

IMW120R220M1H

CoolSiC™ 1200V SiC Trench MOSFET Silicon Carbide MOSFET

Features

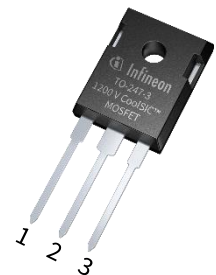
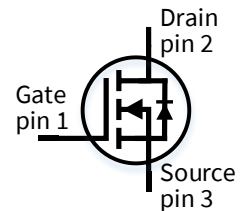
- Very low switching losses
- Threshold-free on state characteristic
- Wide gate-source voltage range
- Benchmark gate threshold voltage, $V_{GS(th)} = 4.5V$
- 0V turn-off gate voltage for easy and simple gate drive
- Fully controllable dV/dt
- Robust body diode for hard commutation
- Temperature independent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

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

Table 1 Key Performance and Package Parameters

| Type | V_{DS} | I_D <small>$T_C = 25^\circ C, R_{th(j-c,max)}$</small> | $R_{DS(on)}$ <small>$T_{vj} = 25^\circ C, I_D = 4A, V_{GS} = 18V$</small> | $T_{vj,max}$ | Marking | Package |
|---------------|----------|--|---|--------------|----------|------------|
| IMW120R220M1H | 1200V | 13A | 220m Ω | 175°C | 12M1H220 | PG-TO247-3 |

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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 $T_{vj,max}$, $V_{GS} = 18\text{V}$, $T_C = 25^\circ\text{C}$ | I_D | 13 | A |
| $T_C = 100^\circ\text{C}$ | | 9.5 | |
| Pulsed drain current, t_p limited by $T_{vj,max}$, $V_{GS} = 18\text{V}$ | $I_{D,pulse}^1$ | 21 | A |
| DC body diode forward current for $R_{th(j-c,max)}$, limited by $T_{vj,max}$, $V_{GS} = 0\text{V}$ | I_{SD} | 13 | A |
| $T_C = 100^\circ\text{C}$ | | 9.3 | |
| Pulsed body diode current, t_p limited by $T_{vj,max}$ | $I_{SD,pulse}^1$ | 32 | A |
| Gate-source voltage ² | | | |
| 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 | |
| Short-circuit withstand time $V_{DD} = 800\text{V}$, $V_{DS,peak} < 1200\text{V}$, $V_{GS,on} = 15\text{V}$, $T_{j,start} = 25^\circ\text{C}$ | t_{SC} | 3 | μs |
| Power dissipation, limited by $T_{vj,max}$ | P_{tot} | 75 | W |
| $T_C = 100^\circ\text{C}$ | | 37.5 | |
| Virtual junction temperature | T_{vj} | -55... 175 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | -55... 150 | $^\circ\text{C}$ |
| Soldering temperature, wave soldering only allowed at leads, 1.6mm (0.063 in.) from case for 10 s | T_{sold} | 260 | $^\circ\text{C}$ |
| Mounting torque, M3 screw Maximum of mounting processes: 3 | M | 0.6 | Nm |

¹ verified by design

² **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 | $R_{th(j-c)}$ | | - | 1.5 | 2 | 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 | $R_{DS(on)}$ | $V_{GS} = 18\text{V}, I_D = 4\text{A},$ $T_{vj} = 25^\circ\text{C}$ | - | 220 | 294 | mΩ |
| | | $T_{vj} = 100^\circ\text{C}$ | - | 280 | - | |
| | | $T_{vj} = 175^\circ\text{C}$ | - | 416 | - | |
| | | $V_{GS} = 15\text{V}, I_D = 4\text{A},$ $T_{vj} = 25^\circ\text{C}$ | - | 280 | 372 | |
| | | | | | | |
| Body diode forward voltage | V_{SD} | $V_{GS} = 0\text{V}, I_{SD} = 4\text{A}$ $T_{vj} = 25^\circ\text{C}$ | - | 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 | $V_{GS(th)}$ | <i>(tested after 1 ms pulse at</i> $V_{GS} = 20\text{V})$ $I_D = 1.6\text{mA}, V_{DS} = V_{GS}$ $T_{vj} = 25^\circ\text{C}$ | 3.5 | 4.5 | 5.7 | V |
| | | $T_{vj} = 175^\circ\text{C}$ | - | 3.6 | - | |
| | | | | | | |
| Zero gate voltage drain current | I_{DSS} | $V_{GS} = 0\text{V}, V_{DS} = 1200\text{V}$ $T_{vj} = 25^\circ\text{C}$ | - | 0.2 | 95 | μA |
| | | $T_{vj} = 175^\circ\text{C}$ | - | 0.6 | - | |
| | | | | | | |
| 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} | $V_{DS} = 20\text{V}, I_D = 4\text{A}$ | - | 2 | - | S |
| Internal gate resistance | $R_{G,int}$ | $f = 1\text{MHz}, V_{AC} = 25\text{mV}$ | - | 22 | - | 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} | $V_{DD} = 800\text{V}, V_{GS} = 0\text{V},$ $f = 1\text{MHz}, V_{AC} = 25\text{mV}$ | - | 289 | - | pF |
| Output capacitance | C_{oss} | | - | 16 | - | |
| Reverse capacitance | C_{rss} | | - | 2 | - | |
| C_{oss} stored energy | E_{oss} | | - | 6 | - | μJ |
| Total gate charge | Q_G | $V_{DD} = 800\text{V}, I_D = 4\text{A},$ $V_{GS} = 0/18\text{V}, \text{turn-on pulse}$ | - | 8.5 | - | nC |
| Gate to source charge | $Q_{GS,pl}$ | | - | 2.5 | - | |
| Gate to drain charge | Q_{GD} | | - | 2 | - | |

