

IMW120R045M1

CoolSiC™ 1200V SiC Trench MOSFET Silicon Carbide MOSFET

Features

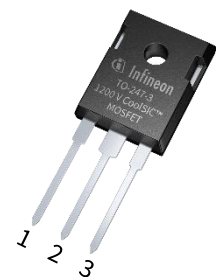
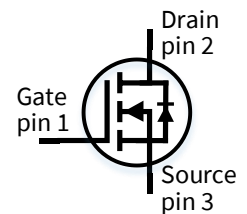
- Very low switching losses
- Threshold-free on state characteristic
- Wide gate-source voltage range
- Benchmark gate threshold voltage, $V_{GS(th)} = 4.5V$
- 0V turn-off gate voltage
- Fully controllable dv/dt
- Commutation robust body diode, ready for synchronous rectification
- Temperature independent 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	$t_{d(\text{on})}$	$V_{DD} = 800\text{V}$, $I_D = 20\text{A}$, $V_{GS} = 0/15\text{V}$, $R_{G,\text{ext}} = 2\Omega$, $L_{\sigma} = 40\text{nH}$, diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	9	-	ns
Rise time	t_r		-	24	-	
Turn-off delay time	$t_{d(\text{off})}$		-	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

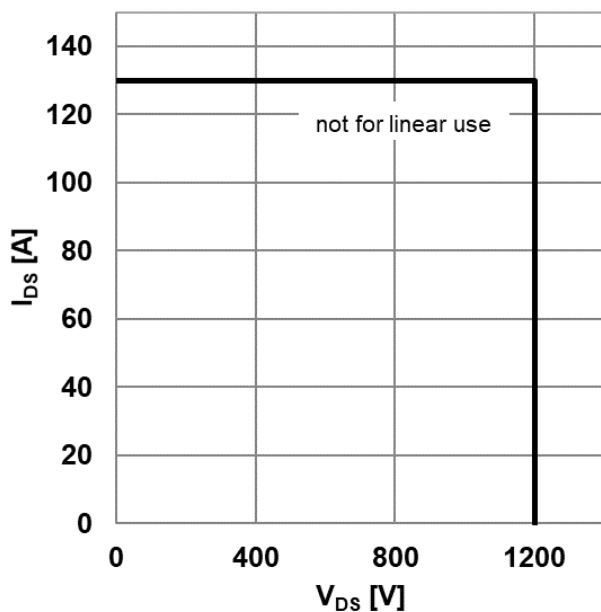


Figure 1 Reverse bias safe operating area (RBSOA) ($V_{GS} = 0/15V$, $T_C = 25^\circ C$, $T_J < 175^\circ C$)

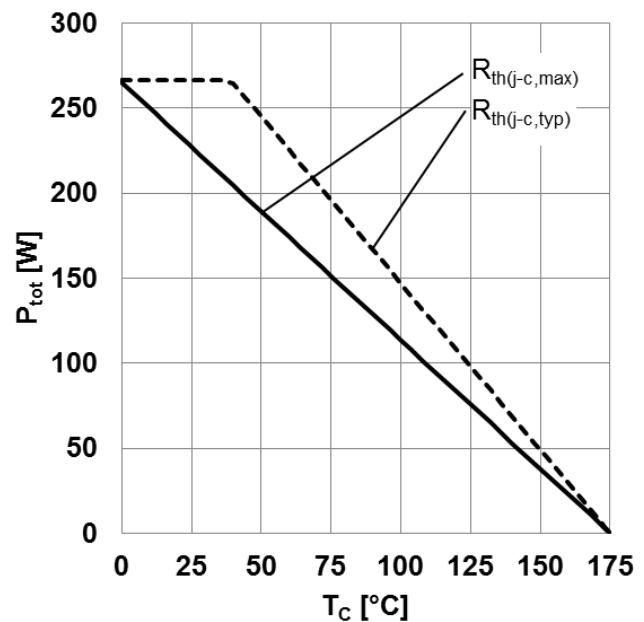


Figure 2 Power dissipation as a function of case temperature limited by bond wire ($P_{tot} = f(T_C)$)

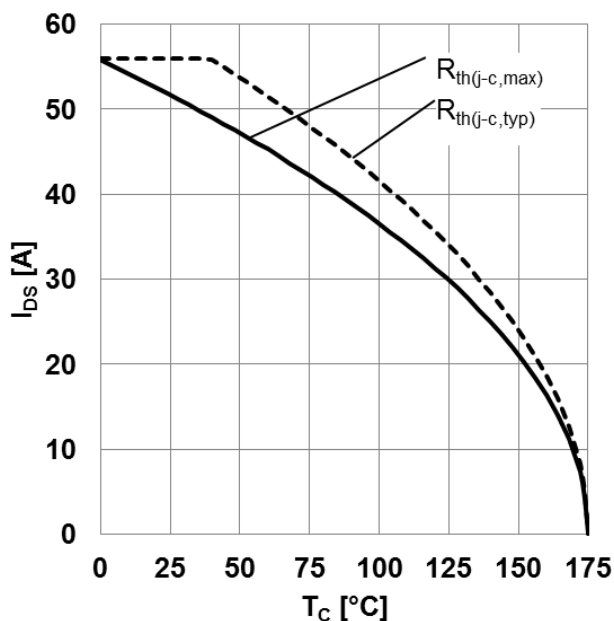


Figure 3 Maximum DC drain to source current as a function of case temperature limited by bond wire ($I_{DS} = f(T_C)$)

