

英飞凌CoolSiC™
400V CoolSiC™ G2 MOSFET

特性

- 非常适合高频开关和同步整流
- 具有低 Q_{fr} 值的快速体二极管确保换向的稳健性
- 低 $R_{DS(ON)}$ 对温度的依赖
- 基准栅极阈值电压， $V_{GS(th)}=4.5V$
- 建议栅极驱动电压0V至18V
- .XT 互连技术，实现行业领先的热性能
- 100% 雪崩测试

潜在应用

- 开关电源
- 太阳能逆变器
- 储能，UPS和电池化成
- D类功放
- 电机驱动

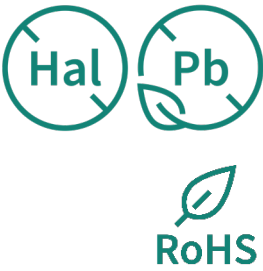
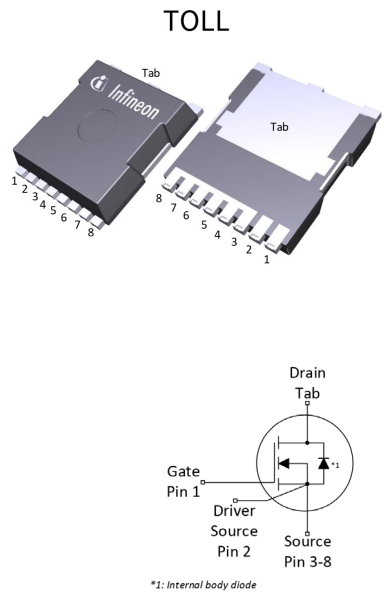
产品验证

完全符合 JEDEC 工业应用标准

表 1 主要性能参数

Parameter	Value	Unit
V_{DS}	400	V
$R_{DS(on),typ}$	44.9	mΩ
I_D	43	A
Q_{OSS}	34	nC
E_{OSS}	2.4	μJ
Q_G	21	nC

Type/Ordering Code	Package	Marking	Related Links
IMT40R045M2H	PG-HSOF-8	40R045M2	-



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1 最大额定值

除非另有规定, $T_A=25\text{ }^{\circ}\text{C}$

表 2 最大额定值

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Continuous drain current ¹⁾	I_D	-	-	43 30 6.8	A	$V_{GS}=18\text{ V}, T_C=25\text{ }^{\circ}\text{C}$ $V_{GS}=18\text{ V}, T_C=100\text{ }^{\circ}\text{C}$ $V_{GS}=18\text{ V}, T_A=25\text{ }^{\circ}\text{C}, R_{THJA}=40\text{ }^{\circ}\text{C/W}^{2)}$
Pulsed drain current ³⁾	$I_{D,pulse}$	-	-	129	A	$T_C=25\text{ }^{\circ}\text{C}$
Avalanche energy, single pulse ⁴⁾	E_{AS}	-	-	53	mJ	$I_D=8.9\text{ A}, R_{GS}=25\text{ }\Omega$
Avalanche energy, repetitive	E_{AR}	-	-	0.27	mJ	$I_D=8.9\text{ A}, R_{GS}=25\text{ }\Omega$
Gate source voltage (static)	$V_{GS,DC}$	-7	-	23	V	-
Gate source voltage (transient)	$V_{GS,AC}$	-10	-	25	V	$t_{pulse}\leq 500\text{ ns}, \text{duty cycle}\leq 1\%$
Power dissipation	P_{tot}	-	-	150 3.8	W	$T_C=25\text{ }^{\circ}\text{C}$ $T_A=25\text{ }^{\circ}\text{C}, R_{THJA}=40\text{ }^{\circ}\text{C/W}^{2)}$
Storage temperature	T_{stg}	-55	-	150	$^{\circ}\text{C}$	-
Operating junction temperature	T_j	-55	-	175	$^{\circ}\text{C}$	-

¹⁾ 额定值的适用条件: 产品在数据手册中规定的绝对最大值条件下运行、确保外壳温度为 $25\text{ }^{\circ}\text{C}$ 更高的外壳温度请参见图 2。需要根据实际环境条件降低额定值。

²⁾ 器件置于 $40\text{ mm}\times 40\text{ mm}\times 1.5\text{ mm}$ 环氧树脂印刷电路板 FR4 上, 配有 6 cm^2 (单层, $70\text{ }\mu\text{m}$ 厚) 铜层面积用于漏极连接。印刷电路板在静止空气中垂直放置。

³⁾ 详细信息请参见图 3

⁴⁾ 详细信息请参见图 19

2 热特性

表 3 热特性

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	1	°C/W	-
Thermal resistance, junction - ambient, 6 cm ² cooling area ⁵⁾	R_{thJA}	-	-	40	°C/W	-

⁵⁾ 器件置于40 mm × 40 mm × 1.5 mm 环氧树脂印刷电路板 FR4 上，配有6 cm²（单层，70 μm厚）铜层面积用于漏极连接。印刷电路板在静止空气中垂直放置。

3 工作范围

表 4 工作范围

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Recommended turn-on voltage	$V_{GS(on)}$	-	18	-	V	-
Recommended turn-off voltage	$V_{GS(off)}$	-	0	-	V	-

4 电气特性

除非另有规定, $T_j=25\text{ }^{\circ}\text{C}$

表 5 静态特性

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	400	-	-	V	$V_{GS}=0\text{ V}$, $I_D=0.32\text{ mA}$
Gate threshold voltage ⁶⁾	$V_{GS(th)}$	3.5	4.5	5.6	V	$V_{DS}=V_{GS}$, $I_D=3.2\text{ mA}$
Zero gate voltage drain current	I_{DSS}	-	1 2	75 -	μA	$V_{DS}=400\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ }^{\circ}\text{C}$ $V_{DS}=400\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=175\text{ }^{\circ}\text{C}$
Gate-source leakage current	I_{GSS}	-	1	100	nA	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	44.9 64.5 55.0	56.2 -	m Ω	$V_{GS}=18\text{ V}$, $I_D=8.9\text{ A}$, $T_j=25\text{ }^{\circ}\text{C}$ $V_{GS}=18\text{ V}$, $I_D=8.9\text{ A}$, $T_j=175\text{ }^{\circ}\text{C}$ $V_{GS}=15\text{ V}$, $I_D=8.9\text{ A}$, $T_j=25\text{ }^{\circ}\text{C}$
Gate resistance	R_G	-	5.8	8.7	Ω	-

