# BGU7033

## 1 GHz wideband low-noise amplifier with bypass

Rev. 2 — 13 September 2010 Product data sheet

## 1. Product profile

### 1.1 General description

The BGU7033 MMIC is a wideband amplifier with selectable gain and bypass mode. It is designed specifically for high linearity, low noise applications over a frequency range of 40 MHz to 1 GHz. It is especially suited to Set-Top Box applications.

The LNA is housed in a 6-pin SOT363 plastic SMD package.

**CAUTION**

This device is sensitive to ElectroStatic Discharge (ESD). Therefore care should be taken during transport and handling.

### 1.2 Features and benefits

- Internally biased
- Programmable gain and bypass modes: $G_p$ = 10 dB, $G_p$ = 5 dB and bypass
- Flat gain between 40 MHz and 1 GHz
- Noise figure of 4.5 dB
- High linearity with an $IP3_O$ of 29 dBm
- 75 Ω input and output impedance
- Power-down during bypass mode
- Bypass mode current consumption < 5 mA
- ESD protection > 2 kV Human Body Model (HBM) on all pins

### 1.3 Applications

- Terrestrial and cable Set-Top Boxes (STB)
- Silicon and “Can” tuners
- Personal and Digital Video Recorders (PVR and DVR)
- Home networking and in-house signal distribution

### 1.4 Quick reference data

**Table 1. Quick reference data**

*$T_{amb}$ = 25 °C; typical values at $V_{CC}$ = 5 V; $Z_S$ = $Z_L$ = 75 Ω; $R_{bias}$ = 43 Ω; 40 MHz ≤ $f_1$ ≤ 1000 MHz.*

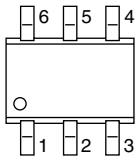
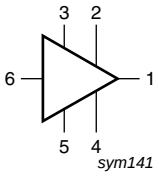
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | RF input AC coupled | | 4.75 | 5.0 | 5.25 | V |
| $I_{CC(tot)}$ | total supply current | $G_p$ = 5 dB mode | [1] | - | 43 | - | mA |
| | | $G_p$ = 10 dB mode | [1] | - | 43 | - | mA |
| | | bypass mode | [1] | - | 4 | - | mA |
| $T_{amb}$ | ambient temperature | | | −10 | - | +70 | °C |
| NF | noise figure | $G_p$ = 10 dB mode | [1] | - | 4.5 | - | dB |
| | | bypass mode | [1] | - | 2.5 | - | dB |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | 1 GHz; $G_p$ = 10 dB mode | [1] | - | 14 | - | dBm |
| $IP3_O$ | output third-order intercept point | $G_p$ = 10 dB mode | [1][2] | - | 29 | - | dBm |

[1] Mode depends on setting of $V_{CTRL1}$ and $V_{CTRL2}$; see Table 8.

[2] The fundamental frequency ($f_1$) is 1000 MHz. The intermodulation product (IM3) is $2 \times f_2 - f_1$, where $f_2 = f_1 \pm 1$ MHz. Input power $P_i$ = −10 dBm.

## 2. Pinning information

**Table 2. Pinning**

| Pin | Description | Simplified outline | Graphic symbol |
|---|---|---|---|
| 1 | RF_OUT |  |  |
| 2 | $V_{CC}$ | | |
| 3 | CTRL1 (gain control) | | |
| 4 | CTRL2 (bypass control) | | |
| 5 | GND | | |
| 6 | RF_IN | | |



## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BGU7033 | - | plastic surface-mounted package; 6 leads | SOT363 |

## 4. Marking

**Table 4. Marking codes**

| Type number | Marking code |
|---|---|
| BGU7033 | SE% |

Note: % character indicates the location of production.

## 5. Limiting values

**Table 5. Limiting values**

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

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | RF input AC coupled | | –0.6 | 5.25 | V |
| $V_{ctrl(Gp)}$ | power gain control voltage | pin CTRL1 | [1] | 0 | $V_{CC}$ | V |
| $V_{ctrl(bp)}$ | bypass control voltage | pin CTRL2 | [2] | 0 | $V_{CC}$ | V |
| $I_{CC(tot)}$ | total supply current | | | - | 60 | mA |
| $P_{tot}$ | total power dissipation | $T_{sp} \leq 100$ °C | [3] | - | 250 | mW |
| $P_i$ | input power | single tone | | - | 10 | dBm |
| $T_{stg}$ | storage temperature | | | –65 | +150 | °C |
| $T_j$ | junction temperature | | | - | 150 | °C |
| $T_{amb}$ | ambient temperature | | | –10 | +70 | °C |
| $V_{ESD}$ | electrostatic discharge voltage | Human Body Model (HBM); according to JEDEC standard 22-A114E | | 2 | - | kV |

[1] $V_{ctrl(Gp)}$ must not exceed $V_{CC}$; $I_{CTRL1}$ must be limited to 5 mA (maximum).

