MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ E6 600V

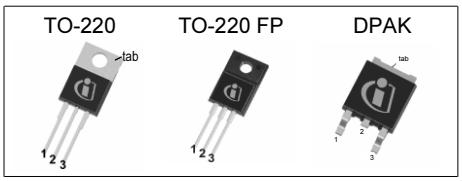
600V CoolMOS™ E6 Power Transistor
IPx60R380E6

Data Sheet

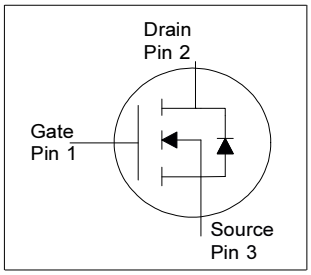
Rev. 2.5
Final

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. CoolMOS™ E6 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 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 Rdson*Qg and Eoss
- Very high commutation ruggedness
- Easy to use/drive
- Pb-free plating, available in Halogen free mold compound[a)]
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

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.

Table 1 Key Performance Parameters

Parameter	Value	Unit
V_{DS} @ $T_{j\,max}$	650	V
RDS(on),max	0.38	Ω
Qg,typ	32	nC
ID,pulse	30	A
Eoss @ 400V	2.8	µJ
Body diode di/dt	500	A/µs

Type / Ordering Code	Package	Marking	Related Links
IPP60R380E6	PG-TO 220	6R380E6	see Appendix A
IPA60R380E6	PG-TO 220 FullPAK		
IPD60R380E6	PG-TO 252		

a) For PG-TO 252: non-Halogen free (OPN: IPD60R380E6BT); Halogen free (OPN: IPD60R380E6AT)

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			10.6	A	T_C = 25°C
				6.7		T_C = 100°C
Pulsed drain current [2]	$I_{D,pulse}$			30	A	T_C = 25°C
Avalanche energy, single pulse	E_{AS}			210	mJ	I_D = 1.8A, V_{DD} = 50V (see table 22)
Avalanche energy, repetitive	E_{AR}			0.32	mJ	I_D = 1.8A, V_{DD} = 50V
Avalanche current, repetitive	I_{AR}			1.8	A	
MOSFET dv/dt ruggedness	dv/dt			50	V/ns	V_{DS} = 0 ... 480V
Gate source voltage	V_{GS}	-20		20	V	static
		-30		30		AC (f > 1 Hz)
Power dissipation (non FullPAK) TO-220	P_{tot}			83	W	T_C = 25°C
Power dissipation (FullPAK) TO-220 FP	P_{tot}			31	W	T_C = 25°C
Operating and storage temperature	T_j, T_{stg}	-55		150	°C	
Mounting torque (non FullPAK) TO-220				60	Ncm	M3 and M3.5 screws
Mounting torque (FullPAK) TO-220 FP				50	Ncm	M2.5 screws
Continuous diode forward current	I_S			9.2	A	T_C = 25°C
Diode pulse current	$I_{S,pulse}$			30	A	T_C = 25°C
Reverse diode dv/dt [3]	dv/dt			15	V/ns	V_{DS} = 0 ... 480V, $I_{SD} \le I_D$, T_j = 25°C (see table 20)
Maximum diode commutation speed	di_f/dt			500	A/µs	

[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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}			1.5	°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}			4.0	°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 DPAK

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}			1.5	°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	$V_{(BR)DSS}$	600			V	V_{GS} = 0V, I_D = 0.25mA
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5	V	V_{DS} = V_{GS}, I_D = 0.3mA
Zero gate voltage drain current	I_{DSS}			1	µA	V_{DS} = 600V, V_{GS} = 0V, T_j = 25°C
			10			V_{DS} = 600V, 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	$R_{DS(on)}$		0.340	0.38	Ω	V_{GS} = 10V, I_D = 3.8A, T_j = 25°C
			0.890			V_{GS} = 10V, I_D = 3.8A, T_j = 150°C
Gate resistance	R_G		7.5		Ω	f = 1MHz, open drain

Table 7 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}		700		pF	V_{GS} = 0V, V_{DS} = 100V, f = 1MHz
Output capacitance	C_{oss}		46		pF	
Effective output capacitance, energy related [1]	$C_{o(er)}$		30		pF	V_{GS} = 0V, V_{DS} = 0 ... 480V
Effective output capacitance, time related [2]	$C_{o(tr)}$		136		pF	I_D = constant, V_{GS} = 0V, V_{DS} = 0 ... 480V
Turn-on delay time	$t_{d(on)}$		11		ns	V_{DD} = 400V, V_{GS} = 13V, I_D = 4.8A, R_G = 3.4Ω (see table 22)
Rise time	t_r		9		ns	
Turn-off delay time	$t_{d(off)}$		56		ns	
Fall time	t_f		8		ns	

Table 8 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}		4		nC	V_{DD} = 480V, I_D = 4.8A, V_{GS} = 0 to 10V
Gate to drain charge	Q_{gd}		16		nC	
Gate charge total	Q_g		32		nC	
Gate plateau voltage	$V_{plateau}$		5.4		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 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 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 = 4.8A, T_j = 25°C
Reverse recovery time	t_{rr}		290		ns	V_R = 400V, I_F = 4.8A, di_F/dt = 100A/µs (see table 20)
Reverse recovery charge	Q_{rr}		3.3		µC	
Peak reverse recovery current	I_{rrm}		21		A	

