

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

#### Features

- $V_{DSS} = 1200\text{ V}$  at  $T_{vj} = 25^\circ\text{C}$
- $I_{DCC} = 55\text{ A}$  at  $T_{vj} = 25^\circ\text{C}$
- $R_{DS(on)} = 39\text{ m}\Omega$  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,  $0\text{ V}$  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

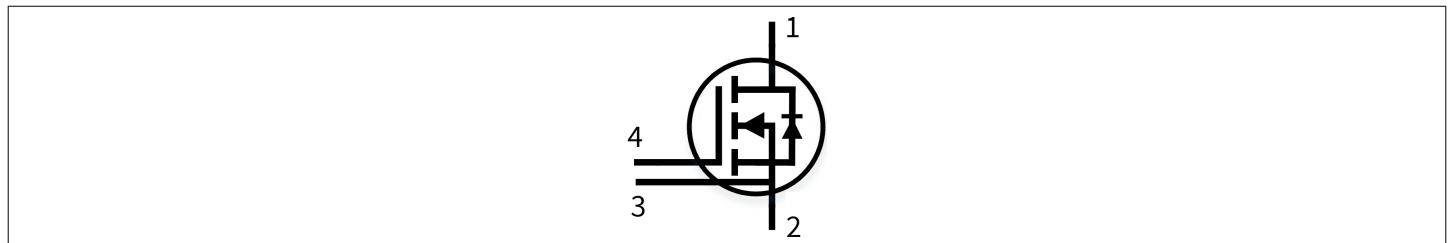
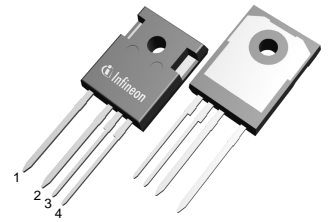
#### Product validation

- 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
IMZA120R040M1H	PG-TO247-4-STD-T3.7	12M1H040

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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 $T_{vj(max)}$	$I_{DDC}$	$V_{GS} = 18 \text{ V}$	$T_c = 25 \text{ °C}$	55	A
			$T_c = 100 \text{ °C}$	39	
Peak drain current, $t_p$ limited by $T_{vj(max)}$	$I_{DM}$	$V_{GS} = 18 \text{ V}$	117	A	
Gate-source voltage, max. transient voltage <sup>1)</sup>	$V_{GS}$	$t_p \leq 0.5 \text{ }\mu\text{s}$ , $D < 0.01$	-10/23	V	
Gate-source voltage, max. static voltage	$V_{GS}$		-5/20	V	
Avalanche energy, single pulse	$E_{AS}$	$I_D = 18.8 \text{ A}$ , $V_{DD} = 50 \text{ V}$ , $L = 1.9 \text{ mH}$	339	mJ	
Avalanche energy, repetitive	$E_{AR}$	$I_D = 18.8 \text{ A}$ , $V_{DD} = 50 \text{ V}$ , $L = 9.5 \text{ }\mu\text{H}$	1.68	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	$\mu\text{s}$	
Power dissipation, limited by $T_{vj(max)}$	$P_{tot}$		$T_c = 25 \text{ °C}$	227	W
			$T_c = 100 \text{ °C}$	114	

<sup>1)</sup> 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	$R_{DS(on)}$	$I_D = 19.3 \text{ A}$	$T_{vj} = 25 \text{ °C}$ , $V_{GS(on)} = 18 \text{ V}$		39	54.4	mΩ
			$T_{vj} = 100 \text{ °C}$ , $V_{GS(on)} = 18 \text{ V}$		54		
			$T_{vj} = 175 \text{ °C}$ , $V_{GS(on)} = 18 \text{ V}$		77		
			$T_{vj} = 25 \text{ °C}$ , $V_{GS(on)} = 15 \text{ V}$		50.4	61.5	
Gate-emitter threshold voltage	$V_{GS(th)}$	$I_D = 8.3 \text{ mA}$ , $V_{DS} = V_{GS}$ (tested after 1 ms pulse at $V_{GS} = 20 \text{ V}$ )	$T_{vj} = 25 \text{ °C}$	3.5	4.2	5.2	V
			$T_{vj} = 175 \text{ °C}$		3.6		
Zero gate-voltage drain current	$I_{DSS}$	$V_{DS} = 1200 \text{ V}$ , $V_{GS} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$			150	μA
			$T_{vj} = 175 \text{ °C}$		2.6		
Gate leakage current	$I_{GSS}$	$V_{DS} = 0 \text{ V}$	$V_{GS} = 23 \text{ V}$			100	nA
			$V_{GS} = -10 \text{ V}$			-100	
Forward transconductance	$g_{fs}$	$I_D = 19.3 \text{ A}$ , $V_{DS} = 20 \text{ V}$		12.9		S	
Internal gate resistance	$R_{G,int}$	$f = 1 \text{ MHz}$ , $V_{AC} = 25 \text{ mV}$		2.5		Ω	
Input capacitance	$C_{iss}$	$V_{DD} = 25 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 100 \text{ kHz}$ , $V_{AC} = 25 \text{ mV}$		1620		nF	
Output capacitance	$C_{oss}$	$V_{DD} = 25 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 100 \text{ kHz}$ , $V_{AC} = 25 \text{ mV}$		75		pF	
Reverse transfer capacitance	$C_{rss}$	$V_{DD} = 25 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 100 \text{ kHz}$ , $V_{AC} = 25 \text{ mV}$		11		pF	
$C_{oss}$ stored energy	$E_{oss}$	$V_{DD} = 25 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 100 \text{ kHz}$ , $V_{AC} = 25 \text{ mV}$		30		μJ	
Total gate charge	$Q_G$	$V_{DD} = 800 \text{ V}$ , $I_D = 19.3 \text{ A}$ , $V_{GS} = -2/18 \text{ V}$ , turn-on pulse		39		nC	
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 800 \text{ V}$ , $I_D = 19.3 \text{ A}$ , $V_{GS} = -2/18 \text{ V}$ , turn-on pulse		13		nC	
Gate-to-drain charge	$Q_{GD}$	$V_{DD} = 800 \text{ V}$ , $I_D = 19.3 \text{ A}$ , $V_{GS} = -2/18 \text{ V}$ , turn-on pulse		11		nC	

