NPN LOW VOLTAGE AVALANCHE TRANSISTOR IN SOT23

Features

- 80A Peak Avalanche Current
- BV_{CES} > 80V
- BV_{CEO} > 15V
- Specifically Designed for Low Voltage Avalanche Mode Operation
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative. https://www.diodes.com/quality/product-definitions/**

Mechanical Data

- Case: SOT23
- Case Material: Molded Plastic. "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish - Matte Tin-Plated Leads. Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.008 grams (Approximate)

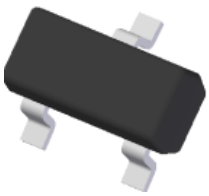
Description

The FMMT411 is a silicon planar bipolar transistor designed for operating in avalanche mode. Tight process control and low inductance packaging combine to produce high-current pulses with fast edges.

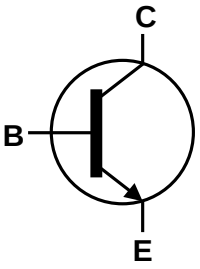
Applications

- Laser Diode Drivers for Ranging and Measurement (LIDAR)
- Fast Edge Switch Generator
- High-Speed Pulse Generators

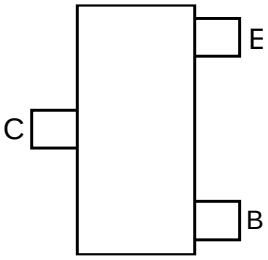
SOT23 (Type DN)



Top View



Device Symbol



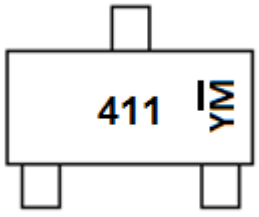
Top View
Pin-Out

Ordering Information (Note 4)

Part Number	Marking	Reel Size (inches)	Tape Width (mm)	Quantity Per Reel
FMMT411TD	411	7	8	500
FMMT411TA	411	7	8	3000

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

Marking Information



411 = Product Type Marking Code
YM = Date Code Marking
Y or $\overline{Y}$ = Year (ex: H = 2020)
M or $\overline{M}$ = Month (ex: 9 = September)

Date Code Key

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Code	H	I	J	K	L	M	N	O	P	R	S	T

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Code	1	2	3	4	5	6	7	8	9	O	N	D

Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

Characteristic	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage	V_{CES}	80	V
Collector-Emitter Voltage	V_{CEO}	15	V
Emitter-Base Voltage	V_{EBO}	7	V
Continuous Collector Current	I_C	600	mA
Peak Collector Current (Pulse Width = 20ns) (Note 5)	I_{CM}	60	A

Thermal Characteristics (@T_A = +25°C, unless otherwise specified.)

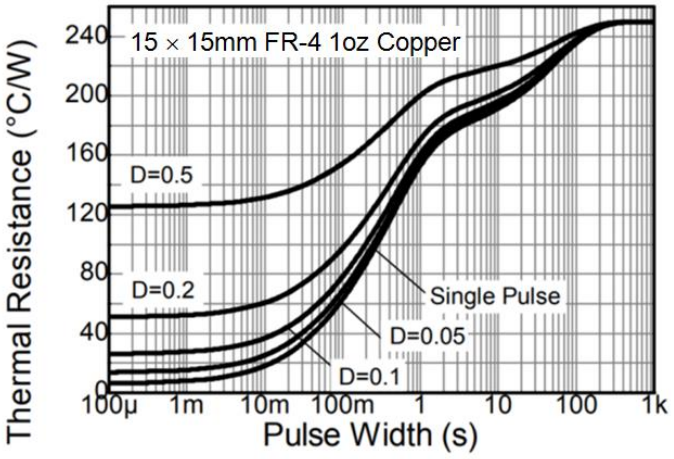
Characteristic		Symbol	Value	Unit
Power Dissipation	(Note 6)	P_D	730	mW
Thermal Resistance, Junction to Ambient	(Note 6)	$R_{\theta JA}$	171	°C/W
Thermal Resistance, Junction to Leads	(Note 7)	$R_{\theta JL}$	70	°C/W
Operating and Storage Temperature Range		T_J, T_{STG}	-55 to +150	°C

