N-channel SiC power MOSFET bare die

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain - Source voltage</td>
<td>V_{DSS}</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>Continuous drain current</td>
<td>I_D^*1</td>
<td>95</td>
<td>A</td>
</tr>
<tr>
<td>Pulsed drain current</td>
<td>I_{D,pulse}^*2</td>
<td>237</td>
<td>A</td>
</tr>
<tr>
<td>Gate - Source voltage (DC)</td>
<td>V_{GSS}</td>
<td>-4 to +22</td>
<td>V</td>
</tr>
<tr>
<td>Gate-Source Surge Voltage</td>
<td>V_{GSS,surge}^*3</td>
<td>-4 to +26</td>
<td>V</td>
</tr>
<tr>
<td>Recommended Drive Voltage</td>
<td>V_{GS_op}^*4</td>
<td>0 / +18</td>
<td>V</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_J</td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>Range of storage temperature</td>
<td>T_{stg}</td>
<td>-55 to +175</td>
<td>°C</td>
</tr>
</tbody>
</table>

Features
1) Low on-resistance
2) Fast switching speed
3) Fast reverse recovery
4) Easy to parallel
5) Simple to drive

Application
- Solar inverters
- DC/DC converters
- Switch mode power supplies
- Induction heating
- Motor drives

Absolute maximum ratings (T_a = 25°C)
### Electrical characteristics \((T_a = 25^\circ C)\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Values</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain - Source breakdown voltage</td>
<td>(V_{(BR)DSS})</td>
<td>(V_{GS} = 0,V, , I_D = 1,mA)</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>Zero gate voltage drain current</td>
<td>(I_{DSS})</td>
<td>(V_{DS} = 1200,V, , V_{GS} = 0,V)</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Gate - Source leakage current</td>
<td>(I_{GSS+})</td>
<td>(V_{GS} = +22,V, , V_{DS} = 0,V)</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>Gate - Source leakage current</td>
<td>(I_{GSS-})</td>
<td>(V_{GS} = -4,V, , V_{DS} = 0,V)</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>Gate threshold voltage</td>
<td>(V_{GS,(th)})</td>
<td>(V_{DS} = 10,V, , I_D = 18.2,mA)</td>
<td>2.7</td>
<td>5.6</td>
</tr>
<tr>
<td>Static drain - source on - state resistance</td>
<td>(R_{DS(on)}^{,*})</td>
<td>(V_{GS} = 18,V, , I_D = 36,A)</td>
<td>22</td>
<td>27.5</td>
</tr>
<tr>
<td>Gate input resistance</td>
<td>(R_G)</td>
<td>(f = 1,MHz, , \text{open drain})</td>
<td>4</td>
<td>-</td>
</tr>
</tbody>
</table>
### Electrical characteristics (T<sub>a</sub> = 25°C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Values</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transconductance</td>
<td>g&lt;sub&gt;fs&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 10V, I&lt;sub&gt;D&lt;/sub&gt; = 36A</td>
<td>- 14.2 -</td>
<td>S</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>C&lt;sub&gt;iss&lt;/sub&gt;</td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 0V</td>
<td>- 2879 -</td>
<td>pF</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>C&lt;sub&gt;oss&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 800V</td>
<td>- 237 -</td>
<td>pF</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>C&lt;sub&gt;rss&lt;/sub&gt;</td>
<td>f = 1MHz</td>
<td>- 108 -</td>
<td></td>
</tr>
<tr>
<td>Effective output capacitance, energy related</td>
<td>C&lt;sub&gt;Q(er)&lt;/sub&gt;</td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 0V, V&lt;sub&gt;DS&lt;/sub&gt; = 0V to 600V</td>
<td>- 213 -</td>
<td>pF</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>t&lt;sub&gt;d(on)&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt; = 400V, I&lt;sub&gt;D&lt;/sub&gt; = 18A</td>
<td>- 29 -</td>
<td>ns</td>
</tr>
<tr>
<td>Rise time</td>
<td>t&lt;sub&gt;r&lt;/sub&gt;</td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 18V/0V</td>
<td>- 44 -</td>
<td></td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>t&lt;sub&gt;d(off)&lt;/sub&gt;</td>
<td>R&lt;sub&gt;L&lt;/sub&gt; = 22Ω</td>
<td>- 67 -</td>
<td></td>
</tr>
<tr>
<td>Fall time</td>
<td>t&lt;sub&gt;f&lt;/sub&gt;</td>
<td>R&lt;sub&gt;G&lt;/sub&gt; = 0Ω</td>
<td>- 28 -</td>
<td></td>
</tr>
<tr>
<td>Turn-on switching loss</td>
<td>E&lt;sub&gt;on&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt; = 600V, I&lt;sub&gt;D&lt;/sub&gt; = 36A, V&lt;sub&gt;GS&lt;/sub&gt; = 18V/0V, R&lt;sub&gt;G&lt;/sub&gt; = 0Ω, L = 250μH</td>
<td>- 632 -</td>
<td>μJ</td>
</tr>
<tr>
<td>Turn-off switching loss</td>
<td>E&lt;sub&gt;off&lt;/sub&gt;</td>
<td>*E&lt;sub&gt;on&lt;/sub&gt; includes diode reverse recovery</td>
<td>- 243 -</td>
<td></td>
</tr>
</tbody>
</table>

