



# STB25NM60Nx - STF25NM60N STP25NM60N - STW25NM60N

N-channel 600 V, 0.130  $\Omega$ , 21 A, MDmesh™ II Power MOSFET  
TO-220, TO-220FP, I<sup>2</sup>PAK, D<sup>2</sup>PAK, TO-247

## Features

Type	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub> max	I <sub>D</sub>
STB25NM60N	650 V	< 0.160 $\Omega$	21 A
STB25NM60N-1	650 V	< 0.160 $\Omega$	21 A
STF25NM60N	650 V	< 0.160 $\Omega$	21 A <sup>(1)</sup>
STP25NM60N	650 V	< 0.160 $\Omega$	21 A
STW25NM60N	650 V	< 0.160 $\Omega$	21 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 is realized with the second generation of MDmesh™ technology. This revolutionary MOSFET associates a new vertical structure to the company's 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

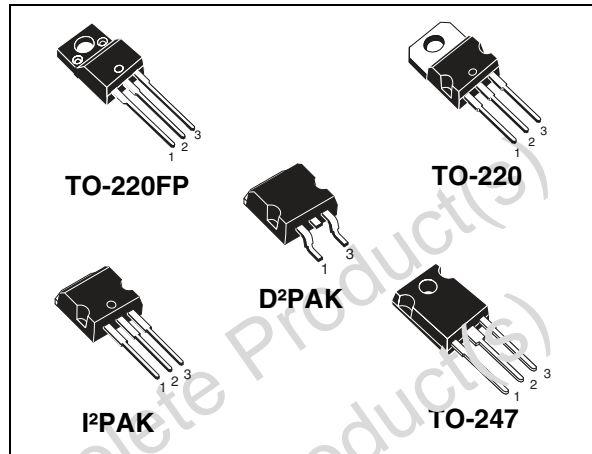


Figure 1. Internal schematic diagram

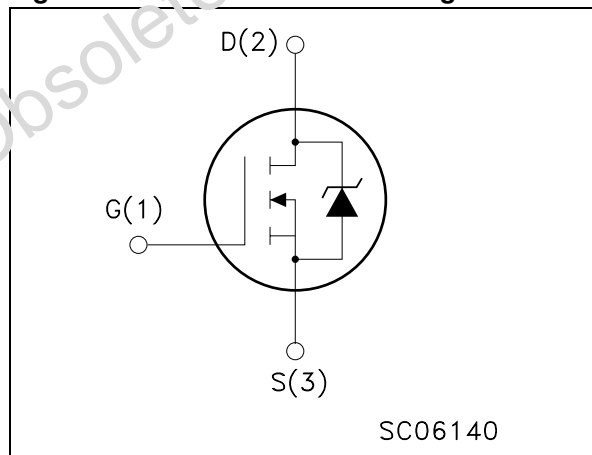


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB25NM60N	B25NM60N	D <sup>2</sup> PAK	Tape and reel
STB25NM60N-1	B25NM60N	I <sup>2</sup> PAK	Tube
STF25NM60N	F25NM60N	TO-220FP	Tube
STP25NM60N	P25NM60N	TO-220	Tube
STW25NM60N	W25NM60N	TO-247	Tube

# Contents

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Obsolete Product(s) - Obsolete Product(s)  
Obsolete Product(s) - Obsolete Product(s)

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220 - I <sup>2</sup> PAK D <sup>2</sup> PAK - TO-247	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	21	21 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	13	13 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	84	84 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	160	40	W
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
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	15		V/ns
T <sub>stg</sub>	Storage temperature	-55 to 150		°C
T <sub>j</sub>	Max. operating junction temperature	150		°C

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I<sub>SD</sub> ≤ 21 A, di/dt ≤ 400 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

Symbol	Parameter	Value					Unit
		TO-220	I <sup>2</sup> PAK	D <sup>2</sup> PAK	TO-247	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case max	0.78				3.1	°C/W
R <sub>thj-pcb</sub>	Thermal resistance junction-pcb max	--	--	30	--	--	
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	62.5	--	--	50	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>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> Max)	10	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> =I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	850	mJ

