Never stop thinking

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS CFD

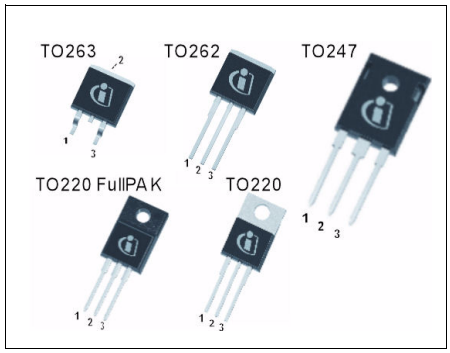
650V CoolMOS™ CFD Power Transistor
IPx65R660CFD

Data Sheet

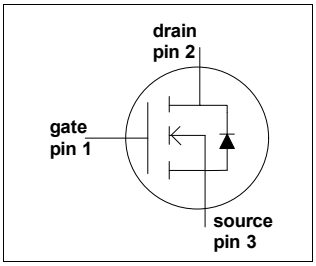
Rev. 2.0, 2011-02-01
Final

Industrial & Multimarket

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 Rdson*Qg and Eoss
- Easy to use/drive
- Qualified for industrial grade applications according to JEDEC[1)]
- 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.

RoHS

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
IPB65R660CFD	PG-TO263		IFX Design tools
IPP65R660CFD	PG-TO220		
IPA65R660CFD	PG-TO220 FullPAK		
IPI65R660CFD	PG-TO262		
IPW65R660CFD	PG-TO247		

1) J-STD20 and JESD22

Table of Contents

2 Maximum ratings

at T_j = 25 °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 °C
				3.8		T_C= 100°C
Pulsed drain current[2]	$I_{D,pulse}$	-	-	17	A	T_C=25 °C
Avalanche energy, single pulse	E_{AS}	-	-	115	mJ	I_D=1.2 A, V_{DD}=50 V
Avalanche energy, repetitive	E_{AR}	-	-	0.21		I_D=1.2 A, V_{DD}=50 V
Avalanche current, repetitive	I_{AR}	-	-	1.2	A	
MOSFET dv/dt ruggedness	dv/dt	-	-	50	V/ns	V_{DS}=0...480 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 °C
Power dissipation for FullPAK	P_{tot}	-	-	28	W	T_C=25 °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 °C
Diode pulse current[2]	$I_{S,pulse}$	-	-	17	A	T_C=25 °C
Reverse diode dv/dt[3]	dv/dt	-	-	15	V/ns	V_{DS}=0...480 V, $I_{SD} \leq I_D$, T_j=125 °C
Maximum diode commutation speed[3]	di_f/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	
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-220FullPAK

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 and TO-252

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- & reflowsoldering allowed	T_{sold}	-	-	260	°C	reflow MSL1

1) Device on 40mm*40mm*1.5 epoxy PCB FR4 with 6cm^2 (one layer, 70µm thick) copper area for drain connection. PCB is vertical without air stream cooling.

4 Electrical characteristics

Electrical characteristics, at Tj=25 °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 V, I_D=1.0 mA
Gate threshold voltage	$V_{GS(th)}$	3.5	4	4.5		V_{DS}=V_{GS}, I_D=0.21 mA
Zero gate voltage drain current	I_{DSS}	-	-	5	µA	V_{DS}=600 V, V_{GS}=0 V, T_j=25 °C
		-	600	-		V_{DS}=600 V, V_{GS}=0 V, T_j=150 °C
Gate-source leakage current	I_{GSS}	-	-	100	nA	V_{GS}=20 V, V_{DS}=0 V
Drain-source on-state resistance	$R_{DS(on)}$	-	0.59	0.66	Ω	V_{GS}=10 V, I_D=2.1 A, T_j=25 °C
		-	1.54	-		V_{GS}=10 V, I_D=2.1 A, T_j=150 °C
Gate resistance	R_G	-	6.5	-	Ω	f=1 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 V, V_{DS}=100 V, f=1 MHz
Output capacitance	C_{oss}	-	33	-		
Effective output capacitance, energy related[1)]	$C_{o(er)}$	-	21	-		V_{GS}=0 V, V_{DS}=0...480 V
Effective output capacitance, time related[2)]	$C_{o(tr)}$	-	88	-		I_D=constant, V_{GS}=0 V V_{DS}=0...480V
Turn-on delay time	$t_{d(on)}$	-	9	-	ns	V_{DD}=400 V, V_{GS}=13 V, I_D=3.2A, R_G= 6.8 Ω
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 V, I_D=3.2 A, V_{GS}=0 to 10 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 V, I_F=3.2 A, T_j=25 °C
Reverse recovery time	t_{rr}	-	65	-	ns	V_R=400 V, I_F=3.2 A, di_F/dt=100 A/µs
Reverse recovery charge	Q_{rr}	-	0.20	-	µC	
Peak reverse recovery current	I_{rrm}	-	4.5	-	A	

5 Electrical characteristics diagrams

Table 10

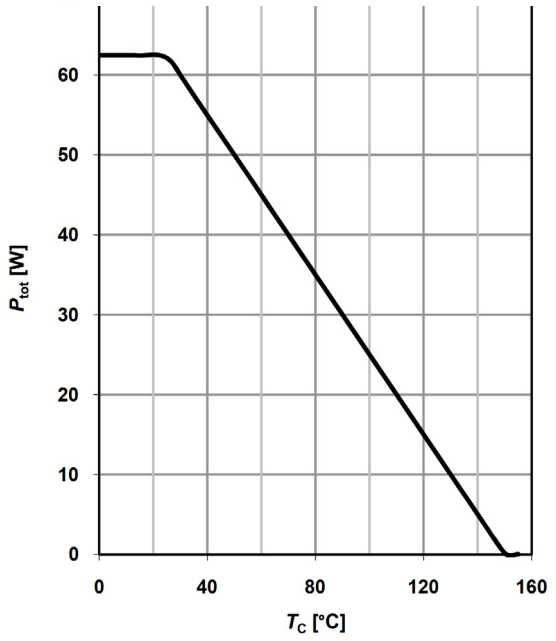
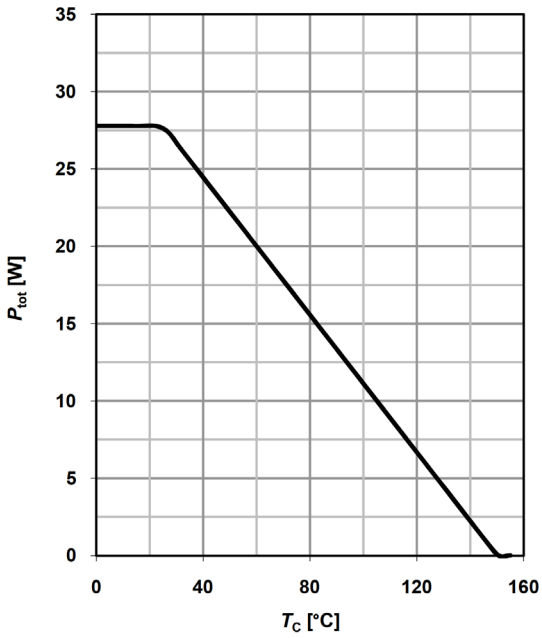
Power dissipation Non FullPAK	Power dissipation FullPAK
	
