



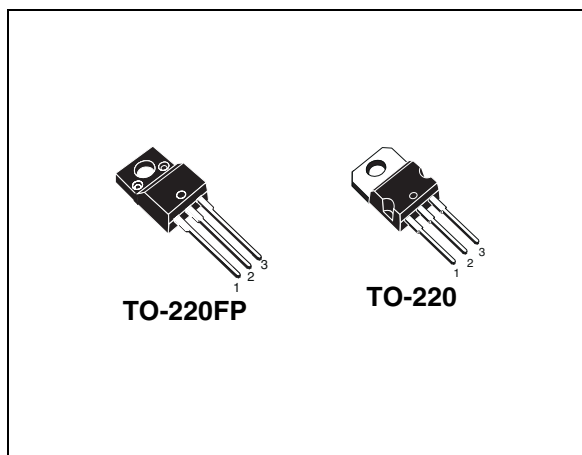
# STP12NK60Z STF12NK60Z

N-channel 650V @Tjmax- 0.53Ω - 10A - TO-220 /TO-220FP  
Zener-protected SuperMESH™ Power MOSFET

## Features

Type	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>W</sub>
STP12NK60Z	650V	<0.640Ω	10A	150W
STF12NK60Z	650V	<0.640Ω	10A	35W

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability



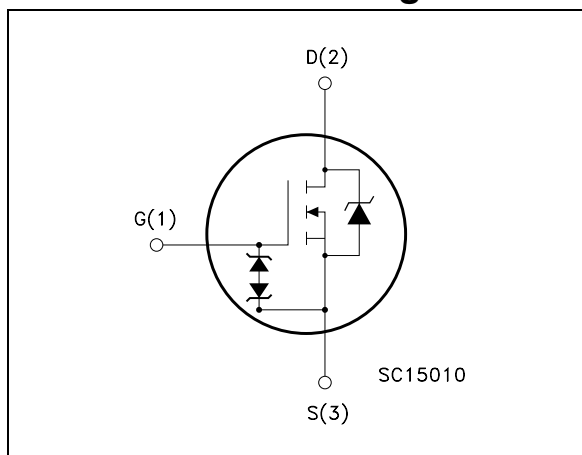
## Description

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, specialties is taken to ensure a very good dv/dt capability for the most demanding application. Such series complements ST full range of high voltage Power MOSFETs.

## Application

- Switching application

## Internal schematic diagram



## Order codes

Part number	Marking	Package	Packaging
STP12NK60Z	P12NK60Z	TO-220	Tube
STF12NK60Z	F12NK60Z	TO-220FP	Tube

# Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>3</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>4</b>
	2.1 Electrical characteristics (curves) .....	6
<b>3</b>	<b>Test circuit</b> .....	<b>9</b>
<b>4</b>	<b>Package mechanical data</b> .....	<b>10</b>
<b>5</b>	<b>Revision history</b> .....	<b>13</b>

# 1 Electrical ratings

( $T_{CASE}=25^{\circ}C$  unless otherwise specified)

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220	TO-220FP	
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0$ )	600		V
$V_{GS}$	Gate-source voltage	$\pm 30$		V
$I_D$	Drain current (continuous) at $T_C = 25^{\circ}C$	10	10 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100^{\circ}C$	6.3	6.3 <sup>(1)</sup>	A
$I_{DM}^{(2)}$	Drain current (pulsed)	40	40 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25^{\circ}C$	150	35	W
	Derating factor	1.2	0.27	W/ $^{\circ}C$
$V_{ESD(G-S)}$	Gate source ESD(HBM-C=100pF, R=1.5K $\Omega$ )	--	2500	V
$dv/dt^{(3)}$	Peak diode recovery voltage slope	15		V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t=1s; T_C=25^{\circ}C$ )	--	2500	V
$T_j$	Operating junction temperature	-55 to 150		$^{\circ}C$
$T_{stg}$	Storage temperature			

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3.  $I_{SD} \leq 10A$ ,  $di/dt \leq 200 A/\mu s$ ,  $V_{DD}=480V$

