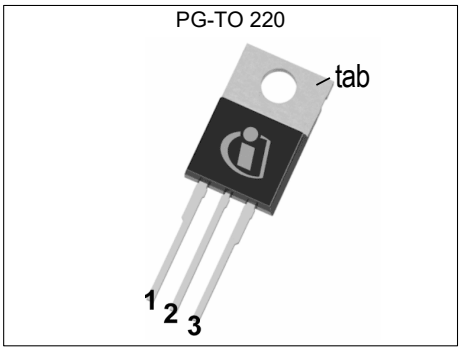
英飞凌MOSFET功率晶体管

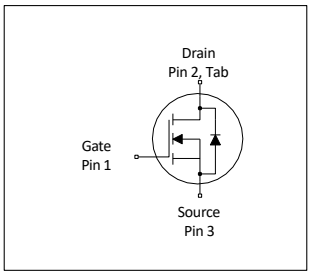
英飞凌IPP60R099P7 600V CoolMOS™ P7 功率晶体管



CoolMOS™ 第 7 代平台是高压功率 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。600V CoolMOS™ P7 系列是 CoolMOS™ P6 的后续产品。它将快速开关 SJ MOSFET 的优点与出色的易用性相结合，例如极低的振铃趋势、出色的体二极管抗硬换向能力和卓越的 ESD 能力。此外，极低的开关和传导损耗使开关应用更加高效、紧凑和低温。

特性

- 换向坚固耐用，适用于硬开关和软开关（PFC 和 LLC）
- 显著减少开关和传导损耗
- 卓越的静电放电稳健性 > 2 kV (HBM) 适用于所有产品
- 低 $R_{DS(on)}$ *A（低于 1Ohm*mm²）使 $R_{DS(on)}$ / 封装产品优于同类产品
- 完全符合用于工业应用的 JEDEC



优点

- 低振铃趋势使其在 PFC 和 PWM 阶段均可实现易于使用和快速设计
- 开关和传导损耗低，简化了热管理
- 由于采用 > 2 kV 的 ESD 保护技术，可以使用封装更小、制造质量更高的产品，实现更高的功率密度解决方案
- 适用于多种应用和功率范围

潜在应用

例如，PFC 级、硬开关 PWM 级和谐振开关级。PC Silverbox、适配器、LCD & PDP TV、照明、服务器、电信和 UPS。

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
$R_{DS(on),max}$	99	mΩ
$Q_{g,typ}$	45	nC
$I_{D,pulse}$	100	A
E_{oss} @ 400V	5.0	µJ
Body diode di_F/dt	900	A/µs

Type / Ordering Code	Package	Marking	Related Links
IPP60R099P7	PG-TO 220-3	60R099P7	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）。

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1 最大额定值

除非另有规定，T_j = 25 °C

表 2 最大额定值

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current[1]	I_D	- -	- -	31 20	A	T_C=25°C T_C=100°C
Pulsed drain current[2]	$I_{D,pulse}$	-	-	100	A	T_C=25°C
Avalanche energy, single pulse	E_{AS}	-	-	105	mJ	I_D=5.1A; V_{DD}=50V; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.53	mJ	I_D=5.1A; V_{DD}=50V; see table 10
Avalanche current, single pulse	I_{AS}	-	-	5.1	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	80	V/ns	V_{DS}=0...400V
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}	-	-	117	W	T_C=25°C
Storage temperature	T_{stg}	-55	-	150	°C	-
Operating junction temperature	T_j	-55	-	150	°C	-
Mounting torque	-	-	-	60	Ncm	M3 and M3.5 screws
Continuous diode forward current	I_S	-	-	31	A	T_C=25°C
Diode pulse current[2]	$I_{S,pulse}$	-	-	100	A	T_C=25°C
Reverse diode dv/dt[3]	dv/dt	-	-	50	V/ns	V_{DS}=0...400V, I_{SD}<=31A, T_j=25°C see table 8
Maximum diode commutation speed	di_F/dt	-	-	900	A/µs	V_{DS}=0...400V, I_{SD}<=31A, T_j=25°C see table 8
Insulation withstand voltage	V_{ISO}	-	-	n.a.	V	V_{rms}, T_C=25°C, t=1min

[1] 受$T_{j,max}$限制。最大占空比 D = 0.50
[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}	-	-	1.07	°C/W	-
Thermal resistance, junction - ambient	R_{thJA}	-	-	62	°C/W	leaded
Thermal resistance, junction - ambient for SMD version	R_{thJA}	-	-	-	°C/W	-
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 °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	3.5	4	V	V_{DS}=V_{GS}, I_D=0.53mA
Zero gate voltage drain current	I_{DSS}	- -	- 10	1 -	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	$R_{DS(on)}$	- -	0.077 0.180	0.099 -	Ω	V_{GS}=10V, I_D=10.5A, T_j=25°C V_{GS}=10V, I_D=10.5A, T_j=150°C
Gate resistance	R_G	-	5.9	-	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}	-	1952	-	pF	V_{GS}=0V, V_{DS}=400V, f=250kHz
Output capacitance	C_{oss}	-	33	-	pF	V_{GS}=0V, V_{DS}=400V, f=250kHz
Effective output capacitance, energy related[1)]	$C_{o(er)}$	-	62	-	pF	V_{GS}=0V, V_{DS}=0...400V
Effective output capacitance, time related[2)]	$C_{o(tr)}$	-	648	-	pF	I_D=constant, V_{GS}=0V, V_{DS}=0...400V
Turn-on delay time	$t_{d(on)}$	-	23	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=10.5A, R_G=5.3Ω; see table 9
Rise time	t_r	-	15	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=10.5A, R_G=5.3Ω; see table 9
Turn-off delay time	$t_{d(off)}$	-	89	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=10.5A, R_G=5.3Ω; see table 9
Fall time	t_f	-	5	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=10.5A, R_G=5.3Ω; 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}	-	10	-	nC	V_{DD}=400V, I_D=10.5A, V_{GS}=0 to 10V
Gate to drain charge	Q_{gd}	-	14	-	nC	V_{DD}=400V, I_D=10.5A, V_{GS}=0 to 10V
Gate charge total	Q_g	-	45	-	nC	V_{DD}=400V, I_D=10.5A, V_{GS}=0 to 10V
Gate plateau voltage	$V_{plateau}$	-	5.2	-	V	V_{DD}=400V, I_D=10.5A, V_{GS}=0 to 10V

