

CoolSiC™  
400V CoolSiC™ G2 MOSFET

Features

- Ideal for high frequency switching and synchronous rectification
- Commutation robust fast body diode with low  $Q_{tr}$
- Low  $R_{DS(on)}$  dependency on temperature
- Benchmark gate threshold voltage,  $V_{GS(th)} = 4.5\text{ V}$
- Recommended gate driving voltage 0 V to 18 V
- .XT interconnection technology for best-in-class thermal performance
- 100% avalanche tested

Potential applications

- SMPS
- Solar PV inverters
- Energy storage, UPS and battery formation
- Class-D audio
- Motor drives

Product validation

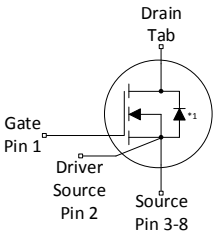
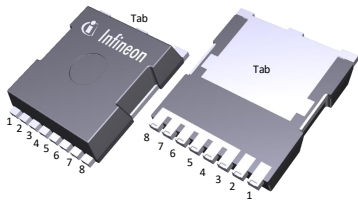
Fully qualified according to JEDEC for Industrial Applications

Table 1 Key Performance Parameters

| Parameter        | Value | Unit |
|------------------|-------|------|
| $V_{DS}$         | 400   | V    |
| $R_{DS(on),typ}$ | 36.4  | mΩ   |
| $I_D$            | 50    | A    |
| $Q_{oss}$        | 42    | nC   |
| $E_{oss}$        | 3.0   | μJ   |
| $Q_G$            | 26    | nC   |

| Type/Ordering Code | Package   | Marking  | Related Links |
|--------------------|-----------|----------|---------------|
| IMT40R036M2H       | PG-HSOF-8 | 40R036M2 | -             |

TOLL



\*1: Internal body diode

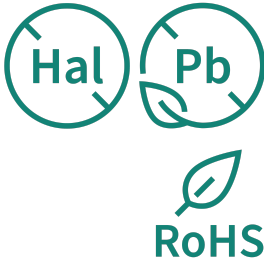




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## 1 Maximum ratings

at  $T_A=25\text{ °C}$ , unless otherwise specified

**Table 2 Maximum ratings**

| Parameter                                    | Symbol        | Values |      |                 | Unit | Note/ Test Condition                                                                                                                                                           |
|----------------------------------------------|---------------|--------|------|-----------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                              |               | Min.   | Typ. | Max.            |      |                                                                                                                                                                                |
| Continuous drain current <sup>1)</sup>       | $I_D$         | -      | -    | 50<br>36<br>7.6 | A    | $V_{GS}=18\text{ V}$ , $T_C=25\text{ °C}$<br>$V_{GS}=18\text{ V}$ , $T_C=100\text{ °C}$<br>$V_{GS}=18\text{ V}$ , $T_A=25\text{ °C}$ , $R_{THJA}=40\text{ °C/W}$ <sup>2)</sup> |
| Pulsed drain current <sup>3)</sup>           | $I_{D,pulse}$ | -      | -    | 150             | A    | $T_C=25\text{ °C}$                                                                                                                                                             |
| Avalanche energy, single pulse <sup>4)</sup> | $E_{AS}$      | -      | -    | 66              | mJ   | $I_D=11.1\text{ A}$ , $R_{GS}=25\text{ }\Omega$                                                                                                                                |
| Avalanche energy, repetitive                 | $E_{AR}$      | -      | -    | 0.33            | mJ   | $I_D=11.1\text{ A}$ , $R_{GS}=25\text{ }\Omega$                                                                                                                                |
| Gate source voltage (static)                 | $V_{GS,DC}$   | -7     | -    | 23              | V    | -                                                                                                                                                                              |
| Gate source voltage (transient)              | $V_{GS,AC}$   | -10    | -    | 25              | V    | $t_{pulse} \leq 500\text{ ns}$ , duty cycle $\leq 1\%$                                                                                                                         |
| Power dissipation                            | $P_{tot}$     | -      | -    | 167<br>3.8      | W    | $T_C=25\text{ °C}$<br>$T_A=25\text{ °C}$ , $R_{THJA}=40\text{ °C/W}$ <sup>2)</sup>                                                                                             |
| Storage temperature                          | $T_{stg}$     | -55    | -    | 150             | °C   | -                                                                                                                                                                              |
| Operating junction temperature               | $T_j$         | -55    | -    | 175             | °C   | -                                                                                                                                                                              |

<sup>1)</sup> Rating refers to the product only with datasheet specified absolute maximum values, maintaining case temperature at 25°C. For higher case temperature please refer to Diagram 2. De-rating will be required based on the actual environmental conditions.

<sup>2)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70 µm thick) copper area for drain connection. PCB is vertical in still air.

<sup>3)</sup> See Diagram 3 for more detailed information.

<sup>4)</sup> See Diagram 19 for more detailed information.

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter                                                                               | Symbol     | Values |      |      | Unit | Note/ Test Condition |
|-----------------------------------------------------------------------------------------|------------|--------|------|------|------|----------------------|
|                                                                                         |            | Min.   | Typ. | Max. |      |                      |
| Thermal resistance, junction - case                                                     | $R_{thJC}$ | -      | -    | 0.9  | °C/W | -                    |
| Thermal resistance, junction - ambient,<br>6 cm <sup>2</sup> cooling area <sup>5)</sup> | $R_{thJA}$ | -      | -    | 40   | °C/W | -                    |

<sup>5)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70 µm thick) copper area for drain connection. PCB is vertical in still air.

## 3 Operating range

**Table 4 Operating range**

| Parameter                    | Symbol        | Values |      |      | Unit | Note/ Test Condition |
|------------------------------|---------------|--------|------|------|------|----------------------|
|                              |               | Min.   | Typ. | Max. |      |                      |
| Recommended turn-on voltage  | $V_{GS(on)}$  | -      | 18   | -    | V    | -                    |
| Recommended turn-off voltage | $V_{GS(off)}$ | -      | 0    | -    | V    | -                    |

## 4 Electrical characteristics

at  $T_j=25\text{ °C}$ , unless otherwise specified

**Table 5 Static characteristics**

| Parameter                            | Symbol        | Values |                      |                | Unit | Note/ Test Condition                                                                                                                                                                                   |
|--------------------------------------|---------------|--------|----------------------|----------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      |               | Min.   | Typ.                 | Max.           |      |                                                                                                                                                                                                        |
| Drain-source breakdown voltage       | $V_{(BR)DSS}$ | 400    | -                    | -              | V    | $V_{GS}=0\text{ V}$ , $I_D=0.4\text{ mA}$                                                                                                                                                              |
| Gate threshold voltage <sup>6)</sup> | $V_{GS(th)}$  | 3.5    | 4.5                  | 5.6            | V    | $V_{DS}=V_{GS}$ , $I_D=4\text{ mA}$                                                                                                                                                                    |
| Zero gate voltage drain current      | $I_{DSS}$     | -      | 1<br>2               | 75<br>-        | μA   | $V_{DS}=400\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$<br>$V_{DS}=400\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=175\text{ °C}$                                                                  |
| Gate-source leakage current          | $I_{GSS}$     | -      | 1                    | 100            | nA   | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                                                                                                                                                             |
| Drain-source on-state resistance     | $R_{DS(on)}$  | -      | 36.4<br>52.5<br>44.6 | 45.7<br>-<br>- | mΩ   | $V_{GS}=18\text{ V}$ , $I_D=11.1\text{ A}$ , $T_j=25\text{ °C}$<br>$V_{GS}=18\text{ V}$ , $I_D=11.1\text{ A}$ , $T_j=175\text{ °C}$<br>$V_{GS}=15\text{ V}$ , $I_D=11.1\text{ A}$ , $T_j=25\text{ °C}$ |
| Gate resistance                      | $R_G$         | -      | 5.5                  | 8.3            | Ω    | -                                                                                                                                                                                                      |

<sup>6)</sup> Tested after 1ms pulse at  $V_{GS} = +20\text{V}$ .

