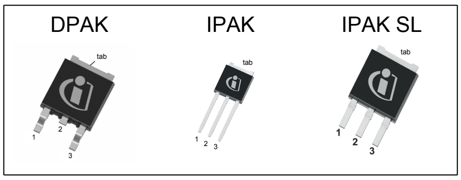
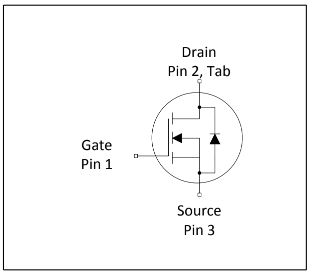
MOSFET

600V CoolMOS™ CE Power Transistor

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ CE is a price-performance optimized platform enabling to target cost sensitive applications in Consumer and Lighting markets by still meeting highest efficiency standards. The new series provides all benefits of a fast switching Superjunction MOSFET while not sacrificing ease of use and offering the best cost down performance ratio available on the market.





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 standard grade applications

Applications

PFC stages, hard switching PWM stages and resonant switching stages for e.g. PC Silverbox, Adapter, LCD & PDP TV and indoor Lighting.

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
$R_{DS(on),max}$	3400	mΩ
$I_{d.}$	2.6	A
$Q_{g.typ}$	4.6	nC
$I_{D,pulse}$	3.9	A
E_{oss}@400V	0.57	µJ

Type / Ordering Code	Package	Marking	Related Links
IPD60R3K4CE	PG-TO 252	60S3K4CE	see Appendix A
IPU60R3K4CE	PG-TO 251		
IPS60R3K4CE	PG-TO 251		

Table of Contents

1 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	- -	- -	2.6 1.6	A	T_C=25°C T_C=100°C
Pulsed drain current[2]	$I_{D,pulse}$	-	-	3.9	A	T_C=25°C
Avalanche energy, single pulse	E_{AS}	-	-	6	mJ	I_D=0.3A; V_{DD}=50V; see table 11
Avalanche energy, repetitive	E_{AR}	-	-	0.04	mJ	I_D=0.3A; V_{DD}=50V; see table 11
Avalanche current, repetitive	I_{AR}	-	-	0.3	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	50	V/ns	V_{DS}=0...480V
Gate source voltage (static)	V_{GS}	-20	-	20	V	static;
Gate source voltage (dynamic)	V_{GS}	-30	-	30	V	AC (f>1 Hz)
Power dissipation TO-252	P_{tot}	-	-	29	W	T_C=25°C
Storage temperature	T_{stg}	-40	-	150	°C	-
Operating junction temperature	T_j	-40	-	150	°C	-
Continuous diode forward current	I_S	-	-	1.8	A	T_C=25°C
Diode pulse current[2]	$I_{S,pulse}$	-	-	4	A	T_C=25°C
Reverse diode dv/dt[3]	dv/dt	-	-	15	V/ns	V_{DS}=0...400V, I_{SD}<=I_S, T_j=25°C see table 9
Maximum diode commutation speed	di_f/dt	-	-	500	A/µs	V_{DS}=0...400V, I_{SD}<=I_S, T_j=25°C see table 9

2 Thermal characteristics

Table 3 Thermal characteristics TO-252 / TO-251

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	4.26	°C/W	-
Thermal resistance, junction - ambient	R_{thJA}	-	-	62	°C/W	device on PCB, minimal footprint
Thermal resistance, junction - ambient for SMD version	R_{thJA}	-	35	45	°C/W	Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70µm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling.
Soldering temperature, wave & reflow soldering allowed	T_{sold}	-	-	260	°C	reflow MSL1

[1] Limited by $T_{j\,max}$. Maximum duty cycle D=0.50
[2] Pulse width t_p limited by $T_{j,max}$
[3] Identical low side and high side switch with identical R_G

3 Electrical characteristics

at T_j=25°C, unless otherwise specified

Table 4 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	3.0	3.5	V	V_{DS}=V_{GS}, I_D=0.04mA
Zero gate voltage drain current	I_{DSS}	- -	- 10	1 -	µA	V_{DS}=600, V_{GS}=0V, T_j=25°C V_{DS}=600, 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	$R_{DS(on)}$	- -	3.17 8.22	3.40 -	Ω	V_{GS}=10V, I_D=0.5A, T_j=25°C V_{GS}=10V, I_D=0.5A, T_j=150°C
Gate resistance	R_G	-	15	-	Ω	f=1MHz, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	93	-	pF	V_{GS}=0V, V_{DS}=100V, f=1MHz
Output capacitance	C_{oss}	-	9	-	pF	V_{GS}=0V, V_{DS}=100V, f=1MHz
Effective output capacitance, energy related[1]	$C_{o(er)}$	-	6.4	-	pF	V_{GS}=0V, V_{DS}=0...480V
Effective output capacitance, time related[2]	$C_{o(tr)}$	-	20.6	-	pF	I_D=constant, V_{GS}=0V, V_{DS}=0...480V
Turn-on delay time	$t_{d(on)}$	-	8	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=0.6A, R_G=20Ω; see table 10
Rise time	t_r	-	10	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=0.6A, R_G=20Ω; see table 10
Turn-off delay time	$t_{d(off)}$	-	40	-	ns	V_{DD}=400V, V_{GS}=13V, I_D=0.6A, R_G=20Ω; see table 10
Fall time	t_f	-	60	-	ns	V_{DD}=400V, V_{GS}=13 V, I_D=0.6A, R_G=20Ω; see table 10

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	0.5	-	nC	V_{DD}=480V, I_D=0.6A, V_{GS}=0 to 10V
Gate to drain charge	Q_{gd}	-	2.6	-	nC	V_{DD}=480V, I_D=0.6A, V_{GS}=0 to 10V
Gate charge total	Q_g	-	4.6	-	nC	V_{DD}=480V, I_D=0.6A, V_{GS}=0 to 10V
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	V_{DD}=480V, I_D=0.6A, V_{GS}=0 to 10V

