Infineon

MOSFET

600V CoolMOS™ P6 Power Transistor

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ P6 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The offered devices provide all benefits of a fast switching SJ MOSFET while not sacrificing ease of use. Extremely low switching and conduction losses make switching applications even more efficient, more compact, lighter and cooler.

Features

• Increased MOSFET dv/dt ruggedness
• Extremely low losses due to very low FOM Rdson*Qg and Eoss
• Very high commutation ruggedness
• Easy to use/drive
• Pb-free plating, Halogen free mold compound
• Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

Potential applications

PFC stages, hard switching PWM stages and resonant switching stages for e.g. PC Silverbox, Adapter, LCD & PDP TV, Lighting, Server, Telecom and UPS.
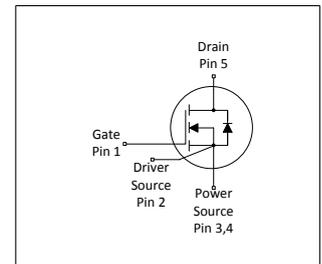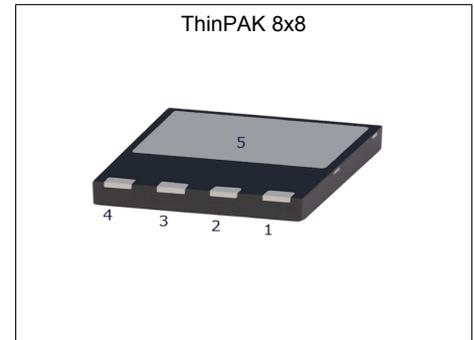
ThinPAK 8x8

Table 1 Key Performance Parameters

Parameter	Value	Unit
V_{DS} @ $T_{j,max}$	650	V
$R_{DS(on),max}$	210	mΩ
$Q_{g,typ}$	37	nC
$I_{D,pulse}$	52	A
E_{oss} @ 400V	4.9	µJ
Body diode di_F/dt	500	A/µs

Type / Ordering Code	Package	Marking	Related Links
IPL60R210P6	PG-VSON-4	6R210P6	see Appendix A

600V CoolMOS™ P6 Power Transistor
IPL60R210P6

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.		
Continuous drain current[1]	I_D	- -	- -	19.2 12.1	A	T_C=25°C T_C=100°C
Pulsed drain current[2]	$I_{D,pulse}$	-	-	52	A	T_C=25°C
Avalanche energy, single pulse	E_{AS}	-	-	419	mJ	I_D=3.3A; V_{DD}=50V; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.63	mJ	I_D=3.3A; V_{DD}=50V; see table 10
Avalanche current, repetitive	I_{AR}	-	-	3.3	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	100	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}	-	-	151	W	T_C=25°C
Storage temperature	T_{stg}	-40	-	150	°C	-
Operating junction temperature	T_j	-40	-	150	°C	-
Continuous diode forward current	I_S	-	-	16.6	A	T_C=25°C
Diode pulse current[2]	$I_{S,pulse}$	-	-	52	A	T_C=25°C
Reverse diode dv/dt[3]	dv/dt	-	-	15	V/ns	V_{DS}=0...400V, I_{SD}<=I_S, T_j=25°C see table 8
Maximum diode commutation speed	di_F/dt	-	-	500	A/µs	V_{DS}=0...400V, I_{SD}<=I_S, T_j=25°C see table 8

[1] Limited by $T_{j\,max}$. Maximum duty cycle D=0.75
[2] Pulse width t_p limited by $T_{j,max}$
[3] Identical low side and high side switch with identical R_G

2 Thermal characteristics

Table 3 Thermal characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.83	°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}	-	-	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 MSL2a

3 Electrical characteristics

at T_j=25°C, unless otherwise specified

Table 4 Static characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note / Test Condition
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=0.63mA
Zero gate voltage drain current	I_{DSS}	- -	- 10	1 -	µA	V_{DS}=600, V_{GS}=0V, T_j=25°C V_{DS}=600, 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	$R_{DS(on)}$	- -	0.189 0.491	0.210 -	Ω	V_{GS}=10V, I_D=7.6A, T_j=25°C V_{GS}=10V, I_D=7.6A, T_j=150°C
Gate resistance	R_G	-	3.4	-	Ω	f=1MHz, open drain

Table 5 Dynamic characteristics

| Parameter	Symbol	Min.	Typ.	Max.	Unit	Note / Test Condition
Input capacitance	C_{iss}	-	1750	-	pF	V_{GS}=0V, V_{DS}=100V, f=1MHz
Output capacitance	C_{oss}	-	76	-	pF	V_{GS}=0V, V_{DS}=100V, f=1MHz
Effective output capacitance, energy related[1]	$C_{o(er)}$	-	61	-	pF	V_{GS}=0V, V_{DS}=0...400V
Effective output capacitance, time related[2]	$C_{o(tr)}$	-	264	-	pF	I_D=constant, V_{GS}=0V, V_{DS}=0...400V
Turn-on delay time	$t_{d(on)}$	-	15	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=9.5A, R_G=3.4Ω; see table 9
Rise time	t_r	-	8	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=9.5A, R_G=3.4Ω; see table 9
Turn-off delay time	$t_{d(off)}$	-	45	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=9.5A, R_G=3.4Ω; see table 9
Fall time	t_f	-	7	-	ns	V_{DD}=400V, V_{GS}=13 V, I_D=9.5A, R_G=3.4Ω; see table 9