⁶⁾ 在 $V_{GS}=+20\text{ V}$ 时, 施加 1 ms 脉冲后进行测试。

表 6 动态特性

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	710	910	pF	$V_{GS}=0\text{ V}$, $V_{DS}=200\text{ V}$, $f=1\text{ MHz}$
Output capacitance	C_{oss}	-	100	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=200\text{ V}$, $f=1\text{ MHz}$
Reverse transfer capacitance	C_{rss}	-	9	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=200\text{ V}$, $f=1\text{ MHz}$
Effective output capacitance, energy related ⁷⁾	$C_{o(er)}$	-	121	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=0\ldots 200\text{ V}$
Effective output capacitance, time related ⁸⁾	$C_{o(tr)}$	-	170	-	pF	$I_D=\text{constant}$, $V_{GS}=0\text{ V}$, $V_{DS}=0\ldots 200\text{ V}$
Turn-on delay time ⁹⁾	$t_{d(on)}$	-	12.0	-	ns	$V_{DD}=200\text{ V}$, $V_{GS}=0\ldots 18\text{ V}$, $I_D=8.9\text{ A}$, $R_{G,ext}=1.8\text{ }\Omega$
Rise time ⁹⁾	t_r	-	10.7	-	ns	$V_{DD}=200\text{ V}$, $V_{GS}=0\ldots 18\text{ V}$, $I_D=8.9\text{ A}$, $R_{G,ext}=1.8\text{ }\Omega$
Turn-off delay time ⁹⁾	$t_{d(off)}$	-	17.3	-	ns	$V_{DD}=200\text{ V}$, $V_{GS}=18\ldots 0\text{ V}$, $I_D=8.9\text{ A}$, $R_{G,ext}=1.8\text{ }\Omega$
Fall time ⁹⁾	t_f	-	8.3	-	ns	$V_{DD}=200\text{ V}$, $V_{GS}=18\ldots 0\text{ V}$, $I_D=8.9\text{ A}$, $R_{G,ext}=1.8\text{ }\Omega$

⁷⁾ $C_{o(er)}$ 是一个固定电容, 其储存能量与 C_{oss} 相同, 当 V_{DS} 从 0 上升至 200 V。

⁸⁾ $C_{o(tr)}$ 是一个固定电容, 其充电时间与 C_{oss} 相同, 当 V_{DS} 从 0 上升至 200 V。

⁹⁾ 测试设置请参见表 9。

表 7 栅极电荷特性¹⁰⁾

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	5.6	-	nC	$V_{DD}=200\text{ V}$, $I_D=8.9\text{ A}$, $V_{GS}=0\text{ to }18\text{ V}$
Gate to drain charge	Q_{gd}	-	4.4	-	nC	$V_{DD}=200\text{ V}$, $I_D=8.9\text{ A}$, $V_{GS}=0\text{ to }18\text{ V}$
Gate charge total	Q_g	-	21	-	nC	$V_{DD}=200\text{ V}$, $I_D=8.9\text{ A}$, $V_{GS}=0\text{ to }18\text{ V}$
Gate charge total, sync. FET	$Q_{g(sync)}$	-	19	-	nC	$V_{DS}=0.1\text{ V}$, $V_{GS}=0\text{ to }18\text{ V}$
Output charge	Q_{oss}	-	34	-	nC	$V_{DS}=200\text{ V}$, $V_{GS}=0\text{ V}$
Output Energy	E_{oss}	-	2.4	-	μJ	$V_{DS}=200\text{ V}$, $V_{GS}=0\text{ V}$

¹⁰⁾ 依据 JEP192, SiC MOSFET 栅极电荷 (Q_G) 测试方法指南。

表 8 反向二极管特性

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Diode continuous forward current	I_S	-	-	21	A	$T_C=25\text{ °C}$
Diode pulse current	$I_{S,pulse}$	-	-	129	A	$T_C=25\text{ °C}$, $t_{pulse}\leq 250\text{ ns}$
Diode forward voltage	V_{SD}	-	3.5	4.3	V	$V_{GS}=0\text{ V}$, $I_S=8.9\text{ A}$, $T_J=25\text{ °C}$
MOSFET forward recovery time	t_{fr}	-	11.1 8.7	-	ns	$V_R=200\text{ V}$, $I_S=8.9\text{ A}$, $di_S/dt=1000\text{ A}/\mu\text{s}$ $V_R=200\text{ V}$, $I_S=8.9\text{ A}$, $di_S/dt=3000\text{ A}/\mu\text{s}$
MOSFET forward recovery charge ¹¹⁾	Q_{fr}	-	38 74	-	nC	$V_R=200\text{ V}$, $I_S=8.9\text{ A}$, $di_S/dt=1000\text{ A}/\mu\text{s}$ $V_R=200\text{ V}$, $I_S=8.9\text{ A}$, $di_S/dt=3000\text{ A}/\mu\text{s}$

