

CoolSiC™
400V CoolSiC™ G2 MOSFET

PG-TO263-7

Features

- Ideal for high frequency switching and synchronous rectification
- Commutation robust fast body diode with low Q_{fr}
- Low $R_{DS(on)}$ dependency on temperature
- Benchmark gate threshold voltage, $V_{GS(th)} = 4.5\text{ V}$
- Recommended gate driving voltage 0 V to 18 V
- .XT interconnection technology for best-in-class thermal performance
- 100% avalanche tested

Potential applications

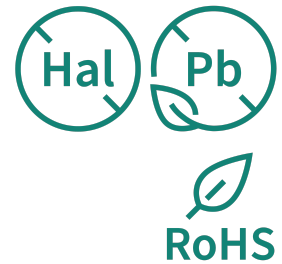
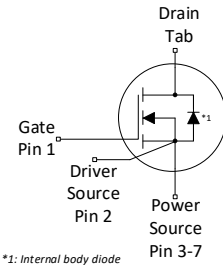
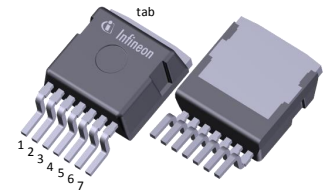
- SMPS
- Solar PV inverters
- Energy storage, UPS and battery formation
- Class-D audio
- Motor drives

Product validation

Fully qualified according to JEDEC for Industrial Applications

Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|------------------|-------|------|
| V_{DS} | 400 | V |
| $R_{DS(on),typ}$ | 15.0 | mΩ |
| I_D | 111 | A |
| Q_{oss} | 101 | nC |
| E_{oss} | 7.3 | μJ |
| Q_G | 62 | nC |



| Type/Ordering Code | Package | Marking | Related Links |
|--------------------|------------|----------|---------------|
| IMBG40R015M2H | PG-TO263-7 | 40R015M2 | - |

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1 Maximum ratings

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

Table 2 Maximum ratings

| Parameter | Symbol | Values | | | Unit | Note/ Test Condition |
|--|---------------|--------|------|-------------------|------|---|
| | | Min. | Typ. | Max. | | |
| Continuous drain current ¹⁾ | I_D | - | - | 111 79 11.7 | A | $V_{GS}=18\text{ V}$, $T_C=25\text{ °C}$ $V_{GS}=18\text{ V}$, $T_C=100\text{ °C}$ $V_{GS}=18\text{ V}$, $T_A=25\text{ °C}$, $R_{THJA}=40\text{ °C/W}^2)$ |
| Pulsed drain current ³⁾ | $I_{D,pulse}$ | - | - | 333 | A | $T_C=25\text{ °C}$ |
| Avalanche energy, single pulse ⁴⁾ | E_{AS} | - | - | 162 | mJ | $I_D=27.1\text{ A}$, $R_{GS}=25\text{ }\Omega$ |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.81 | mJ | $I_D=27.1\text{ A}$, $R_{GS}=25\text{ }\Omega$ |
| Gate source voltage (static) | $V_{GS,DC}$ | -7 | - | 23 | V | - |
| Gate source voltage (transient) | $V_{GS,AC}$ | -10 | - | 25 | V | $t_{pulse} \leq 500\text{ ns}$, duty cycle $\leq 1\%$ |
| Power dissipation | P_{tot} | - | - | 341 3.8 | W | $T_C=25\text{ °C}$ $T_A=25\text{ °C}$, $R_{THJA}=40\text{ °C/W}^2)$ |
| Storage temperature | T_{stg} | -55 | - | 150 | °C | - |
| Operating junction temperature | T_j | -55 | - | 175 | °C | - |

¹⁾ Rating refers to the product only with datasheet specified absolute maximum values, maintaining case temperature at 25°C. For higher case temperature please refer to Diagram 2. De-rating will be required based on the actual environmental conditions.

²⁾ Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm² (one layer, 70 μm thick) copper area for drain connection. PCB is vertical in still air.

³⁾ See Diagram 3 for more detailed information.

⁴⁾ See Diagram 19 for more detailed information.

2 Thermal characteristics

Table 3 Thermal characteristics

| Parameter | Symbol | Values | | | Unit | Note/ Test Condition |
|---|------------|--------|------|------|------|----------------------|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 0.44 | °C/W | - |
| Thermal resistance, junction - ambient, 6 cm ² cooling area ⁵⁾ | R_{thJA} | - | - | 40 | °C/W | - |

⁵⁾ Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm² (one layer, 70 μm thick) copper area for drain connection. PCB is vertical in still air.

3 Operating range

Table 4 Operating range

| Parameter | Symbol | Values | | | Unit | Note/ Test Condition |
|------------------------------|---------------|--------|------|------|------|----------------------|
| | | Min. | Typ. | Max. | | |
| Recommended turn-on voltage | $V_{GS(on)}$ | - | 18 | - | V | - |
| Recommended turn-off voltage | $V_{GS(off)}$ | - | 0 | - | V | - |

4 Electrical characteristics

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

Table 5 Static characteristics

| Parameter | Symbol | Values | | | Unit | Note/ Test Condition |
|--------------------------------------|---------------|--------|----------------------|-----------|---------------|--|
| | | Min. | Typ. | Max. | | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | 400 | - | - | V | $V_{GS}=0\text{ V}$, $I_D=0.97\text{ mA}$ |
| Gate threshold voltage ⁶⁾ | $V_{GS(th)}$ | 3.5 | 4.5 | 5.6 | V | $V_{DS}=V_{GS}$, $I_D=9.7\text{ mA}$ |
| Zero gate voltage drain current | I_{DSS} | - | 1 2 | 75 - | μA | $V_{DS}=400\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$ $V_{DS}=400\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=175\text{ °C}$ |
| Gate-source leakage current | I_{GSS} | - | 1 | 100 | nA | $V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 15.0 21.7 18.4 | 19.1 - | m Ω | $V_{GS}=18\text{ V}$, $I_D=27.1\text{ A}$, $T_j=25\text{ °C}$ $V_{GS}=18\text{ V}$, $I_D=27.1\text{ A}$, $T_j=175\text{ °C}$ $V_{GS}=15\text{ V}$, $I_D=27.1\text{ A}$, $T_j=25\text{ °C}$ |
| Gate resistance | R_G | - | 2.8 | 4.2 | Ω | - |

⁶⁾ Tested after 1ms pulse at $V_{GS} = +20\text{V}$.

Table 6 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note/ Test Condition |
|--|--------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 2100 | 2730 | pF | $V_{GS}=0\text{ V}$, $V_{DS}=200\text{ V}$, $f=1\text{ MHz}$ |
| Output capacitance | C_{oss} | - | 300 | - | pF | $V_{GS}=0\text{ V}$, $V_{DS}=200\text{ V}$, $f=1\text{ MHz}$ |
| Reverse transfer capacitance | C_{rss} | - | 24 | - | pF | $V_{GS}=0\text{ V}$, $V_{DS}=200\text{ V}$, $f=1\text{ MHz}$ |
| Effective output capacitance, energy related ⁷⁾ | $C_{o(er)}$ | - | 363 | - | pF | $V_{GS}=0\text{ V}$, $V_{DS}=0\dots200\text{ V}$ |
| Effective output capacitance, time related ⁸⁾ | $C_{o(tr)}$ | - | 510 | - | pF | $I_D=\text{constant}$, $V_{GS}=0\text{ V}$, $V_{DS}=0\dots200\text{ V}$ |
| Turn-on delay time ⁹⁾ | $t_{d(on)}$ | - | 13.9 | - | ns | $V_{DD}=200\text{ V}$, $V_{GS}=0\dots18\text{ V}$, $I_D=27.1\text{ A}$, $R_{G,ext}=1.8\text{ }\Omega$ |
| Rise time ⁹⁾ | t_r | - | 15.7 | - | ns | $V_{DD}=200\text{ V}$, $V_{GS}=0\dots18\text{ V}$, $I_D=27.1\text{ A}$, $R_{G,ext}=1.8\text{ }\Omega$ |
| Turn-off delay time ⁹⁾ | $t_{d(off)}$ | - | 26.5 | - | ns | $V_{DD}=200\text{ V}$, $V_{GS}=18\dots0\text{ V}$, $I_D=27.1\text{ A}$, $R_{G,ext}=1.8\text{ }\Omega$ |
| Fall time ⁹⁾ | t_f | - | 9.0 | - | ns | $V_{DD}=200\text{ V}$, $V_{GS}=18\dots0\text{ V}$, $I_D=27.1\text{ A}$, $R_{G,ext}=1.8\text{ }\Omega$ |

⁷⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 200 V.

