



# BGU8051

## Low noise high linearity amplifier

Rev. 7 — 8 June 2017

Product data sheet  
COMPANY PUBLIC

## 1 General description

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The BGU8051 is, also known as the BTS1001L, a low noise high linearity amplifier for wireless infrastructure applications, equipped with fast shutdown to support TDD systems. The LNA has a high input and output return loss and is designed to operate between 0.3 GHz and 1.5 GHz. It is housed in a 2 mm × 2 mm × 0.75 mm 8-terminal plastic thin small outline package. The LNA is ESD protected on all terminals.

## 2 Features and benefits

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- Low noise performance: NF = 0.43 dB
- High linearity performance: IP<sub>3O</sub> = 39 dBm
- High input return loss > 15 dB
- High output return loss > 20 dB
- Unconditionally stable
- Programmable bias current (via resistor)
- Small 8-terminal leadless package 2 mm × 2 mm × 0.75 mm
- ESD protection on all terminals
- Moisture sensitivity level 1
- Fast shut down to support TDD systems
- 3 V to 5 V single supply

## 3 Applications

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- Wireless infrastructure
- Low noise and high linearity applications
- LTE, W-CDMA, CDMA, GSM
- General-purpose wireless applications
- TDD or FDD systems
- Suitable for small cells



4 Quick reference data

Table 1. Quick reference data  
*f* = 900 MHz, *V*<sub>CC</sub> = 5 V, *T*<sub>amb</sub> = 25 °C, input and output 50 Ω; *R*<sub>bias</sub> = 5.1 kΩ; unless otherwise specified. All RF parameters are measured in an application board as shown in Figure 16 with components listed in Table 9 optimized for *f* = 900 MHz.

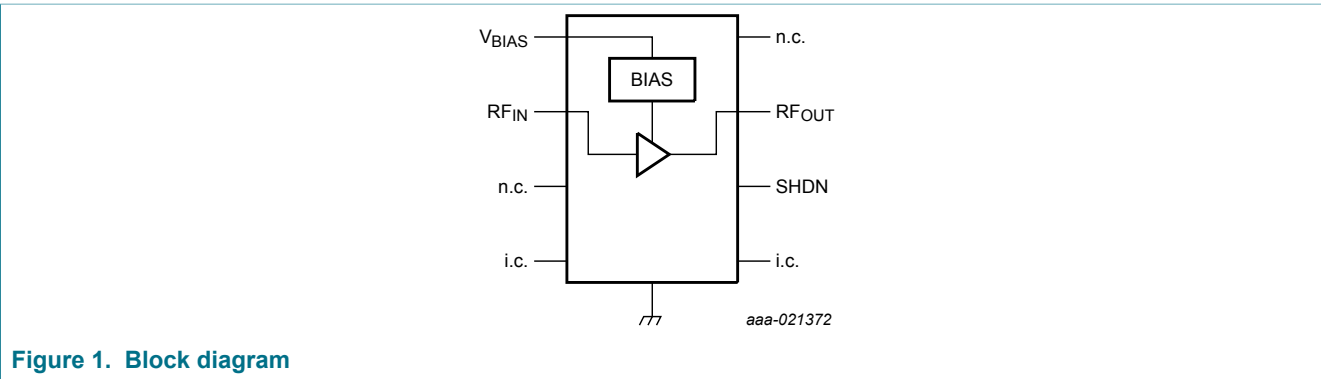
| Symbol              | Parameter                             | Conditions                                                      | Min | Typ  | Max  | Unit |
|---------------------|---------------------------------------|-----------------------------------------------------------------|-----|------|------|------|
| I <sub>CC</sub>     | supply current                        | on state                                                        | 36  | 48   | 60   | mA   |
|                     |                                       | off state                                                       | -   | 2.8  | -    | mA   |
| G <sub>ass</sub>    | associated gain                       | on state                                                        | 17  | 18.3 | 20   | dB   |
|                     |                                       | off state                                                       | -   | -21  | -    | dB   |
| NF                  | noise figure                          |                                                                 | -   | 0.43 | 0.63 | dB   |
| P <sub>L(1dB)</sub> | output power at 1 dB gain compression |                                                                 | -   | 19   | -    | dBm  |
| IP3 <sub>O</sub>    | output third-order intercept point    | 2-tone; tone spacing = 1 MHz; P <sub>i</sub> = -15 dBm per tone | 35  | 39   | -    | dBm  |

5 Ordering information

Table 2. Ordering information

| Type number | Package |                                                                                                            | Version   |
|-------------|---------|------------------------------------------------------------------------------------------------------------|-----------|
|             | Name    | Description                                                                                                |           |
| BGU8051     | HWSO8   | plastic thermal enhanced very very thin small outline package; no leads; 8 terminals; body 2 × 2 × 0.75 mm | SOT1327-1 |

