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

### Eigenschaften




- $V_{DSS}$ = 1200 V at $T_{vj}$ = 25°C
- $I_{DDC}$ = 55 A at $T_c$ = 25°C
- $R_{DS(on)}$ = 39 mΩ at $V_{GS}$ = 18 V, $T_{vj}$ = 25°C
- Very low switching losses
- Short circuit withstand time 3 µs
- Benchmark gate threshold voltage, $V_{GS(th)}$ = 4.2 V
- Robust against parasitic turn on, 0 V turn-off gate voltage can be applied
- Robust body diode for hard commutation
- .XT interconnection technology for best-in-class thermal performance

### Potenzielle Anwendungen

- Industrial drives
- Industrial power supplies
- Solar inverters

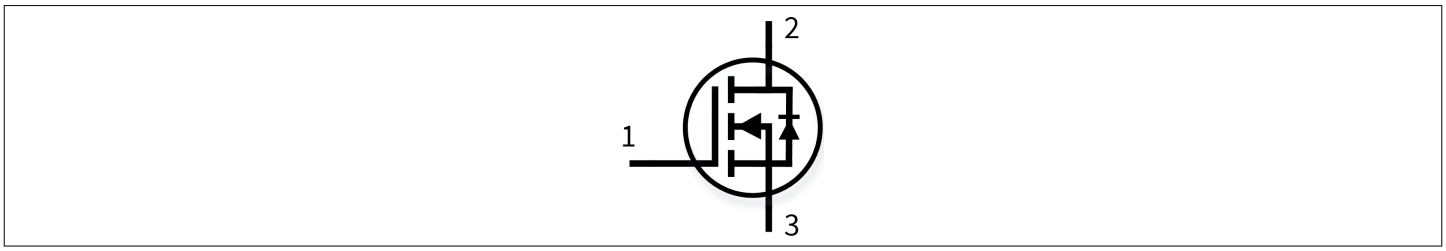
### Produktvalidierung

- Qualified for industrial applications according to the relevant tests of JEDEC47/20/22
- Please also note the application note AN2019-05 for power and thermal cycling

Lead-Free
Green
Halogen-Free
RoHS

### Beschreibung

1 – gate
2 – drain
3 – source




| Type | Package | Marking |
|---|---|---|
| IMW120R040M1H | PG-TO247-3-STD-NN2.5 | 12M1H040 |

# Inhalt

**Beschreibung** . . . . . 1
**Eigenschaften** . . . . . 1
**Potenzielle Anwendungen** . . . . . 1
**Produktvalidierung** . . . . . 1
**Inhalt** . . . . . 2
**1 Gehäuse** . . . . . 3
**2 MOSFET** . . . . . 3
**3 Body diode** . . . . . 6
**4 Kennlinien** . . . . . 8
**5 Gehäuseabmessungen** . . . . . 14
**6 Testing conditions** . . . . . 15
**Änderungshistorie** . . . . . 16
**Disclaimer** . . . . . 17

# 1 Gehäuse

**Tabelle 1 Charakteristische Werte**

| Parameter | Symbol | Notiz oder Prüfbedingung | Werte | | | Einh. |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Storage temperature | $T_{stg}$ | | -55 | | 150 | °C |
| Soldering temperature | $T_{sold}$ | wave soldering 1.6 mm (0.063 in.) from case for 10 s | | | 260 | °C |
| Mounting torque | $M$ | M3 screw Maximum of mounting process: 3 | | | 0.6 | Nm |
| Thermal resistance, junction-ambient | $R_{th(j-a)}$ | | | | 62 | K/W |

# 2 MOSFET

**Tabelle 2 Höchstzulässige Werte**

| Parameter | Symbol | Notiz oder Prüfbedingung | | Werte | Einh. |
|---|---|---|---|---|---|
| Drain-Source-Spannung | $V_{DSS}$ | $T_{vj} \geq 25$ °C | | 1200 | V |
| Continuous DC drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$ | $I_{DDC}$ | $V_{GS} = 18$ V | $T_c = 25$ °C | 55 | A |
| | | | $T_c = 100$ °C | 39 | |
| Peak drain current, $t_p$ limited by $T_{vj(max)}$ | $I_{DM}$ | $V_{GS} = 18$ V | | 117 | A |
| Gate-source voltage, max. transient voltage[1)] | $V_{GS}$ | $t_p \leq 0.5$ µs, $D < 0.01$ | | -10/23 | V |
| Gate-source voltage, max. static voltage | $V_{GS}$ | | | -7/20 | V |
| Avalanche energy, single pulse | $E_{AS}$ | $I_D = 18.8$ A, $V_{DD} = 50$ V, $L = 1.9$ mH | | 339 | mJ |
| Avalanche energy, repetitive | $E_{AR}$ | $I_D = 18.8$ A, $V_{DD} = 50$ V, $L = 9.5$ µH | | 1.68 | mJ |
| Short-circuit withstand time | $t_{SC}$ | $V_{DD} \leq 800$ V, $V_{DS,peak} < 1200$ V, $V_{GS(on)} = 15$ V, $T_{vj(start)} = 25$ °C | | 3 | µs |
| MOSFET dv/dt robustness | $dv/dt$ | $V_{DS} = 0...800$ V | | 150 | V/ns |
| Power dissipation, limited by $T_{vj(max)}$ | $P_{tot}$ | | $T_c = 25$ °C | 227 | W |
| | | | $T_c = 100$ °C | 114 | |

*1)* 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.

**Tabelle 3 Empfohlene Werte**

| Parameter | Symbol | Notiz oder Prüfbedingung | Werte | Einh. |
|---|---|---|---|---|
| Recommended turn-on gate voltage | $V_{GS(on)}$ | | 15...18 | V |
| Recommended turn-off gate voltage | $V_{GS(off)}$ | | -5...0 | V |

**Tabelle 4 Charakteristische Werte**

| Parameter | Symbol | Notiz oder Prüfbedingung | | Werte | | | Einh. |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $I_D$ = 19.3 A | $T_{vj}$ = 25 °C, $V_{GS(on)}$ = 18 V | | 39 | 54.4 | mΩ |
| | | | $T_{vj}$ = 100 °C, $V_{GS(on)}$ = 18 V | | 54 | | |
| | | | $T_{vj}$ = 175 °C, $V_{GS(on)}$ = 18 V | | 77 | | |
| | | | $T_{vj}$ = 25 °C, $V_{GS(on)}$ = 15 V | | 50.4 | 61.5 | |
| Gate-emitter threshold voltage | $V_{GS(th)}$ | $I_D$ = 10 mA, $V_{DS}$ = $V_{GS}$ (tested after 1 ms pulse at $V_{GS}$ = 20 V) | $T_{vj}$ = 25 °C | 3.5 | 4.2 | 5.2 | V |
| | | | $T_{vj}$ = 175 °C | | 3.6 | | |
| Zero gate-voltage drain current | $I_{DSS}$ | $V_{DS}$ = 1200 V, $V_{GS}$ = 0 V | $T_{vj}$ = 25 °C | | | 150 | µA |
| | | | $T_{vj}$ = 175 °C | | 2615 | | |
| Gate leakage current | $I_{GSS}$ | $V_{DS}$ = 0 V | $V_{GS}$ = 23 V | | | 100 | nA |
| | | | $V_{GS}$ = -10 V | | | -100 | |
| Forward transconductance | $g_{fs}$ | $I_D$ = 19.3 A, $V_{DS}$ = 20 V | | | 12.9 | | S |
| Internal gate resistance | $R_{G,int}$ | $f$ = 1 MHz, $V_{AC}$ = 25 mV | | | 2.5 | | Ω |
| Input capacitance | $C_{iss}$ | $V_{DD}$ = 800 V, $V_{GS}$ = 0 V, $f$ = 100 kHz, $V_{AC}$ = 25 mV | | | 1620 | | pF |
| Output capacitance | $C_{oss}$ | $V_{DD}$ = 800 V, $V_{GS}$ = 0 V, $f$ = 100 kHz, $V_{AC}$ = 25 mV | | | 75 | | pF |
| Reverse transfer capacitance | $C_{rss}$ | $V_{DD}$ = 800 V, $V_{GS}$ = 0 V, $f$ = 100 kHz, $V_{AC}$ = 25 mV | | | 11 | | pF |
| $C_{oss}$ stored energy | $E_{oss}$ | $V_{DD}$ = 800 V, $V_{GS}$ = 0 V, $f$ = 100 kHz, $V_{AC}$ = 25 mV | | | 30 | | µJ |
| Total gate charge | $Q_G$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, turn-on pulse | | | 39 | | nC |
| Plateau gate charge | $Q_{GS(pl)}$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, turn-on pulse | | | 13 | | nC |
| Gate-to-drain charge | $Q_{GD}$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, turn-on pulse | | | 11 | | nC |

