

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ E6 600V

600V CoolMOS™ E6 Power Transistor
IPx60R380E6

Data Sheet

Rev. 2.5
Final

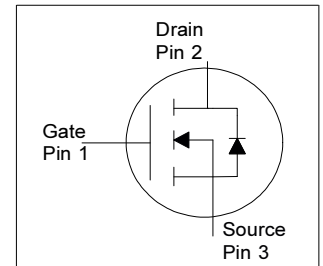
Industrial & Multimarket

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, available in Halogen free mold compound^{a)}
- Qualified for industrial grade applications according to JEDEC (J-S 7D20 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	Ω
Q_g,typ	32	nC
$I_D,pulse$	30	A
$E_{oss} @ 400V$	2.8	μJ
Body diode di/dt	500	A/ μs

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

a) For PG-TO 252: non-Halogen free (OPN: IPD60R380E6BT); Halogen free (OPN: IPD60R380E6AT)

Table of Contents

Description	2
Table of Contents	3
Maximum ratings	4
Thermal characteristics	5
Electrical characteristics	6
Electrical characteristics diagrams	8
Test Circuits	13
Package Outlines	14
Appendix A	17
Revision History	18
Disclaimer	18

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			10.6	A	$T_C = 25^\circ\text{C}$
				6.7		$T_C = 100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$			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 ³⁾	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/ μs	

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

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

³⁾ 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	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}			4.0	°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

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 ¹⁾	R_{thJA}			62	°C/W	SMD version, device on PCB, minimal footprint
			35			SMD version, device on PCB, 6cm ² cooling area
Soldering temperature, wave- & reflowsoldering allowed	T_{sold}			260	°C	reflow MSL

¹⁾ Device on 40mm*40mm*1.5mm one layer epoxy PCB FR4 with 6cm² 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	μA	$V_{DS} = 600V, V_{GS} = 0V, T_j = 25^\circ C$
			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	Ω	$V_{GS} = 10V, I_D = 3.8A, T_j = 25^\circ C$
			0.890			$V_{GS} = 10V, I_D = 3.8A, T_j = 150^\circ C$
Gate resistance	R_G		7.5		Ω	$f = 1MHz$, 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 ¹⁾	$C_{o(er)}$		30		pF	$V_{GS} = 0V, V_{DS} = 0 \dots 480V$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$		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	

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 80% $V_{(BR)DSS}$

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 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		μC	
Peak reverse recovery current	I_{rrm}		21		A	

