

EasyPACK™ module with CoolSiC™ Trench MOSFET and PressFIT / NTC

Features

- Electrical features
 - $V_{DSS} = 2000\text{ V}$
 - $I_{DN} = 60\text{ A} / I_{DRM} = 120\text{ A}$
 - High current density
 - Low inductive design
- Mechanical features
 - Rugged mounting due to integrated mounting clamps
 - PressFIT contact technology
 - Integrated NTC temperature sensor



Potential applications

- Solar applications

Product validation

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

Description

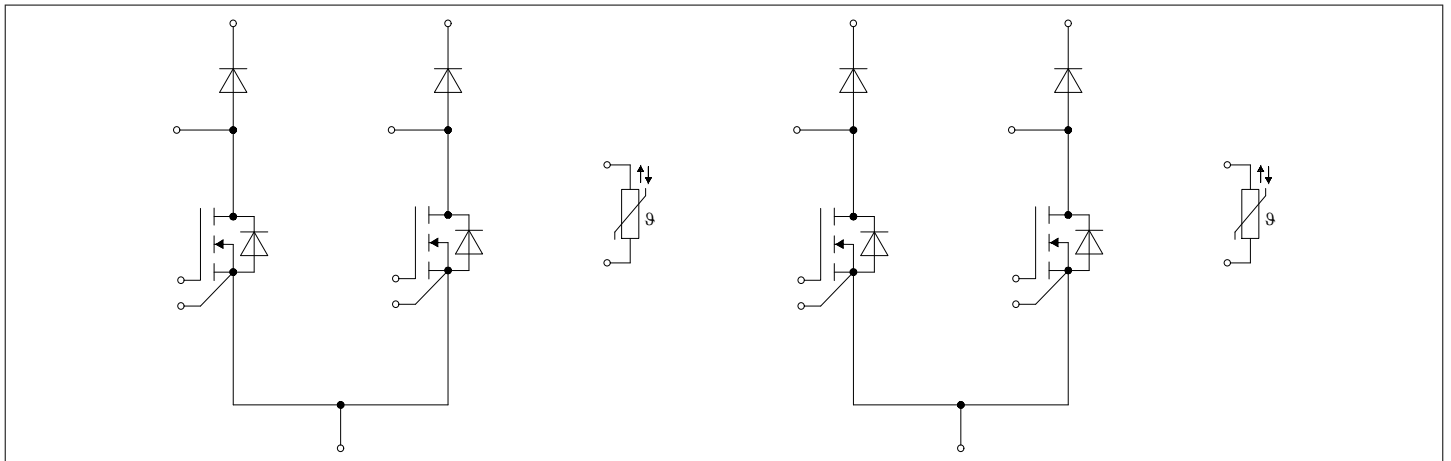


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1 Package

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 |
| Internal isolation | | basic insulation (class 1, IEC 61140) | Al_2O_3 | |
| Creepage distance | d_{Creep} | terminal to heatsink | 10.4 | mm |
| Creepage distance | d_{Creep} | terminal to terminal | 10.2 | mm |
| Clearance | d_{Clear} | terminal to heatsink | 10.1 | mm |
| Clearance | d_{Clear} | terminal to terminal | 9.4 | mm |
| 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} | | | 14 | | nH |
| 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 25 A rms per connector pin.

2 MOSFET

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} | | 60 | A |
| Continuous DC drain current | I_{DDC} | $T_{vj} = 175$ °C, $V_{GS} = 18$ V $T_H = 65$ °C | 50 | A |
| Repetitive peak drain current | I_{DRM} | verified by design, t_p limited by T_{vjmax} | 120 | 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 | $V_{GS(on)}$ | | 18 | V |
| Off-state gate voltage | $V_{GS(off)}$ | | -3 | V |

