

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C6 600V

600V CoolMOS™ C6 Power Transistor
IPx60R190C6

Data Sheet

Rev. 2.2
Final

600V CoolMOS™ C6 Power Transistor

IPA60R190C6, IPB60R190C6
 IPI60R190C6, IPP60R190C6
 IPW60R190C6

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.

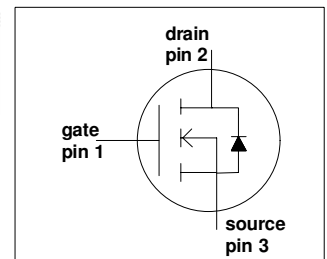
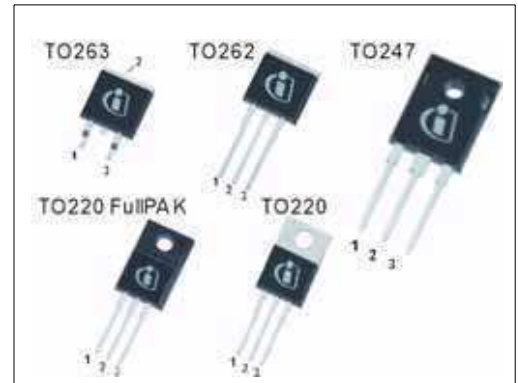


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.19	Ω
$Q_{g,typ}$	63	nC
$I_{D,pulse}$	59	A
$E_{oss} @ 400V$	5.2	μJ
Body diode di/dt	500	A/ μs

Type / Ordering Code	Package	Marking	Related Links
IPW60R190C6	PG-TO247	6R190C6	IFX C6 Product Brief
IPB60R190C6	PG-TO263		IFX C6 Portfolio
IPI60R190C6	PG-TO262		IFX CoolMOS Webpage
IPP60R190C6	PG-TO220		IFX Design tools
IPA60R190C6	PG-TO220 FullPAK		

1) J-STD20 and JESD22

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Maximum ratings

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	-	-	20.2	A	$T_C = 25\text{ °C}$
				128		$T_C = 100\text{ °C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	59	A	$T_C = 25\text{ °C}$
Avalanche energy, single pulse	E_{AS}	-	-	418	mJ	$I_D = 3.4\text{ A}$, $V_{DD} = 50\text{ V}$ (see table 21)
Avalanche energy, repetitive	E_{AR}	-	-	0.63		$I_D = 3.4\text{ A}$, $V_{DD} = 50\text{ V}$
Avalanche current, repetitive	I_{AR}	-	-	3.4	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-262, TO-263	P_{tot}	-	-	151	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	-	-	17.5	A	$T_C = 25\text{ °C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	59	A	$T_C = 25\text{ °C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	15	V/ns	$V_{DS} = 0 \dots 400\text{ V}$, $I_{SD} \sim I_D$,
Maximum diode commutation speed ³⁾	di/dt	-	-	500	A/μs	$T_j = 25\text{ °C}$ (see table 22)
Insulation withstand voltage TO-220 FullPAK	V_{ISO}	-	-	2500	V	V_{RMS} , $T_C = 25\text{ °C}$, $t = 1\text{ min}$

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 (IPP60R190C6), TO-247 (IPW60R190C6), TO-262 (IPI60R190C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.83	°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-220 FullPAK (IPA60R190C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	3.7	°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 (IPB60R190C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.83	°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		$V_{DS}=V_{GS}$, $I_D=0.63\text{ mA}$
Zero gate voltage drain current	I_{DSS}	-	-	1	μA	$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_J=25\text{ °C}$
		-	10	-		$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_J=150\text{ °C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.17	0.19	Ω	$V_{GS}=10\text{ V}$, $I_D=9.5\text{ A}$, $T_J=25\text{ °C}$
		-	0.44	-		$V_{GS}=10\text{ V}$, $I_D=9.5\text{ A}$, $T_J=150\text{ °C}$
Gate resistance	R_G	-	8.5	-	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}	-	1400	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=100\text{ V}$, $f=1\text{ MHz}$
Output capacitance	C_{oss}	-	85	-		
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$	-	56	-		$V_{GS}=0\text{ V}$, $V_{DS}=0\ldots480\text{ V}$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$	-	266	-		$I_D=\text{constant}$, $V_{GS}=0\text{ V}$ $V_{DS}=0\ldots480\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	15	-	ns	$V_{DD}=400\text{ V}$, $V_{GS}=13\text{ V}$, $I_D=9.5\text{ A}$, $R_G=3.4\Omega$ (see table 20)
Rise time	t_r	-	11	-		
Turn-off delay time	$t_{d(off)}$	-	110	-		
Fall time	t_f	-	9	-		

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% $V_{(BR)DSS}$

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Electrical characteristics

Table 8 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	7.6	-	nC	$V_{DD}=480\text{ V}$, $I_D=9.5\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	Q_{gd}	-	32	-		
Gate charge total	Q_g	-	63	-		
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	$V_{GS}=0\text{ V}$, $I_F=9.5\text{ A}$, $T_j=25\text{ °C}$
Reverse recovery time	t_{rr}	-	430	-	ns	$V_R=400\text{ V}$, $I_F=9.5\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$ (see table 22)
Reverse recovery charge	Q_{rr}	-	6.9	-	μC	
Peak reverse recovery current	I_{rrm}	-	30	-	A	