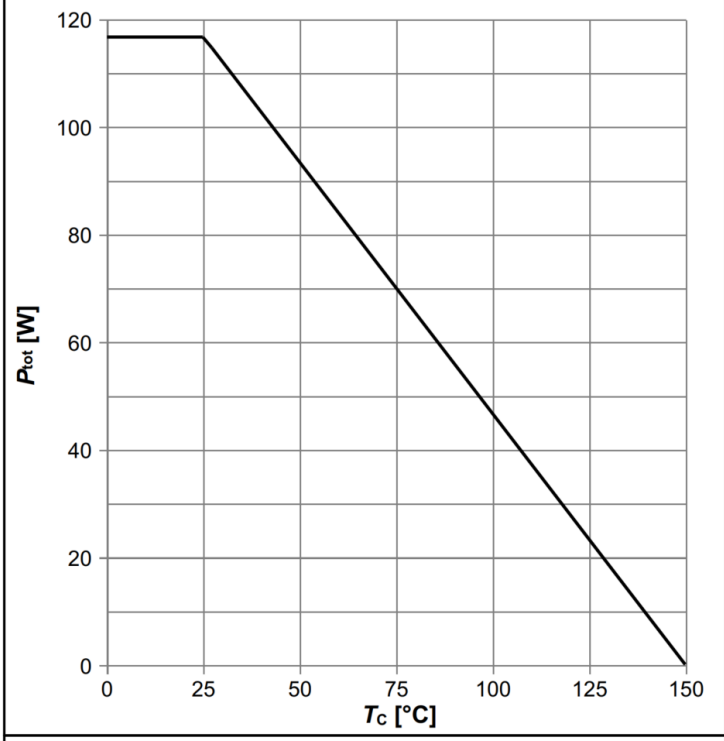
[1)] $C_{o(er)}$ 是一个固定电容，当 V_{DS} 从 0 上升至 400 V 时，其存储能量与 C_{oss} 相同
[2)] $C_{o(tr)}$ 是一个固定电容，当 V_{DS} 从 0 上升至 400 V 时，其充电时间与 C_{oss} 相同

表 7　　反向二极管特性

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.9	-	V	V_{GS}=0V, I_F=10.5A, T_j=25°C
Reverse recovery time	t_{rr}	-	211	-	ns	V_R=400V, I_F=4A, di_F/dt=100A/µs; see table 8
Reverse recovery charge	Q_{rr}	-	2.1	-	µC	V_R=400V, I_F=4A, di_F/dt=100A/µs; see table 8
Peak reverse recovery current	I_{rrm}	-	20.1	-	A	V_R=400V, I_F=4A, di_F/dt=100A/µs; see table 8

