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MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C6 600V

600V CoolMOS™ C6 Power Transistor
IPx60R600C6

Data Sheet

Rev. 2.2
Final



600V CoolMOS™ C6 Power Transistor

IPD60R600C6, IPB60R600C6
IPP60R600C6, IPA60R600C6

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 $R_{dson} \cdot Q_g$ and E_{oss}
- Very high commutation ruggedness
- Easy to use/drive
- JEDEC¹⁾ qualified, Pb-free plating

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.

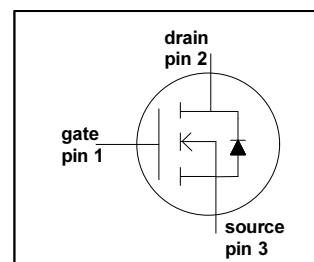
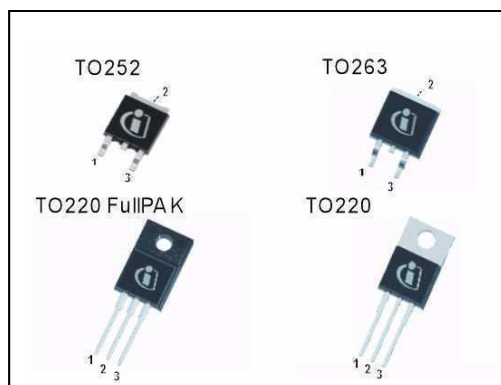


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.6	Ω
$Q_{g,typ}$	20.5	nC
$I_{D,pulse}$	19	A
$E_{oss} @ 400V$	1.9	μJ
Body diode di/dt	500	A/ μs

Type / Ordering Code	Package	Marking	Related Links
IPB60R600C6	PG-TO263	6R600C6	IFX C6 Product Brief
IPD60R600C6	PG-TO252		IFX C6 Portfolio
IPP60R600C6	PG-TO220		IFX CoolMOS Webpage
IPA60R600C6	PG-TO220 FullPAK		IFX Design tools

1) J-STD20 and JESD22



**600V CoolMOS™ C6 Power Transistor
IPx60R600C6**

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**600V CoolMOS™ C6 Power Transistor
IPx60R600C6**
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	-	-	7.3	A	$T_C = 25\text{ °C}$
				4.6		$T_C = 100\text{ °C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	19	A	$T_C = 25\text{ °C}$
Avalanche energy, single pulse	E_{AS}	-	-	133	mJ	$I_D = 1.3\text{ A}, V_{DD} = 50\text{ V}$ (see table 21)
Avalanche energy, repetitive	E_{AR}	-	-	0.2		$I_D = 1.3\text{ A}, V_{DD} = 50\text{ V}$
Avalanche current, repetitive	I_{AR}	-	-	1.3	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-252, TO-263	P_{tot}	-	-	63	W	$T_C = 25\text{ °C}$
Power dissipation for TO-220 FullPAK	P_{tot}	-	-	28	W	$T_C = 25\text{ °C}$
Operating and storage temperature	T_j, T_{stg}	-55	-	150	°C	
Mounting torque TO-220				60	Ncm	M3 and M3.5 screws
				50		M2.5 screws
Continuous diode forward current	I_S	-	-	6.3	A	$T_C = 25\text{ °C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	19	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/ μ s	(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



600V CoolMOS™ C6 Power Transistor IPx60R600C6

Thermal characteristics

3 Thermal characteristics

Table 3 Thermal characteristics TO-220 (IPP60R600C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	2.0	°C/W	
Thermal resistance, junction - ambient	R_{thJA}	-	-	62		leaded
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 (IPA60R600C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	4.5	°C/W	
Thermal resistance, junction - ambient	R_{thJA}	-	-	80		leaded
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 (IPB60R600C6), TO-252 (IPD60R600C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	2.0	°C/W	
Thermal resistance, junction - ambient	R_{thJA}	-	-	62		SMD version, device on PCB, minimal footprint
			35			SMD version, device on PCB, 6cm ² cooling area ¹⁾
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.



600V CoolMOS™ C6 Power Transistor IPx60R600C6

Electrical characteristics

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		$V_{DS}=V_{GS}$, $I_D=0.20\text{ mA}$
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	$R_{DS(on)}$	-	0.54	0.60	Ω	$V_{GS}=10\text{ V}$, $I_D=2.4\text{ A}$, $T_j=25\text{ °C}$
		-	1.40	-		$V_{GS}=10\text{ V}$, $I_D=2.4\text{ A}$, $T_j=150\text{ °C}$
Gate resistance	R_G	-	17.5	-	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}	-	440	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=100\text{ V}$, $f=1\text{ MHz}$	
Output capacitance	C_{oss}	-	30	-			
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$	-	21	-			$V_{GS}=0\text{ V}$, $V_{DS}=0\dots480\text{ V}$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$	-	88	-			$I_D=\text{constant}$, $V_{GS}=0\text{ V}$ $V_{DS}=0\dots480\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	12	-	ns	$V_{DD}=400\text{ V}$, $V_{GS}=13\text{ V}$, $I_D=3\text{ A}$, $R_G=6.8\text{ }\Omega$ (see table 20)	
Rise time	t_r	-	9	-			
Turn-off delay time	$t_{d(off)}$	-	80	-			
Fall time	t_f	-	13	-			

