

# BGA2776

MMIC wideband amplifier

Rev. 04 — 29 August 2007

Product data sheet

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NXP Semiconductors

MMIC wideband amplifier

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FEATURES

- Internally matched
- Very wide frequency range
- Very flat gain
- High gain
- High output power
- Unconditionally stable.

APPLICATIONS

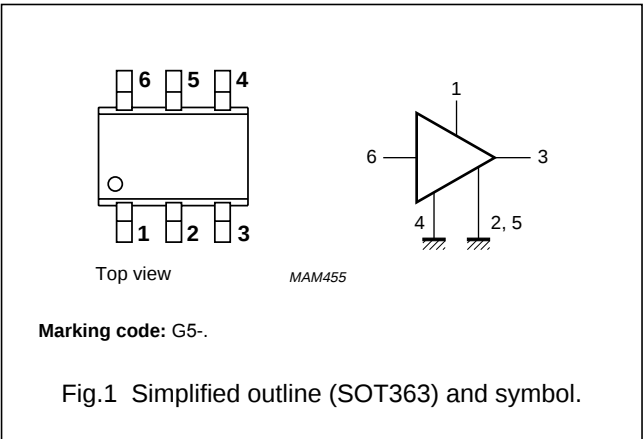
- Cable systems
- LNB IF amplifiers
- General purpose
- ISM.

DESCRIPTION

Silicon Monolithic Microwave Integrated Circuit (MMIC) wideband amplifier with internal matching circuit in a 6-pin SOT363 SMD plastic package.

PINNING

| PIN  | DESCRIPTION    |
|------|----------------|
| 1    | V <sub>S</sub> |
| 2, 5 | GND2           |
| 3    | RF out         |
| 4    | GND1           |
| 6    | RF in          |



QUICK REFERENCE DATA

| SYMBOL                         | PARAMETER            | CONDITIONS | TYP. | MAX. | UNIT |
|--------------------------------|----------------------|------------|------|------|------|
| V <sub>S</sub>                 | DC supply voltage    |            | 5    | 6    | V    |
| I <sub>S</sub>                 | DC supply current    |            | 24.4 | –    | mA   |
| S <sub>21</sub>   <sup>2</sup> | insertion power gain | f = 1 GHz  | 23.2 | –    | dB   |
| NF                             | noise figure         | f = 1 GHz  | 4.9  | –    | dB   |
| P <sub>L(sat)</sub>            | saturated load power | f = 1 GHz  | 10.5 | –    | dBm  |

| CAUTION                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| This product is supplied in anti-static packing to prevent damage caused by electrostatic discharge during transport and handling. For further information, refer to Philips specs.: SNW-EQ-608, SNW-FQ-302A and SNW-FQ-302B. |

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## 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    |
| $I_S$     | supply current                 |                         | –    | 34   | mA   |
| $P_{tot}$ | total power dissipation        | $T_S \leq 80\text{ °C}$ | –    | 200  | mW   |
| $T_{stg}$ | storage temperature            |                         | –65  | +150 | °C   |
| $T_j$     | operating junction temperature |                         | –    | 150  | °C   |
| $P_D$     | maximum drive power            |                         | –    | 10   | dBm  |

## THERMAL CHARACTERISTICS

| SYMBOL        | PARAMETER                                        | CONDITIONS                                          | VALUE | UNIT |
|---------------|--------------------------------------------------|-----------------------------------------------------|-------|------|
| $R_{th\ j-s}$ | thermal resistance from junction to solder point | $P_{tot} = 200\text{ mW}$ ; $T_S \leq 80\text{ °C}$ | 300   | K/W  |

## CHARACTERISTICS

$V_S = 5\text{ V}$ ;  $I_S = 24.4\text{ mA}$ ;  $f = 1\text{ GHz}$ ;  $T_j = 25\text{ °C}$ ; unless otherwise specified.