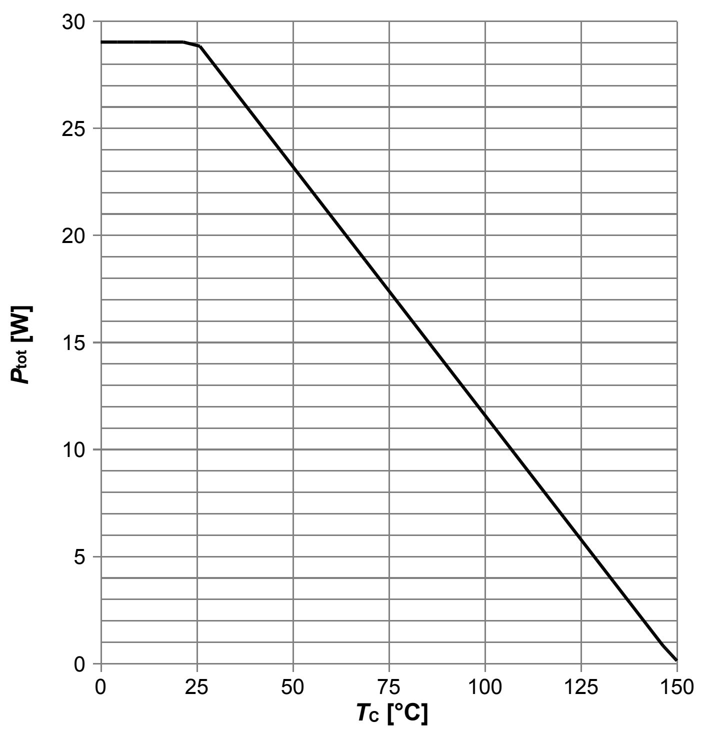
[1] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% $V_{o(BR)DSS}$
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% $V_{o(BR)DSS}$

Table 7 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=0.6A, T_j=25°C
Reverse recovery time	t_{rr}	-	160	-	ns	V_R=400V, I_F=0.6A, di_F/dt=100A/µs; see table 9
Reverse recovery charge	Q_{rr}	-	0.42	-	µC	V_R=400V, I_F=0.6A, di_F/dt=100A/µs; see table 9
Peak reverse recovery current	I_{rrm}	-	5.1	-	A	V_R=400V, I_F=0.6A, di_F/dt=100A/µs; see table 9

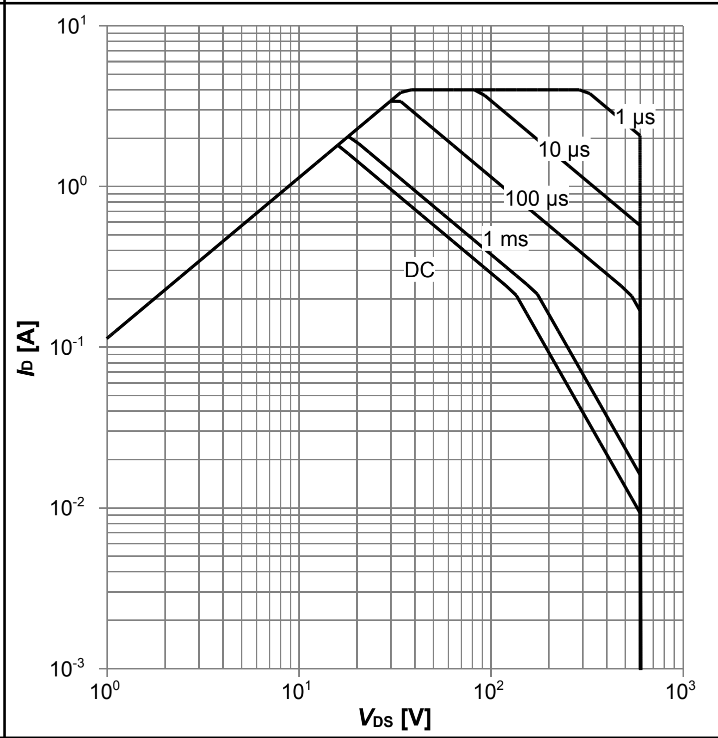
4 Electrical characteristics diagrams

Diagram 1: Power dissipation (Non FullPAK)



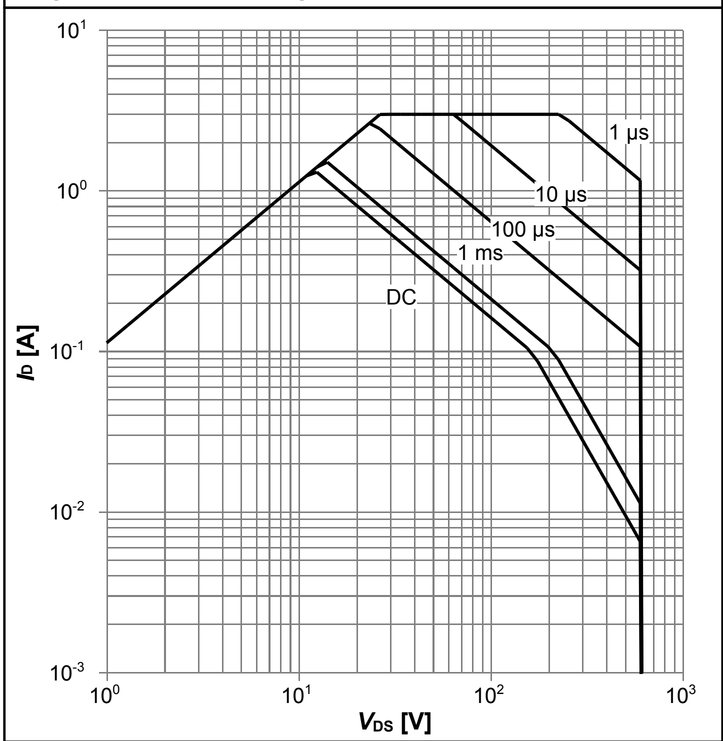
P_{tot}=f(T_C)

