

## 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

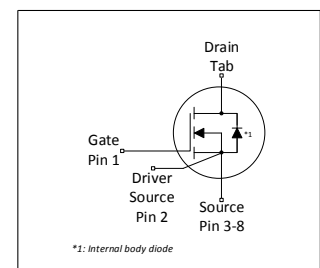
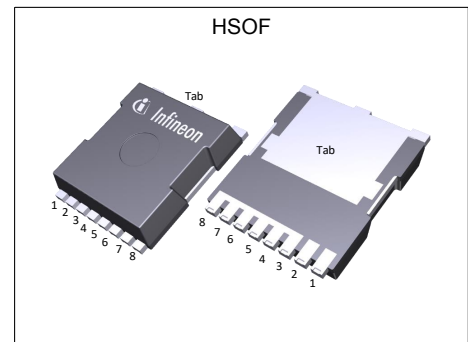
### Potential applications

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 $\Omega$
$Q_{g,typ}$	28	nC
$I_{D,pulse}$	51	A
$E_{oss} @ 400V$	3.2	$\mu$ J
Body diode $di_F/dt$	1300	A/ $\mu$ s

Type / Ordering Code	Package	Marking	Related Links
IPT60R145CFD7	PG-HSO8-8	60R145F7	see Appendix A

## Table of Contents

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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 <sup>1)</sup>	$I_D$	-	-	19 12	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	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 <sup>1)</sup>	$I_S$	-	-	19	A	$T_C=25^\circ\text{C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	51	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	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 <sub>F</sub> /dt	-	-	1300	A/ $\mu\text{s}$	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 14\text{A}$ , $T_j=25^\circ\text{C}$ see table 8
Insulation withstand voltage	$V_{ISO}$	-	-	n.a.	V	$V_{rms}$ , $T_C=25^\circ\text{C}$ , $t=1\text{min}$

<sup>1)</sup> Limited by  $T_{j,max}$ .

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>3)</sup> Identical low side and high side switch with identical  $R_\theta$

## 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 <sup>2</sup> (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 <sup>1)</sup>	$I_{DSS}$	-	-	1	$\mu\text{A}$	$V_{DS}=600\text{V}$ , $V_{GS}=0\text{V}$ , $T_j=25^\circ\text{C}$ $V_{DS}=600\text{V}$ , $V_{GS}=0\text{V}$ , $T_j=125^\circ\text{C}$
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 -	$\Omega$	$V_{GS}=10\text{V}$ , $I_D=6.0\text{A}$ , $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$ , $I_D=6.0\text{A}$ , $T_j=150^\circ\text{C}$
Gate resistance	$R_G$	-	10.9	-	$\Omega$	$f=1\text{MHz}$ , 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 <sup>2)</sup>	$C_{o(er)}$	-	40	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$
Effective output capacitance, time related <sup>3)</sup>	$C_{o(tr)}$	-	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 $10\text{V}$
Gate to drain charge	$Q_{gd}$	-	9	-	nC	$V_{DD}=400\text{V}$ , $I_D=7.3\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate charge total	$Q_g$	-	28	-	nC	$V_{DD}=400\text{V}$ , $I_D=7.3\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate plateau voltage	$V_{\text{plateau}}$	-	5.7	-	V	$V_{DD}=400\text{V}$ , $I_D=7.3\text{A}$ , $V_{GS}=0$ to $10\text{V}$

<sup>1)</sup> Maximum specification is defined by calculated six sigma upper confidence bound

