



MMBZxVCL; MMBZxVDL series

Double ESD protection diodes for transient overvoltage suppression

Rev. 01 — 3 September 2008

Product data sheet

1. Product profile

1.1 General description

Unidirectional double ElectroStatic Discharge (ESD) protection diodes in a common cathode 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 ^[1] | Package | | Configuration |
|----------------------------|---------|----------|---------------------|
| | NXP | JEDEC | |
| MMBZ12VDL | SOT23 | TO-236AB | dual common cathode |
| MMBZ15VDL | | | |
| MMBZ18VCL | | | |
| MMBZ20VCL | | | |
| MMBZ27VCL | | | |
| MMBZ33VCL | | | |

[1] All types available as /DG halogen-free version.

1.2 Features

- Unidirectional ESD protection of two lines
- Bidirectional ESD protection of one line
- Low diode capacitance: $C_d \leq 140$ pF
- Rated peak pulse power: $P_{PPM} \leq 40$ W
- Ultra low leakage current: $I_{RM} \leq 5$ 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

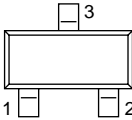
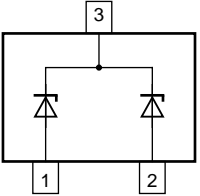
1.4 Quick reference data

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 | | | | | |
| | MMBZ12VDL MMBZ12VDL/DG | | - | - | 8.5 | V |
| | MMBZ15VDL MMBZ15VDL/DG | | - | - | 12.8 | V |
| | MMBZ18VCL MMBZ18VCL/DG | | - | - | 14.5 | V |
| | MMBZ20VCL MMBZ20VCL/DG | | - | - | 17 | V |
| | MMBZ27VCL MMBZ27VCL/DG | | - | - | 22 | V |
| | MMBZ33VCL MMBZ33VCL/DG | | - | - | 26 | V |
| | C _d | diode capacitance | f = 1 MHz; V _R = 0 V | | | |
| MMBZ12VDL MMBZ12VDL/DG | | | - | 110 | 140 | pF |
| MMBZ15VDL MMBZ15VDL/DG | | | - | 85 | 105 | pF |
| MMBZ18VCL MMBZ18VCL/DG | | | - | 70 | 90 | pF |
| MMBZ20VCL MMBZ20VCL/DG | | | - | 65 | 80 | pF |
| MMBZ27VCL MMBZ27VCL/DG | | | - | 48 | 60 | pF |
| MMBZ33VCL MMBZ33VCL/DG | | | - | 45 | 55 | pF |

2. Pinning information

Table 3. Pinning

| Pin | Description | Simplified outline | Graphic symbol |
|-----|-----------------|--|---|
| 1 | anode (diode 1) |  |  <p style="text-align: right; font-size: small;">006aaa150</p> |
| 2 | anode (diode 2) | | |
| 3 | common cathode | | |

3. Ordering information

Table 4. Ordering information

| Type number | Package | | |
|--------------|---------|--|---------|
| | Name | Description | Version |
| MMBZ12VDL | - | plastic surface-mounted package; 3 leads | SOT23 |
| MMBZ15VDL | | | |
| MMBZ18VCL | | | |
| MMBZ20VCL | | | |
| MMBZ27VCL | | | |
| MMBZ33VCL | | | |
| MMBZ12VDL/DG | - | plastic surface-mounted package; 3 leads | SOT23 |
| MMBZ15VDL/DG | | | |
| MMBZ18VCL/DG | | | |
| MMBZ20VCL/DG | | | |
| MMBZ27VCL/DG | | | |
| MMBZ33VCL/DG | | | |

4. Marking

Table 5. Marking codes

| Type number | Marking code ^[1] | Type number | Marking code ^[1] |
|-------------|-----------------------------|--------------|-----------------------------|
| MMBZ12VDL | *MA | MMBZ12VDL/DG | TJ* |
| MMBZ15VDL | *MB | MMBZ15VDL/DG | TL* |
| MMBZ18VCL | *MC | MMBZ18VCL/DG | TN* |
| MMBZ20VCL | *MD | MMBZ20VCL/DG | TQ* |
| MMBZ27VCL | *ME | MMBZ27VCL/DG | TS* |
| MMBZ33VCL | *MF | MMBZ33VCL/DG | TU* |

