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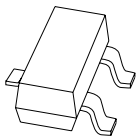


MMBZxAL series

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

1.4 Quick reference data

Table 2. Quick reference data

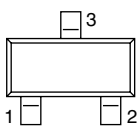
T_{amb} = 25 °C unless otherwise specified.

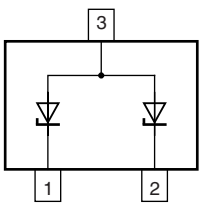
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Per diode						
V_{RWM}	reverse standoff voltage					
	MMBZ5V6AL		-	-	3	V
	MMBZ6V2AL		-	-	3	V
	MMBZ6V8AL		-	-	4.5	V
	MMBZ9V1AL		-	-	6	V
	MMBZ10VAL		-	-	6.5	V
	MMBZ12VAL		-	-	8.5	V
	MMBZ15VAL		-	-	12	V
	MMBZ18VAL		-	-	14.5	V
	MMBZ20VAL		-	-	17	V
	MMBZ27VAL		-	-	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		





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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

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					

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

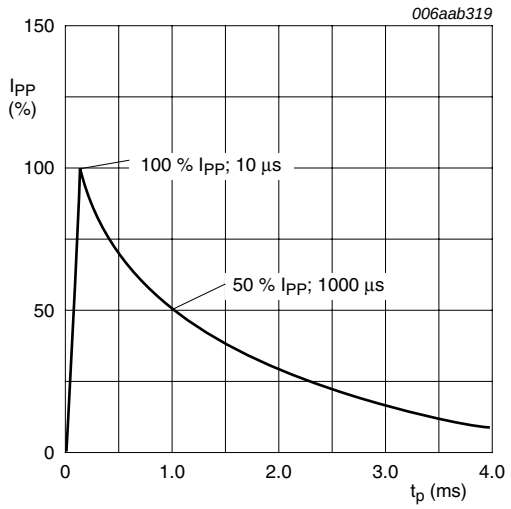


Fig 1. 10/1000 µs pulse waveform according to IEC 61643-321

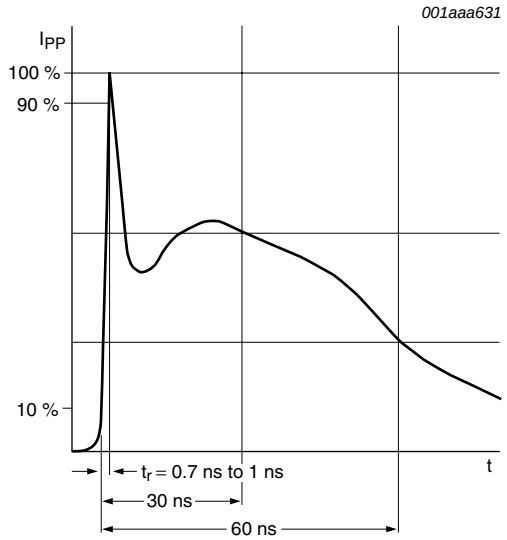


Fig 2. ESD pulse waveform according to IEC 61000-4-2

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 MMBZ6V2AL MMBZ6V8AL		[2]	-	-	420	K/W
	MMBZ9V1AL MMBZ10VAL MMBZ12VAL MMBZ15VAL MMBZ18VAL MMBZ20VAL MMBZ27VAL MMBZ33VAL		[2]	-	-	340	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		[3]				
	MMBZ5V6AL MMBZ6V2AL MMBZ6V8AL			-	-	150	K/W
	MMBZ9V1AL MMBZ10VAL MMBZ12VAL MMBZ15VAL MMBZ18VAL MMBZ20VAL MMBZ27VAL 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.

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

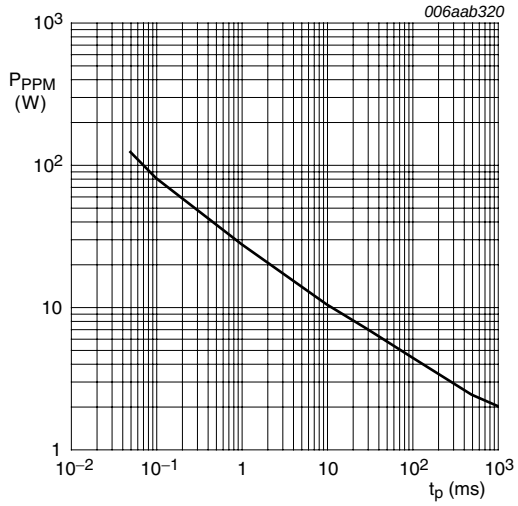
Table 10. Characteristics *...continued*

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.



