NPN LOW VOLTAGE AVALANCHE TRANSISTOR IN DFN2020-3

Description

The FMMT411FDBW is a silicon planar bipolar transistor designed for operating in avalanche mode. Tight process control and low inductance packaging combine to produce high on current pulses with fast edges.

Features

- 80A Peak Avalanche Current
- BV_{CBO} > 80V
- BV_{CEO} > 15V
- Specifically Designed for Low Voltage Avalanche Mode Operation
- Low Profile 0.62mm High Package for Thin Applications
- Sidewall tin plating for wettable flanks in AOI
- 4mm2 Footprint, 50% Smaller than SOT23
- **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/

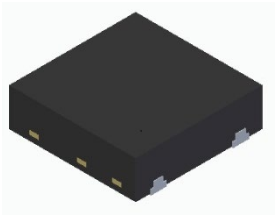
Applications

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

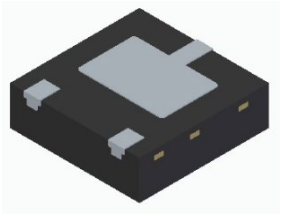
Mechanical Data

- Case: W-DFN2020-3/SWP (Type A)
- Nominal Package Height: 0.6mm
- Case Material: Molded Plastic. "Green" Molding Compound. UL Flammability Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish - Matte Tin, Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.01 grams (Approximate)

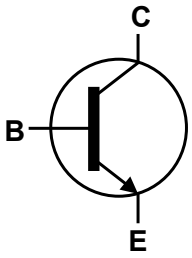
W-DFN2020-3/SWP (Type A)



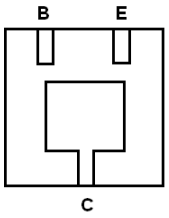
Top View



Bottom View



Device Symbol



Bottom View
Pin-Out

Ordering Information (Note 4)

Part Number	Marking	Reel Size (inches)	Tape Width (mm)	Quantity Per Reel
FMMT411FDBW-7	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/.

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Marking Information

U-DFN2020-3 (Type A)



411 = Product Type Marking Code
Y = Year: 0~9
W = Week: A~Z: 1~26 Week;
a~z; 27~52 Week; z Represents
52 and 53 Week
X = A~Z: Internal Code

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	5	A
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 5)	P_D	1.7	W
Thermal Resistance, Junction to Ambient	(Note 5)	$R_{\theta JA}$	75	°C/W
Thermal Resistance, Junction to Case	(Note 6)	$R_{\theta JC}$	23	°C/W
Operating and Storage Temperature Range		T_J, T_{STG}	-55 to +150	°C

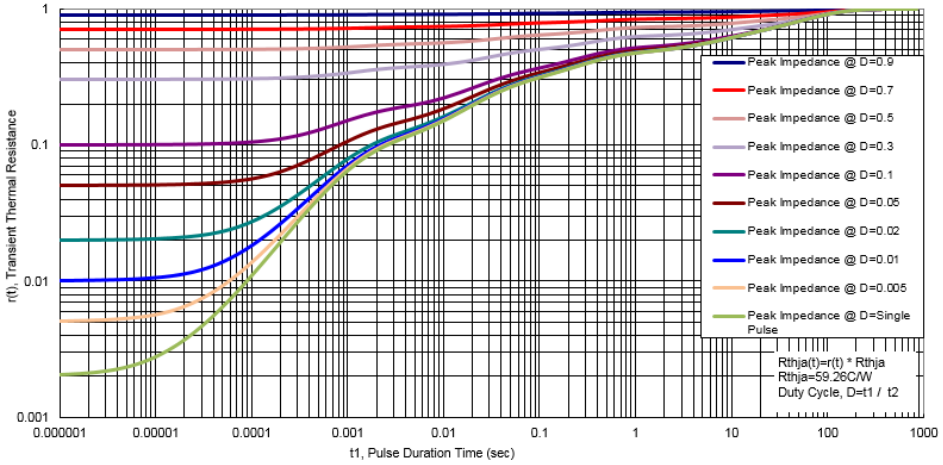
ESD Ratings (Note 7)