Diagram 2: Safe operating area (Non FullPAK)



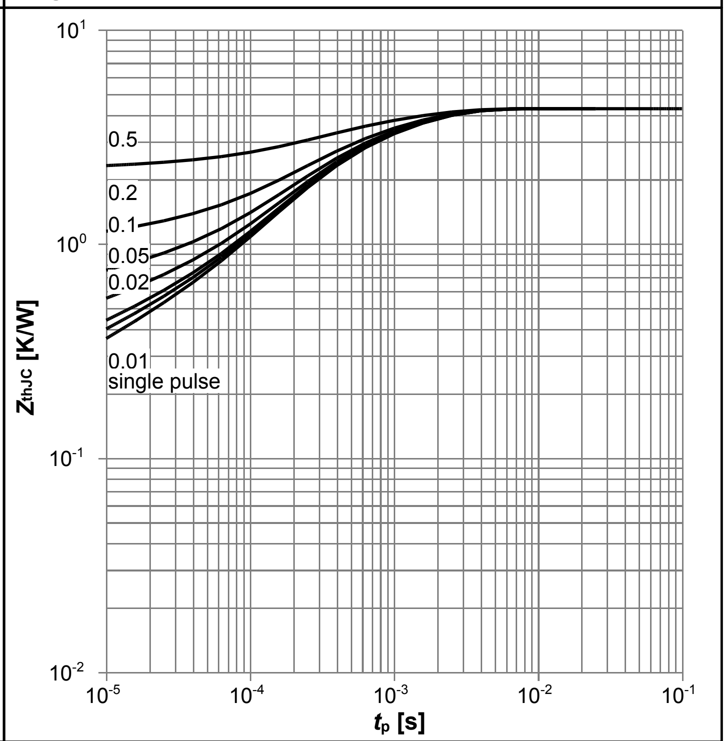
I_D=f(V_{DS}); T_C=25 °C; D=0; parameter: t_p

Diagram 3: Safe operating area (Non FullPAK)



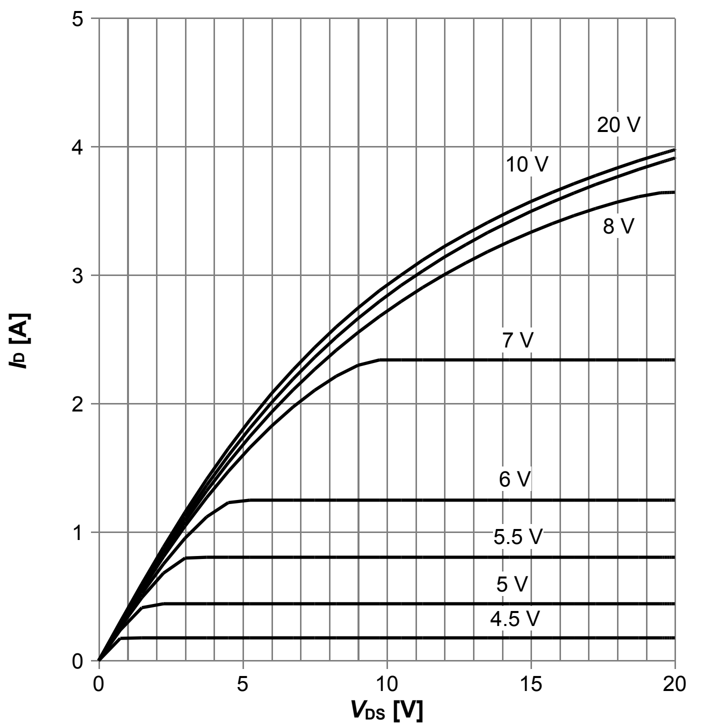
I_D=f(V_{DS}); T_C=80 °C; D=0; parameter: t_p

Diagram 4: Max. transient thermal impedance (Non FullPAK)