Table 6 Gate charge characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note / Test Condition
Gate to source charge	Q_{gs}	-	11	-	nC	V_{DD}=400V, I_D=9.5A, V_{GS}=0 to 10V
Gate to drain charge	Q_{gd}	-	13	-	nC	V_{DD}=400V, I_D=9.5A, V_{GS}=0 to 10V
Gate charge total	Q_g	-	37	-	nC	V_{DD}=400V, I_D=9.5A, V_{GS}=0 to 10V
Gate plateau voltage	$V_{plateau}$	-	6.1	-	V	V_{DD}=400V, I_D=9.5A, V_{GS}=0 to 10V

[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 400V
[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 400V

Table 7   Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.9	-	V	V_{GS}=0V, I_F=9.5A, T_j=25°C
Reverse recovery time	t_{rr}	-	310	-	ns	V_R=400V, I_F=9.5A, di_F/dt=100A/µs; see table 8
Reverse recovery charge	Q_{rr}	-	4	-	µC	V_R=400V, I_F=9.5A, di_F/dt=100A/µs; see table 8
Peak reverse recovery current	I_{rrm}	-	25	-	A	V_R=400V, I_F=9.5A, 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
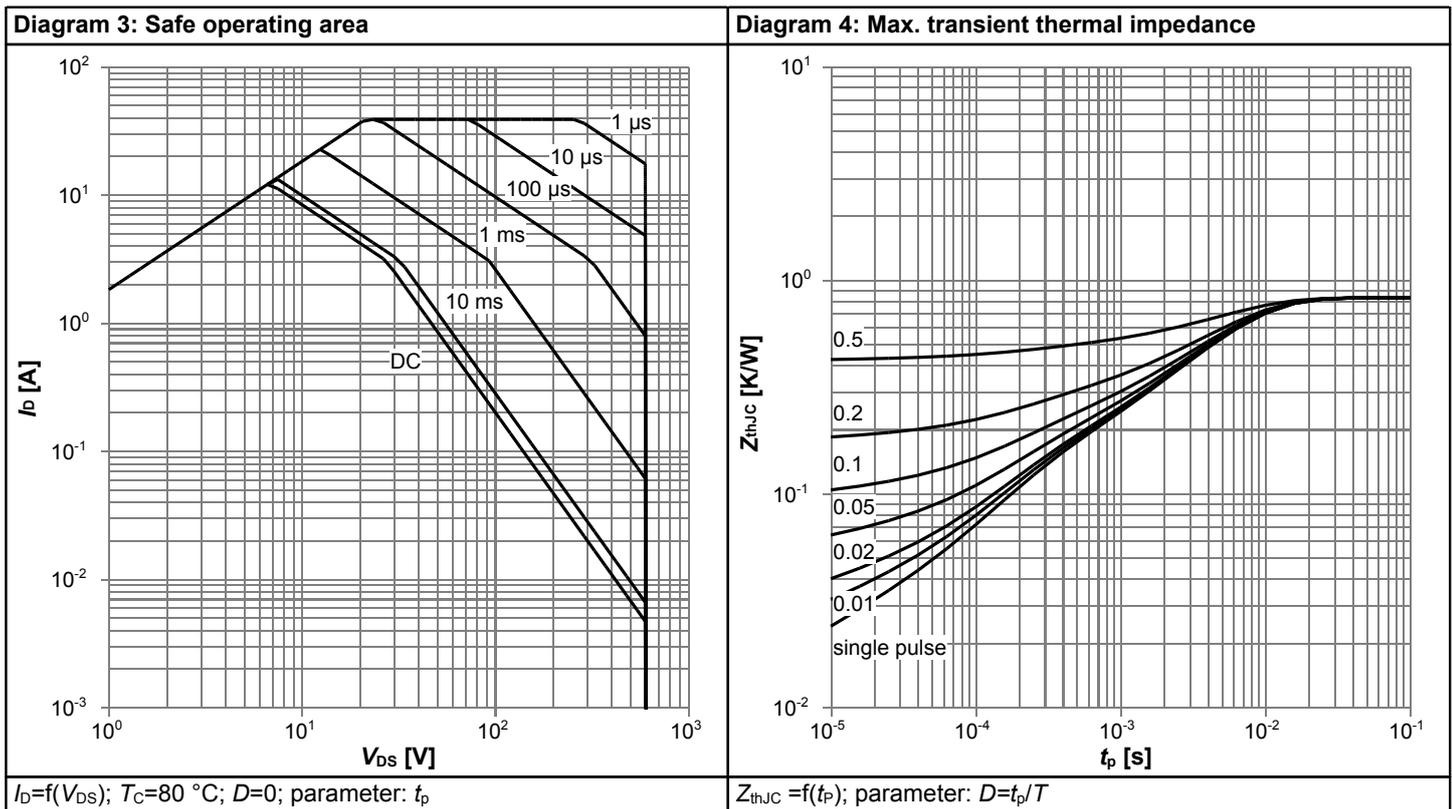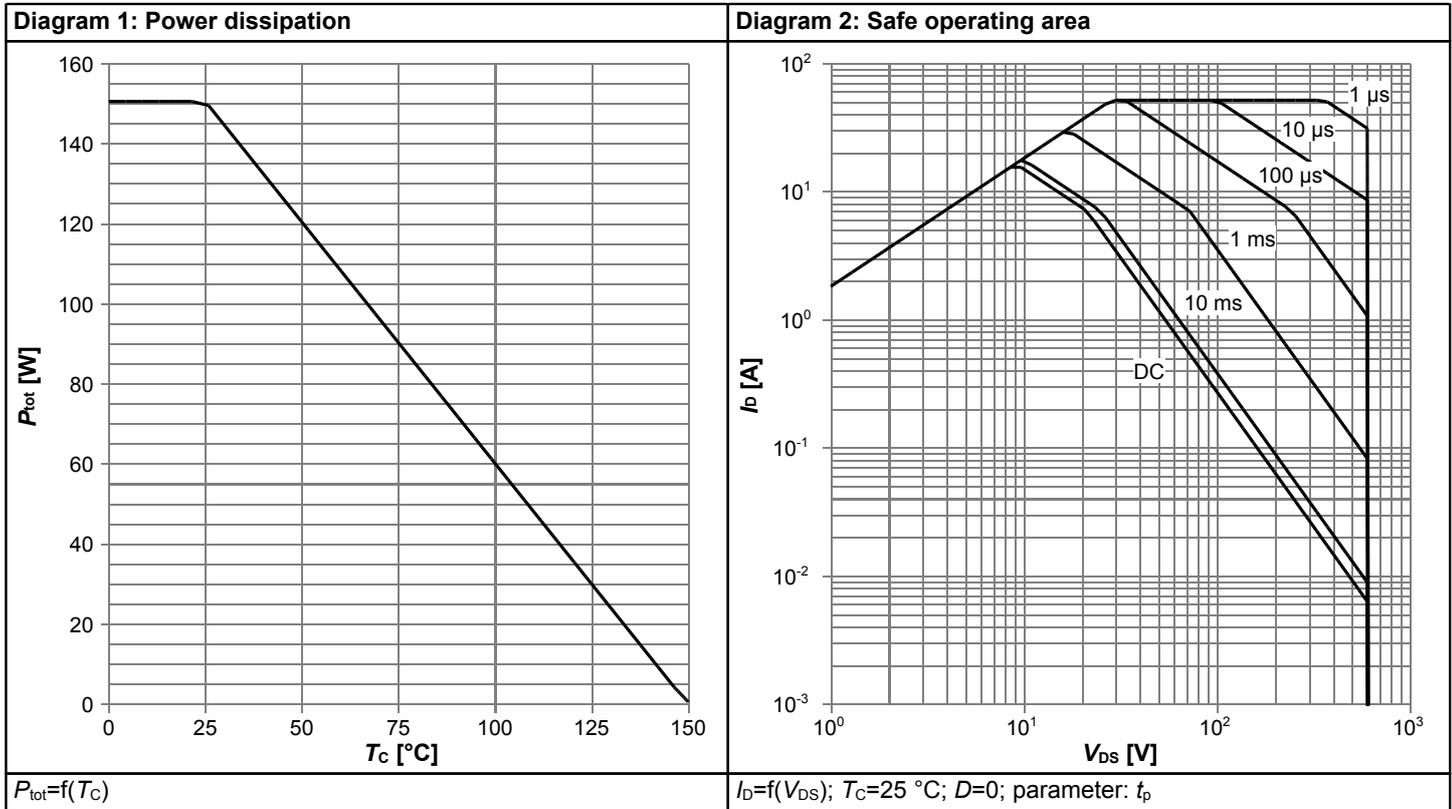
Diagram 5: Typ. output characteristics
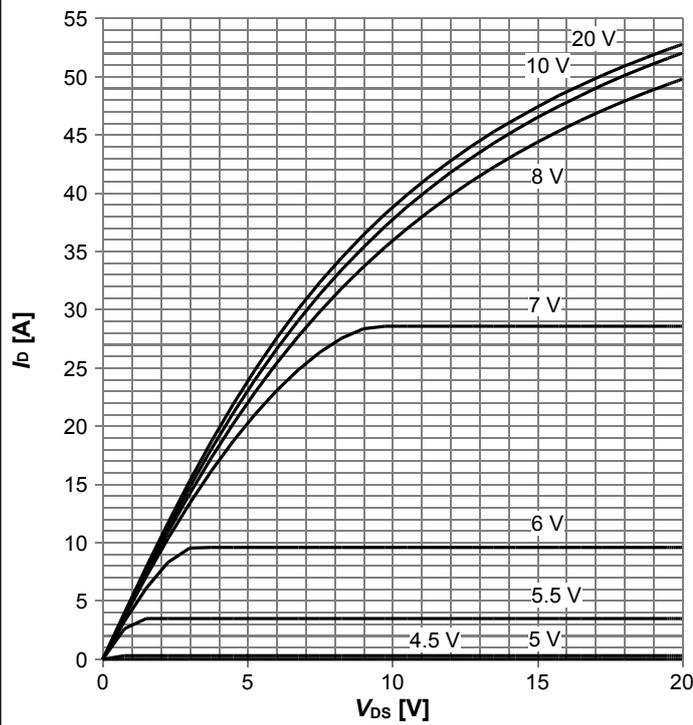
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}

