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1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK/I ² PAK TO-220/TO-247	TO-220FP	
V _{DS}	Drain-source voltage (V _{GS} =0)	600		V
V _{GS}	Gate-source voltage	± 25		V
I _D	Drain current (continuous) at T _C = 25°C	14	14 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100°C	9	9 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	56	56 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25°C	125	30	W
dv/dt ⁽³⁾	Peak diode recovery voltage slope	15		V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s; T _C =25°C)	--	2500	V
T _j T _{stg}	Operating junction temperature Storage temperature	-55 to 150		°C

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I_{SD} ≤ 14A, di/dt ≤ 400A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 2. Thermal data

Symbol	Parameter	D ² PAK/I ² PAK TO-220/TO-247	TO-220FP	Unit
R _{thj-case}	Thermal resistance junction-case max	1	4.2	°C/W
R _{thj-amb}	Thermal resistance junction-amb max	62.5		°C/W
T _l	Maximum lead temperature for soldering purposes	300		°C

Table 3. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I _{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _j max)	6	A
E _{AS}	Single pulse avalanche energy (starting T _j =25°C, I _D =I _{AS} , V _{DD} = 50V)	300	mJ

2 Electrical characteristics

(T_{CASE}=25°C unless otherwise specified)

Table 4. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V _{(BR)DSS}	Drain-source breakdown voltage	I _D = 1mA, V _{GS} = 0	600			V
dv/dt ⁽¹⁾	Drain-source voltage slope	V _{DD} = 480V, I _D = 14A, V _{GS} = 10V	30			V/ns
I _{DSS}	Zero gate voltage drain current (V _{GS} = 0)	V _{DS} = Max rating, V _{DS} = Max rating, @ 125°C			100	μA
I _{GSS}	Gate body leakage current (V _{DS} = 0)	V _{GS} = ±20V			100	nA
V _{GS(th)}	Gate threshold voltage	V _{DS} = V _{GS} , I _D = 250μA	2	3	4	V
R _{DS(on)}	Static drain-source on resistance	V _{GS} = 10V, I _D = 1A		0.270	0.299	Ω

1. Value measured at turn off under inductive load

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g _{fs} ⁽¹⁾	Forward transconductance	V _{DS} = 15V, I _D = 7A		10		S
C _{iss} C _{oss} C _{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V _{DS} = 50V, f = 1MHz, V _{GS} = 0		1250 100 10		pF pF pF
C _{oss eq.} ⁽²⁾	Equivalent output capacitance	V _{GS} = 0, V _{DS} = 0V to 480V		137		pF
R _g	Gate input resistance	f = 1MHz Gate DC Bias = 0 Test signal level = 20mV open drain		6.0		Ω
Q _g Q _{gs} Q _{gd}	Total gate charge Gate-source charge Gate-drain charge	V _{DD} = 480V, I _D = 14A V _{GS} = 10V (see Figure 18)		37 6 18		nC nC nC

1. Pulsed: pulse duration = 300μs, duty cycle 1.5%

2. C_{oss eq.} is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}

Table 6. Switching times

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300V, I_D = 7A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 17)		12		ns
t_r	Rise time			14		ns
$t_{d(off)}$	Turn-off delay time			80		ns
t_f	Fall time			30		ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
I_{SD}	Source-drain current				14	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				50	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 14A, V_{GS}=0$			1.3	V
t_{rr}	Reverse recovery time	$I_{SD} = 14A, di/dt = 100A/\mu s,$ $V_{DD} = 100V, T_J = 25^\circ C$ (see Figure 19)		390		ns
Q_{rr}	Reverse recovery charge			5		μC
I_{RRM}	Reverse recovery current			25		A
t_{rr}	Reverse recovery time	$V_{DD} = 100V$ $di/dt = 100A/\mu s, I_{SD} = 14A$ $T_J = 150^\circ C$ (see Figure 19)		500		ns
Q_{rr}	Reverse recovery charge			7		μC
I_{RRM}	Reverse recovery current			25		A

