

英飞凌工业用CoolSiC™ 2000 V SiC 沟槽MOSFET：采用 .XT 互连技术的碳化硅 MOSFET

特点

- $V_{DS} = 2000\text{ V}$ at $T_{vj} = 25^{\circ}\text{C}$
- $I_{DC} = 123\text{ A}$ at $T_c = 25^{\circ}\text{C}$
- $R_{DS(on)} = 12\text{ m}\Omega$ at $V_{GS} = 18\text{ V}$, $T_{vj} = 25^{\circ}\text{C}$
- 开关损耗非常低
- 基准栅极阈值电压, $V_{GS(th)} = 4.5\text{ V}$
- 坚固的体二极管, 适用于硬换向
- 英飞凌.XT 互连技术, 实现、行业领先的热性能

潜在应用

- 组串式逆变器
- 太阳能优化器
- 电动汽车充电

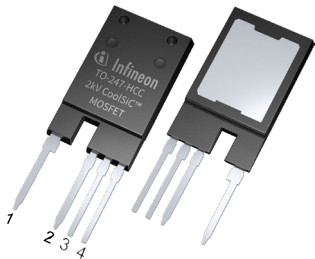
产品验证

- 符合JEDEC47/20/22相关测试的工业应用要求
- 另请注意有关功率和热循环的应用说明 AN2019-05

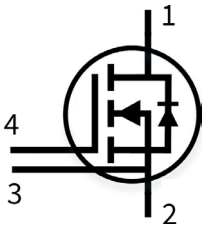
描述

- 1 - 漏极
- 2 - 来源
- 3 - 开尔文检测
- 4 - 栅极

注：源极和开尔文传感触点引脚不可互换，互换可能会导致故障（仅适用于 4 pin及TO263-7L封装）



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



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

本数据手册的原文使用英文撰写。为方便起见，英飞凌提供了译文；由于翻译过程中可能使用了自动化工具，英飞凌不保证译文的准确性。为确认准确性，请务必访问 infineon.com 参考最新的英文版本（控制文档）。



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1封装

1 封装

表1 特征值

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

表2 最大额定值

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) **重要注释：** 正负栅极源电压的选择会影响器件的长期行为。为了确保器件在计划使用寿命内的正常运行，必须考虑应用说明AN2018-09中描述的设计指南。

表3 建议值

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

表4 特征值

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		

(表格续下页.....)

表 4 (续) 特征值

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	$^\circ\text{C}$

注： 该芯片技术的特征高达100 kV/ μs 。测量的dV/dt 受到测量测试设置和封装的限制。
动态测试电路见图F。

3 体二极管 (MOSFET)

3 体二极管 (MOSFET)

表5 最大额定值

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

表6 特征值

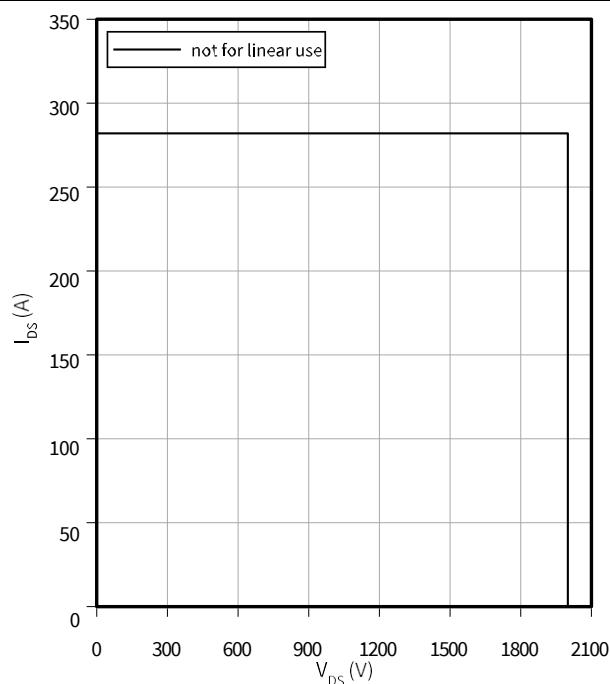
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Drain-source reverse voltage	V_{SD}	$I_{SD} = 60\text{ A}$, $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$	3.4	5.5	V
			$T_{vj} = 100\text{ }^{\circ}\text{C}$	3.3		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$	3.2		
MOSFET 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	$T_{vj} = 25\text{ }^{\circ}\text{C}$	2000		nC
			$T_{vj} = 175\text{ }^{\circ}\text{C}$	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	$T_{vj} = 25\text{ }^{\circ}\text{C}$	54		A
			$T_{vj} = 175\text{ }^{\circ}\text{C}$	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	$T_{vj} = 25\text{ }^{\circ}\text{C}$	920		μJ
			$T_{vj} = 175\text{ }^{\circ}\text{C}$	1835		
Virtual junction temperature	T_{vj}		-55		175	$^{\circ}\text{C}$

4 特性图

Reverse bias safe operating area (RBSOA)

