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MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ CE

800V CoolMOS™ CE Power Transistor
IPA80R1K4CE

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 for retrofit applications in QR Flyback topology

Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.

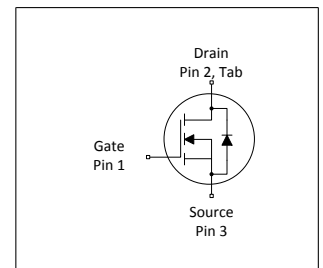


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_j=25^\circ\text{C}$	800	V
$R_{DS(on),max}$	1400	m Ω
$Q_{g,typ}$	23	nC
$I_{D,pulse}$	12	A
$E_{oss}@400\text{V}$	1.8	μJ
Body diode di/dt	400	A/ μs

Type / Ordering Code	Package	Marking	Related Links
IPA80R1K4CE	PG-TO 220 FullPAK	8R1K4CE	see Appendix A

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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 ¹⁾	I_D	-	-	3.9 2.3	A	$T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	12	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}	-	-	170	mJ	$I_D=1.2\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.14	mJ	$I_D=1.2\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche current, repetitive	I_{AR}	-	-	1.20	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}	-	-	31	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	-	-	3.9	A	$T_C=25^\circ\text{C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	12	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt ³⁾	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/ μs	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq I_S$, $T_j=25^\circ\text{C}$ see table 8
Insulation withstand voltage for TO-220FP	V_{ISO}	-	-	2500	V	V_{rms} , $T_C=25^\circ\text{C}$, $t=1\text{min}$

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

²⁾ Pulse width t_p limited by $T_{j,max}$

³⁾ Identical low side and high side switch with identical R_θ

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}	-	-	4	°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	$V_{DS}=V_{GS}$, $I_D=0.24\text{mA}$
Zero gate voltage drain current	I_{DSS}	-	-	10	μA	$V_{DS}=800$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$ $V_{DS}=800$, $V_{GS}=0\text{V}$, $T_j=150^\circ\text{C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	1.22	1.40	Ω	$V_{GS}=10\text{V}$, $I_D=2.3\text{A}$, $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$, $I_D=2.3\text{A}$, $T_j=150^\circ\text{C}$
Gate resistance	R_G	-	1.2	-	Ω	$f=1\text{MHz}$, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	570	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=100\text{V}$, $f=1\text{MHz}$
Output capacitance	C_{oss}	-	25	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=100\text{V}$, $f=1\text{MHz}$
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$	-	19	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=0\dots480\text{V}$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$	-	51	-	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	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=3.9\text{A}$, $R_G=22\Omega$; see table 9
Rise time	t_r	-	15	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=3.9\text{A}$, $R_G=22\Omega$; see table 9
Turn-off delay time	$t_{d(off)}$	-	72	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=3.9\text{A}$, $R_G=22\Omega$; see table 9
Fall time	t_f	-	12	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=10\text{V}$, $I_D=3.9\text{A}$, $R_G=22\Omega$; see table 9

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	3	-	nC	$V_{DD}=640\text{V}$, $I_D=3.9\text{A}$, $V_{GS}=0$ to 10V
Gate to drain charge	Q_{gd}	-	12	-	nC	$V_{DD}=640\text{V}$, $I_D=3.9\text{A}$, $V_{GS}=0$ to 10V
Gate charge total	Q_g	-	23	-	nC	$V_{DD}=640\text{V}$, $I_D=3.9\text{A}$, $V_{GS}=0$ to 10V
Gate plateau voltage	$V_{plateau}$	-	5.5	-	V	$V_{DD}=640\text{V}$, $I_D=3.9\text{A}$, $V_{GS}=0$ to 10V

