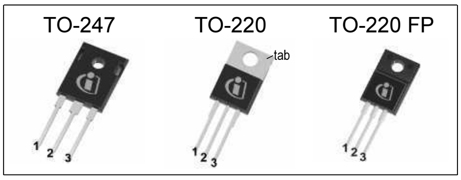
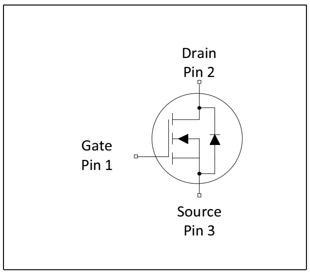
600V CoolMOS™ E6 Power Transistor

IPW60R190E6, IPP60R190E6, IPA60R190E6

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, Halogen free mold compound
- 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	0.19	Ω
Qg,typ	63	nC
ID,pulse	59	A
Eoss @ 400V	5.2	µJ
Body diode di/dt	500	A/µs

Type / Ordering Code	Package	Marking	Related Links
IPW60R190E6	PG-TO 247	6R190E6	see Appendix A
IPP60R190E6	PG-TO 220		
IPA60R190E6	PG-TO 220 FullPAK		

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			20.2	A	T_C = 25°C
				12.8		T_C = 100°C
Pulsed drain current[2]	$I_{D,pulse}$			59	A	T_C = 25°C
Avalanche energy, single pulse	E_{AS}			418	mJ	I_D = 3.4A, V_{DD} = 50V (see table 11)
Avalanche energy, repetitive	E_{AR}			0.63	mJ	I_D = 3.4A, V_{DD} = 50V
Avalanche current, repetitive	I_{AR}			3.4	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-247, TO-220	P_{tot}			151.0	W	T_C = 25°C
Power dissipation (FullPAK) TO-220 FP	P_{tot}			34.0	W	T_C = 25°C
Operating and storage temperature	T_j, T_{stg}	-55		150	°C	
Mounting torque (non FullPAK) TO-247, 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			17.5	A	T_C = 25°C
Diode pulse current	$I_{S,pulse}$			59	A	T_C = 25°C
Reverse diode dv/dt[3]	dv/dt			15	V/ns	V_{DS} = 0 ... 400V, $I_{SD} \leq I_D$, T_j = 25°C (see table 9)
Maximum diode commutation speed	di_f/dt			500	A/µs	
Insulation withstand voltage for TO-220FP	V_{ISO}	-	-	2500	V	V_{rms}, T_C=25°C, t=1min

[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-247, TO-220

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}			0.83	°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}			3.7	°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

4 Electrical characteristics

at T_j = 25°C, unless otherwise specified

Table 5 Static characteristics

Parameter	Symbol	Values Min.	Values Typ.	Values Max.	Unit	Note / Test Condition
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 = 0.63mA
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	$R_{DS(on)}$		0.170	0.19	Ω	V_{GS} = 10V, I_D = 9.5A, T_j = 25°C
			0.440			V_{GS} = 10V, I_D = 9.5A, T_j = 150°C
Gate resistance	R_G		6		Ω	f = 1MHz, open drain

Table 6 Dynamic characteristics

Parameter	Symbol	Values Min.	Values Typ.	Values Max.	Unit	Note / Test Condition
Input capacitance	C_{iss}		1400		pF	V_{GS} = 0V, V_{DS} = 100V, f = 1MHz
Output capacitance	C_{oss}		85		pF	
Effective output capacitance, energy related[1]	$C_{o(er)}$		56		pF	V_{GS} = 0V, V_{DS} = 0 ... 480V
Effective output capacitance, time related[2]	$C_{o(tr)}$		266		pF	I_D = constant, V_{GS} = 0V, V_{DS} = 0 ... 480V
Turn-on delay time	$t_{d(on)}$		12		ns	V_{DD} = 400V, V_{GS} = 13V, I_D = 9.5A, R_G = 3.4Ω (see table 10)
Rise time	t_r		10		ns	
Turn-off delay time	$t_{d(off)}$		90		ns	
Fall time	t_f		8		ns	

Table 7 Gate charge characteristics

Parameter	Symbol	Values Min.	Values Typ.	Values Max.	Unit	Note / Test Condition
Gate to source charge	Q_{gs}		7.6		nC	V_{DD} = 480V, I_D = 9.5A, V_{GS} = 0 to 10V
Gate to drain charge	Q_{gd}		32		nC	
Gate charge total	Q_g		63		nC	
Gate plateau voltage	$V_{plateau}$		5.4		V	

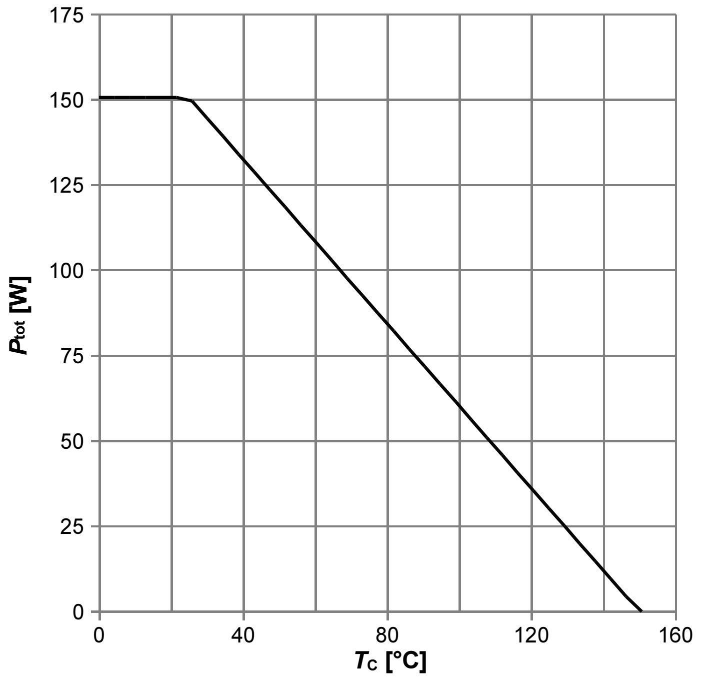
[1] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(BR)DSS}$
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(BR)DSS}$

Table 8 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 = 9.5A, T_j = 25°C
Reverse recovery time	t_{rr}		430		ns	V_R = 400V, I_F = 9.5A, di_F/dt = 100A/µs (see table 9)
Reverse recovery charge	Q_{rr}		6.9		µC	
Peak reverse recovery current	I_{rrm}		30		A	

