

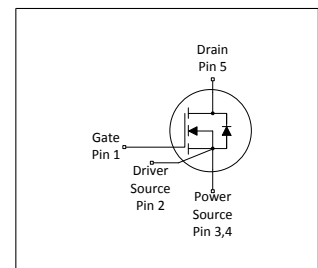
## MOSFET

### 650V CoolMOS™ CFD2 Power Transistor

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. 650V CoolMOS™ CFD2 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The resulting devices provide all benefits of a fast switching SJ MOSFET while offering an extremely fast and robust body diode. This combination of extremely low switching, commutation and conduction losses together with highest robustness make especially resonant switching applications more reliable, more efficient, lighter and cooler.

#### ThinPAK

ThinPAK is a new leadless SMD package for HV MOSFETs. The new package has a very small footprint of only 64mm<sup>2</sup> (vs. 150mm<sup>2</sup> for the D<sup>2</sup>PAK) and a very low profile with only 1mm height (vs. 4.4mm for the D<sup>2</sup>PAK). The significantly smaller package size, combined with benchmark low parasitic inductances, provides designers with a new and effective way to decrease system solution size in power-density driven designs.



#### Features

- Reduced board space consumption
- Increased power density
- Short commutation loop
- Smooth switching waveform
- Ultra-fast body diode
- Very high commutation ruggedness
- Extremely low losses due to very low FOM  $R_{DS(on)} \cdot Q_g$  and  $E_{oss}$
- Easy to use/drive
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)
- Pb-free plating, Halogen free mold compound



#### Potential applications

650V CoolMOS™ CFD2 is especially suitable for resonant switching stages for e.g. PC Silverbox, LCD TV, Lighting, Server and Telecom.

**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{ds} @ T_{jmax}$	700	V
$R_{DS(on),max}$	0.34	$\Omega$
$Q_{g,typ}$	41	nC
$I_{D,pulse}$	32	A
$E_{oss} @ 400V$	3.5	$\mu J$
Body diode $di_F/dt$	900	A/ $\mu s$
$Q_{rr}$	0.35	$\mu C$
$t_r$	95	ns
$I_{rrm}$	6.5	A

Type / Ordering Code	Package	Marking	Related Links
IPL65R340CFD	PG-VSON-4	65F6340	see Appendix A

## Table of Contents

Description .....	1
Maximum ratings .....	3
Thermal characteristics .....	3
Electrical characteristics .....	4
Electrical characteristics diagrams .....	6
Test Circuits .....	10
Package Outlines .....	11
Appendix A .....	12
Revision History .....	13
Trademarks .....	13
Disclaimer .....	13

## 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>	$I_D$	-	-	10.9 6.9	A	$T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	32	A	$T_C = 25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	290	mJ	$I_D = 2.2\text{ A}$ ; $V_{DD} = 50\text{ V}$
Avalanche energy, repetitive	$E_{AR}$	-	-	0.44	mJ	$I_D = 2.2\text{ A}$ ; $V_{DD} = 50\text{ V}$
Avalanche current, repetitive	$I_{AR}$	-	-	2.2	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	50	V/ns	$V_{DS} = 0 \dots 400\text{ V}$
Gate source voltage	$V_{GS}$	-20 -30	-	20 30	V	static; AC ( $f > 1\text{ Hz}$ )
Power dissipation	$P_{tot}$	-	-	104.2	W	$T_C = 25^\circ\text{C}$
Operating and storage temperature	$T_j, T_{stg}$	-40	-	150	$^\circ\text{C}$	-
Continuous diode forward current	$I_S$	-	-	10.9	A	$T_C = 25^\circ\text{C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	32	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt	-	-	50	V/ns	$V_{DS} = 0 \dots 400\text{ V}$ , $I_{SD} \leq I_D$ , $T_j = 25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di <sub>f</sub> /dt	-	-	900	A/ $\mu\text{s}$	$V_{DS} = 0 \dots 400\text{ V}$ , $I_{SD} \leq I_D$ , $T_j = 25^\circ\text{C}$ see table 8

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	1.2	$^\circ\text{C/W}$	-
Thermal resistance, junction - ambient <sup>4)</sup>	$R_{thJA}$	-	-	62 45	$^\circ\text{C/W}$	SMD version, device on PCB, minimal footprint SMD version, device on PCB, 6cm <sup>2</sup> cooling area
Soldering temperature, wavesoldering only allowed at leads	$T_{sold}$	-	-	260	$^\circ\text{C}$	reflow MSL2a

<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  $R_G$

<sup>4)</sup> Device on 40mm\*40mm\*1.5mm one layer epoxy PCB FR4 with 6cm<sup>2</sup> copper area (thickness 70 $\mu\text{m}$ ) for drain connection. PCB is vertical without air steam cooling.

### 3 Electrical characteristics

**Table 4 Static characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	650	-	-	V	$V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$
Gate threshold voltage	$V_{(GS)th}$	3.5	4	4.5	V	$V_{DS}=V_{GS}$ , $I_D=0.4\text{ mA}$
Zero gate voltage drain current	$I_{DSS}$	-	-	1	$\mu\text{A}$	$V_{DS}=650\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ }^\circ\text{C}$ $V_{DS}=650\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=150\text{ }^\circ\text{C}$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.306	0.340	$\Omega$	$V_{GS}=10\text{ V}$ , $I_D=4.4\text{ A}$ , $T_j=25\text{ }^\circ\text{C}$ $V_{GS}=10\text{ V}$ , $I_D=4.4\text{ A}$ , $T_j=150\text{ }^\circ\text{C}$
Gate resistance	$R_G$	-	4.5	-	$\Omega$	$f=1\text{ MHz}$ , open drain