$P_{tot} = f(T_C)$	$P_{tot} = f(T_C)$

Table 11

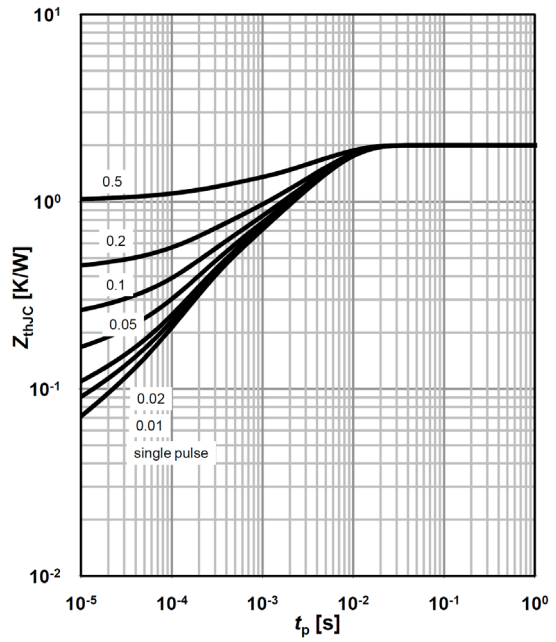
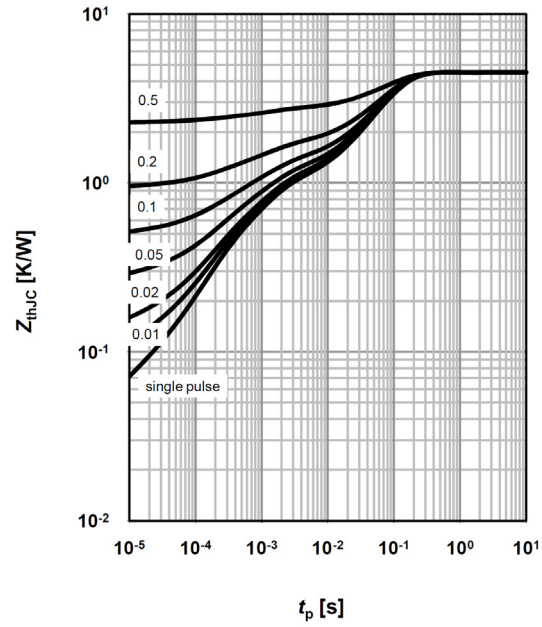
Max. transient thermal impedance Non FullPAK	Max. transient thermal impedance FullPAK
	
$Z_{(thJC)}$=f(tp); parameter: D=t_p/T	$Z_{(thJC)}$=f(tp); parameter: D=t_p/T

Table 12

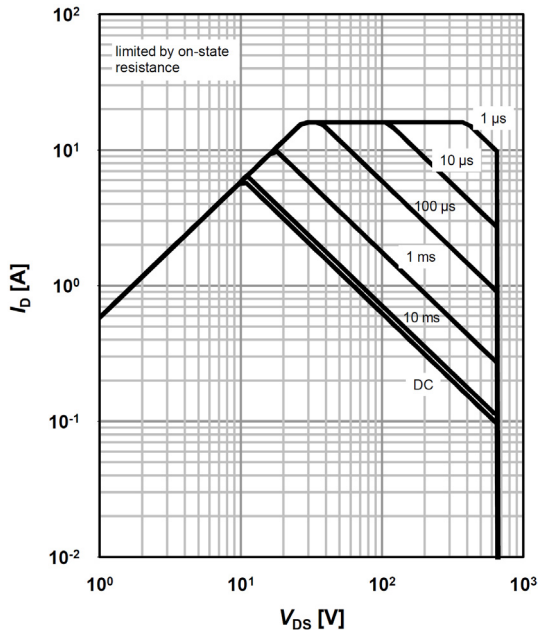
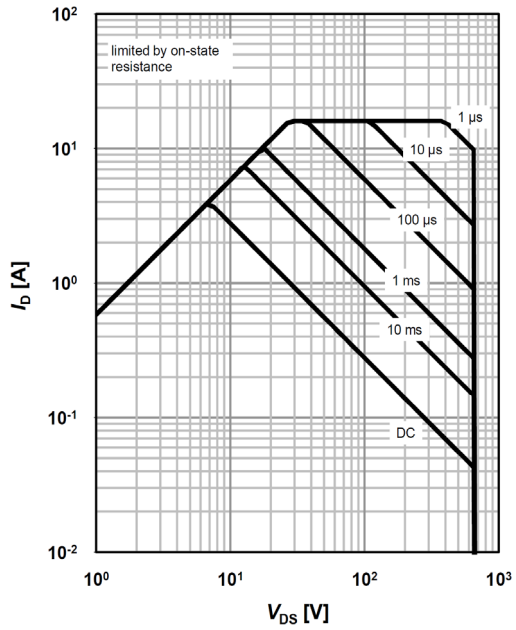
Safe operating area T_C=25 °C Non FullPAK	Safe operating area T_C=25 °C FullPAK
	
I_D=f(V_{DS}); T_C=25 °C; V_{GS} > 7.5V; D=0; parameter t_p	I_D=f(V_{DS}); T_C=25 °C; V_{GS} > 7.5V; D=0; parameter t_p