ESD Ratings (Note 8)

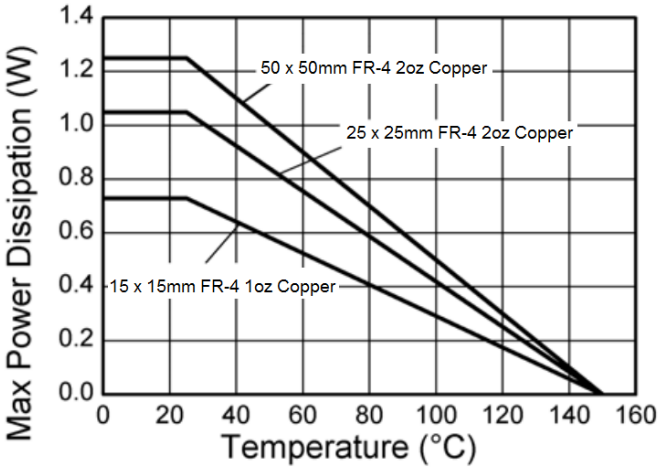
Characteristic	Symbol	Value	Unit	JEDEC Class
Electrostatic Discharge - Human Body Model	ESD HBM	4,000	V	3A
Electrostatic Discharge - Machine Model	ESD MM	400	V	C

Notes:
5. Measured under pulsed conditions. Duty cycle ≤ 1%.
6. For a device mounted with the collector lead on 15mm × 15mm 1oz copper that is on a single-sided 1.6mm FR-4 PCB; device is measured under still air conditions whilst operating in a steady state.
7. Thermal resistance from junction to solder-point (at the end of the collector lead).
8. Refer to JEDEC specification JESD22-A114 and JESD22-A115.

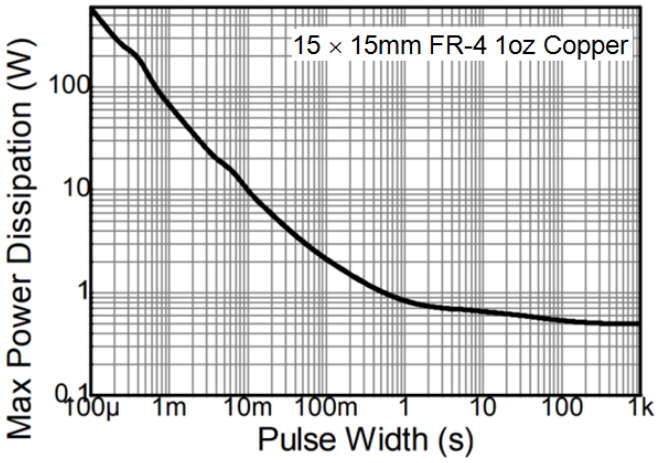
Thermal Characteristics and Derating information