**(wird fortgesetzt...)**

**Tabelle 4 (Fortsetzung) Charakteristische Werte**

| Parameter | Symbol | Notiz oder Prüfbedingung | | Werte | | | Einh. |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, $R_{GS(on)}$ = 2 Ω, $R_{GS(off)}$ = 2 Ω, diode: body diode at $V_{GS}$ = 0 V, $L_\sigma$ = 15 nH | $T_{vj}$ = 25 °C | | 17 | | ns |
| | | | $T_{vj}$ = 175 °C | | 16 | | |
| Rise time | $t_r$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, $R_{GS(on)}$ = 2 Ω, $R_{GS(off)}$ = 2 Ω, diode: body diode at $V_{GS}$ = 0 V, $L_\sigma$ = 15 nH | $T_{vj}$ = 25 °C | | 6.4 | | ns |
| | | | $T_{vj}$ = 175 °C | | 7.3 | | |
| Turn-off delay time | $t_{d(off)}$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, $R_{GS(on)}$ = 2 Ω, $R_{GS(off)}$ = 2 Ω, diode: body diode at $V_{GS}$ = 0 V, $L_\sigma$ = 15 nH | $T_{vj}$ = 25 °C | | 20.6 | | ns |
| | | | $T_{vj}$ = 175 °C | | 21 | | |
| Fall time | $t_f$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, $R_{GS(on)}$ = 2 Ω, $R_{GS(off)}$ = 2 Ω, diode: body diode at $V_{GS}$ = 0 V, $L_\sigma$ = 15 nH | $T_{vj}$ = 25 °C | | 6.9 | | ns |
| | | | $T_{vj}$ = 175 °C | | 6.9 | | |
| Turn-on energy | $E_{on}$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, $R_{GS(on)}$ = 2 Ω, $R_{GS(off)}$ = 2 Ω, diode: body diode at $V_{GS}$ = 0 V, $L_\sigma$ = 15 nH | $T_{vj}$ = 25 °C | | 190 | | µJ |
| | | | $T_{vj}$ = 175 °C | | 305 | | |
| Turn-off energy | $E_{off}$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, $R_{GS(on)}$ = 2 Ω, $R_{GS(off)}$ = 2 Ω, diode: body diode at $V_{GS}$ = 0 V, $L_\sigma$ = 15 nH | $T_{vj}$ = 25 °C | | 50 | | µJ |
| | | | $T_{vj}$ = 175 °C | | 53 | | |
| Total switching energy | $E_{tot}$ | $V_{DD}$ = 800 V, $I_D$ = 19.3 A, $V_{GS}$ = 0/18 V, $R_{GS(on)}$ = 2 Ω, $R_{GS(off)}$ = 2 Ω, diode: body diode at $V_{GS}$ = 0 V, $L_\sigma$ = 15 nH | $T_{vj}$ = 25 °C | | 270 | | µJ |
| | | | $T_{vj}$ = 175 °C | | 478 | | |

**(wird fortgesetzt...)**

**Tabelle 4 (Fortsetzung) Charakteristische Werte**

| Parameter | Symbol | Notiz oder Prüfbedingung | Werte | | | Einh. |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| MOSFET/body diode thermal resistance, junction-case | $R_{th(j-c)}$ | | | 0.51 | 0.66 | K/W |
| Virtual junction temperature | $T_{vj}$ | | -55 | | 175 | °C |

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

*The chip technology was characterized up to 200 kV/µs. The measured dV/dt was limited by measurement test setup and package.*

*Dynamic test circuit see Fig. F.*

## 3 Body diode

**Tabelle 5 Höchstzulässige Werte**

| Parameter | Symbol | Notiz oder Prüfbedingung | | Werte | Einh. |
|---|---|---|---|---|---|
| Drain-Source-Spannung | $V_{DSS}$ | $T_{vj} \geq 25$ °C | | 1200 | V |
| Continuous reverse drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$ | $I_{SDC}$ | $V_{GS} = 0$ V | $T_c = 25$ °C | 54 | A |
| | | | $T_c = 100$ °C | 33 | |
| Peak reverse drain current, $t_p$ limited by $T_{vj(max)}$ | $I_{SM}$ | $V_{GS} = 0$ V | | 117 | A |

**Tabelle 6 Charakteristische Werte**

| Parameter | Symbol | Notiz oder Prüfbedingung | | Werte | | | Einh. |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| Drain-source reverse voltage | $V_{SD}$ | $I_{SD} = 19.3$ A, $V_{GS} = 0$ V | $T_{vj} = 25$ °C | | 3.8 | 5 | V |
| | | | $T_{vj} = 100$ °C | | 3.7 | | |
| | | | $T_{vj} = 175$ °C | | 3.6 | | |
| MOSFET forward recovery charge | $Q_{fr}$ | $V_{DD} = 800$ V, $I_{SD} = 19.3$ A, $V_{GS} = 0$ V, $di_{SD}/dt = 3000$ A/µs, $Q_{fr}$ includes also $Q_C$ | $T_{vj} = 25$ °C | | 160 | | nC |
| | | | $T_{vj} = 175$ °C | | 293 | | |
| MOSFET peak forward recovery current | $I_{frm}$ | $V_{DD} = 800$ V, $I_{SD} = 19.3$ A, $V_{GS} = 0$ V, $di_{SD}/dt = 3000$ A/µs, $Q_{fr}$ includes also $Q_C$ | $T_{vj} = 25$ °C | | 36 | | A |
| | | | $T_{vj} = 175$ °C | | 57 | | |