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220 / D²PAK / I²PAK

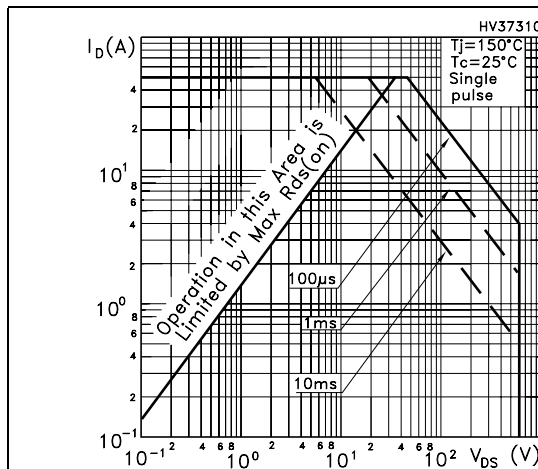


Figure 2. Thermal impedance for TO-220 / D²PAK / I²PAK

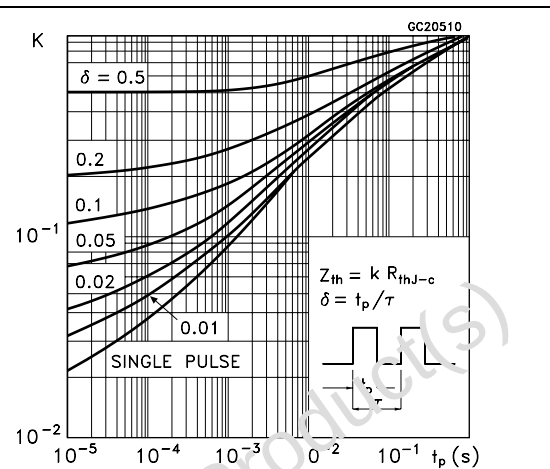


Figure 3. Safe operating area for TO-220FP

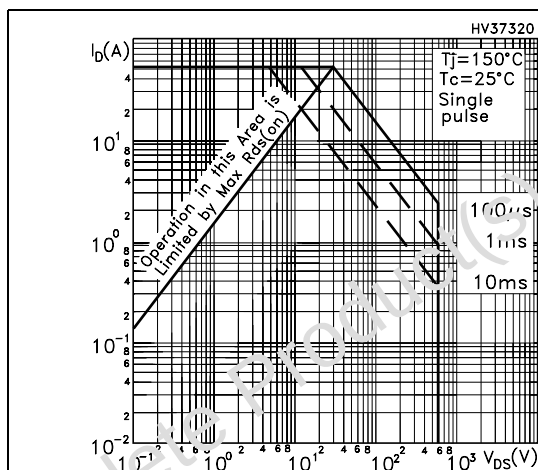


Figure 4. Thermal impedance for TO-220FP

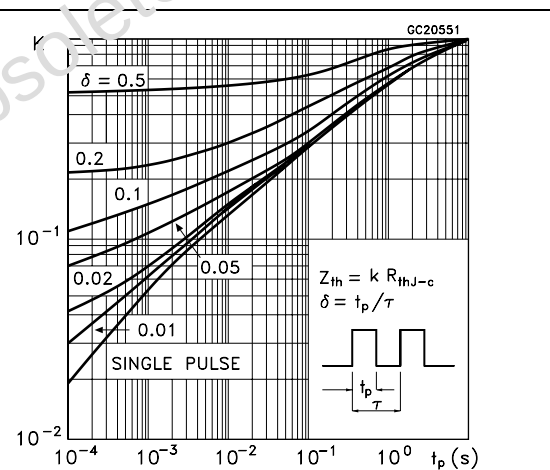


Figure 5. Safe operating area for TO-247

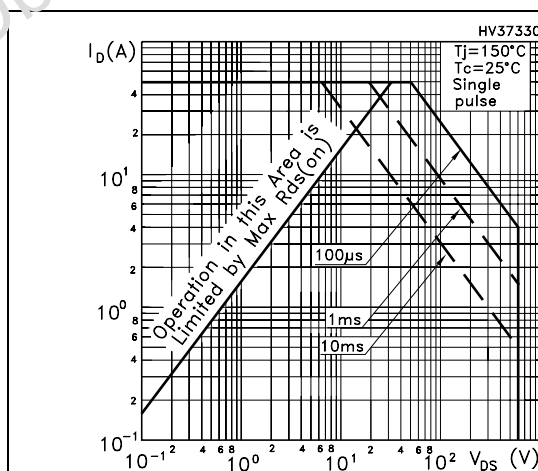


