

## MOSFET

Metal Oxide Semiconductor Field Effect Transistor

### CoolMOS™ E6 600V

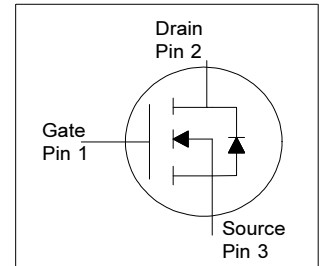
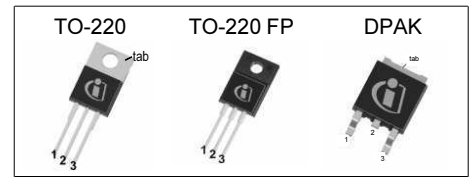
600V CoolMOS™ E6 Power Transistor  
IPx60R380E6

## Data Sheet

Rev. 2.6  
Final

## 1 Description

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ E6 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 not sacrificing ease of use. Extremely low switching and conduction losses make switching applications even more efficient, more compact, lighter and cooler.



## Features

- Extremely low losses due to very low FOM  $R_{ds(on)} \cdot Q_g$  and  $E_{oss}$
- Very high commutation ruggedness
- Easy to use/drive
- Pb-free plating, Halogen free mold compound (except PG-TO252)
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)



## Applications

PFC stages, hard switching PWM stages and resonant switching PWM stages for e.g. PC Silverbox, Adapter, LCD & PDP TV, Lighting, Server, Telecom and UPS.



**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.38	$\Omega$
$Q_g,typ$	32	nC
$I_D,pulse$	30	A
$E_{oss} @ 400V$	2.8	$\mu J$
Body diode $di/dt$	500	A/ $\mu s$

Type / Ordering Code	Package	Marking	Related Links
IPP60R380E6	PG-TO 220	6R380E6	see Appendix A
IPA60R380E6	PG-TO 220 FullPAK		
IPD60R380E6	PG-TO 252		



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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 <sup>1)</sup>	$I_D$			10.6	A	$T_C = 25^\circ\text{C}$
				6.7		$T_C = 100^\circ\text{C}$
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 22)
Avalanche energy, repetitive	$E_{AR}$			0.32	mJ	$I_D = 1.8\text{A}$ , $V_{DD} = 50\text{V}$
Avalanche current, repetitive	$I_{AR}$			1.8	A	
MOSFET dv/dt ruggedness	dv/dt			50	V/ns	$V_{DS} = 0 \dots 480\text{V}$
Gate source voltage	$V_{GS}$	-20		20	V	static
		-30		30		AC ( $f > 1\text{Hz}$ )
Power dissipation (non FullPAK) TO-220	$P_{tot}$			83	W	$T_C = 25^\circ\text{C}$
Power dissipation (FullPAK) TO-220 FP	$P_{tot}$			31	W	$T_C = 25^\circ\text{C}$
Operating and storage temperature	$T_j, T_{stg}$	-55		150	$^\circ\text{C}$	
Mounting torque (non FullPAK) TO-220				60	Ncm	M3 and M3.5 screws
Mounting torque (FullPAK) TO-220 FP				50	Ncm	M2.5 screws
Continuous diode forward current	$I_S$			9.2	A	$T_C = 25^\circ\text{C}$
Diode pulse current	$I_{S,pulse}$			30	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt			15	V/ns	$V_{DS} = 0 \dots 480\text{V}$ , $I_{SD} \leq I_D$ , $T_j = 25^\circ\text{C}$ (see table 20)
Maximum diode commutation speed	di/dt			500	A/ $\mu\text{s}$	

<sup>1)</sup> Limited by  $T_{j,max}$ . Maximum duty cycle  $D=0.75$

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

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

### 3 Thermal characteristics

**Table 3 Thermal characteristics TO-220**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$			1.5	°C/W	
Thermal resistance, junction - ambient	$R_{thJA}$			62	°C/W	lead
Soldering temperature, wavesoldering only allowed at leads	$T_{sold}$			260	°C	1.6 mm (0.063 in.) from case for 10s

**Table 4 Thermal characteristics TO-220 FP**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$			4.0	°C/W	
Thermal resistance, junction - ambient	$R_{thJA}$			80	°C/W	lead
Soldering temperature, wavesoldering only allowed at leads	$T_{sold}$			260	°C	1.6 mm (0.063 in.) from case for 10s

**Table 5 Thermal characteristics DPAK**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$			1.5	°C/W	
Thermal resistance, junction - ambient <sup>1)</sup>	$R_{thJA}$			62	°C/W	SMD version, device on PCB, minimal footprint
			35			SMD version, device on PCB, 6cm <sup>2</sup> cooling area
Soldering temperature, wave- & reflowsoldering allowed	$T_{sold}$			260	°C	reflow MSL

<sup>1)</sup> Device on 40mm\*40mm\*1.5mm one layer epoxy PCB FR4 with 6cm<sup>2</sup> copper area (thickness 70µm) for drain connection. PCB is vertical without air stream cooling.

## 4 Electrical characteristics

at  $T_j = 25^\circ\text{C}$ , unless otherwise specified

**Table 6 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	3.5	V	$V_{DS} = V_{GS}, I_D = 0.3mA$
Zero gate voltage drain current	$I_{DSS}$			1	$\mu A$	$V_{DS} = 600V, V_{GS} = 0V, T_j = 25^\circ C$
			10			$V_{DS} = 600V, V_{GS} = 0V, T_j = 150^\circ C$
Gate-source leakage current	$I_{GSS}$			100	nA	$V_{GS} = 20V, V_{DS} = 0V$
Drain-source on-state resistance	$R_{DS(on)}$		0.340	0.38	$\Omega$	$V_{GS} = 10V, I_D = 3.8A, T_j = 25^\circ C$
			0.890			$V_{GS} = 10V, I_D = 3.8A, T_j = 150^\circ C$
Gate resistance	$R_G$		7.5		$\Omega$	$f = 1MHz, \text{open drain}$

**Table 7 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	
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$		30		pF	$V_{GS} = 0V, V_{DS} = 0 \dots 480V$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$		136		pF	$I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 480V$
Turn-on delay time	$t_{d(on)}$		11		ns	$V_{DD} = 400V, V_{GS} = 13V, I_D = 4.8A, R_G = 3.4\Omega$ (see table 22)
Rise time	$t_r$		9		ns	
Turn-off delay time	$t_{d(off)}$		56		ns	
Fall time	$t_f$		8		ns	

**Table 8 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	
Gate charge total	$Q_g$		32		nC	
Gate plateau voltage	$V_{plateau}$		5.4		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 80%  $V_{(BR)DSS}$

<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 80%  $V_{(BR)DSS}$

**Table 9 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 20)
Reverse recovery charge	$Q_{rr}$		3.3		$\mu C$	
Peak reverse recovery current	$I_{rrm}$		21		A	

