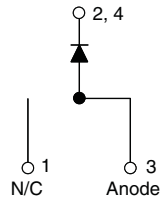


# HEXFRED<sup>®</sup> Ultrafast Soft Recovery Diode, 4 A



D-PAK (TO-252AA)


**FEATURES**

- Ultrafast recovery time
- Ultrasoft recovery
- Very low  $I_{RRM}$
- Very low  $Q_{rr}$
- Guaranteed avalanche
- Specified at operating temperature
- Compliant to RoHS Directive 2002/95/EC
- Meets MSL level 1, per J-STD-020, LF maximum peak of 260 °C


**RoHS**  
COMPLIANT

**BENEFITS**

- Reduced RFI and EMI
- Reduced power loss in diode and switching transistor
- Higher frequency operation
- Reduced snubbing
- Reduced parts count

**DESCRIPTION/APPLICATIONS**

These diodes are optimized to reduce losses and EMI/RFI in high frequency power conditioning systems. The softness of the recovery eliminates the need for a snubber in most applications. These devices are ideally suited for freewheeling, flyback, power converters, motor drives, and other applications where high speed and reduced switching losses are design requirements.

PRODUCT SUMMARY	
Package	D-PAK (TO-252AA)
$I_{F(AV)}$	4 A
$V_R$	600 V
$V_F$ at $I_F$	1.8 V
$t_{rr}$ typ.	17 ns
$T_J$ max.	150 °C
Diode variation	Single die

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	VALUES	UNITS
Cathode to anode voltage	$V_{RRM}$		600	V
Maximum continuous forward current	$I_{F(AV)}$	$T_C = 100$ °C	4	A
Single pulse forward current	$I_{FSM}$		25	
Repetitive peak forward current	$I_{FRM}$	$T_C = 116$ °C	16	
Maximum power dissipation	$P_D$	$T_C = 100$ °C	10	W
Operating junction and storage temperatures	$T_J, T_{Stg}$		- 55 to 150	°C

ELECTRICAL SPECIFICATIONS ( $T_J = 25$ °C unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Breakdown voltage, blocking voltage	$V_{BR}, V_R$	$I_R = 100$ $\mu$ A	600	-	-	V
Forward voltage See fig. 1	$V_F$	$I_F = 4$ A	-	1.5	1.8	
		$I_F = 8$ A	-	1.8	2.2	
Maximum reverse leakage current	$I_R$	$V_R = V_R$ rated	-	0.17	3.0	$\mu$ A
		$T_J = 125$ °C, $V_R = 0.8 \times V_R$ rated	-	44	300	
Junction capacitance	$C_T$	$V_R = 200$ V	-	4	8	pF
Series inductance	$L_S$	Measured lead to lead 5 mm from package body	-	8.0	-	nH



DYNAMIC RECOVERY CHARACTERISTICS (T <sub>C</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 = 200 A/μA, V <sub>R</sub> = 30 V	-	17	-	ns
		T <sub>J</sub> = 25 °C	-	28	42	
		T <sub>J</sub> = 125 °C	-	38	57	
Peak recovery current	I <sub>RRM</sub>	T <sub>J</sub> = 25 °C	-	2.9	5.2	A
		T <sub>J</sub> = 125 °C	-	3.7	6.7	
Reverse recovery charge	Q <sub>rr</sub>	T <sub>J</sub> = 25 °C	-	40	60	nC
		T <sub>J</sub> = 125 °C	-	70	105	
Rate of fall of recovery current	dI <sub>(rec)M</sub> /dt	T <sub>J</sub> = 25 °C	-	280	-	A/μs
		T <sub>J</sub> = 125 °C	-	235	-	

THERMAL - MECHANICAL SPECIFICATIONS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Maximum junction and storage temperature range	T <sub>J</sub> , T <sub>Stg</sub>		- 55	-	150	°C
Thermal resistance, junction to case	R <sub>thJC</sub>		-	-	5.0	°C/W
Thermal resistance, junction to ambient	R <sub>thJA</sub>	Typical socket mount	-	-	80	
Weight			-	2.0	-	g
			-	0.07	-	oz.
Mounting torque			6.0 (5.0)	-	12 (10)	kgf · cm (lbf · in)
Marking device		Case style D-PAK	HFA04SD60S			