Figure 6. Thermal impedance for TO-247

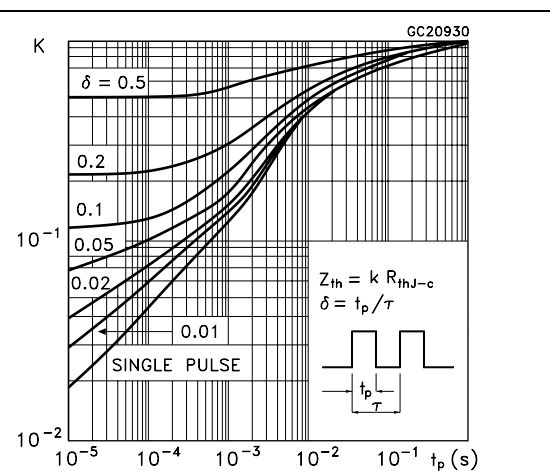


Figure 7. Output characteristics

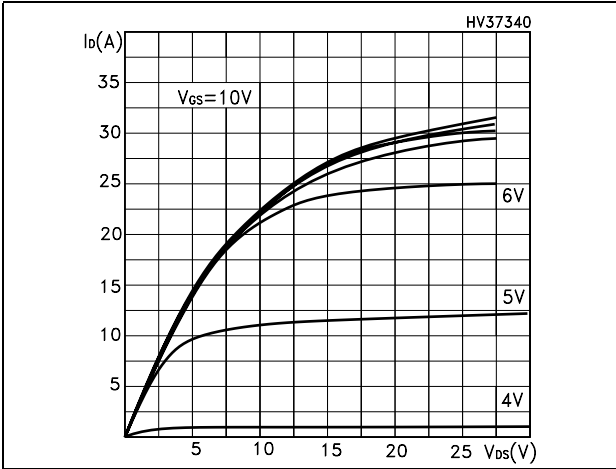


Figure 8. Transfer characteristics

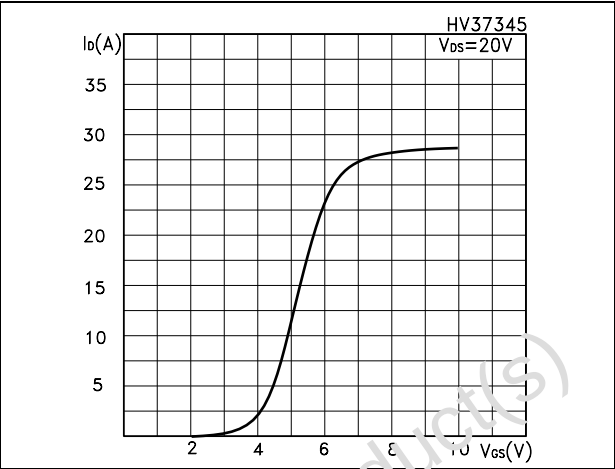


Figure 9. Transconductance

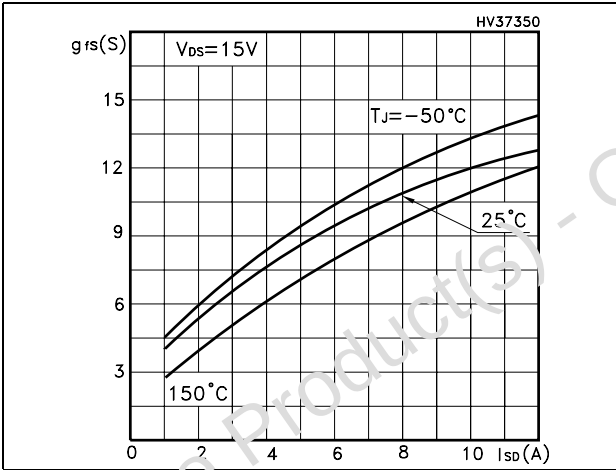


Figure 10. Static drain-source on resistance

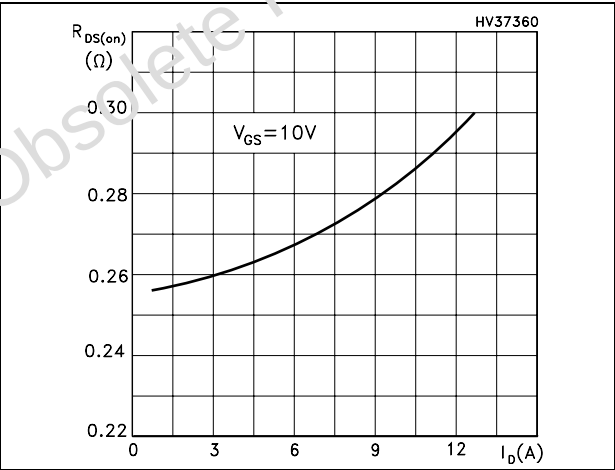


Figure 11. Gate charge vs gate-source voltage