5 Electrical characteristics diagrams

Table 10

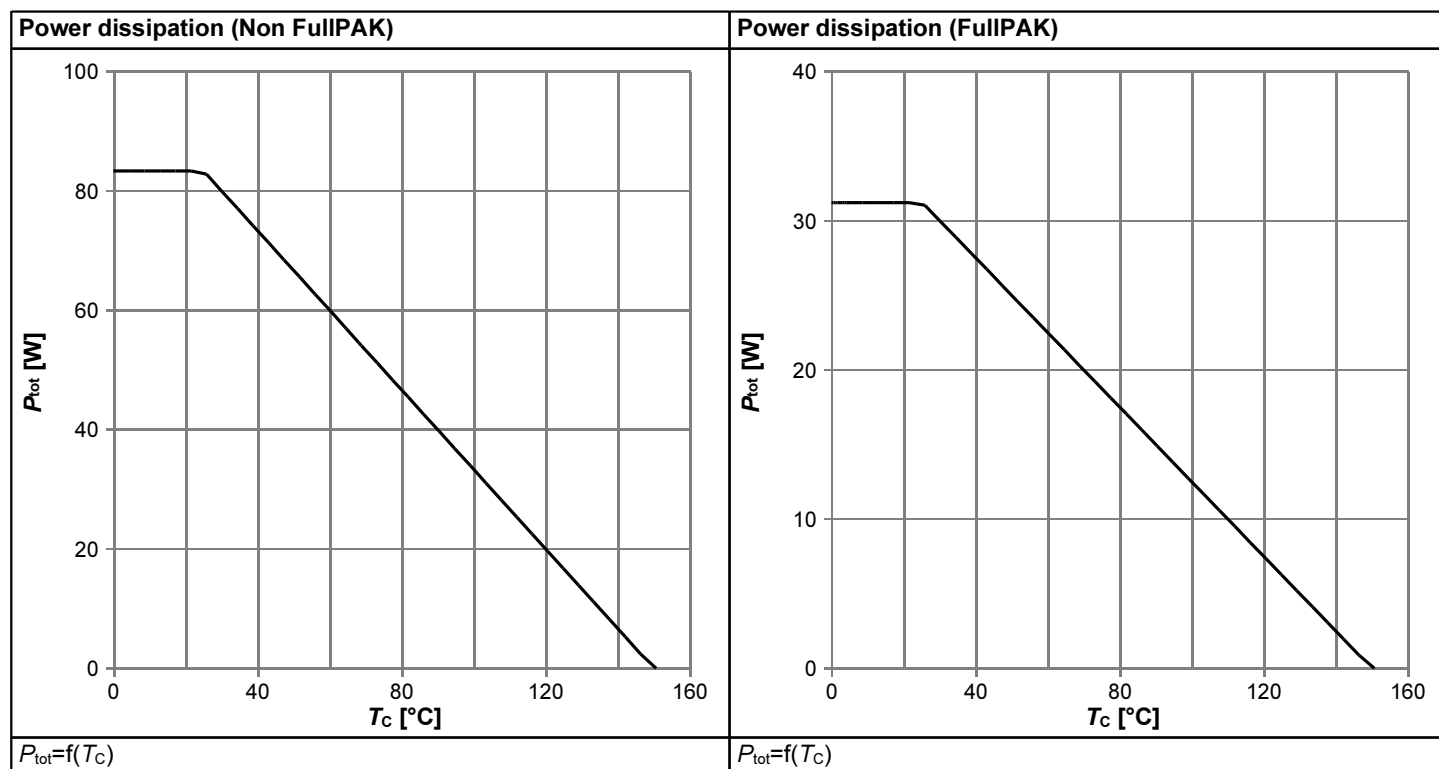


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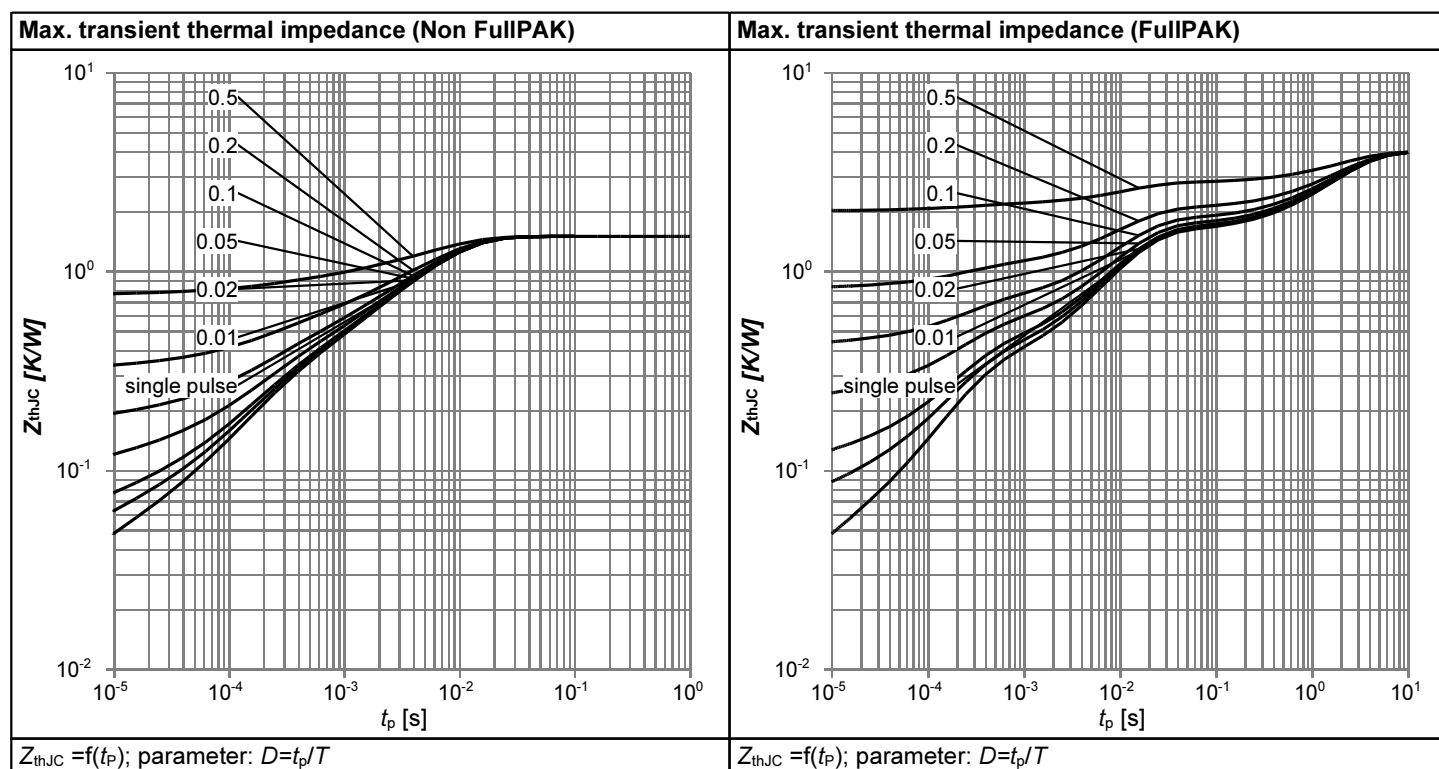


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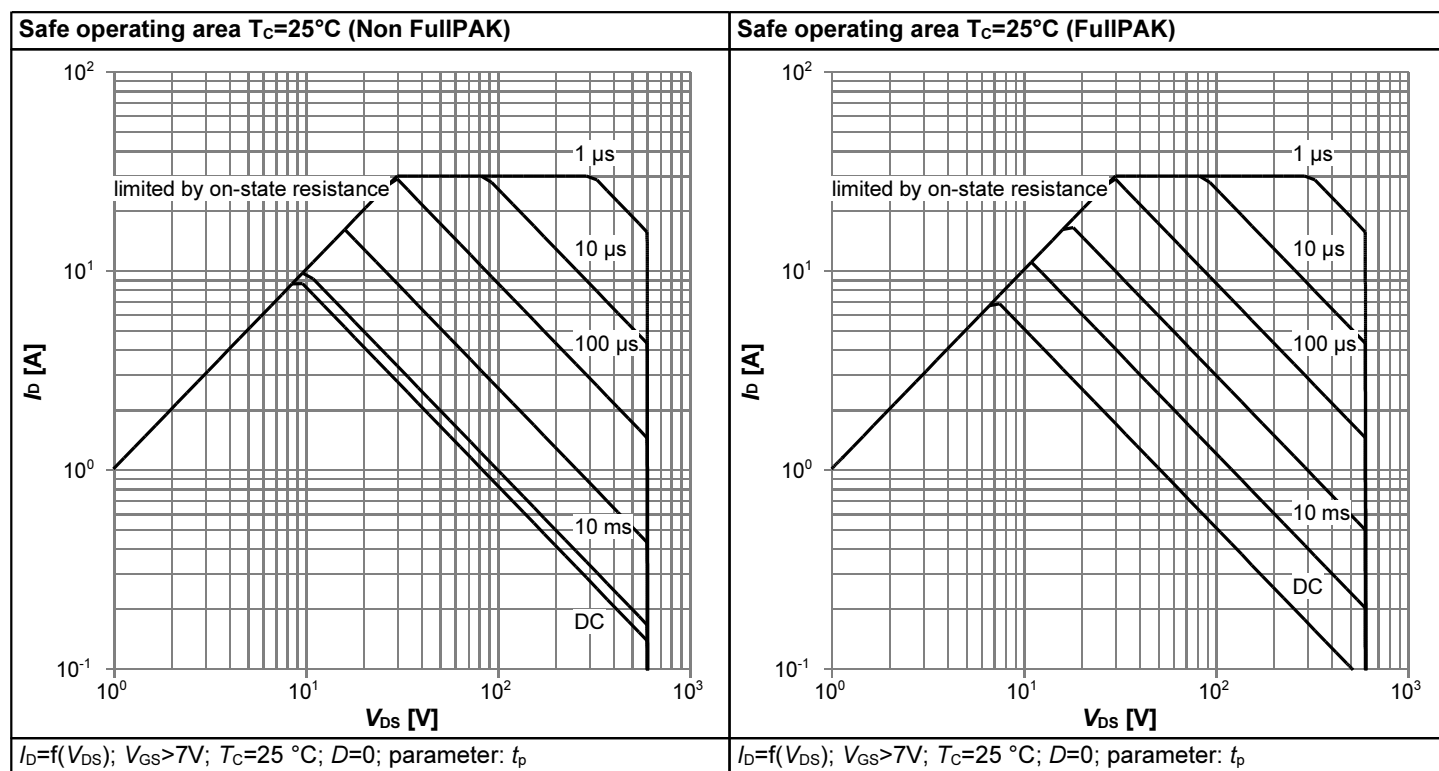


