

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

Features

- $V_{DS} = 1200\text{ V}$ at $T_{vj} = 25^{\circ}\text{C}$
- $I_{DDC} = 98\text{ A}$ at $T_c = 25^{\circ}\text{C}$
- $R_{DS(on)} = 19\text{ m}\Omega$ at $V_{GS} = 18\text{ V}$, $T_{vj} = 25^{\circ}\text{C}$
- Very low switching losses
- Short circuit withstand time $3\text{ }\mu\text{s}$
- 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 UPS
- String inverters
- Solar power optimizer

Product validation

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

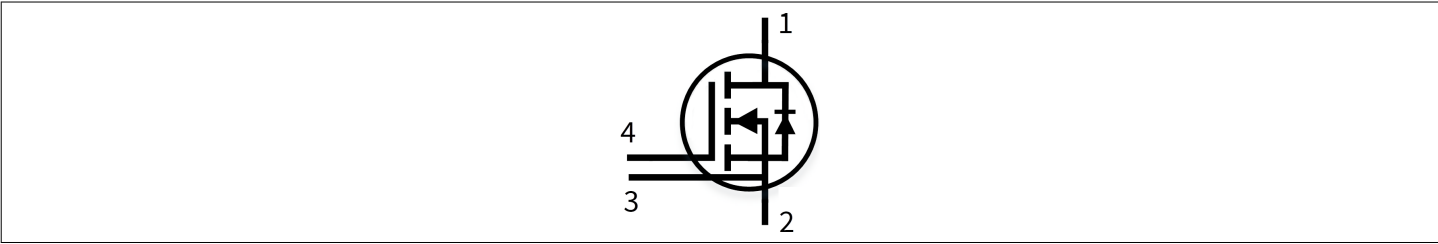


- Lead-Free
- Green
- Halogen-Free
- RoHS

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
IMZA120R020M1H	PG-TO247-4-STD-NT3.7	12M1H020



Table of contents

	Description	1
	Features	1
	Potential applications	1
	Product validation	1
	Table of contents	2
1	Package	3
2	MOSFET	3
3	Body diode	6
4	Characteristics diagrams	8
5	Package outlines	14
6	Testing conditions	15
	Revision history	16
	Disclaimer	17

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
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}	$V_{GS} = 18\text{ V}$	$T_c = 25\text{ °C}$	98	A
			$T_c = 100\text{ °C}$	71	
Peak drain current, t_p limited by $T_{vj(max)}$	I_{DM}	$V_{GS} = 18\text{ V}$		213	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
Avalanche energy, single pulse	E_{AS}	$I_D = 40.1\text{ A}$, $V_{DD} = 50\text{ V}$, $L = 0.9\text{ mH}$		721	mJ
Avalanche energy, repetitive	E_{AR}	$I_D = 40.1\text{ A}$, $V_{DD} = 50\text{ V}$, $L = 4.5\text{ }\mu\text{H}$		3.58	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}		$T_c = 25\text{ °C}$	375	W
			$T_c = 100\text{ °C}$	188	

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	$R_{DS(on)}$	$I_D = 41\text{ A}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$, $V_{GS(on)} = 18\text{ V}$		19	26.9	mΩ
			$T_{vj} = 100\text{ }^{\circ}\text{C}$, $V_{GS(on)} = 18\text{ V}$		25		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $V_{GS(on)} = 18\text{ V}$		36		
			$T_{vj} = 25\text{ }^{\circ}\text{C}$, $V_{GS(on)} = 15\text{ V}$		23.7	30	
Gate-emitter threshold voltage	$V_{GS(th)}$	$I_D = 17.6\text{ mA}$, $V_{DS} = V_{GS}$ (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}	$V_{DS} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$			320	μA
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		5.4		
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}	$I_D = 41\text{ A}$, $V_{DS} = 20\text{ V}$			27.4		S
Internal gate resistance	$R_{G,int}$	$f = 1\text{ MHz}$, $V_{AC} = 25\text{ mV}$			1.8		Ω
Input capacitance	C_{iss}	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$			3460		pF
Output capacitance	C_{oss}	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$			159		pF
Reverse transfer capacitance	C_{rss}	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$			23		pF
C_{oss} stored energy	E_{oss}	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$, $V_{AC} = 25\text{ mV}$			65		μJ
Total gate charge	Q_G	$V_{DD} = 800\text{ V}$, $I_D = 41\text{ A}$, $V_{GS} = -2/18\text{ V}$, turn-on pulse			83		nC
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 800\text{ V}$, $I_D = 41\text{ A}$, $V_{GS} = -2/18\text{ V}$, turn-on pulse			27		nC
Gate-to-drain charge	Q_{GD}	$V_{DD} = 800\text{ V}$, $I_D = 41\text{ A}$, $V_{GS} = -2/18\text{ V}$, turn-on pulse			24		nC

(table continues...)

Table 4 (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800 \text{ V}$, $I_D = 41 \text{ A}$, $V_{GS} = 0/18 \text{ V}$, $R_{GS(on)} = 1 \Omega$, $R_{GS(off)} = 1 \Omega$, diode: body diode at $V_{GS} = 0 \text{ V}$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	36		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	34		
Rise time	t_r	$V_{DD} = 800 \text{ V}$, $I_D = 41 \text{ A}$, $V_{GS} = 0/18 \text{ V}$, $R_{GS(on)} = 1 \Omega$, $R_{GS(off)} = 1 \Omega$, diode: body diode at $V_{GS} = 0 \text{ V}$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	13.7		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	15.5		
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 800 \text{ V}$, $I_D = 41 \text{ A}$, $V_{GS} = 0/18 \text{ V}$, $R_{GS(on)} = 1 \Omega$, $R_{GS(off)} = 1 \Omega$, diode: body diode at $V_{GS} = 0 \text{ V}$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	43.8		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	46		
Fall time	t_f	$V_{DD} = 800 \text{ V}$, $I_D = 41 \text{ A}$, $V_{GS} = 0/18 \text{ V}$, $R_{GS(on)} = 1 \Omega$, $R_{GS(off)} = 1 \Omega$, diode: body diode at $V_{GS} = 0 \text{ V}$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	14.8		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$	14.7		
Turn-on energy	E_{on}	$V_{DD} = 800 \text{ V}$, $I_D = 41 \text{ A}$, $V_{GS} = 0/18 \text{ V}$, $R_{GS(on)} = 1 \Omega$, $R_{GS(off)} = 1 \Omega$, diode: body diode at $V_{GS} = 0 \text{ V}$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	470		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	722		
Turn-off energy	E_{off}	$V_{DD} = 800 \text{ V}$, $I_D = 41 \text{ A}$, $V_{GS} = 0/18 \text{ V}$, $R_{GS(on)} = 1 \Omega$, $R_{GS(off)} = 1 \Omega$, diode: body diode at $V_{GS} = 0 \text{ V}$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	140		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	145		
Total switching energy	E_{tot}	$V_{DD} = 800 \text{ V}$, $I_D = 41 \text{ A}$, $V_{GS} = 0/18 \text{ V}$, $R_{GS(on)} = 1 \Omega$, $R_{GS(off)} = 1 \Omega$, diode: body diode at $V_{GS} = 0 \text{ V}$, $L_\sigma = 15 \text{ nH}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	671		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	1111		

(table continues...)

Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
MOSFET/body diode thermal resistance, junction-case	$R_{th(j-c)}$			0.31	0.40	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}	$V_{GS} = 0\text{ V}$	$T_c = 25\text{ °C}$	94	A
			$T_c = 100\text{ °C}$	58	
Peak reverse drain current, t_p limited by $T_{vj(max)}$	I_{SM}	$V_{GS} = 0\text{ V}$		213	A

Table 6 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Drain-source reverse voltage	V_{SD}	$I_{SD} = 41\text{ A}, V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		3.8	5	V
			$T_{vj} = 100\text{ °C}$		3.7		
			$T_{vj} = 175\text{ °C}$		3.6		
MOSFET forward recovery charge	Q_{fr}	$V_{DD} = 800\text{ V}, I_{SD} = 41\text{ A}, V_{GS} = 0\text{ V}, di_{SD}/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also Q_C	$T_{vj} = 25\text{ °C}$		340		nC
			$T_{vj} = 175\text{ °C}$		622		
MOSFET peak forward recovery current	I_{frm}	$V_{DD} = 800\text{ V}, I_{SD} = 41\text{ A}, V_{GS} = 0\text{ V}, di_{SD}/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also Q_C	$T_{vj} = 25\text{ °C}$		14		A
			$T_{vj} = 175\text{ °C}$		23		
MOSFET forward recovery energy	E_{fr}	$V_{DD} = 800\text{ V}, I_{SD} = 41\text{ A}, V_{GS} = 0\text{ V}, di_{SD}/dt = 3000\text{ A}/\mu\text{s}, Q_{fr}$ includes also Q_C	$T_{vj} = 25\text{ °C}$		63		μJ
			$T_{vj} = 175\text{ °C}$		254		

(table continues...)

Table 6 (continued) Characteristic values

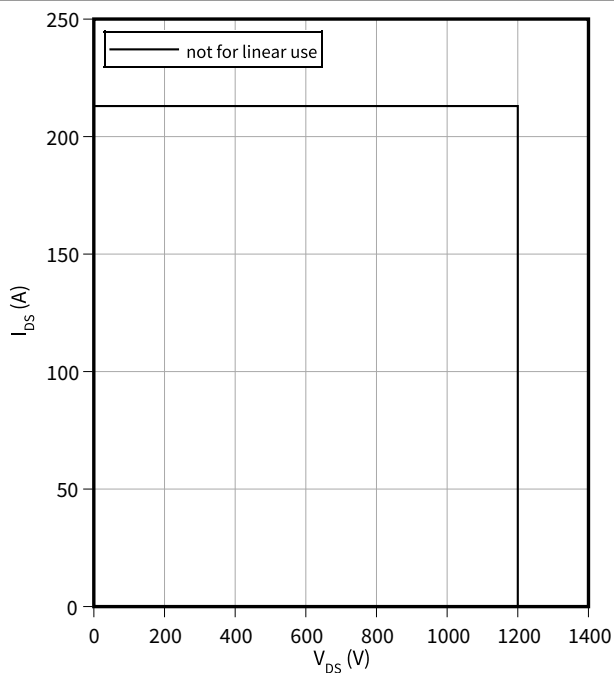
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
MOSFET/body diode thermal resistance, junction-case	$R_{th(j-c)}$			0.31	0.40	K/W
Virtual junction temperature	T_{vj}		-55		175	°C

4 Characteristics diagrams

Reverse bias safe operating area (RBSOA)

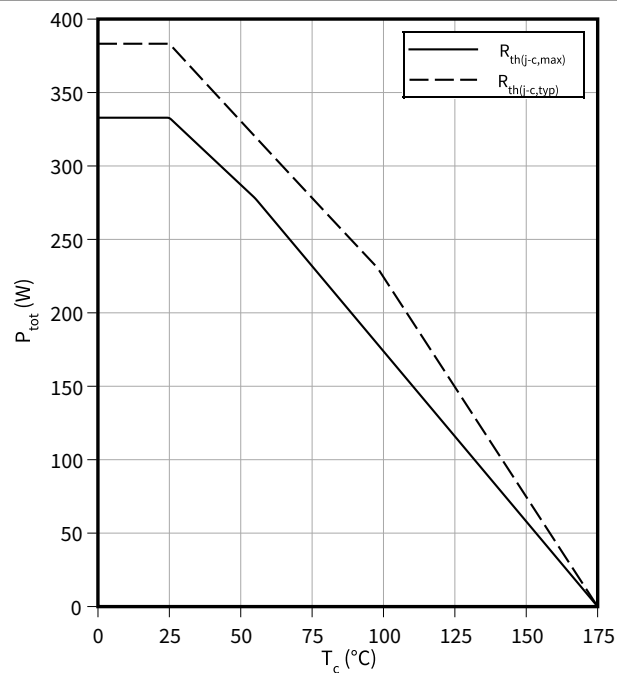
$$I_{DS} = f(V_{DS})$$

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



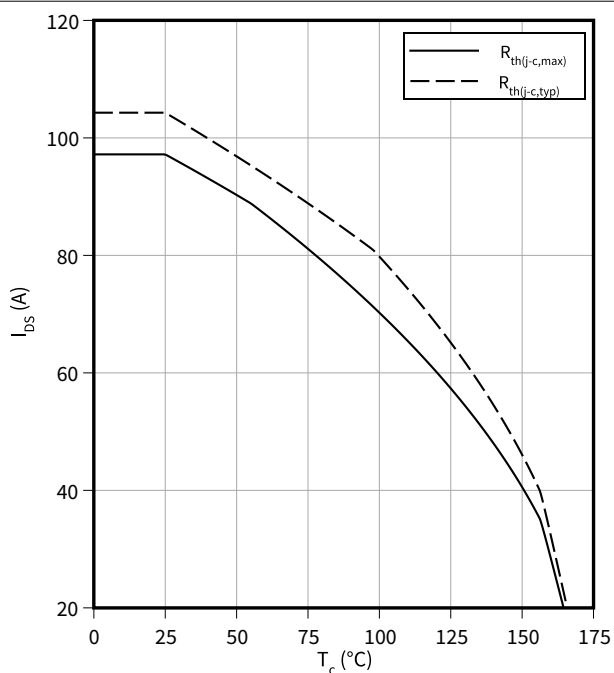
Power dissipation as a function of case temperature limited by bond wire