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	1100	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ , $f=1\text{ MHz}$
Output capacitance	$C_{oss}$	-	55	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ , $f=1\text{ MHz}$
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	44	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=0\dots400\text{ V}$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	204	-	pF	$I_D=\text{constant}$ , $V_{GS}=0\text{ V}$ , $V_{DS}=0\dots400\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	11	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=13\text{ V}$ , $I_D=6.6\text{ A}$ , $R_G=3.4\Omega$ ; see table 9
Rise time	$t_r$	-	7.5	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=13\text{ V}$ , $I_D=6.6\text{ A}$ , $R_G=3.4\Omega$ ; see table 9
Turn-off delay time	$t_{d(off)}$	-	45	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=13\text{ V}$ , $I_D=6.6\text{ A}$ , $R_G=3.4\Omega$ ; see table 9
Fall time	$t_f$	-	7	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=13\text{ V}$ , $I_D=6.6\text{ A}$ , $R_G=3.4\Omega$ ; 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	$V_{DD}=480\text{ V}$ , $I_D=6.6\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	$Q_{gd}$	-	22	-	nC	$V_{DD}=480\text{ V}$ , $I_D=6.6\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total	$Q_g$	-	41	-	nC	$V_{DD}=480\text{ V}$ , $I_D=6.6\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate plateau voltage	$V_{plateau}$	-	6.4	-	V	$V_{DD}=480\text{ V}$ , $I_D=6.6\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$

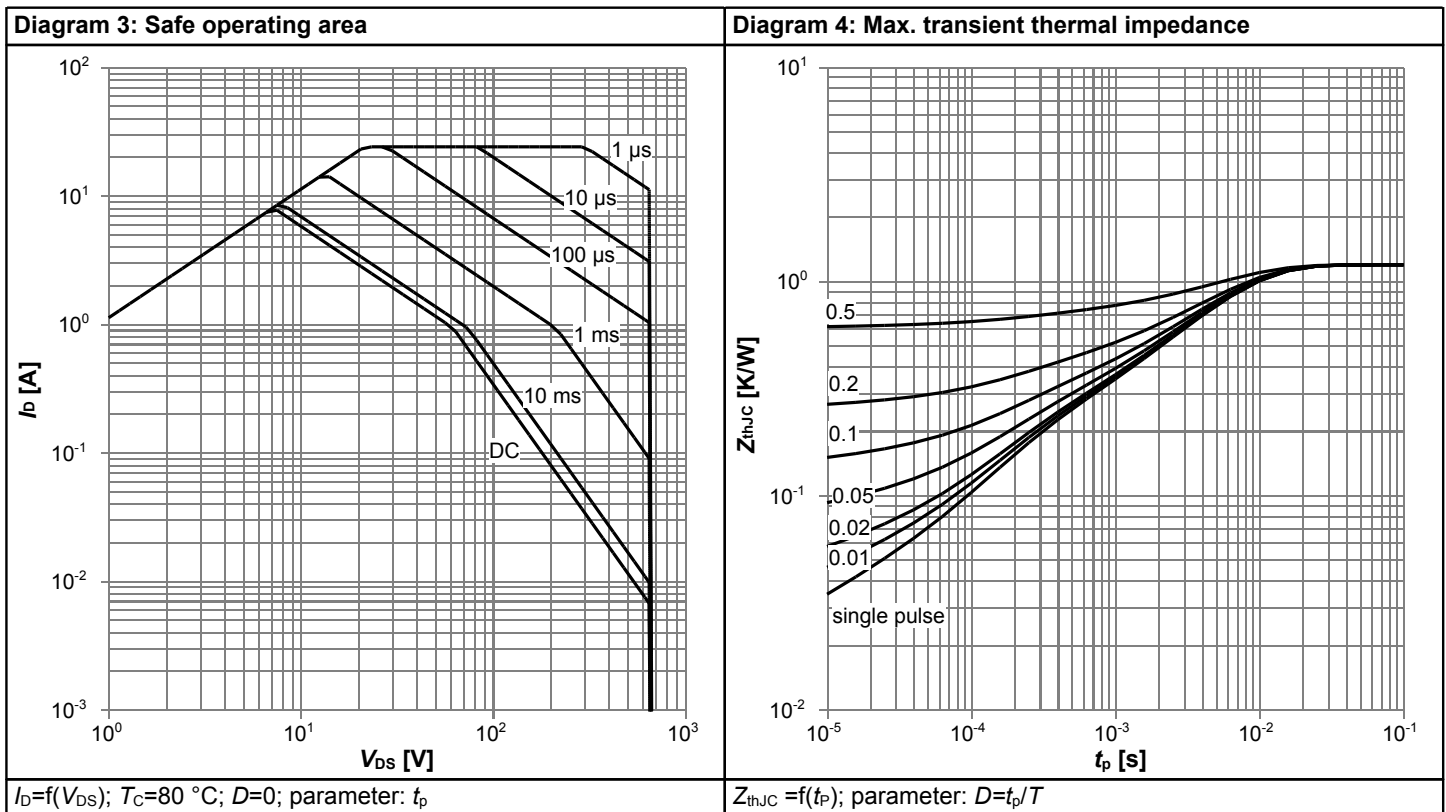
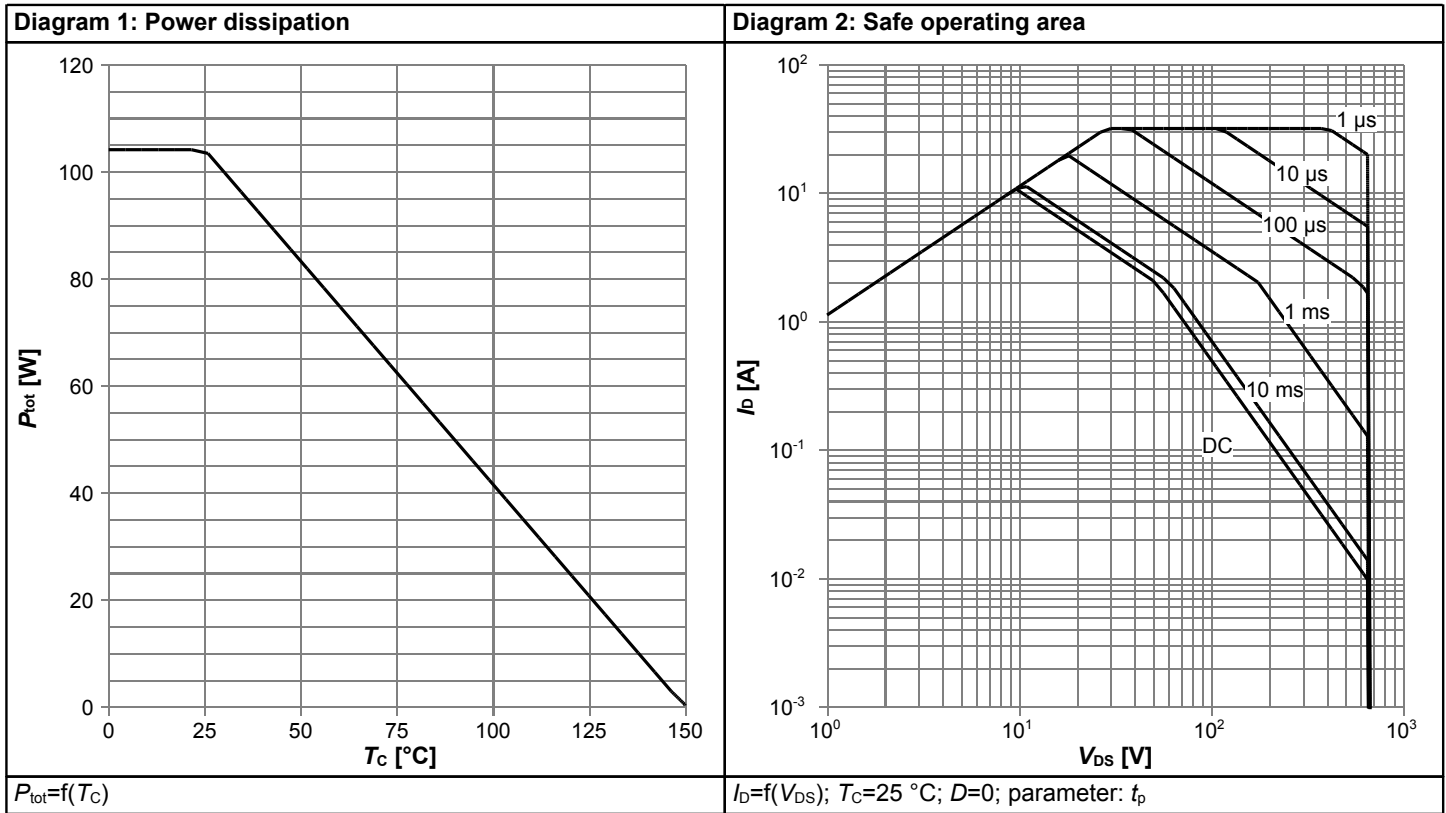
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

