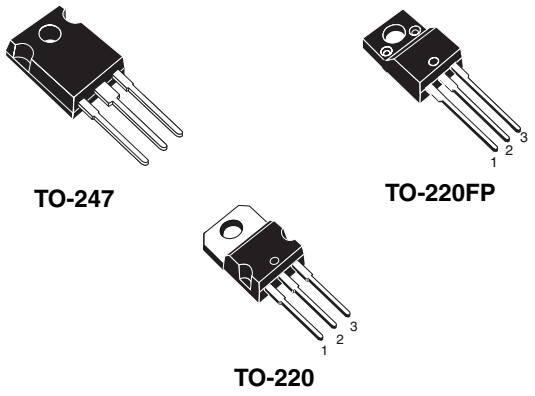
STF20NM60D - STP20NM60FD
STW20NM60FD

N-channel 600V - 0.26Ω - 20A - TO-220 - TO-220FP - TO-247
FDmesh™ Power MOSFET (with fast diode)

General features

Type	V_{DSS}	$R_{DS(on)}$	I_D	Pw
STF20NM60D	600V	<0.29Ω	20A	192W
STP20NM60FD	600V	<0.29Ω	20A	45W
STW20NM60FD	600V	<0.29Ω	20A	214W

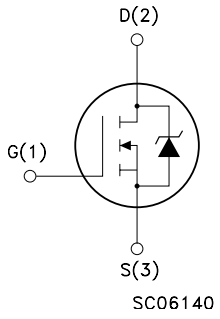
- High dv/dt and avalanche capabilities
- 100% Avalanche tested
- Low input capacitance and gate charge
- Low gate input resistancE
- Tight process control and high manufacturing yields



Description

The FDmesh™ associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in particular ZVS phase-shift converters.

Internal schematic diagram



Applications

- Switching application

Order codes

Part number	Marking	Package	Packaging
STF20NM60D	F20NM60D	TO-220FP	Tube
STP20NM60FD	P20NM60FD	TO-220	Tube
STW20NM60FD	W20NM60FD	TO-247	Tube

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2 Electrical characteristics 4

2.1 Electrical characteristics (curves) 6

3 Test circuit 9

4 Package mechanical data 10

5 Revision history 14

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TO-220	TO-220FP	TO-247	
V_{DS}	Drain-source voltage (V_{GS} = 0)	600			V
V_{DGR}	Drain-gate voltage (R_{GS} = 20 kΩ)	600			V
V_{GS}	Gate- source voltage	± 30			V
I_D	Drain current (continuous) at T_C = 25°C	20	20 (1)	20	A
I_D	Drain current (continuous) at T_C = 100°C	12.6	12.6 (1)	12.6	A
I_{DM} (2)	Drain current (pulsed)	80	80 (1)	80	A
P_{TOT}	Total dissipation at T_C = 25°C	192	45	214	W
	Derating factor	1.20	0.36	1.42	W/°C
dv/dt (3)	Peak diode recovery voltage slope	20			V/ns
V_{ISO}	Insulation withstand voltage (DC)	-	2500	-	V
T_j T_{stg}	Operating junction temperature Storage temperature	– 65 to 150			°C °C

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 20A$, di/dt ≤ 400A/µs, $V_{DD} = 80\%V_{(BR)DSS}$

Table 2. Thermal resistance

Symbol	Parameter	Value			Unit
		TO-220	TO-220FP	TO-247	
Rthj-case	Thermal resistance junction-case Max	0.65	2.8	0.585	°C/W
Rthj-amb	Thermal resistance junction-ambient Max	62.5		30	°C/W
T_l	Maximum lead temperature for soldering purpose	300			°C