## 2 Electrical characteristics

( $T_{CASE} = 25\text{ °C}$  unless otherwise specified)

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	600			V
$dv/dt^{(1)}$	Drain source voltage slope	$V_{DD} = 480\text{ V}$ , $I_D = 21\text{ A}$ , $V_{GS} = 10\text{ V}$		48		V/ns
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max rating}$ $V_{DS} = \text{Max rating}$ , @125 °C			1 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{ V}$			100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 10.5\text{ A}$		0.130	0.160	$\Omega$

1. Characteristic value at turn off on inductive load

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS}=15\text{ V}$ , $I_D=11\text{ A}$		17		S
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$		2400		pF
$C_{oss}$	Output capacitance			200		pF
$C_{rss}$	Reverse transfer capacitance			25		pF
$C_{oss\text{ eq.}}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0$ , $V_{DS} = 0$ to 480 V		310		pF
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 21\text{ A}$ , $V_{GS} = 10\text{ V}$ , <i>(see Figure 19)</i>		84		nC
$Q_{gs}$	Gate-source charge			14		nC
$Q_{gd}$	Gate-drain charge			44		nC
$R_g$	Gate input resistance	f=1 MHz Gate DC Bias=0 Test signal level=20 mV open drain		1.6		$\Omega$

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

2.  $C_{oss\text{ eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DS}$

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 10\text{ A}$ $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 18)		24.5		ns
$t_r$	Rise time			18		ns
$t_{d(off)}$	Turn-off delay time			94		ns
$t_f$	Fall time			24		ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$	Source-drain current				21	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				84	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 21\text{ A}$ , $V_{GS} = 0$			1.3	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 21\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$		427		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100\text{ V}$		7.2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 23)		33.6		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 21\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$		526		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$		9.1		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 23)		34.5		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 / I<sup>2</sup>PAK

