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# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ CFD2 650V

650V CoolMOS™ CFD2 Power Transistor  
IPx65R420CFD

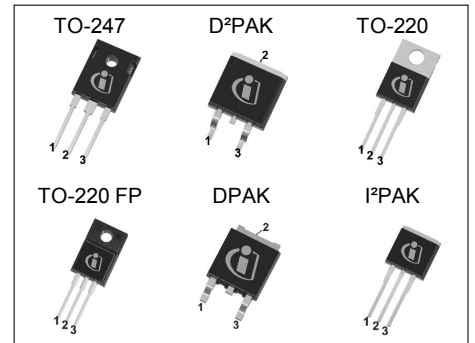
## Data Sheet

Rev. 2.5  
Final



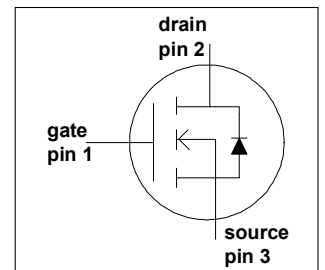
## 1 Description

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. 650V CoolMOS™ CFD2 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 offering an extremely fast and robust body diode. This combination of extremely low switching, commutation and conduction losses together with highest robustness make especially resonant switching applications more reliable, more efficient, lighter and cooler.



## Features

- Ultra-fast body diode
- Very high commutation ruggedness
- Extremely low losses due to very low FOM  $R_{ds(on)} \cdot Q_g$  and  $E_{oss}$
- Easy to use/drive, available in Halogen free mold compound<sup>1)</sup>
- Qualified for industrial (J-STD20 and JESD22)
- Pb-free plating, Halogen free mold compound (except PG-TO252)



## Applications

650V CoolMOS™ CFD2 is especially suitable for resonant switching PWM stages for e.g. PC Silverbox, LCD TV, Lighting, Server and Telecom



**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{DS} @ T_{j \max}$	700	V
$R_{DS(on),max}$	0.42	$\Omega$
$Q_g,typ$	31.5	nC
$I_D,pulse$	27	A
$E_{oss} @ 400V$	2.8	$\mu J$
Body diode $di/dt$	900	A/ $\mu s$
$Q_{rr}$	0.3	$\mu C$
$t_{rr}$	90	ns
$I_{rrm}$	6.2	A

Type / Ordering Code	Package	Marking	Related Links
IPW65R420CFD	PG-TO 247	65F6420	see Appendix A
IPB65R420CFD	PG-TO 263		
IPP65R420CFD	PG-TO 220		
IPA65R420CFD	PG-TO 220 FullPAK		
IPD65R420CFD	PG-TO 252		
IPI65R420CFD	PG-TO 262		

1) For PG-TO 252: non-Halogen free (OPN: IPD65R420CFDBT); Halogen free (OPN: IPD65R420CFDAT)



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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>	$I_D$			8.7	A	$T_C = 25^\circ\text{C}$
				5.5		$T_C = 100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$			27	A	$T_C = 25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$			227	mJ	$I_D = 1.8\text{A}$ , $V_{DD} = 50\text{V}$ (see table 22)
Avalanche energy, repetitive	$E_{AR}$			0.34	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	$V_{DS} = 0 \dots 400\text{V}$
Gate source voltage	$V_{GS}$	-20		20	V	static
		-30		30		AC ( $f > 1\text{Hz}$ )
Power dissipation (non FullPAK) TO-247, TO-220, I <sup>2</sup> PAK	$P_{tot}$			83.3	W	$T_C = 25^\circ\text{C}$
Power dissipation (FullPAK) TO-220 FP	$P_{tot}$			31.2	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, I <sup>2</sup> PAK				60	Ncm	M3 and M3.5 screws
Mounting torque (FullPAK) TO-220 FP				50	Ncm	M2.5 screws
Continuous diode forward current	$I_S$			8.7	A	$T_C = 25^\circ\text{C}$
Diode pulse current	$I_{S,pulse}$			27	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt			50	V/ns	$V_{DS} = 0 \dots 400\text{V}$ , $I_{SD} \leq I_D$ , $T_j = 25^\circ\text{C}$ (see table 20)
Maximum diode commutation speed	$di_r/dt$			900	A/ $\mu\text{s}$	

<sup>1)</sup> Limited by  $T_{j\text{max}}$ .

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

<sup>3)</sup>  $V_{peak} < V_{(BR)DSS}$ ,  $T_j < T_{j\text{max}}$ , identical low side and high side switch with same  $R_g$

### 3 Thermal characteristics

**Table 3 Thermal characteristics TO-247, TO-220, I<sup>2</sup>PAK**

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	°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 D<sup>2</sup>PAK, 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	$V_{(BR)DSS}$	650			V	$V_{GS} = 0V, I_D = 1mA$
Gate threshold voltage	$V_{GS(th)}$	3.5	4	4.5	V	$V_{DS} = V_{GS}, I_D = 0.3mA$
Zero gate voltage drain current	$I_{DSS}$			1	$\mu A$	$V_{DS} = 650V, V_{GS} = 0V, T_j = 25^\circ C$
			100			$V_{DS} = 650V, V_{GS} = 0V, T_j = 150^\circ C$
Gate-source leakage current	$I_{GSS}$			100	nA	$V_{GS} = 20V, V_{DS} = 0V$
Drain-source on-state resistance	$R_{DS(on)}$		0.378	0.42	$\Omega$	$V_{GS} = 10V, I_D = 3.4A, T_j = 25^\circ C$
			0.983			$V_{GS} = 10V, I_D = 3.4A, T_j = 150^\circ C$
Gate resistance	$R_G$		4		$\Omega$	$f = 1MHz, \text{open drain}$

**Table 7 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$		870		pF	$V_{GS} = 0V, V_{DS} = 100V, f = 1MHz$
Output capacitance	$C_{oss}$		45		pF	
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$		36		pF	$V_{GS} = 0V, V_{DS} = 0 \dots 400V$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$		161		pF	$I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 400V$
Turn-on delay time	$t_{d(on)}$		10		ns	$V_{DD} = 400V, V_{GS} = 13V, I_D = 5.2A, R_G = 3.4\Omega$ (see table 21)
Rise time	$t_r$		7		ns	
Turn-off delay time	$t_{d(off)}$		38		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	$Q_{gs}$		6.4		nC	$V_{DD} = 480V, I_D = 5.2A, V_{GS} = 0 \text{ to } 10V$
Gate to drain charge	$Q_{gd}$		18.6		nC	
Gate charge total	$Q_g$		31.5		nC	
Gate plateau voltage	$V_{plateau}$		6.4		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 400V

<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 400V



**Table 9 Reverse diode characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	$V_{SD}$		0.9		V	$V_{GS} = 0V, I_F = 5.2A, T_j = 25^\circ C$
Reverse recovery time	$t_{rr}$		90		ns	$V_R = 400V, I_F = 5.2A,$ $di_F/dt = 100A/\mu s$ (see table 20)
Reverse recovery charge	$Q_{rr}$		0.3		$\mu C$	
Peak reverse recovery current	$I_{rrm}$		6.2		A	