Diagram 6: Typ. output characteristics
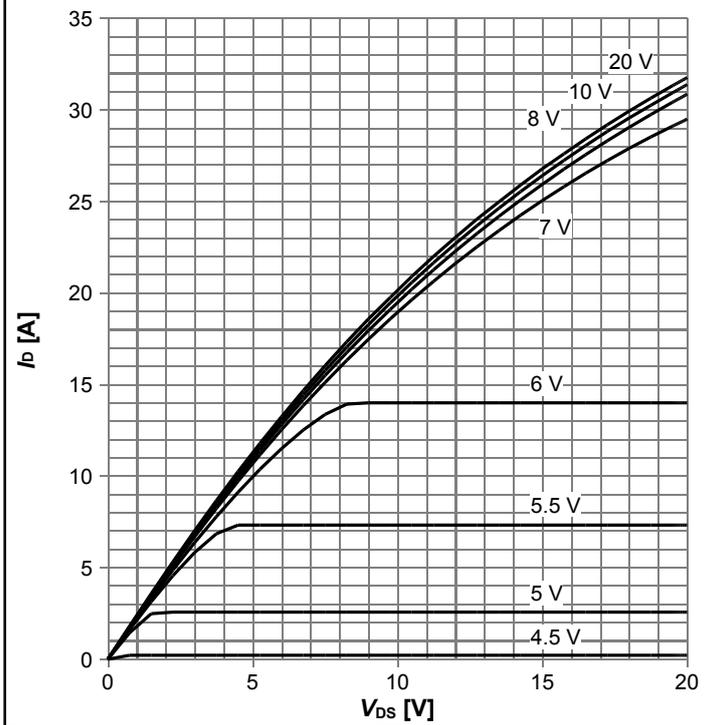
I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

Diagram 7: Typ. drain-source on-state resistance
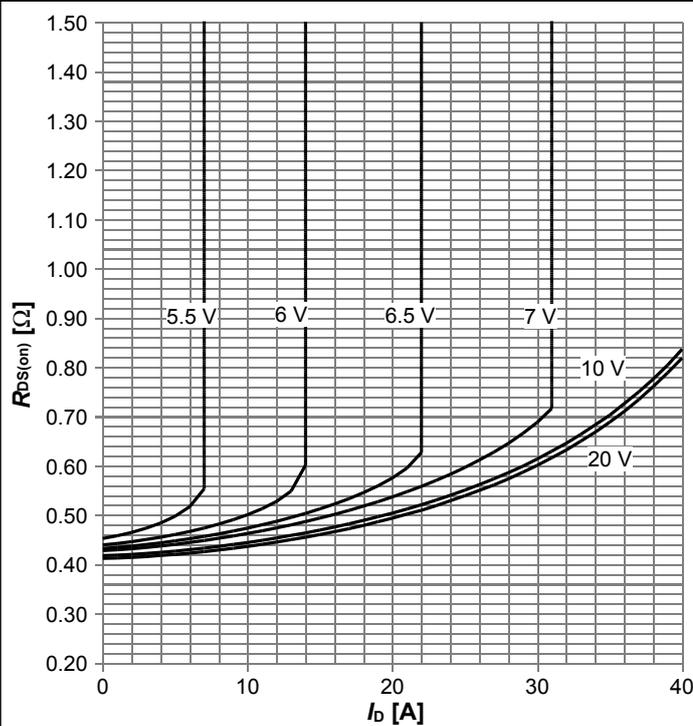
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance
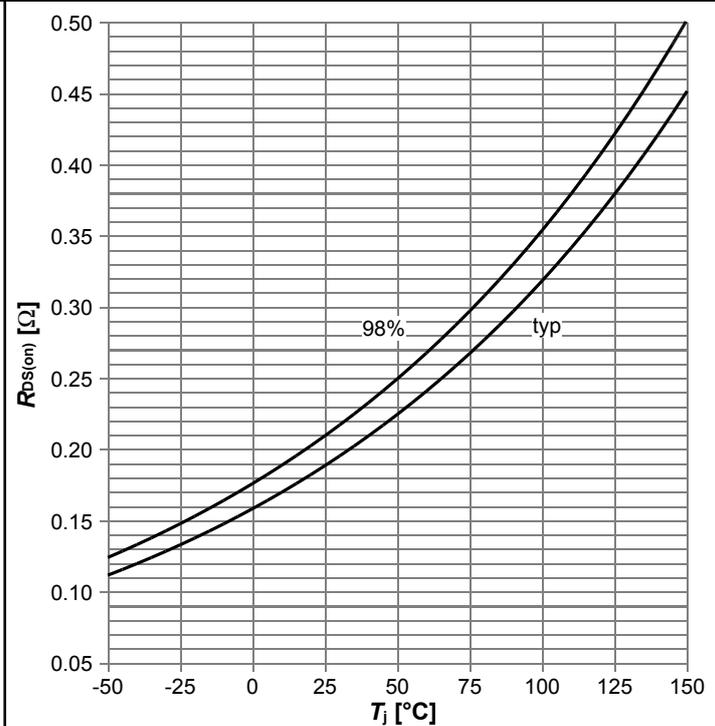
$R_{DS(on)}$=f(T_j); I_D=7.6 A; V_{GS}=10 V