6 Block diagram



7 Pinning information

7.1 Pinning

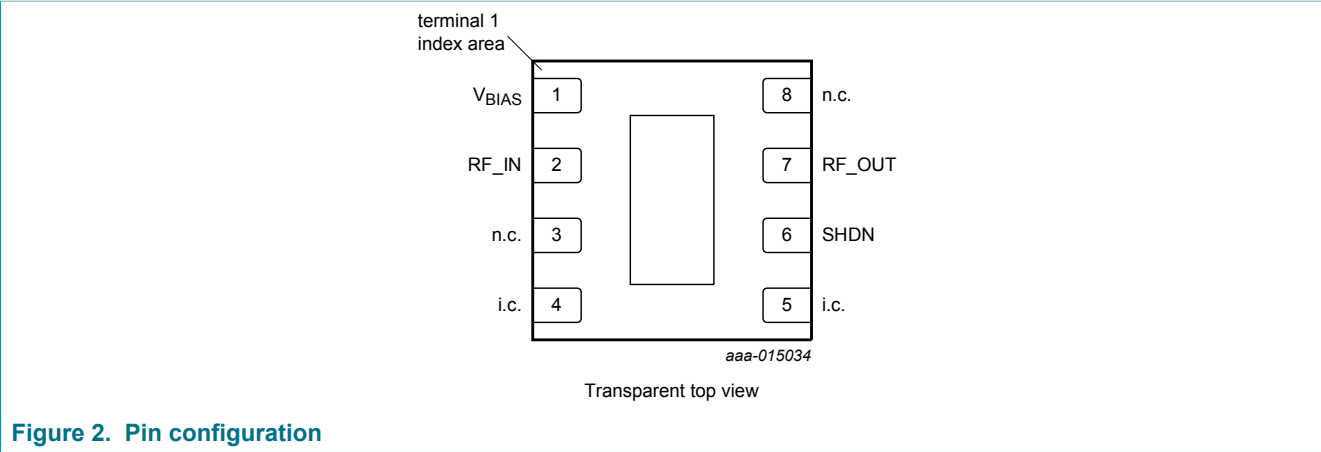


Figure 2. Pin configuration

7.2 Pin description

Table 3. Pin description

| Symbol            | Pin             | Description                                                           |
|-------------------|-----------------|-----------------------------------------------------------------------|
| V <sub>BIAS</sub> | 1               | bias voltage                                                          |
| RF_IN             | 2               | RF input                                                              |
| n.c.              | 3, 8            | not connected                                                         |
| i.c.              | 4, 5            | internally connected. Can be grounded or left open in the application |
| SHDN              | 6               | shutdown                                                              |
| RF_OUT            | 7               | RF output                                                             |
| GND               | exposed die pad | ground                                                                |

## 8 Limiting values

**Table 4. Limiting values**

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

| Symbol                | Parameter                          | Conditions                                                               | Min | Max  | Unit |
|-----------------------|------------------------------------|--------------------------------------------------------------------------|-----|------|------|
| V <sub>CC</sub>       | supply voltage                     |                                                                          | -   | 6    | V    |
| V <sub>ctrl(sd)</sub> | shutdown control voltage           |                                                                          | -   | 3    | V    |
| I <sub>CC</sub>       | supply current                     |                                                                          | -   | 85   | mA   |
| P <sub>I(RF)CW</sub>  | continuous waveform RF input power |                                                                          | -   | 20   | dBm  |
| T <sub>stg</sub>      | storage temperature                |                                                                          | -40 | +150 | °C   |
| T <sub>j</sub>        | junction temperature               |                                                                          | -   | 150  | °C   |
| P                     | power dissipation                  | T <sub>case</sub> ≤ 125 °C [1]                                           | -   | 510  | mW   |
| V <sub>ESD</sub>      | electrostatic discharge voltage    | Human Body Model (HBM) According to ANSI/ESDA/JEDEC standard JS-001-2010 | -   | 1.5  | kV   |
|                       |                                    | Charged Device Model (CDM); According to JEDEC standard 22-C101B         | -   | 2    | kV   |

[1] Case is ground solder pad.

## 9 Recommended operating conditions

**Table 5. Recommended operating conditions**

| Symbol            | Parameter                | Conditions | Min | Typ | Max  | Unit |
|-------------------|--------------------------|------------|-----|-----|------|------|
| V <sub>CC</sub>   | supply voltage           |            | 3.3 | 5   | 5.25 | V    |
| Z <sub>0</sub>    | characteristic impedance |            | -   | 50  | -    | Ω    |
| T <sub>case</sub> | case temperature         |            | -40 | -   | +85  | °C   |

## 10 Thermal characteristics

**Table 6. Thermal characteristics**

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

[1] Case is ground solder pad.

[2] Thermal resistance measured using infrared measurement technique, device mounted on application board and placed in still air.

## 11 Characteristics

**Table 7. Characteristics**

$f = 900\text{ MHz}$ ,  $V_{CC} = 5\text{ V}$ ,  $T_{amb} = 25\text{ }^{\circ}\text{C}$ , input and output  $50\text{ }\Omega$ ;  $R_{bias} = 5.1\text{ k}\Omega$ ; unless otherwise specified. All RF parameters are measured in an application board as shown in Figure 16 with components listed in Table 9 optimized for  $f = 900\text{ MHz}$ .

| Symbol         | Parameter                             | Conditions                                                                   | Min | Typ  | Max  | Unit          |
|----------------|---------------------------------------|------------------------------------------------------------------------------|-----|------|------|---------------|
| $I_{CC}$       | supply current                        | on state                                                                     | 36  | 48   | 60   | mA            |
|                |                                       | off state                                                                    | -   | 2.8  | -    | mA            |
| $G_{ass}$      | associated gain                       | on state                                                                     | 17  | 18.3 | 20   | dB            |
|                |                                       | off state                                                                    | -   | -21  | -    | dB            |
| NF             | noise figure                          |                                                                              | -   | 0.43 | 0.63 | dB            |
| $P_{L(1dB)}$   | output power at 1 dB gain compression |                                                                              | -   | 19   | -    | dBm           |
| $IP3O$         | output third-order intercept point    | 2-tone; tone spacing = 1 MHz; $P_i = -15\text{ dBm}$ per tone                | 35  | 39   | -    | dBm           |
|                |                                       | 2-tone; tone spacing = 1 MHz; $P_i = -15\text{ dBm}$ per tone <sup>[1]</sup> | 33  | 37   | -    | dBm           |
| $RL_{in}$      | input return loss                     | on state                                                                     | -   | 15.9 | -    | dB            |
|                |                                       | off state                                                                    | -   | 12.5 | -    | dB            |
| $RL_{out}$     | output return loss                    |                                                                              | -   | 29   | -    | dB            |
| ISL            | isolation                             |                                                                              | -   | 21   | -    | dB            |
| $t_{s(pon)}$   | power-on settling time                | $P_i = -20\text{ dBm}$ ; SHDN (pin 6) from HIGH to LOW <sup>[1]</sup>        | -   | 1.4  | -    | $\mu\text{s}$ |
| $t_{s(poff)}$  | power-off settling time               | $P_i = -20\text{ dBm}$ ; SHDN (pin 6) from LOW to HIGH <sup>[1]</sup>        | -   | 0.4  | -    | $\mu\text{s}$ |
| K              | Rollett stability factor              | both on state and off state up to $f = 20\text{ GHz}$                        | 1   | -    | -    |               |
| $R_{pd(SHDN)}$ | pull-down resistance on pin SHDN      |                                                                              | -   | 10   | -    | k $\Omega$    |

