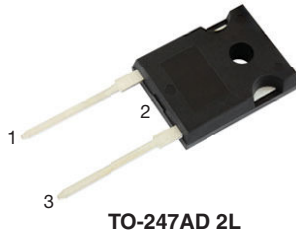
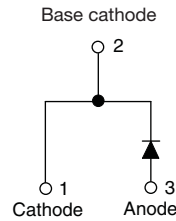


## Hyperfast Soft Recovery Diode, 60 A FRED Pt<sup>®</sup> Gen 4



TO-247AD 2L



### FEATURES

- Gen 4 FRED Pt<sup>®</sup> technology
- Low  $I_{RRM}$  and reverse recovery charge
- Very low forward voltage drop
- Polyimide passivated chip for high reliability standard
- 175 °C operating junction temperature
- AEC-Q101 qualified, meets JESD 201 class 1 whisker test
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



| PRODUCT SUMMARY |                    |
|-----------------|--------------------|
| Package         | TO-247AD 2L        |
| $I_{F(AV)}$     | 60 A               |
| $V_R$           | 600 V              |
| $V_F$ at $I_F$  | 1.48 V             |
| $t_{rr}$ typ.   | see Recovery table |
| $T_J$ max.      | 175 °C             |
| Diode variation | Single die         |

### DESCRIPTION

Gen 4 Fred technology, state of the art, ultralow  $V_F$ , soft switching optimized for Discontinuous (Critical) Mode (DCM) and IGBT F/W diode.

The minimized conduction loss, optimized stored charge and low recovery current minimized the switching losses and reduce over dissipation in the switching element and snubbers.

| ABSOLUTE MAXIMUM RATINGS                    |                |   |             |       |
|---|----------------|---|-------------|-------|
| PARAMETER                                   | SYMBOL         | TEST CONDITIONS   | MAX.        | UNITS |
| Cathode to anode voltage                    | $V_R$          |   | 600         | V     |
| Average rectified forward current           | $I_{F(AV)}$    | $T_C = 106\text{ °C}$   | 60          | A     |
| Single pulse forward current                | $I_{FSM}$      | $T_C = 25\text{ °C}$ , $t_p = 8.3\text{ ms}$ , half sine wave | 425         |       |
| Operating junction and storage temperatures | $T_J, T_{Stg}$ |   | -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  | $V_F$         | $I_F = 50\text{ A}$                         | -    | 1.68 | -    |               |
|  |               | $I_F = 60\text{ A}$                         | -    | 1.75 | 2.0  |               |
|  |               | $I_F = 50\text{ A}$ , $T_J = 125\text{ °C}$ | -    | 1.44 | -    |               |
|  |               | $I_F = 60\text{ A}$ , $T_J = 125\text{ °C}$ | -    | 1.55 | -    |               |
|  |               | $I_F = 50\text{ A}$ , $T_J = 150\text{ °C}$ | -    | 1.39 | -    |               |
| Reverse leakage current  | $I_R$         | $V_R = V_R$ rated                           | -    | -    | 50   | $\mu\text{A}$ |
|  |               | $T_J = 125\text{ °C}$ , $V_R = V_R$ rated   | -    | -    | 500  |               |
| Junction capacitance   | $C_T$         | $V_R = 600\text{ V}$                        | -    | 30   | -    | pF            |



| <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  | $t_{rr}$  | $T_J = 25\text{ }^\circ\text{C}$  | $I_F = 60\text{ A}$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}$<br>$V_R = 400\text{ V}$ | -    | 68   | -    | ns    |
|  |           | $T_J = 125\text{ }^\circ\text{C}$ |  | -    | 92   | -    |       |
| Peak recovery current  | $I_{RRM}$ | $T_J = 25\text{ }^\circ\text{C}$  |  | -    | 20   | -    | A     |
|  |           | $T_J = 125\text{ }^\circ\text{C}$ |  | -    | 40   | -    |       |
| Reverse recovery charge  | $Q_{rr}$  | $T_J = 25\text{ }^\circ\text{C}$  |  | -    | 945  | -    | nC    |
|  |           | $T_J = 125\text{ }^\circ\text{C}$ |  | -    | 2500 | -    |       |

| <b>THERMAL - MECHANICAL SPECIFICATIONS</b> |            |  |  |            |      |            |                           |
|--|------------|--|--|------------|------|------------|---------------------------|
| PARAMETER                                  | SYMBOL     | TEST CONDITIONS                            |  | MIN.       | TYP. | MAX.       | UNITS                     |
| Thermal resistance, junction to case       | $R_{thJC}$ |  |  | -          | -    | 0.6        | $^\circ\text{C}/\text{W}$ |
| Thermal resistance, case to heat sink      | $R_{thCS}$ | Mounting surface, flat, smooth and greased |  | -          | 0.25 | -          |                           |
| Weight                                     |            |  |  | -          | 6.0  | -          | g                         |
|  |            |  |  | -          | 0.21 | -          | oz.                       |
| Mounting torque                            |            |  |  | 6.0<br>(5) | -    | 12<br>(20) | kgf · cm<br>(lbf · in)    |
| Marking device                             |            | Case style TO-247AD 2L                     |  | E4PH6006LH |      |            |                           |

