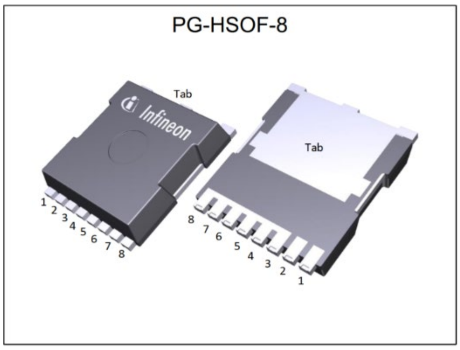
英飞凌MOSFET

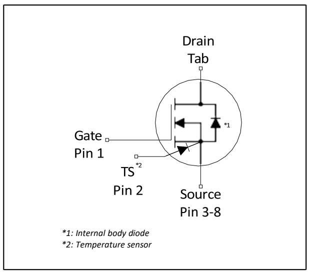
英飞凌600V CoolMOS™ SJ S7 功率器件

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 Rdson 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
$R_{DS(on),max}$	22	mΩ
$Q_{g,typ}$	150	nC
V_{SD}	0.82	V
Pulsed I_{SD}, I_{DS}	371	A
ESD class (HBM)	2	JEDEC JS-001

Type / Ordering Code	Package	Marking	Related Links
IPT60T022S7	PG-HSOF-8	60I022S7	see Appendix A

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

1 最大额定值

除非另有规定，T_j = 25 °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	-	-	23	A	T_C=140°C Current is limited by $T_{j\ max}$ = 150°C; Lower case temp does increase current capability
Pulsed drain current[2)]	$I_{D,pulse}$	-	-	371	A	T_C=25°C
Avalanche energy, single pulse	E_{AS}	-	-	286	mJ	I_D=3.7A; V_{DD}=50V; see table 11
Avalanche current, single pulse	I_{AS}	-	-	3.7	A	-
MOSFET dv/dt ruggedness[3)]	dv/dt	-	-	20	V/ns	V_{DS}= 0V to 300V
Gate source voltage (static)	V_{GS}	-20	-	20	V	static
Gate source voltage (dynamic)	V_{GS}	-30	-	30	V	AC (f>1 Hz)
Power dissipation	P_{tot}	-	-	390	W	T_C=25°C
Storage temperature	T_{stg}	-55	-	150	°C	-
Operating junction temperature[1)]	T_j	-55	-	150	°C	-
Extended operating junction temperature	T_j	150	-	175	°C	≤50 h in the application lifetime
Mounting torque	-	-	-	n.a.	Ncm	-
Diode forward current rating	I_S	-	-	23	A	T_C=25°C Current is limited by $T_{j\ max}$ = 150°C
Diode pulse current[1)]	$I_{S,pulse}$	-	-	371	A	T_C=25°C
Reverse diode dv/dt[4)]	dv/dt	-	-	5	V/ns	V_{DS}=0 to 300V, I_{SD}<=23A, T_j=25°C see table 9
Maximum diode commutation speed	di_f/dt	-	-	800	A/µs	V_{DS}=0 to 300V, I_{SD}<=23A, T_j=25°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 delta T_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}	-	-	0.32	°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 6cm² (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 °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	4.0	4.5	V	V_{DS}=V_{GS}, I_D=1.43mA
Zero gate voltage drain current[1]	I_{DSS}	- -	-50	5 -	µA	V_{DS}=600V, V_{GS}=0V, T_j=25°C V_{DS}=600V, V_{GS}=0V, T_j=150°C
Gate-source leakage current	I_{GSS}	-	-	100	nA	V_{GS}=20V, V_{DS}=0V
Drain-source on-state resistance	$R_{DS(on)}$	- -	0.02 0.046	0.022 -	Ω	V_{GS}=12V, I_D=23.0A, T_j=25°C V_{GS}=12V, I_D=23.0A, T_j=150°C
Gate resistance	R_G	-	0.8	-	Ω	f=1MHz, open drain

表 5 动态特性

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	5640	-	pF	V_{GS}=0V, V_{DS}=300V, f=250kHz
Output capacitance	C_{oss}	-	89	-	pF	V_{GS}=0V, V_{DS}=300V, f=250kHz
Effective output capacitance, energy related[2]	$C_{o(er)}$	-	303	-	pF	V_{GS}=0V, V_{DS}=0 to 300V
Effective output capacitance, time related[3]	$C_{o(tr)}$	-	2678	-	pF	I_D=constant, V_{GS}=0V, V_{DS}=0 to 300V
Output charge	Q_{oss}	-	803	-	nC	V_{GS}=0V, V_{DS}=0 to 300V
Turn-on delay time	$t_{d(on)}$	-	23	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=23.0A, R_G=5.3Ω; see table 9
Rise time	t_r	-	15	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=23.0A, R_G=5.3Ω; see table 9
Turn-off delay time	$t_{d(off)}$	-	150	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=23.0A, R_G=5.3Ω; see table 9
Fall time	t_f	-	9	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=23.0A, R_G=5.3Ω; 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}	-	31	-	nC	V_{DD}=300V, I_D=23.0A, V_{GS}=0 to 12V
Gate to drain charge	Q_{gd}	-	50	-	nC	V_{DD}=300V, I_D=23.0A, V_{GS}=0 to 12V
Gate charge total	Q_g	-	150	-	nC	V_{DD}=300V, I_D=23.0A, V_{GS}=0 to 12V
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	V_{DD}=300V, I_D=23.0A, V_{GS}=0 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=23.0A, T_j=25°C
Reverse recovery time	t_{rr}	-	460	-	ns	V_R=400V, I_F=23.0A, di_F/dt=100A/µs; see table 8
Reverse recovery charge	Q_{rr}	-	9.00	-	µC	V_R=400V, I_F=23.0A, di_F/dt=100A/µs; see table 8
Peak reverse recovery current	I_{rrm}	-	40.0	-	A	V_R=400V, I_F=23.0A, di_F/dt=100A/µs; see table 8

