

MOSFET

650 V CoolSiC™ M1 SiC Trench Power Device

The 650 V CoolSiC™ is built over the solid silicon carbide technology developed in Infineon in more than 20 years. Leveraging the wide bandgap SiC material characteristics, the 650V CoolSiC™ MOSFET offers a unique combination of performance, reliability and ease of use. Suitable for high temperature and harsh operations, it enables the simplified and cost effective deployment of the highest system efficiency.

Features

- Optimized switching behavior at higher currents
- Commutation robust fast body diode with low Q_{rr}
- Superior gate oxide reliability
- Best thermal conductivity and behavior
- Lower $R_{DS(on)}$ and pulse current dependency on temperature
- Increased avalanche capability
- Compatible with standard drivers (recommended driving voltage: 18V)
- Kelvin source provides up to 4 times lower switching losses

Benefits

- Unique combination of high performance, high reliability and ease of use
- Ease of use and integration
- Suitable for topologies with continuous hard commutation
- Higher robustness and system reliability
- Efficiency improvement
- Reduced system size leading to higher power density

Potential applications

- SMPS
- UPS (uninterruptable power supplies)
- Solar PV inverters
- EV charging infrastructure
- Energy storage and battery formation
- Class D amplifiers

Product validation

Fully qualified according to JEDEC for Industrial Applications

Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|--|-------|---------------|
| $V_{DS} @ T_J = 25 \text{ }^\circ\text{C}$ | 650 | V |
| $R_{DS(on),typ}$ | 27 | m Ω |
| $Q_{G,typ}$ | 63 | nC |
| $I_{D,pulse}$ | 184 | A |
| $Q_{oss} @ 400 \text{ V}$ | 147 | nC |
| $E_{oss} @ 400 \text{ V}$ | 22.2 | μJ |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|---------------|----------|----------------|
| IMZA65R027M1H | PG-TO 247-4-3 | 65R027M1 | see Appendix A |

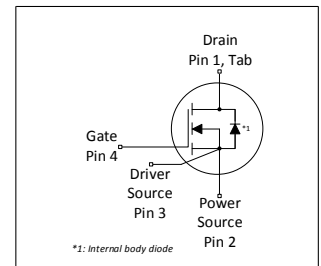
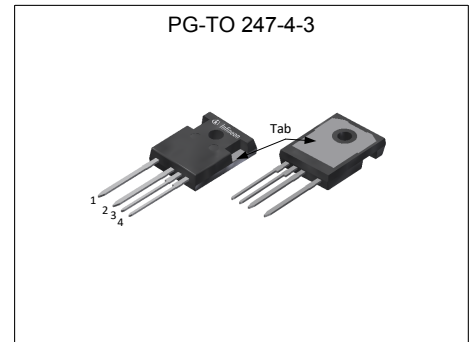


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1 Maximum ratings

at $T_J = 25\text{ °C}$, unless otherwise specified

Table 2 Maximum ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---------------|--------|------|----------|------|--|
| | | Min. | Typ. | Max. | | |
| Continuous drain current ¹⁾ | I_D | - | - | 59 41 | A | $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | - | - | 184 | A | $T_C = 25\text{ °C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 326 | mJ | $I_D = 12.2\text{ A}$, $V_{DD} = 50\text{ V}$, $L = 4.4\text{ mH}$; see table 10 |
| Avalanche energy, repetitive | E_{AR} | - | - | 1.63 | mJ | $I_D = 12.2\text{ A}$, $V_{DD} = 50\text{ V}$; see table 10 |
| Avalanche current, single pulse | I_{AS} | - | - | 12.2 | A | - |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 200 | V/ns | $V_{DS} = 0...400\text{ V}$ |
| Gate source voltage (recommended driving voltage) | V_{GS} | 0 | - | 18 | V | AC ($f > 1\text{ Hz}$) |
| Gate source voltage (dynamic) | V_{GS} | -5 | - | 23 | V | $t_{pulse,negative} \leq 15\text{ ns}$ |
| Power dissipation | P_{tot} | - | - | 189 | W | $T_C = 25\text{ °C}$ |
| Storage temperature | T_{stg} | -55 | - | 150 | °C | - |
| Operating junction temperature | T_J | -55 | - | 150 | °C | - |
| Mounting torque | - | - | - | 60 | Ncm | M3 and M3.5 screws |
| Continuous diode forward current ¹⁾ | I_S | - | - | 59 | A | $T_C = 25\text{ °C}$ |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | - | - | 184 | A | $T_C = 25\text{ °C}$ |
| Insulation withstand voltage | V_{ISO} | - | - | n.a. | V | V_{rms} , $T_C = 25\text{ °C}$, $t = 1\text{ min}$ |

¹⁾ Limited by $T_{J,max}$

²⁾ Pulse width t_p limited by $T_{J,max}$

2 Thermal characteristics

Table 3 Thermal characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|------------|--------|------|------|------|-------------------------------------|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 0.66 | °C/W | - |
| Thermal resistance, junction - ambient | R_{thJA} | - | - | 62 | °C/W | leaded |
| Thermal resistance, junction - ambient for SMD version | R_{thJA} | - | - | - | °C/W | n.a. |
| Soldering temperature, wavesoldering only allowed at leads | T_{sold} | - | - | 260 | °C | 1.6mm (0.063 in.) from case for 10s |

3 Electrical characteristics
 at $T_J = 25\text{ °C}$, unless otherwise specified

Table 4 Static characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--------------------------------------|---------------|--------|----------------|------------|---------------|---|
| | | Min. | Typ. | Max. | | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | 650 | - | - | V | $V_{GS} = 0\text{ V}$, $I_D = 1.1\text{ mA}$ |
| Gate threshold voltage ¹⁾ | $V_{(GS)th}$ | 3.5 | 4.5 | 5.7 | V | $V_{DS} = V_{GS}$, $I_D = 11\text{ mA}$ |
| Zero gate voltage drain current | I_{DSS} | - | 1 2 | 150 - | μA | $V_{DS} = 650\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 25\text{ °C}$ $V_{DS} = 650\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 150\text{ °C}$ |
| Gate-source leakage current | I_{GSS} | - | - | 100 | nA | $V_{GS} = 20\text{ V}$, $V_{DS} = 0\text{ V}$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 0.027 0.035 | 0.034 - | Ω | $V_{GS} = 18\text{ V}$, $I_D = 38.3\text{ A}$, $T_J = 25\text{ °C}$ $V_{GS} = 18\text{ V}$, $I_D = 38.3\text{ A}$, $T_J = 150\text{ °C}$ |
| Gate resistance | R_G | - | 3.0 | - | Ω | $f = 1\text{ MHz}$, open drain |

Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 2131 | - | pF | $V_{GS} = 0\text{ V}$, $V_{DS} = 400\text{ V}$, $f = 250\text{ kHz}$ |
| Reverse capacitance | C_{riss} | - | 22 | - | pF | $V_{GS} = 0\text{ V}$, $V_{DS} = 400\text{ V}$, $f = 250\text{ kHz}$ |
| Output capacitance ²⁾ | C_{oss} | - | 244 | 317 | pF | $V_{GS} = 0\text{ V}$, $V_{DS} = 400\text{ V}$, $f = 250\text{ kHz}$ |
| Output charge ²⁾ | Q_{oss} | - | 147 | 191 | nC | calculation based on C_{oss} |
| Effective output capacitance, energy related ³⁾ | $C_{o(er)}$ | - | 278 | - | pF | $V_{GS} = 0\text{ V}$, $V_{DS} = 0...400\text{ V}$ |
| Effective output capacitance, time related ⁴⁾ | $C_{o(tr)}$ | - | 368 | - | pF | $I_D = \text{constant}$, $V_{GS} = 0\text{ V}$, $V_{DS} = 0...400\text{ V}$ |
| Turn-on delay time | $t_{d(on)}$ | - | 21.4 | - | ns | $V_{DD} = 400\text{ V}$, $V_{GS} = 18\text{ V}$, $I_D = 38.3\text{ A}$, $R_G = 1.8\text{ }\Omega$; see table 9 |
| Rise time | t_r | - | 4.2 | - | ns | $V_{DD} = 400\text{ V}$, $V_{GS} = 18\text{ V}$, $I_D = 38.3\text{ A}$, $R_G = 1.8\text{ }\Omega$; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 21.6 | - | ns | $V_{DD} = 400\text{ V}$, $V_{GS} = 18\text{ V}$, $I_D = 38.3\text{ A}$, $R_G = 1.8\text{ }\Omega$; see table 9 |
| Fall time | t_f | - | 8.4 | - | ns | $V_{DD} = 400\text{ V}$, $V_{GS} = 18\text{ V}$, $I_D = 38.3\text{ A}$, $R_G = 1.8\text{ }\Omega$; see table 9 |

¹⁾ Tested after 1 ms pulse at $V_{GS} = +20\text{ V}$

²⁾ Maximum specification is defined by calculated six sigma upper confidence bound

³⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400 V

⁴⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 400 V

Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|----------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | - | 17 | - | nC | $V_{DD} = 400\text{ V}$, $I_D = 38.3\text{ A}$, $V_{GS} = 0\text{ to }18\text{ V}$ |
| Gate to drain charge | Q_{gd} | - | 14 | - | nC | $V_{DD} = 400\text{ V}$, $I_D = 38.3\text{ A}$, $V_{GS} = 0\text{ to }18\text{ V}$ |
| Gate charge total | Q_g | - | 63 | - | nC | $V_{DD} = 400\text{ V}$, $I_D = 38.3\text{ A}$, $V_{GS} = 0\text{ to }18\text{ V}$ |

Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-------------------------------|-----------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | V_{SD} | - | 4.0 | - | V | $V_{GS} = 0\text{ V}$, $I_F = 38.3\text{ A}$, $T_J = 25\text{ °C}$ |
| Reverse recovery time | t_{rr} | - | 102 | - | ns | $V_R = 400\text{ V}$, $I_F = 38.3\text{ A}$, $di_F/dt = 1000\text{ A}/\mu\text{s}$; see table 8 |
| Reverse recovery charge | Q_{rr} | - | 239 | - | nC | $V_R = 400\text{ V}$, $I_F = 38.3\text{ A}$, $di_F/dt = 1000\text{ A}/\mu\text{s}$; see table 8 |
| Peak reverse recovery current | I_{rrm} | - | 10.6 | - | A | $V_R = 400\text{ V}$, $I_F = 38.3\text{ A}$, $di_F/dt = 1000\text{ A}/\mu\text{s}$; see table 8 |

