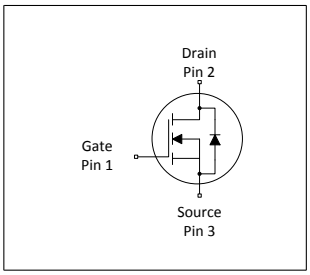
MOSFET

600V CoolMOS™ CFD7 Power Transistor

PG-TO 220 FP



CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. The latest CoolMOS™ CFD7 is the successor to the CoolMOS™ CFD2 series and is an optimized platform tailored to target soft switching applications such as phase-shift full-bridge (ZVS) and LLC. Resulting from reduced gate charge (Q_g), best-in-class reverse recovery charge (Q_{rr}) and improved turn off behavior CoolMOS™ CFD7 offers highest efficiency in resonant topologies. As part of Infineon's fast body diode portfolio, this new product series blends all advantages of a fast switching technology together with superior hard commutation robustness, without sacrificing easy implementation in the design-in process. The CoolMOS™ CFD7 technology meets highest efficiency and reliability standards and furthermore supports high power density solutions. Altogether, CoolMOS™ CFD7 makes resonant switching topologies more efficient, more reliable, lighter and cooler.

Features

- Ultra-fast body diode
- Low gate charge
- Best-in-class reverse recovery charge (Q_{rr})
- Improved MOSFET reverse diode dv/dt and di_F/dt ruggedness
- Lowest FOM $R_{DS(on)}$*Q_g and $R_{DS(on)}$*E_{oss}
- Best-in-class $R_{DS(on)}$ in SMD and THD packages

Benefits

- Excellent hard commutation ruggedness
- Highest reliability for resonant topologies
- Highest efficiency with outstanding ease-of-use / performance tradeoff
- Enabling increased power density solutions

Potential applications

Suiteable for Soft Switching topologies
Optimized for phase-shift full-bridge (ZVS), LLC Applications – Server, Telecom, EV Charging

Product Validation: Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

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
$R_{DS(on),max}$	170	mΩ
$Q_{g,typ}$	28	nC
$I_{D,pulse}$	51	A
E_{oss} @ 400V	3.2	µJ
Body diode di_F/dt	1300	A/µs

Type / Ordering Code	Package	Marking	Related Links
IPA60R170CFD7	PG-TO 220 FullPAK	60R170F7	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.		
Continuous drain current[1)]	I_D	- -	- -	8 5	A	T_C=25°C T_C=100°C
Pulsed drain current[2)]	$I_{D,pulse}$	-	-	51	A	T_C=25°C
Avalanche energy, single pulse	E_{AS}	-	-	60	mJ	I_D=3.7A; V_{DD}=50V; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.30	mJ	I_D=3.7A; V_{DD}=50V; see table 10
Avalanche current, single pulse	I_{AS}	-	-	3.7	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	120	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}	-	-	26	W	T_C=25°C
Storage temperature	T_{stg}	-55	-	150	°C	-
Operating junction temperature	T_j	-55	-	150	°C	-
Mounting torque	-	-	-	50	Ncm	M2.5 screws
Continuous diode forward current	I_S	-	-	8	A	T_C=25°C
Diode pulse current[2)]	$I_{S,pulse}$	-	-	51	A	T_C=25°C
Reverse diode dv/dt[3)]	dv/dt	-	-	70	V/ns	V_{DS}=0...400V, I_{SD}<=8A, T_j=25°C see table 8
Maximum diode commutation speed	di_F/dt	-	-	1300	A/µs	V_{DS}=0...400V, I_{SD}<=8A, T_j=25°C see table 8
Insulation withstand voltage	V_{ISO}	-	-	2500	V	V_{rms}, T_C=25°C, t=1min

[1)] Limited by $T_{j,max}$.
[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}	-	-	4.79	°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 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	4.5	V	V_{DS}=V_{GS}, I_D=0.3mA
Zero gate voltage drain current[1]	I_{DSS}	- -	- 7	1 37	µA	V_{DS}=600V, V_{GS}=0V, T_j=25°C V_{DS}=600V, V_{GS}=0V, T_j=125°C
Gate-source leakage current	I_{GSS}	-	-	100	nA	V_{GS}=20V, V_{DS}=0V
Drain-source on-state resistance	$R_{DS(on)}$	- -	0.144 0.328	0.17 -	Ω	V_{GS}=10V, I_D=6.0A, T_j=25°C V_{GS}=10V, I_D=6.0A, T_j=150°C
Gate resistance	R_G	-	10.9	-	Ω	f=1MHz, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	1199	-	pF	V_{GS}=0V, V_{DS}=400V, f=250kHz
Output capacitance	C_{oss}	-	22	-	pF	V_{GS}=0V, V_{DS}=400V, f=250kHz
Effective output capacitance, energy related[2]	$C_{o(er)}$	-	40	-	pF	V_{GS}=0V, V_{DS}=0...400V
Effective output capacitance, time related[3]	$C_{o(tr)}$	-	402	-	pF	I_D=constant, V_{GS}=0V, V_{DS}=0...400V
Turn-on delay time	$t_{d(on)}$	-	31	-	ns	V_{DD}=400V, V_{GS}=10V, I_D=7.0A, R_G=10.2Ω; see table 9
Rise time	t_r	-	15	-	ns	V_{DD}=400V, V_{GS}=10V, I_D=7.0A, R_G=10.2Ω; see table 9
Turn-off delay time	$t_{d(off)}$	-	68	-	ns	V_{DD}=400V, V_{GS}=10V, I_D=7.0A, R_G=10.2Ω; see table 9
Fall time	t_f	-	9	-	ns	V_{DD}=400V, V_{GS}=10V, I_D=7.0A, R_G=10.2Ω; see table 9

