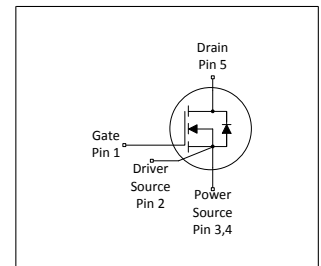
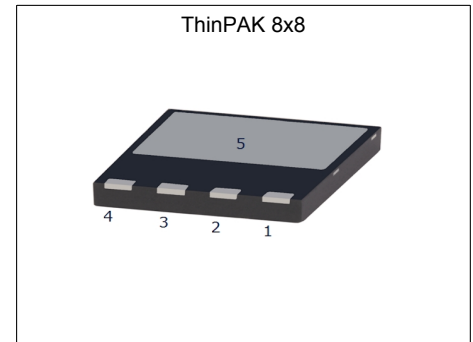


# MOSFET

## 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  $R_{DS(on)} \cdot Q_g$  and  $R_{DS(on)} \cdot E_{oss}$
- 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:** Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

*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
$R_{DS(on),max}$	95	mΩ
$Q_{g,typ}$	51	nC
$I_{D,pulse}$	97	A
$E_{oss} @ 400V$	5.9	μJ
Body diode $di_F/dt$	1300	A/μs

Type / Ordering Code	Package	Marking	Related Links
IPL60R095CFD7	PG-VSON-4	60R095F7	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 <sup>1)</sup>	$I_D$	-	-	25 16.0	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	97	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	114	mJ	$I_D=5.3\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche energy, repetitive	$E_{AR}$	-	-	0.57	mJ	$I_D=5.3\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche current, single pulse	$I_{AS}$	-	-	5.3	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	$P_{tot}$	-	-	147	W	$T_C=25^\circ\text{C}$
Storage temperature	$T_{stg}$	-40	-	150	$^\circ\text{C}$	-
Operating junction temperature	$T_j$	-40	-	150	$^\circ\text{C}$	-
Mounting torque	-	-	-	-	Ncm	-
Continuous diode forward current	$I_S$	-	-	25	A	$T_C=25^\circ\text{C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	97	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt	-	-	70	V/ns	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 25\text{A}$ , $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di/dt	-	-	1300	A/ $\mu\text{s}$	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 25\text{A}$ , $T_j=25^\circ\text{C}$ 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	$R_{thJC}$	-	-	0.85	°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, wavesoldering only allowed at leads	$T_{sld}$	-	-	260	°C	reflow MSL2A

### 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	$V_{GS}=0V$ , $I_D=1mA$
Gate threshold voltage	$V_{(GS)th}$	3.5	4	4.5	V	$V_{DS}=V_{GS}$ , $I_D=0.57mA$
Zero gate voltage drain current <sup>1)</sup>	$I_{DSS}$	-	-	1	$\mu A$	$V_{DS}=600V$ , $V_{GS}=0V$ , $T_j=25^\circ\text{C}$ $V_{DS}=600V$ , $V_{GS}=0V$ , $T_j=125^\circ\text{C}$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20V$ , $V_{DS}=0V$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.076 0.172	0.095 -	$\Omega$	$V_{GS}=10V$ , $I_D=11.4A$ , $T_j=25^\circ\text{C}$ $V_{GS}=10V$ , $I_D=11.4A$ , $T_j=150^\circ\text{C}$
Gate resistance	$R_G$	-	8	-	$\Omega$	$f=1MHz$ , open drain

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	2103	-	pF	$V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$
Output capacitance	$C_{oss}$	-	40	-	pF	$V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$
Effective output capacitance, energy related <sup>2)</sup>	$C_{o(er)}$	-	73	-	pF	$V_{GS}=0V$ , $V_{DS}=0...400V$
Effective output capacitance, time related <sup>3)</sup>	$C_{o(tr)}$	-	752	-	pF	$I_D=\text{constant}$ , $V_{GS}=0V$ , $V_{DS}=0...400V$
Turn-on delay time	$t_{d(on)}$	-	37	-	ns	$V_{DD}=400V$ , $V_{GS}=10V$ , $I_D=9.4A$ , $R_G=5.3\Omega$ ; see table 9
Rise time	$t_r$	-	14.5	-	ns	$V_{DD}=400V$ , $V_{GS}=10V$ , $I_D=9.4A$ , $R_G=5.3\Omega$ ; see table 9
Turn-off delay time	$t_{d(off)}$	-	127	-	ns	$V_{DD}=400V$ , $V_{GS}=10V$ , $I_D=9.4A$ , $R_G=5.3\Omega$ ; see table 9
Fall time	$t_f$	-	5.7	-	ns	$V_{DD}=400V$ , $V_{GS}=10V$ , $I_D=9.4A$ , $R_G=5.3\Omega$ ; see table 9

**Table 6 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	12	-	nC	$V_{DD}=400V$ , $I_D=9.4A$ , $V_{GS}=0$ to $10V$
Gate to drain charge	$Q_{gd}$	-	18	-	nC	$V_{DD}=400V$ , $I_D=9.4A$ , $V_{GS}=0$ to $10V$
Gate charge total	$Q_g$	-	51	-	nC	$V_{DD}=400V$ , $I_D=9.4A$ , $V_{GS}=0$ to $10V$
Gate plateau voltage	$V_{plateau}$	-	5.6	-	V	$V_{DD}=400V$ , $I_D=9.4A$ , $V_{GS}=0$ to $10V$

