



# BGM1013

MMIC wideband amplifier

Rev. 5 — 19 September 2011

Product data sheet

## 1. Product profile

### 1.1 General description

Silicon Monolithic Microwave Integrated Circuit (MMIC) wideband amplifier with internal matching circuit in a 6-pin SOT363 SMD plastic 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 matched to 50  $\Omega$
- Good output match to 75  $\Omega$
- Very high gain; 35.5 dB at 1 GHz
- Upper corner frequency at 2.1 GHz
- 31 dB flat gain up to 2.2 GHz application
- 14 dBm saturated output power at 1 GHz
- High linearity (23 dBm IP3<sub>out</sub> and 43 dBc IM2)
- 40 dB isolation.

### 1.3 Applications

- Low Noise Block (LNB) Intermediate Frequency (IF) amplifiers
- Cable systems
- General purpose.

### 1.4 Quick reference data

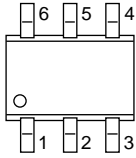
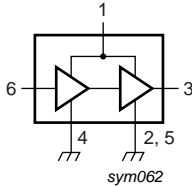
Table 1. Quick reference data

| Symbol                         | Parameter            | Conditions           | Min  | Typ  | Max  | Unit |
|--------------------------------|----------------------|----------------------|------|------|------|------|
| V <sub>S</sub>                 | DC supply voltage    | RF input; AC coupled | -    | 5    | 6    | V    |
| I <sub>S</sub>                 | DC supply current    |                      | 23   | 27.5 | 33   | mA   |
| S <sub>21</sub>   <sup>2</sup> | insertion power gain | f = 1 GHz            | 34.5 | 35.5 | 36.2 | dB   |
| NF                             | noise figure         | f = 1 GHz            | -    | 4.6  | 4.7  | dB   |
| P <sub>L(sat)</sub>            | saturated load power | f = 1 GHz            | 13.0 | 14.0 | -    | dBm  |



## 2. Pinning information

**Table 2. Pinning**

| Pin  | Description    | Simplified outline  | Symbol  |
|------|----------------|---|---|
| 1    | V <sub>S</sub> |  |  <p style="text-align: center;">sym062</p> |
| 2, 5 | GND2           |   |   |
| 3    | RF_OUT         |   |   |
| 4    | GND1           |   |   |
| 6    | RF_IN          |   |   |
|      |                |   |   |

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package |  |         |
|-------------|---------|--|---------|
|             | Name    | Description                              | Version |
| BGM1013     | SC-88   | plastic surface mounted package; 6 leads | SOT363  |

## 4. Marking

**Table 4. Marking codes**

| Type number | Marking code |
|-------------|--------------|
| BGM1013     | C4-          |

## 5. Limiting values

**Table 5. Limiting values**

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

| Symbol           | Parameter               | Conditions              | Min | Max  | Unit |
|------------------|-------------------------|-------------------------|-----|------|------|
| V <sub>S</sub>   | DC supply voltage       | RF input; AC coupled    | -   | 6    | V    |
| I <sub>S</sub>   | DC supply current       |                         | -   | 35   | mA   |
| P <sub>tot</sub> | total power dissipation | T <sub>sp</sub> ≤ 90 °C | -   | 200  | mW   |
| T <sub>stg</sub> | storage temperature     |                         | -65 | +150 | °C   |
| T <sub>j</sub>   | junction temperature    |                         | -   | 150  | °C   |
| P <sub>D</sub>   | maximum drive power     |                         | -   | -10  | dBm  |

## 6. Recommended operating conditions

**Table 6. Operating conditions**

| Symbol    | Parameter           | Conditions | Min | Typ | Max | Unit |
|-----------|---------------------|------------|-----|-----|-----|------|
| $V_S$     | supply voltage      |            | 4.5 | 5.0 | 5.5 | V    |
| $T_{amb}$ | ambient temperature |            | -40 | 25  | 85  | °C   |

## 7. Thermal characteristics

**Table 7. Thermal characteristics**

| Symbol         | Parameter  | Conditions   | Typ | Unit |
|----------------|--|--|-----|------|
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | $P_{tot} = 200 \text{ mW}$ ; $T_{sp} \leq 90 \text{ °C}$ | 300 | K/W  |

## 8. Characteristics

**Table 8. Characteristics**

$V_S = 5 \text{ V}$ ;  $I_S = 27.5 \text{ mA}$ ;  $T_j = 25 \text{ °C}$ ; measured on demo board; unless otherwise specified.