## 5 Electrical characteristics diagrams

Table 10

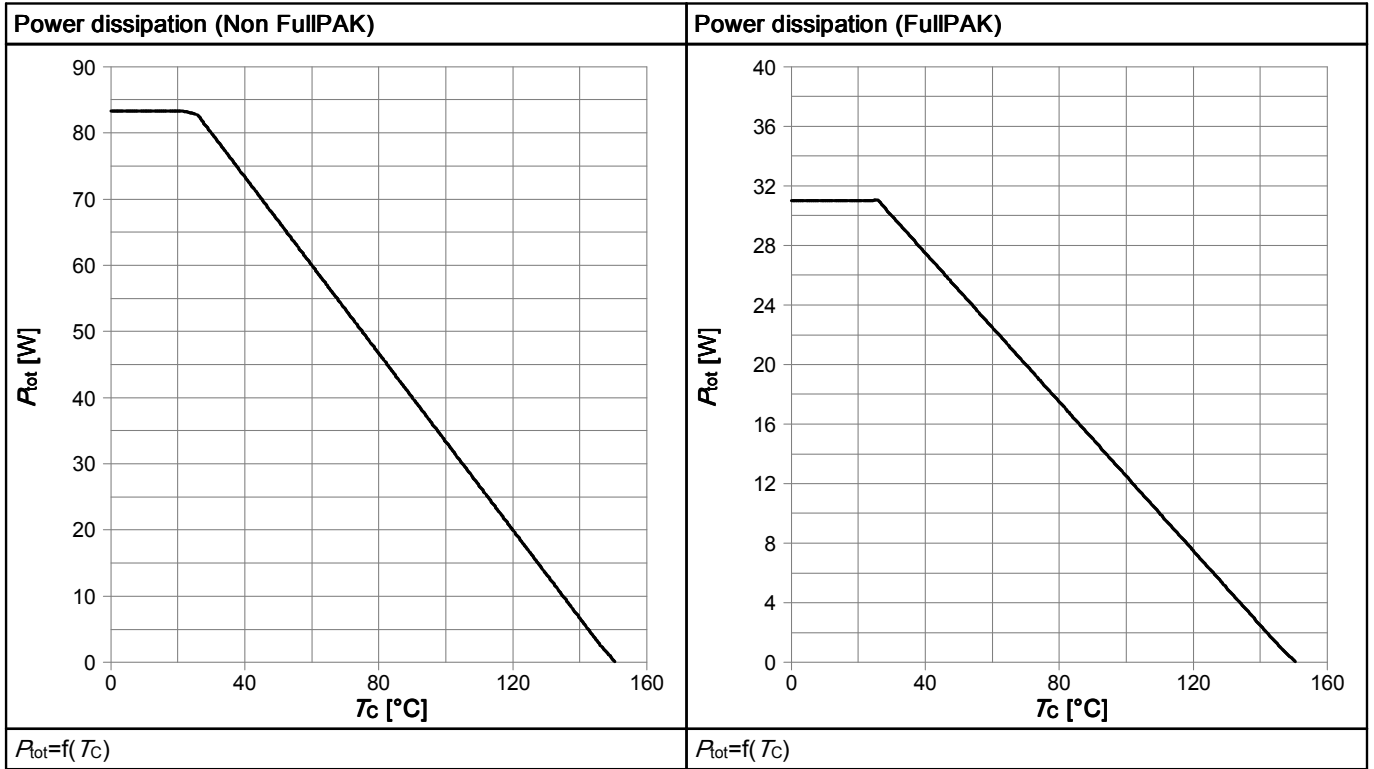


Table 11

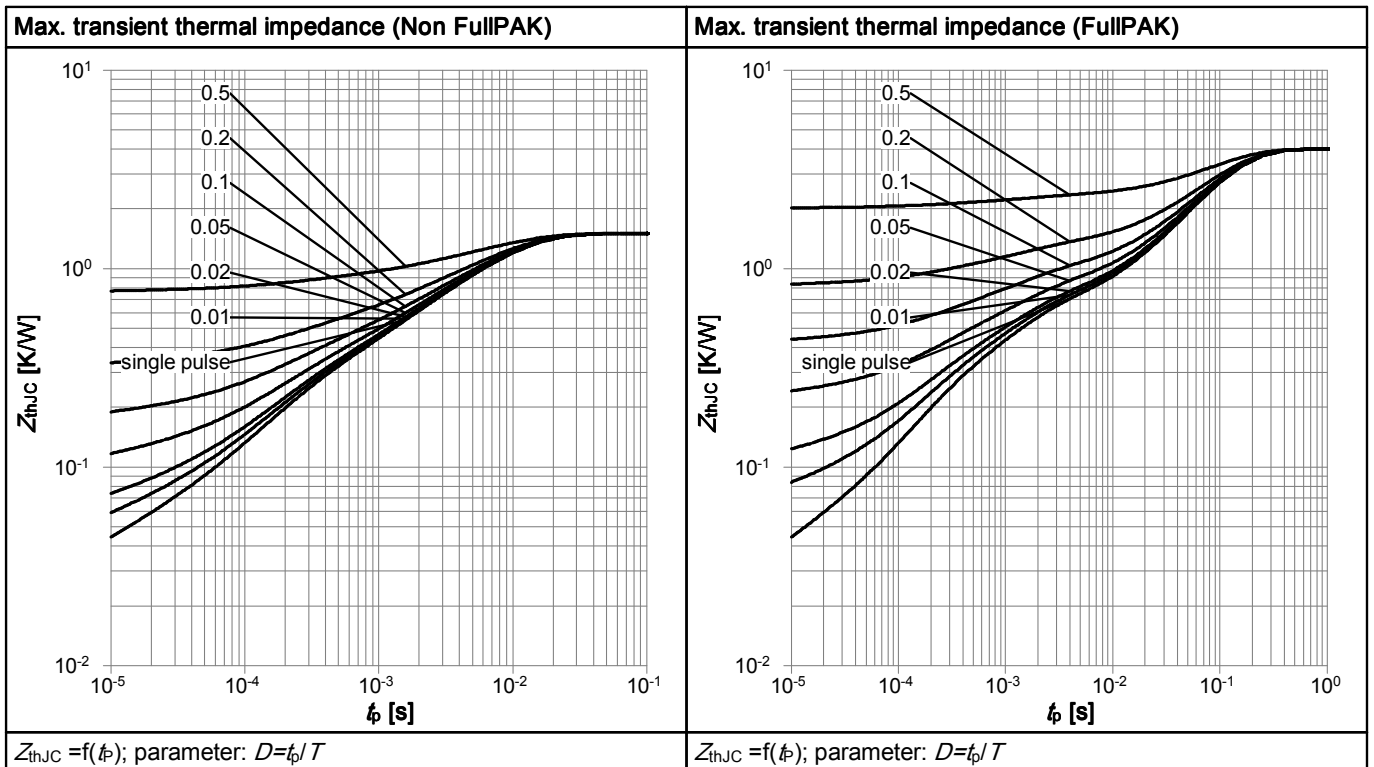


Table 12

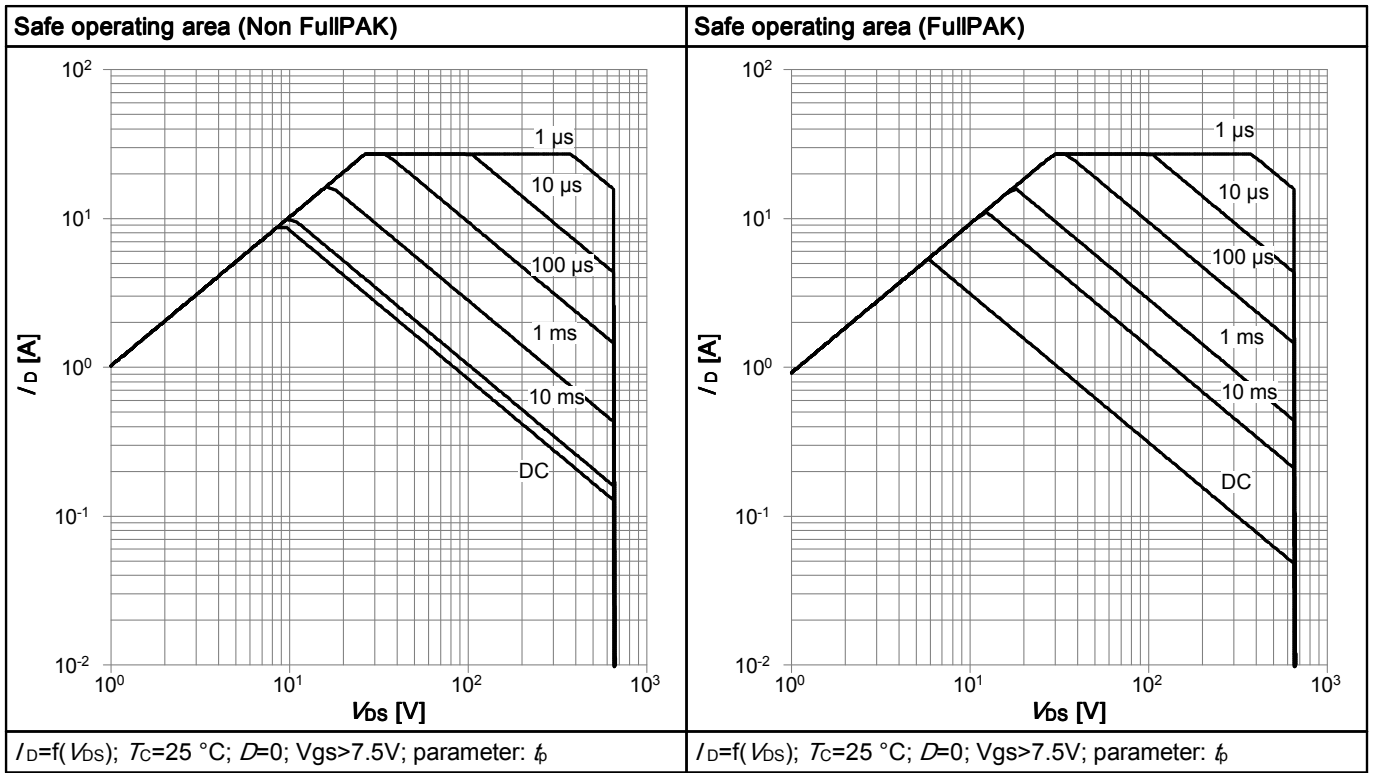


