

英飞凌MOSFET功率器件

英飞凌 600V CoolMOS™ SJ S7 功率器件

IPT60T022S7 为低频开关应用实现了最佳的性价比。CoolMOS™ S7 拥有 HV SJ MOSFET 中最低的 $R_{DS(on)}$ 值，且能效显著提高。嵌入式温度传感器提高了结温传感的准确性和稳健性，同时保持了简单、无缝的实施。CoolMOS™ S7 针对“静态开关”和大电流应用进行了优化。它非常适合固态继电器、断路器设计以及 SMPS 和逆变器拓扑中的线路整流。新的温度传感器增强了 S7 的功能，可以最大限度地利用功率晶体管。

特性

- CoolMOS™ S7 技术可在最小尺寸内实现最低的 $R_{DS(on)}$
- 低频开关应用的最佳性价比
- 高脉冲电流能力
- 最低系统的无缝诊断
- 温度感应功能可提供保护并优化热设备利用成本

优点

- 最小化传导损耗（消除/减少散热器）
- 提高了系统性能
- 更紧凑、更直接的设计
- 在更长的使用寿命内降低 BOM 或/和 TCO
- 减少外部传感元件

与机电设备相比：

- 切换时间更快
- 更高的可靠性和更长的系统寿命
- 抗冲击和抗振动
- 无接触电弧或弹跳

潜在应用

- 固态继电器和断路器
- 高功率/性能应用中的线路整流，例如计算、电信、UPS 和太阳能

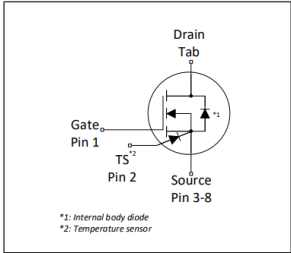
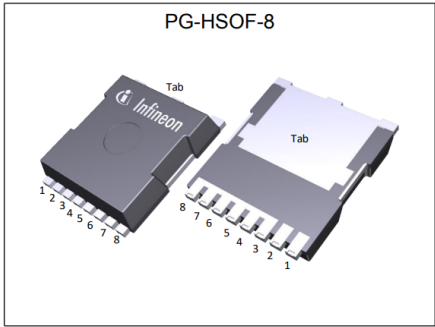
产品验证

完全符合 JEDEC 工业应用标准

表 1 主要性能参数

Parameter	Value	Unit
$R_{DS(on),max}$	65	mΩ
$Q_{g,typ}$	51	nC
V_{SD}	0.82	V
Pulsed I_{SD}, I_{DS}	123	A
ESD class (HBM)	2	JEDEC JS-001

Type / Ordering Code	Package	Marking	Related Links
IPT60T065S7	PG-HSOF-8	60I065S7	see Appendix A



RoHS

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）。

目录

描述1

最大额定值3

热特性4

电气特性5

温度传感器参数7

电气特性图8

测试电路13

封装外形14

附录 A15

修订记录16

商标16

免责声明16

1 最大额定值

除非另有规定， $T_j = 25^\circ\text{C}$

表 2 最大MOSFET额定值

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain current rating ¹⁾	I_D	-	-	8	A	$T_c=140^\circ\text{C}$ Current is limited by $T_{j\max} = 150^\circ\text{C}$; Lower case temp does increase current capability
Pulsed drain current ²⁾	$I_{D,\text{pulse}}$	-	-	123	A	$T_c=25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}	-	-	95	mJ	$I_D=2.3\text{A}$; $V_{DD}=50\text{V}$; see table 11
Avalanche current, single pulse	I_{AS}	-	-	2.3	A	-
MOSFET dv/dt ruggedness ³⁾	dv/dt	-	-	20	V/ns	$V_{DS}=0\text{V to }300\text{V}$
Gate source voltage (static)	V_{GS}	-20	-	20	V	static
Gate source voltage (dynamic)	V_{GS}	-30	-	30	V	AC ($f>1\text{ Hz}$)
Power dissipation	P_{tot}	-	-	167	W	$T_c=25^\circ\text{C}$
Storage temperature	T_{stg}	-55	-	150	$^\circ\text{C}$	-
Operating junction temperature ¹⁾	T_j	-55	-	150	$^\circ\text{C}$	-
Extended operating junction temperature	T_j	150	-	175	$^\circ\text{C}$	$\leq 50\text{ h}$ in the application lifetime
Mounting torque	-	-	-	n.a.	Ncm	-
Diode forward current rating	I_S	-	-	8	A	$T_c=25^\circ\text{C}$ Current is limited by $T_{j\max} = 150^\circ\text{C}$
Diode pulse current ¹⁾	$I_{S,\text{pulse}}$	-	-	123	A	$T_c=25^\circ\text{C}$
Reverse diode dv/dt ⁴⁾	dv/dt	-	-	5	V/ns	$V_{DS}=0\text{ to }300\text{V}$, $I_{SD}\leq 8\text{A}$, $T_j=25^\circ\text{C}$ see table 9
Maximum diode commutation speed	di/dt	-	-	800	A/ μs	$V_{DS}=0\text{ to }300\text{V}$, $I_{SD}\leq 8\text{A}$, $T_j=25^\circ\text{C}$ see table 9
Insulation withstand voltage	V_{ISO}	-	-	n.a.	V	-

¹⁾请参考应用说明：AN_2308_PL52_2309_111546，了解高 ΔT_j 的使用情况

²⁾脉冲宽度 t_p 受 $T_{j\max}$ 限制

³⁾dv/dt 必须通过适当的栅极电阻来限制

⁴⁾相同的低侧和高侧开关

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}	-	-	0.75	°C/W	-
Thermal resistance, junction - ambient	R_{thJA}	-	-	62	°C/W	device on PCB, minimal footprint
Thermal resistance, junction - ambient for SMD version	R_{thJA}	-	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 MSL1

3 电气特性

除非另有规定, $T_j = 25^\circ\text{C}$

表4 静态特性

对于施加阻断电压>420V的应用, 要求客户在早期设计阶段评估宇宙辐射效应的影响, 并联系英飞凌销售办事处以获得英飞凌必要的技术支持

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	600	-	-	V	$V_{GS}=0V, I_D=1mA$
Gate threshold voltage	$V_{(GS)th}$	3.5	4	4.5	V	$V_{DS}=V_{GS}, I_D=0.47mA$
Zero gate voltage drain current ¹⁾	I_{DSS}	-	-	1	μA	$V_{DS}=600V, V_{GS}=0V, T_j=25^\circ C$ $V_{DS}=600V, V_{GS}=0V, T_j=150^\circ C$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20V, V_{DS}=0V$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.059 0.137	0.065	Ω	$V_{GS}=12V, I_D=8.0A, T_j=25^\circ C$ $V_{GS}=12V, I_D=8.0A, T_j=150^\circ C$
Gate resistance	R_G	-	0.8	-	Ω	$f=1MHz, \text{open drain}$

