**Final datasheet**

**EasyPACK™ module with CoolSiC™ Trench MOSFET and High Current Pin / NTC**

## Features

- Electrical features
  - $V_{DSS}$ = 2000 V
  - $I_{DN}$ = 400 A / $I_{DRM}$ = 640 A
  - Low switching losses
  - High current density
  - Suitable Infineon gate drivers can be found under https://www.infineon.com/gdfinder
- Mechanical features
  - 3.2 kV AC 1 minute insulation
  - High current pin
  - PressFIT contact technology
  - Rugged mounting due to integrated mounting clamps
  - Integrated NTC temperature sensor

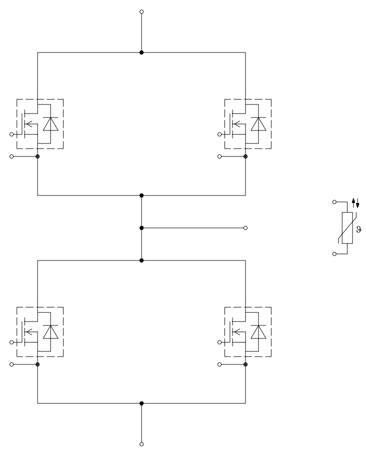
## Potential applications

- Energy storage systems (ESS)
- EV charging
- UPS systems
- Solar applications

## Product validation

- Qualified for industrial applications according to the relevant tests of IEC 60747, 60749 and 60068

## Description



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# 1 Package

**Table 1 Insulation coordination**

| Parameter | Symbol | Note or test condition | Values | Unit |
|---|---|---|---|---|
| Isolation test voltage | $V_{ISOL}$ | RMS, f = 50 Hz, $t$ = 1 min | 3.2 | kV |
| Isolation test voltage NTC | $V_{ISOL(NTC)}$ | RMS, f = 50 Hz, $t$ = 1 min | 3.2 | kV |
| Internal isolation | | basic insulation (class 1, IEC 61140) | $Al_2O_3$ | |
| Comparative tracking index | *CTI* | | > 400 | |
| Relative thermal index (electrical) | *RTI* | housing | 140 | °C |

**Table 2 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Stray inductance module | $L_{sCE}$ | | | | 17 | | nH |
| Module lead resistance, terminals - chip | $R_{CC'+EE'}$ | $T_H$ = 25 °C, per switch | | | 1 | | mΩ |
| Storage temperature | $T_{stg}$ | | | -40 | | 125 | °C |
| Mounting torque for module mounting | *M* | - Mounting according to valid application note | M5, Screw | 1.3 | | 1.5 | Nm |
| Weight | *G* | | | | 78 | | g |

***Note***: *The current under continuous operation is limited to 50A rms per high current pin.*

# 2 MOSFET, T1.1-T1.2 / T2.1-T2.2

**Table 3 Maximum rated values**

| Parameter | Symbol | Note or test condition | | Values | Unit |
|---|---|---|---|---|---|
| Drain-source voltage | $V_{DSS}$ | | $T_{vj}$ = 25 °C | 2000 | V |
| Implemented drain current | $I_{DN}$ | | | 400 | A |
| Continuous DC drain current | $I_{DDC}$ | $T_{vj}$ = 175 °C, $V_{GS}$ = 18 V | $T_H$ = 65 °C | 275 | A |
| Repetitive peak drain current | $I_{DRM}$ | verified by design, $t_p$ limited by $T_{vjmax}$ | | 640 | A |
| Gate-source voltage, max. transient voltage | $V_{GS}$ | $D$ < 0.01 | | -10/23 | V |
| Gate-source voltage, max. static voltage | $V_{GS}$ | | | -7/20 | V |

**Table 4 Recommended values**

| Parameter | Symbol | Note or test condition | Values | Unit |
|---|---|---|---|---|
| On-state gate voltage | $V_{GS(on)}$ | | 15...18 | V |
| Off-state gate voltage | $V_{GS(off)}$ | | -5...0 | V |

**Table 5 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Drain-source on-resistance | $R_{DS(on)}$ | $I_D$ = 320 A | $V_{GS}$ = 18 V, $T_{vj}$ = 25 °C | | 2.6 | 4.1 | mΩ |
| | | | $V_{GS}$ = 18 V, $T_{vj}$ = 125 °C | | 5.4 | | |
| | | | $V_{GS}$ = 18 V, $T_{vj}$ = 175 °C | | 7.7 | | |
| | | | $V_{GS}$ = 15 V, $T_{vj}$ = 25 °C | | 2.8 | | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D$ = 224 mA, $V_{DS}$ = $V_{GS}$, (tested after 1ms pulse at $V_{GS}$ = +20 V), $T_{vj}$ = 25 °C | | 3.45 | 4.3 | 5.15 | V |
| Total gate charge | $Q_G$ | $V_{DD}$ = 1200 V, $V_{GS}$ = -3/18 V, $T_{vj}$ = 25 °C | | | 1.56 | | µC |
| Internal gate resistor | $R_{Gint}$ | $T_{vj}$ = 25 °C | | | 0.9 | | Ω |
| Input capacitance | $C_{ISS}$ | $f$ = 100 kHz, $V_{DS}$ = 1500 V, $V_{GS}$ = 0 V | $T_{vj}$ = 25 °C | | 47.9 | | nF |
| Output capacitance | $C_{OSS}$ | $f$ = 100 kHz, $V_{DS}$ = 1500 V, $V_{GS}$ = 0 V | $T_{vj}$ = 25 °C | | 1.12 | | nF |
| Reverse transfer capacitance | $C_{rss}$ | $f$ = 100 kHz, $V_{DS}$ = 1500 V, $V_{GS}$ = 0 V | $T_{vj}$ = 25 °C | | 0.084 | | nF |
| $C_{OSS}$ stored energy | $E_{OSS}$ | $V_{DS}$ = 1500 V, $V_{GS}$ = -3/18 V, $T_{vj}$ = 25 °C | | | 1470 | | µJ |
| Drain-source leakage current | $I_{DSS}$ | $V_{DS}$ = 2000 V, $V_{GS}$ = -3 V | $T_{vj}$ = 25 °C | | 0.08 | 660 | µA |
| Gate-source leakage current | $I_{GSS}$ | $V_{DS}$ = 0 V, $T_{vj}$ = 25 °C | $V_{GS}$ = 20 V | | | 400 | nA |
| Turn-on delay time (inductive load) | $t_{d\,on}$ | $I_D$ = 320 A, $R_{Gon}$ = 3 Ω, $V_{DD}$ = 1500 V, $V_{GS}$ = -3/18 V, $t_{dead}$ = 1000 ns | $T_{vj}$ = 25 °C | | 86 | | ns |
| | | | $T_{vj}$ = 125 °C | | 82 | | |
| | | | $T_{vj}$ = 175 °C | | 81 | | |
| Rise time (inductive load) | $t_r$ | $I_D$ = 320 A, $R_{Gon}$ = 3 Ω, $V_{DD}$ = 1500 V, $V_{GS}$ = -3/18 V, $t_{dead}$ = 1000 ns | $T_{vj}$ = 25 °C | | 44 | | ns |
| | | | $T_{vj}$ = 125 °C | | 39 | | |
| | | | $T_{vj}$ = 175 °C | | 39 | | |