**Table 6 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note/ Test Condition                                                                                    |
|------------------------------------------------------------|--------------|--------|------|------|------|---------------------------------------------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                                                         |
| Input capacitance                                          | $C_{iss}$    | -      | 870  | 1170 | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=200\text{ V}$ , $f=1\text{ MHz}$                                          |
| Output capacitance                                         | $C_{oss}$    | -      | 120  | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=200\text{ V}$ , $f=1\text{ MHz}$                                          |
| Reverse transfer capacitance                               | $C_{rss}$    | -      | 10   | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=200\text{ V}$ , $f=1\text{ MHz}$                                          |
| Effective output capacitance, energy related <sup>7)</sup> | $C_{o(er)}$  | -      | 150  | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=0\ldots200\text{ V}$                                                      |
| Effective output capacitance, time related <sup>8)</sup>   | $C_{o(tr)}$  | -      | 210  | -    | pF   | $I_D=\text{constant}$ , $V_{GS}=0\text{ V}$ , $V_{DS}=0\ldots200\text{ V}$                              |
| Turn-on delay time <sup>9)</sup>                           | $t_{d(on)}$  | -      | 13.0 | -    | ns   | $V_{DD}=200\text{ V}$ , $V_{GS}=0\ldots18\text{ V}$ , $I_D=11.1\text{ A}$ ,<br>$R_{G,ext}=1.8\text{ Ω}$ |
| Rise time <sup>9)</sup>                                    | $t_r$        | -      | 11.9 | -    | ns   | $V_{DD}=200\text{ V}$ , $V_{GS}=0\ldots18\text{ V}$ , $I_D=11.1\text{ A}$ ,<br>$R_{G,ext}=1.8\text{ Ω}$ |
| Turn-off delay time <sup>9)</sup>                          | $t_{d(off)}$ | -      | 17.9 | -    | ns   | $V_{DD}=200\text{ V}$ , $V_{GS}=18\ldots0\text{ V}$ , $I_D=11.1\text{ A}$ ,<br>$R_{G,ext}=1.8\text{ Ω}$ |
| Fall time <sup>9)</sup>                                    | $t_f$        | -      | 8.1  | -    | ns   | $V_{DD}=200\text{ V}$ , $V_{GS}=18\ldots0\text{ V}$ , $I_D=11.1\text{ A}$ ,<br>$R_{G,ext}=1.8\text{ Ω}$ |

<sup>7)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 200 V.

<sup>8)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 200 V.

<sup>9)</sup> Refer to Table 9 for test setup.

**Table 7 Gate Charge Characteristics** <sup>10)</sup>

| Parameter                    | Symbol        | Values |      |      | Unit | Note/ Test Condition                                                           |
|------------------------------|---------------|--------|------|------|------|--------------------------------------------------------------------------------|
|                              |               | Min.   | Typ. | Max. |      |                                                                                |
| Gate to source charge        | $Q_{gs}$      | -      | 7    | -    | nC   | $V_{DD}=200\text{ V}$ , $I_D=11.1\text{ A}$ , $V_{GS}=0\text{ to }18\text{ V}$ |
| Gate to drain charge         | $Q_{gd}$      | -      | 5.4  | -    | nC   | $V_{DD}=200\text{ V}$ , $I_D=11.1\text{ A}$ , $V_{GS}=0\text{ to }18\text{ V}$ |
| Gate charge total            | $Q_g$         | -      | 26   | -    | nC   | $V_{DD}=200\text{ V}$ , $I_D=11.1\text{ A}$ , $V_{GS}=0\text{ to }18\text{ V}$ |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | -      | 24   | -    | nC   | $V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }18\text{ V}$                       |
| Output charge                | $Q_{oss}$     | -      | 42   | -    | nC   | $V_{DS}=200\text{ V}$ , $V_{GS}=0\text{ V}$                                    |
| Output Energy                | $E_{oss}$     | -      | 3.0  | -    | μJ   | $V_{DS}=200\text{ V}$ , $V_{GS}=0\text{ V}$                                    |

<sup>10)</sup> As per JEP192, Guidelines for Gate Charge ( $Q_g$ ) Test Method for SiC MOSFET.

**Table 8 Reverse diode characteristics**

| Parameter                                     | Symbol        | Values |             |      | Unit | Note/ Test Condition                                                                                                                                                   |
|-----------------------------------------------|---------------|--------|-------------|------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                               |               | Min.   | Typ.        | Max. |      |                                                                                                                                                                        |
| Diode continuous forward current              | $I_S$         | -      | -           | 24   | A    | $T_C=25\text{ °C}$                                                                                                                                                     |
| Diode pulse current                           | $I_{S,pulse}$ | -      | -           | 150  | A    | $T_C=25\text{ °C}$ , $t_{pulse} \leq 250\text{ ns}$                                                                                                                    |
| Diode forward voltage                         | $V_{SD}$      | -      | 3.5         | 4.3  | V    | $V_{GS}=0\text{ V}$ , $I_S=11.1\text{ A}$ , $T_j=25\text{ °C}$                                                                                                         |
| MOSFET forward recovery time                  | $t_{fr}$      | -      | 11.5<br>8.5 | -    | ns   | $V_R=200\text{ V}$ , $I_S=11.1\text{ A}$ ,<br>$di_S/dt=1000\text{ A}/\mu\text{s}$<br>$V_R=200\text{ V}$ , $I_S=11.1\text{ A}$ ,<br>$di_S/dt=3000\text{ A}/\mu\text{s}$ |
| MOSFET forward recovery charge <sup>11)</sup> | $Q_{fr}$      | -      | 39<br>77    | -    | nC   | $V_R=200\text{ V}$ , $I_S=11.1\text{ A}$ ,<br>$di_S/dt=1000\text{ A}/\mu\text{s}$<br>$V_R=200\text{ V}$ , $I_S=11.1\text{ A}$ ,<br>$di_S/dt=3000\text{ A}/\mu\text{s}$ |

<sup>11)</sup>  $Q_{fr}$  includes  $Q_{oss}$ . Refer to Table 10 for test setup.

