

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.

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

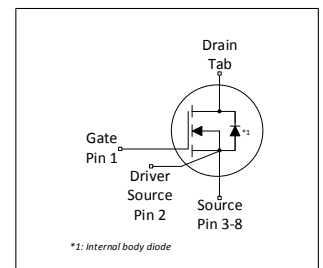
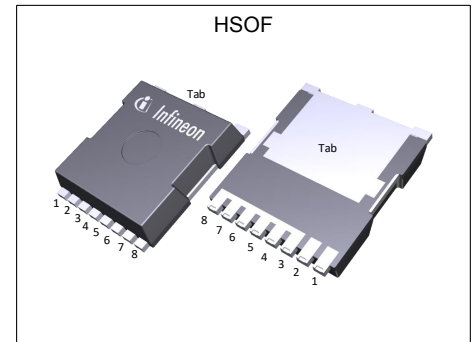
Potential applications

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: The source and sense source pins are not exchangeable. Their exchange might lead to malfunction. For paralleling 4pin MOSFET devices the placement of the gate resistor is generally recommended to be on the Driver Source instead of the Gate.



RoHS

Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	145	m Ω
$Q_{g,typ}$	28	nC
$I_{D,pulse}$	51	A
$E_{oss} @ 400V$	3.2	μ J
Body diode di_F/dt	1300	A/ μ s

Type / Ordering Code	Package	Marking	Related Links
IPT60R145CFD7	PG-HSOF-8	60R145F7	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	-	-	19 12	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	51	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}	-	-	60	mJ	$I_D=3.8\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.30	mJ	$I_D=3.8\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche current, single pulse	I_{AS}	-	-	3.8	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}	-	-	116	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	-	-	-	n.a.	Ncm	-
Continuous diode forward current ¹⁾	I_S	-	-	19	A	$T_C=25^\circ\text{C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	51	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	70	V/ns	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 14\text{A}$, $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di _F /dt	-	-	1300	A/ μs	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 14\text{A}$, $T_j=25^\circ\text{C}$ see table 8
Insulation withstand voltage	V_{ISO}	-	-	n.a.	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}	-	-	1.08	°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}	-	35	45	°C/W	Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm ² (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 MSL1

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	$V_{DS}=V_{GS}$, $I_D=0.3\text{mA}$
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	$R_{DS(on)}$	-	0.114 0.259	0.145	Ω	$V_{GS}=10\text{V}$, $I_D=6.0\text{A}$, $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$, $I_D=6.0\text{A}$, $T_j=150^\circ\text{C}$
Gate resistance	R_G	-	10.9	-	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}	-	1199	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$
Output capacitance	C_{oss}	-	22	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$
Effective output capacitance, energy related ²⁾	$C_{o(er)}$	-	40	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$
Effective output capacitance, time related ³⁾	$C_{o(tr)}$	-	401	-	pF	$I_D=\text{constant}$, $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$
Turn-on delay time	$t_{d(on)}$	-	23	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=7.3\text{A}$, $R_G=10.2\Omega$; see table 9
Rise time	t_r	-	13	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=7.3\text{A}$, $R_G=10.2\Omega$; see table 9
Turn-off delay time	$t_{d(off)}$	-	83	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=7.3\text{A}$, $R_G=10.2\Omega$; see table 9
Fall time	t_f	-	5	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=7.3\text{A}$, $R_G=10.2\Omega$; see table 9

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{GS}	-	7	-	nC	$V_{DD}=400\text{V}$, $I_D=7.3\text{A}$, $V_{GS}=0$ to 10V
Gate to drain charge	Q_{gd}	-	9	-	nC	$V_{DD}=400\text{V}$, $I_D=7.3\text{A}$, $V_{GS}=0$ to 10V
Gate charge total	Q_g	-	28	-	nC	$V_{DD}=400\text{V}$, $I_D=7.3\text{A}$, $V_{GS}=0$ to 10V
Gate plateau voltage	$V_{plateau}$	-	5.7	-	V	$V_{DD}=400\text{V}$, $I_D=7.3\text{A}$, $V_{GS}=0$ to 10V

