

## MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ CE

800V CoolMOS™ CE Power Transistor  
IPA80R650CE

## Data Sheet

Rev. 2.1  
Final

## 1 Description

CoolMOS™ CE is a revolutionary technology for high voltage power MOSFETs. The high voltage capability combines safety with performance and ruggedness to allow stable designs at highest efficiency level. CoolMOS™ 800V CE comes with selected package choice offering the benefit of reduced system costs and higher power density designs.

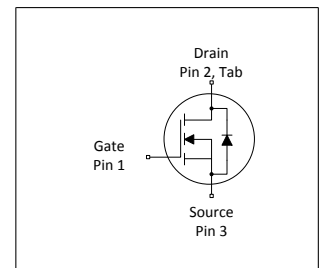
### Features

- High voltage technology
- Extreme  $dv/dt$  rated
- High peak current capability
- Low gate charge
- Low effective capacitances
- Pb-free plating, RoHS Compliant, Halogen free mold compound
- Qualified for consumer grade applications

### Applications

LED Lighting and Adapter in QR Flyback topology

*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
$V_{DS} @ T_j=25^\circ\text{C}$	800	V
$R_{DS(on),max}$	650	$m\Omega$
$Q_{g,typ}$	45	nC
$I_{D,pulse}$	24	A
$E_{oss}@400V$	3.3	$\mu\text{J}$
Body diode $di/dt$	400	$\text{A}/\mu\text{s}$

Type / Ordering Code	Package	Marking	Related Links
IPA80R650CE	PG-TO 220 FullPAK	8R650CE	see Appendix A

**Table of Contents**

Description .....	2
Maximum ratings .....	4
Thermal characteristics .....	5
Electrical characteristics .....	6
Electrical characteristics diagrams .....	8
Test Circuits .....	12
Package Outlines .....	13
Appendix A .....	14
Revision History .....	15
Disclaimer .....	15

## 2 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>	$I_D$	-	-	8.0 5.1	A	$T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	24	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	340	mJ	$I_D=1.6\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche energy, repetitive	$E_{AR}$	-	-	0.20	mJ	$I_D=1.6\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche current, repetitive	$I_{AR}$	-	-	1.60	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	50	V/ns	$V_{DS}=0\dots640\text{V}$
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	$P_{tot}$	-	-	33	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	-	-	-	50	Ncm	M2.5 screws
Continuous diode forward current	$I_S$	-	-	8.0	A	$T_C=25^\circ\text{C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	24	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt	-	-	4	V/ns	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di/dt	-	-	400	A/ $\mu\text{s}$	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$ see table 8
Insulation withstand voltage for TO-220FP	$V_{ISO}$	-	-	2500	V	$V_{rms}$ , $T_C=25^\circ\text{C}$ , $t=1\text{min}$

<sup>1)</sup> Limited by  $T_{j,max} < 150^\circ\text{C}$ .

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

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

### 3 Thermal characteristics

**Table 3 Thermal characteristics TO-220 FullPAK**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	3.8	°C/W	-
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	80	°C/W	leaded
Soldering temperature, wavesoldering only allowed at leads	$T_{sold}$	-	-	260	°C	1.6mm (0.063 in.) from case for 10s

## 4 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	$V_{(BR)DSS}$	800	-	-	V	$V_{GS}=0\text{V}$ , $I_D=0.25\text{mA}$
Gate threshold voltage	$V_{(GS)th}$	2.1	3.0	3.9	V	$V_{DS}=V_{GS}$ , $I_D=0.47\text{mA}$
Zero gate voltage drain current	$I_{DSS}$	-	-	20	$\mu\text{A}$	$V_{DS}=800$ , $V_{GS}=0\text{V}$ , $T_j=25^\circ\text{C}$ $V_{DS}=800$ , $V_{GS}=0\text{V}$ , $T_j=150^\circ\text{C}$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20\text{V}$ , $V_{DS}=0\text{V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.56	0.65	$\Omega$	$V_{GS}=10\text{V}$ , $I_D=5.1\text{A}$ , $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$ , $I_D=5.1\text{A}$ , $T_j=150^\circ\text{C}$
Gate resistance	$R_G$	-	1.2	-	$\Omega$	$f=1\text{MHz}$ , 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	$C_{oss}$	-	46	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=100\text{V}$ , $f=1\text{MHz}$
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	36	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=0\dots480\text{V}$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	99	-	pF	$I_D=\text{constant}$ , $V_{GS}=0\text{V}$ , $V_{DS}=0\dots480\text{V}$
Turn-on delay time	$t_{d(on)}$	-	25	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=10\text{V}$ , $I_D=8\text{A}$ , $R_G=10\Omega$ ; see table 9
Rise time	$t_r$	-	15	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=10\text{V}$ , $I_D=8\text{A}$ , $R_G=10\Omega$ ; see table 9
Turn-off delay time	$t_{d(off)}$	-	72	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=10\text{V}$ , $I_D=8\text{A}$ , $R_G=10\Omega$ ; see table 9
Fall time	$t_f$	-	10	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=10\text{V}$ , $I_D=8\text{A}$ , $R_G=10\Omega$ ; see table 9