T_{amb} = 25 °C

unidirectional and bidirectional

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

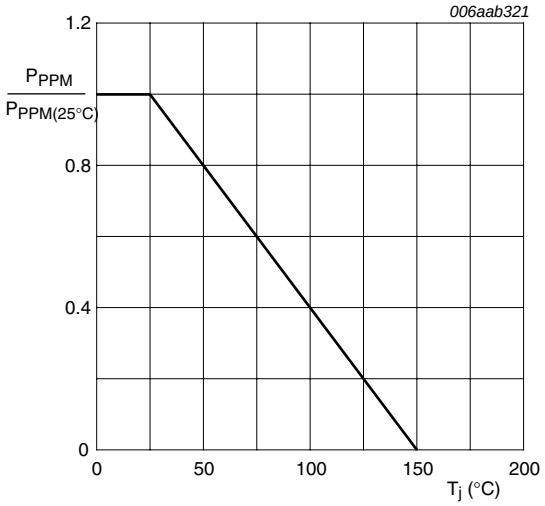
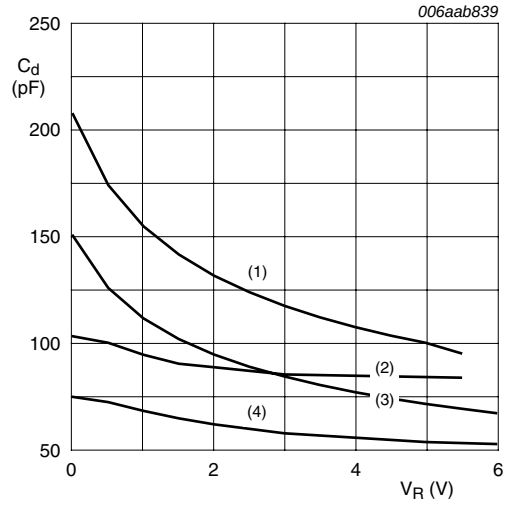


Fig 4. Relative variation of rated peak pulse power as a function of junction temperature; typical values