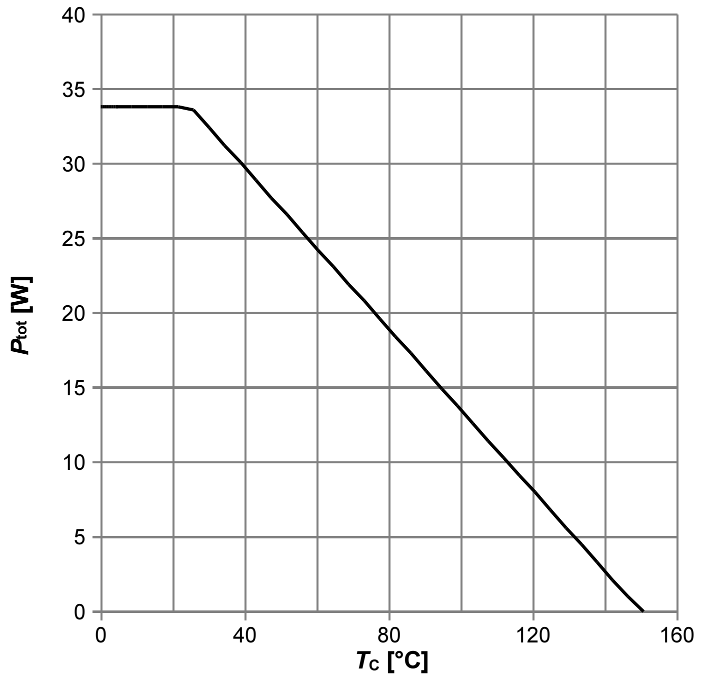
5 Electrical characteristics diagrams

Power dissipation (Non FullPAK)



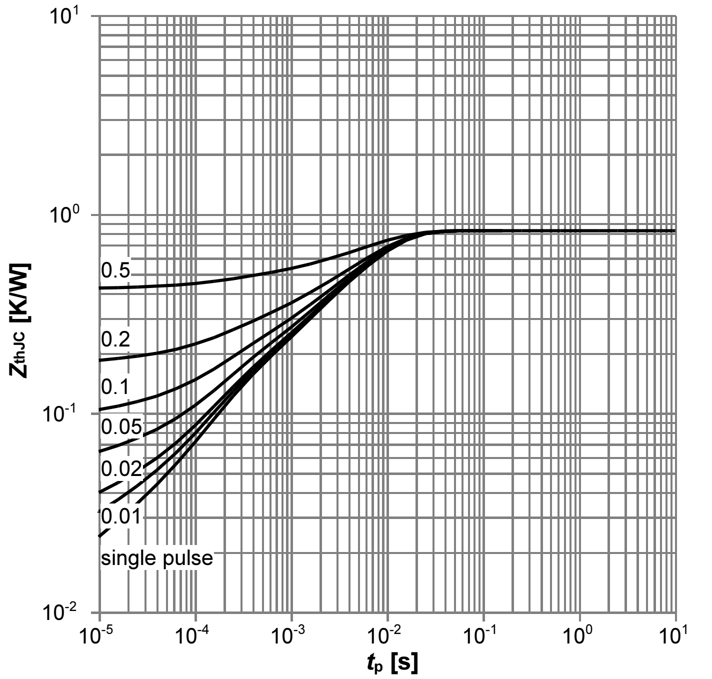
P_{tot}=f(T_C)

Power dissipation (FullPAK)



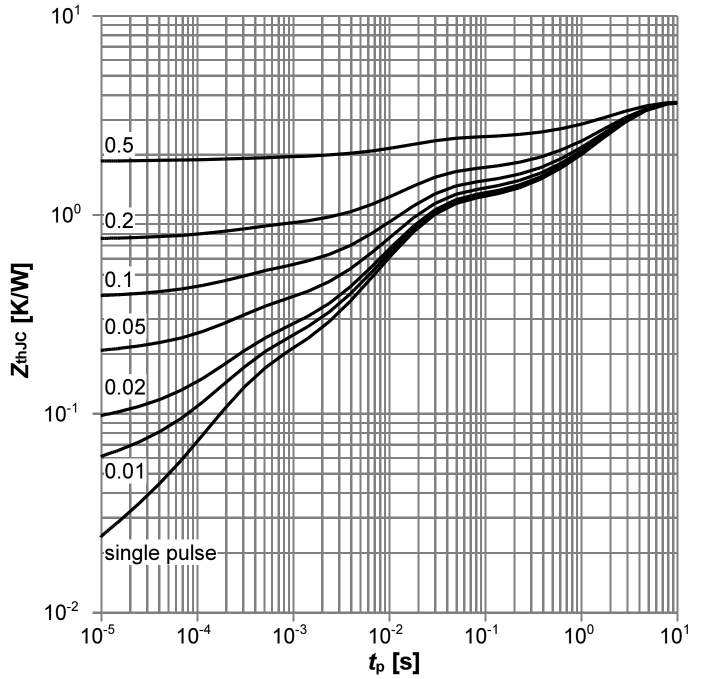
P_{tot}=f(T_C)

Max. transient thermal impedance (Non FullPAK)



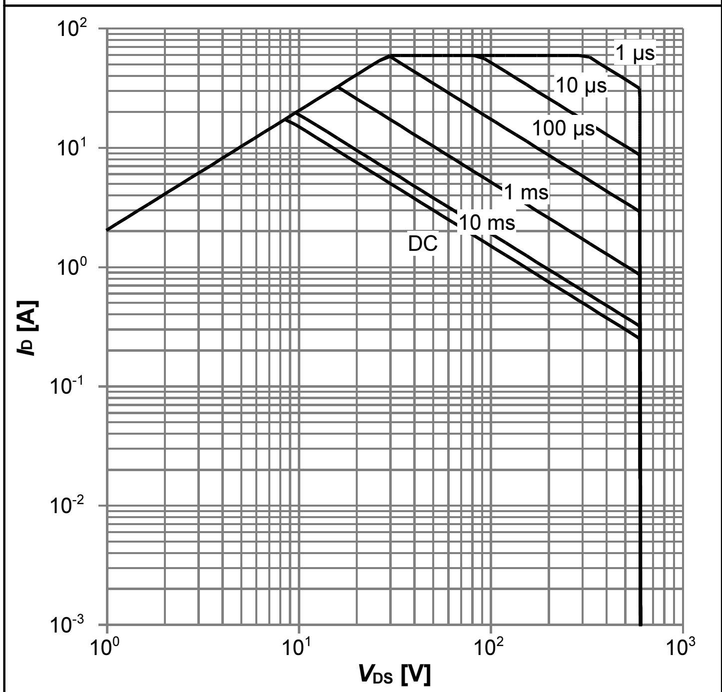
Z_{thJC} =f(t_P); parameter: D=t_p/T

Max. transient thermal impedance (FullPAK)