| Symbol       | Parameter            | Conditions                                  | Min  | Typ  | Max  | Unit |
|--------------|----------------------|---|------|------|------|------|
| $V_S$        | DC supply voltage    | RF input; AC coupled                        | -    | 5    | 6    | V    |
| $I_S$        | DC supply current    |   | 23   | 27.5 | 33   | mA   |
| $ S_{21} ^2$ | insertion power gain | $f = 100 \text{ MHz}$                       | 34.5 | 35.2 | 35.9 | dB   |
|              |                      | $f = 1 \text{ GHz}$                         | 34.5 | 35.5 | 36.2 | dB   |
|              |                      | $f = 1.8 \text{ GHz}$                       | 33.0 | 34.0 | 35.2 | dB   |
|              |                      | $f = 2.2 \text{ GHz}$                       | 30.5 | 31.8 | 33.1 | dB   |
|              |                      | $f = 2.6 \text{ GHz}$                       | 25.2 | 29.7 | 31.2 | dB   |
|              |                      | $f = 3 \text{ GHz}$                         | 24.0 | 26.1 | 27.9 | dB   |
| $ S_{11} ^2$ | input return loss    | $f = 1 \text{ GHz}$                         | 10.1 | 10.6 | -    | dB   |
|              |                      | $f = 2.2 \text{ GHz}$                       | 9.3  | 10.2 | -    | dB   |
| $ S_{22} ^2$ | output return loss   | $Z_L = 50 \text{ } \Omega$                  |      |      |      |      |
|              |                      | $f = 1 \text{ GHz}$                         | 18   | 20   | -    | dB   |
|              |                      | $f = 2.2 \text{ GHz}$                       | 13   | 16   | -    | dB   |
|              |                      | $Z_L = 75 \text{ } \Omega$                  |      |      |      |      |
|              |                      | $f = 1 \text{ GHz}$                         | 15   | 17   | -    | dB   |
|              |                      | $f = 2.2 \text{ GHz}$                       | 12   | 15   | -    | dB   |
| $ S_{12} ^2$ | isolation            | $f = 1 \text{ GHz}$                         | 40   | 42   | -    | dB   |
|              |                      | $f = 2.2 \text{ GHz}$                       | 34   | 36   | -    | dB   |
| NF           | noise figure         | $f = 1 \text{ GHz}$                         | -    | 4.6  | 4.7  | dB   |
|              |                      | $f = 2.2 \text{ GHz}$                       | -    | 4.9  | 5.1  | dB   |
| B            | bandwidth            | 3 dB below flat gain at $f = 1 \text{ GHz}$ | -    | 2.1  | -    | GHz  |
| K            | stability factor     | $f = 1 \text{ GHz}$                         | 1.2  | 1.3  | -    |      |
|              |                      | $f = 2.2 \text{ GHz}$                       | 0.9  | 1.0  | -    |      |
| $P_{L(sat)}$ | saturated load power | $f = 1 \text{ GHz}$                         | 13.0 | 14.0 | -    | dBm  |
|              |                      | $f = 2.2 \text{ GHz}$                       | 9.0  | 10.2 | -    | dBm  |

**Table 8. Characteristics ...continued**

$V_S = 5\text{ V}$ ;  $I_S = 27.5\text{ mA}$ ;  $T_j = 25\text{ }^\circ\text{C}$ ; measured on demo board; unless otherwise specified.

| Symbol       | Parameter                            | Conditions   | Min  | Typ   | Max | Unit |
|--------------|--------------------------------------|--|------|-------|-----|------|
| $P_{L(1dB)}$ | load power at 1 dB gain compression  | $f = 1\text{ GHz}$   | 12.0 | 13.0  | -   | dBm  |
|              |                                      | $f = 2.2\text{ GHz}$   | 7.0  | 8.1   | -   | dBm  |
| $IP3_{in}$   | input third order intercept point    | $f = 1\text{ GHz}$   | -14  | -12.8 | -   | dBm  |
|              |                                      | $f = 2.2\text{ GHz}$   | -15  | -13.2 | -   | dBm  |
| $IP3_{out}$  | output third order intercept point   | $f = 1\text{ GHz}$   | 21   | 22.7  | -   | dBm  |
|              |                                      | $f = 2.2\text{ GHz}$   | 17   | 18.6  | -   | dBm  |
| IM2          | second order intermodulation product | $f_0 = 1\text{ GHz}$ ; $P_D = -45\text{ dBm}$ ( $P_L = -10\text{ dBm}$ ) | -    | 45    | 43  | dBc  |
|              |                                      | $f_0 = 1\text{ GHz}$ ; $P_D = -40\text{ dBm}$ ( $P_L = -5\text{ dBm}$ )  | -    | 43    | 41  | dBc  |

## 9. Application information

Figure 1 shows a typical application circuit for the BGM1013 MMIC. The device is internally matched to  $50\ \Omega$  and therefore does not need any external matching. Output impedance is also very good to  $75\ \Omega$  load. The value of the input and output DC blocking capacitors C1 and C2 should be not more than  $100\text{ pF}$  for applications above  $100\text{ MHz}$ . Their values can be used to fine-tune the input and output impedance.

For the RF-choke, optimal results are obtained with a good quality chip inductor like the TDK MLG1608 (0603) or a wire-wound SMD. The value of the inductor can be used to fine-tune the output impedance.

The RF choke and supply decoupling components should be located as close as possible to the MMIC.

Ground paths must be as short as possible. The printed-circuit board (PCB) top ground plane must be as close as possible to the MMIC, and ideally directly beneath it. When using vias, use at least 3 vias for the top ground plane in order to limit ground path inductance. Supply decoupling with C3 should be from pin 1 to the same top ground plane.