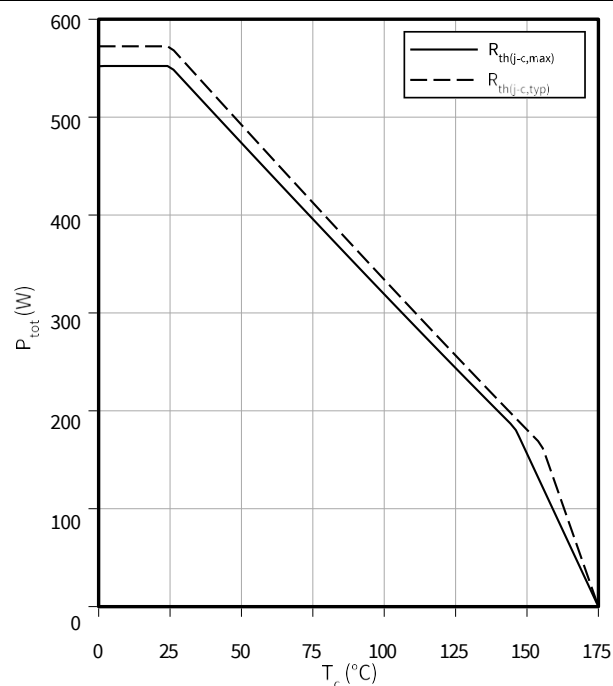
$$I_{DS} = f(V_{DS})$$

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



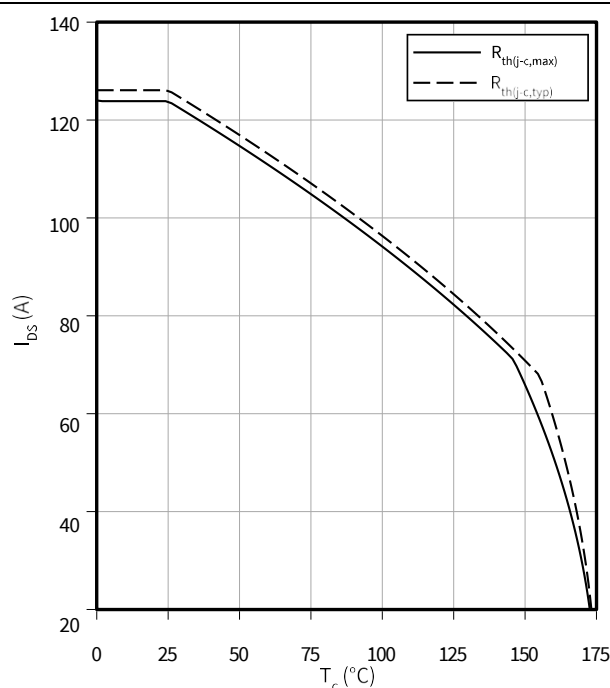
Power dissipation as a function of case temperature limited by bond wire

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



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

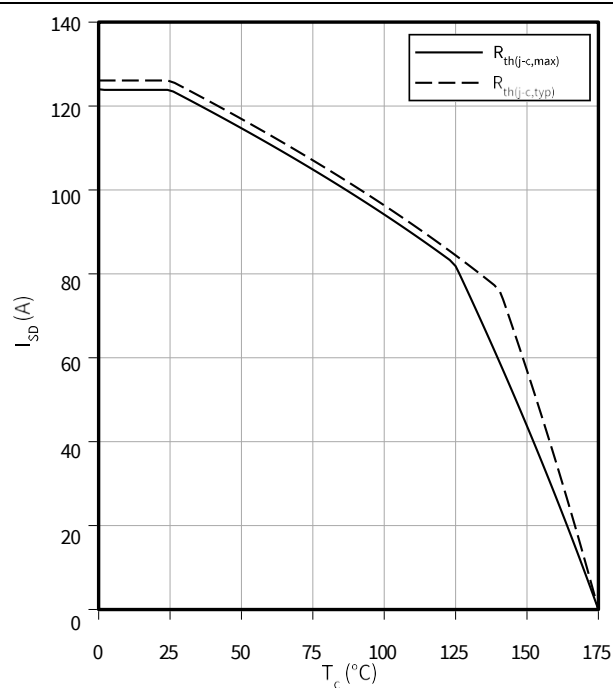
$$I_{DS} = f(T_c)$$



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

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

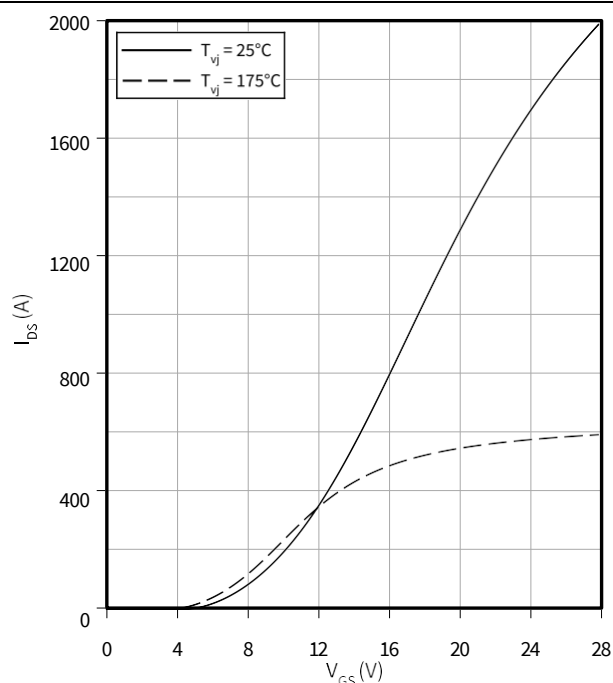
$$V_{GS} = 0\text{ V}$$



Typical transfer characteristic

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

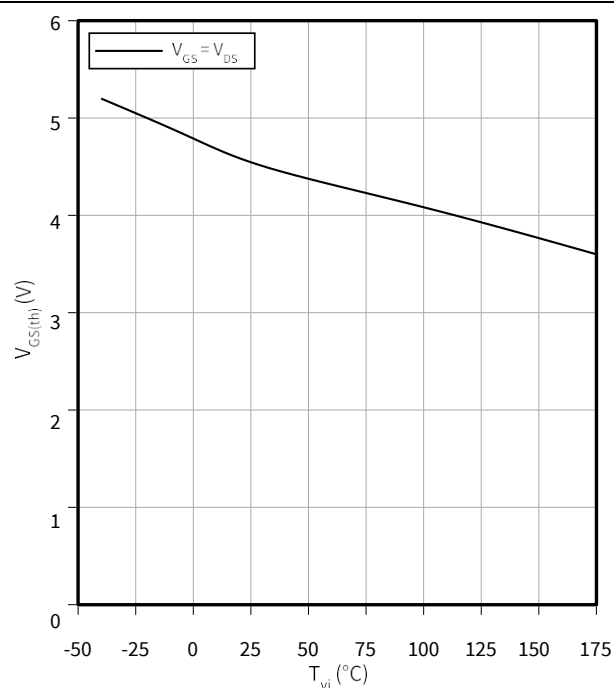
$V_{DS} = 20 \text{ V}$, $t_p = 20 \mu\text{s}$