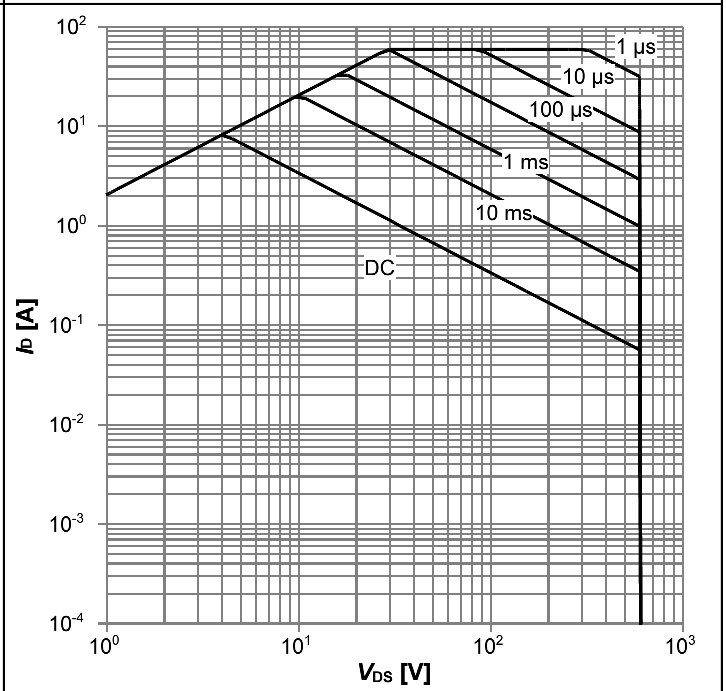
Z_{thJC} =f(t_P); parameter: D=t_p/T

Safe operating area T_C=25°C (Non FullPAK)



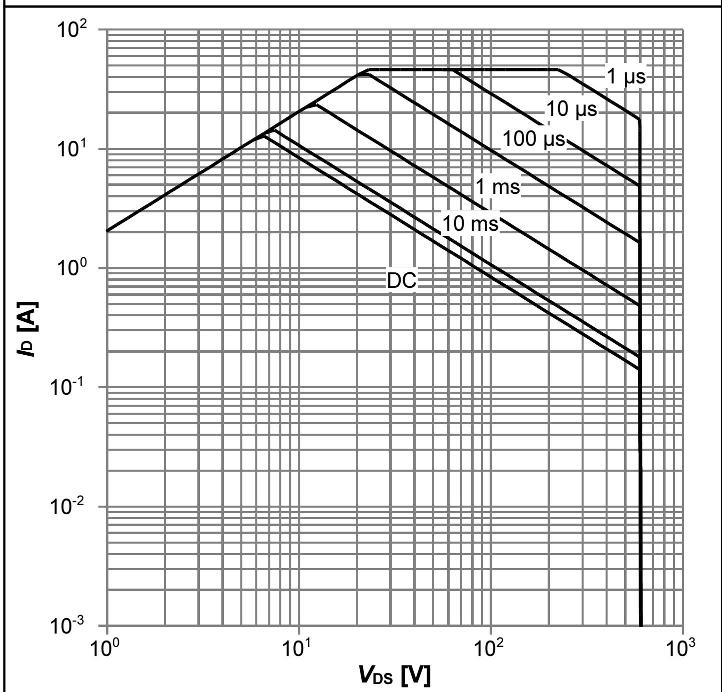
I_D=f(V_{DS}); T_C=25 °C; D=0; parameter: t_p

Safe operating area T_C=25°C (FullPAK)



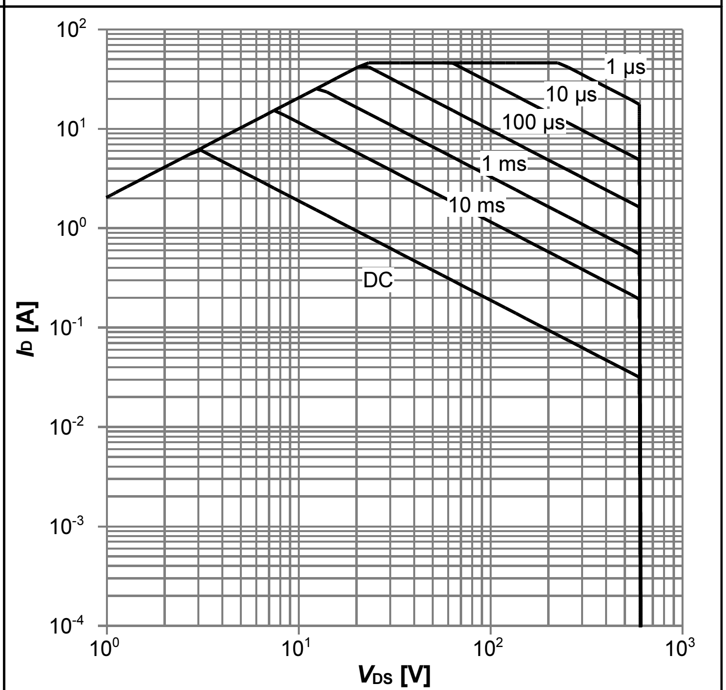
I_D=f(V_{DS}); T_C=25 °C; D=0; parameter: t_p

Safe operating area T_C=80°C (Non FullPAK)



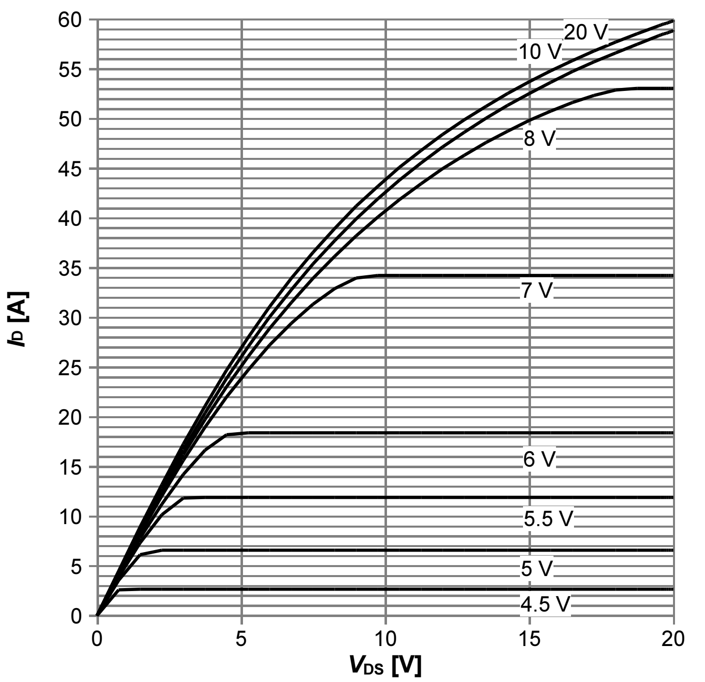
I_D=f(V_{DS}); T_C=80 °C; D=0; parameter: t_p

