



**THE DATASHEET OF
IMBG65R057M1HXTMA1**



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_f
- Superior gate oxide reliability
- $T_{j,max}=175^{\circ}\text{C}$ and excellent thermal behavior
- Lower $R_{DS(on)}$ and pulse current dependency on temperature
- Increased avalanche capability
- Compatible with standard drivers (recommended driving voltage: 0V-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

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

Product validation

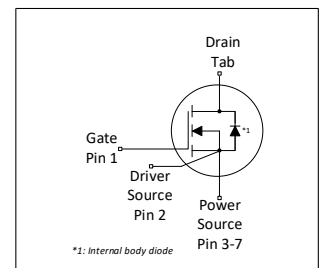
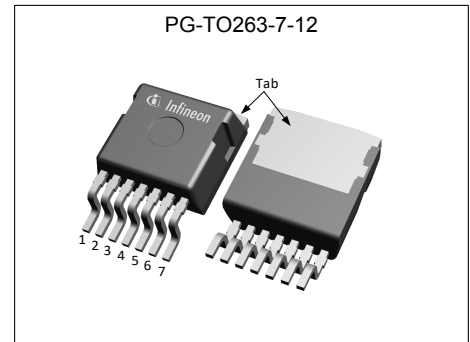
Fully qualified according to JEDEC for Industrial Applications

Please note: The source and sense source pins are not exchangeable. Their exchange might lead to malfunction.

Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|---------------------------------------|-------|---------------|
| V_{DS} @ $T_J = 25^{\circ}\text{C}$ | 650 | V |
| $R_{DS(on),typ}$ | 57 | m Ω |
| $R_{DS(on),max}$ | 74 | m Ω |
| $Q_{G,typ}$ | 28 | nC |
| I_{DM} | 84 | A |
| Q_{oss} @ 400 V | 65 | nC |
| E_{oss} @ 400 V | 9.8 | μJ |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|---------------|----------|----------------|
| IMBG65R057M1H | PG-TO263-7-12 | 65R057M1 | see Appendix A |



RoHS

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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 DC drain current ¹⁾ | I_D | - | - | 39 28 | A | $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$ |
| Peak drain current ²⁾ | I_{DM} | - | - | 84 | A | $T_C = 25\text{ °C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 142 | mJ | $I_D = 5.3\text{ A}$, $V_{DD} = 50\text{ V}$; see table 11 |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.71 | mJ | $I_D = 5.3\text{ A}$, $V_{DD} = 50\text{ V}$; see table 11 |
| Avalanche current, single pulse | I_{AS} | - | - | 5.3 | A | - |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 200 | V/ns | $V_{DS} = 0\text{...}400\text{ V}$ |
| Gate source voltage (static) ³⁾ | V_{GS} | -5 | - | 23 | V | static |
| Gate source voltage (transient) | V_{GS} | -7 | - | 25 | V | $t_{pulse, positive} \leq 1\%$ duty cycle/ f_{sw} |
| Power dissipation | P_{tot} | - | - | 161 | W | $T_C = 25\text{ °C}$ |
| Storage temperature | T_{stg} | -55 | - | 150 | °C | - |
| Operating junction temperature | T_J | -55 | - | 175 | °C | - |
| Mounting torque | - | - | - | n.a. | Ncm | - |
| Continuous reverse drain current ¹⁾ | I_{SDC} | - | - | 39 26 | A | $V_{GS}=18\text{ V}$, $T_C = 25\text{ °C}$ $V_{GS}=0\text{ V}$, $T_C = 25\text{ °C}$ |
| Repetitive peak reverse drain current ¹⁾ | I_{SRM} | - | - | 84 | A | $T_C = 25\text{ °C}$, pulse width $t_p \leq 250\text{ ns}$ |
| 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 $T_{J,max}$

³⁾ The maximum gate-source voltage in the application design should be in accordance to IPC-9592B

2 Thermal characteristics

Table 3 Thermal characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 0.93 | °C/W | - |
| Thermal resistance, junction - ambient | R_{thJA} | - | - | 62 | °C/W | device on PCB, minimal footprint |
| Thermal resistance, junction - ambient for SMD version | R_{thJA} | - | 35 | 45 | °C/W | Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm ² (one layer, 70µm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling. |
| Soldering temperature, wave- & reflow soldering allowed | T_{sold} | - | - | 260 | °C | reflow MSL1 |

3 Operating range

Table 4 Operating range

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|----------|--------|------|------|------|-----------------------|
| | | Min. | Typ. | Max. | | |
| Gate-source voltage operating range including undershoots ¹⁾ | V_{GS} | -2 | - | 20 | V | - |

¹⁾ **Important note: the selection of positive and negative gate-source voltages impacts the long-term behavior of the device.** The design guidelines described in the CoolSiC™ MOSFET 650 V M1 trench power device application note AN_1907_PL52_1911_144109 must be considered to ensure sound operation of the device over the planned lifetime.

