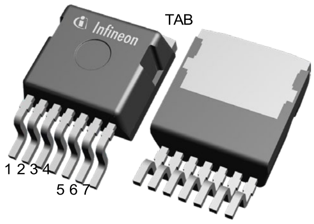
最终数据手册

英飞凌 CoolSiC™ 1200 V SiC 沟槽 MOSFET： 碳化硅MOSFET



特性

- T_{vj} = -55...175°C 时 V_{DSS} = 1200 V
- T_C = 25°C 时 I_{DDC} = 54 A
- $R_{DS(on)}$ = 40mΩ （V_{GS} = 20V、T_{vj} = 25°C 时）
- 新的性能优化芯片技术 (Gen1p)，改善了 R_{DSon} * A
- 业界领先的开关能量特性，可降低开关损耗并减少冷却需求
- 最低的器件电容值，可实现更高的开关速度和更高的功率密度
- 低 C_{rss} /C_{iss} 电容比值和高 $V_{GS(th)}$ 的组合，可避免寄生导通并实现单极性栅极驱动
- 降低了总栅极电荷 Q_G, 可降低驱动功率和损耗
- 提高了建议开启电压 ($V_{GS(on)}$ = 20 V) 以降低 $R_{DS(on)}$
- .XT 芯片粘接技术，实现业界领先的热性能
- 低封装杂散电感，可实现更快、更干净的开关动作
- 带有开尔文（Kelvin) 源极引脚，实现更好的栅极控制并降低开关损耗
- 爬电距离为 5.8 毫米（材料组 II），适用于 800 V 应用
- SMT 封装，便于自动化装配并降低系统成本

Halogen-free
Green
Lead-free
RoHS

潜在的应用

- 车载充电器
- 直流/直流转换器
- 辅助驱动

产品验证

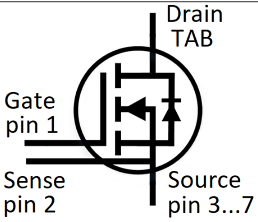
- 适合汽车应用。根据 AEC-Q100/101 进行产品验证

描述

引脚定义：

- Pin 1 - 栅极
- Pin 2 - 开尔文检测
- Pin 3…7 - 源极
- Tab - 漏极

注意：源极引脚和检测引脚不可互换，



Type	Package	Marking
AIMBG120R040M1	PG-TO263-7-U01	AS40MM1

目录

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}				260	°C
MOSFET/body diode thermal resistance, junction-case[1]	$R_{th(j-c)}$			0.43	0.56	K/W

1) 无需经过生产测试 - 经过设计/特性验证

2 MOSFET

表2 最大额定值

Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage[1]	V_{DSS}	T_{vj} = -55...175 °C		1200	V
Continuous DC drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$[2]	I_{DDC}	V_{GS} = 20 V	T_c = 25 °C	54	A
			T_c = 100 °C	38	
Peak drain current, t_p limited by $T_{vj(max)}$[2]	I_{DM}	V_{GS} = 20 V		139	A
Gate-source voltage, max. transient voltage[3]	V_{GS}	$t_p \le 0.5$ µs, $D < 0.01$		-10...25	V
Gate-source voltage, max. static voltage[3]	V_{GS}			-5...23	V
Avalanche energy, single pulse	E_{AS}	I_D = 15 A, V_{DD} = 50 V, L = 2.41 mH		269	mJ
Power dissipation, limited by $T_{vj(max)}$[2]	P_{tot}		T_c = 25 °C	268	W
			T_c = 100 °C	134	

1) 在 Tvj=25°C 下进行测试，并通过全温度范围内的设计/特性验证
2) 无需经过生产测试 - 经过设计/特性验证
3) **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	$V_{GS(on)}$		20	V
Recommended turn-off gate voltage	$V_{GS(off)}$		0	V

表4 特征值

Parameter	Symbol	Note or test condition		Values Min.	Typ.	Max.	Unit
Drain-source on-state resistance	$R_{DS(on)}$	$I_D = 20$ A	$T_{vj} = 25$ °C, $V_{GS(on)} = 20$ V		40	50	mΩ
			$T_{vj} = 100$ °C, $V_{GS(on)} = 20$ V		56		
			$T_{vj} = 175$ °C, $V_{GS(on)} = 20$ V		80		
			$T_{vj} = 25$ °C, $V_{GS(on)} = 18$ V		44		
Gate-source threshold voltage	$V_{GS(th)}$	$I_D = 6.4$ mA, $V_{DS} = V_{GS}$ (tested after 1 ms pulse at $V_{GS} = 20$ V)	$T_{vj} = 25$ °C	3.7	4.4	5.1	V
			$T_{vj} = 175$ °C		3.6		
Zero gate-voltage drain current	I_{DSS}	$V_{DS} = 1200$ V, $V_{GS} = 0$ V	$T_{vj} = 25$ °C		0.4	19	µA
			$T_{vj} = 175$ °C		10		
Gate leakage current	I_{GSS}	$V_{DS} = 0$ V	$V_{GS} = 25$ V			100	nA
			$V_{GS} = -10$ V			-100	
Forward transconductance	g_{fs}	$I_D = 20$ A, $V_{DS} = 20$ V			12.4		S
Short-circuit withstand time[2)]	t_{SC}	$V_{DD} \leq 800$ V, $V_{DS,peak} < 1200$ V, $T_{vj(start)} = 25$ °C, $R_{G,ext} = 2\ \Omega$	$V_{GS(on)} = 20$ V		1.5		µs
			$V_{GS(on)} = 18$ V		2		
			$V_{GS(on)} = 15$ V		2.5		
Internal gate resistance	$R_{G,int}$	$f = 1$ MHz, $V_{AC} = 25$ mV			3.7		Ω
Input capacitance	C_{iss}	$V_{DS} = 800$ V, $V_{GS} = 0$ V, $f = 100$ kHz, $V_{AC} = 25$ mV			1264		pF
Output capacitance	C_{oss}	$V_{DS} = 800$ V, $V_{GS} = 0$ V, $f = 100$ kHz, $V_{AC} = 25$ mV			63		pF
Reverse transfer capacitance	C_{rss}	$V_{DS} = 800$ V, $V_{GS} = 0$ V, $f = 100$ kHz, $V_{AC} = 25$ mV			3.6		pF
C_{oss} stored energy	E_{oss}	$V_{DS} = 800$ V, $V_{GS} = 0$ V, $f = 100$ kHz, $V_{AC} = 25$ mV			26		µJ
Total gate charge	Q_G	$V_{DD} = 800$ V, $I_D = 20$ A, $V_{GS} = 0/20$ V, turn-on pulse			43		nC
Plateau gate charge	$Q_{GS(pl)}$	$V_{DD} = 800$ V, $I_D = 20$ A, $V_{GS} = 0/20$ V, turn-on pulse			12		nC
Gate-to-drain charge	Q_{GD}	$V_{DD} = 800$ V, $I_D = 20$ A, $V_{GS} = 0/20$ V, turn-on pulse			7		nC
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800$ V, $I_D = 20$ A, $V_{GS} = 0/20$ V, $R_{G,ext} = 2\ \Omega$, $L_\sigma = 20$ nH, diode: body diode at $V_{GS} = 0$ V	$T_{vj} = 25$ °C		7.3		ns
			$T_{vj} = 175$ °C		7.3		