⁸⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 200 V.

⁹⁾ Refer to Table 9 for test setup.

Table 7 Gate Charge Characteristics ¹⁰⁾

| Parameter | Symbol | Values | | | Unit | Note/ Test Condition |
|------------------------------|---------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | - | 16.9 | - | nC | $V_{DD}=200\text{ V}$, $I_D=27.1\text{ A}$, $V_{GS}=0\text{ to }18\text{ V}$ |
| Gate to drain charge | Q_{gd} | - | 12.8 | - | nC | $V_{DD}=200\text{ V}$, $I_D=27.1\text{ A}$, $V_{GS}=0\text{ to }18\text{ V}$ |
| Gate charge total | Q_g | - | 62 | - | nC | $V_{DD}=200\text{ V}$, $I_D=27.1\text{ A}$, $V_{GS}=0\text{ to }18\text{ V}$ |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | - | 58 | - | nC | $V_{DS}=0.1\text{ V}$, $V_{GS}=0\text{ to }18\text{ V}$ |
| Output charge | Q_{oss} | - | 101 | - | nC | $V_{DS}=200\text{ V}$, $V_{GS}=0\text{ V}$ |
| Output Energy | E_{oss} | - | 7.3 | - | μJ | $V_{DS}=200\text{ V}$, $V_{GS}=0\text{ V}$ |

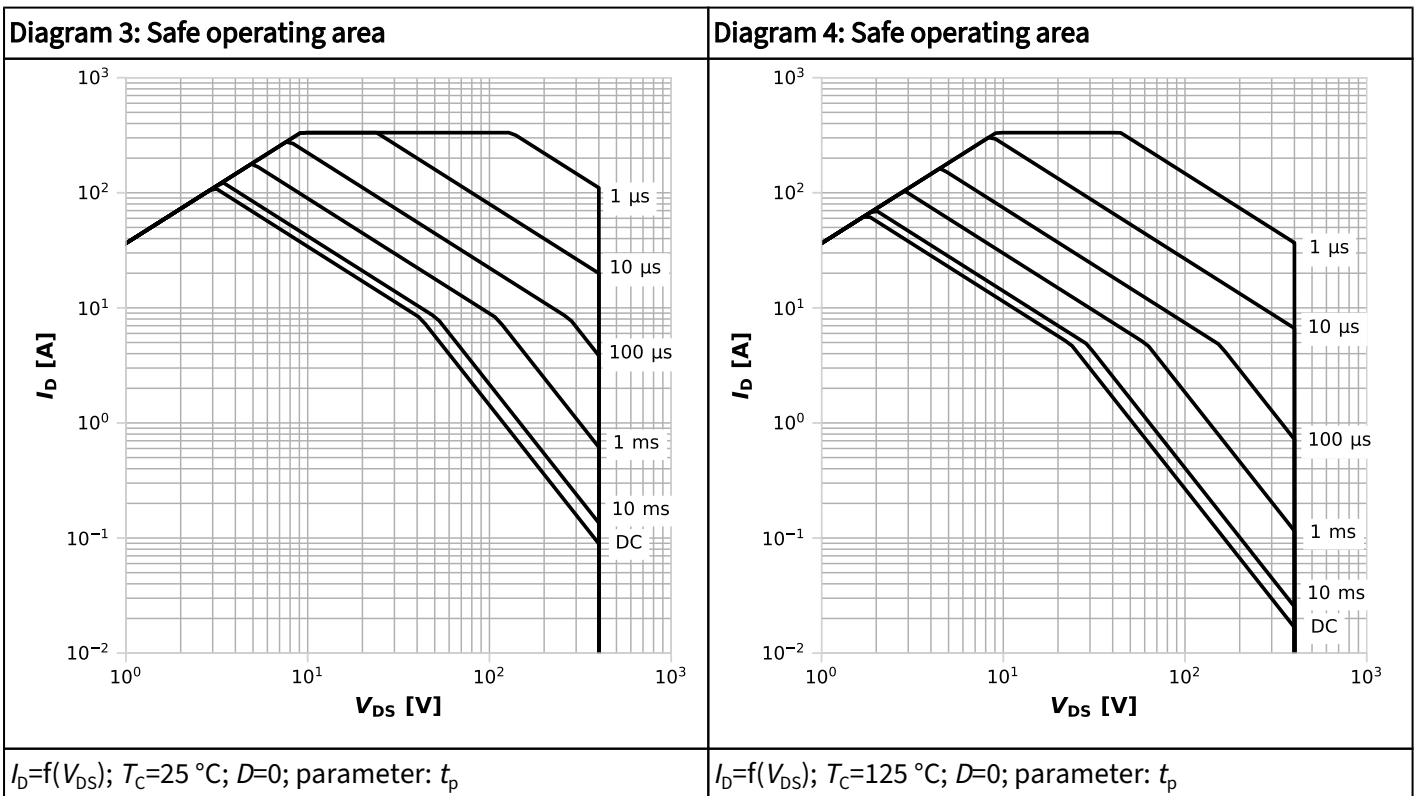
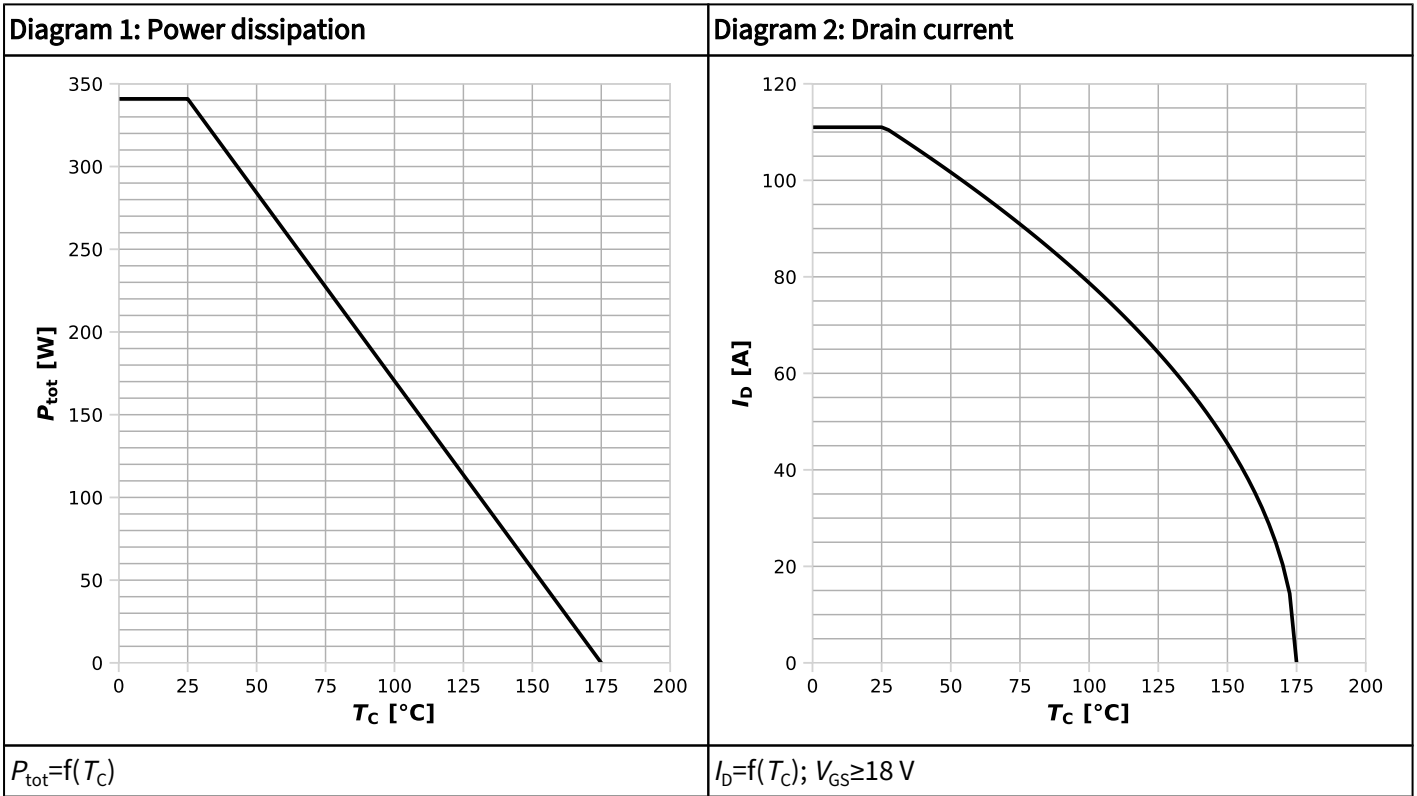
¹⁰⁾ As per JEP192, Guidelines for Gate Charge (Q_g) Test Method for SiC MOSFET.