¹⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 480V

²⁾ $C_{o(tr)}$ 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	$V_{GS}=0V, I_F=3.9A, T_j=25^\circ C$
Reverse recovery time	t_{rr}	-	520	-	ns	$V_R=400V, I_F=3.9A, di_F/dt=100A/\mu s$; see table 8
Reverse recovery charge	Q_{rr}	-	4	-	μC	$V_R=400V, I_F=3.9A, di_F/dt=100A/\mu s$; see table 8
Peak reverse recovery current	I_{rrm}	-	12	-	A	$V_R=400V, I_F=3.9A, di_F/dt=100A/\mu s$; see table 8

5 Electrical characteristics diagrams

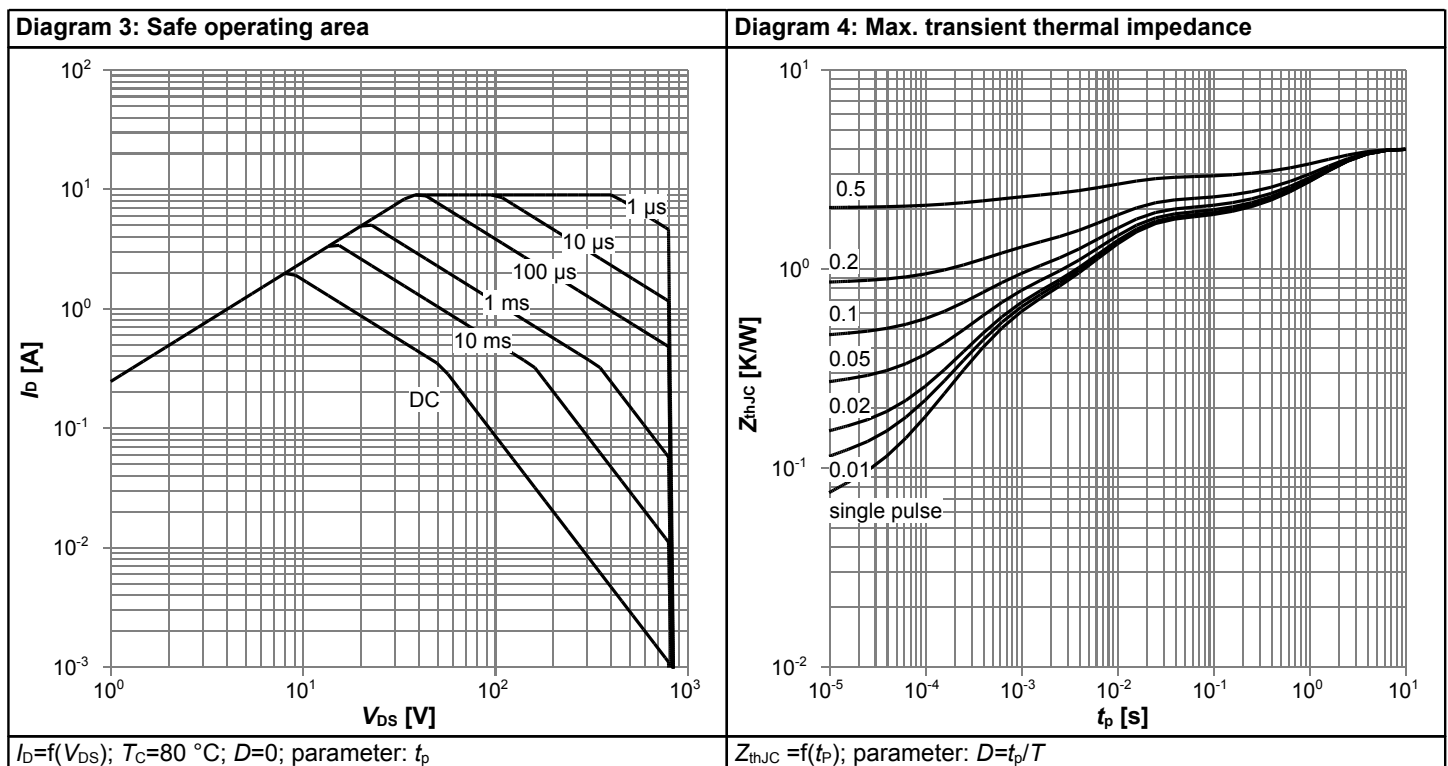
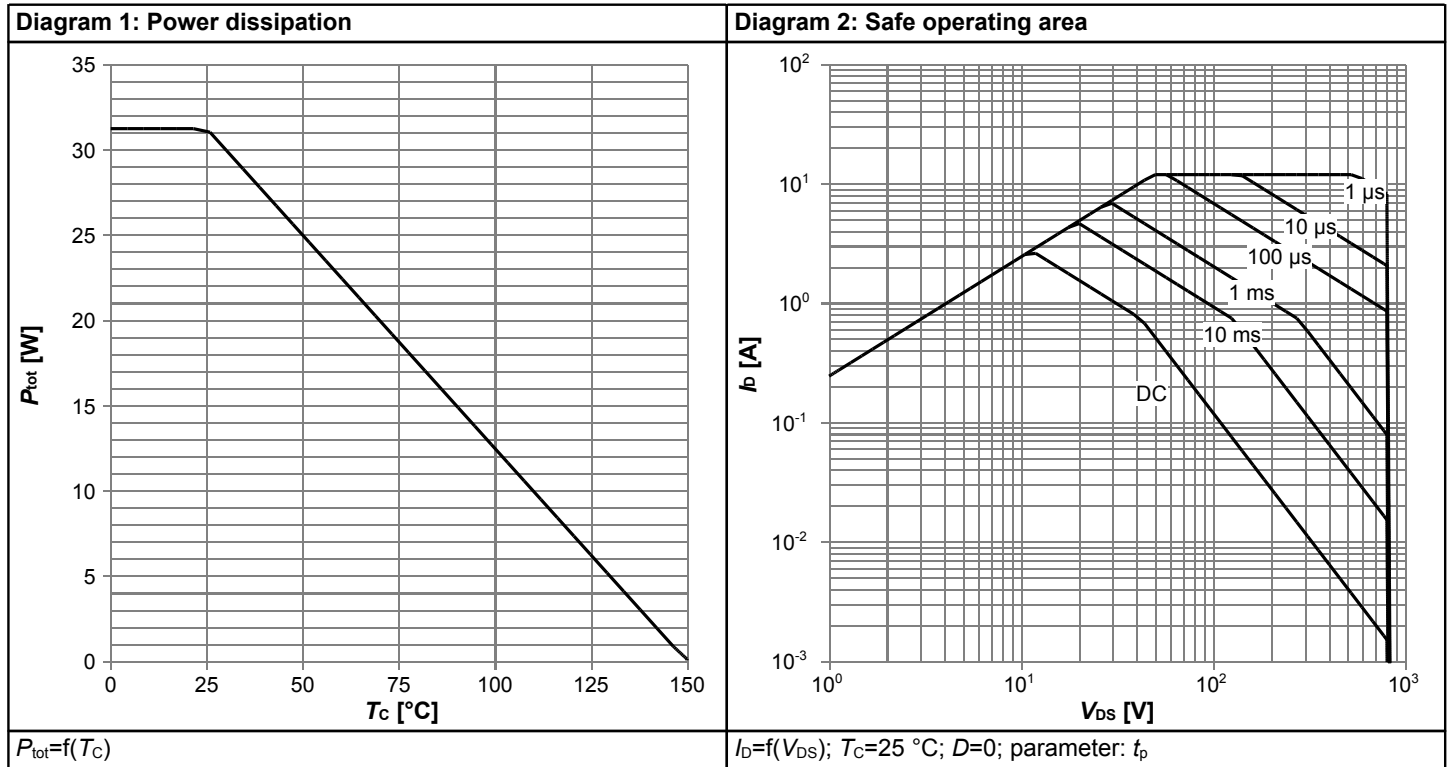
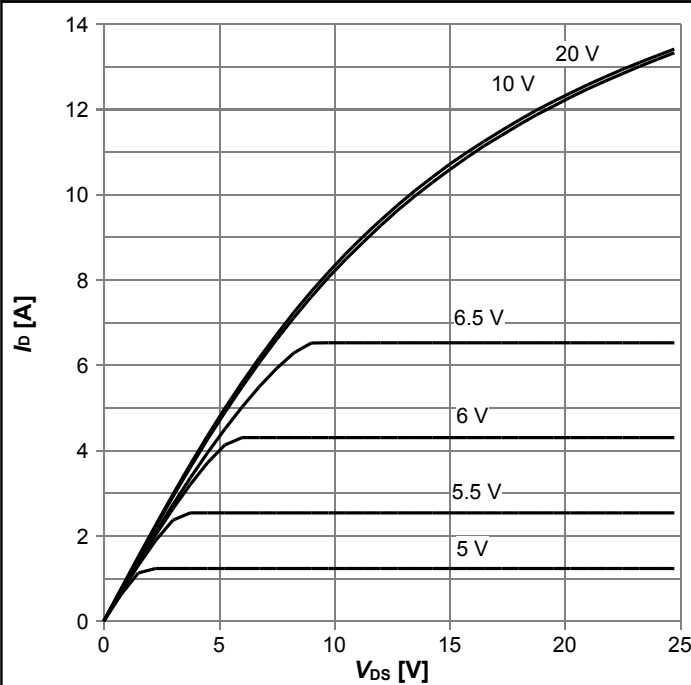
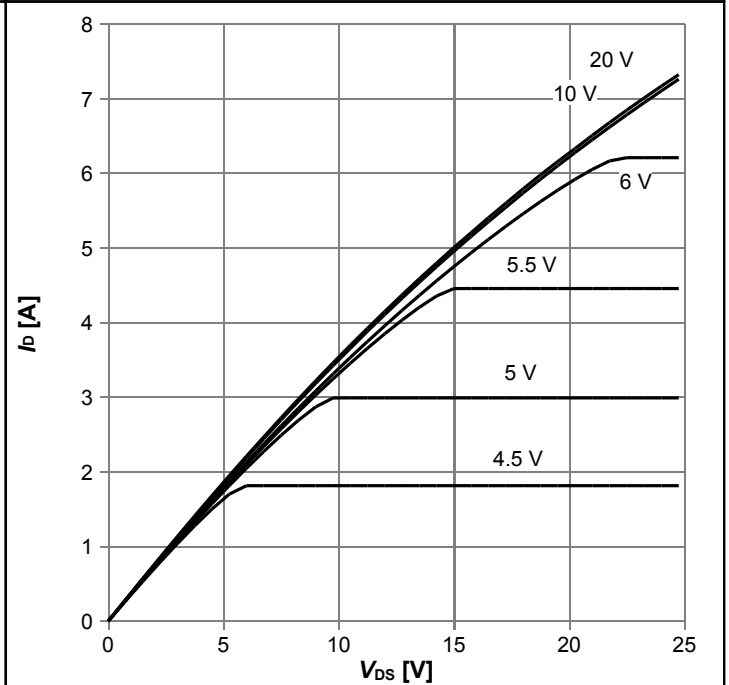