（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} = 800 V, I_D = 20 A, V_{GS} = 0/20 V, $R_{G,ext}$ = 2 Ω, L_σ = 20 nH, diode: body diode at V_{GS} = 0 V	T_{vj} = 25 °C		6.5		ns
			T_{vj} = 175 °C		7.8		
Turn-off delay time	$t_{d(off)}$	V_{DD} = 800 V, I_D = 20 A, V_{GS} = 0/20 V, $R_{G,ext}$ = 2 Ω, L_σ = 20 nH, diode: body diode at V_{GS} = 0 V	T_{vj} = 25 °C		15.8		ns
			T_{vj} = 175 °C		16.9		
Fall time	t_f	V_{DD} = 800 V, I_D = 20 A, V_{GS} = 0/20 V, $R_{G,ext}$ = 2 Ω, L_σ = 20 nH, diode: body diode at V_{GS} = 0 V	T_{vj} = 25 °C		6.5		ns
			T_{vj} = 175 °C		6.7		
Turn-on energy	E_{on}	V_{DD} = 800 V, I_D = 20 A, V_{GS} = 0/20 V, $R_{G,ext}$ = 2 Ω, L_σ = 20 nH, diode: body diode at V_{GS} = 0 V	T_{vj} = 25 °C		126		µJ
			T_{vj} = 175 °C		181		
Turn-off energy	E_{off}	V_{DD} = 800 V, I_D = 20 A, V_{GS} = 0/20 V, $R_{G,ext}$ = 2 Ω, L_σ = 20 nH, diode: body diode at V_{GS} = 0 V	T_{vj} = 25 °C		42		µJ
			T_{vj} = 175 °C		40		
Total switching energy	E_{tot}	V_{DD} = 800 V, I_D = 20 A, V_{GS} = 0/20 V, $R_{G,ext}$ = 2 Ω, L_σ = 20 nH, diode: body diode at V_{GS} = 0 V	T_{vj} = 25 °C		168		µJ
			T_{vj} = 175 °C		221		
Virtual junction temperature	T_{vj}			-55		175	°C

注释： 特征参数在Tvj = 25°C下测定，除非另有说明。

3 体二极管（MOSFET）

表5 最大额定值

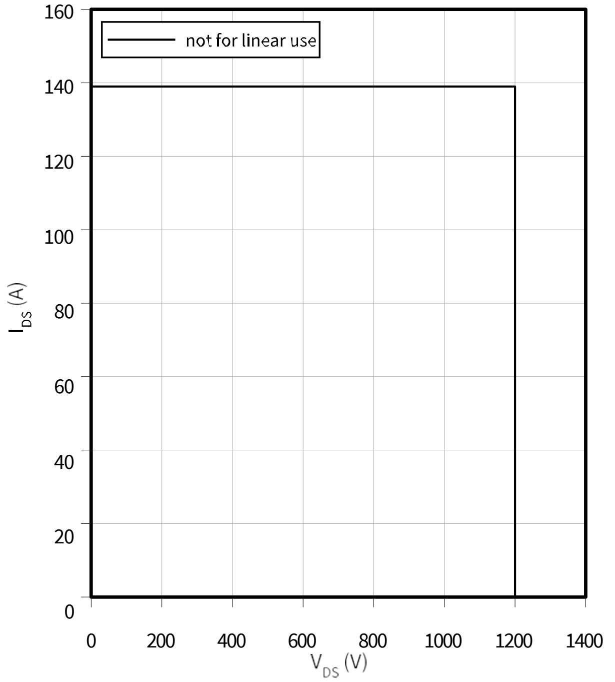
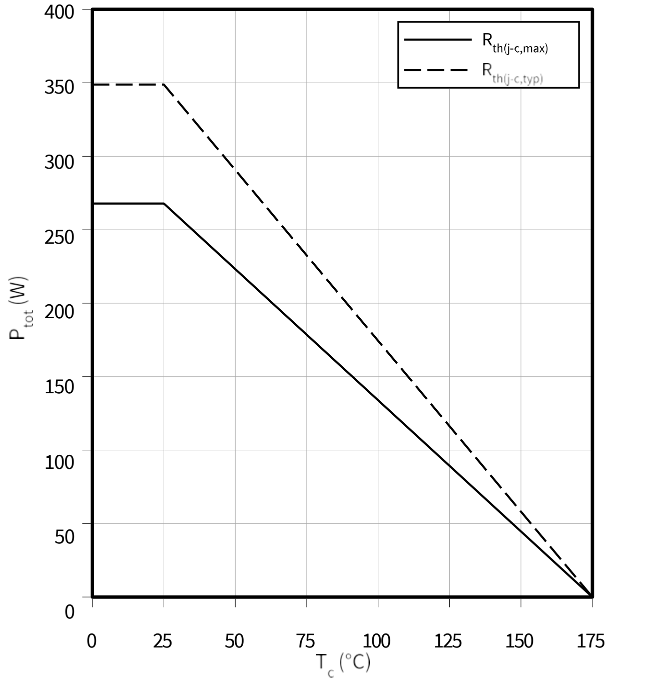
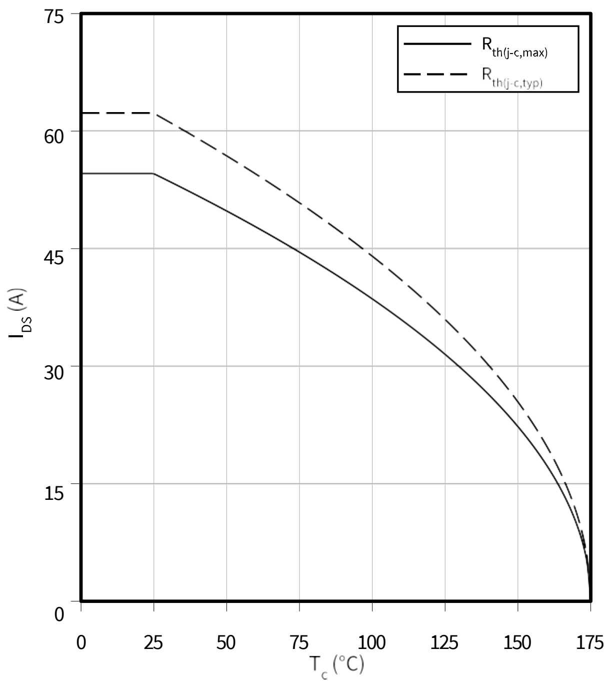
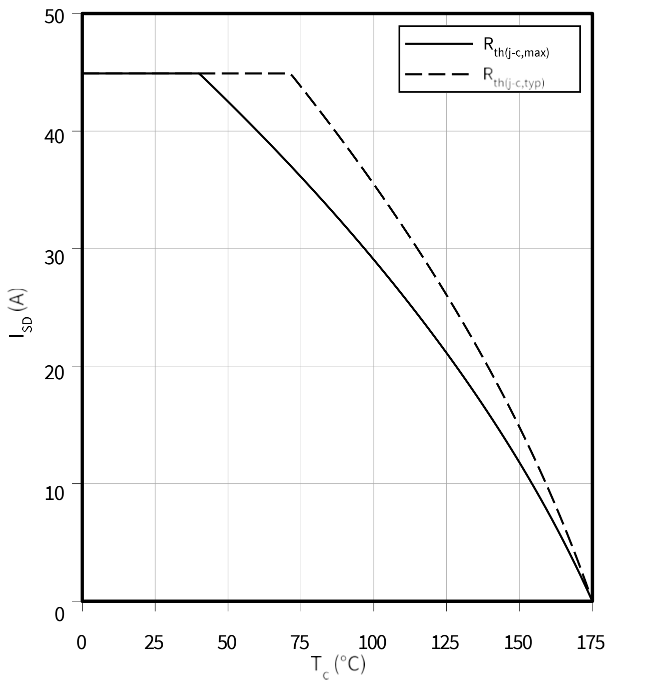
Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage[1)]	V_{DSS}	T_{vj} = -55...175 °C		1200	V
Continuous reverse drain current for $R_{th(j-c,max)}$, limited by $T_{vj(max)}$[2)]	I_{SDC}	V_{GS} = 0 V	T_c = 25 °C	45	A
			T_c = 100 °C	29	
Peak reverse drain current, t_p limited by $T_{vj(max)}$ [2)]	I_{SM}	V_{GS} = 0 V		45	A