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

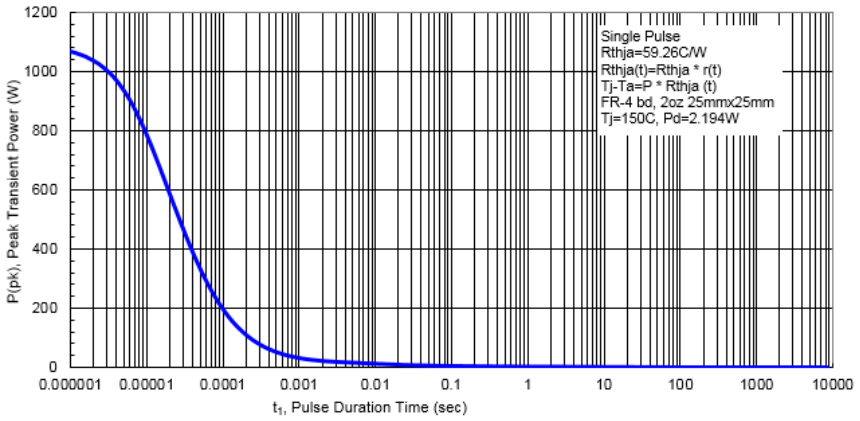
Notes:
5. For a device mounted with the collector lead on 15mm x 15mm 1oz copper that is on a single-sided 1.6mm FR-4 PCB; device is measured under still air conditions whilst operating in a steady-state.
6. Thermal resistance from junction to solder-point (at the end of the collector lead).
7. Refer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

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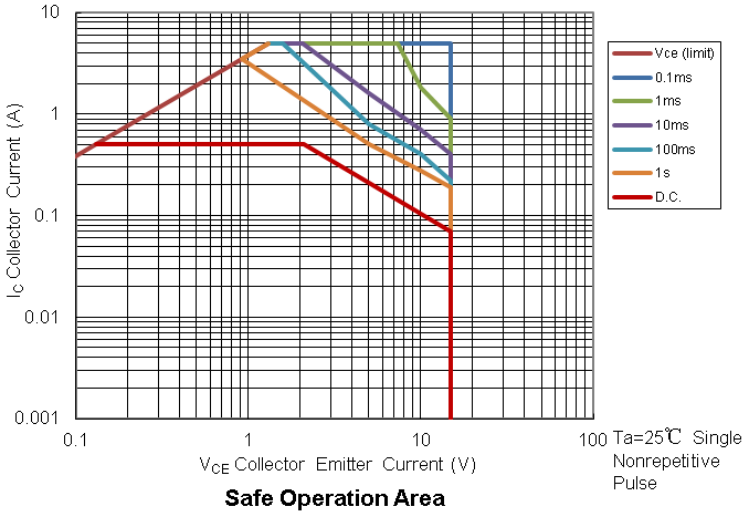
Thermal Characteristics and Derating information



Transient Thermal Resistance



Single Pulse Maximum Power Dissipation



Safe Operation Area

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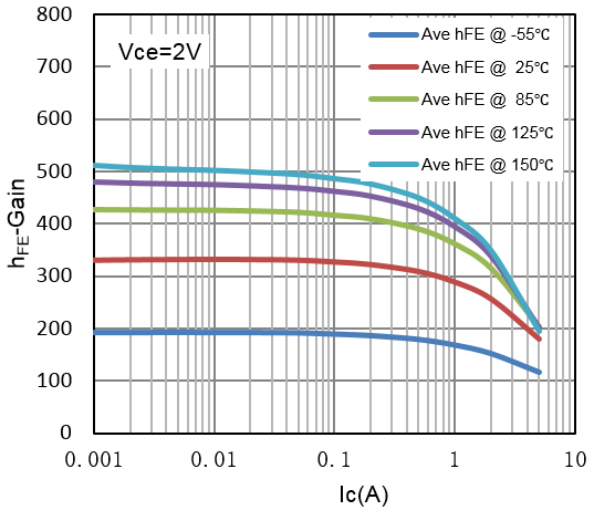
Electrical Characteristics (@ T_A = +25°C, unless otherwise specified.)

Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
Collector-Base Breakdown Voltage	BV_{CBO}	80	—	—	V	I_C = 100µA
Collector-Emitter Breakdown Voltage	BV_{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 8)	h_{FE}	100	—	—	—	I_C = 10mA, V_{CE} = 10V
Collector-Emitter Saturation Voltage (Note 8)	$V_{CE(sat)}$	—	—	100	mV	I_C = 10mA, I_B = 1mA
Base-Emitter Saturation Voltage (Note 8)	$V_{BE(sat)}$	—	—	800	mV	I_C = 10mA, I_B = 1mA
Current in Second Breakdown (Pulsed)	I_{USB}	— —	25 35	— —	A A	V_C = 60V, C_{CE} = 470pF V_C = 70V, C_{CE} = 470pF
Input Capacitance	C_{ibo}	—	49	—	pF	V_{EB} = 0.5V. f = 1MHz
Output Capacitance	C_{obo}	—	17	—	pF	V_{CB} = 20V, I_E = 0 f = 1MHz
Transition Frequency	f_T	80	110	—	MHz	V_{CE} = 20V, I_C = 10mA, f = 20MHz
Turn-On Time	$t_{d(on)}$	—	59	—	ns	V_{CE} = 10V, I_C = 100mA I_{B1} = 10mA, I_{B2} = -10mA
	t_r	—	37	—	ns	
Turn-Off Time	$t_{d(off)}$	—	320	—	ns	
	t_f	—	25	—	ns	

