

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CFDA Automotive

650V CoolMOS™ CFDA Power Transistor
IPx65R310CFDA

Data Sheet

Rev. 2.0
Final

Automotive

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™ CFDA 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
- Qualified according to AEC Q101
- Green package (RoHS compliant), Pb-free plating, halogen free for mold compound

Applications

650V CoolMOS™ CFDA is designed for switching applications.

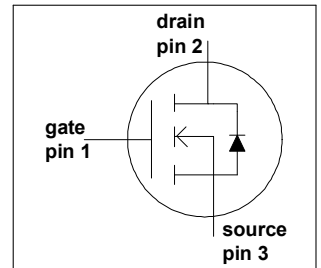
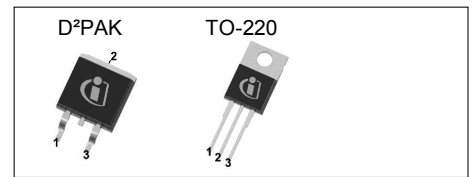


Table 1 Key Performance Parameters

Parameter	Value	Unit
V_{DS}	650	V
$R_{DS(on),max}$	0.31	Ω
Q_g,typ	41	nC
$I_D,pulse$	34.4	A
$E_{oss} @ 400V$	3.5	μJ
Body diode di/dt	900	A/ μs
Q_{rr}	0.35	μC
t_{rr}	95	ns
I_{rrm}	6.5	A

Type / Ordering Code	Package	Marking	Related Links
IPB65R310CFDA	PG-TO 263	65F6310A	-
IPP65R310CFDA	PG-TO 220		

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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 ¹⁾	I_D			11.4	A	$T_C = 25^\circ\text{C}$
				7.2		$T_C = 100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$			34.4	A	$T_C = 25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}			290	mJ	$I_D = 2.3\text{A}$, $V_{DD} = 50\text{V}$ (see table 19)
Avalanche energy, repetitive	E_{AR}			0.43	mJ	$I_D = 2.3\text{A}$, $V_{DD} = 50\text{V}$
Avalanche current, repetitive	I_{AR}			2.3	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, SMD) TO-220, D ² PAK	P_{tot}			104.2	W	$T_C = 25^\circ\text{C}$
Operating and storage temperature	T_j, T_{stg}	-40		150	$^\circ\text{C}$	
Mounting torque (non FullPAK) TO-220				60	Ncm	M3 and M3.5 screws
Continuous diode forward current	I_S			11.4	A	$T_C = 25^\circ\text{C}$
Diode pulse current	$I_{S,pulse}$			34.4	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt ³⁾	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 17)
Maximum diode commutation speed	di _f /dt			900	A/ μs	

¹⁾ Limited by $T_{j\text{ max}}$.

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

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}			1.2	K/W	
Thermal resistance, junction - ambient	R_{thJA}			62	K/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 D²PAK

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}			1.2	K/W	
Thermal resistance, junction - ambient ¹⁾	R_{thJA}			62	K/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 5 Static characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage ¹⁾	$V_{(BR)DSS}$	650			V	$V_{GS} = 0V$, $I_D = 1mA$
Gate threshold voltage	$V_{GS(th)}$	3.5	4	4.5	V	$V_{DS} = V_{GS}$, $I_D = 0.44mA$
Zero gate voltage drain current	I_{DSS}			1	μA	$V_{DS} = 650V$, $V_{GS} = 0V$, $T_j = 25^\circ\text{C}$
			150			$V_{DS} = 650V$, $V_{GS} = 0V$, $T_j = 150^\circ\text{C}$
Gate-source leakage current	I_{GSS}			100	nA	$V_{GS} = 20V$, $V_{DS} = 0V$
Drain-source on-state resistance	$R_{DS(on)}$		0.28	0.31	Ω	$V_{GS} = 10V$, $I_D = 4.4A$, $T_j = 25^\circ\text{C}$
			0.725			$V_{GS} = 10V$, $I_D = 4.4A$, $T_j = 150^\circ\text{C}$
Gate resistance	R_G		4.5		Ω	$f = 1MHz$, open drain

Table 6 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}		1110		pF	$V_{GS} = 0V$, $V_{DS} = 100V$, $f = 1MHz$
Output capacitance	C_{oss}		55		pF	
Effective output capacitance, energy related ²⁾	$C_{o(er)}$		44		pF	$V_{GS} = 0V$, $V_{DS} = 0 \dots 400V$
Effective output capacitance, time related ³⁾	$C_{o(tr)}$		204		pF	$I_D = \text{constant}$, $V_{GS} = 0V$, $V_{DS} = 0 \dots 400V$
Turn-on delay time	$t_{d(on)}$		11		ns	$V_{DD} = 480V$, $V_{GS} = 13V$, $I_D = 6.6A$, $R_G = 3.4\Omega$ (see table 18)
Rise time	t_r		7.5		ns	
Turn-off delay time	$t_{d(off)}$		45		ns	
Fall time	t_f		7		ns	

Table 7 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}		7		nC	$V_{DD} = 480V$, $I_D = 6.6A$, $V_{GS} = 0 \text{ to } 10V$
Gate to drain charge	Q_{gd}		22		nC	
Gate charge total	Q_g		41		nC	
Gate plateau voltage	$V_{plateau}$		6.4		V	

¹⁾ For applications with applied blocking voltage > 65% of the specified blocking voltage, we recommend to evaluate the impact of the cosmic radiation effect in early design phase. For assessment please contact local Infineon sales office.

²⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V

³⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 400V

Table 8 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}		0.9		V	$V_{GS} = 0V, I_F = 6.6A, T_j = 25^\circ C$
Reverse recovery time	t_{rr}		95		ns	$V_R = 400V, I_F = 6.6A,$ $di_F/dt = 100A/\mu s$ (see table 17)
Reverse recovery charge	Q_{rr}		0.35		μC	
Peak reverse recovery current	I_{rrm}		6.5		A	

5 Electrical characteristics diagrams

Table 9

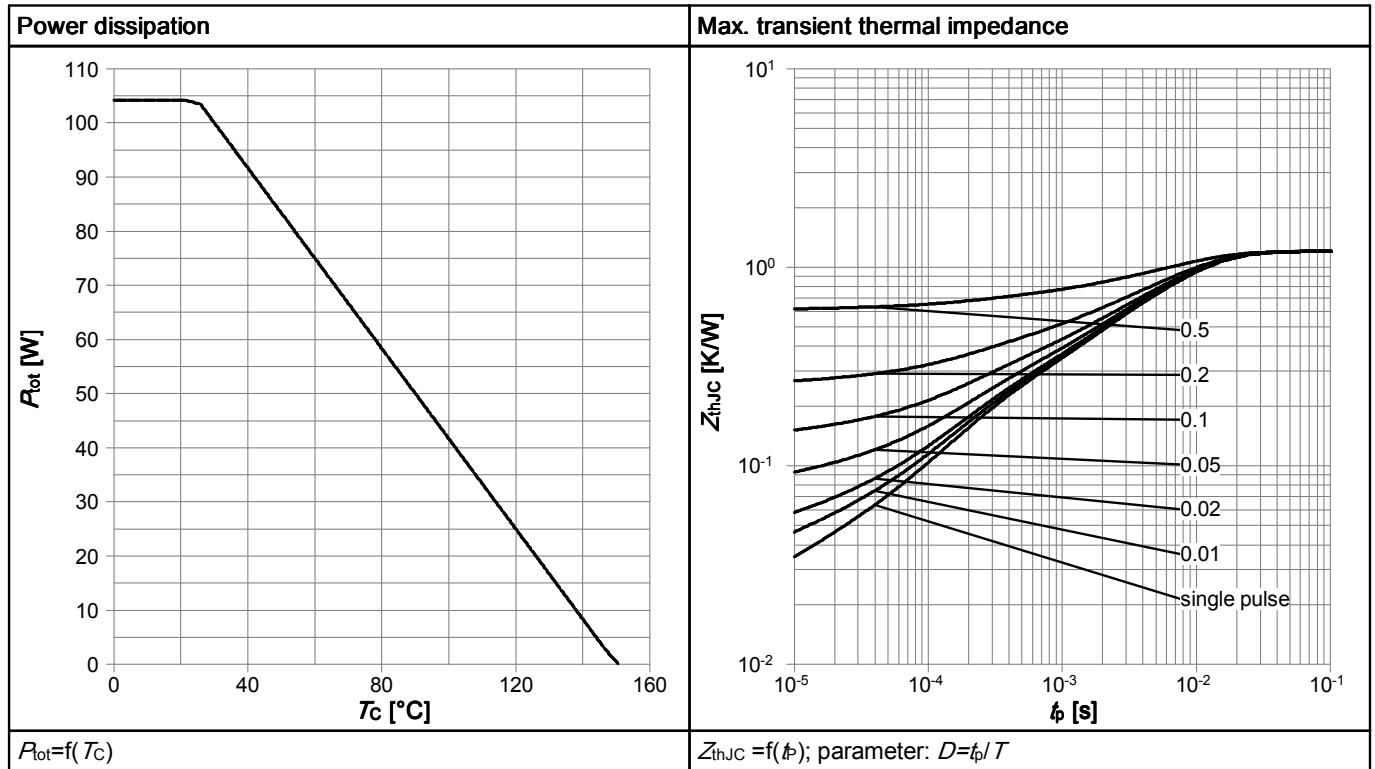


Table 10

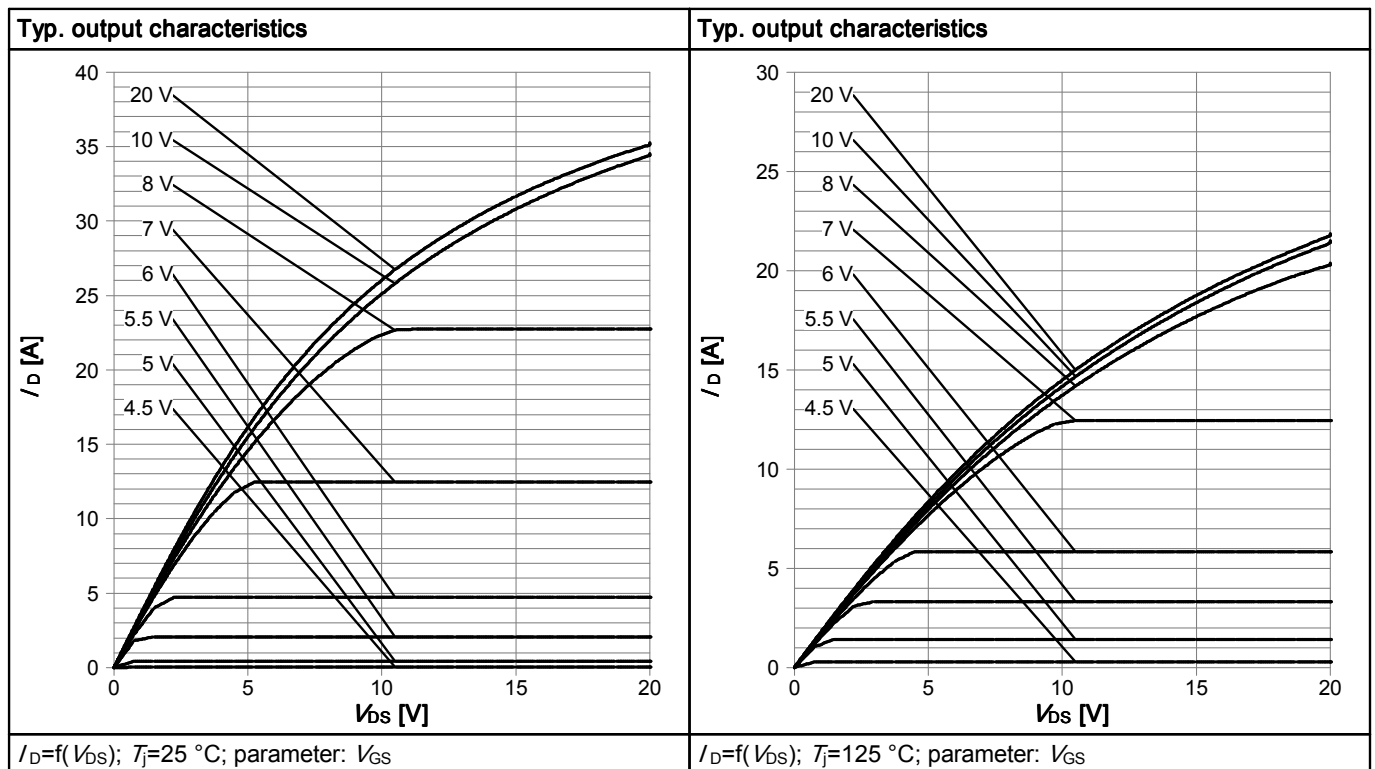


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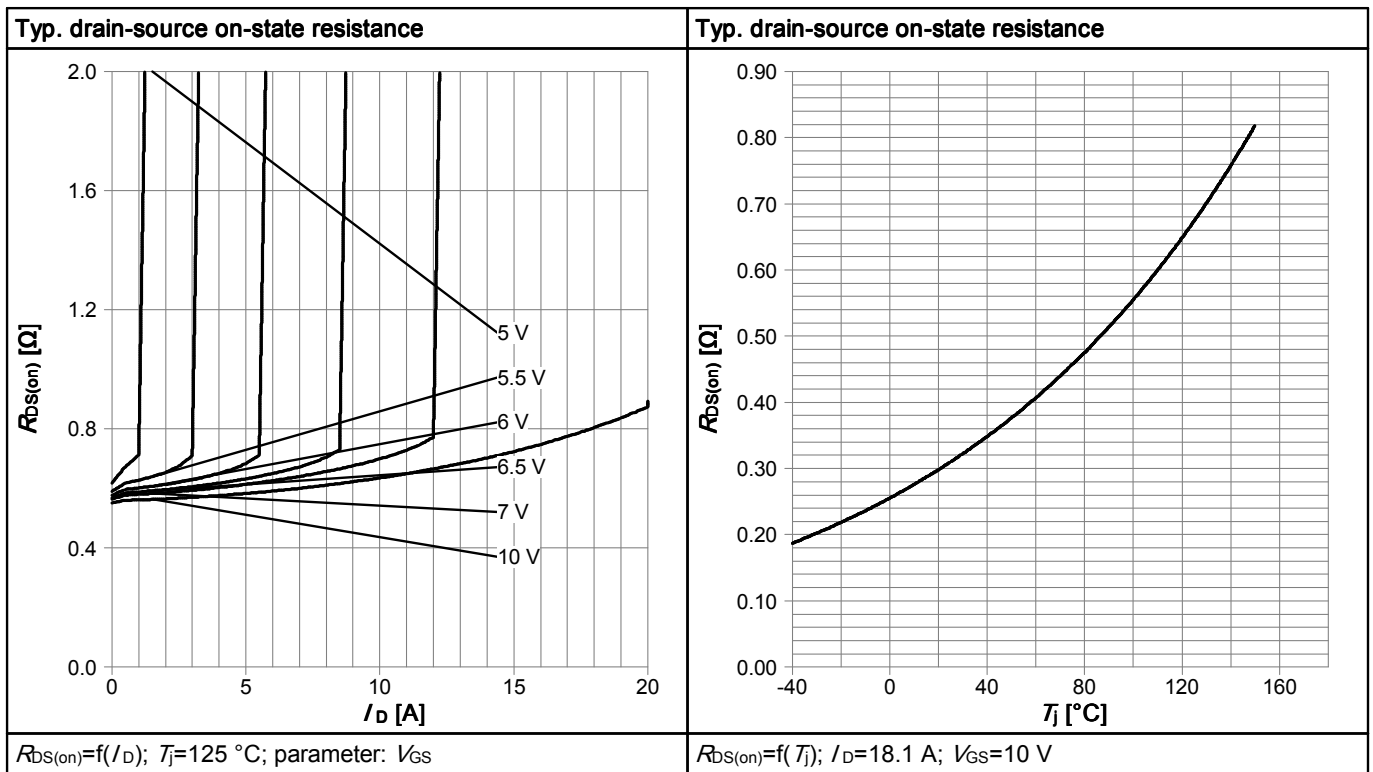