### Gate Charge characteristics (T<sub>a</sub> = 25°C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Values</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total gate charge</td>
<td>Q&lt;sub&gt;g&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt; = 600V</td>
<td>- 178 -</td>
<td>nC</td>
</tr>
<tr>
<td>Gate - Source charge</td>
<td>Q&lt;sub&gt;gs&lt;/sub&gt;</td>
<td>I&lt;sub&gt;D&lt;/sub&gt; = 36A</td>
<td>- 40 -</td>
<td></td>
</tr>
<tr>
<td>Gate - Drain charge</td>
<td>Q&lt;sub&gt;gd&lt;/sub&gt;</td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 18V</td>
<td>- 80 -</td>
<td></td>
</tr>
<tr>
<td>Gate plateau voltage</td>
<td>V&lt;sub&gt;(plateau)&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt; = 600V, I&lt;sub&gt;D&lt;/sub&gt; = 36A</td>
<td>- 9.6 -</td>
<td>V</td>
</tr>
</tbody>
</table>
### Body diode electrical characteristics (Source-Drain) \((T_a = 25°C)\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Values</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverse diode continuous, forward current</td>
<td>(I_S)</td>
<td>(T_c = 25°C)</td>
<td>-</td>
<td>95</td>
</tr>
<tr>
<td>Inverse diode direct current, pulsed</td>
<td>(I_{SM})</td>
<td></td>
<td>-</td>
<td>237</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>(V_{SD})</td>
<td>(V_{GS} = 0V, \ I_S = 36A)</td>
<td>-</td>
<td>3.2</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>(t_{rr})</td>
<td></td>
<td>-</td>
<td>28</td>
</tr>
<tr>
<td>Reverse recovery charge</td>
<td>(Q_{rr})</td>
<td>(I_F = 36A, \ V_R = 600V)</td>
<td>-</td>
<td>175</td>
</tr>
<tr>
<td>Peak reverse recovery current</td>
<td>(I_{rrm})</td>
<td></td>
<td>-</td>
<td>12</td>
</tr>
</tbody>
</table>

*1 For \(T_F = 175°C\) and thermal dissiparion to ambience of 427W or more. Limited only by maximum temperature allowed.

*2 \(PW \leq 10\mu s\), Duty cycle \(\leq 1\%\)

*3 Example of acceptable \(V_{gs}\) waveform

*4 Please be advised not to use SiC-MOSFETs with \(V_{gs}\) below 13V as doing so may cause thermal runaway.

*5 Pulsed
Electrical characteristic curves

Fig. 1 Typical Output Characteristics (I)

Drain Current : $I_D$ [A]

Drain - Source Voltage : $V_{DS}$ [V]

$T_a = 25^\circ C$
Pulsed

$V_{GS} = 8\, V$

Fig. 2 Typical Output Characteristics (II)

Drain Current : $I_D$ [A]

Drain - Source Voltage : $V_{DS}$ [V]

$T_a = 25^\circ C$
Pulsed

$V_{GS} = 8\, V$

Fig. 3 $T_j = 150^\circ C$ Typical Output Characteristics (I)

Drain Current : $I_D$ [A]

Drain - Source Voltage : $V_{DS}$ [V]

$T_a = 150^\circ C$
Pulsed

$V_{GS} = 8\, V$

Fig. 4 $T_j = 150^\circ C$ Typical Output Characteristics (II)

Drain Current : $I_D$ [A]

Drain - Source Voltage : $V_{DS}$ [V]

$T_a = 150^\circ C$
Pulsed

$V_{GS} = 8\, V$
Electrical characteristic curves

Fig. 5 Typical Transfer Characteristics (I)

Gate - Source Voltage : $V_{GS}$ [V]

Drain Current : $I_D$ [A]

$V_{DS} = 10$V Pulsed

$T_a = 150^\circ$C
$T_a = 75^\circ$C
$T_a = 25^\circ$C
$T_a = -25^\circ$C

Fig. 6 Typical Transfer Characteristics (II)

Gate - Source Voltage : $V_{GS}$ [V]

Drain Current : $I_D$ [A]

$V_{DS} = 10$V Pulsed

$T_a = 150^\circ$C
$T_a = 75^\circ$C
$T_a = 25^\circ$C
$T_a = -25^\circ$C

Fig. 7 Gate Threshold Voltage vs. Junction Temperature

Gate Threshold Voltage : $V_{GS(th)}$ [V]

Junction Temperature : $T_j$ [°C]

$V_{DS} = 10$V
$I_D = 18.2$mA

Fig. 8 Transconductance vs. Drain Current

Transconductance : $g_{fs}$ [S]