Table 8 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note/ Test Condition |
|---|---------------|--------|--------------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Diode continuous forward current | I_S | - | - | 52 | A | $T_C=25\text{ °C}$ |
| Diode pulse current | $I_{S,pulse}$ | - | - | 333 | A | $T_C=25\text{ °C}$, $t_{pulse} \leq 250\text{ ns}$ |
| Diode forward voltage | V_{SD} | - | 3.5 | 4.3 | V | $V_{GS}=0\text{ V}$, $I_S=27.1\text{ A}$, $T_J=25\text{ °C}$ |
| MOSFET forward recovery time | t_{fr} | - | 17.1 11.0 | - | ns | $V_R=200\text{ V}$, $I_S=27.1\text{ A}$, $di_S/dt=1000\text{ A}/\mu\text{s}$ $V_R=200\text{ V}$, $I_S=27.1\text{ A}$, $di_S/dt=4000\text{ A}/\mu\text{s}$ |
| MOSFET forward recovery charge ¹¹⁾ | Q_{fr} | - | 86 173 | - | nC | $V_R=200\text{ V}$, $I_S=27.1\text{ A}$, $di_S/dt=1000\text{ A}/\mu\text{s}$ $V_R=200\text{ V}$, $I_S=27.1\text{ A}$, $di_S/dt=4000\text{ A}/\mu\text{s}$ |

¹¹⁾ Q_{fr} includes Q_{oss} . Refer to Table 10 for test setup.

