

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

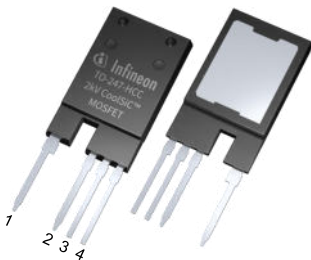
Product validation

- 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

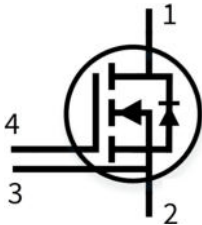
Description

- 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 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}		$T_c = 25\text{ °C}$	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		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	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		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	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		μJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$	3675		
Virtual junction temperature	T_{vj}		-55		175	$^\circ\text{C}$

Note: The chip technology was characterized up to $100 \text{ kV}/\mu\text{s}$. 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

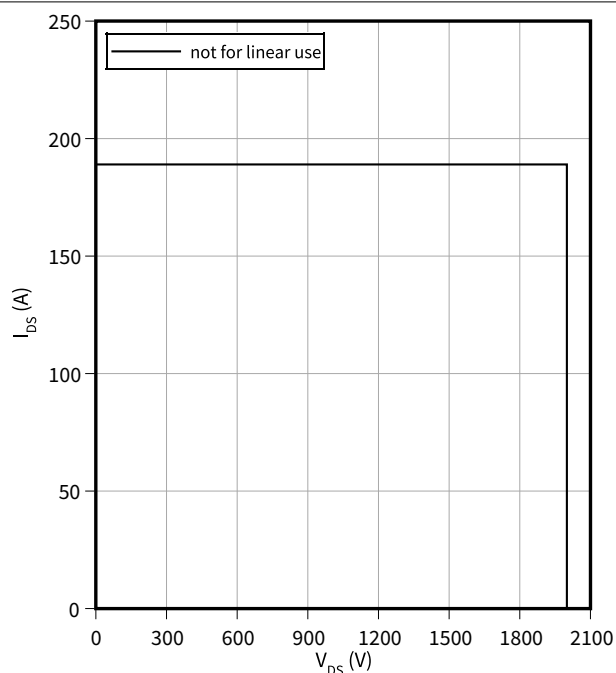
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Drain-source reverse voltage	V_{SD}	$I_{SD} = 40\text{ A}$, $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		3.7	5.5	V
			$T_{vj} = 100\text{ °C}$		3.6		
			$T_{vj} = 175\text{ °C}$		3.5		
MOSFET forward recovery charge	Q_{fr}	$V_{DD} = 1200\text{ V}$, $I_{SD} = 40\text{ A}$, $V_{GS} = -2\text{ V}$, $R_{GS(on)} = 2\text{ }\Omega$, 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		μJ
			$T_{vj} = 175\text{ °C}$		1100		
Virtual junction temperature	T_{vj}			-55		175	$^{\circ}\text{C}$

4 Characteristics diagrams

Reverse bias safe operating area (RBSOA)

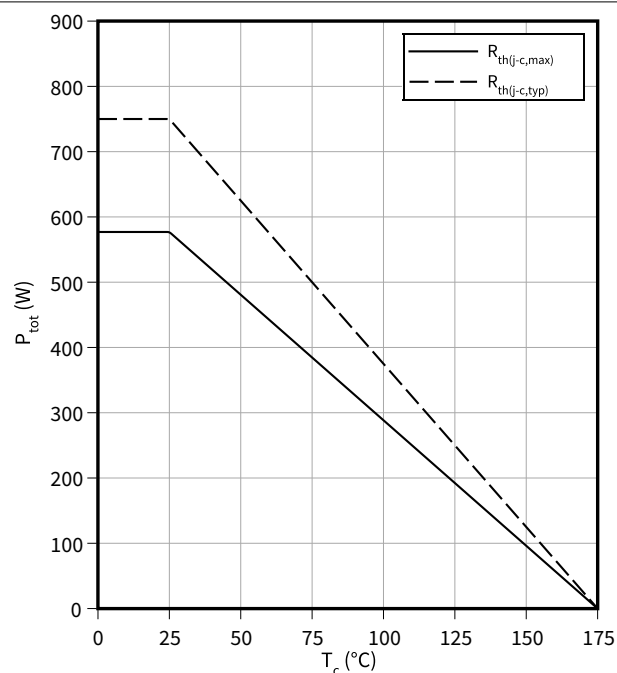
$$I_{DS} = f(V_{DS})$$

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



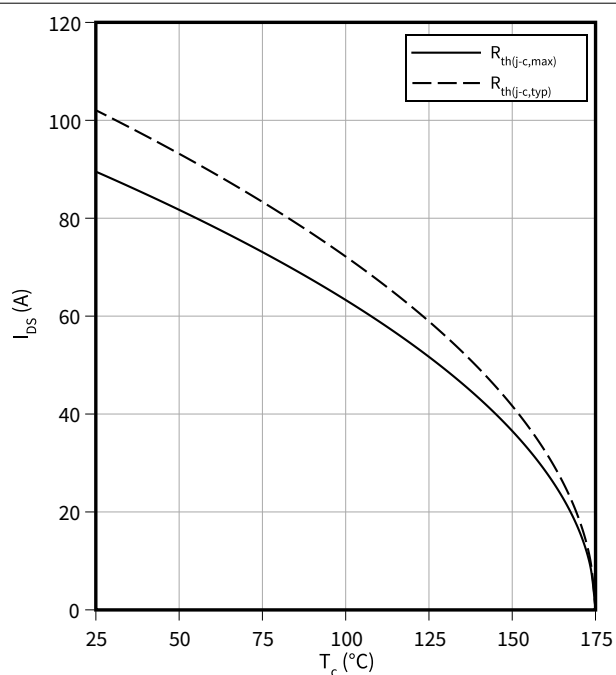
Power dissipation as a function of case temperature limited by bond wire

