

# 英飞凌IMSQ120R012M2HH

## CoolSiC™ 1200 V SiC MOSFET G2

采用顶部冷却和 .XT 技术的碳化硅 MOSFET

### 特性

- $T_{vj} = 25^{\circ}\text{C}$  时  $V_{DSS} = 1200\text{ V}$
- $I_{DDC} = 89\text{ A}$  at  $T_C = 100^{\circ}\text{C}$
- $R_{DS(on)} = 12\text{ m}\Omega$  at  $V_{GS} = 18\text{ V}$ ,  $T_{vj} = 25^{\circ}\text{C}$
- 内部布局经过优化, 可实现快速切换
- 开关损耗非常低
- 过载运行最高结温可达  $T_{vj} = 200^{\circ}\text{C}$
- 短路耐受时间  $2\text{ }\mu\text{s}$
- 基准栅极阈值电压,  $V_{GS(th)} = 4.2\text{ V}$
- 具有抗寄生导通能力, 可应用  $0\text{ V}$  关断栅极电压
- 坚固的体二极管, 适用于硬换向
- .XT 互连技术, 实现、行业领先的热性能
- 合适的英飞凌栅极驱动器可在 <https://www.infineon.com/gdfinder> 找到

### 潜在应用

- 通用驱动器 (GPD)
- 电动汽车充电桩
- 在线式UPS/工业UPS
- 组串式逆变器
- 伺服驱动器

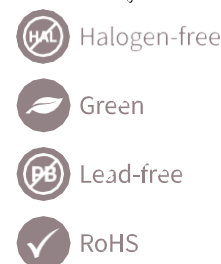
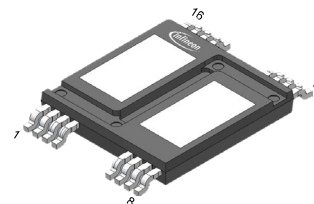
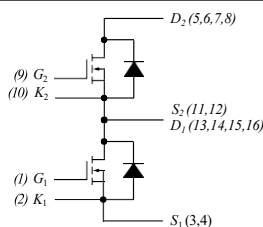
### 产品验证

- 符合 JEDEC47/20/22 相关测试的工业应用要求

### 描述

- 13-16 (5-8) – case 1(2) and drain D1(D2)
- 3,4 (11,12) – source S1(S2)
- 2(10) – kelvin sense K1(K2)
- 1(9) – gate G1(G2)

注: 源极引脚和检测引脚不可互换, 互换可能会导致故障



Type	Package	Marking
IMSQ120R012M2HH	PG-HDSOP-16-U03	12M2H012

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](http://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	$T_{sold}$	reflow soldering (MSL2 according to JEDEC J-STD-020)			260	°C
Thermal resistance, junction-ambient	$R_{th(j-a)}$				62	K/W
MOSFET/body diode thermal resistance, junction-case	$R_{th(j-c)}$			0.15	0.2	K/W

## 2 MOSFET

表 2 最大额定值

Parameter	Symbol	Note or test condition	Values	Unit	
Drain-source voltage	$V_{DSS}$	$T_{vj} \geq 25 \text{ °C}$	1200	V	
Continuous DC drain current for $R_{th(j-c,max)}$ , limited by $T_{vj(max)}$	$I_{DDC}$	$V_{GS}=18 \text{ V}$	$T_c = 25 \text{ °C}$	121	A
			$T_c = 100 \text{ °C}$	89	
Peak drain current, $t_p$ limited by $T_{vj(max)}$ <sup>1)</sup>	$I_{DM}$	$V_{GS}=18 \text{ V}$	267	A	
Gate-source voltage, max. transient voltage <sup>2)</sup>	$V_{GS}$	$t_p \leq 0.5 \text{ }\mu\text{s}, D < 0.01$	-10...25	V	
Gate-source voltage, max. static voltage	$V_{GS}$		-7...23	V	
Avalanche energy, single pulse	$E_{AS}$	$I_D = 57 \text{ A}, V_{DD} = 50 \text{ V}, L = 0.4 \text{ mH}, T_{vj(start)} = 25 \text{ °C}$	712	mJ	
Avalanche energy, repetitive	$E_{AR}$	$I_D = 57 \text{ A}, V_{DD} = 50 \text{ V}, L = 2.2 \text{ }\mu\text{H}, T_{vj(start)} = 25 \text{ °C}$	3.56	mJ	
Short-circuit withstand time	$t_{SC}$	$V_{DD} \leq 800 \text{ V}, V_{DS,peak} < 1200 \text{ V}, V_{GS(on)} = 15 \text{ V}, T_{vj(start)} = 25 \text{ °C}$	2	$\mu\text{s}$	
Power dissipation, limited by $T_{vj(max)}$	$P_{tot}$		$T_c = 25 \text{ °C}$	758	W
			$T_c = 100 \text{ °C}$	379	

1) 已通过设计验证。

2) 应用设计中的最大栅源电压应符合IPC-9592B的规定。

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	$R_{DS(on)}$	$I_D = 57\text{ A}$	$T_{vj} = 25\text{ °C}$ , $V_{GS(on)} = 18\text{ V}$		12		mΩ
			$T_{vj} = 150\text{ °C}$ , $V_{GS(on)} = 18\text{ V}$		25	33	
			$T_{vj} = 175\text{ °C}$ , $V_{GS(on)} = 18\text{ V}$		29		
			$T_{vj} = 25\text{ °C}$ , $V_{GS(on)} = 15\text{ V}$		15.3		
Gate-source threshold voltage	$V_{GS(th)}$	$I_D = 17.8\text{ mA}$ , $V_{DS} = V_{GS}$ (tested after 1 ms pulse at $V_{GS} = 20\text{ V}$ )	$T_{vj} = 25\text{ °C}$	3.5	4.2	5.1	V
			$T_{vj} = 175\text{ °C}$		3.2		
Zero gate-voltage drain current	$I_{DSS}$	$V_{DS} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			500	μA
			$T_{vj} = 175\text{ °C}$		8.5		
Gate leakage current	$I_{GSS}$	$V_{DS} = 0\text{ V}$	$V_{GS} = 23\text{ V}$			120	nA
			$V_{GS} = -10\text{ V}$			-120	
Forward transconductance	$g_{fs}$	$I_D = 57\text{ A}$ , $V_{DS} = 20\text{ V}$		38		S	
Internal gate resistance	$R_{G,int}$	$f = 1\text{ MHz}$ , $V_{AC} = 25\text{ mV}$		4		Ω	
Input capacitance	$C_{iss}$	$V_{DS} = 800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		4050		pF	
Output capacitance	$C_{oss}$	$V_{DS} = 800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		176		pF	
Reverse transfer capacitance	$C_{rss}$	$V_{DS} = 800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$		15		pF	
$C_{oss}$ stored energy	$E_{oss}$	$V_{DS} = 0...800\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ , $V_{AC} = 25\text{ mV}$ , Calculated based on $C_{oss}$		74		μJ	
Output charge	$Q_{oss}$	$V_{DS} = 0...800\text{ V}$ , $V_{GS} = 0\text{ V}$ , Calculated based on $C_{oss}$		275		nC	
Effective output capacitance, energy related	$C_{o(er)}$	$V_{DS} = 0...800\text{ V}$ , $V_{GS} = 0\text{ V}$		231		pF	
Effective output capacitance, time related	$C_{o(tr)}$	$I_D = \text{constant}$ , $V_{DS} = 0...800\text{ V}$ , $V_{GS} = 0\text{ V}$		344		pF	