| SYMBOL               | PARAMETER              | CONDITIONS                                            | MIN. | TYP. | MAX. | UNIT |
|----------------------|------------------------|-------------------------------------------------------|------|------|------|------|
| $I_S$                | supply current         |                                                       | 19   | 24.4 | 34   | mA   |
| $ S_{21} ^2$         | insertion power gain   | $f = 1\text{ GHz}$                                    | –    | 23.2 | –    | dB   |
|                      |                        | $f = 2\text{ GHz}$                                    | –    | 23.2 | –    | dB   |
| $R_{L\ IN}$          | return losses input    | $f = 1\text{ GHz}$                                    | –    | 9    | –    | dB   |
|                      |                        | $f = 2\text{ GHz}$                                    | –    | 7    | –    | dB   |
| $R_{L\ OUT}$         | return losses output   | $f = 1\text{ GHz}$                                    | –    | 17   | –    | dB   |
|                      |                        | $f = 2\text{ GHz}$                                    | –    | 9    | –    | dB   |
| NF                   | noise figure           | $f = 1\text{ GHz}$                                    | –    | 4.9  | –    | dB   |
|                      |                        | $f = 2\text{ GHz}$                                    | –    | 5.3  | –    | dB   |
| BW                   | bandwidth              | at $ S_{21} ^2 -3\text{ dB}$ below flat gain at 1 GHz | –    | 2.8  | –    | GHz  |
| $P_{L(sat)}$         | saturated load power   | $f = 1\text{ GHz}$                                    | –    | 10.5 | –    | dBm  |
|                      |                        | $f = 2\text{ GHz}$                                    | –    | 8.1  | –    | dBm  |
| $P_{L\ 1\text{ dB}}$ | load power             | at 1 dB gain compression; $f = 1\text{ GHz}$          | –    | 7.2  | –    | dBm  |
|                      |                        | at 1 dB gain compression; $f = 2\text{ GHz}$          | –    | 6    | –    | dBm  |
| IP3(in)              | input intercept point  | $f = 1\text{ GHz}$                                    | –    | –4.6 | –    | dBm  |
|                      |                        | $f = 2\text{ GHz}$                                    | –    | –8.8 | –    | dBm  |
| IP3(out)             | output intercept point | $f = 1\text{ GHz}$                                    | –    | 18.6 | –    | dBm  |
|                      |                        | $f = 2\text{ GHz}$                                    | –    | 14.4 | –    | dBm  |

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## APPLICATION INFORMATION

Figure 2 shows a typical application circuit for the BGA2776 MMIC. The device is internally matched to  $50\ \Omega$ , and therefore does not need any external matching. The value of the input and output DC blocking capacitors C2 and C3 should be not more than 100 pF for applications above 100 MHz. However, when the device is operated below 100 MHz, the capacitor value should be increased.

The nominal value of the RF choke L1 is 100 nH. At frequencies below 100 MHz this value should be increased to 220 nH. At frequencies above 1 GHz a much lower value must be used (e.g. 10 nH) to improve return losses. For optimal results, a good quality chip inductor such as the TDK MLG 1608 (0603), or a wire-wound SMD type should be chosen.

Both the RF choke L1 and the 22 nF supply decoupling capacitor C1 should be located as closely as possible to the MMIC.

Separate paths must be used for the ground planes of the ground pins GND1 and GND2, and these paths must be as short as possible. When using vias, use multiple vias per pin in order to limit ground path inductance.

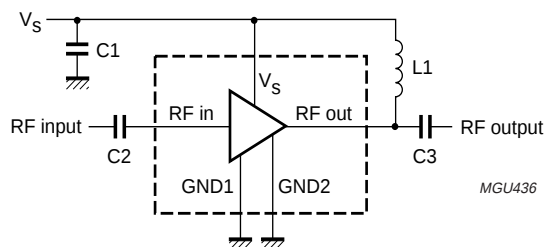


Fig.2 Typical application circuit.

Figure 3 shows two cascaded MMICs. This configuration doubles overall gain while preserving broadband characteristics. Supply decoupling and grounding conditions for each MMIC are the same as those for the circuit of Fig.2.

The excellent wideband characteristics of the MMIC make it an ideal building block in IF amplifier applications such as LBNs (see Fig.4).

As a buffer amplifier between an LNA and a mixer in a receiver circuit, the MMIC offers an easy matching, low noise solution (see Fig.5).

In Fig.6 the MMIC is used as a driver to the power amplifier as part of a transmitter circuit. Good linear performance and matched input and output offer quick design solutions in such applications.

