



# THE DATASHEET OF STB6NM60N





# STx6NM60N

N-channel 600 V, 0.85  $\Omega$ , 4.6 A MDmesh™ II Power MOSFET  
TO-220, TO-220FP, IPAK, DPAK, D<sup>2</sup>PAK

## Features

Type	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub> max	I <sub>D</sub>
STB6NM60N	650 V	< 0.92 $\Omega$	4.6 A
STD6NM60N	650 V	< 0.92 $\Omega$	4.6 A
STD6NM60N-1	650 V	< 0.92 $\Omega$	4.6 A
STF6NM60N	650 V	< 0.92 $\Omega$	4.6 A <sup>(1)</sup>
STP6NM60N	650 V	< 0.92 $\Omega$	4.6 A

1. Limited only by maximum temperature allowed

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Application

- Switching applications

## Description

This series of devices implements second generation MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the STMicroelectronics' strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high-efficiency converters.

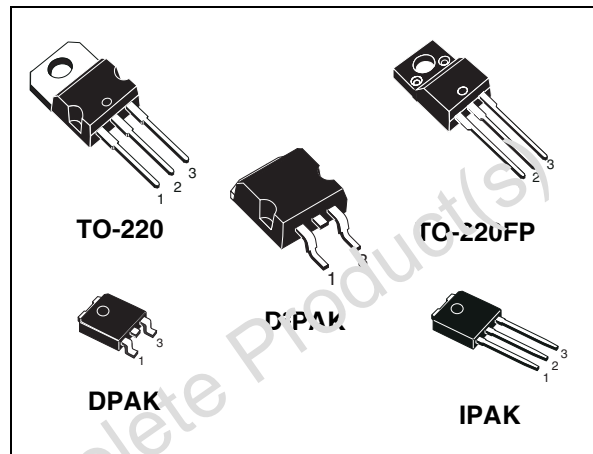
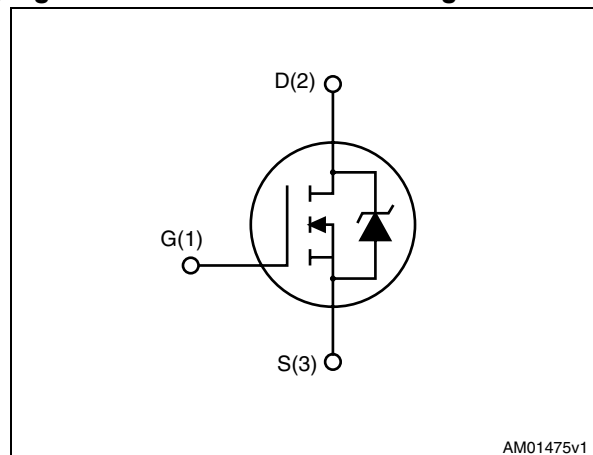


Figure 1. Internal schematic diagram



AM01475v1

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB6NM60N	B6NM60N	D <sup>2</sup> PAK	Tape and reel
STD6NM60N-1	D6NM60N	IPAK	Tube
STD6NM60N	D6NM60N	DPAK	Tape and reel
STF6NM60N	F6NM60N	TO-220FP	Tube
STP6NM60N	P6NM60N	TO-220	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>Packaging mechanical data</b> .....	<b>16</b>
<b>6</b>	<b>Revision history</b> .....	<b>18</b>

Obsolete Product(s) - Obsolete Product(s)

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220, D <sup>2</sup> PAK, DPAK, IPAK	TO-220FP	
V <sub>DS</sub>	Drain-source voltage (V <sub>GS</sub> =0)	600		V
V <sub>GS</sub>	Gate-source voltage	± 25		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	4.6	4.6 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	2.9	2.9 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	18.4	18.4 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	45	20	W
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	15		V/ns
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T <sub>C</sub> =25 °C)	2500		V
T <sub>j</sub> T <sub>stg</sub>	Operating junction temperature Storage temperature	-55 to 150		°C

- Limited by maximum temperature allowed
- Pulse width limited by safe operating area
- I<sub>SD</sub> ≤ 4.6A, di/dt ≤ 400V/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

Symbol	Parameter	Value					Unit
		TO-220	IPAK	DPAK	D <sup>2</sup> PAK	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case	2.78			5	°C/W	
R <sub>thj-amb</sub>	Thermal resistance junction-amb	62.5	100		62.5	°C/W	
T <sub>l</sub>	Maximum lead temperature for soldering purpose	300				°C	

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AS</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> max)	2	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>j</sub> =25°C, I <sub>D</sub> =I <sub>AS</sub> , V <sub>DD</sub> = 50 V)	65	mJ

## 2 Electrical characteristics

(T<sub>CASE</sub> = 25 °C unless otherwise specified)

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0	600			V
dv/dt <sup>(1)</sup>	Drain-source voltage slope	V <sub>DD</sub> = 400 V, V <sub>GS</sub> = 10 V, I <sub>D</sub> = 4.6 A	40			V/ns
I <sub>DSS</sub>	Zero gate voltage drain current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = Max rating, V <sub>DS</sub> = Max rating @ 125 °C			1 100	μA μA
I <sub>GSS</sub>	Gate body leakage current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ±20 V			±100	nA
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	2	3	4	V
R <sub>DS(on)</sub>	Static drain-source on resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 2.3 A		0.85	0.92	Ω