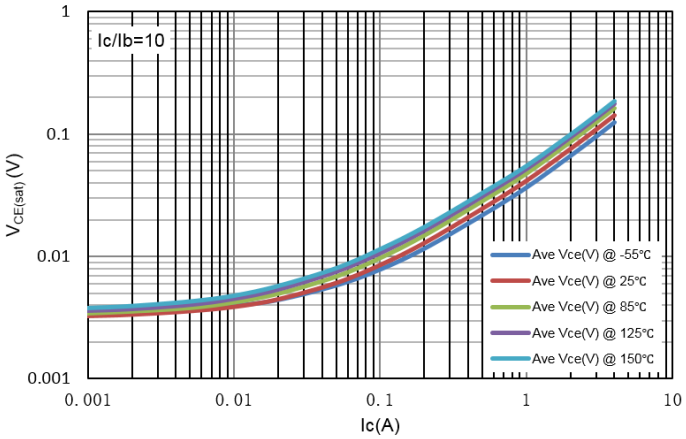
Note: 8. Measured under pulsed conditions. Pulse width ≤ 300µs. Duty cycle ≤ 2%.

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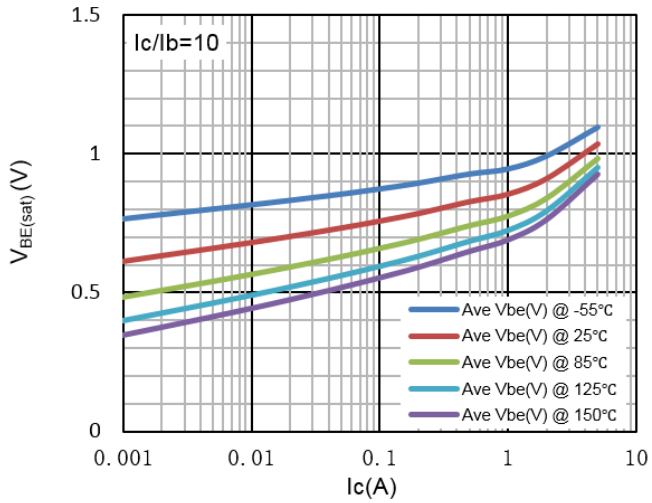
Typical Characteristics



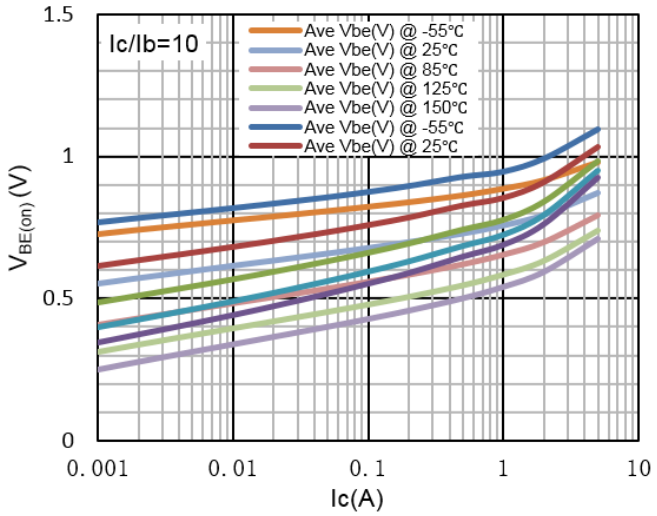
h_{FE} vs I_C



$V_{CE(sat)}$ vs I_C



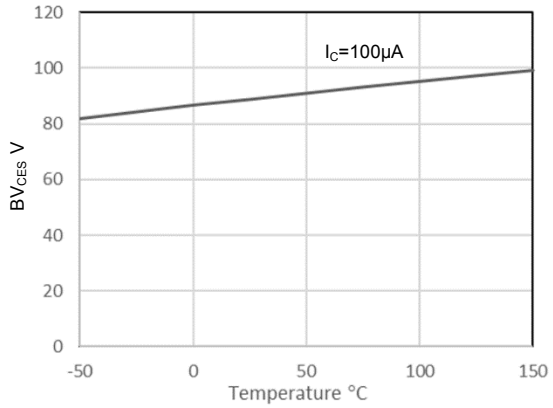
$V_{BE(sat)}$ vs I_C



$V_{BE(on)}$ vs I_C

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Avalanche Power & Switching Times Characteristic Curves



