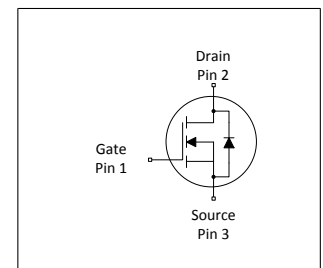


MOSFET

600V CoolMOS™ CFD7 Power Transistor

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

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

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
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	360	mΩ
$Q_{g,typ}$	14	nC
$I_{D,pulse}$	24	A
$E_{oss} @ 400V$	1.6	μJ
Body diode di_f/dt	1300	A/μs

Type / Ordering Code	Package	Marking	Related Links
IPA60R360CFD7	PG-TO 220 FullPAK	60R360F7	see Appendix A

Table of Contents

Description	1
Maximum ratings	3
Thermal characteristics	4
Electrical characteristics	5
Electrical characteristics diagrams	7
Test Circuits	11
Package Outlines	12
Appendix A	13
Revision History	14
Trademarks	14
Disclaimer	14

1 Maximum ratings

at $T_j = 25^\circ\text{C}$, unless otherwise specified

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current ¹⁾	I_D	-	-	5 3	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	24	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}	-	-	29	mJ	$I_D=2.0\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.14	mJ	$I_D=2.0\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche current, single pulse	I_{AS}	-	-	2.0	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	120	V/ns	$V_{DS}=0\dots400\text{V}$
Gate source voltage (static)	V_{GS}	-20	-	20	V	static;
Gate source voltage (dynamic)	V_{GS}	-30	-	30	V	AC ($f>1\text{ Hz}$)
Power dissipation	P_{tot}	-	-	23	W	$T_C=25^\circ\text{C}$
Storage temperature	T_{stg}	-55	-	150	$^\circ\text{C}$	-
Operating junction temperature	T_j	-55	-	150	$^\circ\text{C}$	-
Mounting torque	-	-	-	50	Ncm	M2.5 and M3 screws
Continuous diode forward current	I_S	-	-	5	A	$T_C=25^\circ\text{C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	24	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	70	V/ns	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 5\text{A}$, $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di _F /dt	-	-	1300	A/ μs	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 5\text{A}$, $T_j=25^\circ\text{C}$ see table 8
Insulation withstand voltage	V_{ISO}	-	-	2500	V	V_{rms} , $T_C=25^\circ\text{C}$, $t=1\text{min}$

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_θ

2 Thermal characteristics

Table 3 Thermal characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	5.54	°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 $T_j=25^\circ\text{C}$, 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	$V_{GS}=0\text{V}$, $I_D=1\text{mA}$
Gate threshold voltage	$V_{(GS)th}$	3.5	4	4.5	V	$V_{DS}=V_{GS}$, $I_D=0.14\text{mA}$
Zero gate voltage drain current ¹⁾	I_{DSS}	-	-	1	μA	$V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$ $V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=125^\circ\text{C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.295 0.674	0.36	Ω	$V_{GS}=10\text{V}$, $I_D=2.9\text{A}$, $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$, $I_D=2.9\text{A}$, $T_j=150^\circ\text{C}$
Gate resistance	R_G	-	11.6	-	Ω	$f=1\text{MHz}$, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	679	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$
Output capacitance	C_{oss}	-	11	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$
Effective output capacitance, energy related ²⁾	$C_{o(er)}$	-	20	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$
Effective output capacitance, time related ³⁾	$C_{o(tr)}$	-	198	-	pF	$I_D=\text{constant}$, $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$
Turn-on delay time	$t_{d(on)}$	-	15.5	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=4.0\text{A}$, $R_G=10.2\Omega$; see table 9
Rise time	t_r	-	12	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=4.0\text{A}$, $R_G=10.2\Omega$; see table 9
Turn-off delay time	$t_{d(off)}$	-	41.5	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=4.0\text{A}$, $R_G=10.2\Omega$; see table 9
Fall time	t_f	-	8.5	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=4.0\text{A}$, $R_G=10.2\Omega$; see table 9

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{GS}	-	4	-	nC	$V_{DD}=400\text{V}$, $I_D=4.0\text{A}$, $V_{GS}=0$ to 10V
Gate to drain charge	Q_{gd}	-	4	-	nC	$V_{DD}=400\text{V}$, $I_D=4.0\text{A}$, $V_{GS}=0$ to 10V
Gate charge total	Q_g	-	14	-	nC	$V_{DD}=400\text{V}$, $I_D=4.0\text{A}$, $V_{GS}=0$ to 10V
Gate plateau voltage	$V_{plateau}$	-	5.8	-	V	$V_{DD}=400\text{V}$, $I_D=4.0\text{A}$, $V_{GS}=0$ to 10V