Safe operating area T_C=80°C (FullPAK)



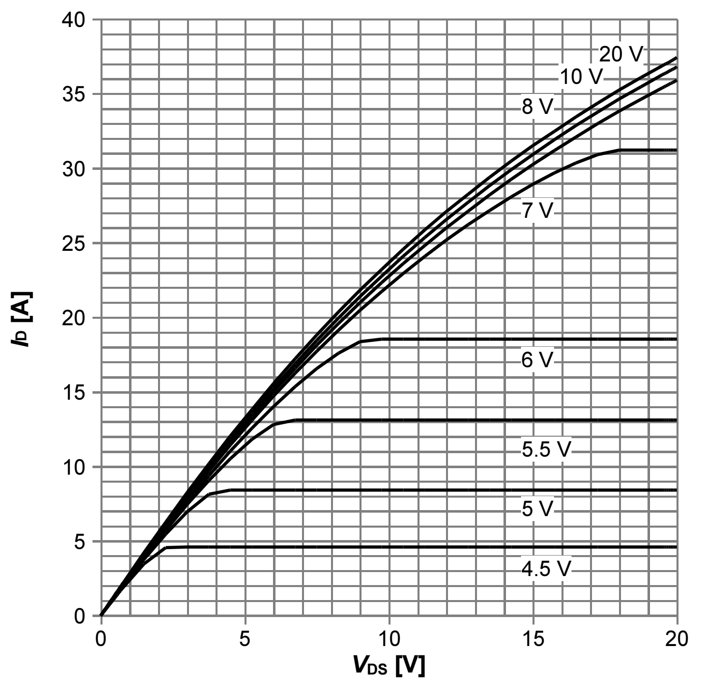
I_D=f(V_{DS}); T_C=80 °C; D=0; parameter: t_p

Typ. output characteristics T_C=25°C



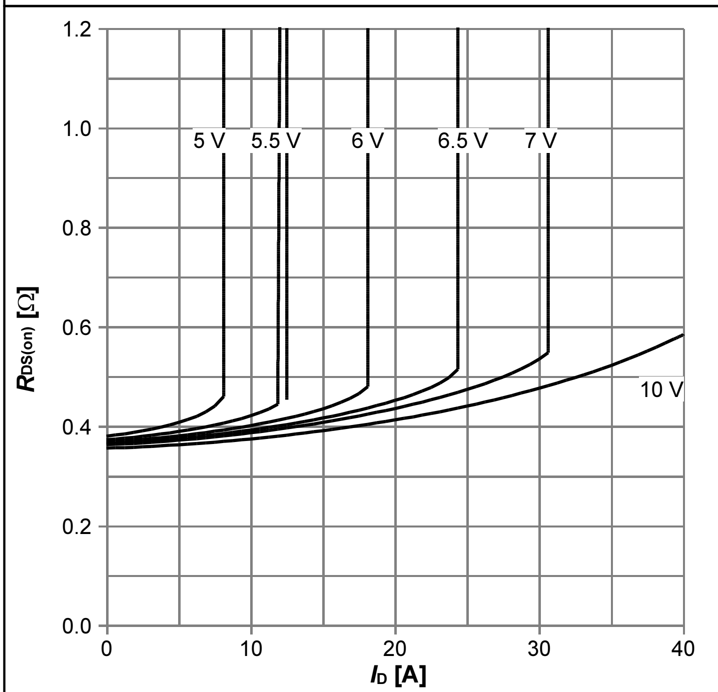
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}

Typ. output characteristics T_C=125°C



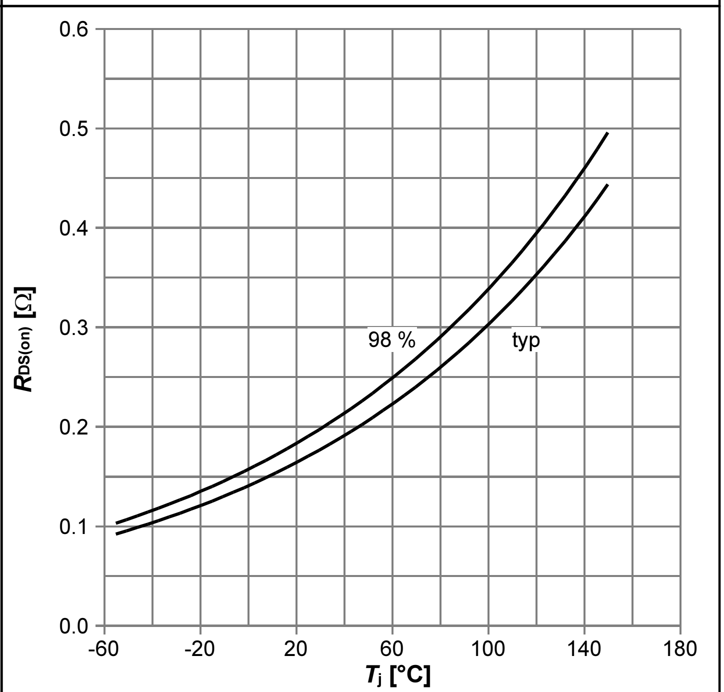
I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

Typ. drain-source on-state resistance



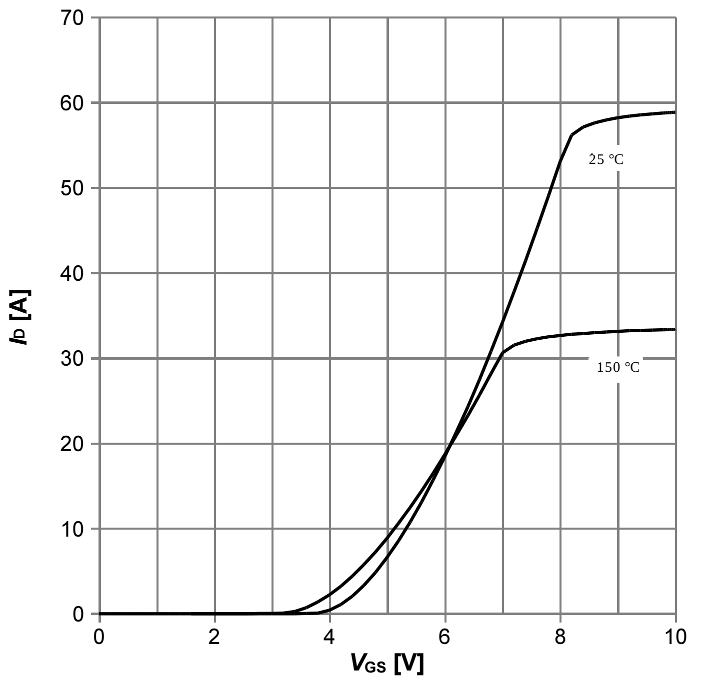
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}