5 Electrical characteristics diagrams



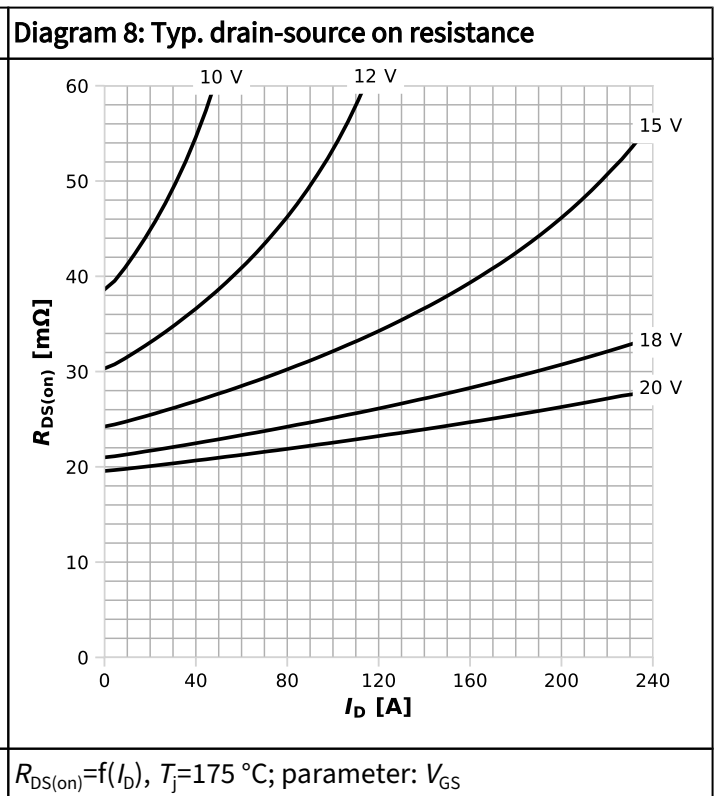
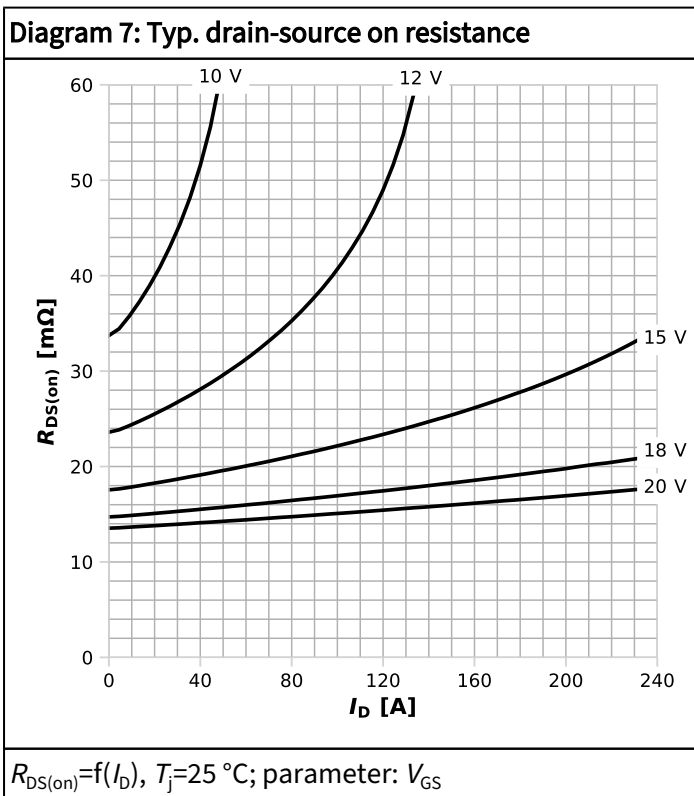
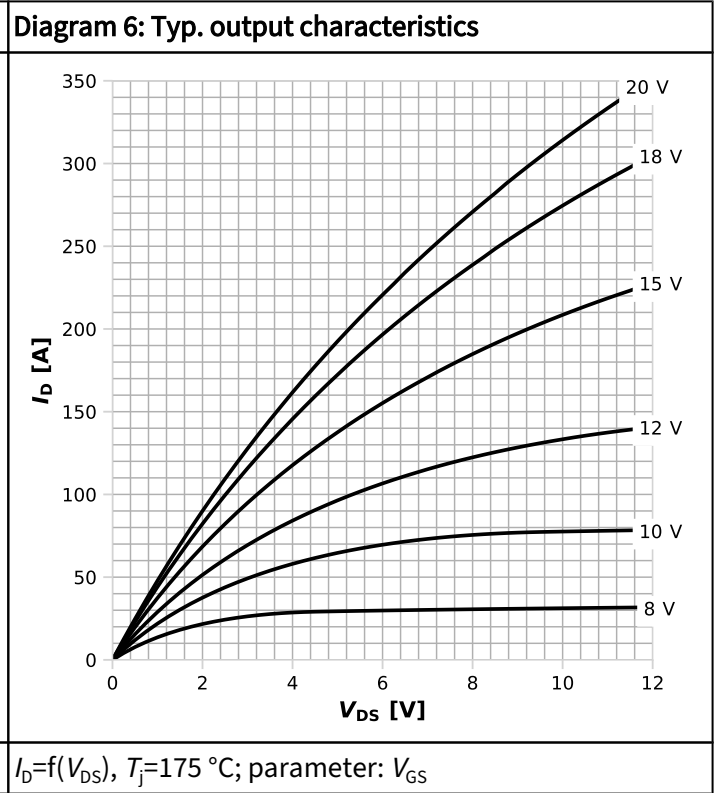
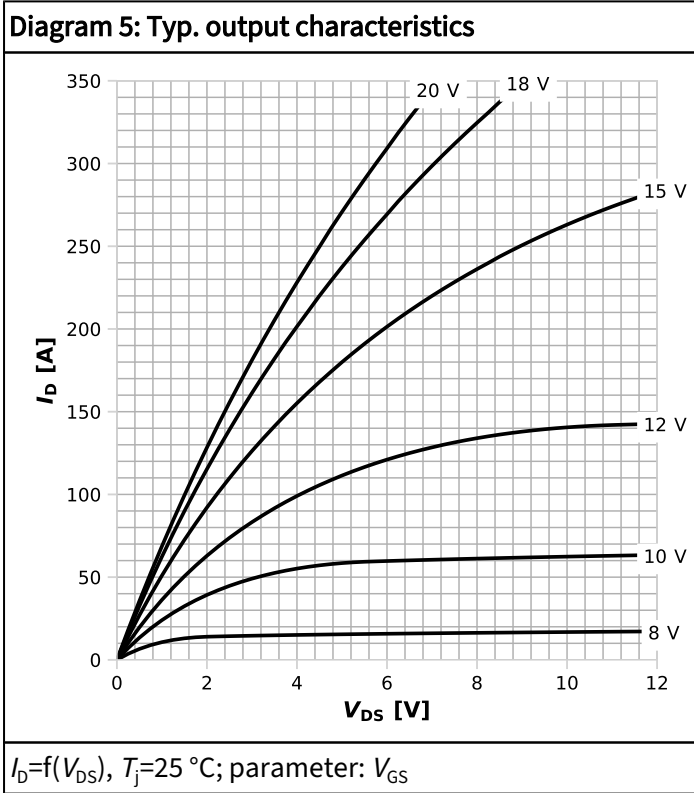
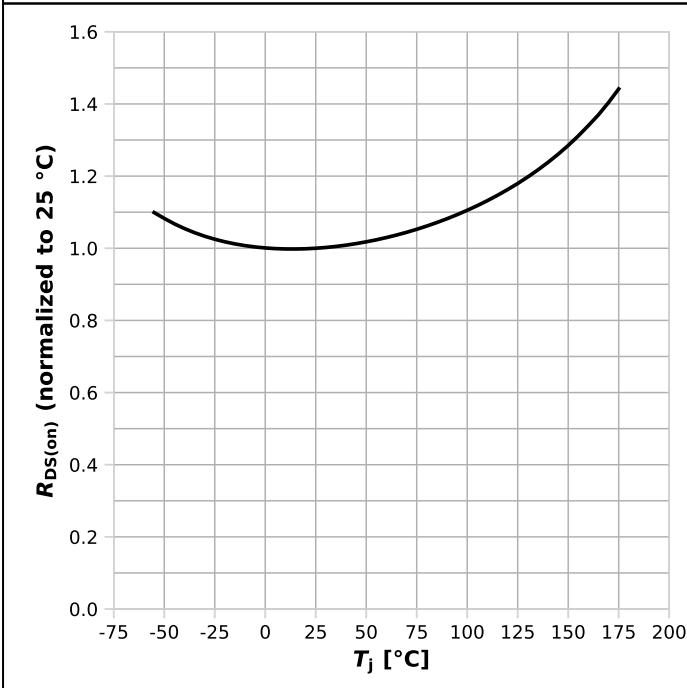
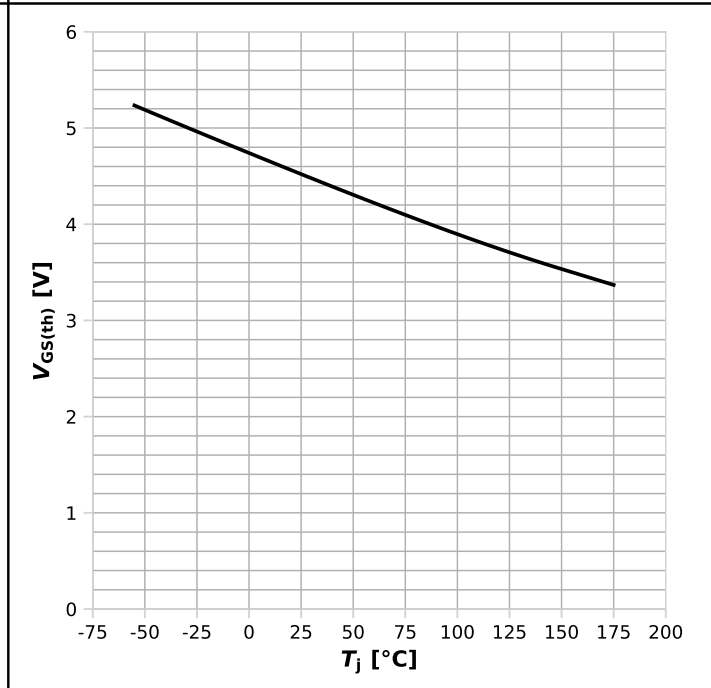


Diagram 9: Normalized drain-source on resistance



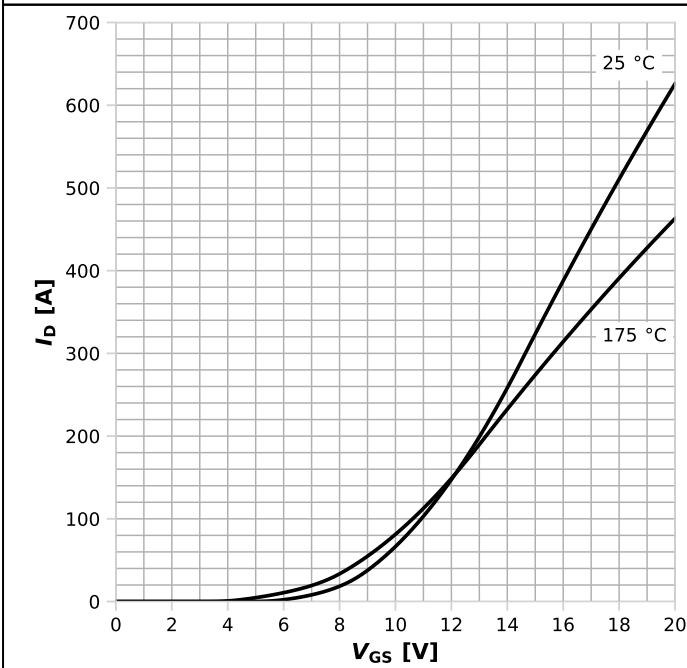
$R_{DS(on)}=f(T_j), I_D=27.1\text{ A}, V_{GS}=18\text{ V}$

