

International  
**IR** Rectifier  
HEXFRED™

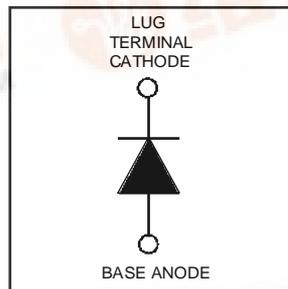
PD -2.455 rev. B 03/99

# HFA135NH40R

Ultrafast, Soft Recovery Diode

### Features

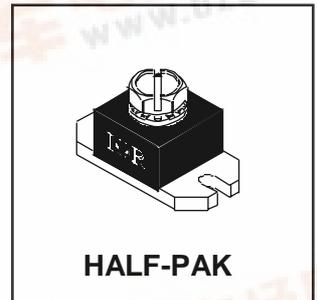
- Reduced RFI and EMI
- Reduced Snubbing
- Extensive Characterization of Recovery Parameters



|                                                             |
|-------------------------------------------------------------|
| $V_R = 400V$                                                |
| $V_F(\text{typ.})^{\textcircled{3}} = 1V$                   |
| $I_{F(AV)} = 135A$                                          |
| $Q_{rr}(\text{typ.}) = 290nC$                               |
| $I_{RRM}(\text{typ.}) = 7.5A$                               |
| $t_{rr}(\text{typ.}) = 50ns$                                |
| $di_{(rec)}/dt(\text{typ.})^{\textcircled{3}} = 270A/\mu s$ |

### Description

HEXFRED™ diodes are optimized to reduce losses and EMI/RFI in high frequency power conditioning systems. An extensive characterization of the recovery behavior for different values of current, temperature and di/dt simplifies the calculations of losses in the operating conditions. The softness of the recovery eliminates the need for a snubber in most applications. These devices are ideally suited for power converters, motors drives and other applications where switching losses are significant portion of the total losses.



### Absolute Maximum Ratings (per Leg)

|                           | Parameter                                        | Max.        | Units |
|---------------------------|--------------------------------------------------|-------------|-------|
| $V_R$                     | Cathode-to-Anode Voltage                         | 400         | V     |
| $I_F @ T_C = 25^\circ C$  | Continuous Forward Current                       | 211         | A     |
| $I_F @ T_C = 100^\circ C$ | Continuous Forward Current                       | 103         |       |
| $I_{FSM}$                 | Single Pulse Forward Current <sup>①</sup>        | 900         |       |
| $E_{AS}$                  | Non-Repetitive Avalanche Energy <sup>②</sup>     | 1.4         | mJ    |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                        | 379         | W     |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation                        | 152         |       |
| $T_J$<br>$T_{STG}$        | Operating Junction and Storage Temperature Range | -55 to +150 | °C    |

### Thermal - Mechanical Characteristics

|            | Parameter                           | Min.     | Typ.     | Max.     | Units           |
|------------|-------------------------------------|----------|----------|----------|-----------------|
| $R_{thJC}$ | Junction-to-Case                    | —        | —        | 0.33     | °CW             |
| $R_{thCS}$ | Case-to-Sink, Flat, Greased Surface | —        | 0.15     | —        | KW              |
| $Wt$       | Weight                              | —        | 26 (0.9) | —        | g (oz)          |
|            | Mounting Torque <sup>④</sup>        | 15 (1.7) | —        | 25 (2.8) | lbf·in<br>(N·m) |
|            | Terminal Torque                     | 30 (3.4) | —        | 40 (4.6) |                 |
|            | Vertical Pull                       | —        | —        | 80       | lbf·in          |
|            | 2 inch Lever Pull                   | —        | —        | 40       |                 |

**Note:** <sup>①</sup> Limited by junction temperature  
<sup>②</sup> L = 100μH, duty cycle limited by max  $T_J$   
<sup>③</sup> 125°C

<sup>④</sup> Mounting surface must be smooth, flat, free of burrs or other protrusions. Apply a thin even film of thermal grease to mounting surface. Gradually tighten each mounting bolt in 5-10 lbf·in steps until desired or maximum torque limits are reached. Module



