MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ P6

600V CoolMOS™ P6 Power Transistor
IPZ60R041P6

Data Sheet

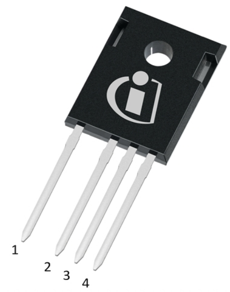
Rev. 2.0
Final

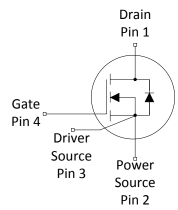
Power Management & Multimarket

1 Description

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.

PG-TO 247-4





Features

- Increased MOSFET dv/dt ruggedness
- Extremely low losses due to very low FOM Rdson*Qg and Eoss
- Very high commutation ruggedness
- Best in class $R_{DS(on)}$ /package
- Easy to use/drive due to driver source pin for better control of the gate
- Pb-free plating, Halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)
- 4-pin kelvin source concept

Applications

PFC stages, hard switching PWM stages and resonant switching stages for e.g. Computing, Server, Telecom and UPS.

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
V_{DS} @ $T_{j,max}$	650	V
$R_{DS(on),max}$	41	mΩ
$Q_{g.typ}$	170	nC
$I_{D,pulse}$	267	A
E_{oss}@400V	20.5	µJ
Body diode di/dt	250	A/µs

Type / Ordering Code	Package	Marking	Related Links
IPZ60R041P6	PG-TO 247-4	6R041P6	see Appendix A

Table of Contents

2 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	- -	- -	77.5 49.0	A	T_C=25°C T_C=100°C
Pulsed drain current[2]	$I_{D,pulse}$	-	-	267	A	T_C=25°C
Avalanche energy, single pulse	E_{AS}	-	-	1954	mJ	I_D=13.4A; V_{DD}=50V; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	2.96	mJ	I_D=13.4A; V_{DD}=50V; see table 10
Avalanche current, repetitive	I_{AR}	-	-	13.4	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}	-	-	481	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	-	-	67.2	A	T_C=25°C
Diode pulse current[2]	$I_{S,pulse}$	-	-	267	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	-	-	250	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

3 Thermal characteristics

Table 3 Thermal characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.26	°C/W	-
Thermal resistance, junction - ambient	R_{thJA}	-	-	62	°C/W	leaded
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6mm (0.063 in.) from case for 10s

4 Electrical characteristics

at T_j=25°C, unless otherwise specified

Table 4 Static characteristics

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=2.96mA
Zero gate voltage drain current	I_{DSS}	- -	- 10	5 -	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	$R_{DS(on)}$	- -	0.037 0.096	0.041 -	Ω	V_{GS}=10V, I_D=35.5A, T_j=25°C V_{GS}=10V, I_D=35.5A, T_j=150°C
Gate resistance	R_G	-	1	-	Ω	f=1MHz, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	8180	-	pF	V_{GS}=0V, V_{DS}=100V, f=1MHz
Output capacitance	C_{oss}	-	310	-	pF	V_{GS}=0V, V_{DS}=100V, f=1MHz
Effective output capacitance, energy related[1]	$C_{o(er)}$	-	260	-	pF	V_{GS}=0V, V_{DS}=0...400V
Effective output capacitance, time related[2]	$C_{o(tr)}$	-	1200	-	pF	I_D=constant, V_{GS}=0V, V_{DS}=0...400V
Turn-on delay time	$t_{d(on)}$	-	27	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=44.4A, R_G=1.7Ω; see table 9
Rise time	t_r	-	25	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=44.4A, R_G=1.7Ω; see table 9
Turn-off delay time	$t_{d(off)}$	-	87	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=44.4A, R_G=1.7Ω; see table 9
Fall time	t_f	-	5	-	ns	V_{DD}=400V, V_{GS}=13 V, I_D=44.4A, R_G=1.7Ω; see table 9

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	50	-	nC	V_{DD}=400V, I_D=44.4A, V_{GS}=0 to 10V
Gate to drain charge	Q_{gd}	-	59	-	nC	V_{DD}=400V, I_D=44.4A, V_{GS}=0 to 10V
Gate charge total	Q_g	-	170	-	nC	V_{DD}=400V, I_D=44.4A, V_{GS}=0 to 10V
Gate plateau voltage	$V_{plateau}$	-	6.1	-	V	V_{DD}=400V, I_D=44.4A, V_{GS}=0 to 10V

