

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

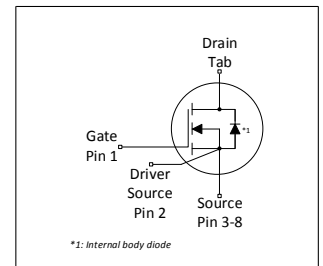
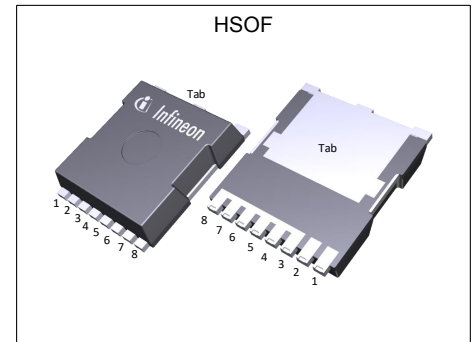
Potential applications

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
$R_{DS(on),max}$	45	m Ω
$Q_{g,typ}$	79	nC
$I_{D,pulse}$	153	A
$E_{oss} @ 400V$	9.1	μ J
Body diode di_F/dt	1300	A/ μ s

Type / Ordering Code	Package	Marking	Related Links
IPT60R045CFD7	PG-HSOF-8	60R045F7	see Appendix A

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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	-	-	52 33	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	153	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}	-	-	180	mJ	$I_D=6.5\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.90	mJ	$I_D=6.5\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche current, single pulse	I_{AS}	-	-	6.5	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}	-	-	272	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	-	-	52	A	$T_C=25^\circ\text{C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	153	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	70	V/ns	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 38\text{A}$, $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di _F /dt	-	-	1300	A/ μs	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 38\text{A}$, $T_j=25^\circ\text{C}$ 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}	-	-	0.46	°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	$V_{DS}=V_{GS}$, $I_D=0.9\text{mA}$
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	$R_{DS(on)}$	-	0.038 0.086	0.045	Ω	$V_{GS}=10\text{V}$, $I_D=18.0\text{A}$, $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$, $I_D=18.0\text{A}$, $T_j=150^\circ\text{C}$
Gate resistance	R_G	-	5.8	-	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}	-	3194	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$
Output capacitance	C_{oss}	-	62	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$
Effective output capacitance, energy related ²⁾	$C_{o(er)}$	-	114	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$
Effective output capacitance, time related ³⁾	$C_{o(tr)}$	-	1166	-	pF	$I_D=\text{constant}$, $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$
Turn-on delay time	$t_{d(on)}$	-	27	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=13.7\text{A}$, $R_G=3.0\Omega$; see table 9
Rise time	t_r	-	19	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=13.7\text{A}$, $R_G=3.0\Omega$; see table 9
Turn-off delay time	$t_{d(off)}$	-	101	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=13.7\text{A}$, $R_G=3.0\Omega$; see table 9
Fall time	t_f	-	5	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=13.7\text{A}$, $R_G=3.0\Omega$; see table 9

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{GS}	-	18	-	nC	$V_{DD}=400\text{V}$, $I_D=13.7\text{A}$, $V_{GS}=0$ to 10V
Gate to drain charge	Q_{gd}	-	28	-	nC	$V_{DD}=400\text{V}$, $I_D=13.7\text{A}$, $V_{GS}=0$ to 10V
Gate charge total	Q_g	-	79	-	nC	$V_{DD}=400\text{V}$, $I_D=13.7\text{A}$, $V_{GS}=0$ to 10V
Gate plateau voltage	$V_{plateau}$	-	5.5	-	V	$V_{DD}=400\text{V}$, $I_D=13.7\text{A}$, $V_{GS}=0$ to 10V

