

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

**Features**

- $V_{DS} = 2000\text{ V}$  at  $T_{vj} = 25^\circ\text{C}$
- $I_{DCC} = 89\text{ A}$  at  $T_c = 25^\circ\text{C}$
- $R_{DS(on)} = 24\text{ m}\Omega$  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

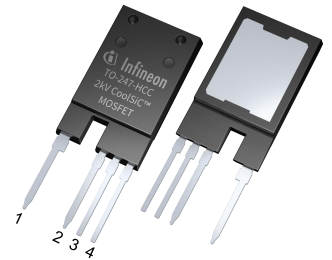
**Product validation**

- 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

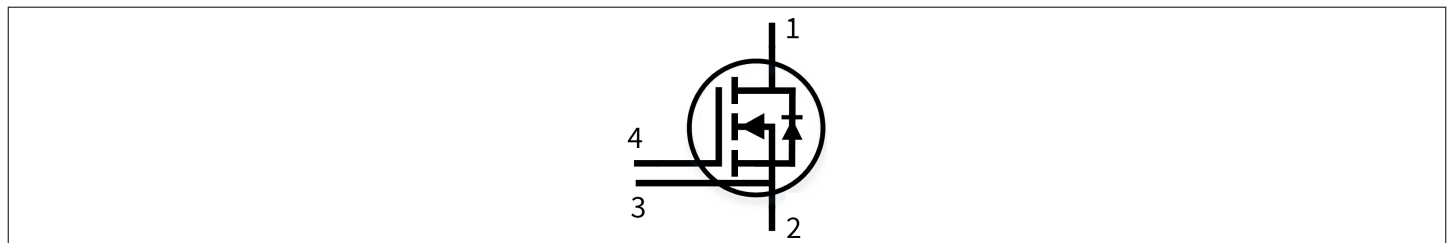
**Description**

- 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
IMYH200R024M1H	PG-TO247-4-PLUS-NT14	20M1H024

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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	$R_{th(j-c)}$			0.20	0.26	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 $T_{vj(max)}$	$I_{DDC}$	$V_{GS} = 18\text{ V}$	$T_c = 25\text{ °C}$	89	A
			$T_c = 100\text{ °C}$	63	
Peak drain current, $t_p$ limited by $T_{vj(max)}$	$I_{DM}$	$V_{GS} = 18\text{ V}$	189	A	
Gate-source voltage, max. transient voltage <sup>1)</sup>	$V_{GS}$	$t_p \leq 0.5\ \mu\text{s}$ , $D < 0.01$	-10/23	V	
Gate-source voltage, max. static voltage	$V_{GS}$		-7/20	V	
Power dissipation, limited by $T_{vj(max)}$	$P_{tot}$	$T_c = 25\text{ °C}$	576	W	
		$T_c = 100\text{ °C}$	288		

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	$R_{DS(on)}$	$I_D = 40\text{ A}$	$T_{vj} = 25\text{ °C}$ , $V_{GS(on)} = 18\text{ V}$		24	33	mΩ
			$T_{vj} = 100\text{ °C}$ , $V_{GS(on)} = 18\text{ V}$		41		
			$T_{vj} = 175\text{ °C}$ , $V_{GS(on)} = 18\text{ V}$		72		
			$T_{vj} = 25\text{ °C}$ , $V_{GS(on)} = 15\text{ V}$		27	35	
Gate-source threshold voltage	$V_{GS(th)}$	$I_D = 24\text{ mA}$ , $V_{DS} = V_{GS}$ (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	$I_{DSS}$	$V_{DS} = 2000\text{ V}$ , $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			400	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	$g_{fs}$	$I_D = 40\text{ A}$ , $V_{DS} = 20\text{ V}$		20			S
Internal gate resistance	$R_{G,int}$	$f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		6			Ω
Input capacitance	$C_{iss}$	$V_{DD} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		4850			pF
Output capacitance	$C_{oss}$	$V_{DD} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		161			pF
Reverse transfer capacitance	$C_{rss}$	$V_{DD} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		11			pF
$C_{oss}$ stored energy	$E_{oss}$	$V_{DD} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		109			μJ
Total gate charge	$Q_G$	$V_{DD} = 1200\text{ V}$ , $I_D = 40\text{ A}$ , $V_{GS} = -2/18\text{ V}$ , turn-on pulse		137			nC
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 1200\text{ V}$ , $I_D = 40\text{ A}$ , $V_{GS} = -2/18\text{ V}$ , turn-on pulse		38			nC
Gate-to-drain charge	$Q_{GD}$	$V_{DD} = 1200\text{ V}$ , $I_D = 40\text{ A}$ , $V_{GS} = -2/18\text{ V}$ , turn-on pulse		22			nC
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 1200\text{ V}$ , $I_D = 40\text{ A}$ , $V_{GS} = -2/18\text{ V}$ , $R_{GS(on)} = 2\text{ Ω}$ , $R_{GS(off)} = 2\text{ Ω}$ , $L_\sigma = 15\text{ nH}$ , diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ °C}$		19		ns
			$T_{vj} = 175\text{ °C}$		23		

(table continues...)

**Table 4 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rise time	$t_r$	$V_{DD} = 1200\text{ V}, I_D = 40\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		11	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		14	
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 1200\text{ V}, I_D = 40\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		40	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		58	
Fall time	$t_f$	$V_{DD} = 1200\text{ V}, I_D = 40\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		16	ns
			$T_{vj} = 175\text{ }^\circ\text{C}$		18	
Turn-on energy	$E_{on}$	$V_{DD} = 1200\text{ V}, I_D = 40\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		1150	$\mu\text{J}$
			$T_{vj} = 175\text{ }^\circ\text{C}$		2140	
Turn-off energy	$E_{off}$	$V_{DD} = 1200\text{ V}, I_D = 40\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		400	$\mu\text{J}$
			$T_{vj} = 175\text{ }^\circ\text{C}$		435	
Total switching energy	$E_{tot}$	$V_{DD} = 1200\text{ V}, I_D = 40\text{ A},$ $V_{GS} = -2/18\text{ V},$ $R_{GS(on)} = 2\ \Omega,$ $R_{GS(off)} = 2\ \Omega, L_\sigma = 15\text{ nH},$ diode: body diode at $V_{GS} = -2\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		2100	$\mu\text{J}$
			$T_{vj} = 175\text{ }^\circ\text{C}$		3675	
Virtual junction temperature	$T_{vj}$			-55	175	$^\circ\text{C}$