Table 3. Avalanche data

Symbol	Parameter	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 °C, $I_D = I_{AR}$, V_{DD} = 35 V)	700	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	600			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0) 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) Gate-body leakage current (V_{DS} = 0)	V_{GS} = ±30V			±10 0	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 10V, I_D = 10A		0.26	0.29	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
g_{fs} (1)	Forward transconductance	V_{DS} > $I_{D(on)}$ x $R_{DS(on)max}$, I_D = 10A		9		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 25V, f = 1 MHz, V_{GS} = 0		1300 500 35		pF pF pF
$C_{oss\ eq.}$ (2)	Equivalent output capacitance	V_{GS} = 0V, V_{DS} = 0V to 480V		190		pF
R_G	Gate input resistance	f=1 MHz Gate DC Bias = 0 Test signal level = 20mV open drain		2.7		Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 480V, I_D = 20A, V_{GS} = 10V *(see Figure 17)*		37 10 17	52	nC nC nC

1. Pulsed: Pulse duration = 300 µs, 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%

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} = 300V, I_D = 10A R_G = 4.7Ω V_{GS} = 10V *(see Figure 16)*		25 12		ns ns
$t_{r(Voff)}$ t_f t_c	Off-voltage rise time Fall time Cross-over time	V_{DD} = 480 V, I_D = 20A, R_G = 4.7Ω, V_{GS} = 10V *(see Figure 16)*		8 22 30		ns ns ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
I_{SD} I_{SDM} (1)	Source-drain current Source-drain current (pulsed)				20 80	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 20 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 A, T_j = 25°C di/dt =100A/µs,V_{DD}=60V *(see Figure 21)*		240 1800 16		ns nC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 20 A, T_j = 150°C di/dt =100A/µs,V_{DD}=60V *(see Figure 21)*		396 2960 20		ns nC 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

