

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220/D ² PAK/I ² PAK	TO-220FP	
V_{GS}	Gate-Source Voltage	± 30		V
I_D	Drain Current (continuous) at $T_C = 25^\circ\text{C}$	20	20 (<i>Note 3</i>)	A
I_D	Drain Current (continuous) at $T_C = 100^\circ\text{C}$	12.6	12.6 (<i>Note 3</i>)	A
I_{DM} <i>Note 2</i>	Drain Current (pulsed)	80	80 (<i>Note 3</i>)	A
P_{TOT}	Total Dissipation at $T_C = 25^\circ\text{C}$	192	45	W
	Derating Factor	1.2	0.36	W/ $^\circ\text{C}$
dv/dt <i>Note 1</i>	Peak Diode Recovery voltage slope	15		V/ns
V_{ISO}	Insulation Withstand Voltage (DC)	--	2000	V
T_j T_{stg}	Operating Junction Temperature Storage Temperature	-65 to 150		$^\circ\text{C}$

Table 2. Thermal data

		TO-220/D ² PAK/I ² PAK	TO-220FP	Unit
R _{thj-case}	Thermal Resistance Junction-case Max	0.65	2.8	$^\circ\text{C}/\text{W}$
R _{thj-amb}	Thermal Resistance Junction-amb Max	62.5		$^\circ\text{C}/\text{W}$
T_l	Maximum Lead Temperature For Soldering Purpose	300		$^\circ\text{C}$

Table 3. Avalanche characteristics

Symbol	Parameter	Max Value	Unit
I_{AR}	Avalanche Current, repetitive or Not-Repetitive (pulse width limited by T_j max)	10	A
E_{AS}	Single Pulse Avalanche Energy (starting $T_j=25^\circ\text{C}$, $I_D=5\text{A}$, $V_{DD}=50\text{V}$)	650	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 = 250μA, V _{GS} = 0	500			V
I _{DSS}	Zero Gate Voltage Drain Current (V _{GS} = 0)	V _{DS} = Max Rating, V _{DS} = Max Rating, T _c = 125°C			1 10	μA μA
I _{GSS}	Gate Body Leakage Current (V _{DS} = 0)	V _{GS} = ±30V			±100	μA
V _{GS(th)}	Gate Threshold Voltage	V _{DS} = V _{GS} , I _D = 250 μA	3	4	5	V
R _{DS(on)}	Static Drain-Source On Resistance	V _{GS} = 10 V, I _D = 10 A		0.20	0.25	Ω

Table 5. Dynamic

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g _{fs} <i>Note 4</i>	Forward Transconductance	V _{DS} > I _{D(ON)} × R _{DS(ON)max} , I _D = 10A		10		S
C _{iss} C _{oss} C _{rss}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V _{DS} = 25V, f = 1 MHz, V _{GS} = 0		1480 285 34		pF pF pF
C _{oss eq.} <i>Note 5</i>	Equivalent Output Capacitance	V _{GS} = 0, V _{DS} = 0V to 400V		130		pF
R _g	Gate Input Resistance	f = 1MHz Gate DC Bias = 0 Test Signal Level = 20mV Open Drain		1.6		Ω
Q _g Q _{gs} Q _{gd}	Total Gate Charge Gate-Source Charge Gate-Drain Charge	V _{DD} = 400V, I _D = 20A V _{GS} = 10V (see Figure 15)		40 13 19	56	nC nC nC

Table 6. Switching times

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r	Turn-on Delay Time Rise Time	$V_{DD}=250\text{ V}$, $I_D=10\text{ A}$, $R_G=4.7\Omega$, $V_{GS}=10\text{ V}$ (see Figure 16)		24 16		ns ns
$t_{r(Voff)}$ t_f t_c	Off-voltage Rise Time Fall Time Cross-over Time	$V_{DD}=400\text{ V}$, $I_D=20\text{ A}$, $R_G=4.7\Omega$, $V_{GS}=10\text{ V}$ (see Figure 16)		9 8.5 23		ns ns ns

