



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

$f = 3.5 \text{ GHz}$; $V_{CC} = 5 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; input $100 \text{ } \Omega$, and output $50 \text{ } \Omega$; 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, $P_o = 15 \text{ dBm}$ | - | 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, $P_o = 15 \text{ dBm}$ | - | -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

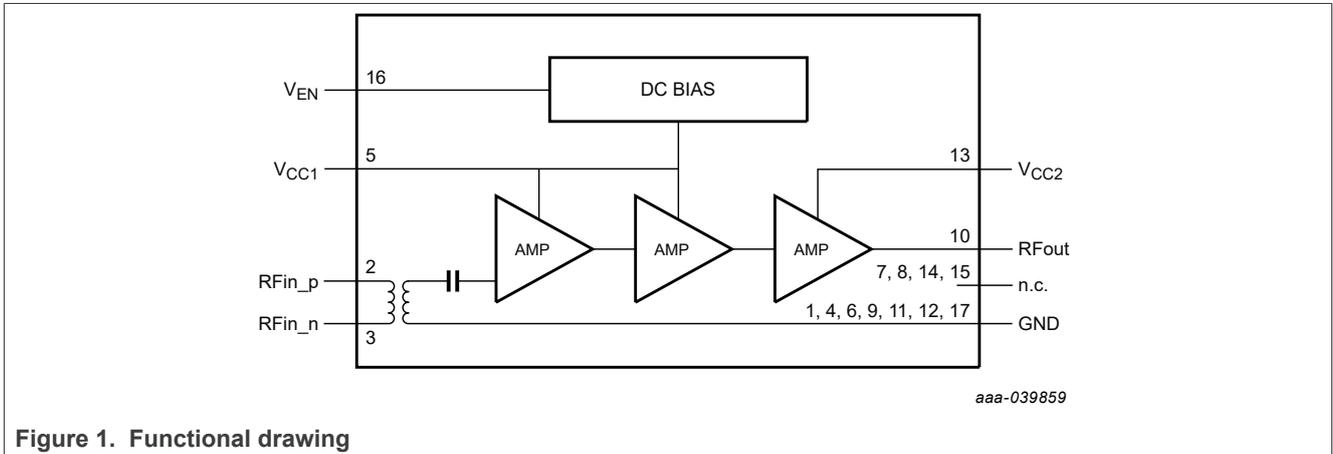
| Type number | Orderable part number | Package | | |
|-------------|-----------------------|---------|--|----------|
| | | Name | Description | Version |
| BTS6302U | BTS6302UJ | HVQFN16 | 3 mm × 3 mm × 0.85 mm, 16 terminals no leads | SOT758-1 |

6 Marking

Table 3. Marking

| Type number | Marking code |
|-------------|--------------|
| BTS6302U | 32U |

7 Functional diagram



8 Pinning information

8.1 Pinning

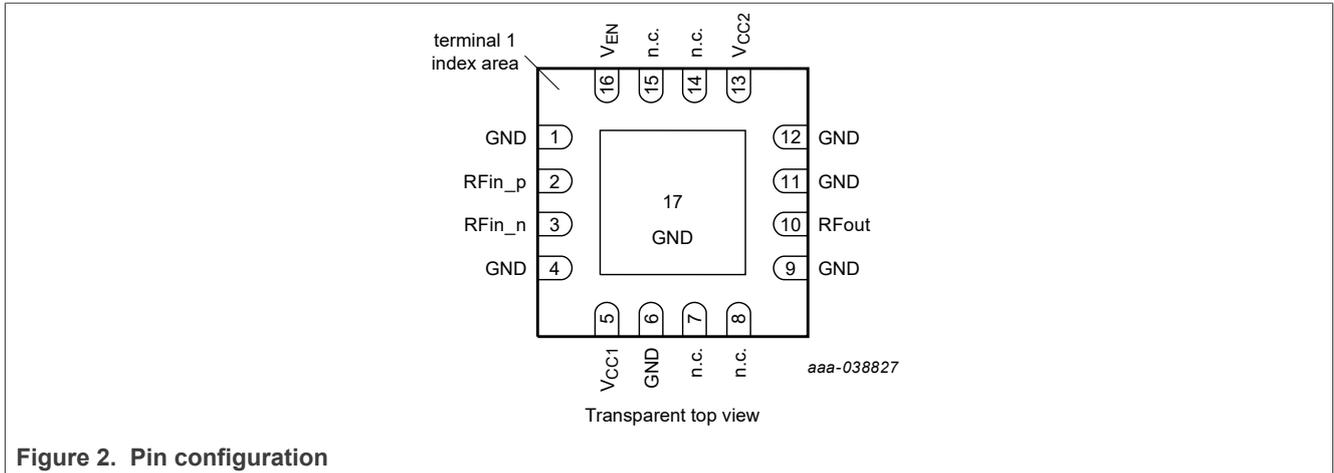


Figure 2. Pin configuration

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 | V _{CC2} | 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-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 at 1 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 |
| IP _{3o} | 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 |