## 5 Electrical characteristics diagrams

Table 10

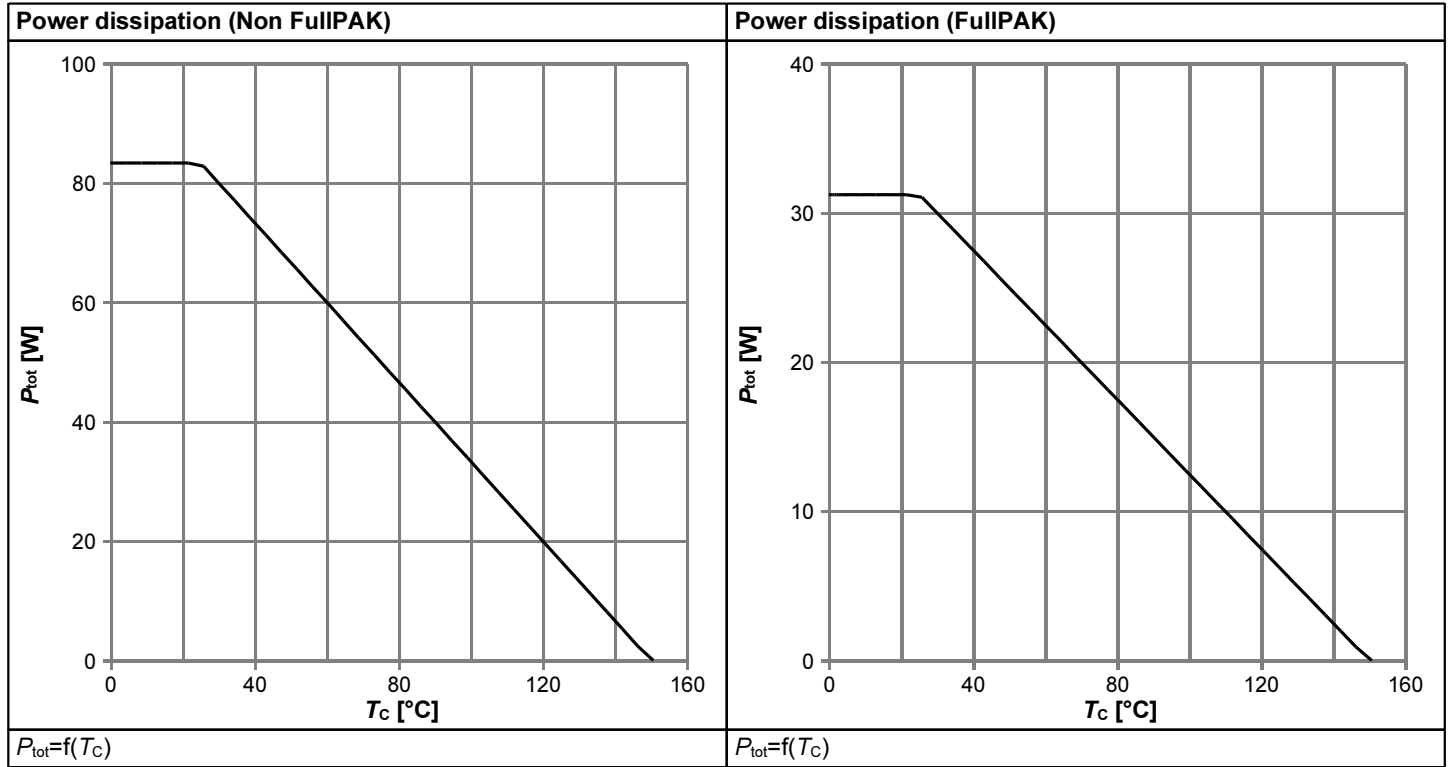


Table 11

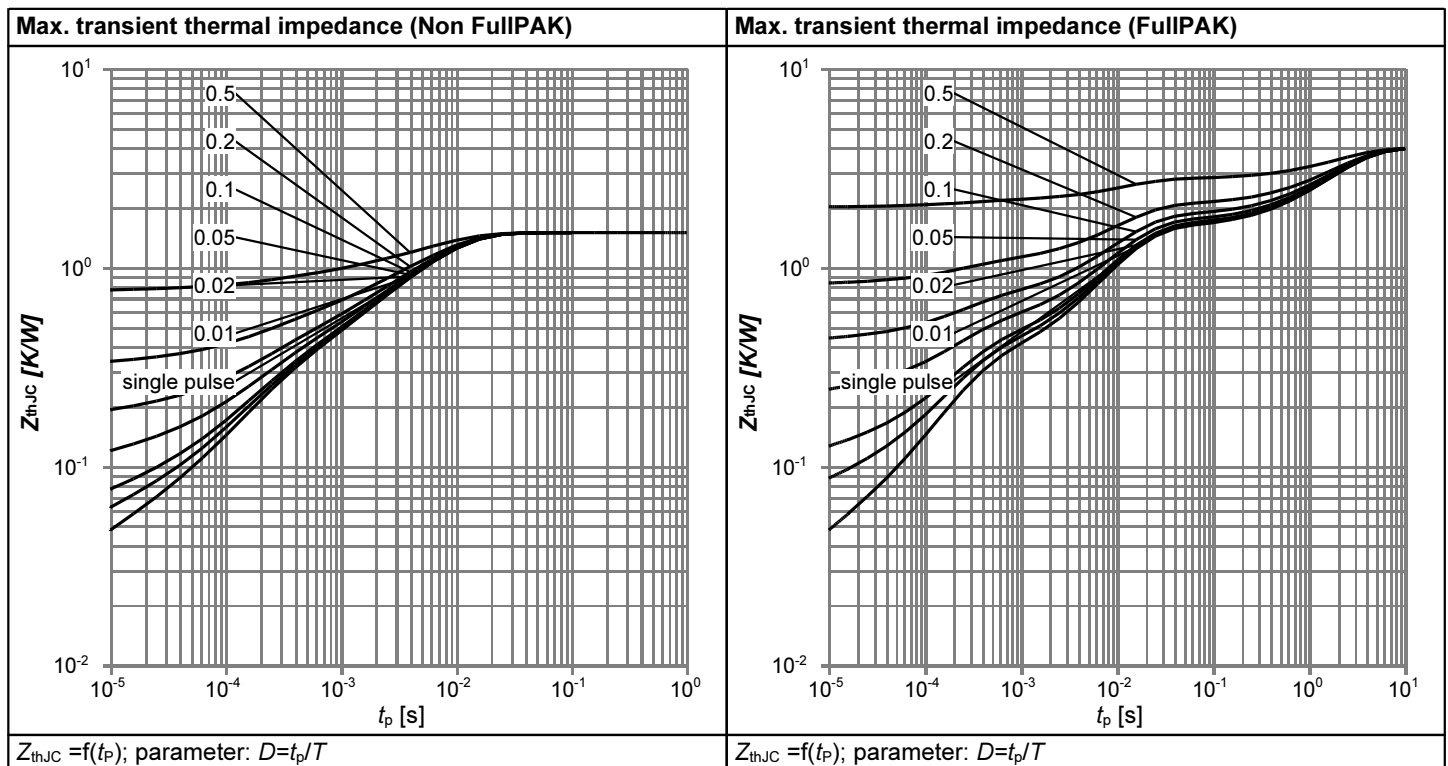




