

IMW120R045M1

CoolSiC™ 1200V SiC Trench MOSFET Silicon Carbide MOSFET

Features

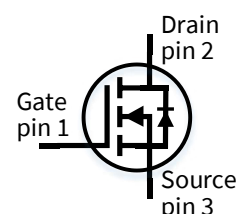
- Very low switching losses
- Threshold-free on state characteristic
- Wide gate-source voltage range
- Benchmark gate threshold voltage, $V_{GS(th)} = 4.5V$
- 0V turn-off gate voltage
- Fully controllable dv/dt
- Commutation robust body diode, ready for synchronous rectification
- Temperature independent 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 ($T_C = 25^\circ C, R_{th(j-c,max)}$)	$R_{DS(on)}$ ($T_{vj} = 25^\circ C, I_D = 20A, V_{GS} = 15V$)	$T_{j,max}$	Marking	Package
IMW120R045M1	1200V	52A	45mΩ	175°C	120M1045	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_{vjmax} , $V_{GS} = 15\text{V}$, $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	I_D	52 36	A
Pulsed drain current, t_p limited by T_{vjmax} , $V_{GS} = 15\text{V}$	$I_{D,pulse}^1$	130	A
DC body diode forward current for $R_{th(j-c,max)}$, limited by T_{vjmax} , $V_{GS} = 0\text{V}$ $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	I_{SD}	52 28	A
Pulsed body diode current, t_p limited by T_{vjmax}	$I_{SD,pulse}^1$	130	A
Gate-source voltage ² Max transient voltage, < 1% duty cycle Recommended turn-on gate voltage Recommended turn-off gate voltage	V_{GSS} $V_{GSS,on}$ $V_{GSS,off}$	-10... 20 15 0	V
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_{vjmax} $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	P_{tot}	228 114	W
Virtual junction temperature	T_{vj}	-55... 175	$^{\circ}\text{C}$
Storage temperature	T_{stg}	-55... 150	$^{\circ}\text{C}$
Soldering temperature, wavesoldering 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.

2 Thermal resistances

Table 3

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET/body diode thermal resistance, junction – case	$R_{th(j-c)}$		-	0.51	0.66	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	$R_{DS(on)}$	$V_{GS} = 15\text{V}, I_D = 20\text{A},$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 100^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- - -	45 55 75	59 - -	m Ω
Body diode forward voltage	V_{SD}	$V_{GS} = 0\text{V}, I_{SD} = 20\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 100^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- - -	4.1 4.0 3.9	5.2 - -	V
Gate-source threshold voltage	$V_{GS(th)}$	<i>(tested after 1 ms pulse at</i> $V_{GS} = 20\text{V})$ $I_D = 10\text{mA}, V_{DS} = V_{GS}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	3.5 -	4.5 3.6	5.7 -	V
Zero gate voltage drain current	I_{DSS}	$V_{GS} = 0\text{V}, V_{DS} = 1200\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	2 4	200 -	μA
Gate-source leakage current	I_{GSS}	$V_{GS} = 20\text{V}, V_{DS} = 0\text{V}$	-	-	120	nA
		$V_{GS} = -10\text{V}, V_{DS} = 0\text{V}$	-	-	-120	nA
Transconductance	g_{fs}	$V_{DS} = 20\text{V}, I_D = 20\text{A}$	-	11.1	-	S
Internal gate resistance	$R_{G,int}$	$f = 1\text{MHz}, V_{AC} = 25\text{mV}$	-	4	-	Ω

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}	$V_{DD} = 800\text{V}, V_{GS} = 0\text{V},$ $f = 1\text{MHz}, V_{AC} = 25\text{mV}$	-	1900	-	pF
Output capacitance	C_{oss}		-	115	-	
Reverse capacitance	C_{rss}		-	13	-	
C_{oss} stored energy	E_{oss}		-	44	-	μJ
Total gate charge	Q_G	$V_{DD} = 800\text{V}, I_D = 20\text{A},$ $V_{GS} = 0/15\text{V}, \text{turn-on pulse}$	-	52	-	nC
Gate to source charge	$Q_{GS,pl}$		-	15	-	
Gate to drain charge	Q_{GD}		-	13	-	

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	$t_{d(\text{on})}$	$V_{DD} = 800\text{V}$, $I_D = 20\text{A}$, $V_{GS} = 0/15\text{V}$, $R_{G,\text{ext}} = 2\Omega$, $L_{\sigma} = 40\text{nH}$, diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	9	-	ns
Rise time	t_r		-	24	-	
Turn-off delay time	$t_{d(\text{off})}$		-	17	-	
Fall time	t_f		-	13	-	
Turn-on energy	E_{on}		-	350	-	μJ
Turn-off energy	E_{off}		-	70	-	
Total switching energy	E_{tot}		-	420	-	
Body Diode Characteristics, $T_{vj} = 25^{\circ}\text{C}$						
Diode reverse recovery charge	Q_{rr}	$V_{DD} = 800\text{V}$, $I_{SD} = 20\text{A}$, V_{GS} at diode = 0V , $di_f/dt = 1000\text{A}/\mu\text{s}$, Q_{rr} includes also Q_C , see Fig. C	-	0.15	-	μC
Diode peak reverse recovery current	I_{rrm}		-	8	-	A

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

Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800\text{V}$, $I_D = 20\text{A}$, $V_{GS} = 0/15\text{V}$, $R_{G,ext} = 2\Omega$, $L_{\sigma} = 40\text{nH}$, diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	9	-	ns
Rise time	t_r		-	24	-	
Turn-off delay time	$t_{d(off)}$		-	20	-	
Fall time	t_f		-	14	-	
Turn-on energy	E_{on}		-	380	-	μJ
Turn-off energy	E_{off}		-	75	-	
Total switching energy	E_{tot}		-	455	-	

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

Diode reverse recovery charge	Q_{rr}	$V_{DD} = 800\text{V}$, $I_{SD} = 20\text{A}$, V_{GS} at diode = 0V , $di_f/dt = 1000\text{A}/\mu\text{s}$, Q_{rr} includes also Q_C , see Fig. C	-	0.25	-	μC
Diode peak reverse recovery current	I_{rrm}		-	10	-	A

⁴ The chip technology was characterized up to $200\text{ kV}/\mu\text{s}$. The measured dV/dt was limited by measurement test setup and package.