**Table 6 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	6	-	nC	$V_{DD}=640\text{V}$ , $I_D=8\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate to drain charge	$Q_{gd}$	-	22	-	nC	$V_{DD}=640\text{V}$ , $I_D=8\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate charge total	$Q_g$	-	45	-	nC	$V_{DD}=640\text{V}$ , $I_D=8\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate plateau voltage	$V_{plateau}$	-	5.5	-	V	$V_{DD}=640\text{V}$ , $I_D=8\text{A}$ , $V_{GS}=0$ 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 480V

<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 480V

**Table 7 Reverse diode characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	$V_{SD}$	-	1	-	V	$V_{GS}=0V, I_F=8A, T_j=25^\circ C$
Reverse recovery time	$t_{rr}$	-	550	-	ns	$V_R=400V, I_F=8A, di_F/dt=100A/\mu s$ ; see table 8
Reverse recovery charge	$Q_{rr}$	-	7	-	$\mu C$	$V_R=400V, I_F=8A, di_F/dt=100A/\mu s$ ; see table 8
Peak reverse recovery current	$I_{rrm}$	-	24	-	A	$V_R=400V, I_F=8A, di_F/dt=100A/\mu s$ ; see table 8

### 5 Electrical characteristics diagrams

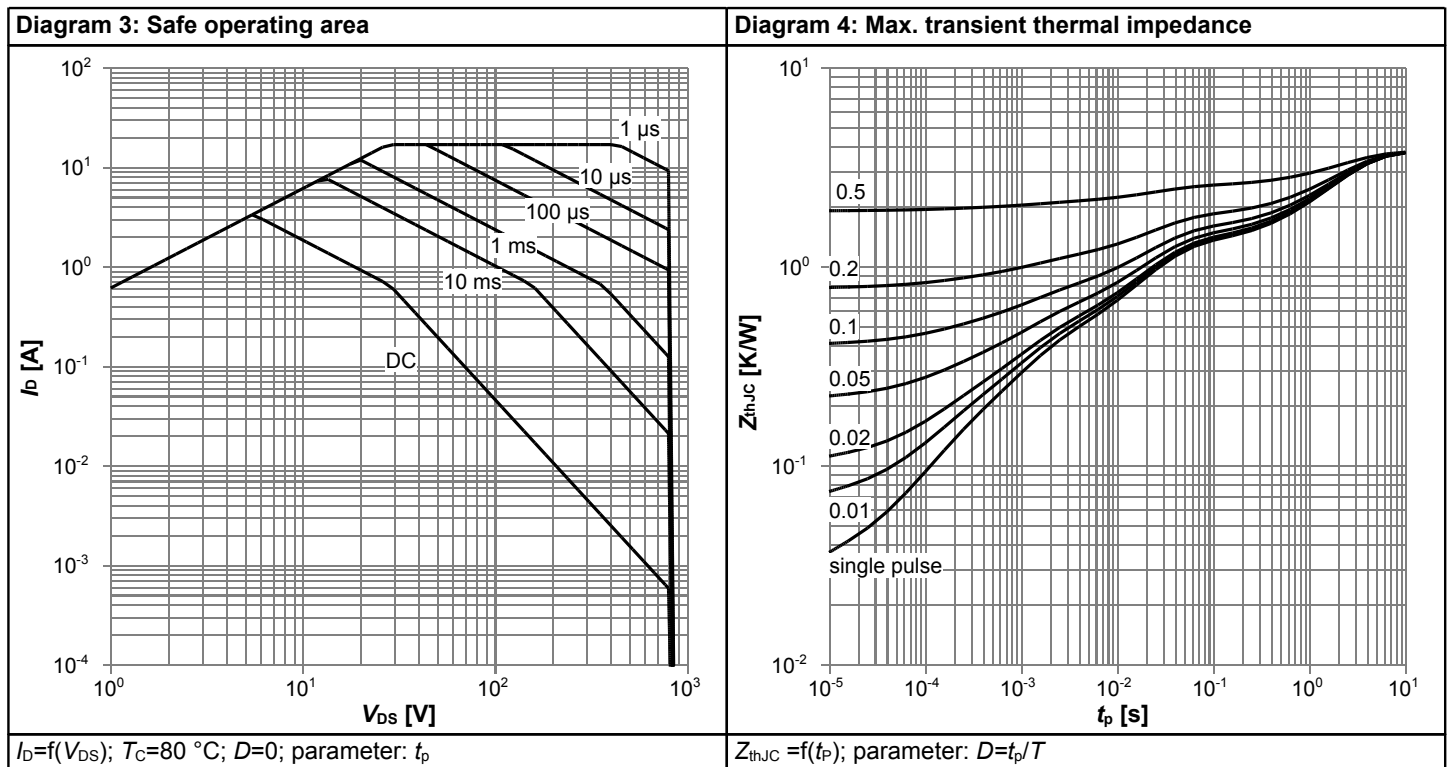
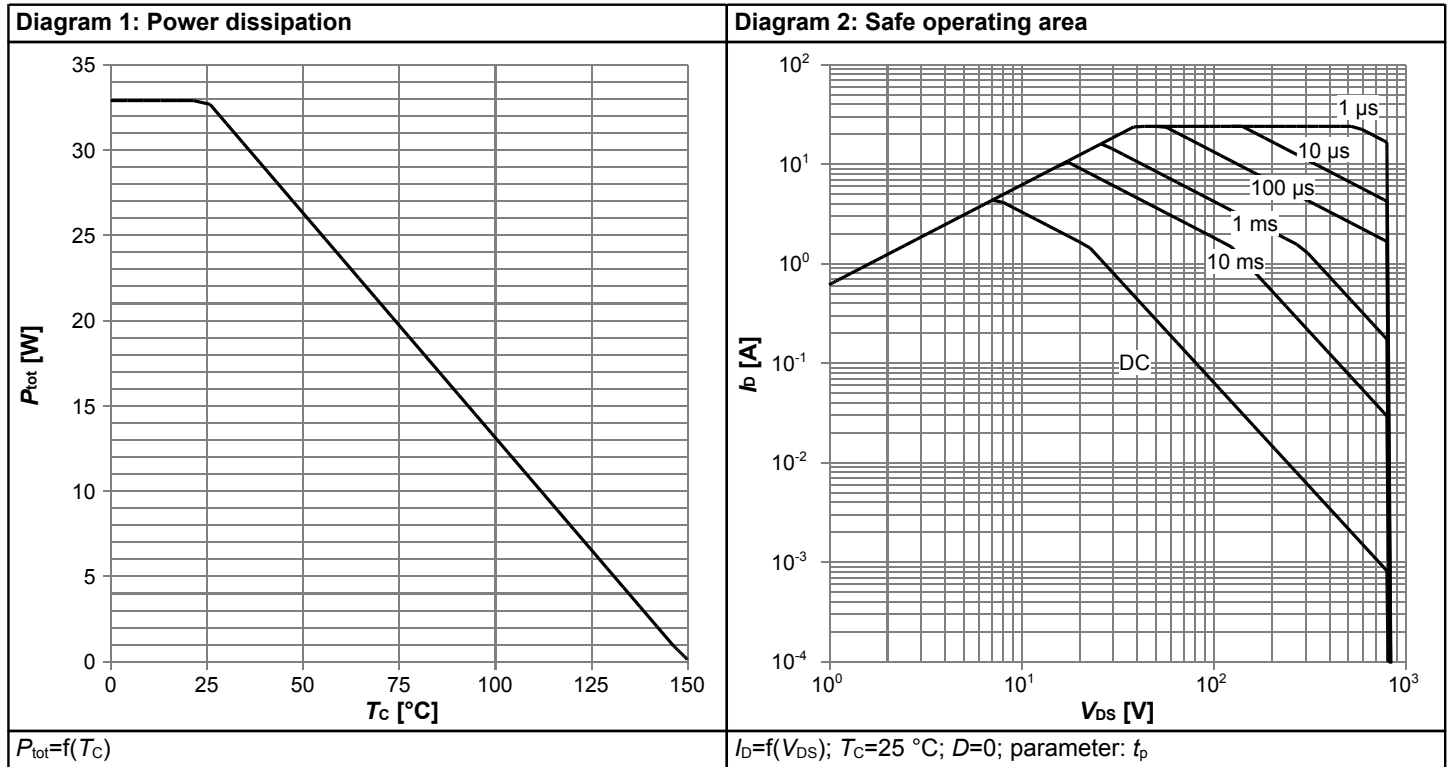
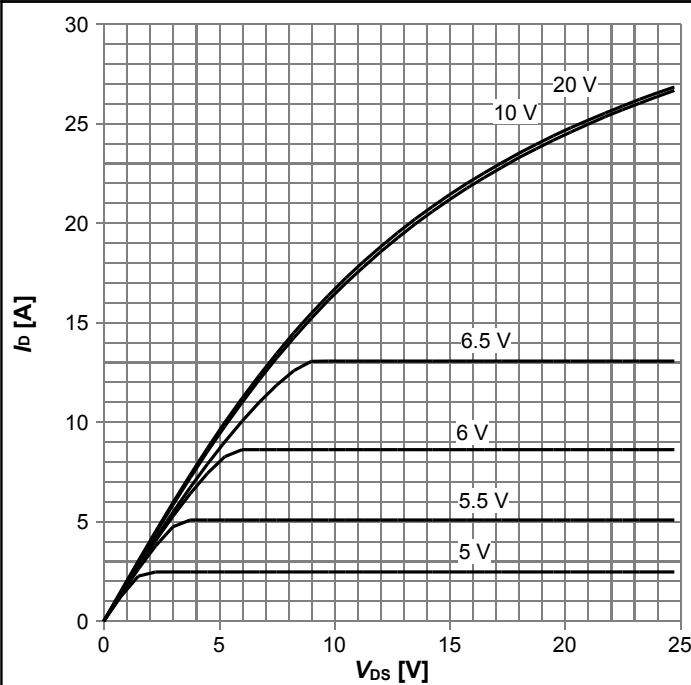