4 Electrical characteristics diagrams

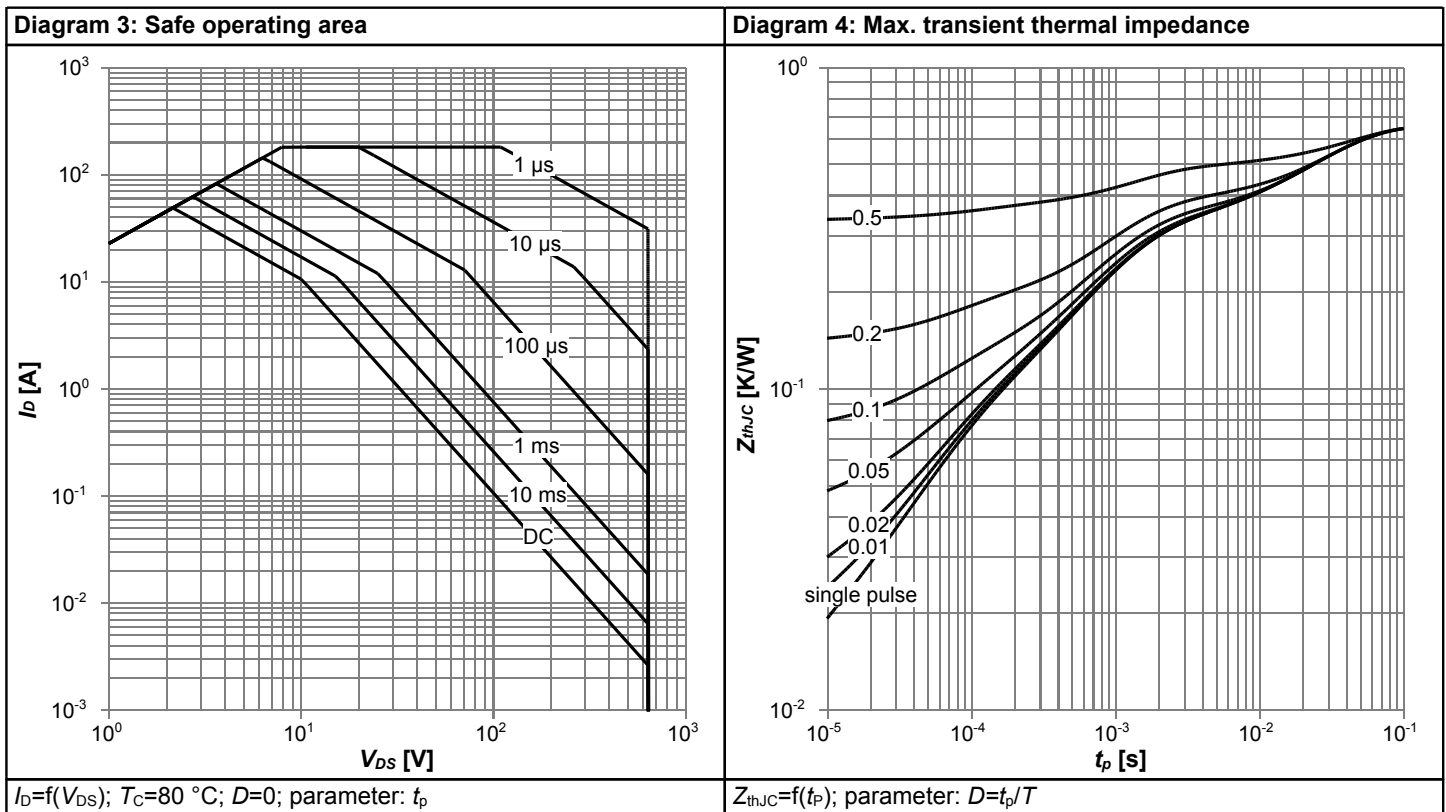
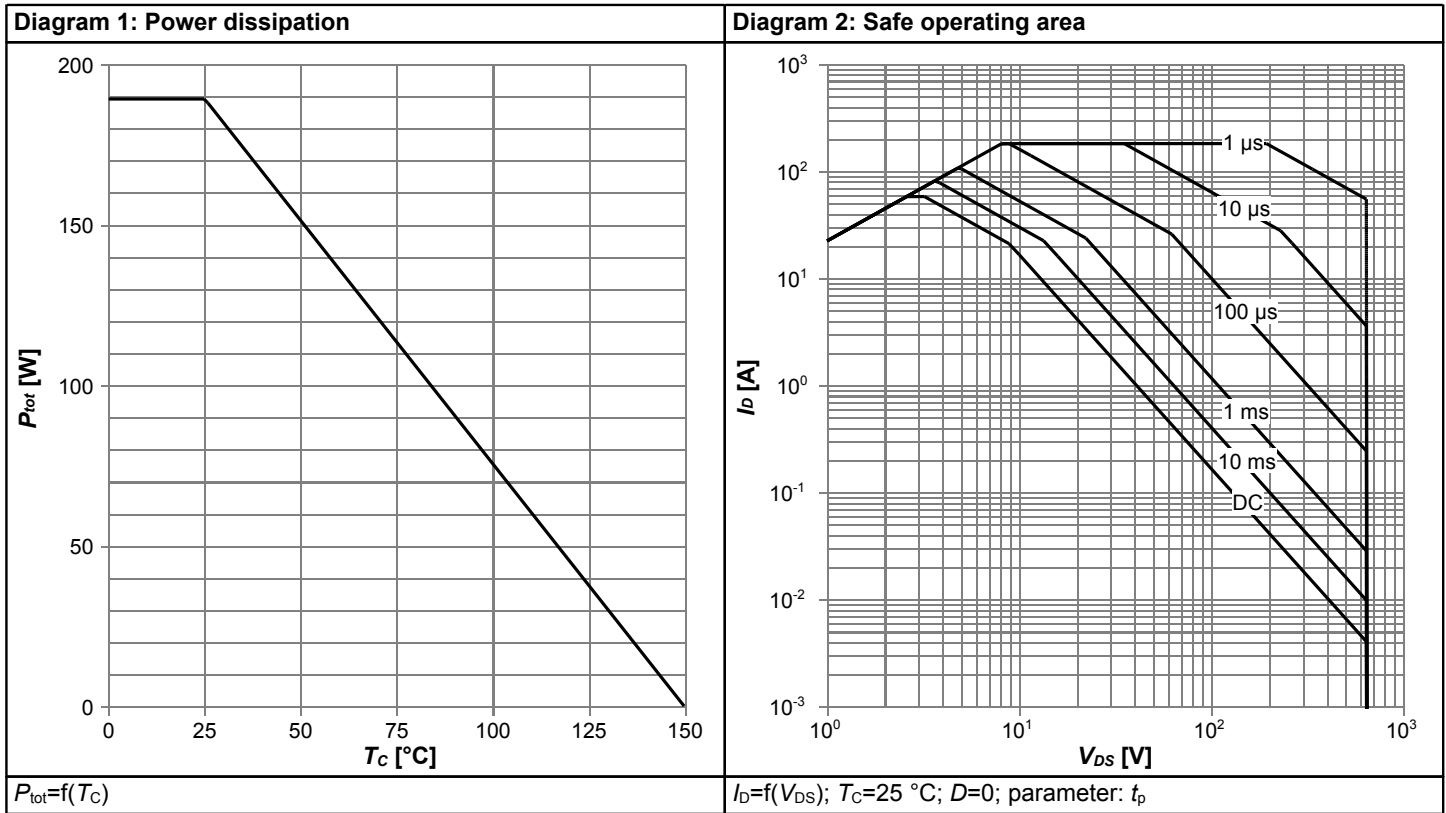
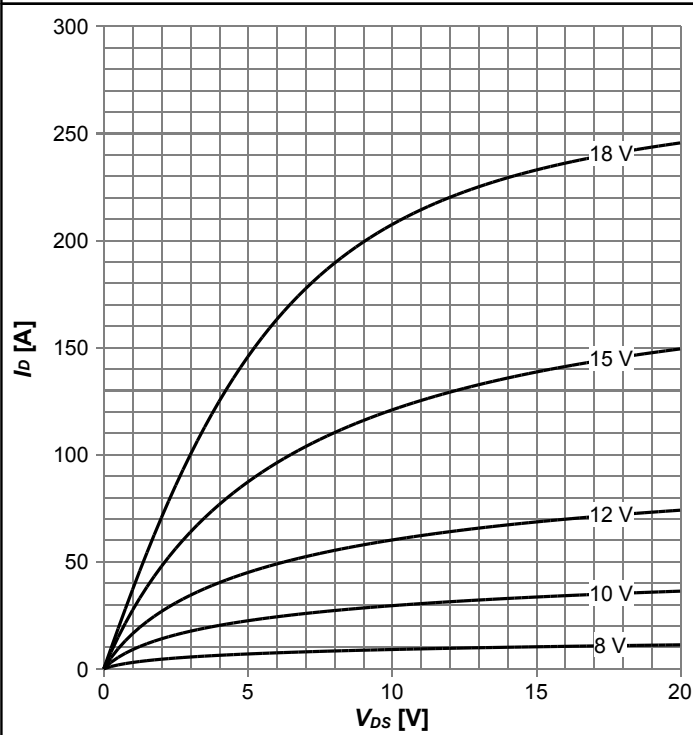
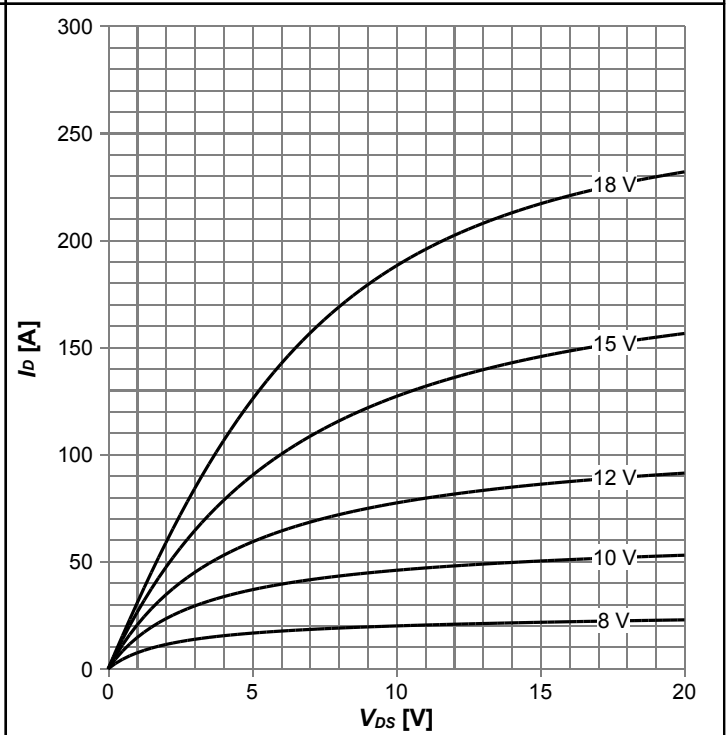