Drain-source on-state resistance



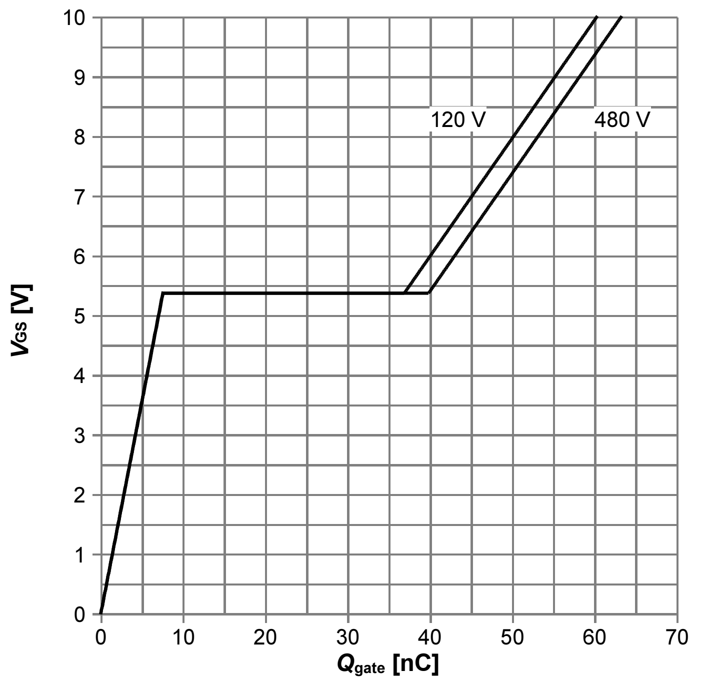
$R_{DS(on)}$=f(T_j); I_D=9.5 A; V_{GS}=10 V

Typ. transfer characteristics



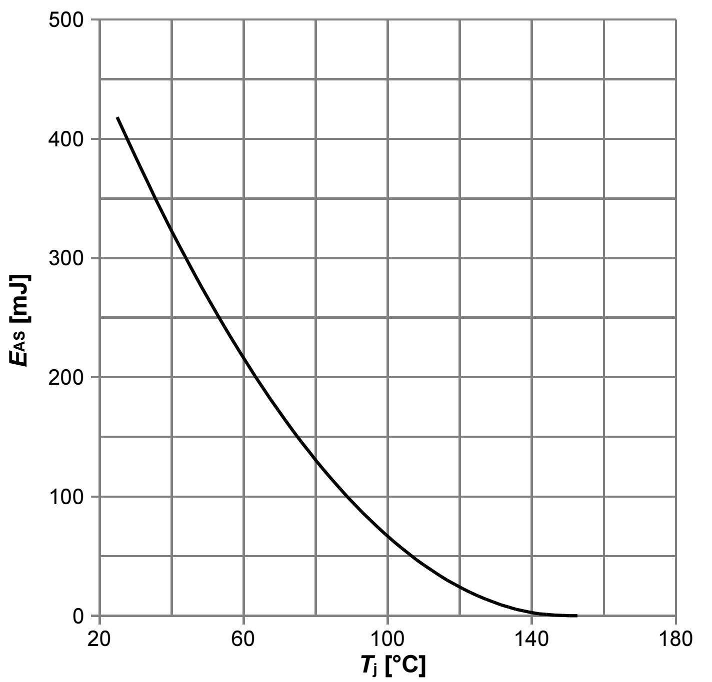
I_D=f(V_{GS}); V_{DS}=20V; parameter: T_j

Typ. gate charge



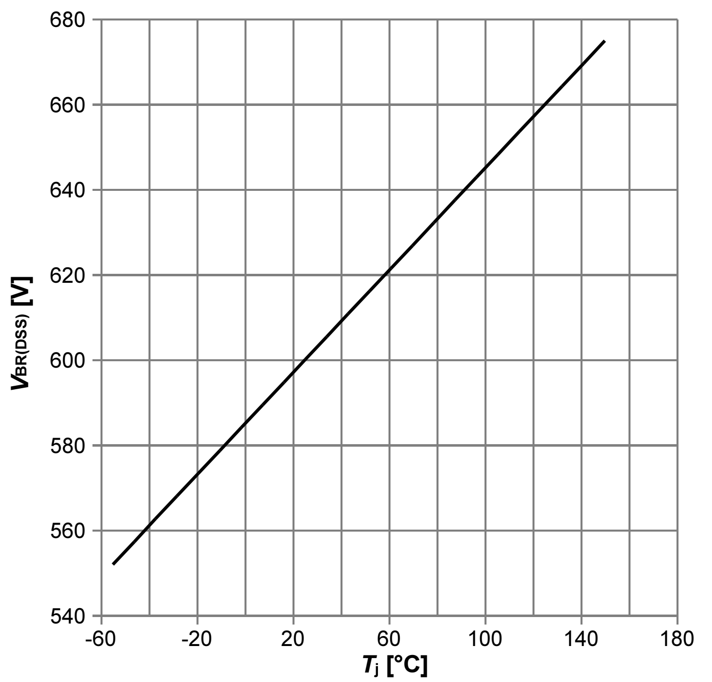
V_{GS}=f(Q_{gate}); I_D=9.5 A pulsed; parameter: V_{DD}