**(wird fortgesetzt...)**

**Tabelle 6 (Fortsetzung) Charakteristische Werte**

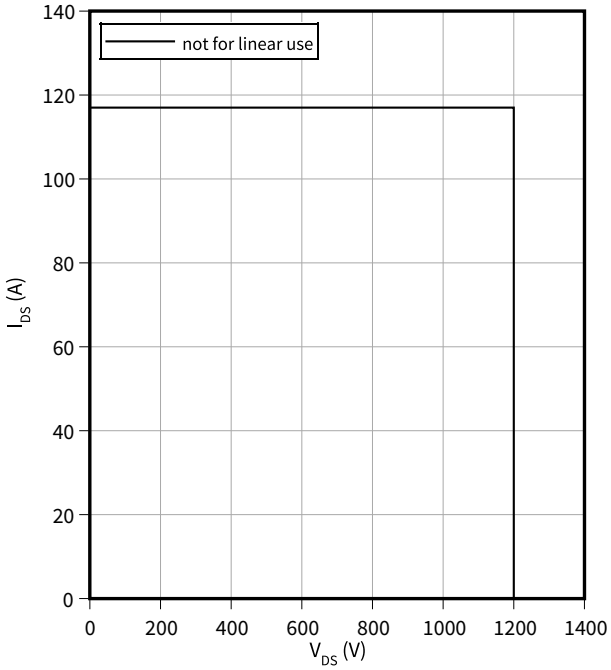
| Parameter | Symbol | Notiz oder Prüfbedingung | | Werte | | | Einh. |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| MOSFET forward recovery energy | $E_{fr}$ | $V_{DD}$ = 800 V, $I_{SD}$ = 19.3 A, $V_{GS}$ = 0 V, $di_{SD}/dt$ = 3000 A/µs, $Q_{fr}$ includes also $Q_C$ | $T_{vj}$ = 25 °C | | 30 | | µJ |
| | | | $T_{vj}$ = 175 °C | | 120 | | |
| Virtual junction temperature | $T_{vj}$ | | | -55 | | 175 | °C |