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

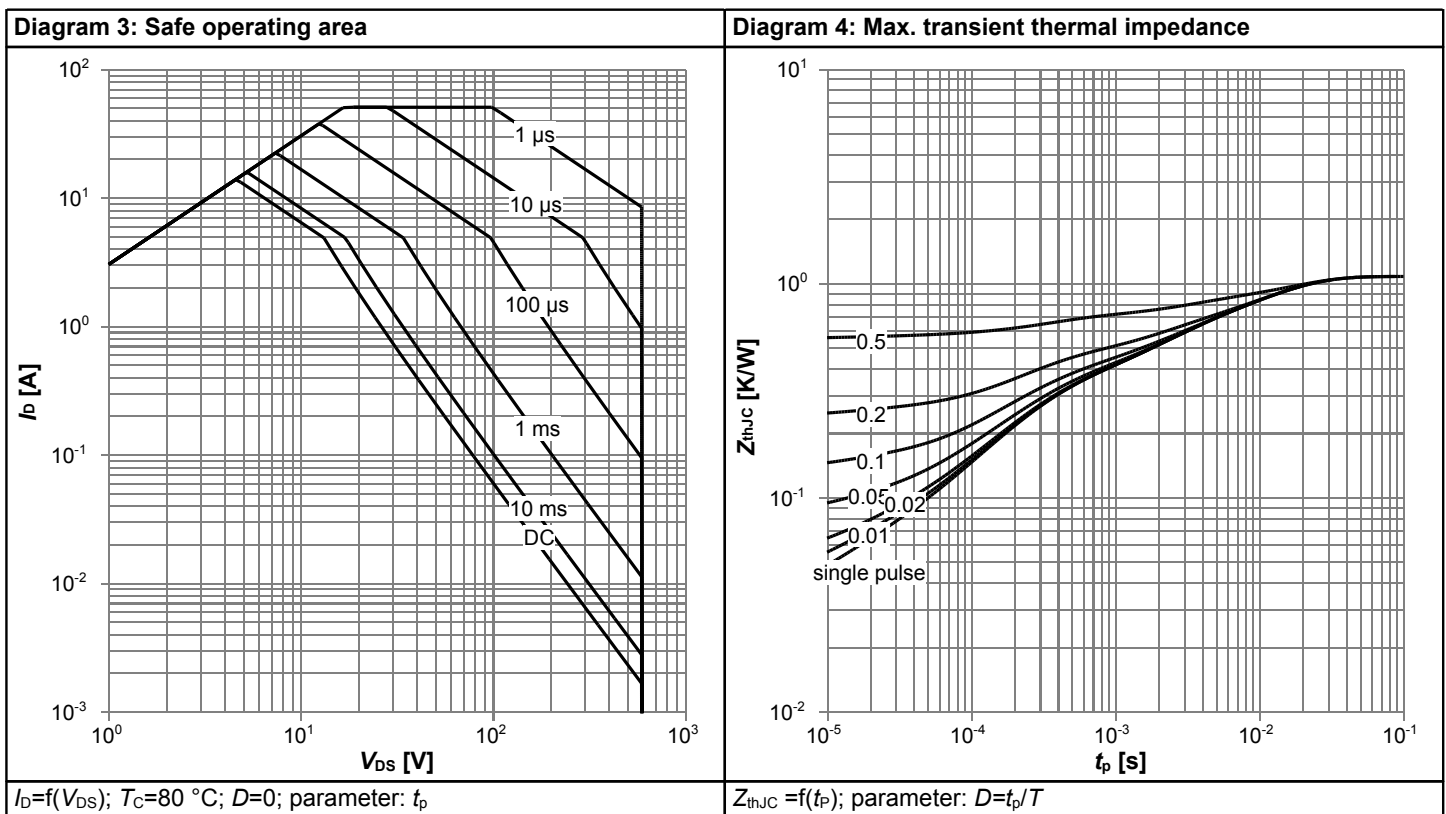
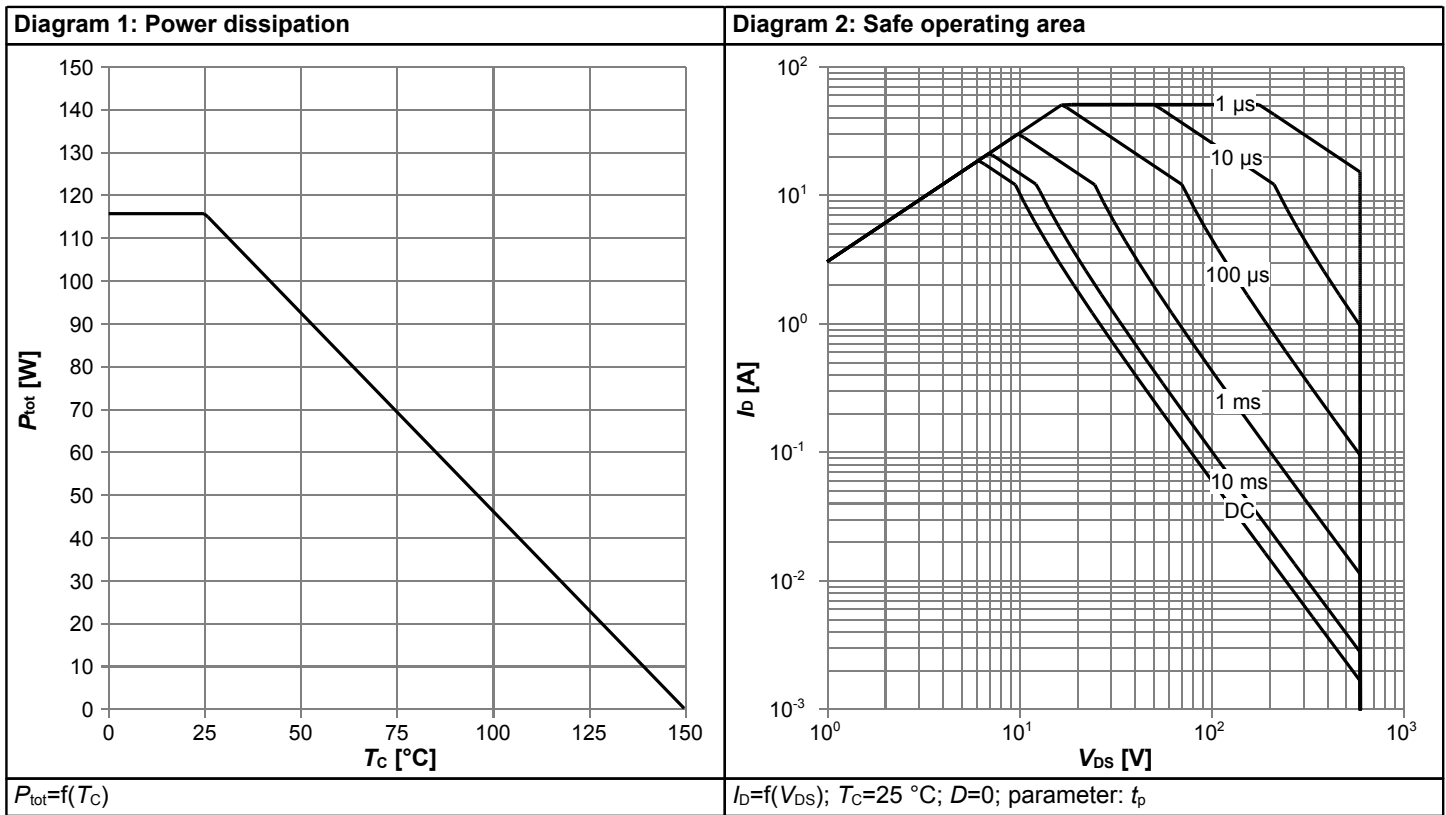
²⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V

