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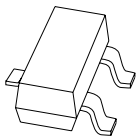
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Kind regards,

Team Nexperia



# MMBZxAL series

## Low capacitance unidirectional double ESD protection diodes

Rev. 02 — 10 December 2009 Product data sheet

## 1. Product profile

### 1.1 General description

Unidirectional double ElectroStatic Discharge (ESD) protection diodes in a common anode configuration, encapsulated in a SOT23 (TO-236AB) small Surface-Mounted Device (SMD) plastic package. The devices are designed for ESD and transient overvoltage protection of up to two signal lines.

**Table 1. Product overview**

| Type number | Package | | Configuration |
|---|---|---|---|
| | NXP | JEDEC | |
| MMBZ5V6AL | SOT23 | TO-236AB | dual common anode |
| MMBZ6V2AL | | | |
| MMBZ6V8AL | | | |
| MMBZ9V1AL | | | |
| MMBZ10VAL | | | |
| MMBZ12VAL | | | |
| MMBZ15VAL | | | |
| MMBZ18VAL | | | |
| MMBZ20VAL | | | |
| MMBZ27VAL | | | |
| MMBZ33VAL | | | |

### 1.2 Features

- Unidirectional ESD protection of two lines
- Bidirectional ESD protection of one line
- Low diode capacitance: $C_d \leq 280$ pF
- Rated peak pulse power: $P_{PPM} = 40$ W
- Ultra low leakage current: $I_{RM} = 5$ nA
- ESD protection up to 30 kV (contact discharge)
- IEC 61000-4-2; level 4 (ESD)
- IEC 61643-321
- AEC-Q101 qualified

### 1.3 Applications

- Computers and peripherals
- Audio and video equipment
- Cellular handsets and accessories
- Automotive electronic control units
- Portable electronics

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## 1.4 Quick reference data

**Table 2. Quick reference data**

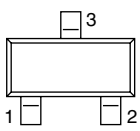
*$T_{amb}$ = 25 °C unless otherwise specified.*

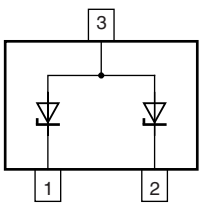
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Per diode** | | | | | | |
| $V_{RWM}$ | reverse standoff voltage | | | | | |
| | MMBZ5V6AL | | - | - | 3 | V |
| | MMBZ6V2AL | | - | - | 3 | V |
| | MMBZ6V8AL | | - | - | 4.5 | V |
| | MMBZ9V1AL | | - | - | 6 | V |
| | MMBZ10VAL | | - | - | 6.5 | V |
| | MMBZ12VAL | | - | - | 8.5 | V |
| | MMBZ15VAL | | - | - | 12 | V |
| | MMBZ18VAL | | - | - | 14.5 | V |
| | MMBZ20VAL | | - | - | 17 | V |
| | MMBZ27VAL | | - | - | 22 | V |
| | MMBZ33VAL | | - | - | 26 | V |
| $C_d$ | diode capacitance | f = 1 MHz; $V_R$ = 0 V | | | | |
| | MMBZ5V6AL | | - | 210 | 280 | pF |
| | MMBZ6V2AL | | - | 175 | 230 | pF |
| | MMBZ6V8AL | | - | 150 | 200 | pF |
| | MMBZ9V1AL | | - | 155 | 200 | pF |
| | MMBZ10VAL | | - | 130 | 170 | pF |
| | MMBZ12VAL | | - | 110 | 140 | pF |
| | MMBZ15VAL | | - | 85 | 105 | pF |
| | MMBZ18VAL | | - | 70 | 90 | pF |
| | MMBZ20VAL | | - | 65 | 80 | pF |
| | MMBZ27VAL | | - | 48 | 60 | pF |
| | MMBZ33VAL | | - | 45 | 55 | pF |

# 2. Pinning information

**Table 3. Pinning**

| Pin | Description | Simplified outline | Graphic symbol |
|---|---|---|---|
| 1 | cathode (diode 1) | | |
| 2 | cathode (diode 2) | | |
| 3 | common anode | | |




006aaa154



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## 3. Ordering information

**Table 4. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| MMBZ5V6AL | - | plastic surface-mounted package; 3 leads | SOT23 |
| MMBZ6V2AL | | | |
| MMBZ6V8AL | | | |
| MMBZ9V1AL | | | |
| MMBZ10VAL | | | |
| MMBZ12VAL | | | |
| MMBZ15VAL | | | |
| MMBZ18VAL | | | |
| MMBZ20VAL | | | |
| MMBZ27VAL | | | |
| MMBZ33VAL | | | |