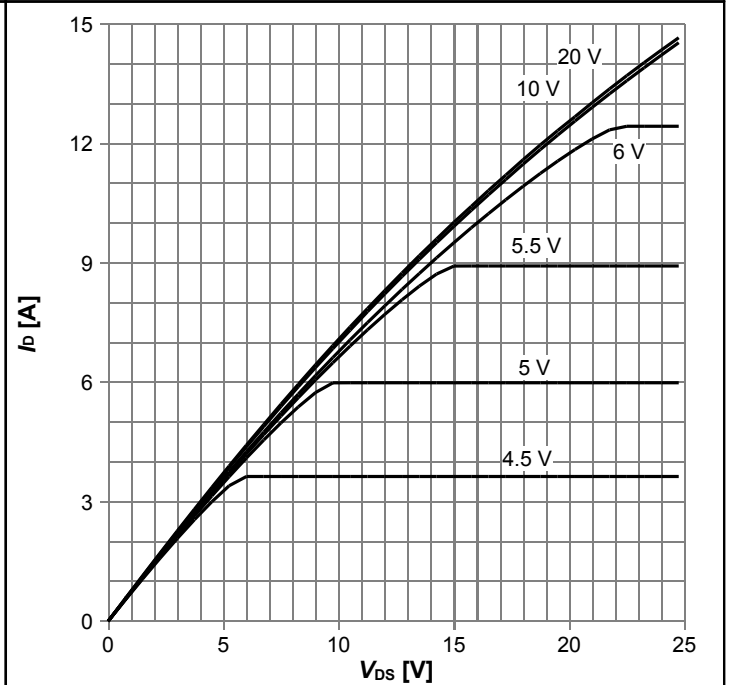


Diagram 5: Typ. output characteristics



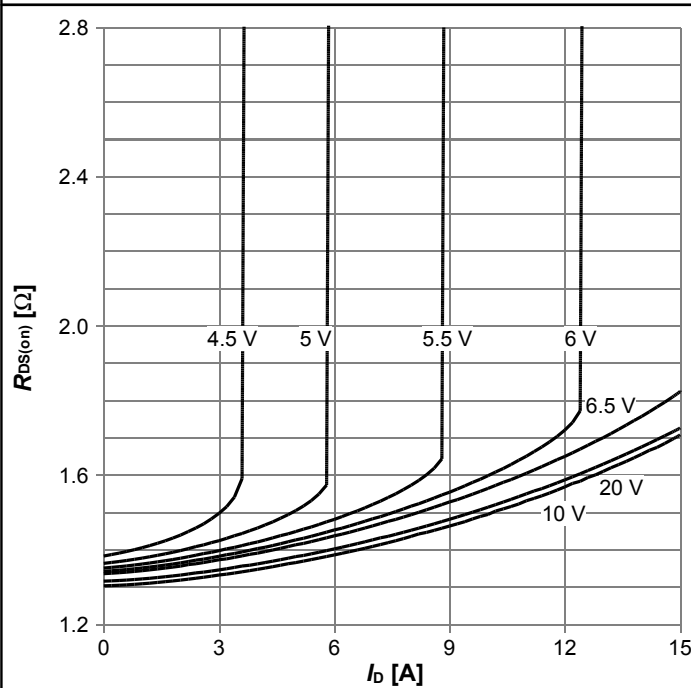
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C}; t_p=10\text{ }\mu\text{s}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics



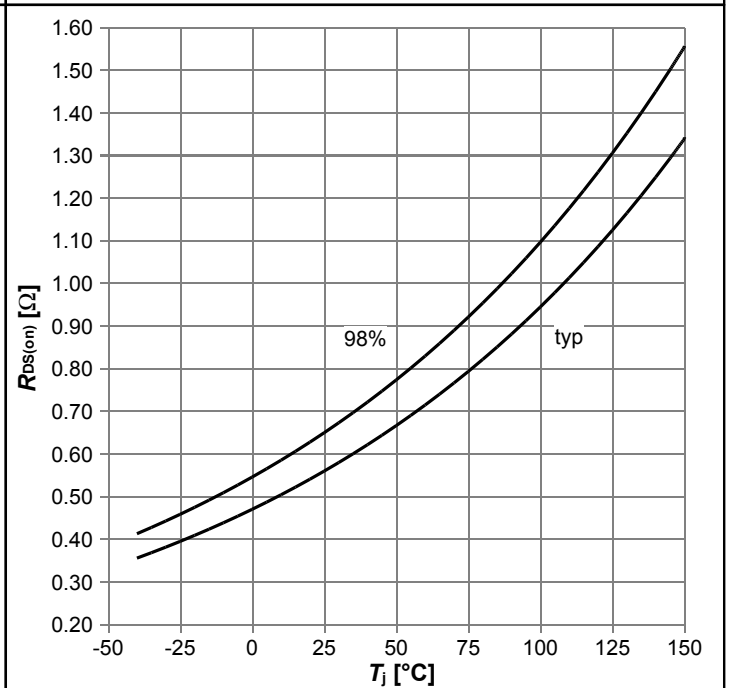
$I_D=f(V_{DS}); T_j=150\text{ }^\circ\text{C}; t_p=10\text{ }\mu\text{s}; \text{parameter: } V_{GS}$