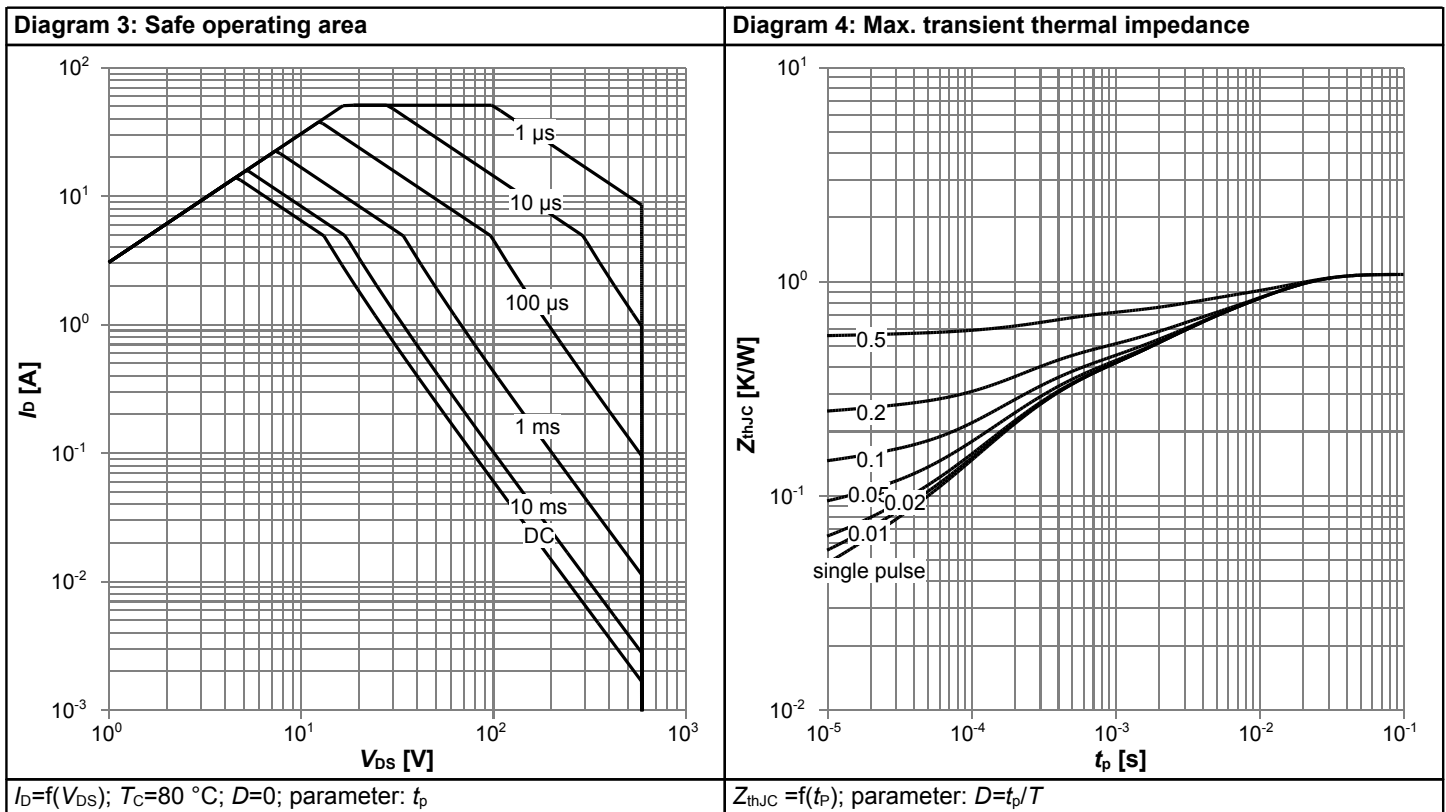
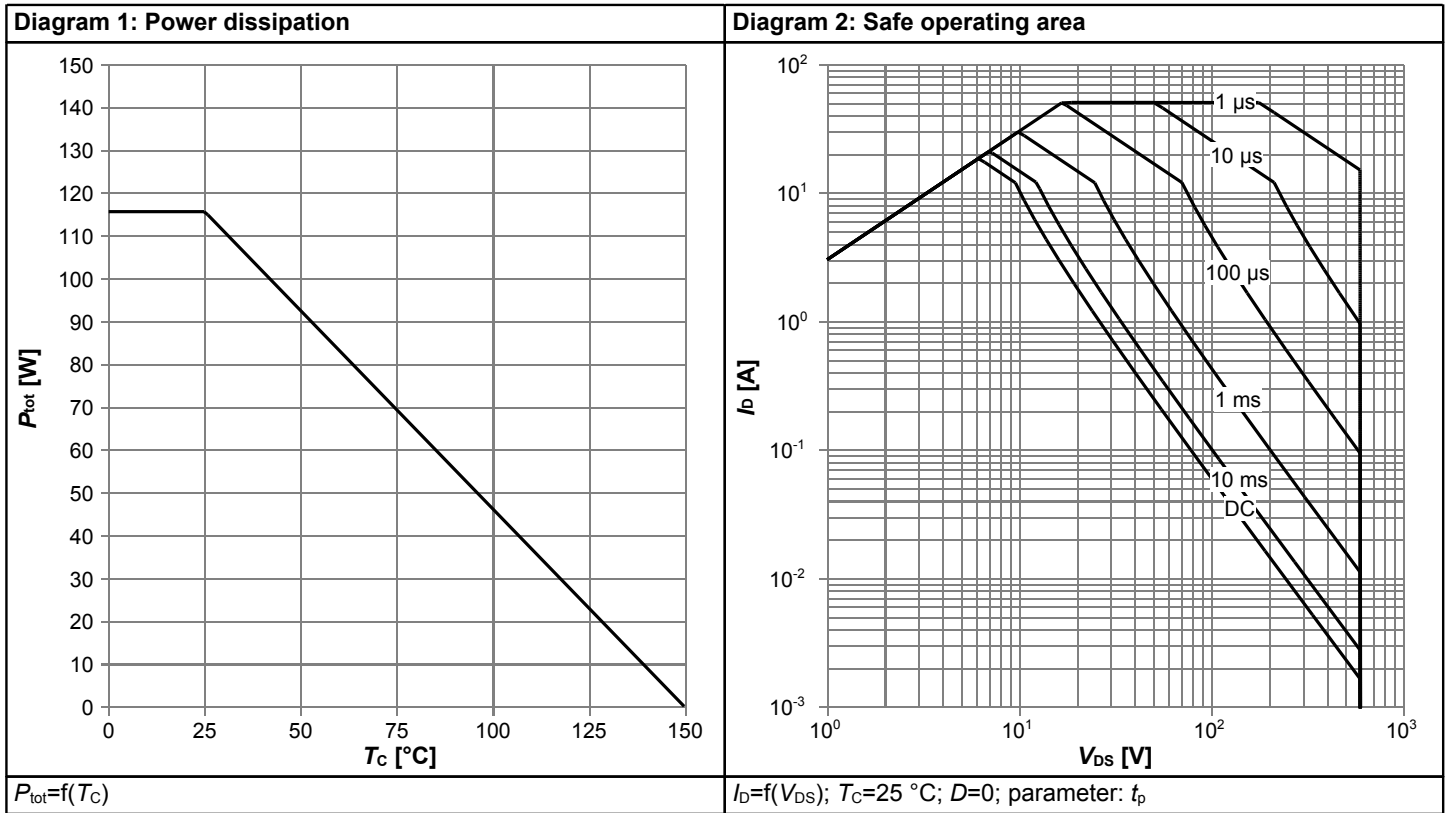
<sup>2)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