Diagram 5: Typ. output characteristics



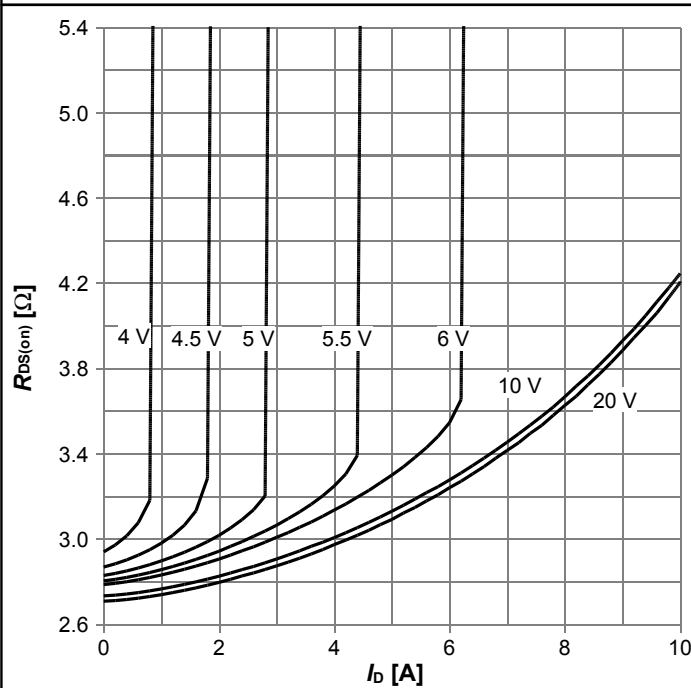
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C}; t_p=10\text{ }\mu\text{s}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics



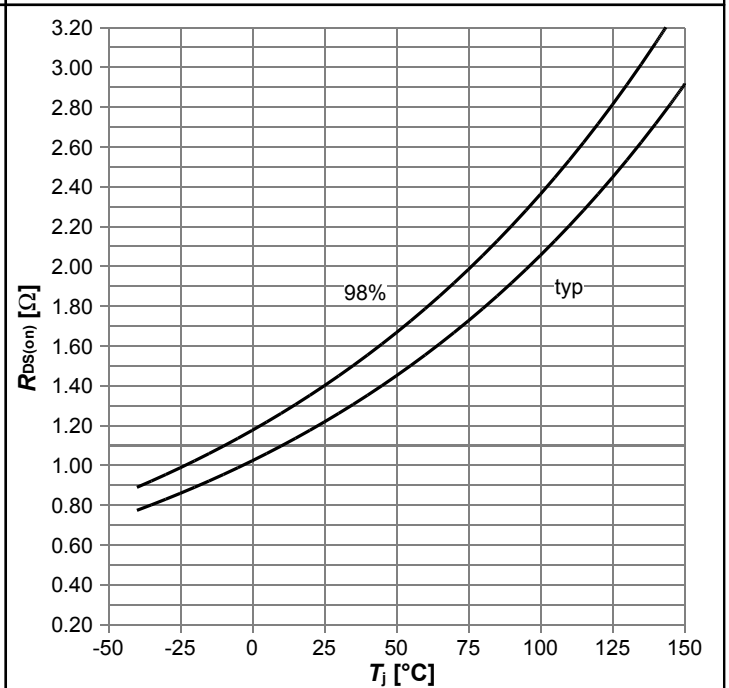
$I_D=f(V_{DS}); T_j=150\text{ }^\circ\text{C}; t_p=10\text{ }\mu\text{s}; \text{parameter: } V_{GS}$