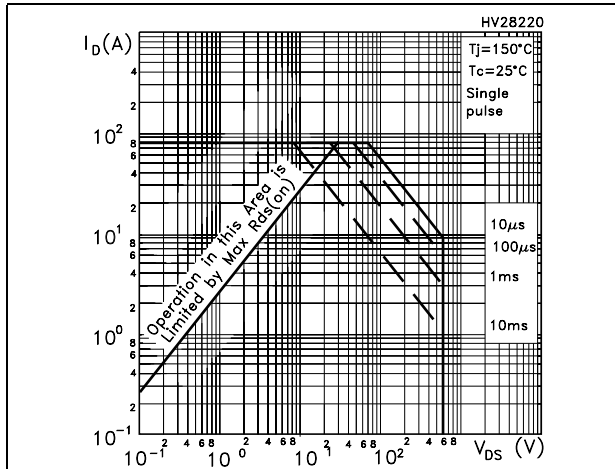


Figure 3. Thermal impedance for TO-220 / D<sup>2</sup>PAK / I<sup>2</sup>PAK

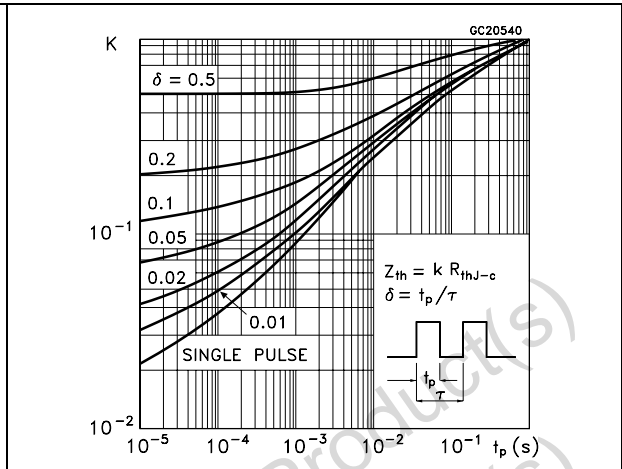


Figure 4. Safe operating area for TO-220FP

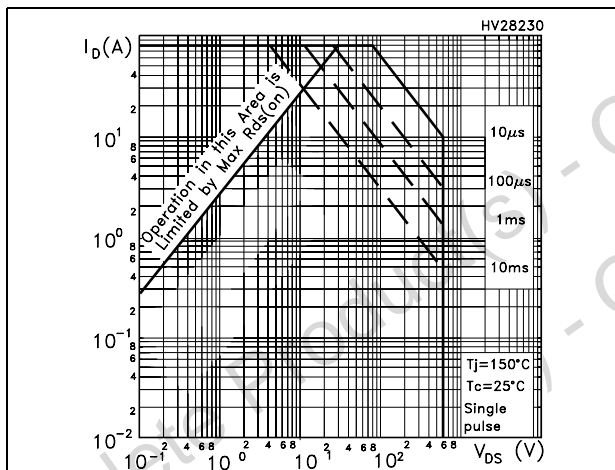


Figure 5. Thermal impedance for TO-220FP

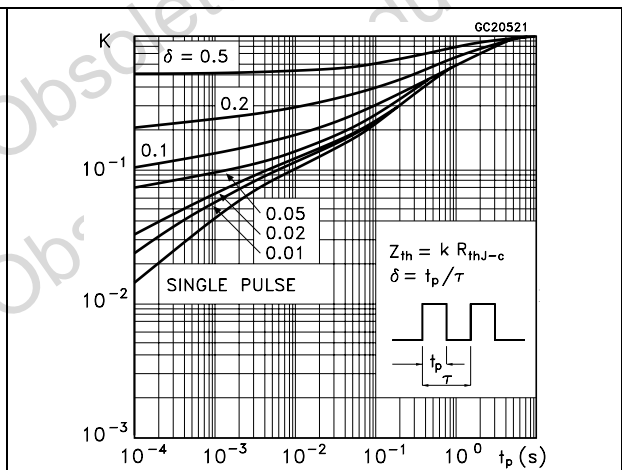