*Note:* The chip technology was characterized up to 100 kV/ $\mu\text{s}$ . 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 $T_{vj(max)}$	$I_{SDC}$	$V_{GS} = 0\text{ V}$	$T_c = 25\text{ °C}$	91	A
			$T_c = 100\text{ °C}$	69	
Peak reverse drain current, $t_p$ limited by $T_{vj(max)}$	$I_{SM}$	$V_{GS} = 0\text{ V}$	128	A	

**Table 6** Characteristic values

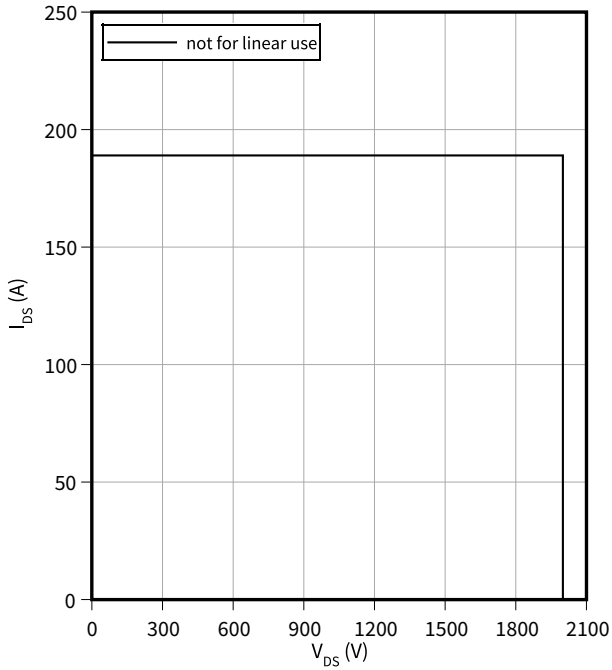
Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Drain-source reverse voltage	$V_{SD}$	$I_{SD} = 40\text{ A}, V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		3.7	5.5	V
			$T_{vj} = 100\text{ °C}$		3.6		
			$T_{vj} = 175\text{ °C}$		3.5		
MOSFET forward recovery charge	$Q_{fr}$	$V_{DD} = 1200\text{ V}, I_{SD} = 40\text{ A}, V_{GS} = -2\text{ V}, R_{GS(on)} = 2\text{ }\Omega, Q_{fr}$ includes also $Q_C$	$T_{vj} = 25\text{ °C}$		1000		nC
			$T_{vj} = 175\text{ °C}$		1975		
MOSFET peak forward recovery current	$I_{frm}$	$V_{DD} = 1200\text{ V}, I_{SD} = 40\text{ A}, V_{GS} = -2\text{ V}, di_{SD}/dt = 1500\text{ A}/\mu\text{s}, Q_{fr}$ includes also $Q_C$	$T_{vj} = 25\text{ °C}$		27		A
			$T_{vj} = 175\text{ °C}$		32		
MOSFET forward recovery energy	$E_{fr}$	$V_{DD} = 1200\text{ V}, I_{SD} = 40\text{ A}, V_{GS} = -2\text{ V}, R_{GS(on)} = 2\text{ }\Omega, Q_{fr}$ includes also $Q_C$	$T_{vj} = 25\text{ °C}$		550		$\mu\text{J}$
			$T_{vj} = 175\text{ °C}$		1100		
Virtual junction temperature	$T_{vj}$		-55		175	$\text{°C}$	

## 4 Characteristics diagrams

### Reverse bias safe operating area (RBSOA)

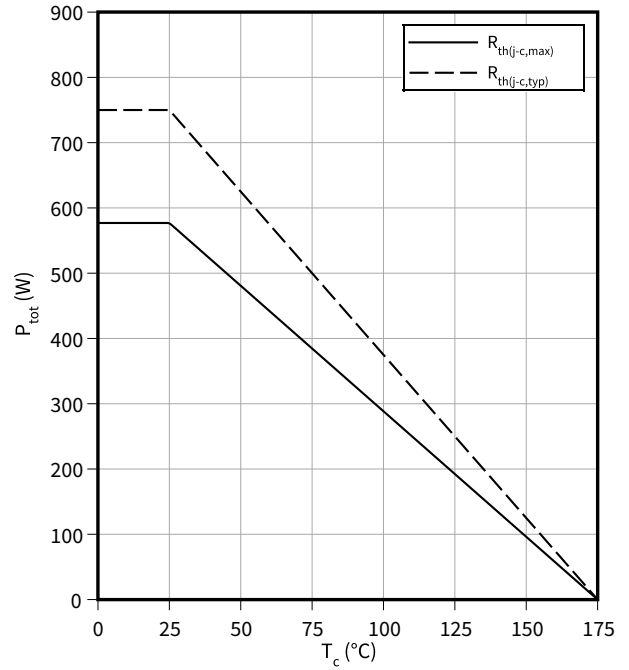
$$I_{DS} = f(V_{DS})$$

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



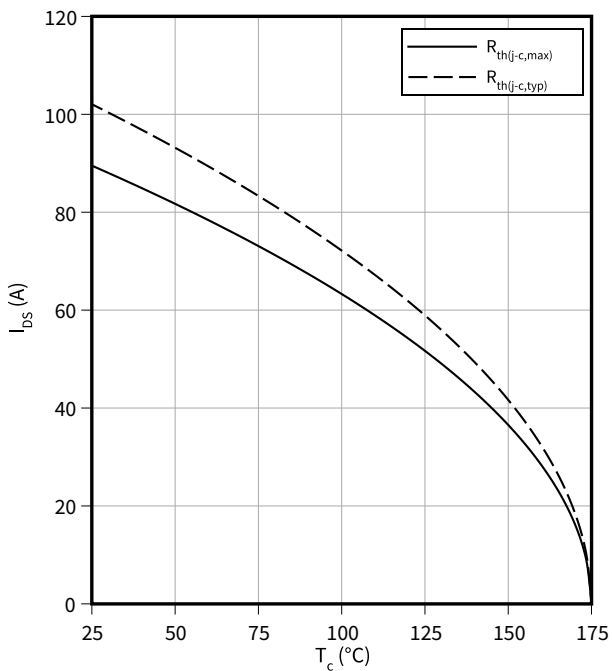
### Power dissipation as a function of case temperature limited by bond wire

