

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS CFD

650V CoolMOS™ CFD Power Transistor
IPx65R660CFD

Data Sheet

Rev. 2.0, 2011-02-01
Final

Industrial & Multimarket

650V CoolMOS™ CFD Power Transistor

IPD65R660CFD IPB65R660CFD,
IPP65R660CFD IPA65R660CFD

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™ CFD 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 for industrial grade applications according to JEDEC¹⁾
- Pb-free plating, Halogen free mold compound

Applications

650V CoolMOS™ CFD is especially suitable for resonant switching PWM stages for e.g. PC Silverbox, LCD TV, Lighting, Server, Telecom.

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

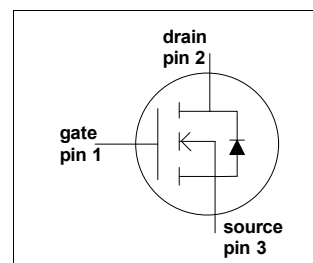
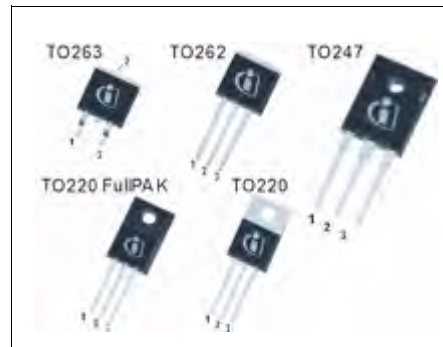


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	700	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	500	A/ μs

Type / Ordering Code	Package	Marking	Related Links
IPD65R660CFD	PG-TO252	65F660	IFX CoolMOS Webpage IFX Design tools
IPB65R660CFD	PG-TO263		
IPP65R660CFD	PG-TO220		
IPA65R660CFD	PG-TO220 FullPAK		
IPI65R660CFD	PG-TO262		
IPW65R660CFD	PG-TO247		

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	-	-	6.0	A	$T_C = 25\text{ °C}$
				3.8		$T_C = 100\text{ °C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	17	A	$T_C = 25\text{ °C}$
Avalanche energy, single pulse	E_{AS}	-	-	115	mJ	$I_D = 1.2\text{ A}, V_{DD} = 50\text{ V}$
Avalanche energy, repetitive	E_{AR}	-	-	0.21		$I_D = 1.2\text{ A}, V_{DD} = 50\text{ V}$
Avalanche current, repetitive	I_{AR}	-	-	1.2	A	
MOSFET dv/dt ruggedness	dv/dt	-	-	50	V/ns	$V_{DS} = 0 \dots 480\text{ V}$
Gate source voltage	V_{GS}	-20	-	20	V	static
		-30		30		AC (f > 1 Hz)
Power dissipation for Non FullPAK	P_{tot}	-	-	63	W	$T_C = 25\text{ °C}$
Power dissipation for FullPAK	P_{tot}	-	-	28	W	$T_C = 25\text{ °C}$
Operating and storage temperature	T_j, T_{stg}	-55	-	150	°C	
Mounting torque non FullPAK		-	-	60	Ncm	M3 and M3.5 screws
Mounting torque FullPAK				50		M2.5 screws
Continuous diode forward current	I_S	-	-	6.0	A	$T_C = 25\text{ °C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	17	A	$T_C = 25\text{ °C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	15	V/ns	$V_{DS} = 0 \dots 480\text{ V}, I_{SD} \leq I_D,$ $T_j = 125\text{ °C}$
Maximum diode commutation speed ³⁾	di/dt			500	A/μs	

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; TO-247 & TO-262

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	2.0	°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-220FullPAK

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	4.5	°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 and TO-252

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	2.0	°C/W	SMD version, device on PCB, minimal footprint
Thermal resistance, junction - ambient	R_{thJA}	-	-	62		
			35			
Soldering temperature, wave- & reflowsoldering allowed	T_{sold}	-	-	260	°C	reflow MSL1

1) Device on 40mm*40mm*1.5 epoxy PCB FR4 with 6cm² (one layer, 70µm thick) copper area 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	$V_{(BR)DSS}$	650	-	-	V	$V_{GS}=0\text{ V}$, $I_D=1.0\text{ mA}$
Gate threshold voltage	$V_{GS(th)}$	3.5	4	4.5		$V_{DS}=V_{GS}$, $I_D=0.21\text{ mA}$
Zero gate voltage drain current	I_{DSS}	-	-	5	μA	$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$
		-	600	-		$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ °C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.59	0.66	Ω	$V_{GS}=10\text{ V}$, $I_D=2.1\text{ A}$, $T_j=25\text{ °C}$
		-	1.54	-		$V_{GS}=10\text{ V}$, $I_D=2.1\text{ A}$, $T_j=150\text{ °C}$
Gate resistance	R_G	-	6.5	-	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}	-	615	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=100\text{ V}$, $f=1\text{ MHz}$
Output capacitance	C_{oss}	-	33	-		
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	$t_{d(on)}$	-	9	-	ns	$V_{DD}=400\text{ V}$, $V_{GS}=13\text{ V}$, $I_D=3.2\text{ A}$, $R_G=6.8\text{ }\Omega$
Rise time	t_r	-	8	-		
Turn-off delay time	$t_{d(off)}$	-	40	-		
Fall time	t_f	-	10	-		

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.		
IGate to source charge	Q_{gs}	-	3.5	-	nC	$V_{DD}=480\text{ V}$, $I_D=3.2\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	Q_{gd}	-	12	-		
Gate charge total	Q_g	-	22	-		
Gate plateau voltage	$V_{plateau}$	-	6.4	-	V	

Table 9 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.9	-	V	$V_{GS}=0\text{ V}$, $I_F=3.2\text{ A}$, $T_j=25\text{ °C}$
Reverse recovery time	t_{rr}	-	65	-	ns	$V_R=400\text{ V}$, $I_F=3.2\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$
Reverse recovery charge	Q_{rr}	-	0.20	-	μC	
Peak reverse recovery current	I_{rrm}	-	4.5	-	A	