Avalanche energy



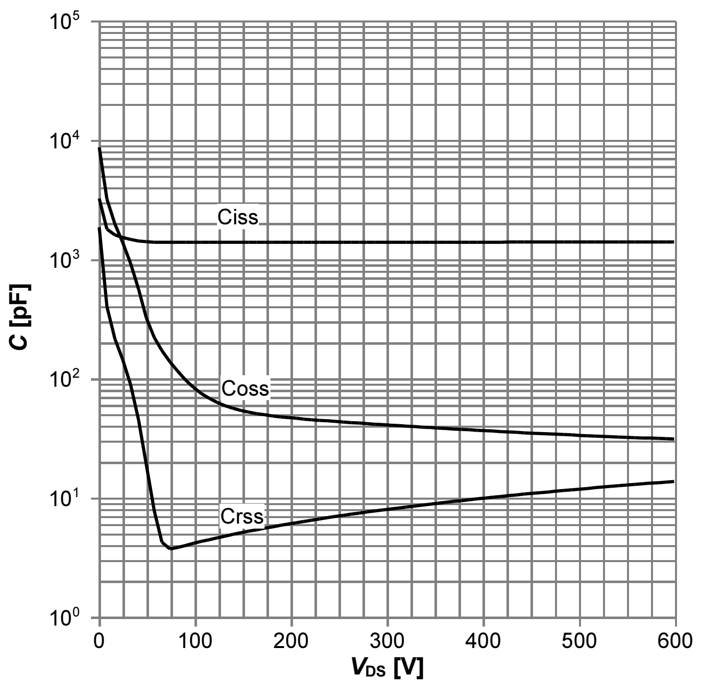
E_{AS}=f(T_j); I_D=3.4 A; V_{DD}=50 V

Drain-source breakdown voltage



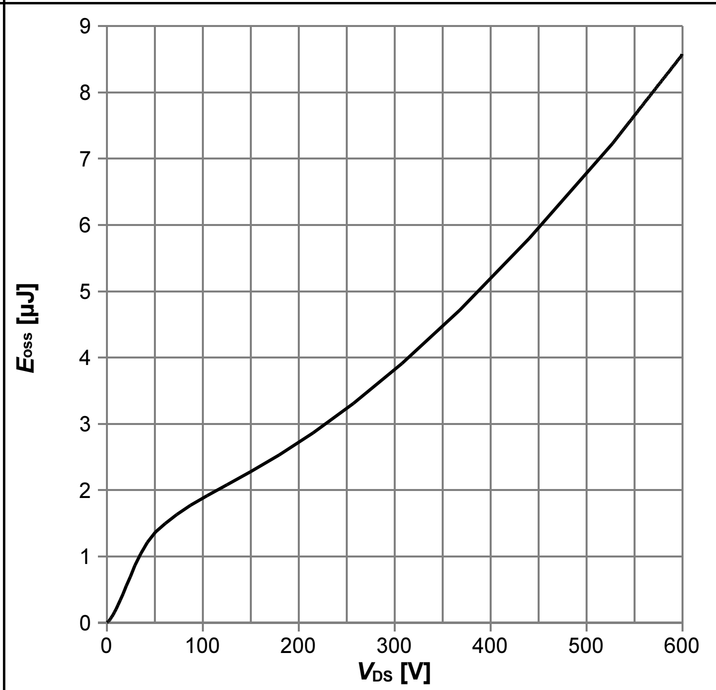
$V_{BR(DSS)}$=f(T_j); I_D=0.25 mA

Typ. capacitances



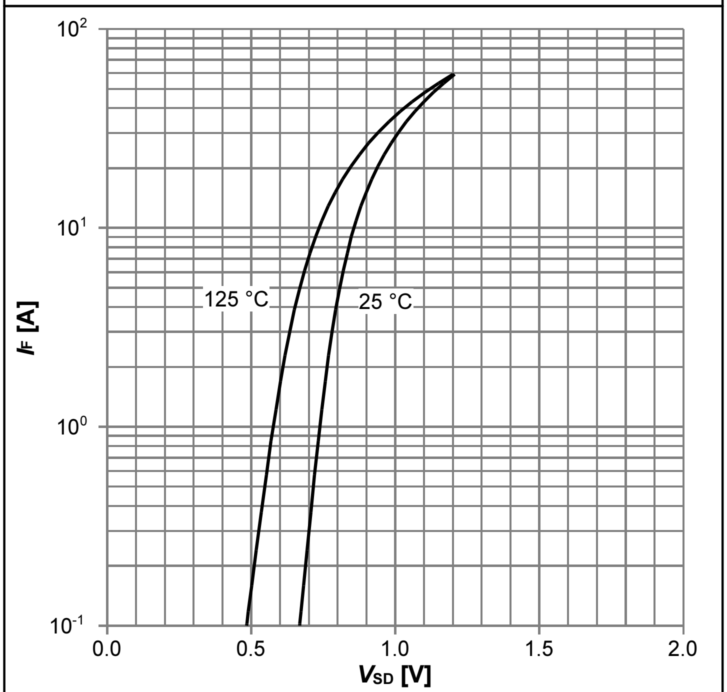
C=f(V_{DS}); V_{GS}=0 V; f=1 MHz

Typ. C_{oss} stored energy



E_{oss}=f(V_{DS})

Forward characteristics of reverse diode



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

6 Test Circuits

Table 9 Diode characteristics

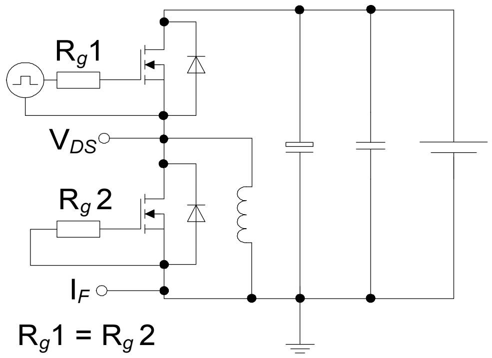
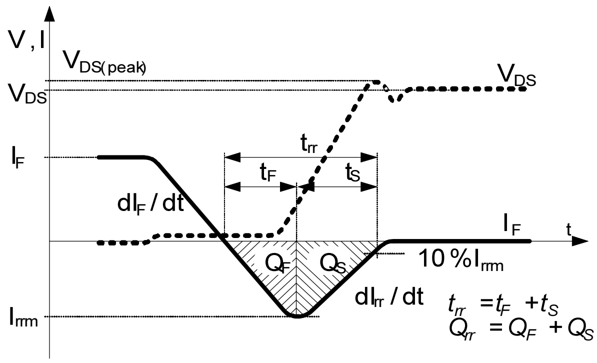
Test circuit for diode characteristics	Diode recovery waveform
	

