

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS C6

600V CoolMOS™ C6 Power Transistor
IPx60R099C6

Data Sheet

Rev. 2.1, 2010-02-09
Final

Industrial & Multimarket

600V CoolMOS™ C6 Power Transistor

IPA60R099C6, IPB60R099C6
IPP60R099C6 IPW60R099C6

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.

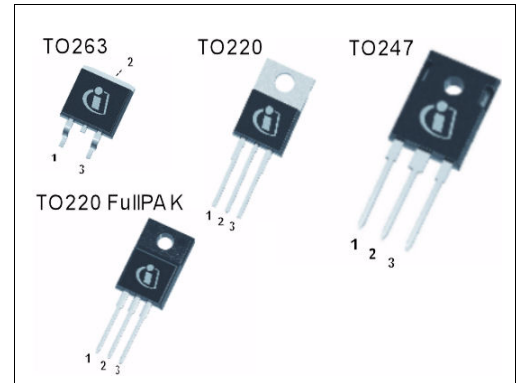
Features

- 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, UPS and Solar.

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



RoHS

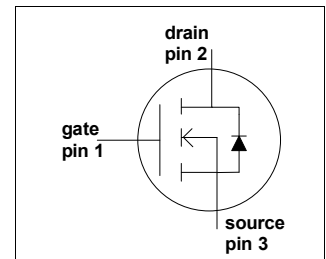


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.099	Ω
$Q_{g,typ}$	119	nC
$I_{D,pulse}$	112	A
$E_{oss} @ 400V$	9.3	μJ
Body diode di/dt	300	A/ μs

Type / Ordering Code	Package	Marking	Related Links
IPW60R099C6	PG-TO247	6R099C6	IFX C6 Product Brief IFX C6 Portfolio IFX CoolMOS Webpage IFX Design tools
IPB60R099C6	PG-TO263		
IPP60R099C6	PG-TO220		
IPA60R099C6	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	-	-	37.9	A	$T_C = 25\text{ °C}$
				24		$T_C = 100\text{ °C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	112	A	$T_C = 25\text{ °C}$
Avalanche energy, single pulse	E_{AS}	-	-	796	mJ	$I_D = 6.6\text{ A}, V_{DD} = 50\text{ V}$ (see table 21)
Avalanche energy, repetitive	E_{AR}	-	-	1.2		$I_D = 6.6\text{ A}, V_{DD} = 50\text{ V}$
Avalanche current, repetitive	I_{AR}	-	-	6.6	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}	-	-	278	W	$T_C = 25\text{ °C}$
Power dissipation for TO-220 FullPAK	P_{tot}	-	-	35		
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	-	-	33	A	$T_C = 25\text{ °C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	112	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			300	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 (IPP60R099C6), TO-247 (IPW60R099C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.45	°C/W	leaded
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 (IPA60R099C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	3.6	°C/W	leaded
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 (IPB60R099C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.45	°C/W	SMD version, device on PCB, minimal footprint
Thermal resistance, junction - ambient	R_{thJA}	-	-	62		
		-	35	-		
Soldering temperature, wave- & reflow soldering allowed	T_{sold}	-	-	260	°C	reflow MSL1

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		$V_{DS}=V_{GS}$, $I_D=1.21\text{ mA}$
Zero gate voltage drain current	I_{DSS}	-	-	5	μA	$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_J=25\text{ °C}$
		-	50	-		$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_J=150\text{ °C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.09	0.099	Ω	$V_{GS}=10\text{ V}$, $I_D=18.1\text{ A}$, $T_J=25\text{ °C}$
		-	0.23	-		$V_{GS}=10\text{ V}$, $I_D=18.1\text{ A}$, $T_J=150\text{ °C}$
Gate resistance	R_G	-	1.6	-	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}	-	2660	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=100\text{ V}$, $f=1\text{ MHz}$
Output capacitance	C_{oss}	-	154	-		
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$	-	100	-		
Effective output capacitance, time related ²⁾	$C_{o(tr)}$	-	500	-		$I_D=\text{constant}$, $V_{GS}=0\text{ V}$ $V_{DS}=0\dots480\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	15	-	ns	$V_{DD}=400\text{ V}$, $V_{GS}=13\text{ V}$, $I_D=18.1\text{ A}$, $R_G=1.7\Omega$ (see table 20)
Rise time	t_r	-	12	-		
Turn-off delay time	$t_{d(off)}$	-	75	-		
Fall time	t_f	-	6	-		

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}	-	14	-	nC	$V_{DD}=480\text{ V}$, $I_D=18.1\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	Q_{gd}	-	61	-		
Gate charge total	Q_g	-	119	-		
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	$V_{GS}=0\text{ V}$, $I_F=18.1\text{ A}$, $T_j=25\text{ °C}$
Reverse recovery time	t_{rr}	-	580	-	ns	$V_R=400\text{ V}$, $I_F=18.1\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$ (see table 22)
Reverse recovery charge	Q_{rr}	-	13	-	μC	
Peak reverse recovery current	I_{rrm}	-	43	-	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: $D = t_p/T$

