

英飞凌MOSFET

600V CoolMOS™ PFD7 SJ 功率器件

CoolMOS™ 是高压功率 MOSFET 的革命性技术，根据超结 (SJ) 原理设计，由英飞凌科技率先推出。

最新的 CoolMOS™ PFD7 是一个优化的平台，专为充电器、适配器、电机驱动、照明等对成本敏感的消费市场应用而定制。

新系列具有快速开关超结 MOSFET 的所有优点，同时具有出色的性价比和最先进的易用性。该技术符合最高效率标准，支持高功率密度，使客户能够实现超薄设计。

特性

- 由非常低的 FOM $R_{DS(on)} \cdot Q_g$ 和 $R_{DS(on)} \cdot E_{oss}$ 带来的极低损耗
- 低开关损耗 E_{oss} ，出色的热性能
- 快速体二极管
- 宽范围的 $R_{DS(on)}$ 集合和封装变体

优点

- 实现高功率密度设计和小外形尺寸
- 开关频率越高，效率越高
- 出色的换向鲁棒性
- 易于选择合适的部件并优化设计

潜在应用

建议用于高密度充电器、适配器、照明和电机驱动等应用中的 ZVS 拓扑。

产品验证

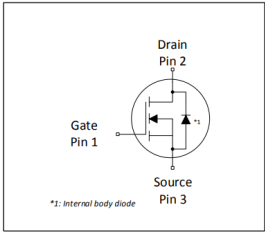
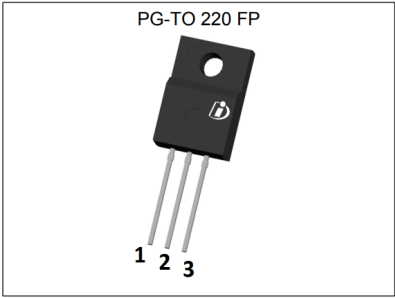
符合 JEDEC 标准

请注意：对于 MOSFET 并联，通常建议在栅极上使用铁氧体磁珠或单独的图腾柱。

表 1 主要性能参数

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	125	mΩ
$Q_{g,typ}$	36	nC
$I_{D,pulse}$	66	A
$E_{oss} @ 400V$	4.1	μJ
Body diode di_F/dt	1300	A/μs
ESD Class (HBM)	2	-

Type / Ordering Code	Package	Marking	Related Links
IPAN60R125PFD7S	PG-TO 220 FullPAK - Narrow Lead	60S125D7	see Appendix A



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1 最大额定值

除非另有规定, $T_j = 25^\circ\text{C}$

表 2 最大额定值

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current ¹⁾	I_D	-	-	25 16	A	$T_c=25^\circ\text{C}$ $T_c=100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	66	A	$T_c=25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}	-	-	78	mJ	$I_D=4.4\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.39	mJ	$I_D=4.4\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche current, single pulse	I_{AS}	-	-	4.4	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	120	V/ns	$V_{DS}=0\dots400\text{V}$
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}	-	-	32	W	$T_c=25^\circ\text{C}$
Storage temperature	T_{stg}	-40	-	150	$^\circ\text{C}$	-
Operating junction temperature	T_j	-40	-	150	$^\circ\text{C}$	-
Mounting torque	-	-	-	50	Ncm	M2.5 screws
Continuous diode forward current ¹⁾	I_S	-	-	25	A	$T_c=25^\circ\text{C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	66	A	$T_c=25^\circ\text{C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	70	V/ns	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 18\text{A}$, $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di _F /dt	-	-	1300	A/ μs	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 18\text{A}$, $T_j=25^\circ\text{C}$ see table 8
Insulation withstand voltage	V_{ISO}	-	-	2500	V	V_{rms} , $T_c=25^\circ\text{C}$, $t=1\text{min}$

¹⁾ 受 $T_{j,max}$ 限制。最大占空比 $D = 0.50$; 等效 TO-220

²⁾ 脉冲宽度 t_p 受 $T_{j,max}$ 限制

³⁾ 相同的低侧和高侧开关, 具有相同的 R_G

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}	-	-	3.92	°C/W	-
Thermal resistance, junction - ambient	R_{thJA}	-	-	80	°C/W	leaded
Thermal resistance, junction - ambient for SMD version	R_{thJA}	-	-	-	°C/W	n.a.
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6mm (0.063 in.) from case for 10s

3 电气特性

除非另有规定, $T_j = 25^\circ\text{C}$

表 4 静态特性

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	$V_{DS}=V_{GS}, I_D=0.39mA$
Zero gate voltage drain current ¹⁾	I_{DSS}	-	-	1 8 37	μA	$V_{DS}=600V, V_{GS}=0V, T_j=25^\circ C$ $V_{DS}=600V, V_{GS}=0V, T_j=125^\circ C$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20V, V_{DS}=0V$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.104 0.235	0.125 -	Ω	$V_{GS}=10V, I_D=7.8A, T_j=25^\circ C$ $V_{GS}=10V, I_D=7.8A, T_j=150^\circ C$
Gate resistance	R_G	-	8.8	-	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}	-	1503	-	pF	$V_{GS}=0V, V_{DS}=400V, f=250kHz$
Output capacitance	C_{oss}	-	28	-	pF	$V_{GS}=0V, V_{DS}=400V, f=250kHz$
Effective output capacitance, energy related ²⁾	$C_{o(er)}$	-	51	-	pF	$V_{GS}=0V, V_{DS}=0...400V$
Effective output capacitance, time related ³⁾	$C_{o(tr)}$	-	520	-	pF	$I_D=\text{constant}, V_{GS}=0V, V_{DS}=0...400V$
Turn-on delay time	$t_{d(on)}$	-	26	-	ns	$V_{DD}=400V, V_{GS}=10V, I_D=7.8A, R_G=5.3\Omega$; see table 9
Rise time	t_r	-	13	-	ns	$V_{DD}=400V, V_{GS}=10V, I_D=7.8A, R_G=5.3\Omega$; see table 9
Turn-off delay time	$t_{d(off)}$	-	69	-	ns	$V_{DD}=400V, V_{GS}=10V, I_D=7.8A, R_G=5.3\Omega$; see table 9
Fall time	t_f	-	6	-	ns	$V_{DD}=400V, V_{GS}=10V, I_D=7.8A, R_G=5.3\Omega$; see table 9