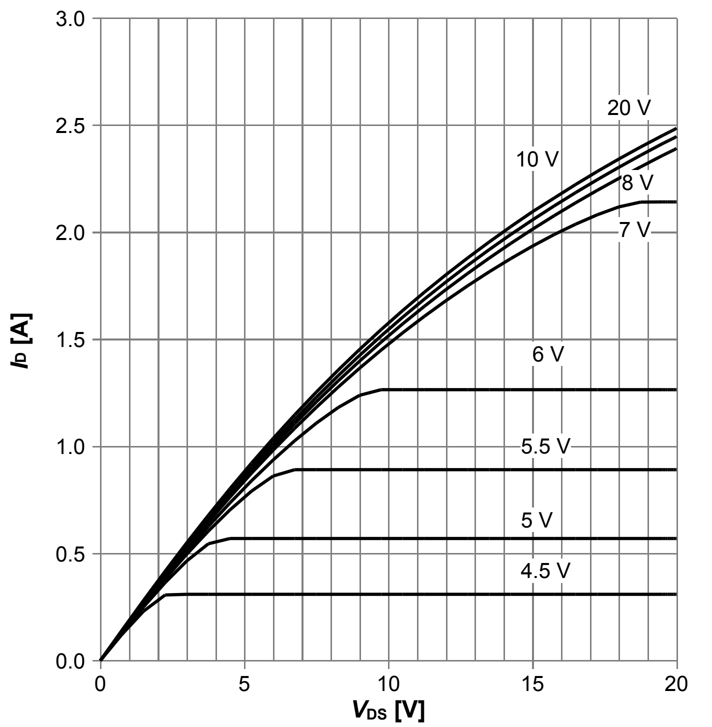
Z_{thJC} =f(t_P); parameter: D=t_p/T

Diagram 5: Typ. output characteristics



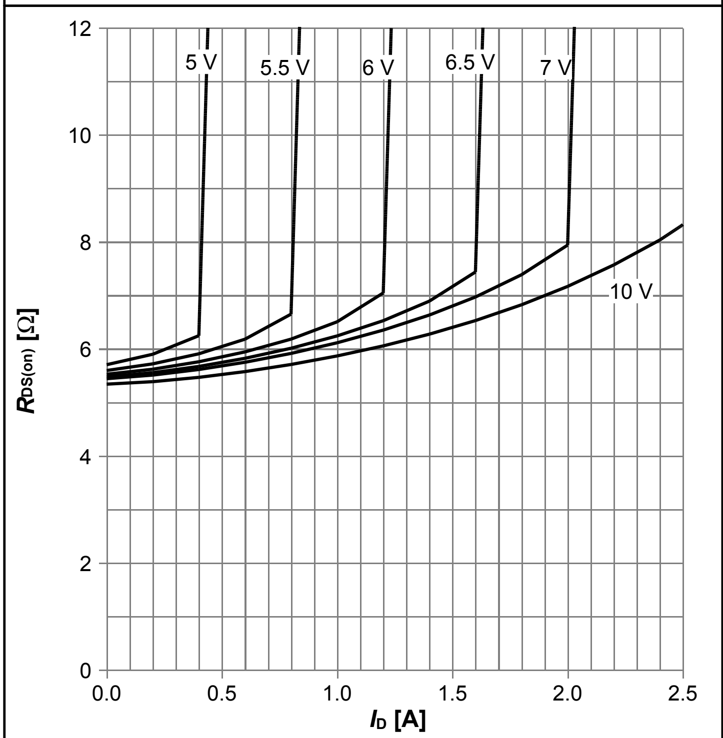
$I_D=f(V_{DS})$; $T_j=25$ °C; parameter: V_{GS}

Diagram 6: Typ. output characteristics



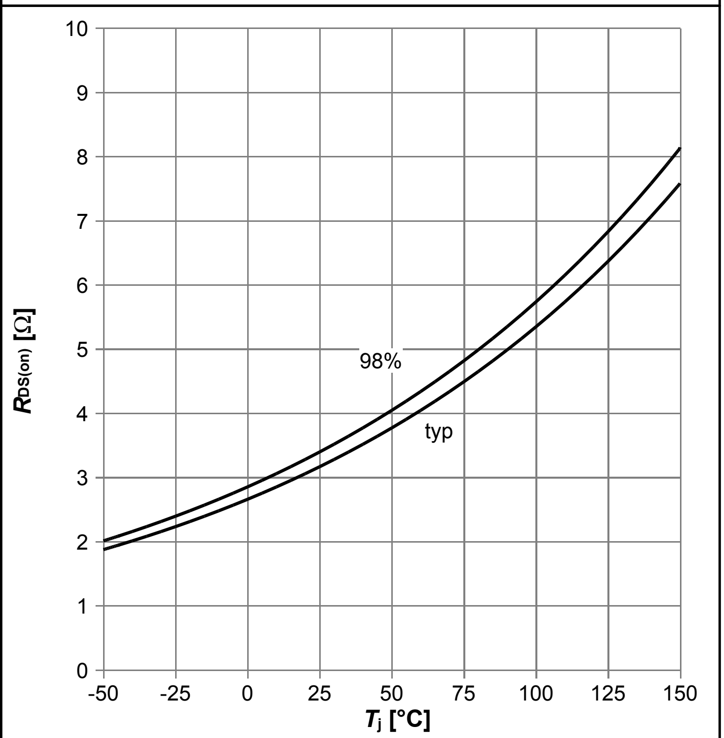
$I_D=f(V_{DS})$; $T_j=125$ °C; parameter: V_{GS}

Diagram 7: Typ. drain-source on-state resistance



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

Diagram 8: Drain-source on-state resistance



$R_{DS(on)}=f(T_j)$; $I_D=0.5$ A; $V_{GS}=10$ V

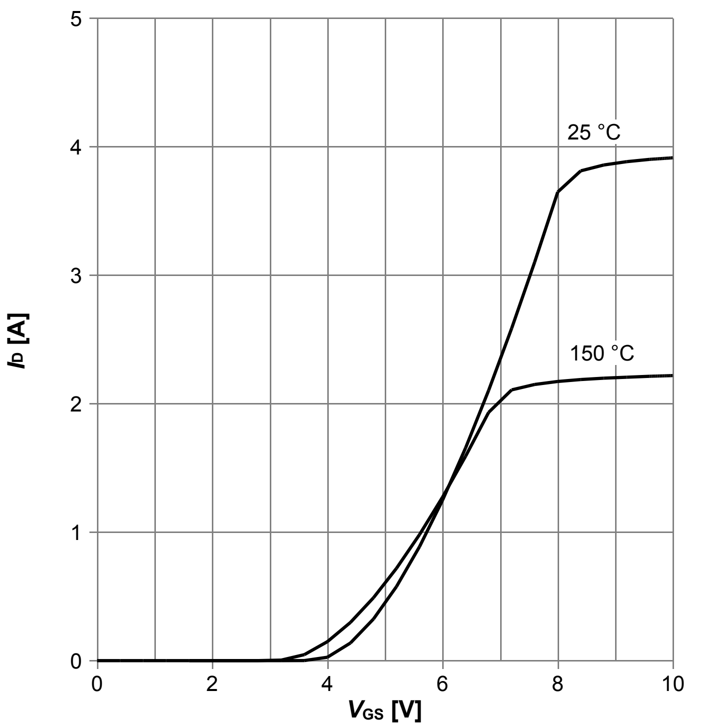
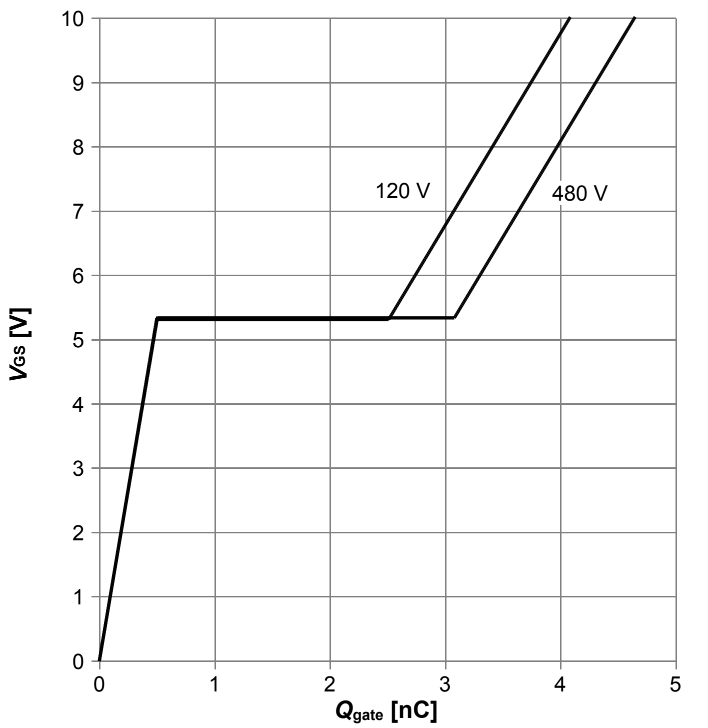
Diagram 9: Typ. transfer characteristics	Diagram 10: Typ. gate charge
	