表5 动态特性

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	1932	-	pF	$V_{GS}=0V, V_{DS}=300V, f=250kHz$
Output capacitance	C_{oss}	-	32	-	pF	$V_{GS}=0V, V_{DS}=300V, f=250kHz$
Effective output capacitance, energy related ²⁾	$C_{o(er)}$	-	104	-	pF	$V_{GS}=0V, V_{DS}=0 \text{ to } 300V$
Effective output capacitance, time related ³⁾	$C_{o(tr)}$	-	904	-	pF	$I_D=\text{constant}, V_{GS}=0V, V_{DS}=0 \text{ to } 300V$
Output charge	Q_{oss}	-	271	-	nC	$V_{GS}=0V, V_{DS}=0 \text{ to } 300V$
Turn-on delay time	$t_{d(on)}$	-	15	-	ns	$V_{DD}=300V, V_{GS}=13V, I_D=8.0A, R_G=10.0\Omega; \text{ see table 9}$
Rise time	t_r	-	9	-	ns	$V_{DD}=300V, V_{GS}=13V, I_D=8.0A, R_G=10.0\Omega; \text{ see table 9}$
Turn-off delay time	$t_{d(off)}$	-	100	-	ns	$V_{DD}=300V, V_{GS}=13V, I_D=8.0A, R_G=10.0\Omega; \text{ see table 9}$
Fall time	t_f	-	9	-	ns	$V_{DD}=300V, V_{GS}=13V, I_D=8.0A, R_G=10.0\Omega; \text{ see table 9}$

¹⁾ 打开

²⁾ $C_{o(er)}$ 是一个固定电容, 当 V_{DS} 从 0 V 上升到 300 V 时, 其存储的能量与 C_{oss} 相同

³⁾ $C_{o(tr)}$ 是一个固定电容, 当 V_{DS} 从 0 V 上升到 300 V 时, 其充电时间与 C_{oss} 相同

表6 栅极电荷特性

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	11	-	nC	$V_{DD}=300V, I_D=8.0A, V_{GS}=0 \text{ to } 12V$
Gate to drain charge	Q_{gd}	-	17	-	nC	$V_{DD}=300V, I_D=8.0A, V_{GS}=0 \text{ to } 12V$
Gate charge total	Q_g	-	51	-	nC	$V_{DD}=300V, I_D=8.0A, V_{GS}=0 \text{ to } 12V$
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	$V_{DD}=300V, I_D=8.0A, V_{GS}=0 \text{ to } 12V$

表7 反向二极管特性

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.82	-	V	$V_{GS}=0V, I_F=8.0A, T_J=25^\circ C$
Reverse recovery time	t_{rr}	-	310	-	ns	$V_R=400V, I_F=8.0A, di_F/dt=100A/\mu s$; see table 8
Reverse recovery charge	Q_{rr}	-	3.90	-	μC	$V_R=400V, I_F=8.0A, di_F/dt=100A/\mu s$; see table 8
Peak reverse recovery current	I_{rrm}	-	27.0	-	A	$V_R=400V, I_F=8.0A, di_F/dt=100A/\mu s$; see table 8

4 温度传感器参数

除非另有规定, $T_j = 25^\circ\text{C}$

表 8 最大额定值

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Repetitive Peak Reverse Voltage	V_{RRM}	-	-	15	V	$I_R = 100\ \mu\text{A}$
Sensor forward current	I_F	-	-	5	mA	-
Repetitive peak forward current	I_{F_pulse}	-	-	25	mA	$t_{pulse} = 1\ \text{ms}, T_{period} = 10\ \text{ms}$
Non-repetitive peak forward current	I_{FSM}	-	-	1.5 0.2 0.1	A	$T_C = 25^\circ\text{C}, t_{pulse} = 1\ \mu\text{s}$ $T_C = 25^\circ\text{C}, t_{pulse} = 1\ \text{ms}$ $T_C = 25^\circ\text{C}, t_{pulse} = 1\ \text{s}$
Junction Temperature	T_j	-	-	185	$^\circ\text{C}$	$t < 50\text{h}$, Sensor only

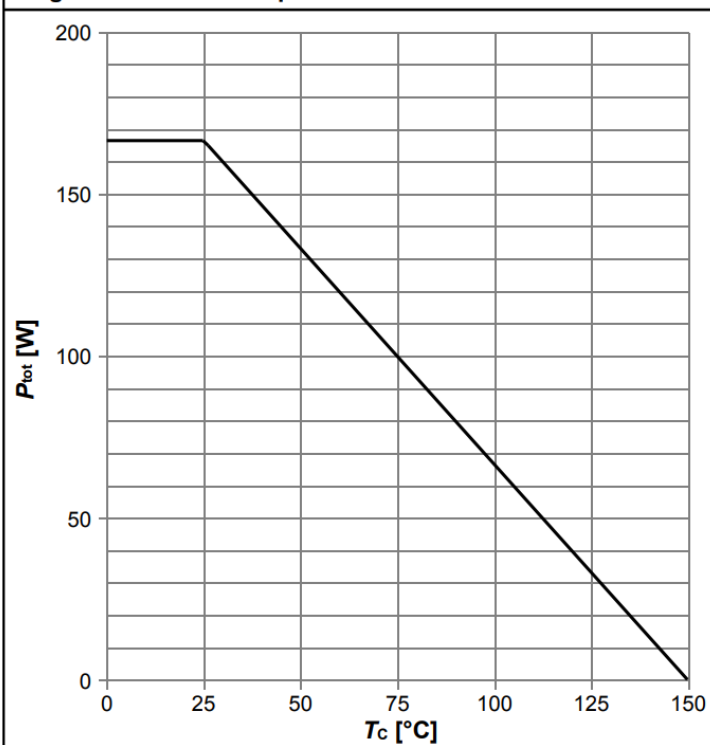
表 9 电气特性

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Sensor forward voltage ¹⁾	V_{F_25}	1.5601 - -2.0665	1.6019 1.8103 1.9806 2.0966	1.6436 - -2.1266	V	$T_j = 25^\circ\text{C}, I_F = 10\ \mu\text{A}$ $T_j = 25^\circ\text{C}, I_F = 50\ \mu\text{A}$ $T_j = 25^\circ\text{C}, I_F = 200\ \mu\text{A}$ $T_j = 25^\circ\text{C}, I_F = 500\ \mu\text{A}$
Sensor forward voltage temperature coefficient	TC	- - - -	5.9644 5.5880 5.2287 5.0135	- - - -	mV/K	$25^\circ\text{C} \leq T_j \leq 175^\circ\text{C}, I_F = 10\ \mu\text{A}$ $25^\circ\text{C} \leq T_j \leq 175^\circ\text{C}, I_F = 50\ \mu\text{A}$ $25^\circ\text{C} \leq T_j \leq 175^\circ\text{C}, I_F = 200\ \mu\text{A}$ $25^\circ\text{C} \leq T_j \leq 175^\circ\text{C}, I_F = 500\ \mu\text{A}$
Sensor forward voltage	V_{F_175}	0.6655 - -1.3144	0.7072 0.9721 1.1963 1.3445	0.7490 - -1.3746	V	$T_j = 175^\circ\text{C}, I_F = 10\ \mu\text{A}$ $T_j = 175^\circ\text{C}, I_F = 50\ \mu\text{A}$ $T_j = 175^\circ\text{C}, I_F = 200\ \mu\text{A}$ $T_j = 175^\circ\text{C}, I_F = 500\ \mu\text{A}$
Reverse leakage current	I_R	- -	- -	1 20	μA	$V_R = 10\text{V}, T_j = 25^\circ\text{C}$ $V_R = 10\text{V}, T_j = 175^\circ\text{C}$
Sensor G Capacitance	C_{GTS}	-	4.2	-	pF	$f = 1\ \text{MHz}, I_F = 50\ \mu\text{A}$
Sensor Capacitance	C_{STS}	-	4.8	-	pF	$f = 1\ \text{MHz}, I_F = 50\ \mu\text{A}$
Anode-Drain Capacitance	C_{DTS}	-	0.5	-	pF	$f = 1\ \text{MHz}, V_{DS} = 0\ \text{V}$

