# BGU7062N2

## Analog high linearity low noise variable gain amplifier

Rev. 1 — 8 July 2013 Product data sheet

## 1. Product profile

### 1.1 General description

The BGU7062N2 is a fully integrated analog-controlled variable gain amplifier module. Its low noise and high linearity performance makes it ideal for sensitive receivers in cellular base station applications. The BGU7062N2 is designed for the 1710 MHz to 1785 MHz frequency range. It has a gain control range of more than 35 dB. At maximum gain the noise figure is 0.77 dB. The gain is analog-controlled having maximum gain at 0 V and minimum gain at 3.3 V. The LNA can be bypassed extending the dynamic range. The BGU7062N2 is internally matched to 50 ohm, meaning no external matching is required, enabling ease of use. It is housed in a 16 pins 8 mm × 8 mm × 1.3 mm leadless HLQFN16R package SOT1301.

### 1.2 Features and benefits

- Input and output internally matched to 50 Ω
- Low noise figure of 0.77 dB
- High $IP3_i$ of 1 dBm
- High $P_{i(1dB)}$ of −12.3 dBm
- Bypass mode of LNA giving high dynamic gain range
- Gain control range of 0 dB to 35 dB
- Single 5 V supply
- Single analog gain control of 0 V to 3.3 V
- Unconditionally stable up to 12.75 GHz
- Moisture sensitivity level 3
- ESD protection at all pins

### 1.3 Applications

- Cellular base stations, remote radio heads
- 3G, LTE infrastructure
- Low noise applications with variable gain and high linearity requirements
- Active antenna

### 1.4 Quick reference data

**Table 1. Quick reference data**

*$V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz; $T_{amb}$ = 25 °C; input and output 50 Ω; unless otherwise specified.*

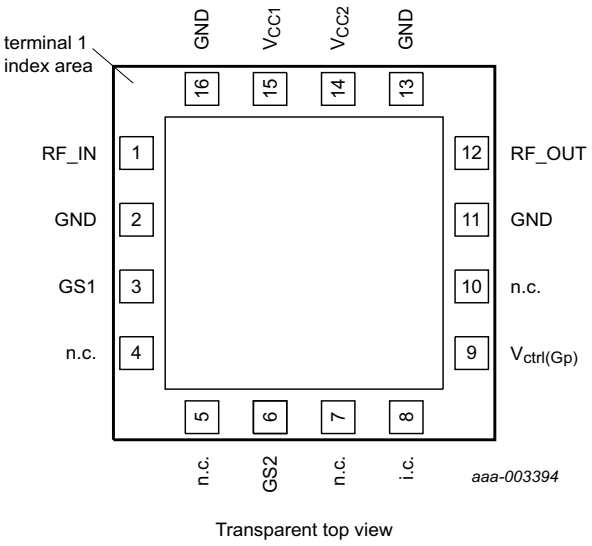
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{CC(tot)}$ | total supply current | high gain mode | [1] | 190 | 215 | 250 | mA |
| | | low gain mode | [2] | 165 | 185 | 215 | mA |
| NF | noise figure | $V_{ctrl(Gp)}$ = 0 V (maximum power gain) | [1] | - | 0.77 | - | dB |
| | | $G_p$ = 35 dB | [1] | - | 0.94 | 1.1 | dB |
| $IP3_i$ | input third-order intercept point | $G_p$ = 35 dB; 2-tone; tone-spacing = 1.0 MHz | [1] | 0 | 1.0 | - | dBm |
| $P_{i(1dB)}$ | input power at 1 dB gain compression | $G_p$ = 35 dB | [1] | −14 | −12.3 | - | dBm |

[1] high gain mode: GS1 = LOW; GS2 = HIGH (see Table 9)

[2] low gain mode: GS1 = HIGH; GS2 = LOW (see Table 9)

## 2. Pinning information

### 2.1 Pinning




Transparent top view

**Fig 1. Pin configuration**

### 2.2 Pin description

**Table 2. Pin description**

| Symbol | Pin | Description |
|---|---|---|
| RF_IN | 1 | RF input |
| GND | 2, 11, 13, 16 | ground |
| GS1 | 3 | gain switch control 1 |
| n.c. | 4, 5, 7, 10 | not connected, internally open |

**Table 2. Pin description** *...continued*

| Symbol | Pin | Description |
|---|---|---|
| GS2 | 6 | gain switch control 2 |
| i.c. | 8 | internally connected to ground |
| $V_{ctrl(Gp)}$ | 9 | power gain control voltage |
| RF_OUT | 12 | RF output |
| $V_{CC2}$ | 14 | supply voltage 2 |
| $V_{CC1}$ | 15 | supply voltage 1 |

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BGU7062N2 | HLQFN16R | plastic thermal enhanced low profile quad flat package; no leads; 16 terminals; body 8 × 8 × 1.3 mm | SOT1301-1 |