<sup>2)</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	$V_{SD}$	-	0.9	-	V	$V_{GS}=0\text{ V}$ , $I_F=6.6\text{ A}$ , $T_j=25\text{ °C}$
Reverse recovery time	$t_{rr}$	-	95	-	ns	$V_R=400\text{ V}$ , $I_F=6.6\text{ A}$ $di_F/dt=100\text{ A}/\mu\text{s}$ see table 8
Reverse recovery charge	$Q_{rr}$	-	0.35	-	$\mu\text{C}$	$V_R=400\text{ V}$ , $I_F=6.6\text{ A}$ $di_F/dt=100\text{ A}/\mu\text{s}$ see table 8
Peak reverse recovery current	$I_{rrm}$	-	6.5	-	A	$V_R=400\text{ V}$ , $I_F=6.6\text{ A}$ $di_F/dt=100\text{ A}/\mu\text{s}$ see table 8

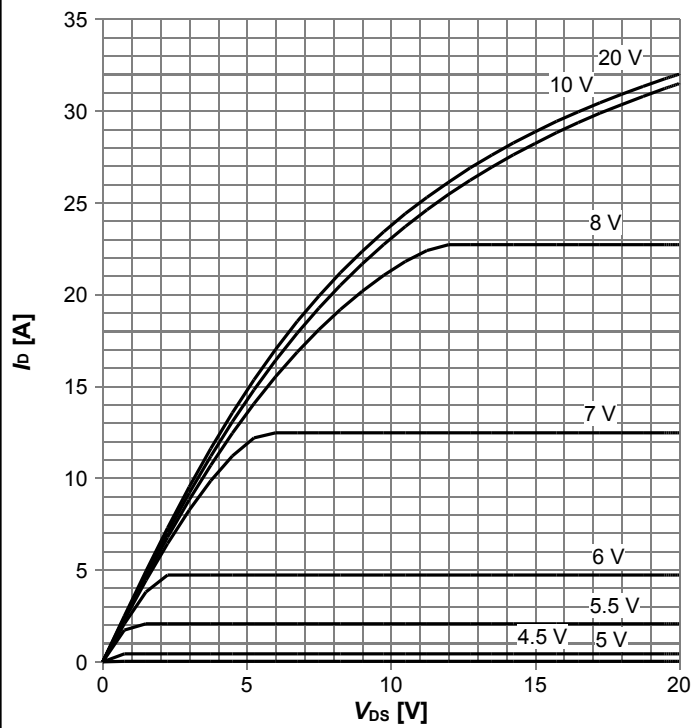
### 4 Electrical characteristics diagrams