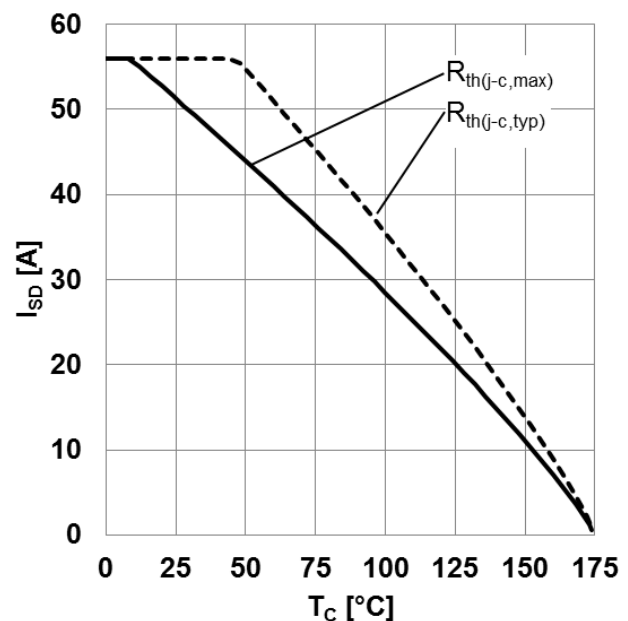


Figure 4 Maximum source to drain current as a function of case temperature limited by bond wire ($I_{SD} = f(T_C)$, $V_{GS} = 0V$)

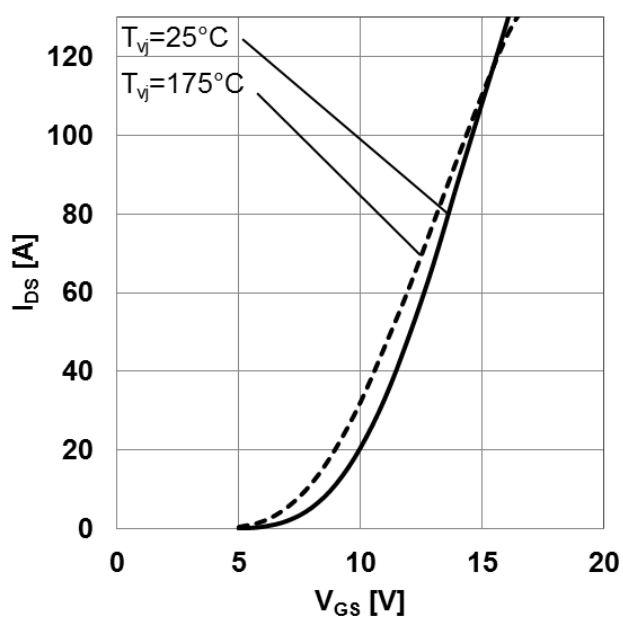


Figure 5 Typical transfer characteristic
($I_{DS} = f(V_{GS})$, $V_{DS} = 20V$, $t_P = 20\mu s$)

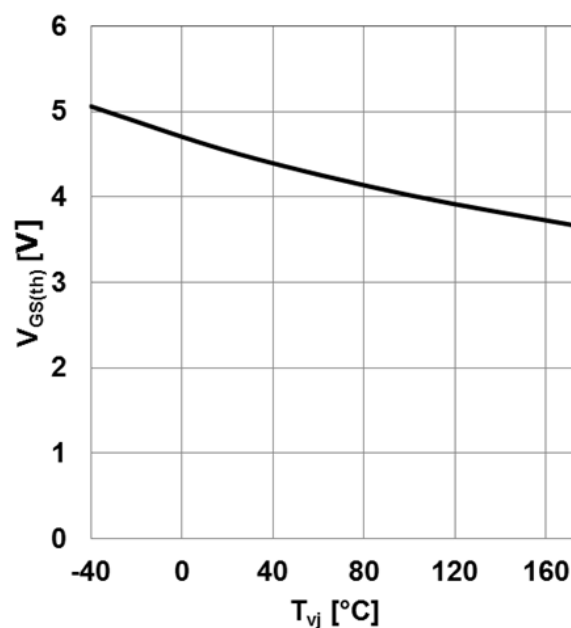


Figure 6 Typical gate-source threshold voltage as a function of junction temperature
($V_{GS(th)} = f(T_{vj})$, $I_{DS} = 10mA$, $V_{GS} = V_{DS}$)