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 | $V_{(BR)DSS}$ | 650 | - | - | V | $V_{GS} = 0\text{ V}$, $I_D = 0.5\text{ mA}$ |
| Gate threshold voltage ¹⁾ | $V_{GS(th)}$ | 3.5 | 4.5 | 5.7 | V | $V_{DS} = V_{GS}$, $I_D = 5\text{ mA}$ |
| Zero gate voltage drain current | I_{DSS} | - | 1 3 | 150 - | μA | $V_{DS} = 650\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 25\text{ °C}$ $V_{DS} = 650\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 175\text{ °C}$ |
| Gate leakage current | I_{GSS} | - | - | 100 | nA | $V_{GS} = 20\text{ V}$, $V_{DS} = 0\text{ V}$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 0.057 0.080 | 0.074 - | Ω | $V_{GS} = 18\text{ V}$, $I_D = 16.7\text{ A}$, $T_J = 25\text{ °C}$ $V_{GS} = 18\text{ V}$, $I_D = 16.7\text{ A}$, $T_J = 175\text{ °C}$ |
| Internal gate resistance | R_G | - | 8.0 | - | Ω | $f = 1\text{ MHz}$ |

Table 6 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 930 | - | pF | $V_{GS} = 0\text{ V}$, $V_{DS} = 400\text{ V}$, $f = 250\text{ kHz}$ |
| Reverse transfer capacitance | C_{riss} | - | 11 | - | pF | $V_{GS} = 0\text{ V}$, $V_{DS} = 400\text{ V}$, $f = 250\text{ kHz}$ |
| Output capacitance ²⁾ | C_{oss} | - | 107 | 139 | pF | $V_{GS} = 0\text{ V}$, $V_{DS} = 400\text{ V}$, $f = 250\text{ kHz}$ |
| Output charge ²⁾ | Q_{oss} | - | 65 | 84 | nC | calculation based on C_{oss} |
| Effective output capacitance, energy related ³⁾ | $C_{o(er)}$ | - | 122 | - | pF | $V_{GS} = 0\text{ V}$, $V_{DS} = 0...400\text{ V}$ |
| Effective output capacitance, time related ⁴⁾ | $C_{o(tr)}$ | - | 162 | - | pF | $I_D = \text{constant}$, $V_{GS} = 0\text{ V}$, $V_{DS} = 0...400\text{ V}$ |
| Turn-on delay time | $t_{d(on)}$ | - | 6.4 | - | ns | $V_{DD} = 400\text{ V}$, $V_{GS} = 18\text{ V}$, $I_D = 16.7\text{ A}$, $R_G = 1.8\text{ }\Omega$; see table 10 |
| Rise time | t_r | - | 8.8 | - | ns | $V_{DD} = 400\text{ V}$, $V_{GS} = 18\text{ V}$, $I_D = 16.7\text{ A}$, $R_G = 1.8\text{ }\Omega$; see table 10 |
| Turn-off delay time | $t_{d(off)}$ | - | 13.6 | - | ns | $V_{DD} = 400\text{ V}$, $V_{GS} = 18\text{ V}$, $I_D = 16.7\text{ A}$, $R_G = 1.8\text{ }\Omega$; see table 10 |
| Fall time | t_f | - | 7 | - | ns | $V_{DD} = 400\text{ V}$, $V_{GS} = 18\text{ V}$, $I_D = 16.7\text{ A}$, $R_G = 1.8\text{ }\Omega$; see table 10 |

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 7 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|----------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | - | 7 | - | nC | $V_{DD} = 400\text{ V}$, $I_D = 16.7\text{ A}$, $V_{GS} = 0\text{ to }18\text{ V}$ |
| Gate to drain charge | Q_{gd} | - | 6 | - | nC | $V_{DD} = 400\text{ V}$, $I_D = 16.7\text{ A}$, $V_{GS} = 0\text{ to }18\text{ V}$ |
| Gate charge total | Q_g | - | 28 | - | nC | $V_{DD} = 400\text{ V}$, $I_D = 16.7\text{ A}$, $V_{GS} = 0\text{ to }18\text{ V}$ |

Table 8 Body diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--------------------------------------|-----------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Drain-source reverse voltage | V_{SD} | - | 4.0 | - | V | $V_{GS} = 0\text{ V}$, $I_S = 16.7\text{ A}$, $T_J = 25\text{ °C}$ |
| MOSFET forward recovery time | t_{fr} | - | 19.4 | - | ns | $V_{DD} = 400\text{ V}$, $I_{S0} = 16.7\text{ A}$, $di_S/dt = 1000\text{ A}/\mu\text{s}$; see table 9 |
| MOSFET forward recovery charge | Q_f | - | 69 | - | nC | $V_{DD} = 400\text{ V}$, $I_{S0} = 16.7\text{ A}$, $di_S/dt = 1000\text{ A}/\mu\text{s}$; see table 9 |
| MOSFET peak forward recovery current | I_{frm} | - | 6.7 | - | A | $V_{DD} = 400\text{ V}$, $I_{S0} = 16.7\text{ A}$, $di_S/dt = 1000\text{ A}/\mu\text{s}$; see table 9 |

