

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C6 600V

600V CoolMOS™ C6 Power Transistor
IPx60R125C6

Data Sheet

Rev. 2.3
Final

600V CoolMOS™ C6 Power Transistor

IPA60R125C6, IPB60R125C6
IPP60R125C6 IPW60R125C6

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™ C6 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The offered 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
- JEDEC¹⁾ qualified, Pb-free plating, Halogen free

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.

Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.

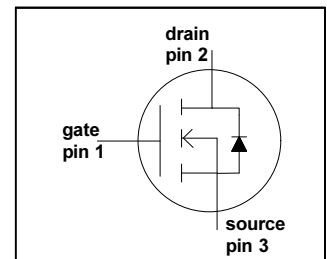
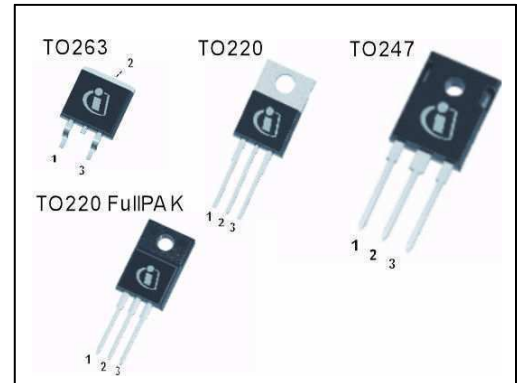


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.125	Ω
$Q_{g,typ}$	96	nC
$I_{D,pulse}$	89	A
$E_{oss} @ 400V$	7.6	μJ
Body diode di/dt	500	A/ μs

Type / Ordering Code	Package	Marking	Related Links
IPW60R125C6	PG-TO247	6R125C6	IFX C6 Product Brief IFX C6 Portfolio IFX CoolMOS Webpage IFX Design tools
IPB60R125C6	PG-TO263		
IPP60R125C6	PG-TO220		
IPA60R125C6	PG-TO220 FullPAK		

1) J-STD20 and JESD22

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2 Maximum ratings

at $T_j = 25\text{ °C}$, unless otherwise specified.

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current ¹⁾	I_D	-	-	30	A	$T_C = 25\text{ °C}$
				19		$T_C = 100\text{ °C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	89	A	$T_C = 25\text{ °C}$
Avalanche energy, single pulse	E_{AS}	-	-	636	mJ	$I_D = 5.2\text{ A}, V_{DD} = 50\text{ V}$ (see table 21)
Avalanche energy, repetitive	E_{AR}	-	-	0.96		$I_D = 5.2\text{ A}, V_{DD} = 50\text{ V}$
Avalanche current, repetitive	I_{AR}	-	-	5.2	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 for TO-220, TO-247, TO-263	P_{tot}	-	-	219	W	$T_C = 25\text{ °C}$
Power dissipation for TO-220 FullPAK	P_{tot}	-	-	34		
Operating and storage temperature	T_j, T_{stg}	-55	-	150	°C	
Mounting torque TO-220, TO-247		-	-	60	Ncm	M3 and M3.5 screws
Mounting torque TO-220 FullPAK				50		M2.5 screws
Continuous diode forward current	I_S	-	-	26	A	$T_C = 25\text{ °C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	89	A	$T_C = 25\text{ °C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	15	V/ns	$V_{DS} = 0 \dots 400\text{ V}, I_{SD} \leq I_D,$ $T_j = 25\text{ °C}$
Maximum diode commutation speed ³⁾	di/dt			500	A/μs	(see table 22)

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 (IPP60R125C6), TO-247 (IPW60R125C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.57	°C/W	leded
Thermal resistance, junction - ambient	R_{thJA}	-	-	62		
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6 mm (0.063 in.) from case for 10 s

Table 4 Thermal characteristics TO-220FullIPAK (IPA60R125C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	3.65	°C/W	leded
Thermal resistance, junction - ambient	R_{thJA}	-	-	80		
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6 mm (0.063 in.) from case for 10 s

Table 5 Thermal characteristics TO-263 (IPB60R125C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.57	°C/W	SMD version, device on PCB, minimal footprint SMD version, device on PCB, 6cm ² cooling area ¹⁾ reflow MSL1
Thermal resistance, junction - ambient	R_{thJA}	-	-	62		
		-	35	-		
Soldering temperature, wave- & reflow soldering allowed	T_{sold}	-	-	260	°C	

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

Electrical characteristics, at $T_j=25\text{ °C}$, 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	$V_{GS}=0\text{ V}$, $I_D=0.25\text{ mA}$
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5		$V_{DS}=V_{GS}$, $I_D=0.96\text{ mA}$
Zero gate voltage drain current	I_{DSS}	-	-	2	μA	$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$
		-	20	-		$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ °C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.11	0.125	Ω	$V_{GS}=10\text{ V}$, $I_D=14.5\text{ A}$, $T_j=25\text{ °C}$
		-	0.29	-		$V_{GS}=10\text{ V}$, $I_D=14.5\text{ A}$, $T_j=150\text{ °C}$
Gate resistance	R_G	-	3.7	-	Ω	$f=1\text{ MHz}$, open drain

Table 7 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	2127	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=100\text{ V}$, $f=1\text{ MHz}$
Output capacitance	C_{oss}	-	125	-		
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$	-	82	-		$V_{GS}=0\text{ V}$, $V_{DS}=0\dots480\text{ V}$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$	-	400	-		$I_D=\text{constant}$, $V_{GS}=0\text{ V}$ $V_{DS}=0\dots480\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	15	-	ns	$V_{DD}=400\text{ V}$, $V_{GS}=13\text{ V}$, $I_D=14.5\text{ A}$, $R_G=1.7\Omega$ (see table 20)
Rise time	t_r	-	12	-		
Turn-off delay time	$t_{d(off)}$	-	83	-		
Fall time	t_f	-	7	-		