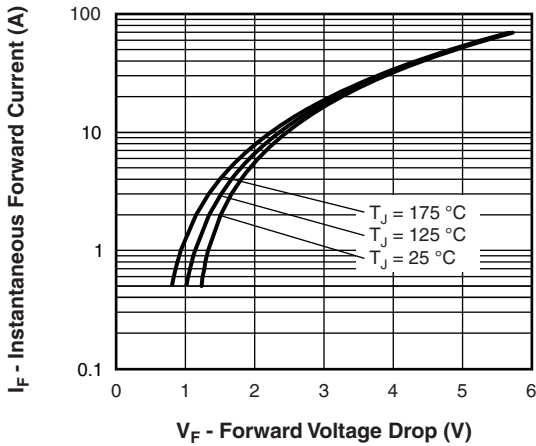


Fig. 1 - Typical Forward Voltage Drop Characteristics

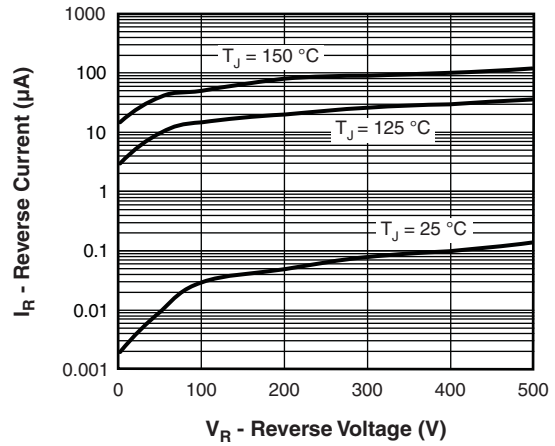


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

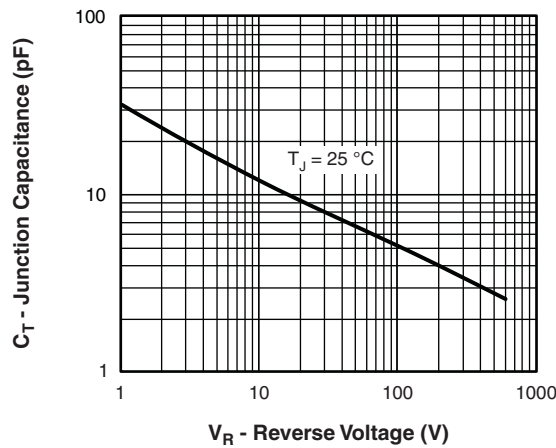


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

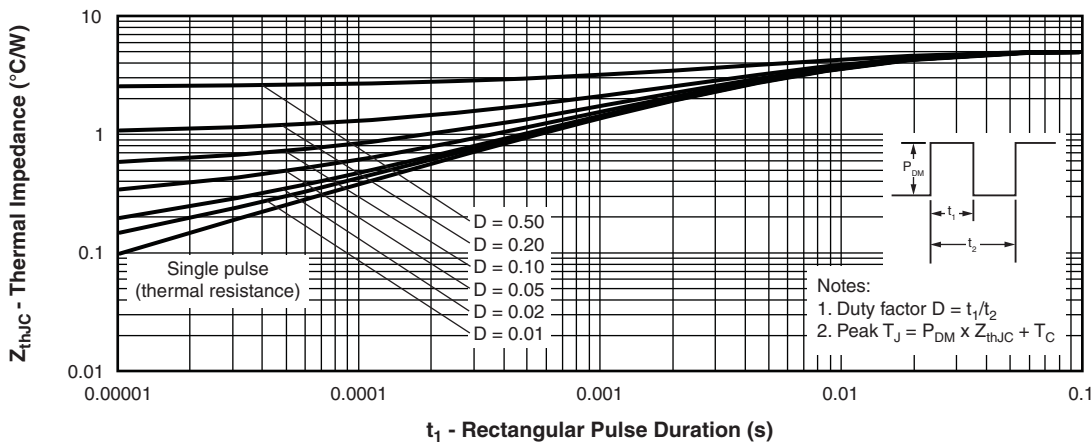


Fig. 4 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics

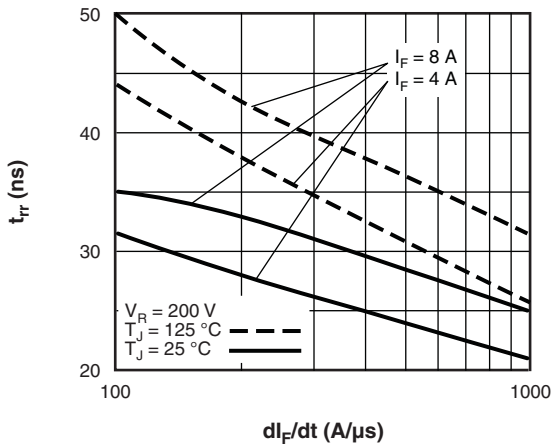


Fig. 5 - Typical Reverse Recovery Time vs.  $di_F/dt$