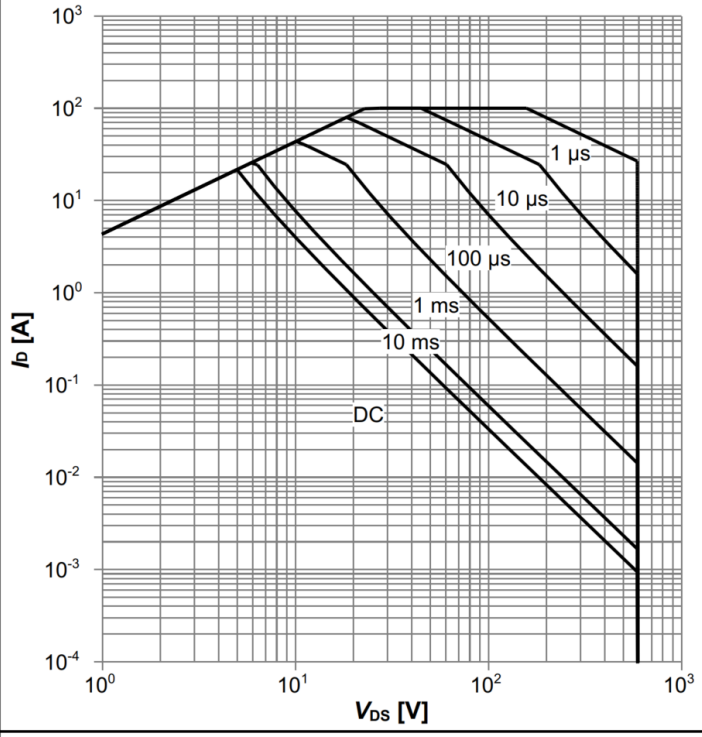
4 电气特性图

Diagram 1: Power dissipation



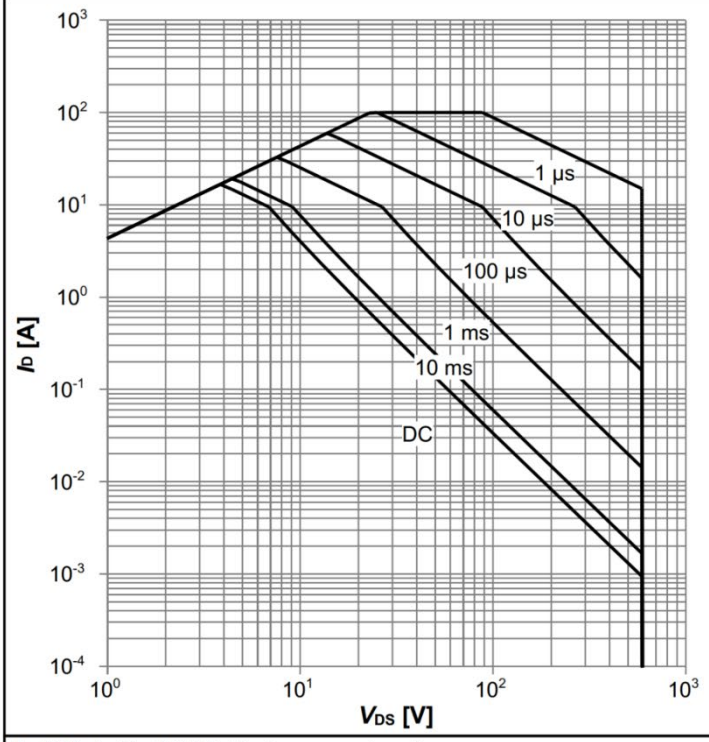
$P_{tot}=f(T_C)$

Diagram 2: Safe operating area



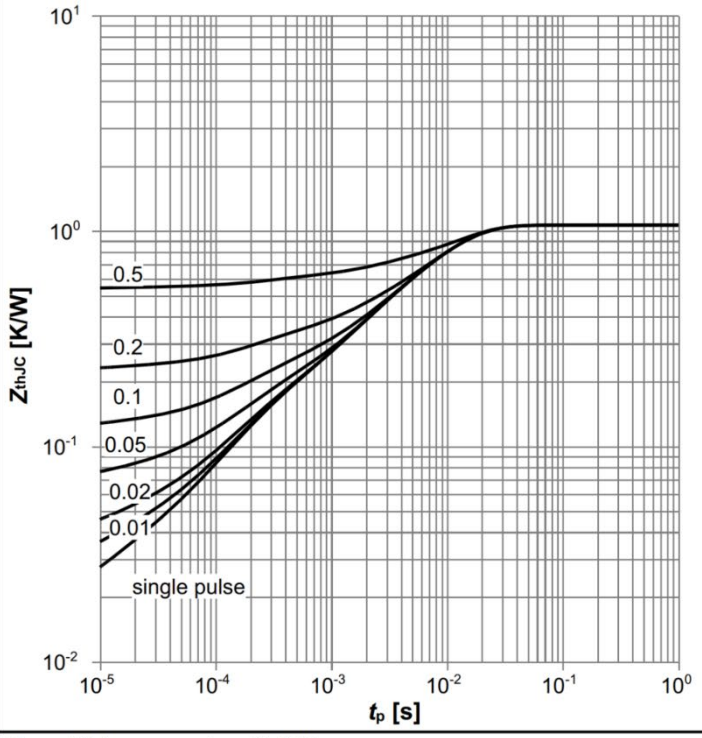
$I_D=f(V_{DS})$; T_C=25 °C; D=0; parameter: t_p

Diagram 3: Safe operating area



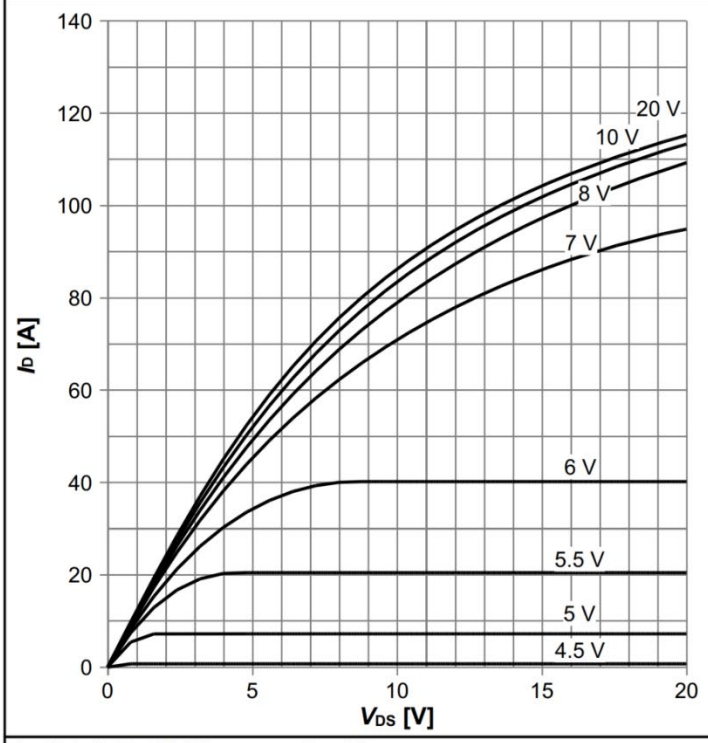
$I_D=f(V_{DS})$; T_C=80 °C; D=0; parameter: t_p