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	7	-	nC	V_{DD}=400V, I_D=7.0A, V_{GS}=0 to 10V
Gate to drain charge	Q_{gd}	-	9	-	nC	V_{DD}=400V, I_D=7.0A, V_{GS}=0 to 10V
Gate charge total	Q_g	-	28	-	nC	V_{DD}=400V, I_D=7.0A, V_{GS}=0 to 10V
Gate plateau voltage	$V_{plateau}$	-	5.7	-	V	V_{DD}=400V, I_D=7.0A, V_{GS}=0 to 10V

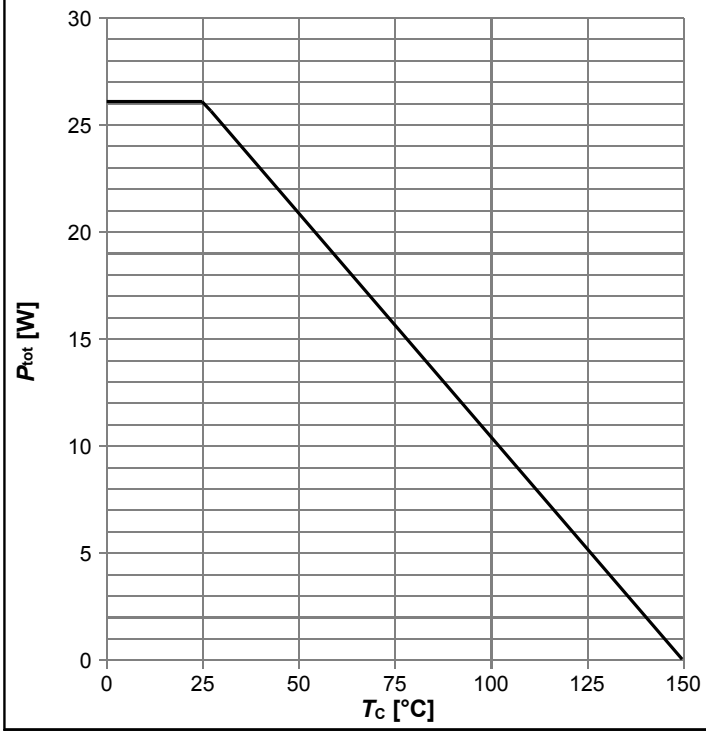
[1] Maximum specification is defined by calculated six sigma upper confidence bound
[2] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V
[3] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} 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}	-	1.0	-	V	V_{GS}=0V, I_F=6.0A, T_j=25°C
Reverse recovery time	t_{rr}	-	89	134	ns	V_R=400V, I_F=7A, di_F/dt=100A/µs; see table 8
Reverse recovery charge	Q_{rr}	-	0.34	0.68	µC	V_R=400V, I_F=7A, di_F/dt=100A/µs; see table 8
Peak reverse recovery current	I_{rrm}	-	6.8	-	A	V_R=400V, I_F=7A, di_F/dt=100A/µs; see table 8