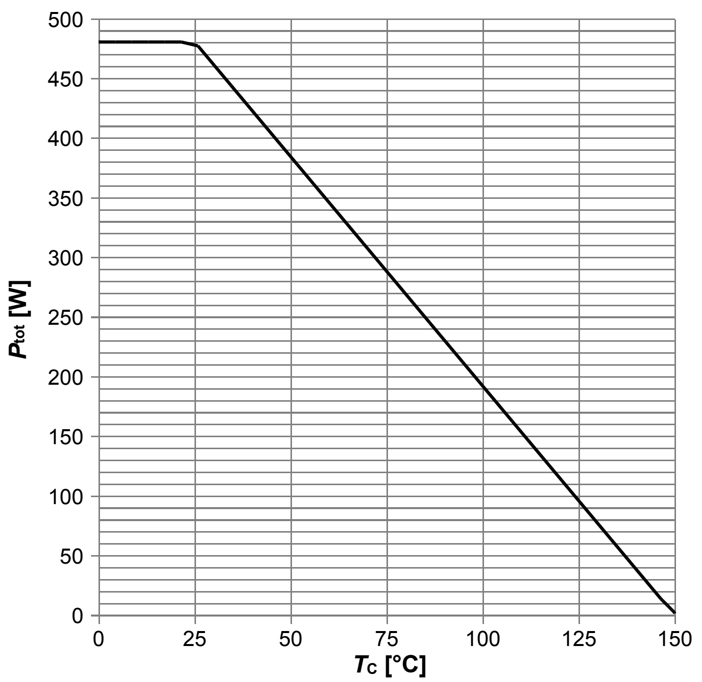
[1] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 400V

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=44.4A, T_j=25°C
Reverse recovery time	t_{rr}	-	630	-	ns	V_R=400V, I_F=44.4A, di_F/dt=100A/µs; see table 8
Reverse recovery charge	Q_{rr}	-	19	-	µC	V_R=400V, I_F=44.4A, di_F/dt=100A/µs; see table 8
Peak reverse recovery current	I_{rrm}	-	56	-	A	V_R=400V, I_F=44.4A, di_F/dt=100A/µs; see table 8

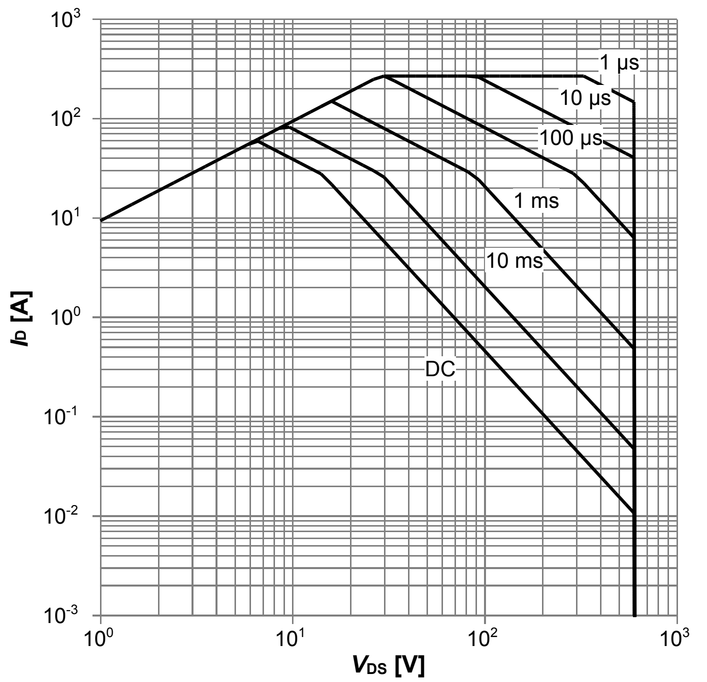
5 Electrical characteristics diagrams

Diagram 1: Power dissipation



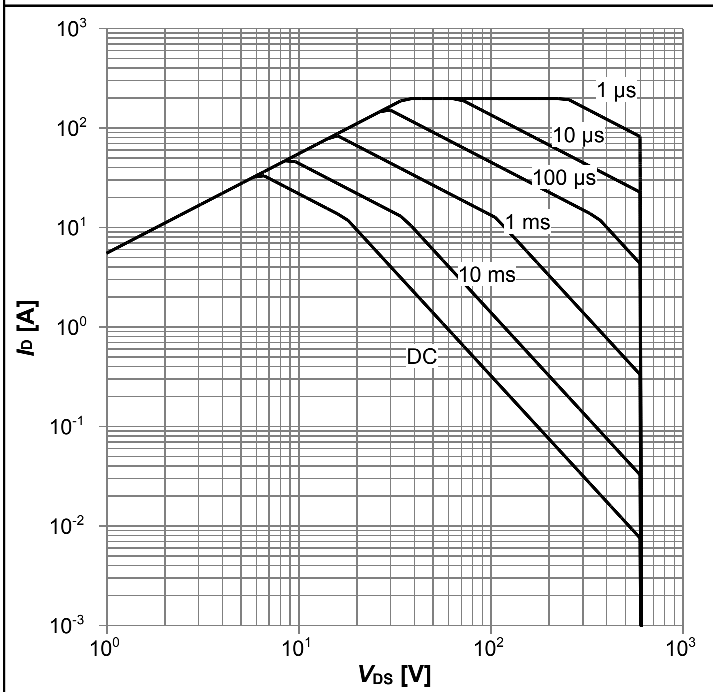
P_{tot}=f(T_C)