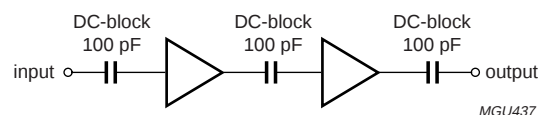


Fig.3 Simple cascade circuit.

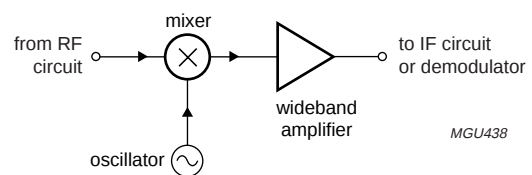


Fig.4 IF amplifier application.

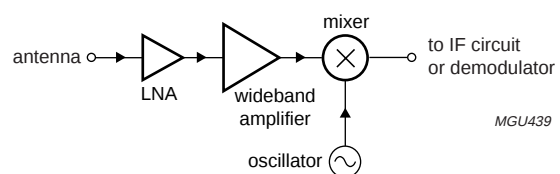


Fig.5 RF amplifier application.

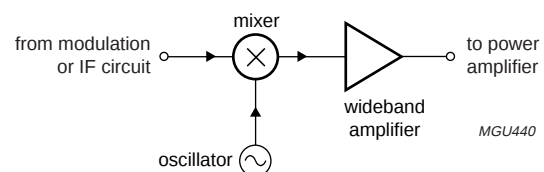
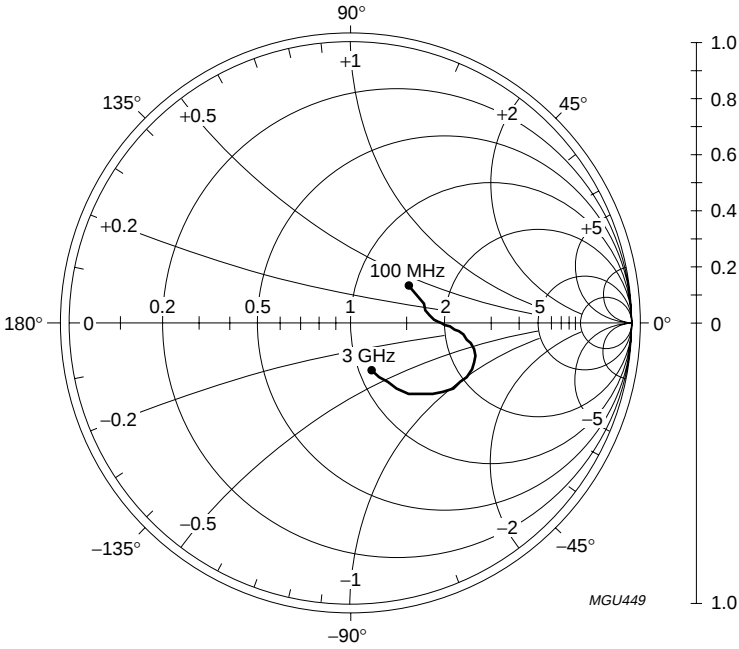


Fig.6 Power amplifier driver application.

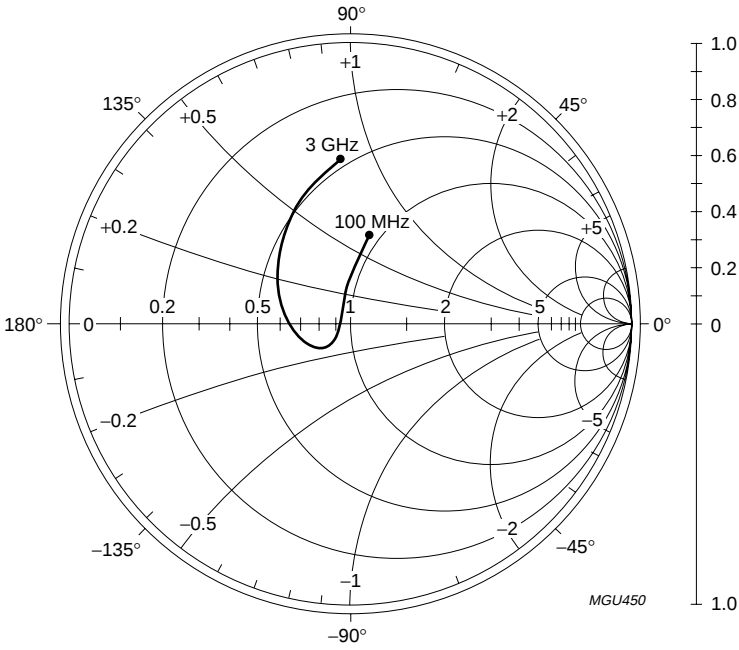
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$I_S = 23.8 \text{ mA}$ ;  $V_S = 5 \text{ V}$ ;  $P_D = -30 \text{ dBm}$ ;  $Z_O = 50 \Omega$ .