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% $V_{(BR)DSS}$


**600V CoolMOS™ C6 Power Transistor
IPx60R600C6**
Electrical characteristics
Table 8 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	2.5	-	nC	$V_{DD}=480\text{ V}$, $I_D=3.0\text{ A}$, $V_{GS}=0$ to 10 V
Gate to drain charge	Q_{gd}	-	10.5	-		
Gate charge total	Q_g	-	20.5	-		
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	$V_{GS}=0\text{ V}$, $I_F=3.0\text{ A}$, $T_j=25\text{ °C}$
Reverse recovery time	t_{rr}	-	250	-	ns	$V_R=400\text{ V}$, $I_F=3.0\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$ (see table 22)
Reverse recovery charge	Q_{rr}	-	2.1	-	μC	
Peak reverse recovery current	I_{rrm}	-	16	-	A	



**600V CoolMOS™ C6 Power Transistor
 IPx60R600C6**

Electrical characteristics diagrams

5 Electrical characteristics diagrams

Table 10

Power dissipation TO-220, TO-252, 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-252, 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: $D = t_p / T$



**600V CoolMOS™ C6 Power Transistor
 IPx60R600C6**

Electrical characteristics diagrams

Table 12

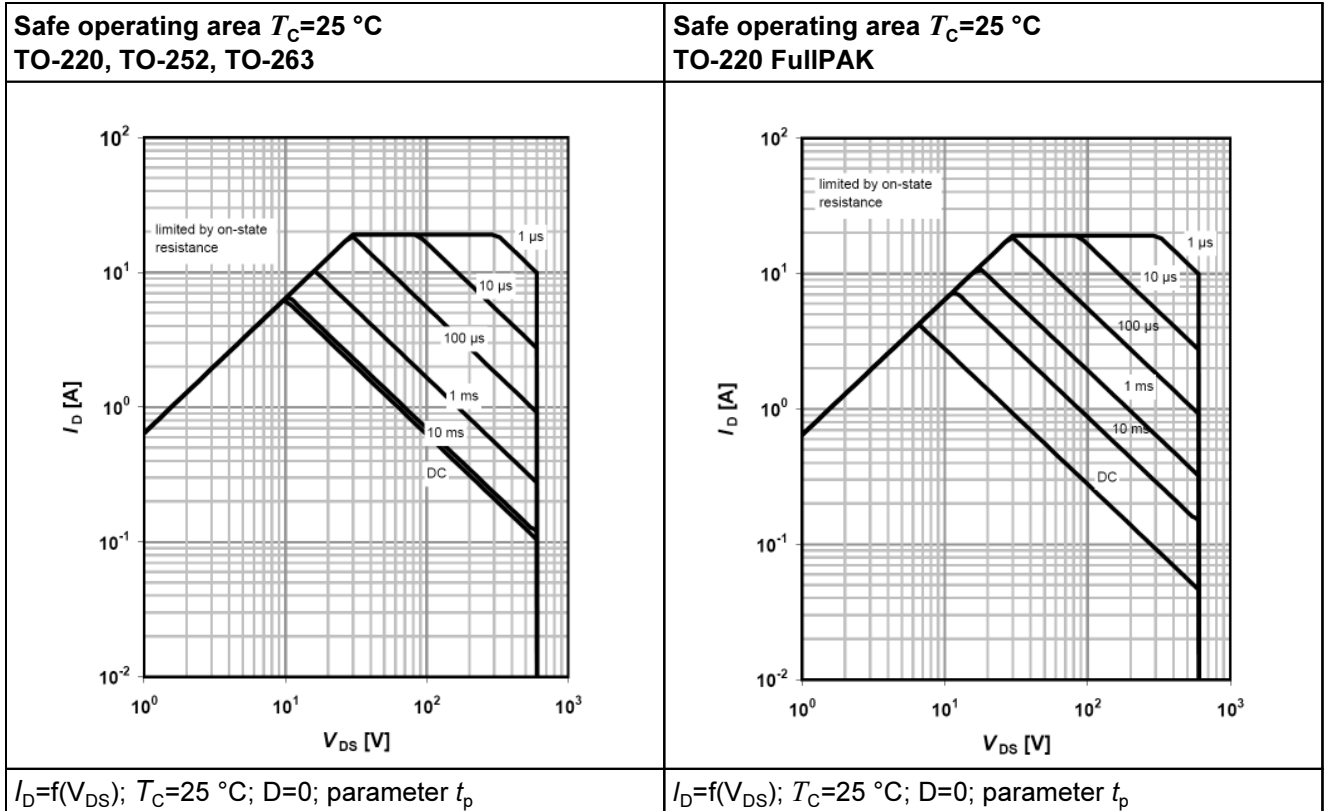
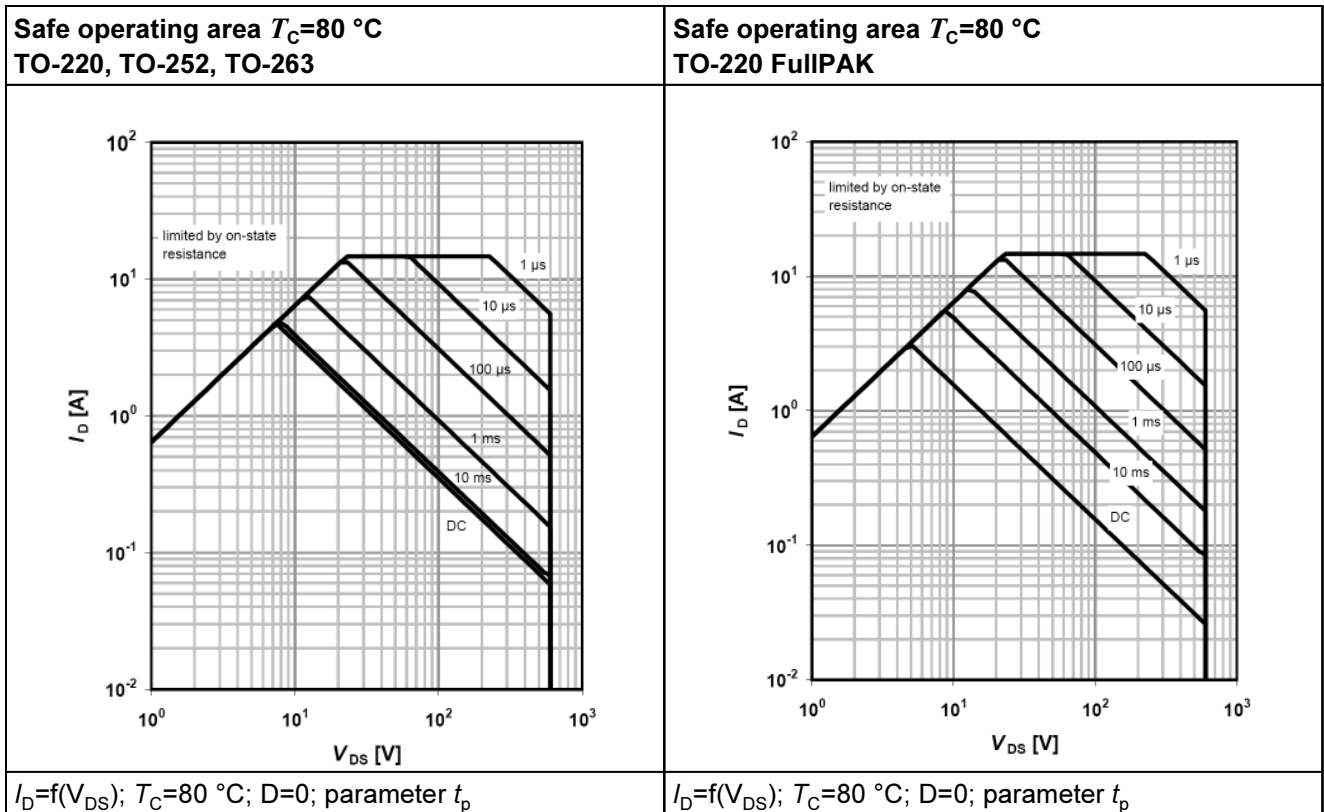