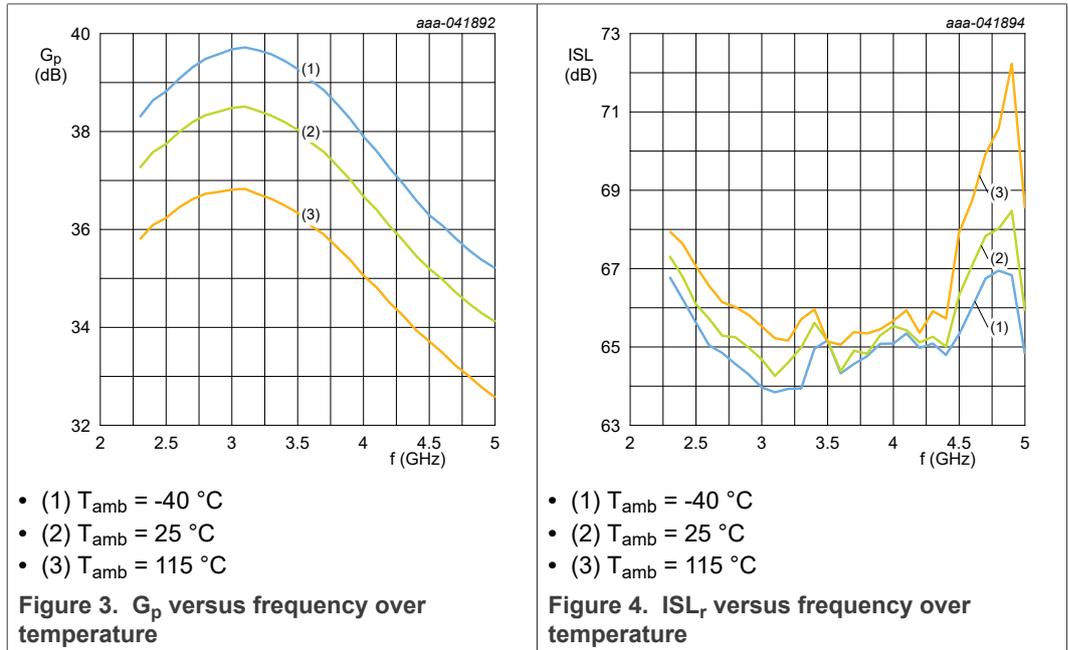
Table 9. Characteristics...continued

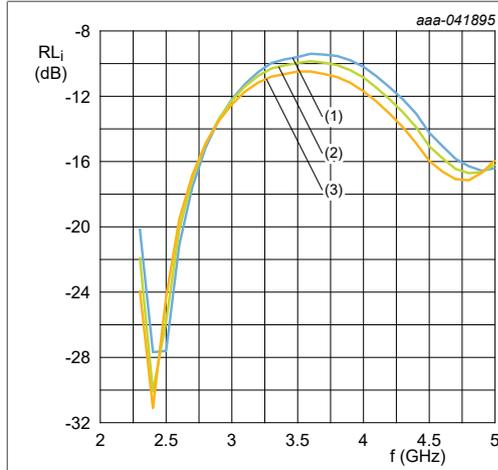
$f = 3.5 \text{ GHz}$; $V_{CC} = 5 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; input $100 \text{ } \Omega$, and output $50 \text{ } \Omega$; unless otherwise specified. Values under **Min/Max** in boldface font are guaranteed by test; Values in lightface font are based on simulation or characterization.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------|--------------------------------|--|-----|------|-----|---------------|
| NF | noise figure | $f = 2.6 \text{ GHz}$ [3] | - | 3.1 | 3.2 | dB |
| | | $f = 3.5 \text{ GHz}$ [3] | - | 3.4 | 3.5 | dB |
| | | $f = 4.2 \text{ GHz}$ [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, $P_o = 15 \text{ dBm}$ | - | -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