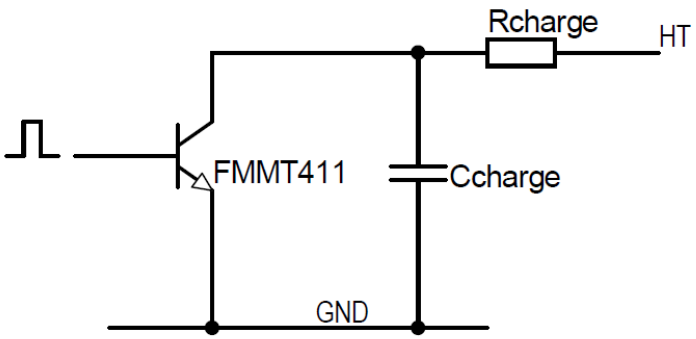
BV_{CES} vs Temperature

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—and 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

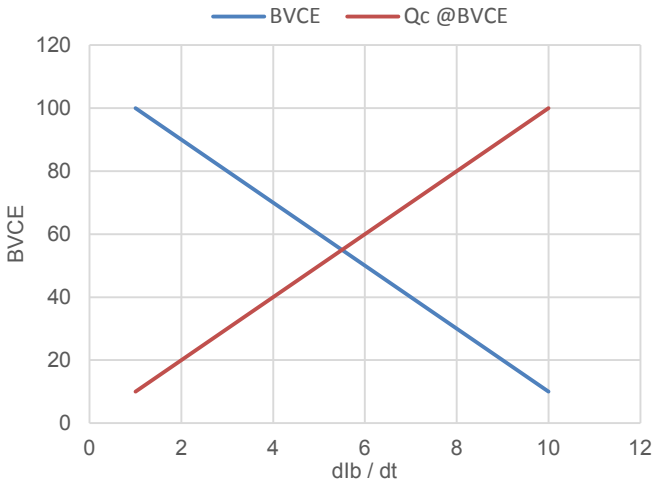
In a typical circuit, a large pulse is applied to the base and the resultant energy is enough to cause the onset of avalanche multiplication. Once breakdown has been established, it will continue until the energy in the breakdown region is insufficient to maintain the condition or until the crystal lattice 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.



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Application Information (continued)

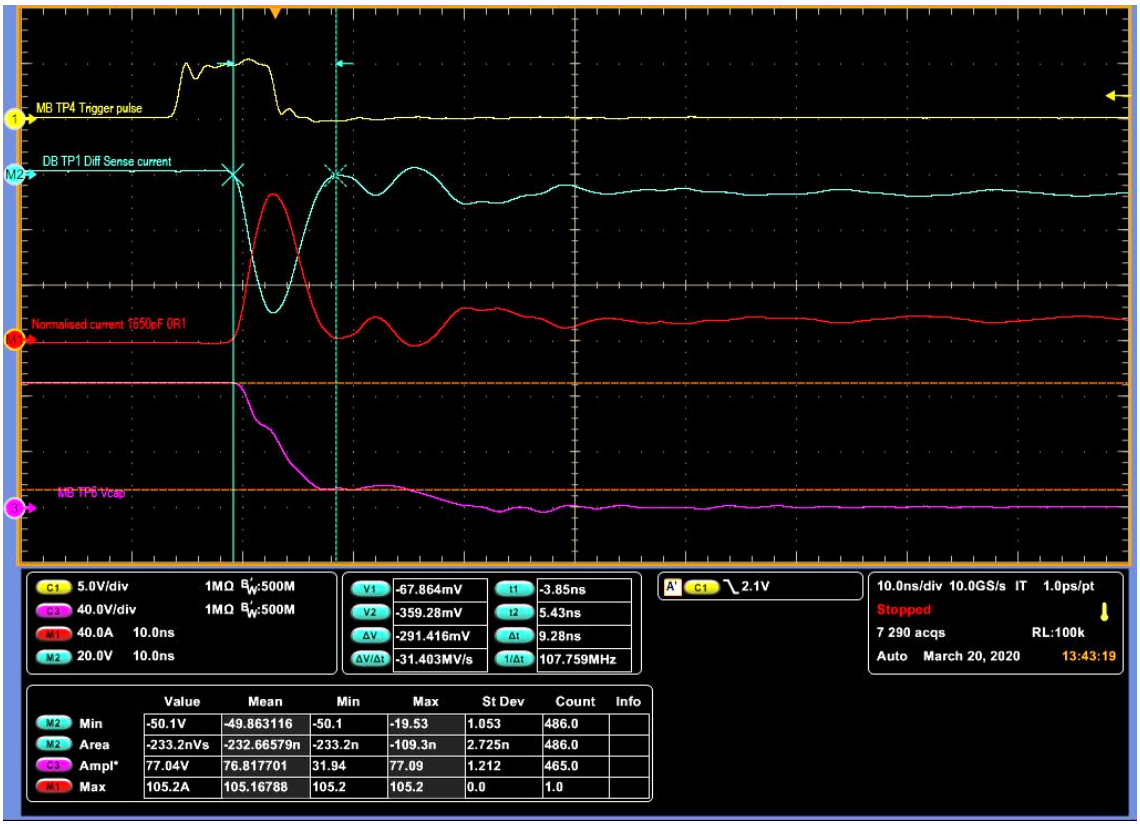
Capacitor C_{charge} is charged via a high value resistor R_{charge} to the required voltage and avalanche breakdown is initiated by a pulse on the base. The total energy available for breakdown operation is limited by the capacitor charge at avalanche breakdown, which is a function of voltage and capacitance 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.



