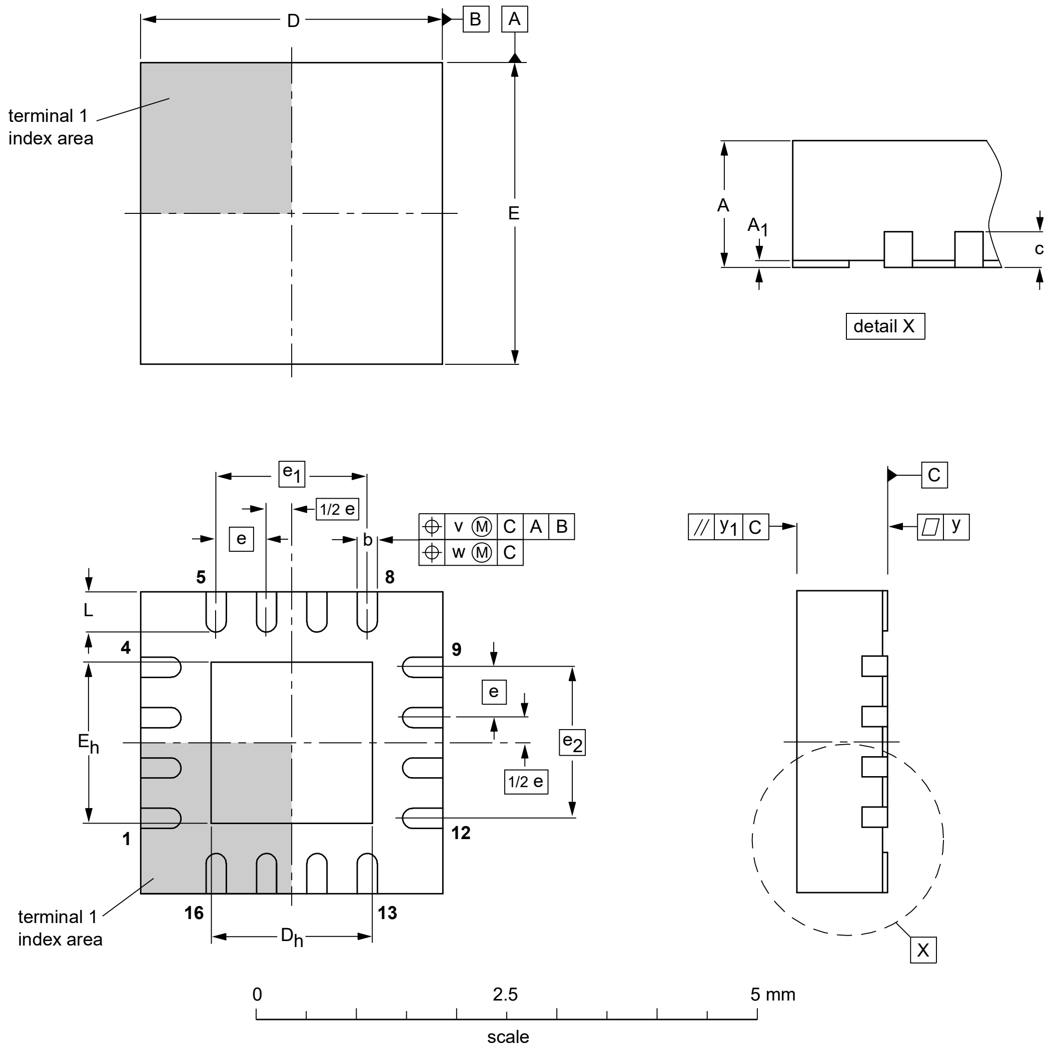

**Figure 15. BTS6403C application diagram**

**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 | capacitor | 10 µF | optional |
| RSET | resistor | 10kΩ | default |

# 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<br>0.00 | 0.30<br>0.18 | 0.2 | 3.1<br>2.9 | 1.75<br>1.45 | 3.1<br>2.9 | 1.75<br>1.45 | 0.5 | 1.5 | 1.5 | 0.5<br>0.3 | 0.1 | 0.05 | 0.05 | 0.1 |