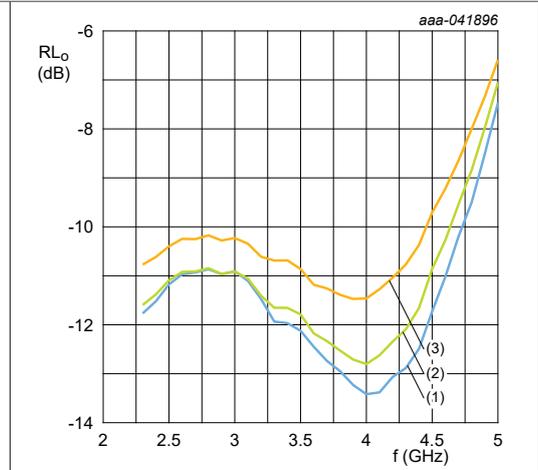
14 Graphs





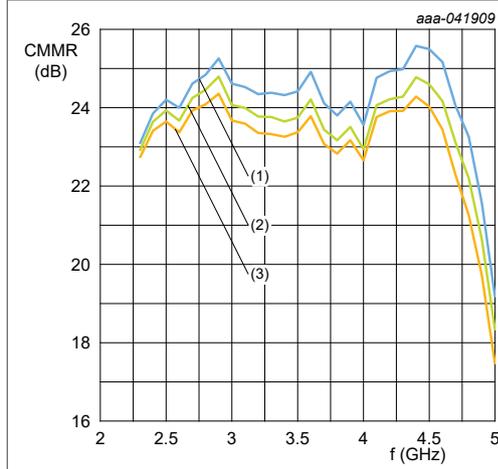
- (1) $T_{amb} = -40\text{ °C}$
- (2) $T_{amb} = 25\text{ °C}$
- (3) $T_{amb} = 115\text{ °C}$

Figure 5. RL_i S11 versus frequency over temperature



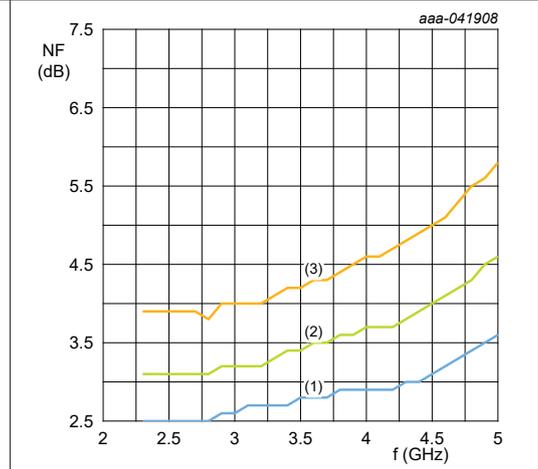
- (1) $T_{amb} = -40\text{ °C}$
- (2) $T_{amb} = 25\text{ °C}$
- (3) $T_{amb} = 115\text{ °C}$

Figure 6. RL_o S22 versus frequency over temperature



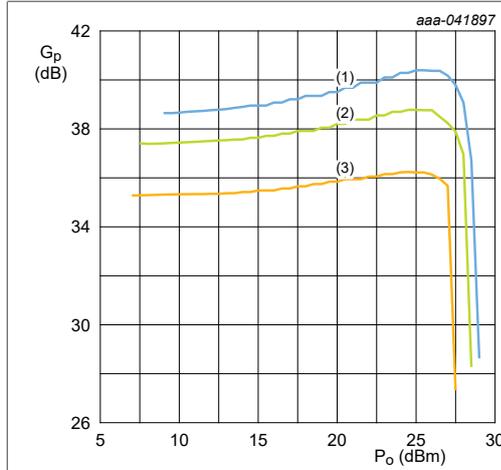
- (1) $T_{amb} = -40\text{ °C}$
- (2) $T_{amb} = 25\text{ °C}$
- (3) $T_{amb} = 115\text{ °C}$

