

CoolSiC™ 2000 V SiC Trench MOSFET : Silicon Carbide MOSFET with .XT interconnection technology

Features

- $V_{DS} = 2000\text{ V}$ at $T_{vj} = 25^\circ\text{C}$
- $I_{DCC} = 123\text{ A}$ at $T_c = 25^\circ\text{C}$
- $R_{DS(on)} = 12\text{ m}\Omega$ at $V_{GS} = 18\text{ V}$, $T_{vj} = 25^\circ\text{C}$
- Very low switching losses
- Benchmark gate threshold voltage, $V_{GS(th)} = 4.5\text{ V}$
- Robust body diode for hard commutation
- .XT interconnection technology for best-in-class thermal performance

Potential applications

- String inverter
- Solar power optimizer
- EV-Charging

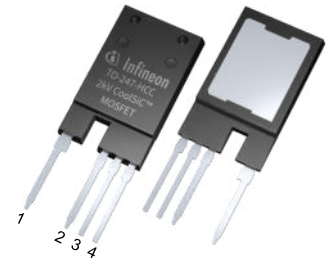
Product validation

- Qualified for industrial applications according to the relevant tests of JEDEC47/20/22
- Please also note the application note AN2019-05 for power and thermal cycling

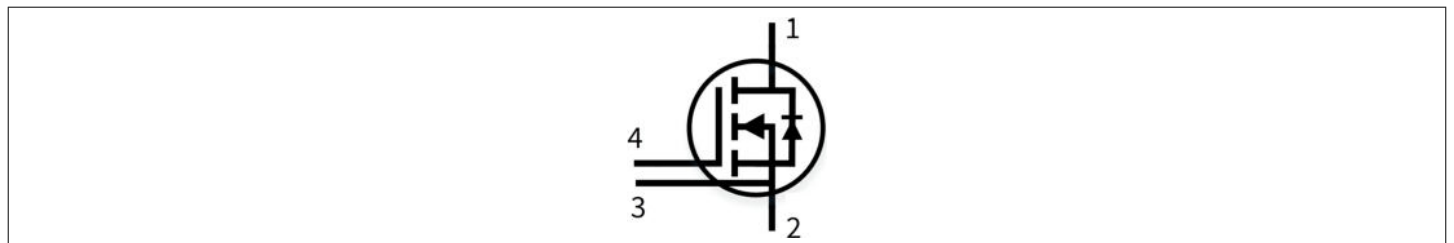
Description

- 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)



- Halogen-free
- Green
- Lead-free
- RoHS



Type	Package	Marking
IMYH200R012M1H	PG-TO247-4-PLUS-NT14	20M1H012

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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	T_{sold}	wave soldering 1.6 mm (0.063 in.) from case for 10 s			260	°C
Thermal resistance, junction-ambient	$R_{th(j-a)}$				62	K/W
MOSFET/body diode thermal resistance, junction-case	$R_{th(j-c)}$			0.12	0.16	K/W

2 MOSFET

Table 2 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Drain-source voltage	V_{DSS}	$T_{vj} \geq 25 \text{ °C}$	2000	V	
Continuous DC drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$	I_{DDC}	$V_{GS} = 18 \text{ V}$	$T_c = 25 \text{ °C}$	123	A
			$T_c = 100 \text{ °C}$	94	
Peak drain current, t_p limited by $T_{vj(max)}$	I_{DM}	$V_{GS} = 18 \text{ V}$	282	A	
Gate-source voltage, max. transient voltage ¹⁾	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}		-7/20	V	
Power dissipation, limited by $T_{vj(max)}$	P_{tot}	$T_c = 25 \text{ °C}$	552	W	
		$T_c = 100 \text{ °C}$	319		

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
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	$R_{DS(on)}$	$I_D = 60\text{ A}$	$T_{vj} = 25\text{ °C}$, $V_{GS(on)} = 18\text{ V}$		12	16.5	mΩ
			$T_{vj} = 100\text{ °C}$, $V_{GS(on)} = 18\text{ V}$		20		
			$T_{vj} = 175\text{ °C}$, $V_{GS(on)} = 18\text{ V}$		36		
			$T_{vj} = 25\text{ °C}$, $V_{GS(on)} = 15\text{ V}$		13	18	
Gate-source threshold voltage	$V_{GS(th)}$	$I_D = 48\text{ mA}$, $V_{DS} = V_{GS}$ (tested after 1 ms pulse at $V_{GS} = 20\text{ V}$)	$T_{vj} = 25\text{ °C}$	3.5	4.5	5.5	V
			$T_{vj} = 175\text{ °C}$		3.6		
Zero gate-voltage drain current	I_{DSS}	$V_{DS} = 2000\text{ V}$, $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			800	μA
			$T_{vj} = 175\text{ °C}$		10		
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}	$I_D = 60\text{ A}$, $V_{DS} = 20\text{ V}$		30			S
Internal gate resistance	$R_{G,int}$	$f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$		3			Ω
Input capacitance	C_{iss}	$V_{DD} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$		9700			pF
Output capacitance	C_{oss}	$V_{DD} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$		322			pF
Reverse transfer capacitance	C_{rss}	$V_{DD} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$		22			pF
C_{oss} stored energy	E_{oss}	$V_{DD} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$		216			μJ
Total gate charge	Q_G	$V_{DD} = 1200\text{ V}$, $I_D = 60\text{ A}$, $V_{GS} = -2/18\text{ V}$, turn-on pulse		246			nC
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 1200\text{ V}$, $I_D = 60\text{ A}$, $V_{GS} = -2/18\text{ V}$, turn-on pulse		66			nC
Gate-to-drain charge	Q_{GD}	$V_{DD} = 1200\text{ V}$, $I_D = 60\text{ A}$, $V_{GS} = -2/18\text{ V}$, turn-on pulse		44			nC
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 1200\text{ V}$, $I_D = 60\text{ A}$, $V_{GS} = -2/18\text{ V}$, $R_{GS(on)} = 2\text{ Ω}$, $R_{GS(off)} = 2\text{ Ω}$, $L_\sigma = 15\text{ nH}$, diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ °C}$		16		ns
			$T_{vj} = 175\text{ °C}$		21		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rise time	t_r	$V_{DD} = 1200\text{ V}, I_D = 60\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		13	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		19	
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 1200\text{ V}, I_D = 60\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		50	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		77	
Fall time	t_f	$V_{DD} = 1200\text{ V}, I_D = 60\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		24	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		27	
Turn-on energy	E_{on}	$V_{DD} = 1200\text{ V}, I_D = 60\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		2400	μJ
			$T_{vj} = 175\text{ }^\circ\text{C}$		3800	
Turn-off energy	E_{off}	$V_{DD} = 1200\text{ V}, I_D = 60\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		960	μJ
			$T_{vj} = 175\text{ }^\circ\text{C}$		1200	
Total switching energy	E_{tot}	$V_{DD} = 1200\text{ V}, I_D = 60\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		4280	μJ
			$T_{vj} = 175\text{ }^\circ\text{C}$		6835	
Virtual junction temperature	T_{vj}		-55		175	$^\circ\text{C}$

Note: The chip technology was characterized up to 100 kV/ μs . The measured dV/dt was limited by measurement test setup and package.