1. Characteristics value at turn off on inductive load

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g <sub>fs</sub> <sup>(1)</sup>	Forward transconductance	V <sub>DS</sub> = 15 V, I <sub>D</sub> = 2.3 A		4		S
C <sub>iss</sub> C <sub>oss</sub> C <sub>res</sub>	Input capacitance Output capacitance Reverse transfer capacitance	V <sub>DS</sub> = 50 V, f = 1 MHz, V <sub>GS</sub> = 0		420 30 4		pF pF pF
C <sub>oss eq.</sub> <sup>(2)</sup>	Output equivalent capacitance	V <sub>GS</sub> = 0, V <sub>DS</sub> = 0 to 480 V		70		pF
R <sub>g</sub>	Gate input resistance	f = 1 MHz Gate DC Bias = 0 test signal level = 20 mV open drain		6		Ω
Q <sub>g</sub> Q <sub>gs</sub> Q <sub>gd</sub>	Total gate charge Gate-source charge Gate-drain charge	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 4.6 A V <sub>GS</sub> = 10 V <i>Figure 19</i>		13 2 7		nC nC nC

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

2. C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 2.3\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ <i>Figure 18</i>		10		ns
$t_r$	Rise time			8		ns
$t_{d(off)}$	Turn-off delay time			40		ns
$t_f$	Fall time			9		ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$	Source-drain current				4.6	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				18.4	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 4.6\text{ A}$ , $V_{GS} = 0$			1.3	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 4.6\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 20\text{ V}$ , <i>Figure 20</i>		300		ns
$Q_{rr}$	Reverse recovery charge			2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			12		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 4.6\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 20\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ <i>Figure 20</i>		470		ns
$Q_{rr}$	Reverse recovery charge			3		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			12		A