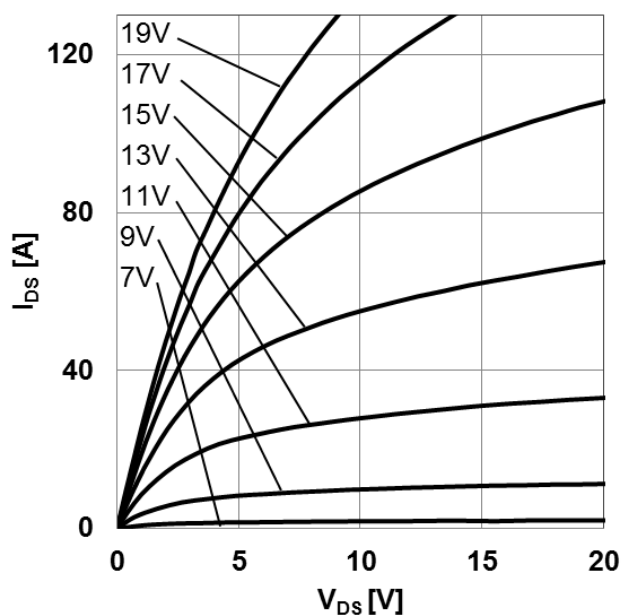


Figure 7 Typical output characteristic, V_{GS} as parameter
($I_{DS} = f(V_{DS})$, $T_{vj} = 25^\circ C$, $t_P = 20\mu s$)

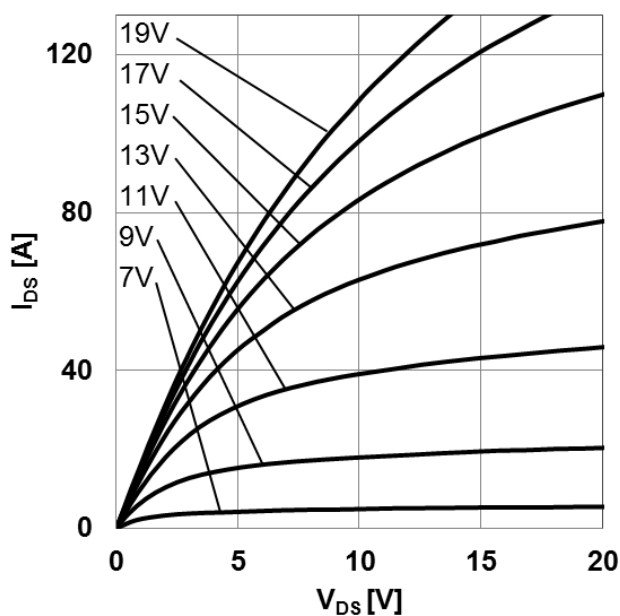


Figure 8 Typical output characteristic, V_{GS} as parameter
($I_{DS} = f(V_{DS})$, $T_{vj} = 175^\circ C$, $t_P = 20\mu s$)

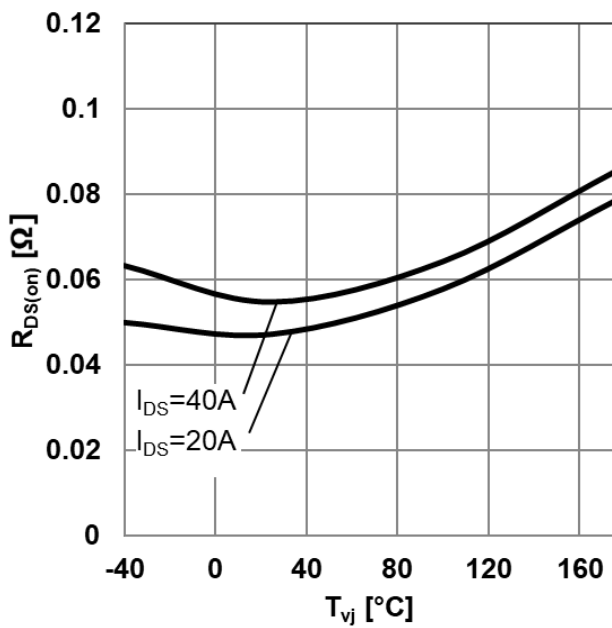


Figure 9 Typical on-resistance as a function of junction temperature
 $(R_{DS(on)} = f(T_{vj}), V_{GS}=15V)$

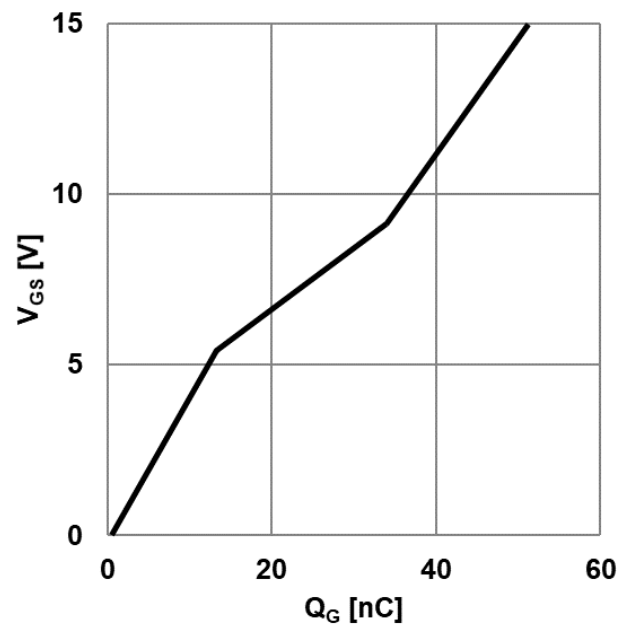


Figure 10 Typical gate charge ($V_{GS} = f(Q_G)$, $I_{DS} = 20A$, $V_{DS} = 800V$, turn-on pulse)