# 4 Kennlinien

**Reverse bias safe operating area (RBSOA)**

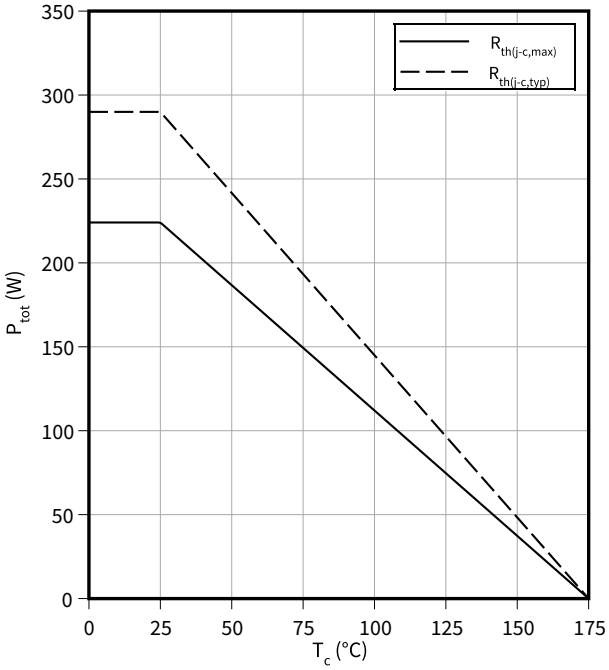
$I_{DS} = f(V_{DS})$

$T_{vj} \leq 175\ °C$, $V_{GS} = 0/18\ V$, $T_c = 25\ °C$



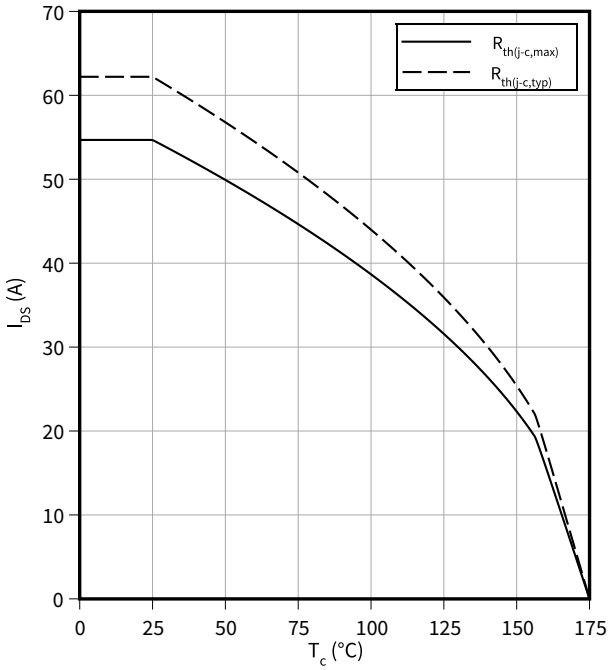

**Power dissipation as a function of case temperature limited by bond wire**

$P_{tot} = f(T_c)$




**Maximum DC drain to source current as a function of case temperature limited by bond wire**

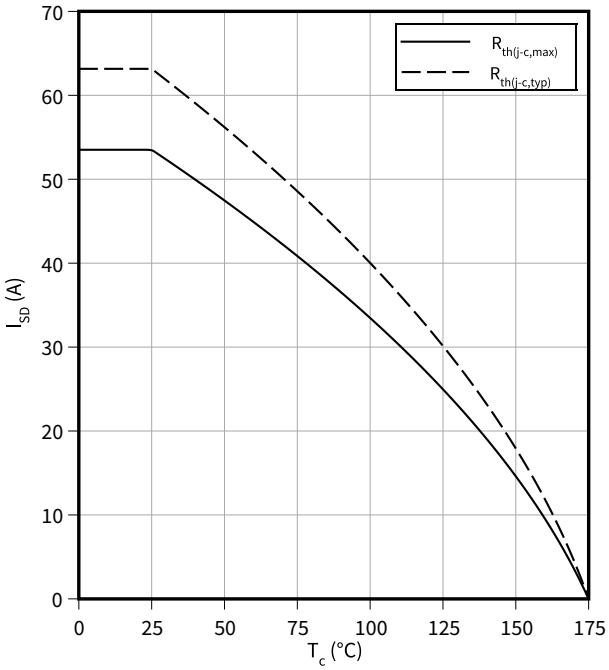
$I_{DS} = f(T_c)$




**Maximum source to drain current as a function of case temperature limited by bond wire**

$I_{SD} = f(T_c)$

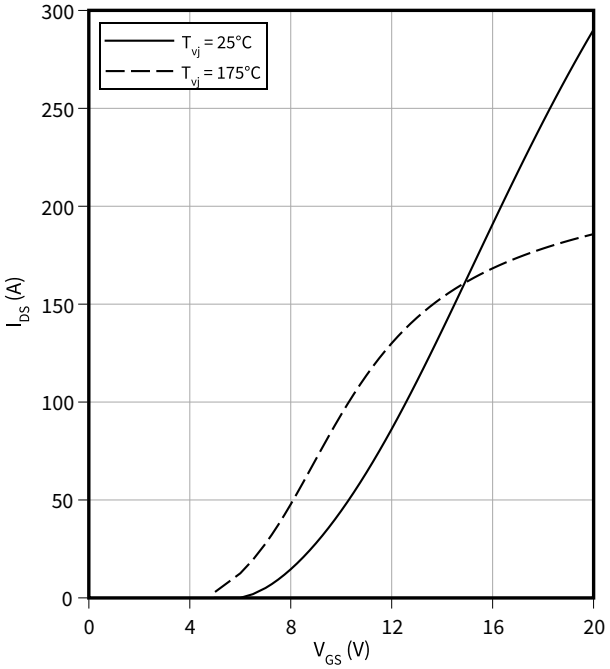
$V_{GS} = 0\ V$



### Typical transfer characteristic

$I_{DS} = f(V_{GS})$

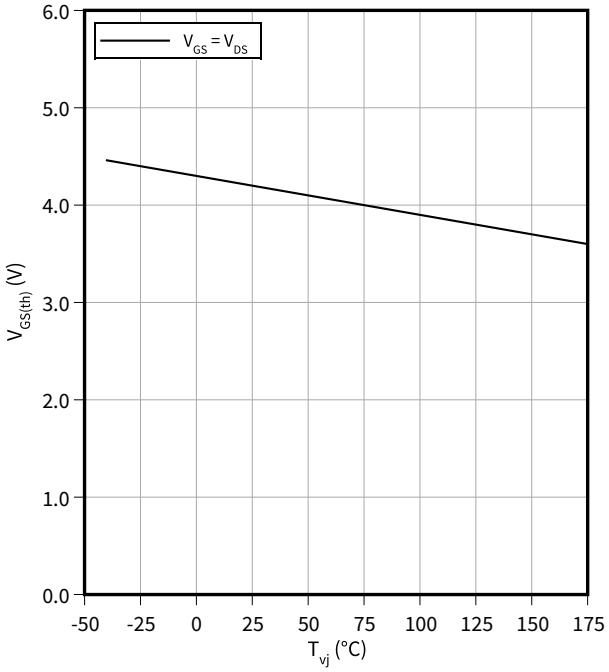
$V_{DS}$ = 20 V, $t_p$ = 20 µs




### Typical gate-source threshold voltage as a function of junction temperature

$V_{GS(th)} = f(T_{vj})$

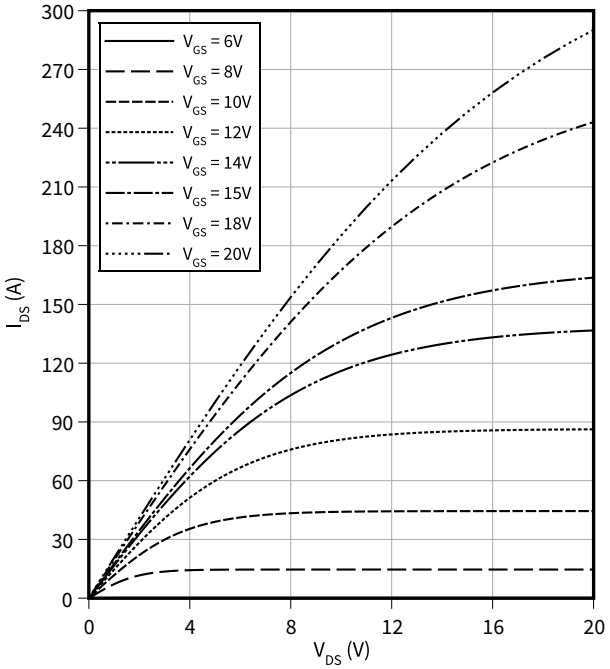
$I_D$ = 8.3 mA




### Typical output characteristic 25°C, VGS as parameter

$I_{DS} = f(V_{DS})$

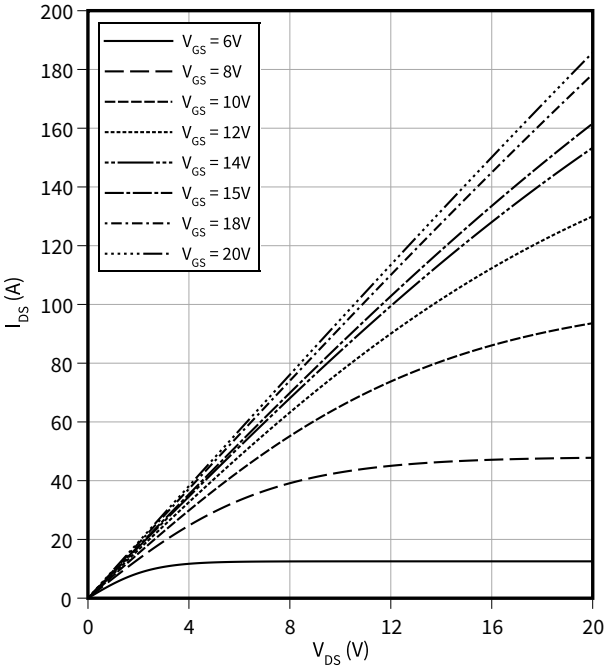