## 4. Functional diagram

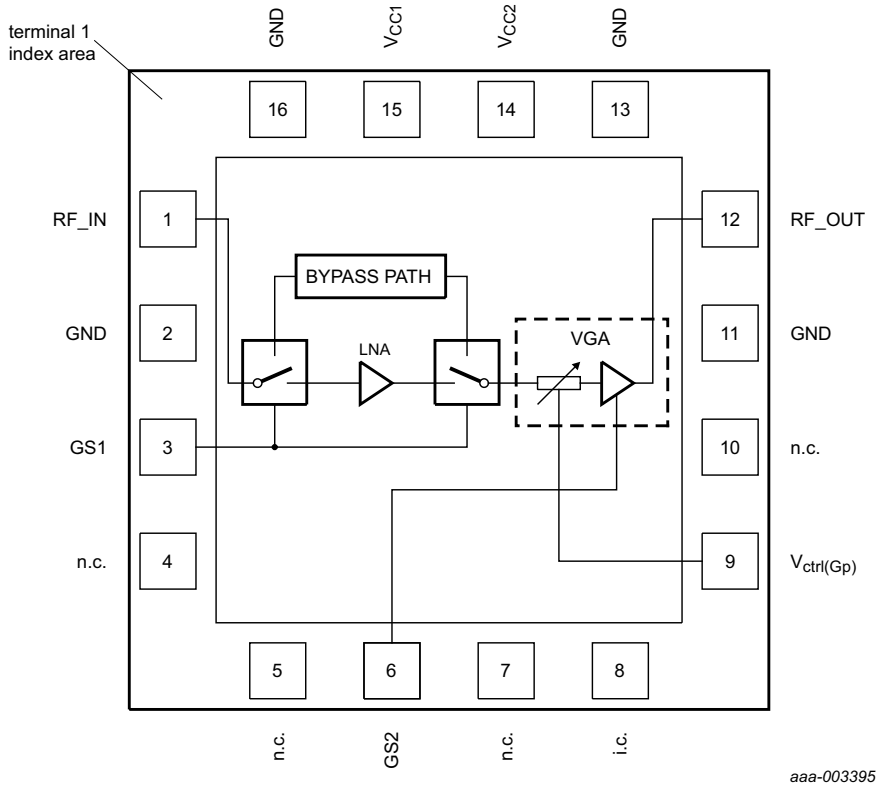



**Fig 2. Functional diagram**

# 5. Limiting values

**Table 4. Limiting values**

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

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | | 0 | 6 | V |
| $V_{ctrl(Gp)}$ | power gain control voltage | | | –1 | +3.6 | V |
| $V_{I(GS1)}$ | input voltage on pin GS1 | | | –1 | +3.6 | V |
| $V_{I(GS2)}$ | input voltage on pin GS2 | | | –1 | +3.6 | V |
| $P_{i(RF)CW}$ | continuous waveform RF input power | high gain mode; $V_{ctrl(Gp)}$ = 0 V; 1710 MHz ≤ f ≤ 1785 MHz | [1] | - | 10 | dBm |
| | | low gain mode; $V_{ctrl(Gp)}$ = 0 V; 1710 MHz ≤ f ≤ 1785 MHz | [2] | - | 15 | dBm |
| $T_j$ | junction temperature | | | - | 150 | °C |
| $T_{stg}$ | storage temperature | | | –40 | +150 | °C |
| $V_{ESD}$ | electrostatic discharge voltage | Human Body Model (HBM); according to ANSI/ESDA-JEDEC JS-001-2010-Device Testing, Human Body Model | | - | ±2 | kV |
| | | Charged Device Model (CDM); according to JEDEC standard 22-C101 | | - | ±750 | V |

[1] high gain mode: GS1 = LOW; GS2 = HIGH (see Table 9)

[2] low gain mode: GS1 = HIGH; GS2 = LOW (see Table 9)

# 6. Recommended operating conditions

**Table 5. Recommended operating conditions**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC1}$ | supply voltage 1 | | 4.75 | 5 | 5.25 | V |
| $V_{CC2}$ | supply voltage 2 | | 4.75 | 5 | 5.25 | V |
| $V_{ctrl(Gp)}$ | power gain control voltage | | 0 | - | 3.3 | V |
| $V_{I(GS1)}$ | input voltage on pin GS1 | | 0 | - | 3.3 | V |
| $V_{I(GS2)}$ | input voltage on pin GS2 | | 0 | - | 3.3 | V |
| $Z_0$ | characteristic impedance | | - | 50 | - | Ω |
| $T_{case}$ | case temperature | | –40 | - | +85 | °C |

# 7. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | | Typ | Unit |
|---|---|---|---|---|---|
| $R_{th(j-case)}$ | thermal resistance from junction to case | | [1] | 42 | K/W |

[1] The case temperature is measured at the ground solder pad.