<sup>3)</sup>  $C_{o(tr)}$  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	$\mu C$	$V_R=400V, I_F=7.3A, di_F/dt=100A/\mu s$ ; 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

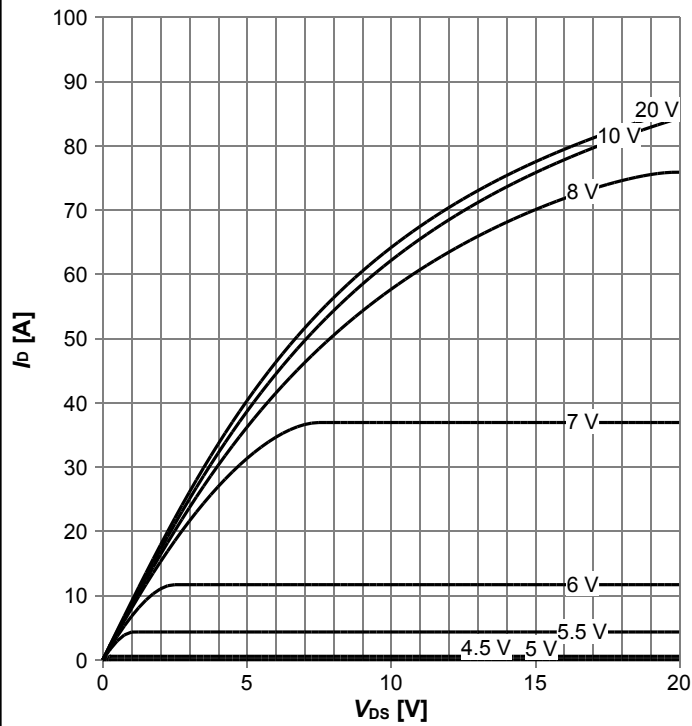
### 4 Electrical characteristics diagrams



