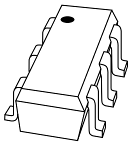


# BGM1013

## MMIC wideband amplifier

Rev. 04 — 1 May 2006 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

- Internally matched to 50 Ω
- Good output match to 75 Ω
- 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 $IP3_{out}$ and 43 dBc IM2)
- 40 dB isolation.

## 1.3 Applications

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

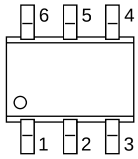
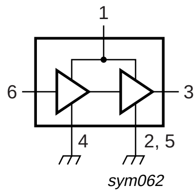
## 1.4 Quick reference data

**Table 1: Quick reference data**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_S$ | 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 = 1 GHz | 34.5 | 35.5 | 36.2 | dB |
| NF | noise figure | f = 1 GHz | - | 4.6 | 4.7 | dB |
| $P_{L(sat)}$ | saturated load power | f = 1 GHz | 13.0 | 14.0 | - | dBm |

## 2. Pinning information

**Table 2: Pinning**

| Pin | Description | Simplified outline | Symbol |
|---|---|---|---|
| 1 | $V_S$ |  |  |
| 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 |
|---|---|---|---|---|---|
| $V_S$ | DC supply voltage | RF input; AC coupled | - | 6 | V |
| $I_S$ | DC supply current | | - | 35 | mA |
| $P_{tot}$ | total power dissipation | $T_{sp} \leq 90$ °C | - | 200 | mW |
| $T_{stg}$ | storage temperature | | –65 | +150 | °C |
| $T_j$ | junction temperature | | - | 150 | °C |
| $P_D$ | 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 mW; $T_{sp} \leq 90$ °C | 300 | K/W |

## 8. Characteristics

**Table 8: Characteristics**

*$V_S$ = 5 V; $I_S$ = 27.5 mA; $T_j$ = 25 °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 MHz | 34.5 | 35.2 | 35.9 | dB |
| | | f = 1 GHz | 34.5 | 35.5 | 36.2 | dB |
| | | f = 1.8 GHz | 33.0 | 34.0 | 35.2 | dB |
| | | f = 2.2 GHz | 30.5 | 31.8 | 33.1 | dB |
| | | f = 2.6 GHz | 25.2 | 29.7 | 31.2 | dB |
| | | f = 3 GHz | 24.0 | 26.1 | 27.9 | dB |
| $\|s_{11}\|^2$ | input return loss | f = 1 GHz | 10.1 | 10.6 | - | dB |
| | | f = 2.2 GHz | 9.3 | 10.2 | - | dB |
| $\|s_{22}\|^2$ | output return loss | $Z_L$ = 50 Ω | | | | |
| | | f = 1 GHz | 18 | 20 | - | dB |
| | | f = 2.2 GHz | 13 | 16 | - | dB |
| | | $Z_L$ = 75 Ω | | | | |
| | | f = 1 GHz | 15 | 17 | - | dB |
| | | f = 2.2 GHz | 12 | 15 | - | dB |
| $\|s_{12}\|^2$ | isolation | f = 1 GHz | 40 | 42 | - | dB |
| | | f = 2.2 GHz | 34 | 36 | - | dB |
| NF | noise figure | f = 1 GHz | - | 4.6 | 4.7 | dB |
| | | f = 2.2 GHz | - | 4.9 | 5.1 | dB |
| B | bandwidth | 3 dB below flat gain at f = 1 GHz | - | 2.1 | - | GHz |
| K | stability factor | f = 1 GHz | 1.2 | 1.3 | - | |
| | | f = 2.2 GHz | 0.9 | 1.0 | - | |
| $P_{L(sat)}$ | saturated load power | f = 1 GHz | 13.0 | 14.0 | - | dBm |
| | | f = 2.2 GHz | 9.0 | 10.2 | - | dBm |