Table 12

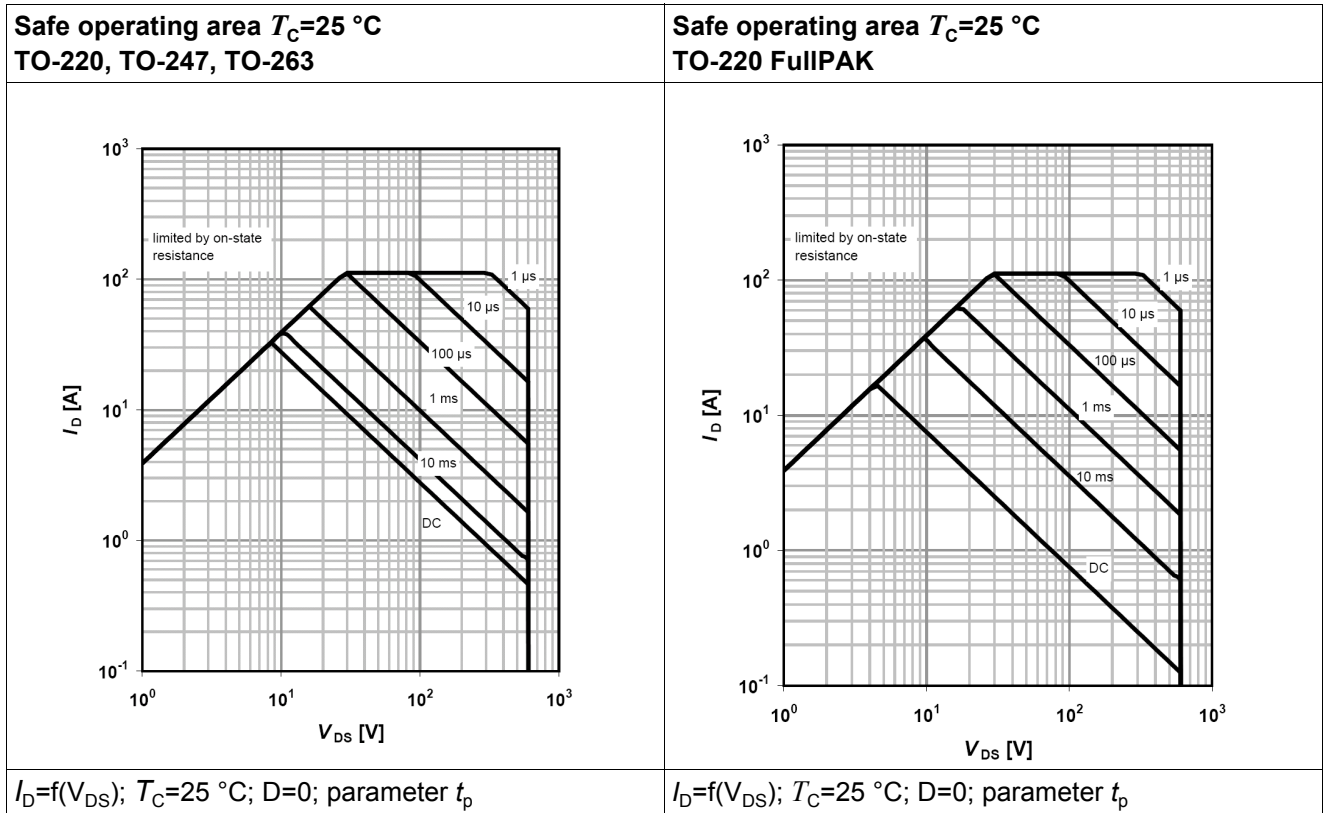


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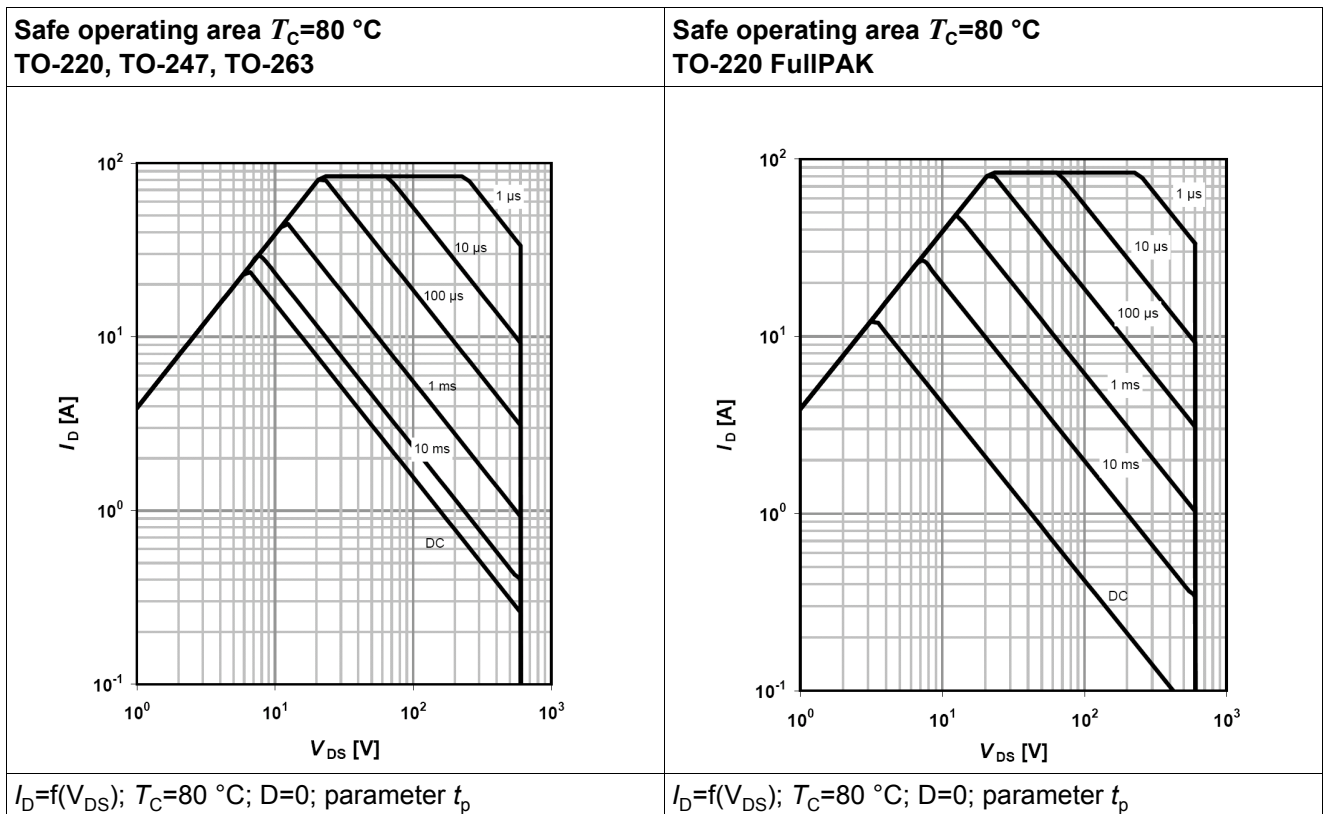