Table 5 Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit | |
|--------------------------------------|--------------|--|--|-------|------|------|----|
| | | | Min. | Typ. | Max. | | |
| Drain-source on-resistance | $R_{DS(on)}$ | $I_D = 60\text{ A}$ | $V_{GS} = 18\text{ V}, T_{vj} = 25\text{ °C}$ | | 17.2 | 26.5 | mΩ |
| | | | $V_{GS} = 18\text{ V}, T_{vj} = 125\text{ °C}$ | | 36.6 | | |
| | | | $V_{GS} = 18\text{ V}, T_{vj} = 175\text{ °C}$ | | 51.7 | | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D = 34\text{ mA}, V_{DS} = V_{GS}, T_{vj} = 25\text{ °C},$ (tested after 1ms pulse at $V_{GS} = +20\text{ V}$) | 3.45 | 4.3 | 5.15 | V | |
| Total gate charge | Q_G | $V_{DD} = 1200\text{ V}, V_{GS} = -3/18\text{ V}$ | | 0.234 | | μC | |
| Internal gate resistor | R_{Gint} | $T_{vj} = 25\text{ °C}$ | | 3.8 | | Ω | |
| Input capacitance | C_{ISS} | $f = 100\text{ kHz}, V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}, T_{vj} = 25\text{ °C}$ | | 7.24 | | nF | |
| Output capacitance | C_{OSS} | $f = 100\text{ kHz}, V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}, T_{vj} = 25\text{ °C}$ | | 0.169 | | nF | |
| Reverse transfer capacitance | C_{rss} | $f = 100\text{ kHz}, V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}, T_{vj} = 25\text{ °C}$ | | 0.012 | | nF | |
| C_{OSS} stored energy | E_{OSS} | $V_{DS} = 1200\text{ V}, V_{GS} = -3/18\text{ V}, T_{vj} = 25\text{ °C}$ | | 154 | | μJ | |
| Drain-source leakage current | I_{DSS} | $V_{DS} = 2000\text{ V}, V_{GS} = -3\text{ V}, T_{vj} = 25\text{ °C}$ | | 0.012 | 205 | μA | |
| Gate-source leakage current | I_{GSS} | $V_{DS} = 0\text{ V}, T_{vj} = 25\text{ °C}$ | $V_{GS} = 20\text{ V}$ | | 400 | nA | |
| Turn-on delay time (inductive load) | $t_{d on}$ | $I_D = 60\text{ A}, R_{Gon} = 1.6\text{ Ω}, V_{DD} = 1200\text{ V}, V_{GS} = -3/18\text{ V}$ | $T_{vj} = 25\text{ °C}$ | | 38.1 | | ns |
| | | | $T_{vj} = 125\text{ °C}$ | | 38.1 | | |
| | | | $T_{vj} = 175\text{ °C}$ | | 38.1 | | |
| Rise time (inductive load) | t_r | $I_D = 60\text{ A}, R_{Gon} = 1.6\text{ Ω}, V_{DD} = 1200\text{ V}, V_{GS} = -3/18\text{ V}$ | $T_{vj} = 25\text{ °C}$ | | 26 | | ns |
| | | | $T_{vj} = 125\text{ °C}$ | | 26 | | |
| | | | $T_{vj} = 175\text{ °C}$ | | 26 | | |
| Turn-off delay time (inductive load) | $t_{d off}$ | $I_D = 60\text{ A}, R_{Goff} = 2\text{ Ω}, V_{DD} = 1200\text{ V}, V_{GS} = -3/18\text{ V}$ | $T_{vj} = 25\text{ °C}$ | | 74.4 | | ns |
| | | | $T_{vj} = 125\text{ °C}$ | | 81.5 | | |
| | | | $T_{vj} = 175\text{ °C}$ | | 83.9 | | |

(table continues...)

Table 5 (continued) Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|--------------|--|--------------------------------------|------|-------|------------------|
| | | | Min. | Typ. | Max. | |
| Fall time (inductive load) | t_f | $I_D = 60\text{ A}$, $R_{Goff} = 2\ \Omega$, $V_{DD} = 1200\text{ V}$, $V_{GS} = -3/18\text{ V}$ | $T_{vj} = 25\text{ }^\circ\text{C}$ | | 16 | ns |
| | | | $T_{vj} = 125\text{ }^\circ\text{C}$ | | 16.1 | |
| | | | $T_{vj} = 175\text{ }^\circ\text{C}$ | | 17.1 | |
| Turn-on energy loss per pulse | E_{on} | $I_D = 60\text{ A}$, $V_{DD} = 1200\text{ V}$, $L_\sigma = 35\text{ nH}$, $V_{GS} = -3/18\text{ V}$, $R_{Gon} = 1.6\ \Omega$, $di/dt = 5\text{ kA}/\mu\text{s}$ ($T_{vj} = 175\text{ }^\circ\text{C}$) | $T_{vj} = 25\text{ }^\circ\text{C}$ | | 1.5 | mJ |
| | | | $T_{vj} = 125\text{ }^\circ\text{C}$ | | 1.5 | |
| | | | $T_{vj} = 175\text{ }^\circ\text{C}$ | | 1.5 | |
| Turn-off energy loss per pulse | E_{off} | $I_D = 60\text{ A}$, $V_{DD} = 1200\text{ V}$, $L_\sigma = 35\text{ nH}$, $V_{GS} = -3/18\text{ V}$, $R_{Goff} = 2\ \Omega$, $dv/dt = 56.14\text{ kV}/\mu\text{s}$ ($T_{vj} = 175\text{ }^\circ\text{C}$) | $T_{vj} = 25\text{ }^\circ\text{C}$ | | 0.435 | mJ |
| | | | $T_{vj} = 125\text{ }^\circ\text{C}$ | | 0.481 | |
| | | | $T_{vj} = 175\text{ }^\circ\text{C}$ | | 0.529 | |
| Thermal resistance, junction to heat sink | R_{thJH} | per MOSFET | | | 0.515 | K/W |
| Temperature under switching conditions | $T_{vj\ op}$ | | -40 | | 175 | $^\circ\text{C}$ |

Note: The body diode of CoolSiC™ Trench MOSFET cannot be used for polarity protection. An external diode is needed for this purpose.

The selection of positive and negative gate-source voltages impacts 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.

$T_{vj\ op} > 150\text{ }^\circ\text{C}$ is allowed for operation at overload conditions for MOSFET and body diode. For detailed specifications, please refer to AN 2021-13

3 Body diode

Table 6 Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit | |
|-----------------|----------|---|--------------------------------------|------|------|------|---|
| | | | Min. | Typ. | Max. | | |
| Forward voltage | V_{SD} | $I_{SD} = 60\text{ A}$, $V_{GS} = -3\text{ V}$ | $T_{vj} = 25\text{ }^\circ\text{C}$ | | 4.6 | 6.15 | V |
| | | | $T_{vj} = 125\text{ }^\circ\text{C}$ | | 4.15 | | |
| | | | $T_{vj} = 175\text{ }^\circ\text{C}$ | | 4 | | |