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



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

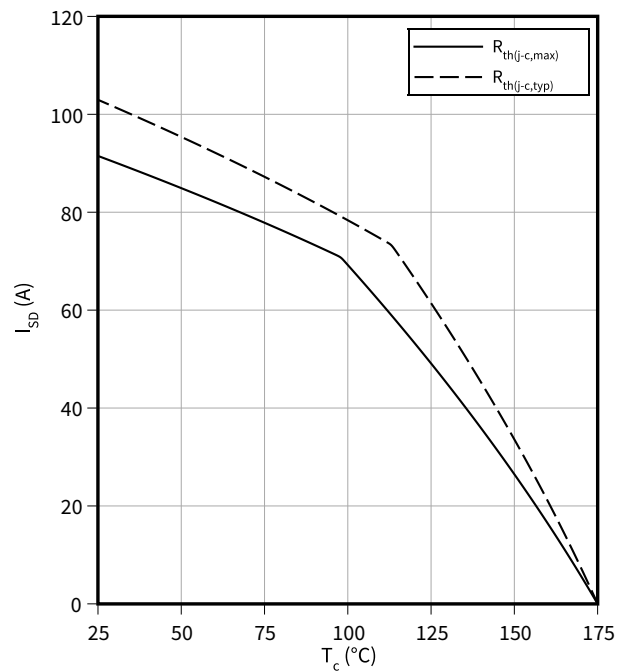
$$I_{DS} = f(T_c)$$



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

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

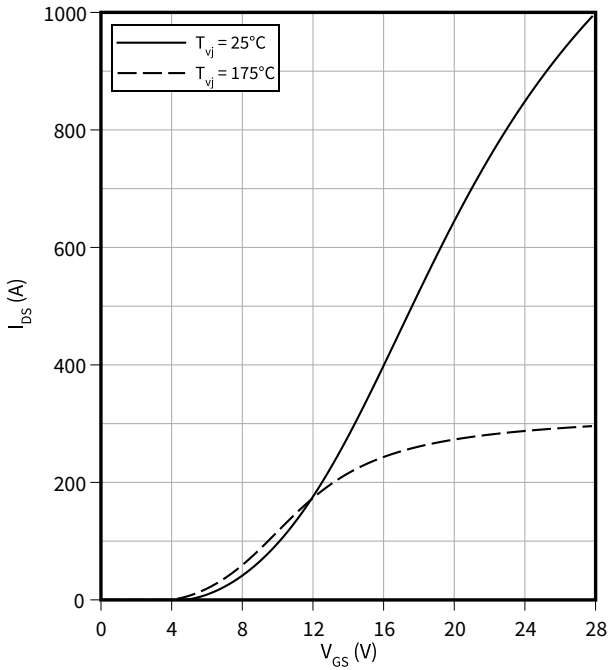
$$V_{GS} = 0\text{ V}$$



4 Characteristics diagrams

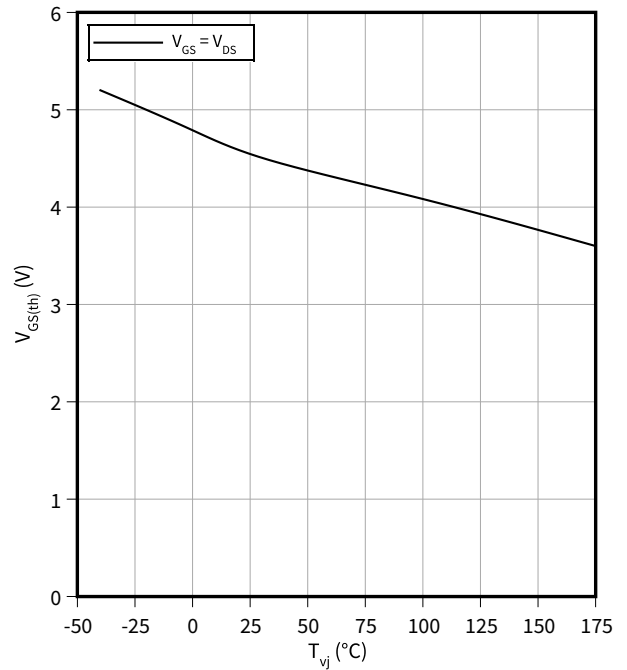
**Typical transfer characteristic**

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



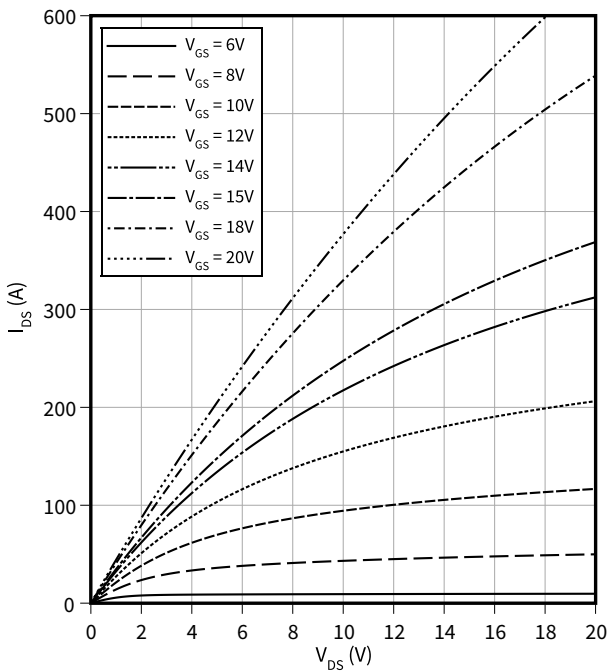
**Typical gate-source threshold voltage as a function of junction temperature**