5 Electrical characteristics diagrams

Table 10

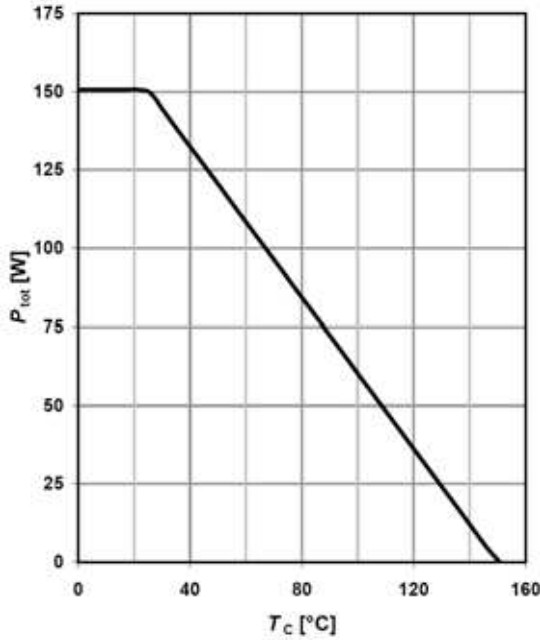
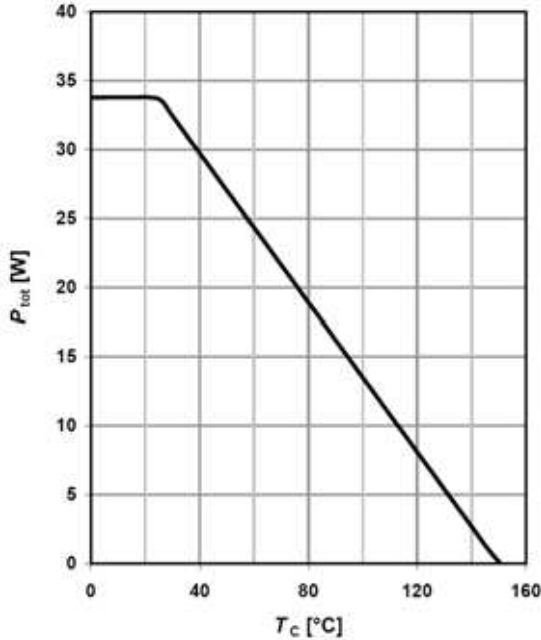
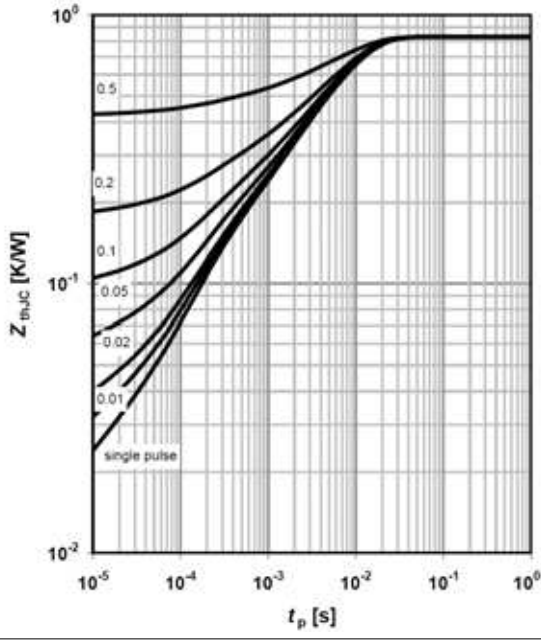
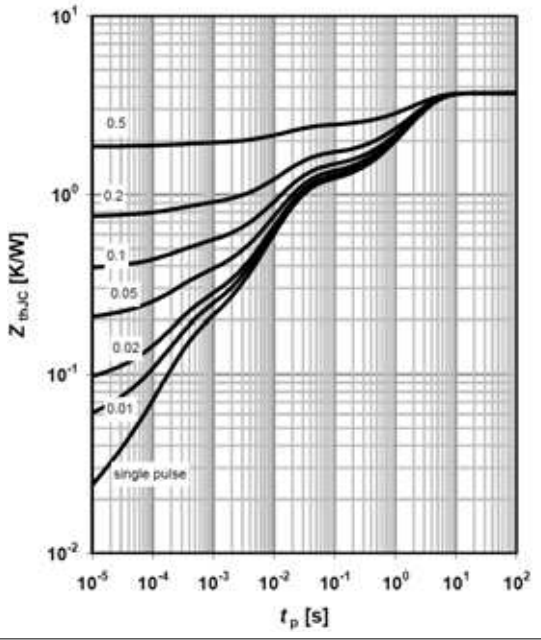
Power dissipation TO-220, TO-247, TO-262, TO-263	Power dissipation TO-220 FullPAK
	
$P_{tot} = f(T_C)$	$P_{tot} = f(T_C)$

Table 11

Max. transient thermal impedance TO-220, TO-247, TO-262, 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