Dynamic test circuit see Fig. F.

3 Body diode (MOSFET)

Table 5 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Drain-source voltage	V_{DSS}	$T_{vj} \geq 25\text{ °C}$	2000	V	
Continuous reverse drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$	I_{SDC}	$V_{GS} = 0\text{ V}$	$T_c = 25\text{ °C}$	123	A
			$T_c = 100\text{ °C}$	94	
Peak reverse drain current, t_p limited by $T_{vj(max)}$	I_{SM}	$V_{GS} = 0\text{ V}$	256	A	

Table 6 Characteristic values

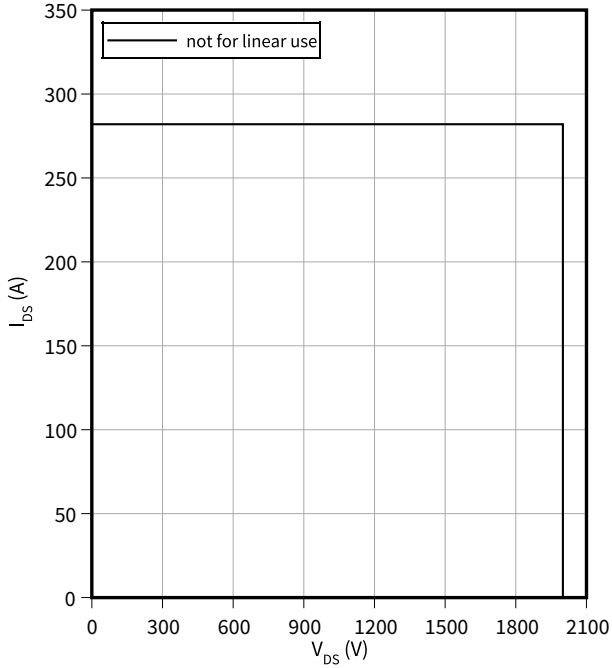
Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Drain-source reverse voltage	V_{SD}	$I_{SD} = 60\text{ A}, V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		3.4	5.5	V
			$T_{vj} = 100\text{ °C}$		3.3		
			$T_{vj} = 175\text{ °C}$		3.2		
MOSFET forward recovery charge	Q_{fr}	$V_{DD} = 1200\text{ V}, I_{SD} = 60\text{ A}, V_{GS} = -2\text{ V}, R_{GS(on)} = 2\text{ }\Omega, Q_{fr}$ includes also Q_C	$T_{vj} = 25\text{ °C}$		2000		nC
			$T_{vj} = 175\text{ °C}$		3950		
MOSFET peak forward recovery current	I_{frm}	$V_{DD} = 1200\text{ V}, I_{SD} = 60\text{ A}, V_{GS} = -2\text{ V}, di_{SD}/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also Q_C	$T_{vj} = 25\text{ °C}$		54		A
			$T_{vj} = 175\text{ °C}$		63		
MOSFET forward recovery energy	E_{fr}	$V_{DD} = 1200\text{ V}, I_{SD} = 60\text{ A}, V_{GS} = -2\text{ V}, R_{GS(on)} = 2\text{ }\Omega, Q_{fr}$ includes also Q_C	$T_{vj} = 25\text{ °C}$		920		μJ
			$T_{vj} = 175\text{ °C}$		1835		
Virtual junction temperature	T_{vj}		-55		175	$^{\circ}\text{C}$	

4 Characteristics diagrams

Reverse bias safe operating area (RBSOA)

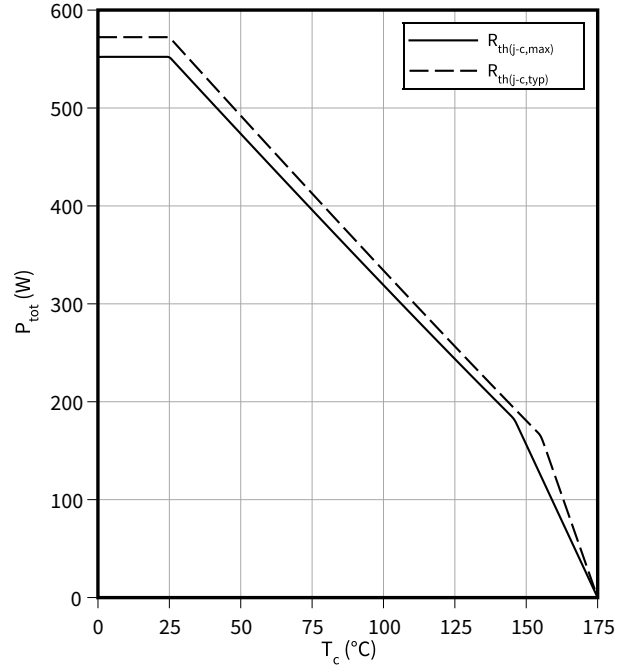
$$I_{DS} = f(V_{DS})$$

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



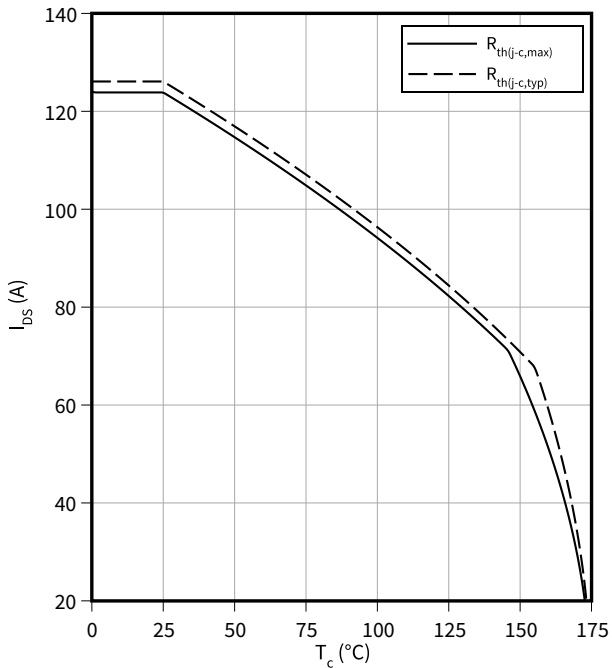
Power dissipation as a function of case temperature limited by bond wire