## 4. Marking

**Table 5. Marking codes**

| Type number | Marking code[1] |
|---|---|
| MMBZ5V6AL | RR* |
| MMBZ6V2AL | RS* |
| MMBZ6V8AL | RT* |
| MMBZ9V1AL | RU* |
| MMBZ10VAL | RV* |
| MMBZ12VAL | *H1 |
| MMBZ15VAL | *H2 |
| MMBZ18VAL | *H3 |
| MMBZ20VAL | *H4 |
| MMBZ27VAL | *H5 |
| MMBZ33VAL | *H6 |

[1] * = -: made in Hong Kong
* = p: made in Hong Kong
* = t: made in Malaysia
* = W: made in China


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## 5. Limiting values

**Table 6. Limiting values**

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

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| **Per diode** | | | | | | |
| $P_{PPM}$ | rated peak pulse power | $t_p$ = 10/1000 μs | [1][2] | | | |
| | MMBZ5V6AL | | | - | 24 | W |
| | MMBZ6V2AL | | | | | |
| | MMBZ6V8AL | | | | | |
| | MMBZ9V1AL | | | | | |
| | MMBZ10VAL | | | | | |
| | MMBZ12VAL | | | - | 40 | W |
| | MMBZ15VAL | | | | | |
| | MMBZ18VAL | | | | | |
| | MMBZ20VAL | | | | | |
| | MMBZ27VAL | | | | | |
| | MMBZ33VAL | | | | | |
| $I_{PPM}$ | rated peak pulse current | $t_p$ = 10/1000 μs | [1][2] | | | |
| | MMBZ5V6AL | | | - | 3 | A |
| | MMBZ6V2AL | | | - | 2.76 | A |
| | MMBZ6V8AL | | | - | 2.5 | A |
| | MMBZ9V1AL | | | - | 1.7 | A |
| | MMBZ10VAL | | | - | 1.7 | A |
| | MMBZ12VAL | | | - | 2.35 | A |
| | MMBZ15VAL | | | - | 1.9 | A |
| | MMBZ18VAL | | | - | 1.6 | A |
| | MMBZ20VAL | | | - | 1.4 | A |
| | MMBZ27VAL | | | - | 1 | A |
| | MMBZ33VAL | | | - | 0.87 | A |
| **Per device** | | | | | | |
| $P_{tot}$ | total power dissipation | $T_{amb} \leq 25$ °C | | | | |
| | MMBZxAL series | | [3] | - | 265 | mW |
| | MMBZ5V6AL | | [4] | - | 290 | mW |
| | MMBZ6V2AL | | | | | |
| | MMBZ6V8AL | | | | | |
| | MMBZ9V1AL | | [4] | - | 360 | mW |
| | MMBZ10VAL | | | | | |
| | MMBZ12VAL | | | | | |
| | MMBZ15VAL | | | | | |
| | MMBZ18VAL | | | | | |
| | MMBZ20VAL | | | | | |
| | MMBZ27VAL | | | | | |
| | MMBZ33VAL | | | | | |



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**Table 6. Limiting values** *...continued*

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

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $T_j$ | junction temperature | | - | 150 | °C |
| $T_{amb}$ | ambient temperature | | −55 | +150 | °C |
| $T_{stg}$ | storage temperature | | −65 | +150 | °C |

[1] In accordance with IEC 61643-321 (10/1000 μs current waveform).

[2] Measured from pin 1 or 2 to pin 3.

[3] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[4] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for cathode 1 $cm^2$.

**Table 7. ESD maximum ratings**

*$T_{amb}$ = 25 °C unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| **Per diode** | | | | | | |
| $V_{ESD}$ | electrostatic discharge voltage | IEC 61000-4-2 (contact discharge) | [1][2] | - | 30 | kV |
| | | machine model | [2] | - | 2 | kV |

[1] Device stressed with ten non-repetitive ESD pulses.

[2] Measured from pin 1 or 2 to pin 3.