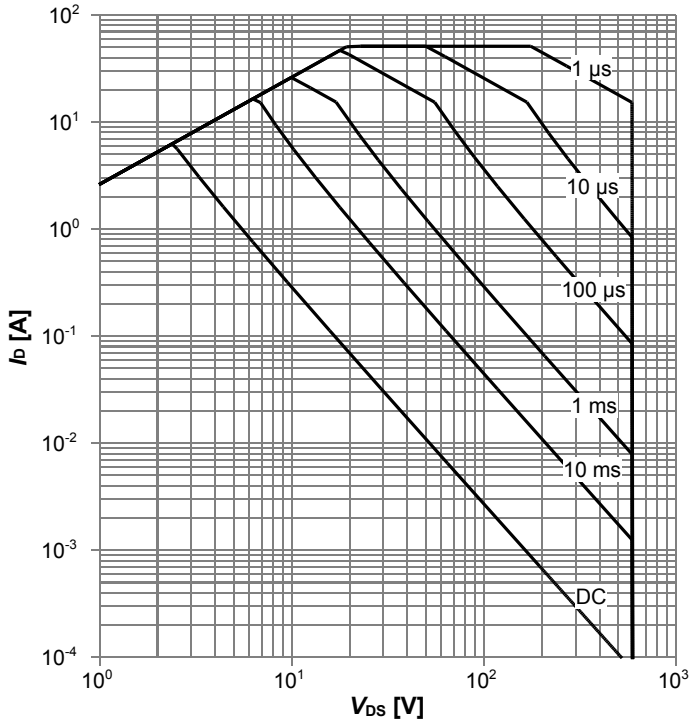
4 Electrical characteristics diagrams

Diagram 1: Power dissipation



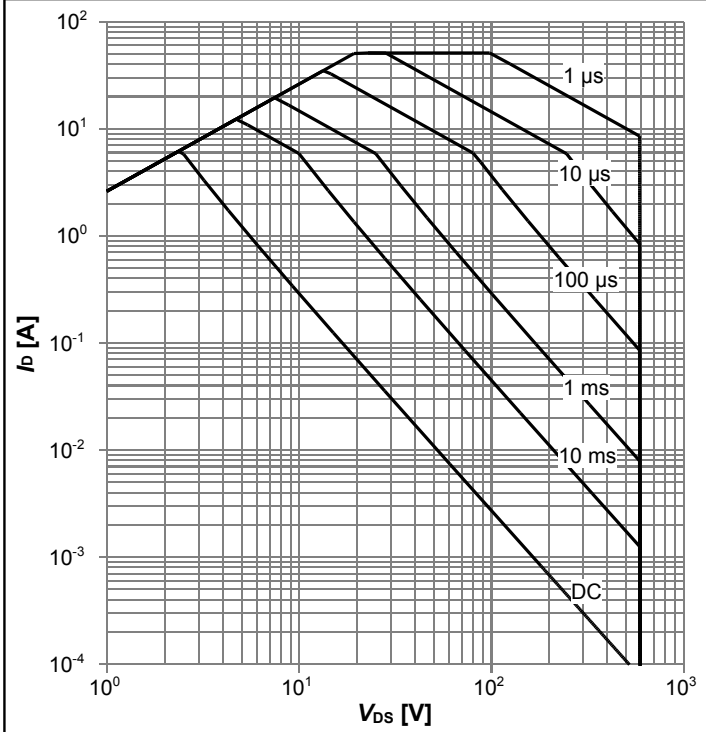
$P_{tot}=f(T_C)$

Diagram 2: Safe operating area



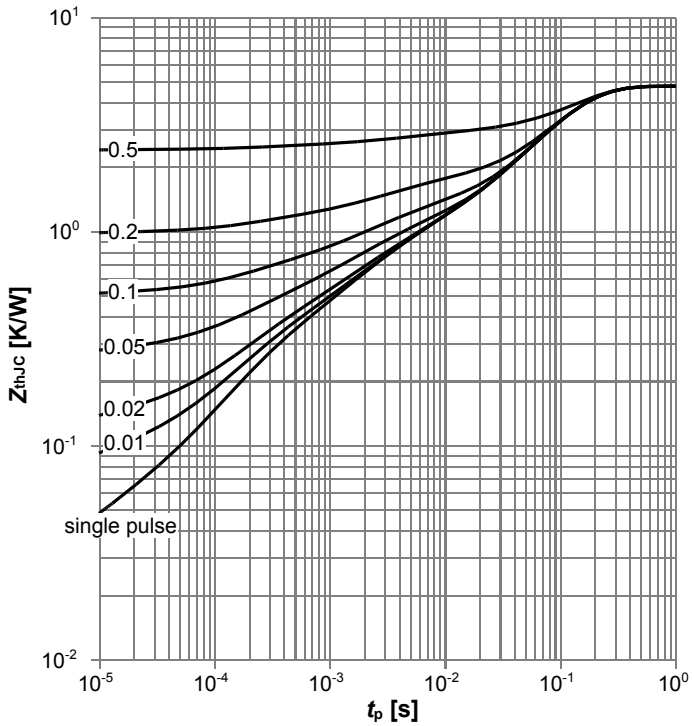
$I_D=f(V_{DS})$; $T_C=25$ °C; $D=0$; parameter: t_p

Diagram 3: Safe operating area



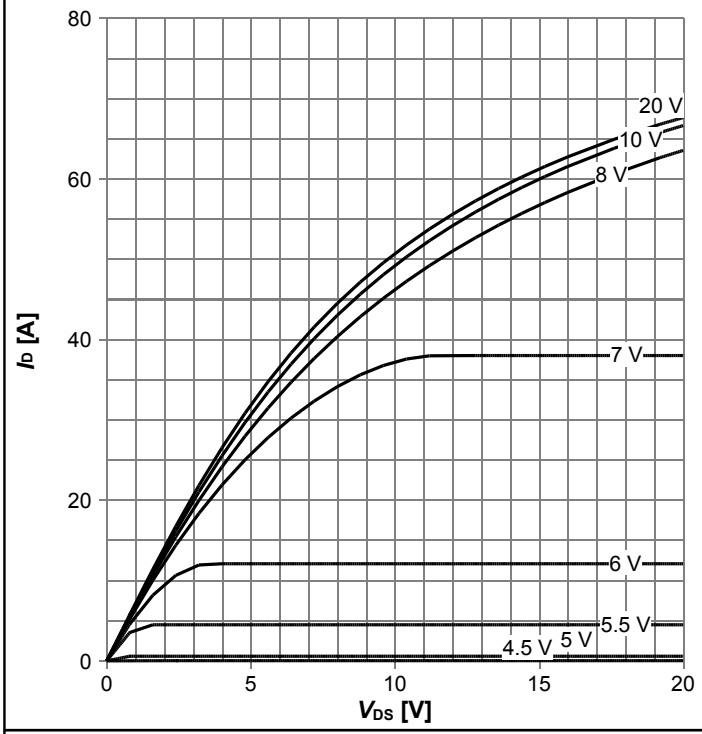
$I_D=f(V_{DS})$; $T_C=80$ °C; $D=0$; parameter: t_p

