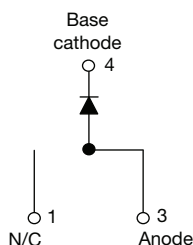


# Hyperfast Rectifier, 20 A FRED Pt® G5


**D²PAK 2L (TO-263AB 2L)**


## FEATURES

- Minimum creepage and clearance distances are 5.2 mm and 5.4 mm respectively
- 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
- Meets MSL level 1, per J-STD-020, LF maximum peak of 245 °C
- 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  |                        |
|--------------------------|------------------------|
| $I_{F(AV)}$              | 20 A                   |
| $V_R$                    | 1200 V                 |
| $V_F$ at $I_F$ at 125 °C | 2.40 V                 |
| $t_{rr}$                 | 29 ns                  |
| $T_J$ max.               | 175 °C                 |
| Package                  | D²PAK 2L (TO-263AB 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.

## MECHANICAL DATA

**Case:** D²PAK 2L (TO-263AB 2L)

Molding compound meets UL 94 V-0 flammability rating

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

| ABSOLUTE MAXIMUM RATINGS                   |                   |                                                         |             |       |
|--------------------------------------------|-------------------|---------------------------------------------------------|-------------|-------|
| PARAMETER                                  | SYMBOL            | TEST CONDITIONS                                         | VALUES      | UNITS |
| Repetitive peak reverse voltage            | $V_{RRM}$         |                                                         | 1200        | V     |
| Average rectified forward current          | $I_{F(AV)}$       | $T_C = 88\text{ °C}$                                    | 20          | A     |
| Repetitive peak forward current            | $I_{FRM}$         | $T_C = 88\text{ °C}$ , $D = 0.50$ , $f = 20\text{ kHz}$ | 33          |       |
| Non-repetitive peak surge current          | $I_{FSM}$         | $T_C = 45\text{ °C}$ , $t_p = 10\text{ ms}$ , sine wave | 110         |       |
| 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                                                              | $V_F$            | $I_F = 20\text{ A}$                         | -    | 2.71 | 3.6  |               |
|                                                                              |                  | $I_F = 20\text{ A}$ , $T_J = 125\text{ °C}$ | -    | 2.40 | -    |               |
| 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                                                         | $C_T$            | $V_R = 200\text{ V}$                        | -    | 10   | -    | 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                                                                                    | $t_{rr}$  | $I_F = 1.0\text{ A}$ , $dI_F/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$ | -    | 29   | -    |       |
|                                                                                                          |           | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 115  | -    | ns    |
|                                                                                                          |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 170  | -    |       |
| Peak recovery current                                                                                    | $I_{RRM}$ | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 10   | -    | A     |
|                                                                                                          |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 16   | -    |       |
| Reverse recovery charge                                                                                  | $Q_{rr}$  | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 430  | -    | nC    |
|                                                                                                          |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 1045 | -    |       |
| Reverse recovery time                                                                                    | $t_{rr}$  | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 93   | -    | ns    |
|                                                                                                          |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 122  | -    |       |
| Peak recovery current                                                                                    | $I_{RRM}$ | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 21   | -    | A     |
|                                                                                                          |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 32   | -    |       |
| Reverse recovery charge                                                                                  | $Q_{rr}$  | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 850  | -    | nC    |
|                                                                                                          |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 2020 | -    |       |

| <b>THERMAL - MECHANICAL SPECIFICATIONS</b>     |                |                                                |            |      |      |                             |
|------------------------------------------------|----------------|------------------------------------------------|------------|------|------|-----------------------------|
| PARAMETER                                      | SYMBOL         | TEST CONDITIONS                                | MIN.       | TYP. | MAX. | UNITS                       |
| Thermal resistance, junction-to-case           | $R_{thJC}$     |                                                | -          | -    | 1.7  | $^{\circ}\text{C}/\text{W}$ |
| Weight                                         |                |                                                | -          | 2.0  | -    | g                           |
| Maximum junction and storage temperature range | $T_J, T_{Stg}$ |                                                | -55        | -    | 175  | $^{\circ}\text{C}$          |
| Marking device                                 |                | Case style D <sup>2</sup> PAK 2L (TO-263AB 2L) | E5TX2112SH |      |      |                             |

