

## MOSFET

### 600V CoolMOS™ CE Power Transistor

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ CE is a price-performance optimized platform enabling to target cost sensitive applications in Consumer and Lighting markets by still meeting highest efficiency standards. The new series provides all benefits of a fast switching Superjunction MOSFET while not sacrificing ease of use and offering the best cost down performance ratio available on the market.

PG - TO220 FullPAK WideCreepage



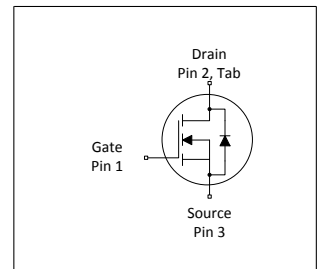
### Features

- Extremely low losses due to very low FOM  $R_{DS(on)} \cdot Q_g$  and Eoss
- Very high commutation ruggedness
- Easy to use/drive
- Pb-free plating, Halogen free mold compound
- Qualified for standard grade applications
- Wide distance of 4.25mm between the leads

### Applications

PFC stages, hard switching PWM stages and resonant switching stages for e.g. PC Silverbox, Adapter, LCD & PDP TV and indoor lighting.

*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
$R_{DS(on),max}$	380	mΩ
$I_D$	15	A
$Q_{g,typ}$	32	nC
$I_{D,pulse}$	30	A
$E_{oss@400V}$	2.8	μJ

Type / Ordering Code	Package	Marking	Related Links
IPAW60R380CE	PG - TO220 FullPAK WideCreepage	60S380CE	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>	$I_D$	-	-	15 9.5	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	30	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	210	mJ	$I_D=1.8\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche energy, repetitive	$E_{AR}$	-	-	0.32	mJ	$I_D=1.8\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche current, repetitive	$I_{AR}$	-	-	1.8	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	50	V/ns	$V_{DS}=0\dots480\text{V}$
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 (Full PAK)	$P_{tot}$	-	-	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	$I_S$	-	-	10.6	A	$T_C=25^\circ\text{C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	30	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt	-	-	15	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	-	-	500	A/ $\mu\text{s}$	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$ see table 8
Power dissipation (Non FullPAK) TO-220	$P_{tot}$	-	-	112	W	-
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  $T_{j,max}$ . Maximum duty cycle  $D=0.50$ , TO220 equivalent

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

<sup>3)</sup> Identical low side and high side switch with identical  $R_G$

## 2 Thermal characteristics

**Table 3 Thermal characteristics (Full PAK)**

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

### 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	$V_{GS}=0V, I_D=0.25mA$
Gate threshold voltage	$V_{(GS)th}$	2.5	3.0	3.5	V	$V_{DS}=V_{GS}, I_D=0.32mA$
Zero gate voltage drain current	$I_{DSS}$	-	-	1	$\mu A$	$V_{DS}=600, V_{GS}=0V, T_j=25^\circ C$ $V_{DS}=600, V_{GS}=0V, T_j=150^\circ C$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20V, V_{DS}=0V$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.34 0.89	0.38	$\Omega$	$V_{GS}=10V, I_D=3.8A, T_j=25^\circ C$ $V_{GS}=10V, I_D=3.8A, T_j=150^\circ C$
Gate resistance	$R_G$	-	7.5	-	$\Omega$	$f=1MHz, \text{open drain}$

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	700	-	pF	$V_{GS}=0V, V_{DS}=100V, f=1MHz$
Output capacitance	$C_{oss}$	-	46	-	pF	$V_{GS}=0V, V_{DS}=100V, f=1MHz$
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	30	-	pF	$V_{GS}=0V, V_{DS}=0...480V$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	136	-	pF	$I_D=\text{constant}, V_{GS}=0V, V_{DS}=0...480V$
Turn-on delay time	$t_{d(on)}$	-	11	-	ns	$V_{DD}=400V, V_{GS}=13V, I_D=4.8A,$ $R_G=3.4\Omega; \text{see table 9}$
Rise time	$t_r$	-	9	-	ns	$V_{DD}=400V, V_{GS}=13V, I_D=4.8A,$ $R_G=3.4\Omega; \text{see table 9}$
Turn-off delay time	$t_{d(off)}$	-	56	-	ns	$V_{DD}=400V, V_{GS}=13V, I_D=4.8A,$ $R_G=3.4\Omega; \text{see table 9}$
Fall time	$t_f$	-	8	-	ns	$V_{DD}=400V, V_{GS}=13V, I_D=4.8A,$ $R_G=3.4\Omega; \text{see table 9}$