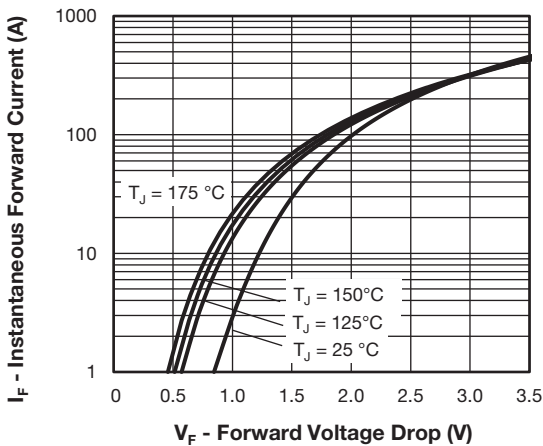


Fig. 1 - Typical Forward Voltage Drop Characteristics

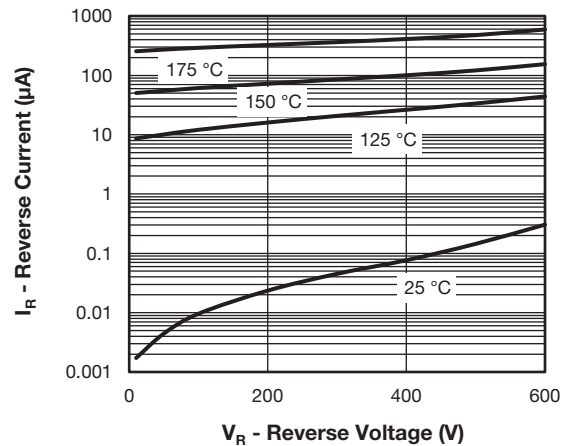


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

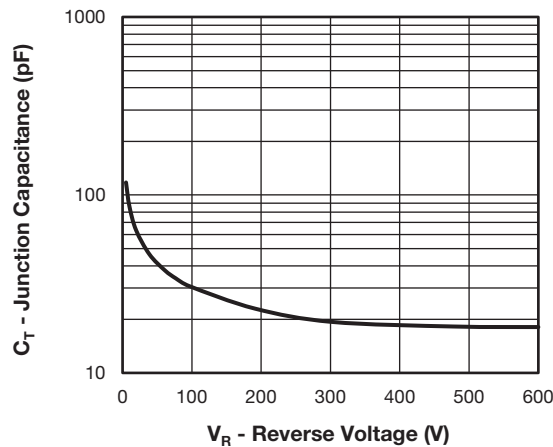


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

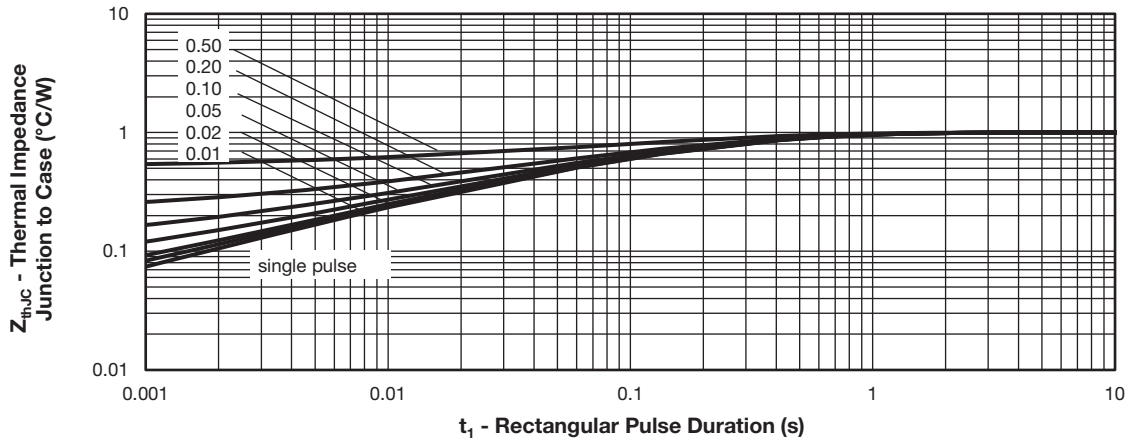


Fig. 4 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics

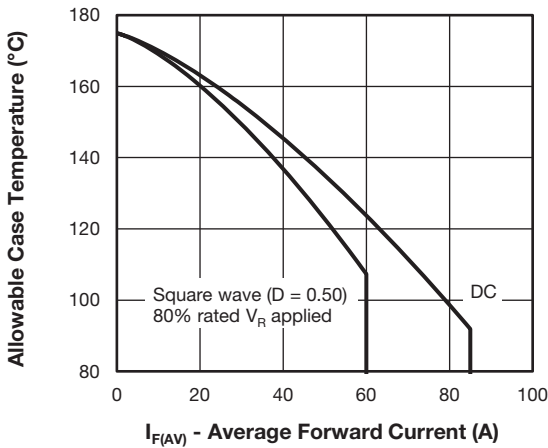


Fig. 5 - Max. Allowable Case Temperature vs. Average Forward Current