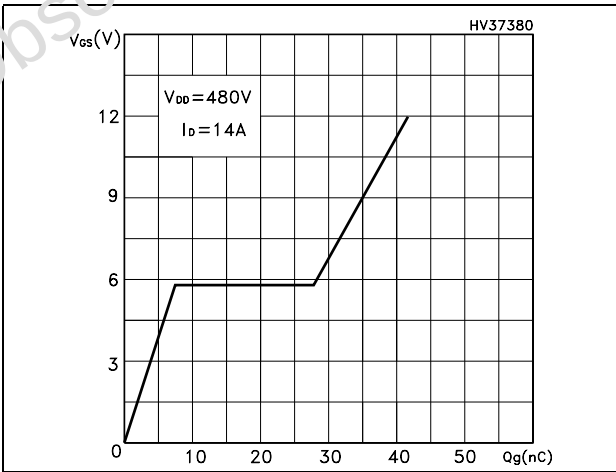


Figure 12. Capacitance variations

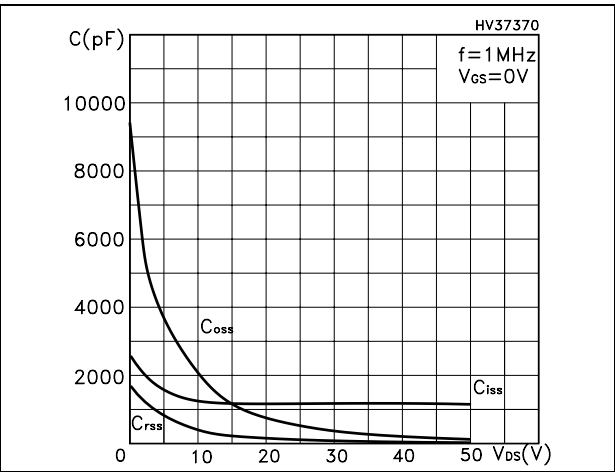


Figure 13. Normalized gate threshold voltage vs temperature

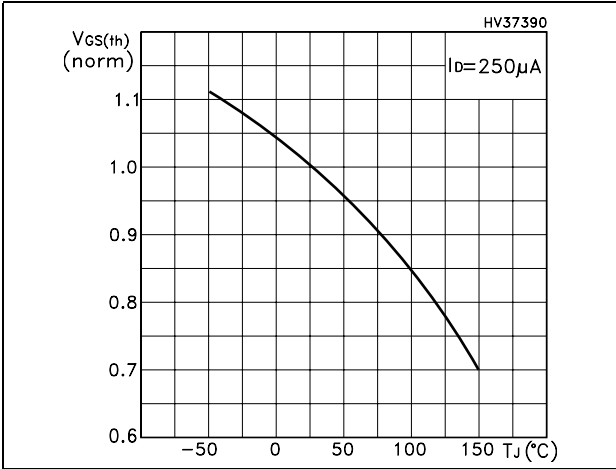


Figure 14. Normalized on resistance vs temperature

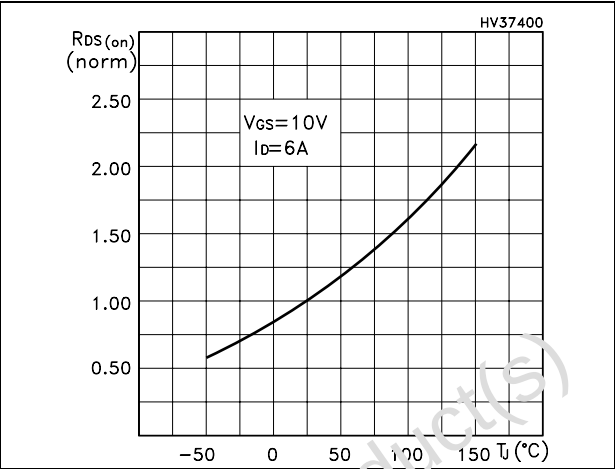


Figure 15. Source-drain diode forward characteristics

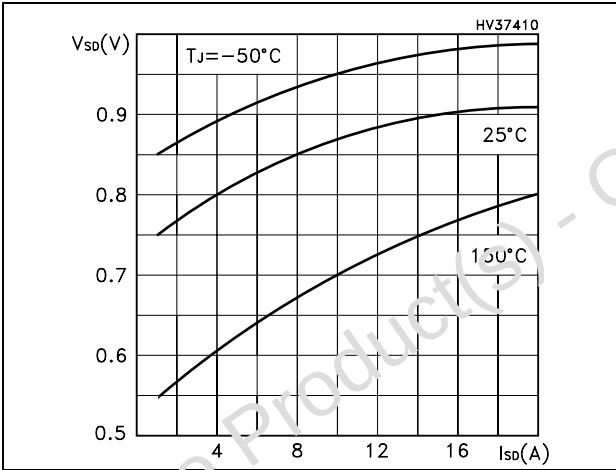
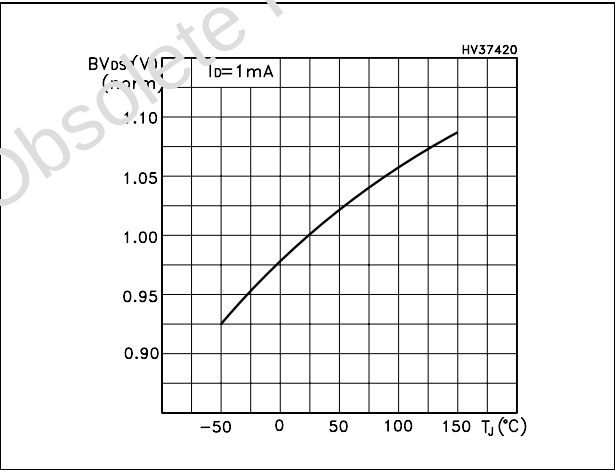