**Table 8: Characteristics** *…continued*

*$V_S$ = 5 V; $I_S$ = 27.5 mA; $T_j$ = 25 °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 GHz | 12.0 | 13.0 | - | dBm |
| | | f = 2.2 GHz | 7.0 | 8.1 | - | dBm |
| $IP3_{in}$ | input third order intercept point | f = 1 GHz | –14 | –12.8 | - | dBm |
| | | f = 2.2 GHz | –15 | –13.2 | - | dBm |
| $IP3_{out}$ | output third order intercept point | f = 1 GHz | 21 | 22.7 | - | dBm |
| | | f = 2.2 GHz | 17 | 18.6 | - | dBm |
| IM2 | second order intermodulation product | $f_0$ = 1 GHz; $P_D$ = –45 dBm ($P_L$ = –10 dBm) | - | 45 | 43 | dBc |
| | | $f_0$ = 1 GHz; $P_D$ = –40 dBm ($P_L$ = –5 dBm) | - | 43 | 41 | dBc |

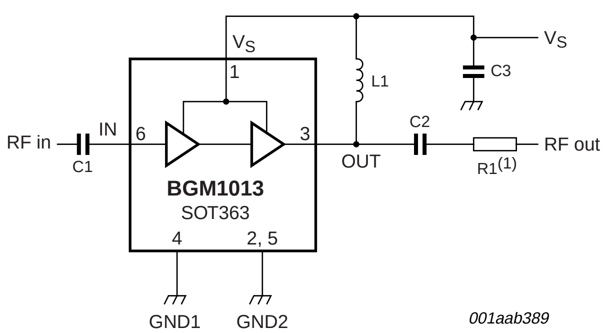
## 9. Application information

Figure 1 shows a typical application circuit for the BGM1013 MMIC. The device is internally matched to 50 Ω and therefore does not need any external matching. Output impedance is also very good to 75 Ω load. The value of the input and output DC blocking capacitors C1 and C2 should be not more than 100 pF for applications above 100 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.

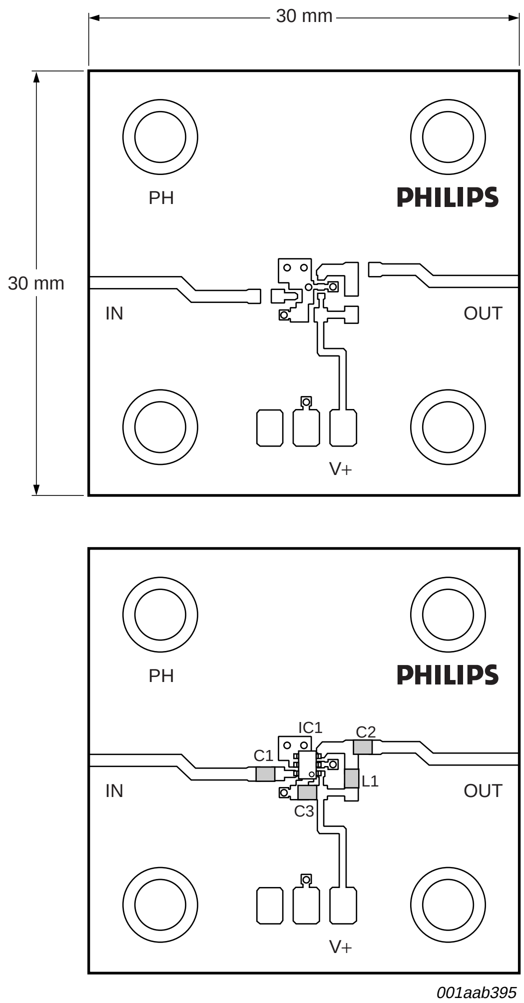
Ground paths must be as short as possible. The printed-circuit board (PCB) top ground plane must be as close as possible to the MMIC, and ideally directly beneath it. When using vias, use at least 3 vias for the top ground plane in order to limit ground path inductance. Supply decoupling with C3 should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




(1) R1 is omitted in typical application.

**Fig 1. Typical application circuit**

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




Material = FR4; thickness = 0.6 mm; $\varepsilon_r$ = 4.6.

**Fig 2. Printed-circuit board layout and component view for 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. $P_{L(1dB)}$ is 10 dBm at 1 GHz and 5.7 dBm at 2.2 GHz.