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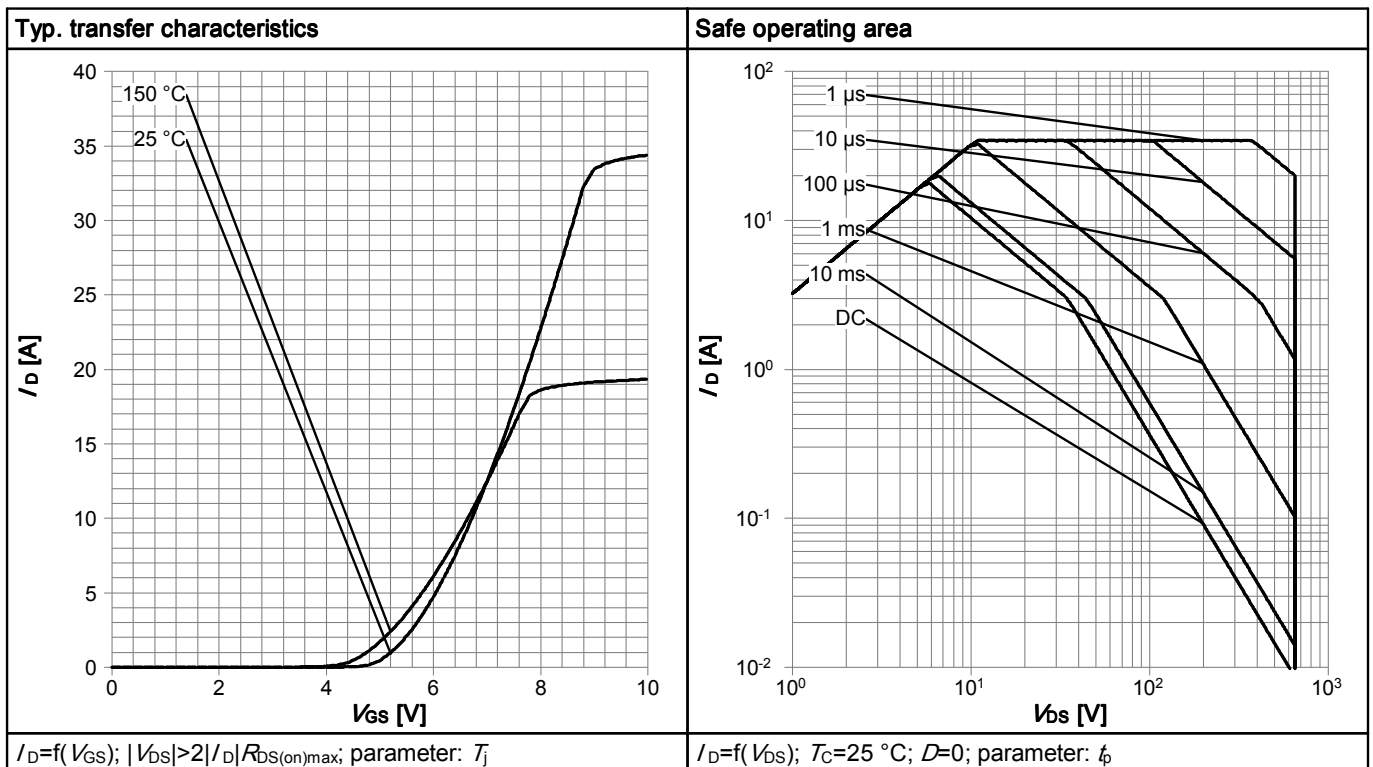


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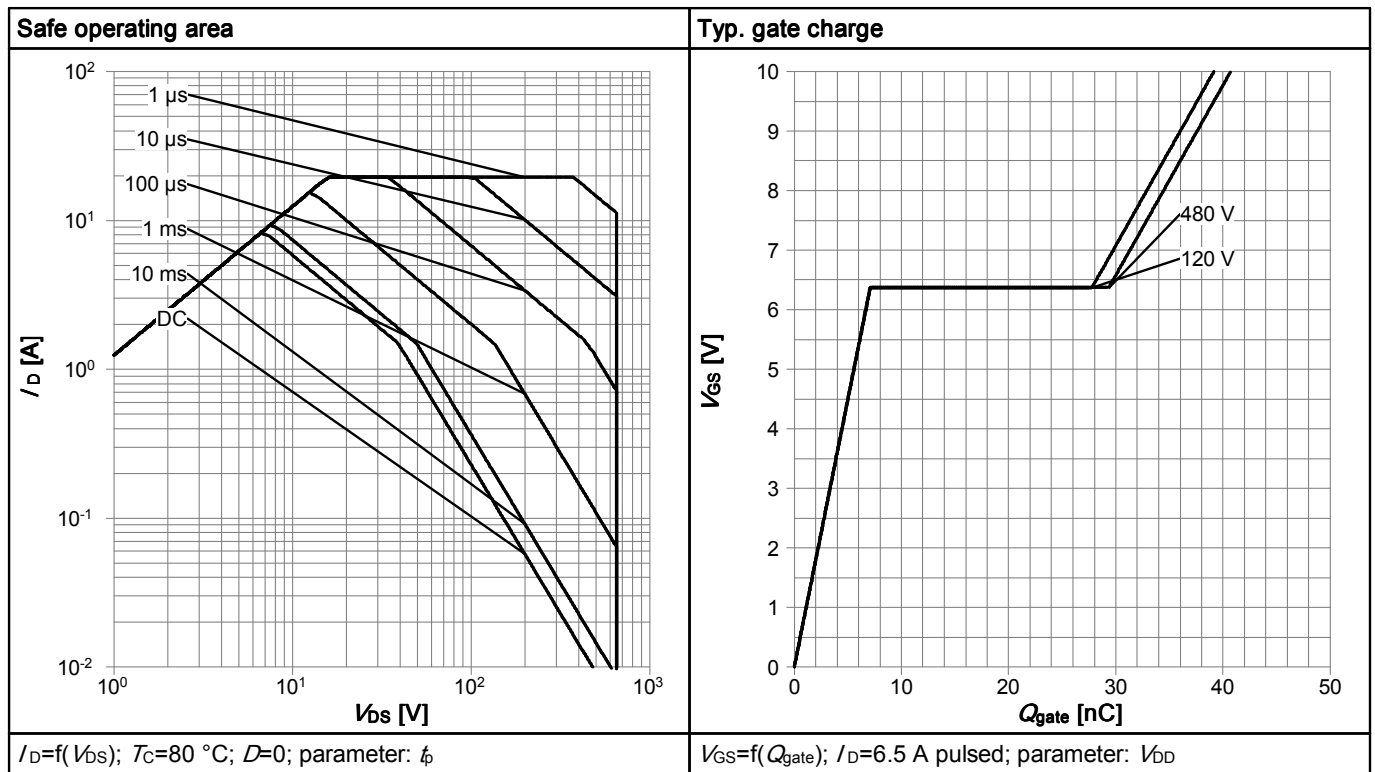