Fig.7 Input reflection coefficient ( $s_{11}$ ); typical values.

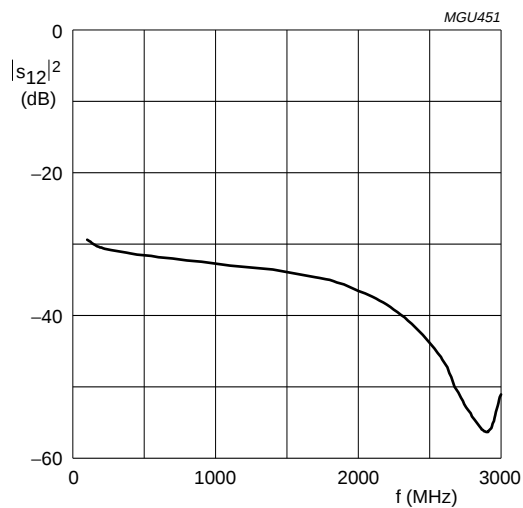


$I_S = 23.8 \text{ mA}$ ;  $V_S = 5 \text{ V}$ ;  $P_D = -30 \text{ dBm}$ ;  $Z_O = 50 \Omega$ .

Fig.8 Output reflection coefficient ( $s_{22}$ ); typical values.

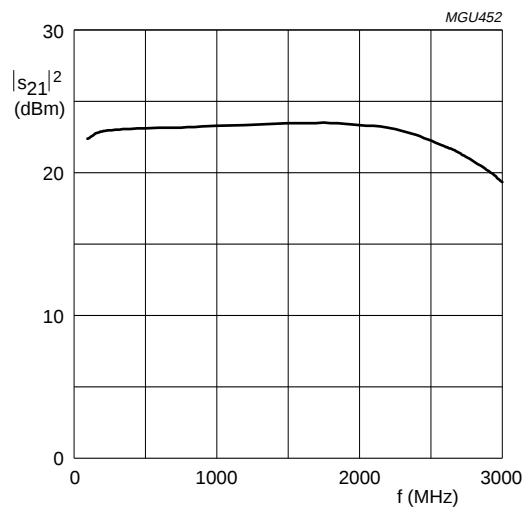
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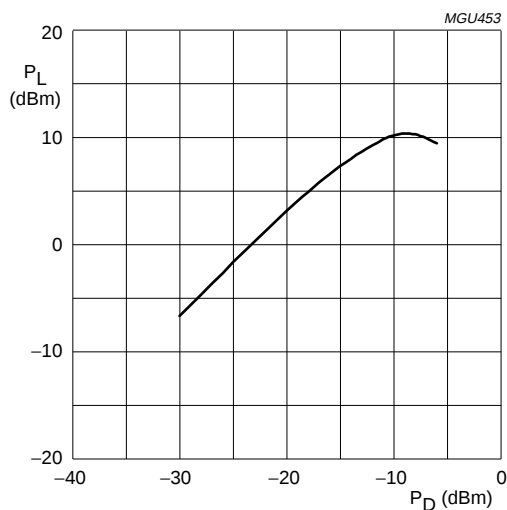
$I_S = 23.8 \text{ mA}$ ;  $V_S = 5 \text{ V}$ ;  $P_D = -30 \text{ dBm}$ ;  $Z_O = 50 \Omega$ .

Fig.9 Isolation ( $|s_{12}|^2$ ) as a function of frequency; typical values.