**(table continues...)**

**Table 5** **(continued) Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Turn-off delay time (inductive load) | $t_{d\ off}$ | $I_D$ = 320 A, $R_{Goff}$ = 1 Ω, $V_{DD}$ = 1500 V, $V_{GS}$ = -3/18 V | $T_{vj}$ = 25 °C | | 123 | | ns |
| | | | $T_{vj}$ = 125 °C | | 136 | | |
| | | | $T_{vj}$ = 175 °C | | 142 | | |
| Fall time (inductive load) | $t_f$ | $I_D$ = 320 A, $R_{Goff}$ = 1 Ω, $V_{DD}$ = 1500 V, $V_{GS}$ = -3/18 V | $T_{vj}$ = 25 °C | | 62 | | ns |
| | | | $T_{vj}$ = 125 °C | | 65 | | |
| | | | $T_{vj}$ = 175 °C | | 67 | | |
| Turn-on energy loss per pulse | $E_{on}$ | $I_D$ = 320 A, $V_{DD}$ = 1500 V, $L_\sigma$ = 8 nH, $V_{GS}$ = -3/18 V, $R_{Gon}$ = 3 Ω, di/dt = 9 kA/µs ($T_{vj}$ = 175 °C), $t_{dead}$ = 1000 ns | $T_{vj}$ = 25 °C | | 44.3 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 49.7 | | |
| | | | $T_{vj}$ = 175 °C | | 56.5 | | |
| Turn-on energy loss per pulse, optimized | $E_{on,o}$ | $I_D$ = 320 A, $V_{DD}$ = 1500 V, $L_\sigma$ = 8 nH, $V_{GS}$ = -3/18 V, $R_{Gon,o}$ = 1 Ω, di/dt = 17 kA/µs ($T_{vj}$ = 175 °C), $t_{dead}$ = 100 ns | $T_{vj}$ = 25 °C | | 22.2 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 23.7 | | |
| | | | $T_{vj}$ = 175 °C | | 26.6 | | |
| Turn-off energy loss per pulse | $E_{off}$ | $I_D$ = 320 A, $V_{DD}$ = 1500 V, $L_\sigma$ = 8 nH, $V_{GS}$ = -3/18 V, $R_{Goff}$ = 1 Ω, dv/dt = 26.6 kV/µs ($T_{vj}$ = 175 °C) | $T_{vj}$ = 25 °C | | 12 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 13.5 | | |
| | | | $T_{vj}$ = 175 °C | | 14 | | |
| Thermal resistance, junction to heat sink | $R_{thJH}$ | per MOSFET, $\lambda_{grease}$ = 3.3 W/(m·K) | | | 0.12 | | K/W |
| Temperature under switching conditions | $T_{vj\ op}$ | | | -40 | | 175 | °C |

***Note***: *The selection of positive and negative gate-source voltages impacts losses and the long-term behavior of the MOSFET and body diode. The design guidelines described in Application Notes AN 2018-09 and AN 2021-13 must be considered to ensure sound operation of the device over the planned lifetime.*

*$T_{vj\ op}$ > 150 °C is allowed for operation at overload conditions. For detailed specifications, please refer to AN 2018-14.*

# 3 Body diode (MOSFET, T1.1-T1.2 / T2.1-T2.2)

**Table 6** **Maximum rated values**

| Parameter | Symbol | Note or test condition | | Values | Unit |
|---|---|---|---|---|---|
| DC body diode forward current | $I_{SD}$ | $T_{vj}$ = 175 °C, $V_{GS}$ = -3 V | $T_H$ = 65 °C | 210 | A |

**Table 7** **Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Forward voltage | $V_{SD}$ | $I_{SD}$ = 320 A, $V_{GS}$ = -3 V | $T_{vj}$ = 25 °C | | 4.4 | 5.95 | V |
| | | | $T_{vj}$ = 125 °C | | 4 | | |
| | | | $T_{vj}$ = 175 °C | | 3.85 | | |
| Peak reverse recovery current | $I_{rrm}$ | $I_{SD}$ = 320 A, $di_s/dt$ = 9 kA/µs, $V_{DD}$ = 1500 V, $V_{GS}$ = -3 V, $t_{dead}$ = 1000 ns | $T_{vj}$ = 25 °C | | 156 | | A |
| | | | $T_{vj}$ = 125 °C | | 229 | | |
| | | | $T_{vj}$ = 175 °C | | 292 | | |
| Recovered charge | $Q_{rr}$ | $I_{SD}$ = 320 A, $di_s/dt$ = 9 kA/µs, $V_{DD}$ = 1500 V, $V_{GS}$ = -3 V, $t_{dead}$ = 1000 ns | $T_{vj}$ = 25 °C | | 9.2 | | µC |
| | | | $T_{vj}$ = 125 °C | | 14.8 | | |
| | | | $T_{vj}$ = 175 °C | | 19.7 | | |
| Reverse recovery energy | $E_{rec}$ | $I_{SD}$ = 320 A, $di_s/dt$ = 9 kA/µs ($T_{vj}$ = 175 °C), $V_{DD}$ = 1500 V, $V_{GS}$ = -3 V, $t_{dead}$ = 1000 ns | $T_{vj}$ = 25 °C | | 8.1 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 10.2 | | |
| | | | $T_{vj}$ = 175 °C | | 11.9 | | |
| Reverse recovery energy, optimized | $E_{rec,o}$ | $I_{SD}$ = 320 A, $di_s/dt$ = 17 kA/µs ($T_{vj}$ = 175 °C), $V_{DD}$ = 1500 V, $V_{GS}$ = -3 V, $t_{dead}$ = 100 ns | $T_{vj}$ = 25 °C | | 10.8 | | mJ |
| | | | $T_{vj}$ = 125 °C | | 12.5 | | |
| | | | $T_{vj}$ = 175 °C | | 13 | | |

# 4 NTC-Thermistor

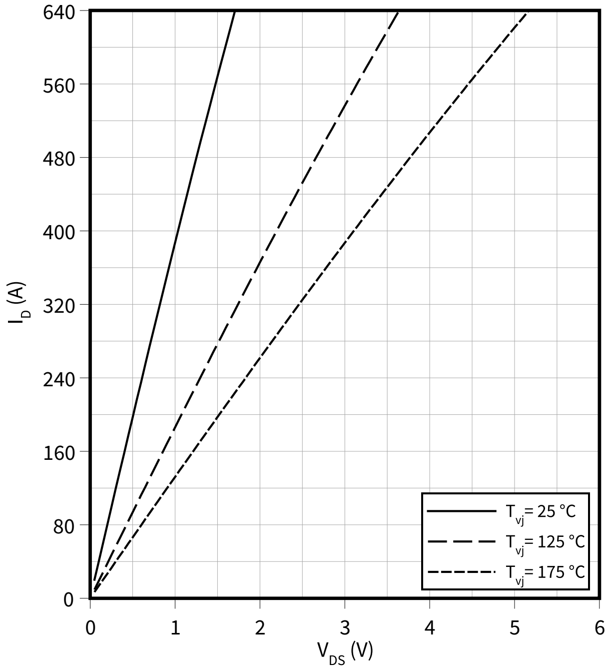
**Table 8** **Characteristic values**

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Rated resistance | $R_{25}$ | $T_{NTC}$ = 25 °C | | 5 | | kΩ |
| Deviation of $R_{100}$ | $\Delta R/R$ | $T_{NTC}$ = 100 °C, $R_{100}$ = 493 Ω | -5 | | 5 | % |
| Power dissipation | $P_{25}$ | $T_{NTC}$ = 25 °C | | | 20 | mW |
| B-value | $B_{25/50}$ | $R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15\ K))]$ | | 3375 | | K |
| B-value | $B_{25/80}$ | $R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298,15\ K))]$ | | 3411 | | K |
| B-value | $B_{25/100}$ | $R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15\ K))]$ | | 3433 | | K |