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

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

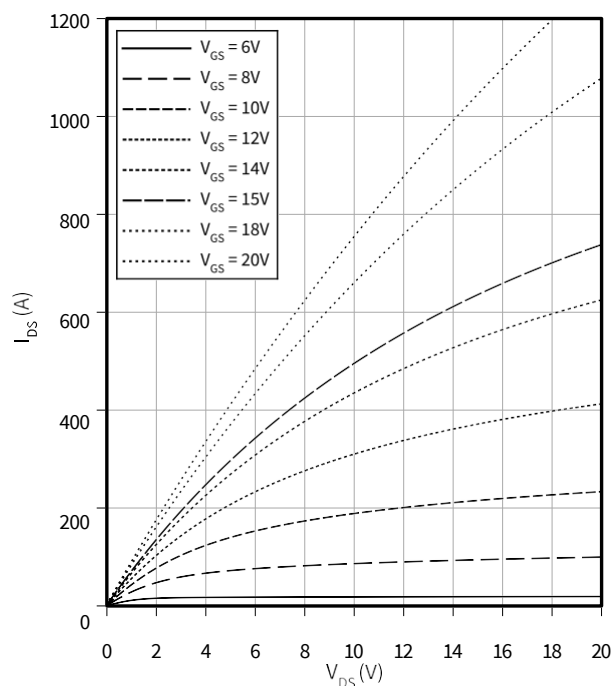
$I_D = 48 \text{ mA}$



Typical output characteristic, V_{GS} as parameter

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

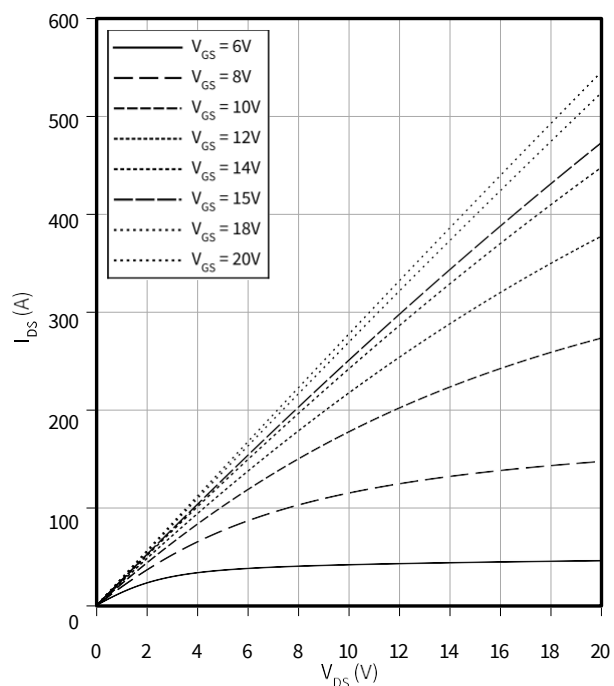
$T_{vj} = 25^\circ\text{C}$, $t_p = 20 \mu\text{s}$



Typical output characteristic, V_{GS} as parameter

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

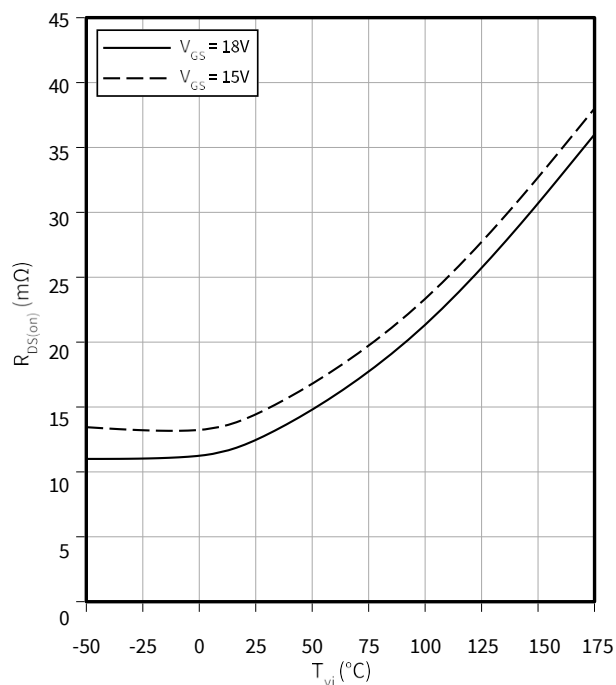
$T_{vj} = 175^\circ\text{C}$, $t_p = 20 \mu\text{s}$