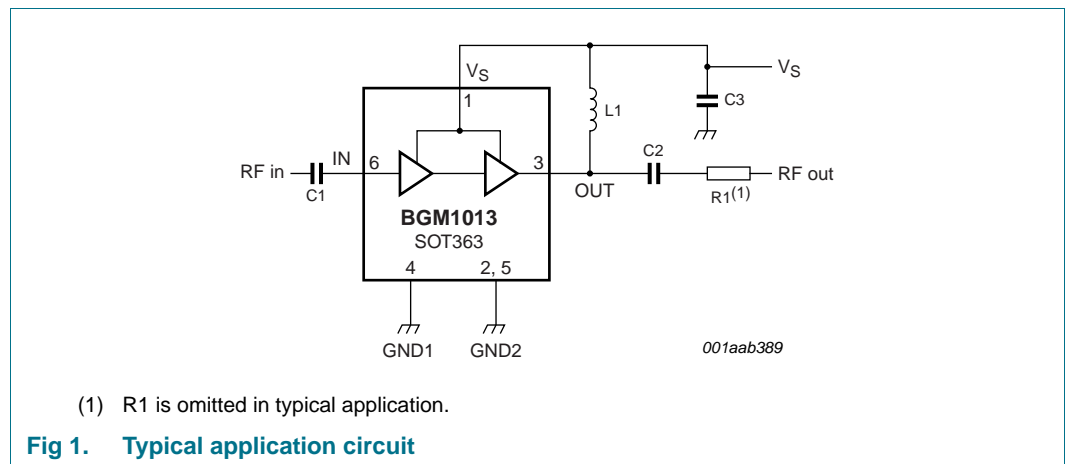
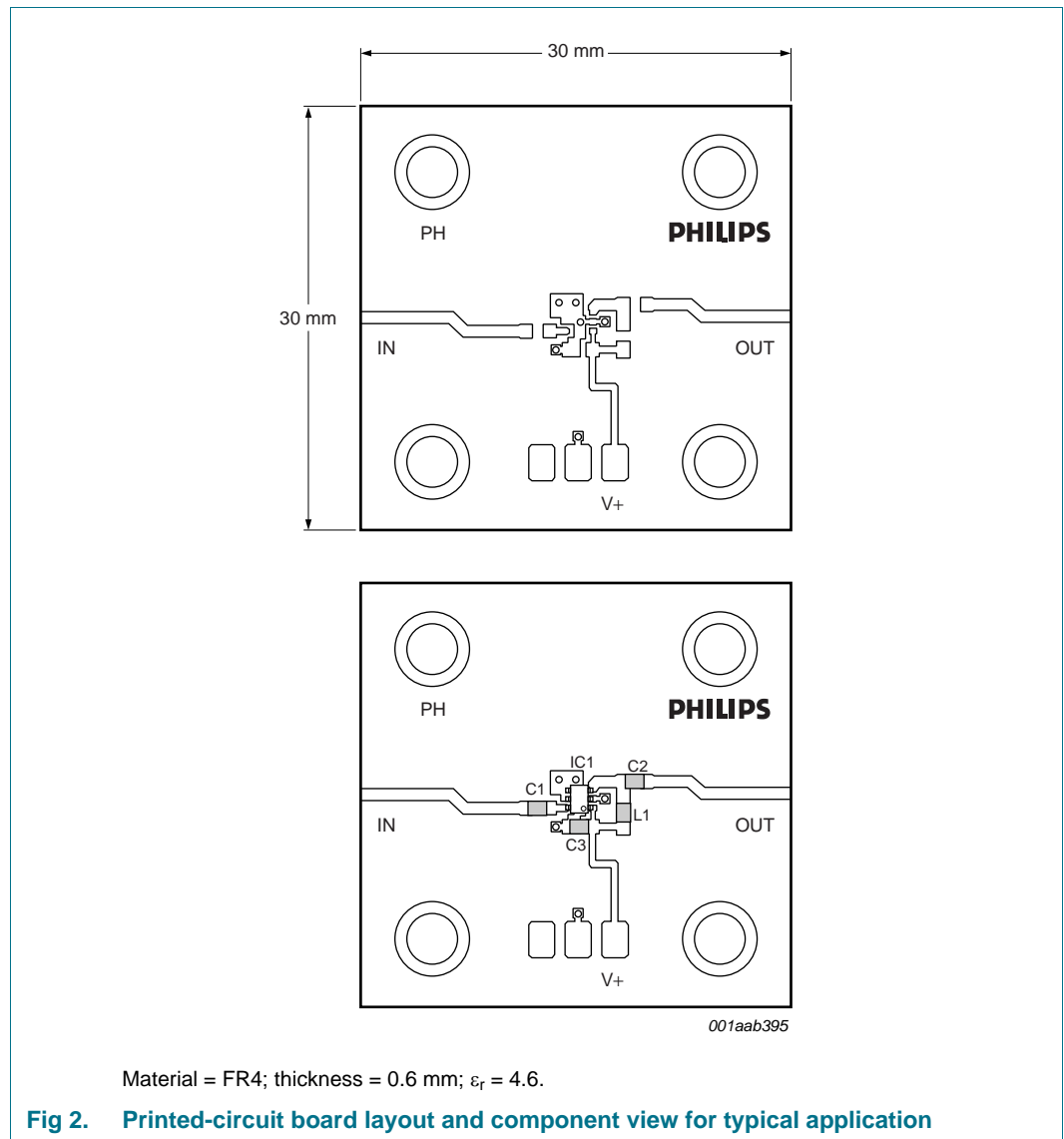


Figure 2 shows the PCB layout used for the typical application.

