

CoolSiC™ 1200 V SiC Trench MOSFET : Silicon Carbide MOSFET with .XT interconnection technology

Features

- $V_{DS} = 1200\text{ V}$ at $T_{vj} = 25^\circ\text{C}$
- $I_{DCC} = 127\text{ A}$ at $T_{vj} = 25^\circ\text{C}$
- $R_{DS(on)} = 14\text{ m}\Omega$ at $V_{GS} = 18\text{ V}$, $T_{vj} = 25^\circ\text{C}$
- Very low switching losses
- Short circuit withstand time $3\ \mu\text{s}$
- Benchmark gate threshold voltage, $V_{GS(th)} = 4.2\text{ V}$
- Robust against parasitic turn on, 0 V turn-off gate voltage can be applied
- Robust body diode for hard commutation
- .XT interconnection technology for best-in-class thermal performance

Potential applications

- General purpose drives (GPD)
- EV-Charging
- Online UPS/Industrial UP
- String inverters
- Solar power optimizer

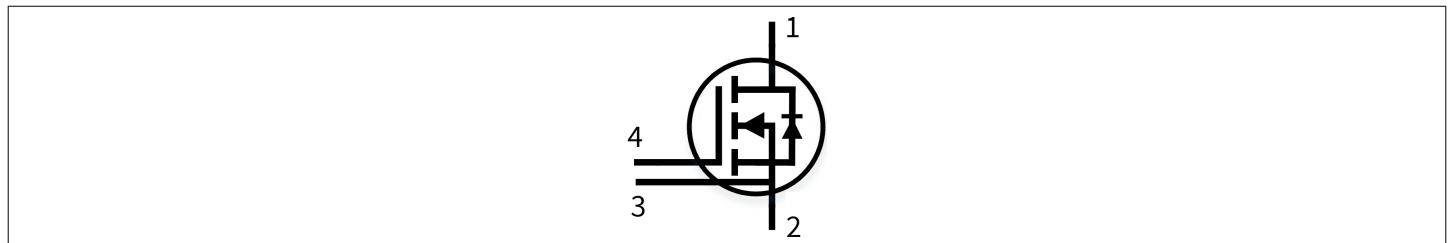
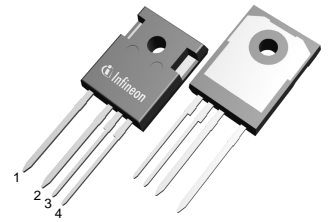
Product validation

- Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

Description

- 1 – drain
- 2 – source
- 3 – Kelvin sense contact
- 4 – gate

Note: the source and sense pins are not exchangeable, their exchange might lead to malfunction (only for 4pin, TO263-7L)



Type	Package	Marking
IMZA120R014M1H	PG-TO247-4-STD-T3.7	12M1H014

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1 Package

Table 1 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature		wave soldering 1.6 mm (0.063 in.) from case for 10 s			260	°C
Mounting torque	M	M3 screw Maximum of mounting process: 3			0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				62	K/W

2 MOSFET

Table 2 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Drain-source voltage	V_{DSS}	$T_{vj} \geq 25\text{ °C}$	1200	V	
Continuous DC drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$	I_{DDC}	$V_{GS} = 18\text{ V}$	$T_c = 25\text{ °C}$	127	A
			$T_c = 100\text{ °C}$	89.3	
Peak drain current, t_p limited by $T_{vj(max)}$	I_{DM}	$V_{GS} = 18\text{ V}$	268	A	
Gate-source voltage, max. transient voltage ¹⁾	V_{GS}	$t_p \leq 0.5\ \mu\text{s}$, $D < 0.01$	-10/23	V	
Gate-source voltage, max. static voltage	V_{GS}		-5/20	V	
Avalanche energy, single pulse	E_{AS}	$I_D = 53\text{ A}$, $V_{DD} = 50\text{ V}$, $L = 0.7\text{ nH}$	956	mJ	
Avalanche energy, repetitive	E_{AR}	$I_D = 53\text{ A}$, $V_{DD} = 50\text{ V}$	4.7	mJ	
Short-circuit withstand time	t_{SC}	$V_{DD} \leq 800\text{ V}$, $V_{DS,peak} < 1200\text{ V}$, $V_{GS(on)} = 15\text{ V}$, $T_{vj(start)} = 25\text{ °C}$	3	μs	
Power dissipation, limited by $T_{vj(max)}$	P_{tot}		$T_c = 25\text{ °C}$	455	W
			$T_c = 100\text{ °C}$	227	

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 Application Note AN2018-09 must be considered to ensure sound operation of the device over the planned lifetime.

Table 3 Recommended values

Parameter	Symbol	Note or test condition	Values	Unit
Recommended turn-on gate voltage	$V_{GS(on)}$		15...18	V

(table continues...)

Table 3 (continued) Recommended values

Parameter	Symbol	Note or test condition	Values	Unit
Recommended turn-off gate voltage	$V_{GS(off)}$		-5...0	V

Table 4 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Drain-source on-state resistance	$R_{DS(on)}$	$I_D = 54.3 \text{ A}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $V_{GS(on)} = 18 \text{ V}$		14	18.4	mΩ
			$T_{vj} = 100 \text{ }^\circ\text{C}$, $V_{GS(on)} = 18 \text{ V}$		19		
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GS(on)} = 18 \text{ V}$		27		
			$T_{vj} = 25 \text{ }^\circ\text{C}$, $V_{GS(on)} = 15 \text{ V}$		17.9	21.9	
Gate-emitter threshold voltage	$V_{GS(th)}$	$I_D = 23.4 \text{ mA}$, $V_{DS} = V_{GS}$ (tested after 1 ms pulse at $V_{GS} = 20 \text{ V}$)	$T_{vj} = 25 \text{ }^\circ\text{C}$	3.5	4.2	5.2	V
			$T_{vj} = 175 \text{ }^\circ\text{C}$		3.6		
Zero gate-voltage drain current	I_{DSS}	$V_{DS} = 1200 \text{ V}$, $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$			430	μA
			$T_{vj} = 175 \text{ }^\circ\text{C}$		7.3		
Gate leakage current	I_{GSS}	$V_{DS} = 0 \text{ V}$	$V_{GS} = 23 \text{ V}$			200	nA
			$V_{GS} = -10 \text{ V}$			-200	
Forward transconductance	g_{fs}	$I_D = 54.3 \text{ A}$, $V_{DS} = 20 \text{ V}$		36.3		S	
Internal gate resistance	$R_{G,int}$	$f = 1 \text{ MHz}$, $V_{AC} = 25 \text{ mV}$		3.7		Ω	
Input capacitance	C_{iss}	$V_{DD} = 25 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$		4580		nF	
Output capacitance	C_{oss}	$V_{DD} = 25 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$		211		pF	
Reverse transfer capacitance	C_{rss}	$V_{DD} = 25 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$		30		pF	
C_{oss} stored energy	E_{oss}	$V_{DD} = 25 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 100 \text{ kHz}$, $V_{AC} = 25 \text{ mV}$		86		μJ	
Total gate charge	Q_G	$V_{DD} = 800 \text{ V}$, $I_D = 54.3 \text{ A}$, $V_{GS} = -2/18 \text{ V}$, turn-on pulse		110		nC	
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 800 \text{ V}$, $I_D = 54.3 \text{ A}$, $V_{GS} = -2/18 \text{ V}$, turn-on pulse		36		nC	
Gate-to-drain charge	Q_{GD}	$V_{DD} = 800 \text{ V}$, $I_D = 54.3 \text{ A}$, $V_{GS} = -2/18 \text{ V}$, turn-on pulse		32		nC	