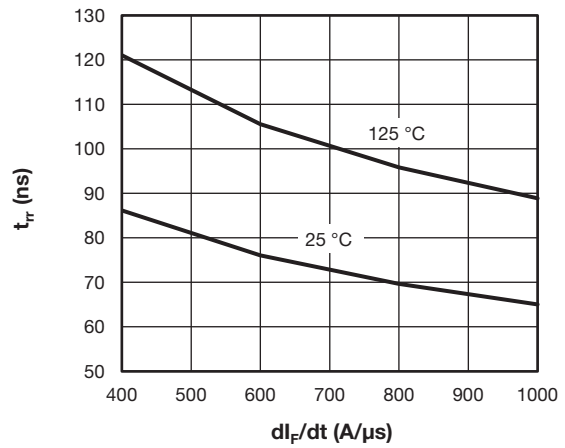


Fig. 7 - Typical Reverse Recovery Time vs.  $dI_F/dt$

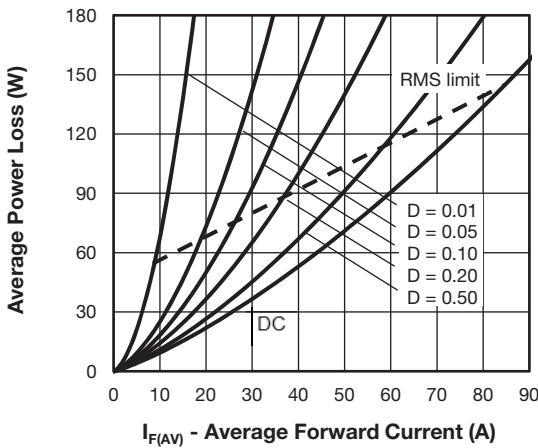


Fig. 6 - Forward Power Loss Characteristics

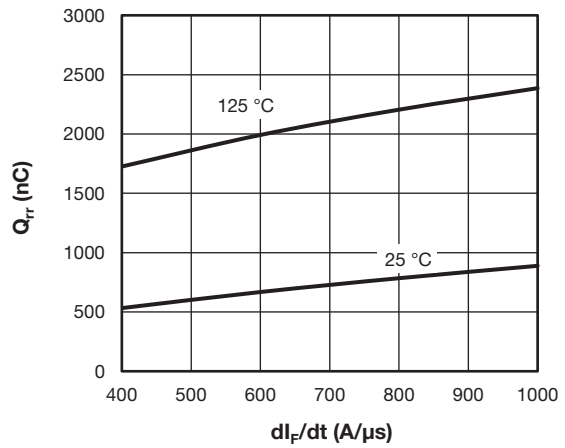


Fig. 8 - Typical Stored Charge vs.  $dI_F/dt$

**Note**

- (1) Formula used:  $T_C = T_J - (P_d + P_{dREV}) \times R_{thJC}$ ;  
 $P_d$  = Forward power loss =  $I_{F(AV)} \times V_{FM}$  at  $(I_{F(AV)}/D)$  (see Fig.5)  
 $P_{dREV}$  = Inverse power loss =  $V_{R1} \times I_R (1 - D)$ ;  $I_R$  at  $V_R$  = rated  $V_R$