$T_{vj}$ = 25 °C, $t_p$ = 20 µs




### Typical output characteristic 175°C, VGS as parameter

$I_{DS} = f(V_{DS})$

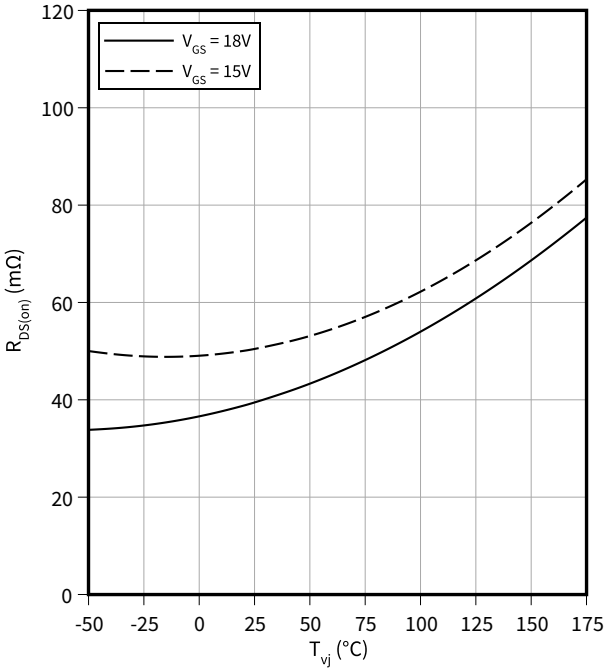
$T_{vj}$ = 175 °C, $t_p$ = 20 µs



### Typical on-state resistance as a function of junction temperature

$R_{DS(on)} = f(T_{vj})$

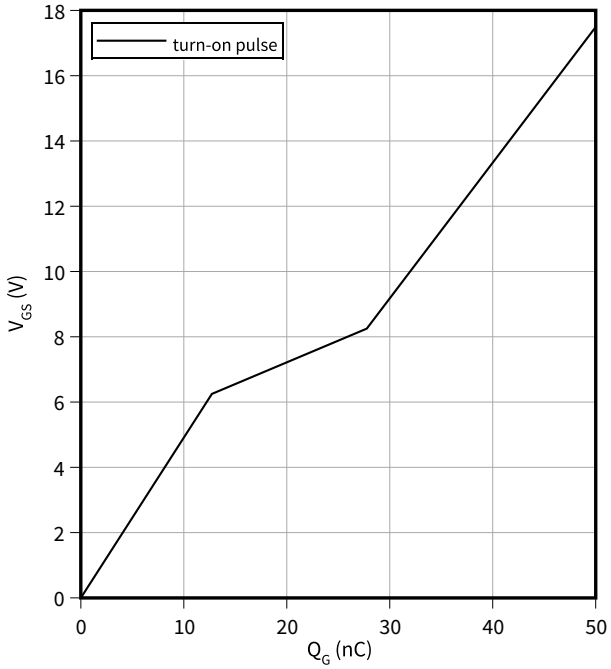
$I_D = 19.3$ A




### Typical gate charge

$V_{GS} = f(Q_G)$

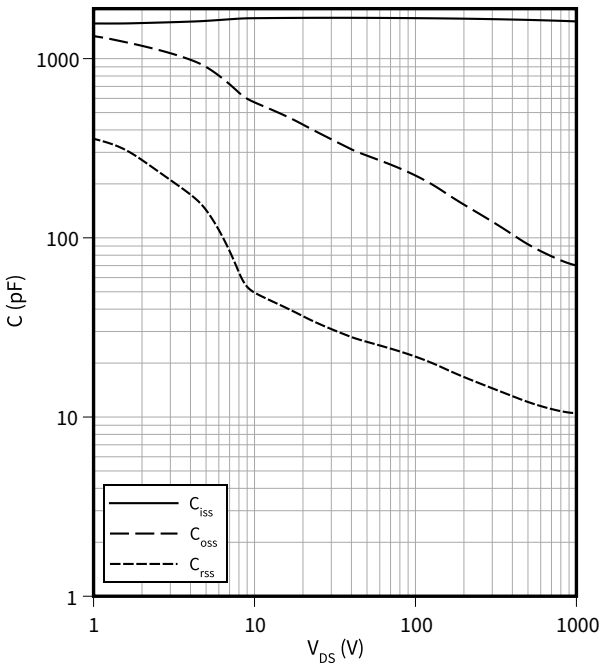
$I_D = 19.3$ A, $V_{DS} = 800$ V




### Typical capacitance as a function of drain-source voltage

$C = f(V_{DS})$

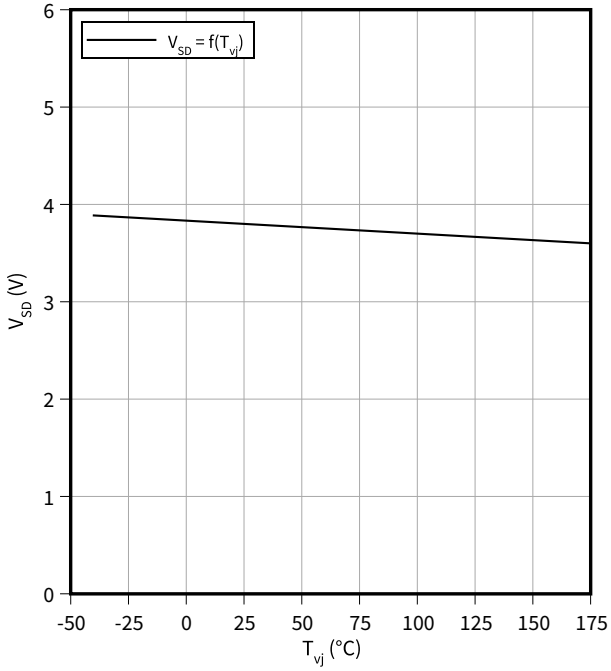
$f = 100$ kHz, $V_{GS} = 0$ V




### Typical reverse drain voltage as function of junction temperature

$V_{SD} = f(T_{vj})$

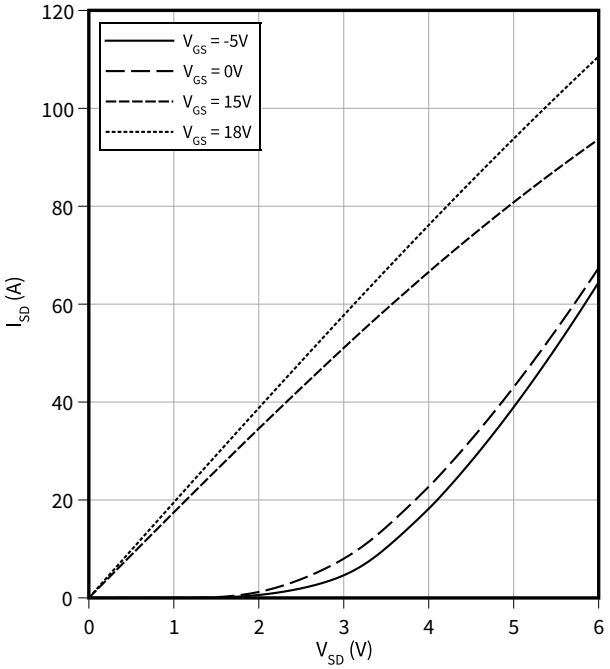
$I_{SD} = 19.3$ A, $V_{GS} = 0$ V



### Typical reverse drain current as function of reverse drain voltage 25°C, VGS as parameter

$I_{SD} = f(V_{SD})$

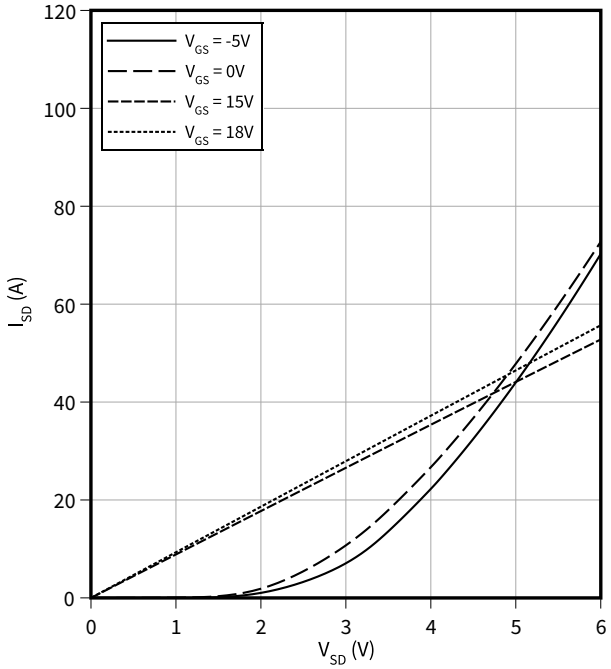
$T_{vj} = 25\ °C$, $t_p = 20\ µs$




### Typical reverse drain current as function of reverse drain voltage 175°C, VGS as parameter

$I_{SD} = f(V_{SD})$