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220	TO-220FP	
Rthj-case	Thermal resistance junction-case max	0.83	3.6	$^{\circ}C/W$
Rthj-amb	Thermal resistance junction-ambient max	62.5		$^{\circ}C/W$
$T_l$	Maximum lead temperature for soldering purpose	300		$^{\circ}C$

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AS}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ Max)	10	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j=25^{\circ}C$ , $I_D=I_{AS}$ , $V_{DD}=50V$ )	260	mJ

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}C$  unless otherwise specified)

**Table 4. On/off**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1mA, V_{GS} = 0$	600			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max rating}$ $V_{DS} = \text{Max rating}, T_C=125^{\circ}C$			1 50	$\mu A$ $\mu A$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20V$			$\pm 10$	$\mu A$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 100\mu A$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10V, I_D = 5A$		0.53	0.64	$\Omega$

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS}=10V, I_D=5A$		9		S
$C_{iss}$ $C_{oss}$ $C_{rss}$	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 25V, f = 1MHz,$ $V_{GS} = 0$		1740 195 49		pF pF pF
$C_{oss\ eq.}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0V, V_{DS} = 0V \text{ to } 480V$		101		pF
$T_{d(on)}$ $T_r$ $T_{d(off)}$ $t_f$	Turn-on delay time Rise time Turn-off delay time Fall time	$V_{DD} = 300V, I_D = 5A, R_G = 4.7\Omega$ $V_{GS} = 10V,$ <i>(see Figure 16)</i>		22.5 18.5 55 31.5		ns ns ns ns
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 480V, I_D = 10A,$ $V_{GS} = 10V$ <i>(see Figure 17)</i>		59 10 32		nC nC nC

1. Pulsed: pulse duration = 300  $\mu s$ , 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%  $V_{DS}$

**Table 6. Source drain diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$	Source-drain current				10	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				40	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 10A, V_{GS} = 0$			1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 10A, di/dt = 100A/\mu s$		358		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 50V, T_j = 25^\circ C$		3		$\mu C$
$I_{RRM}$	Reverse recovery current	(see Figure 21)		17		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 10A, di/dt = 100A/\mu s$		460		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 50V, T_j = 150^\circ C$		4.2		$\mu C$
$I_{RRM}$	Reverse recovery current	(see Figure 21)		18.2		A

1. Pulse width limited by safe operating area
2. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5%

**Table 7. Gate-source Zener diode**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$BV_{GSO}^{(1)}$	Gate-Source breakdown voltage	$I_{gs} = \pm 1mA$ (Open drain)	30			V

