

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CFDA Automotive

650V CoolMOS™ CFDA Power Transistor
IPx65R660CFDA

Data Sheet

Rev. 2.1
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™ 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.

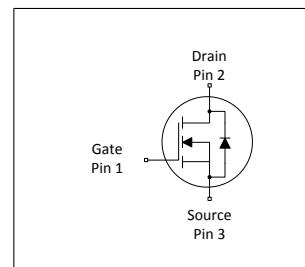
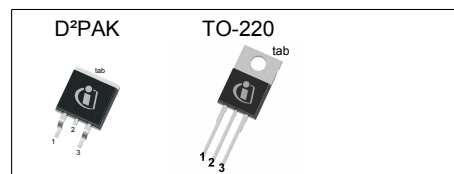


Table 1 Key Performance Parameters

Parameter	Value	Unit
V_{DS}	650	V
$R_{DS(on),max}$	0.66	Ω
Q_g,typ	20	nC
$I_D,pulse$	17	A
$E_{oss @ 400V}$	1.8	μJ
Body diode di/dt	900	A/ μs
Q_{rr}	0.2	μC
t_{rr}	65	ns
I_{rrm}	4.5	A

Type / Ordering Code	Package	Marking	Related Links
IPB65R660CFDA	PG-TO 263	65F660A	-
IPP65R660CFDA	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			6	A	$T_C = 25^\circ\text{C}$
				3.8		$T_C = 100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$			17	A	$T_C = 25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}			115	mJ	$I_D = 1.2\text{A}$, $V_{DD} = 50\text{V}$ (see table 11)
Avalanche energy, repetitive	E_{AR}			0.21	mJ	$I_D = 1.2\text{A}$, $V_{DD} = 50\text{V}$
Avalanche current, repetitive	I_{AR}			1.2	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}			62.5	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			6	A	$T_C = 25^\circ\text{C}$
Diode pulse current	$I_{S,pulse}$			17	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt ³⁾	dv/dt			50	V/ns	$V_{DS} = 0 \dots 400\text{V}$, $I_{SD} \leq I_D$, $T_j = 25^\circ\text{C}$
Maximum diode commutation speed	di/dt			900	A/ μs	(see table 9)

¹⁾ Limited by $T_{j,max}$.

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}			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}			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, 6cm² 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	$V_{DS} = V_{GS}, I_D = 0.2mA$
Zero gate voltage drain current	I_{DSS}			1	μA	$V_{DS} = 650V, V_{GS} = 0V, T_j = 25^\circ C$
			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	$R_{DS(on)}$		0.594	0.66	Ω	$V_{GS} = 10V, I_D = 3.2A, T_j = 25^\circ C$
			1.544			$V_{GS} = 10V, I_D = 3.2A, T_j = 150^\circ C$
Gate resistance	R_G		6.5		Ω	$f = 1MHz$, open drain

Table 6 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}		543		pF	$V_{GS} = 0V, V_{DS} = 100V, f = 1MHz$
Output capacitance	C_{oss}		32		pF	
Effective output capacitance, energy related ²⁾	$C_{o(er)}$		24		pF	$V_{GS} = 0V, V_{DS} = 0 \dots 400V$
Effective output capacitance, time related ³⁾	$C_{o(tr)}$		97		pF	$I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 400V$
Turn-on delay time	$t_{d(on)}$		9		ns	$V_{DD} = 400V, V_{GS} = 13V, I_D = 3.2A, R_G = 6.8\Omega$ (see table 10)
Rise time	t_r		8		ns	
Turn-off delay time	$t_{d(off)}$		40		ns	
Fall time	t_f		10		ns	

Table 7 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}		3.5		nC	$V_{DD} = 480V, I_D = 3.2A, V_{GS} = 0 \text{ to } 10V$
Gate to drain charge	Q_{gd}		11		nC	
Gate charge total	Q_g		20		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.