[1] For applications where fast switching is required, the value of C1 and C2 should be changed to 100 pF.

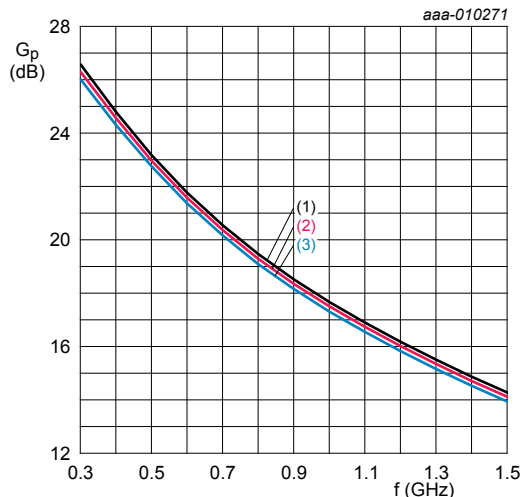
**Table 8. Shutdown control**

$V_{CC} = 5\text{ V}$ ,  $T_{amb} = 25\text{ }^{\circ}\text{C}$ , input and output  $50\text{ }\Omega$ ;  $R_{bias} = 5.1\text{ k}\Omega$ ; unless otherwise specified. All RF parameters are measured in an application board as shown in Figure 16 with components listed in Table 9 optimized for  $f = 900\text{ MHz}$ .

| State     | $V_{ctrl(sd)}$ <sup>[1]</sup> | Unit |
|-----------|-------------------------------|------|
| on state  | $\leq 0.6$                    | V    |
| off state | $\geq 1.2$                    | V    |

[1] Voltage on pin 6 (SHDN).

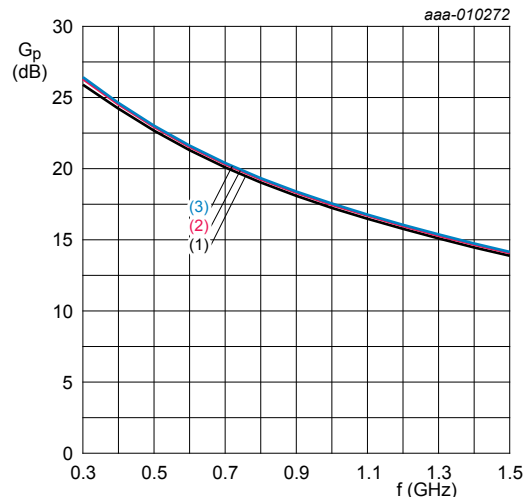
## 11.1 Graphics



$V_{CC} = 5\text{ V}$ ;  $I_{CC} = 48\text{ mA}$ .

- (1)  $T_{amb} = -40^\circ\text{C}$
- (2)  $T_{amb} = +25^\circ\text{C}$
- (3)  $T_{amb} = +85^\circ\text{C}$

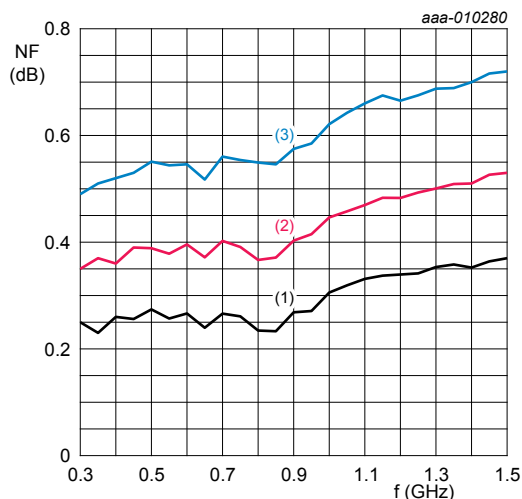
**Figure 3. Power gain as a function of frequency; typical values**



$V_{CC} = 5\text{ V}$ ;  $T_{amb} = 25^\circ\text{C}$ .

- (1)  $I_{CC} = 30\text{ mA}$
- (2)  $I_{CC} = 45\text{ mA}$
- (3)  $I_{CC} = 60\text{ mA}$

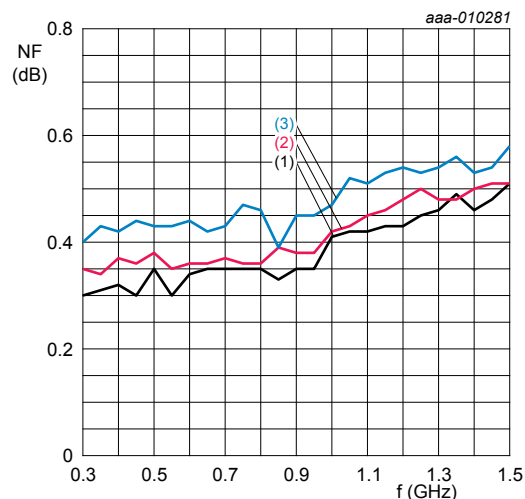
**Figure 4. Power gain as a function of frequency; typical values**



$V_{CC} = 5\text{ V}$ ;  $I_{CC} = 48\text{ mA}$ .