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800\text{ V}, I_D = 54.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		48	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		46	
Rise time	t_r	$V_{DD} = 800\text{ V}, I_D = 54.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		18	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		21	
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 800\text{ V}, I_D = 54.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		58	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		60	
Fall time	t_f	$V_{DD} = 800\text{ V}, I_D = 54.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		20	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		20	
Turn-on energy	E_{on}	$V_{DD} = 800\text{ V}, I_D = 54.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		560	μJ
			$T_{vj} = 175\text{ }^\circ\text{C}$		900	
Turn-off energy	E_{off}	$V_{DD} = 800\text{ V}, I_D = 54.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		150	μJ
			$T_{vj} = 175\text{ }^\circ\text{C}$		170	
Total switching energy	E_{tot}	$V_{DD} = 800\text{ V}, I_D = 54.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		793	μJ
			$T_{vj} = 175\text{ }^\circ\text{C}$		1403	

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
MOSFET/body diode thermal resistance, junction to case	$R_{th(j-c)}$			0.25	0.33	K/W
Virtual junction temperature	T_{vj}		-55		175	°C

Note: The chip technology was characterized up to 200 kV/μs. The measured dV/dt was limited by measurement test setup and package.

Dynamic test circuit see Fig. F.

3 Body diode

Table 5 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Drain-source voltage	V_{DSS}	$T_{vj} \geq 25\text{ °C}$	1200	V	
Continuous reverse drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$	I_{SDC}	$V_{GS} = 0\text{ V}$	$T_c = 25\text{ °C}$	95	A
			$T_c = 100\text{ °C}$	55	
Peak reverse drain current, t_p limited by $T_{vj(max)}$	I_{SM}	$V_{GS} = 0\text{ V}$	267.9	A	

Table 6 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Drain-source reverse voltage	V_{SD}	$I_{SD} = 54.3\text{ A}, V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		3.8	5	V
			$T_{vj} = 100\text{ °C}$		3.7		
			$T_{vj} = 175\text{ °C}$		3.6		
MOSFET forward recovery charge	Q_{fr}	$V_{DD} = 800\text{ V}, I_{SD} = 54.3\text{ A}, V_{GS} = 0\text{ V}, di_f/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also Q_C	$T_{vj} = 25\text{ °C}$		450		nC
			$T_{vj} = 175\text{ °C}$		825		
MOSFET peak forward recovery current	I_{frm}	$V_{DD} = 800\text{ V}, I_{SD} = 54.3\text{ A}, V_{GS} = 0\text{ V}, di_f/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also Q_C	$T_{vj} = 25\text{ °C}$		11		A
			$T_{vj} = 175\text{ °C}$		18		
MOSFET forward recovery energy	E_{fr}	$V_{DD} = 800\text{ V}, I_{SD} = 54.3\text{ A}, V_{GS} = 0\text{ V}, di_f/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also Q_C	$T_{vj} = 25\text{ °C}$		83		μJ
			$T_{vj} = 175\text{ °C}$		333		

(table continues...)

Table 6 (continued) Characteristic values

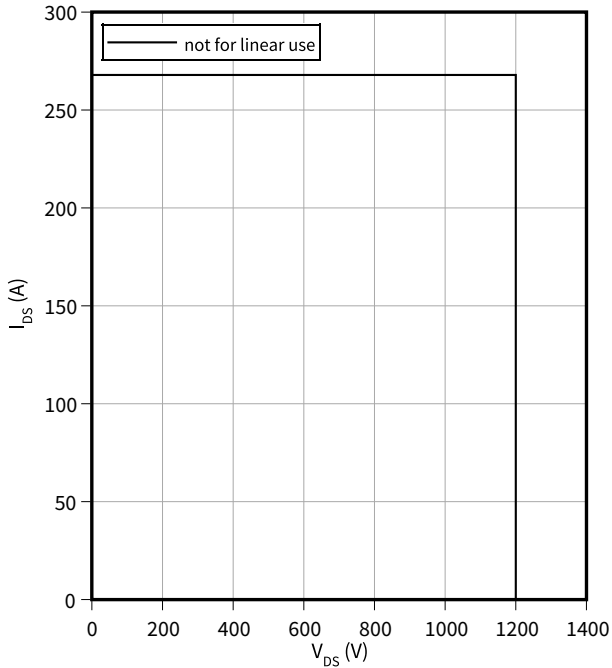
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
MOSFET/body diode thermal resistance, junction to case	$R_{th(j-c)}$			0.25	0.33	K/W
Virtual junction temperature	T_{vj}		-55		175	°C

