MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ CFD2 650V

650V CoolMOS™ CFD2 Power Transistor
IPx65R110CFD

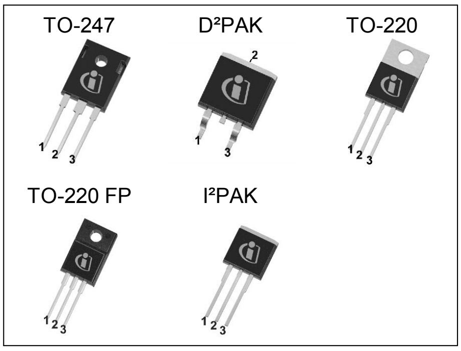
Data Sheet

Rev. 2.6
Final

Industrial & Multimarket

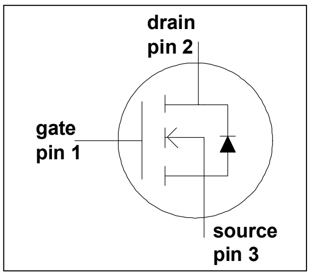
1 Description

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. 650V CoolMOS™ CFD2 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 (J-STD20 and JESD22)
- Pb-free plating, Halogen free mold compound



Applications

650V CoolMOS™ CFD2 is especially suitable for resonant switching PWM stages for e.g. PC Silverbox, LCD TV, Lighting, Server,Telecom and Solar.

Table 1 Key Performance Parameters

Parameter	Value	Unit
V_{DS} @ $T_{j\ max}$	700	V
RDS(on),max	0.11	Ω
Qg,typ	118	nC
ID,pulse	99.6	A
Eoss @ 400V	9.2	µJ
Body diode di/dt	900	A/µs
Qrr	0.8	µC
trr	150	ns
Irrm	8.3	A

Type / Ordering Code	Package	Marking	Related Links
IPW65R110CFD	PG-TO 247	65F6110	see Appendix A
IPB65R110CFD	PG-TO 263		
IPP65R110CFD	PG-TO 220		
IPA65R110CFD	PG-TO 220 FullPAK		
IPI65R110CFD	PG-TO 262		

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			31.2	A	T_C = 25°C
				19.7		T_C = 100°C
Pulsed drain current[2]	$I_{D,pulse}$			99.6	A	T_C = 25°C
Avalanche energy, single pulse	E_{AS}			845	mJ	I_D = 6.2A, V_{DD} = 50V
Avalanche energy, repetitive	E_{AR}			1.30	mJ	I_D = 6.2A, V_{DD} = 50V
Avalanche current, repetitive	I_{AR}			6.2	A	
MOSFET dv/dt ruggedness	dv/dt			50	V/ns	V_{DS} = 0 ... 400V
Gate source voltage	V_{GS}	-20		20	V	static
		-30		30		AC (f > 1 Hz)
Power dissipation (non FullPAK) TO-247, TO-220, I²PAK	P_{tot}			277.8	W	T_C = 25°C
Power dissipation (FullPAK) TO-220 FP	P_{tot}			34.7	W	T_C = 25°C
Operating and storage temperature	T_j, T_{stg}	-55		150	°C	
Mounting torque (non FullPAK) TO-247, TO-220, I²PAK				60	Ncm	M3 and M3.5 screws
Mounting torque (FullPAK) TO-220 FP				50	Ncm	M2.5 screws
Continuous diode forward current	I_S			31.2	A	T_C = 25°C
Diode pulse current	$I_{S,pulse}$			99.6	A	T_C = 25°C
Reverse diode dv/dt[3]	dv/dt			50	V/ns	V_{DS} = 0 ... 400V, $I_{SD} \leq I_D$, T_j = 25°C
Maximum diode commutation speed	di_f/dt			900	A/µs	

[1] Limited by $T_{j\ max}$. Maximum
[2] Pulse width t_p limited by $T_{j\ max}$
[3] V_{peak}<$V_{(BR)DSS}$, T_j<$T_{j\ max}$, identical low side and high side switch with same Rg

3 Thermal characteristics

Table 3 Thermal characteristics TO-247, TO-220, I²PAK

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}			0.45	°C/W	
Thermal resistance, junction - ambient	R_{thJA}			62	°C/W	leaded
Soldering temperature, wavesoldering only allowed at leads	T_{sold}			260	°C	1.6 mm (0.063 in.) from case for 10s

Table 4 Thermal characteristics TO-220 FP

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}			3.6	°C/W	
Thermal resistance, junction - ambient	R_{thJA}			80	°C/W	leaded
Soldering temperature, wavesoldering only allowed at leads	T_{sold}			260	°C	1.6 mm (0.063 in.) from case for 10s

Table 5 Thermal characteristics D²PAK

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}			0.45	°C/W	
Thermal resistance, junction - ambient[1]	R_{thJA}			62	°C/W	SMD version, device on PCB, minimal footprint
			35			SMD version, device on PCB, 6cm² cooling area
Soldering temperature, wave- & reflowsoldering allowed	T_{sold}			260	°C	reflow MSL

[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

at T_j = 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} = 0V, I_D = 1mA
Gate threshold voltage	$V_{GS(th)}$	3.5	4	4.5	V	V_{DS} = V_{GS}, I_D = 1.3mA
Zero gate voltage drain current	I_{DSS}			1.5	µA	V_{DS} = 650V, V_{GS} = 0V, T_j = 25°C
			400			V_{DS} = 650V, V_{GS} = 0V, T_j = 150°C
Gate-source leakage current	I_{GSS}			100	nA	V_{GS} = 20V, V_{DS} = 0V
Drain-source on-state resistance	$R_{DS(on)}$		0.099	0.11	Ω	V_{GS} = 10V, I_D = 12.7A, T_j = 25°C
			0.257			V_{GS} = 10V, I_D = 12.7A, T_j = 150°C
Gate resistance	R_G		1.3		Ω	f = 1MHz, open drain

Table 7 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}		3240		pF	V_{GS} = 0V, V_{DS} = 100V, f = 1MHz
Output capacitance	C_{oss}		160		pF	
Effective output capacitance, energy related[1]	$C_{o(er)}$		118		pF	V_{GS} = 0V, V_{DS} = 0 ... 400V
Effective output capacitance, time related[2]	$C_{o(tr)}$		582		pF	I_D = constant, V_{GS} = 0V, V_{DS} = 0 ... 400V
Turn-on delay time	$t_{d(on)}$		16		ns	V_{DD} = 400V, V_{GS} = 13V, I_D = 19.1A, R_G = 1.8Ω
Rise time	t_r		11		ns	
Turn-off delay time	$t_{d(off)}$		68		ns	
Fall time	t_f		6		ns	

Table 8 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}		21		nC	V_{DD} = 480V, I_D = 19.1A, V_{GS} = 0 to 10V
Gate to drain charge	Q_{gd}		64		nC	
Gate charge total	Q_g		118		nC	
Gate plateau voltage	$V_{plateau}$		6.4		V	

[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 400V
[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 400V

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} = 0V, I_F = 19.1A, T_j = 25°C
Reverse recovery time	t_{rr}		150		ns	V_R = 400V, I_F = 19.1A, di_F/dt = 100A/µs
Reverse recovery charge	Q_{rr}		0.8		µC	
Peak reverse recovery current	I_{rrm}		8.3		A	