[2] $V_{ctrl(bp)}$ must not exceed $V_{CC}$; $I_{CTRL2}$ must be limited to 5 mA (maximum).

[3] $T_{sp}$ is the temperature at the solder point of the ground lead.

**Remark:** $V_{ctrl(Gp)}$ must not exceed $V_{CC}$; $I_{CTRL1}$ must be limited to a maximum of 5 mA.

**Remark:** $V_{ctrl(bp)}$ must not exceed $V_{CC}$; $I_{CTRL2}$ must be limited to a maximum of 5 mA.

## 6. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | Typ | Unit |
|---|---|---|---|---|
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | 240 | K/W |

## 7. Characteristics

**Table 7. Characteristics**

*$T_{amb}$ = 25 °C; typical values at $V_{CC}$ = 5 V; $Z_S = Z_L$ = 75 Ω; $R_{bias}$ = 43 Ω; 40 MHz ≤ $f_1$ ≤ 1000 MHz.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | RF input AC coupled | | 4.75 | 5.0 | 5.25 | V |
| $I_{CC(tot)}$ | total supply current | $G_p$ = 5 dB mode | [1][2] | - | 43 | - | mA |
| | | $G_p$ = 10 dB mode | [1][2] | - | 43 | - | mA |
| | | bypass mode | [1][2] | - | 4 | - | mA |
| $\|s_{21}\|^2$ | insertion power gain | $G_p$ = 5 dB mode | [1] | - | 5 | | dB |
| | | $G_p$ = 10 dB mode | [1] | - | 10 | - | dB |
| | | bypass mode | [1] | - | –2 | - | dB |
| $SL_{sl}$ | slope straight line | | | - | –1 | - | dB |

**Table 7. Characteristics** *...continued*

*$T_{amb}$ = 25 °C; typical values at $V_{CC}$ = 5 V; $Z_S$ = $Z_L$ = 75 Ω; $R_{bias}$ = 43 Ω; 40 MHz ≤ $f_1$ ≤ 1000 MHz.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| FL | flatness of frequency response | | | - | –0.2 | - | dB |
| NF | noise figure | $G_p$ = 5 dB mode | [1] | - | 6.0 | - | dB |
| | | $G_p$ = 10 dB mode | [1] | - | 4.5 | - | dB |
| | | bypass mode | [1] | - | 2.5 | - | dB |
| $RL_{in}$ | input return loss | $G_p$ = 5 dB mode | [1] | - | 17 | - | dB |
| | | $G_p$ = 10 dB mode | [1] | - | 18 | - | dB |
| | | bypass mode | [1] | - | 8 | - | dB |
| $RL_{out}$ | output return loss | $G_p$ = 5 dB mode | [1] | - | 12 | - | dB |
| | | $G_p$ = 10 dB mode | [1] | - | 12 | - | dB |
| | | bypass mode | [1] | - | 8 | - | dB |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | 1 GHz; $G_p$ = 5 dB mode | [1] | - | 9 | - | dBm |
| | | $G_p$ = 10 dB mode | [1] | - | 14 | - | dBm |
| $IP3_O$ | output third-order intercept point | $G_p$ = 5 dB mode | [1][2] | - | 29 | - | dBm |
| | | $G_p$ = 10 dB mode | [1][2] | - | 29 | - | dBm |
| | | bypass mode | [1][2] | - | 29 | - | dBm |

[1] Mode depends on setting of $V_{CTRL1}$ and $V_{CTRL2}$; see Table 8.

[2] The fundamental frequency ($f_1$) is 1000 MHz. The intermodulation product (IM3) is $2 \times f_2 - f_1$, where $f_2 = f_1 \pm 1$ MHz. Input power $P_i$ = –10 dBm.