Table 10 Switching times

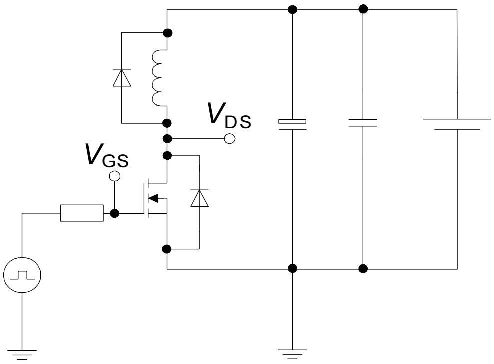
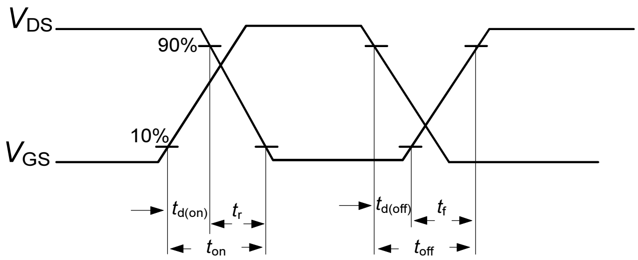
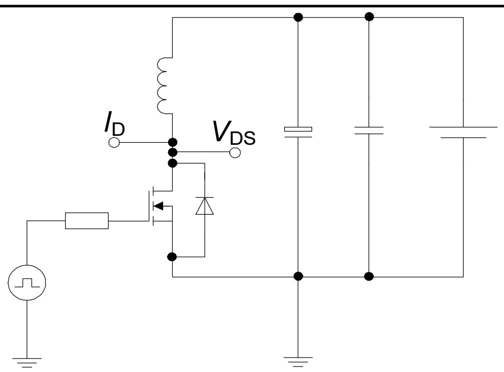
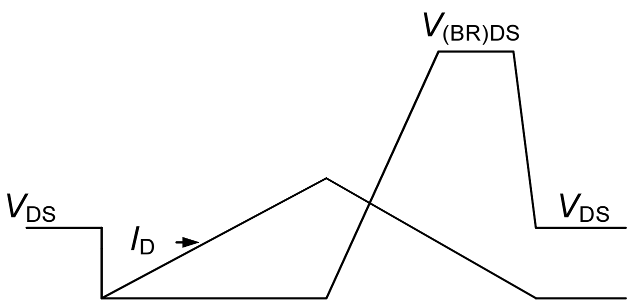
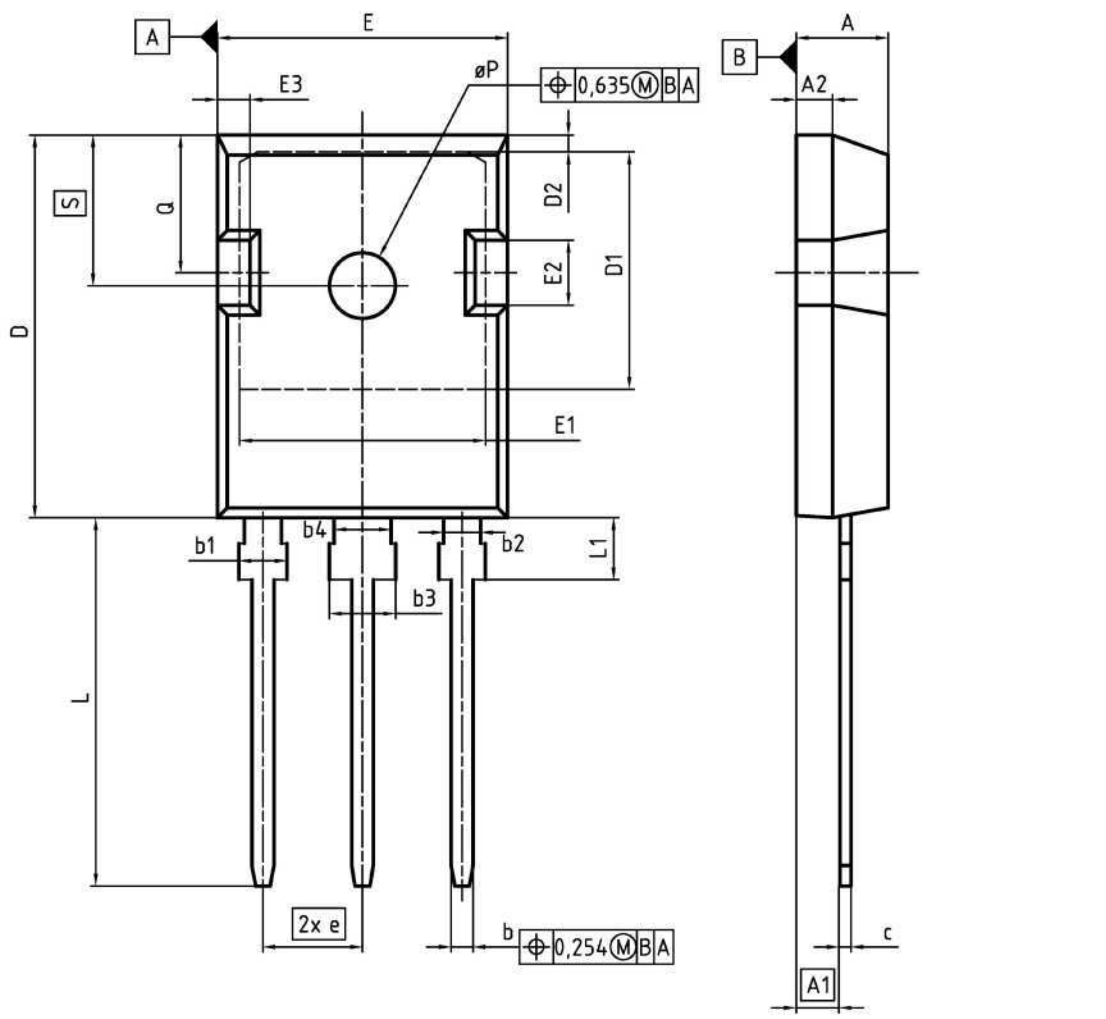
Switching times test circuit for inductive load	Switching times waveform
	

Table 11 Unclamped inductive load

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

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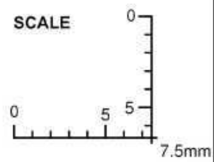
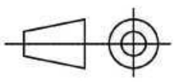