# 600V CoolMOS™ CFD7 Power Transistor

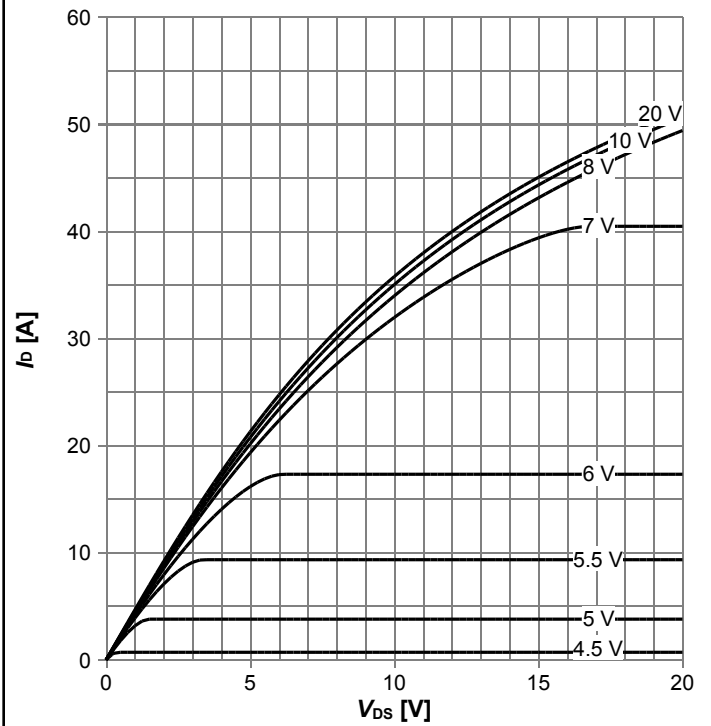
## IPT60R145CFD7

Diagram 5: Typ. output characteristics



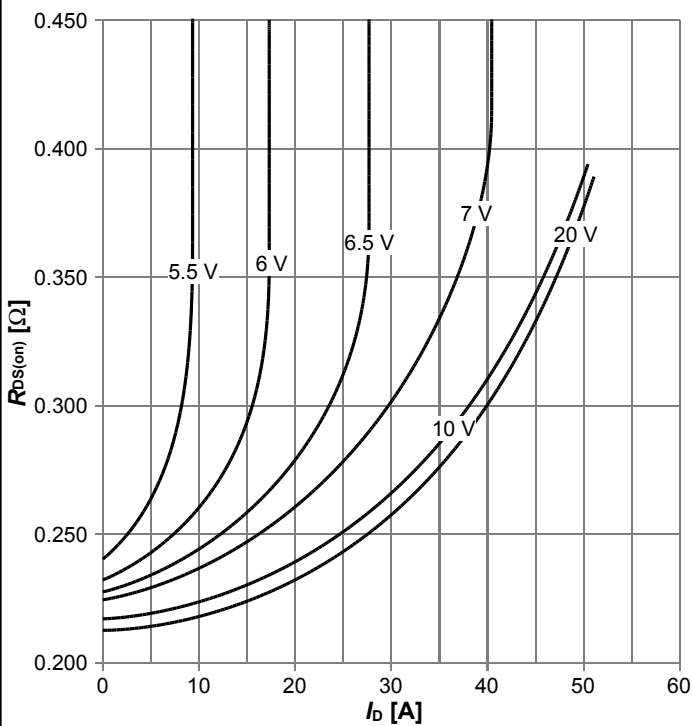
$I_D=f(V_{DS})$ ;  $T_j=25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



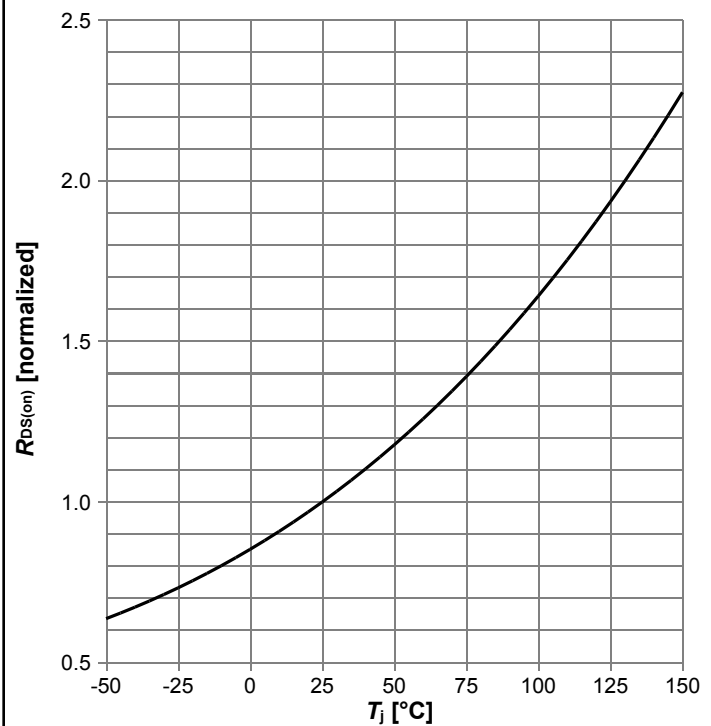
$I_D=f(V_{DS})$ ;  $T_j=125\text{ °C}$ ; parameter:  $V_{GS}$

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



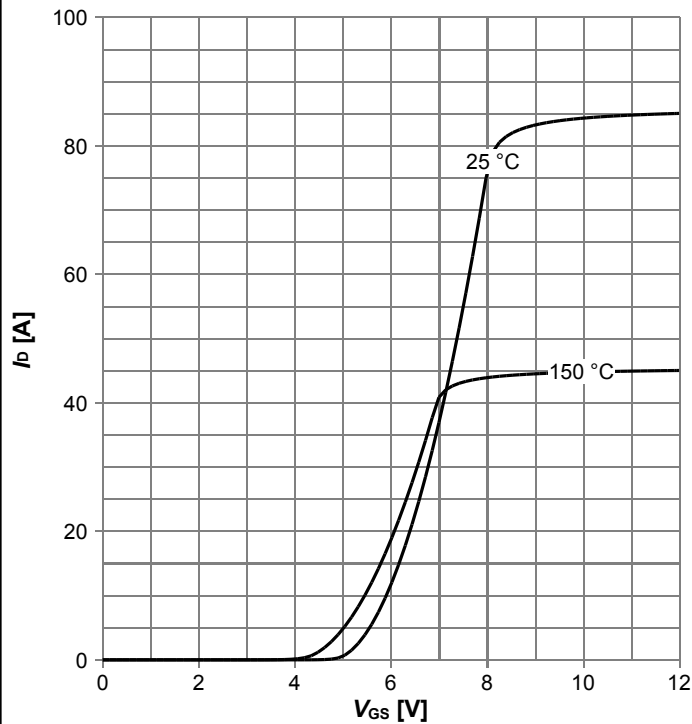
$R_{DS(on)}=f(T_j)$ ;  $I_D=6.0\text{ A}$ ;  $V_{GS}=10\text{ V}$