1) 在 Tvj=25°C 下进行测试，并通过全温度范围内的设计/特性验证
2) 无需经过生产测试 - 经过设计/特性验证

表6 特征值

Parameter	Symbol	Note or test condition		Values Min.	Typ.	Max.	Unit
Drain-source reverse voltage	V_{SD}	I_{SD} = 20 A, V_{GS} = 0 V	T_{vj} = 25 °C		3.9	5	V
			T_{vj} = 100 °C		3.8		
			T_{vj} = 175 °C		3.7		
MOSFET forward recovery charge	Q_{fr}	V_{DD} = 800 V, I_{SD} = 20 A, V_{GS} = 0 V, $-di_{SD}/dt$ = 2000 A/µs, Q_{fr} includes also Q_C	T_{vj} = 25 °C		140		nC
			T_{vj} = 175 °C		272		
MOSFET peak forward recovery current	I_{frm}	V_{DD} = 800 V, I_{SD} = 20 A, V_{GS} = 0 V, $-di_{SD}/dt$ = 2000 A/µs, Q_{fr} includes also Q_C	T_{vj} = 25 °C		10.9		A
			T_{vj} = 175 °C		14.3		
Virtual junction temperature	T_{vj}			-55		175	°C

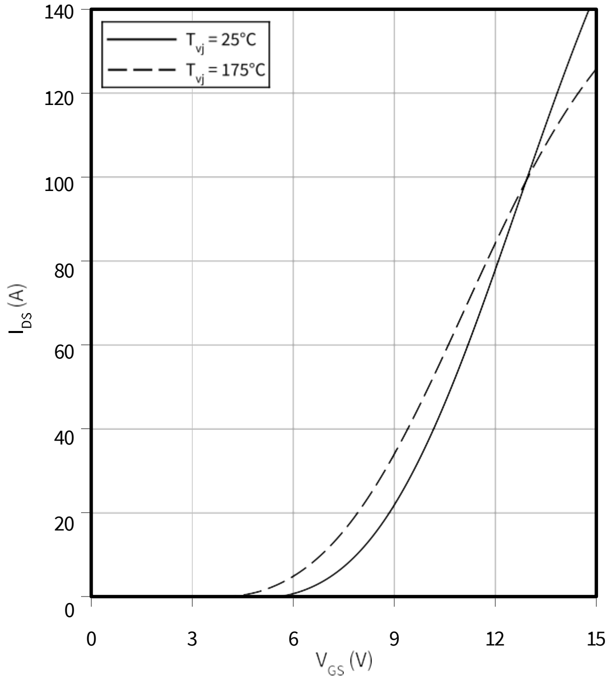
4 特性图

Reverse bias safe operating area (RBSOA) $I_{DS} = f(V_{DS})$ $V_{GS} = 0/20$ V, $T_c = 25$ °C, $T_{vj} \leq 175$ °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 $I_{DS} = f(T_c)$	**Maximum source to drain current as a function of case temperature** $I_{SD} = f(T_c)$ $V_{GS} = 0$ V
	