4 温度传感器参数

除非另有规定， $T_j = 25$ °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	$I_R = 100$ µA
Sensor forward current	I_F	-	-	5	mA	-
Repetitive peak forward current	I_{F_pulse}	-	-	25	mA	$t_{pulse} = 1$ ms, $T_{period} = 10$ ms
Non-repetitive peak forward current	I_{FSM}	- - -	- - -	1.5 0.2 0.1	A	$T_C = 25$°C, $t_{pulse} = 1$ µs $T_C = 25$°C, $t_{pulse} = 1$ ms $T_C = 25$°C, $t_{pulse} = 1$ s
Junction Temperature	T_j	-	-	185	°C	t < 50h, Sensor only

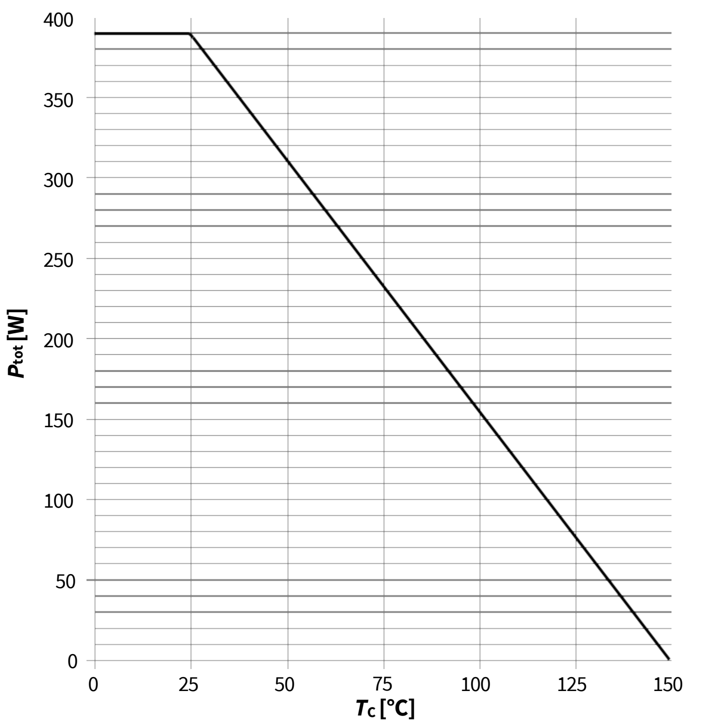
表 9 电气特性

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	$T_j = 25$°C, $I_F = 10$ µA $T_j = 25$°C, $I_F = 50$ µA $T_j = 25$°C, $I_F = 200$ µA $T_j = 25$°C, $I_F = 500$ µA
Sensor forward voltage temperature coefficient	TC	- - - -	5.9644 5.5880 5.2287 5.0135	- - - -	mV/K	25°C ≤ T_j ≤ 175°C, $I_F = 10$ µA 25°C ≤ T_j ≤ 175°C, $I_F = 50$ µA 25°C ≤ T_j ≤ 175°C, $I_F = 200$ µA 25°C ≤ T_j ≤ 175°C, $I_F = 500$ µA
Sensor forward voltage	V_{F_175}	0.6655 - - 1.3144	0.7072 0.9721 1.1963 1.3445	0.7490 - - 1.3746	V	$T_j = 175$°C, $I_F = 10$ µA $T_j = 175$°C, $I_F = 50$ µA $T_j = 175$°C, $I_F = 200$ µA $T_j = 175$°C, $I_F = 500$ µA
Reverse leakage current	I_R	- -	- -	1 20	µA	$V_R = 10$V, $T_j = 25$°C V_R = 10V, $T_j = 175$°C
Sensor G Capacitance	C_{GTS}	-	4.2	-	pF	f = 1 MHz, $I_F = 50$ µA
Sensor Capacitance	C_{STS}	-	4.8	-	pF	f = 1 MHz, $I_F = 50$ µA
Anode-Drain Capacitance	C_{DTS}	-	0.5	-	pF	f = 1 MHz, $V_{DS} = 0$ V