Figure 7. CMMR versus frequency over temperature



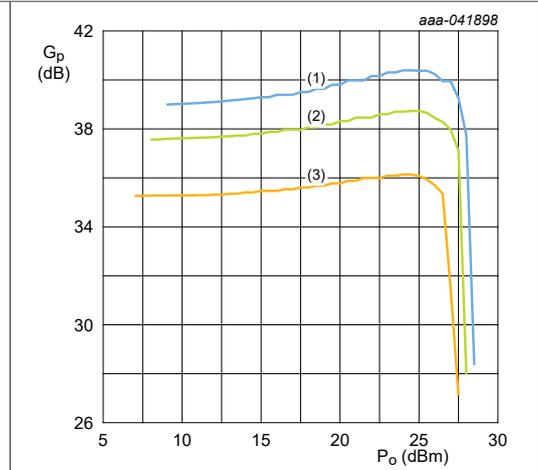
- (1) $T_{amb} = -40\text{ °C}$
- (2) $T_{amb} = 25\text{ °C}$
- (3) $T_{amb} = 115\text{ °C}$

Figure 8. NF versus frequency over temperature



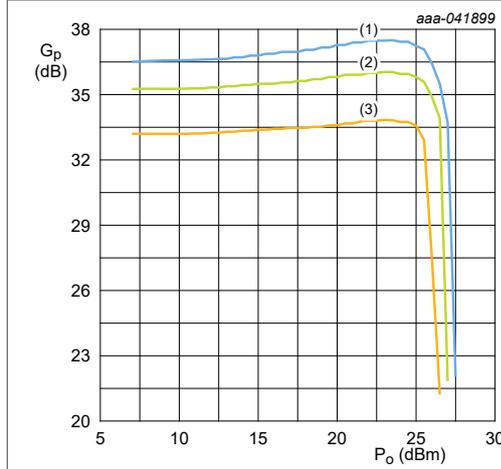
- (1) $T_{amb} = -40\text{ °C}$
- (2) $T_{amb} = 25\text{ °C}$
- (3) $T_{amb} = 115\text{ °C}$

Figure 9. G_p versus P_o at 2.6 GHz over temperature



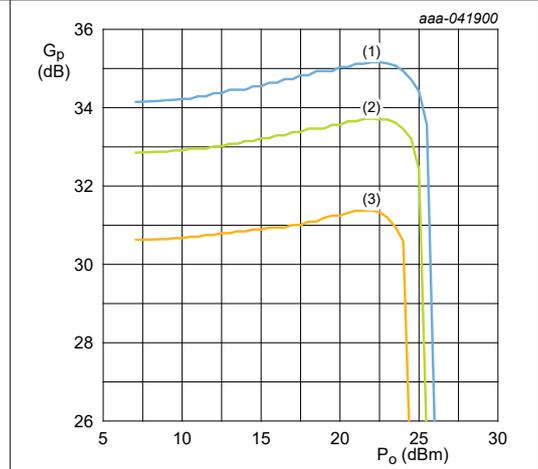
- (1) $T_{amb} = -40\text{ °C}$
- (2) $T_{amb} = 25\text{ °C}$
- (3) $T_{amb} = 115\text{ °C}$