¹⁾ Maximum specification is defined by calculated six sigma upper confidence bound

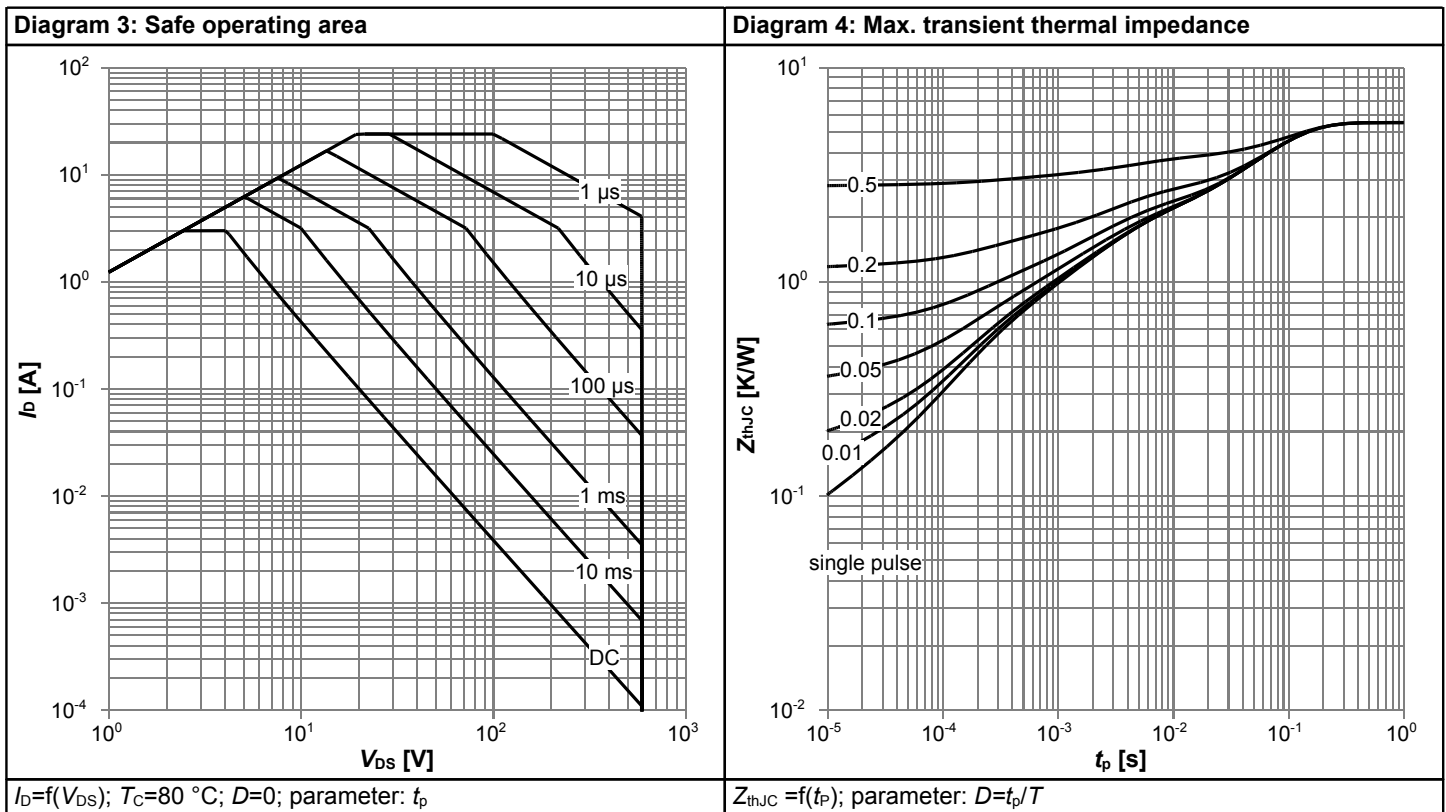