**Table 8. Gain selection (pins CTRL1, CTRL2)**

*–10 °C ≤ $T_{amb}$ ≤ +70 °C; recommended power-up condition: $V_{CTRL1}$ and $V_{CTRL2}$ = logic 0 or < 0.7 V.*

| $V_{CTRL1}$ ($V_{ctrl(Gp)}$) (V) | $V_{CTRL2}$ ($V_{ctrl(bp)}$) (V) | Mode |
|---|---|---|
| ≤ 0.7 | ≤ 0.7 | bypass |
| ≥ 4.3 | ≤ 0.7 | bypass |
| ≤ 0.7 | ≥ 4.3 | $G_p$ = 5 dB |
| ≥ 4.3 | ≥ 4.3 | $G_p$ = 10 dB |

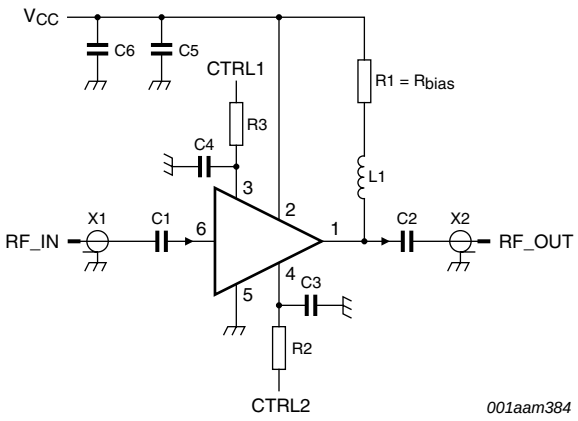
**Remark:** $V_{ctrl(Gp)}$ must not exceed $V_{CC}$; $I_{CTRL1}$ must be limited to a maximum of 5 mA.

**Remark:** $V_{ctrl(bp)}$ must not exceed $V_{CC}$; $I_{CTRL2}$ must be limited to a maximum of 5 mA.

# 8. Application information

Other applications are possible. Please contact your local sales representative for more information. Application notes are available on the NXP website.

## 8.1 Application circuit

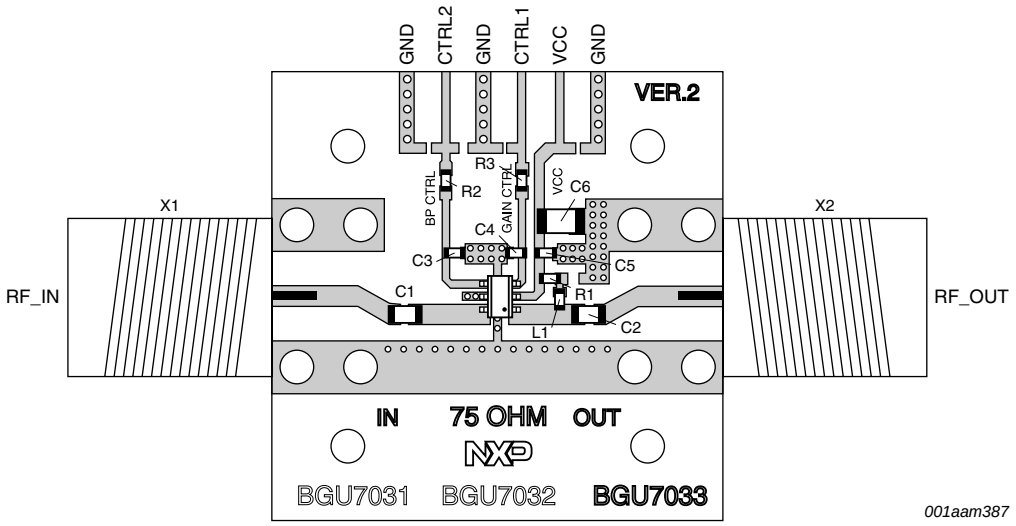



Components are listed in Table 9.

**Fig 1. BGU7033 application circuit**

All control and supply lines must be decoupled properly. The decoupling capacitors must be placed as close to the device as possible.

## 8.2 Application circuit board layout




PCB material = FR4.

PCB thickness = 1.6 mm.

PCB size = 30 mm × 30 mm.

$\varepsilon_r$ = 4.5; thickness of copper layer = 35 μm.

Components are listed in Table 9.

