



MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C6 600V

600V CoolMOS™ C6 Power Transistor
IPx60R380C6

Data Sheet

Rev. 2.4
Final

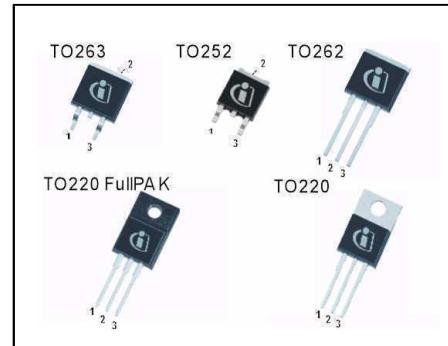
Power Management & Multimarket

600V CoolMOS™ C6 Power Transistor

**IPD60R380C6, IPI60R380C6
IPB60R380C6, IPP60R380C6
IPA60R380C6**

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 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.

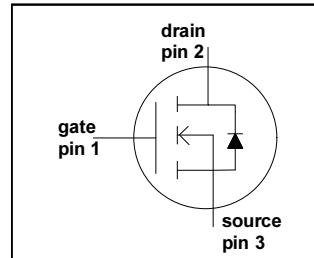


Features

- Extremely low losses due to very low FOM $R_{dson} \cdot Q_g$ and E_{oss}
- Very high commutation ruggedness
- Easy to use/drive, Pb-free plating, Halogen free
- Fully qualified according to JEDEC for Industrial Applications

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
$R_{DS(on),max}$	0.38	Ω
$Q_{g,typ}$	32	nC
$I_{D,pulse}$	30	A
$E_{oss} @ 400V$	2.8	μJ
Body diode dI/dt	500	A/ μs

Type / Ordering Code	Package	Marking	Related Links
IPD60R380C6	PG-T0252	6R380C6	IFX C6 Product Brief
IPI60R380C6	PG-T0262		IFX C6 Portfolio
IPB60R380C6	PG-T0263		IFX CoolMOS Webpage
IPP60R380C6	PG-T0220		IFX Design tools
IPA60R380C6	PG-T0220 FullPAK		

Table of Contents

Description	2
Table of Contents	3
Maximum ratings	4
Thermal characteristics	5
Electrical characteristics	6
Electrical characteristics diagrams	8
Test circuits	13
Package outlines	14
Revision History	19

Maximum ratings

2 Maximum ratings

at $T_j = 25^\circ\text{C}$, unless otherwise specified.

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current ¹⁾	I_D	-	-	10.6	A	$T_C = 25^\circ\text{C}$
				6.7		$T_C = 100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,\text{pulse}}$	-	-	30	A	$T_C = 25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}	-	-	210	mJ	$I_D = 1.8 \text{ A}, V_{DD} = 50 \text{ V}$ (see table 21)
Avalanche energy, repetitive	E_{AR}	-	-	0.32		$I_D = 1.8 \text{ A}, V_{DD} = 50 \text{ V}$
Avalanche current, repetitive	I_{AR}	-	-	1.8	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-262, TO-263	P_{tot}	-	-	83	W	$T_C = 25^\circ\text{C}$
Power dissipation for TO-220 FullPAK	P_{tot}	-	-	31	W	$T_C = 25^\circ\text{C}$
Operating and storage temperature	T_j, T_{stg}	-55	-	150	°C	
Mounting torque TO-220		-	-	60	Ncm	M3 and M3.5 screws
Mounting torque TO-220 FullPAK				50		M2.5 screws
Continuous diode forward current	I_S	-	-	9.2	A	$T_C = 25^\circ\text{C}$
Diode pulse current ²⁾	$I_{S,\text{pulse}}$	-	-	30	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	15	V/ns	$V_{DS} = 0 \dots 480 \text{ V}, I_{SD} \leq I_D, T_j = 125^\circ\text{C}$ (see table 22)
Maximum diode commutation speed ³⁾	di _f /dt			500	A/μs	

1) Limited by $T_{j,\text{max}}$. Maximum duty cycle D=0.75

2) Pulse width t_p limited by $T_{j,\text{max}}$

3) Identical low side and high side switch with identical R_G

Thermal characteristics

3 Thermal characteristics

Table 3 Thermal characteristics TO-220 (IPP60R380C6),TO-262 (IPI60R380C6)

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		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 (IPA60R380C6)

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		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 (IPB60R380C6),TO-252 (IPD60R380C6)

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		SMD version, device on PCB, minimal footprint
			35			SMD version, device on PCB, 6cm² 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 6cm² (one layer, 70µm thick) copper area for drain connection. PCB is vertical without air stream cooling.

4 Electrical characteristics

Electrical characteristics, at $T_j=25\text{ }^\circ\text{C}$, unless otherwise specified

Table 6 Static characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(\text{BR})\text{DSS}}$	600	-	-	V	$V_{\text{GS}}=0\text{ V}$, $I_D=0.25\text{ mA}$
Gate threshold voltage	$V_{\text{GS}(\text{th})}$	2.5	3	3.5		$V_{\text{DS}}=V_{\text{GS}}$, $I_D=0.32\text{ mA}$
Zero gate voltage drain current	I_{DSS}	-	-	1	μA	$V_{\text{DS}}=600\text{ V}$, $V_{\text{GS}}=0\text{ V}$, $T_j=25\text{ }^\circ\text{C}$
		-	10	-		$V_{\text{DS}}=600\text{ V}$, $V_{\text{GS}}=0\text{ V}$, $T_j=150\text{ }^\circ\text{C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{\text{GS}}=20\text{ V}$, $V_{\text{DS}}=0\text{ V}$
Drain-source on-state resistance	$R_{\text{DS}(\text{on})}$	-	0.34	0.38	Ω	$V_{\text{GS}}=10\text{ V}$, $I_D=3.8\text{ A}$, $T_j=25\text{ }^\circ\text{C}$
		-	0.89	-		$V_{\text{GS}}=10\text{ V}$, $I_D=3.8\text{ A}$, $T_j=150\text{ }^\circ\text{C}$
Gate resistance	R_G	-	17	-	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}	-	700	-	pF	$V_{\text{GS}}=0\text{ V}$, $V_{\text{DS}}=100\text{ V}$, $f=1\text{ MHz}$
Output capacitance	C_{oss}	-	46	-		
Effective output capacitance, energy related ¹⁾	$C_{\text{o(er)}}$	-	30	-		$V_{\text{GS}}=0\text{ V}$, $V_{\text{DS}}=0\text{...}480\text{ V}$
Effective output capacitance, time related ²⁾	$C_{\text{o(tr)}}$	-	136	-		$I_D=\text{constant}$, $V_{\text{GS}}=0\text{ V}$, $V_{\text{DS}}=0\text{...}480\text{ V}$
Turn-on delay time	$t_{\text{d(on)}}$	-	15	-	ns	$V_{\text{DD}}=400\text{ V}$, $V_{\text{GS}}=13\text{ V}$, $I_D=4.8\text{ A}$, $R_G=3.4\text{ }\Omega$ (see table 20)
Rise time	t_r	-	10	-		
Turn-off delay time	$t_{\text{d(off)}}$	-	110	-		
Fall time	t_f	-	9	-		

1) $C_{\text{o(er)}}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(\text{BR})\text{DSS}}$