4 Electrical characteristic diagrams

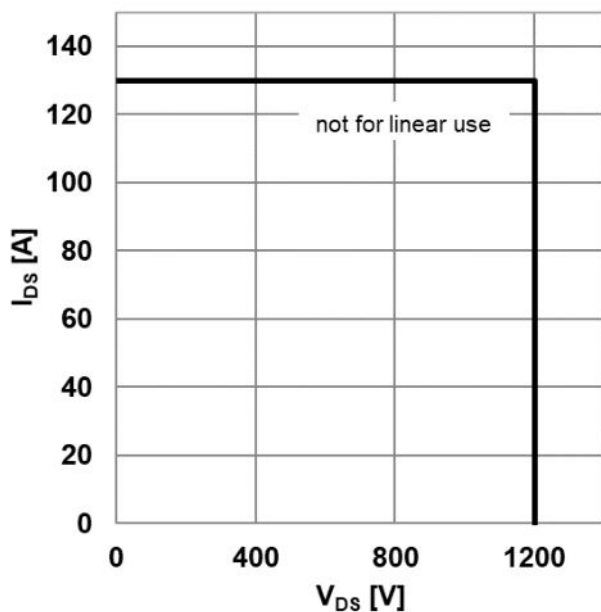


Figure 1 Reverse bias safe operating area (RBSOA) ($V_{GS} = 0/15V$, $T_C = 25^\circ C$, $T_J < 175^\circ C$)

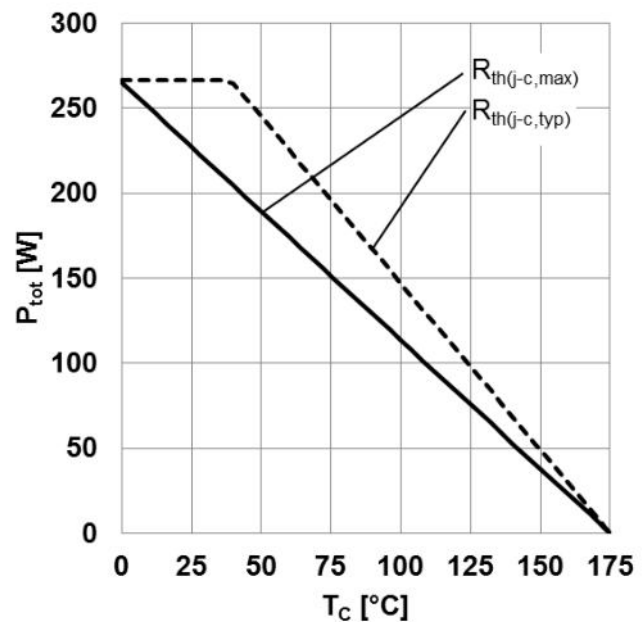


Figure 2 Power dissipation as a function of case temperature limited by bond wire ($P_{tot} = f(T_C)$)

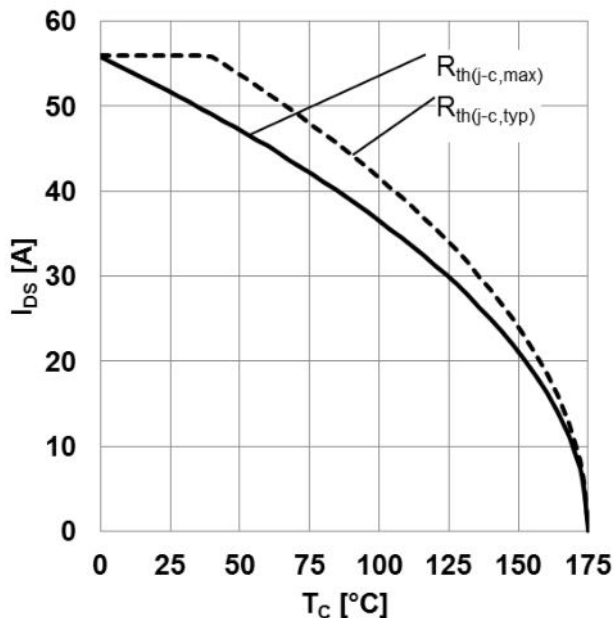


Figure 3 Maximum DC drain to source current as a function of case temperature limited by bond wire ($I_{DS} = f(T_C)$)

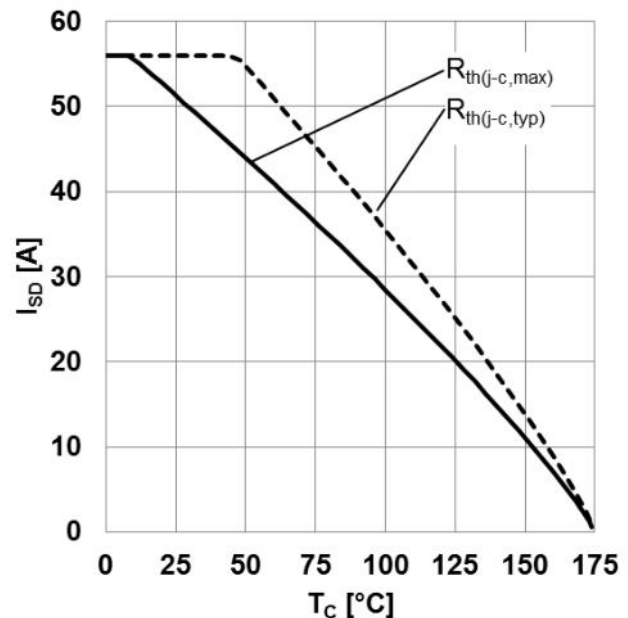


Figure 4 Maximum source to drain current as a function of case temperature limited by bond wire ($I_{SD} = f(T_C)$, $V_{GS} = 0V$)