Table 13





**600V CoolMOS™ C6 Power Transistor
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Electrical characteristics diagrams

Table 14

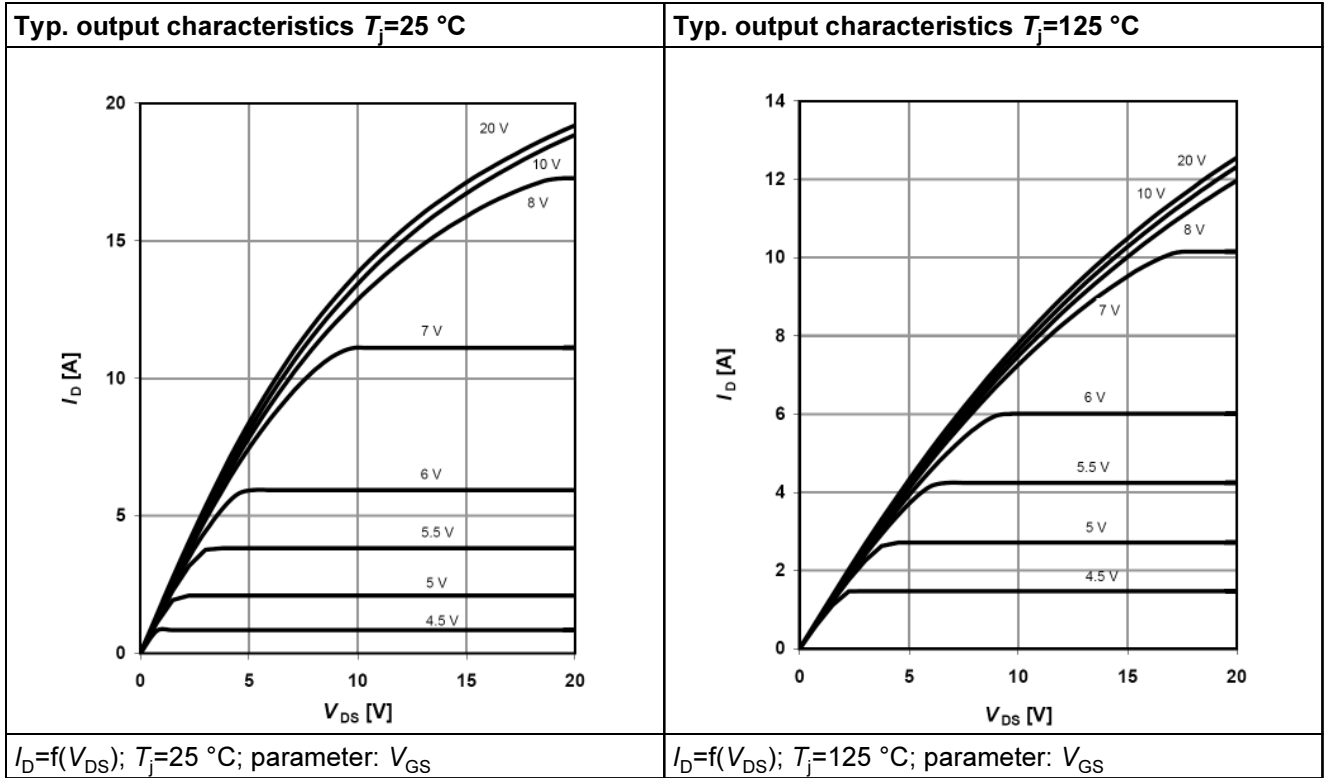
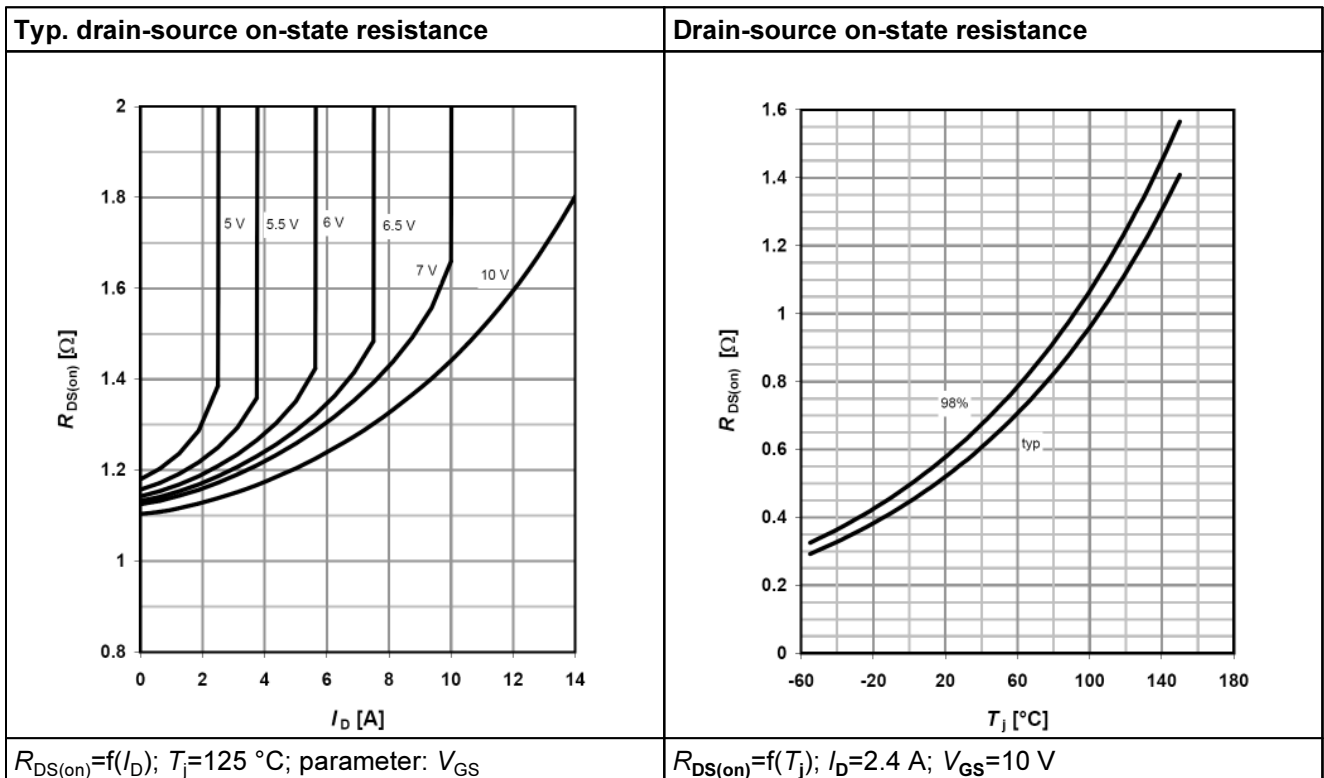


Table 15





**600V CoolMOS™ C6 Power Transistor
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Electrical characteristics diagrams