¹⁾由设计定义, 未经测试

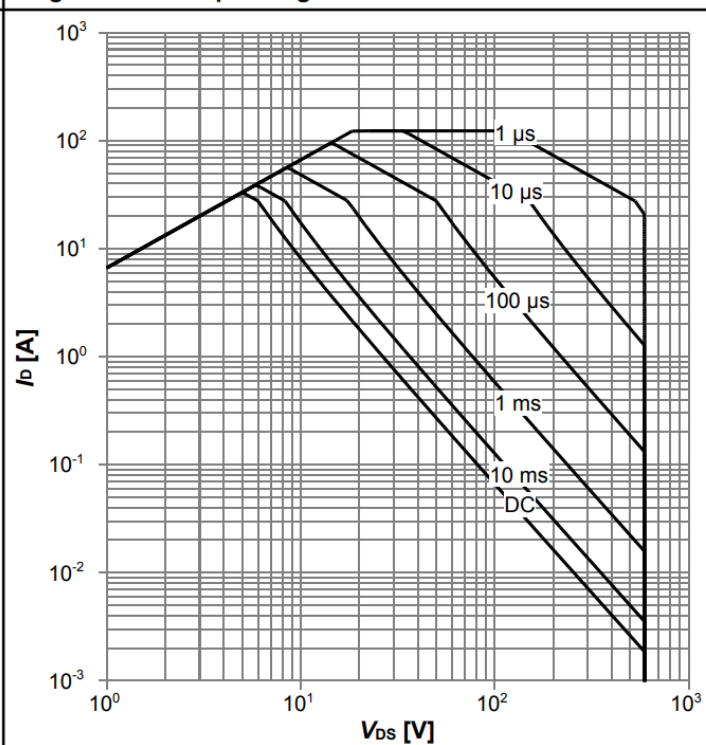
5 电气特性图

Diagram 1: Power dissipation



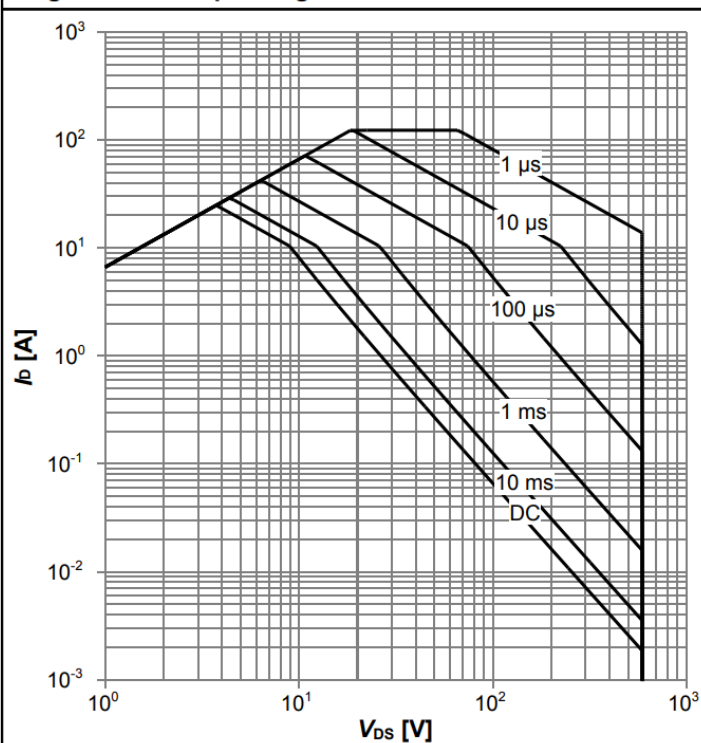
$$P_{\text{tot}} = f(T_c)$$

Diagram 2: Safe operating area



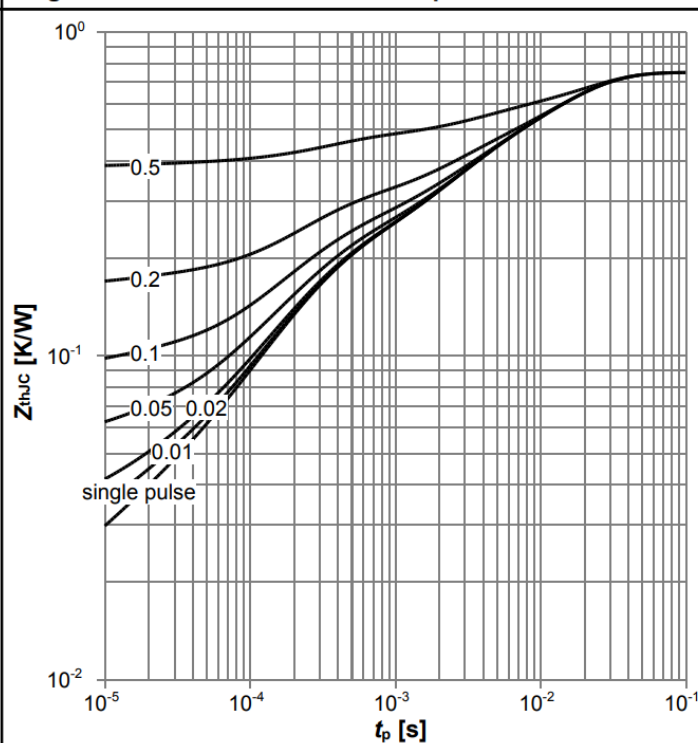
$$I_D = f(V_{DS}); T_c = 25^\circ\text{C}; D = 0; \text{parameter: } t_p$$