Diagram 10: Typ. gate threshold voltage



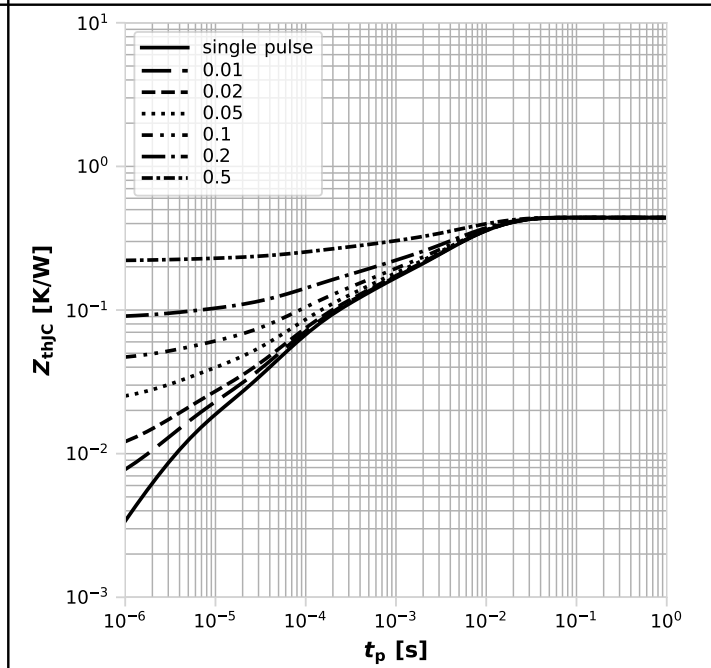
$V_{GS(th)}=f(T_j), V_{GS}=V_{DS}, I_D=9.7\text{ mA}$

Diagram 11: Typ. transfer characteristics



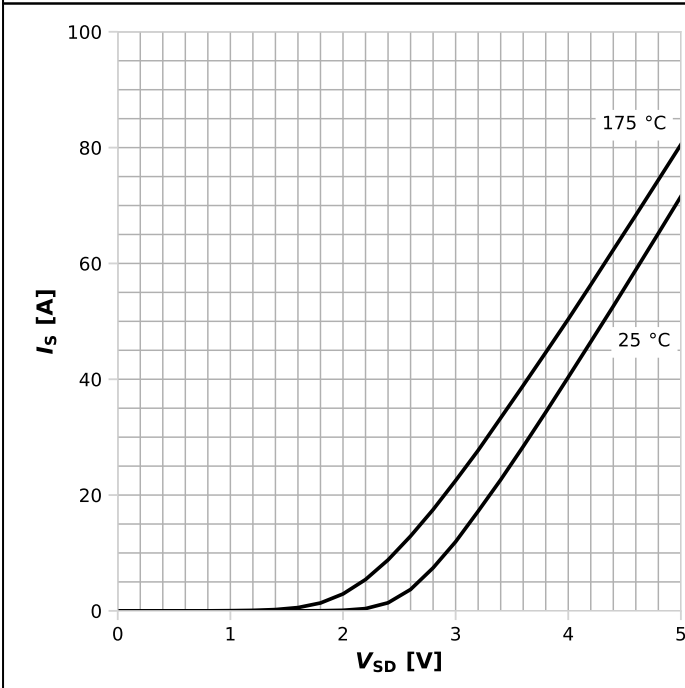
$I_D=f(V_{GS}), |V_{DS}|>2|I_D|R_{DS(on)max}; \text{parameter: } T_j$

Diagram 12: Max. transient thermal impedance



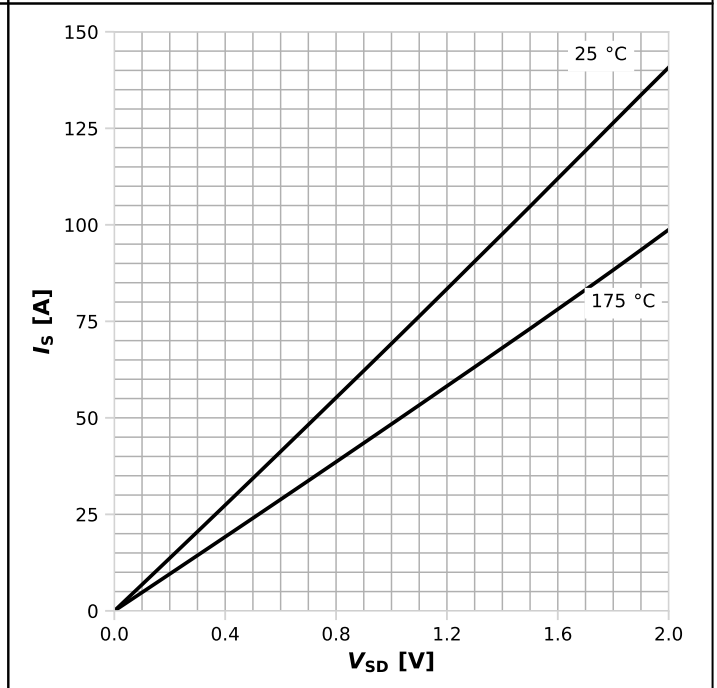
$Z_{thJC}=f(t_p); \text{parameter: } D=t_p/T$

Diagram 13: Reverse output characteristics



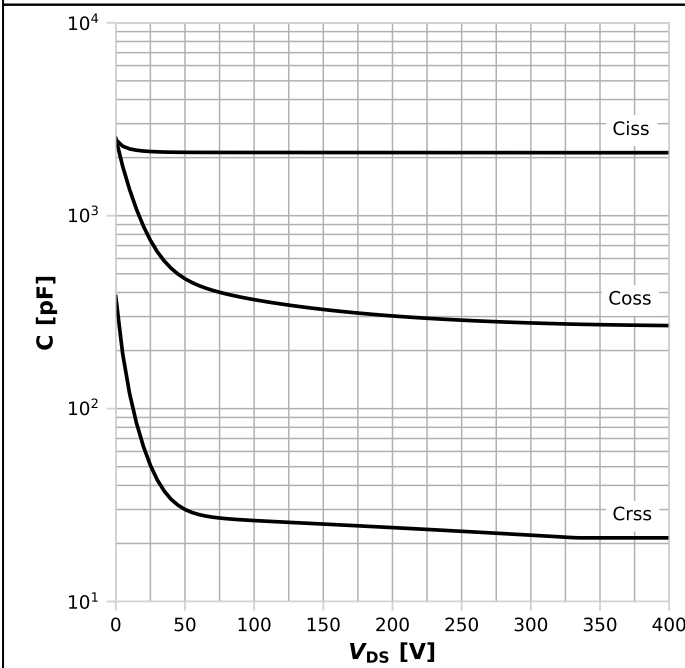
$I_F=f(V_{SD}), V_{GS}=0\text{ V};$ parameter: T_j