<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	$V_{GS}=0V$ , $I_F=11.4A$ , $T_J=25^{\circ}C$
Reverse recovery time	$t_{rr}$	-	103	206	ns	$V_R=400V$ , $I_F=9.4A$ , $di_F/dt=100A/\mu s$ ; see table 8
Reverse recovery charge	$Q_{rr}$	-	0.53	1.06	$\mu C$	$V_R=400V$ , $I_F=9.4A$ , $di_F/dt=100A/\mu s$ ; see table 8
Peak reverse recovery current	$I_{rrm}$	-	8.9	-	A	$V_R=400V$ , $I_F=9.4A$ , $di_F/dt=100A/\mu s$ ; see table 8

## 4 Electrical characteristics diagrams

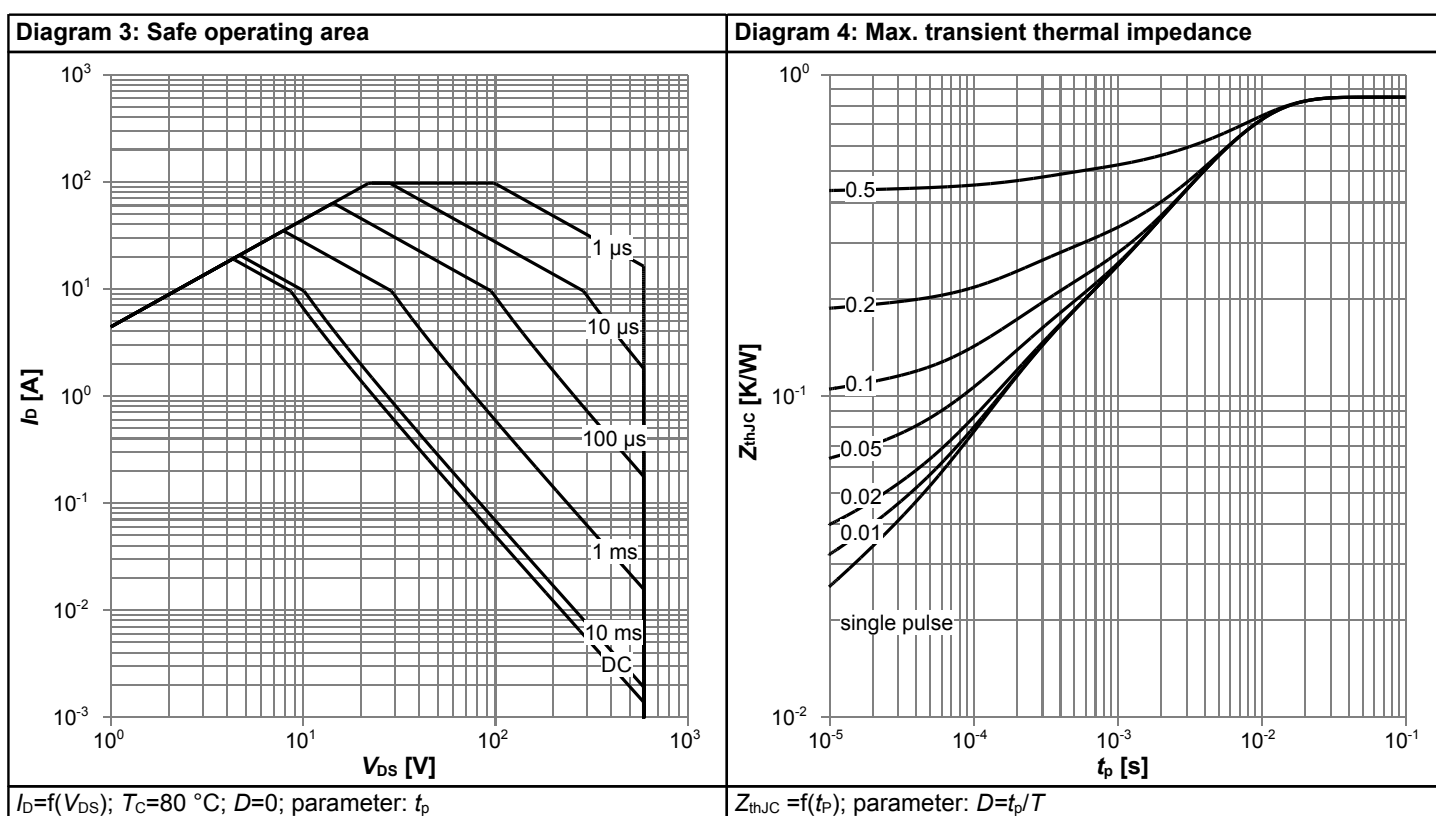
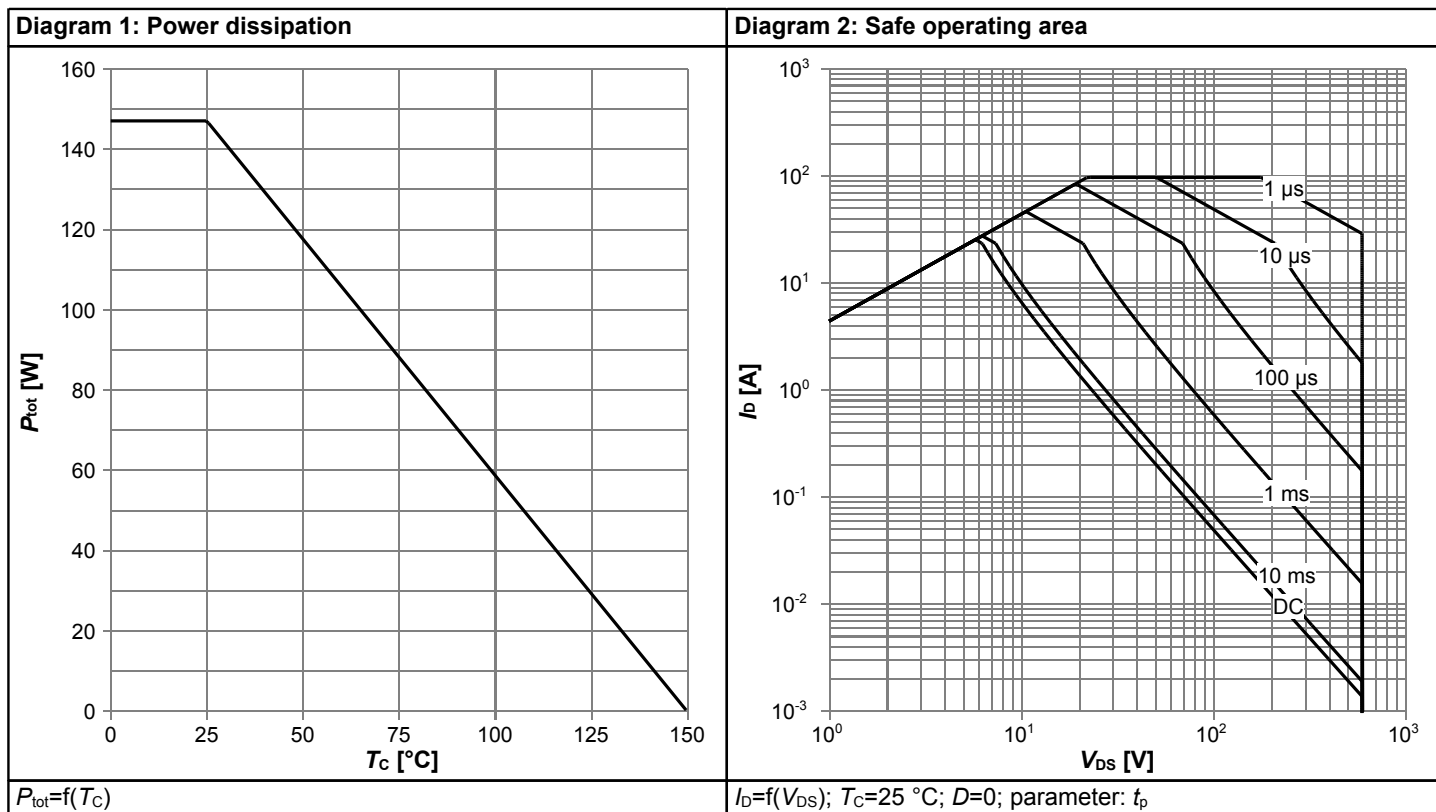
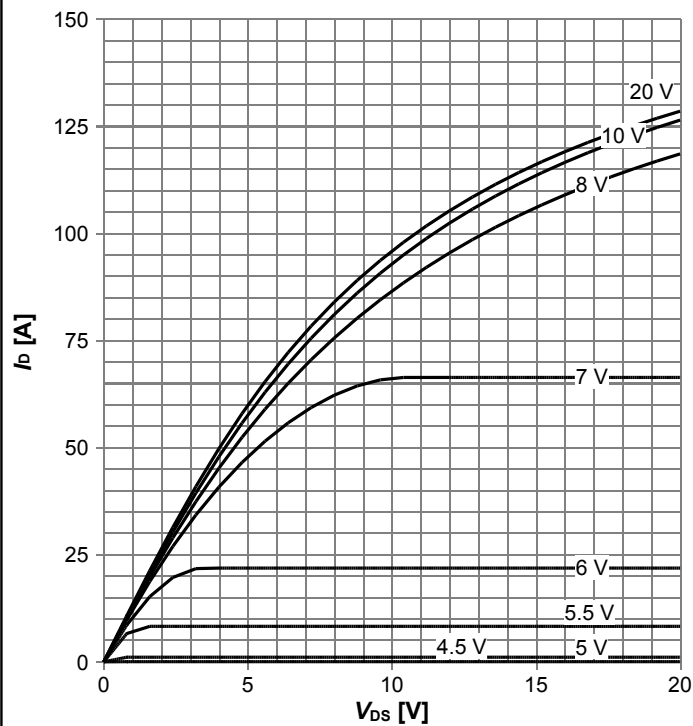
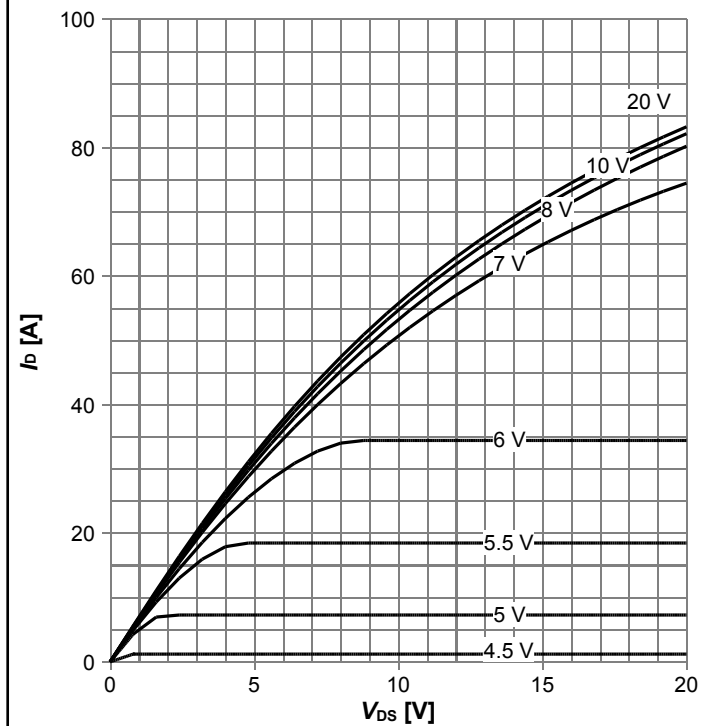