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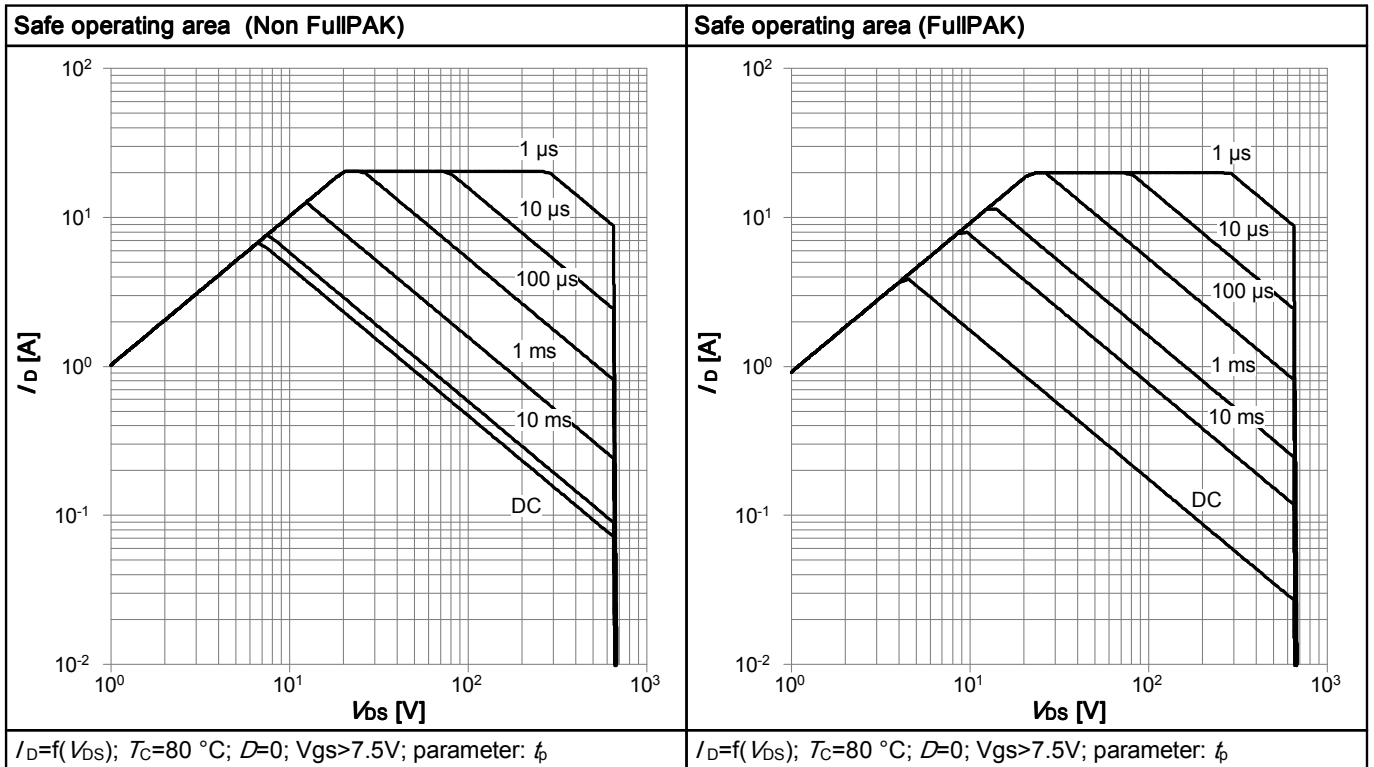


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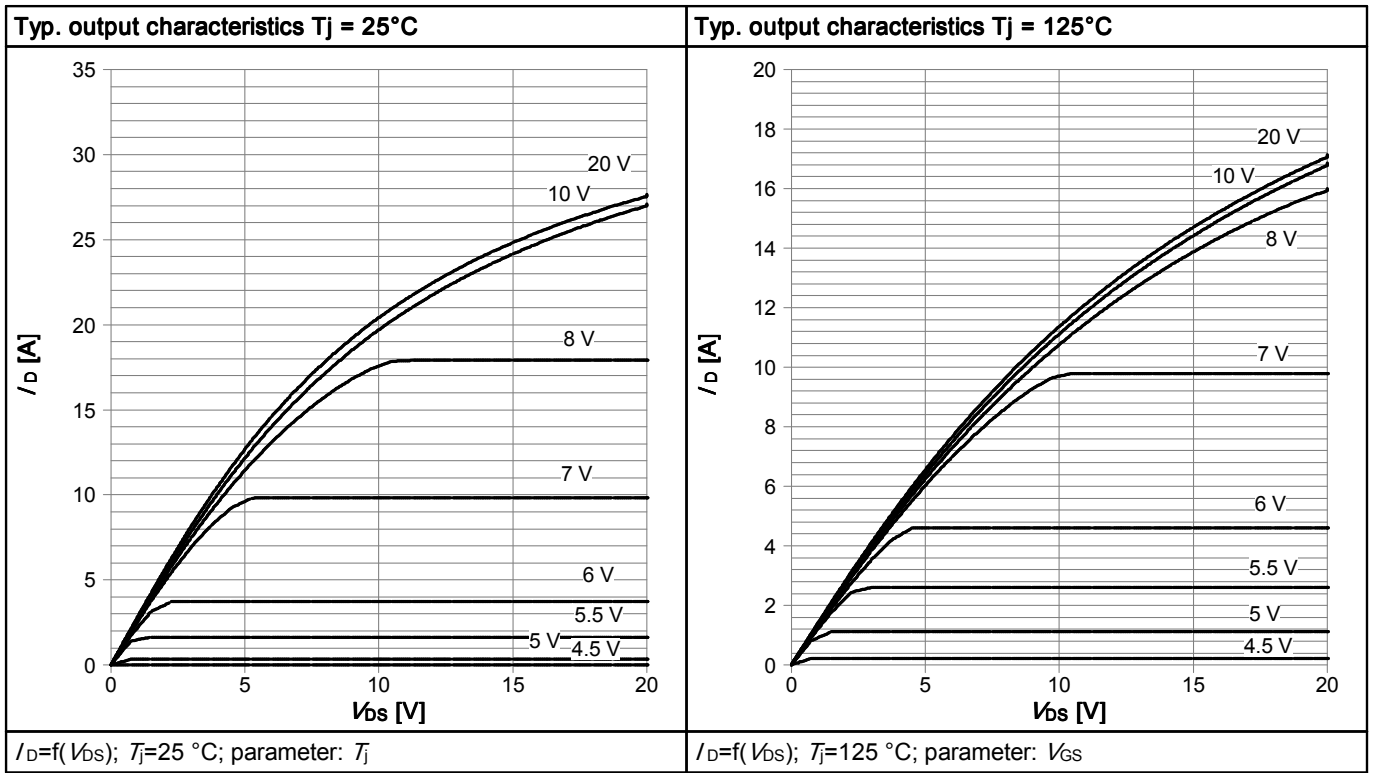