Diagram 4: Max. transient thermal impedance



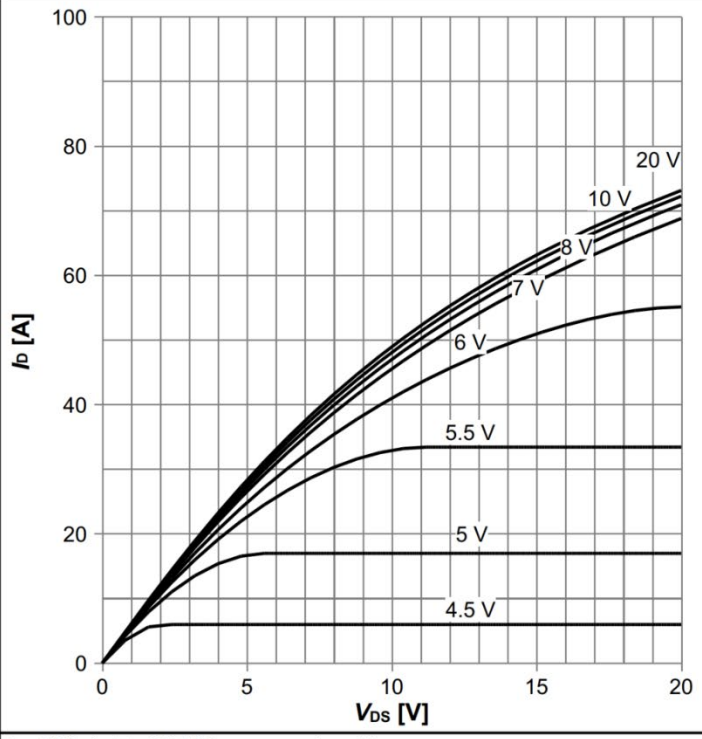
$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

Diagram 5: Typ. output characteristics



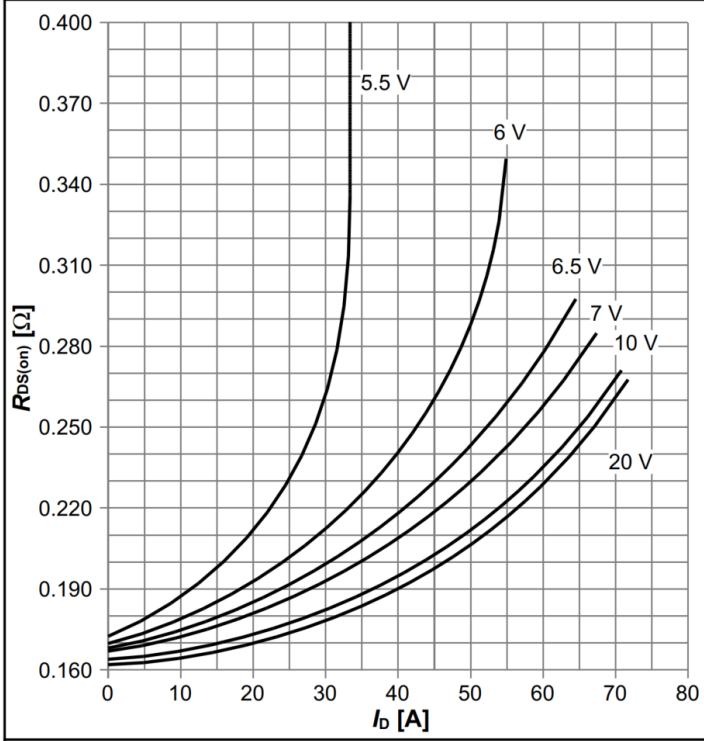
$I_D=f(V_{DS})$; $T_j=25$ °C; parameter: V_{GS}

Diagram 6: Typ. output characteristics



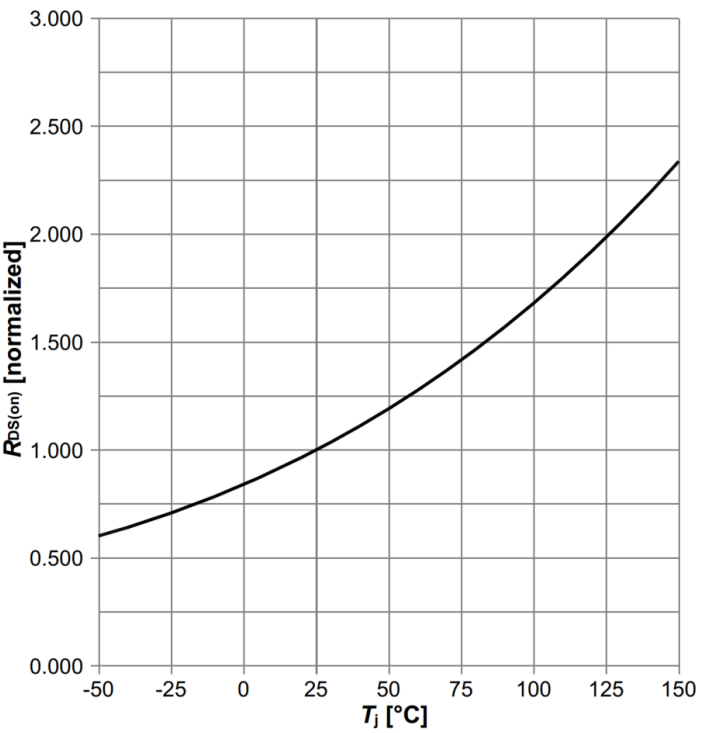
$I_D=f(V_{DS})$; $T_j=125$ °C; parameter: V_{GS}

