

## MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ E6 600V

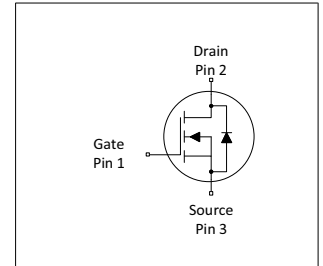
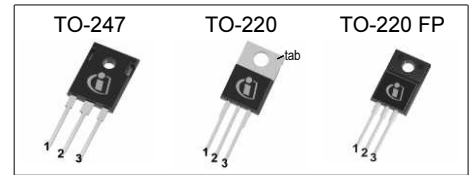
600V CoolMOS™ E6 Power Transistor  
IPx60R190E6

## Data Sheet

Rev. 2.3  
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
- 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
$R_{DS(on),max}$	0.19	$\Omega$
$Q_g,typ$	63	nC
$I_{D,pulse}$	59	A
$E_{oss} @ 400V$	5.2	$\mu J$
Body diode $di/dt$	500	A/ $\mu s$

Type / Ordering Code	Package	Marking	Related Links
IPW60R190E6	PG-TO 247	6R190E6	see Appendix A
IPP60R190E6	PG-TO 220		
IPA60R190E6	PG-TO 220 FullPAK		



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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>	$I_D$			20.2	A	$T_C = 25^\circ\text{C}$
				12.8		$T_C = 100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$			59	A	$T_C = 25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$			418	mJ	$I_D = 3.4\text{A}$ , $V_{DD} = 50\text{V}$ (see table 11)
Avalanche energy, repetitive	$E_{AR}$			0.63	mJ	$I_D = 3.4\text{A}$ , $V_{DD} = 50\text{V}$
Avalanche current, repetitive	$I_{AR}$			3.4	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-247, TO-220	$P_{tot}$			151.0	W	$T_C = 25^\circ\text{C}$
Power dissipation (FullPAK) TO-220 FP	$P_{tot}$			34.0	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-247, TO-220				60	Ncm	M3 and M3.5 screws
Mounting torque (FullPAK) TO-220 FP				50	Ncm	M2.5 screws
Continuous diode forward current	$I_S$			17.5	A	$T_C = 25^\circ\text{C}$
Diode pulse current	$I_{S,pulse}$			59	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt			15	V/ns	$V_{DS} = 0 \dots 400\text{V}$ , $I_{SD} \leq I_D$ , $T_j = 25^\circ\text{C}$
Maximum diode commutation speed	$di_f/dt$			500	A/ $\mu\text{s}$	(see table 9)

<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  $R_\theta$

### 3 Thermal characteristics

**Table 3 Thermal characteristics TO-247, TO-220**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$			0.83	°C/W	
Thermal resistance, junction - ambient	$R_{thJA}$			62	°C/W	leaded
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	$R_{thJC}$			3.7	°C/W	
Thermal resistance, junction - ambient	$R_{thJA}$			80	°C/W	leaded
Soldering temperature, wavesoldering only allowed at leads	$T_{sold}$			260	°C	1.6 mm (0.063 in.) from case for 10s

## 4 Electrical characteristics

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

**Table 5 Static characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	600			V	$V_{GS} = 0V, I_D = 0.25\text{mA}$
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5	V	$V_{DS} = V_{GS}, I_D = 0.63\text{mA}$
Zero gate voltage drain current	$I_{DSS}$			1	$\mu\text{A}$	$V_{DS} = 600V, V_{GS} = 0V, T_j = 25^\circ\text{C}$
			10			$V_{DS} = 600V, V_{GS} = 0V, T_j = 150^\circ\text{C}$
Gate-source leakage current	$I_{GSS}$			100	nA	$V_{GS} = 20V, V_{DS} = 0V$
Drain-source on-state resistance	$R_{DS(on)}$		0.170	0.19	$\Omega$	$V_{GS} = 10V, I_D = 9.5A, T_j = 25^\circ\text{C}$
			0.440			$V_{GS} = 10V, I_D = 9.5A, T_j = 150^\circ\text{C}$
Gate resistance	$R_G$		6		$\Omega$	$f = 1\text{MHz}$ , open drain

**Table 6 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$		1400		pF	$V_{GS} = 0V, V_{DS} = 100V, f = 1\text{MHz}$
Output capacitance	$C_{oss}$		85		pF	
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$		56		pF	$V_{GS} = 0V, V_{DS} = 0 \dots 480V$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$		266		pF	$I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 480V$
Turn-on delay time	$t_{d(on)}$		12		ns	$V_{DD} = 400V, V_{GS} = 13V, I_D = 9.5A, R_G = 3.4\Omega$ (see table 10)
Rise time	$t_r$		10		ns	
Turn-off delay time	$t_{d(off)}$		90		ns	
Fall time	$t_f$		8		ns	

**Table 7 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$		7.6		nC	$V_{DD} = 480V, I_D = 9.5A, V_{GS} = 0 \text{ to } 10V$
Gate to drain charge	$Q_{gd}$		32		nC	
Gate charge total	$Q_g$		63		nC	
Gate plateau voltage	$V_{plateau}$		5.4		V	