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



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

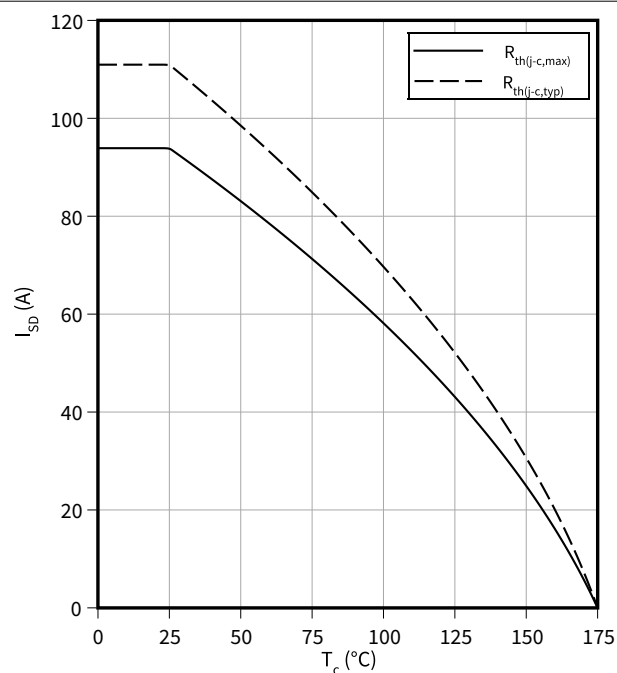
$$I_{DS} = f(T_c)$$



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

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

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

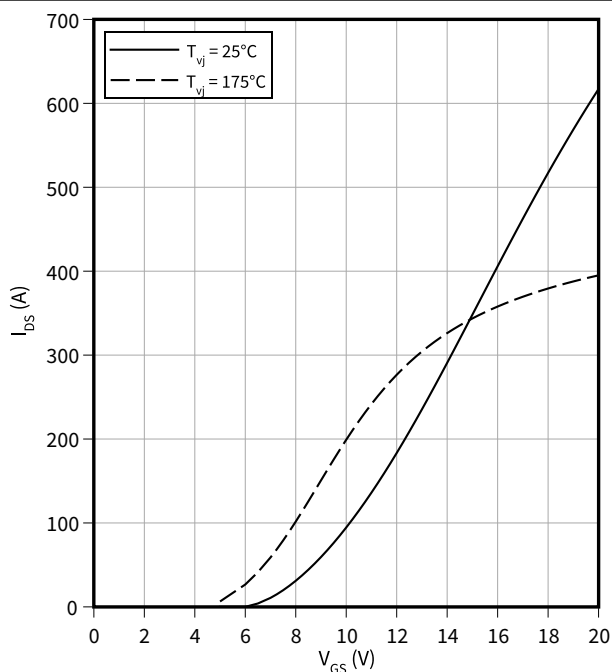


4 Characteristics diagrams

Typical transfer characteristic

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

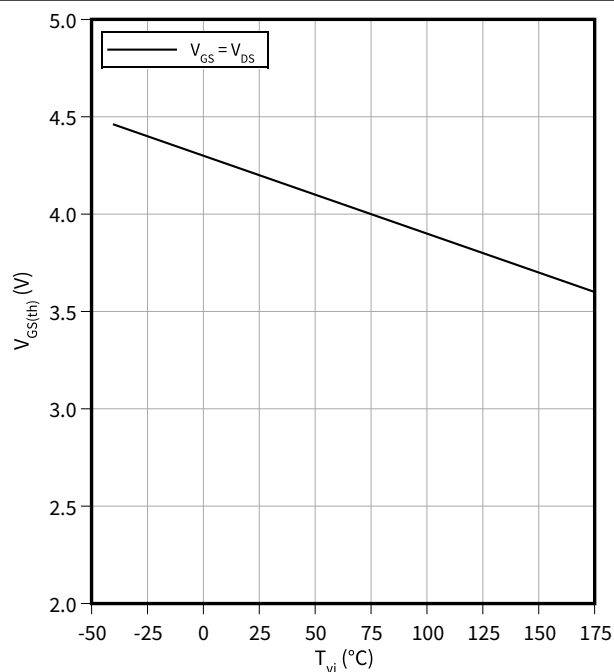
$$V_{DS} = 20 \text{ V}, t_p = 20 \mu\text{s}$$



