60V NPN ULTRA-LOW VCE(sat) TRANSISTOR IN PowerDI3333-8

Description

A proprietary structure is used in achieving ultra-low $V_{CE(sat)}$ performance and reduced operating temperature. This has the benefit of reducing thermal management requirements and increasing long-term reliability.

Features

- BV_{CEO} > 60V
- 5.5A Continuous Collector Current
- Low Saturation Voltage $V_{CE(sat)}$ < 45mV @ 1A
- High Current $R_{CE(sat)}$ typ = 24mΩ
- h_{FE} Characterized up to 6A
- 2W Power Dissipation
- Fast Switching with Short Storage Time
- Sidewall Tin Plating for Wettable Flanks in AOI
- **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-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative. https://www.diodes.com/quality/product-definitions/**

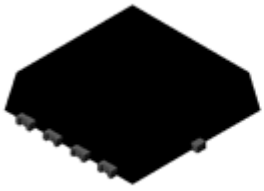
Applications

- Medium-power DC-DC converters
- High-side/low-side switches
- Linear voltage regulation

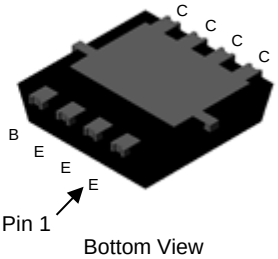
Mechanical Data

- Package: PowerDI®3333-8
- Package 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: 0.03 grams (Approximate)

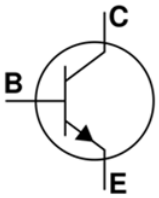
PowerDI3333-8/SWP (Type UX)



Top View



Bottom View



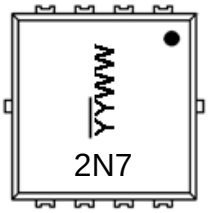
Device Symbol

Ordering Information (Note 4)

Orderable Part Number	Package	Marking	Reel Size (inches)	Tape Width (mm)	Packing	
					Qty.	Carrier
DXTN69060CFG-7	PowerDI3333-8/SWP (Type UX)	2N7	7	12	2,000	Reel

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



2N7 = Product Type Marking Code
YYWW = Date Code Marking
YY = Last Two Digits of Year (ex: 25 = 2025)
WW = Week Code (01 to 53)

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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_{CEO}	60	V
Emitter-Base Voltage	V_{EBO}	7	V
Continuous Collector Current (Note 5)	I_C	5.5	A
Continuous Collector Current (Note 6)	I_C	3.5	A
Peak Pulse Current	I_{CM}	12	A
Base Current	I_B	1	A

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

Characteristic		Symbol	Value	Unit
Power Dissipation Linear Derating Factor	(Note 5)	P_D	2 16	W mW/°C
	(Note 6)		1.35 10.8	
	(Note 7)		0.9 7.2	
Thermal Resistance, Junction to Ambient	(Note 5)	$R_{\theta JA}$	62.5	°C/W
	(Note 6)		92	
	(Note 7)		139	
Thermal Resistance, Junction to Lead	(Note 8)	$R_{\theta JL}$	8.5	°C/W
Operating and Storage Temperature Range		T_J, T_{STG}	-55 to +150	°C

Notes: 5. For a device mounted with the exposed collector pad on 25mm x 25mm 2oz copper that is on a single-sided 1.6mm FR4 PCB; device is measured under still air conditions whilst operating in a steady state.
6. Same as Note 5, except the device is mounted on 15mm x 15mm 2oz copper.
7. Same as Note 5, except the device is mounted on minimum recommended pad layout.
8. Thermal resistance from junction to solder-point (at the end of the collector lead).

ESD Ratings (Note 9)

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
Electrostatic Discharge – Charged Device Model	ESD CDM	1,000	V	IV

Note: 9. Refer to JEDEC specification JESD22-A114, JESD22-A115 and JESD22-C101.