**Table 6 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{GS}$	-	4	-	nC	$V_{DD}=480V, I_D=4.8A, V_{GS}=0 \text{ to } 10V$
Gate to drain charge	$Q_{gd}$	-	16	-	nC	$V_{DD}=480V, I_D=4.8A, V_{GS}=0 \text{ to } 10V$
Gate charge total	$Q_g$	-	32	-	nC	$V_{DD}=480V, I_D=4.8A, V_{GS}=0 \text{ to } 10V$
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	$V_{DD}=480V, I_D=4.8A, V_{GS}=0 \text{ to } 10V$

<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	$V_{SD}$	-	0.9	-	V	$V_{GS}=0V, I_F=4.8A, T_j=25^\circ C$
Reverse recovery time	$t_{rr}$	-	290	-	ns	$V_R=400V, I_F=4.8A, di_F/dt=100A/\mu s$ ; see table 8
Reverse recovery charge	$Q_{rr}$	-	3.3	-	$\mu C$	$V_R=400V, I_F=4.8A, di_F/dt=100A/\mu s$ ; see table 8
Peak reverse recovery current	$I_{rrm}$	-	21	-	A	$V_R=400V, I_F=4.8A, di_F/dt=100A/\mu s$ ; see table 8

### 4 Electrical characteristics diagrams

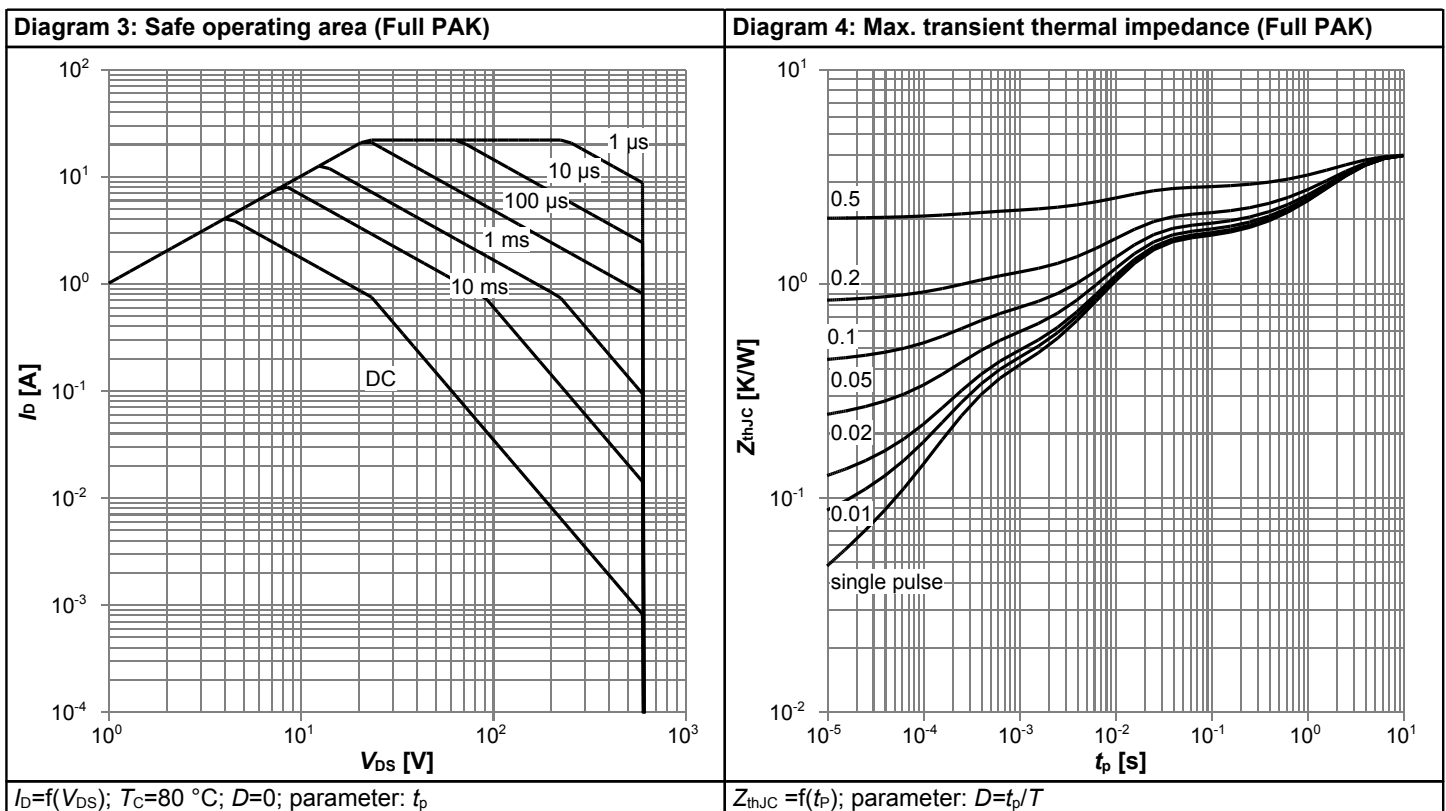
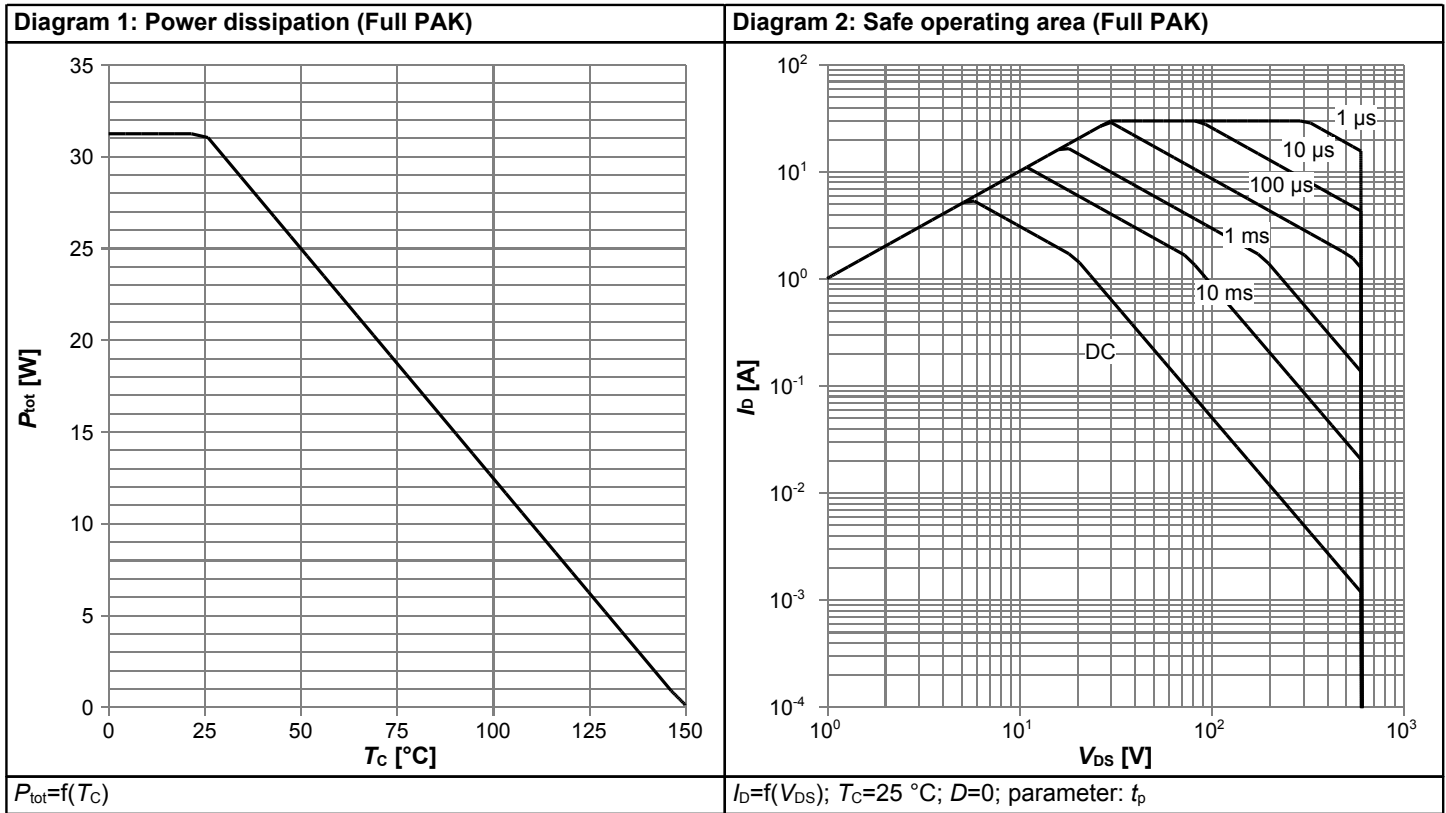
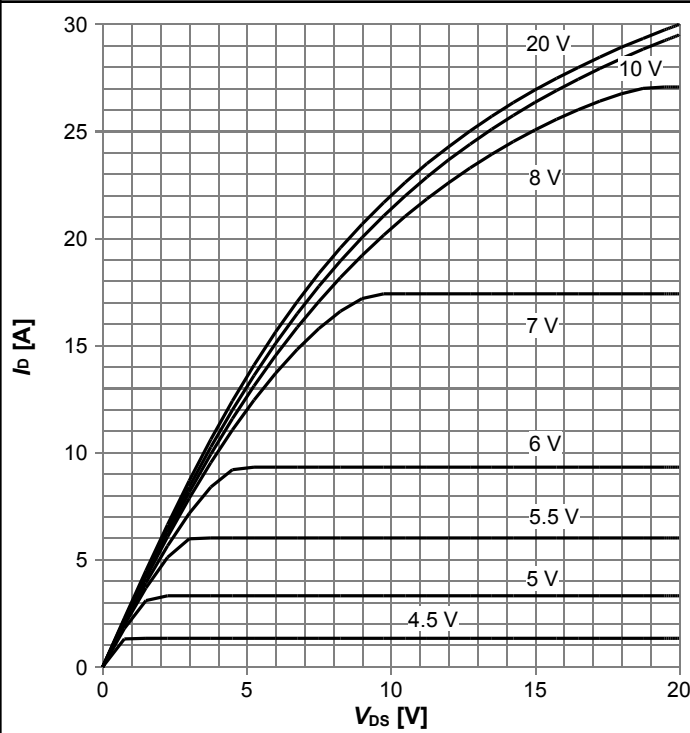
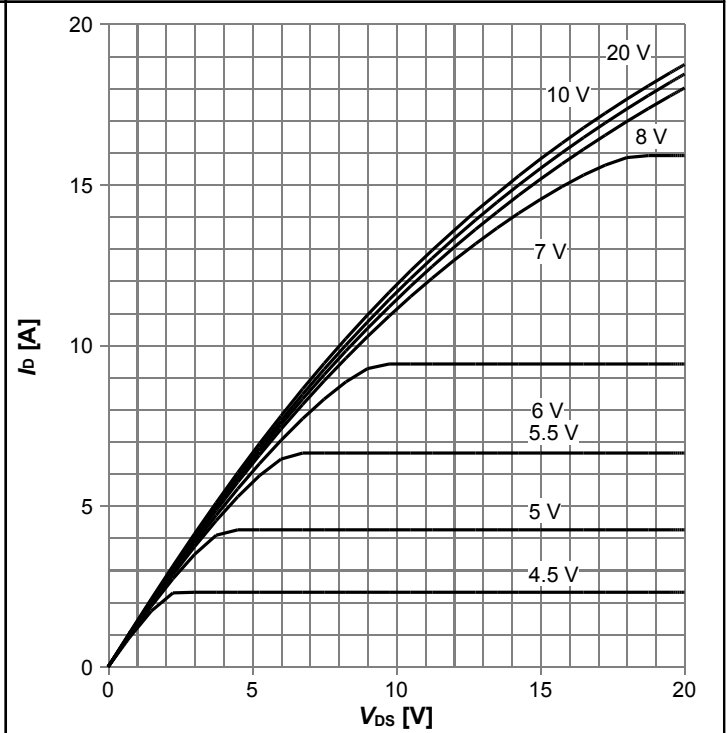