**Table 8. ESD standards compliance**

| Standard | Conditions |
|---|---|
| **Per diode** | |
| IEC 61000-4-2; level 4 (ESD) | > 15 kV (air); > 8 kV (contact) |
| MIL-STD-883; class 3 (human body model) | > 8 kV |



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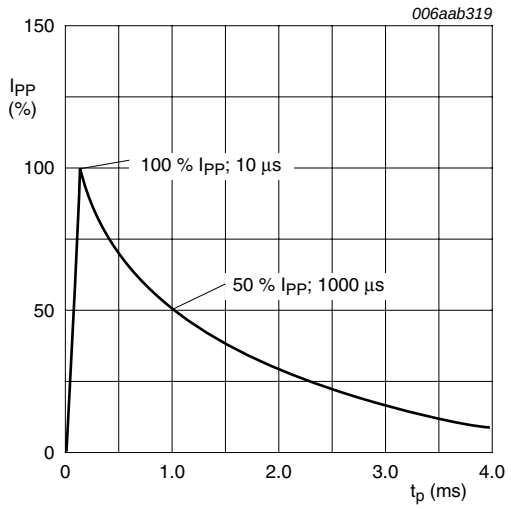



**Fig 1. 10/1000 µs pulse waveform according to IEC 61643-321**

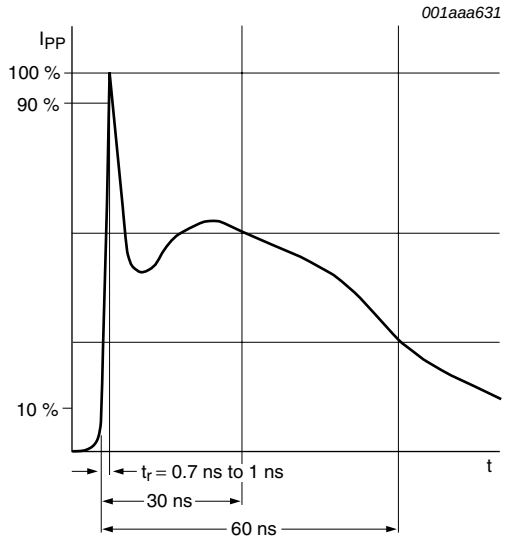



**Fig 2. ESD pulse waveform according to IEC 61000-4-2**


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## 6. Thermal characteristics

Table 9. Thermal characteristics

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Per device** | | | | | | | |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | | | | | |
| | MMBZxAL series | | [1] | - | - | 460 | K/W |
| | MMBZ5V6AL<br>MMBZ6V2AL<br>MMBZ6V8AL | | [2] | - | - | 420 | K/W |
| | MMBZ9V1AL<br>MMBZ10VAL<br>MMBZ12VAL<br>MMBZ15VAL<br>MMBZ18VAL<br>MMBZ20VAL<br>MMBZ27VAL<br>MMBZ33VAL | | [2] | - | - | 340 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | [3] | | | | |
| | MMBZ5V6AL<br>MMBZ6V2AL<br>MMBZ6V8AL | | | - | - | 150 | K/W |
| | MMBZ9V1AL<br>MMBZ10VAL<br>MMBZ12VAL<br>MMBZ15VAL<br>MMBZ18VAL<br>MMBZ20VAL<br>MMBZ27VAL<br>MMBZ33VAL | | | - | - | 50 | K/W |

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for cathode 1 $cm^2$.

[3] Measured from pin 1 or 2 to pin 3.



