1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220	TO-220FP	
V_{DS}	Drain-Source Voltage (V_{GS} = 0)	700		V
V_{DGR}	Drain-gate Voltage (R_{GS} = 20kΩ)	700		V
V_{GS}	Gate-Source Voltage	± 30		V
I_D	Drain Current (continuous) at T_C = 25°C	8.6	8.6 (Note 3)	A
I_D	Drain Current (continuous) at T_C = 100°C	5.4	5.4 (Note 3)	A
I_{DM} Note 2	Drain Current (pulsed)	34	34 (Note 3)	A
P_{TOT}	Total Dissipation at T_C = 25°C	150	35	W
	Derating Factor	1.20	0.28	W/°C
Vesd(G-S)	G-S ESD (HBM C=100pF, R=1.5kΩ)	4000		V
dv/dt Note 1	Peak Diode Recovery voltage slope	4.5		V/ns
V_{ISO}	Insulation Withstand Volatge (DC)	--	2500	V
T_j T_{stg}	Operating Junction Temperature Storage Temperature	-55 to 150		°C

Table 2. Thermal data

		TO-220	TO-220FP	Unit
Rthj-case	Thermal Resistance Junction-case Max	0.83	3.6	°C/W
Rthj-amb	Thermal Resistance Junction-amb Max	62.5		°C/W
T_l	Maximum Lead Temperature For Soldering Purpose	300		°C

Table 3. Avalanche characteristics

Symbol	Parameter	Max Value	Unit
I_{AR}	Avalanche Current, repetitive or Not-Repetitive (pulse width limited by Tj max)	8.6	A
E_{AS}	Single Pulse Avalanche Energy (starting Tj=25°C, I_D=I_{AR}, V_{DD}= 50V)	350	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	700			V
I_{DSS}	Zero Gate Voltage Drain Current (V_{GS} = 0)	V_{DS} = Max Rating, V_{DS} = Max Rating,Tc = 125°C			1 50	µA µA
I_{GSS}	Gate Body Leakage Current (V_{DS} = 0)	V_{GS} = ±20V, V_{DS} = 0			±10	µA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS}= V_{GS}, I_D = 100 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static Drain-Source On Resistance	V_{GS}= 10 V, I_D= 4.5 A		0.75	0.85	Ω

Table 5. Dynamic

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g_{fs} *Note* 4	Forward Transconductance	V_{DS} =15V, I_D = 4.5A		7.7		S
C_{iss} C_{oss} C_{rss}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V_{DS} =25V, f=1 MHz, V_{GS}=0		2000 190 41		pF pF pF
$C_{oss\ eq.}$ *Note* 5	Equivalent Ouput Capacitance	V_{GS}=0, V_{DS} =0V to 560V		98		pF
Q_g Q_{gs} Q_{gd}	Total Gate Charge Gate-Source Charge Gate-Drain Charge	V_{DD}=560V, I_D = 9 A V_{GS} =10V (see Figure 17)		64 12 33	90	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}=350 V, I_D=4.5 A, R_G=4.7Ω, V_{GS}=10V (see Figure 18)		22 19		ns ns
$t_{d(off)}$ t_f	Turn-off Delay Time Fall Time	V_{DD}=350 V, I_D=4.5A, R_G=4.7Ω, V_{GS}=10V (see Figure 18)		46 19		ns ns
$t_{r(Voff)}$ t_f t_c	Off-voltage Rise Time Fall Time Cross-over Time	V_{DD}=560 V, I_D=9A, R_G=4.7Ω, V_{GS}=10V (see Figure 18)		11 10 22		ns ns ns

Table 7. Source drain diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} *Note* 2	Source-drain Current Source-drain Current (pulsed)				8.6 34	A A
V_{SD} *Note* 4	Forward on Voltage	I_{SD}=8.6 A, V_{GS}=0			1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I_{SD}=9A, di/dt = 100A/µs, V_{DD}=35 V, Tj=150°C		720 5.4 15		ns µC A

Table 8. Gate-source zener diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
BV_{GSO} *Note* 6	Gate-Source Breakdown Voltage	Igs=±1mA (Open Drain)	30			V

(1) $I_{SD} \leq 8.6$ A, di/dt ≤200A/µs, $V_{DD} \leq V_{(BR)DSS}$, $T_j \leq T_{JMAX}$