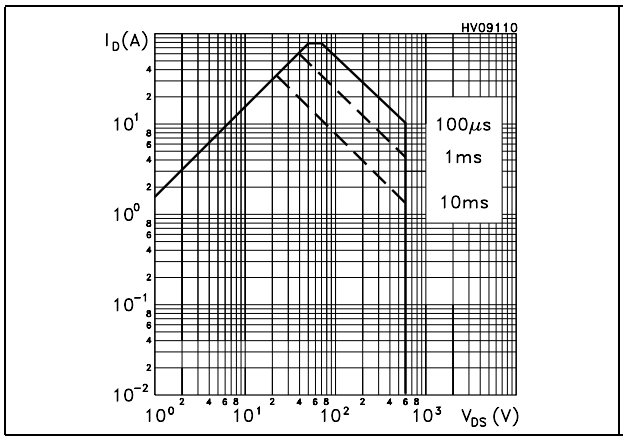


Figure 2. Thermal impedance for TO-220

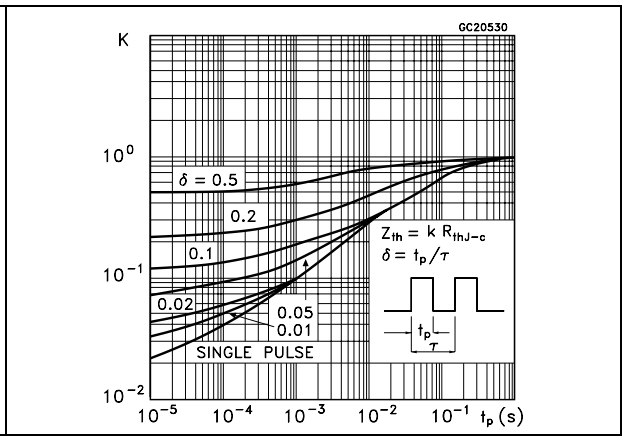


Figure 3. Safe operating areafor TO-220FP

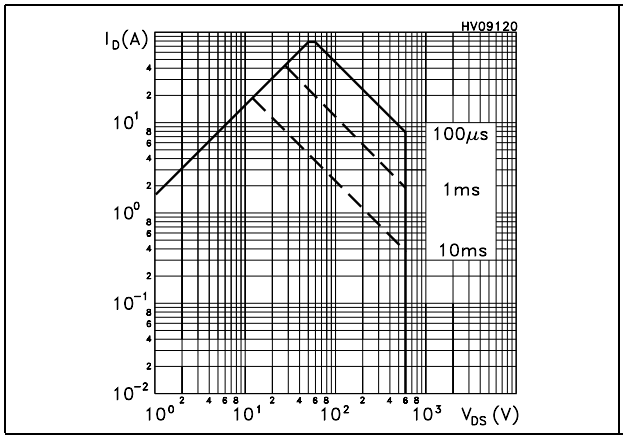


Figure 4. Thermal impedance for TO-220FP

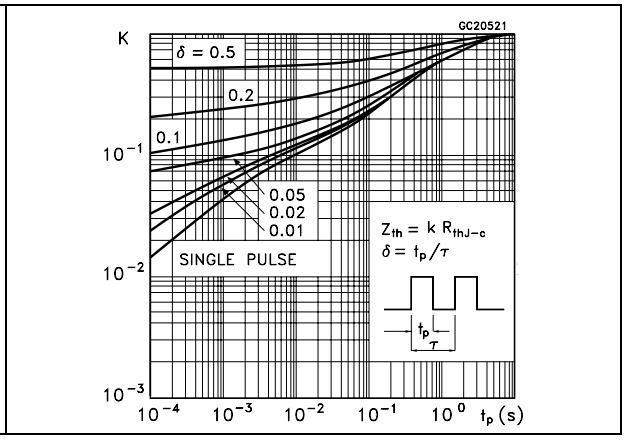