1. 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

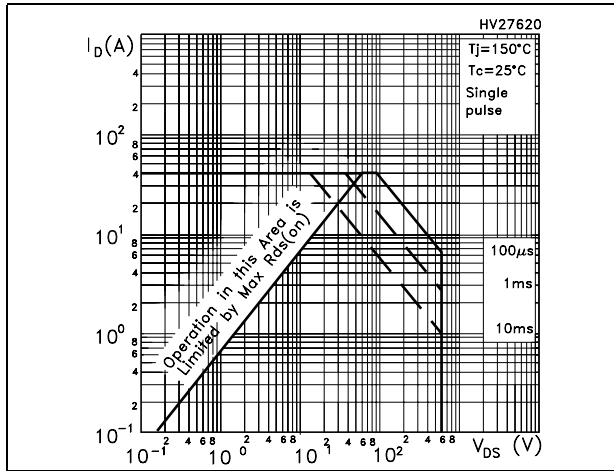


Figure 2. Thermal impedance for TO-220

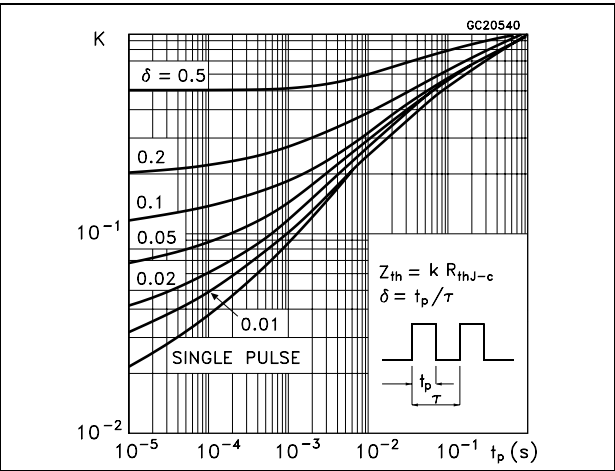


Figure 3. Safe operating area for TO-220FP

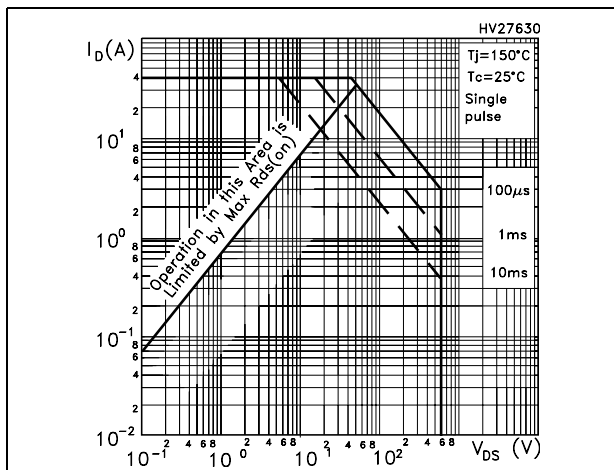


Figure 4. Thermal impedance for TO-220FP

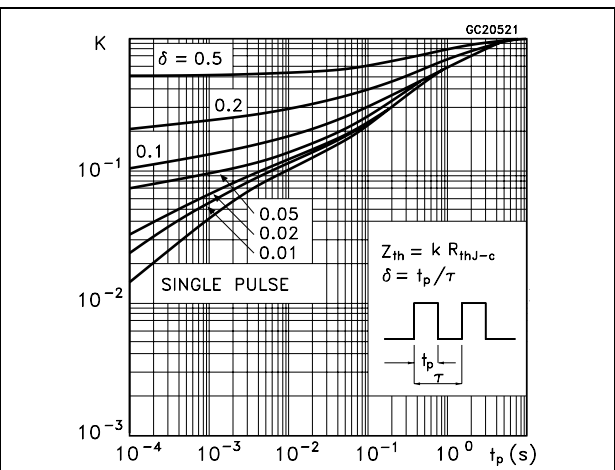