Diagram 5: Typ. output characteristics



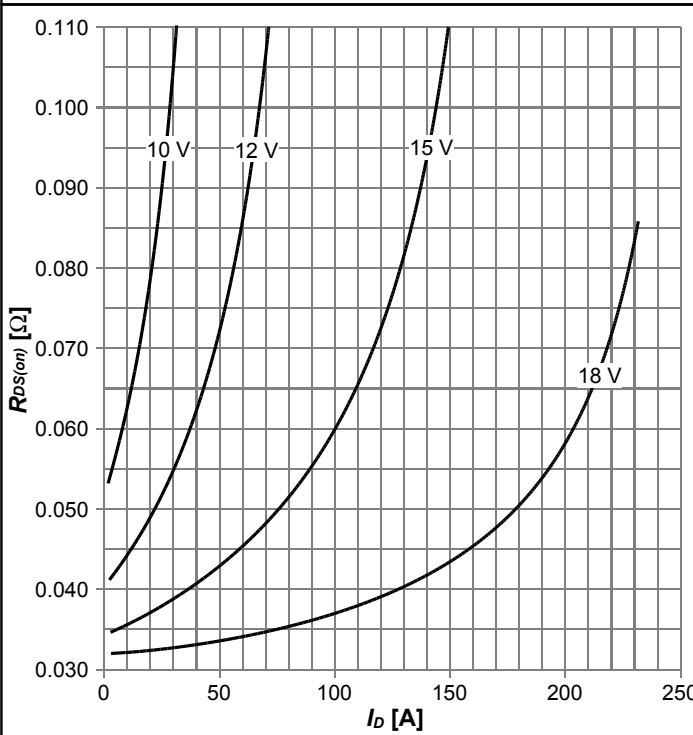
$I_D = f(V_{DS})$; $T_j = 25\text{ °C}$; parameter: V_{GS}

Diagram 6: Typ. output characteristics



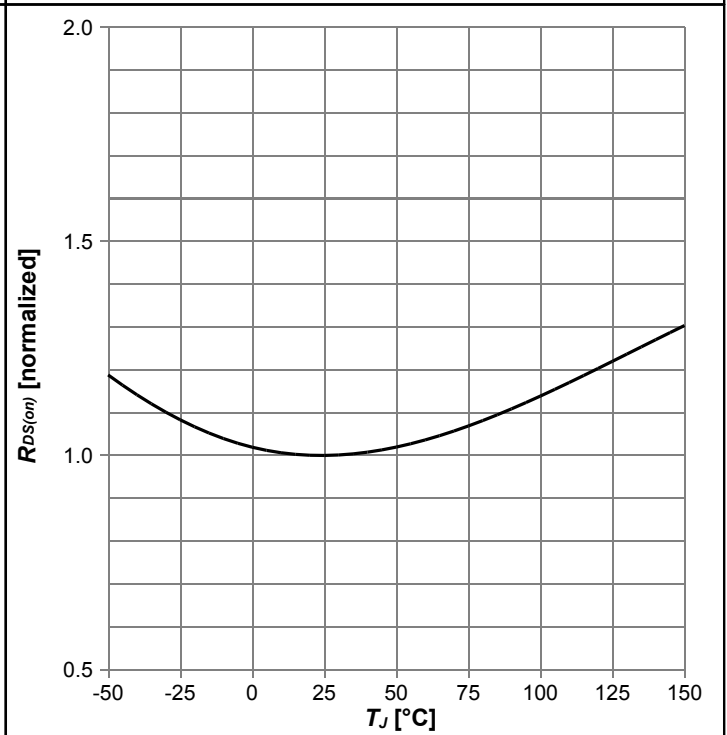
$I_D = f(V_{DS})$; $T_j = 125\text{ °C}$; parameter: V_{GS}

Diagram 7: Typ. drain-source on-state resistance



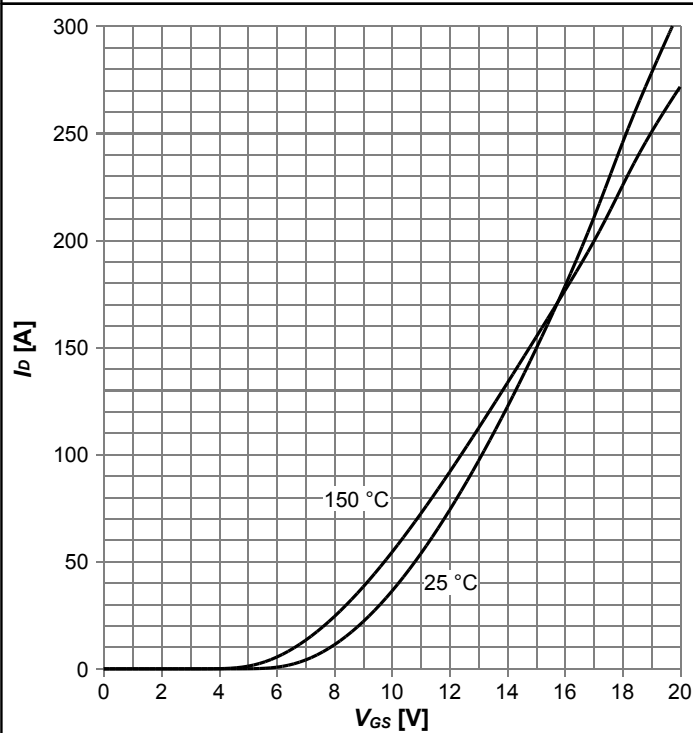
$R_{DS(on)} = f(I_D)$; $T_j = 125\text{ °C}$; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