Transient Thermal Impedance



Derating Curve



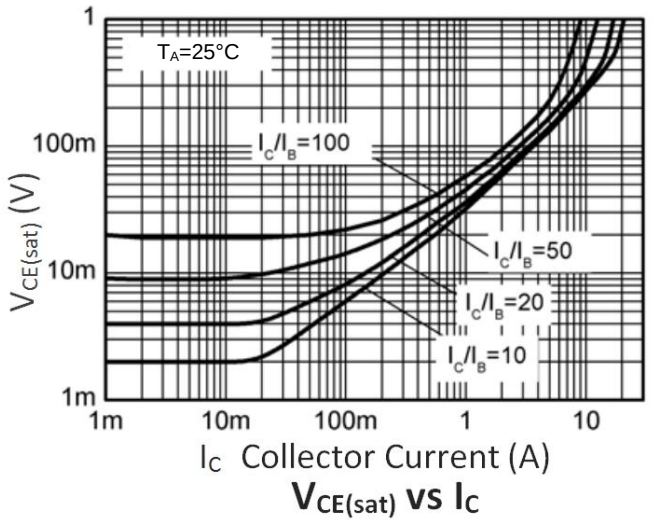
Pulse Power Dissipation

Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

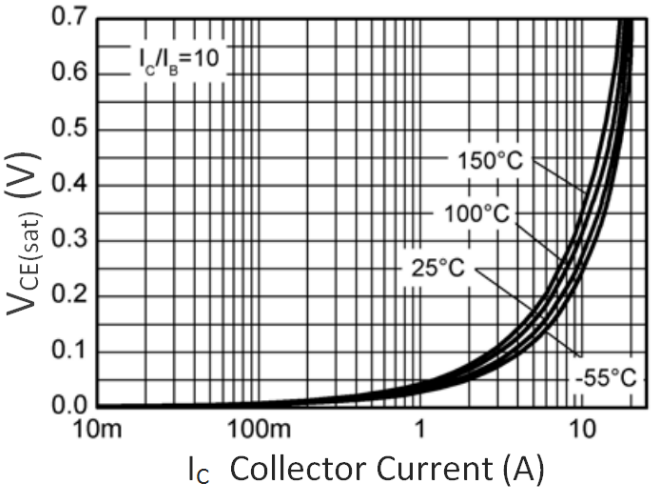
Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
Collector-Base Breakdown Voltage	BV_{CBO}	80	—	—	V	I_C = 100µA
Collector-Emitter Breakdown Voltage	BV_{CES}	80 75	—	—	V	I_C = 100µA T_J = -50°C to +150°C
Collector-Emitter Breakdown Voltage	BV_{CEO}	15	—	—	V	I_C = 100µA
Emitter-Base Breakdown Voltage	BV_{EBO}	7	—	—	V	I_E = 100µA
Collector Cutoff Current	I_{CBO}	—	—	100 10	nA µA	V_{CB} = 75V V_{CB} = 75V, T_J = +100°C
Emitter Cutoff Current	I_{EBO}	—	—	20	nA	V_{EB} = 6V
Static Forward Current Transfer Ratio (Note 9)	h_{FE}	100	—	—	—	I_C = 10mA, V_{CE} = 10V
Collector-Emitter Saturation Voltage (Note 9)	$V_{CE(sat)}$	—	—	100	mV	I_C = 10mA, I_B = 1mA
Base-Emitter Saturation Voltage (Note 9)	$V_{BE(sat)}$	—	—	800	mV	I_C = 10mA, I_B = 1mA
Current in Second Breakdown (Pulsed) (Note 10)	I_{USB}	—	—	80	A	V_C = 60V, C_{CE} = 470pF
Collector-Emitter Inductance	L_{ce}	—	2	—	nH	Standard SOT23 leads
Output Capacitance	C_{cbo}	—	—	8	pF	V_{CB} = 20V, I_E = 0 f = 100MHz
Transition Frequency	f_T	40	—	—	MHz	V_{CE} = 20V, I_C = 10mA, f = 20MHz

Notes: 9. Measured under pulsed conditions. Pulse width ≤ 300µs. Duty cycle ≤ 2%.
10. V_C Depends on circuit layout parasitics and Base drive di/dt.

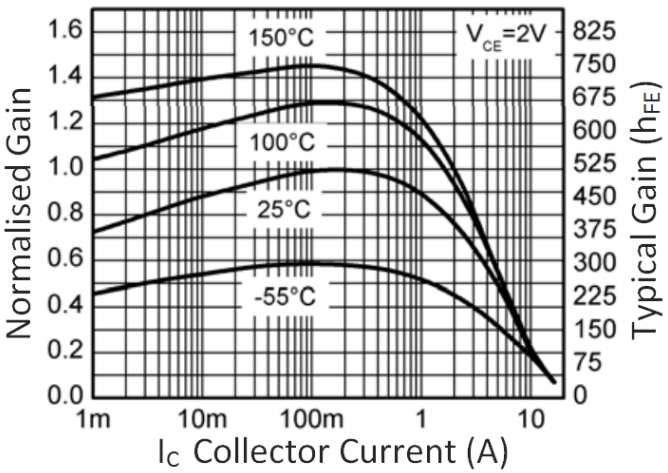
Typical Characteristics (@T_A = +25°C, unless otherwise specified.)