Table 7. Source drain diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} <i>Note 2</i>	Source-drain Current Source-drain Current (pulsed)				20 80	A A
V_{SD} <i>Note 4</i>	Forward on Voltage	$I_{SD}=20\text{ A}$, $V_{GS}=0$			1.5	V
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD}=20\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=100\text{ V}$, $T_j=25^\circ\text{C}$		350 4.6 26		ns μC A
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD}=20\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=100\text{ V}$, $T_j=150^\circ\text{C}$		435 5.9 27		ns μC A

(1) $I_{SD} \leq 20\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$, $T_j \leq T_{JMAX}$

(2) Pulse width limited by safe operating area

(3) Limited only by maximum temperature allowed

(4) Pulsed: pulse duration = 300 μs , duty cycle 1.5%

(5) $C_{oss\text{ eq}}$ 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}

2.1 Electrical Characteristics (curves)

Figure 1. Safe Operating Area for TO-220/D²PAK/I²PAK

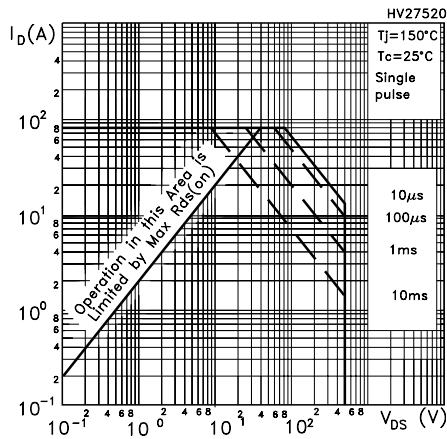


Figure 2. Thermal Impedance for TO-220/D²PAK/I²PAK

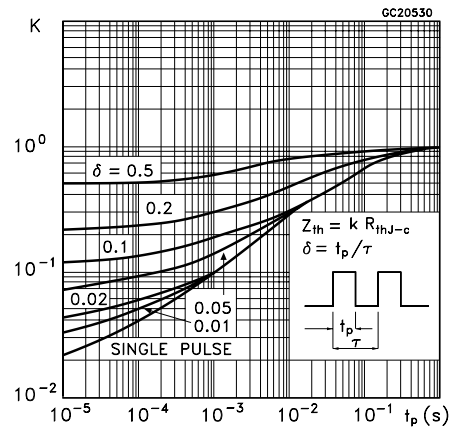


Figure 3. Safe Operating Area for TO-220FP

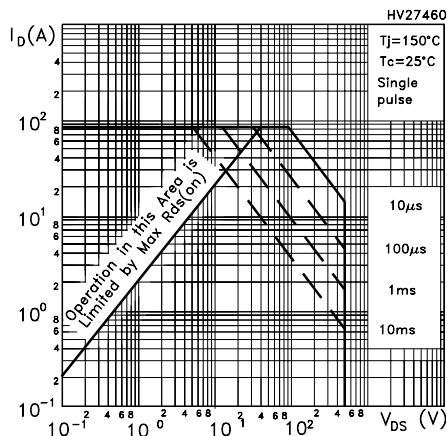


Figure 4. Thermal Impedance for TO-220FP

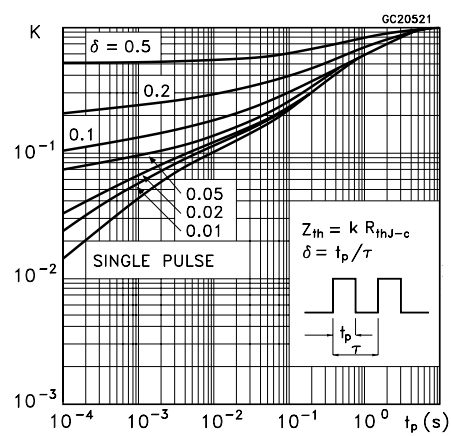


Figure 5. Output Characteristics

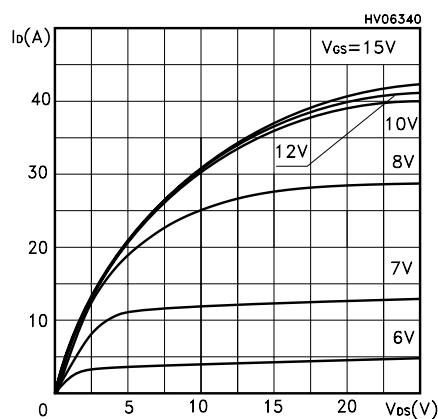


Figure 6. Transfer Characteristics

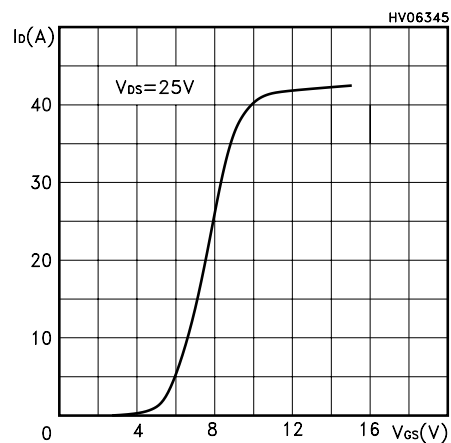


Figure 7. Transconductance

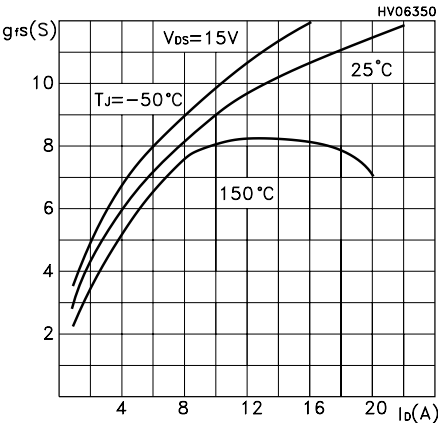


Figure 8. Static Drain-Source on Resistance

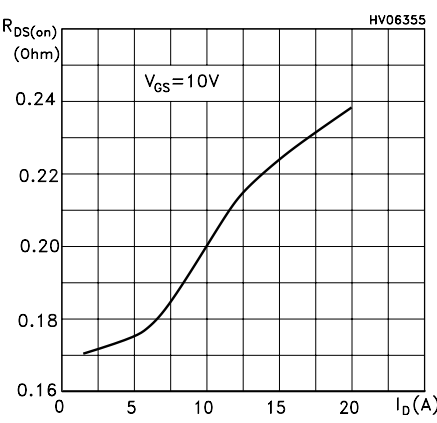


Figure 9. Gate Charge vs Gate -Source Voltage

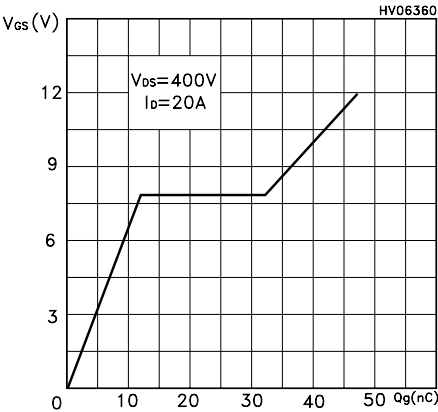