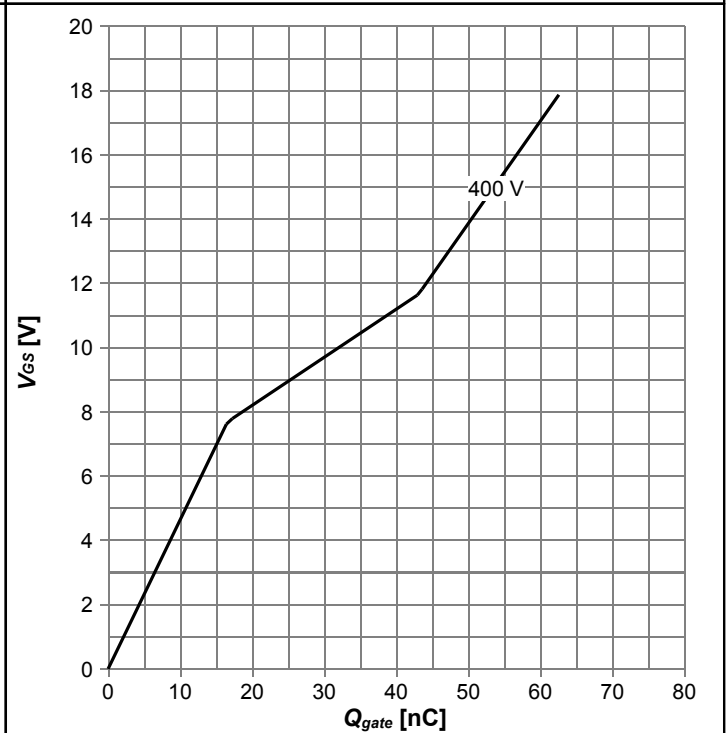
$R_{DS(on)} = f(T_j)$; $I_D = 38.3\text{ A}$; $V_{GS} = 18\text{ V}$

Diagram 9: Typ. transfer characteristics



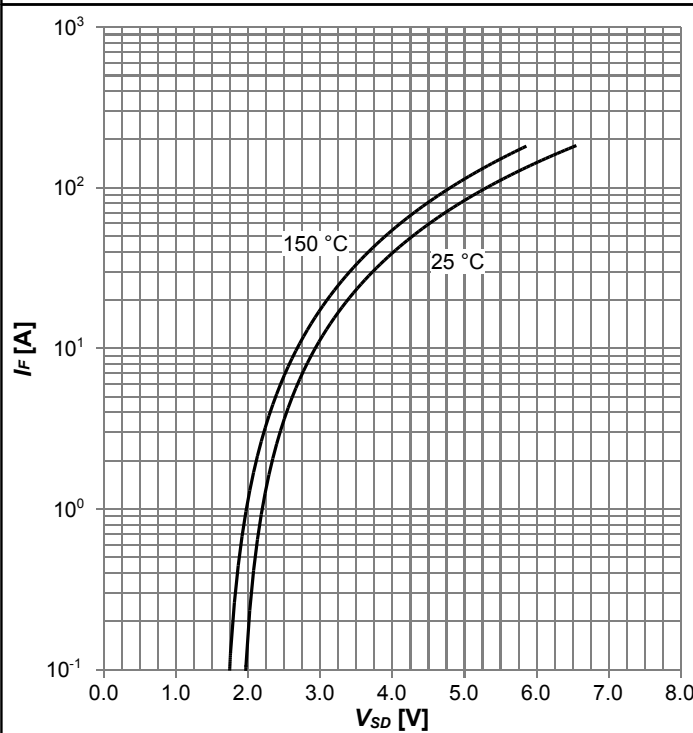
$I_D=f(V_{GS})$; $V_{DS}=20V$; parameter: T_j

Diagram 10: Typ. gate charge



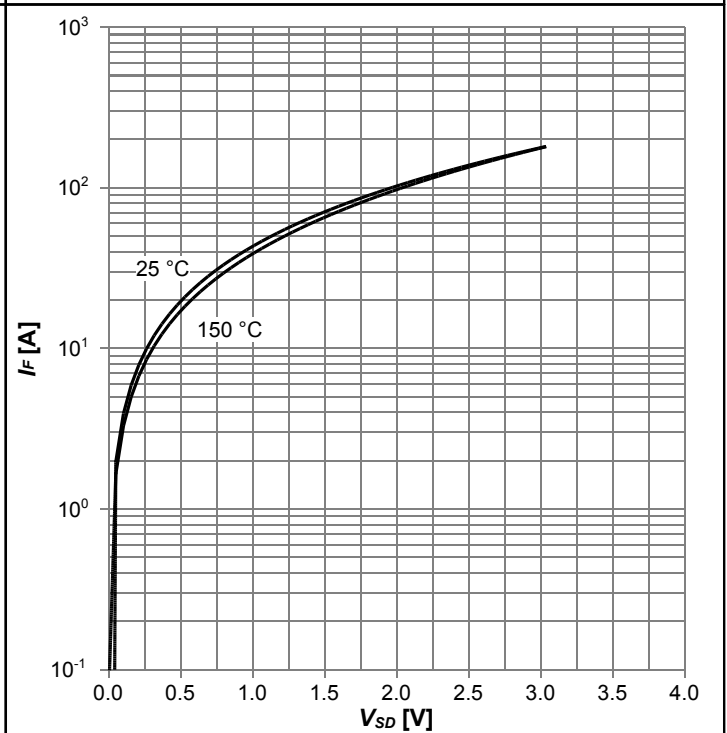
$V_{GS}=f(Q_{gate})$; $I_D=38.3 A$ pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