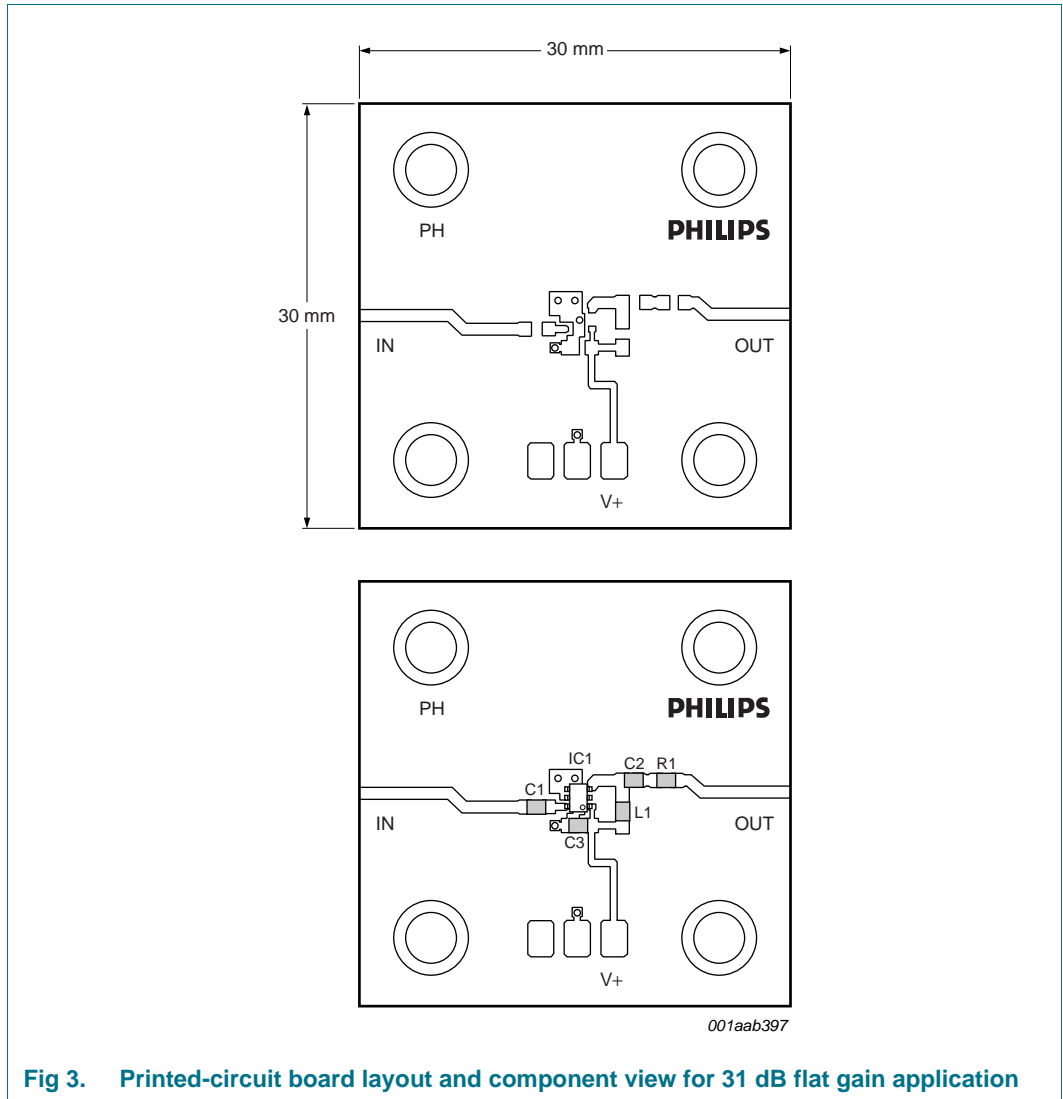


**Table 9. List of components used for the typical application**

| Component | Description                       | Value  | Dimensions |
|-----------|-----------------------------------|--------|------------|
| C1, C2    | multilayer ceramic chip capacitor | 100 pF | 0603       |
| C3        | multilayer ceramic chip capacitor | 22 nF  | 0603       |
| R1        | SMD resistor                      | -      | 0603       |
| L1        | SMD inductor                      | 100 nH | 0603       |

**9.1 Flat gain application: 31 dB between 800 MHz and 2.2 GHz**

By changing the components at the output of the amplifier, a flatter gain can be obtained. The gain is 31 dB ± 1 dB between 800 MHz and 2.2 GHz. P<sub>L(1dB)</sub> is 10 dBm at 1 GHz and 5.7 dBm at 2.2 GHz.