5 Electrical characteristics diagrams

Table 10

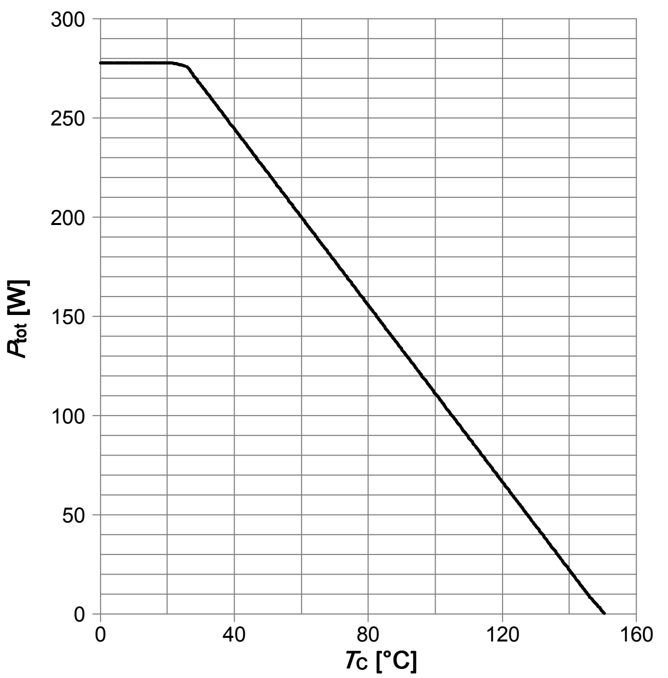
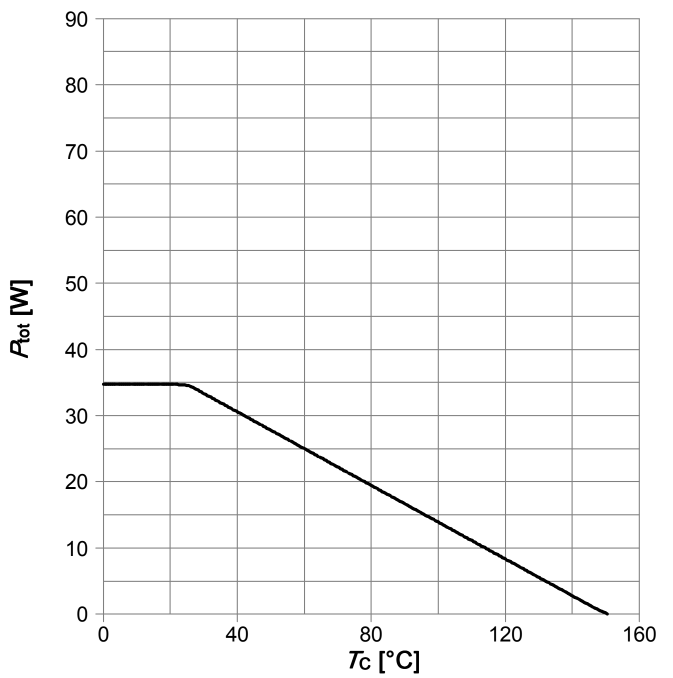
Power dissipation (Non FullPAK)	Power dissipation (FullPAK)
	
P_{tot}=f(T_C)	P_{tot}=f(T_C)

Table 11

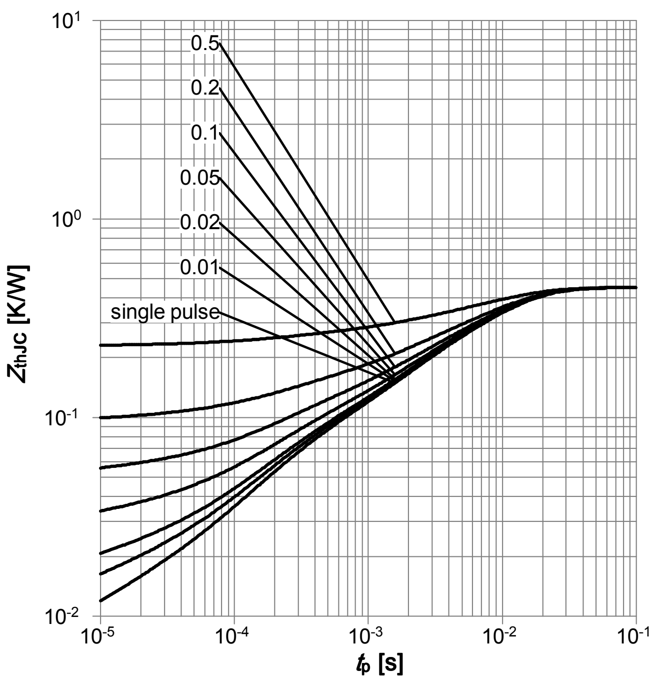
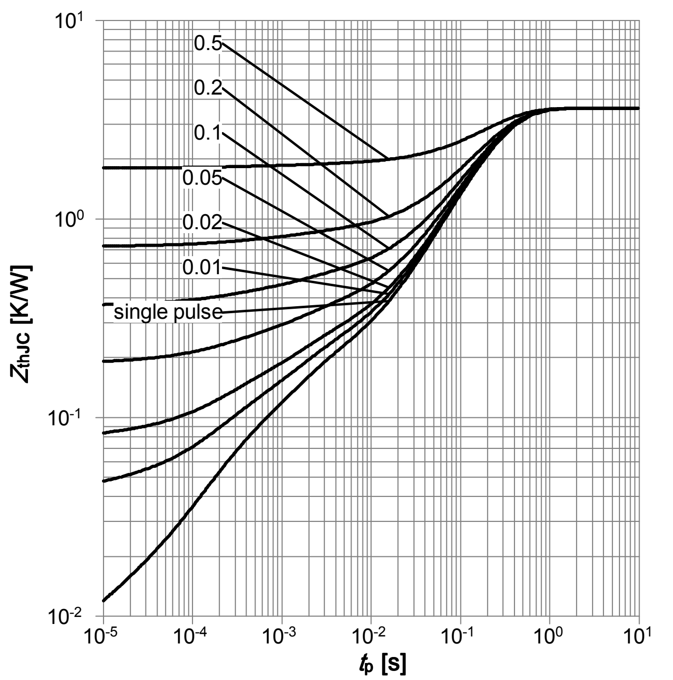
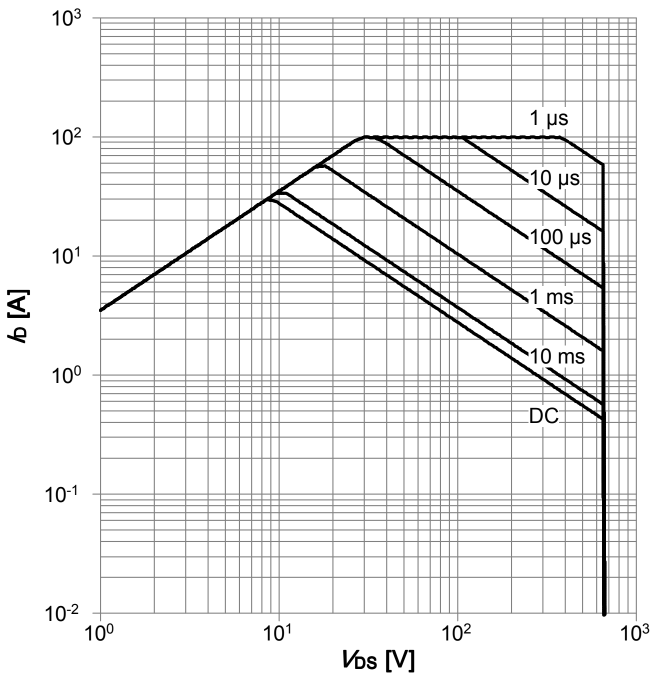
Max. transient thermal impedance (Non FullPAK)	Max. transient thermal impedance (FullPAK)
	