(2) Pulse width limited by safe operating area

(3) Limited only by maximum temperature allowed

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

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

(6)The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

2.1 Electrical Characteristics (curves)

Figure 1. Safe Operating Area for TO-220

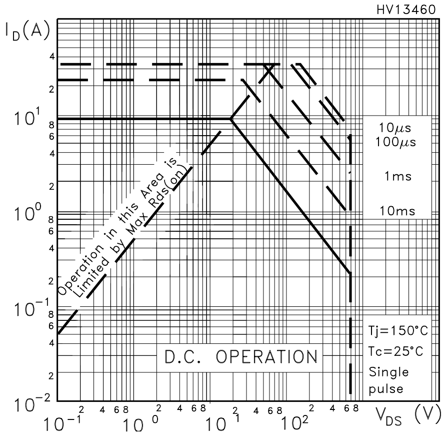


Figure 2. Thermal Impedanc for TO-220

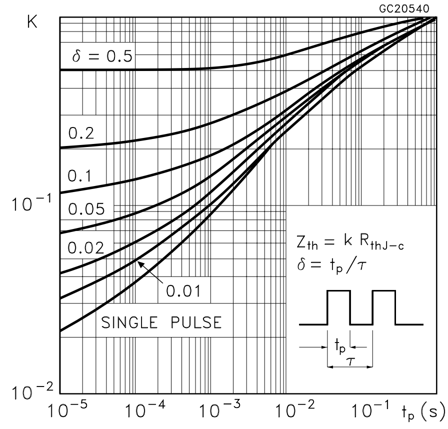


Figure 3. Safe Operating Area for TO-220FP

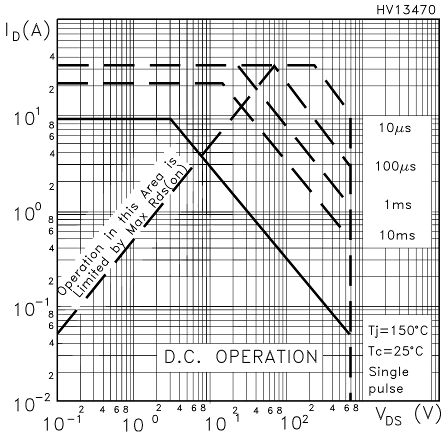


Figure 4. Thermal Impedance for TO-220FP

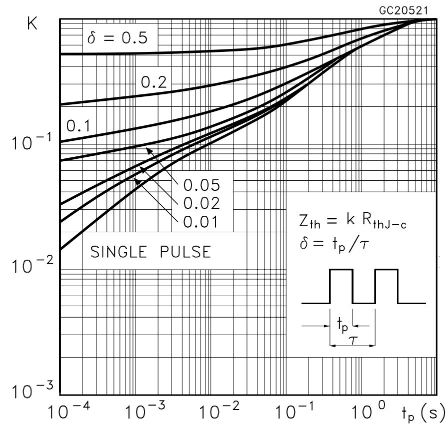


Figure 5. Output Characteristics

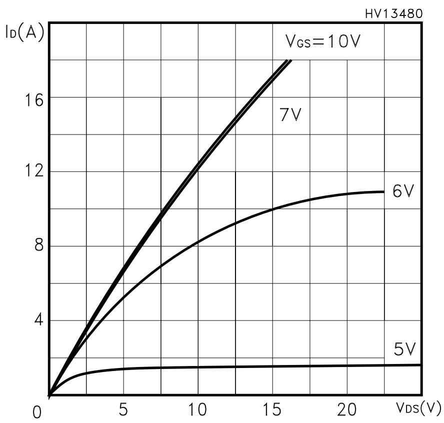


Figure 6. Transfer Characteristics