**(table continues...)**

**Table 4 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800\text{ V}, I_D = 19.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		17	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		16	
Rise time	$t_r$	$V_{DD} = 800\text{ V}, I_D = 19.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		6.4	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		7.3	
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 800\text{ V}, I_D = 19.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		20.6	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		21	
Fall time	$t_f$	$V_{DD} = 800\text{ V}, I_D = 19.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		6.9	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		6.9	
Turn-on energy	$E_{on}$	$V_{DD} = 800\text{ V}, I_D = 19.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		190	$\mu\text{J}$
			$T_{vj} = 175\text{ }^\circ\text{C}$		305	
Turn-off energy	$E_{off}$	$V_{DD} = 800\text{ V}, I_D = 19.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		50	$\mu\text{J}$
			$T_{vj} = 175\text{ }^\circ\text{C}$		53	
Total switching energy	$E_{tot}$	$V_{DD} = 800\text{ V}, I_D = 19.3\text{ A},$ $V_{GS} = 0/18\text{ V},$ $R_{GS(on)} = 1\ \Omega,$ $R_{GS(off)} = 1\ \Omega,$ diode: body diode at $V_{GS} = 0\text{ V},$ $L_\sigma = 15\text{ nH}$	$T_{vj} = 25\text{ }^\circ\text{C}$		270	$\mu\text{J}$
			$T_{vj} = 175\text{ }^\circ\text{C}$		478	

(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	$R_{th(j-c)}$			0.51	0.66	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 $T_{vj(max)}$	$I_{SDC}$	$V_{GS} = 0\text{ V}$	$T_c = 25\text{ °C}$	44	A
			$T_c = 100\text{ °C}$	26	
Peak reverse drain current, $t_p$ limited by $T_{vj(max)}$	$I_{SM}$	$V_{GS} = 0\text{ V}$	117	A	

**Table 6** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Drain-source reverse voltage	$V_{SD}$	$I_{SD} = 19.3\text{ A}, V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		3.8	5	V
			$T_{vj} = 100\text{ °C}$		3.7		
			$T_{vj} = 175\text{ °C}$		3.6		
MOSFET forward recovery charge	$Q_{fr}$	$V_{DD} = 800\text{ V}, I_{SD} = 19.3\text{ A}, V_{GS} = 0\text{ V}, di_f/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also $Q_C$	$T_{vj} = 25\text{ °C}$		160		nC
			$T_{vj} = 175\text{ °C}$		293		
MOSFET peak forward recovery current	$I_{frm}$	$V_{DD} = 800\text{ V}, I_{SD} = 19.3\text{ A}, V_{GS} = 0\text{ V}, di_f/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also $Q_C$	$T_{vj} = 25\text{ °C}$		31		A
			$T_{vj} = 175\text{ °C}$		50		
MOSFET forward recovery energy	$E_{fr}$	$V_{DD} = 800\text{ V}, I_{SD} = 19.3\text{ A}, V_{GS} = 0\text{ V}, di_f/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also $Q_C$	$T_{vj} = 25\text{ °C}$		30		μJ
			$T_{vj} = 175\text{ °C}$		122		

(table continues...)

**Table 6** (continued) Characteristic values

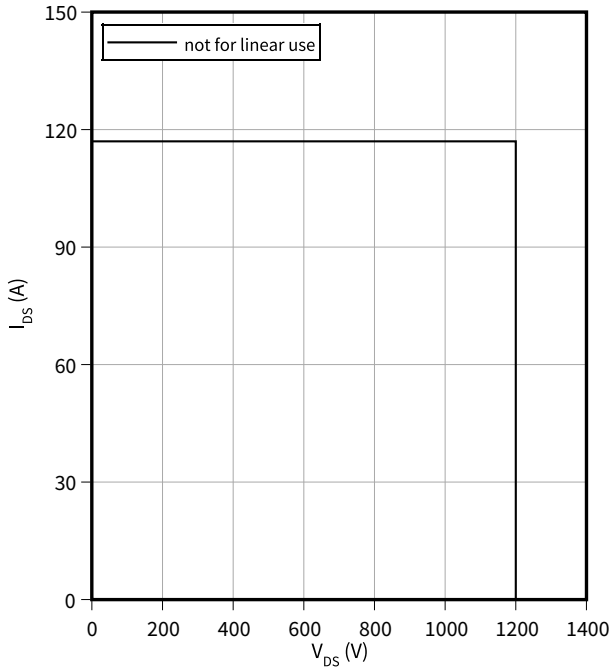
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
MOSFET/body diode thermal resistance, junction to case	$R_{th(j-c)}$			0.51	0.66	K/W
Virtual junction temperature	$T_{vj}$		-55		175	°C