# 8. Characteristics

**Table 7. Characteristics high gain mode**

*GS1 = LOW; GS2 = HIGH (see Table 9); $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz; $T_{amb}$ = 25 °C; input and output 50 Ω; unless otherwise specified. All RF parameters have been characterized at the device RF input and RF output terminals.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CC(tot)}$ | total supply current | | 190 | 215 | 250 | mA |
| $G_{p(min)}$ | minimum power gain | $V_{ctrl(Gp)}$ = 3.3 V | - | 13.3 | - | dB |
| $G_{p(max)}$ | maximum power gain | $V_{ctrl(Gp)}$ = 0 V | - | 37.2 | - | dB |
| $G_{p(flat)}$ | power gain flatness | 1710 MHz ≤ f ≤ 1785 MHz; 18 dB ≤ $G_p$ ≤ 35 dB | - | 0.3 | - | dB |
| NF | noise figure | $V_{ctrl(Gp)}$ = 0 V (maximum power gain) | - | 0.77 | - | dB |
| | | $G_p$ = 35 dB | - | 0.94 | 1.1 | dB |
| | | $G_p$ = 18 dB | - | 5.95 | - | dB |
| $IP3_i$ | input third-order intercept point | 2-tone; tone-spacing = 1.0 MHz | | | | |
| | | $G_p$ = 35 dB | 0 | 1.0 | - | dBm |
| | | $G_p$ = 30 dB | - | 3.6 | - | dBm |
| | | $G_p$ = 29 dB | - | 4.0 | - | dBm |
| | | $G_p$ = 18 dB | - | 4.6 | - | dBm |
| $P_{i(1dB)}$ | input power at 1 dB gain compression | $G_p$ = 35 dB | −14 | −12.3 | - | dBm |
| | | $G_p$ = 30 dB | - | −7.2 | - | dBm |
| | | $G_p$ = 29 dB | - | −6.8 | - | dBm |
| | | $G_p$ = 18 dB | - | −6.1 | - | dBm |
| $RL_{in}$ | input return loss | $V_{ctrl(Gp)}$ = 0 V (maximum power gain) | - | 24.9 | - | dB |
| | | $G_p$ = 35 dB | - | 23.5 | - | dB |
| $RL_{out}$ | output return loss | $V_{ctrl(Gp)}$ = 0 V (maximum power gain) | - | 17.5 | - | dB |
| K | Rollett stability factor | 0 GHz ≤ f ≤ 12.75 GHz | 1 | - | - | |

**Table 8. Characteristics low gain mode**

*GS1 = HIGH; GS2 = LOW (see Table 9); $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz; $T_{amb}$ = 25 °C; input and output 50 Ω; unless otherwise specified. All RF parameters have been characterized at the device RF input and RF output terminals.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CC(tot)}$ | total supply current | | 165 | 185 | 215 | mA |
| $G_{p(min)}$ | minimum power gain | $V_{ctrl(Gp)}$ = 3.3 V | - | −6.5 | - | dB |
| $G_{p(max)}$ | maximum power gain | $V_{ctrl(Gp)}$ = 0 V | - | 18.0 | - | dB |
| $G_{p(flat)}$ | power gain flatness | 1710 MHz ≤ f ≤ 1785 MHz; 3 dB ≤ $G_p$ ≤ 17 dB | - | 0.2 | - | dB |
| NF | noise figure | $G_p$ = 17 dB | - | 10.5 | - | dB |
| | | $G_p$ = 3 dB | - | 22.1 | - | dB |
| $IP3_i$ | input third-order intercept point | 2-tone; tone-spacing = 1.0 MHz | | | - | |
| | | $G_p$ = 17 dB | - | 20.9 | - | dBm |
| | | $G_p$ = 12 dB | - | 25.1 | - | dBm |
| | | $G_p$ = 11 dB | - | 25.9 | - | dBm |
| | | $G_p$ = 3 dB | - | 30.0 | - | dBm |

**Table 8. Characteristics low gain mode** *...continued*

*GS1 = HIGH; GS2 = LOW (see Table 9); $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz; $T_{amb}$ = 25 °C; input and output 50 Ω; unless otherwise specified. All RF parameters have been characterized at the device RF input and RF output terminals.*

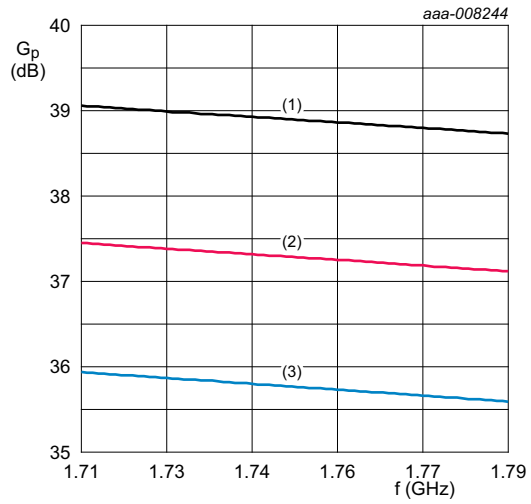
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $P_{i(1dB)}$ | input power at 1 dB gain compression | $G_p$ = 17 dB | - | 5.8 | - | dBm |
| | | $G_p$ = 12 dB | - | 9.9 | - | dBm |
| | | $G_p$ = 11 dB | - | 10.3 | - | dBm |
| | | $G_p$ = 3 dB | - | 10.9 | - | dBm |
| $RL_{in}$ | input return loss | $V_{ctrl(Gp)}$ = 0 V (maximum power gain) | - | 19.3 | - | dB |
| | | $G_p$ = 17 dB | - | 22 | - | dB |
| $RL_{out}$ | output return loss | $V_{ctrl(Gp)}$ = 0 V (maximum power gain) | - | 17.3 | - | dB |
| K | Rollett stability factor | 0 GHz ≤ f ≤ 12.75 GHz | 1 | - | - | |