Table 15

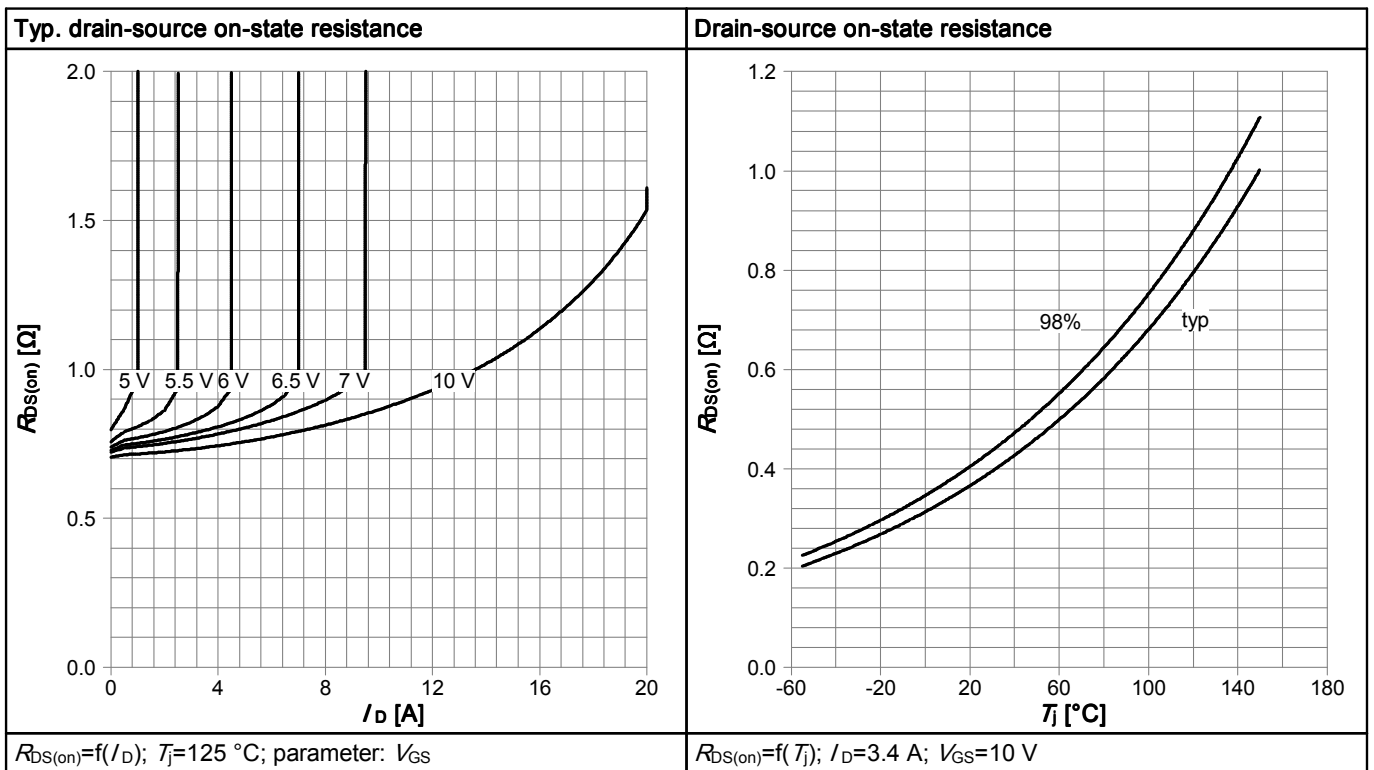


Table 16

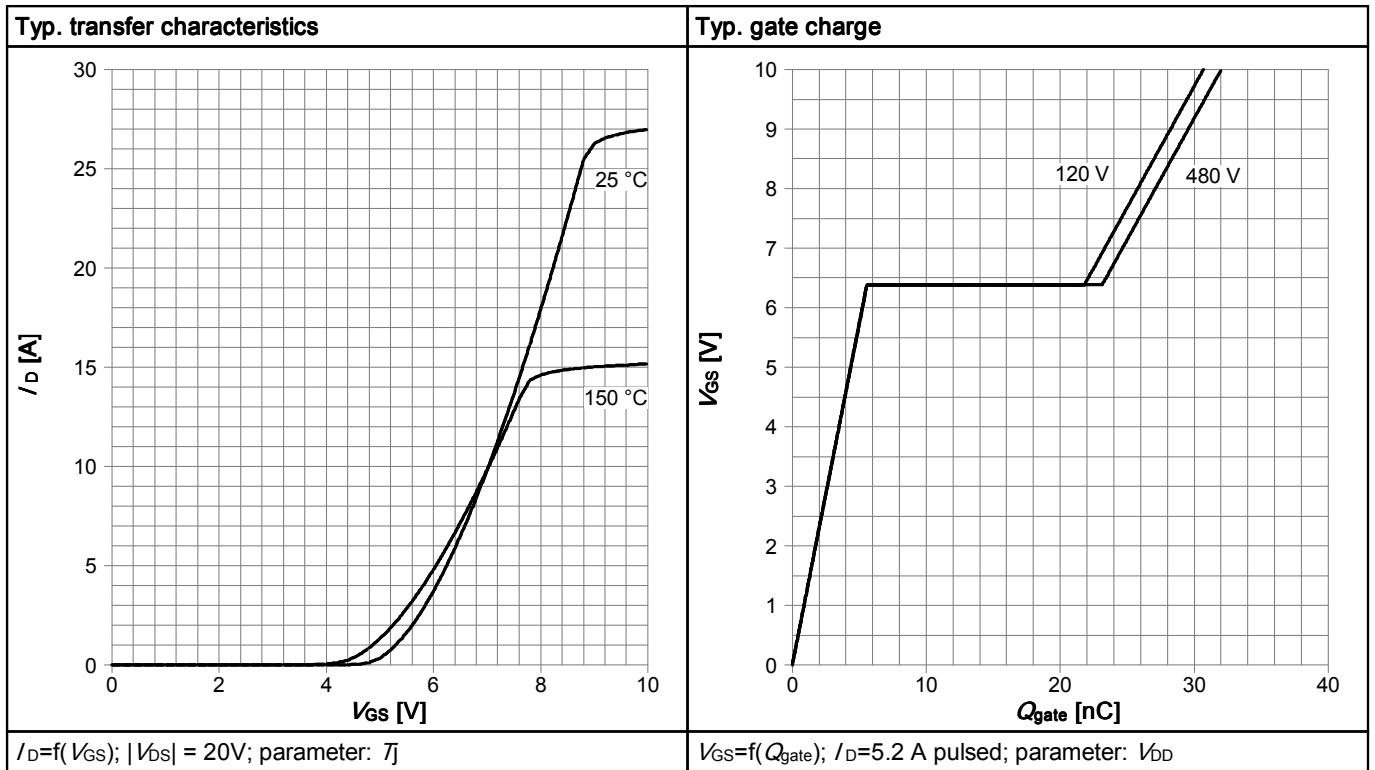


Table 17