I_D=f(V_{GS}); V_{DS}=20V; parameter: T_j	V_{GS}=f(Q_{gate}); I_D=0.6 A pulsed; parameter: V_{DD}

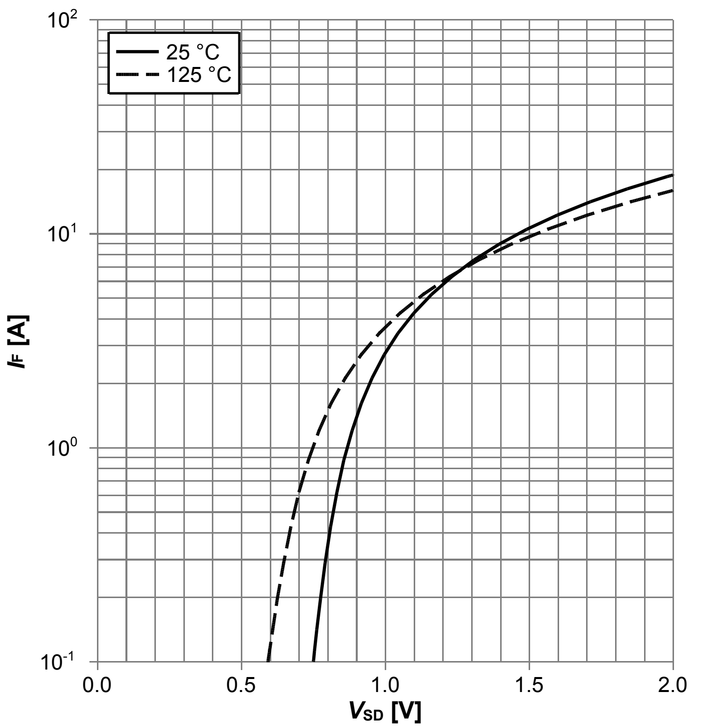
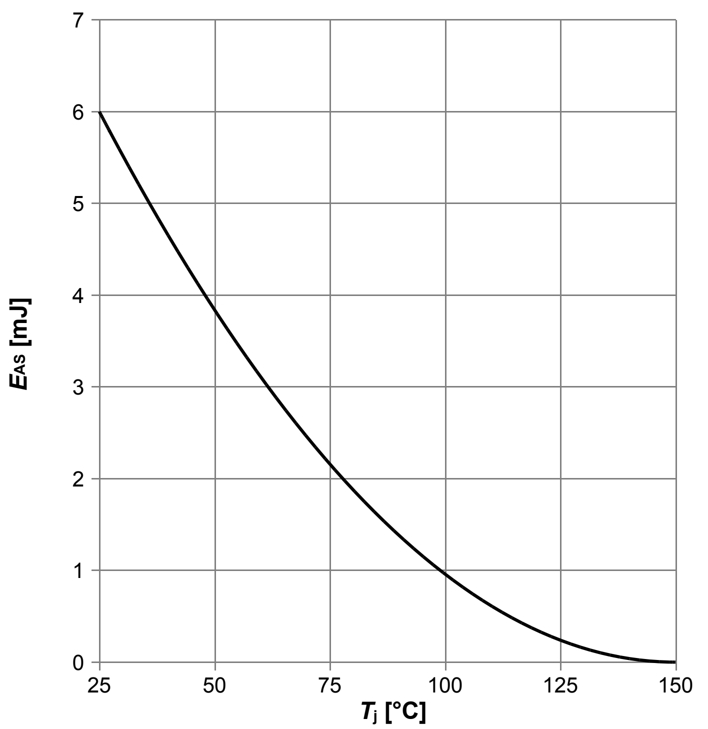
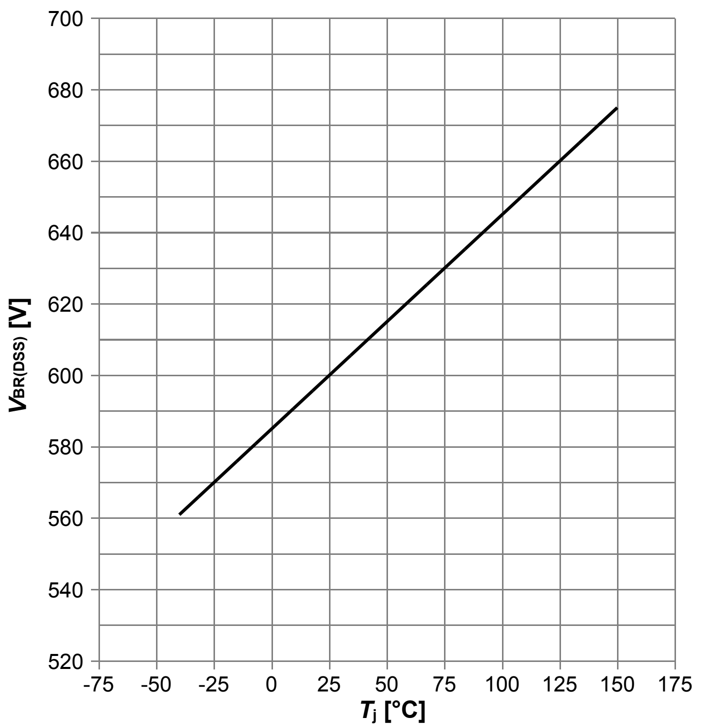
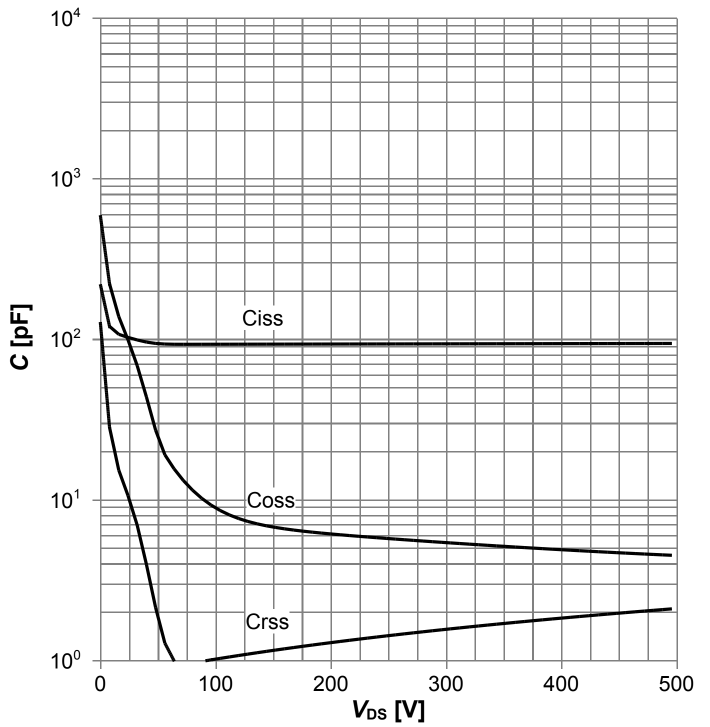
Diagram 11: Forward characteristics of reverse diode	Diagram 12: Avalanche energy
	