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



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

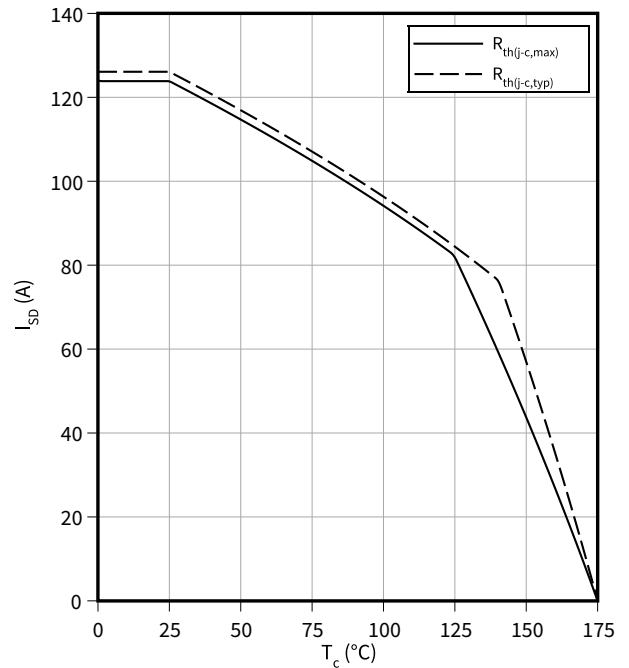
$$I_{DS} = f(T_c)$$



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

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

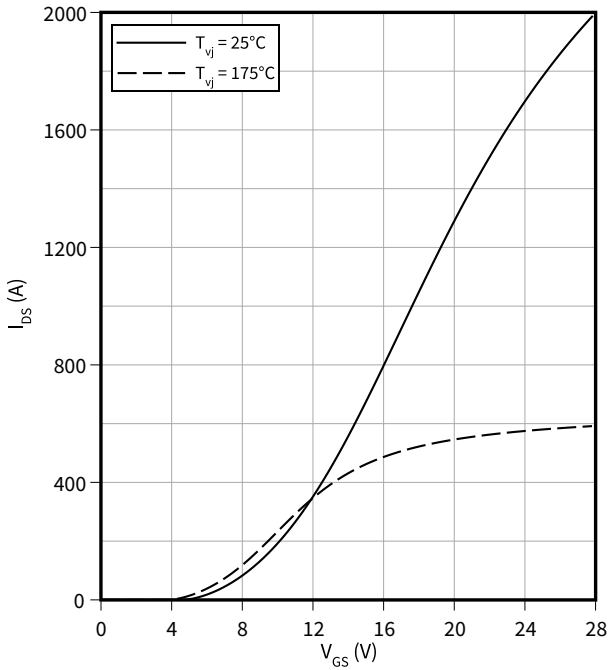
$$V_{GS} = 0\text{ V}$$



4 Characteristics diagrams

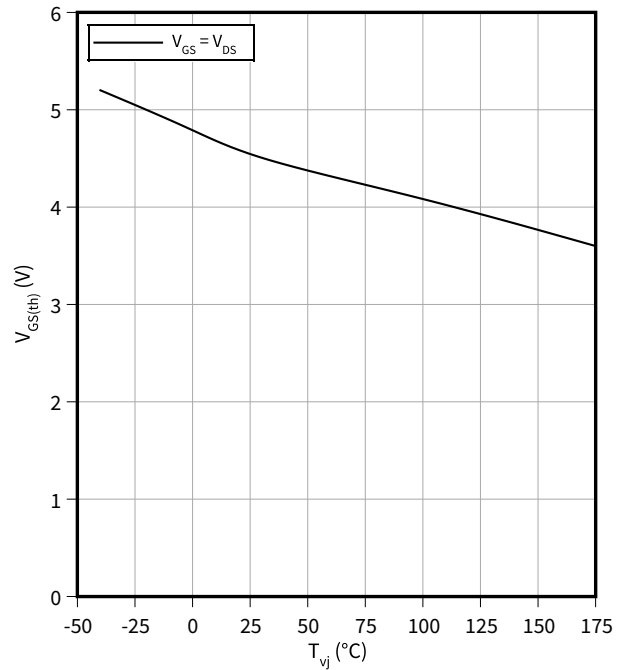
Typical transfer characteristic

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



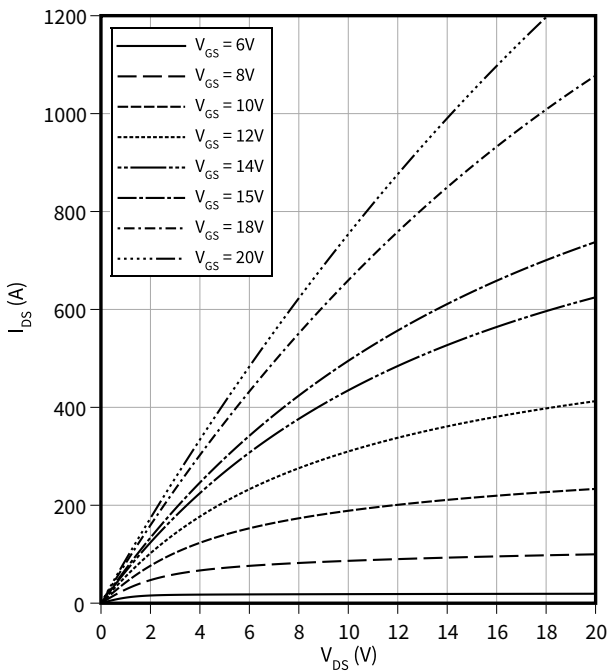
Typical gate-source threshold voltage as a function of junction temperature