5 Electrical characteristics diagrams

Table 10

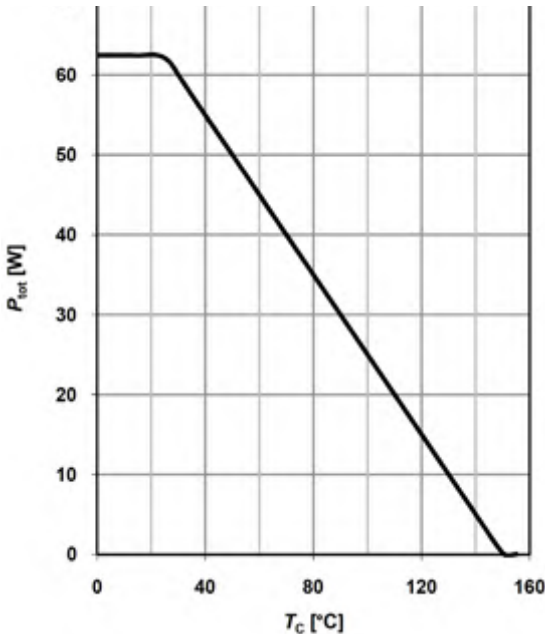
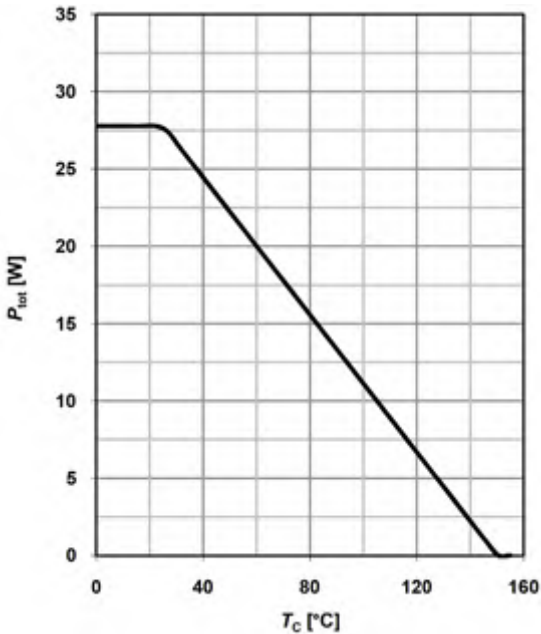
Power dissipation Non FullPAK	Power dissipation FullPAK
	
$P_{\text{tot}} = f(T_c)$	$P_{\text{tot}} = f(T_c)$

Table 11

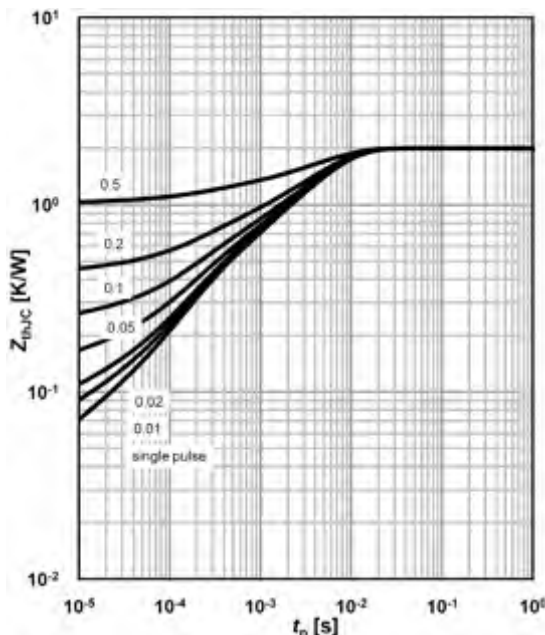
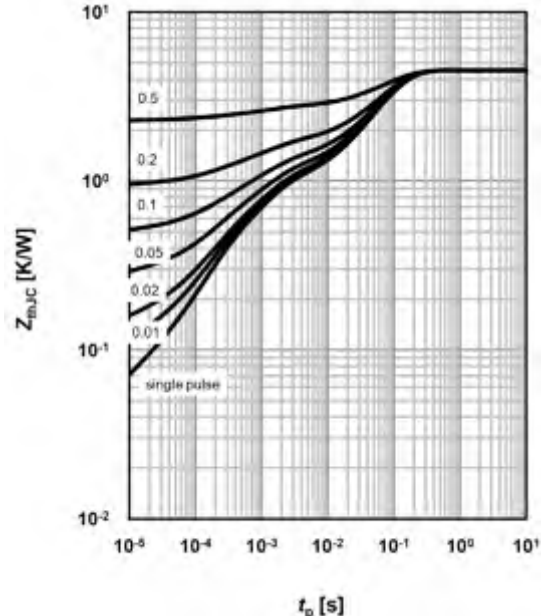
Max. transient thermal impedance Non FullPAK	Max. transient thermal impedance FullPAK
	
$Z_{(\text{thJC})} = f(t_p)$; parameter: $D = t_p / T$	$Z_{(\text{thJC})} = f(t_p)$; parameter: $D = t_p / T$

Table 12

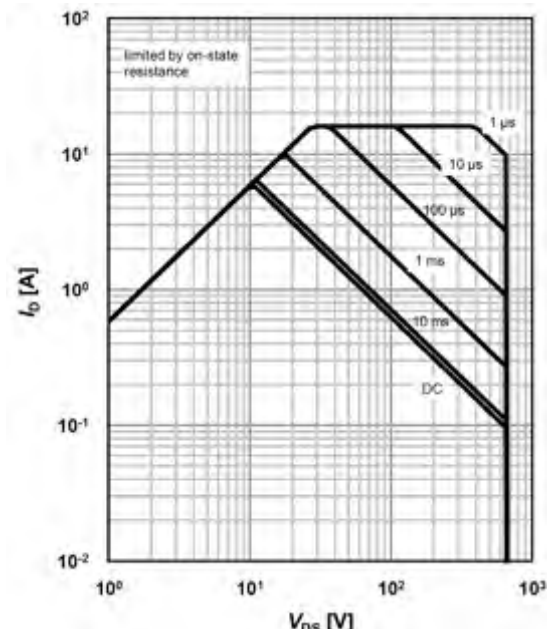
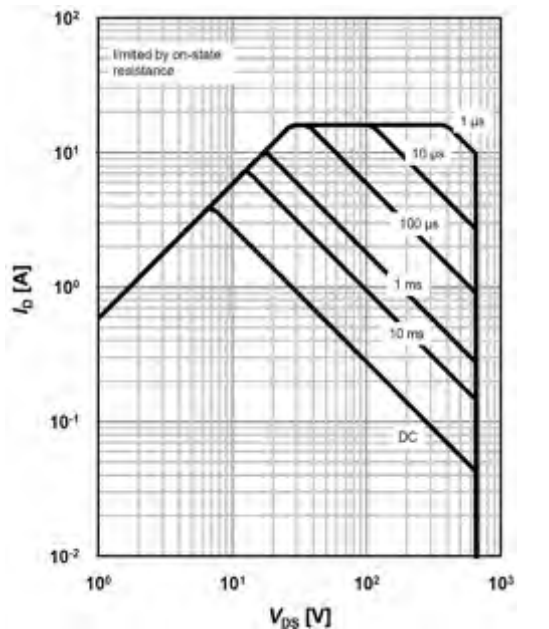
Safe operating area $T_C=25\text{ °C}$ Non FullPAK	Safe operating area $T_C=25\text{ °C}$ FullPAK
	
$I_D=f(V_{DS}); T_C=25\text{ °C}; V_{GS} > 7.5\text{V}; D=0; \text{parameter } t_p$	$I_D=f(V_{DS}); T_C=25\text{ °C}; V_{GS} > 7.5\text{V}; D=0; \text{parameter } t_p$