# 650V CoolMOS™ CFD2 Power Transistor

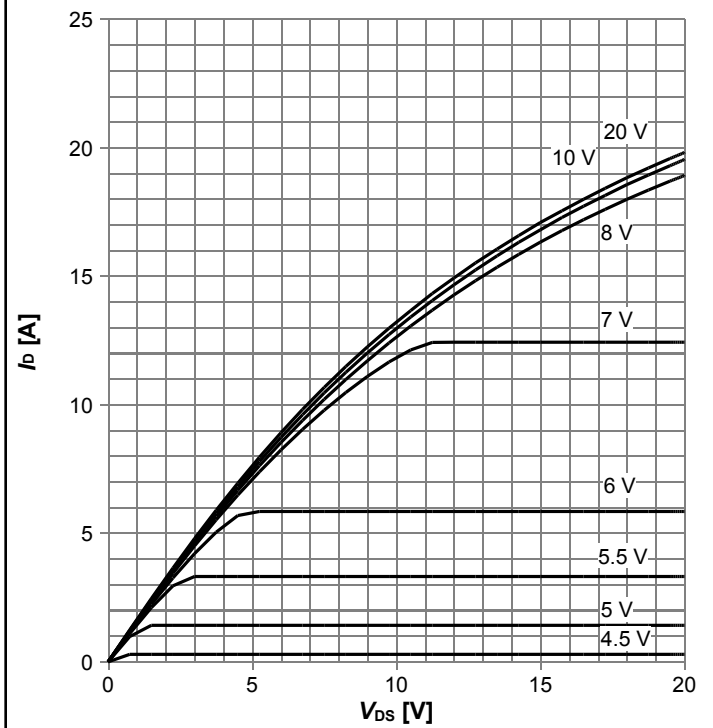
## IPL65R340CFD

Diagram 5: Typ. output characteristics



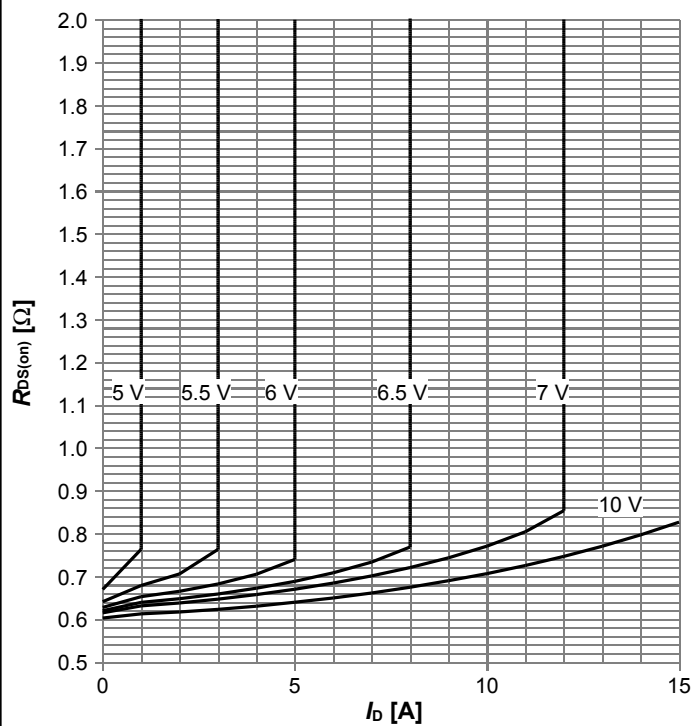
$I_D=f(V_{DS}); T_j=25\text{ °C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics



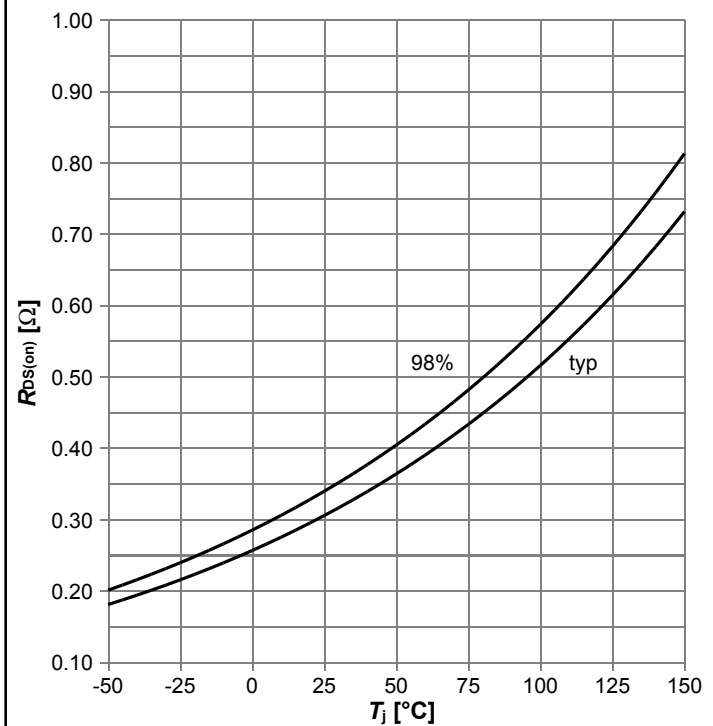
$I_D=f(V_{DS}); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

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



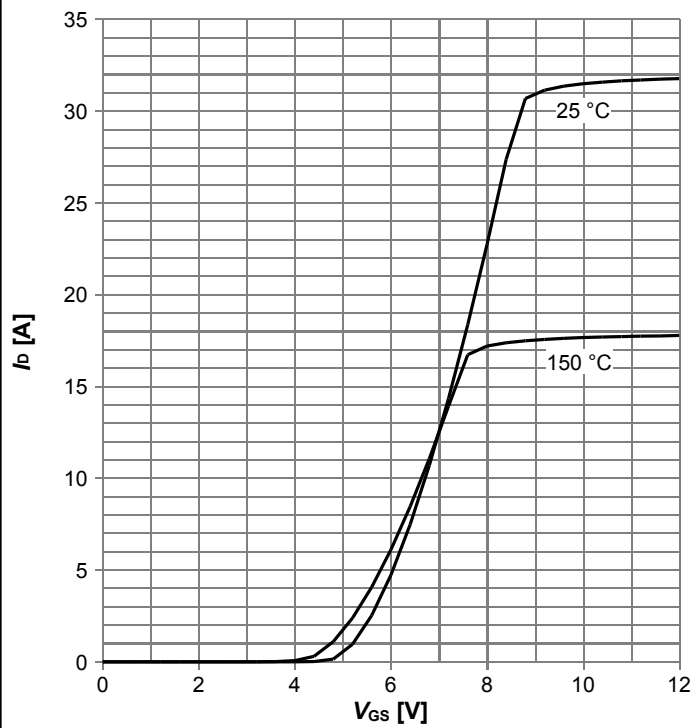
$R_{DS(on)}=f(I_D); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance



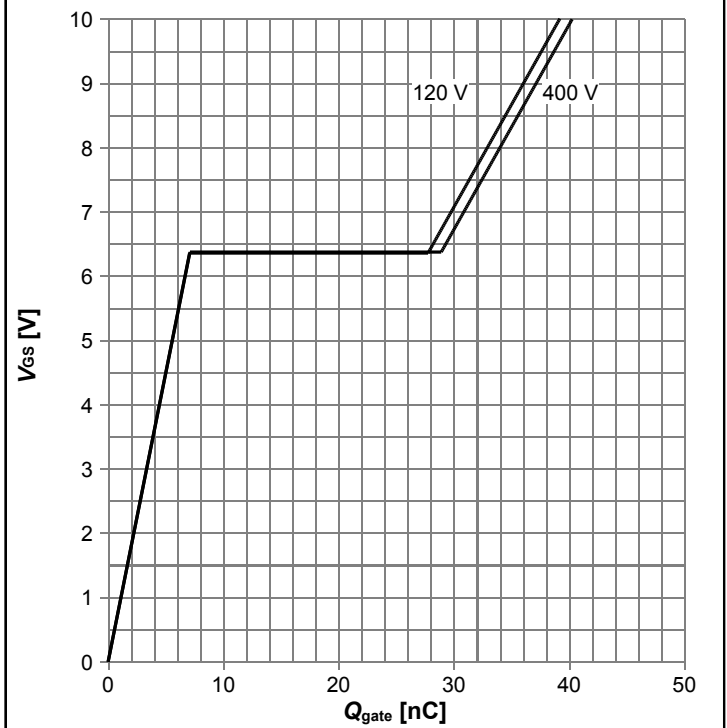
$R_{DS(on)}=f(T_j); I_D=4.4\text{ A}; V_{GS}=10\text{ V}$

**Diagram 9: Typ. transfer characteristics**



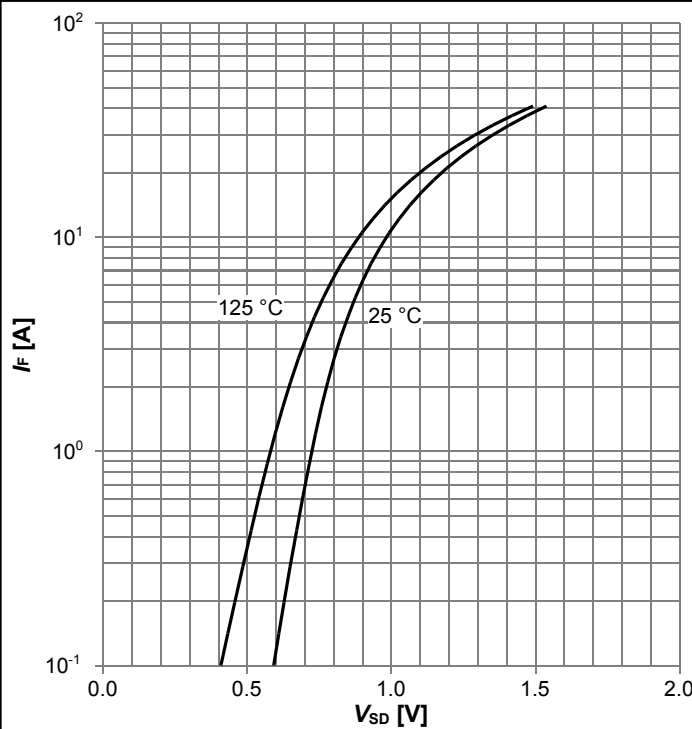
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

**Diagram 10: Typ. gate charge**



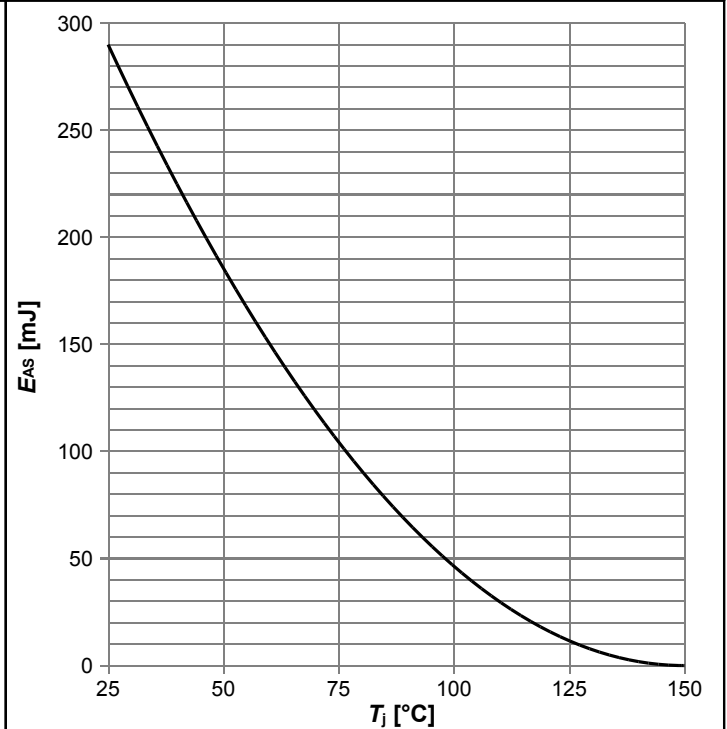
$V_{GS} = f(Q_{gate}); I_D = 6.6 \text{ A pulsed}; \text{parameter: } V_{DD}$