I_F=f(V_{SD}); parameter: T_j	E_{AS}=f(T_j); I_D=0.3 A; V_{DD}=50 V

Diagram 13: Drain-source breakdown voltage



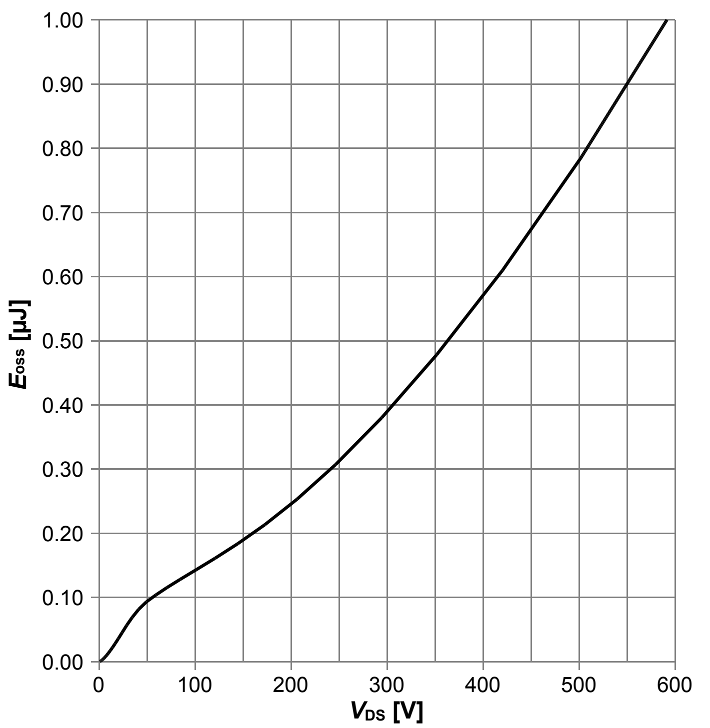
$V_{BR(DSS)}$=f(T_j); I_D=0.25 mA

Diagram 14: Typ. capacitances



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

Diagram 15: Typ. Coss stored energy



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

5 Test Circuits

Table 8 Diode characteristics

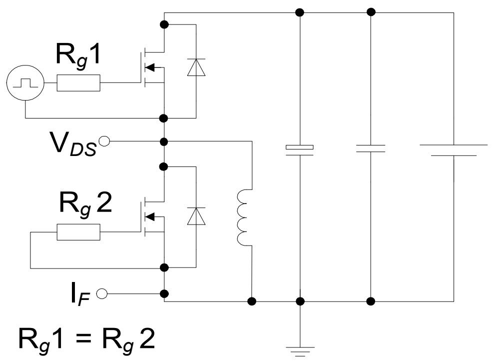
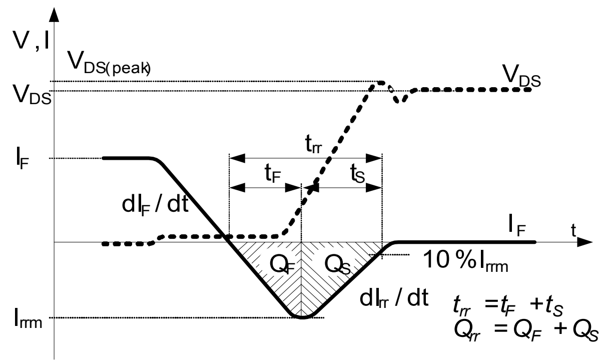
Test circuit for diode characteristics	Diode recovery waveform
	