Figure 5. Output characteristics

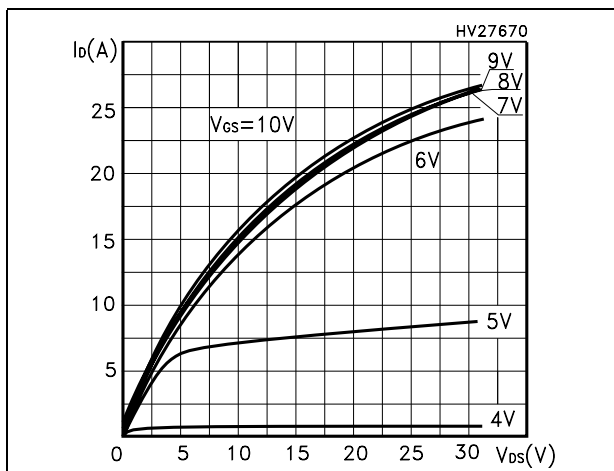


Figure 6. Transfer characteristics

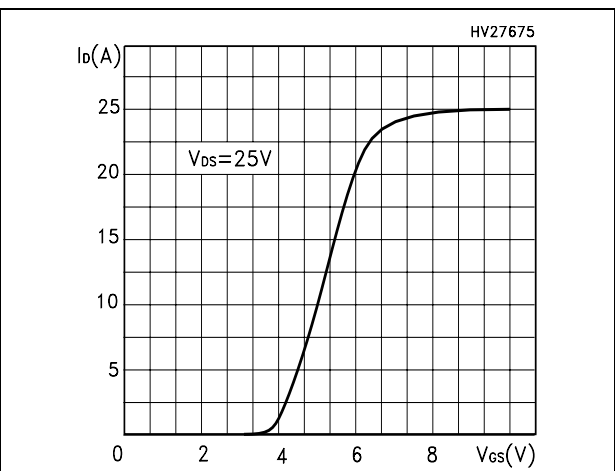


Figure 7. Transconductance

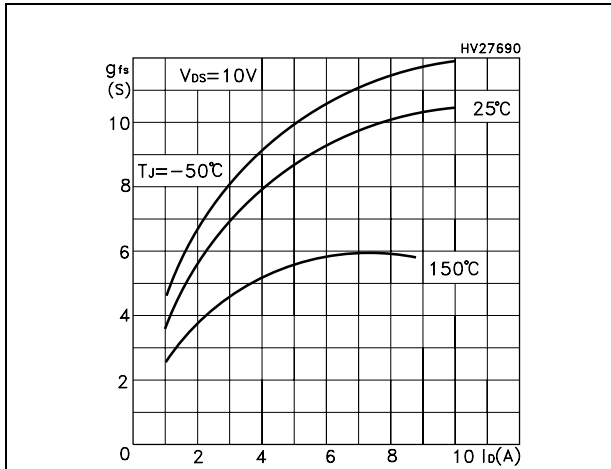


Figure 8. Static drain-source on resistance

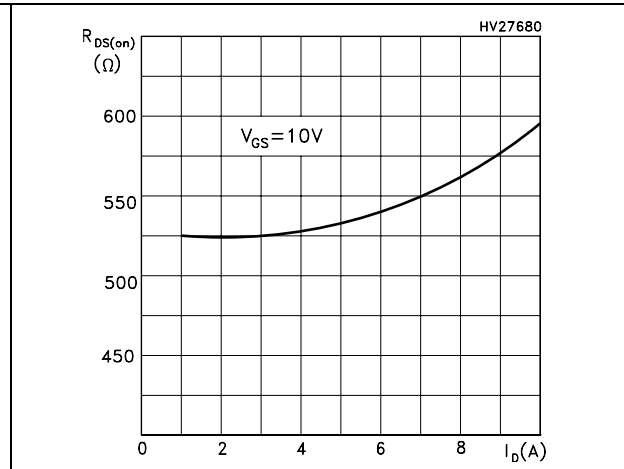


Figure 9. Gate charge vs gate-source voltage

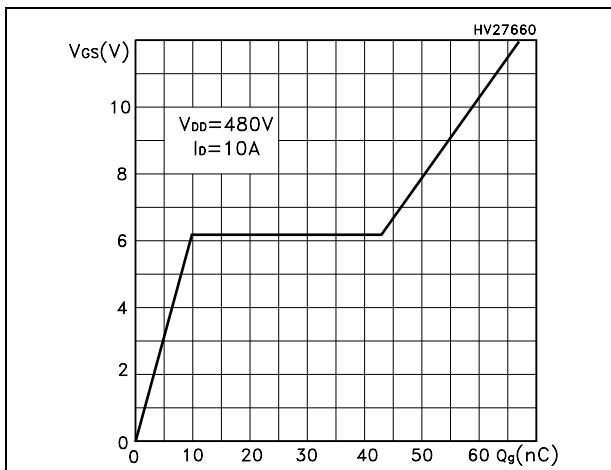