Diagram 2: Safe operating area



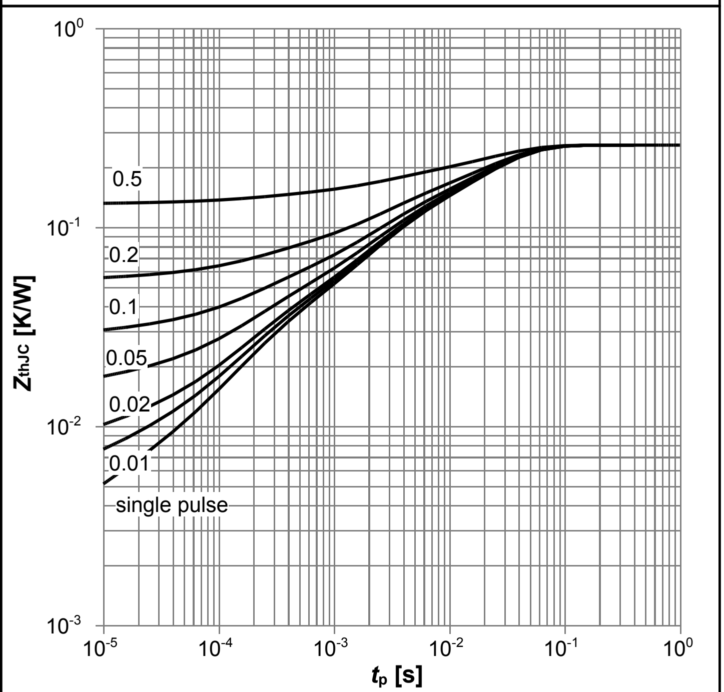
I_D=f(V_{DS}); T_C=25 °C; D=0; parameter: t_p

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

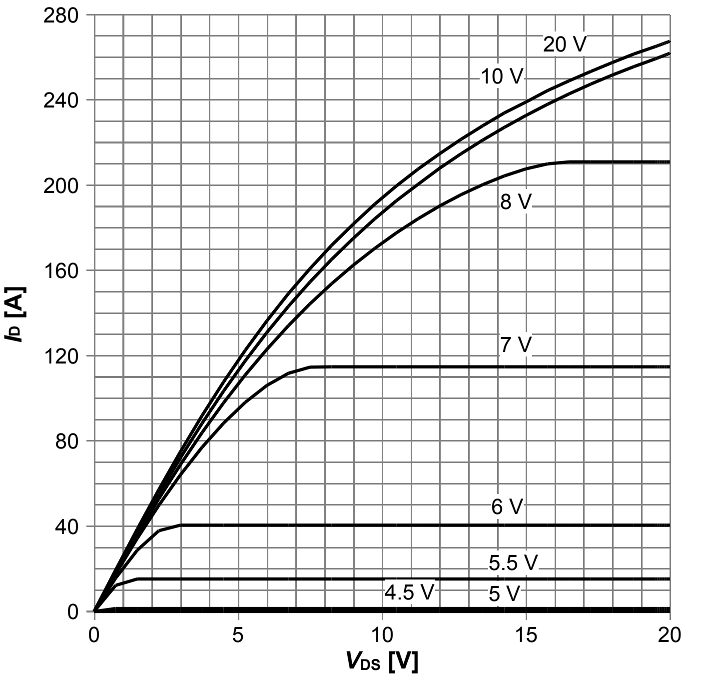
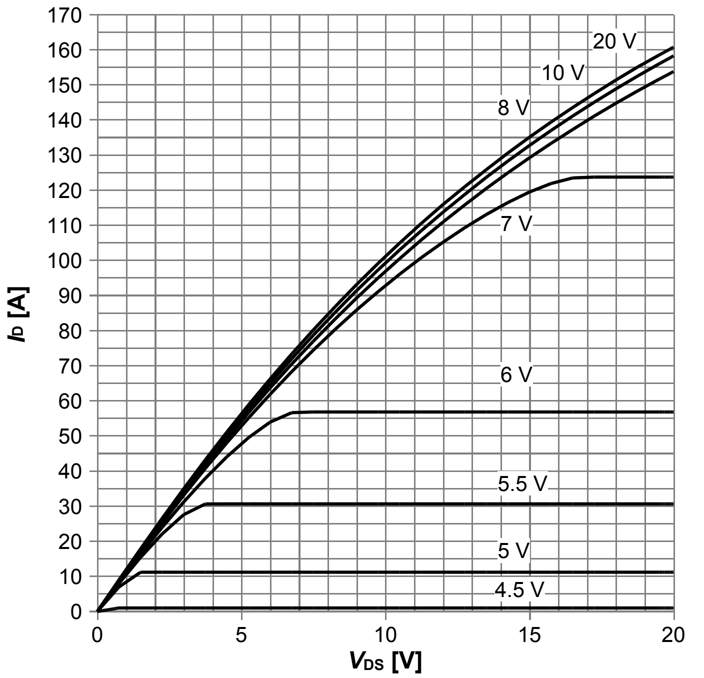
Diagram 5: Typ. output characteristics	Diagram 6: Typ. output characteristics
	
