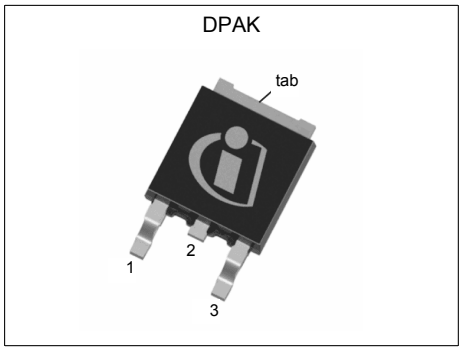
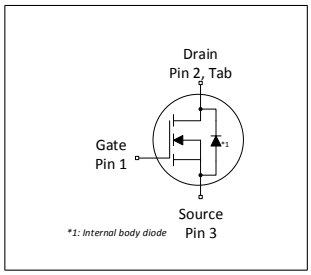
MOSFET

600V CoolMOS™ CFD7 Power Device





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

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
$R_{DS(on),max}$	210	mΩ
$Q_{g,typ}$	23	nC
$I_{D,pulse}$	42	A
E_{oss} @ 400V	2.6	µJ
Body diode di_F/dt	1300	A/µs

Type / Ordering Code	Package	Marking	Related Links
IPD60R210CFD7	PG-TO252-3	60R210F7	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	- -	- -	12 7.0	A	T_C=25°C T_C=100°C
Pulsed drain current[2)]	$I_{D,pulse}$	-	-	42	A	T_C=25°C
Avalanche energy, single pulse	E_{AS}	-	-	49	mJ	I_D=3.2A; V_{DD}=50V; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.24	mJ	I_D=3.2A; V_{DD}=50V; see table 10
Avalanche current, single pulse	I_{AS}	-	-	3.2	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}	-	-	64	W	T_C=25°C
Storage temperature	T_{stg}	-55	-	150	°C	-
Operating junction temperature	T_j	-55	-	150	°C	-
Mounting torque	-	-	-	-	Ncm	-
Continuous diode forward current	I_S	-	-	12	A	T_C=25°C
Diode pulse current[2)]	$I_{S,pulse}$	-	-	42	A	T_C=25°C
Reverse diode dv/dt[3)]	dv/dt	-	-	70	V/ns	V_{DS}=0...400V, I_{SD}<=12A, T_j=25°C see table 8
Maximum diode commutation speed	di_F/dt	-	-	1300	A/µs	V_{DS}=0...400V, I_{SD}<=12A, T_j=25°C see table 8
Insulation withstand voltage	V_{ISO}	-	-	n.a.	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}	-	-	1.94	°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 6cm² (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°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=0.24mA
Zero gate voltage drain current[1]	I_{DSS}	- -	- 5	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	$R_{DS(on)}$	- -	0.171 0.39	0.21 -	Ω	V_{GS}=10V, I_D=4.9A, T_j=25°C V_{GS}=10V, I_D=4.9A, T_j=150°C
Gate resistance	R_G	-	11	-	Ω	f=1MHz, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	1015	-	pF	V_{GS}=0V, V_{DS}=400V, f=250kHz
Output capacitance	C_{oss}	-	18	-	pF	V_{GS}=0V, V_{DS}=400V, f=250kHz
Effective output capacitance, energy related[2]	$C_{o(er)}$	-	33	-	pF	V_{GS}=0V, V_{DS}=0...400V
Effective output capacitance, time related[3]	$C_{o(tr)}$	-	330	-	pF	I_D=constant, V_{GS}=0V, V_{DS}=0...400V
Turn-on delay time	$t_{d(on)}$	-	22	-	ns	V_{DD}=400V, V_{GS}=10V, I_D=6.0A, R_G=10.2Ω; see table 9
Rise time	t_r	-	16.5	-	ns	V_{DD}=400V, V_{GS}=10V, I_D=6.0A, R_G=10.2Ω; see table 9
Turn-off delay time	$t_{d(off)}$	-	54	-	ns	V_{DD}=400V, V_{GS}=10V, I_D=6.0A, R_G=10.2Ω; see table 9
Fall time	t_f	-	7.5	-	ns	V_{DD}=400V, V_{GS}=10V, I_D=6.0A, 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}	-	6	-	nC	V_{DD}=400V, I_D=6.0A, V_{GS}=0 to 10V
Gate to drain charge	Q_{gd}	-	7	-	nC	V_{DD}=400V, I_D=6.0A, V_{GS}=0 to 10V
Gate charge total	Q_g	-	23	-	nC	V_{DD}=400V, I_D=6.0A, V_{GS}=0 to 10V
Gate plateau voltage	$V_{plateau}$	-	5.7	-	V	V_{DD}=400V, I_D=6.0A, V_{GS}=0 to 10V