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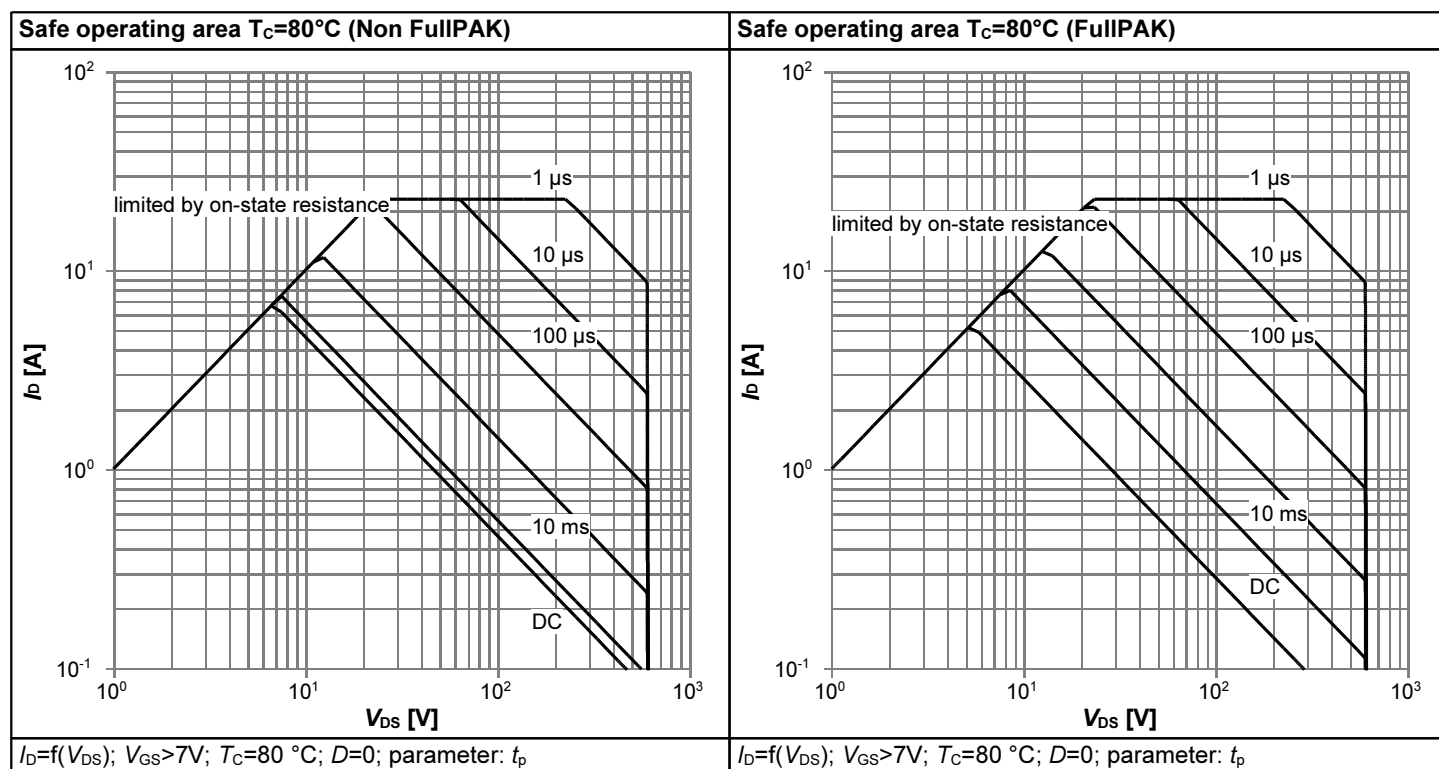


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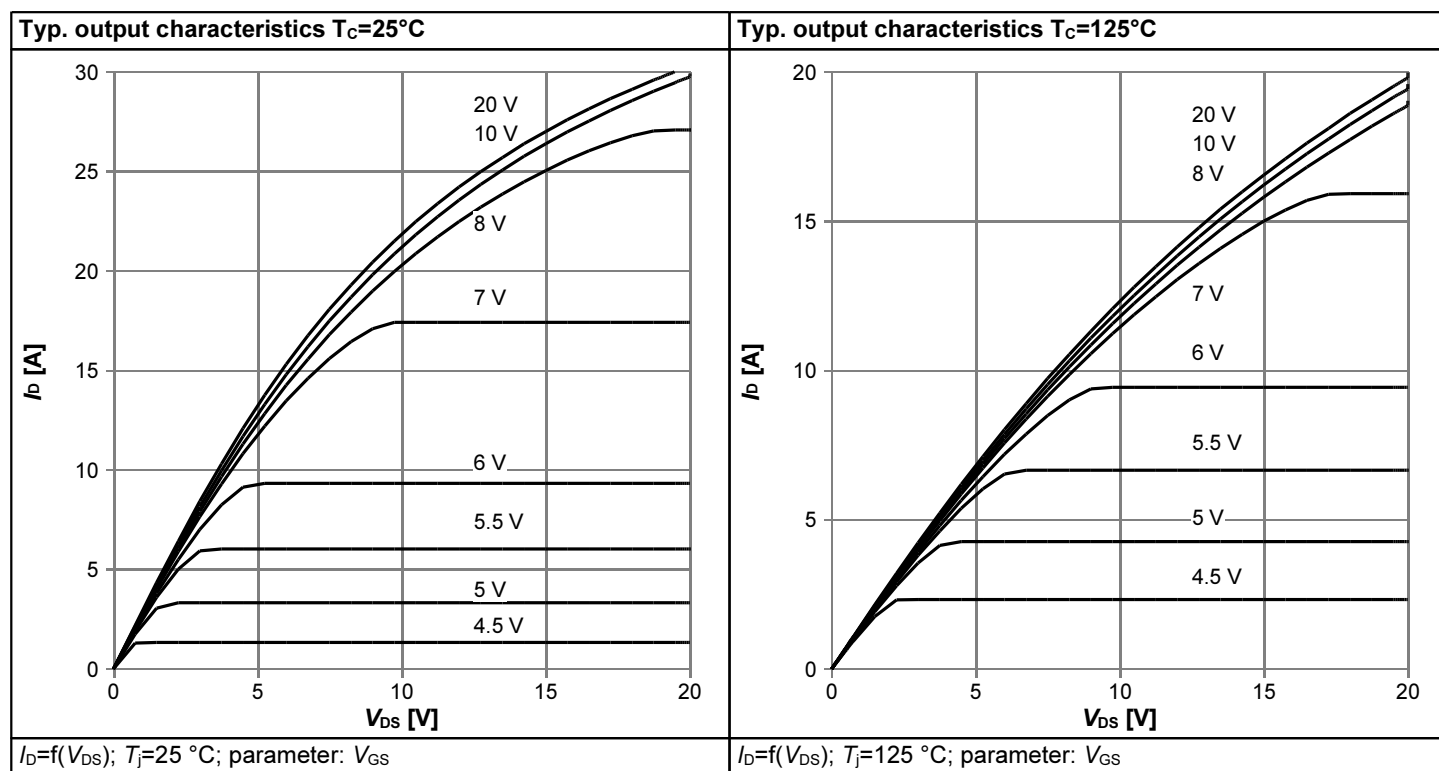