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

$$V_{GS(th)} = f(T_{vj})$$

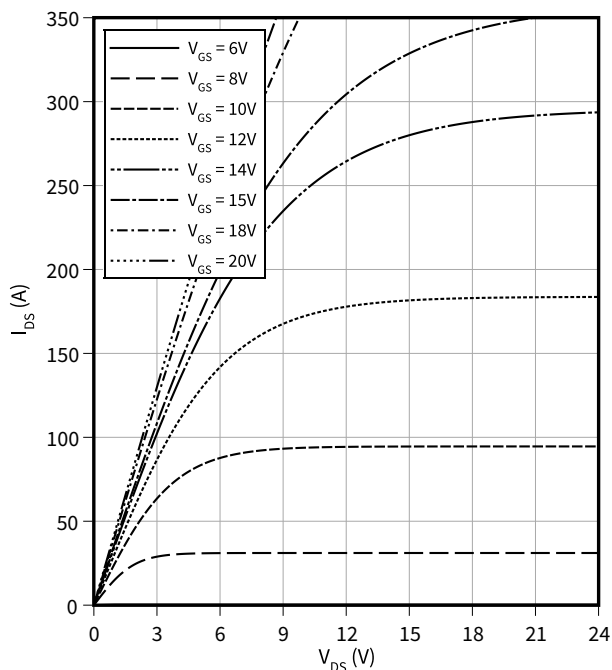
$$I_D = 17.6 \text{ mA}$$



Typical output characteristic, V_{GS} as parameter

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

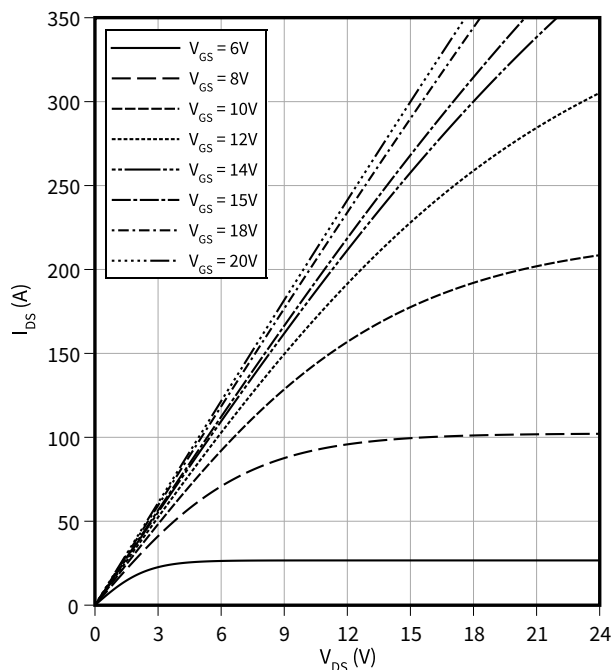
$$T_{vj} = 25^\circ\text{C}, t_p = 20 \mu\text{s}$$



Typical output characteristic, V_{GS} as parameter

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

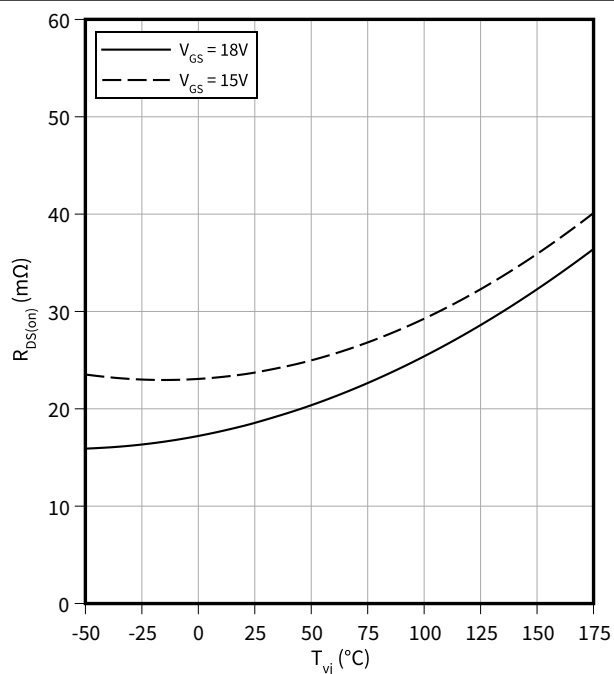
$$T_{vj} = 175^\circ\text{C}, t_p = 20 \mu\text{s}$$



4 Characteristics diagrams

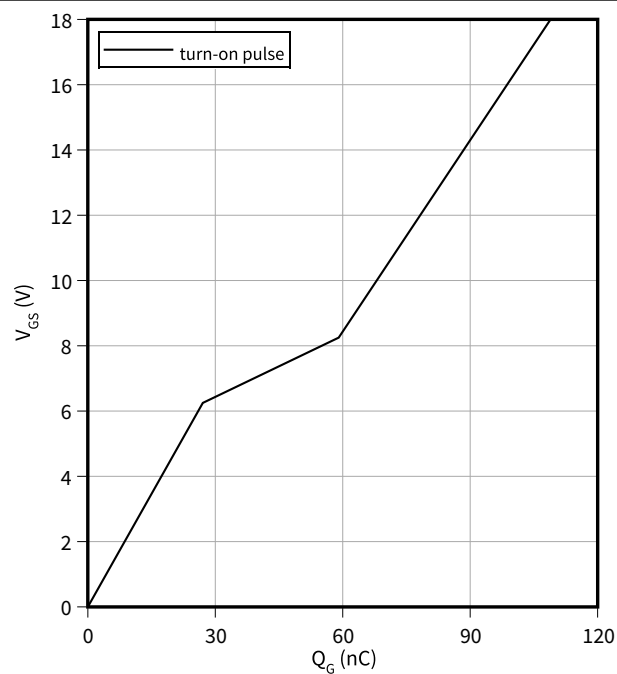
Typical on-state resistance as a function of junction temperature

$R_{DS(on)} = f(T_{vj})$
 $I_D = 41 \text{ A}$



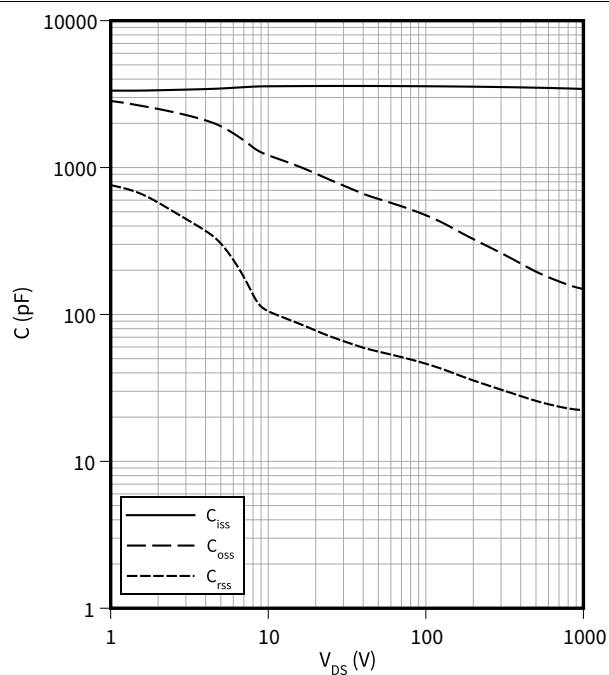
Typical gate charge

$V_{GS} = f(Q_G)$
 $I_D = 41 \text{ A}, V_{DS} = 800 \text{ V}$



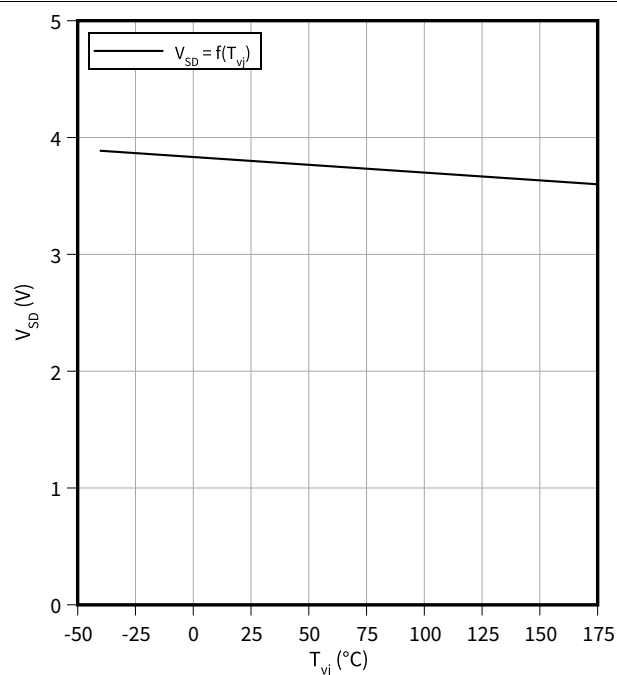
Typical capacitance as a function of drain-source voltage