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

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] - | 40 | W |
| I _{PPM} | rated peak pulse current | t _p = 10/1000 μs | [1][2] | | |
| | MMBZ12VDL MMBZ12VDL/DG | | - | 2.35 | A |
| | MMBZ15VDL MMBZ15VDL/DG | | - | 1.9 | A |
| | MMBZ18VCL MMBZ18VCL/DG | | - | 1.6 | A |
| | MMBZ20VCL MMBZ20VCL/DG | | - | 1.4 | A |
| | MMBZ27VCL MMBZ27VCL/DG | | - | 1 | A |
| | MMBZ33VCL MMBZ33VCL/DG | | - | 0.87 | A |
| Per device | | | | | |
| P _{tot} | total power dissipation | T _{amb} ≤ 25 °C | [3] - | 350 | mW |
| | | | [4] - | 440 | mW |
| 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 cm².

Table 7. ESD maximum ratings

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

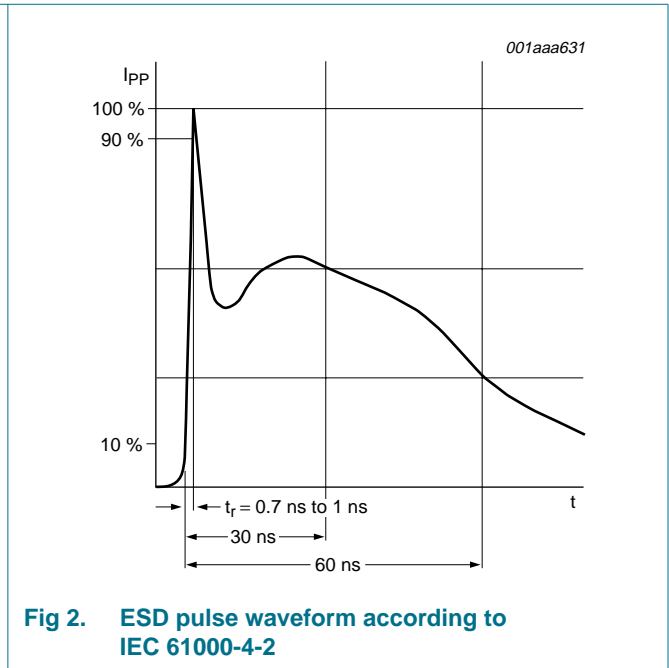
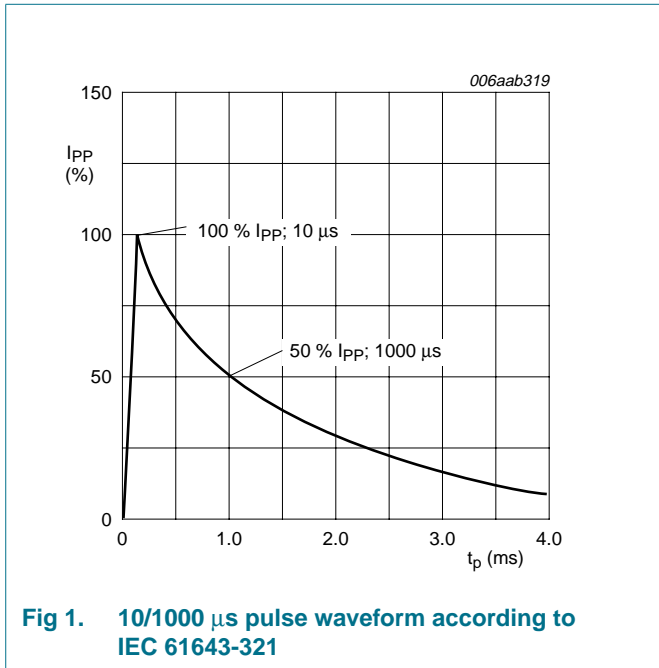
| Symbol | Parameter | Conditions | Min | Max | Unit |
|------------------|---------------------------------|--------------------------------------|--------|-----|------|
| Per diode | | | | | |
| V _{ESD} | electrostatic discharge voltage | | [1][2] | | |
| | | IEC 61000-4-2 (contact discharge) | -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



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 | [1] - | - | 350 | K/W |
| | | | [2] - | - | 280 | K/W |
| R _{th(j-sp)} | thermal resistance from junction to solder point | | [3] - | - | 60 | 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 cm².

[3] Soldering point at pin 3.