Typical on-state resistance as a function of junction temperature

$$R_{DS(on)} = f(T_{vj})$$

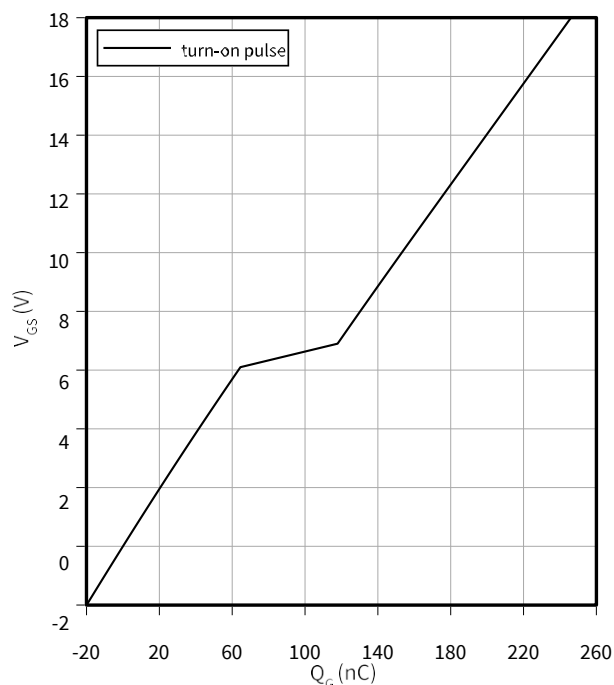
$I_D = 60 \text{ A}$



Typical gate charge

$$V_{GS} = f(Q_G)$$

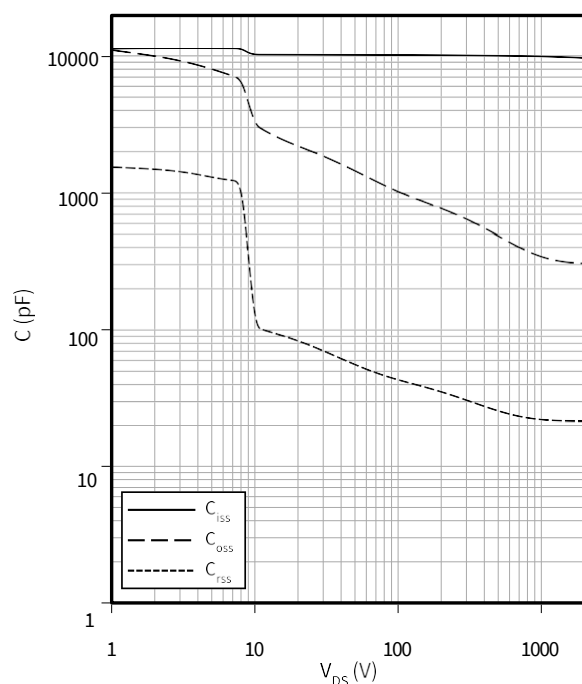
$I_D = 60 \text{ A}, V_{DS} = 1200 \text{ V}$



Typical capacitance as a function of drain-source voltage

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

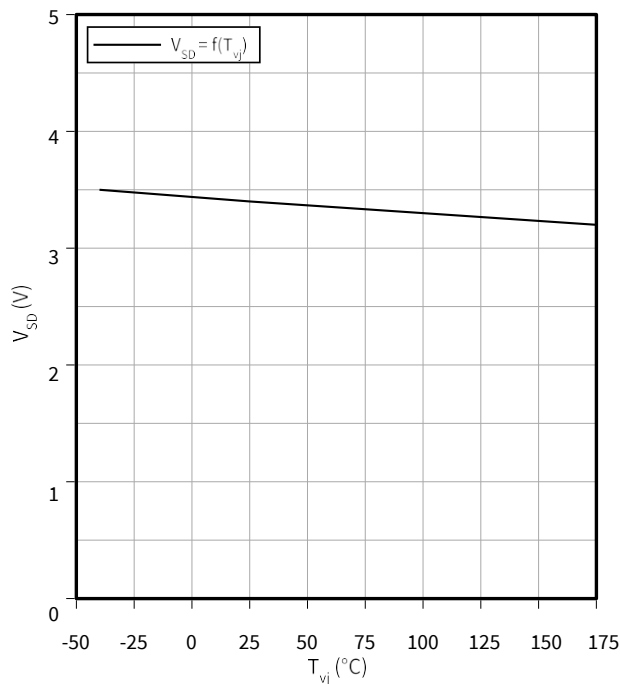
$f = 100 \text{ kHz}, V_{GS} = 0 \text{ V}$



Typical reverse drain voltage as function of junction temperature

$$V_{SD} = f(T_{vj})$$

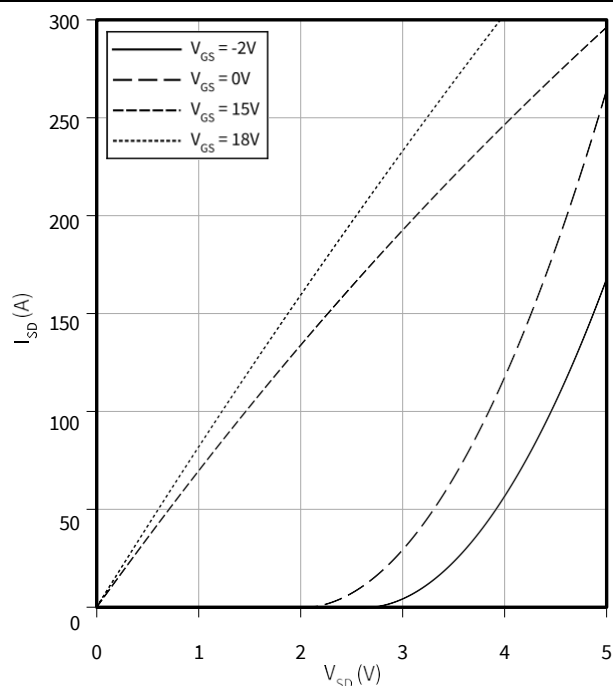
$I_{SD} = 60 \text{ A}, V_{GS} = 0 \text{ V}$