Drain Current : $I_D$ [A]

$V_{DS} = 10$V Pulsed

$T_a = 150^\circ$C
$T_a = 75^\circ$C
$T_a = 25^\circ$C
$T_a = -25^\circ$C
Electrical characteristic curves

**Fig. 9 Static Drain - Source On - State Resistance vs. Gate - Source Voltage**

![Graph showing Static Drain - Source On - State Resistance vs. Gate - Source Voltage](image)

- Static Drain - Source On - State Resistance: $R_{DS(on)}$
- Gate - Source Voltage: $V_{GS}$ [V]
- Temperature: $T_a = 25^\circ C$
- Pulsed
- $I_D = 63A$
- $I_D = 36A$

**Fig. 10 Static Drain - Source On - State Resistance vs. Junction Temperature**

![Graph showing Static Drain - Source On - State Resistance vs. Junction Temperature](image)

- Static Drain - Source On - State Resistance: $R_{DS(on)}$
- Junction Temperature: $T_j$ [°C]
- Pulsed
- $V_{GS} = 18V$
- $I_D = 63A$
- $I_D = 36A$

**Fig. 11 Static Drain - Source On - State Resistance vs. Drain Current**

![Graph showing Static Drain - Source On - State Resistance vs. Drain Current](image)

- Static Drain - Source On - State Resistance: $R_{DS(on)}$
- Drain Current: $I_D$ [A]
- Temperature: $T_a$
  - $150^\circ C$
  - $125^\circ C$
  - $75^\circ C$
  - $25^\circ C$
  - $-25^\circ C$
- $V_{GS} = 18V$
- Pulsed
Electrical characteristic curves

Fig. 12 Typical Capacitance vs. Drain - Source Voltage

- Capacitance: C [pF]
- Drain - Source Voltage: V_DS [V]
- Ciss, Coss, Cros
- T_a = 25°C
- f = 1 MHz
- V_GS = 0 V

Fig. 13 Coss Stored Energy

- Coss Stored Energy: E_{Coss} [μJ]
- Drain - Source Voltage: V_DS [V]
- T_a = 25°C

Fig. 14 Switching Characteristics

- Switching Time: t [ns]
- Drain Current: I_D [A]
- T_a = 25°C
- V_DD = 400 V
- V_GS = 18 V
- R_G = 0 Ω
- Pulsed

Fig. 15 Dynamic Input Characteristics

- Total Gate Charge: Q_g [nC]
- Gate - Source Voltage: V_GS [V]
- T_a = 25°C
- V_DD = 600 V
- I_D = 36 A
- Pulsed
**Electrical characteristic curves**

**Fig.16 Typical Switching Loss vs. Drain - Source Voltage**

- $T_a = 25^\circ C$
- $I_D = 36A$
- $V_{DS} = 18V/0V$
- $R_G = 0\Omega$
- $L = 250\mu H$

- Switching Energy: $E_{on}$
- $E_{off}$

**Fig.17 Typical Switching Loss vs. Drain Current**

- $T_a = 25^\circ C$
- $V_{DD} = 600V$
- $V_{GS} = 18V/0V$
- $R_G = 0\Omega$
- $L = 250\mu H$

- Switching Energy: $E_{on}$
- $E_{off}$

**Fig.18 Typical Switching Loss vs. External Gate Resistance**

- $T_a = 25^\circ C$
- $V_{DD} = 600V$
- $I_D = 36A$
- $V_{GS} = 18V/0V$
- $L = 250\mu H$

- Switching Energy: $E_{on}$
- $E_{off}$
Electrical characteristic curves

**Fig. 19** Inverse Diode Forward Current vs. Source - Drain Voltage

- **V_{GS}** = 0V, Pulsed
- Temperatures: T_a = 150°C, T_a = 75°C, T_a = 25°C, T_a = -25°C

Source - Drain Voltage : V_{SD} [V]

**Fig. 20** Reverse Recovery Time vs. Inverse Diode Forward Current

- T_a = 25°C
- di / dt = 1100 A / us
- V_R = 600V
- V_{GS} = 0V, Pulsed

Recovery Time : t_{rr} [ns]

Inverse Diode Forward Current : I_s [A]
● Measurement circuits

**Fig.1-1  Switching Time Measurement Circuit**

![Switching Time Measurement Circuit](image)

**Fig.1-2  Switching Waveforms**

![Switching Waveforms](image)

**Fig.2-1  Gate Charge Measurement Circuit**

![Gate Charge Measurement Circuit](image)

**Fig.2-2  Gate Charge Waveform**

![Gate Charge Waveform](image)

**Fig.3-1  Switching Energy Measurement Circuit**

![Switching Energy Measurement Circuit](image)

**Fig.3-2  Switching Waveforms**

![Switching Waveforms](image)

**Fig.4-1  Reverse Recovery Time Measurement Circuit**

![Reverse Recovery Time Measurement Circuit](image)

**Fig.4-2  Reverse Recovery Waveform**

![Reverse Recovery Waveform](image)
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