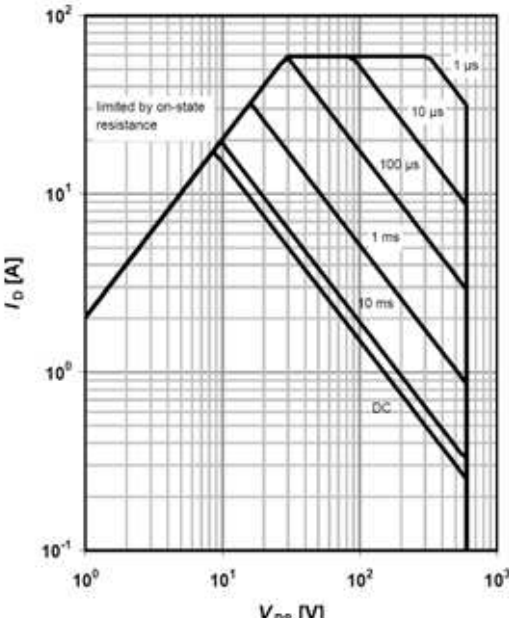
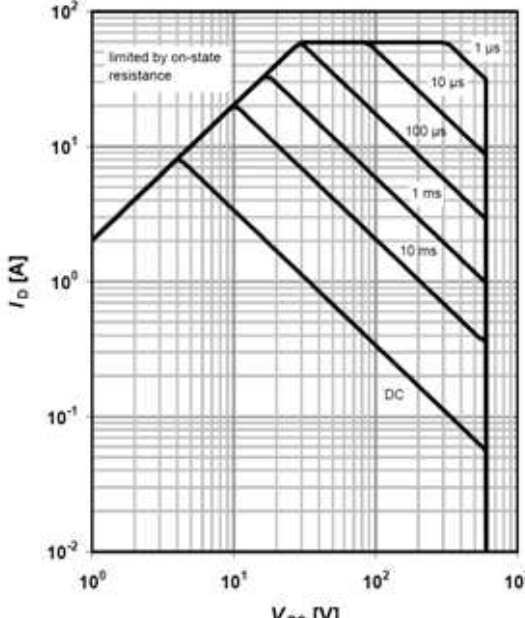
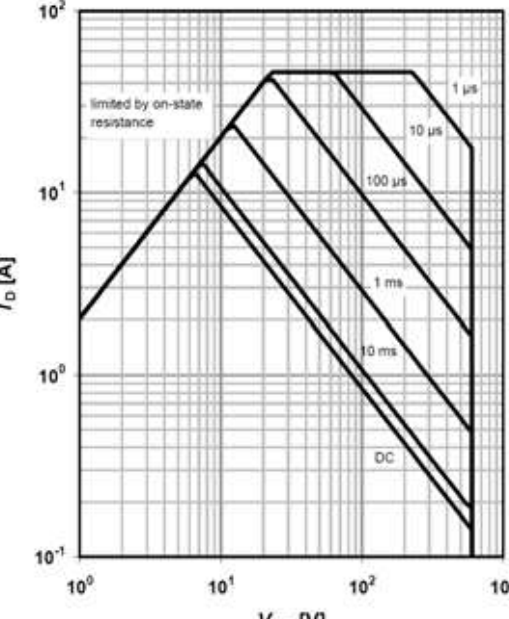
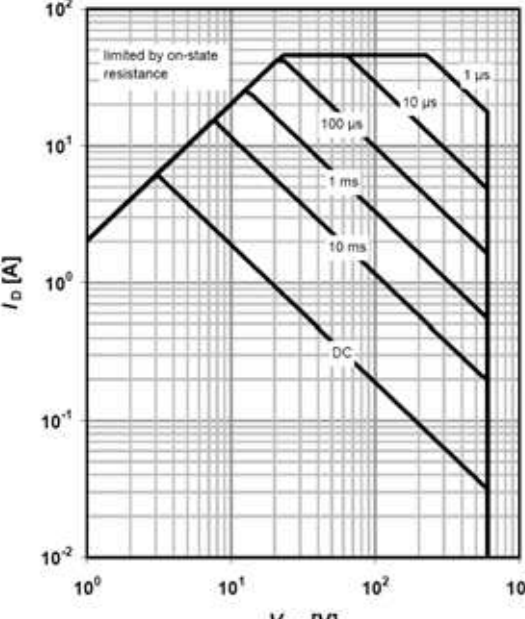
Safe operating area $T_C=25\text{ °C}$ TO-220, TO-247, TO-262, TO-263	Safe operating area $T_C=25\text{ °C}$ TO-220 FullPAK
	
$I_D=f(V_{DS}); T_C=25\text{ °C}; D=0; \text{parameter } t_p$	$I_D=f(V_{DS}); T_C=25\text{ °C}; D=0; \text{parameter } t_p$

Table 13

Safe operating area $T_C=80\text{ °C}$ TO-220, TO-247, TO-262, TO-263	Safe operating area $T_C=80\text{ °C}$ TO-220 FullPAK
	
$I_D=f(V_{DS}); T_C=80\text{ °C}; D=0; \text{parameter } t_p$	$I_D=f(V_{DS}); T_C=80\text{ °C}; D=0; \text{parameter } t_p$

Electrical characteristics diagrams

Table 14

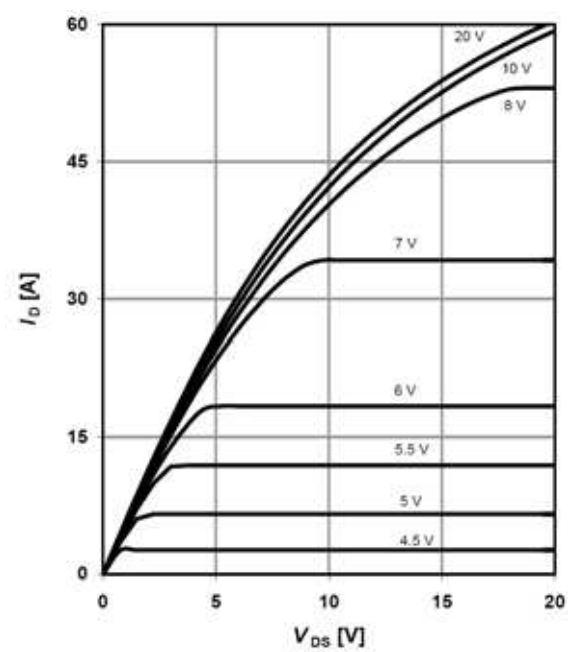
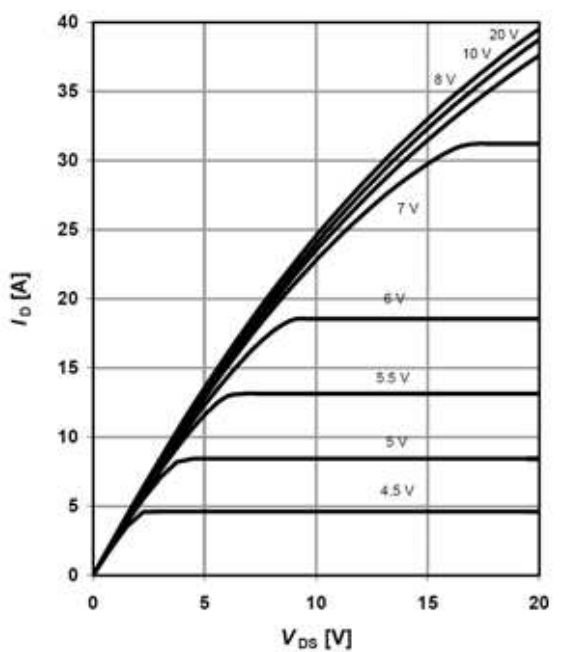
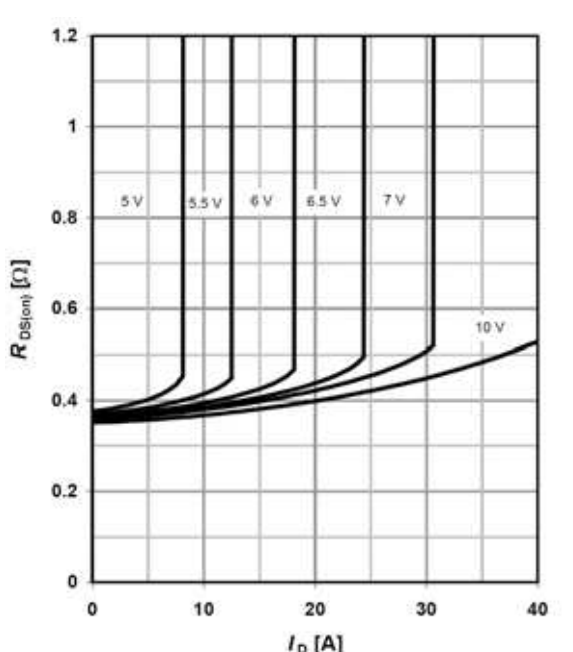
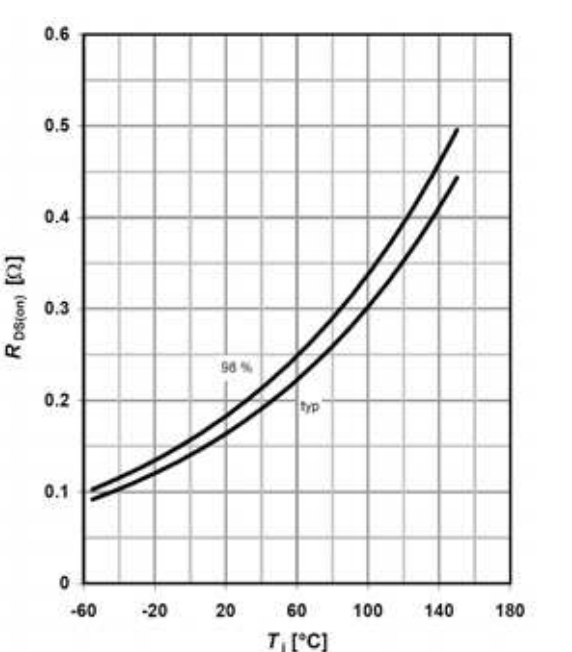
Typ. output characteristics $T_c=25\text{ }^{\circ}\text{C}$	Typ. output characteristics $T_j=125\text{ }^{\circ}\text{C}$
	