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



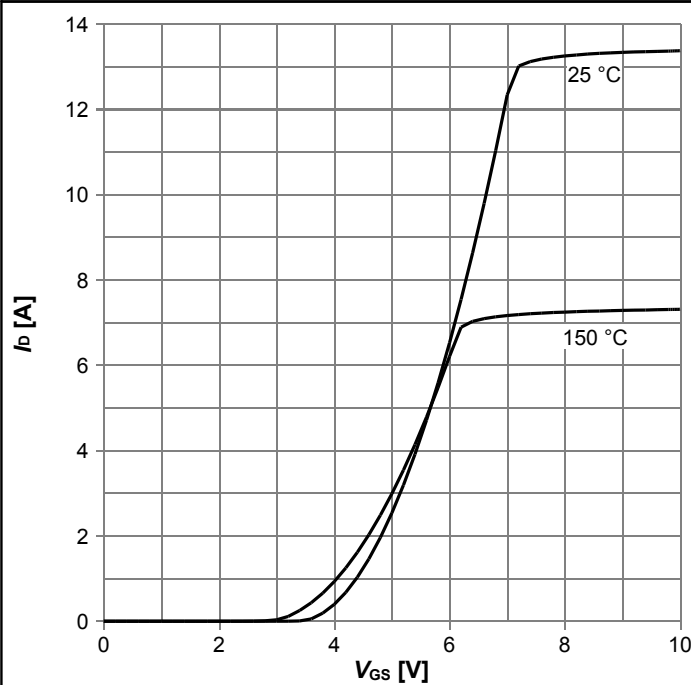
$R_{DS(on)}=f(I_D); T_j=150\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance



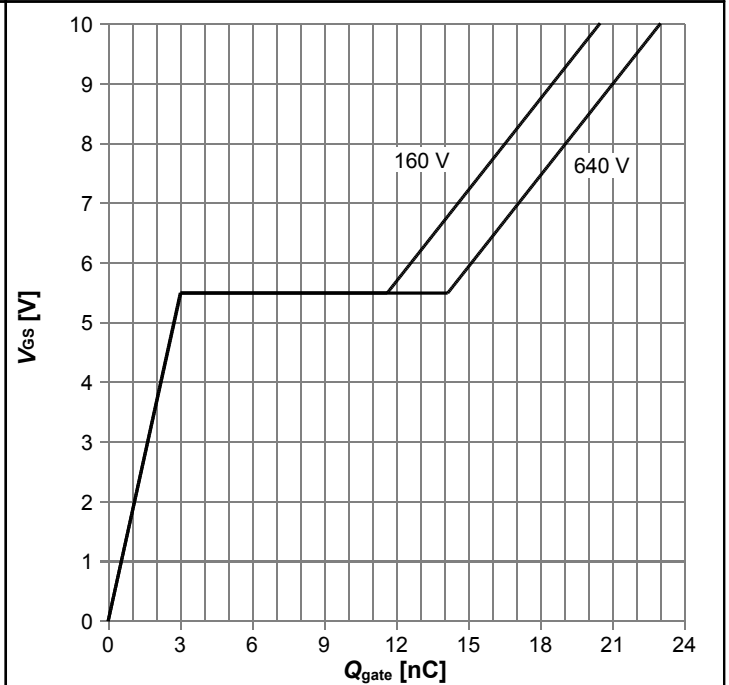
$R_{DS(on)}=f(T_j); I_D=2.3\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



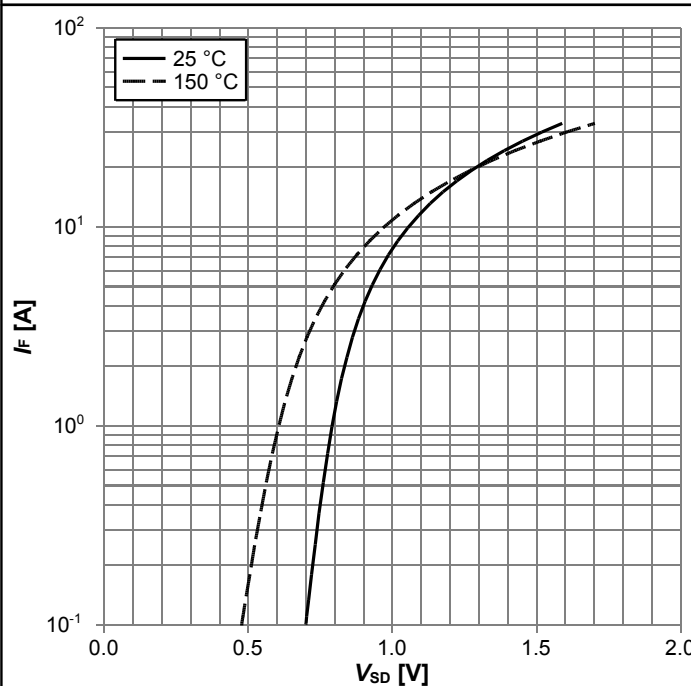
$I_D=f(V_{GS}); |V_{DS}|>2|I_D|R_{DS(on)max}; t_p=10 \mu s; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