## 4 Characteristics diagrams

### Reverse bias safe operating area (RBSOA), MOSFET

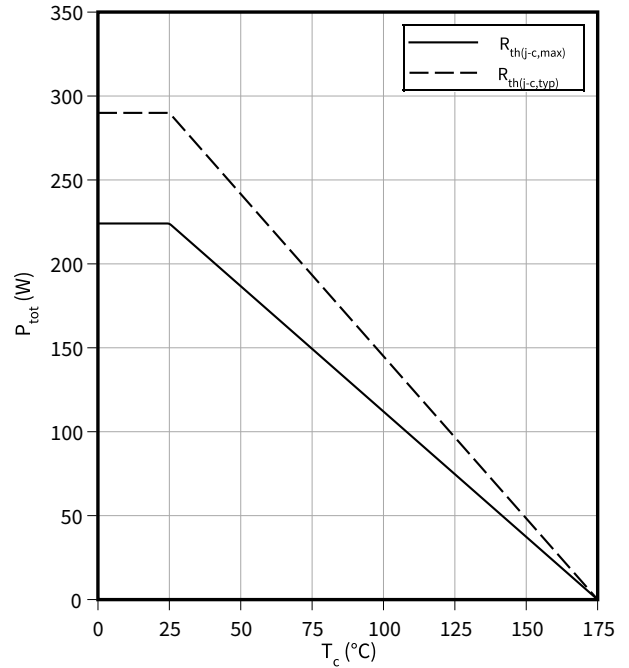
$$I_{DS} = f(V_{DS})$$

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



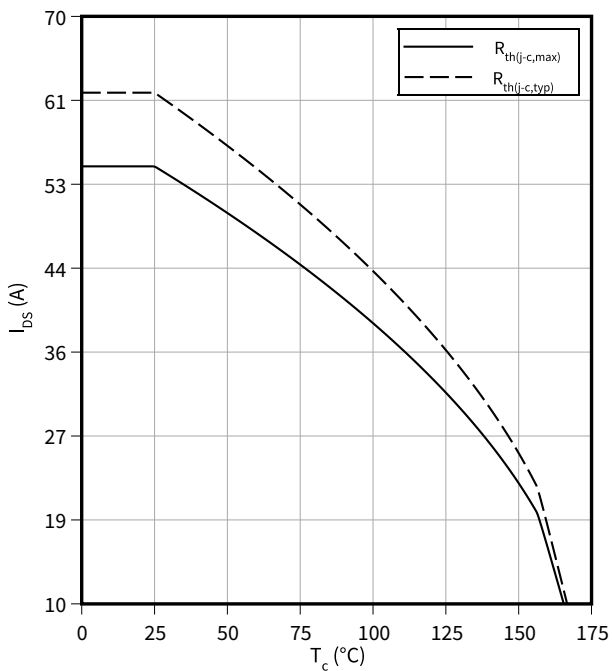
### Power dissipation as a function of case temperature limited by bond wire, MOSFET

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



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

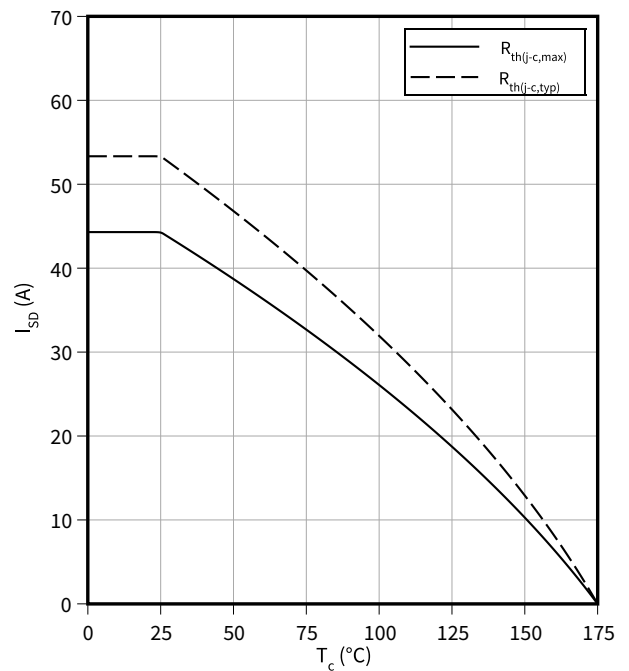
$$I_{DS} = f(T_c)$$



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

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

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

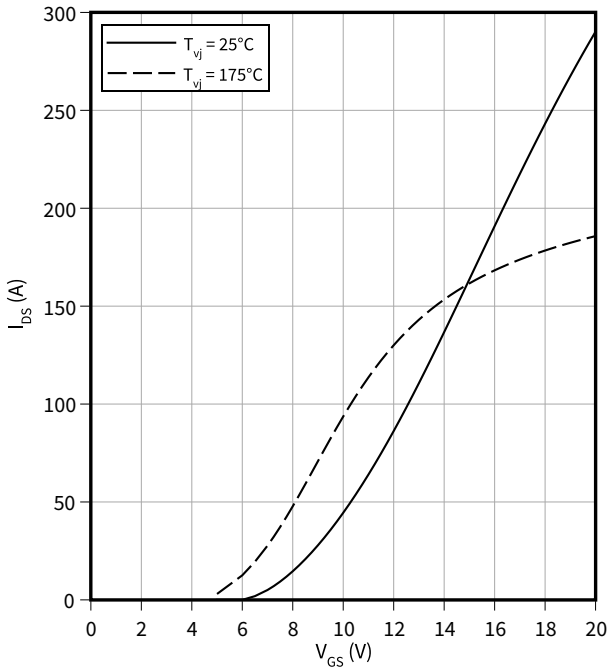




4 Characteristics diagrams

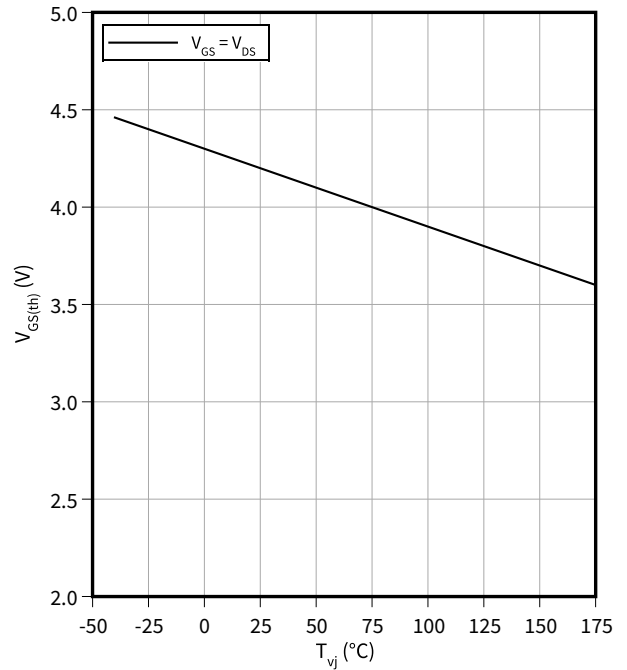
**Typical transfer characteristic , MOSFET**

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



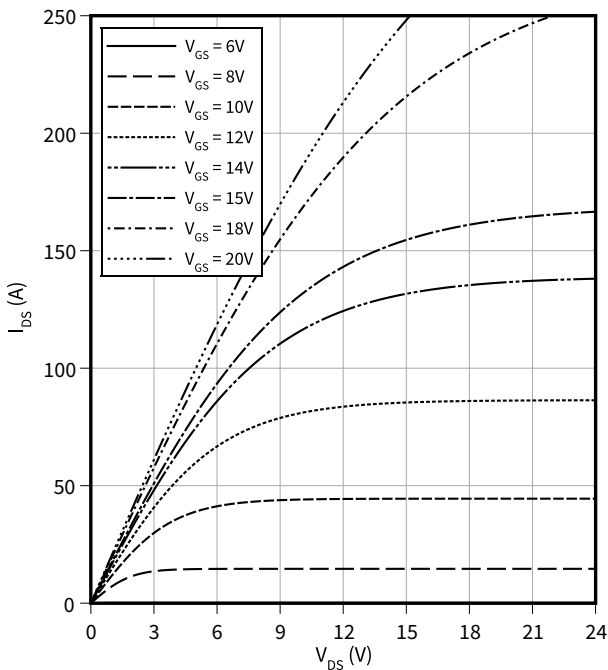
**Typical gate-source threshold voltage as a function of junction temperature , MOSFET**