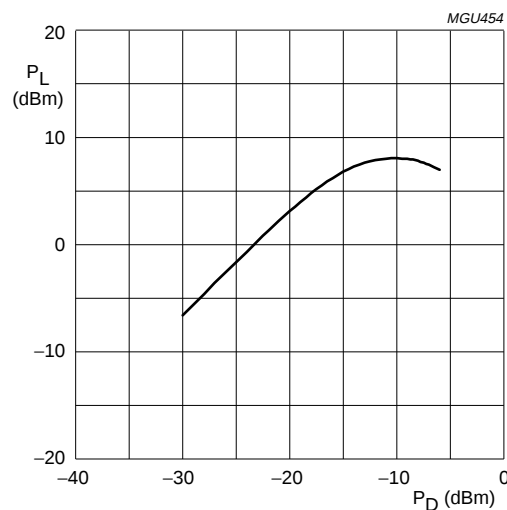
$I_S = 23.8 \text{ mA}$ ;  $V_S = 5 \text{ V}$ ;  $P_D = -30 \text{ dBm}$ ;  $Z_O = 50 \Omega$ .

Fig.10 Insertion gain ( $|s_{21}|^2$ ) as a function of frequency; typical values.



$V_S = 5 \text{ V}$ ;  $f = 1 \text{ GHz}$ ;  $Z_O = 50 \Omega$ .

Fig.11 Load power as a function of drive power at 1 GHz; typical values.

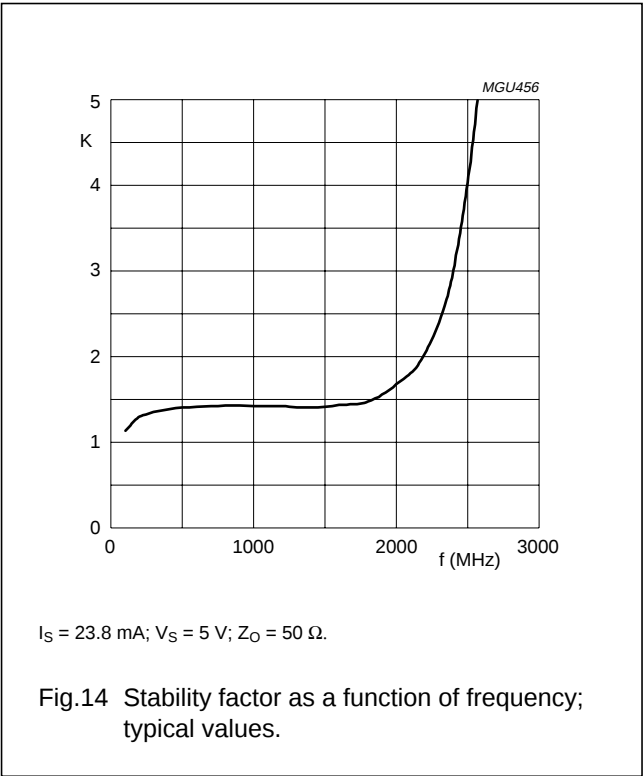
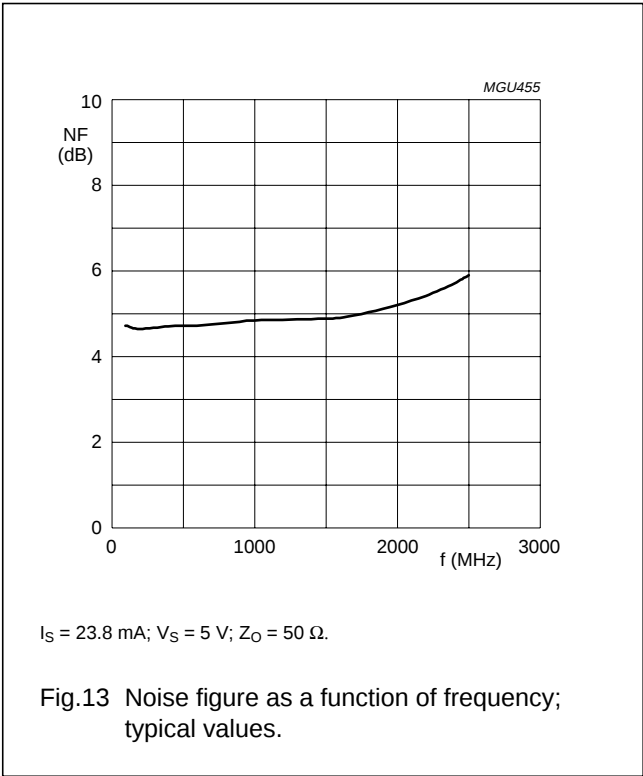


$V_S = 5 \text{ V}$ ;  $f = 2 \text{ GHz}$ ;  $Z_O = 50 \Omega$ .