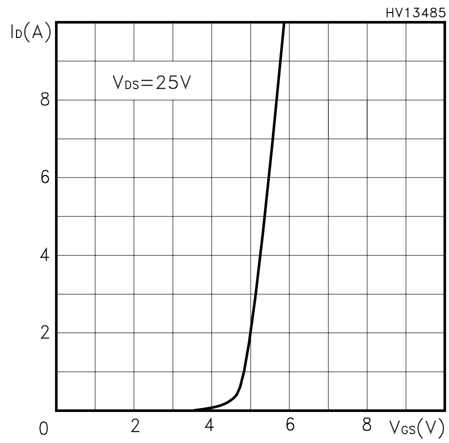


Figure 7. Transconductance

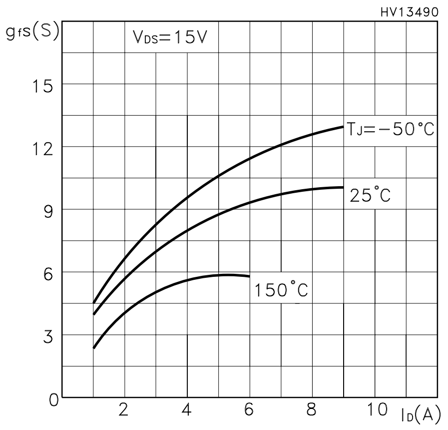


Figure 8. Static Drain-Source on Resistance

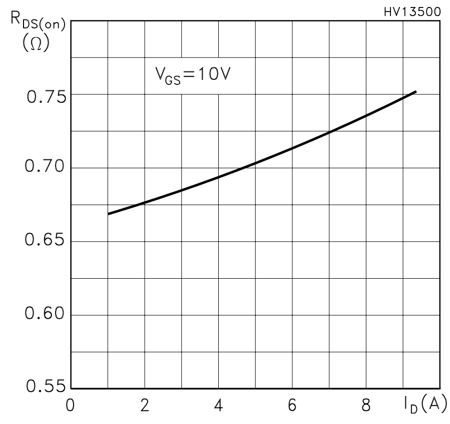


Figure 9. Gate Charge vs Gate -Source Voltage

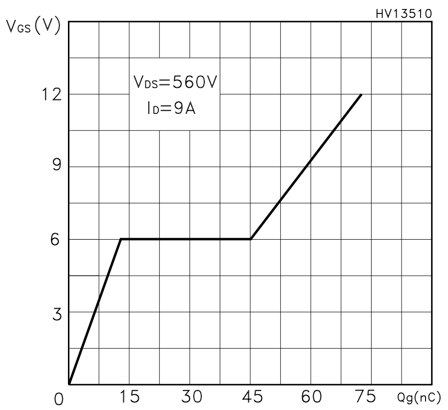


Figure 11. Capacitance Variations

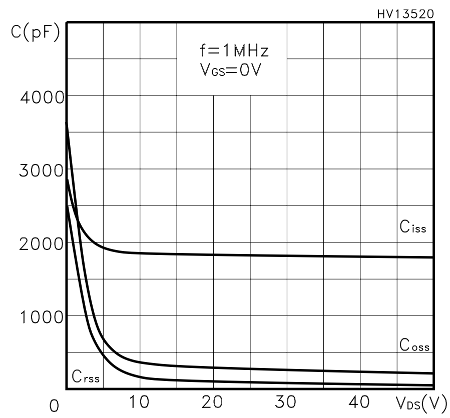


Figure 10. Normalized Gate Threshold Voltage vs Temperatute

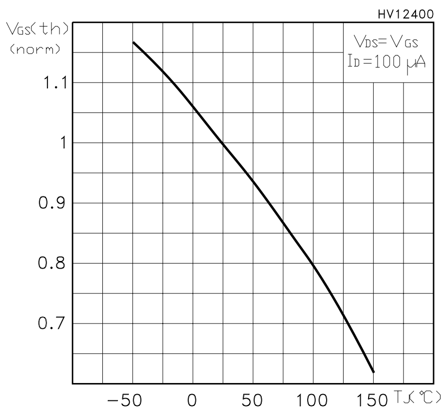


Figure 12. Normalized on Resistance vs Temperature

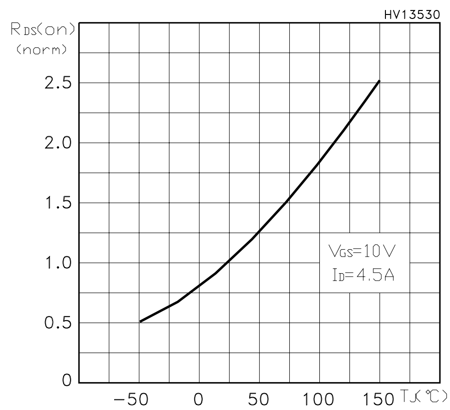


Figure 13. Source-drain Diode Forward Characteristics

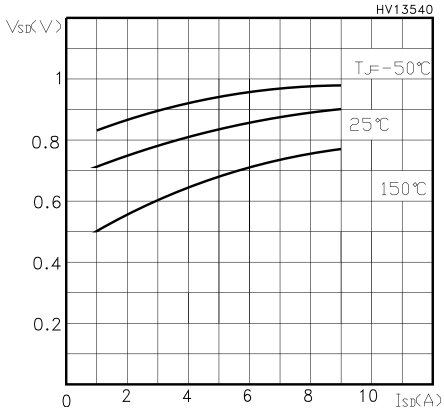


Figure 14. Normalized BVDSS vs Temperature

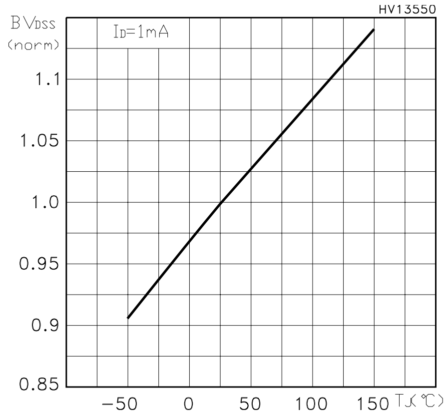
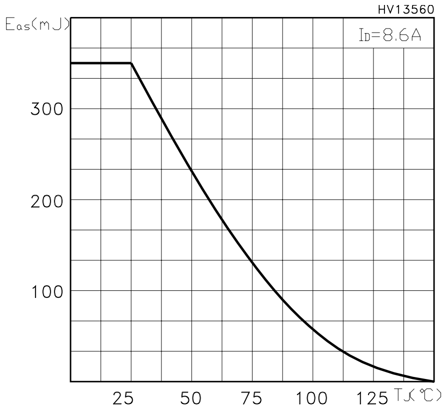