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表 4 (续) 特征值

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	$Q_G$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0\text{ V}$ , turn-on pulse		109		nC
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0\text{ V}$ , turn-on pulse		24		nC
Gate-to-drain charge	$Q_{GD}$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0\text{ V}$ , turn-on pulse		27		nC
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0/18\text{ V}$ , $R_{GS(on)} = 2.3\ \Omega$ , $R_{GS(off)} = 2.3\ \Omega$ , $L_\sigma = 9\text{ nH}$ , diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	17.3		ns
			$T_{vj} = 175\text{ }^\circ\text{C}$	13.2		
Rise time	$t_r$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0/18\text{ V}$ , $R_{GS(on)} = 2.3\ \Omega$ , $R_{GS(off)} = 2.3\ \Omega$ , $L_\sigma = 9\text{ nH}$ , diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	11.4		ns
			$T_{vj} = 175\text{ }^\circ\text{C}$	10.1		
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0/18\text{ V}$ , $R_{GS(on)} = 2.3\ \Omega$ , $R_{GS(off)} = 2.3\ \Omega$ , $L_\sigma = 9\text{ nH}$ , diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	34.8		ns
			$T_{vj} = 175\text{ }^\circ\text{C}$	40.6		
Fall time	$t_f$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0/18\text{ V}$ , $R_{GS(on)} = 2.3\ \Omega$ , $R_{GS(off)} = 2.3\ \Omega$ , $L_\sigma = 9\text{ nH}$ , diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	15.1		ns
			$T_{vj} = 175\text{ }^\circ\text{C}$	17.8		
Turn-on energy	$E_{on}$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0/18\text{ V}$ , $R_{GS(on)} = 2.3\ \Omega$ , $R_{GS(off)} = 2.3\ \Omega$ , $L_\sigma = 9\text{ nH}$ , diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	680		$\mu\text{J}$
			$T_{vj} = 175\text{ }^\circ\text{C}$	1050		
Turn-off energy	$E_{off}$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0/18\text{ V}$ , $R_{GS(on)} = 2.3\ \Omega$ , $R_{GS(off)} = 2.3\ \Omega$ , $L_\sigma = 9\text{ nH}$ , diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$	350		$\mu\text{J}$
			$T_{vj} = 175\text{ }^\circ\text{C}$	470		

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3 体二极管 (MOSFET)

表 4 (续) 特征值

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Total switching energy <sup>1)</sup>	$E_{tot}$	$V_{DD} = 800\text{ V}$ , $I_D = 57\text{ A}$ , $V_{GS} = 0/18\text{ V}$ , $R_{GS(on)} = 2.3\ \Omega$ , $R_{GS(off)} = 2.3\ \Omega$ , $L_\sigma = 9\text{ nH}$ , diode: body diode at $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		1200	$\mu\text{J}$
			$T_{vj} = 175\text{ }^\circ\text{C}$		2000	
Virtual junction temperature	$T_{vj(min \dots max)}$		-55		175	$^\circ\text{C}$
Virtual junction temperature	$T_{vj(over)}$	overload, cumulative max. 100 h <sup>2)</sup>			200	$^\circ\text{C}$

1) 包括  $E_{fr}$

2) 最多 5000 次循环。最大  $\Delta T$  限制为 100 K。

注：芯片技术的特征是高达 200 kV/ $\mu\text{s}$ 。测量的  $dV/dt$  受到测量测试设置和封装的限制。

除非另有规定，特性均为  $T_{vj} = 25^\circ\text{C}$ 。

### 3 体二极管 (MOSFET)

表5 最大额定值

Parameter	Symbol	Note or test condition	Values	Unit
Drain-source voltage	$V_{DSS}$	$T_{vj} \geq 25\text{ }^\circ\text{C}$	1200	V
Peak reverse drain current, $t_p$ limited by $T_{vj(max)}$	$I_{SM}$	$V_{GS} = 0\text{ V}$	267	A

表6 特征值

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Drain-source reverse voltage	$V_{SD}$	$I_{SD} = 57\text{ A}$ , $V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^\circ\text{C}$		4.2	V
			$T_{vj} = 100\text{ }^\circ\text{C}$		4.11	
			$T_{vj} = 175\text{ }^\circ\text{C}$		4.05	
MOSFET forward recovery charge	$Q_{fr}$	$V_{DD} = 800\text{ V}$ , $I_{SD} = 57\text{ A}$ , $V_{GS} = 0\text{ V}$ , $R_{GS(on)} = 2.3\ \Omega$ , $Q_{fr}$ includes also $Q_C$	$T_{vj} = 25\text{ }^\circ\text{C}$		280	nC
			$T_{vj} = 175\text{ }^\circ\text{C}$		1150	
MOSFET peak forward recovery current	$I_{frm}$	$V_{DD} = 800\text{ V}$ , $I_{SD} = 57\text{ A}$ , $V_{GS} = 0\text{ V}$ , $R_{GS(on)} = 2.3\ \Omega$ , $Q_{fr}$ includes also $Q_C$	$T_{vj} = 25\text{ }^\circ\text{C}$		38.6	A
			$T_{vj} = 175\text{ }^\circ\text{C}$		61.2	

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3 体二极管 (MOSFET)

表6 (续) 特征值

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
MOSFET forward recovery energy	$E_{fr}$	$V_{DD} = 800 \text{ V}$ , $I_{SD} = 57 \text{ A}$ , $V_{GS} = 0 \text{ V}$ , $R_{GS(on)} = 2.3 \Omega$ , $Q_{fr}$ includes also $Q_c$	$T_{vj} = 25 \text{ }^\circ\text{C}$		170		$\mu\text{J}$
			$T_{vj} = 175 \text{ }^\circ\text{C}$		480		
Virtual junction temperature	$T_{vj(\text{min} \dots \text{max})}$			-55		175	$^\circ\text{C}$
Virtual junction temperature	$T_{vj(\text{over})}$	overload, cumulative max. 100 h <sup>1)</sup>				200	$^\circ\text{C}$