$I_D=f(V_{DS}); T_j=25\text{ }^{\circ}\text{C}; \text{parameter: } V_{GS}$	$I_D=f(V_{DS}); T_j=125\text{ }^{\circ}\text{C}; \text{parameter: } V_{GS}$

Table 15

Typ. drain-source on-state resistance	Drain-source on-state resistance
	
$R_{DS(on)}=f(I_D); T_j=125\text{ }^{\circ}\text{C}; \text{parameter: } V_{GS}$	$R_{DS(on)}=f(T_j); I_D=9.5\text{ A}; V_{GS}=10\text{ V}$

Electrical characteristics diagrams

Table 16

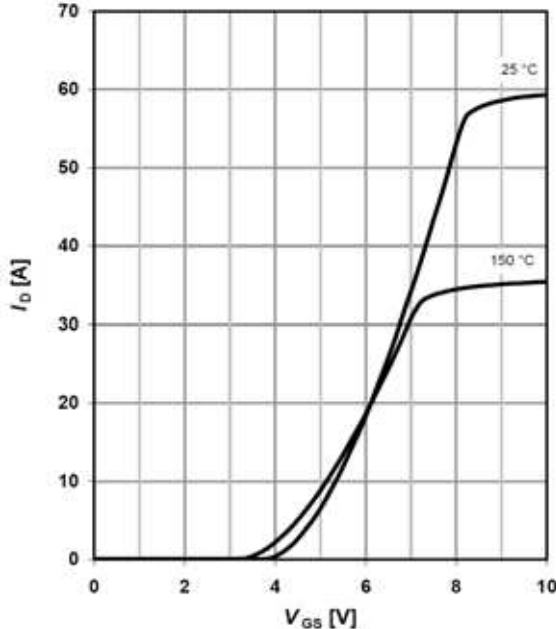
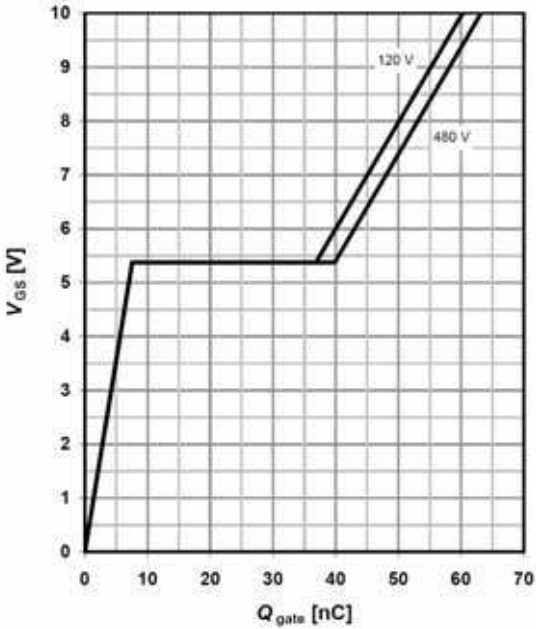
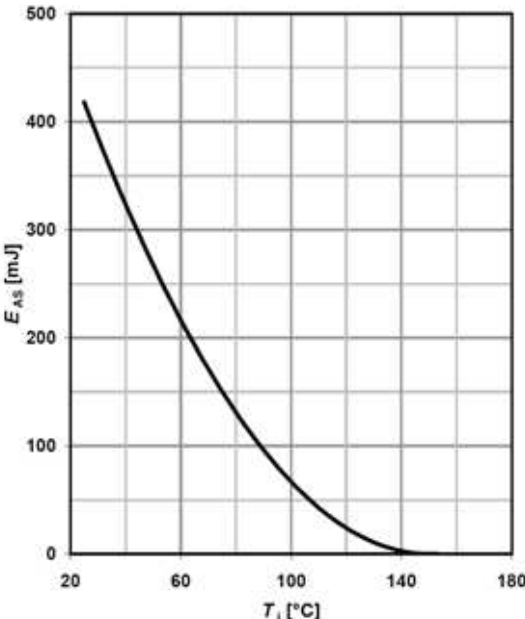
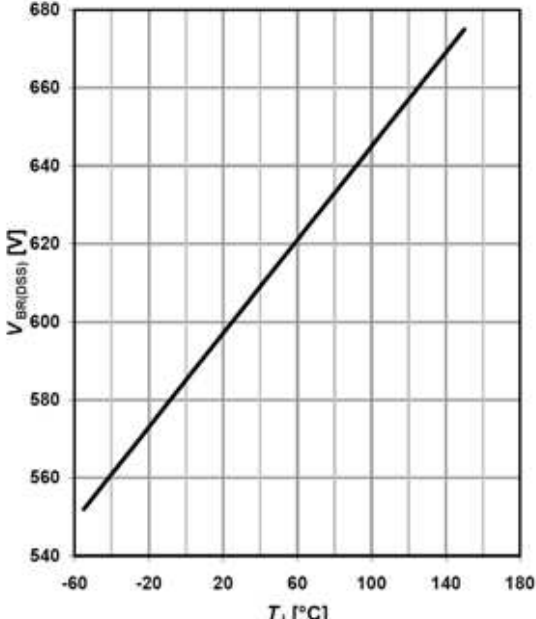
Typ. transfer characteristics	Typ. gate charge
	