Fig.12 Load power as a function of drive power at 2 GHz; typical values.

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Scattering parameters

$I_S = 23.8 \text{ mA}; V_S = 5 \text{ V}; P_D = -30 \text{ dBm}; Z_O = 50 \Omega; T_{amb} = 25 \text{ }^\circ\text{C}.$

| f<br>(MHz) | S <sub>11</sub>      |                | S <sub>21</sub>      |                | S <sub>12</sub>      |                | S <sub>22</sub>      |                |
|------------|----------------------|----------------|----------------------|----------------|----------------------|----------------|----------------------|----------------|
|            | MAGNITUDE<br>(ratio) | ANGLE<br>(deg) | MAGNITUDE<br>(ratio) | ANGLE<br>(deg) | MAGNITUDE<br>(ratio) | ANGLE<br>(deg) | MAGNITUDE<br>(ratio) | ANGLE<br>(deg) |
| 100        | 0.24807              | 33.20          | 13.128               | 18.88          | 0.03393              | 18.97          | 0.33203              | 77.92          |
| 200        | 0.27028              | 15.23          | 13.939               | 1.305          | 0.02979              | 7.840          | 0.16144              | 92.47          |
| 400        | 0.28518              | 5.613          | 14.233               | -16.20         | 0.02720              | -3.208         | 0.04702              | 127.5          |
| 600        | 0.30074              | 1.998          | 14.370               | -29.60         | 0.02573              | -8.356         | 0.05168              | -147.7         |
| 800        | 0.32672              | 0.099          | 14.418               | -42.25         | 0.02434              | -11.95         | 0.09810              | -134.1         |
| 1000       | 0.35611              | -1.702         | 14.566               | -54.66         | 0.02310              | -14.59         | 0.13562              | -139.8         |
| 1200       | 0.38865              | -4.465         | 14.683               | -67.44         | 0.02189              | -17.14         | 0.16792              | -152.8         |
| 1400       | 0.41966              | -7.778         | 14.828               | -80.86         | 0.02100              | -20.38         | 0.19808              | -169.9         |
| 1600       | 0.44966              | -12.12         | 14.911               | -94.49         | 0.01929              | -24.40         | 0.23691              | 171.6          |
| 1800       | 0.46509              | -17.78         | 14.941               | -109.4         | 0.01774              | -29.44         | 0.28834              | 153.5          |
| 2000       | 0.45980              | -24.85         | 14.688               | -124.9         | 0.01494              | -36.30         | 0.34770              | 137.6          |
| 2200       | 0.43684              | -32.59         | 14.389               | -140.7         | 0.01193              | -41.31         | 0.40964              | 124.2          |
| 2400       | 0.38779              | -40.66         | 13.533               | -157.9         | 0.00828              | -43.81         | 0.46607              | 113.1          |
| 2600       | 0.32424              | -50.49         | 12.355               | -174.5         | 0.00477              | -48.94         | 0.51421              | 105.9          |
| 2800       | 0.25311              | -57.33         | 11.049               | 169.3          | 0.00146              | -17.41         | 0.56131              | 98.30          |
| 3000       | 0.18665              | -65.52         | 9.2745               | 154.9          | 0.00279              | 94.00          | 0.59748              | 93.63          |