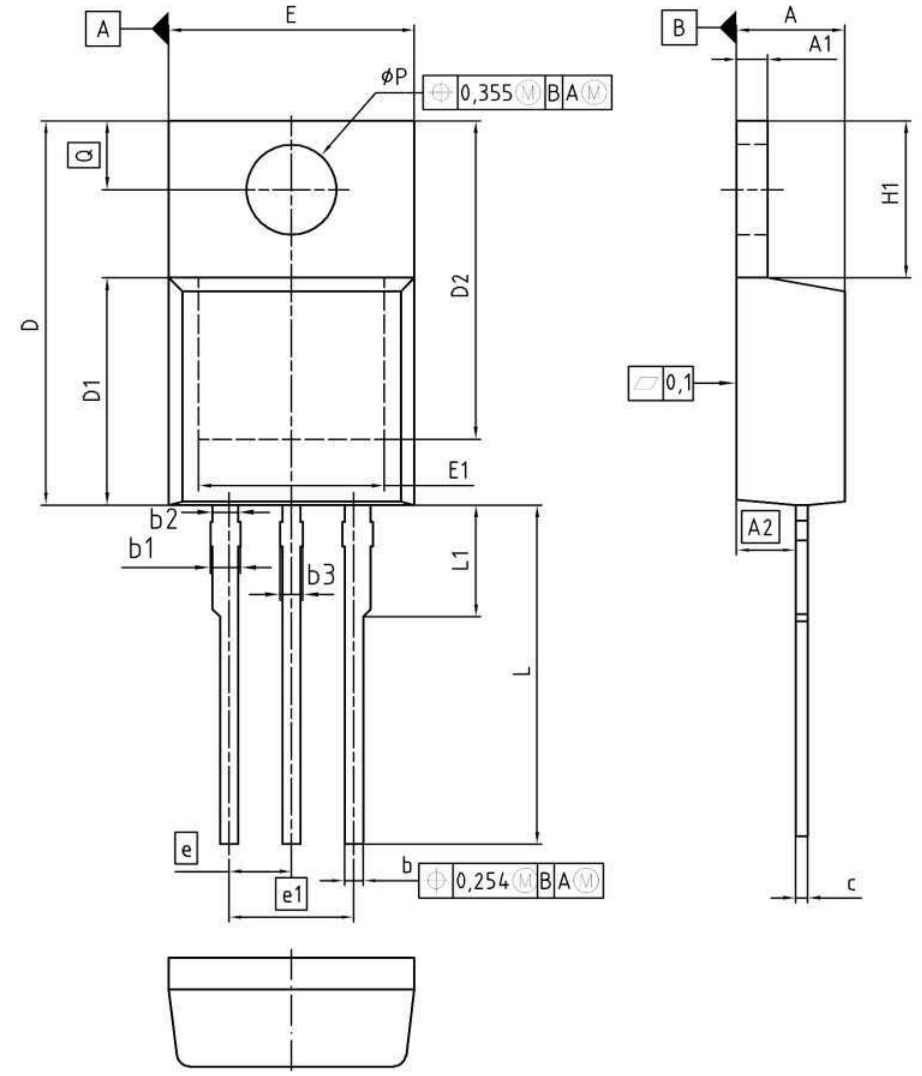
EUROPEAN PROJECTION



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	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

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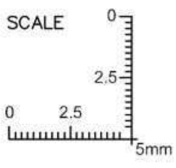

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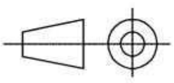
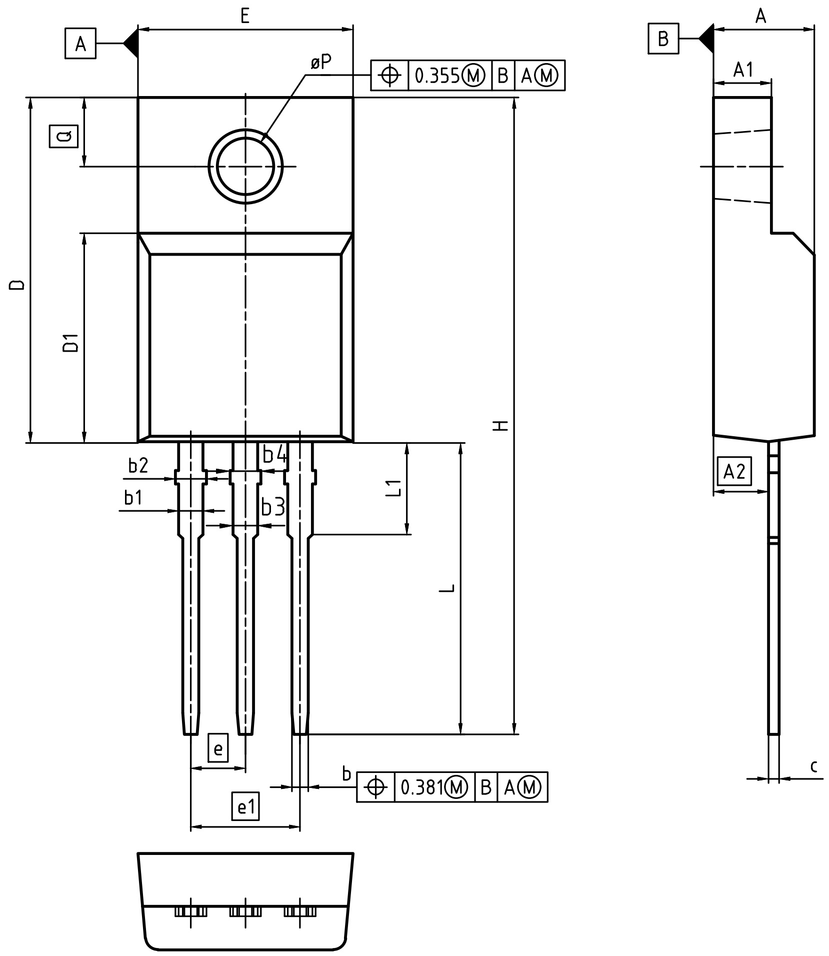


ISSUE DATE
30-07-2009

REVISION
06

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



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.50	4.90	0.177	0.193
A1	2.34	2.85	0.092	0.112
A2	2.42	2.86	0.095	0.113
b	0.65	0.90	0.026	0.035
b1	0.95	1.38	0.037	0.054
b2	0.95	1.51	0.037	0.059
b3	0.65	1.38	0.026	0.054
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.67	16.15	0.617	0.636
D1	8.97	9.83	0.353	0.387
E	10.00	10.65	0.394	0.419
e	2.54 (BSC)		0.100 (BSC)	
e1	5.08		0.200	
N	3		3	
H	28.70	29.75	1.130	1.171
L	12.78	13.75	0.503	0.541
L1	2.83	3.45	0.111	0.136
øP	2.95	3.38	0.116	0.133
Q	3.15	3.50	0.124	0.138

DOCUMENT NO.
Z8B00003319

SCALE 0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
05-05-2014

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

8 Appendix A

Table 12 Related Links

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

Revision History

IPX60R190E6

Revision: 2017-10-17, Rev. 2.4

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.4	2017-10-17	Rev. 2.1 to Rev. 2.3: Package drawing modifications. Rev. 2.4: Added Full PAK insulation voltage rating in Table 2 on page 3. Revised transfer characteristics graph on Page 10

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Published by
Infineon Technologies AG
81726 München, Germany

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