Diagram 3: Safe operating area



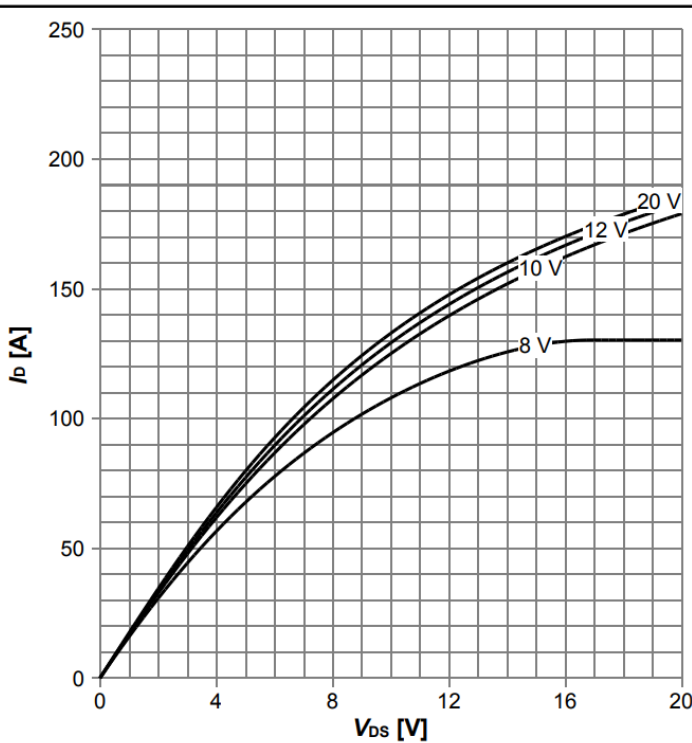
$$I_D = f(V_{DS}); T_c = 80^\circ\text{C}; D = 0; \text{parameter: } t_p$$

Diagram 4: Max. transient thermal impedance



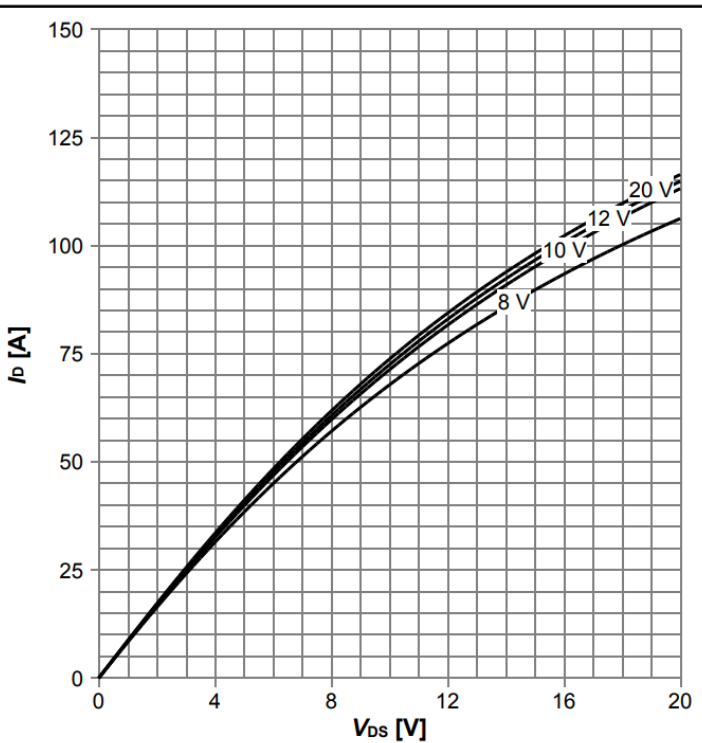
$$Z_{thJC} = f(t_p); \text{parameter: } D = t_p / T$$

Diagram 5: Typ. output characteristics



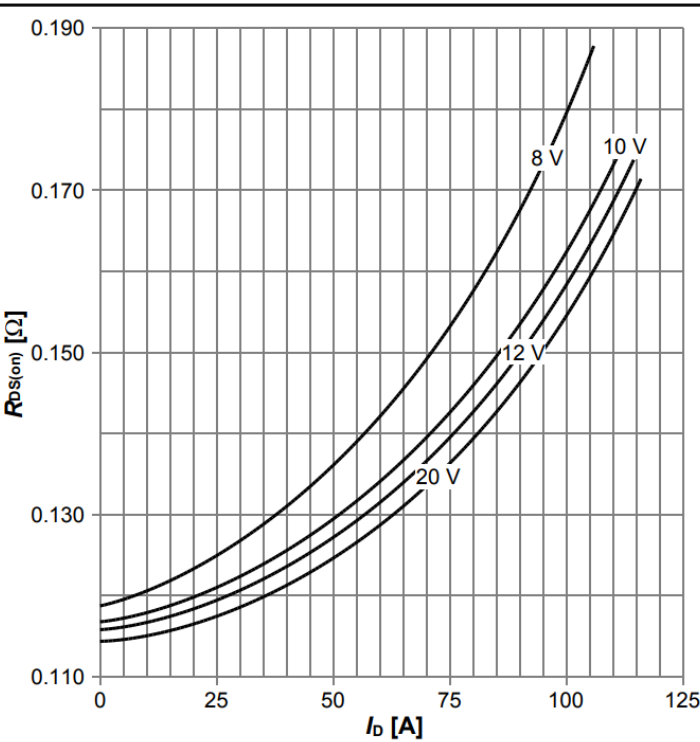
$I_D = f(V_{DS})$; $T_j = 25\text{ °C}$; parameter: V_{GS}

Diagram 6: Typ. output characteristics



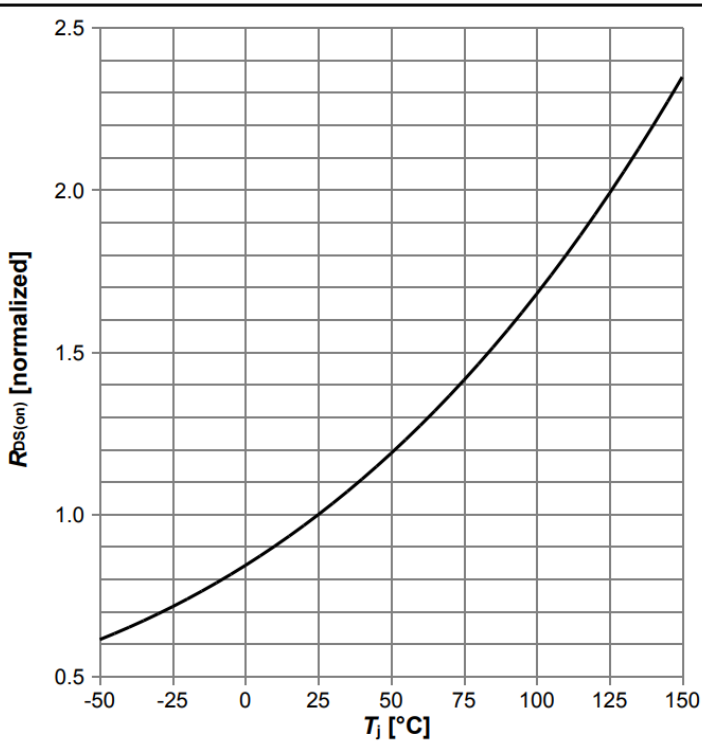
$I_D = f(V_{DS})$; $T_j = 125\text{ °C}$; parameter: V_{GS}