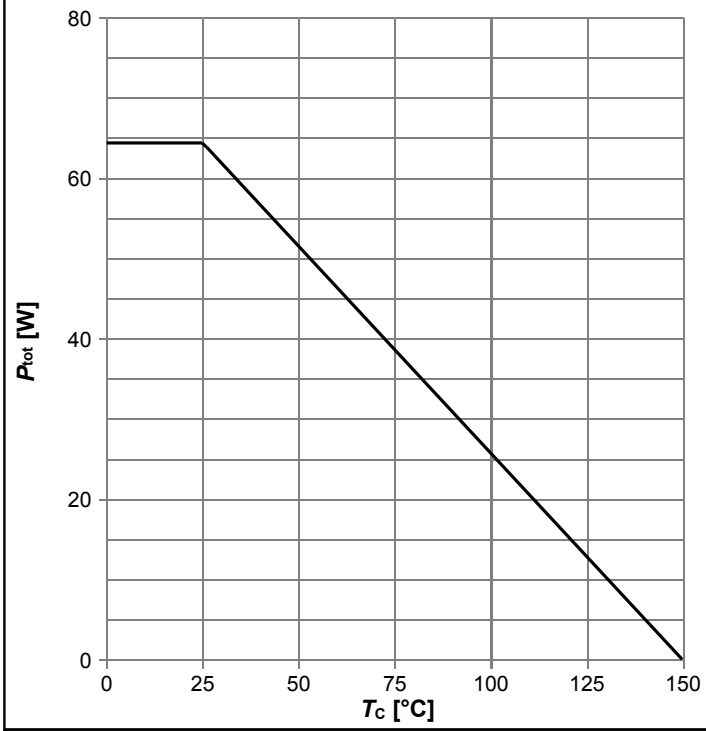
[1] Maximum specification is defined by calculated six sigma upper confidence bound
[2] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V
[3] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} 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=4.9A, T_j=25°C
Reverse recovery time	t_{rr}	-	92	138	ns	V_R=400V, I_F=6.0A, di_F/dt=100A/µs; see table 8
Reverse recovery charge	Q_{rr}	-	0.385	0.77	µC	V_R=400V, I_F=6.0A, di_F/dt=100A/µs; see table 8
Peak reverse recovery current	I_{rrm}	-	7.5	-	A	V_R=400V, I_F=6.0A, di_F/dt=100A/µs; see table 8