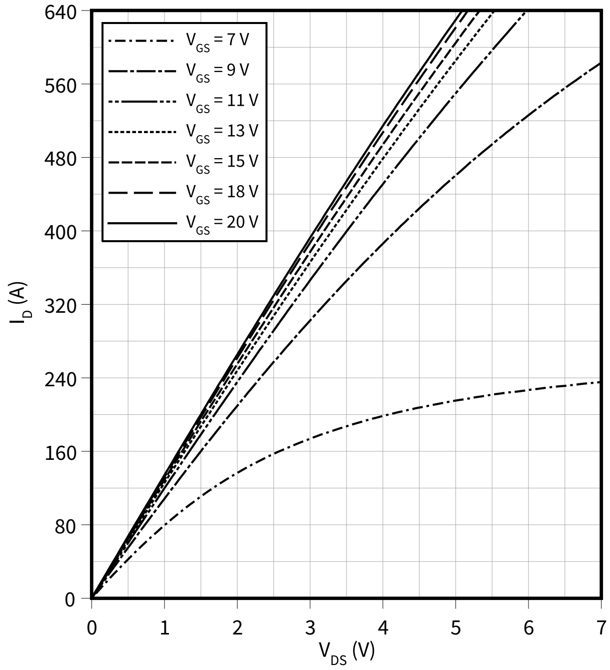
***Note:*** *For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4*

# 5 Characteristics diagrams

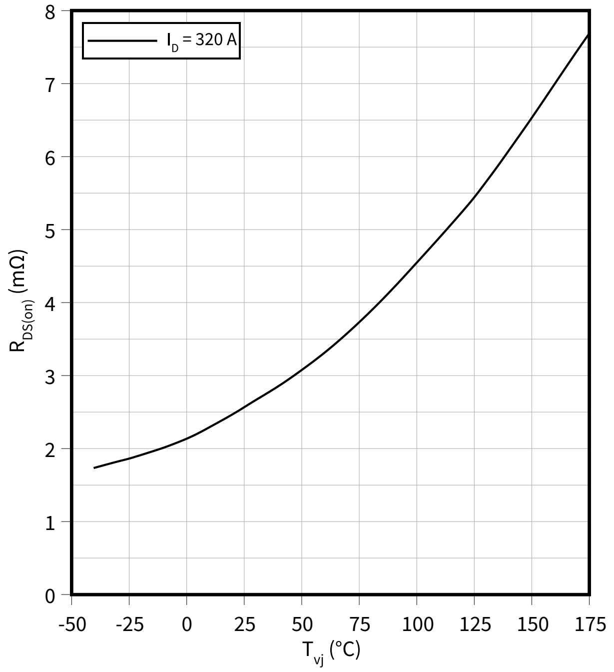
**Output characteristic (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**
$I_D = f(V_{DS})$
$V_{GS} = 18$ V



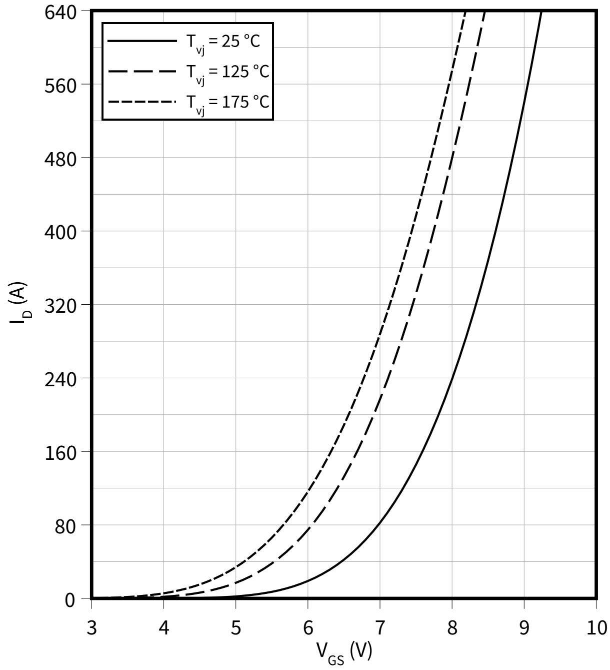

**Output characteristic field (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**
$I_D = f(V_{DS})$
$T_{vj} = 175$ °C




**Drain source on-resistance (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**
$R_{DS(on)} = f(T_{vj})$
$V_{GS} = 18$ V