Z_{thJC} =f(t_P); parameter: D=t_p/T	Z_{thJC} =f(t_P); parameter: D=t_p/T

Table 12

<table>
<tr><th>Safe operating area T_C=25°C (Non FullPAK)</th><th>Safe operating area T_C=25°C (FullPAK)</th></tr>
<tr><td>


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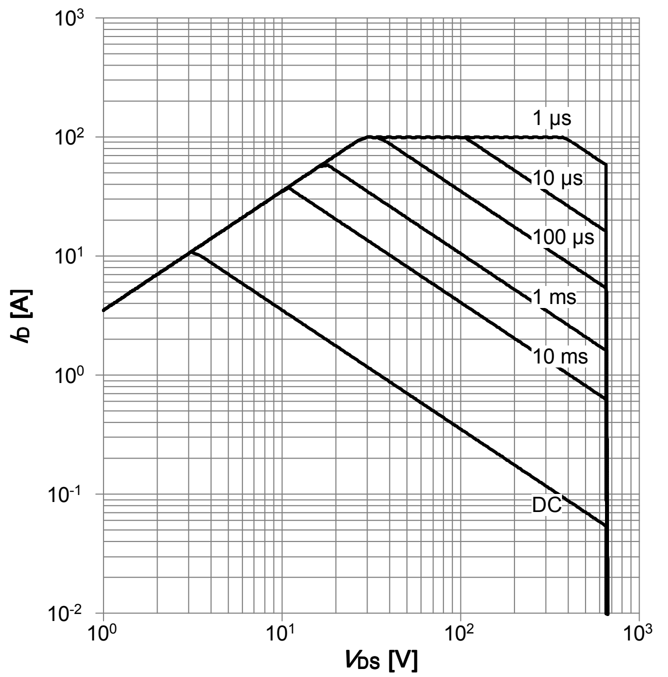

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<tr><td>I_D=f(V_{DS}); T_C=25 °C; D=0; parameter: t_p ; Vgs>7.5V</td><td>I_D=f(V_{DS}); T_C=25 °C; D=0; parameter: t_p ; Vgs>7.5V</td></tr>
</table>

Table 13

<table>
<tr><th>Safe operating area T_C=80°C (Non FullPAK)</th><th>Safe operating area T_C=80°C (FullPAK)</th></tr>
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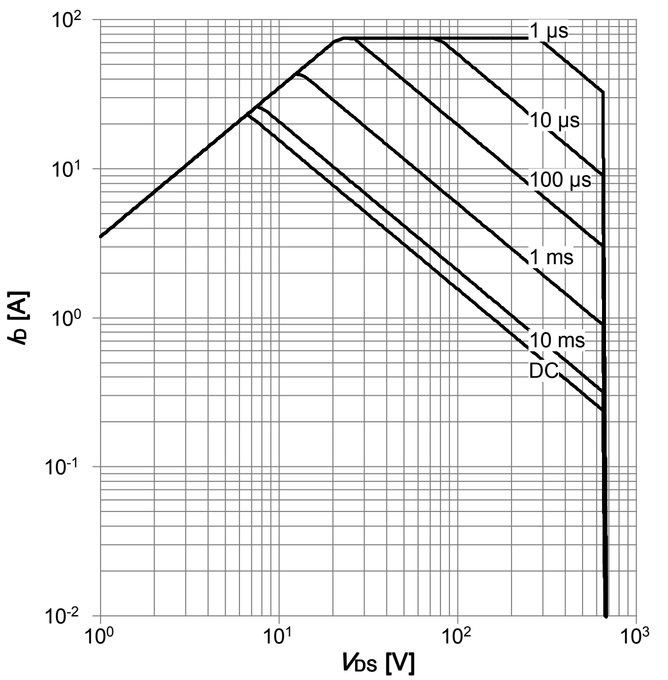

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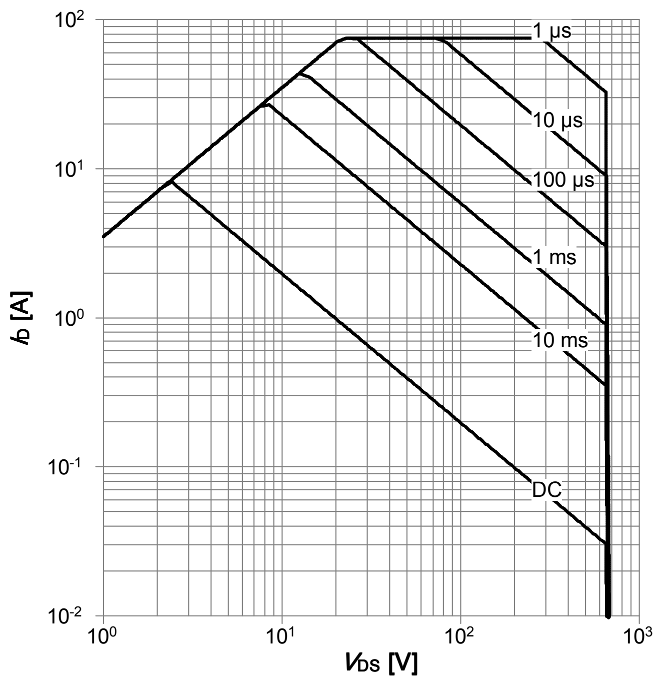

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<tr><td>I_D=f(V_{DS}); T_C=80 °C; D=0; parameter: t_p ; Vgs>7.5V</td><td>I_D=f(V_{DS}); T_C=80 °C; D=0; parameter: t_p ; Vgs>7.5V</td></tr>
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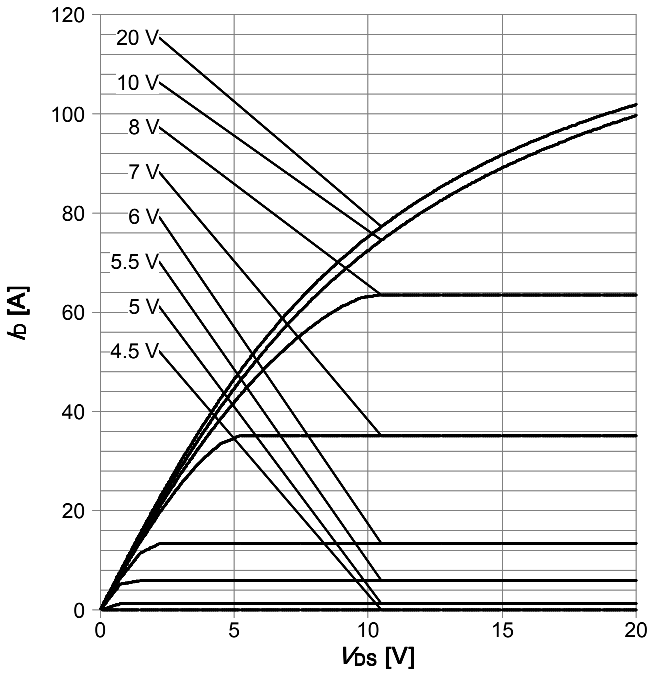
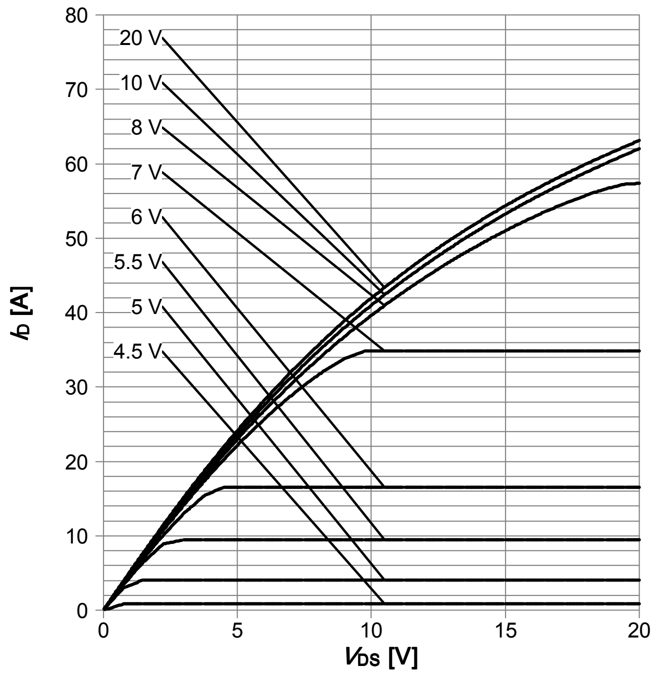
Table 14