$V_{GS(th)} = f(T_{vj})$   
 $I_D = 24\text{ mA}$



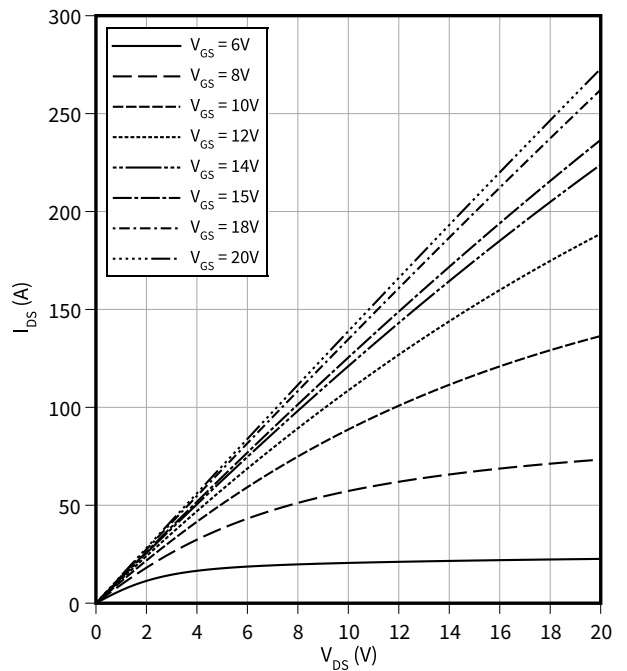
**Typical output characteristic,  $V_{GS}$  as parameter**

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



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

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

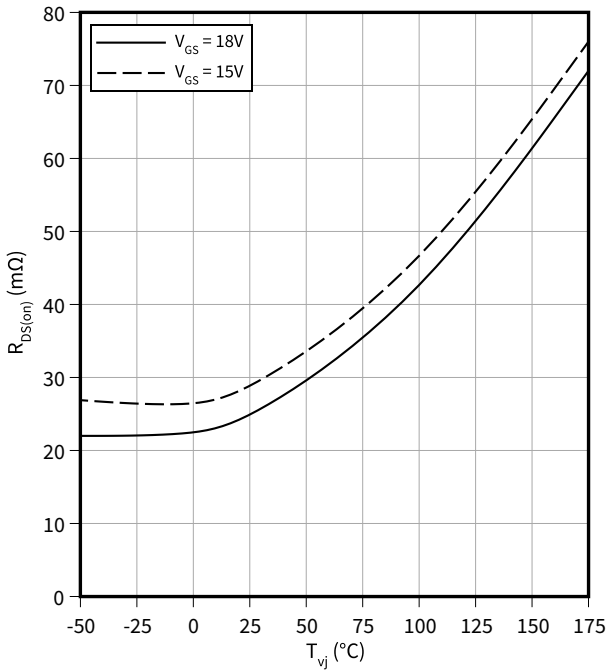




4 Characteristics diagrams

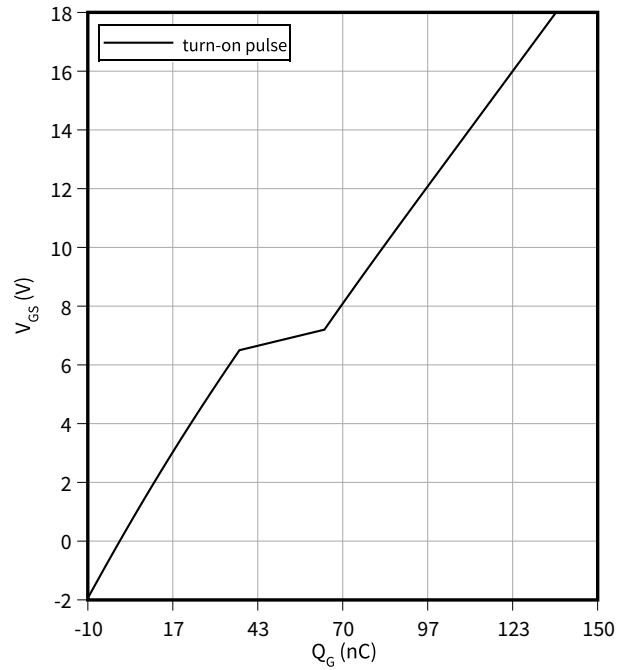
**Typical on-state resistance as a function of junction temperature**