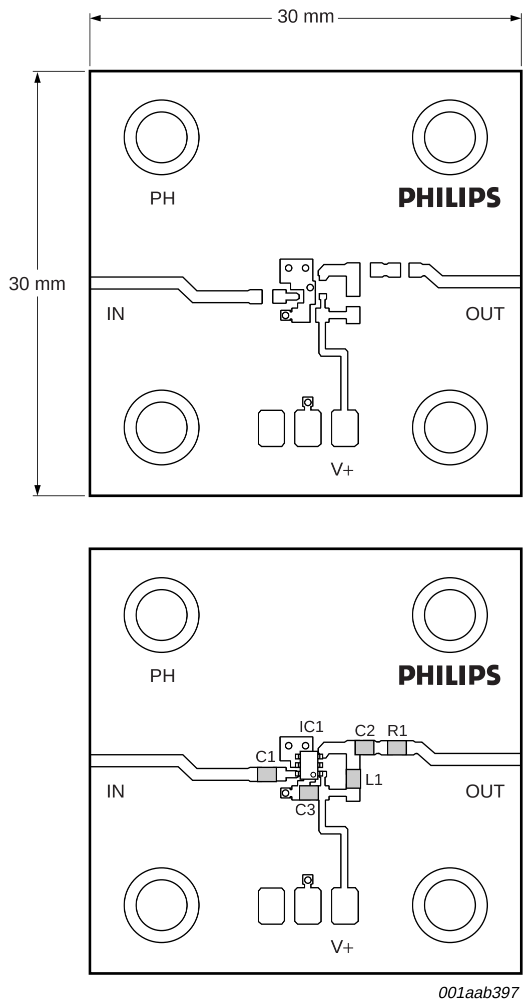
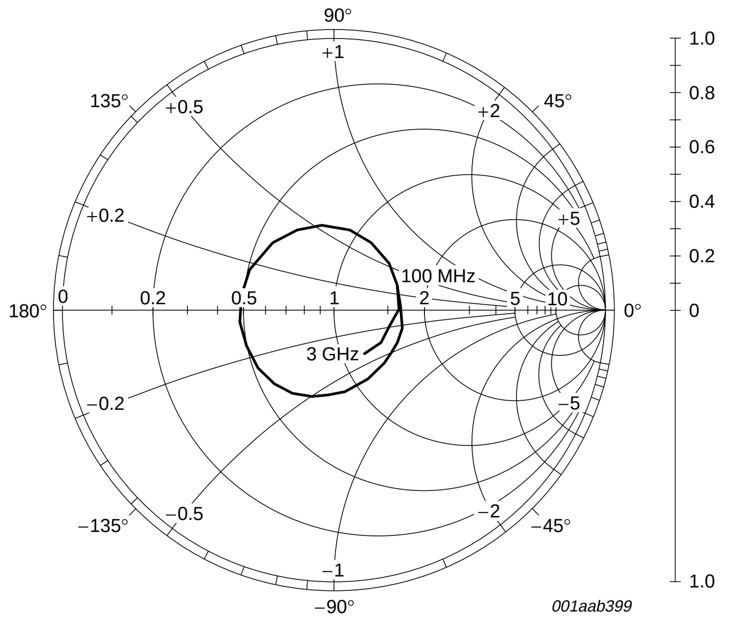



