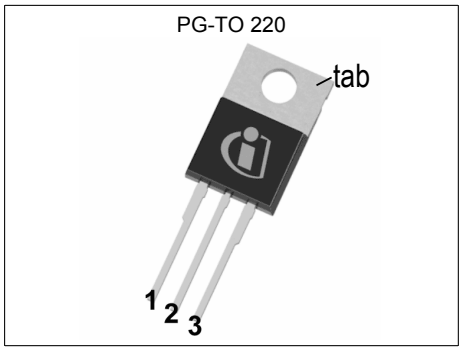
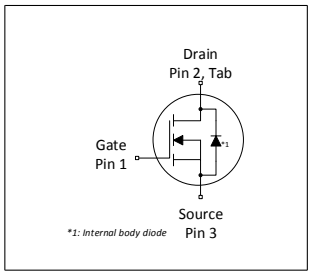
MOSFET

600V CoolMOS™ SJ S7 Power Device



IPP60R022S7 enables the best price performance for low frequency switching applications. CoolMOS™ S7 boasts the lowest Rdson values for a HV SJ MOSFET, with distinctive increase of energy efficiency.

CoolMOS™ S7 is optimized for “static switching” and high current applications. It is an ideal fit for solid state relay and circuit breaker designs as well as for line rectification in SMPS and inverter topologies.



Features

- CoolMOS™ S7 technology enables 22mΩ $R_{DS(on)}$ in the smallest footprint
- Optimized price performance in low frequency switching applications
- High pulse current capability
- TO220 package with total Pb-free die attach

Benefits

- Minimized conduction losses (eliminate / reduce heat sink)
- Increased system performance
- More compact and easier design
- Lower BOM or/and TCO over prolonged life time

Compared to electromechanical devices:
- Faster switching times
- More reliability and longer system life time
- Shock & Vibration resistance
- No contact arcing, bouncing or degradation over life time

Potential applications

- Solid state relays and circuit breakers
- Line rectification in high power/performance applications e.g. Computing, Telecom, UPS and Solar

Product validation

Fully qualified according to JEDEC for Industrial Applications

Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.

Table 1 Key Performance Parameters

Parameter	Value	Unit
$R_{DS(on),max}$	22	mΩ
$Q_{g,typ}$	150	nC
V_{SD}	0.83	V
Pulsed I_{SD}, I_{DS}	375	A

Type / Ordering Code	Package	Marking	Related Links
IPP60R022S7	PG-TO220-3	60R022S7	see Appendix A

Table of Contents

1 Maximum ratings

at T_j = 25°C, unless otherwise specified

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain current rating	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[1]	$I_{D,pulse}$	-	-	375	A	T_C=25°C
Avalanche energy, single pulse	E_{AS}	-	-	289	mJ	I_D=3.8A; V_{DD}=50V; see table 10
Avalanche current, single pulse	I_{AS}	-	-	3.8	A	-
MOSFET dv/dt ruggedness[2]	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	T_j	-55	-	150	°C	-
Mounting torque	-	-	-	60	Ncm	M3 and M3.5 screws
Diode forward current rating	I_S	-	-	23	A	T_C=140°C Current is limited by $T_{j\,max}$ = 150°C; Lower case temp does increase current capability
Diode pulse current[1]	$I_{S,pulse}$	-	-	375	A	T_C=25°C
Reverse diode dv/dt[3]	dv/dt	-	-	5	V/ns	V_{DS}=0 to 300V, I_{SD}<=23A, T_j=25°C see table 8
Maximum diode commutation speed	di_f/dt	-	-	820	A/µs	V_{DS}=0 to 300V, I_{SD}<=23A, T_j=25°C see table 8
Insulation withstand voltage	V_{ISO}	-	-	n.a.	V	V_{rms}, T_C=25°C, t=1min

[1] Pulse width t_p limited by $T_{j,max}$
[2] The dv/dt has to be limited by appropriate gate resistor
[3] Identical low side and high side switch

2 Thermal characteristics

Table 3 Thermal characteristics

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	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 Electrical characteristics

at T_j=25°C, unless otherwise specified

Table 4 Static characteristics

For applications with applied blocking voltage >70% of the specified blocking voltage, it is required that the customer evaluates the impact of cosmic radiation effect in early design phase and contacts the Infineon sales office for the necessary technical support by Infineon

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=1.44mA
Zero gate voltage drain current	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 0.047	0.022 -	Ω	V_{GS}=12V, I_D=23A, T_j=25°C V_{GS}=12V, I_D=23A, T_j=150°C
Gate resistance	R_G	-	0.80	-	Ω	f=1MHz, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	5639	-	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[1)]	$C_{o(er)}$	-	303	-	pF	V_{GS}=0V, V_{DS}=0 to 300V
Effective output capacitance, time related[2)]	$C_{o(tr)}$	-	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	$t_{d(on)}$	-	30	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=23A, R_G=5.3Ω; see table 9
Rise time	t_r	-	9	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=23A, R_G=5.3Ω; see table 9
Turn-off delay time	$t_{d(off)}$	-	150	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=23A, R_G=5.3Ω; see table 9
Fall time	t_f	-	9	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=23A, R_G=5.3Ω; see table 9

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	31	-	nC	V_{DD}=300V, I_D=23A, V_{GS}=0 to 12V
Gate to drain charge	Q_{gd}	-	50	-	nC	V_{DD}=300V, I_D=23A, V_{GS}=0 to 12V
Gate charge total	Q_g	-	150	-	nC	V_{DD}=300V, I_D=23A, V_{GS}=0 to 12V
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	V_{DD}=300V, I_D=23A, V_{GS}=0 to 12V