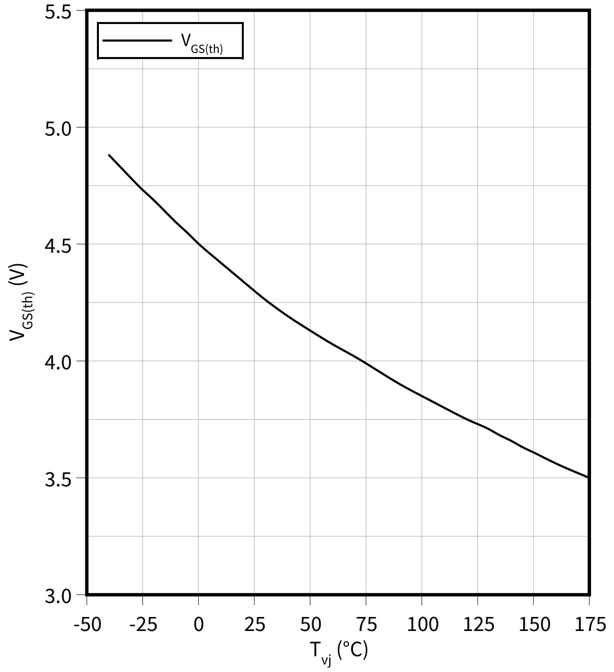

**Transfer characteristic (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**
$I_D = f(V_{GS})$
$V_{DS} = 20$ V



**Gate-source threshold voltage (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**

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

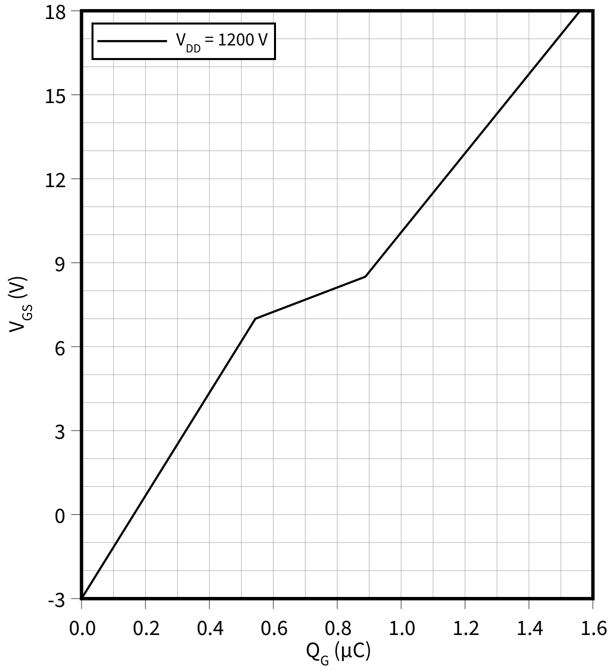
$I_D$ = 224 mA, $V_{GS} = V_{DS}$




**Gate charge characteristic (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**

$V_{GS} = f(Q_G)$

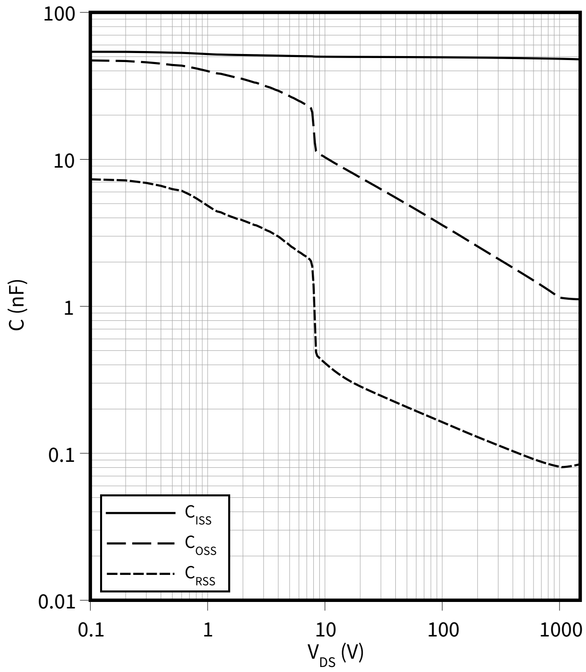
$I_D$ = 320 A, $T_{vj}$ = 25 °C




**Capacity characteristic (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**

$C = f(V_{DS})$

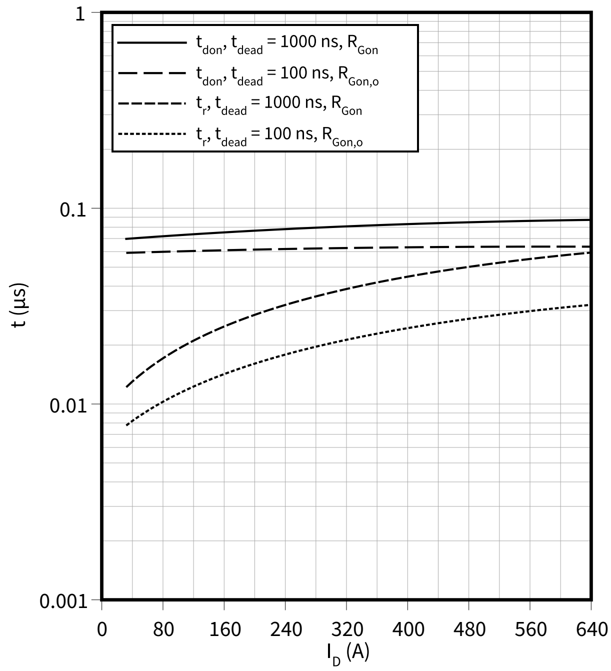
f = 100 kHz, $T_{vj}$ = 25 °C, $V_{GS}$ = 0 V




**Switching times (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**

$t = f(I_D)$

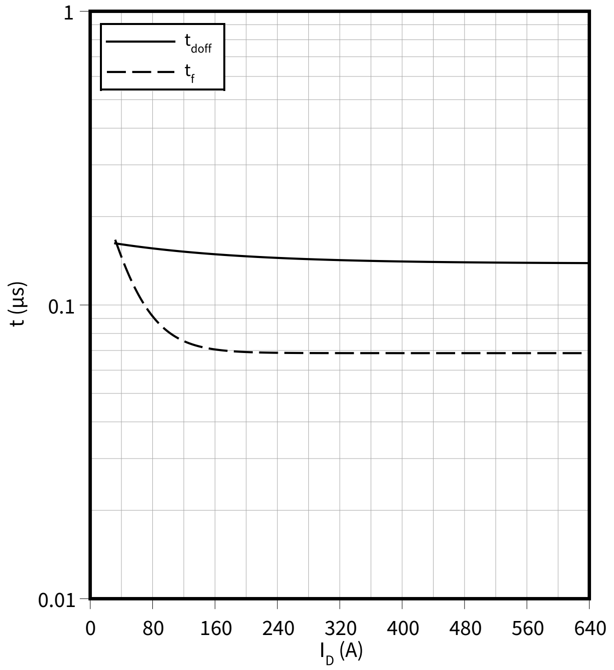
$V_{DD}$ = 1500 V, $R_{Gon}$ = 3 Ω, $R_{Gon,o}$ = 1 Ω, $T_{vj}$ = 175 °C, $V_{GS}$ = -3/18 V



### Switching times (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

$t = f(I_D)$

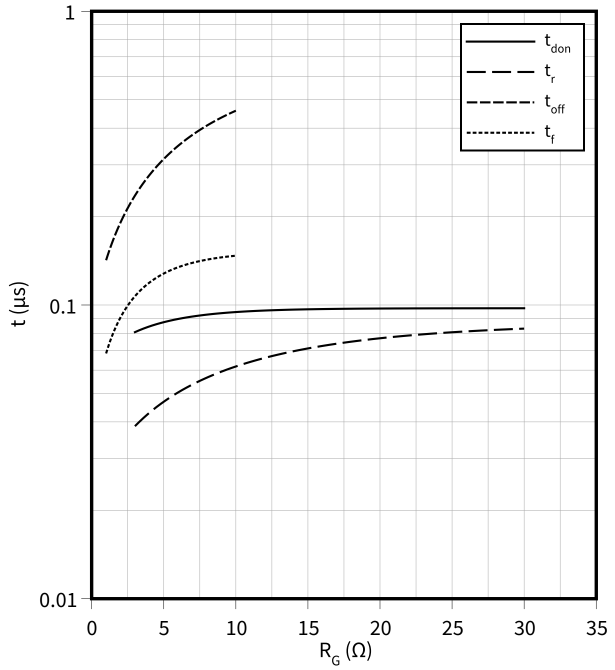
$R_{Goff} = 1\ \Omega$, $V_{DD} = 1500$ V, $T_{vj} = 175$ °C, $V_{GS} = -3/18$ V




### Switching times (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

$t = f(R_G)$

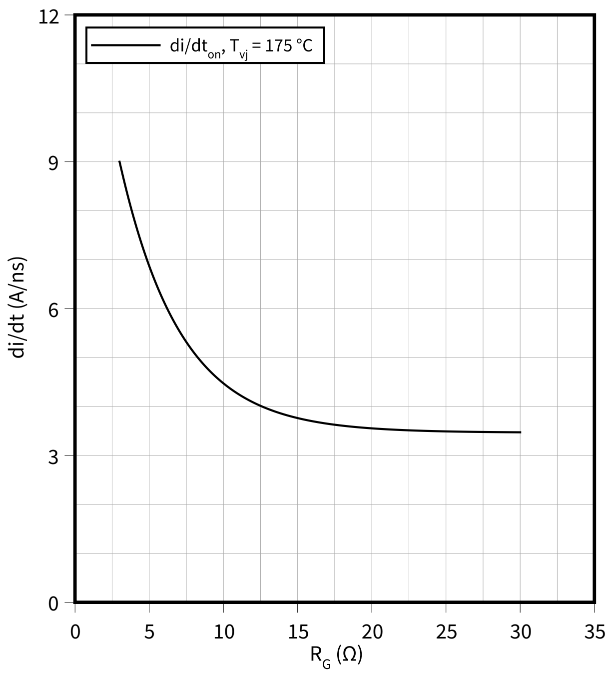
$V_{DD} = 1500$ V, $t_{dead} = 1000$ ns, $I_D = 320$ A, $T_{vj} = 175$ °C, $V_{GS} = -3/18$ V