**Table 9. Gain switch truth table**

*$V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; –40 °C ≤ $T_{amb}$ ≤ +85 °C*

| Gain mode | GS1 | | GS2 | |
|---|---|---|---|---|
| | logic | $V_{GS1}$ | logic | $V_{GS2}$ |
| high gain mode | LOW | 0 V to 0.5 V | HIGH | 2 V to 3.3 V |
| low gain mode | HIGH | 2 V to 3.3 V | LOW | 0 V to 0.5 V |

## 8.1 Graphs



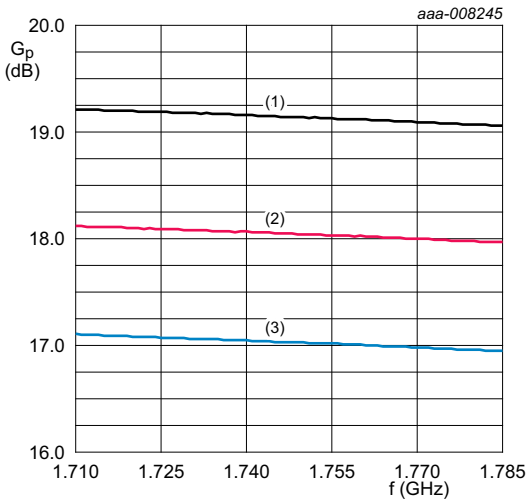

GS1 = LOW; GS2 = HIGH; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) $T_{amb}$ = –40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 3. Power gain as a function of frequency in high gain mode; typical values**



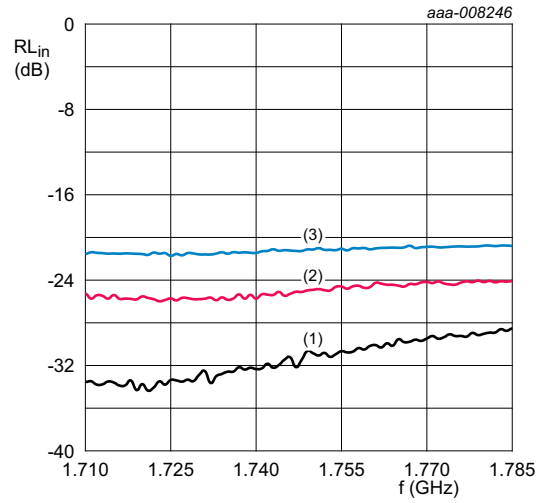

GS1 = HIGH; GS2 = LOW; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) $T_{amb}$ = –40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 4. Power gain as a function of frequency in low gain mode; typical values**



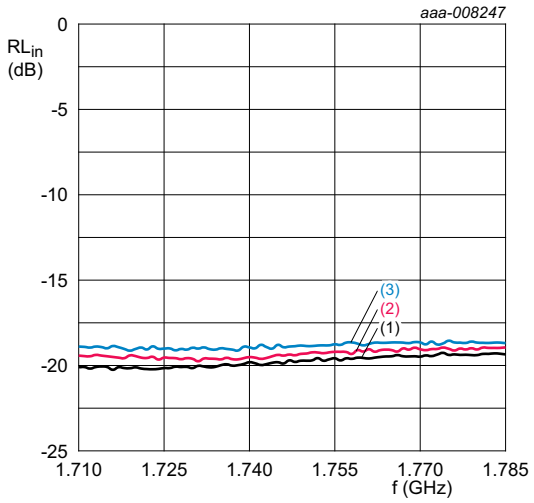

GS1 = LOW; GS2 = HIGH; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 5. Input return loss as a function of frequency in high gain mode; typical values**