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



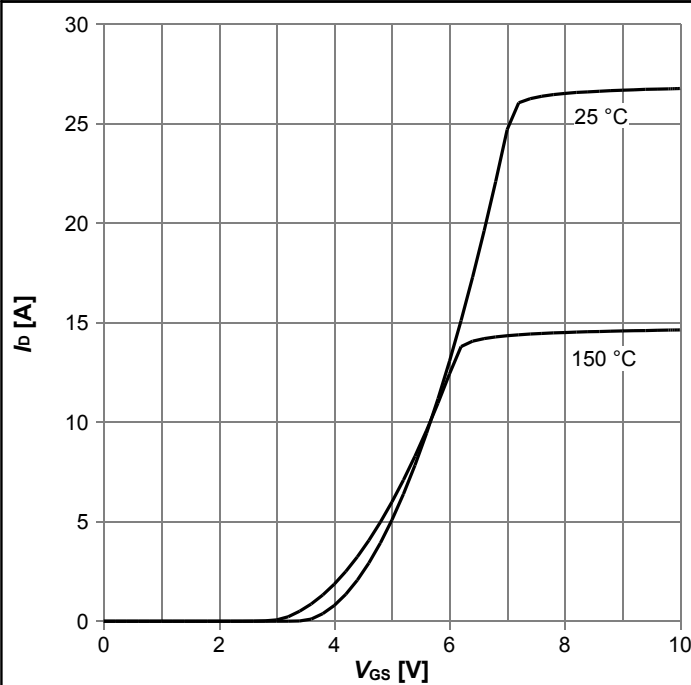
$R_{DS(on)}=f(I_D); T_j=150\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance



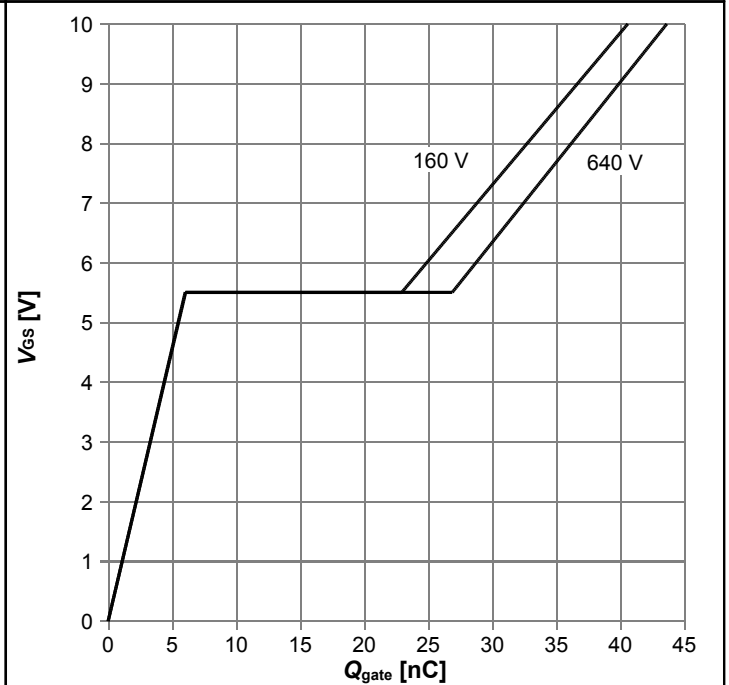
$R_{DS(on)}=f(T_j); I_D=5.1\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



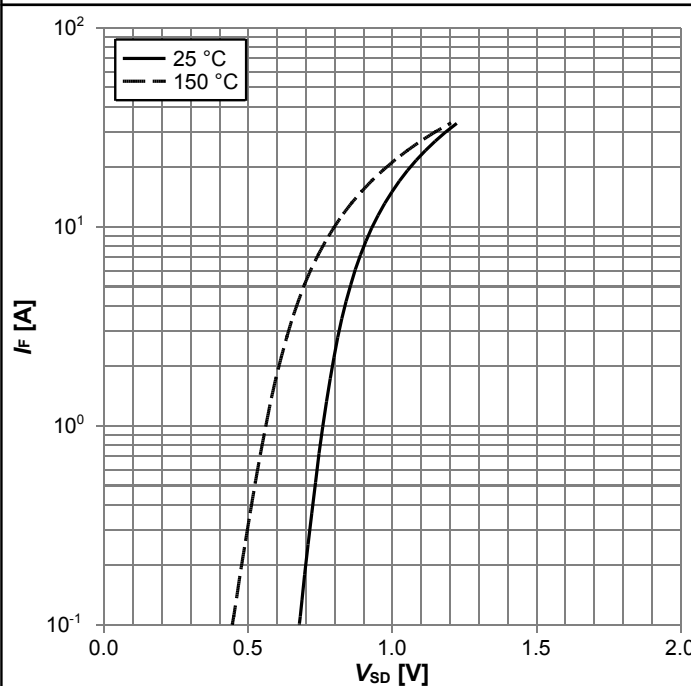
$I_D=f(V_{GS}); |V_{DS}|>2|I_D|R_{DS(on)max}; t_p=10 \mu s; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