$R_{DS(on)} = f(T_{vj})$   
 $I_D = 40\text{ A}$



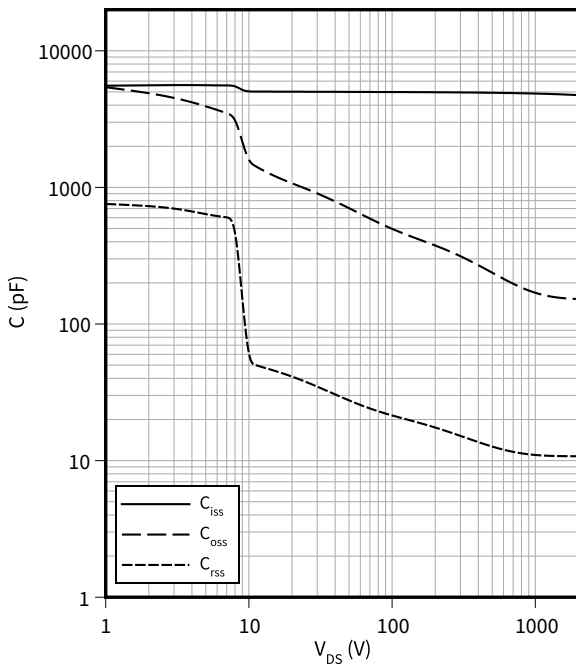
**Typical gate charge**

$V_{GS} = f(Q_G)$   
 $I_D = 40\text{ A}, V_{DS} = 1200\text{ V}$



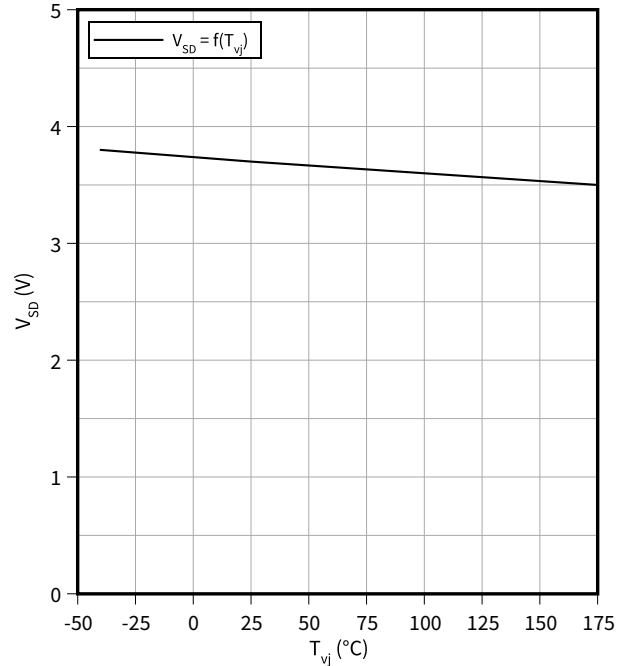
**Typical capacitance as a function of drain-source voltage**

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



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

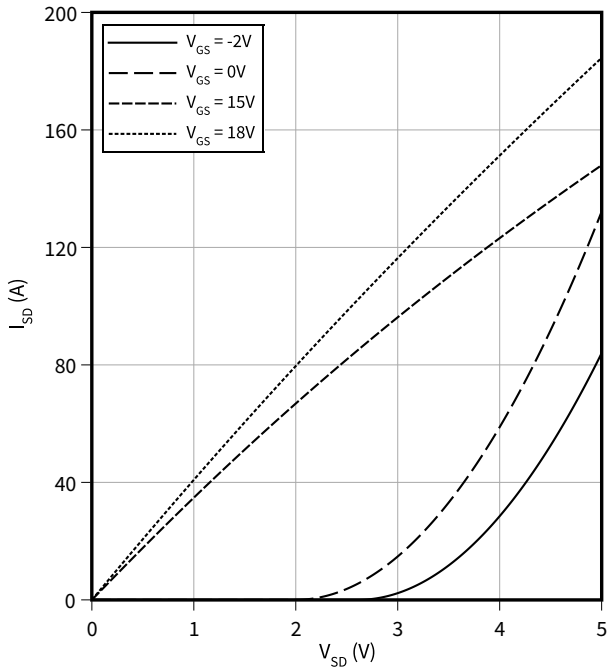
$V_{SD} = f(T_{vj})$   
 $I_{SD} = 40\text{ A}, V_{GS} = 0\text{ V}$



4 Characteristics diagrams

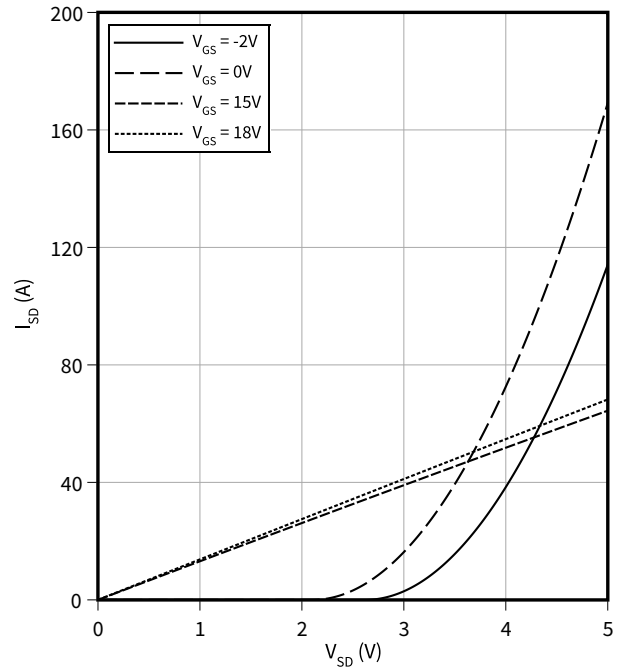
**Typical reverse drain current as function of reverse drain voltage,  $V_{GS}$  as parameter**

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



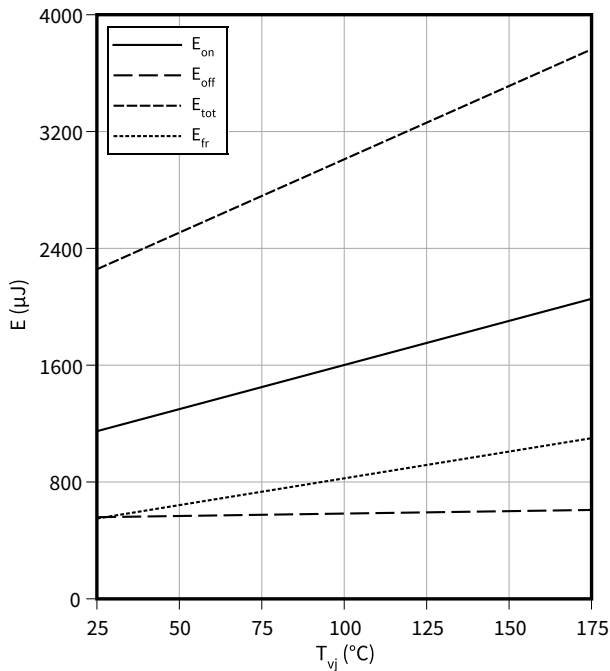
**Typical reverse drain current as function of reverse drain voltage,  $V_{GS}$  as parameter**