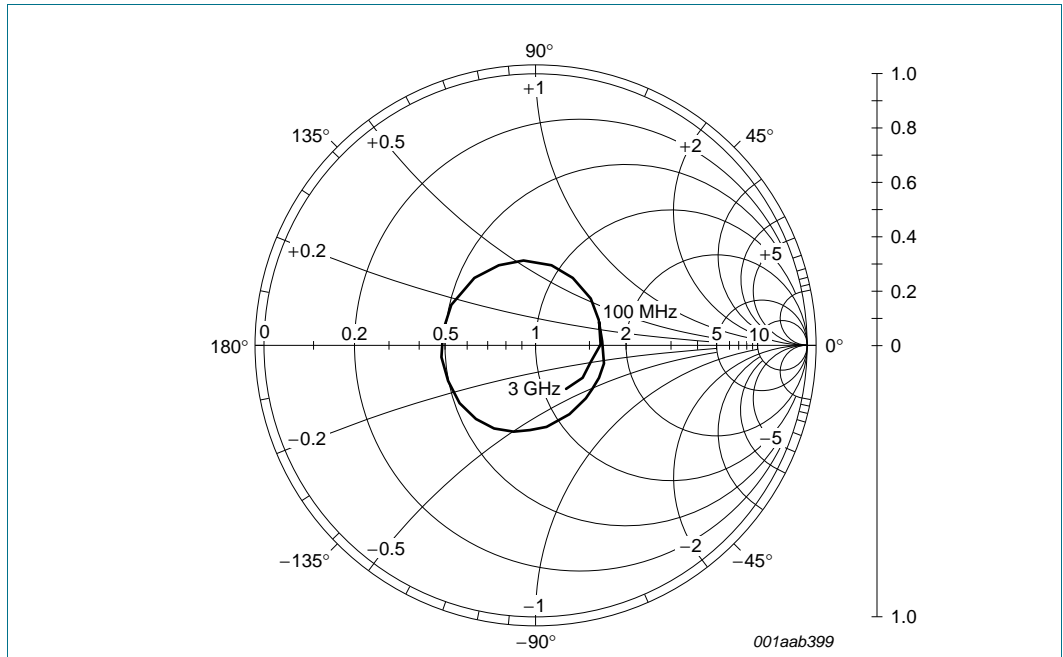


**Fig 3. Printed-circuit board layout and component view for 31 dB flat gain application**

**Table 10. List of components used for the 31 dB flat gain application<sup>[1]</sup>**

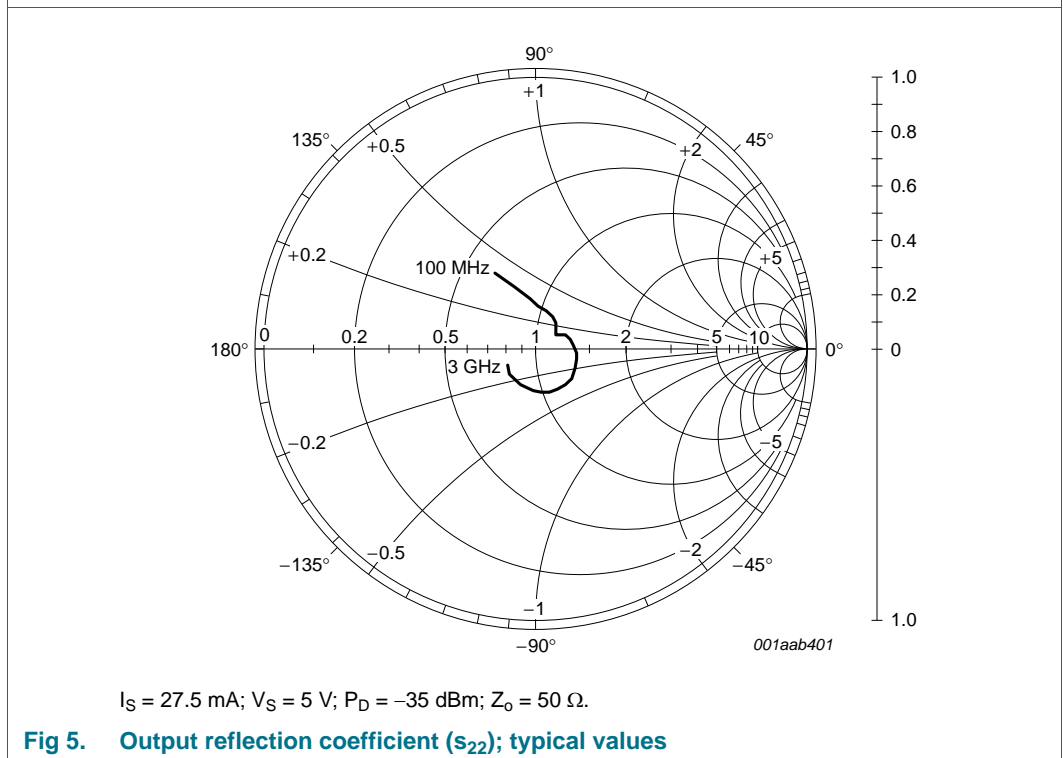
| Component | Description                       | Value  | Dimensions |
|-----------|-----------------------------------|--------|------------|
| C1        | multilayer ceramic chip capacitor | 100 pF | 0603       |
| C2        | multilayer ceramic chip capacitor | 4.7 pF | 0603       |
| C3        | multilayer ceramic chip capacitor | 22 nF  | 0603       |
| R1        | SMD resistor                      | 27 Ω   | 0603       |
| L1        | SMD inductor                      | 5.6 nH | 0603       |

[1] Pin 2 should not be connected in order to obtain optimal input matching.



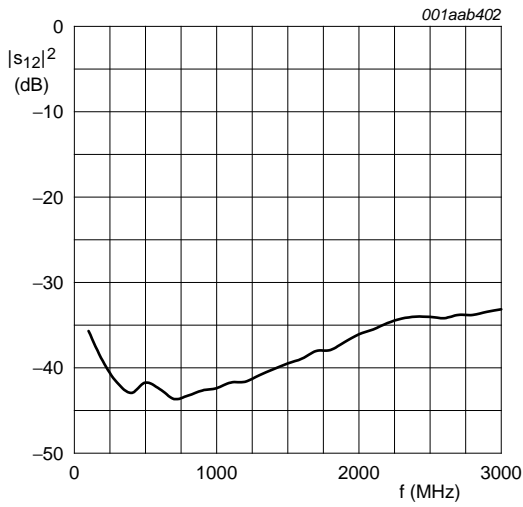
$I_S = 27.5 \text{ mA}$ ;  $V_S = 5 \text{ V}$ ;  $P_D = -35 \text{ dBm}$ ;  $Z_o = 50 \Omega$ .