Typical transfer characteristic

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

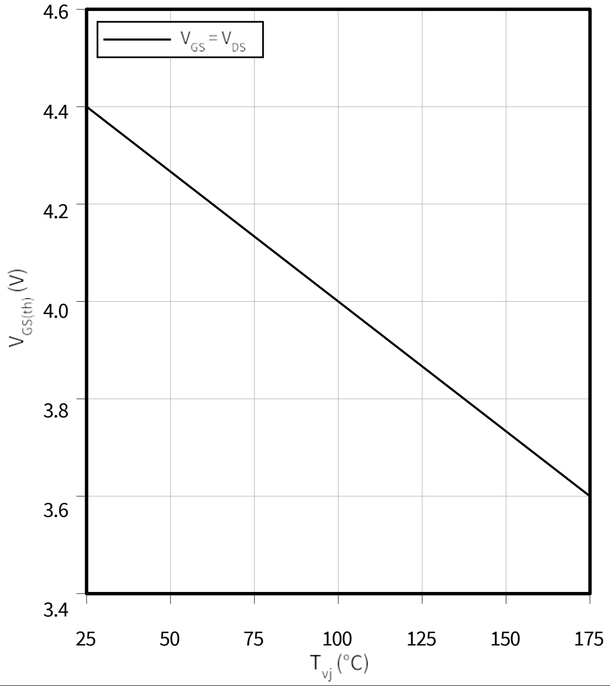
$V_{DS} = 20$ V, $t_p = 20$ µs



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

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

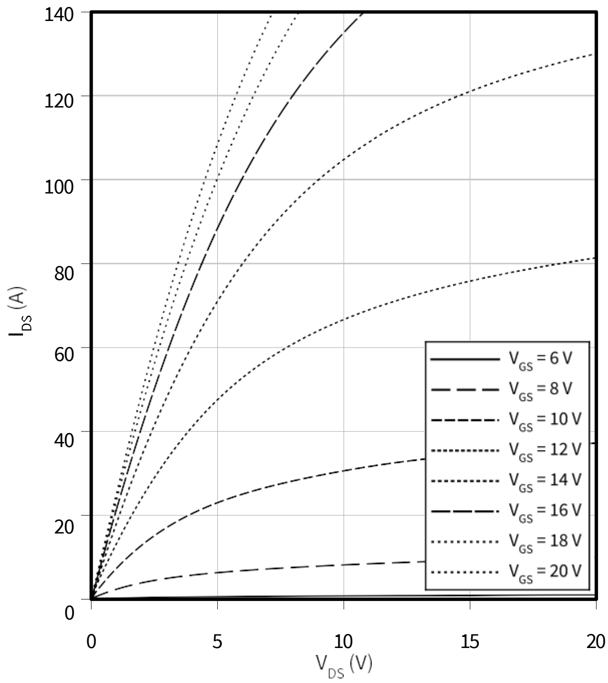
$I_D = 6.4$ mA



Typical output characteristic, V_{GS} as parameter

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

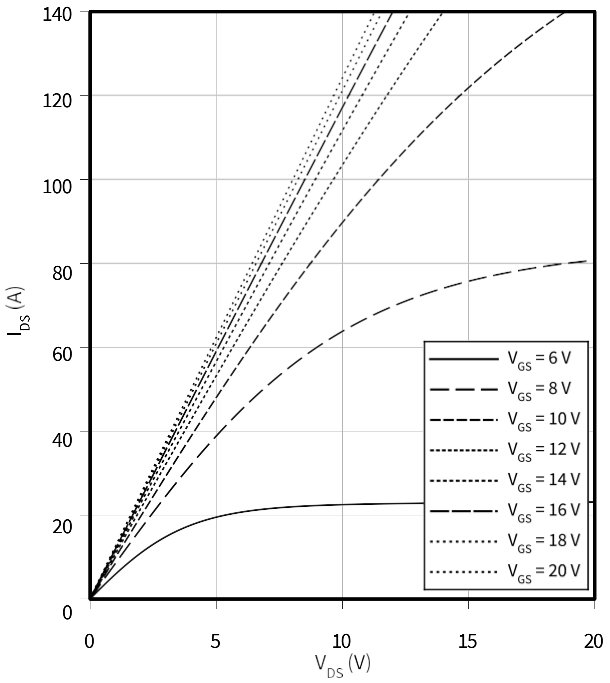
$T_{vj} = 25$ °C, $t_p = 20$ µs



Typical output characteristic, V_{GS} as parameter

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

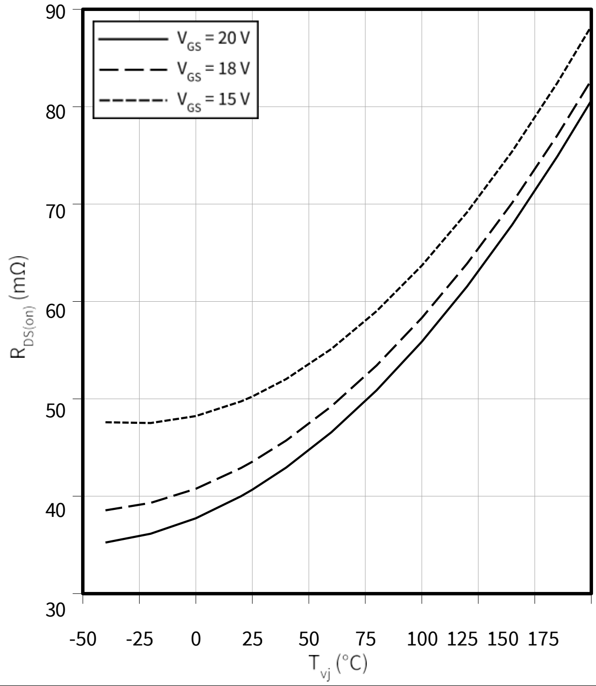
$T_{vj} = 175$ °C, $t_p = 20$ µs



Typical on-state resistance as a function of junction temperature

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