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



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

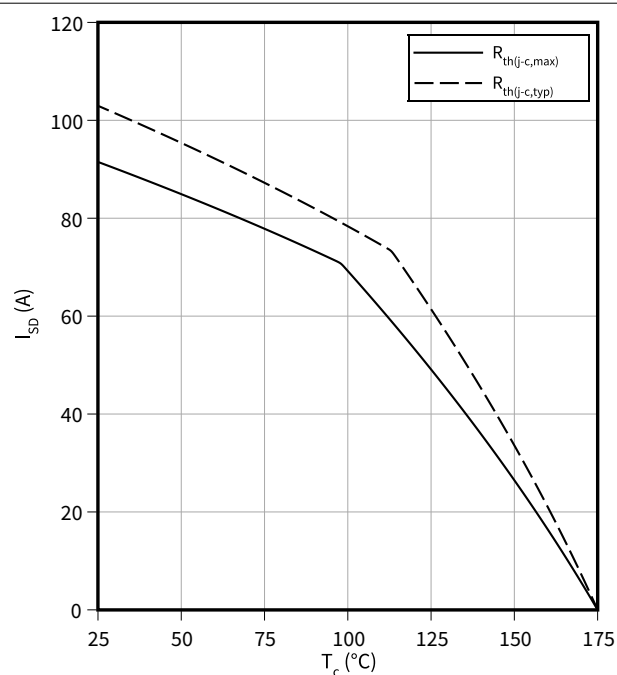
$$I_{DS} = f(T_c)$$



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

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

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

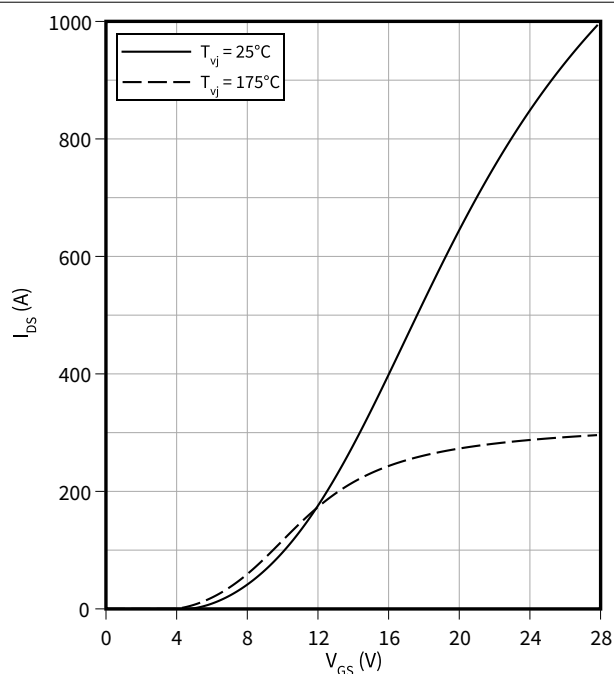


4 Characteristics diagrams

Typical transfer characteristic

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

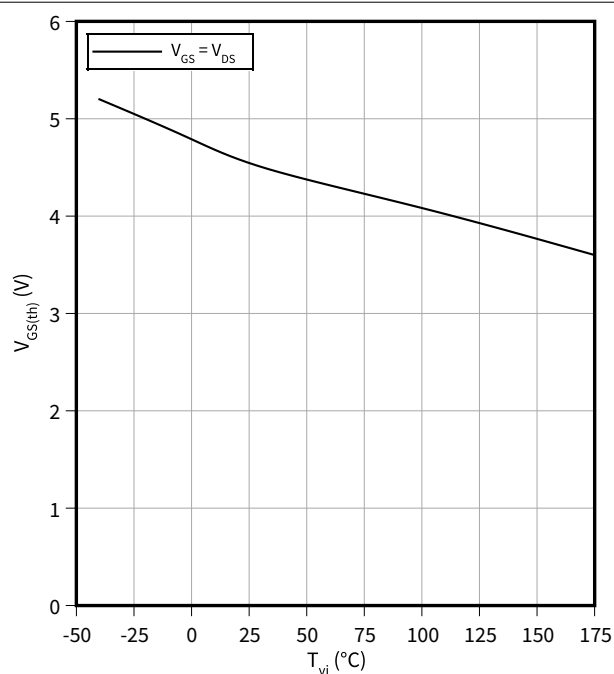
$$V_{DS} = 20 \text{ V}, t_p = 20 \mu\text{s}$$