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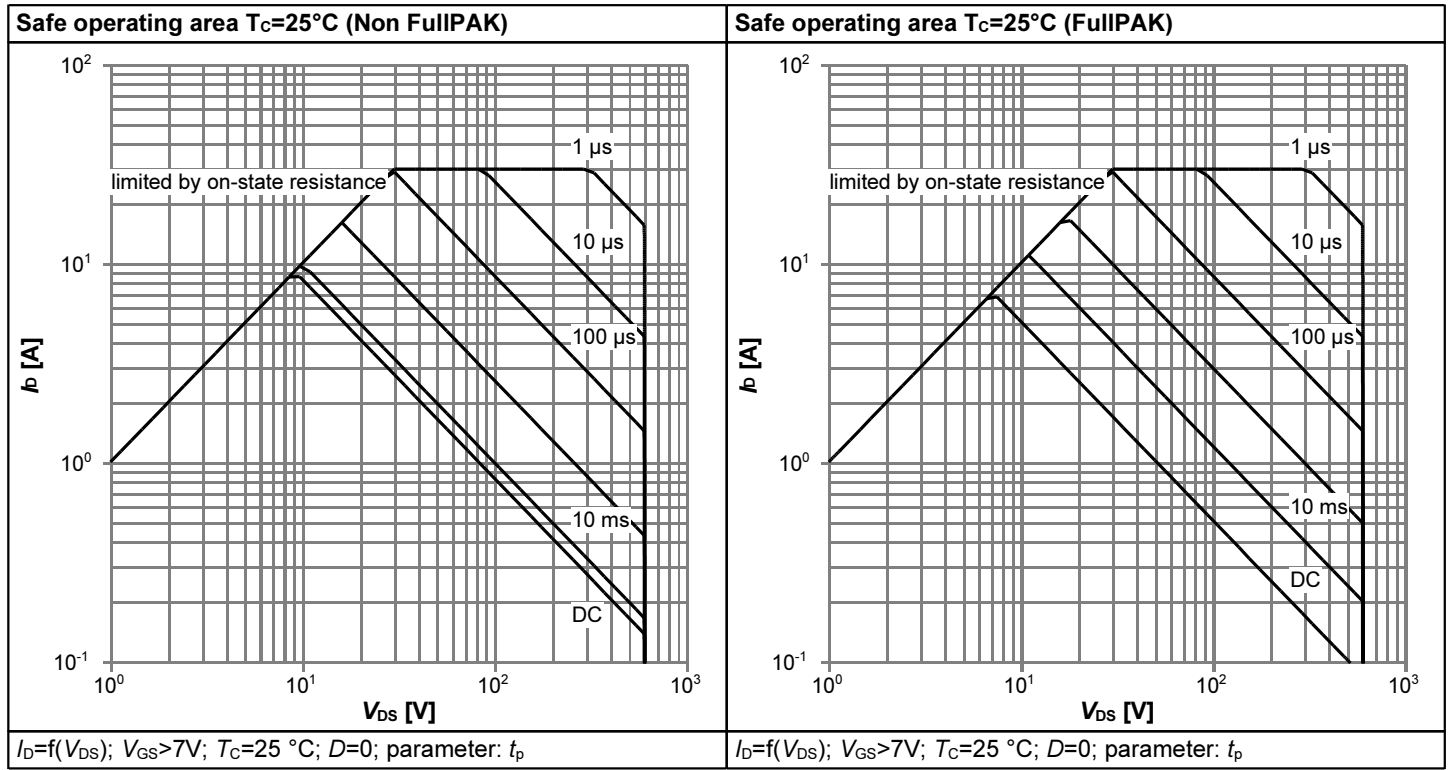


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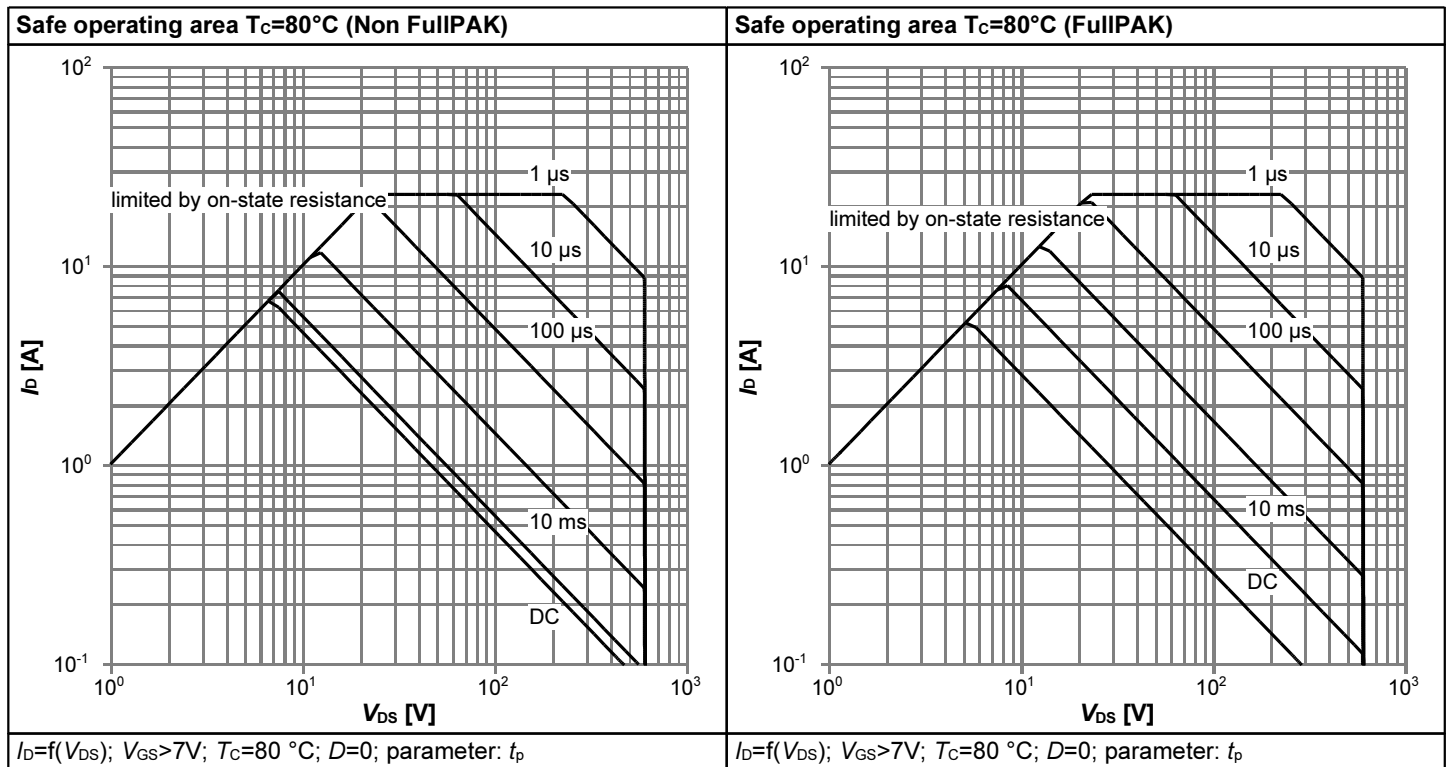