Table 13

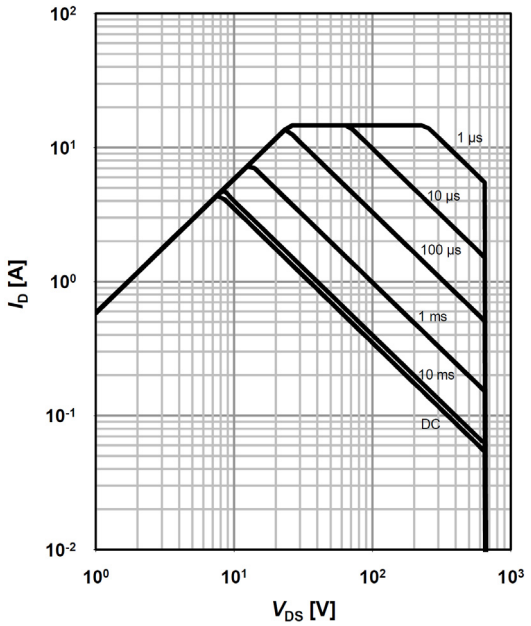
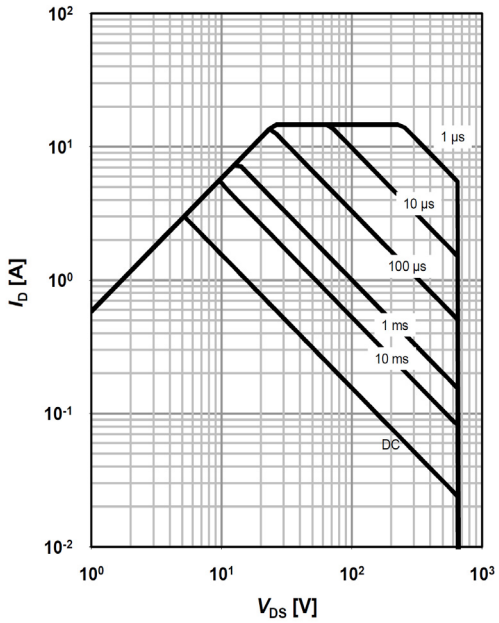
Safe operating area T_C=80 °C Non FullPAK	Safe operating area T_C=80 °C FullPAK
	
I_D=f(V_{DS}); T_C=80 °C; V_{GS} > 7.5V; D=0; parameter t_p	I_D=f(V_{DS}); T_C=80 °C; V_{GS} > 7.5V; D=0; parameter t_p

Table 14

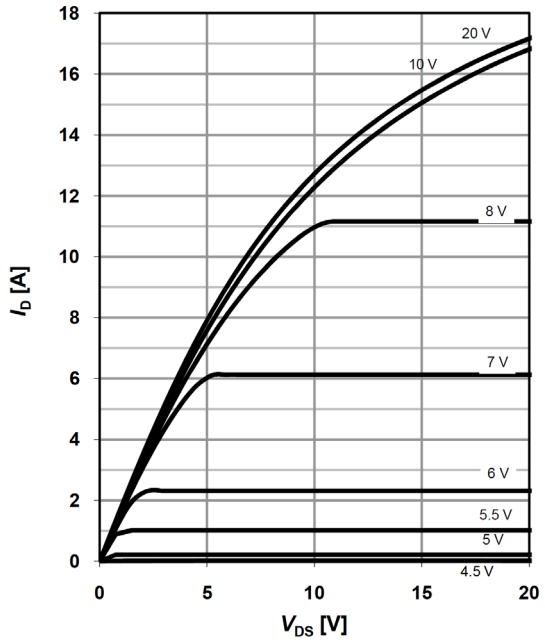
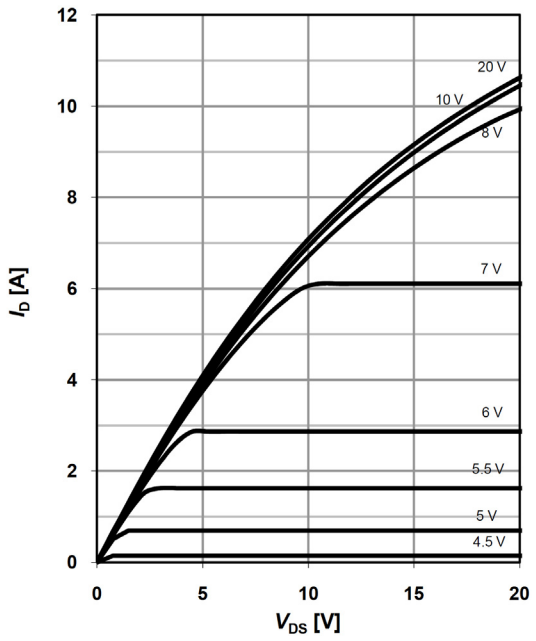
Typ. output characteristics T_j=25 °C	Typ. output characteristics T_j=125 °C
	
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}	I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

Table 15

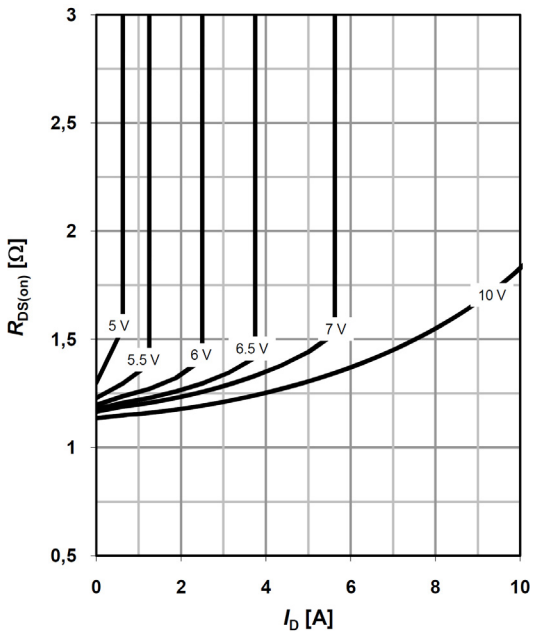
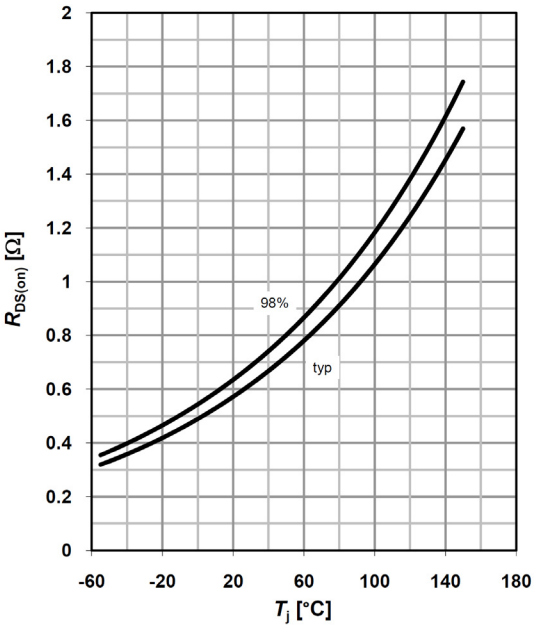
Typ. drain-source on-state resistance	Drain-source on-state resistance
	