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

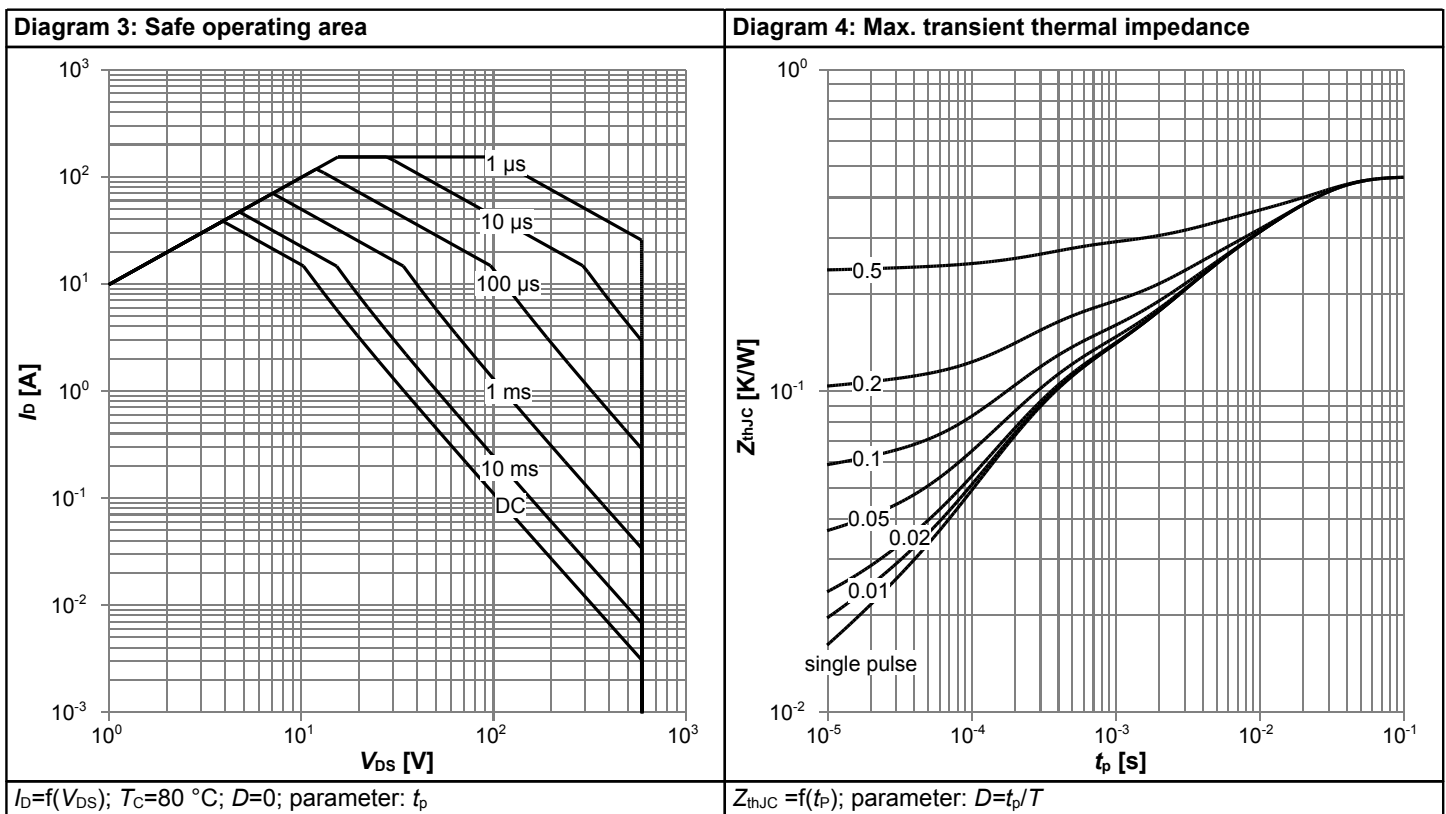