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 | | | | | |
| | MMBZ12VDL MMBZ12VDL/DG | I _F = 10 mA | - | - | 0.9 | V |
| | MMBZ15VDL MMBZ15VDL/DG | I _F = 10 mA | - | - | 0.9 | V |
| | MMBZ18VCL MMBZ18VCL/DG | I _F = 10 mA | - | - | 0.9 | V |
| | MMBZ20VCL MMBZ20VCL/DG | I _F = 10 mA | - | - | 0.9 | V |
| | MMBZ27VCL MMBZ27VCL/DG | I _F = 200 mA | - | - | 1.1 | V |
| | MMBZ33VCL MMBZ33VCL/DG | I _F = 10 mA | - | - | 0.9 | V |
| V _{RWM} | reverse standoff voltage | | | | | |
| | MMBZ12VDL MMBZ12VDL/DG | | - | - | 8.5 | V |
| | MMBZ15VDL MMBZ15VDL/DG | | - | - | 12.8 | V |
| | MMBZ18VCL MMBZ18VCL/DG | | - | - | 14.5 | V |
| | MMBZ20VCL MMBZ20VCL/DG | | - | - | 17 | V |
| | MMBZ27VCL MMBZ27VCL/DG | | - | - | 22 | V |
| | MMBZ33VCL MMBZ33VCL/DG | | - | - | 26 | V |
| I _{RM} | reverse leakage current | | | | | |
| | MMBZ12VDL MMBZ12VDL/DG | V _{RWM} = 8.5 V | - | 0.1 | 5 | nA |
| | MMBZ15VDL MMBZ15VDL/DG | V _{RWM} = 12.8 V | - | 0.1 | 5 | nA |
| | MMBZ18VCL MMBZ18VCL/DG | V _{RWM} = 14.5 V | - | 0.1 | 5 | nA |
| | MMBZ20VCL MMBZ20VCL/DG | V _{RWM} = 17 V | - | 0.1 | 5 | nA |
| | MMBZ27VCL MMBZ27VCL/DG | V _{RWM} = 22 V | - | 0.1 | 5 | nA |
| | MMBZ33VCL MMBZ33VCL/DG | V _{RWM} = 26 V | - | 0.1 | 5 | nA |

Table 10. Characteristics ...continued

 $T_{amb} = 25^{\circ}\text{C}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------|---------------------------|--------------------------------------|-------|-----|-------|------------------------|
| V_{BR} | breakdown voltage | $I_R = 1\text{ mA}$ | | | | |
| | MMBZ12VDL MMBZ12VDL/DG | | 11.4 | 12 | 12.6 | V |
| | MMBZ15VDL MMBZ15VDL/DG | | 14.3 | 15 | 15.8 | V |
| | MMBZ18VCL MMBZ18VCL/DG | | 17.1 | 18 | 18.9 | V |
| | MMBZ20VCL MMBZ20VCL/DG | | 19 | 20 | 21 | V |
| | MMBZ27VCL MMBZ27VCL/DG | | 25.65 | 27 | 28.35 | V |
| | MMBZ33VCL MMBZ33VCL/DG | | 31.35 | 33 | 34.65 | V |
| C_d | diode capacitance | $f = 1\text{ MHz}; V_R = 0\text{ V}$ | | | | |
| | MMBZ12VDL MMBZ12VDL/DG | | - | 110 | 140 | pF |
| | MMBZ15VDL MMBZ15VDL/DG | | - | 85 | 105 | pF |
| | MMBZ18VCL MMBZ18VCL/DG | | - | 70 | 90 | pF |
| | MMBZ20VCL MMBZ20VCL/DG | | - | 65 | 80 | pF |
| | MMBZ27VCL MMBZ27VCL/DG | | - | 48 | 60 | pF |
| | MMBZ33VCL MMBZ33VCL/DG | | - | 45 | 55 | pF |
| V_{CL} | clamping voltage | | | | | [1][2] |
| | MMBZ12VDL MMBZ12VDL/DG | $I_{PPM} = 2.35\text{ A}$ | - | - | 17 | V |
| | MMBZ15VDL MMBZ15VDL/DG | $I_{PPM} = 1.9\text{ A}$ | - | - | 21.2 | V |
| | MMBZ18VCL MMBZ18VCL/DG | $I_{PPM} = 1.6\text{ A}$ | - | - | 25 | V |
| | MMBZ20VCL MMBZ20VCL/DG | $I_{PPM} = 1.4\text{ A}$ | - | - | 28 | V |
| | MMBZ27VCL MMBZ27VCL/DG | $I_{PPM} = 1\text{ A}$ | - | - | 38 | V |
| | MMBZ33VCL MMBZ33VCL/DG | $I_{PPM} = 0.87\text{ A}$ | - | - | 46 | V |