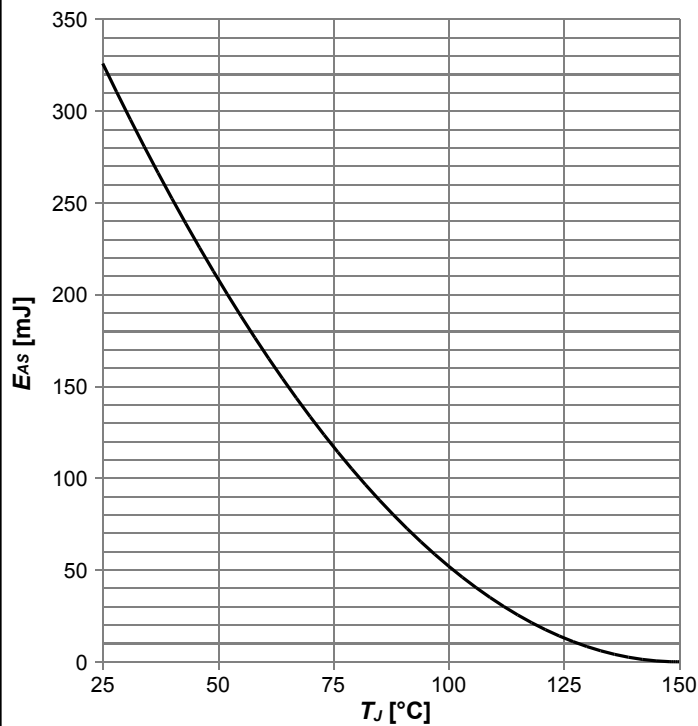
$I_F=f(V_{SD})$; parameter: T_j

Diagram 12: Forward characteristics of reverse diode



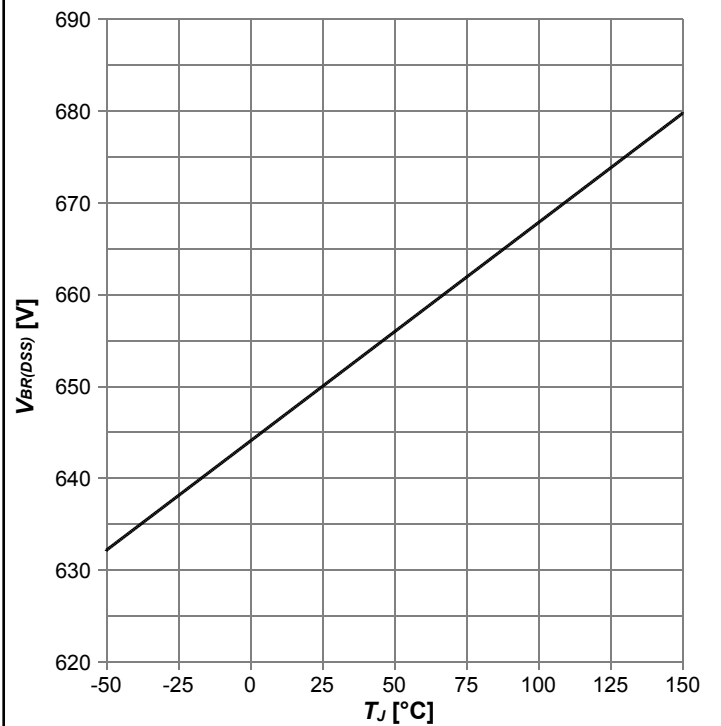
$I_F=f(V_{SD})$; $V_{GS}=18 V$; parameter: T_j

Diagram 13: Avalanche energy



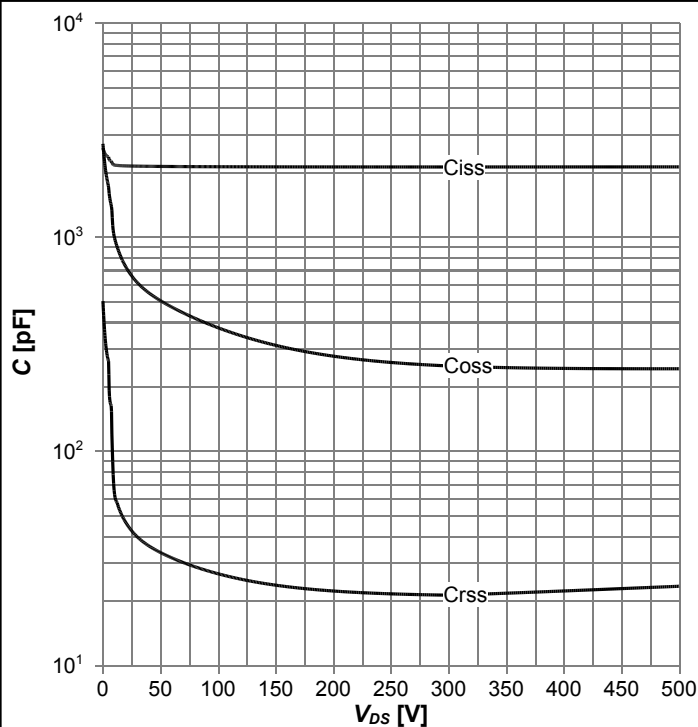
$E_{AS}=f(T_J)$; $I_D=12.2$ A; $V_{DD}=50$ V