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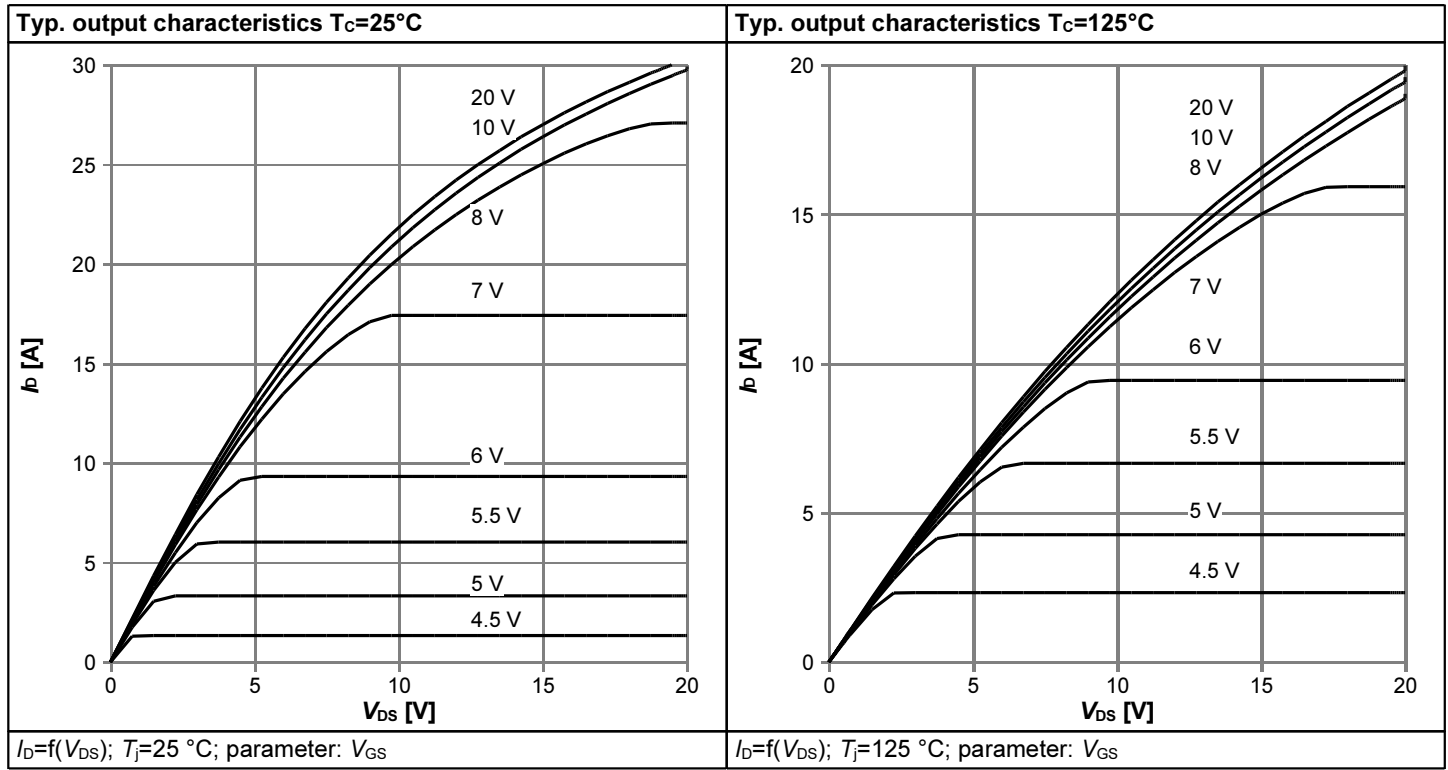


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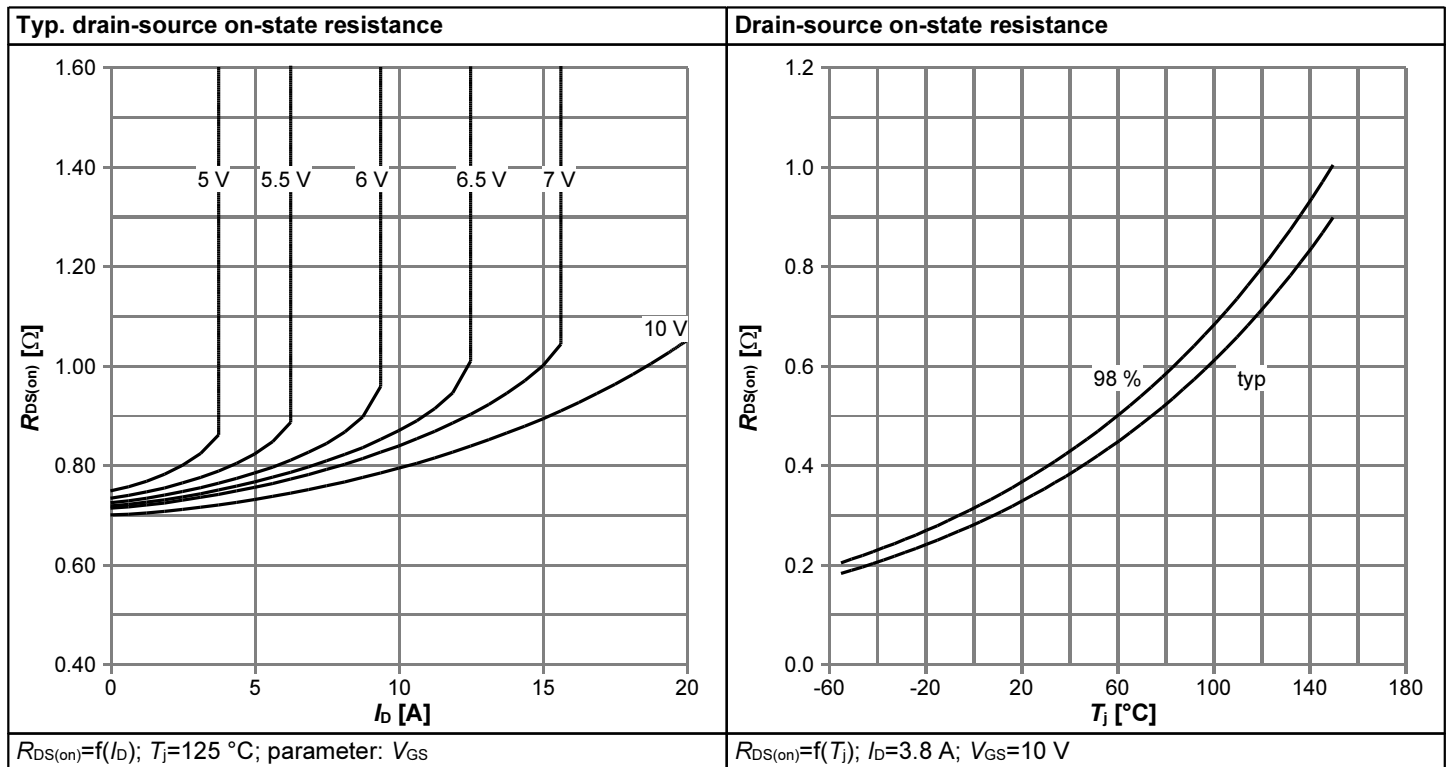