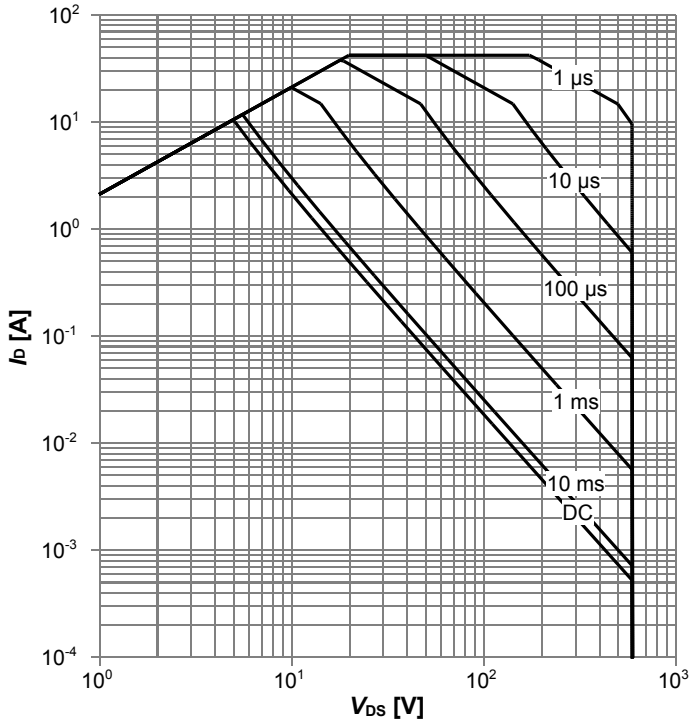
4 Electrical characteristics diagrams

Diagram 1: Power dissipation



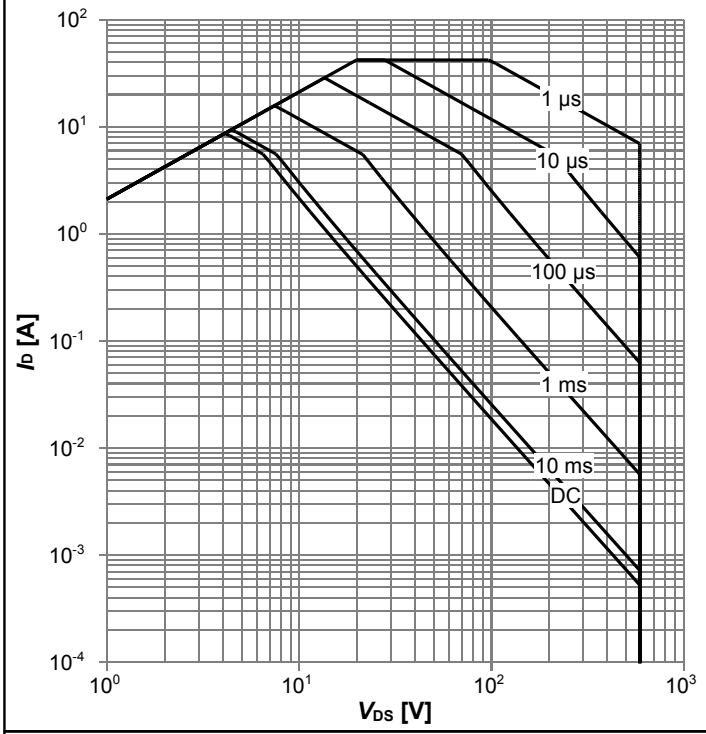
$P_{tot}=f(T_C)$

Diagram 2: Safe operating area



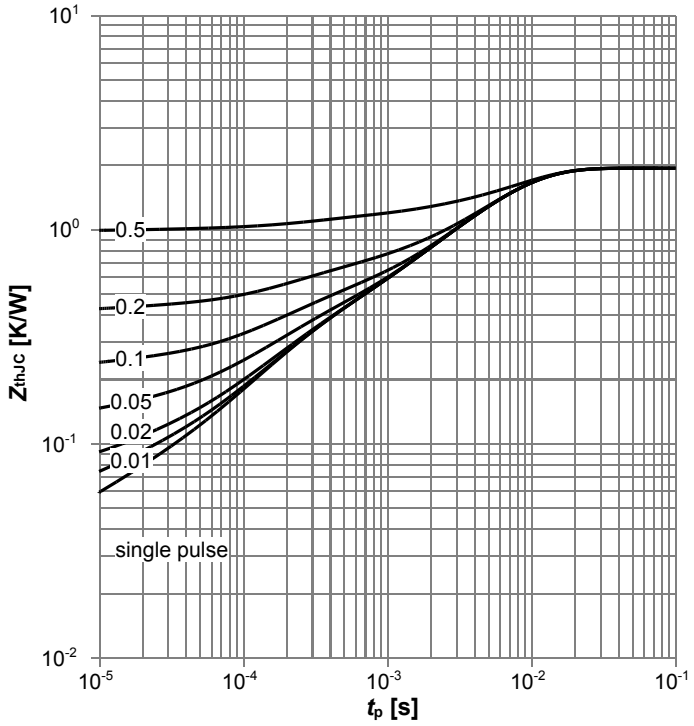
$I_D=f(V_{DS})$; $T_C=25$ °C; $D=0$; parameter: t_p

Diagram 3: Safe operating area



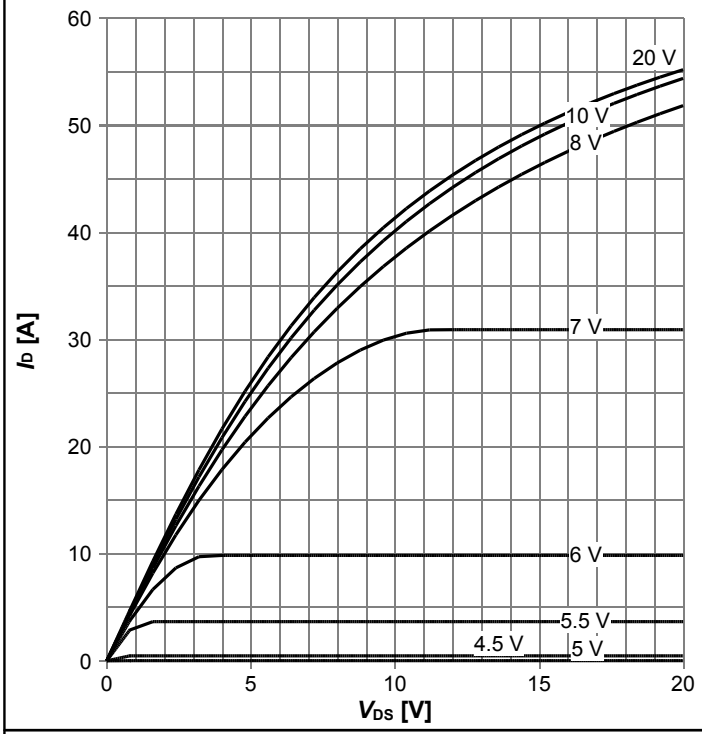
$I_D=f(V_{DS})$; $T_C=80$ °C; $D=0$; parameter: t_p

Diagram 4: Max. transient thermal impedance



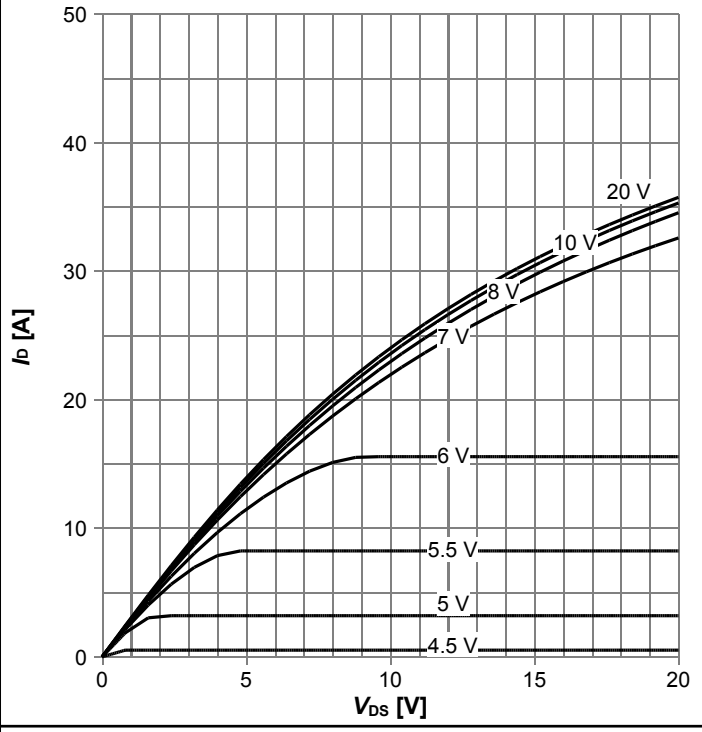
$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