¹¹⁾ Q_{fr} 包括 Q_{oss} 。测试设置请参见表 10。

5 电气特性图

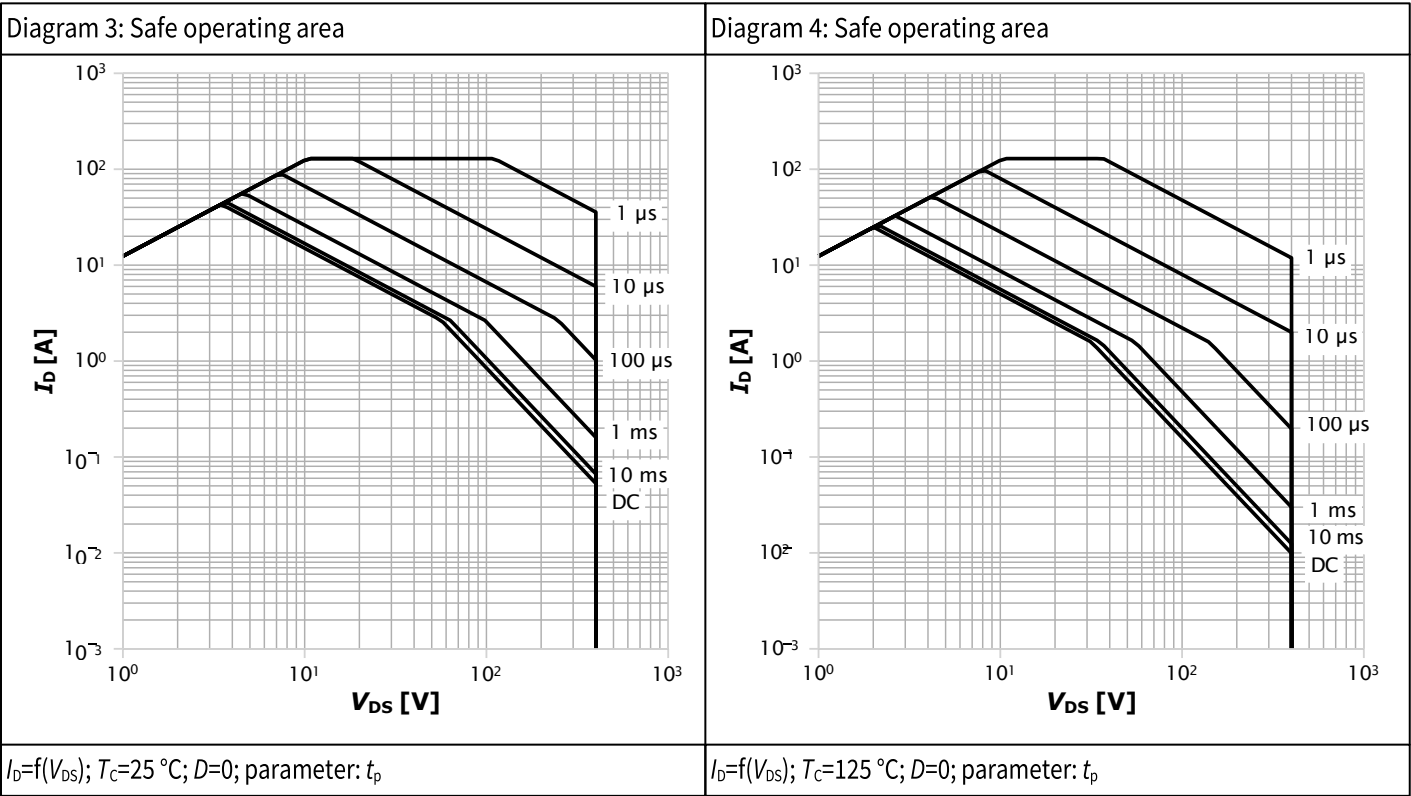
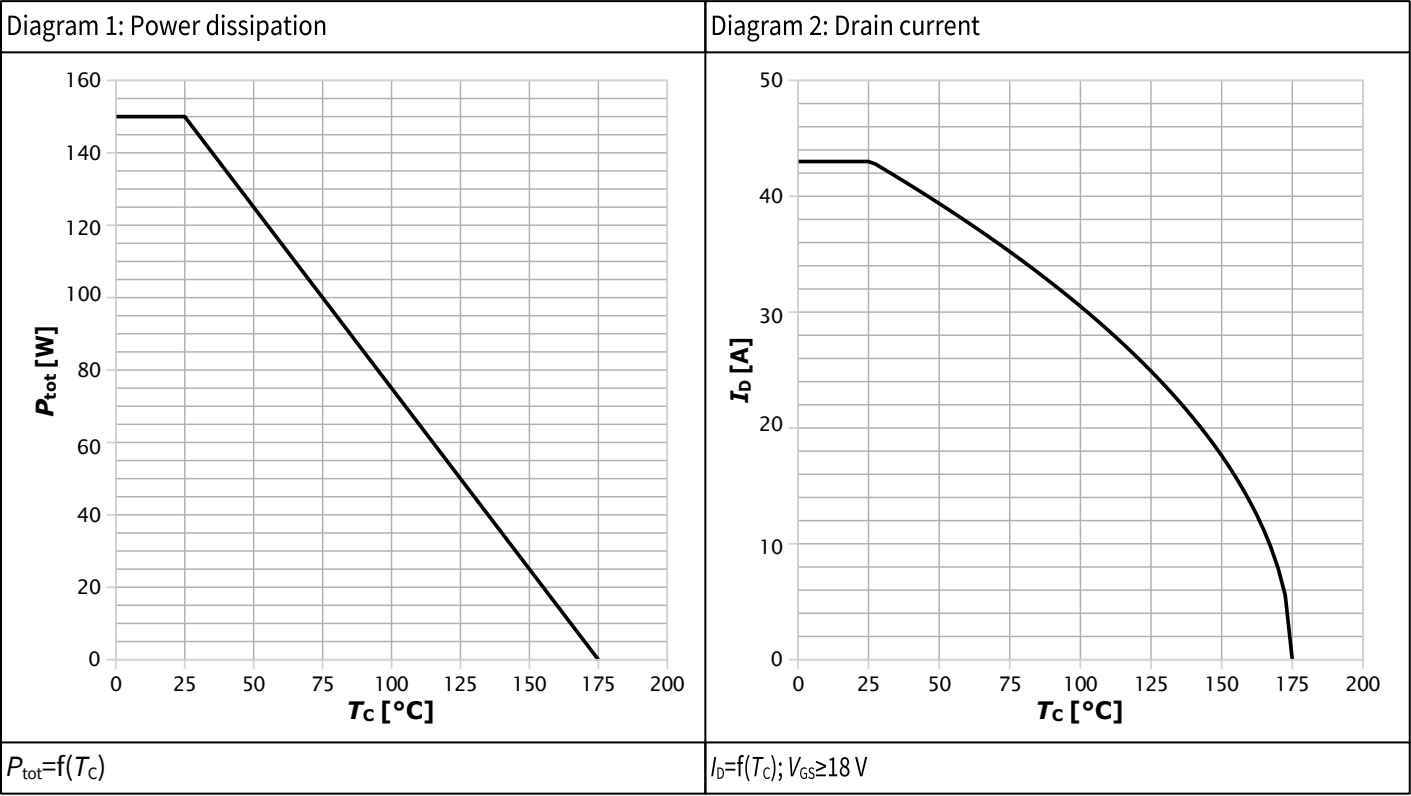
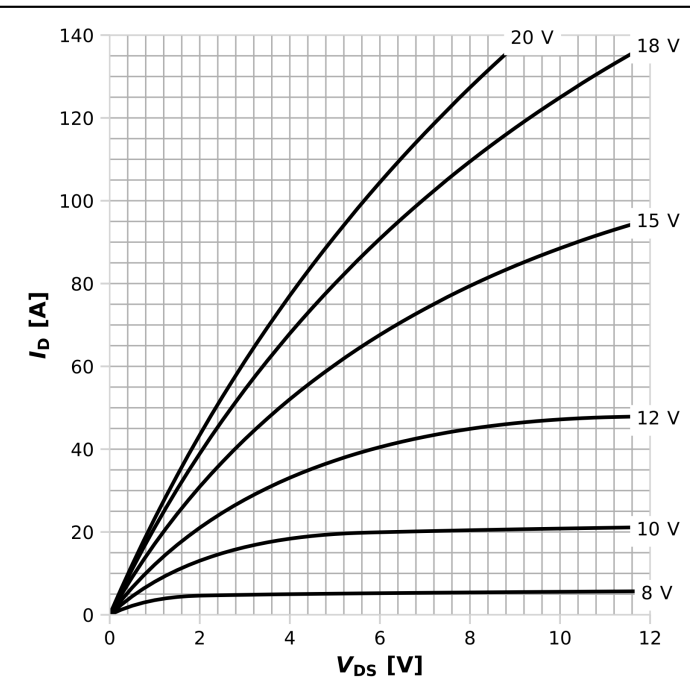
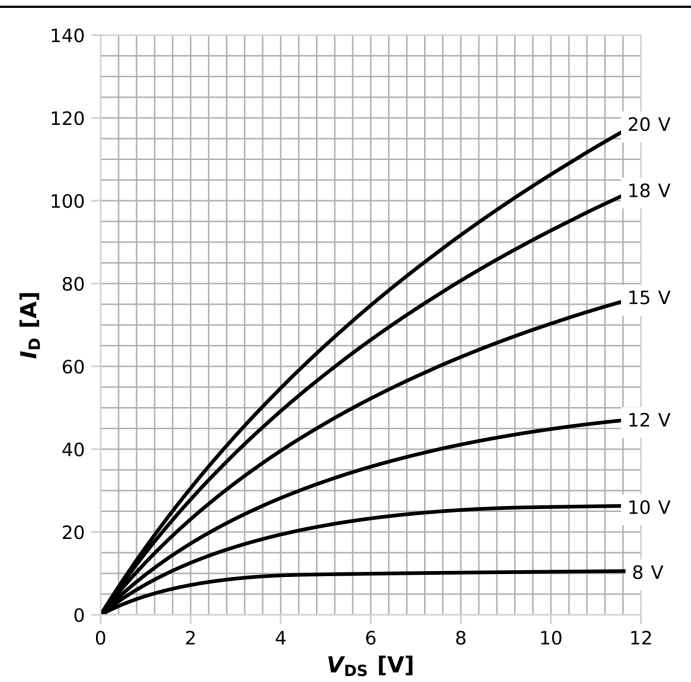