[1]由设计定义，未经测试

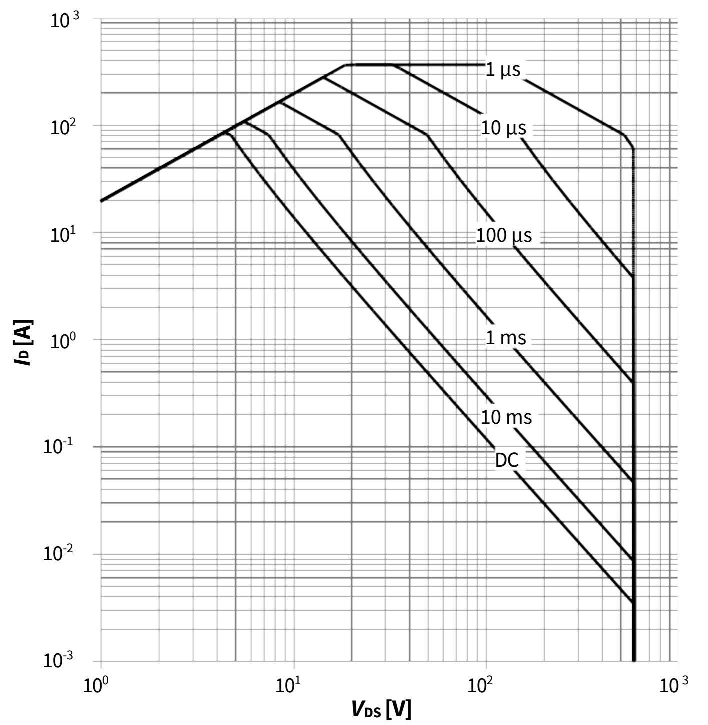
5 电气特性图

Diagram 1: Power dissipation



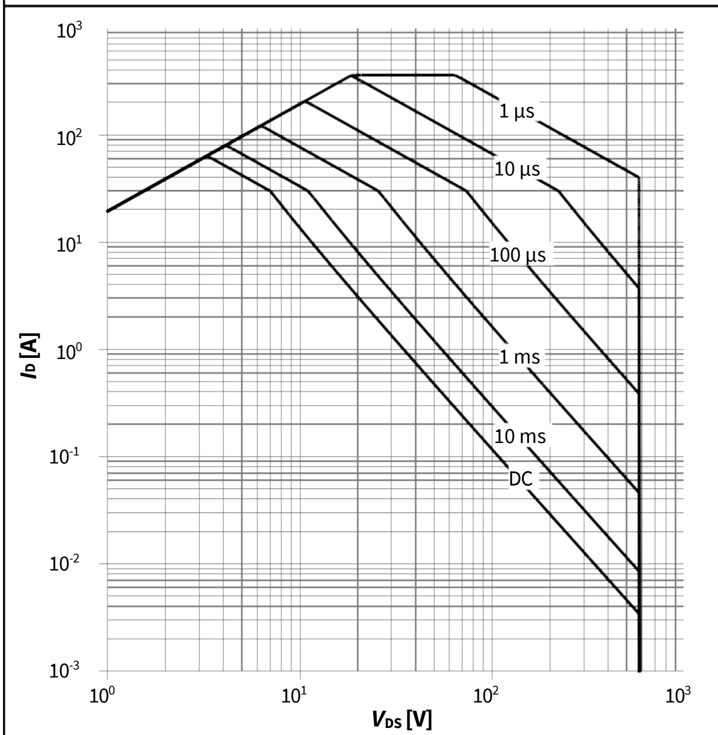
P_{tot}=f(T_C)

Diagram 2: Safe operating area



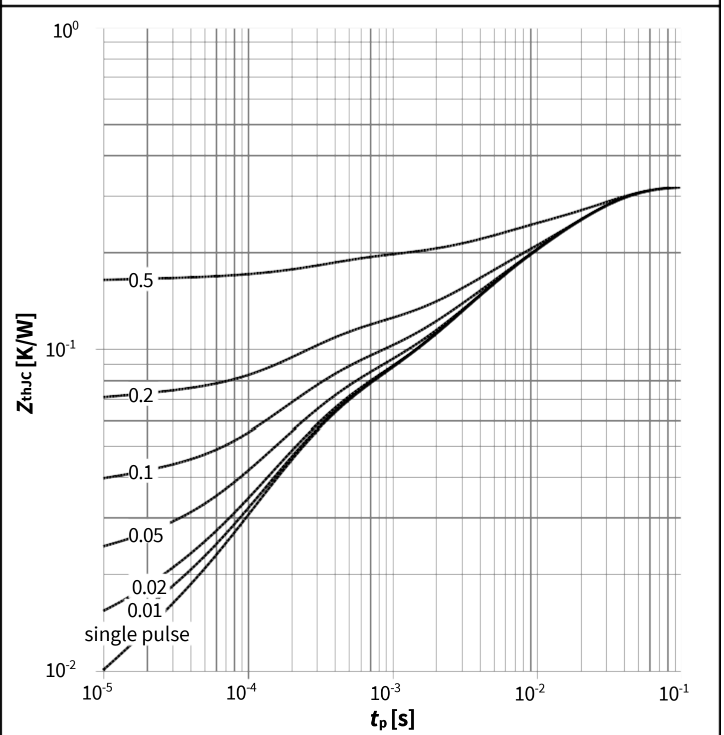
I_D=f(V_{DS}); T_C=25 °C; D=0; parameter: t_p

Diagram 3: Safe operating area



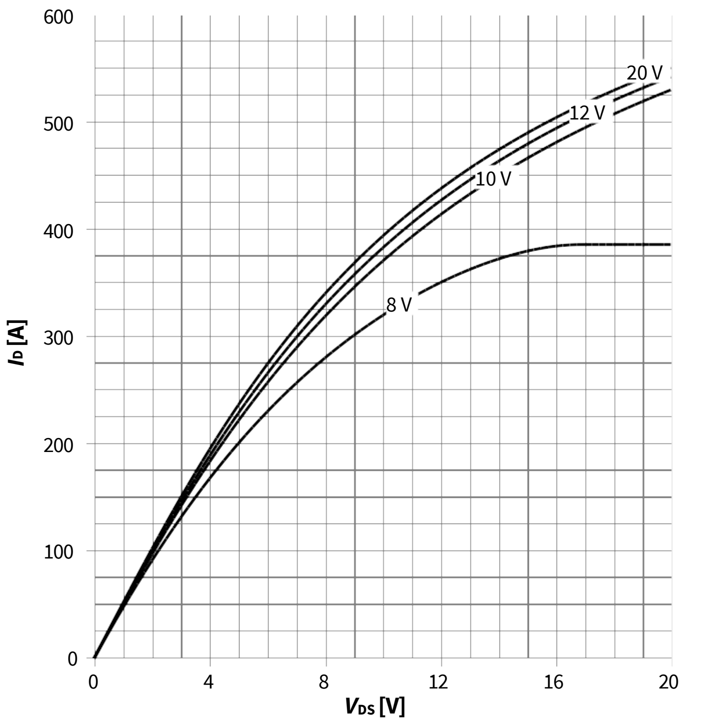
I_D=f(V_{DS}); T_C=80 °C; D=0; parameter: t_p