5 Electrical characteristics diagrams

Table 10

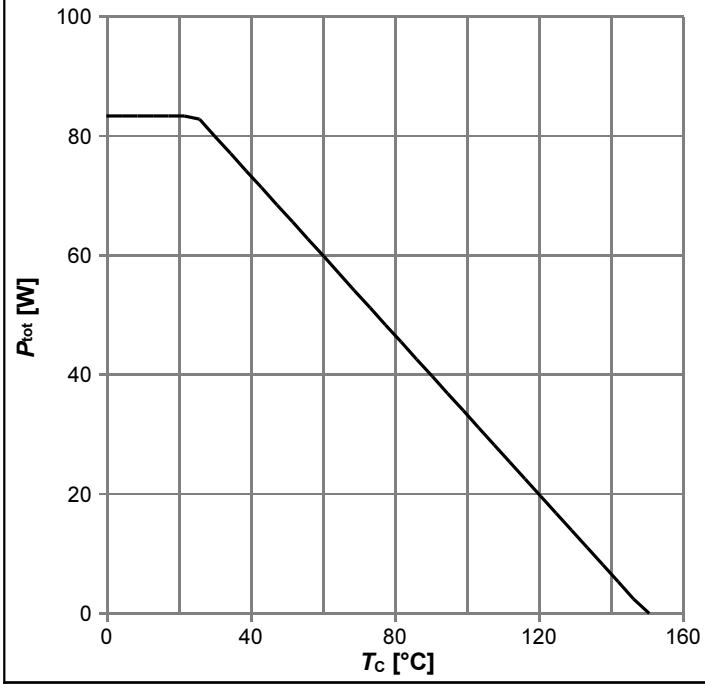
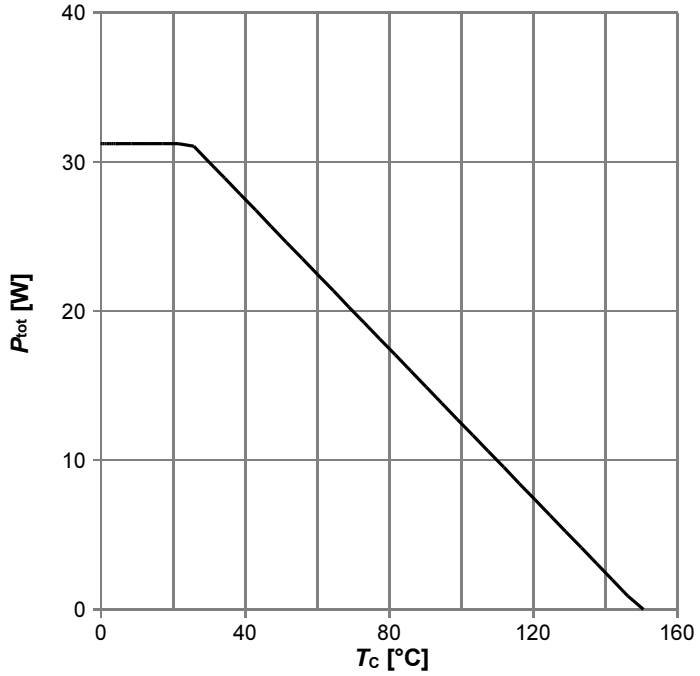
Power dissipation (Non FullPAK)	Power dissipation (FullPAK)
	
$P_{tot}=f(T_C)$	$P_{tot}=f(T_C)$

Table 11

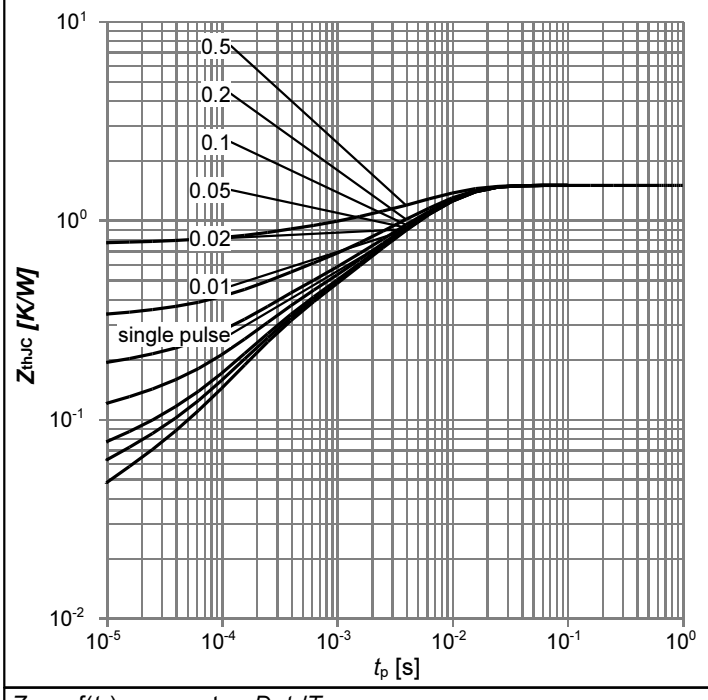
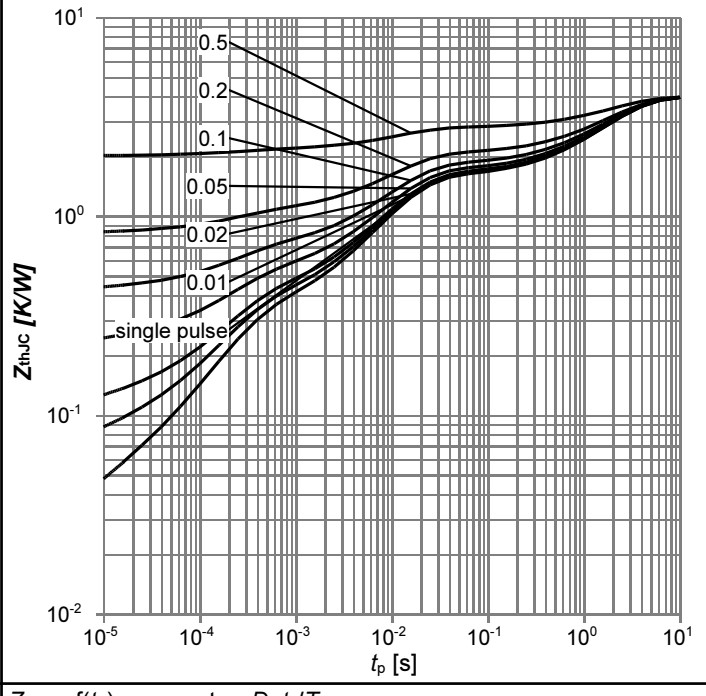
Max. transient thermal impedance (Non FullPAK)	Max. transient thermal impedance (FullPAK)
	
$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$	$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