Figure 5. Safe operating area for TO-247

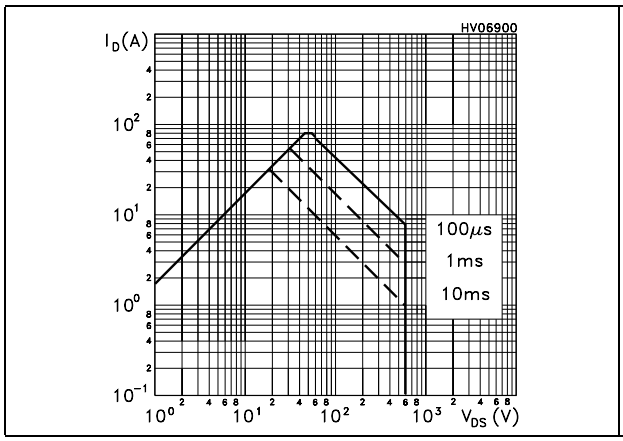


Figure 6. Thermal impedance for TO-247

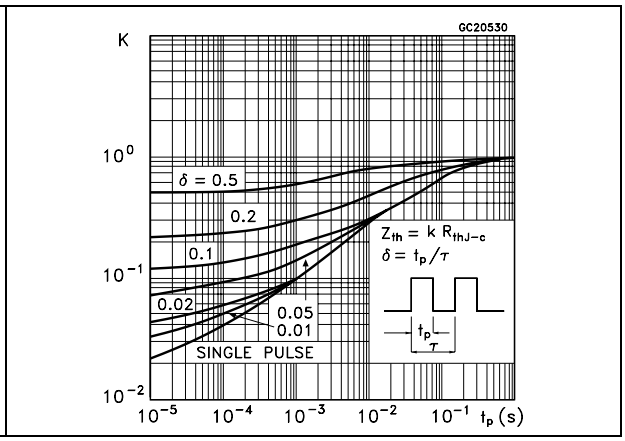


Figure 7. Output characterisics

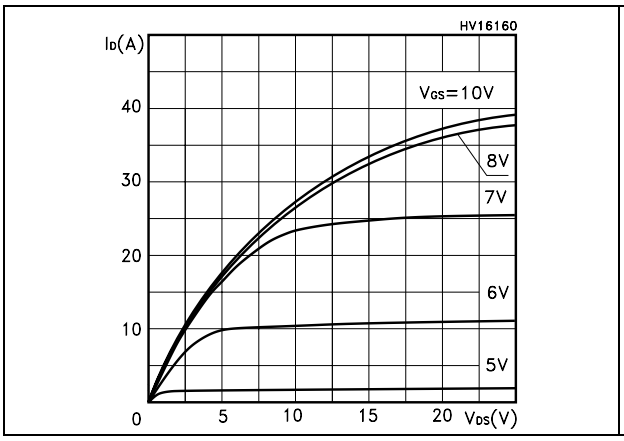


Figure 8. Transfer characteristics