Diagram 4: Max. transient thermal impedance



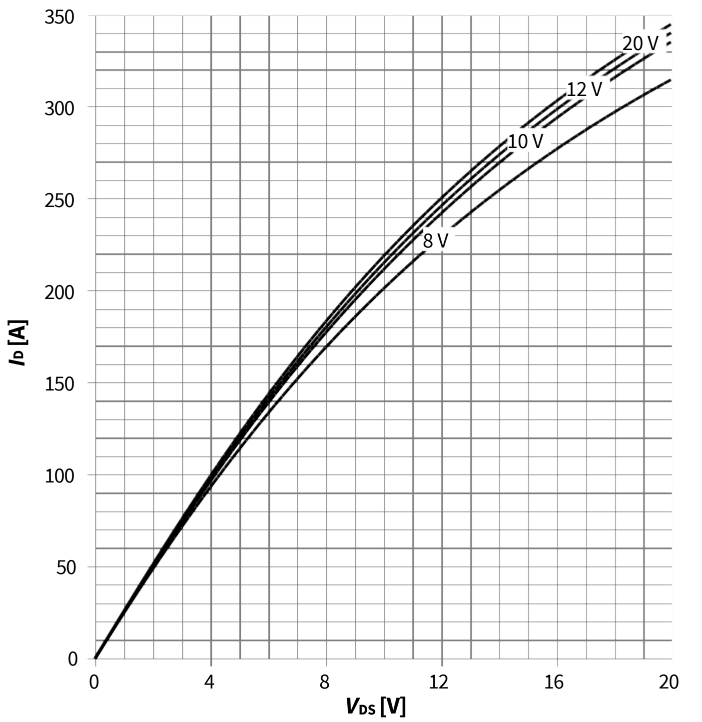
Z_{thJC}=f(t_P); parameter: D=t_p/T

Diagram 5: Typ. output characteristics



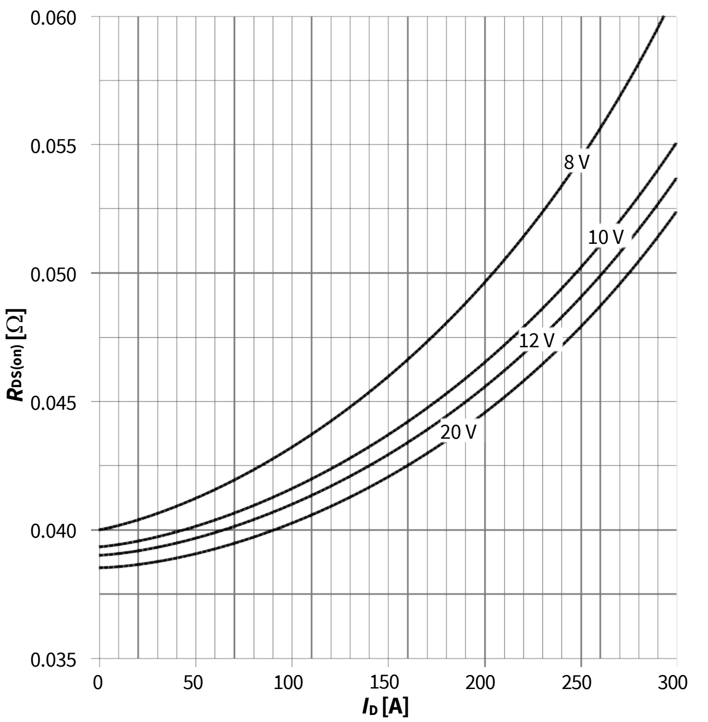
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}

Diagram 6: Typ. output characteristics



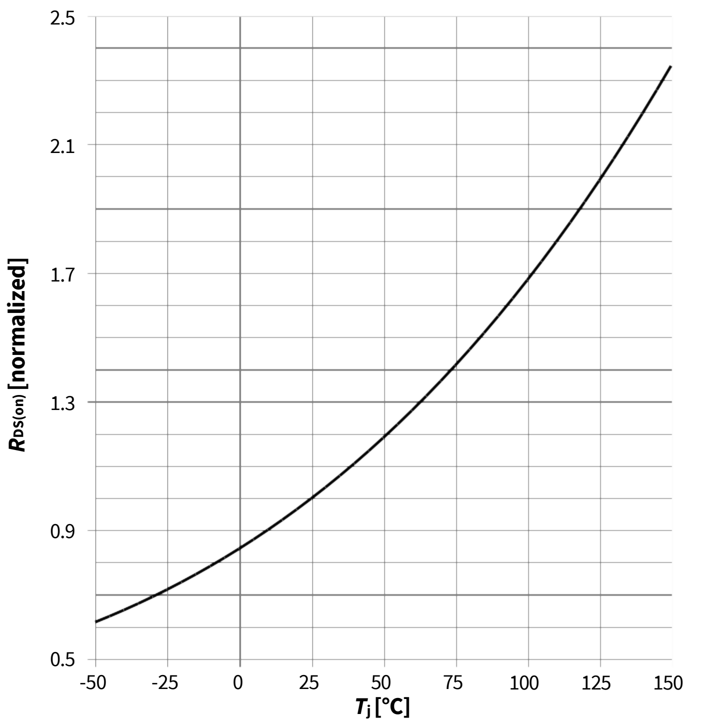
I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