Table 12

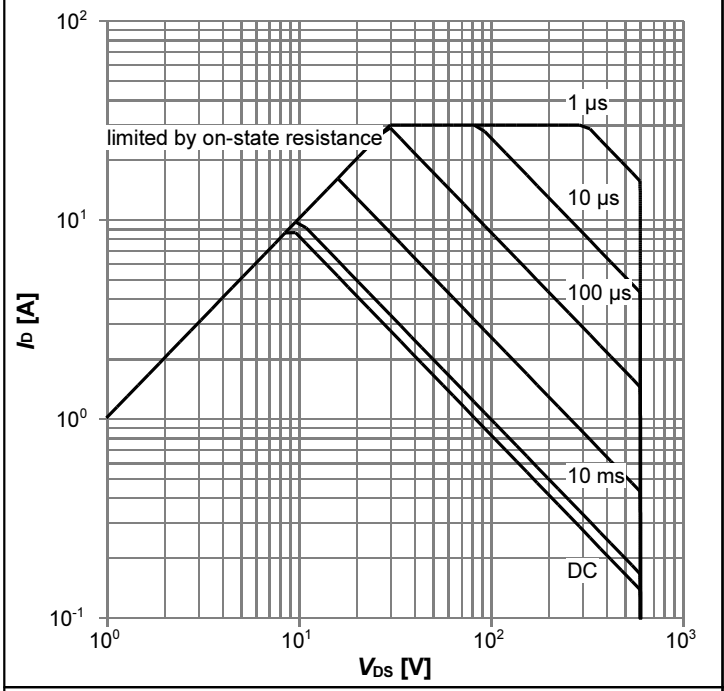
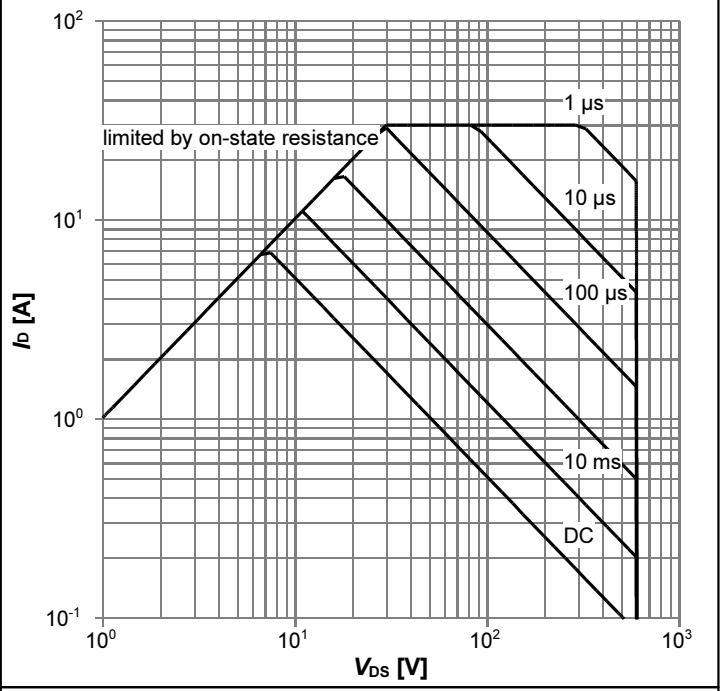
Safe operating area T_C=25°C (Non FullPAK)	Safe operating area T_C=25°C (FullPAK)
	
I_D=f(V_{DS}); V_{GS}>7V; T_C=25 °C; D=0; parameter: t_p	I_D=f(V_{DS}); V_{GS}>7V; T_C=25 °C; D=0; parameter: t_p

Table 13

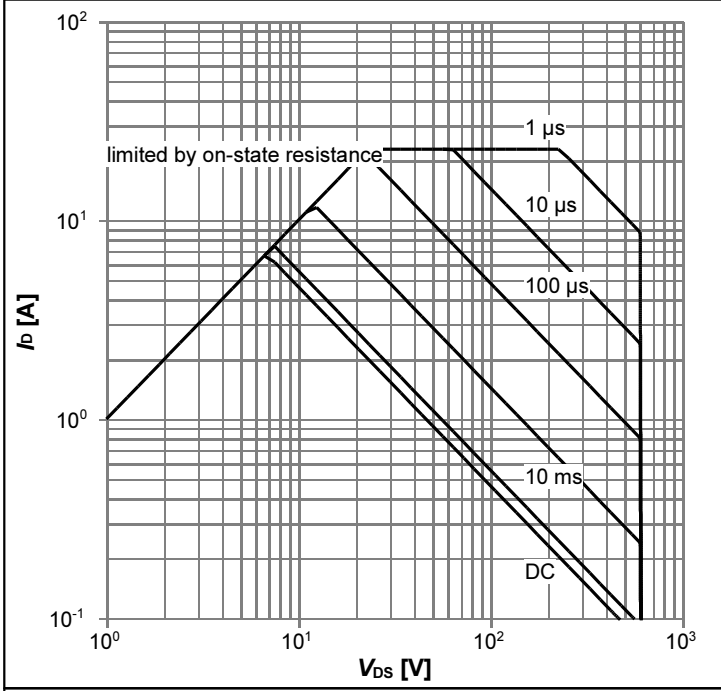
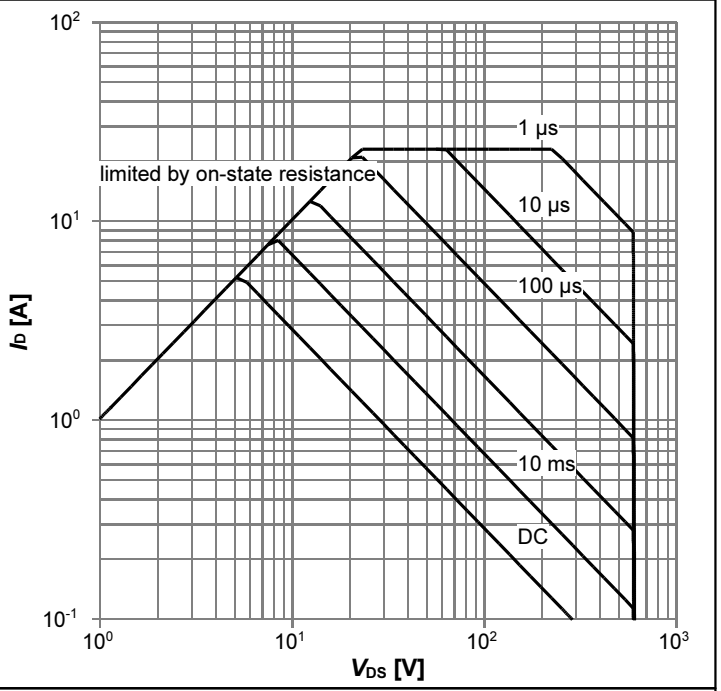
Safe operating area T_C=80°C (Non FullPAK)	Safe operating area T_C=80°C (FullPAK)
	
I_D=f(V_{DS}); V_{GS}>7V; T_C=80 °C; D=0; parameter: t_p	I_D=f(V_{DS}); V_{GS}>7V; T_C=80 °C; D=0; parameter: t_p