2) $C_{\text{o(tr)}}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(\text{BR})\text{DSS}}$

Table 8 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
IGate to source charge	Q_{gs}	-	4	-	nC	$V_{DD}=480\text{ V}$, $I_D=4.8\text{ A}$, $V_{GS}=0$ to 10 V
Gate to drain charge	Q_{gd}	-	16	-		
Gate charge total	Q_g	-	32	-		
Gate plateau voltage	$V_{plateau}$	-	5.4	-		

Table 9 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.9	-	V	$V_{GS}=0\text{ V}$, $I_F=4.8\text{ A}$, $T_j=25\text{ }^\circ\text{C}$
Reverse recovery time	t_{rr}	-	290	-		
Reverse recovery charge	Q_{rr}	-	3.3	-		
Peak reverse recovery current	I_{rrm}	-	21	-		

5 Electrical characteristics diagrams

Electrical characteristics diagrams

Table 10

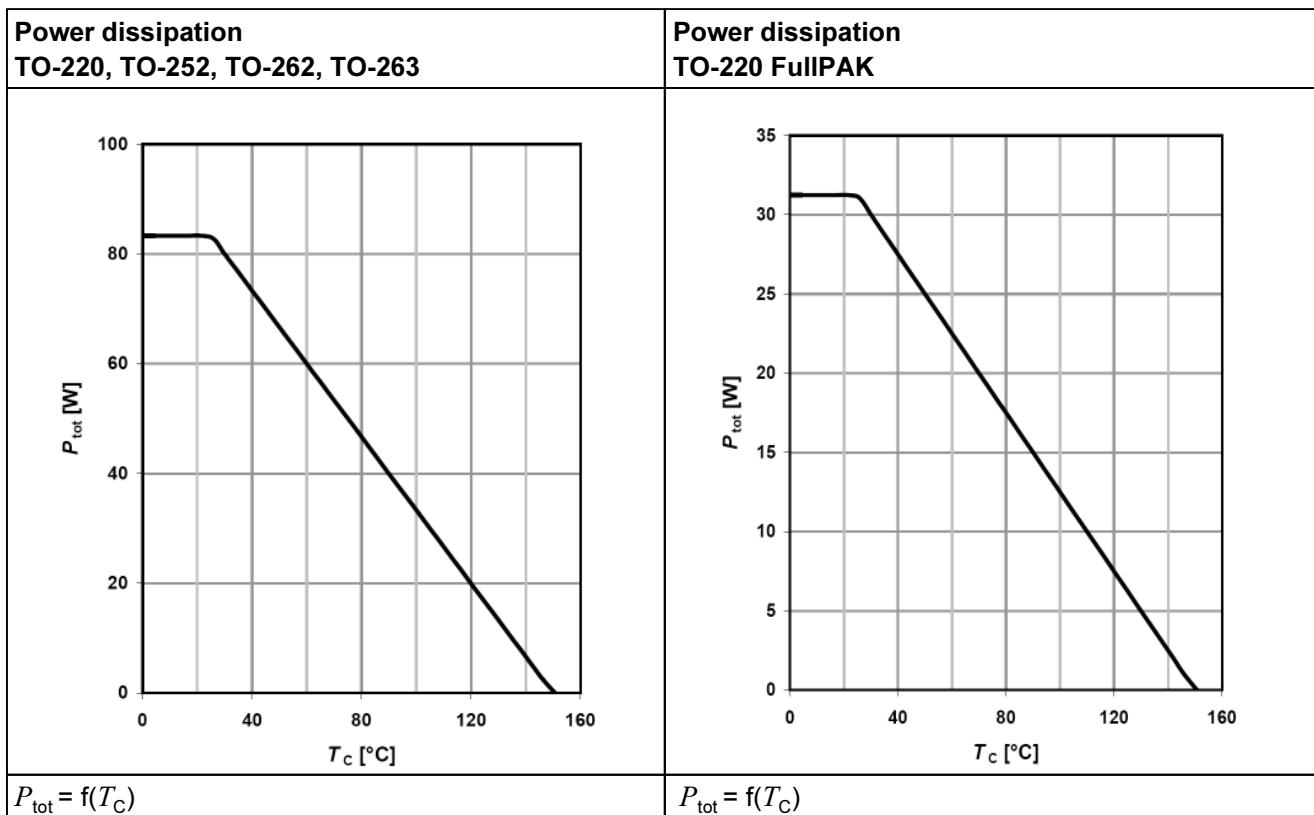


Table 11

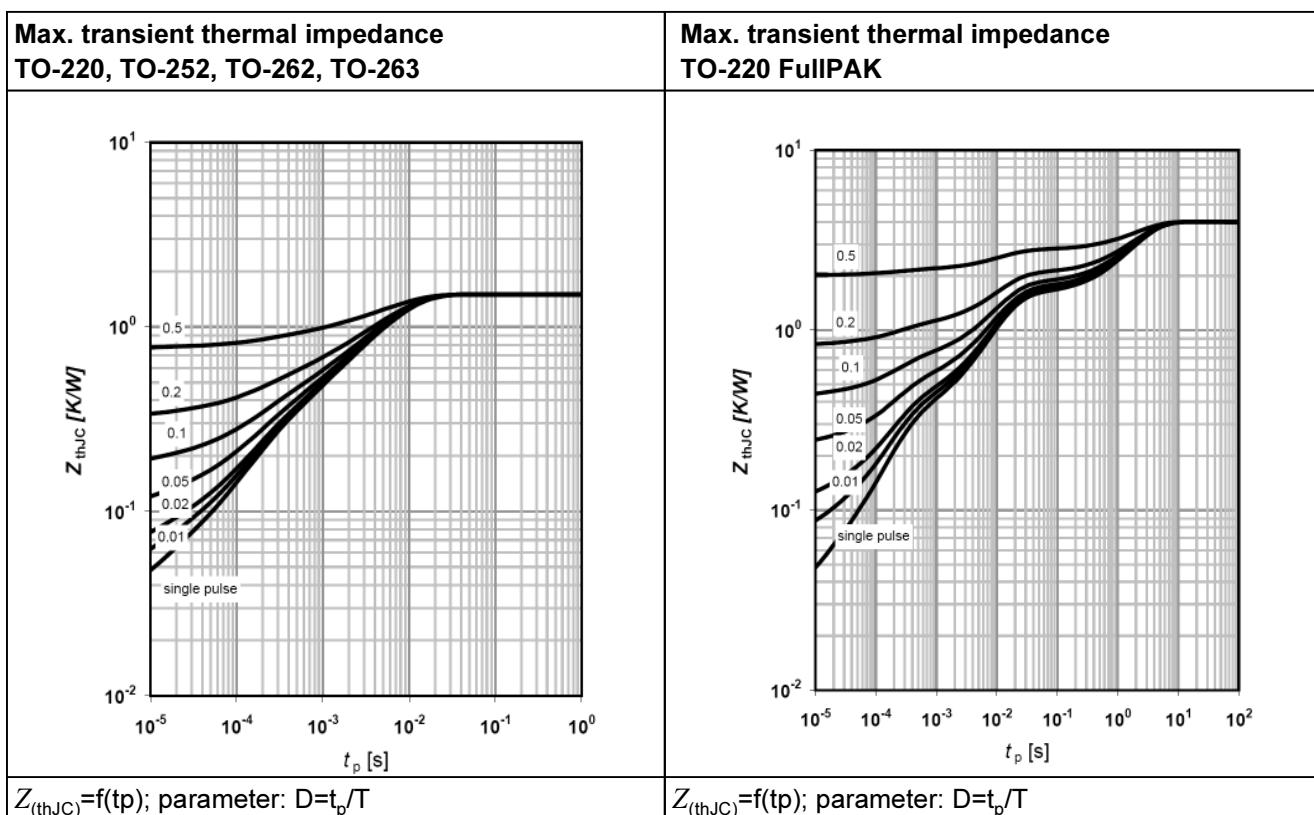
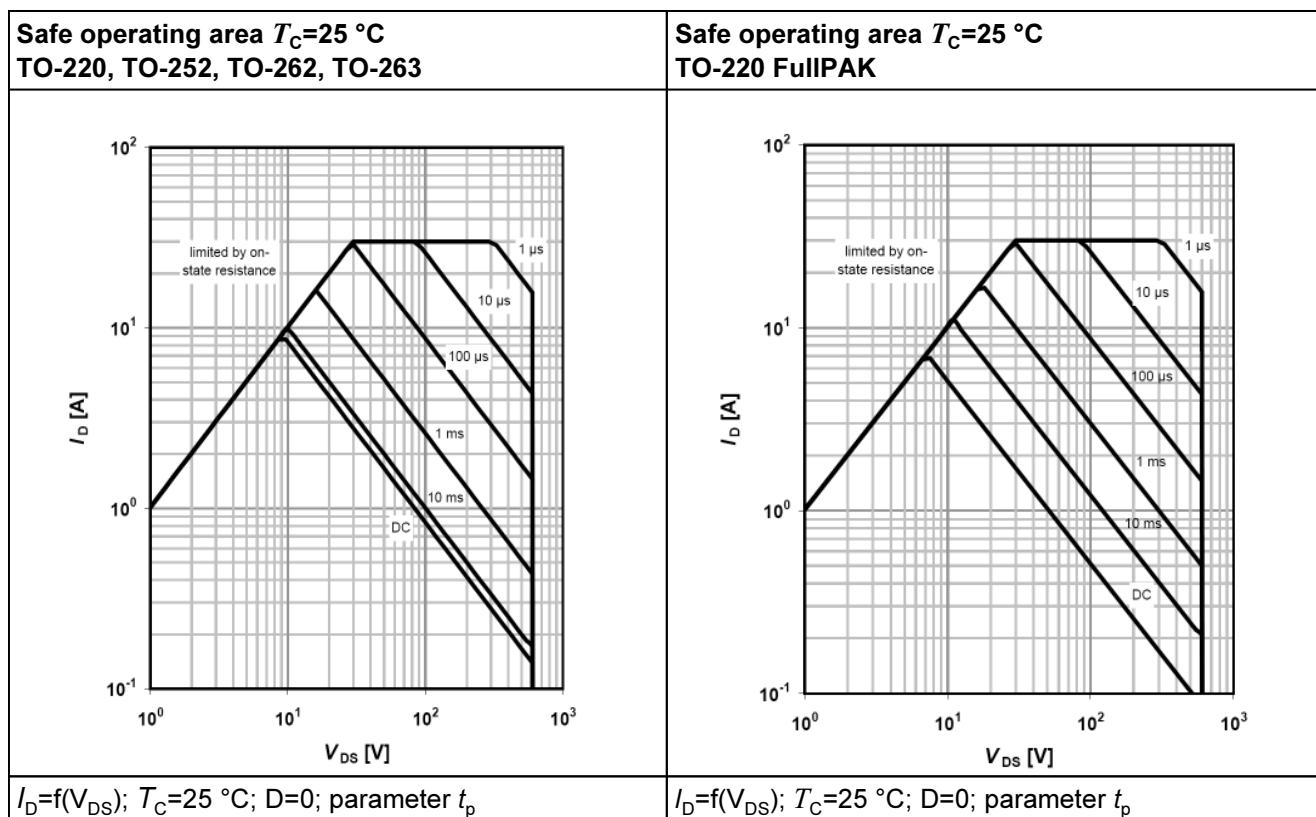