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



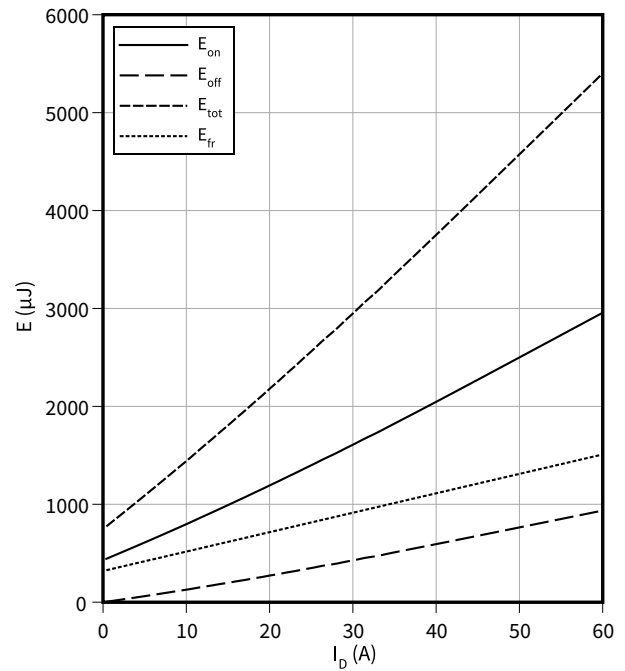
**Typical switching energy as a function of junction temperature, test circuit in Fig. F, 2nd device own body diode:  $V_{GS} = -2\text{ V}$**

$E = f(T_{vj})$   
 $V_{GS} = -2/18\text{ V}$ ,  $I_D = 40\text{ A}$ ,  $R_{G,ext} = 2\text{ }\Omega$ ,  $V_{DD} = 1200\text{ V}$



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

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

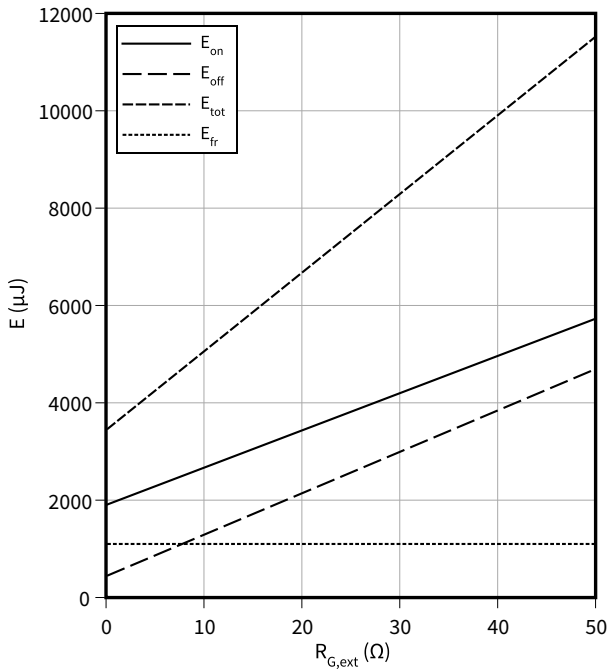


4 Characteristics diagrams

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

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

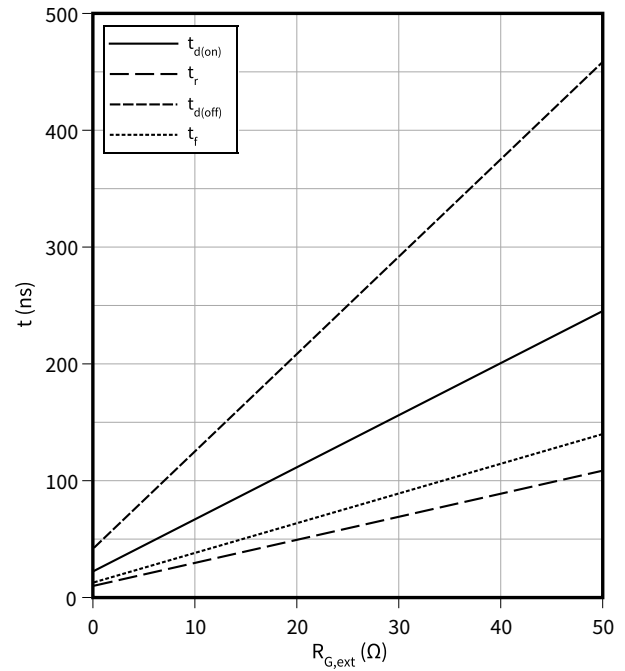
$V_{GS} = -2/18\text{ V}$ ,  $I_D = 40\text{ A}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{DD} = 1200\text{ V}$



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

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

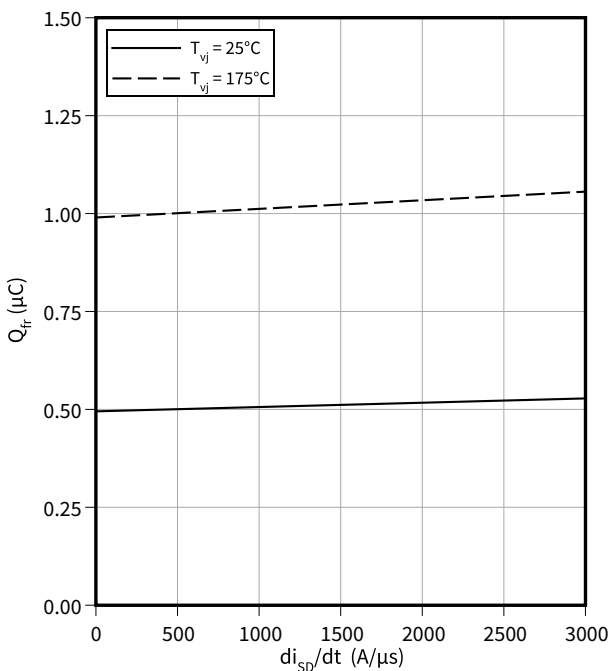
$I_D = 40\text{ A}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{GS} = -2/18\text{ V}$ ,  $V_{DD} = 1200\text{ V}$