Diagram 5: Typ. output characteristics



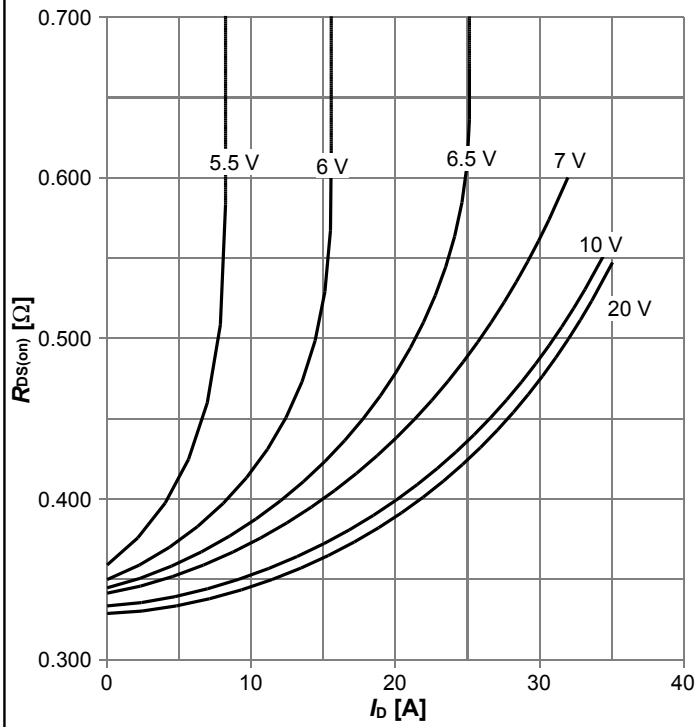
$I_D=f(V_{DS})$; $T_j=25$ °C; parameter: V_{GS}

Diagram 6: Typ. output characteristics



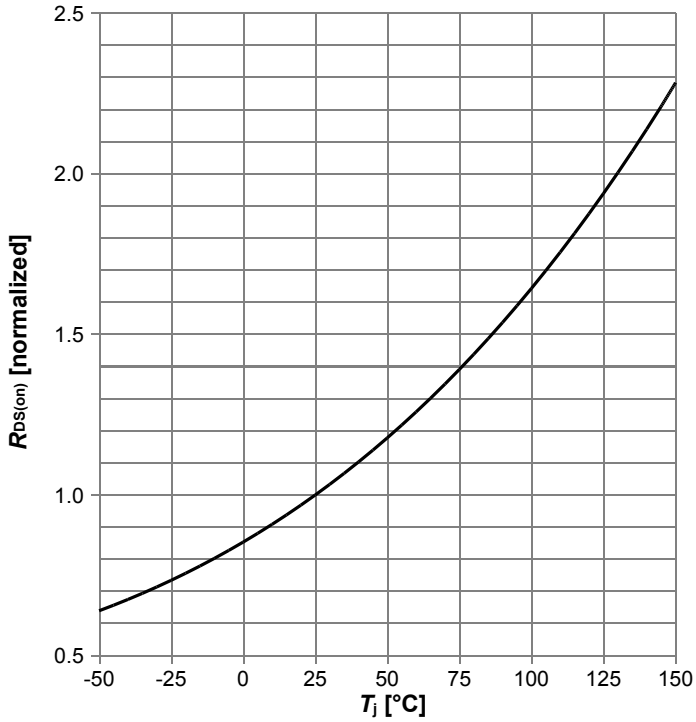
$I_D=f(V_{DS})$; $T_j=125$ °C; parameter: V_{GS}