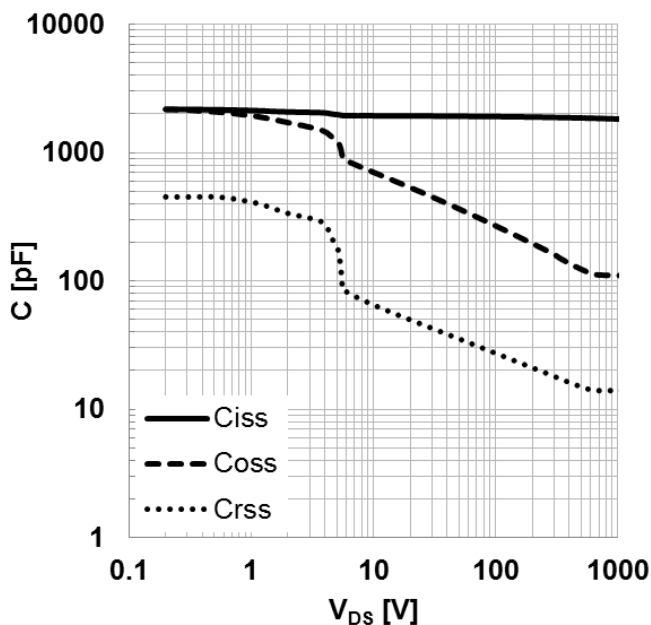


Figure 11 Typical capacitance as a function of drain-source voltage
 $(C = f(V_{DS}), V_{GS} = 0V, f = 1MHz)$

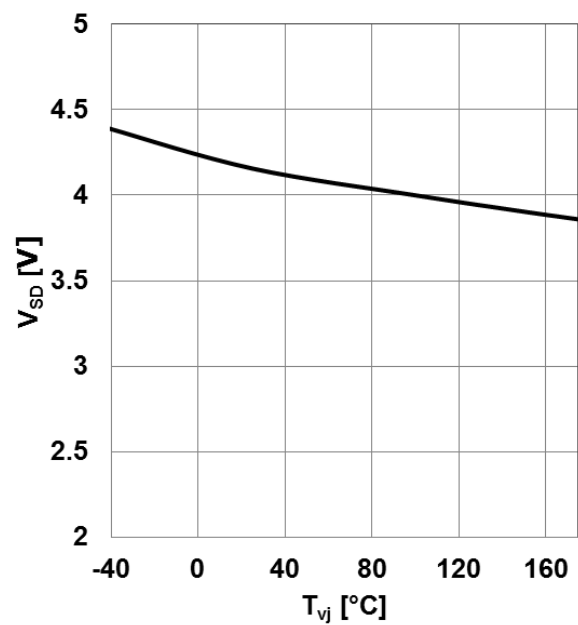


Figure 12 Typical body diode forward voltage as function of junction temperature
 $(V_{SD} = f(T_{vj}), V_{GS} = 0V, I_{SD} = 20A)$

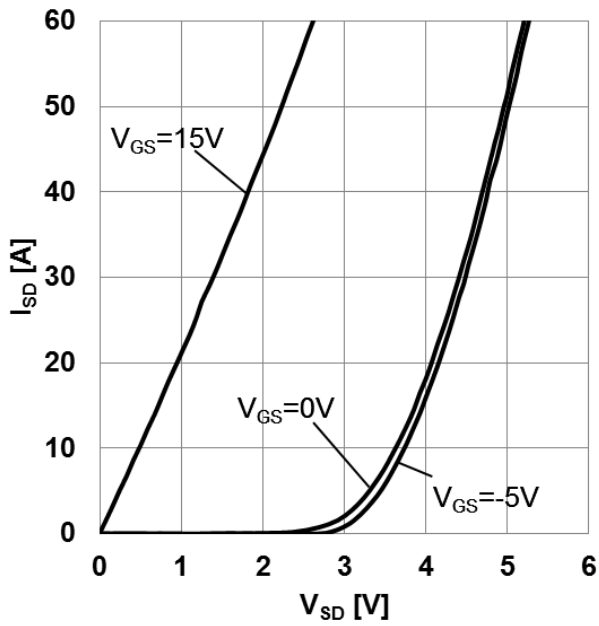


Figure 13 Typical body diode forward current as function of forward voltage, V_{GS} as parameter