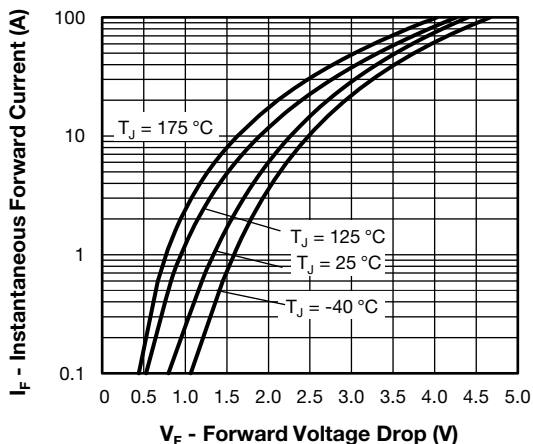


Fig. 1 - Forward Voltage Drop Characteristics

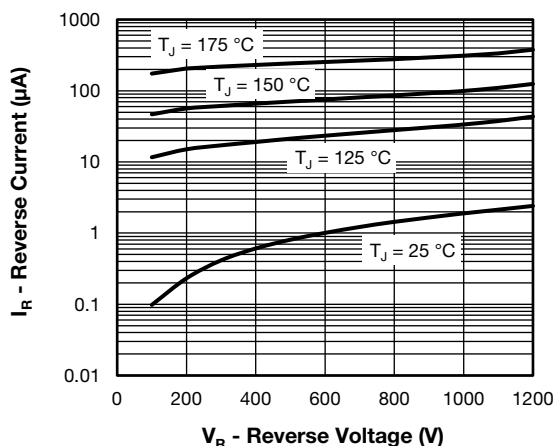


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

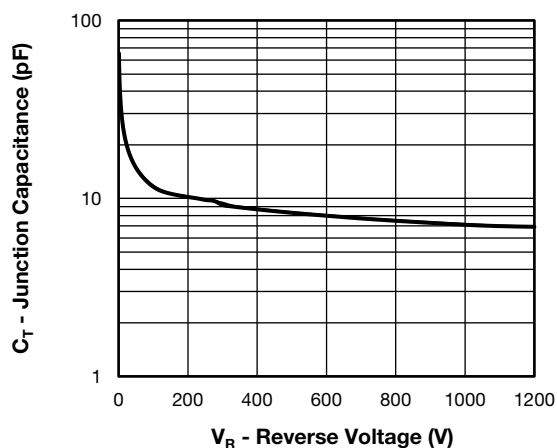


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

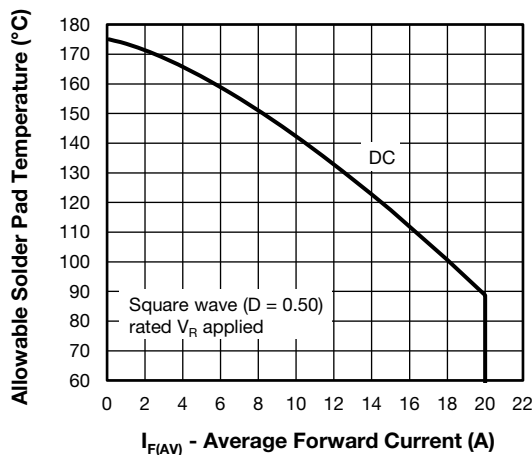