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 8 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	12	-	nC	$V_{DD}=480\text{ V}$, $I_D=14.5\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	Q_{gd}	-	49	-		
Gate charge total	Q_g	-	96	-		
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	

Table 9 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.9	-	V	$V_{GS}=0\text{ V}$, $I_F=14.5\text{ A}$, $T_j=25\text{ °C}$
Reverse recovery time	t_{rr}	-	510	-	ns	$V_R=400\text{ V}$, $I_F=14.5\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$ (see table 22)
Reverse recovery charge	Q_{rr}	-	10	-	μC	
Peak reverse recovery current	I_{rrm}	-	39	-	A	

5 Electrical characteristics diagrams

Table 10

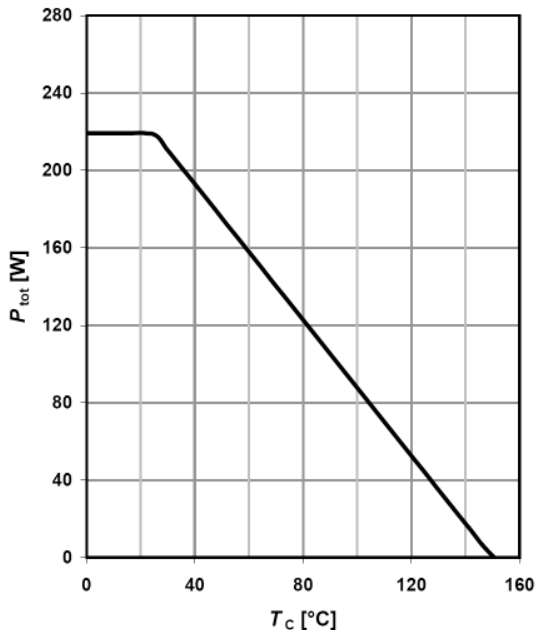
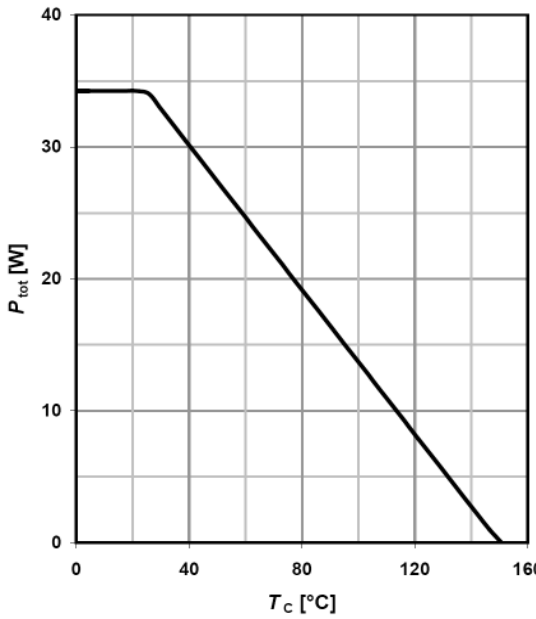
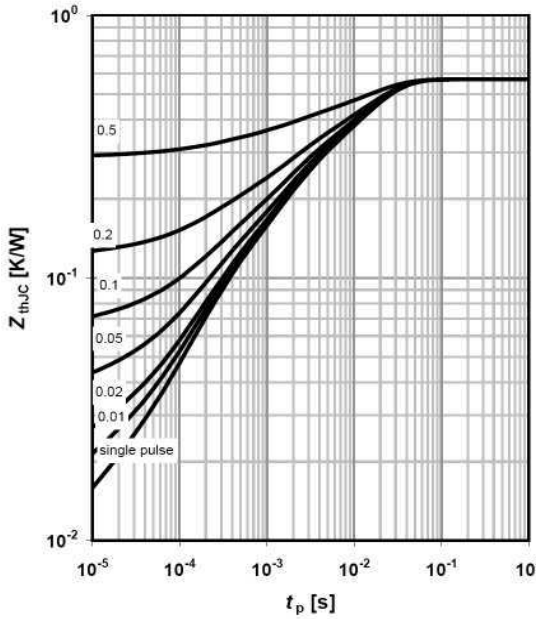
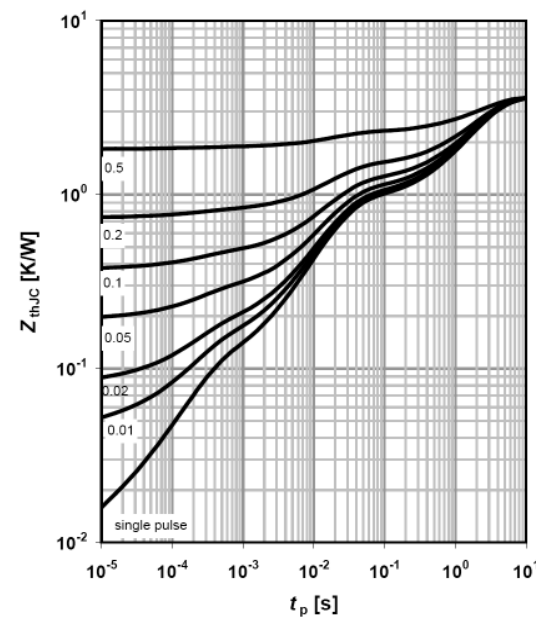
Power dissipation TO-220, TO-247, TO-263	Power dissipation TO-220 FullPAK
	