4 Diode, Boost

Table 7 Maximum rated values

| Parameter | Symbol | Note or test condition | Values | Unit | |
|---------------------------------|-----------|--|--------------------------|------|------------------|
| Repetitive peak reverse voltage | V_{RRM} | $T_{vj} = 25\text{ °C}$ | 2000 | V | |
| Continuous DC forward current | I_F | | 40 | A | |
| Repetitive peak forward current | I_{FRM} | $t_p = 1\text{ ms}$ | 80 | A | |
| I^2t - value | I^2t | $t_p = 10\text{ ms}, V_R = 0\text{ V}$ | $T_{vj} = 125\text{ °C}$ | 90 | A ² s |
| | | | $T_{vj} = 175\text{ °C}$ | 70 | |

Table 8 Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|--------------------|------------------------|--------------------------|-------|------|------|
| | | | Min. | Typ. | Max. | |
| Forward voltage | V_F | $I_F = 40\text{ A}$ | $T_{vj} = 25\text{ °C}$ | 1.50 | 1.85 | V |
| | | | $T_{vj} = 125\text{ °C}$ | 2.17 | | |
| | | | $T_{vj} = 175\text{ °C}$ | 2.67 | | |
| Thermal resistance, junction to heat sink | R_{thJH} | per diode | | 0.685 | | K/W |
| Temperature under switching conditions | $T_{vj\text{ op}}$ | | -40 | | 175 | °C |

Note: $T_{vj\text{ op}} > 150\text{ °C}$ is allowed for operation at overload conditions for booster diode. For detailed specifications, please refer to AN 2021-13

5 NTC-Thermistor

Table 9 Characteristic values

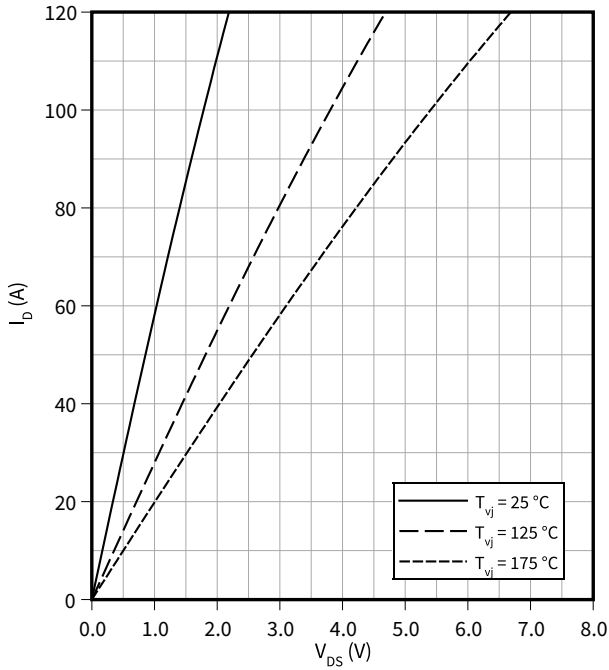
| Parameter | Symbol | Note or test condition | Values | | | Unit |
|------------------------|--------------|--|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Rated resistance | R_{25} | $T_{NTC} = 25\text{ °C}$ | | 5 | | kΩ |
| Deviation of R_{100} | $\Delta R/R$ | $T_{NTC} = 100\text{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

Note: Specification according to the valid application note.

6 Characteristics diagrams

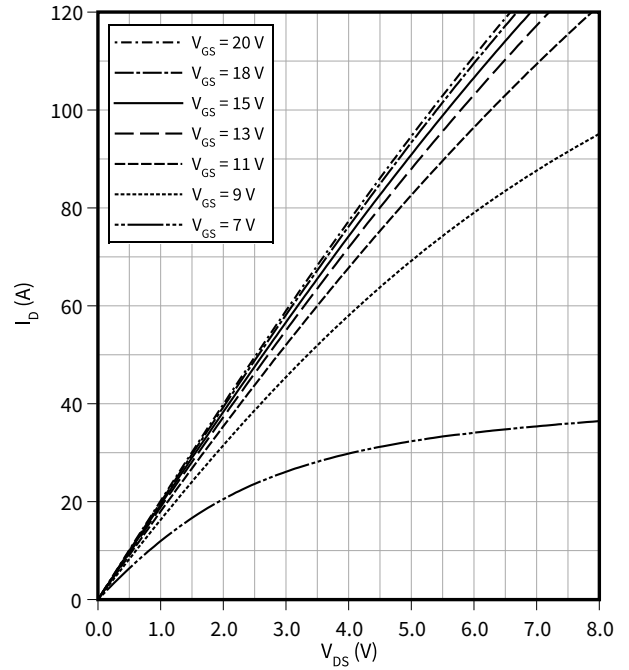
Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$
 $V_{GS} = 18\text{ V}$



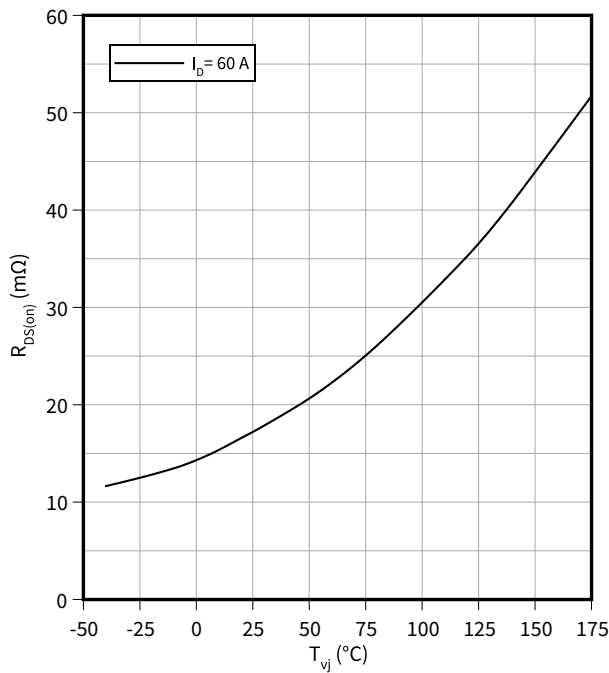
Output characteristic field (typical), MOSFET