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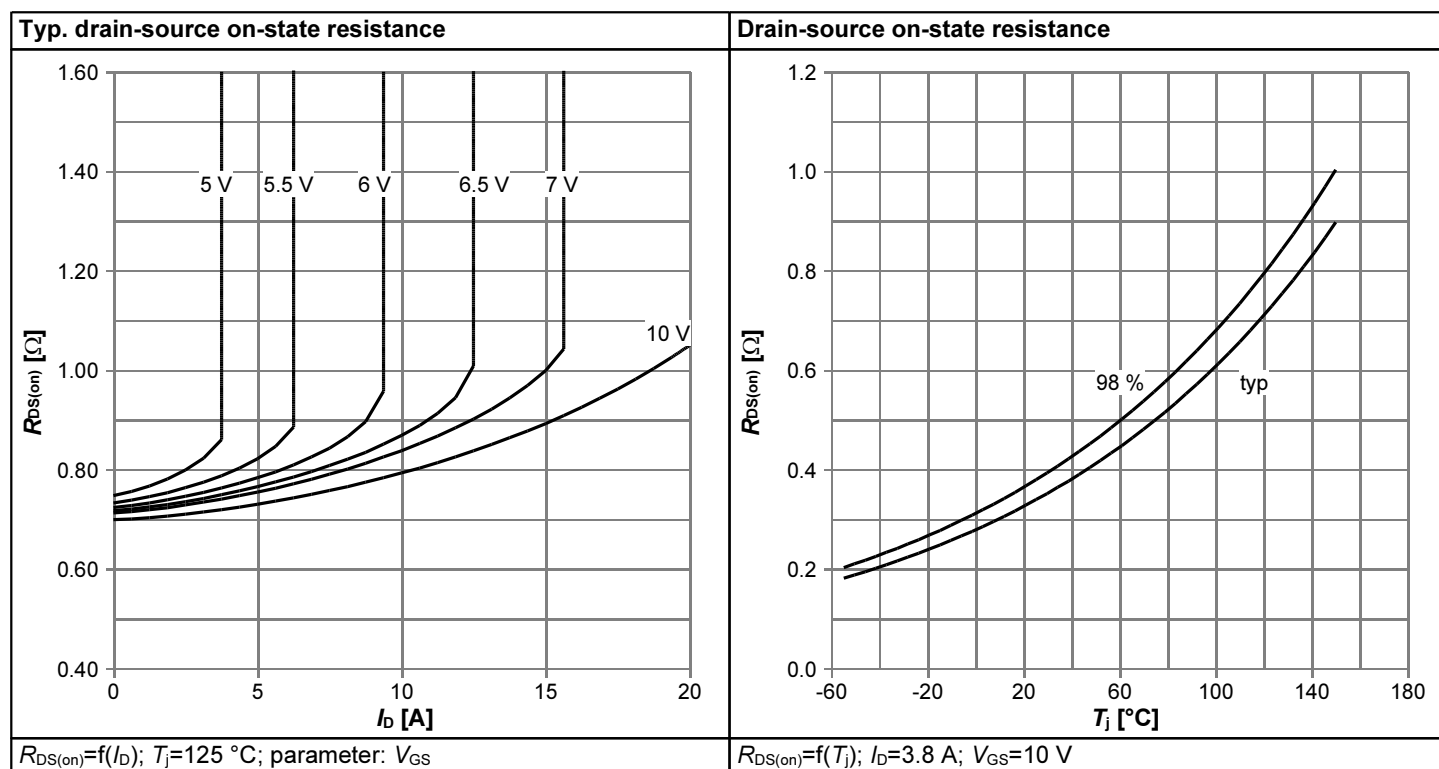