Electrical Characteristics

3.3 Switching characteristics

Table 6 Switching characteristics, Inductive load ⁴

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|--------------|--|-------|------|------|---------------|
| | | | min. | typ. | max. | |
| MOSFET Characteristics, $T_{vj} = 25^{\circ}\text{C}$ | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 800\text{V}, I_D = 4\text{A},$ $V_{GS} = 0/18\text{V}, R_{G,ext} = 2\Omega,$ $L_{\sigma} = 40\text{nH},$ diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E | - | 5 | - | ns |
| Rise time | t_r | | - | 1.4 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 10 | - | |
| Fall time | t_f | | - | 14 | - | |
| Turn-on energy | E_{on} | | - | 61 | - | μJ |
| Turn-off energy | E_{off} | | - | 7 | - | |
| Total switching energy | E_{tot} | | - | 68 | - | |
| Body Diode Characteristics, $T_{vj} = 25^{\circ}\text{C}$ | | | | | | |
| Diode reverse recovery charge | Q_{rr} | $V_{DD} = 800\text{V}, I_{SD} = 4\text{A},$ V_{GS} at diode = $0\text{V},$ $di_f/dt = 1000\text{A}/\mu\text{s},$ Q_{rr} includes also $Q_C,$ see Fig. C | - | 78 | - | nC |
| Diode peak reverse recovery current | I_{rrm} | | - | 1.4 | - | A |

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

| | | | | | | |
|--|--------------|--|---|-----|---|---------------|
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 800\text{V}, I_D = 4\text{A},$ $V_{GS} = 0/18\text{V}, R_{G,ext} = 2\Omega,$ $L_{\sigma} = 40\text{nH},$ diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E | - | 5 | - | ns |
| Rise time | t_r | | - | 3.5 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 10 | - | |
| Fall time | t_f | | - | 14 | - | |
| Turn-on energy | E_{on} | | - | 76 | - | μJ |
| Turn-off energy | E_{off} | | - | 7 | - | |
| Total switching energy | E_{tot} | | - | 83 | - | |
| Body Diode Characteristics, $T_{vj} = 175^{\circ}\text{C}$ | | | | | | |
| Diode reverse recovery charge | Q_{rr} | $V_{DD} = 800\text{V}, I_{SD} = 4\text{A},$ V_{GS} at diode = $0\text{V},$ $di_f/dt = 1000\text{A}/\mu\text{s},$ Q_{rr} includes also $Q_C,$ see Fig. C | - | 98 | - | nC |
| Diode peak reverse recovery current | I_{rrm} | | - | 2 | - | A |

⁴ The chip technology was characterized up to 200 kV/ μs . The measured dV/dt was limited by measurement test setup and package.

Electrical characteristic diagrams

4 Electrical characteristic diagrams

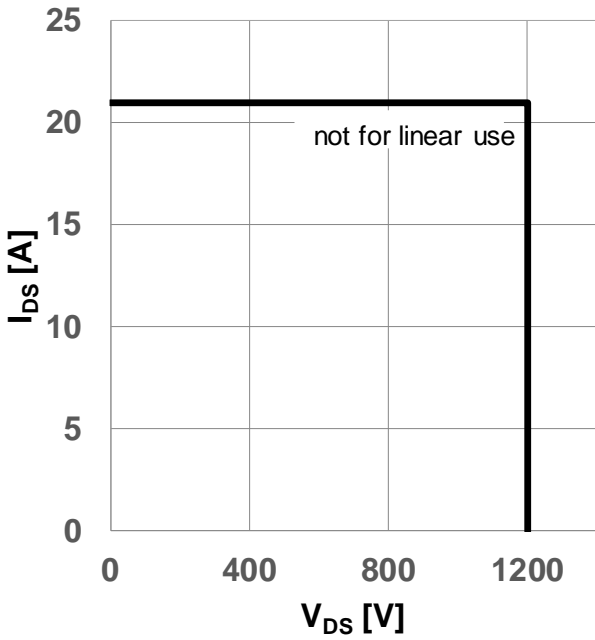


Figure 1 Safe operating area (SOA)
($V_{GS} = 0/18V$, $T_c = 25^\circ C$, $T_j \leq 175^\circ C$)

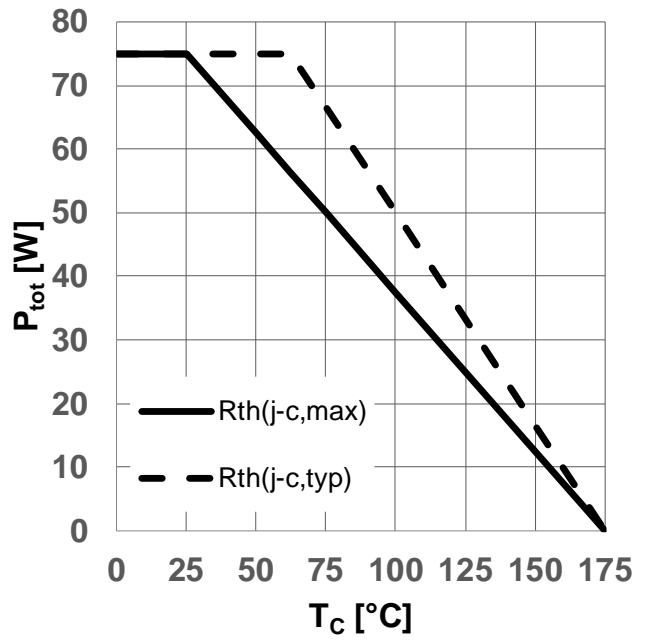


Figure 2 Power dissipation as a function of case temperature limited by bond wire
($P_{tot} = f(T_c)$)

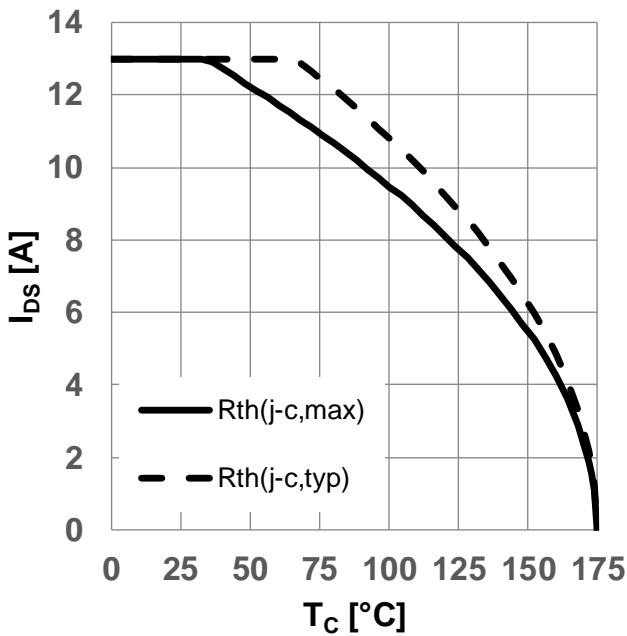


Figure 3 Maximum DC drain to source current as a function of case temperature limited by bond wire ($I_{DS} = f(T_c)$)