5 Electrical characteristics diagrams

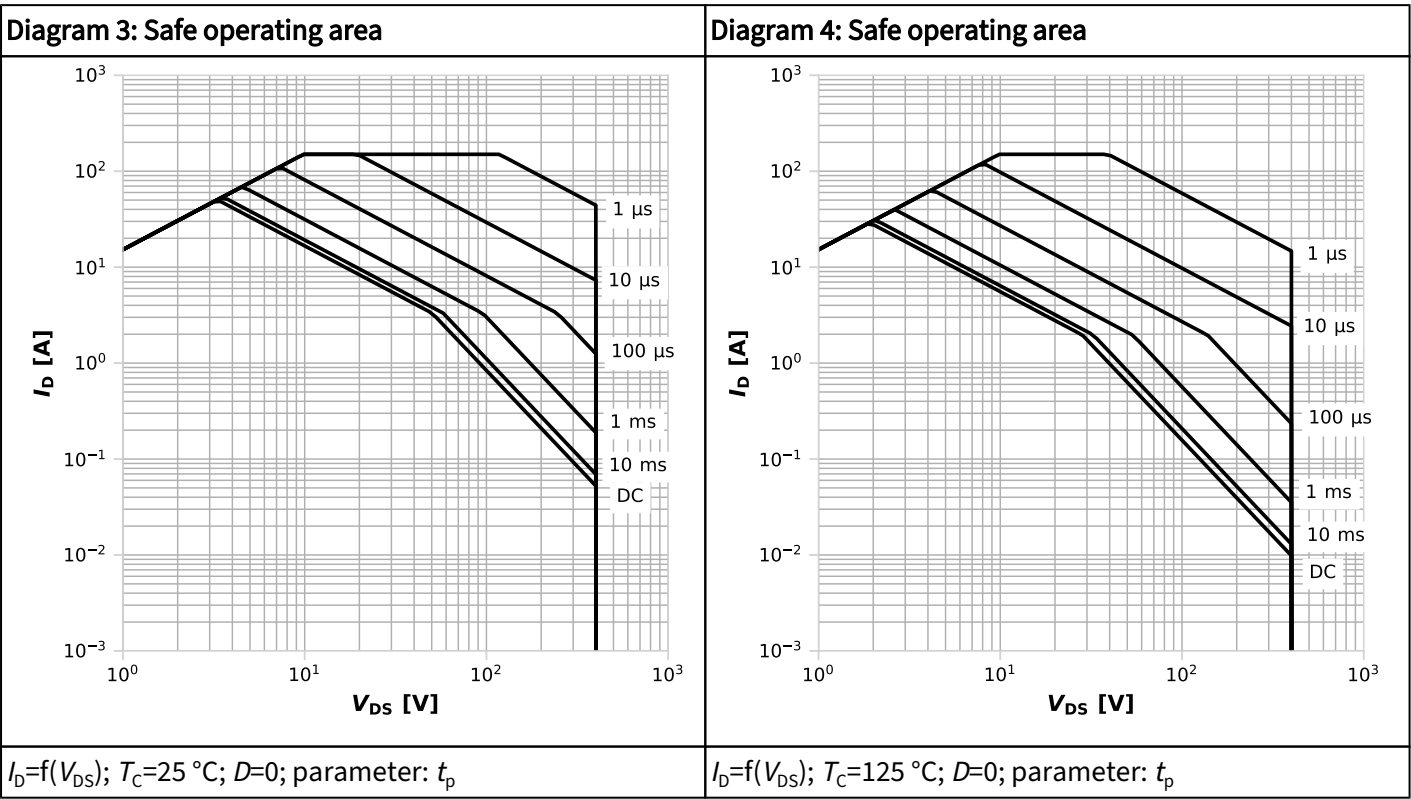
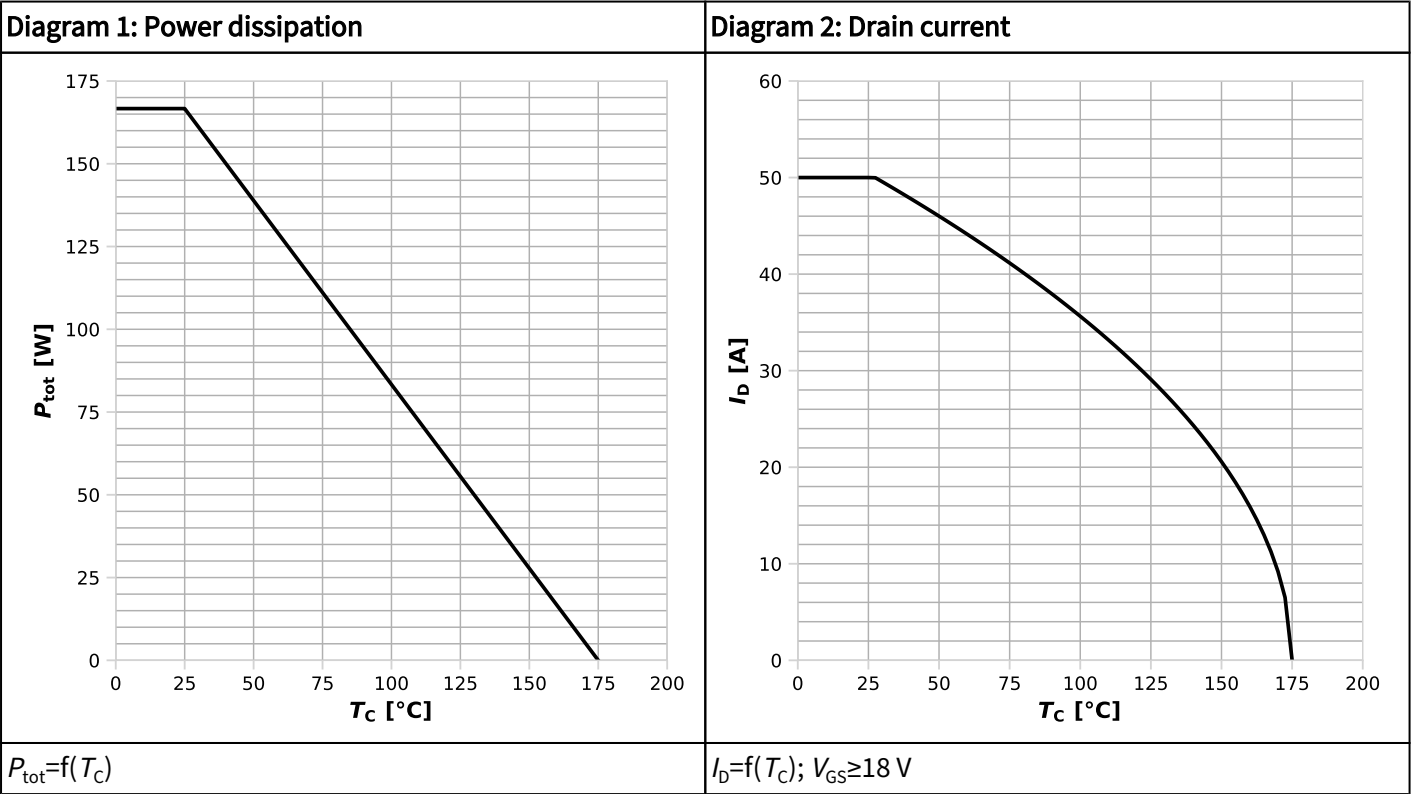
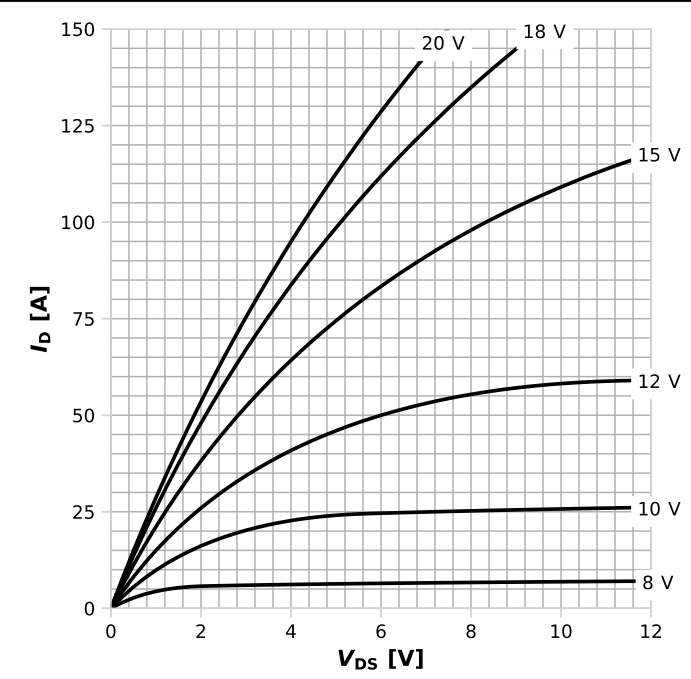
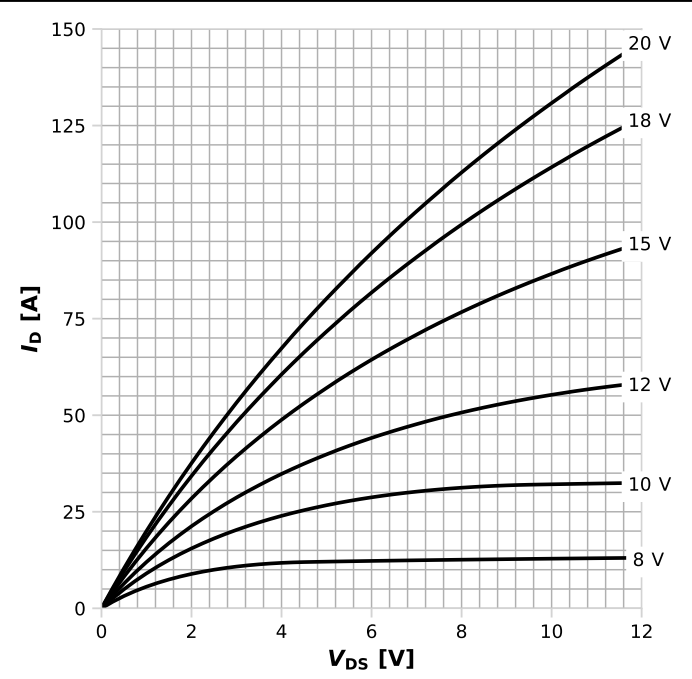