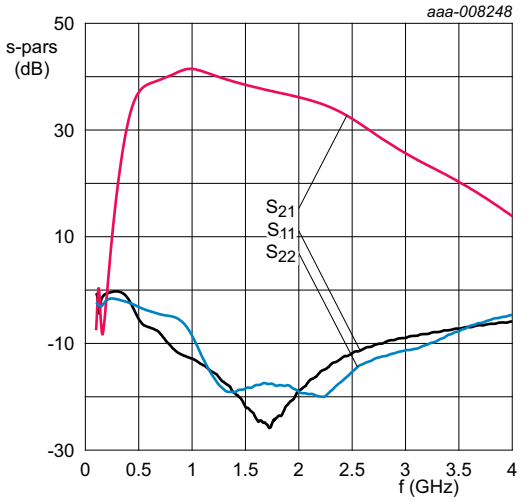

GS1 = HIGH; GS2 = LOW; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

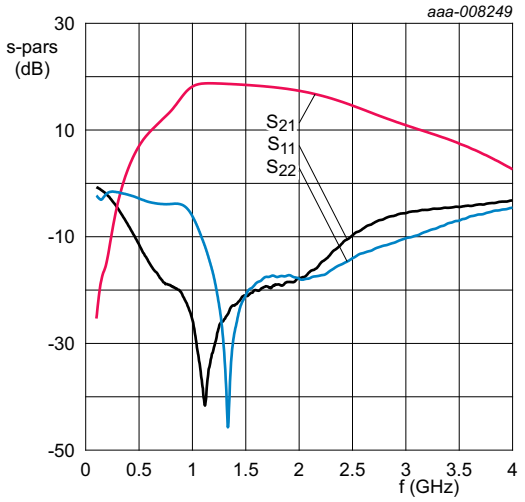
(3) $T_{amb}$ = +85 °C

**Fig 6. Input return loss as a function of frequency in low gain mode; typical values**



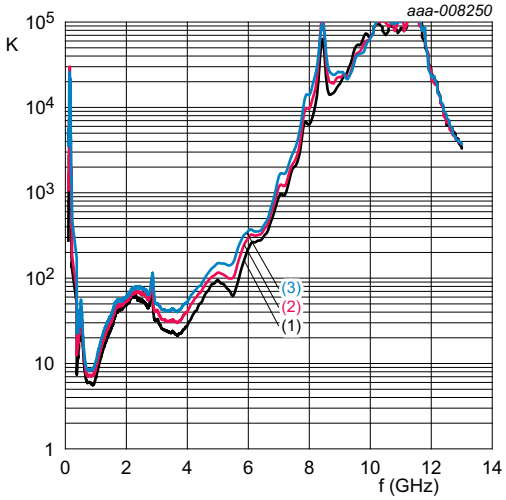

GS1 = LOW; GS2 = HIGH; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; $V_{ctrl(Gp)}$ = 0 V; $T_{amb}$ = 25 °C.

**Fig 7. S-parameters as a function of frequency in high gain mode; typical values**




GS1 = HIGH; GS2 = LOW; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; $V_{ctrl(Gp)}$ = 0 V; $T_{amb}$ = 25 °C.

**Fig 8. S-parameters as a function of frequency in low gain mode; typical values**



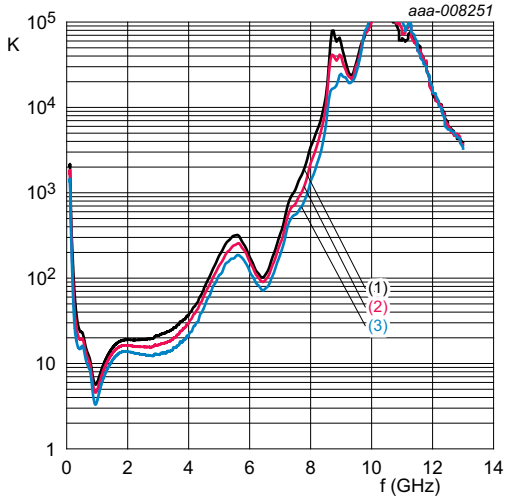

GS1 = LOW; GS2 = HIGH; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 9. Rollet stability factor as a function of frequency in high gain mode; typical values**



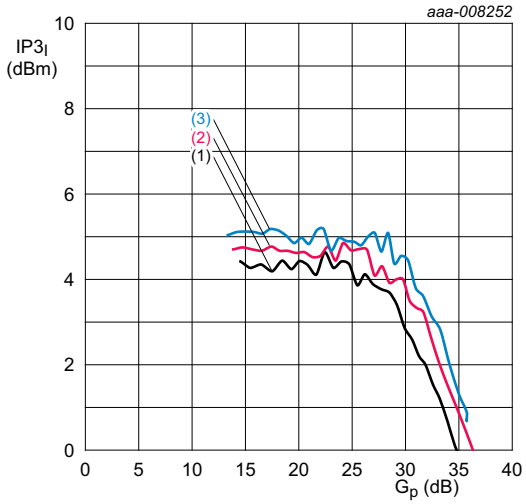

GS1 = HIGH; GS2 = LOW; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 10. Rollet stability factor as a function of frequency in low gain mode; typical values**



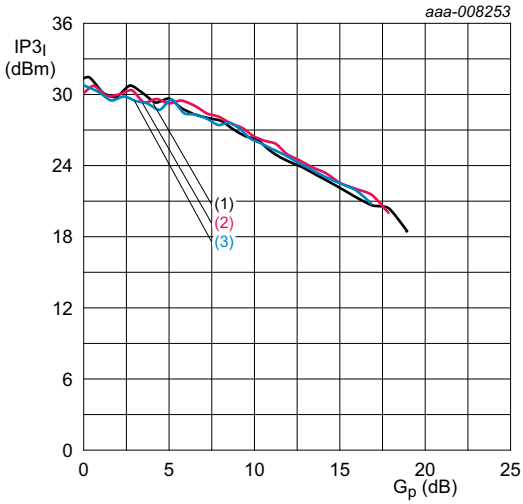

GS1 = LOW; GS2 = HIGH; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 11. Input third-order intercept point as a function of power gain in high gain mode; typical values**



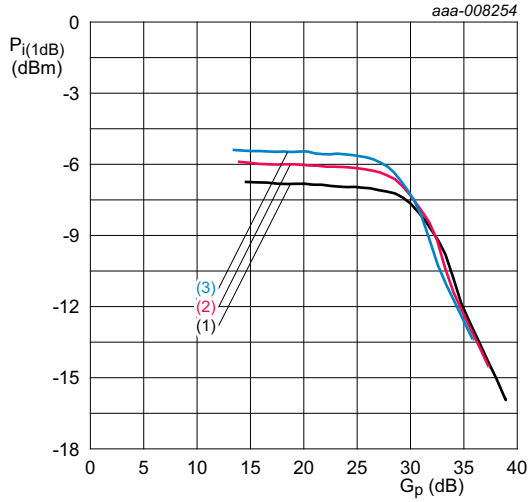

GS1 = HIGH; GS2 = LOW; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 12. Input third-order intercept point as a function of power gain in low gain mode; typical values**