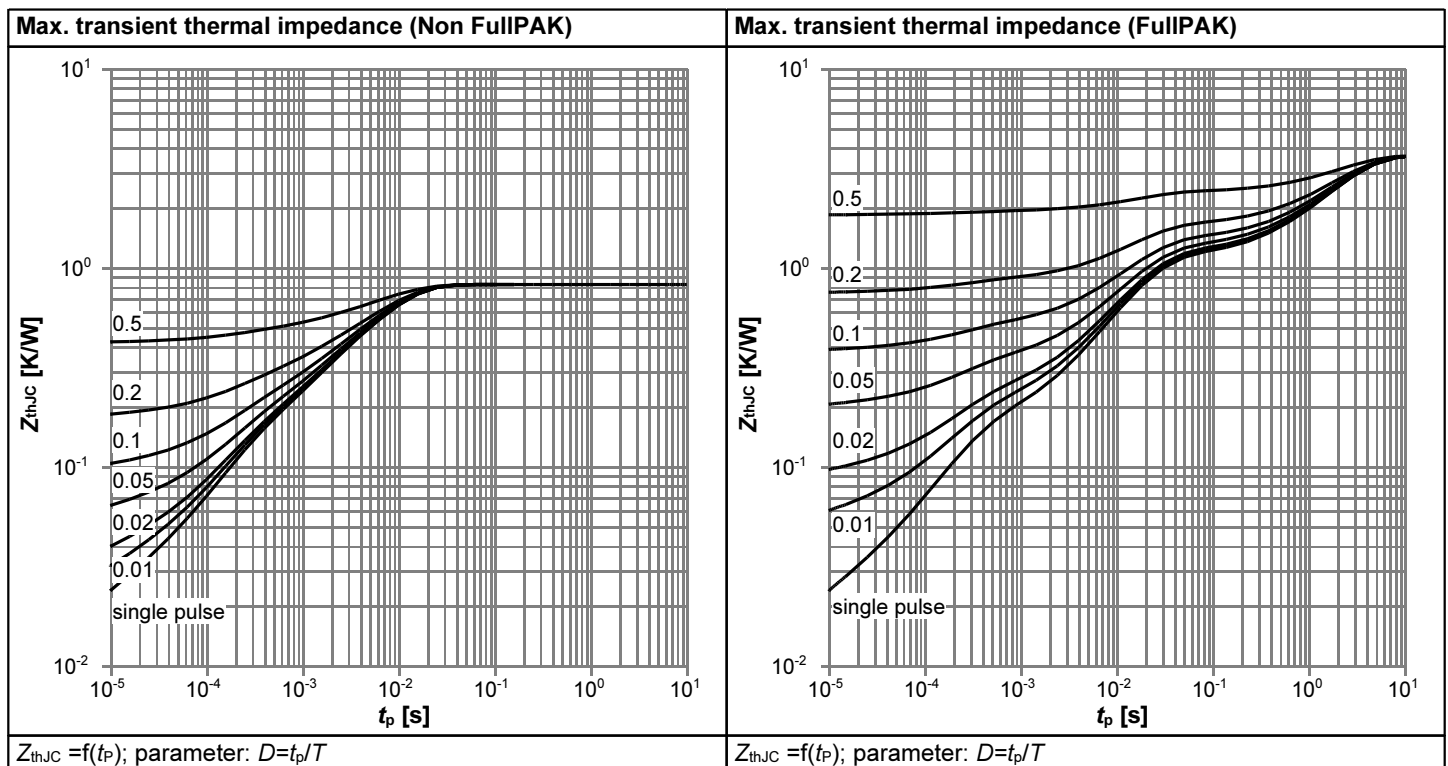
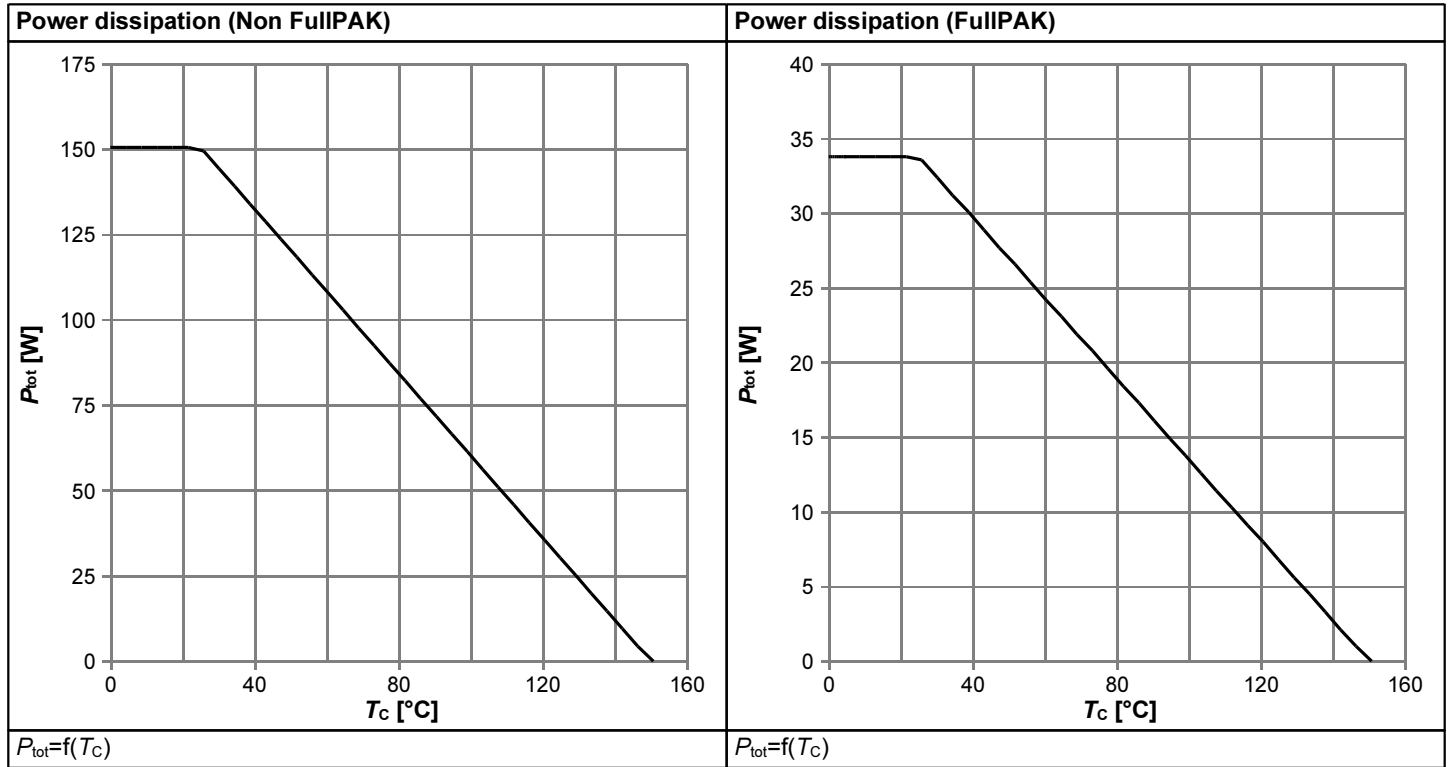
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

<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 8 Reverse diode characteristics**

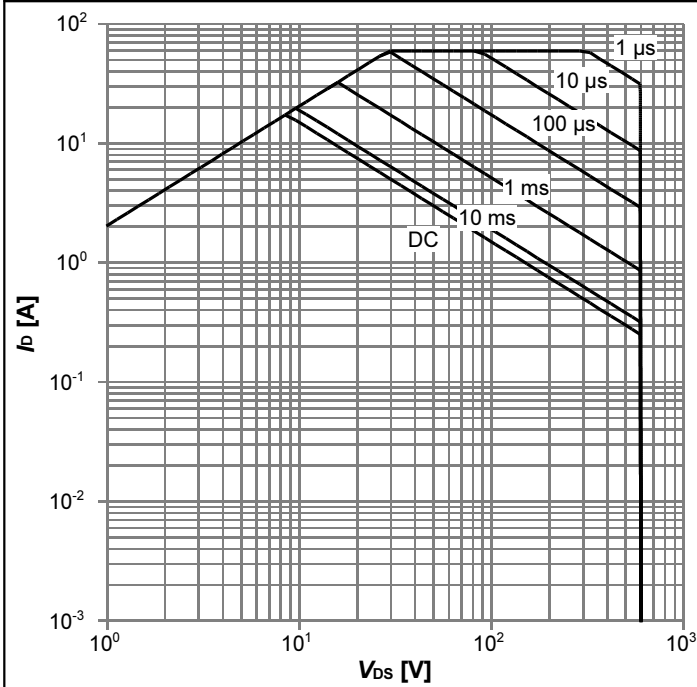
Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	$V_{SD}$		0.9		V	$V_{GS} = 0V, I_F = 9.5A, T_j = 25^\circ C$
Reverse recovery time	$t_{rr}$		430		ns	$V_R = 400V, I_F = 9.5A,$ $di_F/dt = 100A/\mu s$ (see table 9)
Reverse recovery charge	$Q_{rr}$		6.9		$\mu C$	
Peak reverse recovery current	$I_{rrm}$		30		A	