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

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

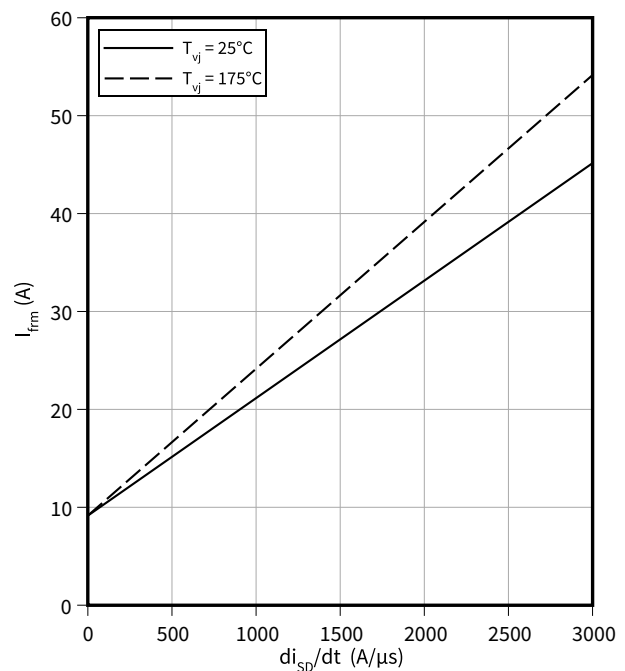
$V_{GS} = -2/18\text{ V}$ ,  $I_{SD} = 40\text{ A}$ ,  $V_{DD} = 1200\text{ V}$



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

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

$V_{GS} = -2/18\text{ V}$ ,  $I_{SD} = 40\text{ A}$ ,  $V_{DD} = 1200\text{ V}$

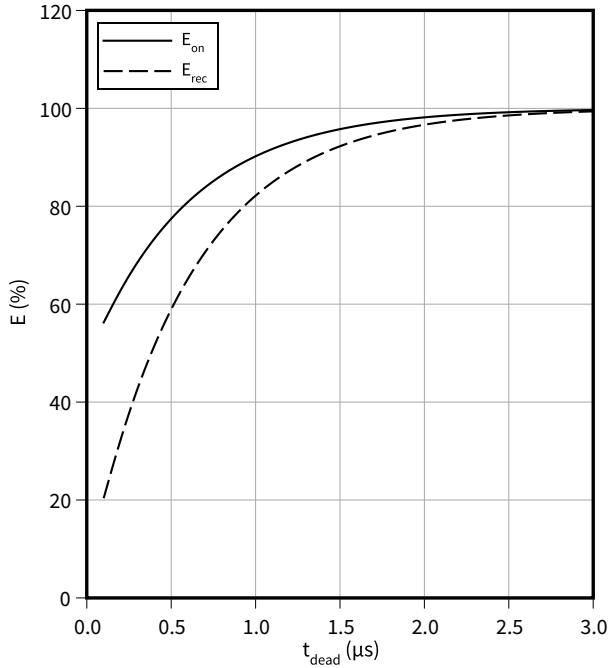


4 Characteristics diagrams

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

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

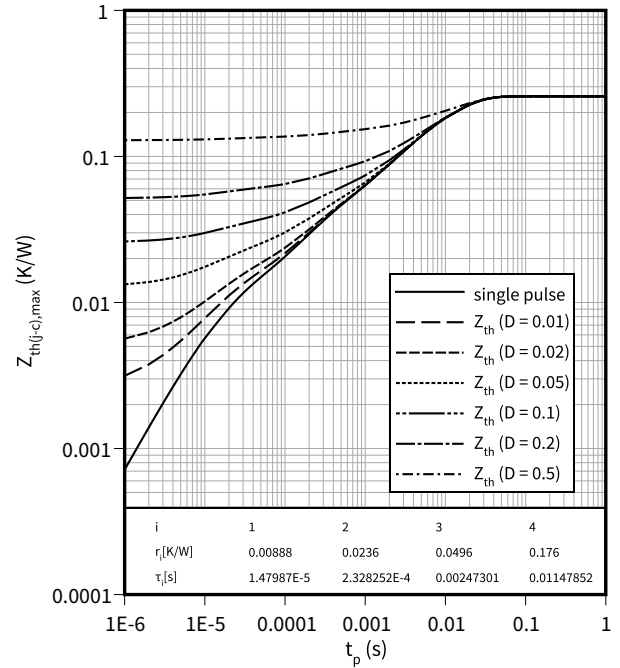
$I_D = 40\text{ A}$ ,  $T_{vj} = 175\text{ °C}$ ,  $R_{G,\text{ext}} = 2\ \Omega$ ,  $V_{DD} = 1200\text{ V}$