Table 16

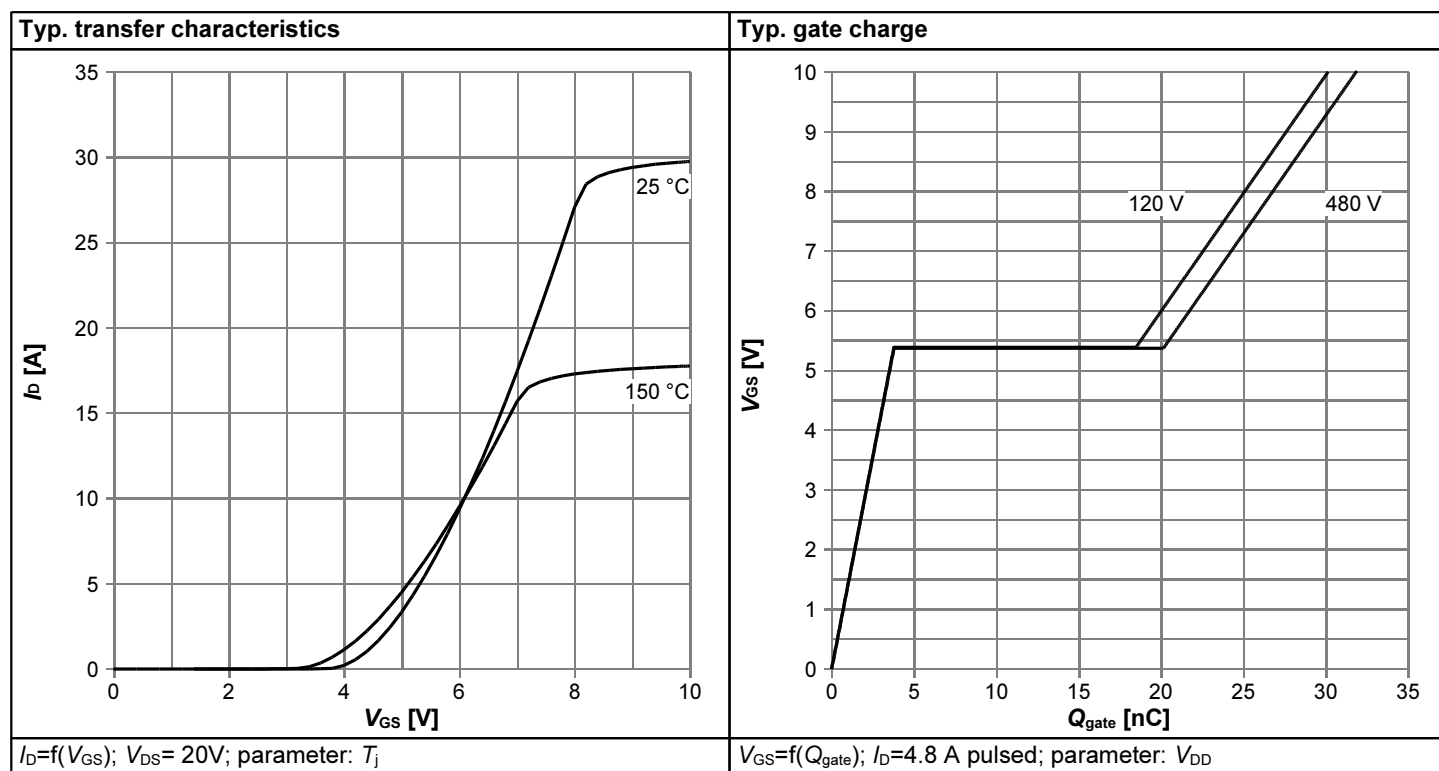


Table 17

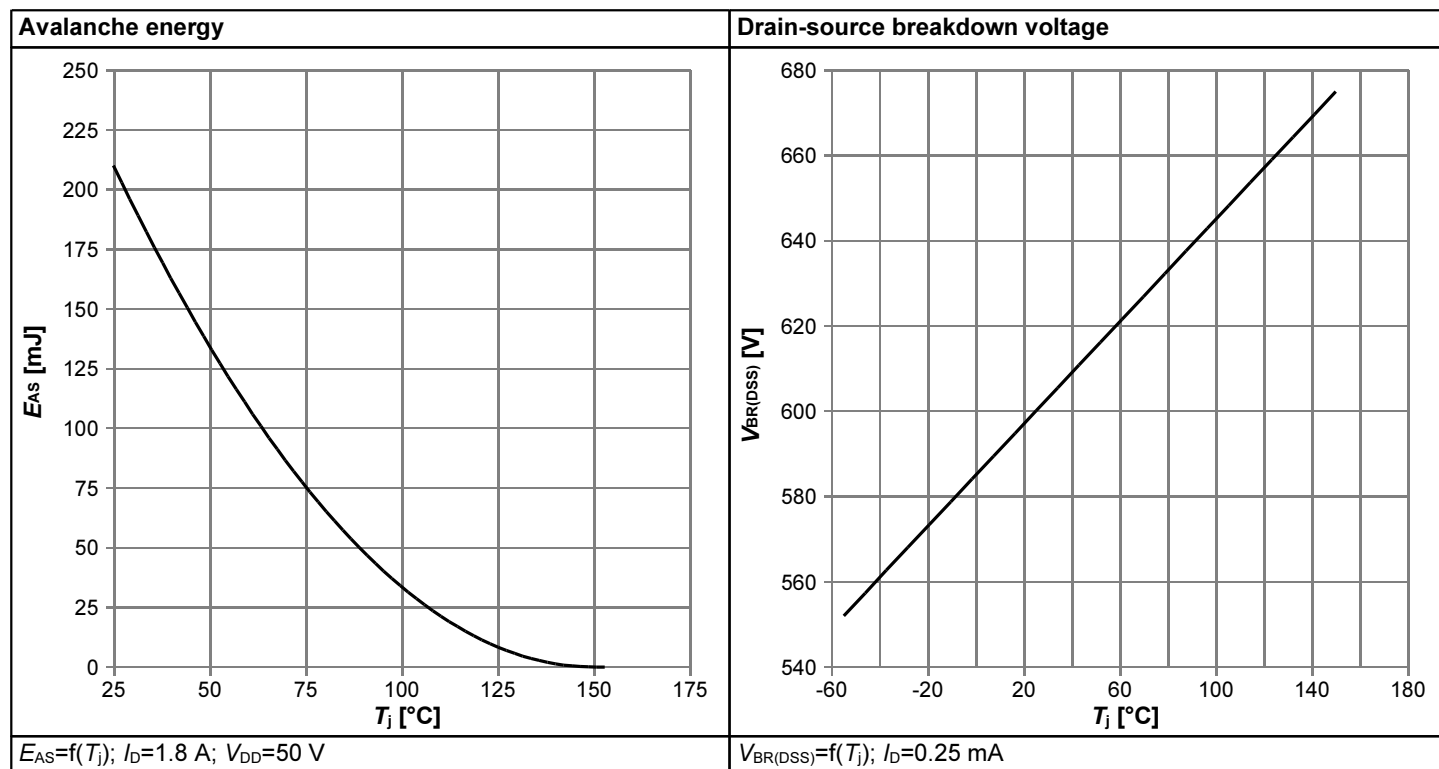


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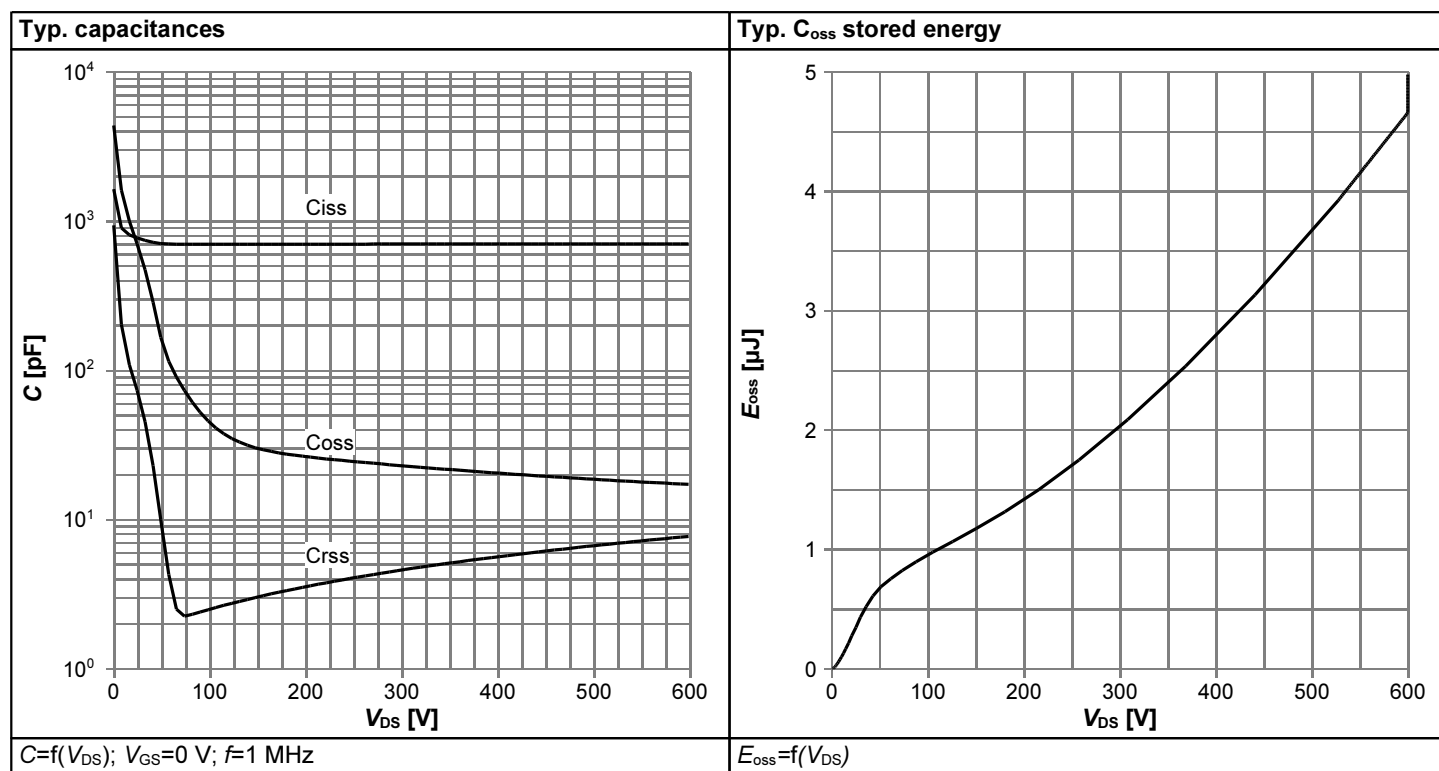
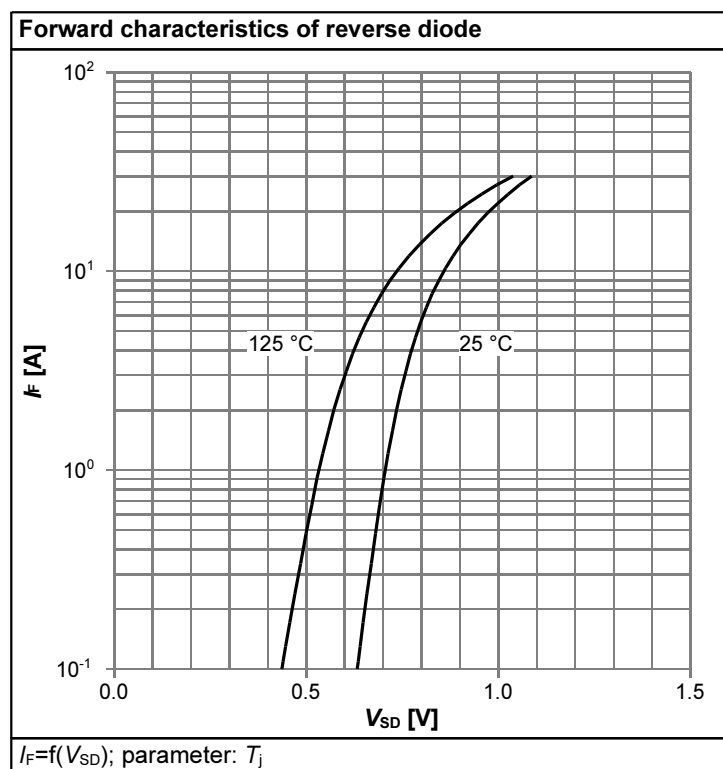


Table 19



6 Test Circuits

Table 20 Diode characteristics

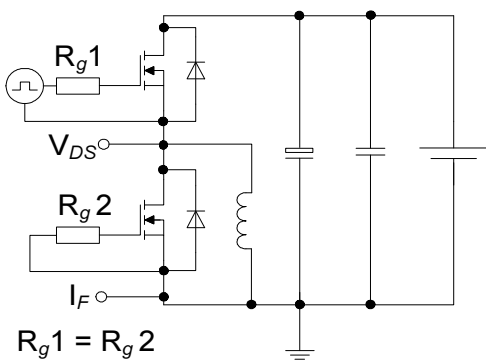
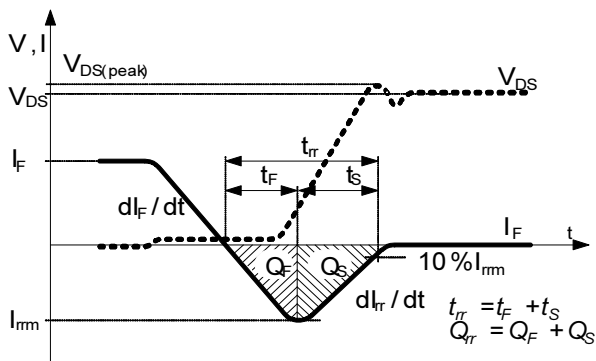