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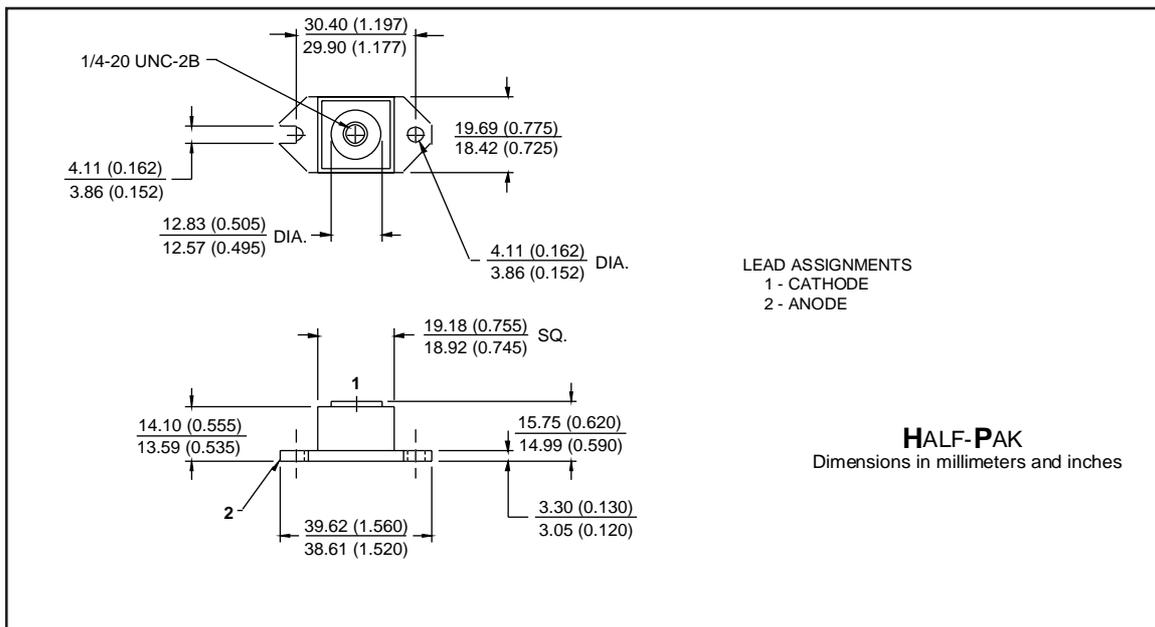
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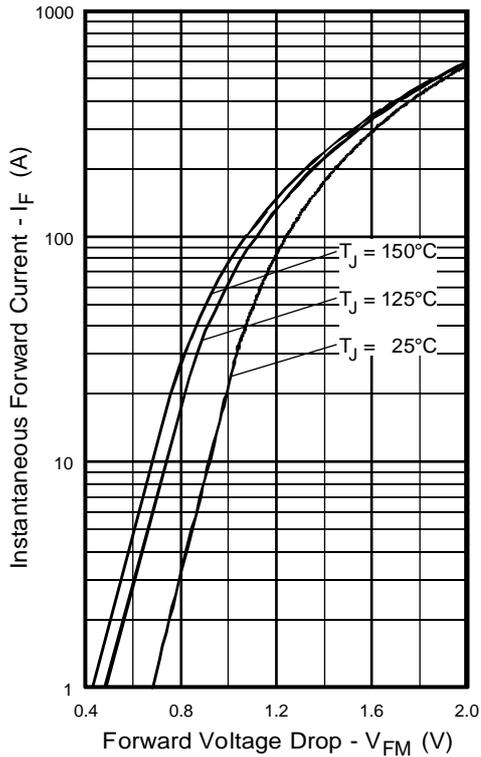
## Electrical Characteristics (per Leg) @ T<sub>J</sub> = 25°C (unless otherwise specified)

| Parameter                                                 | Min. | Typ. | Max. | Units | Test Conditions                               |
|-----------------------------------------------------------|------|------|------|-------|-----------------------------------------------|
| V <sub>BR</sub> Cathode Anode Breakdown Voltage           | 400  | —    | —    | V     | I <sub>R</sub> = 100μA                        |
| V <sub>FM</sub> Max Forward Voltage<br>See Fig. 1         | —    | 1.1  | 1.3  | V     | I <sub>F</sub> = 135A                         |
|                                                           | —    | 1.4  | 1.6  |       | I <sub>F</sub> = 270A                         |
|                                                           | —    | 1.0  | 1.2  |       | I <sub>F</sub> = 135A, T <sub>J</sub> = 125°C |
| I <sub>RM</sub> Max Reverse Leakage Current<br>See Fig. 2 | —    | 1.5  | 9.0  | μA    | V <sub>R</sub> = V <sub>R</sub> Rated         |
|                                                           | —    | 2.3  | 12   | mA    | T <sub>J</sub> = 125°C, V <sub>R</sub> = 320V |
| C <sub>T</sub> Junction Capacitance See Fig. 3            | —    | 280  | 380  | pF    | V <sub>R</sub> = 200V                         |
| L <sub>S</sub> Series Inductance                          | —    | 6.0  | —    | nH    | From top of terminal hole to mounting plane   |