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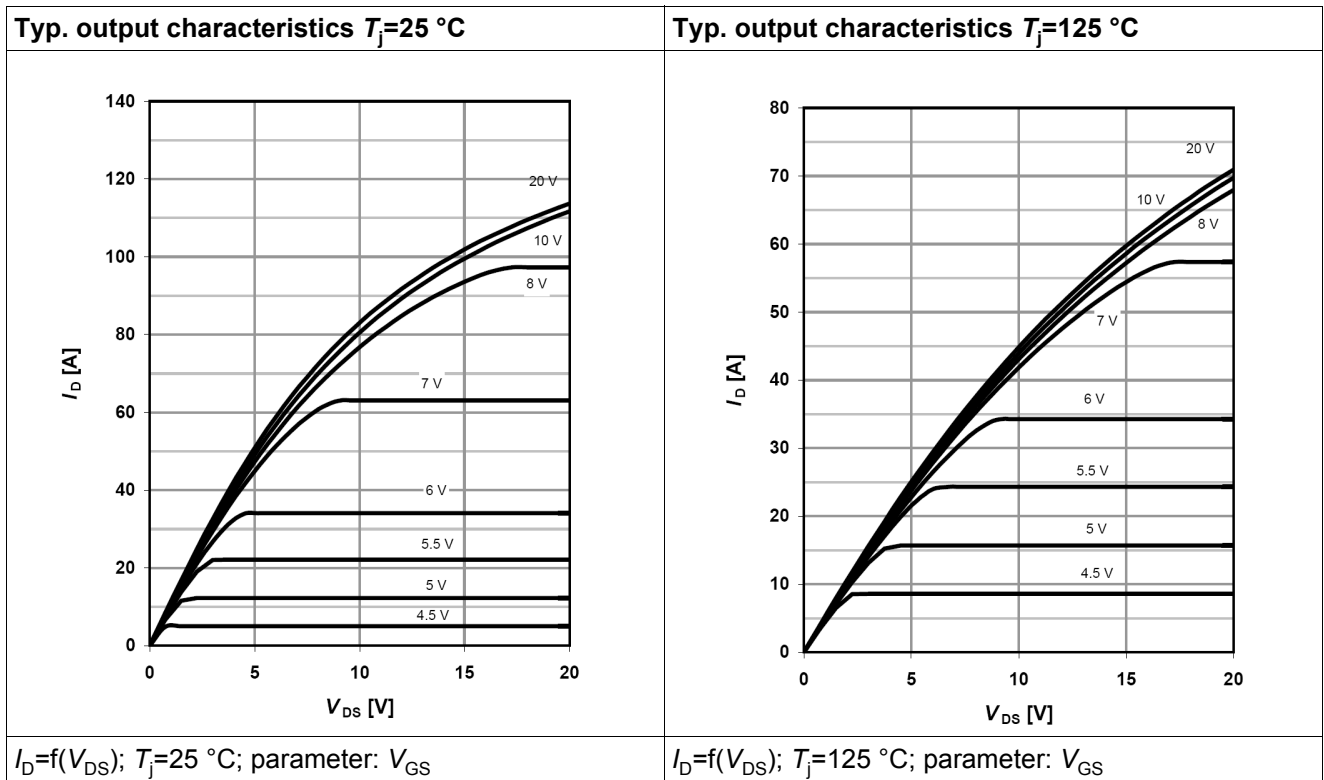


