

英飞凌CoolSiC™ M1

英飞凌CoolSiC™ MOSFET 650V G1

英飞凌650 V CoolSiC™基于英飞凌超过20年的碳化硅技术积累构建。利用宽带隙SiC材料特性，650V CoolSiC™ MOSFET提供独特的性能、可靠性和易用性的结合。它适用于高温和恶劣的操作，能够以简化且经济高效的方式实现行业领先的系统效率。

特性

- 优化高电流下的开关行为
- 具有低 Q_{fr} 值的快速体二极管确保换向的稳健性
- 卓越的栅极氧化物可靠性
- $T_{j,max} = 175^{\circ}\text{C}$ 和优异的热性能
- 较低 $R_{DS(on)}$ 和脉冲电流对温度的依赖性
- 增强雪崩能力
- 与标准驱动兼容
- 开尔文源可将开关损耗降低4倍

优点

- 高性能、高可靠性和易用性的独特组合
- 易于使用和集成
- 适用于连续硬换向拓扑
- 更高的稳健性和系统可靠性
- 提高效率
- 减小系统尺寸，提高功率密度

潜在的应用

- 开关电源
- UPS（不间断电源）
- 太阳能逆变器
- 电动汽车充电基础设施
- 储能和电池化成
- D类放大器

产品认证

完全符合 JEDEC 工业应用标准

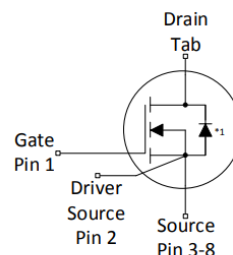
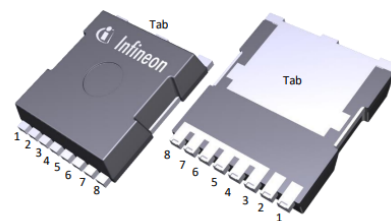
请注意：源和感测源引脚不可互换。它们的交换可能会导致故障。

表 1 主要性能参数

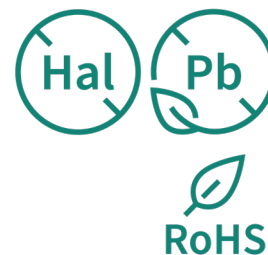
Parameter	Value	Unit
$V_{DS}@T_J = 25^{\circ}\text{C}$	650	V
$R_{DS(on),typ}$	163	m Ω
$R_{DS(on),max}$	217	m Ω
$Q_{G,typ}$	10	nC
$I_{DM,max}$	31	A
$Q_{oss}@400\text{V}$	27	nC
$E_{oss}@400\text{V}$	4.1	μJ

Type/Ordering Code	Package	Marking	Related Links
IMT65R163M1H	PG-HSOF-8	65R163M1	see Appendix A

TOLL



*1: Internal body diode





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1 最大额定值

除非另有规定， $T_j = 25\text{ °C}$ 。

注意：为了获得最佳的使用寿命和可靠性，英飞凌建议工作条件不超过本数据表中所述最大额定值的80%。

表 2 最大额定值

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Continuous DC drain current ¹⁾	I_{DDC}	-	-	19 13	A	$T_c = 25\text{ °C}$ $T_c = 100\text{ °C}$
Peak drain current ²⁾	I_{DM}	-	-	31	A	$T_c = 25\text{ °C}$, $V_{\text{GS}} = 18\text{ V}$
Avalanche energy, single pulse	E_{AS}	-	-	49	mJ	$I_D = 1.8\text{ A}$, $V_{\text{DD}} = 50\text{ V}$; see table 11
Avalanche energy, repetitive	E_{AR}	-	-	0.24	mJ	$I_D = 1.8\text{ A}$, $V_{\text{DD}} = 50\text{ V}$; see table 11
Avalanche current, single pulse	I_{AS}	-	-	1.8	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	200	V/ns	$V_{\text{DS}} = 0 \dots 400\text{ V}$
Gate source voltage (static) ³⁾	V_{GS}	-5	-	23	V	-
Gate source voltage (transient)	V_{GS}	-7	-	25	V	$t_{\text{pulse}} \leq 1\%$ duty cycle/ f_{sw}
Power dissipation	P_{tot}	-	-	106	W	$T_c = 25\text{ °C}$
Storage temperature	T_{stg}	-55	-	150	°C	-
Operating junction temperature	T_j	-55	-	175	°C	-
Mounting torque	-	-	-	n.a.	Ncm	-
Continuous reverse drain current ¹⁾	I_{SDC}	-	-	19 12	A	$V_{\text{GS}} = 18\text{ V}$, $T_c = 25\text{ °C}$ $V_{\text{GS}} = 0\text{ V}$, $T_c = 25\text{ °C}$
Peak reverse drain current ²⁾	I_{SM}	-	-	31	A	$T_c = 25\text{ °C}$, $t_p \leq 250\text{ ns}$
Insulation withstand voltage	V_{ISO}	-	-	n.a.	V	V_{rms} , $T_c = 25\text{ °C}$, $t = 1\text{ min}$

1) 受 $T_{j,\text{max}}$ 限制。

2) 脉冲宽度 t_{pulse} 受 $T_{j,\text{max}}$ 限制。

3) 应用设计中的最大栅极源电压应符合IPC-9592B的规定。

2 热特性

表3 热特性

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{th(j-c)}$	-	-	1.41	°C/W	-
Thermal resistance, junction - ambient	$R_{th(j-a)}$	-	-	62	°C/W	device on PCB, minimal footprint
Thermal resistance, junction - ambient, SMD version	$R_{th(j-a)}$	-	35	45	°C/W	Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm ² (one layer, 70μm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling.
Soldering temperature, wave- & reflow soldering allowed	T_{sold}	-	-	260	°C	reflow MSL2

3 工作范围

表 4 工作范围

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Gate-source voltage operating range including undershoots ⁴⁾	V_{GS}	-2	-	20	V	-
Recommended turn-on voltage	$V_{GS(on)}$	-	18	-	V	-
Recommended turn-off voltage	$V_{GS(off)}$	-	0	-	V	-

4)

重要提示：如果应用中器件的栅极源电压超出工作范围（表 4），则器件 $R_{DS(on)}$ 和 $V_{GS(th)}$ 可能会在器件使用寿命结束时超过数据表中规定的最大值。为了确保器件在计划使用寿命内正常运行，必须考虑最大额定值（表 2）和 CoolSiC™ MOSFET 650V M1 沟槽功率器件应用说明 AN_1907_PL52_1911_144109。

4 电气特性

除非另有规定, $T_j = 25\text{ °C}$

表 5 直流特性

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Drain-source voltage	V_{DS}	650	-	-	V	$V_{GS} = 0\text{ V}, I_D = 0.17\text{ mA}$
Gate threshold voltage ⁵⁾	$V_{GS(th)}$	3.5	4.5	5.7	V	$V_{DS} = V_{GS}, I_D = 1.7\text{ mA}$
Zero gate voltage drain current	I_{DSS}	-	1 3	100 -	μA	$V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}, T_j = 25\text{ °C}$ $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}, T_j = 175\text{ °C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	163 228	217 -	m Ω	$V_{GS} = 18\text{ V}, I_D = 5.7\text{ A}, T_j = 25\text{ °C}$ $V_{GS} = 18\text{ V}, I_D = 5.7\text{ A}, T_j = 175\text{ °C}$
Internal gate resistance	$R_{G,int}$	-	16.0	-	Ω	$f = 1\text{ MHz}$