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

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220, D<sup>2</sup>PAK

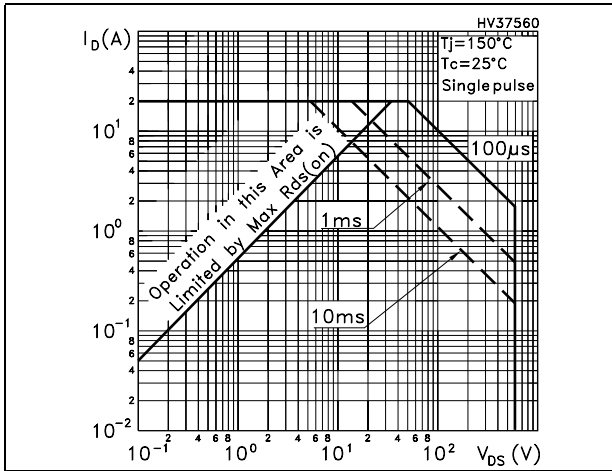


Figure 3. Thermal impedance for TO-220, D<sup>2</sup>PAK

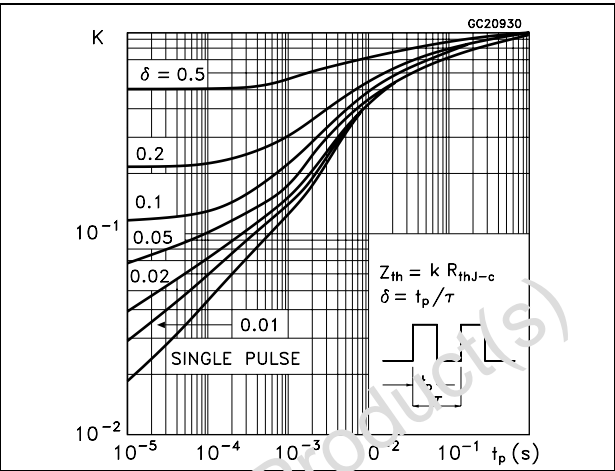


Figure 4. Safe operating area for TO-220FP

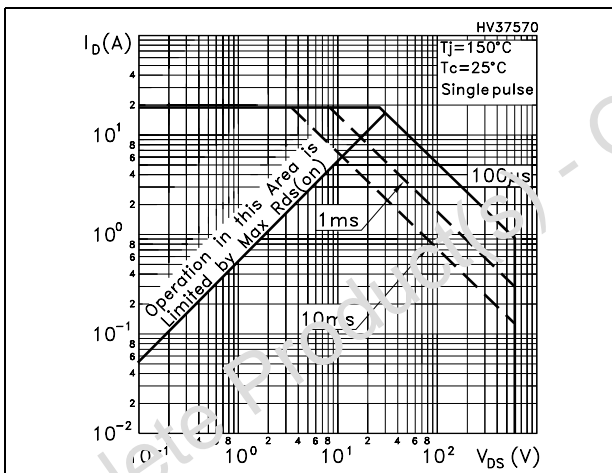


Figure 5. Thermal impedance for TO-220FP

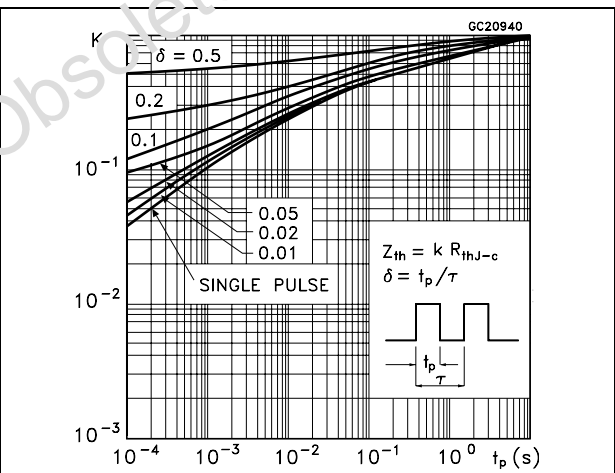


Figure 6. Safe operating area for DPAK, IPAK

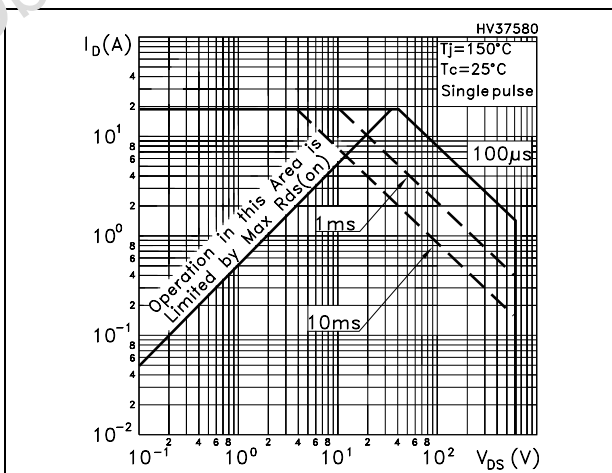


Figure 7. Thermal impedance for DPAK, IPAK

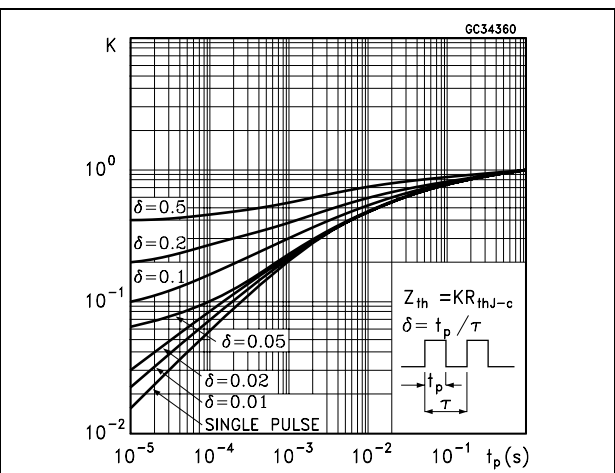


Figure 8. Output characteristics

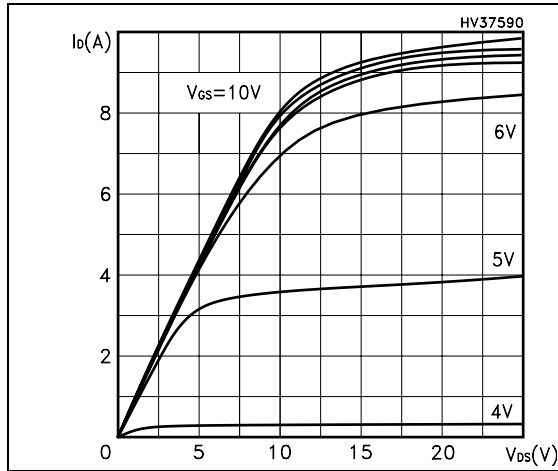


Figure 9. Transfer characteristics

