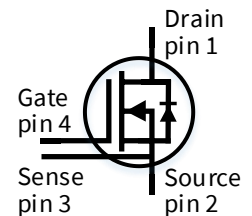


# IMZ120R060M1H

## CoolSiC™ 1200V SiC Trench MOSFET Silicon Carbide MOSFET

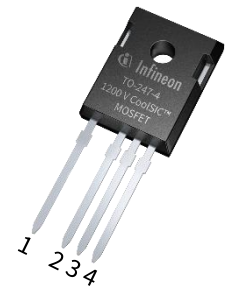
### Features

- Very low switching losses
- Threshold-free on state characteristic
- Benchmark gate threshold voltage,  $V_{GS(th)} = 4.5V$
- 0V turn-off gate voltage for easy and simple gate drive
- Fully controllable dV/dt
- Robust body diode for hard commutation
- Temperature independent turn-off switching losses
- Sense pin for optimized switching performance



### Benefits

- Efficiency improvement
- Enabling higher frequency
- Increased power density
- Cooling effort reduction
- Reduction of system complexity and cost



### Potential applications

- Energy generation
  - Solar string inverter and solar optimizer
- Industrial power supplies
  - Industrial UPS
  - Industrial SMPS
- Infrastructure – Charge
  - Charger



### Product validation

Qualified for industrial applications according to the relevant tests of JEDEC 47/20/22

Note: *the source and sense pins are not exchangeable, their exchange might lead to malfunction*

**Table 1 Key Performance and Package Parameters**

| Type          | $V_{DS}$ | $I_D$<br><small><math>T_C = 25^\circ C, R_{th(j-c,max)}</math></small> | $R_{DS(on)}$<br><small><math>T_{vj} = 25^\circ C, I_D = 13A, V_{GS} = 18V</math></small> | $T_{vj,max}$   | Marking  | Package    |
|---------------|----------|--|--|----------------|----------|------------|
| IMZ120R060M1H | 1200V    | 36A  | 60m $\Omega$   | 175 $^\circ C$ | 12M1H060 | PG-TO247-4 |

## Table of contents

|   |           |
|---|-----------|
| <b>Features .....</b>                             | <b>1</b>  |
| <b>Benefits .....</b>                             | <b>1</b>  |
| <b>Potential applications .....</b>               | <b>1</b>  |
| <b>Product validation .....</b>                   | <b>1</b>  |
| <b>Table of contents .....</b>                    | <b>2</b>  |
| <b>1 Maximum ratings .....</b>                    | <b>3</b>  |
| <b>2 Thermal resistances .....</b>                | <b>4</b>  |
| <b>3 Electrical Characteristics .....</b>         | <b>5</b>  |
| 3.1 Static characteristics .....                  | 5         |
| 3.2 Dynamic characteristics .....                 | 6         |
| 3.3 Switching characteristics .....               | 7         |
| <b>4 Electrical characteristic diagrams .....</b> | <b>8</b>  |
| <b>5 Package drawing .....</b>                    | <b>14</b> |
| <b>6 Test conditions .....</b>                    | <b>15</b> |
| <b>Revision history .....</b>                     | <b>16</b> |

## Maximum ratings

## 1 Maximum ratings

For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

**Table 2 Maximum ratings**

| Parameter   | Symbol           | Value      | Unit             |
|---|------------------|------------|------------------|
| Drain-source voltage, $T_{vj} \geq 25^\circ\text{C}$  | $V_{DSS}$        | 1200       | V                |
| DC drain current for $R_{th(j-c,max)}$ , limited by $T_{vjmax}$ , $V_{GS} = 18\text{V}$ ,<br>$T_C = 25^\circ\text{C}$ | $I_D$            | 36         | A                |
| $T_C = 100^\circ\text{C}$   |                  | 26         |                  |
| Pulsed drain current, $t_p$ limited by $T_{vjmax}$ , $V_{GS} = 18\text{V}$  | $I_{D,pulse}^1$  | 76         | A                |
| DC body diode forward current for $R_{th(j-c,max)}$ ,<br>limited by $T_{vjmax}$ , $V_{GS} = 0\text{V}$                | $I_{SD}$         | 36         | A                |
| $T_C = 100^\circ\text{C}$   |                  | 22         |                  |
| Pulsed body diode current, $t_p$ limited by $T_{vjmax}$   | $I_{SD,pulse}^1$ | 76         | A                |
| Gate-source voltage <sup>2</sup>  |                  |            |                  |
| Max transient voltage, < 1% duty cycle  | $V_{GS}$         | -7... 23   | V                |
| Recommended turn-on gate voltage  | $V_{GS,on}$      | 15... 18   |                  |
| Recommended turn-off gate voltage   | $V_{GS,off}$     | 0          |                  |
| Power dissipation, limited by $T_{vjmax}$   | $P_{tot}$        | 150        | W                |
| $T_C = 100^\circ\text{C}$   |                  | 75         |                  |
| Virtual junction temperature  | $T_{vj}$         | -55... 175 | $^\circ\text{C}$ |
| Storage temperature   | $T_{stg}$        | -55... 150 | $^\circ\text{C}$ |
| Soldering temperature,<br>wave soldering only allowed at leads,<br>1.6mm (0.063 in.) from case for 10 s               | $T_{sold}$       | 260        | $^\circ\text{C}$ |
| Mounting torque, M3 screw<br>Maximum of mounting processes: 3   | $M$              | 0.6        | Nm               |

<sup>1</sup> verified by design

<sup>2</sup> **Important note:** The selection of positive and negative gate-source voltages impacts the long-term behavior of the device. The design guidelines described in [Application Note AN2018-09](#) must be considered to ensure sound operation of the device over the planned lifetime.

## Thermal resistances

## 2 Thermal resistances

Table 3

| Parameter   | Symbol        | Conditions | Value |      |      | Unit |
|---|---------------|------------|-------|------|------|------|
|   |               |            | min.  | typ. | max. |      |
| MOSFET/body diode thermal resistance, junction – case | $R_{th(j-c)}$ |            | -     | 0.8  | 1    | K/W  |
| Thermal resistance, junction – ambient                | $R_{th(j-a)}$ | leaded     | -     | -    | 62   | K/W  |