Diagram 14: Reverse output characteristics



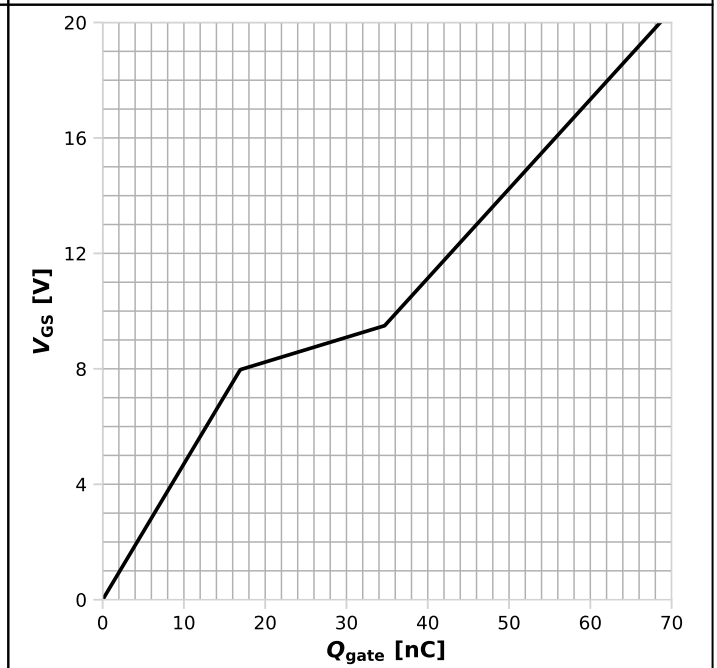
$I_F=f(V_{SD}), V_{GS}=18\text{ V};$ parameter: T_j

Diagram 15: Typ. capacitances



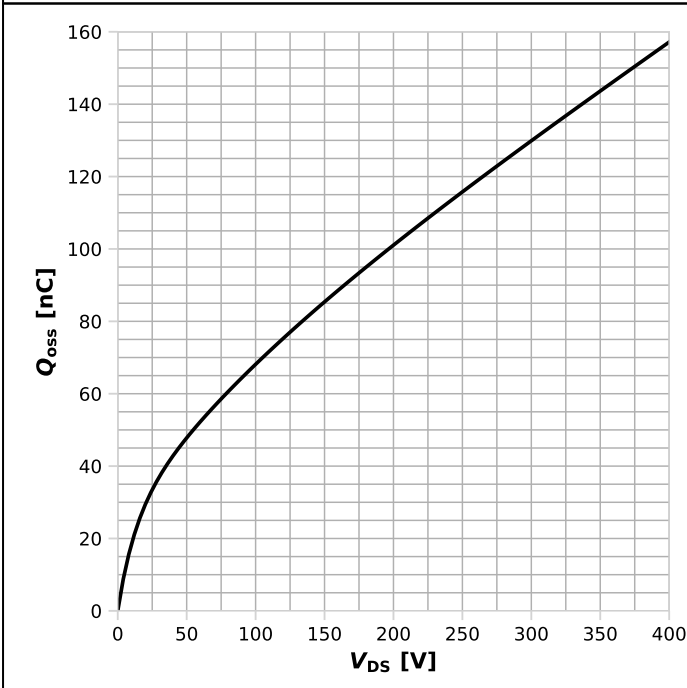
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$

Diagram 16: Typ. gate charge



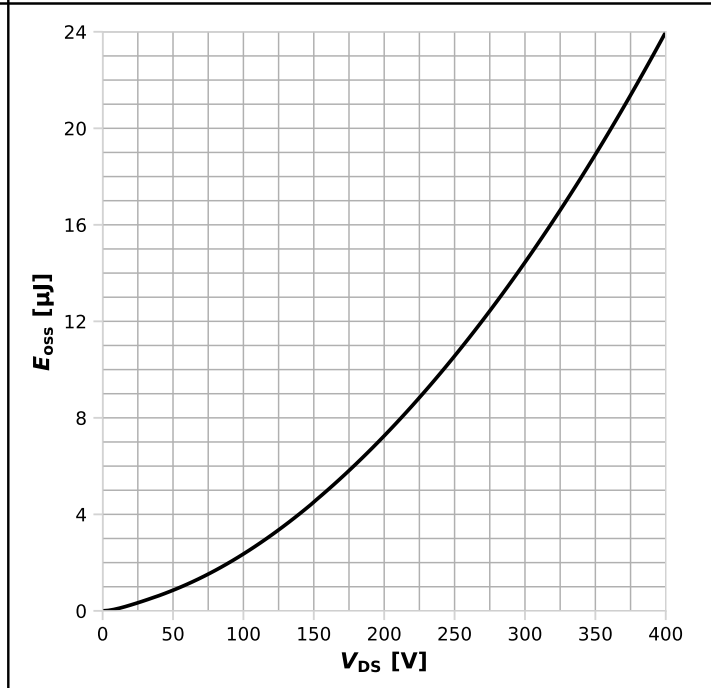
$V_{GS}=f(Q_{gate}), V_{DD}=200\text{ V}, I_D=27.1\text{ A pulsed}, T_j=25\text{ °C}$