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



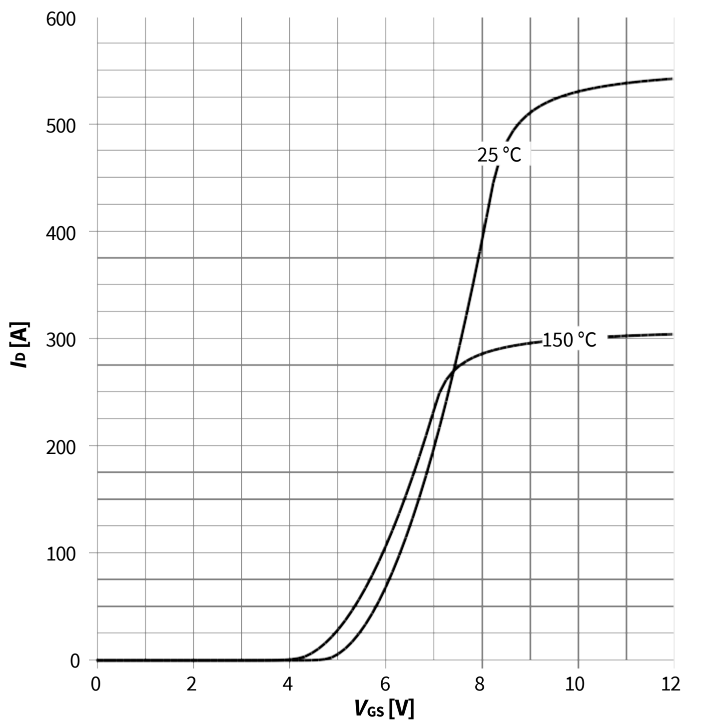
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



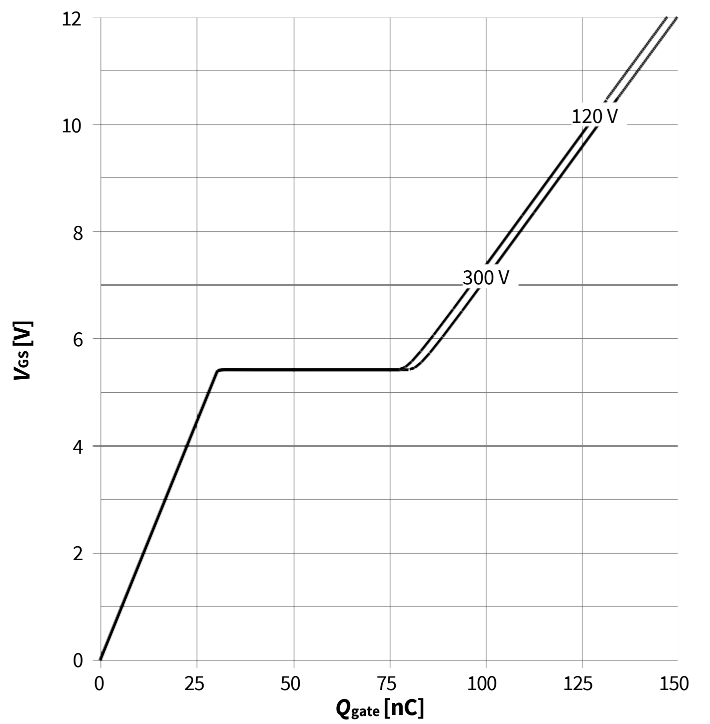
$R_{DS(on)}$=f(T_j); I_D=23.0 A; V_{GS}=12 V

Diagram 9: Typ. transfer characteristics



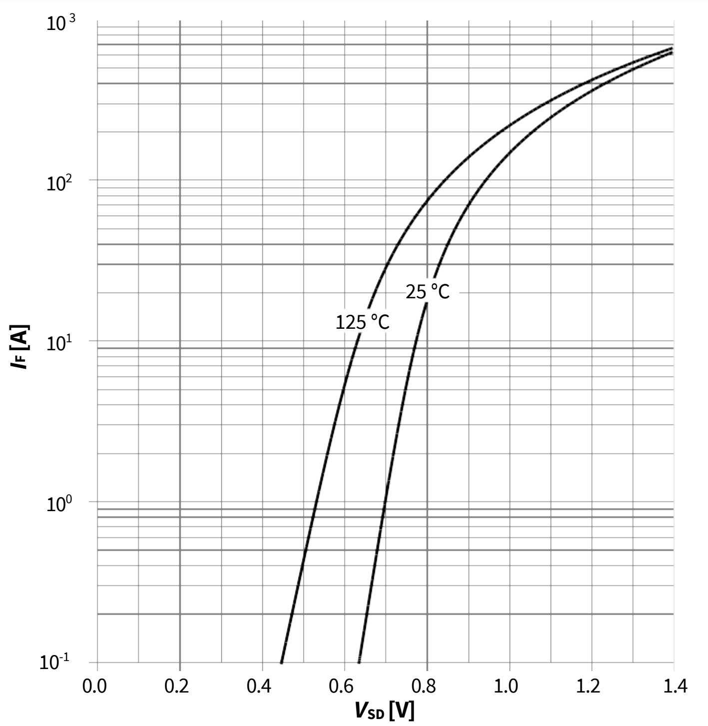
I_D=f(V_{GS}); V_{DS}=20V; parameter: T_j

Diagram 10: Typ. gate charge



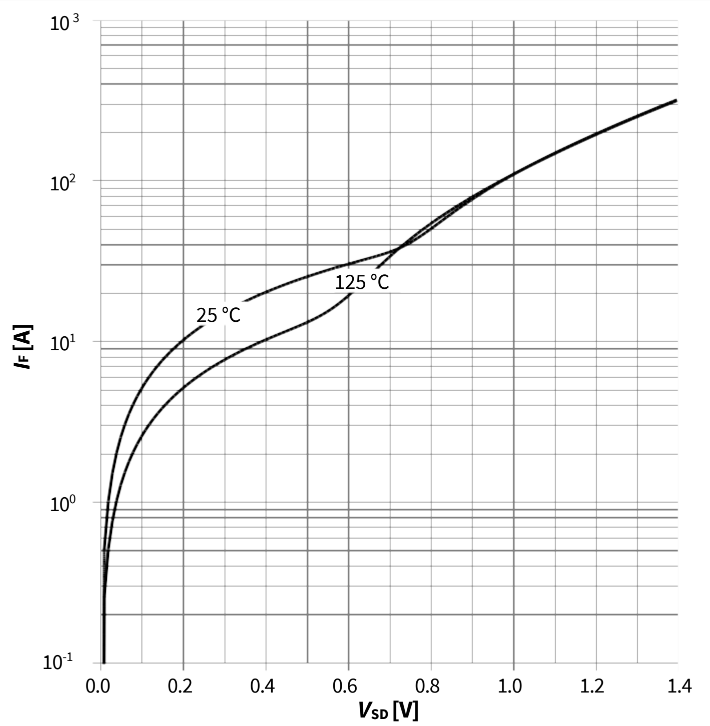
V_{GS}=f(Q_{gate}); I_D=23.0 A pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