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	$V_{GS}=0V, I_F=6.0A, T_j=25^\circ C$
Reverse recovery time	t_{rr}	-	92	138	ns	$V_R=400V, I_F=7.3A, di_F/dt=100A/\mu s$; see table 8
Reverse recovery charge	Q_{rr}	-	0.36	0.72	μC	$V_R=400V, I_F=7.3A, di_F/dt=100A/\mu s$; see table 8
Peak reverse recovery current	I_{rrm}	-	7.1	-	A	$V_R=400V, I_F=7.3A, di_F/dt=100A/\mu s$; see table 8

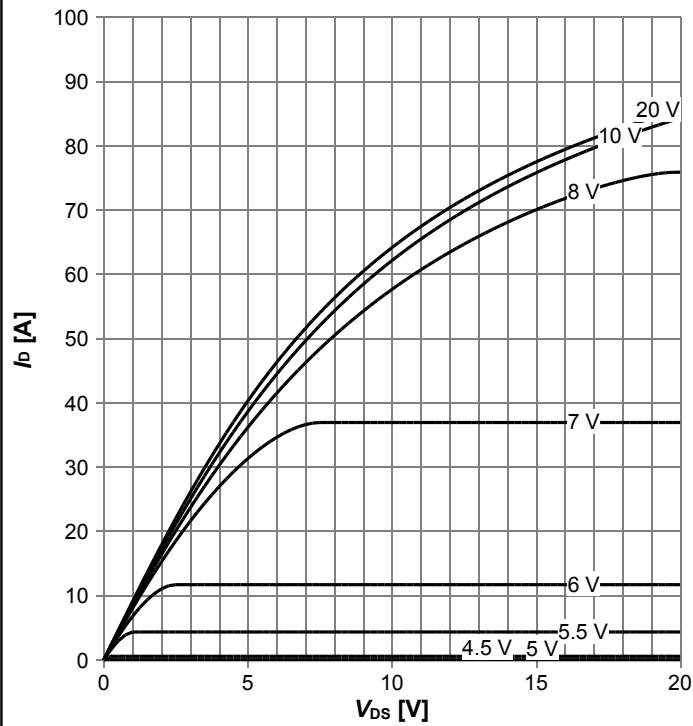
4 Electrical characteristics diagrams



600V CoolMOS™ CFD7 Power Transistor

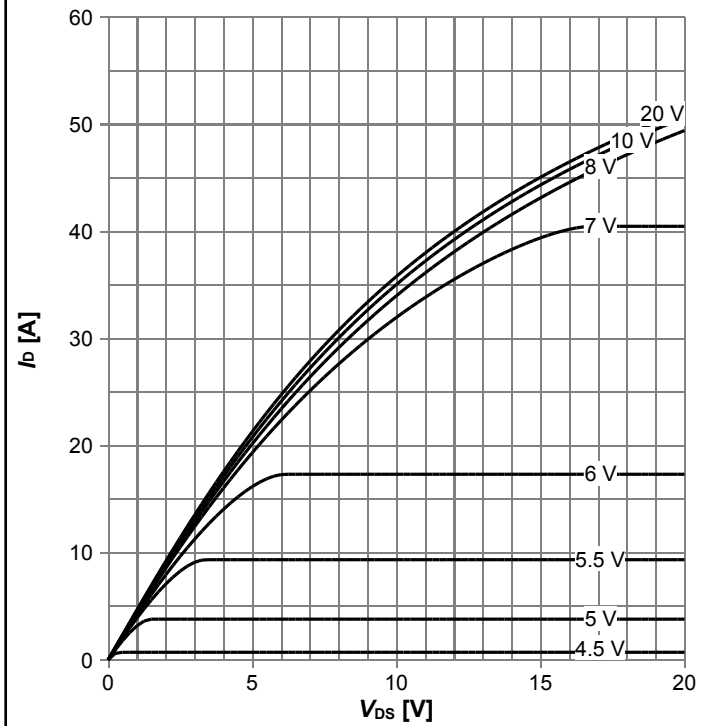
IPT60R145CFD7

Diagram 5: Typ. output characteristics



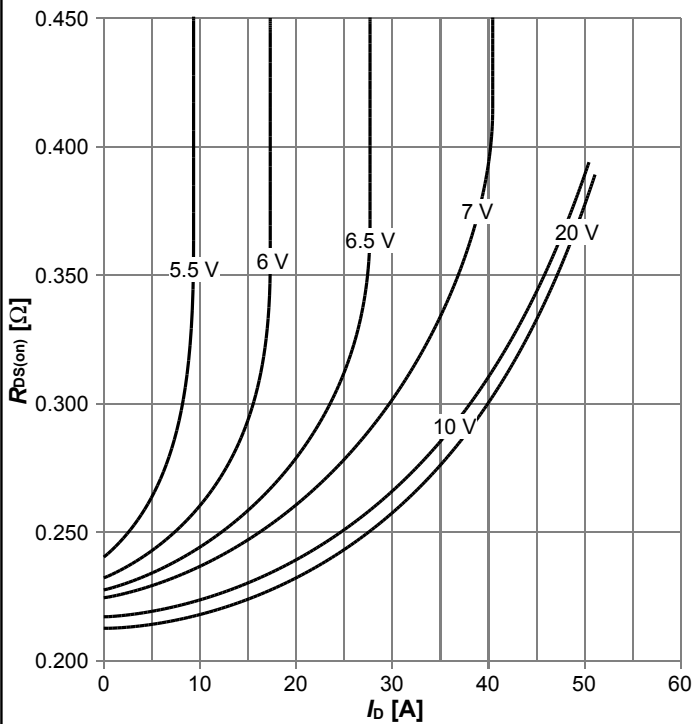
$I_D=f(V_{DS}); T_j=25\text{ °C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics



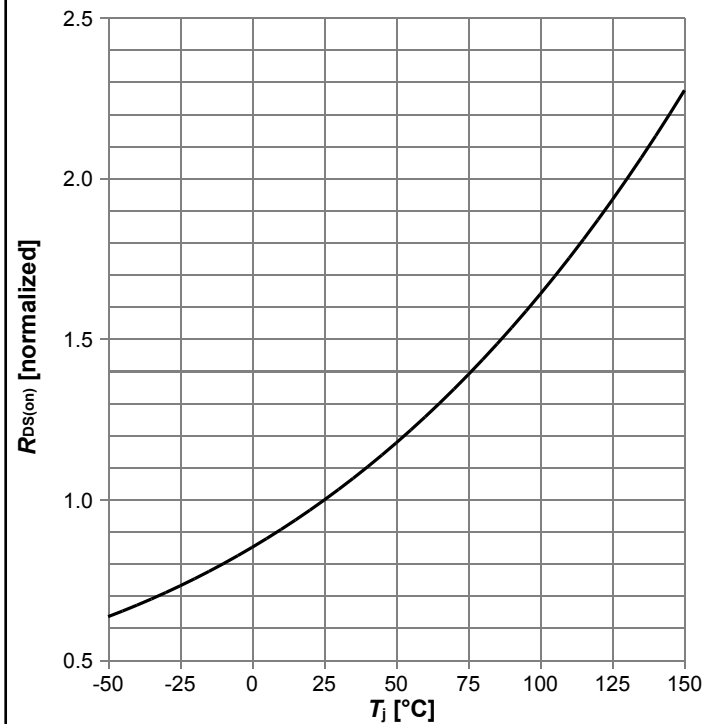
$I_D=f(V_{DS}); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