**Fig 3. Printed-circuit board layout and component view for 31 dB flat gain application**

**Table 10: List of components used for the 31 dB flat gain application [1]**

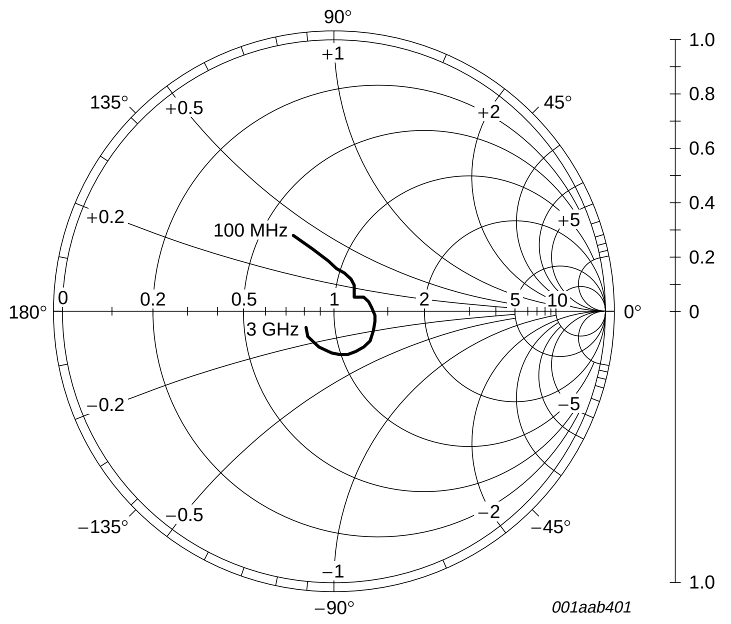
| Component | Description | Value | Dimensions |
|---|---|---|---|
| C1 | multilayer ceramic chip capacitor | 100 pF | 0603 |
| C2 | multilayer ceramic chip capacitor | 4.7 pF | 0603 |
| C3 | multilayer ceramic chip capacitor | 22 nF | 0603 |
| R1 | SMD resistor | 27 Ω | 0603 |
| L1 | SMD inductor |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

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



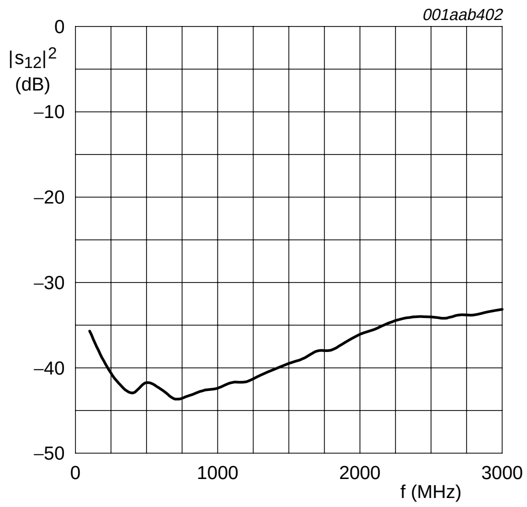

$I_S$ = 27.5 mA; $V_S$ = 5 V; $P_D$ = −35 dBm; $Z_o$ = 50 Ω.

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



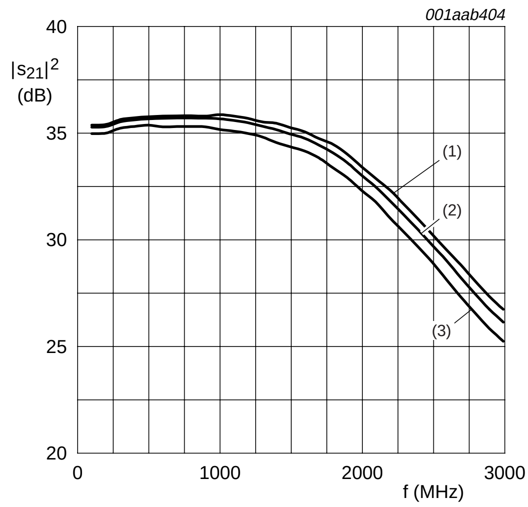

$I_S$ = 27.5 mA; $V_S$ = 5 V; $P_D$ = −35 dBm; $Z_o$ = 50 Ω.

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




$I_S$ = 27.5 mA; $V_S$ = 5 V; $P_D$ = −35 dBm; $Z_o$ = 50 Ω.

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



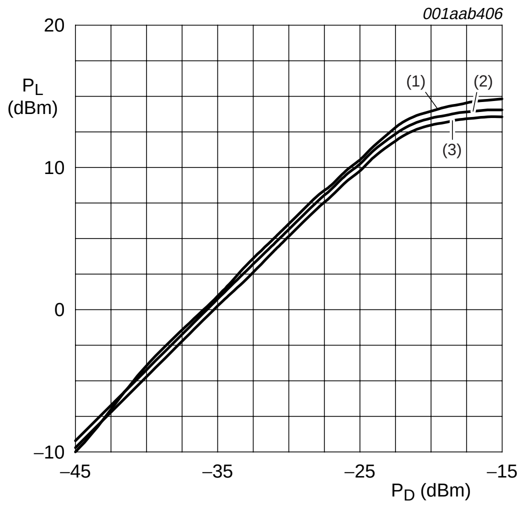

$P_D$ = −35 dBm; $Z_o$ = 50 Ω.