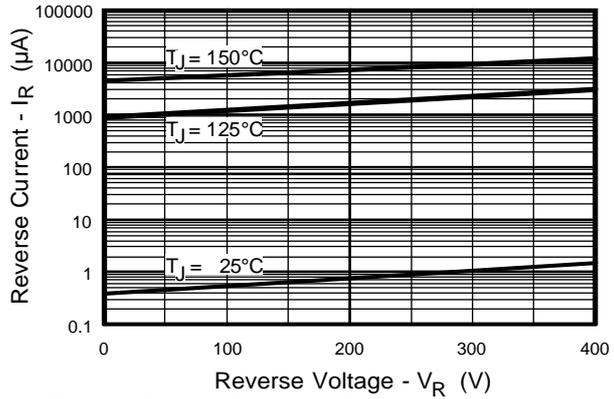
## Dynamic Recovery Characteristics (per Leg) @ T<sub>J</sub> = 25°C (unless otherwise specified)

| Parameter                                                       | Min. | Typ. | Max. | Units | Test Conditions                                                            |                        |
|-----------------------------------------------------------------|------|------|------|-------|----------------------------------------------------------------------------|------------------------|
| t <sub>rr</sub> Reverse Recovery Time                           | —    | 50   | —    | ns    | I <sub>F</sub> = 1.0A, di <sub>F</sub> /dt = 200A/μs, V <sub>R</sub> = 30V |                        |
| t <sub>rr1</sub> See Fig. 5                                     | —    | 77   | 120  |       |                                                                            | T <sub>J</sub> = 25°C  |
| t <sub>rr2</sub>                                                | —    | 290  | 440  |       |                                                                            | T <sub>J</sub> = 125°C |
| I <sub>RRM1</sub> Peak Recovery Current                         | —    | 7.5  | 14   | A     | I <sub>F</sub> = 135A                                                      |                        |
| I <sub>RRM2</sub> See Fig. 6                                    | —    | 16   | 30   |       |                                                                            | T <sub>J</sub> = 125°C |
| Q <sub>rr1</sub> Reverse Recovery Charge                        | —    | 290  | 780  | nC    | V <sub>R</sub> = 200V                                                      |                        |
| Q <sub>rr2</sub> See Fig. 7                                     | —    | 2300 | 6300 |       |                                                                            | T <sub>J</sub> = 125°C |
| di <sub>(rec)M</sub> /dt1 Peak Rate of Fall of Recovery Current | —    | 320  | —    | A/μs  | di <sub>F</sub> /dt = 200A/μs                                              |                        |
| di <sub>(rec)M</sub> /dt2 During t <sub>b</sub> See Fig. 8      | —    | 270  | —    |       |                                                                            | T <sub>J</sub> = 125°C |