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## 7. Characteristics

**Table 10. Characteristics**

*$T_{amb}$ = 25 °C unless otherwise specified.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Per diode** | | | | | | |
| $V_F$ | forward voltage | $I_F$ = 10 mA | - | - | 0.9 | V |
| $V_{RWM}$ | reverse standoff voltage | | | | | |
| | MMBZ5V6AL | | - | - | 3 | V |
| | MMBZ6V2AL | | - | - | 3 | V |
| | MMBZ6V8AL | | - | - | 4.5 | V |
| | MMBZ9V1AL | | - | - | 6 | V |
| | MMBZ10VAL | | - | - | 6.5 | V |
| | MMBZ12VAL | | - | - | 8.5 | V |
| | MMBZ15VAL | | - | - | 12 | V |
| | MMBZ18VAL | | - | - | 14.5 | V |
| | MMBZ20VAL | | - | - | 17 | V |
| | MMBZ27VAL | | - | - | 22 | V |
| | MMBZ33VAL | | - | - | 26 | V |
| $I_{RM}$ | reverse leakage current | | | | | |
| | MMBZ5V6AL | $V_{RWM}$ = 3 V | - | 0.24 | 5 | µA |
| | MMBZ6V2AL | $V_{RWM}$ = 3 V | - | 5 | 200 | nA |
| | MMBZ6V8AL | $V_{RWM}$ = 4.5 V | - | 10 | 300 | nA |
| | MMBZ9V1AL | $V_{RWM}$ = 6 V | - | 5 | 100 | nA |
| | MMBZ10VAL | $V_{RWM}$ = 6.5 V | - | 1 | 20 | nA |
| | MMBZ12VAL | $V_{RWM}$ = 8.5 V | - | 0.1 | 5 | nA |
| | MMBZ15VAL | $V_{RWM}$ = 12 V | - | 0.1 | 5 | nA |
| | MMBZ18VAL | $V_{RWM}$ = 14.5 V | - | 0.1 | 5 | nA |
| | MMBZ20VAL | $V_{RWM}$ = 17 V | - | 0.1 | 5 | nA |
| | MMBZ27VAL | $V_{RWM}$ = 22 V | - | 0.1 | 5 | nA |
| | MMBZ33VAL | $V_{RWM}$ = 26 V | - | 0.1 | 5 | nA |
| $V_{BR}$ | breakdown voltage | | | | | |
| | MMBZ5V6AL | $I_R$ = 20 mA | 5.32 | 5.6 | 5.88 | V |
| | MMBZ6V2AL | $I_R$ = 1 mA | 5.89 | 6.2 | 6.51 | V |
| | MMBZ6V8AL | $I_R$ = 1 mA | 6.46 | 6.8 | 7.14 | V |
| | MMBZ9V1AL | $I_R$ = 1 mA | 8.65 | 9.1 | 9.56 | V |
| | MMBZ10VAL | $I_R$ = 1 mA | 9.5 | 10 | 10.5 | V |
| | MMBZ12VAL | $I_R$ = 1 mA | 11.4 | 12 | 12.6 | V |
| | MMBZ15VAL | $I_R$ = 1 mA | 14.25 | 15 | 15.75 | V |
| | MMBZ18VAL | $I_R$ = 1 mA | 17.1 | 18 | 18.9 | V |
| | MMBZ20VAL | $I_R$ = 1 mA | 19 | 20 | 21 | V |
| | MMBZ27VAL | $I_R$ = 1 mA | 25.65 | 27 | 28.35 | V |
| | MMBZ33VAL | $I_R$ = 1 mA | 31.35 | 33 | 34.65 | V |



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**Table 10. Characteristics** *...continued*

*$T_{amb}$ = 25 °C unless otherwise specified.*

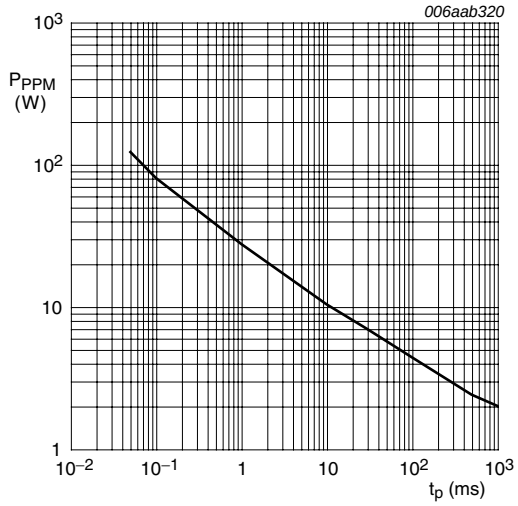
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $C_d$ | diode capacitance | f = 1 MHz; $V_R$ = 0 V | | | | |
| | MMBZ5V6AL | | - | 210 | 280 | pF |
| | MMBZ6V2AL | | - | 175 | 230 | pF |
| | MMBZ6V8AL | | - | 150 | 200 | pF |
| | MMBZ9V1AL | | - | 155 | 200 | pF |
| | MMBZ10VAL | | - | 130 | 170 | pF |
| | MMBZ12VAL | | - | 110 | 140 | pF |
| | MMBZ15VAL | | - | 85 | 105 | pF |
| | MMBZ18VAL | | - | 70 | 90 | pF |
| | MMBZ20VAL | | - | 65 | 80 | pF |
| | MMBZ27VAL | | - | 48 | 60 | pF |
| | MMBZ33VAL | | - | 45 | 55 | pF |
| $V_{CL}$ | clamping voltage | [1][2] | | | | |
| | MMBZ5V6AL | $I_{PPM}$ = 3 A | - | - | 8 | V |
| | MMBZ6V2AL | $I_{PPM}$ = 2.76 A | - | - | 8.7 | V |
| | MMBZ6V8AL | $I_{PPM}$ = 2.5 A | - | - | 9.6 | V |
| | MMBZ9V1AL | $I_{PPM}$ = 1.7 A | - | - | 14 | V |
| | MMBZ10VAL | $I_{PPM}$ = 1.7 A | - | - | 14.2 | V |
| | MMBZ12VAL | $I_{PPM}$ = 2.35 A | - | - | 17 | V |
| | MMBZ15VAL | $I_{PPM}$ = 1.9 A | - | - | 21 | V |
| | MMBZ18VAL | $I_{PPM}$ = 1.6 A | - | - | 25 | V |
| | MMBZ20VAL | $I_{PPM}$ = 1.4 A | - | - | 28 | V |
| | MMBZ27VAL | $I_{PPM}$ = 1 A | - | - | 40 | V |
| | MMBZ33VAL | $I_{PPM}$ = 0.87 A | - | - | 46 | V |
| $S_Z$ | temperature coefficient | | | | | |
| | MMBZ5V6AL | $I_Z$ = 20 mA | - | 1.7 | - | mV/K |
| | MMBZ6V2AL | $I_Z$ = 1 mA | - | 2.1 | - | mV/K |
| | MMBZ6V8AL | $I_Z$ = 1 mA | - | 3.2 | - | mV/K |
| | MMBZ9V1AL | $I_Z$ = 1 mA | - | 5.4 | - | mV/K |
| | MMBZ10VAL | $I_Z$ = 1 mA | - | 6.5 | - | mV/K |
| | MMBZ12VAL | $I_Z$ = 1 mA | - | 8.2 | - | mV/K |
| | MMBZ15VAL | $I_Z$ = 1 mA | - | 11 | - | mV/K |
| | MMBZ18VAL | $I_Z$ = 1 mA | - | 14 | - | mV/K |
| | MMBZ20VAL | $I_Z$ = 1 mA | - | 15.8 | - | mV/K |
| | MMBZ27VAL | $I_Z$ = 1 mA | - | 23 | - | mV/K |
| | MMBZ33VAL | $I_Z$ = 1 mA | - | 29.8 | - | mV/K |