Diagram 14: Drain-source breakdown voltage



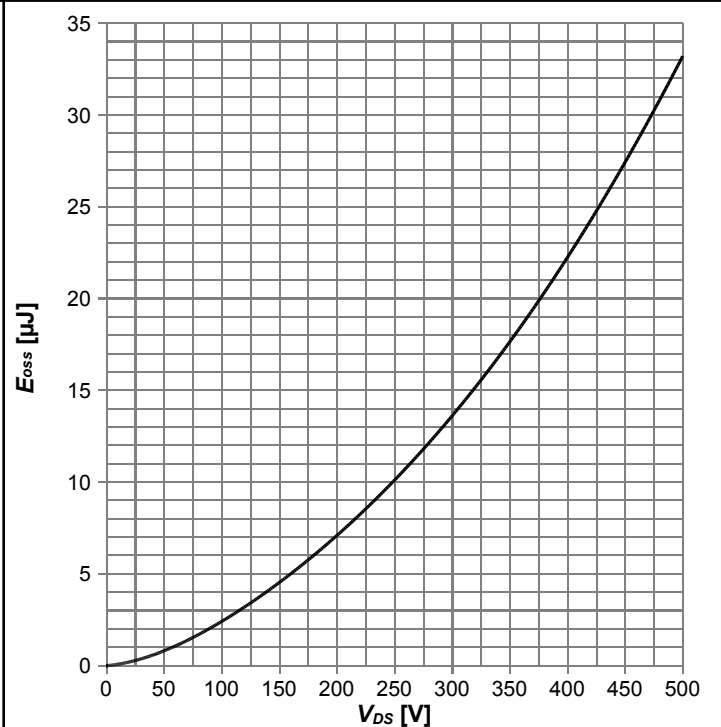
$V_{BR(DSS)}=f(T_J)$; $I_D=1.1$ mA

Diagram 15: Typ. capacitances

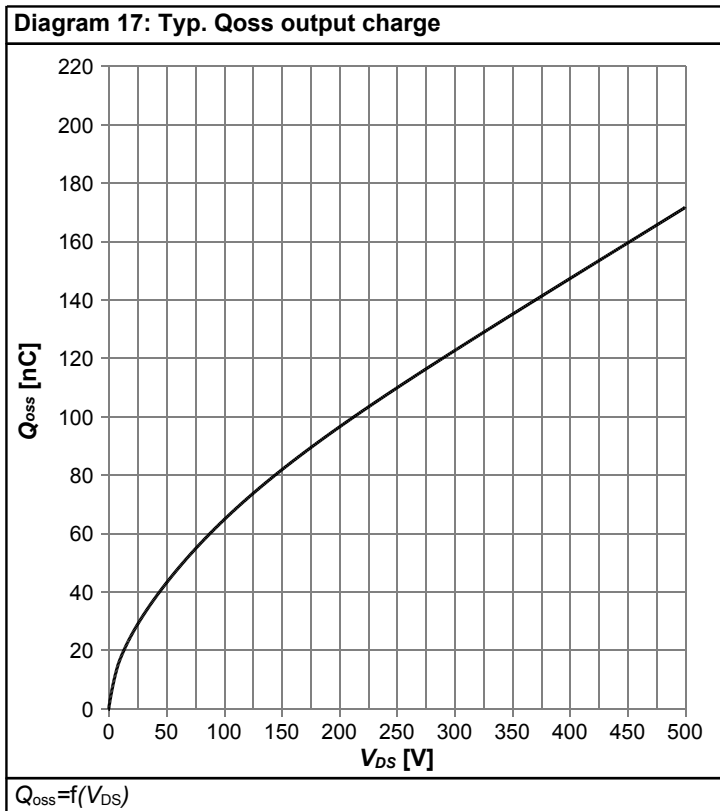


$C=f(V_{DS})$; $V_{GS}=0$ V; $f=250$ kHz

Diagram 16: Typ. Coss stored energy



$E_{oss}=f(V_{DS})$



5 Test Circuits

Table 8 Diode characteristics

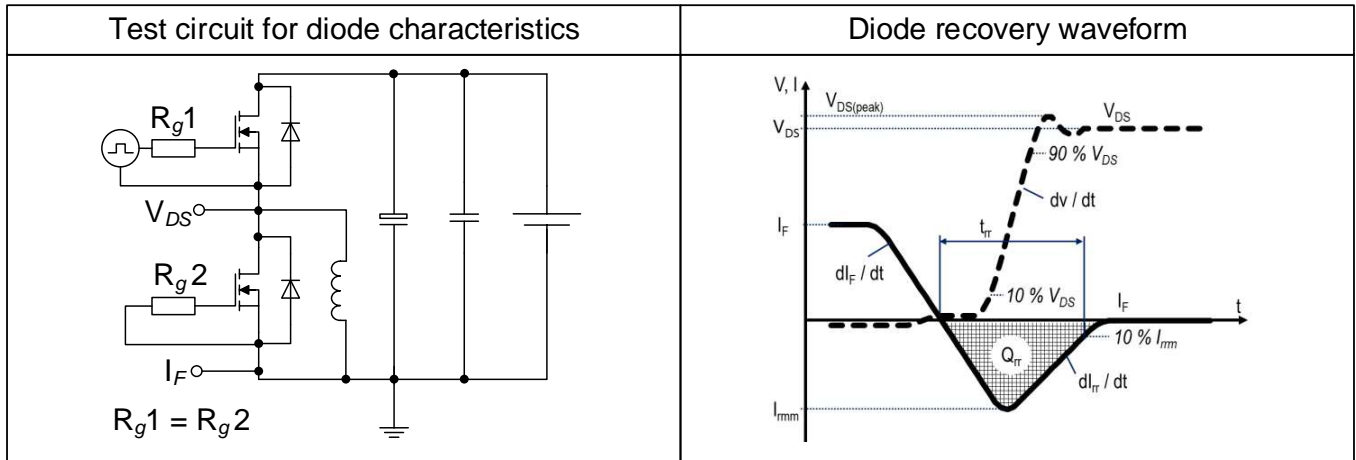


Table 9 Switching times (ss)