Figure 10. G_p versus P_o at 3.5 GHz over temperature



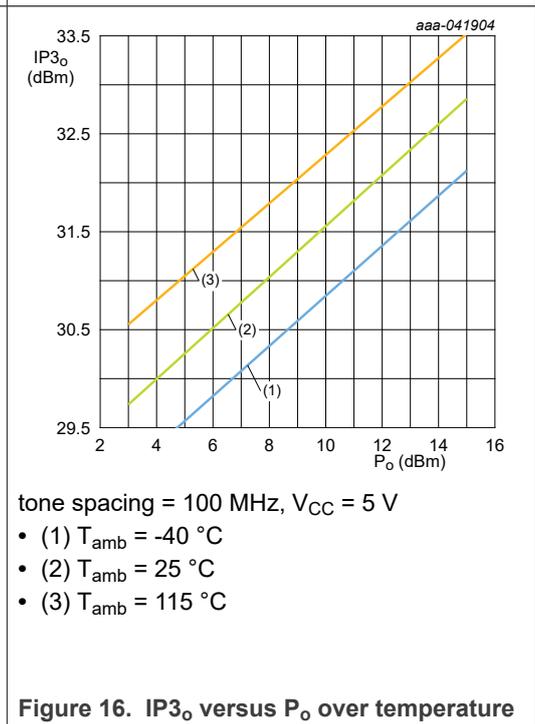
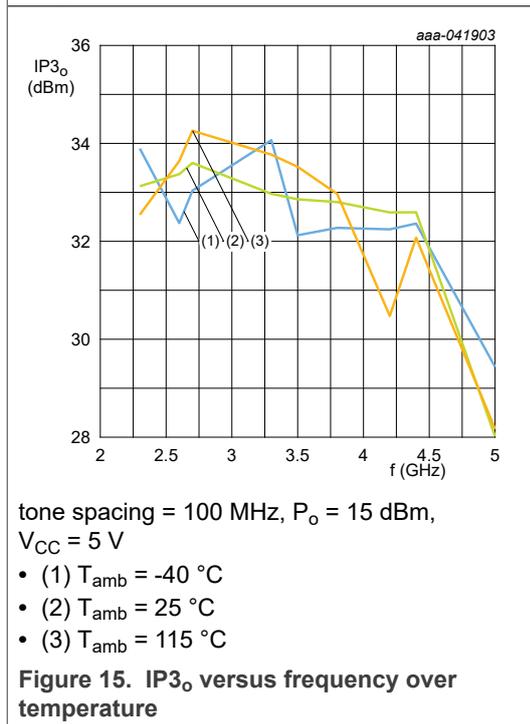
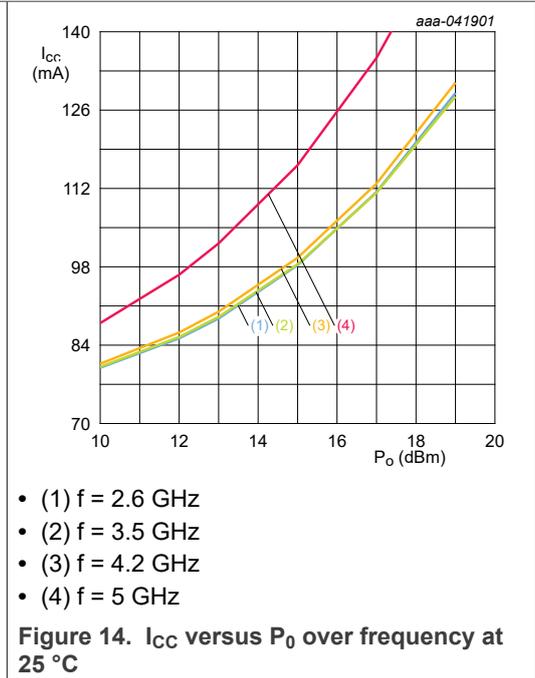
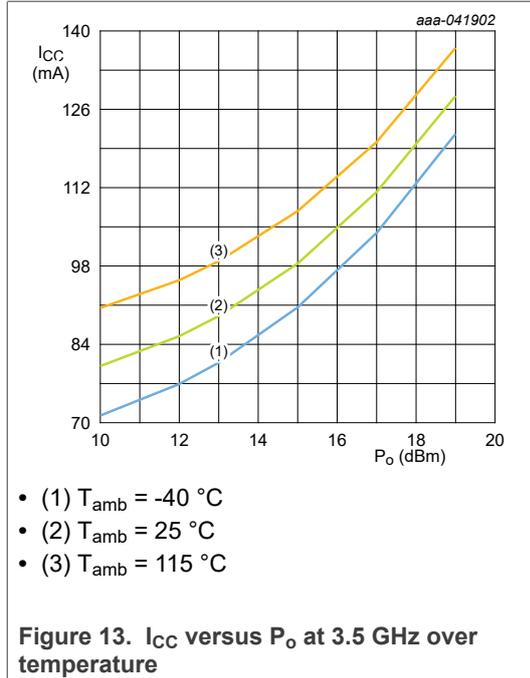
- (1) $T_{amb} = -40\text{ °C}$
- (2) $T_{amb} = 25\text{ °C}$
- (3) $T_{amb} = 115\text{ °C}$