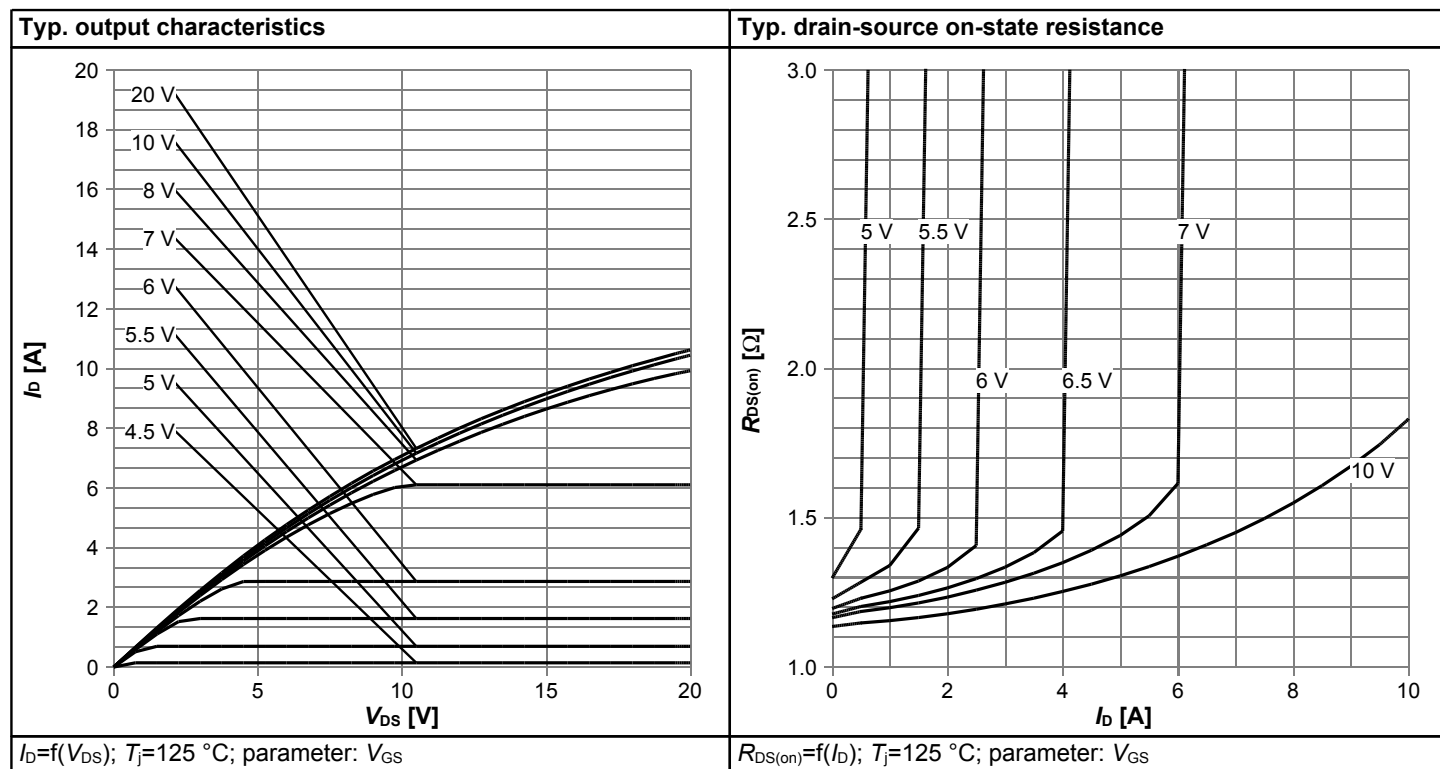
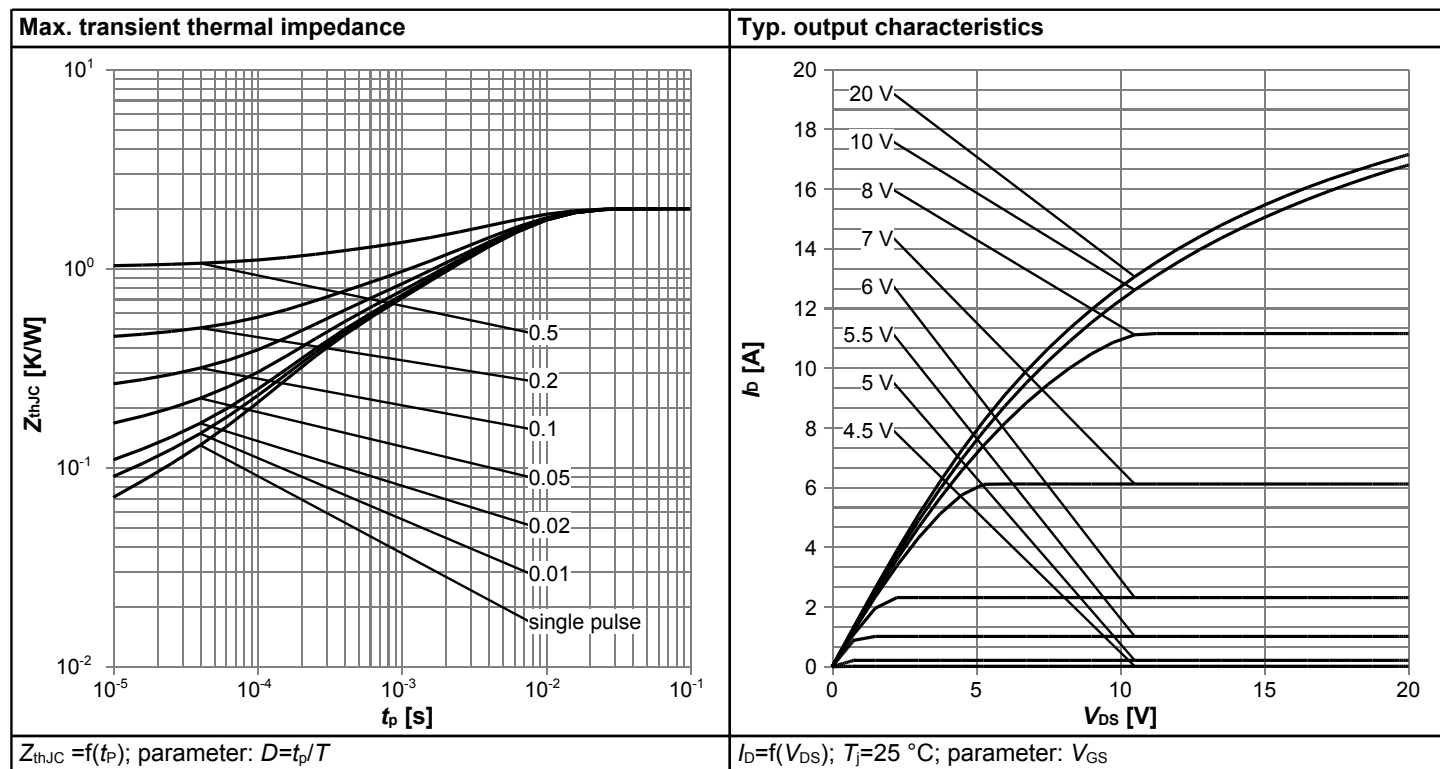
²⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V