### 3 Electrical Characteristics

#### 3.1 Static characteristics

**Table 4** Static characteristics (at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified)

| Parameter                        | Symbol       | Conditions   | Value |      |      | Unit |
|----------------------------------|--------------|--|-------|------|------|------|
|                                  |              |  | min.  | typ. | max. |      |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS} = 18\text{V}, I_D = 13\text{A},$<br>$T_{vj} = 25^{\circ}\text{C}$  | -     | 60   | 83   | mΩ   |
|                                  |              | $T_{vj} = 100^{\circ}\text{C}$   | -     | 76   | -    |      |
|                                  |              | $T_{vj} = 175^{\circ}\text{C}$   | -     | 113  | -    |      |
|                                  |              | $V_{GS} = 15\text{V}, I_D = 13\text{A},$<br>$T_{vj} = 25^{\circ}\text{C}$  | -     | 80   | 106  |      |
| Body diode forward voltage       | $V_{SD}$     | $V_{GS} = 0\text{V}, I_{SD} = 13\text{A}$<br>$T_{vj} = 25^{\circ}\text{C}$   | -     | 4.1  | 5.2  | V    |
|                                  |              | $T_{vj} = 100^{\circ}\text{C}$   | -     | 4.0  | -    |      |
|                                  |              | $T_{vj} = 175^{\circ}\text{C}$   | -     | 3.9  | -    |      |
| Gate-source threshold voltage    | $V_{GS(th)}$ | (tested after 1 ms pulse at<br>$V_{GS} = 20\text{V}$ )<br>$I_D = 5.6\text{mA}, V_{DS} = V_{GS}$<br>$T_{vj} = 25^{\circ}\text{C}$ | 3.5   | 4.5  | 5.7  | V    |
|                                  |              | $T_{vj} = 175^{\circ}\text{C}$   | -     | 3.6  | -    |      |
| Zero gate voltage drain current  | $I_{DSS}$    | $V_{GS} = 0\text{V}, V_{DS} = 1200\text{V}$<br>$T_{vj} = 25^{\circ}\text{C}$   | -     | 0.6  | 180  | μA   |
|                                  |              | $T_{vj} = 175^{\circ}\text{C}$   | -     | 1.9  | -    |      |
| Gate-source leakage current      | $I_{GSS}$    | $V_{GS} = 23\text{V}, V_{DS} = 0\text{V}$  | -     | -    | 100  | nA   |
|                                  |              | $V_{GS} = -7\text{V}, V_{DS} = 0\text{V}$  | -     | -    | -100 | nA   |
| Transconductance                 | $g_{fs}$     | $V_{DS} = 20\text{V}, I_D = 13\text{A}$  | -     | 7    | -    | S    |
| Internal gate resistance         | $R_{G,int}$  | $f = 1\text{MHz}, V_{AC} = 25\text{mV}$  | -     | 6    | -    | Ω    |

Electrical Characteristics

3.2 Dynamic characteristics

Table 5 Dynamic characteristics (at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified)

| Parameter                                 | Symbol      | Conditions  | Value |      |      | Unit          |
|---|-------------|---|-------|------|------|---------------|
|   |             |   | min.  | typ. | max. |               |
| Input capacitance                         | $C_{iss}$   | $V_{DD} = 800\text{V}, V_{GS} = 0\text{V},$<br>$f = 1\text{MHz}, V_{AC} = 25\text{mV}$  | -     | 1060 | -    | pF            |
| Output capacitance                        | $C_{oss}$   |   | -     | 58   | -    |               |
| Reverse capacitance                       | $C_{rss}$   |   | -     | 6.5  | -    |               |
| $C_{oss}$ stored energy                   | $E_{oss}$   |   | -     | 22   | -    | $\mu\text{J}$ |
| Total gate charge                         | $Q_G$       | $V_{DD} = 800\text{V}, I_D = 13\text{A},$<br>$V_{GS} = 0/18\text{V}, \text{turn-on pulse}$  | -     | 31   | -    | nC            |
| Gate to source charge                     | $Q_{GS,pl}$ |   | -     | 9    | -    |               |
| Gate to drain charge                      | $Q_{GD}$    |   | -     | 7    | -    |               |
| Short-circuit withstand time <sup>3</sup> | $t_{SC}$    | $V_{DD} = 800\text{V}, L_{\sigma} = 80\text{nH},$<br>$R_{G,ext} = 80\text{ohm}, T_{vj} = 175^{\circ}\text{C}$<br>$V_{GS,on} = 15\text{V}$ | -     | 3    | -    | $\mu\text{s}$ |

<sup>3</sup> Verified by design for single short circuit event at  $V_{GS,on} = 15\text{V}$ .

## Electrical Characteristics

## 3.3 Switching characteristics

Table 6 Switching characteristics, Inductive load <sup>4</sup>

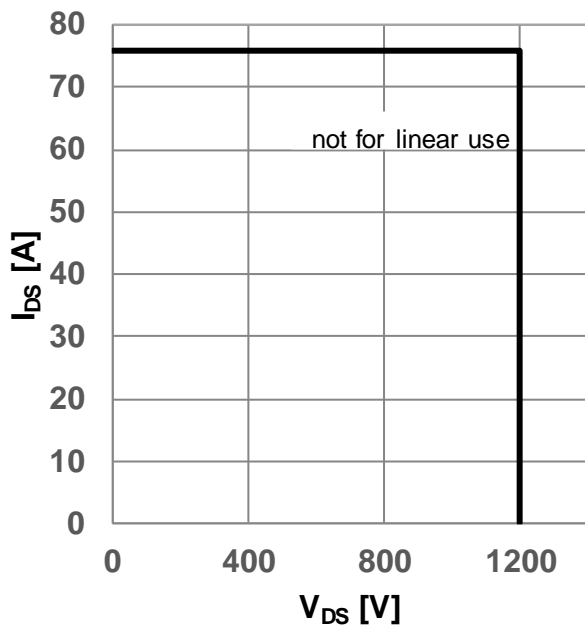
| Parameter   | Symbol       | Conditions  | Value |      |      | Unit          |
|---|--------------|---|-------|------|------|---------------|
|   |              |   | min.  | typ. | max. |               |
| <b>MOSFET Characteristics, <math>T_{vj} = 25^{\circ}\text{C}</math></b>     |              |   |       |      |      |               |
| Turn-on delay time  | $t_{d(on)}$  | $V_{DD} = 800\text{V}, I_D = 13\text{A},$<br>$V_{GS} = 0/18\text{V}, R_{G,ext} = 2\Omega,$<br>$L_{\sigma} = 40\text{nH},$<br>diode:<br>body diode at $V_{GS} = 0\text{V}$<br>see Fig. E | -     | 6    | -    | ns            |
| Rise time   | $t_r$        |   | -     | 5    | -    |               |
| Turn-off delay time   | $t_{d(off)}$ |   | -     | 12.7 | -    |               |
| Fall time   | $t_f$        |   | -     | 10.8 | -    |               |
| Turn-on energy  | $E_{on}$     |   | -     | 135  | -    | $\mu\text{J}$ |
| Turn-off energy   | $E_{off}$    |   | -     | 31   | -    |               |
| Total switching energy  | $E_{tot}$    | -   | 166   | -    |      |               |
| <b>Body Diode Characteristics, <math>T_{vj} = 25^{\circ}\text{C}</math></b> |              |   |       |      |      |               |
| Diode reverse recovery charge   | $Q_{rr}$     | $V_{DD} = 800\text{V}, I_{SD} = 13\text{A},$<br>$V_{GS}$ at diode = $0\text{V},$<br>$di_f/dt = 1000\text{A}/\mu\text{s},$<br>$Q_{rr}$ includes also $Q_C,$<br>see Fig. C                | -     | 180  | -    | nC            |
| Diode peak reverse recovery current   | $I_{rrm}$    |   | -     | 5    | -    | A             |