$I_D=f(V_{GS}); V_{DS}=20V$	$V_{GS}=f(Q_{gate}), I_D=9.5A$ pulsed

Table 17

Avalanche energy	Drain-source breakdown voltage
	
$E_{AS}=f(T_J); I_D=3.4 A; V_{DD}=50 V$	$V_{BR(DSS)}=f(T_J); I_D=0.25 mA$

Electrical characteristics diagrams

Table 18

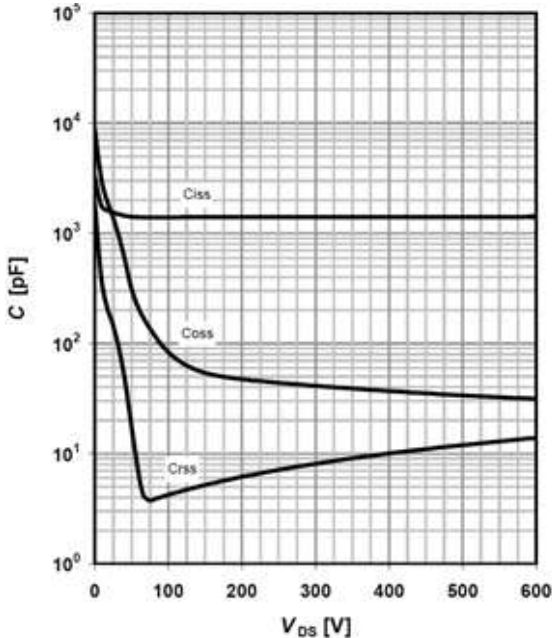
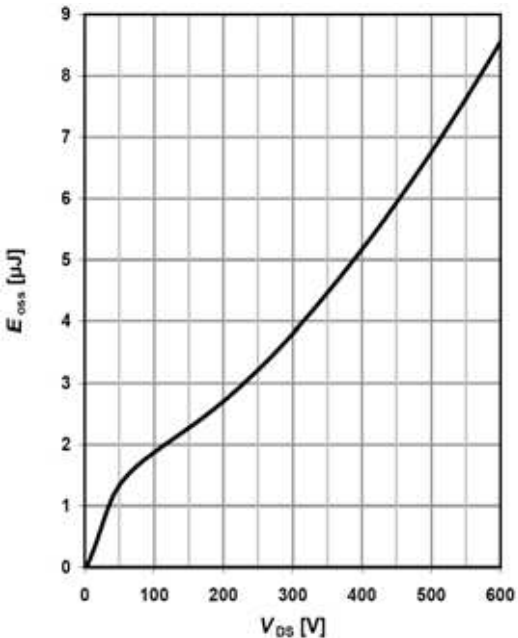
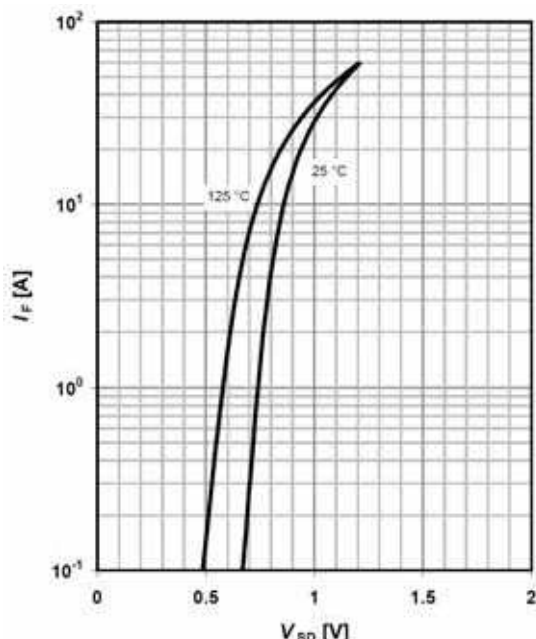
Typ. capacitances	Typ. C_{oss} stored energy
	