## 5 Electrical characteristics diagrams



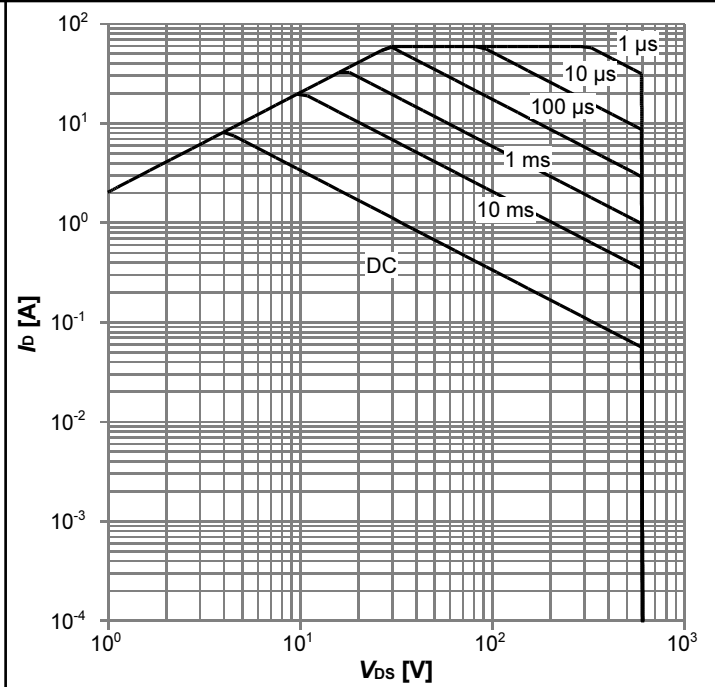


Safe operating area  $T_c=25^\circ\text{C}$  (Non FullPAK)



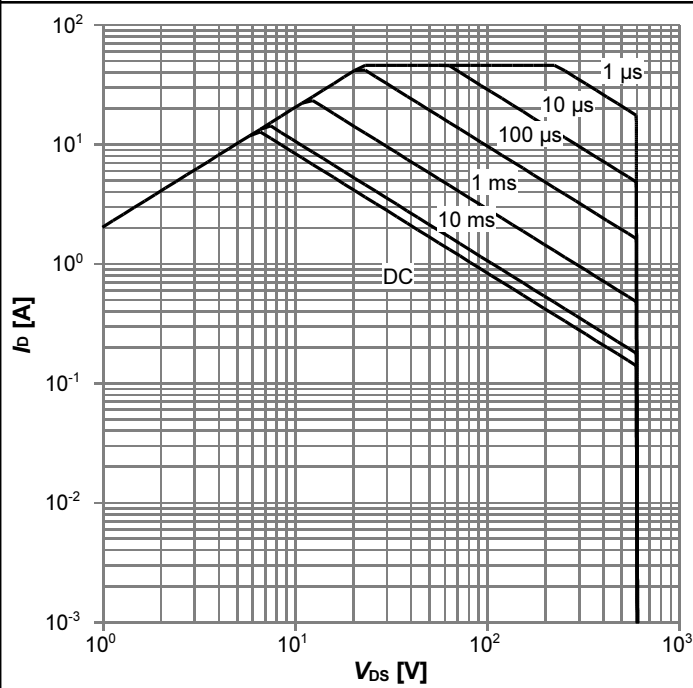
$I_D=f(V_{DS}); T_c=25^\circ\text{C}; D=0$ ; parameter:  $t_p$

Safe operating area  $T_c=25^\circ\text{C}$  (FullPAK)



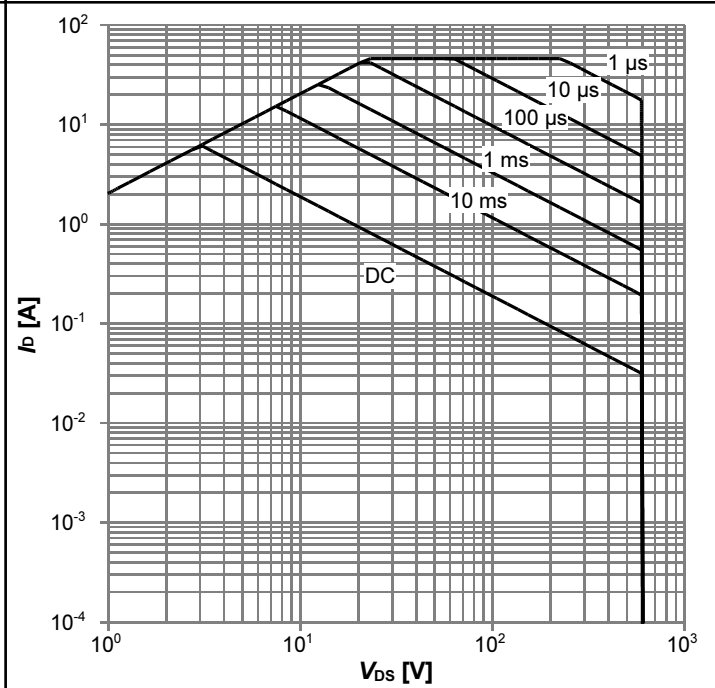
$I_D=f(V_{DS}); T_c=25^\circ\text{C}; D=0$ ; parameter:  $t_p$

Safe operating area  $T_c=80^\circ\text{C}$  (Non FullPAK)