Figure 15. Maximum Avalanche Energy vs Temperature



3 Test circuits

Figure 16. Switching Times Test Circuit For Resistive Load

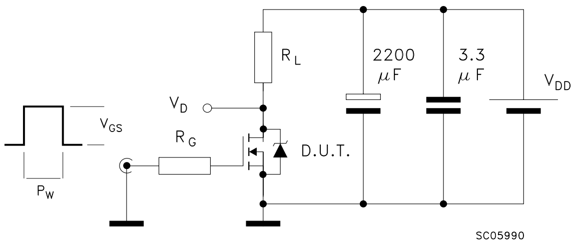


Figure 17. Gate Charge Test Circuit

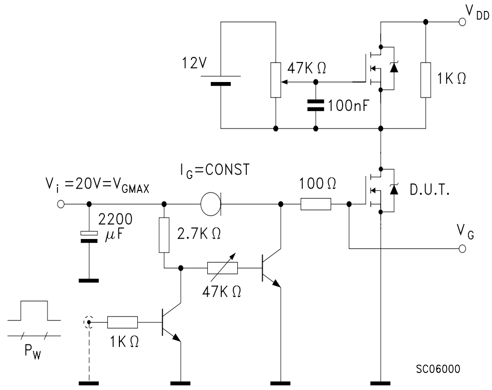


Figure 18. Test Circuit For Indictive Load Switching and Diode Recovery Times

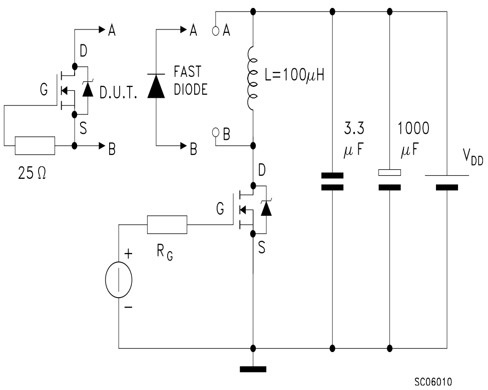


Figure 20. Unclamped Inductive Load Test Circuit