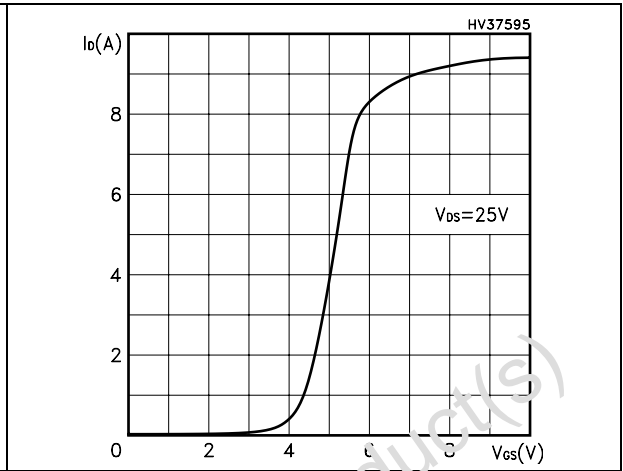


Figure 10. Transconductance

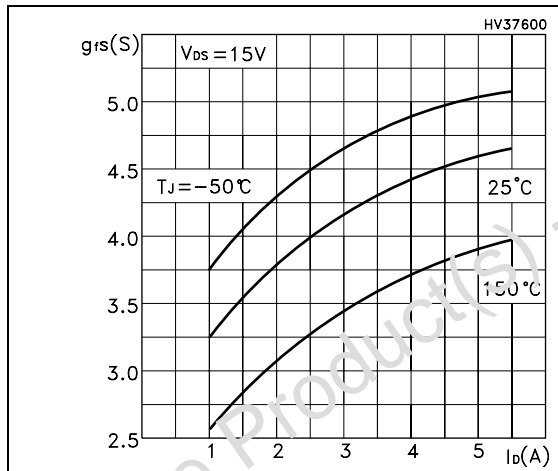


Figure 11. Static drain-source on resistance

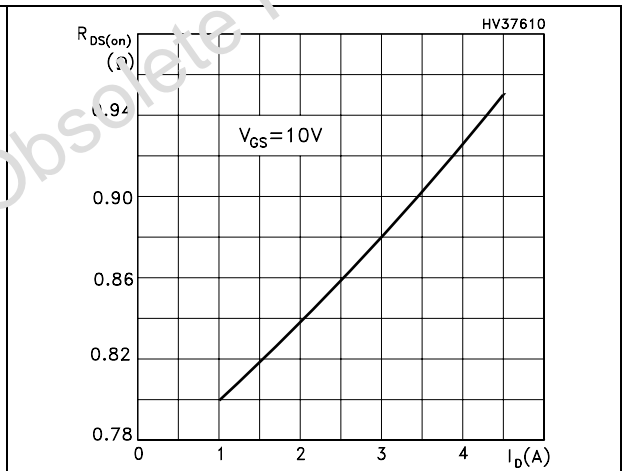


Figure 12. Gate charge vs gate-source voltage Figure 13. Capacitance variations

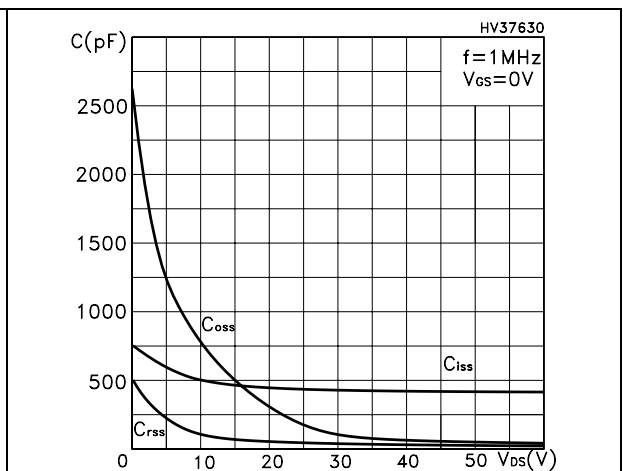
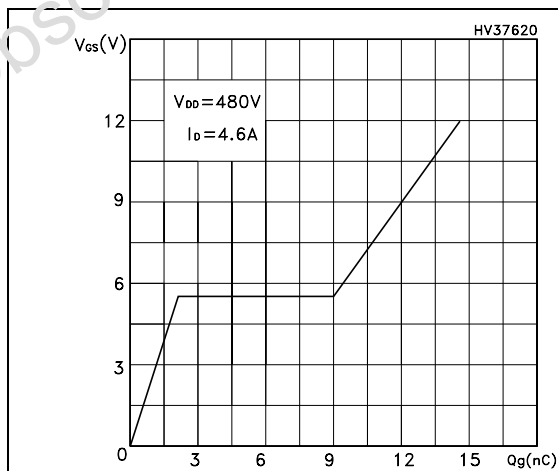


Figure 14. Normalized gate threshold voltage vs temperature

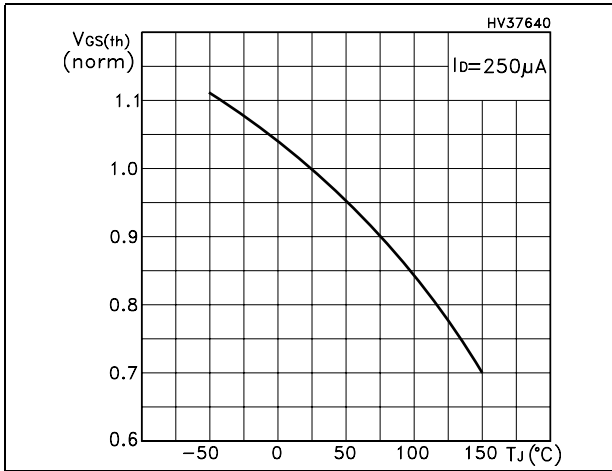


Figure 15. Normalized on resistance vs temperature

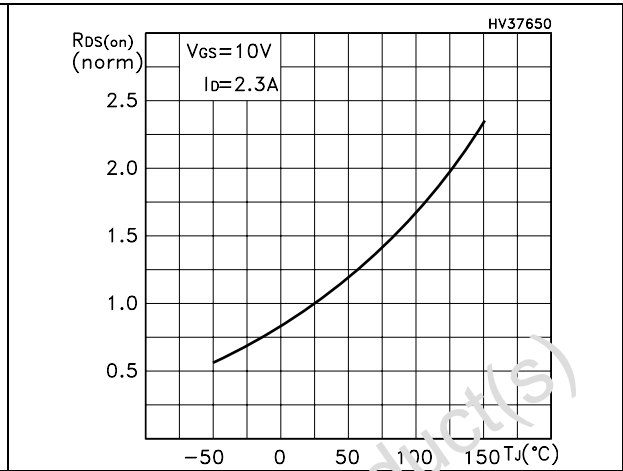


Figure 16. Source-drain diode forward characteristics

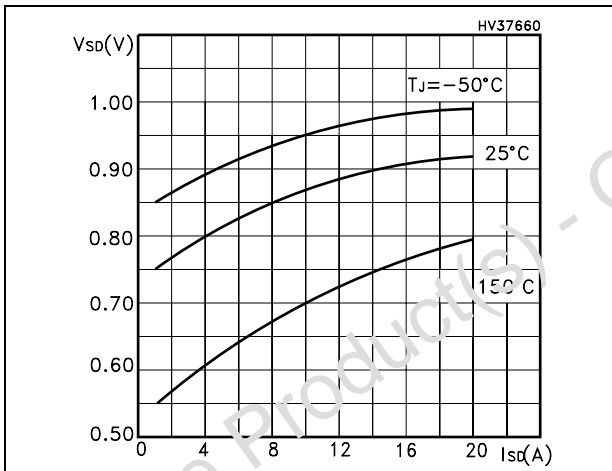
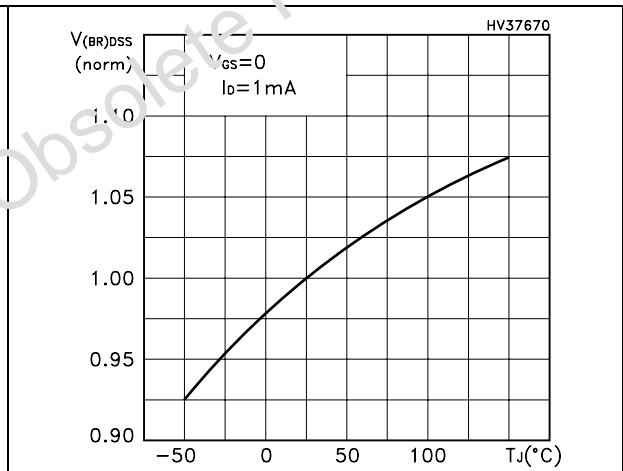