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



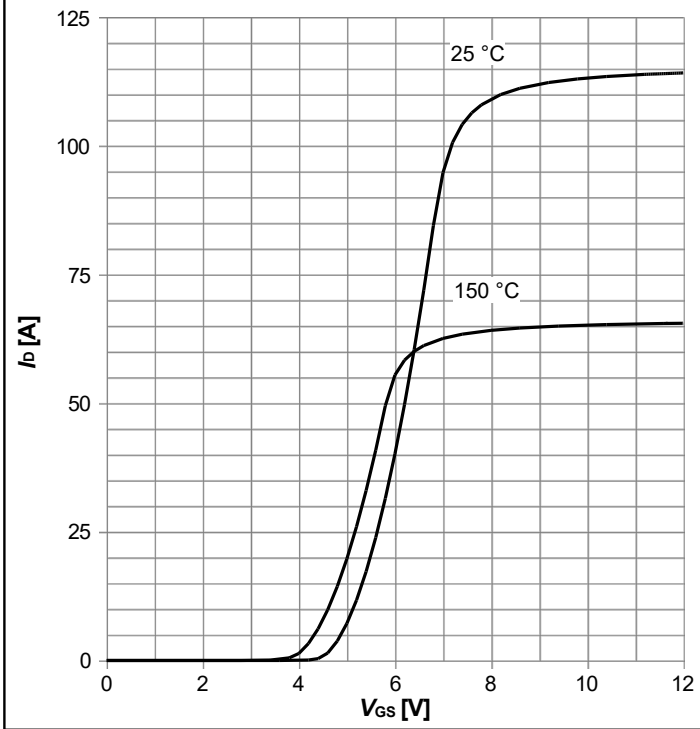
$R_{DS(on)}=f(I_D)$; $T_j=125$ °C; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



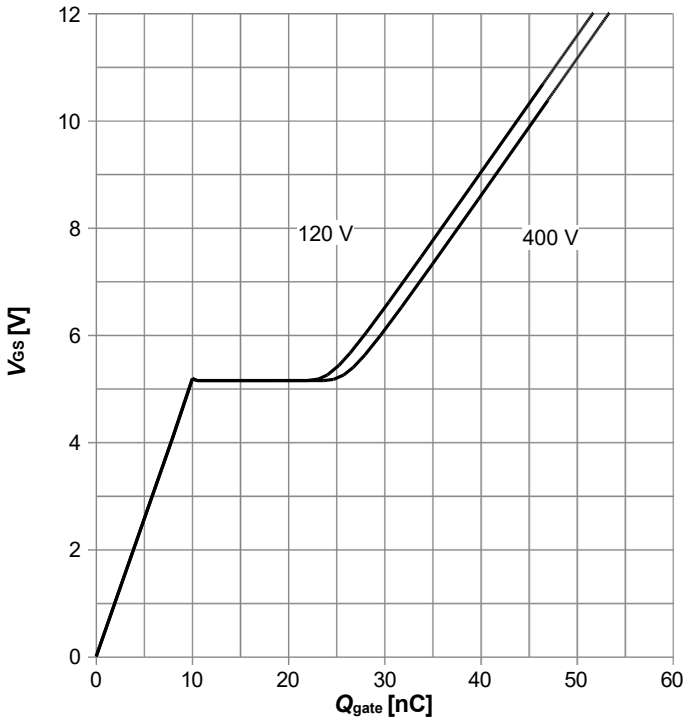
$R_{DS(on)}=f(T_j)$; $I_D=10.5$ A; $V_{GS}=10$ V

Diagram 9: Typ. transfer characteristics



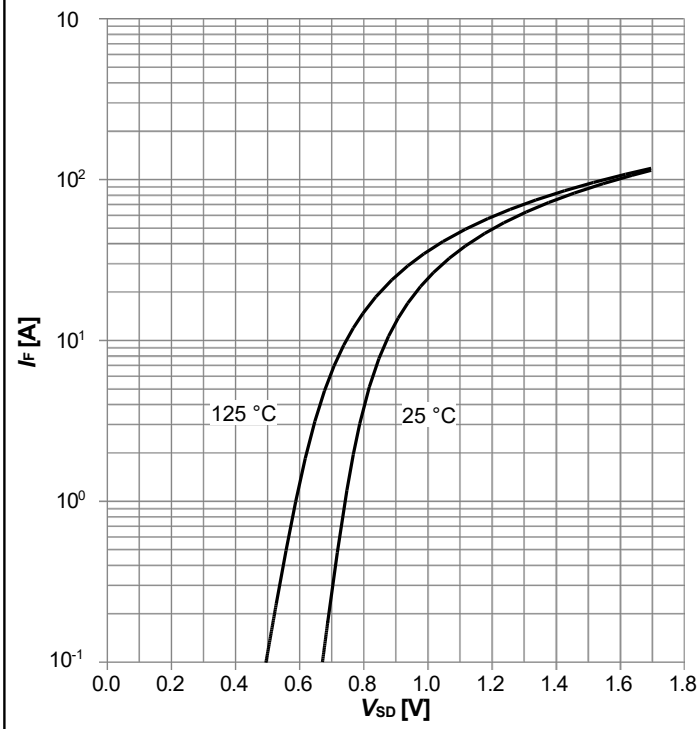
$I_D=f(V_{GS})$; V_{DS}=20V; parameter: T_j