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

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

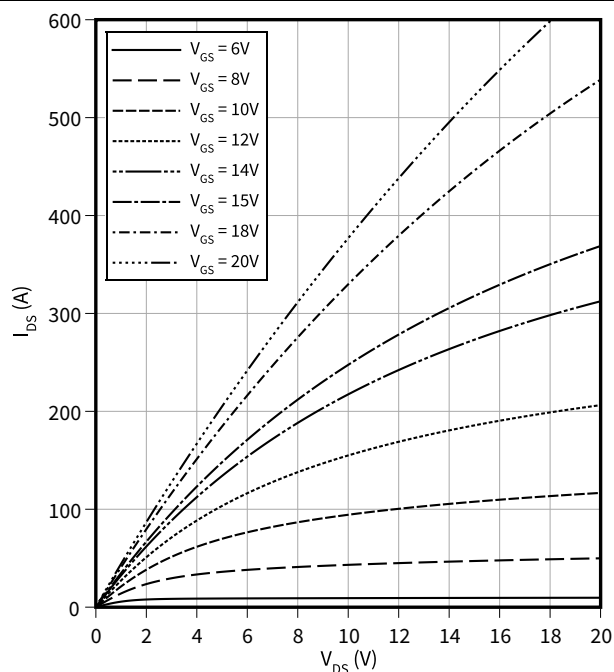
$$I_D = 24 \text{ mA}$$



Typical output characteristic, V_{GS} as parameter

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

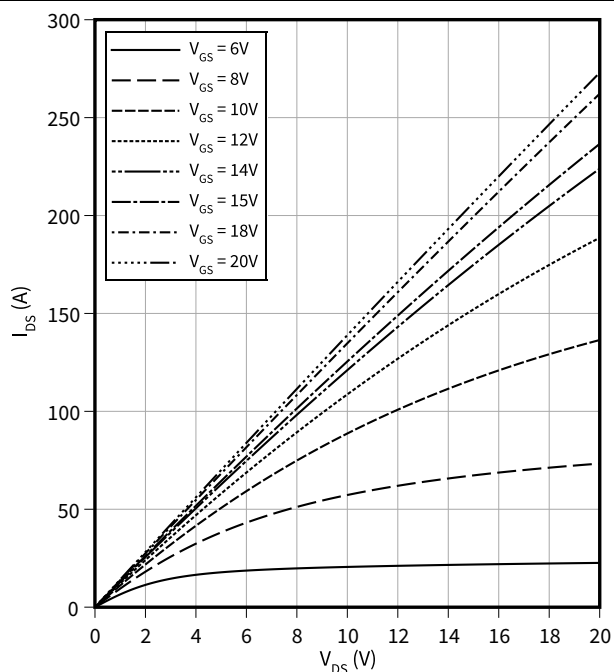
$$T_{vj} = 25^\circ\text{C}, t_p = 20 \mu\text{s}$$



Typical output characteristic, V_{GS} as parameter

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

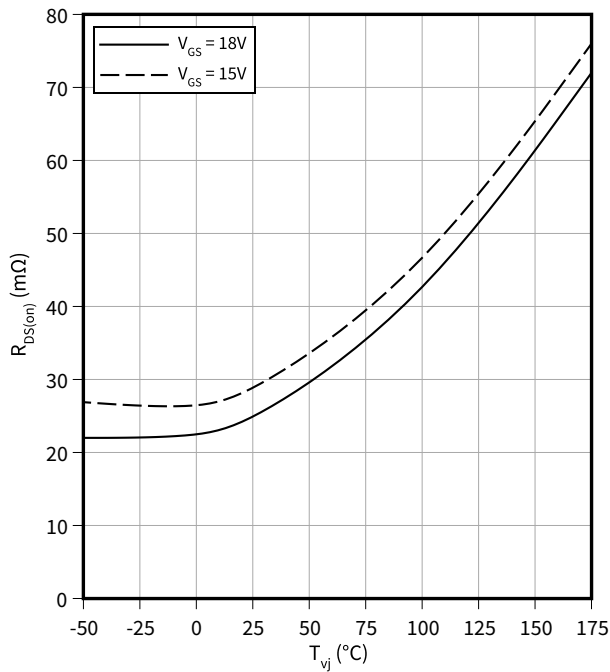
$$T_{vj} = 175^\circ\text{C}, t_p = 20 \mu\text{s}$$



4 Characteristics diagrams

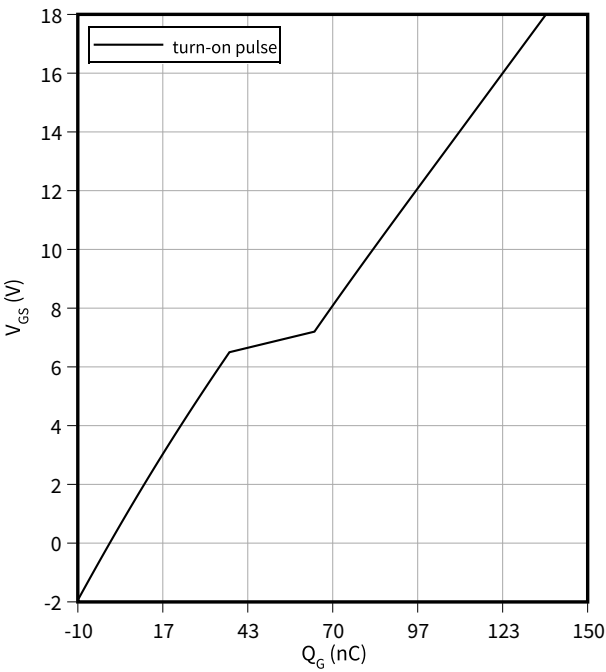
Typical on-state resistance as a function of junction temperature