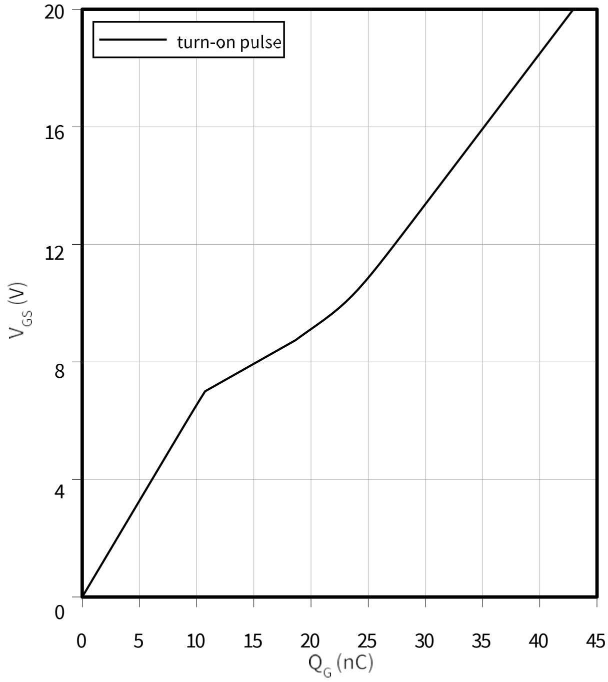
$I_D = 20$ A



Typical gate charge

$V_{GS} = f(Q_G)$

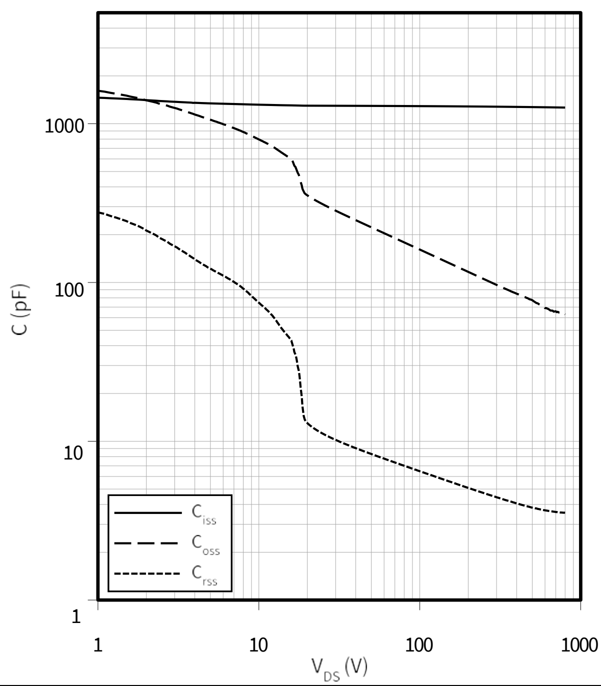
$I_D = 20$ A, $V_{DS} = 800$ V



Typical capacitance as a function of drain-source voltage

$C = f(V_{DS})$

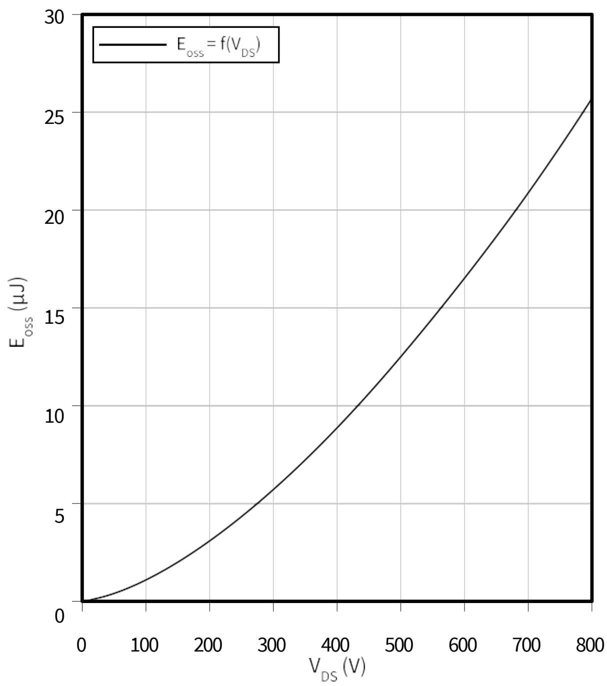
$f = 100$ kHz, $V_{GS} = 0$ V



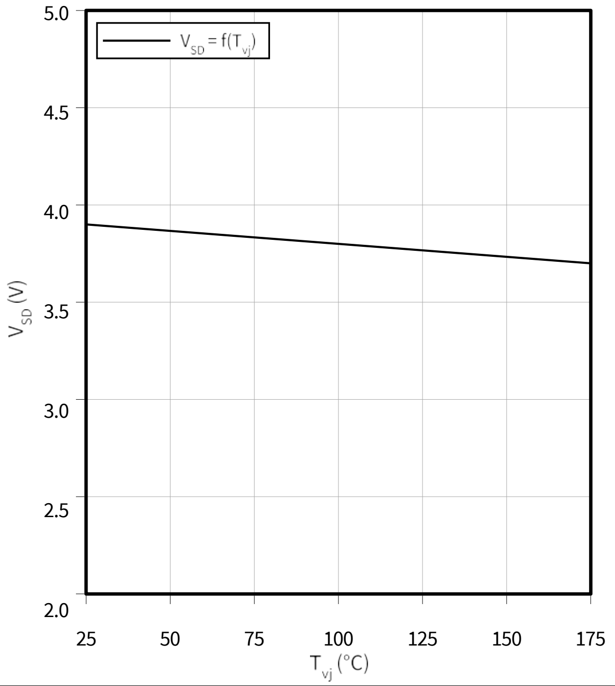
Typical C_{oss} stored energy

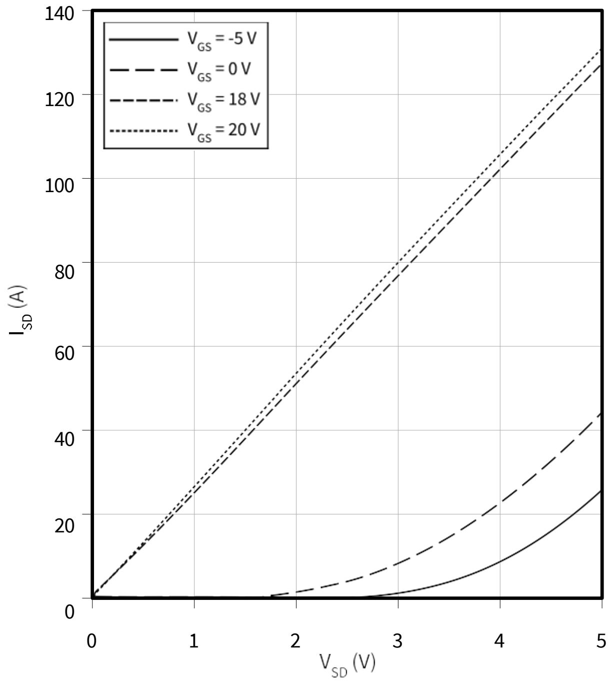
$E_{oss} = f(V_{DS})$

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

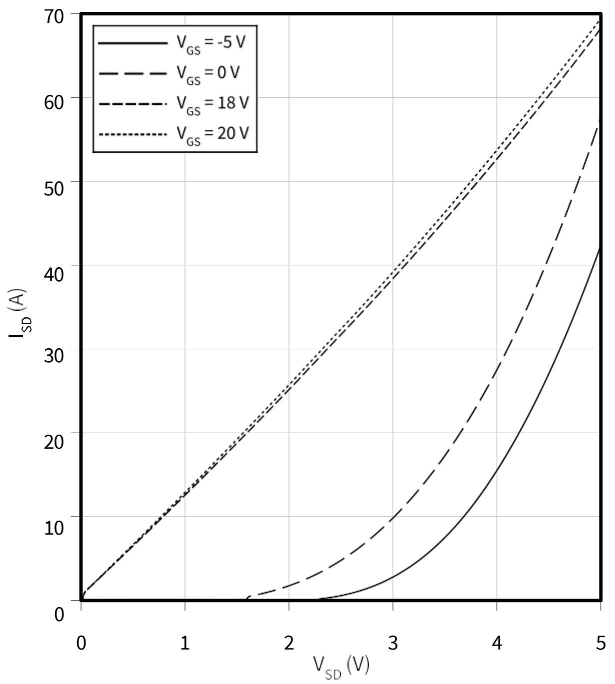


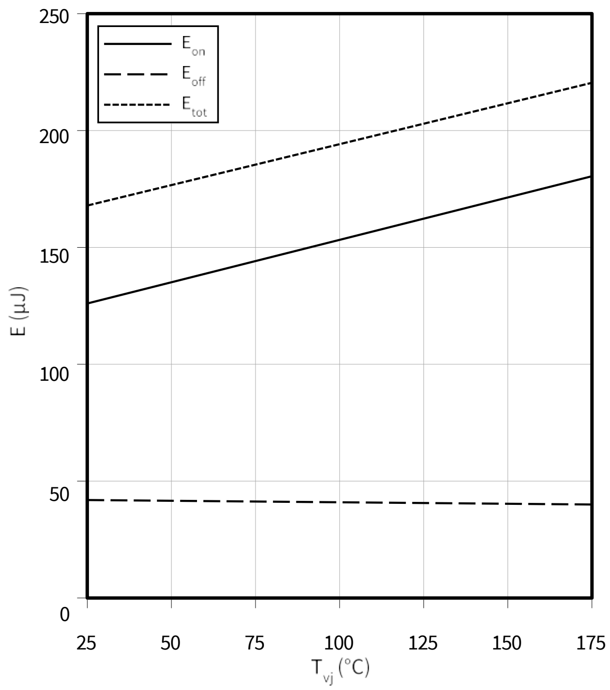
Typical reverse drain voltage as function of junction temperature	Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter
$V_{SD} = f(T_{vj})$ $I_{SD} = 20$ A, $V_{GS} = 0$ V	$I_{SD} = f(V_{SD})$ $T_{vj} = 25$ °C, $t_p = 20$ µs