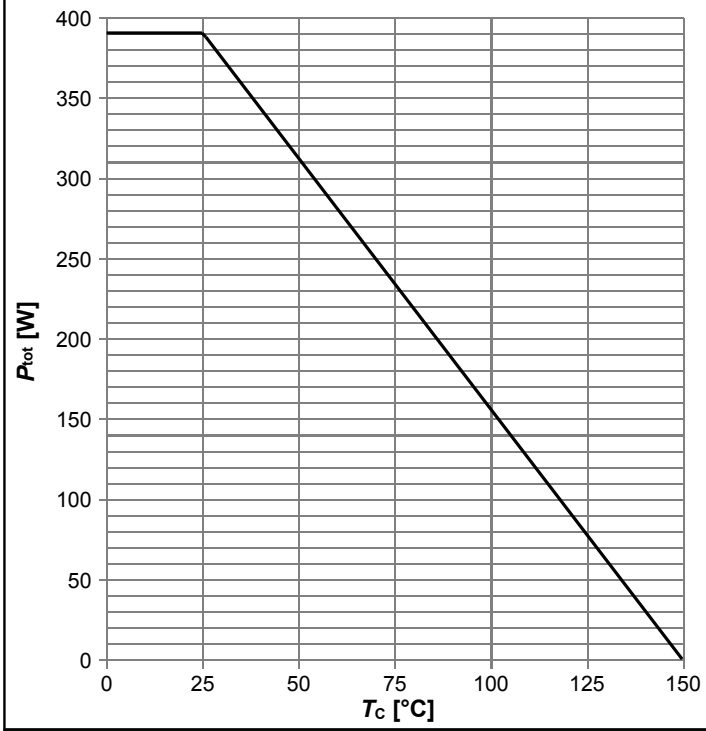
[1)] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 300V
[2)] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 300V

Table 7 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.83	-	V	V_{GS}=0V, I_F=23A, T_j=25°C
Reverse recovery time	t_{rr}	-	460	-	ns	V_R=300V, I_F=23A, di_F/dt=100A/µs; see table 8
Reverse recovery charge	Q_{rr}	-	9	-	µC	V_R=300V, I_F=23A, di_F/dt=100A/µs; see table 8
Peak reverse recovery current	I_{rrm}	-	40	-	A	V_R=300V, I_F=23A, di_F/dt=100A/µs; see table 8