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}	$R_{DS(on)}$=f(T_j); I_D=2.1 A; V_{GS}=10 V

Table 16

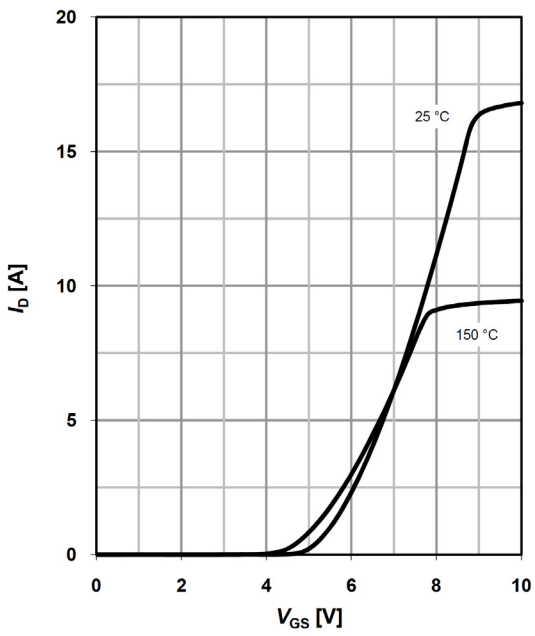
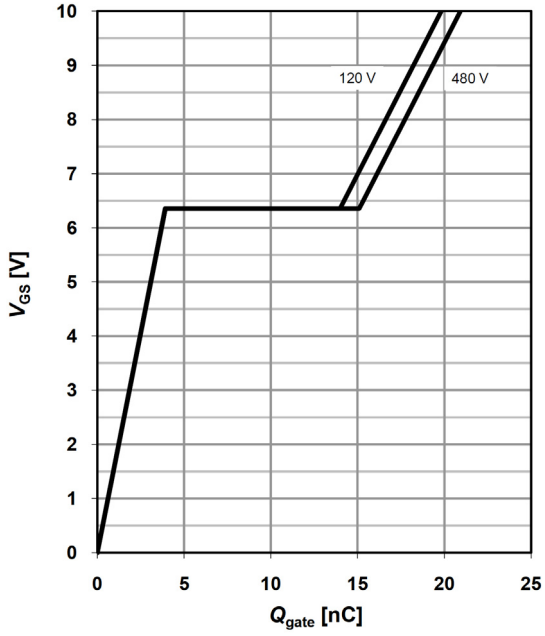
Typ. transfer characteristics	Typ. gate charge
	
I_D=f(V_{GS}); V_{DS}=20V	V_{GS}=f(Q_{gate}), I_D=3.2 A pulsed

Table 17

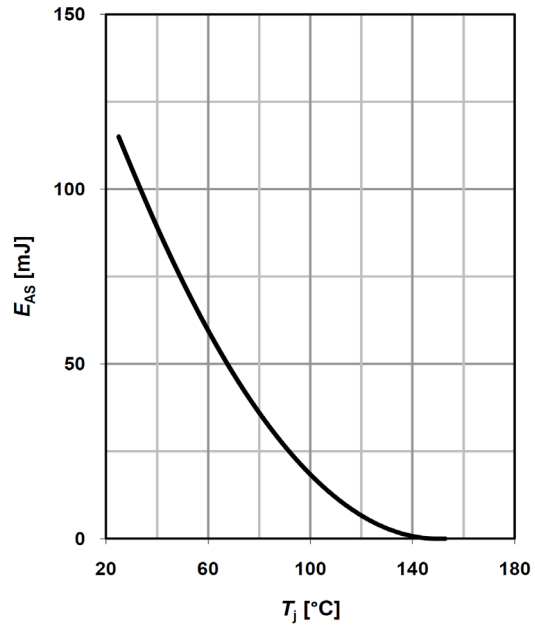
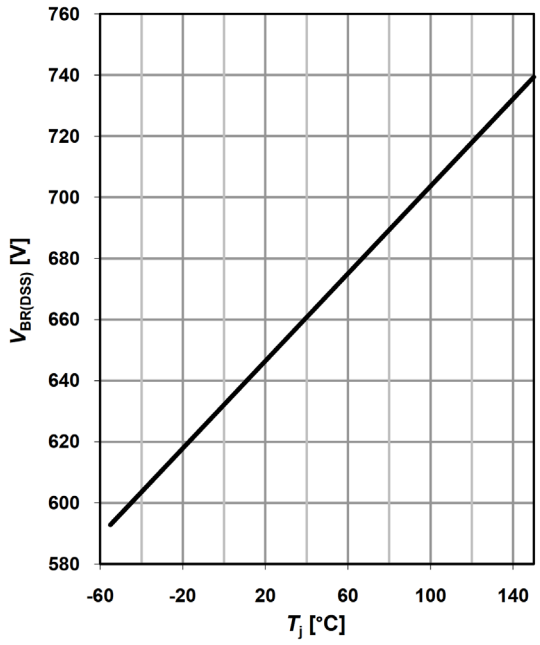
Avalanche energy	Drain-source breakdown voltage
	