Diagram 5: Typ. output characteristics



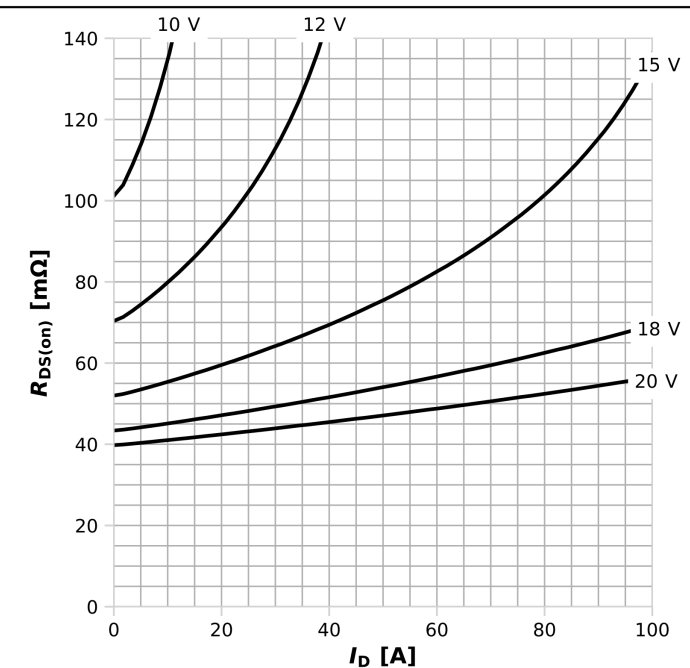
$I_D = f(V_{DS})$, $T_j = 25\text{ °C}$; parameter: V_{GS}

Diagram 6: Typ. output characteristics



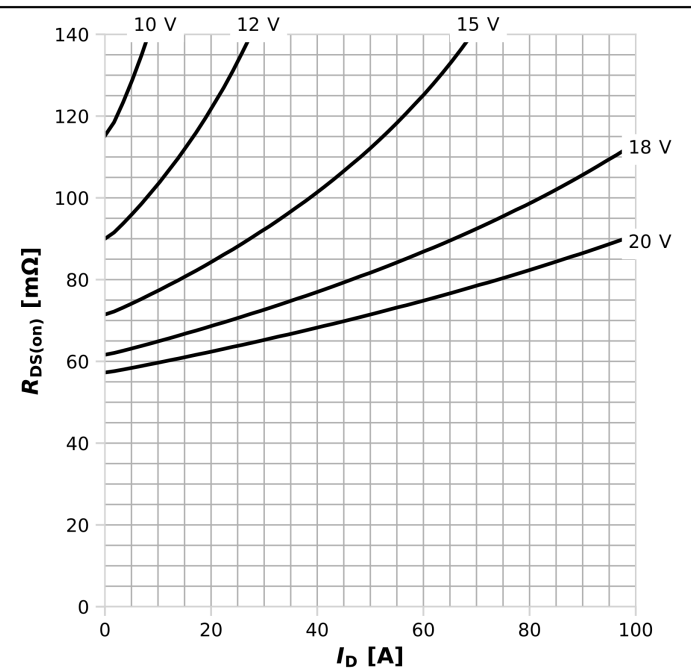
$I_D = f(V_{DS})$, $T_j = 175\text{ °C}$; parameter: V_{GS}

Diagram 7: Typ. drain-source on resistance



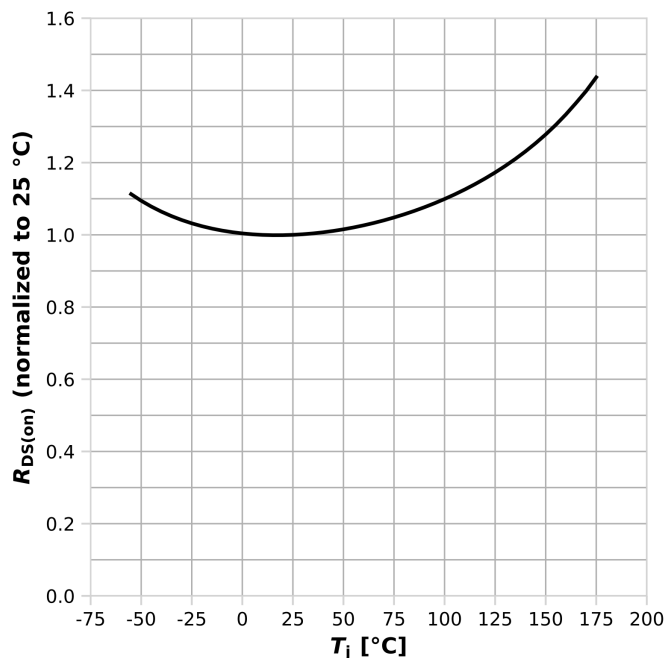
$R_{DS(on)} = f(I_D)$, $T_j = 25\text{ °C}$; parameter: V_{GS}

Diagram 8: Typ. drain-source on resistance



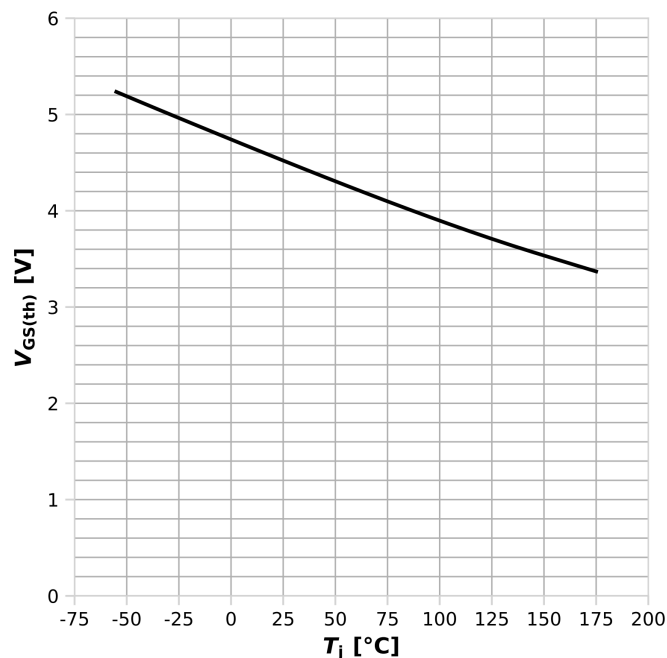
$R_{DS(on)} = f(I_D)$, $T_j = 175\text{ °C}$; parameter: V_{GS}

Diagram 9: Normalized drain-source on resistance



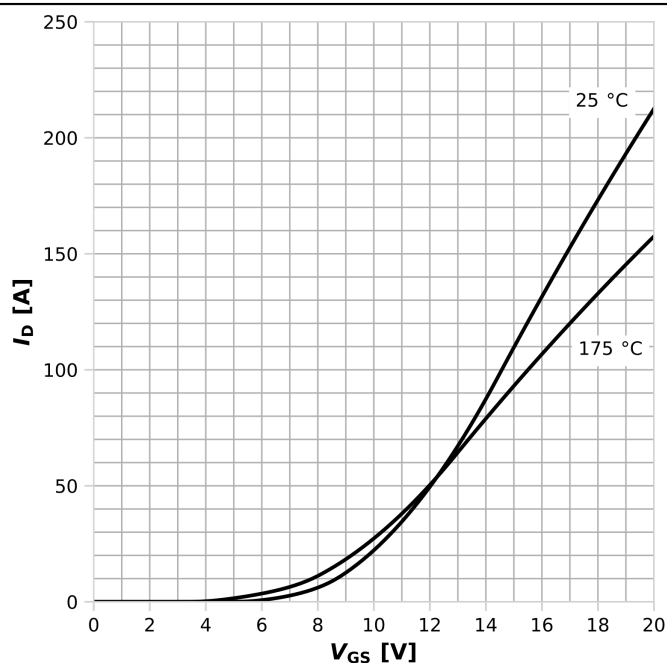
$$R_{DS(on)} = f(T_j), I_D = 8.9 \text{ A}, V_{GS} = 18 \text{ V}$$