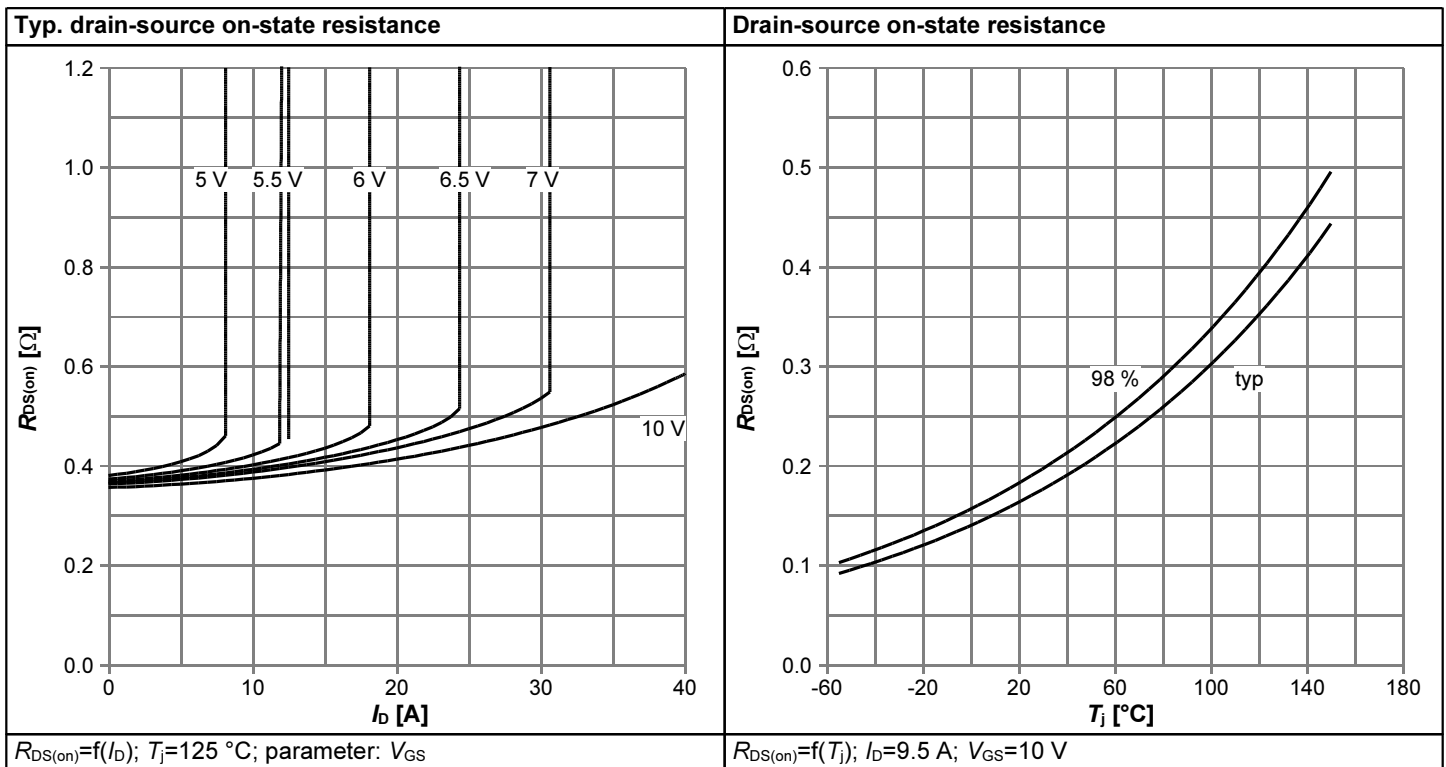
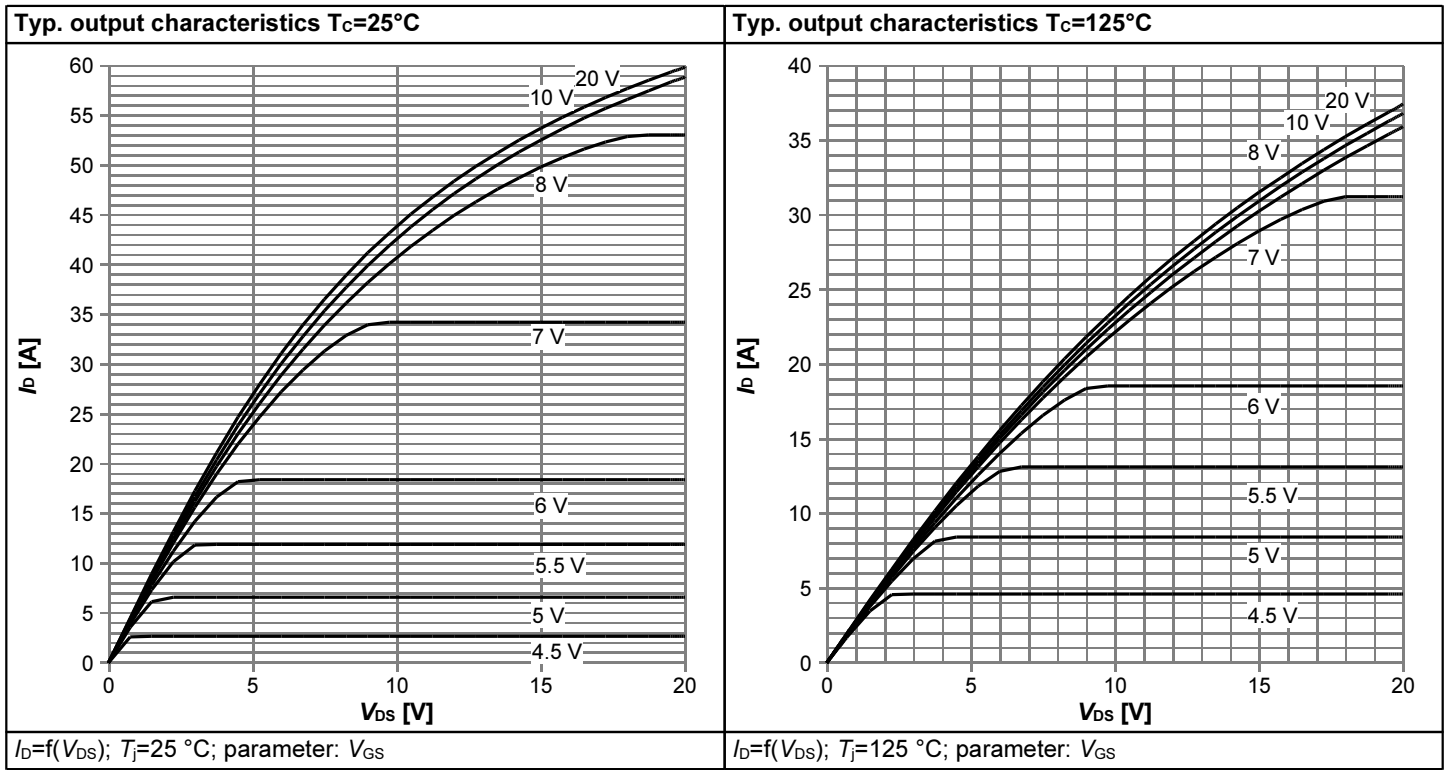