**Fig 4. Input reflection coefficient ( $s_{11}$ ); typical values**



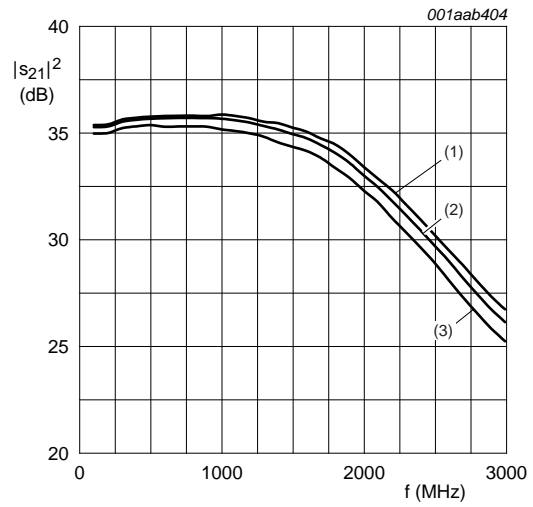
$I_S = 27.5 \text{ mA}$ ;  $V_S = 5 \text{ V}$ ;  $P_D = -35 \text{ dBm}$ ;  $Z_o = 50 \Omega$ .

**Fig 5. Output reflection coefficient ( $s_{22}$ ); typical values**



$I_S = 27.5 \text{ mA}$ ;  $V_S = 5 \text{ V}$ ;  $P_D = -35 \text{ dBm}$ ;  $Z_0 = 50 \Omega$ .

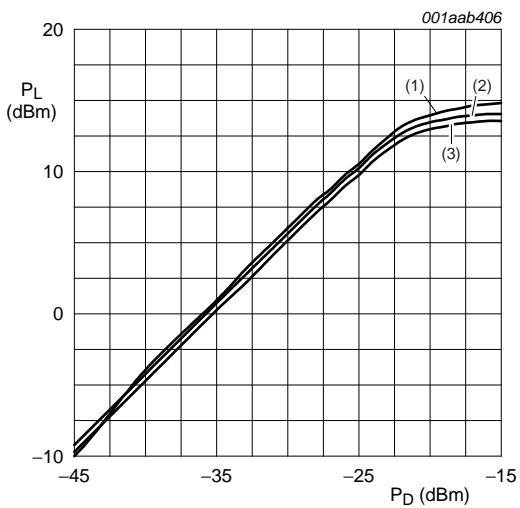
**Fig 6. Isolation ( $|s_{12}|^2$ ) as a function of frequency; typical values**



$P_D = -35 \text{ dBm}$ ;  $Z_0 = 50 \Omega$ .

- (1)  $I_S = 32.6 \text{ mA}$ ;  $V_S = 5.5 \text{ V}$ .
- (2)  $I_S = 27.5 \text{ mA}$ ;  $V_S = 5 \text{ V}$ .
- (3)  $I_S = 21.5 \text{ mA}$ ;  $V_S = 4.5 \text{ V}$ .

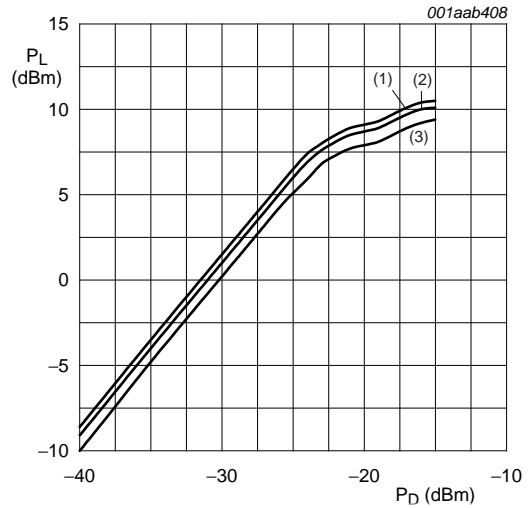
**Fig 7. Insertion gain ( $|s_{21}|^2$ ) as a function of frequency; typical values**



$f = 1 \text{ GHz}$ ;  $Z_0 = 50 \Omega$ .

- (1)  $V_S = 5.5 \text{ V}$ .
- (2)  $V_S = 5 \text{ V}$ .
- (3)  $V_S = 4.5 \text{ V}$ .

**Fig 8. Load power as a function of drive power at 1 GHz; typical values**

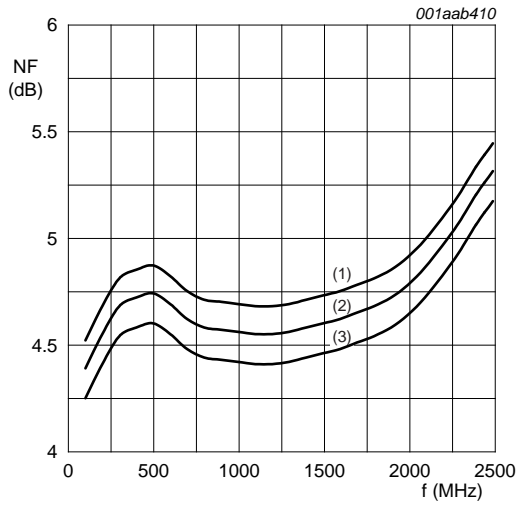


$f = 2.2 \text{ GHz}$ ;  $Z_0 = 50 \Omega$ .

- (1)  $V_S = 5.5 \text{ V}$ .
- (2)  $V_S = 5 \text{ V}$ .
- (3)  $V_S = 4.5 \text{ V}$ .