5) 在 $V_{GS} = +20\text{ V}$ 时 1 ms 脉冲之后进行测试。

表 6 直流特性

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	320	-	pF	$V_{GS} = 0\text{ V}, V_{DS} = 400\text{ V}, f = 250\text{ kHz}$
Reverse transfer capacitance	C_{rss}	-	4.8	-	pF	$V_{GS} = 0\text{ V}, V_{DS} = 400\text{ V}, f = 250\text{ kHz}$
Output capacitance ⁶⁾	C_{oss}	-	45	58	pF	$V_{GS} = 0\text{ V}, V_{DS} = 400\text{ V}, f = 250\text{ kHz}$
Output charge ⁶⁾	Q_{oss}	-	27	35	nC	calculation based on C_{oss}
Effective output capacitance, energy related ⁷⁾	$C_{o(er)}$	-	52	-	pF	$V_{GS} = 0\text{ V},$ $V_{DS} = 0\text{...}400\text{ V}$
Effective output capacitance, time related ⁸⁾	$C_{o(tr)}$	-	68	-	pF	$I_D = \text{constant}, V_{GS} = 0\text{ V}, V_{DS} = 0\text{...}400\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	5.5	-	ns	$V_{DD} = 400\text{ V}, V_{GS} = 0/18\text{ V},$ $I_D = 5.7\text{ A}, R_{G,ext} = 1.8\text{ }\Omega;$ see table 10
Rise time	t_r	-	5.9	-	ns	$V_{DD} = 400\text{ V}, V_{GS} = 0/18\text{ V},$ $I_D = 5.7\text{ A}, R_{G,ext} = 1.8\text{ }\Omega;$ see table 10
Turn-off delay time	$t_{d(off)}$	-	8.6	-	ns	$V_{DD} = 400\text{ V}, V_{GS} = 0/18\text{ V},$ $I_D = 5.7\text{ A}, R_{G,ext} = 1.8\text{ }\Omega;$ see table 10
Fall time	t_f	-	10.0	-	ns	$V_{DD} = 400\text{ V}, V_{GS} = 0/18\text{ V},$ $I_D = 5.7\text{ A}, R_{G,ext} = 1.8\text{ }\Omega;$ see table 10

- 6) 最大规格由计算出的六西格玛置信上限定义。
- 7) $C_{o(er)}$ 是一个固定电容，当 V_{DS} 从 0 上升至 400 V 时，其提供与 C_{oss} 相同的储存能量。
- 8) $C_{o(tr)}$ 是一个固定电容，当 V_{DS} 从 0 上升至 400 V 时，其充电时间与 C_{oss} 相同。

表7 栅极电荷特性

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Plateau gate to source charge	$Q_{GS(pl)}$	-	2	-	nC	$V_{DD} = 400\text{ V}$, $I_D = 5.7\text{ A}$, $V_{GS} = 0\text{ to }18\text{ V}$
Gate to drain charge	Q_{GD}	-	2	-	nC	$V_{DD} = 400\text{ V}$, $I_D = 5.7\text{ A}$, $V_{GS} = 0\text{ to }18\text{ V}$
Total gate charge	Q_G	-	10	-	nC	$V_{DD} = 400\text{ V}$, $I_D = 5.7\text{ A}$, $V_{GS} = 0\text{ to }18\text{ V}$

表8 反向二极管特性

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Drain-source reverse voltage	V_{SD}	-	4.0	-	V	$V_{GS} = 0\text{ V}$, $I_S = 5.7\text{ A}$, $T_j = 25\text{ °C}$
MOSFET forward recovery time	t_{fr}	-	17.0	-	ns	$V_{DD} = 400\text{ V}$, $I_S = 5.7\text{ A}$, $di_S/dt = 1000\text{ A}/\mu\text{s}$; see table 9
MOSFET forward recovery charge ⁹⁾	Q_{fr}	-	39	-	nC	$V_{DD} = 400\text{ V}$, $I_S = 5.7\text{ A}$, $di_S/dt = 1000\text{ A}/\mu\text{s}$; see table 9
MOSFET peak forward recovery current	I_{frm}	-	4.6	-	A	$V_{DD} = 400\text{ V}$, $I_S = 5.7\text{ A}$, $di_S/dt = 1000\text{ A}/\mu\text{s}$; see table 9