Diagram 5: Typ. output characteristics



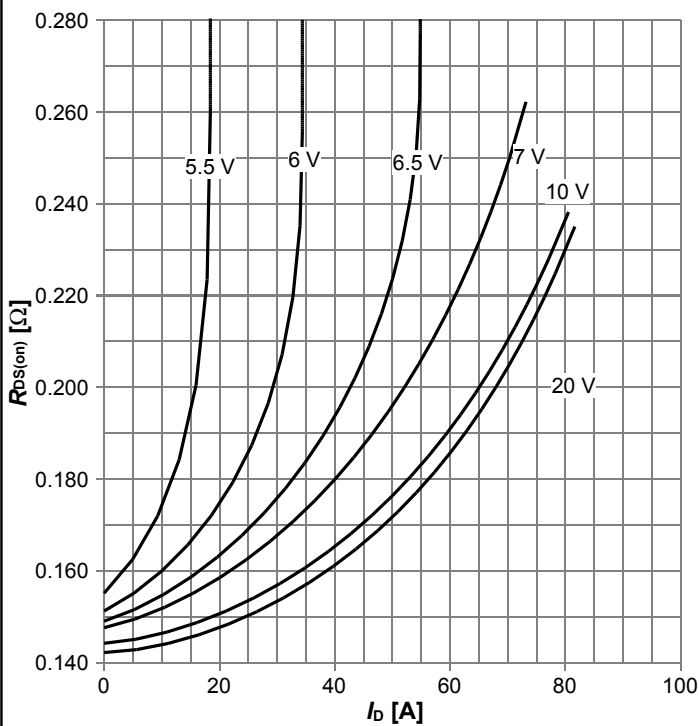
$I_D = f(V_{DS})$ ;  $T_J = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



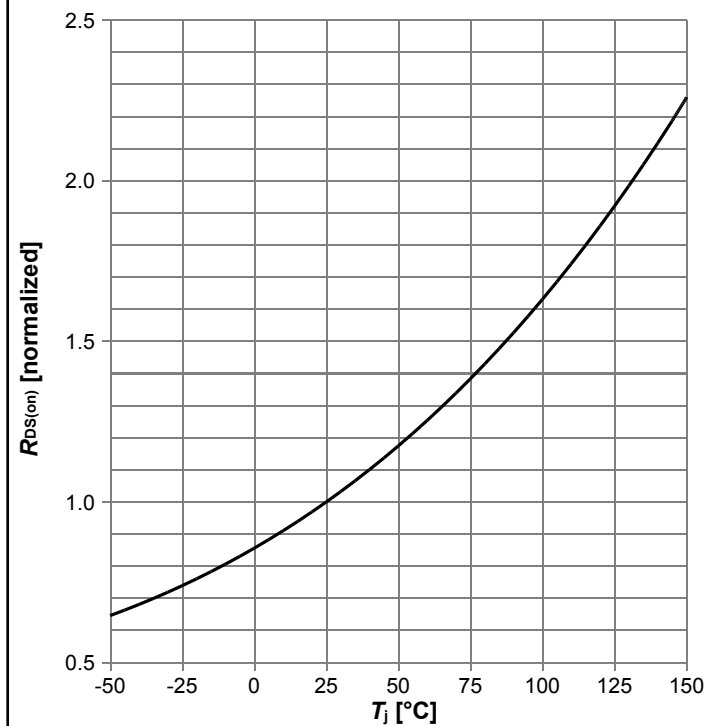
$I_D = f(V_{DS})$ ;  $T_J = 125^\circ\text{C}$ ; parameter:  $V_{GS}$