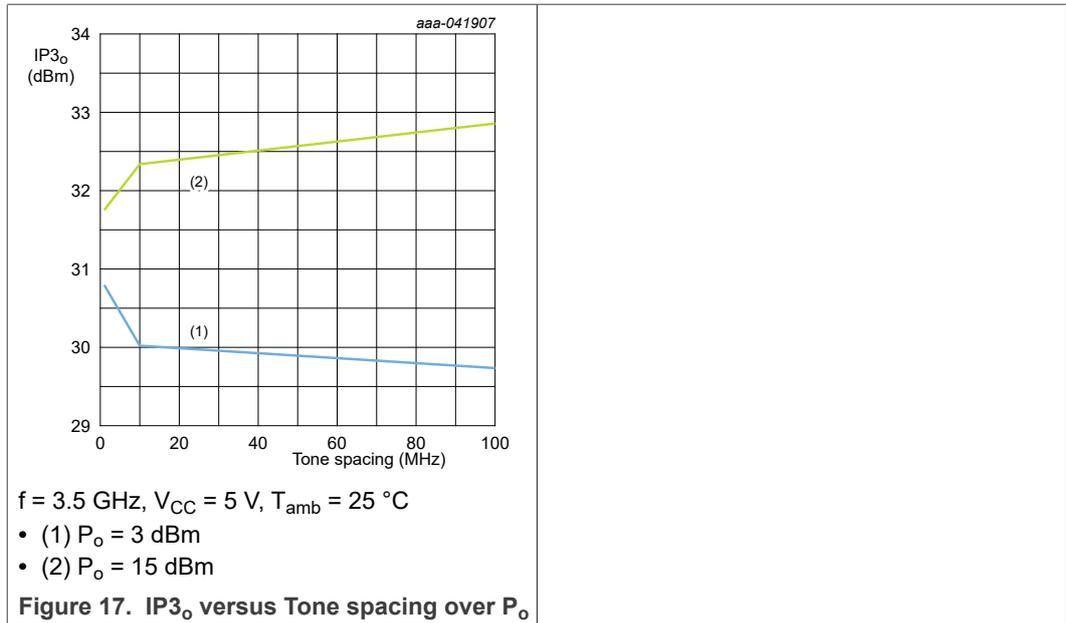
Figure 11. G_p versus P_o at 4.2 GHz over temperature



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

Figure 12. G_p versus P_o at 5 GHz over temperature





15 Application information

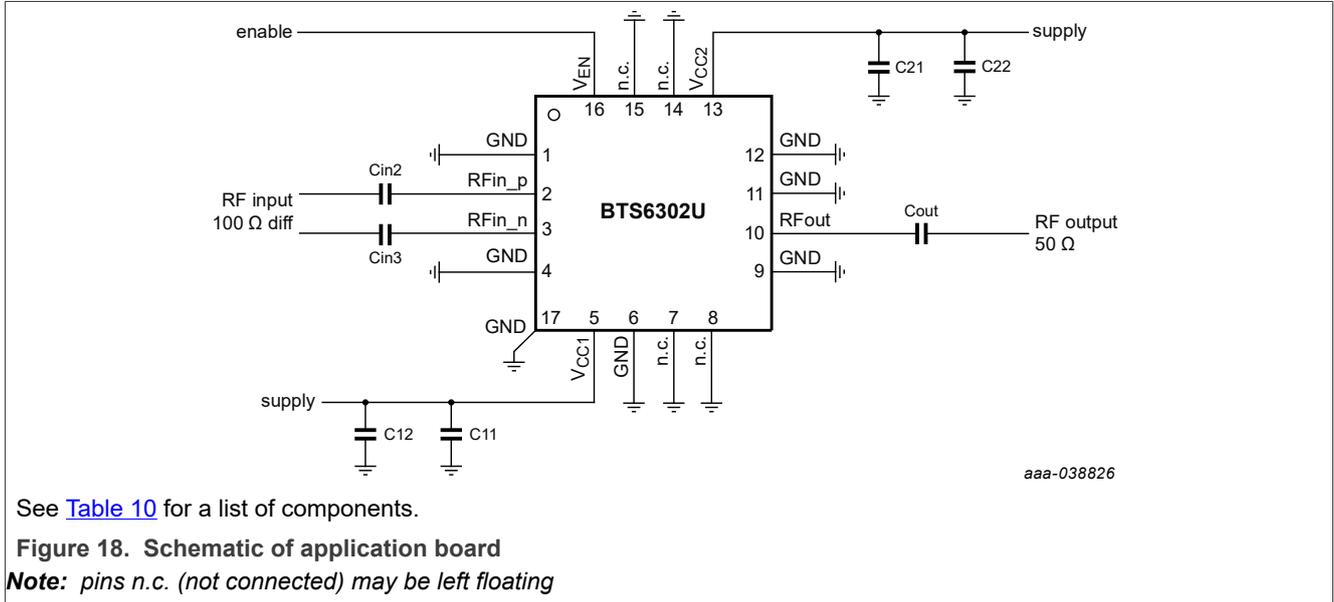


Table 10. List of components

See [Figure 18](#) for schematics.