Test circuit for diode characteristics	Diode recovery waveform
 $R_{g1} = R_{g2}$	 $t_{rr} = t_F + t_S$ $Q_{rr} = Q_F + Q_S$

Table 21 Switching times

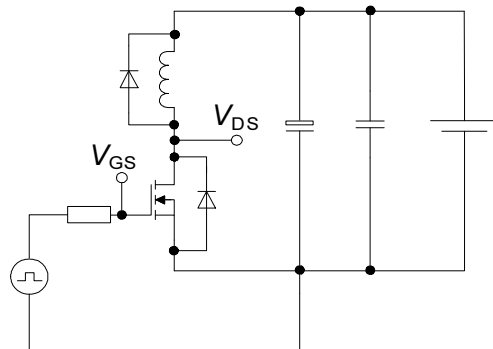
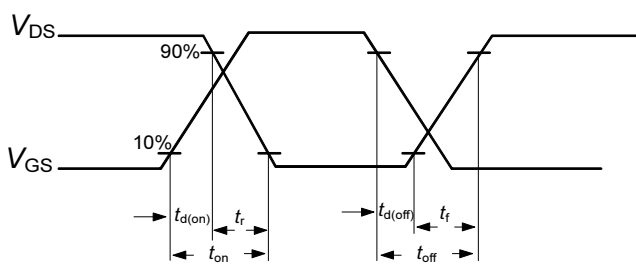
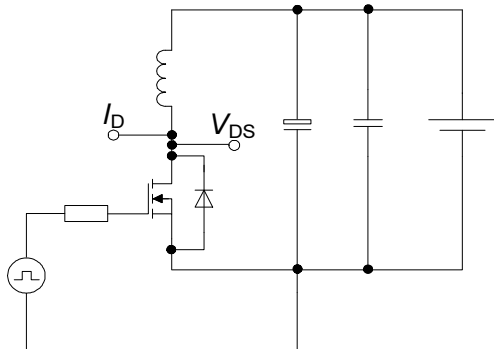
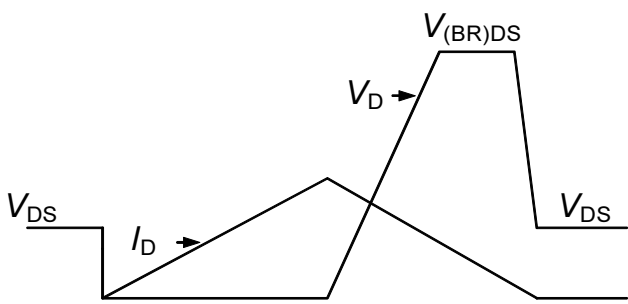
Switching times test circuit for inductive load	Switching times waveform
	

