

BGA3012

1 GHz 12 dB gain wideband amplifier MMIC

Rev. 3 — 26 September 2013

Product data sheet

1. Product profile

1.1 General description

The BGA3012 MMIC is a wideband amplifier with internal biasing. It is designed specifically for high linearity CATV line extenders and drop amplifiers over a frequency range of 5 MHz to 1006 MHz. The LNA is housed in a lead free 3-pin SOT89 package.

1.2 Features and benefits

- Internally biased
- Flat gain
- High linearity with an IP_{3O} of 40 dBm and an IP_{2O} of 60 dBm
- Noise figure of 3.1 dB
- 75 Ω input and output impedance
- Operating from 5 V to 8 V supply

1.3 Applications

- General wideband amplifiers.
- CATV return amplifier; frequency ranges of 5 MHz to 300 MHz.
- CATV infrastructure network driver in optical nodes (FTTx), distribution amplifiers, trunk amplifiers and line extenders in the frequency range from 40 MHz to 1006 MHz.
- The product is ideally suited for applications as drop amplifiers in CATV distribution systems such as FTTH

1.4 Quick reference data

Table 1. Quick reference data

Bandwidth 40 MHz to 1006 MHz; $T_{amb} = 25\text{ }^{\circ}\text{C}$; typical values at $V_{CC} = 8\text{ V}$; $Z_S = Z_L = 75\ \Omega$; $R1 = 100\ \Omega$; $R2 = 300\ \Omega$.

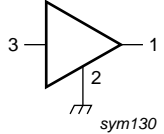
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------|---------------------------------------|----------------------|--------|-----|-----|--------------------|
| V_{CC} | supply voltage | RF input AC coupled | 7.6 | 8 | 8.4 | V |
| $I_{CC(tot)}$ | total supply current | | - | 110 | 125 | mA |
| T_{amb} | ambient temperature | | -40 | - | +85 | $^{\circ}\text{C}$ |
| NF | noise figure | $f = 500\text{ MHz}$ | - | 3.1 | 3.6 | dB |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | 21.5 | 23 | - | dBm |
| IP_{3O} | output third-order intercept point | | [1] 36 | 40 | - | dBm |
| IP_{2O} | output second-order intercept point | | [2] - | 60 | - | dBm |

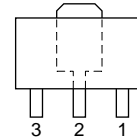
- [1] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 1006 MHz. The intermodulation product (IM3) is $2 \times f_2 - f_1$, where $f_2 = f_1 \pm 6\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.
- [2] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 1006 MHz. The intermodulation product (IM2) is $|f_2 - f_1|$, with $40\text{ MHz} < |f_1 - f_2| < 1006\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.



2. Pinning information

Table 2. Pinning

| Pin | Description | Simplified outline | Graphic symbol |
|-----|--------------------|--------------------|---|
| 1 | RF_OUT and biasing | [1] |  |
| 2 | GND | [2] | |
| 3 | RF_IN | [1] | |



[1] This pin is DC-coupled and requires an external DC-blocking capacitor.

[2] The center metal base of the SOT89 also functions as heatsink for the power amplifier.

3. Ordering information

Table 3. Ordering information

| Type number | Package | | Version |
|-------------|---------|--|---------|
| | Name | Description | |
| BGA3012 | - | plastic surface-mounted package; exposed die pad for good heat transfer; 3 leads | SOT89 |
| OM7858 | EVB | 1 GHz 12 dB gain wideband amplifier application | - |
| OM7862 | EVB | 5 MHz to 300 MHz 12 dB reverse amplifier application | - |
| OM7866 | EVB | 40 MHz to 1006 MHz push-pull amplifier application | - |

4. Marking

Table 4. Marking codes

| Type number | Marking code | Description |
|-------------|--------------|-----------------------|
| BGA3012 | *6W | * = W : made in China |

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 | +15 | V |
| P _i | input power | single tone | - | 20 | dBm |
| T _{stg} | storage temperature | | -65 | +150 | °C |
| T _j | junction temperature | | - | 150 | °C |
| T _{amb} | ambient temperature | | -40 | +85 | °C |
| V _{ESD} | electrostatic discharge voltage | Human Body Model (HBM); According JEDEC standard 22-A114E | 2 | - | kV |
| | | Charged Device Model (CDM); According JEDEC standard 22-C101B | 2 | - | kV |