$V_{GS(th)} = f(T_{vj})$   
 $I_D = 8.3 \text{ mA}$



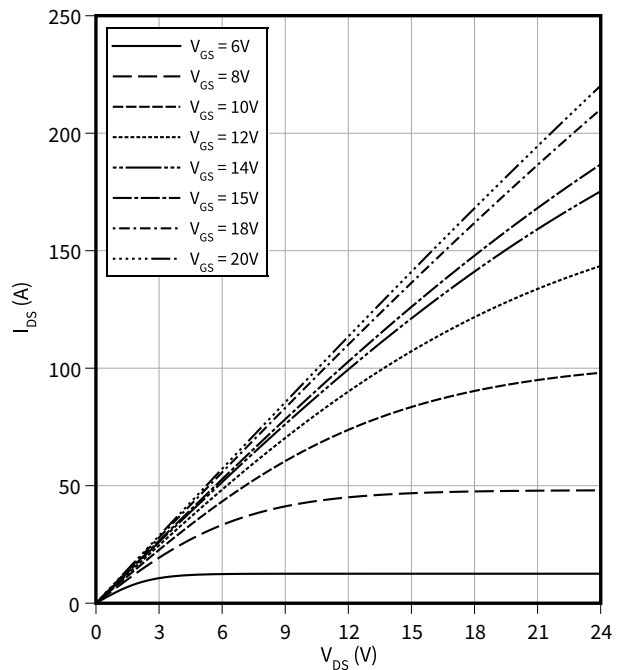
**Typical output characteristic,  $V_{GS}$  as parameter , MOSFET**

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



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

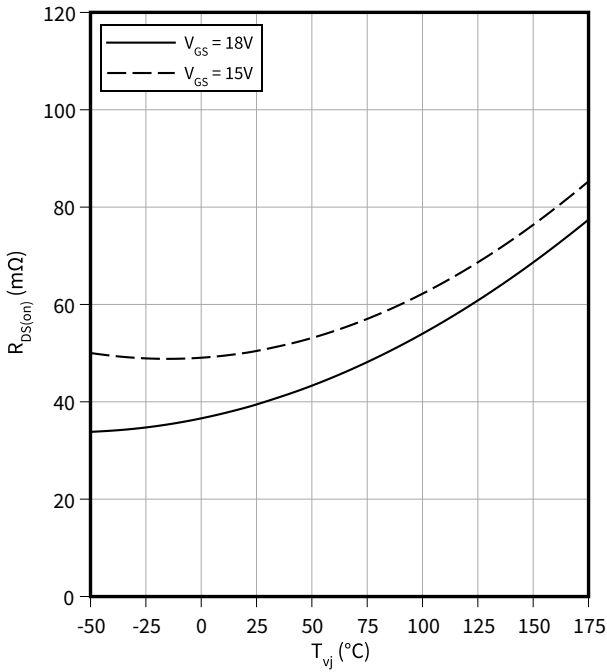
$I_{DS} = f(V_{DS})$   
 $T_{vj} = 175^\circ\text{C}, t_p = 20 \mu\text{s}$



4 Characteristics diagrams

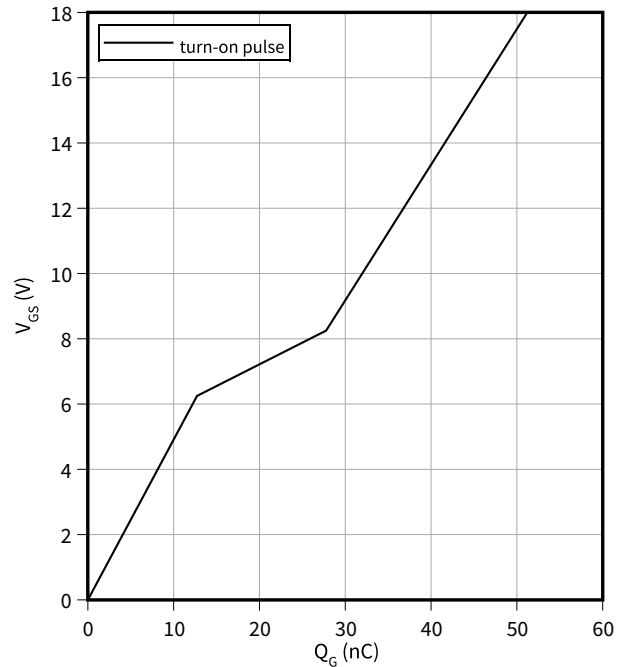
**Typical on-state resistance as a function of junction temperature, MOSFET**