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



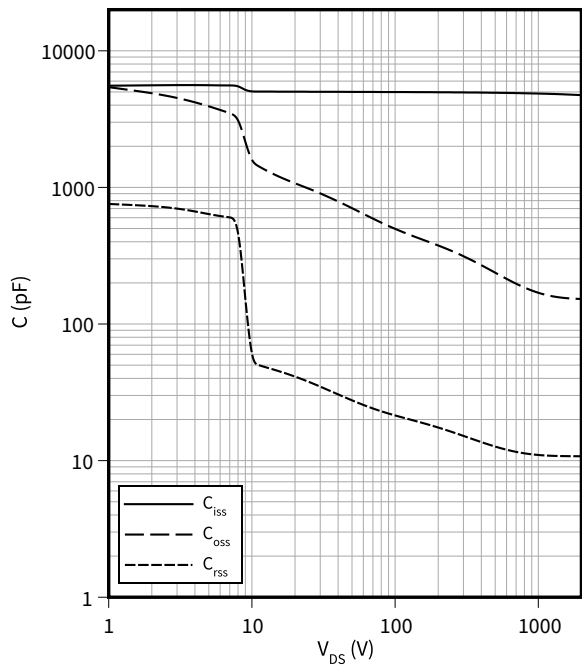
Typical gate charge

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



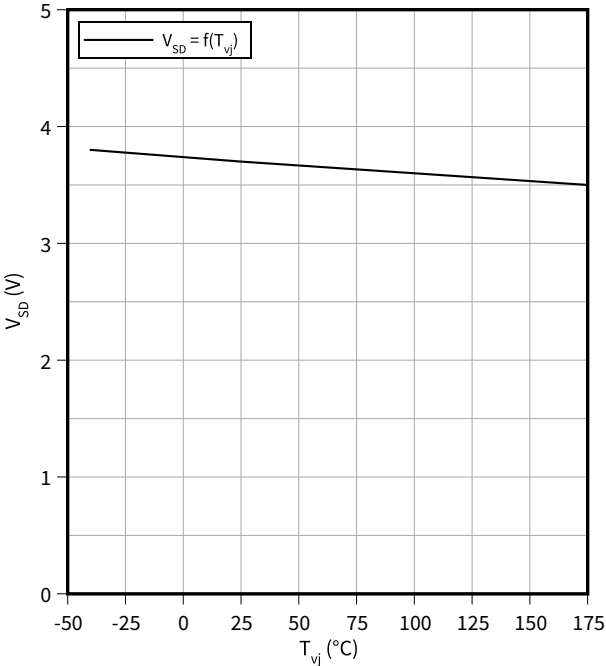
Typical capacitance as a function of drain-source voltage

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



Typical reverse drain voltage as function of junction temperature

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

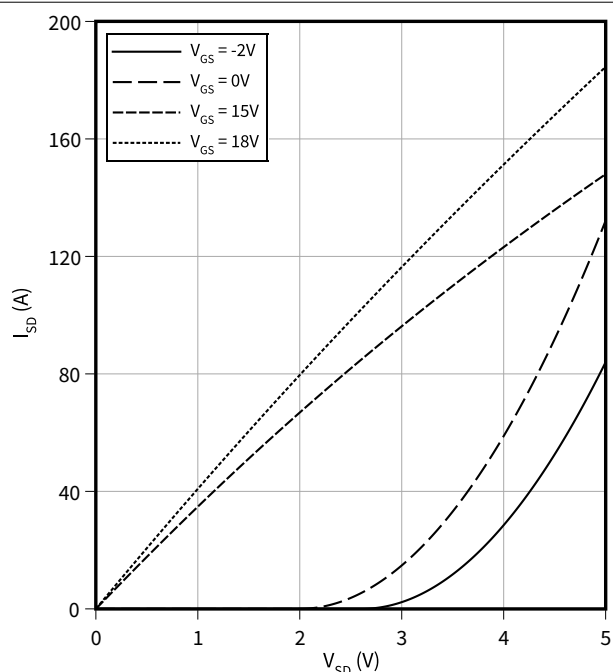


4 Characteristics diagrams

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

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

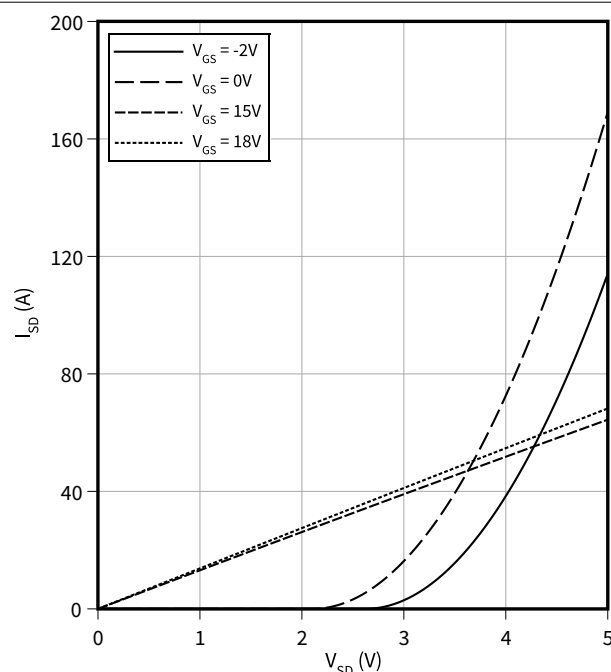
$T_{vj} = 25\text{ °C}$, $t_p = 20\text{ }\mu\text{s}$