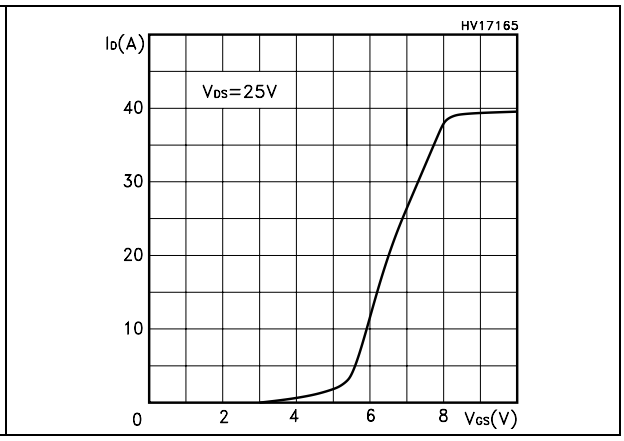


Figure 9. Transconductance

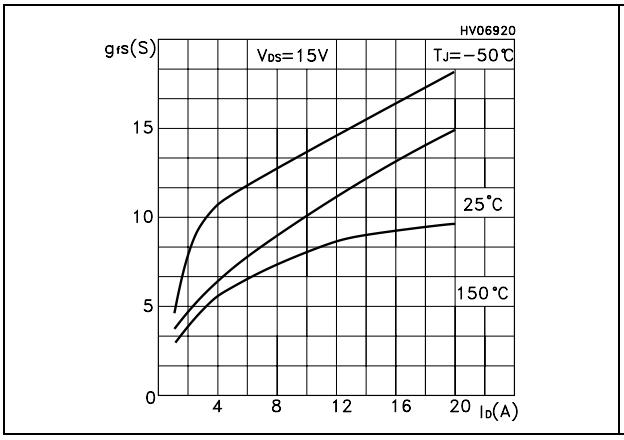


Figure 10. Static drain-source on resistance

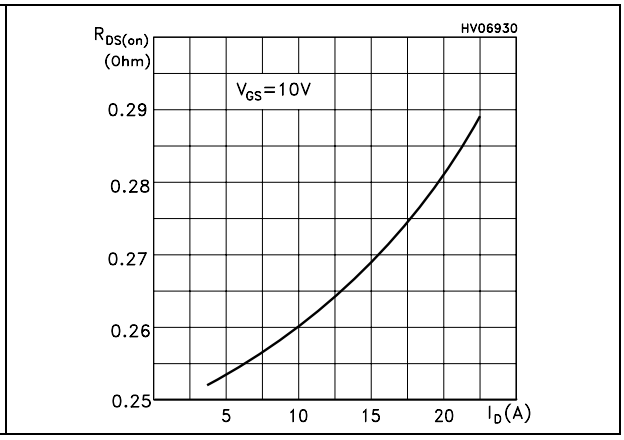


Figure 11. Gate charge vs gate-source voltage

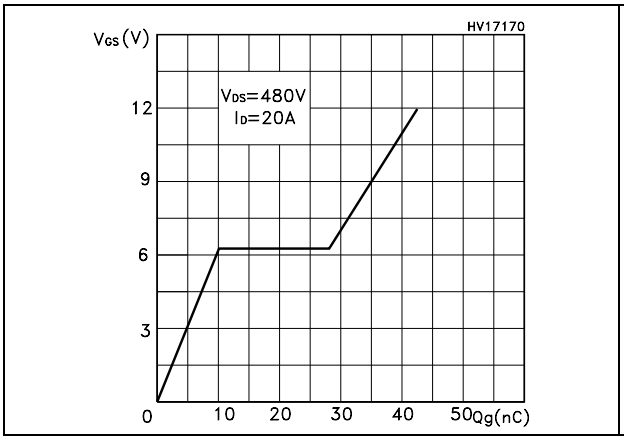


Figure 12. Capacitance variations