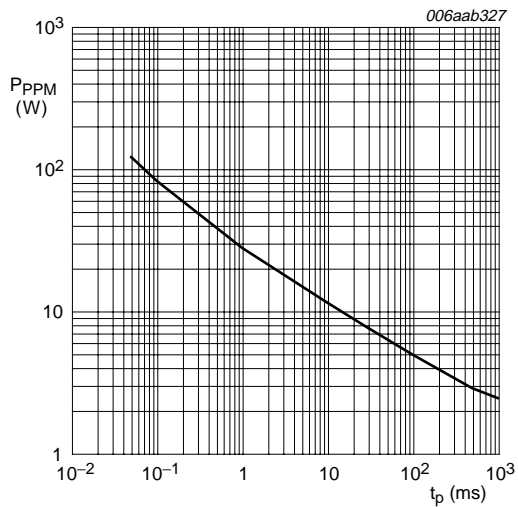
Table 10. Characteristics ...continued

$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------|---------------------------|---------------------|-----|------|-----|------|
| S_Z | temperature coefficient | $I_Z = 1\text{ mA}$ | | | | |
| | MMBZ12VDL MMBZ12VDL/DG | | - | 8.1 | - | mV/K |
| | MMBZ15VDL MMBZ15VDL/DG | | - | 11 | - | mV/K |
| | MMBZ18VCL MMBZ18VCL/DG | | - | 14 | - | mV/K |
| | MMBZ20VCL MMBZ20VCL/DG | | - | 15.8 | - | mV/K |
| | MMBZ27VCL MMBZ27VCL/DG | | - | 23 | - | mV/K |
| | MMBZ33VCL MMBZ33VCL/DG | | - | 29.4 | - | mV/K |

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

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



MMBZ27VCL: unidirectional and bidirectional
 $T_{amb} = 25\text{ }^{\circ}\text{C}$

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

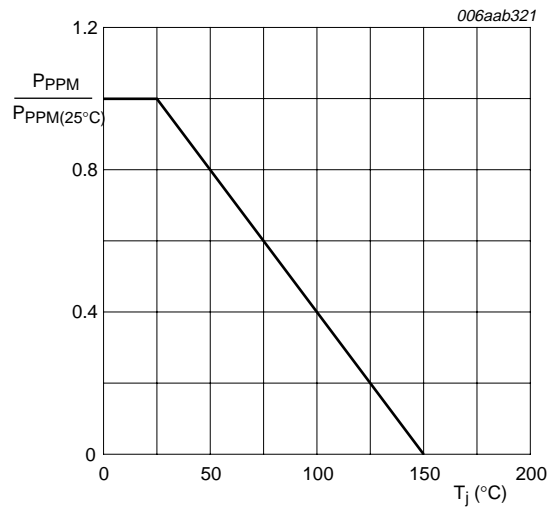
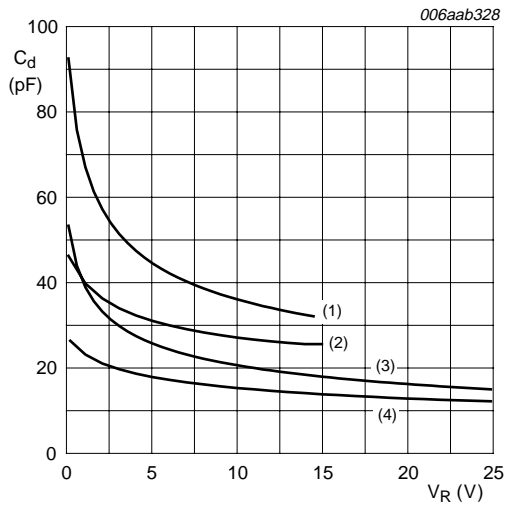
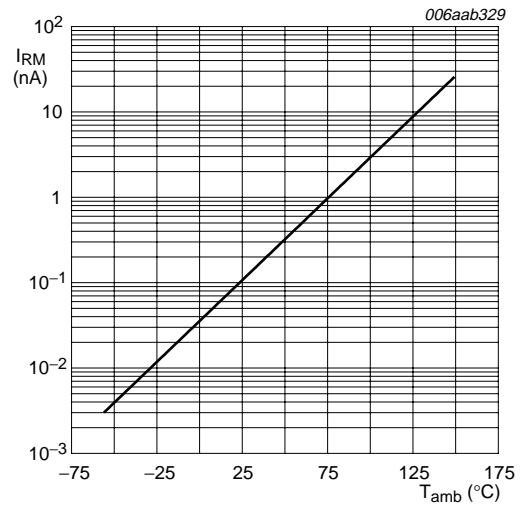