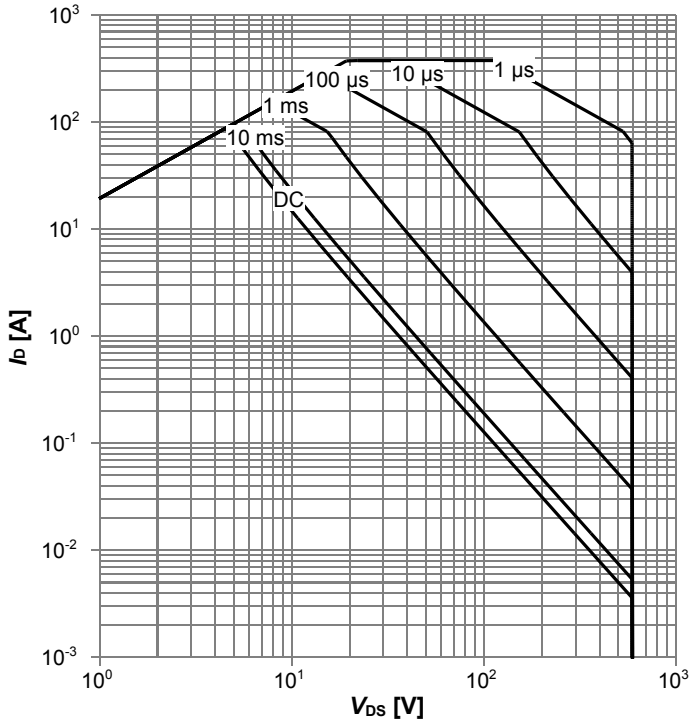
4 Electrical characteristics diagrams

Diagram 1: Power dissipation



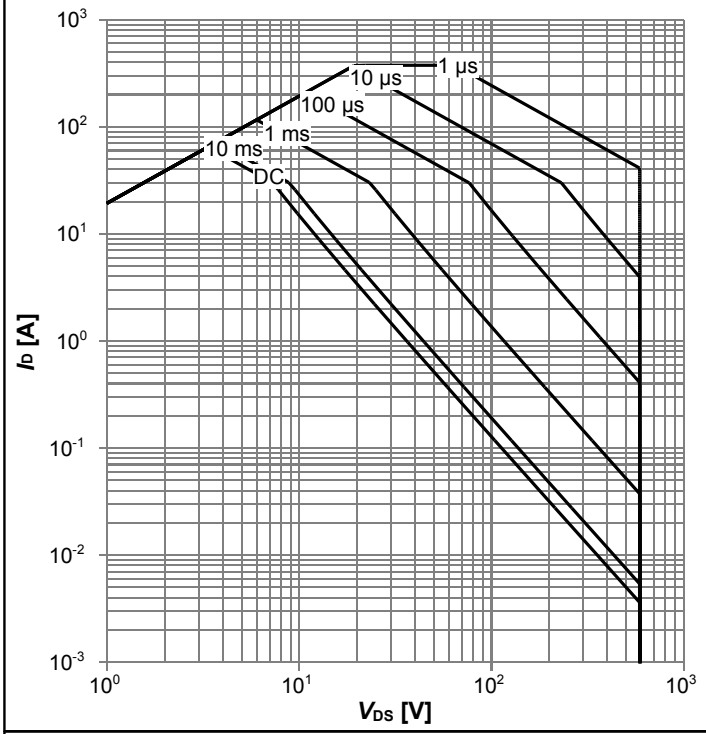
$P_{tot}=f(T_C)$

Diagram 2: Safe operating area



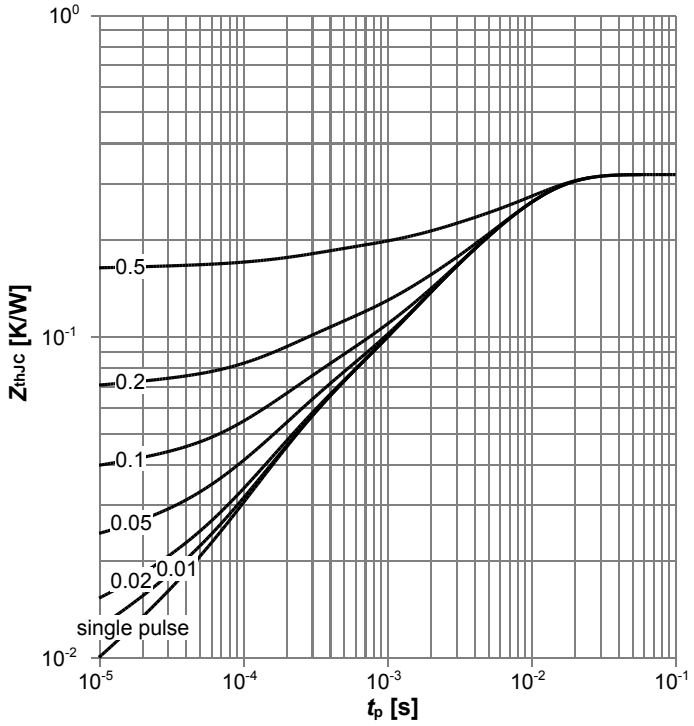
$I_D=f(V_{DS})$; T_C=25 °C; D=0; parameter: t_p

Diagram 3: Safe operating area



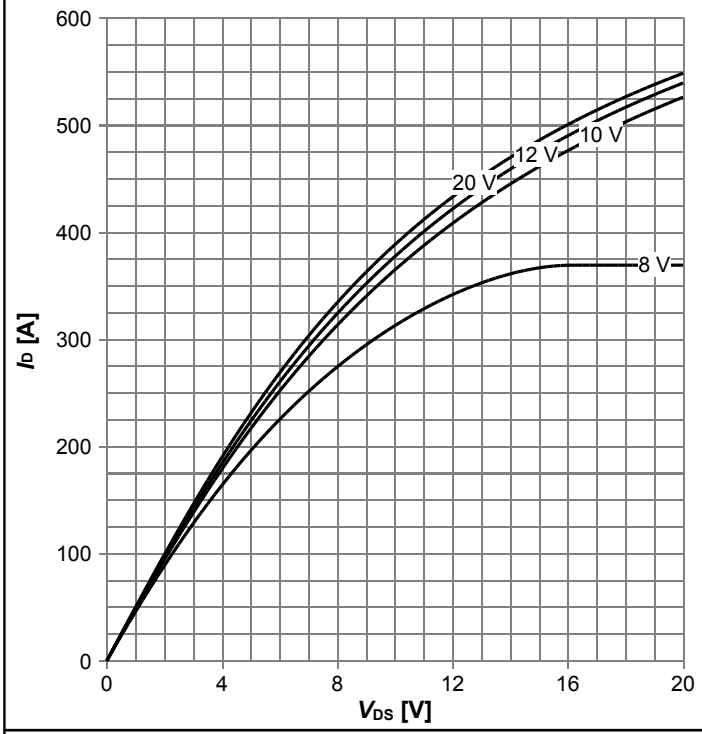
$I_D=f(V_{DS})$; T_C=80 °C; D=0; parameter: t_p

Diagram 4: Max. transient thermal impedance



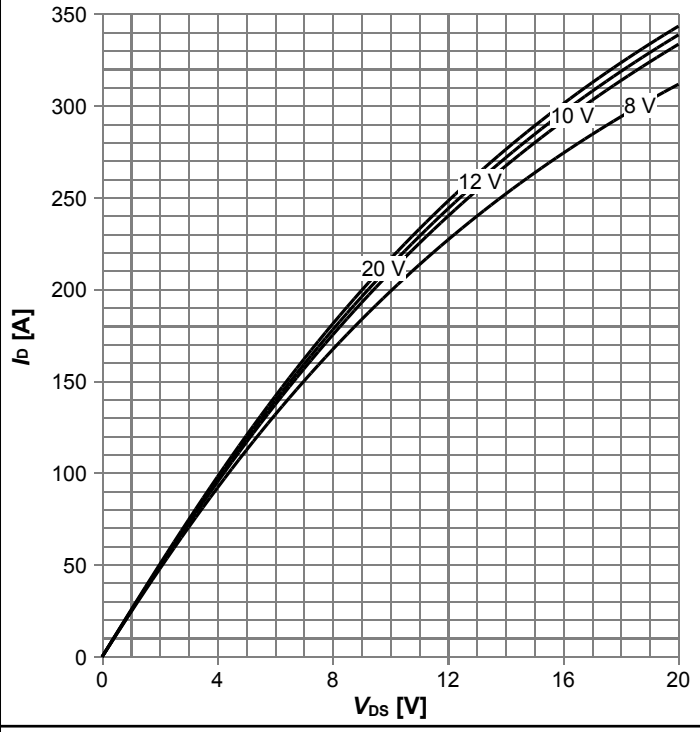
$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