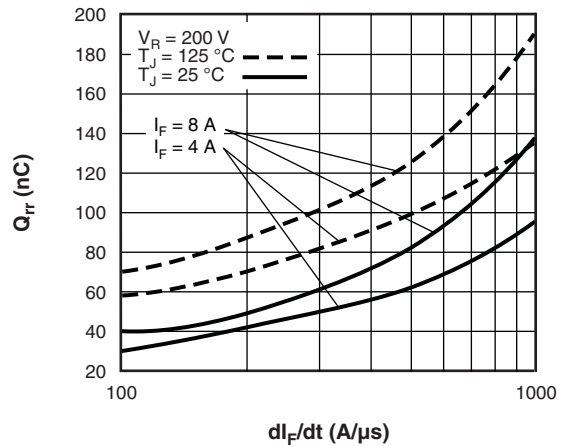


Fig. 7 - Typical Stored Charge vs.  $di_F/dt$

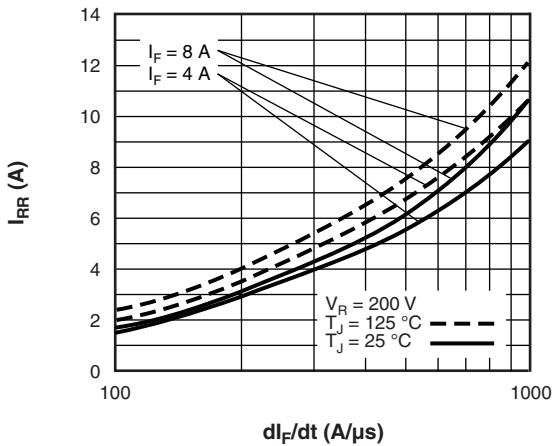


Fig. 6 - Typical Recovery Current vs.  $di_F/dt$

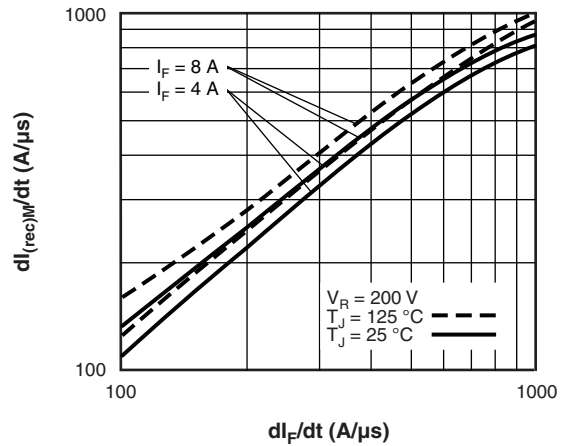


Fig. 8 - Typical  $di_{(rec)M}/dt$  vs.  $di_F/dt$

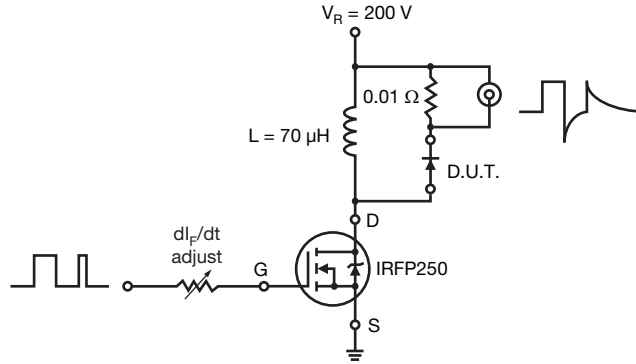
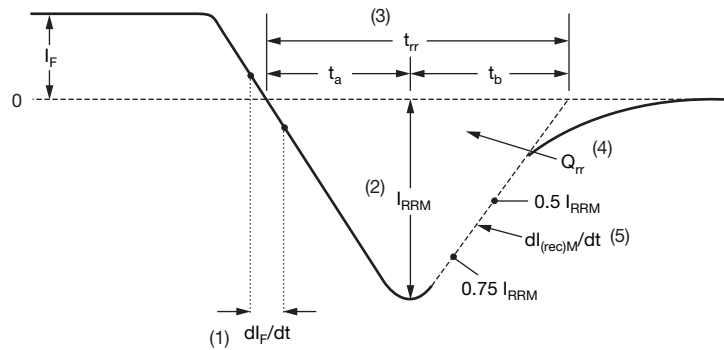


Fig. 9 - Reverse Recovery Parameter Test Circuit



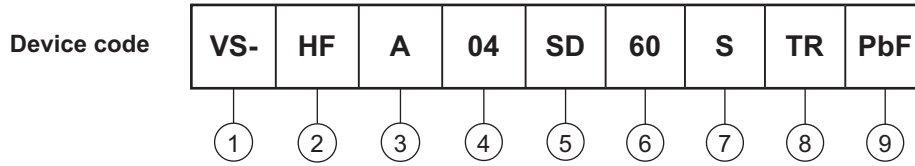
- (1)  $dl_F/dt$  - rate of change of current through zero crossing
- (2)  $I_{RRM}$  - peak reverse recovery current
- (3)  $t_{rr}$  - reverse recovery time measured from zero crossing point of negative going  $I_F$  to point where a line passing through  $0.75 I_{RRM}$  and  $0.50 I_{RRM}$  extrapolated to zero current.
- (4)  $Q_{rr}$  - area under curve defined by  $t_{rr}$  and  $I_{RRM}$
- (5)  $dl_{(rec)M}/dt$  - peak rate of change of current during  $t_b$  portion of  $t_{rr}$