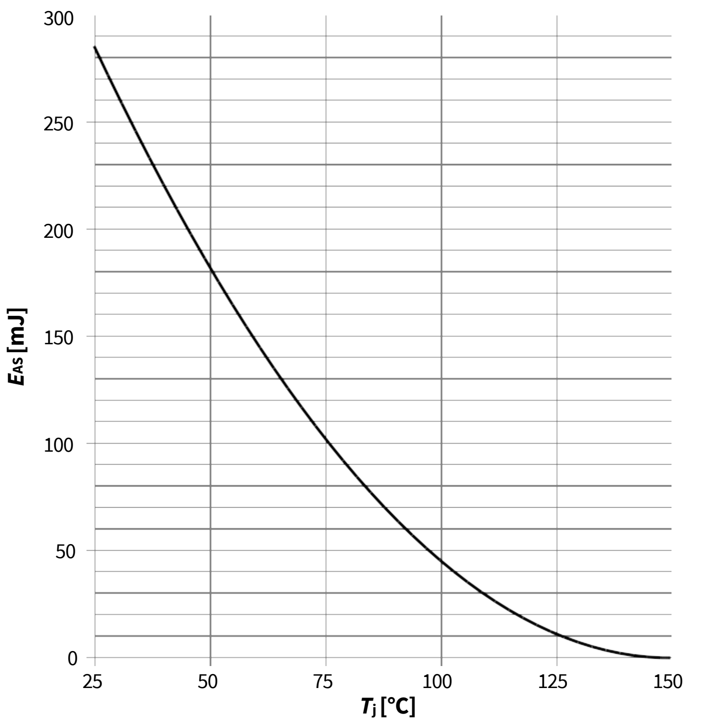
I_F=f(V_{SD}); V_{GS}=0 V; parameter: T_j

Diagram 12: Forward characteristics of reverse diode



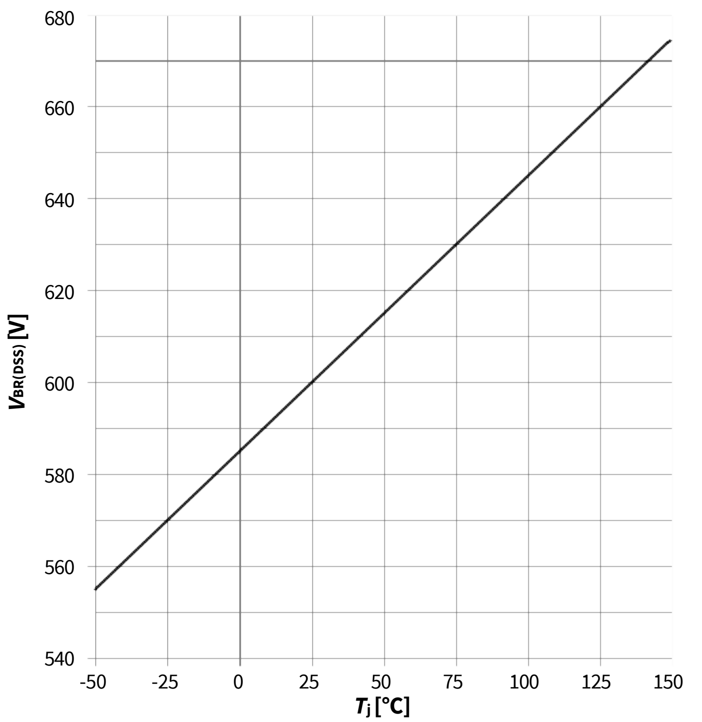
I_F=f(V_{SD}); V_{GS}=12 V; parameter: T_j