Table 14

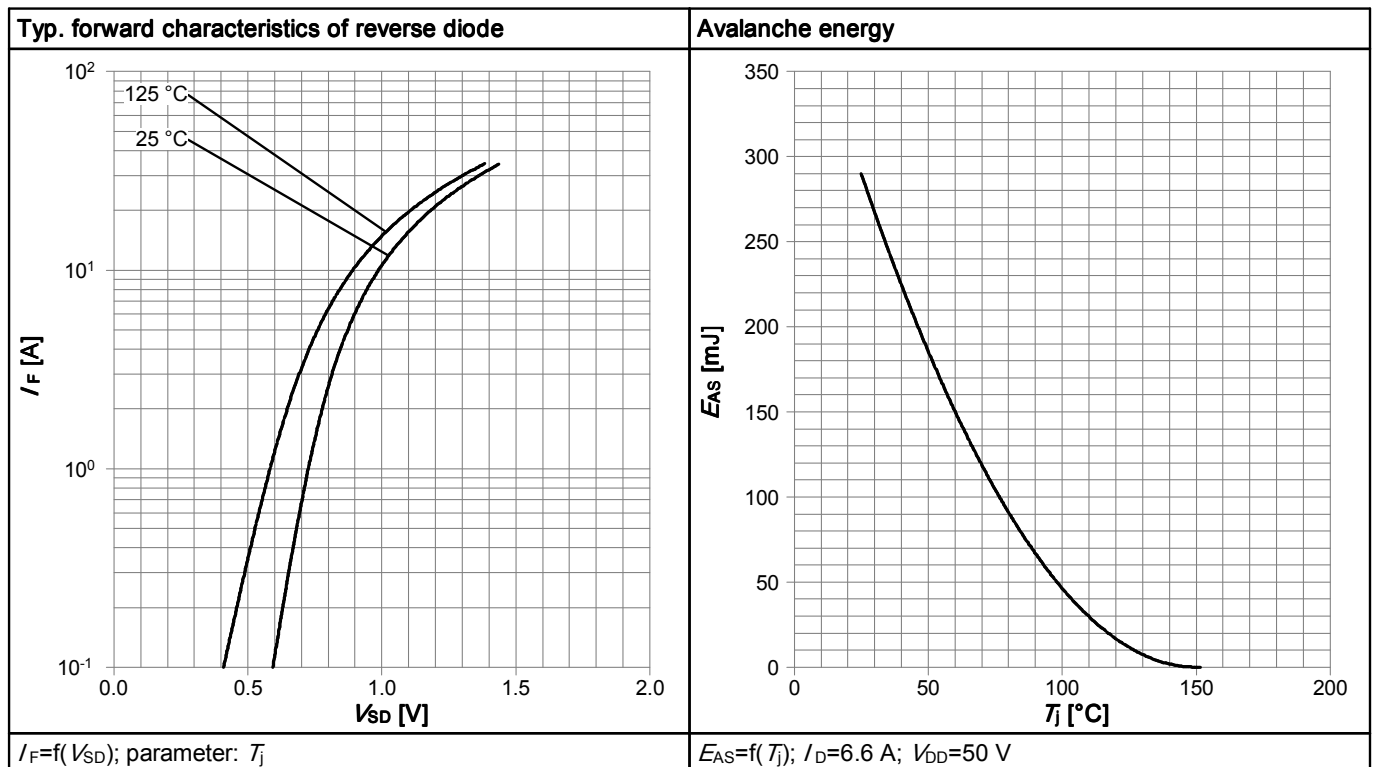


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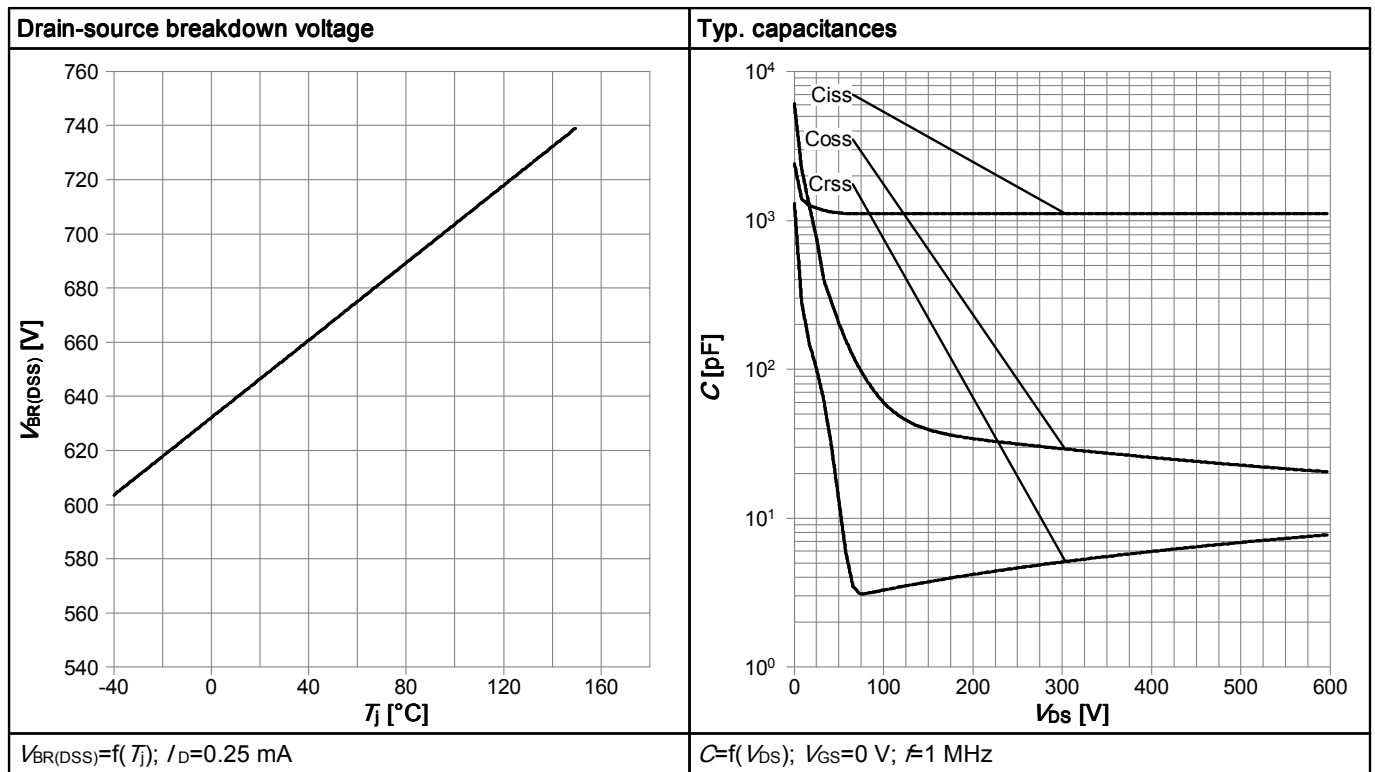
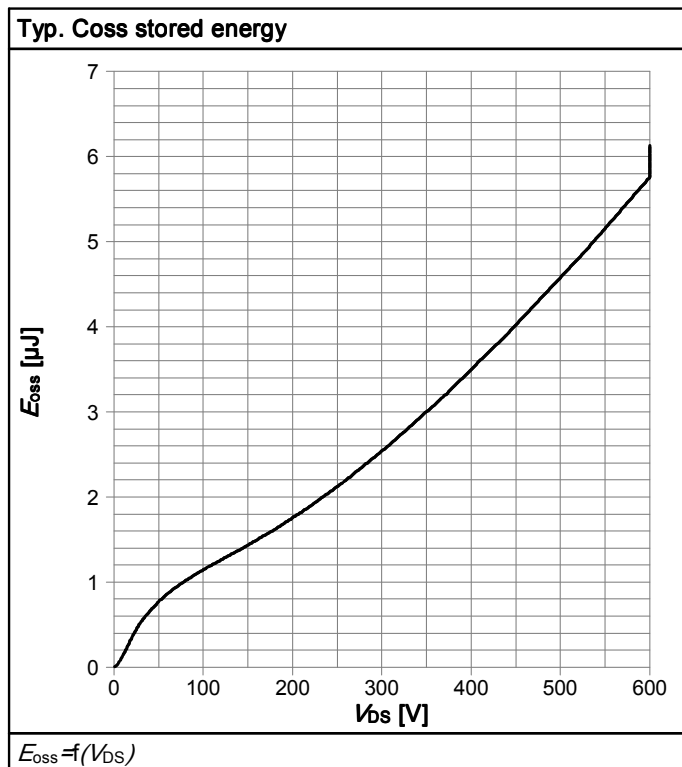


Table 16



6 Test Circuits

Table 17 Diode characteristics

Test circuit for diode characteristics	Diode recovery waveform
 The test circuit for diode characteristics shows a MOSFET switching an inductive load. The MOSFET gate is driven by a pulse generator through a resistor R_{G1}. The drain is connected to the inductive load and a DC supply V_{DS}. The MOSFET source is connected to ground through a resistor R_{G2}. The condition $R_{G1} = R_{G2}$ is specified. The diode current I_D and drain-source voltage V_{DS} are indicated.	 The diode recovery waveform shows the current i and voltage V over time t. It illustrates the forward current I_F, the reverse recovery current I_{RRM}, and the reverse recovery voltage V_{RRM}. Key parameters include the reverse recovery time t_{rr}, the reverse recovery charge Q_{rr}, and the reverse recovery current I_{RRM}. The waveform also shows the forward current I_F and the reverse recovery current I_{RRM} during the reverse recovery phase.