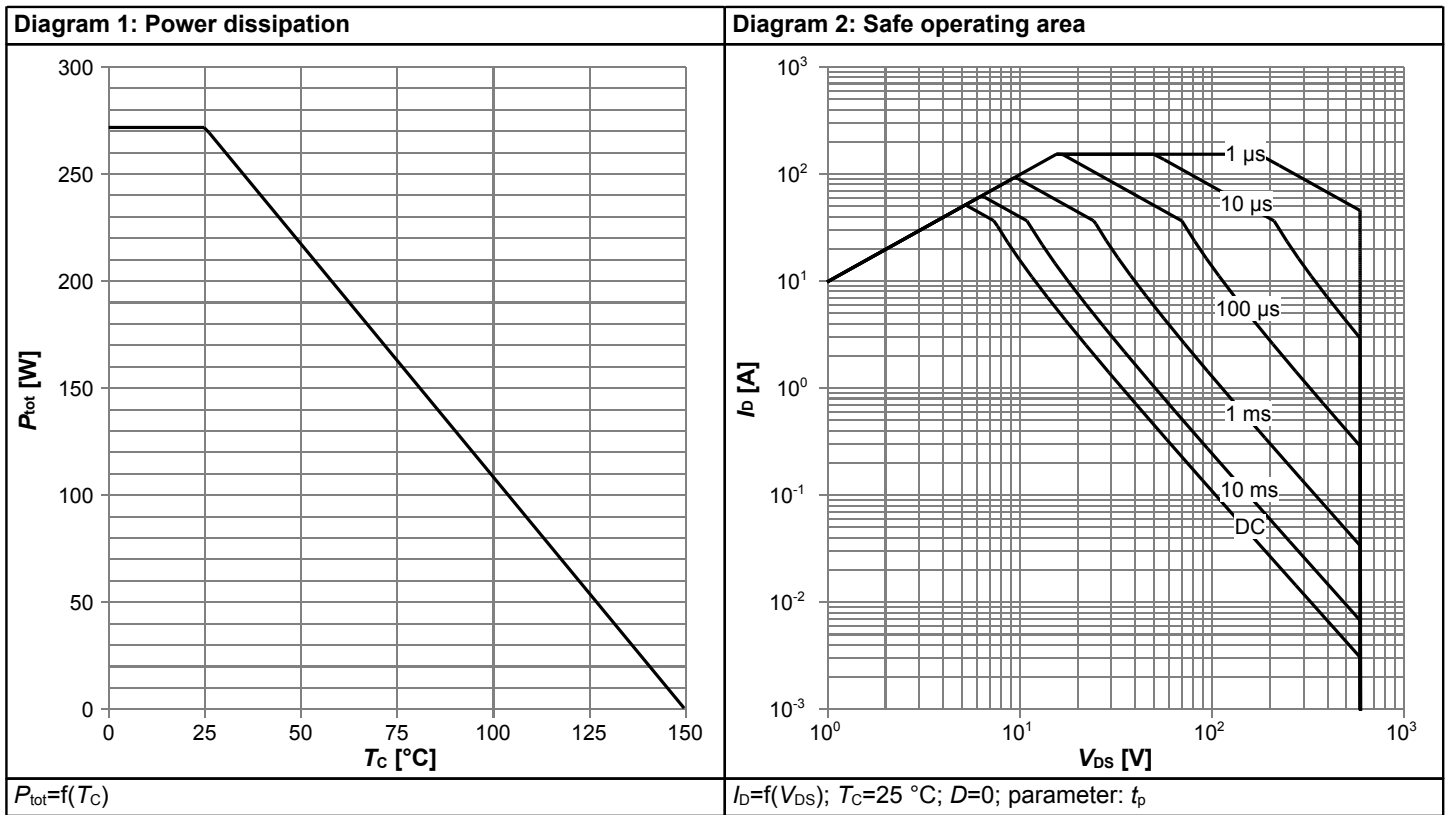
²⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V