Diagram 9: Typ. transfer characteristics
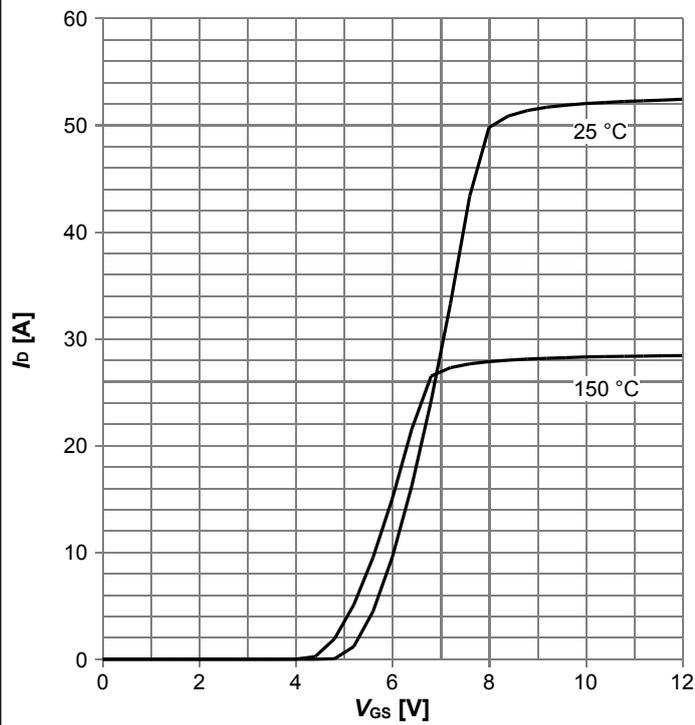
I_D=f(V_{GS}); V_{DS}=20V; parameter: T_j