5 Electrical characteristics diagrams

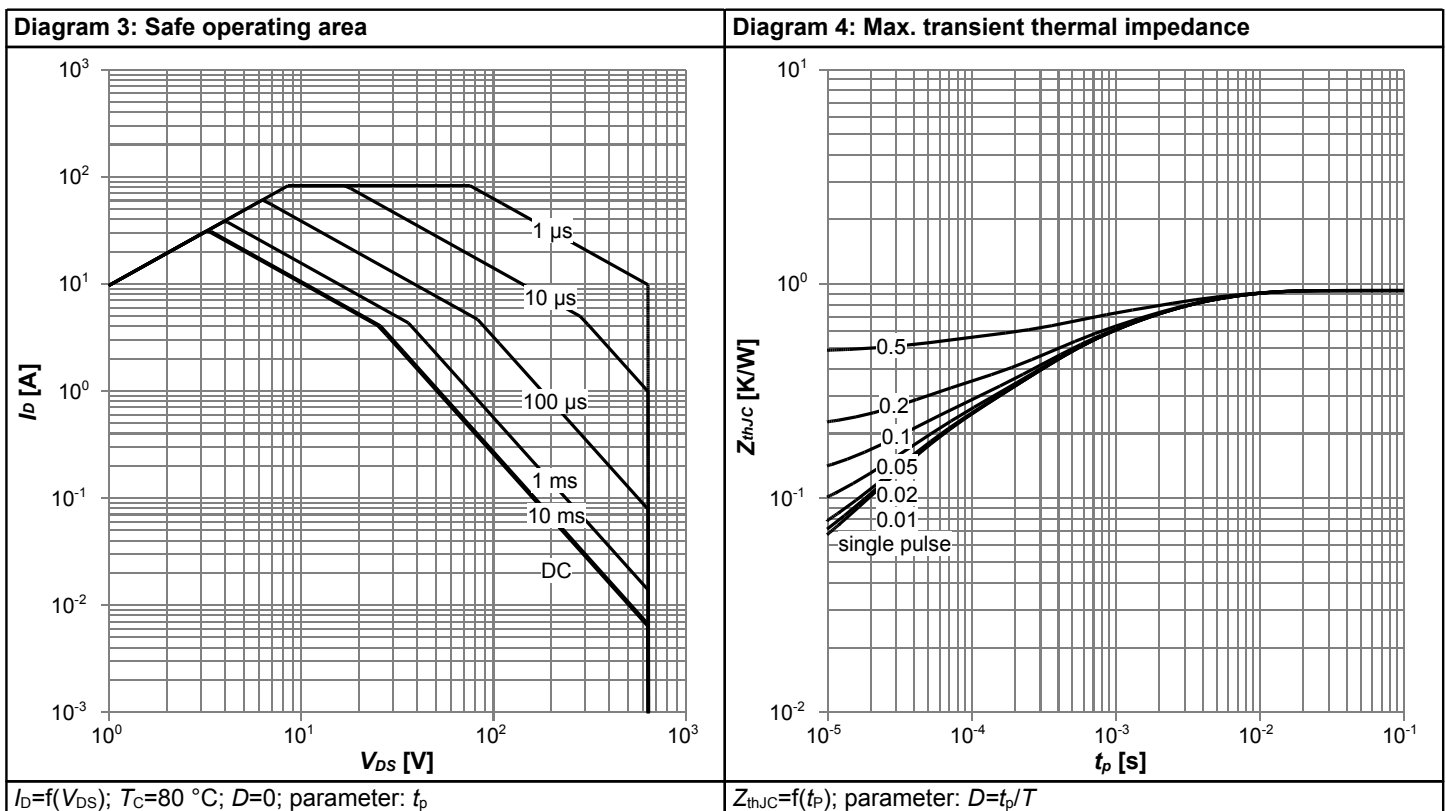
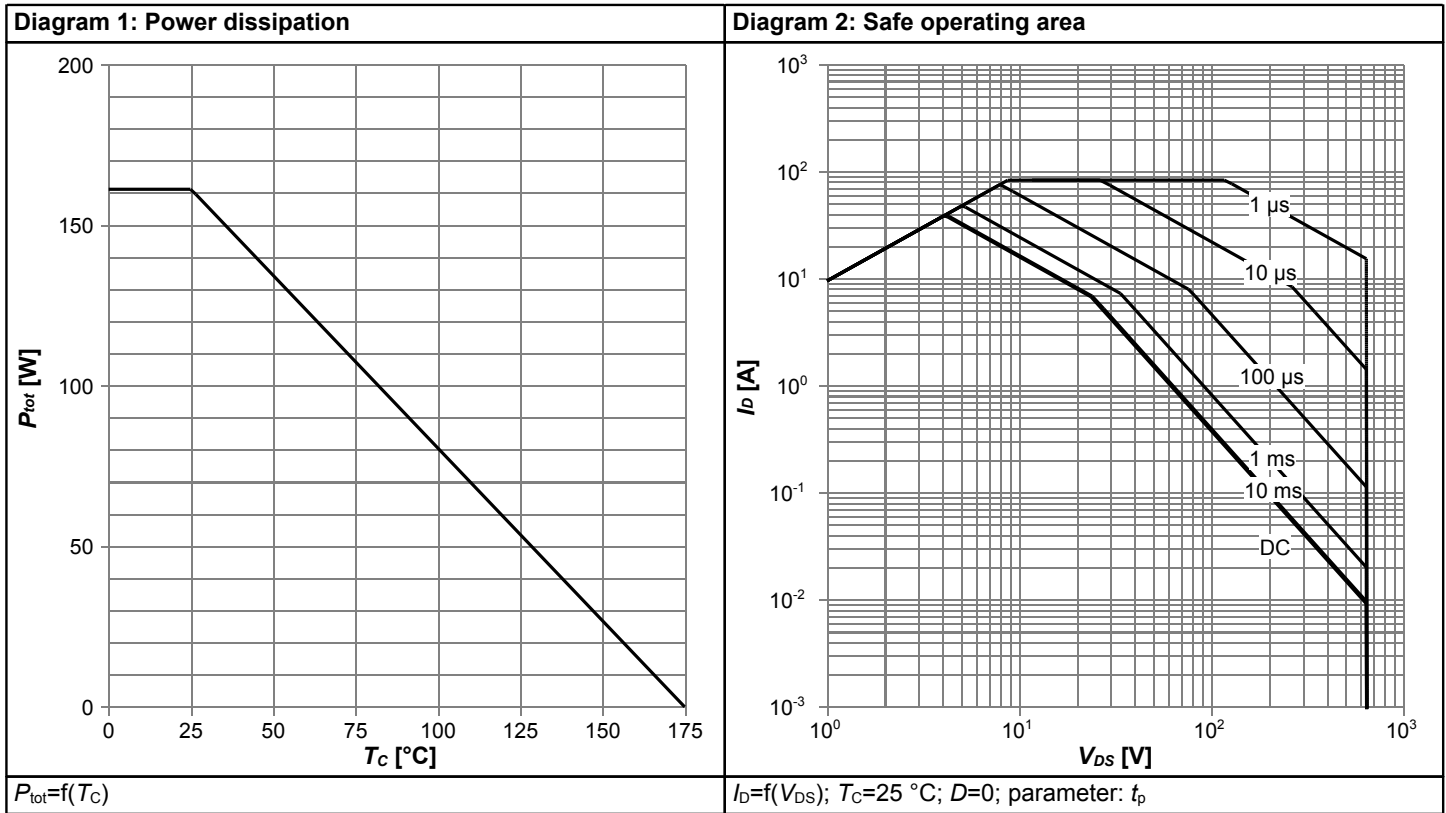
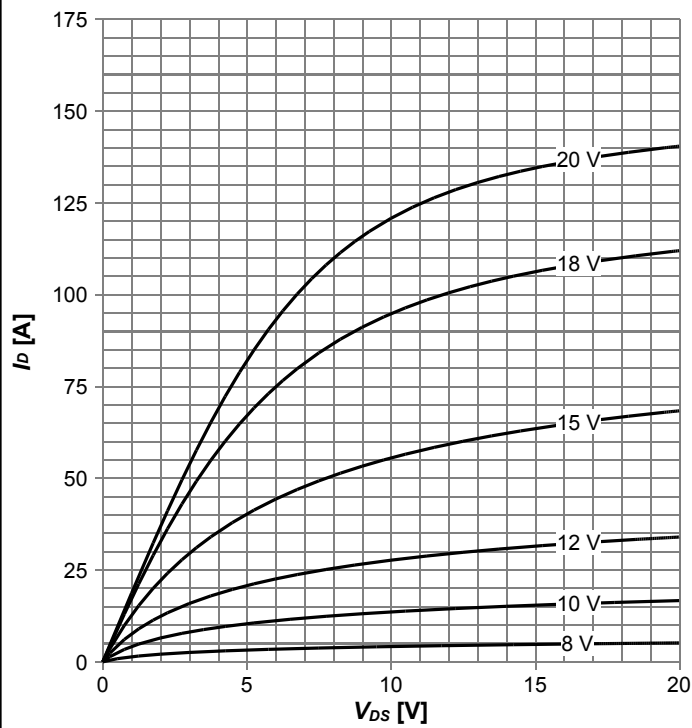
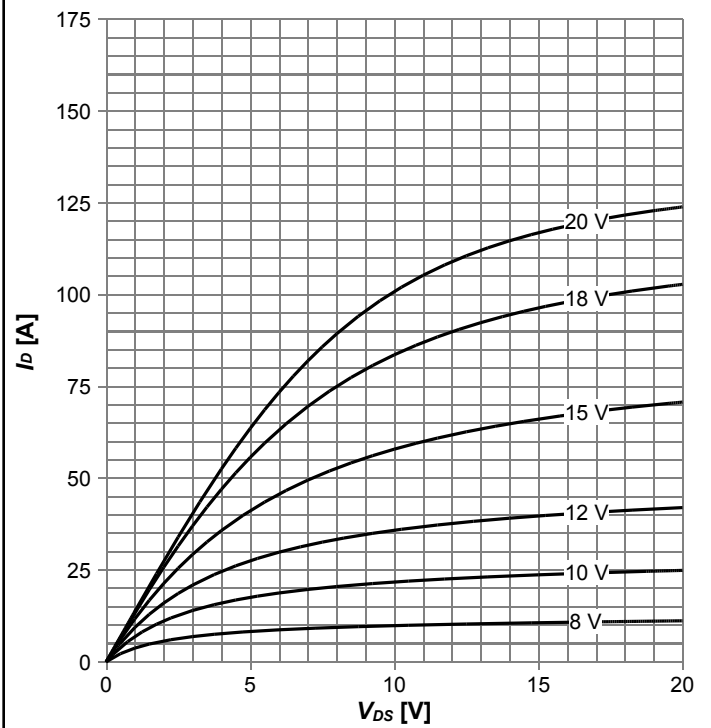