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



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

**Diagram 12: Avalanche energy**

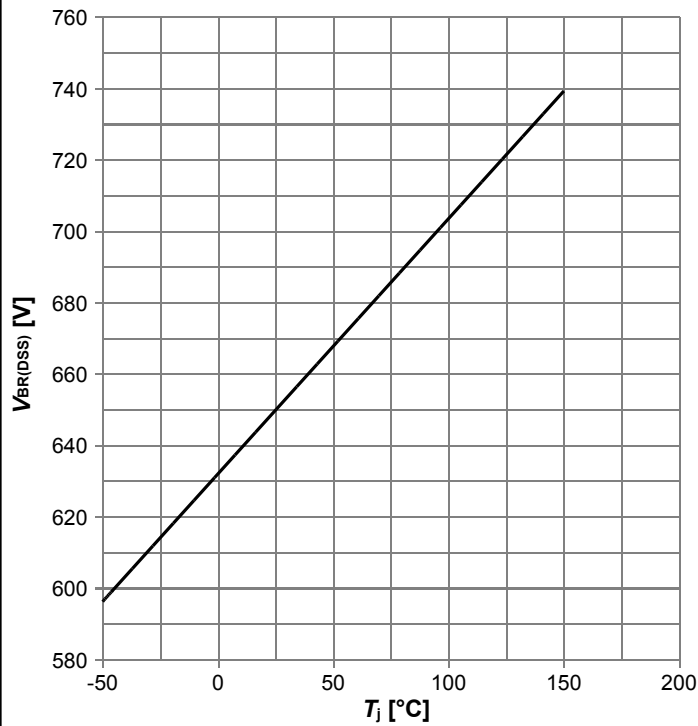


$E_{AS} = f(T_j); I_D = 2.2 \text{ A}; V_{DD} = 50 \text{ V}$



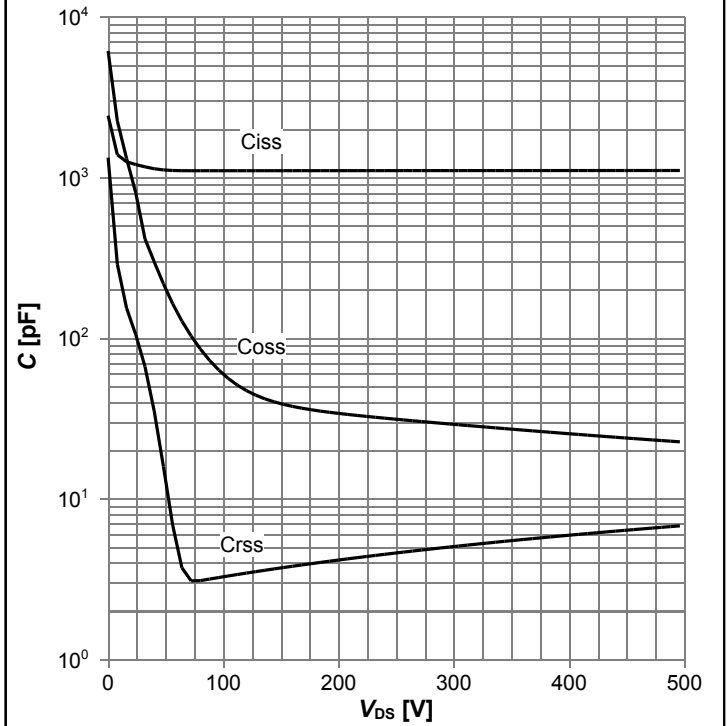
**650V CoolMOS™ CFD2 Power Transistor**  
**IPL65R340CFD**