Table 16

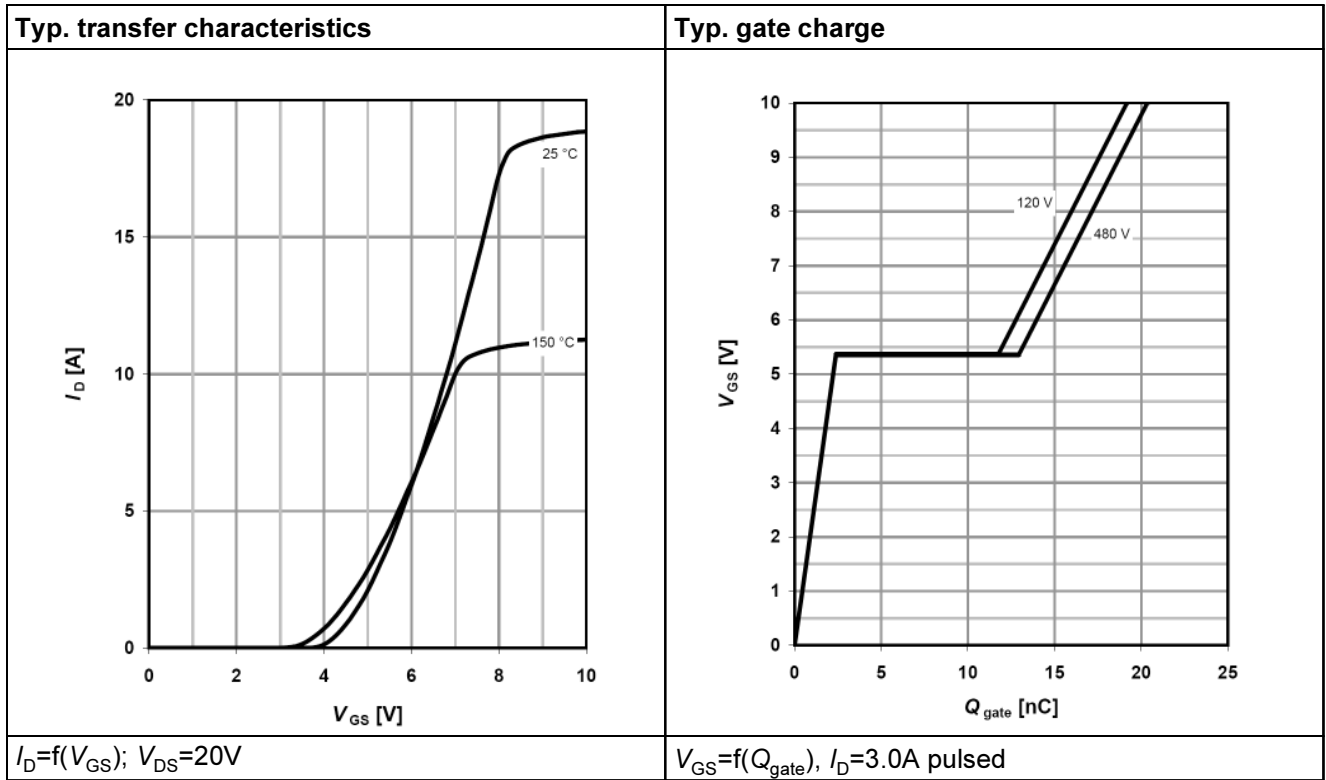
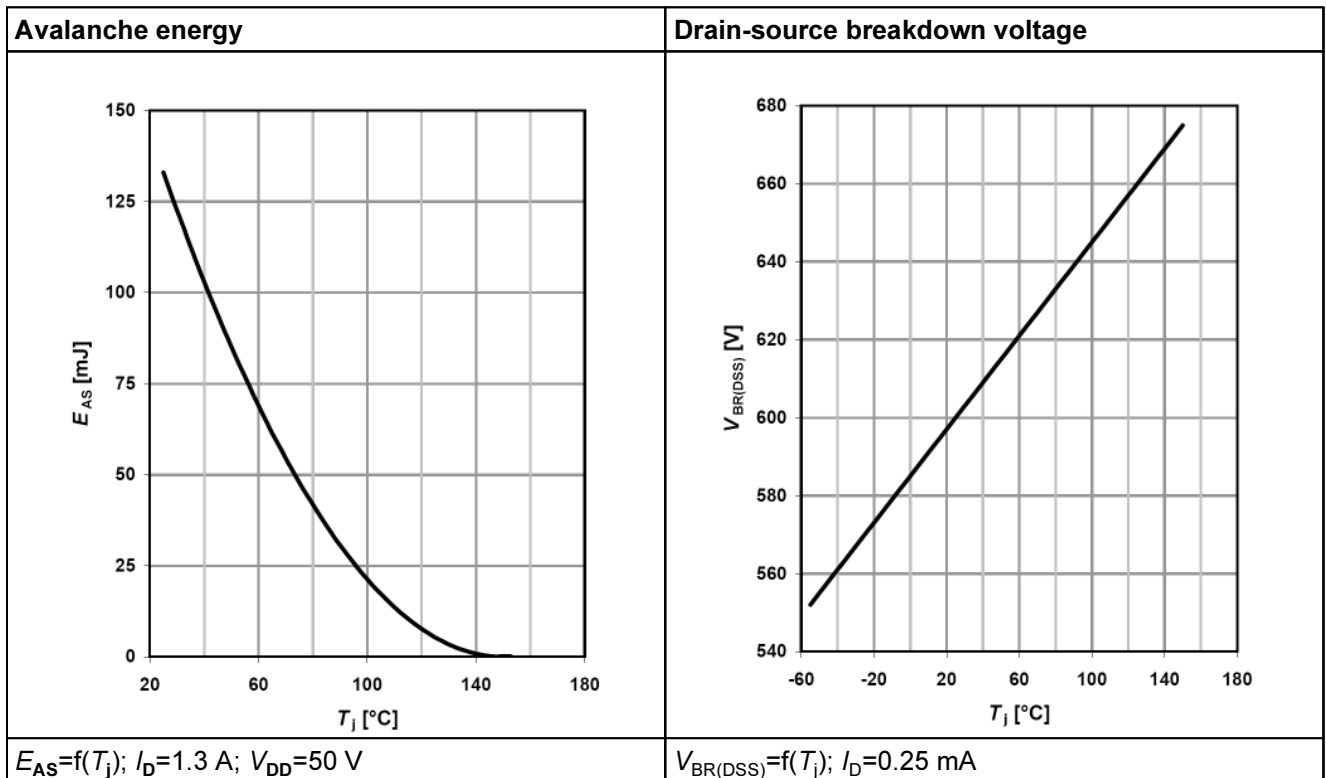