Figure 6. Safe operating area for TO-247

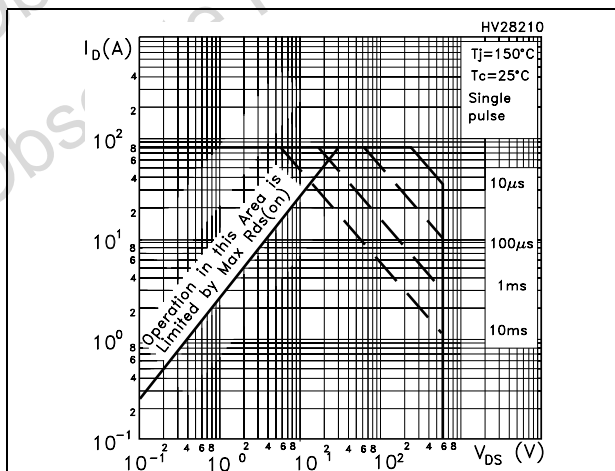


Figure 7. Thermal impedance for TO-247

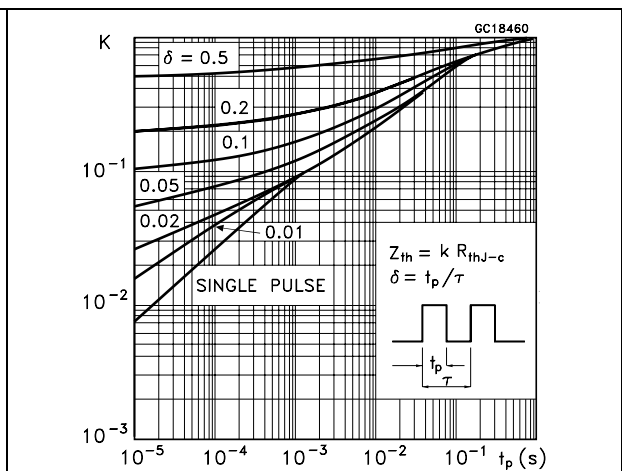


Figure 8. Output characteristics

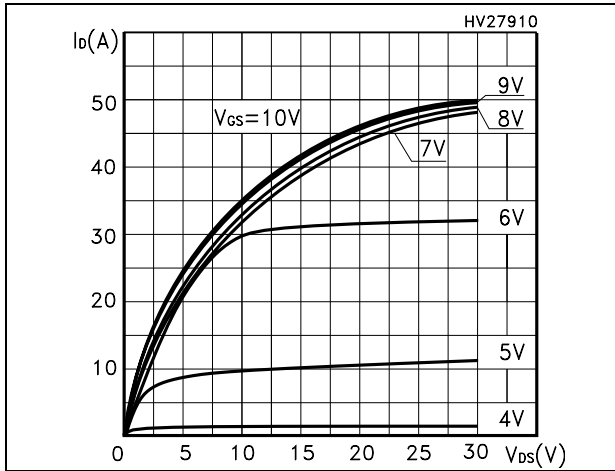


Figure 9. Transfer characteristics

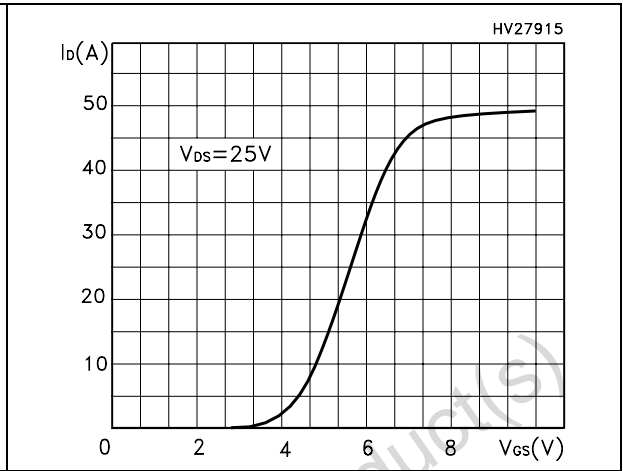