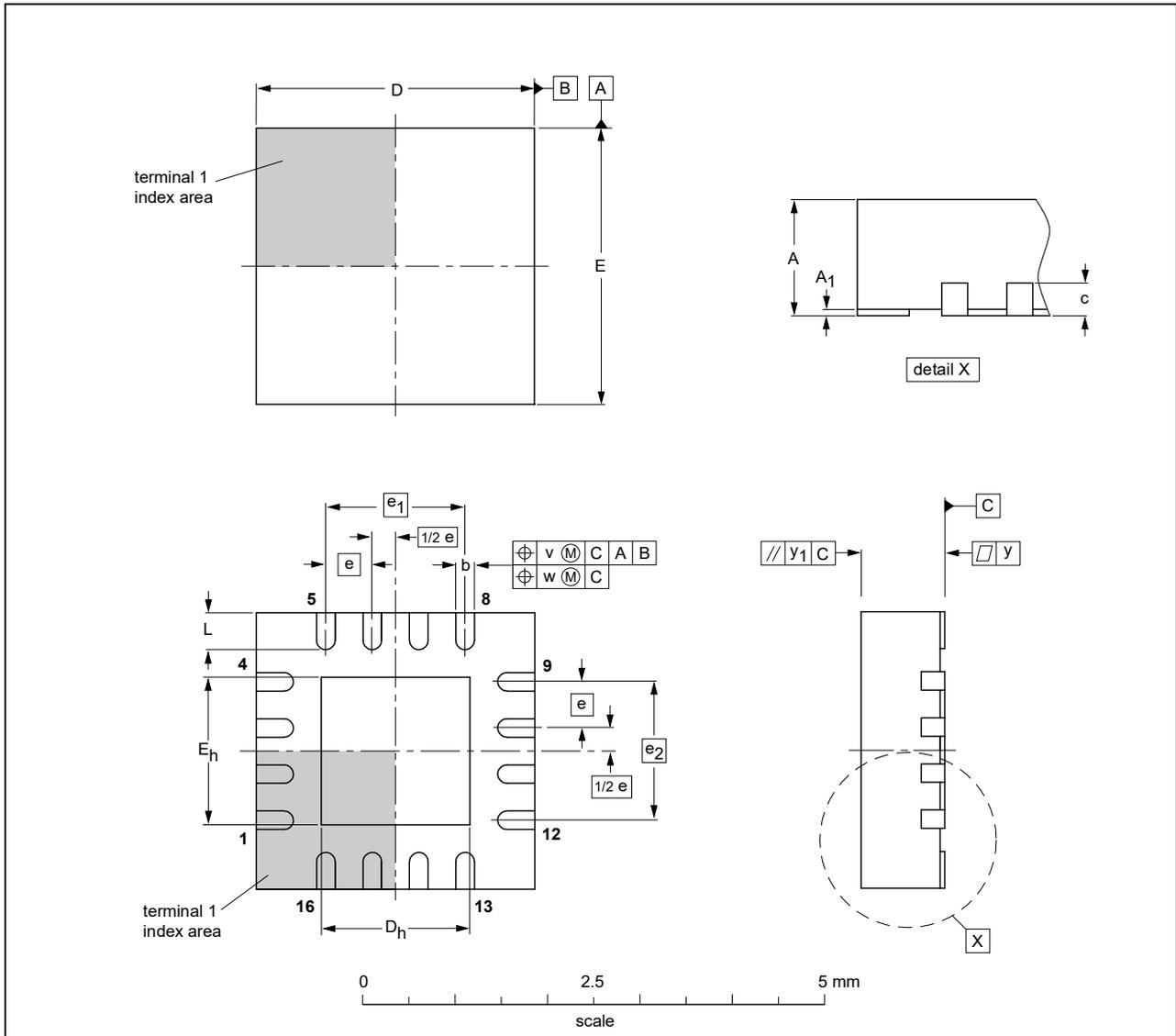
| Component | Description | Value | Remarks |
|------------------|-------------|--------|---------------------|
| Cin2, and Cin3 | capacitor | 18 pF | in a 50 Ω PCB track |
| C _{out} | capacitor | 3.9 pF | in a 50 Ω PCB track |
| C11, and C21 | capacitor | 10 nF | recommended |
| C12, and C22 | capacitor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