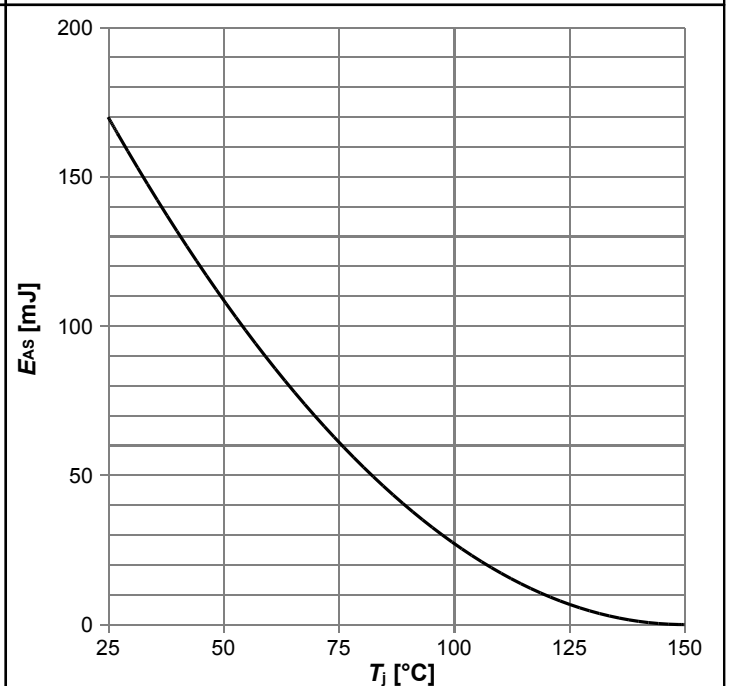
$V_{GS}=f(Q_{gate}); I_D=3.9 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



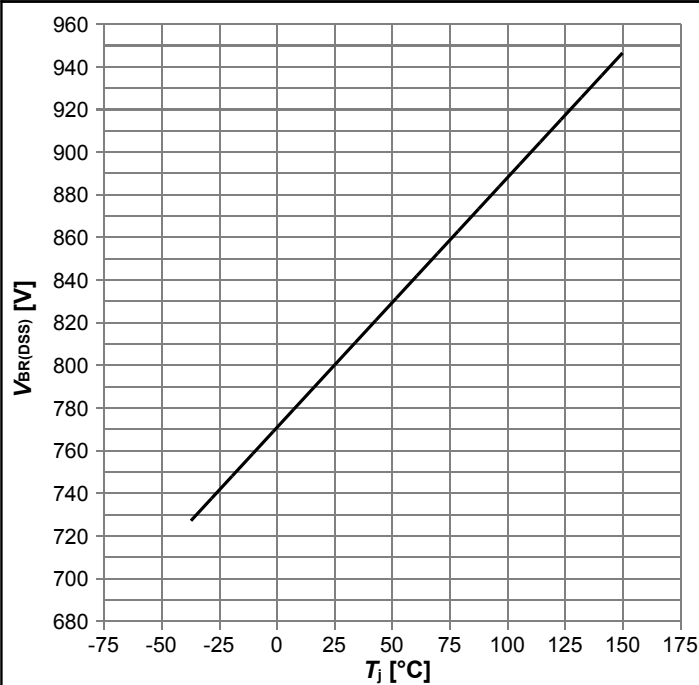
$I_F=f(V_{SD}); t_p=10 \mu s; \text{parameter: } T_j$