6. Thermal characteristics

Table 6. Thermal characteristics

| Symbol | Parameter | Conditions | Typ | Unit |
|----------------|--|------------|-----|------|
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | 40 | K/W |

7. Characteristics

7.1 Forward application

Table 7. Characteristics at $V_{CC} = 8\text{ V}$

Bandwidth 40 MHz to 1006 MHz; $T_{amb} = 25\text{ °C}$; typical values at $V_{CC} = 8\text{ V}$; $Z_S = Z_L = 75\ \Omega$; $R1 = 100\ \Omega$; $R2 = 300\ \Omega$.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------|---------------------------------------|-----------------------|------|-----|-----|------|
| V_{CC} | supply voltage | RF input AC coupled | 7.6 | 8 | 8.4 | V |
| $I_{CC(tot)}$ | total supply current | | - | 110 | 125 | mA |
| $ S_{21} ^2$ | insertion power gain | | 11 | 12 | 13 | dB |
| SL_{sl} | slope straight line | | - | 0.5 | - | dB |
| FL | flatness of frequency response | | - | 0.5 | - | dB |
| NF | noise figure | $f = 50\text{ MHz}$ | - | 3.0 | 3.5 | dB |
| | | $f = 500\text{ MHz}$ | - | 3.1 | 3.6 | dB |
| | | $f = 1000\text{ MHz}$ | - | 3.4 | 3.9 | dB |
| RL_{in} | input return loss | $f = 50\text{ MHz}$ | - | 22 | - | dB |
| | | $f = 500\text{ MHz}$ | - | 27 | - | dB |
| | | $f = 1000\text{ MHz}$ | - | 29 | - | dB |
| RL_{out} | output return loss | $f = 50\text{ MHz}$ | - | 21 | - | dB |
| | | $f = 500\text{ MHz}$ | - | 22 | - | dB |
| | | $f = 1000\text{ MHz}$ | - | 15 | - | dB |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | 21.5 | 23 | - | dBm |
| $IP3_O$ | output third-order intercept point | [1] | 36 | 40 | - | dBm |
| $IP2_O$ | output second-order intercept point | [2] | - | 60 | - | dBm |
| CTB | composite triple beat | [3] | - | -75 | - | dBc |
| CSO | composite second-order distortion | [3] | - | -60 | - | dBc |

[1] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 1006 MHz. The intermodulation product (IM3) is $2 \times f_2 - f_1$, where $f_2 = f_1 \pm 6\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.

[2] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 1006 MHz. The intermodulation product (IM2) is $|f_2 - f_1|$, with $40\text{ MHz} < |f_1 - f_2| < 1006\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.

[3] Measured with 132 NTSC channels $V_O = 30\text{ dBmV}$.

Table 8. Characteristics at $V_{CC} = 5\text{ V}$

Bandwidth 40 MHz to 1006 MHz; $T_{amb} = 25\text{ }^{\circ}\text{C}$; typical values at $V_{CC} = 5\text{ V}$; $Z_S = Z_L = 75\text{ }\Omega$;
 $R1 = 100\text{ }\Omega$; $R2 = 300\text{ }\Omega$.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------------|---------------------------------------|---------------------|------|-----|------|------|
| V_{CC} | supply voltage | RF input AC coupled | 4.75 | 5 | 5.25 | V |
| $I_{CC(\text{tot})}$ | total supply current | | - | 70 | 85 | mA |
| $ S_{21} ^2$ | insertion power gain | | - | 12 | - | dB |
| SL_{sl} | slope straight line | | - | 0.5 | - | dB |
| FL | flatness of frequency response | | - | 0.5 | - | dB |
| NF | noise figure | f = 50 MHz | - | 2.9 | - | dB |
| | | f = 500 MHz | - | 2.9 | - | dB |
| | | f = 1000 MHz | - | 3.2 | - | dB |
| RL_{in} | input return loss | f = 50 MHz | - | 22 | - | dB |
| | | f = 500 MHz | - | 25 | - | dB |
| | | f = 1000 MHz | - | 25 | - | dB |
| RL_{out} | output return loss | f = 50 MHz | - | 22 | - | dB |
| | | f = 500 MHz | - | 22 | - | dB |
| | | f = 1000 MHz | - | 12 | - | dB |
| $P_{L(1\text{dB})}$ | output power at 1 dB gain compression | | - | 18 | - | dBm |
| $IP3_O$ | output third-order intercept point | | [1] | 36 | - | dBm |
| $IP2_O$ | output second-order intercept point | | [2] | 54 | - | dBm |
| CTB | composite triple beat | | [3] | -70 | - | dBc |
| CSO | composite second-order distortion | | [3] | -54 | - | dBc |