Diagram 5: Typ. output characteristics



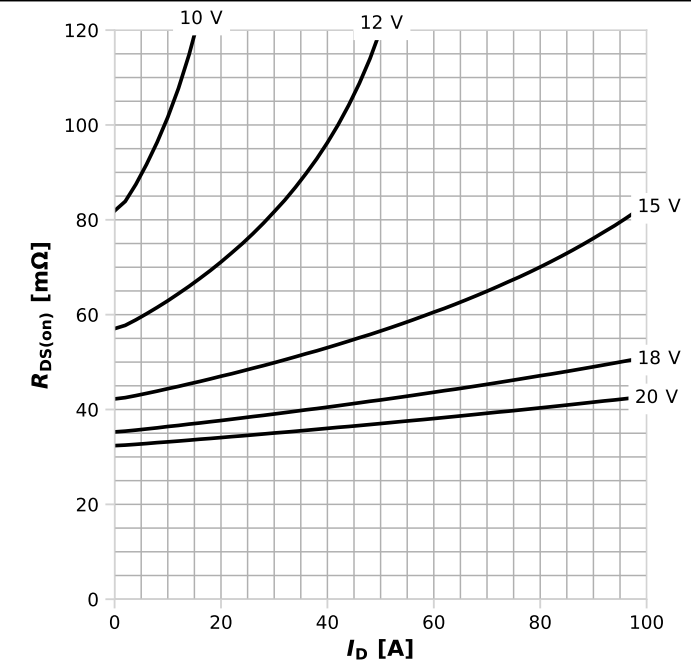
$I_D = f(V_{DS})$ ,  $T_j = 25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



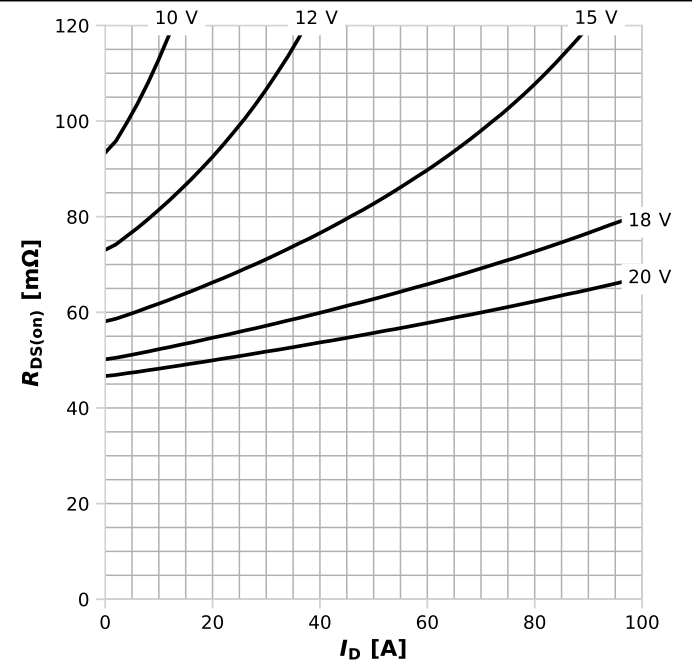
$I_D = f(V_{DS})$ ,  $T_j = 175\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. drain-source on resistance



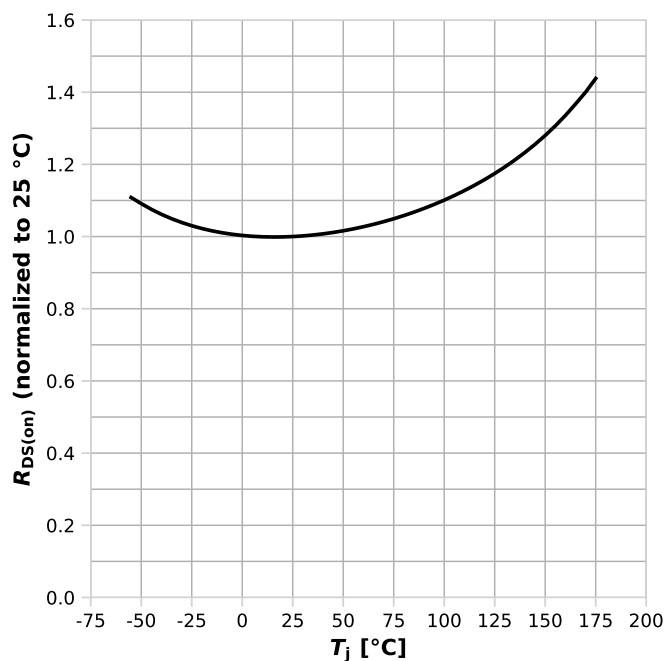
$R_{DS(on)} = f(I_D)$ ,  $T_j = 25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 8: Typ. drain-source on resistance