# 600V CoolMOS™ CFD7 Power Transistor

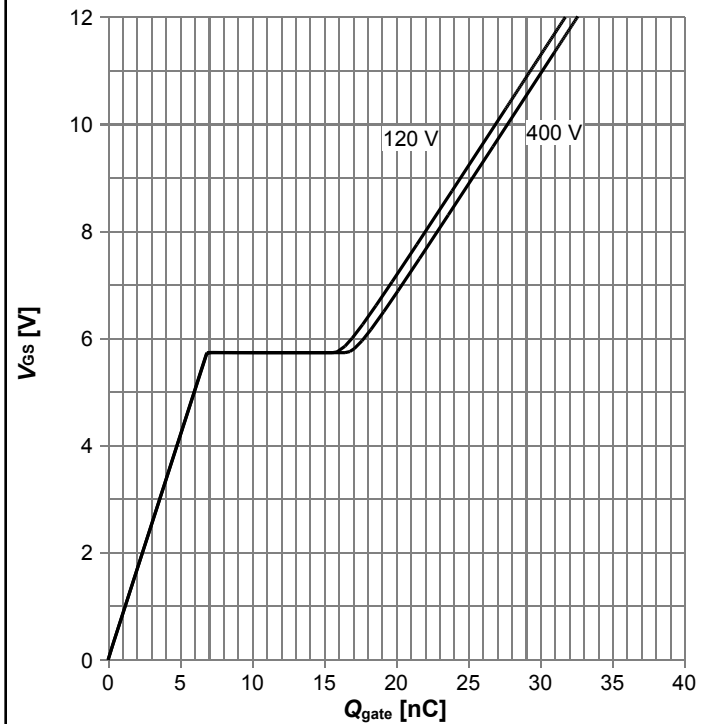
## IPT60R145CFD7

**Diagram 9: Typ. transfer characteristics**



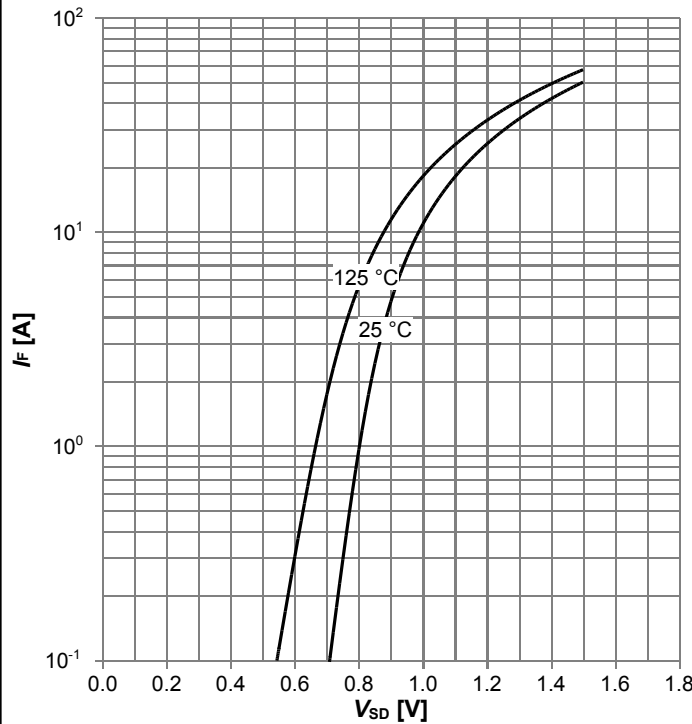
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