$P_{tot} = f(T_c)$	$P_{tot} = f(T_c)$

Table 11

Max. transient thermal impedance TO-220, TO-247, TO-263	Max. transient thermal impedance TO-220 FullPAK
	
$Z_{(thJC)} = f(t_p)$; parameter: $D = t_p / T$	$Z_{(thJC)} = f(t_p)$; parameter: $D = t_p / T$

Electrical characteristics diagrams

Table 12

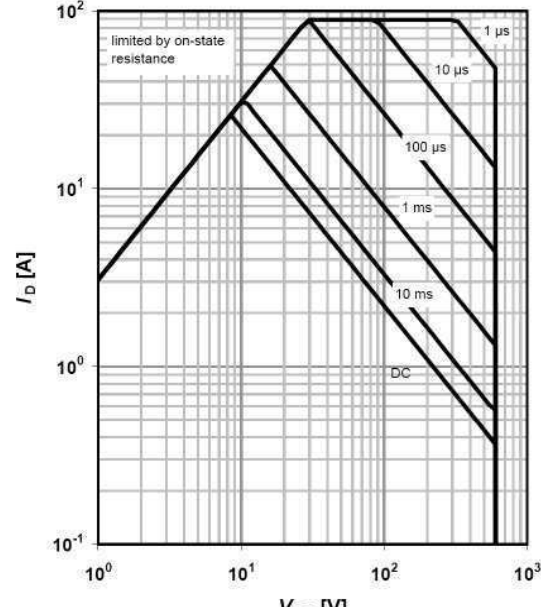
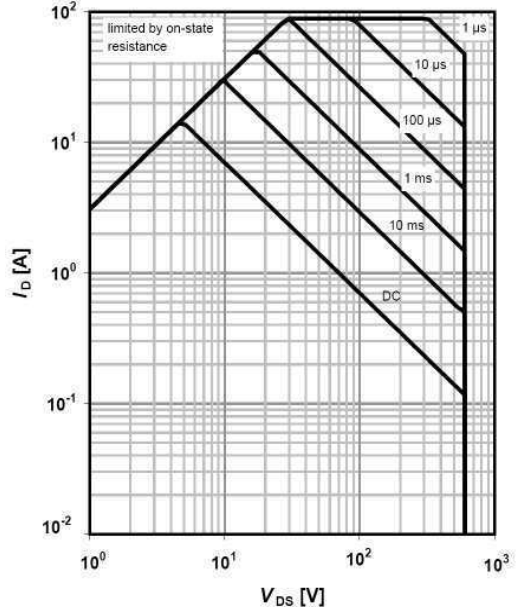
Safe operating area $T_C=25\text{ °C}$ TO-220, TO-247, TO-263	Safe operating area $T_C=25\text{ °C}$ TO-220 FullPAK
	
$I_D=f(V_{DS}); T_C=25\text{ °C}; D=0; \text{parameter } t_p$	$I_D=f(V_{DS}); T_C=25\text{ °C}; D=0; \text{parameter } t_p$

Table 13

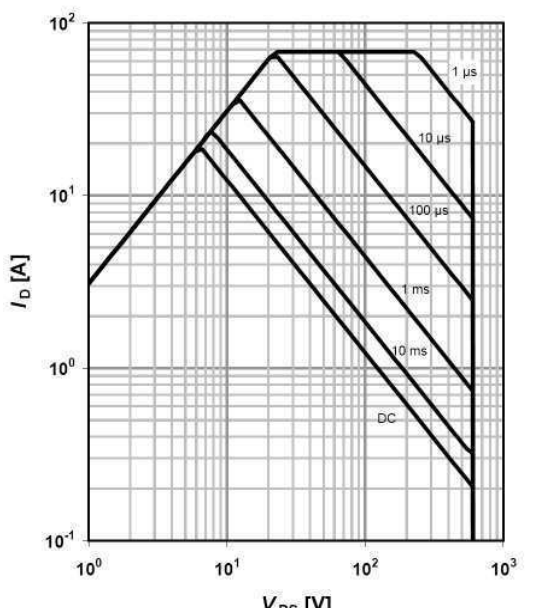
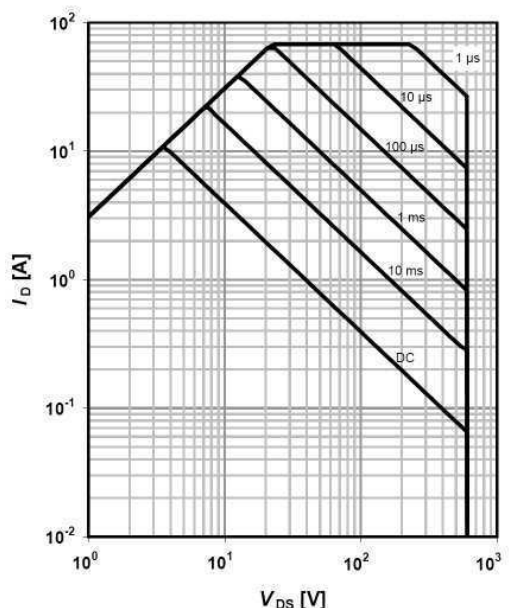
Safe operating area $T_C=80\text{ °C}$ TO-220, TO-247, TO-263	Safe operating area $T_C=80\text{ °C}$ TO-220 FullPAK
	
$I_D=f(V_{DS}); T_C=80\text{ °C}; D=0; \text{parameter } t_p$	$I_D=f(V_{DS}); T_C=80\text{ °C}; D=0; \text{parameter } t_p$