Figure 11. Capacitance Variations

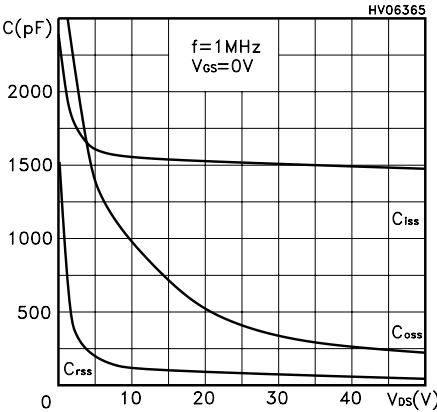


Figure 10. Normalized Gate Threshold Voltage vs Temperature

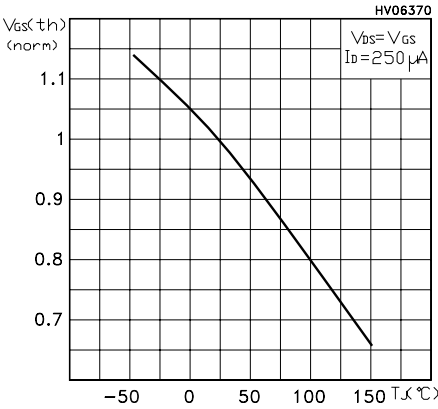


Figure 12. Normalized on Resistance vs Temperature

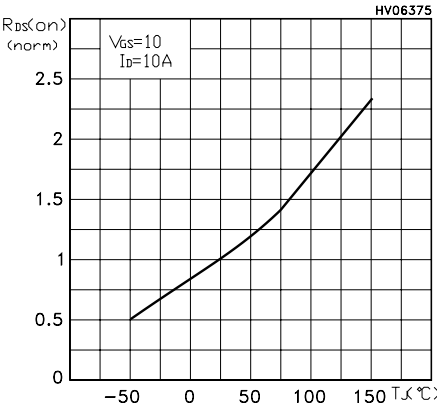
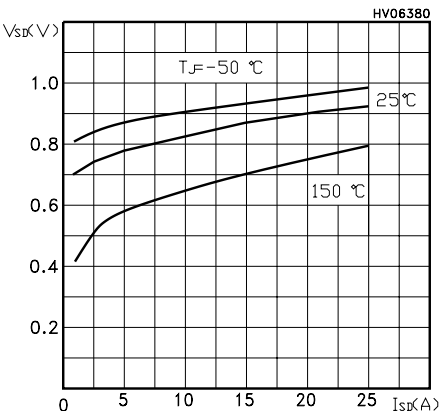


Figure 13. Source-drain Diode Forward Characteristics



3 Test circuits

Figure 14. Switching Times Test Circuit For Resistive Load

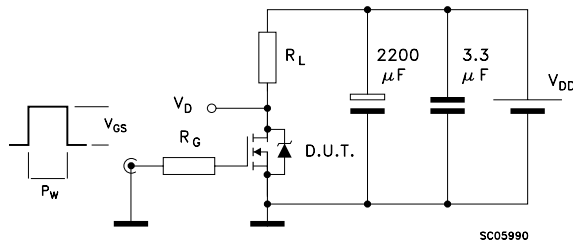


Figure 15. Gate Charge Test Circuit

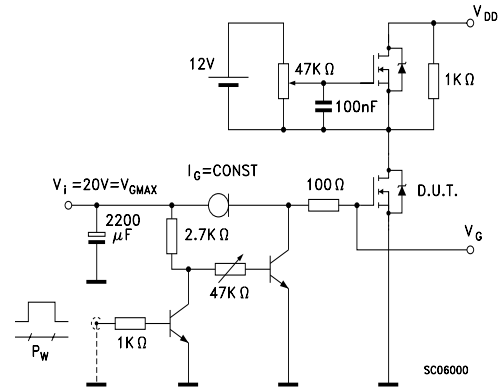


Figure 16. Test Circuit For Inductive Load Switching and Diode Recovery Times

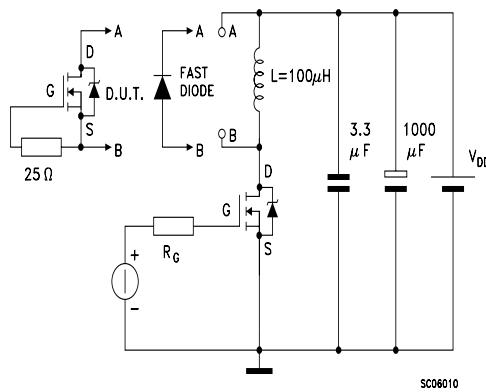


Figure 18. Unclamped Inductive Load Test Circuit

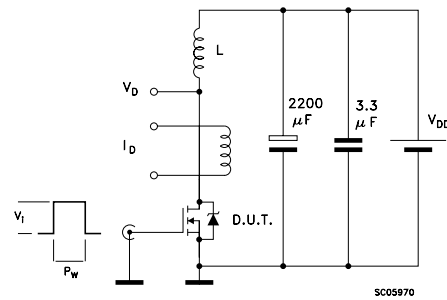
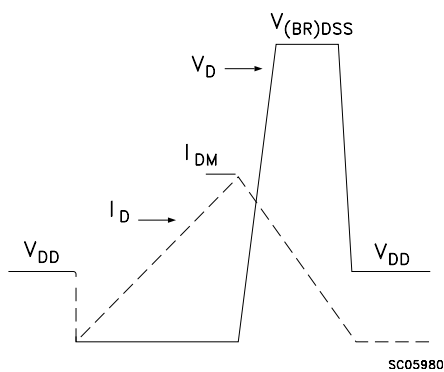