1) 最多 5000 次循环。最大 $\Delta T$  限制为 100 K。

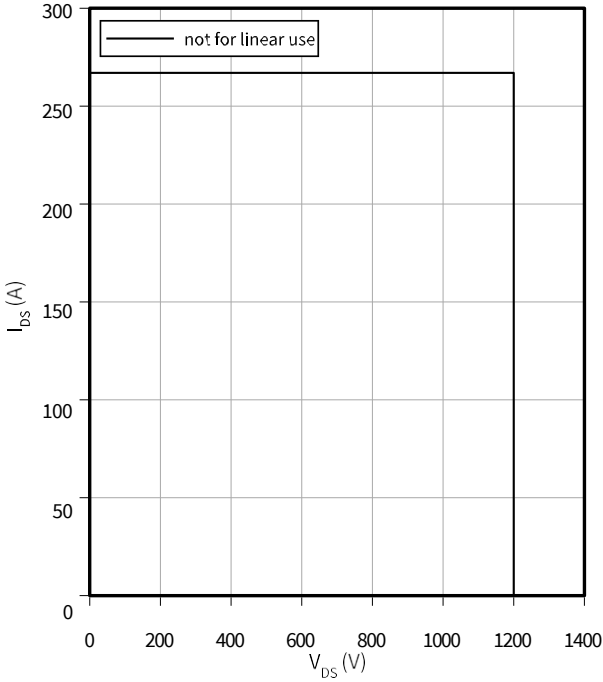
4 特性图

4 特性图

Reverse bias safe operating area (RBSOA)

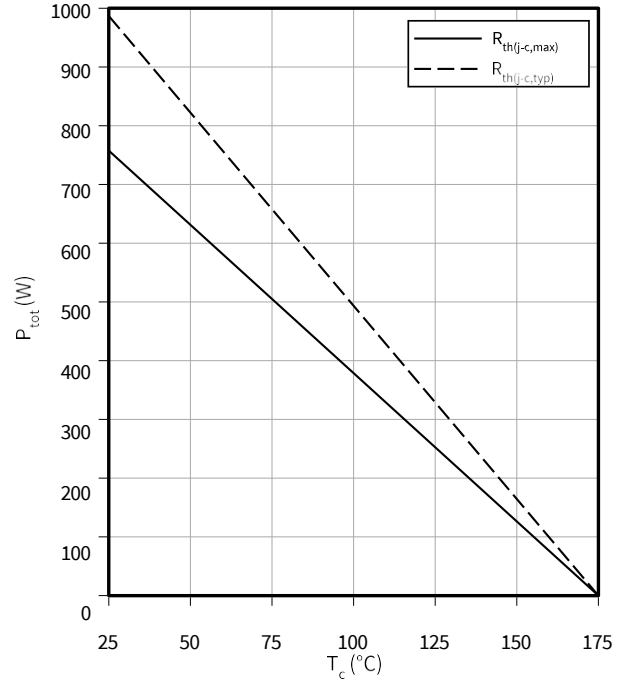
$I_{DS} = f(V_{DS})$

$T_{vj} \leq 200\text{ }^\circ\text{C}$ ,  $V_{GS} = 0/18\text{ V}$ ,  $T_c = 25\text{ }^\circ\text{C}$



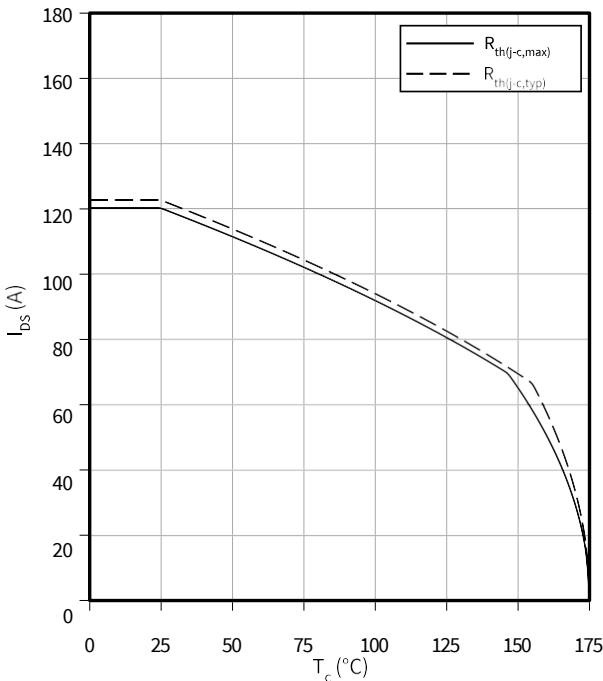
Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$