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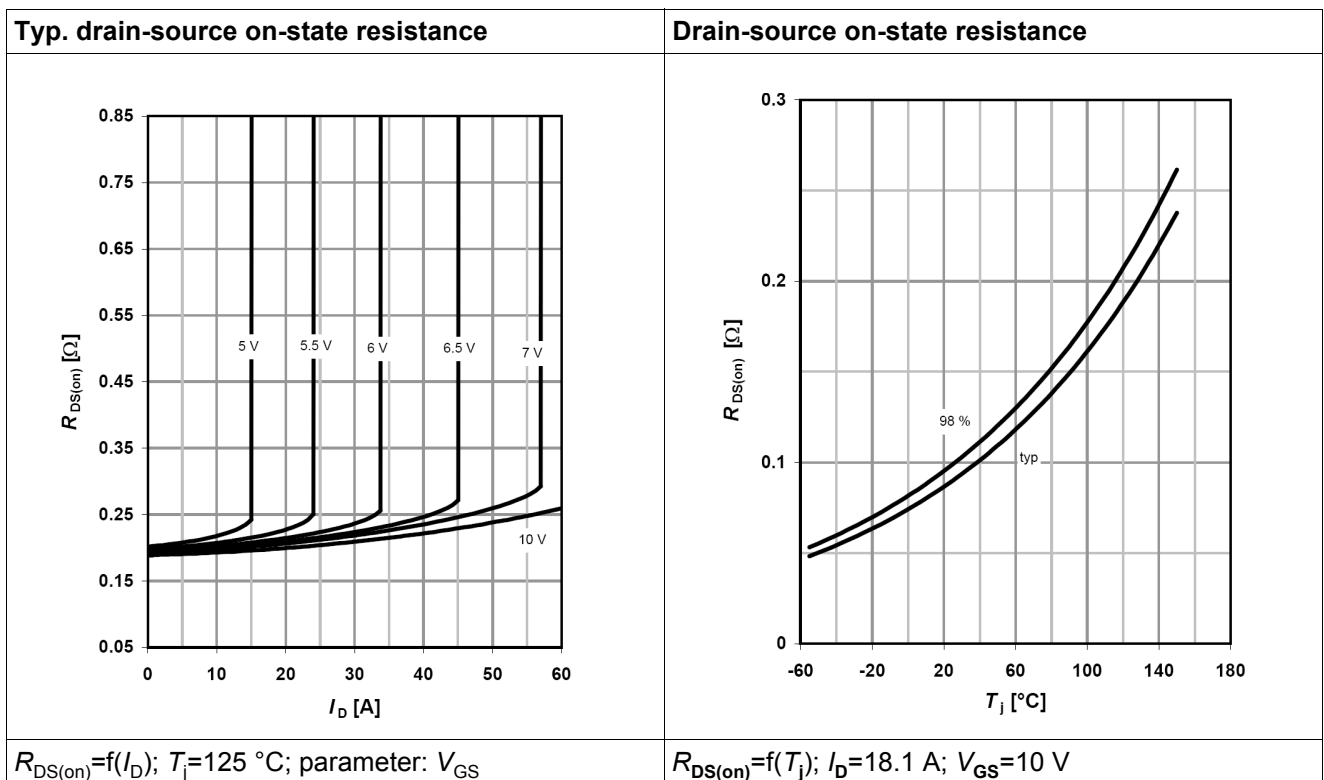


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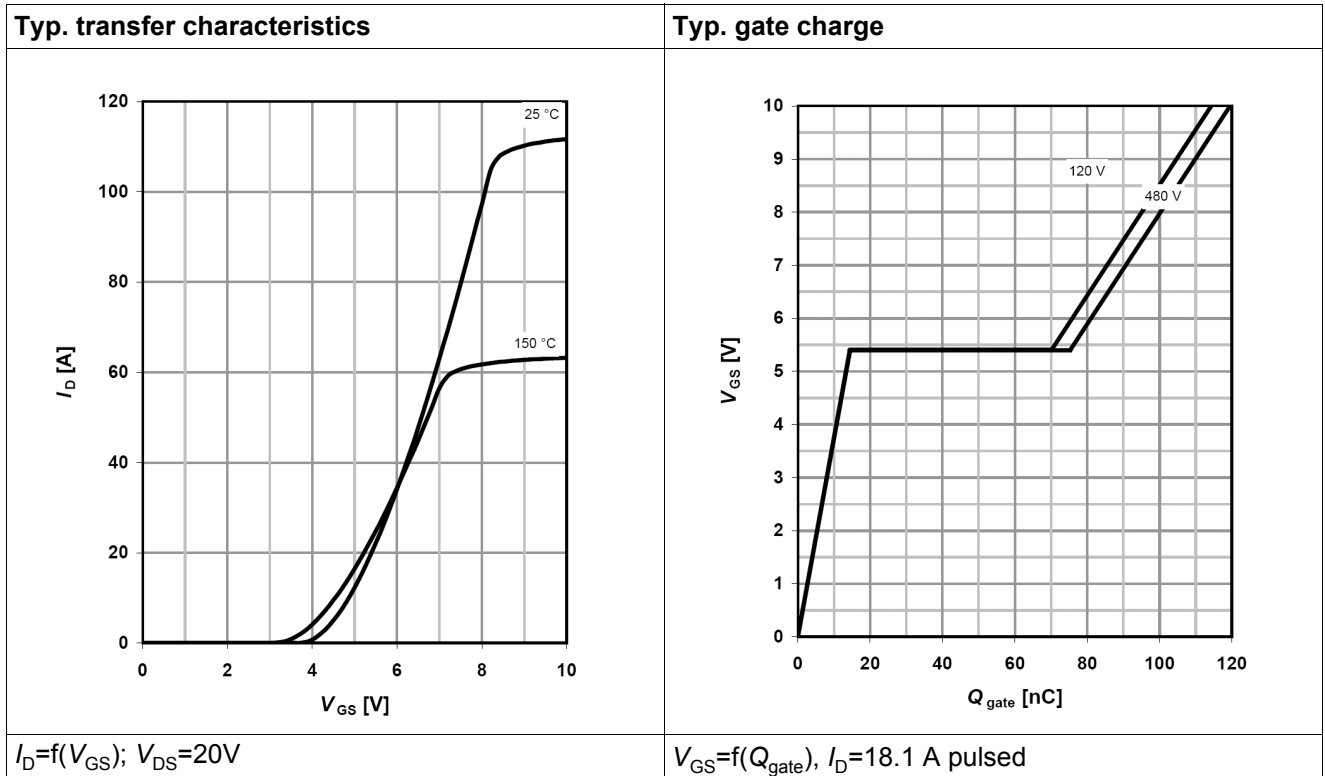