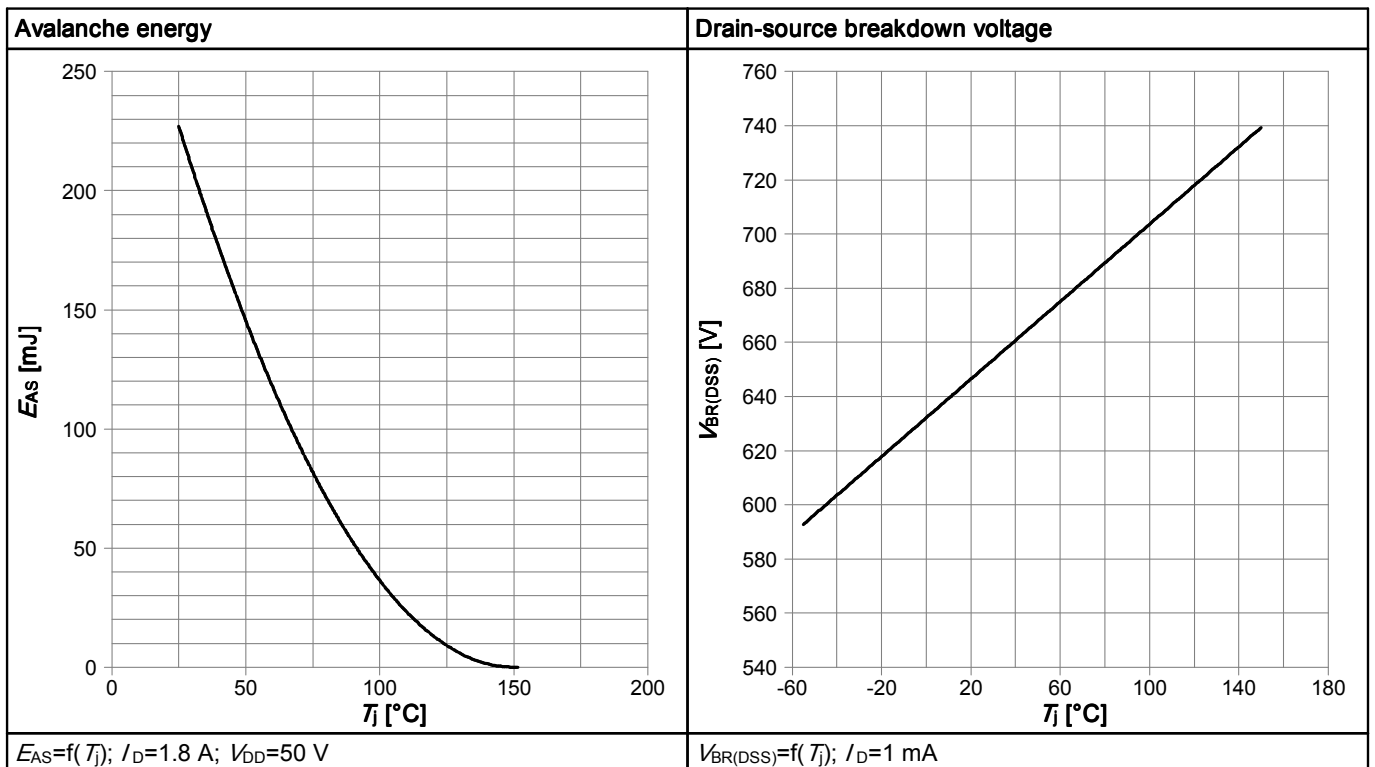


Table 18

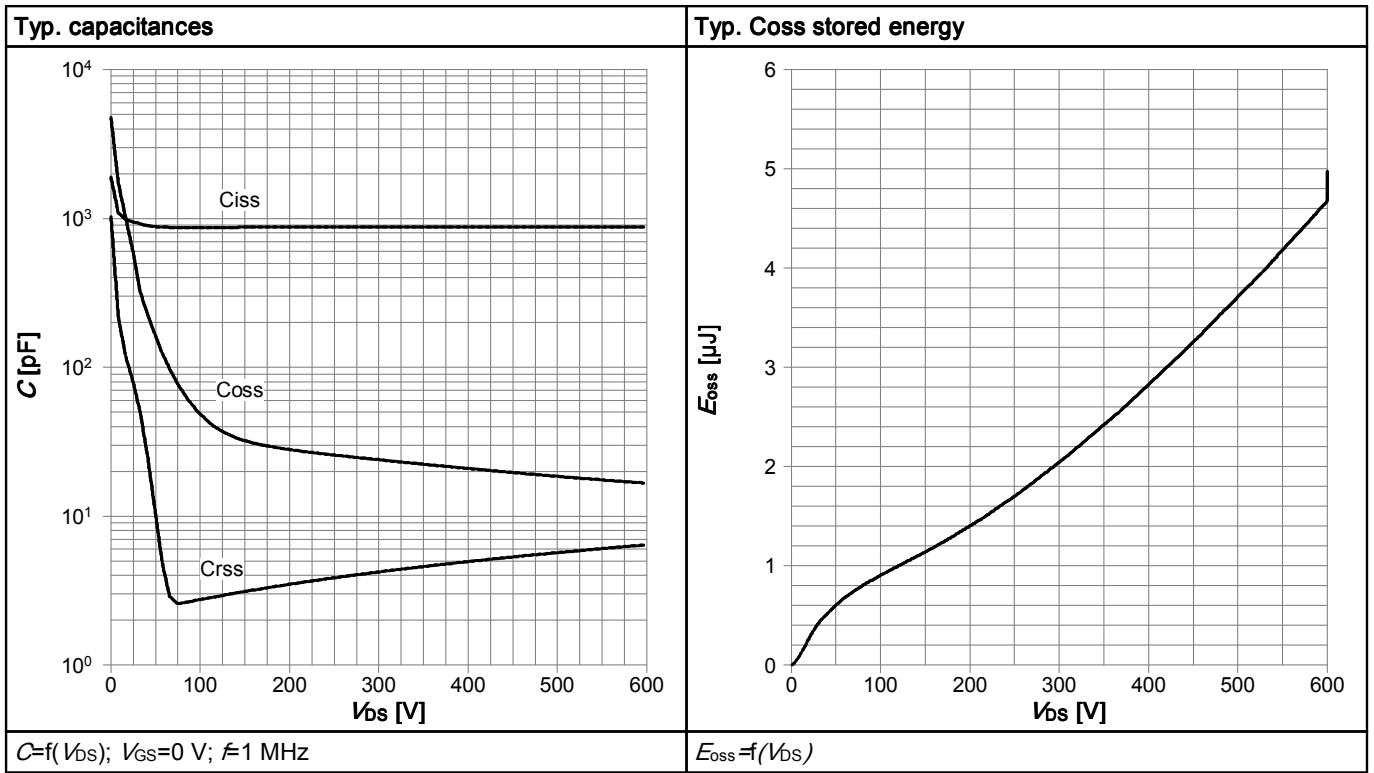
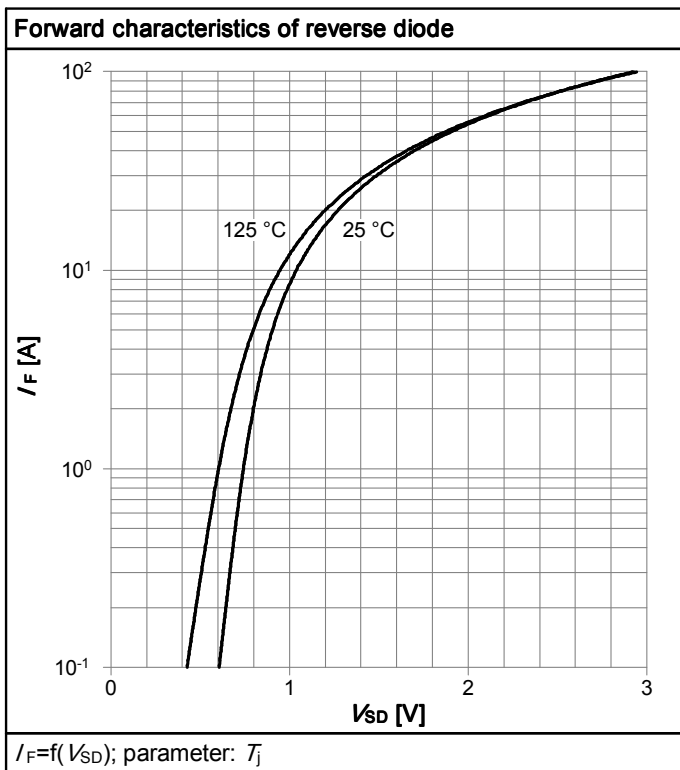