Typical reverse drain current as function of reverse drain voltage, V_{GS} as parameter	Typical switching energy as a function of junction temperature, test circuit in Fig. F, 2nd device own body diode: $V_{GS} = 0$ V
$I_{SD} = f(V_{SD})$ $T_{vj} = 175$ °C, $t_p = 20$ µs	$E = f(T_{vj})$ $V_{GS} = 0/20$ V, $I_D = 20$ A, $R_{G,ext} = 2\ \Omega$, $V_{DD} = 800$ V

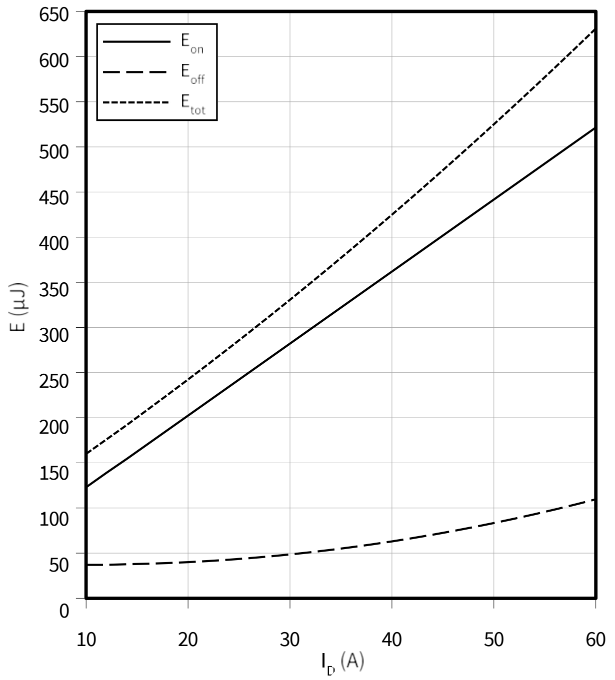




Typical switching energy as a function of drain current, test circuit in Fig. F, 2nd device own body diode: V_{GS} = 0 V

$E = f(I_D)$

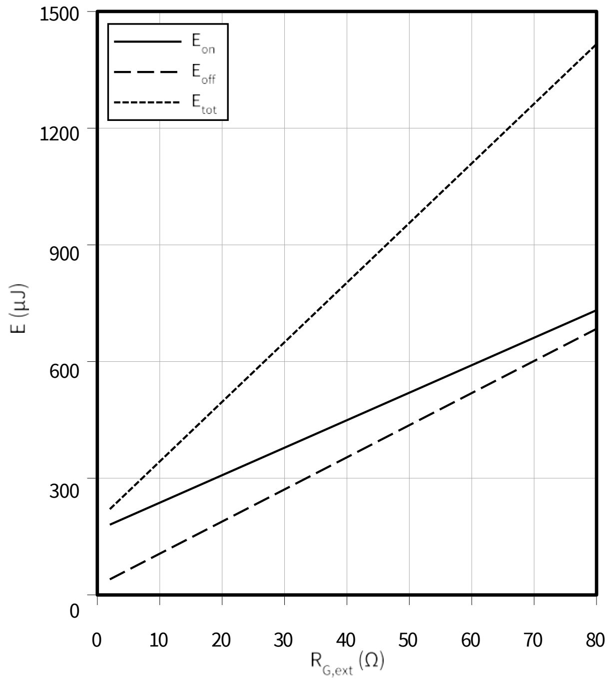
V_{GS} = 0/20 V, T_{vj} = 175 °C, $R_{G,ext}$ = 2 Ω, V_{DD} = 800 V



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

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

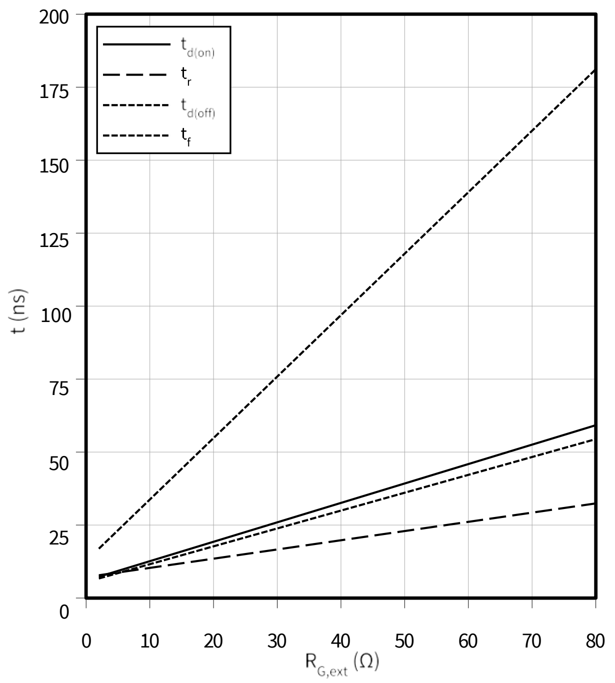
V_{GS} = 0/20 V, I_D = 20 A, T_{vj} = 175 °C, V_{DD} = 800 V



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

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

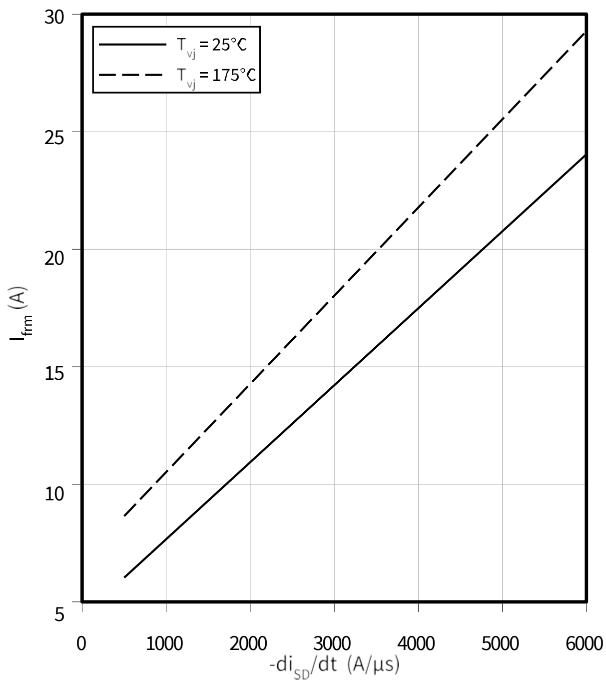
V_{GS} = 0/20 V, I_D = 20 A, T_{vj} = 175 °C, V_{DD} = 800 V