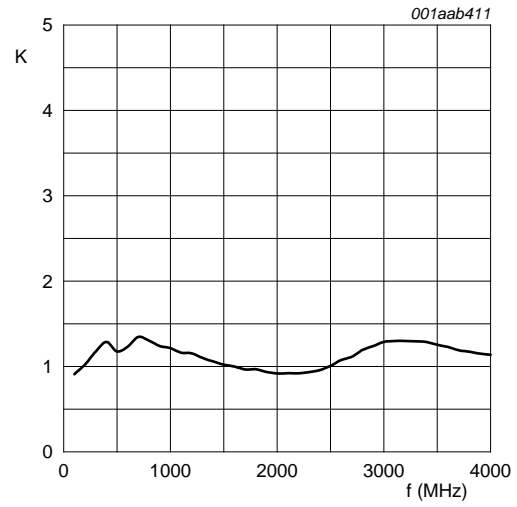
**Fig 9. Load power as a function of drive power at 2.2 GHz; typical values**





- $Z_o = 50 \Omega$ .
- (1)  $V_S = 5.5 \text{ V}$ .
  - (2)  $V_S = 5 \text{ V}$ .
  - (3)  $V_S = 4.5 \text{ V}$ .

**Fig 10. Noise figure as a function of frequency; typical values**



$I_S = 27.5 \text{ mA}$ ;  $V_S = 5 \text{ V}$ ;  $Z_o = 50 \Omega$ .

**Fig 11. Stability factor as a function of frequency; typical values**

**Table 11. Scattering parameters**

$V_S = 5\text{ V}$ ;  $I_S = 27.5\text{ mA}$ ;  $P_D = -35\text{ dBm}$ ;  $Z_o = 50\ \Omega$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ ; measured on demo board.

| f (MHz) | S <sub>11</sub>   |             | S <sub>21</sub>   |             | S <sub>12</sub>   |             | S <sub>22</sub>   |             | K-factor |
|---------|-------------------|-------------|-------------------|-------------|-------------------|-------------|-------------------|-------------|----------|
|         | Magnitude (ratio) | Angle (deg) | Magnitude (ratio) | Angle (deg) | Magnitude (ratio) | Angle (deg) | Magnitude (ratio) | Angle (deg) |          |
| 100     | 0.259             | 19.3        | 57.79             | 2.5         | 0.01642           | 47.3        | 0.325             | 118.6       | 0.9      |
| 200     | 0.258             | 3.2         | 57.96             | -10.9       | 0.01096           | 20.7        | 0.248             | 110.9       | 1.0      |
| 400     | 0.270             | -25.6       | 60.08             | -41.2       | 0.00712           | -12.6       | 0.163             | 87.0        | 1.3      |
| 600     | 0.271             | -43.7       | 60.60             | -67.0       | 0.00751           | -13.9       | 0.134             | 63.2        | 1.2      |
| 800     | 0.281             | -61.5       | 60.74             | -95.6       | 0.00687           | -12.1       | 0.104             | 43.7        | 1.3      |
| 1000    | 0.296             | -80.1       | 60.44             | -121.2      | 0.00759           | -7.3        | 0.092             | 37.7        | 1.2      |
| 1200    | 0.317             | -102.3      | 59.21             | -147.1      | 0.00828           | -11.5       | 0.097             | 33.9        | 1.2      |
| 1400    | 0.335             | -127.7      | 57.01             | -172.9      | 0.00981           | -16.8       | 0.123             | 25.6        | 1.1      |
| 1600    | 0.334             | -158.1      | 54.46             | 160.8       | 0.01130           | -25.1       | 0.142             | 6.0         | 1.0      |
| 1800    | 0.331             | 169.6       | 50.31             | 134.1       | 0.01272           | -34.0       | 0.157             | -14.2       | 1.0      |
| 2000    | 0.326             | 130.6       | 44.63             | 104.7       | 0.01571           | -43.0       | 0.172             | -39.8       | 0.9      |
| 2200    | 0.309             | 95.9        | 38.92             | 79.4        | 0.01826           | -57.0       | 0.172             | -61.9       | 0.9      |
| 2400    | 0.287             | 59.0        | 33.31             | 55.5        | 0.01994           | -69.2       | 0.161             | -83.5       | 1.0      |
| 2600    | 0.257             | 20.4        | 28.20             | 33.1        | 0.01952           | -78.3       | 0.147             | -104.4      | 1.1      |
| 2800    | 0.224             | -15.5       | 23.60             | 13.1        | 0.02037           | -89.9       | 0.139             | -125.1      | 1.2      |
| 3000    | 0.198             | -50.7       | 20.24             | -4.8        | 0.02198           | -99.8       | 0.127             | -151.5      | 1.3      |