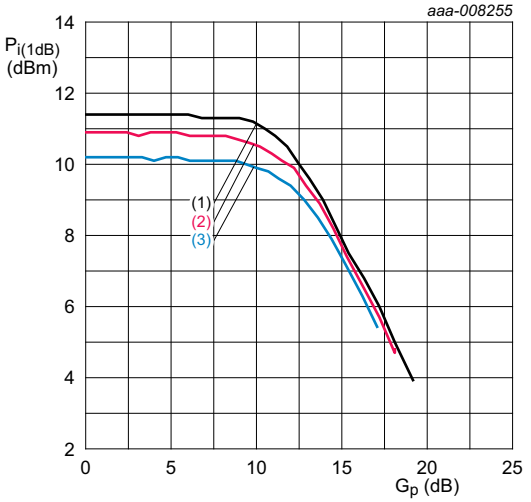

GS1 = LOW; GS2 = HIGH; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 13. Input power at 1 dB gain compression as a function of power gain in high gain mode; typical values**



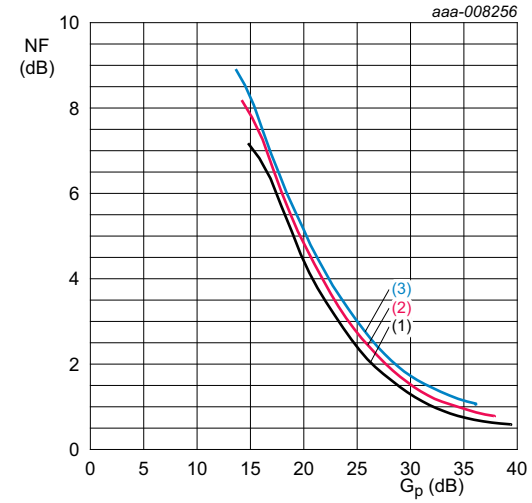

GS1 = HIGH; GS2 = LOW; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 14. Input power at 1 dB gain compression as a function of power gain in low gain mode; typical values**



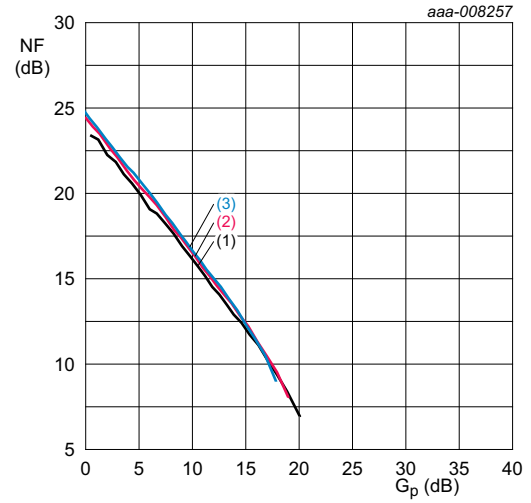

GS1 = LOW; GS2 = HIGH; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 15. Noise figure as a function of power gain in high gain mode; typical values**



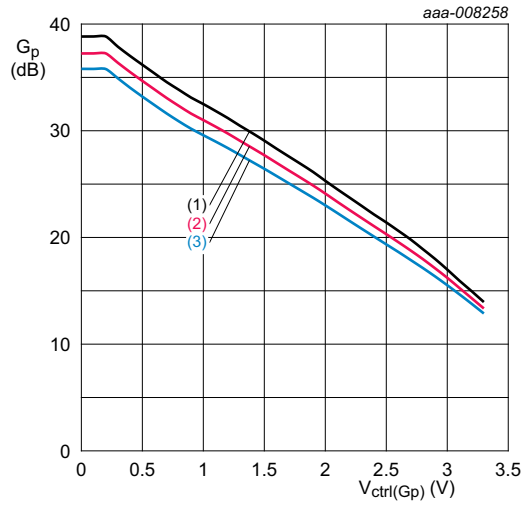

GS1 = HIGH; GS2 = LOW; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 16. Noise figure as a function of power gain in low gain mode; typical values**



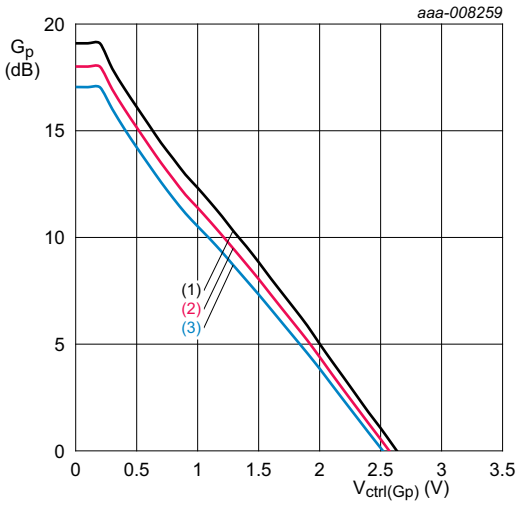

GS1 = LOW; GS2 = HIGH; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 17. Power gain as a function of power gain control voltage in high gain mode; typical values**




GS1 = HIGH; GS2 = LOW; $V_{CC1}$ = 5 V; $V_{CC2}$ = 5 V; f = 1750 MHz.