表 6 栅极电荷特性

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	9	-	nC	$V_{DD}=400V, I_D=7.8A, V_{GS}=0 \text{ to } 10V$
Gate to drain charge	Q_{gd}	-	12	-	nC	$V_{DD}=400V, I_D=7.8A, V_{GS}=0 \text{ to } 10V$
Gate charge total	Q_g	-	36	-	nC	$V_{DD}=400V, I_D=7.8A, V_{GS}=0 \text{ to } 10V$
Gate plateau voltage	$V_{plateau}$	-	5.6	-	V	$V_{DD}=400V, I_D=7.8A, V_{GS}=0 \text{ to } 10V$

¹⁾ 最大规格由计算出的六西格玛置信上限定义。

²⁾ $C_{o(er)}$ 是一个固定电容, 当 V_{DS} 从 0 V 上升到 400 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 400 V 时, 其充电时间与 C_{oss} 相同

表 7 反向二极管特性

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	1.0	-	V	$V_{GS}=0V, I_F=7.8A, T_j=25^{\circ}C$
Reverse recovery time	t_{rr}	-	100	150	ns	$V_R=400V, I_F=7.8A, di_F/dt=100A/\mu s$; see table 8
Reverse recovery charge	Q_{rr}	-	0.45	0.90	μC	$V_R=400V, I_F=7.8A, di_F/dt=100A/\mu s$; see table 8
Peak reverse recovery current	I_{rm}	-	7.9	-	A	$V_R=400V, I_F=7.8A, di_F/dt=100A/\mu s$; see table 8