**MOSFET Characteristics,  $T_{vj} = 175^{\circ}\text{C}$** 

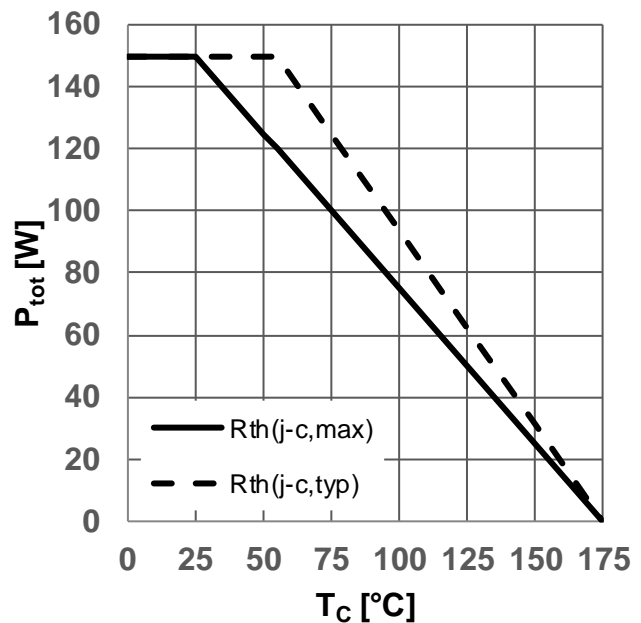
|  |              |   |     |      |   |               |
|--|--------------|---|-----|------|---|---------------|
| Turn-on delay time   | $t_{d(on)}$  | $V_{DD} = 800\text{V}, I_D = 13\text{A},$<br>$V_{GS} = 0/18\text{V}, R_{G,ext} = 2\Omega,$<br>$L_{\sigma} = 40\text{nH},$<br>diode:<br>body diode at $V_{GS} = 0\text{V}$<br>see Fig. E | -   | 6    | - | ns            |
| Rise time  | $t_r$        |   | -   | 11.6 | - |               |
| Turn-off delay time  | $t_{d(off)}$ |   | -   | 12.7 | - |               |
| Fall time  | $t_f$        |   | -   | 10.8 | - |               |
| Turn-on energy   | $E_{on}$     |   | -   | 196  | - | $\mu\text{J}$ |
| Turn-off energy  | $E_{off}$    |   | -   | 36   | - |               |
| Total switching energy   | $E_{tot}$    | -   | 232 | -    |   |               |
| <b>Body Diode Characteristics, <math>T_{vj} = 175^{\circ}\text{C}</math></b> |              |   |     |      |   |               |
| Diode reverse recovery charge  | $Q_{rr}$     | $V_{DD} = 800\text{V}, I_{SD} = 13\text{A},$<br>$V_{GS}$ at diode = $0\text{V},$<br>$di_f/dt = 1000\text{A}/\mu\text{s},$<br>$Q_{rr}$ includes also $Q_C,$<br>see Fig. C                | -   | 225  | - | nC            |
| Diode peak reverse recovery current  | $I_{rrm}$    |   | -   | 7    | - | A             |

<sup>4</sup> The chip technology was characterized up to 200 kV/ $\mu\text{s}$ . The measured dV/dt was limited by measurement test setup and package.

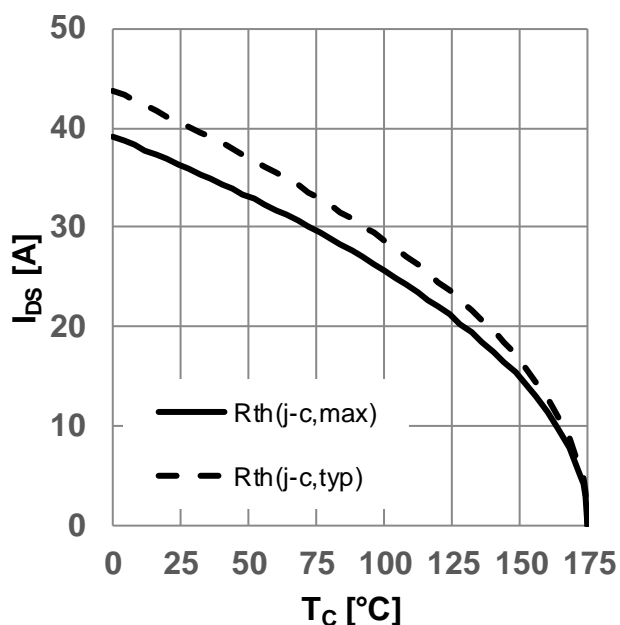
## 4 Electrical characteristic diagrams



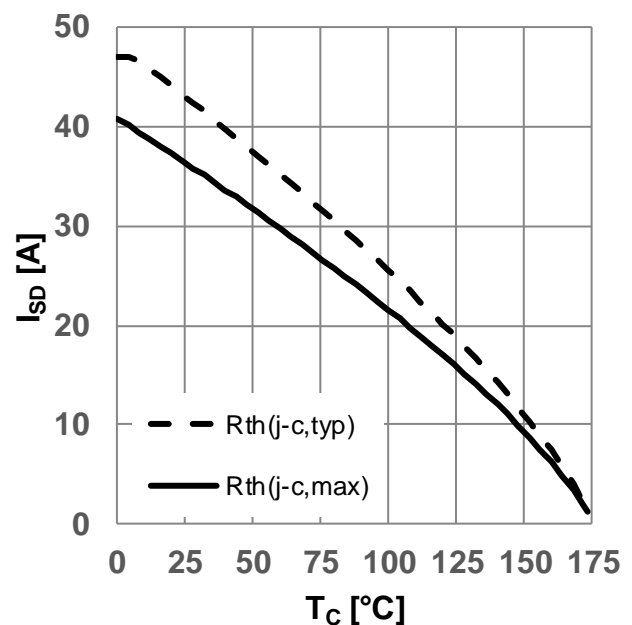
**Figure 1** Safe operating area (SOA)  
( $V_{GS} = 0/18V$ ,  $T_c = 25^\circ C$ ,  $T_j \leq 175^\circ C$ )