Figure 10. Transconductance

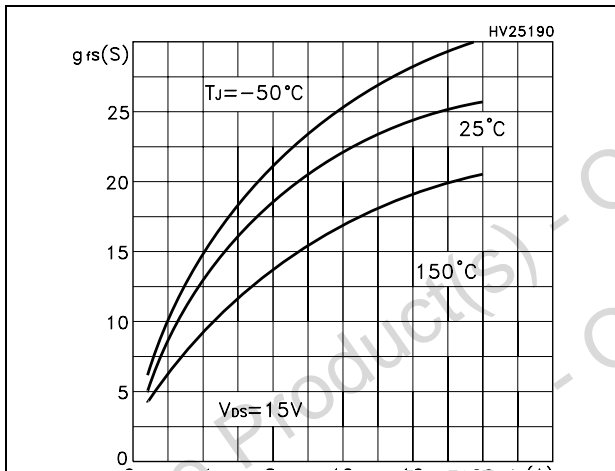


Figure 11. Static drain-source on resistance

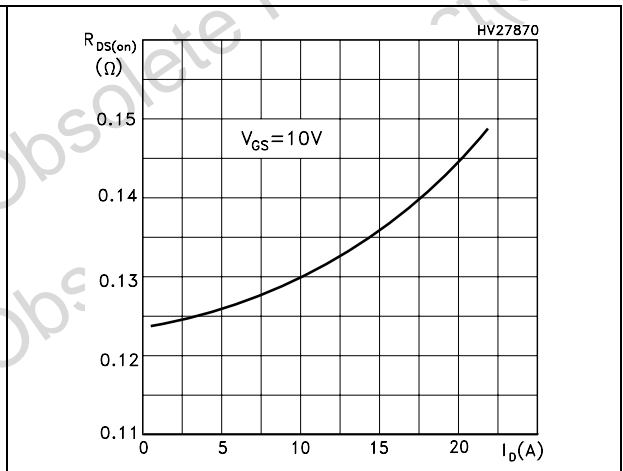


Figure 12. Gate charge vs gate-source voltage

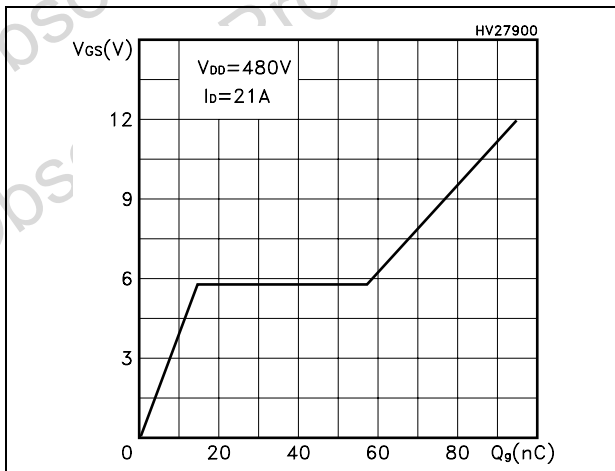


Figure 13. Capacitance variations

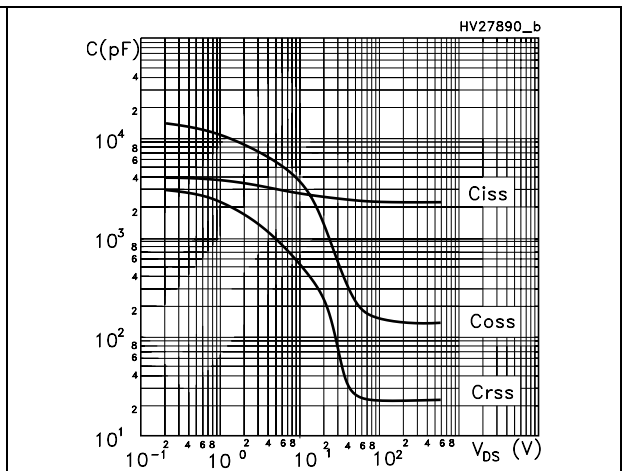