(1) $I_S$ = 32.6 mA; $V_S$ = 5.5 V.

(2) $I_S$ = 27.5 mA; $V_S$ = 5 V.

(3) $I_S$ = 21.5 mA; $V_S$ = 4.5 V.

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



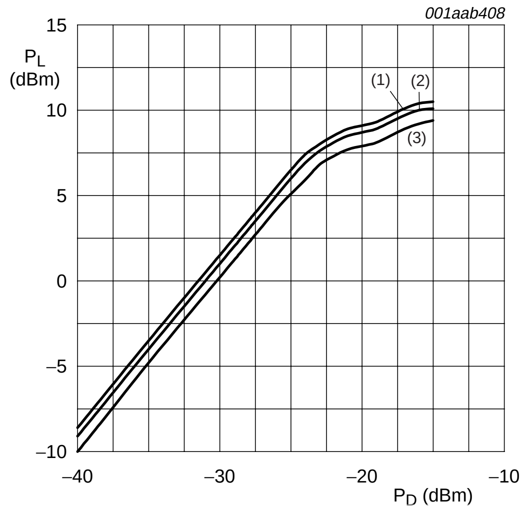

f = 1 GHz; $Z_o$ = 50 Ω.

(1) $V_S$ = 5.5 V.

(2) $V_S$ = 5 V.

(3) $V_S$ = 4.5 V.

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



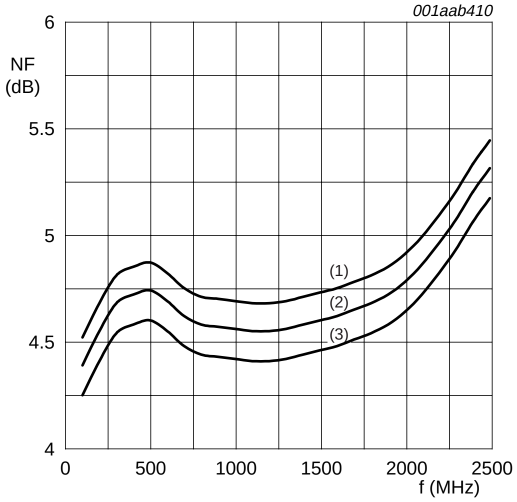

f = 2.2 GHz; $Z_o$ = 50 Ω.

(1) $V_S$ = 5.5 V.

(2) $V_S$ = 5 V.

(3) $V_S$ = 4.5 V.

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



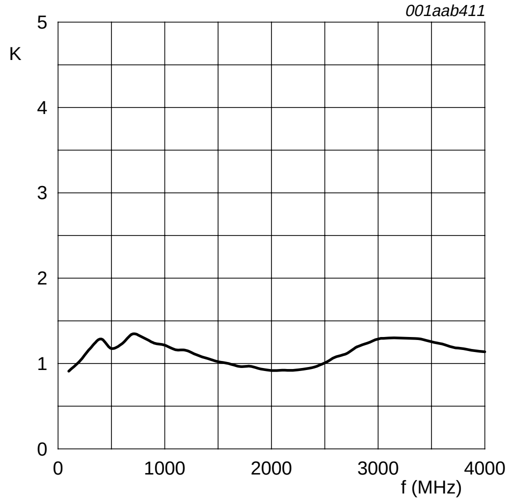

$Z_o = 50\ \Omega$.

(1) $V_S = 5.5$ V.

(2) $V_S = 5$ V.

(3) $V_S = 4.5$ V.