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$	$E_{oss}=f(V_{DS})$

Table 19

Forward characteristics of reverse diode

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

7 Package outlines

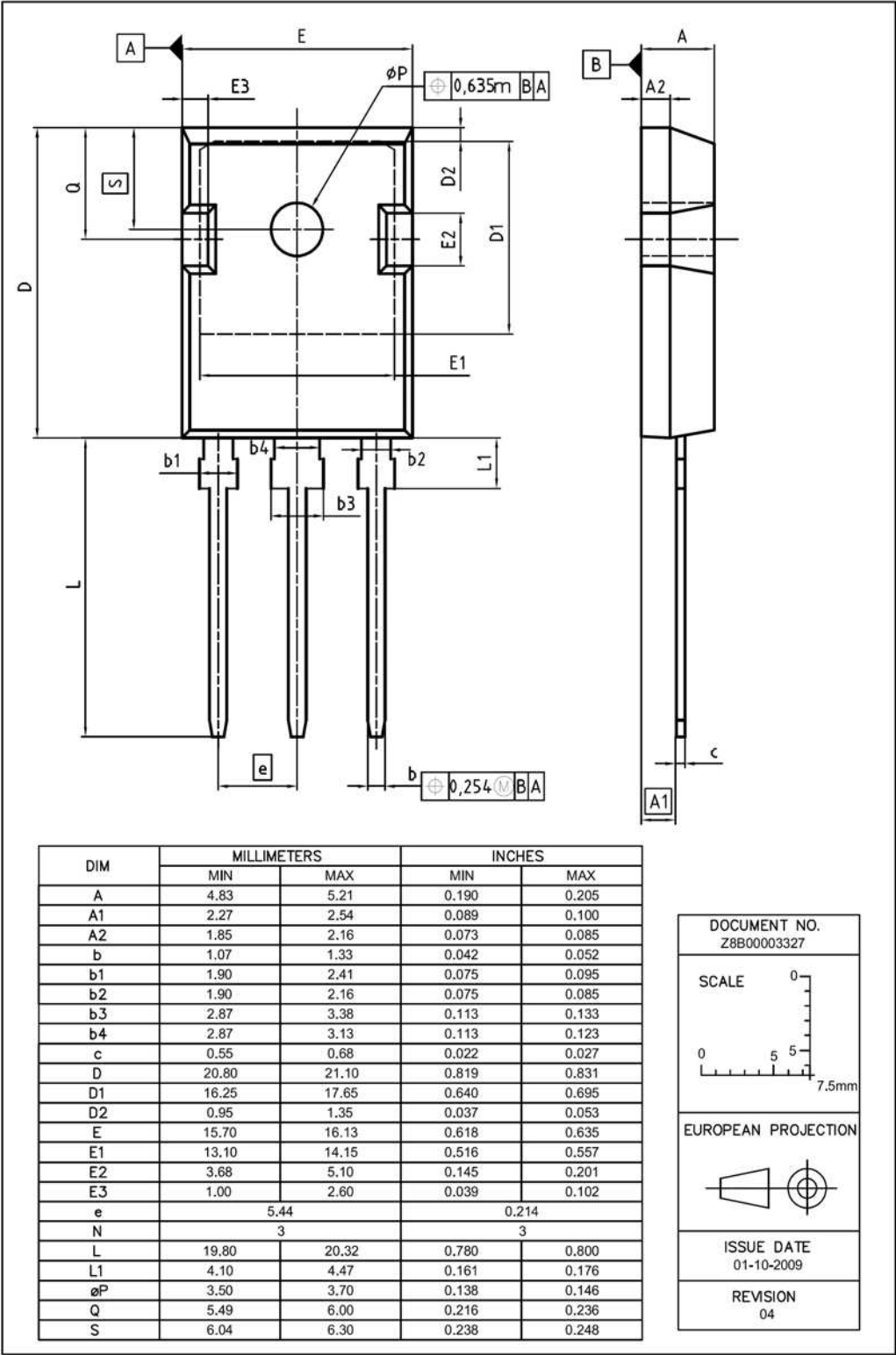
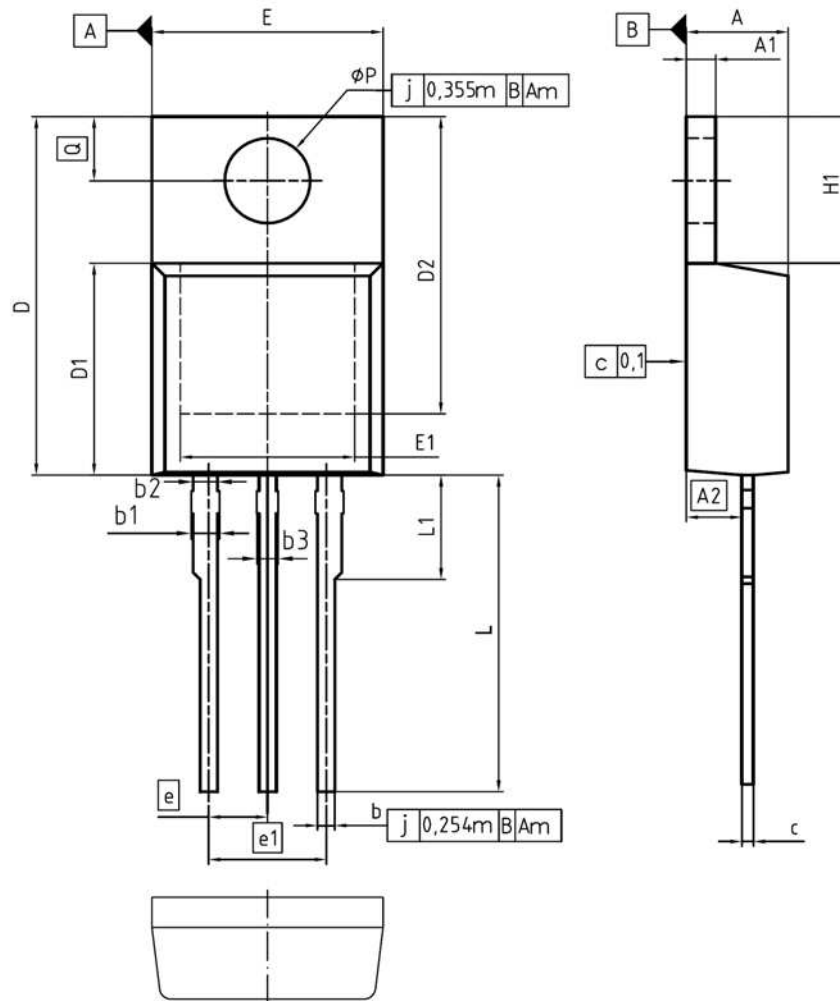