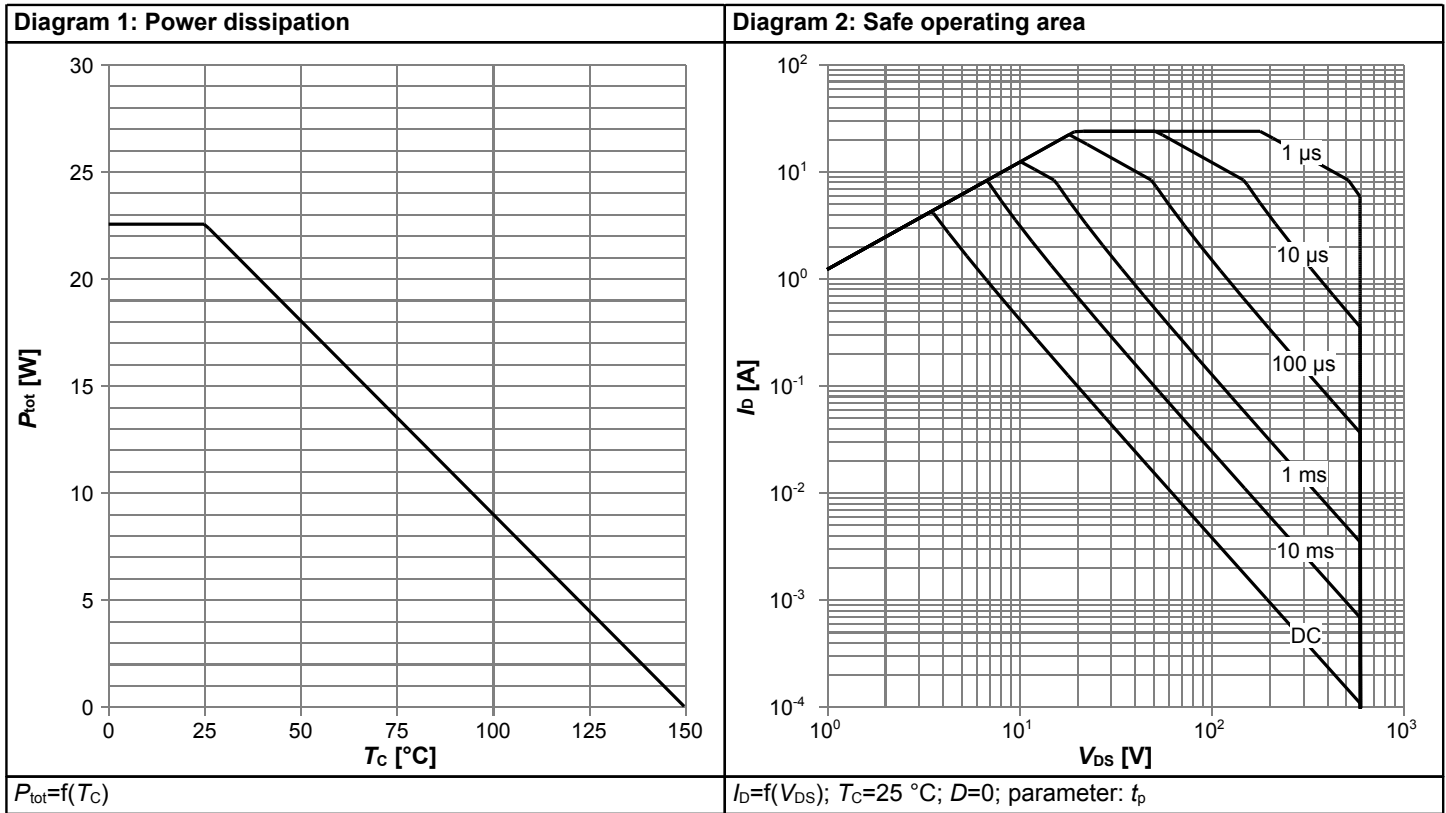
²⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V