Table 17





**600V CoolMOS™ C6 Power Transistor
 IPx60R600C6**

Electrical characteristics diagrams

Table 18

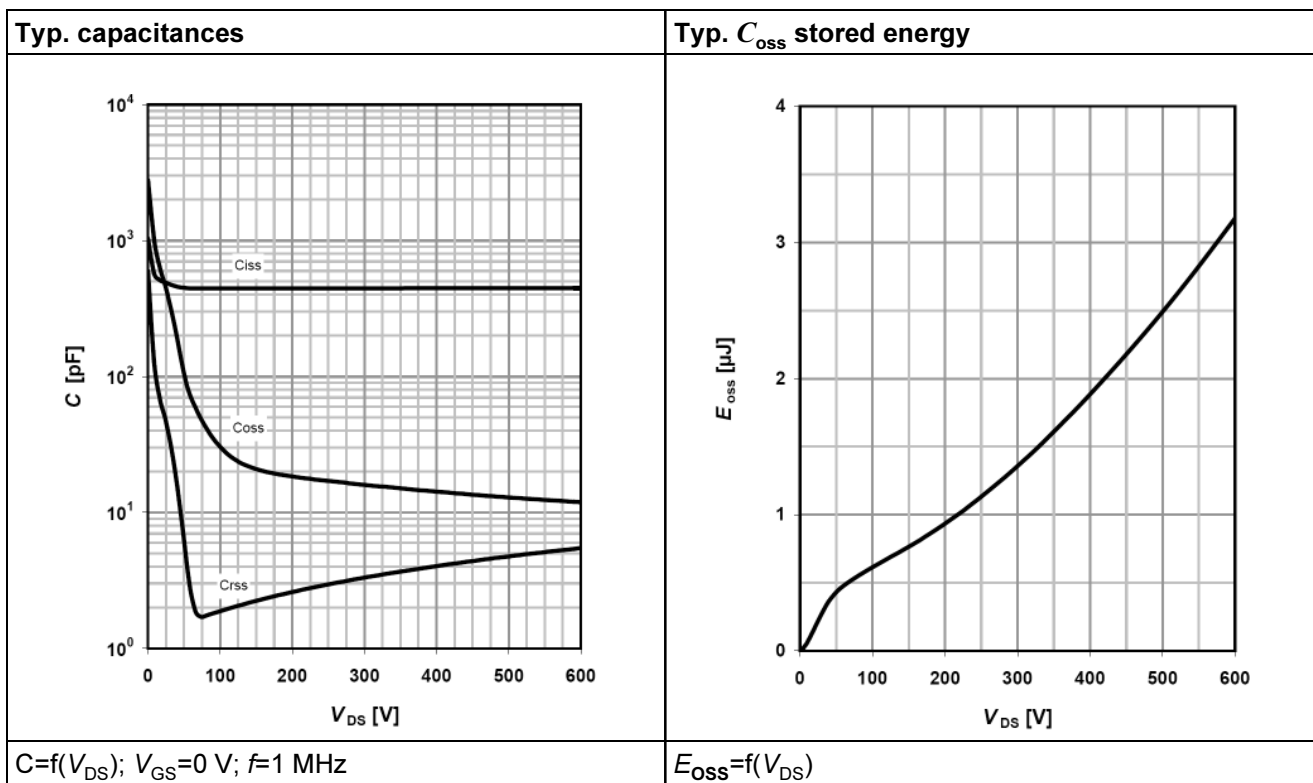
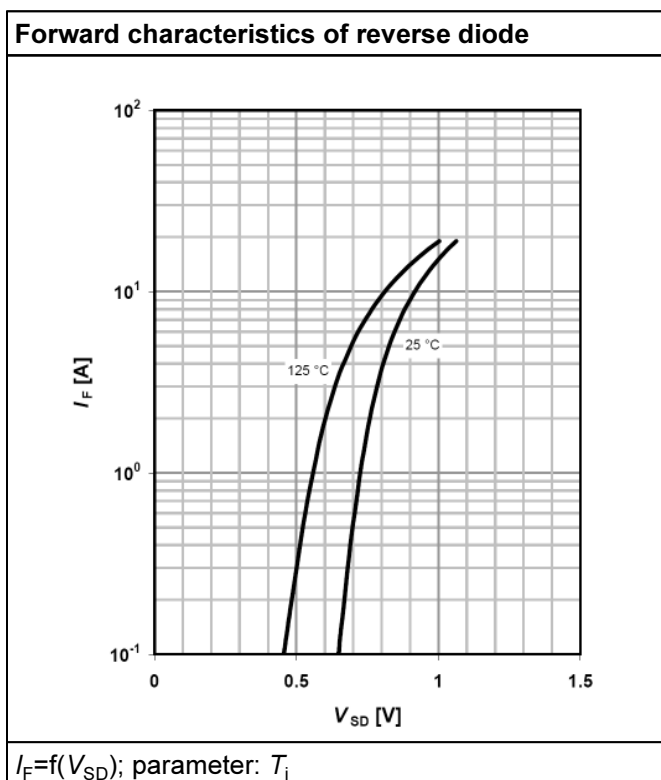


Table 19





**600V CoolMOS™ C6 Power Transistor
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Test circuits

6 Test circuits

Table 20 Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load	Switching time waveform

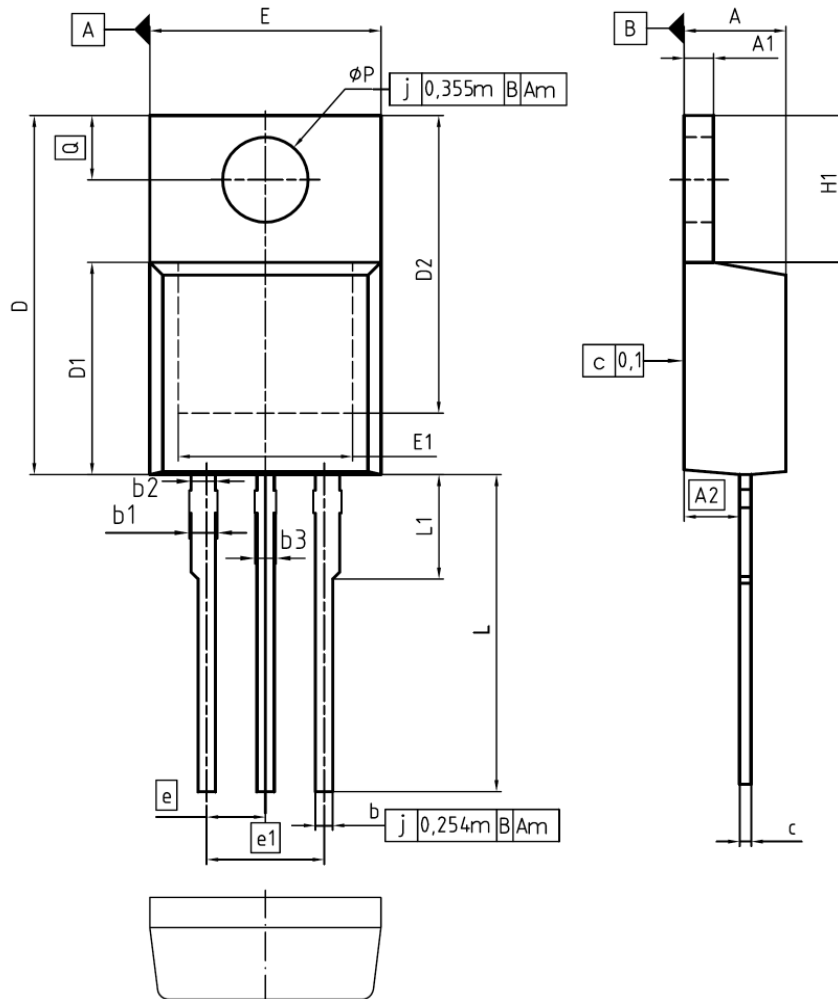
Table 21 Unclamped inductive load test circuit and waveform