Diagram 5: Typ. output characteristics



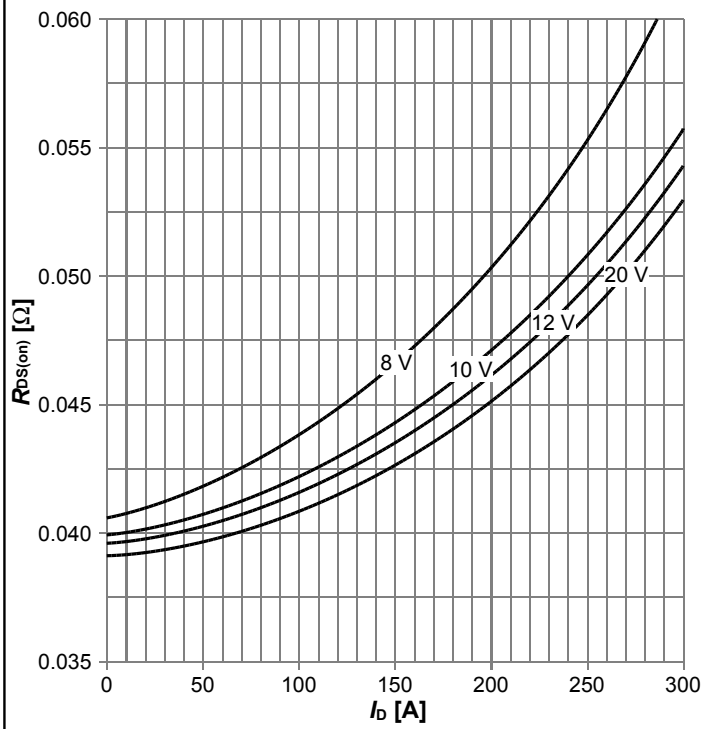
$I_D=f(V_{DS})$; $T_j=25$ °C; parameter: V_{GS}

Diagram 6: Typ. output characteristics



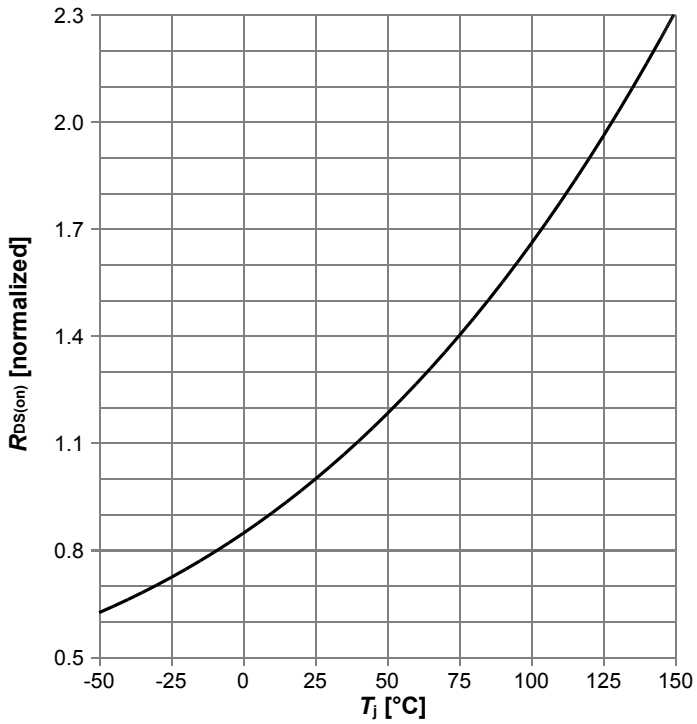
$I_D=f(V_{DS})$; $T_j=125$ °C; parameter: V_{GS}

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



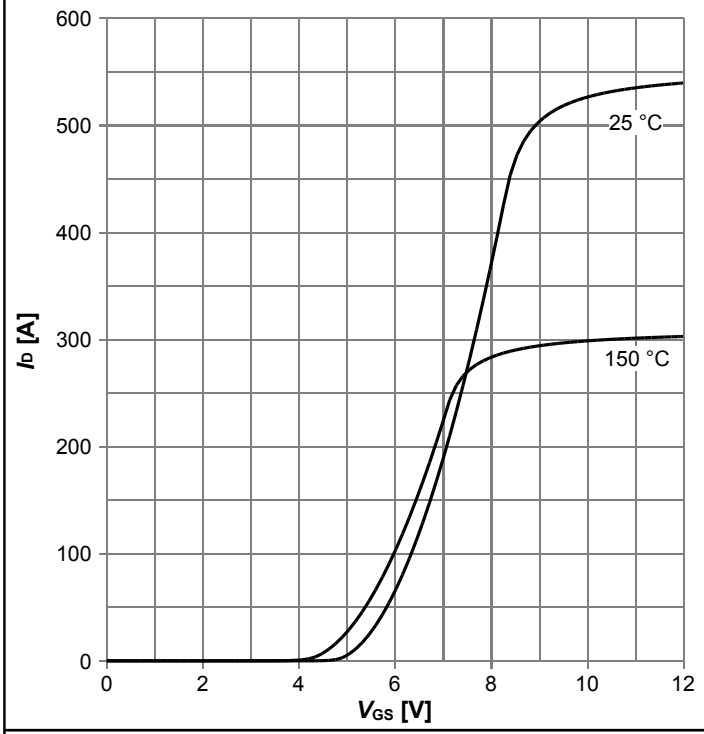
$R_{DS(on)}=f(I_D)$; $T_j=125$ °C; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