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	$V_{GS}=0V, I_F=2.9A, T_j=25^\circ C$
Reverse recovery time	t_{rr}	-	81	122	ns	$V_R=400V, I_F=4.0A, di_F/dt=100A/\mu s$; see table 8
Reverse recovery charge	Q_{rr}	-	0.28	0.56	μC	$V_R=400V, I_F=4.0A, di_F/dt=100A/\mu s$; see table 8
Peak reverse recovery current	I_{rrm}	-	6.4	-	A	$V_R=400V, I_F=4.0A, di_F/dt=100A/\mu s$; see table 8

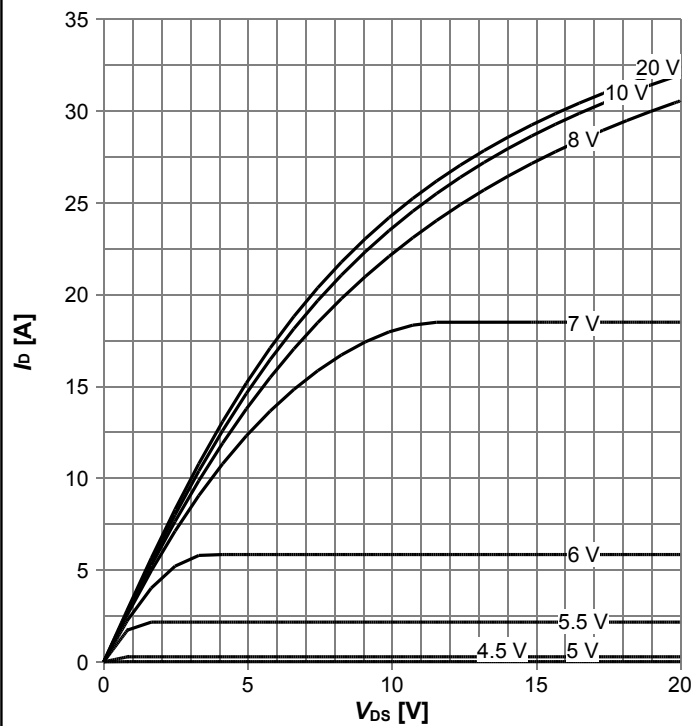
4 Electrical characteristics diagrams



600V CoolMOS™ CFD7 Power Transistor

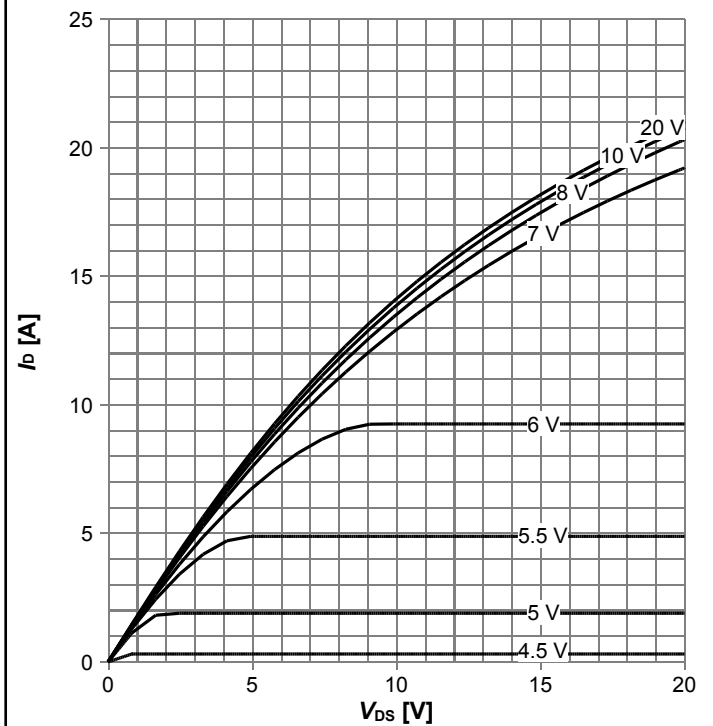
IPA60R360CFD7

Diagram 5: Typ. output characteristics



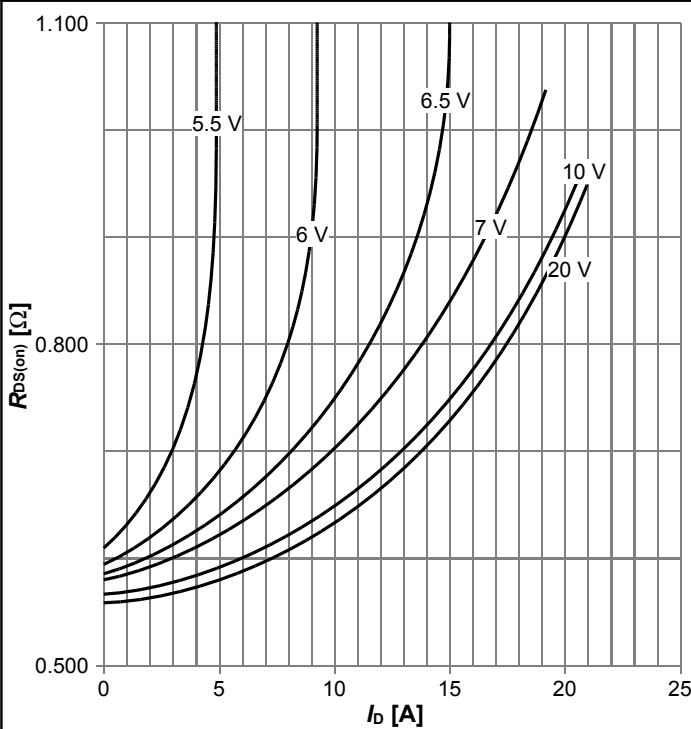
$I_D=f(V_{DS}); T_j=25\text{ °C};$ parameter: V_{GS}