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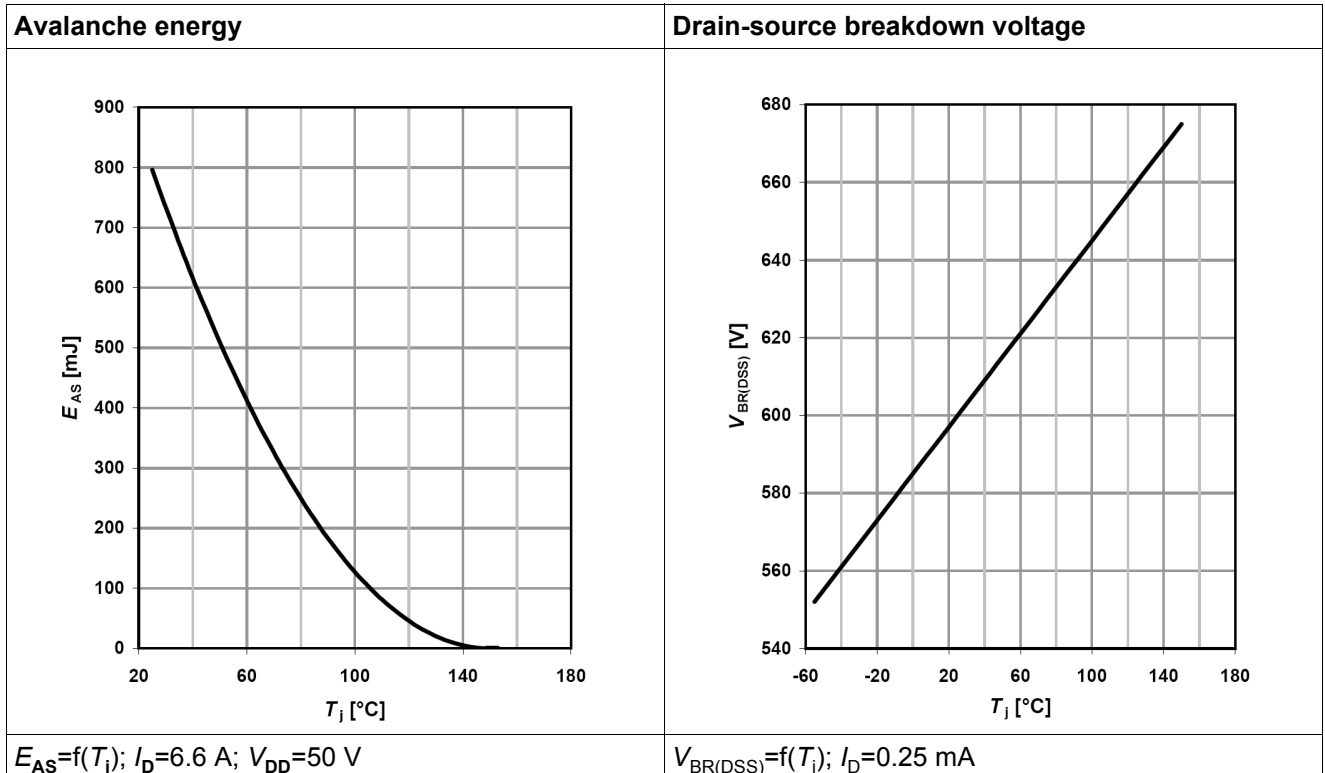