Diagram 5: Typ. output characteristics



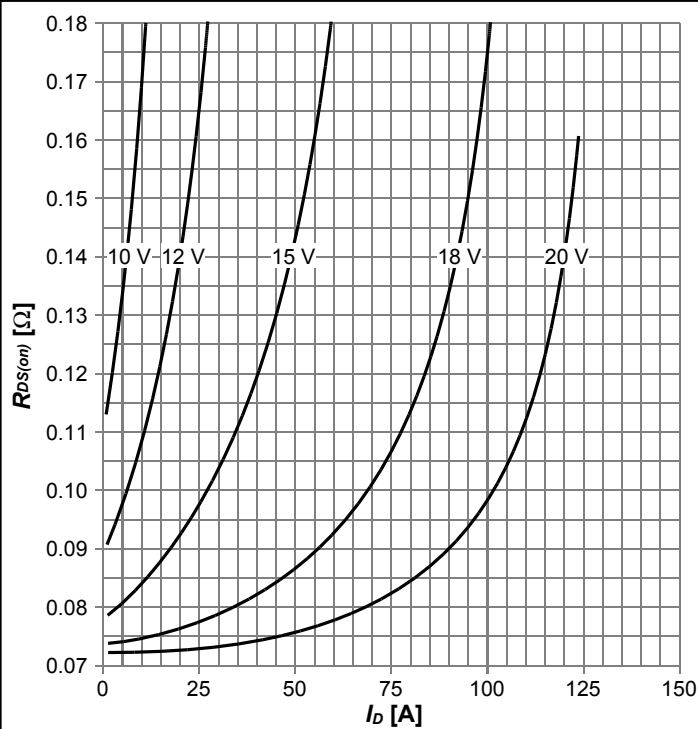
$I_D = f(V_{DS})$; $T_j = 25^\circ\text{C}$; parameter: V_{GS}