Figure 14. Normalized gate threshold voltage vs temperature

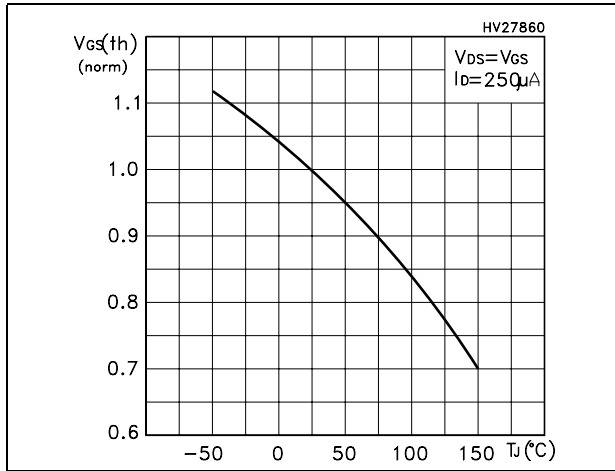


Figure 15. Normalized on resistance vs temperature

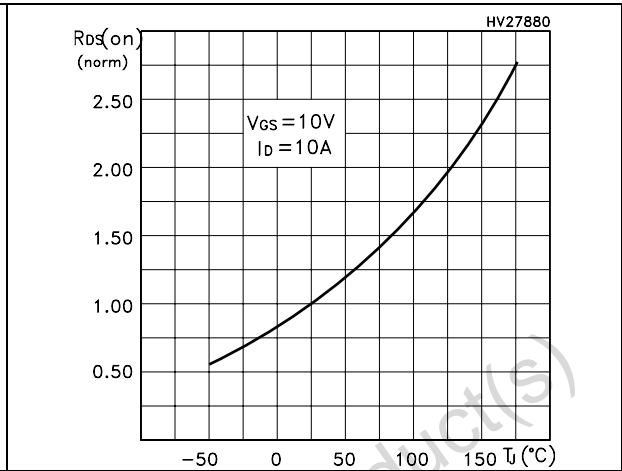


Figure 16. Source-drain diode forward characteristics

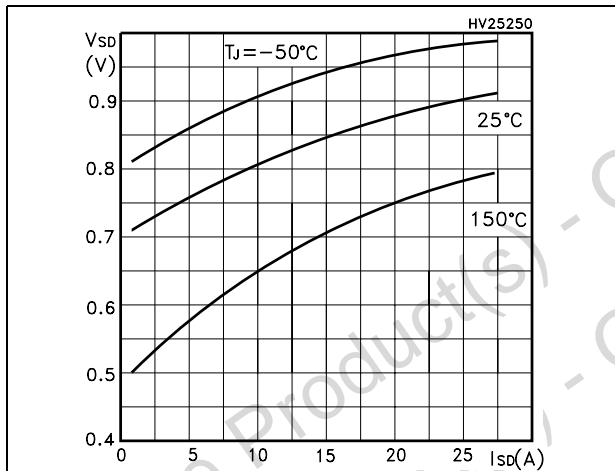
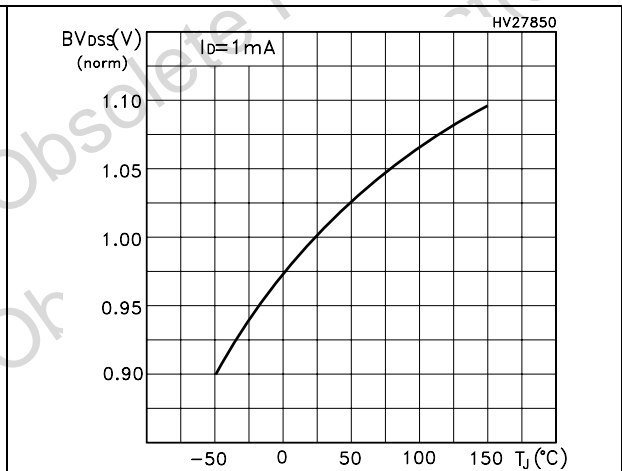