Fig 4. Relative variation of rated peak pulse power as a function of junction temperature; typical values



$f = 1 \text{ MHz}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$
 (1) MMBZ15VDL: unidirectional
 (2) MMBZ15VDL: bidirectional
 (3) MMBZ27VCL: unidirectional
 (4) MMBZ27VCL: bidirectional

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



MMBZ27VCL: $V_{\text{RWM}} = 22 \text{ V}$

Fig 6. Reverse leakage current as a function of junction temperature; typical values

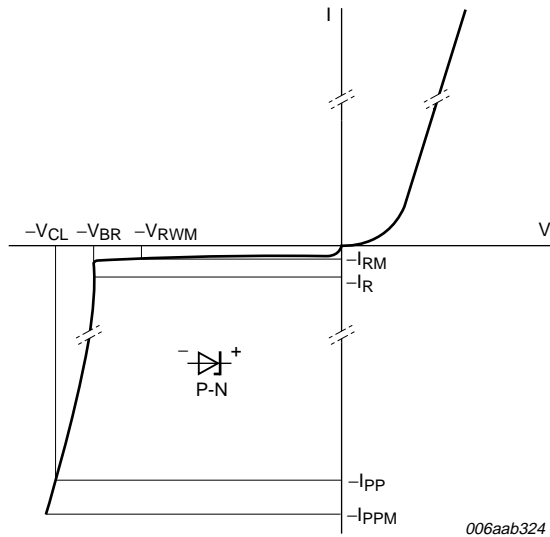


Fig 7. V-I characteristics for a unidirectional ESD protection diode

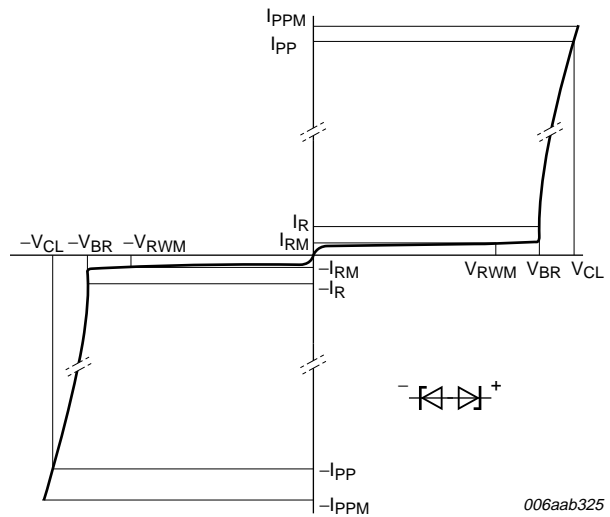


Fig 8. V-I characteristics for a bidirectional ESD protection diode

8. Application information

The MMBZxVCL series and the MMBZxVDL series are 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 devices provide a surge capability of 40 W per line for a 10/1000 μ s waveform.

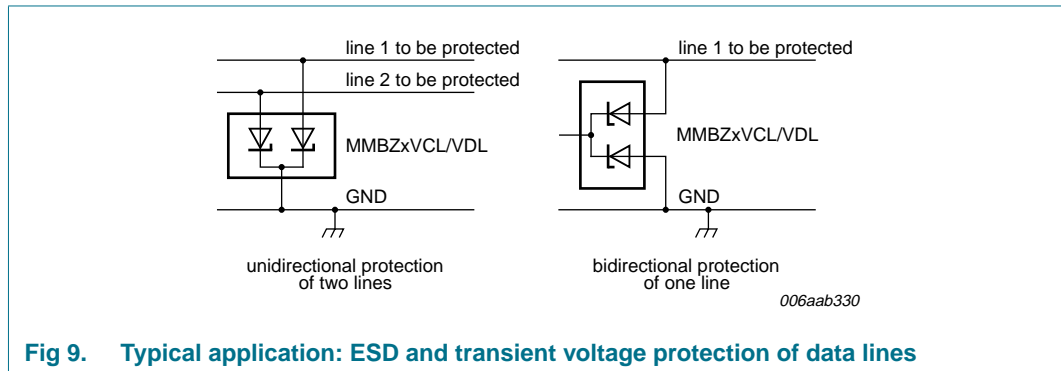


Fig 9. Typical application: ESD and transient voltage protection of data lines

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:

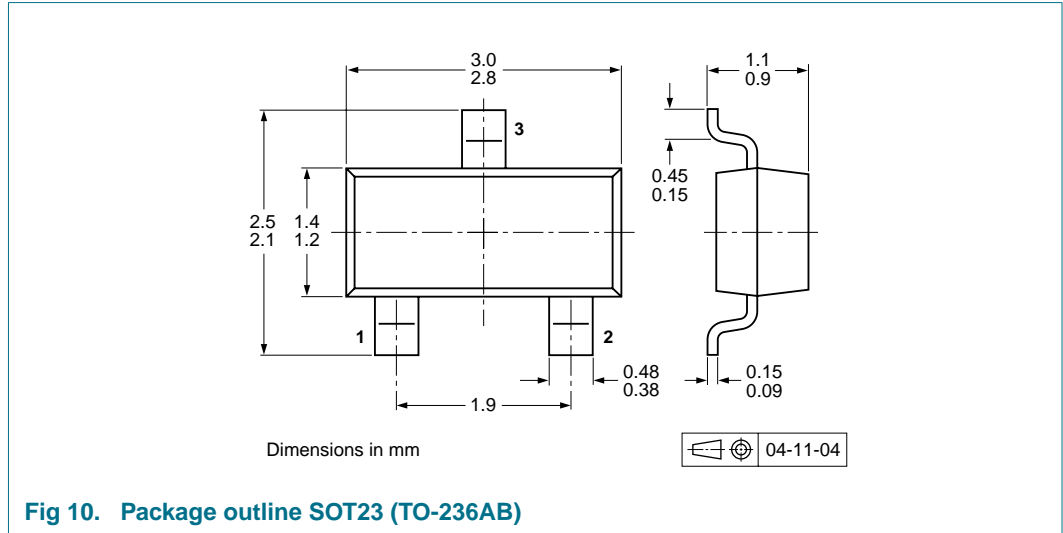
1. Place the devices as close to the input terminal or connector as possible.
2. The path length between the device and the protected line should be minimized.
3. Keep parallel signal paths to a minimum.
4. Avoid running protected conductors in parallel with unprotected conductors.
5. Minimize all Printed-Circuit Board (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.

10. Package outline



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 |
| MMBZ12VDL | SOT23 | 4 mm pitch, 8 mm tape and reel | -215 | -235 |
| MMBZ15VDL | | | | |
| MMBZ18VCL | | | | |
| MMBZ20VCL | | | | |
| MMBZ27VCL | | | | |
| MMBZ33VCL | | | | |
| MMBZ12VDL/DG | SOT23 | 4 mm pitch, 8 mm tape and reel | -215 | -235 |
| MMBZ15VDL/DG | | | | |
| MMBZ18VCL/DG | | | | |
| MMBZ20VCL/DG | | | | |
| MMBZ27VCL/DG | | | | |
| MMBZ33VCL/DG | | | | |