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



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

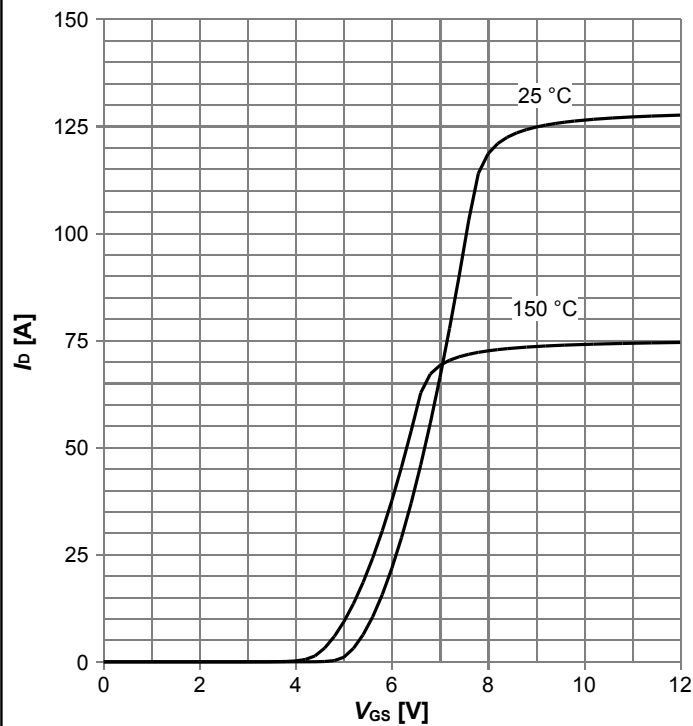
Diagram 8: Drain-source on-state resistance



$R_{DS(on)} = f(T_J)$ ;  $I_D = 11.4\text{ A}$ ;  $V_{GS} = 10\text{ V}$

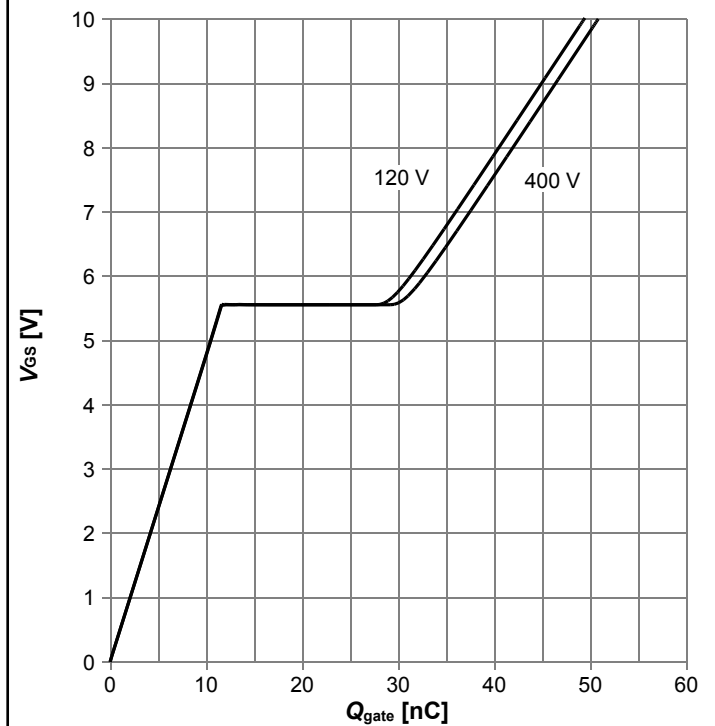


**Diagram 9: Typ. transfer characteristics**



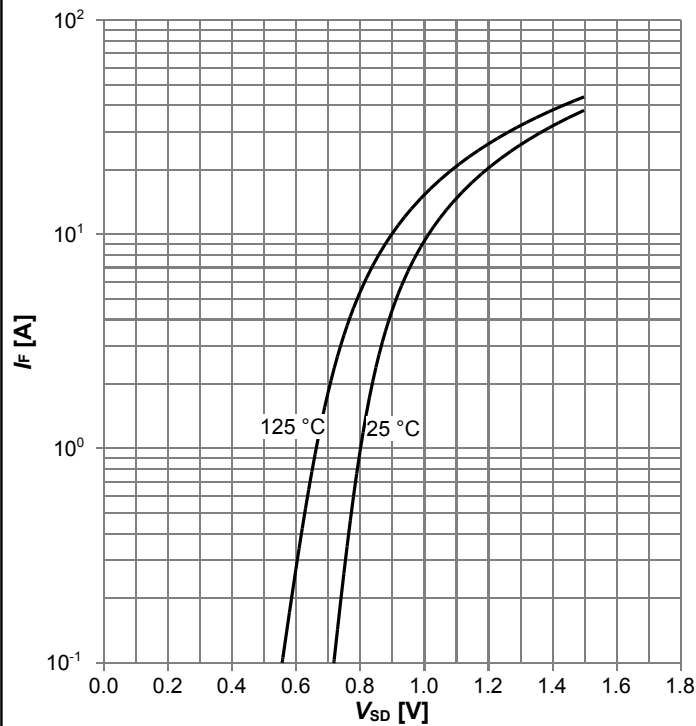
$I_D = f(V_{GS})$ ;  $V_{DS} = 20V$ ; parameter:  $T_j$