[1] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 1006 MHz. The intermodulation product (IM3) is $2 \times f_2 - f_1$, where $f_2 = f_1 \pm 6\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.

[2] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 1006 MHz. The intermodulation product (IM2) is $|f_2 - f_1|$, with $40\text{ MHz} < |f_1 - f_2| < 1006\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.

[3] Measured with 132 NTSC channels $V_O = 30\text{ dBmV}$.

7.2 Return application

Table 9. Characteristics at $V_{CC} = 8\text{ V}$

Bandwidth 5 MHz to 300 MHz; $T_{amb} = 25\text{ }^{\circ}\text{C}$; typical values at $V_{CC} = 8\text{ V}$; $Z_S = Z_L = 75\text{ }\Omega$; $R1 = 100\text{ }\Omega$; $R2 = 300\text{ }\Omega$.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------------|---------------------------------------|----------------------|-----|------|-----|------|
| V_{CC} | supply voltage | RF input AC coupled | 7.6 | 8 | 8.4 | V |
| $I_{CC(\text{tot})}$ | total supply current | | - | 110 | 125 | mA |
| $ S_{21} ^2$ | insertion power gain | | - | 12 | - | dB |
| SL_{sl} | slope straight line | | - | 0.5 | - | dB |
| FL | flatness of frequency response | | - | 0.5 | - | dB |
| NF | noise figure | $f = 50\text{ MHz}$ | - | 3.0 | - | dB |
| RL_{in} | input return loss | $f = 5\text{ MHz}$ | - | 18.5 | - | dB |
| | | $f = 100\text{ MHz}$ | - | 18.5 | - | dB |
| | | $f = 200\text{ MHz}$ | - | 18.5 | - | dB |
| | | $f = 300\text{ MHz}$ | - | 18.5 | - | dB |
| RL_{out} | output return loss | $f = 5\text{ MHz}$ | - | 18.5 | - | dB |
| | | $f = 100\text{ MHz}$ | - | 18.5 | - | dB |
| | | $f = 200\text{ MHz}$ | - | 18.5 | - | dB |
| | | $f = 300\text{ MHz}$ | - | 18.5 | - | dB |
| $P_{L(1\text{dB})}$ | output power at 1 dB gain compression | | - | 23 | - | dBm |
| $IP3_O$ | output third-order intercept point | [1] | - | 40 | - | dBm |
| $IP2_O$ | output second-order intercept point | [2] | - | 60 | - | dBm |

[1] The fundamental frequencies (f_1) and (f_2) lay between 5 MHz and 300 MHz. The intermodulation product (IM3) is $2 \times f_2 - f_1$, where $f_2 = f_1 \pm 6\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.

[2] The fundamental frequencies (f_1) and (f_2) lay between 5 MHz and 300 MHz. The intermodulation product (IM2) is $|f_2 - f_1|$, with $40\text{ MHz} < |f_1 - f_2| < 300\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.