$I_D = f(V_{DS})$
 $T_{vj} = 175\text{ °C}$



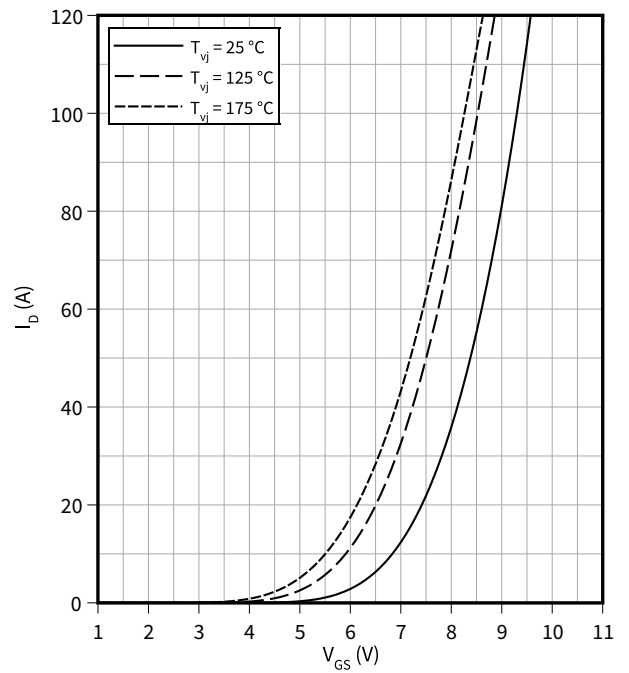
Drain source on-resistance (typical), MOSFET

$R_{DS(on)} = f(T_{vj})$
 $V_{GS} = 18\text{ V}$



Transfer characteristic (typical), MOSFET

$I_D = f(V_{GS})$
 $V_{DS} = 20\text{ V}$

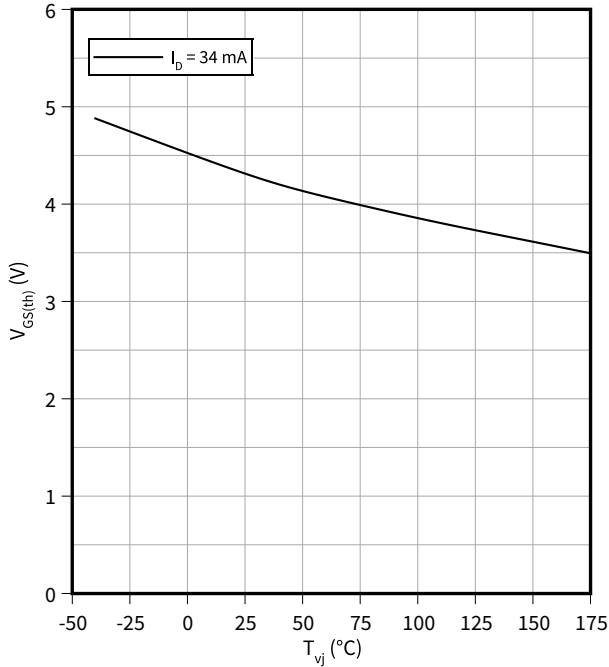


6 Characteristics diagrams

Gate-source threshold voltage (typical), MOSFET

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

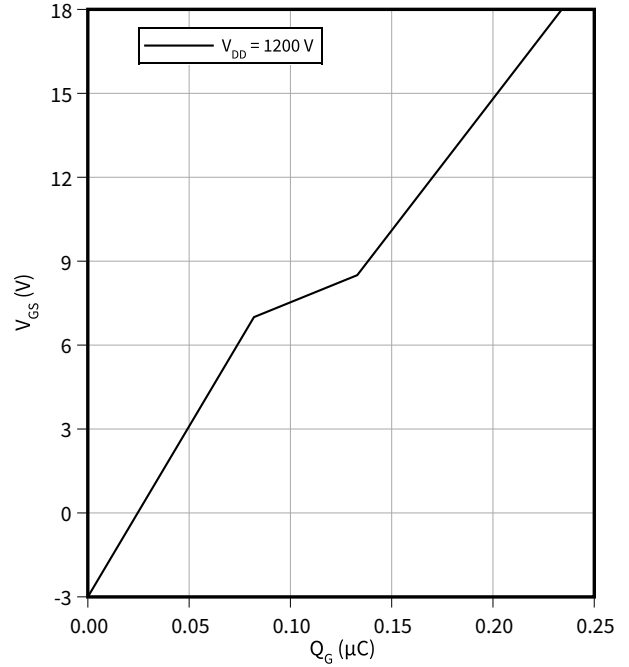
$$V_{GS} = V_{DS}$$



Gate charge characteristic (typical), MOSFET

$$V_{GS} = f(Q_G)$$

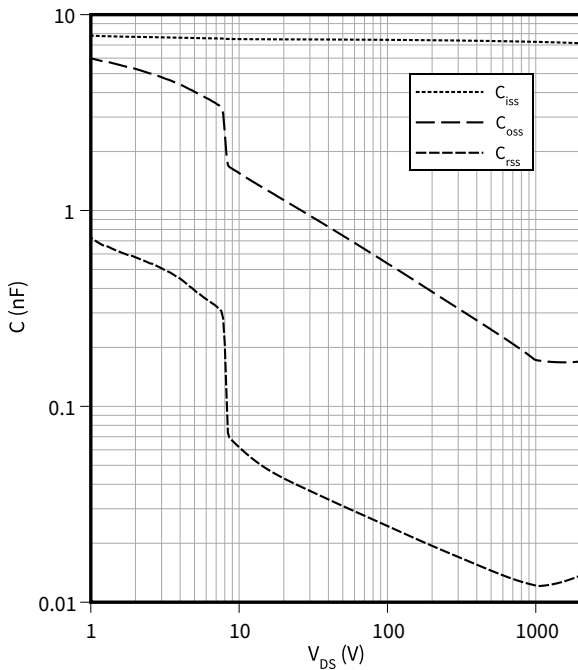
$$I_D = 60 \text{ A}, T_{vj} = 25 \text{ °C}$$