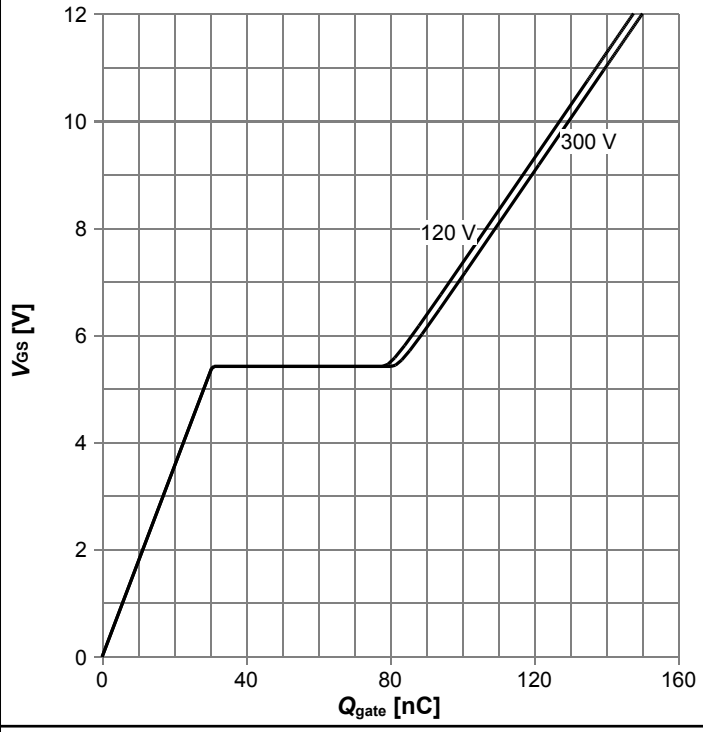
$R_{DS(on)}=f(T_j)$; $I_D=23.0$ A; $V_{GS}=12$ V

Diagram 9: Typ. transfer characteristics



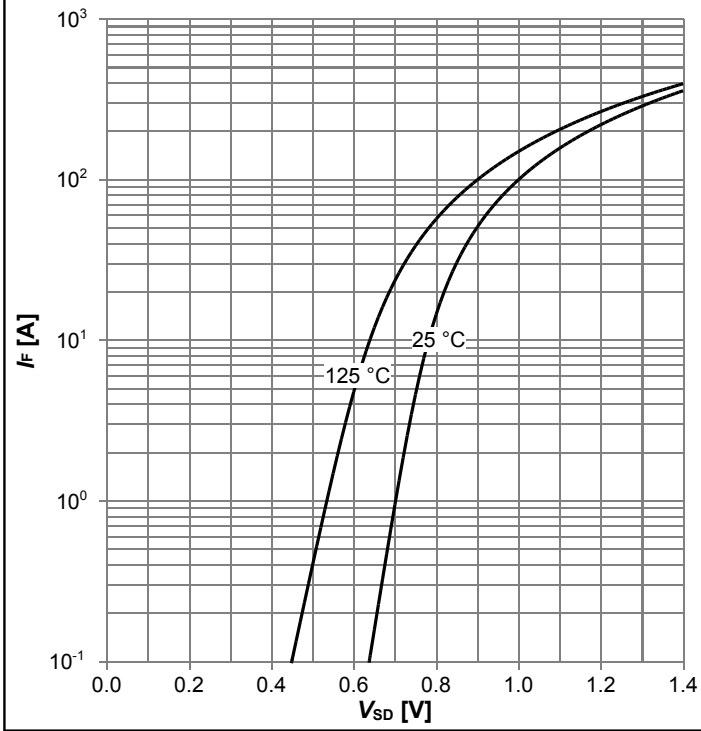
I_D=f(V_{GS}); V_{DS}=20V; parameter: T_j

Diagram 10: Typ. gate charge



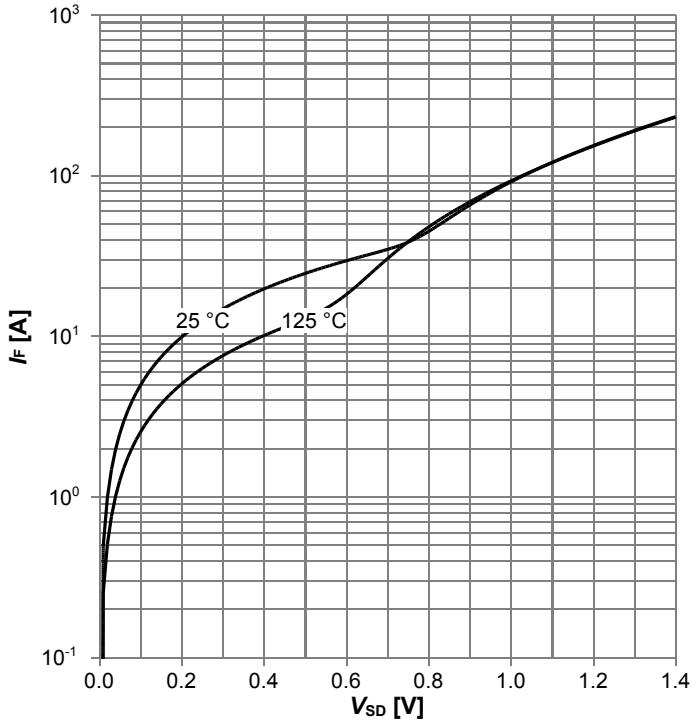
V_{GS}=f(Q_{gate}); I_D=23.0 A pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