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Thermal Characteristics and Derating Information

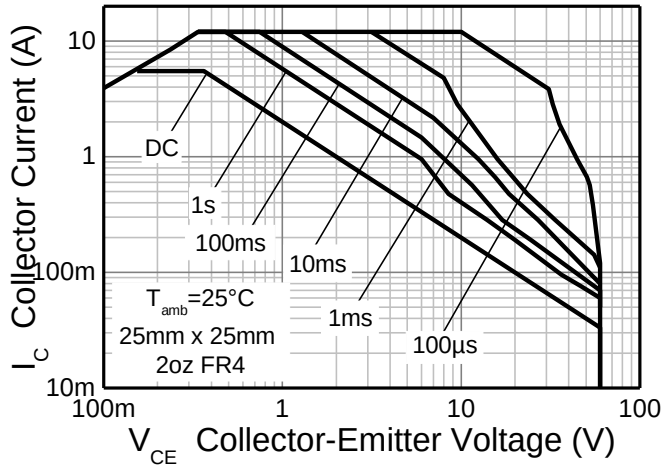


Fig 1. Safe Operating Area

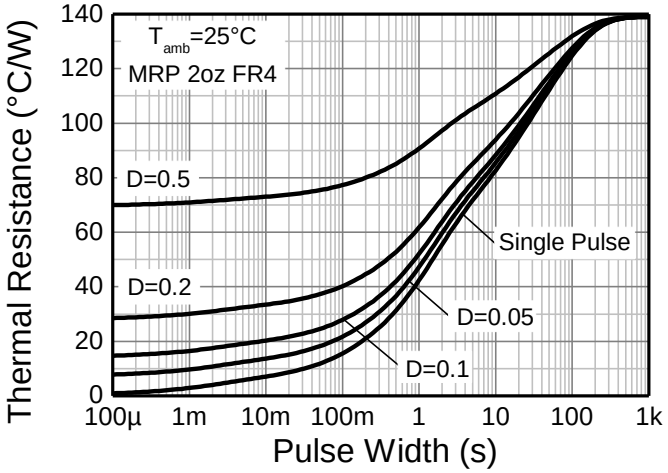


Fig 2. Transient Thermal Impedance

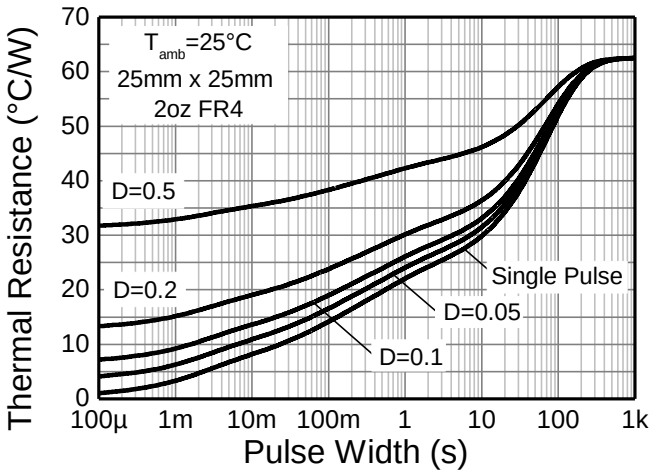


Fig 3. Transient Thermal Impedance

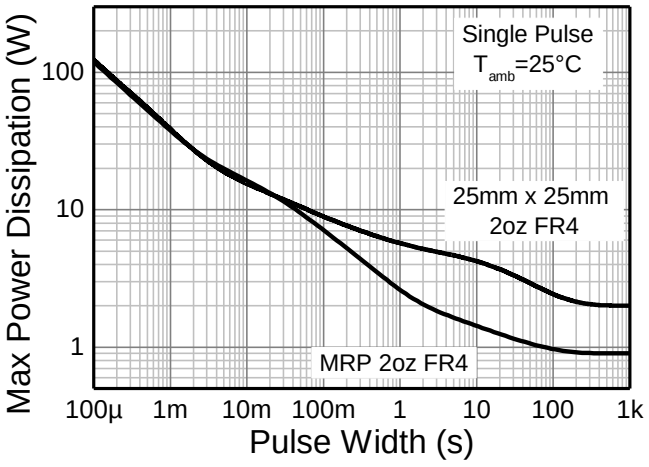


Fig 4. Pulse Power Dissipation

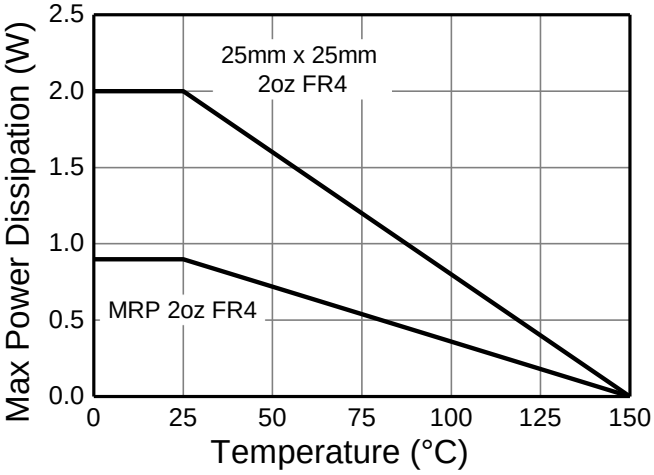


Fig 5. Derating Curve

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

Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
OFF CHARACTERISTICS						
Collector-Base Breakdown Voltage	BV_{CBO}	80	—	—	V	I_C = 100µA
Collector-Emitter Breakdown Voltage (Base Open) (Note 10)	BV_{CEO}	60	—	—	V	I_C = 10mA
Emitter-Base Breakdown Voltage	BV_{EBO}	7	—	—	V	I_E = 100µA
Collector-Base Cutoff Current	I_{CBO}	—	—	100 0.5	nA µA	V_{CB} = 80V V_{CB} = 80V, T_A = +100°C
Emitter-Base Cutoff Current	I_{EBO}	—	—	100	nA	V_{EB} = 6V
ON CHARACTERISTICS (Note 10)						