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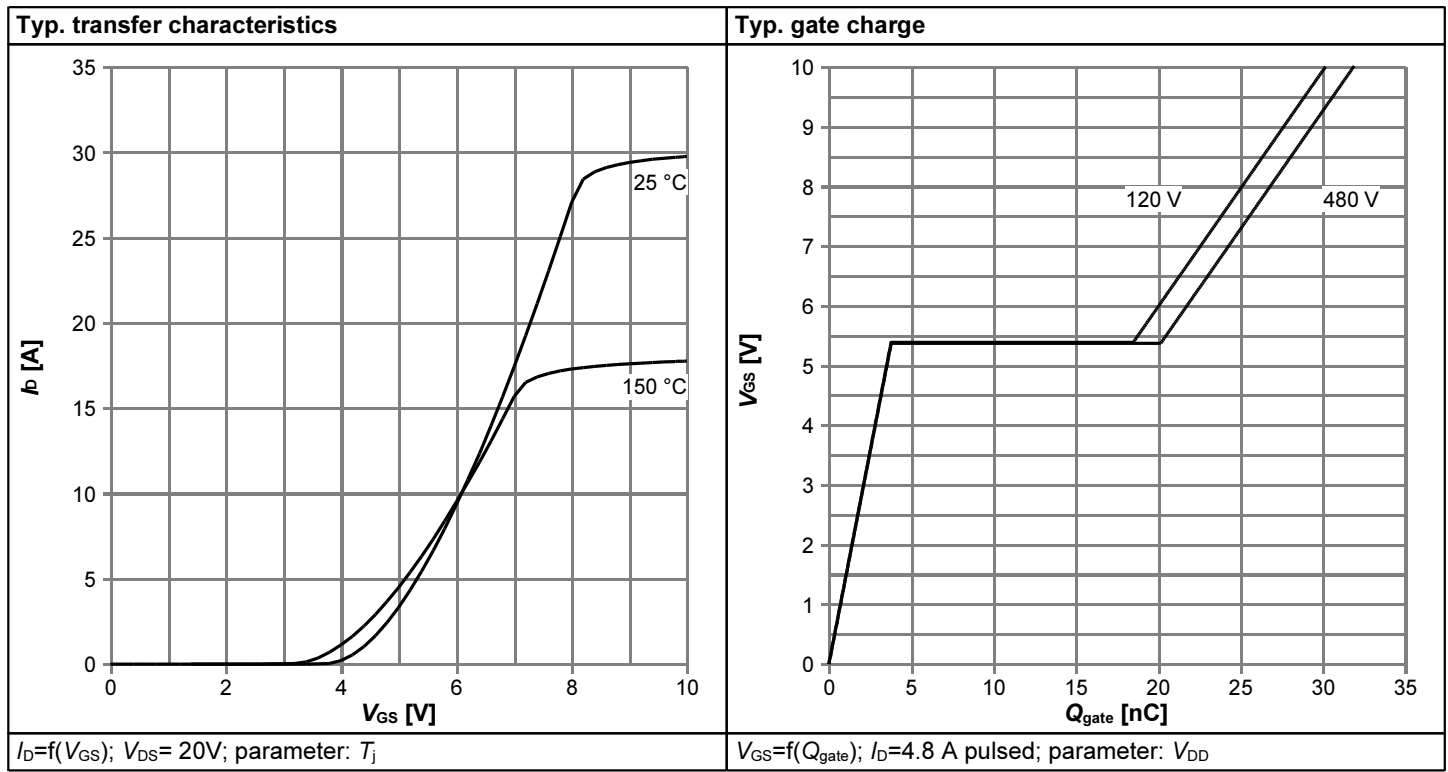


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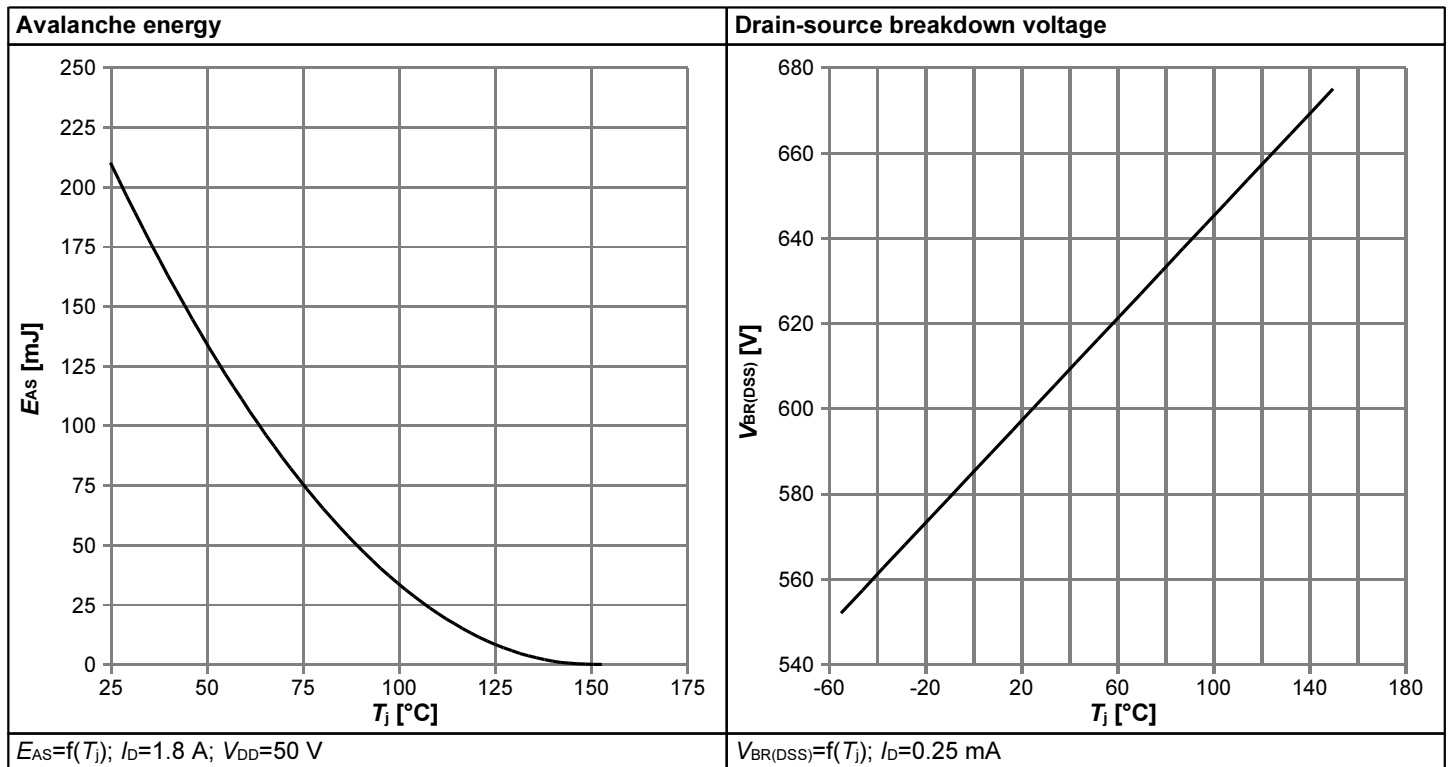