**Figure 2** Power dissipation as a function of case temperature limited by bond wire  
( $P_{tot} = f(T_c)$ )



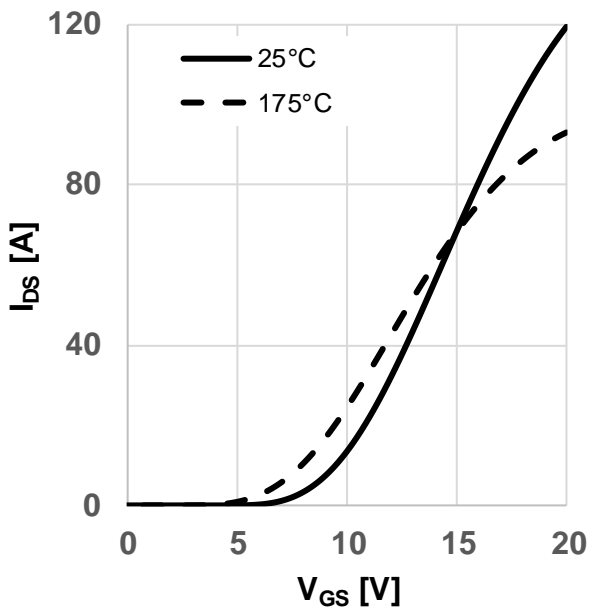
**Figure 3** Maximum DC drain to source current as a function of case temperature limited by bond wire ( $I_{DS} = f(T_c)$ )



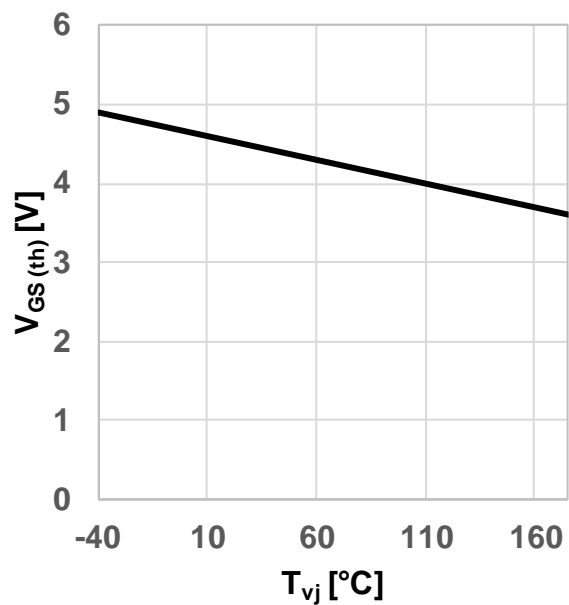
**Figure 4** Maximum source to drain current as a function of case temperature limited by bond wire ( $I_{SD} = f(T_c)$ ,  $V_{GS} = 0V$ )



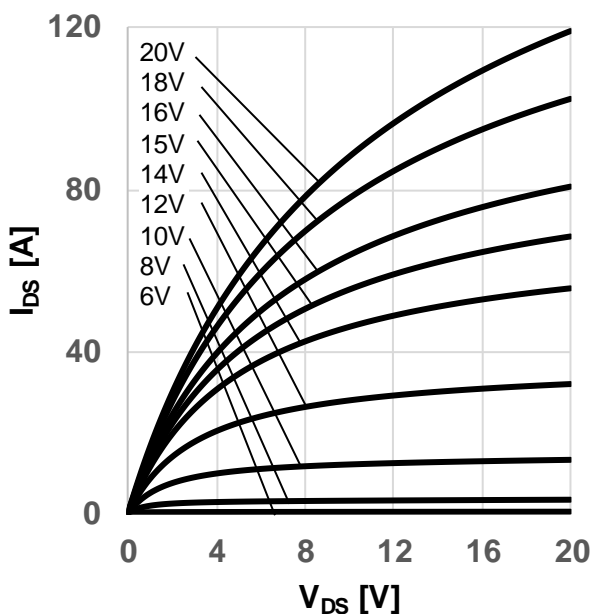
**Electrical characteristic diagrams**



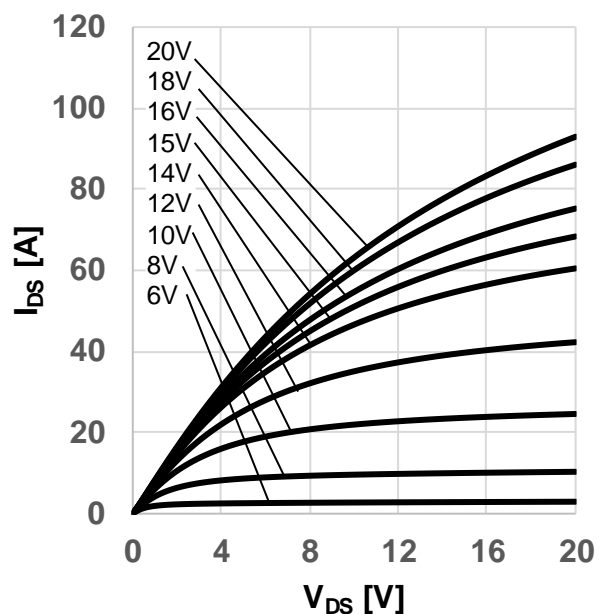
**Figure 5** Typical transfer characteristic  
 ( $I_{DS} = f(V_{GS})$ ,  $V_{DS} = 20V$ ,  $t_P = 20\mu s$ )



**Figure 6** Typical gate-source threshold voltage as a function of junction temperature  
 ( $V_{GS(th)} = f(T_{vj})$ ,  $I_{DS} = 5.6mA$ ,  $V_{GS} = V_{DS}$ )

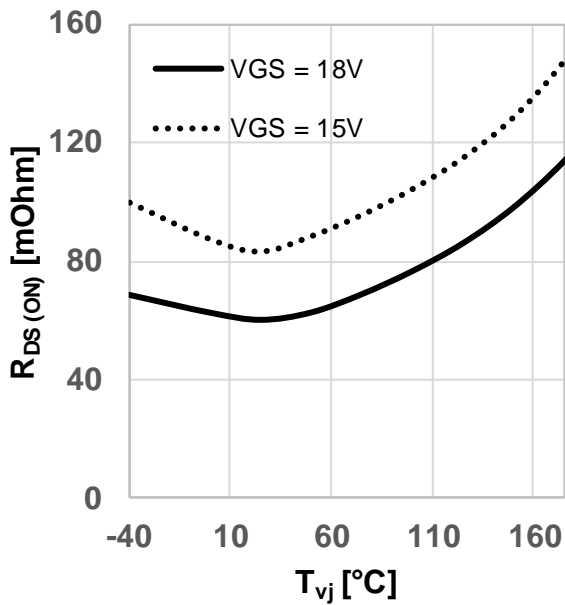


**Figure 7** Typical output characteristic,  $V_{GS}$  as parameter  
 ( $I_{DS} = f(V_{DS})$ ,  $T_{vj} = 25^\circ C$ ,  $t_P = 20\mu s$ )