(1) $T_{amb}$ = −40 °C

(2) $T_{amb}$ = +25 °C

(3) $T_{amb}$ = +85 °C

**Fig 18. Power gain as a function of power gain control voltage in low gain mode; typical values**

# 9. Application information

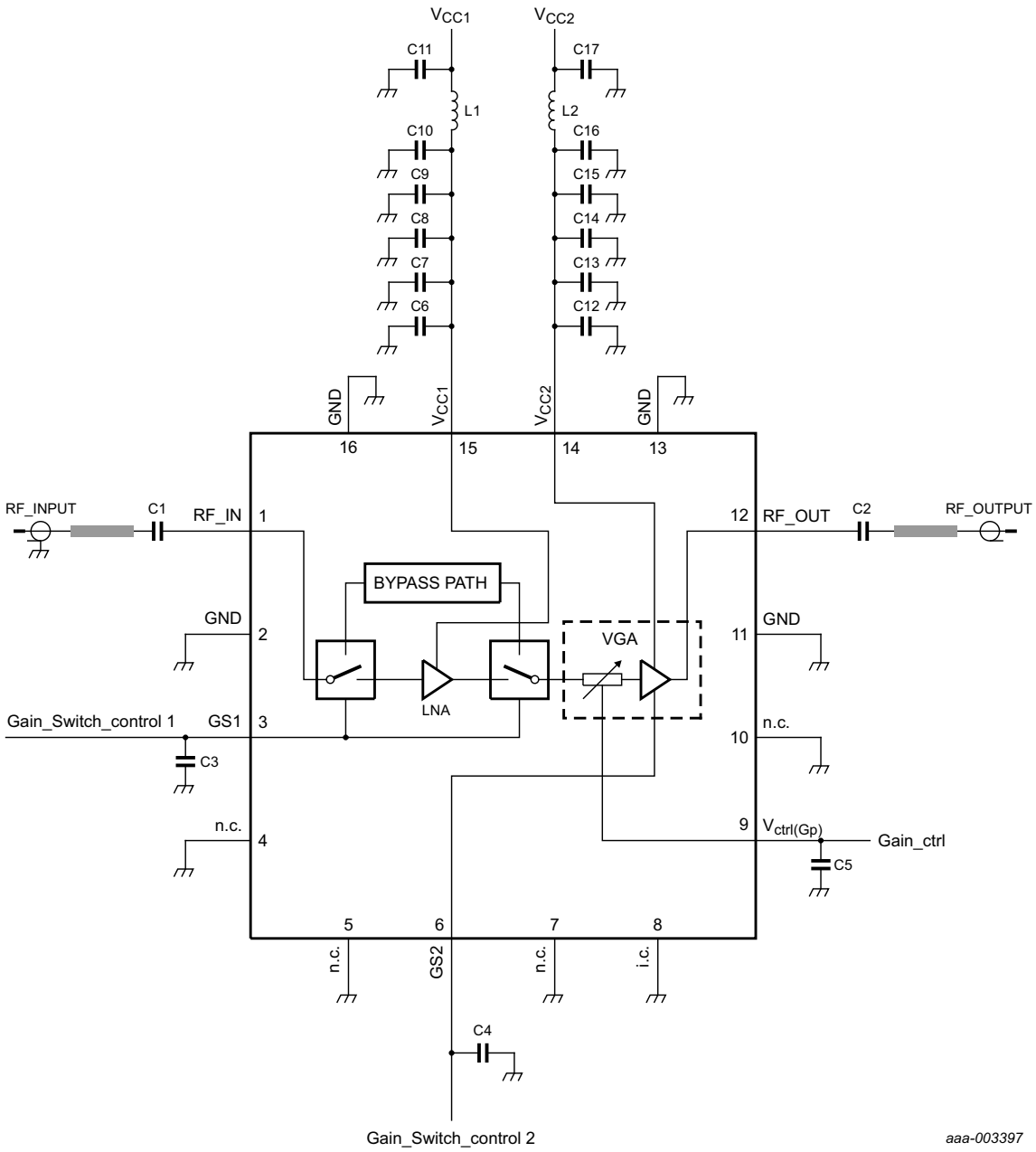
**Table 10. List of components**

*For application circuit see Figure 19.*

| Component | Description | Value | | Remarks |
|---|---|---|---|---|
| C1, C2 | capacitor | 1 nF | [1] | 0402 |
| C3, C4, C5, C6, C12 | capacitor | 100 pF | [1] | 0402 |
| C7, C8, C9, C10, | capacitor | optional | | |
| C11, C17 | capacitor | 100 nF | [1] | 0402 |
| C13, C14, C15, C16 | capacitor | optional | | |
| L1, L2 | inductor | 10 nH | [2] | 0402 |

[1] Murata GRM1555 series.

[2] Murata LQG15 series.