Capacity characteristic (typical), MOSFET

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

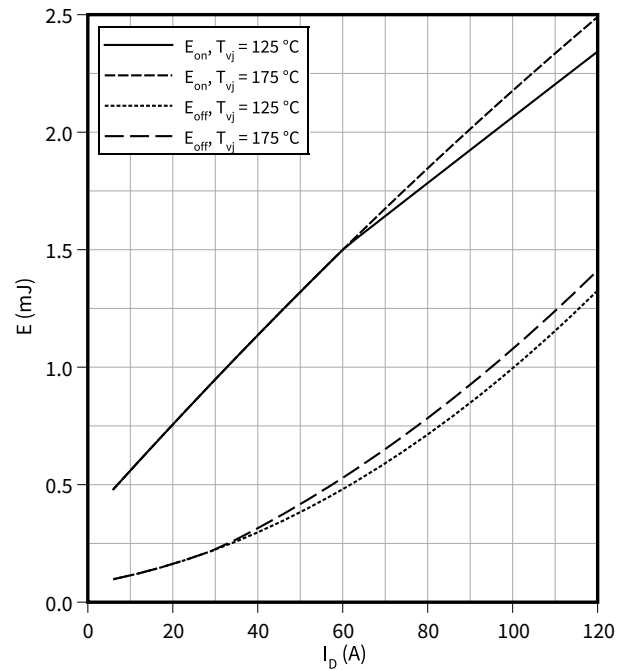
$$f = 100 \text{ kHz}, T_{vj} = 25 \text{ °C}, V_{GS} = 0 \text{ V}$$



Switching losses (typical), MOSFET

$$E = f(I_D)$$

$$R_{Goff} = 2 \text{ } \Omega, R_{Gon} = 1.6 \text{ } \Omega, V_{DD} = 1200 \text{ V}, V_{GS} = -3/18 \text{ V}$$

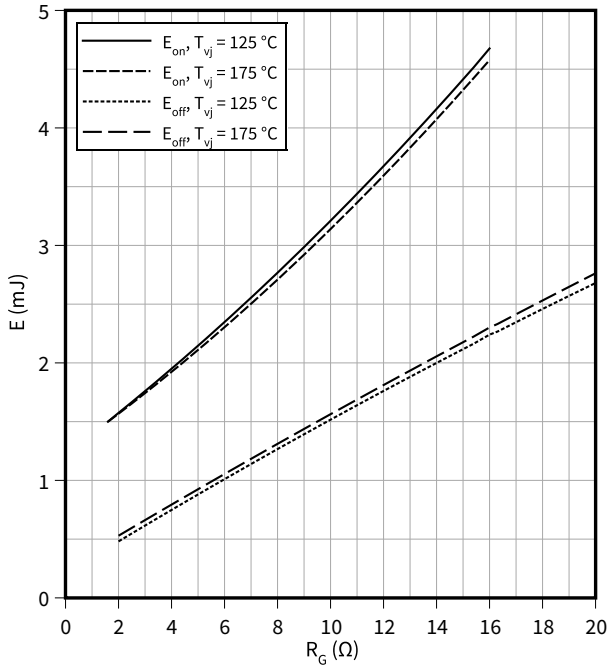


6 Characteristics diagrams

Switching losses (typical), MOSFET

$E = f(R_G)$

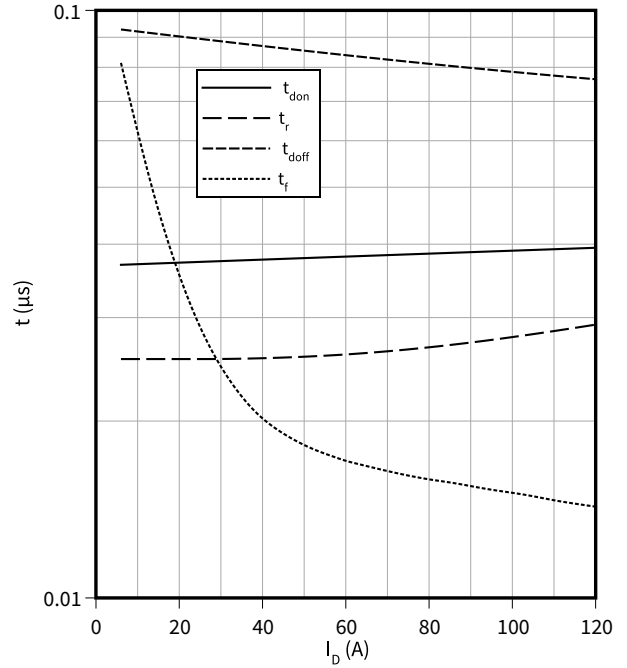
$V_{DD} = 1200\text{ V}, I_D = 60\text{ A}, V_{GS} = -3/18\text{ V}$