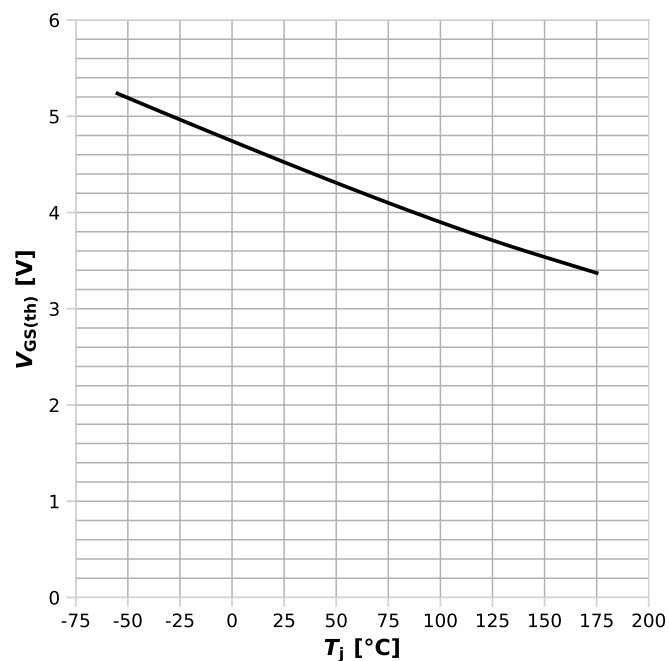
$R_{DS(on)} = f(I_D)$ ,  $T_j = 175\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 9: Normalized drain-source on resistance



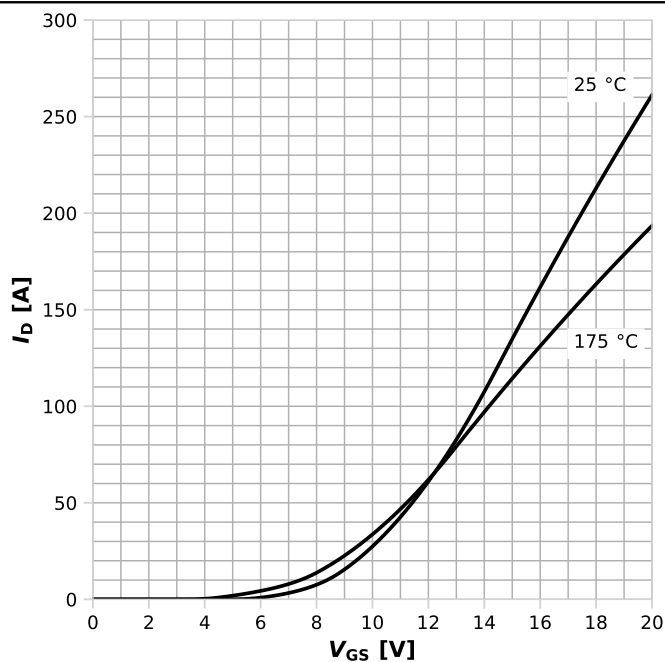
$$R_{DS(on)} = f(T_j), I_D = 11.1 \text{ A}, V_{GS} = 18 \text{ V}$$

Diagram 10: Typ. gate threshold voltage



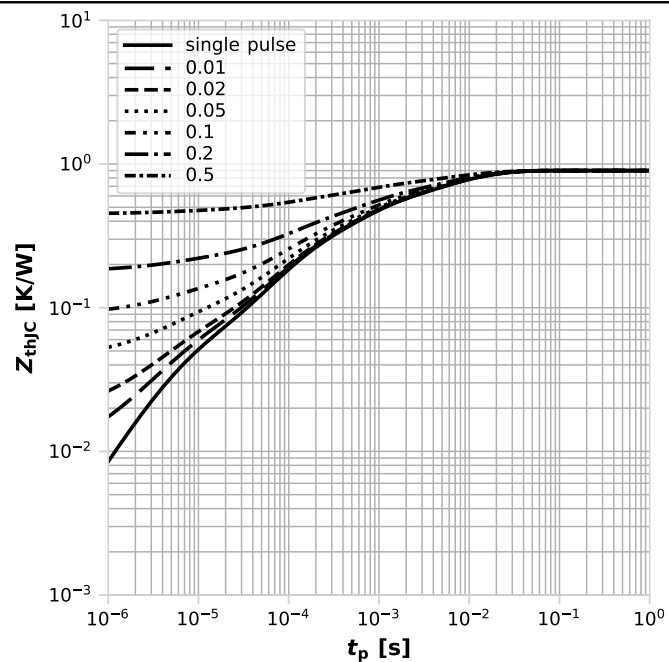
$$V_{GS(th)} = f(T_j), V_{GS} = V_{DS}, I_D = 4 \text{ mA}$$

Diagram 11: Typ. transfer characteristics



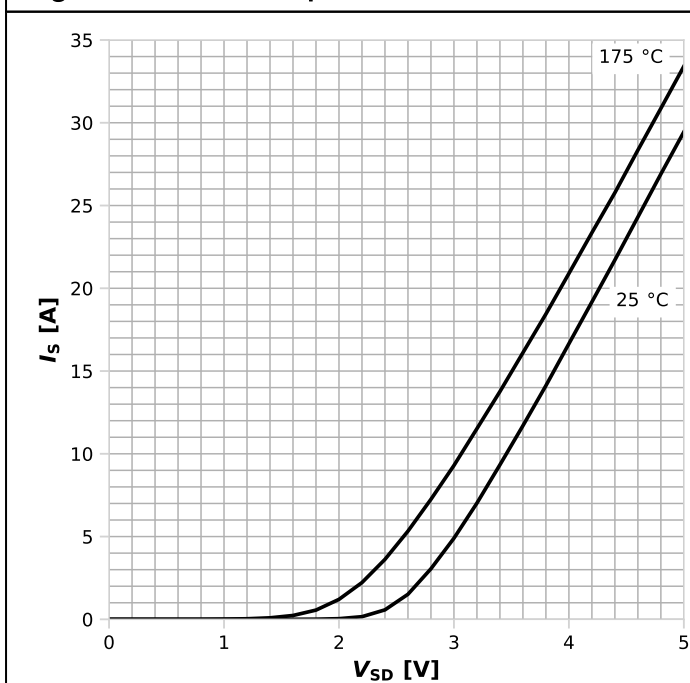
$$I_D = f(V_{GS}), |V_{DS}| > 2|I_D|R_{DS(on)max}, \text{ parameter: } T_j$$