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



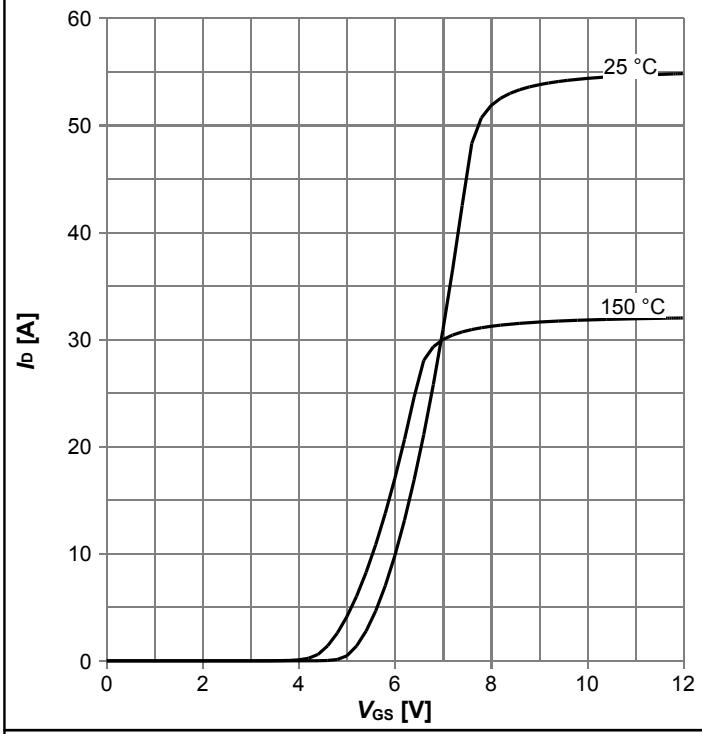
$R_{DS(on)}=f(I_D)$; $T_j=125$ °C; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



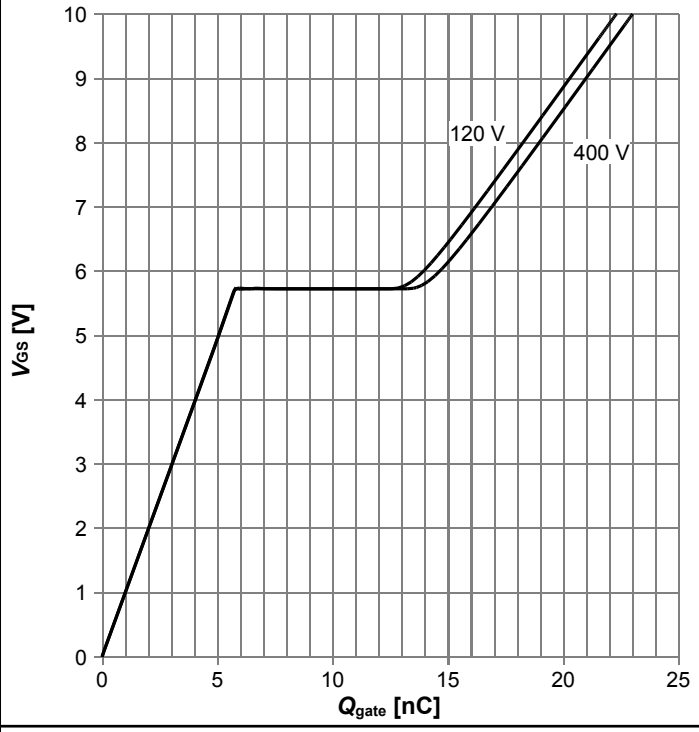
$R_{DS(on)}=f(T_j)$; $I_D=4.9$ A; $V_{GS}=10$ V

Diagram 9: Typ. transfer characteristics



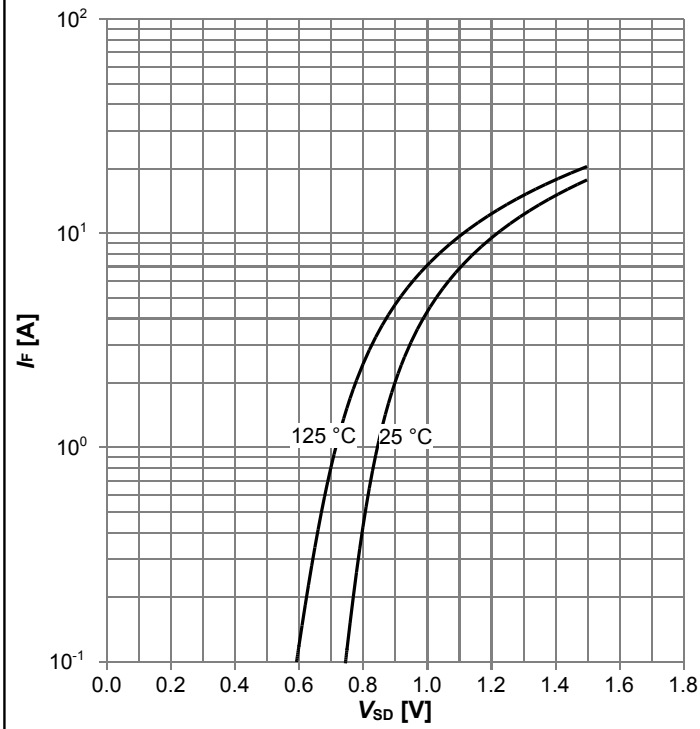
I_D=f(V_{GS}); V_{DS}=20V; parameter: T_j