**Diagram 10: Typ. gate charge**



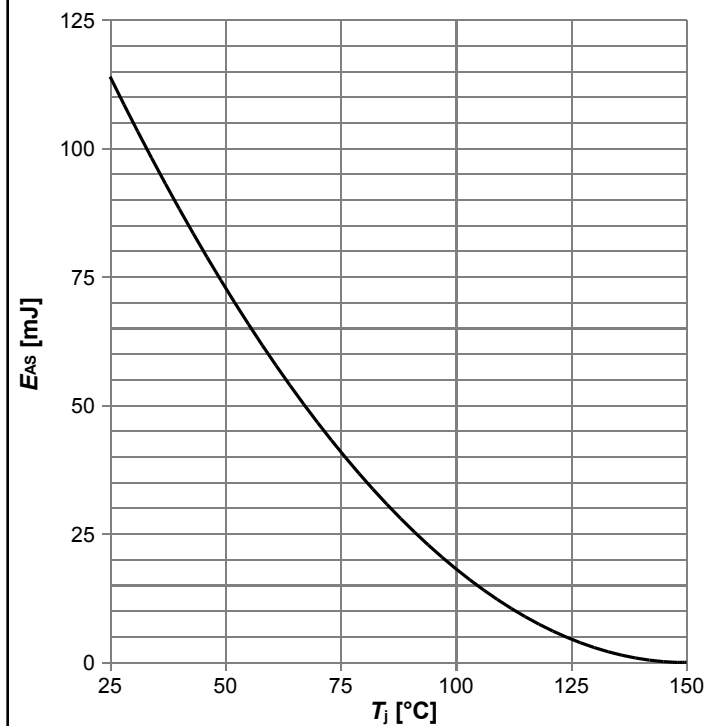
$V_{GS} = f(Q_{gate})$ ;  $I_D = 9.4$  A pulsed; parameter:  $V_{DD}$

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



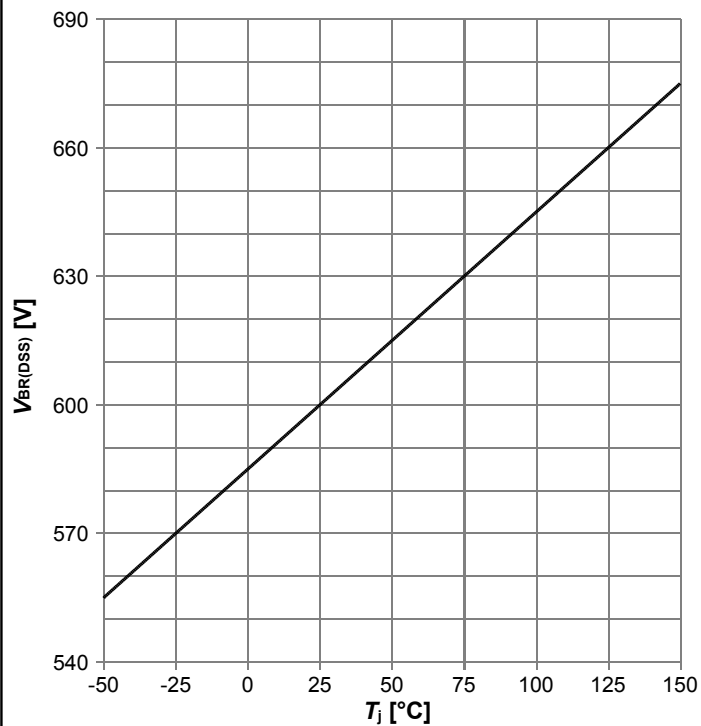
$I_F = f(V_{SD})$ ; parameter:  $T_j$

**Diagram 12: Avalanche energy**



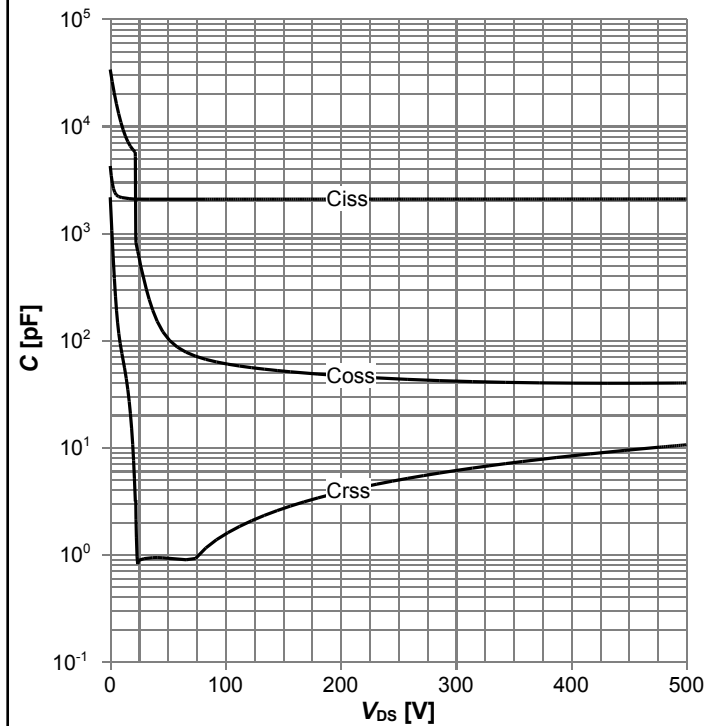
$E_{AS} = f(T_j)$ ;  $I_D = 5.3$  A;  $V_{DD} = 50$  V