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

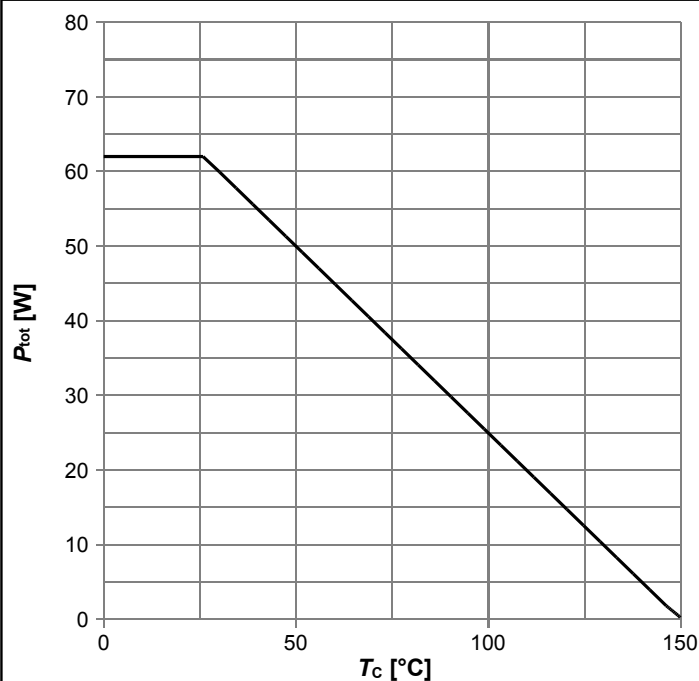
Table 8 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}		0.9		V	$V_{GS} = 0V$, $I_F = 3.2A$, $T_J = 25^\circ C$
Reverse recovery time	t_{rr}		65		ns	$V_R = 400V$, $I_F = 3.2A$, $di_F/dt = 100A/\mu s$ (see table 9)
Reverse recovery charge	Q_{rr}		0.2		μC	
Peak reverse recovery current	I_{rrm}		4.5		A	