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

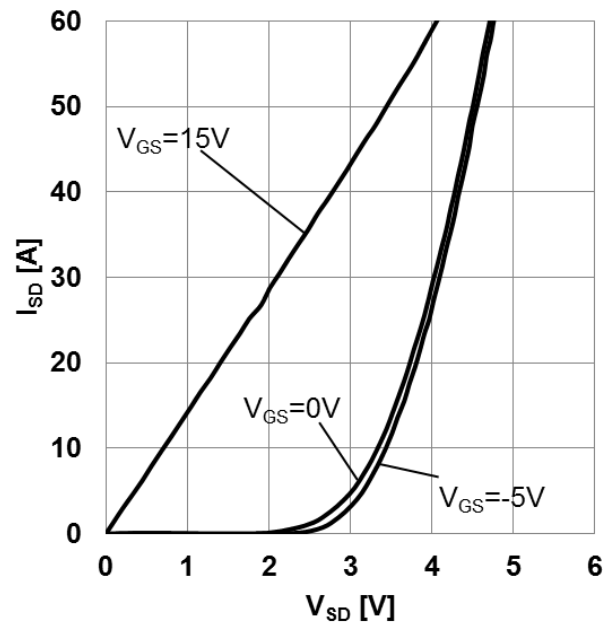


Figure 14 Typical body diode forward current as function of forward voltage, V_{GS} as parameter

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

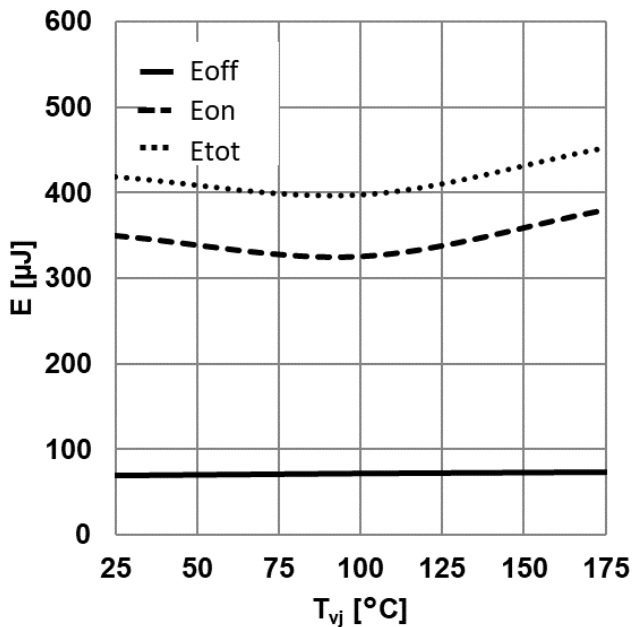


Figure 15 Typical switching energy losses as a function of junction temperature

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

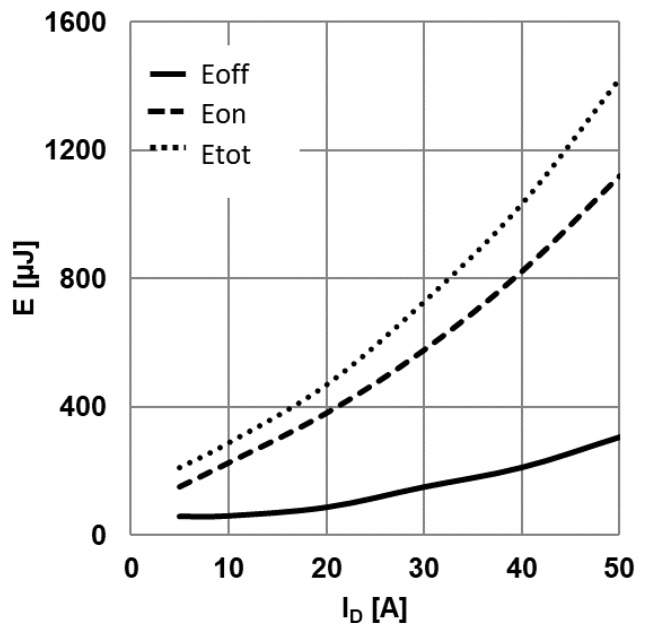


Figure 16 Typical switching energy losses as a function of drain-source current

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

Electrical characteristic diagrams

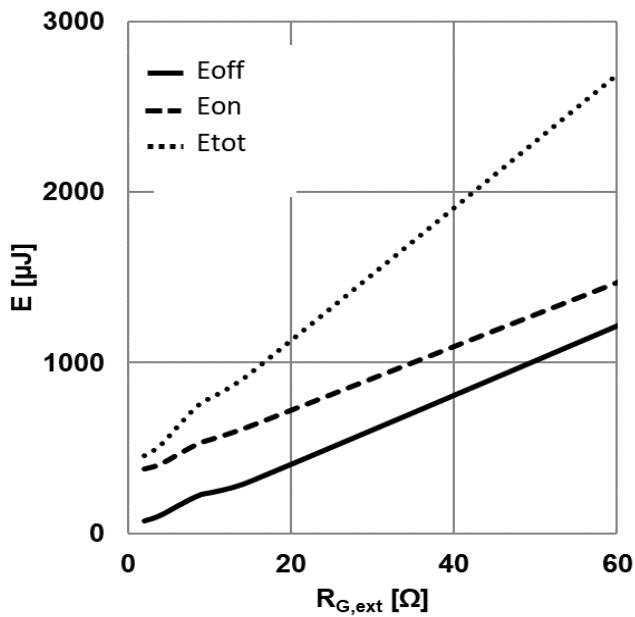


Figure 17 Typical switching energy losses as a function of gate resistance
 $(E = f(R_{G,ext}), V_{DD} = 800V, V_{GS} = 0V/15V, I_D = 20A, T_{vj} = 175^\circ C, \text{ind. load, test circuit in Fig. E, diode: body diode})$