Table 9 Switching times

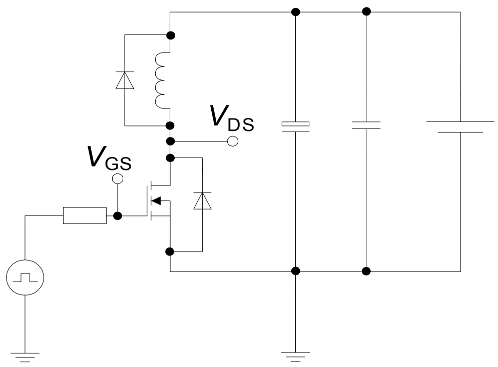
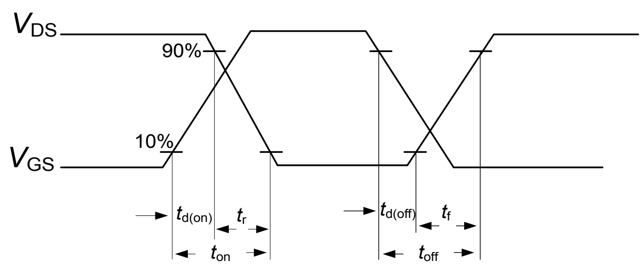
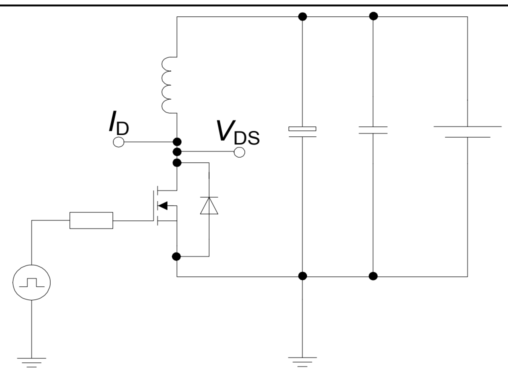
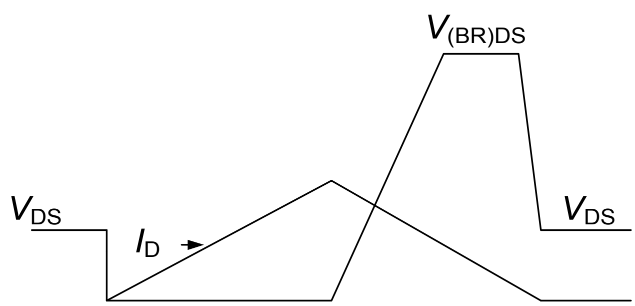
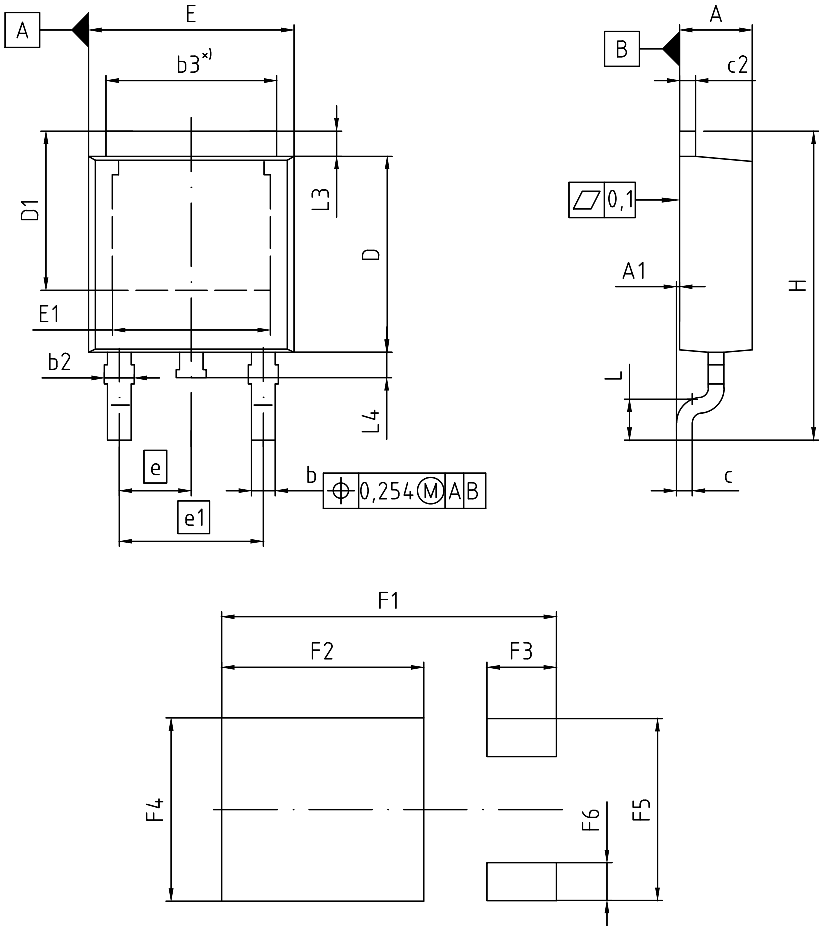
Switching times test circuit for inductive load	Switching times waveform
	

Table 10 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

6 Package Outlines



*) mold flash not included

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	5.60	0.185	0.220
e	2.29 (BSC)		0.090 (BSC)	
e1	4.57 (BSC)		0.180 (BSC)	
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	

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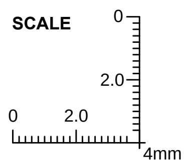
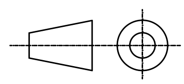