**10. Package outline**

Plastic surface-mounted package; 6 leads

SOT363

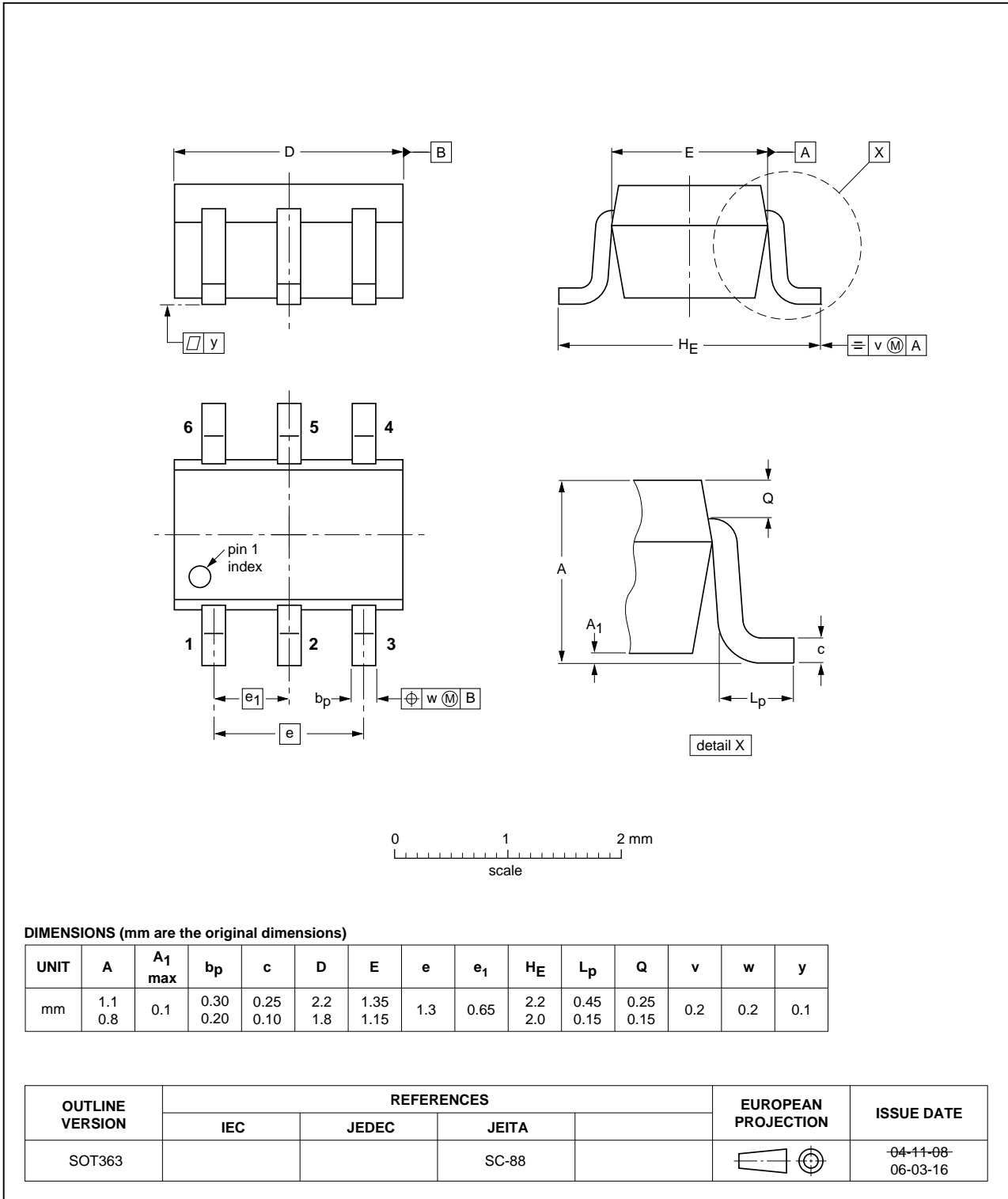


Fig 12. Package outline SOT363 (SC-88)

## 11. Revision history

Table 12. Revision history

| Document ID                     | Release date | Data sheet status  | Change notice | Supersedes  |
|---------------------------------|--------------|--|---------------|-------------|
| BGM1013 v.5                     | 20110919     | Product data sheet   | -             | BGM1013 v.4 |
| Modifications:                  |              | <ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>• Legal texts have been adapted to the new company name where appropriate.</li></ul> |               |             |
| BGM1013 v.4                     | 20060501     | Product data sheet   | -             | BGM1013 v.3 |
| BGM1013 v.3<br>(9397 750 14413) | 20041209     | Product data sheet   | -             | BGM1013 v.2 |
| BGM1013 v.2<br>(9397 750 14229) | 20041130     | Product data sheet   | -             | BGM1013 v.1 |
| BGM1013 v.1<br>(9397 750 13469) | 20040831     | Product data sheet   | -             | -           |

## 12. Legal information

### 12.1 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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## 14. Contents

|           |   |           |
|-----------|---|-----------|
| <b>1</b>  | <b>Product profile</b> . . . . .                                      | <b>1</b>  |
| 1.1       | General description . . . . .   | 1         |
| 1.2       | Features and benefits . . . . .                                       | 1         |
| 1.3       | Applications . . . . .  | 1         |
| 1.4       | Quick reference data . . . . .  | 1         |
| <b>2</b>  | <b>Pinning information</b> . . . . .                                  | <b>2</b>  |
| <b>3</b>  | <b>Ordering information</b> . . . . .                                 | <b>2</b>  |
| <b>4</b>  | <b>Marking</b> . . . . .  | <b>2</b>  |
| <b>5</b>  | <b>Limiting values</b> . . . . .                                      | <b>2</b>  |
| <b>6</b>  | <b>Recommended operating conditions</b> . . . . .                     | <b>3</b>  |
| <b>7</b>  | <b>Thermal characteristics</b> . . . . .                              | <b>3</b>  |
| <b>8</b>  | <b>Characteristics</b> . . . . .                                      | <b>3</b>  |
| <b>9</b>  | <b>Application information</b> . . . . .                              | <b>4</b>  |
| 9.1       | Flat gain application: 31 dB between 800 MHz<br>and 2.2 GHz . . . . . | 6         |
| <b>10</b> | <b>Package outline</b> . . . . .                                      | <b>11</b> |
| <b>11</b> | <b>Revision history</b> . . . . .                                     | <b>12</b> |
| <b>12</b> | <b>Legal information</b> . . . . .                                    | <b>13</b> |
| 12.1      | Data sheet status . . . . .   | 13        |
| 12.2      | Definitions . . . . .   | 13        |
| 12.3      | Disclaimers . . . . .   | 13        |
| 12.4      | Trademarks . . . . .  | 14        |
| <b>13</b> | <b>Contact information</b> . . . . .                                  | <b>14</b> |
| <b>14</b> | <b>Contents</b> . . . . .   | <b>15</b> |

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