- 9) Q_{fr} 包括 Q_{oss} 。

5 电气特性图

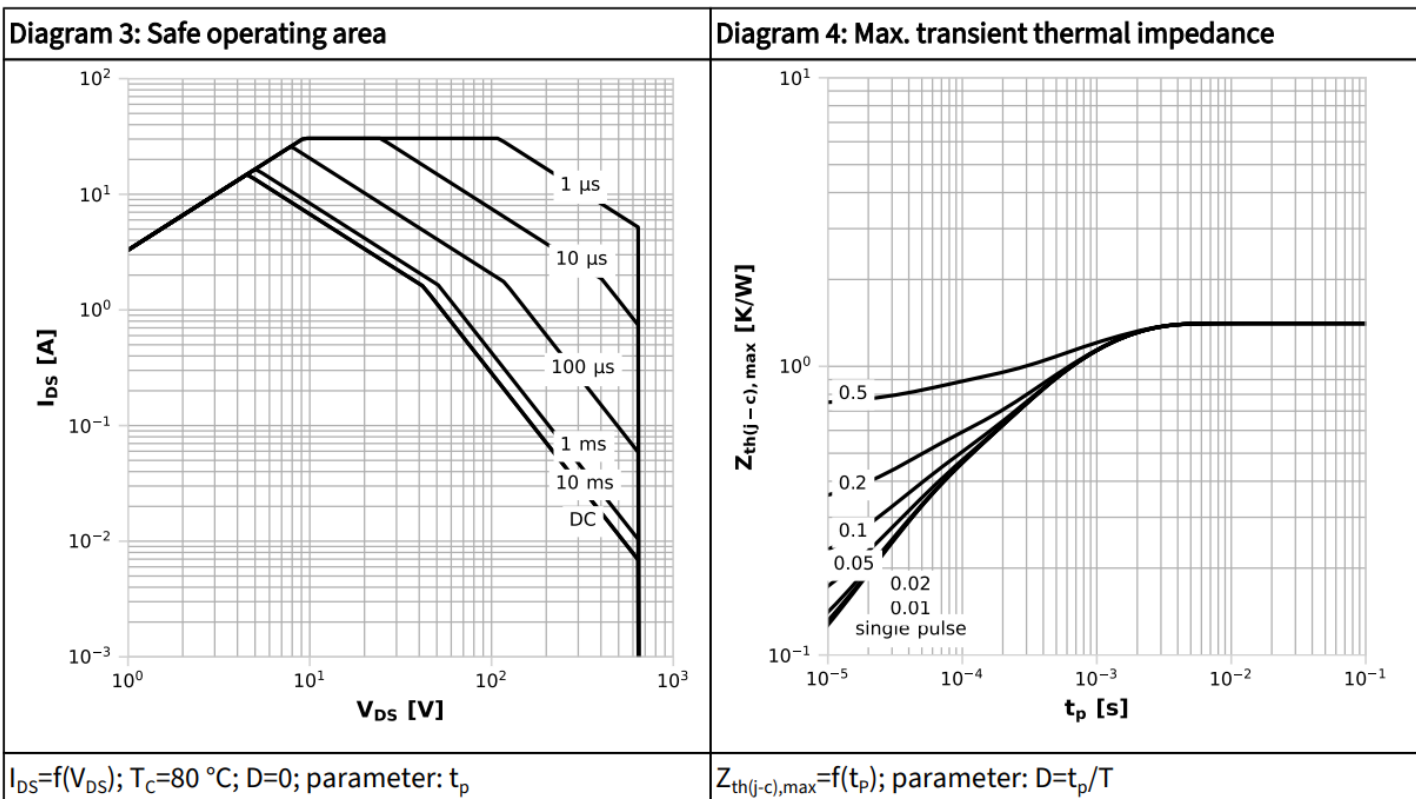
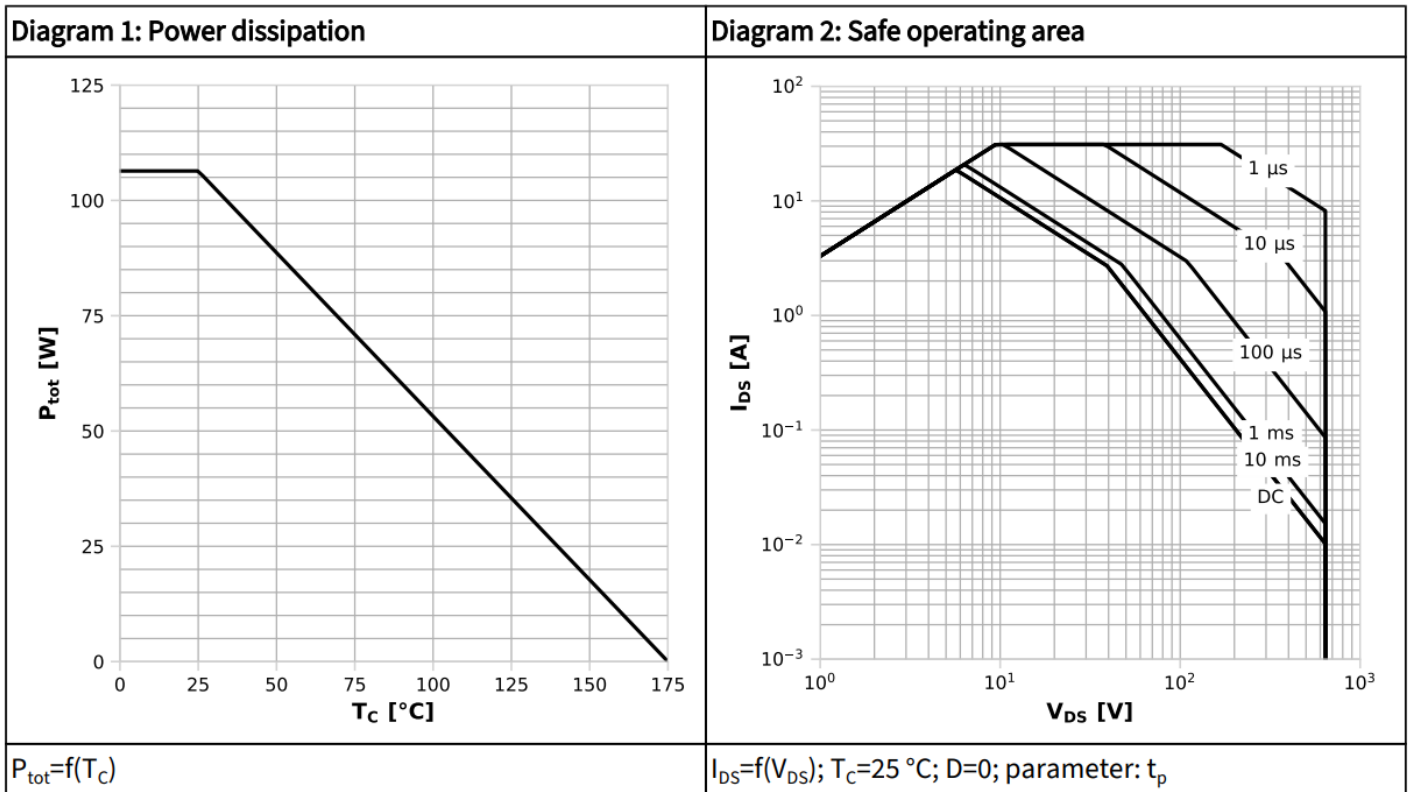
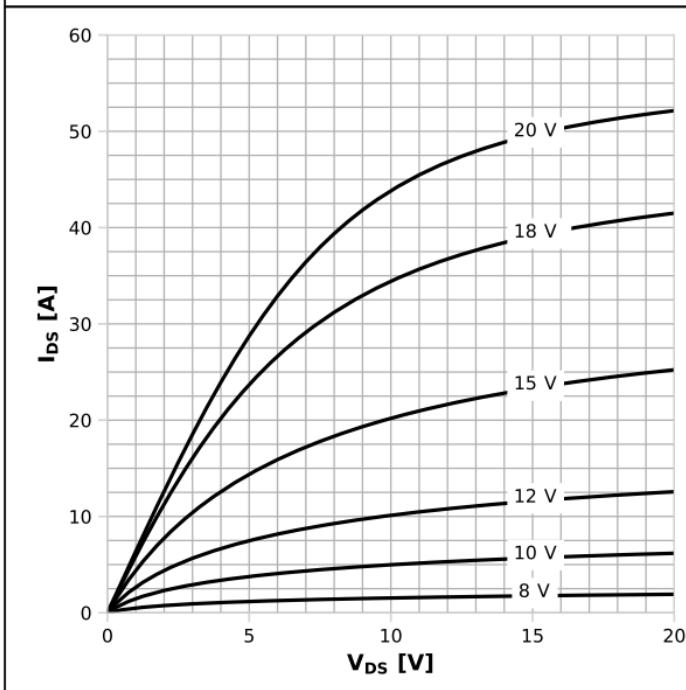
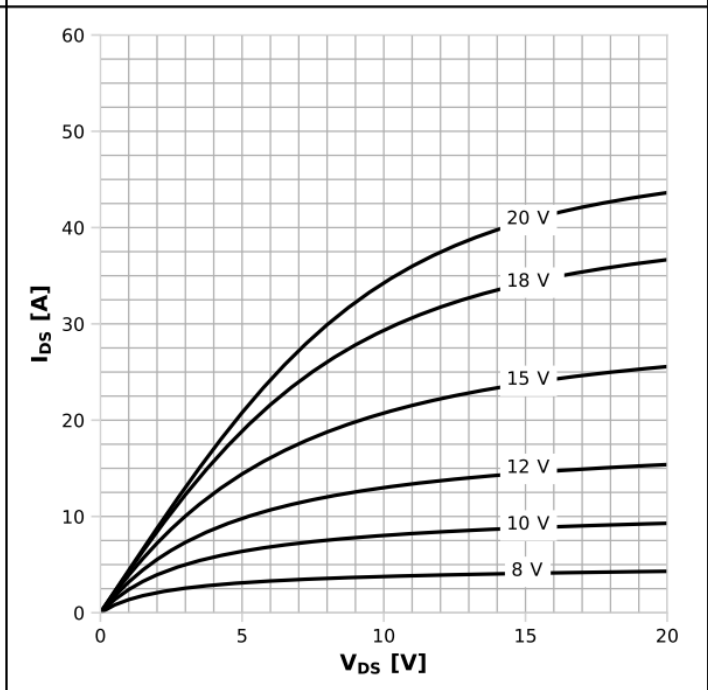