EUROPEAN PROJECTION



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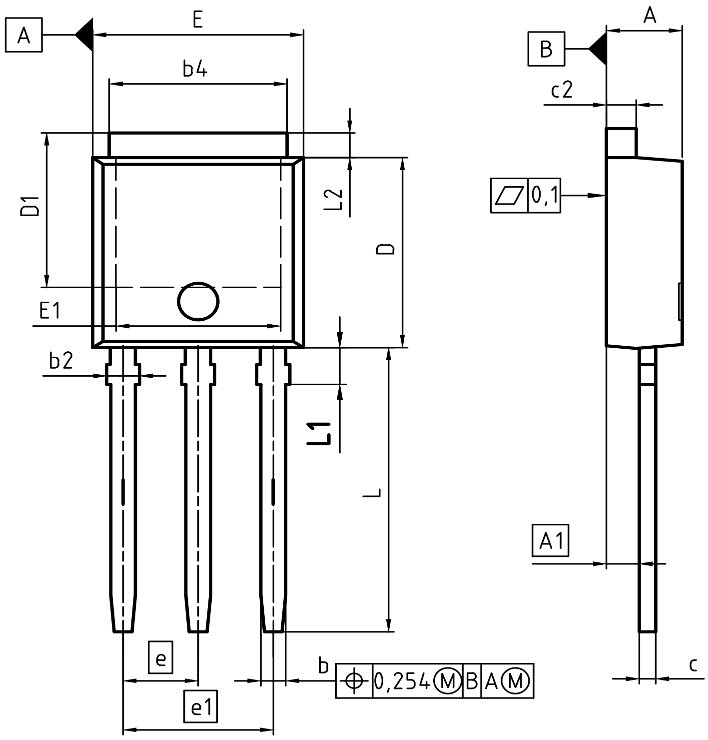
05

Figure 1 Outline PG-TO 252, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.16	2.41	0.085	0.095
A1	0.90	1.14	0.035	0.045
b	0.64	0.89	0.025	0.035
b2	0.65	1.15	0.026	0.045
b4	4.95	5.50	0.195	0.217
c	0.46	0.60	0.018	0.024
c2	0.46	0.89	0.018	0.035
D	5.97	6.22	0.235	0.245
D1	5.04	5.77	0.198	0.227
E	6.35	6.73	0.250	0.265
E1	4.70	5.21	0.185	0.205
e	2.29		0.090	
e1	4.57		0.180	
N	3		3	
L	8.89	9.65	0.350	0.380
L1	0.85	2.29	0.033	0.090
L2	0.89	1.37	0.035	0.054

DOCUMENT NO.
Z8B00003330

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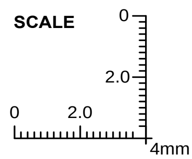

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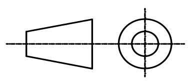

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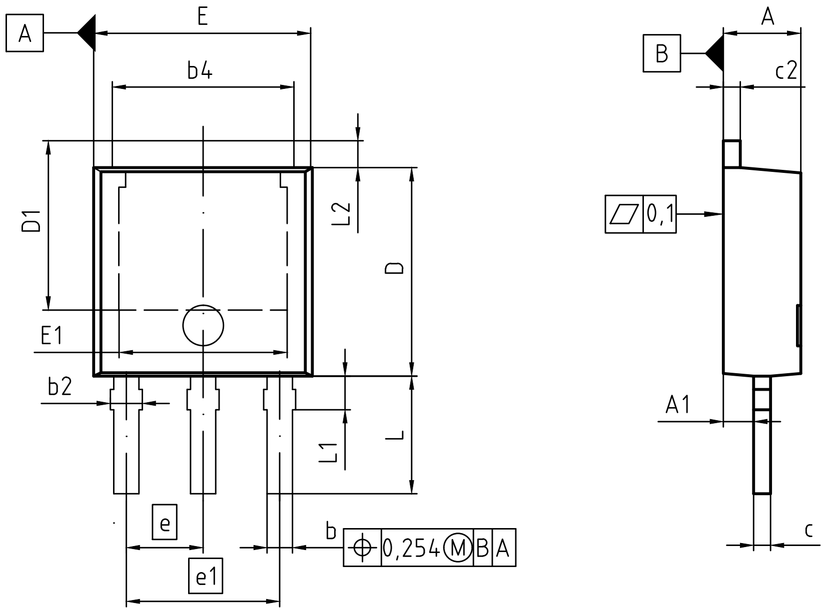
04

Figure 2 Outline PG-TO 251, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.18	2.40	0.086	0.094
A1	0.80	1.14	0.031	0.045
b	0.64	0.89	0.025	0.035
b2	0.65	1.15	0.026	0.045
b4	4.95	5.50	0.195	0.217
c	0.46	0.59	0.018	0.023
c2	0.46	0.89	0.018	0.035
D	5.97	6.22	0.235	0.245
D1	5.04	5.55	0.198	0.219
E	6.35	6.73	0.250	0.265
E1	4.60	5.21	0.181	0.205
e	2.29		0.090	
e1	4.57		0.180	
N	3		3	
L	3.00	3.60	0.118	0.142
L1	0.80	1.25	0.031	0.049
L2	0.88	1.28	0.035	0.050

DOCUMENT NO.
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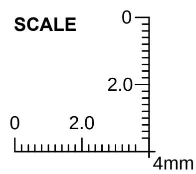

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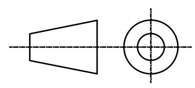

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21-10-2015

REVISION
06

Figure 3 Outline PG-TO 251, dimensions in mm/inches

7 Appendix A

Table 11 Related Links

- **IFX CoolMOS™ CE Webpage:** www.infineon.com
- **IFX CoolMOS™ CE application note:** www.infineon.com
- **IFX CoolMOS™ CE simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

Revision History

IPD60R3K4CE, IPU60R3K4CE, IPS60R3K4CE

Revision: 2016-02-26, Rev. 2.0

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2016-02-26	Release of final version

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