Diagram 5: Typ. output characteristics



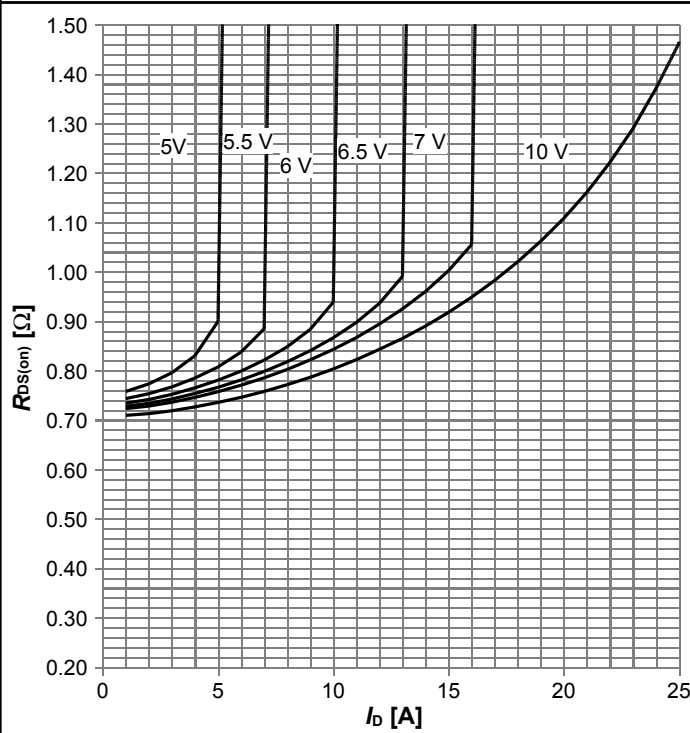
$I_D=f(V_{DS})$ ;  $T_j=25\text{ }^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



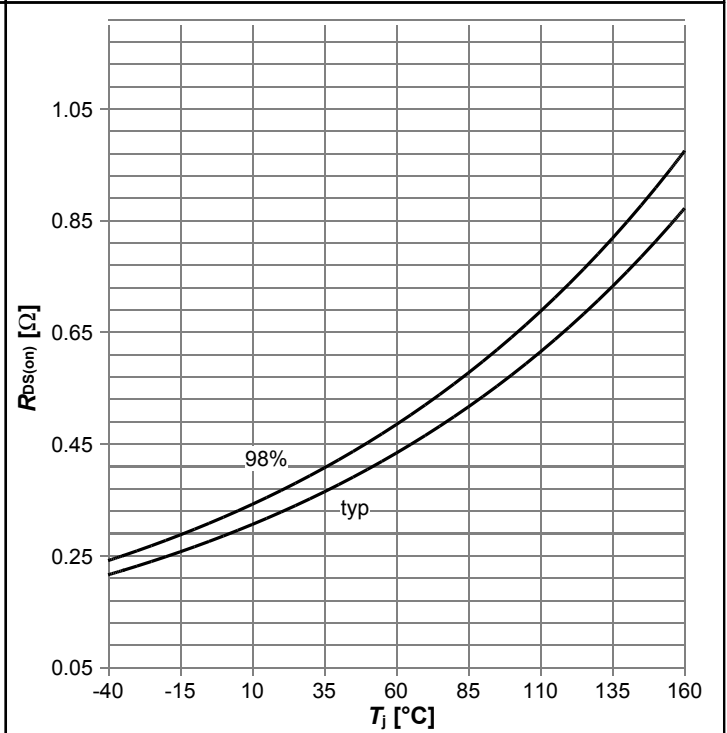
$I_D=f(V_{DS})$ ;  $T_j=125\text{ }^\circ\text{C}$ ; parameter:  $V_{GS}$

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



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

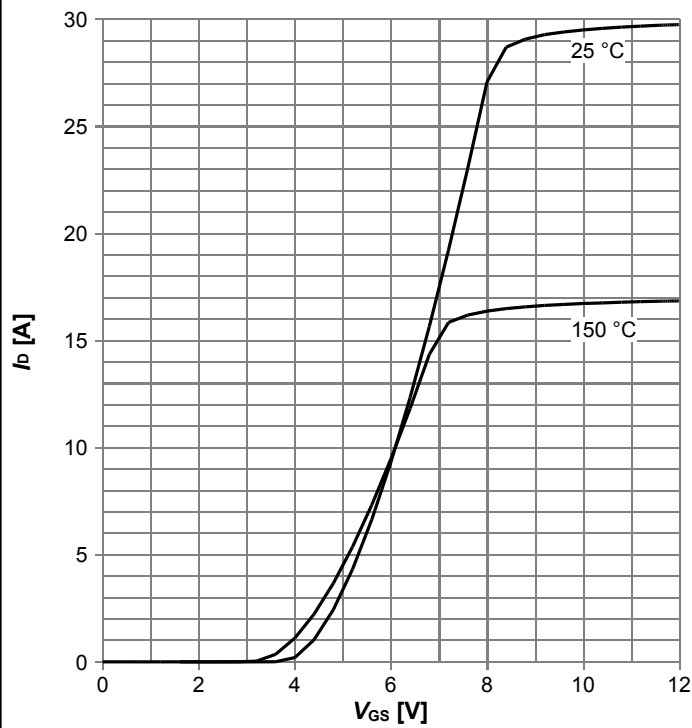
Diagram 8: Drain-source on-state resistance