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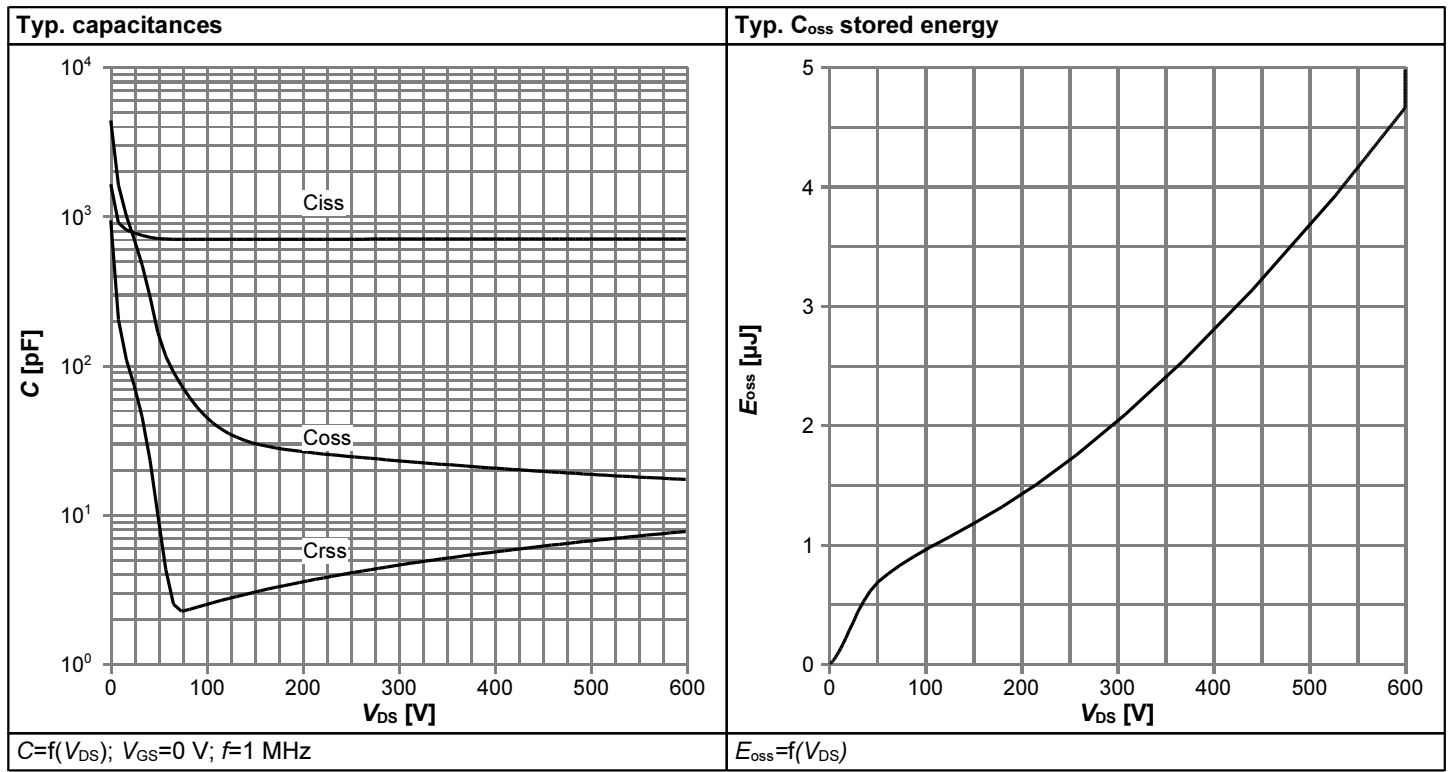
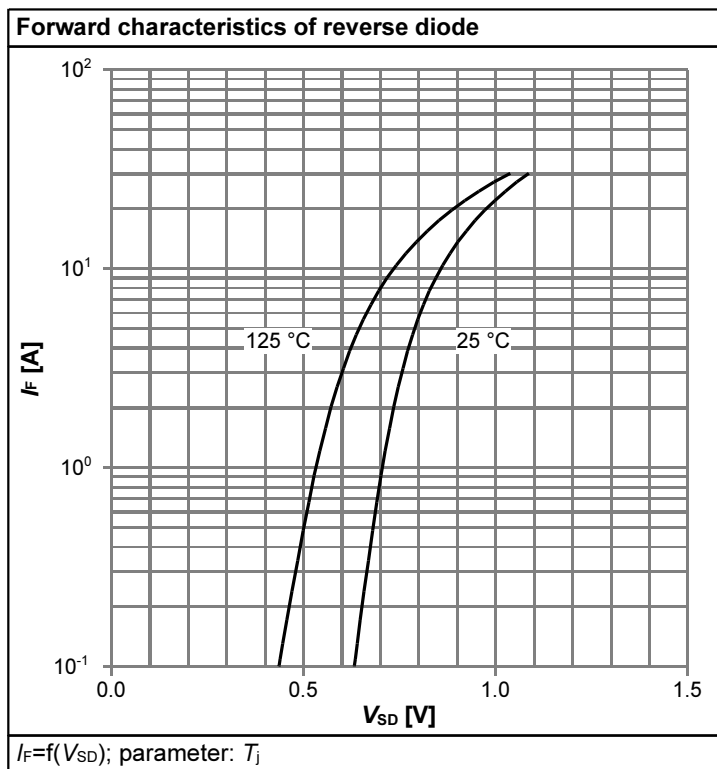
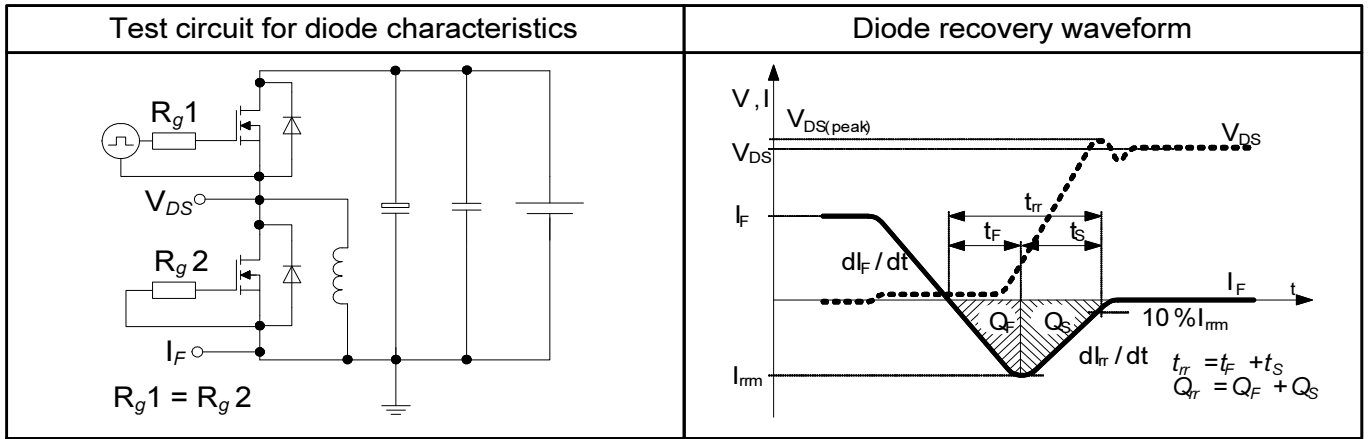


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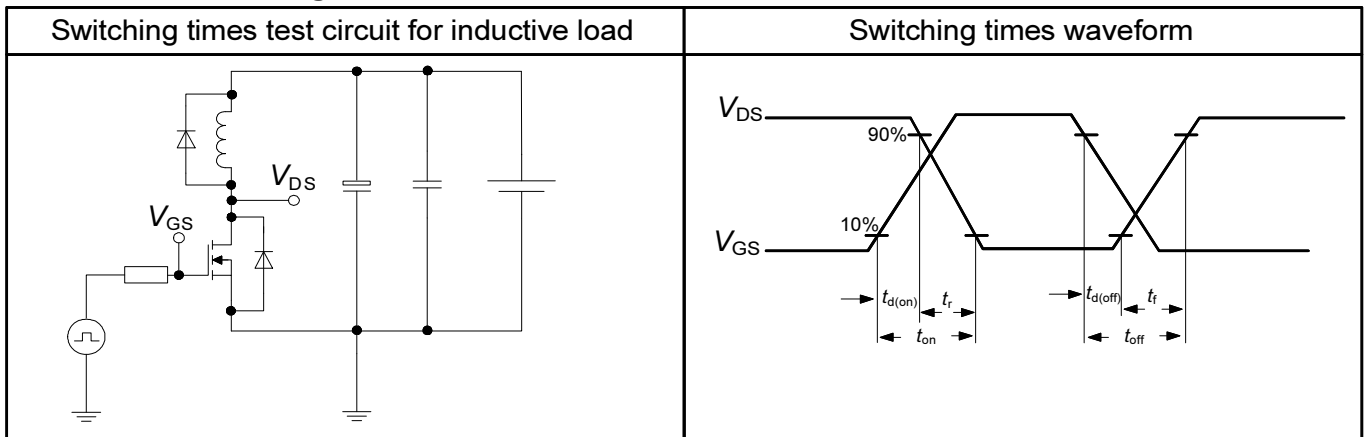