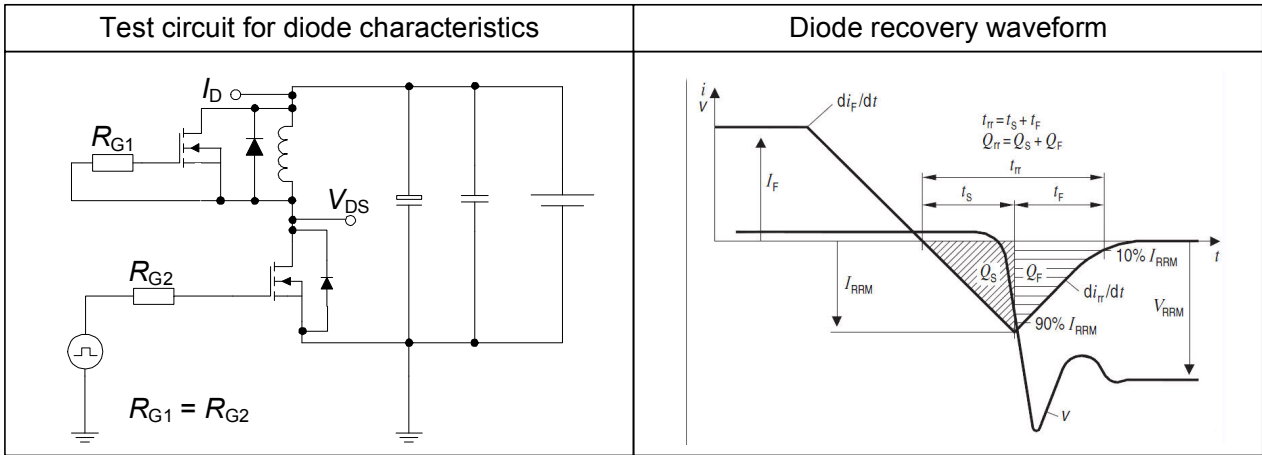
Table 19



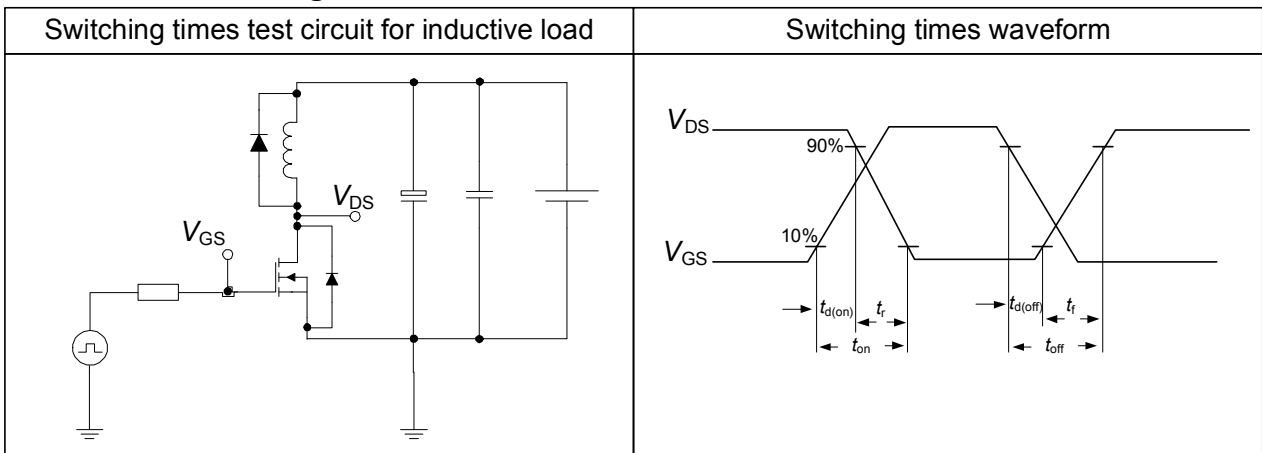


## 6 Test Circuits

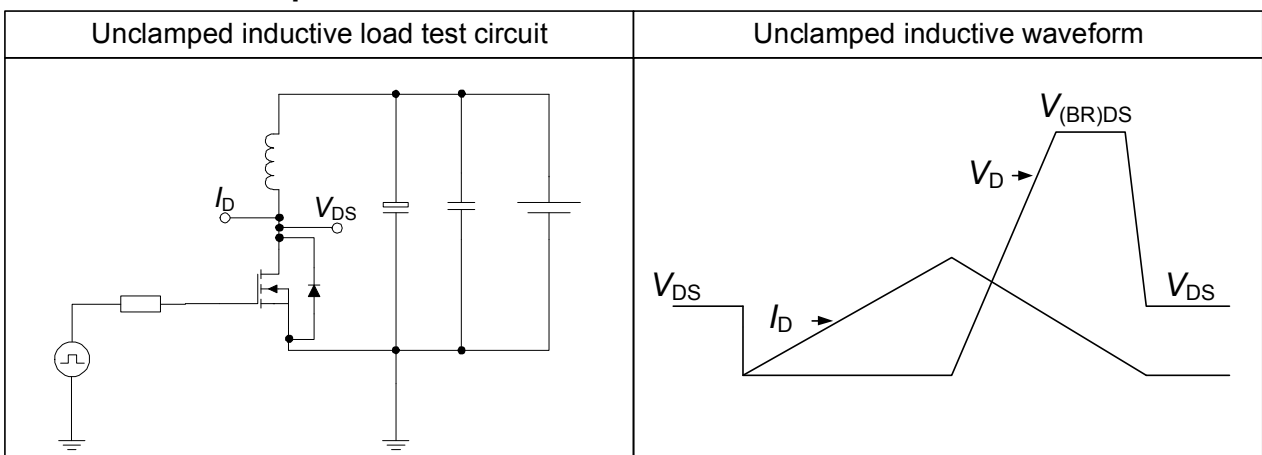
**Table 20 Diode characteristics**



**Table 21 Switching times**



**Table 22 Unclamped inductive**



## 7 Package Outlines

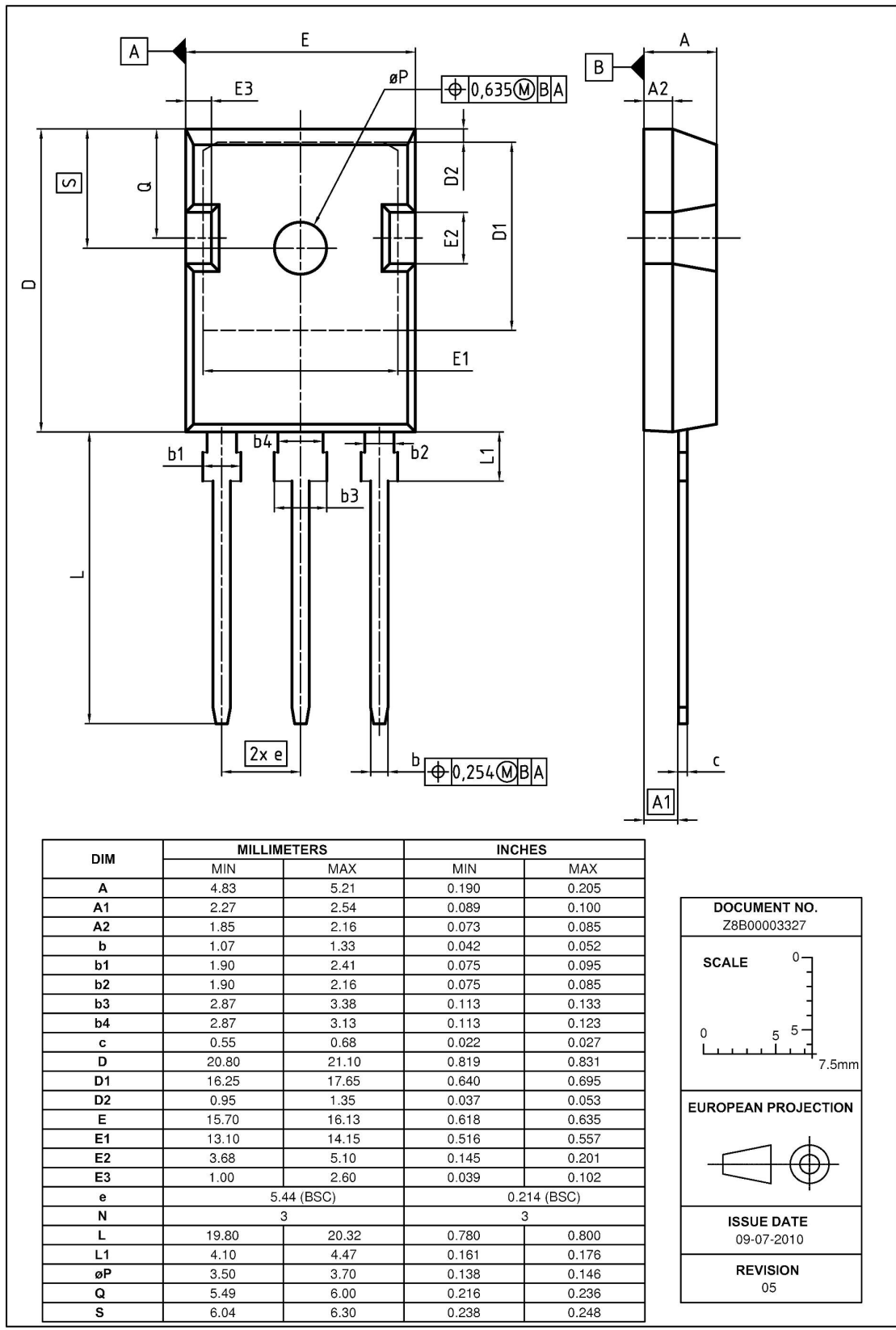


Figure 1 Outline PG-TO 247, dimensions in mm/inches

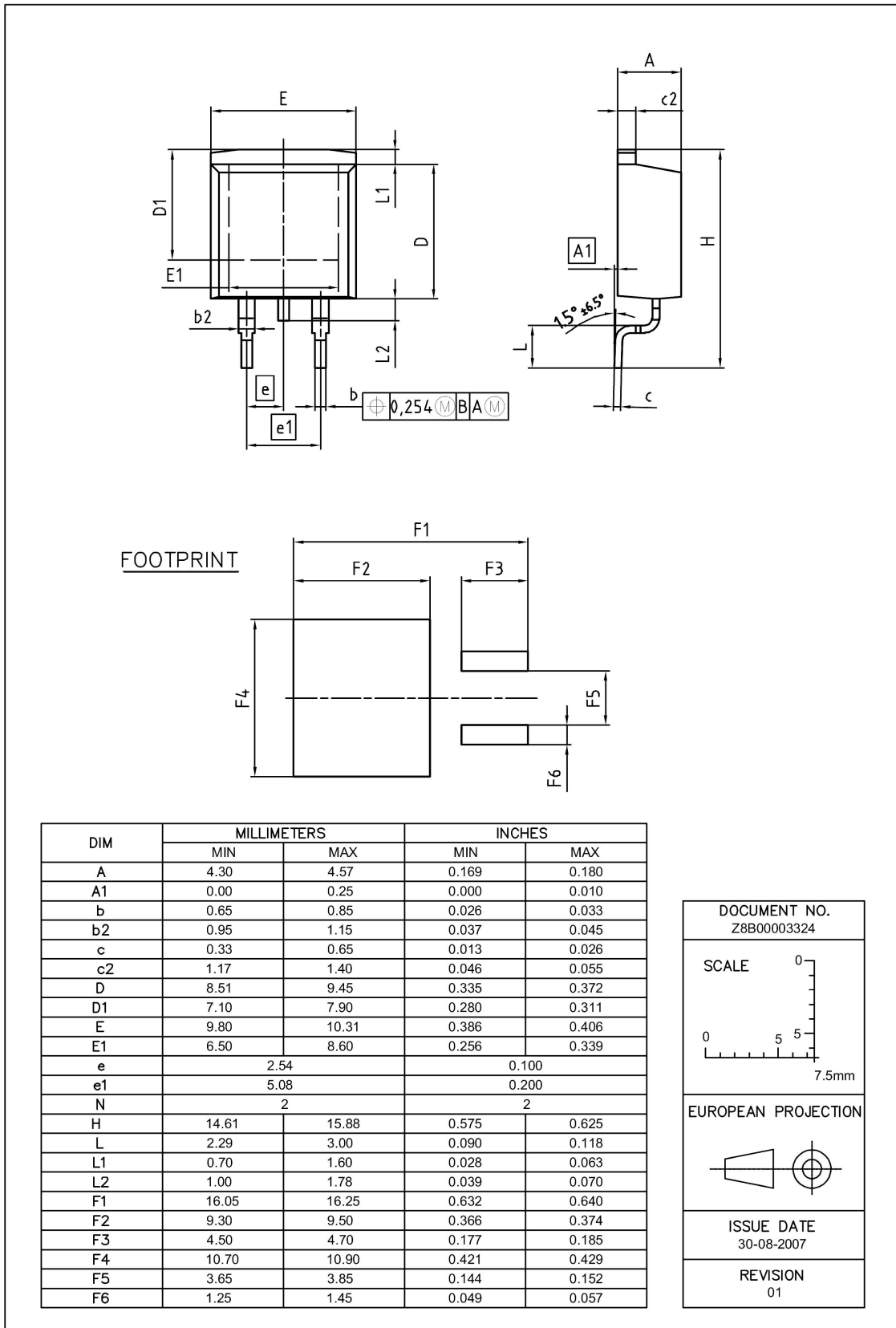


Figure 2 Outline PG-TO 263, dimensions in mm/inches

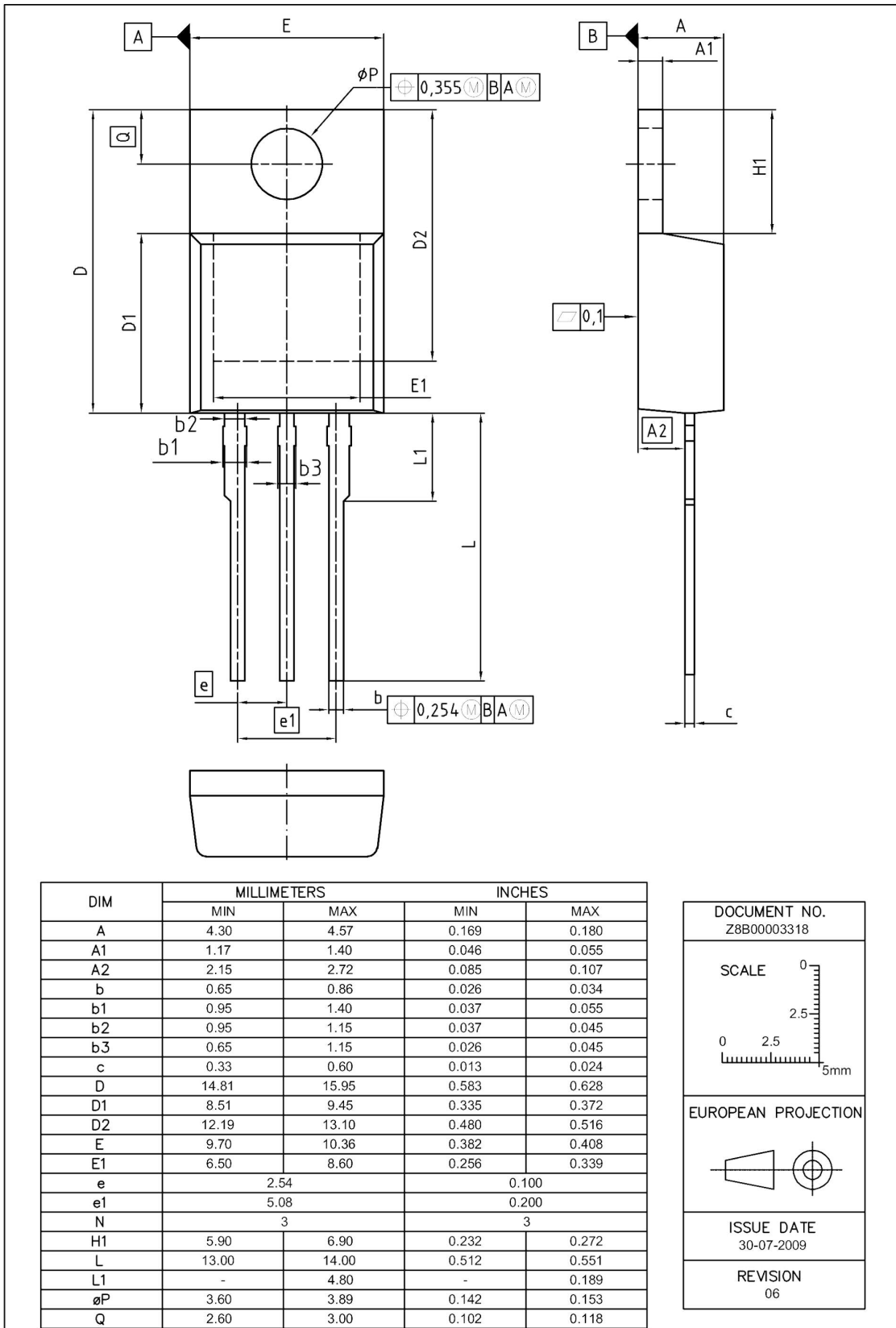


Figure 3 Outline PG-TO 220, dimensions in mm/inches