Table 14

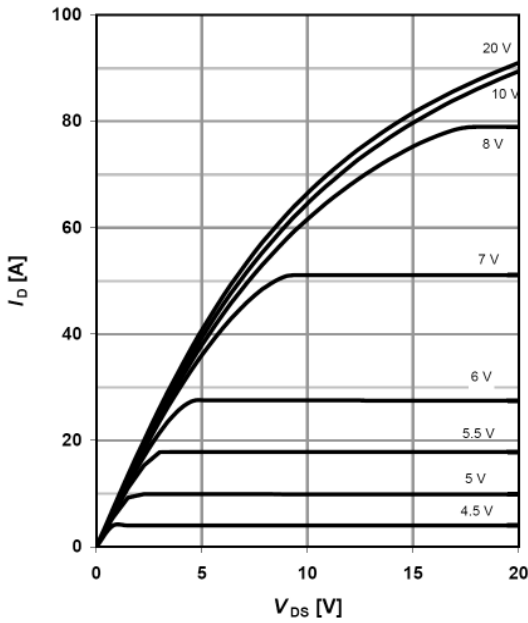
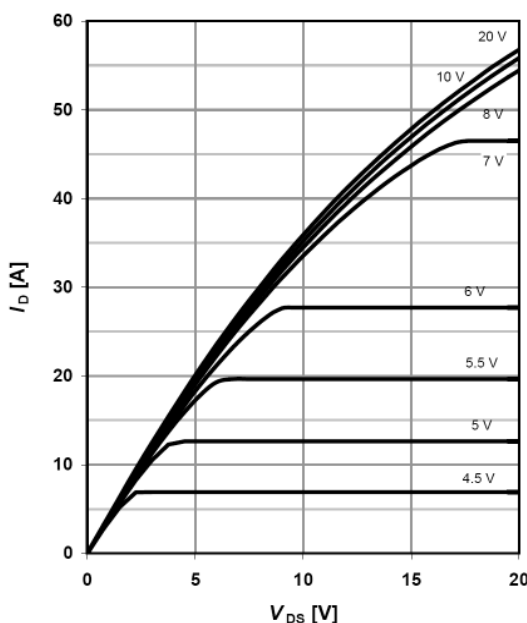
Typ. output characteristics $T_j=25\text{ °C}$	Typ. output characteristics $T_j=125\text{ °C}$
	
$I_D=f(V_{DS}); T_j=25\text{ °C}; \text{parameter: } V_{GS}$	$I_D=f(V_{DS}); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

Table 15

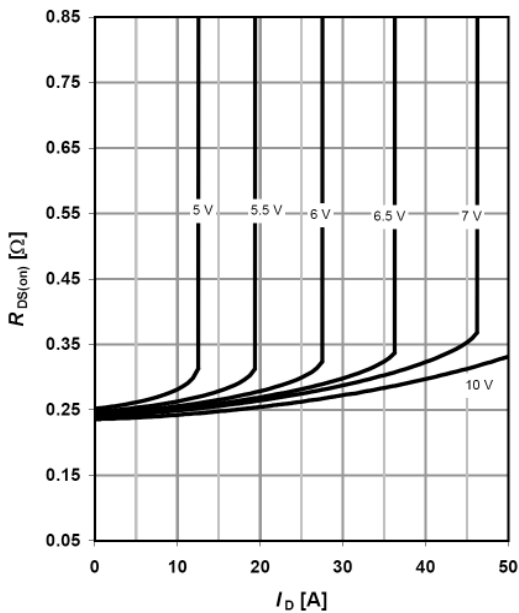
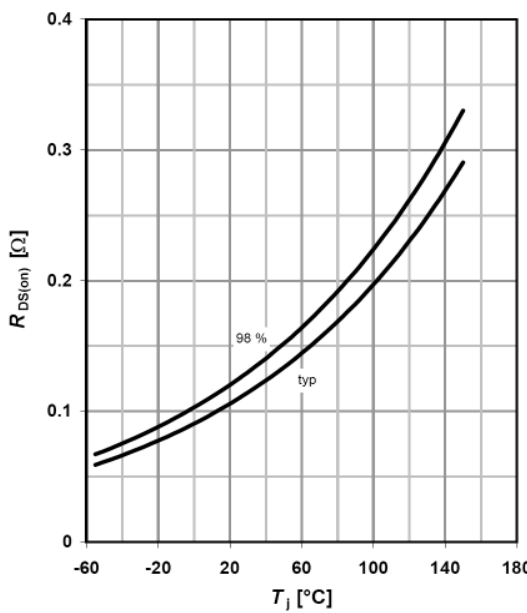
Typ. drain-source on-state resistance	Drain-source on-state resistance
	
$R_{DS(on)}=f(I_D); T_j=125\text{ °C}; \text{parameter: } V_{GS}$	$R_{DS(on)}=f(T_j); I_D=14.5\text{ A}; V_{GS}=10\text{ V}$