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



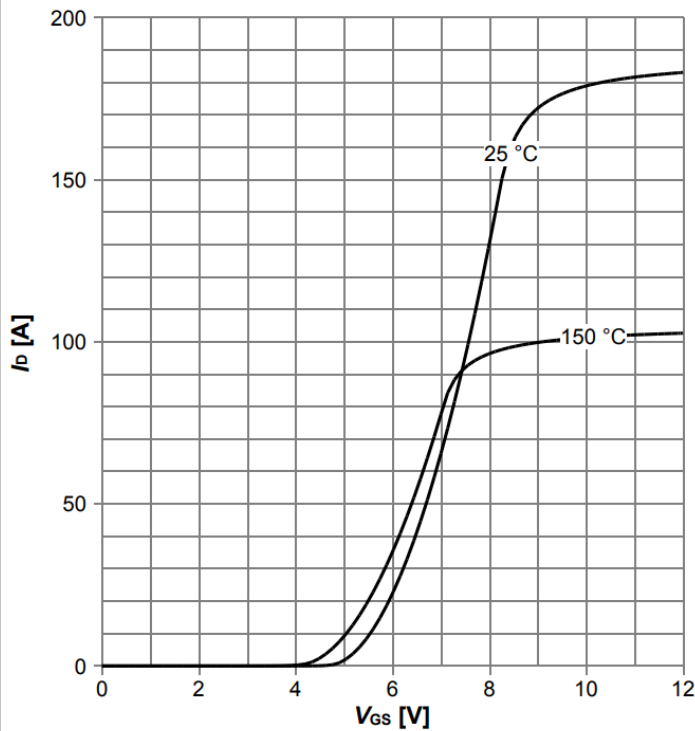
$R_{DS(on)} = f(I_D)$; $T_j = 125\text{ °C}$; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



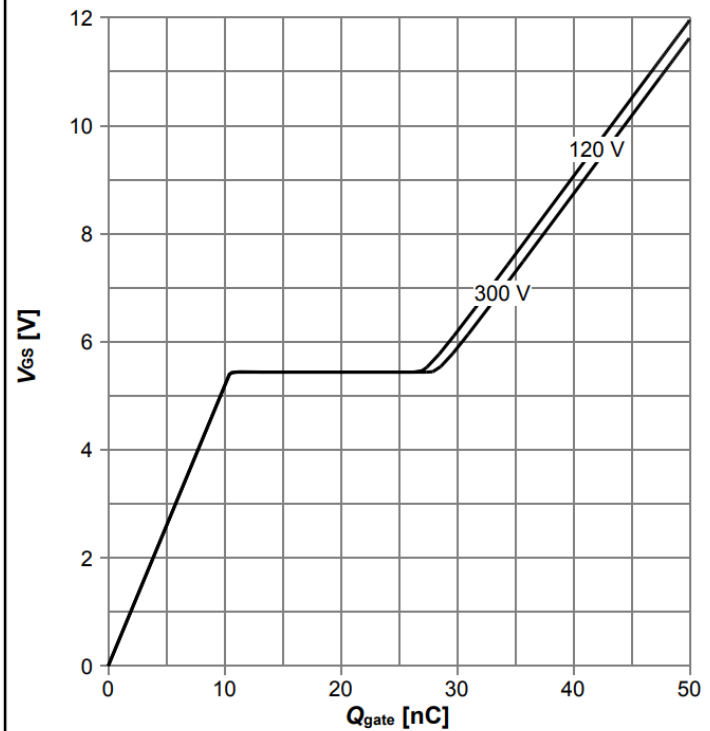
$R_{DS(on)} = f(T_j)$; $I_D = 8.0\text{ A}$; $V_{GS} = 12\text{ V}$

Diagram 9: Typ. transfer characteristics



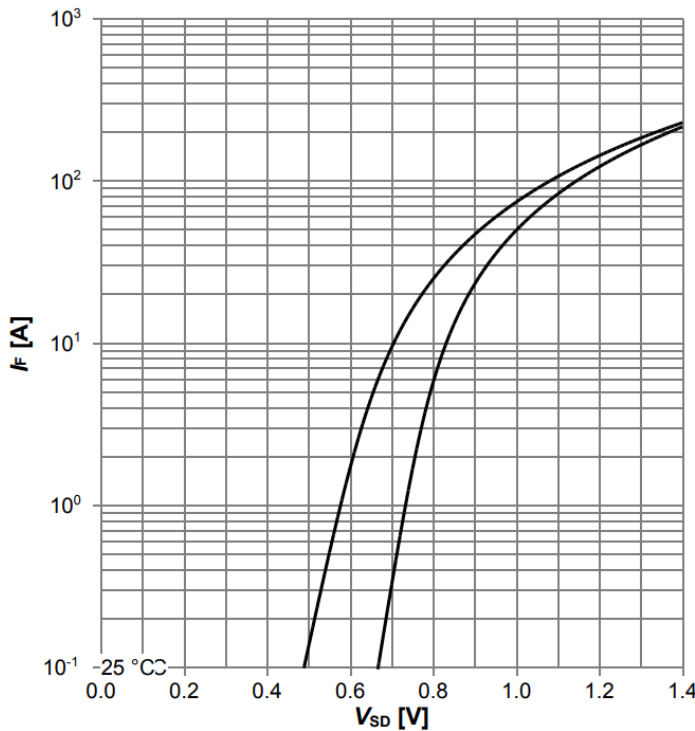
$I_D = f(V_{GS})$; $V_{DS} = 20V$; parameter: T_j

Diagram 10: Typ. gate charge



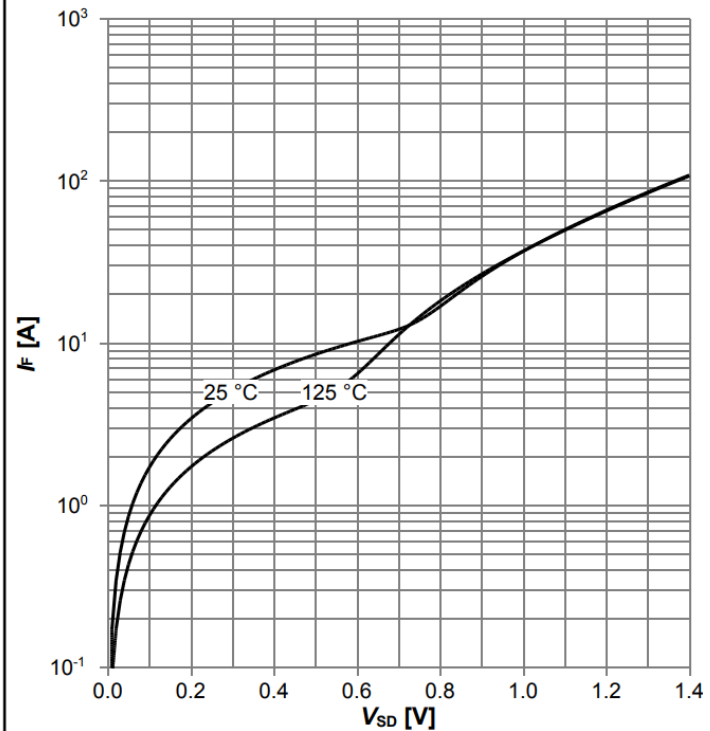
$V_{GS} = f(Q_{gate})$; $I_D = 8.0 A$ pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