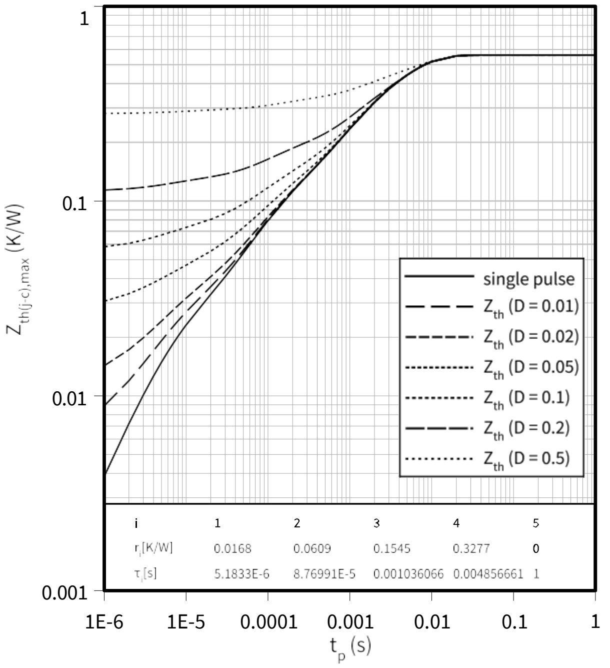


Typical MOSFET peak forward recovery current as a function of reverse drain current slope

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

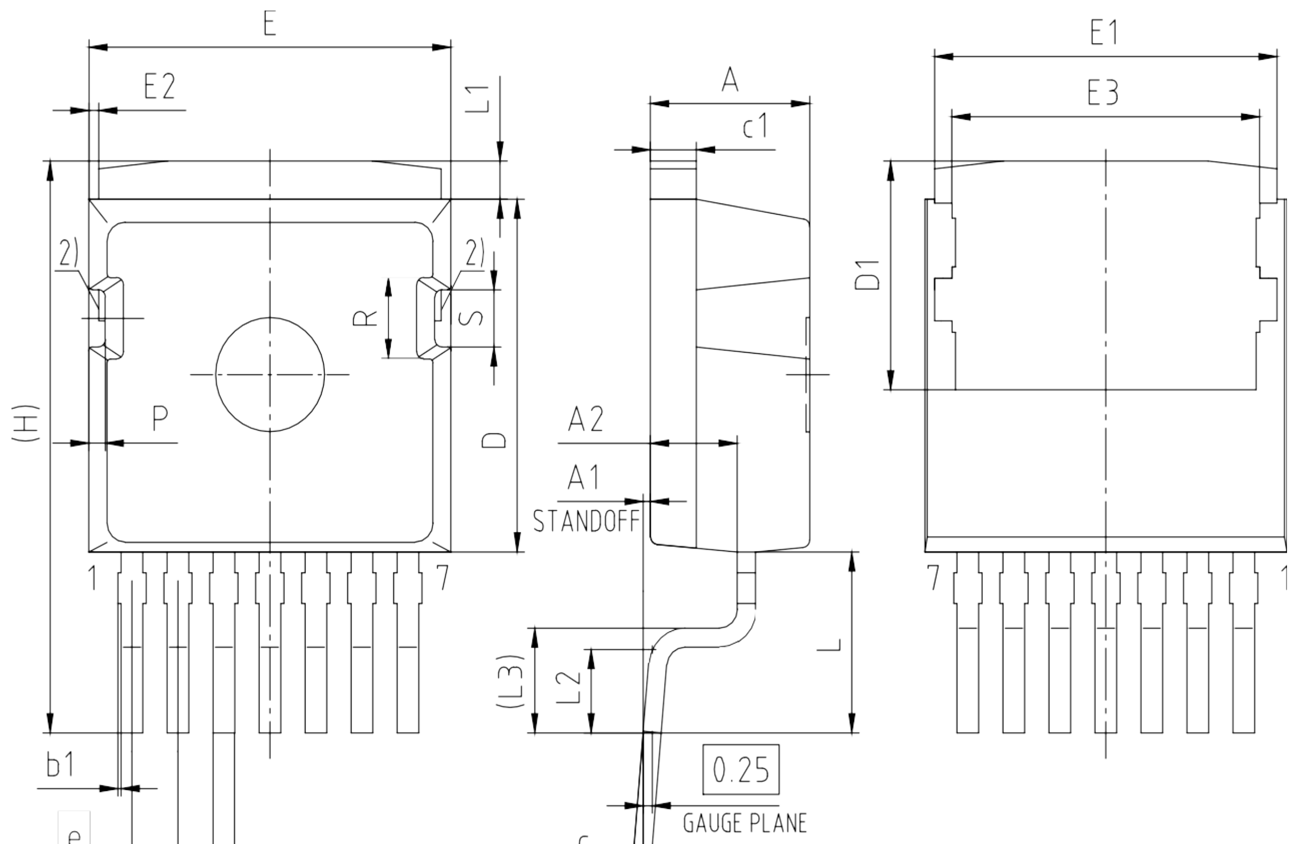
I_{SD} = 20 A, V_{DD} = 800 V, V_{GS} = 0/20 V

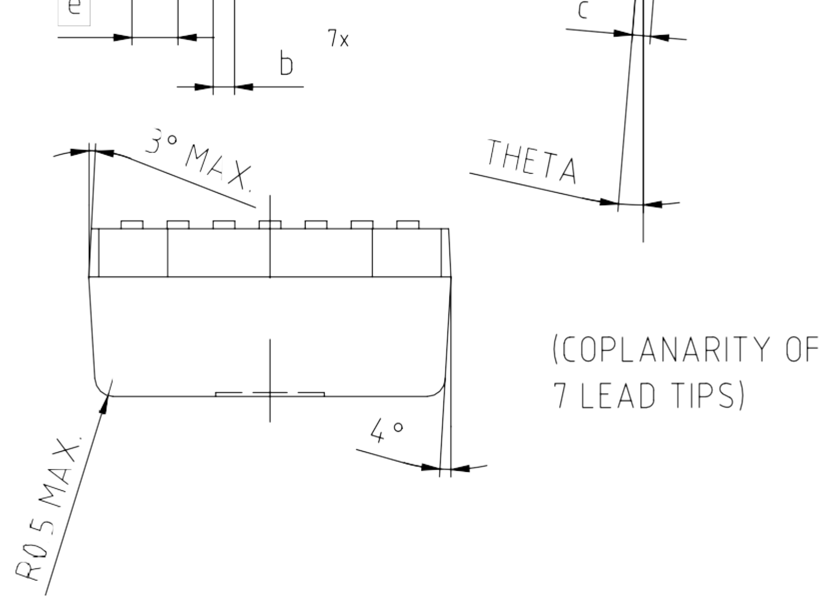


Max. transient thermal impedance (MOSFET/diode) $Z_{th(j\text{-}c),max} = f(t_p)$ $D = t_p/T$	
	

i	1	2	3	4	5
r_i[K/W]	0.0168	0.0609	0.1545	0.3277	0
τ_i[s]	5.1833E-6	8.76991E-5	0.001036066	0.004856661	1