Diagram 12: Max. transient thermal impedance



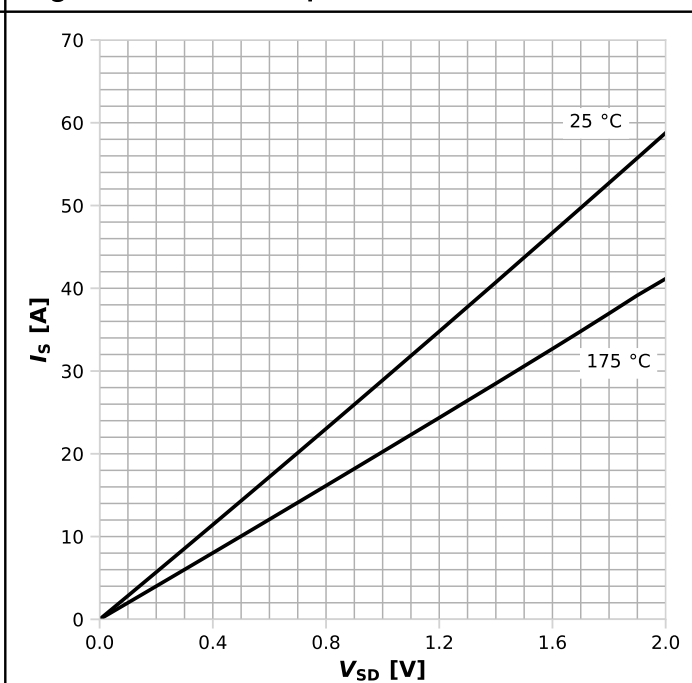
$$Z_{thJC} = f(t_p), \text{ parameter: } D = t_p / T$$

Diagram 13: Reverse output characteristics



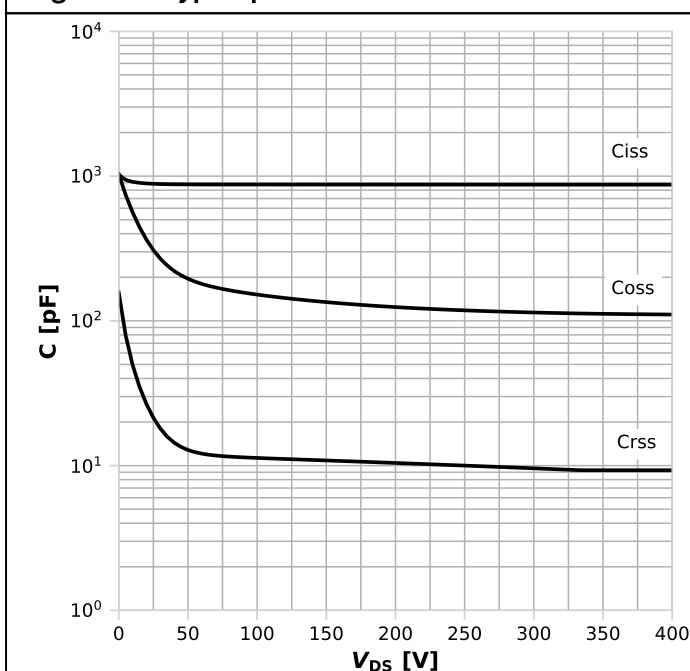
$I_F = f(V_{SD})$ ,  $V_{GS} = 0$  V; parameter:  $T_j$

Diagram 14: Reverse output characteristics



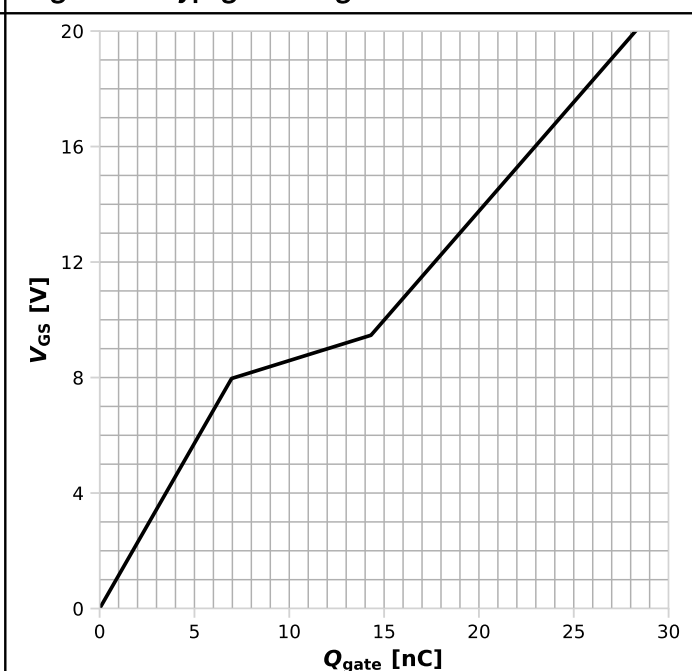
$I_F = f(V_{SD})$ ,  $V_{GS} = 18$  V; parameter:  $T_j$

Diagram 15: Typ. capacitances



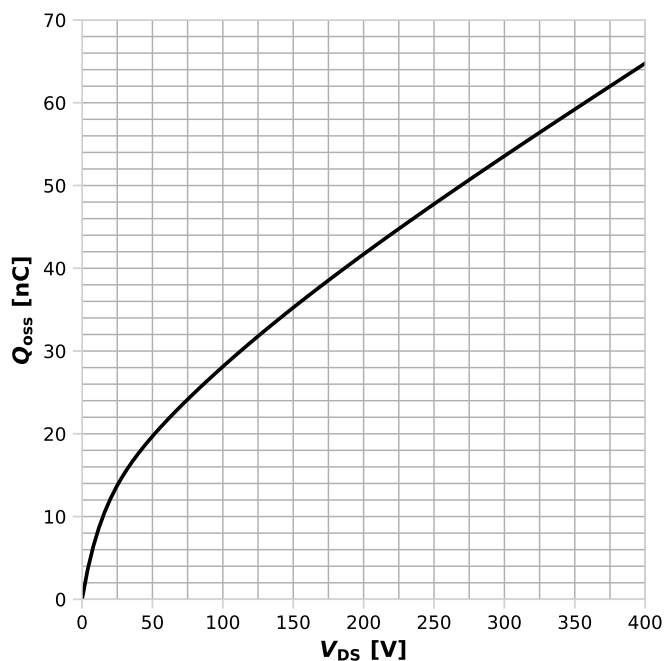
$C = f(V_{DS})$ ;  $V_{GS} = 0$  V;  $f = 1$  MHz

Diagram 16: Typ. gate charge



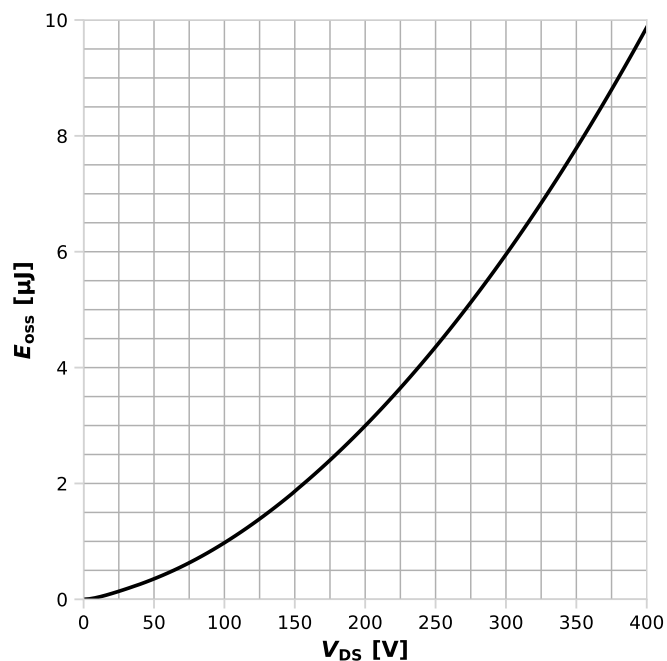
$V_{GS} = f(Q_{gate})$ ,  $V_{DD} = 200$  V,  $I_D = 11.1$  A pulsed,  $T_j = 25$  °C

