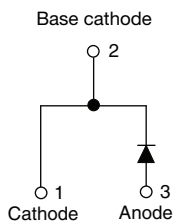


# Hyperfast Rectifier, 60 A FRED Pt® G5



## FEATURES

- Hyperfast and optimized  $Q_{rr}$
- Best in class forward voltage drop and switching losses trade off
- Optimized for high speed operation
- 175 °C maximum operating junction temperature
- Polyimide passivation
- AEC-Q101 qualified, meets JESD 201 class 2 whisker test
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

## LINKS TO ADDITIONAL RESOURCES



PRIMARY CHARACTERISTICS	
$I_{F(AV)}$	60 A
$V_R$	600 V
$V_F$ at $I_F$ at 125 °C	1.2 V
$t_{rr}$ (typ.)	29 ns
$I_{FSM}$	500 A
$T_J$ max.	175 °C
Package	TO-247AD 2L
Circuit configuration	Single

## DESCRIPTION / APPLICATIONS

Featuring a unique combination of low conduction and switching losses, this rectifier is the right choice for soft switched and resonant converters, as well as medium frequency hard switching converters. This device is specifically designed to improve efficiency of high speed LLC output rectification stages of EV / HEV on-board battery chargers

## MECHANICAL DATA

**Case:** TO-247AD 2L

Molding compound meets UL 94 V-0 flammability rating

**Terminal:** matte tin plated leads, solderable per J-STD-002

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	VALUES	UNITS
Repetitive peak reverse voltage	$V_{RRM}$		600	V
Average rectified forward current	$I_{F(AV)}$	$T_C = 110\text{ °C}$ , $D = 0.50$	60	A
Non-repetitive peak surge current	$I_{FSM}$	$T_C = 25\text{ °C}$ , $t_p = 10\text{ ms}$ , sine wave both anodes, (1) and (3) connected	500	
Repetitive peak forward current	$I_{FRM}$	$T_C = 110\text{ °C}$ , $D = 0.50$ , $f = 20\text{ kHz}$	120	
Operating junction and storage temperature	$T_J$ , $T_{Stg}$		-55 to +175	°C

ELECTRICAL SPECIFICATIONS ( $T_J = 25\text{ °C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Breakdown voltage, blocking voltage	$V_{BR}$ , $V_R$	$I_R = 100\text{ }\mu\text{A}$	600	-	-	V
Forward voltage	$V_F$	$I_F = 60\text{ A}$	-	1.4	1.7	
		$I_F = 60\text{ A}$ , $T_J = 125\text{ °C}$	-	1.2	-	
Reverse leakage current	$I_R$	$V_R = V_R$ rated	-	-	25	$\mu\text{A}$
		$T_J = 125\text{ °C}$ , $V_R = V_R$ rated	-	-	500	
Junction capacitance	$C_T$	$V_R = 200\text{ V}$	-	65	-	pF
Series inductance	$L_S$	Measured to lead 5 mm from package body	-	8	-	nH

<b>DYNAMIC RECOVERY CHARACTERISTICS</b> ( $T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Reverse recovery time	$t_{rr}$	$I_F = 1\text{ A}$ , $dI_F/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$	-	29	-	ns
		$T_J = 25\text{ }^{\circ}\text{C}$	-	49	-	
		$T_J = 125\text{ }^{\circ}\text{C}$	-	74	-	
Peak recovery current	$I_{RRM}$	$T_J = 25\text{ }^{\circ}\text{C}$	-	21	-	A
		$T_J = 125\text{ }^{\circ}\text{C}$	-	43	-	
Reverse recovery charge	$Q_{rr}$	$T_J = 25\text{ }^{\circ}\text{C}$	-	640	-	nC
		$T_J = 125\text{ }^{\circ}\text{C}$	-	1979	-	
Reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^{\circ}\text{C}$	-	54	-	ns
		$T_J = 125\text{ }^{\circ}\text{C}$	-	82	-	
Peak recovery current	$I_{RRM}$	$T_J = 25\text{ }^{\circ}\text{C}$	-	22	-	A
		$T_J = 125\text{ }^{\circ}\text{C}$	-	47	-	
Reverse recovery charge	$Q_{rr}$	$T_J = 25\text{ }^{\circ}\text{C}$	-	790	-	nC
		$T_J = 125\text{ }^{\circ}\text{C}$	-	2385	-	