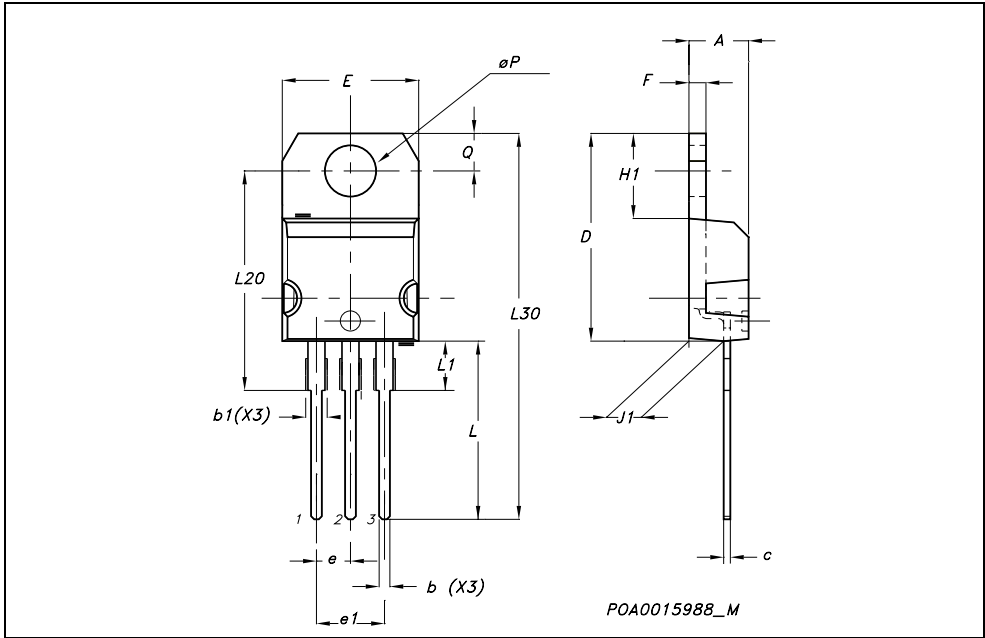
Figure 17. Unclamped Inductive Waveform



4 Package mechanical data

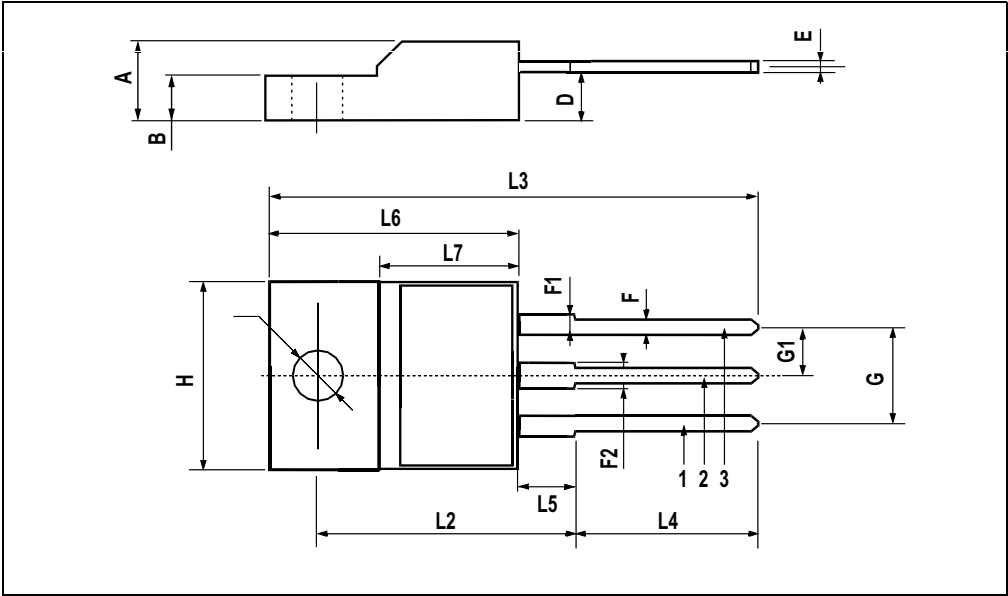
In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings 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	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
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		0.052
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