**Diagram 10: Typ. gate charge**



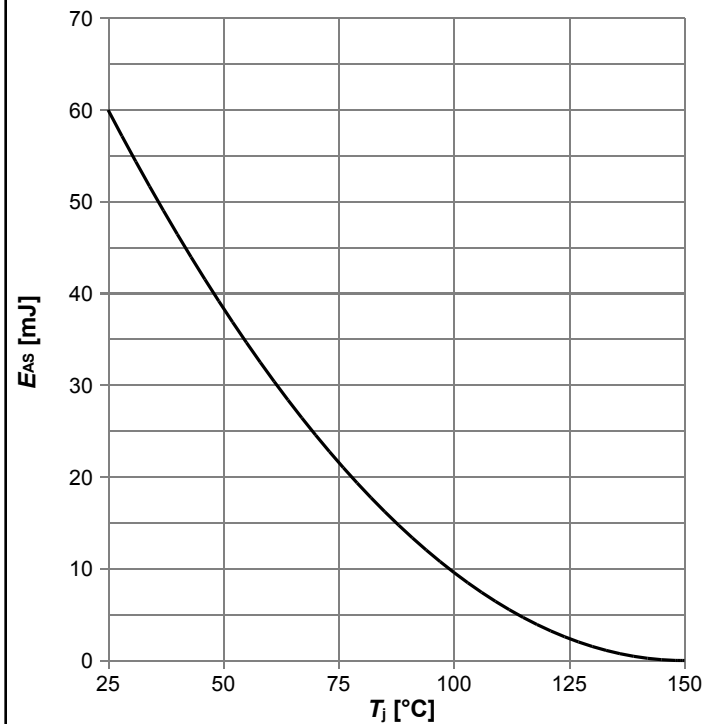
$V_{GS} = f(Q_{gate}); I_D = 7.3 \text{ A pulsed}; \text{parameter: } V_{DD}$

**Diagram 11: Forward characteristics of reverse diode**



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

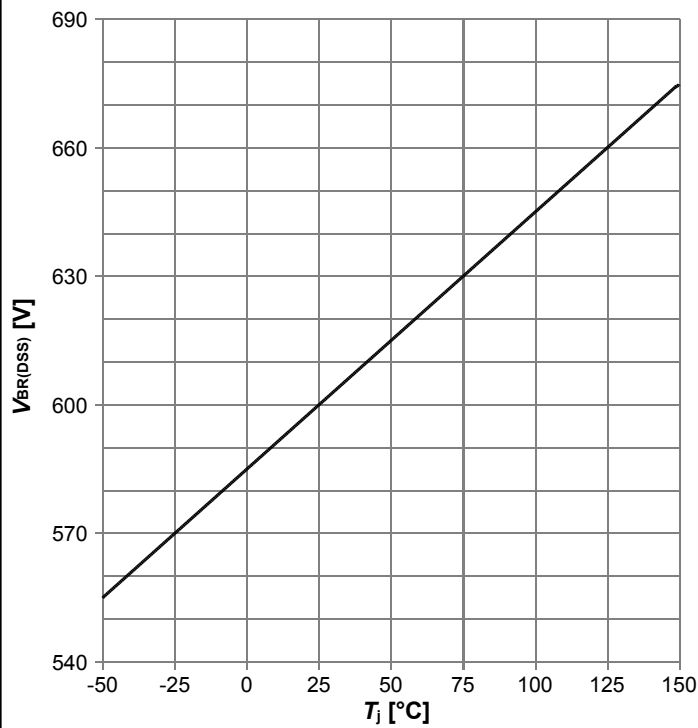
**Diagram 12: Avalanche energy**



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

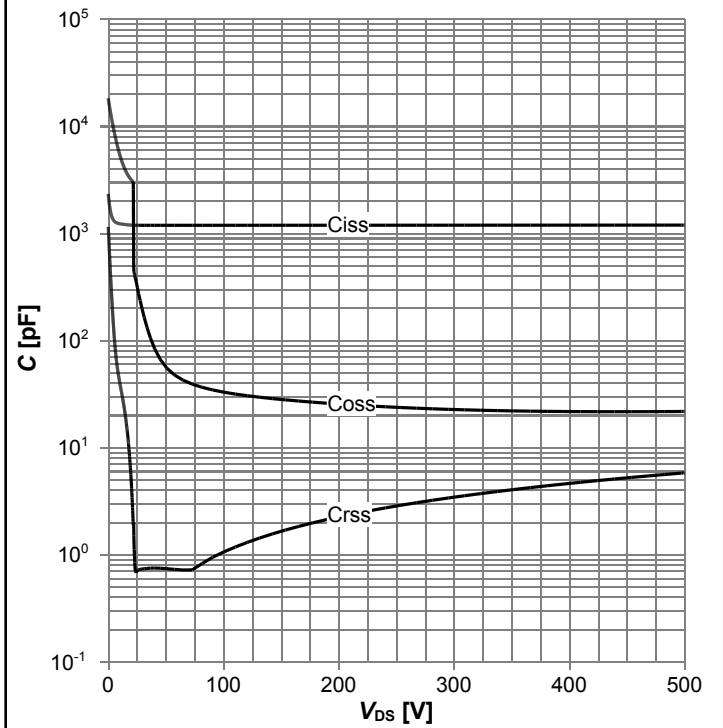
**600V CoolMOS™ CFD7 Power Transistor**  
**IPT60R145CFD7**