Fig. 4 - Maximum Allowable Case Temperature vs. Average Forward Current

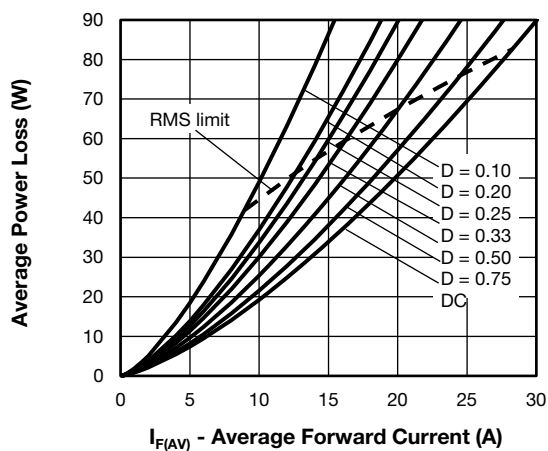


Fig. 5 - Forward Power Loss Characteristics

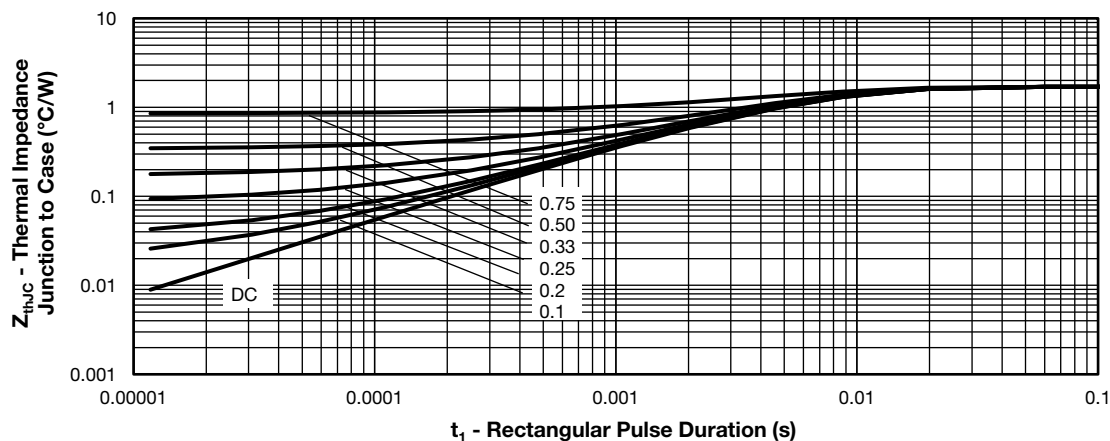
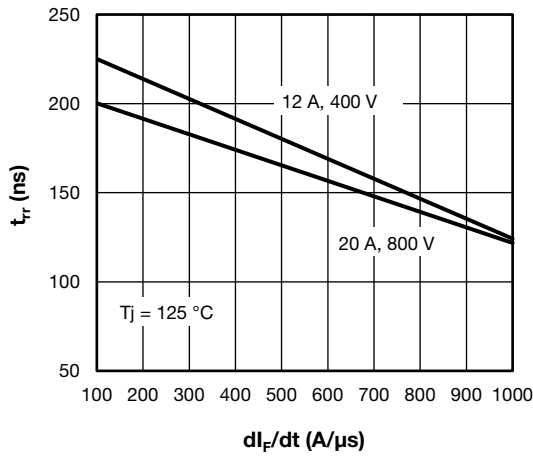
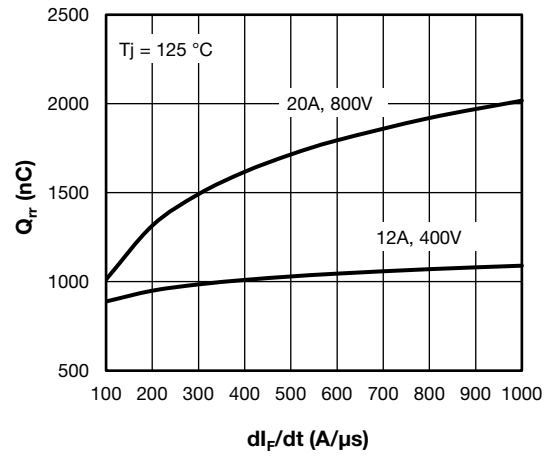
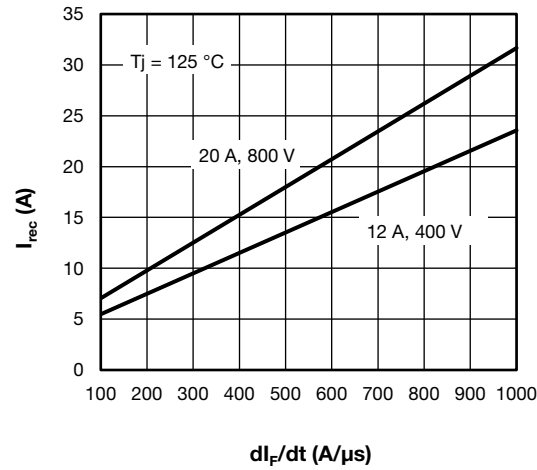