Figure 10. Capacitance variations

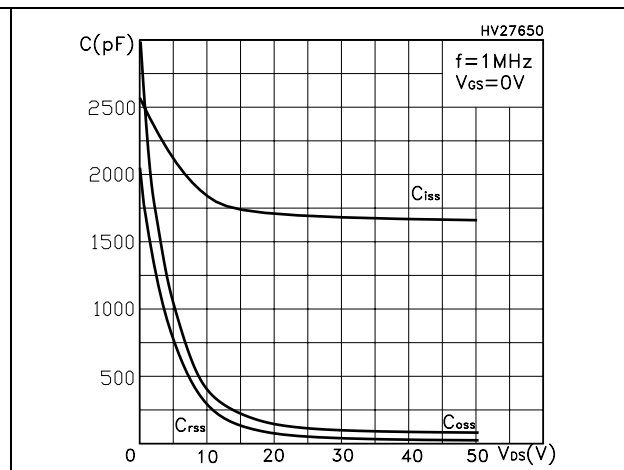


Figure 11. Normalized gate threshold voltage vs temperature

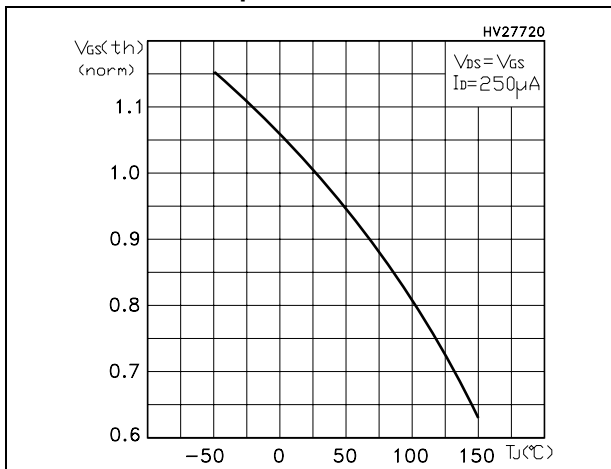
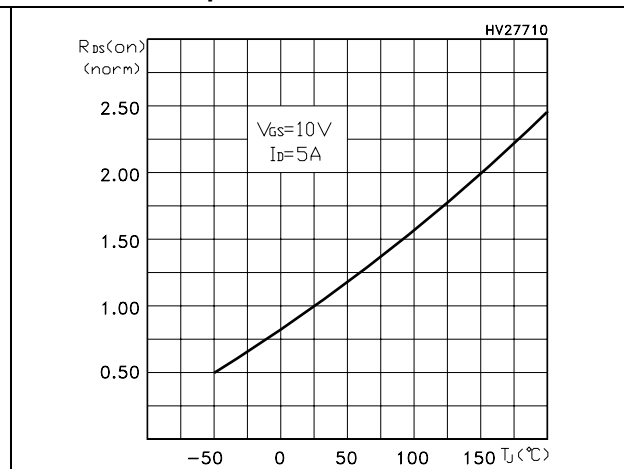
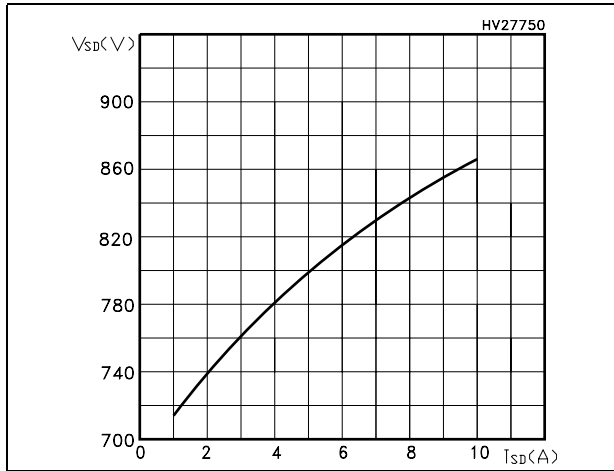


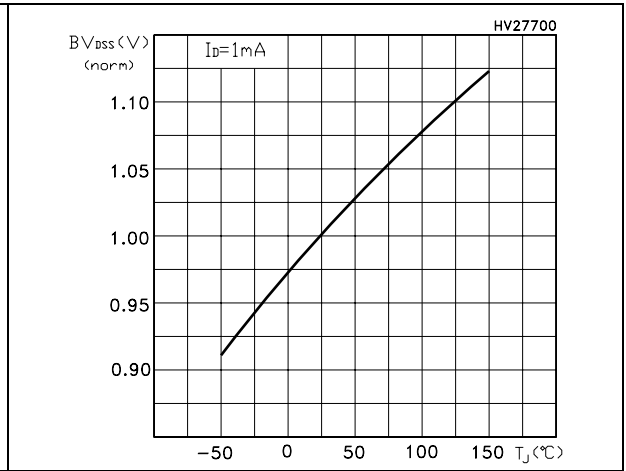
Figure 12. Normalized on resistance vs temperature