$V_{GS(th)} = f(T_{vj})$
 $I_D = 48\text{ mA}$



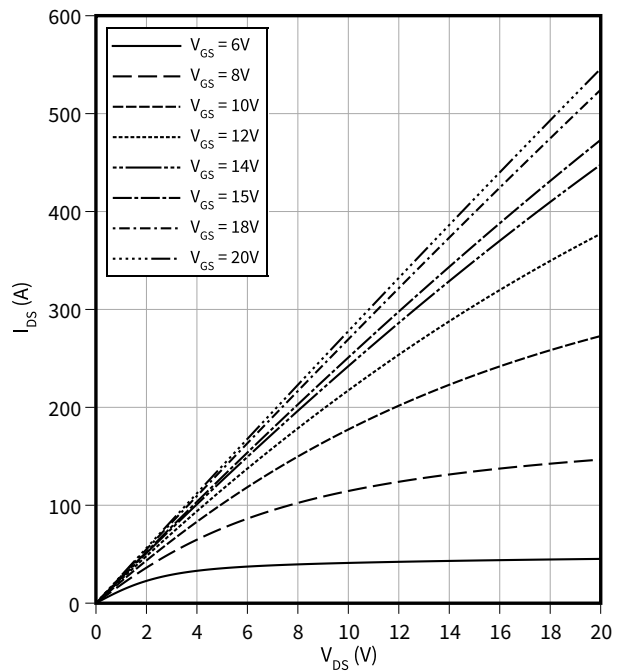
Typical output characteristic, V_{GS} as parameter

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



Typical output characteristic, V_{GS} as parameter

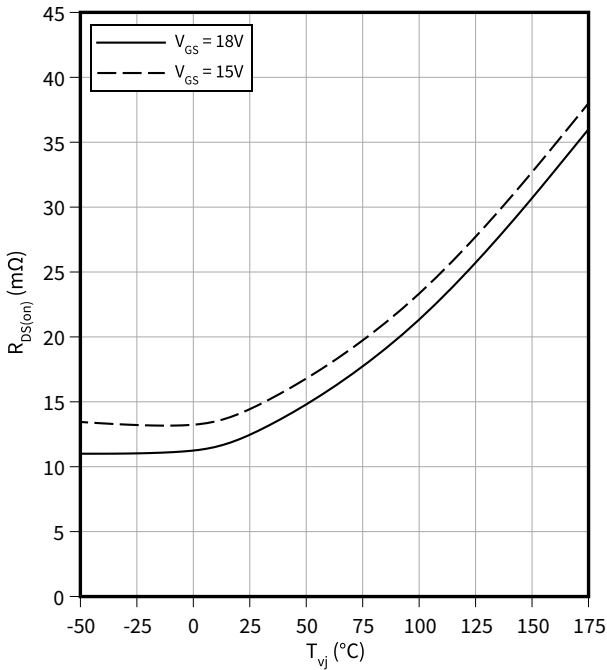
$I_{DS} = f(V_{DS})$
 $T_{vj} = 175\ ^\circ\text{C}$, $t_p = 20\ \mu\text{s}$



4 Characteristics diagrams

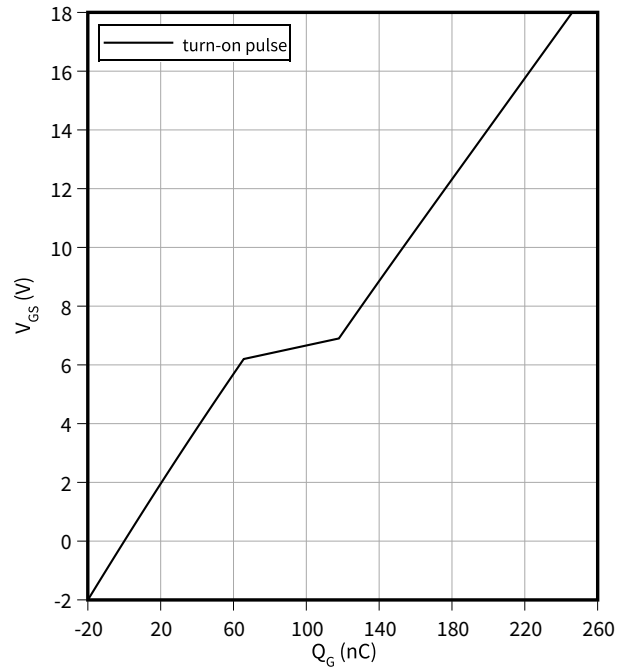
Typical on-state resistance as a function of junction temperature