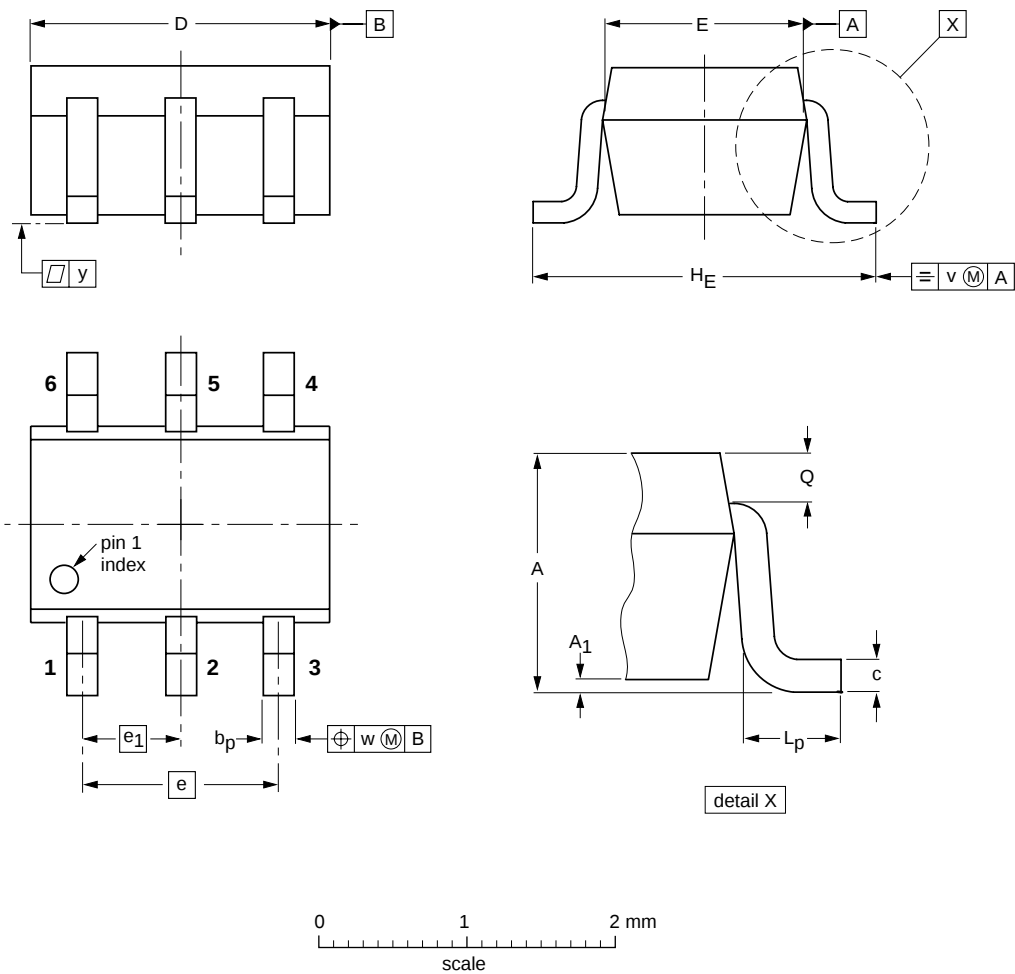
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PACKAGE OUTLINE

Plastic surface mounted package; 6 leads

SOT363



DIMENSIONS (mm are the original dimensions)

| UNIT | A          | A1<br>max | bp           | c            | D          | E            | e   | e1   | HE         | Lp           | 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<br>VERSION | REFERENCES |       |       |  | EUROPEAN<br>PROJECTION                                                                | ISSUE DATE |
|--------------------|------------|-------|-------|--|---------------------------------------------------------------------------------------|------------|
|                    | IEC        | JEDEC | EIAJ  |  |                                                                                       |            |
| SOT363             |            |       | SC-88 |  |  | 97-02-28   |

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### 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".

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Revision history

| Revision history                                                                             |              |                           |               |             |
|----------------------------------------------------------------------------------------------|--------------|---------------------------|---------------|-------------|
| Document ID                                                                                  | Release date | Data sheet status         | Change notice | Supersedes  |
| BGA2776_N_4                                                                                  | 20070829     | Product data sheet        | -             | BGA2776_3   |
| Modifications: <ul style="list-style-type: none"><li>amended marking code (Fig. 1)</li></ul> |              |                           |               |             |
| BGA2776_3<br>(9397 750 10016)                                                                | 20020806     | Product specification     | -             | BGA2776_2   |
| BGA2776_2<br>(9397 750 08548)                                                                | 20011019     | Product specification     | -             | BGA2776_N_1 |
| BGA2776_N_1<br>(9397 750 08193)                                                              | 20010330     | Preliminary specification | -             | -           |



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