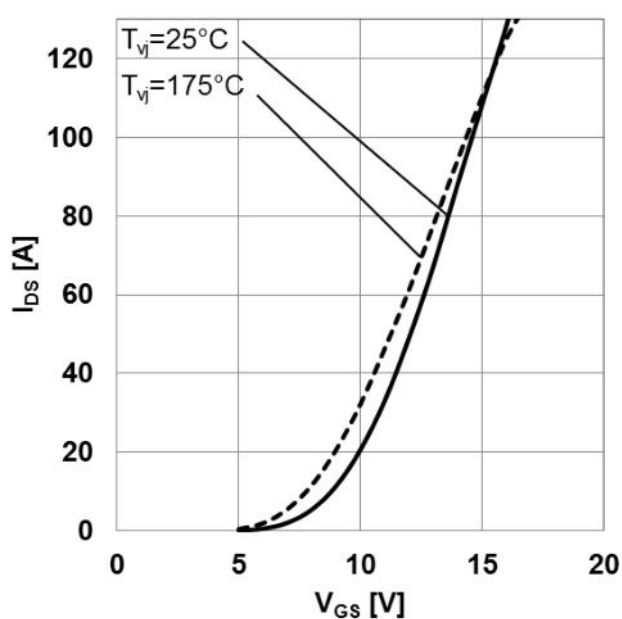


Figure 5 Typical transfer characteristic
($I_{DS} = f(V_{GS})$, $V_{DS} = 20V$, $t_P = 20\mu s$)

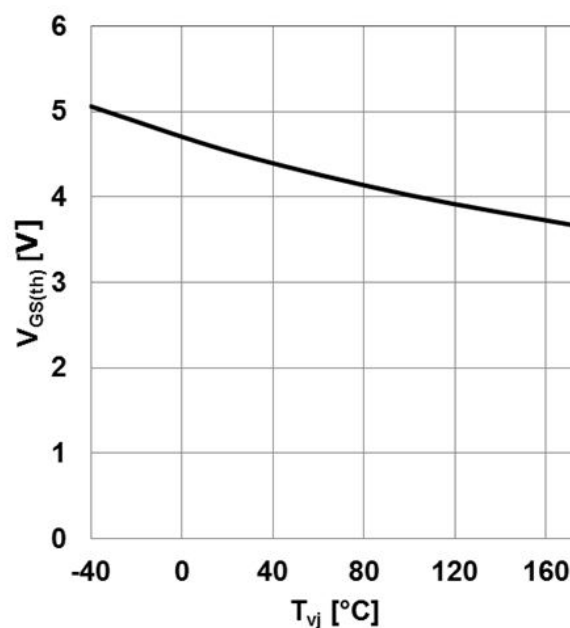


Figure 6 Typical gate-source threshold voltage as a function of junction temperature
($V_{GS(th)} = f(T_{vj})$, $I_{DS} = 10mA$, $V_{GS} = V_{DS}$)

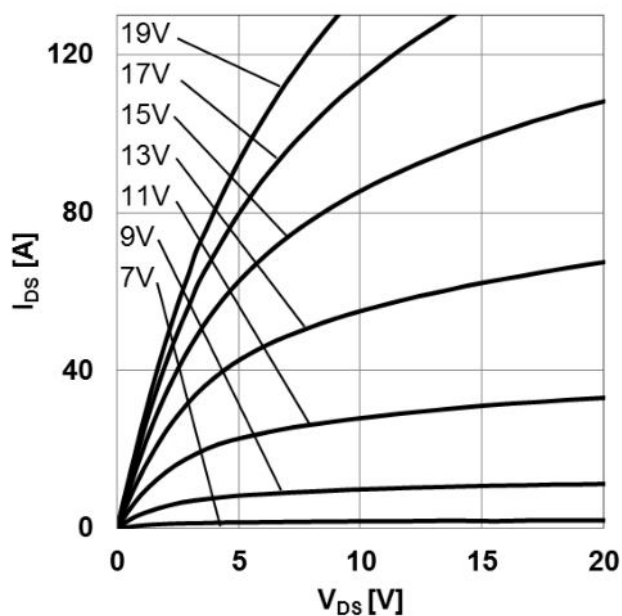


Figure 7 Typical output characteristic, V_{GS} as parameter
($I_{DS} = f(V_{DS})$, $T_{vj} = 25^\circ C$, $t_P = 20\mu s$)

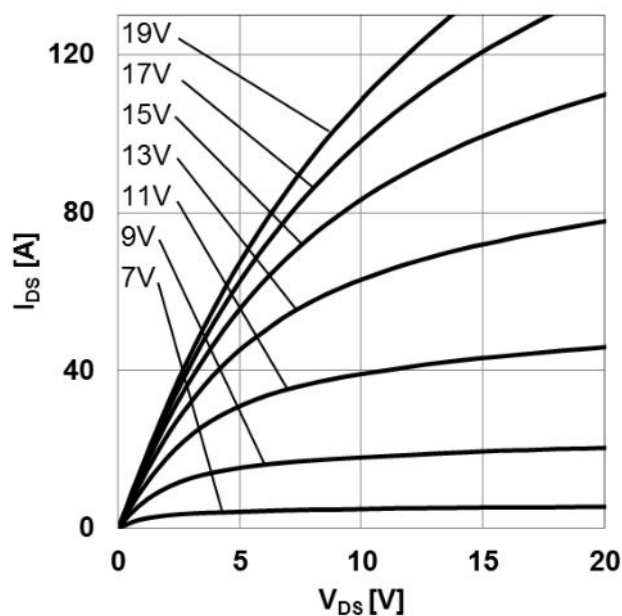


Figure 8 Typical output characteristic, V_{GS} as parameter
($I_{DS} = f(V_{DS})$, $T_{vj} = 175^\circ C$, $t_P = 20\mu s$)