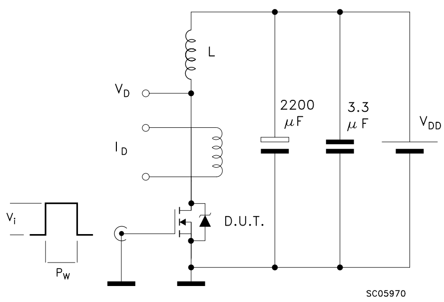
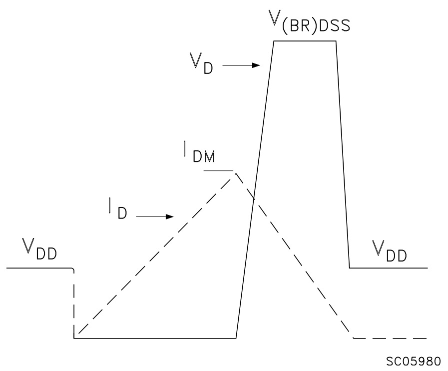


Figure 19. Unclamped Inductive Waveform

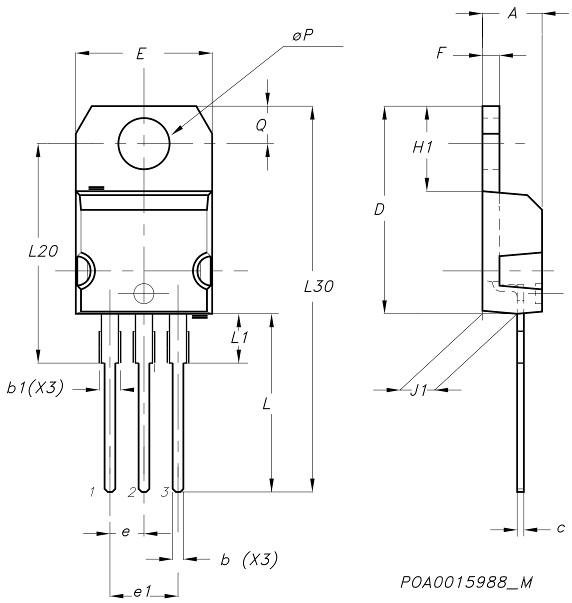


4 Package mechanical data

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

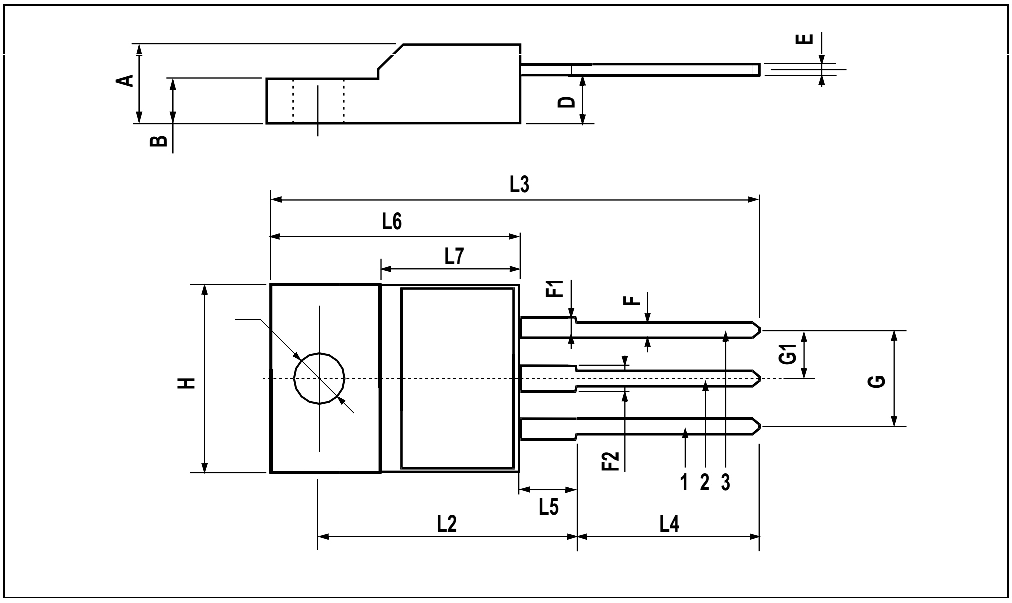
TO-220 MECHANICAL DATA

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



5 Revision History

Date	Revision	Changes
22-Aug-2005	2	Inserted Ecopack indication