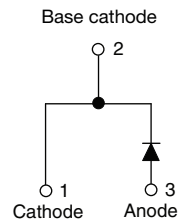
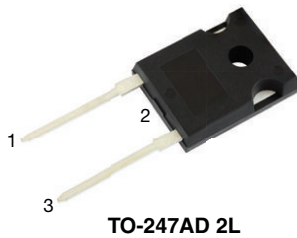


## Hyperfast Rectifier, 60 A FRED Pt® G5



### 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
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### PRIMARY CHARACTERISTICS

|                          |             |
|--------------------------|-------------|
| $I_{F(AV)}$              | 60 A        |
| $V_R$                    | 1200 V      |
| $V_F$ at $I_F$ at 125 °C | 1.7 V       |
| $t_{rr}$                 | 38 ns       |
| $T_J$ 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 high frequency converters, both soft switched / resonant. Specifically designed to improve efficiency of PFC and output rectification stages of EV / HEV battery charging stations, booster stage of solar inverters and UPS applications, these devices are perfectly matched to operate with MOSFETs or high speed IGBTs.

### ABSOLUTE MAXIMUM RATINGS

| PARAMETER                                  | SYMBOL            | TEST CONDITIONS  | VALUES      | UNITS |
|--|-------------------|--|-------------|-------|
| Repetitive peak reverse voltage            | $V_{RRM}$         |  | 1200        | V     |
| Average rectified forward current          | $I_{F(AV)}$       | $T_C = 115\text{ °C}$ , $D = 0.50$                       | 60          | A     |
| Non-repetitive peak surge current          | $I_{FSM}$         | $T_C = 45\text{ °C}$ , $t_p = 10\text{ ms}$ , sine wave  | 460         |       |
| Repetitive peak forward current            | $I_{FRM}$         | $T_C = 115\text{ °C}$ , $D = 0.50$ , $f = 20\text{ kHz}$ | 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 | $V_{BR}$ , $V_R$ | $I_R = 100\text{ }\mu\text{A}$              | 1200 | -    | -    | V             |
| Forward voltage                     | $V_F$            | $I_F = 60\text{ A}$                         | -    | 1.9  | 2.3  |               |
|                                     |                  | $I_F = 60\text{ A}$ , $T_J = 125\text{ °C}$ | -    | 1.7  | -    |               |
| 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                | $C_T$            | $V_R = 200\text{ V}$                        | -    | 32   | -    | pF            |
| Series inductance                   | $L_S$            | Measured to lead 5 mm from package body     | -    | 8    | -    | nH            |



| DYNAMIC RECOVERY CHARACTERISTICS (T <sub>J</sub> = 25 °C unless otherwise specified) |                  |   |      |      |      |       |
|--|------------------|---|------|------|------|-------|
| PARAMETER  | SYMBOL           | TEST CONDITIONS   | MIN. | TYP. | MAX. | UNITS |
| Reverse recovery time  | t <sub>rr</sub>  | I <sub>F</sub> = 1.0 A, di <sub>F</sub> /dt = 100 A/μs, V <sub>R</sub> = 30 V | -    | 38   | -    | ns    |
|  |                  | T <sub>J</sub> = 25 °C  | -    | 130  | -    |       |
|  |                  | T <sub>J</sub> = 125 °C   | -    | 200  | -    |       |
| Peak recovery current  | I <sub>RRM</sub> | T <sub>J</sub> = 25 °C  | -    | 22   | -    | A     |
|  |                  | T <sub>J</sub> = 125 °C   | -    | 39   | -    |       |
| Reverse recovery charge  | Q <sub>rr</sub>  | T <sub>J</sub> = 25 °C  | -    | 1610 | -    | nC    |
|  |                  | T <sub>J</sub> = 125 °C   | -    | 4080 | -    |       |
| Reverse recovery time  | t <sub>rr</sub>  | T <sub>J</sub> = 25 °C  | -    | 100  | -    | ns    |
|  |                  | T <sub>J</sub> = 125 °C   | -    | 153  | -    |       |
| Peak recovery current  | I <sub>RRM</sub> | T <sub>J</sub> = 25 °C  | -    | 40   | -    | A     |
|  |                  | T <sub>J</sub> = 125 °C   | -    | 67   | -    |       |
| Reverse recovery charge  | Q <sub>rr</sub>  | T <sub>J</sub> = 25 °C  | -    | 2590 | -    | nC    |
|  |                  | T <sub>J</sub> = 125 °C   | -    | 6150 | -    |       |