- (1)  $T_{amb} = -40^\circ\text{C}$
- (2)  $T_{amb} = +25^\circ\text{C}$
- (3)  $T_{amb} = +85^\circ\text{C}$

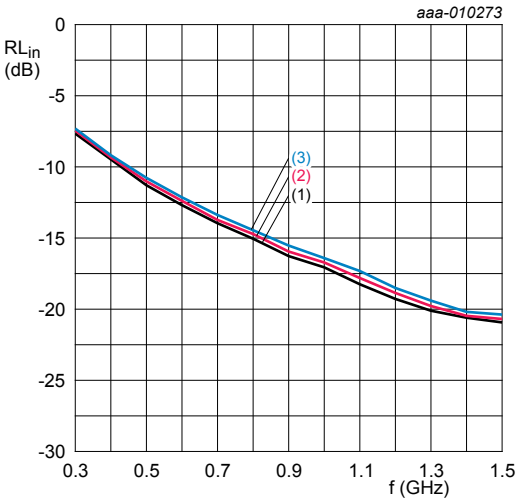
**Figure 5. Noise figure as a function of frequency; typical values**



$V_{CC} = 5\text{ V}$ ;  $T_{amb} = 25^\circ\text{C}$ .

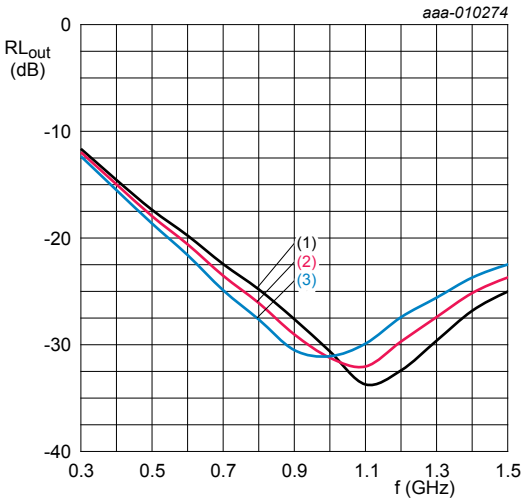
- (1)  $I_{CC} = 30\text{ mA}$
- (2)  $I_{CC} = 45\text{ mA}$
- (3)  $I_{CC} = 60\text{ mA}$

**Figure 6. Noise figure as a function of frequency; typical values**



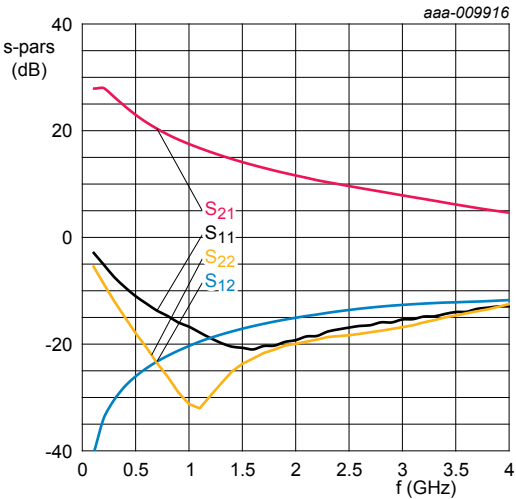
$V_{CC} = 5\text{ V}$ ;  $I_{CC} = 48\text{ mA}$ .  
(1)  $T_{amb} = -40^{\circ}\text{C}$   
(2)  $T_{amb} = +25^{\circ}\text{C}$   
(3)  $T_{amb} = +85^{\circ}\text{C}$

Figure 7. Input return loss as a function of frequency; typical values



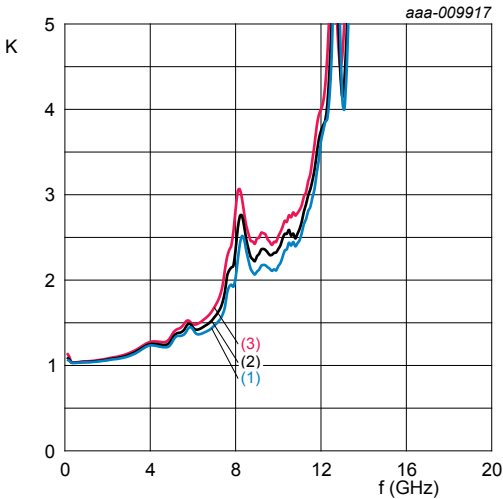
$V_{CC} = 5\text{ V}$ ;  $I_{CC} = 48\text{ mA}$ .  
(1)  $T_{amb} = -40^{\circ}\text{C}$   
(2)  $T_{amb} = +25^{\circ}\text{C}$   
(3)  $T_{amb} = +85^{\circ}\text{C}$