<b>THERMAL - MECHANICAL SPECIFICATIONS</b>						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Thermal resistance, junction-to-case	$R_{thJC}$		-	-	0.63	$^{\circ}\text{C}/\text{W}$
Weight			-	5.5	-	g
Mounting torque			1.2 (5.0)	-	24 (10)	kgf · cm (lbf · in)
Maximum junction and storage temperature range	$T_J$ , $T_{Stg}$		-55	-	175	$^{\circ}\text{C}$
Marking device		Case style TO-247AD 2L	E5PH6006LH			

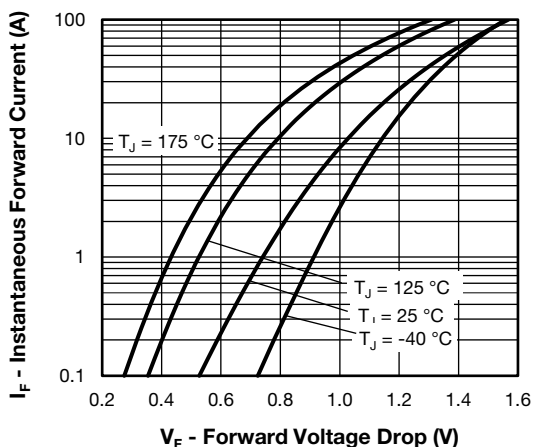


Fig. 1 - Typical Forward Voltage Drop Characteristics

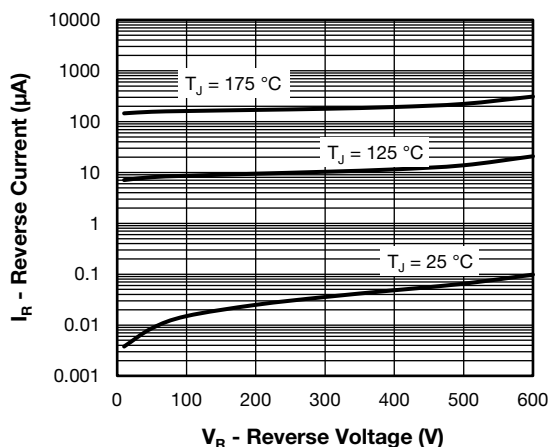


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

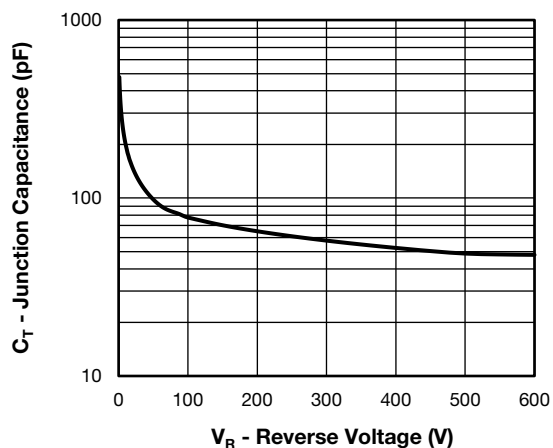


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

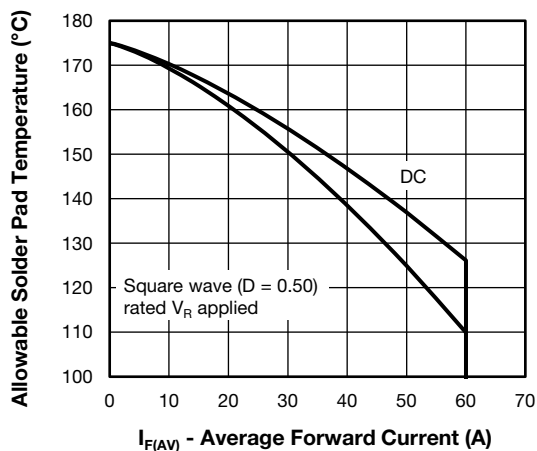