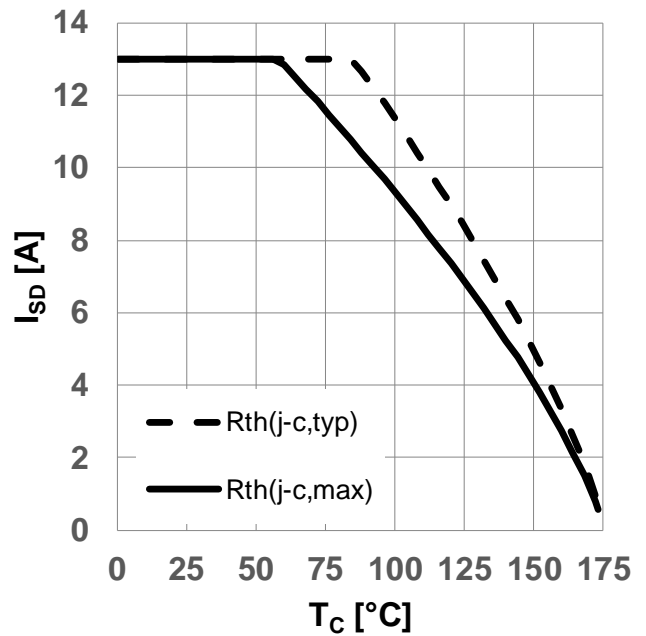


Figure 4 Maximum source to drain current as a function of case temperature limited by bond wire ($I_{SD} = f(T_c)$, $V_{GS} = 0V$)

Electrical characteristic diagrams

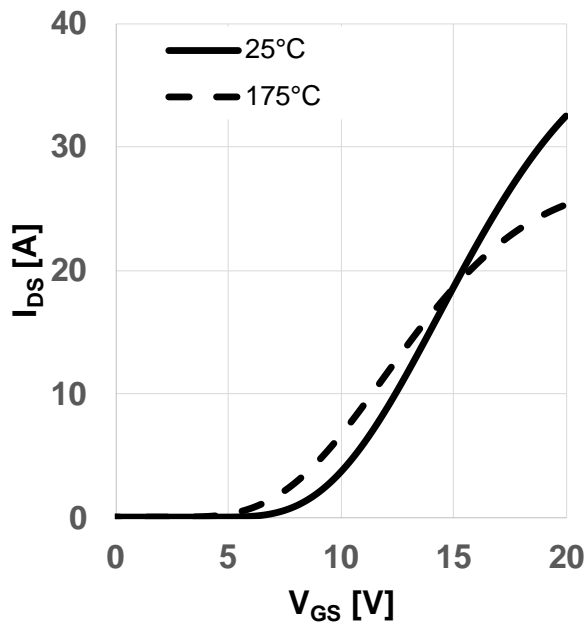


Figure 5 Typical transfer characteristic
($I_{DS} = f(V_{GS}), V_{DS} = 20V, t_P = 20\mu s$)

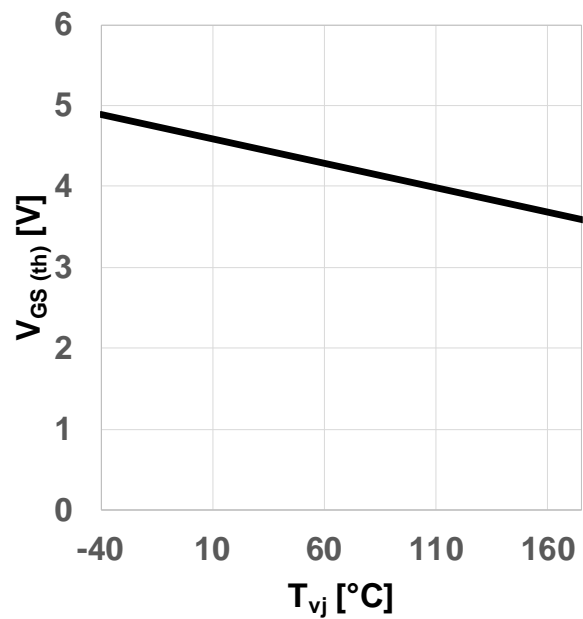


Figure 6 Typical gate-source threshold voltage as a function of junction temperature
($V_{GS(th)} = f(T_{vj}), I_{DS} = 1.6mA, V_{GS} = V_{DS}$)

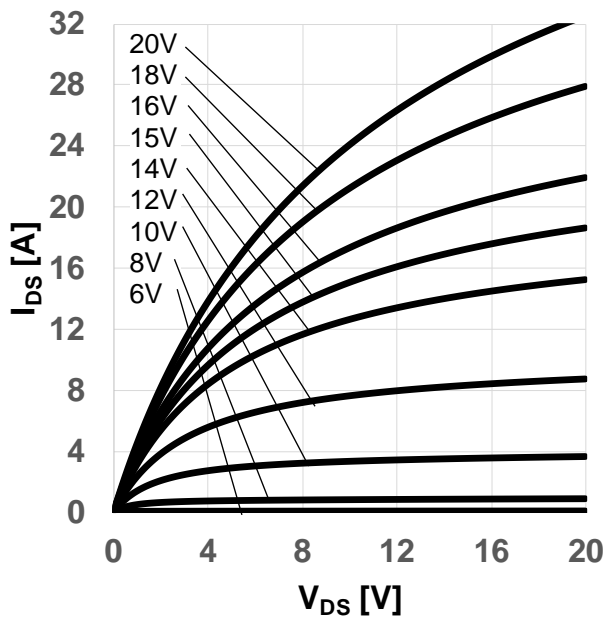


Figure 7 Typical output characteristic, V_{GS} as parameter
($I_{DS} = f(V_{DS}), T_{vj} = 25^\circ C, t_P = 20\mu s$)