Table 13

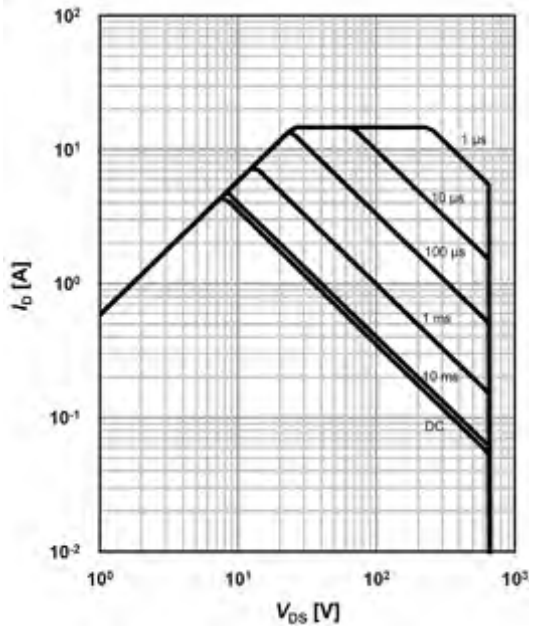
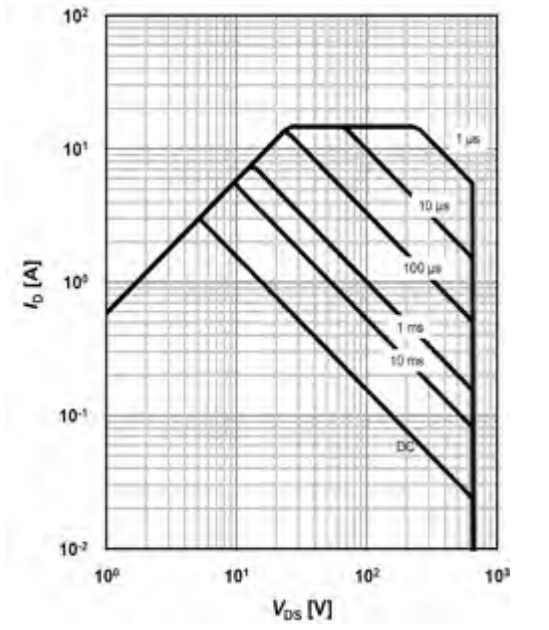
Safe operating area $T_C=80\text{ °C}$ Non FullPAK	Safe operating area $T_C=80\text{ °C}$ FullPAK
	
$I_D=f(V_{DS}); T_C=80\text{ °C}; V_{GS} > 7.5\text{V}; D=0; \text{parameter } t_p$	$I_D=f(V_{DS}); T_C=80\text{ °C}; V_{GS} > 7.5\text{V}; D=0; \text{parameter } t_p$

Table 14

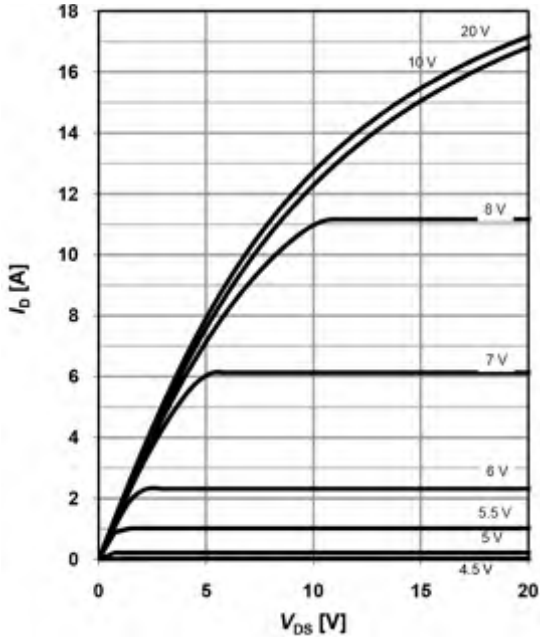
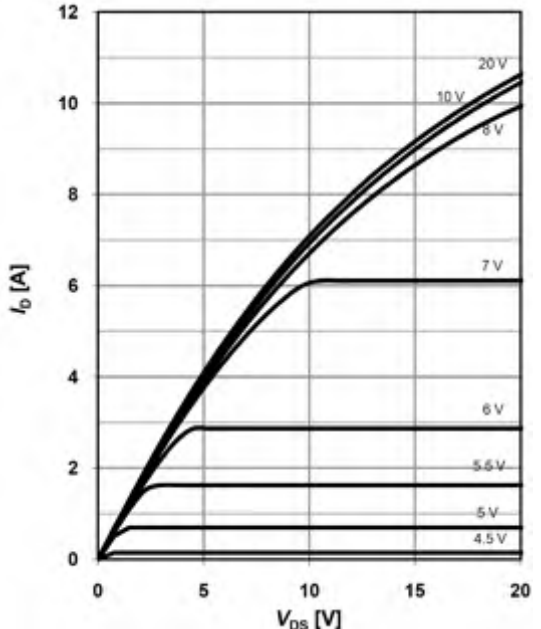
Typ. output characteristics $T_j=25\text{ °C}$	Typ. output characteristics $T_j=125\text{ °C}$
	
$I_D=f(V_{DS}); T_j=25\text{ °C}; \text{parameter: } V_{GS}$	$I_D=f(V_{DS}); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

Table 15

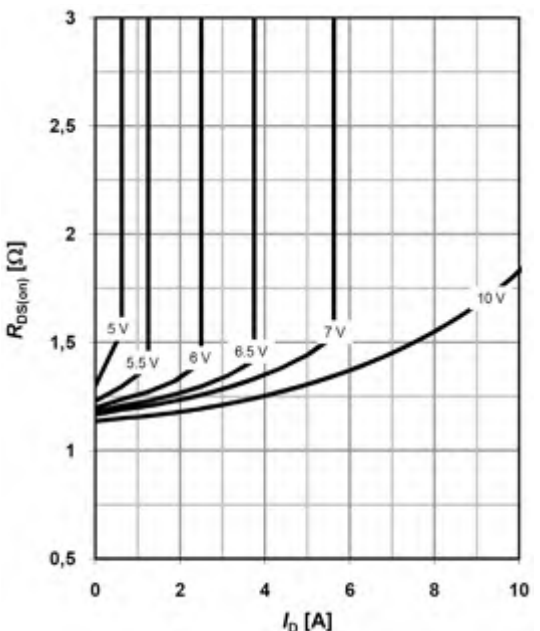
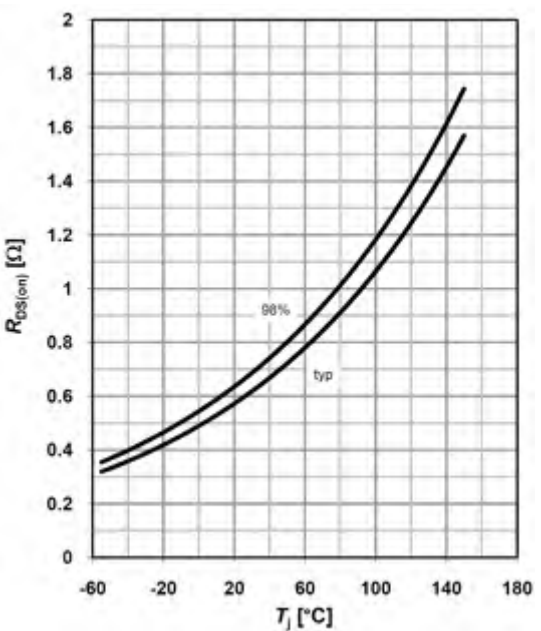
Typ. drain-source on-state resistance	Drain-source on-state resistance
	