$R_{DS(on)} = f(T_{vj})$
 $I_D = 60 \text{ A}$



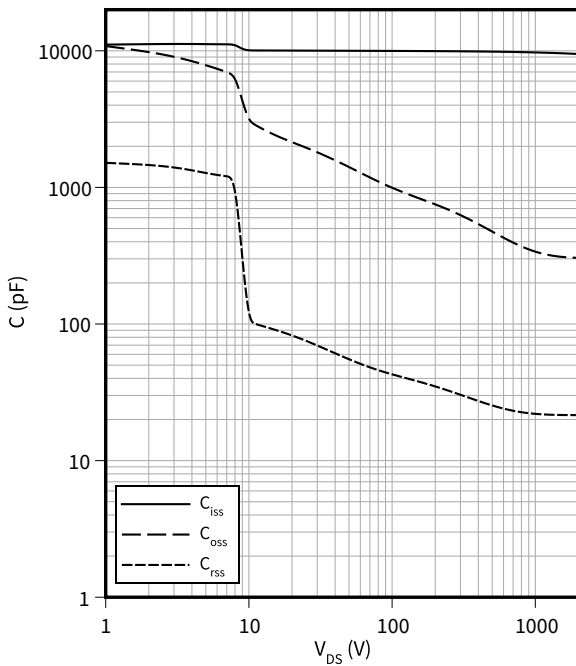
Typical gate charge

$V_{GS} = f(Q_G)$
 $I_D = 60 \text{ A}, V_{DS} = 1200 \text{ V}$



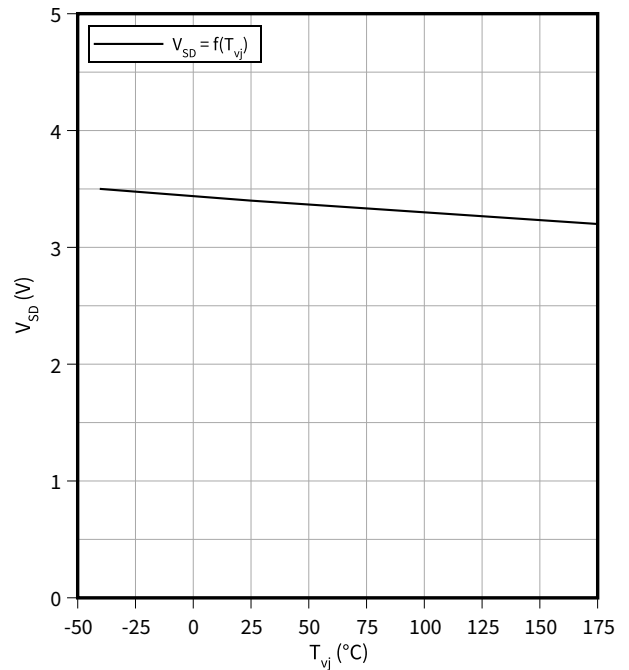
Typical capacitance as a function of drain-source voltage

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



Typical reverse drain voltage as function of junction temperature

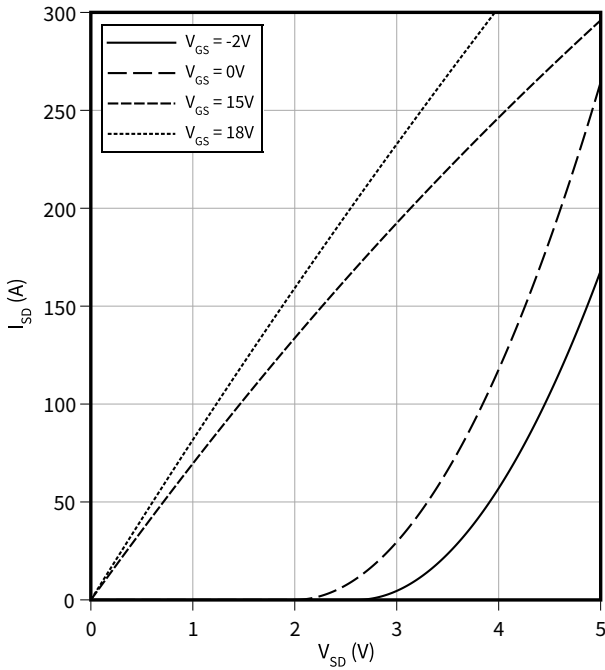
$V_{SD} = f(T_{vj})$
 $I_{SD} = 60 \text{ A}, V_{GS} = 0 \text{ V}$



4 Characteristics diagrams

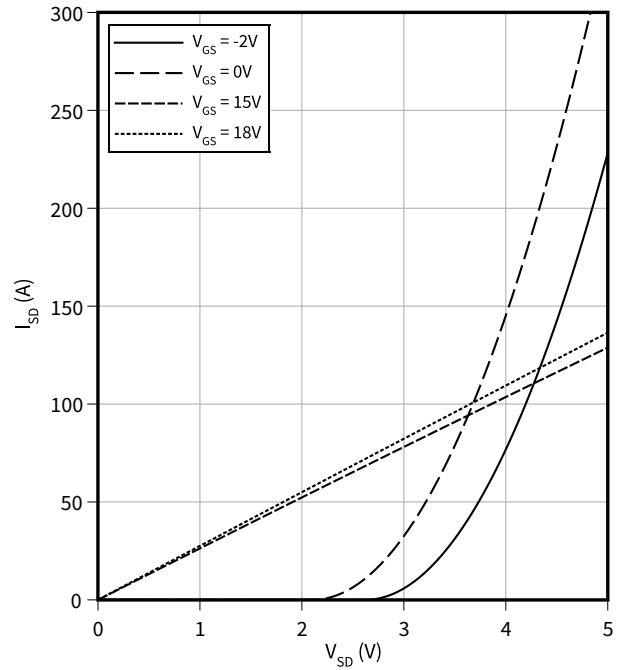
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter

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



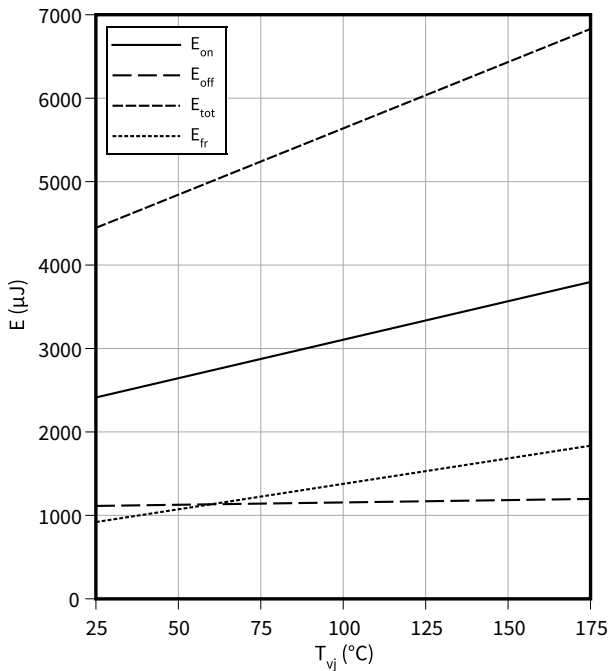
Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter

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



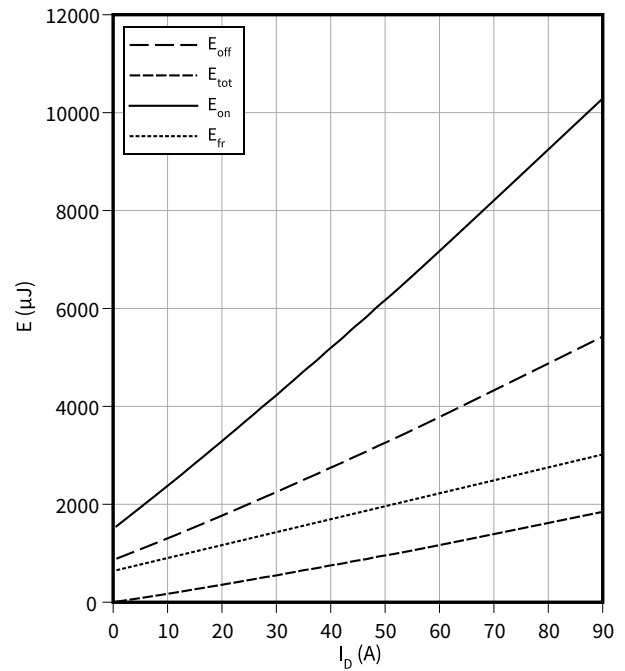
Typical switching energy as a function of junction temperature, test circuit in Fig. F, 2nd device own body diode: $V_{GS} = -2\text{ V}$