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}	I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

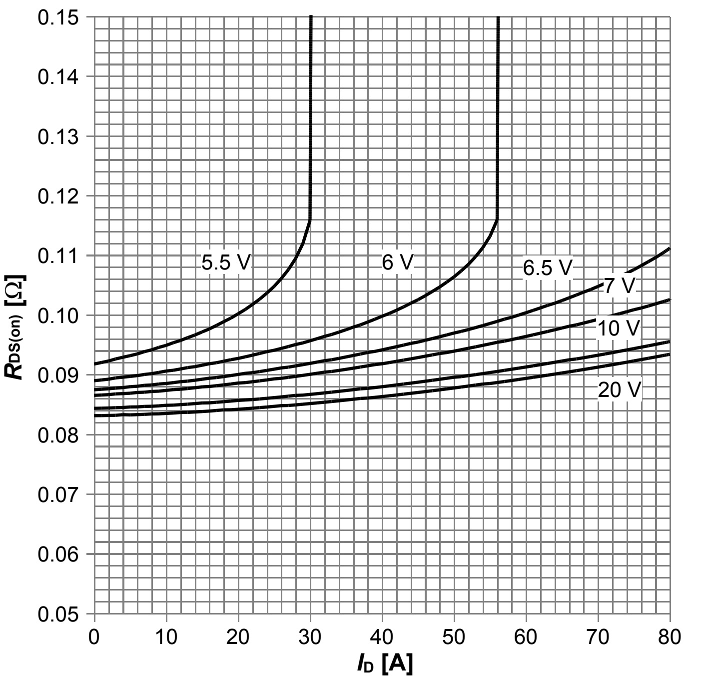
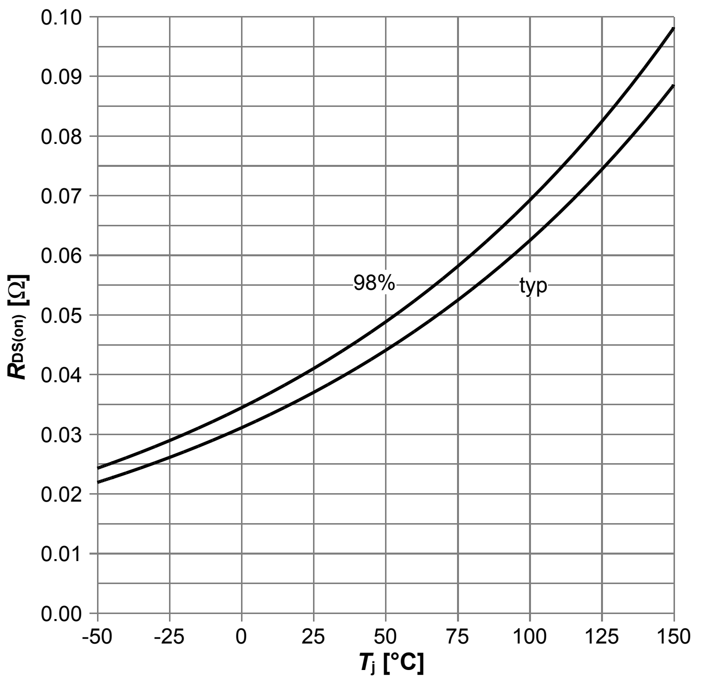
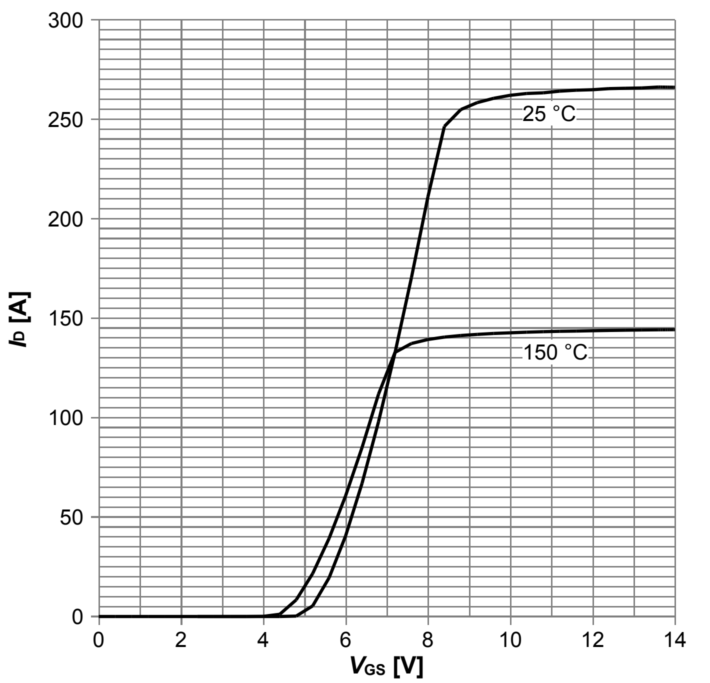
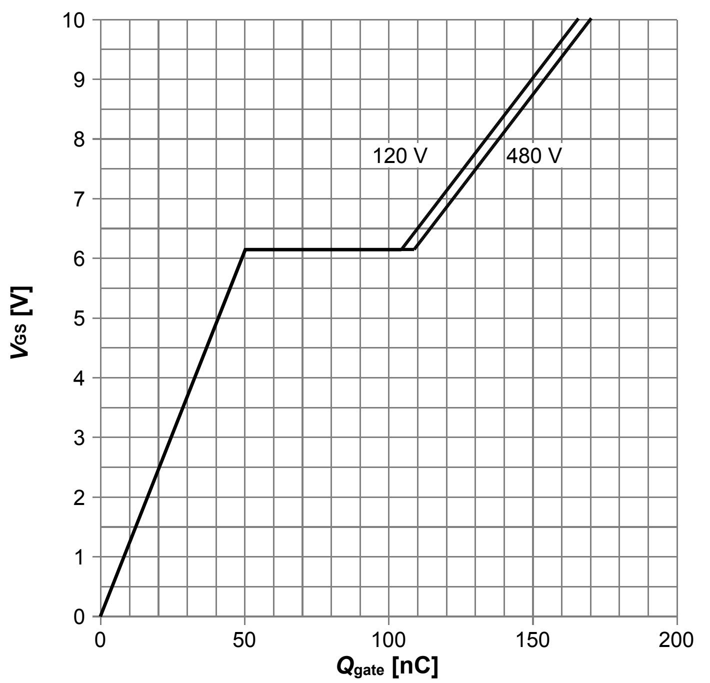
Diagram 7: Typ. drain-source on-state resistance	Diagram 8: Drain-source on-state resistance
	