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

12. Soldering

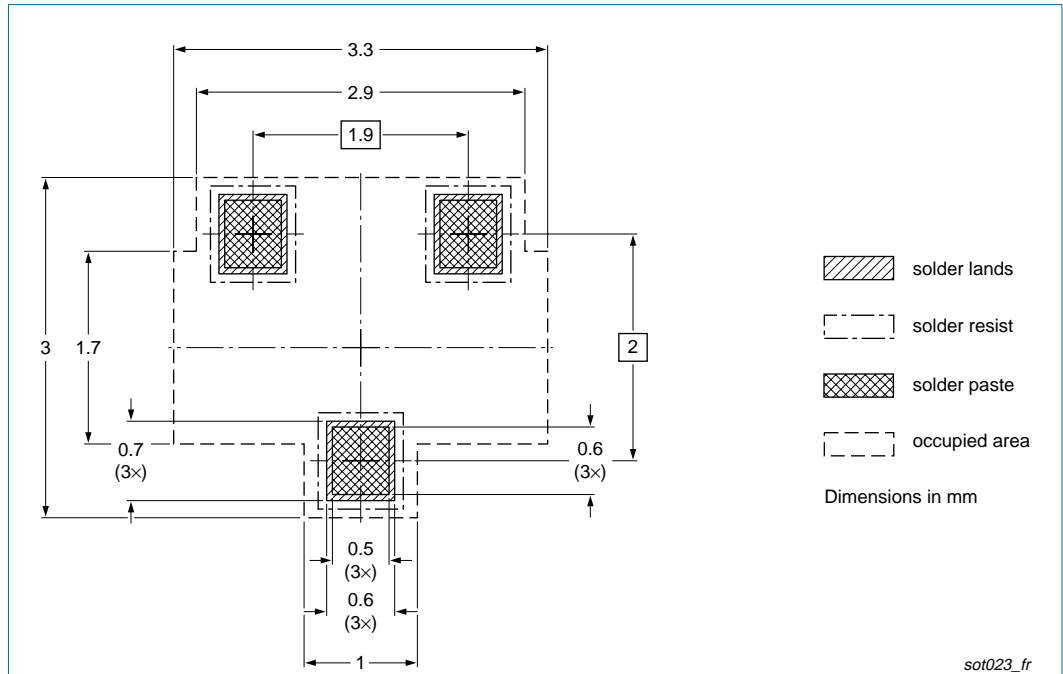


Fig 11. Reflow soldering footprint SOT23 (TO-236AB)

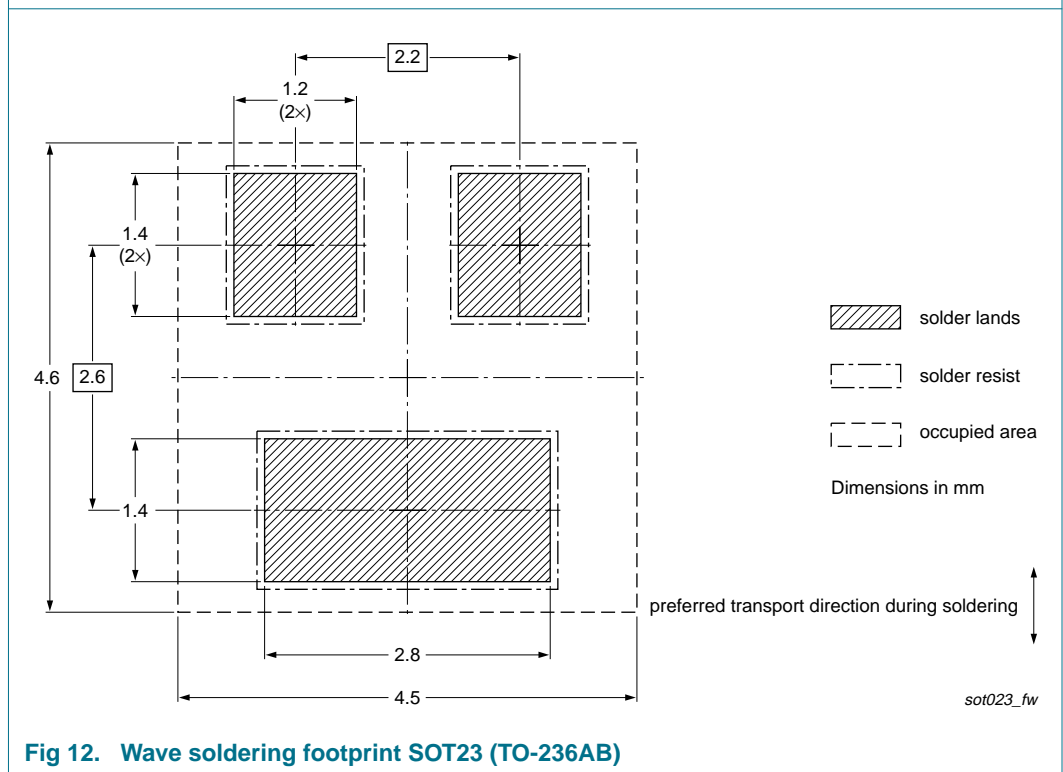


Fig 12. Wave soldering footprint SOT23 (TO-236AB)

13. Revision history

Table 12. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|-------------------------|--------------|--------------------|---------------|------------|
| MMBZXVCL_MMBZXVDL_SER_1 | 20080903 | Product data sheet | - | - |

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.

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