Table 18 Switching times

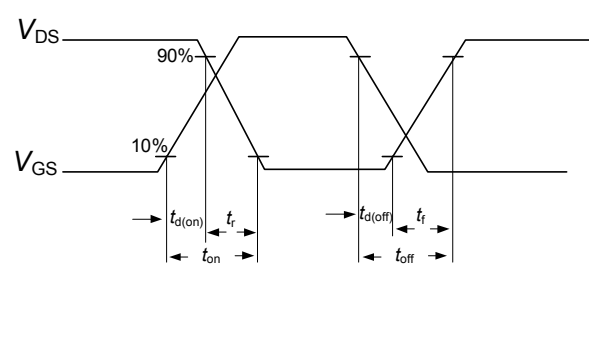
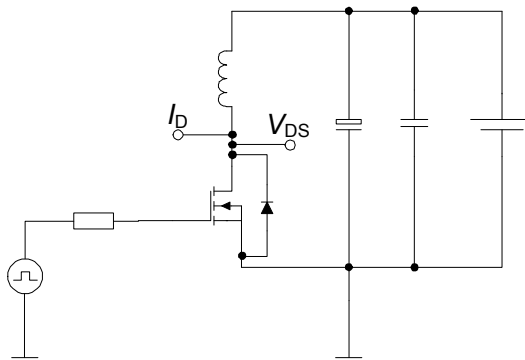
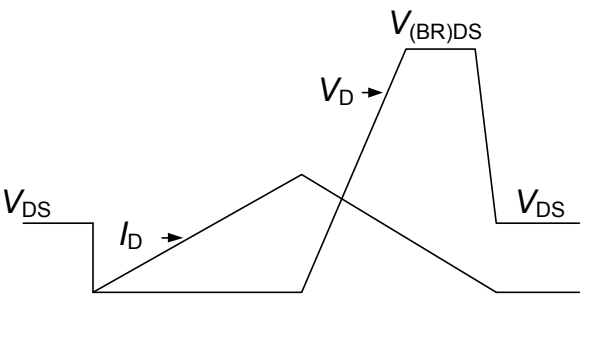
Switching times test circuit for inductive load	Switching times waveform
 The switching times test circuit for inductive load shows a MOSFET switching an inductive load. The MOSFET gate is driven by a pulse generator through a resistor. The drain is connected to the inductive load and a DC supply V_{DS}. The MOSFET source is connected to ground. The gate-source voltage V_{GS} and drain-source voltage V_{DS} are indicated.	 The switching times waveform shows the gate-source voltage V_{GS} and drain-source voltage V_{DS} over time. It illustrates the turn-on time $t_{d(on)}$, the rise time t_r, the fall time t_f, and the turn-off time $t_{d(off)}$. The waveform also shows the 10% and 90% voltage levels for the turn-on and turn-off times.

Table 19 Unclamped inductive

Unclamped inductive load test circuit	Unclamped inductive waveform
 The unclamped inductive load test circuit shows a MOSFET switching an inductive load. The MOSFET gate is driven by a pulse generator through a resistor. The drain is connected to the inductive load and a DC supply V_{DS}. The MOSFET source is connected to ground. The diode current I_D and drain-source voltage V_{DS} are indicated.	 The unclamped inductive waveform shows the drain-source voltage V_{DS} and diode current I_D over time. It illustrates the unclamped inductive voltage $V_{(BR)DS}$ and the diode current I_D during the switching transient. The waveform also shows the peak voltage $V_{(BR)DS}$ and the peak current I_D.