[1] In accordance with IEC 61643-321(10/1000 μs current waveform).

[2] Measured from pin 1 or 2 to pin 3.



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$T_{amb}$ = 25 °C

unidirectional and bidirectional

**Fig 3. Rated peak pulse power as a function of exponential pulse duration (rectangular waveform); typical values**

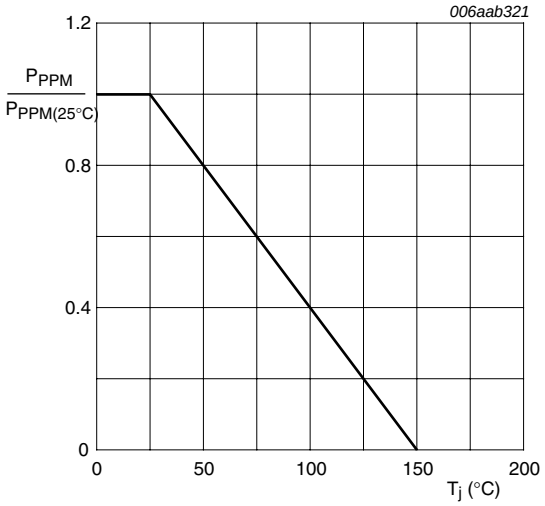
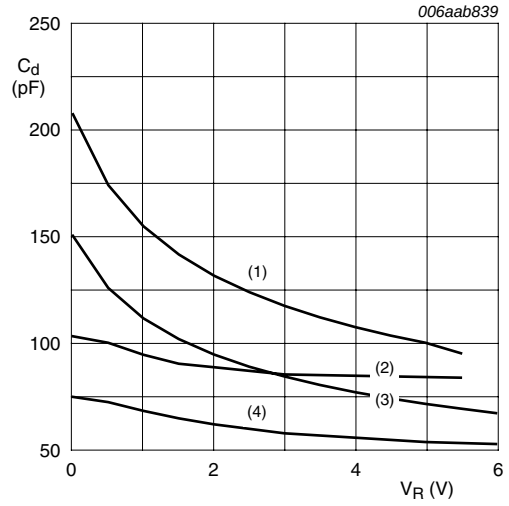



