STF33N60DM2

N-channel 600 V, 0.110 Ω typ., 24 A MDmesh™ DM2 Power MOSFET in TO-220FP package

Datasheet - production data

Features

<table>
<thead>
<tr>
<th>Order code</th>
<th>V_DS @ T_Jmax.</th>
<th>R_DS(on) max.</th>
<th>I_D</th>
</tr>
</thead>
<tbody>
<tr>
<td>STF33N60DM2</td>
<td>650 V</td>
<td>0.130 Ω</td>
<td>24 A</td>
</tr>
</tbody>
</table>

- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

Applications

- Switching applications

Description

This high voltage N-channel Power MOSFET is part of the MDmesh™ DM2 fast recovery diode series. It offers very low recovery charge (Q_rr) and time (t_rr) combined with low R_DS(on), rendering it suitable for the most demanding high efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

Table 1: Device summary

<table>
<thead>
<tr>
<th>Order code</th>
<th>Marking</th>
<th>Package</th>
<th>Packing</th>
</tr>
</thead>
<tbody>
<tr>
<td>STF33N60DM2</td>
<td>33N60DM2</td>
<td>TO-220FP</td>
<td>Tube</td>
</tr>
</tbody>
</table>
## Contents

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# Electrical ratings

## Table 2: Absolute maximum ratings

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{GS}$</td>
<td>Gate-source voltage</td>
<td>±25</td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>Drain current (continuous) at $T_{case} = 25, ^\circ C$</td>
<td>24</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Drain current (continuous) at $T_{case} = 100, ^\circ C$</td>
<td>15.5</td>
<td>A</td>
</tr>
<tr>
<td>$I_{DS(1)}$</td>
<td>Drain current (pulsed)</td>
<td>96</td>
<td>A</td>
</tr>
<tr>
<td>$P_{TOT}$</td>
<td>Total dissipation at $T_{case} = 25, ^\circ C$</td>
<td>35</td>
<td>W</td>
</tr>
<tr>
<td>$dv/dt^{(2)}$</td>
<td>Peak diode recovery voltage slope</td>
<td>50</td>
<td>V/ns</td>
</tr>
<tr>
<td>$dv/dt^{(3)}$</td>
<td>MOSFET $dv/dt$ ruggedness</td>
<td>50</td>
<td>V/ns</td>
</tr>
<tr>
<td>$V_{ISO}$</td>
<td>Insulation withstand voltage (RMS) from all three leads to external heat sink ($t = 1, s; T_C = 25, ^\circ C$)</td>
<td>2500</td>
<td>V</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage temperature range</td>
<td>-55 to 150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_j$</td>
<td>Operating junction temperature range</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

(1) Pulse width is limited by safe operating area.

(2) $I_{SD} \leq 24\, A$, $di/dt=900\, A/\mu s$; $V_{DS(peak)} < V_{(BR)DSS}$, $V_{DD} = 400\, V$.

(3) $V_{DS} \leq 480\, V$.

## Table 3: Thermal data

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{thj-case}$</td>
<td>Thermal resistance junction-case</td>
<td>3.6</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{thj-amb}$</td>
<td>Thermal resistance junction-ambient</td>
<td>62.5</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

## Table 4: Avalanche characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{AR}$</td>
<td>Avalanche current, repetitive or not repetitive (Pulse width limited by $T_{max}$)</td>
<td>5.5</td>
<td>A</td>
</tr>
<tr>
<td>$E_{AS}$</td>
<td>Single pulse avalanche energy (starting $T_j = 25, ^\circ C$, $I_D = I_{AR}$, $V_{DD} = 50, V$)</td>
<td>570</td>
<td>mJ</td>
</tr>
</tbody>
</table>
2 Electrical characteristics

(T\text{case} = 25 \, ^\circ\text{C} \text{ unless otherwise specified})

<table>
<thead>
<tr>
<th>Table 5: Static</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
</tr>
<tr>
<td>( V_{(BR)DSS} )</td>
</tr>
<tr>
<td>( I_{DSS} )</td>
</tr>
<tr>
<td>( I_{GSS} )</td>
</tr>
<tr>
<td>( V_{GS(th)} )</td>
</tr>
<tr>
<td>( R_{DS(on)} )</td>
</tr>
</tbody>
</table>

**Notes:**
(1) Defined by design, not subject to production test.

<table>
<thead>
<tr>
<th>Table 6: Dynamic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
</tr>
<tr>
<td>( C_{iss} )</td>
</tr>
<tr>
<td>( C_{oss} )</td>
</tr>
<tr>
<td>( C_{rss} )</td>
</tr>
<tr>
<td>( C_{oss , eq} ) ( ^{(1)} )</td>
</tr>
<tr>
<td>( R_G )</td>
</tr>
<tr>
<td>( Q_g )</td>
</tr>
<tr>
<td>( Q_{gs} )</td>
</tr>
<tr>
<td>( Q_{gd} )</td>
</tr>
</tbody>
</table>

**Notes:**
(1) \( C_{oss \, eq} \) is defined as a constant equivalent capacitance giving the same charging time as \( C_{oss} \) when \( V_{DS} \) increases from 0 to 80\% \( V_{oss} \).