4 Characteristics diagrams

Reverse bias safe operating area (RBSOA), MOSFET

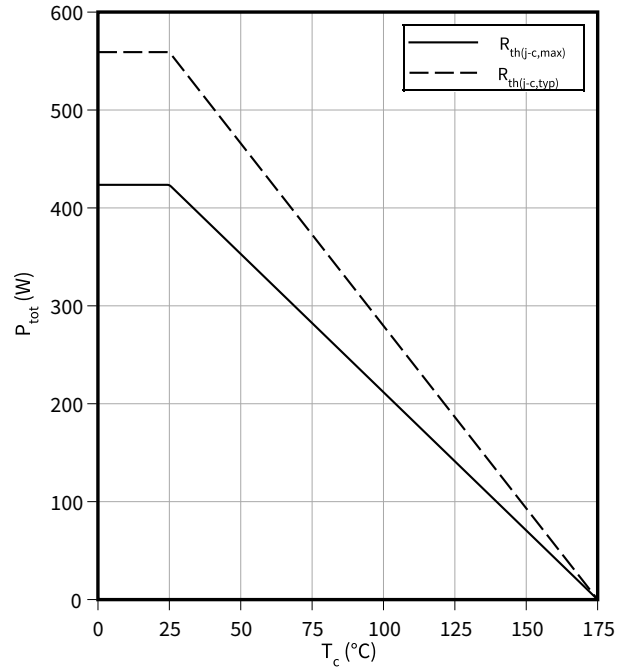
$$I_{DS} = f(V_{DS})$$

$$T_{vj} \leq 175\text{ °C}, V_{GS} = 0/18\text{ V}, T_c = 25\text{ °C}$$



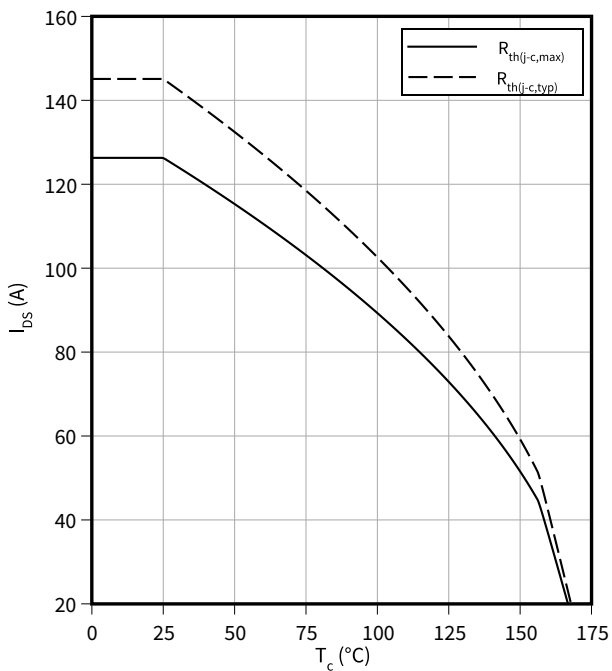
Power dissipation as a function of case temperature limited by bond wire, MOSFET

$$P_{tot} = f(T_c)$$



Maximum DC drain to source current as a function of case temperature limited by bond wire, MOSFET

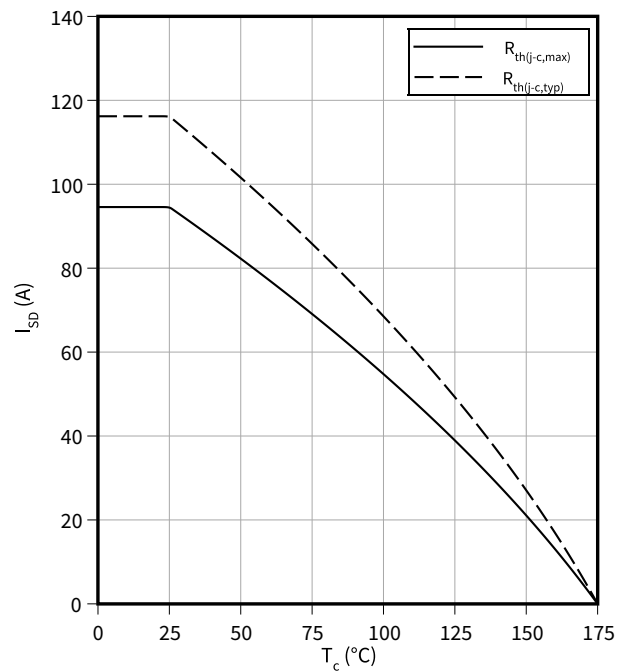
$$I_{DS} = f(T_c)$$



Maximum source to drain current as a function of case temperature limited by bond wire, MOSFET

$$I_{SD} = f(T_c)$$

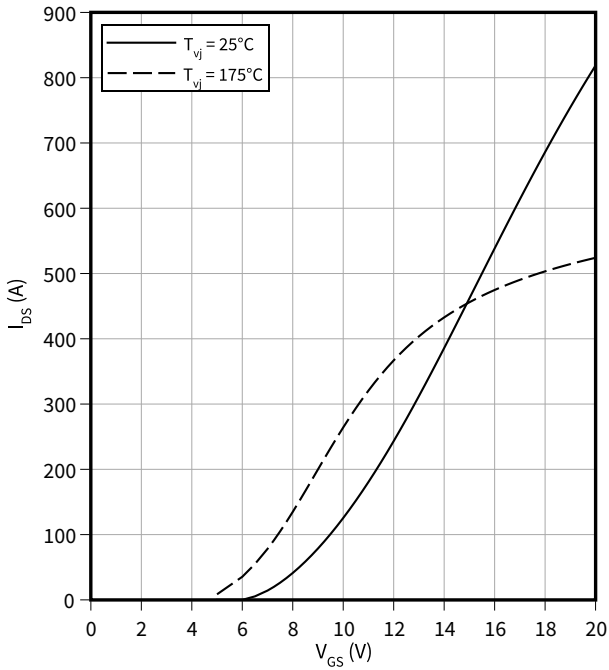
$$V_{GS} = 0\text{ V}$$



4 Characteristics diagrams

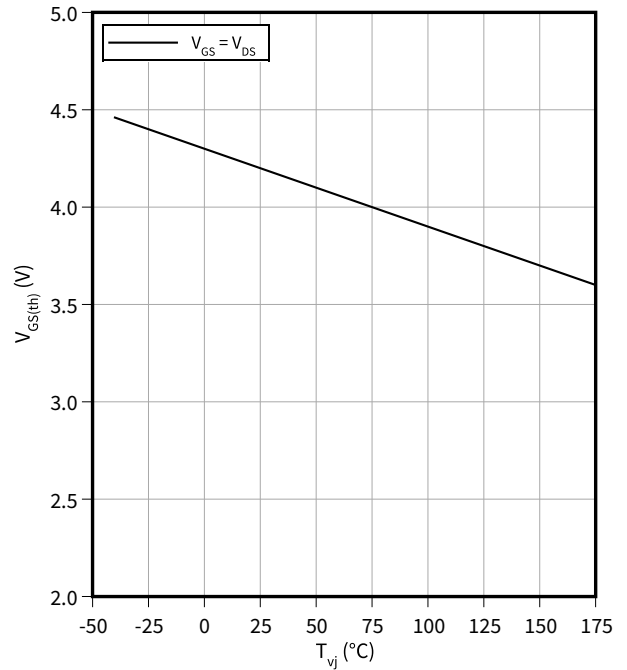
Typical transfer characteristic , MOSFET