Diagram 12: Avalanche energy



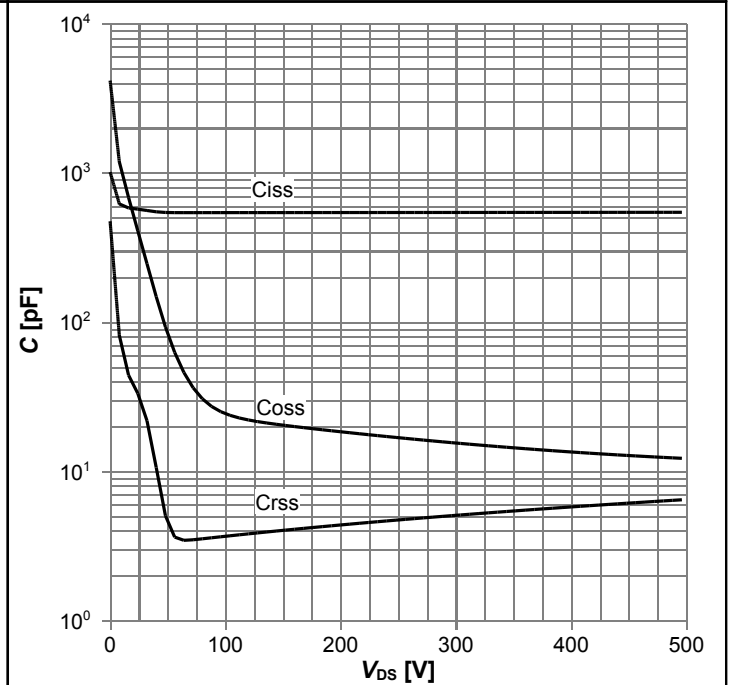
$E_{AS}=f(T_j); I_D=1.2 \text{ A}; V_{DD}=50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



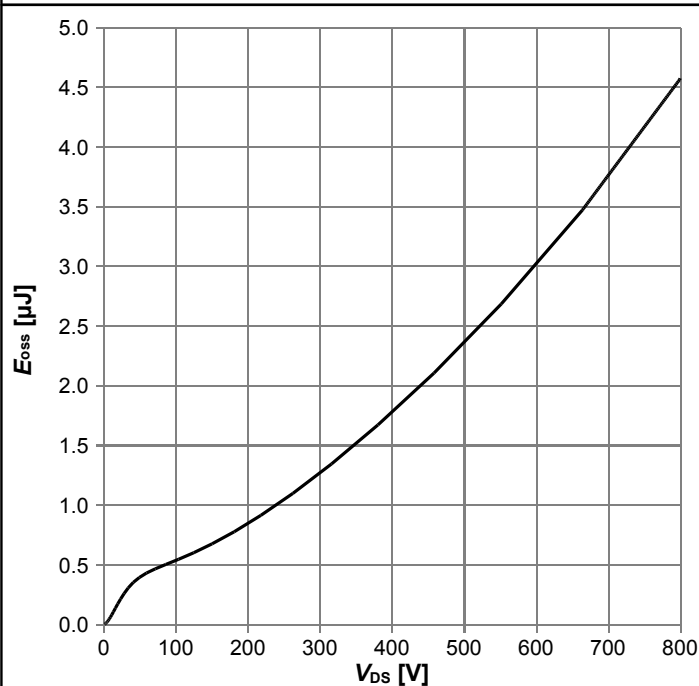
$V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$

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>$R_{g1} = R_{g2}$</p>	<p> $t_{rr} = t_F + t_S$ $Q_r = Q_F + Q_S$ </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
- IFX CoolMOS™ CE application note: www.infineon.com
- IFX CoolMOS™ CE simulation model: www.infineon.com
- IFX Design tools: www.infineon.com

Revision History

IPA80R1K4CE

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

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