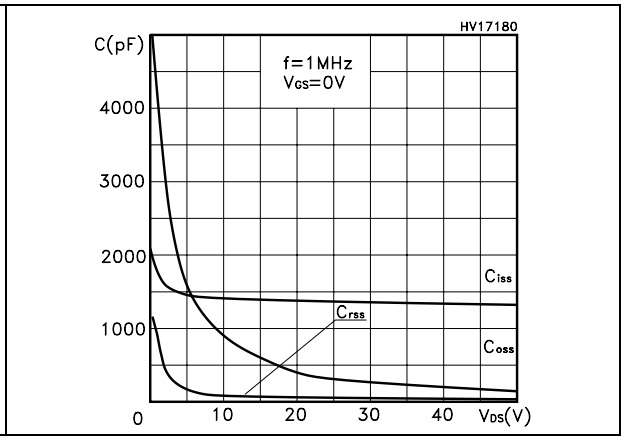


Figure 13. Normalized gate threshold voltage vs temperature

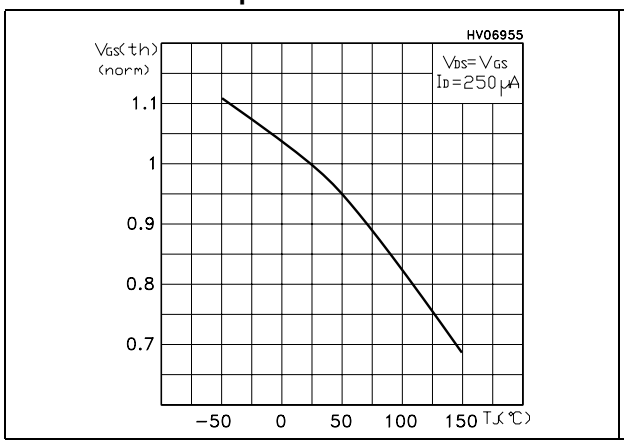


Figure 14. Normalized on resistance vs temperature

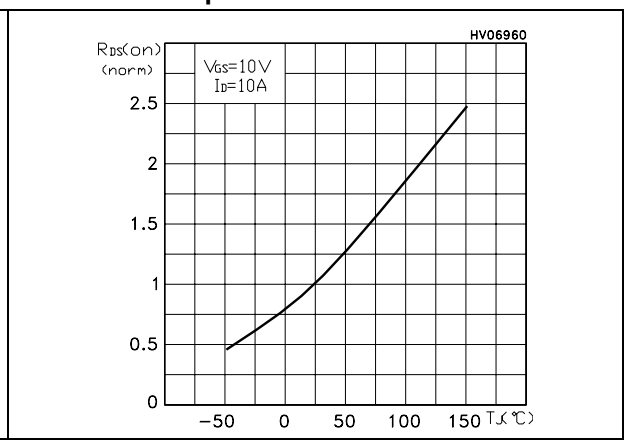
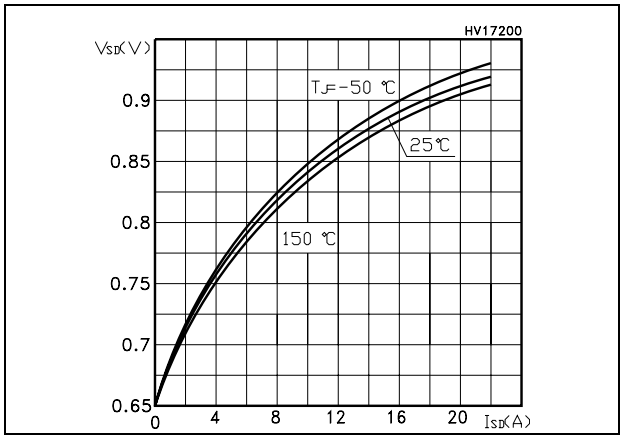