$R_{DS(on)} = f(T_{vj})$   
 $I_D = 19.3 \text{ A}$



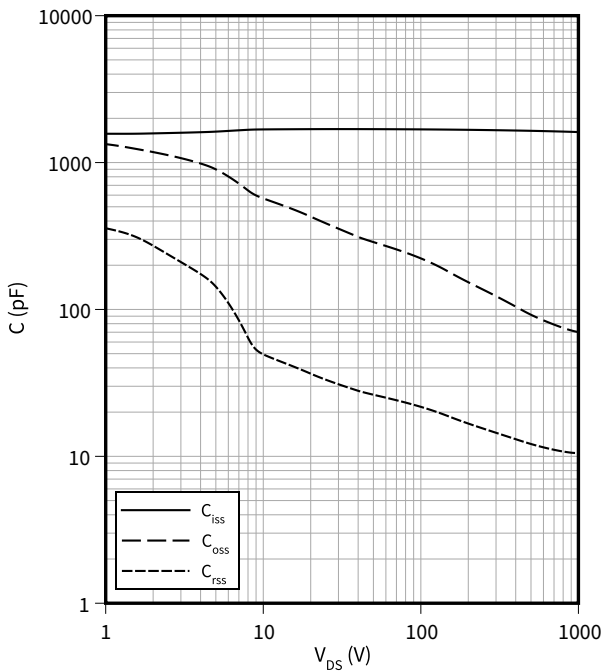
**Typical gate charge, MOSFET**

$V_{GS} = f(Q_G)$   
 $I_D = 19.3 \text{ A}, V_{DS} = 800 \text{ V}$



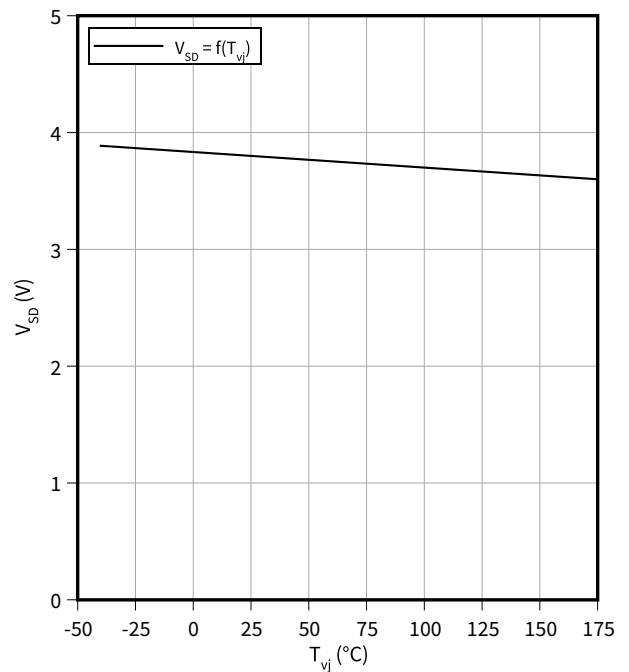
**Typical capacitance as a function of drain-source voltage, MOSFET**

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



**Typical reverse drain voltage as function of junction temperature, MOSFET**

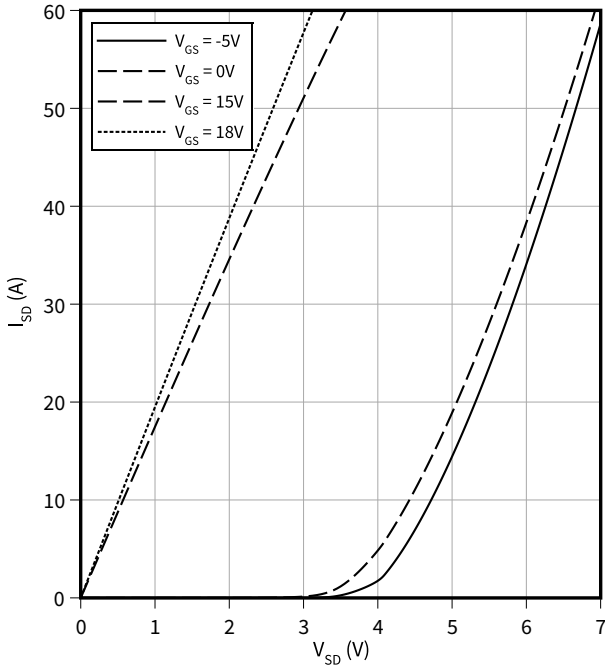
$V_{SD} = f(T_{vj})$   
 $I_{SD} = 19.3 \text{ A}, V_{GS} = 0 \text{ V}$



4 Characteristics diagrams

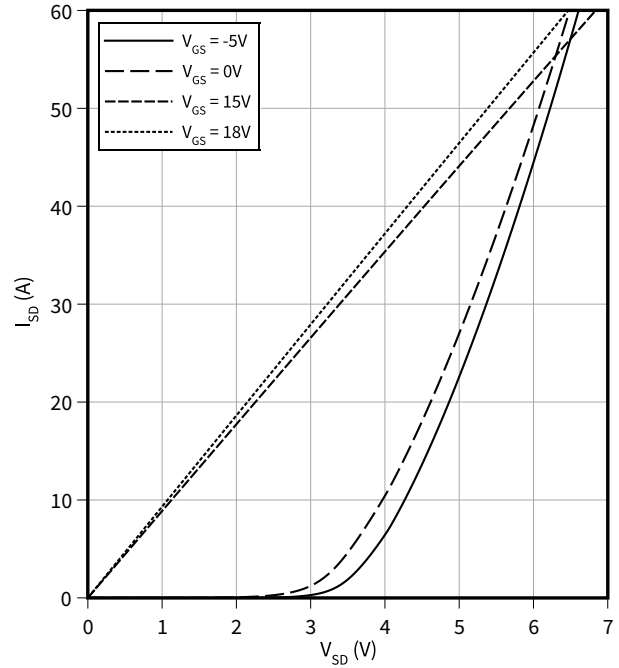
**Typical reverse drain current as function of reverse drain voltage,  $V_{GS}$  as parameter, MOSFET**

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



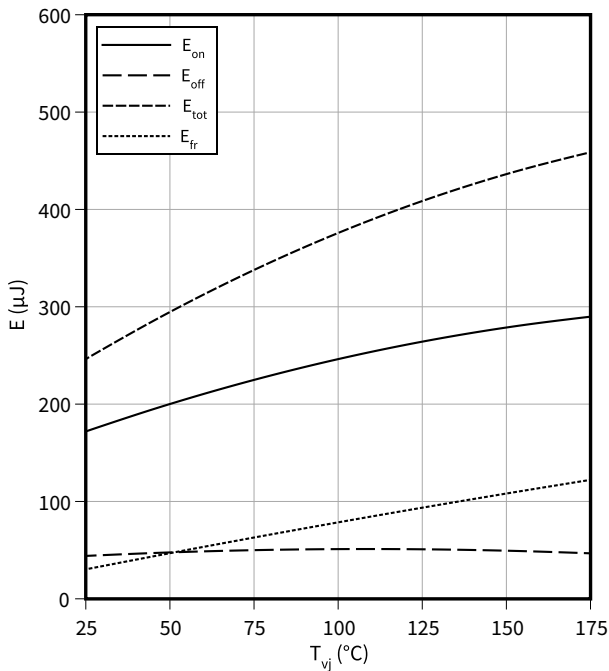
**Typical reverse drain current as function of reverse drain voltage,  $V_{GS}$  as parameter, MOSFET**