Table 10. Characteristics at $V_{CC} = 5\text{ V}$

Bandwidth 5 MHz to 300 MHz; $T_{amb} = 25\text{ °C}$; typical values at $V_{CC} = 5\text{ V}$; $Z_S = Z_L = 75\ \Omega$;
 $R1 = 100\ \Omega$; $R2 = 300\ \Omega$.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit | |
|---------------|---------------------------------------|----------------------|------|------|------|------|-----|
| V_{CC} | supply voltage | RF input AC coupled | 4.75 | 5 | 5.25 | V | |
| $I_{CC(tot)}$ | total supply current | | - | 70 | 85 | mA | |
| $ S_{21} ^2$ | insertion power gain | | - | 12 | - | dB | |
| SL_{sl} | slope straight line | | - | 0.5 | - | dB | |
| FL | flatness of frequency response | | - | 0.5 | - | dB | |
| NF | noise figure | $f = 50\text{ MHz}$ | - | 2.9 | - | dB | |
| RL_{in} | input return loss | $f = 5\text{ MHz}$ | - | 18.5 | - | dB | |
| | | $f = 100\text{ MHz}$ | - | 18.5 | - | dB | |
| | | $f = 200\text{ MHz}$ | - | 18.5 | - | dB | |
| | | $f = 300\text{ MHz}$ | - | 18.5 | - | dB | |
| RL_{out} | output return loss | $f = 5\text{ MHz}$ | - | 18.5 | - | dB | |
| | | $f = 100\text{ MHz}$ | - | 18.5 | - | dB | |
| | | $f = 200\text{ MHz}$ | - | 18.5 | - | dB | |
| | | $f = 300\text{ MHz}$ | - | 18.5 | - | dB | |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | | - | 17 | - | dBm | |
| $IP3_O$ | output third-order intercept point | | [1] | - | 40 | - | dBm |
| $IP2_O$ | output second-order intercept point | | [2] | - | 55 | - | dBm |

[1] The fundamental frequencies (f_1) and (f_2) lay between 5 MHz and 300 MHz. The intermodulation product (IM3) is $2 \times f_2 - f_1$, where $f_2 = f_1 \pm 6\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.

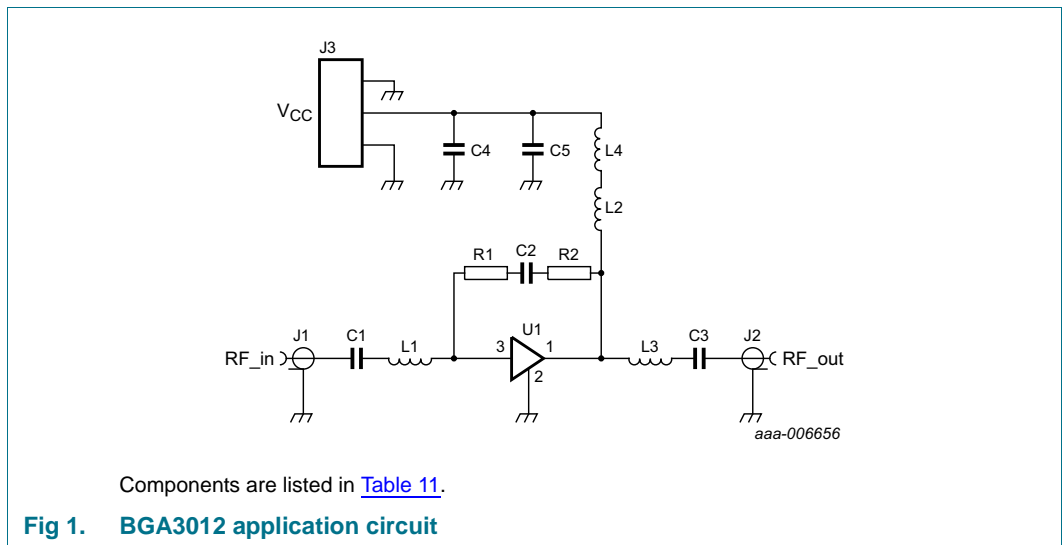
[2] The fundamental frequencies (f_1) and (f_2) lay between 5 MHz and 300 MHz. The intermodulation product (IM2) is $|f_2 - f_1|$, with $40\text{ MHz} < |f_1 - f_2| < 300\text{ MHz}$. Input power $P_i = -20\text{ dBm}$.

8. Application information

8.1 Forward application 40 MHz to 1006 MHz

The BGA3012 can be used in other applications. Please contact your local sales representative for more information. Application notes are available on the NXP website.