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	$V_{GS}=0V, I_F=18.0A, T_j=25^{\circ}C$
Reverse recovery time	t_{rr}	-	132	198	ns	$V_R=400V, I_F=13.7A, di_F/dt=100A/\mu s$; see table 8
Reverse recovery charge	Q_{rr}	-	0.68	1.37	μC	$V_R=400V, I_F=13.7A, di_F/dt=100A/\mu s$; see table 8
Peak reverse recovery current	I_{rrm}	-	8.8	-	A	$V_R=400V, I_F=13.7A, di_F/dt=100A/\mu s$; see table 8

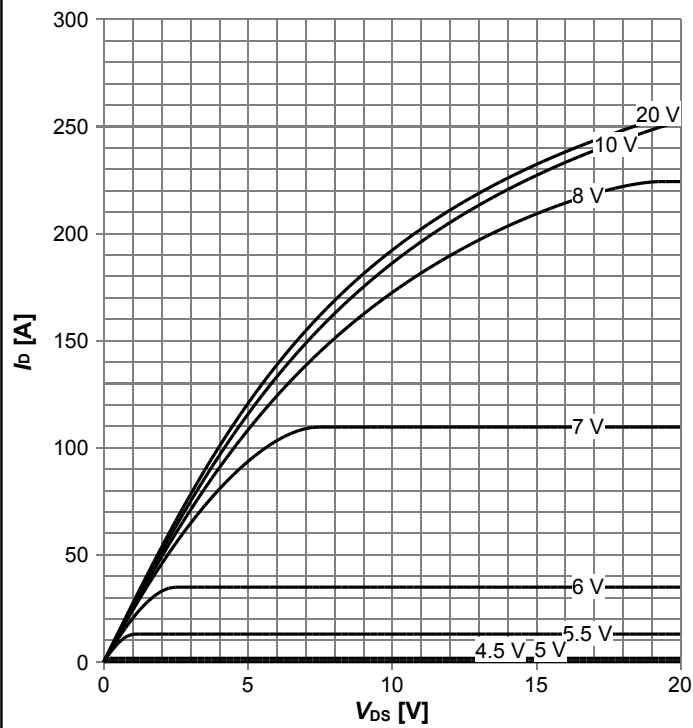
4 Electrical characteristics diagrams



600V CoolMOS™ CFD7 Power Transistor

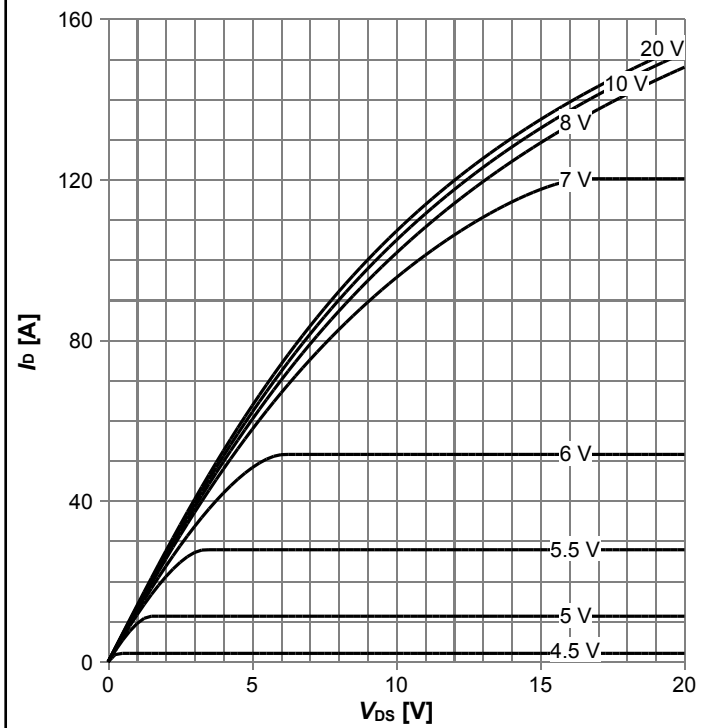
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Diagram 5: Typ. output characteristics



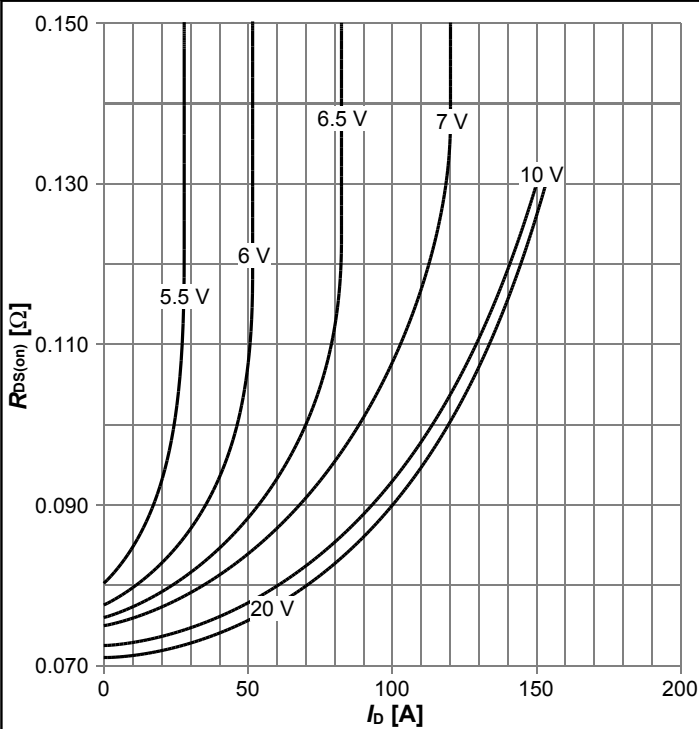
$I_D=f(V_{DS}); T_j=25\text{ °C};$ parameter: V_{GS}