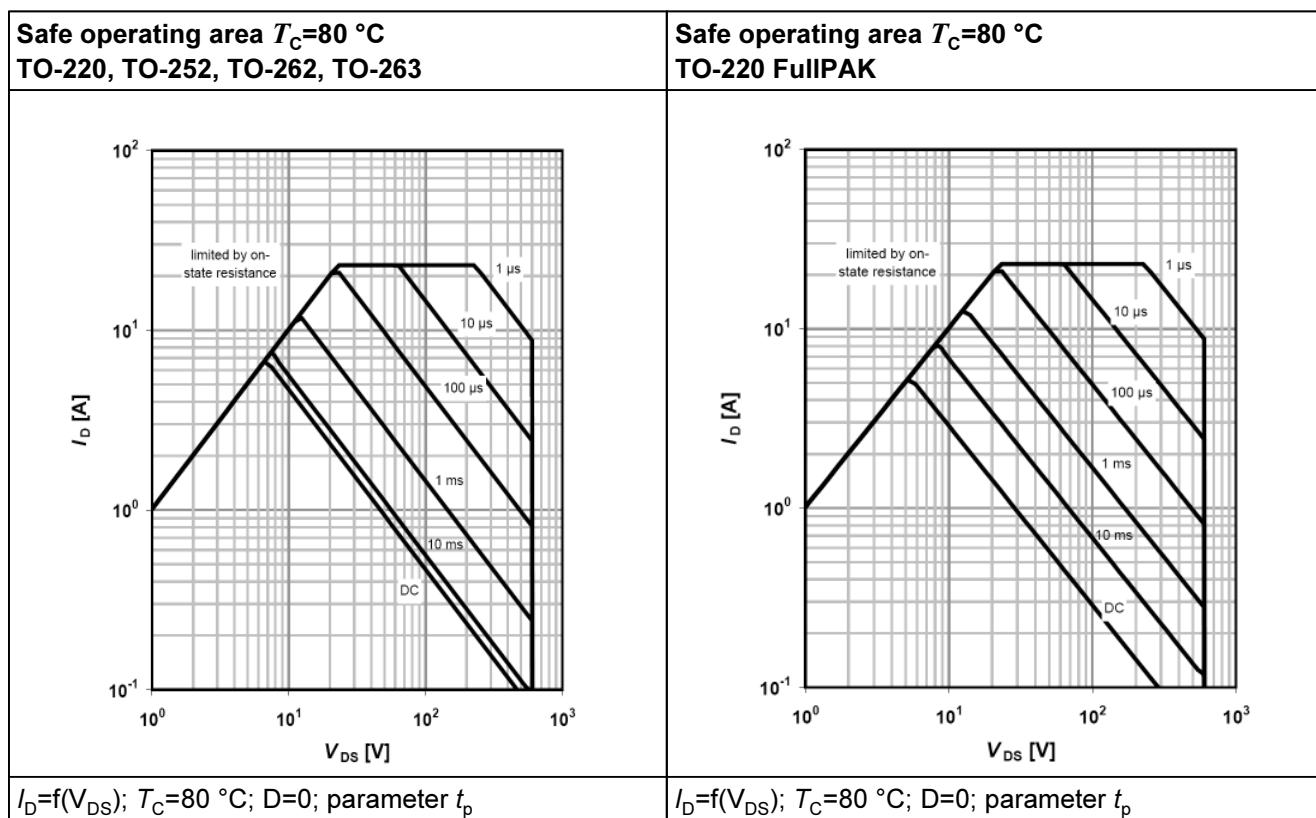
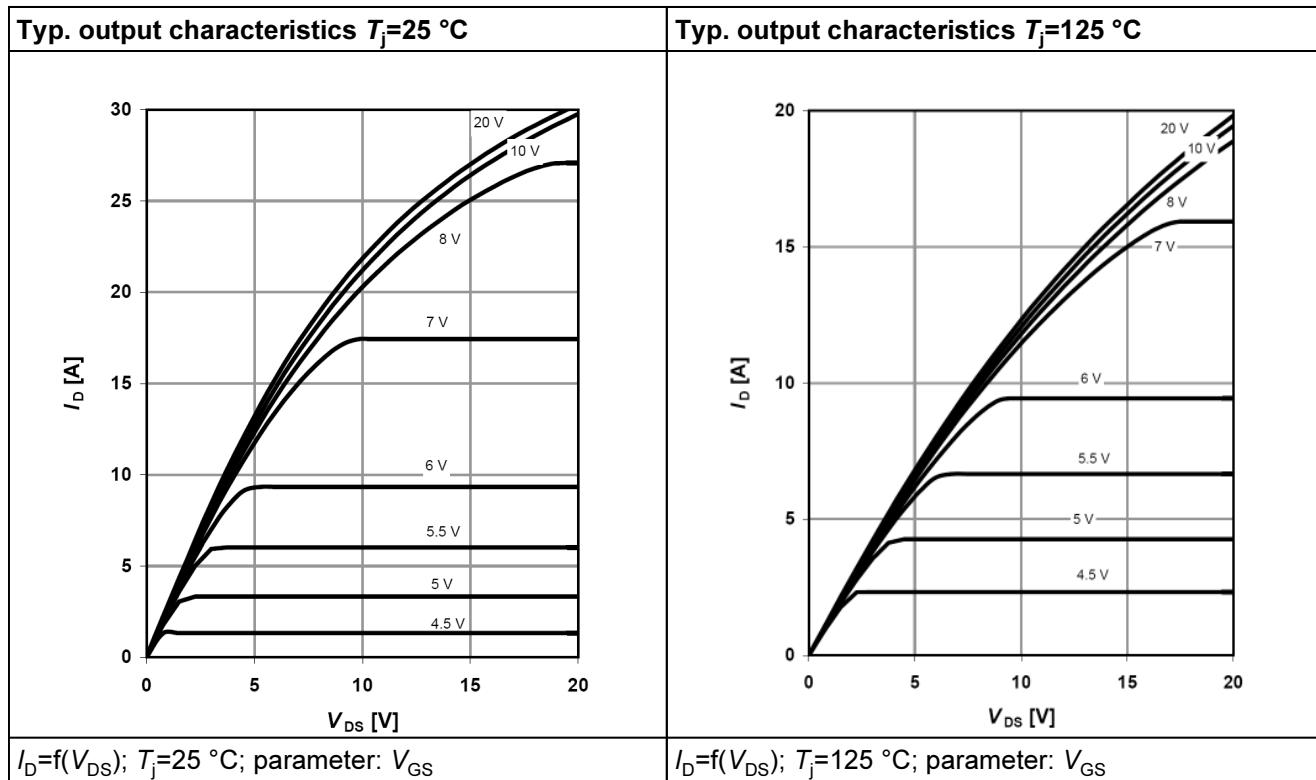
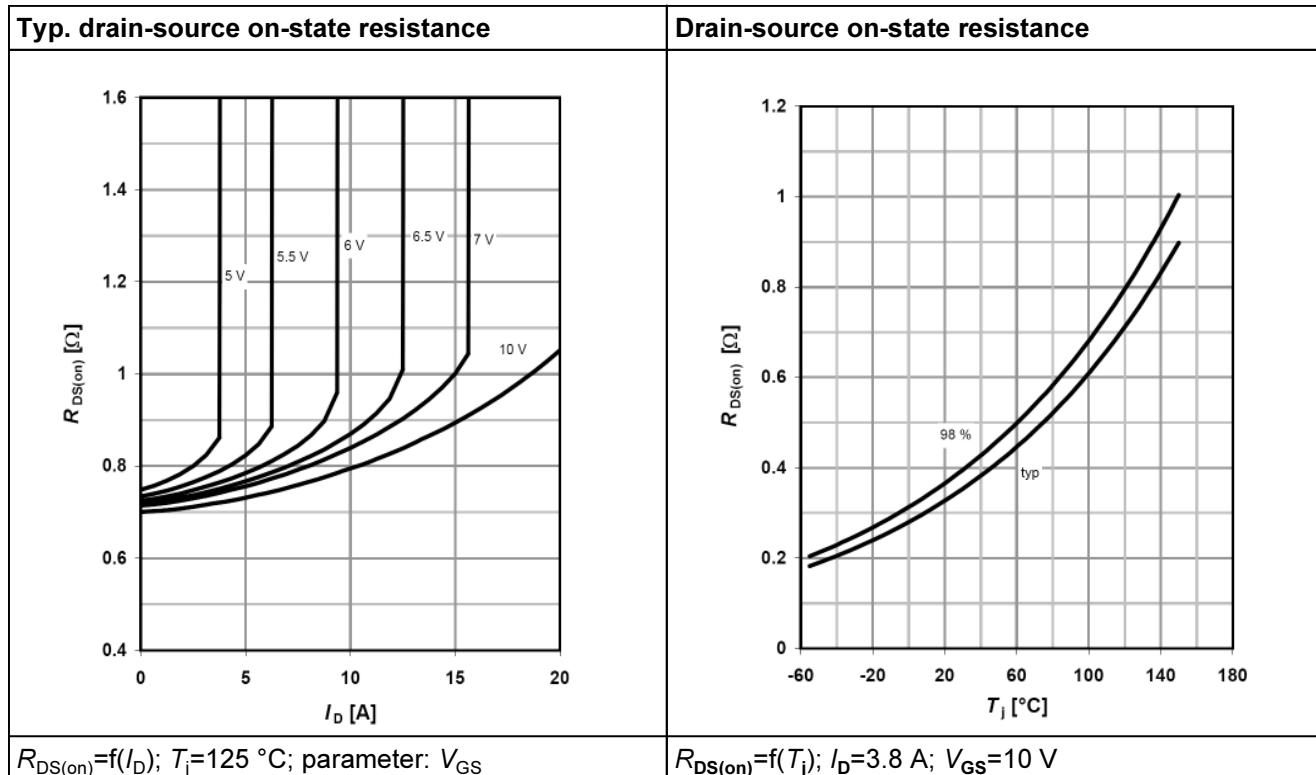
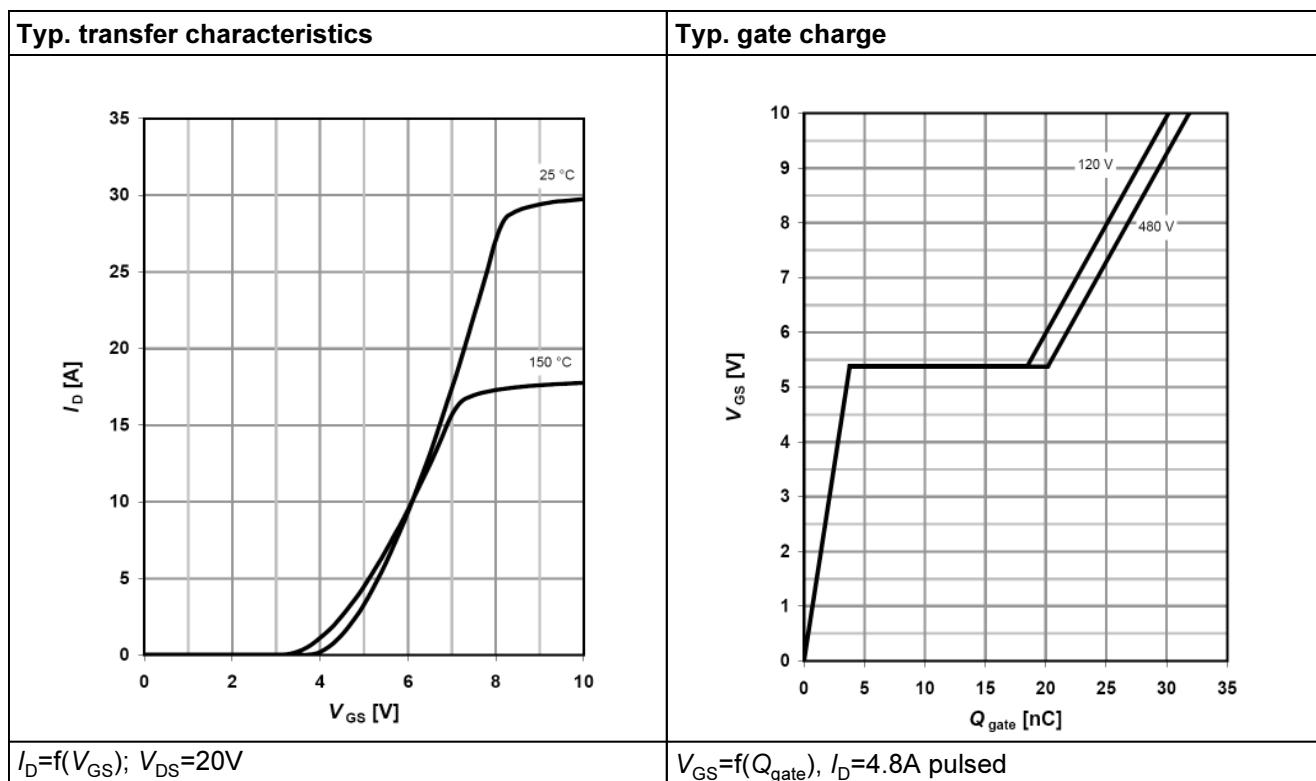
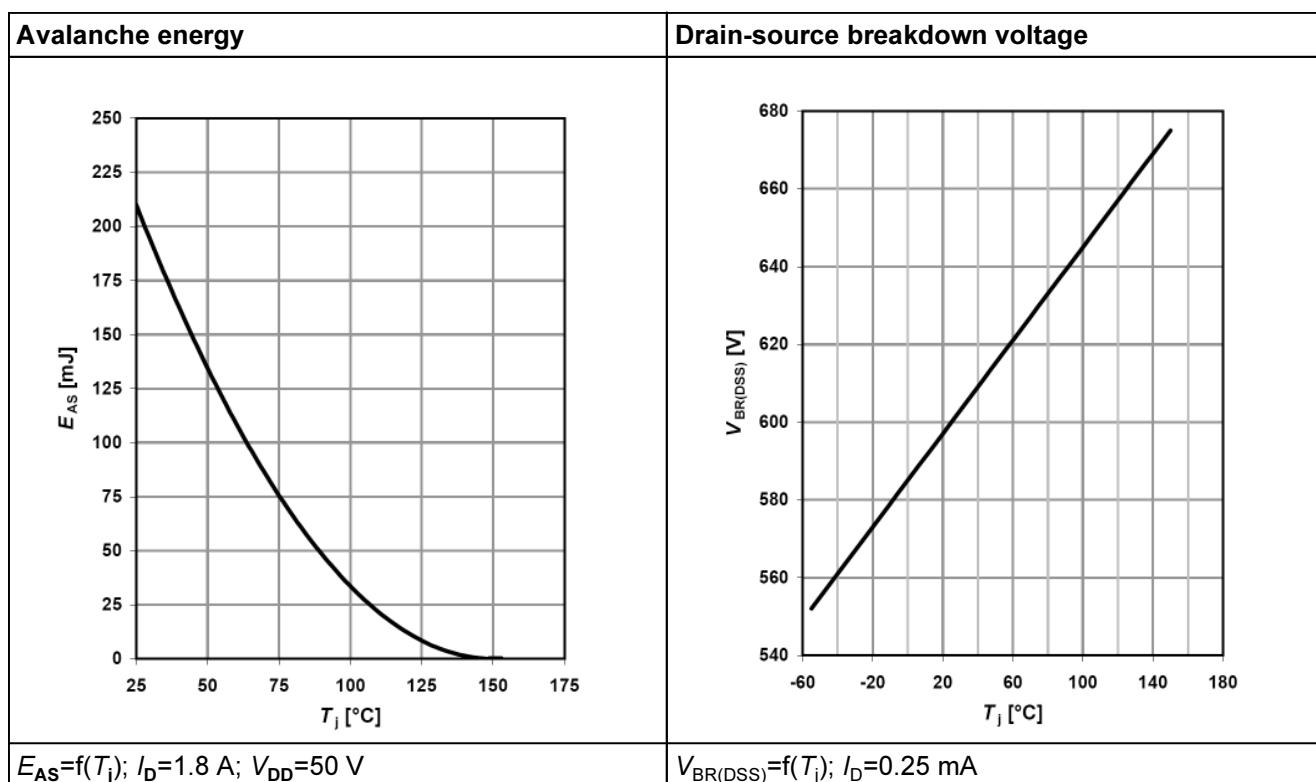
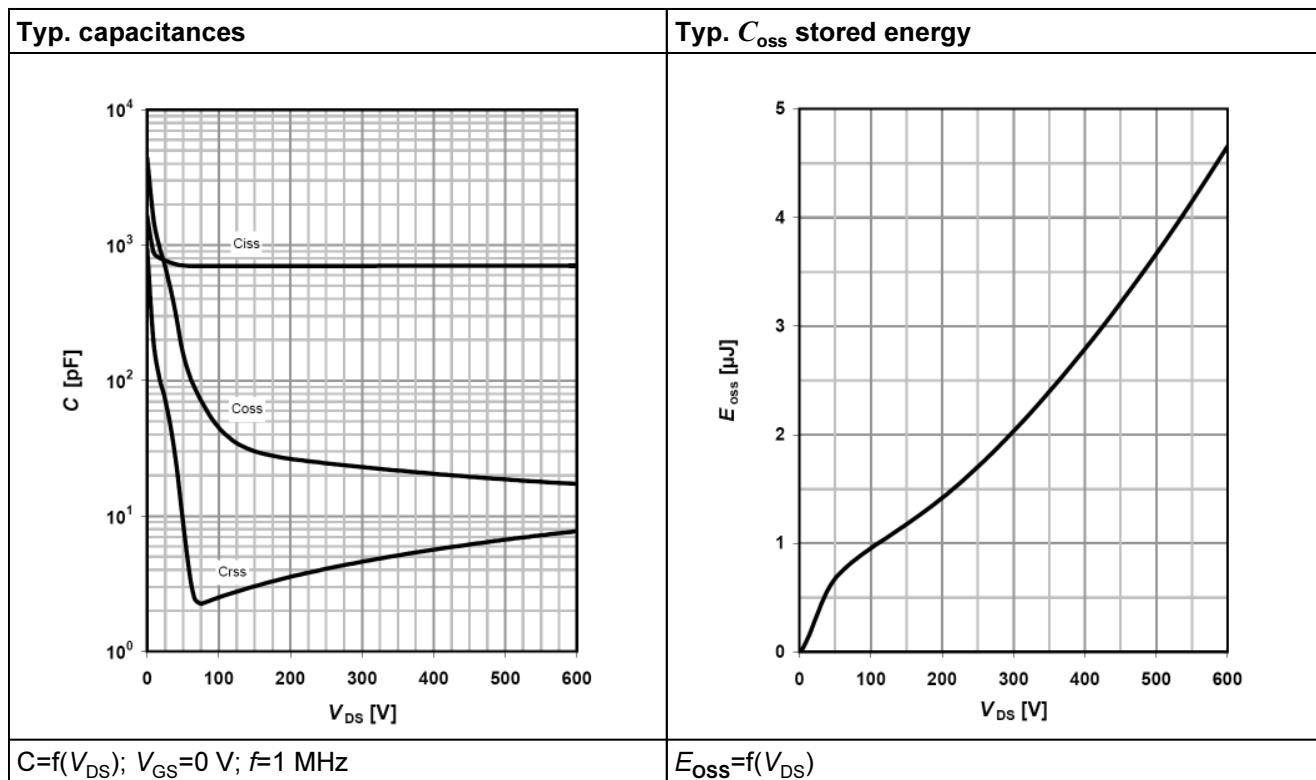
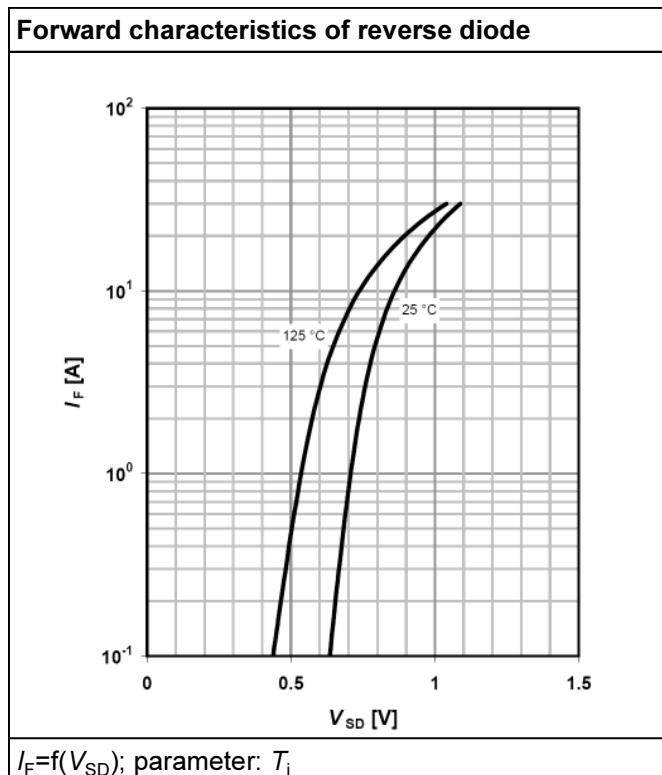