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



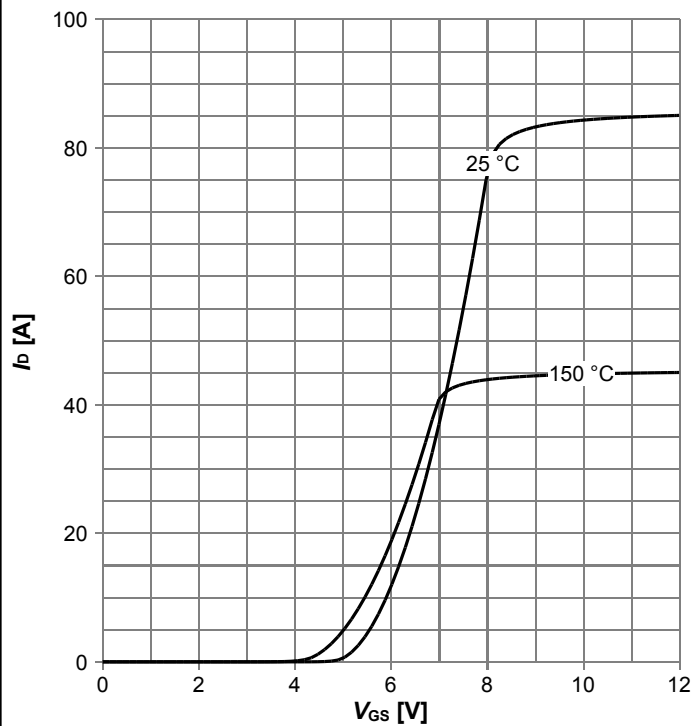
$R_{DS(on)}=f(I_D); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance



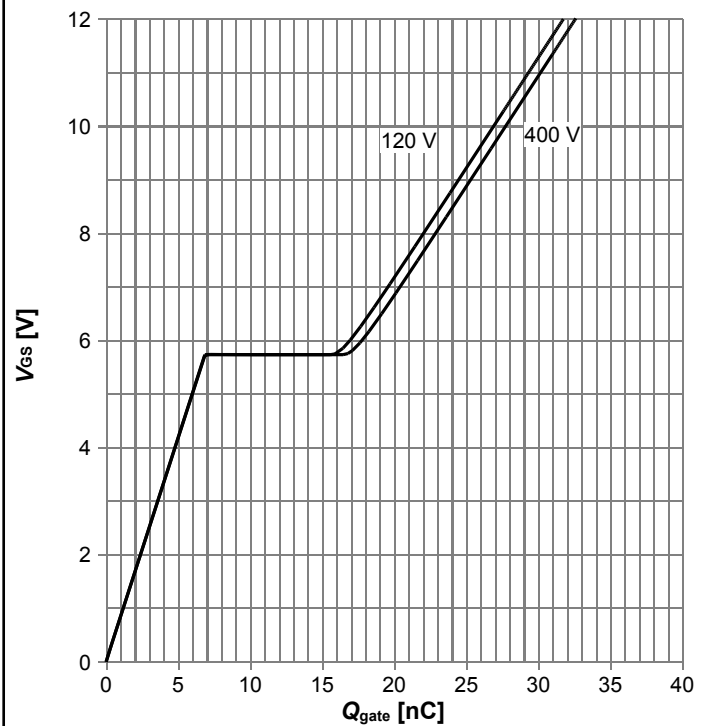
$R_{DS(on)}=f(T_j); I_D=6.0\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



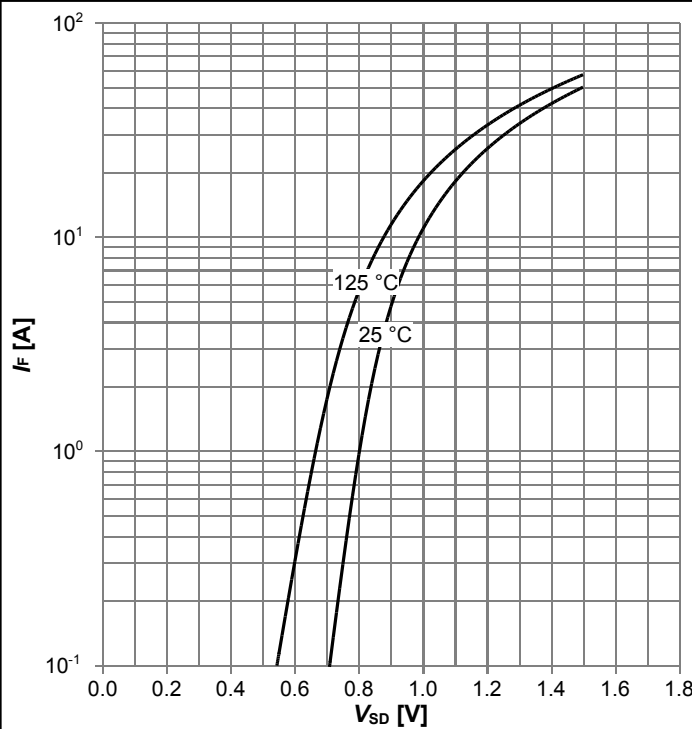
$I_D = f(V_{GS})$; $V_{DS} = 20V$; parameter: T_j