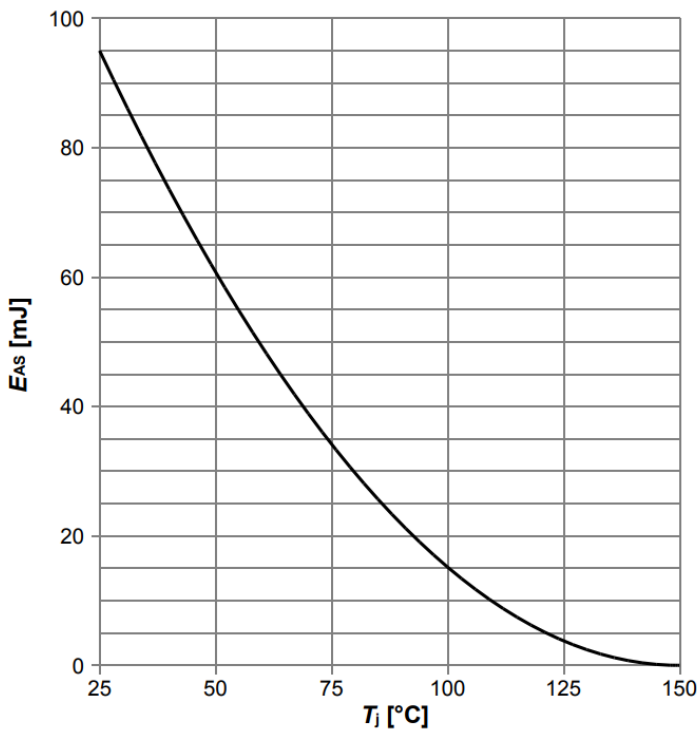
$I_F = f(V_{SD})$; $V_{GS} = 0 V$; parameter: T_j

Diagram 12: Forward characteristics of reverse diode



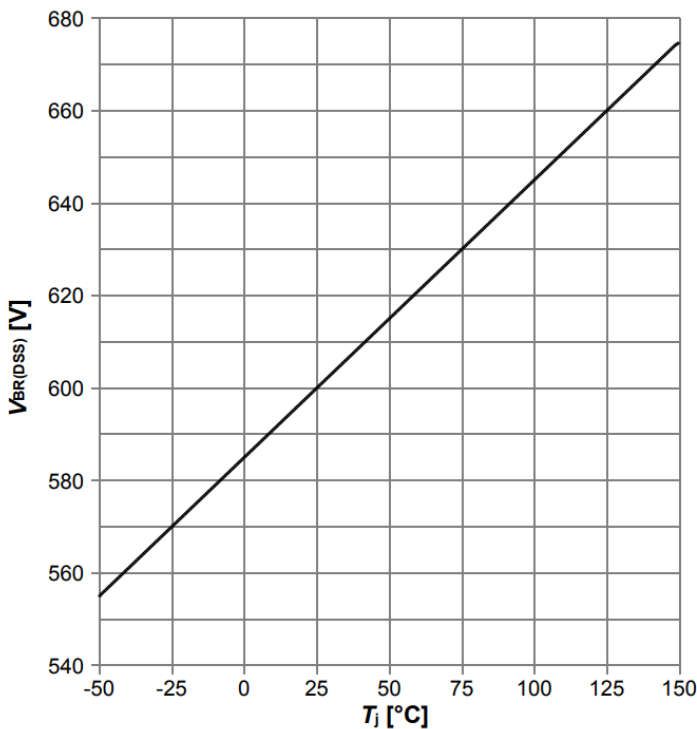
$I_F = f(V_{SD})$; $V_{GS} = 12 V$; parameter: T_j

Diagram 13: Avalanche energy



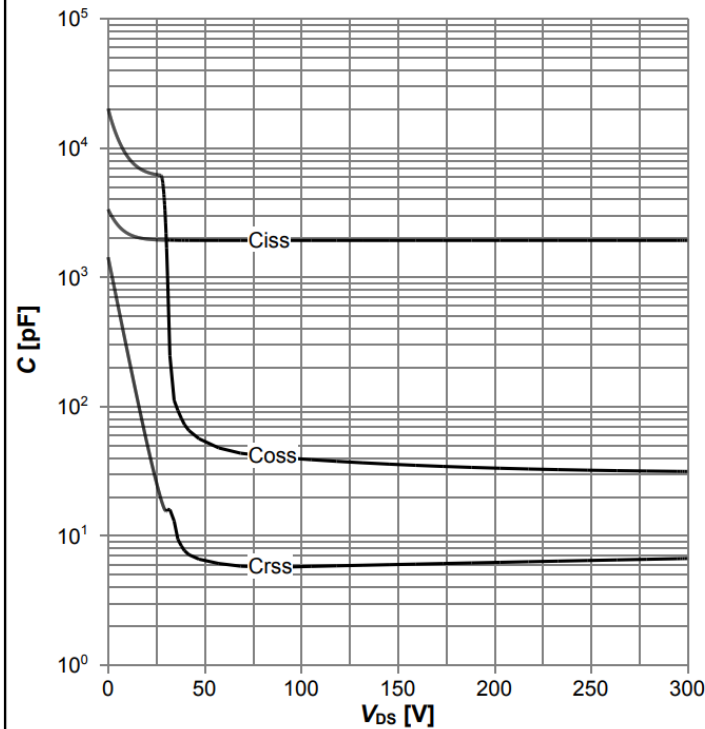
$$E_{AS}=f(T_j); I_D=2.3 \text{ A}; V_{DD}=50 \text{ V}$$

Diagram 14: Drain-source breakdown voltage



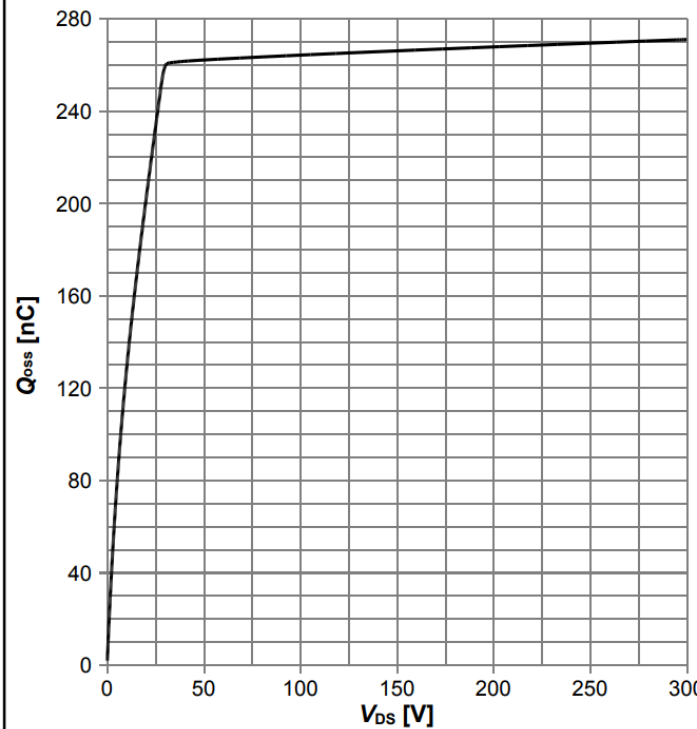
$$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$$