$R_{DS(on)}=f(I_D); T_j=125\text{ °C}; \text{parameter: } V_{GS}$	$R_{DS(on)}=f(T_j); I_D=2.1\text{ A}; V_{GS}=10\text{ V}$

Table 16

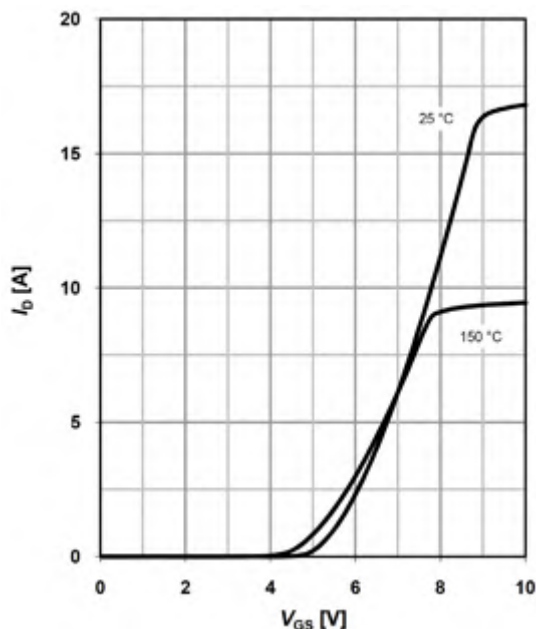
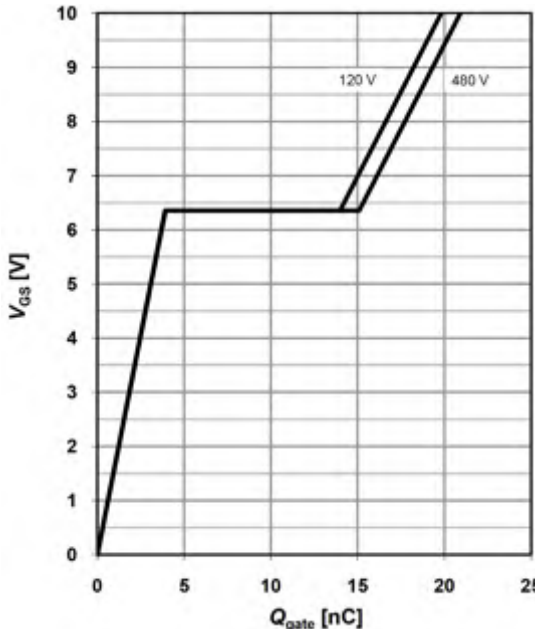
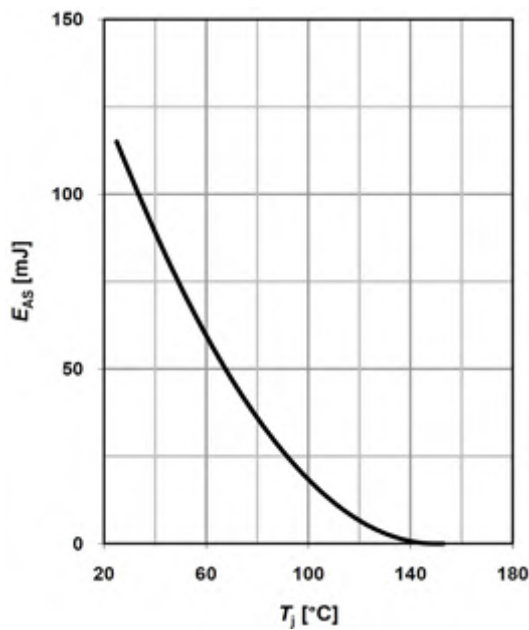
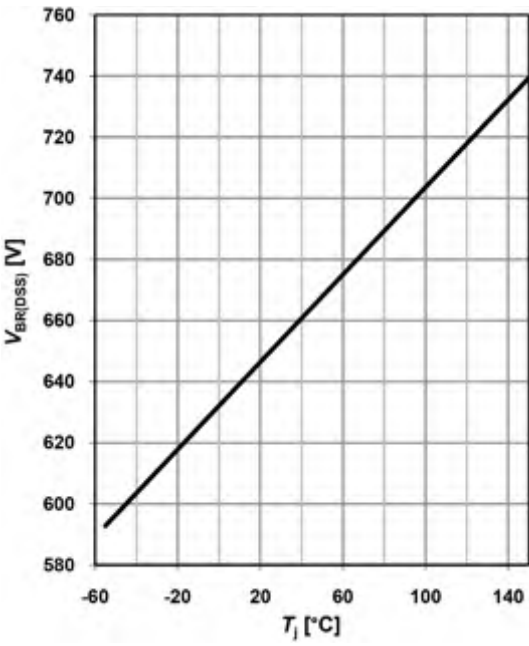
Typ. transfer characteristics	Typ. gate charge
	
$I_D = f(V_{GS}); V_{DS} = 20V$	$V_{GS} = f(Q_{gate}), I_D = 3.2 A \text{ pulsed}$