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



Typical reverse drain voltage as function of junction temperature

$V_{SD} = f(T_{vj})$
 $I_{SD} = 41 \text{ A}, V_{GS} = 0 \text{ V}$

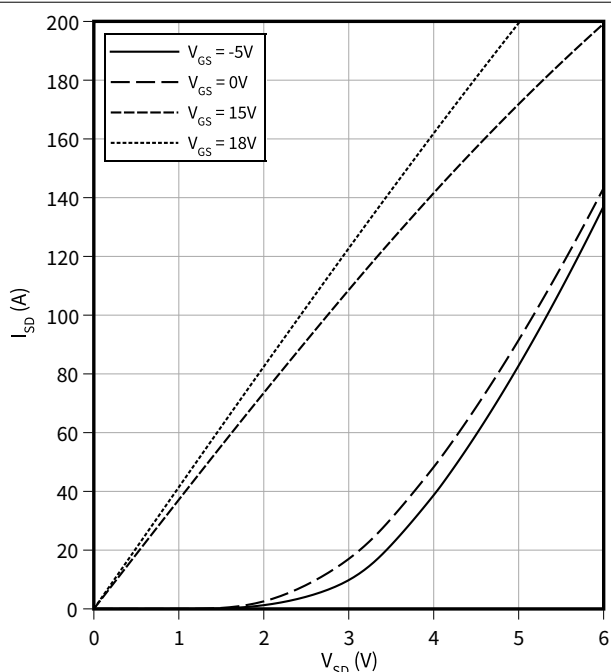


4 Characteristics diagrams

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

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

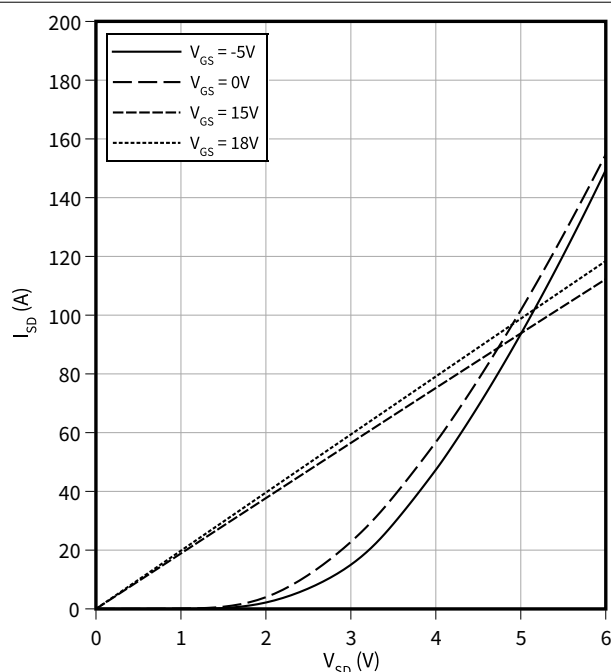
$T_{vj} = 25\text{ °C}$, $t_p = 20\text{ }\mu\text{s}$



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

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

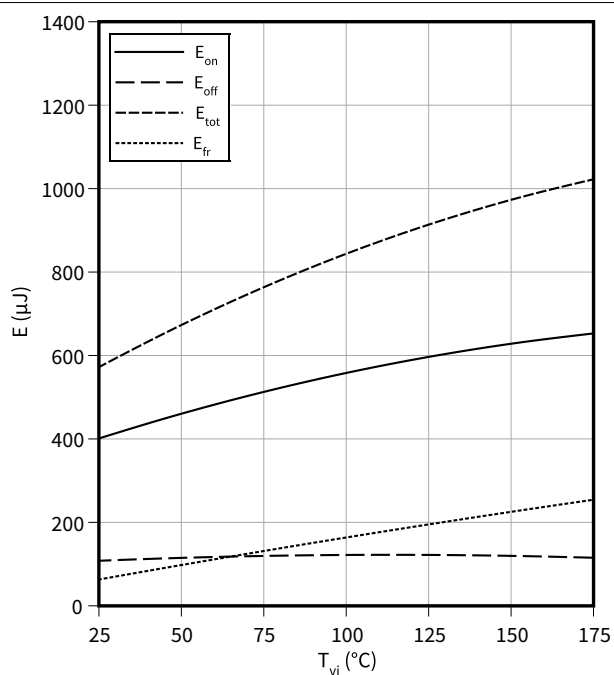
$T_{vj} = 175\text{ °C}$, $t_p = 20\text{ }\mu\text{s}$



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

$$E = f(T_{vj})$$

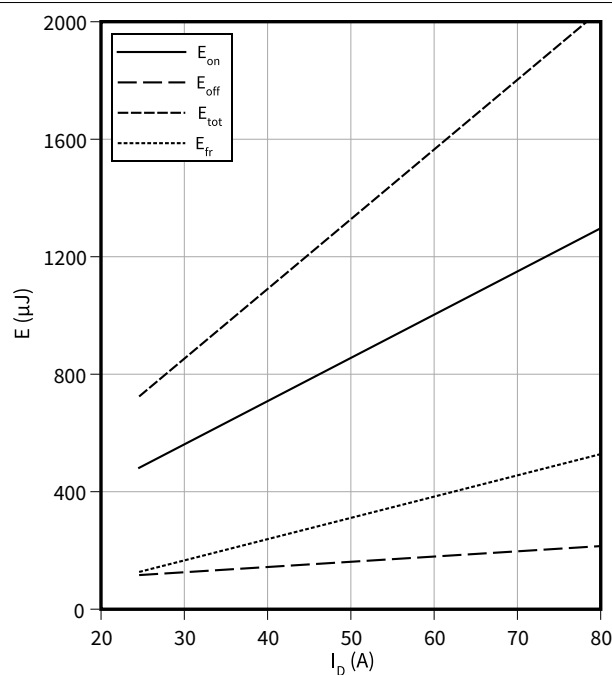
$I_D = 41\text{ A}$, $R_{G,ext} = 1\text{ }\Omega$, $V_{DD} = 800\text{ V}$, $V_{GS} = 0/18\text{ V}$