Table 16

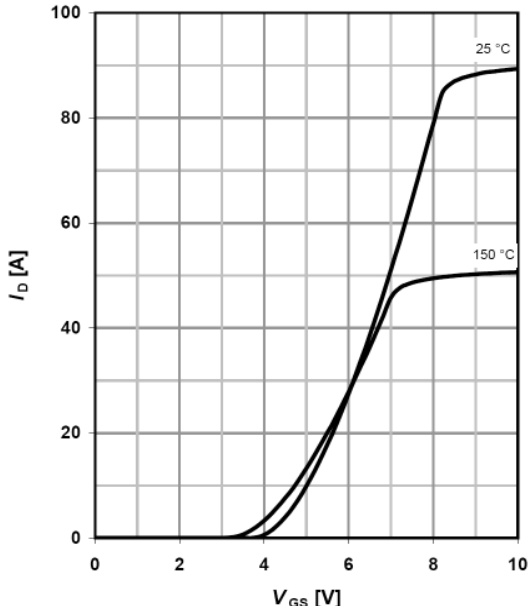
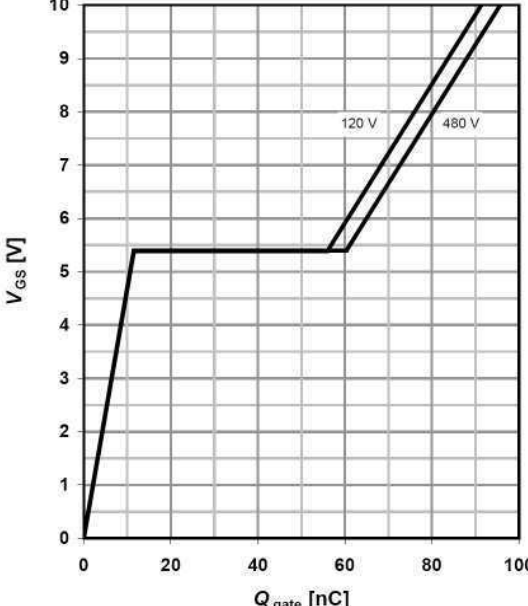
Typ. transfer characteristics	Typ. gate charge
	
$I_D = f(V_{GS}); V_{DS} = 20V$	$V_{GS} = f(Q_{gate}), I_D = 14.5 \text{ A pulsed}$

Table 17

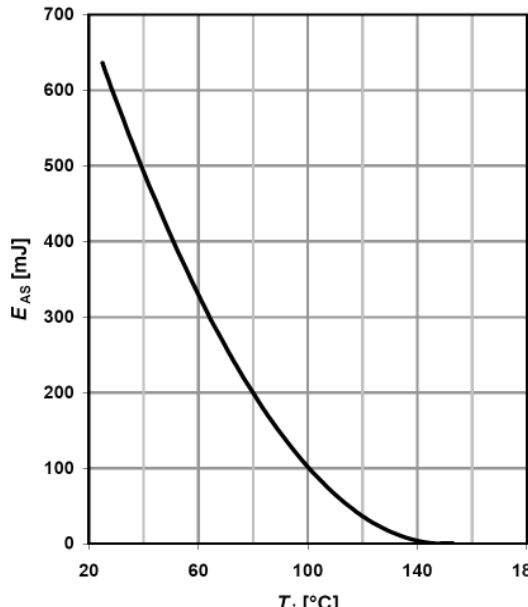
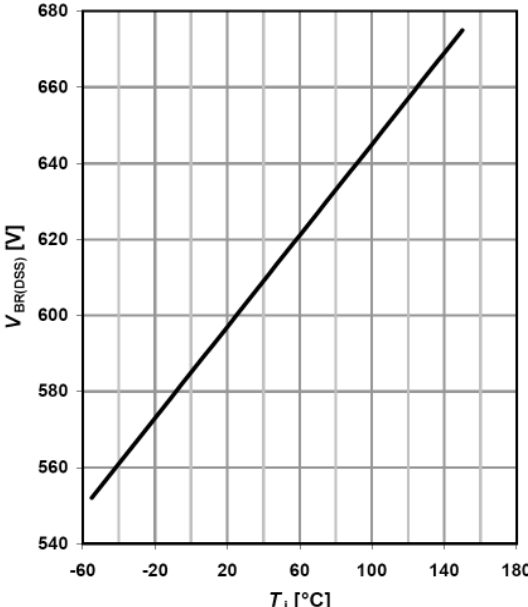
Avalanche energy	Drain-source breakdown voltage
	
$E_{AS} = f(T_j); I_D = 5.2 \text{ A}; V_{DD} = 50 \text{ V}$	$V_{BR(DSS)} = f(T_j); I_D = 0.25 \text{ mA}$