$I_{DS} = f(V_{GS})$
 $V_{DS} = 20 \text{ V}, t_p = 20 \mu\text{s}$



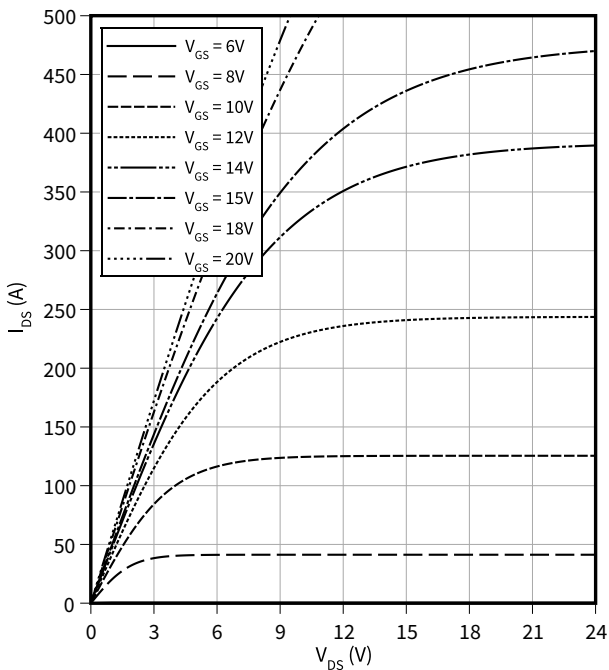
Typical gate-source threshold voltage as a function of junction temperature , MOSFET

$V_{GS(th)} = f(T_{vj})$
 $I_D = 23.4 \text{ mA}$



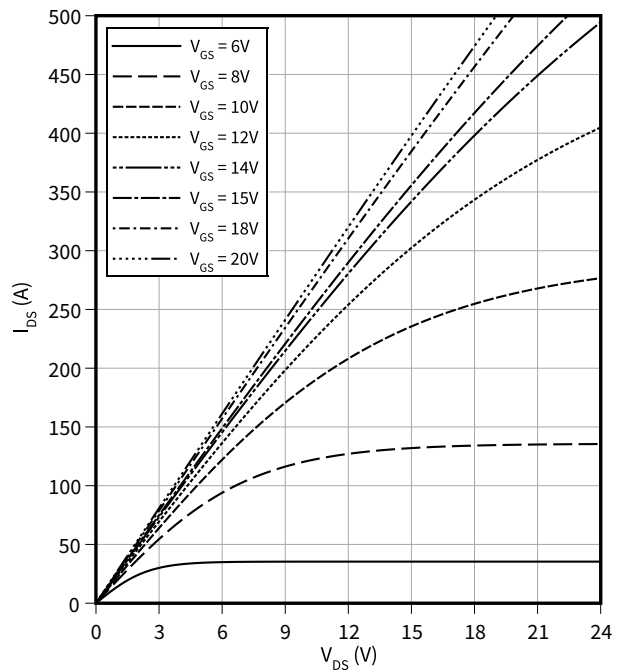
Typical output characteristic, V_{GS} as parameter , MOSFET

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



Typical output characteristic, V_{GS} as parameter , MOSFET

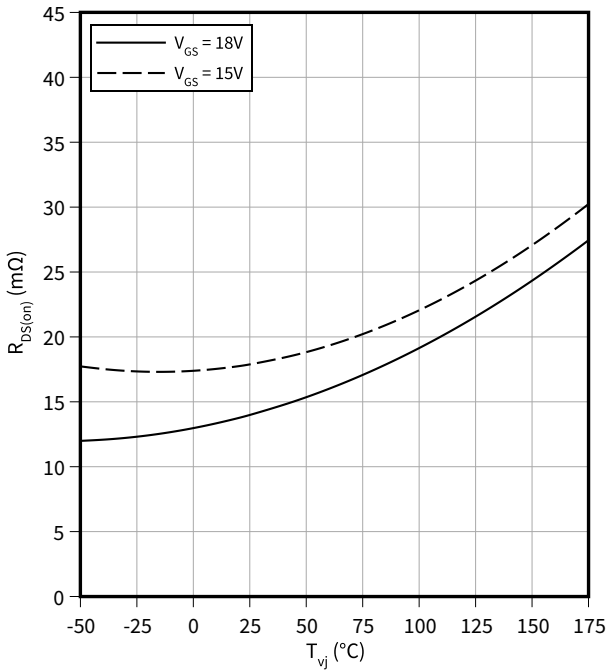
$I_{DS} = f(V_{DS})$
 $T_{vj} = 175^\circ\text{C}, t_p = 20 \mu\text{s}$



4 Characteristics diagrams

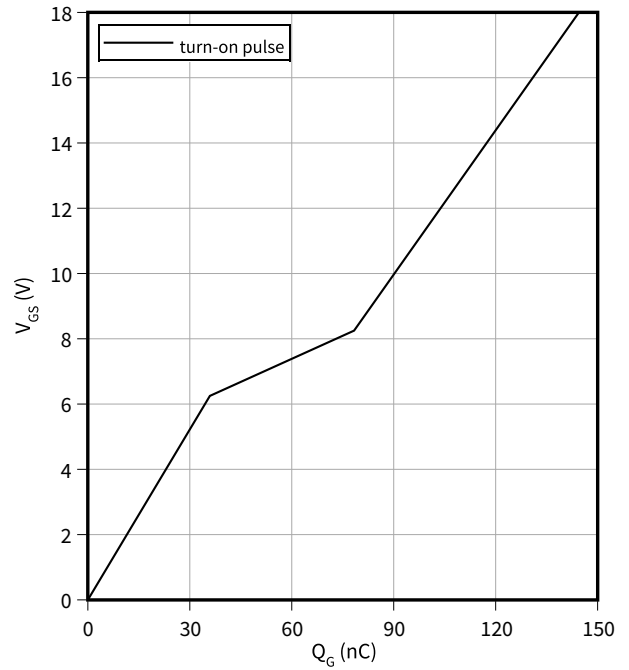
Typical on-state resistance as a function of junction temperature, MOSFET