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

$$E = f(I_D)$$

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

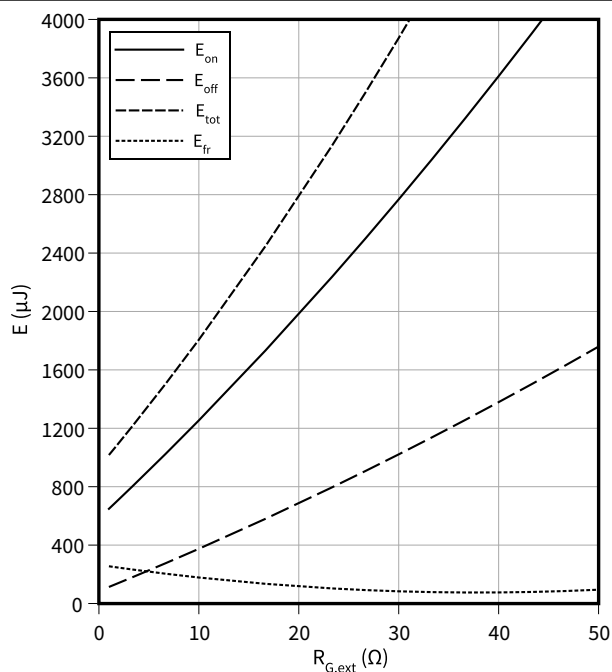


4 Characteristics diagrams

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

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

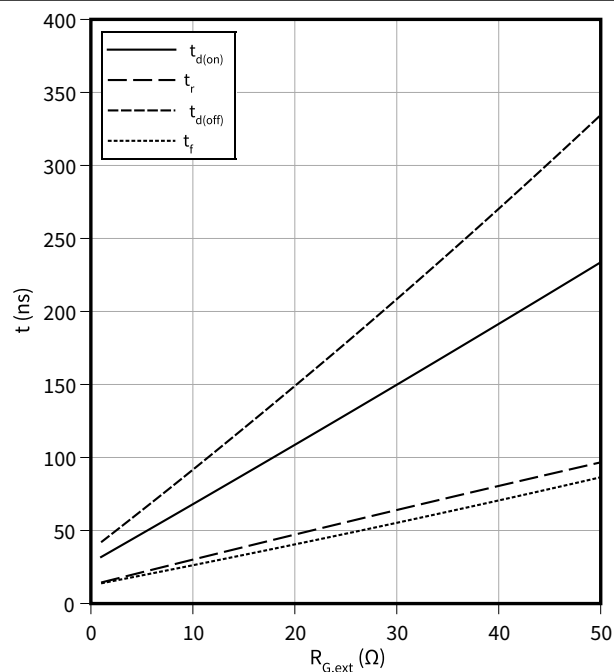
$V_{GS} = 0/18$ V, $I_D = 41$ A, $T_{vj} = 175$ °C, $V_{DD} = 800$ V



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

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

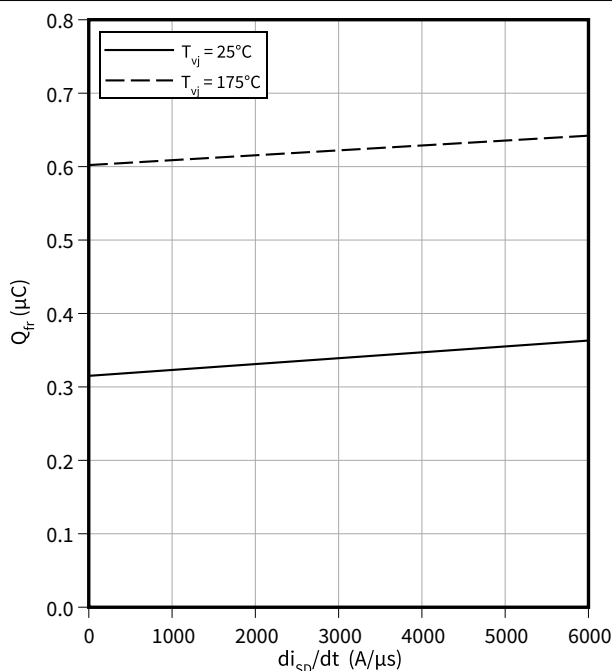
$V_{GS} = 0/18$ V, $I_D = 41$ A, $T_{vj} = 175$ °C, $V_{DD} = 800$ V



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

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

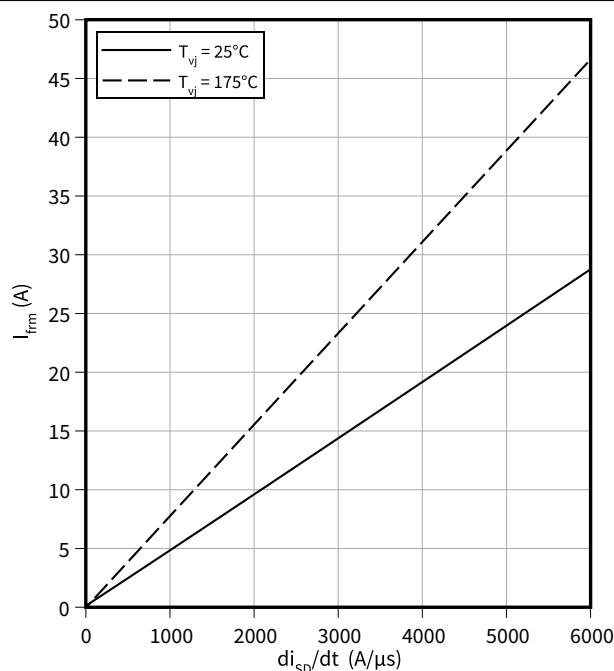
$V_{GS} = 0/18$ V, $I_{SD} = 41$ A, $V_{DD} = 800$ V