Diagram 15: Typ. capacitances

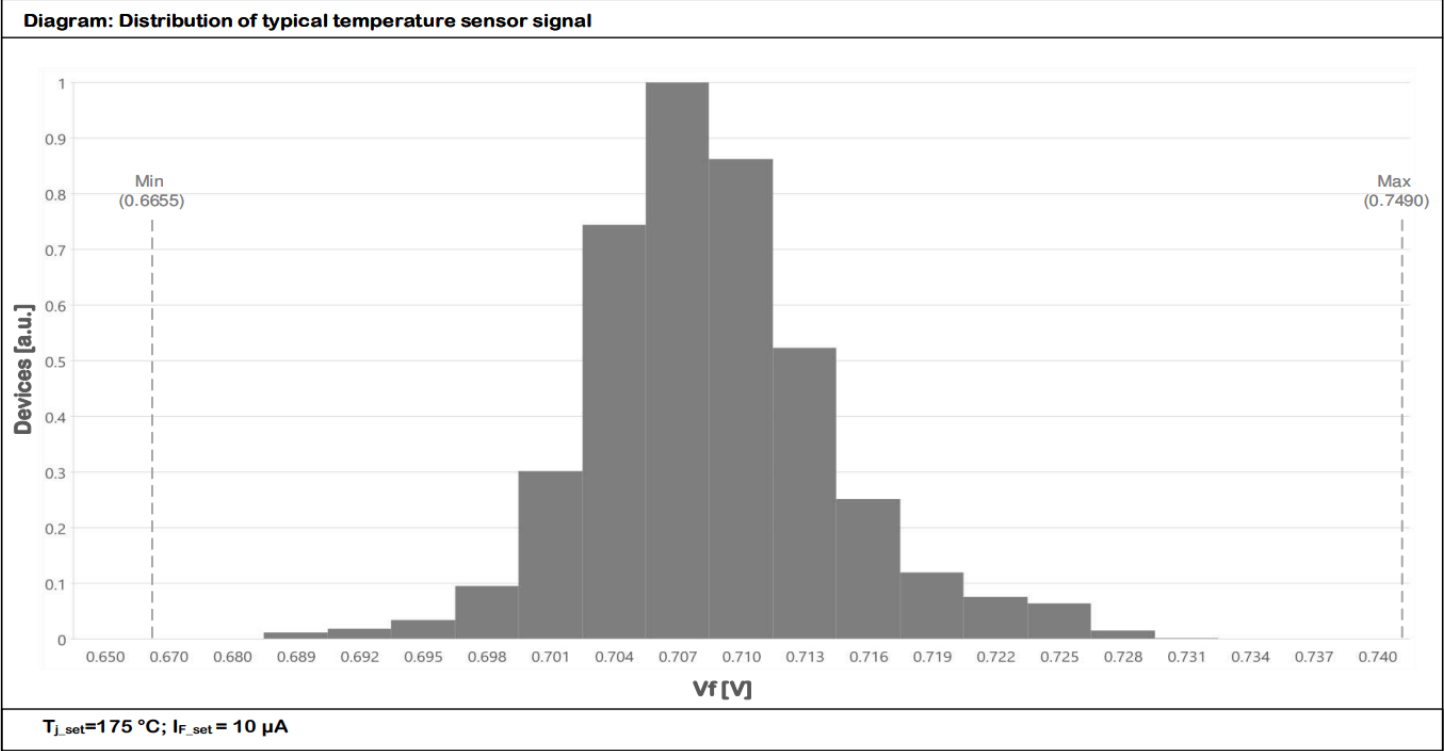


$$C=f(V_{DS}); V_{GS}=0 \text{ V}; f=250 \text{ kHz}$$

Diagram 17: Typ. Qoss output charge



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



6 测试电路

表10 反向二极管特性

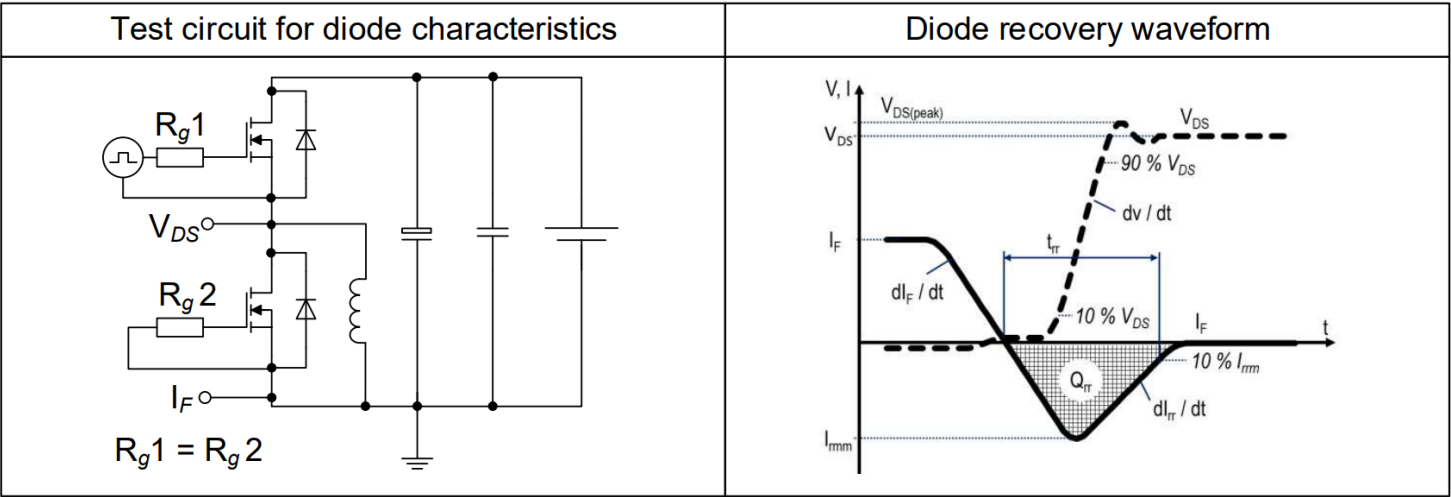


表 11 开关时间 (ss)