Diagram 4: Max. transient thermal impedance



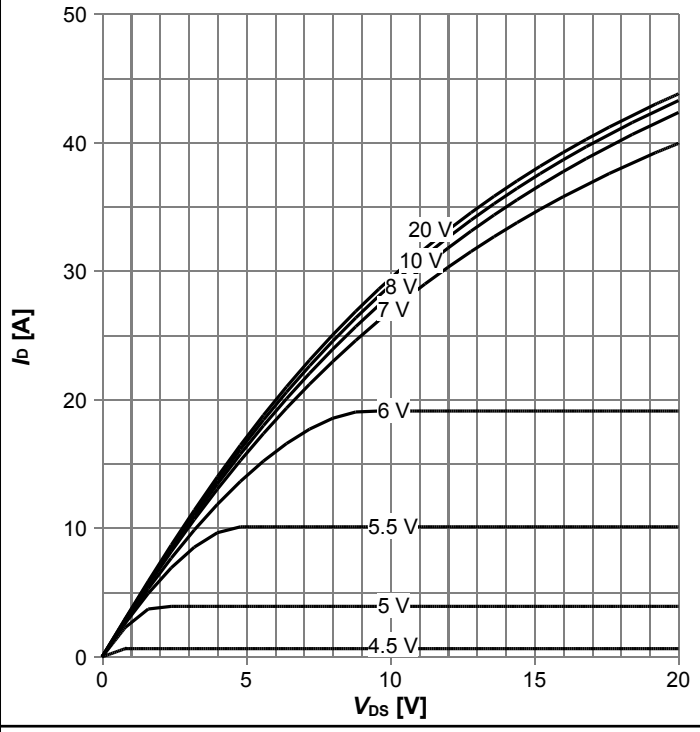
$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

Diagram 5: Typ. output characteristics



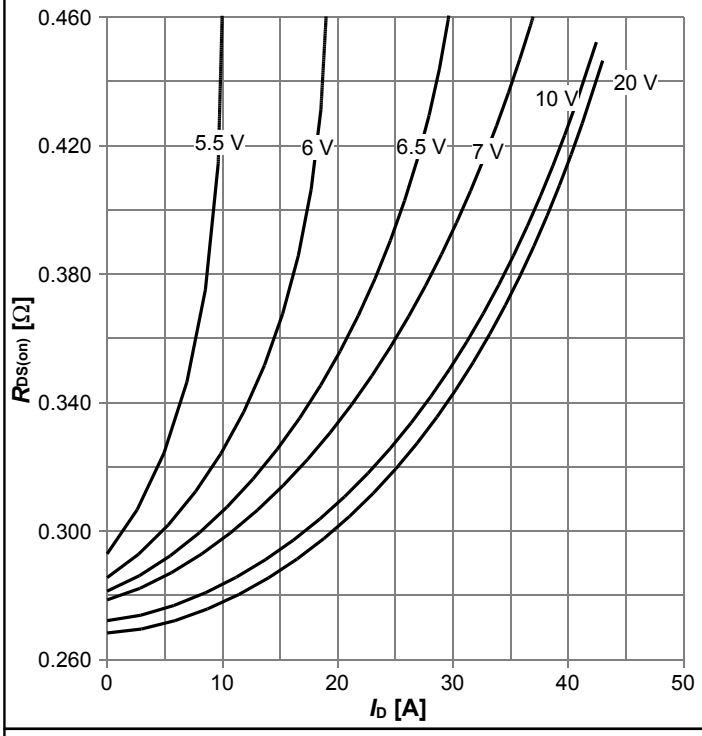
$I_D=f(V_{DS})$; $T_j=25$ °C; parameter: V_{GS}

Diagram 6: Typ. output characteristics



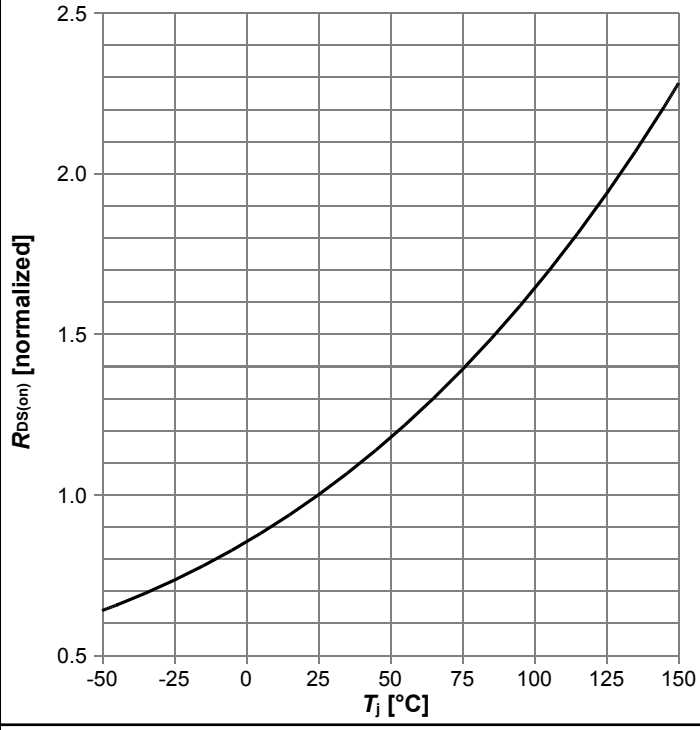
$I_D=f(V_{DS})$; $T_j=125$ °C; parameter: V_{GS}