Table 14

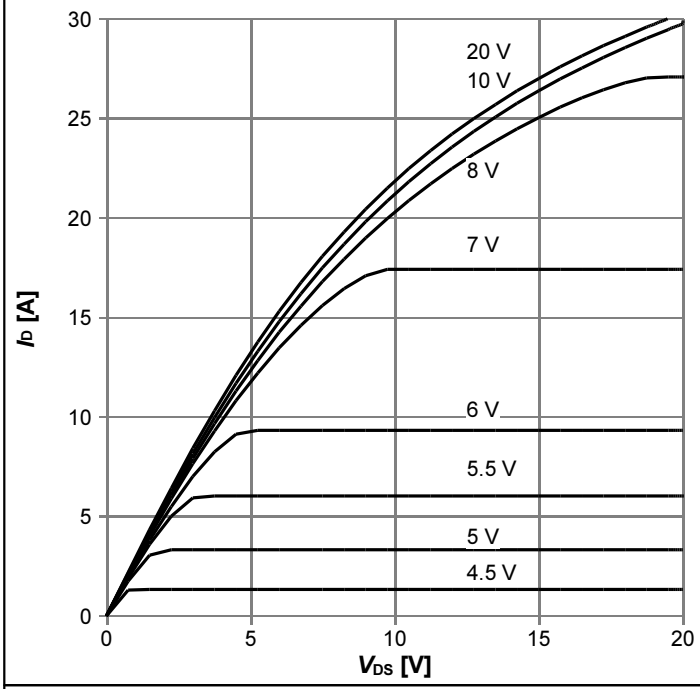
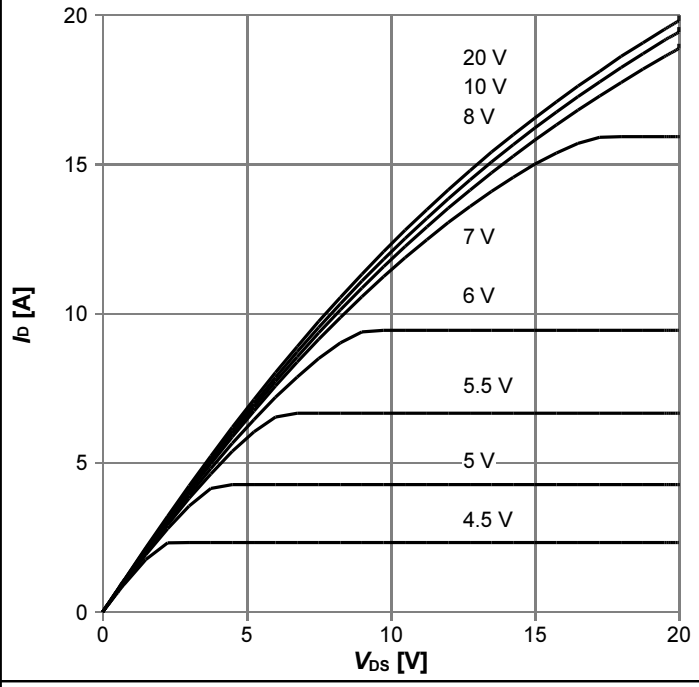
Typ. output characteristics T_C=25°C	Typ. output characteristics T_C=125°C
	
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}	I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

Table 15

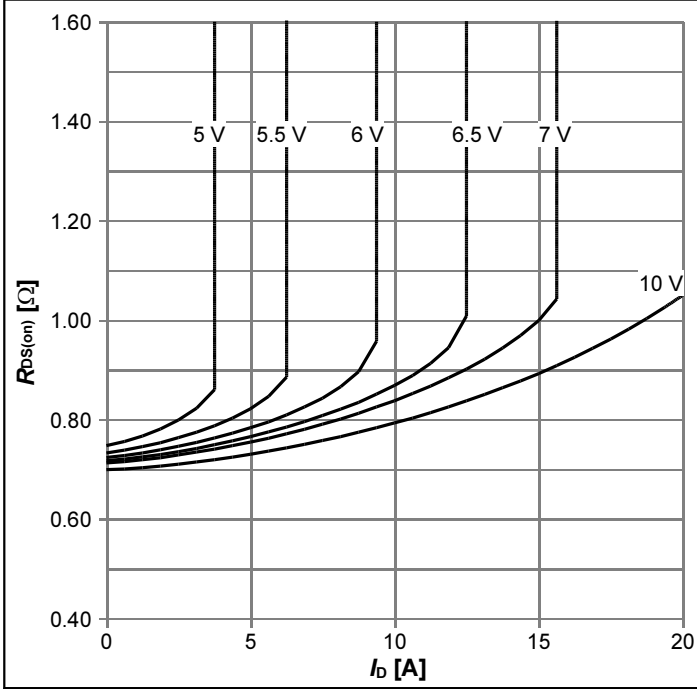
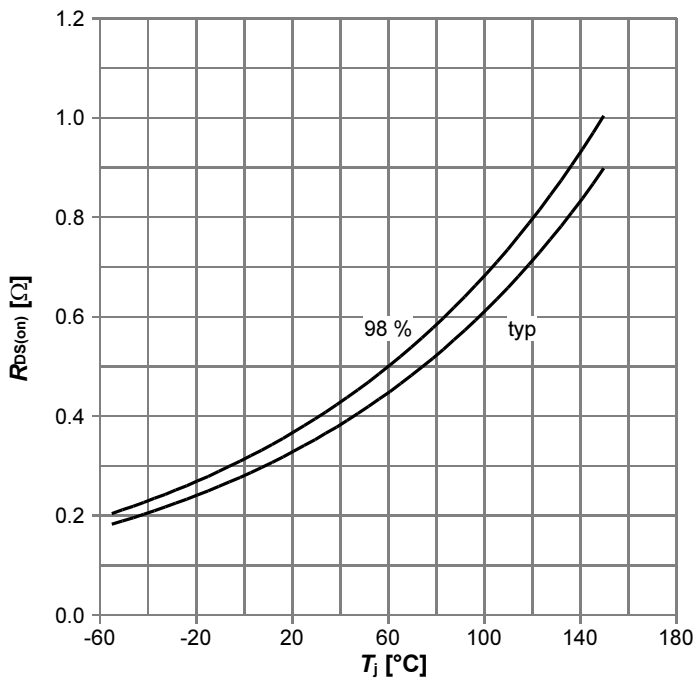
Typ. drain-source on-state resistance	Drain-source on-state resistance
	
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}	$R_{DS(on)}$=f(T_j); I_D=3.8 A; V_{GS}=10 V

Table 16

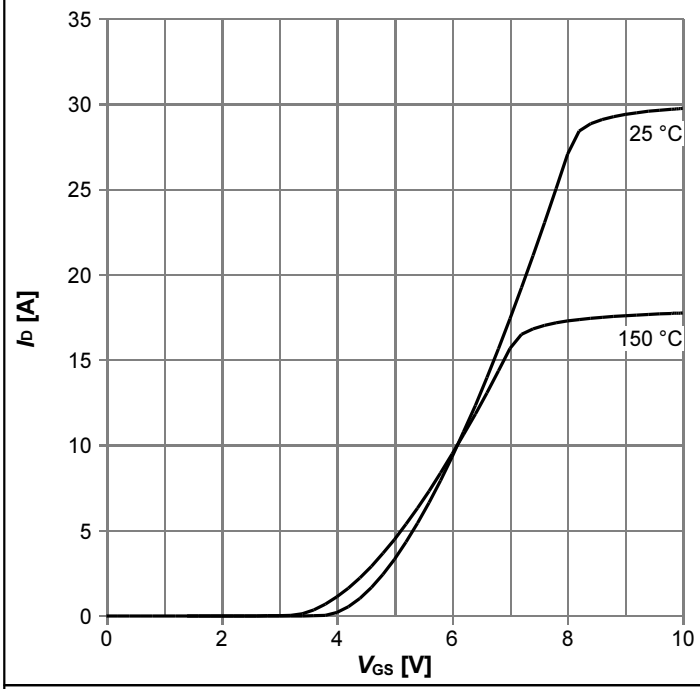
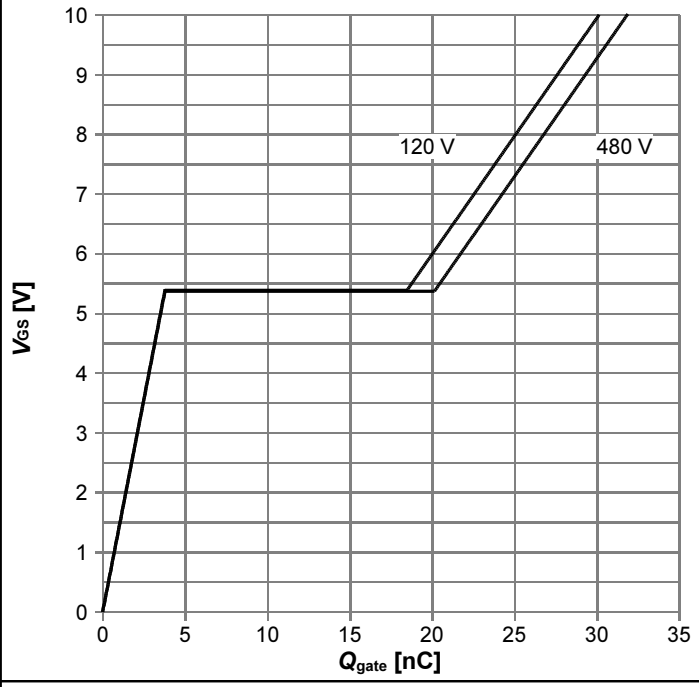
Typ. transfer characteristics	Typ. gate charge
	