Figure 17. Normalized V(BR)DSS vs temperature



### 3 Test circuit

Figure 18. Switching times test circuit for resistive load

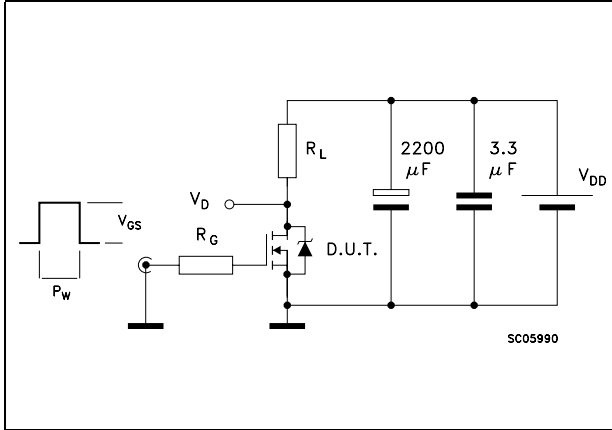


Figure 19. Gate charge test circuit

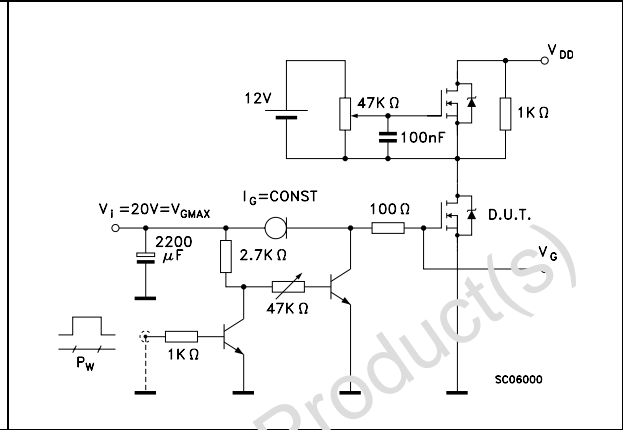


Figure 20. Test circuit for inductive load switching and diode recovery times

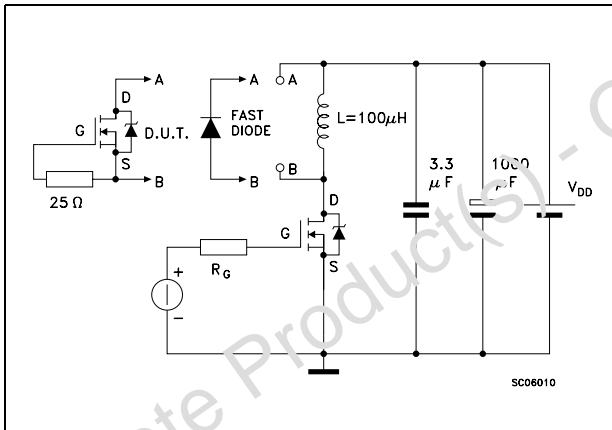


Figure 21. Unclamped inductive load test circuit

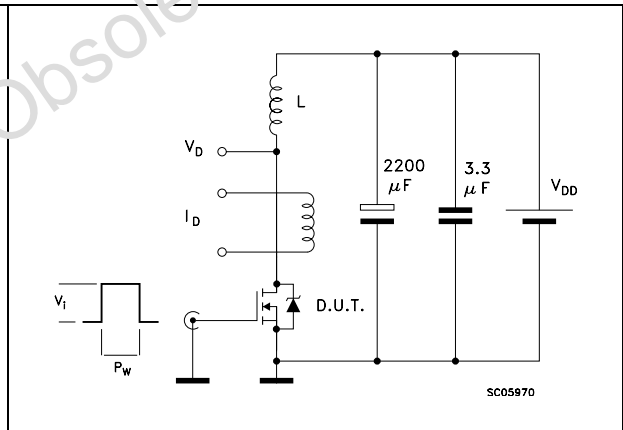


Figure 22. Unclamped inductive waveform

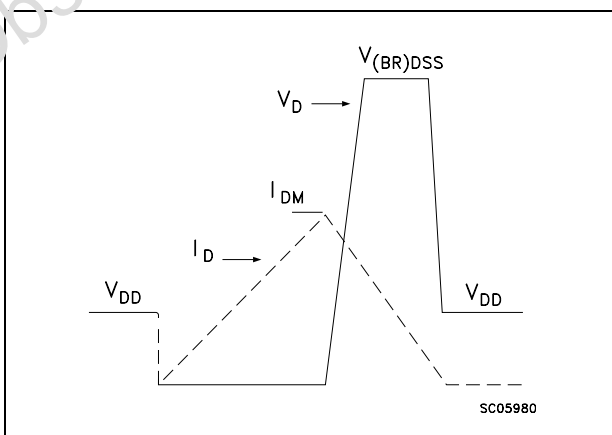
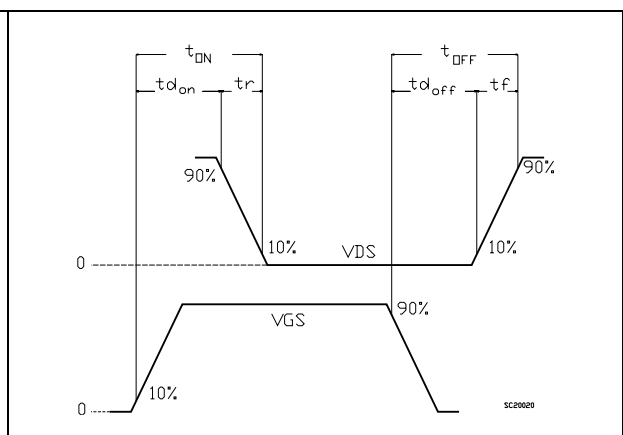