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



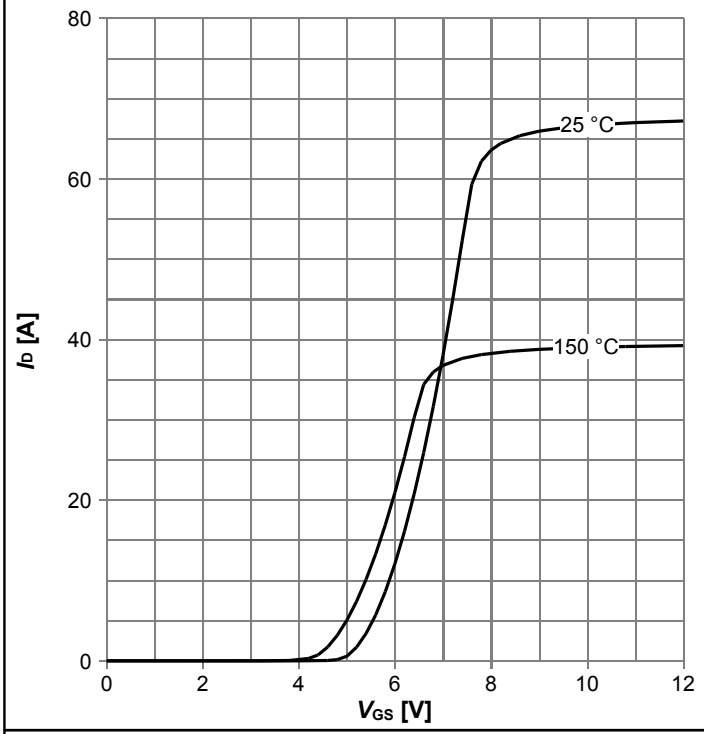
$R_{DS(on)}=f(I_D)$; $T_j=125$ °C; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



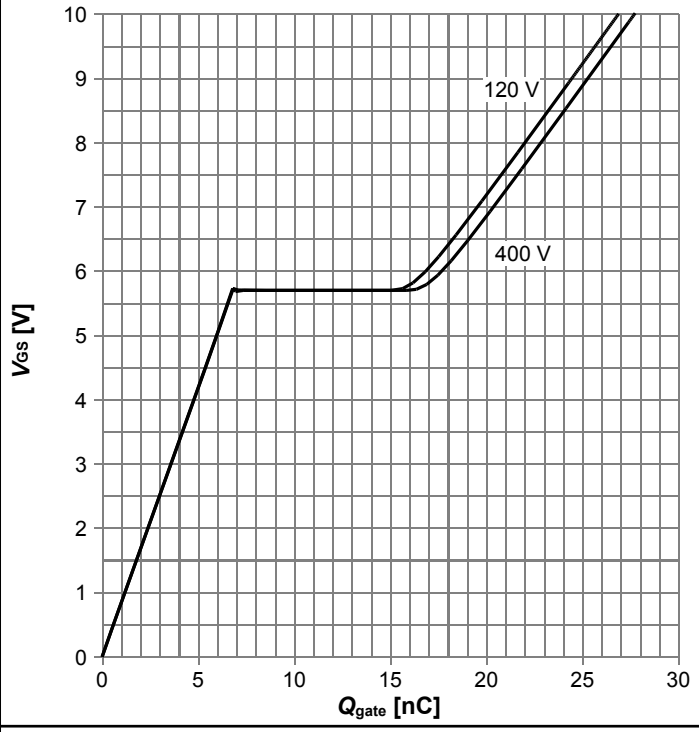
$R_{DS(on)}=f(T_j)$; $I_D=6.0$ A; $V_{GS}=10$ V

Diagram 9: Typ. transfer characteristics



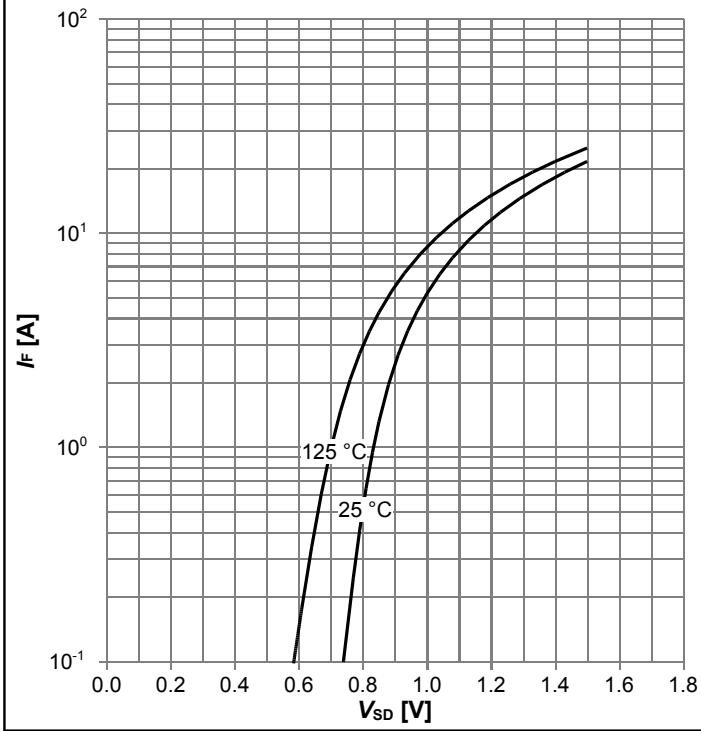
I_D=f(V_{GS}); V_{DS}=20V; parameter: T_j