Diagram 5: Typ. output characteristics



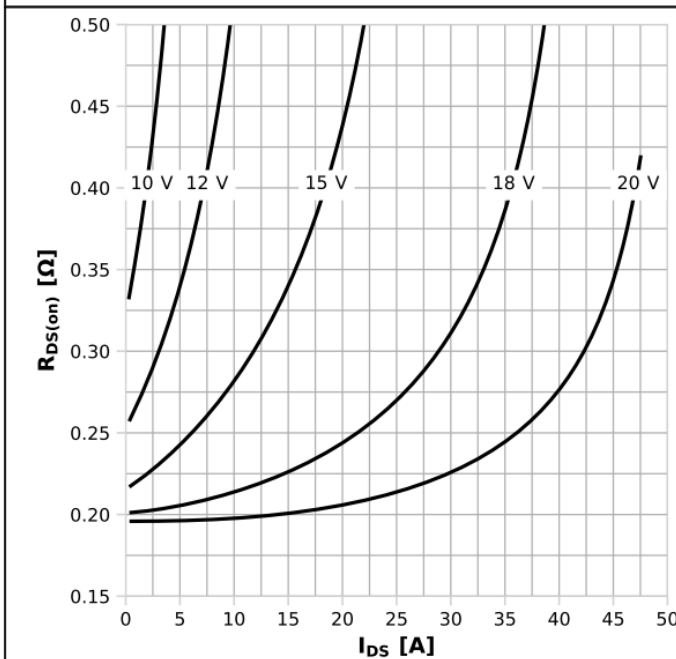
$I_{DS}=f(V_{DS}); T_j=25\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics



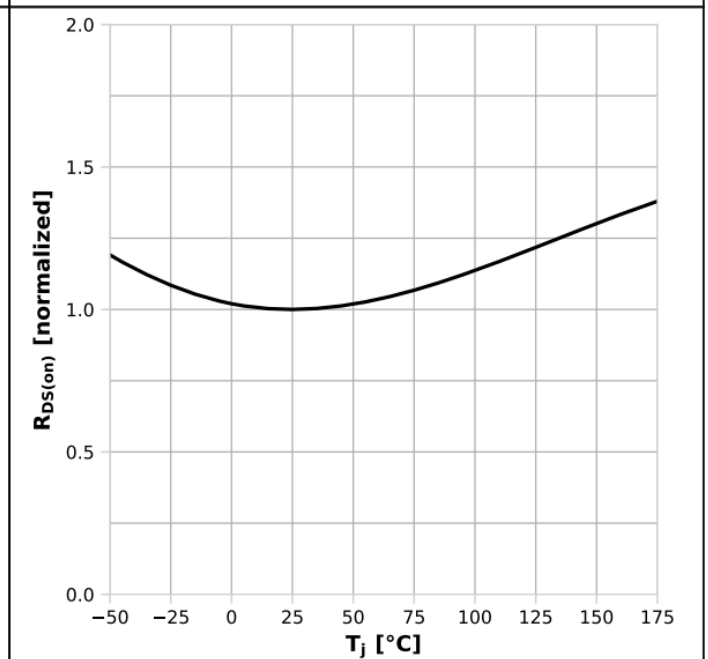
$I_{DS}=f(V_{DS}); T_j=175\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 7: Typ. drain-source on-state resistance



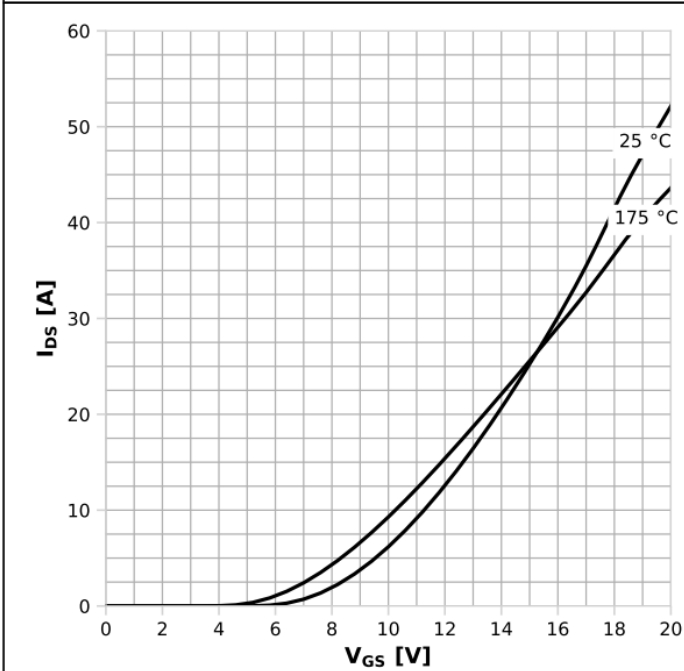
$R_{DS(on)}=f(I_{DS}); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance



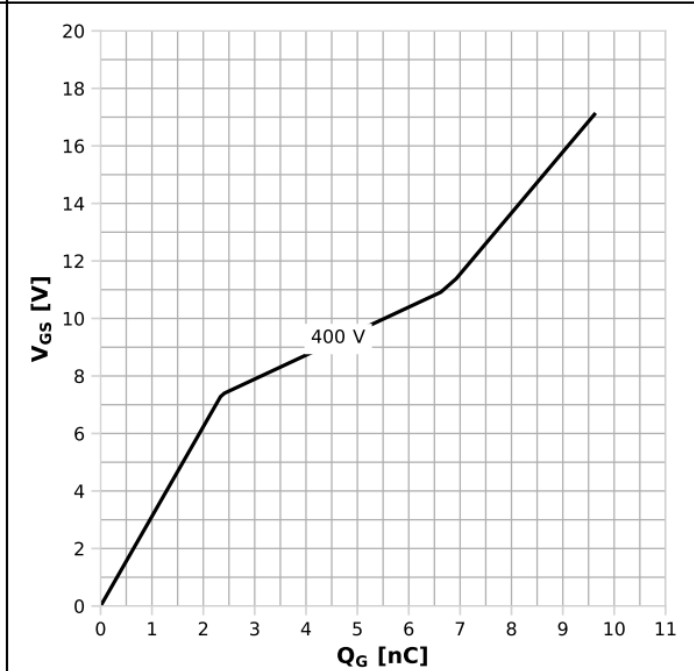
$R_{DS(on)}=f(T_j); I_D=5.7\text{ A}; V_{GS}=18\text{ V}$