Figure 15. Source-drain diode forward characteristics



3 Test circuit

Figure 16. Switching times test circuit for resistive load

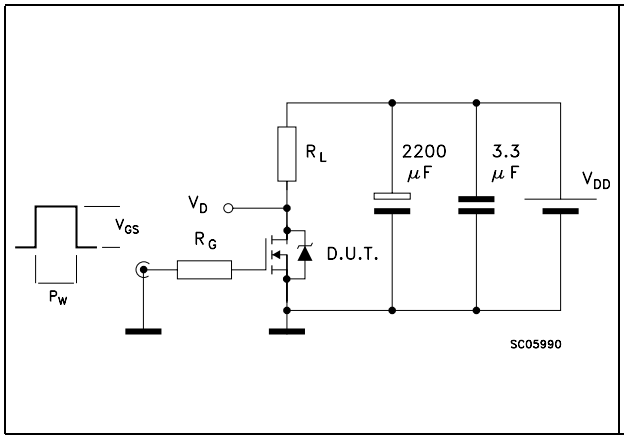


Figure 17. Gate charge test circuit

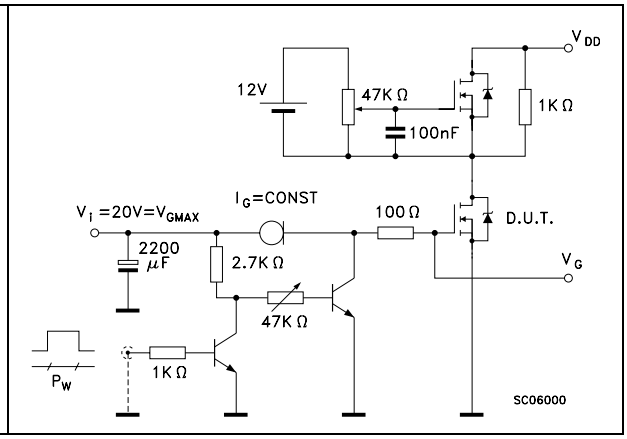


Figure 18. Test circuit for inductive load switching and diode recovery times

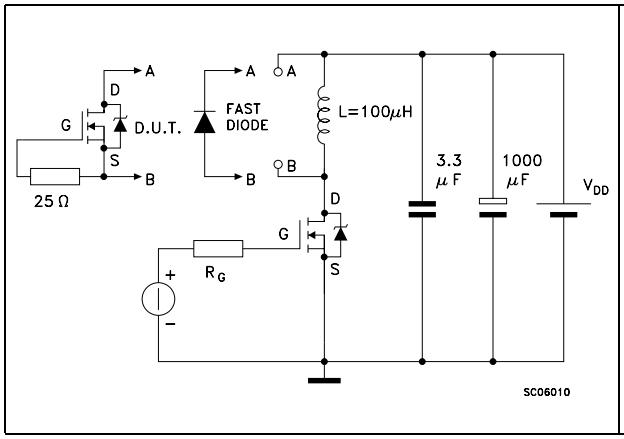


Figure 19. Unclamped inductive load test circuit

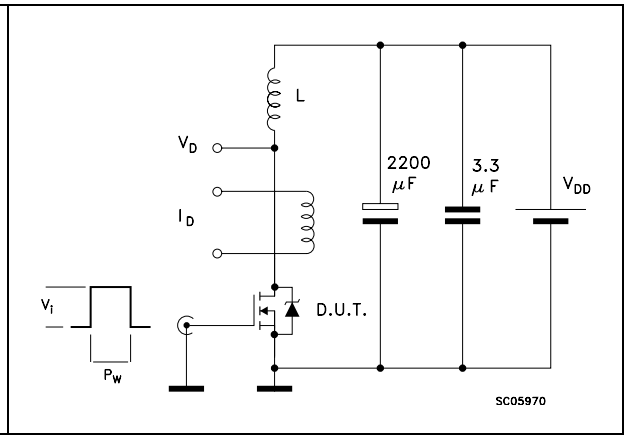


Figure 20. Unclamped inductive waveform

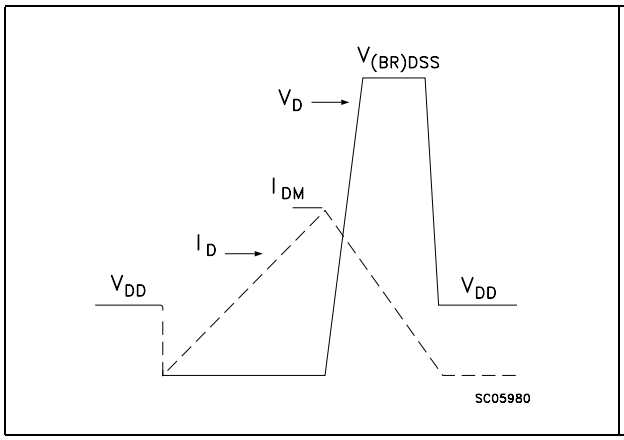
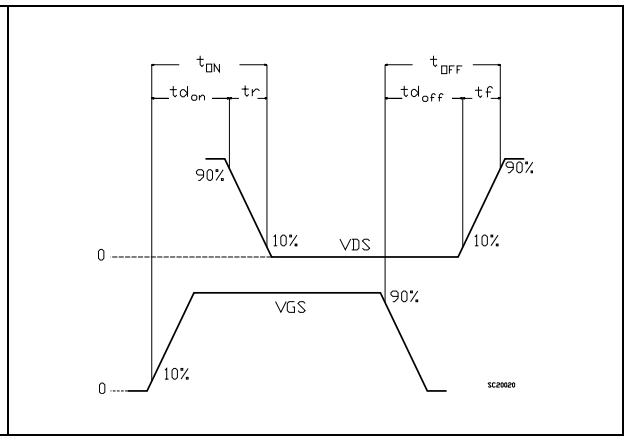