4 电气特性图

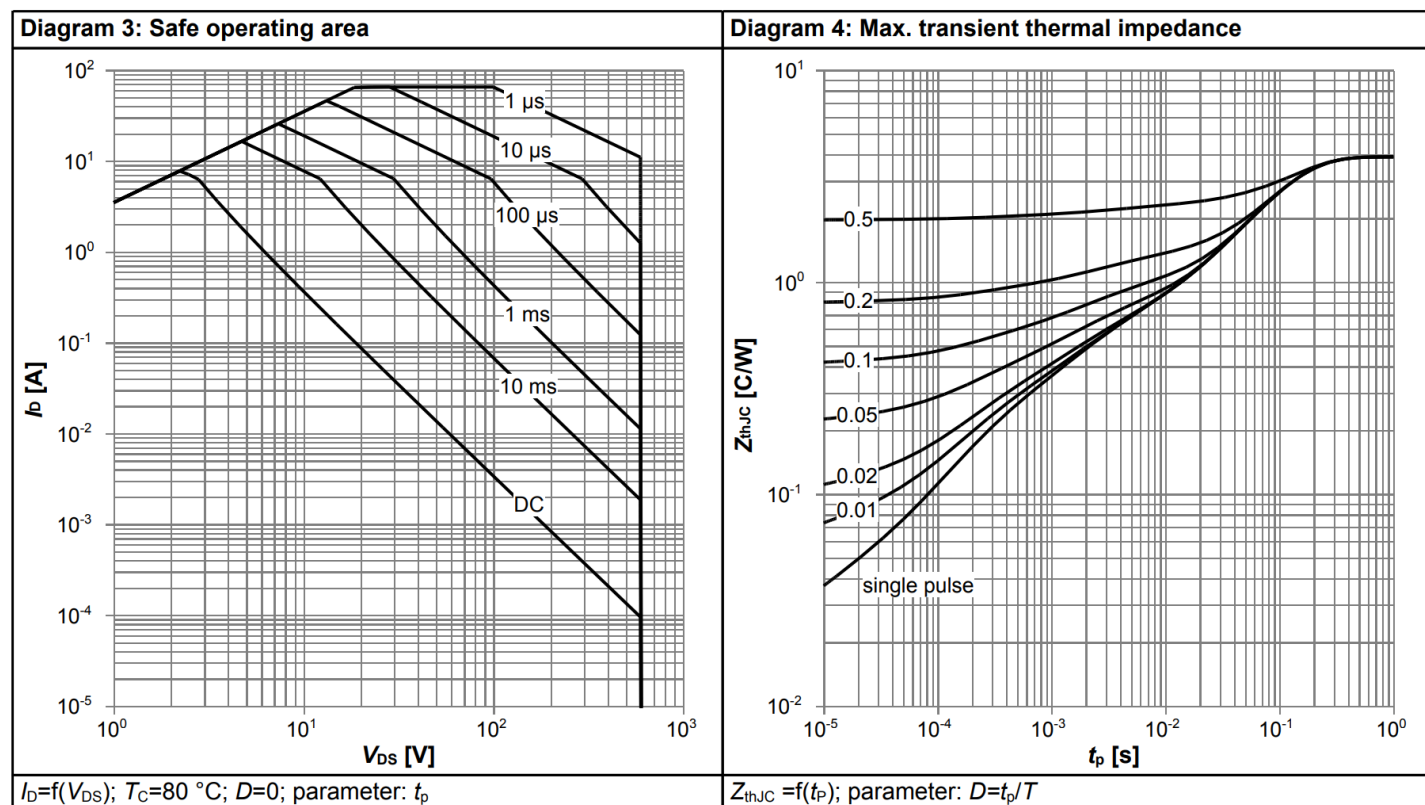
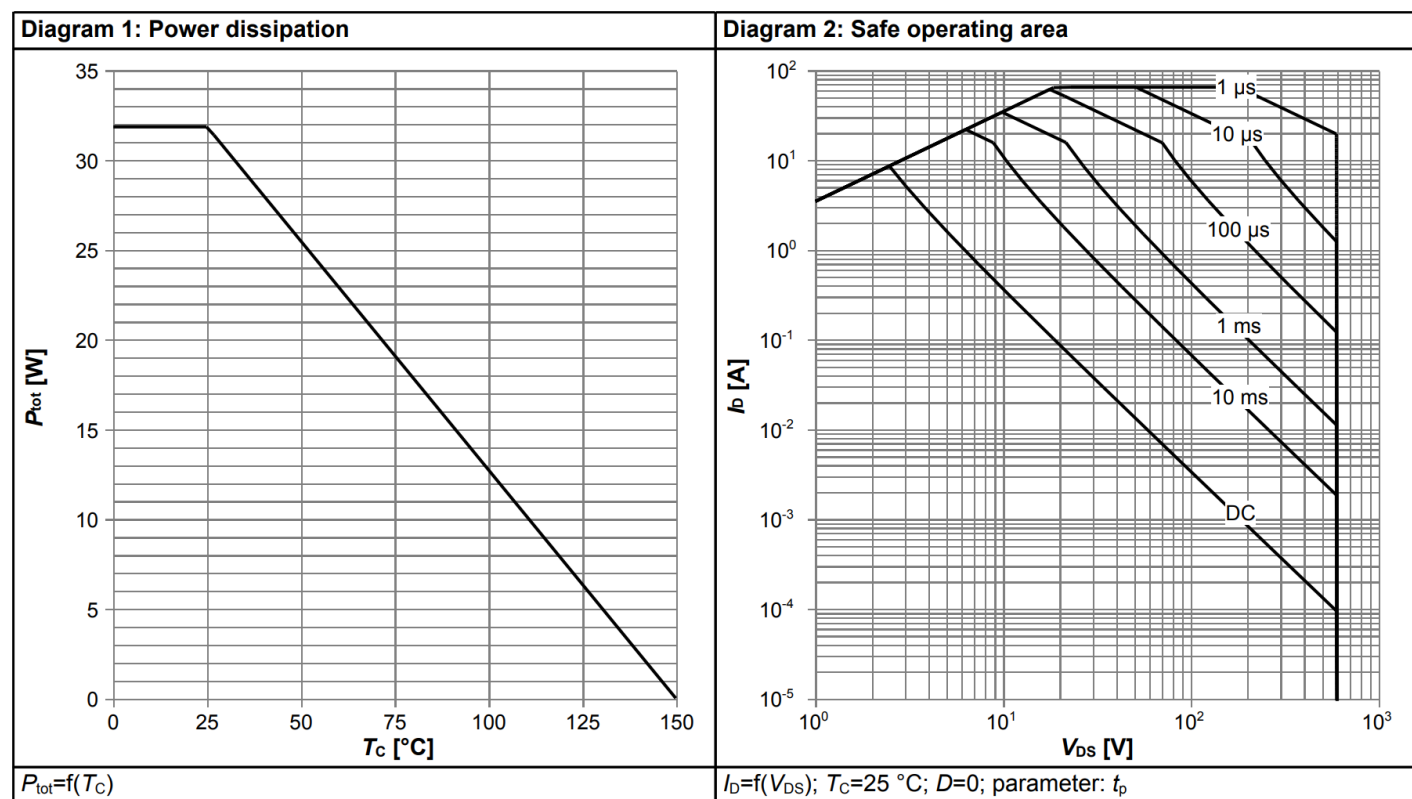


Diagram 5: Typ. output characteristics

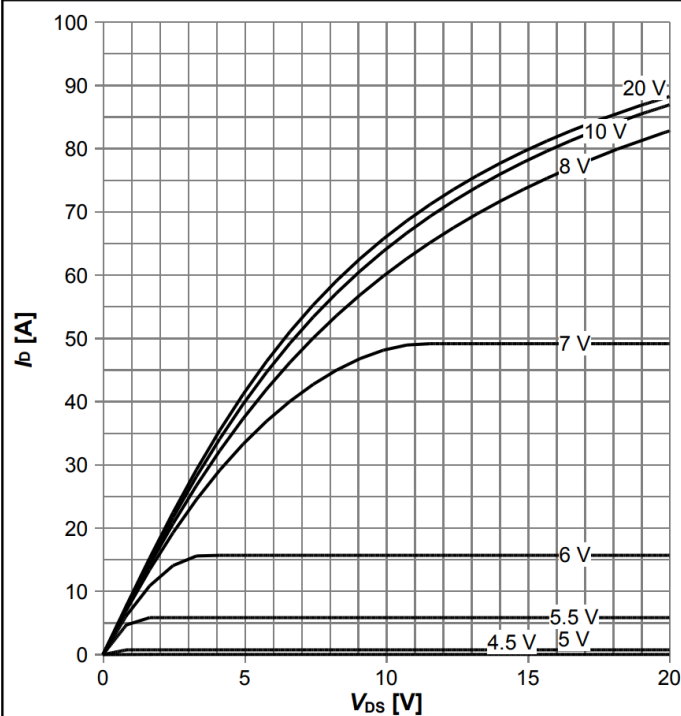

 $I_D = f(V_{DS}); T_J = 25\text{ °C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics

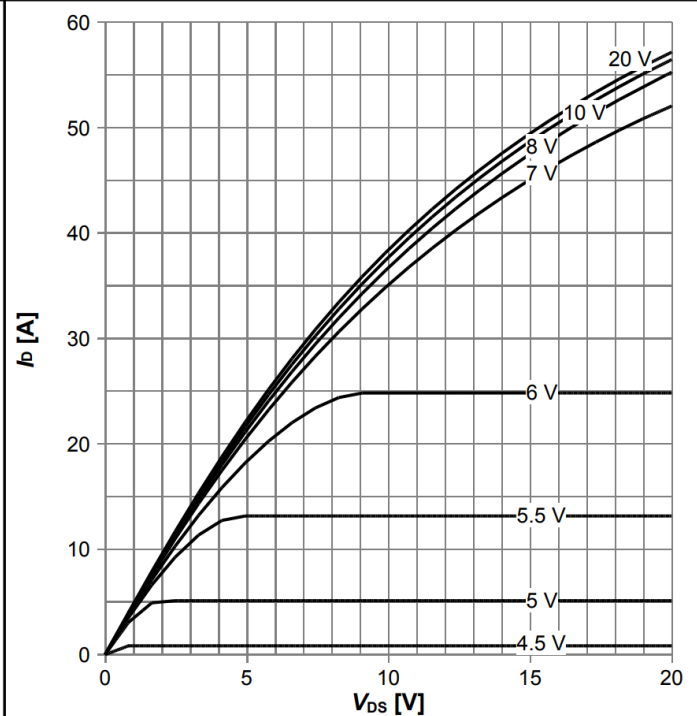

 $I_D = f(V_{DS}); T_J = 125\text{ °C}; \text{parameter: } V_{GS}$

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

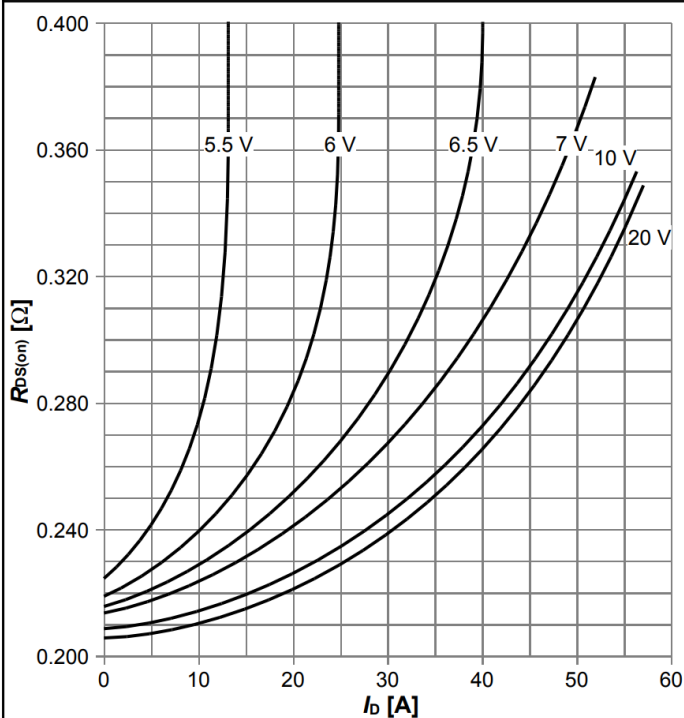

 $R_{DS(on)} = f(I_D); T_J = 125\text{ °C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance

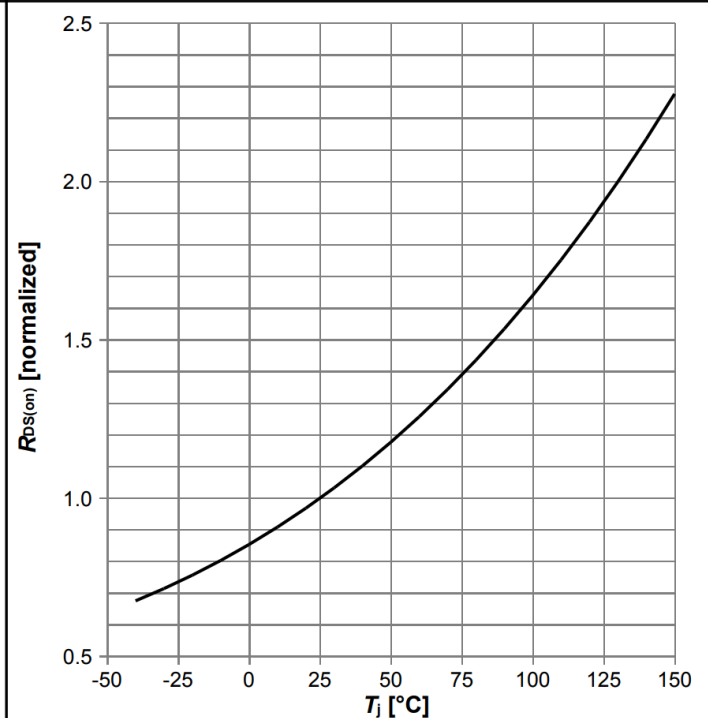

 $R_{DS(on)} = f(T_J); I_D = 7.8\text{ A}; V_{GS} = 10\text{ V}$

Diagram 9: Typ. transfer characteristics

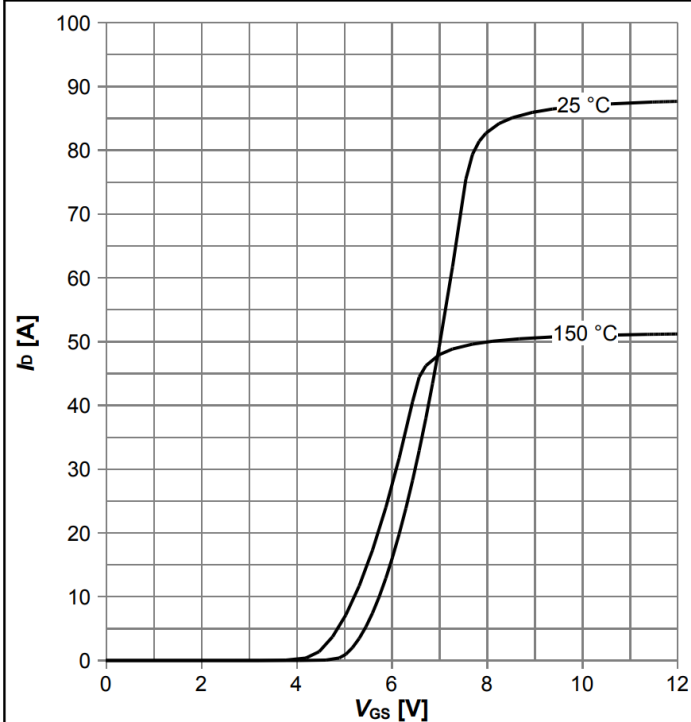
 $I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge

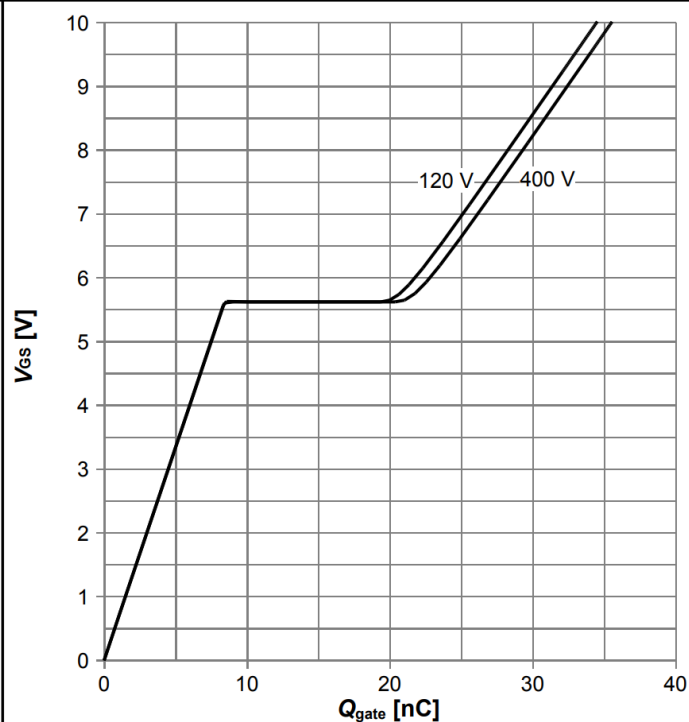
 $V_{GS} = f(Q_{gate}); I_D = 7.8 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode

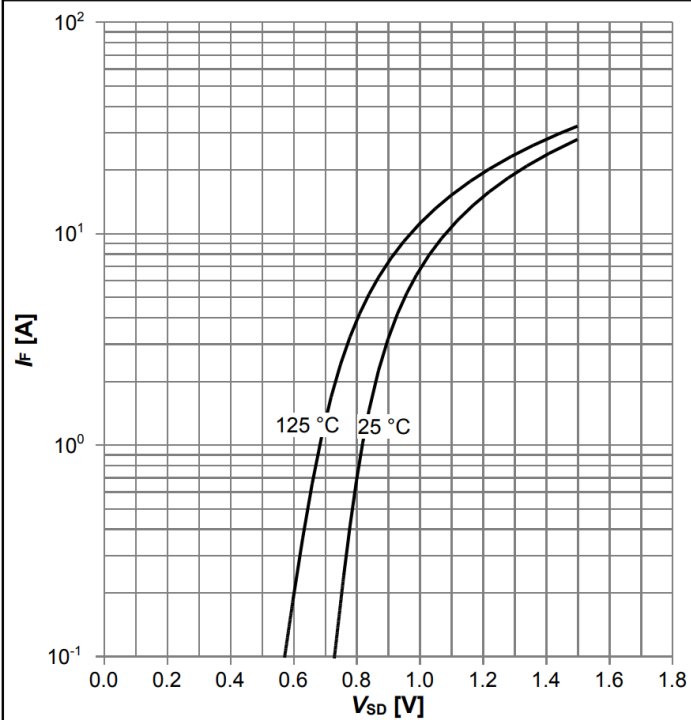
 $I_F = f(V_{SD}); \text{parameter: } T_j$