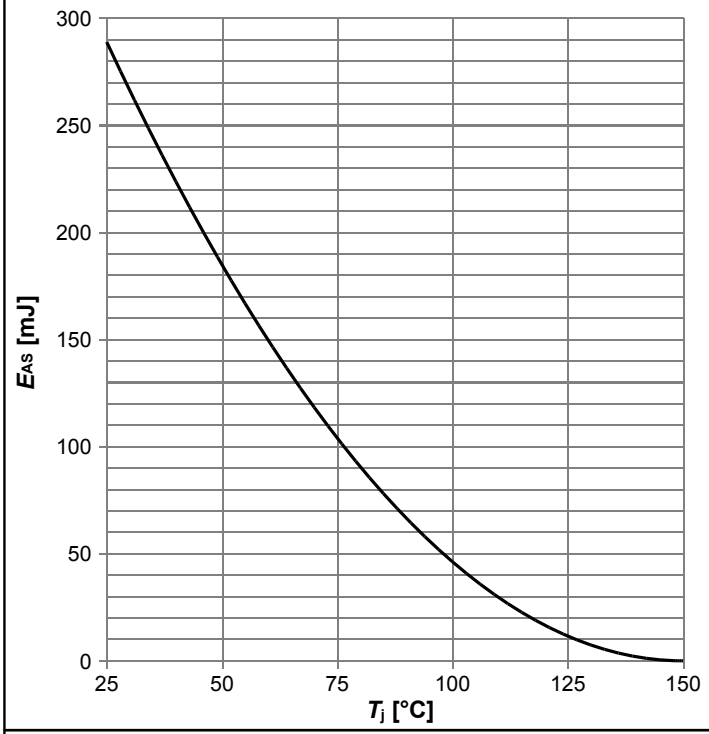
I_F=f(V_{SD}); V_{GS}=0 V; parameter: T_j

Diagram 12: Forward characteristics of reverse diode



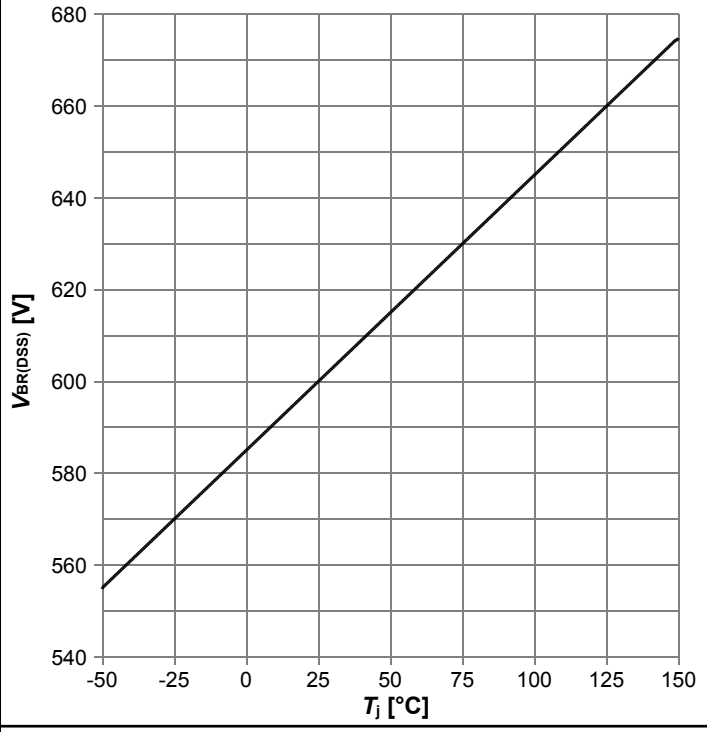
I_F=f(V_{SD}); V_{GS}=12 V; parameter: T_j