5 封装外形





PACKAGE - GROUP NUMBER:	PG-TO263-7-U01	
DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.30	4.50
A1	0.00	0.10
A2	2.30	2.50
b	0.50	0.70
b1	0.00	0.15
c	0.40	0.60
c1	1.17	1.37
D	9.05	9.45
D1	5.90	6.10
E	9.80	10.20
E1	9.36	9.56
E2	0.00	0.30
E3	8.40	8.60
e	1.27	
H	15.00	
L	4.20	5.20
L1	0.70	1.30
L2	1.70	2.30
L3	2.70	
P	0.35	0.55
R	2.03	2.23
S	1.40	1.60
THETA	0.00°	8.00°

NOTES:

1) ALL METAL SURFACES TIN PLATED EXCEPT AREA OF CUT

2) MOLD FILLING IS ACCEPTABLE AT THIS AREA

图 1

6 测试条件

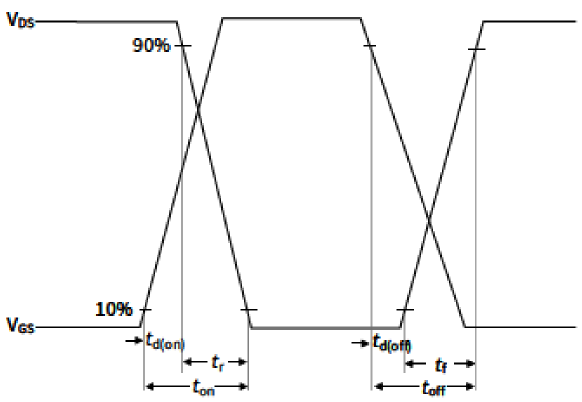


Figure A. **Definition of switching times**

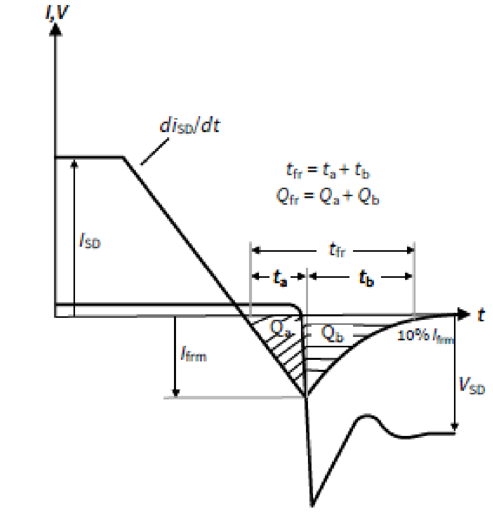


Figure B. **Definition of body diode switching characteristics**

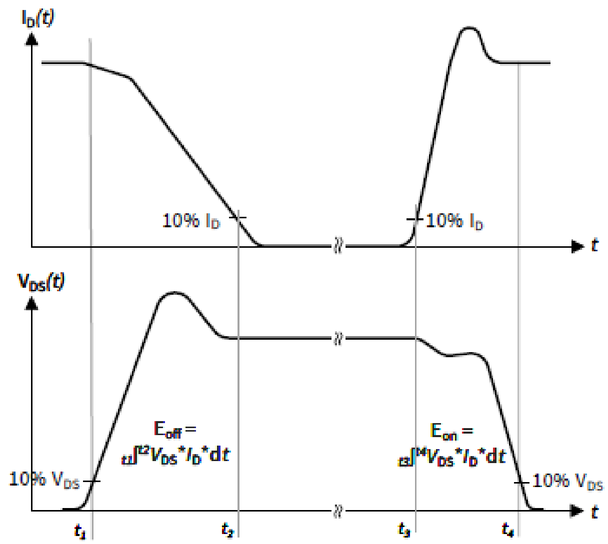


Figure C. **Definition of switching losses**

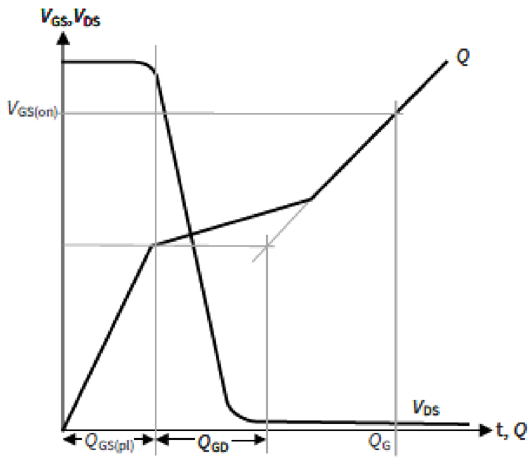


Figure D. **Definition of QGD**

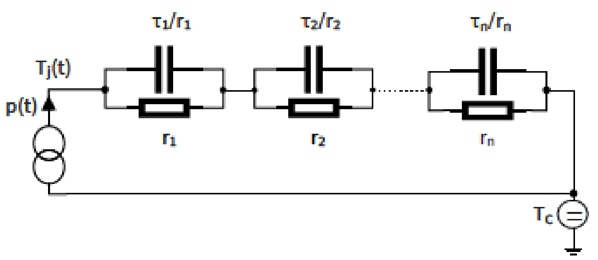


Figure E. **Thermal equivalent circuit**

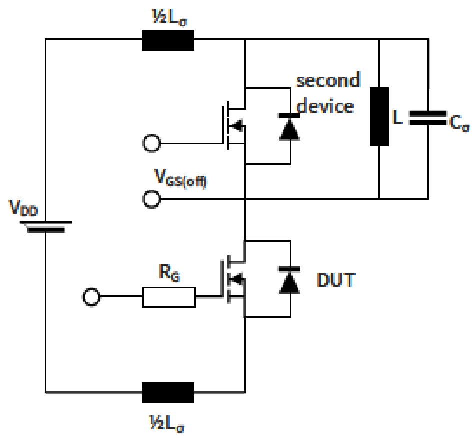


Figure F. **Dynamic test circuit**
Parasitic inductance L_σ,
Parasitic capacitor C_σ,

Figure 2

修订记录

Document revision	Date of release	Description of changes
0.10	2022-11-19	Preliminary datasheet
1.00	2023-04-25	Final datasheet
1.10	2024-04-02	Updated table values: Vgsth, Idss, gfs, Eoss, tdon, tr, tdoff, tf, Eon, Eoff, Etot,Qfr, Ifrm Updated graphs: IDS = f(VGS), VGS(th) = f(Tvj), IDS = f(VDS), RDS(on) = f(Tvj), ISD = f(VSD), E = f(Tvj), E = f(RG,ext), t = f(RG,ext), Ifrm = f(-diSD/dt) Added new graphs: E = f(ID), Eoss = f(VDS) No change to the product, new values based on additional characterization
1.20	2024-11-12	Updated features: “Minimal creepage distance 5.85mm (material group II) to fit 800V applications without coating” changed to “Creepage distance of 5.8mm (material group II) to fit 800V applications” Updated package from PG-TO263-7-HV-ND5.8 to PG-TO263-7-U01

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