5 Electrical characteristics diagrams

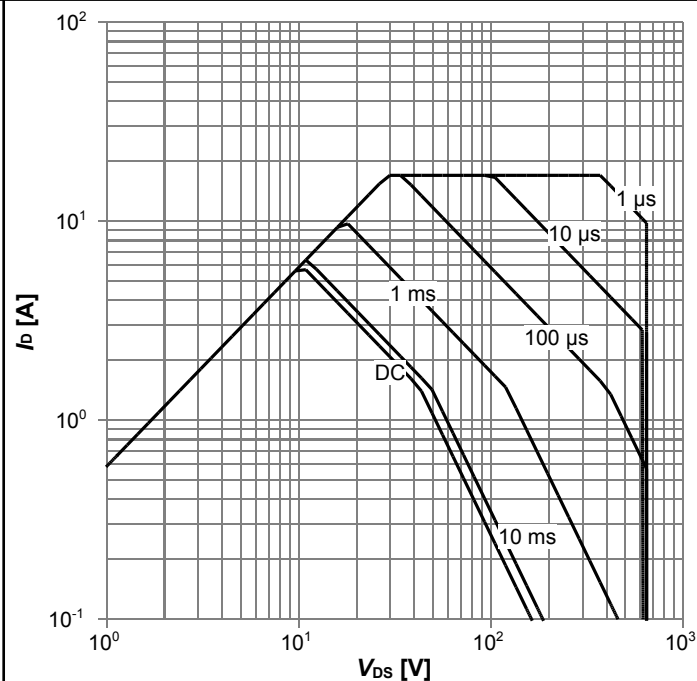


Power dissipation



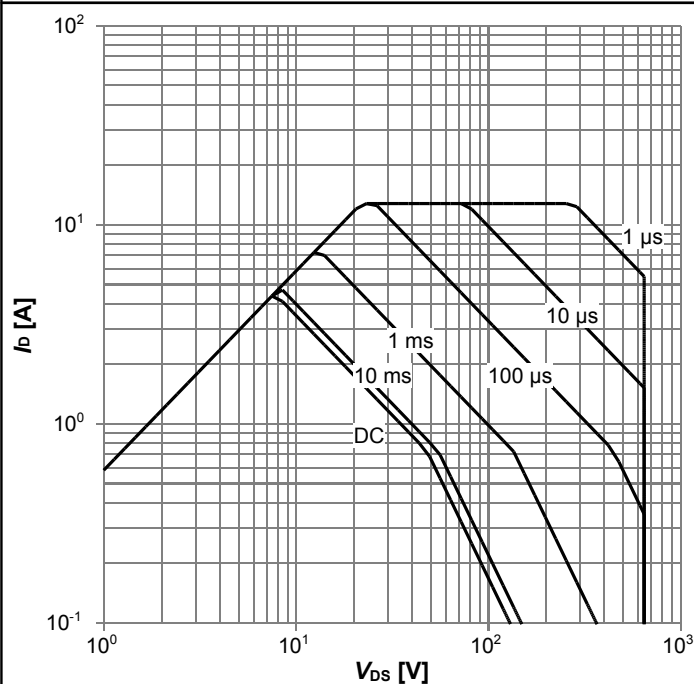
$$P_{tot}=f(T_c)$$

Safe operating area



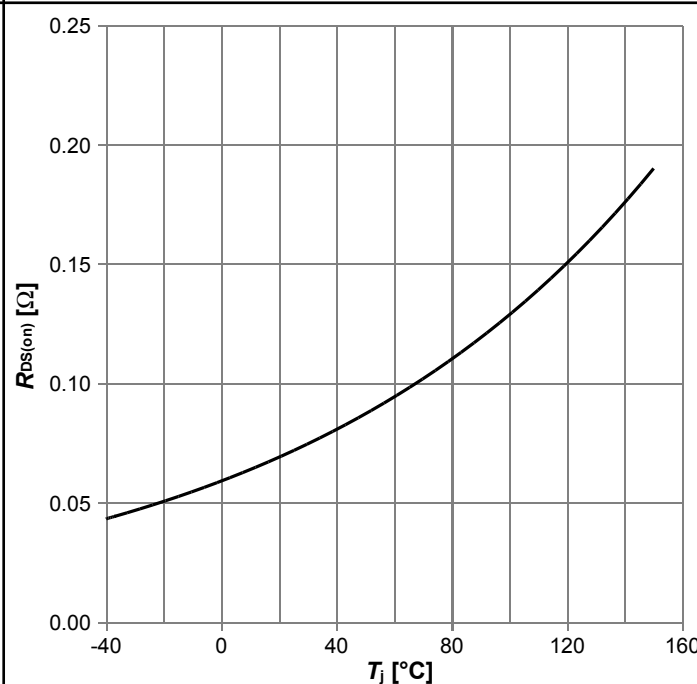
$$I_D=f(V_{DS}); T_c=25\text{ °C}; D=0; \text{parameter: } t_p$$

Safe operating area



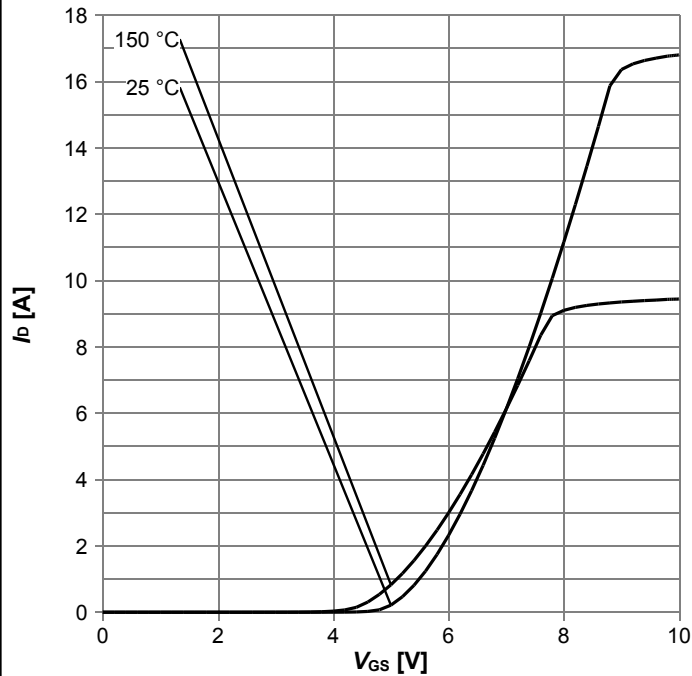
$$I_D=f(V_{DS}); T_c=80\text{ °C}; D=0; \text{parameter: } t_p$$