**Diagram 13: Drain-source breakdown voltage**



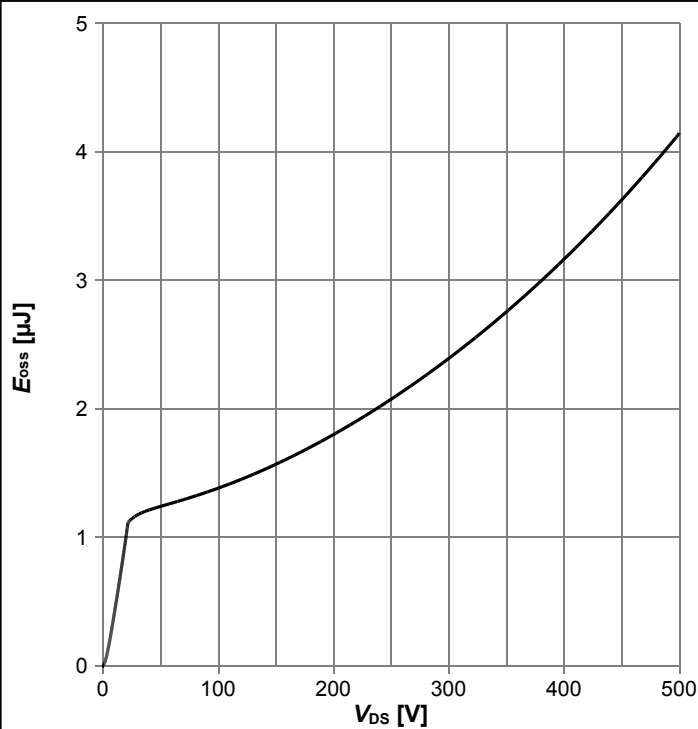
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