E_{AS}=f(T_j); I_D=1.2 A; V_{DD}=50 V	$V_{BR(DSS)}$=f(T_j); I_D=1.0 mA

Table 18

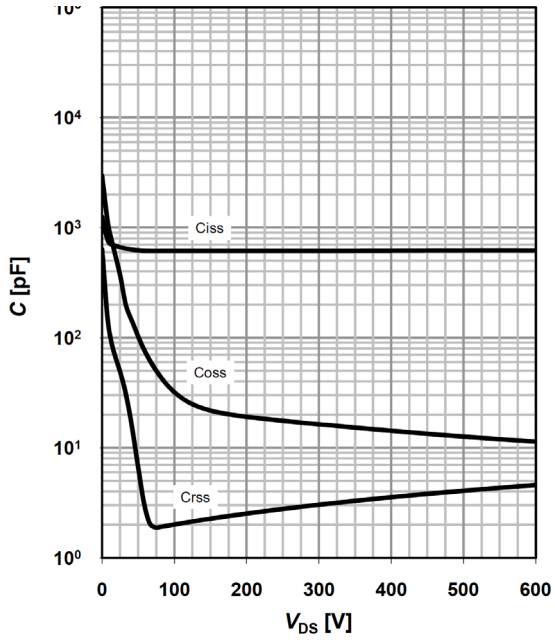
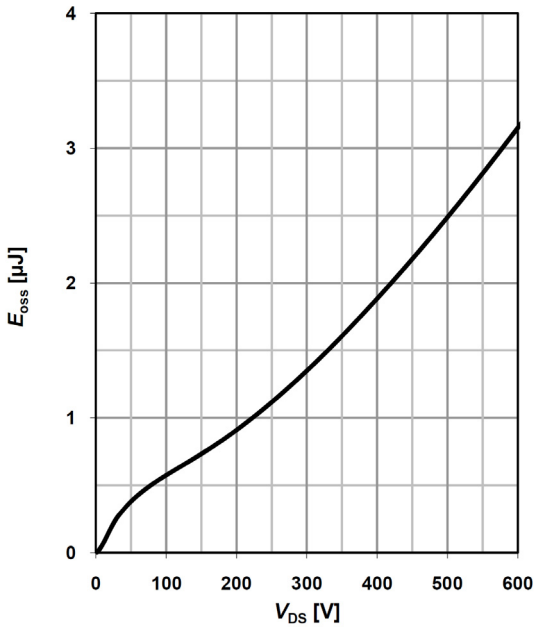
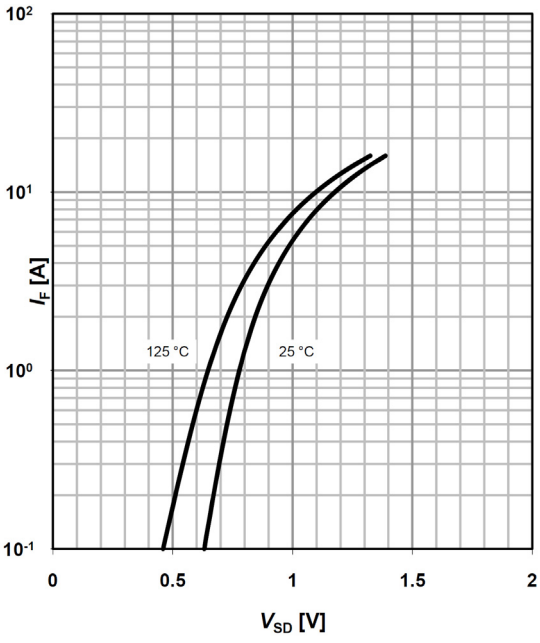
Typ. capacitances	Typ. C_{oss} stored energy
	
C=f(V_{DS}); V_{GS}=0 V; f=1 MHz	E_{oss}=f(V_{DS})

Table 19

Forward characteristics of reverse diode

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

6 Test circuits

Table 20 Switching times test circuit and waveform for inductive load

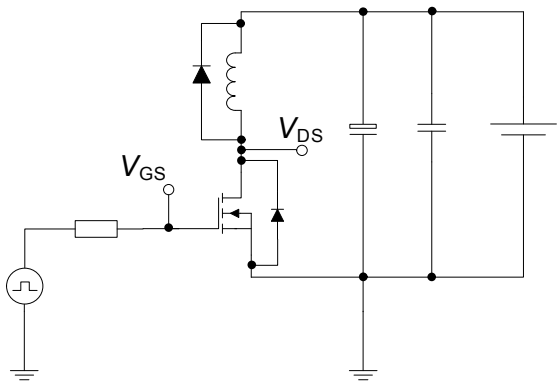
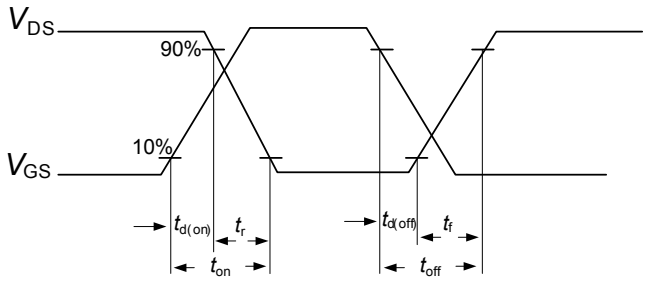
Switching times test circuit for inductive load	Switching time waveform
	