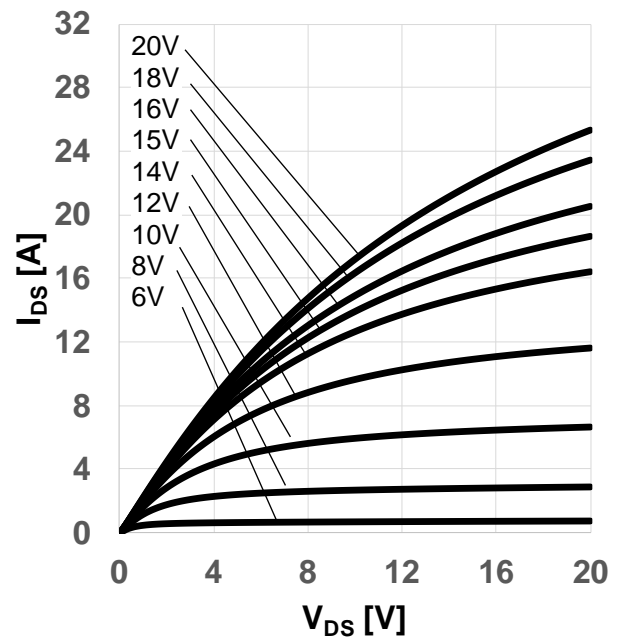


Figure 8 Typical output characteristic, V_{GS} as parameter
($I_{DS} = f(V_{DS}), T_{vj} = 175^\circ C, t_P = 20\mu s$)

Electrical characteristic diagrams

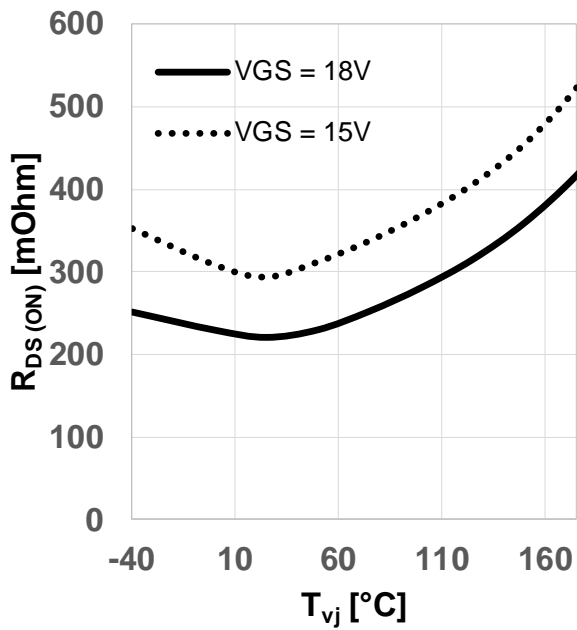


Figure 9 Typical on-resistance as a function of junction temperature
($R_{DS(on)} = f(T_{vj})$, $I_{DS} = 4A$)

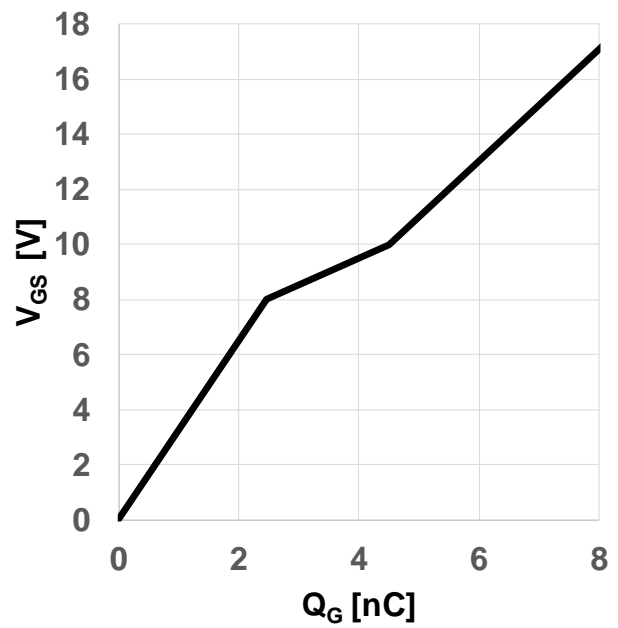


Figure 10 Typical gate charge
($V_{GS} = f(Q_G)$, $I_{DS} = 4A$, $V_{DS} = 800V$, turn-on pulse)

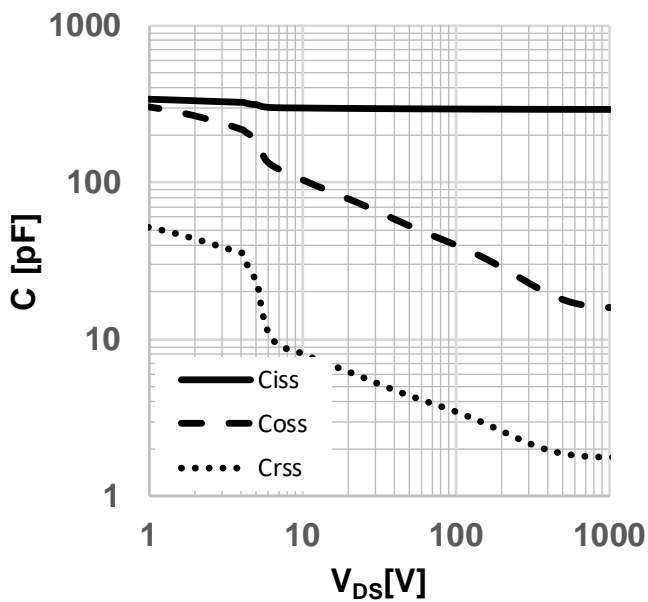


Figure 11 Typical capacitance as a function of drain-source voltage
($C = f(V_{DS})$, $V_{GS} = 0V$, $f = 1MHz$)