Typ. output characteristics T_C=25°C



I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}

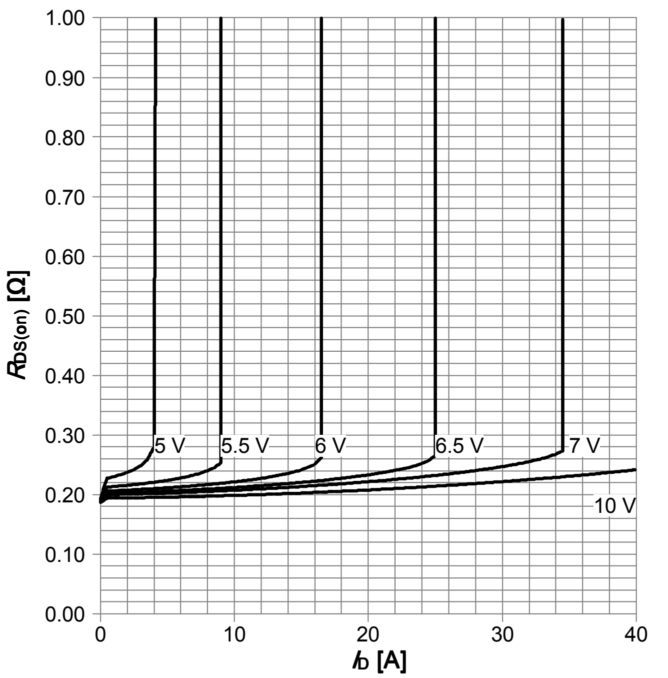
Typ. output characteristics T_C=125°C



I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

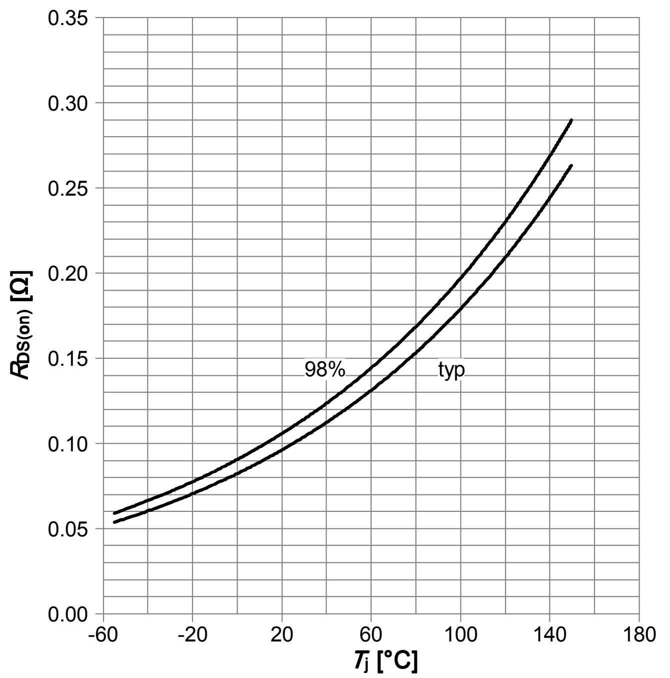
Table 15

Typ. drain-source on-state resistance



$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}

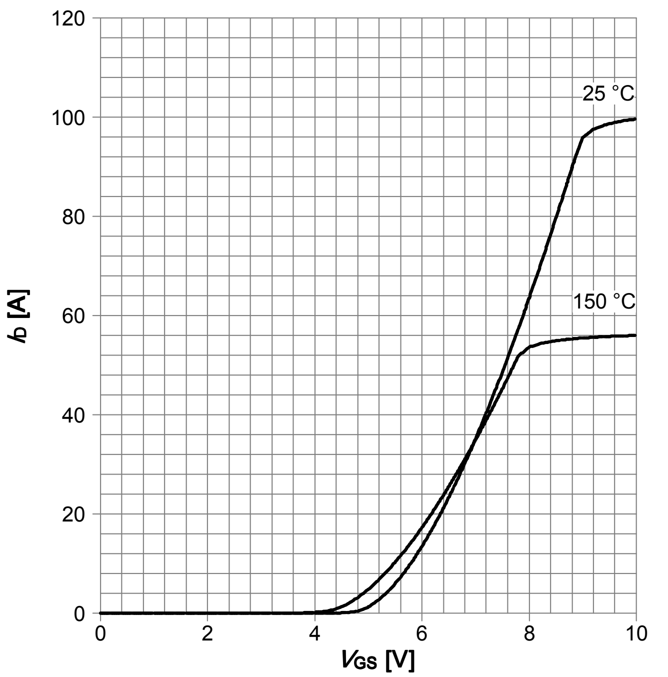
Drain-source on-state resistance



$R_{DS(on)}$=f(T_j); I_D=18.1 A; V_{GS}=10 V

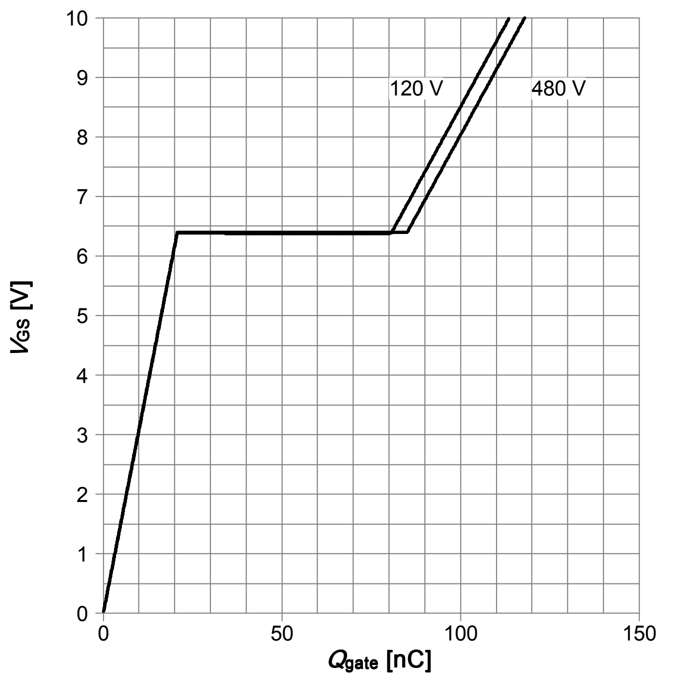
Table 16

Typ. transfer characteristics



I_D=f(V_{GS}); | V_{DS}|=20V;