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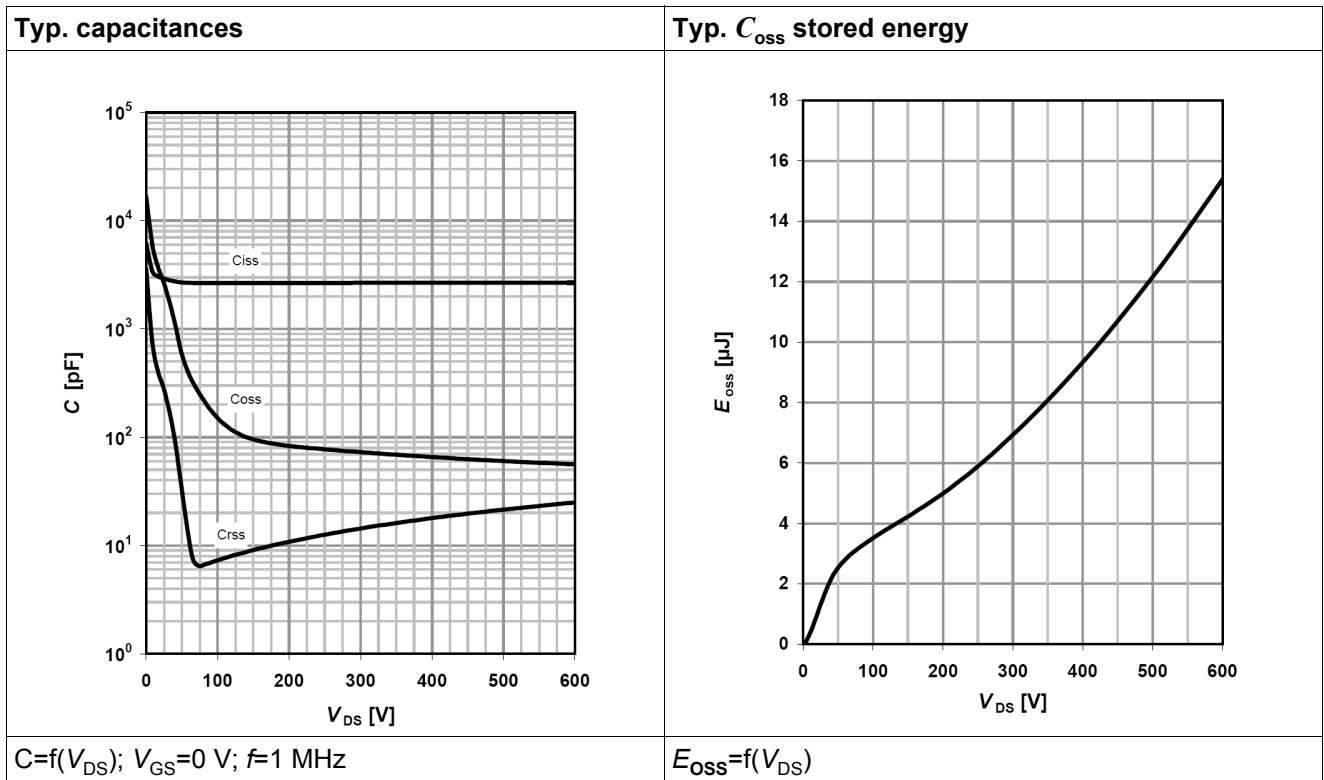
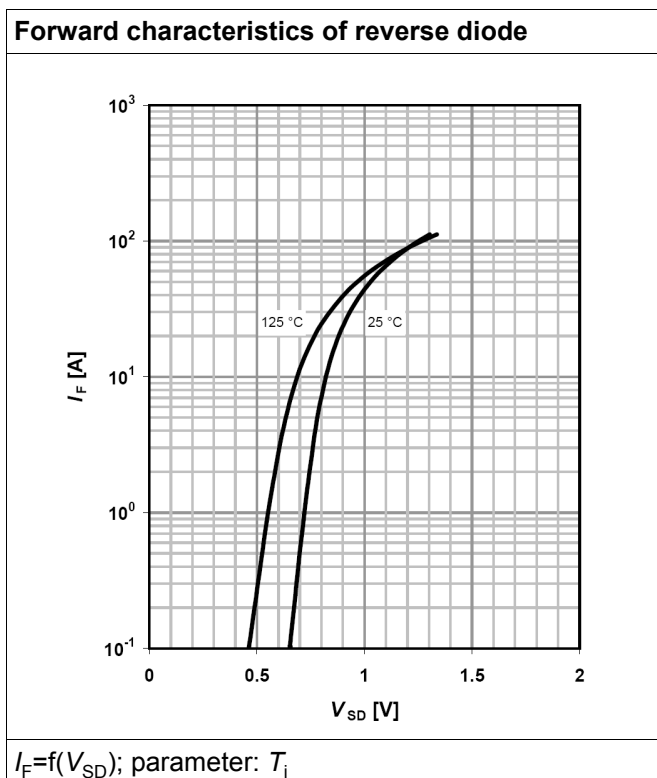