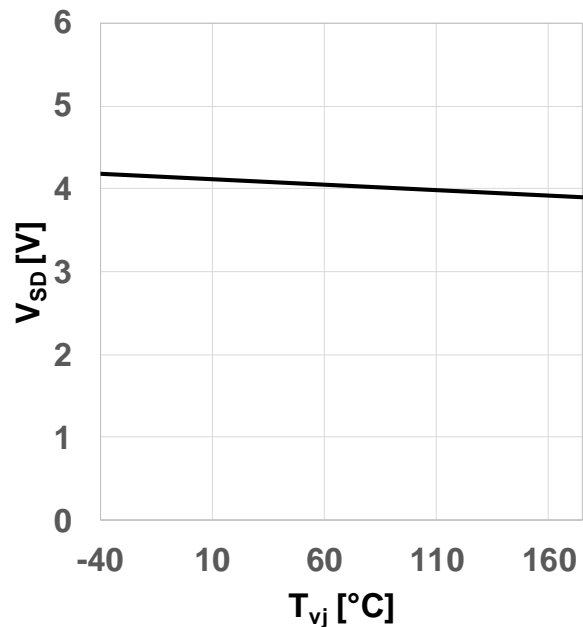


Figure 12 Typical body diode forward voltage as function of junction temperature
($V_{SD} = f(T_{vj})$, $V_{GS} = 0V$, $I_{SD} = 4A$)

Electrical characteristic diagrams

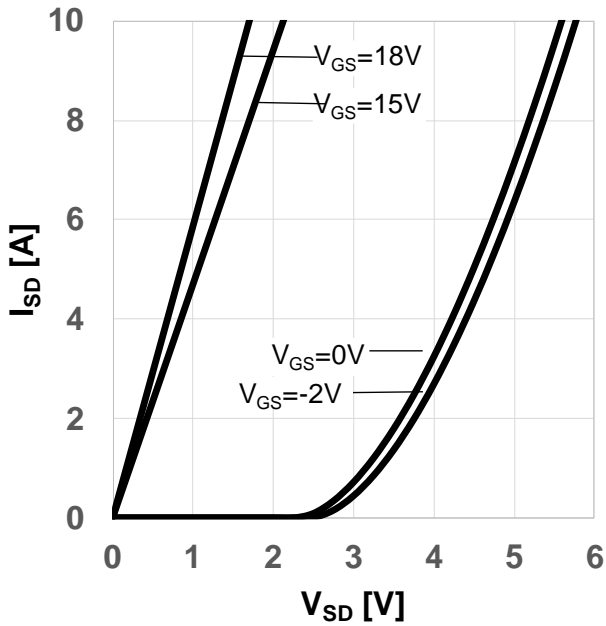


Figure 13 Typical body diode forward current as function of forward voltage, V_{GS} as parameter
($I_{SD} = f(V_{SD})$, $T_{vj} = 25^{\circ}\text{C}$, $t_P = 20\mu\text{s}$)

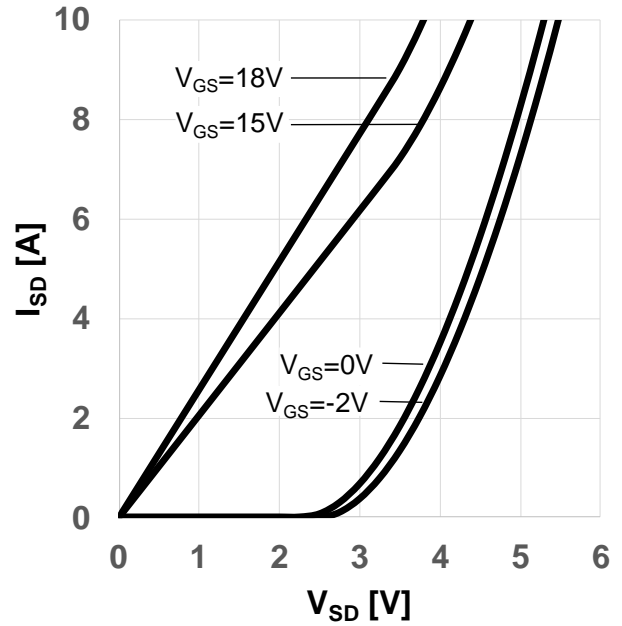


Figure 14 Typical body diode forward current as function of forward voltage, V_{GS} as parameter
($I_{SD} = f(V_{SD})$, $T_{vj} = 175^{\circ}\text{C}$, $t_P = 20\mu\text{s}$)

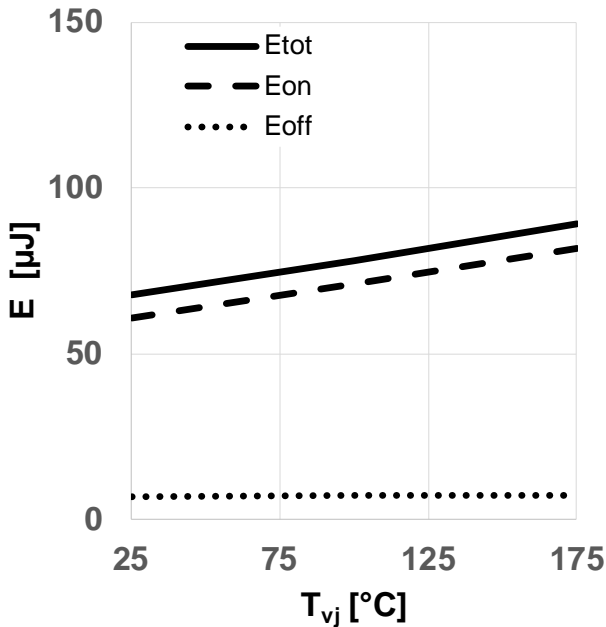


Figure 15 Typical switching energy losses as a function of junction temperature
($E = f(T_{vj})$, $V_{DD} = 800\text{V}$, $V_{GS} = 0\text{V}/18\text{V}$, $R_{G,ext} = 2\Omega$, $I_D = 4\text{A}$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0\text{V}$)

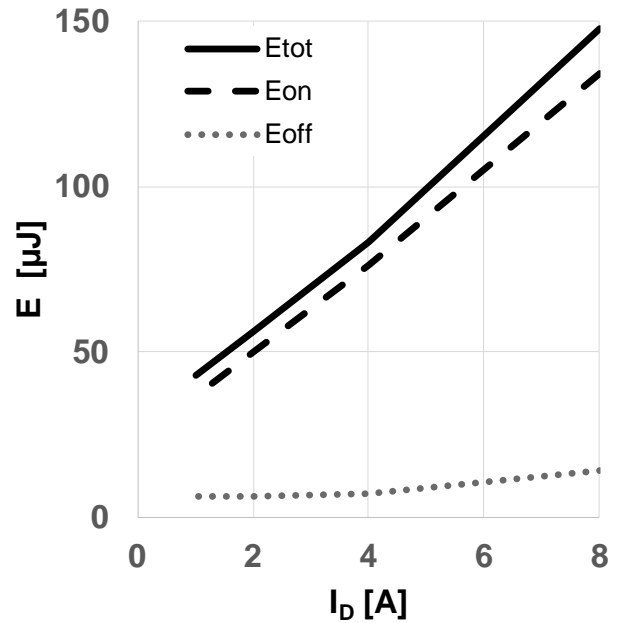


Figure 16 Typical switching energy losses as a function of drain-source current
($E = f(I_{DS})$, $V_{DD} = 800\text{V}$, $V_{GS} = 0\text{V}/18\text{V}$, $R_{G,ext} = 2\Omega$, $T_{vj} = 175^{\circ}\text{C}$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0\text{V}$)