Diagram 10: Typ. gate charge



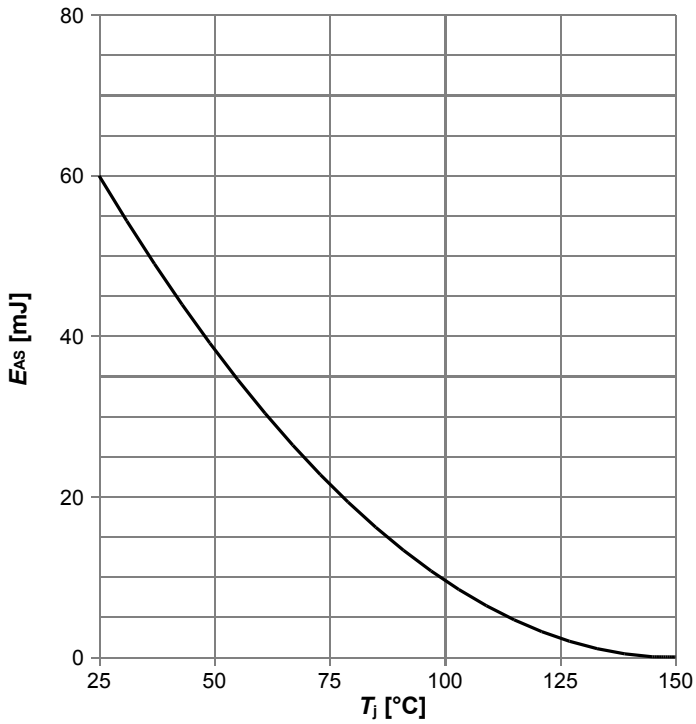
V_{GS}=f(Q_{gate}); I_D=7.0 A pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