Table 21 Unclamped inductive load test circuit and waveform

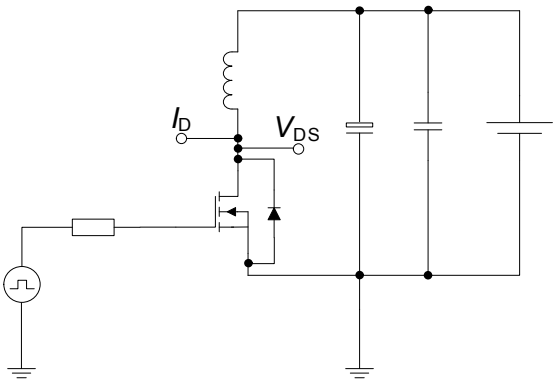
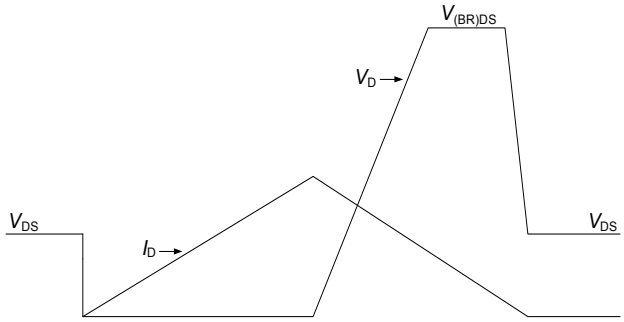
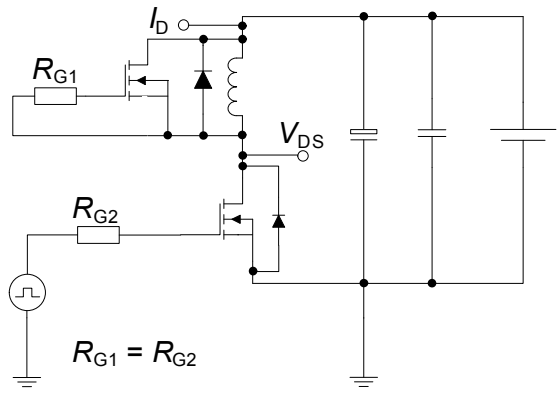
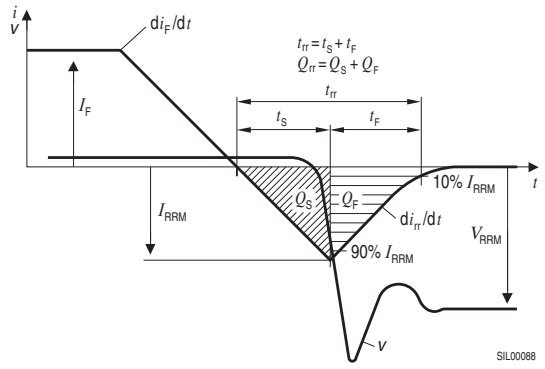
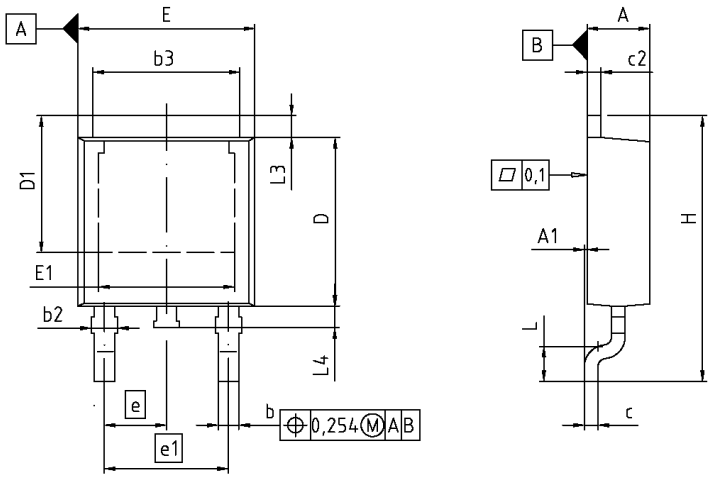
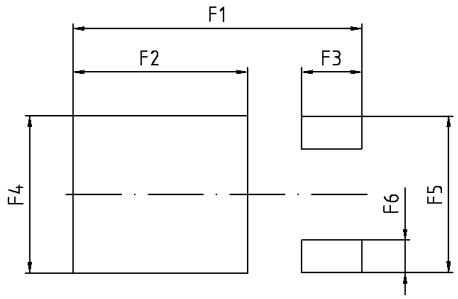
Unclamped inductive load test circuit	Unclamped inductive waveform
	