Diagram 10: Typ. gate charge



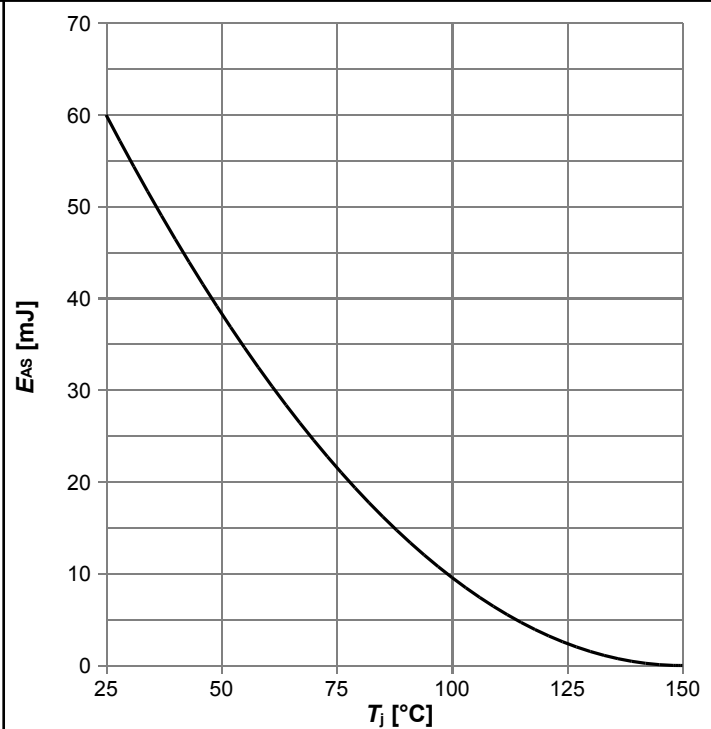
$V_{GS} = f(Q_{gate})$; $I_D = 7.3 A$ pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