Diagram 6: Typ. output characteristics



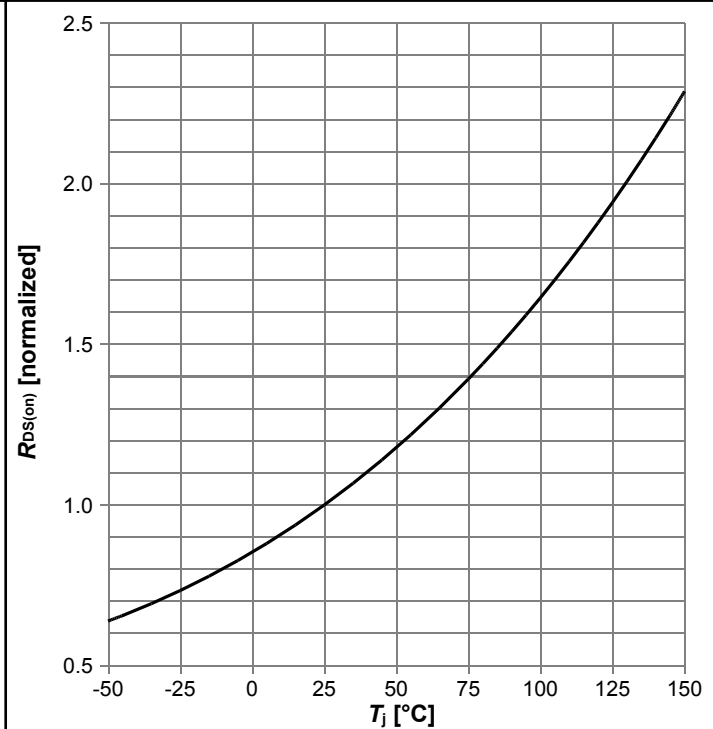
$I_D=f(V_{DS}); T_j=125\text{ °C};$ parameter: V_{GS}