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



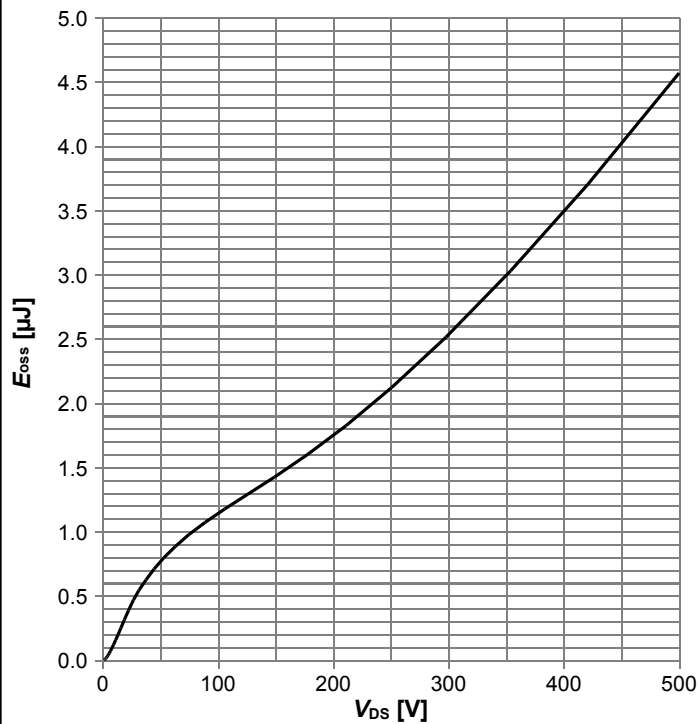
$V_{BR(DSS)}=f(T_j); I_D=1\text{ mA}$

**Diagram 14: Typ. capacitances**



$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$

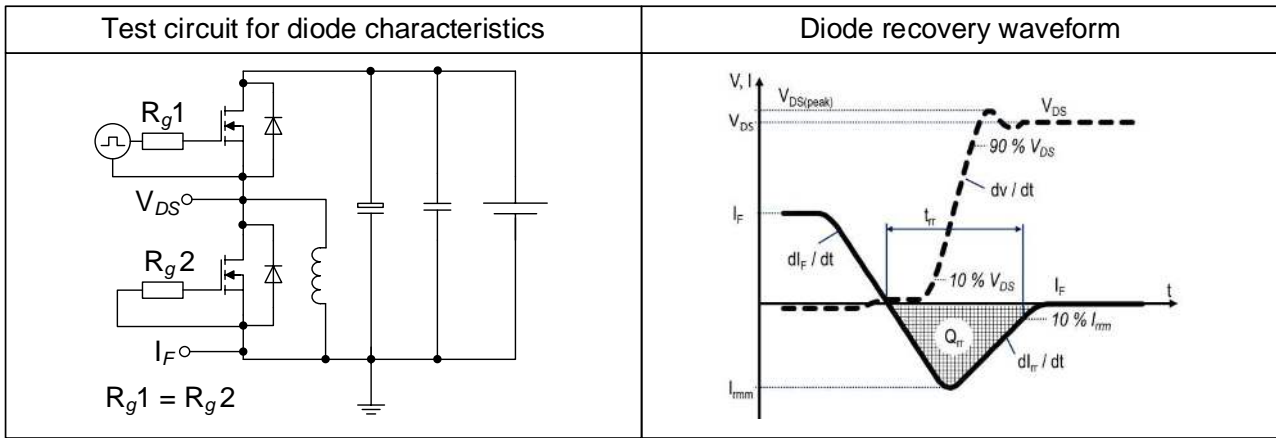
**Diagram 15: Typ. Coss stored energy**



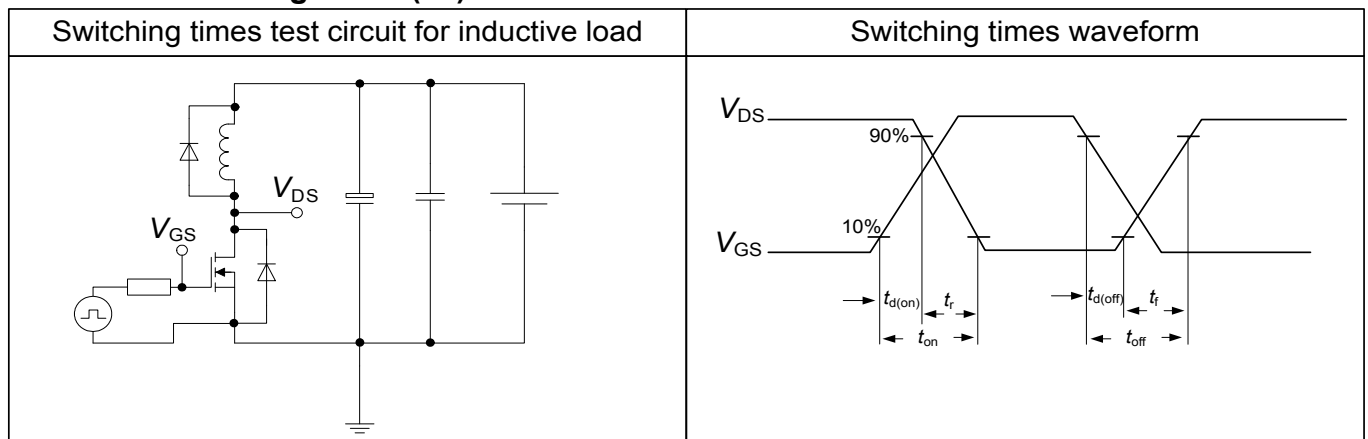
$E_{oss}=f(V_{DS})$

## 5 Test Circuits

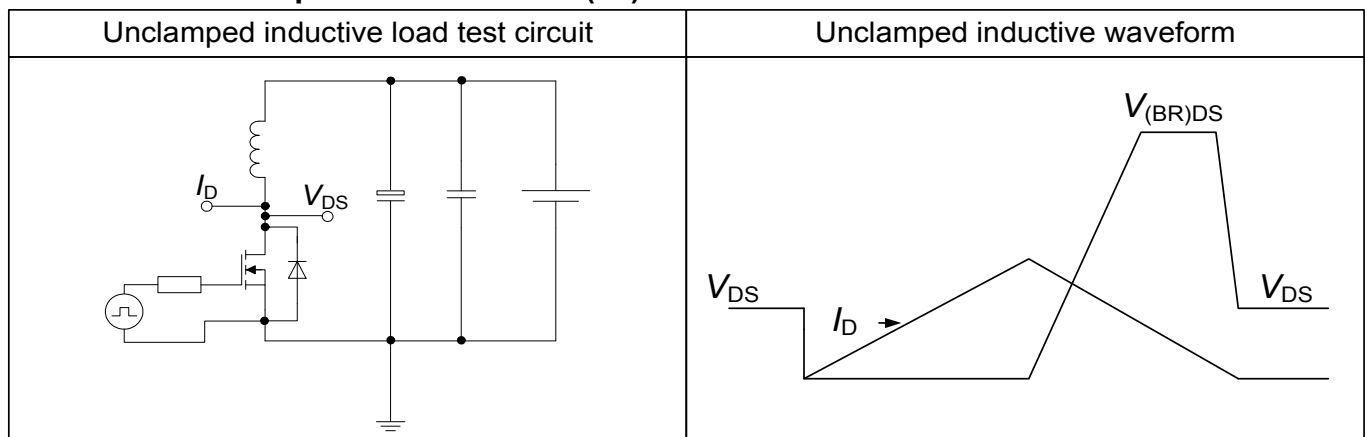
**Table 8 Diode characteristics**



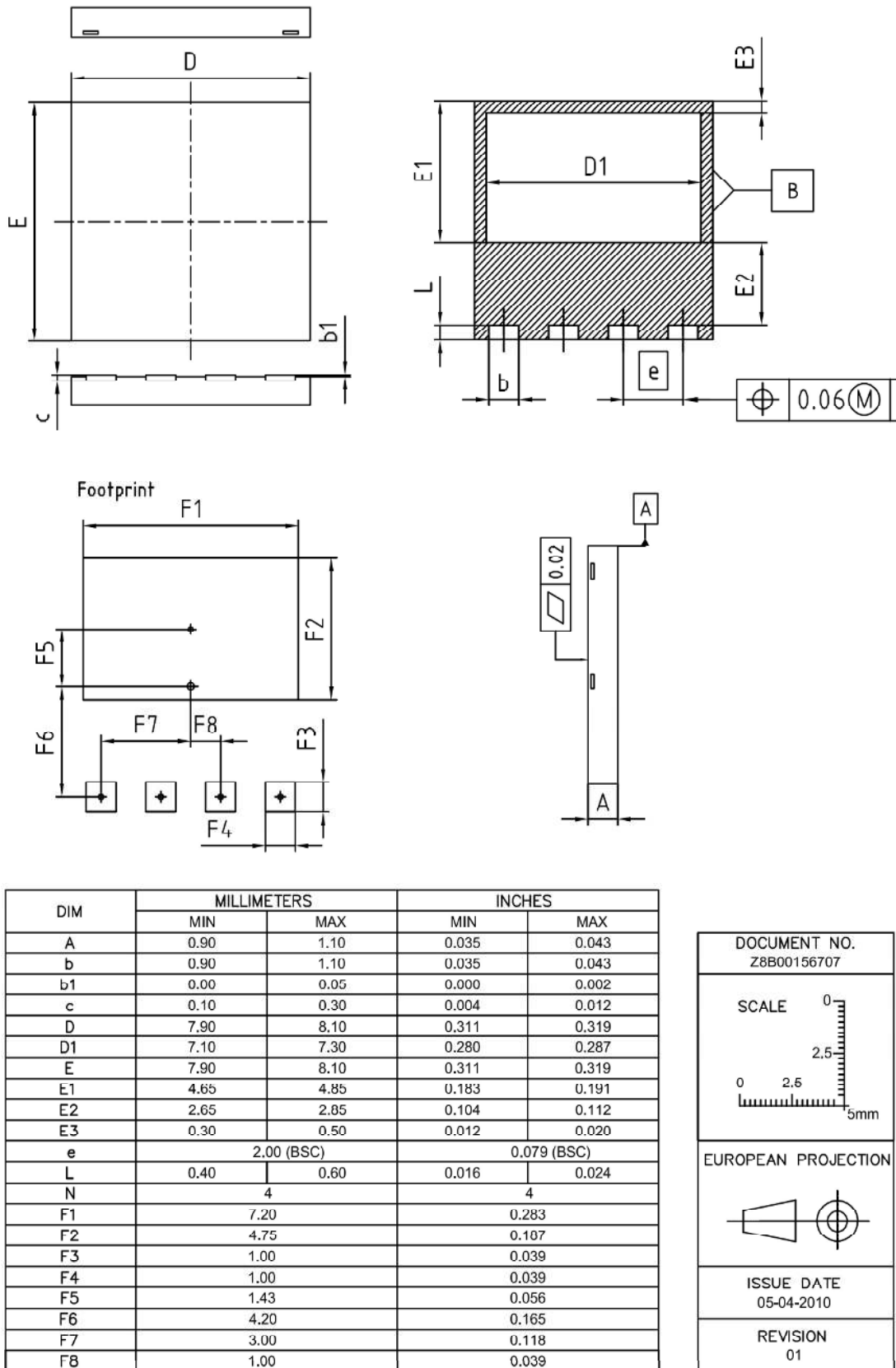
**Table 9 switching times (ss)**



**Table 10 Unclamped inductive load (ss)**



**6 Package Outlines**



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

## 7 Appendix A

### Table 11 Related Links

- IFX CoolMOS Webpage: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

## Revision History

IPL65R340CFD

**Revision: 2017-09-07, Rev. 2.1**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2013-05-29	Release of final version
2.1	2017-09-07	Updated MSL; style updated

### Trademarks of Infineon Technologies AG

AURIX™, C166™, CanPAK™, CIPOS™, CoolGaN™, CoolMOS™, CoolSET™, CoolSiC™, CORECONTROL™, CROSSAVE™, DAVE™, DI-POL™, DrBlade™, EasyPIM™, EconoBRIDGE™, EconoDUAL™, EconoPACK™, EconoPIM™, EiceDRIVER™, eupec™, FCOS™, HITFET™, HybridPACK™, Infineon™, ISOFACE™, IsoPACK™, i-Wafer™, MIPAQ™, ModSTACK™, my-d™, NovalithIC™, OmniTune™, OPTIGA™, OptiMOS™, ORIGA™, POWERCODE™, PRIMARION™, PrimePACK™, PrimeSTACK™, PROFET™, PRO-SIL™, RASIC™, REAL3™, ReverSave™, SatRIC™, SIEGET™, SiPMOS™, SmartLEWIS™, SOLID FLASH™, SPOC™, TEMPFET™, thinQ!™, TRENCHSTOP™, TriCore™.

Trademarks updated August 2015

### Other Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

### We Listen to Your Comments

Any information within this document that you feel is wrong, unclear or missing at all? Your feedback will help us to continuously improve the quality of this document. Please send your proposal (including a reference to this document) to:

[erratum@infineon.com](mailto:erratum@infineon.com)

**Published by**  
**Infineon Technologies AG**  
**81726 München, Germany**  
**© 2017 Infineon Technologies AG**  
**All Rights Reserved.**

### Legal Disclaimer

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

### Information

For further information on technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies Office ([www.infineon.com](http://www.infineon.com)).

### Warnings

Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.

The Infineon Technologies component described in this Data Sheet may be used in life-support devices or systems and/or automotive, aviation and aerospace applications or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support, automotive, aviation and aerospace device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.