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

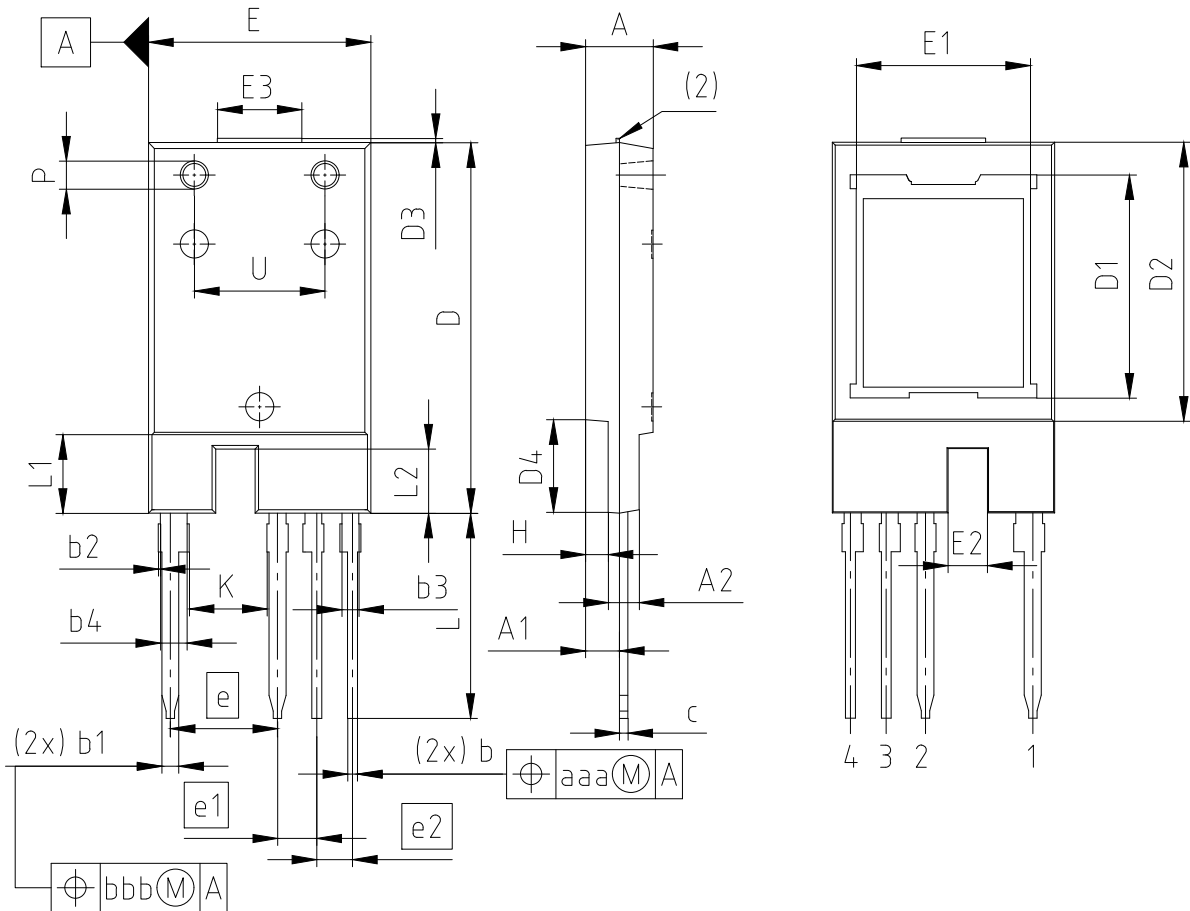
$$Z_{\text{th}(j-c),\text{max}} = f(t_p)$$

$$D = t_p/T$$



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

Figure 1

## 6 Testing conditions

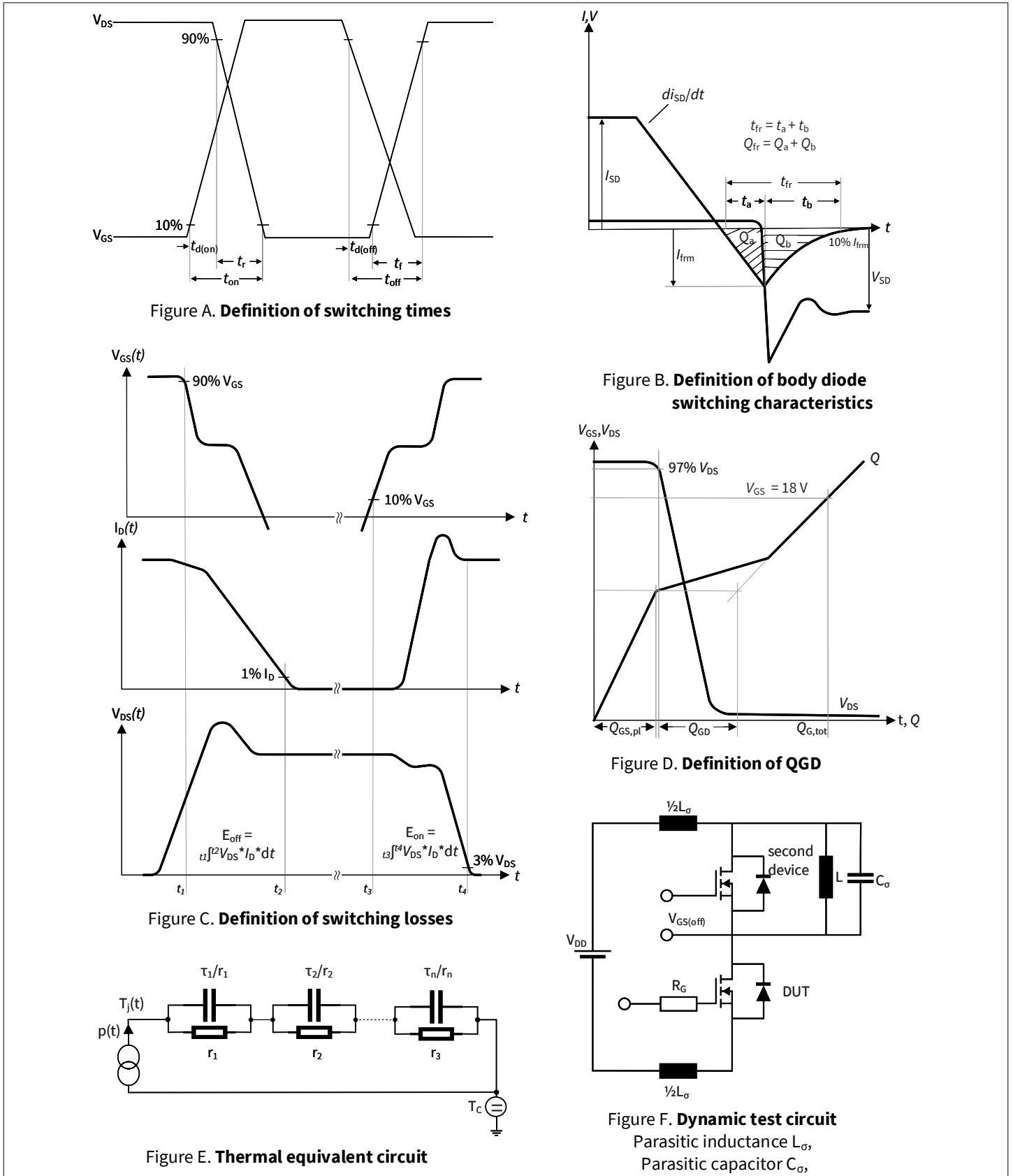


Figure 2

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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