### Current slope (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

$di/dt = f(R_G)$

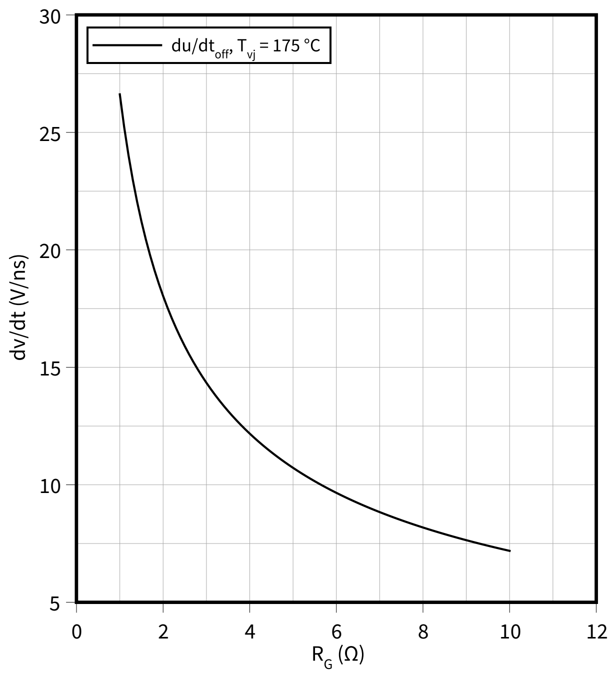
$V_{DD} = 1500$ V, $I_D = 320$ A, $V_{GS} = -3/18$ V




### Voltage slope (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

$dv/dt = f(R_G)$

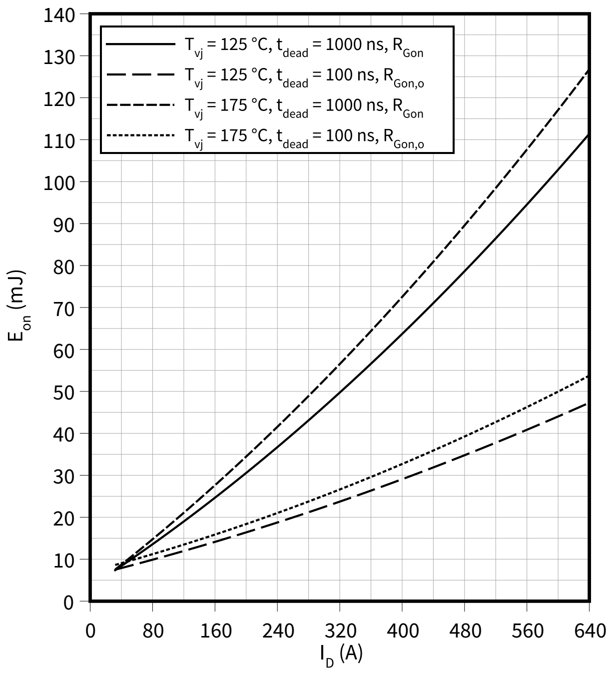
$V_{DD} = 1500$ V, $I_D = 320$ A, $V_{GS} = -3/18$ V



**Switching losses (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**

$E_{on} = f(I_D)$

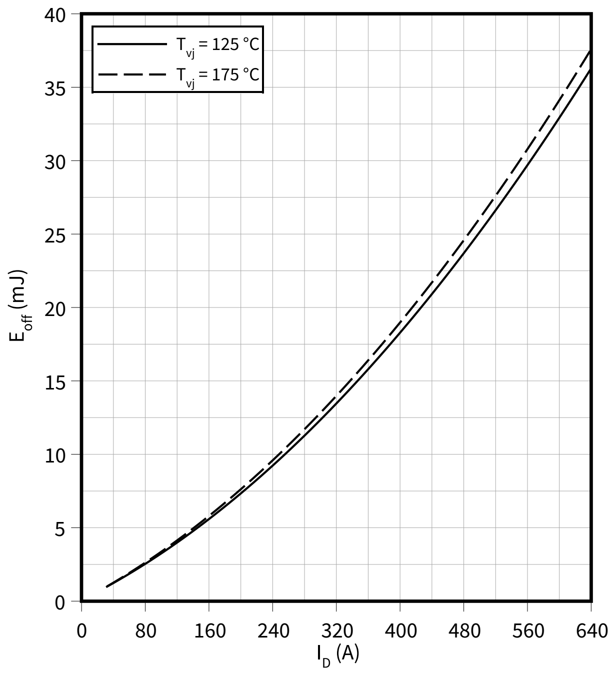
$V_{DD}$ = 1500 V, $R_{Gon}$ = 3 Ω, $R_{Gon,o}$ = 1 Ω, $V_{GS}$ = -3/18 V




**Switching losses (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**

$E_{off} = f(I_D)$

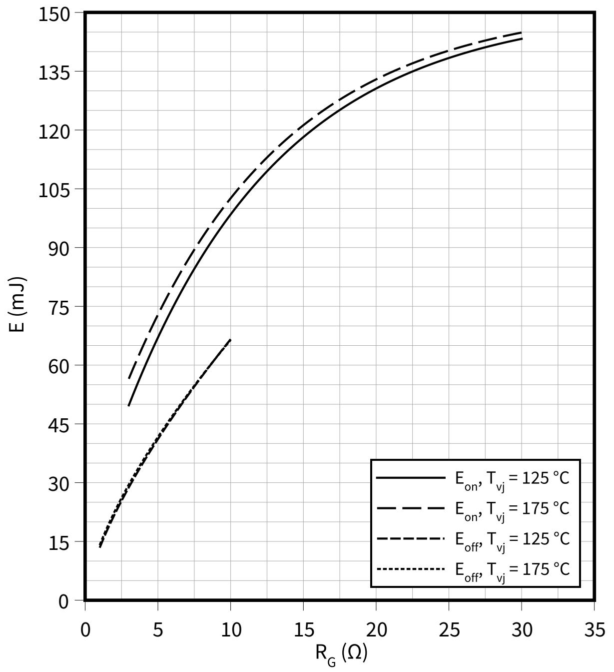
$R_{Goff}$ = 1 Ω, $V_{DD}$ = 1500 V, $V_{GS}$ = -3/18 V




**Switching losses (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**

$E = f(R_G)$

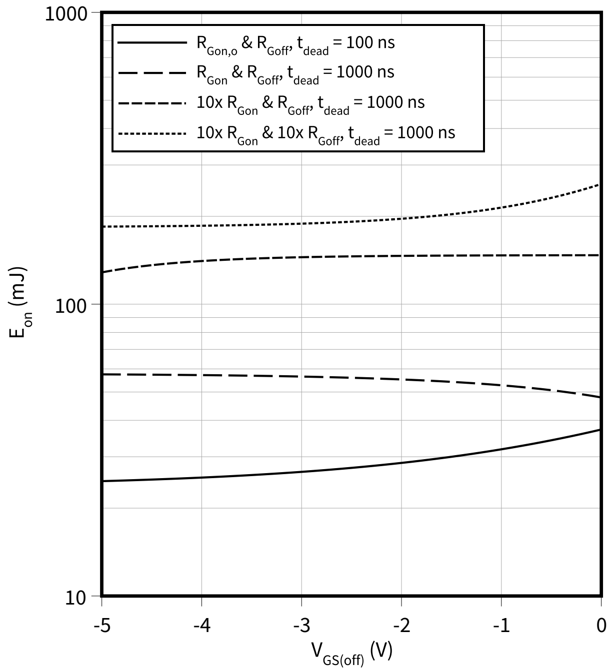
$V_{DD}$ = 1500 V, $t_{dead}$ = 1000 ns, $I_D$ = 320 A, $V_{GS}$ = -3/18 V