$R_{DS(on)} = f(T_{vj})$
 $I_D = 54.3 \text{ A}$



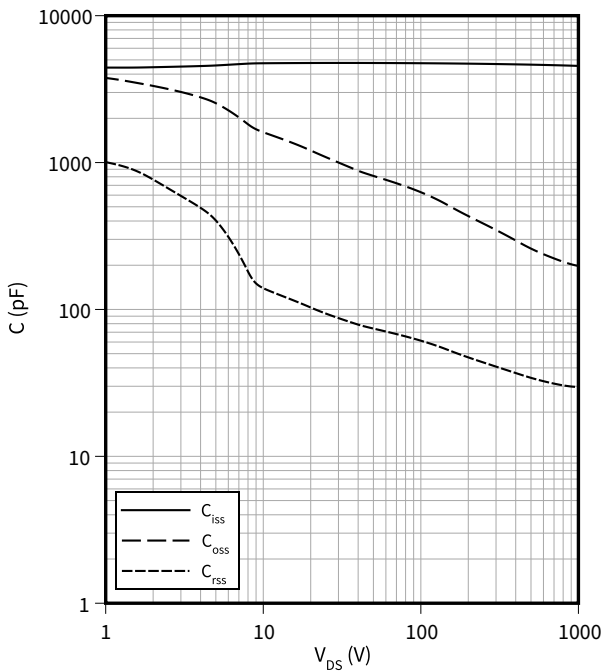
Typical gate charge, MOSFET

$V_{GS} = f(Q_G)$
 $I_D = 54.3 \text{ A}, V_{DS} = 800 \text{ V}$



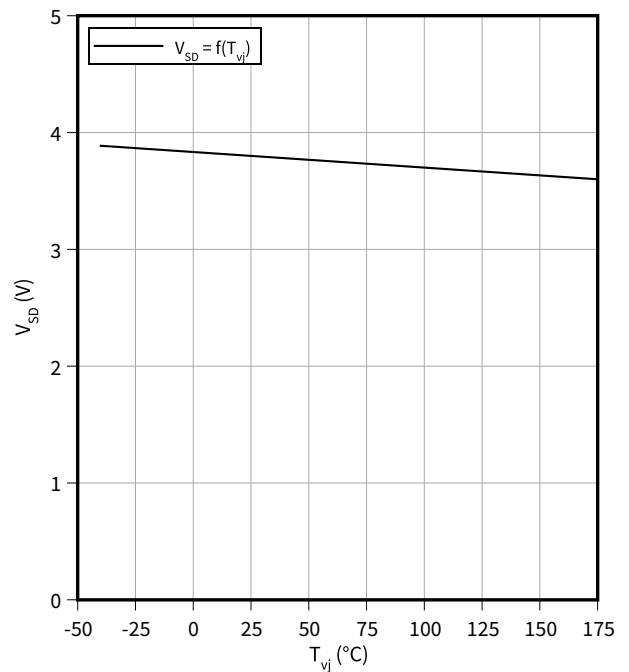
Typical capacitance as a function of drain-source voltage, MOSFET

$C = f(V_{DS})$
 $f = 100 \text{ kHz}, V_{GS} = 0 \text{ V}$



Typical reverse drain voltage as function of junction temperature, MOSFET

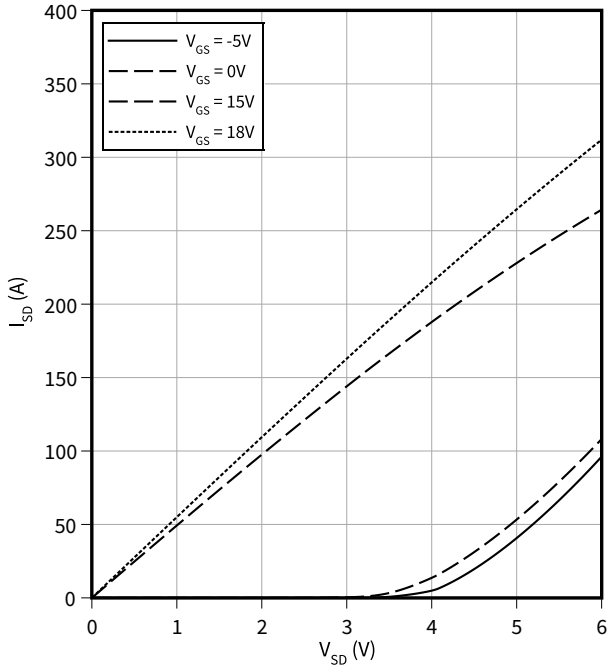
$V_{SD} = f(T_{vj})$
 $I_{SD} = 54.3 \text{ A}, V_{GS} = 0 \text{ V}$



4 Characteristics diagrams

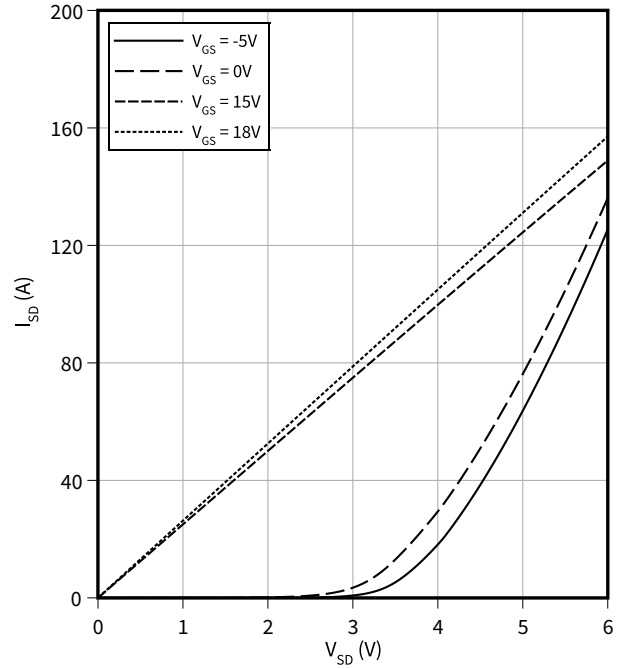
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter, MOSFET

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



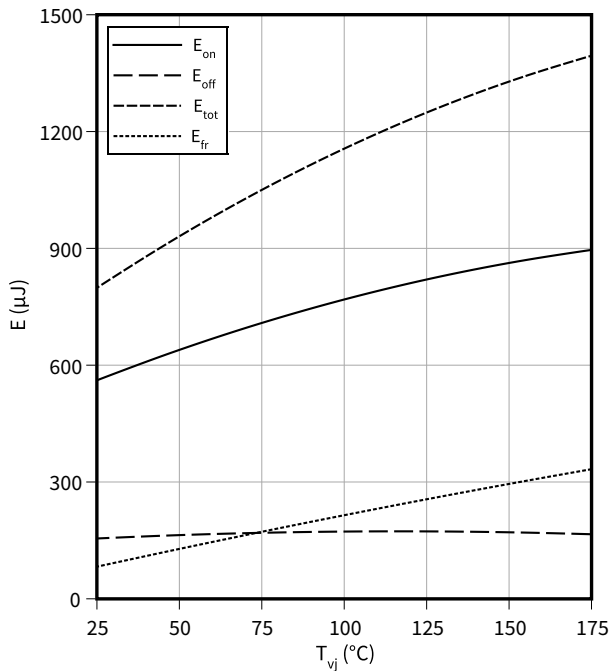
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter, MOSFET