Diagram 17: Typ. output charge



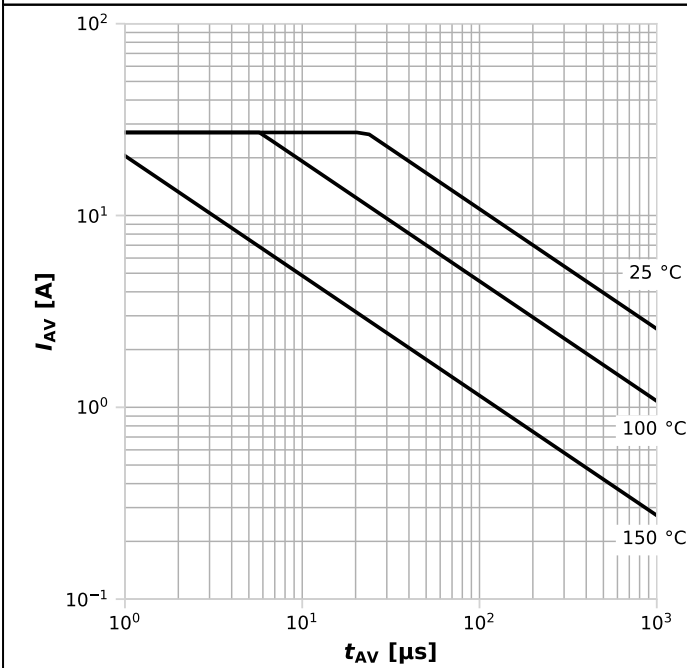
$Q_{oss}=f(V_{DS}), V_{GS}=0\text{ V}$

Diagram 18: Typ. output energy



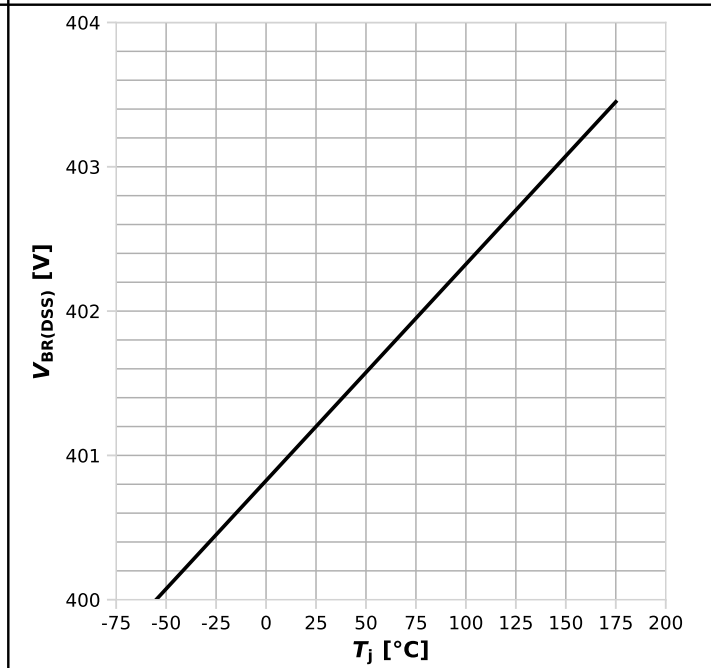
$E_{oss}=f(V_{DS}), V_{GS}=0\text{ V}$

Diagram 19: Avalanche characteristics

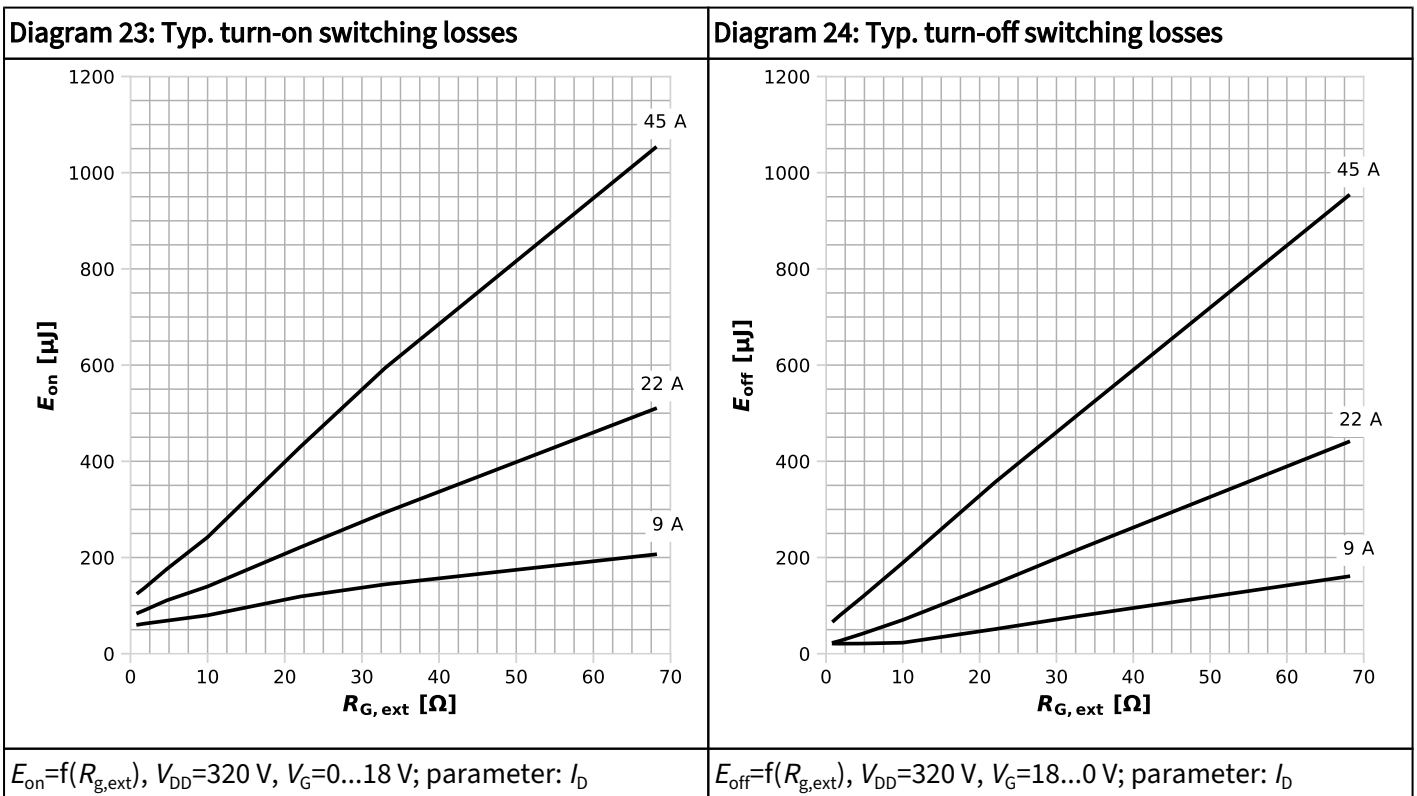
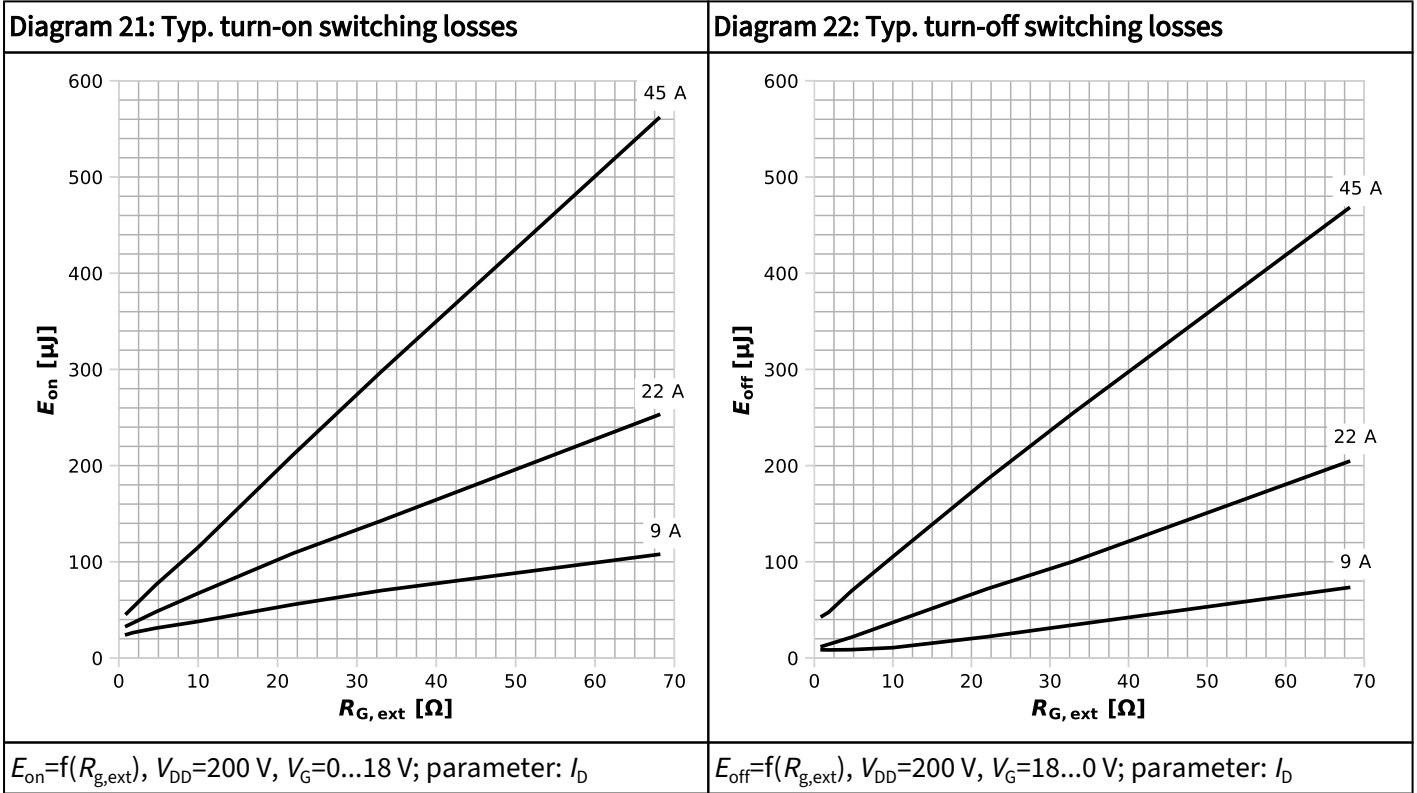