Diagram 10: Typ. gate charge



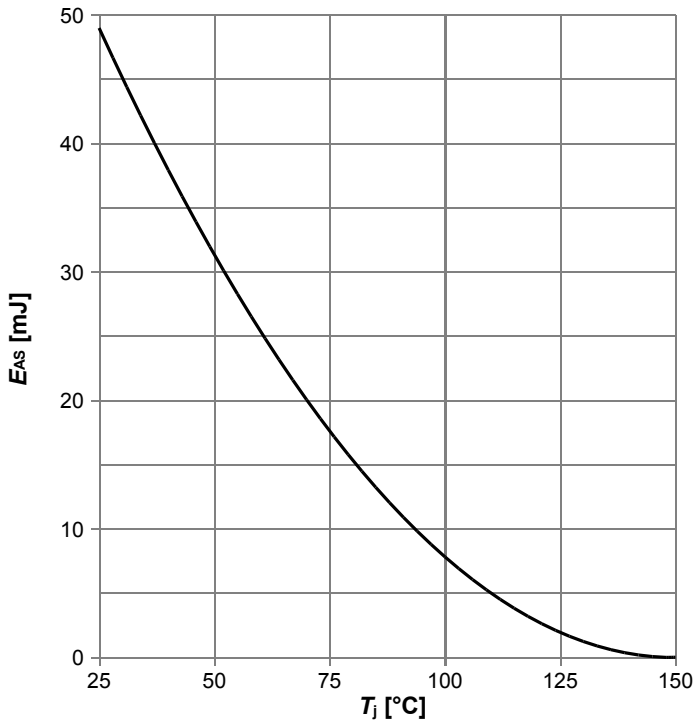
V_{GS}=f(Q_{gate}); I_D=6.0 A pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