Diagram 12: Avalanche energy

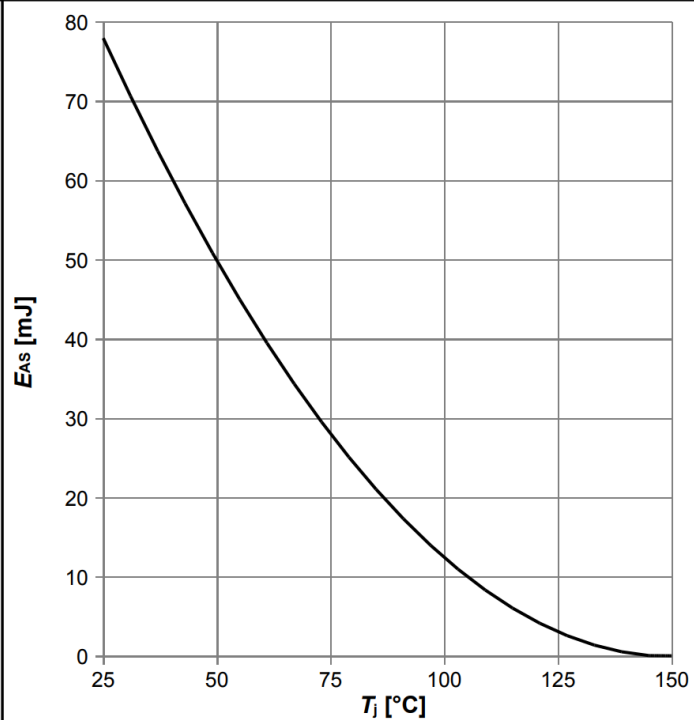
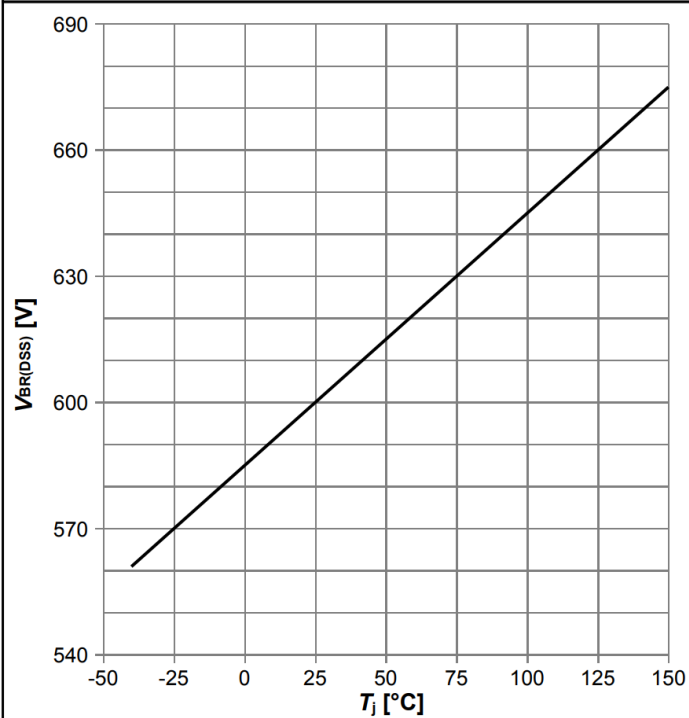
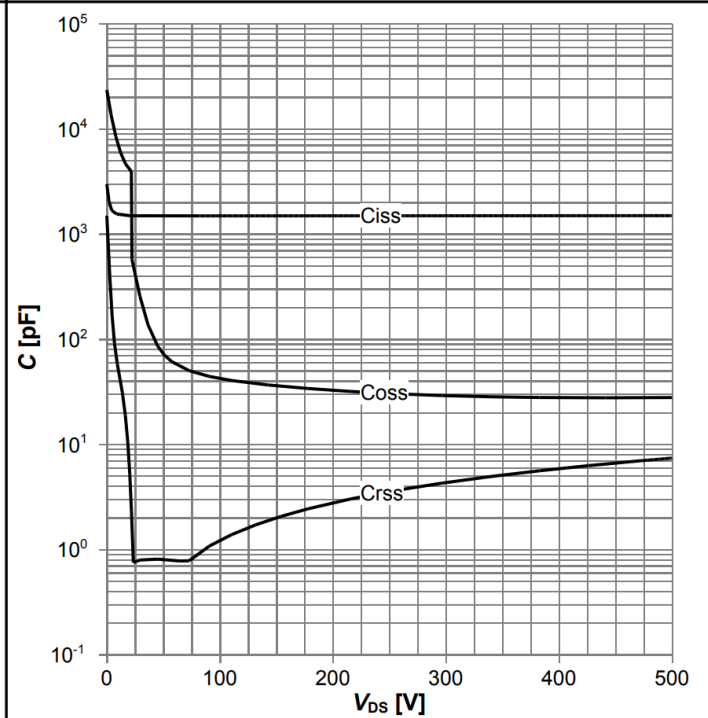
 $E_{AS} = f(T_j); I_D = 4.4 \text{ A}; V_{DD} = 50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