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

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

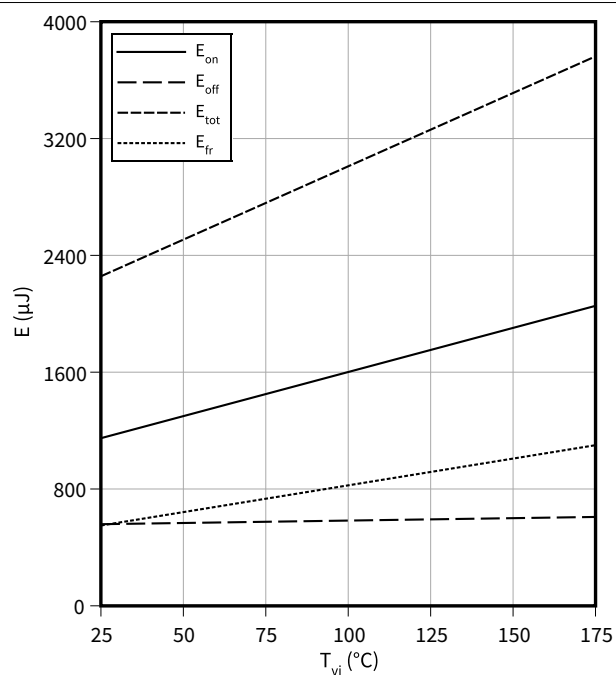
$T_{vj} = 175\text{ °C}$, $t_p = 20\text{ }\mu\text{s}$



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

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

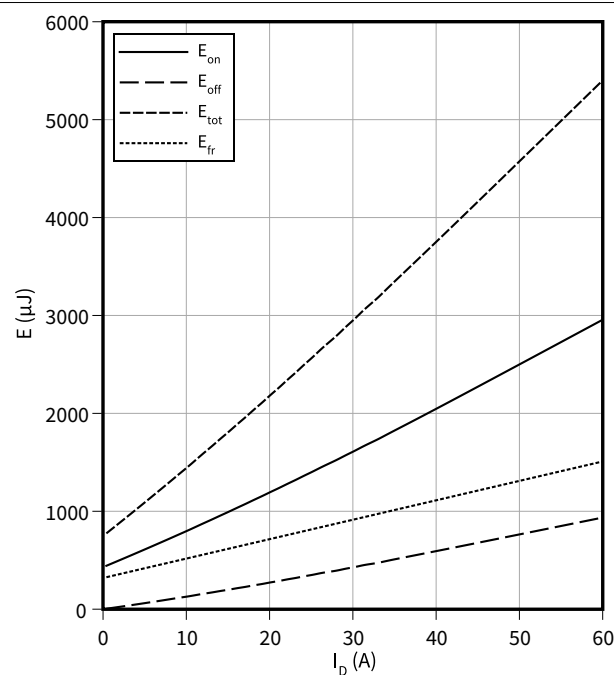
$V_{GS} = -2/18\text{ V}$, $I_D = 40\text{ A}$, $R_{G,ext} = 2\text{ }\Omega$, $V_{DD} = 1200\text{ V}$



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

$$E = f(I_D)$$

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

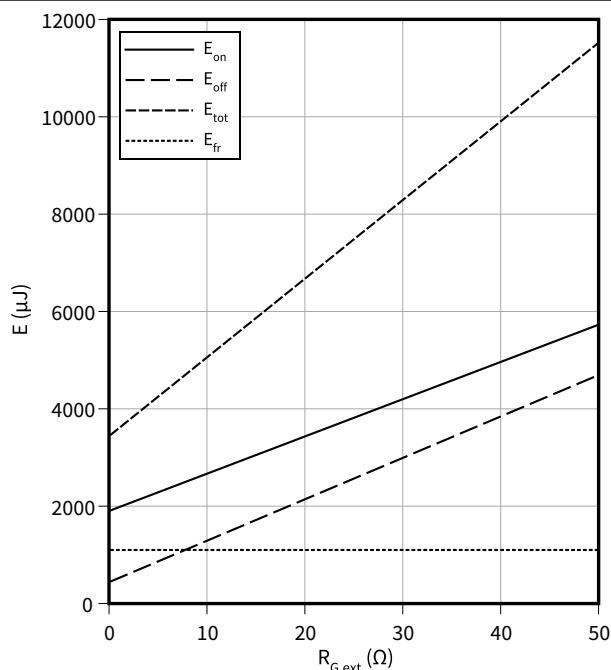


4 Characteristics diagrams

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

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

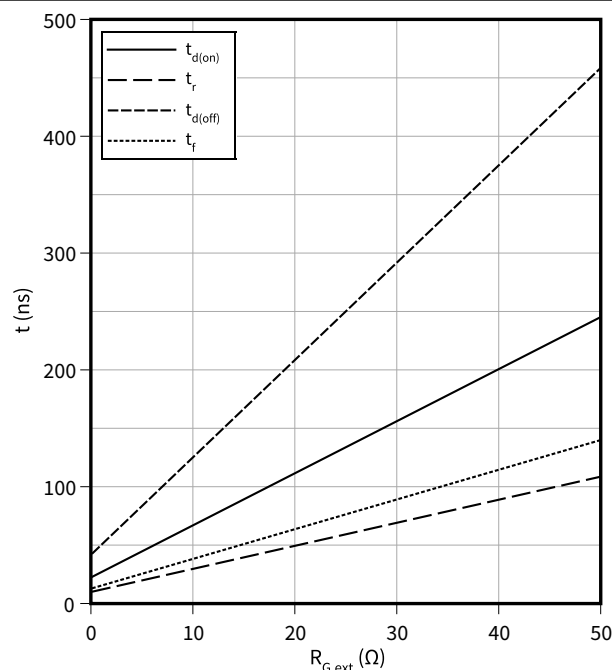
$V_{GS} = -2/18$ V, $I_D = 40$ A, $T_{vj} = 175$ °C, $V_{DD} = 1200$ V