Diagram 6: Typ. output characteristics



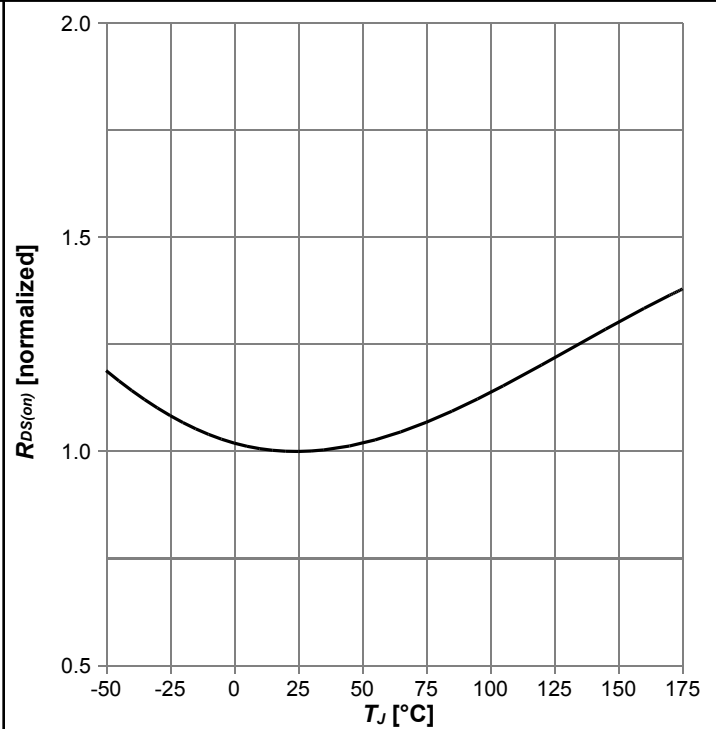
$I_D = f(V_{DS})$; $T_j = 150^\circ\text{C}$; parameter: V_{GS}

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



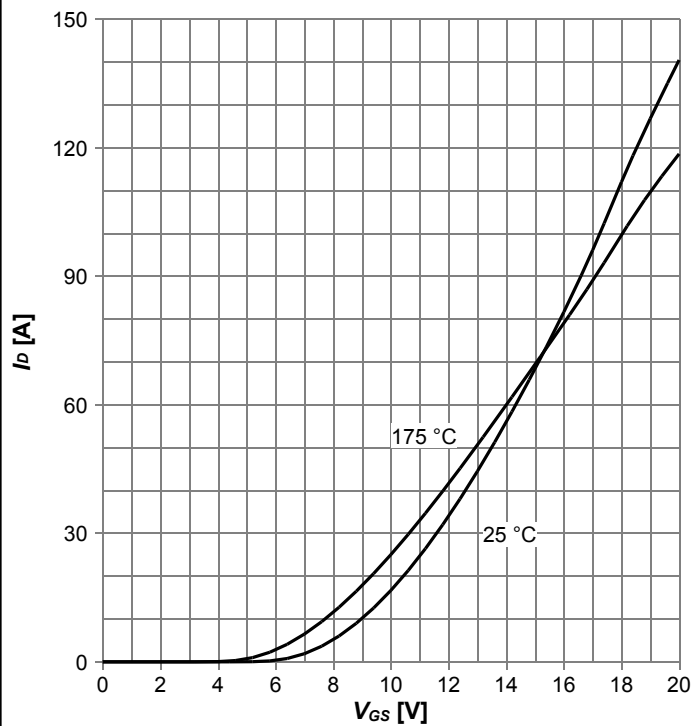
$R_{DS(on)} = f(I_D)$; $T_j = 150^\circ\text{C}$; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



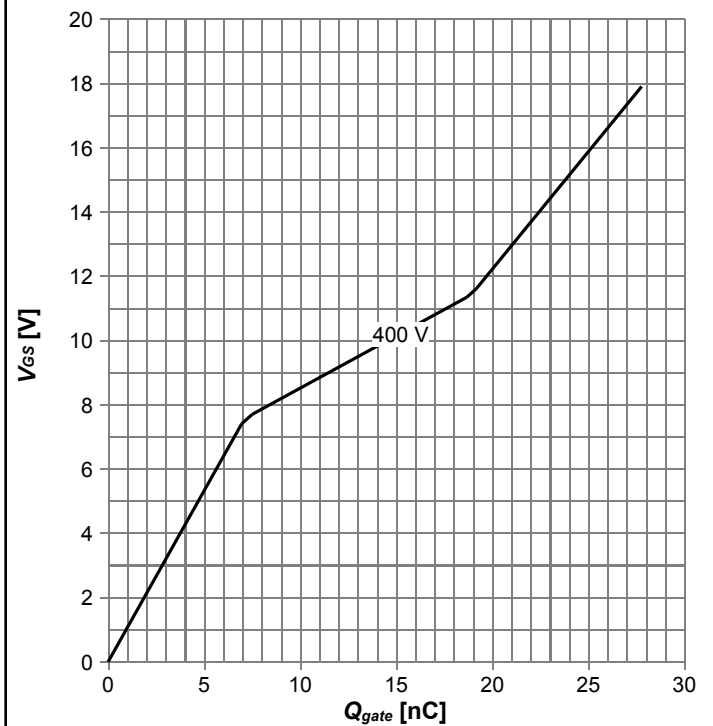
$R_{DS(on)} = f(T_j)$; $I_D = 16.7\text{ A}$; $V_{GS} = 18\text{ V}$