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



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

Diagram 8: Drain-source on-state resistance

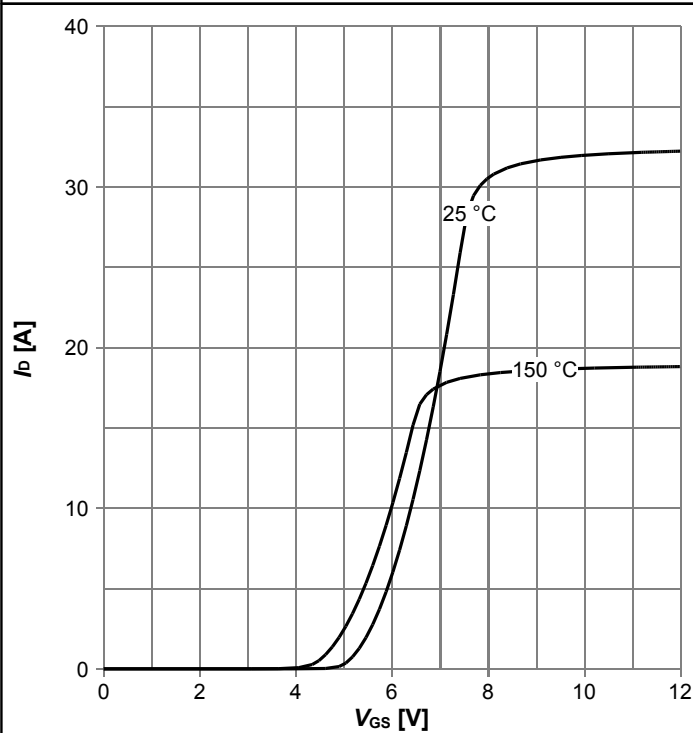


$R_{DS(on)}=f(T_j); I_D=2.9\text{ A}; V_{GS}=10\text{ V}$

600V CoolMOS™ CFD7 Power Transistor

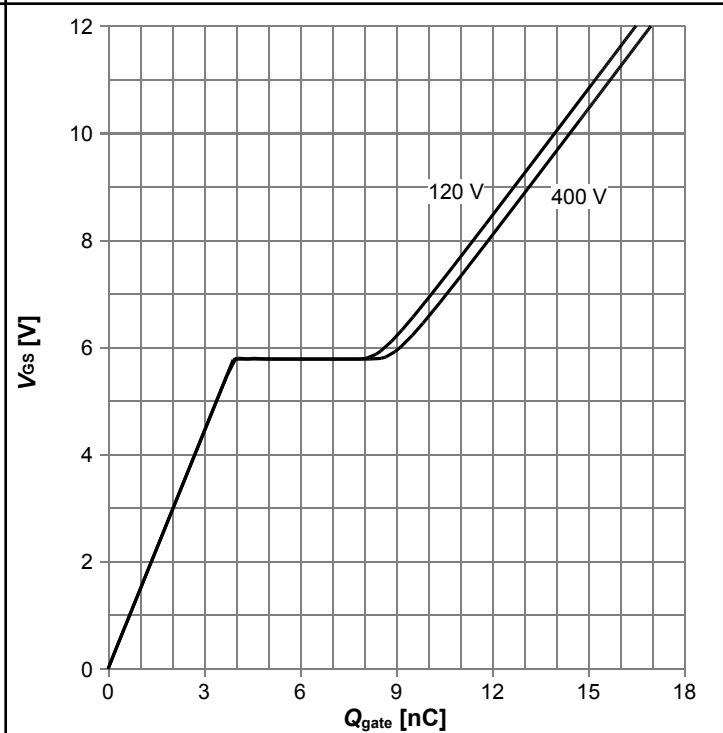
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Diagram 9: Typ. transfer characteristics



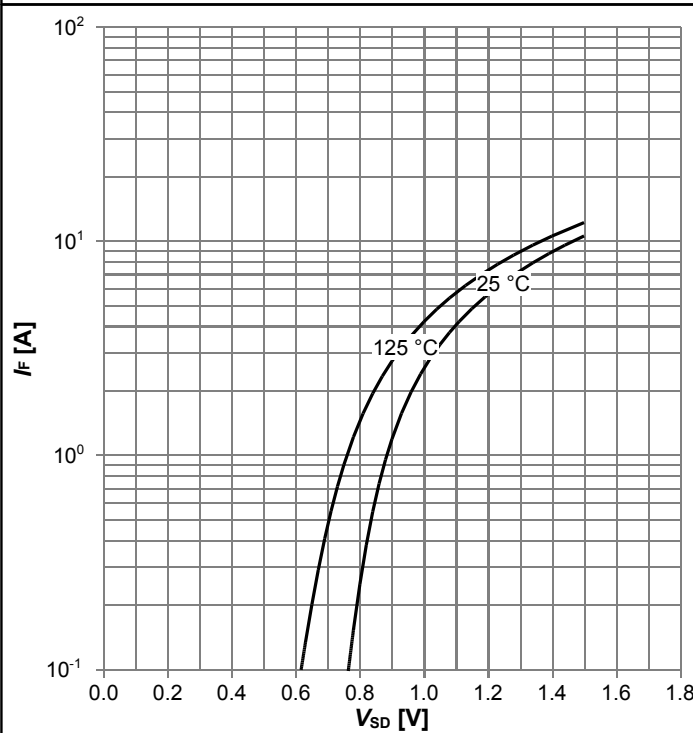
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



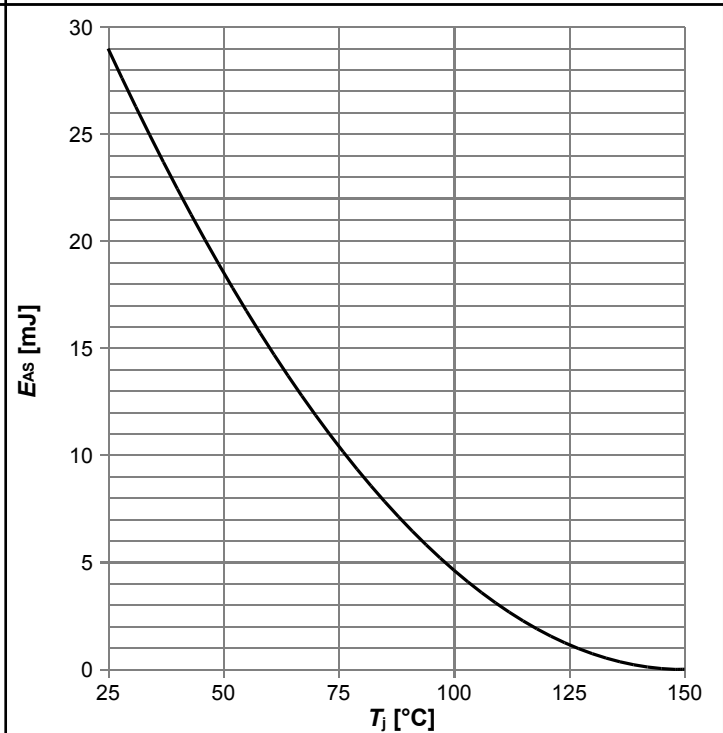
$V_{GS} = f(Q_{gate}); I_D = 4.0 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