Typ. drain-source on-state resistance

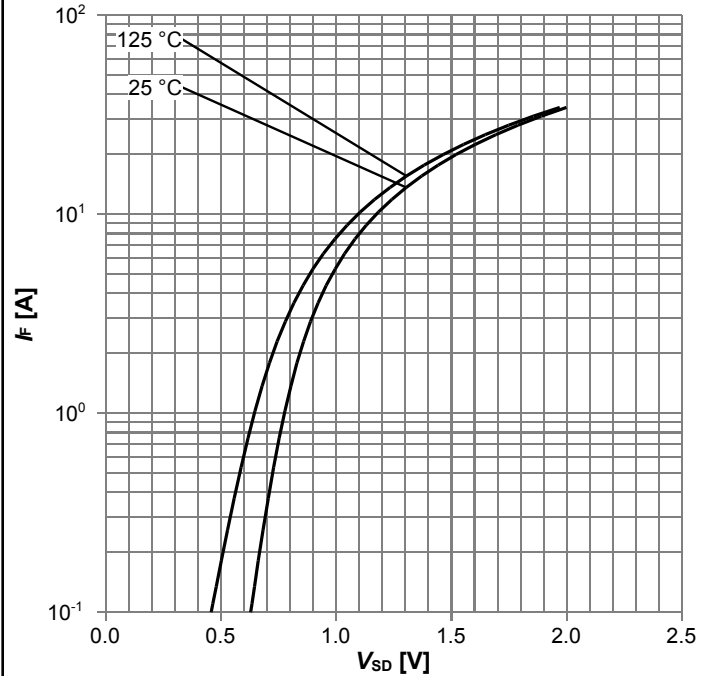


$$R_{DS(on)}=f(T_j); I_D=18.1\text{ A}; V_{GS}=10\text{ V}$$

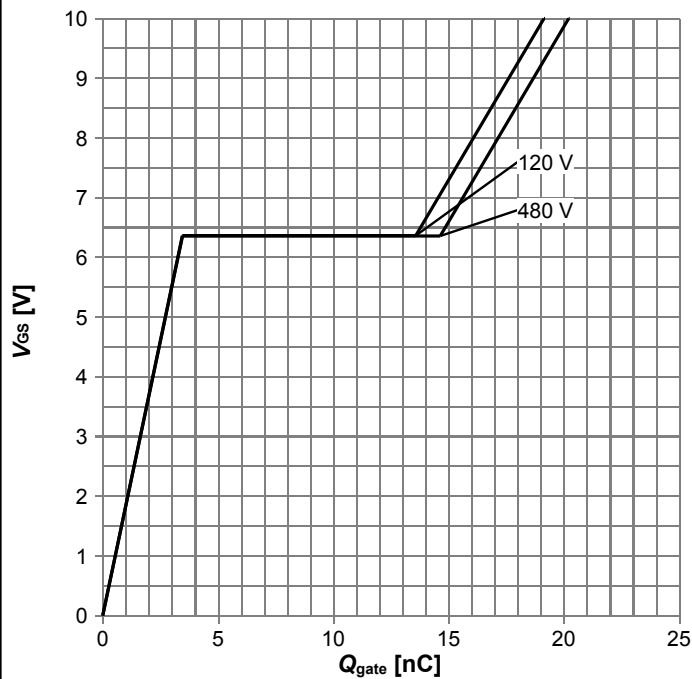
Typ. transfer characteristics


 $I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}; \text{parameter: } T_j$

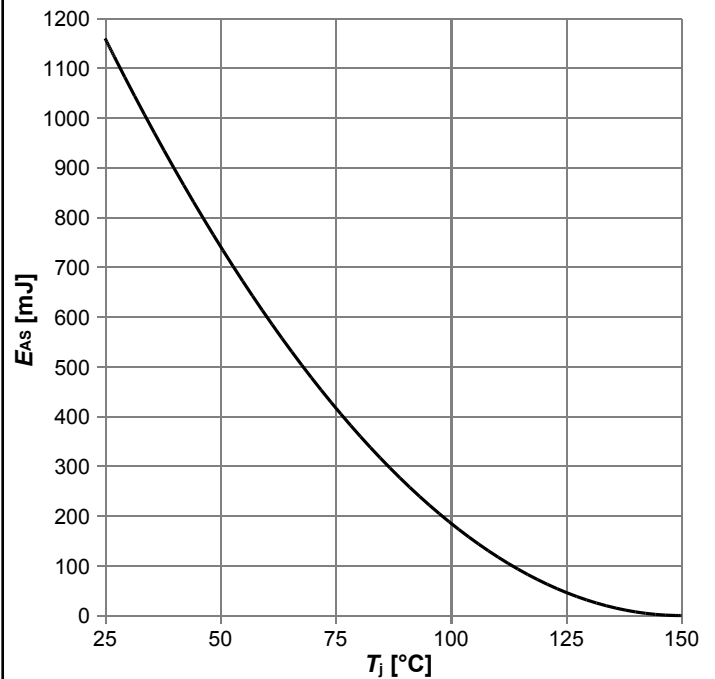
Typ. forward characteristics of reverse diode