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

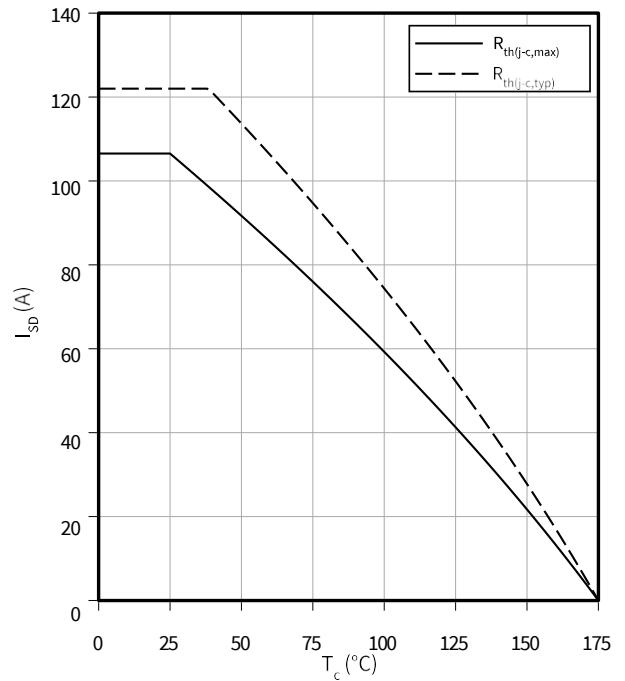
$I_{DS} = f(T_c)$



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

$I_{SD} = f(T_c)$

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

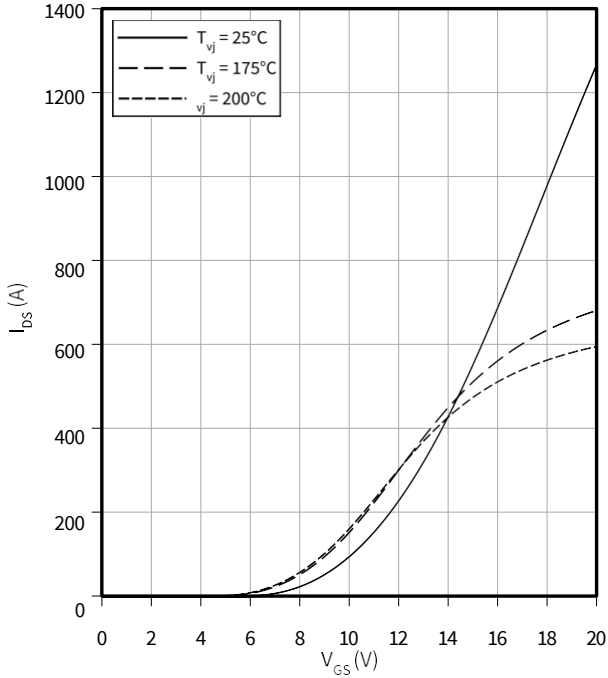


4 特性图

**Typical transfer characteristic**

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

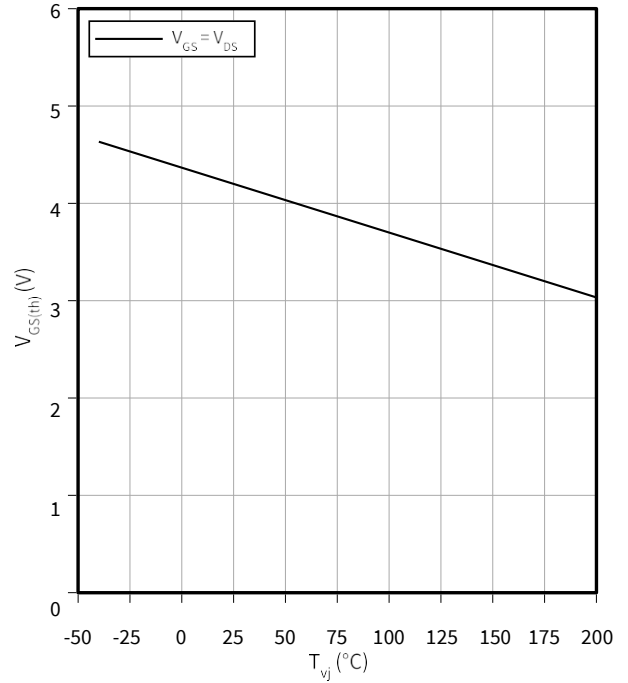
$V_{DS} = 20\text{ V}$ ,  $t_p = 20\ \mu\text{s}$



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

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

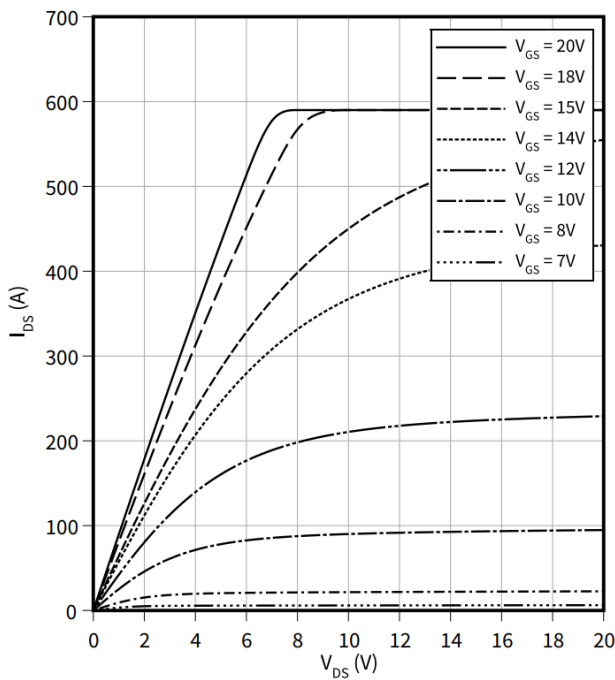
$I_D = 17.8\text{ mA}$



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

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

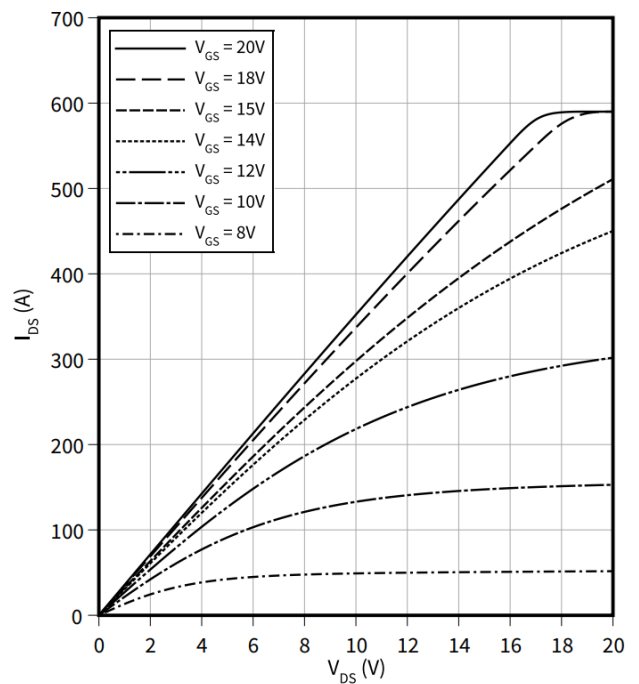
$T_{vj} = 25\text{ °C}$ ,  $t_p = 20\ \mu\text{s}$



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

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

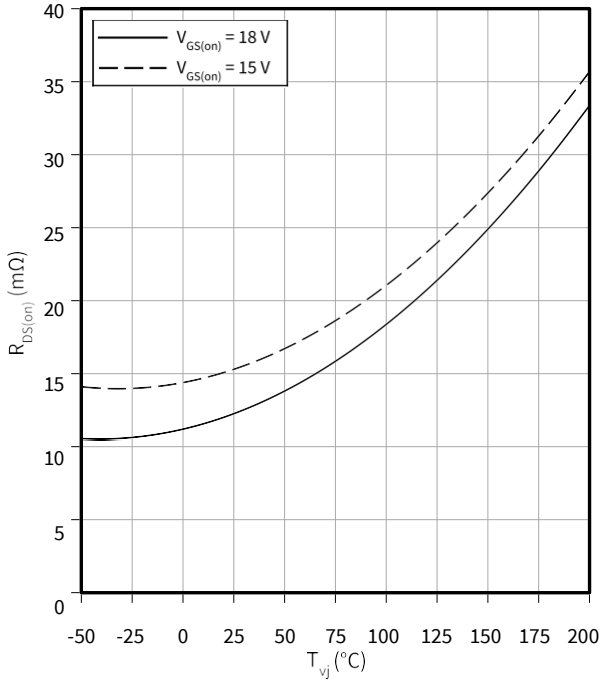
$T_{vj} = 175\text{ °C}$ ,  $t_p = 20\ \mu\text{s}$