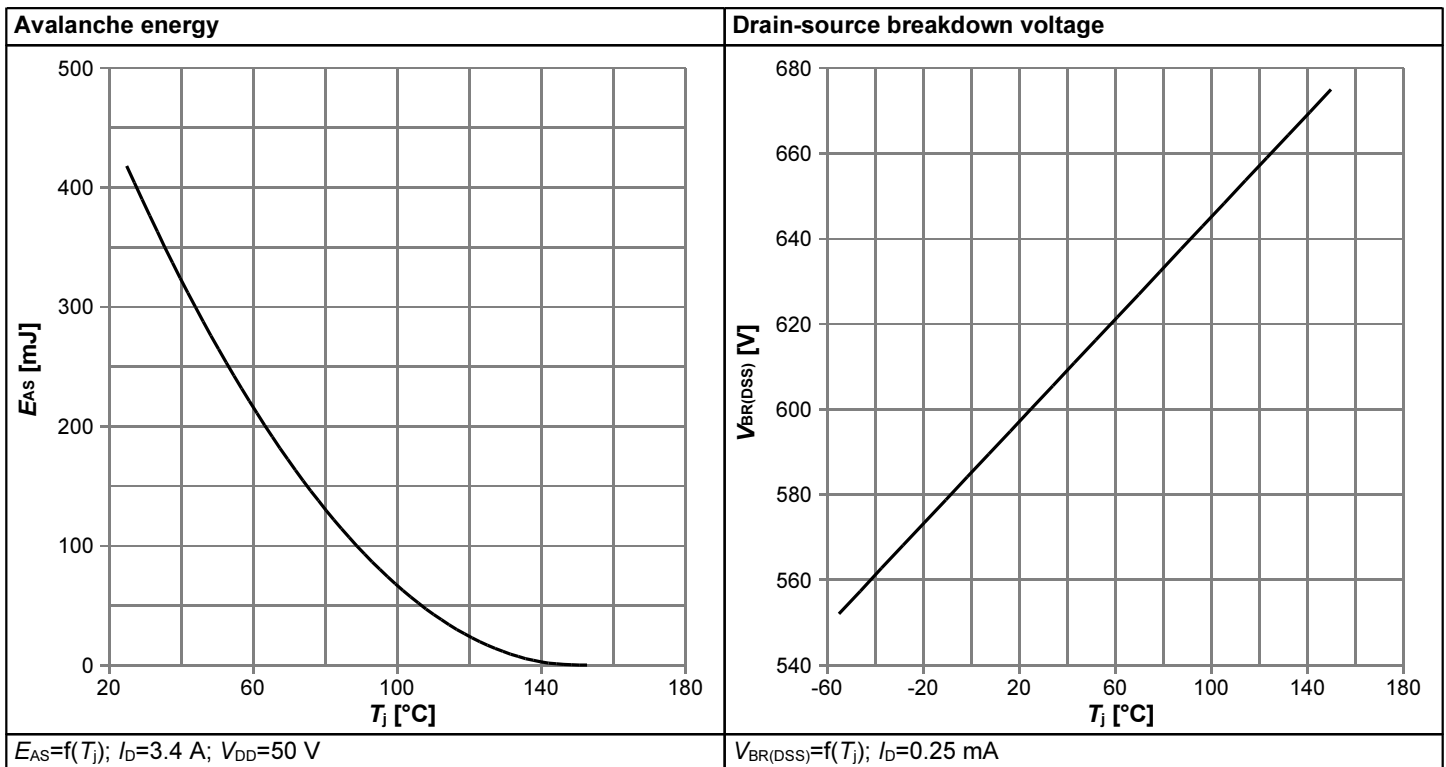
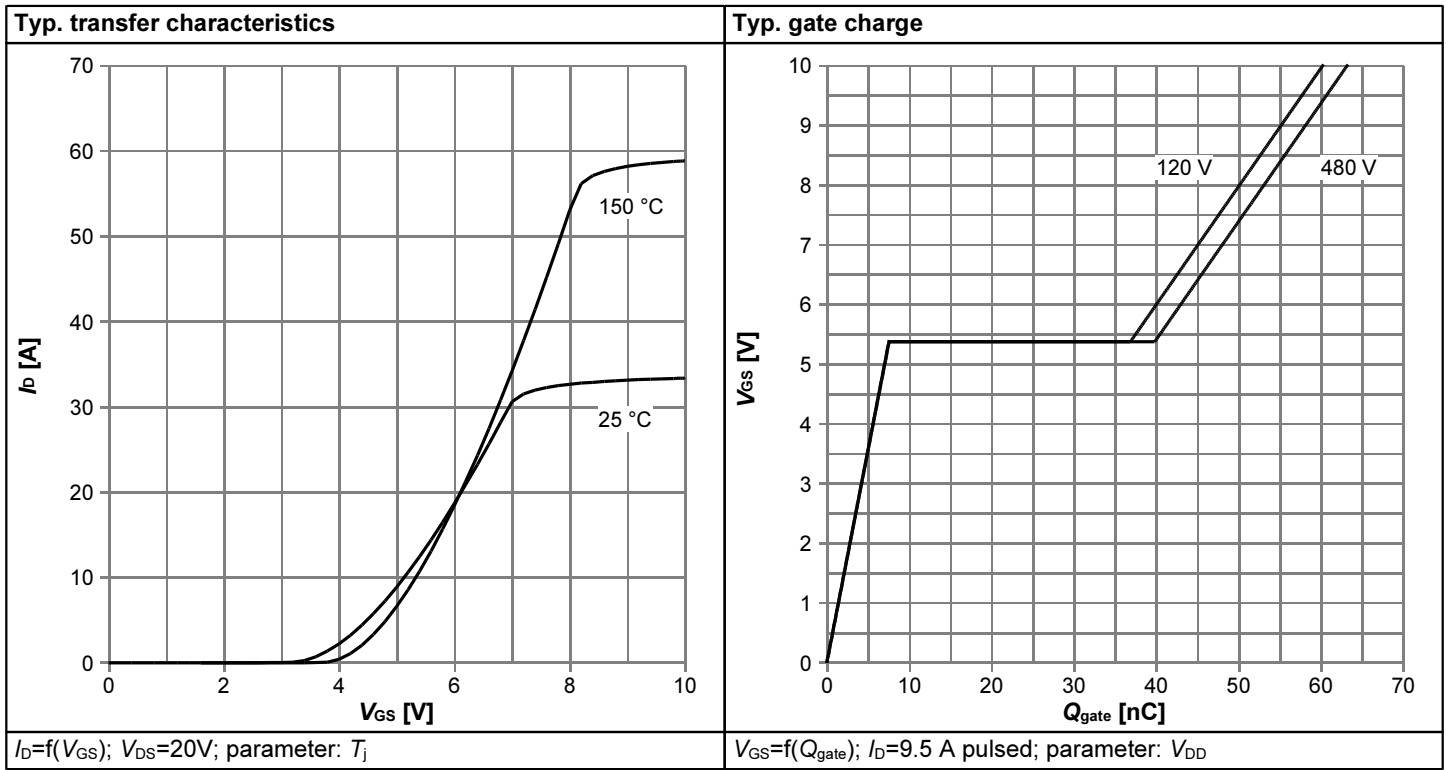
$I_D=f(V_{DS}); T_c=80^\circ\text{C}; D=0$ ; parameter:  $t_p$