| THERMAL - MECHANICAL SPECIFICATIONS            |                                   |                        |              |      |            |                        |
|--|-----------------------------------|------------------------|--------------|------|------------|------------------------|
| PARAMETER                                      | SYMBOL                            | TEST CONDITIONS        | MIN.         | TYP. | MAX.       | UNITS                  |
| Thermal resistance, junction-to-case           | R <sub>thJC</sub>                 |                        | -            | -    | 0.4        | °C/W                   |
| Weight   |                                   |                        | -            | 5.5  | -          | g                      |
|  |                                   |                        | -            | 0.2  | -          | oz.                    |
| Mounting torque                                |                                   |                        | 6.0<br>(5.0) | -    | 12<br>(10) | kgf · cm<br>(lbf · in) |
| Maximum junction and storage temperature range | T <sub>J</sub> , T <sub>Stg</sub> |                        | -55          | -    | 175        | °C                     |
| Marking device                                 |                                   | Case style TO-247AD 2L | E5PH6012L    |      |            |                        |

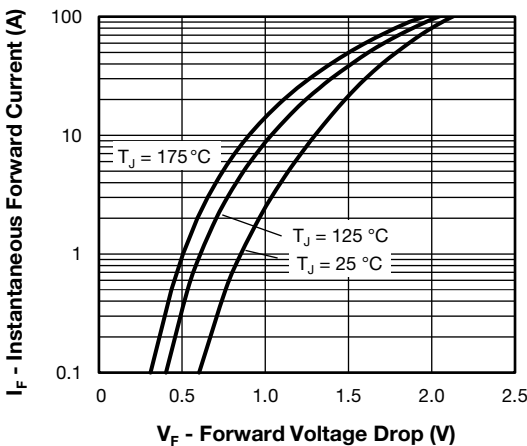


Fig. 1 - Typical Forward Voltage Drop Characteristics

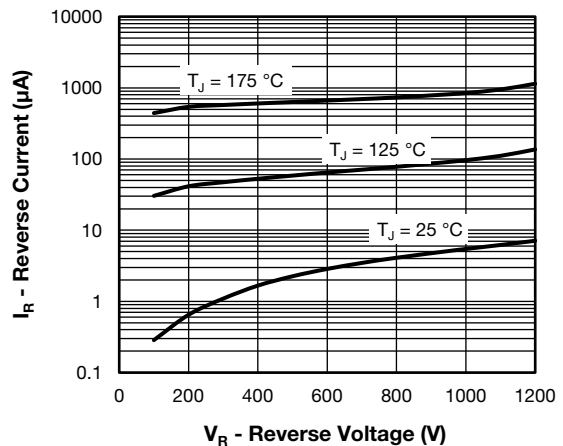


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

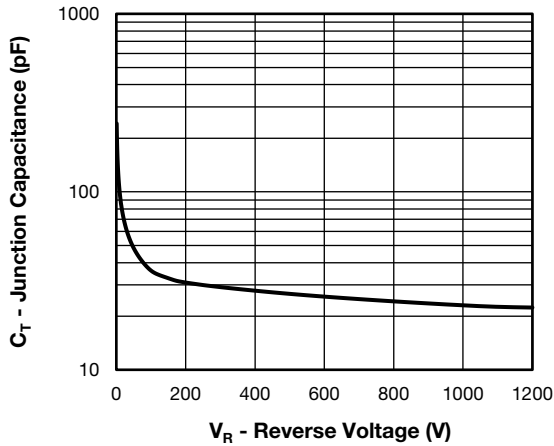


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

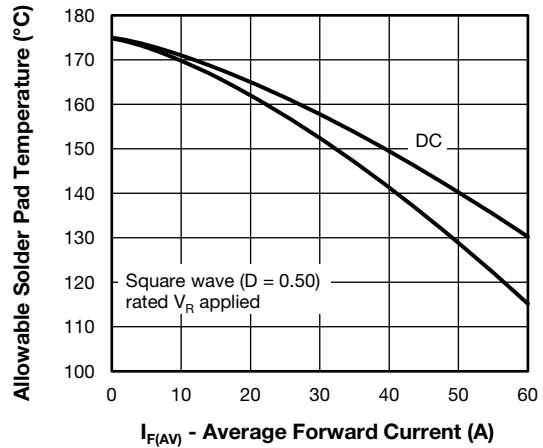


Fig. 4 - Maximum Allowable Case Temperature vs. Average Forward Current

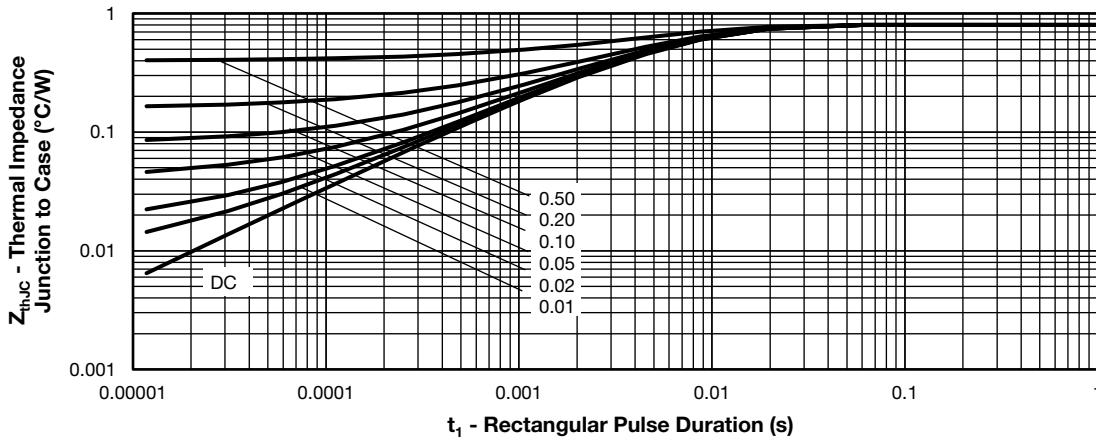


Fig. 5 - Thermal Impedance  $Z_{thJC}$  Characteristics

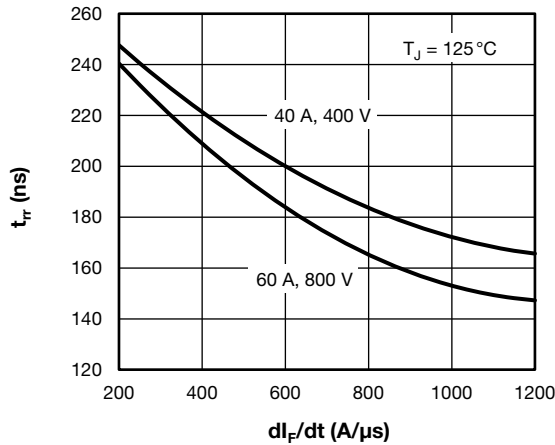


Fig. 6 - Typical Reverse Recovery Time vs.  $di_F/dt$

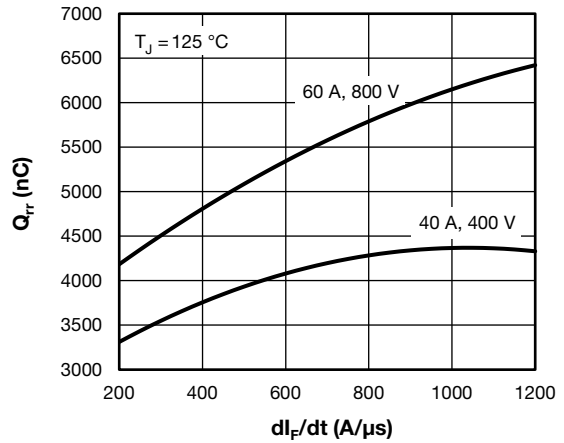


Fig. 7 - Typical Stored Charge vs.  $di_F/dt$

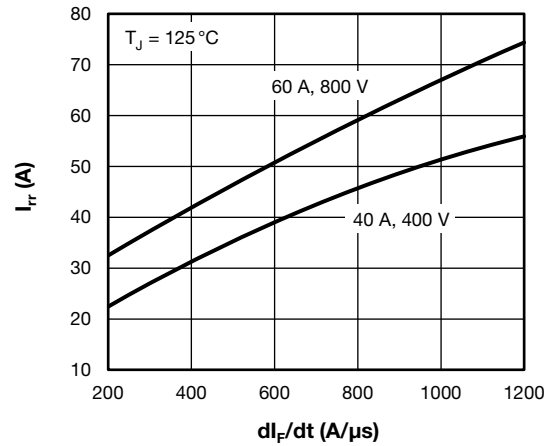


Fig. 8 - Typical Recovery Current vs.  $di_F/dt$

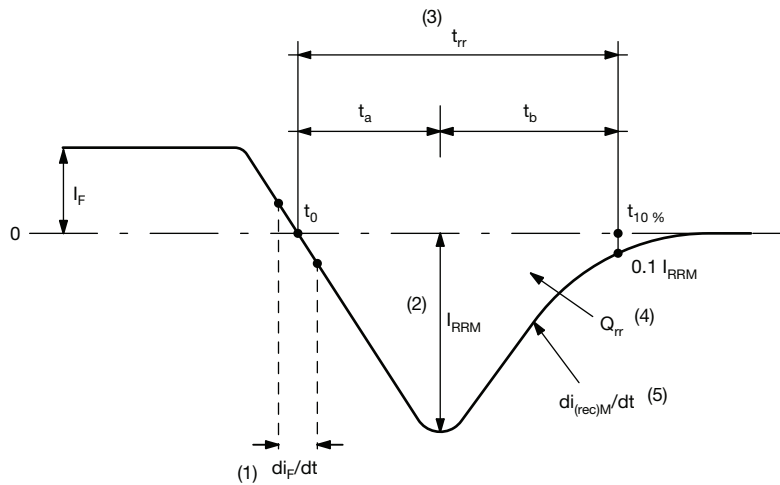


Fig. 9 - Reverse Recovery Waveform and Definitions

**Notes**

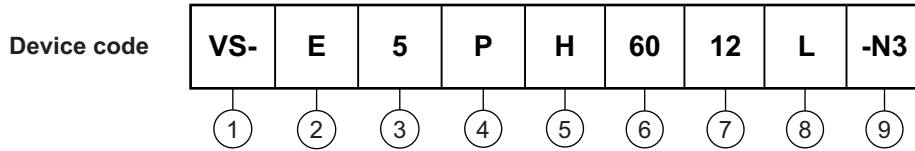
- (1)  $di_F/dt$  - rate of change of current through zero crossing
- (2)  $I_{RRM}$  - peak reverse recovery current
- (3)  $t_{rr}$  - reverse recovery time measured from  $t_0$ , crossing point of negative going  $I_F$ , to point  $t_{10\%}$ ,  $0.1 I_{RRM}$
- (4)  $Q_{rr}$  - area under curve defined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



- 1** - Vishay Semiconductors product
- 2** - E = single diode
- 3** - 5 = Fred generation 5
- 4** - Package:  
P = TO-247 package
- 5** - H = hyperfast recovery
- 6** - Current rating (60 = 60 A)
- 7** - Voltage rating (12 = 1200 V)
- 8** - Package: L = long lead (TO-247AD)
- 9** - 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-E5PH6012L-N3                | 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> |



# 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 |       | Ø 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 |       | Ø P    | 3.56        | 3.66  | 0.14      | 0.144 |       |
| c      | 0.38        | 0.89  | 0.015  | 0.035 |       | Ø 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) Ø 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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