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



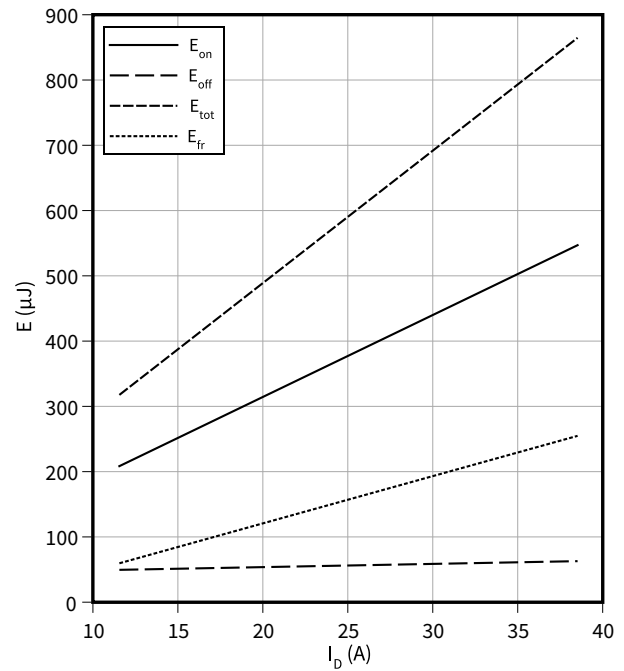
**Typical switching energy as a function of junction temperature, test circuit in Fig. F, 2nd device own body diode:  $V_{GS} = 0\text{ V}$ , MOSFET**

$E = f(T_{vj})$   
 $V_{GS} = 0/18\text{ V}$ ,  $I_D = 19.3\text{ A}$ ,  $R_{G,ext} = 1\text{ }\Omega$ ,  $V_{DD} = 800\text{ V}$



**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**

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

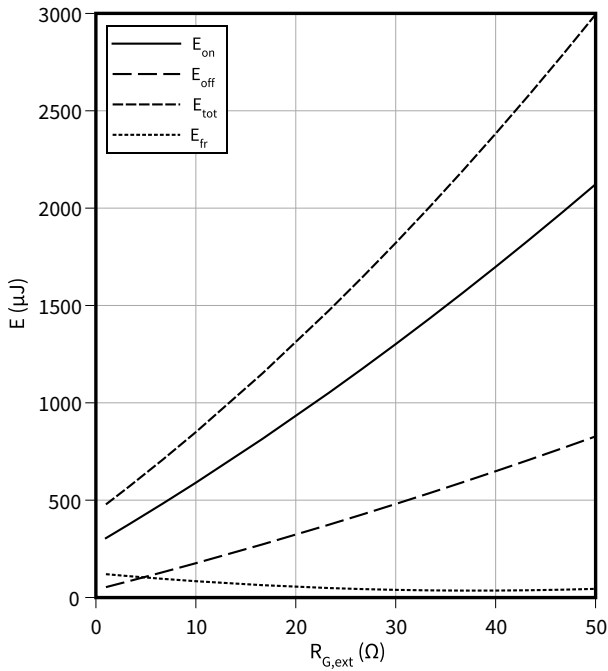


4 Characteristics diagrams

**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**

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

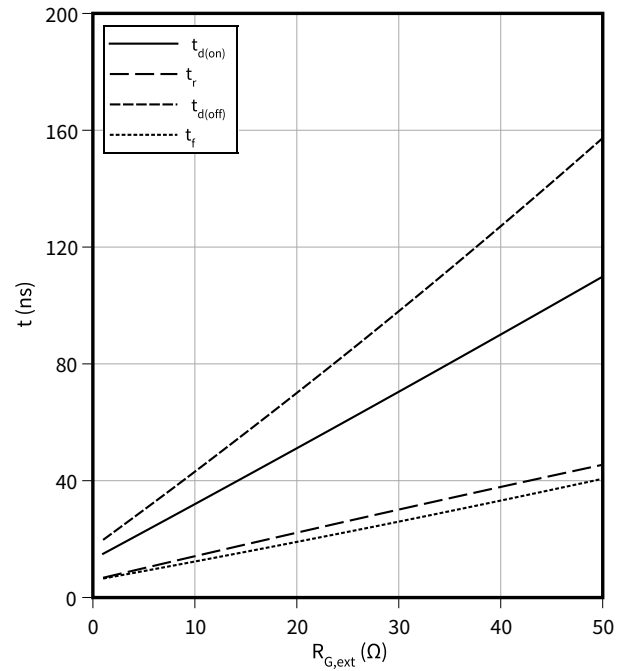
$V_{GS} = 0/18$  V,  $I_D = 19.3$  A,  $T_{vj} = 175$  °C,  $V_{DD} = 800$  V



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

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

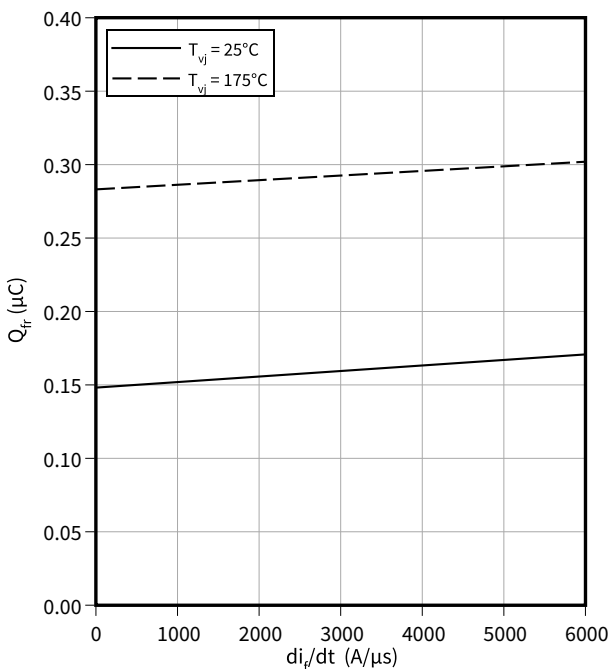
$V_{GS} = 0/18$  V,  $I_D = 19.3$  A,  $T_{vj} = 175$  °C,  $V_{DD} = 800$  V