Figure 16. Normalized B_{VDS} vs temperature



3 Test circuit

Figure 17. Switching times test circuit for resistive load

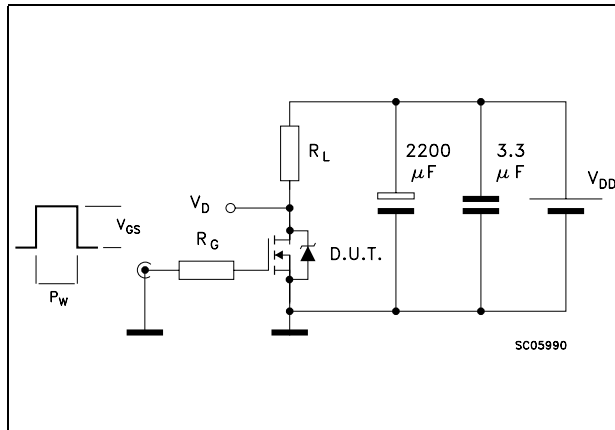


Figure 18. Gate charge test circuit

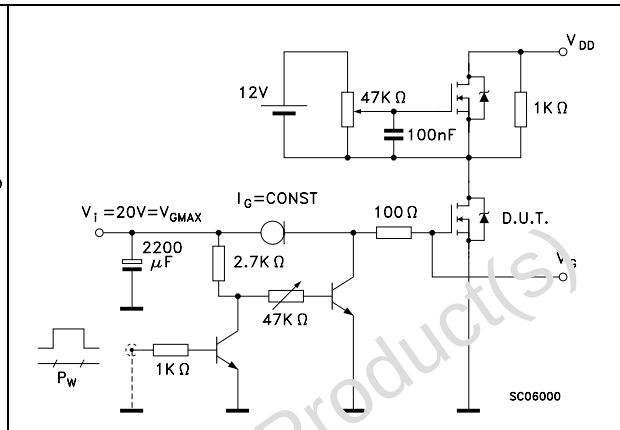


Figure 19. Test circuit for inductive load switching and diode recovery times

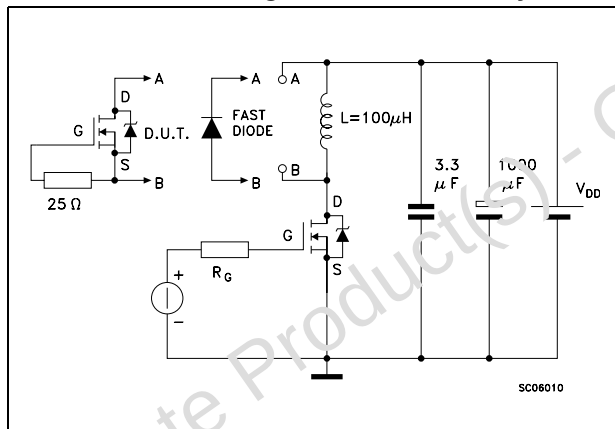


Figure 20. Unclamped Inductive load test circuit

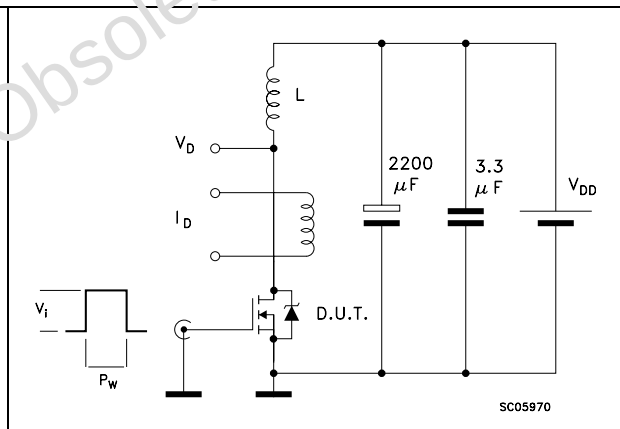


Figure 21. Unclamped inductive waveform

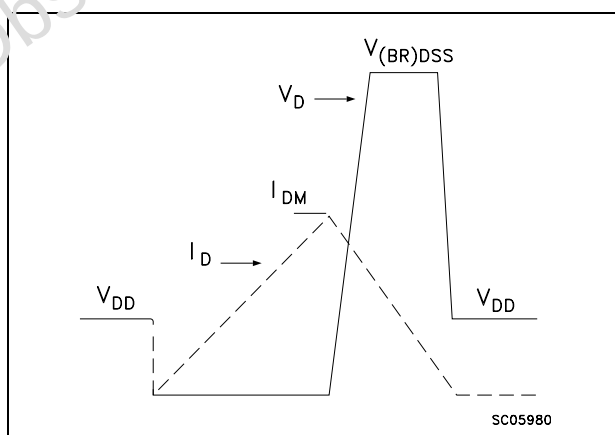
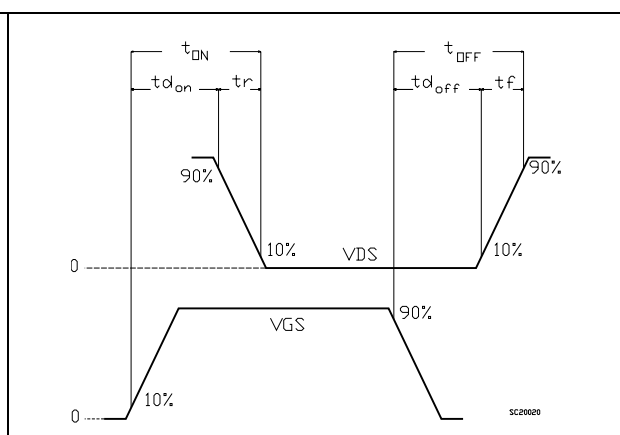