**Switching losses (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2**

$E_{on} = f(V_{GS(off)})$

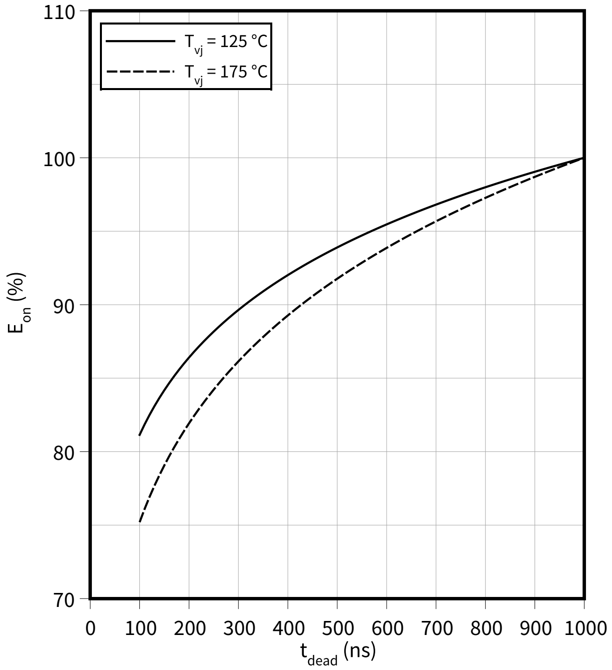
$R_{Goff}$ = 1 Ω, $V_{DD}$ = 1500 V, $R_{Gon}$ = 3 Ω, $V_{GS(on)}$ = 18 V, $I_D$ = 320 A, $R_{Gon,o}$ = 1 Ω, $T_{vj}$ = 175 °C



### Switching losses (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

$E_{on} = f(t_{dead})$

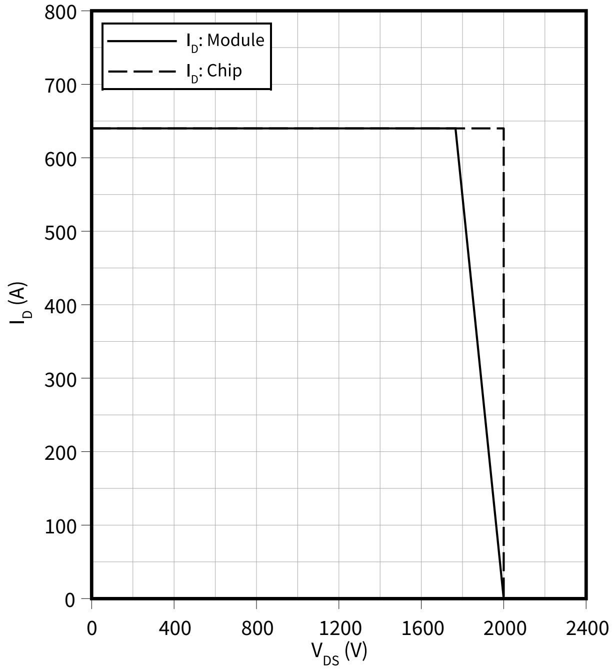
$R_{Gon} = 3\ \Omega$, $I_D = 320$ A, $V_{DD} = 1500$ V, $V_{GS} = -3/18$ V




### Reverse bias safe operating area (RBSOA), MOSFET, T1.1-T1.2 / T2.1-T2.2

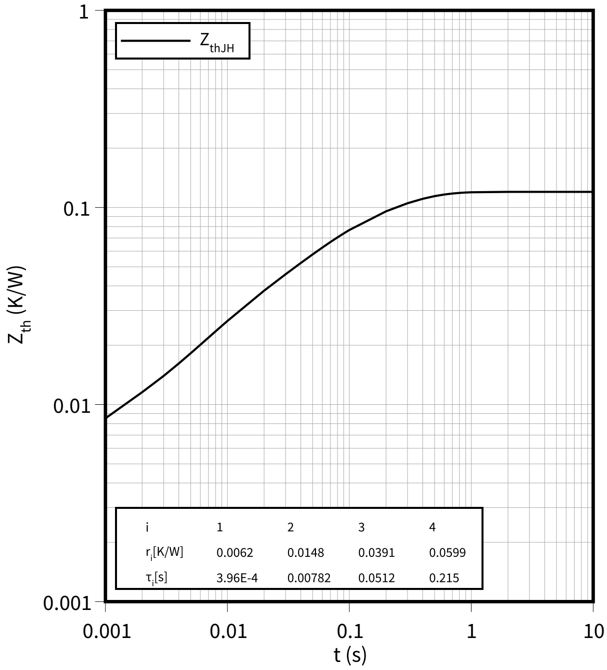
$I_D = f(V_{DS})$

$R_{Goff} = 1\ \Omega$, $T_{vj} = 175$ °C, $V_{GS} = -3/18$ V




### Transient thermal impedance, MOSFET, T1.1-T1.2 / T2.1-T2.2

$Z_{th} = f(t)$

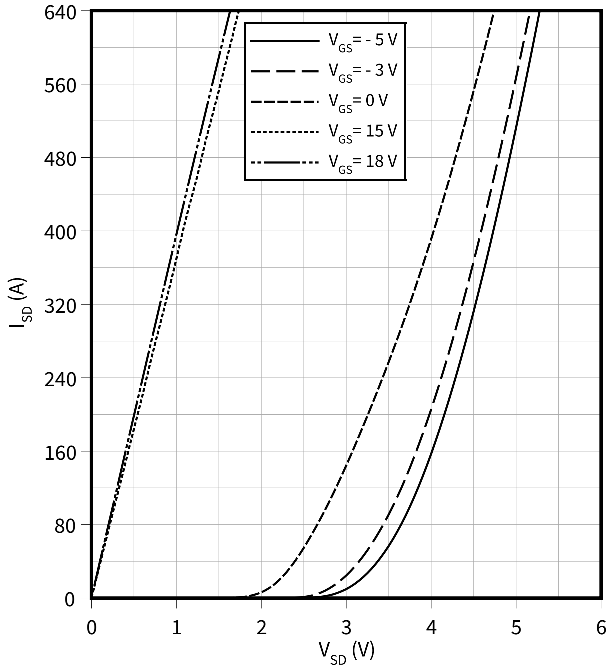



| i | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $r_i$[K/W] | 0.0062 | 0.0148 | 0.0391 | 0.0599 |
| $\tau_i$[s] | 3.96E-4 | 0.00782 | 0.0512 | 0.215 |