Diagram 13: Avalanche energy



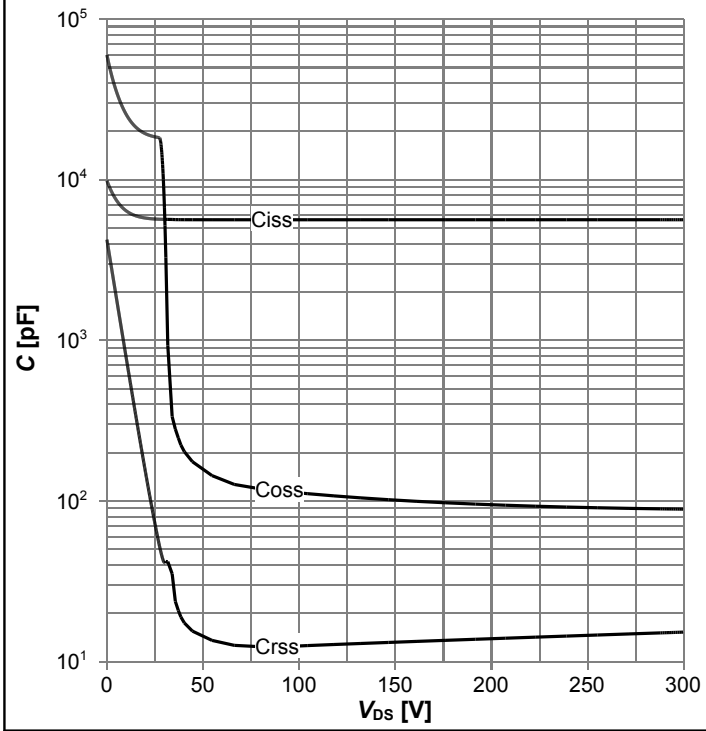
$E_{AS}=f(T_j)$; I_D=3.8 A; V_{DD}=50 V

Diagram 14: Drain-source breakdown voltage



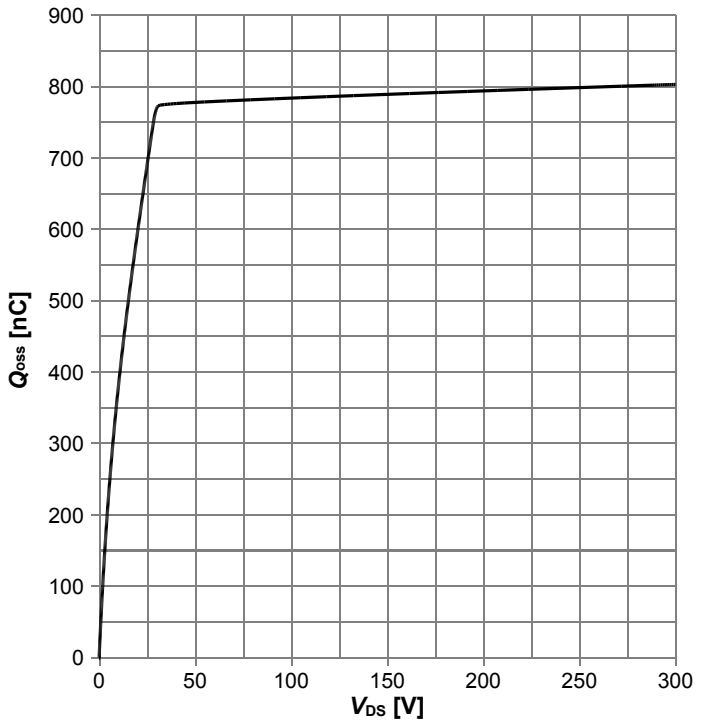
$V_{BR(DSS)}=f(T_j)$; I_D=1 mA

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

5 Test Circuits

Table 8 Diode characteristics

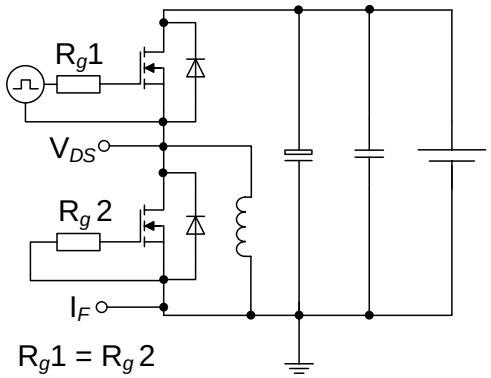
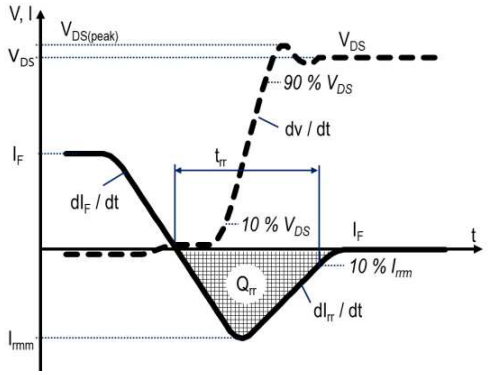
Test circuit for diode characteristics	Diode recovery waveform
	