 $I_F = f(V_{SD}); \text{parameter: } T_j$

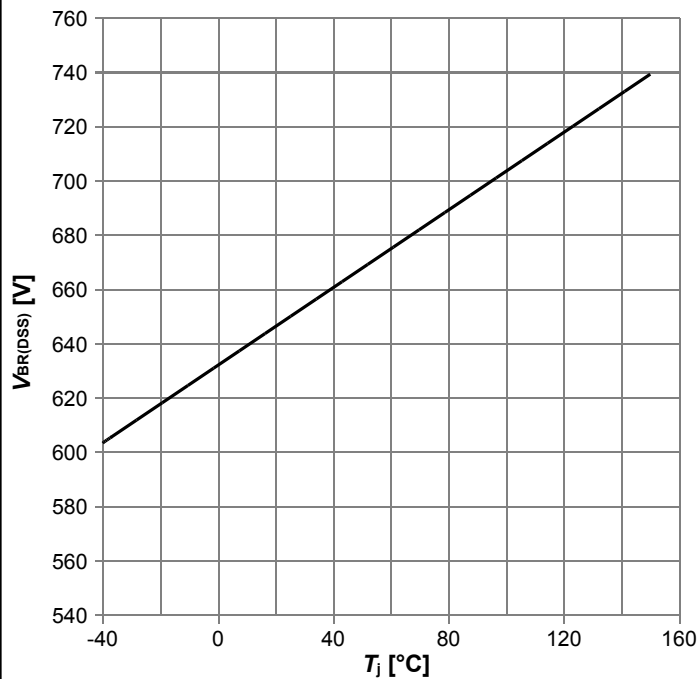
Typ. gate charge


 $V_{GS} = f(Q_{gate}); I_D = 19.2 \text{ A pulsed}; \text{parameter: } V_{DD}$

Avalanche energy

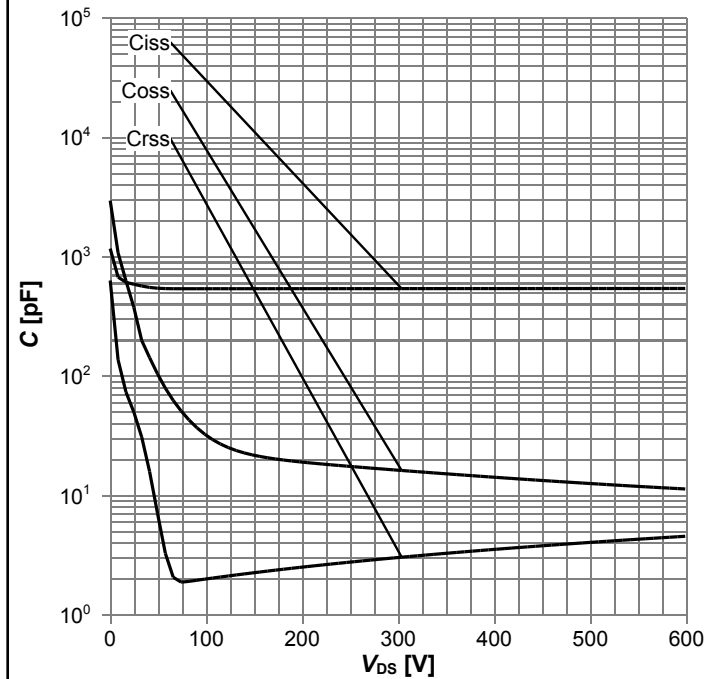

 $E_{AS} = f(T_j); I_D = 6.6 \text{ A}; V_{DD} = 50 \text{ V}$

Drain-source breakdown voltage



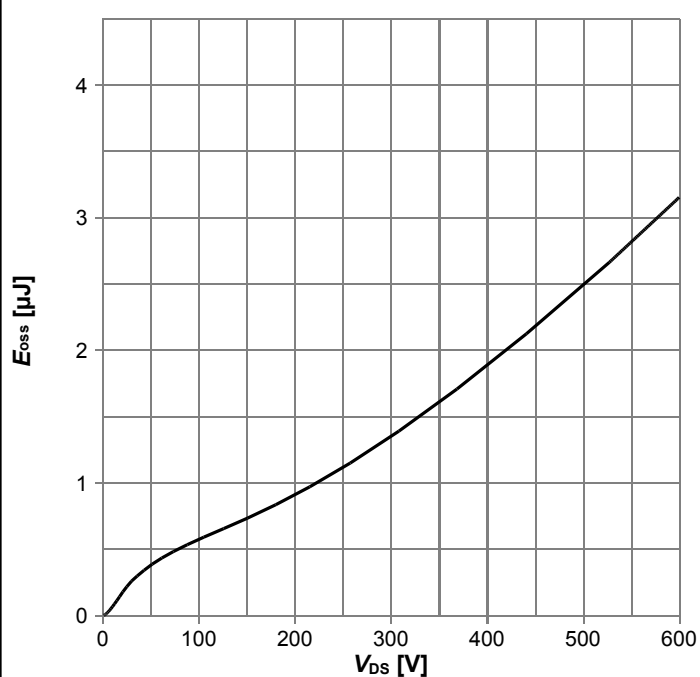
$$V_{BR(DSS)} = f(T_j); I_D = 0.25 \text{ mA}$$

Typ. capacitances



$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$

Typ. Coss stored energy



$$E_{oss} = f(V_{DS})$$

6 Test Circuits

Table 9 Diode characteristics

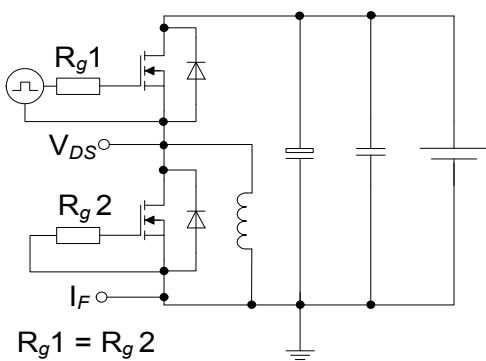
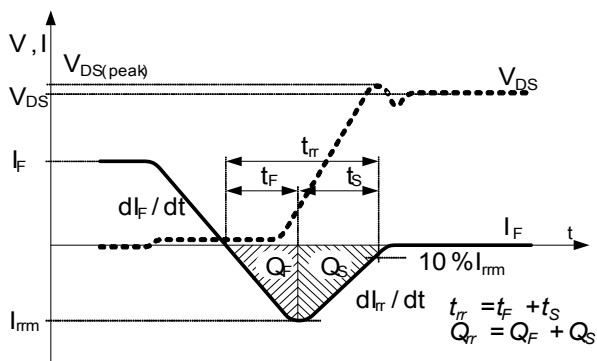
Test circuit for diode characteristics	Diode recovery waveform
 $R_{g1} = R_{g2}$	 $t_{rr} = t_{fr} + t_s$ $Q_r = Q_f + Q_s$