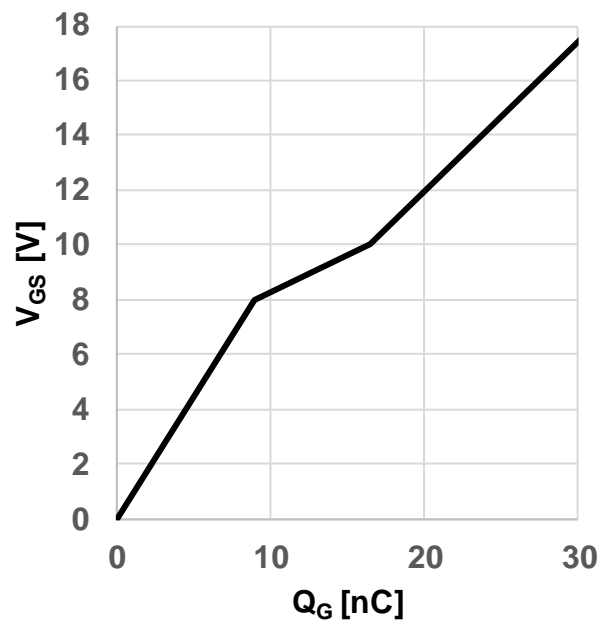


**Figure 8** Typical output characteristic,  $V_{GS}$  as parameter  
 ( $I_{DS} = f(V_{DS})$ ,  $T_{vj} = 175^\circ C$ ,  $t_P = 20\mu s$ )

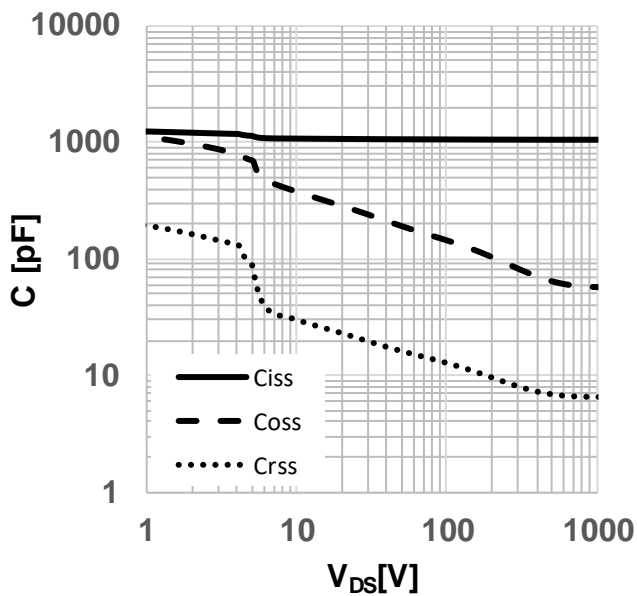
Electrical characteristic diagrams



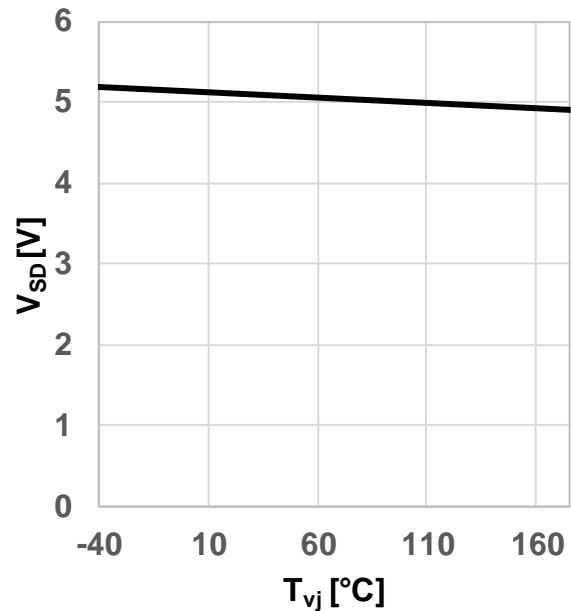
**Figure 9** Typical on-resistance as a function of junction temperature  
( $R_{DS(on)} = f(T_{vj})$ ,  $I_{DS} = 13A$ )



**Figure 10** Typical gate charge  
( $V_{GS} = f(Q_G)$ ,  $I_{DS} = 13A$ ,  $V_{DS} = 800V$ , turn-on pulse)

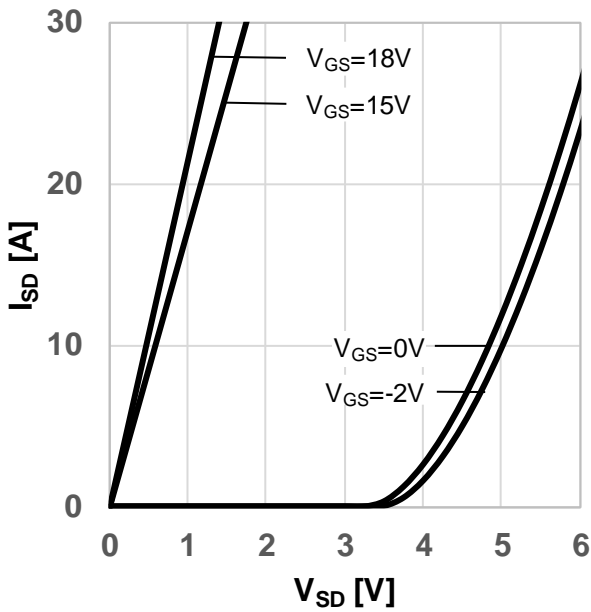


**Figure 11** Typical capacitance as a function of drain-source voltage  
( $C = f(V_{DS})$ ,  $V_{GS} = 0V$ ,  $f = 1MHz$ )

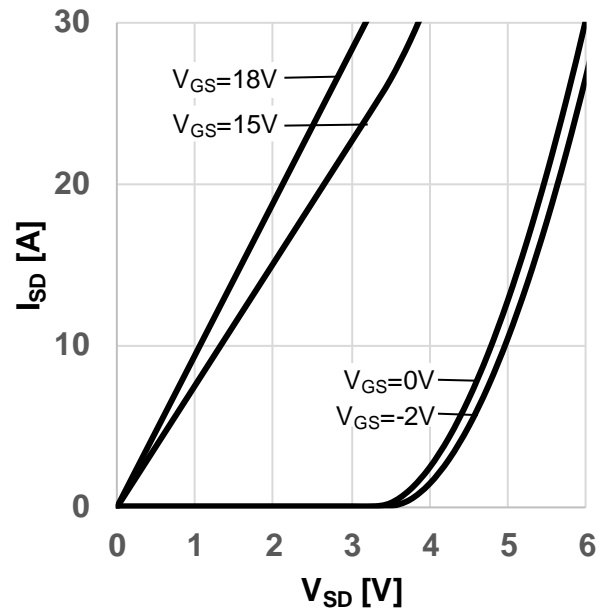


**Figure 12** Typical body diode forward voltage as function of junction temperature  
( $V_{SD} = f(T_{vj})$ ,  $V_{GS} = 0V$ ,  $I_{SD} = 13A$ )