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



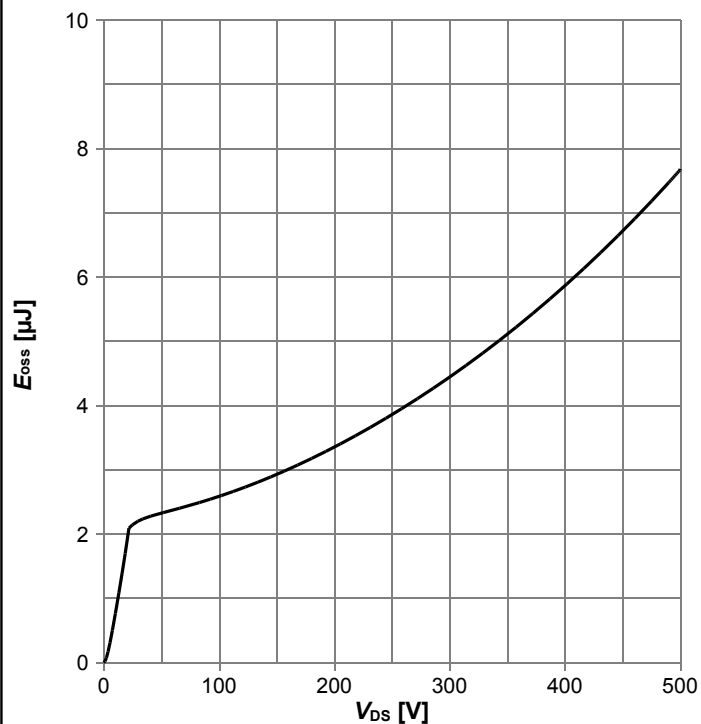
$V_{BR(DSS)} = f(T_J); I_D = 1 \text{ mA}$

**Diagram 14: Typ. capacitances**



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

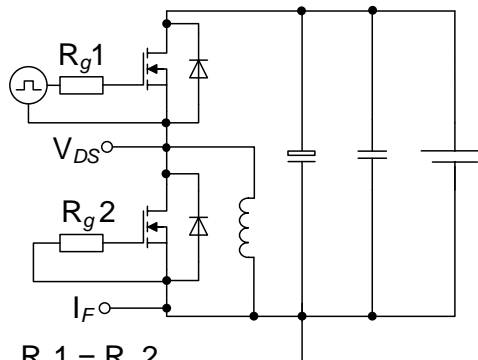
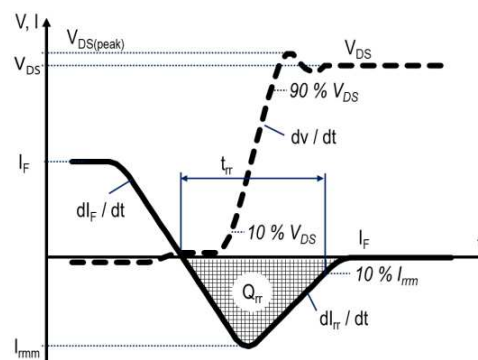
**Diagram 15: Typ. Coss stored energy**



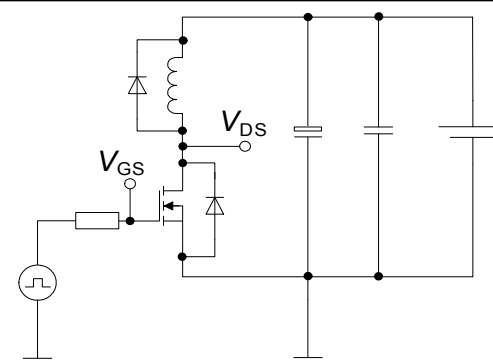
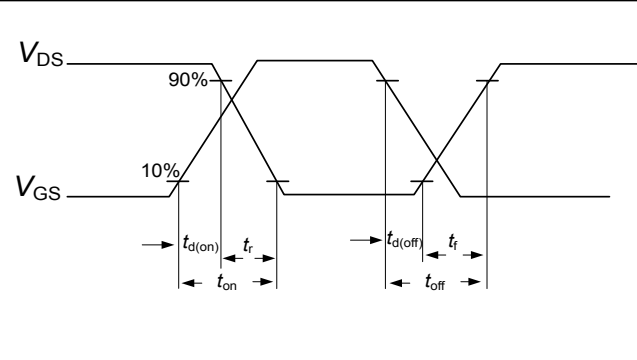
$E_{oss} = f(V_{DS})$