Table 17

Avalanche energy	Drain-source breakdown voltage
	
$E_{AS} = f(T_j); I_D = 1.2 A; V_{DD} = 50 V$	$V_{BR(DSS)} = f(T_j); I_D = 1.0 mA$

Electrical characteristics diagrams

Table 18

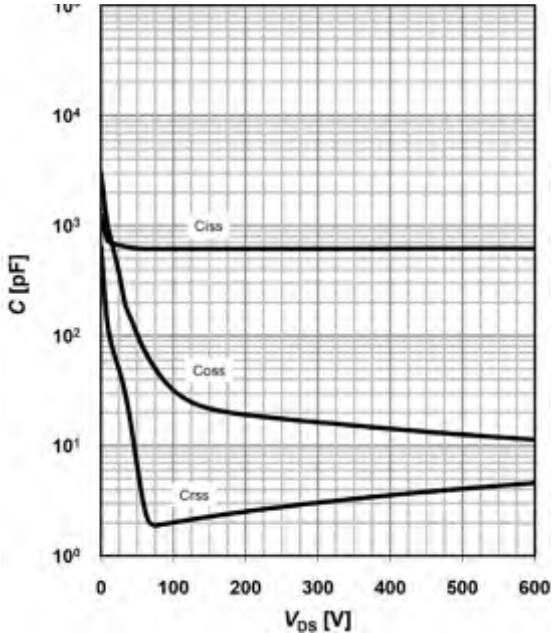
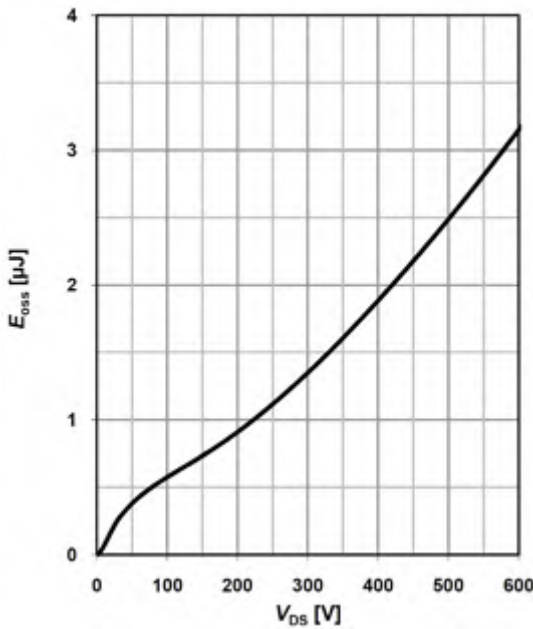
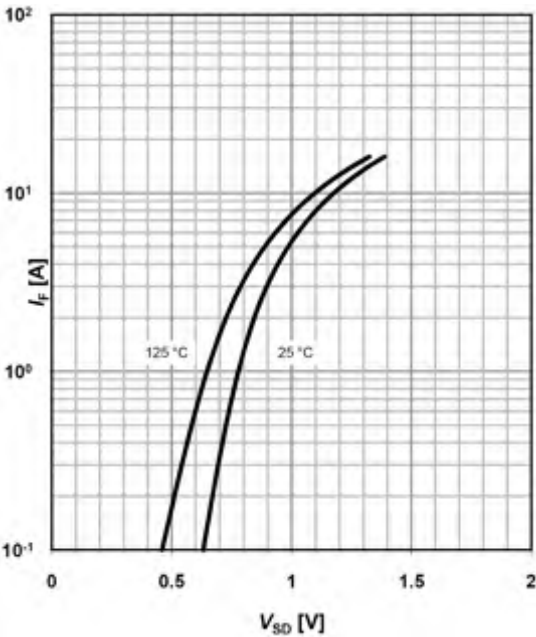
Typ. capacitances	Typ. C_{oss} stored energy
	
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$	$E_{oss}=f(V_{DS})$

Table 19

Forward characteristics of reverse diode

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

6 Test circuits

Table 20 Switching times test circuit and waveform for inductive load

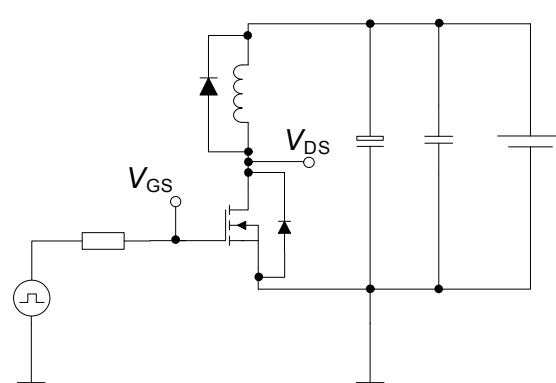
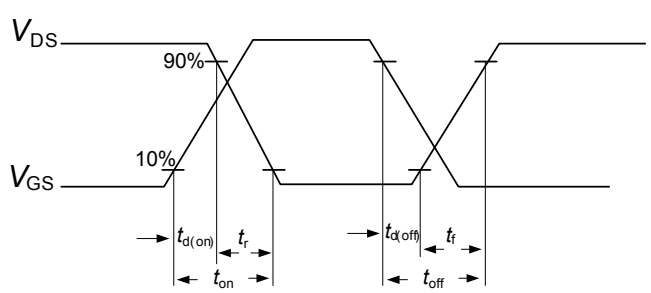
Switching times test circuit for inductive load	Switching time waveform
	

Table 21 Unclamped inductive load test circuit and waveform

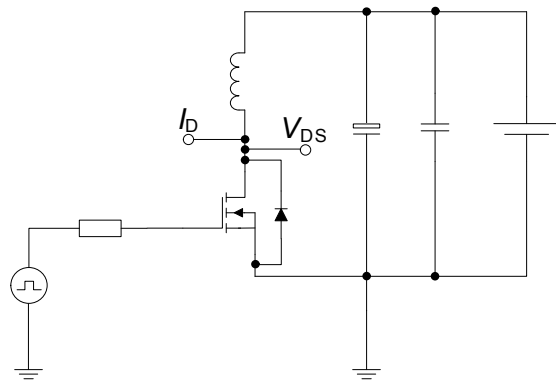
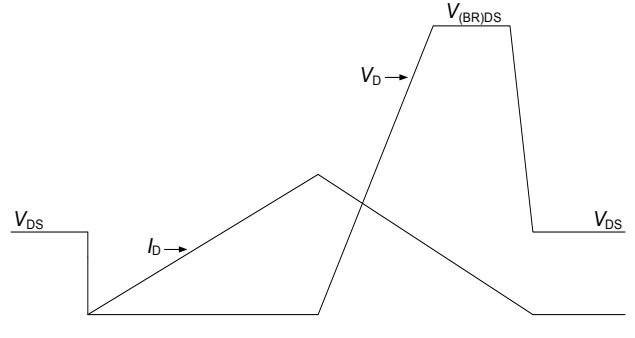
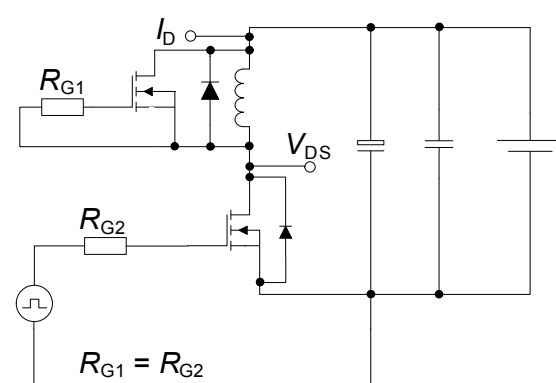
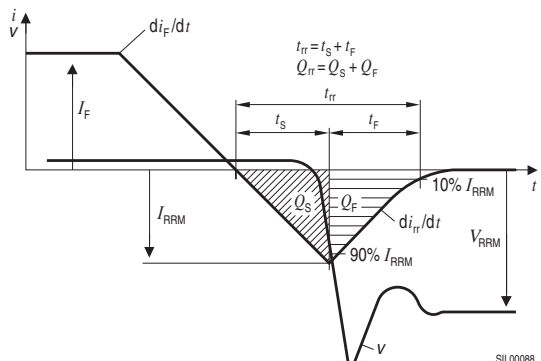
Unclamped inductive load test circuit	Unclamped inductive waveform
	