Diagram 10: Typ. gate charge
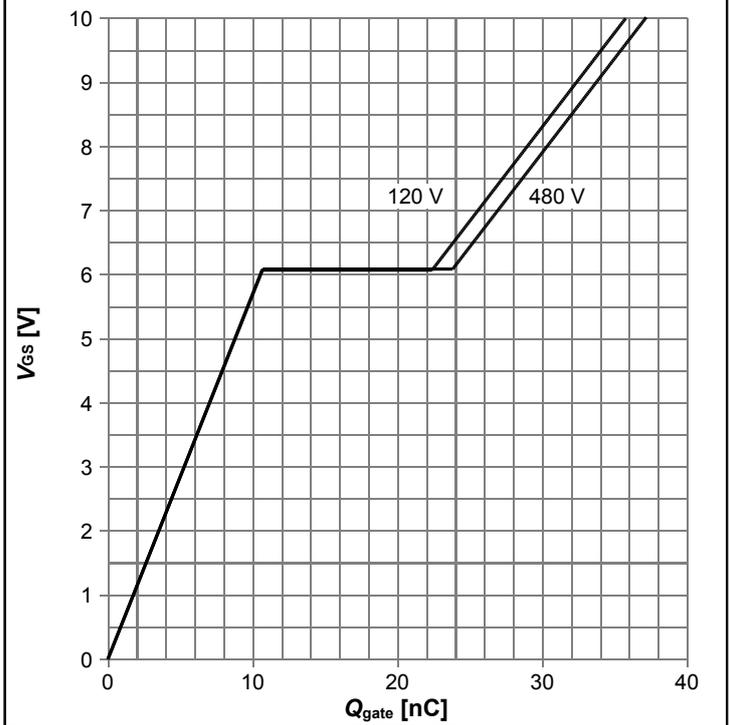
V_{GS}=f(Q_{gate}); I_D=9.5 A pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode
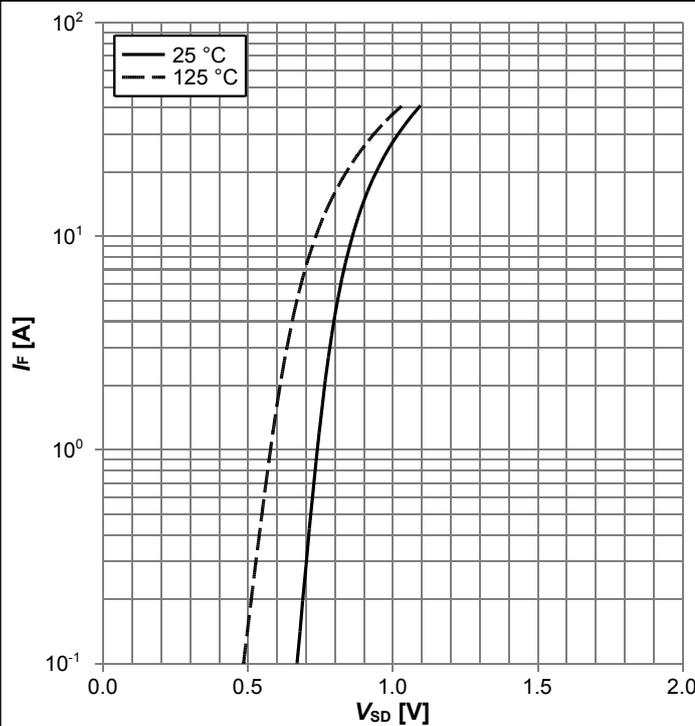
I_F=f(V_{SD}); parameter: T_j

Diagram 12: Avalanche energy
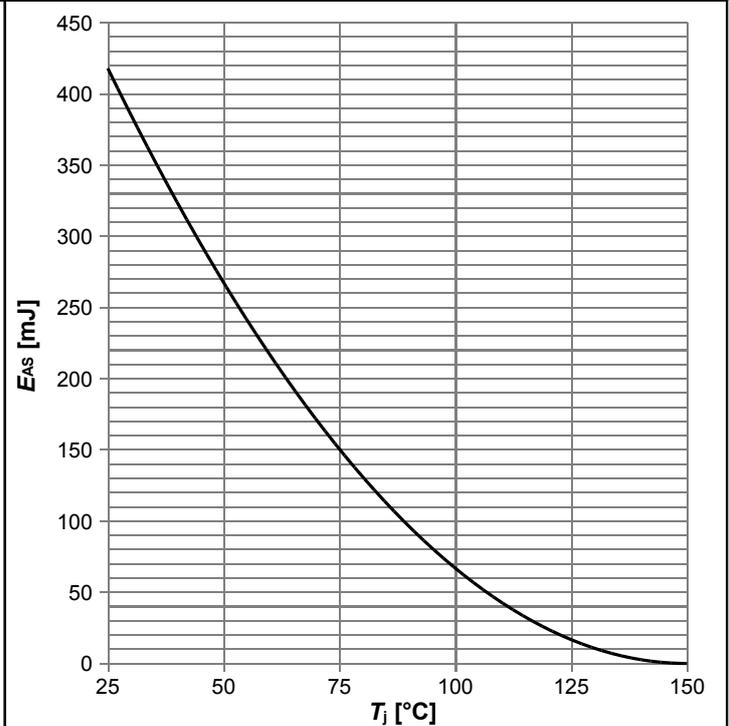
E_{AS}=f(T_j); I_D=3.3 A; V_{DD}=50 V

Diagram 13: Drain-source breakdown voltage
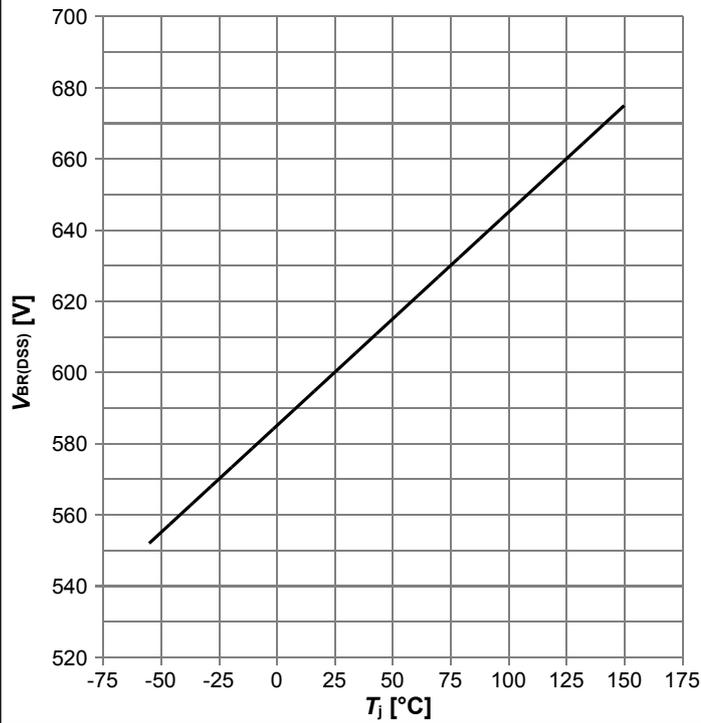
$V_{BR(DSS)}$=f(T_j); I_D=1 mA