Diagram 10: Typ. gate charge



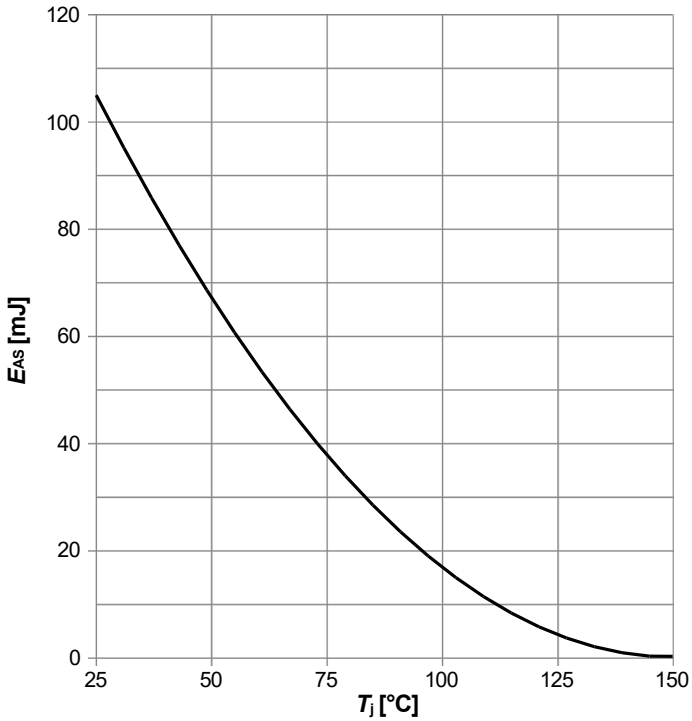
$V_{GS}=f(Q_{gate})$; I_D=10.5 A pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