Diagram 9: Typ. transfer characteristics



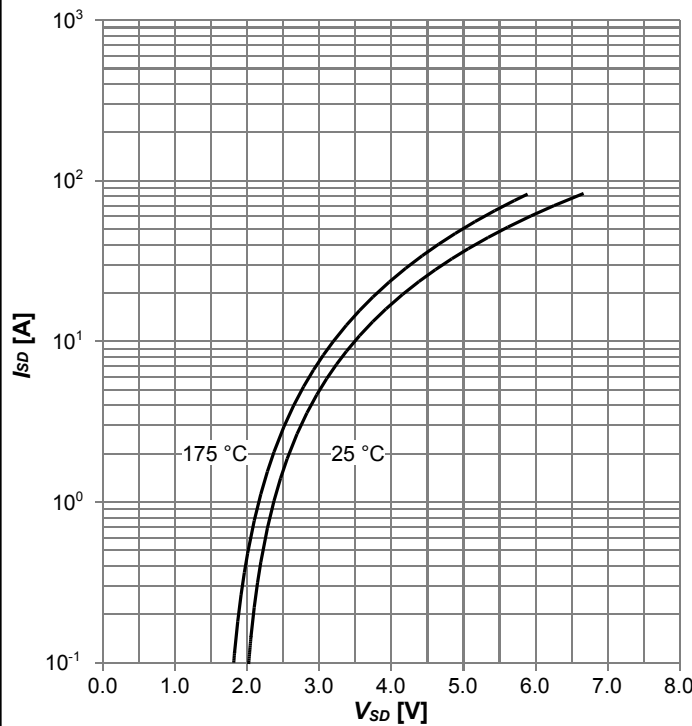
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



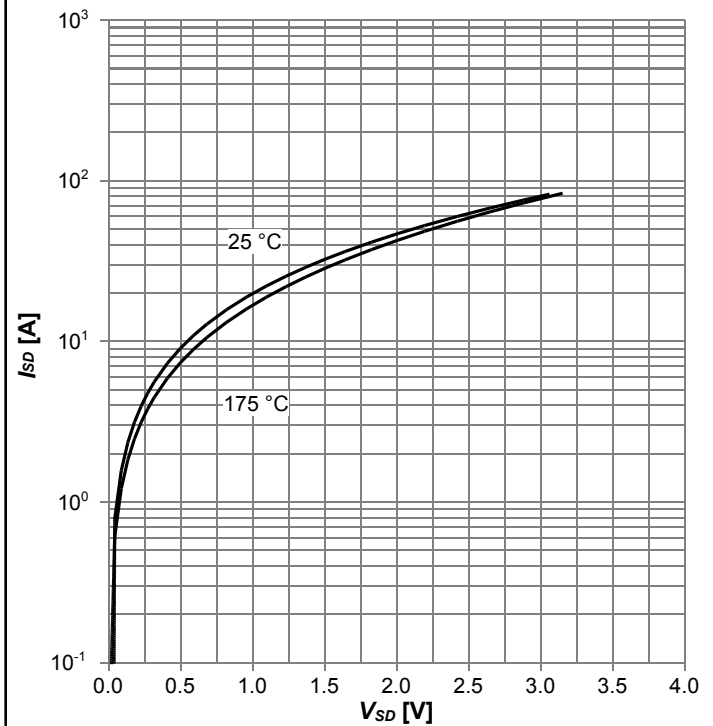
$V_{GS} = f(Q_{gate}); I_D = 16.7 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Typ. reverse characteristics



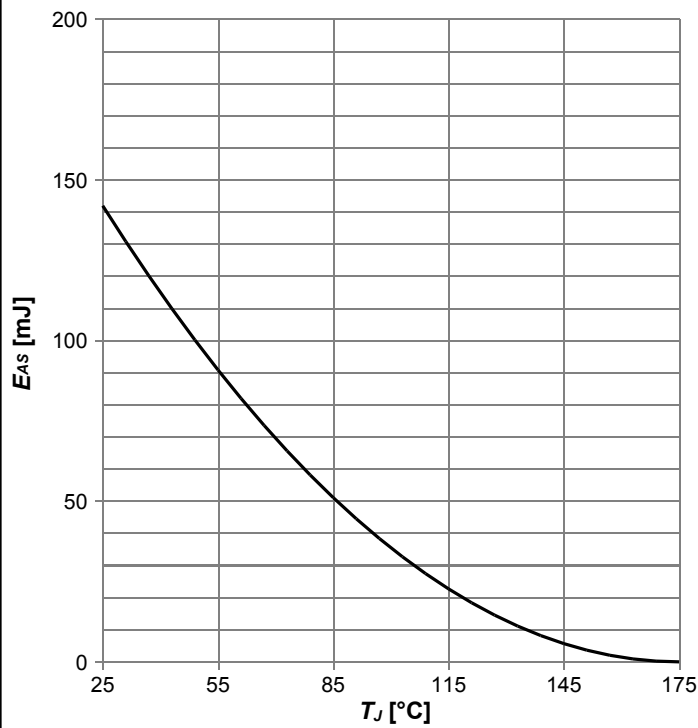
$I_{SD} = f(V_{SD}); V_{GS} = 0 \text{ V}; \text{parameter: } T_j$