Electrical characteristic diagrams

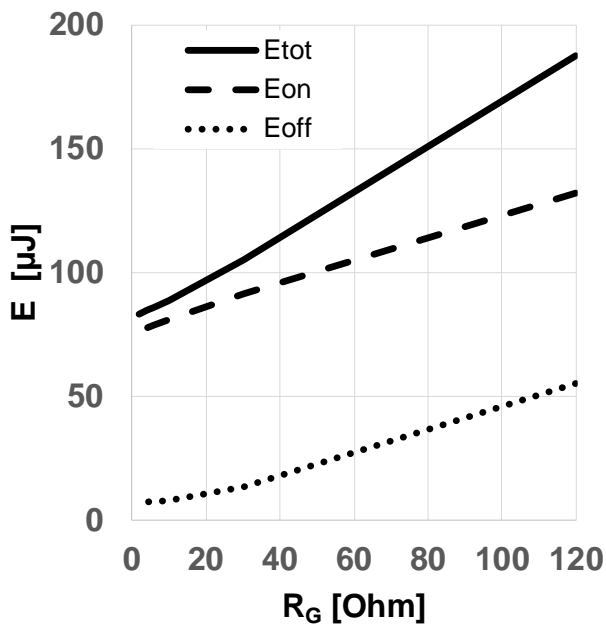


Figure 17 Typical switching energy losses as a function of gate resistance
 $(E = f(R_{G,ext}), V_{DD} = 800V, V_{GS} = 0V/18V,$
 $I_D = 4A, T_{vj} = 175^{\circ}C, \text{ind. load, test circuit in}$
 Fig. E, diode: body diode at $V_{GS} = 0V)$

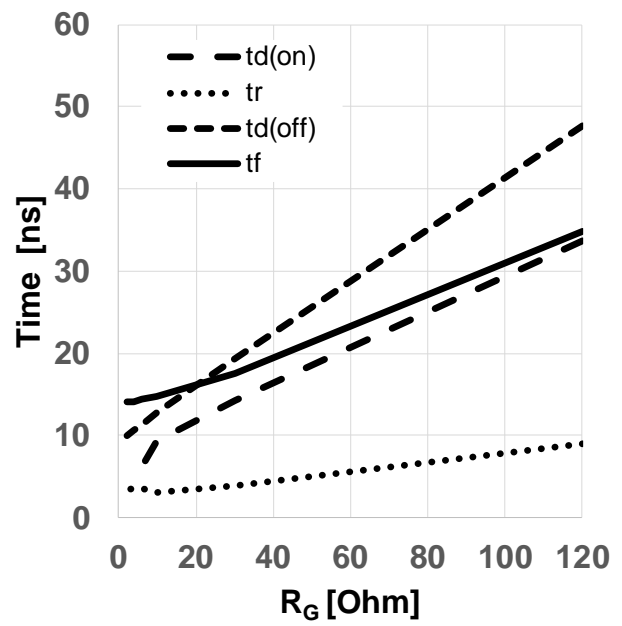


Figure 18 Typical switching times as a function of gate resistor
 $(t = f(R_{G,ext}), V_{DD} = 800V, V_{GS} = 0V/18V,$
 $I_D = 4A, T_{vj} = 175^{\circ}C, \text{ind. load, test circuit in}$
 Fig. E, diode: body diode at $V_{GS} = 0V)$

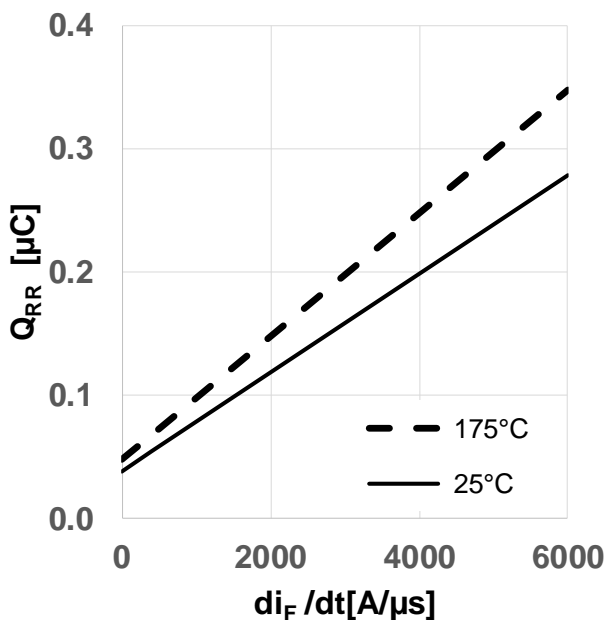


Figure 19 Typical reverse recovery charge as a function of diode current slope
 $(Q_{rr} = f(di_i/dt), V_{DD} = 800V, V_{GS} = 0V/18V,$
 $I_D = 4A, \text{ind. load, test circuit in Fig.E, body}$
 diode at $V_{GS} = 0V)$