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

Diagram 12: Avalanche energy

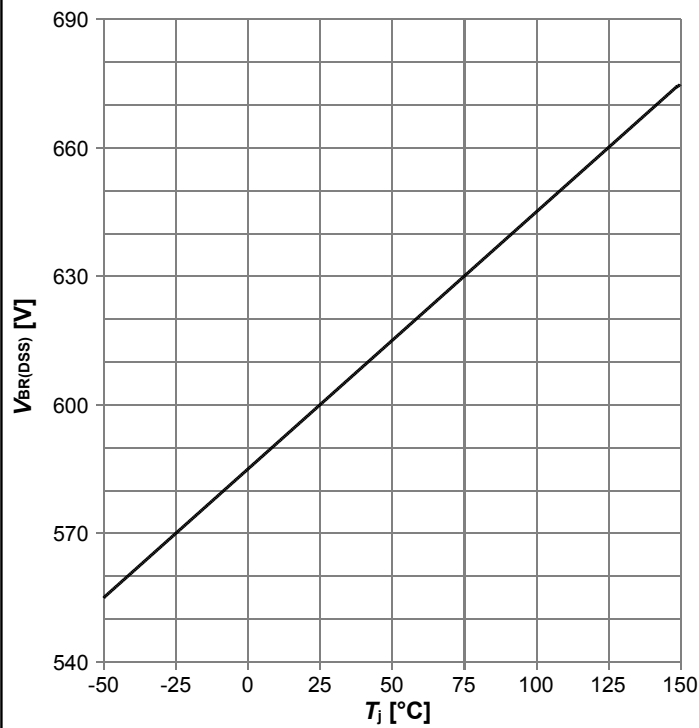


$E_{AS} = f(T_j)$; $I_D = 3.8 A$; $V_{DD} = 50 V$

600V CoolMOS™ CFD7 Power Transistor

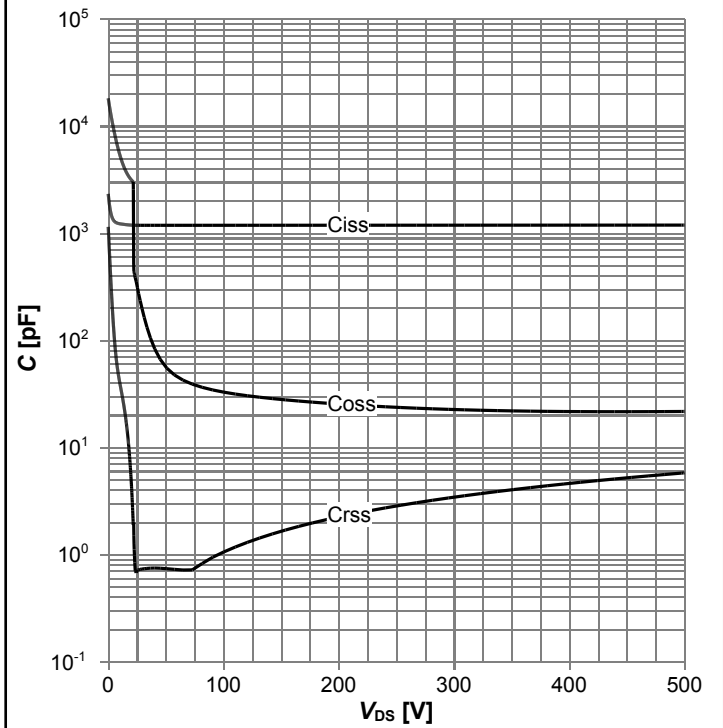
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Diagram 13: Drain-source breakdown voltage