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

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

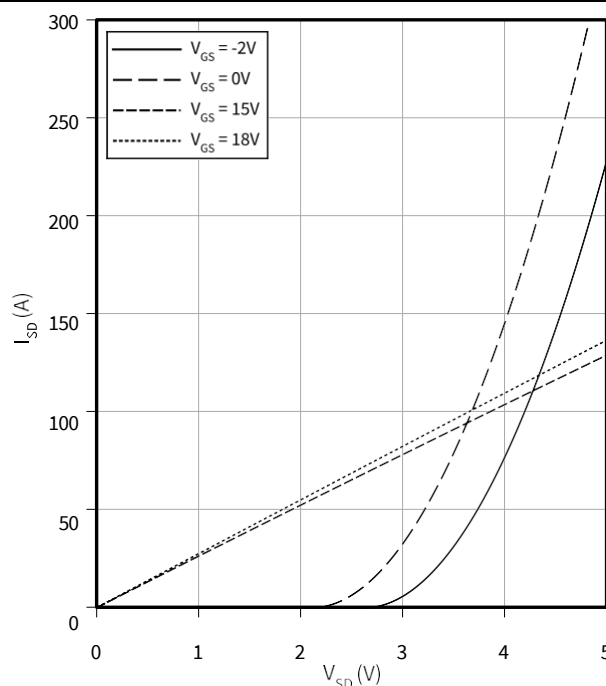
$T_{vj} = 25\text{ °C}$, $t_p = 20\text{ }\mu\text{s}$



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

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

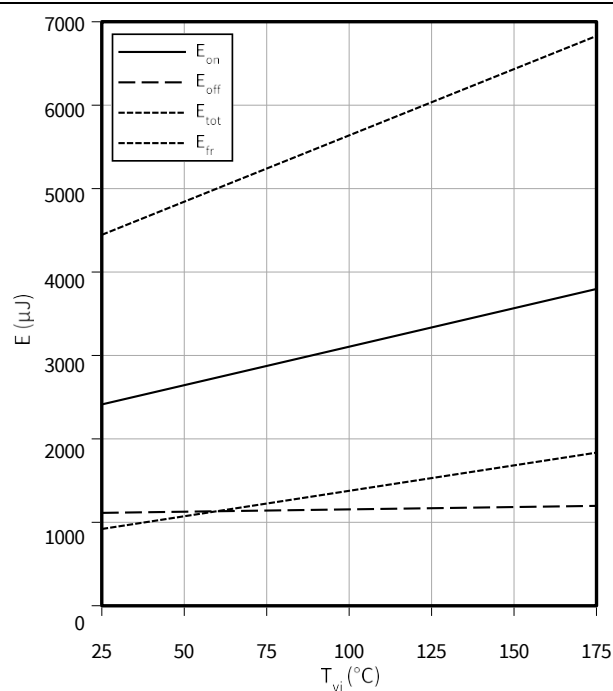
$T_{vj} = 175\text{ °C}$, $t_p = 20\text{ }\mu\text{s}$



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

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

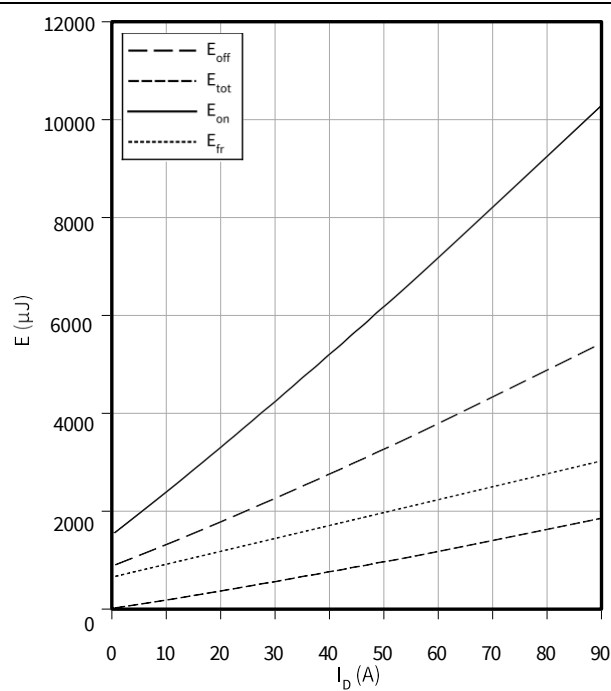
$V_{GS} = -2/18\text{ V}$, $I_D = 60\text{ A}$, $R_{G,ext} = 2\text{ }\Omega$, $V_{DD} = 1200\text{ V}$



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

$$E = f(I_D)$$

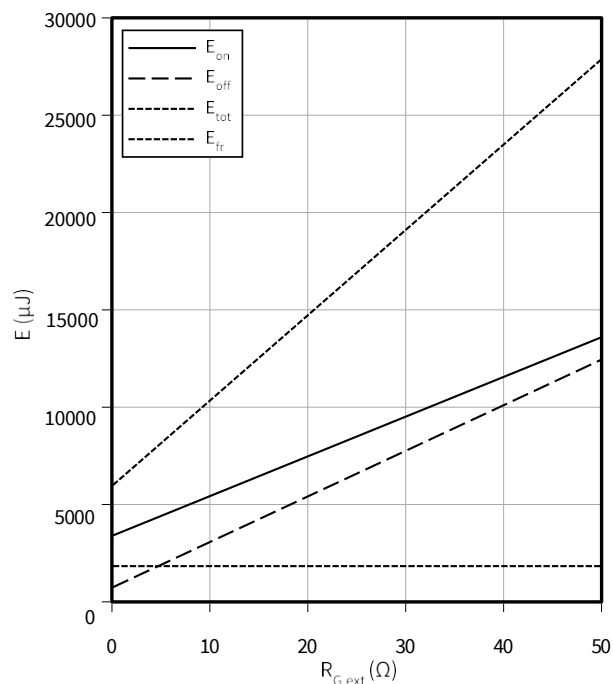
$V_{GS} = -2/18\text{ V}$, $T_{vj} = 175\text{ °C}$, $R_{G,ext} = 2\text{ }\Omega$, $V_{DD} = 1200\text{ V}$