Table 19



7 Package outlines

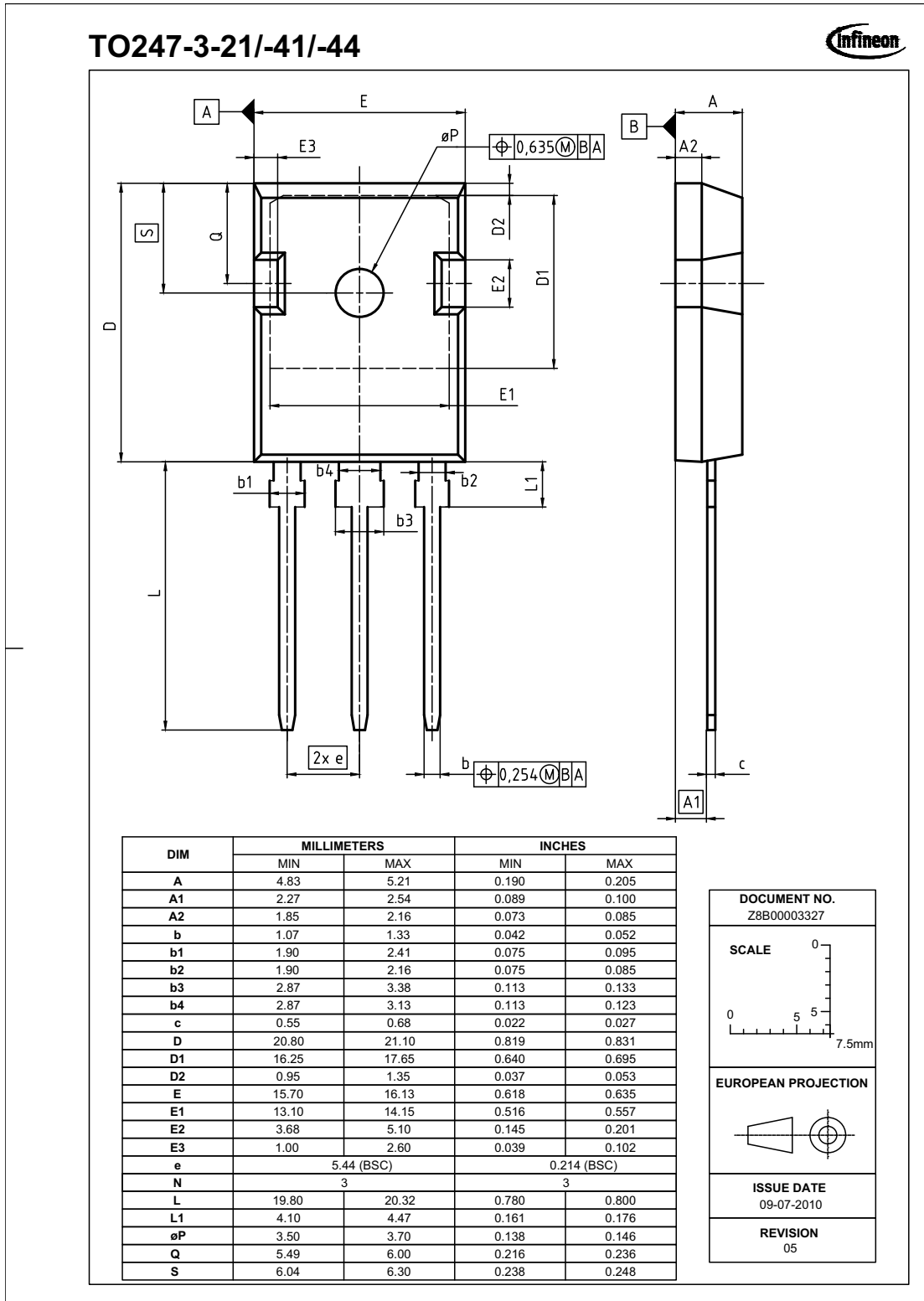
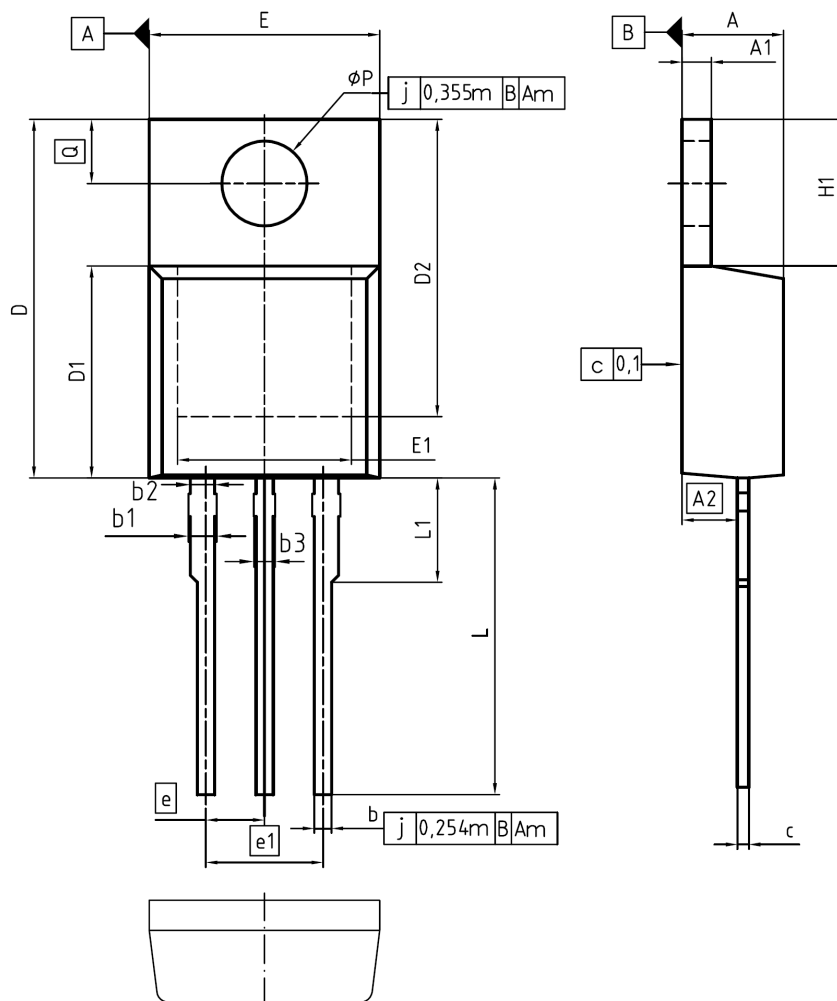


Figure 1 Outlines TO-247, dimensions in mm/inches



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

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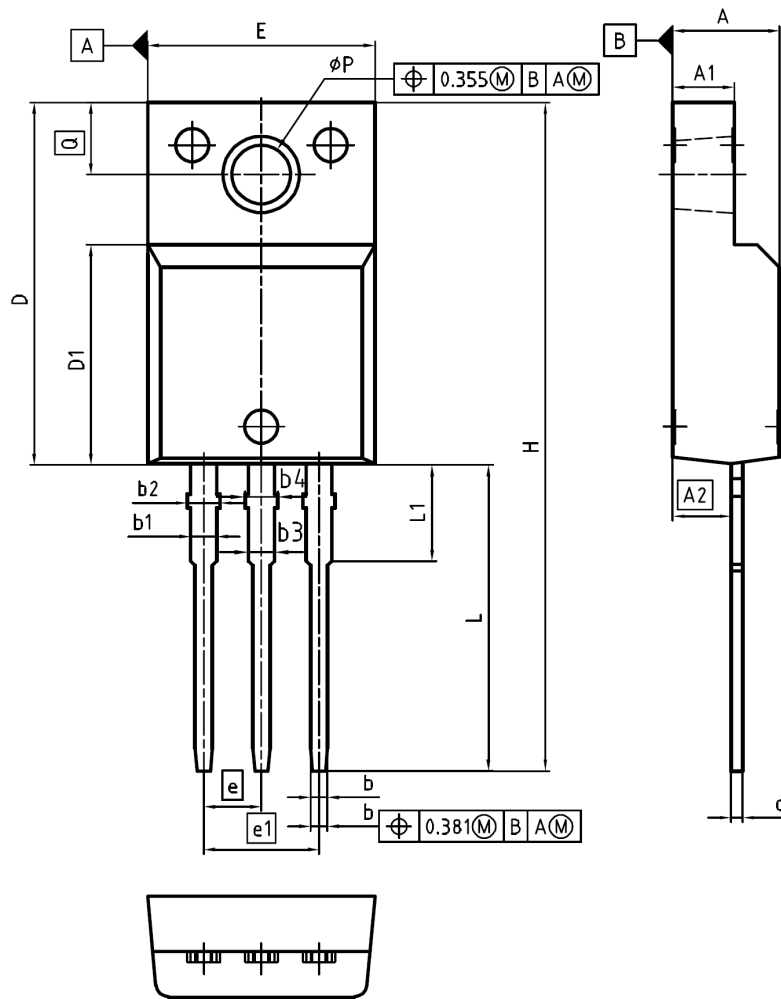
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Figure 2 Outlines TO-220, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.55	4.85	0.179	0.191
A1	2.55	2.85	0.100	0.112
A2	2.42	2.72	0.095	0.107
b	0.65	0.85	0.026	0.033
b1	0.95	1.33	0.037	0.052
b2	0.95	1.51	0.037	0.059
b3	0.65	1.33	0.026	0.052
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.85	16.15	0.624	0.636
D1	9.53	9.83	0.375	0.387
E	10.35	10.65	0.407	0.419
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H	29.45	29.75	1.159	1.171
L	13.45	13.75	0.530	0.541
L1	3.15	3.45	0.124	0.136
øP	2.95	3.20	0.116	0.126
Q	3.15	3.50	0.124	0.138