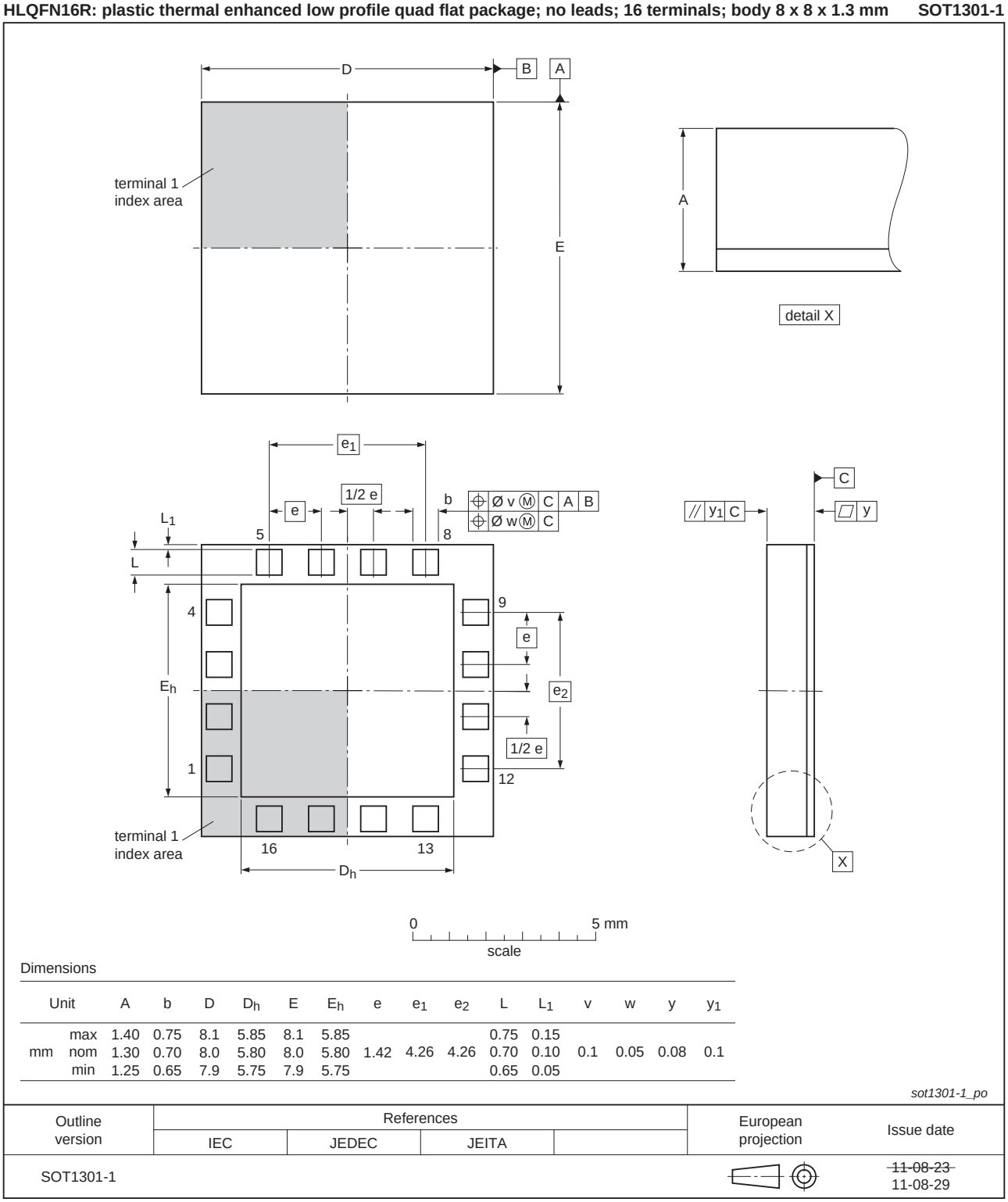



See Table 10 for a list of components.

**Fig 19. Schematic layout for application circuit**

## 10. Package outline

**HLQFN16R: plastic thermal enhanced low profile quad flat package; no leads; 16 terminals; body 8 x 8 x 1.3 mm** **SOT1301-1**




Dimensions

| Unit | | A | b | D | $D_h$ | E | $E_h$ | e | $e_1$ | $e_2$ | L | $L_1$ | v | w | y | $y_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | max | 1.40 | 0.75 | 8.1 | 5.85 | 8.1 | 5.85 | | | | 0.75 | 0.15 | | | | |
| mm | nom | 1.30 | 0.70 | 8.0 | 5.80 | 8.0 | 5.80 | 1.42 | 4.26 | 4.26 | 0.70 | 0.10 | 0.1 | 0.05 | 0.08 | 0.1 |
| | min | 1.25 | 0.65 | 7.9 | 5.75 | 7.9 | 5.75 | | | | 0.65 | 0.05 | | | | |

*sot1301-1_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT1301-1 | | | | | | ~~11-08-23~~ 11-08-29 |

**Fig 20. Package outline SOT1301-1 (HLQFN16R)**

## 11. Abbreviations

Table 11. Abbreviations

| Acronym | Description |
|---|---|
| 3G | 3rd Generation |
| ESD | ElectroStatic Discharge |
| LNA | Low Noise Amplifier |
| LTE | Long Term Evolution |

## 12. Revision history

Table 12. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| BGU7062N2 v.1 | 20130708 | Product data sheet | - | - |

# 13. Legal information

## 13.1 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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## 15. Contents





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**Date of release: 8 July 2013**
**Document identifier: BGU7062N2**

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