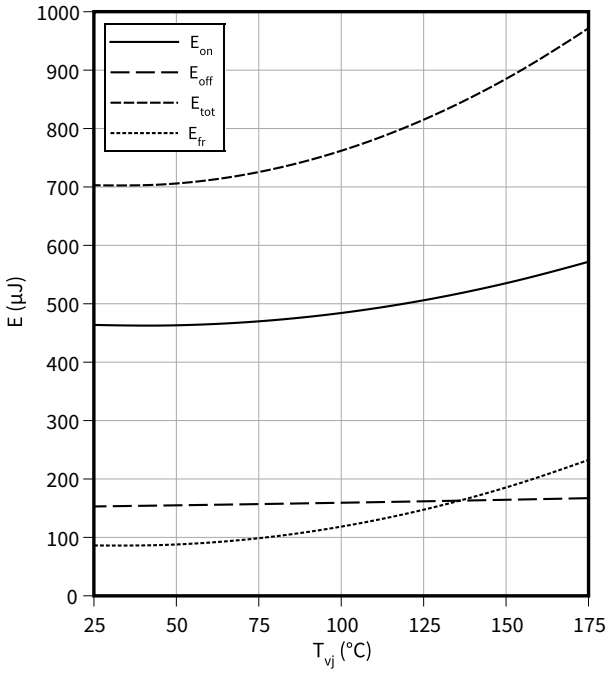
$T_{vj} = 175\ °C$, $t_p = 20\ µs$




### Typical switching energy as a function of junction temperature

$E = f(T_{vj})$

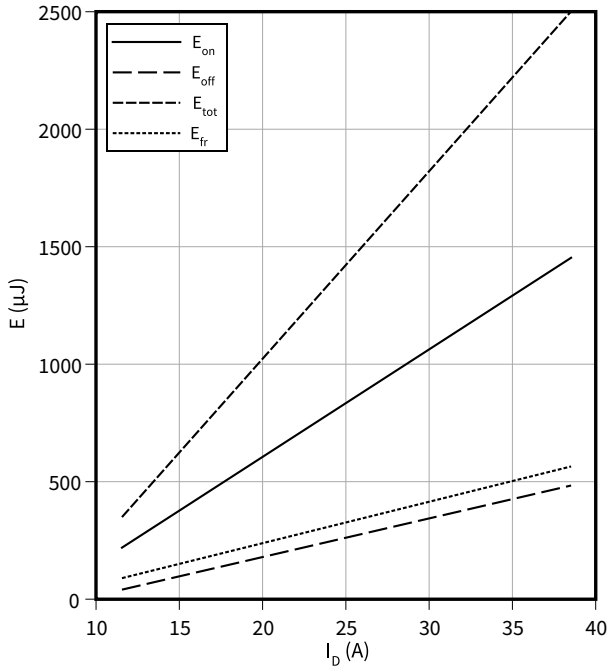
$V_{GS} = 0/18\ V$, $I_D = 19.3\ A$, $R_{G,ext} = 2\ Ω$, $V_{DD} = 800\ V$




### Typical switching energy as a function of drain current

$E = f(I_D)$

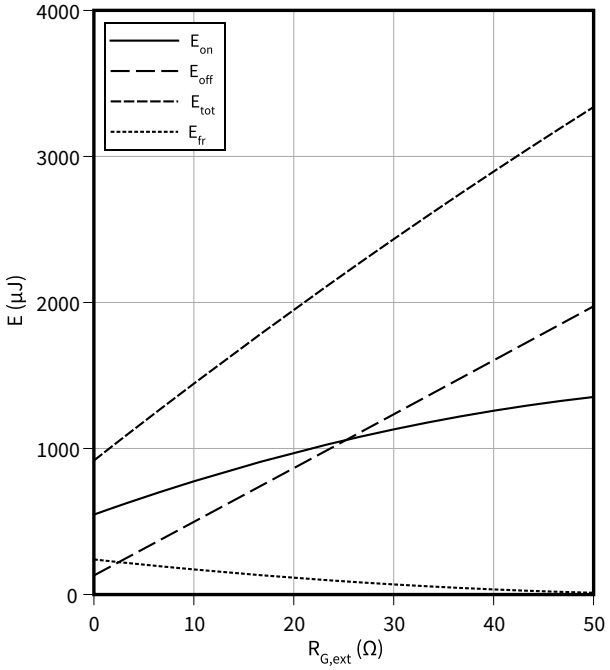
$V_{GS} = 0/18\ V$, $T_{vj} = 175\ °C$, $R_{G,ext} = 2\ Ω$, $V_{DD} = 800\ V$



### Typical switching energy losses as a function of gate resistance

$E = f(R_{G,ext})$

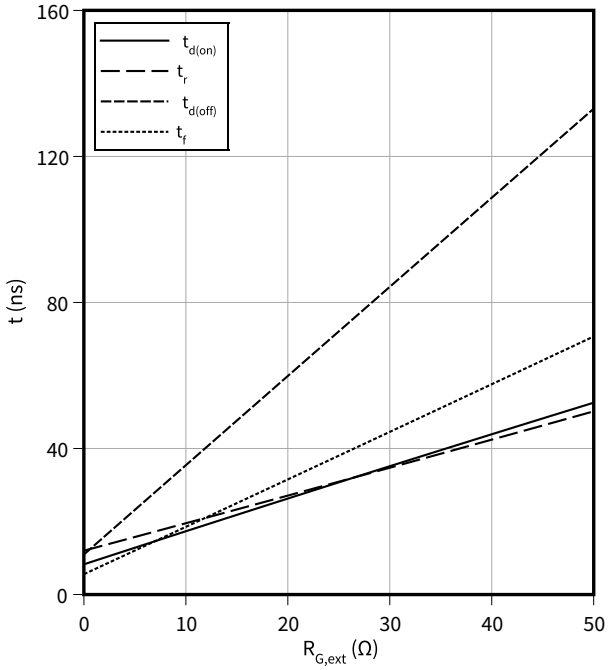
$V_{GS}$ = 0/18 V, $I_D$ = 19.3 A, $T_{vj}$ = 175 °C, $V_{DD}$ = 800 V




### Typical switching times as a function of gate resistance

$t = f(R_{G,ext})$

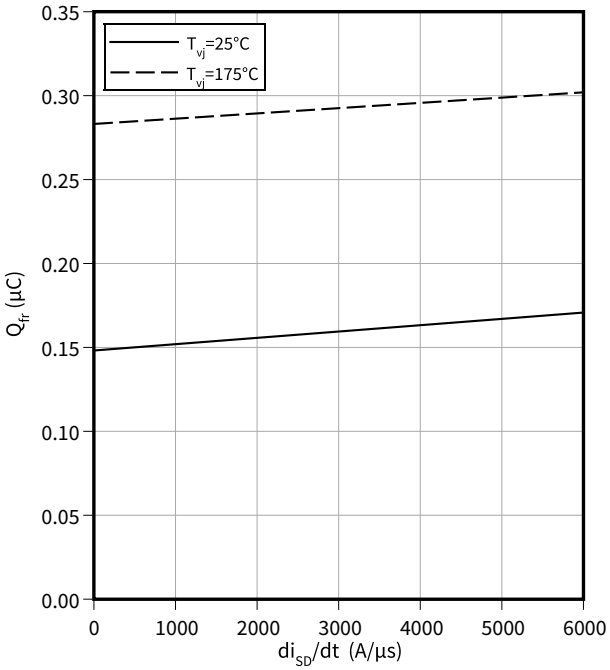
$V_{GS}$ = 0/18 V, $I_D$ = 19.3 A, $T_{vj}$ = 175 °C, $V_{DD}$ = 800 V




### Typical reverse recovery charge as a function of revere drain current slope

$Q_{fr} = f(di_{SD}/dt)$

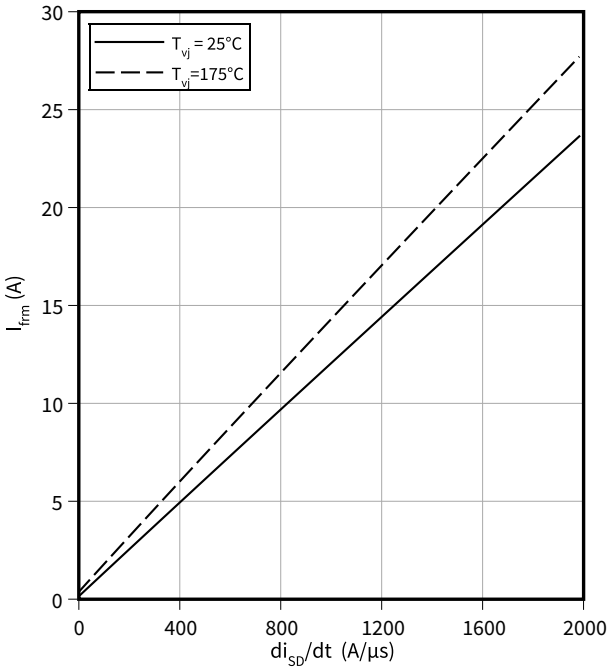
$V_{GS}$ = 0/18 V, $I_{SD}$ = 19.3 A, $V_{DD}$ = 800 V