$R_{DS(on)}=f(T_j)$ ;  $I_D=3.8\text{ A}$ ;  $V_{GS}=10\text{ V}$

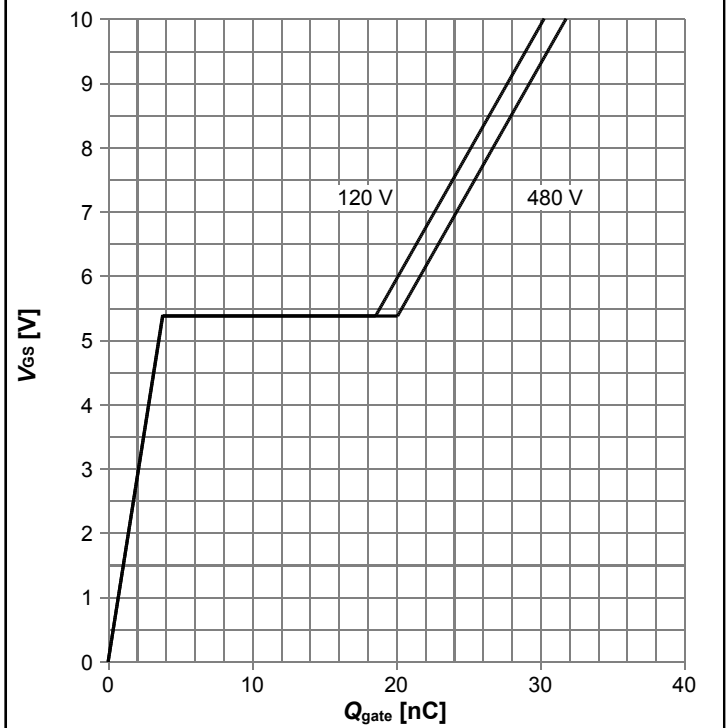


**Diagram 9: Typ. transfer characteristics**



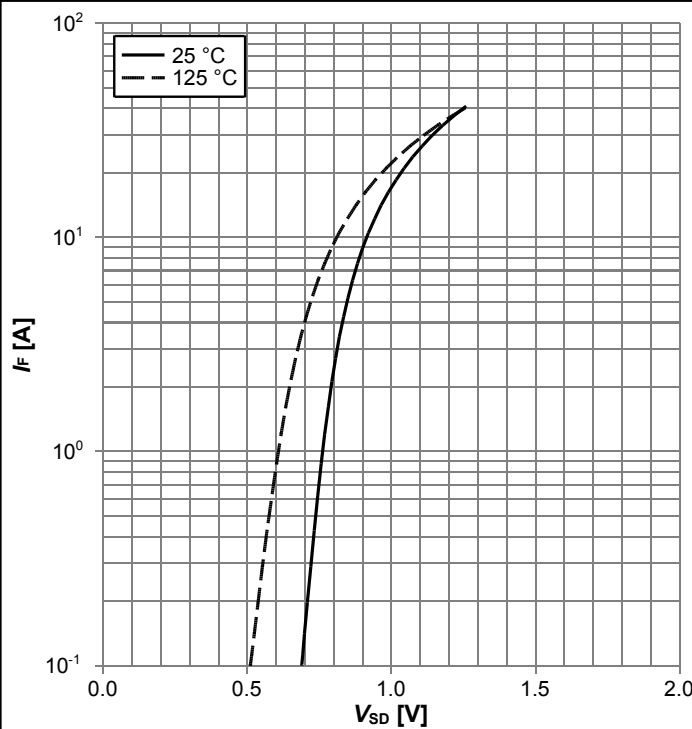
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