Figure 8. Output return loss as a function of frequency; typical values



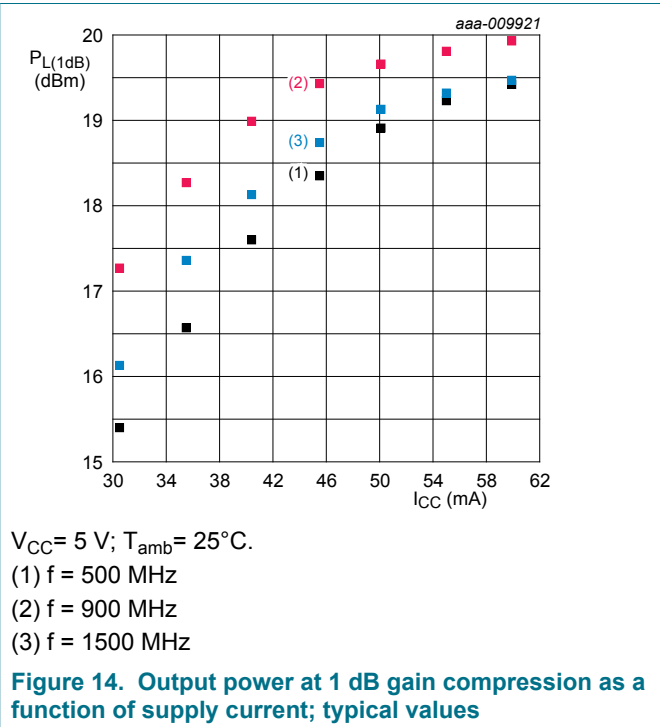
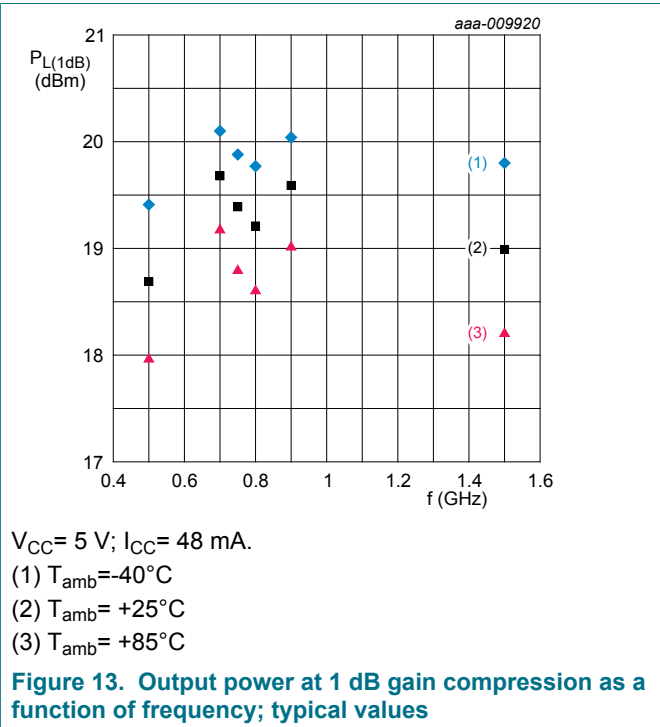
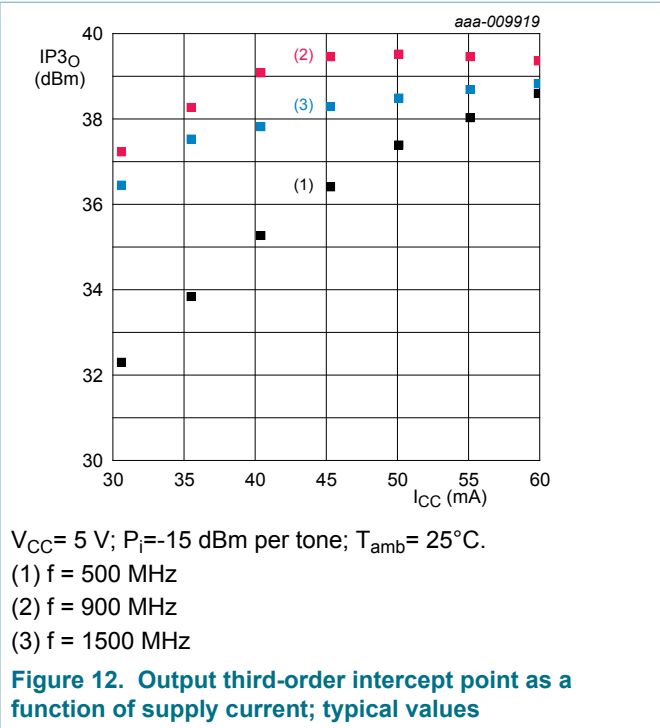
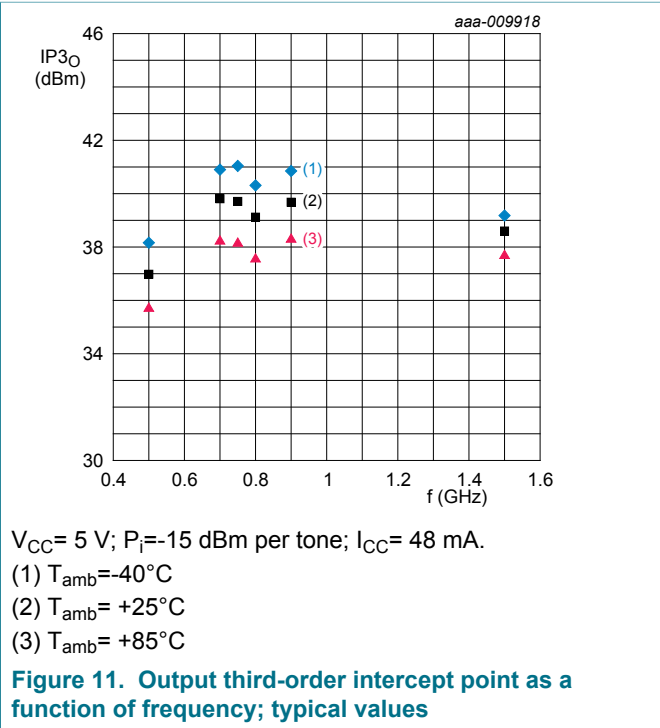
$V_{CC} = 5\text{ V}$ ;  $T_{amb} = 25^{\circ}\text{C}$ ;  $I_{CC} = 48\text{ mA}$ .