### Forward characteristic body diode (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

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

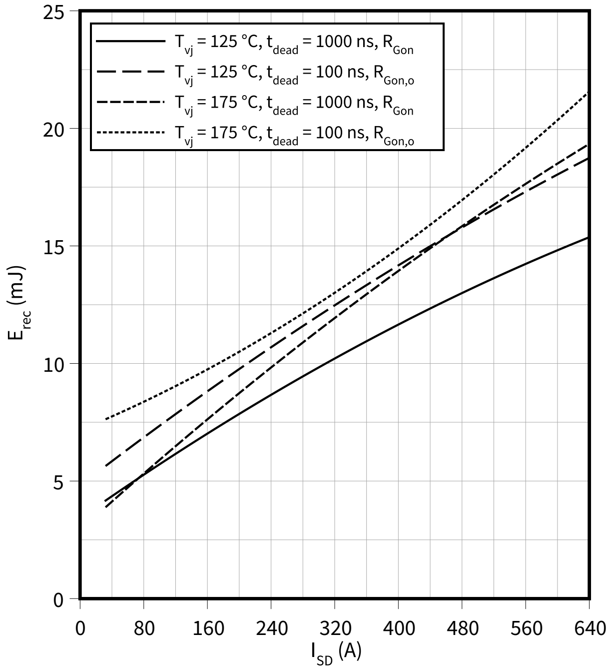
$T_{vj} = 25$ °C



## Switching losses body diode (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

$E_{rec} = f(I_{SD})$

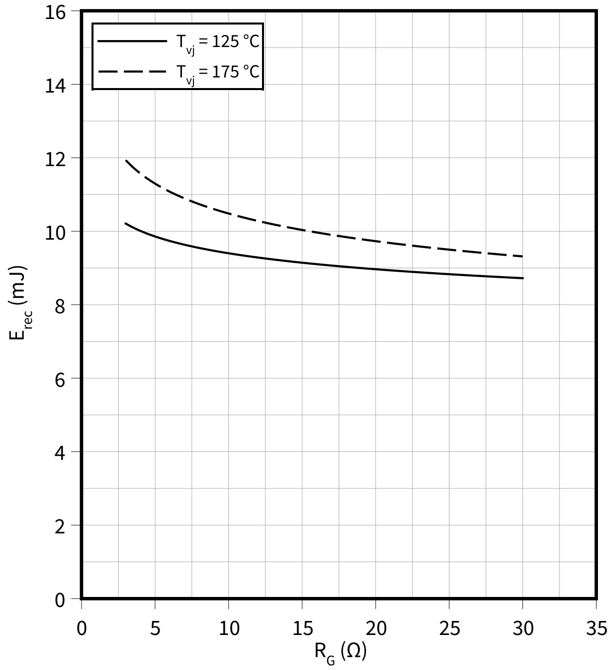
$R_{Gon} = 3\ \Omega$, $R_{Gon,o} = 1\ \Omega$, $V_{DD} = 1500\ V$




## Switching losses body diode (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

$E_{rec} = f(R_G)$

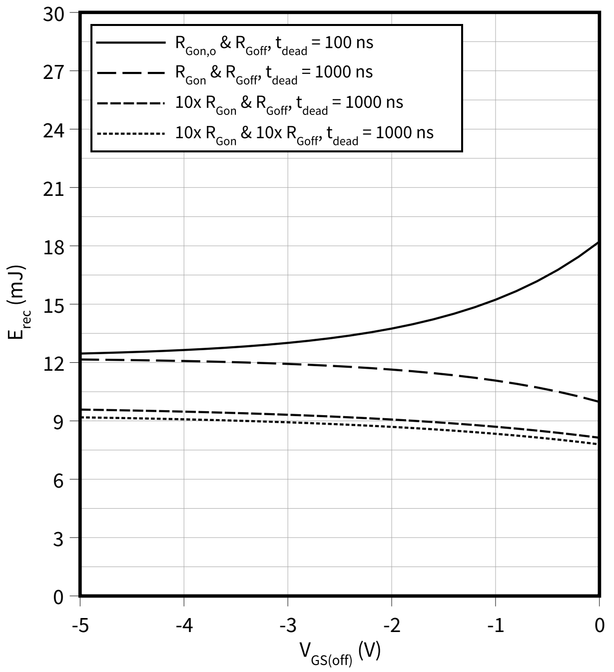
$t_{dead} = 1000\ ns$, $I_{SD} = 320\ A$, $V_{DD} = 1500\ V$




## Switching losses body diode (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

$E_{rec} = f(V_{GS(off)})$

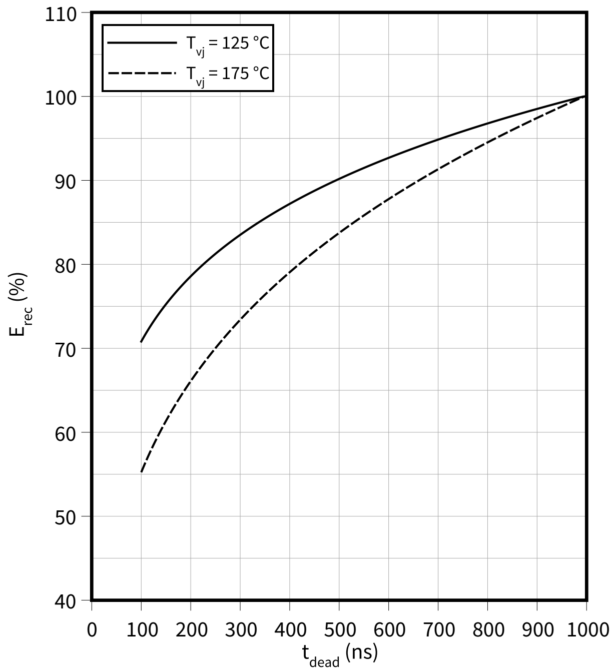
$R_{Goff} = 1\ \Omega$, $R_{Gon} = 3\ \Omega$, $V_{GS(on)} = 18\ V$, $I_{SD} = 320\ A$, $R_{Gon,o} = 1\ \Omega$, $V_{DD} = 1500\ V$, $T_{vj} = 175\ °C$

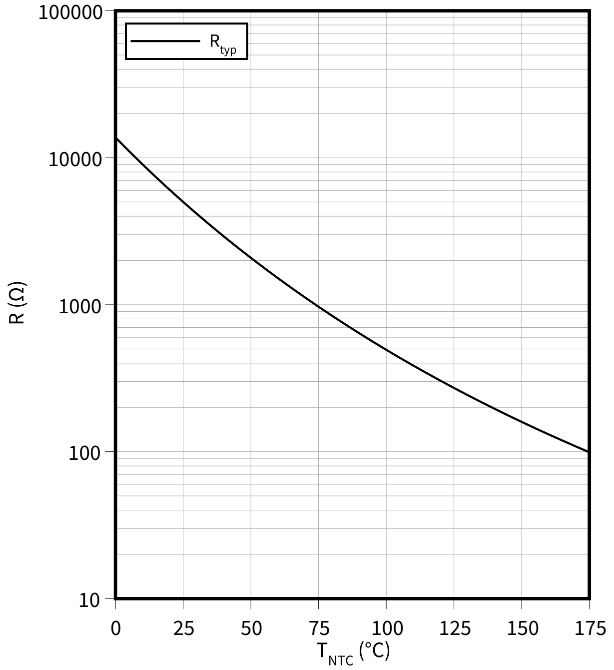



## Switching losses body diode (typical), MOSFET, T1.1-T1.2 / T2.1-T2.2

$E_{rec} = f(t_{dead})$

$R_{Gon} = 3\ \Omega$, $I_D = 320\ A$, $V_{DD} = 1500\ V$, $V_{GS} = -3/18\ V$



| Temperature characteristic (typical), NTC-Thermistor<br>$R = f(T_{NTC})$ | |
|---|---|
|  | |