Diagram 14: Typ. capacitances
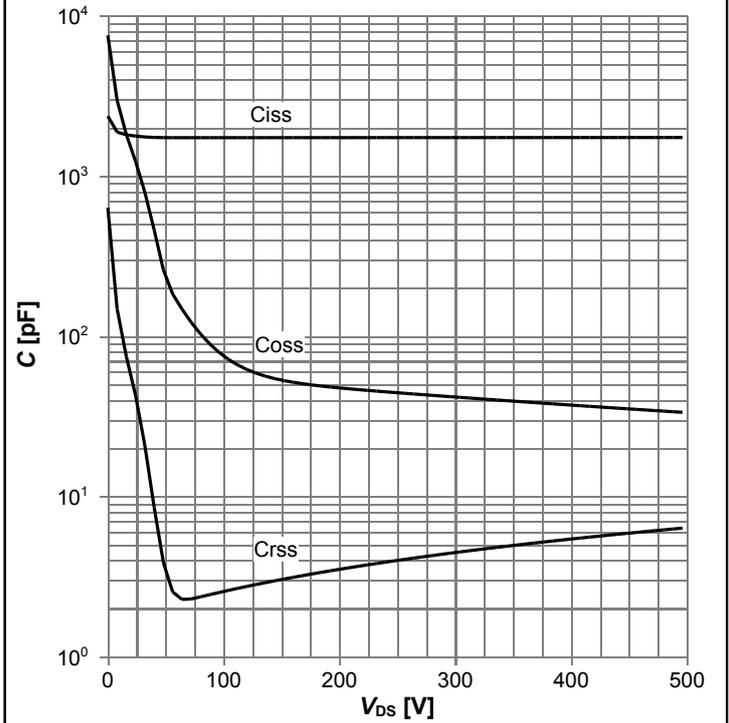
C=f(V_{DS}); V_{GS}=0 V; f=1 MHz

Diagram 15: Typ. Coss stored energy
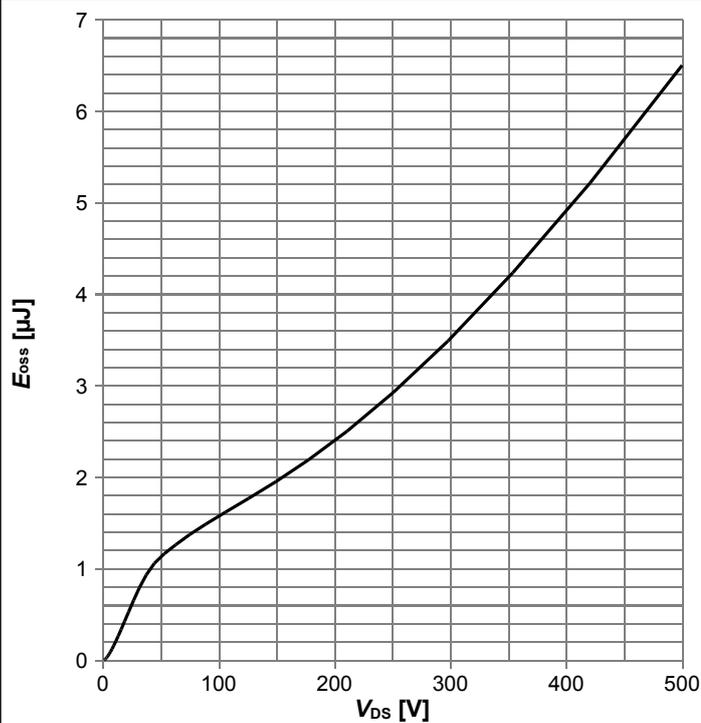
E_{oss}=f(V_{DS})