Switching times (typical), MOSFET

$t = f(I_D)$

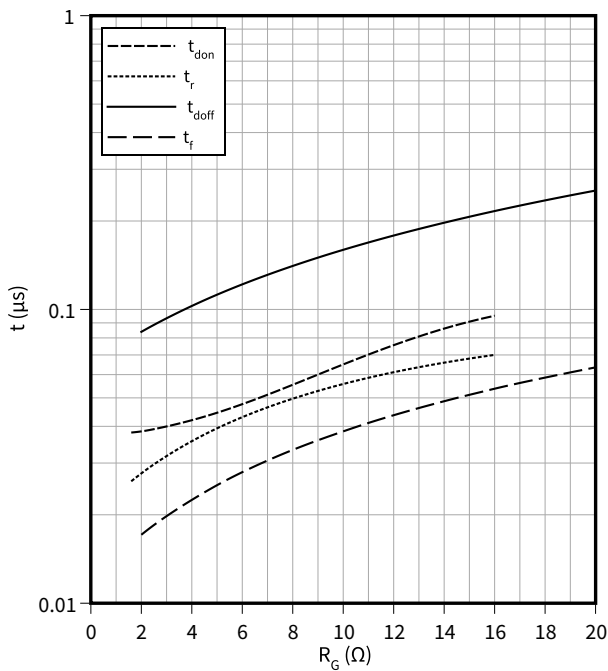
$R_{Goff} = 2.0\ \Omega, R_{Gon} = 1.6\ \Omega, V_{DD} = 1200\text{ V}, T_{vj} = 175\text{ °C}, V_{GS} = -3/18\text{ V}$



Switching times (typical), MOSFET

$t = f(R_G)$

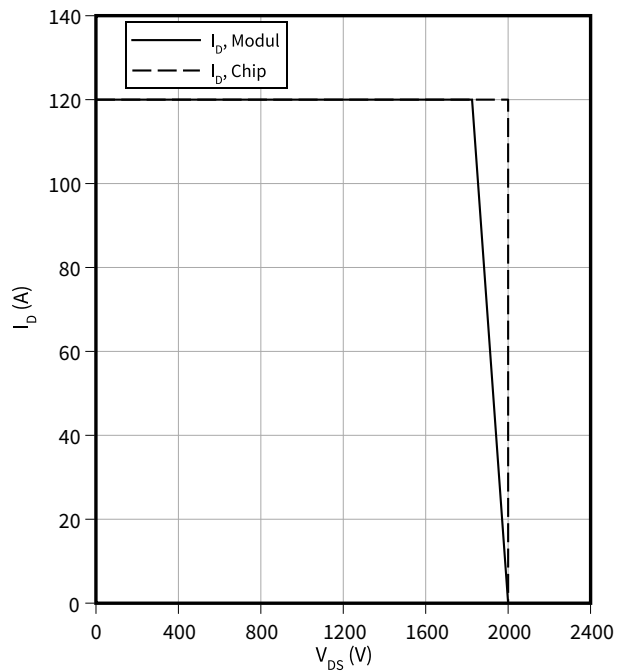
$V_{DD} = 1200\text{ V}, I_D = 60\text{ A}, T_{vj} = 175\text{ °C}, V_{GS} = -3/18\text{ V}$