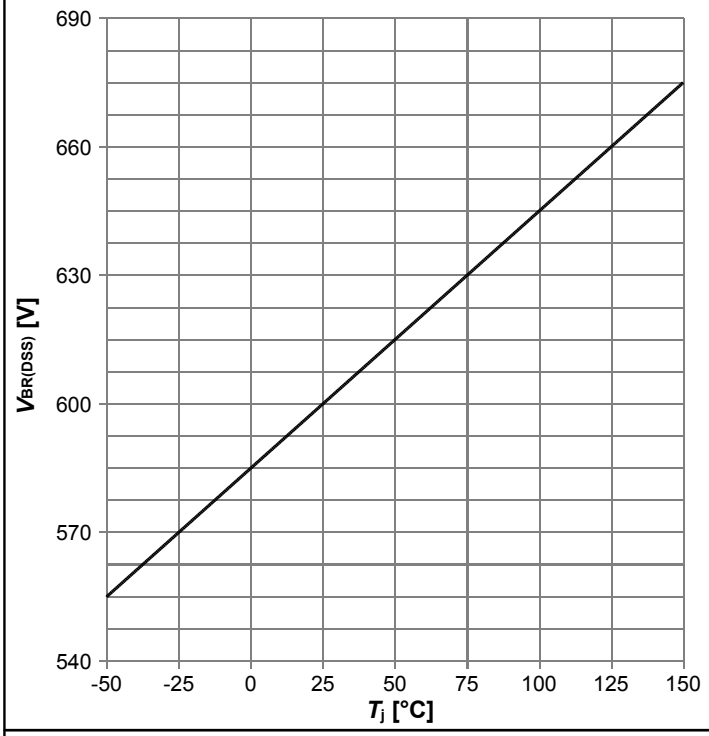
I_F=f(V_{SD}); parameter: T_j

Diagram 12: Avalanche energy



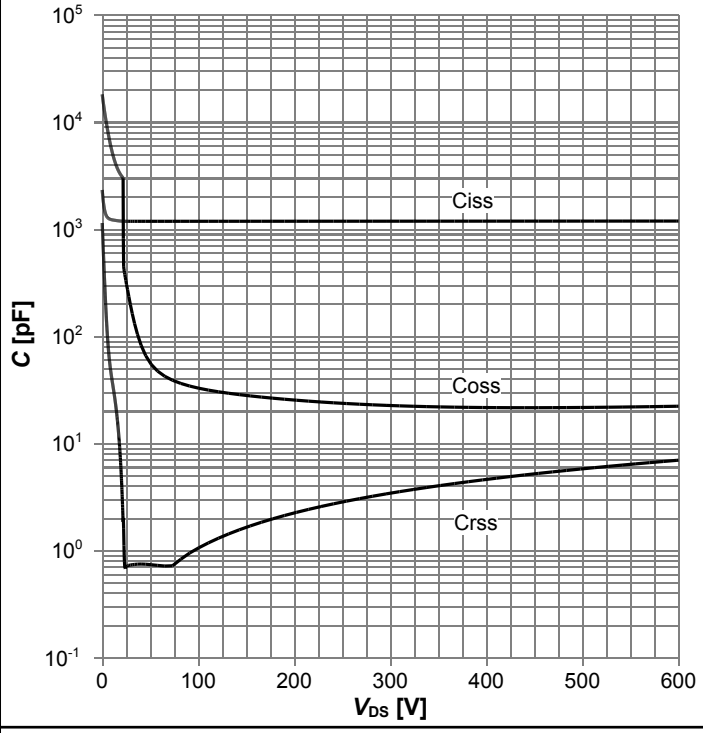
E_{AS}=f(T_j); I_D=3.7 A; V_{DD}=50 V

Diagram 13: Drain-source breakdown voltage



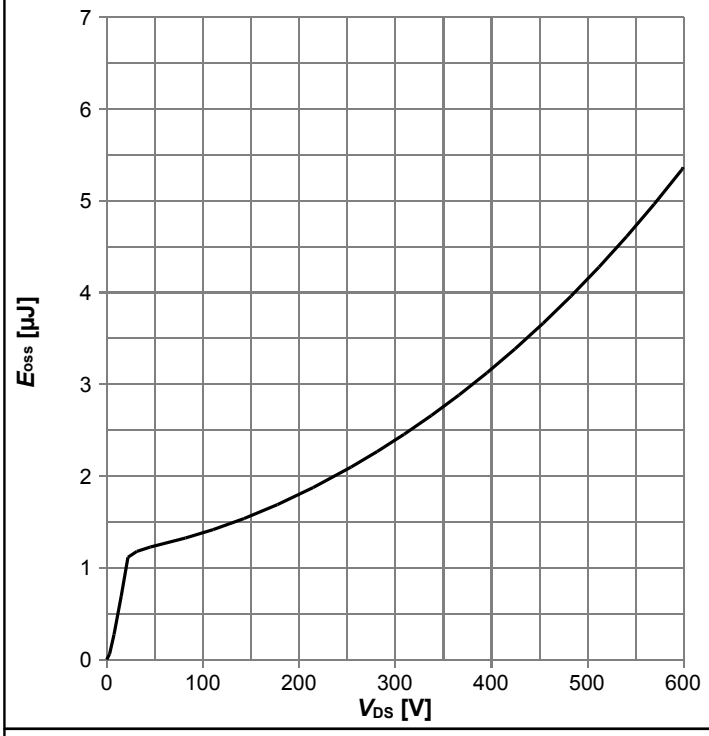
$V_{BR(DSS)}$=f(T_j); I_D=1 mA

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 Test Circuits

Table 8 Diode characteristics

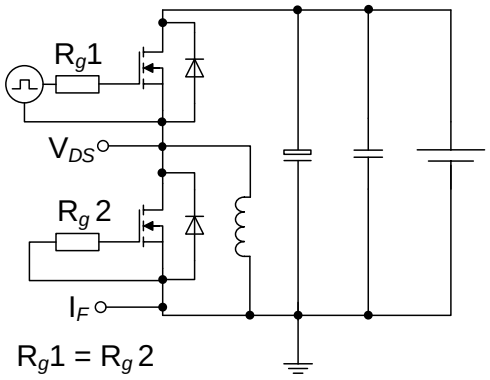
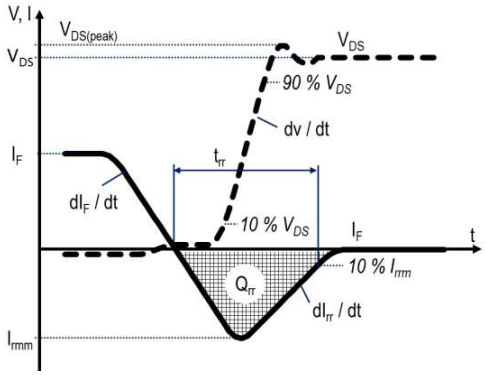
Test circuit for diode characteristics	Diode recovery waveform
	