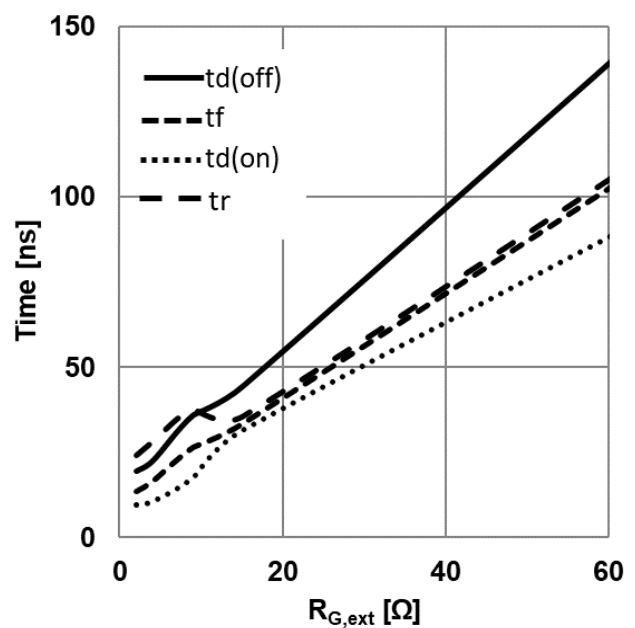


Figure 18 Typical switching times as a function of gate resistor
 $(t = f(R_{G,ext}), V_{DD} = 800V, V_{GS} = 0V/15V, I_D = 20A, T_{vj} = 175^\circ C, \text{ind. load, test circuit in Fig. E, diode: body diode})$

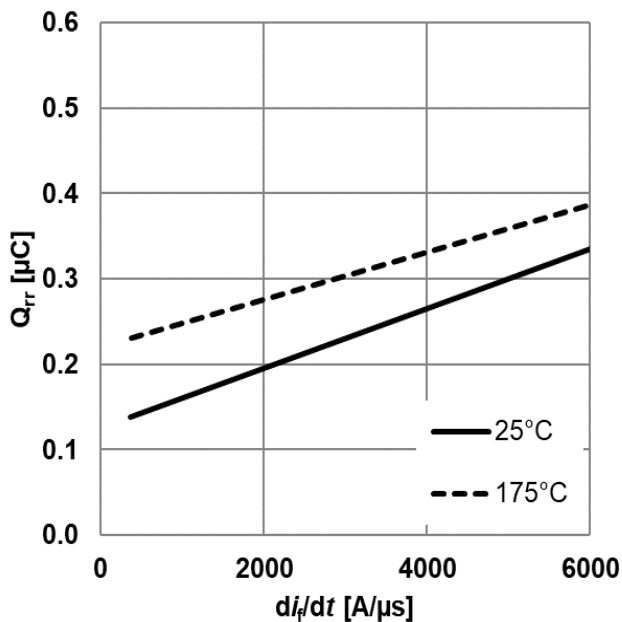


Figure 19 Typical reverse recovery charge as a function of diode current slope
 $(Q_{rr} = f(di_t/dt), V_{DD} = 800V, I_D = 20A, \text{ind. load, test circuit in Fig. E})$

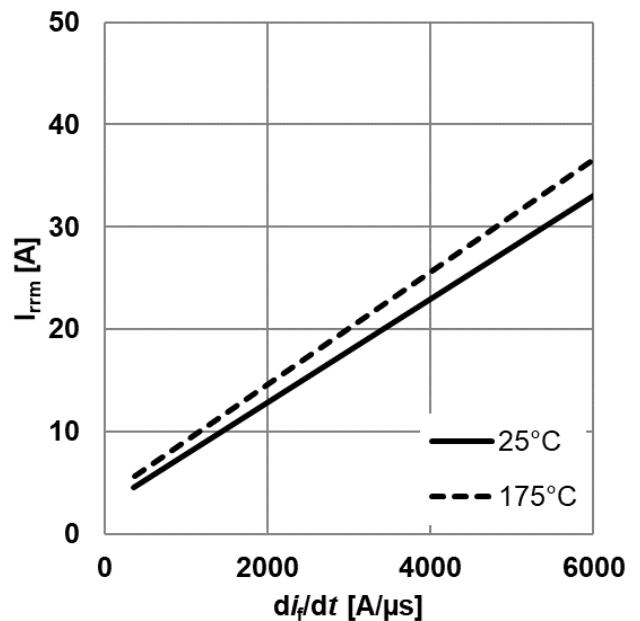


Figure 20 Typical reverse recovery current as a function of diode current slope
 $(I_{rrm} = f(di_t/dt), V_{DD} = 800V, I_D = 20A, \text{ind. load, test circuit in Fig. E})$