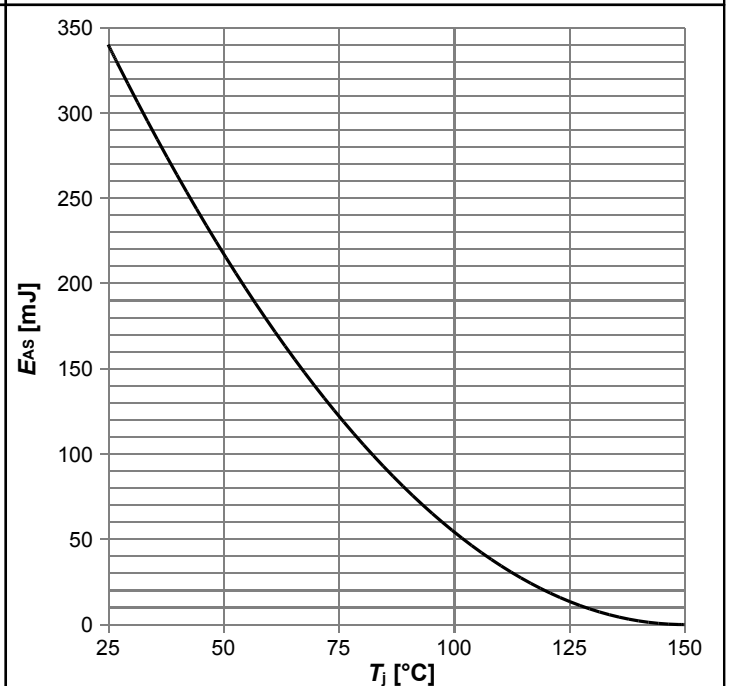
$V_{GS}=f(Q_{gate}); I_D=8.0 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



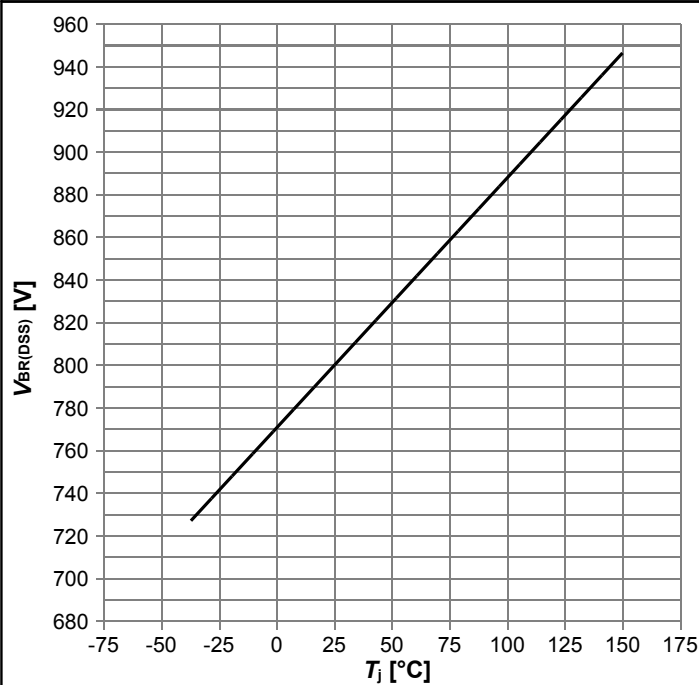
$I_F=f(V_{SD}); t_p=10 \mu s; \text{parameter: } T_j$