Reverse bias safe operating area (RBSOA), MOSFET

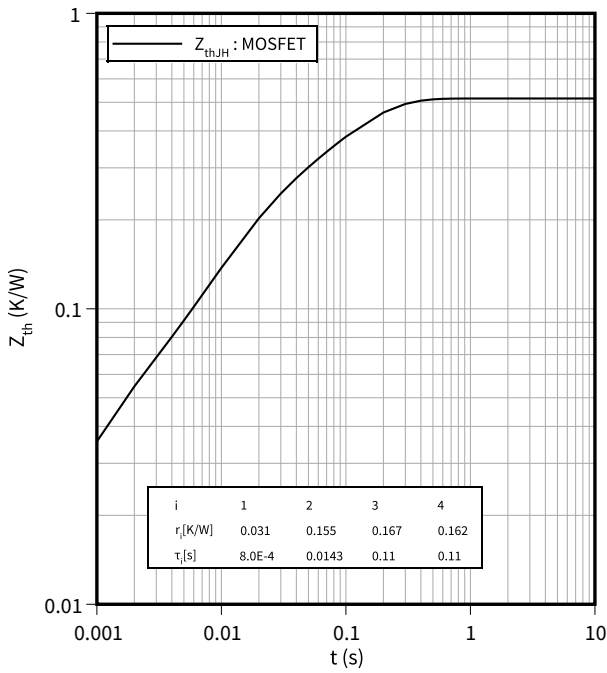
$I_D = f(V_{DS})$

$R_{Goff} = 2\ \Omega, T_{vj} = 175\text{ °C}, V_{GS} = -3/18\text{ V}$



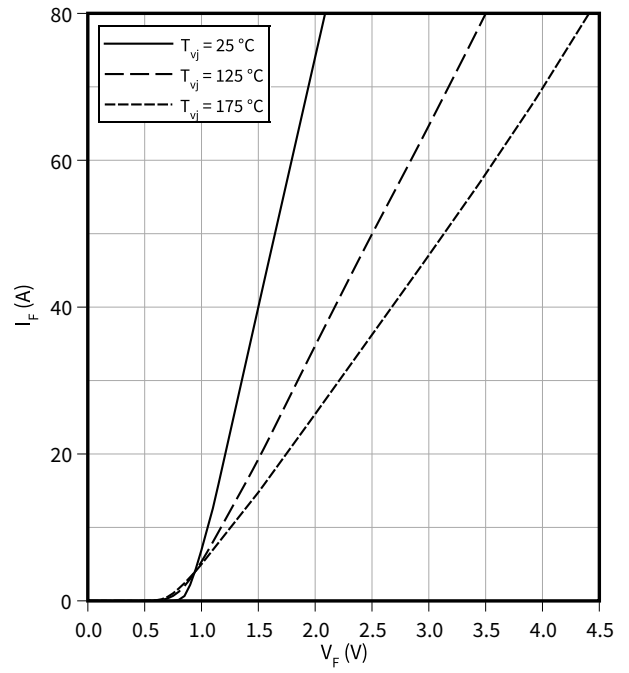
Transient thermal impedance, MOSFET

$Z_{th} = f(t)$



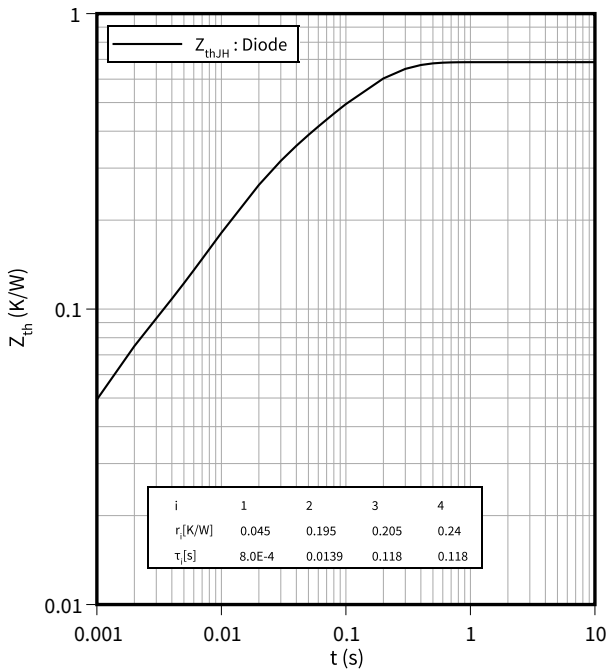
Forward characteristic (typical), Diode, Boost

$I_F = f(V_F)$



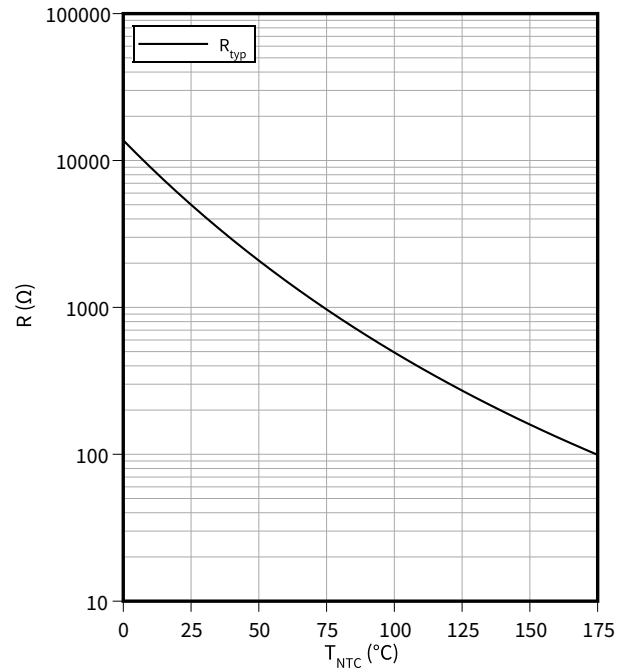
Transient thermal impedance, Diode, Boost