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



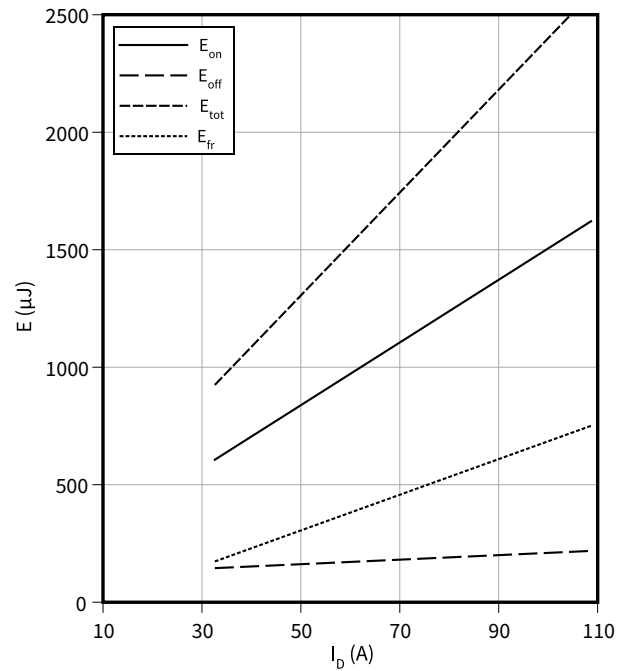
Typical switching energy as a function of junction temperature, test circuit in Fig. F, 2nd device own body diode: $V_{GS} = 0\text{ V}$, MOSFET

$E = f(T_{vj})$
 $V_{GS} = 0/18\text{ V}$, $I_D = 54.3\text{ A}$, $R_{G,ext} = 1\text{ }\Omega$, $V_{DD} = 800\text{ V}$



Typical switching energy as a function of drain current, test circuit in Fig. F, 2nd device own body diode: $V_{GS} = 0\text{ V}$, MOSFET

$E = f(I_D)$
 $V_{GS} = 0/18\text{ V}$, $T_{vj} = 175\text{ }^{\circ}\text{C}$, $R_{G,ext} = 1\text{ }\Omega$, $V_{DD} = 800\text{ V}$

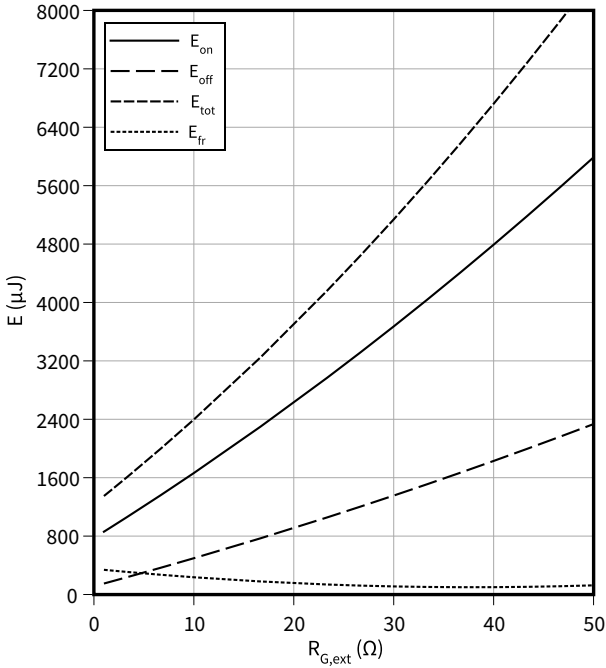


4 Characteristics diagrams

Typical switching energy losses as a function of gate resistance, test circuit in Fig. F, 2nd device own body diode: $V_{GS} = 0$ V, MOSFET

$E = f(R_{G,ext})$

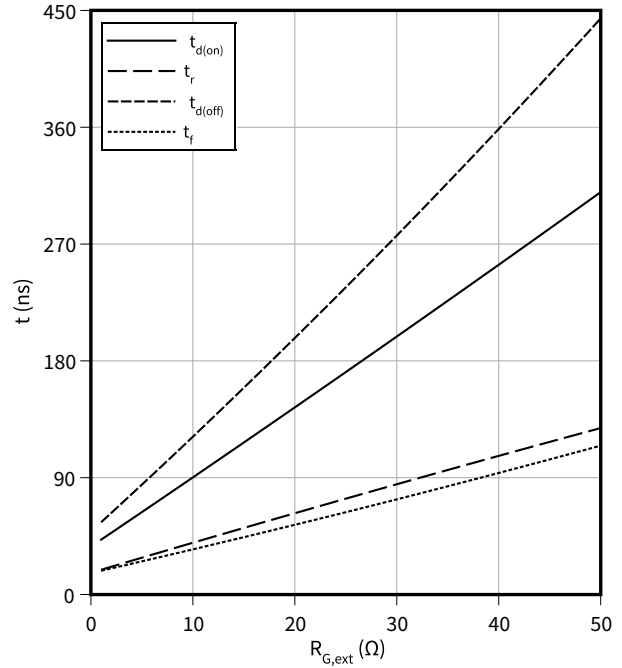
$V_{GS} = 0/18$ V, $I_D = 54.3$ A, $T_{vj} = 175$ °C, $V_{DD} = 800$ V



Typical switching times as a function of gate resistance, test circuit in Fig. F, 2nd device own body diode: $V_{GS} = 0$ V, MOSFET

$t = f(R_{G,ext})$

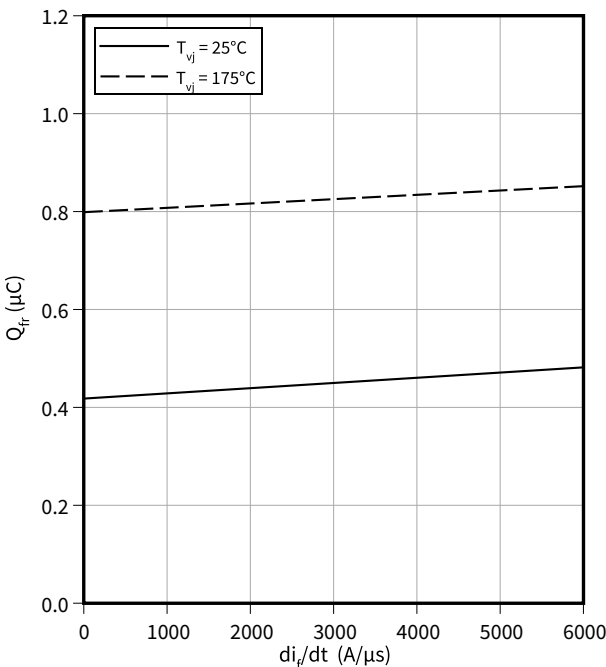
$V_{GS} = 0/18$ V, $I_D = 54.3$ A, $T_{vj} = 175$ °C, $V_{DD} = 800$ V