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}	$R_{DS(on)}$=f(T_j); I_D=35.5 A; V_{GS}=10 V

Diagram 9: Typ. transfer characteristics



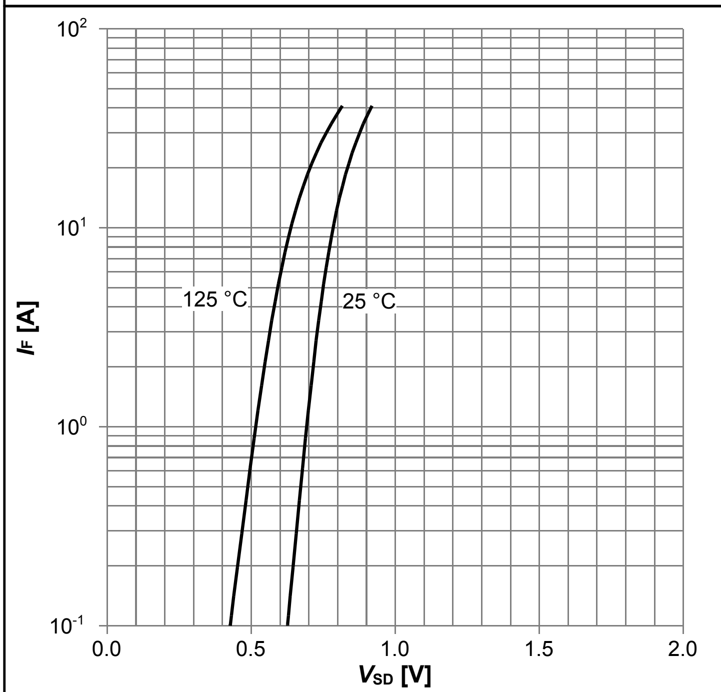
I_D=f(V_{GS}); V_{DS}=20V; parameter: T_j