Figure 21. Switching time waveform

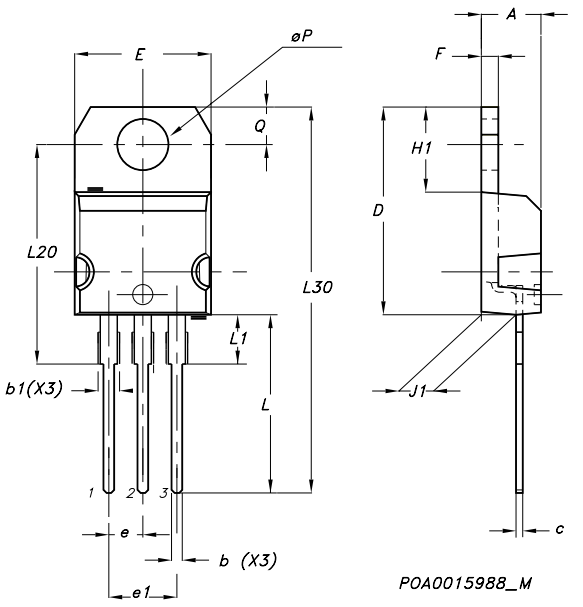


4 Package mechanical data

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*

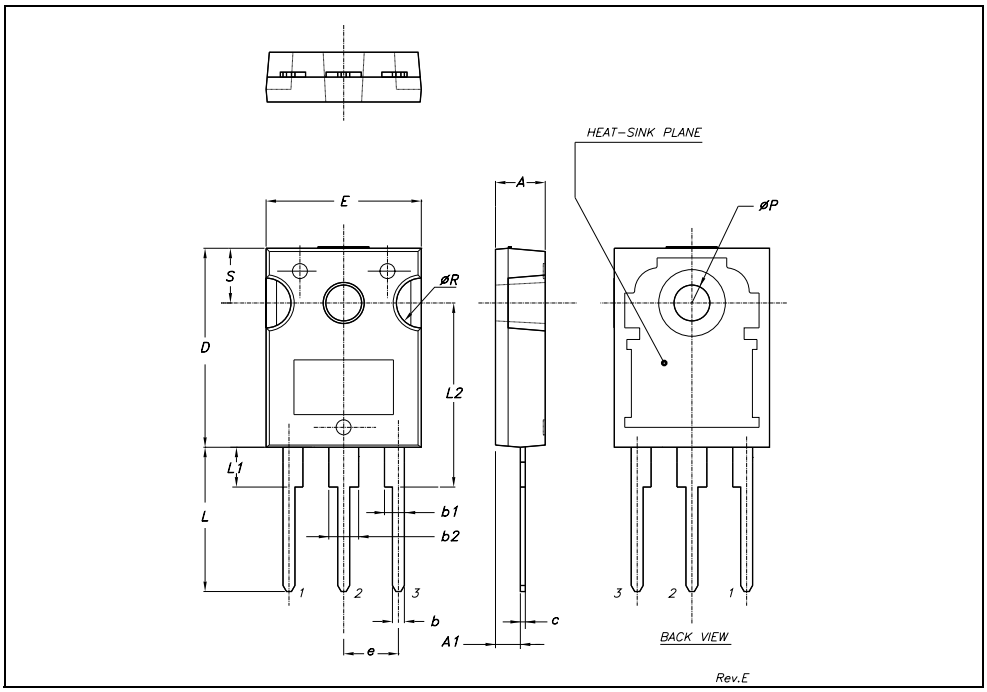
TO-220 MECHANICAL DATA

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	1.15		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



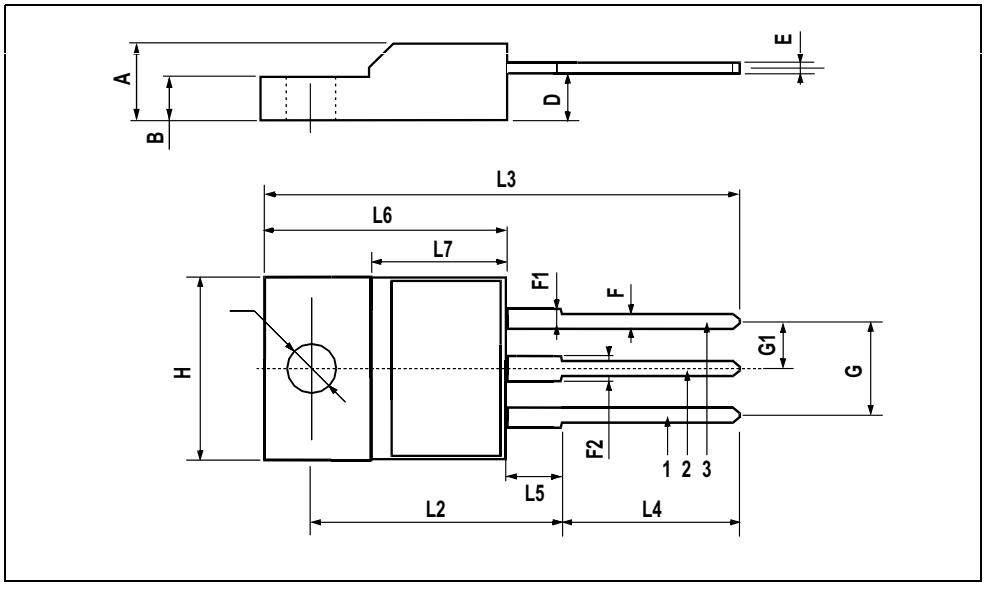
TO-247 MECHANICAL DATA

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	



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

Table 8. Revision history

Date	Revision	Changes
09-Sep-2004	1	First release
21-Apr-2006	2	New template
25-Jul-2006	3	Modified part number
01-Aug-2006	4	Corrected unit on *Table 5.: Dynamic*

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