Fig. 6 - Transient Thermal Impedance, Junction to Case


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

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

Fig. 9 - Typical Stored Charge vs.  $dI_F/dt$

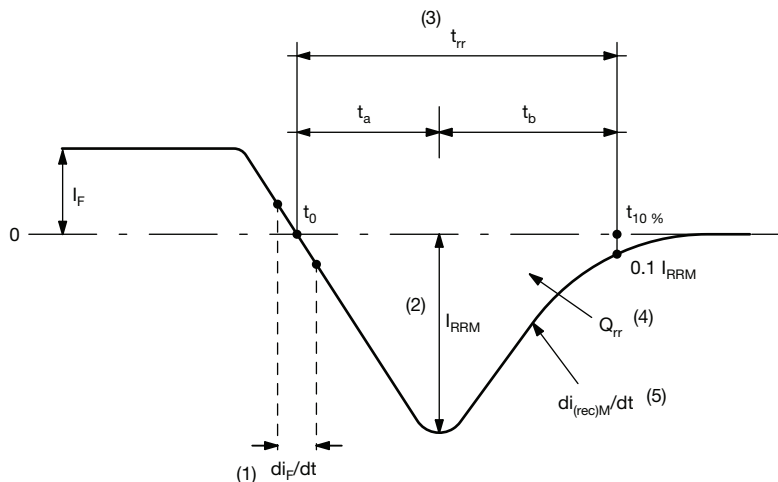


Fig. 10 - Reverse Recovery Waveform and Definitions

#### 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 | T | X | 21 | 12 | S2 | L | H  | M3 |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|----|----|----|---|----|----|
|             | 1                                                                                                                                                                     | 2 | 3 | 4 | 5 | 6  | 7  | 8  | 9 | 10 | 11 |
| 1           | - Vishay Semiconductors product                                                                                                                                       |   |   |   |   |    |    |    |   |    |    |
| 2           | - E = single diode                                                                                                                                                    |   |   |   |   |    |    |    |   |    |    |
| 3           | - 5 = FRED generation 5                                                                                                                                               |   |   |   |   |    |    |    |   |    |    |
| 4           | - Package:<br>T = TO-263 / D <sup>2</sup> PAK package                                                                                                                 |   |   |   |   |    |    |    |   |    |    |
| 5           | - X = hyperfast recovery                                                                                                                                              |   |   |   |   |    |    |    |   |    |    |
| 6           | - Current rating (21 = 20 A)                                                                                                                                          |   |   |   |   |    |    |    |   |    |    |
| 7           | - Voltage rating (12 = 1200 V)                                                                                                                                        |   |   |   |   |    |    |    |   |    |    |
| 8           | - S2 = true 2 pin D <sup>2</sup> PAK                                                                                                                                  |   |   |   |   |    |    |    |   |    |    |
| 9           | - None = tube (50 pieces)<br>• L = tape and reel (left oriented, for D <sup>2</sup> PAK package)<br>If needed different orientation/packaging, please contact factory |   |   |   |   |    |    |    |   |    |    |
| 10          | - H = AEC-Q101 qualified                                                                                                                                              |   |   |   |   |    |    |    |   |    |    |
| 11          | - Environmental digit:<br>M3 = halogen-free, RoHS-compliant, and termination lead (Pb)-free                                                                           |   |   |   |   |    |    |    |   |    |    |