Figure 23. Switching time waveform



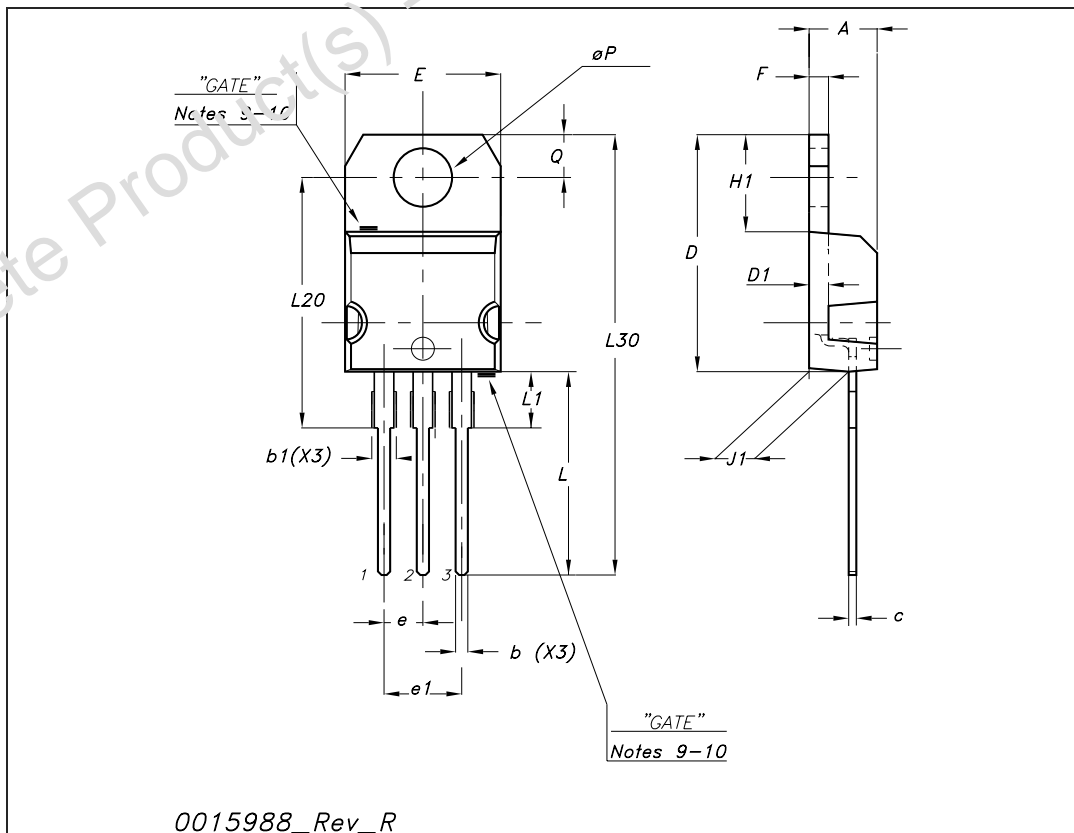
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

Obsolete Product(s) - Obsolete Product(s)

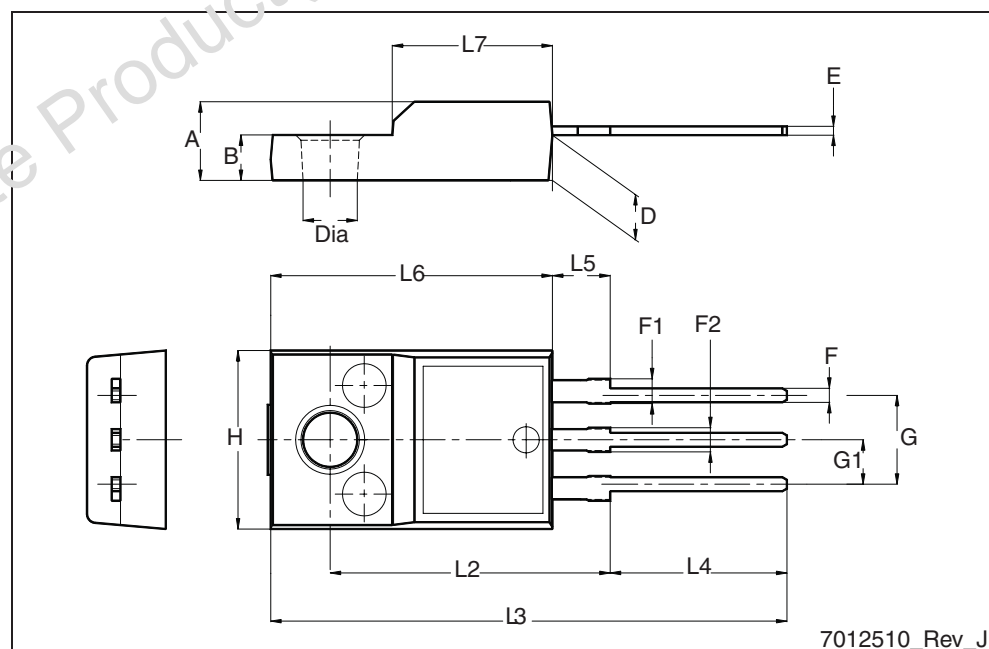
TO-220 mechanical data

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	0.48		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	
∅P	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