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

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

$V_{GS} = 0/18$ V, $I_{SD} = 41$ A, $V_{DD} = 800$ V

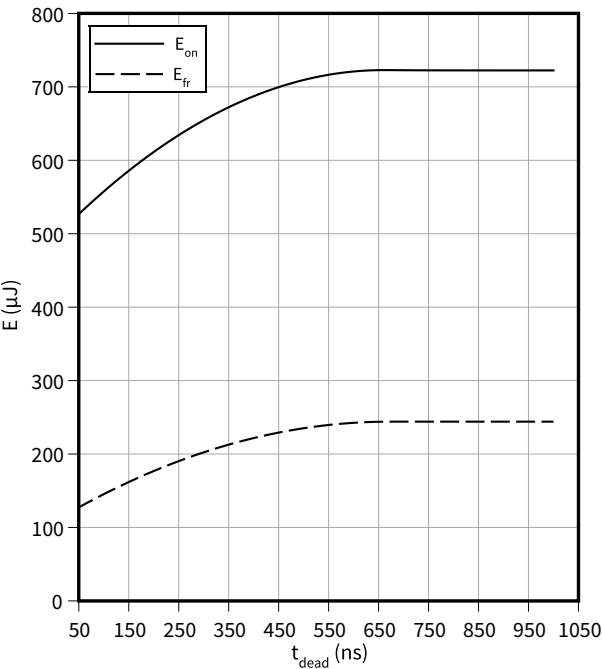


4 Characteristics diagrams

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

$E = f(t_{dead})$

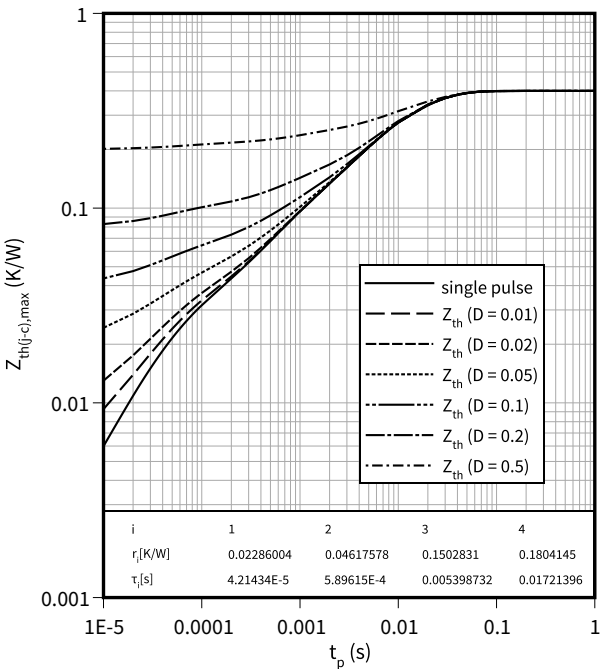
$I_D = 41\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{GS} = -5/18\text{ V}$, $V_{DD} = 800\text{ V}$



Max. transient thermal impedance (MOSFET/diode)