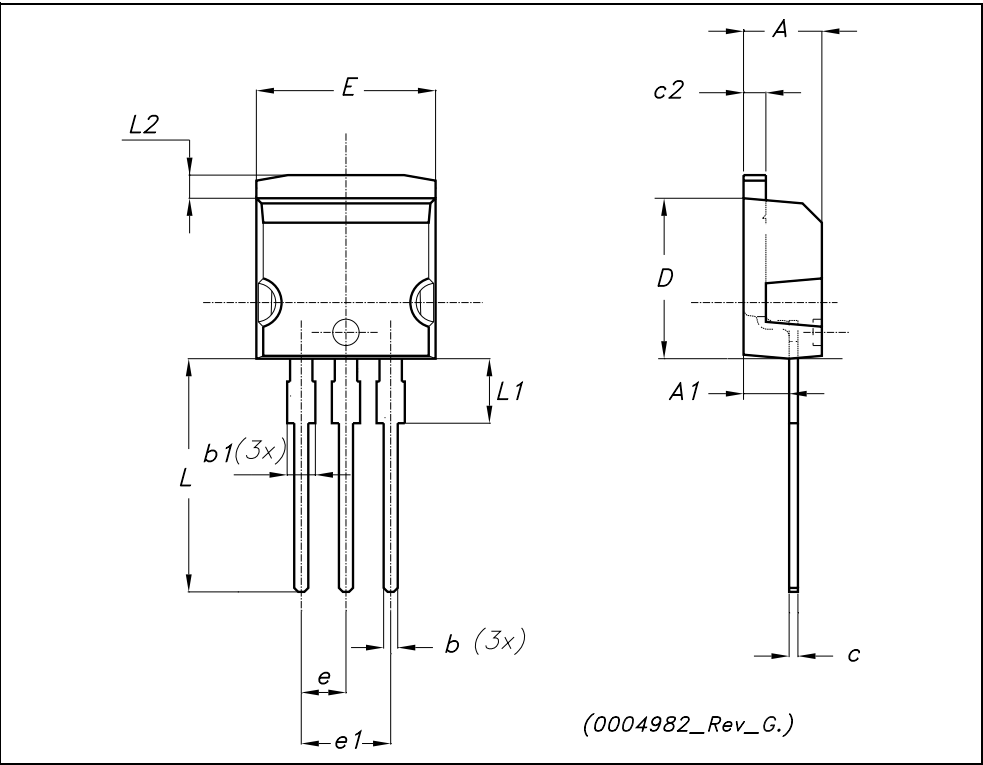
TO-220FP MECHANICAL DATA

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	.0385		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