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Figure 3 Outlines TO-220 FullIPAK, dimensions in mm/inches

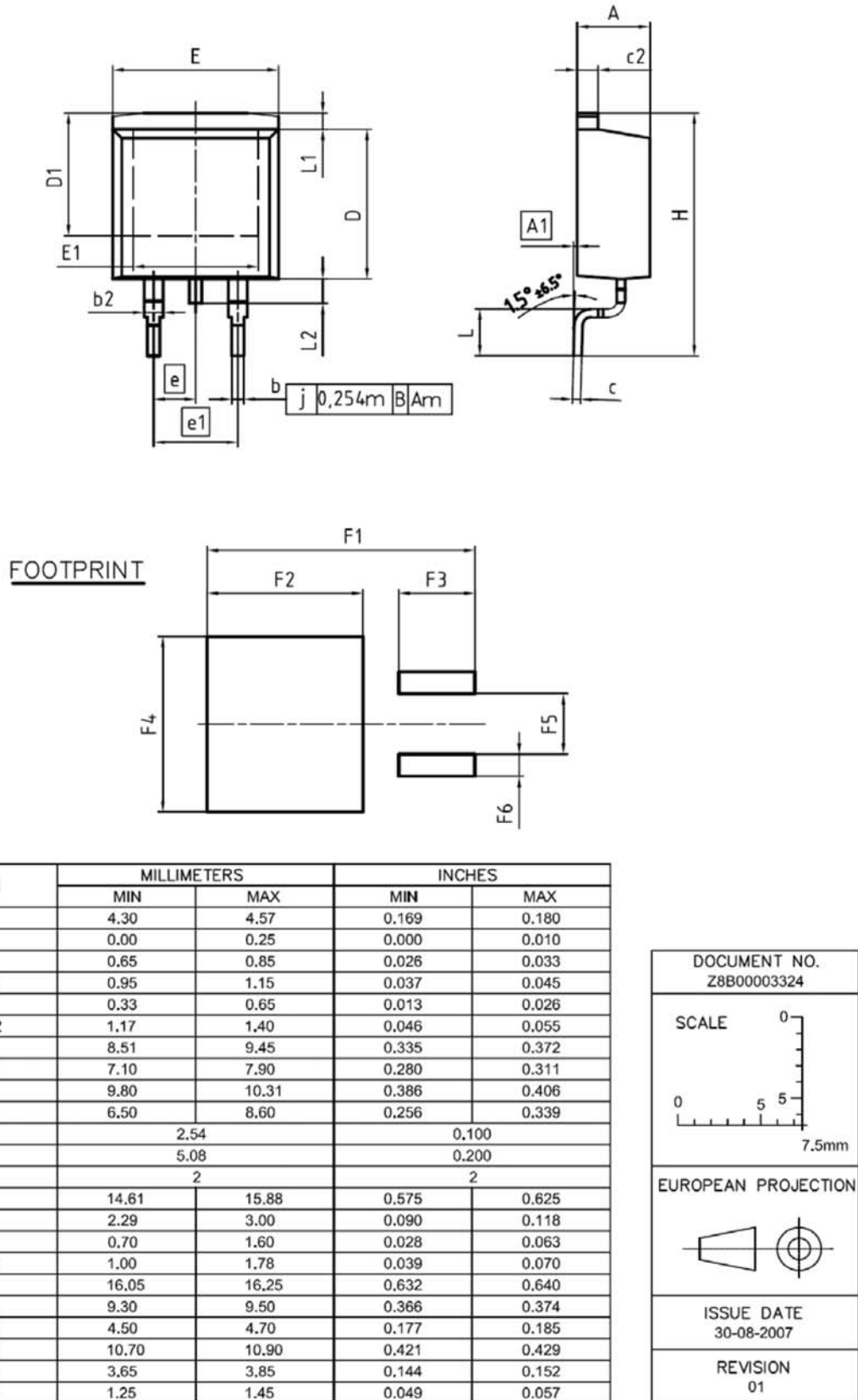


Figure 5 Outlines TO-263, dimensions in mm/inches

8 Revision History

CoolMOS C6 600V CoolMOS™ C6 Power Transistor

Revision History: 2010-02-09, Rev. 2.1

Previous Revision:

Revision	Subjects (major changes since last revision)
2.0	Release of final data sheet
2.1	New package outlines TO-247

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