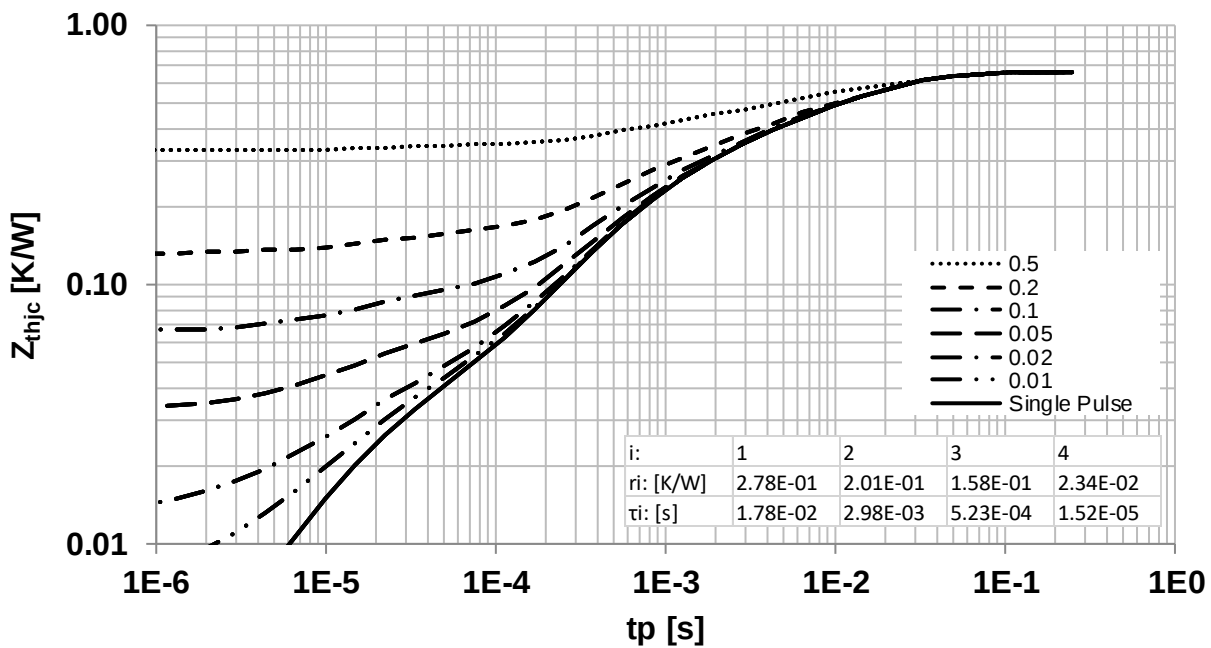


Figure 21 Max. transient thermal resistance (MOSFET/diode)