**Fig 2. BGU7033 application circuit board layout**

**Table 9. List of components**

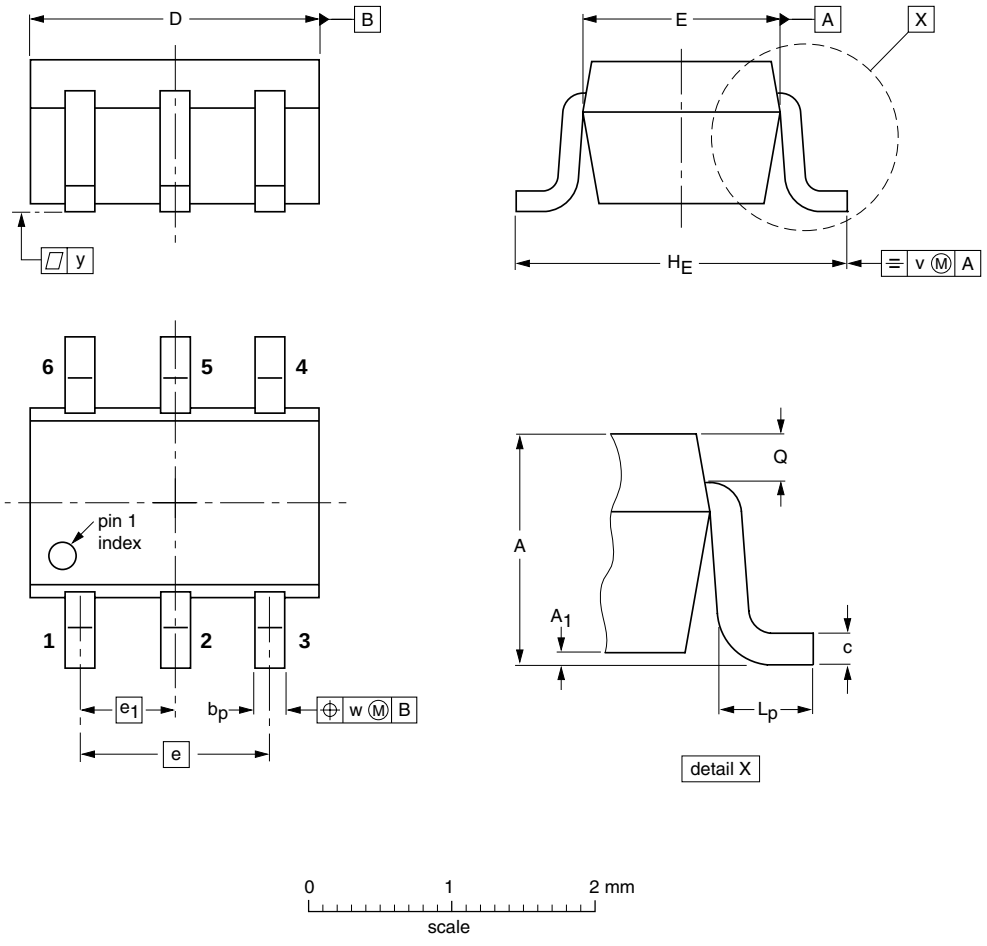
*See Figure 1 and Figure 2.*

| Component | Description | Value | | Remarks | Function |
|---|---|---|---|---|---|
| C1, C2 | capacitor | 10 nF | | | DC blocking |
| C3, C4, C5 | capacitor | 10 nF | | | decoupling |
| C6 | capacitor | 10 μF | | | decoupling |
| L1 | chip ferrite bead | 1.5 kΩ | [1] | Murata BLM18HE152SN1DF | RF choke |
| R1 | resistor | 43 Ω | [1] | $R_{bias}$ | bias setting |
| R2, R3 | resistor | 1.8 kΩ | | | current limiting |
| X1, X2 | connector | 75 Ω | | F-connector, edge mount PCB reflow type, Bomar 861V509ERG | input/output |

[1] L1 and R1 must have a power rating of 0.1 W or higher.

## 9. Package outline

**Plastic surface-mounted package; 6 leads** **SOT363**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ max | $b_p$ | c | D | E | e | $e_1$ | $H_E$ | $L_p$ | Q | v | w | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.1<br>0.8 | 0.1 | 0.30<br>0.20 | 0.25<br>0.10 | 2.2<br>1.8 | 1.35<br>1.15 | 1.3 | 0.65 | 2.2<br>2.0 | 0.45<br>0.15 | 0.25<br>0.15 | 0.2 | 0.2 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT363 | | | SC-88 | | | ~~04-11-08~~<br>06-03-16 |

**Fig 3. Package outline SOT363**

## 10. Abbreviations

Table 10. Abbreviations

| Acronym | Description |
|---|---|
| AC | Alternating Current |
| DC | Direct Current |
| LNA | Low-Noise Amplifier |
| MMIC | Monolithic Microwave Integrated Circuit |
| PCB | Printed-Circuit Board |
| RF | Radio Frequency |
| SMD | Surface-Mounted Device |

## 11. Revision history

Table 11. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| BGU7033 v.2 | 20100913 | Product data sheet | - | BGU7033 v.1 |
| Modifications: | • The status of this data sheet has been changed to Product data sheet. | | | |
| BGU7033 v.1 | 20100816 | Preliminary data sheet | - | - |

# 12. Legal information

## 12.1 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. |
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| Product [short] data sheet | Production | This document contains the product specification. |

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[2] The term 'short data sheet' is explained in section "Definitions".

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## 14. Contents





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Document identifier: BGU7033

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