Table 22 Test circuit and waveform for diode characteristics

Test circuit for diode characteristics	Diode recovery waveform
	

7 Package outlines





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

DOCUMENT NO.
Z8B00003328

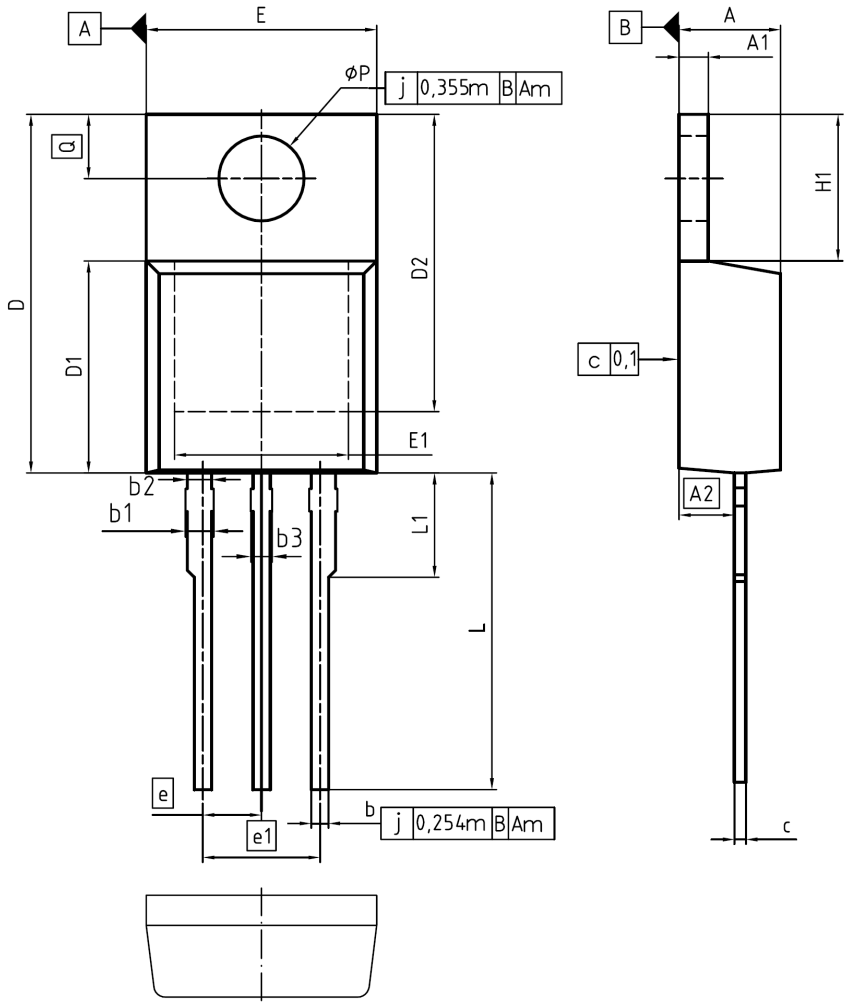
SCALE 0 2.0 0 2.0 4mm

EUROPEAN PROJECTION

ISSUE DATE
19-10-2007

REVISION
03

Figure 1 Outlines TO-252, 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

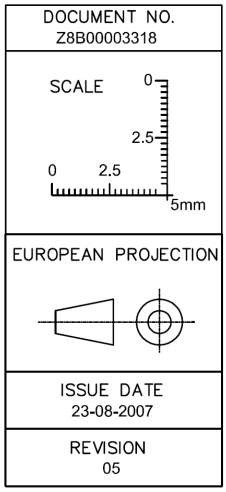
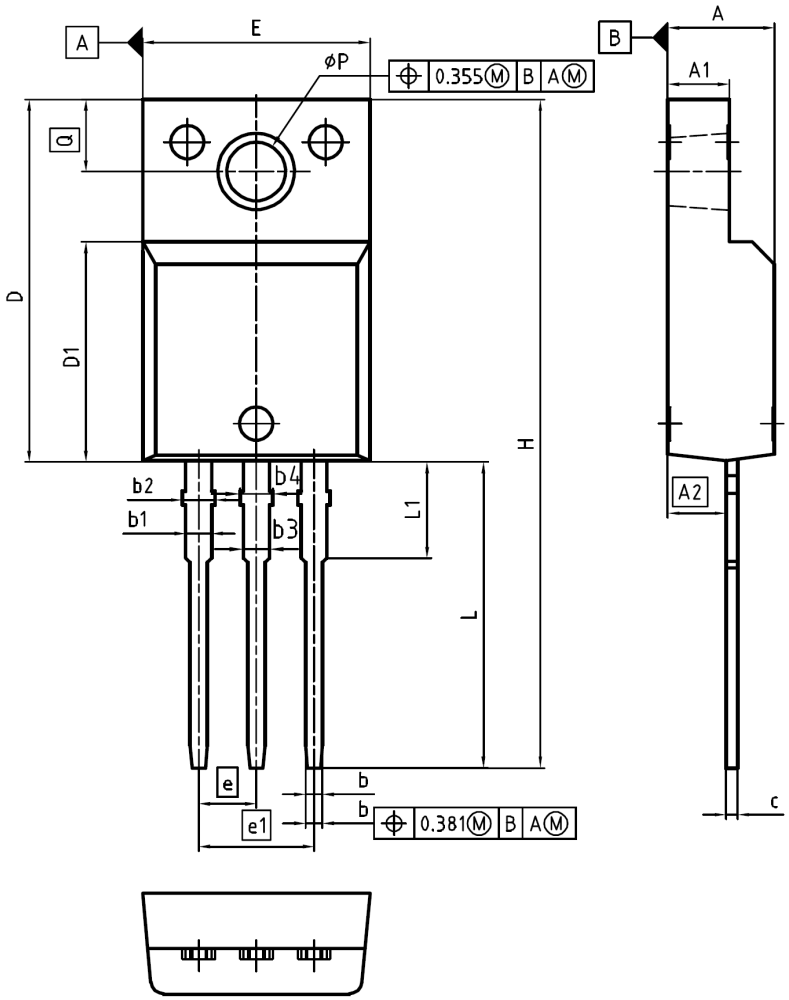


Figure 2 Outlines TO-220, dimensions in mm/inches



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

DOCUMENT NO.
Z8B00003319

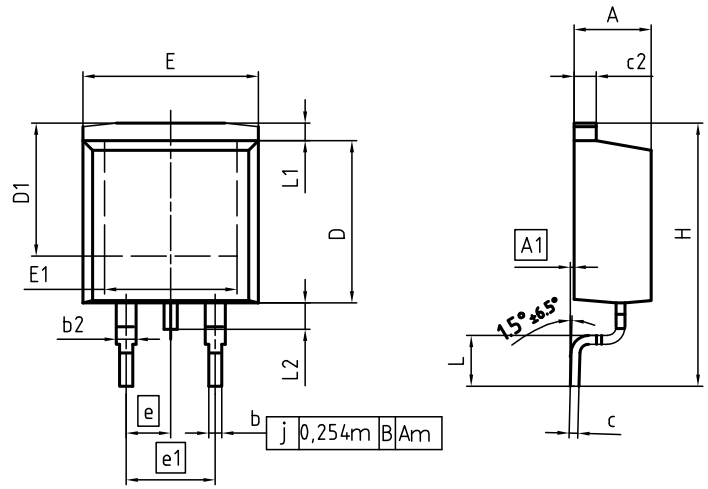
SCALE 0 2.5 0 2.5 5mm

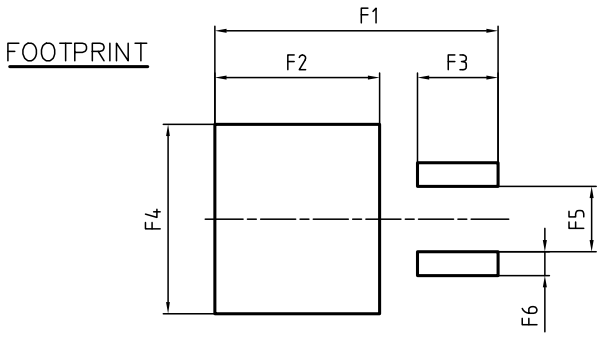
EUROPEAN PROJECTION

ISSUE DATE
08-03-2007

REVISION
03

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

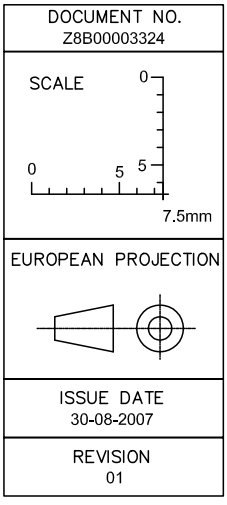
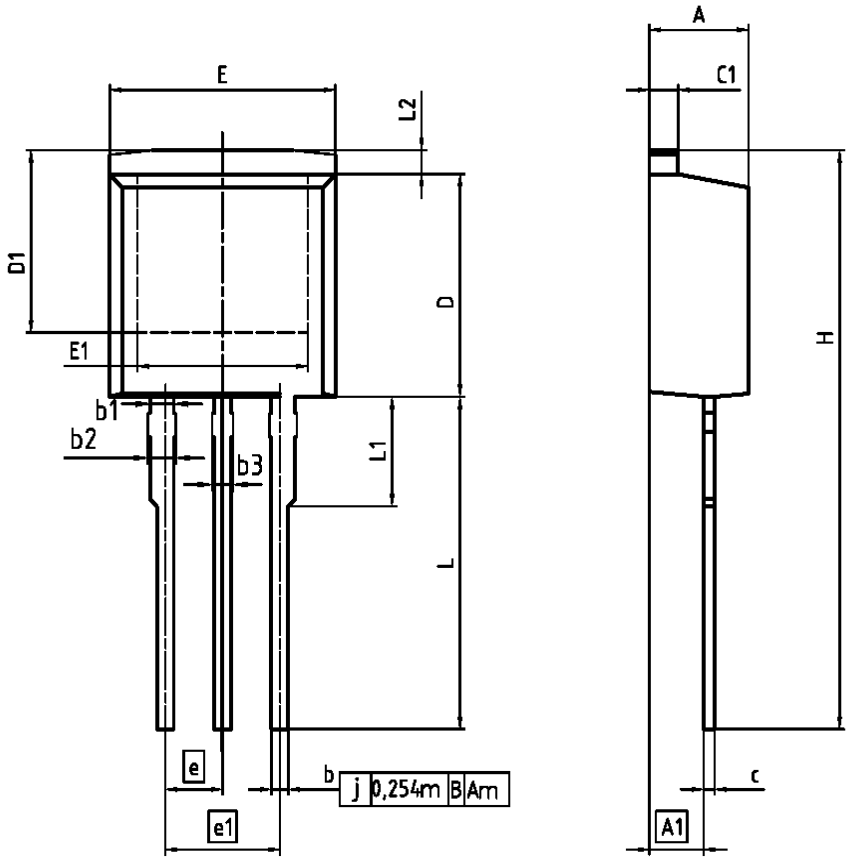