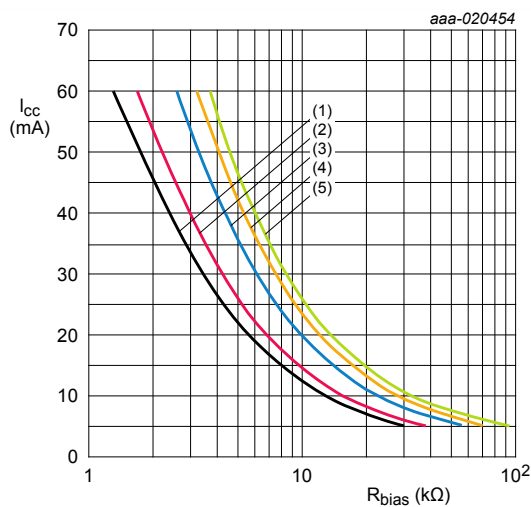
Figure 9. Wideband S-parameters as function of frequency; typical values



$V_{CC} = 5\text{ V}$ ;  $I_{CC} = 48\text{ mA}$ .  
(1)  $T_{amb} = -40^{\circ}\text{C}$   
(2)  $T_{amb} = +25^{\circ}\text{C}$   
(3)  $T_{amb} = +85^{\circ}\text{C}$

Figure 10. Rollett stability factor as a function of frequency; typical values





$T_{amb} = 25\text{ }^{\circ}\text{C}$

(1)  $V_{CC} = 3.0\text{ V}$

(2)  $V_{CC} = 3.3\text{ V}$

(3)  $V_{CC} = 4.0\text{ V}$

(4)  $V_{CC} = 4.5\text{ V}$

(5)  $V_{CC} = 5\text{ V}$

**Figure 15.**  $I_{CC}$  as a function of  $R_{bias}$ ; typical values

12 Application information

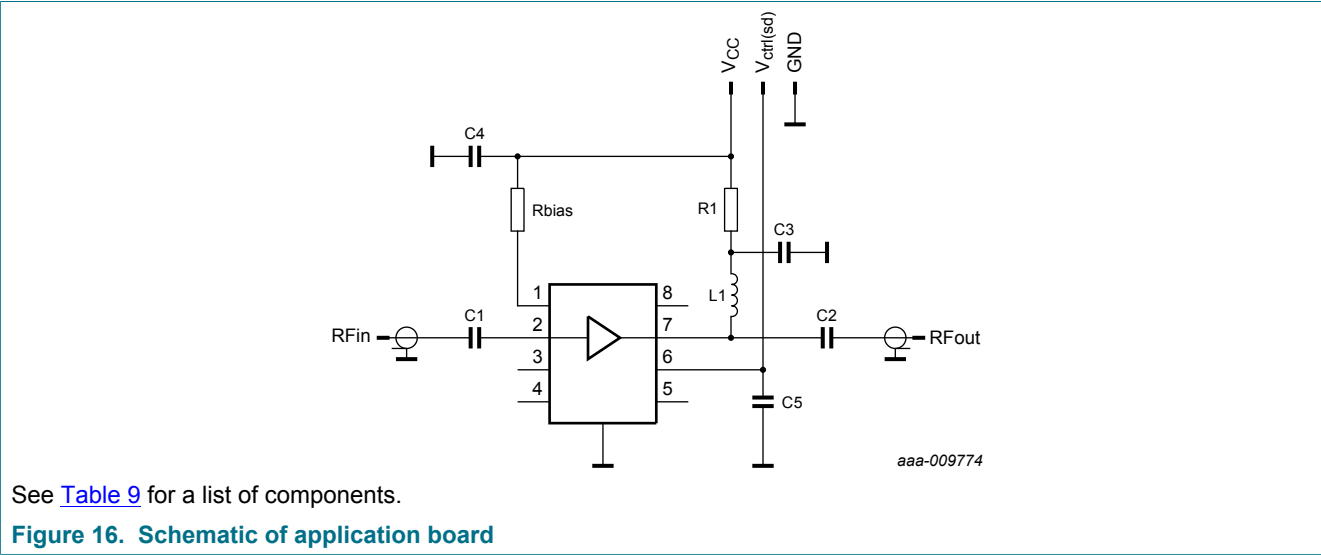


Table 9. List of components

See [Figure 16](#) for schematics.

| Component         | Description | Value  | Remarks                     |
|-------------------|-------------|--------|-----------------------------|
| C1, C2            | capacitor   | 100 nF |                             |
|                   |             | 100 pF | recommended for TDD systems |
| C3, C5            | capacitor   | 10 pF  |                             |
| C4                | capacitor   | 10 nF  |                             |
| L1                | inductor    | 33 nH  |                             |
| R1                | resistor    | 10 Ω   |                             |
| R <sub>bias</sub> | resistor    | 5.1 kΩ | V <sub>CC</sub> = 5 V       |
|                   |             | 2.3 kΩ | V <sub>CC</sub> = 3.3 V     |

**Table 10. Typical performance BGU8051 application board  $V_{CC} = 5\text{ V}$** 

All RF parameters are measured at the application board as shown in Figure 16 with the components as listed in Table 9 while optimized for:  $f = 900\text{ MHz}$ ,  $V_{CC} = 5\text{ V}$ ,  $I_{CC} = 48\text{ mA}$  and  $T_{amb} = 25\text{ }^{\circ}\text{C}$ . Unless otherwise specified.