Fig. 4 - Maximum Allowable Case Temperature vs. Average Forward Current

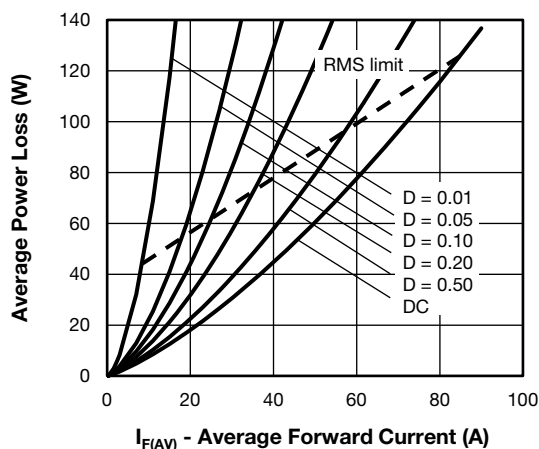
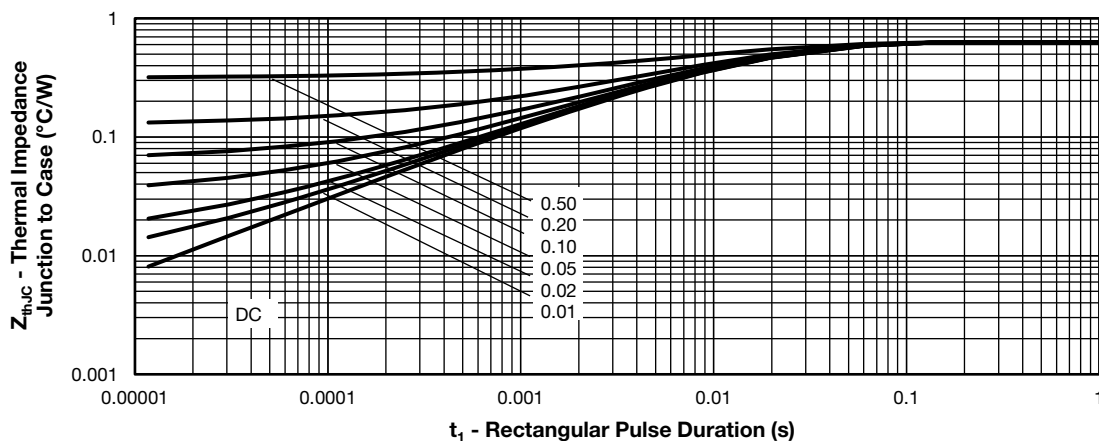
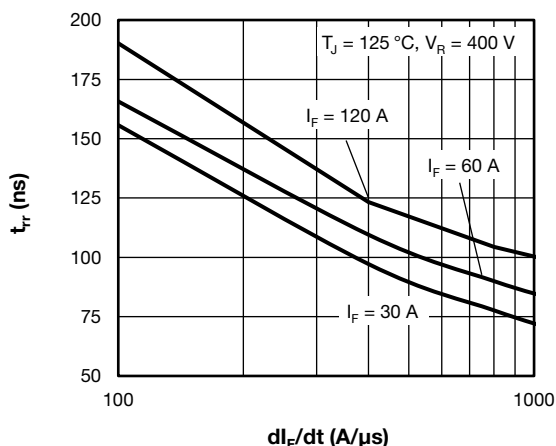
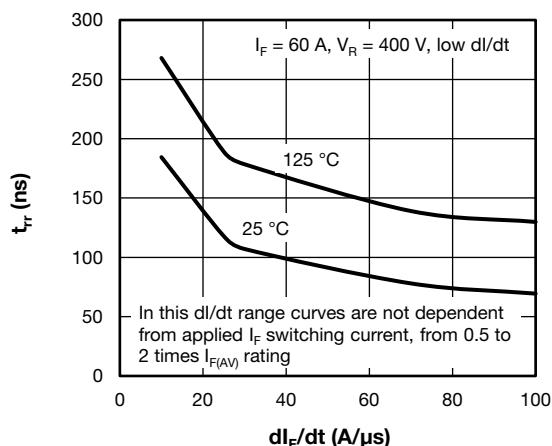
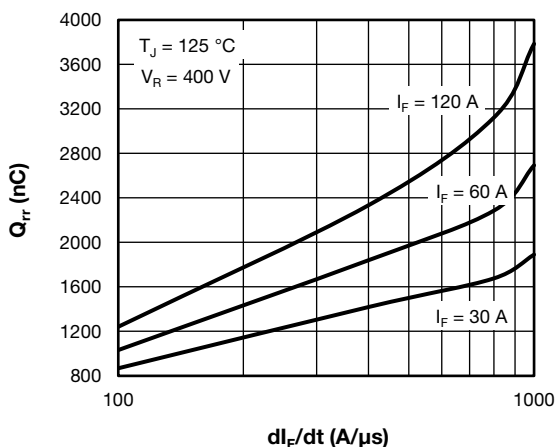
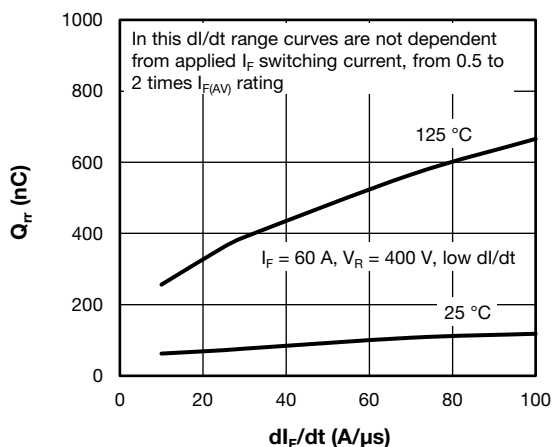
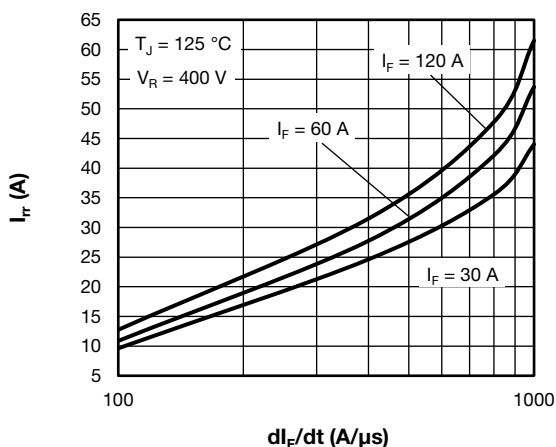
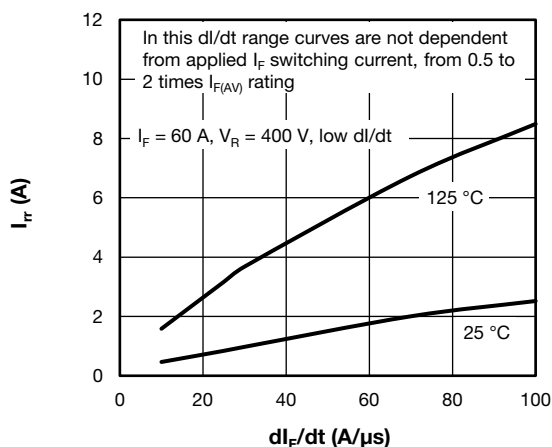