# 6 Circuit diagram

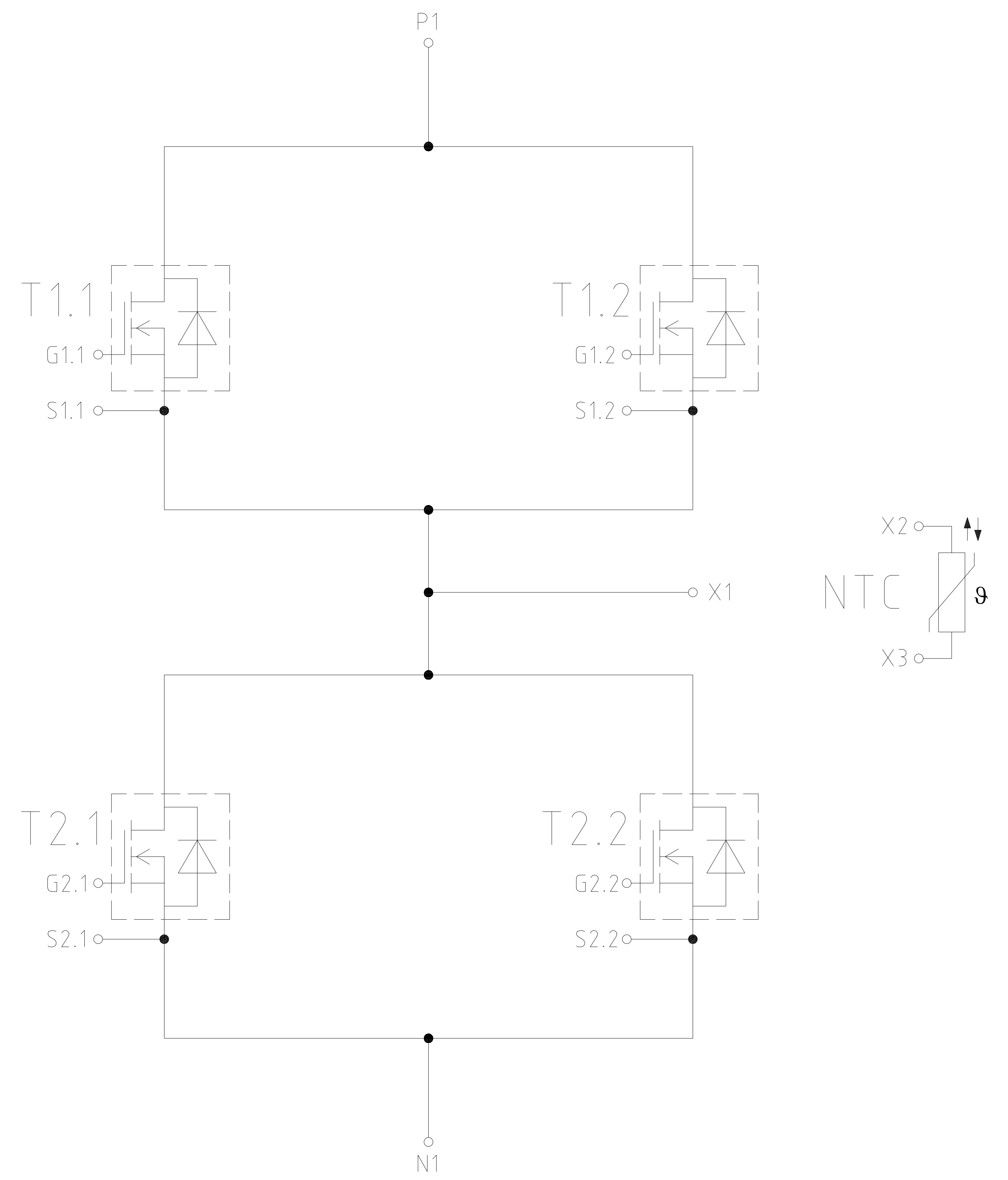



**Figure 1**

# 7 Package outlines

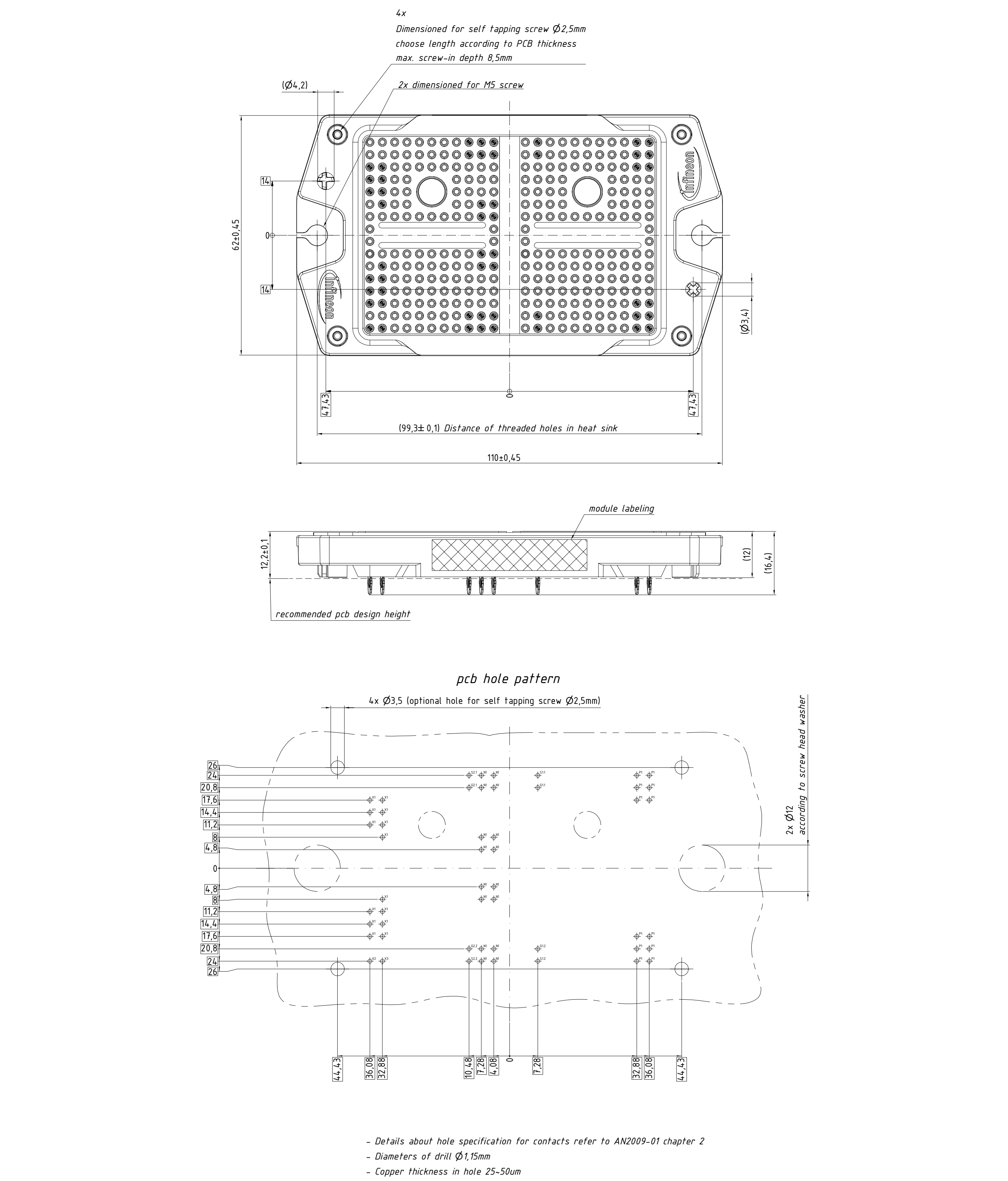



**Figure 2**

# 8 Module label code

| **Module label code** | | | |
|---|---|---|---|
| Code format | Data Matrix | Barcode Code128 | |
| Encoding | ASCII text | Code Set A | |
| Symbol size | 16x16 | 23 digits | |
| Standard | IEC24720 and IEC16022 | IEC8859-1 | |
| Code content | *Content*<br>Module serial number<br>Module material number<br>Production order number<br>Date code (production year)<br>Date code (production week) | *Digit*<br>1 – 5<br>6 - 11<br>12 - 19<br>20 – 21<br>22 – 23 | *Example*<br>71549<br>142846<br>55054991<br>15<br>30 |
| Example | 71549142846550549911530 | 71549142846550549911530 | |

**Figure 3**

# Revision history

| Document version | Date of release | Description of changes |
|---|---|---|
| 0.10 | 2024-02-12 | Initial version |
| 1.00 | 2025-01-13 | Final datasheet |

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**Edition 2025-01-13**

**Published by**

**Infineon Technologies AG**

**81726 Munich, Germany**



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**Document reference**
**IFX-ABJ480-002**