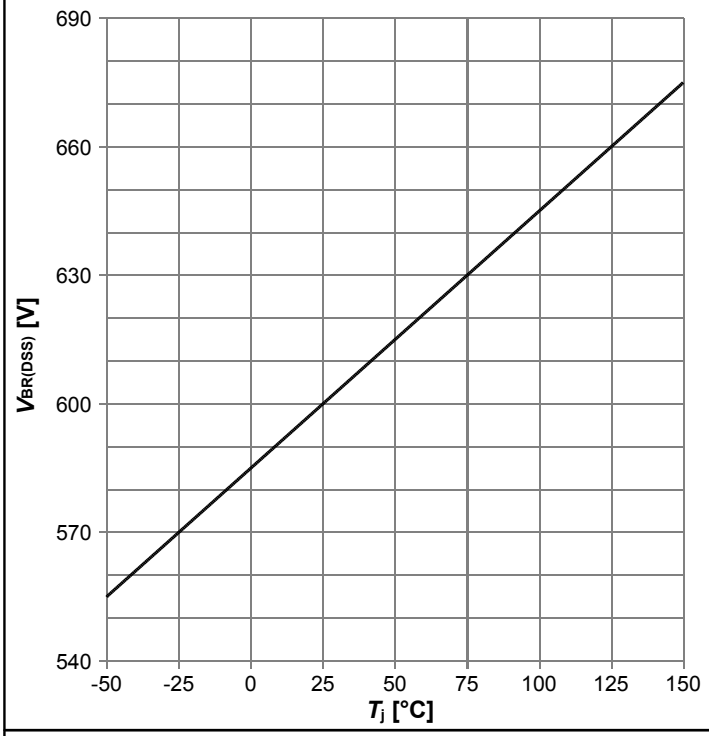
I_F=f(V_{SD}); parameter: T_j

Diagram 12: Avalanche energy



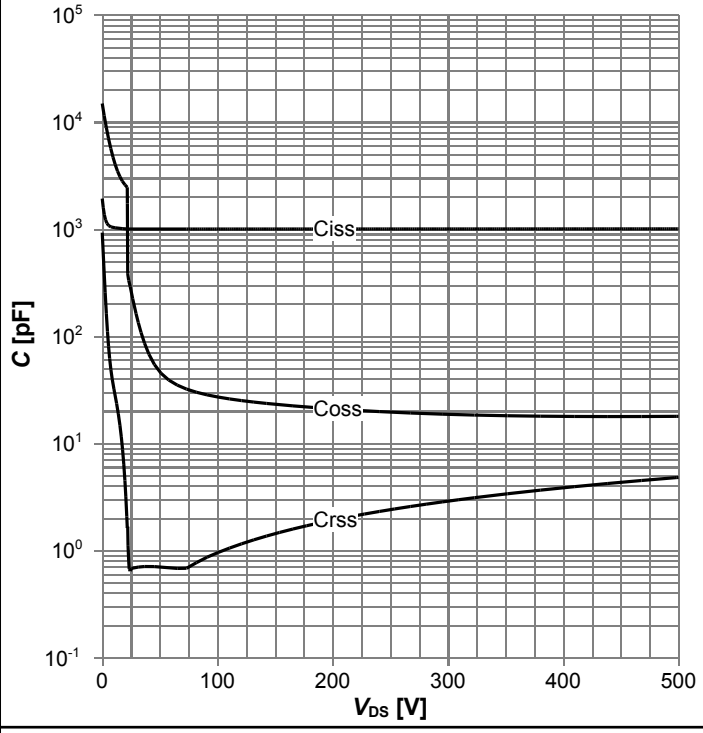
E_{AS}=f(T_j); I_D=3.2 A; V_{DD}=50 V

Diagram 13: Drain-source breakdown voltage



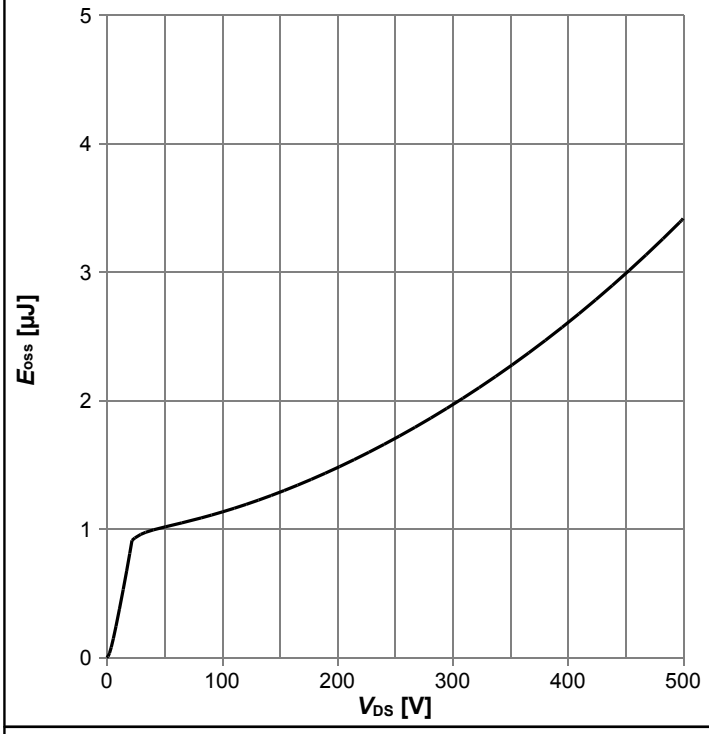
$V_{BR(DSS)}$=f(T_j); I_D=1 mA

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

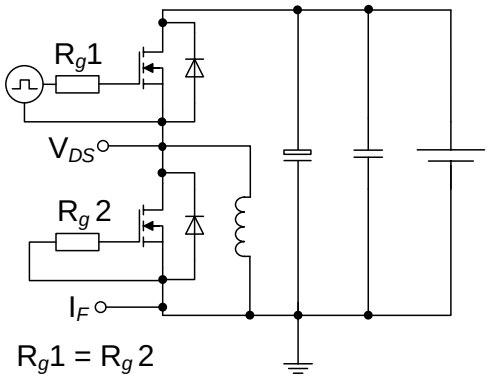
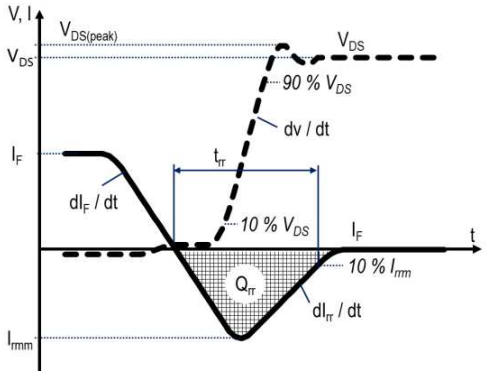
Test circuit for diode characteristics	Diode recovery waveform
	