Static Forward Current Transfer Ratio	h_{FE}	250 200 80	360 325 170	475 — —	—	I_C = 100mA, V_{CE} = 2V I_C = 2A, V_{CE} = 2V I_C = 6A, V_{CE} = 2V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	—	30 70 70 135 170	45 95 100 170 220	mV	I_C = 1A, I_B = 100mA I_C = 1A, I_B = 10mA I_C = 2A, I_B = 40mA I_C = 5.5A, I_B = 550mA I_C = 5.5A, I_B = 150mA
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	—	1,050 890	1,150 —	mV	I_C = 5.5A, I_B = 550mA I_C = 5.5A, I_B = 150mA
Base-Emitter On Voltage	$V_{BE(on)}$	—	760	900	mV	I_C = 5.5A, V_{CE} = 2V
SWITCHING CHARACTERISTICS						
Transition Frequency	f_T	—	200	—	MHz	I_C = 100mA, V_{CE} = 10V f = 100MHz
Input Capacitance	C_{ibo}	—	380	—	pF	V_{EB} = 0.5V, f = 1MHz
Output Capacitance	C_{obo}	—	23	—	pF	V_{CB} = 10V, f = 1MHz
Delay Time	t_d	—	81	—	ns	V_{CC} = 24V, I_C = 750mA I_{B1} = -I_{B2} = 15mA See Fig 6.
Rise Time	t_r	—	64	—	ns	
Storage Time	t_s	—	640	—	ns	
Fall Time	t_f	—	78	—	ns	
Delay Time	t_d	—	87	—	ns	V_{CC} = 48V, I_C = 750mA I_{B1} = -I_{B2} = 15mA See Fig 6.
Rise Time	t_r	—	117	—	ns	
Storage Time	t_s	—	510	—	ns	
Fall Time	t_f	—	101	—	ns	

Note: 10. Measured under pulsed conditions. Pulse width ≤ 300µs. Duty cycle ≤ 2%.