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

$D = t_p/T$



5 Package outlines

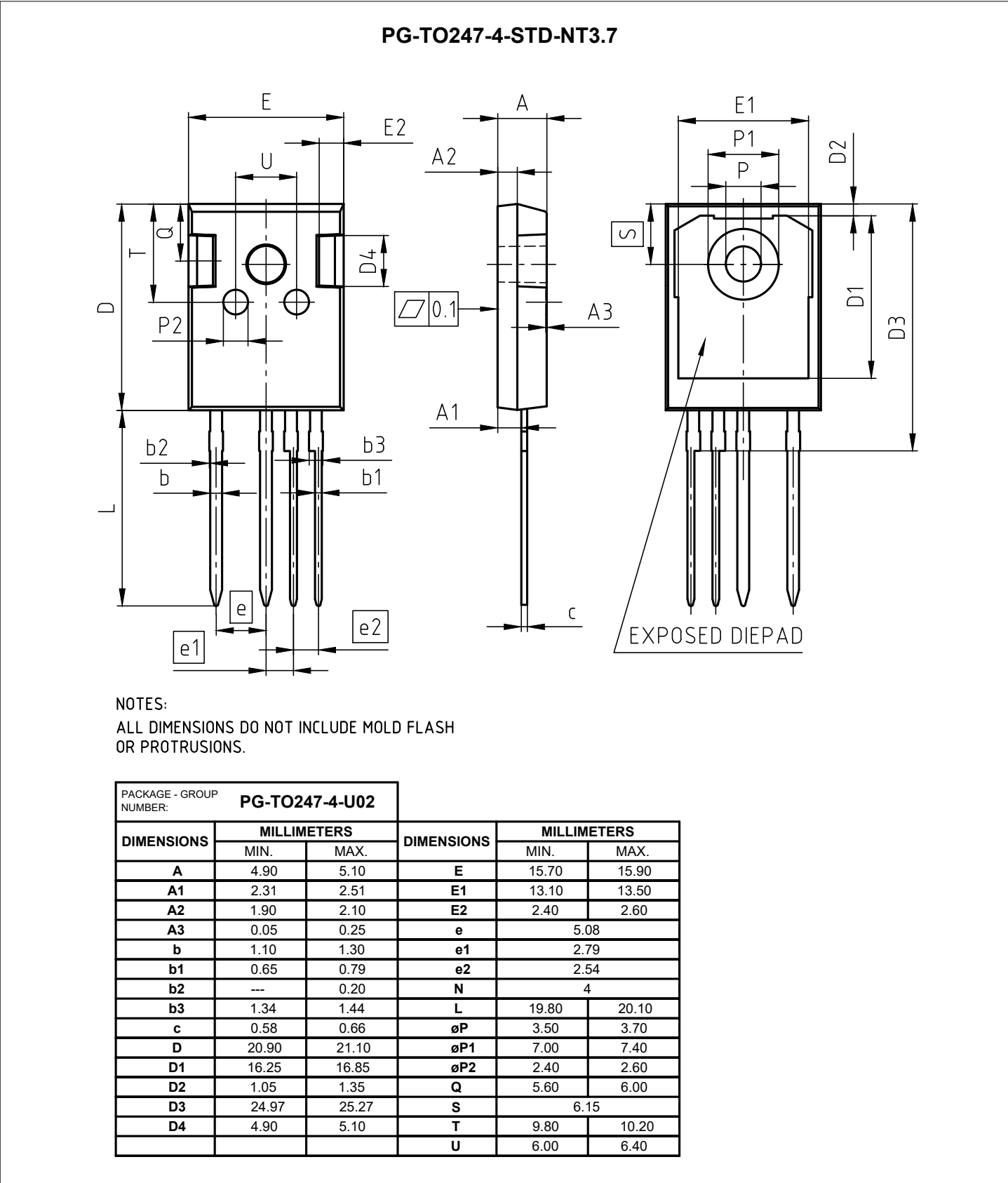


Figure 1

6 Testing conditions

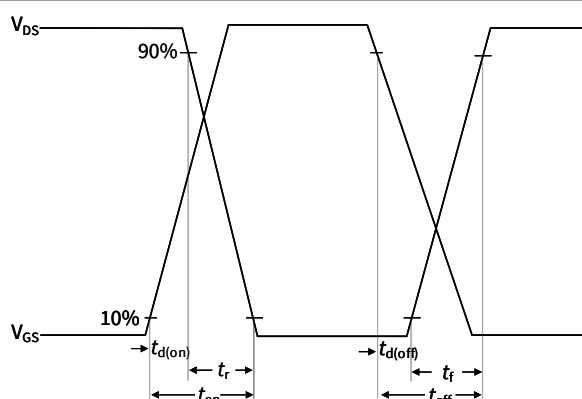


Figure A. Definition of switching times

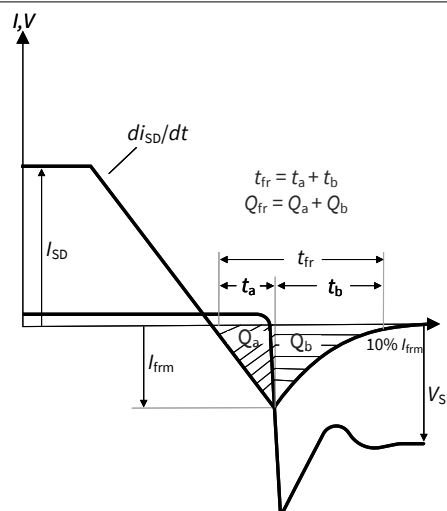


Figure B. Definition of body diode switching characteristics

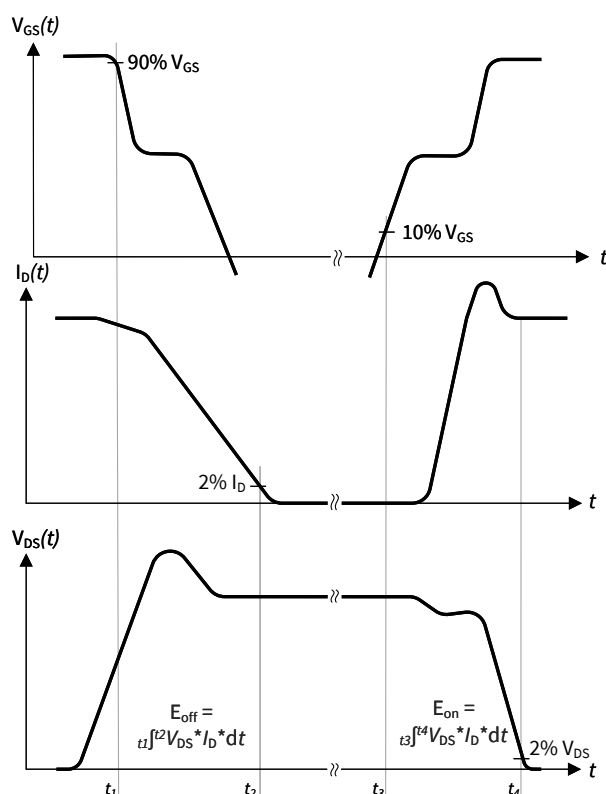


Figure C. Definition of switching losses

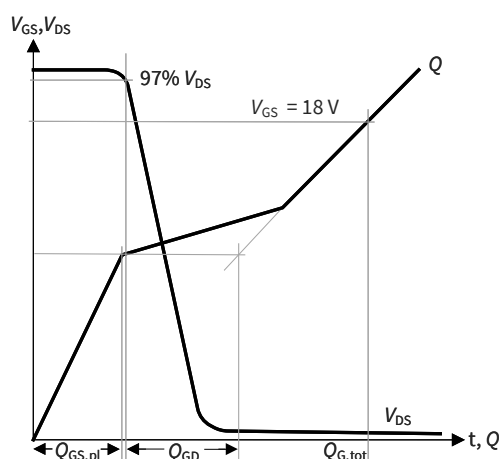


Figure D. Definition of QGD

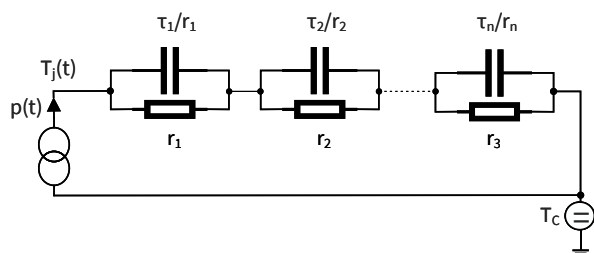


Figure E. Thermal equivalent circuit

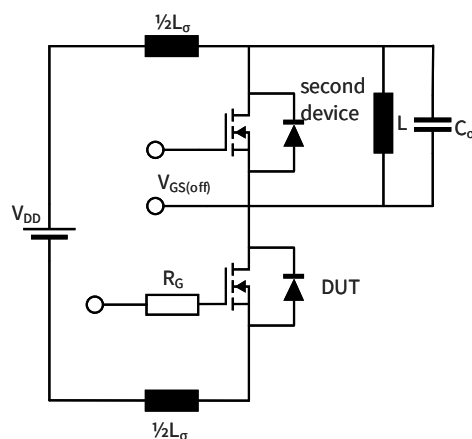


Figure F. Dynamic test circuit

Parasitic inductance L_{σ} ,
Parasitic capacitor C_{σ} ,

Revision history

Document revision	Date of release	Description of changes
1.00	2022-02-03	Final datasheet
1.10	2022-08-10	Change of test condition of dynamic capacitances in Table 4, "Characteristic values" (C_{iss}, C_{oss}, C_{rss}): $V_{DD} = 25\text{ V}$ to $V_{DD} = 800\text{ V}$ Correction of unit of "Input capacitance" C_{iss} from nF to pF Change of V_{GS} "Gate-source voltage, max. static voltage" in Table 2, "Maximum rated values" from -5/20 V to -7/20 V Editorial changes in "Features" on page 1 Editorial changes in "Package" on page 1 Correction of unit of x-axis at diagram "Max. transient thermal impedance (MOSFET/diode)" from μs to s, on page 13 Correction of diagram "Max. transient thermal impedance (MOSFET/diode)", on page 13

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