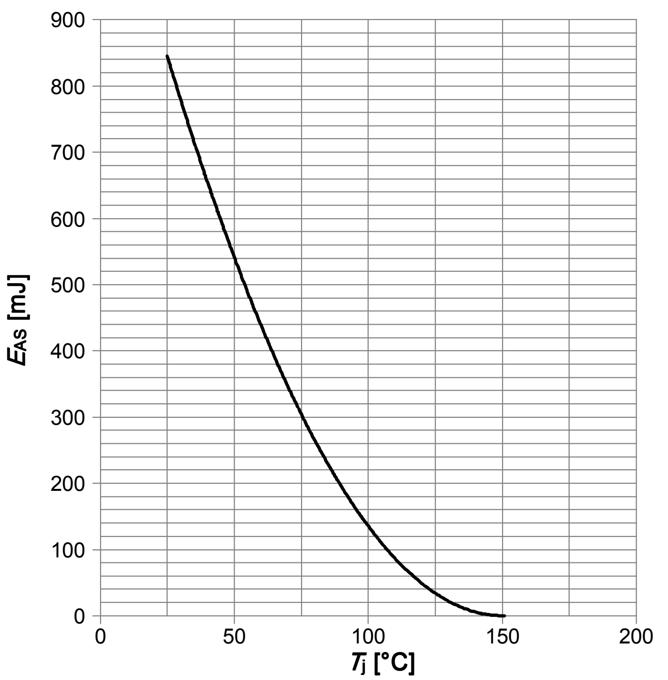
Typ. gate charge



V_{GS}=f(Q_{gate}); I_D=19.2 A pulsed; parameter: V_{DD}

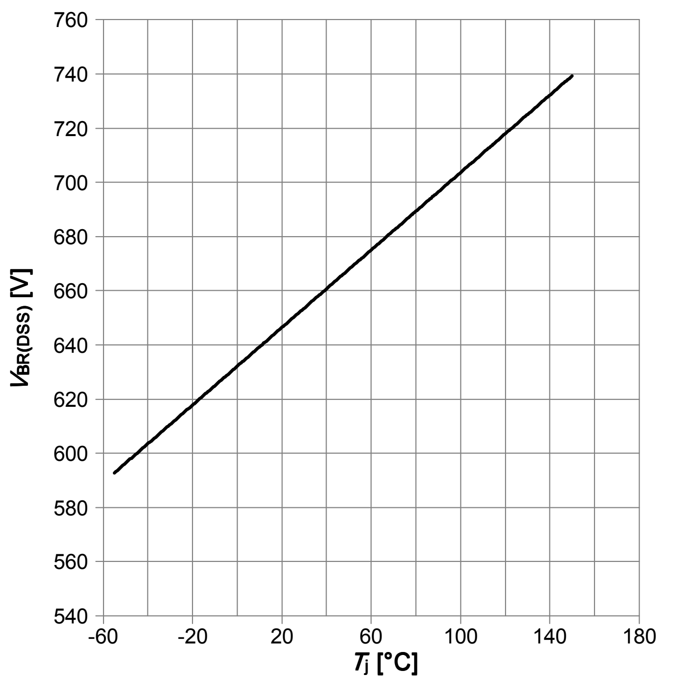
Table 17

Avalanche energy



E_{AS}=f(T_j); I_D=6.2 A; V_{DD}=50 V

Drain-source breakdown voltage



$V_{BR(DSS)}$=f(T_j); I_D=10 mA

Table 18

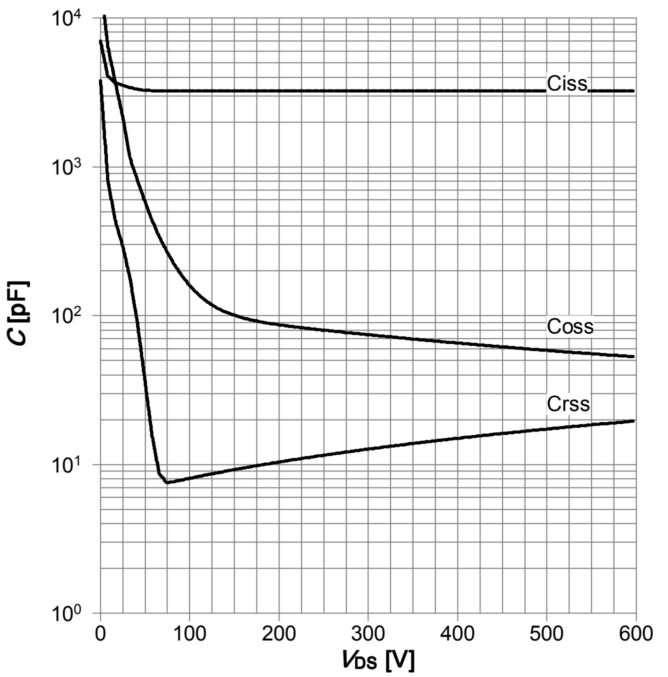
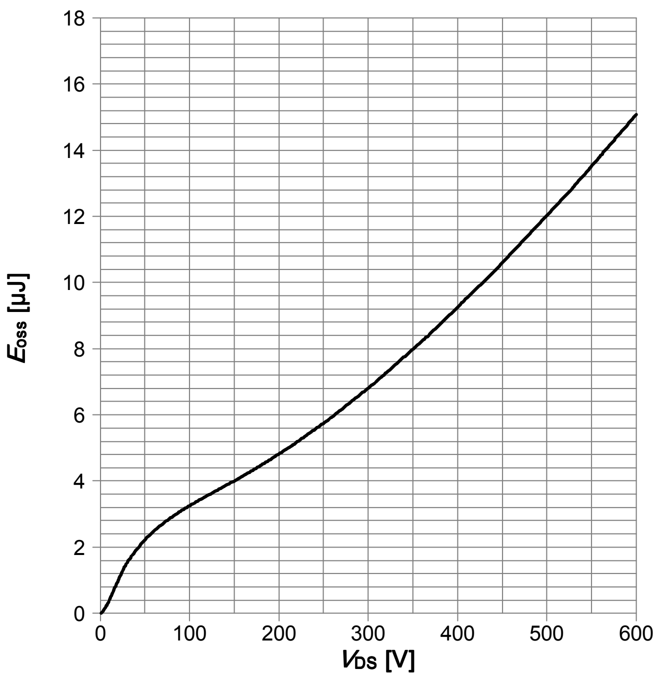
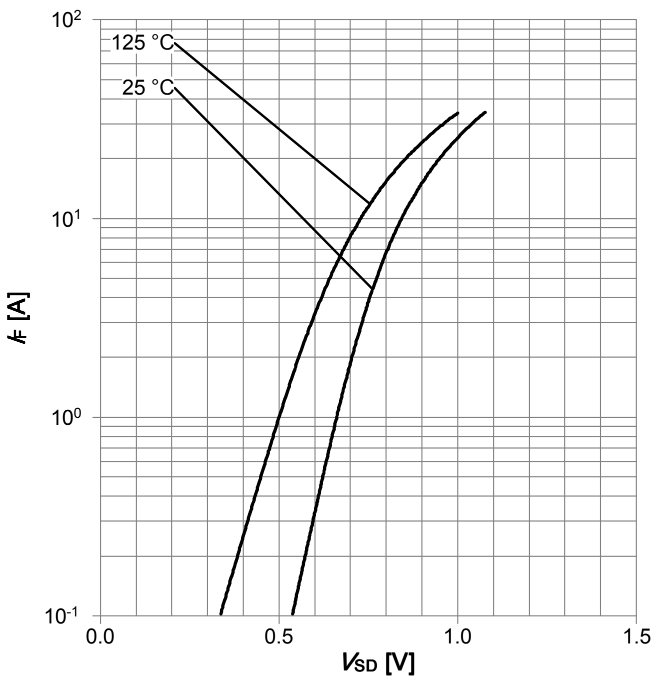
Typ. capacitances	Typ. C_{oss} stored energy
	