Table 18

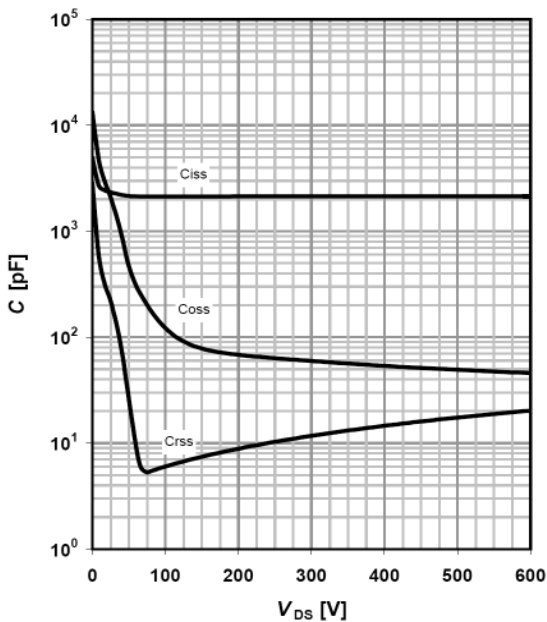
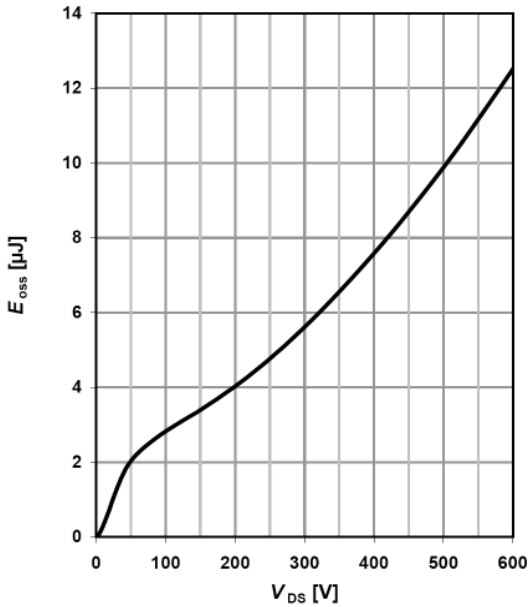
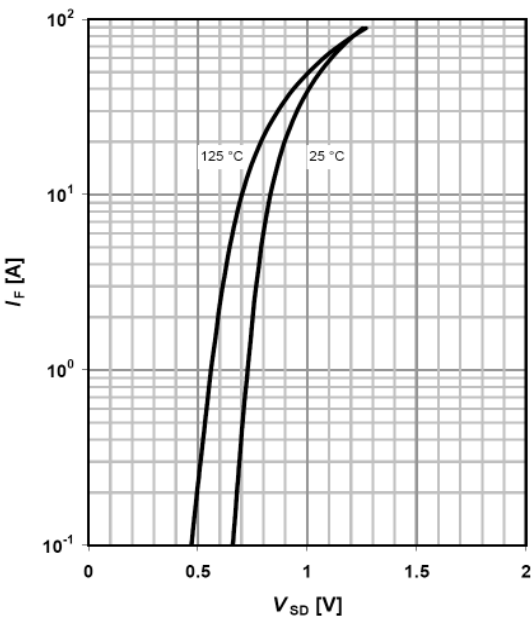
Typ. capacitances	Typ. C_{oss} stored energy
 $C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$	 $E_{oss} = f(V_{DS})$