## 6 Test Circuits

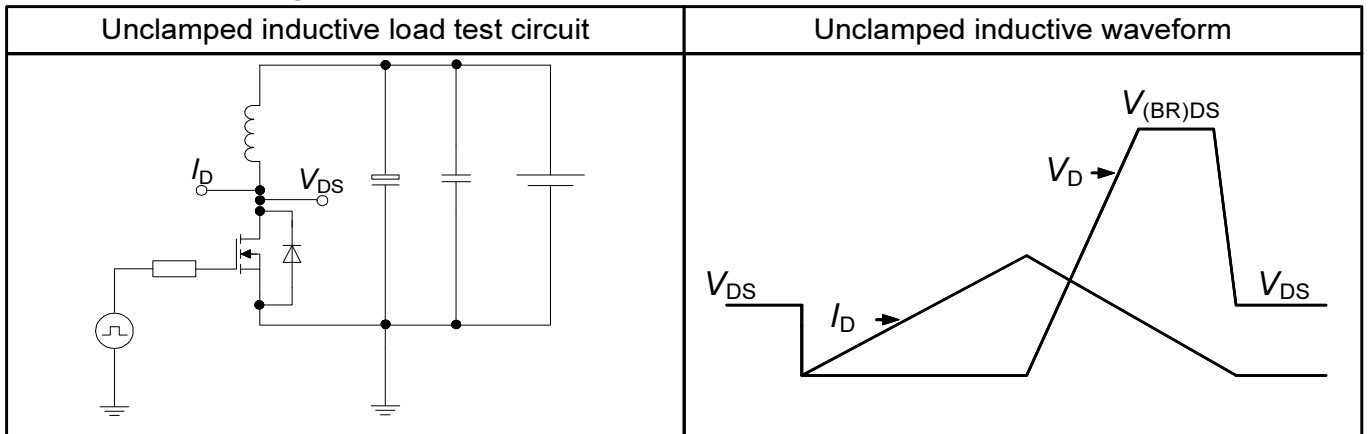
**Table 20 Diode characteristics**



**Table 21 Switching times**



**Table 22 Unclamped inductive load**



7 Package Outlines

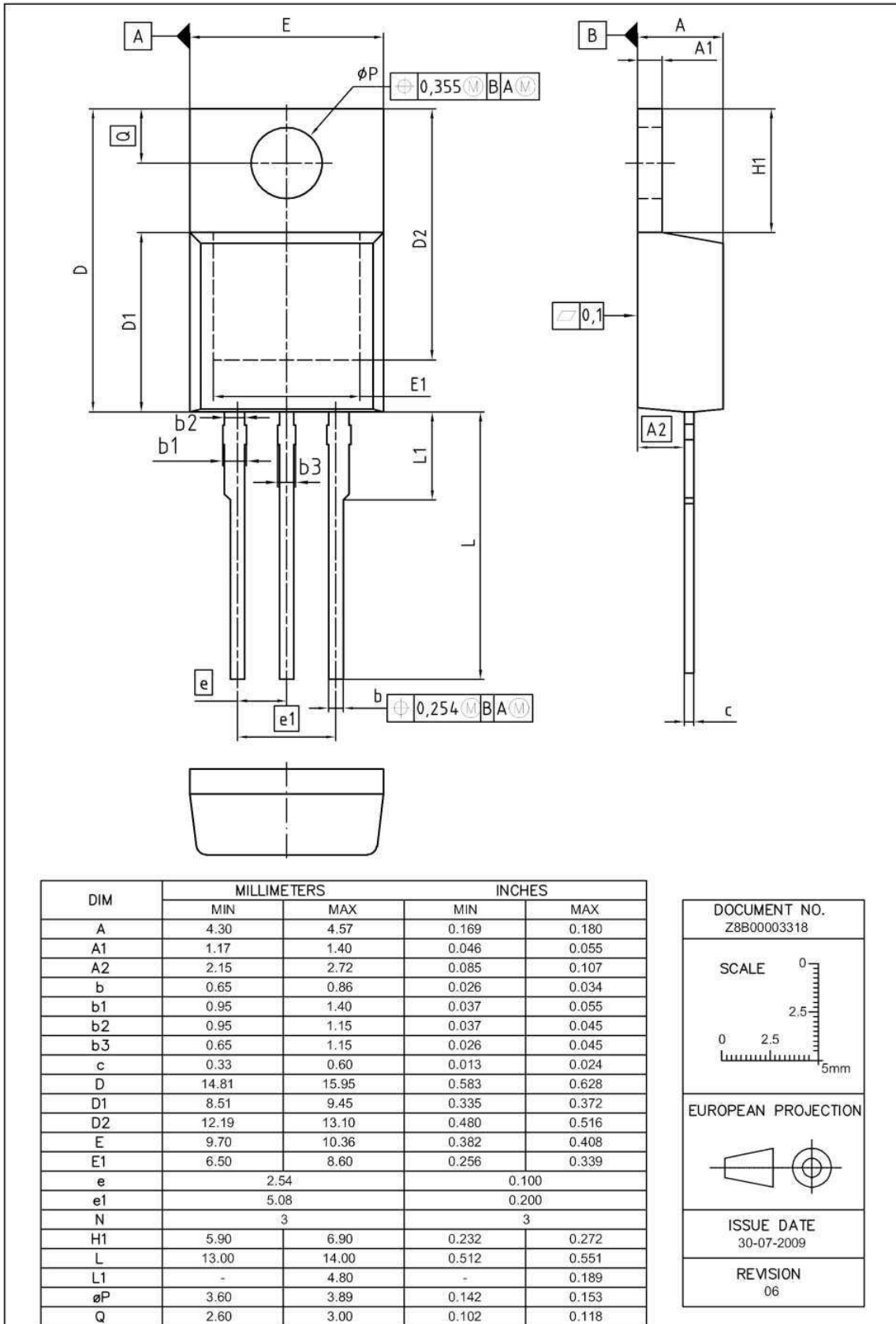


Figure 1 Outline PG-TO 220, dimensions in mm/inches

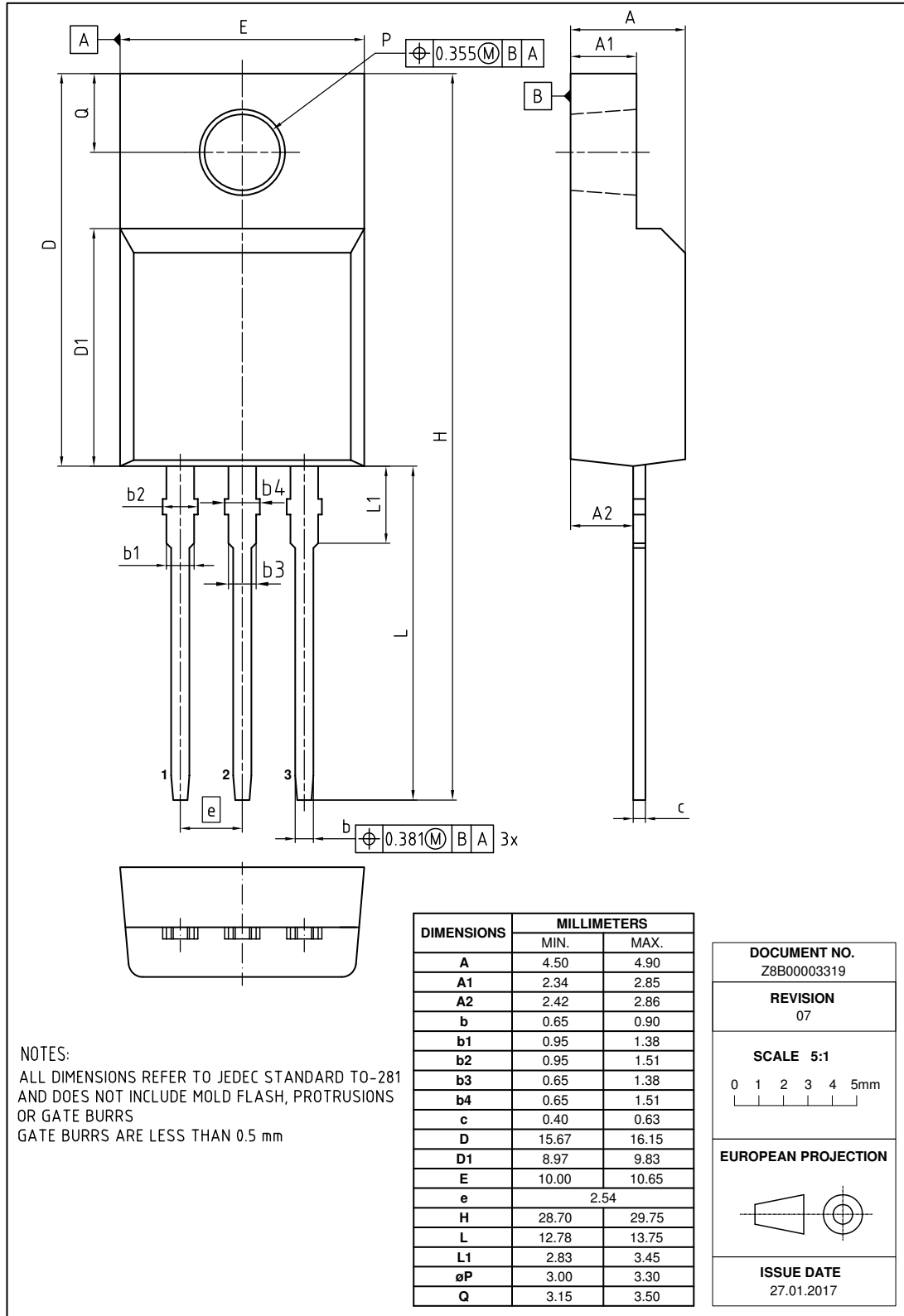


Figure 2 Outline PG-TO 220 FullPAK, dimensions in mm

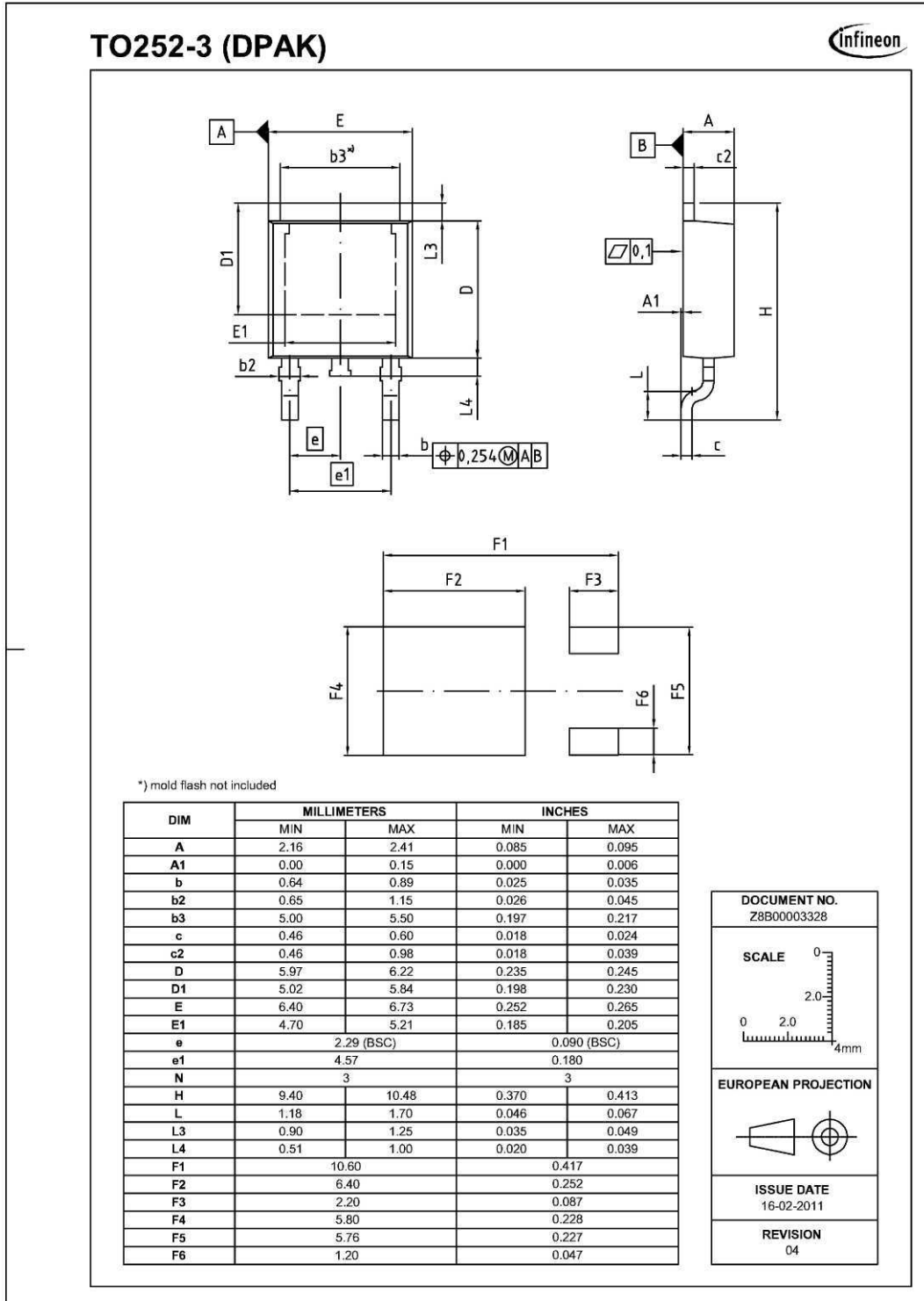


Figure 3 Outline PG-TO 252, dimensions in mm/inches



## 8 Appendix A

### Table 23 Related Links

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

## Revision History

IPx60R380E6

**Revision: 2018-03-04, Rev. 2.6**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.4	2013-05-15	PG-TO252 Package Added
2.5	2015-02-09	PG-TO220 FullPAK package outline update (creation:2014-12-09)
2.6	2018-03-04	Outline PG-TO-220 FullPAK update

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