C=f(V_{DS}); V_{GS}=0 V; f=1 MHz	E_{oss}=f(V_{DS})

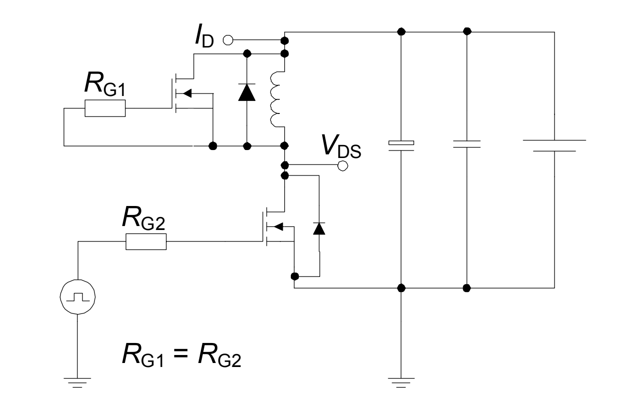
Table 19

Forward characteristics of reverse diode

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

6 Test Circuits

Table 20 Diode_characteristics

Test circuit for diode characteristics	Diode recovery waveform



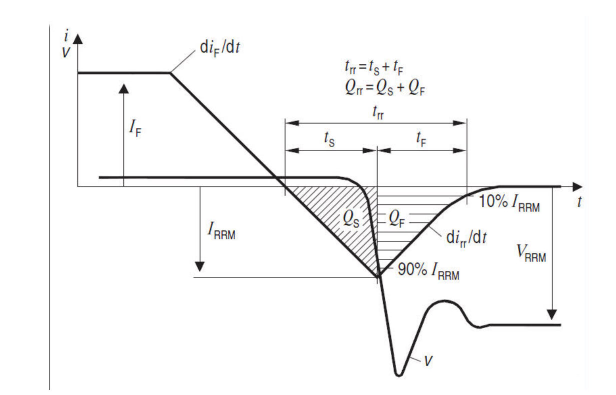
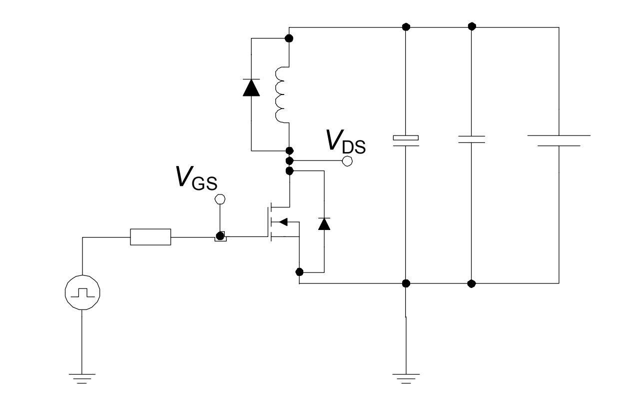


Table 21 Switching_times

Switching times test circuit for inductive load	Switching times waveform



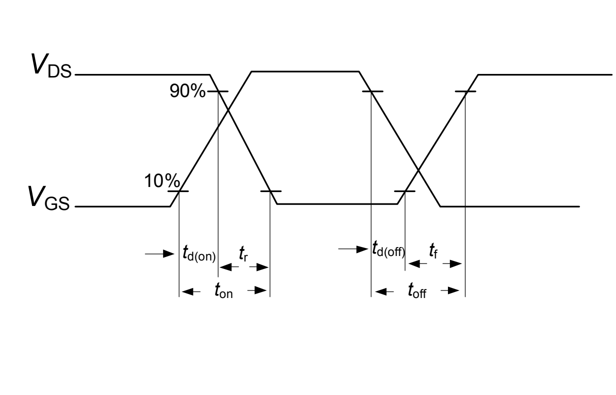
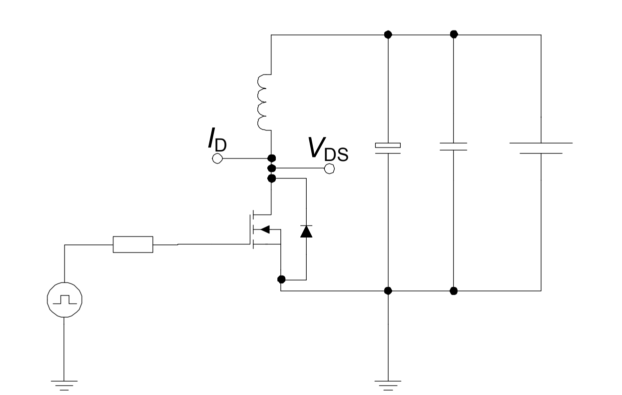
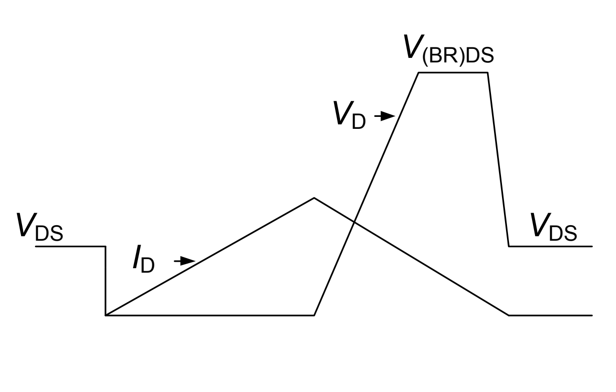