Diagram 13: Avalanche energy



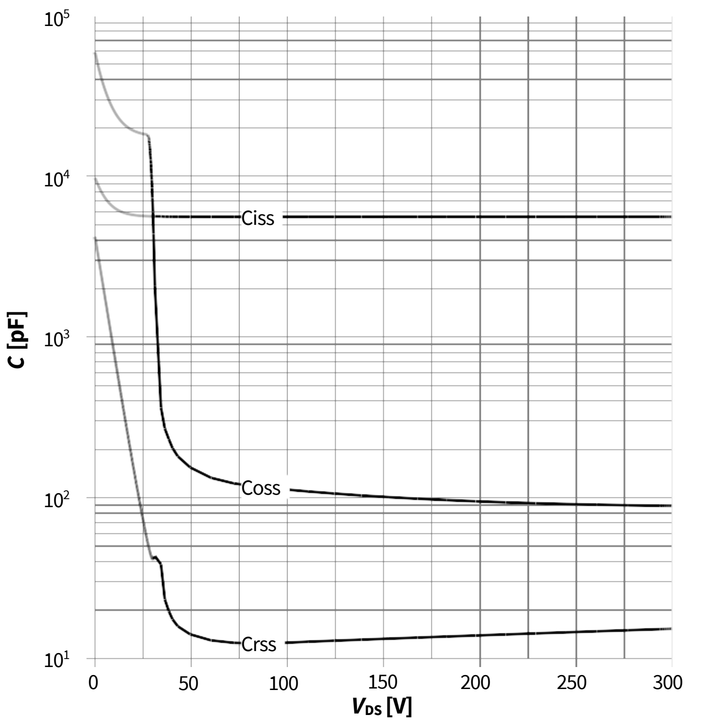
E_{AS}=f(T_j); I_D=3.7 A; V_{DD}=50 V

Diagram 14: Drain-source breakdown voltage



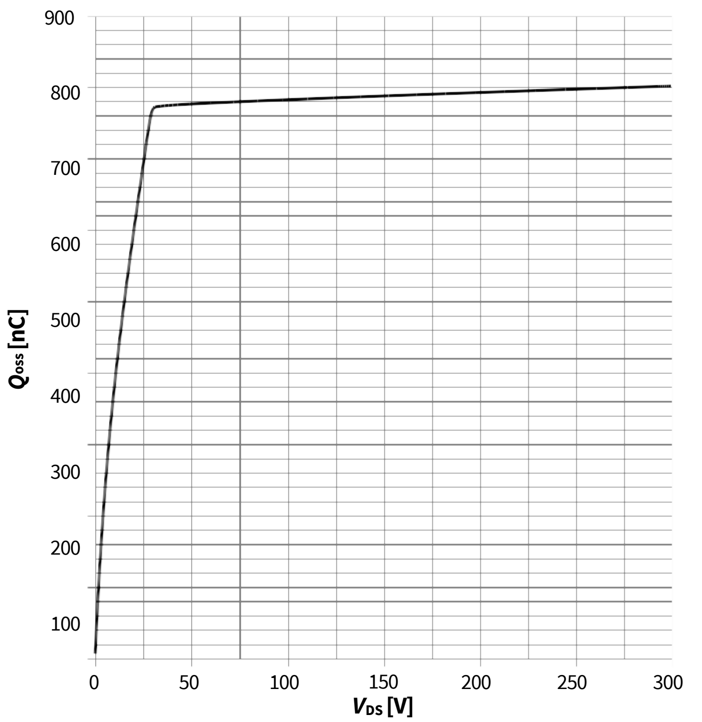
$V_{BR(DSS)}$=f(T_j); I_D=1 mA

Diagram 15: Typ. capacitances



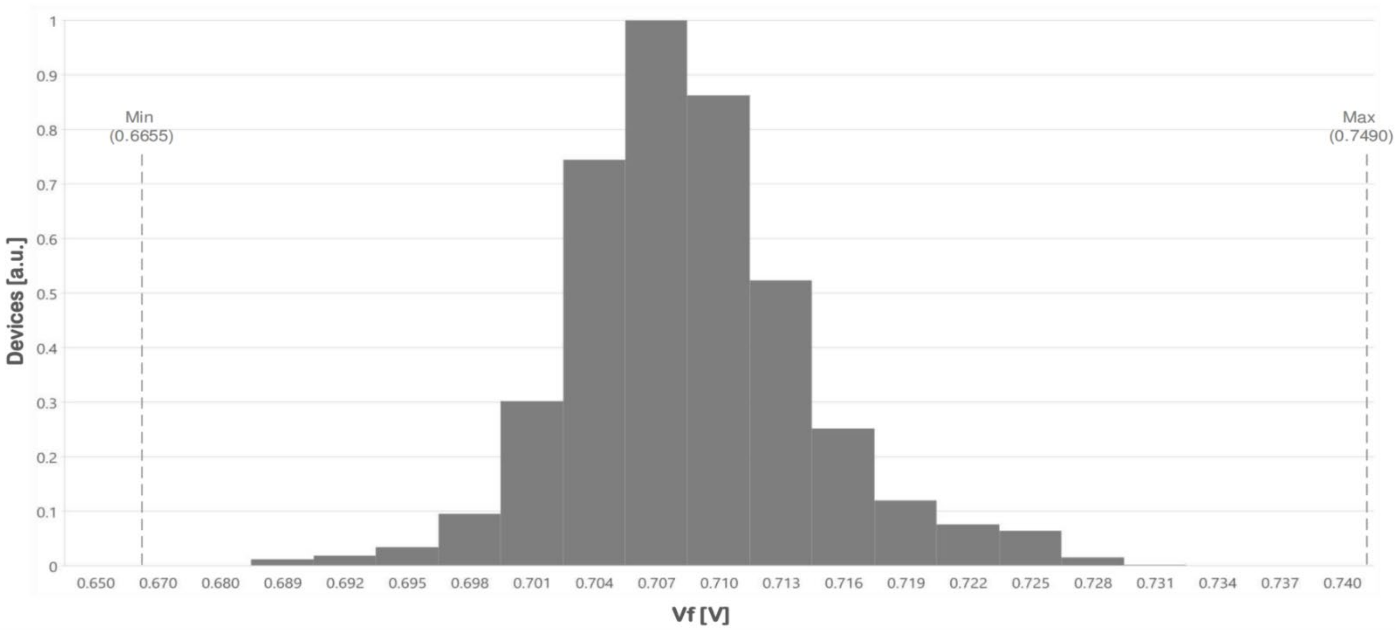
C=f(V_{DS}); V_{GS}=0 V; f=250 kHz

Diagram 17: Typ. Qoss output charge



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

Diagram: Distribution of typical temperature sensor signal



T_{j_set}=175 °C; I_{F_set} = 10 µA

6 测试电路

表10 反向二极管特性

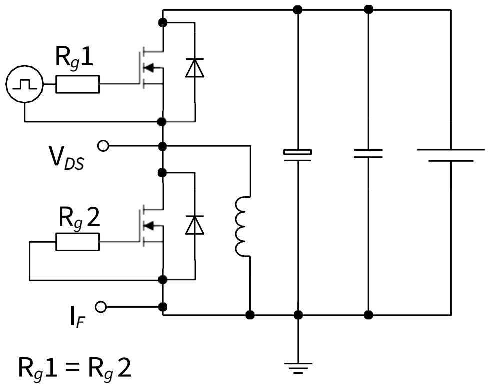
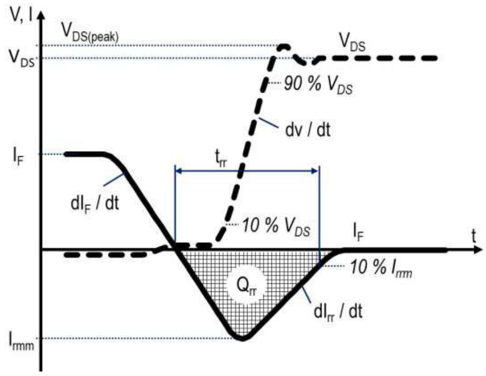
Test circuit for diode characteristics	Diode recovery waveform
	