Figure 1 Outlines TO-247, dimensions in mm/inches

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Package outlines



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
φP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

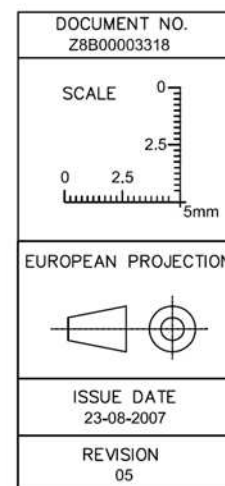
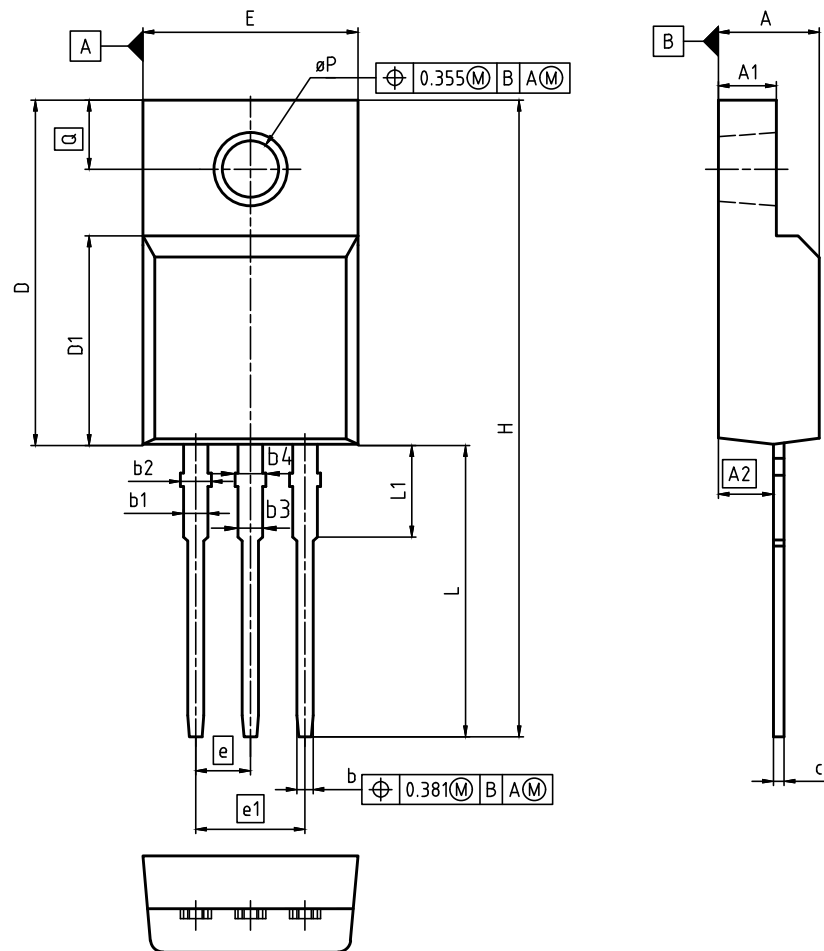


Figure 2 Outlines TO-220, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.50	4.90	0.177	0.193
A1	2.34	2.85	0.092	0.112
A2	2.42	2.86	0.095	0.113
b	0.65	0.90	0.026	0.035
b1	0.95	1.38	0.037	0.054
b2	0.95	1.51	0.037	0.059
b3	0.65	1.38	0.026	0.054
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.67	16.15	0.617	0.636
D1	8.97	9.83	0.353	0.387
E	10.00	10.65	0.394	0.419
e	2.54 (BSC)		0.100 (BSC)	
e1	5.08		0.200	
N	3		3	
H	28.70	29.75	1.130	1.171
L	12.78	13.75	0.503	0.541
L1	2.83	3.45	0.111	0.136
øP	2.95	3.38	0.116	0.133
Q	3.15	3.50	0.124	0.138

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SCALE 0 2.5 5mm
EUROPEAN PROJECTION
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REVISION 04