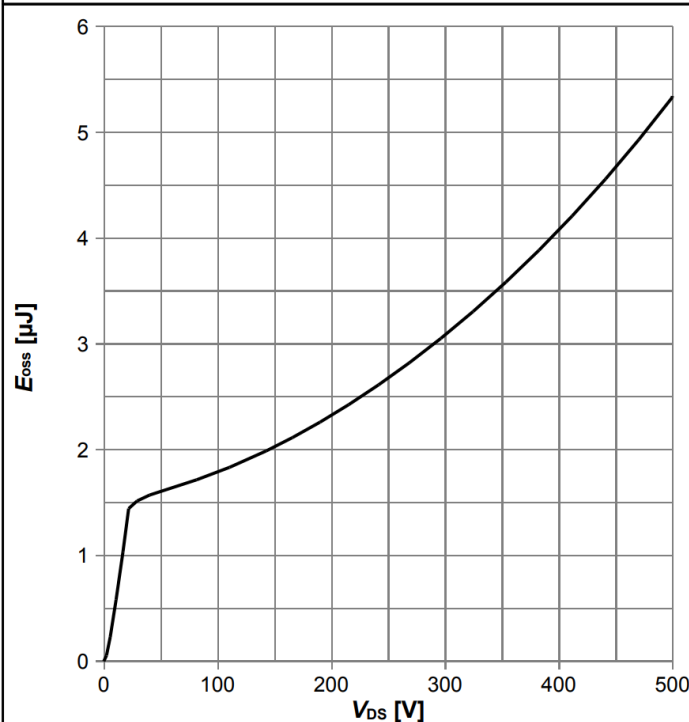
$$V_{BR(DSS)} = f(T_j); I_D = 1 \text{ mA}$$

Diagram 14: Typ. capacitances



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

Diagram 15: Typ. Coss stored energy



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

5 测试电路

表8 二极管特性

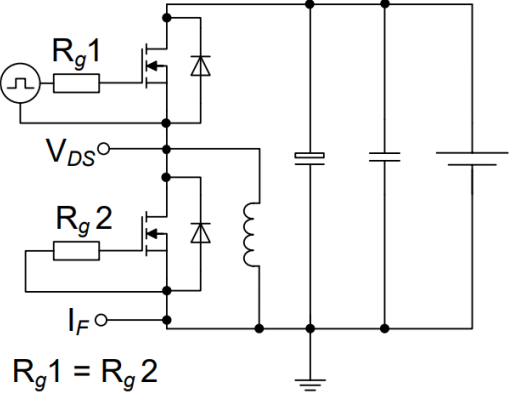
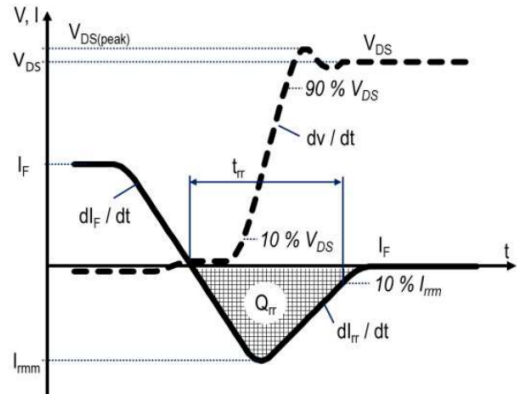
Test circuit for diode characteristics	Diode recovery waveform
 $R_{g1} = R_{g2}$	

表9 切换时间

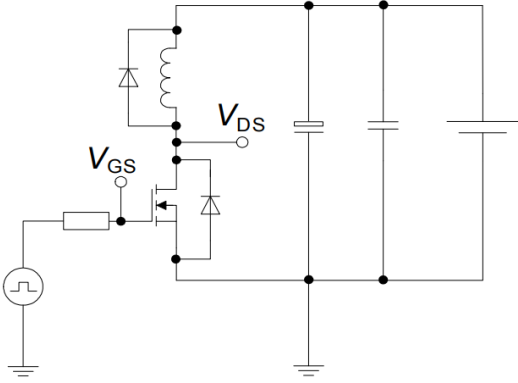
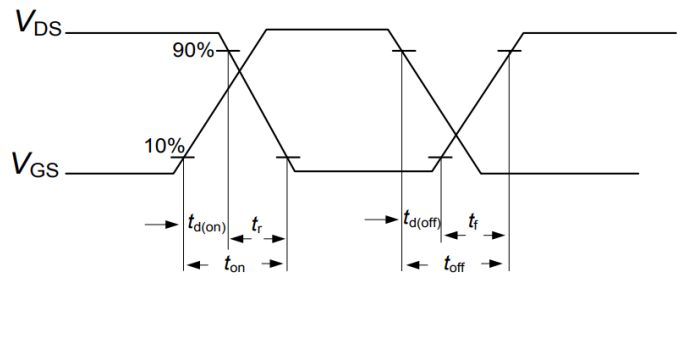
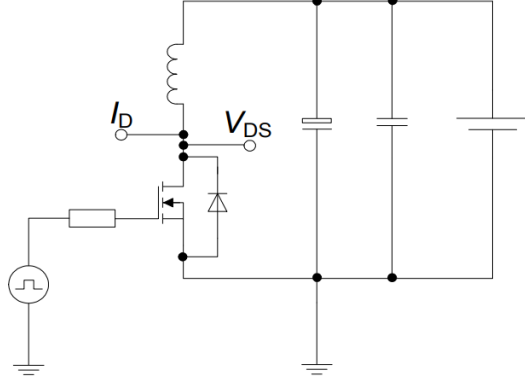
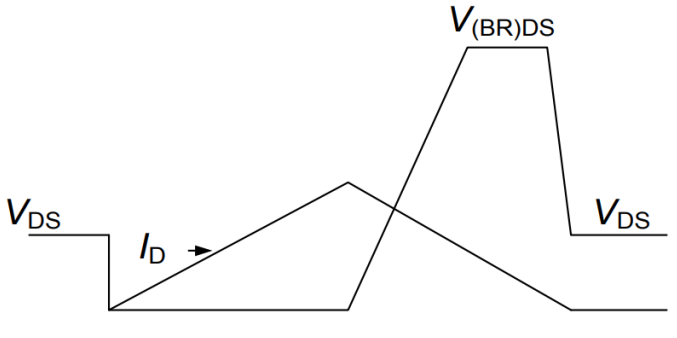
Switching times test circuit for inductive load	Switching times waveform
	