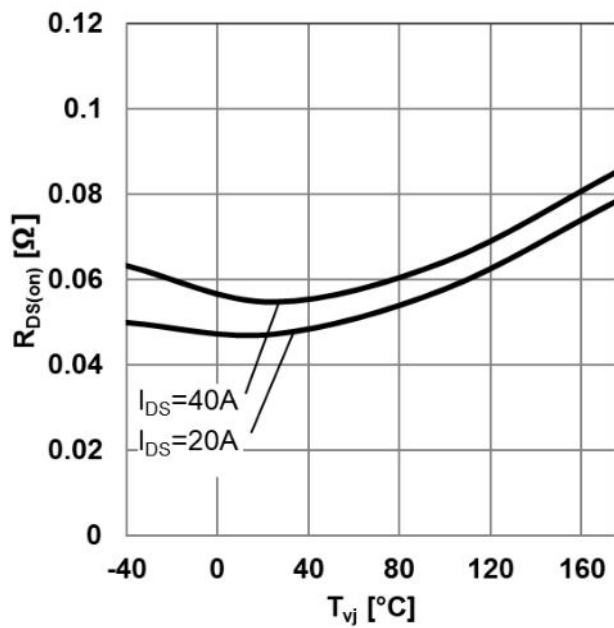


Figure 9 Typical on-resistance as a function of junction temperature
 $(R_{DS(on)} = f(T_{vj}), V_{GS}=15V)$

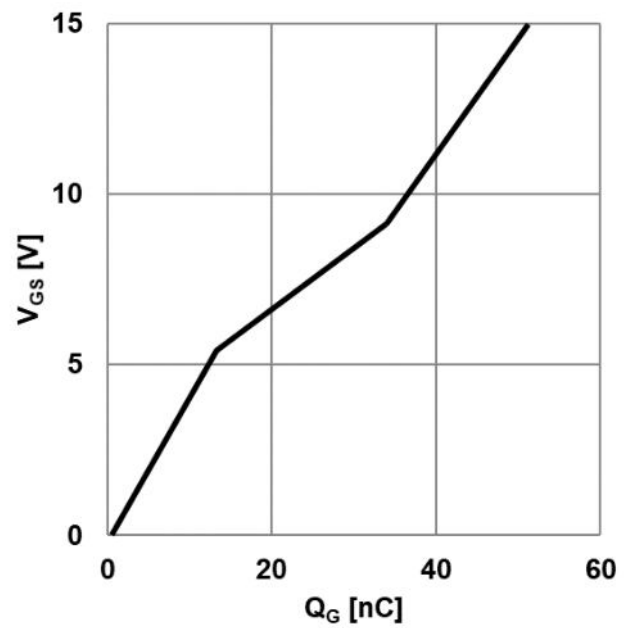


Figure 10 Typical gate charge ($V_{GS} = f(Q_G)$, $I_{DS} = 20A$, $V_{DS} = 800V$, turn-on pulse)

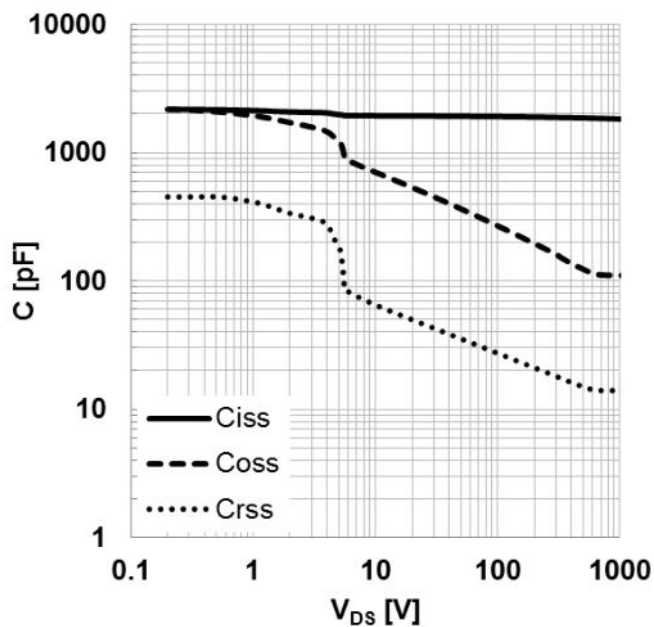


Figure 11 Typical capacitance as a function of drain-source voltage
 $(C = f(V_{DS}), V_{GS} = 0V, f = 1MHz)$

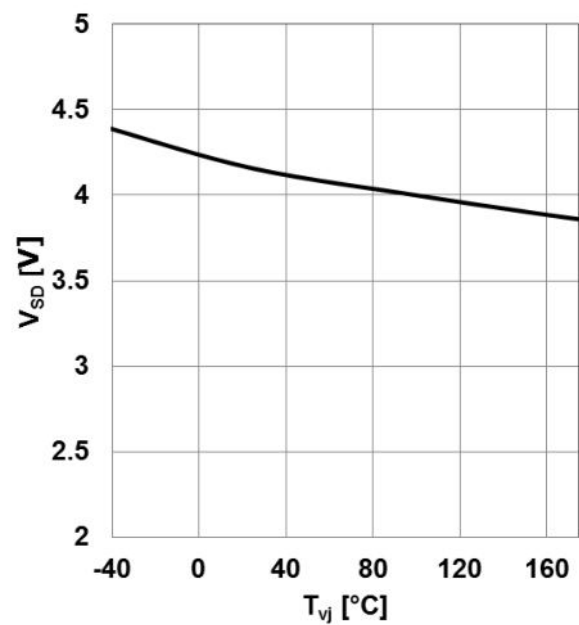


Figure 12 Typical body diode forward voltage as function of junction temperature
 $(V_{SD}=f(T_{vj}), V_{GS}=0V, I_{SD}=20A)$