## 5 Test Circuits

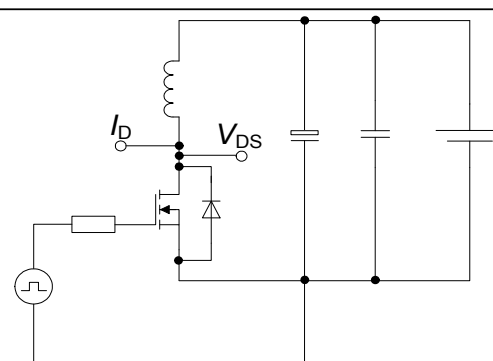
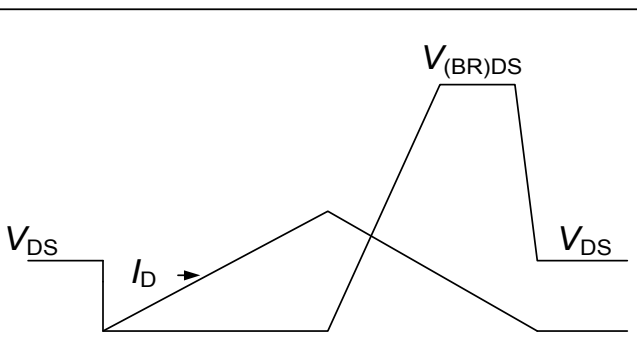
**Table 8 Diode characteristics**

Test circuit for diode characteristics	Diode recovery waveform
 <p><math>R_{g1} = R_{g2}</math></p>	

**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

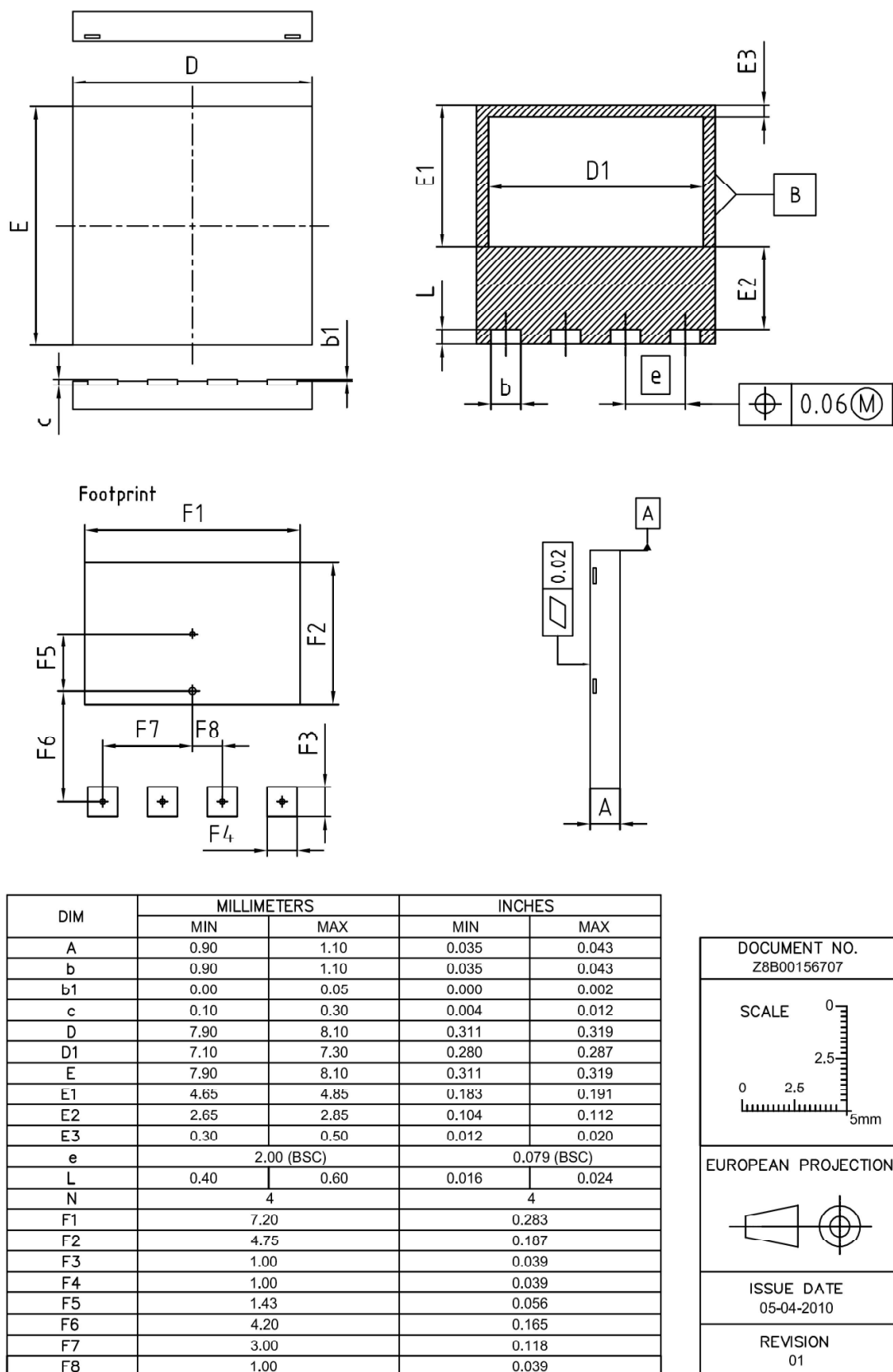


Figure 1 Outline PG-VSON-4, dimensions in mm/inches

## **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

IPL60R095CFD7

**Revision: 2018-04-20, Rev. 2.0**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2018-04-20	Release of final version

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