**Diagram 14: Typ. capacitances**



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

**Diagram 15: Typ. Coss stored energy**



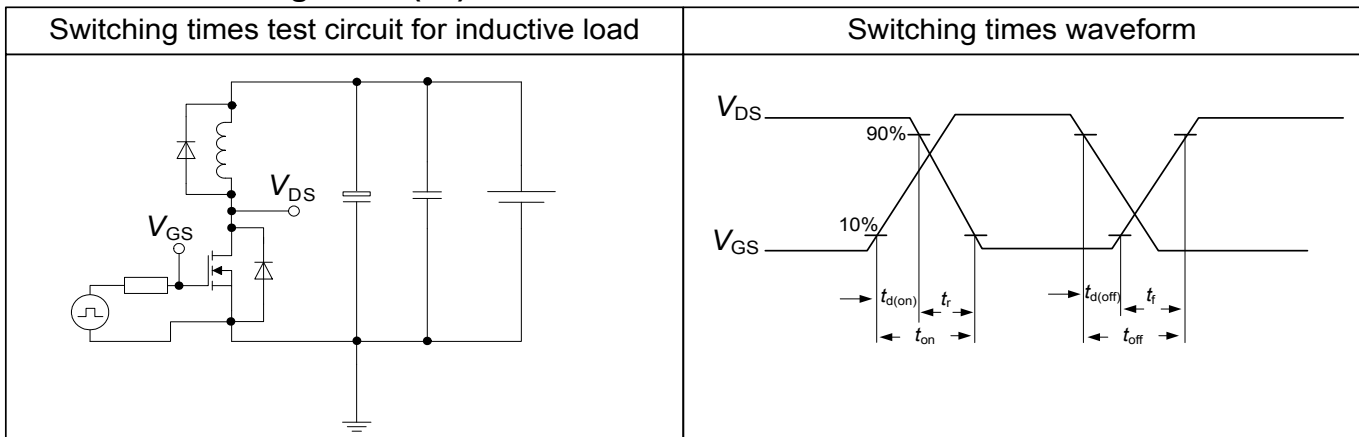
$E_{oss}=f(V_{DS})$

## 5 Test Circuits

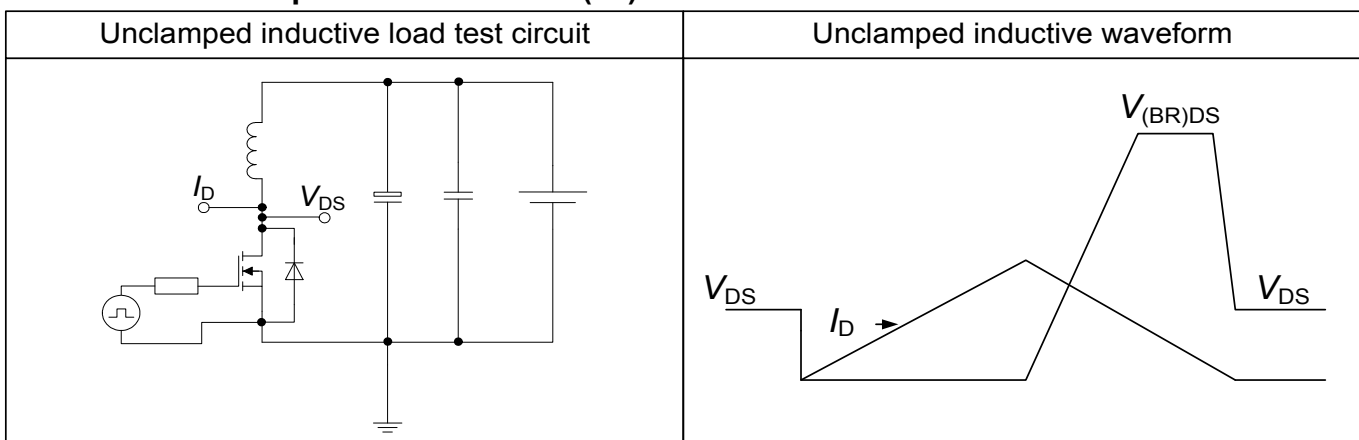
**Table 8 Diode characteristics**



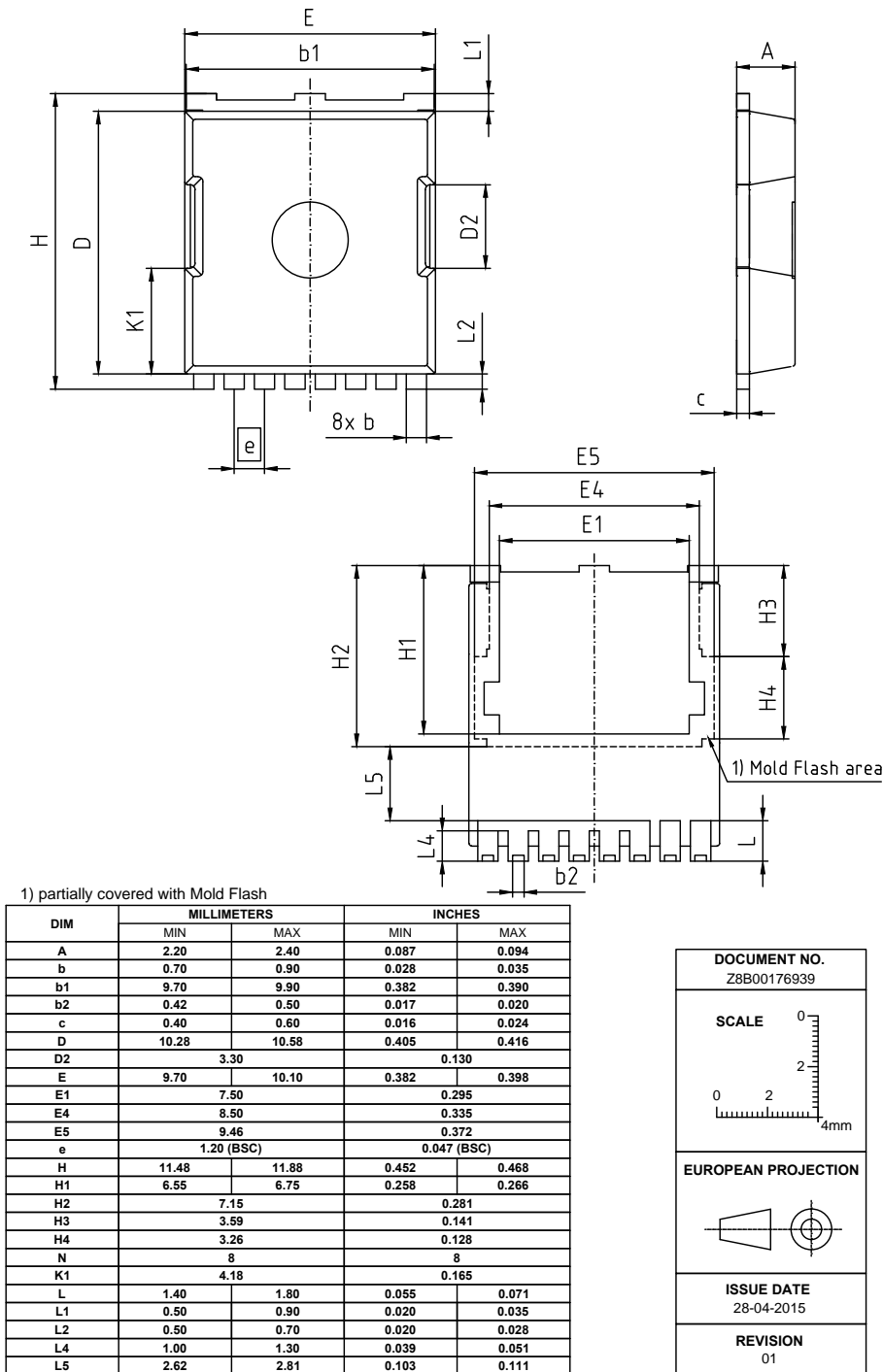
**Table 9 Switching times (ss)**



**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](http://www.infineon.com)
- IFX CoolMOS CFD7 application note: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS CFD7 simulation model: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://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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