Diagram 9: Typ. transfer characteristics



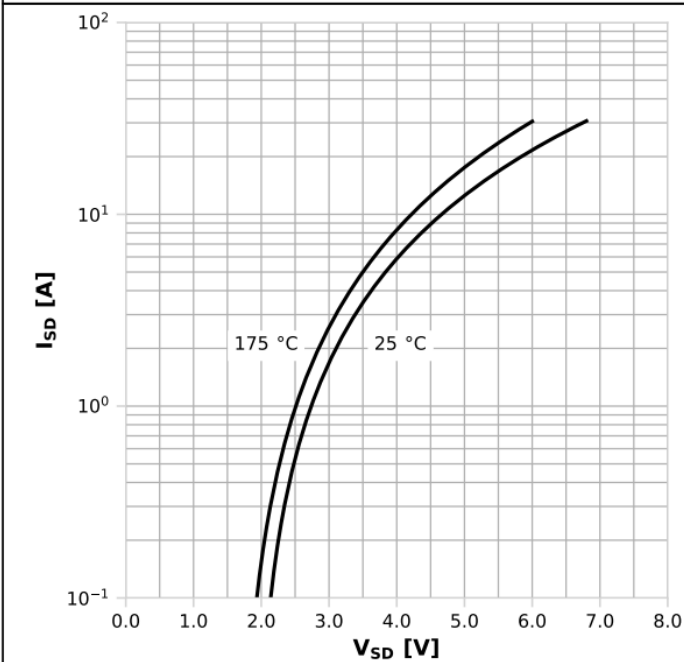
$I_{DS}=f(V_{GS}); V_{DS}=20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



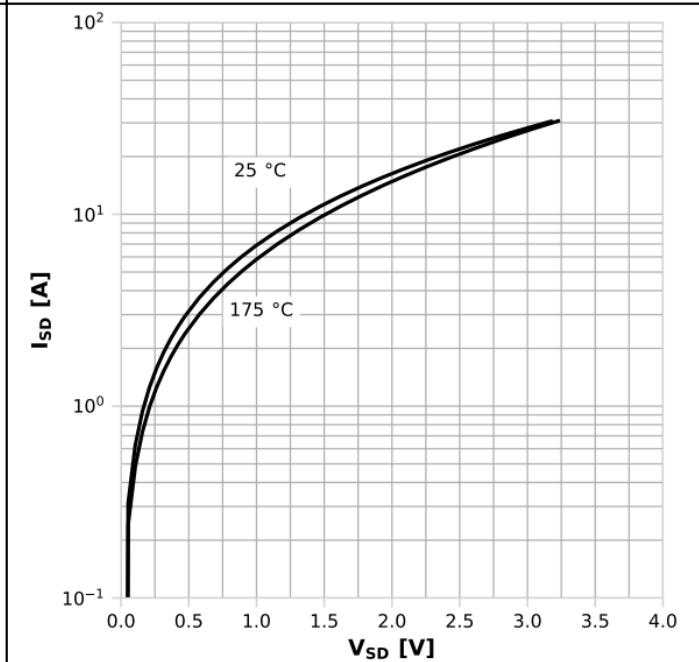
$V_{GS}=f(Q_G); I_D=5.7 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Typ. reverse drain current characteristics



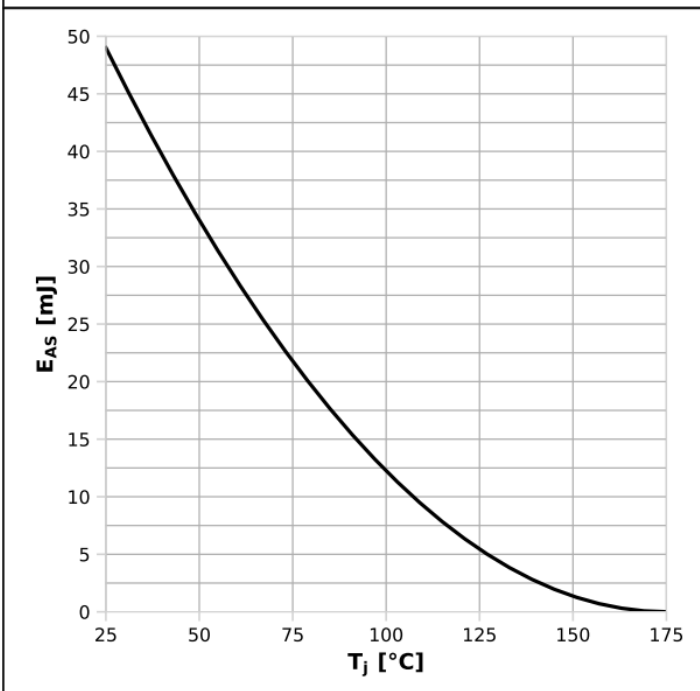
$I_{SD}=f(V_{SD}); V_{GS}=0 \text{ V}; \text{parameter: } T_j$

Diagram 12: Typ. reverse drain current characteristics



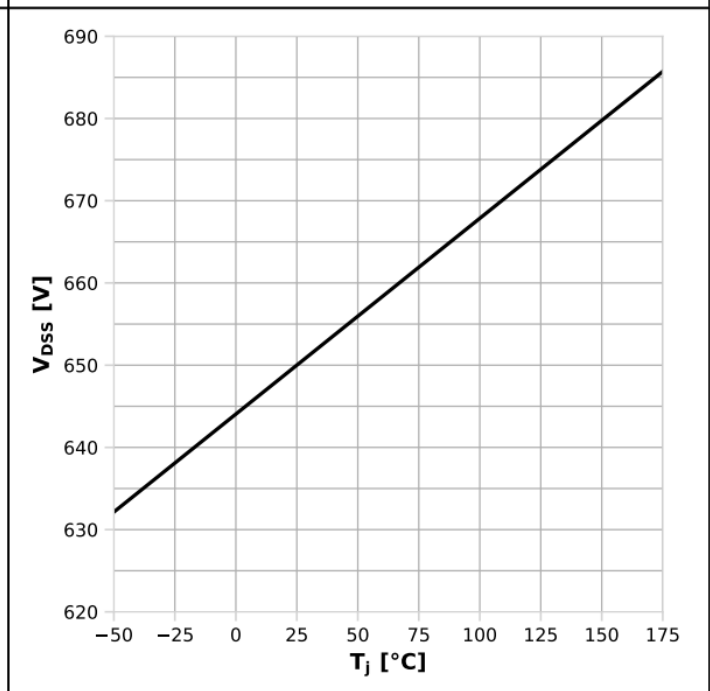
$I_{SD}=f(V_{SD}); V_{GS}=18 \text{ V}; \text{parameter: } T_j$