Diagram 6: Typ. output characteristics



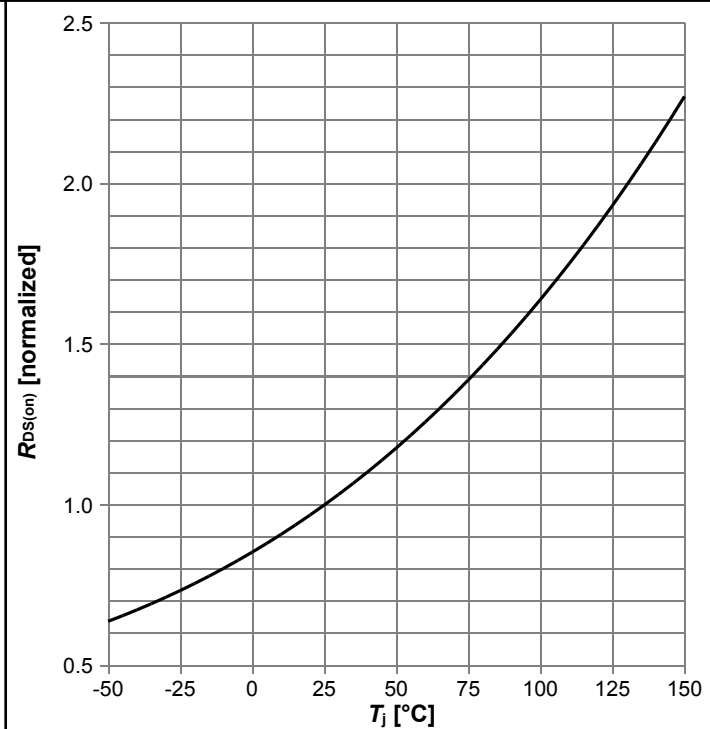
$I_D=f(V_{DS}); T_j=125\text{ °C};$ parameter: V_{GS}