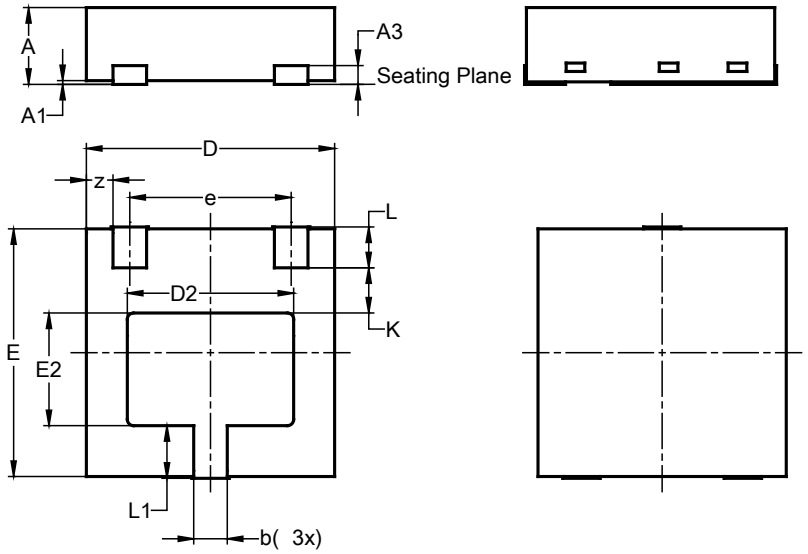
105A 10ns Pulse Obtained from Evaluation Board

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Package Outline Dimensions

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

W-DFN2020-3/SWP (Type A)

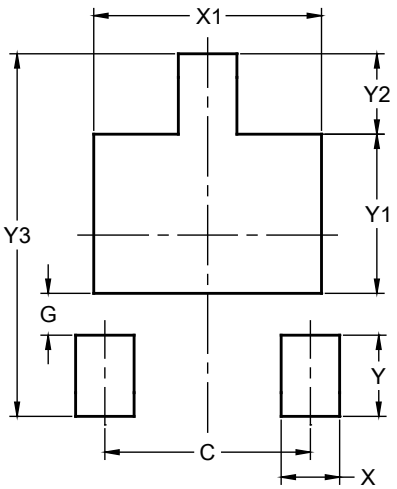


W-DFN2020-3 /SWP (Type A)			
Dim	**Min**	**Max**	**Typ**
A	0.57	0.67	0.62
A1	0.00	0.05	0.03
A3	—	—	0.152
b	0.22	0.32	0.27
D	1.95	2.05	2.00
D2	1.24	1.44	1.34
D4	0.56	0.76	0.66
E	1.95	2.05	2.00
E2	0.81	1.01	0.91
e	—	—	1.30
k	—	—	0.365
L	0.28	0.38	0.33
L1	0.375	0.475	0.425
z	—	—	0.215
All Dimensions in mm			

Suggested Pad Layout

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

W-DFN2020-3/SWP (Type A)



Dimensions	Value (in mm)
C	1.300
G	0.265
X	0.370
X1	1.440
Y	0.515
Y1	1.010
Y2	0.510
Y3	2.300

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