Figure 22. Switching time waveform

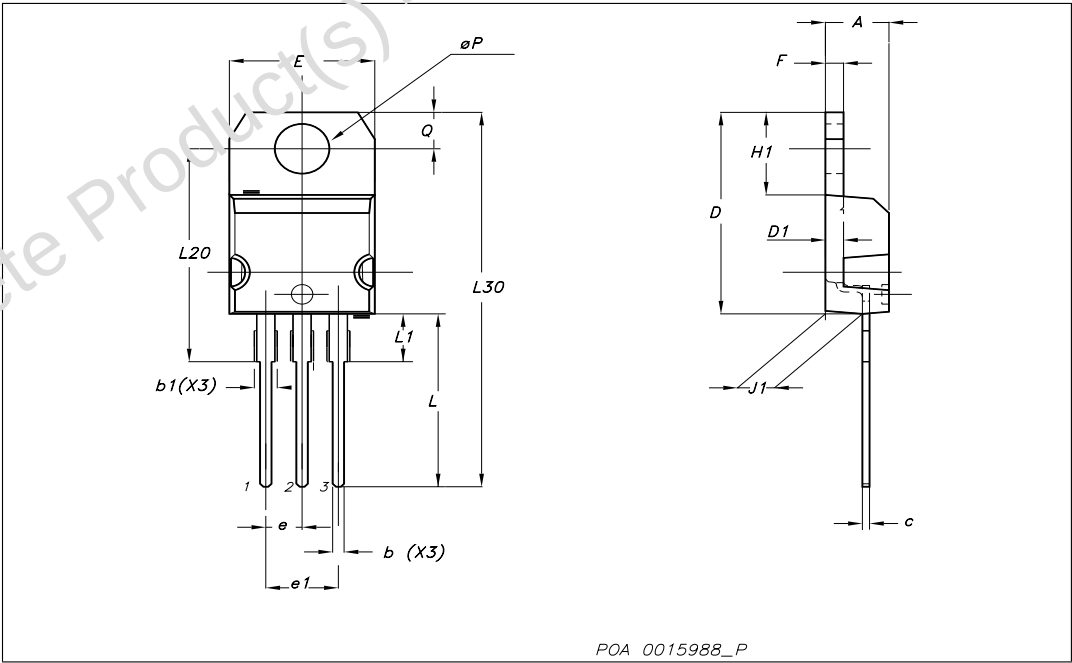


4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com

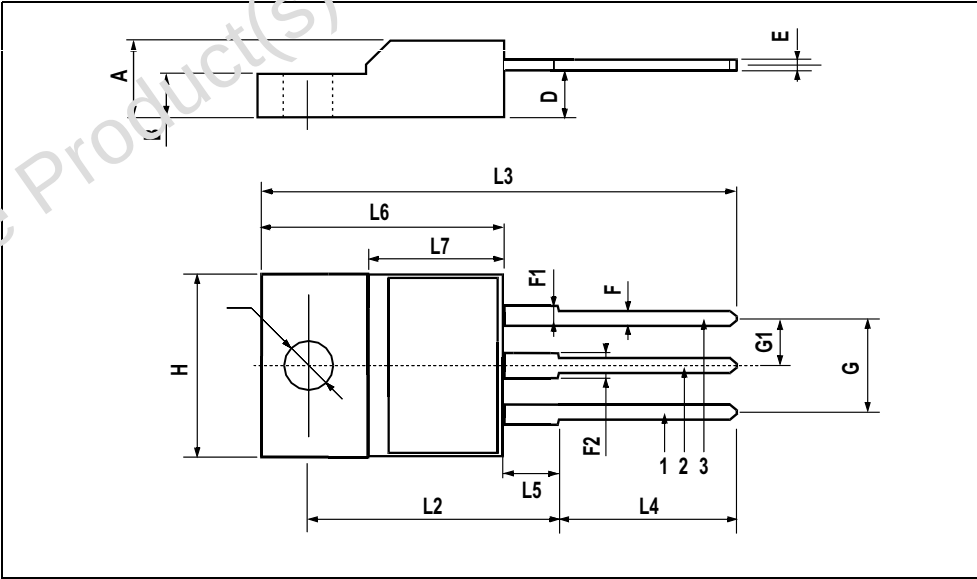
TO-220 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
ØP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