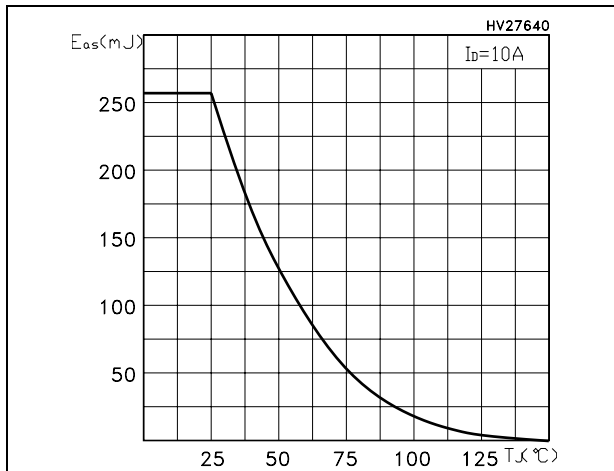
**Figure 13. Source-drain diode forward characteristics**



**Figure 14. Normalized breakdown voltage vs temperature**



**Figure 15. Maximum avalanche energy vs temperature**





### 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



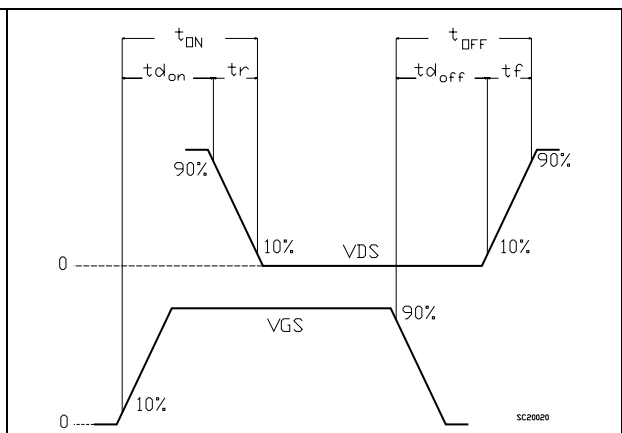
Figure 19. Unclamped inductive load test circuit



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](http://www.st.com)

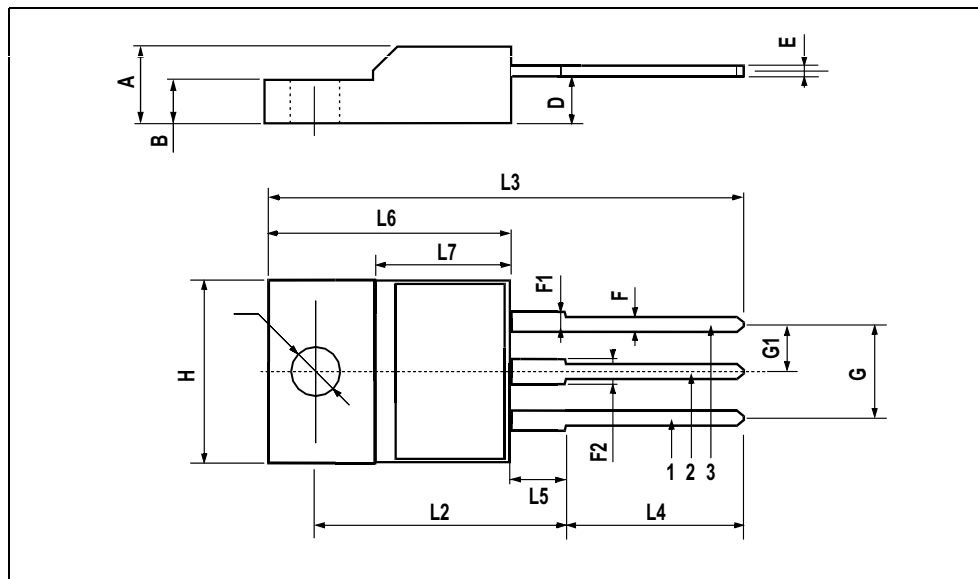
**TO-220 MECHANICAL DATA**

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

Table 8. Revision history

Date	Revision	Changes
12-Apr-2004	1	First release
06-Sep-2005	2	Inserted ecopack indication
13-Sep-2005	3	Final version
05-Sep-2006	4	The document has been reformatted
26-Apr-2007	5	The document has been updated on <a href="#">1: Electrical ratings</a>

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2007 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)