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

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

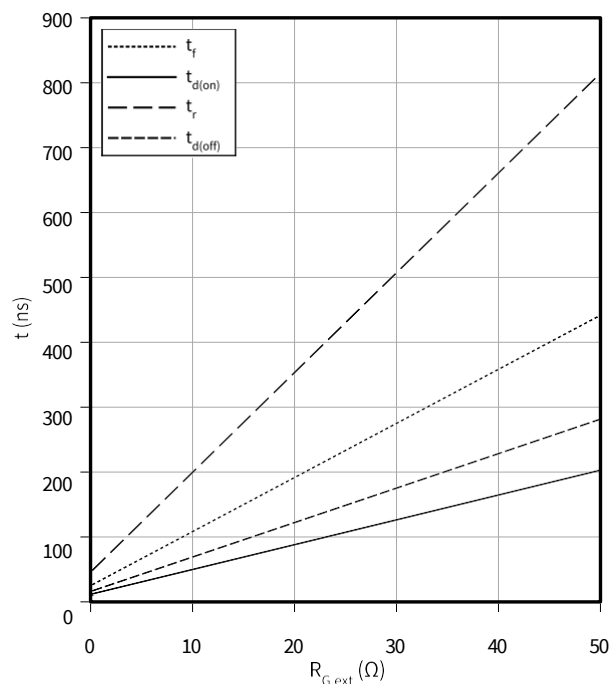
$V_{GS} = -2/18$ V, $I_D = 60$ A, $T_{vj} = 175$ °C, $V_{DD} = 1200$ V



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

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

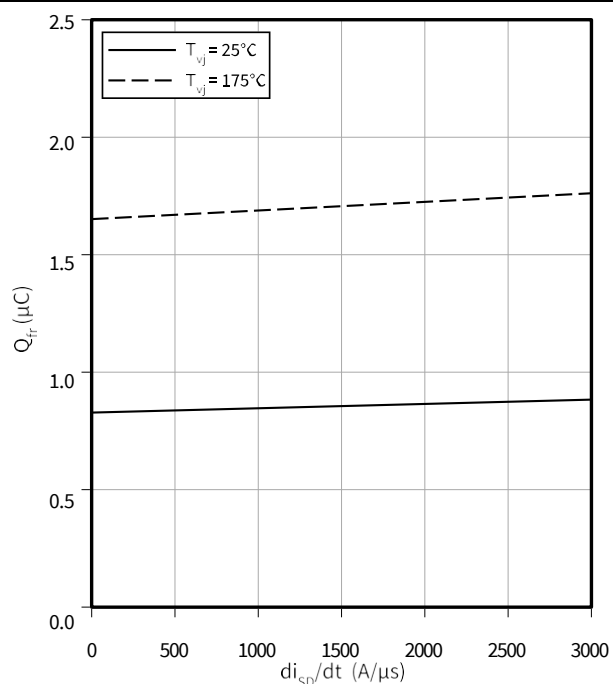
$V_{GS} = -2/18$ V, $I_D = 60$ A, $T_{vj} = 175$ °C, $V_{DD} = 1200$ V



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

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

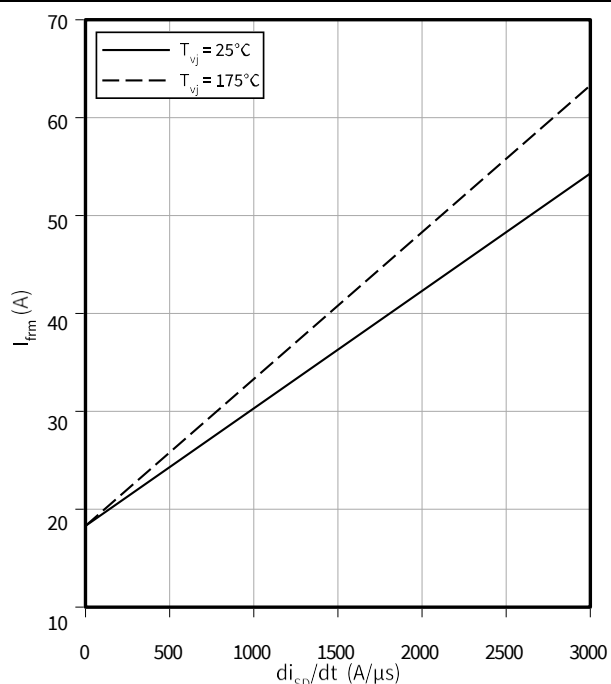
$V_{GS} = -2/18$ V, $I_{SD} = 60$ A, $V_{DD} = 1200$ V



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

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

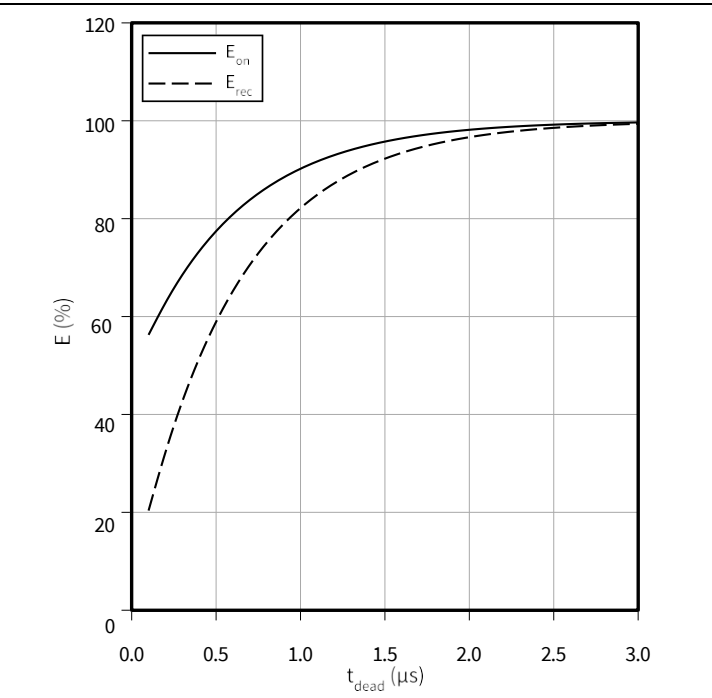
$V_{GS} = -2/18$ V, $I_{SD} = 60$ A, $V_{DD} = 1200$ V