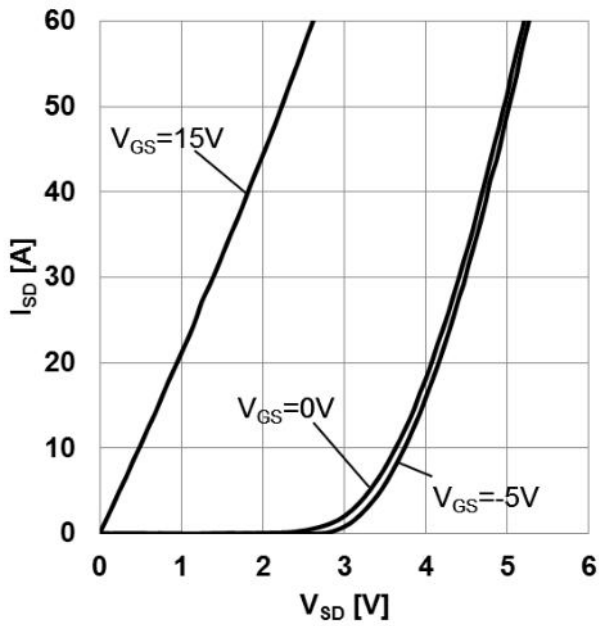


Figure 13 Typical body diode forward current as function of forward voltage, V_{GS} as parameter

($I_{SD} = f(V_{SD})$, $T_{vj} = 25^{\circ}\text{C}$, $t_P = 20\mu\text{s}$)

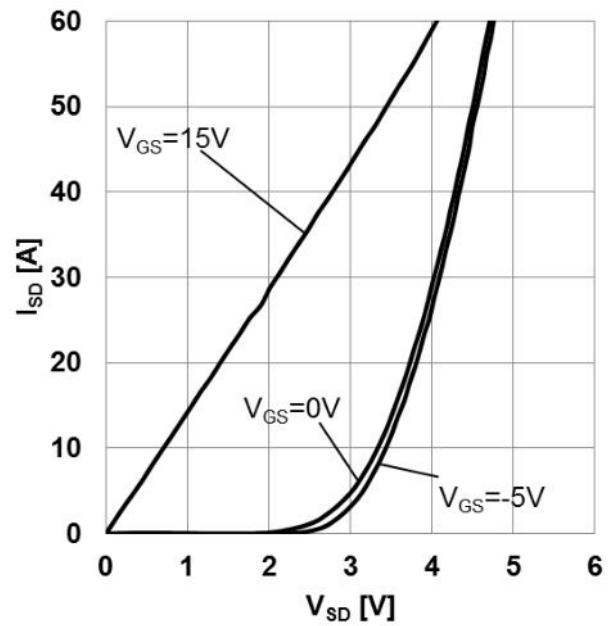


Figure 14 Typical body diode forward current as function of forward voltage, V_{GS} as parameter

($I_{SD} = f(V_{SD})$, $T_{vj} = 175^{\circ}\text{C}$, $t_P = 20\mu\text{s}$)

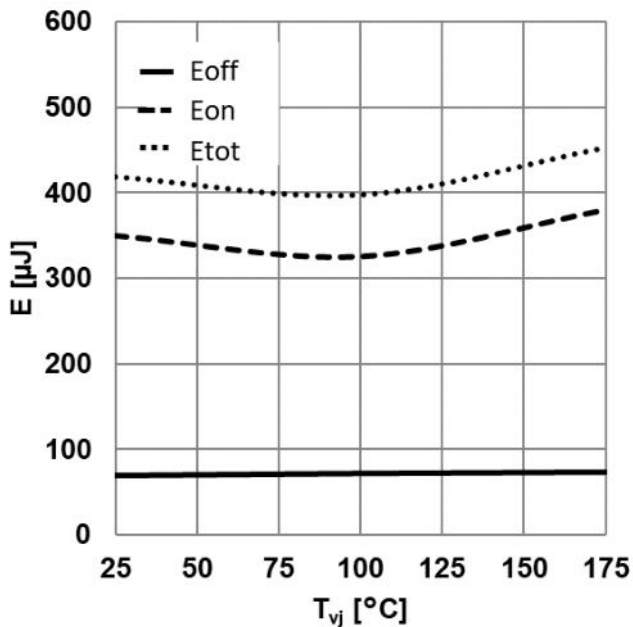


Figure 15 Typical switching energy losses as a function of junction temperature

($E = f(T_{vj})$, $V_{DD} = 800\text{V}$, $V_{GS} = 0\text{V}/15\text{V}$, $R_{G,ext} = 2\Omega$, $I_D = 20\text{A}$, ind. load, test circuit in Fig. E, diode: body diode)

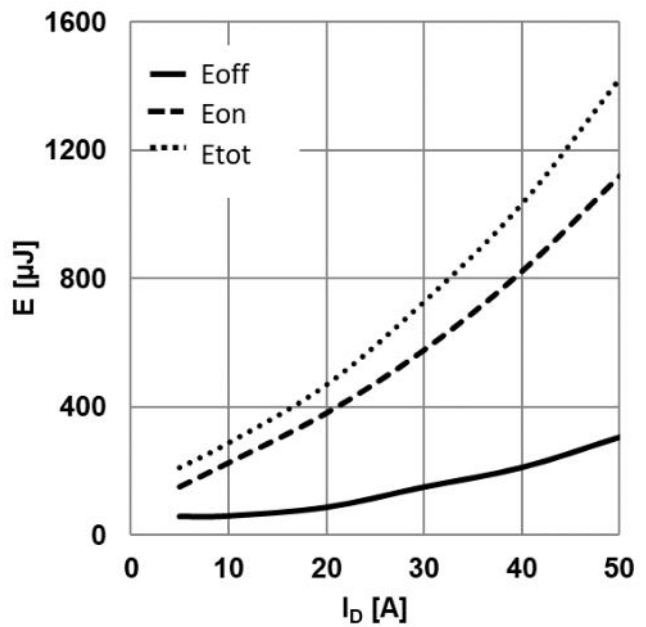


Figure 16 Typical switching energy losses as a function of drain-source current

($E = f(I_{DS})$, $V_{DD} = 800\text{V}$, $V_{GS} = 0\text{V}/15\text{V}$, $R_{G,ext} = 2\Omega$, $T_{vj} = 175^{\circ}\text{C}$, ind. load, test circuit in Fig. E, diode: body diode)