4 特性图

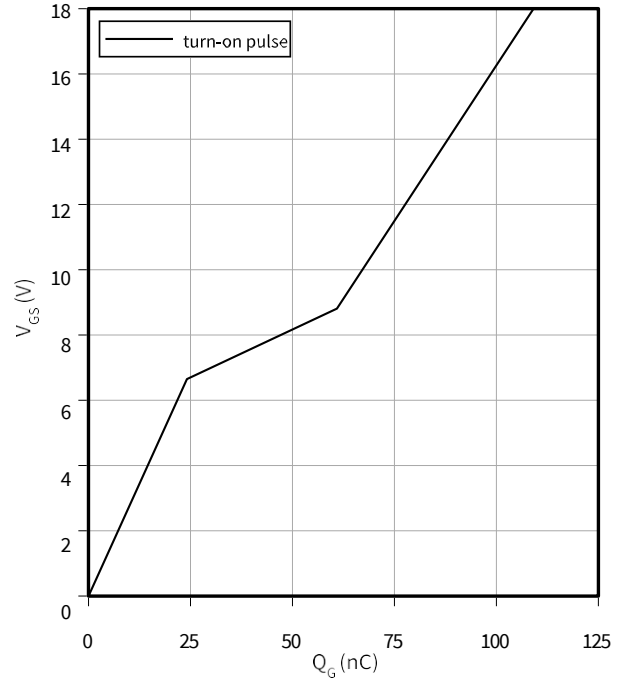
**Typical on-state resistance as a function of junction temperature**

$R_{DS(on)} = f(T_{vj})$   
 $I_D = 57 \text{ A}$



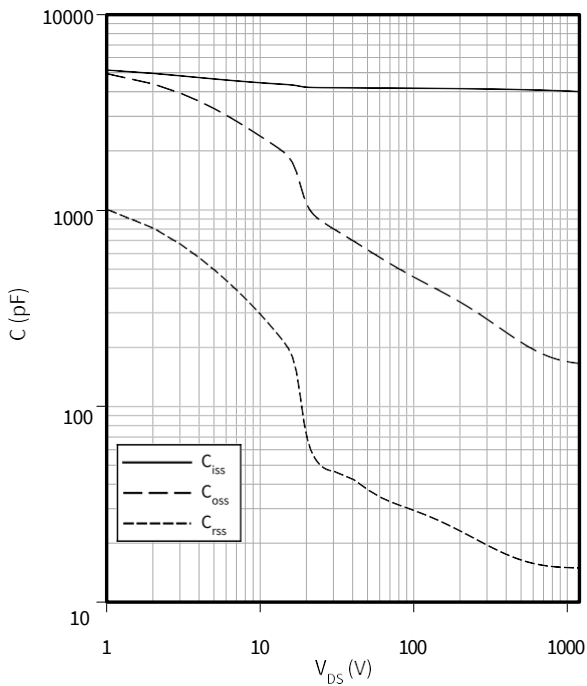
**Typical gate charge**

$V_{GS} = f(Q_G)$   
 $I_D = 57 \text{ A}, V_{DS} = 800 \text{ V}$



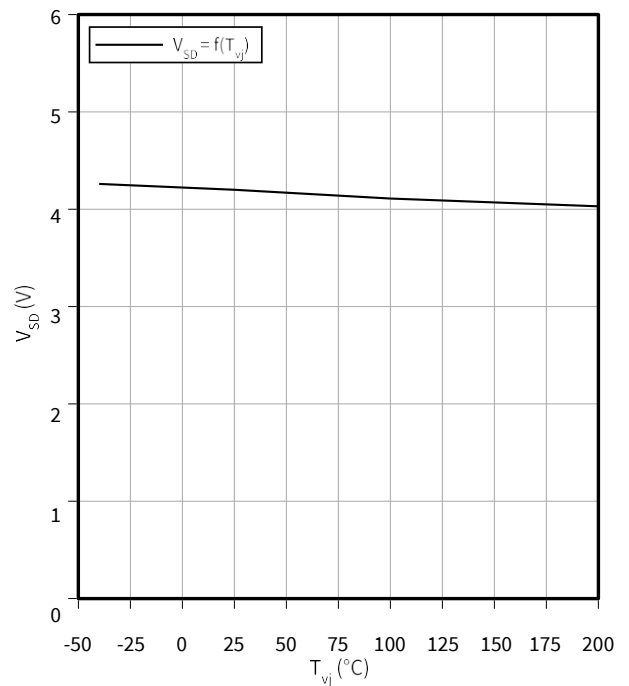
**Typical capacitance as a function of drain-source voltage**

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



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

$V_{SD} = f(T_{vj})$   
 $I_{SD} = 57 \text{ A}, V_{GS} = 0 \text{ V}$

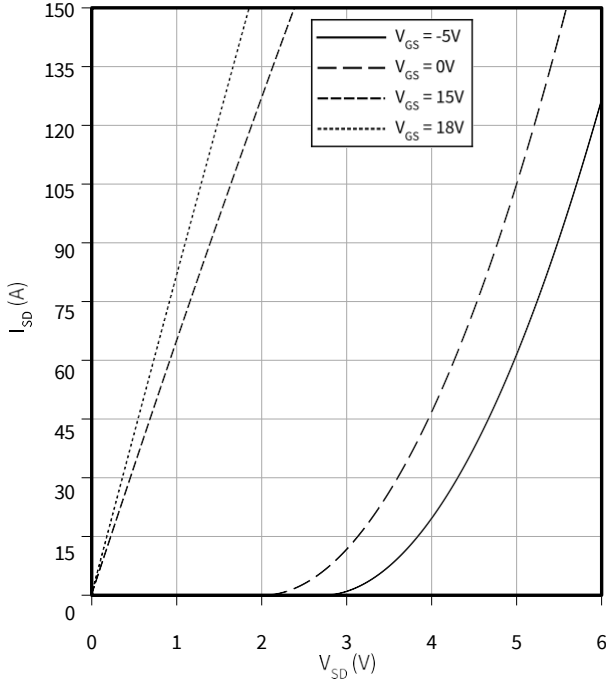


4 特性图

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

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

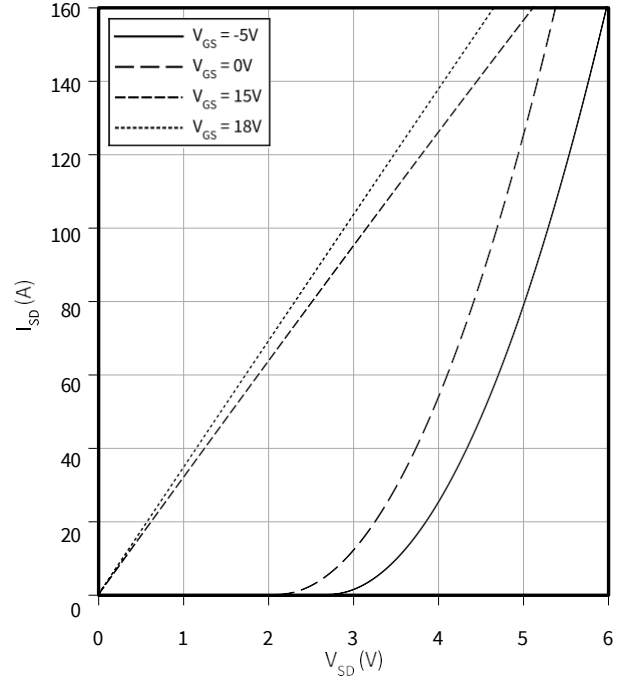
$T_{vj} = 25\text{ °C}$ ,  $t_p = 20\ \mu\text{s}$