Table 10 Switching times

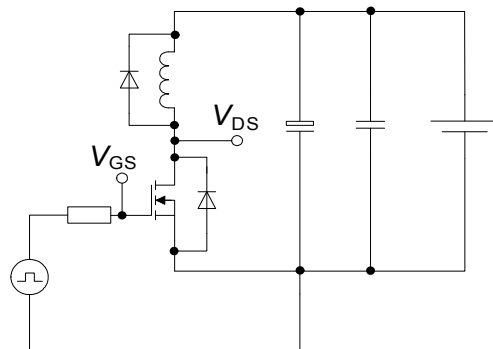
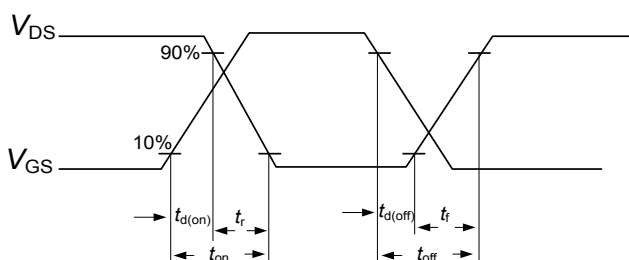
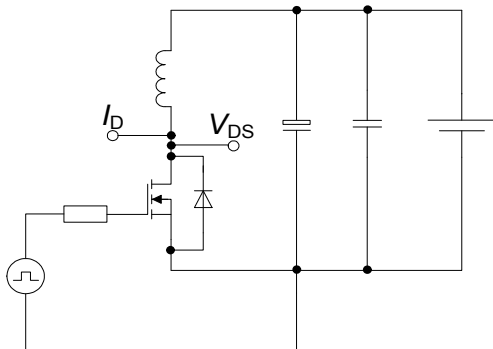
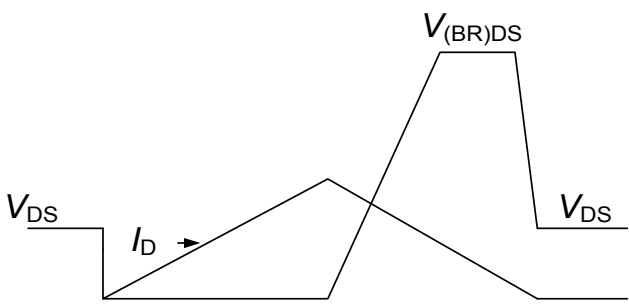
Switching times test circuit for inductive load	Switching times waveform
	