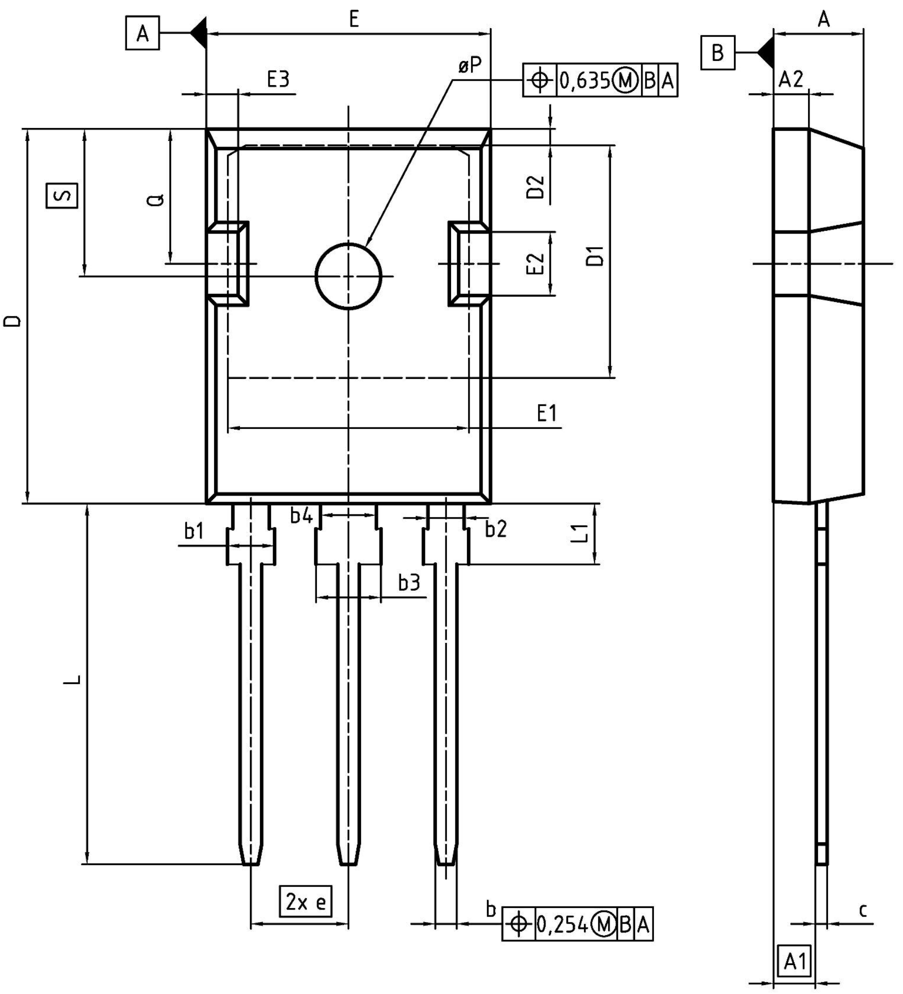
Table 22 Unclamped_inductive

Unclamped inductive load test circuit	Unclamped inductive waveform





7 Package Outlines



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

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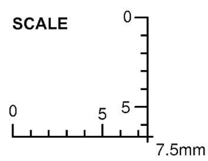
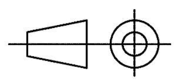


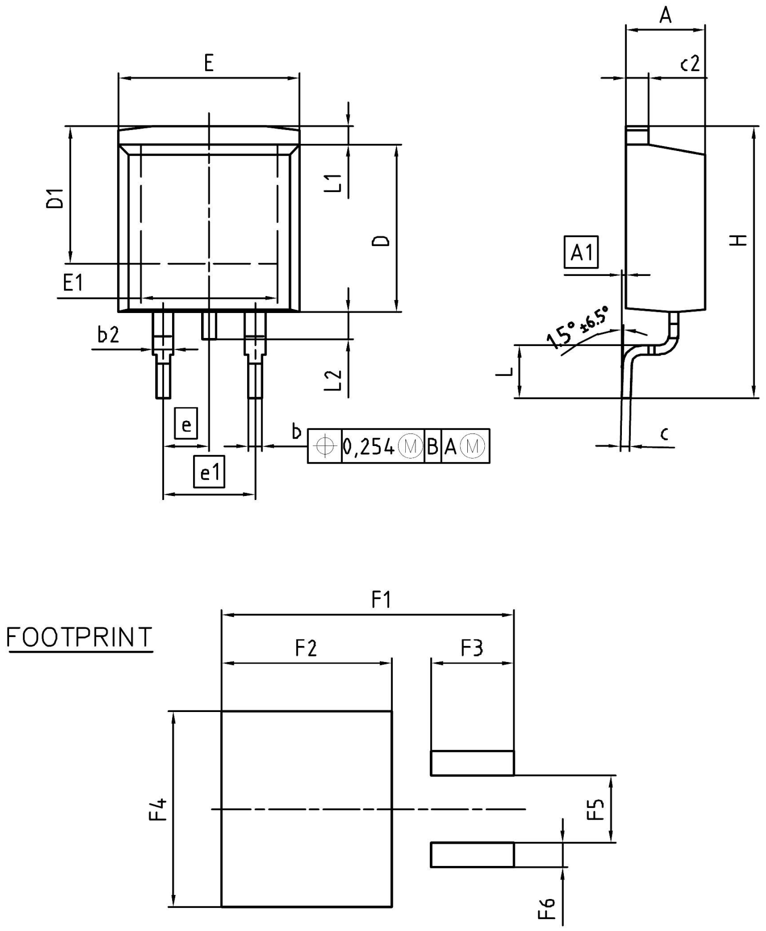
EUROPEAN PROJECTION



ISSUE DATE
09-07-2010

REVISION
05

Figure 1 Outline PG-TO 247, 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

DOCUMENT NO.
Z8B00003324

SCALE 0 5 7.5mm

EUROPEAN PROJECTION

ISSUE DATE
30-08-2007

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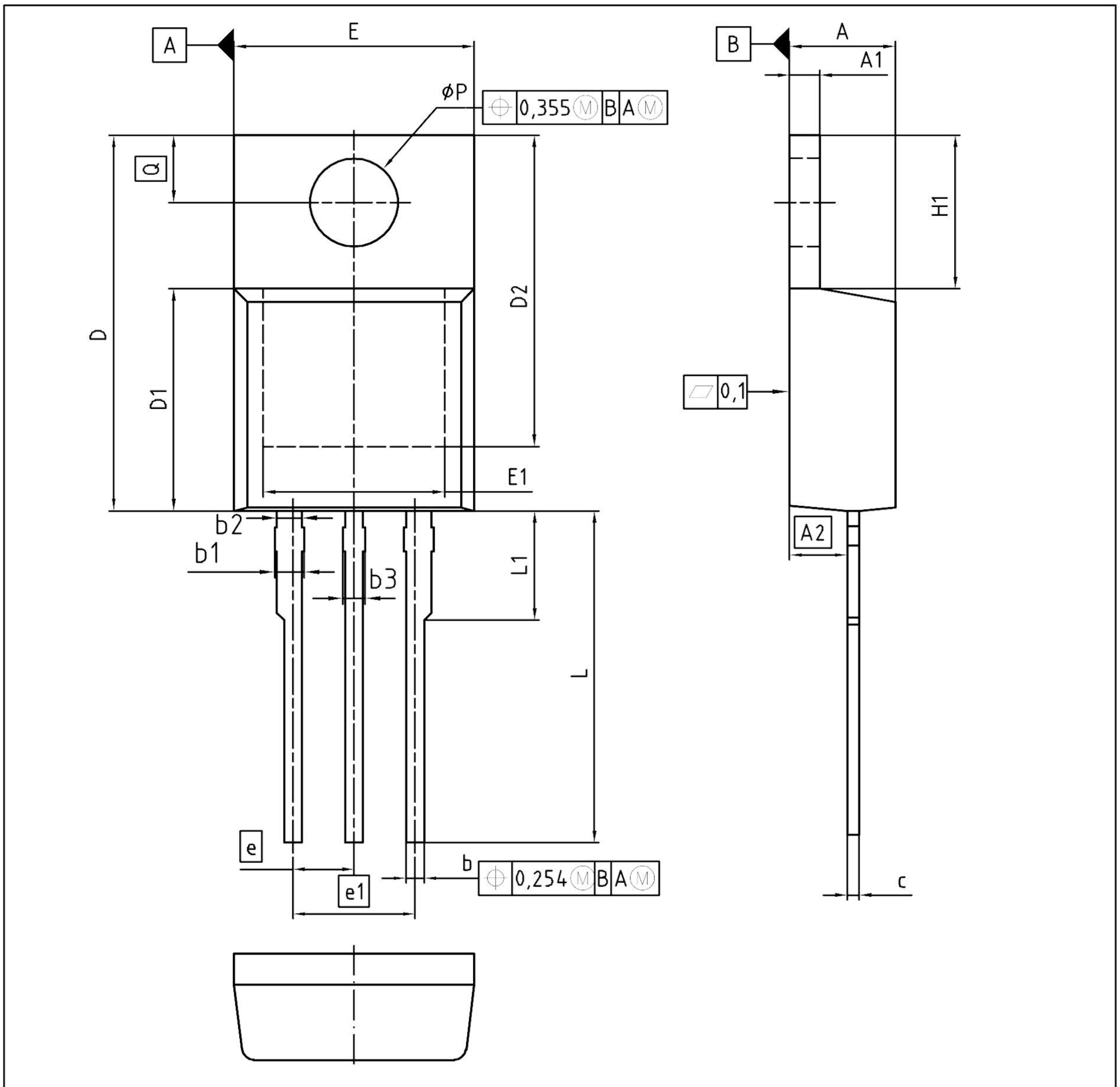
Figure 2 Outline PG-TO 263, dimensions in mm/inches