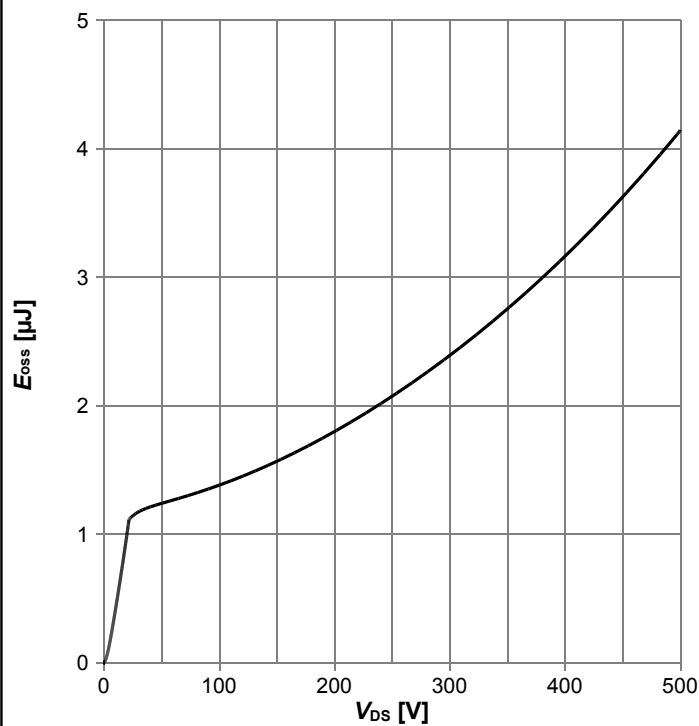
$V_{BR(DSS)}=f(T_j); I_D=1\text{ mA}$

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

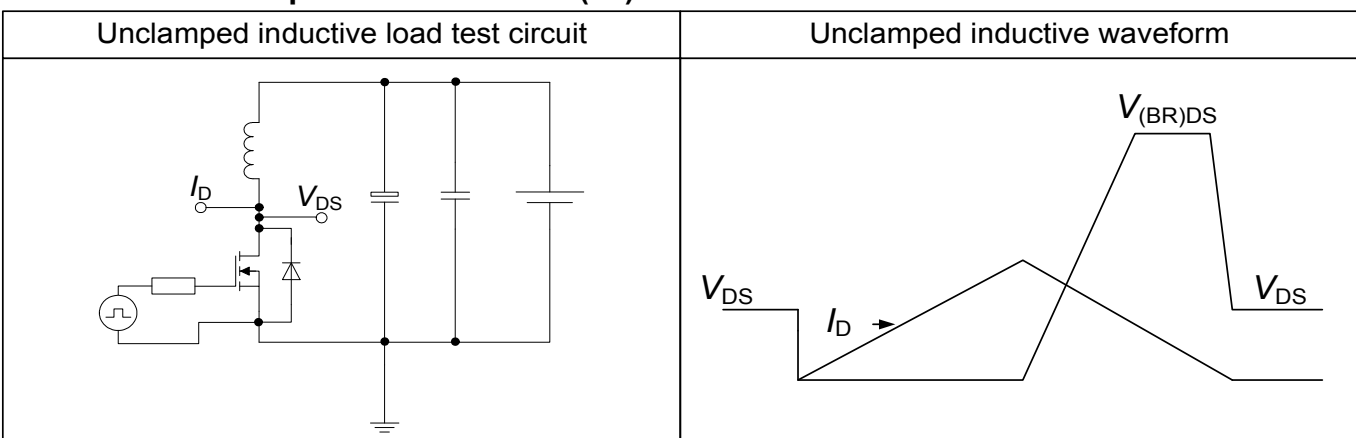
Table 8 Diode characteristics



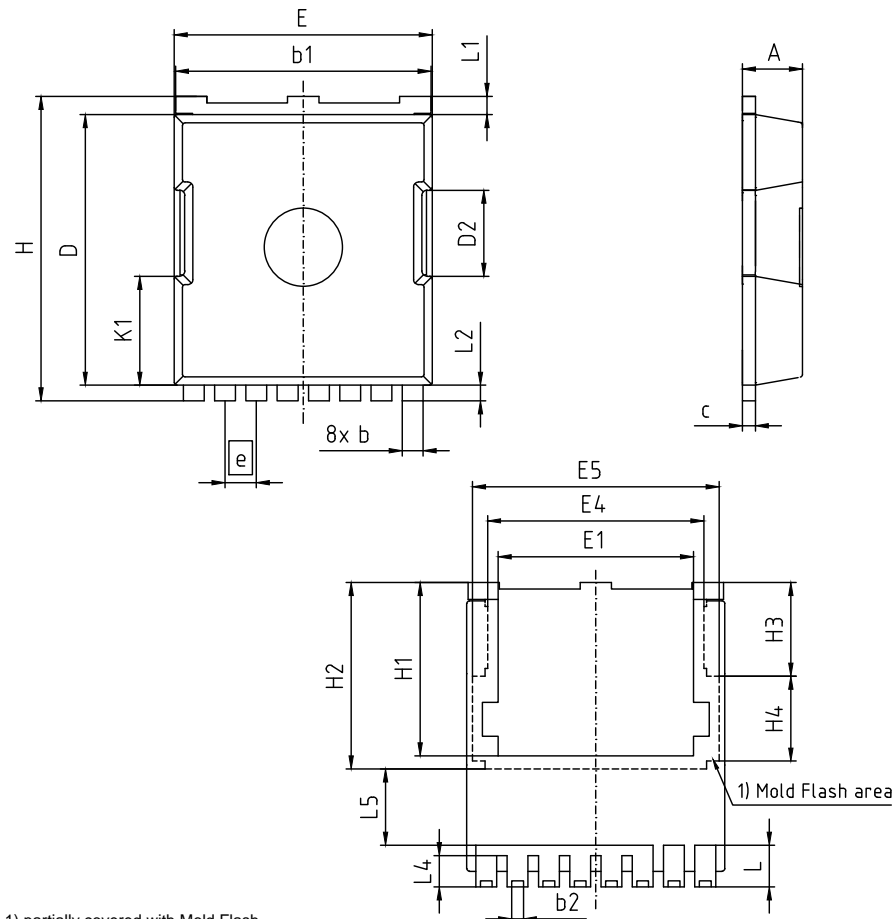
Table 9 Switching times (ss)



Table 10 Unclamped inductive load (ss)



6 Package Outlines



1) partially covered with Mold Flash

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.20	2.40	0.087	0.094
b	0.70	0.90	0.028	0.035
b1	9.70	9.90	0.382	0.390
b2	0.42	0.50	0.017	0.020
c	0.40	0.60	0.016	0.024
D	10.28	10.58	0.405	0.416
D2	3.30		0.130	
E	9.70	10.10	0.382	0.398
E1	7.50		0.295	
E4	8.50		0.335	
E5	9.46		0.372	
e	1.20 (BSC)		0.047 (BSC)	
H	11.48	11.88	0.452	0.468
H1	6.55	6.75	0.258	0.266
H2	7.15		0.281	
H3	3.59		0.141	
H4	3.26		0.128	
N	8		8	
K1	4.18		0.165	
L	1.40	1.80	0.055	0.071
L1	0.50	0.90	0.020	0.035
L2	0.50	0.70	0.020	0.028
L4	1.00	1.30	0.039	0.051
L5	2.62	2.81	0.103	0.111

DOCUMENT NO. Z8B00176939
SCALE 0 2 4mm
EUROPEAN PROJECTION
ISSUE DATE 28-04-2015
REVISION 01

Figure 1 Outline PG-HSOF-8, 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

IPT60R145CFD7

Revision: 2020-10-19, Rev. 2.3

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2020-04-22	Release of final version
2.1	2020-06-23	Changed diode commutation speed current
2.2	2020-08-28	Changed trr and Qrr value
2.3	2020-10-19	Changed diagram 2, 3, 7, 8, 9; Changed typical static and dynamic parameters

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