Fig. 5 - Average Power Loss vs. Average Forward Current


Fig. 6 - Thermal Impedance  $Z_{thJC}$  Characteristics


Fig. 7 - Typical Reverse Recovery Time vs.  $dI_F/dt$ 

Fig. 10 - Typical Reverse Recovery Time vs.  $dI_F/dt$ 

Fig. 8 - Typical Reverse Recovery Charge vs.  $dI_F/dt$ 

Fig. 11 - Typical Reverse Recovery Charge vs.  $dI_F/dt$ 

Fig. 9 - Typical Reverse Recovery Current vs.  $dI_F/dt$ 

Fig. 12 - Typical Reverse Recovery Current vs.  $dI_F/dt$

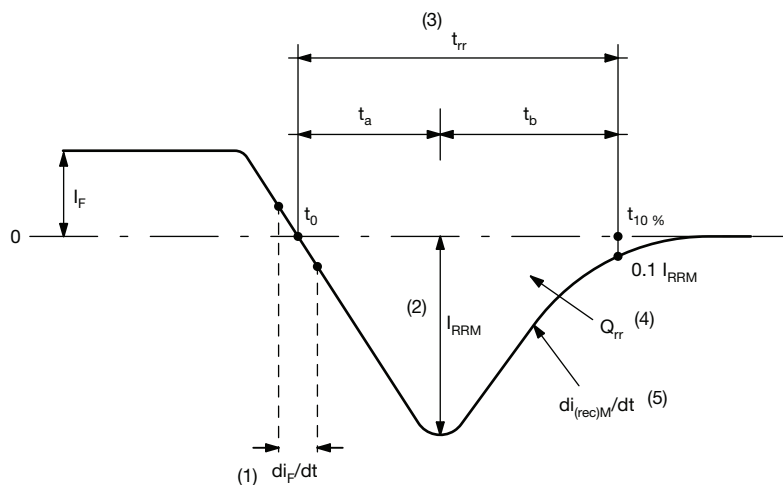


Fig. 13 - Reverse Recovery Waveform and Definitions

#### Notes

- (1)  $di_F/dt$  - rate of change of current through zero crossing
- (2)  $I_{RRM}$  - peak reverse recovery current
- (3)  $t_{rr}$  - reverse recovery time measured from  $t_0$ , crossing point of negative going  $I_F$ , to point  $t_{10\%}$ ,  $0.1 I_{RRM}$
- (4)  $Q_{rr}$  - area under curve defined by  $t_0$  and  $t_{10\%}$

$$Q_{rr} = \int_{t_0}^{t_{10\%}} I(t) dt$$

- (5)  $di_{(rec)M}/dt$  - peak rate of change of current during  $t_b$  portion of  $t_{rr}$

**ORDERING INFORMATION TABLE**

Device code	VS-	E	5	P	H	60	06	L	H	N3
	1	2	3	4	5	6	7	8	9	10
<b>1</b>	- Vishay Semiconductors product									
<b>2</b>	- Circuit configuration E = single diode									
<b>3</b>	- FRED Pt <sup>®</sup> Gen 5									
<b>4</b>	- P = TO-247 package									
<b>5</b>	- Process type: H = hyperfast recovery									
<b>6</b>	- Current rating 60 = 60 A)									
<b>7</b>	- Voltage rating (06 = 600 V)									
<b>8</b>	- Package: L = long lead (TO-247AD)									
<b>9</b>	- H = AEC-Q101 qualified									
<b>10</b>	- Environmental digit: N3 = halogen-free, RoHS-compliant, and totally lead (Pb)-free									

**ORDERING INFORMATION** (Example)

PREFERRED P/N	QUANTITY PER TUBE	MINIMUM ORDER QUANTITY	PACKAGING DESCRIPTION
VS-E5PH6006LHN3	25	500	Antistatic plastic tube