Diagram 10: Typ. gate threshold voltage



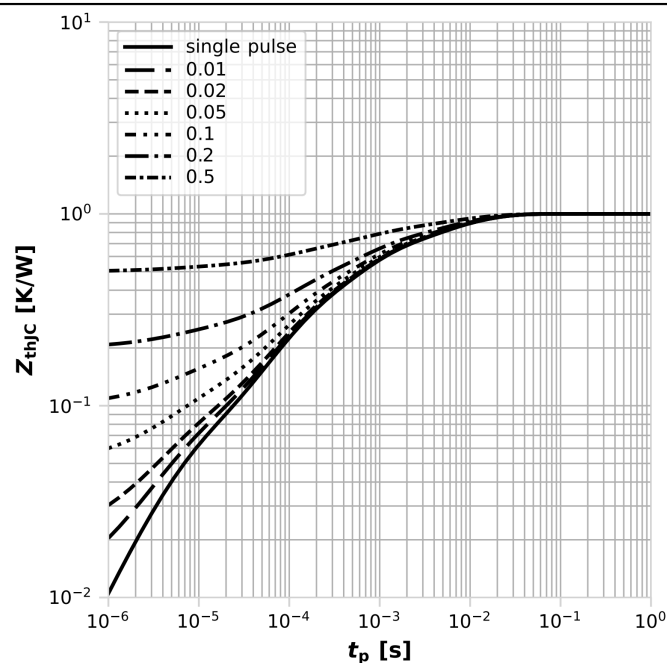
$$V_{GS(th)} = f(T_j), V_{GS} = V_{DS}, I_D = 3.2 \text{ mA}$$

Diagram 11: Typ. transfer characteristics



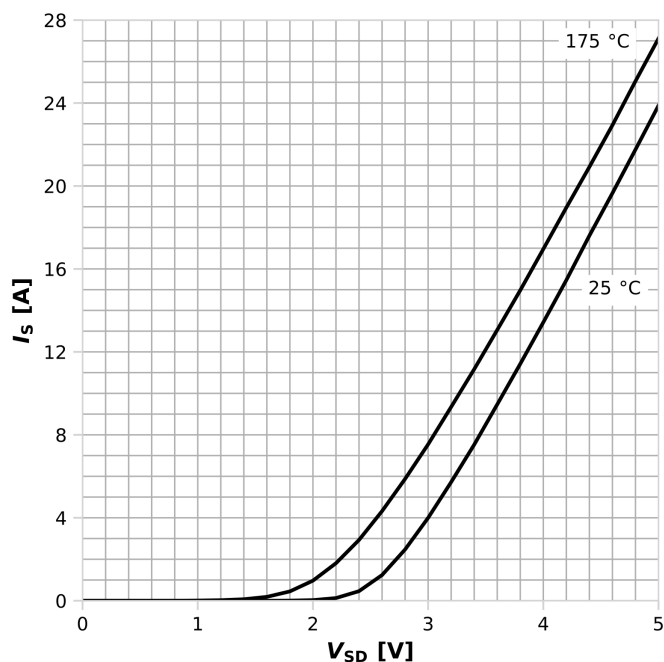
$$I_D = f(V_{GS}), |V_{DS}| > 2|I_D|R_{DS(on)max}; \text{ parameter: } T_j$$

Diagram 12: Max. transient thermal impedance



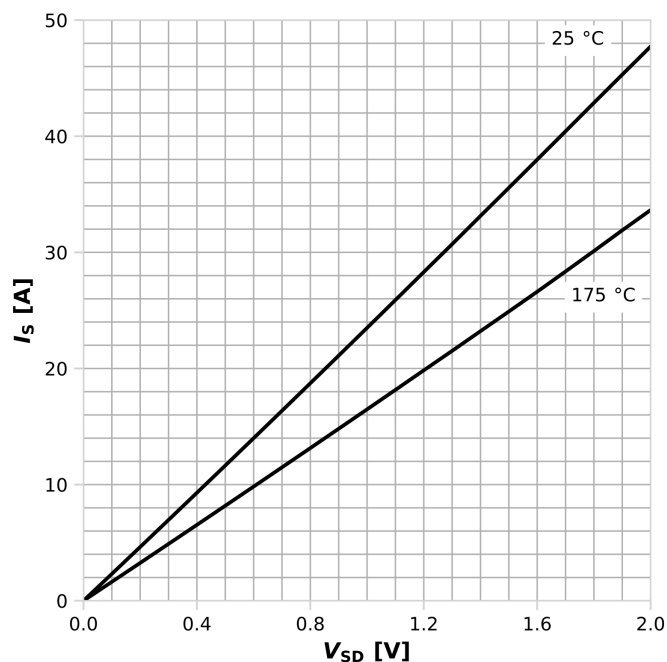
$$Z_{thJC} = f(t_p); \text{ parameter: } D = t_p / T$$

Diagram 13: Reverse output characteristics



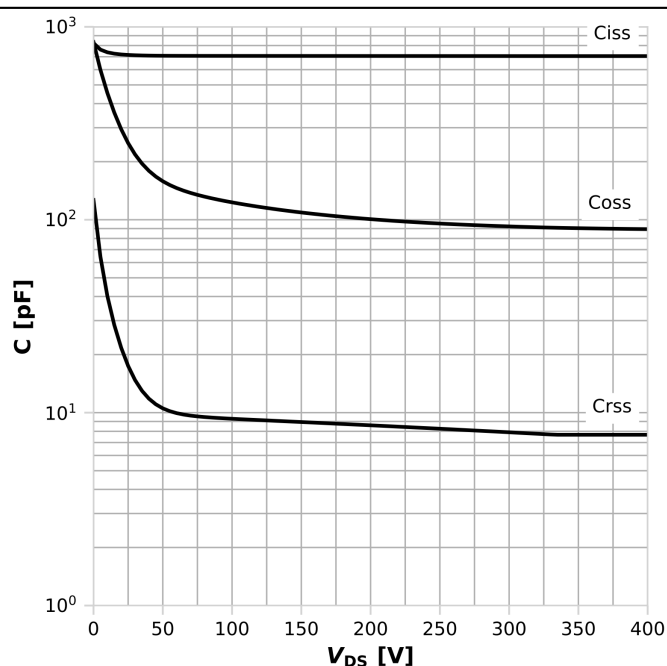
$I_F = f(V_{SD})$, $V_{GS} = 0$ V; parameter: T_j

Diagram 14: Reverse output characteristics



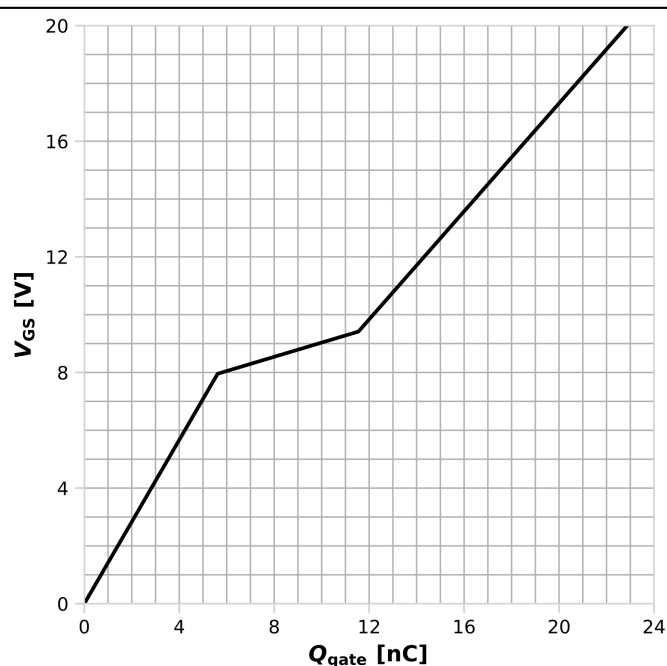
$I_F = f(V_{SD})$, $V_{GS} = 18$ V; parameter: T_j