$$Q_{rr} = \frac{t_{rr} \times I_{RRM}}{2}$$

Fig. 10 - Reverse Recovery Waveform and Definitions



## ORDERING INFORMATION TABLE

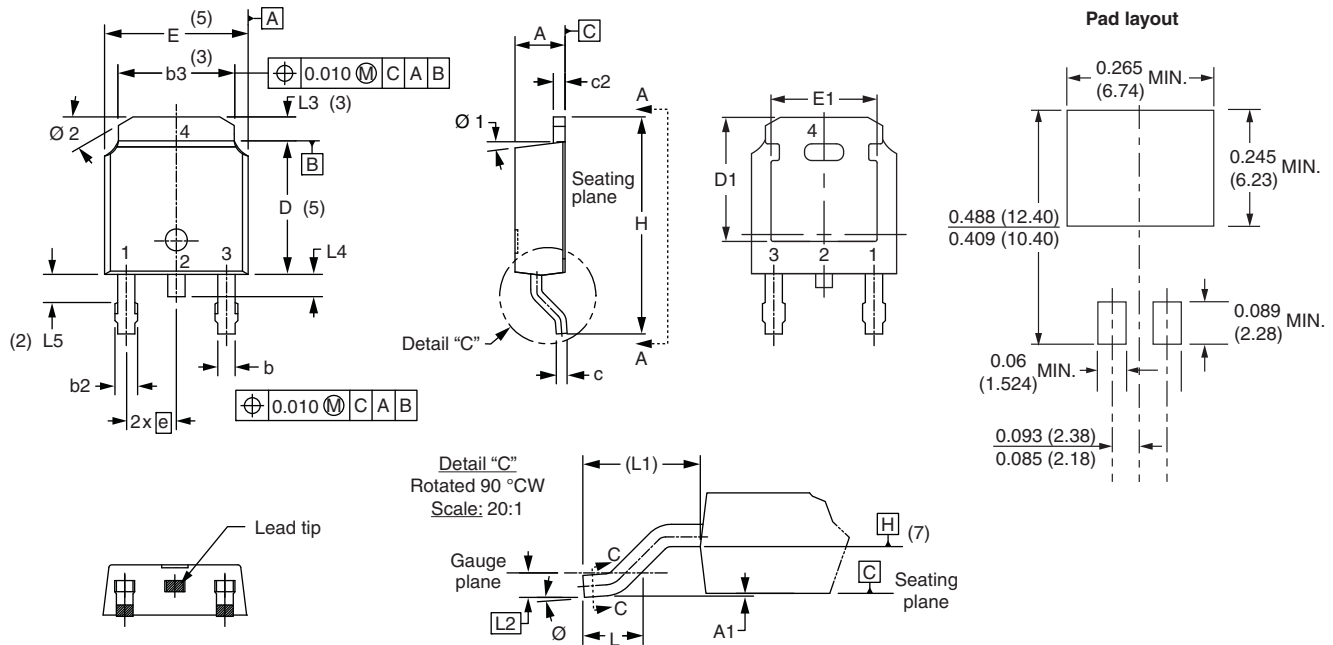


- 1** - Vishay Semiconductors product
- 2** - HEXFRED<sup>®</sup> family
- 3** - Electron irradiated
- 4** - Current rating (04 = 4 A)
- 5** - D-PAK
- 6** - Voltage rating (60 = 600 V)
- 7** - S = D-PAK
- 8** -
  - TR = Tape and reel
  - TRR = Tape and reel (right oriented)
  - TRL = Tape and reel (left oriented)
- 9** -
  - PbF = Lead (Pb)-free
  - P = Lead (Pb)-free (for TRR and TRL)

LINKS TO RELATED DOCUMENTS	
Dimensions	<a href="http://www.vishay.com/doc?95016">www.vishay.com/doc?95016</a>
Part marking information	<a href="http://www.vishay.com/doc?95059">www.vishay.com/doc?95059</a>
Packaging information	<a href="http://www.vishay.com/doc?95033">www.vishay.com/doc?95033</a>

### D-PAK (TO-252AA)

**DIMENSIONS** in millimeters and inches



SYMBOL	MILLIMETERS		INCHES		NOTES	SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.			MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	0.086	0.094		e	2.29 BSC		0.090 BSC		
A1	-	0.13	-	0.005		H	9.40	10.41	0.370	0.410	
b	0.64	0.89	0.025	0.035		L	1.40	1.78	0.055	0.070	
b2	0.76	1.14	0.030	0.045		L1	2.74 BSC		0.108 REF.		
b3	4.95	5.46	0.195	0.215	3	L2	0.51 BSC		0.020 BSC		
c	0.46	0.61	0.018	0.024		L3	0.89	1.27	0.035	0.050	3
c2	0.46	0.89	0.018	0.035		L4	-	1.02	-	0.040	
D	5.97	6.22	0.235	0.245	5	L5	1.14	1.52	0.045	0.060	2
D1	5.21	-	0.205	-	3	∅	0°	10°	0°	10°	
E	6.35	6.73	0.250	0.265	5	∅1	0°	15°	0°	15°	
E1	4.32	-	0.170	-	3	∅2	25°	35°	25°	35°	

**Notes**

- (1) Dimensioning and tolerancing as per ASME Y14.5M-1994
- (2) Lead dimension uncontrolled in L5
- (3) Dimension D1, E1, L3 and b3 establish a minimum mounting surface for thermal pad
- (4) Section C - C dimension apply to the flat section of the lead between 0.13 and 0.25 mm (0.005 and 0.10") from the lead tip
- (5) 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 outermost extremes of the plastic body
- (6) Dimension b1 and c1 applied to base metal only
- (7) Datum A and B to be determined at datum plane H
- (8) Outline conforms to JEDEC outline TO-252AA



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