**ORDERING INFORMATION** (Example)

| PREFERRED P/N     | BASE QUANTITY | PACKAGING DESCRIPTION |
|-------------------|---------------|-----------------------|
| VS-E5TX2112S2LHM3 | 800           | 13" diameter reel     |

**LINKS TO RELATED DOCUMENTS**

|                          |                                                                        |
|--------------------------|------------------------------------------------------------------------|
| Dimensions               | <a href="http://www.vishay.com/doc?96683">www.vishay.com/doc?96683</a> |
| Part marking information | <a href="http://www.vishay.com/doc?96693">www.vishay.com/doc?96693</a> |
| Packaging information    | <a href="http://www.vishay.com/doc?95032">www.vishay.com/doc?95032</a> |
| SPIICE Model             | <a href="http://www.vishay.com/doc?97159">www.vishay.com/doc?97159</a> |

### D<sup>2</sup>PAK 2L (TO-263AB 2L)

#### DIMENSIONS in millimeters and inches

Conforms to JEDEC® outline D<sup>2</sup>PAK (SMD-220)



| SYMBOL | MILLIMETERS |       | INCHES |       | NOTES |
|--------|-------------|-------|--------|-------|-------|
|        | MIN.        | MAX.  | MIN.   | MAX.  |       |
| A      | 4.06        | 4.83  | 0.160  | 0.190 |       |
| A1     | 0.00        | 0.254 | 0.000  | 0.010 |       |
| b      | 0.51        | 0.99  | 0.020  | 0.039 |       |
| b1     | 0.51        | 0.89  | 0.020  | 0.035 | 4     |
| b2     | 1.14        | 1.78  | 0.045  | 0.070 |       |
| b3     | 1.14        | 1.73  | 0.045  | 0.068 | 4     |
| c      | 0.38        | 0.74  | 0.015  | 0.029 |       |
| c1     | 0.38        | 0.58  | 0.015  | 0.023 | 4     |
| c2     | 1.14        | 1.65  | 0.045  | 0.065 |       |
| D      | 8.51        | 9.65  | 0.335  | 0.380 | 2     |

| SYMBOL | MILLIMETERS |       | INCHES    |       | NOTES |
|--------|-------------|-------|-----------|-------|-------|
|        | MIN.        | MAX.  | MIN.      | MAX.  |       |
| D1     | 6.86        | 8.00  | 0.270     | 0.315 | 3     |
| E      | 9.65        | 10.67 | 0.380     | 0.420 | 2, 3  |
| E1     | 7.90        | 8.80  | 0.311     | 0.346 | 3     |
| e      | 2.54 BSC    |       | 0.100 BSC |       |       |
| H      | 14.61       | 15.88 | 0.575     | 0.625 |       |
| L      | 1.78        | 2.79  | 0.070     | 0.110 |       |
| L1     | -           | 1.65  | -         | 0.066 | 3     |
| L3     | 0.25 BSC    |       | 0.010 BSC |       |       |
| L4     | 4.78        | 5.28  | 0.188     | 0.208 |       |

#### Notes

- (1) Dimensioning and tolerancing per ASME Y14.5 M-1994
- (2) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outmost extremes of the plastic body
- (3) Thermal pad contour optional within dimension E, L1, D1 and E1
- (4) Dimension b1 and c1 apply to base metal only
- (5) Datum A and B to be determined at datum plane H
- (6) Controlling dimension: inch
- (7) Outline conforms to JEDEC® outline TO-263AB



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