Table 9 Switching times

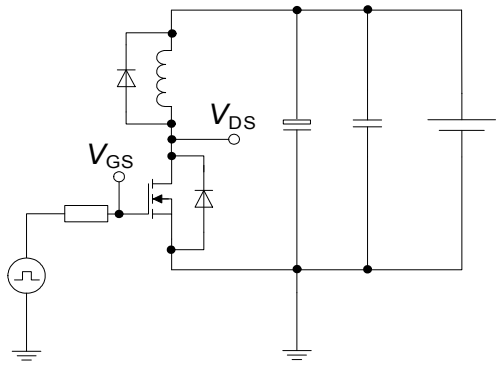
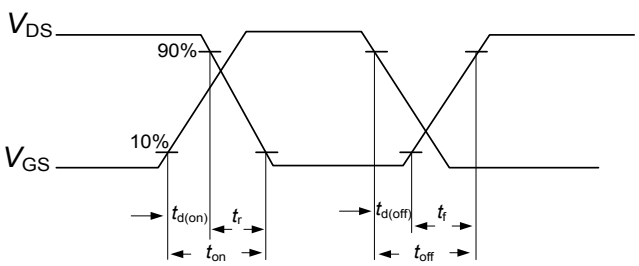
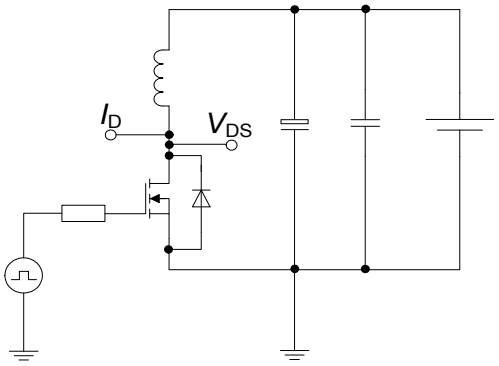
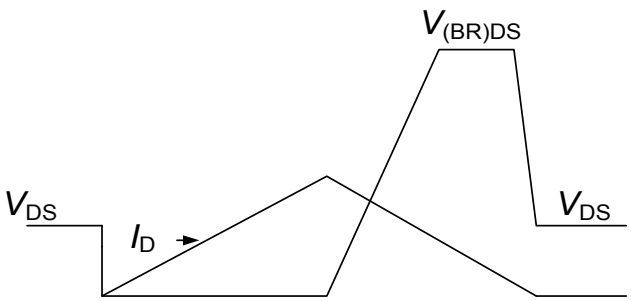
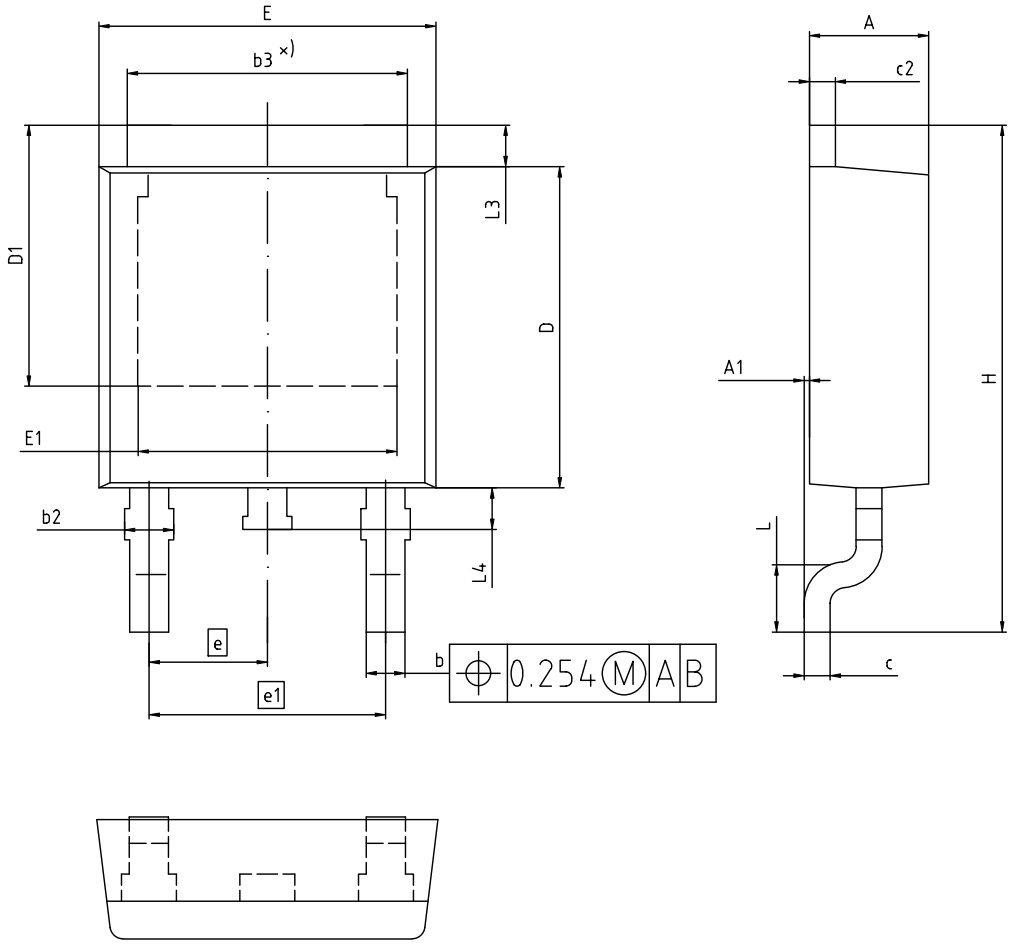
Switching times test circuit for inductive load	Switching times waveform
	

Table 10 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

6 Package Outlines

PG-TO252-3 (DPAK)



ALL DIMENSIONS REFER TO JEDEC
STANDARD TO-252 AND DO NOT INCLUDE MOLD
FLASH OR PROTRUSIONS.

DIMENSION	MILLIMETERS	
	MIN.	MAX.
A	2.16	2.41
A1	0.00	0.15
b	0.64	0.89
b2	0.65	1.15
b3	4.95	5.50
c	0.46	0.61
c2	0.40	0.98
D	5.97	6.22
D1	5.02	5.84
E	6.35	6.73
E1	4.32	5.50
e	2.29	
e1	4.57	
N	3	
H	9.40	10.48
L	1.18	1.78
L3	0.89	1.27
L4	0.51	1.02

DOCUMENT NO. Z8B00003328
REVISION 07
SCALE: 10:1 0 1 2mm
EUROPEAN PROJECTION
ISSUE DATE 01.04.2020

Figure 1 Outline PG-TO252-3, 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

IPD60R210CFD7

Revision: 2020-05-26, Rev. 2.2

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2018-04-20	Release of final version
2.1	2018-11-05	Table 7: Reduced trr,max value; Change of qualification grade nomenclature
2.2	2020-05-26	Updated package/symbol drawing, and product validation

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