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

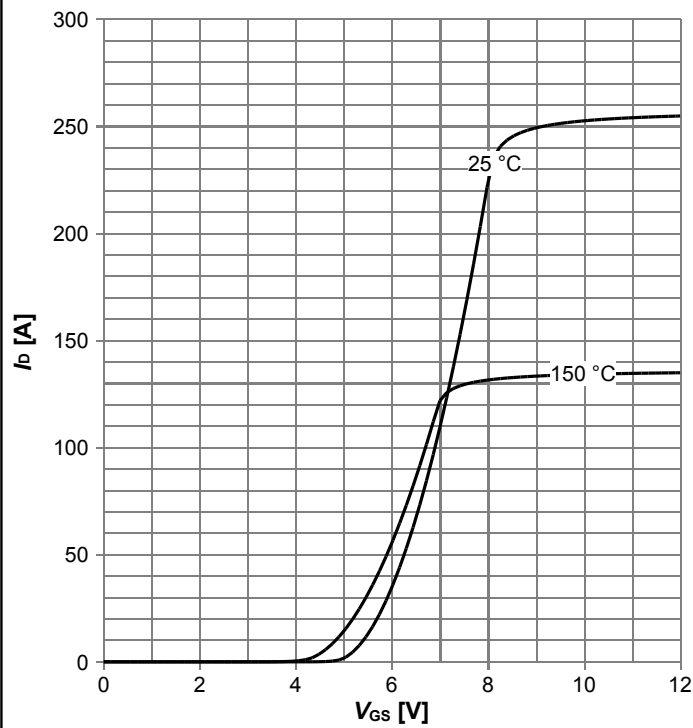


$R_{DS(on)}=f(T_j); I_D=18.0\text{ A}; V_{GS}=10\text{ V}$

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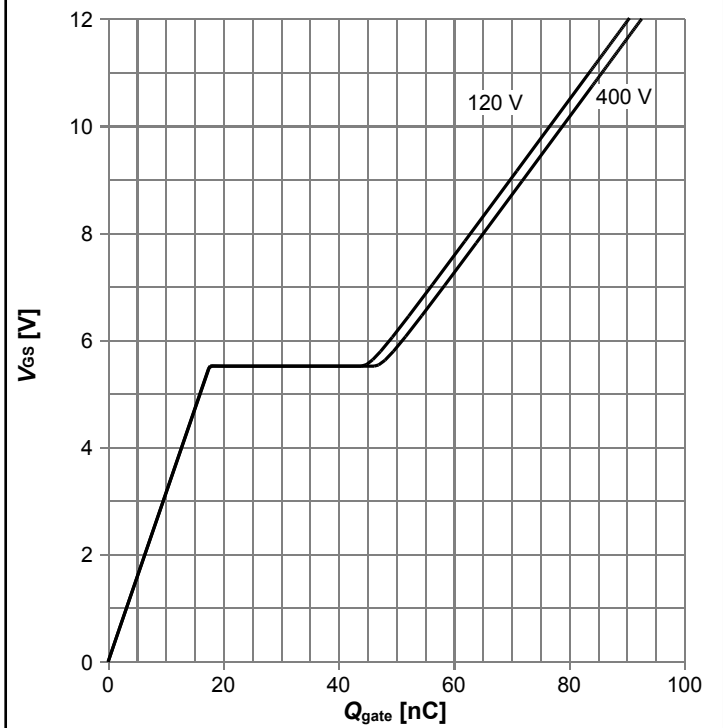
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Diagram 9: Typ. transfer characteristics



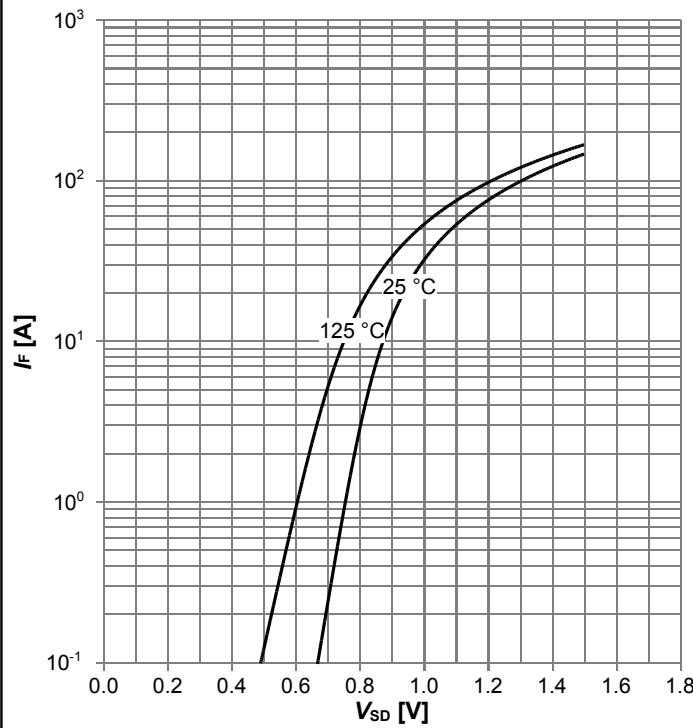
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



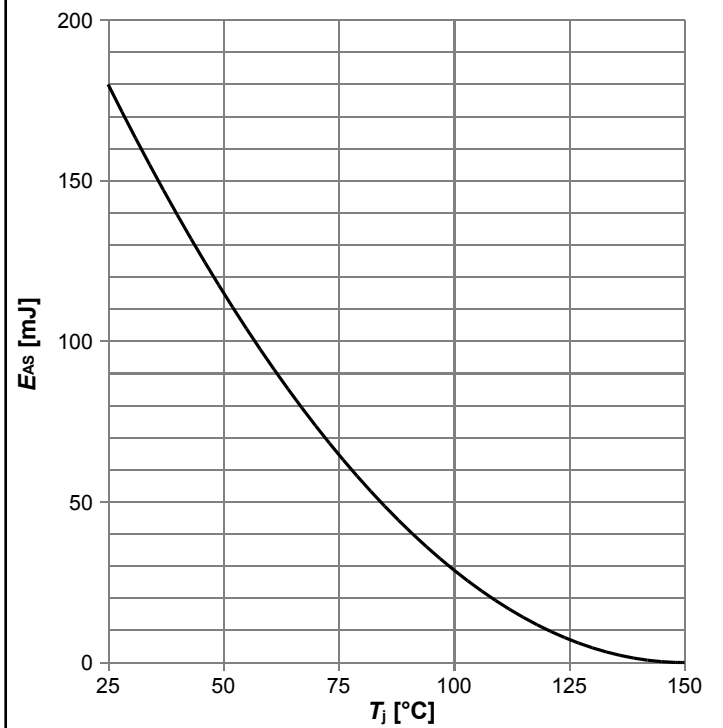
$V_{GS} = f(Q_{gate}); I_D = 13.7 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