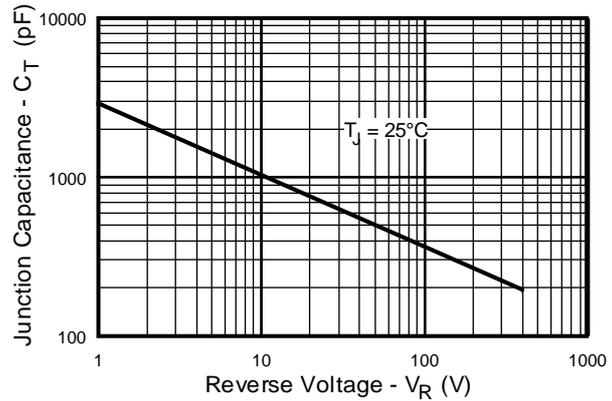




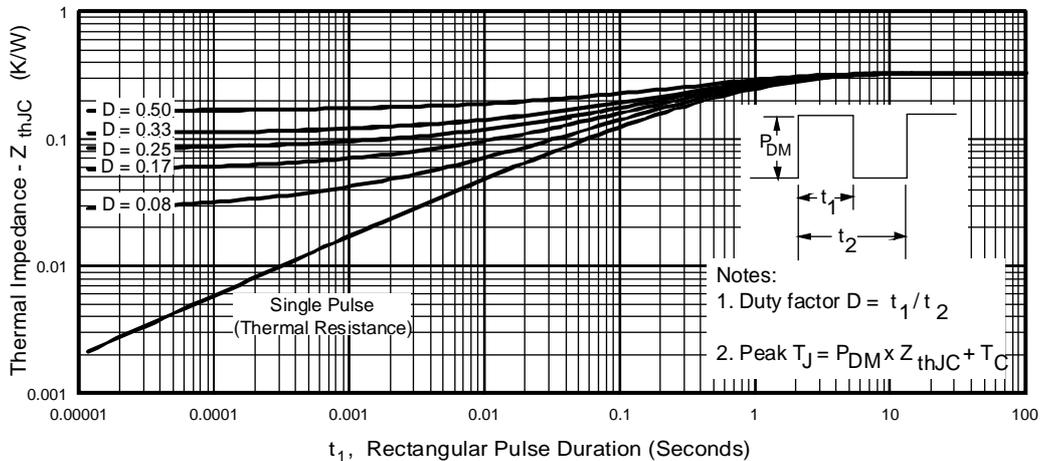
**Fig. 1** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



**Fig. 2** - Typical Reverse Current vs. Reverse Voltage



**Fig. 3** - Typical Junction Capacitance vs. Reverse Voltage



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

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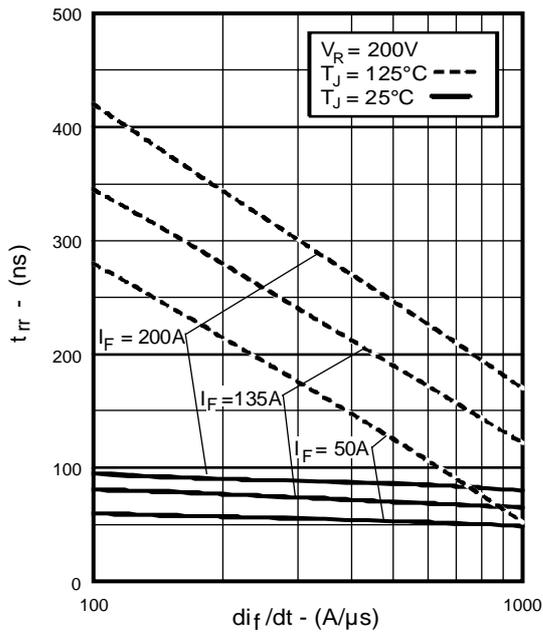