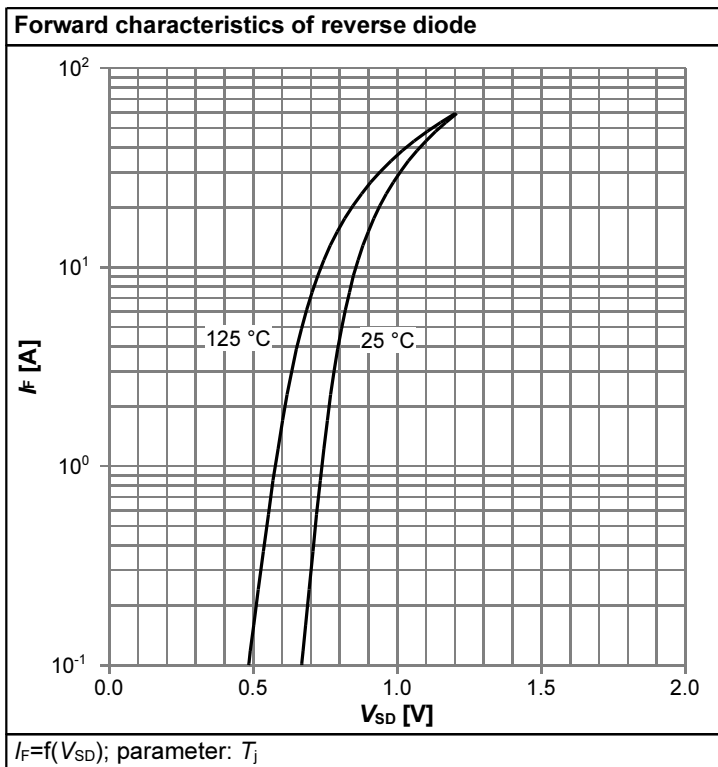
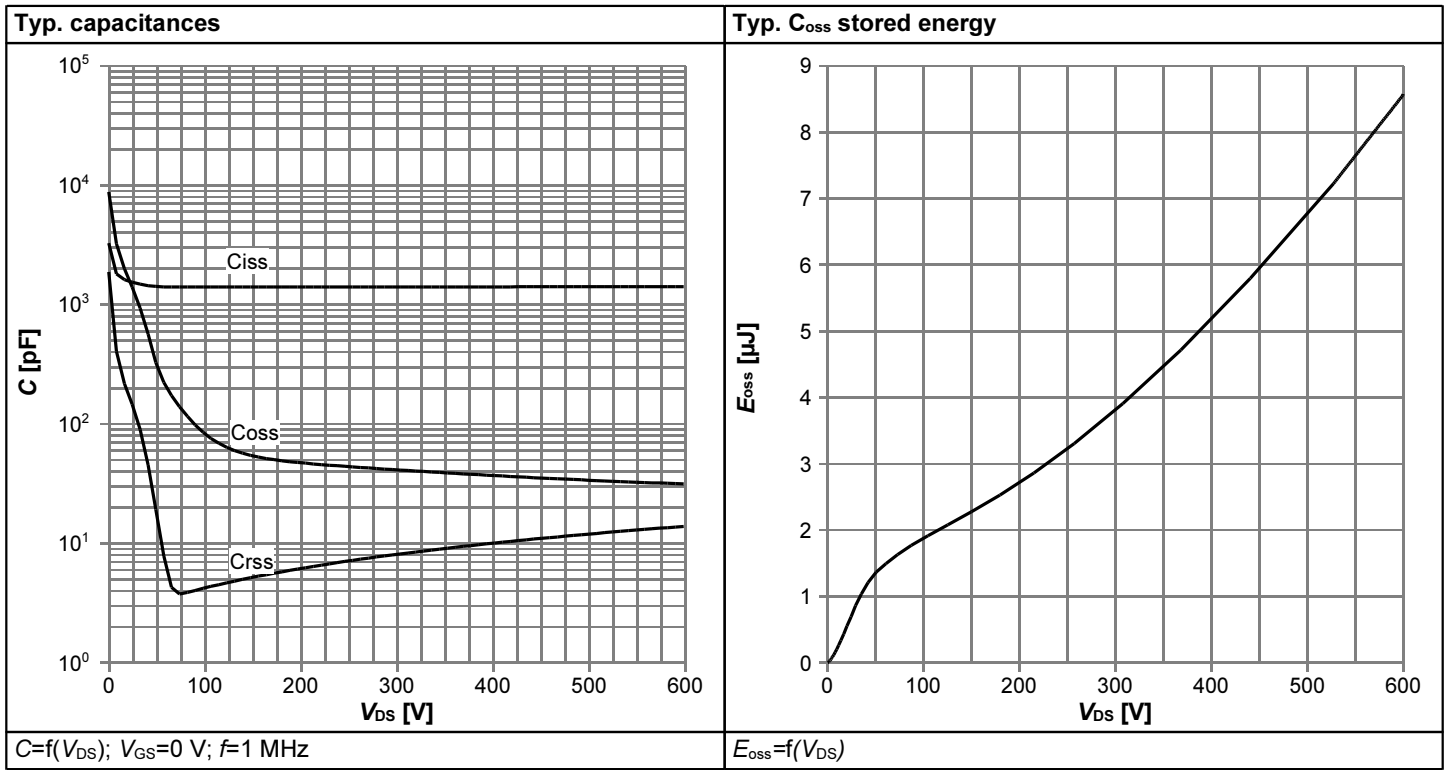
Safe operating area  $T_c=80^\circ\text{C}$  (FullPAK)