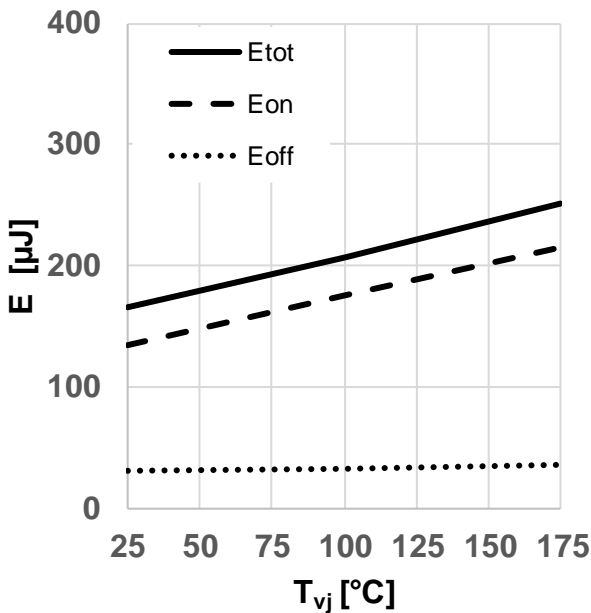
Electrical characteristic diagrams



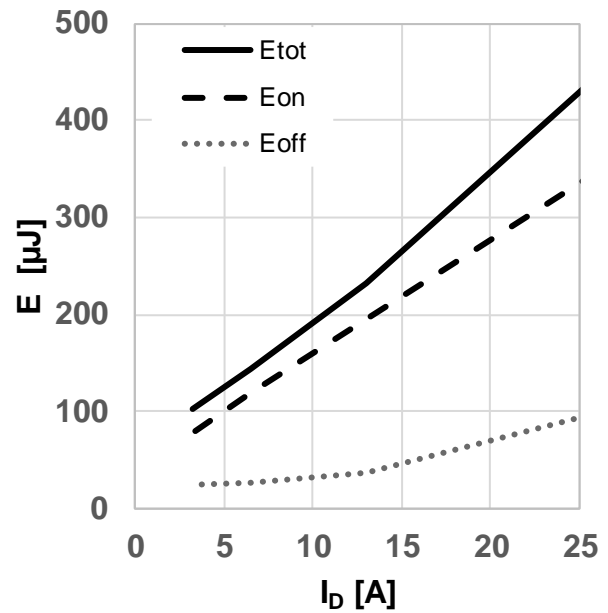
**Figure 13** Typical body diode forward current as function of forward voltage,  $V_{GS}$  as parameter  
( $I_{SD} = f(V_{SD})$ ,  $T_{vj} = 25^{\circ}\text{C}$ ,  $t_P = 20\mu\text{s}$ )



**Figure 14** Typical body diode forward current as function of forward voltage,  $V_{GS}$  as parameter  
( $I_{SD} = f(V_{SD})$ ,  $T_{vj} = 175^{\circ}\text{C}$ ,  $t_P = 20\mu\text{s}$ )

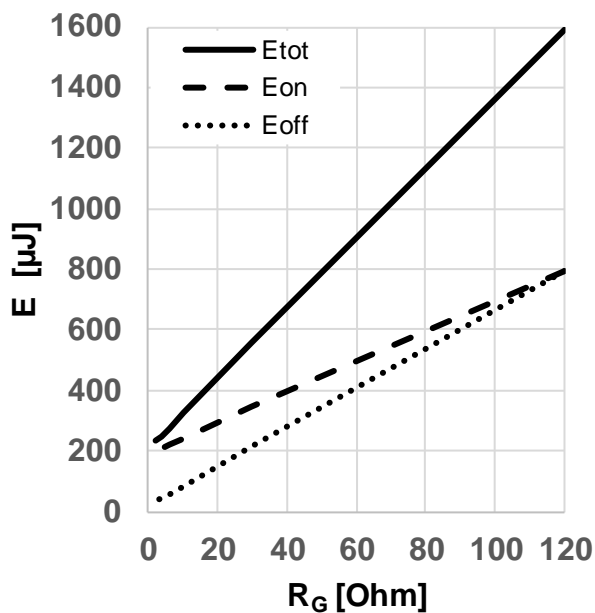


**Figure 15** Typical switching energy losses as a function of junction temperature  
( $E = f(T_{vj})$ ,  $V_{DD} = 800\text{V}$ ,  $V_{GS} = 0\text{V}/18\text{V}$ ,  $R_{G,ext} = 2\Omega$ ,  $I_D = 13\text{A}$ , ind. load, test circuit in Fig. E, diode: body diode at  $V_{GS} = 0\text{V}$ )

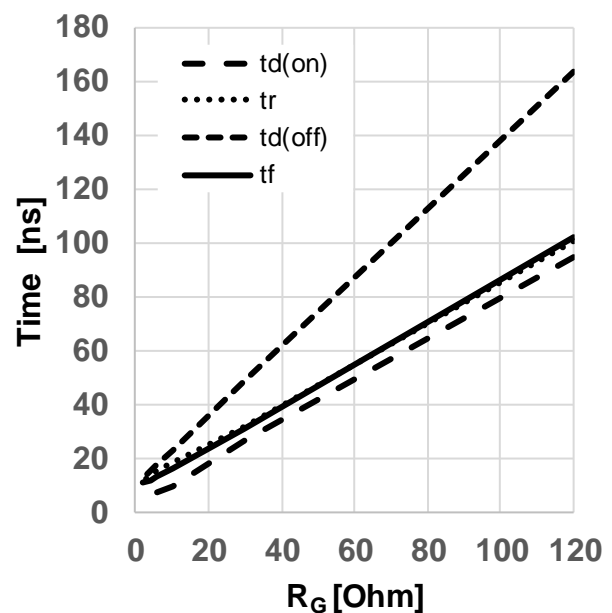


**Figure 16** Typical switching energy losses as a function of drain-source current  
( $E = f(I_{DS})$ ,  $V_{DD} = 800\text{V}$ ,  $V_{GS} = 0\text{V}/18\text{V}$ ,  $R_{G,ext} = 2\Omega$ ,  $T_{vj} = 175^{\circ}\text{C}$ , ind. load, test circuit in Fig. E, diode: body diode at  $V_{GS} = 0\text{V}$ )