$I_{AS}=f(t_{AV}); R_{GS}=25\ \Omega; \text{parameter: } T_{j,\text{start}}$

Diagram 20: Min. drain-source breakdown voltage



$V_{BR(DSS)}=f(T_j); I_D=0.97\text{ mA}$



6 Test Circuits

Table 9 Switching times (CoolSiC)

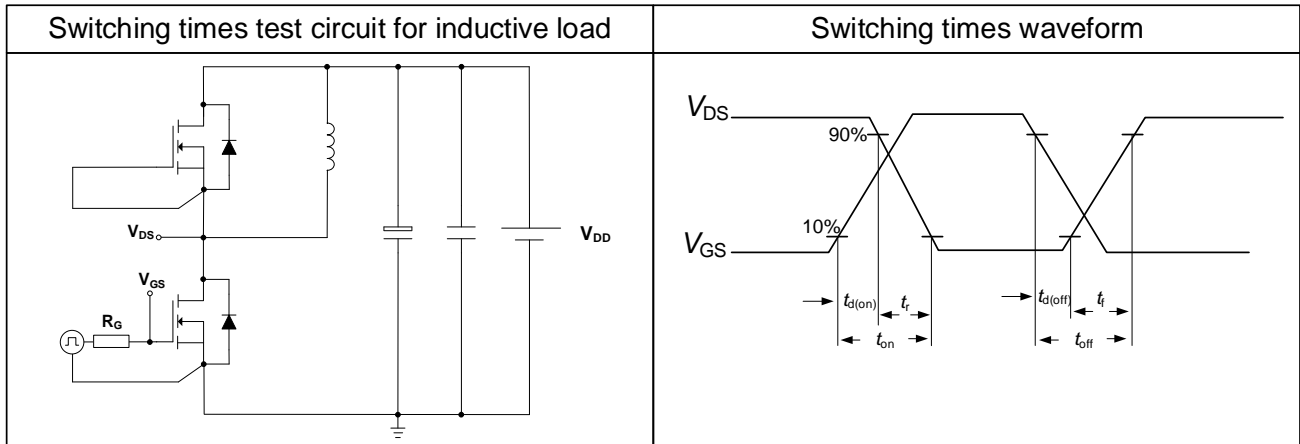
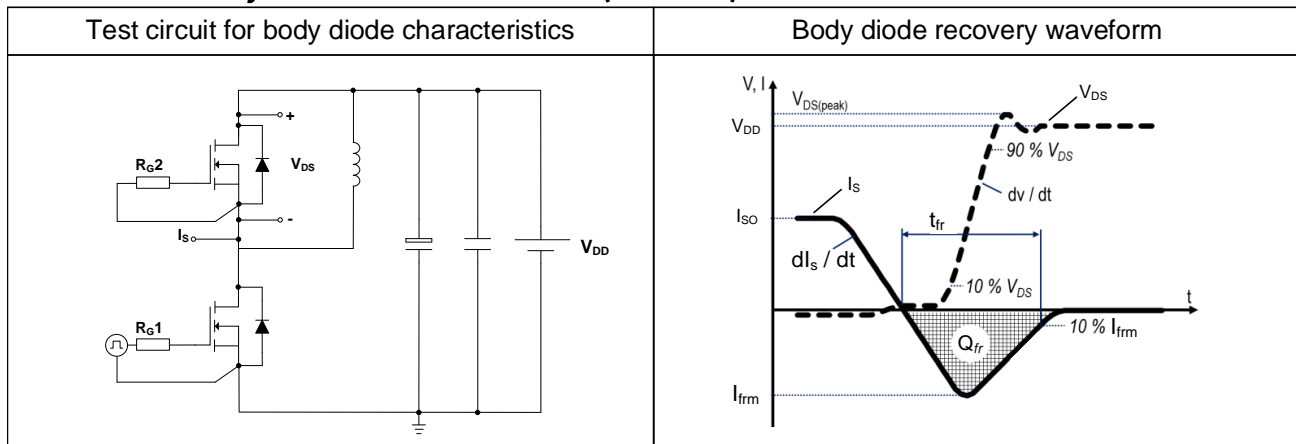
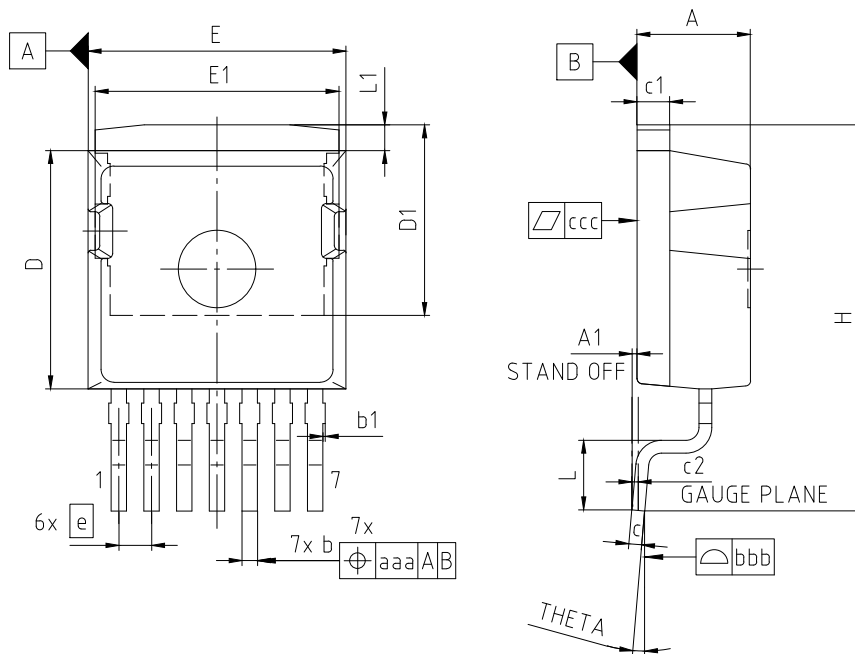


Table 10 Body diode characteristics (CoolSiC)



7 Package Outlines



NOTES:
 ALL METAL SURFACES TIN PLATED EXCEPT AREA OF CUT

| PACKAGE - GROUP NUMBER: PG-T0263-7-U04 | | MILLIMETERS | | MILLIMETERS | |
|--|------|-------------|------------|-------------|-------|
| DIMENSIONS | MIN. | MAX. | DIMENSIONS | MIN. | MAX. |
| A | 4.30 | 4.50 | E1 | 9.46 | |
| A1 | 0.00 | 0.10 | e | 1.27 | |
| b | 0.50 | 0.70 | N | 7 | |
| b1 | 0.00 | 0.15 | H | 15.00 | |
| c | 0.40 | 0.60 | L | 2.50 | 2.90 |
| c1 | 1.17 | 1.37 | L1 | 0.70 | 1.30 |
| c2 | 0.25 | | THETA | --- | 8.00° |
| D | 9.05 | 9.45 | aaa | 0.25 | |
| D1 | 7.30 | 7.50 | bbb | 0.10 | |
| E | 9.80 | 10.20 | ccc | 0.05 | |

Figure 1 Outline PG-T0263-7, dimensions in mm

Revision History

IMBG40R015M2H

Revision 2024-04-27, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 1.0 | 2024-04-26 | Release of preliminary version |
| 2.0 | 2024-04-27 | Release of final |

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