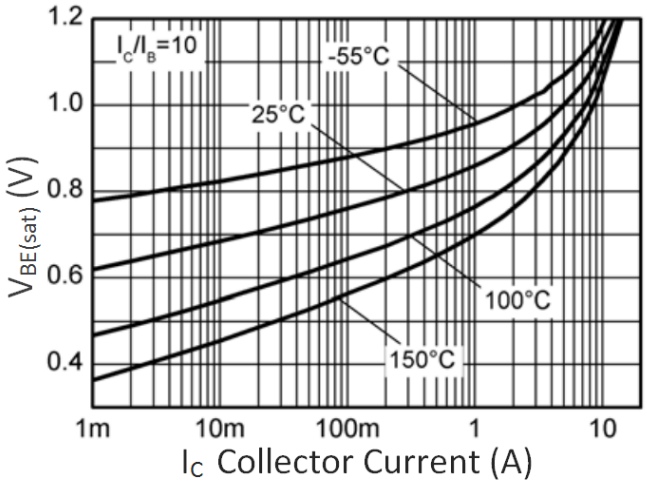
$V_{CE(sat)}$ vs I_C



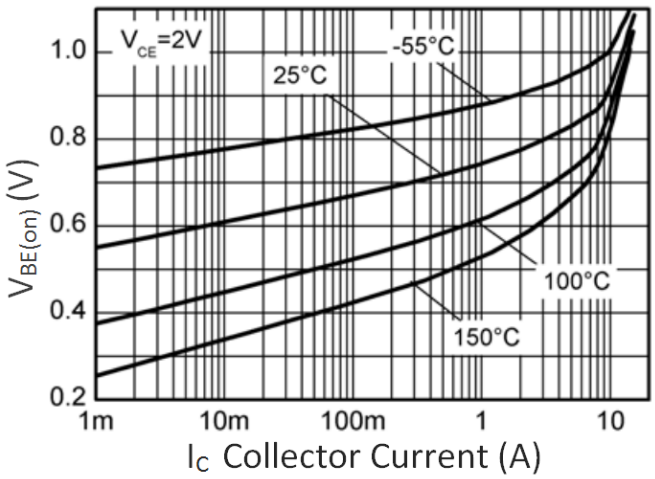
$V_{CE(sat)}$ vs I_C



h_{FE} vs I_C

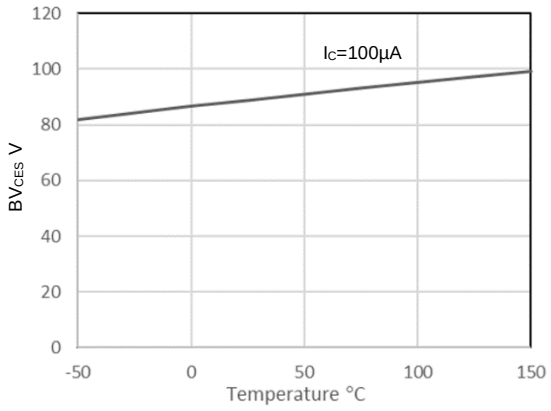


$V_{BE(sat)}$ vs I_C



$V_{BE(on)}$ vs I_C

Avalanche Power & Switching Times Characteristic Curves



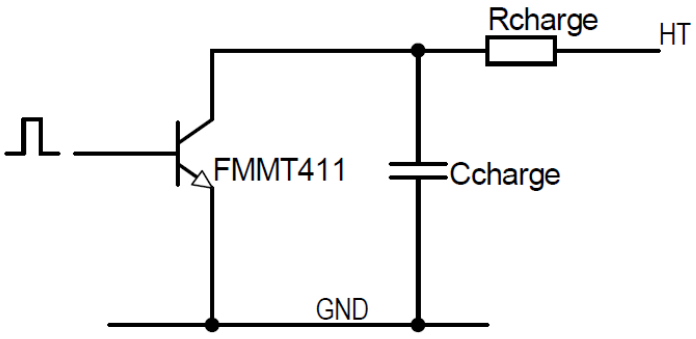
BV_{CES} vs Temperature

Avalanche Mode Operation & Basic Circuit and Description

Avalanche multiplication is the mechanism where free electrons in the diffusion region collide with other atoms with enough force to create new electron-hole pairs where the new free electron repeats the process and so on. The collector – emitter breakdown voltage at which this occurs can be varied by altering the base emitter shunt resistance or injecting current into the base.