Table 12

Table 13


Electrical characteristics diagrams
Table 14

Table 15


Electrical characteristics diagrams
Table 16

Table 17


Electrical characteristics diagrams
Table 18

Table 19


6 Test circuits

Table 20 Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load	Switching time waveform

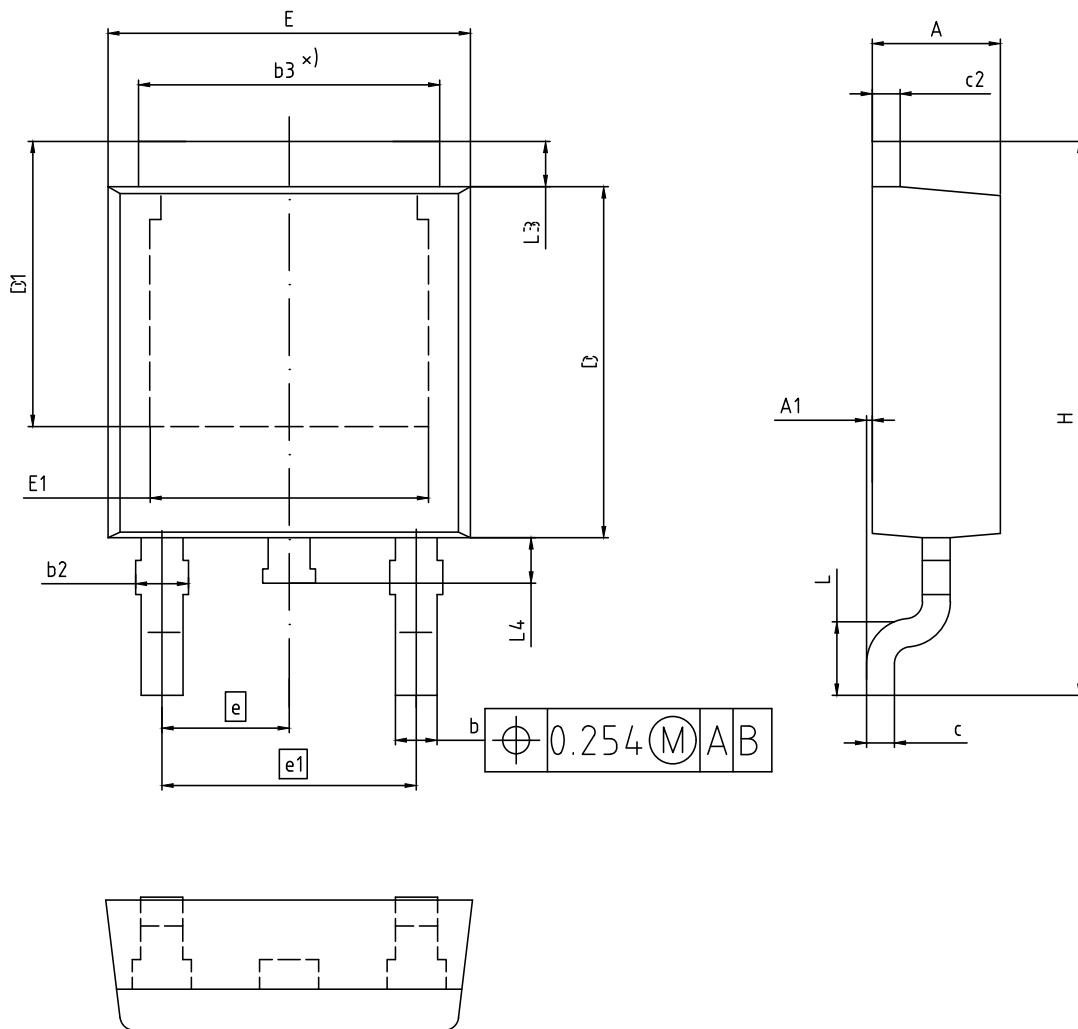
Table 21 Unclamped inductive load test circuit and waveform