8.1.1 Forward application circuit



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

8.1.2 Forward application circuit board layout

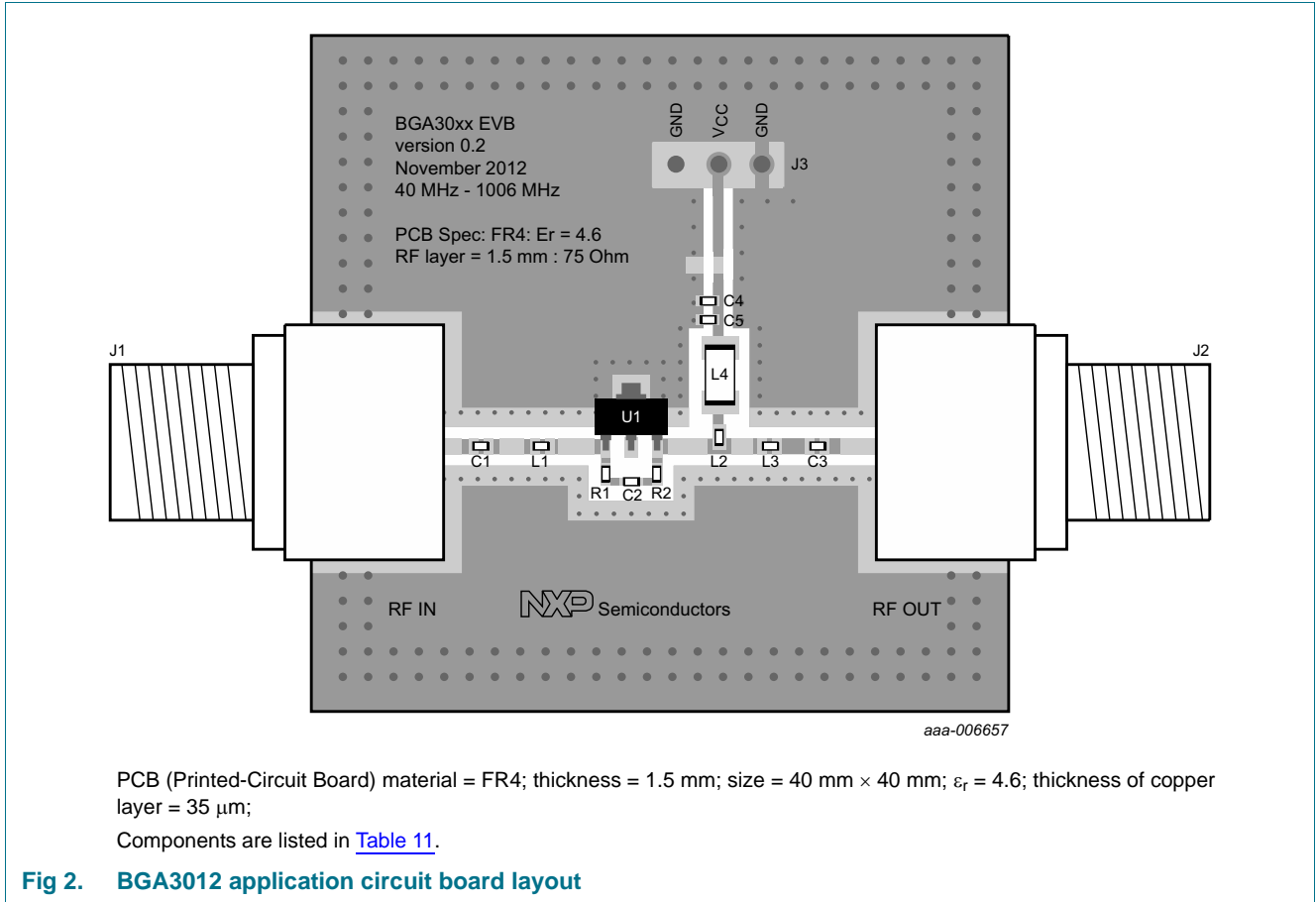


Table 11. List of components

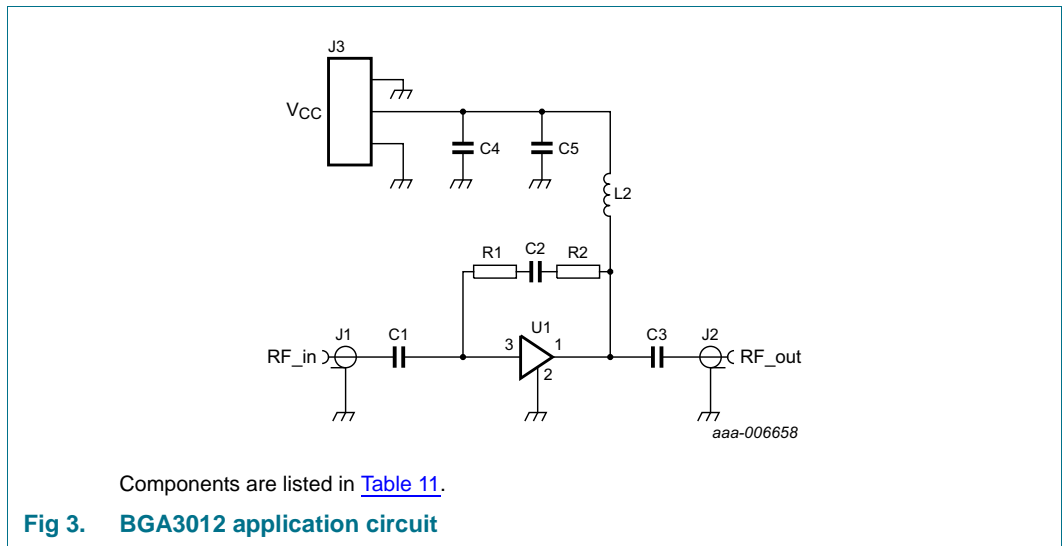
See [Figure 1](#) and [Figure 2](#).

| Component | Description | Value | Size | Remarks |
|----------------|--------------|--------------|----------|--|
| C1, C2, C3, C4 | capacitor | 10 nF | SMD 0402 | Murata GRM155R71E103KA01D or capacitor of same quality |
| C5 | capacitor | 100 pF | SMD 0402 | Murata GRM155C1H101JZ01D or capacitor of same quality |
| J1, J2 | F-connector | 75 Ω | - | Bomar 861V509ER6 or F-connector of same quality |
| J3 | header 3-way | - | - | Molex 90121-0763 or header of the same quality |
| L1, L3 | inductor | 3.9 nH | SMD 0402 | Murata LQG15HS3N9S02D or inductor of same quality |
| L2 | choke | - | SMD 0603 | Murata BLM18HD182SN1D or choke of same quality |
| L4 | inductor | 880 nH | SMD 1206 | Murata LQH31HNR88K03L or inductor of same quality |
| R1 | resistor | 100 Ω | SMD 0402 | Yageo RC0402FR-07100RL or resistor of same quality |
| R2 | resistor | 300 Ω | SMD 0402 | Yageo RC0402FR-07300RL or resistor of same quality |
| U1 | BGA3012 | - | - | NXP |

8.2 Return application 5 MHz to 300 MHz

The BGA3012 can be used in other applications. Please contact your local sales representative for more information. Application notes are available on the NXP website.