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




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

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

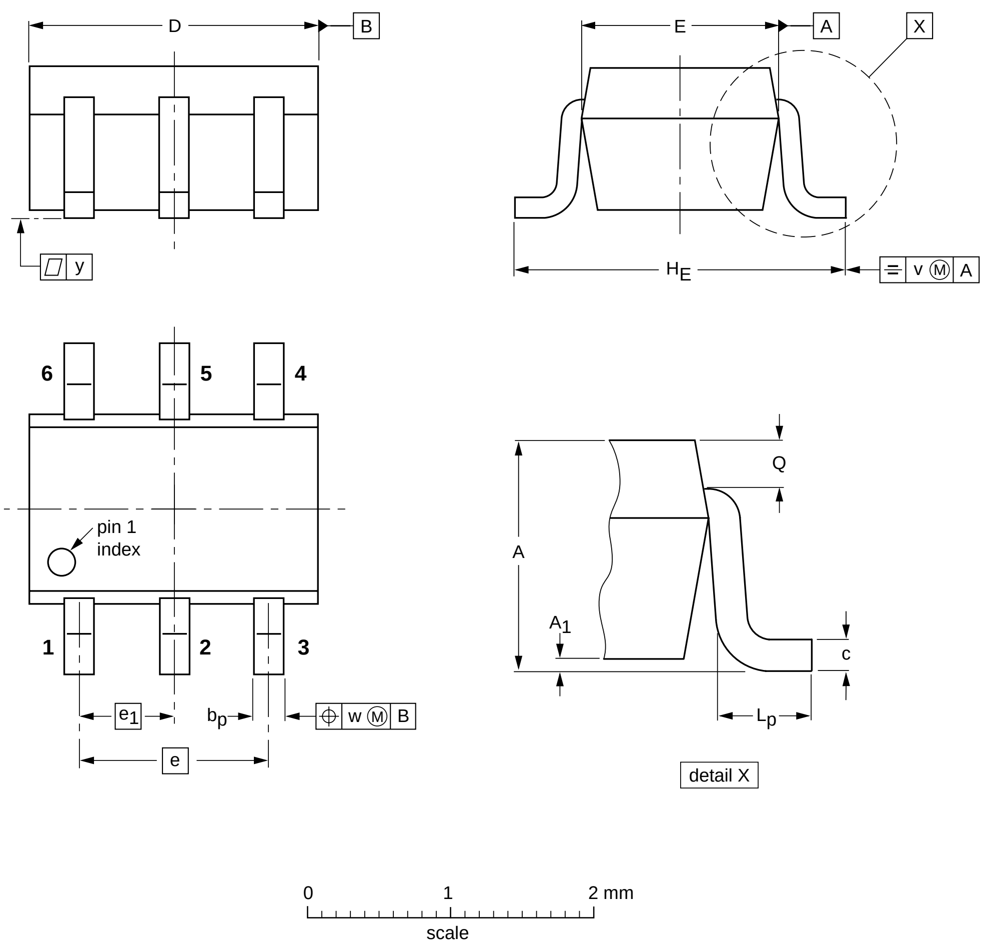
**Table 11: Scattering parameters**

*$V_S$ = 5 V; $I_S$ = 27.5 mA; $P_D$ = –35 dBm; $Z_o$ = 50 Ω; $T_{amb}$ = 25 °C; measured on demo board.*

| f (MHz) | $s_{11}$ | | $s_{21}$ | | $s_{12}$ | | $s_{22}$ | | 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**




**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 12. Package outline SOT363 (SC-88)**

## 11. Revision history

**Table 12: Revision history**

| Document ID | Release date | Data sheet status | Change notice | Doc. number | Supersedes |
|---|---|---|---|---|---|
| BGM1013_4 | 20060501 | Product data sheet | - | - | BGM1013_3 |
| Modifications: | • Figure 3 updated: pin 2 is not connected<br>• Table 10 updated: the value of C2 is 4.7 pF | | | | |
| BGM1013_3 | 20041209 | Product data sheet | - | 9397 750 14413 | BGM1013_2 |
| BGM1013_2 | 20041130 | Product data sheet | - | 9397 750 14229 | BGM1013_1 |
| BGM1013_1 | 20040831 | Product data sheet | - | 9397 750 13469 | - |

# 12. Data sheet status

| Level | Data sheet status [1] | Product status [2] [3] | Definition |
|---|---|---|---|
| I | Objective data | Development | This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice. |
| II | Preliminary data | Qualification | This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product. |
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[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

# 13. Definitions

**Short-form specification** — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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## 16. Contents





**Date of release: 1 May 2006**
**Document number: BGM1013_4**

**Published in The Netherlands**