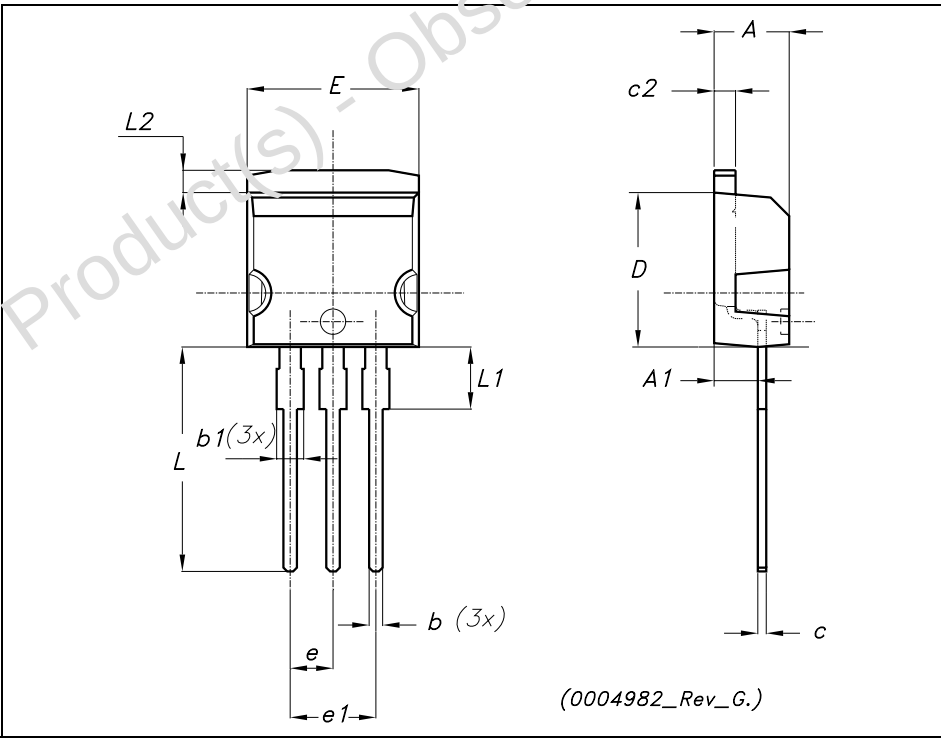
TO-220FP MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	0.385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
Ø	3		3.2	0.118		0.126



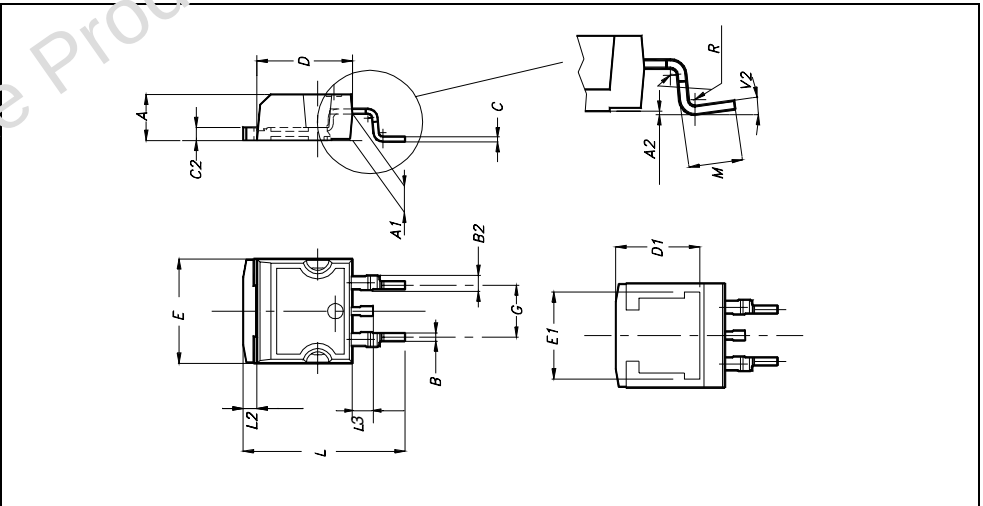
TO-262 (I²PAK) MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
A1	2.40		2.72	0.094		0.107
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.49		0.70	0.019		0.027
c2	1.23		1.32	0.048		0.052
D	8.95		9.35	0.352		0.368
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
E	10		10.40	0.393		0.410
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L2	1.27		1.40	0.050		0.055



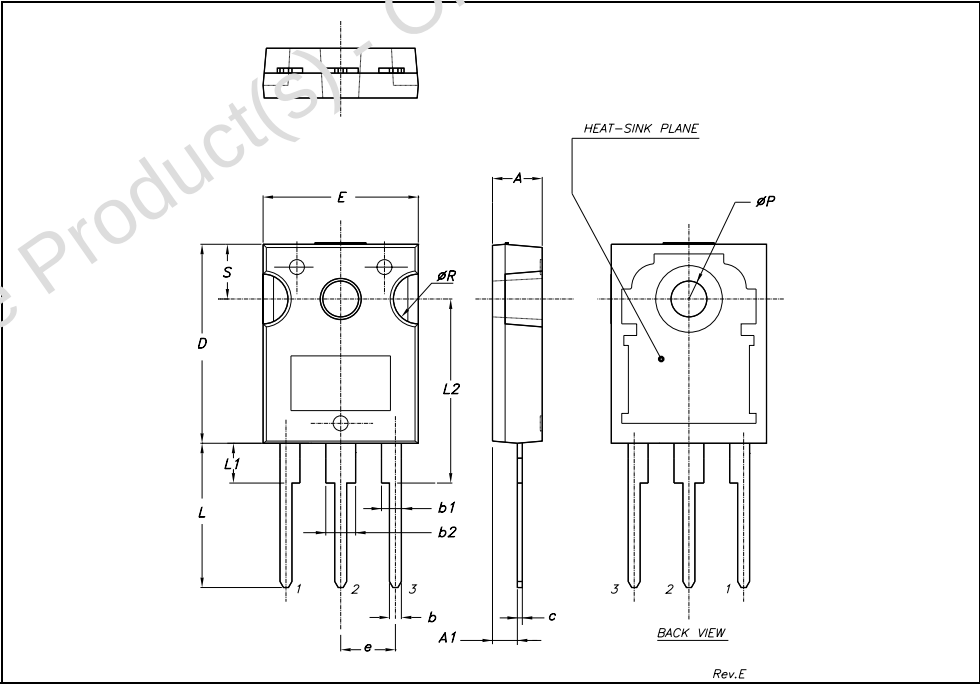
D²PAK MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.625
L2	1.27		1.4	0.050		0.055
L3	1.4		1.75	0.055		0.068
M	2.4		3.2	0.094		0.126
R		0.4			0.015	
V2	0°		4°			