| Symbol              | Parameter                             | Conditions | f (MHz) |      |      |      |      |      |      |  |
|---------------------|---------------------------------------|------------|---------|------|------|------|------|------|------|--|
|                     |                                       |            | 400     | 500  | 700  | 750  | 800  | 900  | 1500 |  |
| G                   | gain                                  |            | 24.6    | 23.0 | 20.4 | 19.8 | 19.3 | 18.3 | 14.1 |  |
| RL <sub>in</sub>    | input return loss                     |            | 9.3     | 11.0 | 13.7 | 14.2 | 14.7 | 15.9 | 20.7 |  |
| RL <sub>out</sub>   | output return loss                    |            | 15.0    | 18.0 | 23.5 | 24.8 | 26.1 | 29.0 | 23.7 |  |
| P <sub>L(1dB)</sub> | output power at 1 dB gain compression |            | 17.9    | 18.8 | 19.8 | 18.7 | 19.4 | 19.4 | 18.5 |  |
| IP3 <sub>O</sub>    | output third-order intercept point    | [1]        | 35.5    | 37.9 | 39.5 | 39.6 | 39.8 | 39.9 | 39.2 |  |
|                     |                                       | [1]<br>[2] | 35.6    | 37.2 | 38.8 | 39.3 | 39.1 | 39.8 | 38.2 |  |
| NF                  | noise figure                          | [3]        | 0.41    | 0.39 | 0.40 | 0.39 | 0.37 | 0.40 | 0.43 |  |

[1] For 2 Tone: tone spacing = 1MHz, Po=5 dBm per tone

[2] For applications where fast switching is required, the value of C1 and C2 should be changed to 100 pF.

[3] Connector and board losses not de-embedded.

**Table 11. Typical performance BGU8051 application board  $V_{CC} = 3.3\text{ V}$** 

All RF parameters measured at application board shown in Figure 16. The components listed in Table 9 optimized for 1900 MHz;  $V_{CC} = 3.3\text{ V}$ ;  $I_{CC} = 48\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

| Symbol              | Parameter                             | Conditions | f (MHz) |      |      |      |      |      |      |
|---------------------|---------------------------------------|------------|---------|------|------|------|------|------|------|
|                     |                                       |            | 400     | 500  | 700  | 750  | 800  | 900  | 1500 |
| G                   | gain                                  |            | 24.5    | 22.9 | 20.4 | 19.8 | 19.3 | 18.2 | 14.0 |
| RL <sub>in</sub>    | input return loss                     |            | 9.1     | 10.5 | 14.1 | 13.5 | 14.1 | 14.3 | 19.2 |
| RL <sub>out</sub>   | output return loss                    |            | 16.8    | 18.1 | 22.3 | 22.4 | 24.1 | 25.0 | 26.5 |
| P <sub>L(1dB)</sub> | output power at 1 dB gain compression |            | 15.9    | 16.4 | 16.6 | 16.1 | 16.3 | 16.3 | 15.4 |
| IP3 <sub>O</sub>    | output third-order intercept point    | [1]        | 32.4    | 34.3 | 35.5 | 34.5 | 34.1 | 35.3 | 31.6 |
|                     |                                       | [1]<br>[2] | 32.4    | 33.1 | 33.6 | 33.6 | 33.1 | 33.2 | 30.2 |
| NF                  | noise figure                          | [3]        | 0.39    | 0.40 | 0.42 | 0.43 | 0.44 | 0.44 | 0.43 |

[1] For 2 Tone: tone spacing = 1MHz, Po=5 dBm per tone

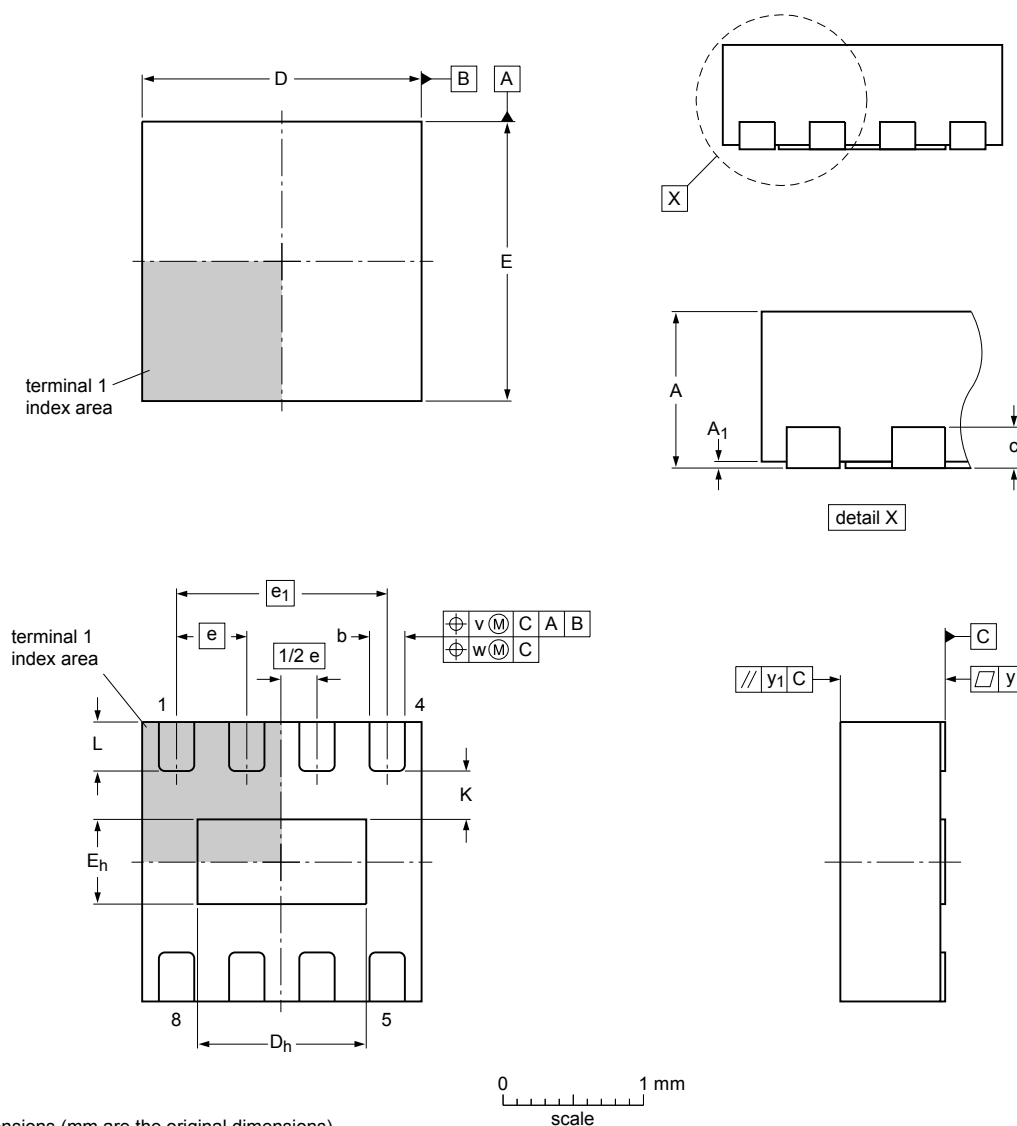
[2] For applications where fast switching is required, the value of C1 and C2 should be changed to 100 pF.