$E = f(T_{vj})$
 $V_{GS} = -2/18\text{ V}$, $I_D = 60\text{ A}$, $R_{G,ext} = 2\text{ }\Omega$, $V_{DD} = 1200\text{ V}$



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

$E = f(I_D)$
 $V_{GS} = -2/18\text{ V}$, $T_{vj} = 175\text{ °C}$, $R_{G,ext} = 2\text{ }\Omega$, $V_{DD} = 1200\text{ V}$

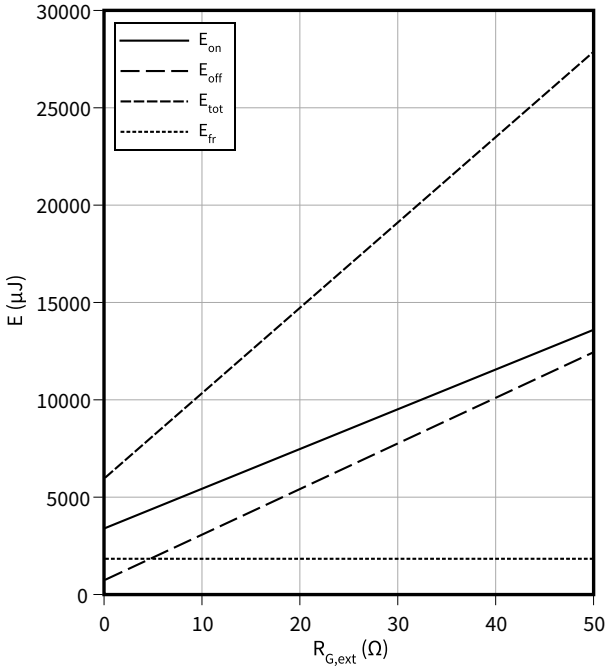


4 Characteristics diagrams

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

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

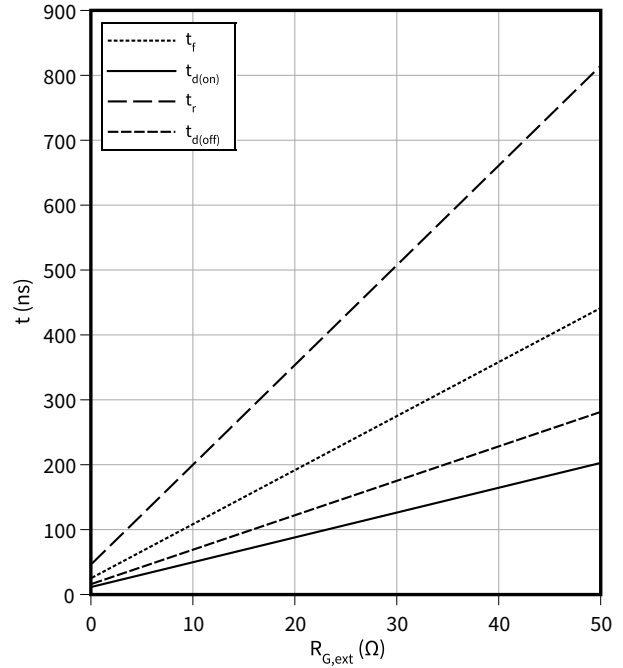
$V_{GS} = -2/18\text{ V}$, $I_D = 60\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{DD} = 1200\text{ V}$



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

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

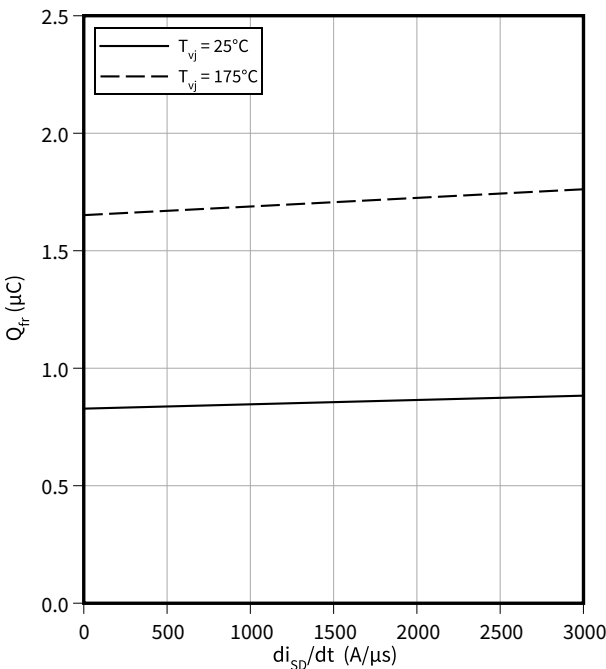
$V_{GS} = -2/18\text{ V}$, $I_D = 60\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{DD} = 1200\text{ V}$



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

$Q_{fr} = f(di_{SD}/dt)$

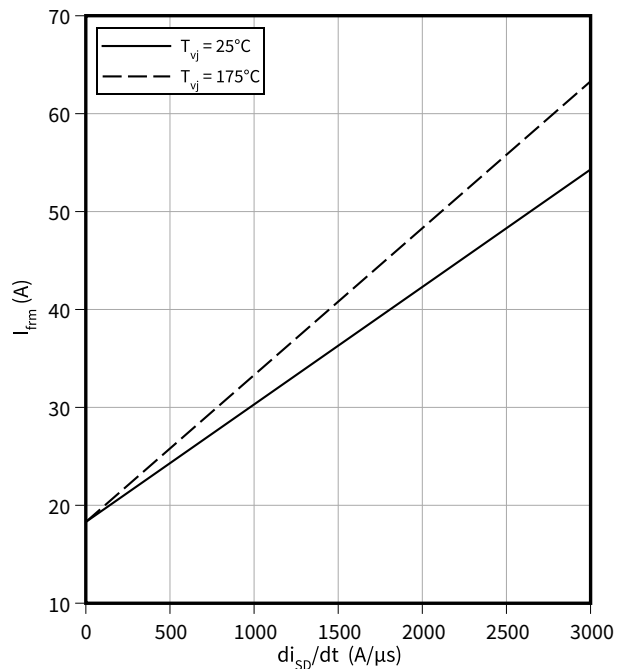
$V_{GS} = -2/18\text{ V}$, $I_{SD} = 60\text{ A}$, $V_{DD} = 1200\text{ V}$