Table 22 Test circuit and waveform for diode characteristics

Test circuit for diode characteristics	Diode recovery waveform
	

7 Package outlines

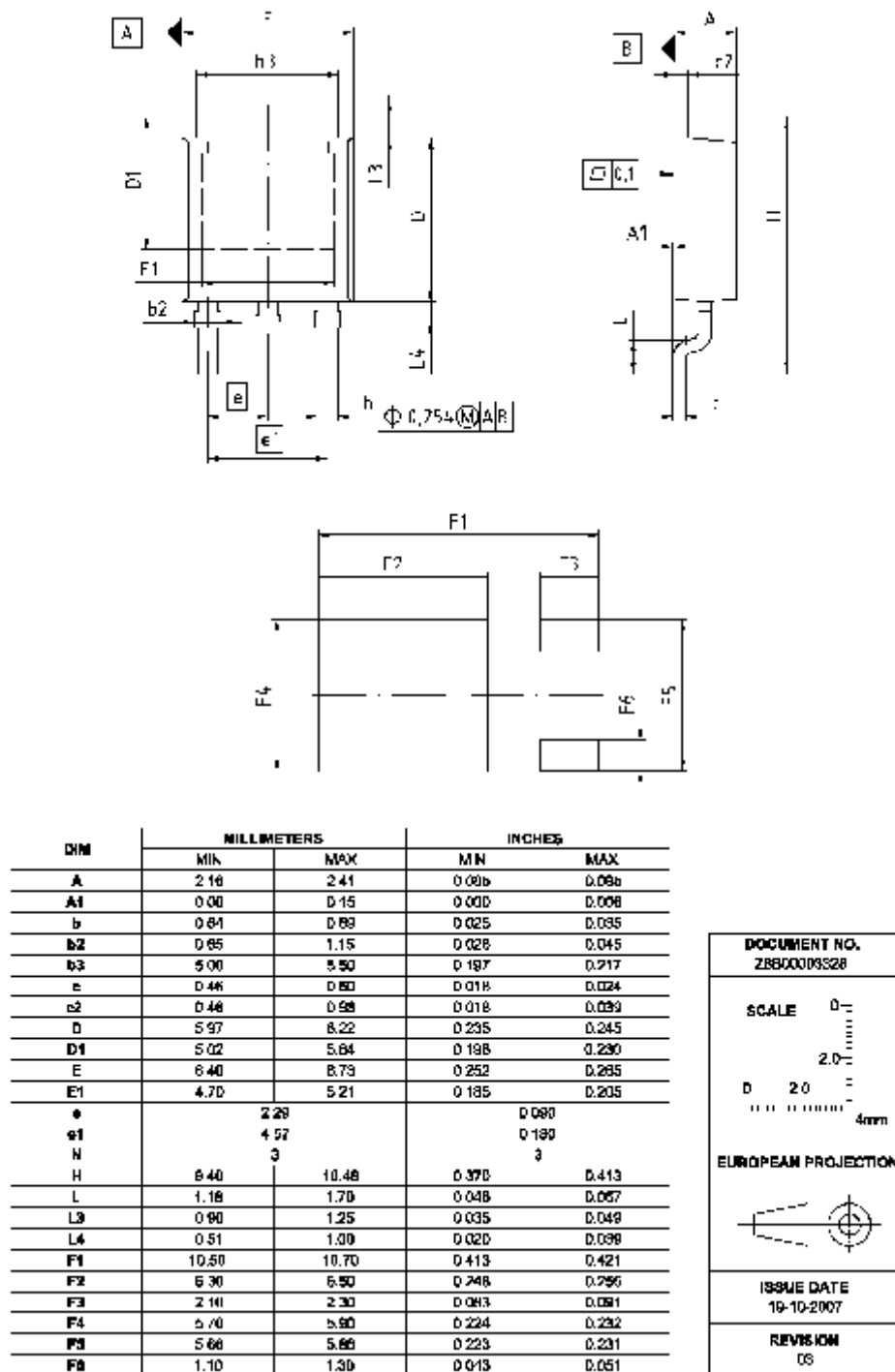
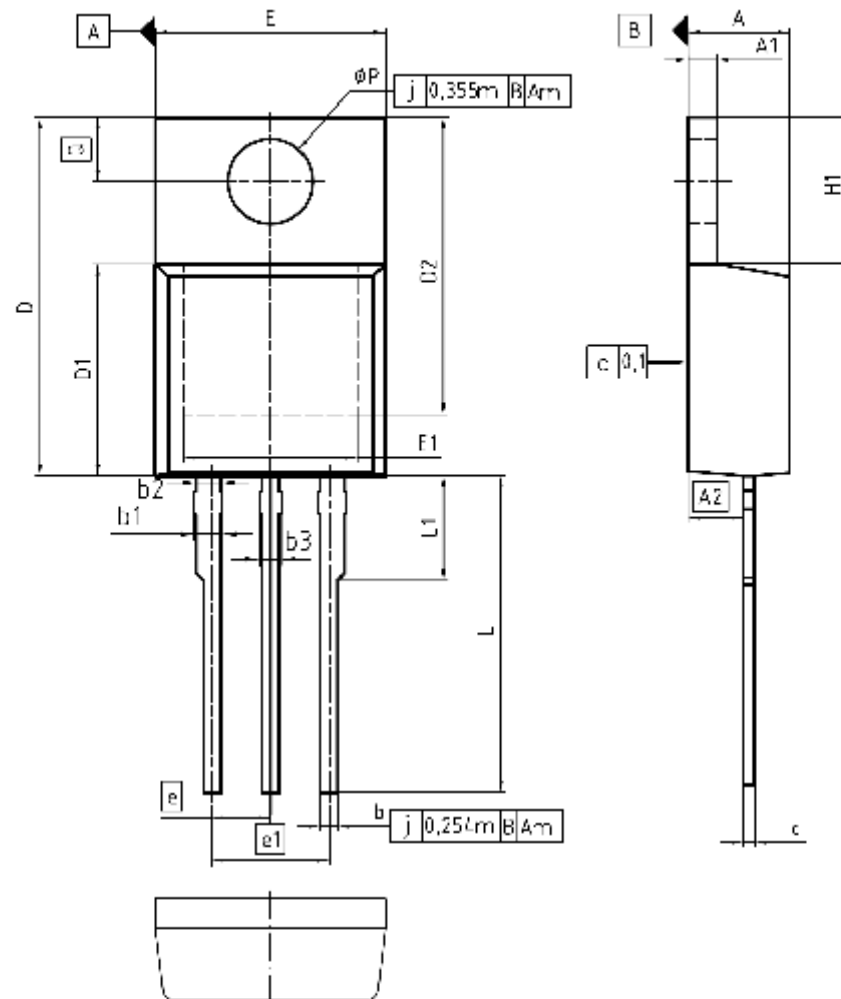


Figure 1 Outlines TO-252, dimensions in mm/inches



D/M	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.32	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	0.05	0.06	0.002	0.003
b1	0.95	1.10	0.037	0.043
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.53	0.60	0.021	0.024
D	14.81	15.05	0.583	0.593
D1	8.51	9.45	0.335	0.372
D2	12.19	13.13	0.480	0.516
E	9.70	10.35	0.382	0.408
F1	6.50	6.60	0.256	0.260
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.50	0.232	0.256
L	13.30	14.00	0.512	0.551
L1	-	4.60	-	0.181
phi P	3.00	3.89	0.118	0.153
Q	2.60	3.00	0.102	0.118