Diagram 13: Avalanche energy



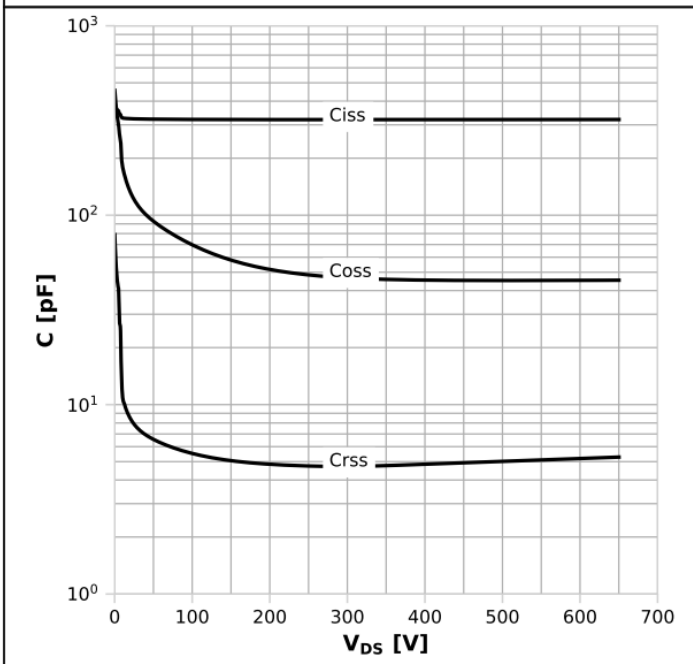
$E_{AS}=f(T_j); I_D=1.8\text{ A}; V_{DD}=50\text{ V}$

Diagram 14: Drain-source breakdown voltage



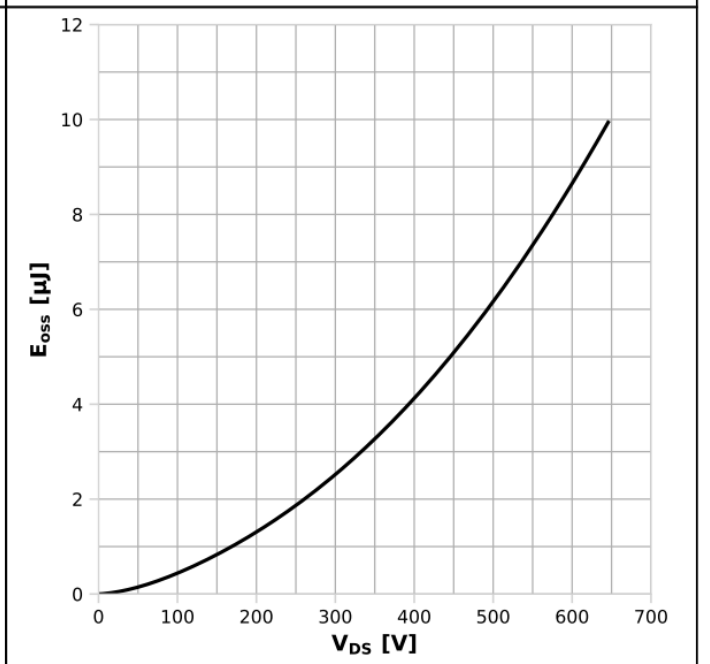
$V_{DSS}=f(T_j); I_D=0.17\text{ mA}$

Diagram 15: Typ. capacitances

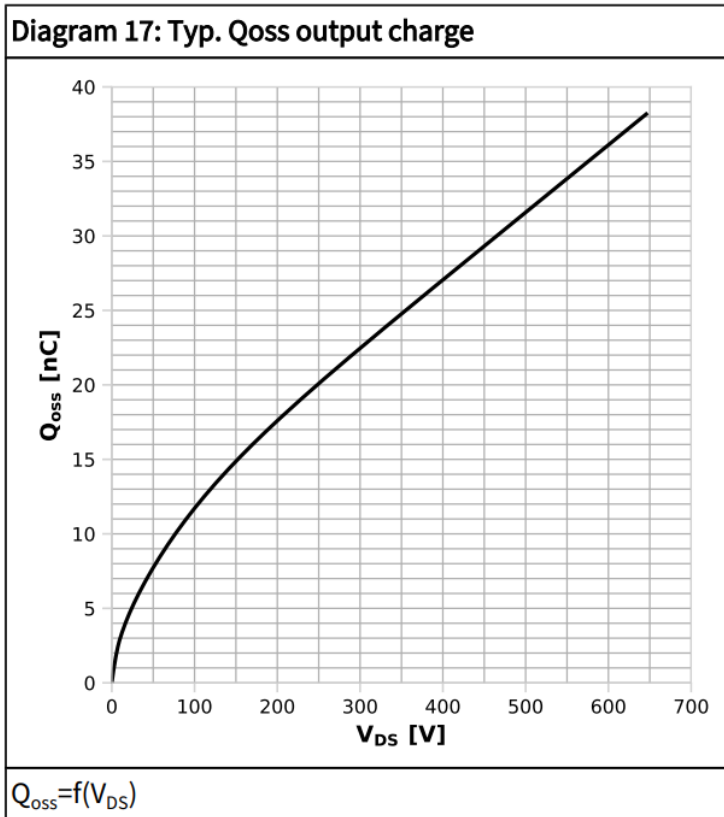


$C=f(V_{DS}); V_{GS}=0\text{ V}; f=250\text{ kHz}$

Diagram 16: Typ. Coss stored energy



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



6 测试电路

表 9 体二极管特性 (CoolSiC)

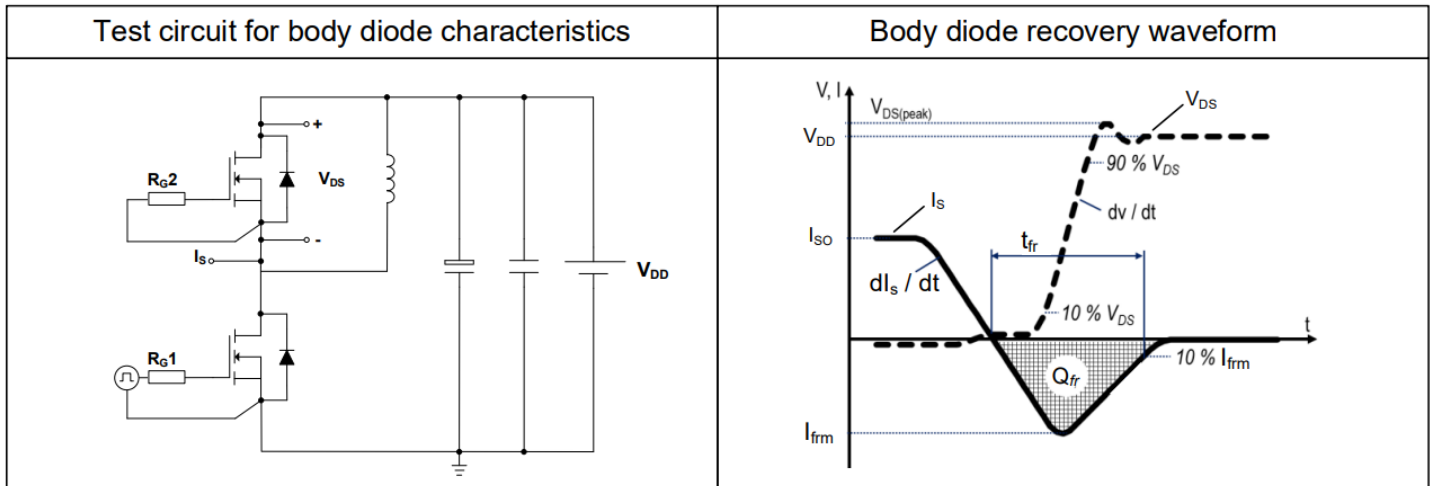


表 10 开关时间 (CoolSiC)