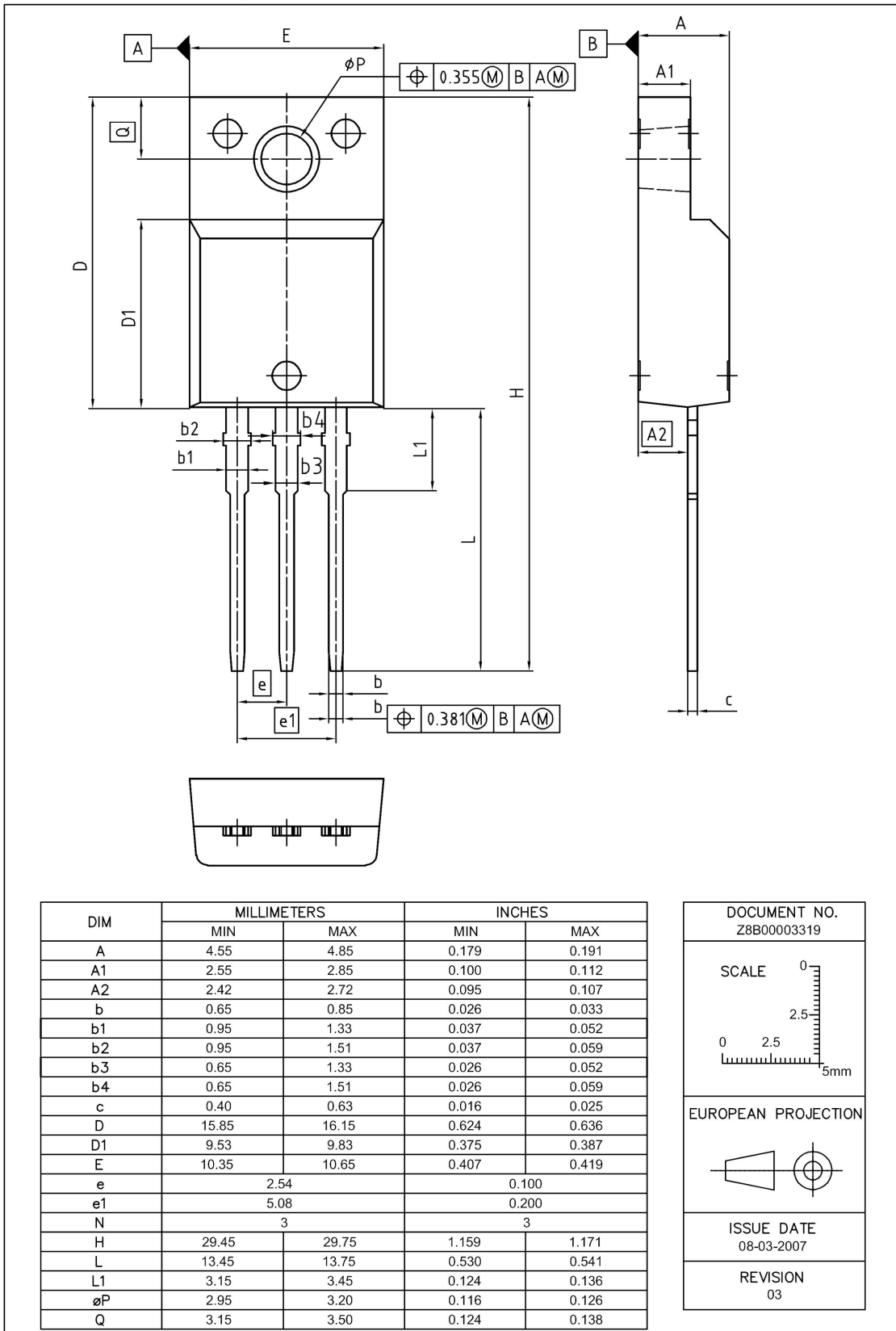


Figure 4 Outline PG-TO 220 FullPAK, dimensions in mm/inches



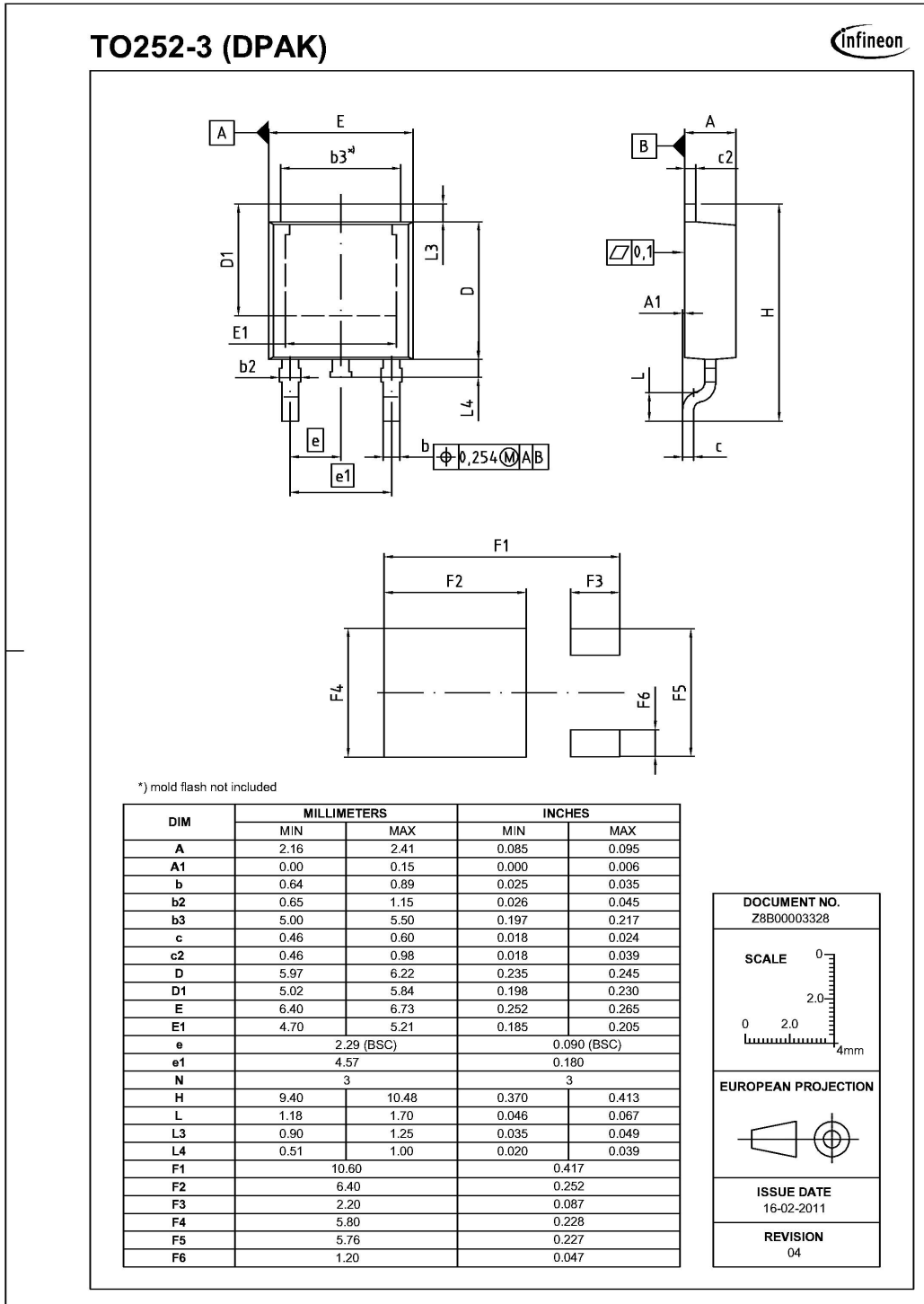


Figure 5 Outline PG-TO 252, dimensions in mm/inches

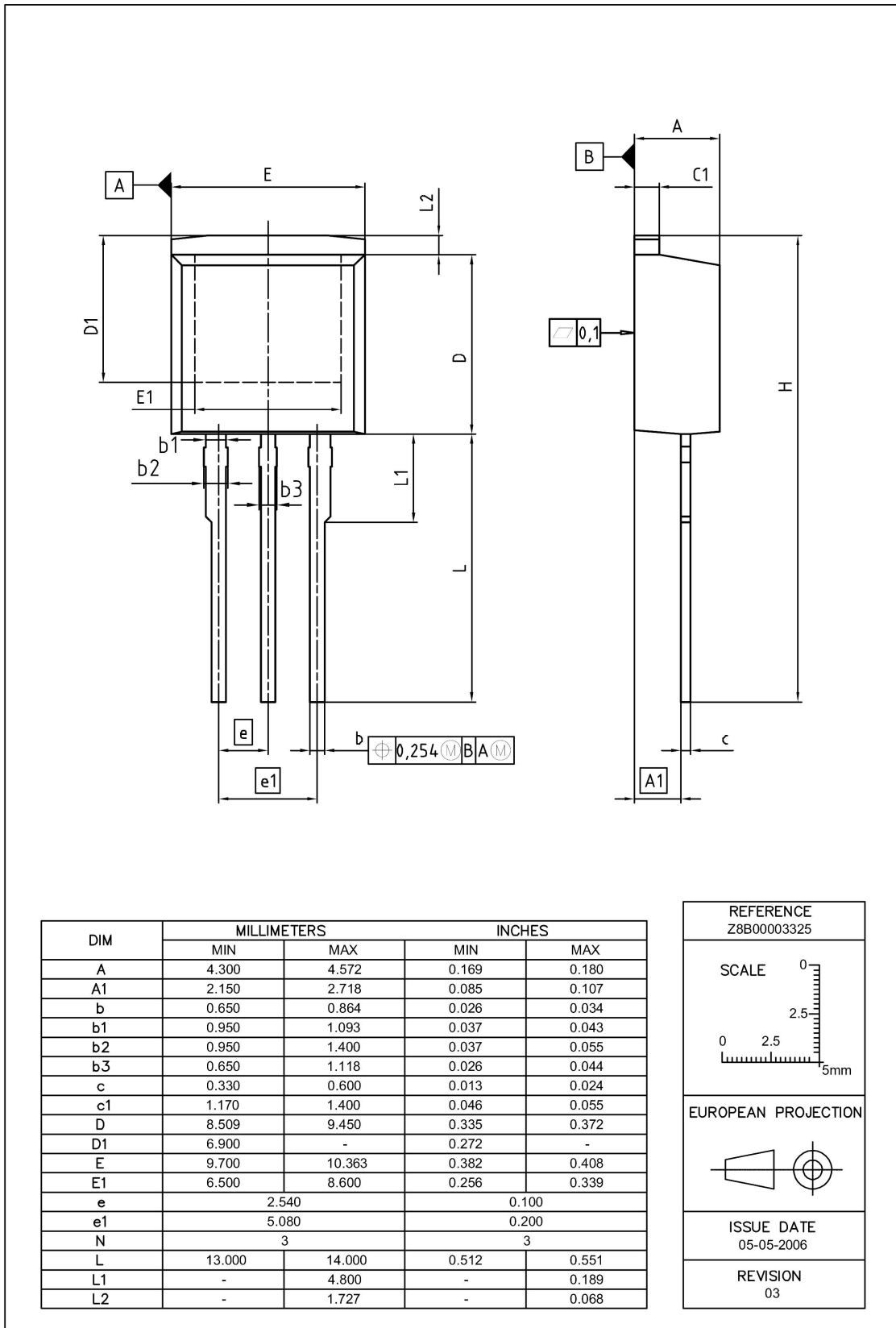


Figure 6 Outline PG-TO 262, dimensions in mm/inches



## 8 Appendix A

### Table 23 Related Links

- **IFX Design Tools:**  
<http://www.infineon.com/cms/en/product/promopages/designtools/index.html>
- **IFX CoolMOS Webpage:**  
<http://www.infineon.com/cms/en/product/channel.html?channel=ff80808112ab681d0112ab6a628704d8>

## Revision History

IPW65R420CFD , IPB65R420CFD , IPP65R420CFD , IPA65R420CFD , IPD65R420CFD , IPI65R420CFD

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

Previous Revision: 2.4

Revision	Date	Subjects (major changes since last revision)
2.0	2011-05-04	Release of final datasheet
2.1	2011-05-05	release of final datasheet
2.2	2011-06-07	Update $V_{DS}$ @ $T_{j\ max}$
2.3	2011-08-29	update $Q_{gd}$
2.4	2012-06-01	update SOA, AE, Typ. Gate Charge
2.5	2013-07-31	Update halogen free mold compound status of PG-TO 252 package

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