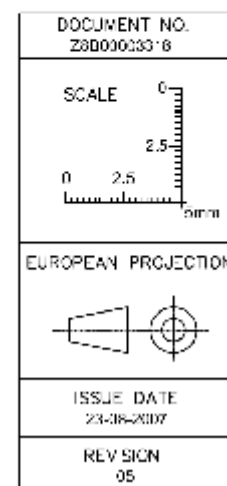
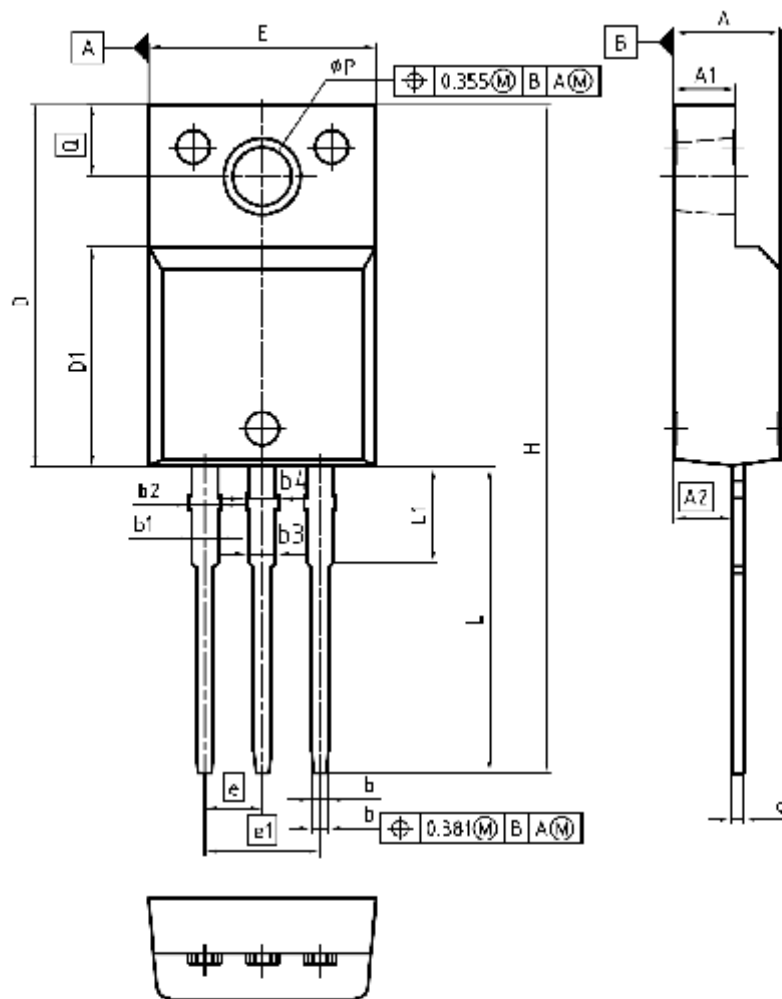


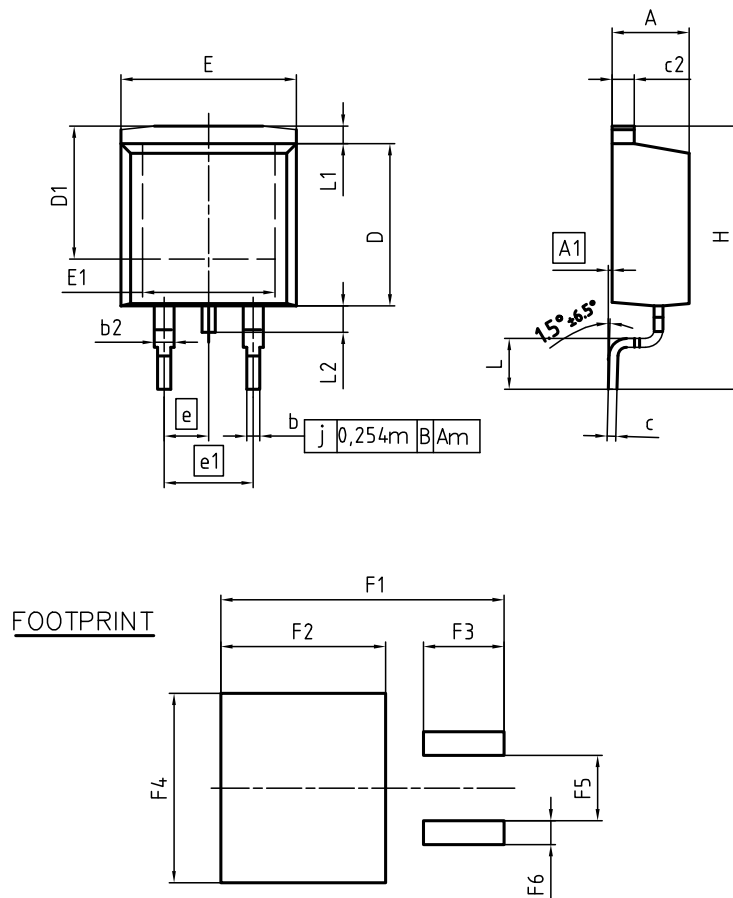
Figure 2 Outlines TO-220, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.55	4.95	0.179	0.191
A1	2.85	2.85	0.110	0.112
A2	2.42	2.72	0.095	0.107
b	0.85	0.85	0.028	0.033
b1	0.95	1.25	0.037	0.052
b2	0.95	1.51	0.037	0.059
b3	0.65	1.35	0.026	0.052
b4	0.85	1.51	0.028	0.059
c	0.40	0.63	0.016	0.025
D	15.85	16.15	0.624	0.636
D1	6.53	6.83	0.257	0.267
F	10.35	10.65	0.407	0.419
e	2.64		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
Q	2.95	3.25	0.116	0.128
Q	3.15	3.50	0.124	0.138

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SCALE 0 2.5 5 mm
EUROPEAN PROJECTION
ISSUE DATE 08-03-2007
REVISION 05

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



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	0.65	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	8.60	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