**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**

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

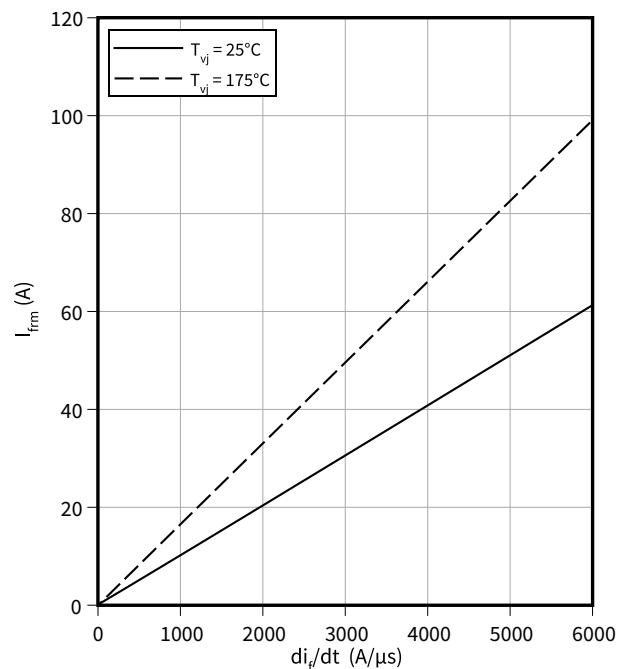
$V_{GS} = 0/18$  V,  $I_D = 19.3$  A,  $V_{DD} = 800$  V



**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,  $I_D = 19.3$  A,  $V_{DD} = 800$  V

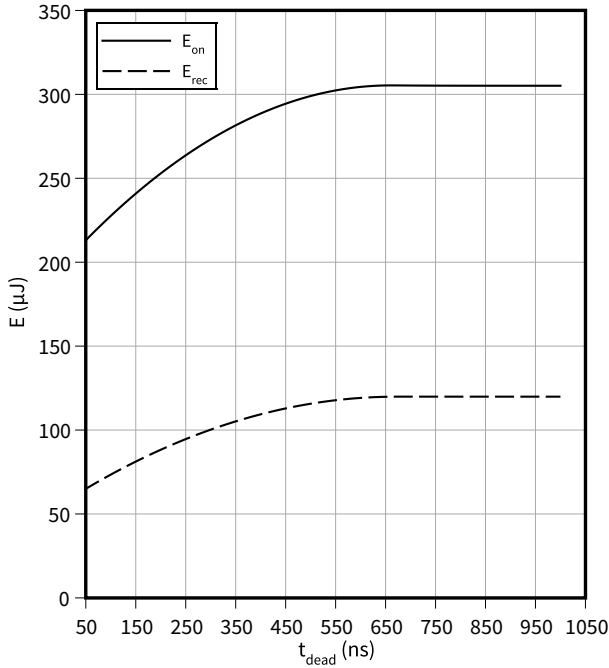


4 Characteristics diagrams

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

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

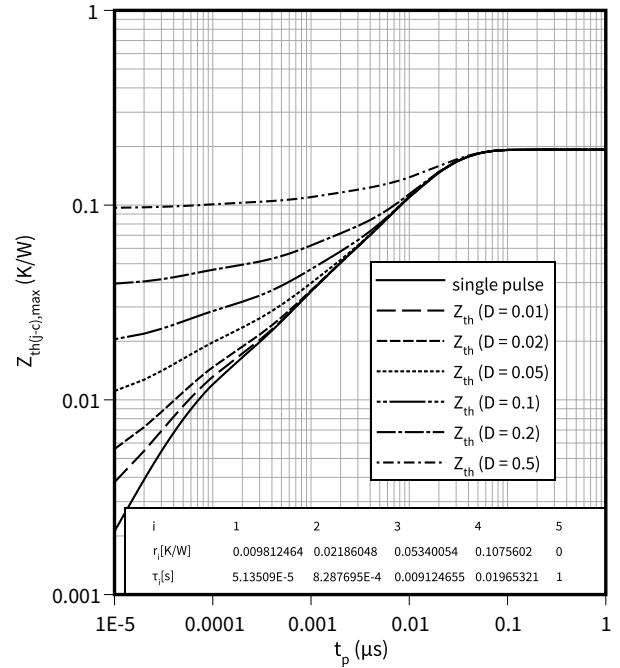
$V_{GS} = -5/18$  V,  $I_D = 19.3$  A,  $T_{vj} = 175$  °C,  $V_{DD} = 800$  V