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

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

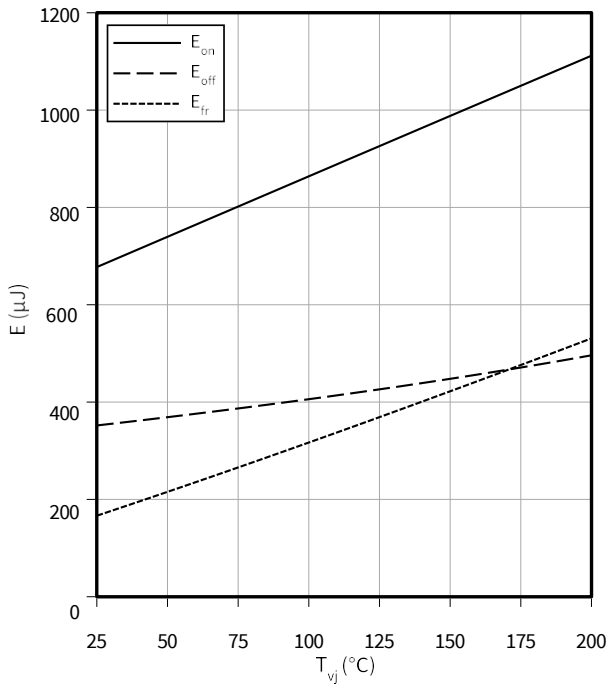
$T_{vj} = 175\text{ °C}$ ,  $t_p = 20\ \mu\text{s}$



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

$E = f(T_{vj})$

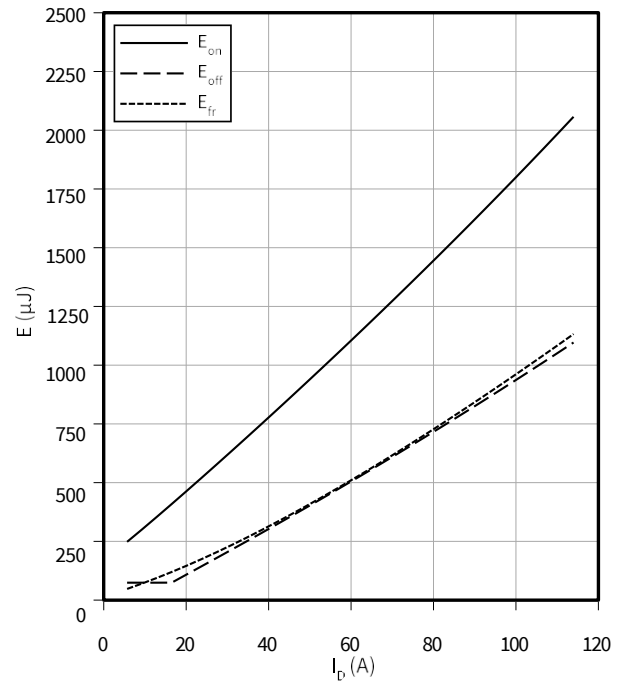
$V_{GS} = 0/18\text{ V}$ ,  $I_D = 57\text{ A}$ ,  $R_{G,ext} = 2.3\ \Omega$ ,  $V_{DD} = 800\text{ V}$



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

$E = f(I_D)$

$V_{GS} = 0/18\text{ V}$ ,  $T_{vj} = 175\text{ °C}$ ,  $R_{G,ext} = 2.3\ \Omega$ ,  $V_{DD} = 800\text{ V}$

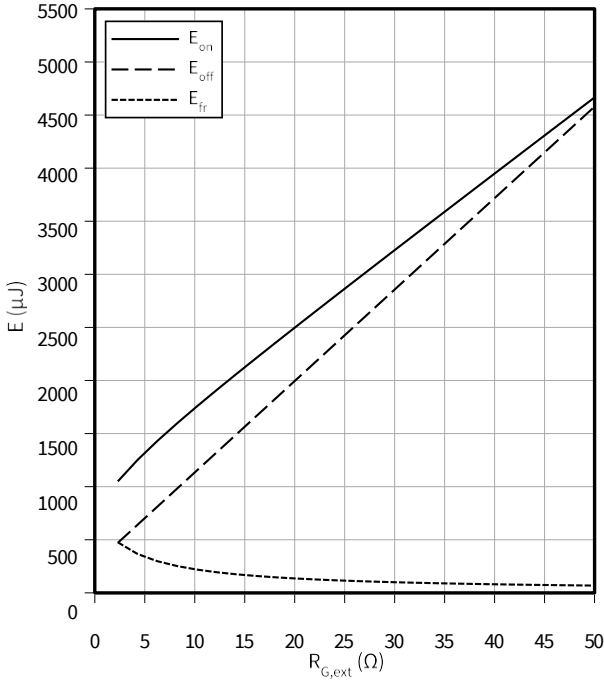


4 特性图

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

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

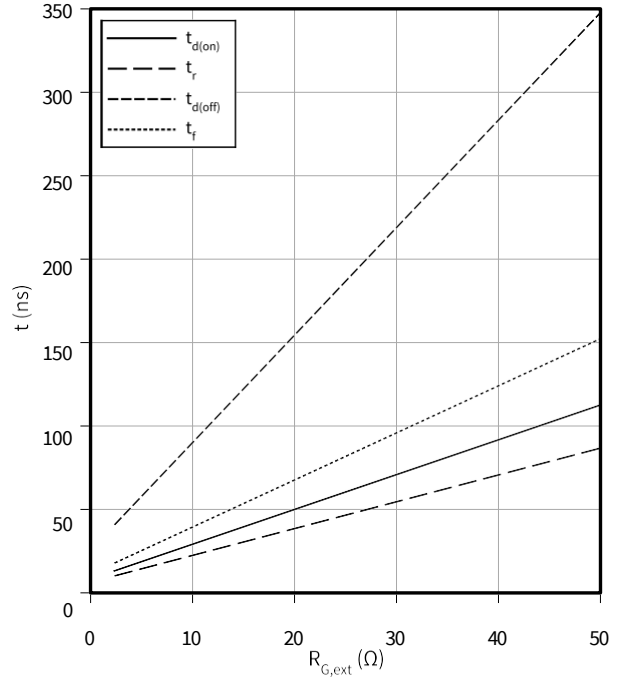
$V_{GS} = 0/18$  V,  $I_D = 57$  A,  $T_{vj} = 175$  °C,  $V_{DD} = 800$  V