Diagram 12: Typ. reverse characteristics



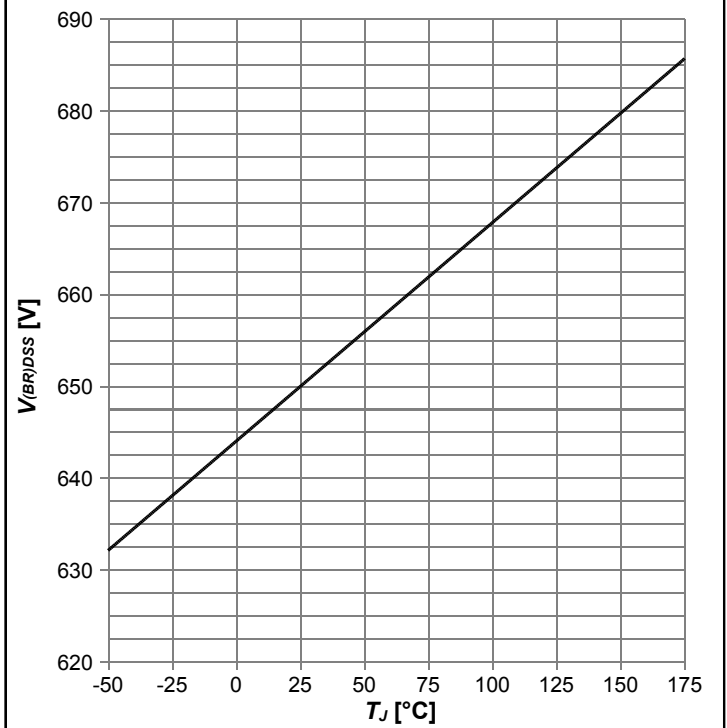
$I_{SD} = f(V_{SD}); V_{GS} = 18 \text{ V}; \text{parameter: } T_j$

Diagram 13: Avalanche energy



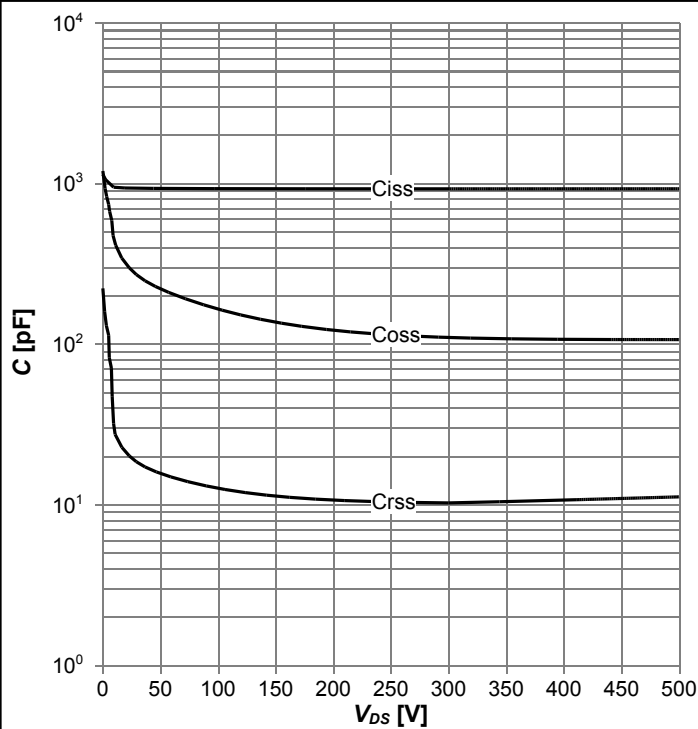
$E_{AS}=f(T_J)$; $I_D=5.3$ A; $V_{DD}=50$ V