Timing Waveform

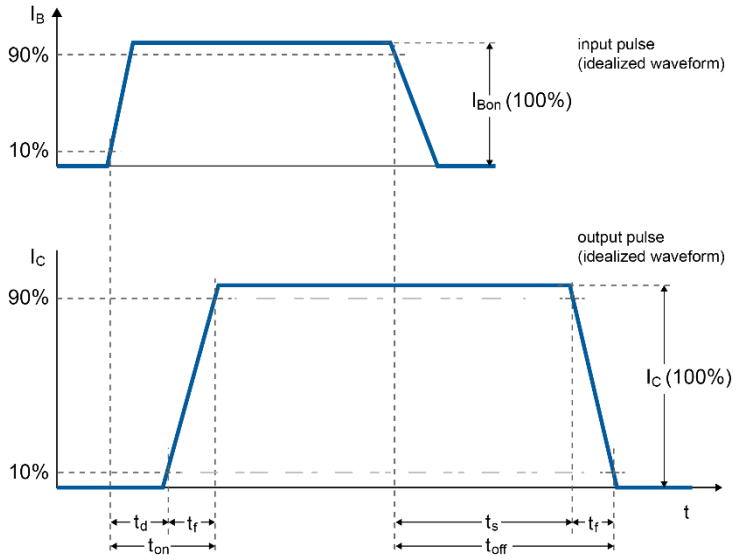


Fig 6. Timing Waveform

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

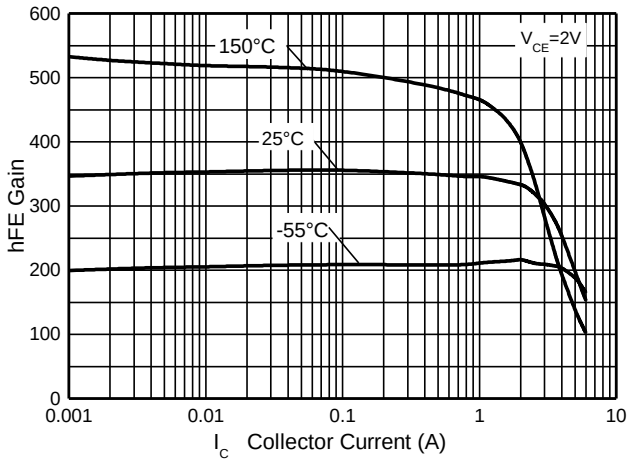


Fig. 7 hFE v I_C

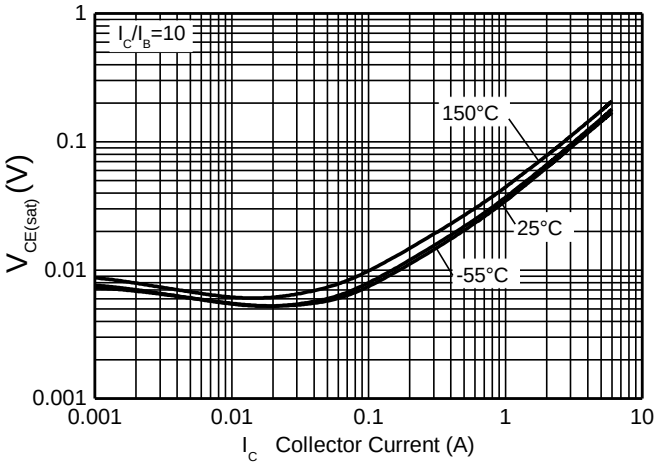


Fig. 8 $V_{CE(sat)}$ v I_C

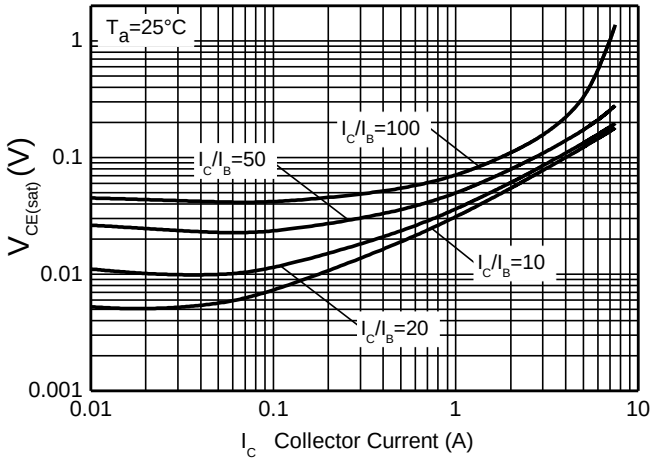


Fig. 9 $V_{CE(sat)}$ v I_C

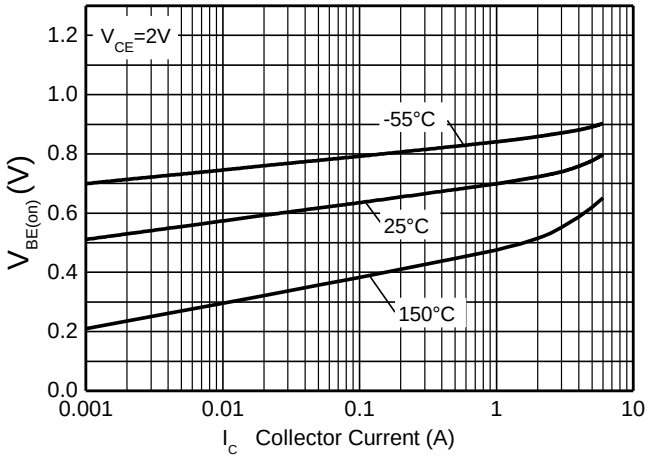


Fig. 10 $V_{BE(on)}$ v I_C

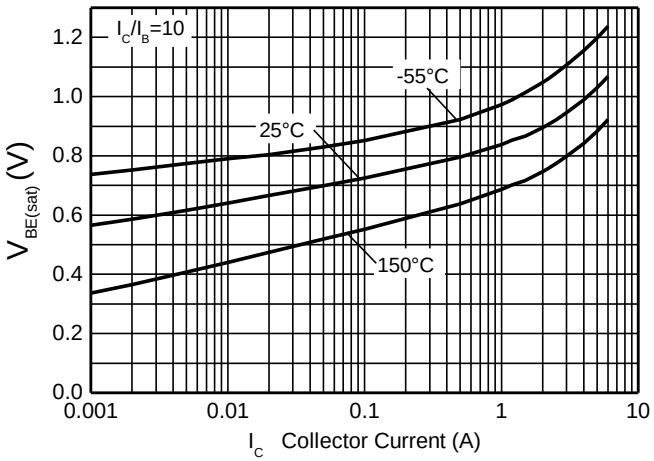


Fig. 11 $V_{BE(sat)}$ v I_C

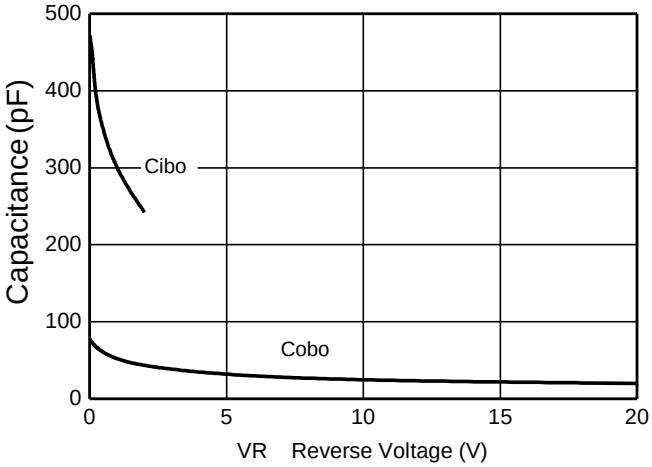


Fig. 12 Typical Junction Capacitance

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Application Notes

Fig. 13 shows the DXTN69060CFG as a low-side switch. When driving high-current inductive loads, it is recommended to apply appropriate protective measures to manage the kick-back voltage that builds up due to the collapse of the inductor's magnetic