8.2.1 Return application circuit



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

8.2.2 Return application circuit board layout

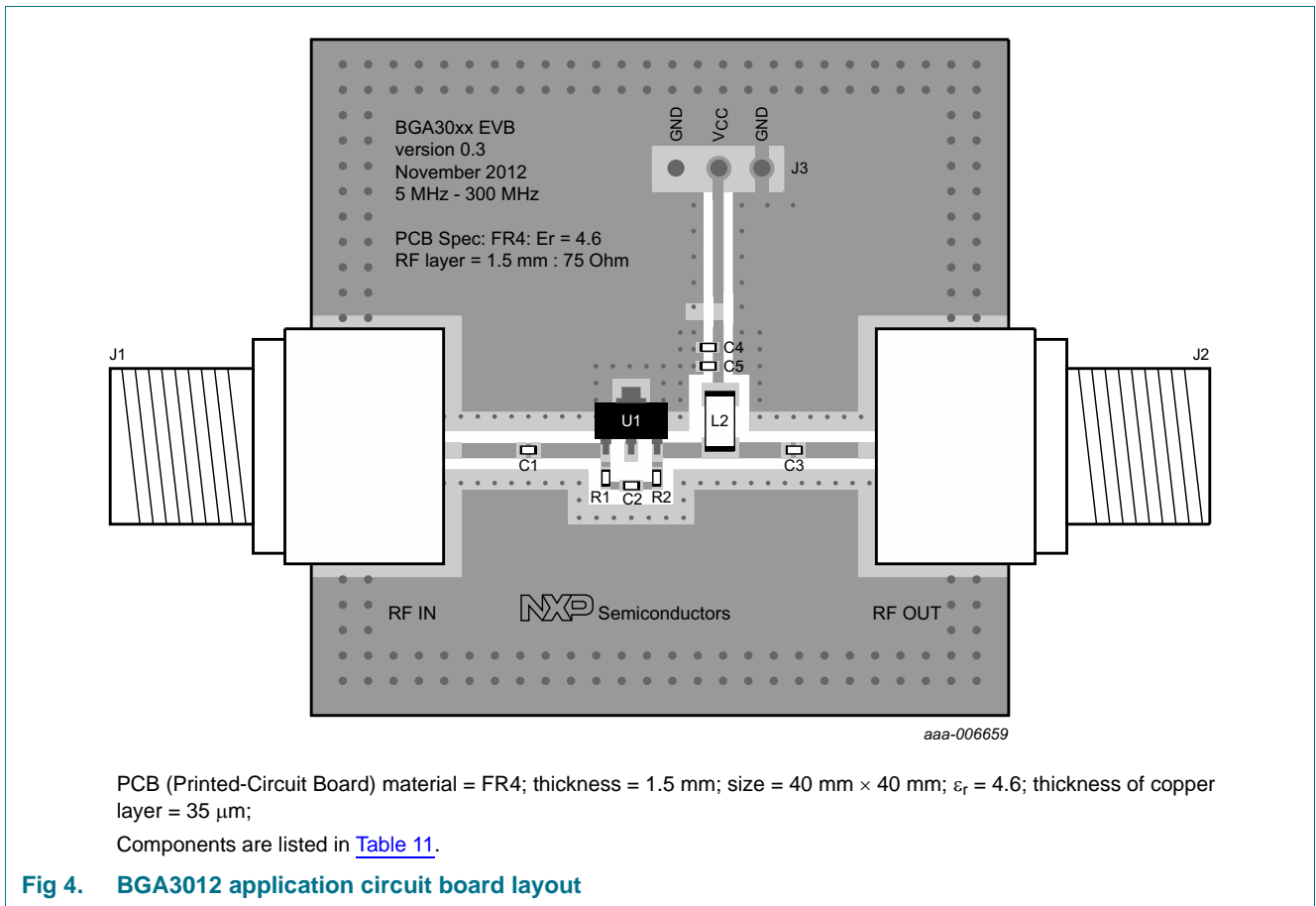


Table 12. List of components

See [Figure 1](#) and [Figure 2](#).

| Component | Description | Value | Size | Remarks |
|----------------|--------------|------------------|----------|--|
| C1, C2, C3, C4 | capacitor | 10 nF | SMD 0402 | Murata GRM155R71E103KA01D or capacitor of same quality |
| C5 | capacitor | 100 pF | SMD 0402 | Murata GRM155C1H101JZ01D or capacitor of same quality |
| J1, J2 | F-connector | 75 Ω | - | Bomar 861V509ER6 or F-connector of same quality |
| J3 | header 3-way | - | - | Molex 90121-0763 or header of the same quality |
| L2 | inductor | 22 μH | SMD 1206 | Murata LQH31CN220K03L or inductor of same quality |
| R1 | resistor | 100 Ω | SMD 0402 | Yageo RC0402FR-07100RL or resistor of same quality |
| R2 | resistor | 300 Ω | SMD 0402 | Yageo RC0402FR-07300RL or resistor of same quality |
| U1 | BGA3012 | - | - | NXP |