Diagram 14: Drain-source breakdown voltage



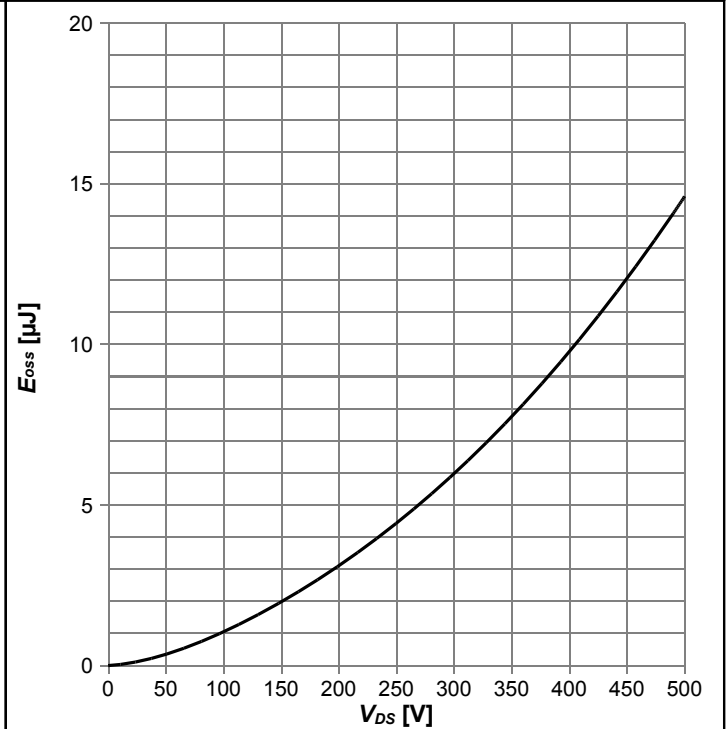
$V_{(BR)DSS}=f(T_J)$; $I_D=0.5$ mA

Diagram 15: Typ. capacitances

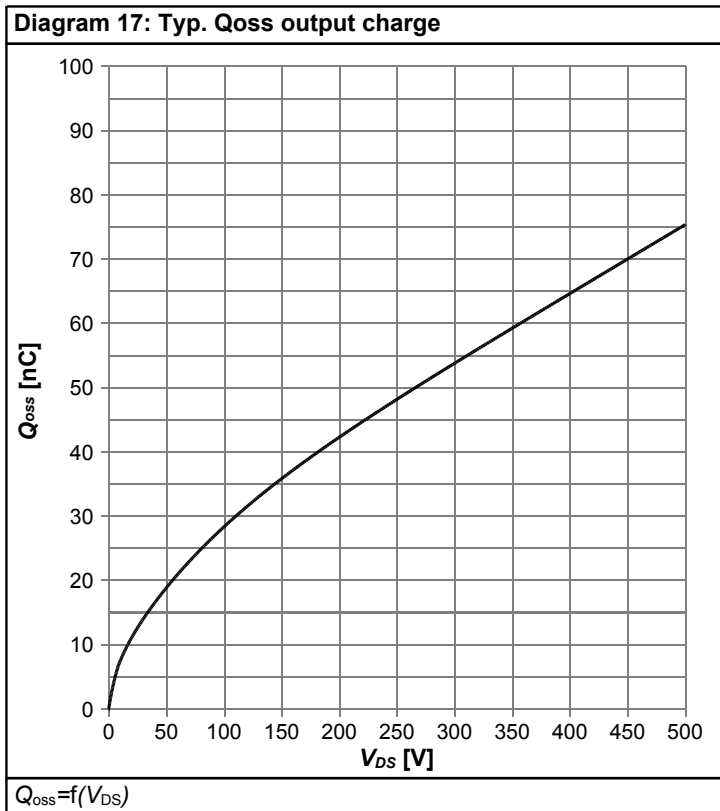


$C=f(V_{DS})$; $V_{GS}=0$ V; $f=250$ kHz

Diagram 16: Typ. Coss stored energy



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



6 Test Circuits

Table 9 Body diode characteristics (650V CoolSiC)

| Test circuit for body diode characteristics | Body diode recovery waveform |
|---|------------------------------|
| | |

Table 10 Switching times (650V CoolSiC)

| Switching times test circuit for inductive load | Switching times waveform |
|---|--------------------------|
| | |

Table 11 Unclamped inductive load (650V CoolSiC)

| Unclamped inductive load test circuit | Unclamped inductive waveform |
|---------------------------------------|------------------------------|
| | |

7 Package Outlines

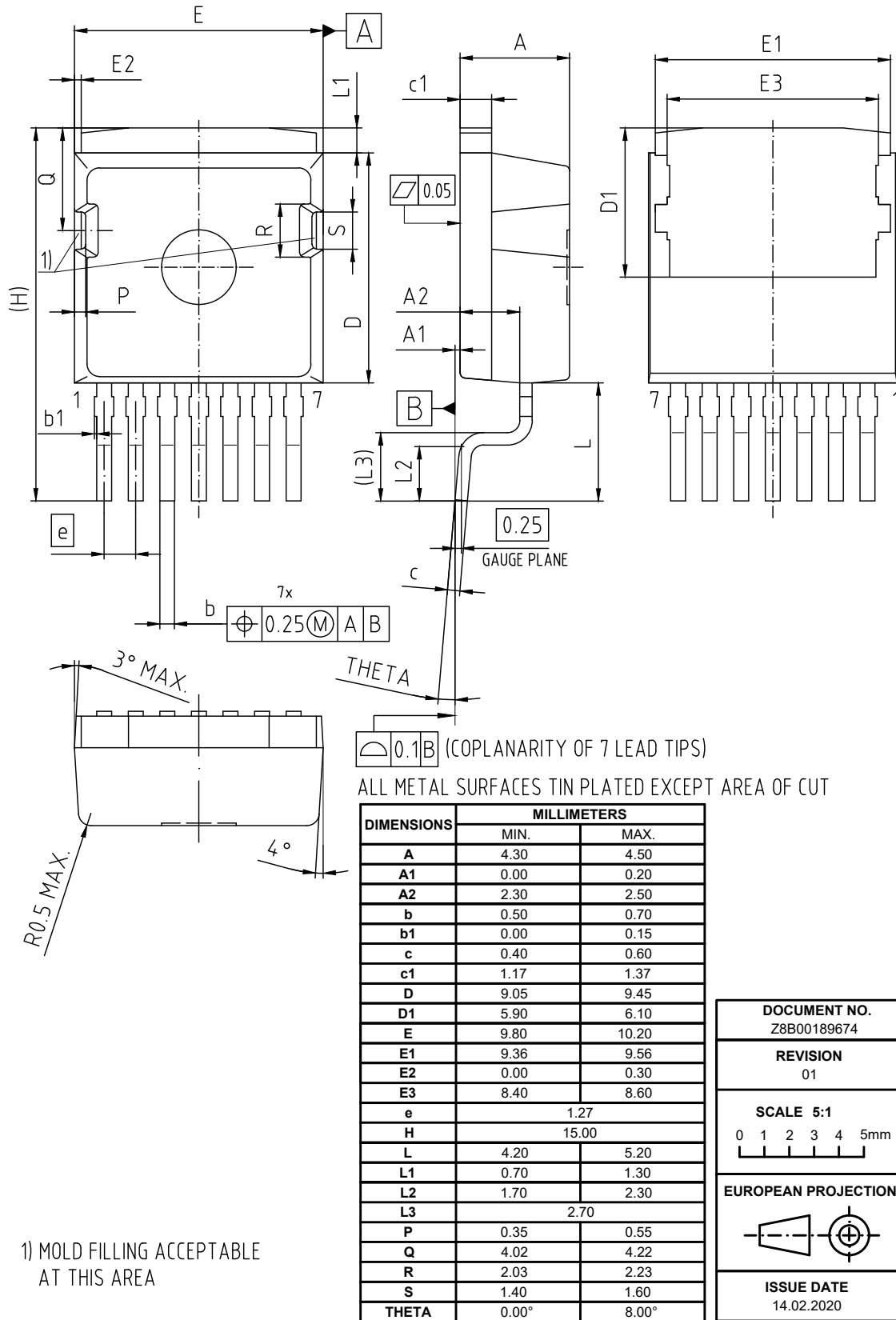


Figure 1 Outline PG-TO263-7-12, dimensions in mm

8 Appendix A

Table 12 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

IMBG65R057M1H

Revision: 2021-12-10, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0 | 2021-12-10 | Release of final version |

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