Diagram 15: Typ. capacitances



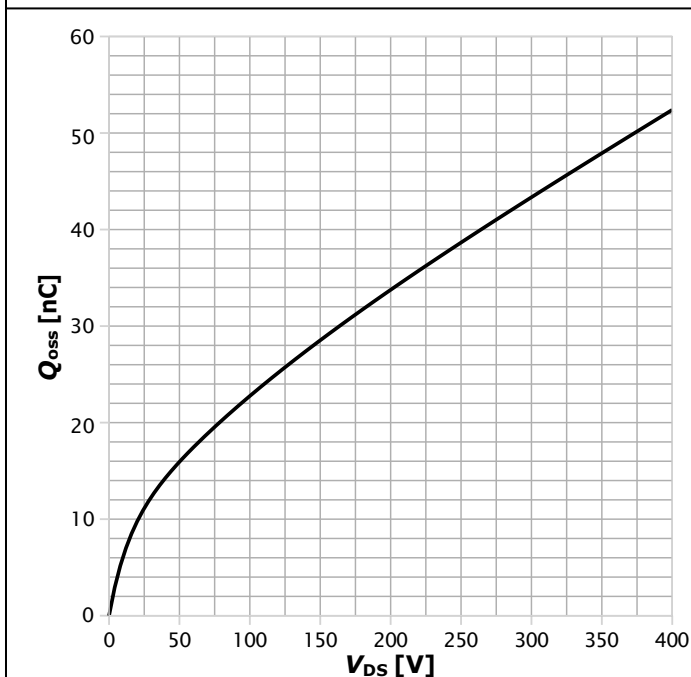
$C = f(V_{DS})$; $V_{GS} = 0$ V; $f = 1$ MHz

Diagram 16: Typ. gate charge



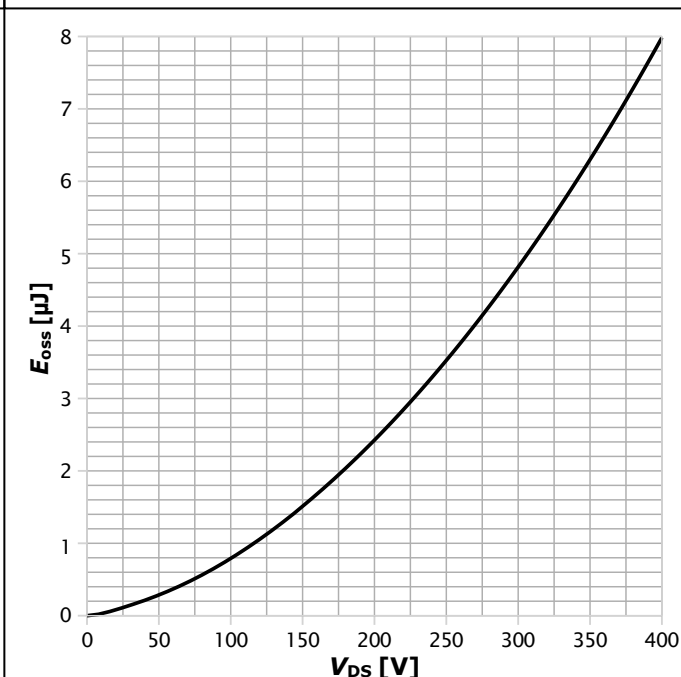
$V_{GS} = f(Q_{gate})$, $V_{DD} = 200$ V, $I_D = 8.9$ A pulsed, $T_j = 25$ °C

Diagram 17: Typ. output charge



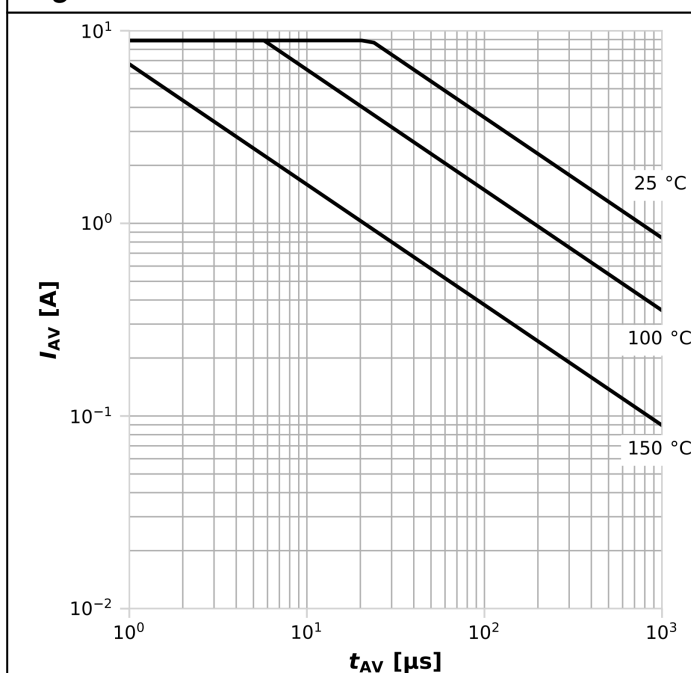
$$Q_{oss}=f(V_{DS}), V_{GS}=0\text{ V}$$

Diagram 18: Typ. output energy



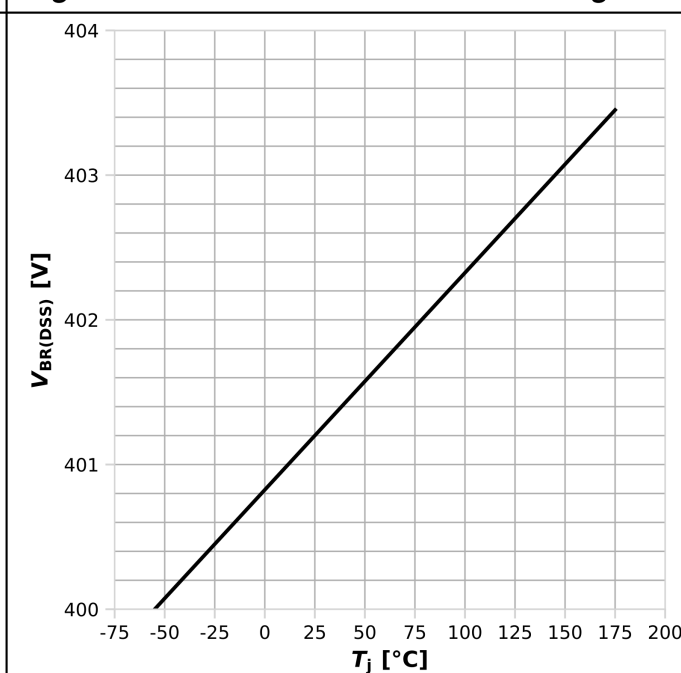
$$E_{oss}=f(V_{DS}), V_{GS}=0\text{ V}$$