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

$I_{frm} = f(di_{SD}/dt)$

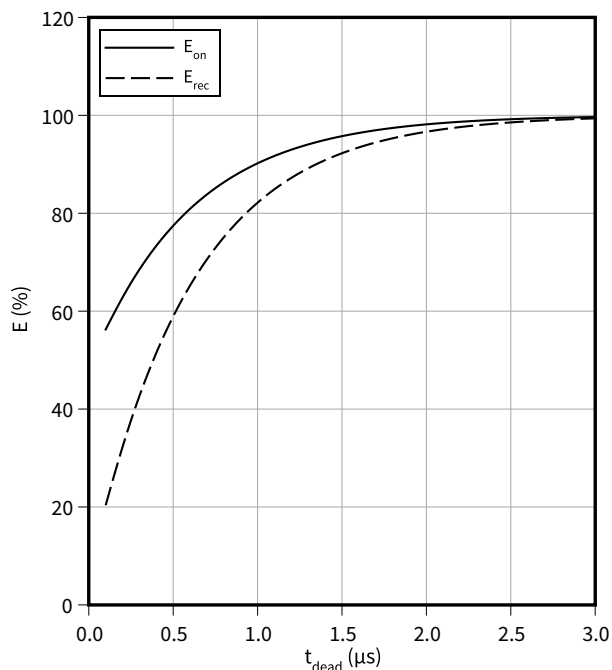
$V_{GS} = -2/18\text{ V}$, $I_{SD} = 60\text{ A}$, $V_{DD} = 1200\text{ V}$



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

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

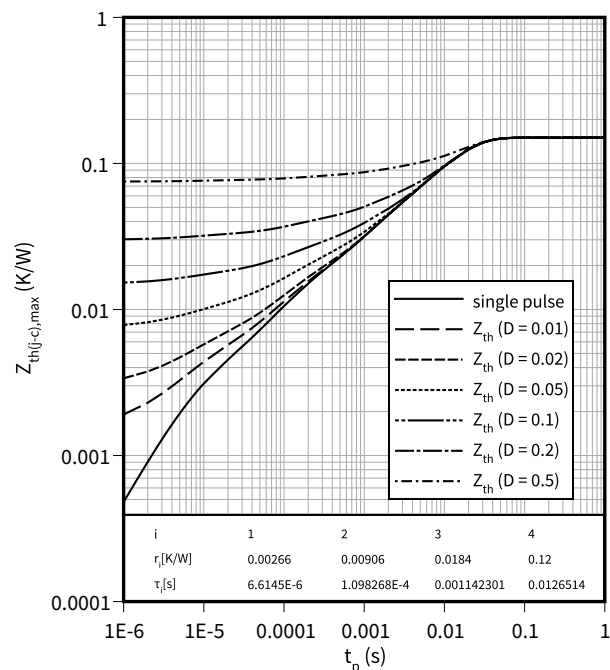
$I_D = 60\text{ A}$, $T_{vj} = 175\text{ °C}$, $R_{G,\text{ext}} = 2\ \Omega$, $V_{DD} = 1200\text{ V}$



Max. transient thermal impedance (MOSFET/diode)

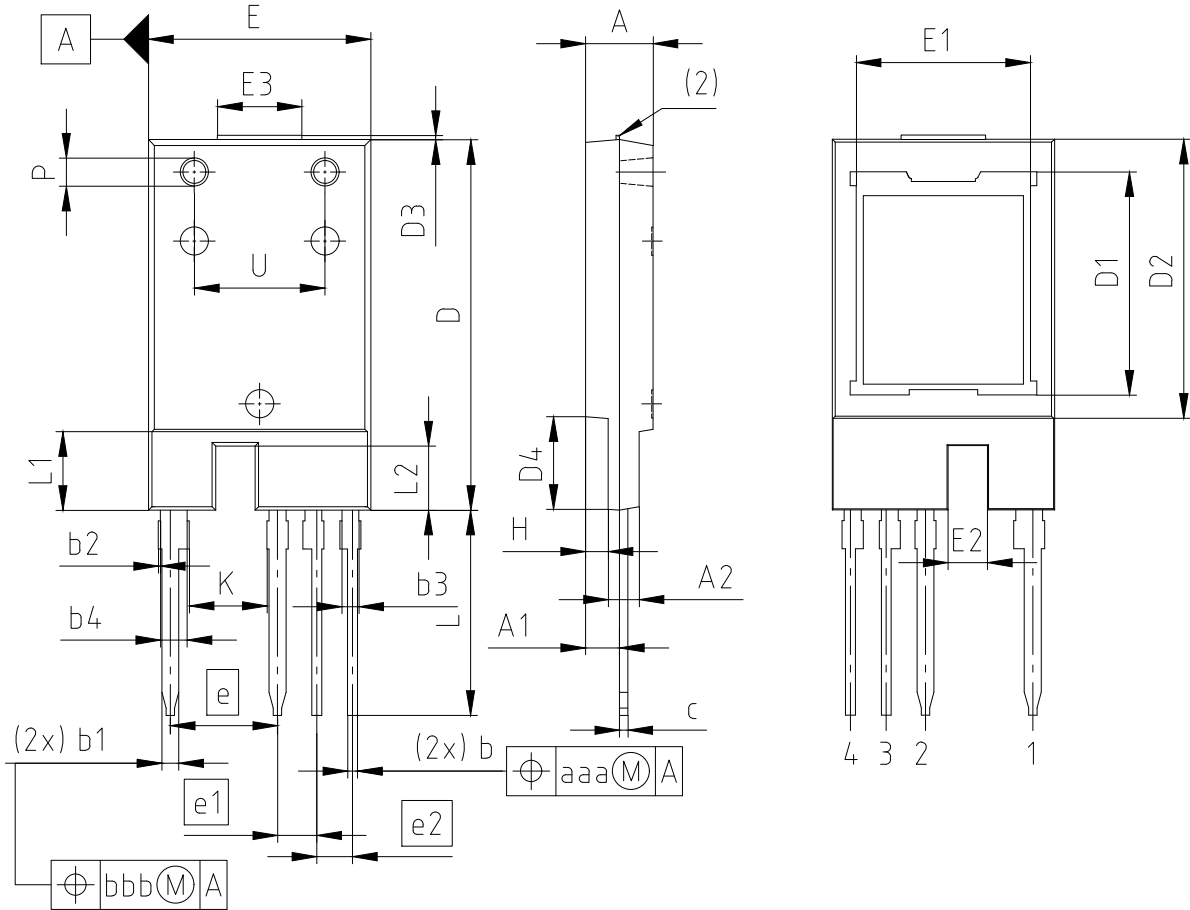
$$Z_{\text{th}(j-c),\text{max}} = f(t_p)$$