表10 非钳位感性负载

Unclamped inductive load test circuit	Unclamped inductive waveform
	

6 封装外形

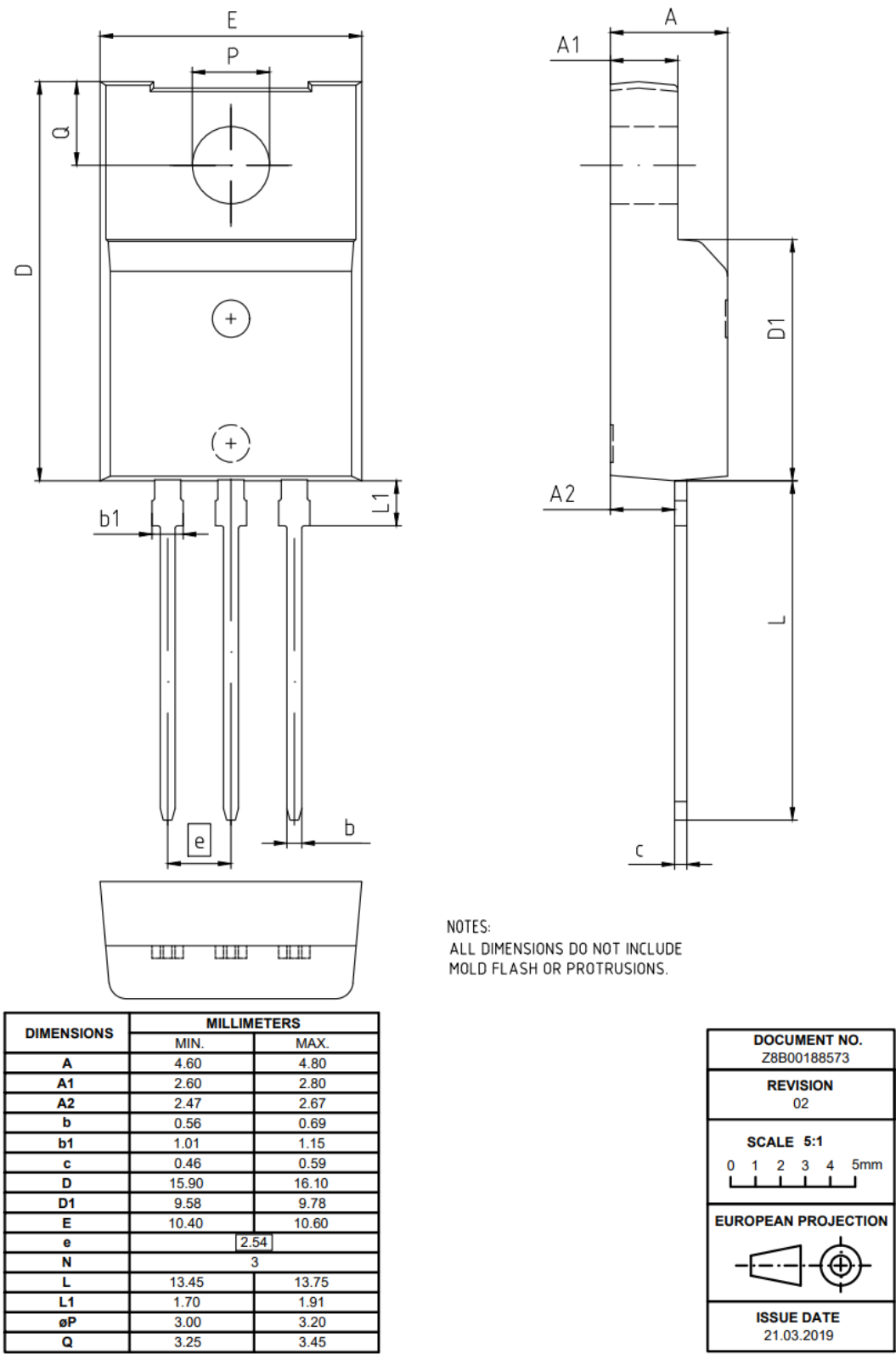


图 1 PG-TO 220 FullPAK - Narrow Lead外形图，尺寸单位：毫米

7 附录 A

表 11 相关链接

- IFX CoolMOS PFD7 网页: www.infineon.com
- IFX CoolMOS PFD7 应用笔记: www.infineon.com
- IFX CoolMOS PFD7 仿真模型: www.infineon.com
- IFX 设计工具: www.infineon.com

修订记录

IPAN60R125PFD7S

Revision: 2019-11-29, Rev. 2.1

历史修订版本

Revision	Date	Subjects (major changes since last revision)
2.0	2019-04-09	Release of final version
2.1	2019-11-29	Modified current Id and Is ratings

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