Diagram 19: Avalanche characteristics



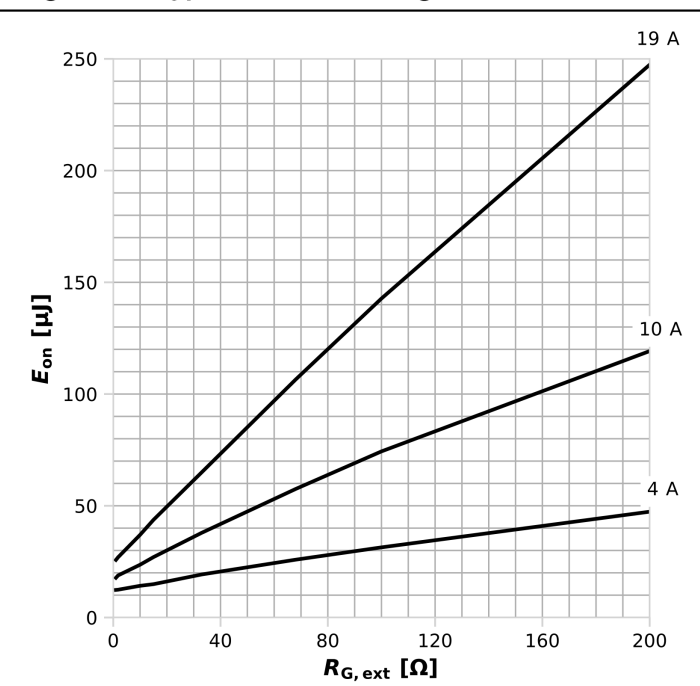
$$I_{AS}=f(t_{AV}); R_{GS}=25\ \Omega; \text{parameter: } T_{j,\text{start}}$$

Diagram 20: Min. drain-source breakdown voltage



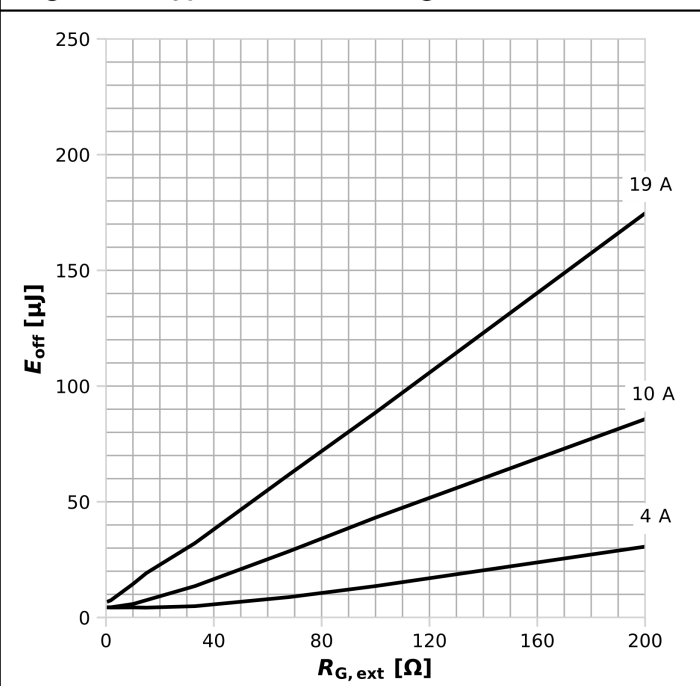
$$V_{BR(DSS)}=f(T_j); I_D=0.32\text{ mA}$$

Diagram 21: Typ. turn-on switching losses



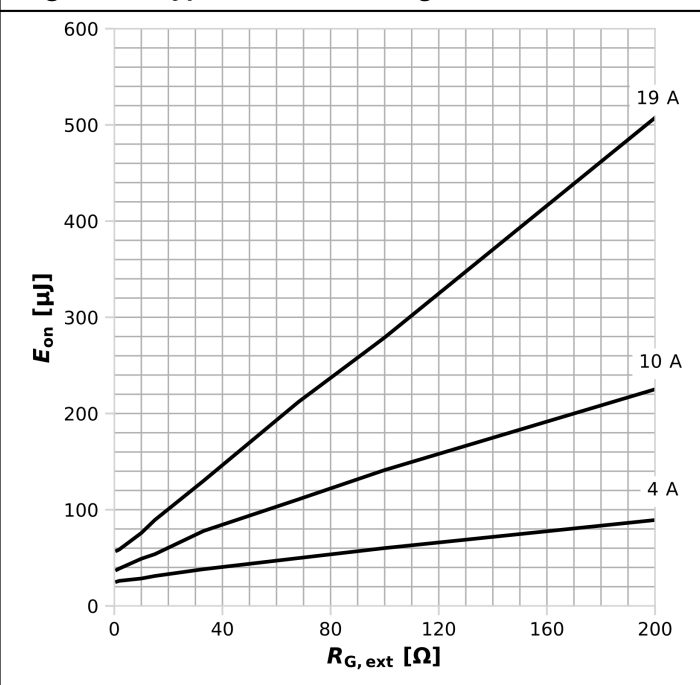
$E_{on}=f(R_{g,ext}), V_{DD}=200\text{ V}, V_G=0...18\text{ V}; \text{parameter: } I_D$

Diagram 22: Typ. turn-off switching losses



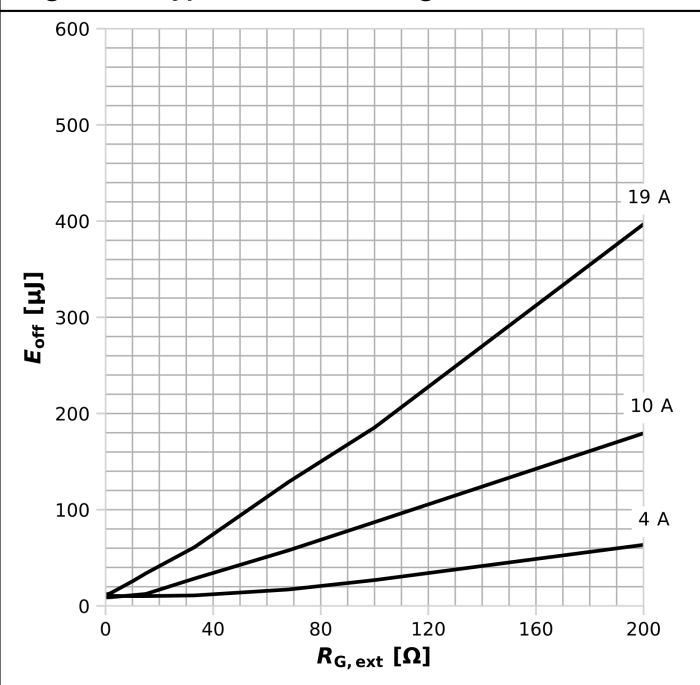
$E_{off}=f(R_{g,ext}), V_{DD}=200\text{ V}, V_G=18...0\text{ V}; \text{parameter: } I_D$

Diagram 23: Typ. turn-on switching losses



$E_{on}=f(R_{g,ext}), V_{DD}=320\text{ V}, V_G=0...18\text{ V}; \text{parameter: } I_D$

Diagram 24: Typ. turn-off switching losses



$E_{off}=f(R_{g,ext}), V_{DD}=320\text{ V}, V_G=18...0\text{ V}; \text{parameter: } I_D$