Diagram 10: Typ. gate charge



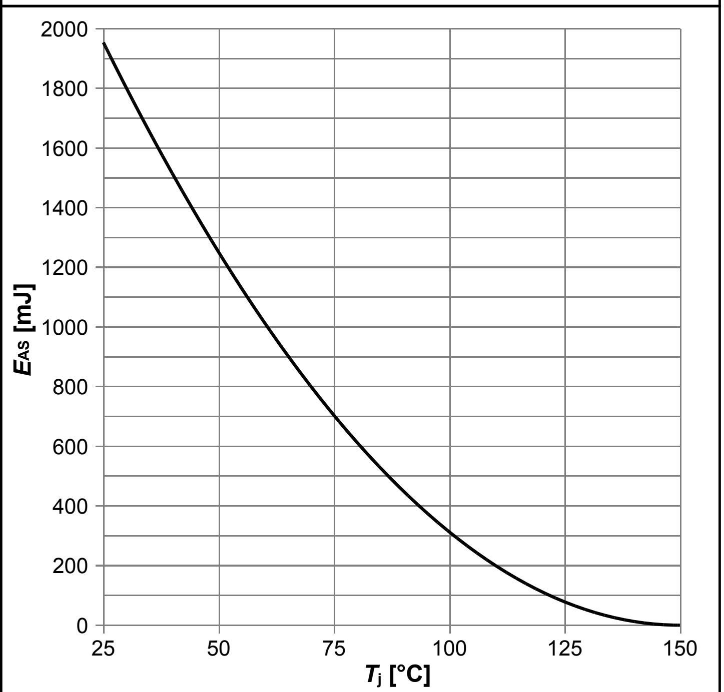
V_{GS}=f(Q_{gate}); I_D=44.4 A pulsed; parameter: V_{DD}

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=13.4 A; V_{DD}=50 V

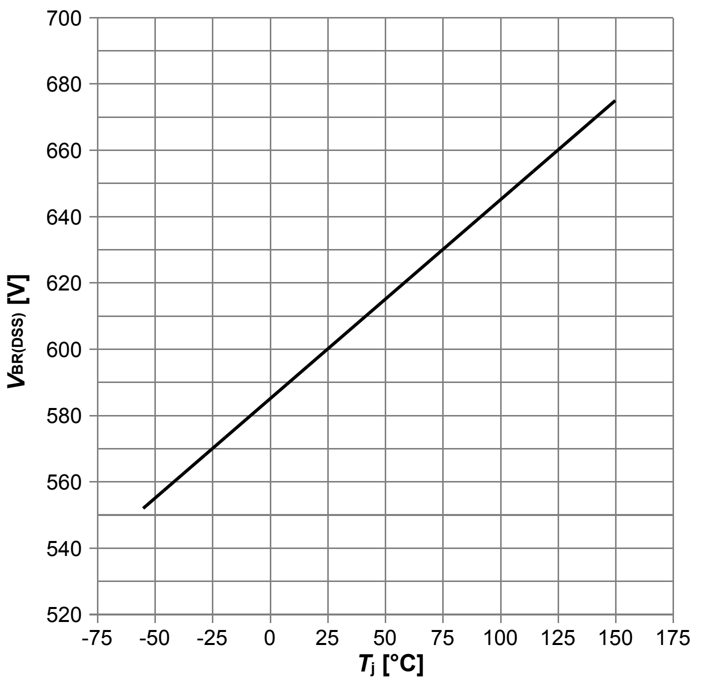
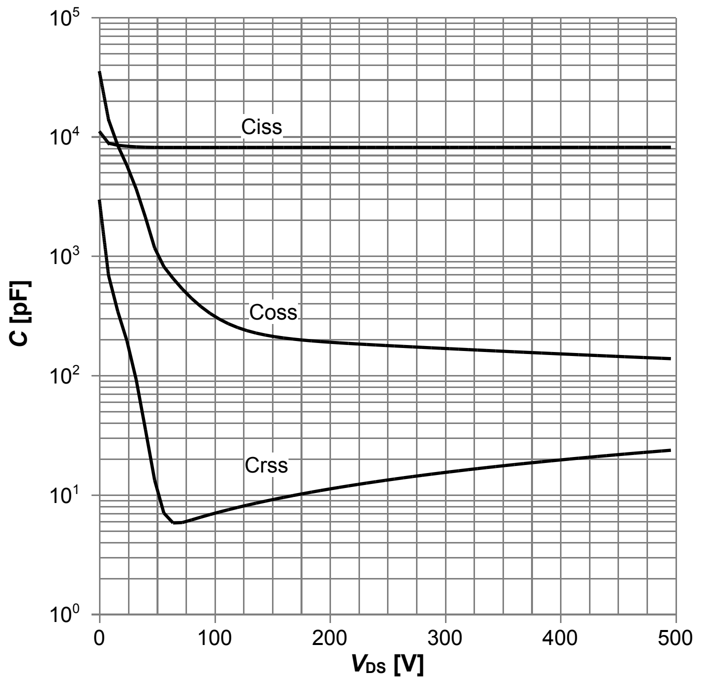
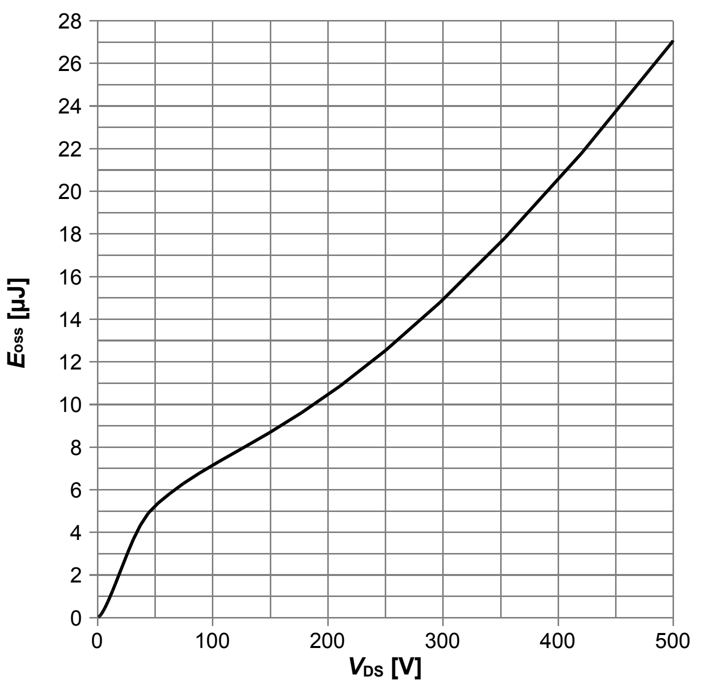
Diagram 13: Drain-source breakdown voltage	Diagram 14: Typ. capacitances
	