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

600V CoolMOS™ C6 Power Transistor
IPx60R190C6

Package outlines

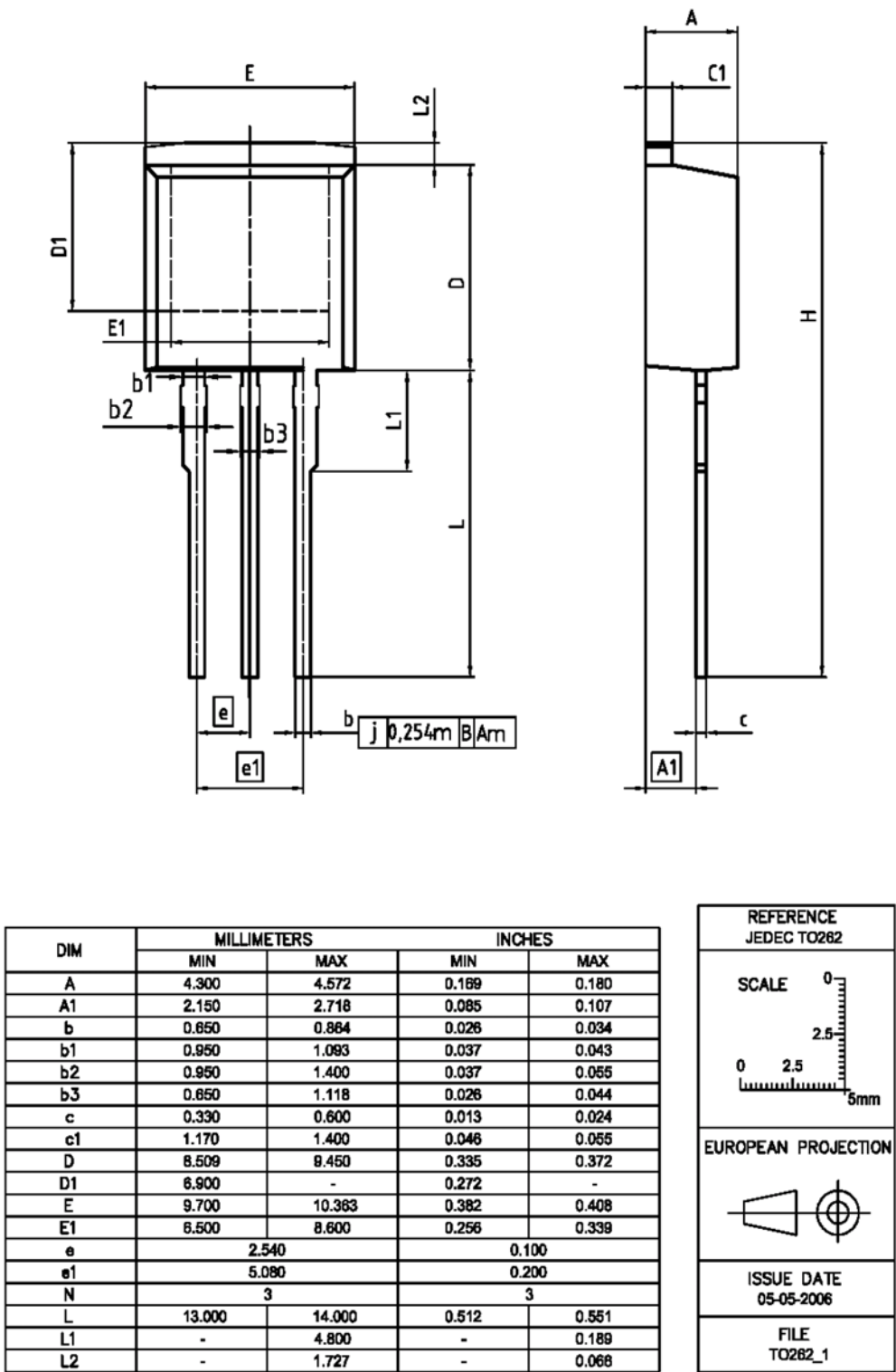


Figure 4 Outlines TO-262, dimensions in mm/inches

600V CoolMOS™ C6 Power Transistor
IPx60R190C6

Package outlines

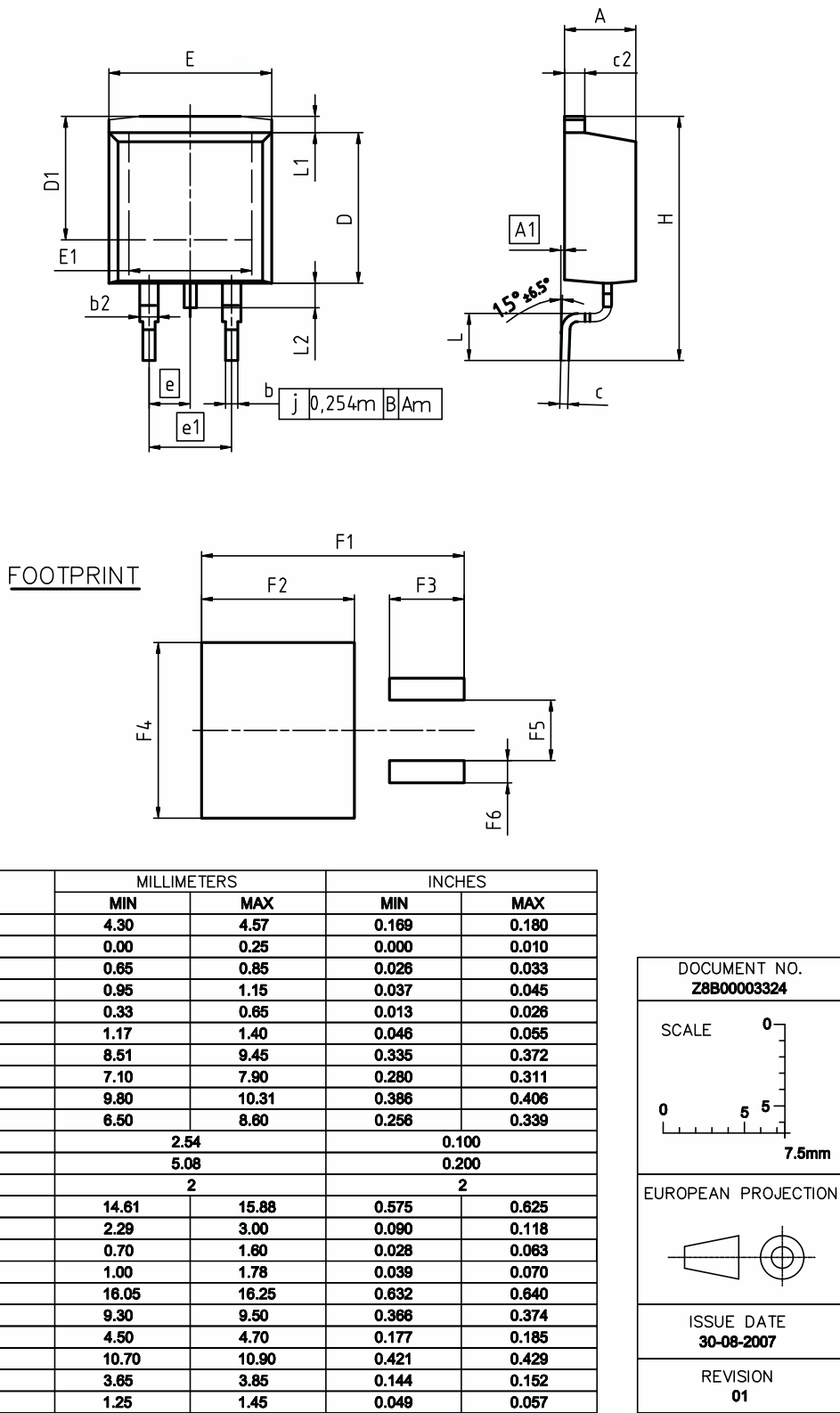


Figure 5 Outlines TO-263, dimensions in mm/inches

Revision History

IPx60R190C6

Revision: 2015-02-09, Rev. 2.2

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	2015-02-09	PG-TO220 FullPAK package outline update (creation:2014-12-02)