Table 9 Switching times

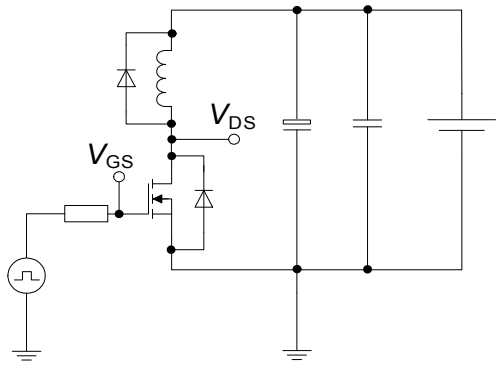
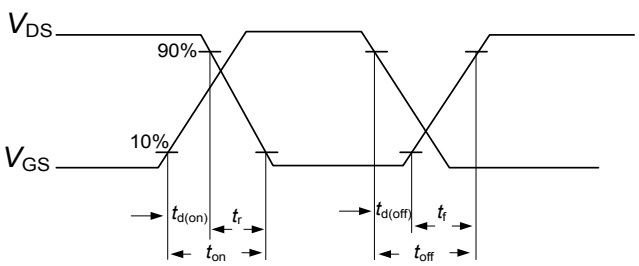
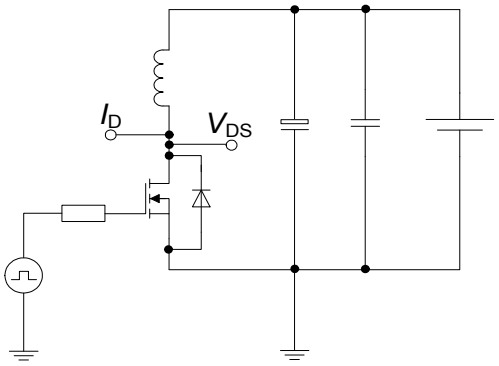
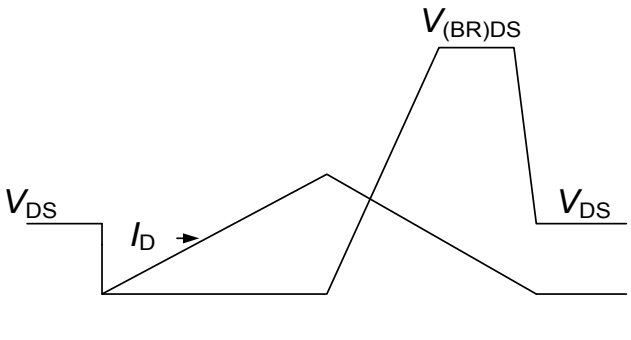
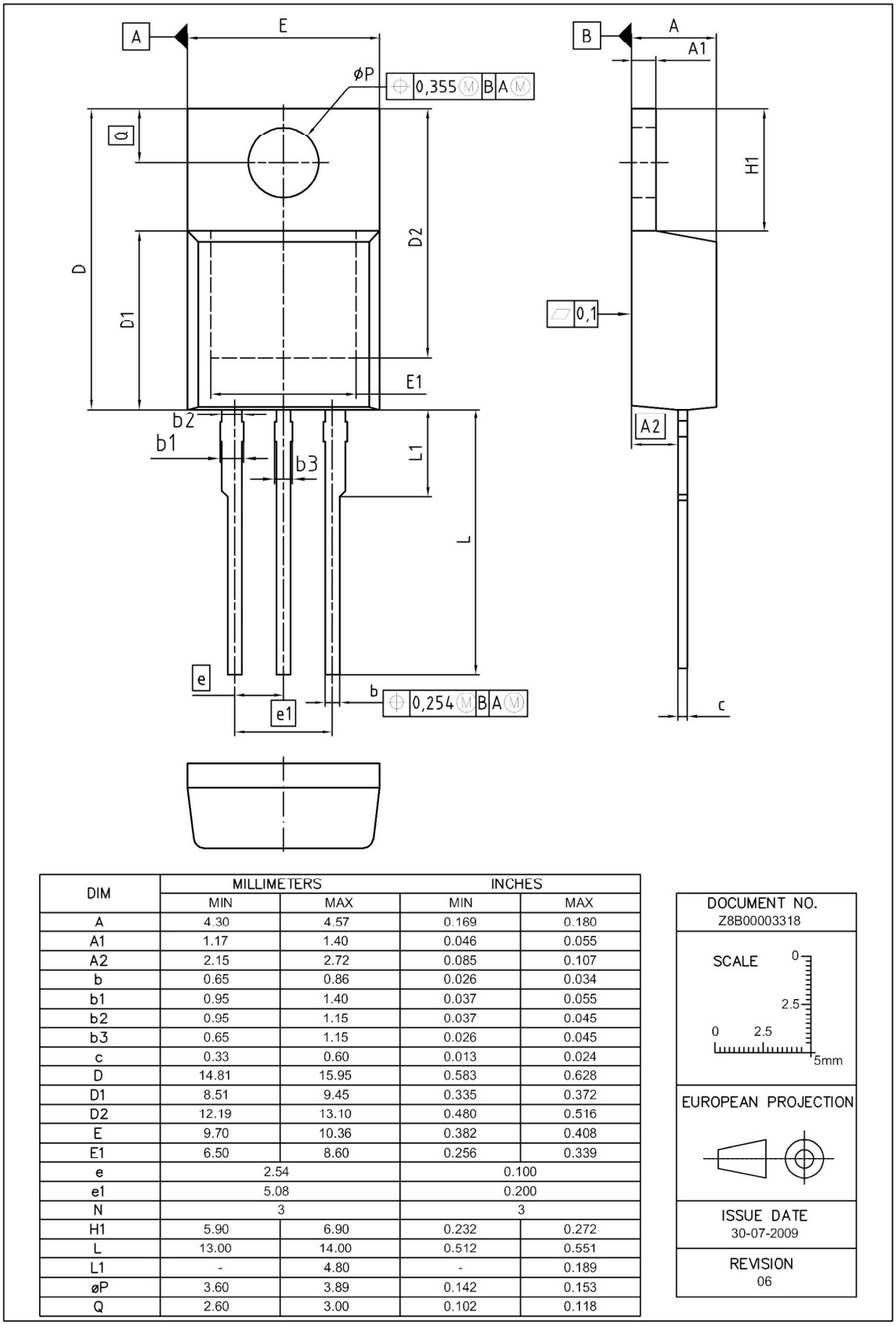
Switching times test circuit for inductive load	Switching times waveform
	

Table 10 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

6 Package Outlines



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

Figure 1 Outline PG-TO220-3, dimensions in mm/inches

7 Appendix A

Table 11 Related Links

- **IFX CoolMOS S7 Webpage:** www.infineon.com
- **IFX CoolMOS S7 application note:** www.infineon.com
- **IFX CoolMOS S7 simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

Revision History

IPP60R022S7

Revision: 2021-10-25, Rev. 2.1

Previous Revision		
Revision	Date	Subjects (major changes since last revision)
2.0	2019-05-07	Release of final version
2.1	2021-10-25	Change of wording regarding breakdown voltage / cosmic ray

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