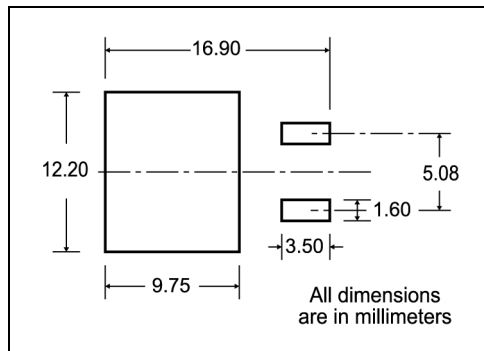
TO-247 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.85		5.15	0.19		0.20
A1	2.20		2.60	0.086		0.102
b	1.0		1.40	0.039		0.055
b1	2.0		2.40	0.079		0.094
b2	3.0		3.40	0.118		0.134
c	0.40		0.80	0.015		0.03
D	19.85		20.15	0.781		0.793
E	15.45		15.75	0.608		0.620
e		5.45			0.214	
L	14.20		14.80	0.560		0.582
L1	3.70		4.30	0.14		0.17
L2		18.50			0.728	
øP	3.55		3.65	0.140		0.143
øR	4.50		5.50	0.177		0.216
S		5.50			0.216	

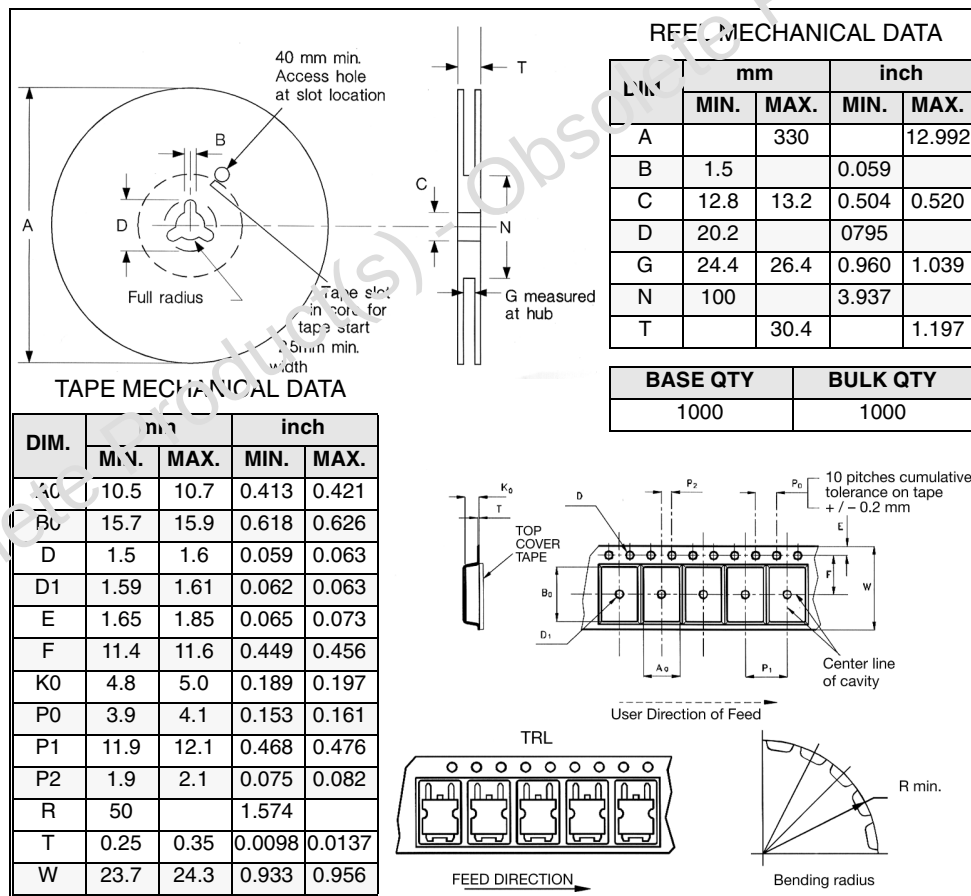


5 Packaging mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



* on sales type

6 Revision history

Table 8. Revision history

Date	Revision	Changes
03-May-2007	1	First release

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