Table 19

Forward characteristics of reverse diode
 $I_F = f(V_{SD}); \text{parameter: } T_j$

7 Package outlines

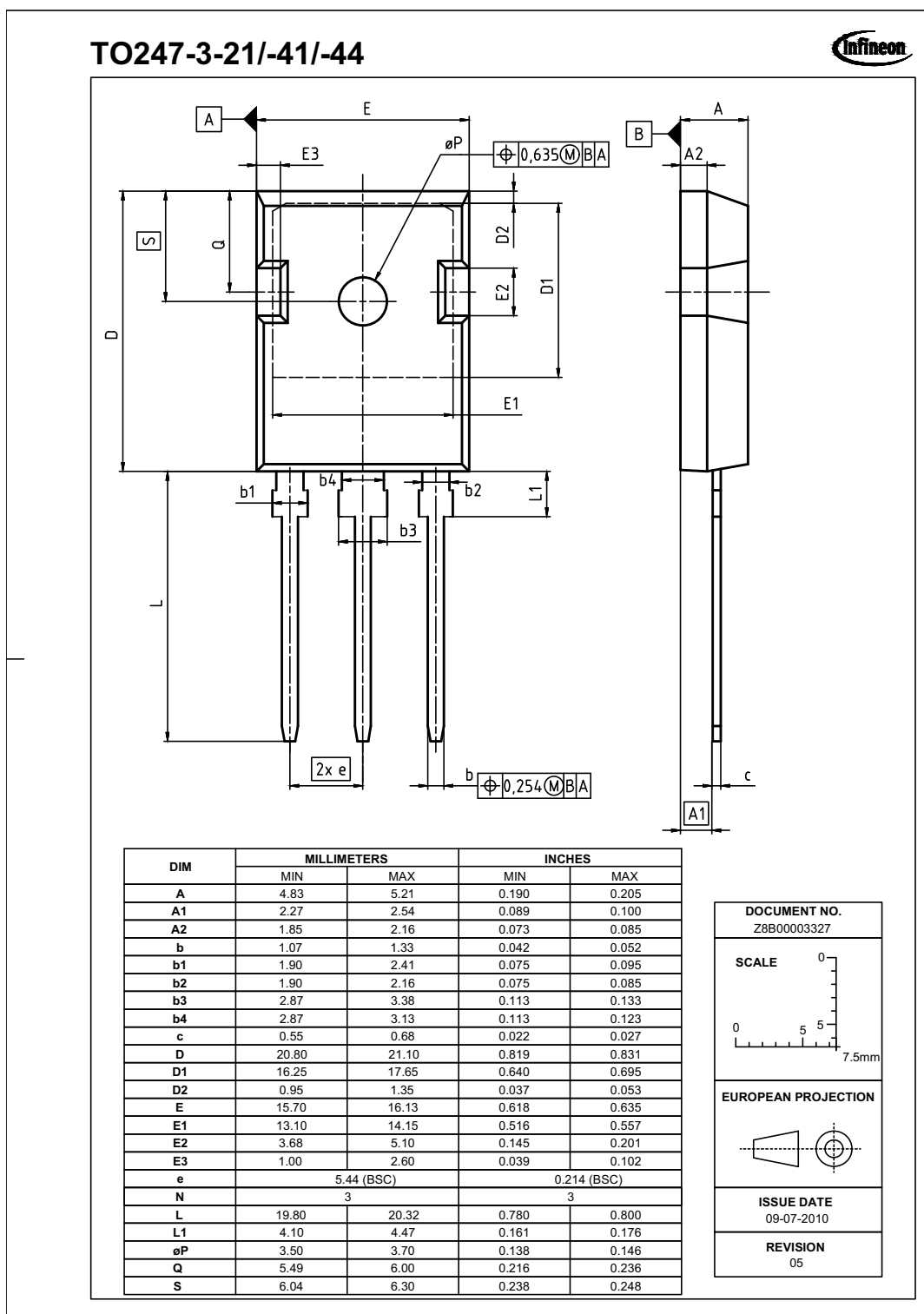
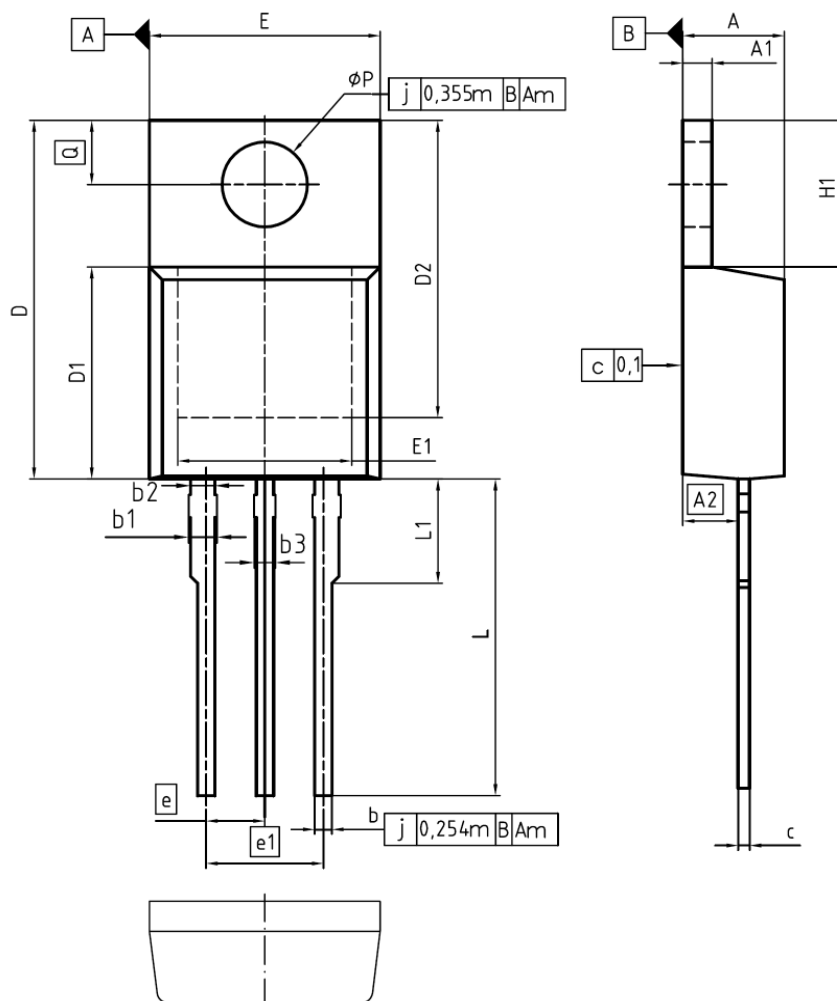