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

Diagram 12: Avalanche energy

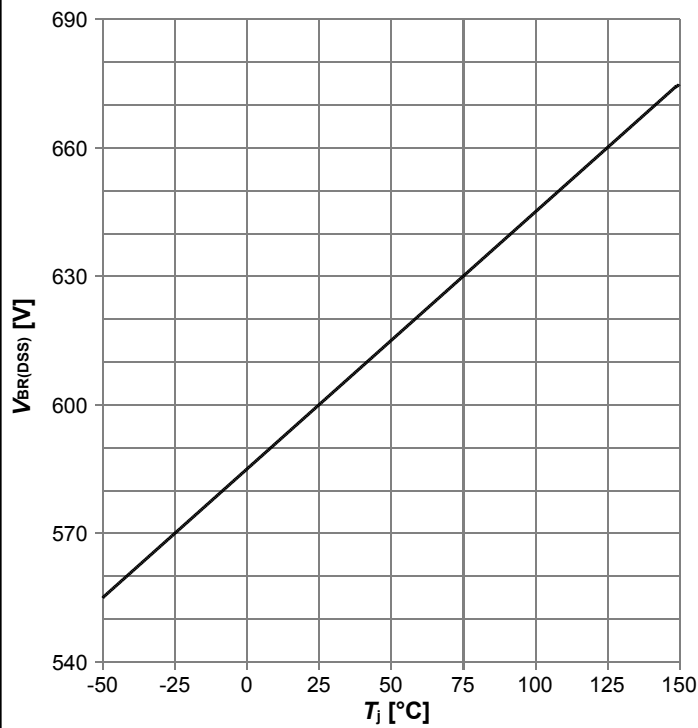


$E_{AS} = f(T_j); I_D = 6.5 \text{ A}; V_{DD} = 50 \text{ V}$

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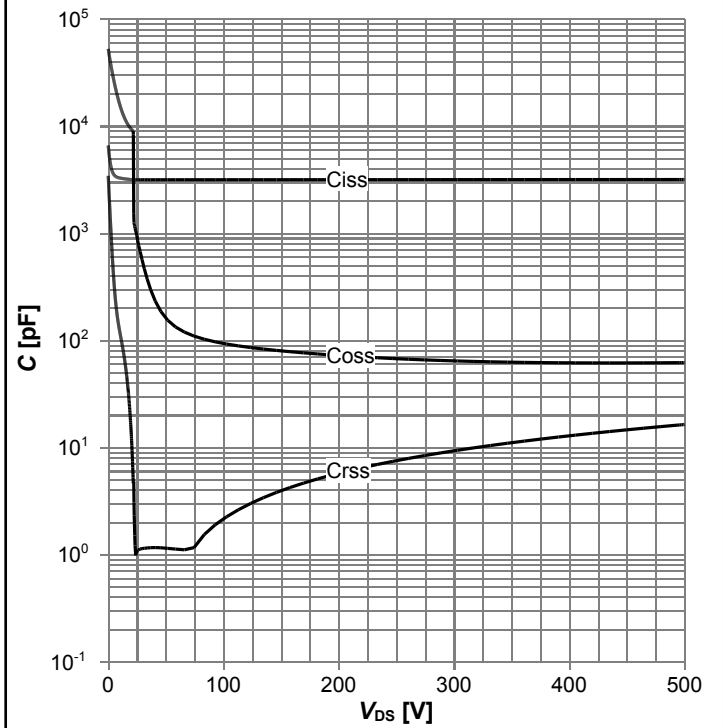
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Diagram 13: Drain-source breakdown voltage