f = 1 MHz; T_{amb} = 25 °C

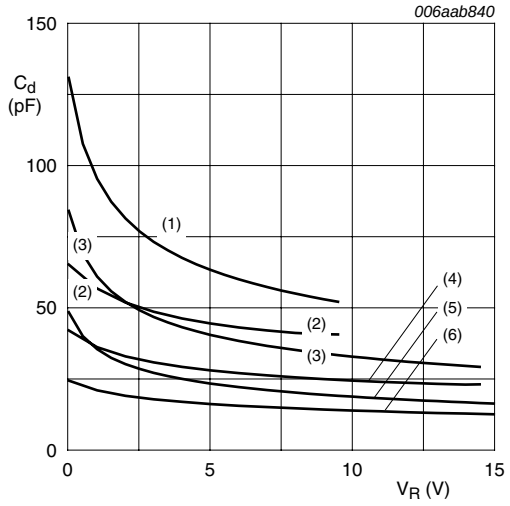
(1) MMBZ5V6AL: unidirectional

(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

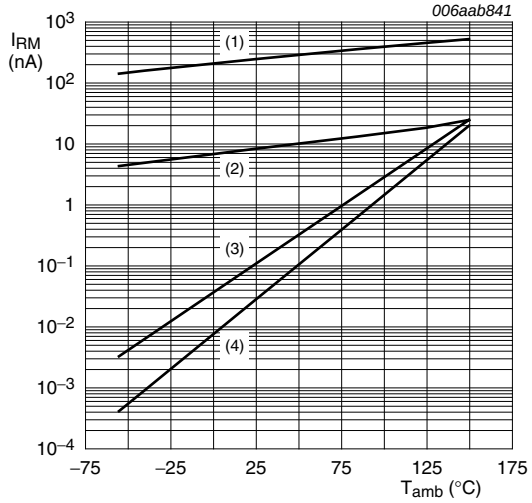
(3) MMBZ15VAL: unidirectional

(4) MMBZ15VAL: bidirectional

(5) MMBZ27VAL: unidirectional

(6) MMBZ27VAL: bidirectional

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



(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

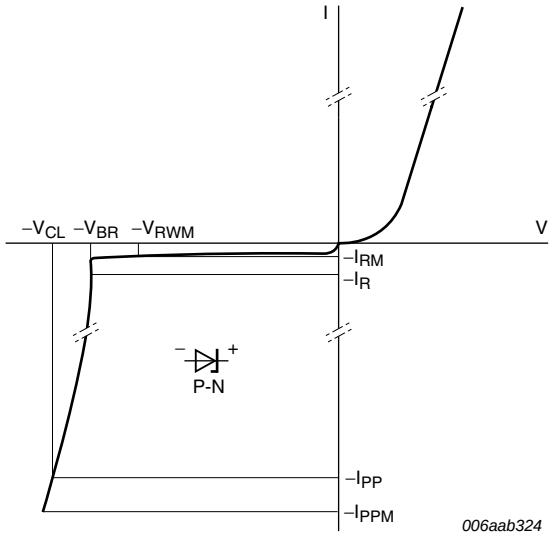


Fig 8. V-I characteristics for a unidirectional ESD protection diode

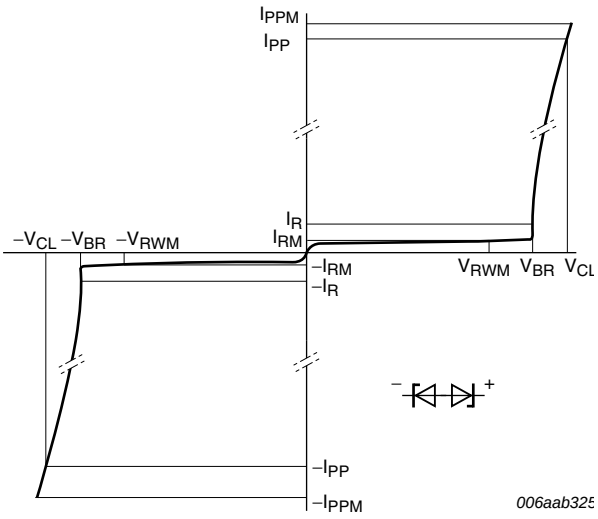


Fig 9. V-I characteristics for a bidirectional ESD protection diode

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.

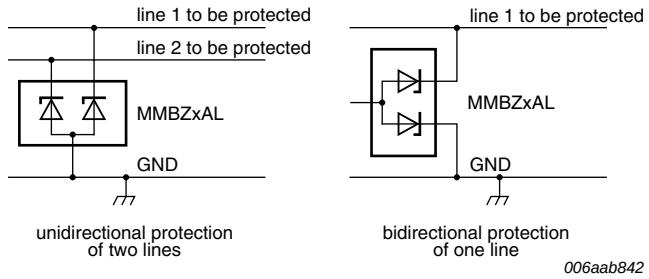


Fig 10. Typical application: ESD and transient voltage protection of data lines

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.

10. Package outline

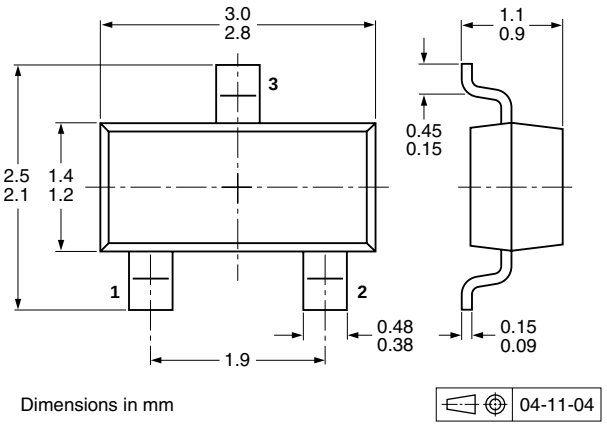


Fig 11. Package outline SOT23 (TO-236AB)

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.