I_D=f(V_{GS}); V_{DS}= 20V; parameter: T_j	V_{GS}=f(Q_{gate}); I_D=4.8 A pulsed; parameter: V_{DD}

Table 17

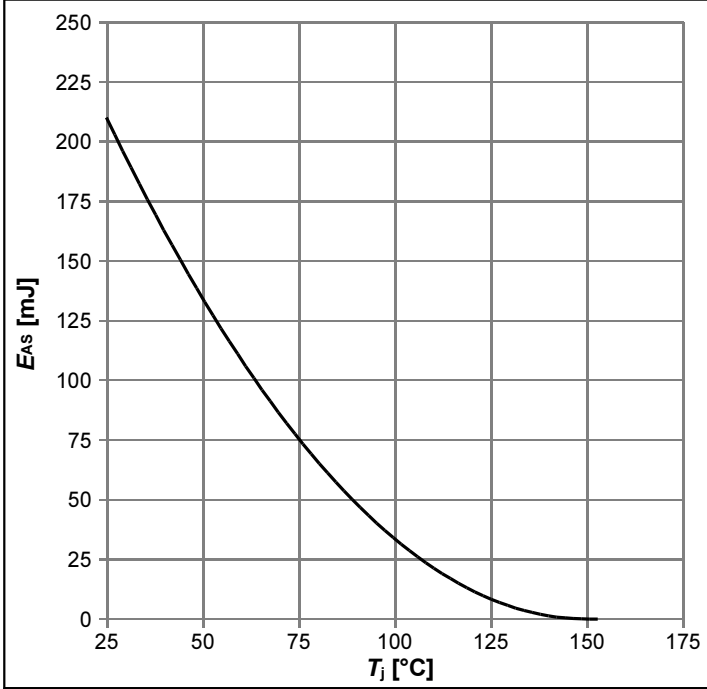
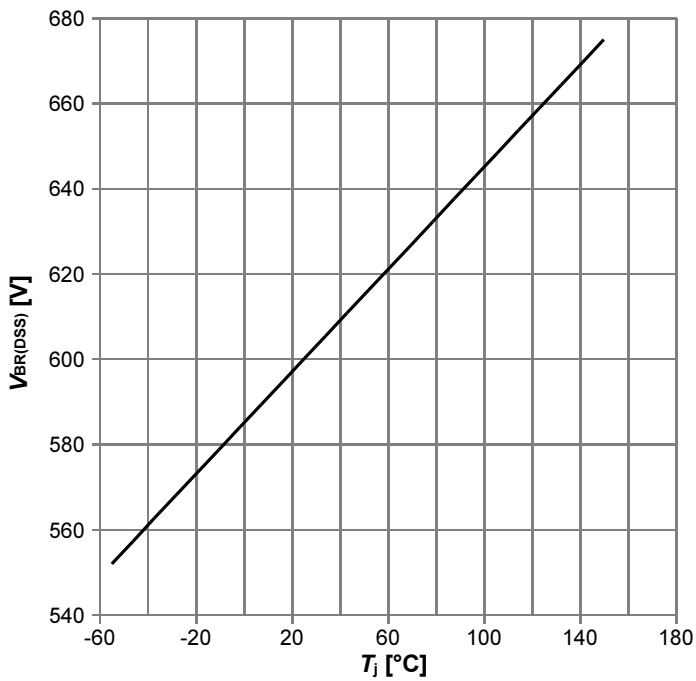
Avalanche energy	Drain-source breakdown voltage
	