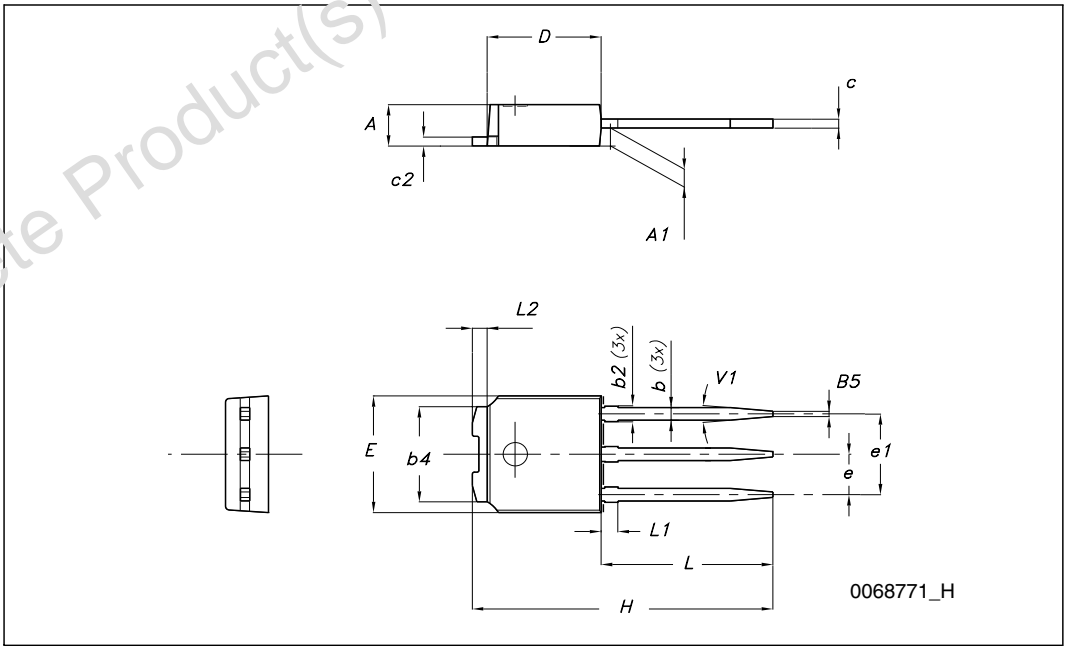
TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.5
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2



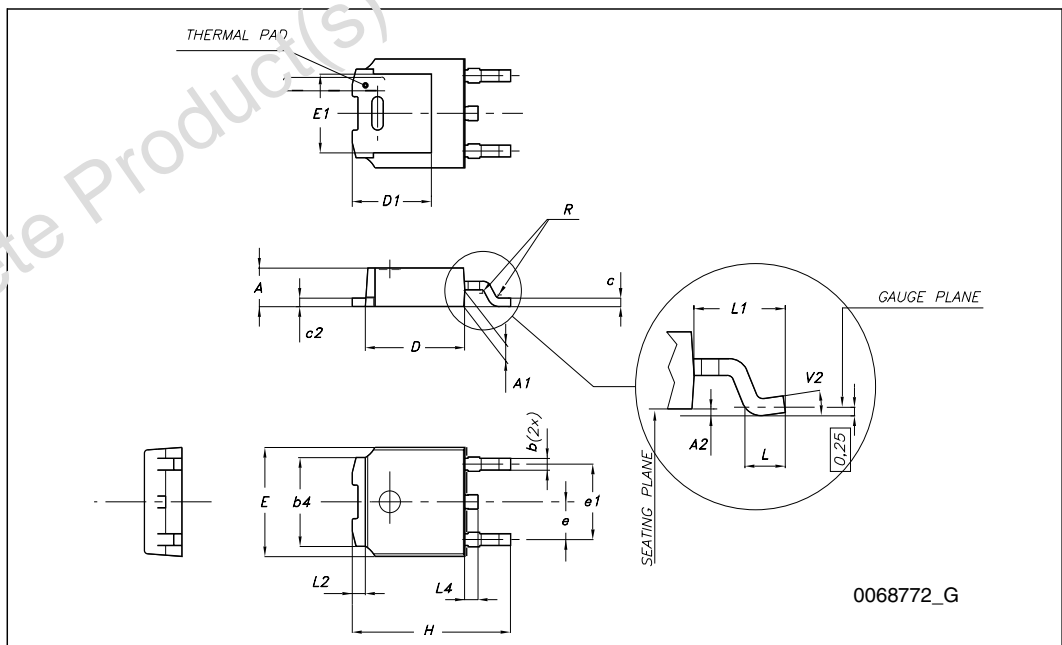
**TO-251 (IPAK) mechanical data**

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
(L1)	0.80		1.20
L2		0.80	
V1		10°	