[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 |

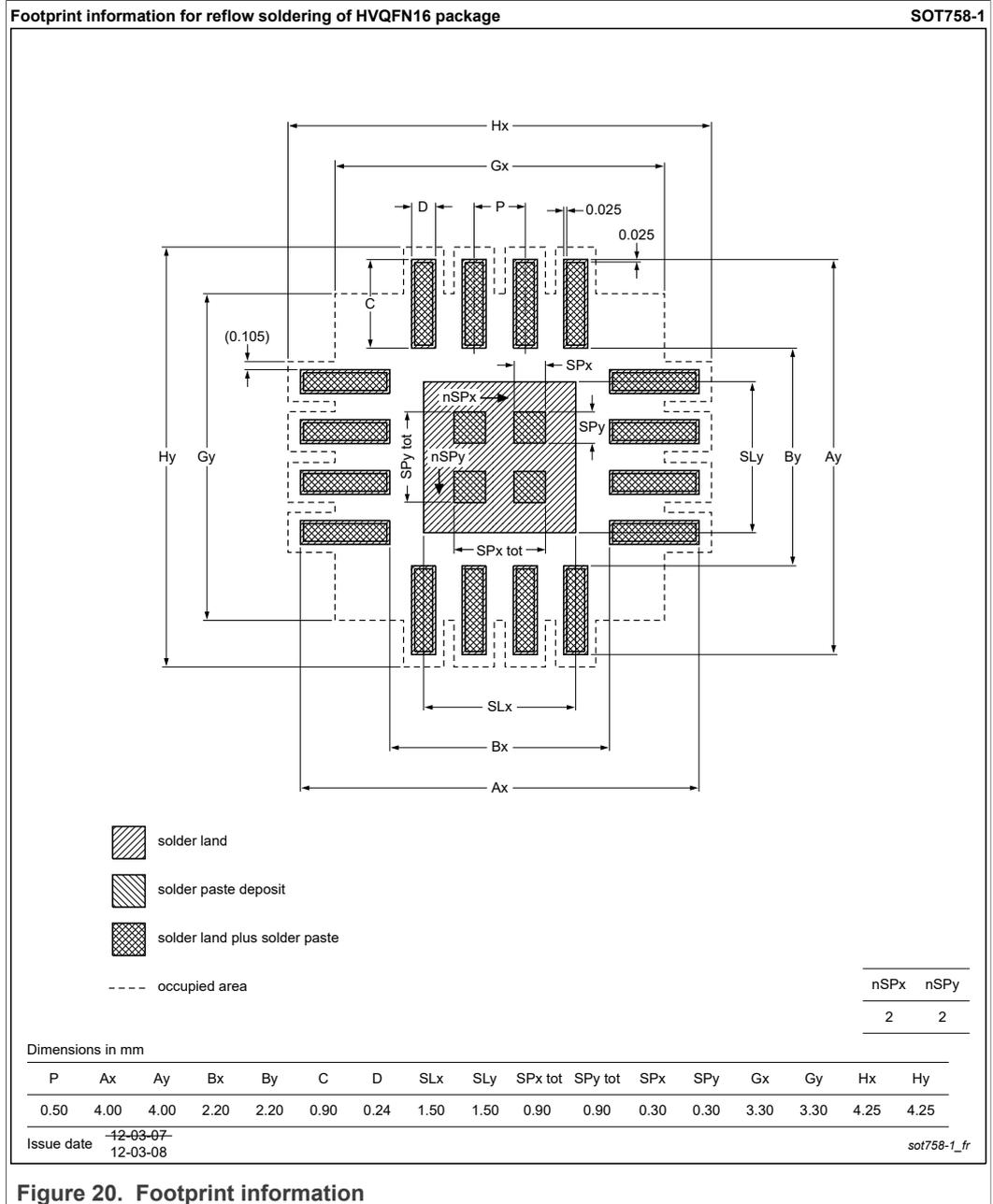
Note

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



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 | 5 th 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 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> added Min/Max values to most parameters | | | |
| BTS6302U v.6.3 | 20210319 | Objective data sheet | - | BTS6302U v.6.2 |
| modification | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> corrected the legend for graphic on NF versus frequency over temperature | | | |
| BTS6302U v.6.1 | 20210317 | Objective data sheet | - | BTS6302U v.6 |
| modification | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> changed ESD value on CMD to +/- 500 V | | | |
| BTS6302U v.4.1 | 20201125 | Objective data sheet | - | BTS6302U v.4 |
| modification | <ul style="list-style-type: none"> added official drawing of the Functional diagram | | | |
| BTS6302U v.4 | 20201120 | Objective data sheet | - | BTS6302U v.3 |
| modification | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> changed description of pin 15 to n.c. added footprint information | | | |
| BTS6302U v.1.1 | 20200901 | Objective data sheet | - | BTS6302U v.1 |
| modification | <ul style="list-style-type: none"> 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>.

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