Figure 4 Outlines TO-263, dimensions in mm/inches



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	0.650	0.864	0.026	0.034
b1	0.950	1.093	0.037	0.043
b2	0.950	1.400	0.037	0.055
b3	0.650	1.118	0.026	0.044
c	0.330	0.600	0.013	0.024
c1	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	10.363	0.382	0.408
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

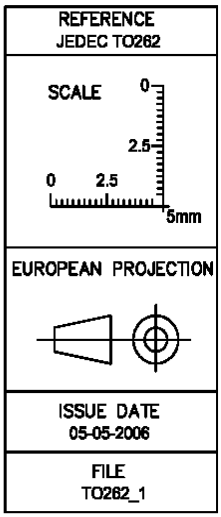
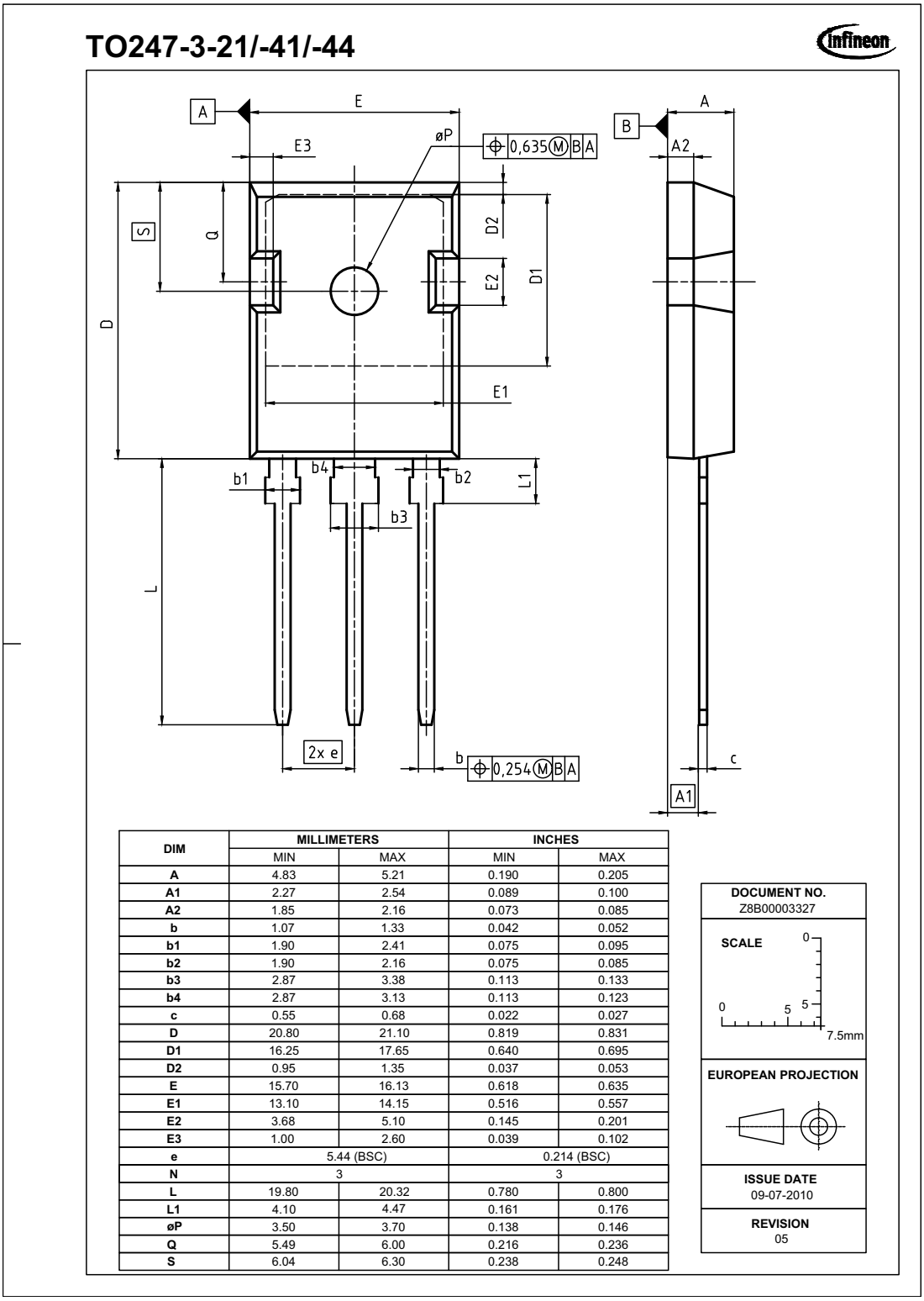


Figure 5 Outlines TO-262, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
øP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

DOCUMENT NO.
Z8B00003327

SCALE
0 5 5 7.5mm

EUROPEAN PROJECTION

ISSUE DATE
09-07-2010

REVISION
05

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

We Listen to Your Comments

Any information within this document that you feel is wrong, unclear or missing at all?
Your feedback will help us to continuously improve the quality of this document.
Please send your proposal (including a reference to this document) to: **erratum@infineon.com**

Edition 2011-02-01

Published by
Infineon Technologies AG
81726 Munich, Germany

Legal Disclaimer

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics. With respect to any examples or hints given herein, any typical values stated herein and/or any information regarding the application of the device, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation, warranties of non-infringement of intellectual property rights of any third party.

Information

For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office (**www.infineon.com**).

Warnings

Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.

The Infineon Technologies component described in this Data Sheet may be used in life-support devices or systems and/or automotive, aviation and aerospace applications or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support, automotive, aviation and aerospace device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.