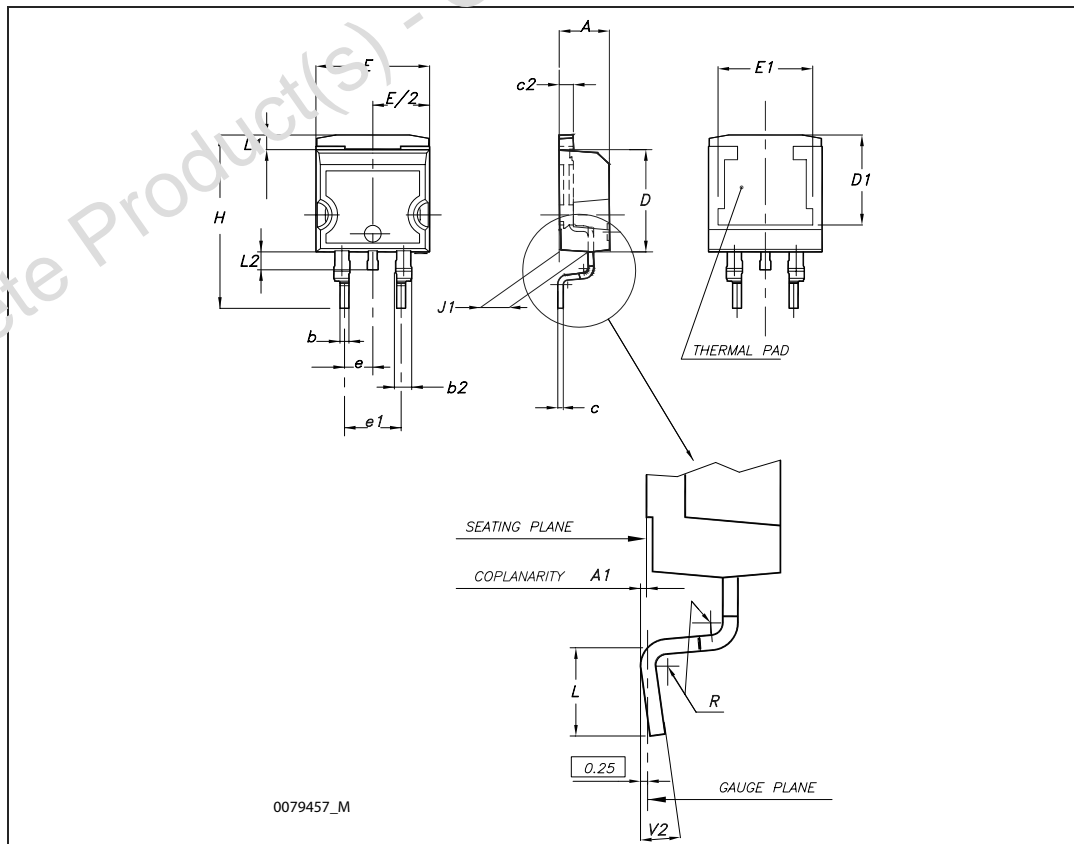
**TO-252 (DPAK) mechanical data**

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		
L1		2.90	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°



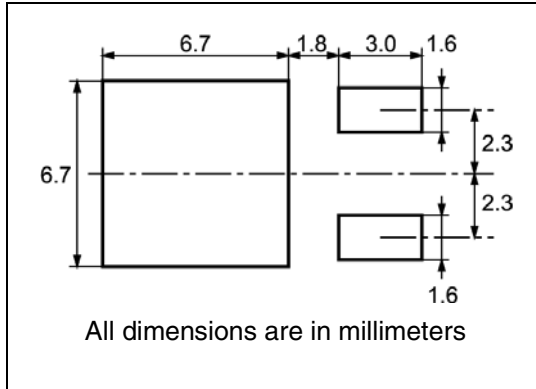
**D<sup>2</sup>PAK (TO-263) mechanical data**

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.369
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54		0.1		
e1	4.88		5.28	0.192		0.208
H	15		15.85	0.590		0.624
J1	2.49		2.69	0.097		0.106
L	2.29		2.79	0.090		0.110
L1	1.27		1.40	0.05		0.055
L2	1.30		1.75	0.051		0.069
R		0.4			0.016	
V2	0°		8°	0°		8°



# 5 Packaging mechanical data

## DPAK FOOTPRINT



## TAPE AND REEL SHIPMENT

### HEEL MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

### TAPE MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618	0.641

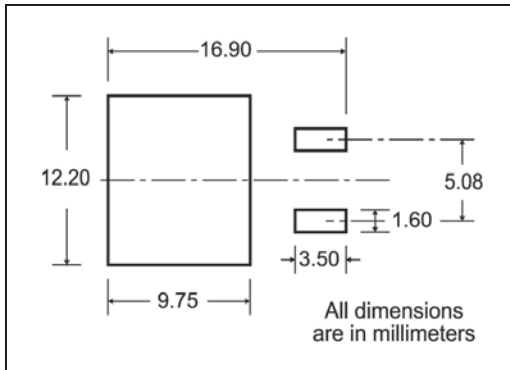
### BASE QTY

2500
------

### BULK QTY

2500
------

D<sup>2</sup>PAK FOOTPRINT



TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

Tape slot in case for tape start 2.5 mm min. width

G measured at hub

**FEEL MECHANICAL DATA**

Dim.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

**TAPE MECHANICAL DATA**

DIM	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	10.5	10.7	0.413	0.421
B0	15.7	15.9	0.618	0.626
D	1.5	1.6	0.059	0.063
D1	1.59	1.61	0.062	0.063
E	1.65	1.85	0.065	0.073
F	11.4	11.6	0.449	0.456
K0	4.8	5.0	0.189	0.197
P0	3.9	4.1	0.153	0.161
P1	11.9	12.1	0.468	0.476
P2	1.9	2.1	0.075	0.082
R	50		1.574	
T	0.25	0.35	0.0098	0.0137
W	23.7	24.3	0.933	0.956

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

TOP COVER TAPE

TRL

FEED DIRECTION

Bending radius R min.

## 6 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
09-May-2007	1	First release
01-Jun-2007	2	Corrected value on <a href="#">Table 8: Source drain diode</a>
21-Jan-2009	3	Added new package, mechanical data D <sup>2</sup> PAK

Obsolete Product(s) - Obsolete Product(s)

**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.

© 2009 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)

## Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

-  [View STB6NM60N on WIN SOURCE](#)
-  [STMicroelectronics Information](#)

## Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management