Fig. 5 - Typical Reverse Recovery vs.  $di_f/dt$

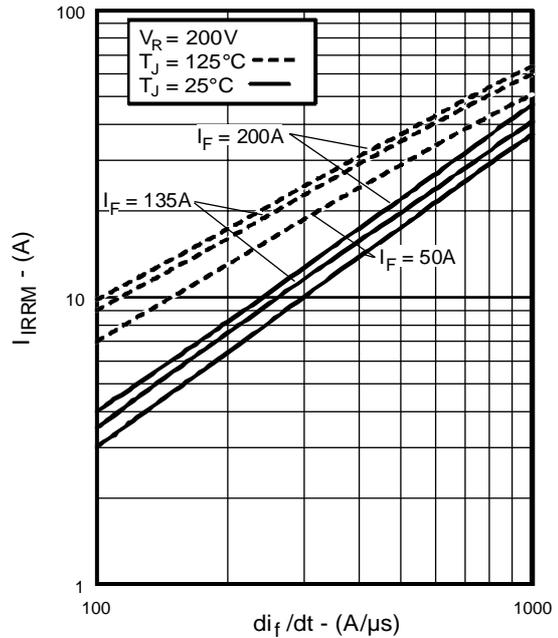


Fig. 6 - Typical Recovery Current vs.  $di_f/dt$

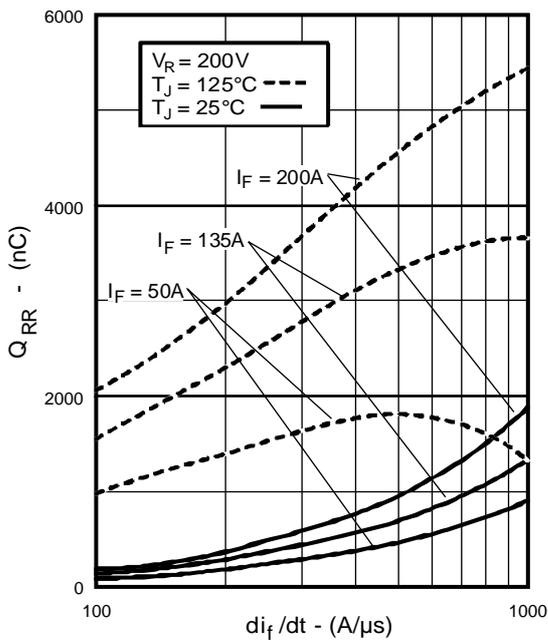


Fig. 7 - Typical Stored Charge vs.  $di_f/dt$

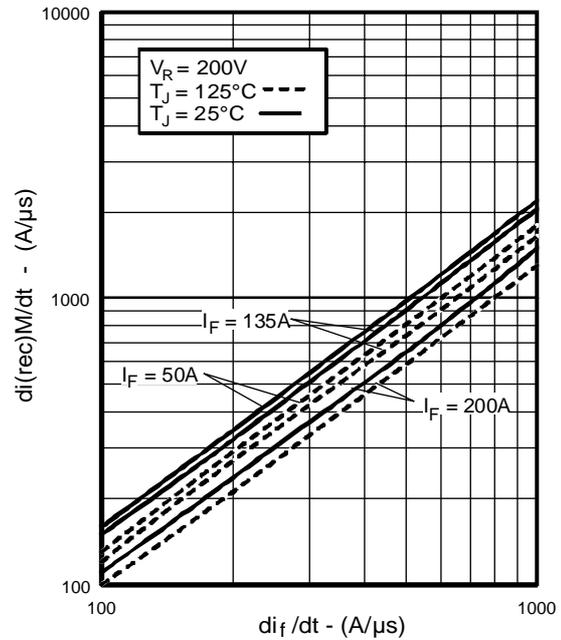
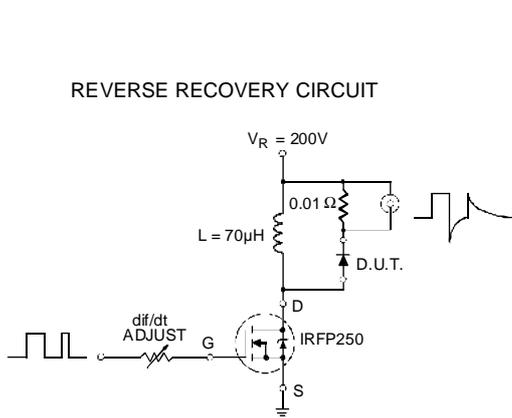
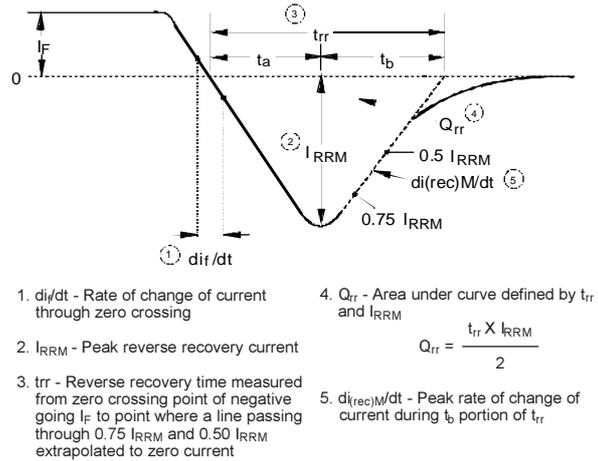


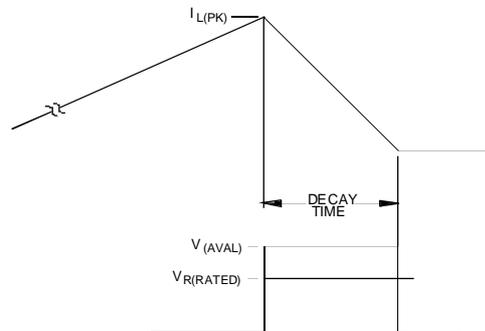
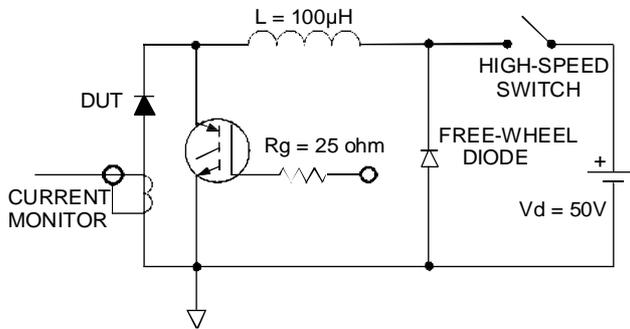
Fig. 8 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$



**Fig. 9 - Reverse Recovery Parameter Test Circuit**



**Fig. 10 - Reverse Recovery Waveform and Definitions**



**Fig. 11 - Avalanche Test Circuit and Waveforms**