**Diagram 10: Typ. gate charge**



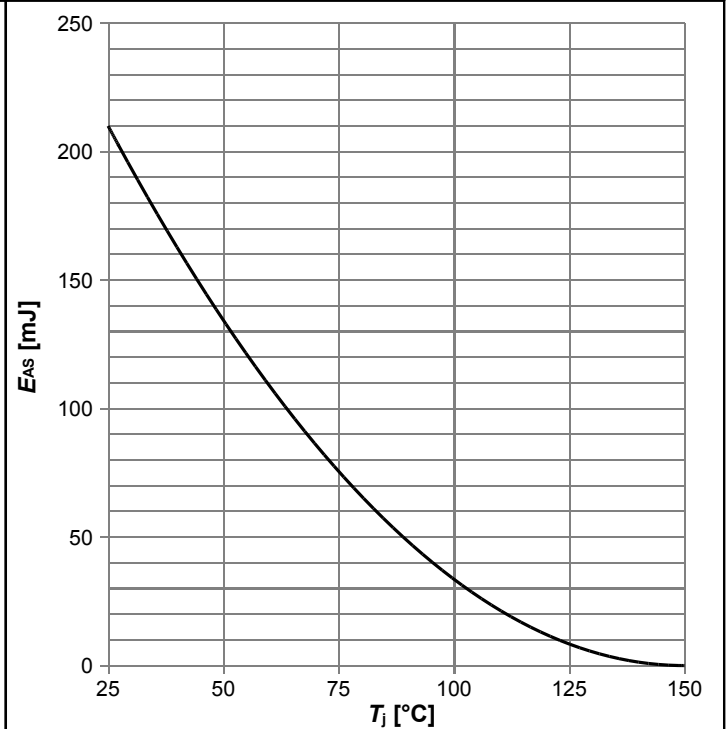
$V_{GS} = f(Q_{gate}); I_D = 4.8 \text{ A pulsed}; \text{parameter: } V_{DD}$