**Fig 4. Relative variation of rated peak pulse power as a function of junction temperature; typical values**




f = 1 MHz; $T_{amb}$ = 25 °C

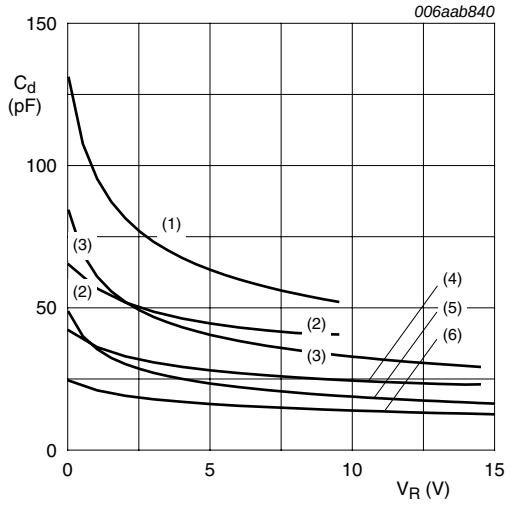
(1) MMBZ5V6AL: unidirectional

(2) MMBZ5V6AL: bidirectional

(3) MMBZ6V8AL: unidirectional

(4) MMBZ6V8AL: bidirectional

**Fig 5. Diode capacitance as a function of reverse voltage; typical values**




f = 1 MHz; $T_{amb}$ = 25 °C

(1) MMBZ10VAL: unidirectional

(2) MMBZ10VAL: bidirectional

(3) MMBZ15VAL: unidirectional

(4) MMBZ15VAL: bidirectional

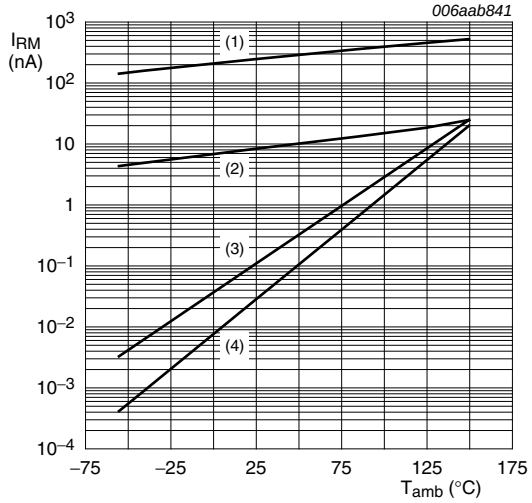
(5) MMBZ27VAL: unidirectional

(6) MMBZ27VAL: bidirectional

**Fig 6. Diode capacitance as a function of reverse voltage; typical values**



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(1) MMBZ5V6AL: $V_{RWM}$ = 3 V

(2) MMBZ6V8AL: $V_{RWM}$ = 4.5 V

(3) MMBZ9V1AL: $V_{RWM}$ = 6 V

(4) MMBZ27VAL: $V_{RWM}$ = 22 V

**Fig 7. Reverse leakage current as a function of ambient temperature; typical values**

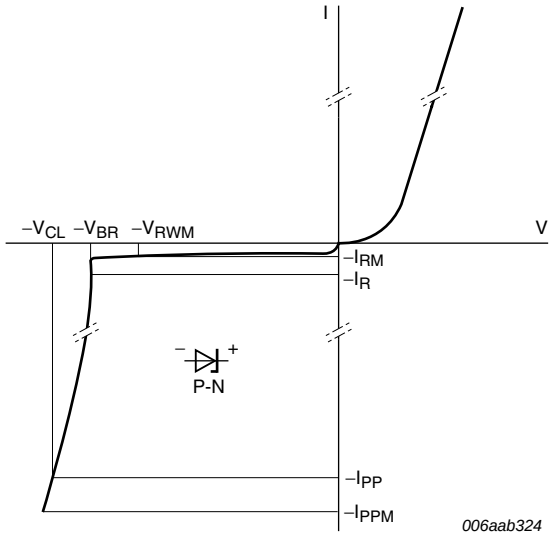



**Fig 8. V-I characteristics for a unidirectional ESD protection diode**

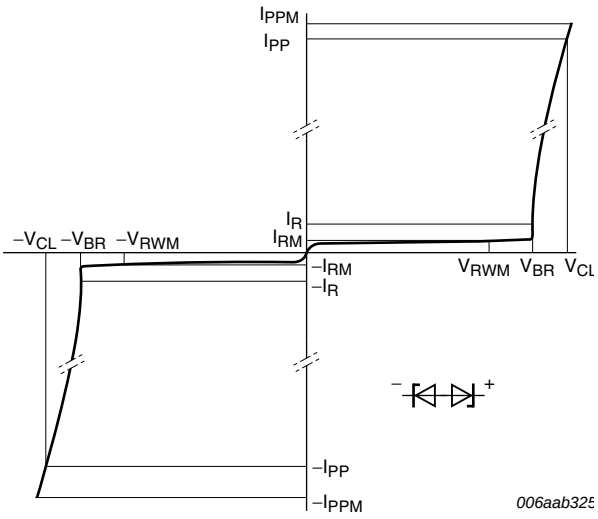



**Fig 9. V-I characteristics for a bidirectional ESD protection diode**



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# 8. Application information

The MMBZxAL series is designed for the protection of up to two unidirectional data or signal lines from the damage caused by ESD and surge pulses. The devices may be used on lines where the signal polarities are either positive or negative with respect to ground. The MMBZ5V6AL, MMBZ6V2AL, MMBZ6V8AL, MMBZ9V1AL and MMBZ10VAL provide a surge capability of 24 W per line, the MMBZ12VAL, MMBZ15VAL, MMBZ18VAL, MMBZ20VAL, MMBZ27VAL and MMBZ33VAL provide a surge capability of 40 W per line, for a 10/1000 μs waveform.