Diagram 12: Avalanche energy



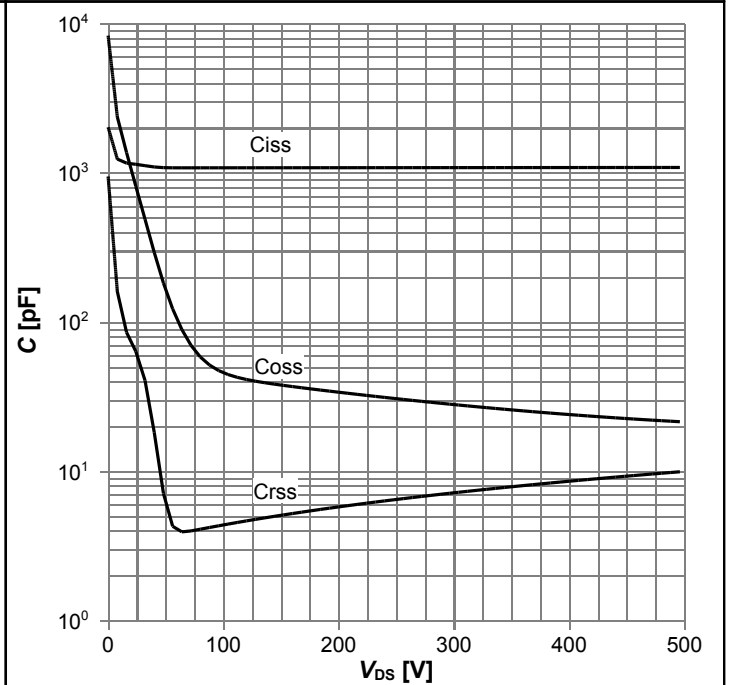
$E_{AS}=f(T_j); I_D=1.6 \text{ A}; V_{DD}=50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



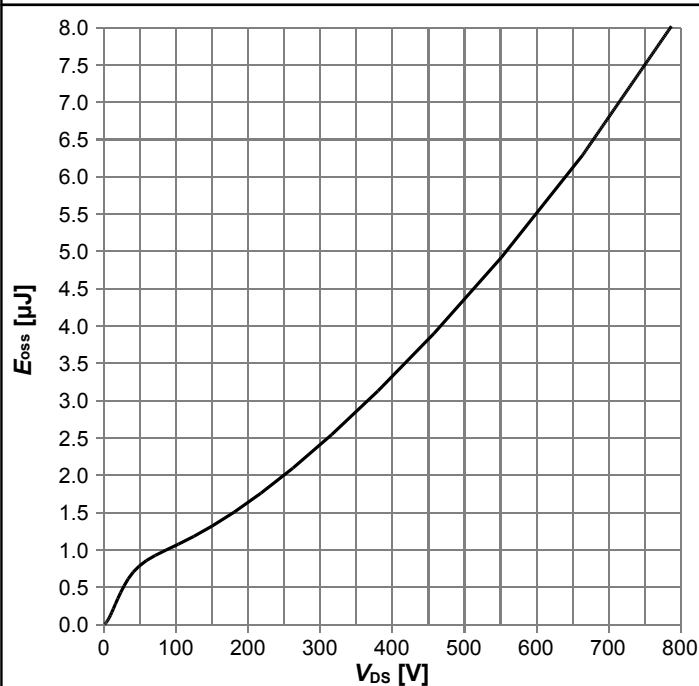
$V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$

Diagram 14: Typ. capacitances



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

Diagram 15: Typ. Coss stored energy



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

## 6 Test Circuits

**Table 8 Diode characteristics**

Test circuit for diode characteristics	Diode recovery waveform
<p><math>R_{g1} = R_{g2}</math></p>	<p> <math>t_{tr} = t_F + t_S</math>  <math>Q_r = Q_F + Q_S</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



## 8 Appendix A

### Table 11 Related Links

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

## Revision History

IPA80R650CE

Revision: 2015-06-23, Rev. 2.1

### Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2014-09-25	Release of final version
2.1	2015-06-23	Continuous current Id update

### 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  
© 2015 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. With respect to any examples or hints given herein, any typical values stated herein and/or any information regarding the application of the device, 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.

### 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.