Typical reverse recovery charge as a function of reverse drain current slope, test circuit in Fig. F, 2nd device own body diode: $V_{GS} = 0$ V, MOSFET

$Q_{fr} = f(di_f/dt)$

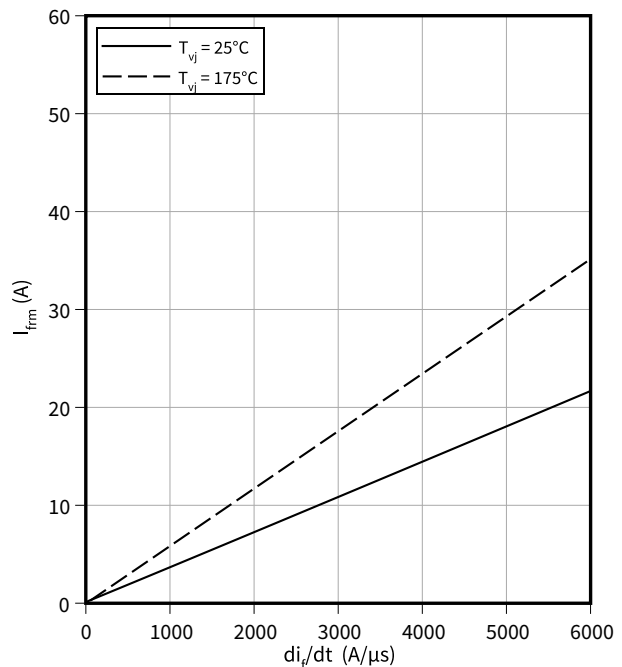
$V_{GS} = 0/18$ V, $I_D = 54.3$ A, $V_{DD} = 800$ V



Typical reverse recovery current as a function of reverse drain current slope, test circuit in Fig. F, 2nd device own body diode: $V_{GS} = 0$ V, MOSFET

$I_{frm} = f(di_f/dt)$

$V_{GS} = 0/18$ V, $I_D = 54.3$ A, $V_{DD} = 800$ V

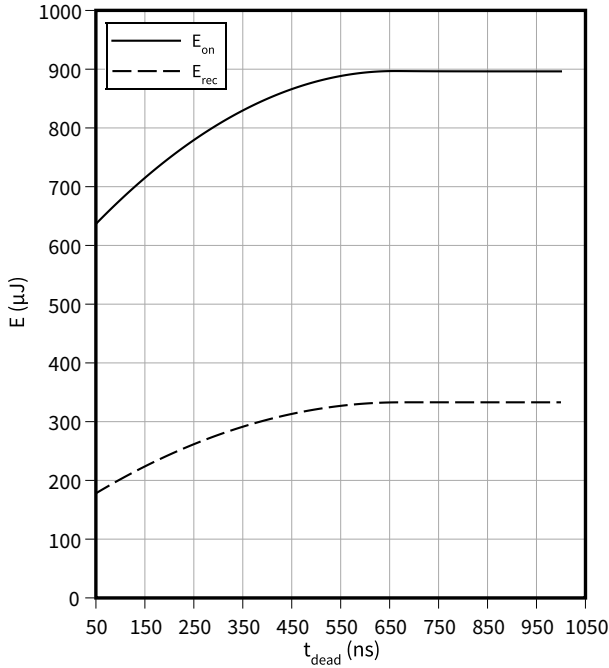


4 Characteristics diagrams

Typical switching energy losses as a function of dead time / blanking time, test circuit in Fig. F, 2nd device own bodydiode: $V_{GS} = -5$ V, MOSFET

$$E = f(t_{dead})$$

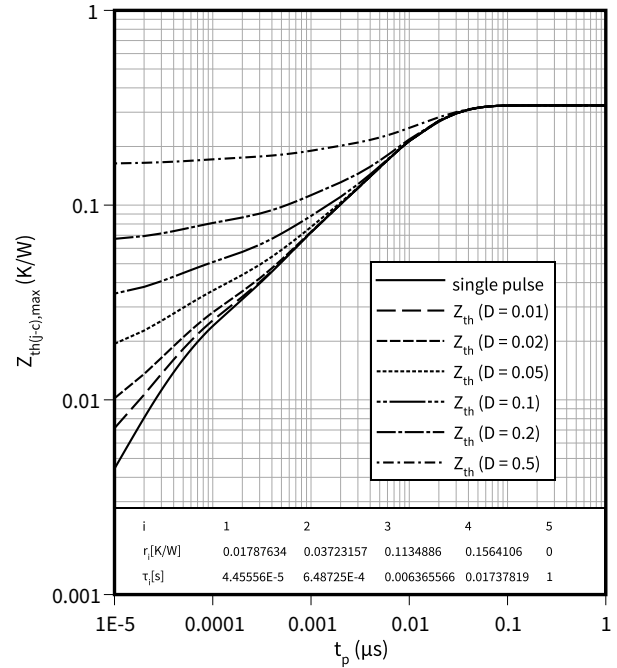
$V_{GS} = -5/18$ V, $I_D = 54.3$ A, $T_{vj} = 175$ °C, $V_{DD} = 800$ V