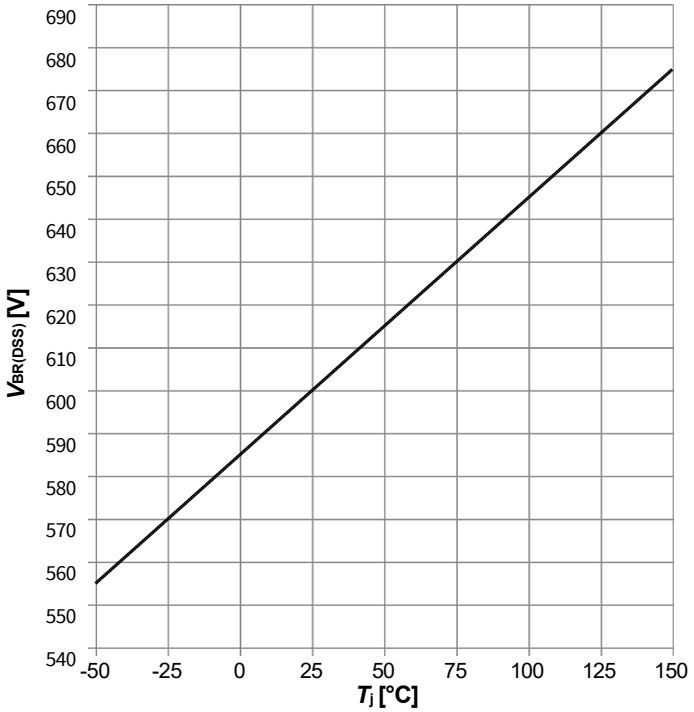
$I_F=f(V_{SD})$; parameter: T_j

Diagram 12: Avalanche energy



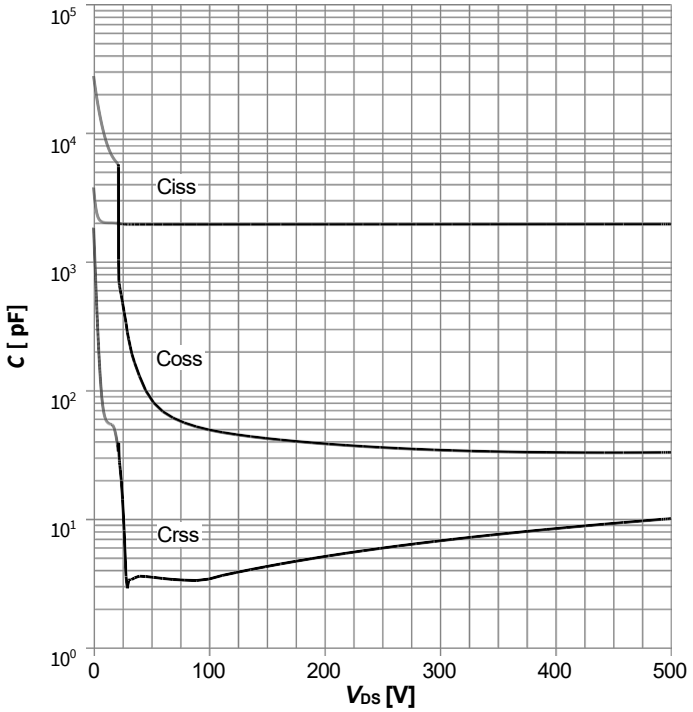
$E_{AS}=f(T_j)$; I_D=5.1 A; V_{DD}=50 V

Diagram 13: Drain-source breakdown voltage



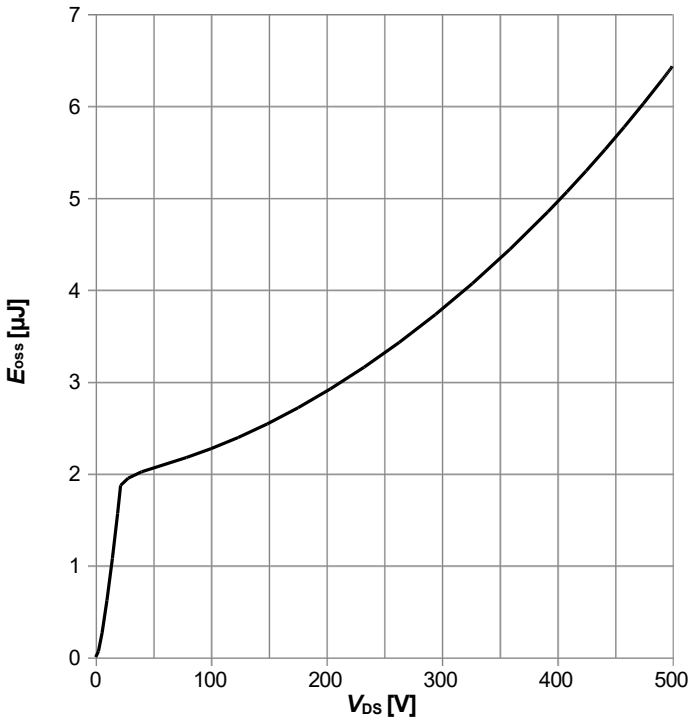
$V_{BR(DSS)}$=f(T_j); I_D=1 mA

Diagram 14: Typ. capacitances



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

Diagram 15: Typ. Coss stored energy



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

5 测试电路

表 8 二极管特性

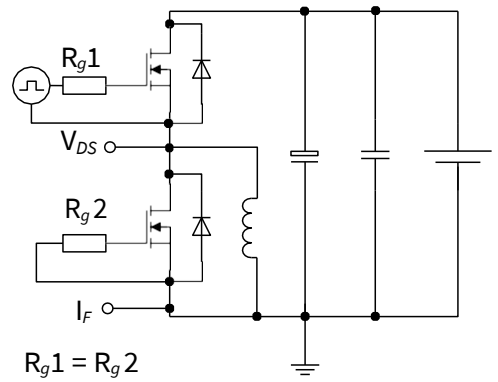
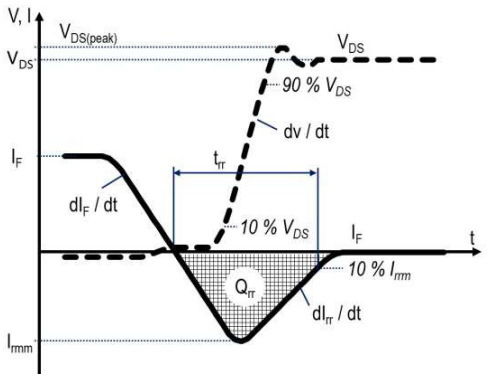
Test circuit for diode characteristics	Diode recovery waveform
	