Electrical characteristic diagrams

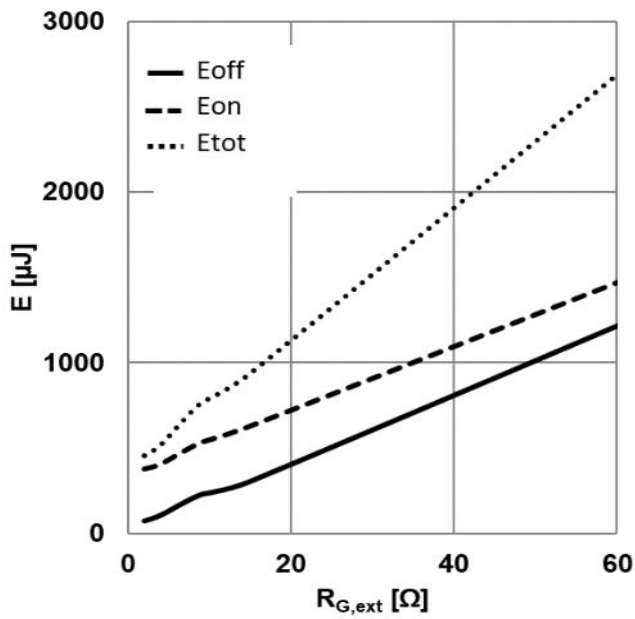


Figure 17 Typical switching energy losses as a function of gate resistance
 $(E = f(R_{G,ext}), V_{DD} = 800V, V_{GS} = 0V/15V, I_D = 20A, T_{vj} = 175^\circ C, \text{ind. load, test circuit in Fig. E, diode: body diode})$

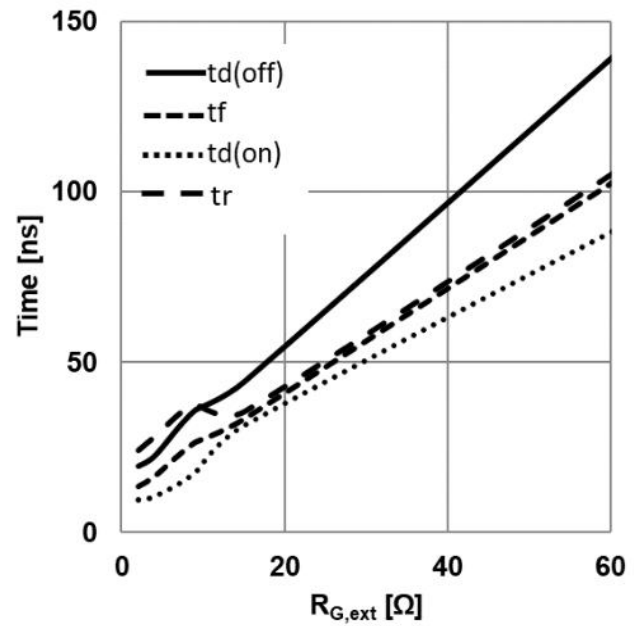


Figure 18 Typical switching times as a function of gate resistor
 $(t = f(R_{G,ext}), V_{DD} = 800V, V_{GS} = 0V/15V, I_D = 20A, T_{vj} = 175^\circ C, \text{ind. load, test circuit in Fig. E, diode: body diode})$

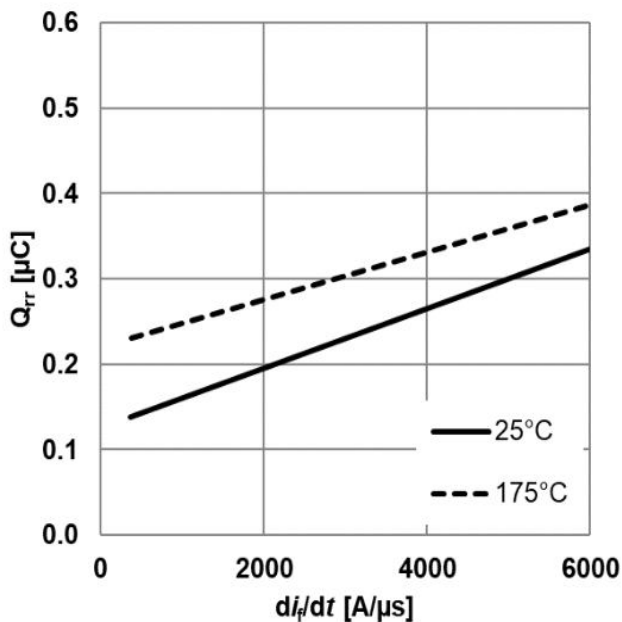


Figure 19 Typical reverse recovery charge as a function of diode current slope
 $(Q_{rr} = f(di_t/dt), V_{DD} = 800V, I_D = 20A, \text{ind. load, test circuit in Fig. E})$

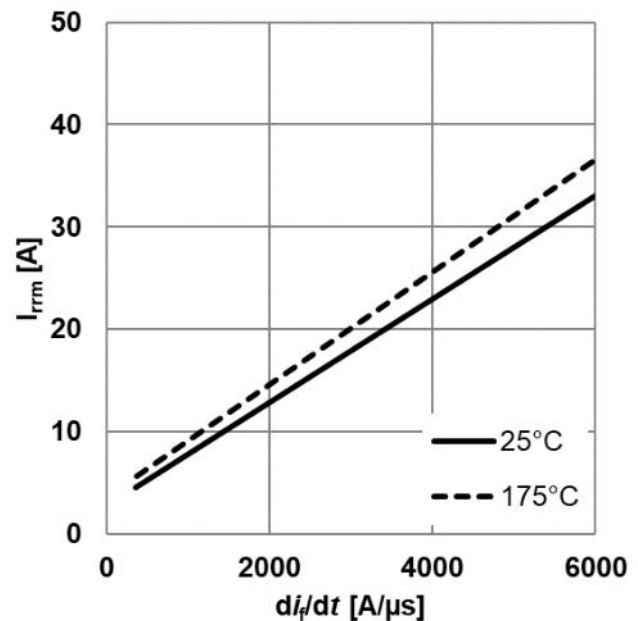


Figure 20 Typical reverse recovery current as a function of diode current slope
 $(I_{rrm} = f(di_t/dt), V_{DD} = 800V, I_D = 20A, \text{ind. load, test circuit in Fig. E})$

