Ultrafast Rectifier

**Features**
- Ultrafast Recovery Time
- Low Forward Voltage Drop
- Low Leakage Current
- 175°C Operating Junction Temperature

**Description/ Applications**
International Rectifier’s FRED.. series are the state of the art Ultra fast recovery rectifiers specifically designed with optimized performance of forward voltage drop and ultra fast recovery time. The planar structure and the platinum doped life time control, guarantee the best overall performance, ruggedness and reliability characteristics.

These devices are intended for use in the output rectification stage of SMPS, UPS, DC-DC converters as well as free-wheeling diode in low voltage inverters and chopper motor drives.

Their extremely optimized stored charge and low recovery current minimize the switching losses and reduce over dissipation in the switching element and snubbers.

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{RRM} Peak Repetitive Peak Reverse Voltage</td>
<td>400</td>
<td>V</td>
</tr>
<tr>
<td>I_{F(AV)} Average Rectified Forward Current Per Leg</td>
<td>8</td>
<td>A</td>
</tr>
<tr>
<td>Total Device, (Rated V_{R}), T_C = 155°C Total Device</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>I_{F(SM)} Non Repetitive Peak Surge Current, T_C = 25°C</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>I_{F(RM)} Peak Repetitive Forward Current (Rated V_{R}, Square wave, 20KHz), T_C = 155°C</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>T_J, T_{STG} Operating Junction and Storage Temperatures</td>
<td>-65 to 175</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Case Styles**

- **16CTU04**
  - TO-220AB

- **16CTU04S**
  - D²PAK

- **16CTU04-1**
  - TO-262

www.irf.com
## Electrical Characteristics @ T_J = 25°C, Per Leg (unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_BR, V_R</td>
<td></td>
<td></td>
<td>400</td>
<td>V</td>
<td>I_R = 100μA</td>
</tr>
<tr>
<td></td>
<td>1.19</td>
<td>1.3</td>
<td>V</td>
<td></td>
<td>I_F = 8A, VR = VR Rated</td>
</tr>
<tr>
<td></td>
<td>0.94</td>
<td>1.0</td>
<td>V</td>
<td></td>
<td>I_F = 8A, T_J = 150°C</td>
</tr>
<tr>
<td>I_R</td>
<td>0.2</td>
<td>10</td>
<td>μA</td>
<td></td>
<td>VR = VR Rated</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>500</td>
<td>μA</td>
<td></td>
<td>T_J = 150°C, VR = VR Rated</td>
</tr>
<tr>
<td>C_T</td>
<td>14</td>
<td></td>
<td>pF</td>
<td></td>
<td>VR = 400V</td>
</tr>
<tr>
<td>L_S</td>
<td>8.0</td>
<td></td>
<td>nH</td>
<td></td>
<td>Measured lead to lead 5mm from package body</td>
</tr>
</tbody>
</table>

## Dynamic Recovery Characteristics @ T_J = 25°C, Per Leg (unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_rr</td>
<td>35</td>
<td>60</td>
<td>ns</td>
<td></td>
<td>I_R = 1.0A, dI/dt = 50A/μA, VR = 30V T_J = 25°C</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td>VR = VR Rated</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td></td>
<td></td>
<td></td>
<td>VR = 200V</td>
</tr>
<tr>
<td>I_RRM</td>
<td>2.8</td>
<td></td>
<td>A</td>
<td></td>
<td>T_J = 25°C</td>
</tr>
<tr>
<td></td>
<td>6.3</td>
<td></td>
<td></td>
<td></td>
<td>T_J = 125°C</td>
</tr>
<tr>
<td>Q_rr</td>
<td>60</td>
<td></td>
<td>nC</td>
<td></td>
<td>T_J = 25°C</td>
</tr>
<tr>
<td></td>
<td>210</td>
<td></td>
<td></td>
<td></td>
<td>T_J = 125°C</td>
</tr>
</tbody>
</table>