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

$E = f(t_{dead})$

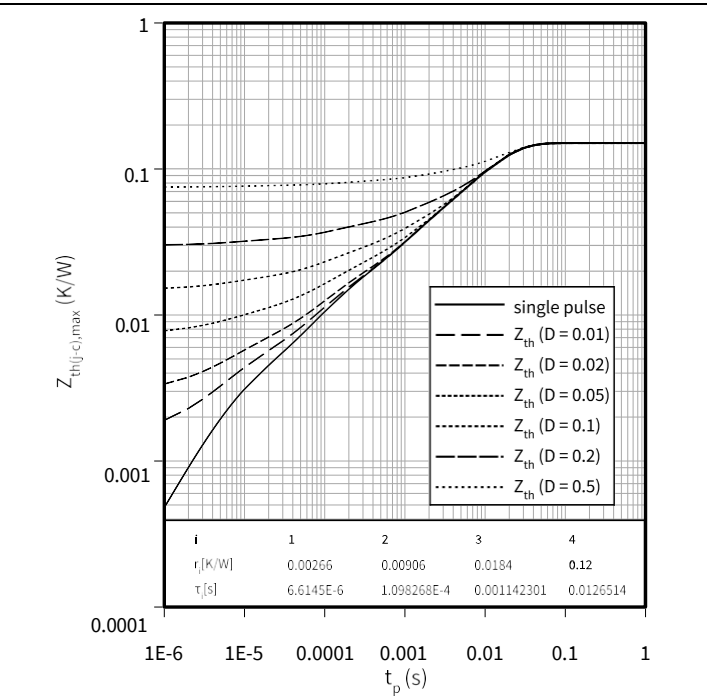
$I_D = 60\text{ A}$, $T_{vj} = 175\text{ °C}$, $R_{G,ext} = 2\text{ }\Omega$, $V_{DD} = 1200\text{ V}$



Max. transient thermal impedance (MOSFET/diode)