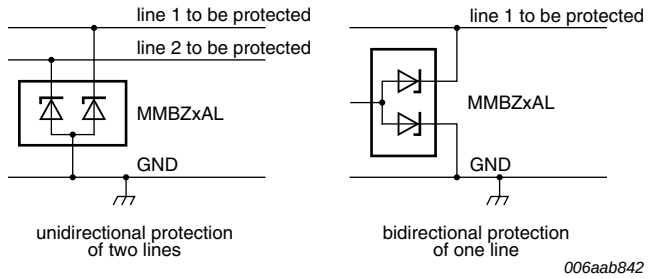



**Fig 10. Typical application: ESD and transient voltage protection of data lines**

**Circuit board layout and protection device placement**

Circuit board layout is critical for the suppression of ESD, Electrical Fast Transient (EFT) and surge transients. The following guidelines are recommended:

1. Place the MMBZxAL series as close to the input terminal or connector as possible.
2. The path length between the MMBZxAL series and the protected line should be minimized.
3. Keep parallel signal paths to a minimum.
4. Avoid running protected conductors in parallel with unprotected conductors.
5. Minimize all PCB conductive loops including power and ground loops.
6. Minimize the length of the transient return path to ground.
7. Avoid using shared transient return paths to a common ground point.
8. Ground planes should be used whenever possible. For multilayer PCBs, use ground vias.

# 9. Test information

## 9.1 Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard *Q101 - Stress test qualification for discrete semiconductors*, and is suitable for use in automotive applications.


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## 10. Package outline

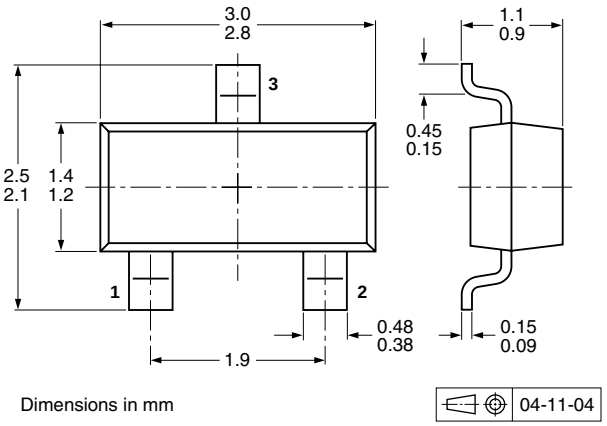



**Fig 11. Package outline SOT23 (TO-236AB)**

## 11. Packing information

**Table 11. Packing methods**

*The indicated -xxx are the last three digits of the 12NC ordering code.*[1]

| Type number | Package | Description | Packing quantity | |
|---|---|---|---|---|
| | | | 3000 | 10000 |
| MMBZ5V6AL | SOT23 | 4 mm pitch, 8 mm tape and reel | -215 | -235 |
| MMBZ6V2AL | | | | |
| MMBZ6V8AL | | | | |
| MMBZ9V1AL | | | | |
| MMBZ10VAL | | | | |
| MMBZ12VAL | | | | |
| MMBZ15VAL | | | | |
| MMBZ18VAL | | | | |
| MMBZ20VAL | | | | |
| MMBZ27VAL | | | | |
| MMBZ33VAL | | | | |

[1] For further information and the availability of packing methods, see Section 15.