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

Diagram 12: Avalanche energy

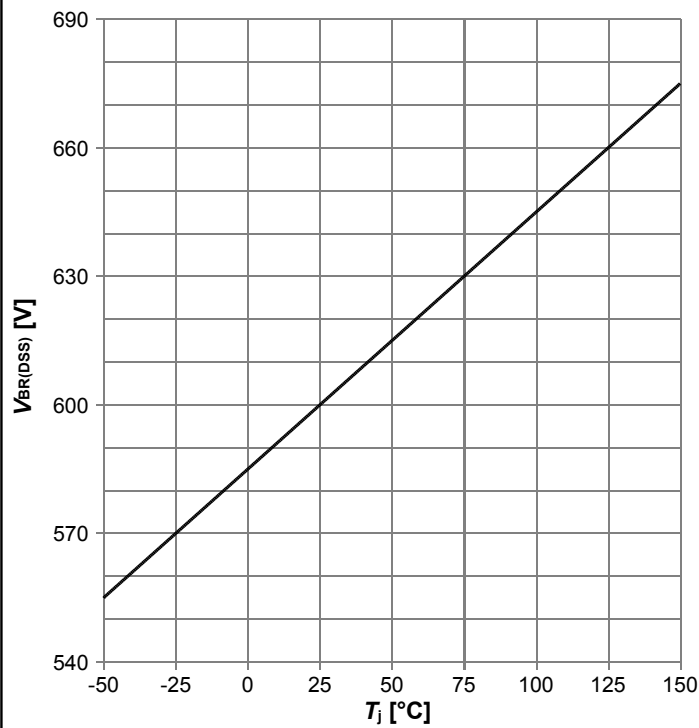


$E_{AS} = f(T_j); I_D = 2.0 \text{ A}; V_{DD} = 50 \text{ V}$

600V CoolMOS™ CFD7 Power Transistor

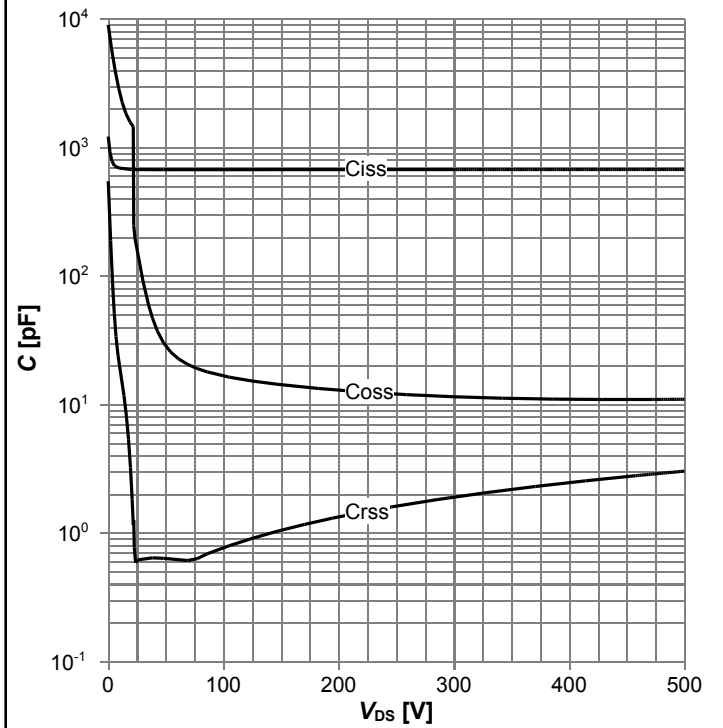
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Diagram 13: Drain-source breakdown voltage