12. Soldering

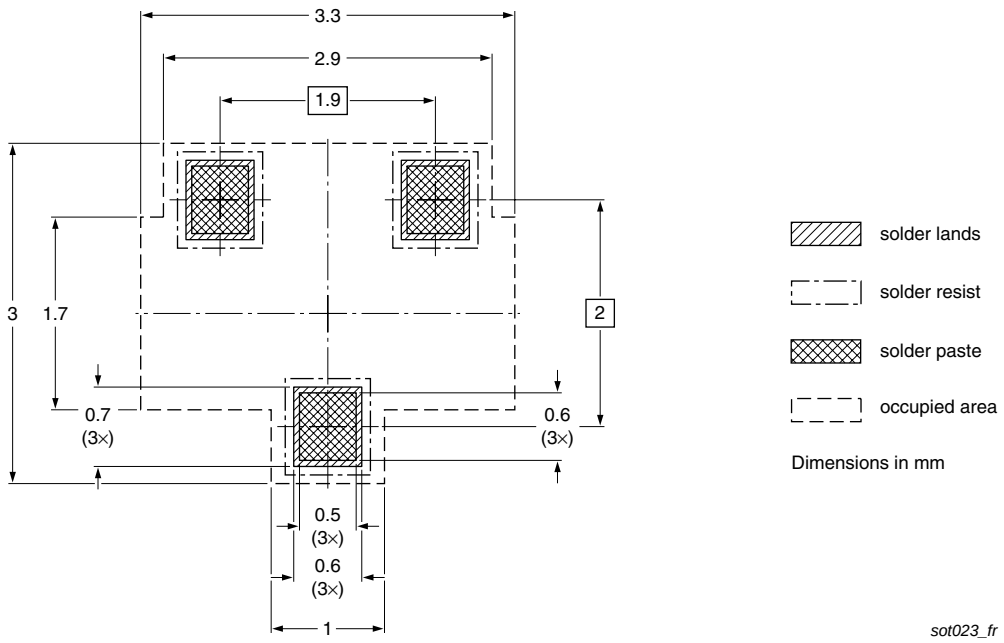


Fig 12. Reflow soldering footprint SOT23 (TO-236AB)

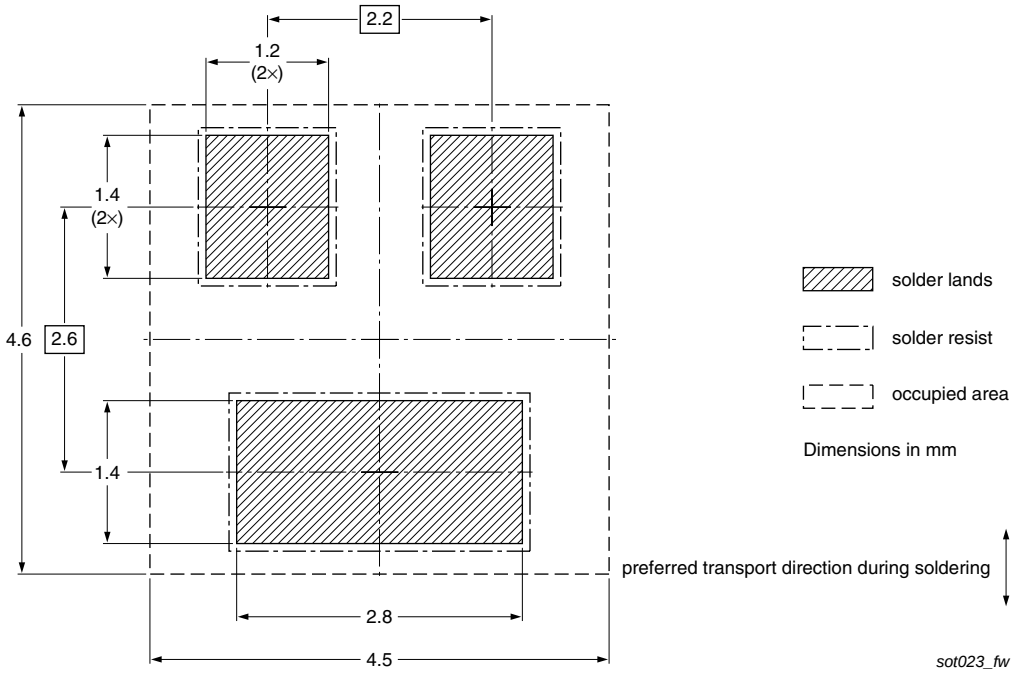


Fig 13. Wave soldering footprint SOT23 (TO-236AB)

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 • Type numbers MMBZ12VAL/DG, MMBZ15VAL/DG, MMBZ18VAL/DG, MMBZ20VAL/DG, MMBZ27VAL/DG, MMBZ33VAL/DG removed • Figure 5 and 7: updated • Figure 6: added • Figure 10: updated • Section 14 “Legal information”: updated			
MMBZXVAL_SER_1	20080901	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.

[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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16. Contents

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Date of release: 10 December 2009
Document identifier: MMBZXAL_SER_2