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



7 Circuit diagram

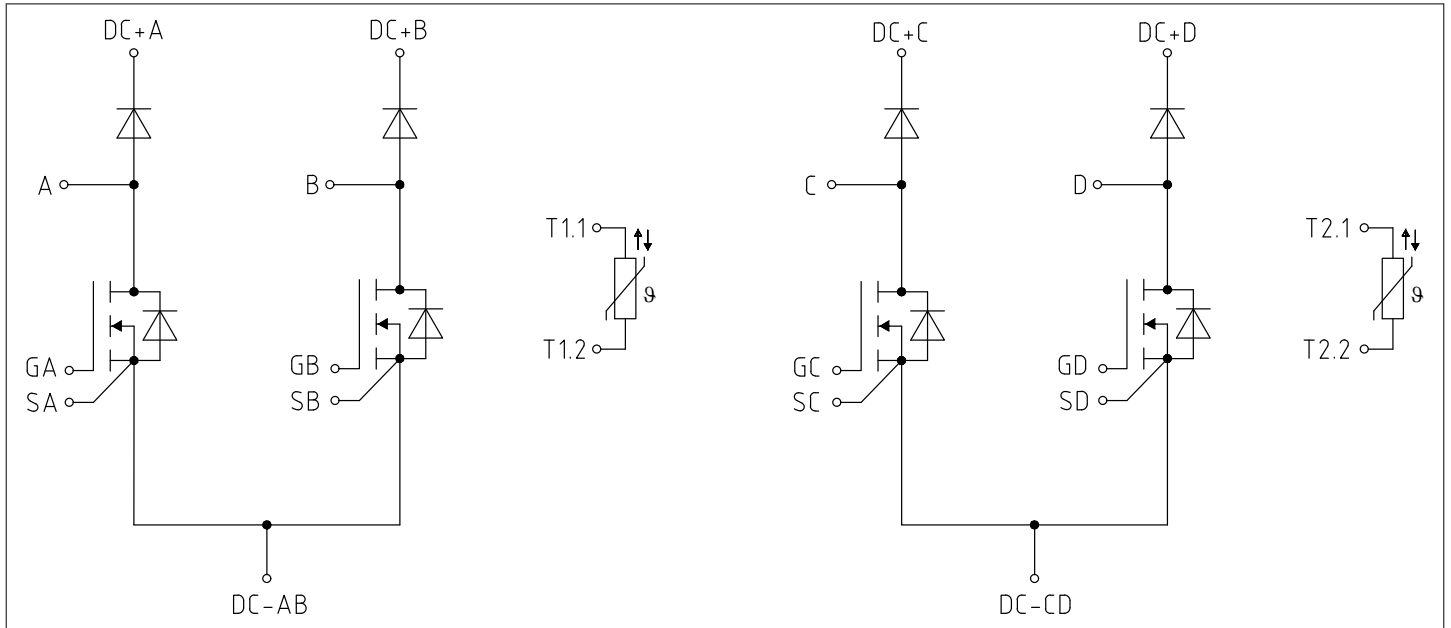


Figure 1

8 Package outlines

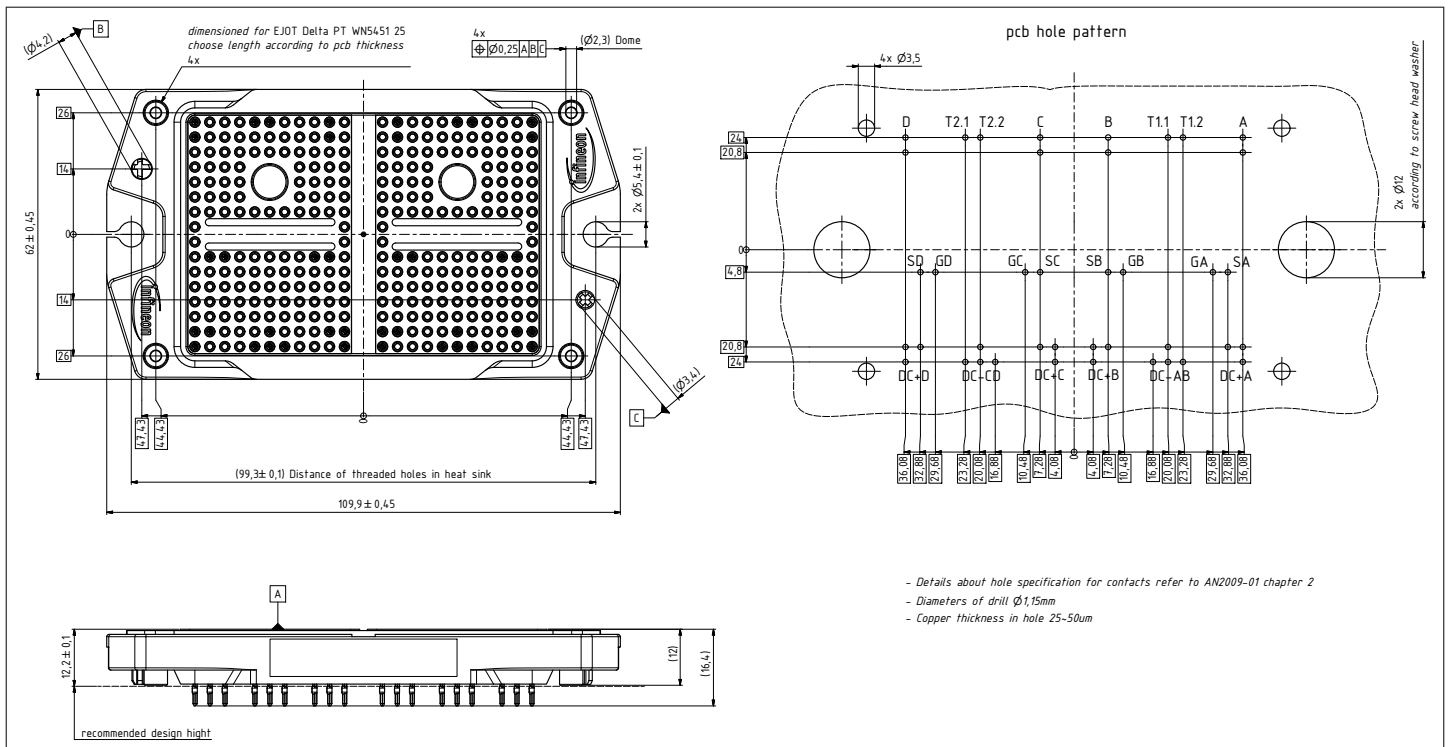


Figure 2

9 Module label code


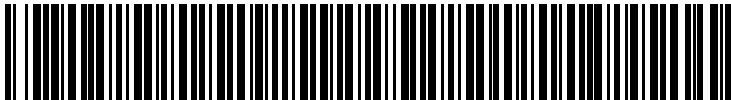
| Module label code | | | |
|-------------------|--|-----------------|-------------------------|
| Code format | Data Matrix | Barcode Code128 | |
| Encoding | ASCII text | Code Set A | |
| Symbol size | 16x16 | 23 digits | |
| Standard | IEC24720 and IEC16022 | IEC8859-1 | |
| Code content | <i>Content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

Figure 3

Revision history

| Document revision | Date of release | Description of changes |
|-------------------|-----------------|------------------------|
| 0.10 | 2022-07-05 | Initial version |
| 1.00 | 2022-07-15 | Final datasheet |

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