Max. transient thermal impedance (MOSFET/diode), MOSFET

$$Z_{th(j-c),max} = f(t_p)$$

$$D = t_p/T$$



5 Package outlines

PG-TO247-4-STD-T3.7

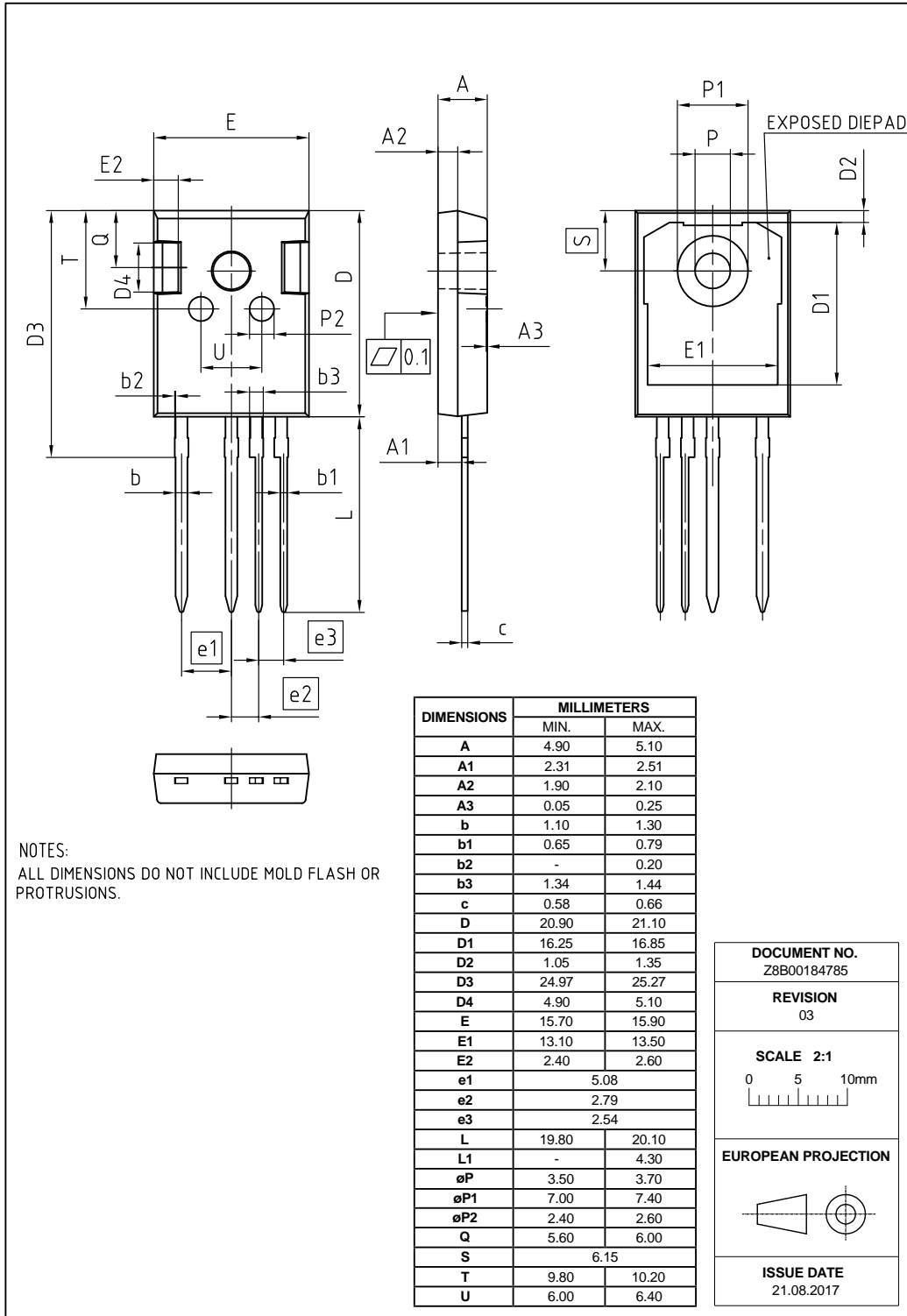


Figure 1

6 Testing conditions

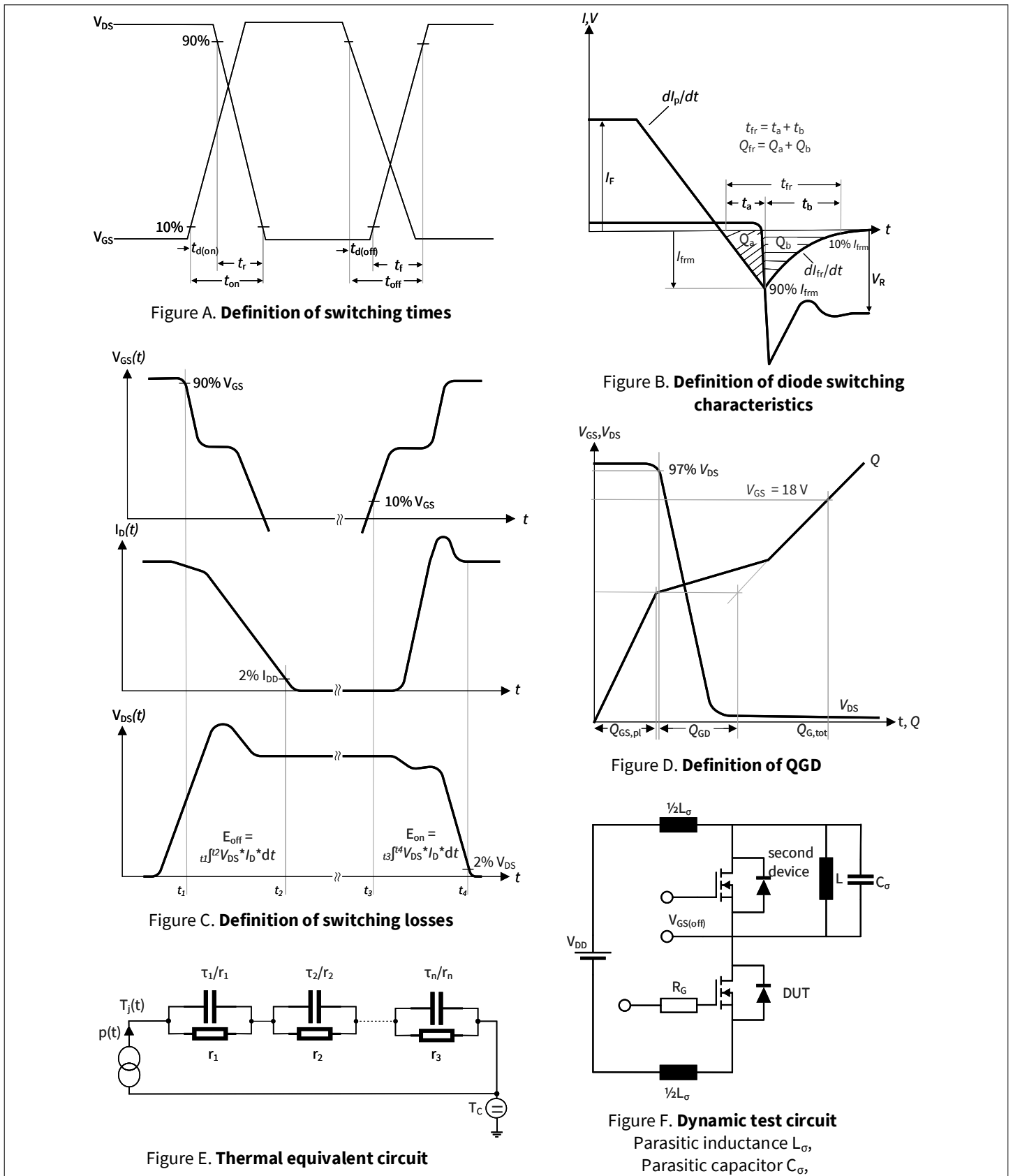


Figure 2

Revision history

Revision history

Document revision	Date of release	Description of changes
1.00	2022-01-31	Final datasheet

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