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CoolSiC™ 1200V SiC Trench MOSFET

Electrical characteristic diagrams

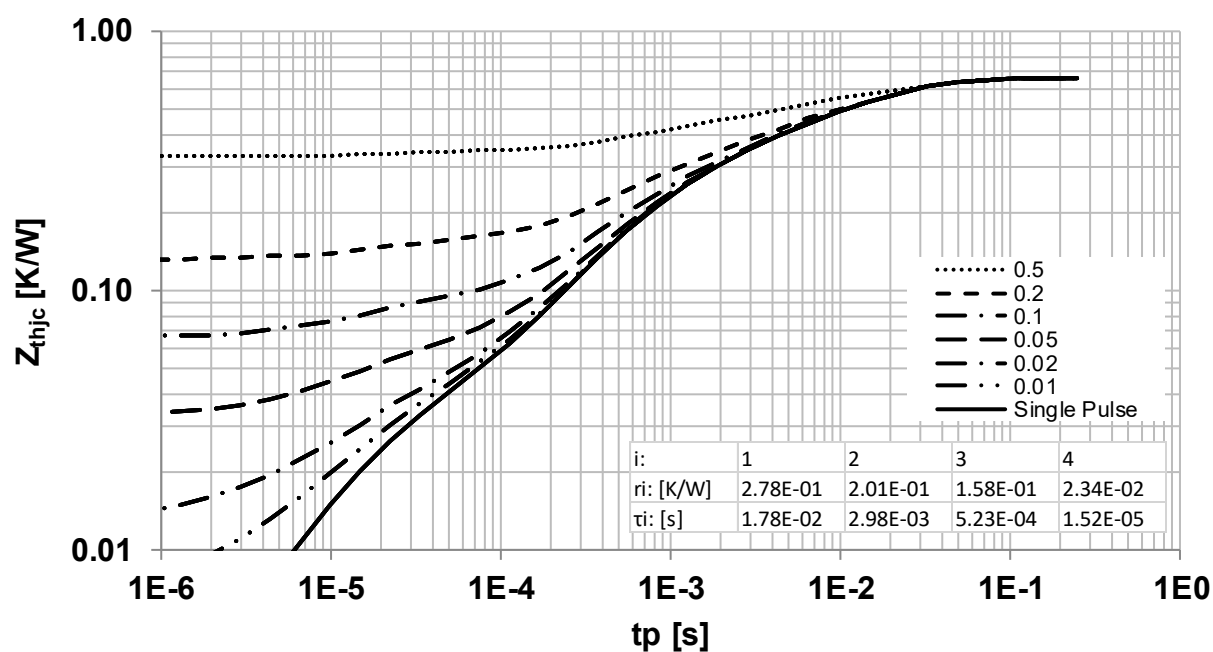


Figure 21 Max. transient thermal resistance (MOSFET/diode)

($Z_{th(j-c,max)} = f(t_p)$, parameter $D = t_p/T$, thermal equivalent circuit in Fig. D)