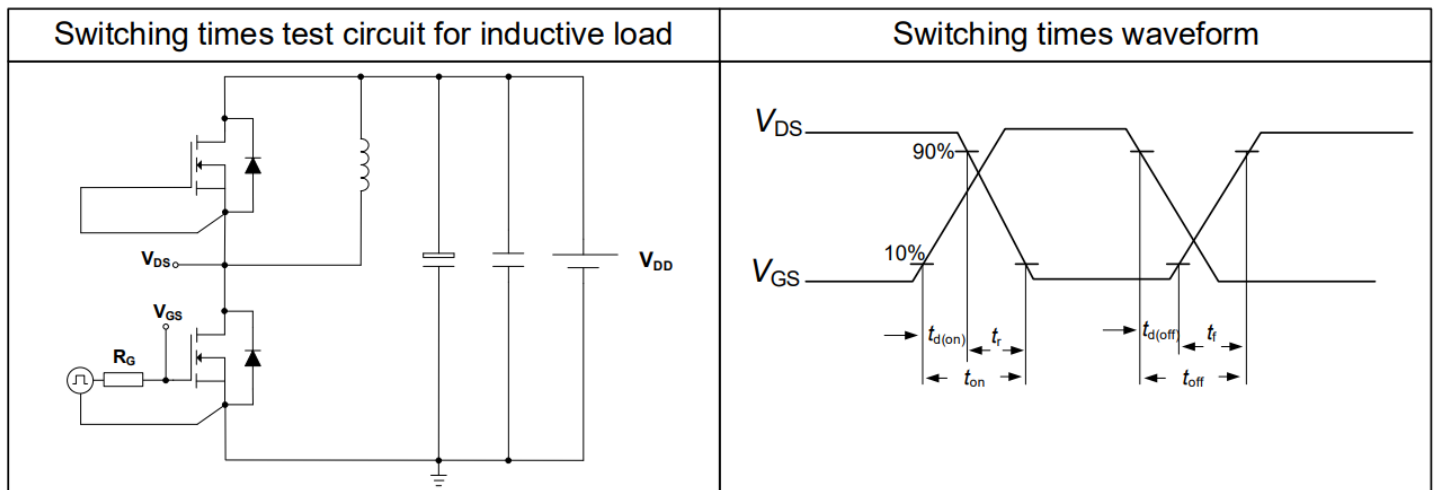
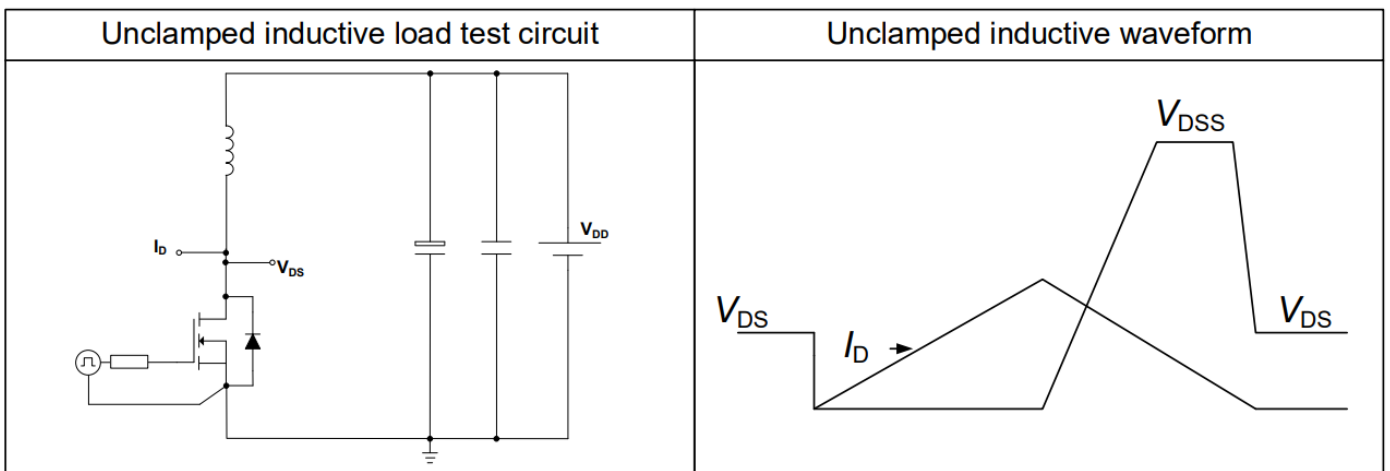
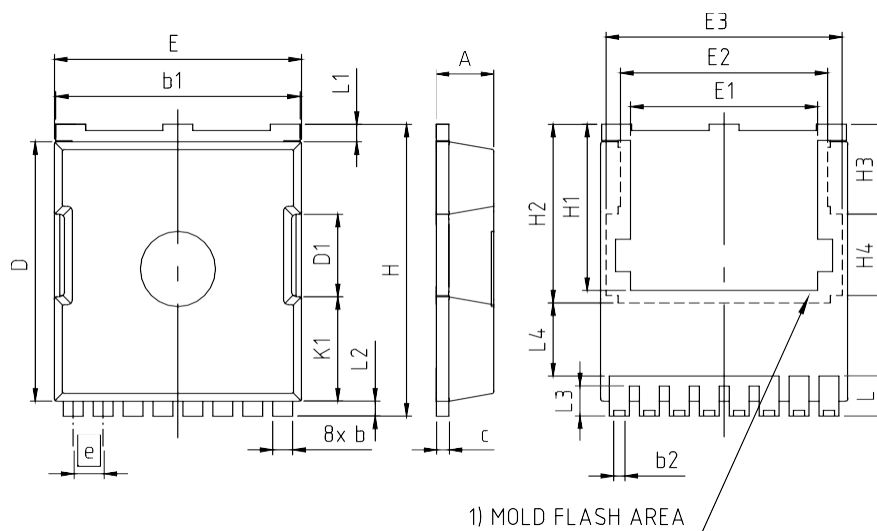


表 11 非钳位感性负载



7 封装外形



PACKAGE - GROUP		
PG-HSOF-8-U02		
NUMBER:		
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