$V_{BR(DSS)}$=f(T_j); I_D=1 mA	C=f(V_{DS}); V_{GS}=0 V; f=1 MHz

Diagram 15: Typ. Coss stored energy

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

6 Test Circuits

Table 8 Diode characteristics

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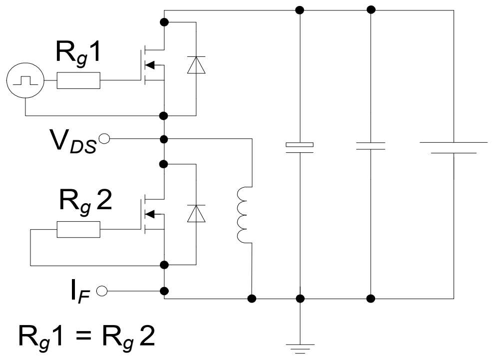
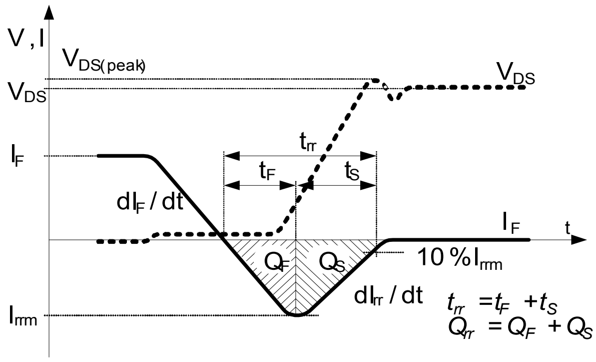
<tr><th>Test circuit for diode characteristics</th><th>Diode recovery waveform</th></tr>
<tr><td>
</td><td>
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Table 9 switching times (ss)

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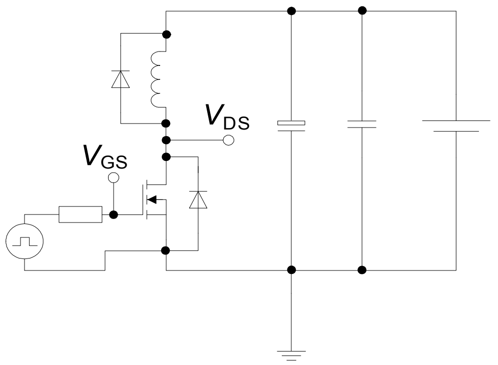
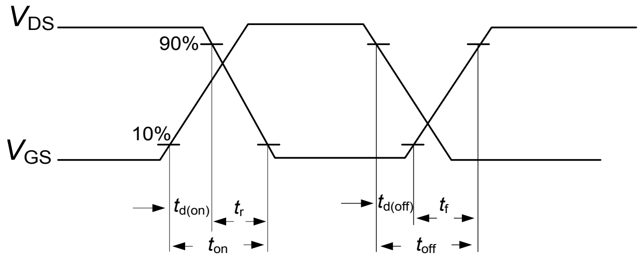
<tr><th>Switching times test circuit for inductive load</th><th>Switching times waveform</th></tr>
<tr><td>
</td><td>
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Table 10 Unclamped inductive load (ss)