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

5 Package drawing

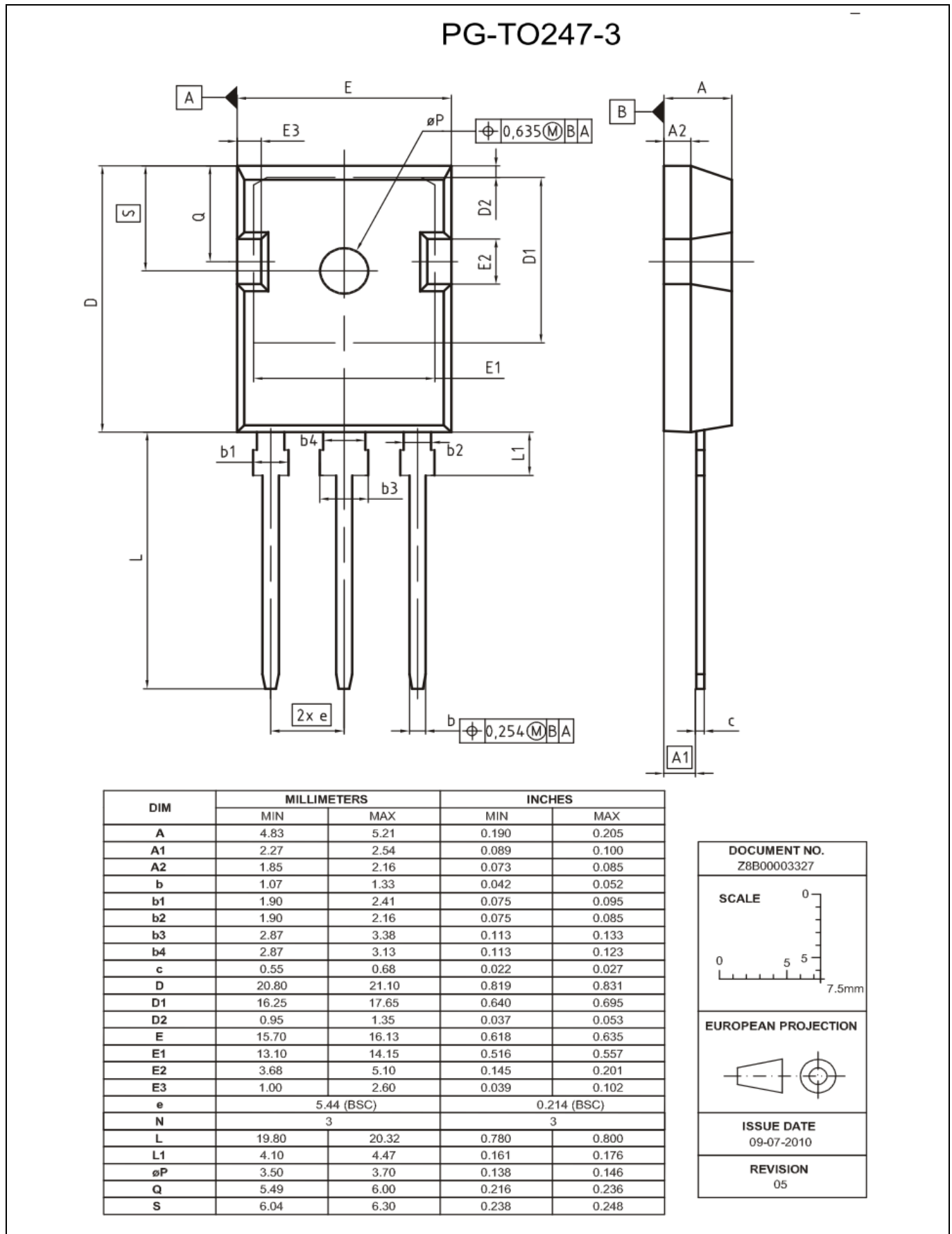


Figure 22 Package drawing

6 Test conditions

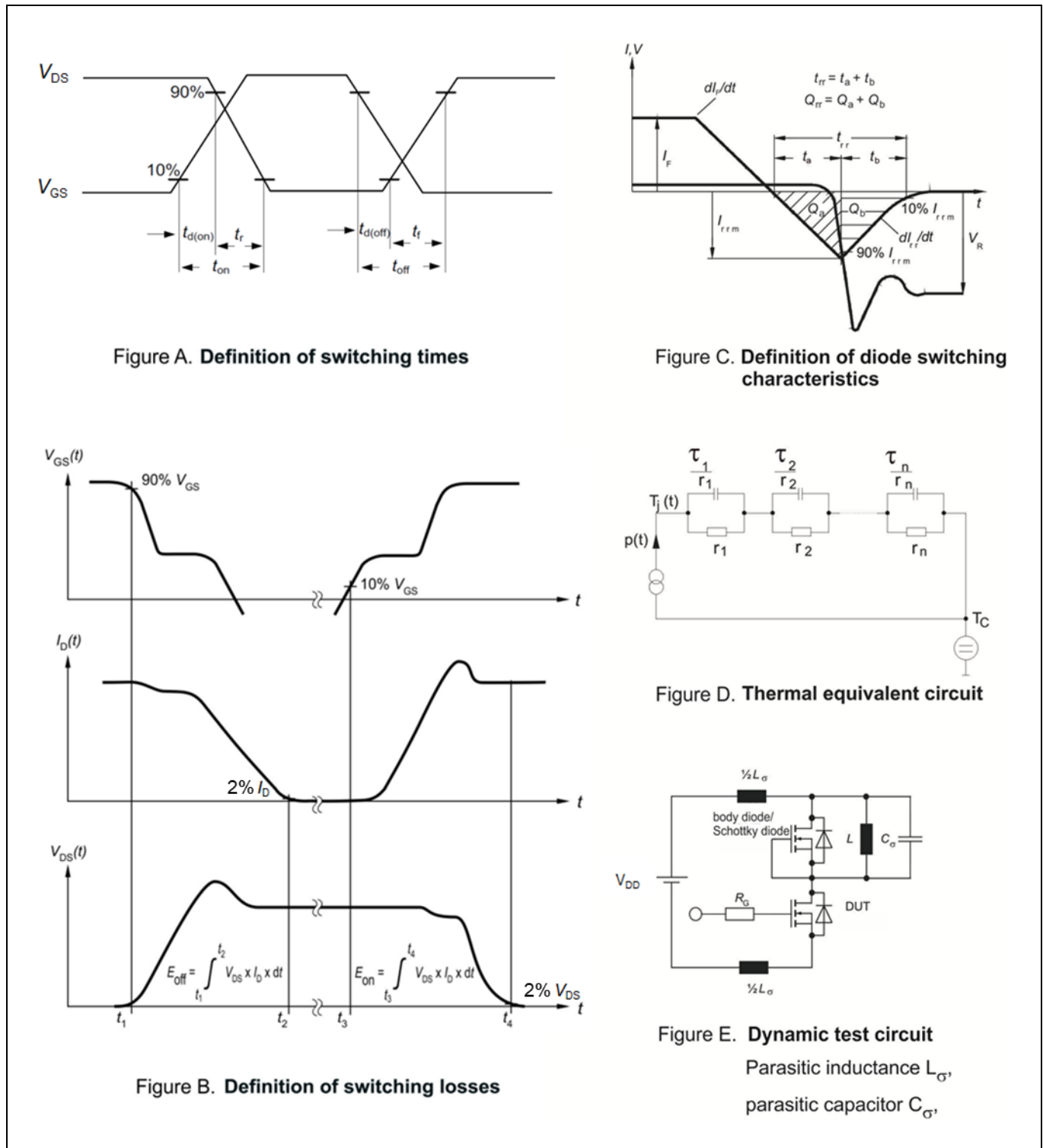


Figure 23 Test conditions

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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