<table>
<thead>
<tr>
<th>Table 7: Switching times</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
</tr>
<tr>
<td>( t_{(on)} )</td>
</tr>
<tr>
<td>( t_r )</td>
</tr>
<tr>
<td>( t_{(off)} )</td>
</tr>
<tr>
<td>( t_f )</td>
</tr>
</tbody>
</table>

**Notes:**
### Table 8: Source-drain diode

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{SD}$</td>
<td>Source-drain current</td>
<td>-</td>
<td>24</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SDM}$&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>Source-drain current (pulsed)</td>
<td>-</td>
<td>96</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{SD}$&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>Forward on voltage</td>
<td>$V_{GS} = 0$ V, $I_{SD} = 24$ A</td>
<td>-</td>
<td>1.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>Reverse recovery time</td>
<td>$I_{SD} = 24$ A, $di/dt = 100$ A/µs, $V_{DD} = 60$ V (see Figure 16: &quot;Test circuit for inductive load switching and diode recovery times&quot;)</td>
<td>-</td>
<td>120</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>Reverse recovery charge</td>
<td>$V_{DD} = 60$ V</td>
<td>-</td>
<td>0.53</td>
<td>µC</td>
<td></td>
</tr>
<tr>
<td>$I_{RRM}$</td>
<td>Reverse recovery current</td>
<td>-</td>
<td>8.8</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>Reverse recovery time</td>
<td>$I_{SD} = 24$ A, $di/dt = 100$ A/µs, $V_{DD} = 60$ V, $T_j = 150$ °C (see Figure 16: &quot;Test circuit for inductive load switching and diode recovery times&quot;)</td>
<td>-</td>
<td>316</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>Reverse recovery charge</td>
<td>-</td>
<td>2.85</td>
<td>µC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{RRM}$</td>
<td>Reverse recovery current</td>
<td>-</td>
<td>18</td>
<td>A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

<sup>(1)</sup> Pulse width is limited by safe operating area.

<sup>(2)</sup> Pulse test: pulse duration = 300 µs, duty cycle 1.5%.

### Table 9: Gate-source Zener diode

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{BR(GS)}$</td>
<td>Gate-source breakdown voltage</td>
<td>$I_{GS} = \pm 250$ µA, $I_{D} = 0$ A</td>
<td>±30</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
</tbody>
</table>

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.
2.1 Electrical characteristics (curves)

Figure 2: Safe operating area

Figure 3: Thermal impedance

Figure 4: Output characteristics

Figure 5: Transfer characteristics

Figure 6: Gate charge vs gate-source voltage

Figure 7: Static drain-source on-resistance
3 Test circuits

Figure 14: Test circuit for resistive load switching times

Figure 15: Test circuit for gate charge behavior

Figure 16: Test circuit for inductive load switching and diode recovery times

Figure 17: Unclamped inductive load test circuit

Figure 18: Unclamped inductive waveform

Figure 19: Switching time waveform
4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of 
ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® 
 specifications, grade definitions and product status are available at: www.st.com.

ECOPACK® is an ST trademark.
4.1 TO-220FP package information

Figure 20: TO-220FP package outline
Table 10: TO-220FP package mechanical data

<table>
<thead>
<tr>
<th>Dim.</th>
<th>mm</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>4.4</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>2.5</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>2.5</td>
<td>2.75</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>0.45</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>0.75</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F1</td>
<td></td>
<td>1.15</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td></td>
<td>1.15</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td>4.95</td>
<td>5.2</td>
<td></td>
</tr>
<tr>
<td>G1</td>
<td></td>
<td>2.4</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td>10</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td>L2</td>
<td></td>
<td>16</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>L3</td>
<td></td>
<td>28.6</td>
<td>30.6</td>
<td></td>
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<tr>
<td>L4</td>
<td></td>
<td>9.8</td>
<td>10.6</td>
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</tr>
<tr>
<td>L5</td>
<td></td>
<td>2.9</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>L6</td>
<td></td>
<td>15.9</td>
<td>16.4</td>
<td></td>
</tr>
<tr>
<td>L7</td>
<td></td>
<td>9</td>
<td>9.3</td>
<td></td>
</tr>
<tr>
<td>Dia</td>
<td></td>
<td>3</td>
<td>3.2</td>
<td></td>
</tr>
</tbody>
</table>
## 5 Revision history

Table 11: Document revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
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<tbody>
<tr>
<td>04-Sep-2014</td>
<td>1</td>
<td>First release.</td>
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<tr>
<td>05-Jul-2016</td>
<td>2</td>
<td>Document status promoted from preliminary to production data.</td>
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<tr>
<td></td>
<td></td>
<td>Updated title and features in cover page.</td>
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<tr>
<td></td>
<td></td>
<td>Updated Section 1: “Electrical ratings” and Section 2: “Electrical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>characteristics”.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Added Section 2.1: “Electrical characteristics (curves)”.</td>
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<tr>
<td></td>
<td></td>
<td>Minor text changes.</td>
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