**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

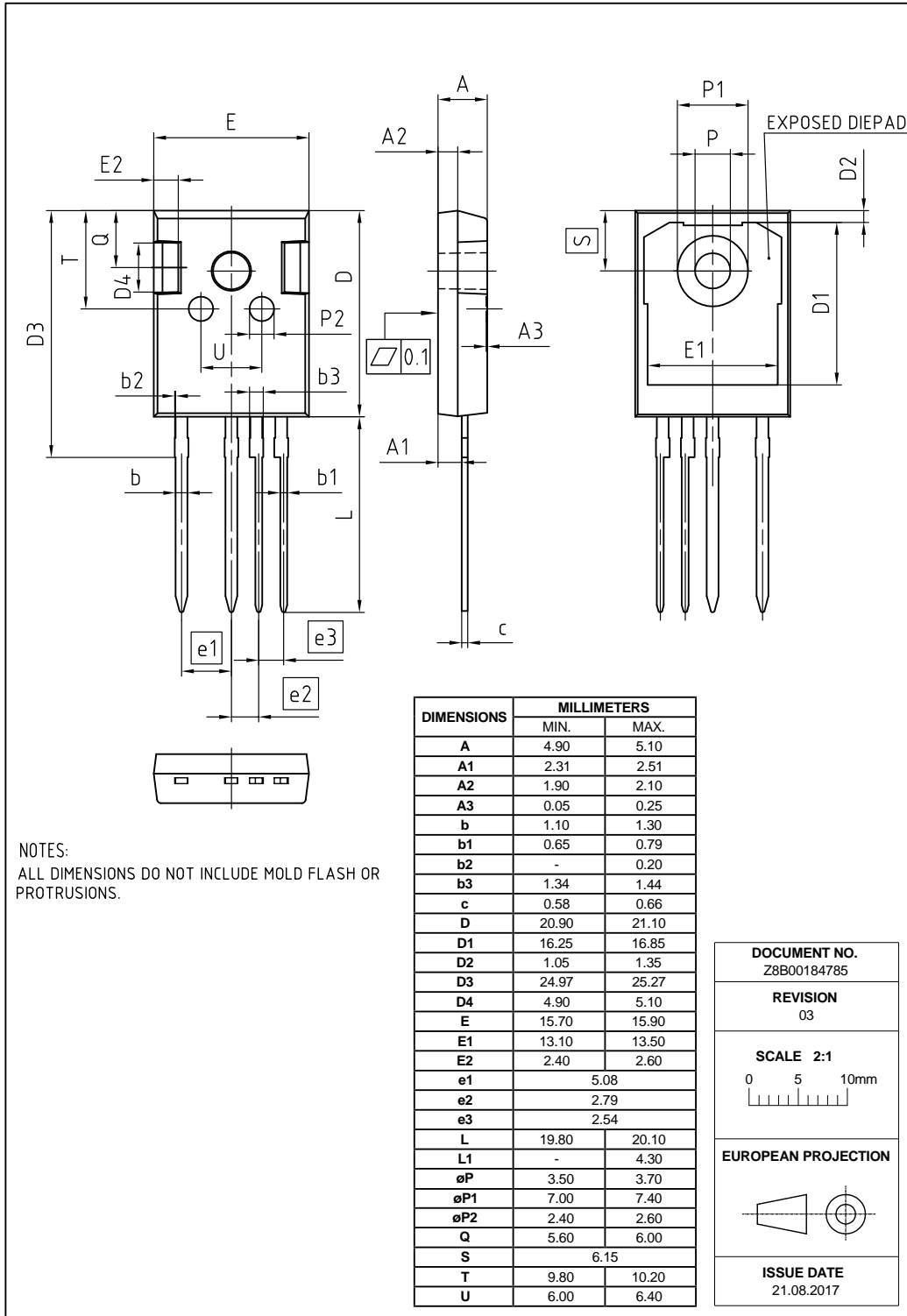


Figure 1

## 6 Testing conditions

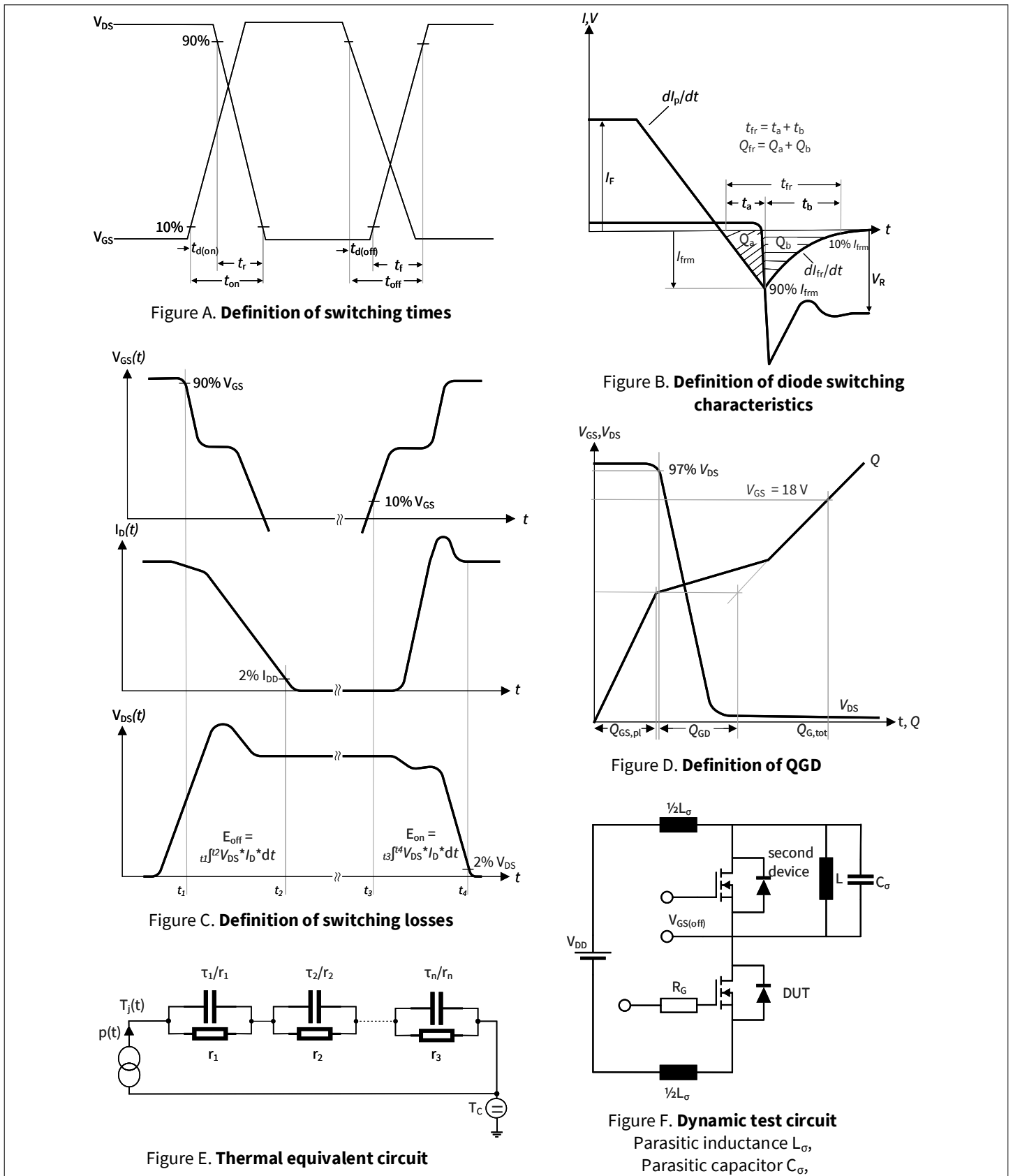


Figure 2

Revision history

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**Revision history**

<b>Document revision</b>	<b>Date of release</b>	<b>Description of changes</b>
1.00	2022-01-31	Final datasheet



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