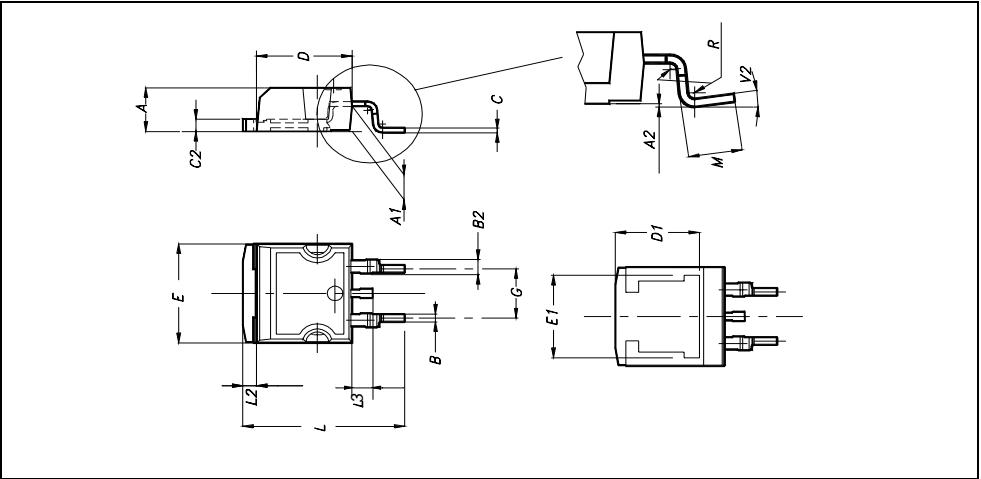
TO-262 (I²PAK) MECHANICAL DATA

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



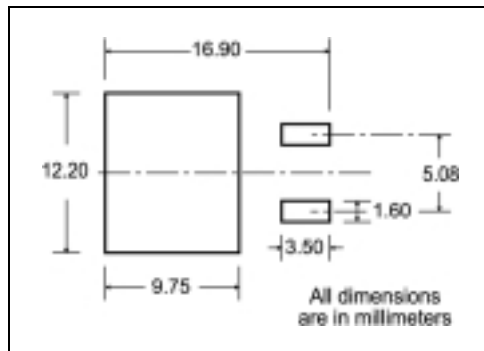
D²PAK MECHANICAL DATA

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°			

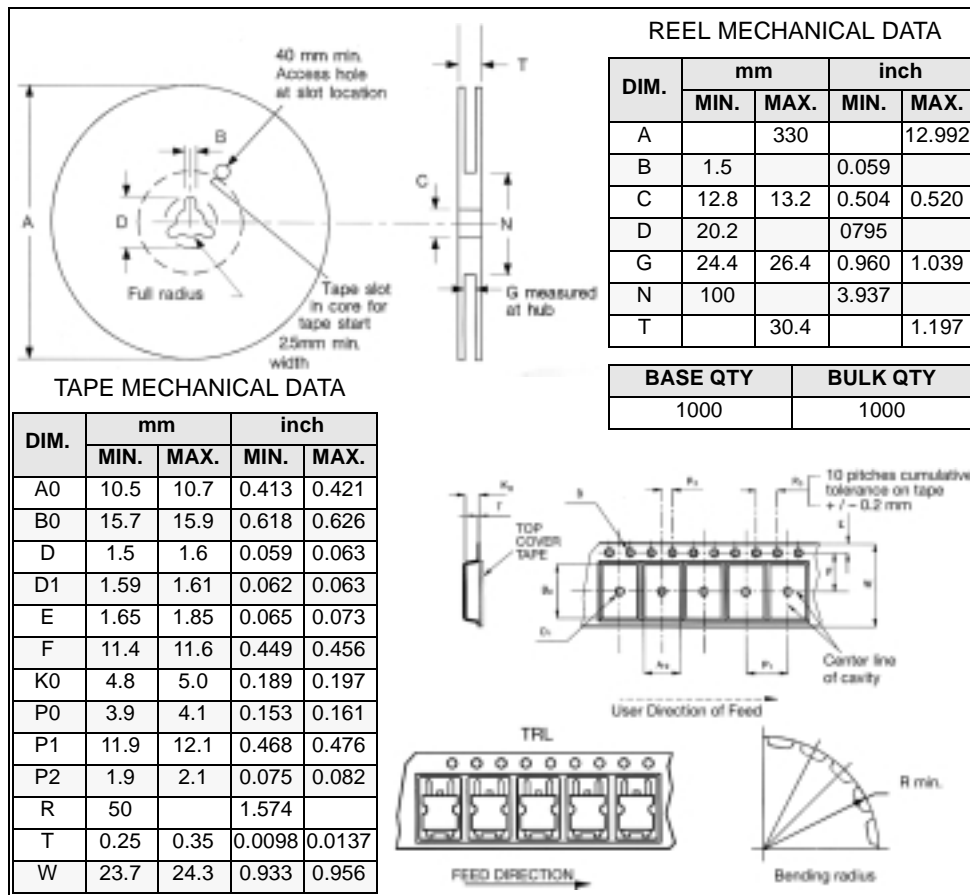


5 Packing mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



* on sales type

6 Revision History

Date	Revision	Changes
05-Sep-2005	2	Inserted Ecopack indication

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