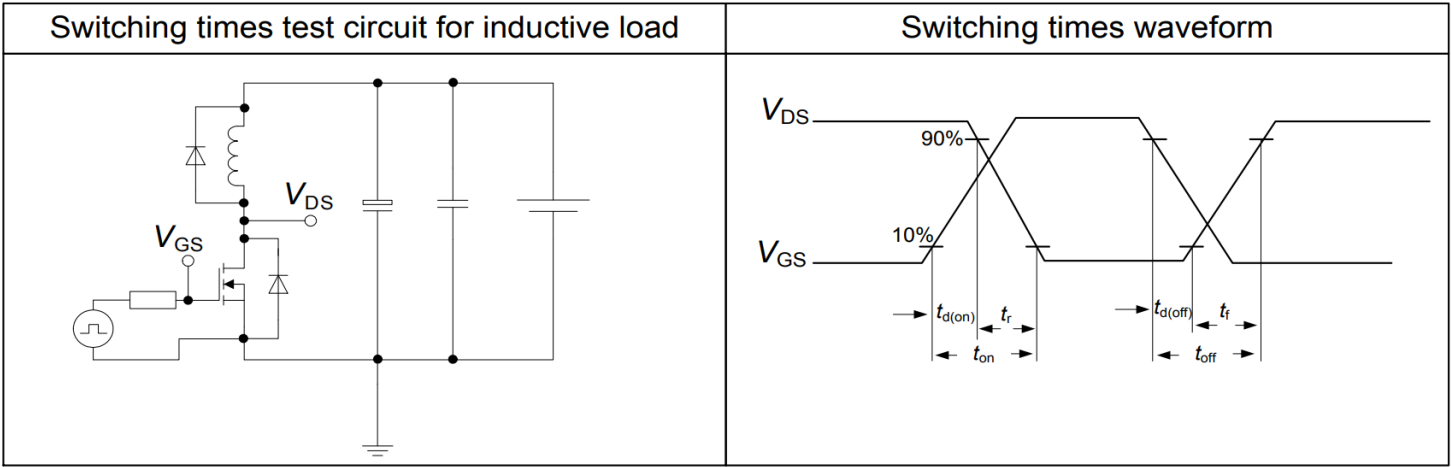
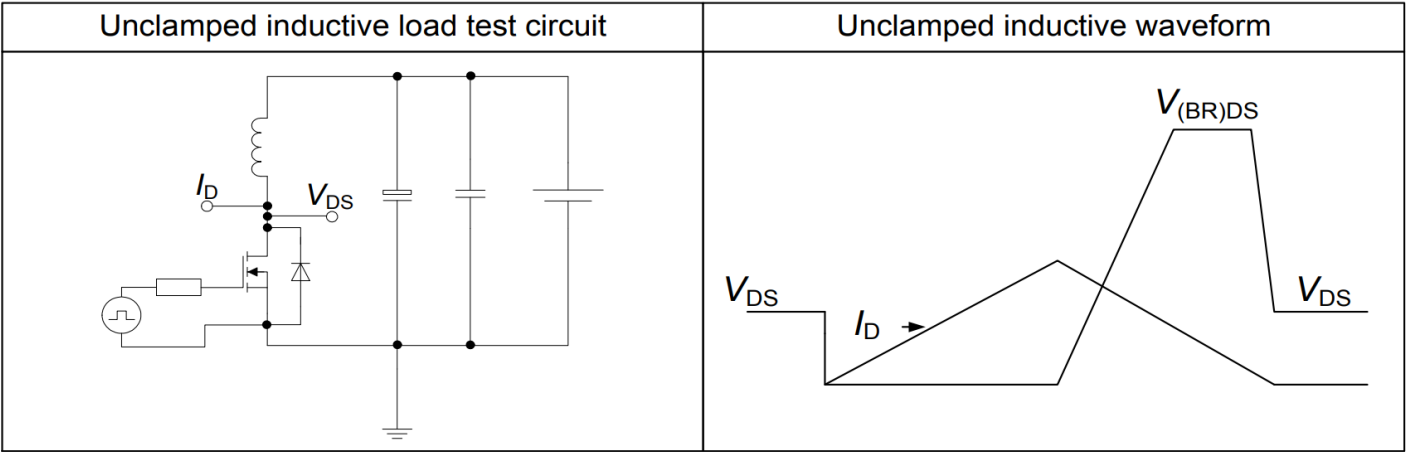
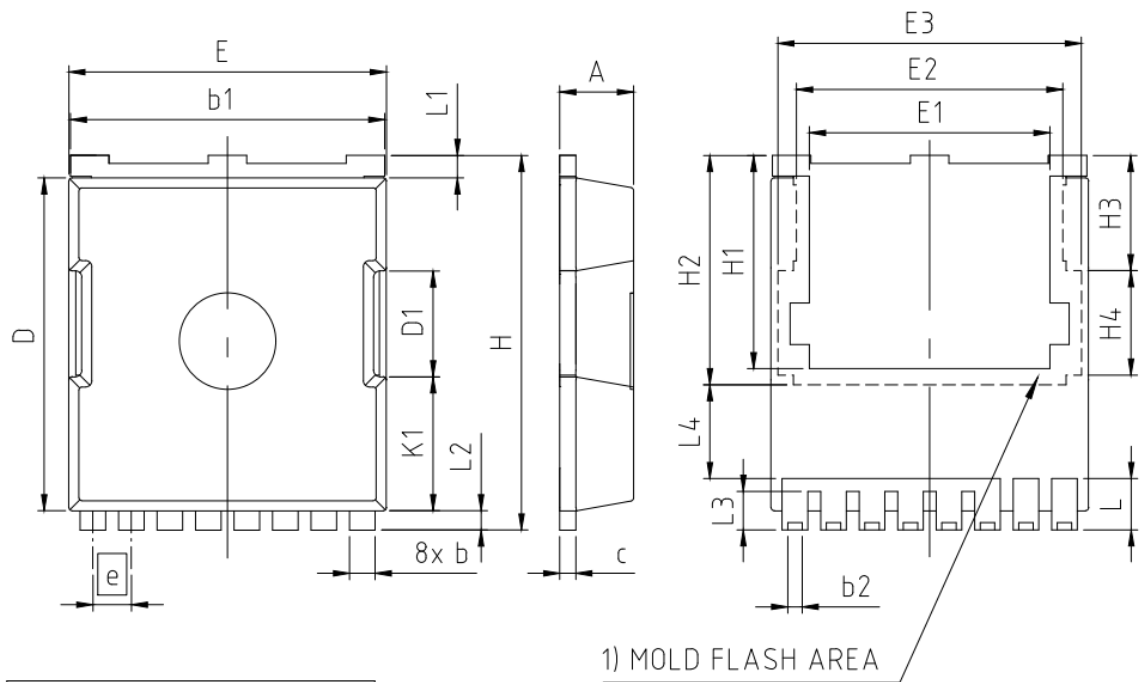


表 12 非钳位感性负载(ss)



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

8 附录 A

表 13 相关链接

- IFX CoolMOS S7T 网页: www.infineon.com
- IFX CoolMOS S7T 应用说明: www.infineon.com
- IFX CoolMOS S7T 仿真模型: www.infineon.com
- IFX 设计工具: www.infineon.com

修订记录

IPT60T065S7

Revision: 2023-09-25, Rev. 2.1

历史修订版本

Revision	Date	Subjects (major changes since last revision)
2.0	2023-09-18	Release of final version
2.1	2023-09-25	Drain current – change of test condition

Trademarks

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