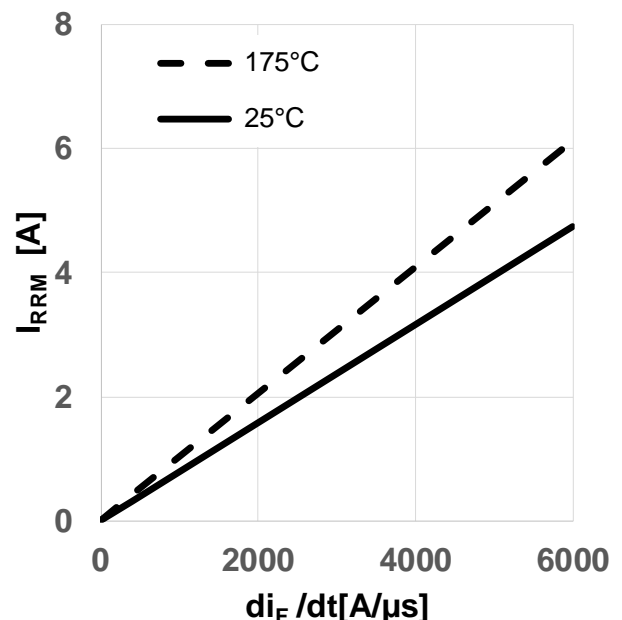


Figure 20 Typical reverse recovery current as a function of diode current slope
 $(I_{rrm} = f(di_i/dt), V_{DD} = 800V, V_{GS} = 0V/18V,$
 $I_D = 4A, \text{ind. load, test circuit in Fig.E,}$
 body diode at $V_{GS} = 0V)$

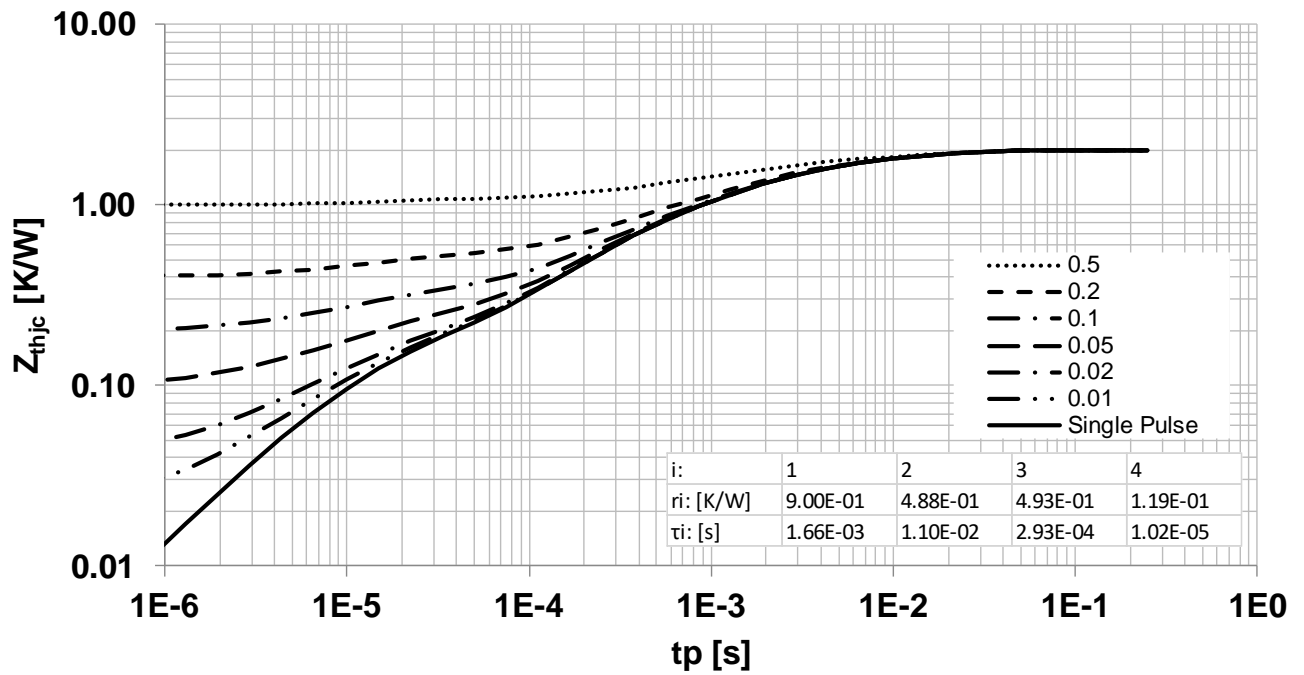


Figure 21 Max. transient thermal resistance (MOSFET/diode)
 ($Z_{th(j-c,max)} = f(t_p)$, parameter $D = t_p/T$, thermal equivalent circuit in Fig. D)