$I_D=f(V_{DS}); T_c=80^\circ\text{C}; D=0$ ; parameter:  $t_p$

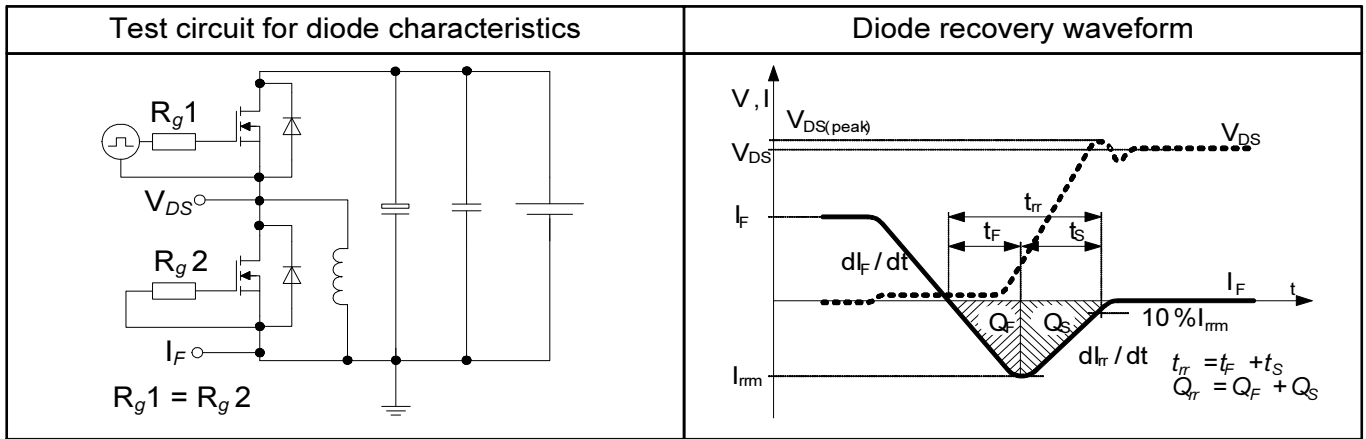




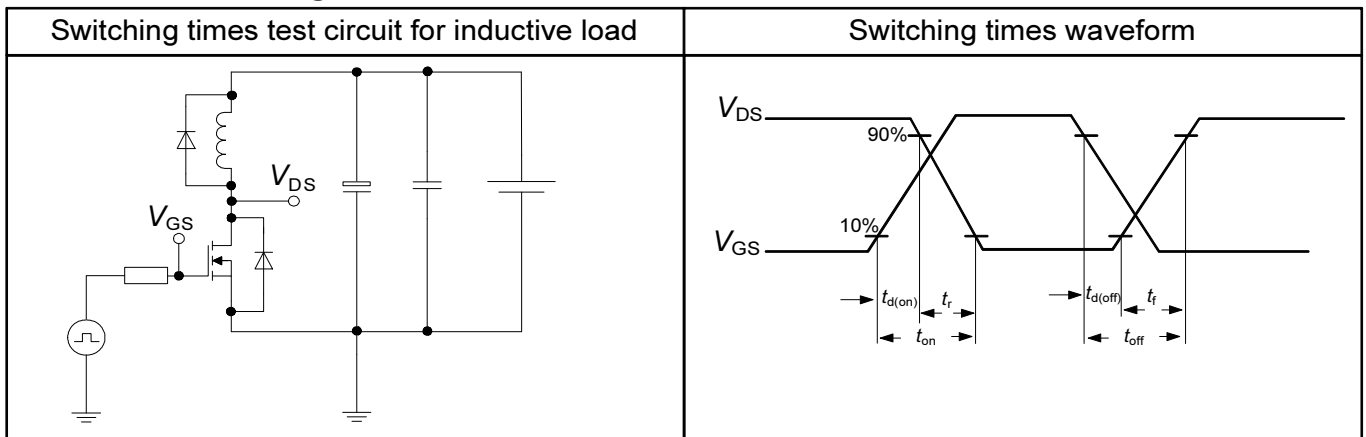


## 6 Test Circuits

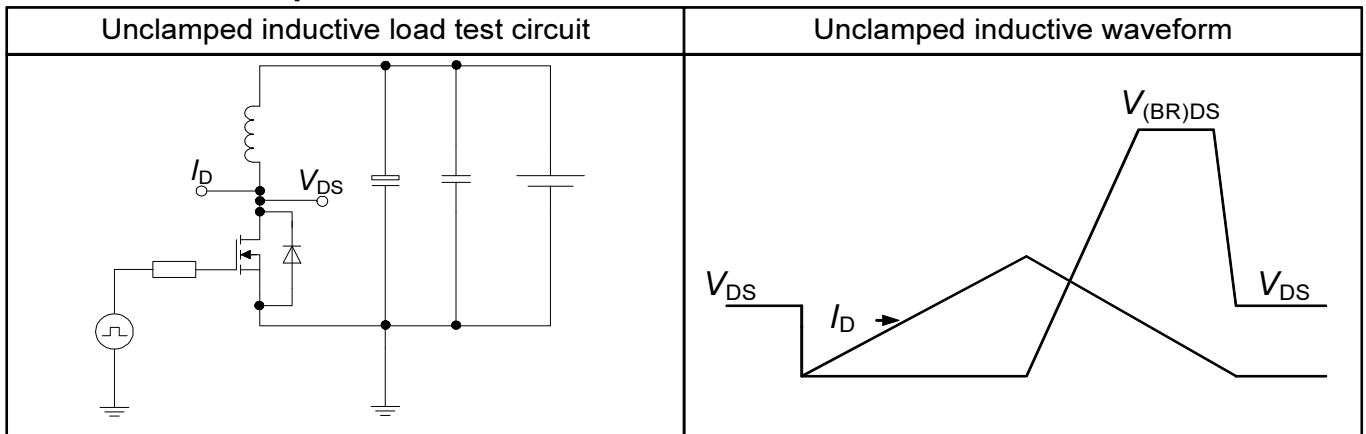
**Table 9 Diode characteristics**



**Table 10 Switching times**



**Table 11 Unclamped inductive load**



## 7 Package Outlines

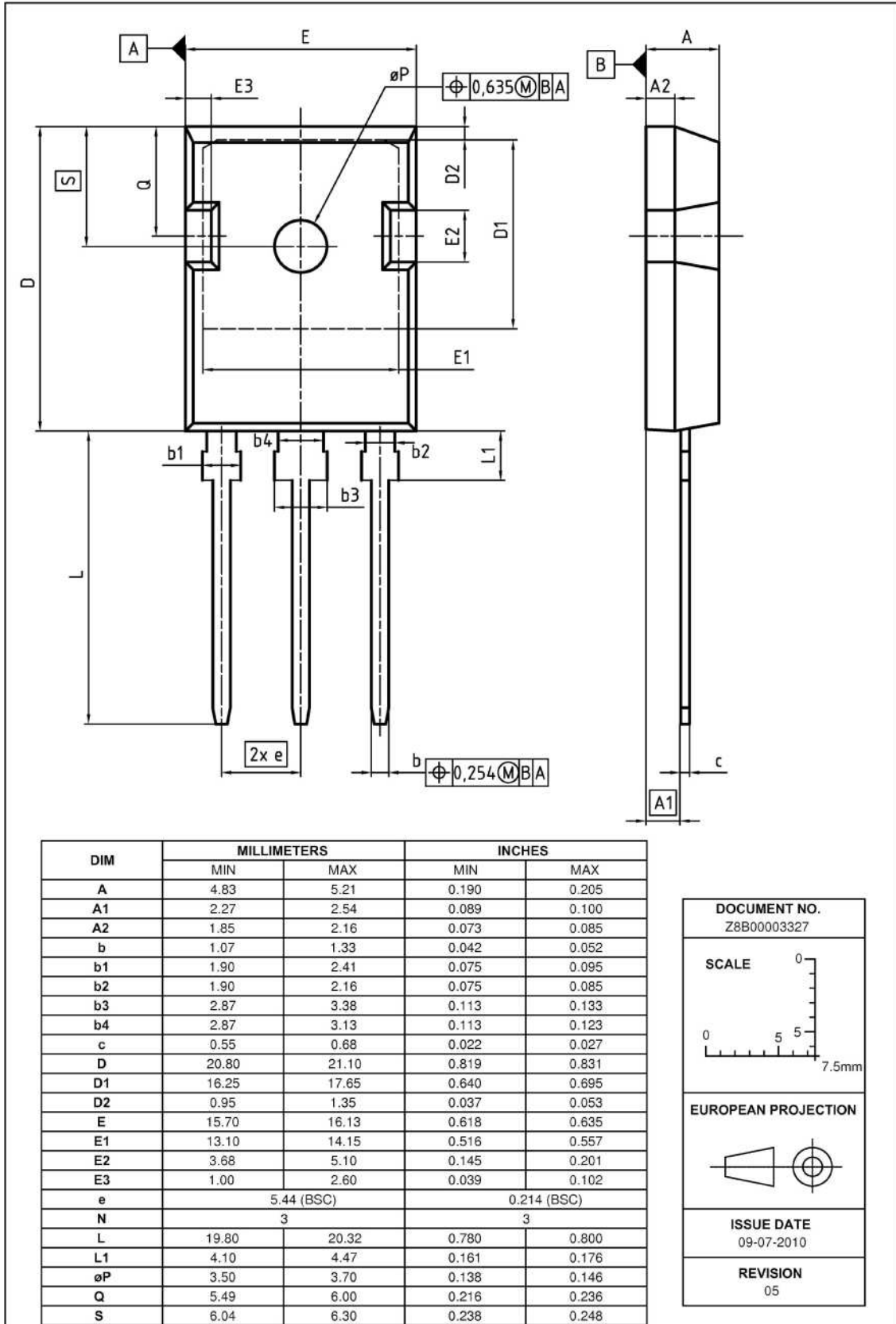


Figure 1 Outline PG-TO 247, dimensions in mm/inches

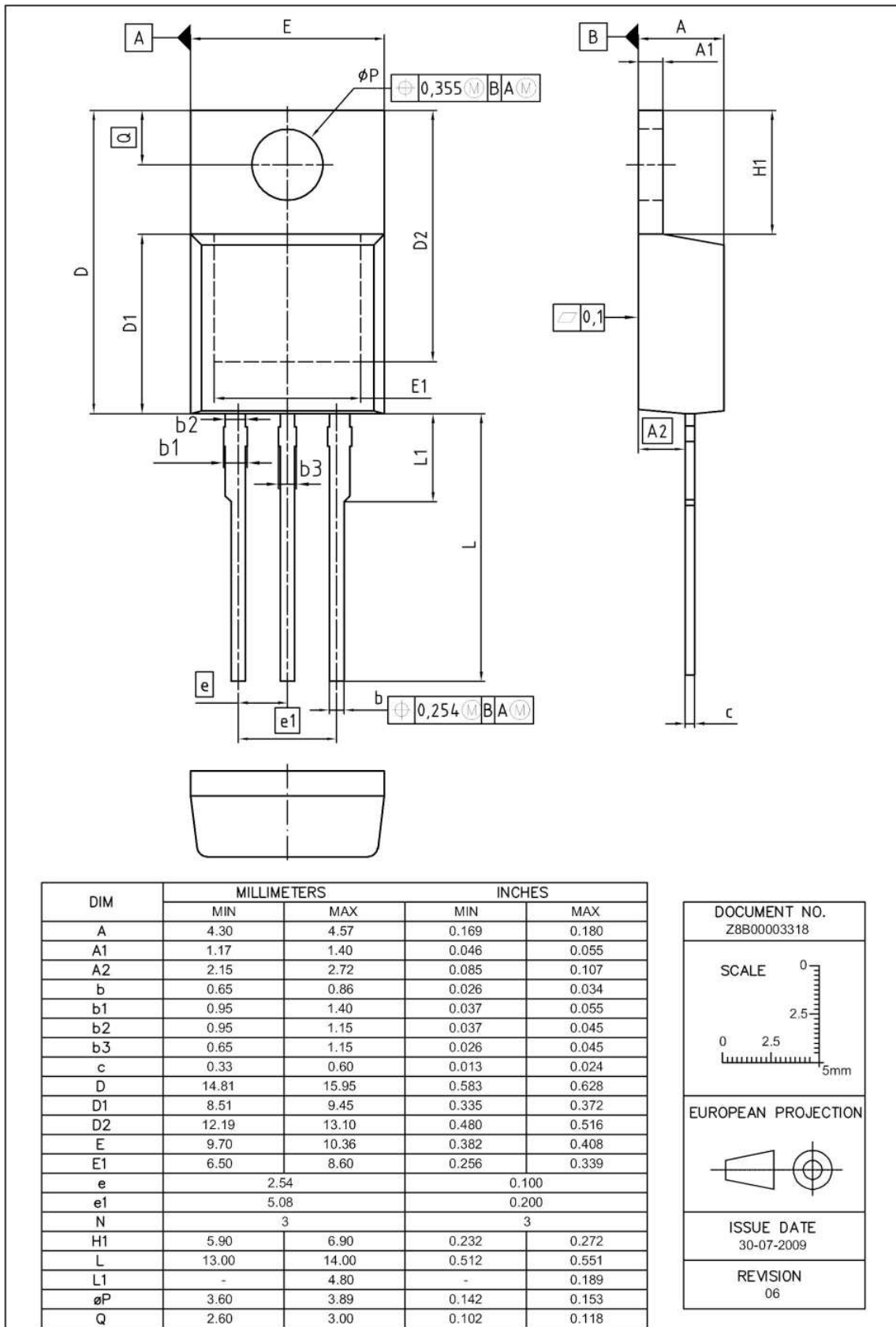
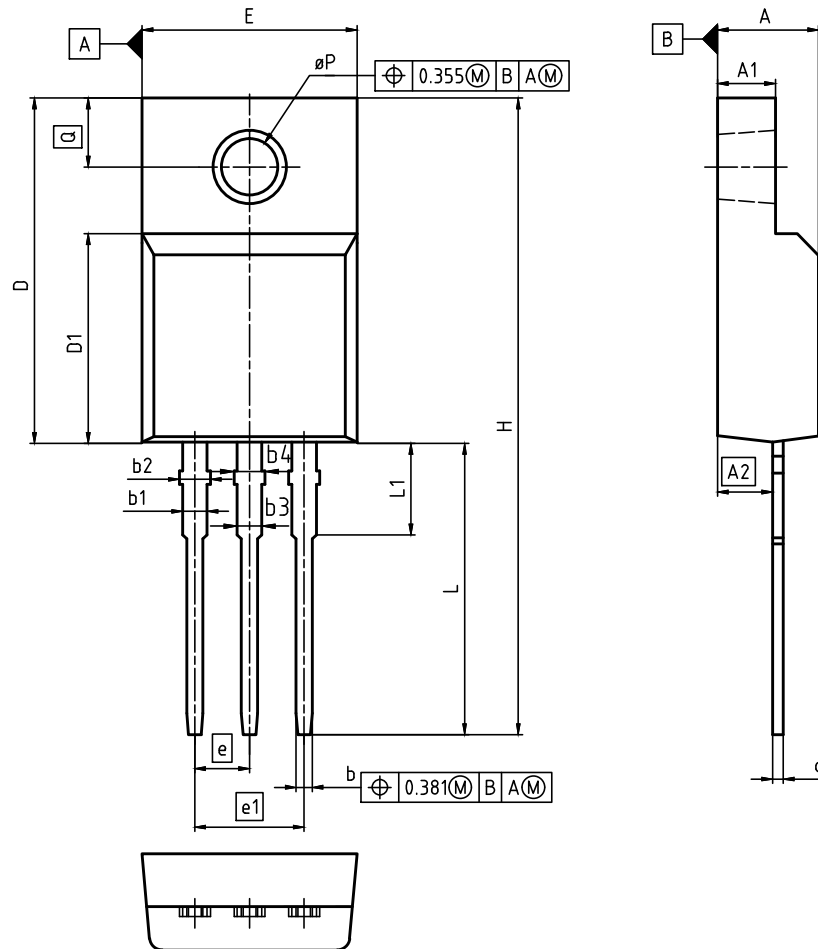


Figure 2 Outline PG-TO 220, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.50	4.90	0.177	0.193
A1	2.34	2.85	0.092	0.112
A2	2.42	2.86	0.095	0.113
b	0.65	0.90	0.026	0.035
b1	0.95	1.38	0.037	0.054
b2	0.95	1.51	0.037	0.059
b3	0.65	1.38	0.026	0.054
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.67	16.15	0.617	0.636
D1	8.97	9.83	0.353	0.387
E	10.00	10.65	0.394	0.419
e	2.54 (BSC)		0.100 (BSC)	
e1	5.08		0.200	
N	3		3	
H	28.70	29.75	1.130	1.171
L	12.78	13.75	0.503	0.541
L1	2.83	3.45	0.111	0.136
øP	2.95	3.38	0.116	0.133
Q	3.15	3.50	0.124	0.138

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Figure 3 Outline PG-TO 220 FullPAK, dimensions in mm/inches



## 8 Appendix A

### Table 12 Related Links

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

## Revision History

IPx60R190E6

**Revision: 2015-02-09, Rev. 2.3**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2011-06-08	Release of final data sheet
2.1	2011-09-14	-
2.2	2014-07-15	Package update and table reference correction
2.3	2015-02-09	PG-TO220 FullPAK package outline update (creation:2014-12-02)

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