5 Package drawing

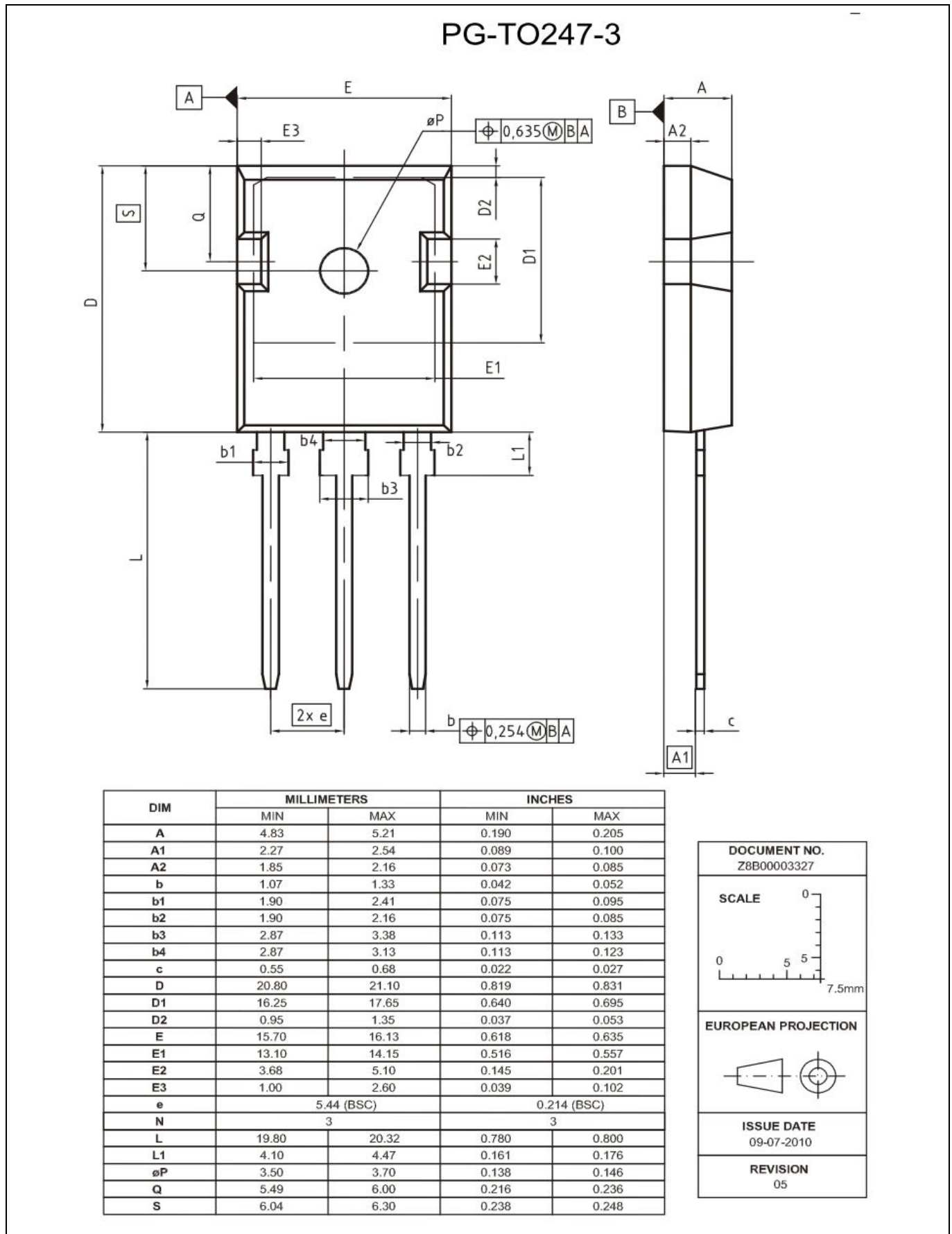


Figure 22 Package drawing

6 Test conditions

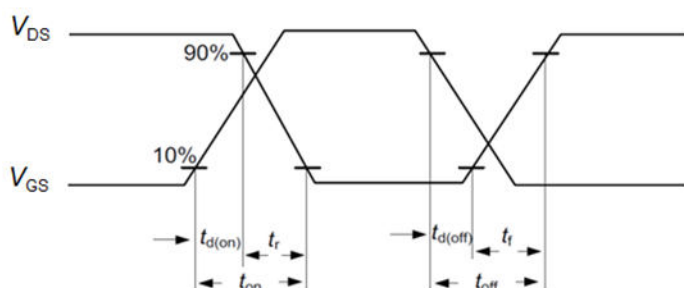


Figure A. Definition of switching times

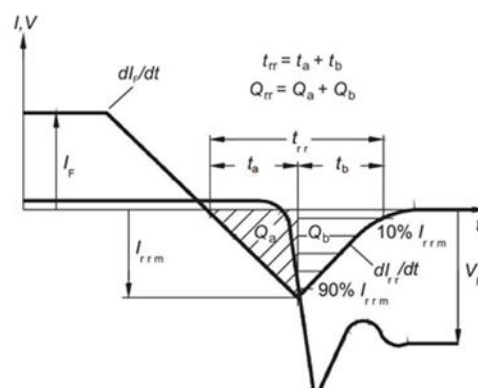


Figure C. Definition of diode switching characteristics

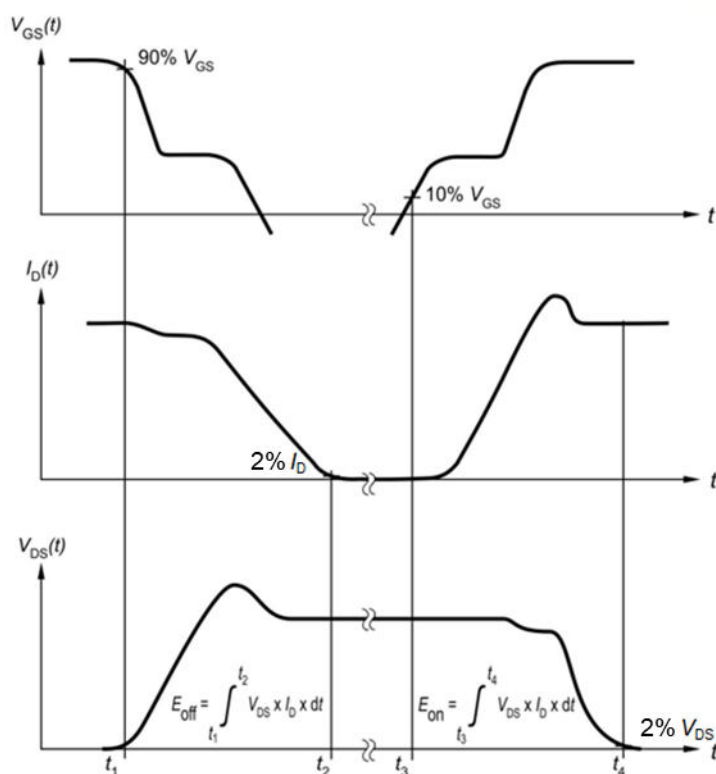


Figure B. Definition of switching losses

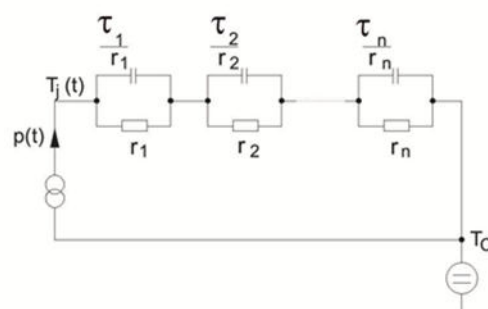


Figure D. Thermal equivalent circuit

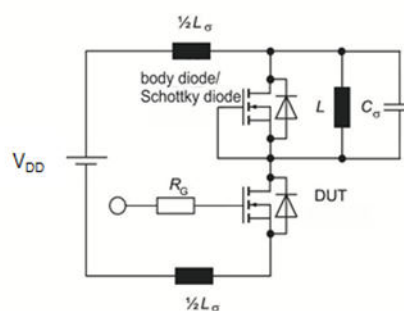


Figure E. Dynamic test circuit
Parasitic inductance L_{σ} ,
parasitic capacitor C_{σ} ,

Figure 23 Test conditions

Revision history

Revision history

Major changes since the last revision

Document version	Date of release	Description of changes
2.1	2018-03-01	Initial version
2.2	2018-05-30	Important footnote update in chapter 1 Change of conditions for switching dynamic characteristics in chapter 3.2 and 3.3 Additional figures for $V_{GS}=0V/15V$ in chapter 4
2.3	2019-04-18	Add Recommended gate voltage in chapter 1 Add SOA figure in chapter 4 Figures removed for $V_{GS}=-5V/15V$ in chapter 4
2.4	2019-12-10	Move the short circuit time from dynamic characteristics table 5 to maximum ratings table 2. Update the Figure 21 Zth curve.
2.5	2020-06-12	Correction of marking letters in table 1
2.6	2020-12-11	Correction of circuit symbol on page 1

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