Diagram 17: Typ. output charge



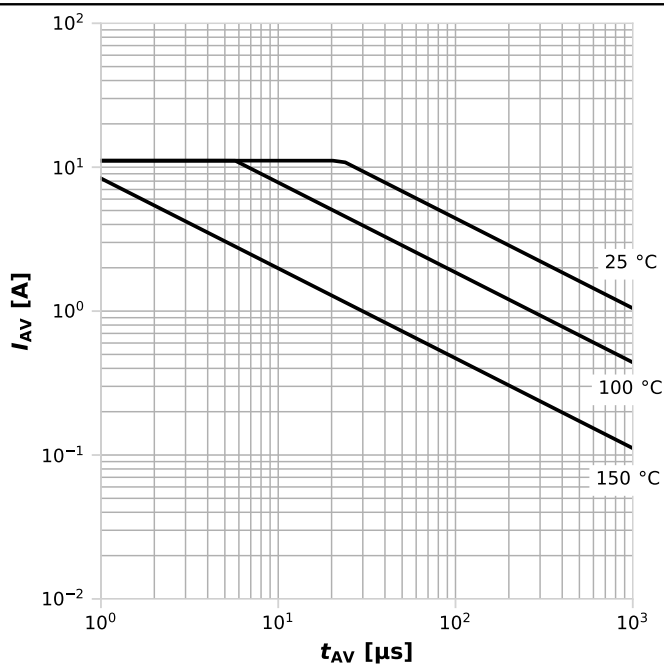
$$Q_{oss}=f(V_{DS}), V_{GS}=0\text{ V}$$

Diagram 18: Typ. output energy



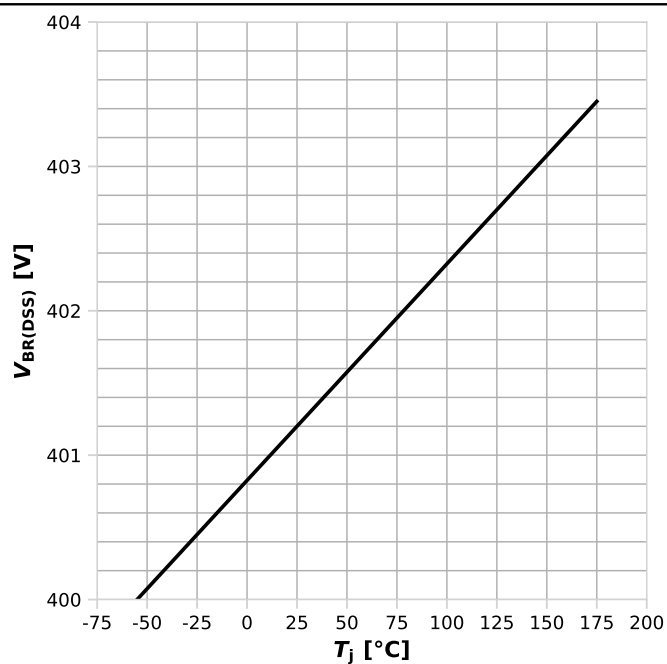
$$E_{oss}=f(V_{DS}), V_{GS}=0\text{ V}$$

Diagram 19: Avalanche characteristics



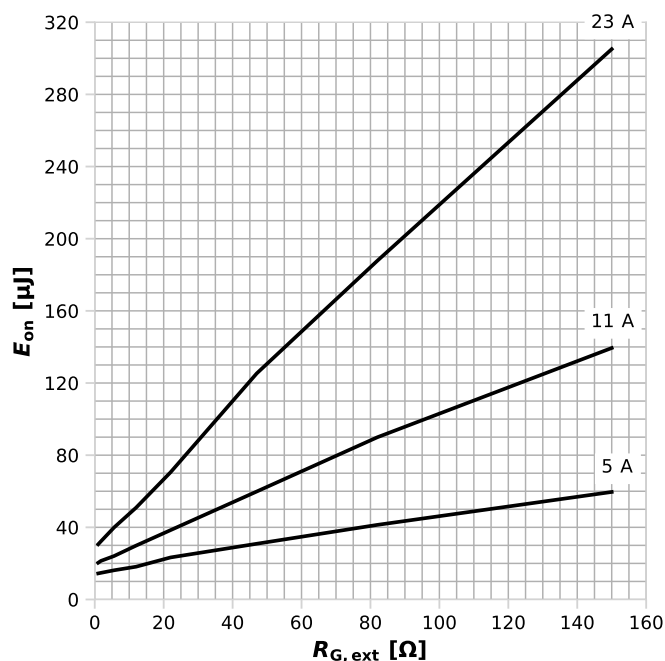
$$I_{AS}=f(t_{AV}); R_{GS}=25\ \Omega; \text{parameter: } T_{j,\text{start}}$$

Diagram 20: Min. drain-source breakdown voltage



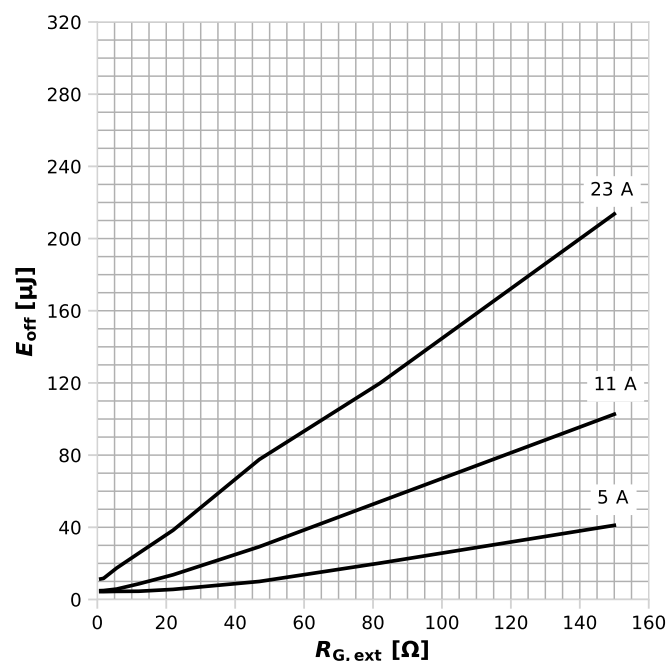
$$V_{BR(DSS)}=f(T_j); I_D=0.4\text{ mA}$$