### Typical reverse recovery current as a function of reverse drain current slope

$I_{frm} = f(di_{SD}/dt)$

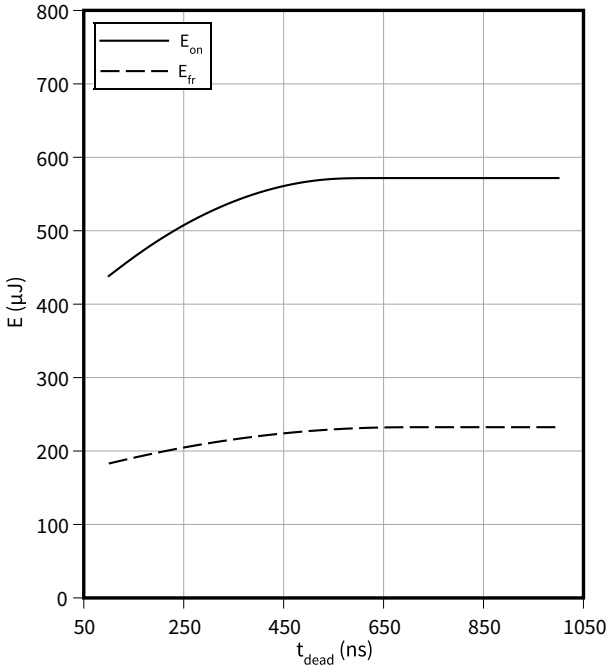
$V_{GS}$ = 0/18 V, $I_{SD}$ = 19.3 A, $V_{DD}$ = 800 V



**Typical switching energy losses as a function of dead time / blanking time, test circuit in Fig. F, 2nd device own body diode: $V_{GS}$ = -5 V**

$E = f(t_{dead})$

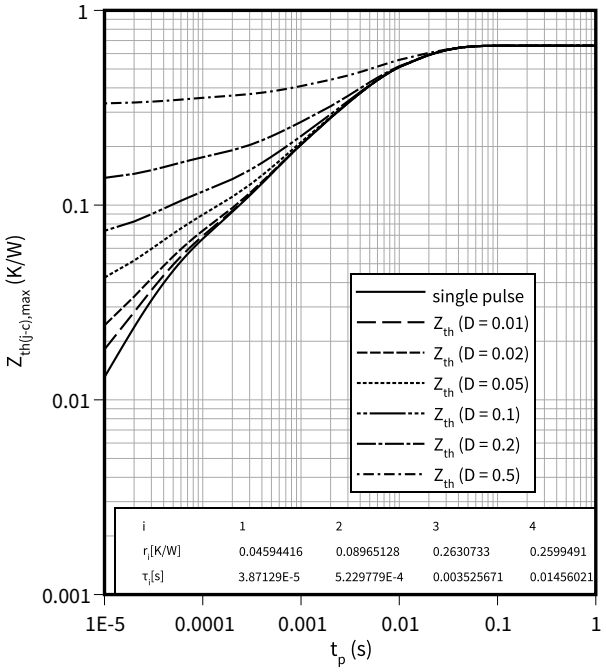
$V_{GS}$ = -5/18 V, $I_D$ = 19.3 A, $T_{vj}$ = 175 °C, $V_{DD}$ = 800 V




**Max. transient thermal impedance (MOSFET/diode)**

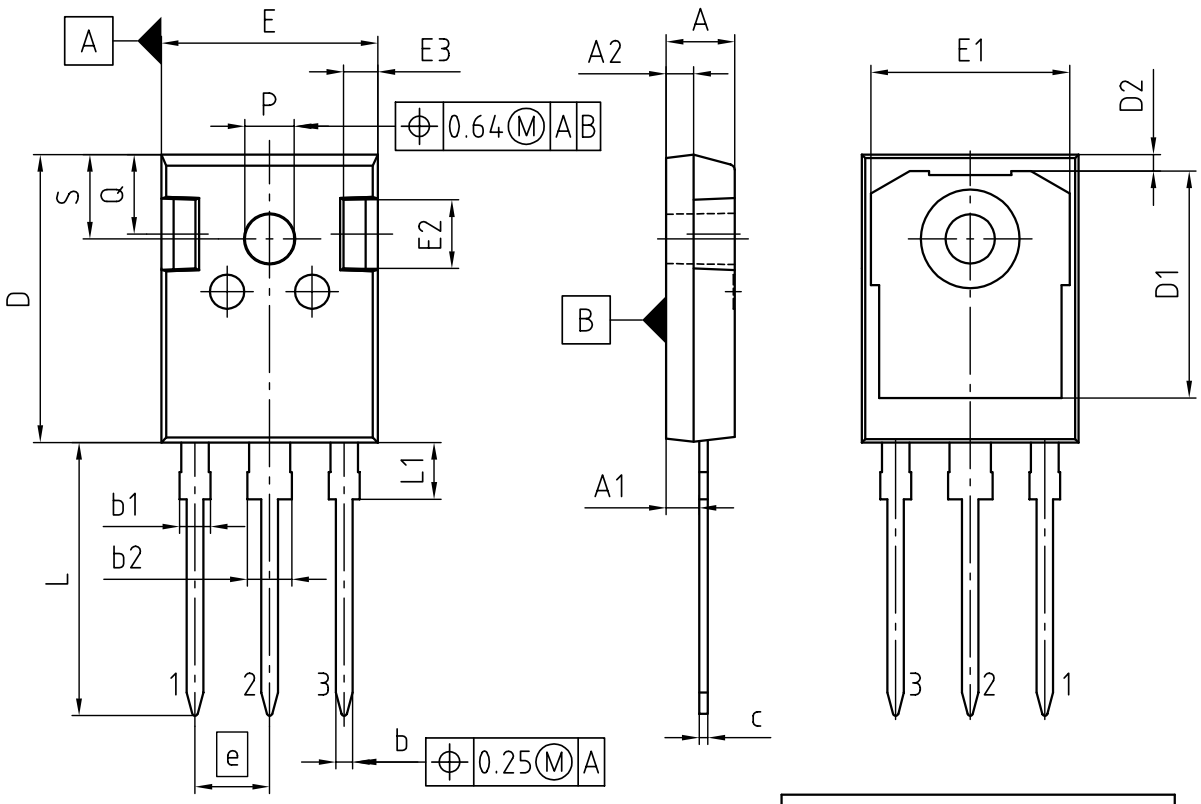
$Z_{th(j-c),max} = f(t_p)$

$D = t_p/T$



# 5 Gehäuseabmessungen

## PG-TO247-3-STD-NN2.5




| PACKAGE - GROUP NUMBER: | PG-TO247-3-U06 | |
|---|---|---|
| **DIMENSIONS** | **MILLIMETERS** | |
| | MIN. | MAX. |
| **A** | 4.83 | 5.21 |
| **A1** | 2.27 | 2.54 |
| **A2** | 1.85 | 2.16 |
| **b** | 1.07 | 1.33 |
| **b1** | 1.90 | 2.41 |
| **b2** | 2.87 | 3.38 |
| **c** | 0.55 | 0.68 |
| **D** | 20.80 | 21.10 |
| **D1** | 16.25 | 17.65 |
| **D2** | 0.95 | 1.35 |
| **E** | 15.70 | 16.13 |
| **E1** | 13.10 | 14.15 |
| **E2** | 3.68 | 5.10 |
| **E3** | 1.00 | 2.60 |
| **e** | 5.44 | |
| **N** | 3 | |
| **L** | 19.80 | 20.32 |
| **L1** | 4.10 | 4.47 |
| **øP** | 3.50 | 3.70 |
| **Q** | 5.49 | 6.00 |
| **S** | 6.04 | 6.30 |