Unclamped inductive load test circuit	Unclamped inductive waveform

Table 22 Test circuit and waveform for diode characteristics

Test circuit for diode characteristics	Diode recovery waveform

7 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
øP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

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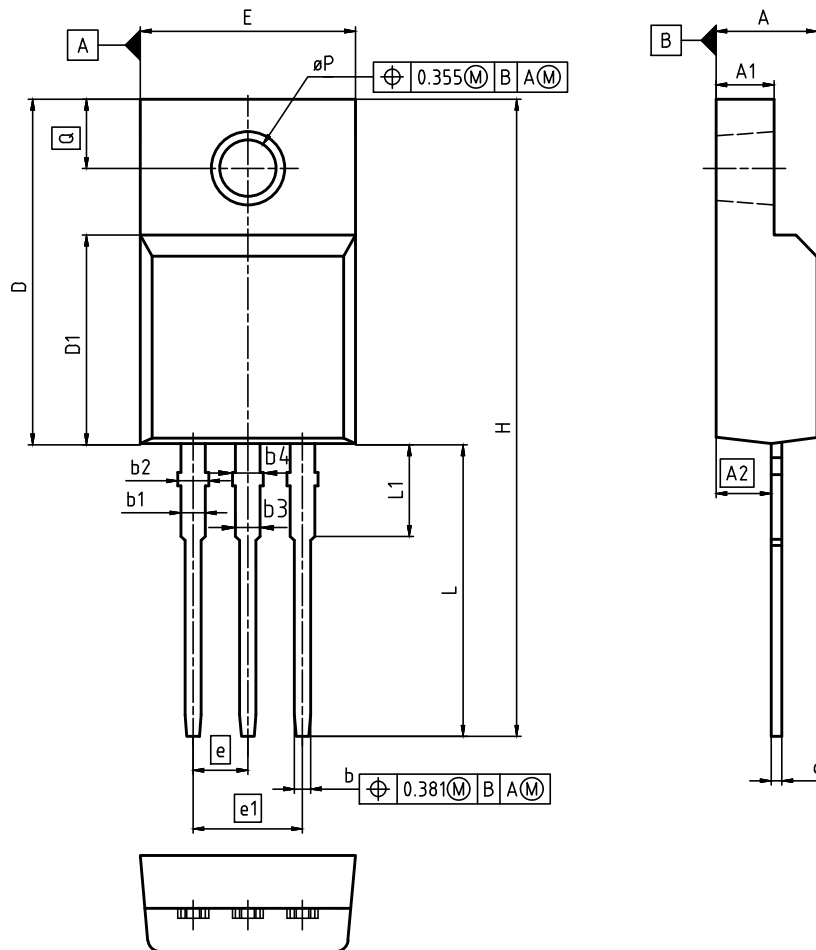
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Figure 1 Outlines TO-220, dimensions in mm/inches



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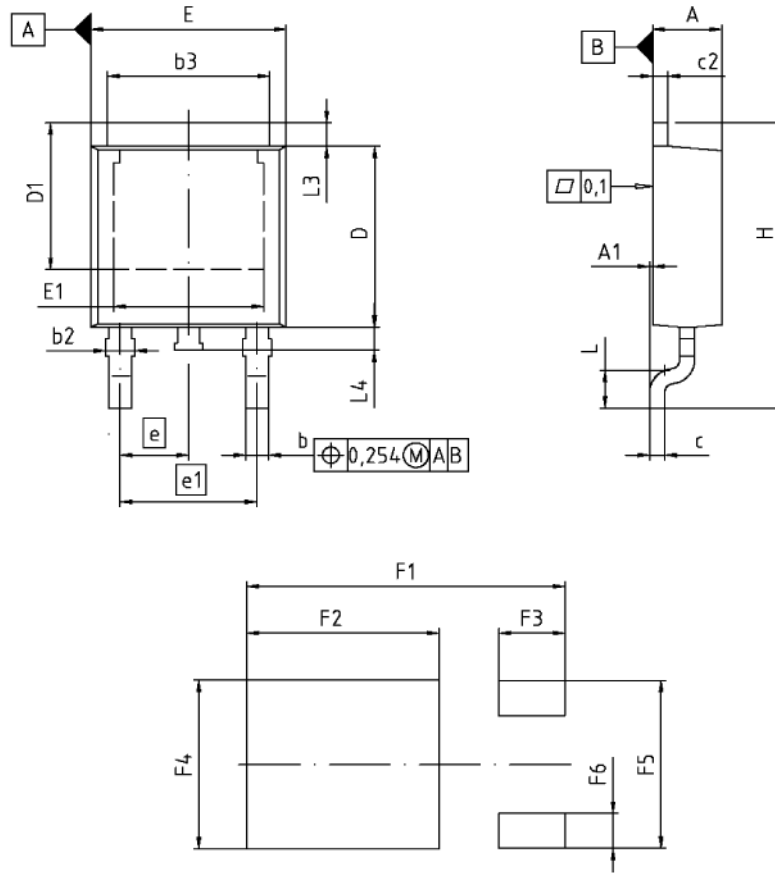
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Figure 2 Outline PG-TO 220 FullPAK, dimensions in mm/inches