Figure 1 Outlines TO-247, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
øP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118



Figure 2 Outlines TO-220, dimensions in mm/inches

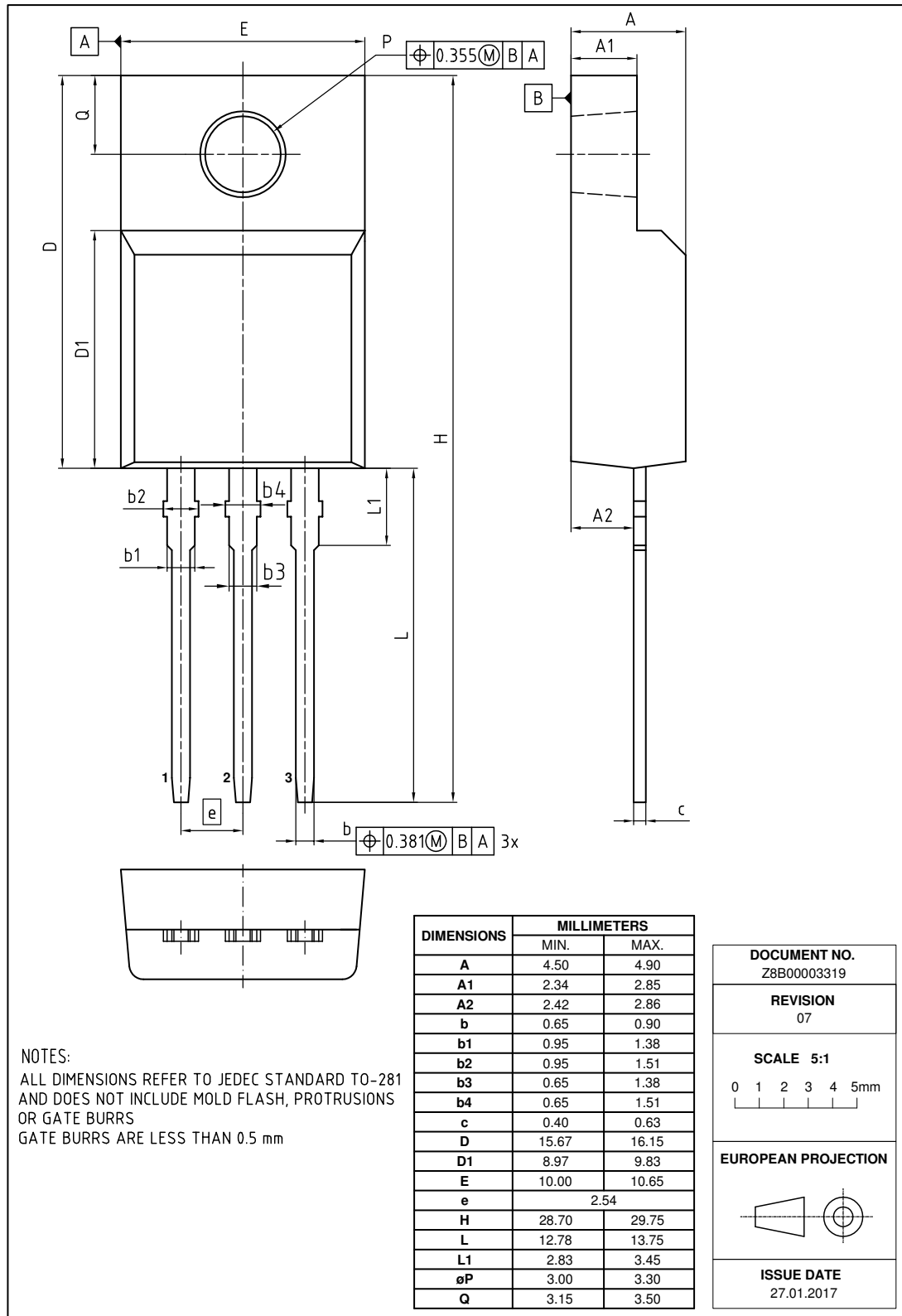


Figure 3 Outline PG-TO-220 FullPAK dimensions in mm

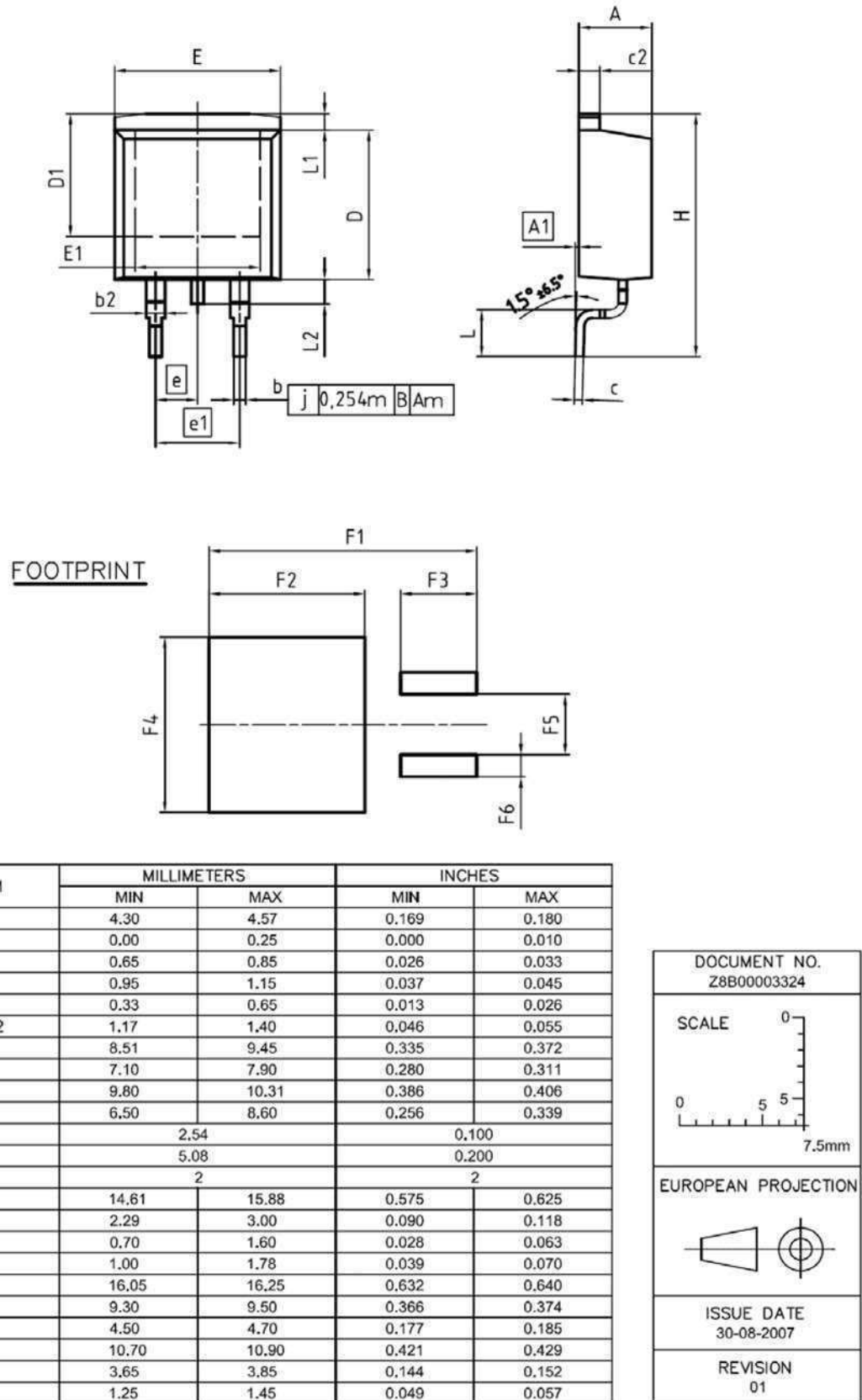


Figure 4 Outlines TO-263, dimensions in mm/inches

Revision History

IPx60R125C6

Revision: 2018-03-04, 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	2015-02-03	PG-TO220 FullPAK package outline update (creation:2014-12-02)
2.3	2018-03-04	Outline PG-TO220 FullPAK update

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