field after a switch-off event. The voltage spikes that originate this way can potentially overstress the device above its Maximum Ratings. During evaluation, ensure that the Collector-Emitter Voltage stays below V_{CEO} rating of 60V. An easy way to suppress induced voltage spikes is to place an additional free-wheeling diode in parallel with the load as shown in Fig. 14.

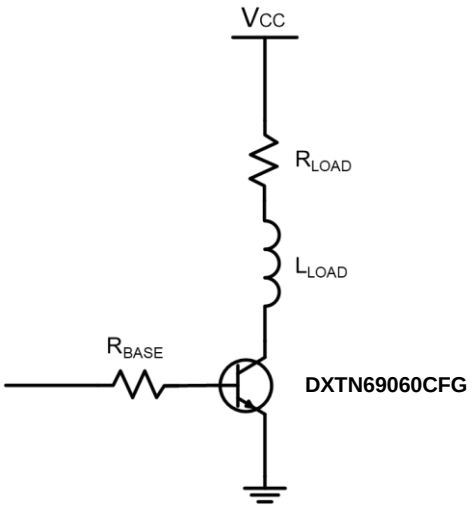


Fig. 13 DXTN69060CFG in a Low-Side Switch Configuration

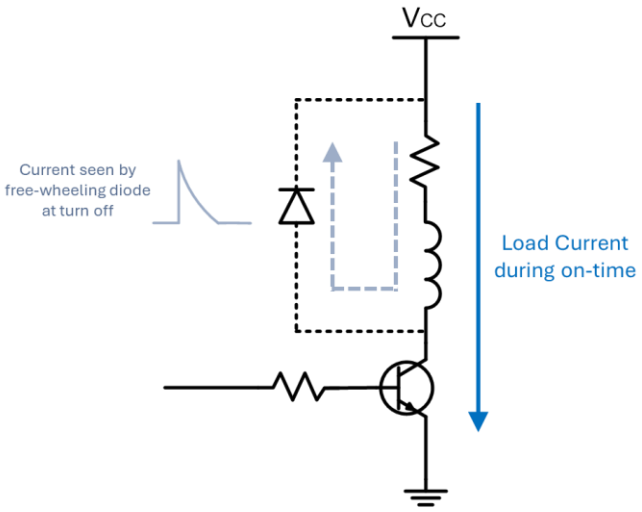


Fig. 14 Additional Free-Wheeling Diode Across Inductive Load for Voltage Spikes Suppression

The appropriate free-wheeling diode should have:

- An Average Rectified Output Current (I_O) rating of at least twice the full Load Current.
- A Working Peak Reverse Voltage (V_{RWM}) equal to the voltage applied to the load (minimum) or twice its value (recommended).