[3] Connector and board losses not de-embedded.

## 13 Package outline

**HWSON8: plastic thermal enhanced very very thin small outline package; no leads; 8 terminals; body 2 x 2 x 0.75 mm**

**SOT1327-1**



Dimensions (mm are the original dimensions)

| Unit |     | A    | 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> | K    | L    | v   | w    | y    | y <sub>1</sub> |
|------|-----|------|----------------|------|-----|------------------|----------------|------------------|----------------|-----|----------------|------|------|-----|------|------|----------------|
| mm   | max | 0.80 | 0.05           | 0.30 | 0.2 | 2.05             | 1.25           | 2.05             | 0.65           | 0.5 | 1.5            | 0.35 | 0.40 | 0.1 | 0.05 | 0.05 | 0.1            |
|      | nom | 0.75 | 0.03           | 0.25 |     | 2.00             | 1.20           | 2.00             | 0.60           |     |                |      | 0.35 |     |      |      |                |
|      | min | 0.70 | 0.00           | 0.20 |     | 1.95             | 1.15           | 1.95             | 0.55           |     |                |      | 0.30 |     |      |      |                |

### Note

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

sot1327-1 po

| Outline version | References |        |       |  | European projection                                                                   | Issue date                      |
|-----------------|------------|--------|-------|--|---------------------------------------------------------------------------------------|---------------------------------|
|                 | IEC        | JEDEC  | JEITA |  |                                                                                       |                                 |
| SOT1327-1       |            | MO-229 |       |  |  | <del>12-04-11</del><br>12-04-15 |

**Figure 17. Package outline SOT1327-1 (HWSON8)**

## 14 Abbreviations

Table 12. Abbreviations

| Acronym | Description                            |
|---------|----------------------------------------|
| CDMA    | Code Division Multiple Access          |
| ESD     | ElectroStatic Discharge                |
| FDD     | Frequency-Division Duplexing           |
| GSM     | Global System for Mobile Communication |
| LNA     | Low Noise Amplifier                    |
| LTE     | Long-Term Evolution                    |
| RF      | Radio Frequency                        |
| TDD     | Time-Division Duplexing                |
| W-CDMA  | Wideband Code Division Multiple Access |

## 15 Revision history

Table 13. Revision history

| Document ID    | Release date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Data sheet status  | Change notice | Supersedes  |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------|-------------|
| BGU8051 v.7    | 20170608                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Product data sheet | -             | BGU8051 v.6 |
| Modifications: | <ul style="list-style-type: none"> <li><a href="#">Table 4</a>: the maximum value of <math>V_{ESD}</math> has been changed into 1.5 kV</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |               |             |
| BGU8051 v.6    | 20170502                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Product data sheet | -             | BGU8051 v.5 |
| Modifications: | <ul style="list-style-type: none"> <li><a href="#">Table 5 "Recommended operating conditions"</a>: the minimum value of <math>V_{CC}</math> has been changed into 3.3 V</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                    |                    |               |             |
| BGU8051 v.5    | 20170120                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Product data sheet | -             | BGU8051 v.4 |
| Modifications: | <ul style="list-style-type: none"> <li><a href="#">Section 1 "General description"</a>: added BTS1001L according to our new naming convention</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                              |                    |               |             |
| BGU8051 v.4    | 20160418                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Product data sheet | -             | BGU8051 v.3 |
| Modifications: | <ul style="list-style-type: none"> <li>3 V to 5 V single supply, added to <a href="#">Section 2 "Features and benefits"</a></li> <li>An additional curve added to <a href="#">Figure "Output power at 1 dB gain compression as a function of supply current; typical values" on page 8</a></li> <li>Added <a href="#">Table 11 "Typical performance BGU8051 application board VCC = 3.3 V" on page 11</a></li> <li>Added <a href="#">Figure 1 "Block diagram" on page 2</a></li> <li>Added remark to <math>R_{bias}</math> in <a href="#">Table 9 "List of components"</a></li> </ul> |                    |               |             |
| BGU8051 v.3    | 20140929                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Product data sheet | -             | BGU8051 v.2 |
| Modifications: | <ul style="list-style-type: none"> <li>Figure 1 on page 2: figure has been corrected</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                    |               |             |
| BGU8051 v.2    | 20131230                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Product data sheet | -             | BGU8051 v.1 |
| BGU8051 v.1    | 20131127                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Product data sheet | -             | -           |

## 16 Legal information

### 16.1 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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