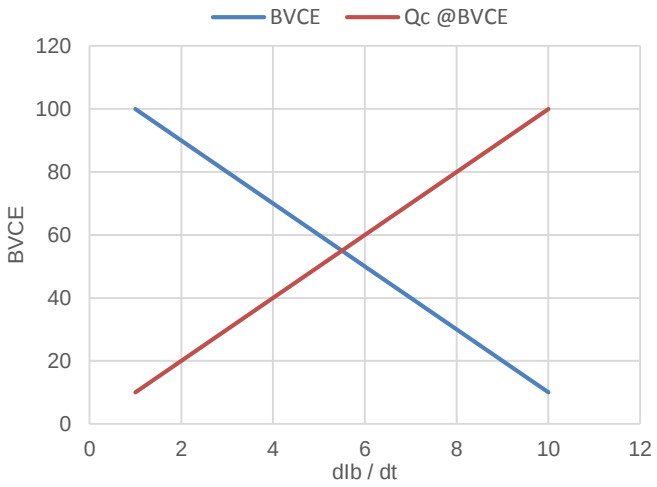
Application Information

In a typical circuit a large pulse is applied to the base and the resultant energy is enough to cause the onset of avalanche multiplication. Once breakdown has been established it will continue until the energy in the breakdown region is insufficient to maintain the condition, or the crystal lattice is permanently damaged. It is important therefore to limit the total energy expended during breakdown. The typical method of achieving avalanche uses the circuit shown below.



Application Information (continued)

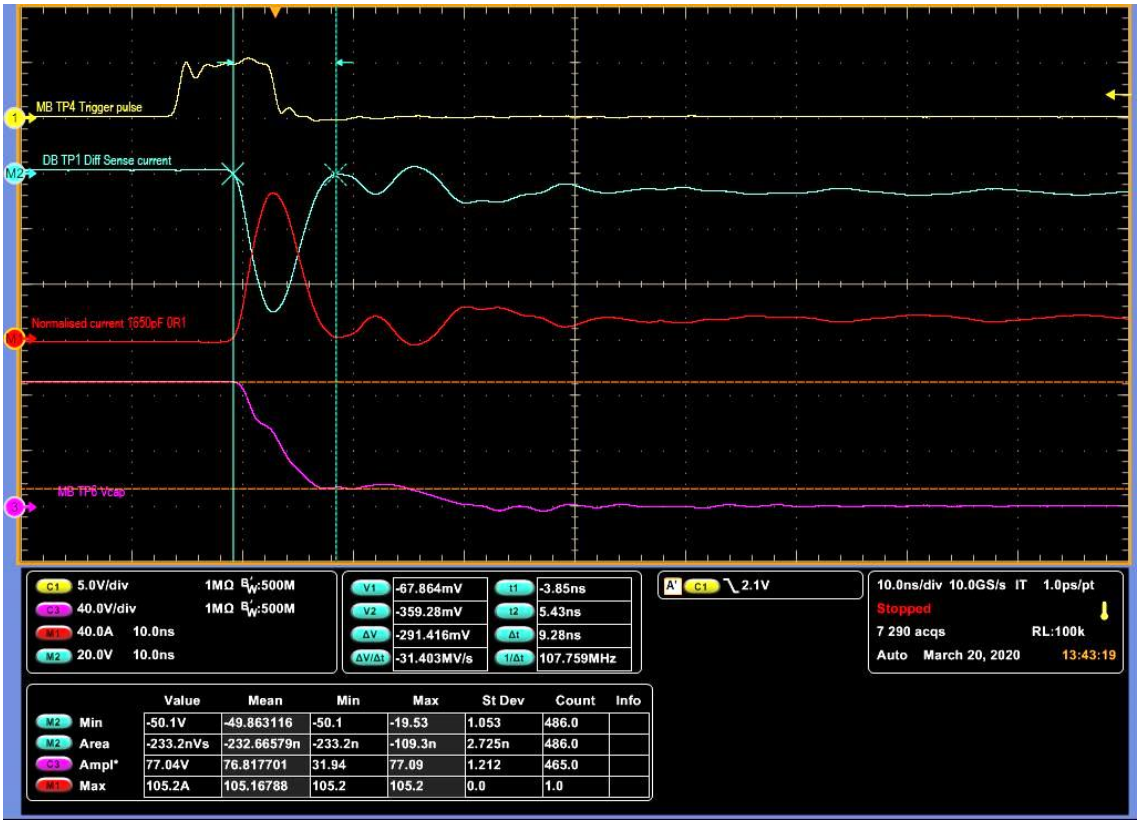
Capacitor Ccharge is charged via a high value resistor Rcharge to the required voltage and avalanche breakdown is initiated by a pulse on the base. The total energy available for breakdown operation is limited by the capacitor charge at avalanche breakdown which is a function of voltage and capacitance and turn on time. The rise time of the base current pulse will affect the time the transistor operates in the linear and saturated region before entering avalanche breakdown. During this period, the capacitor will be discharging and so the energy available for breakdown will be reduced as demonstrated in the following graph.