E_{AS}=f(T_j); I_D=1.8 A; V_{DD}=50 V	$V_{BR(DSS)}$=f(T_j); I_D=0.25 mA

Table 18

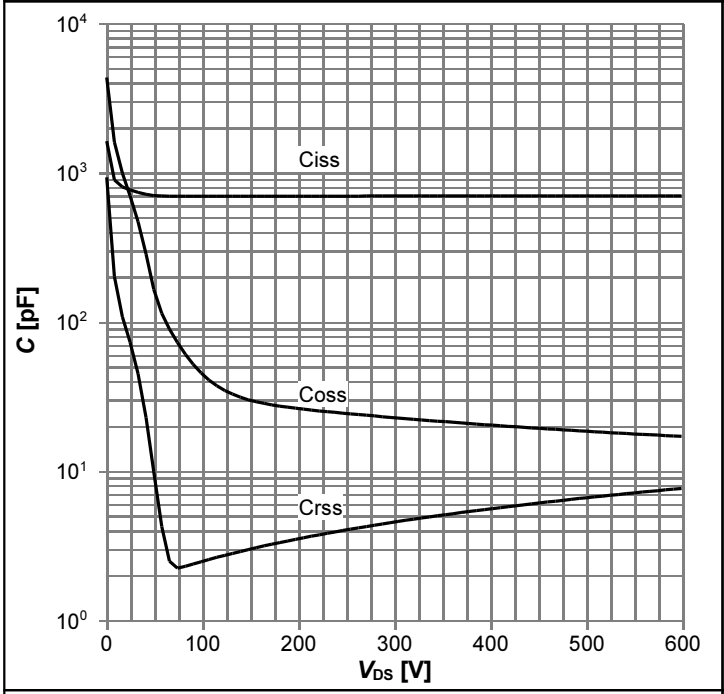
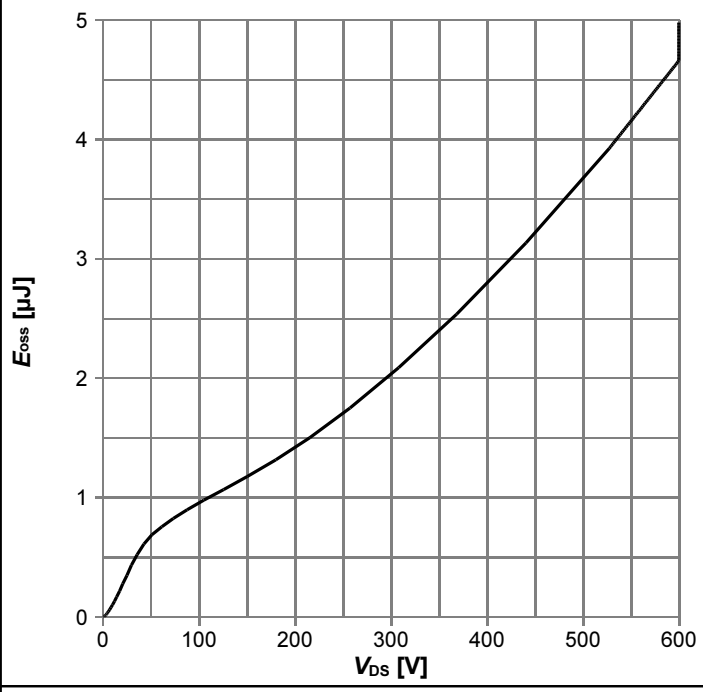
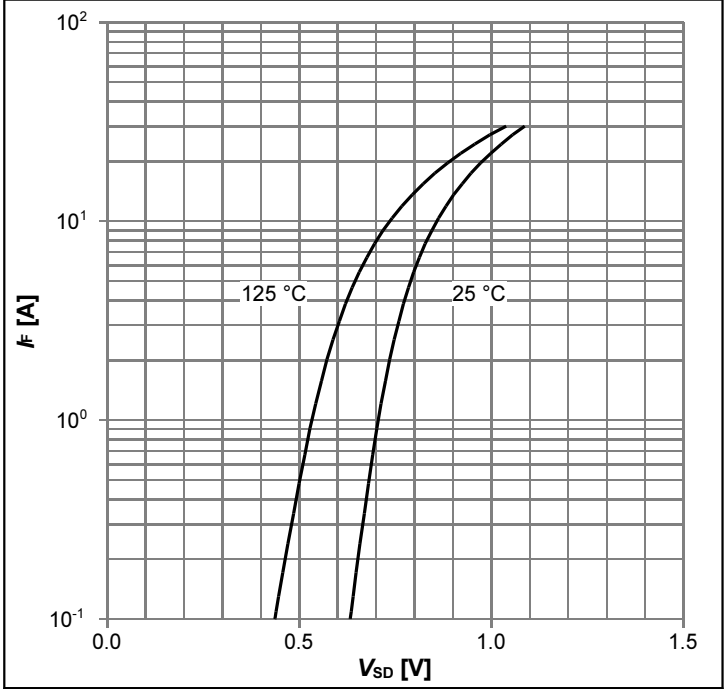
Typ. capacitances	Typ. C_{oss} stored energy
	
C=f(V_{DS}); V_{GS}=0 V; f=1 MHz	E_{oss}=f(V_{DS})

Table 19

Forward characteristics of reverse diode

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

6 Test Circuits

Table 20 Diode characteristics

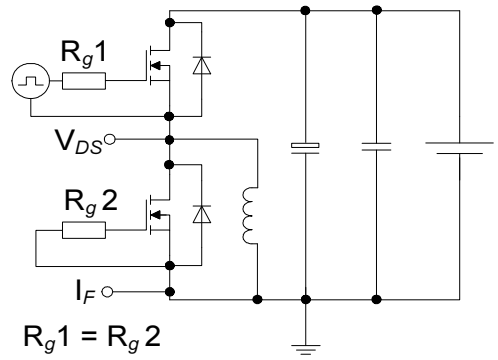
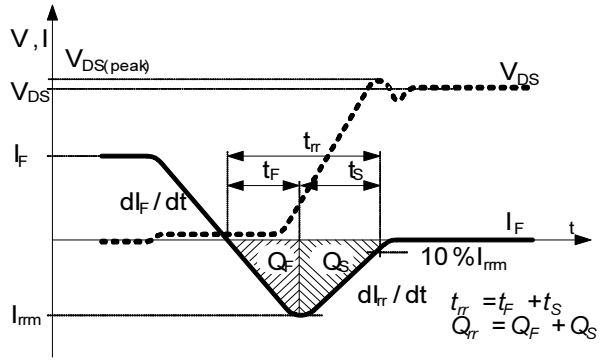
Test circuit for diode characteristics	Diode recovery waveform
	