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

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

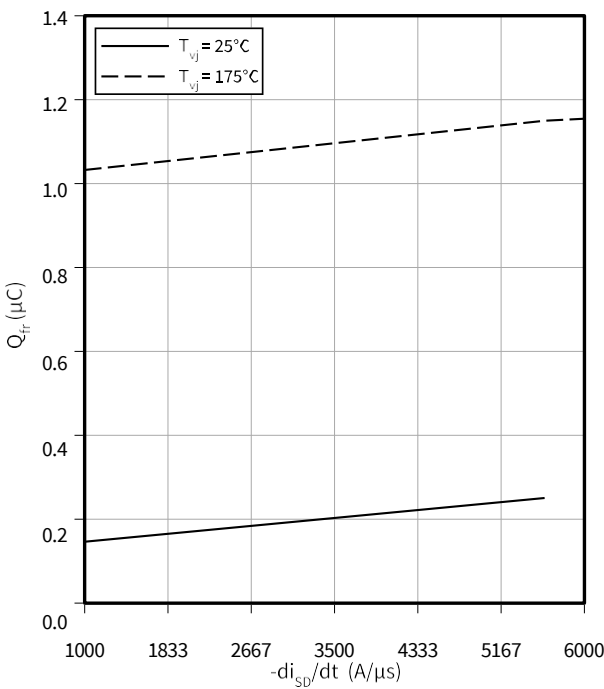
$V_{GS} = 0/18$  V,  $I_D = 57$  A,  $T_{vj} = 175$  °C,  $V_{DD} = 800$  V



**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**

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

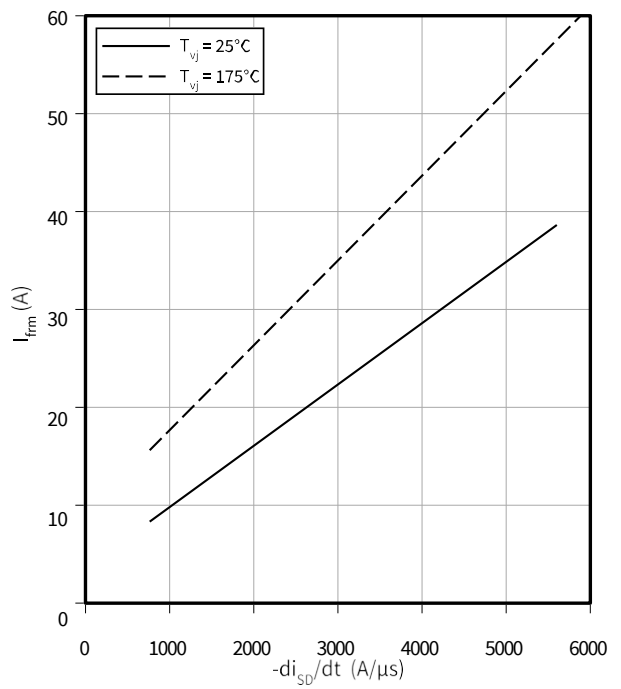
$V_{GS} = 0/18$  V,  $I_{SD} = 57$  A,  $V_{DD} = 800$  V



**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,  $I_{SD} = 57$  A,  $V_{DD} = 800$  V



4 特性图

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

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

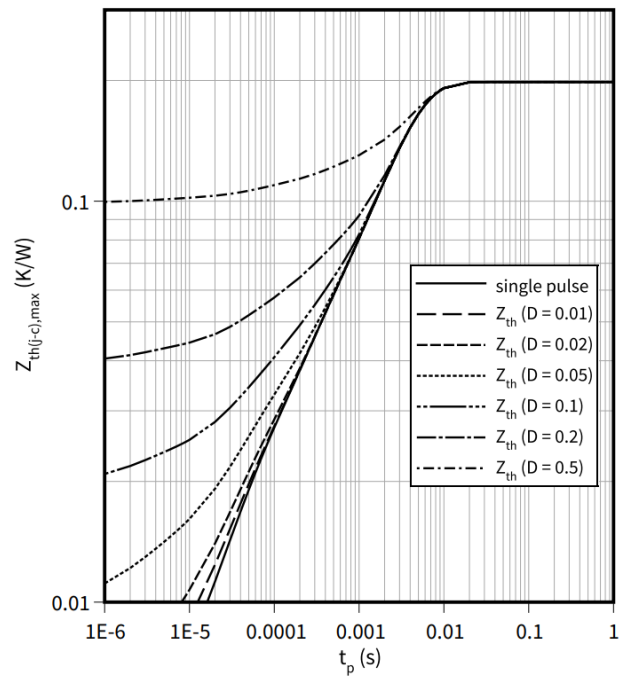
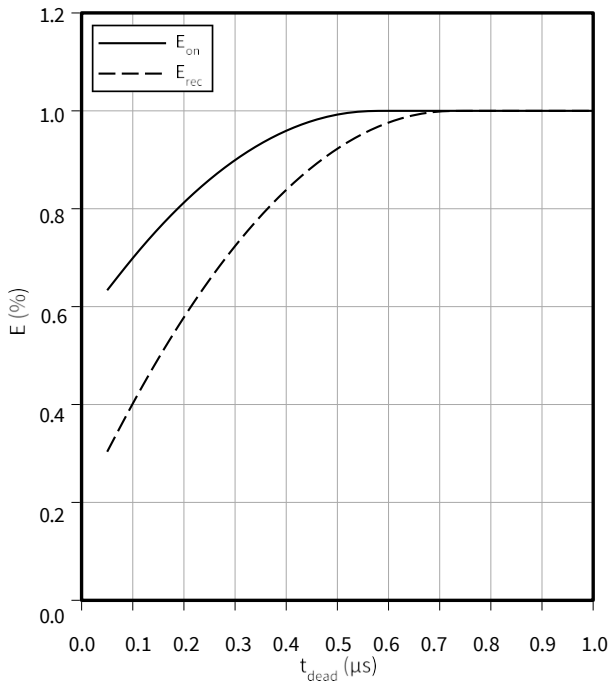
$V_{GS} = 0/18\text{ V}$ ,  $I_D = 57\text{ A}$ ,  $T_{vj} = 175\text{ °C}$ ,  $R_{G,\text{ext}} = 2.3\text{ }\Omega$