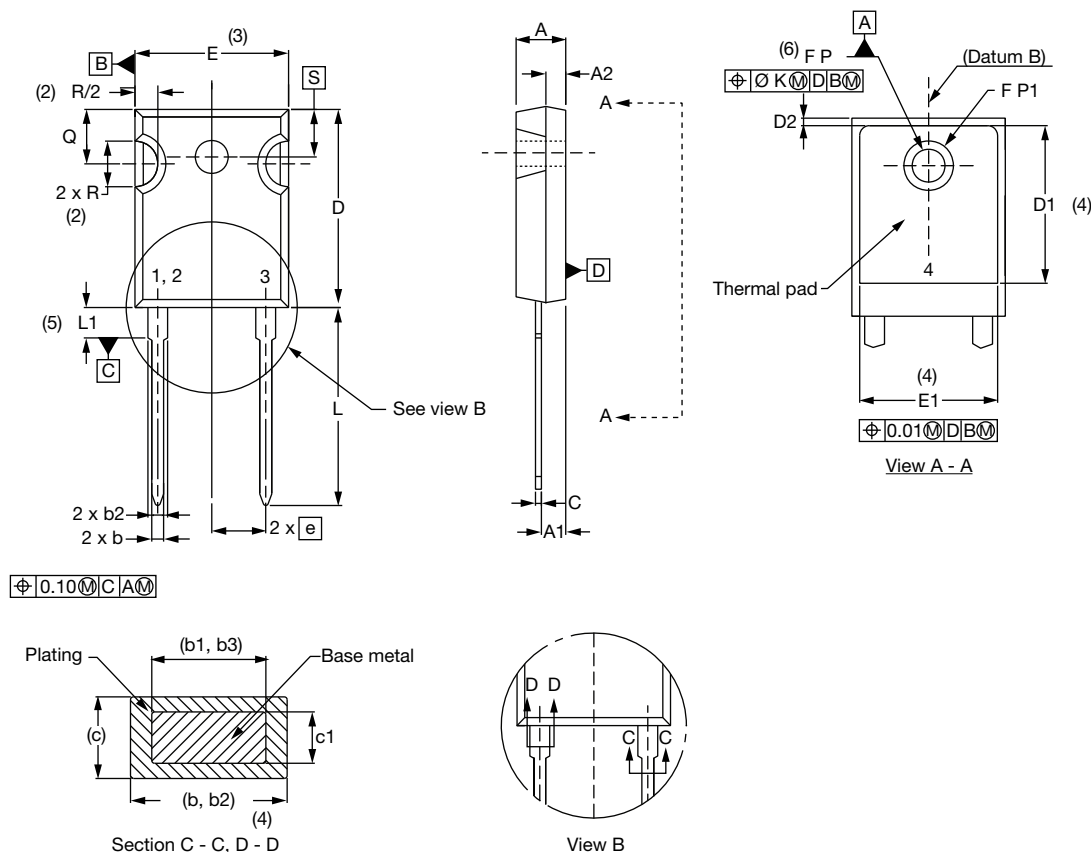
**LINKS TO RELATED DOCUMENTS**

Dimensions	<a href="http://www.vishay.com/doc?95536">www.vishay.com/doc?95536</a>
Part marking information	<a href="http://www.vishay.com/doc?95648">www.vishay.com/doc?95648</a>
SPIICE model	<a href="http://www.vishay.com/doc?96957">www.vishay.com/doc?96957</a>



## TO-247AD 2L

DIMENSIONS in millimeters and inches



SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	4.65	5.31	0.183	0.209	
A1	2.21	2.59	0.087	0.102	
A2	1.50	2.49	0.059	0.098	
b	0.99	1.40	0.039	0.055	
b1	0.99	1.35	0.039	0.053	
b2	1.65	2.39	0.065	0.094	
b3	1.65	2.34	0.065	0.092	
c	0.38	0.89	0.015	0.035	
c1	0.38	0.84	0.015	0.033	
D	19.71	20.70	0.776	0.815	3
D1	13.08	-	0.515	-	4
D2	0.51	1.35	0.020	0.053	

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
E	15.29	15.87	0.602	0.625	3
E1	13.46	-	0.53	-	
e	5.46 BSC		0.215 BSC		
$\phi K$	0.254		0.010		
L	19.81	20.32	0.780	0.800	
L1	3.71	4.29	0.146	0.169	
$\phi P$	3.56	3.66	0.14	0.144	
$\phi P1$	-	6.98	-	0.275	
Q	5.31	5.69	0.209	0.224	
R	4.52	5.49	0.178	0.216	
S	5.51 BSC		0.217 BSC		

## Notes

- (1) Dimensioning and tolerancing per ASME Y14.5M-1994
- (2) Contour of slot optional
- (3) Dimension D and E do not include mold flash. These dimensions are measured at the outermost extremes of the plastic body
- (4) Thermal pad contour optional with dimensions D1 and E1
- (5) Lead finish uncontrolled in L1
- (6)  $\phi P$  to have a maximum draft angle of 1.5 to the top of the part with a maximum hole diameter of 3.91 mm (0.154")
- (7) Outline conforms to JEDEC® outline TO-247 with exception of dimension A min., D, E min., Q min., S, and note 4



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