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
<p>$R_{G1} = R_{G2}$</p>	

7 Package outlines

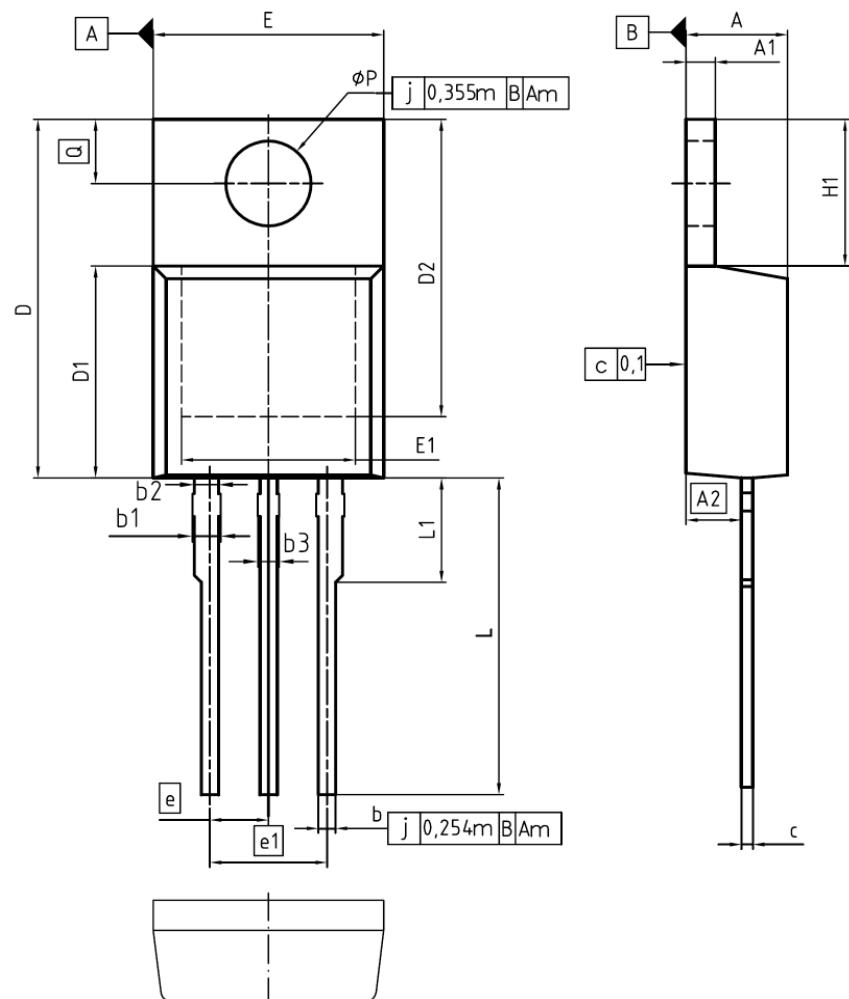


ALL DIMENSIONS REFER TO JEDEC
STANDARD TO-252 AND DO NOT INCLUDE MOLD
FLASH OR PROTRUSIONS.

DIMENSION	MILLIMETERS	
	MIN.	MAX.
A	2.16	2.41
A1	0.00	0.15
b	0.64	0.89
b2	0.65	1.15
b3	4.95	5.50
c	0.46	0.61
c2	0.40	0.98
D	5.97	6.22
D1	5.02	5.84
E	6.35	6.73
E1	4.32	5.50
e	2.29	
e1	4.57	
N	3	
H	9.40	10.48
L	1.18	1.78
L3	0.89	1.27
L4	0.51	1.02

DOCUMENT NO. Z8B00003328
REVISION 07
SCALE: 10:1
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EUROPEAN PROJECTION
ISSUE DATE 01.04.2020

Figure 1 Outlines TO-252, dimensions in mm



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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EUROPEAN PROJECTION	
ISSUE DATE	23-08-2007
REVISION	05