**600V CoolMOS™ C6 Power Transistor
IPx60R600C6**

Package outlines



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.16	2.41	0.085	0.095
A1	0.00	0.15	0.000	0.006
b	0.64	0.89	0.025	0.035
b2	0.65	1.15	0.026	0.045
b3	5.00	5.50	0.197	0.217
c	0.46	0.60	0.018	0.024
c2	0.46	0.98	0.018	0.039
D	5.97	6.22	0.235	0.245
D1	5.02	5.84	0.198	0.230
E	6.40	6.73	0.252	0.265
E1	4.70	5.21	0.185	0.205
e	2.29		0.090	
e1	4.57		0.180	
N	3		3	
H	9.40	10.48	0.370	0.413
L	1.18	1.70	0.046	0.067
L3	0.90	1.25	0.035	0.049
L4	0.51	1.00	0.020	0.039
F1	10.50	10.70	0.413	0.421
F2	6.30	6.50	0.248	0.256
F3	2.10	2.30	0.083	0.091
F4	5.70	5.90	0.224	0.232
F5	5.66	5.86	0.223	0.231
F6	1.10	1.30	0.043	0.051

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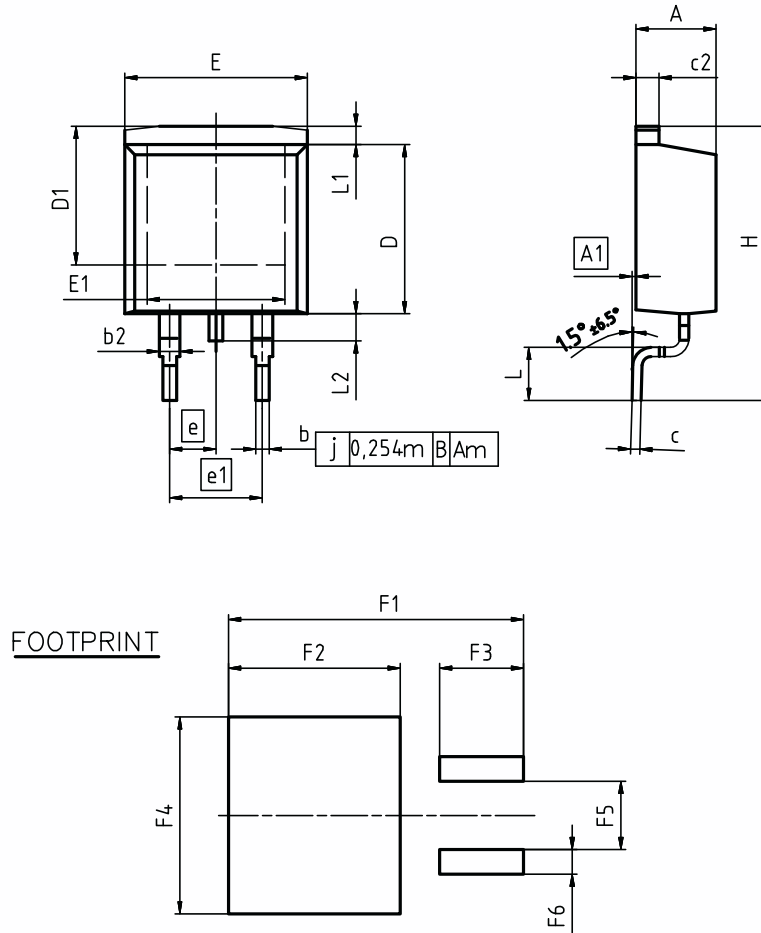
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Figure 3 Outlines TO-252, dimensions in mm/inches



**600V CoolMOS™ C6 Power Transistor
IPx60R600C6**

Package outlines



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	0.00	0.25	0.000	0.010
b	0.65	0.85	0.026	0.033
b2	0.95	1.15	0.037	0.045
c	0.33	0.85	0.013	0.026
c2	1.17	1.40	0.046	0.055
D	8.51	9.45	0.335	0.372
D1	7.10	7.90	0.280	0.311
E	9.80	10.31	0.386	0.406
E1	6.50	8.80	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	2		2	
H	14.61	15.88	0.575	0.625
L	2.29	3.00	0.090	0.118
L1	0.70	1.60	0.028	0.063
L2	1.00	1.78	0.039	0.070
F1	16.05	16.25	0.632	0.640
F2	9.30	9.50	0.366	0.374
F3	4.50	4.70	0.177	0.185
F4	10.70	10.90	0.421	0.429
F5	3.65	3.85	0.144	0.152
F6	1.25	1.45	0.049	0.057

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01

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

**600V CoolMOS™ C6 Power Transistor****IPx60R600C6****Revision History**

IPx60R600C6

Revision: 2015-02-11, 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	2015-02-11	PG-TO220 FullPAK package outline update (creation:2014-12-10)

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