**Diagram 21: Typ. turn-on switching losses**



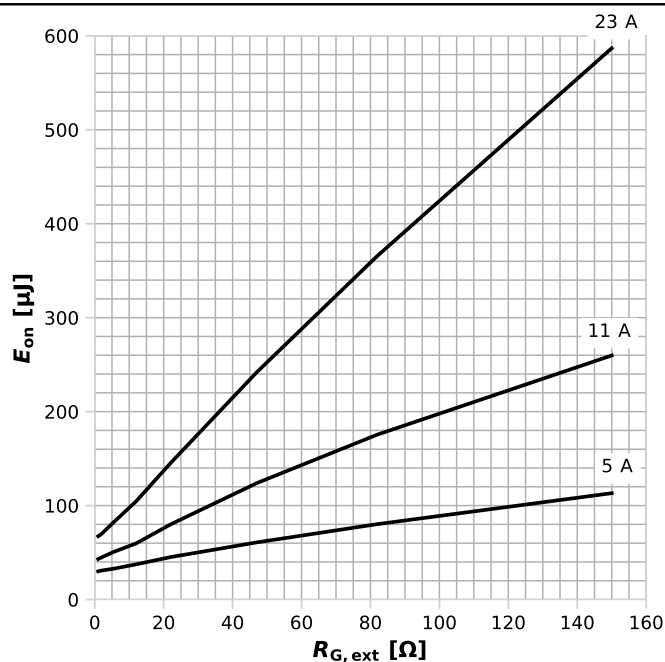
$E_{on}=f(R_{G,ext})$ ,  $V_{DD}=200$  V,  $V_G=0...18$  V; parameter:  $I_D$

**Diagram 22: Typ. turn-off switching losses**



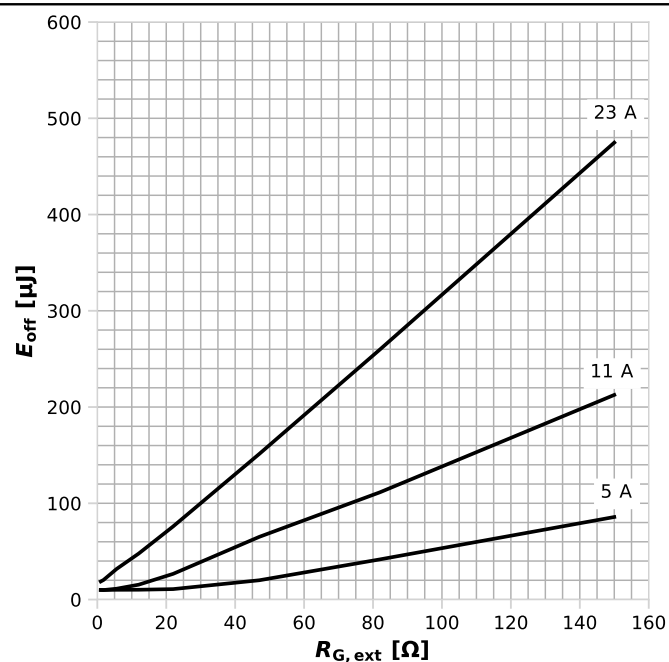
$E_{off}=f(R_{G,ext})$ ,  $V_{DD}=200$  V,  $V_G=18...0$  V; parameter:  $I_D$

**Diagram 23: Typ. turn-on switching losses**



$E_{on}=f(R_{G,ext})$ ,  $V_{DD}=320$  V,  $V_G=0...18$  V; parameter:  $I_D$

**Diagram 24: Typ. turn-off switching losses**



$E_{off}=f(R_{G,ext})$ ,  $V_{DD}=320$  V,  $V_G=18...0$  V; parameter:  $I_D$

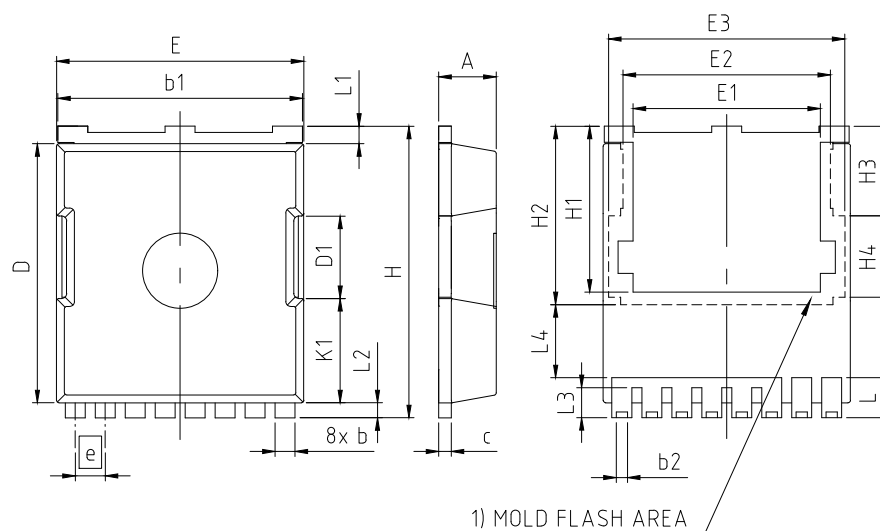
**Table 9      Switching times (CoolSiC)**

**Table 9      Switching times (CoolSiC)**

**Table 10**     **Body diode characteristics (CoolSiC)**

The graph plots voltage  $V_s$  and current  $I$  against time  $t$ . The dashed line represents  $V_{DS}$ , which rises from 0 to  $V_{DD}$ . The solid line represents  $I_{DS}$ , which falls from  $I_{DS0}$  to  $I_{DSfr}$ . The switching time  $t_{fr}$  is the duration where  $V_{DS}$  is between 10% and 90% of  $V_{DD}$ . The switching energy  $Q_{fr}$  is the shaded area under the  $I_{DS}$  curve during this transition.

## 7 Package Outlines



| PACKAGE - GROUP<br>NUMBER: <b>PG-HSOF-8-U02</b> |             |       |
|-------------------------------------------------|-------------|-------|
| DIMENSIONS                                      | MILLIMETERS |       |
|                                                 | MIN.        | MAX.  |
| <b>A</b>                                        | 2.20        | 2.40  |
| <b>b</b>                                        | 0.70        | 0.90  |
| <b>b1</b>                                       | 9.70        | 9.90  |
| <b>b2</b>                                       | 0.42        | 0.50  |
| <b>c</b>                                        | 0.40        | 0.60  |
| <b>D</b>                                        | 10.28       | 10.58 |
| <b>D1</b>                                       | 3.30        |       |
| <b>E</b>                                        | 9.70        | 10.10 |
| <b>E1</b>                                       | 7.50        |       |
| <b>E2</b>                                       | 8.50        |       |
| <b>E3</b>                                       | 9.46        |       |
| <b>e</b>                                        | 1.20 (BSC)  |       |
| <b>H</b>                                        | 11.48       | 11.88 |
| <b>H1</b>                                       | 6.55        | 6.95  |
| <b>H2</b>                                       | 7.15        |       |
| <b>H3</b>                                       | 3.59        |       |
| <b>H4</b>                                       | 3.26        |       |
| <b>N</b>                                        | 8           |       |
| <b>K1</b>                                       | 4.18        |       |
| <b>L</b>                                        | 1.40        | 1.80  |
| <b>L1</b>                                       | 0.50        | 0.90  |
| <b>L2</b>                                       | 0.50        | 0.70  |
| <b>L3</b>                                       | 1.00        | 1.30  |
| <b>L4</b>                                       | 2.62        | 2.81  |

1) PARTIALLY COVERED WITH MOLD FLASH

**Figure 1** Outline PG-HSOF-8, dimensions in mm

## Revision History

IMT40R036M2H

### Revision 2024-04-27, Rev. 2.0

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 1.0      | 2024-04-26 | Release of preliminary version               |
| 2.0      | 2024-04-27 | Release of final                             |

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