表 9 切换时间

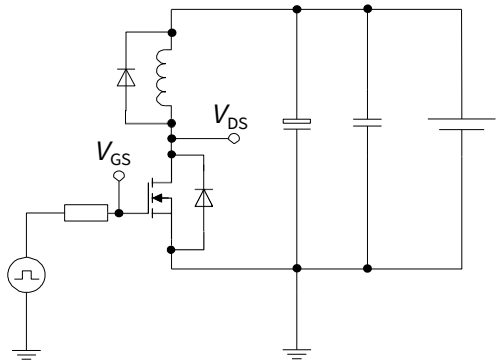
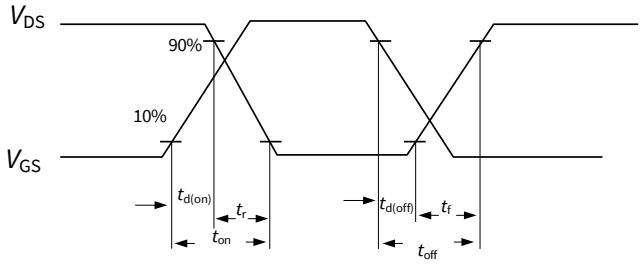
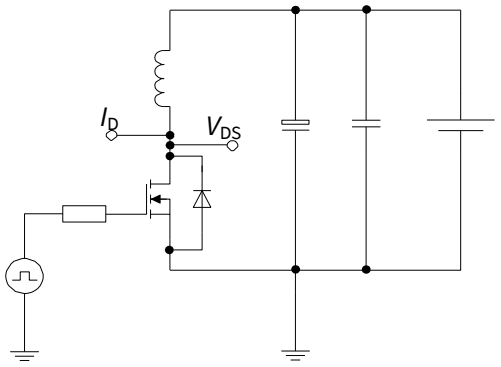
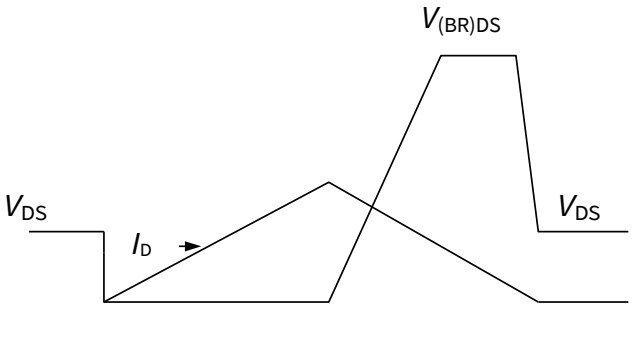
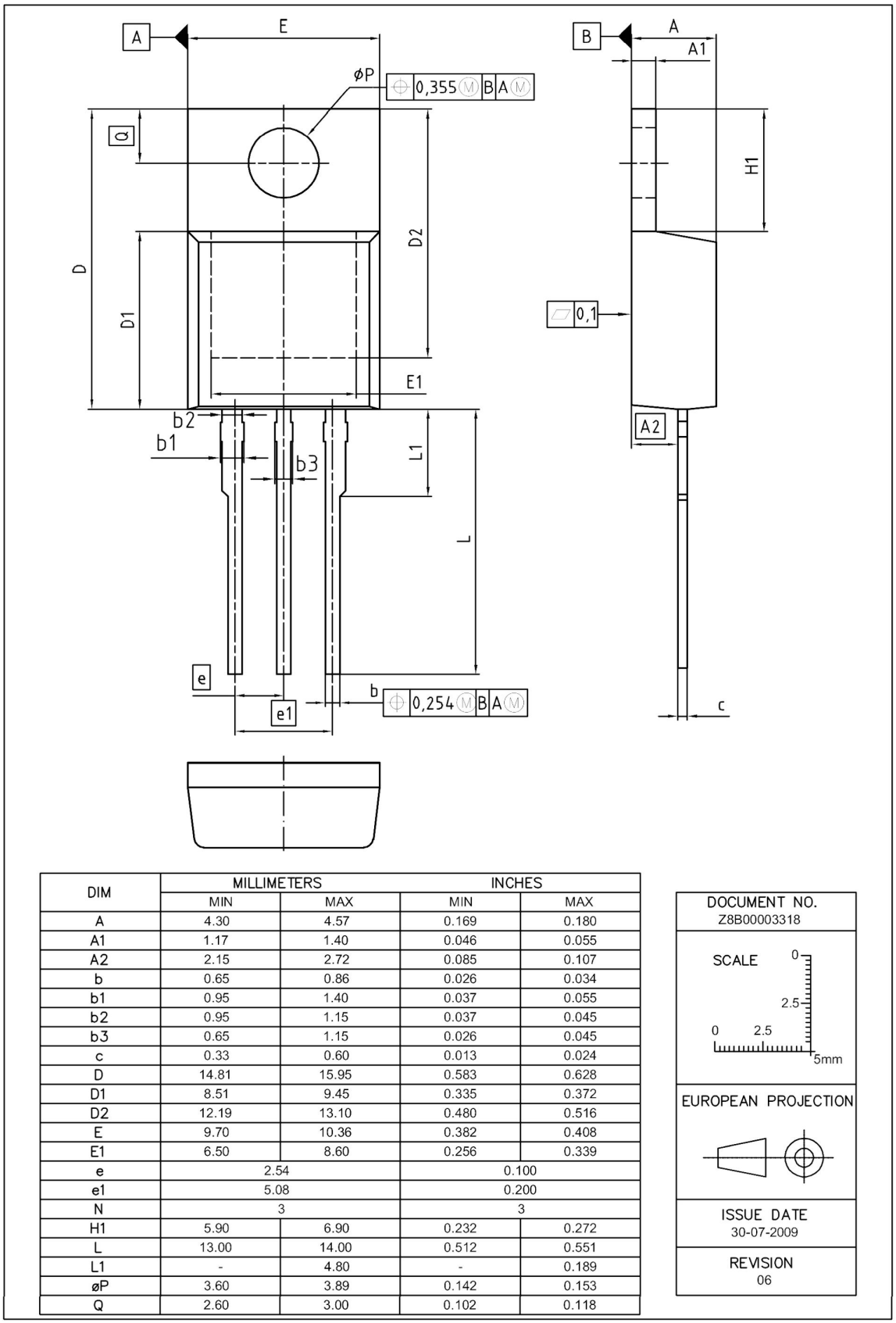
Switching times test circuit for inductive load	Switching times waveform
	

表 10 非钳位感性负载

Unclamped inductive load test circuit	Unclamped inductive waveform
	

6 封装外形



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
øP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

DOCUMENT NO.
Z8B00003318

SCALE 0 2.5 0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
30-07-2009

REVISION
06

图 1 PG-TO 220-3 外形图，尺寸单位为毫米/英寸

7 附录 A

表 11 相关链接

- **IFX CoolMOS P7 网页:** www.infineon.com
- **IFX CoolMOS P7 应用说明:** www.infineon.com
- **IFX CoolMOS P7 仿真模型:** www.infineon.com
- **IFX 设计工具：** www.infineon.com

修订记录

IPP60R099P7

Revision: 2018-05-15, Rev. 2.1

历史修订版本

Revision	Date	Subjects (major changes since last revision)
2.0	2017-05-18	Release of final version
2.1	2018-05-15	Updated diagram scalings; Nomenclature of product qualification grade was changed

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