dIb / dt vs Avalanche Voltage

The effect of parasitic inductance in the circuit must be considered. As a rule of thumb pcb traces have an inductance of ~1nH/mm and larger chip resistors and capacitors (0603) may also have a further 1nH of series inductance in the end caps.

Below is a trace obtained from the FMMT411 evaluation PCB showing a 105A 10ns pulse.

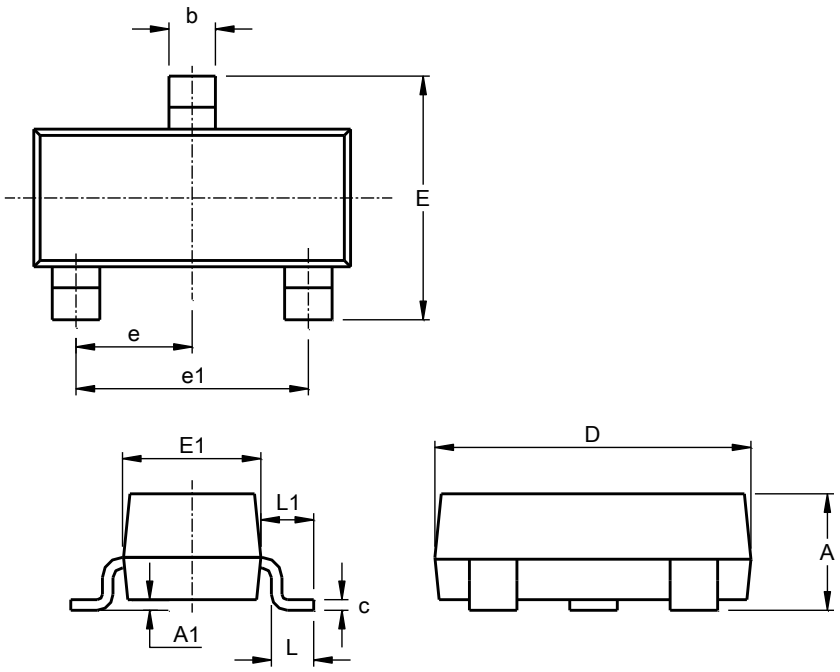


105A 10ns Pulse Obtained from Evaluation Board

Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT23 (Type DN)

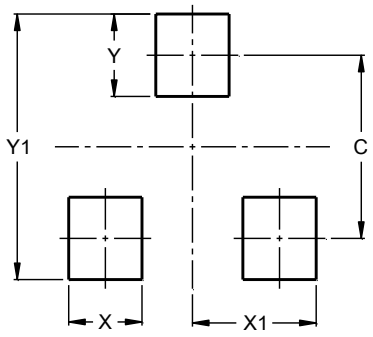


SOT23 Type DN			
Dim	**Min**	**Max**	**Typ**
A	0.89	1.12	1.00
A1	0.01	0.10	0.05
b	0.30	0.51	0.45
c	0.08	0.20	0.10
D	2.80	3.04	3.00
E	2.10	2.64	2.42
E1	1.20	1.40	1.37
e	0.95 REF		
e1	1.90 REF		
L	0.25	0.60	0.30
L1	0.45	0.62	0.54
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT23 (Type DN)



Dimensions	Value (in mm)
C	2.0
X	0.8
X1	1.35
Y	0.9
Y1	2.9

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