**Note**

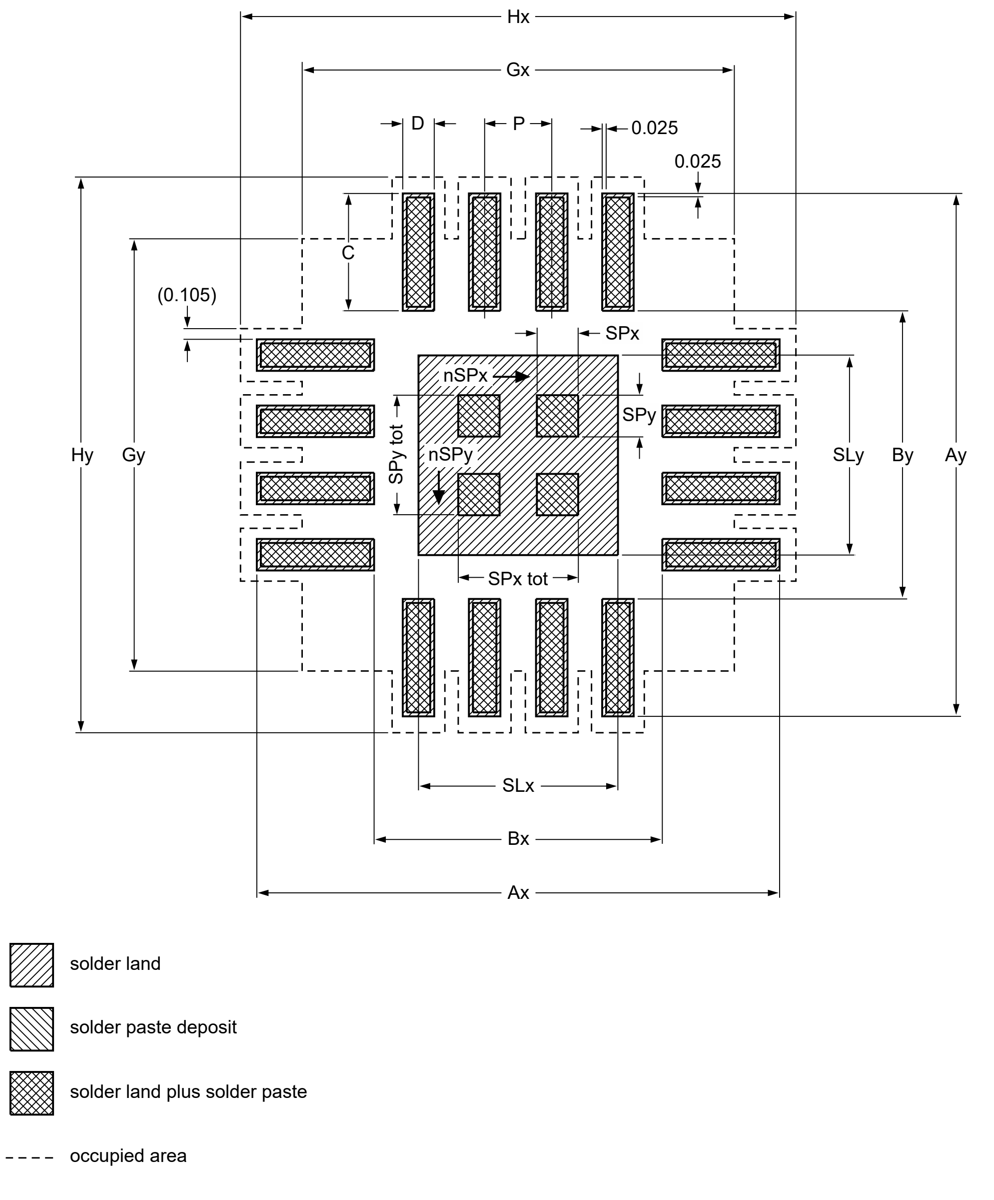
1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

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

**Figure 16. 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 17. 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 |
|---|---|---|---|---|
| BTS6403C v.5 | 20230615 | Product data sheet | - | BTS6403C v.4 |
| modification | • Changed max case temperarture from 115$^{o}$C to 120$^{o}$C | | | |
| BTS6403C v.4 | 20230323 | Product data sheet | - | BTS6403C v.3 |
| modification | • updated table 1 quick reference data<br>• updated table 9 characteristics | | | |

# 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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