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

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

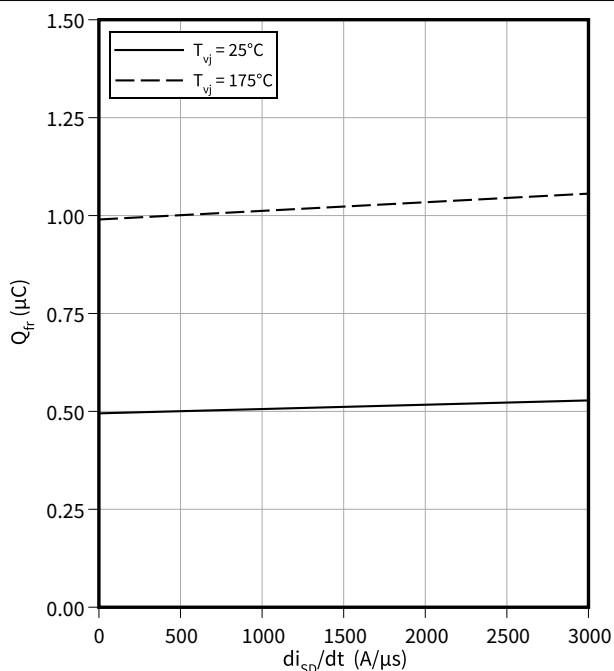
$I_D = 40$ A, $T_{vj} = 175$ °C, $V_{GS} = -2/18$ V, $V_{DD} = 1200$ V



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

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

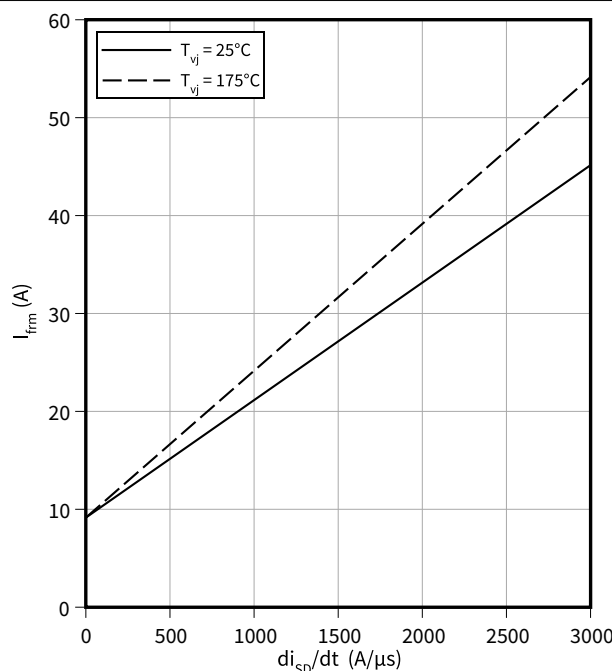
$V_{GS} = -2/18$ V, $I_{SD} = 40$ A, $V_{DD} = 1200$ V