NOTE:
DIMENSIONS DO NOT INCLUDE MOLDFLASH; PROTRUSION OR GATE BURRS

**Abbildung 1**

# 6 Testing conditions

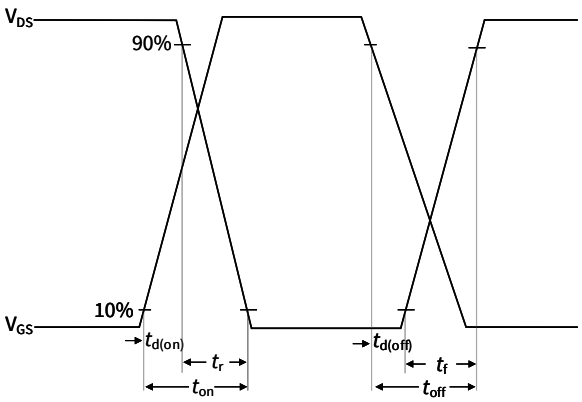



Figure A. **Definition of switching times**

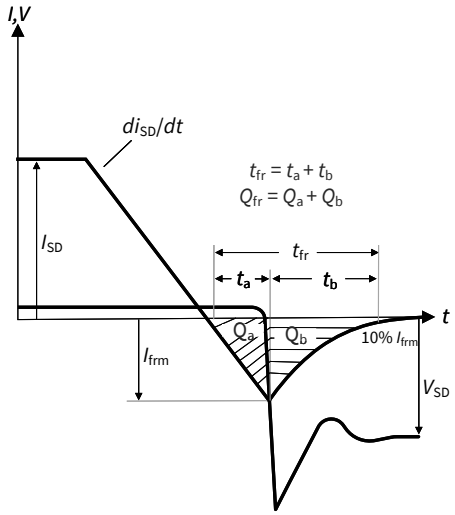



Figure B. **Definition of body diode switching characteristics**

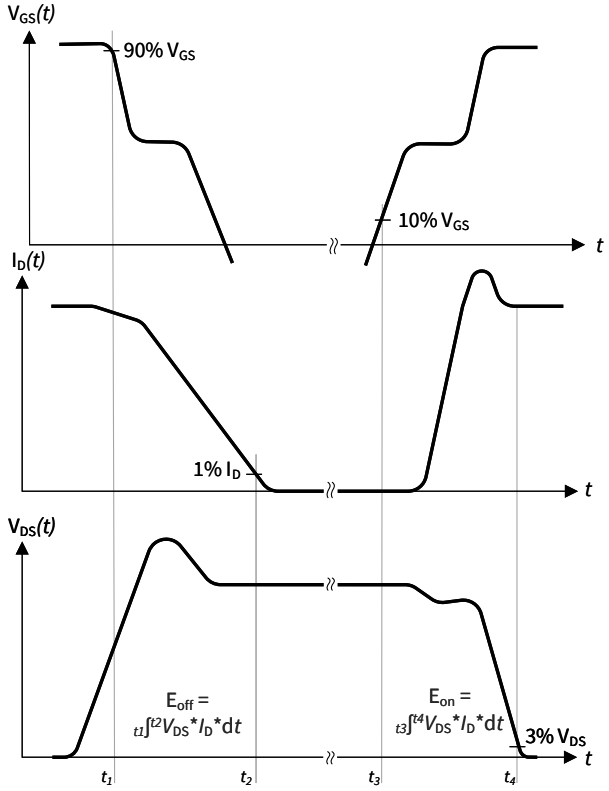



Figure C. **Definition of switching losses**

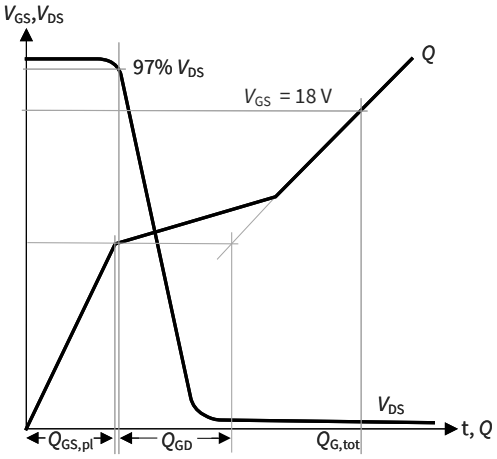



Figure D. **Definition of QGD**

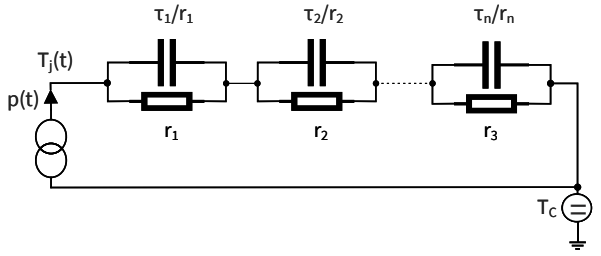



Figure E. **Thermal equivalent circuit**

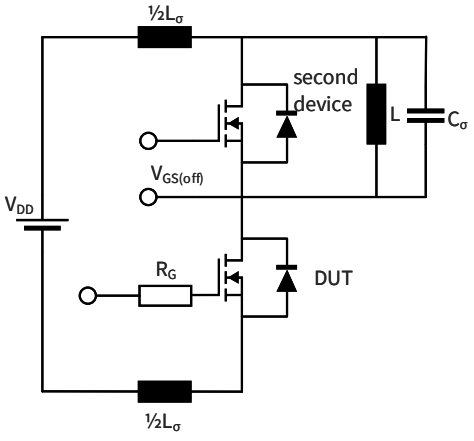



Figure F. **Dynamic test circuit**
Parasitic inductance $L_\sigma$,
Parasitic capacitor $C_\sigma$,

**Abbildung 2**

# Änderungshistorie

| Dokumentenrevision | Freigabedatum | Beschreibung der Änderungen |
|---|---|---|
| 1.00 | 2022-02-02 | Final datasheet |
| 1.10 | 2022-08-10 | Change of test condition of dynamic capacitances in Table 4, “Characteristic values” ($C_{iss}$, $C_{oss}$, $C_{rss}$): $V_{DD}$= 25 V to $V_{DD}$= 800 V<br>Correction of unit of “Input capacitance” $C_{iss}$ from nF to pF<br>Change of $V_{GS}$ “Gate-source voltage, max. static voltage” in Table 2, “Maximum rated values” from -5/20 V to -7/20 V<br>Editorial changes in “Features” on page 1<br>Editorial changes in “Package” on page 1<br>Correction of unit of x-axis at diagram “Max. transient thermal impedance (MOSFET/diode)” from µs to s, on page 13<br>Correction of diagram “Typical reverse drain current as a function of reverse drain voltage, $V_{GS}$ as parameter”, on page 11 |

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