Table 9 Switching times

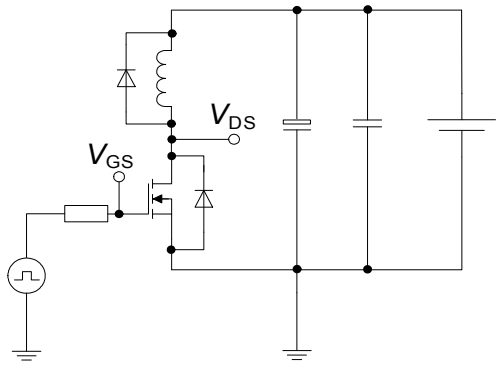
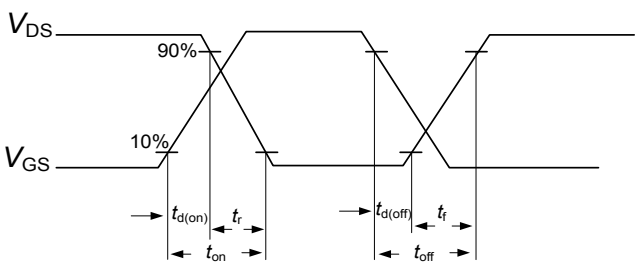
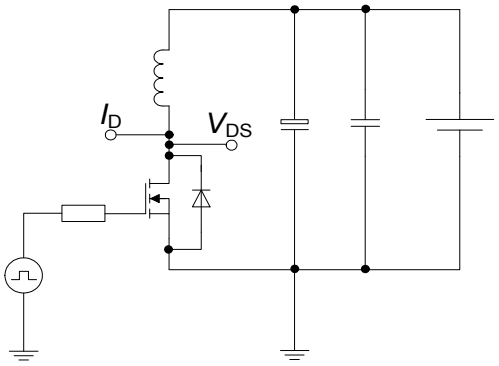
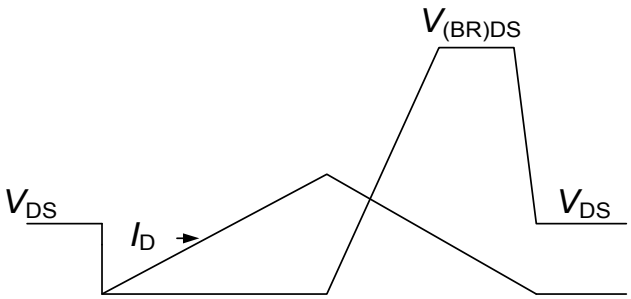
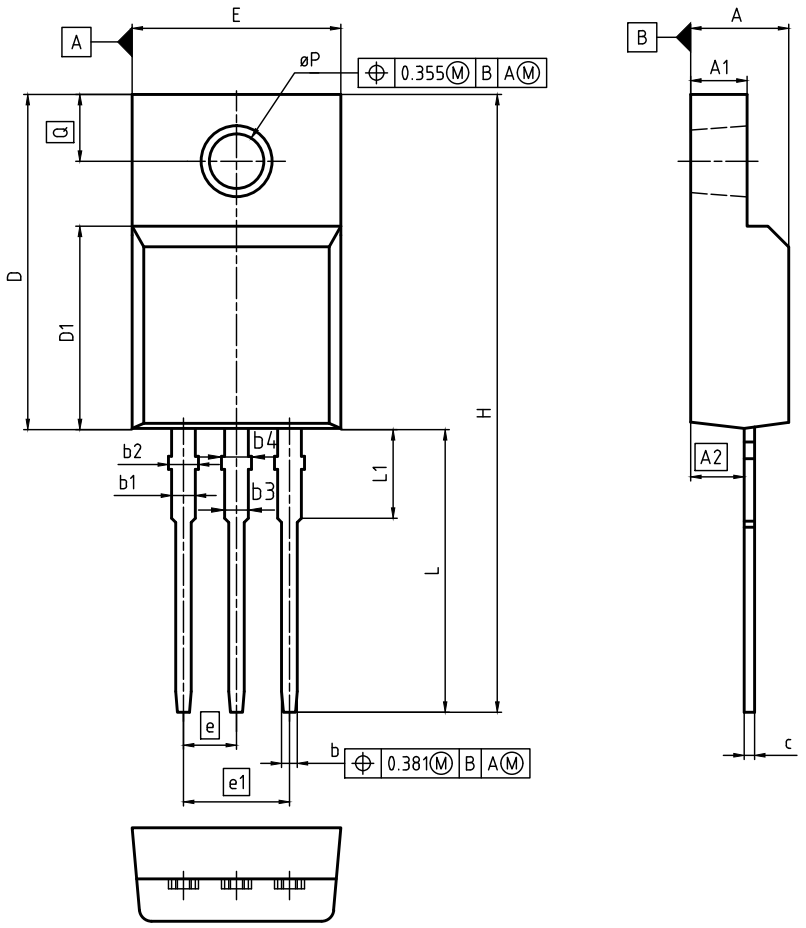
Switching times test circuit for inductive load	Switching times waveform
	

Table 10 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

6 Package Outlines



DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.50	4.90	0.177	0.193
A1	2.34	2.85	0.092	0.112
A2	2.42	2.86	0.095	0.113
b	0.65	0.90	0.026	0.035
b1	0.95	1.38	0.037	0.054
b2	0.95	1.51	0.037	0.059
b3	0.65	1.38	0.026	0.054
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.67	16.15	0.617	0.636
D1	8.97	9.83	0.353	0.387
E	10.00	10.65	0.394	0.419
e	2.54 (BSC)		0.100 (BSC)	
e1	5.08		0.200	
N	3		3	
H	28.70	29.75	1.130	1.171
L	12.78	13.75	0.503	0.541
L1	2.83	3.45	0.111	0.136
øP	2.95	3.38	0.116	0.133
Q	3.15	3.50	0.124	0.138

DOCUMENT NO.	Z8B00003319
SCALE	0 2.5 0 2.5 5mm
EUROPEAN PROJECTION	
ISSUE DATE	24-10-2014
REVISION	05

Figure 1 Outline PG-TO 220 FullPAK, dimensions in mm/inches

7 Appendix A

Table 11 Related Links

- **IFX CoolMOS CFD7 Webpage:** www.infineon.com
- **IFX CoolMOS CFD7 application note:** www.infineon.com
- **IFX CoolMOS CFD7 simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

Revision History

IPA60R170CFD7

Revision: 2018-01-22, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2017-08-25	Release of final version
2.1	2018-01-22	Raised diode current for dv/dt and dif/dt (table 2) to value of continuous drain current; Changed internal Rg (table 4); Renamed related links (table 11)

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