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

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

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

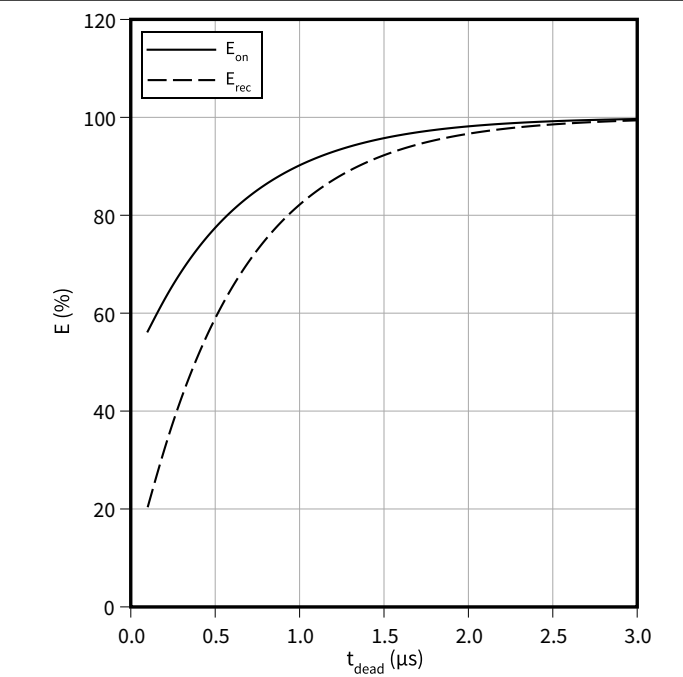


4 Characteristics diagrams

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

$E = f(t_{dead})$

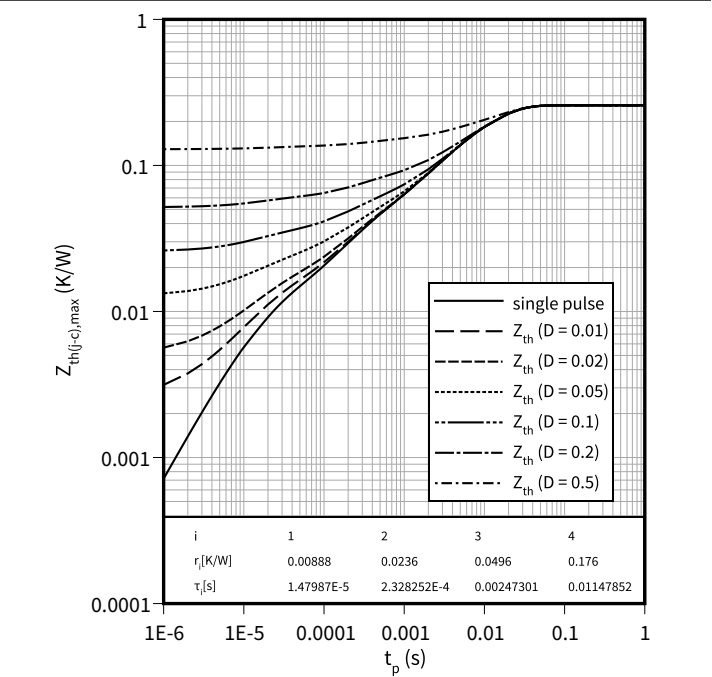
$I_D = 40\text{ A}$, $T_{vj} = 175\text{ °C}$, $R_{G,ext} = 2\text{ }\Omega$, $V_{DD} = 1200\text{ V}$



Max. transient thermal impedance (MOSFET/diode)