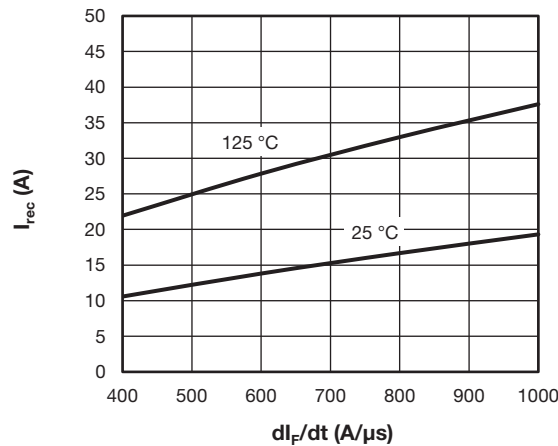


Fig. 9 - Typical Reverse Recovery vs. diF/dt

**ORDERING INFORMATION TABLE**

|             |            |          |          |          |          |           |           |          |          |           |
|-------------|------------|----------|----------|----------|----------|-----------|-----------|----------|----------|-----------|
| Device code | <b>VS-</b> | <b>E</b> | <b>4</b> | <b>P</b> | <b>H</b> | <b>60</b> | <b>06</b> | <b>L</b> | <b>H</b> | <b>N3</b> |
|             | ①          | ②        | ③        | ④        | ⑤        | ⑥         | ⑦         | ⑧        | ⑨        | ⑩         |

- 1** - Vishay Semiconductors product
- 2** - Circuit configuration:  
E = single diode 2 pins
- 3** - FRED Gen 4
- 4** - P = TO-247 package
- 5** - Process type:  
H = Hyperfast recovery
- 6** - Current rating (60 = 60 A)
- 7** - Voltage rating (06 = 600 V)
- 8** - L = long lead
- 9** - H = AEC-Q101 qualified
- 10** - Environmental digit:  
N3 = halogen-free, RoHS-compliant, and totally lead (Pb)-free

| <b>ORDERING INFORMATION</b> (Example) |                   |                        |                         |
|---------------------------------------|-------------------|------------------------|-------------------------|
| PREFERRED P/N                         | QUANTITY PER TUBE | MINIMUM ORDER QUANTITY | PACKAGING DESCRIPTION   |
| VS-E4PH6006LHN3                       | 25                | 500                    | Antistatic plastic tube |

| <b>LINKS TO RELATED DOCUMENTS</b> |             |  |
|-----------------------------------|-------------|--|
| Dimensions                        | TO-247AD 2L | <a href="http://www.vishay.com/doc?95536">www.vishay.com/doc?95536</a> |
| Part marking information          | TO-247AD 2L | <a href="http://www.vishay.com/doc?95648">www.vishay.com/doc?95648</a> |

### TO-247AD 2L

**DIMENSIONS** in millimeters and inches



| SYMBOL | MILLIMETERS |       | INCHES |       | NOTES | SYMBOL           | MILLIMETERS |       | INCHES    |       | NOTES |
|--------|-------------|-------|--------|-------|-------|------------------|-------------|-------|-----------|-------|-------|
|        | MIN.        | MAX.  | MIN.   | MAX.  |       |                  | MIN.        | MAX.  | MIN.      | MAX.  |       |
| A      | 4.65        | 5.31  | 0.183  | 0.209 |       | E                | 15.29       | 15.87 | 0.602     | 0.625 | 3     |
| A1     | 2.21        | 2.59  | 0.087  | 0.102 |       | E1               | 13.46       | -     | 0.53      | -     |       |
| A2     | 1.50        | 2.49  | 0.059  | 0.098 |       | e                | 5.46 BSC    |       | 0.215 BSC |       |       |
| b      | 0.99        | 1.40  | 0.039  | 0.055 |       | $\varnothing K$  | 0.254       |       | 0.010     |       |       |
| b1     | 0.99        | 1.35  | 0.039  | 0.053 |       | L                | 19.81       | 20.32 | 0.780     | 0.800 |       |
| b2     | 1.65        | 2.39  | 0.065  | 0.094 |       | L1               | 3.71        | 4.29  | 0.146     | 0.169 |       |
| b3     | 1.65        | 2.34  | 0.065  | 0.092 |       | $\varnothing P$  | 3.56        | 3.66  | 0.14      | 0.144 |       |
| c      | 0.38        | 0.89  | 0.015  | 0.035 |       | $\varnothing P1$ | -           | 6.98  | -         | 0.275 |       |
| c1     | 0.38        | 0.84  | 0.015  | 0.033 |       | Q                | 5.31        | 5.69  | 0.209     | 0.224 |       |
| D      | 19.71       | 20.70 | 0.776  | 0.815 | 3     | R                | 4.52        | 5.49  | 0.178     | 0.216 |       |
| D1     | 13.08       | -     | 0.515  | -     | 4     | S                | 5.51 BSC    |       | 0.217 BSC |       |       |
| D2     | 0.51        | 1.35  | 0.020  | 0.053 |       |                  |             |       |           |       |       |

**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)  $\varnothing P$  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<sup>®</sup> outline TO-247 with exception of dimension A min., D, E min., Q min., S, and note 4



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