Table 21 Switching times

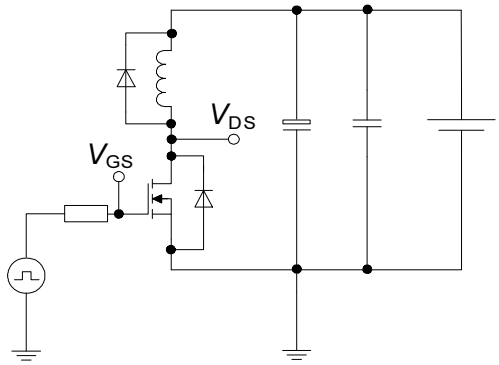
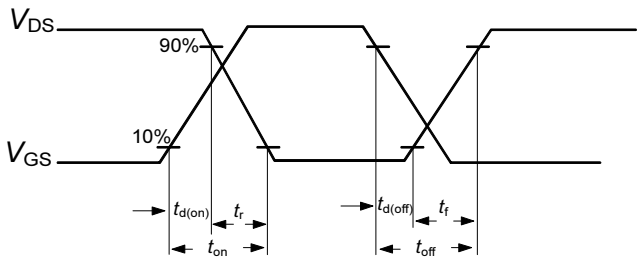
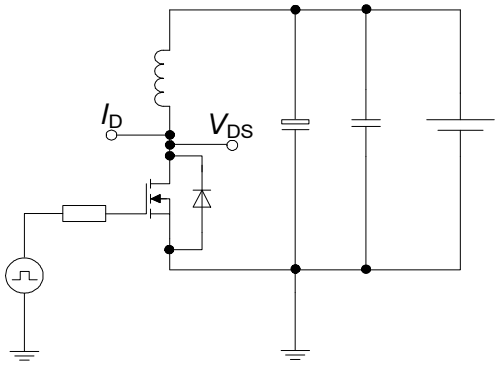
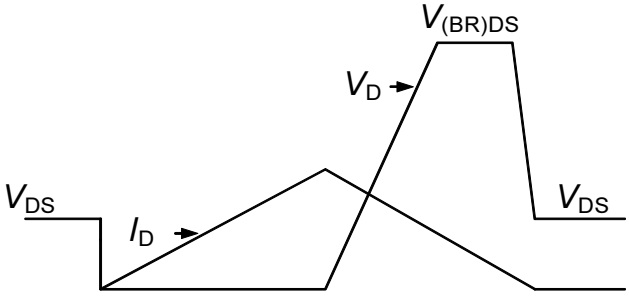
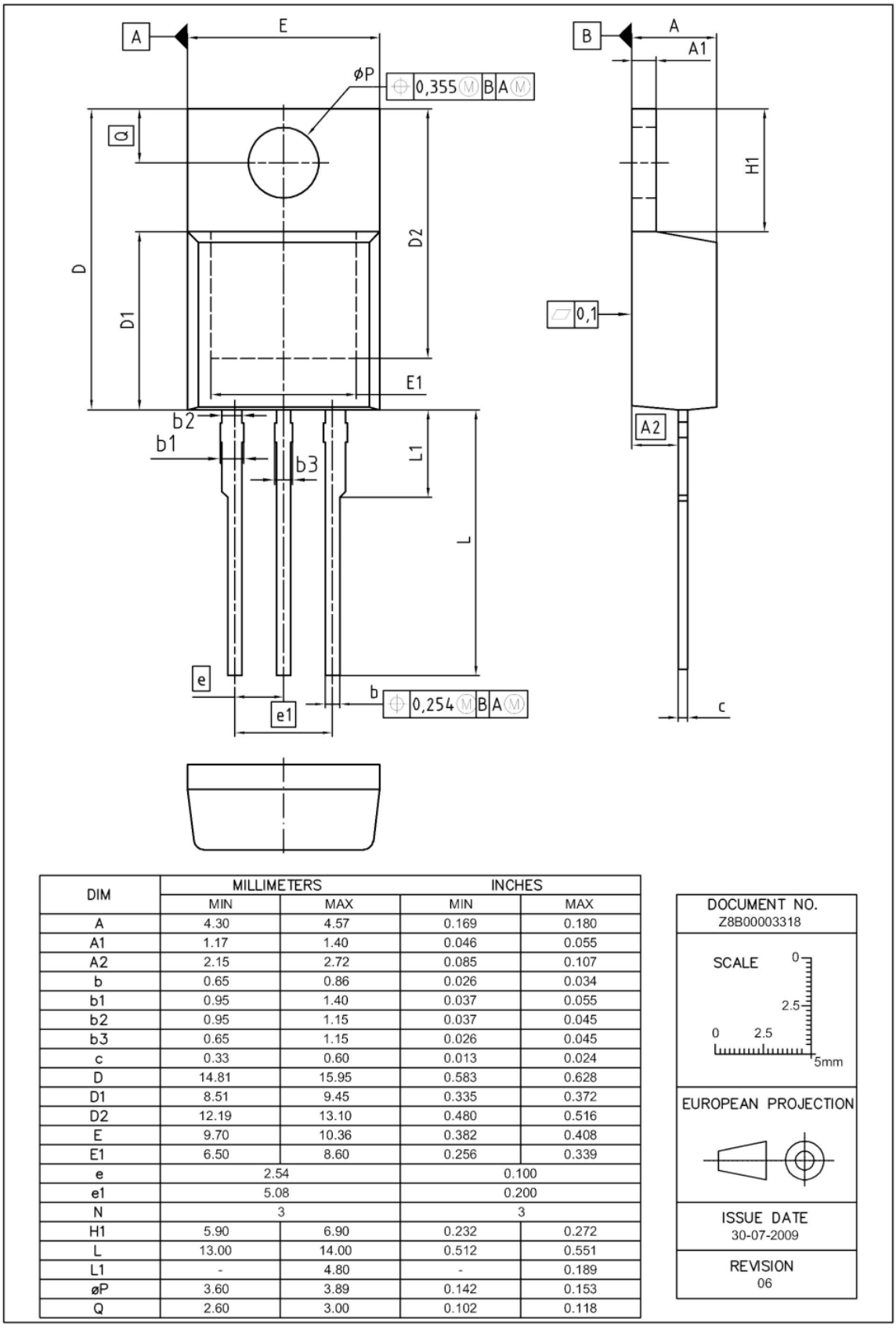
Switching times test circuit for inductive load	Switching times waveform
	

Table 22 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive 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

DOCUMENT NO.
Z8B00003318

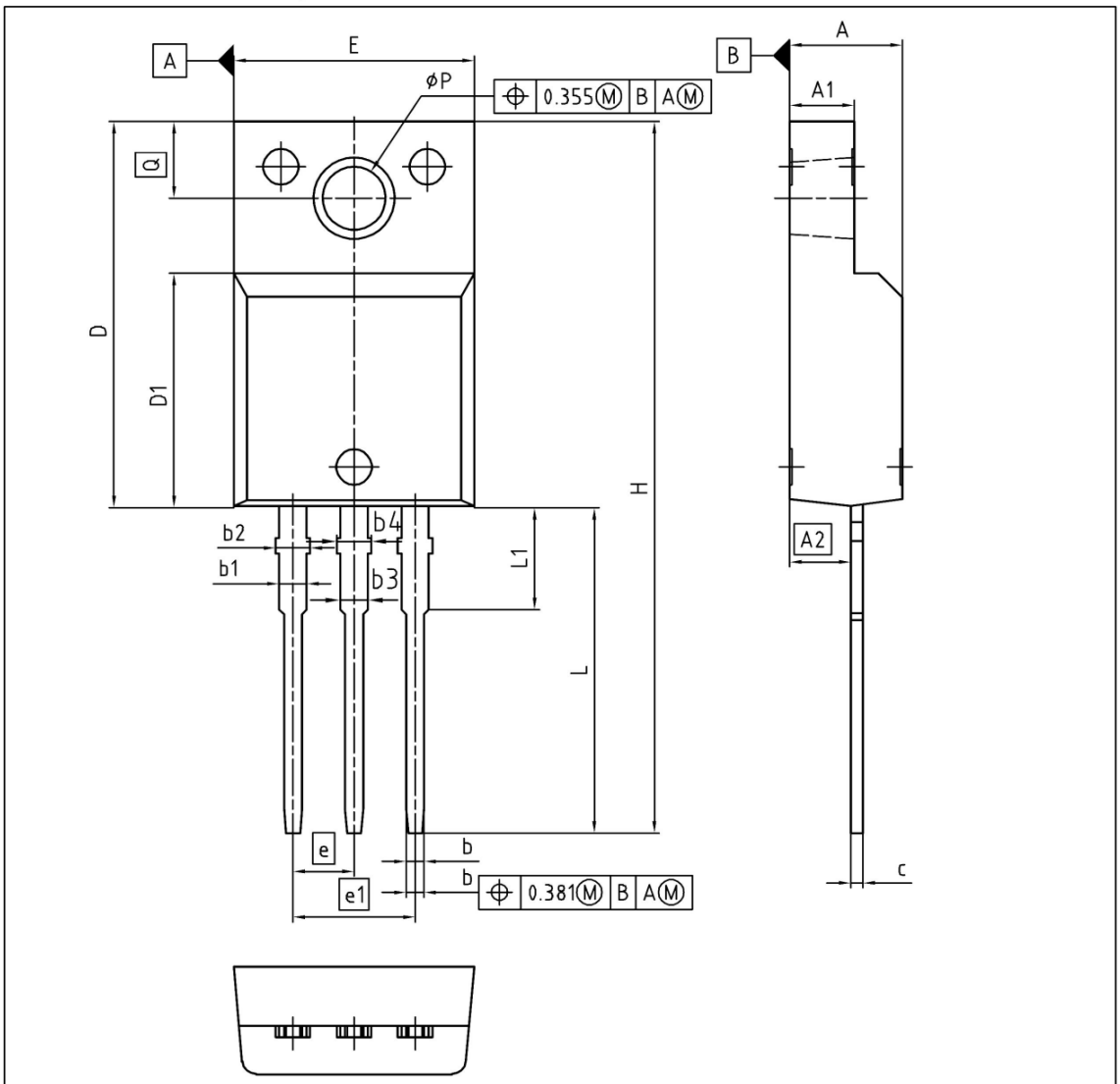
SCALE 0 2.5 0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
30-07-2009