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

$D = t_p/T$



5 Package outlines

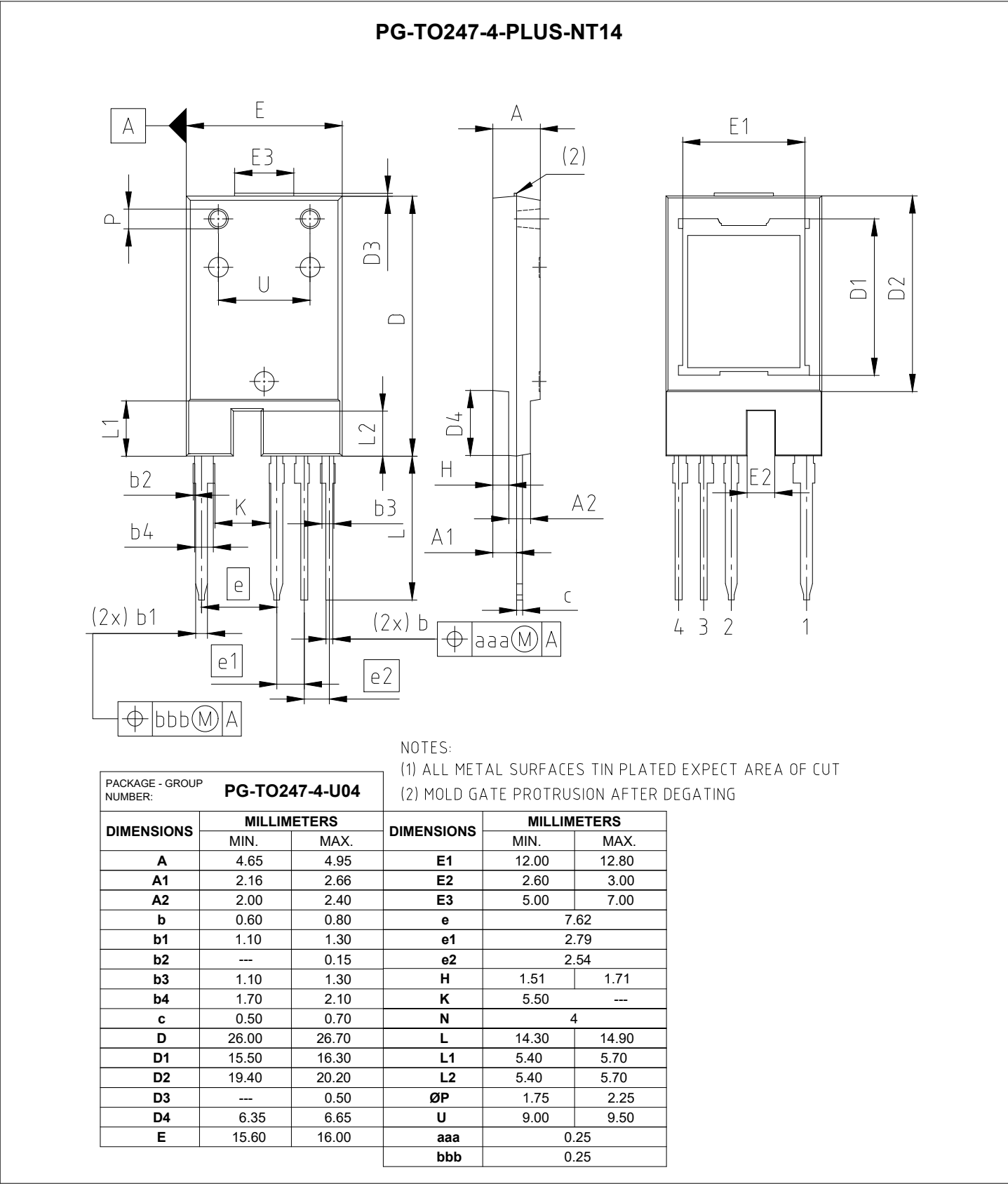


Figure 1

6 Testing conditions

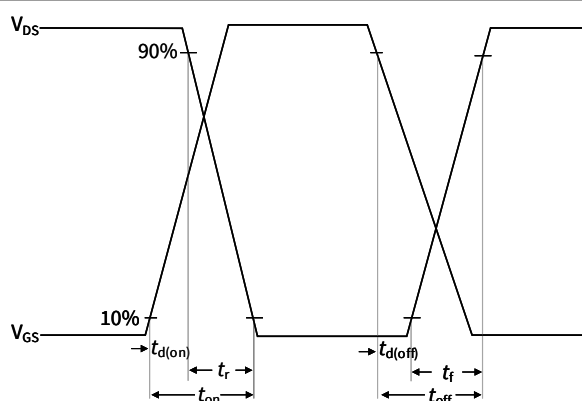


Figure A. Definition of switching times

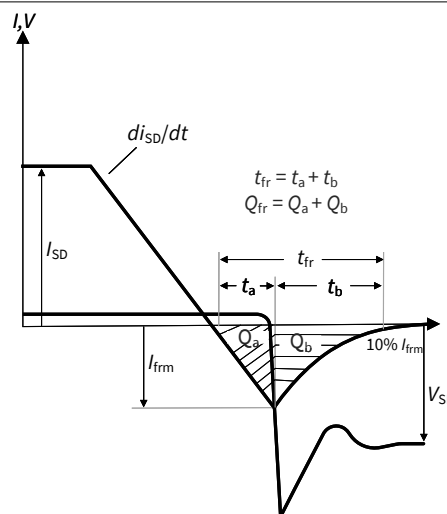


Figure B. Definition of body diode switching characteristics

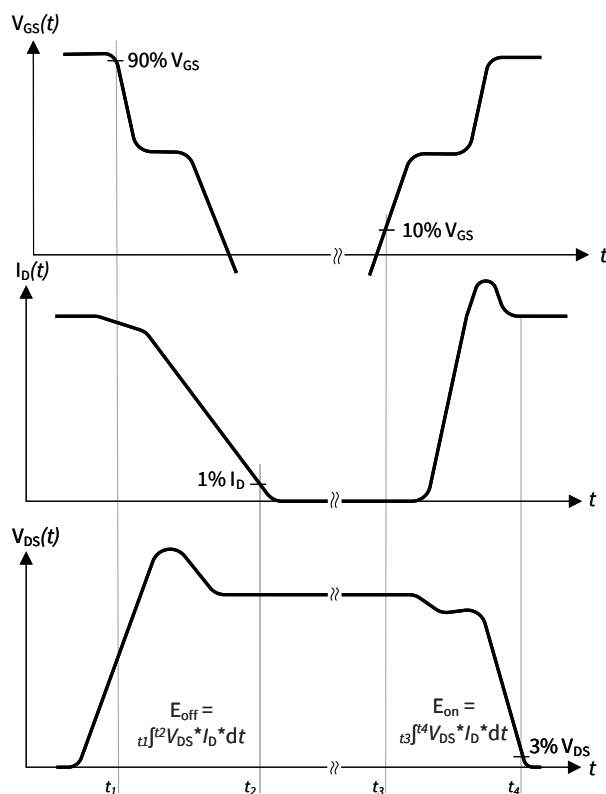


Figure C. Definition of switching losses

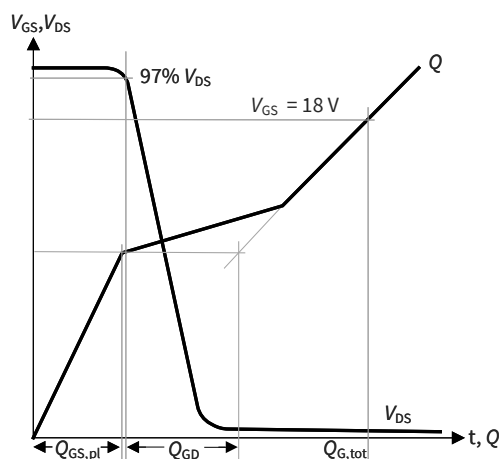


Figure D. Definition of QGD

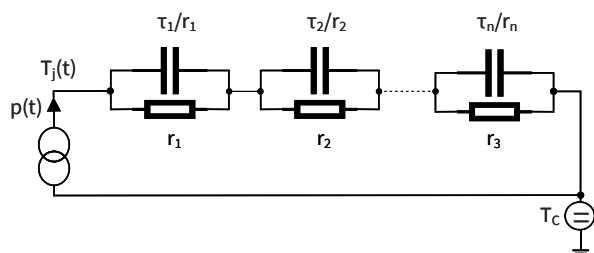


Figure E. Thermal equivalent circuit

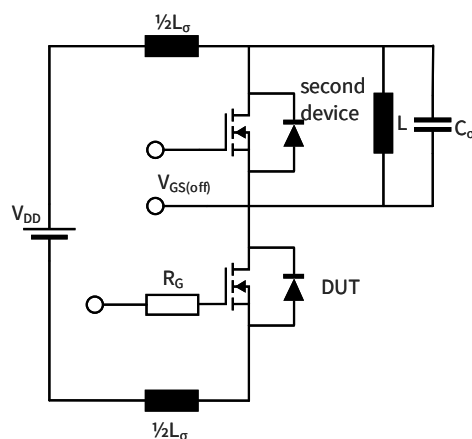


Figure F. Dynamic test circuit

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

Revision history

Document revision	Date of release	Description of changes
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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