9. Package outline

Plastic surface-mounted package; exposed die pad for good heat transfer; 3 leads

SOT89

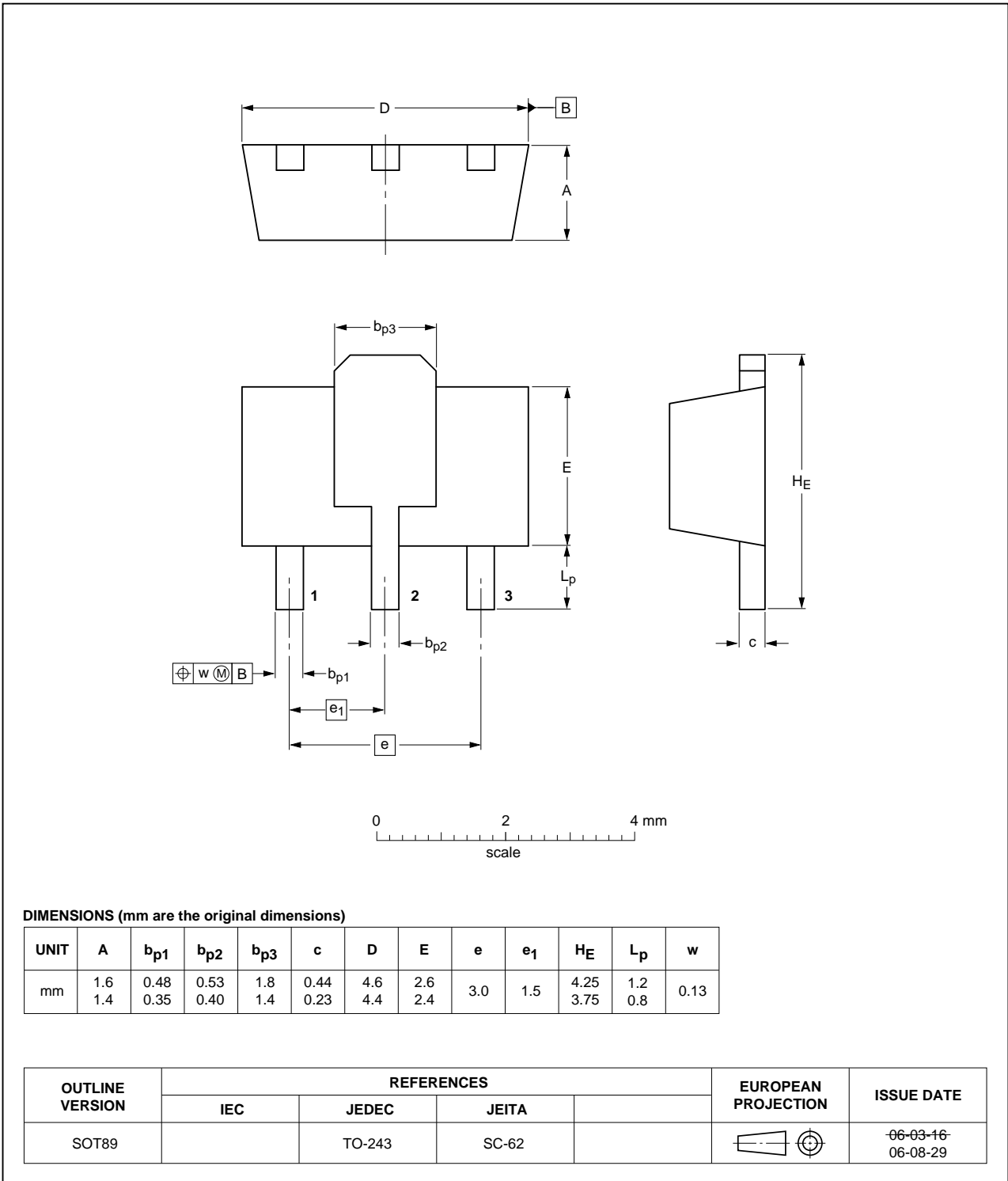


Fig 5. Package outline SOT89 (SC-62)

10. Abbreviations

Table 13. Abbreviations

| Acronym | Description |
|---------|---|
| CATV | Community Antenna TeleVision |
| FTTH | Fiber To The Home |
| FTTx | Fiber To The "x" |
| LNA | Low-Noise Amplifier |
| MMIC | Monolithic Microwave Integrated Circuit |

11. Revision history

Table 14. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------|--|------------------------|---------------|-------------|
| BGA3012 v.3 | 20130926 | Product data sheet | - | BGA3012 v.2 |
| Modifications: | • Table 3 on page 2 : Evaluation boards have been added. | | | |
| BGA3012 v.2 | 20130415 | Product data sheet | - | BGA3012 v.1 |
| BGA3012 v.1 | 20130319 | 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. |
| 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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Date of release: 26 September 2013

Document identifier: BGA3012