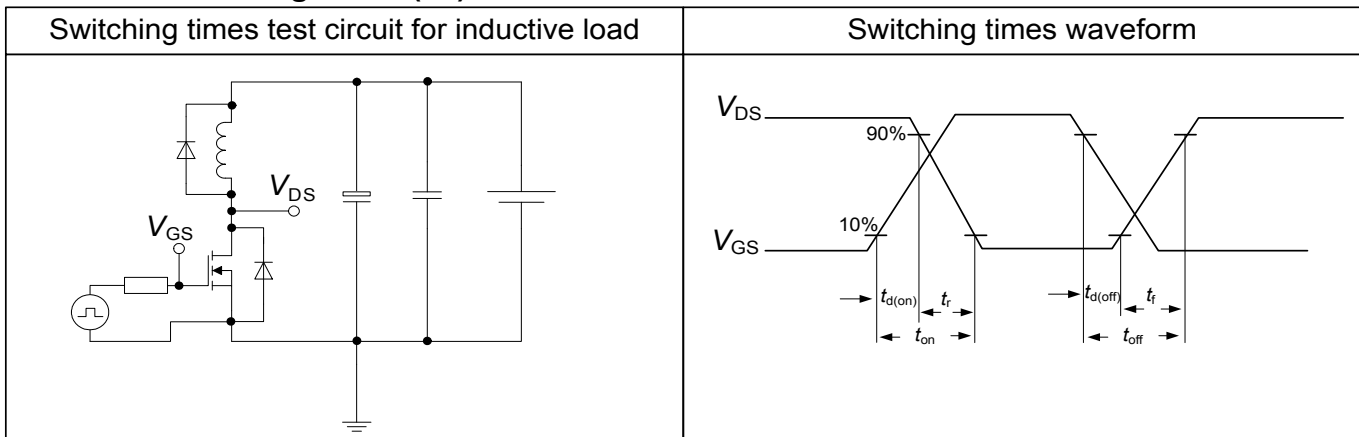
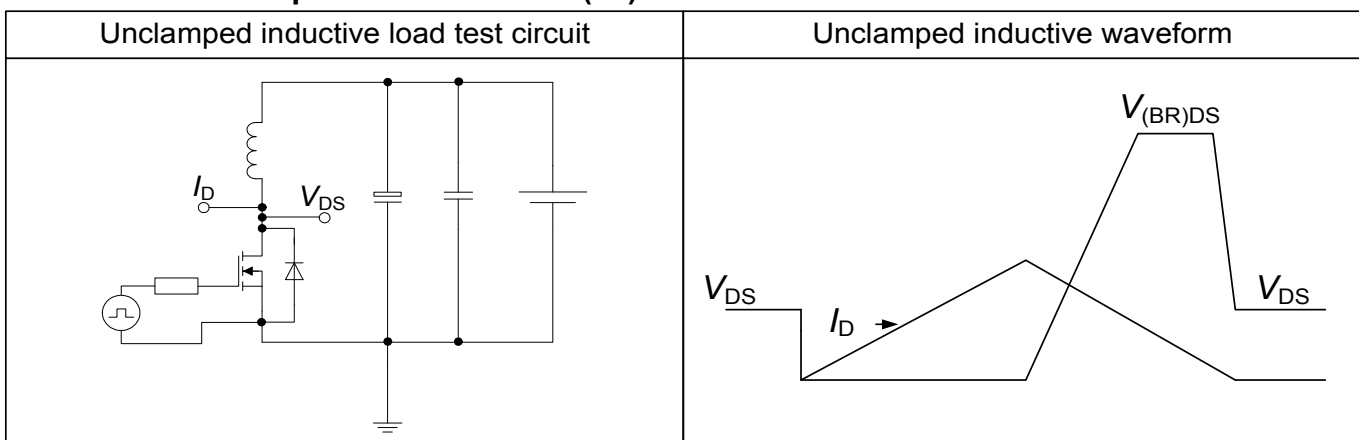
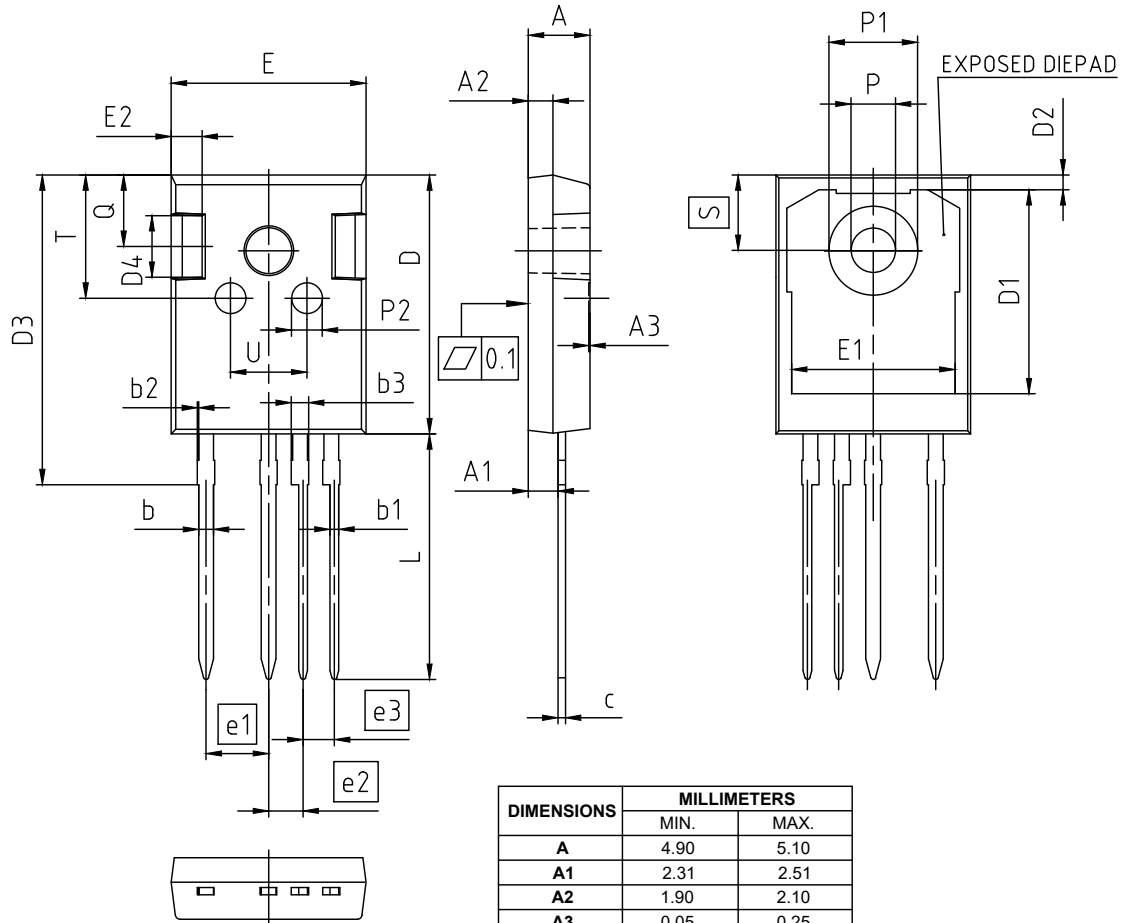


Table 10 Unclamped inductive load (ss)



6 Package Outlines



NOTES:
 ALL DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

| DIMENSIONS | MILLIMETERS | |
|------------|-------------|-------|
| | MIN. | MAX. |
| A | 4.90 | 5.10 |
| A1 | 2.31 | 2.51 |
| A2 | 1.90 | 2.10 |
| A3 | 0.05 | 0.25 |
| b | 1.10 | 1.30 |
| b1 | 0.65 | 0.79 |
| b2 | - | 0.20 |
| b3 | 1.34 | 1.44 |
| c | 0.58 | 0.66 |
| D | 20.90 | 21.10 |
| D1 | 16.25 | 16.85 |
| D2 | 1.05 | 1.35 |
| D3 | 24.97 | 25.27 |
| D4 | 4.90 | 5.10 |
| E | 15.70 | 15.90 |
| E1 | 13.10 | 13.50 |
| E2 | 2.40 | 2.60 |
| e1 | 5.08 | |
| e2 | 2.79 | |
| e3 | 2.54 | |
| L | 19.80 | 20.10 |
| L1 | - | 4.30 |
| øP | 3.50 | 3.70 |
| øP1 | 7.00 | 7.40 |
| øP2 | 2.40 | 2.60 |
| Q | 5.60 | 6.00 |
| S | 6.15 | |
| T | 9.80 | 10.20 |
| U | 6.00 | 6.40 |

| |
|------------------------------------|
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| REVISION 03 |
| SCALE 2:1 0 5 10mm |
| EUROPEAN PROJECTION |
| ISSUE DATE 21.08.2017 |

Figure 1 Outline PG-TO 247-4-3, dimensions in mm

7 Appendix A

Table 11 Related Links

- IFX CoolSiC M1 Webpage: www.infineon.com
- IFX CoolSiC M1 application note: www.infineon.com
- IFX CoolSiC M1 simulation model: www.infineon.com
- IFX Design tools: www.infineon.com

Revision History

IMZA65R027M1H

Revision: 2019-12-16, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0 | 2019-12-16 | Release of final version |

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