表 11 开关时间 (ss)

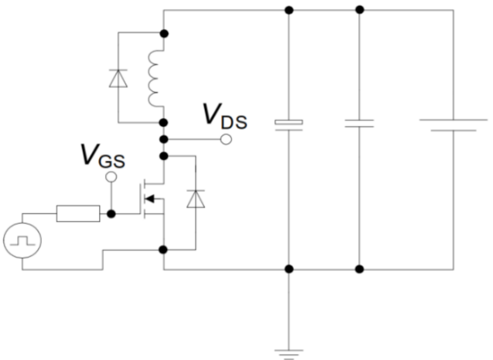
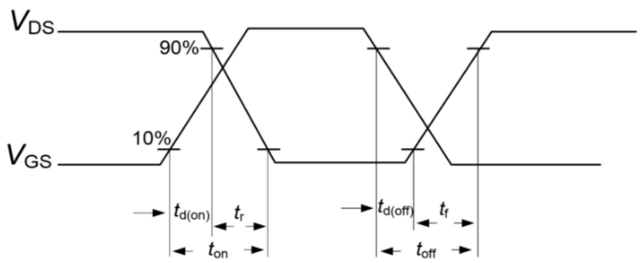
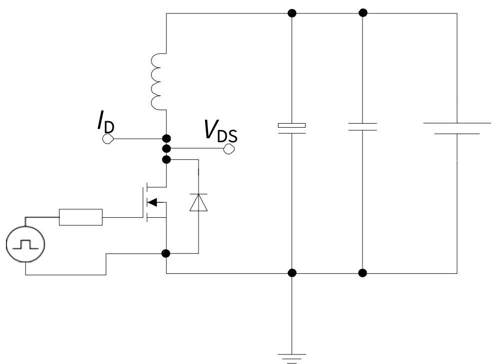
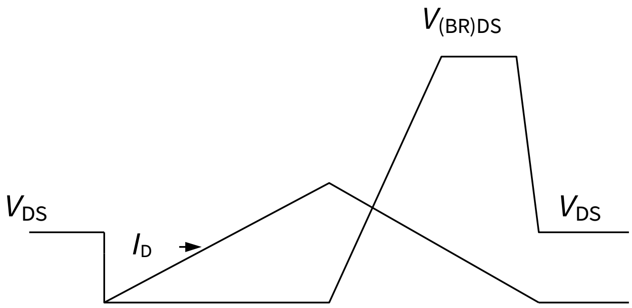
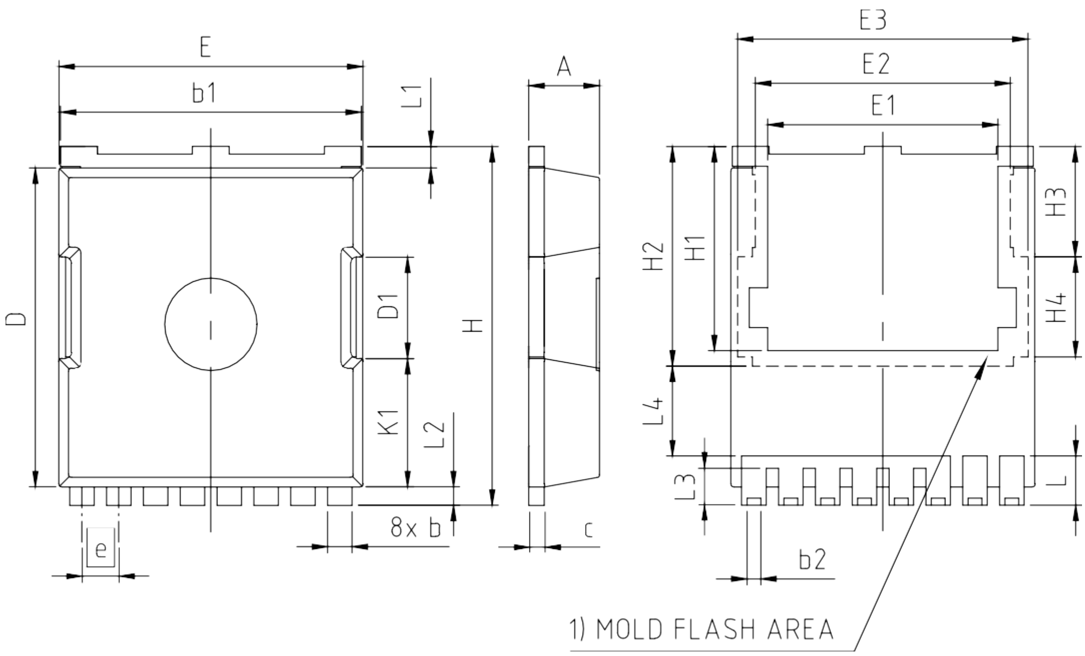
Switching times test circuit for inductive load	Switching times waveform
	

表 12 非钳位感性负载(ss)

Unclamped inductive load test circuit	Unclamped inductive waveform
	

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 应用笔记:** www.infineon.com
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修订记录

IPT60T022S7

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

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