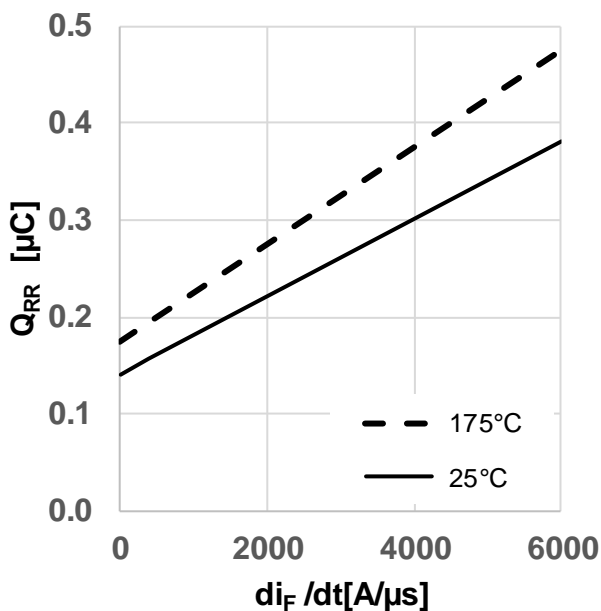
Electrical characteristic diagrams



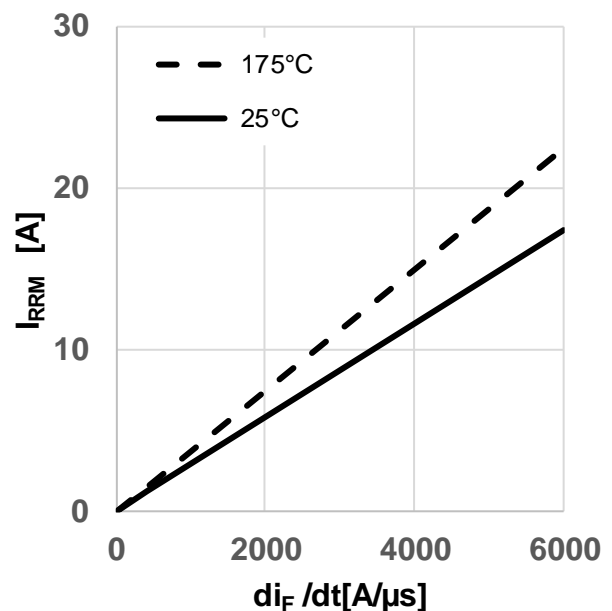
**Figure 17 Typical switching energy losses as a function of gate resistance**  
 ( $E = f(R_{G,ext})$ ,  $V_{DD} = 800V$ ,  $V_{GS} = 0V/18V$ ,  $I_D = 13A$ ,  $T_{vj} = 175^\circ C$ , ind. load, test circuit in Fig. E, diode: body diode at  $V_{GS} = 0V$ )



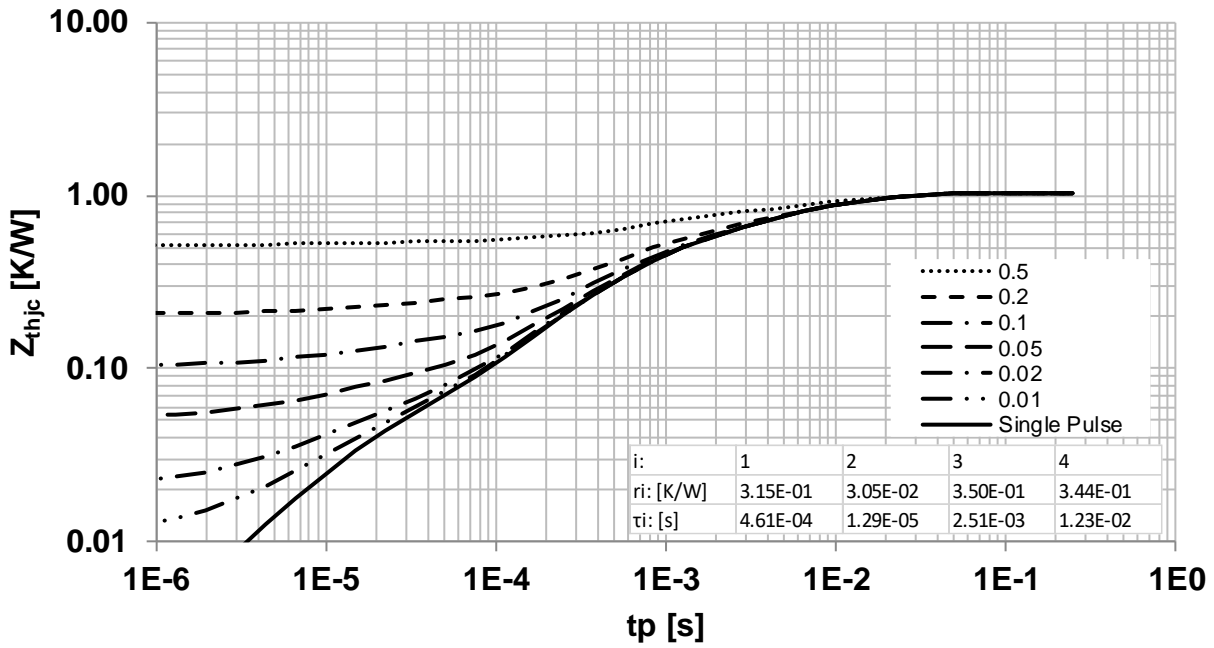
**Figure 18 Typical switching times as a function of gate resistor**  
 ( $t = f(R_{G,ext})$ ,  $V_{DD} = 800V$ ,  $V_{GS} = 0V/18V$ ,  $I_D = 13A$ ,  $T_{vj} = 175^\circ C$ , ind. load, test circuit in Fig. E, diode: body diode at  $V_{GS} = 0V$ )



**Figure 19 Typical reverse recovery charge as a function of diode current slope**  
 ( $Q_{rr} = f(di_i/dt)$ ,  $V_{DD} = 800V$ ,  $V_{GS} = 0V/18V$ ,  $I_D = 13A$ , ind. load, test circuit in Fig.E, body diode at  $V_{GS} = 0V$ )



**Figure 20 Typical reverse recovery current as a function of diode current slope**  
 ( $I_{rrm} = f(di_i/dt)$ ,  $V_{DD} = 800V$ ,  $V_{GS} = 0V/18V$ ,  $I_D = 13A$ , ind. load, test circuit in Fig.E, body diode at  $V_{GS} = 0V$ )



**Figure 21 Max. transient thermal resistance (MOSFET/diode)**  
 ( $Z_{th(j-c,max)} = f(t_p)$ , parameter  $D = t_p/T$ , thermal equivalent circuit in Fig. D)