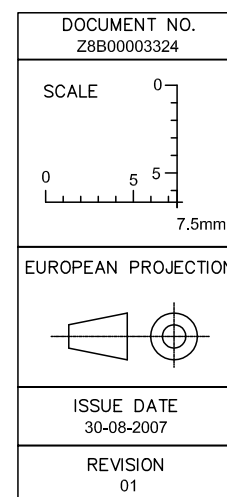
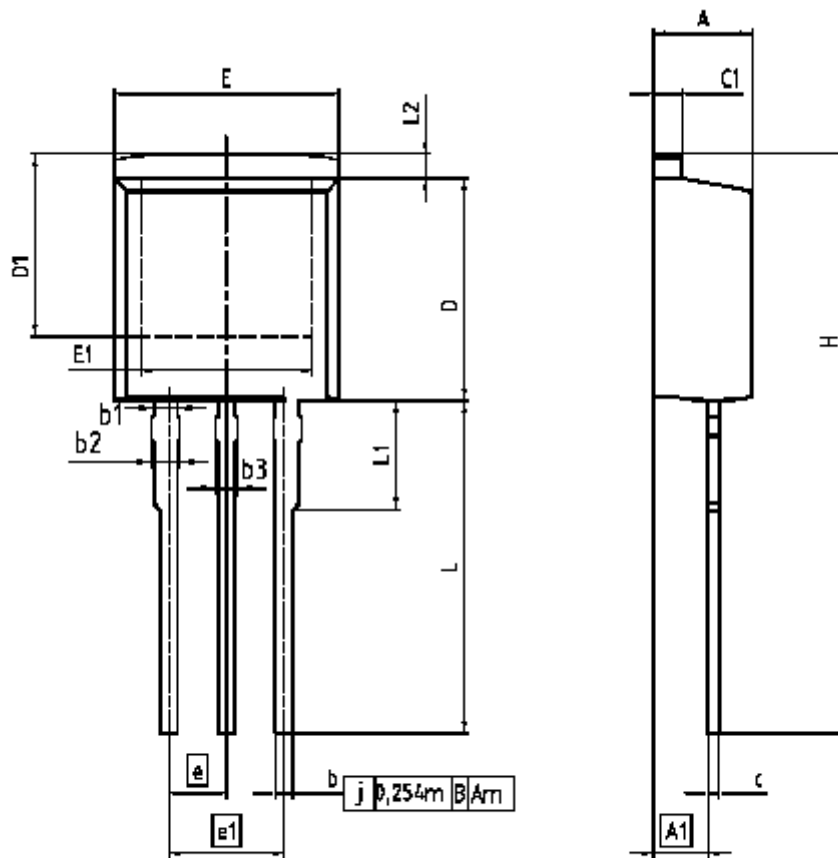


Figure 4 Outlines TO-263, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.572	0.169	0.180
A1	2.150	2.718	0.085	0.107
b	0.850	0.864	0.033	0.034
b1	0.950	1.083	0.037	0.043
b2	0.900	1.400	0.035	0.055
b3	0.850	1.118	0.033	0.044
c	0.330	0.600	0.013	0.024
e	1.170	1.400	0.046	0.055
D	8.509	9.450	0.335	0.372
D1	6.900	-	0.272	-
E	9.700	10.383	0.382	0.409
E1	6.500	8.600	0.256	0.339
e	2.540		0.100	
e1	5.080		0.200	
N	3		3	
L	13.000	14.000	0.512	0.551
L1	-	4.800	-	0.189
L2	-	1.727	-	0.068

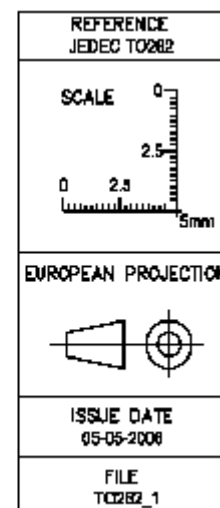


Figure 5 Outlines TO-262, dimensions in mm/inches

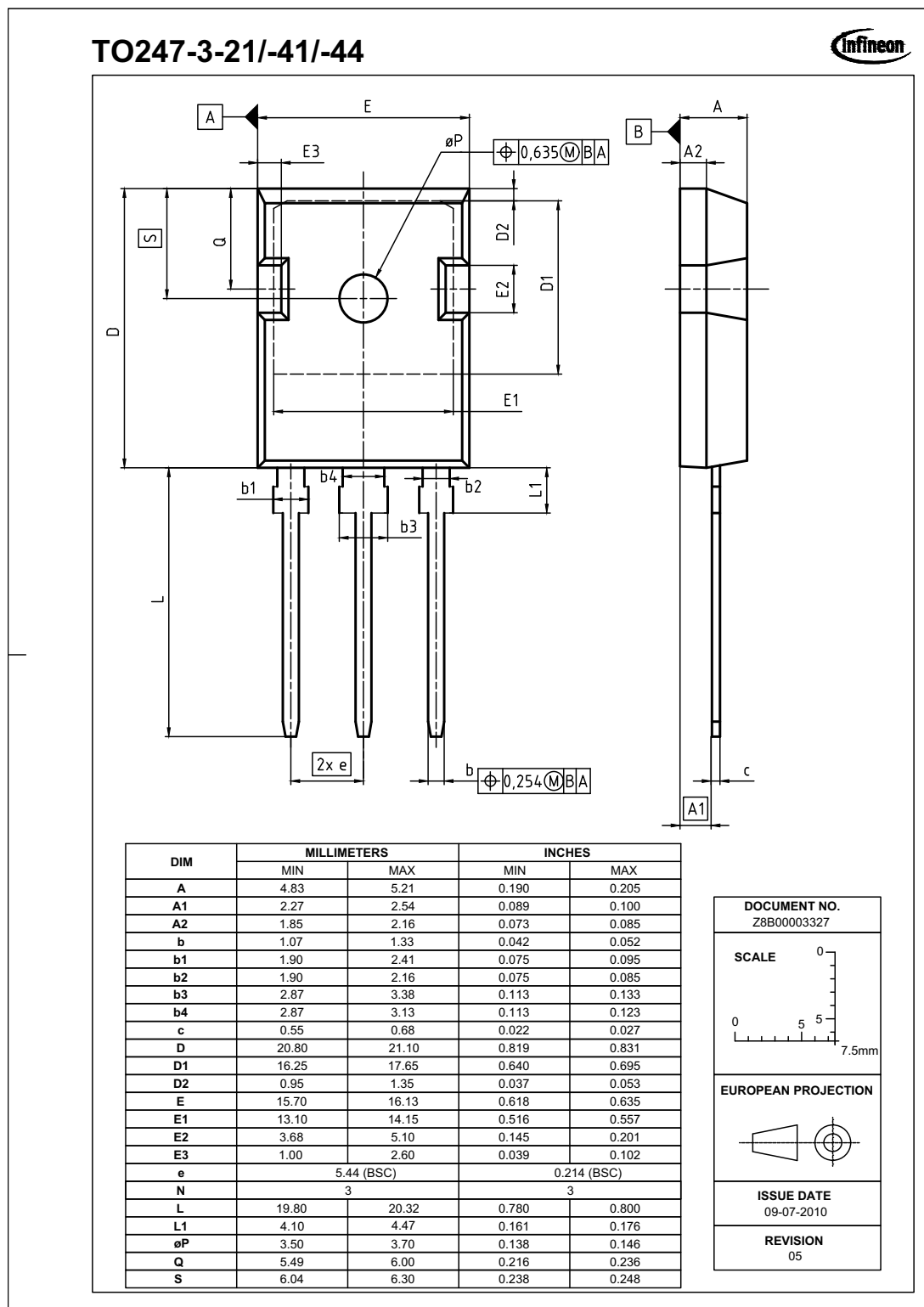


Figure 6 Outlines TO-247, dimensions in mm/inches

8 Revision History

Revision History: 2011-02-01, Rev. 2.0

Previous Revision:

Revision	Subjects (major changes since last revision)
2.0	Release of final data sheet

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