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## 12. Soldering

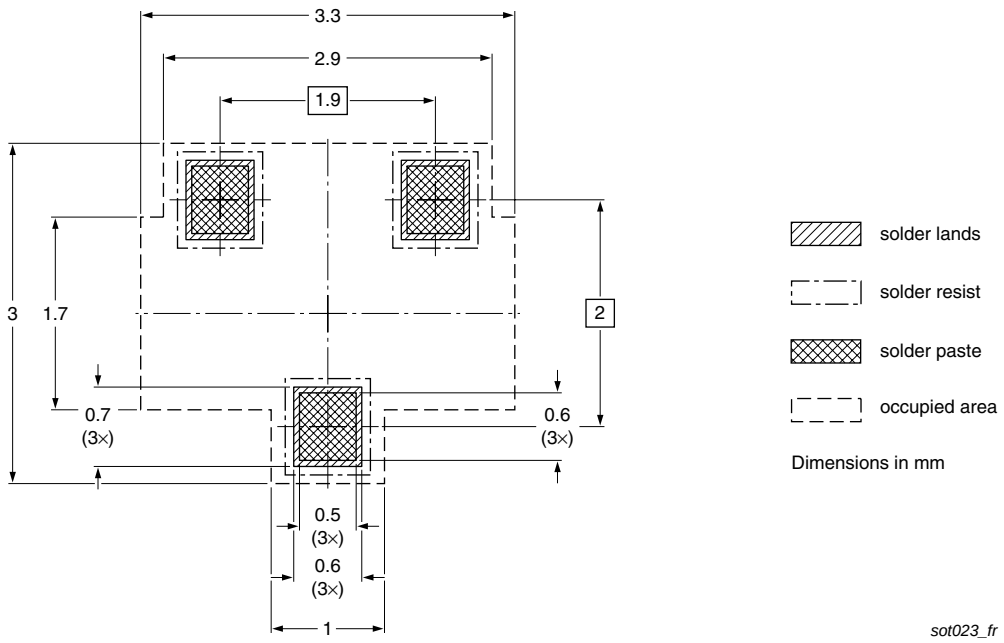



Fig 12. Reflow soldering footprint SOT23 (TO-236AB)

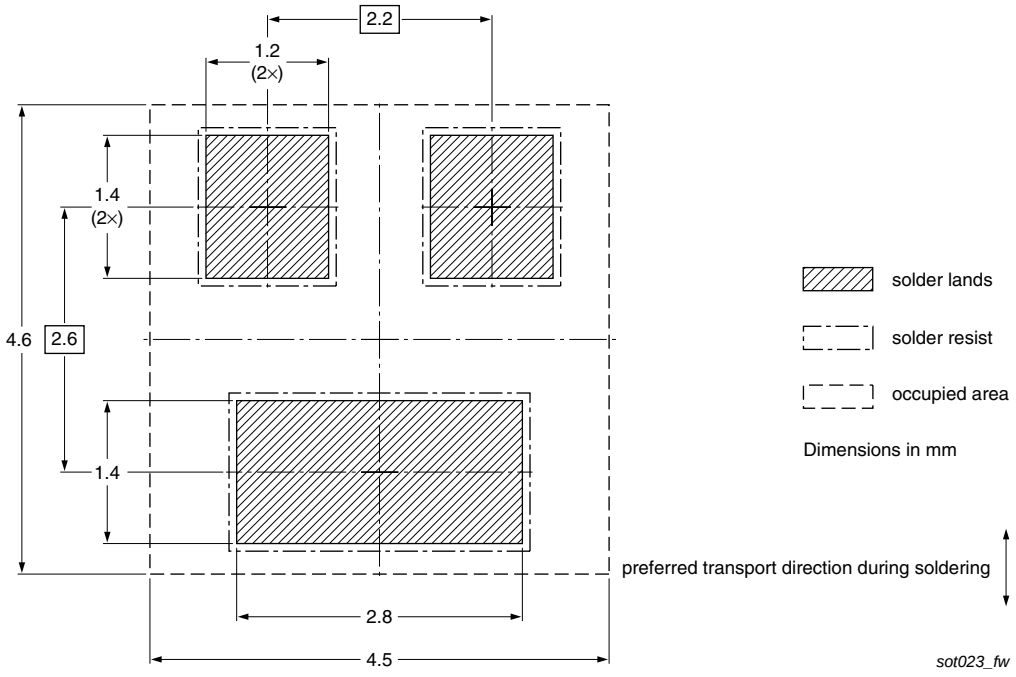



Fig 13. Wave soldering footprint SOT23 (TO-236AB)


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## 13. Revision history

**Table 12. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| MMBZXAL_SER_2 | 20091210 | Product data sheet | - | MMBZXVAL_SER_1 |
| Modifications: | • Type numbers MMBZ5V6AL, MMBZ6V2AL, MMBZ6V8AL, MMBZ9V1AL and MMBZ10VAL added<br>• Type numbers MMBZ12VAL/DG, MMBZ15VAL/DG, MMBZ18VAL/DG, MMBZ20VAL/DG, MMBZ27VAL/DG, MMBZ33VAL/DG removed<br>• Figure 5 and 7: updated<br>• Figure 6: added<br>• Figure 10: updated<br>• Section 14 “Legal information”: updated | | | |
| MMBZXVAL_SER_1 | 20080901 | Product data sheet | - | - |


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# 14. Legal information

## 14.1 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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