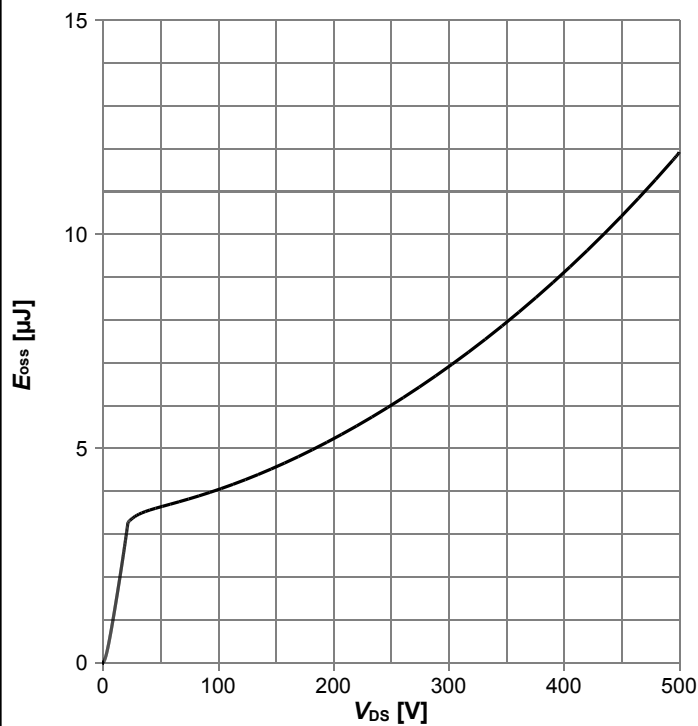
$V_{BR(DSS)}=f(T_j); I_D=1\text{ mA}$

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

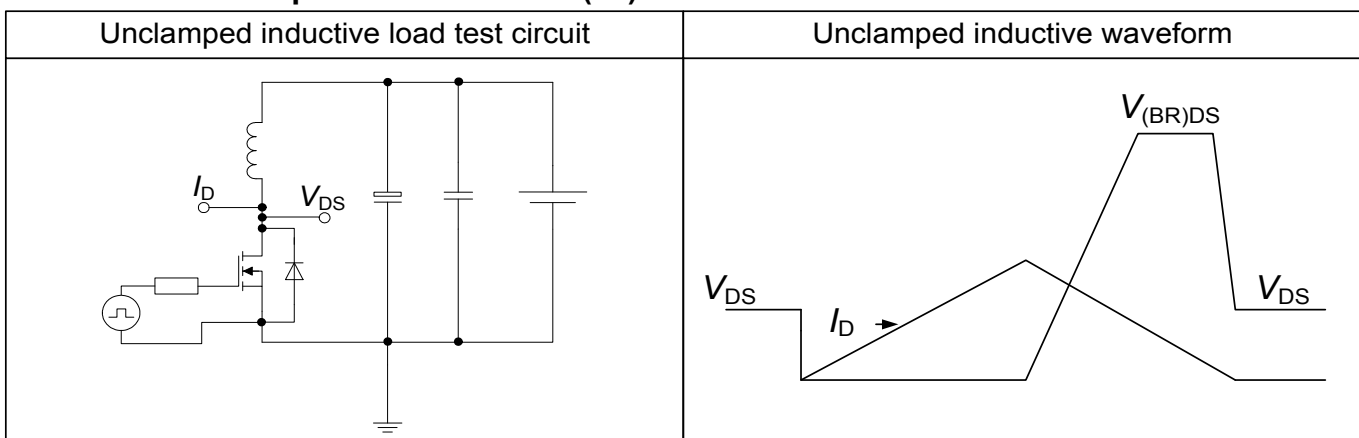
Table 8 Diode characteristics



Table 9 Switching times (ss)



Table 10 Unclamped inductive load (ss)



6 Package Outlines



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

IPT60R045CFD7

Revision: 2020-11-11, 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 value
2.3	2020-11-11	Changed diagram 2, 3, 7, 8, 9; Changed typical static and dynamic parameters

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