5 Test Circuits

Table 8 Diode characteristics

Test circuit for diode characteristics	Diode recovery waveform
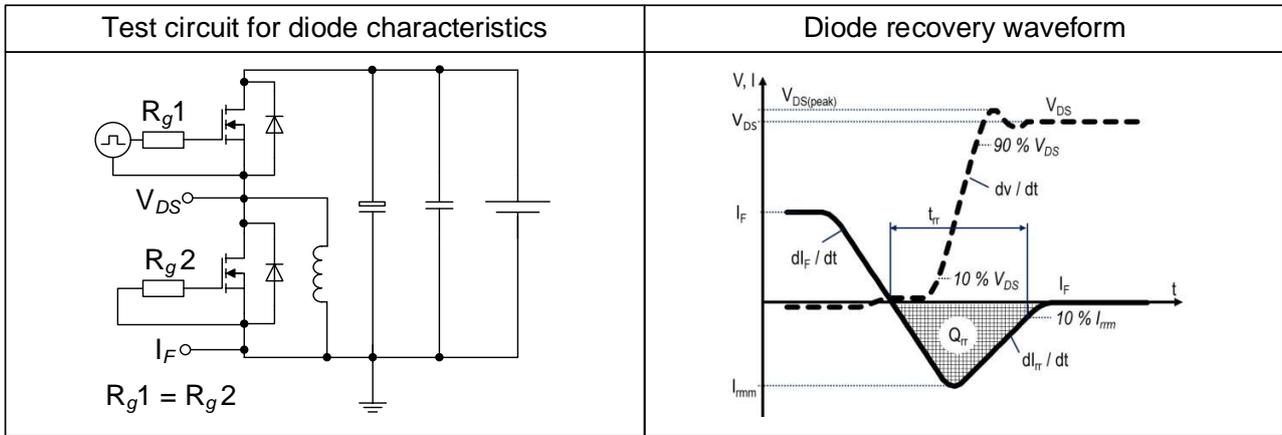
Table 9 switching times (ss)

Switching times test circuit for inductive load	Switching times waveform
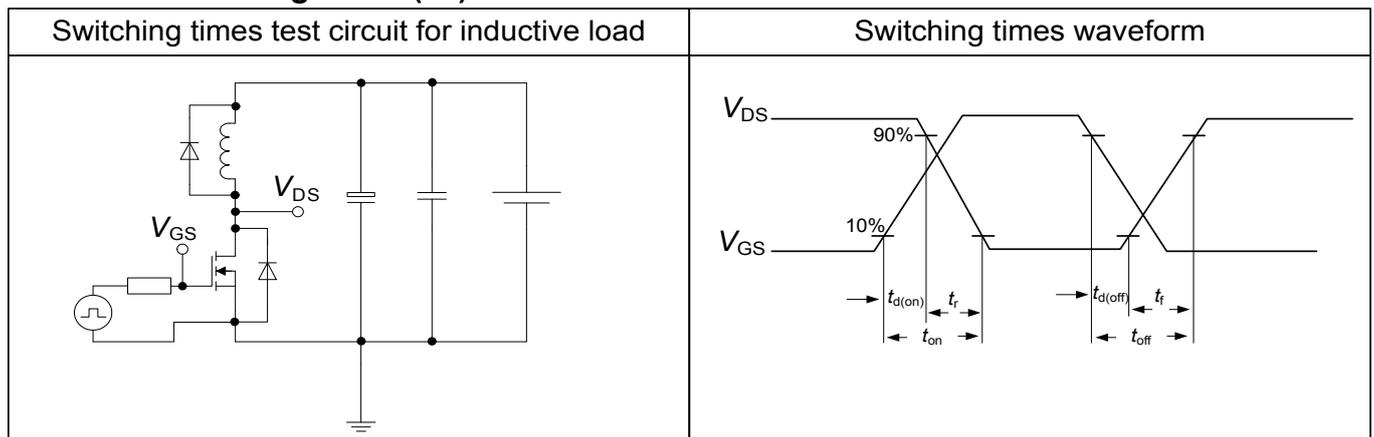
Table 10 Unclamped inductive load (ss)

Unclamped inductive load test circuit	Unclamped inductive waveform

6   Package Outlines

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.90	1.10	0.035	0.043
b	0.90	1.10	0.035	0.043
b1	0.00	0.05	0.000	0.002
c	0.10	0.30	0.004	0.012
D	7.90	8.10	0.311	0.319
D1	7.10	7.30	0.280	0.287
E	7.90	8.10	0.311	0.319
E1	4.65	4.85	0.183	0.191
E2	2.65	2.85	0.104	0.112
E3	0.30	0.50	0.012	0.020
e	2.00 (BSC)		0.079 (BSC)	
L	0.40	0.60	0.016	0.024
N	4		4	
F1	7.20		0.283	
F2	4.75		0.107	
F3	1.00		0.039	
F4	1.00		0.039	
F5	1.43		0.056	
F6	4.20		0.165	
F7	3.00		0.118	
F8	1.00		0.039	

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Figure 1   Outline PG-VSON-4, dimensions in mm/inches

7   Appendix A

Table 11   Related Links

- **IFX CoolMOS™ P6 Webpage:** www.infineon.com

- **IFX CoolMOS™ P6 application note:** www.infineon.com

- **IFX CoolMOS™ P6 simulation model:** www.infineon.com

- **IFX Design tools:** www.infineon.com

Revision History

IPL60R210P6

Revision: 2017-08-30, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2014-05-16	Release of final version
2.1	2017-08-30	Updated MSL; style updated