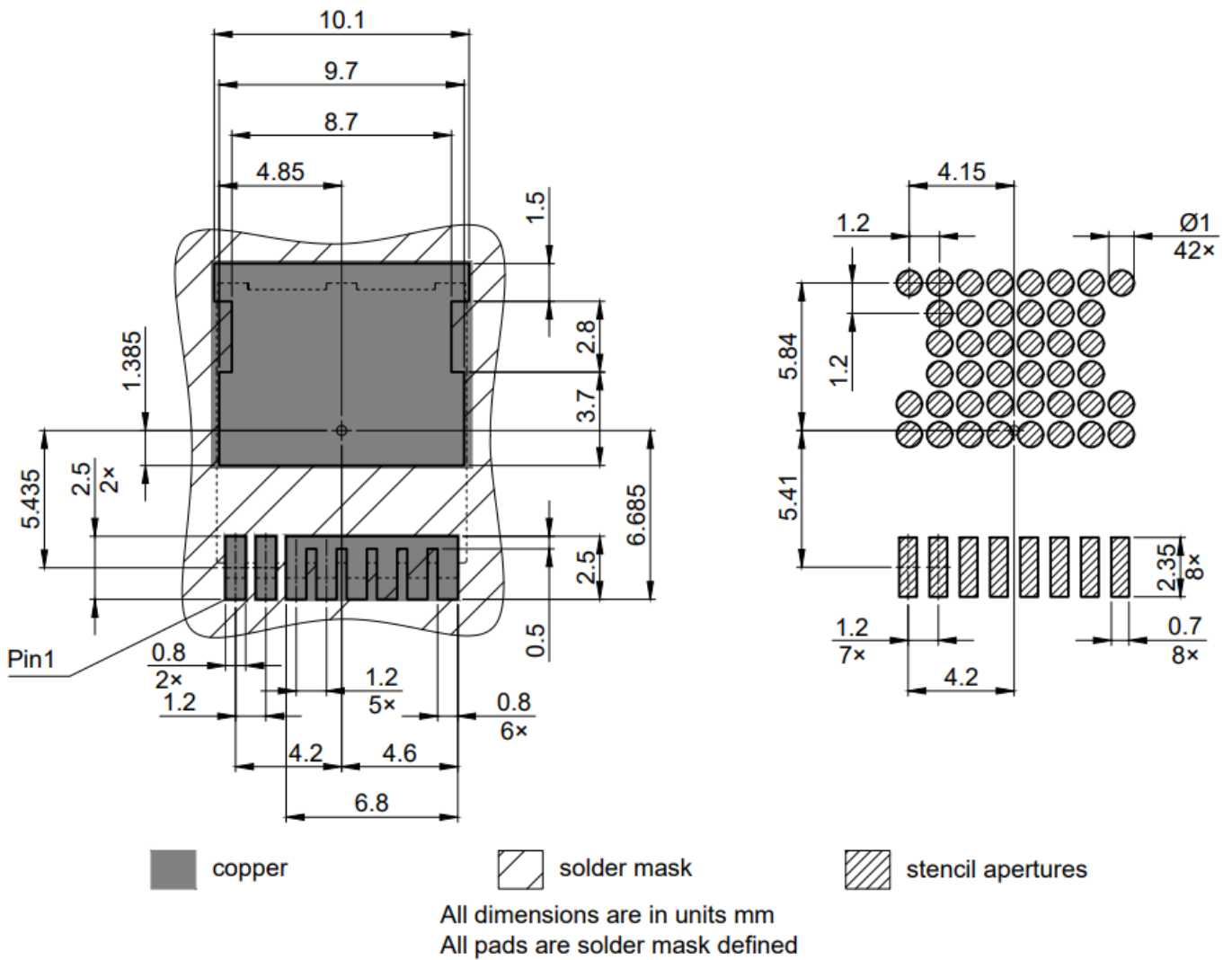
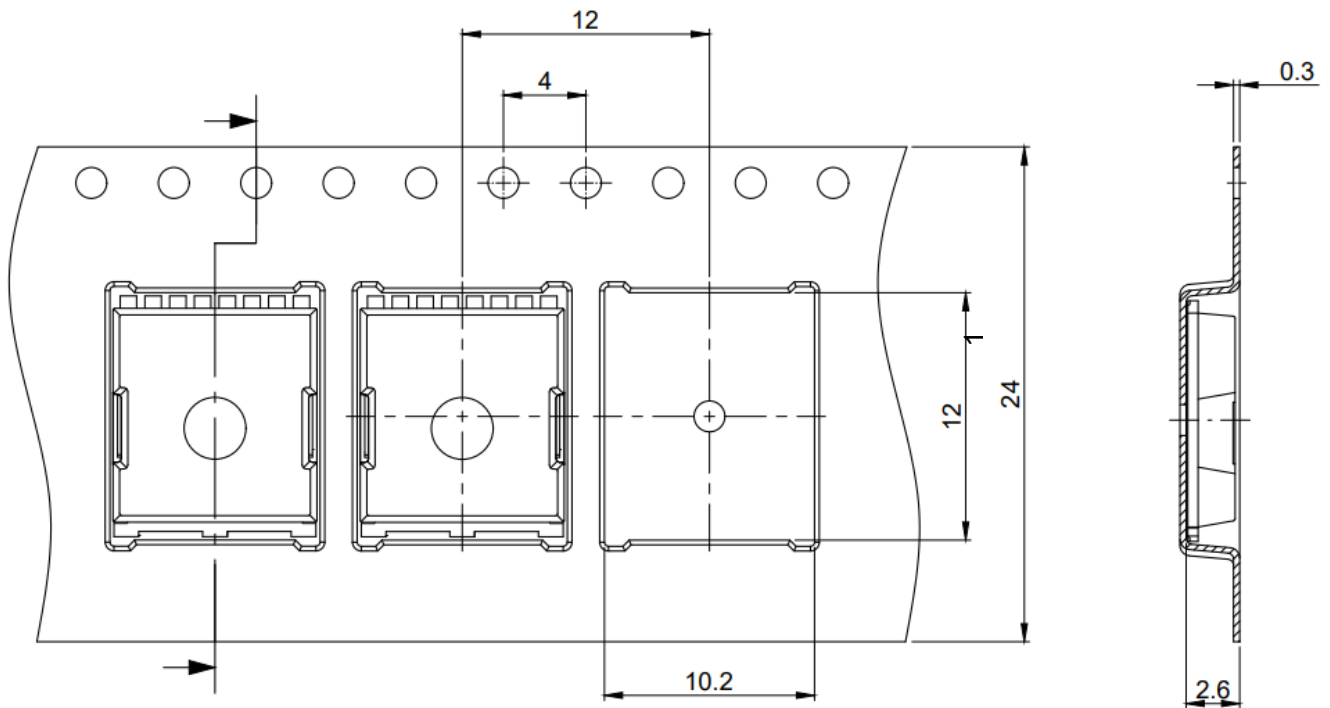


图 2 PG-HSOF-8 封装图，尺寸单位为毫米



All dimensions are in units mm


The drawing is in compliance with ISO 128-30, Projection Method 1 []

图 3 包装变体 PG-HSOF-8, 尺寸单位为毫米

8 附录 A

表 12 相关链接

- [英飞凌 CoolSiC CoolSiC™ MOSFET 650 V G1 网页](#)
- [英飞凌 CoolSiC CoolSiC™ MOSFET 650 V G1 应用笔记](#)
- [英飞凌 CoolSiC CoolSiC™ MOSFET 650 V G1 仿真模型](#)
- [英飞凌设计工具](#)

修订记录

IMT65R163M1H

Revision 2024 - 10 - 07 , Rev. 2 . 2

历史修订版本

Revision	Date	Subjects (major changes since last revision)
2.0	2023-03-08	Release of final version
2.1	2024-08-26	IDSS update, nomenclature update, datasheet layout and POD update
2.2	2024-10-07	Update with package footprint and outline drawing correction

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