6 测试电路

表 9 开关时间 (CoolSiC)

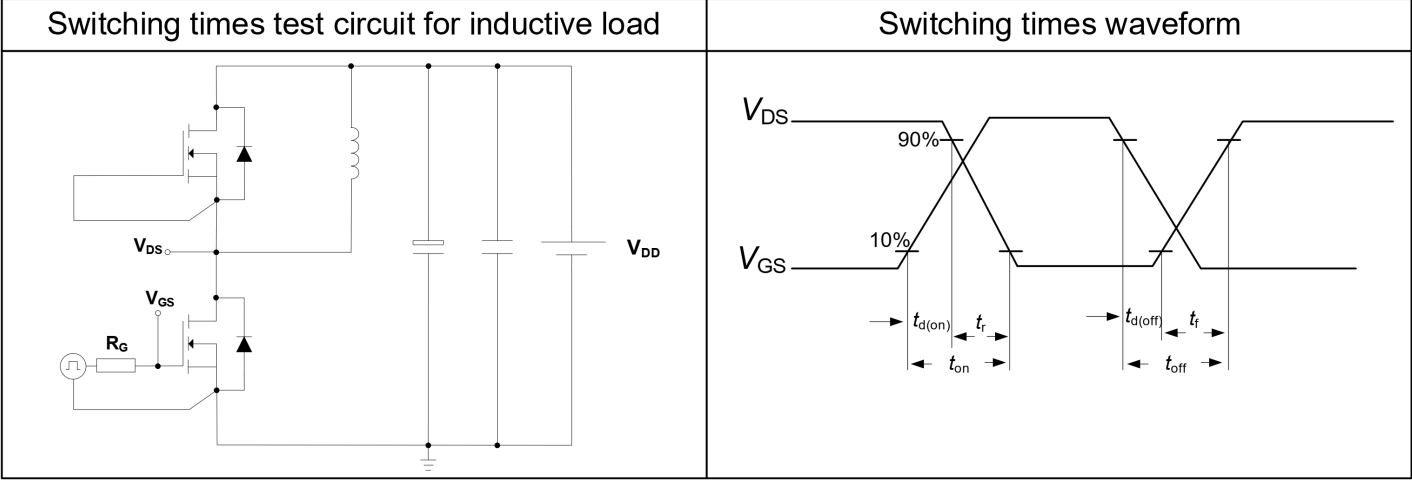
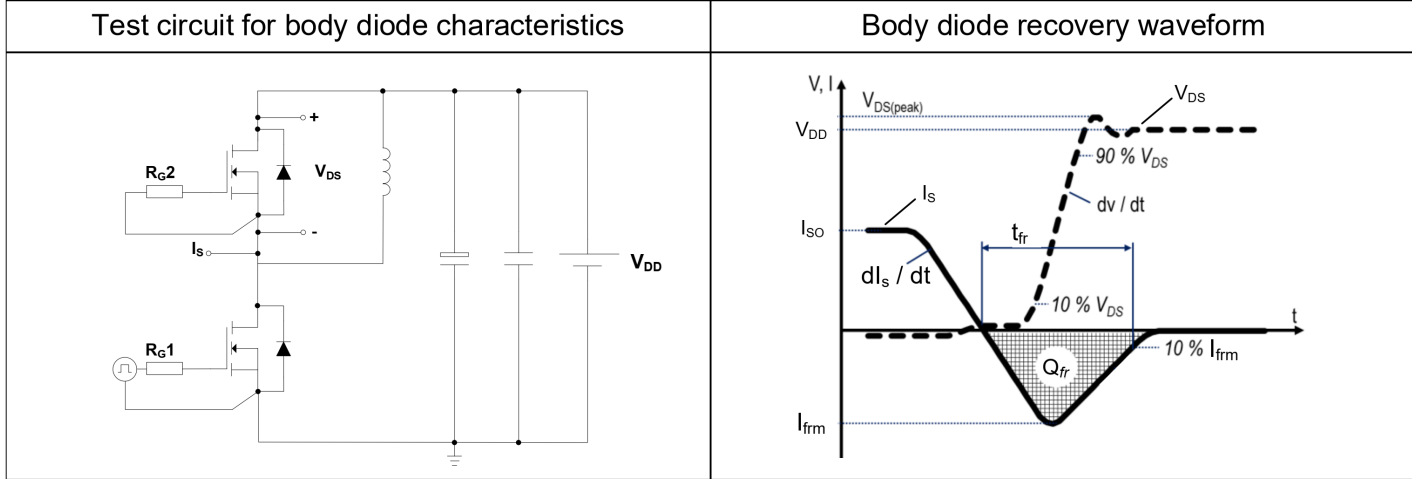
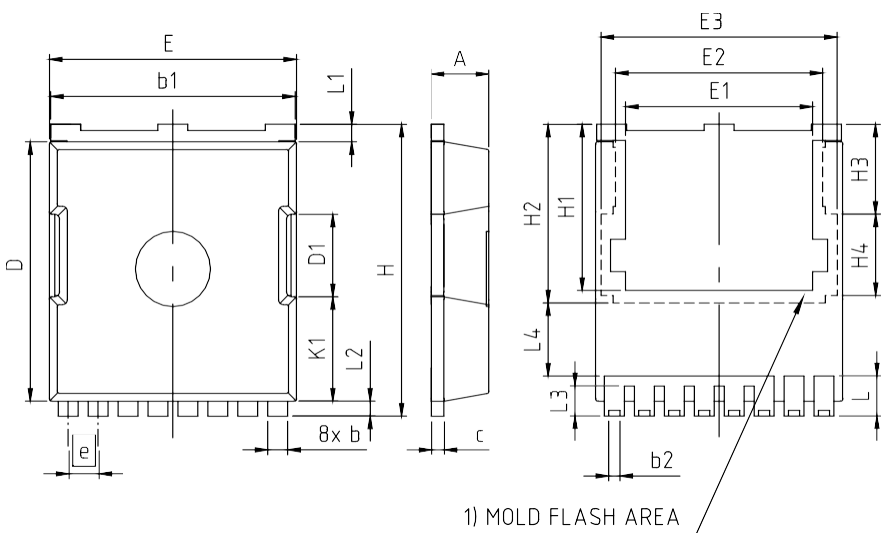


表 10 体二极管特性 (CoolSiC)



7 封装外形



PACKAGE - GROUP NUMBER: PG-HSOF-8-U02		
DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	2.20	2.40
b	0.70	0.90
b1	9.70	9.90
b2	0.42	0.50
c	0.40	0.60
D	10.28	10.58
D1	3.30	
E	9.70	10.10
E1	7.50	
E2	8.50	
E3	9.46	
e	1.20 (BSC)	
H	11.48	11.88
H1	6.55	6.95
H2	7.15	
H3	3.59	
H4	3.26	
N	8	
K1	4.18	
L	1.40	1.80
L1	0.50	0.90
L2	0.50	0.70
L3	1.00	1.30
L4	2.62	2.81

1) PARTIALLY COVERED WITH MOLD FLASH

图 1 PG-HSOF-8 外形图，尺寸单位为毫米

修订记录

IMT40R045M2H

Revision 2024 - 04 - 27 , Rev. 2 . 0

历史修订版本

Revision	Date	Subjects (major changes since last revision)
1.0	2024-04-26	Release of preliminary version
2.0	2024-04-27	Release of final

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