7 Package Outlines

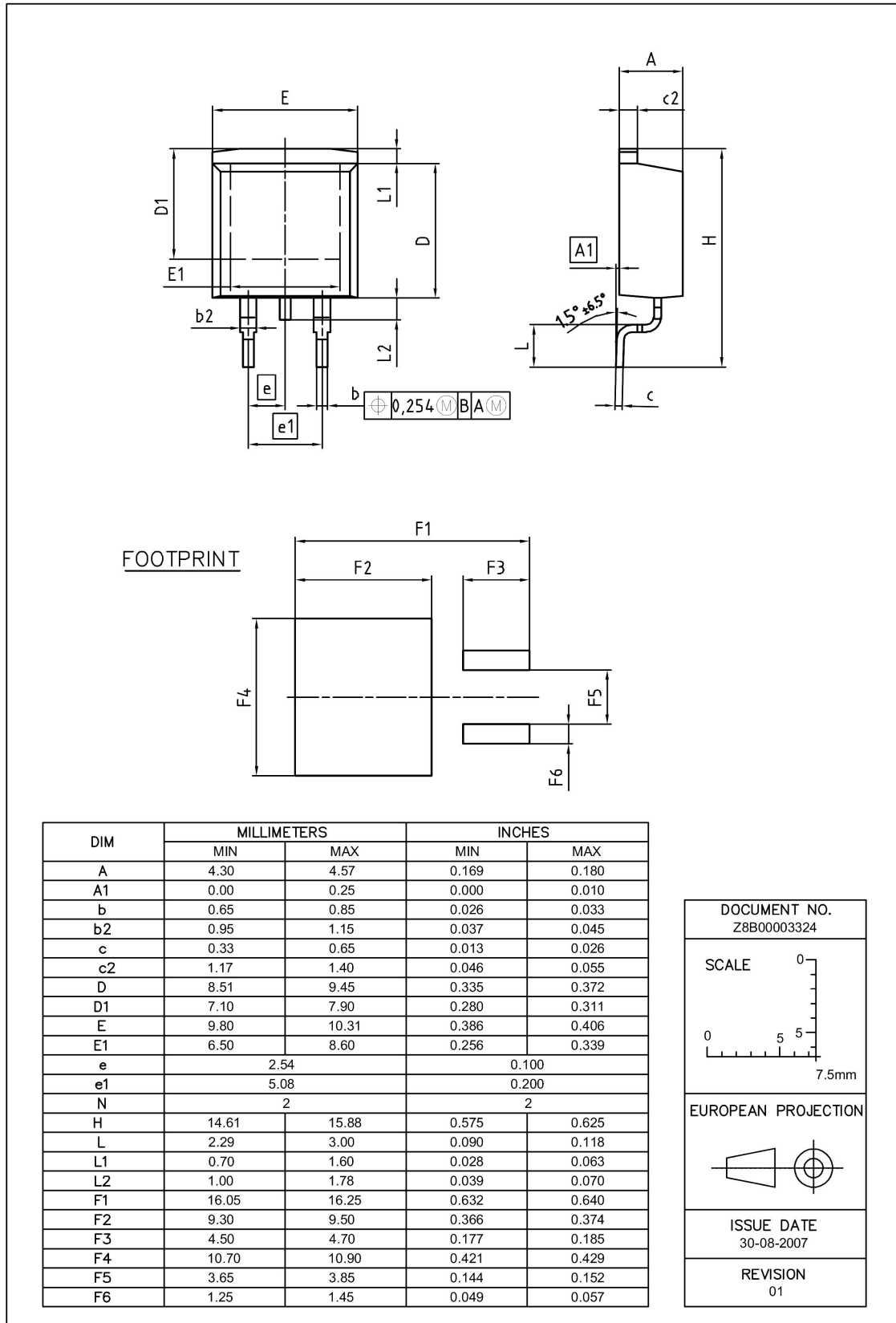


Figure 1 Outline PG-TO 263, dimensions in mm/inches

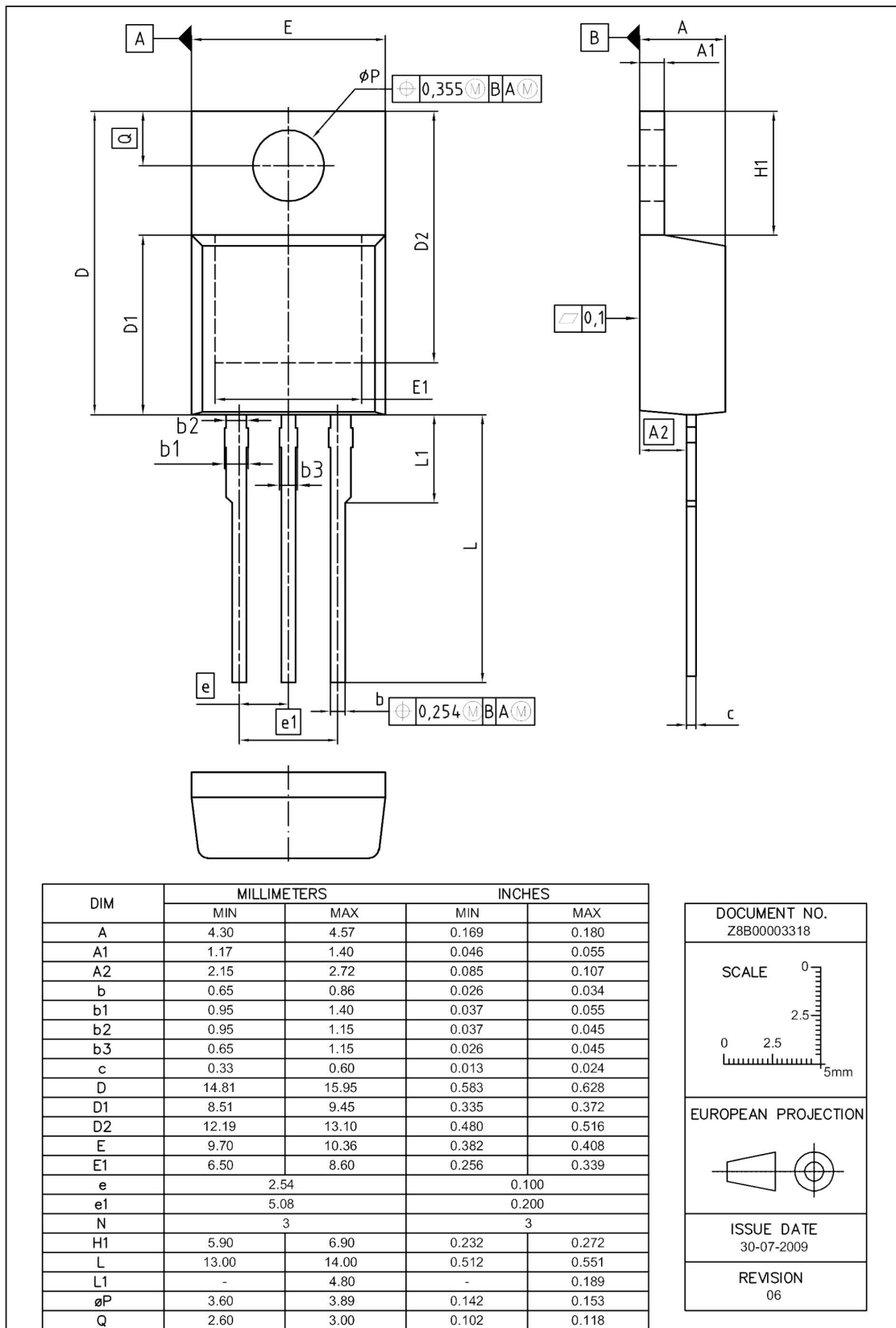


Figure 2 Outline PG-TO 220, dimensions in mm/inches

Revision History

IPB65R310CFDA, IPP65R310CFDA

Revision: 2012-03-28, Rev. 2.0

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2012-03-28	Final datasheet

Disclaimer ATV

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Edition 2011-09-30

Published by

Infineon Technologies AG

81726 München, Germany

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