REVISION
06

Figure 1 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

DOCUMENT NO.
Z8B00003319

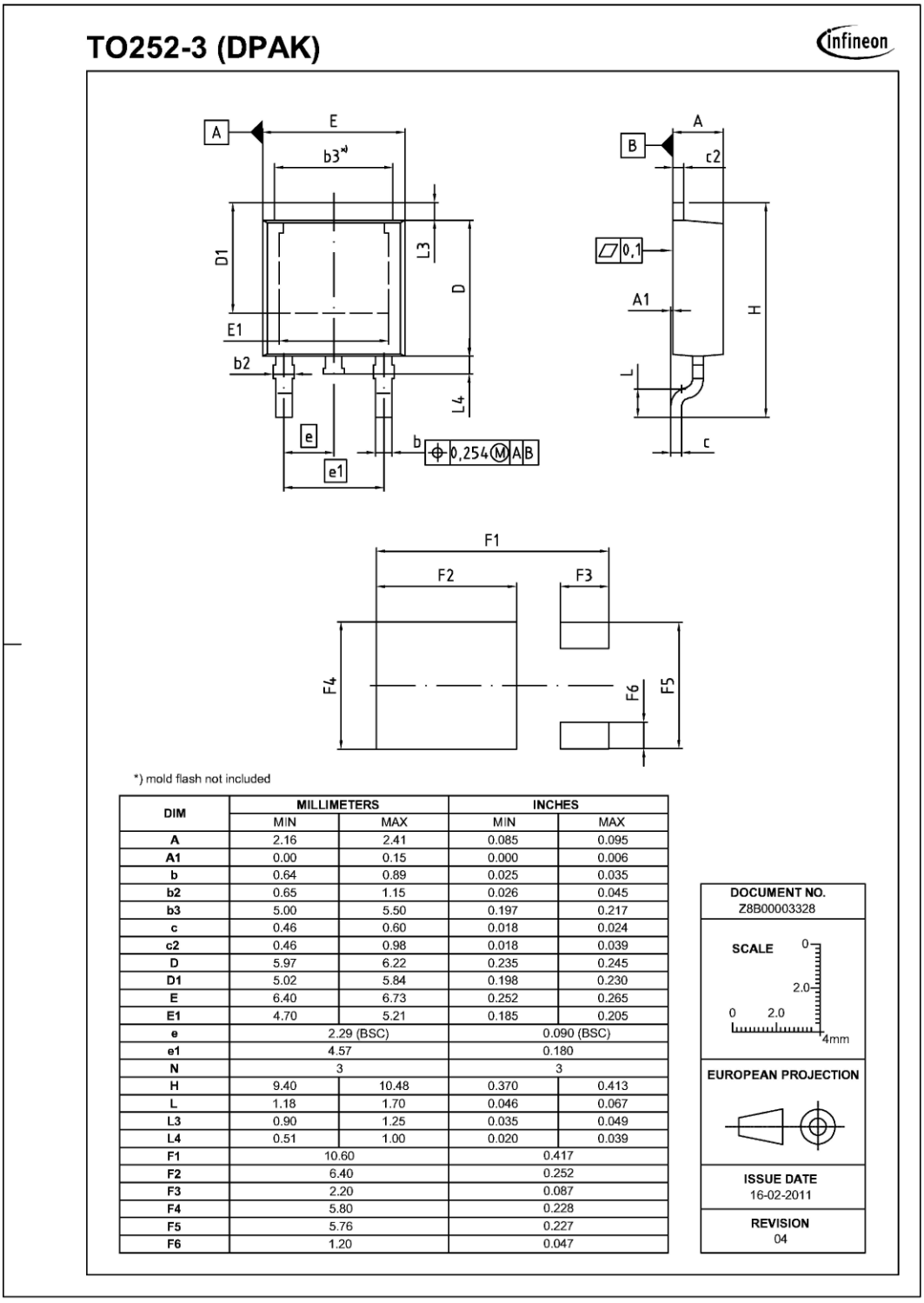
SCALE 0 2.5 0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
08-03-2007

REVISION
03

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



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 (BSC)		0.090 (BSC)	
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	10.60		0.417	
F2	6.40		0.252	
F3	2.20		0.087	
F4	5.80		0.228	
F5	5.76		0.227	
F6	1.20		0.047	

Figure 3 Outline PG-TO 252, dimensions in mm/inches

8 Appendix A

Table 23 Related Links

- **IFX CoolMOS Webpage:** www.infineon.com
- **IFX Design Tools:** www.infineon.com

Revision History

IPP60R380E6, IPA60R380E6, IPD60R380E6

Revision History: 2013-07-31, Rev. 2.5

Previous Revision: 2.4

Revision	Date	Subjects (major changes since last revision)
2.0	2011-06-08	Release Final data sheet
2.1	2011-09-14	-
2.2	2011-09-14	-
2.3	2011-09-20	-
2.4	2013-05-15	PG-TO252 Package Added
2.5	2013-07-31	Update halogen free mold compound status of PG-TO 252 package

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 2011-08-01
Published by
Infineon Technologies AG
81726 München, 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 your 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.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Infineon:
IPD60R380E6BTMA1

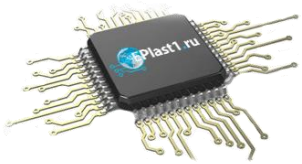
Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)
Факс: 8 (812) 320-02-42
Электронная почта: org@eplast1.ru
Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.