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

$D = t_p/T$



5 封装外形

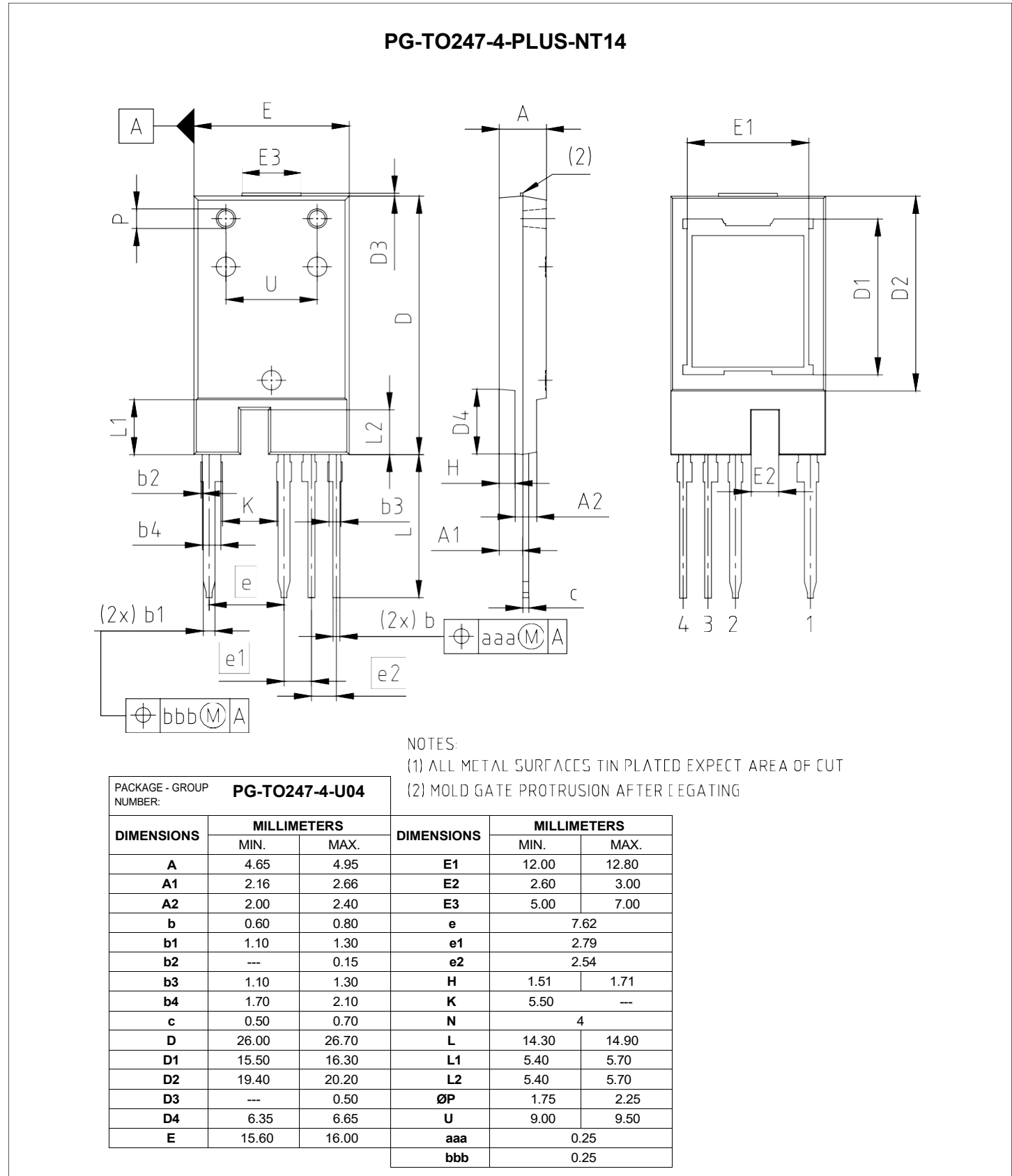


图 1

6 测试条件

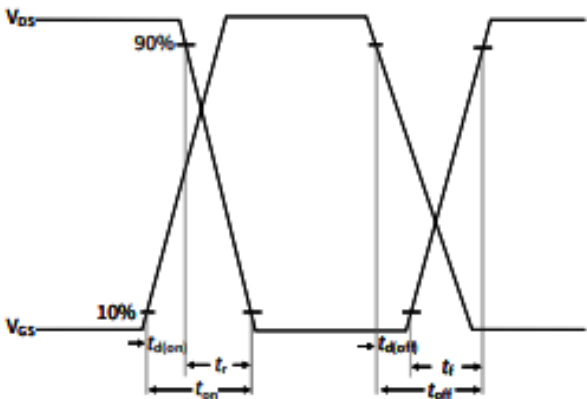


Figure A. Definition of switching times

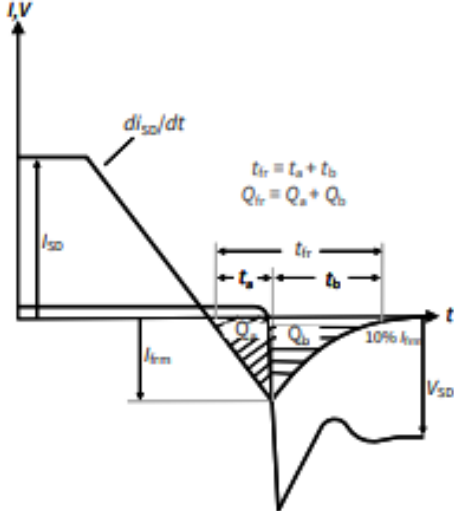


Figure B. Definition of body diode switching characteristics

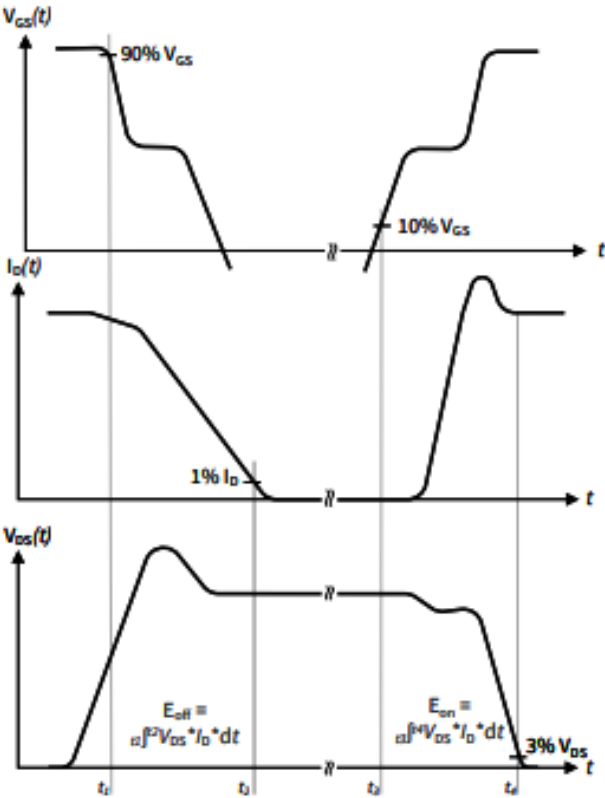


Figure C. Definition of switching losses

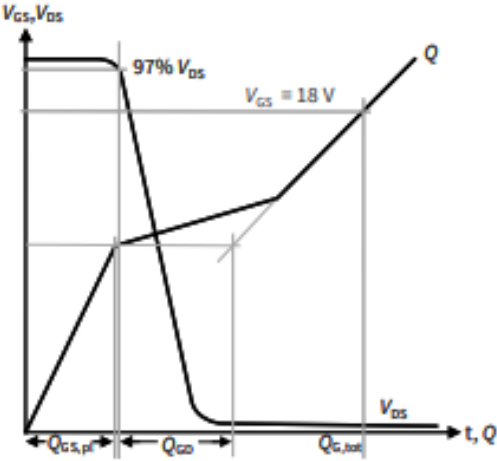


Figure D. Definition of QGD

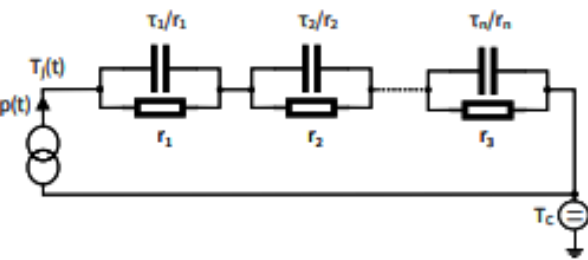


Figure E. Thermal equivalent circuit

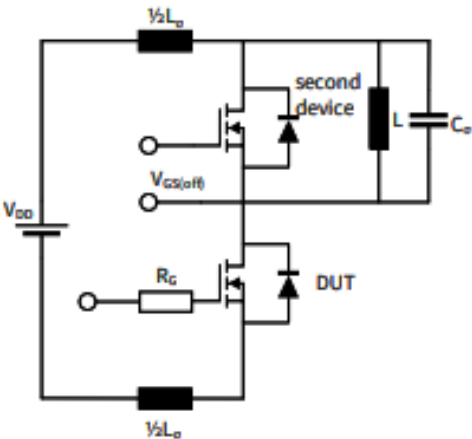


Figure F. Dynamic test circuit
Parasitic inductance L_{σ} ,
Parasitic capacitor C_{σ}

修订记录

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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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