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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Z8B00003318

SCALE 0 2.5 5mm

EUROPEAN PROJECTION

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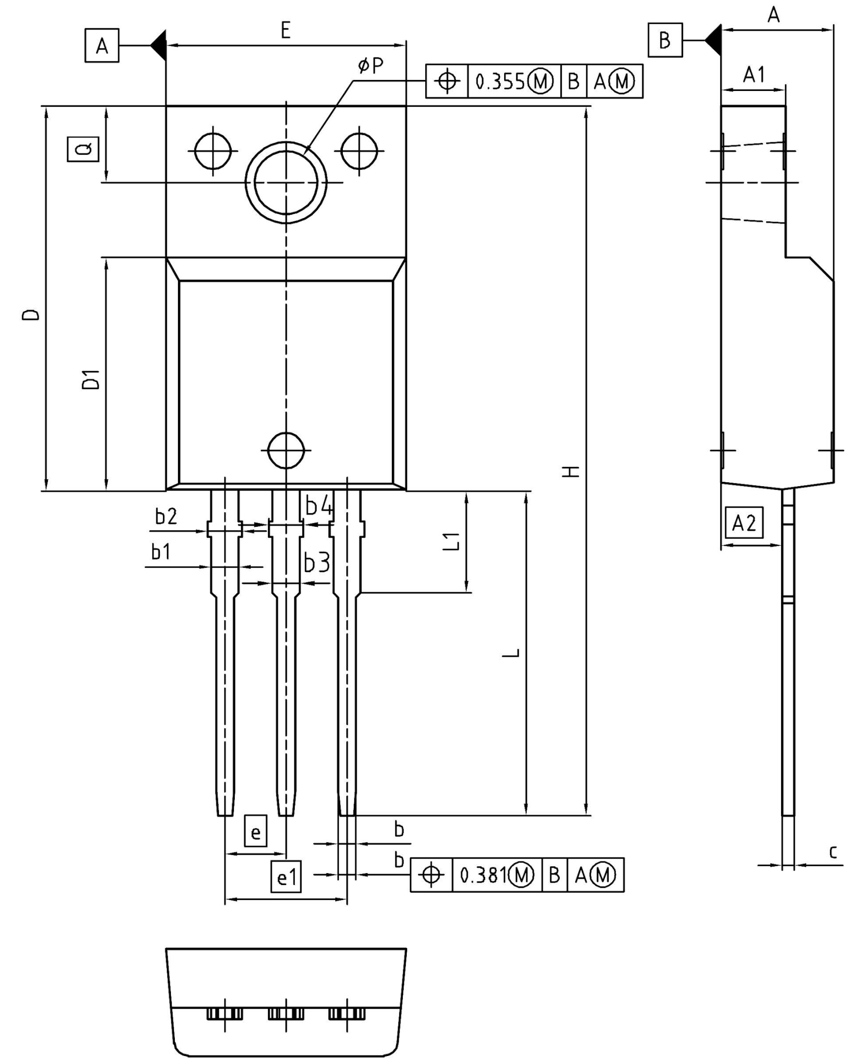
REVISION
06

Figure 3 Outline PG-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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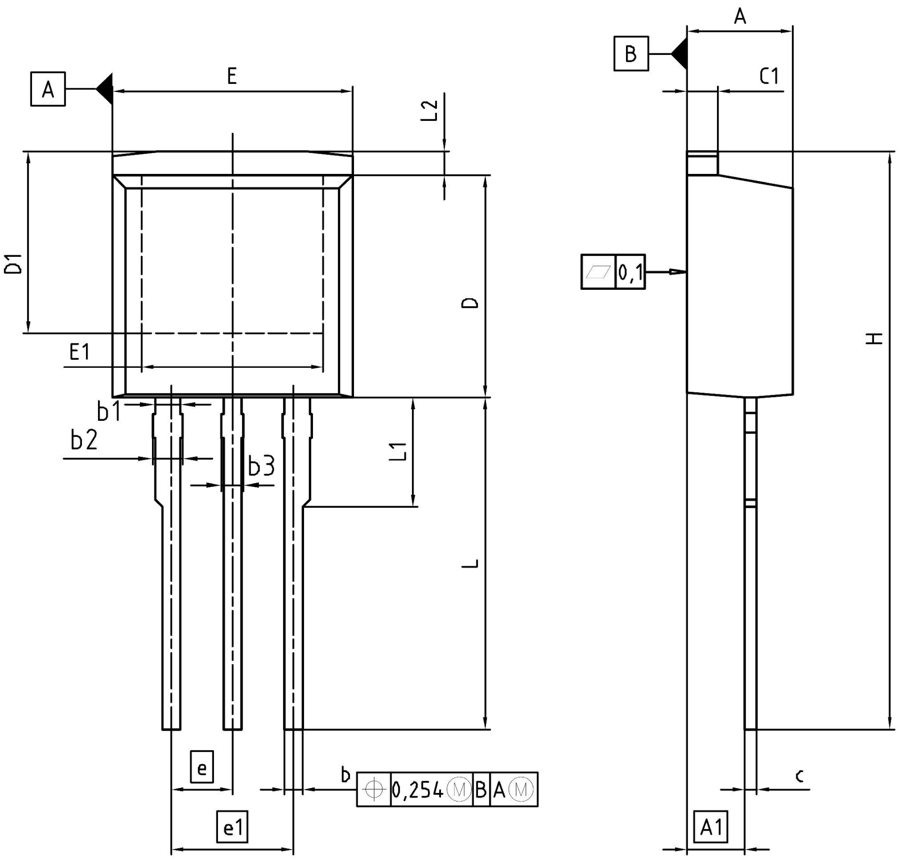
Figure 4 Outline PG-TO 220 FullPAK, dimensions in mm/inches



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

REFERENCE
Z8B00003325

SCALE
0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
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03

Figure 5 Outline PG-TO 262, dimensions in mm/inches

8 Appendix A

Table 23 Related Links

- **IFX Design Tools:**
  http://www.infineon.com/cms/en/product/promopages/designtools/index.html

- **IFX CoolMOS Webpage:**
  http://www.infineon.com/cms/en/product/channel.html?channel=ff80808112ab681d0112ab6a628704d8

Revision History

IPW65R110CFD, IPB65R110CFD, IPP65R110CFD, IPA65R110CFD, IPI65R110CFD

Revision: 2011-09-26, Rev. 2.6

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2011-06-07	Release the final datasheet
2.2	2011-06-22	-
2.3	2011-08-30	update to CFD2 standard
2.4	2011-09-14	update pin naming
2.5	2011-09-16	release of new pin naming
2.6	2011-09-26	update the Igss test condition

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