## Thermal - Mechanical Characteristics

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_J</td>
<td></td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>T_stg</td>
<td></td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>R_JC</td>
<td></td>
<td>1.8</td>
<td>2</td>
<td>°C/W</td>
</tr>
<tr>
<td>R_JA</td>
<td></td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R_JCS</td>
<td></td>
<td></td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Wt</td>
<td></td>
<td>2.0</td>
<td></td>
<td>g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.07</td>
<td></td>
<td>(oz)</td>
</tr>
<tr>
<td>Mounting Torque</td>
<td></td>
<td>6.0</td>
<td>12</td>
<td>Kg-cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.0</td>
<td>10</td>
<td>lbf-in</td>
</tr>
</tbody>
</table>

① Typical Socket Mount
② Mounting Surface, Flat, Smooth and Greased
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 - Max. Thermal Impedance Characteristics

Notes:
1. Duty factor D = t1/t2
2. Peak Tj = Pdm x ZthJC + Tc
Formula used: $TC = TJ - (PD + PD_{REV}) \times R_{thJC}$

$PD = $ Forward Power Loss = $IF(AV) \times VFM @ \frac{IF(AV)}{D}$ (see Fig. 6);

$PD_{REV} = $ Inverse Power Loss = $VR1 \times IR (1 - D)$; $IR @ VR1 = $ rated VR.

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

Fig. 6 - Forward Power Loss Characteristics

Fig. 7 - Typical Reverse Recovery vs. $di/dt$

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

(3) Formula used: $TC = TJ - (PD + PD_{REV}) \times R_{thJC}$

$PD = $ Forward Power Loss = $IF(AV) \times VFM @ \frac{IF(AV)}{D}$ (see Fig. 6);

$PD_{REV} = $ Inverse Power Loss = $VR1 \times IR (1 - D)$; $IR @ VR1 = $ rated VR.
Reverse Recovery Circuit

Fig. 9 - Reverse Recovery Parameter Test Circuit

Fig. 10 - Reverse Recovery Waveform and Definitions

1. $\frac{di}{dt}$ - Rate of change of current through zero crossing
2. $I_{RRM}$ - Peak reverse recovery current
3. $t_R$ - 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 $t_R$ and $I_{RRM}$
   
   \[ Q_{rr} = \frac{1}{2} \cdot t_R \cdot I_{RRM} \]
5. $\frac{di_{(rec)}}{dt}$ - Peak rate of change of current during $t_B$ portion of $t_R$
Outline Table

Conform to JEDEC outline TO-220AB

Conform to JEDEC outline D^2Pak (SMD-220)
Dimensions in millimeters and (inches)
Outline Table

Modified JEDEC outline TO-262
Dimensions in millimeters and (inches)

Tape & Reel Information

Dimensions in millimeters and (inches)
Part Marking Information

**TO-220AB**

**Example:** This is a 16CTU04
Lot Code 1789
Assembled on WW 19, 2000
In the Assembly Line "C"

**D²PAK**

**Example:** This is a 16CTU04S
Lot Code 8024
Assembled on WW 02, 2000
In the Assembly Line "L"

**TO-262**

**Example:** This is a 16CTU04-1
Lot Code 1789
Assembled on WW 19, 1999
In the Assembly Line "C"
### Ordering Information Table

<table>
<thead>
<tr>
<th>Device Code</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 CTU04 - 1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

1. **Current Rating (16 = 16A)**
2. **C = Common Cathode**
3. **T = TO-220**
4. **U = Ultrafast Recovery**
5. **Voltage Rating (04 = 400V)**
6. **None = TO-220AB**
   - **S = D²Pak**
   - **-1 = TO-262 Option**
7. **None = Tube (50 pieces)**
   - **TRL = Tape & Reel (Left Oriented - for D²Pak only)**
   - **TRR = Tape & Reel (Right Oriented - for D²Pak only)**
8. **- none = Standard Production**
   - **PbF = Lead-Free**

Data and specifications subject to change without notice.
This product has been designed and qualified for Industrial Level.
Qualification Standards can be found on IR’s Web site.

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