Package drawing

5 Package drawing

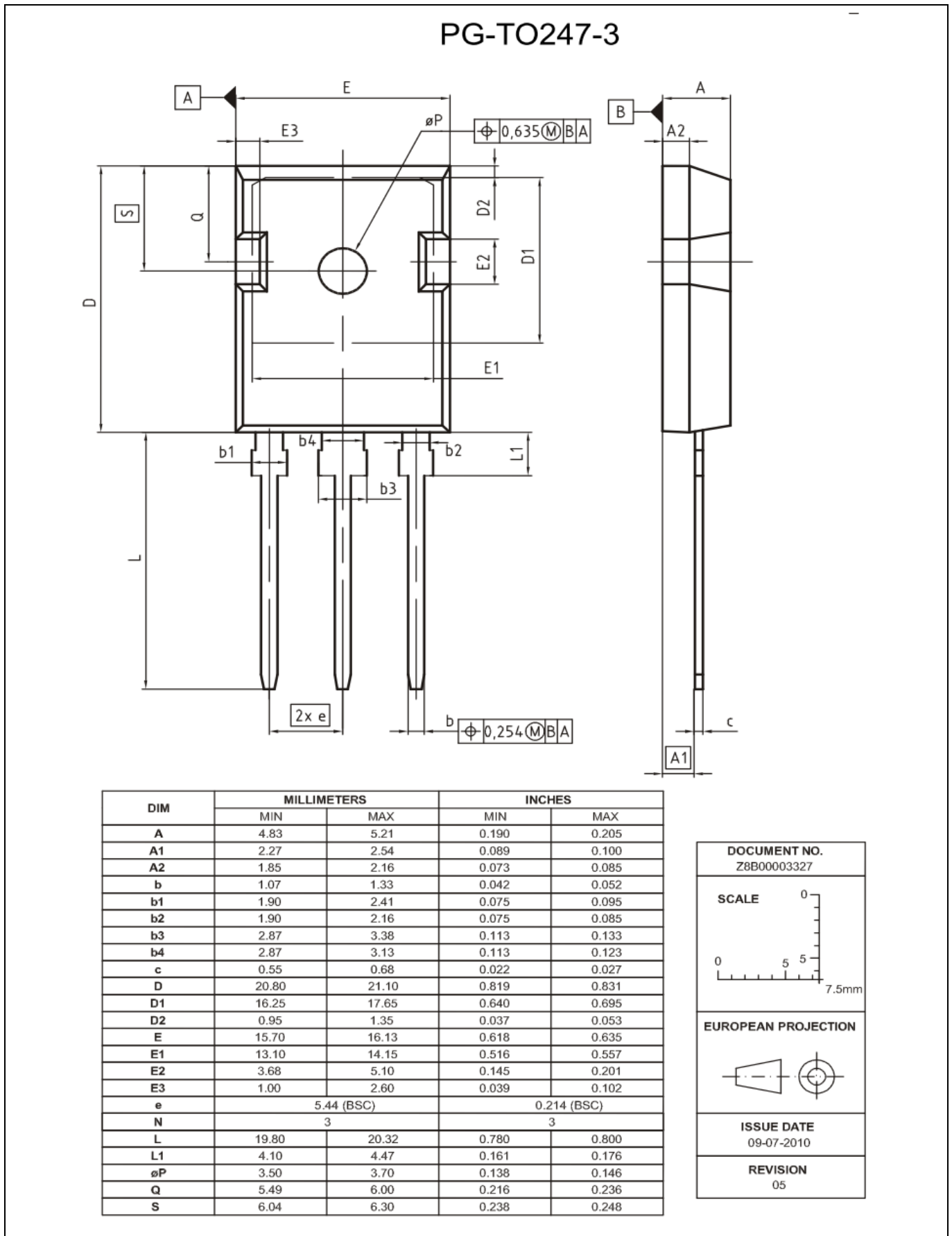


Figure 22 Package drawing

Test conditions

6 Test conditions

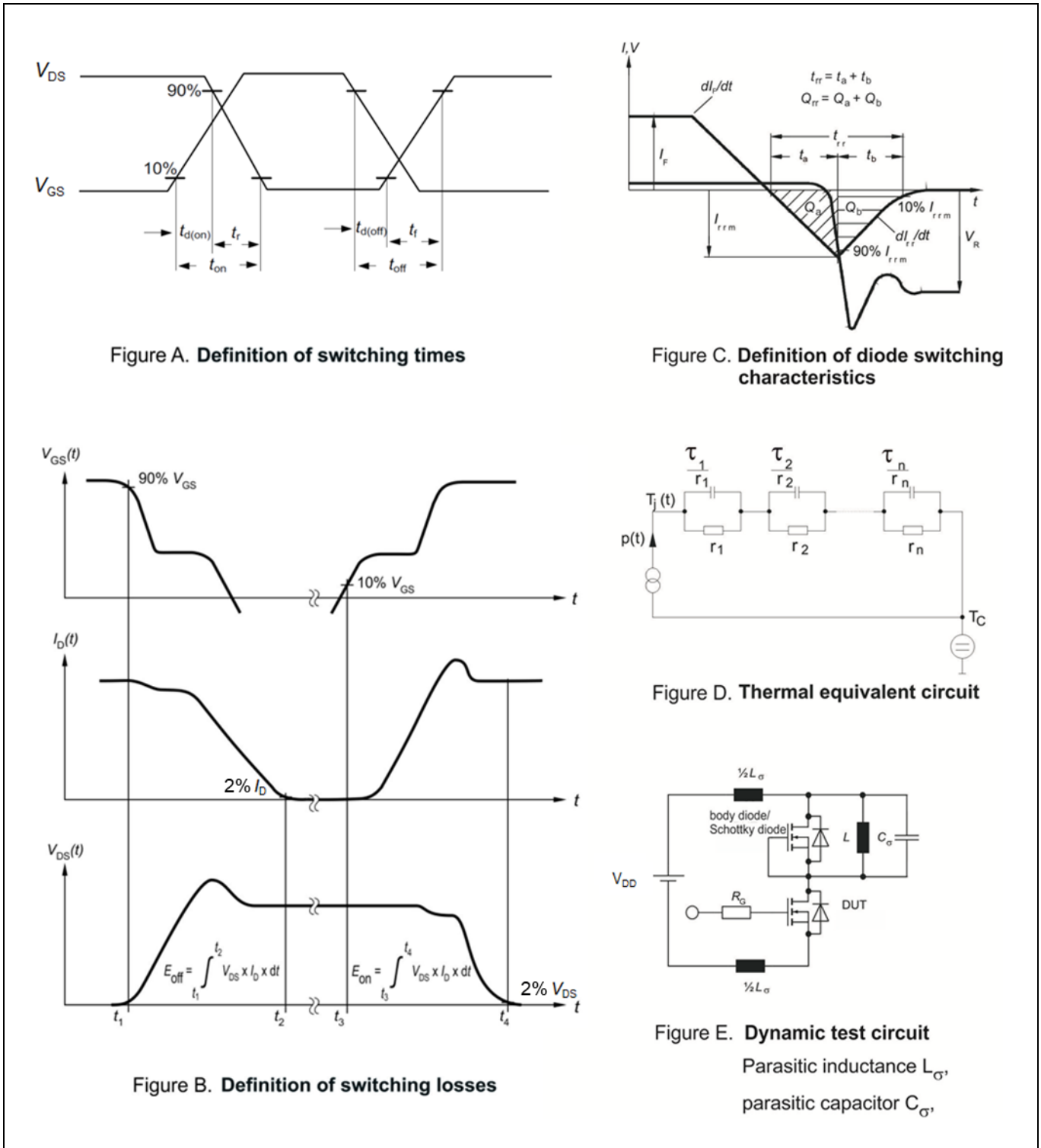


Figure 23 Test conditions

Revision history

Revision history

| Document version | Date of release | Description of changes |
|-------------------------|------------------------|---|
| 2.0 | 2019-08-22 | Final Datasheet |
| 2.1 | 2019-12-10 | <ul style="list-style-type: none">• Move the short circuit time from dynamic characteristics table 5 to maximum ratings table 2.• Update the Figure 12, 13, 14 the body diode forward voltage. |
| 2.2 | 2020-12-11 | Correction of circuit symbol on page 1 |

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