### 5 Package drawing

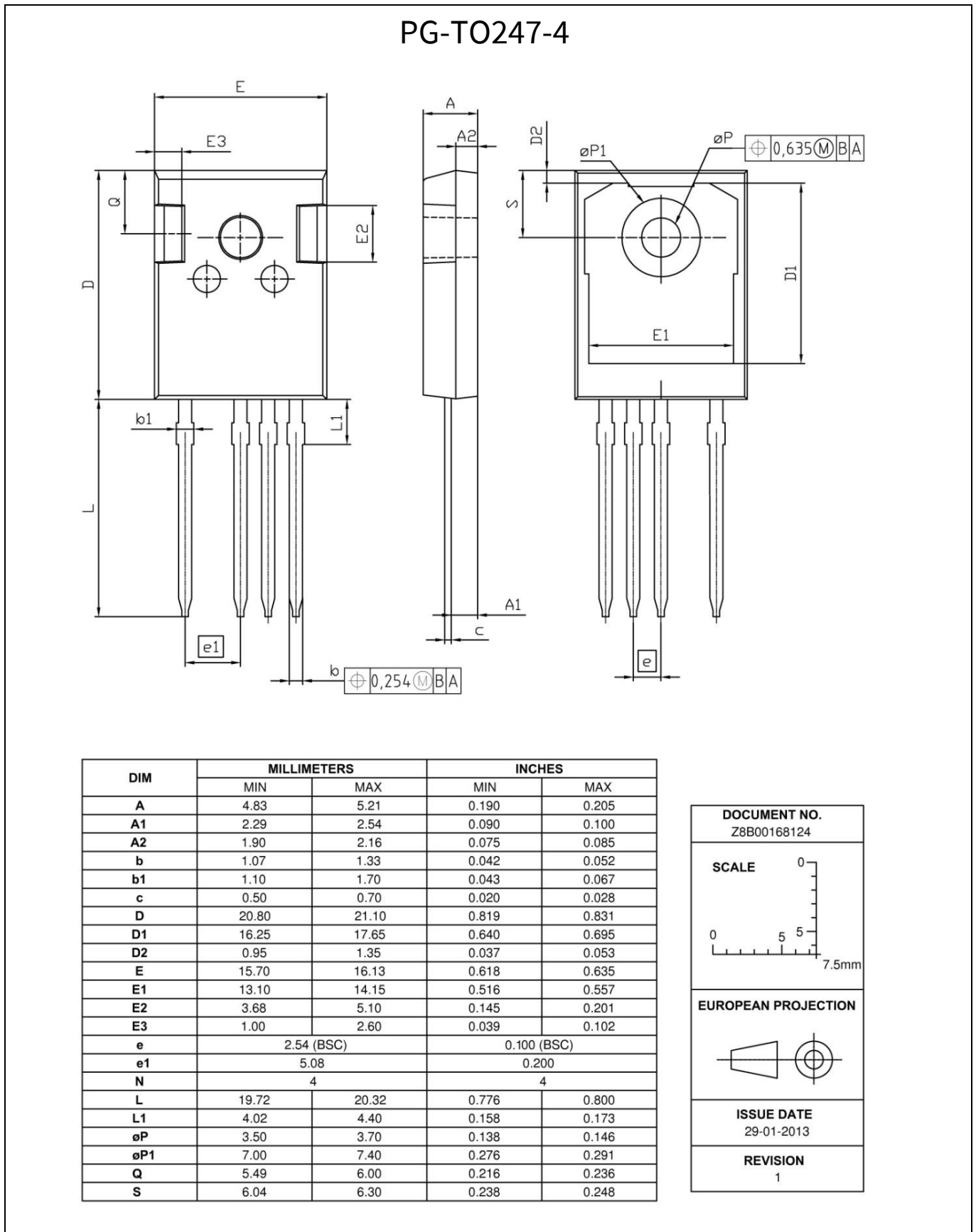


Figure 22 Package drawing

Test conditions

6 Test conditions

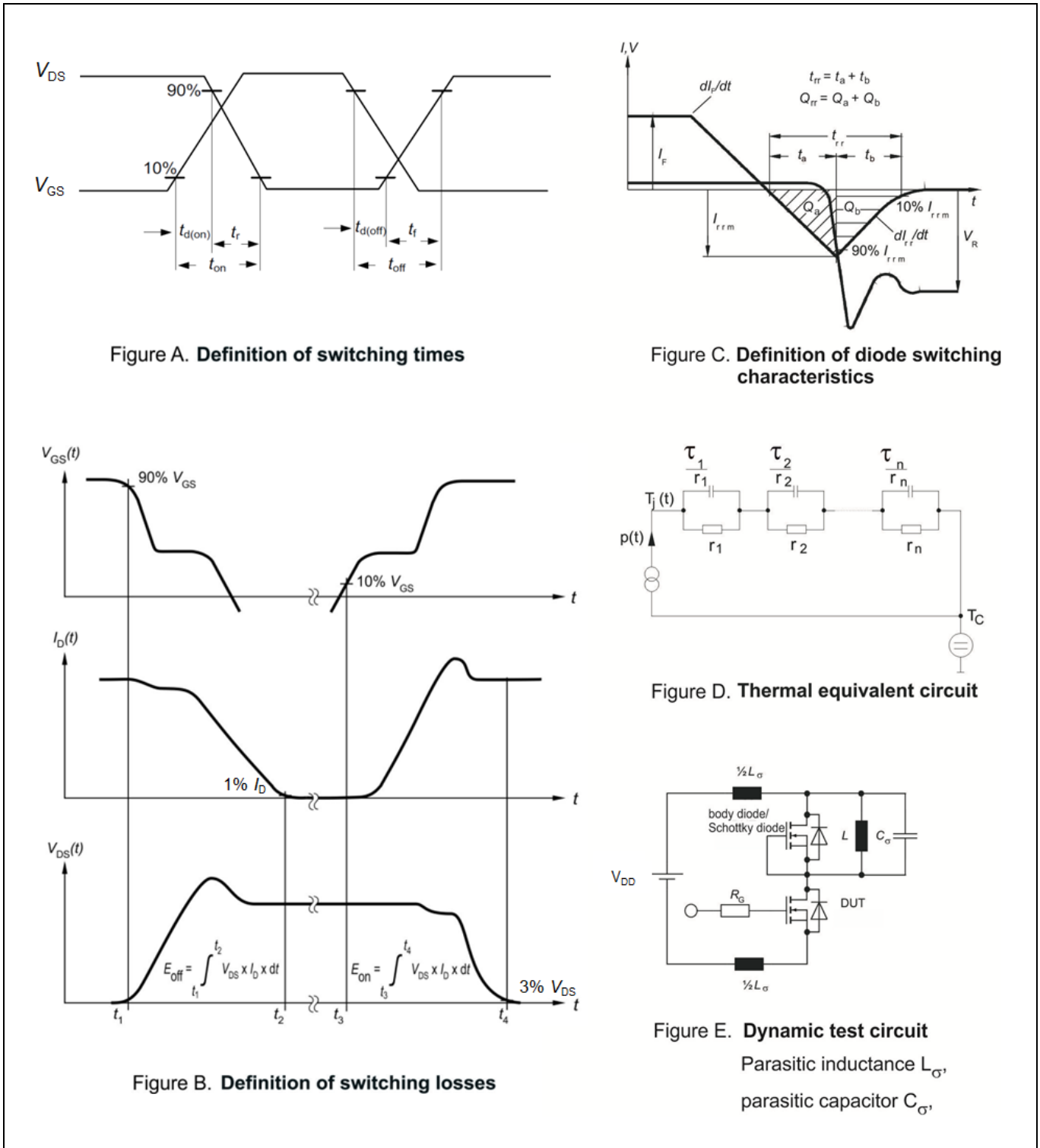


Figure 23 Test conditions

**Revision history**

**Revision history**

| <b>Document version</b> | <b>Date of release</b> | <b>Description of changes</b> |
|-------------------------|------------------------|-------------------------------|
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