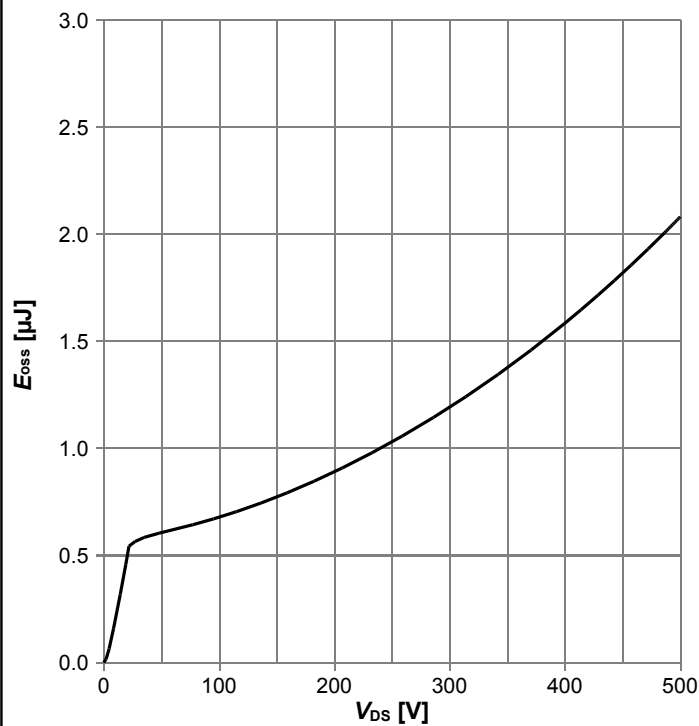
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

Diagram 14: Typ. capacitances



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

Diagram 15: Typ. Coss stored energy



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

5 Test Circuits

Table 8 Diode characteristics



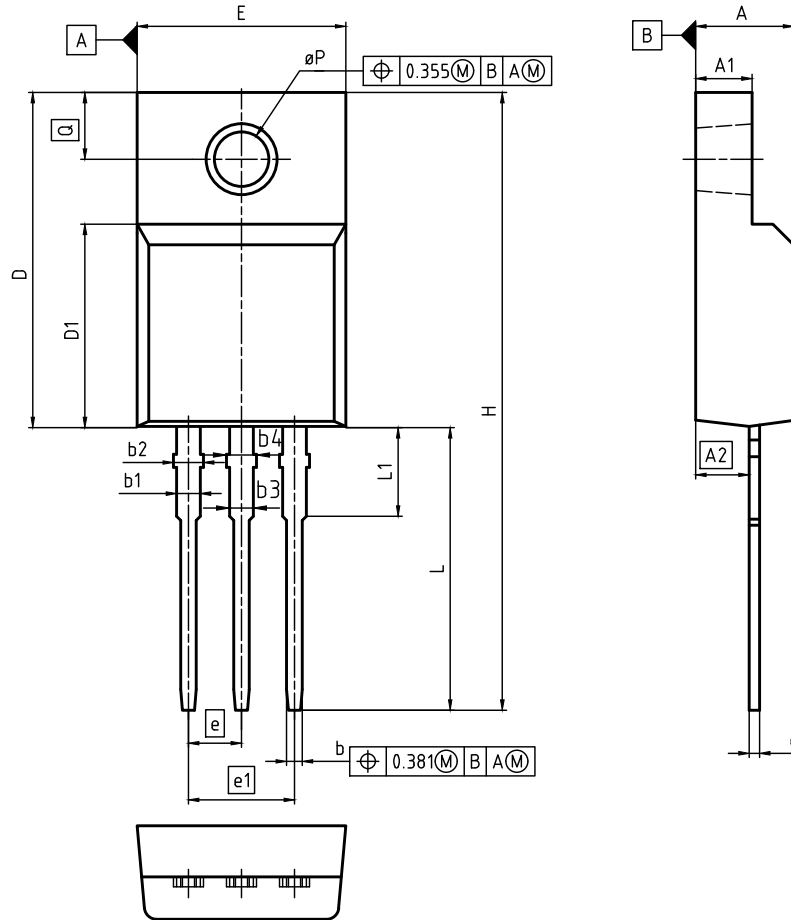
Table 9 Switching times



Table 10 Unclamped inductive load



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

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SCALE

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

IPA60R360CFD7

Revision: 2019-06-06, Rev. 2.0

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2019-06-06	Release of final version

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