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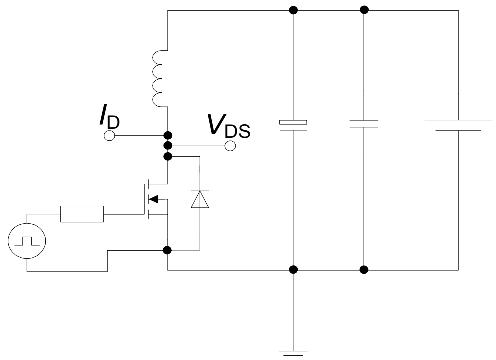
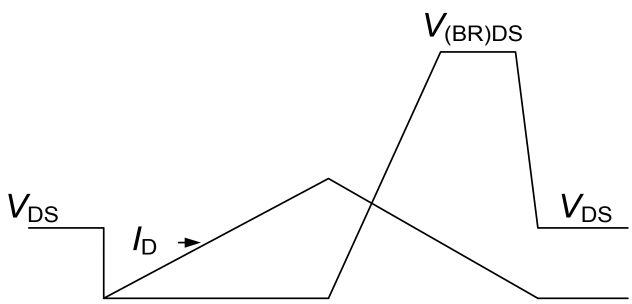
<tr><td>
</td><td>
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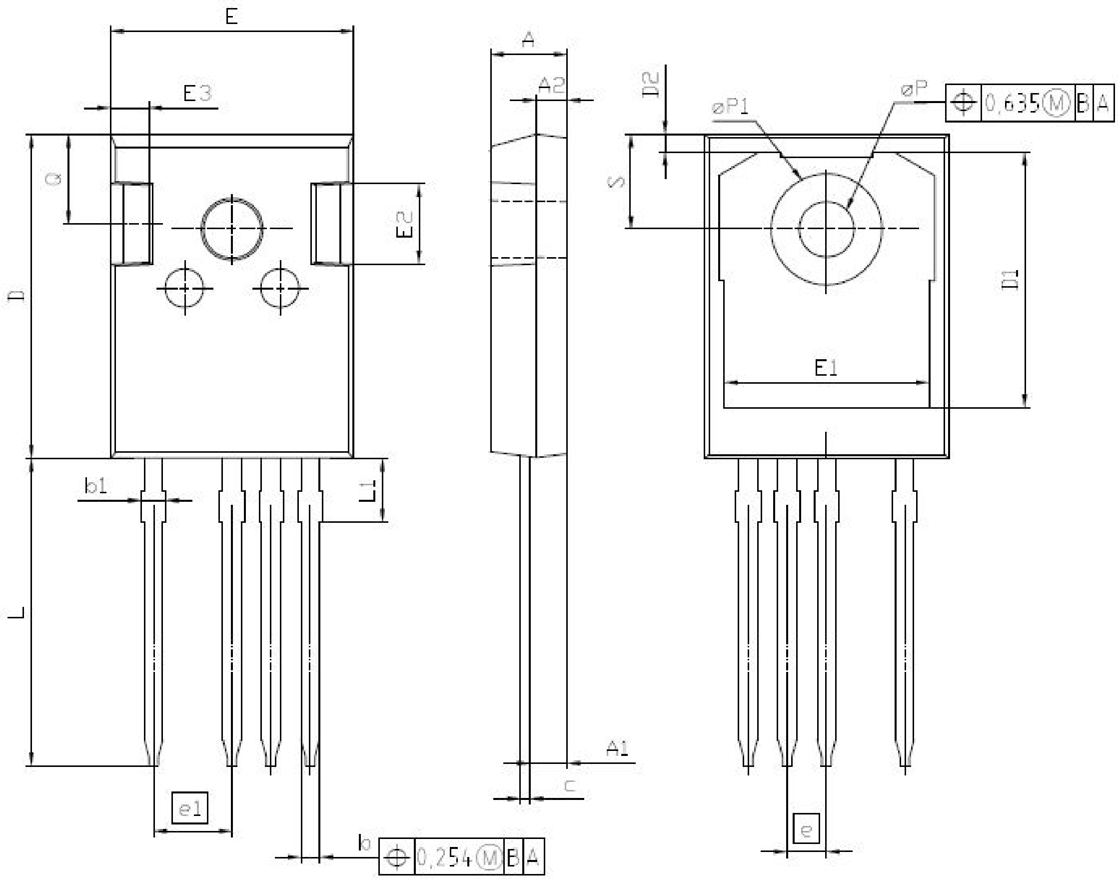
7 Package Outlines



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.29	2.54	0.090	0.100
A2	1.90	2.16	0.075	0.085
b	1.07	1.33	0.042	0.052
b1	1.10	1.70	0.043	0.067
c	0.50	0.70	0.020	0.028
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	2.54 (BSC)		0.100 (BSC)	
e1	5.08		0.200	
N	4		4	
L	19.72	20.32	0.776	0.800
L1	4.02	4.40	0.158	0.173
øP	3.50	3.70	0.138	0.146
øP1	7.00	7.40	0.276	0.291
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

DOCUMENT NO.
Z8B00168124

SCALE

0 5 7.5mm

EUROPEAN PROJECTION

ISSUE DATE
29-01-2013

REVISION
1

Figure 1 Outline PG-TO 247-4

8 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

IPZ60R041P6

Revision: 2015-07-13, Rev. 2.0

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2015-07-13	Release of final version

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