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

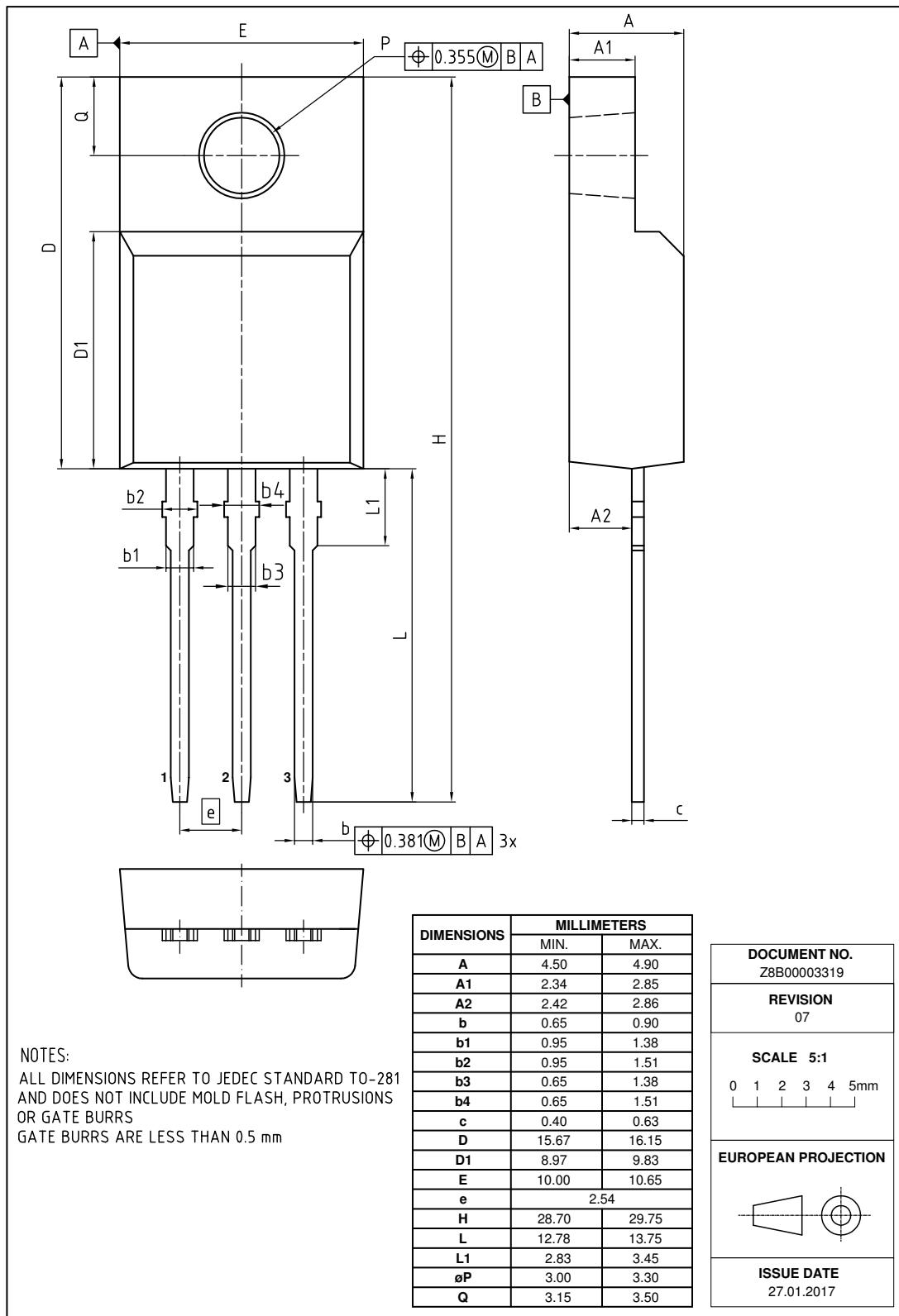
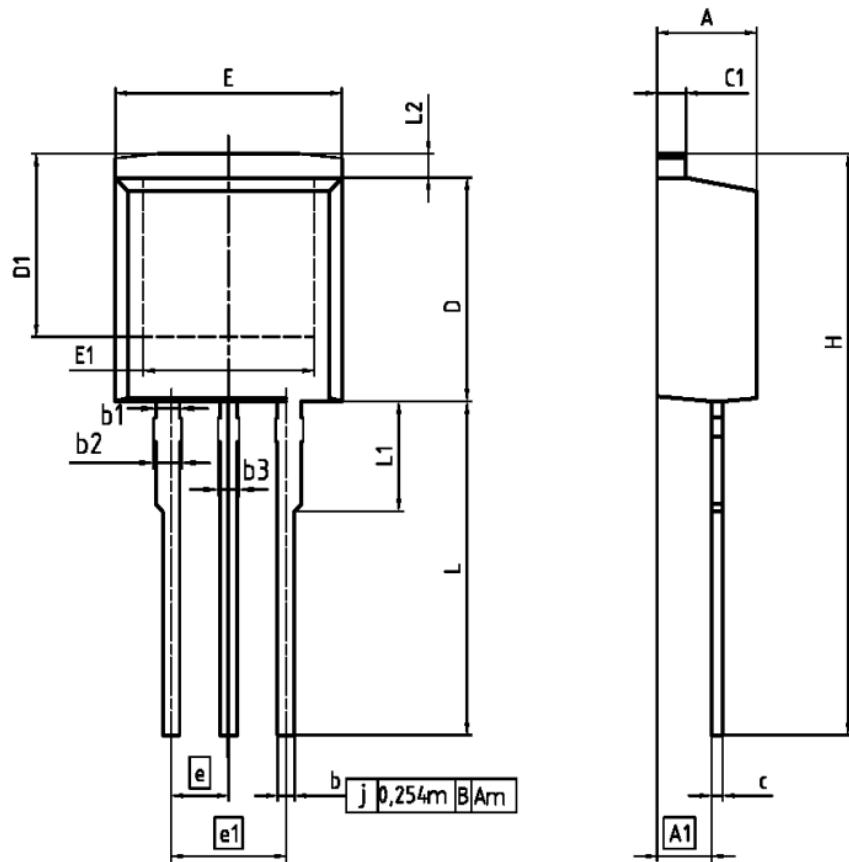


Figure 3 Outline PG-T0-220 FullPAK dimensions in mm

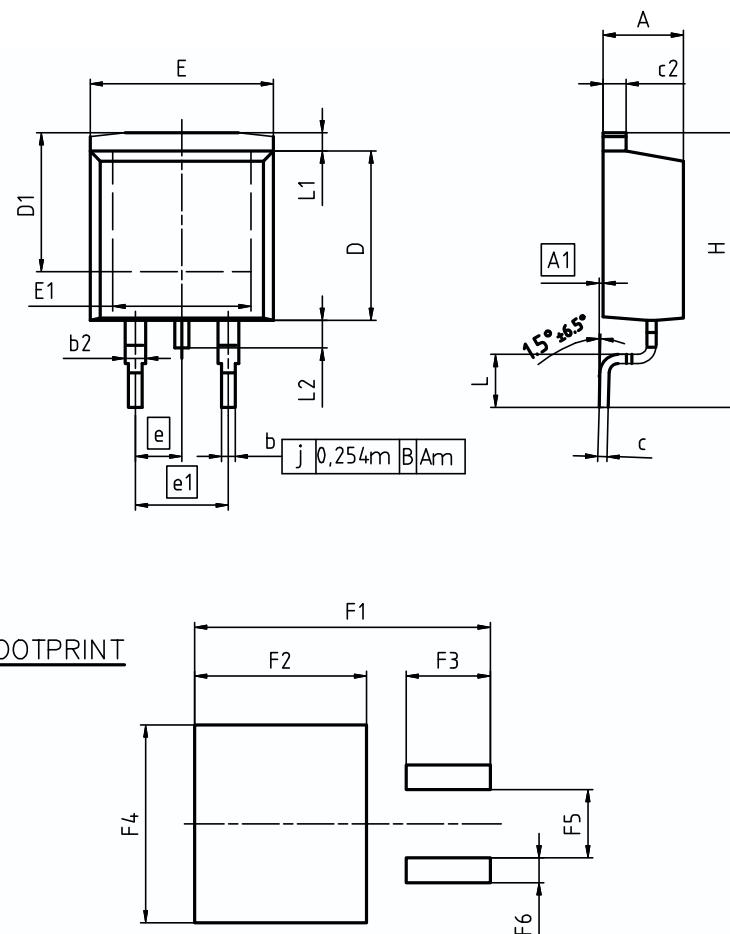


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.572	0.169	0.180
A1	2.150	2.718	0.085	0.107
b	0.650	0.864	0.026	0.034
b1	0.950	1.093	0.037	0.043
b2	0.950	1.400	0.037	0.055
b3	0.650	1.118	0.026	0.044
c	0.330	0.600	0.013	0.024
c1	1.170	1.400	0.046	0.055
D	8.509	8.450	0.335	0.372
D1	6.900	-	0.272	-
E	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 JEDEC TO262
SCALE
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2.5
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5mm
EUROPEAN PROJECTION
ISSUE DATE 05-05-2006
FILE TO262_1

Figure 4 Outlines TO-262, dimensions in mm/inches

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	0.65	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
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EUROPEAN PROJECTION
ISSUE DATE 30-08-2007
REVISION 01

Figure 5 Outlines TO-263, dimensions in mm/inches

Revision History

IPx60R380C6

Revision: 2020-05-20, Rev. 2.4

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	2015-02-09	PG-T0220 FullPAK package outline update (creation:2014-12-09)
2.3	2018-03-04	Outline PG-T0220 FullPAK update
2.4	2020-05-20	Update of the package outlines TO-252

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