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



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

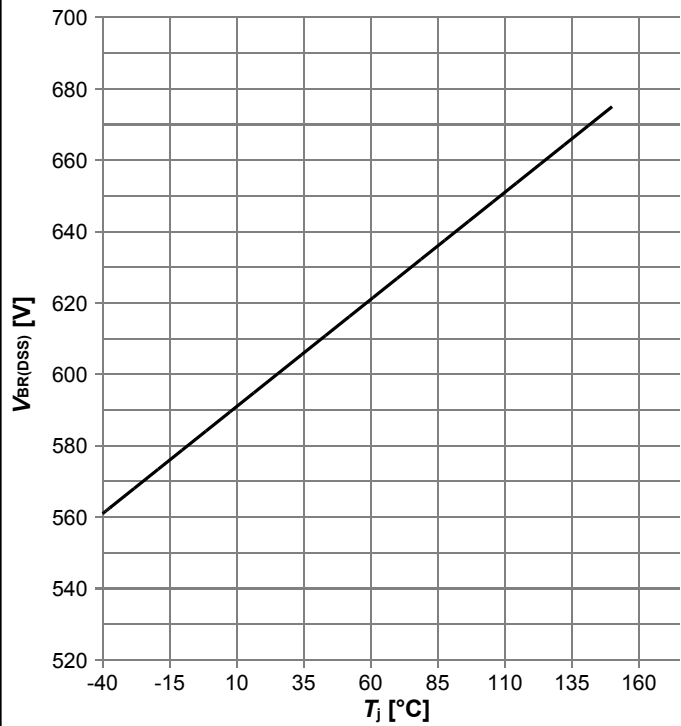
**Diagram 12: Avalanche energy**



$E_{AS} = f(T_j); I_D = 1.8A; V_{DD} = 50 \text{ V}$

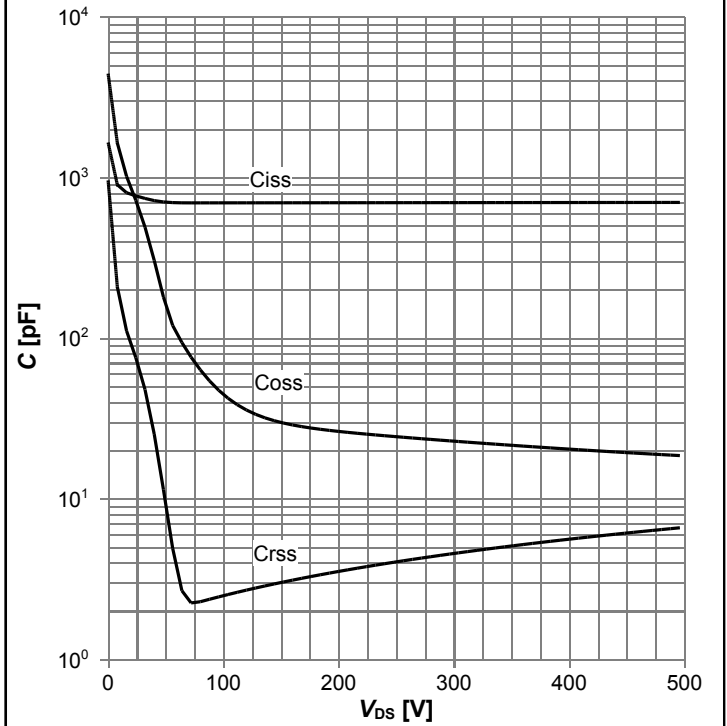
**600V CoolMOS™ CE Power Transistor**  
**IPAW60R380CE**

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



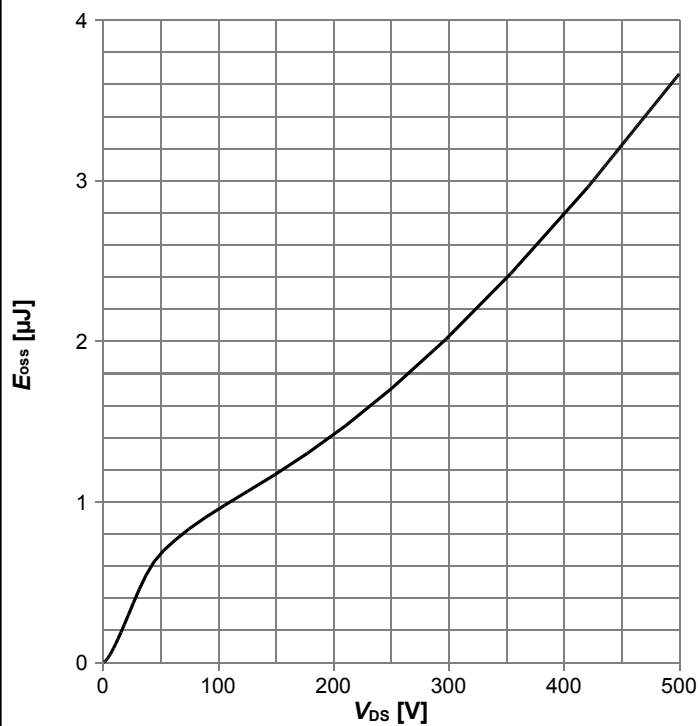
$V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$

**Diagram 14: Typ. capacitances**



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

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



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

## 5 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_{rr} = t_F + t_S</math>  <math>Q_{rr} = 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
	<p><math>V_{(BR)DS}</math></p>

**6 Package Outlines**



DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.50	4.90	0.177	0.193
A1	2.34	2.74	0.092	0.108
A2	2.65	2.95	0.104	0.116
b	0.75	0.90	0.030	0.035
b2	0.98	1.26	0.039	0.050
b3	1.00	1.40	0.039	0.055
b5	3.00	-	0.118	-
c	0.40	0.60	0.016	0.024
D	15.47	16.27	0.609	0.641
D1	9.17		0.361	
E	10.70	11.30	0.421	0.445
e	4.25 (BSC)		0.167 (BSC)	
N	3		3	
H	28.25	29.45	1.112	1.159
L	12.58	13.38	0.495	0.527
L1	1.70	2.30	0.067	0.091
$\phi P$	3.00	3.30	0.118	0.130
Q	3.10	3.50	0.122	0.138

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EUROPEAN PROJECTION

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**Figure 1 Outline PG - TO220 FullPAK WideCreep, dimensions in mm/inches**

## 7 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

IPAW60R380CE

**Revision: 2016-03-31**

Previous Revision

Date	Subjects (major changes since last revision)
2015-10-07	Release of final version
2016-03-31	Modified Id Ratings

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