Table 11 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

7 Package Outlines

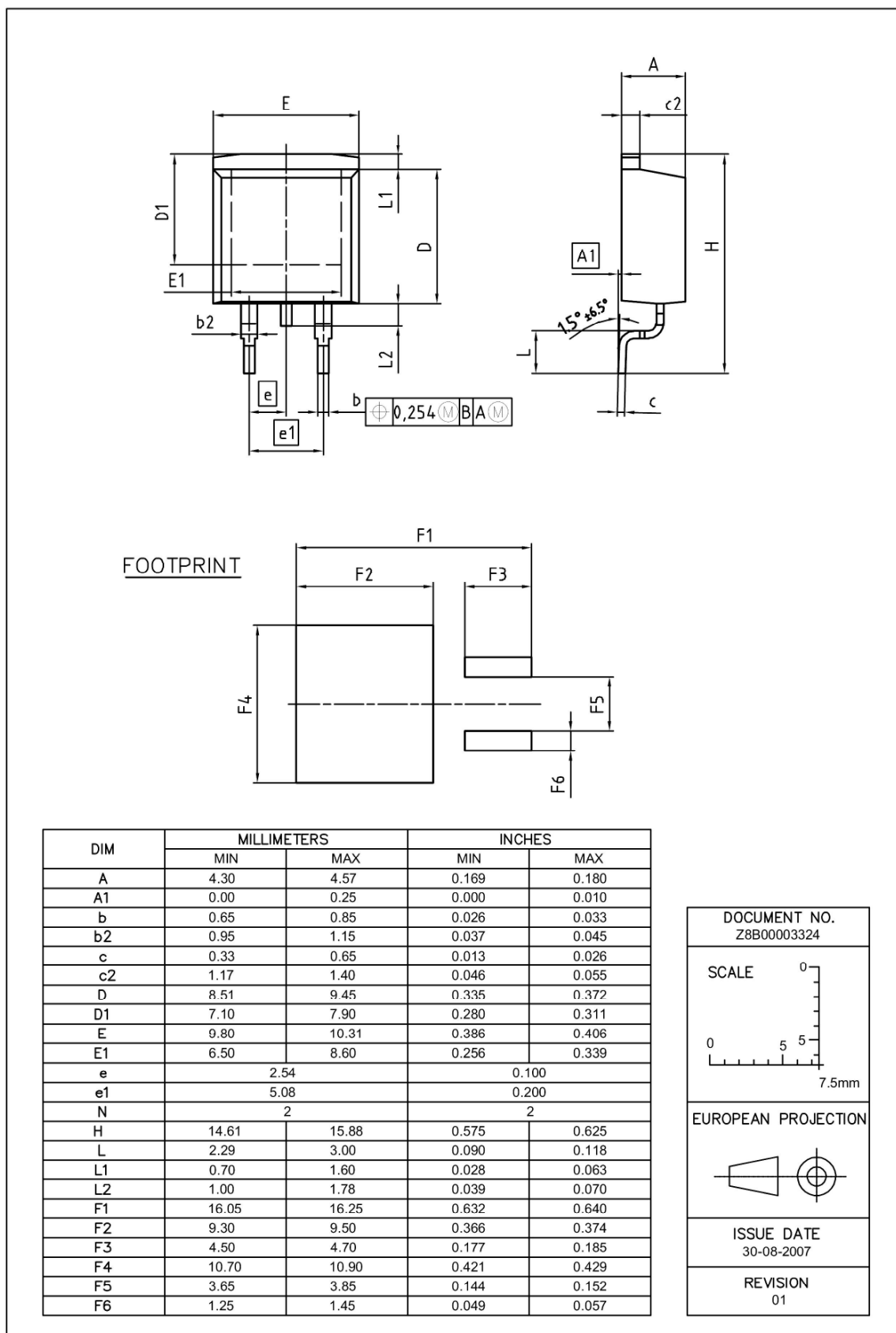


Figure 1 Outline PG-TO 263, dimensions in mm/inches

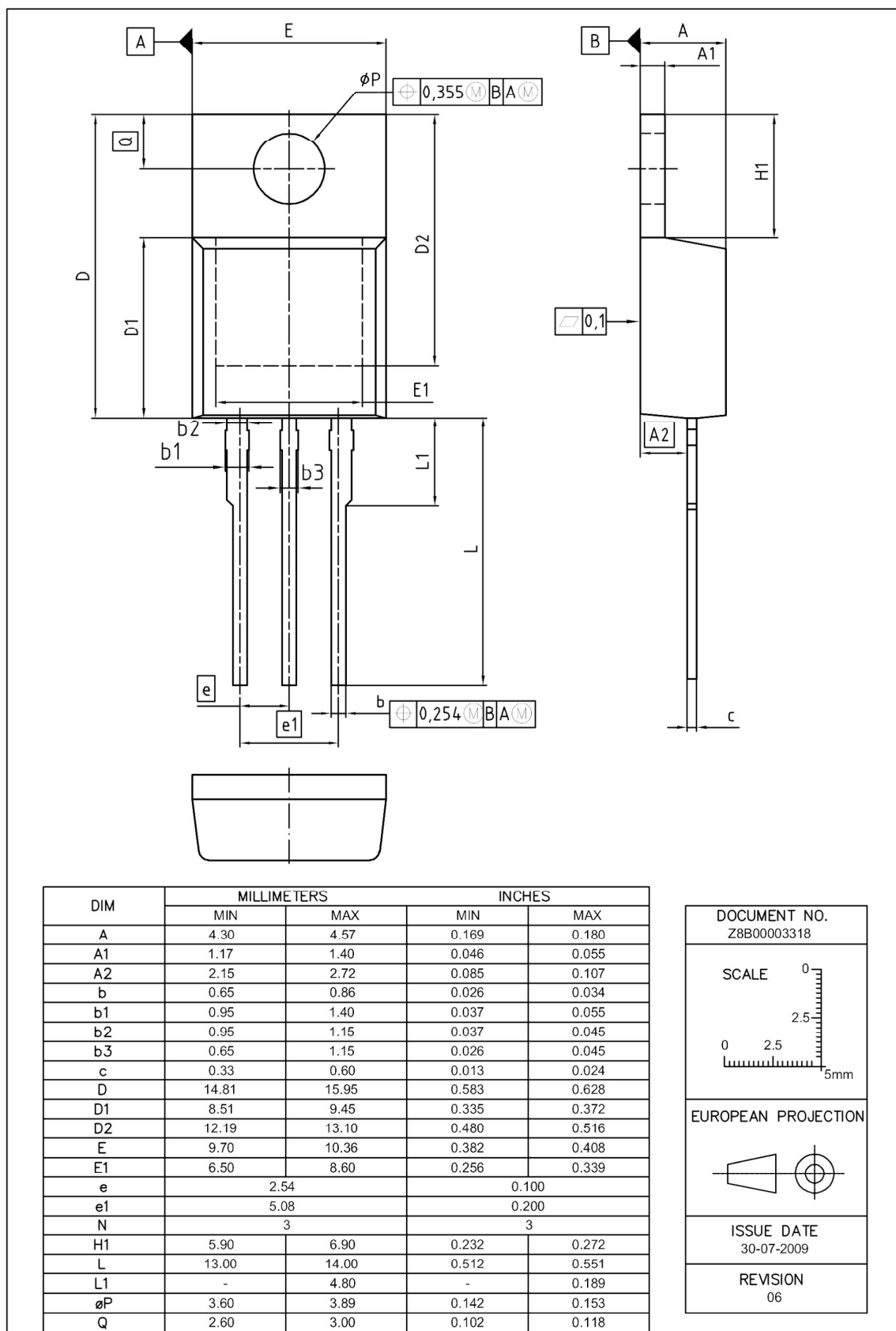


Figure 2 Outline PG-TO 220, dimensions in mm/inches

Revision History

IPB65R660CFDA, IPP65R660CFDA

Revision: 2014-11-19, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2012-03-28	Final datasheet
2.1	2014-11-19	Correction of Markingcode

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