$V_{DD} = 800\text{ V}$

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

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

$$D = t_p/T$$



5 封装外形

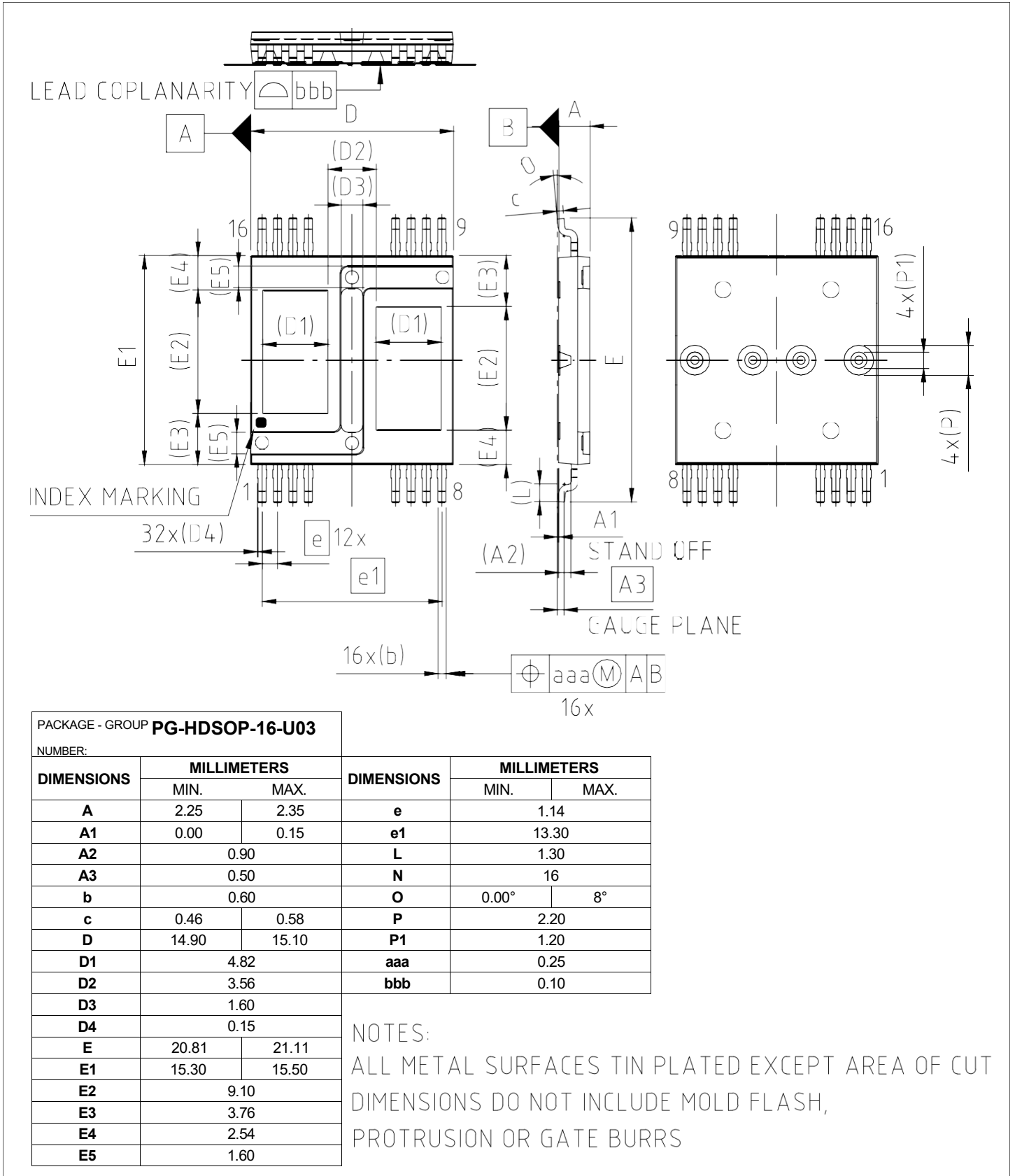


图 1

6 测试条件

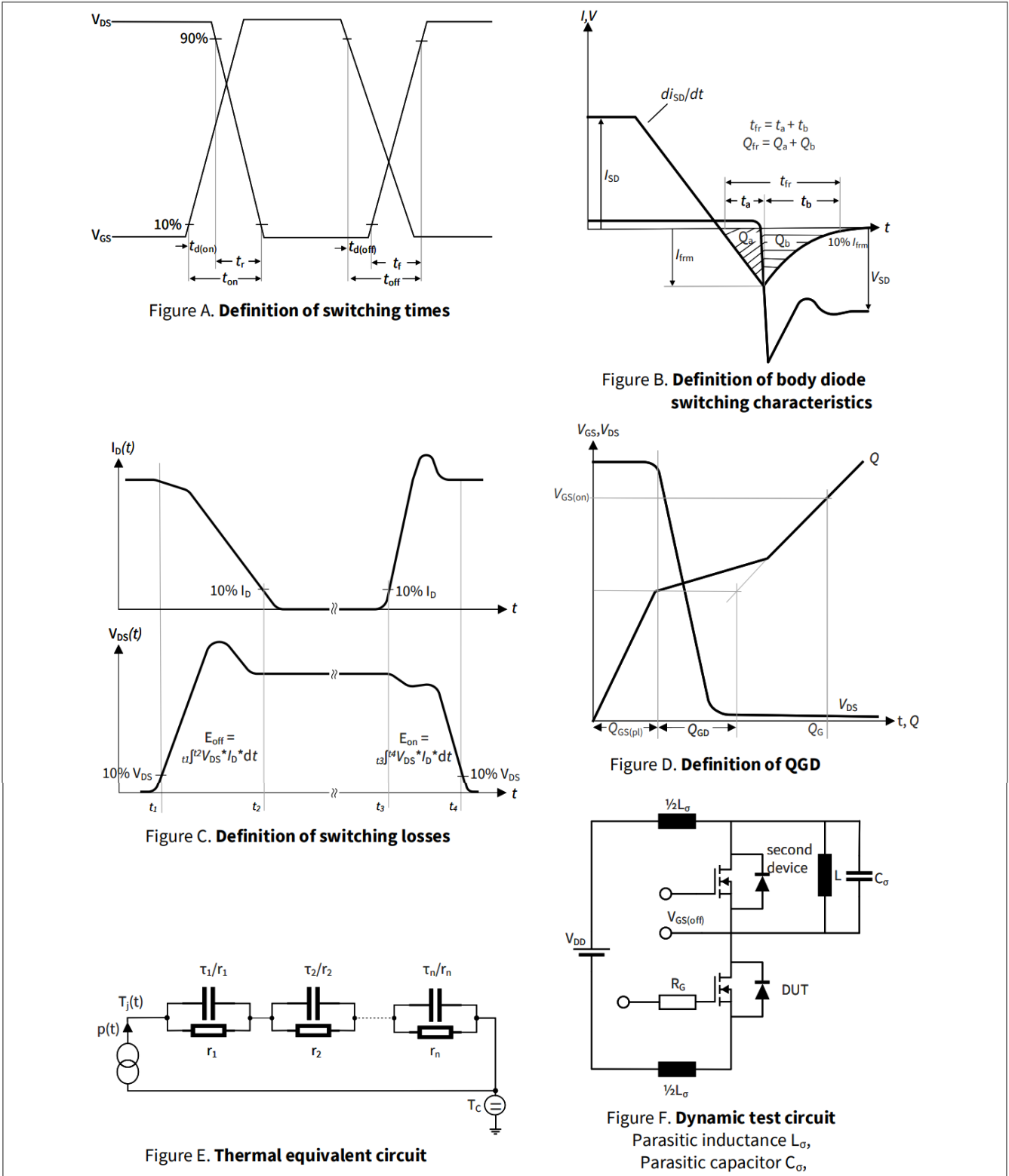


图 2

修订记录

## 修订记录

Document revision	Date of release	Description of changes
0.10	2022-10-28	Target datasheet
0.20	2023-11-24	Preliminary datasheet
1.00	2025-02-13	Final datasheet



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