$$D = t_p/T$$



5 Package outlines

PG-T0247-4-PLUS-NT14



NOTES:
(1) ALL METAL SURFACES TIN PLATED EXPECT AREA OF CUT
(2) MOLD GATE PROTRUSION AFTER DEGATING

PACKAGE - GROUP NUMBER: **PG-T0247-4-U04**

DIMENSIONS	MILLIMETERS		DIMENSIONS	MILLIMETERS	
	MIN.	MAX.		MIN.	MAX.
A	4.65	4.95	E1	12.00	12.80
A1	2.16	2.66	E2	2.60	3.00
A2	2.00	2.40	E3	5.00	7.00
b	0.60	0.80	e	7.62	
b1	1.10	1.30	e1	2.79	
b2	---	0.15	e2	2.54	
b3	1.10	1.30	H	1.51	1.71
b4	1.70	2.10	K	5.50	---
c	0.50	0.70	N	4	
D	26.00	26.70	L	14.30	14.90
D1	15.50	16.30	L1	5.40	5.70
D2	19.40	20.20	L2	5.40	5.70
D3	---	0.50	ØP	1.75	2.25
D4	6.35	6.65	U	9.00	9.50
E	15.60	16.00	aaa	0.25	
			bbb	0.25	

Figure 1

6 Testing conditions

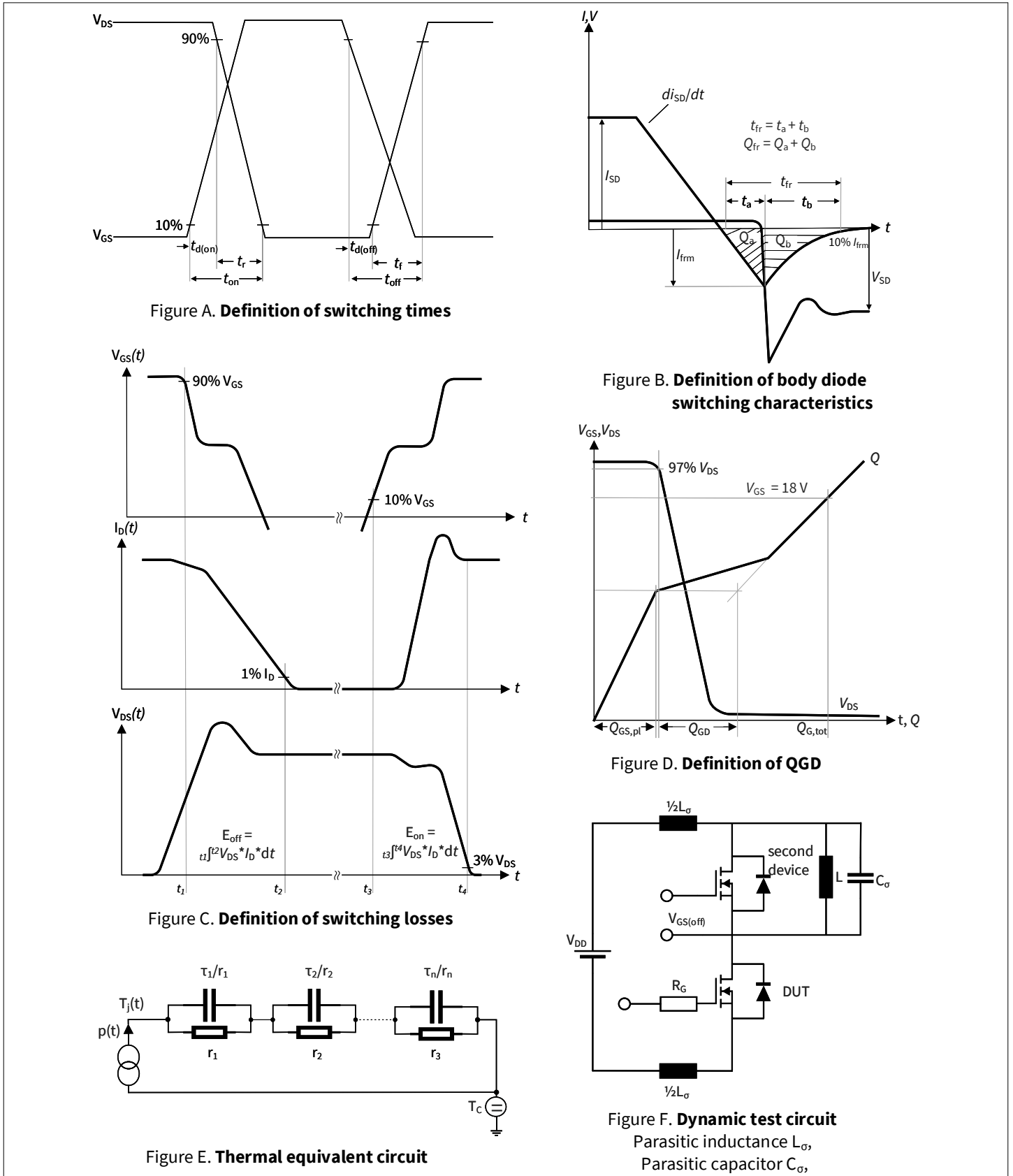


Figure 2

Revision history

Revision history

Document revision	Date of release	Description of changes
0.10	2022-03-08	Preliminary datasheet
1.00	2022-10-04	Final datasheet
1.01	2022-10-06	Editorial changes
1.10	2023-01-16	Change of picture on page 1 Change of product outline drawing on page 13 Editorial changes

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