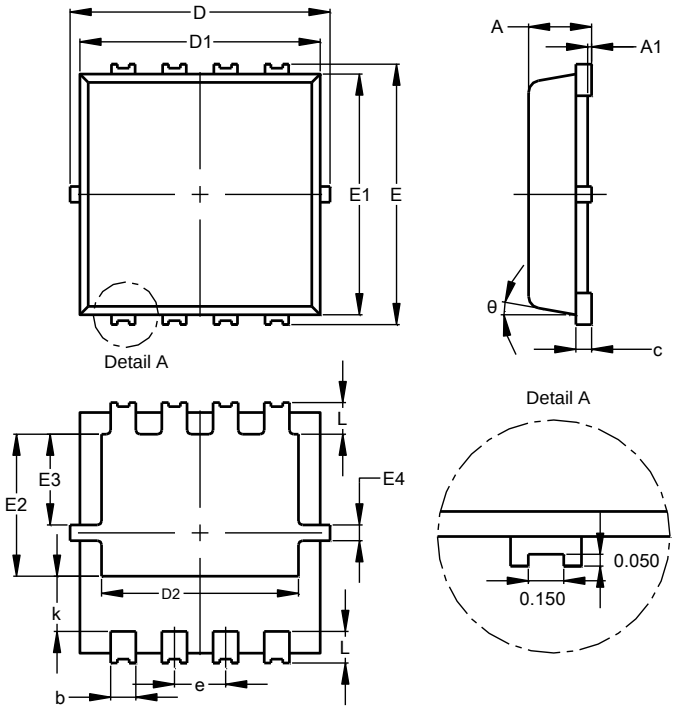
For example, in the figures above, V_{CC} = 24V and I_{LOAD} = 3A. The PDS760 Schottky Barrier Rectifier with I_O = 7A and V_{RWM} = 60V will protect the transistor from turn-off inductive voltage spikes and ensure a safe system operation.

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Package Outline Dimensions (Note 11)

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

PowerDI3333-8/SWP (Type UX)



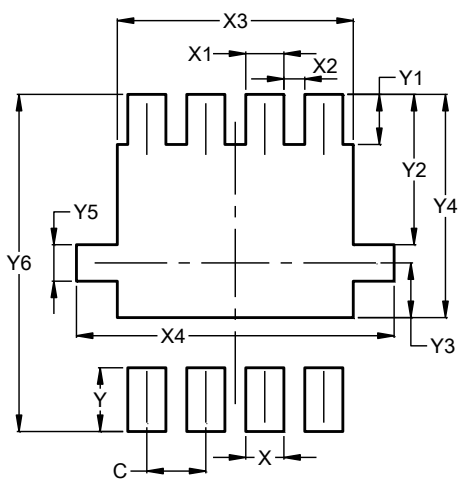
PowerDI3333-8/SWP (Type UX)			
Dim	**Min**	**Max**	**Typ**
A	0.75	0.85	0.80
A1	0.00	0.05	--
b	0.25	0.40	0.32
c	0.10	0.25	0.15
D	3.20	3.40	3.30
D1	2.95	3.15	3.05
D2	2.30	2.70	2.50
E	3.20	3.40	3.30
E1	2.95	3.15	3.05
E2	1.60	2.00	1.80
E3	0.95	1.35	1.15
E4	0.10	0.30	0.20
e	–	–	0.65
k	0.50	0.90	0.70
L	0.30	0.50	0.40
θ	0°	12°	10°
All Dimensions in mm			

Note: 11. Sidewall tin plated package for wettable flanks in AOI.

Suggested Pad Layout

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

PowerDI3333-8/SWP (Type UX)



Dimensions	Value (in mm)
C	0.650
X	0.420
X1	0.420
X2	0.230
X3	2.600
X4	3.500
Y	0.700
Y1	0.550
Y2	1.650
Y3	0.600
Y4	2.450
Y5	0.400
Y6	3.700

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