Table 22 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

7 Package Outlines

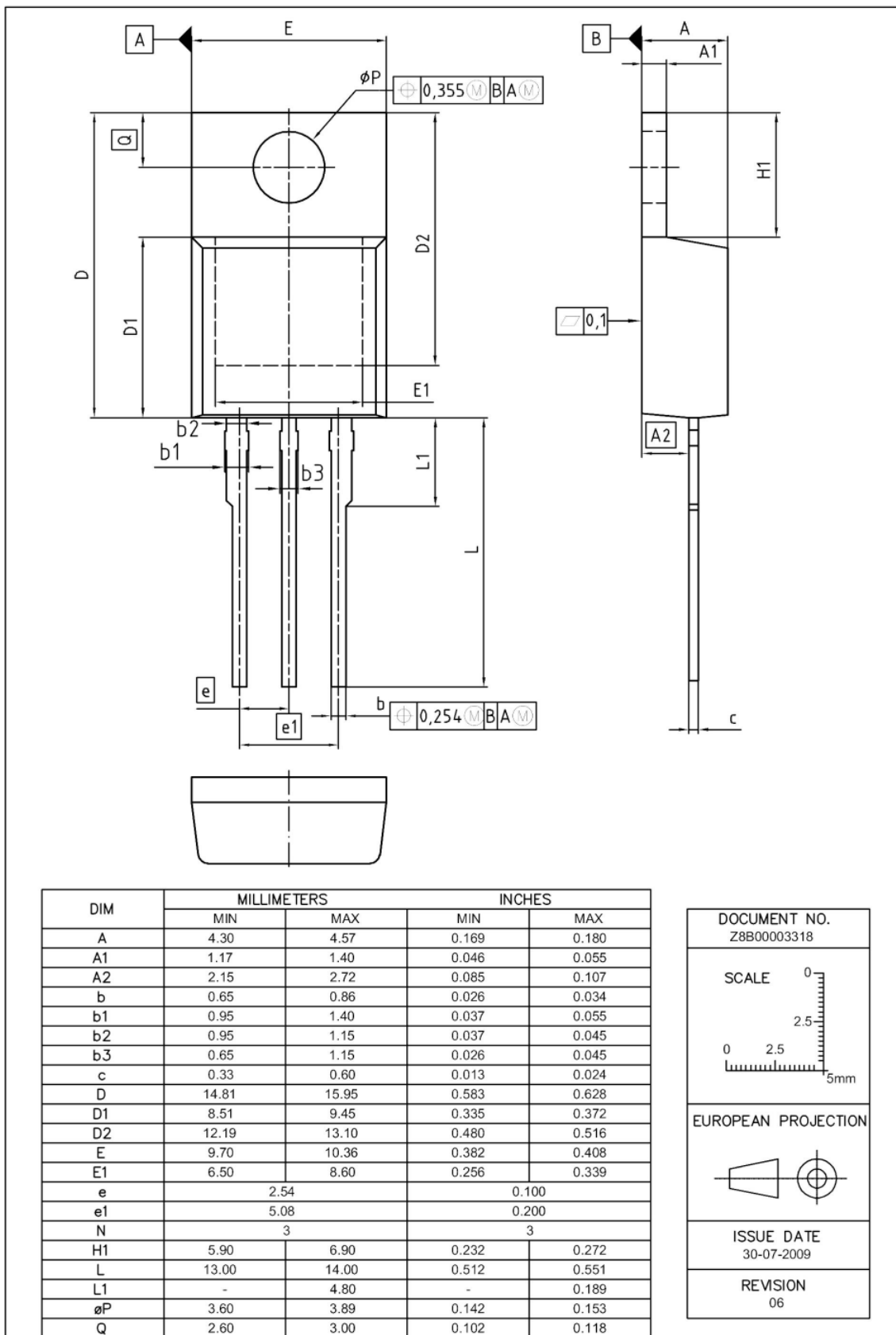


Figure 1 Outline PG-TO 220, dimensions in mm/inches

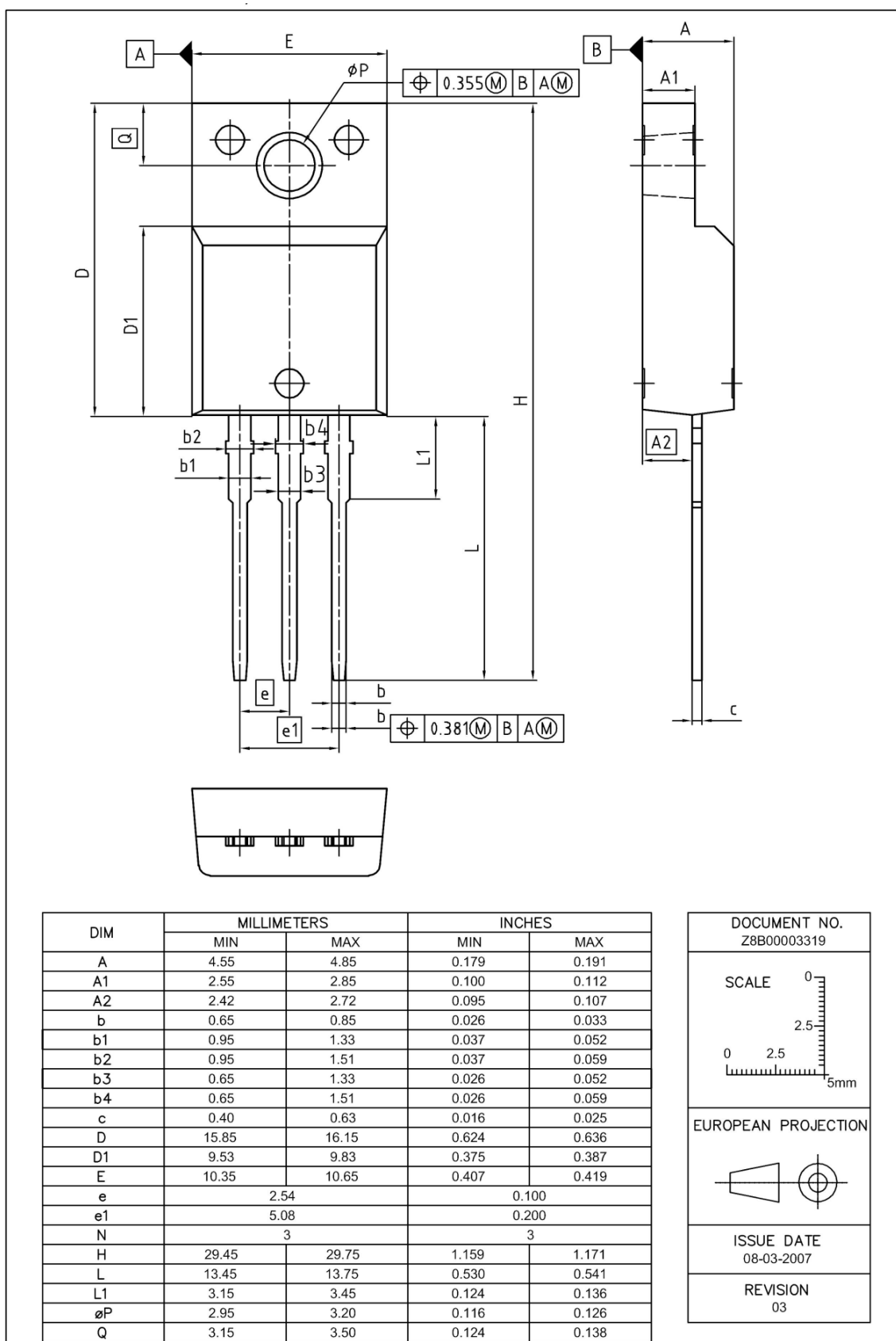


Figure 2 Outline PG-TO 220 FullPAK, dimensions in mm/inches

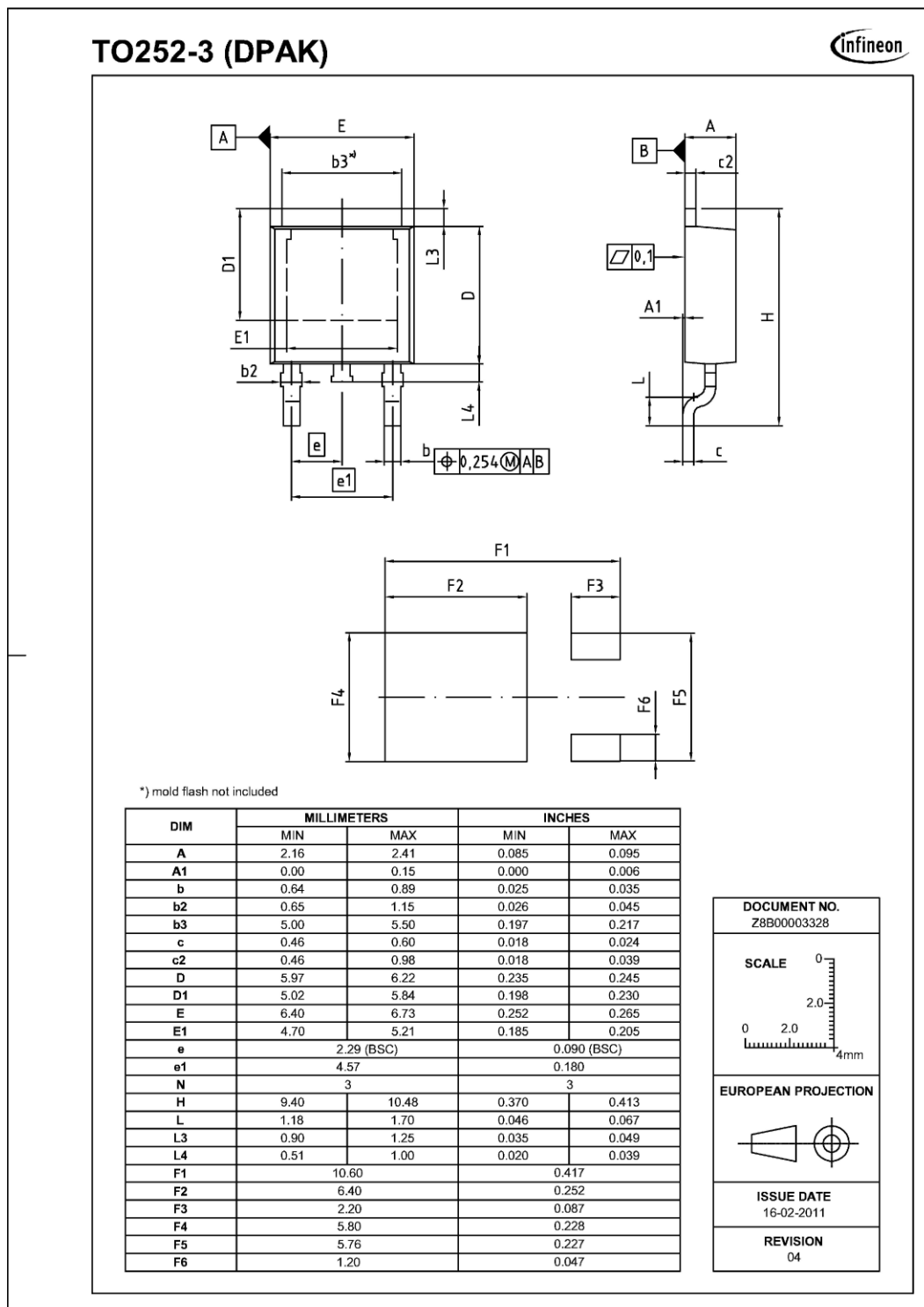


Figure 3 Outline PG-TO 252, dimensions in mm/inches

8 Appendix A

Table 23 Related Links

- IFX CoolMOS Webpage: www.infineon.com
- IFX Design Tools: www.infineon.com

Revision History

IPP60R380E6, IPA60R380E6, IPD60R380E6

Revision History: 2013-07-31, Rev. 2.5

Previous Revision: 2.4

Revision	Date	Subjects (major changes since last revision)
2.0	2011-06-08	Release Final data sheet
2.1	2011-09-14	-
2.2	2011-09-14	-
2.3	2011-09-20	-
2.4	2013-05-15	PG-TO252 Package Added
2.5	2013-07-31	Update halogen free mold compound status of PG-TO 252 package

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