Figure 17. Normalized  $BV_{DSS}$  vs temperature





### 3 Test circuit

Figure 18. Switching times test circuit for resistive load

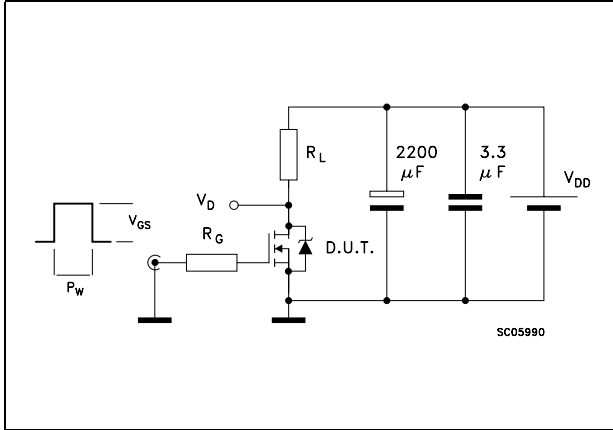


Figure 19. Gate charge test circuit

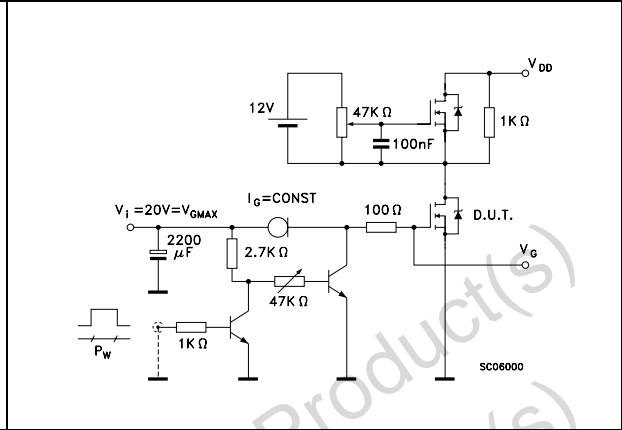


Figure 20. Test circuit for inductive load switching and diode recovery times

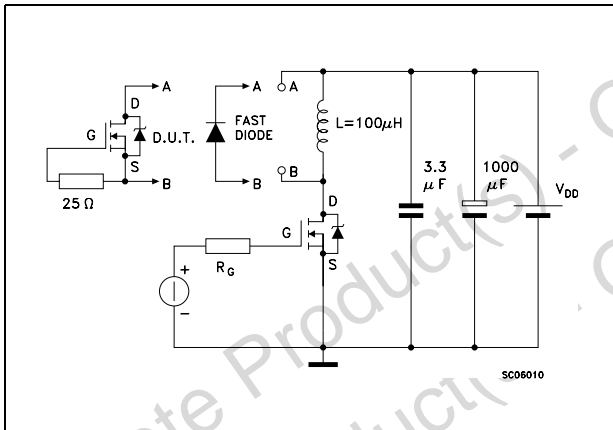


Figure 21. Unclamped Inductive load test circuit

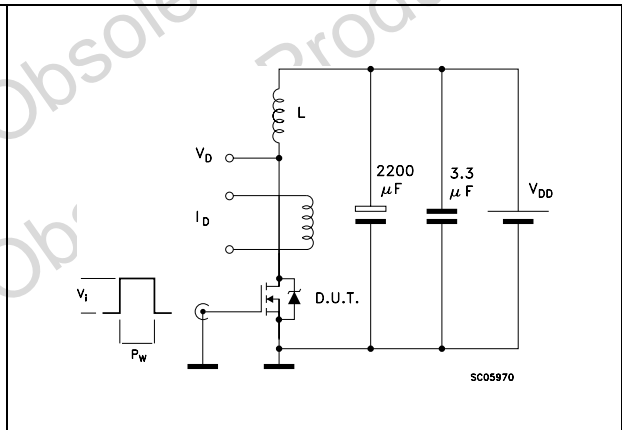


Figure 22. Unclamped inductive waveform

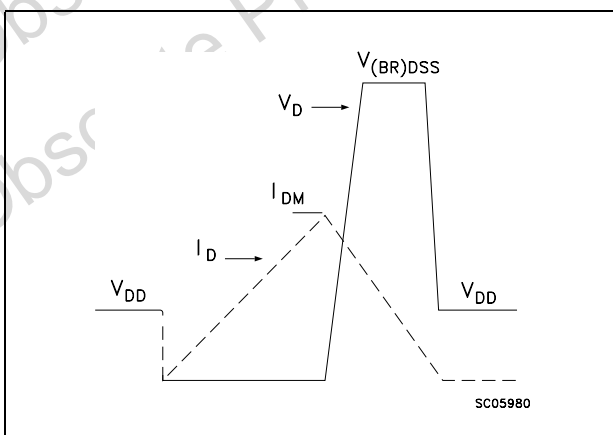
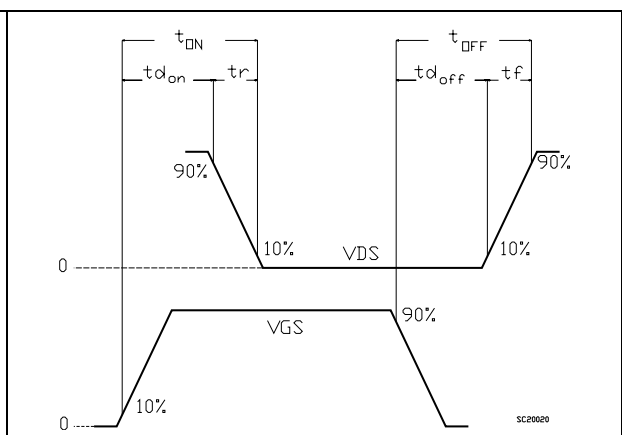


Figure 23. Switching time waveform



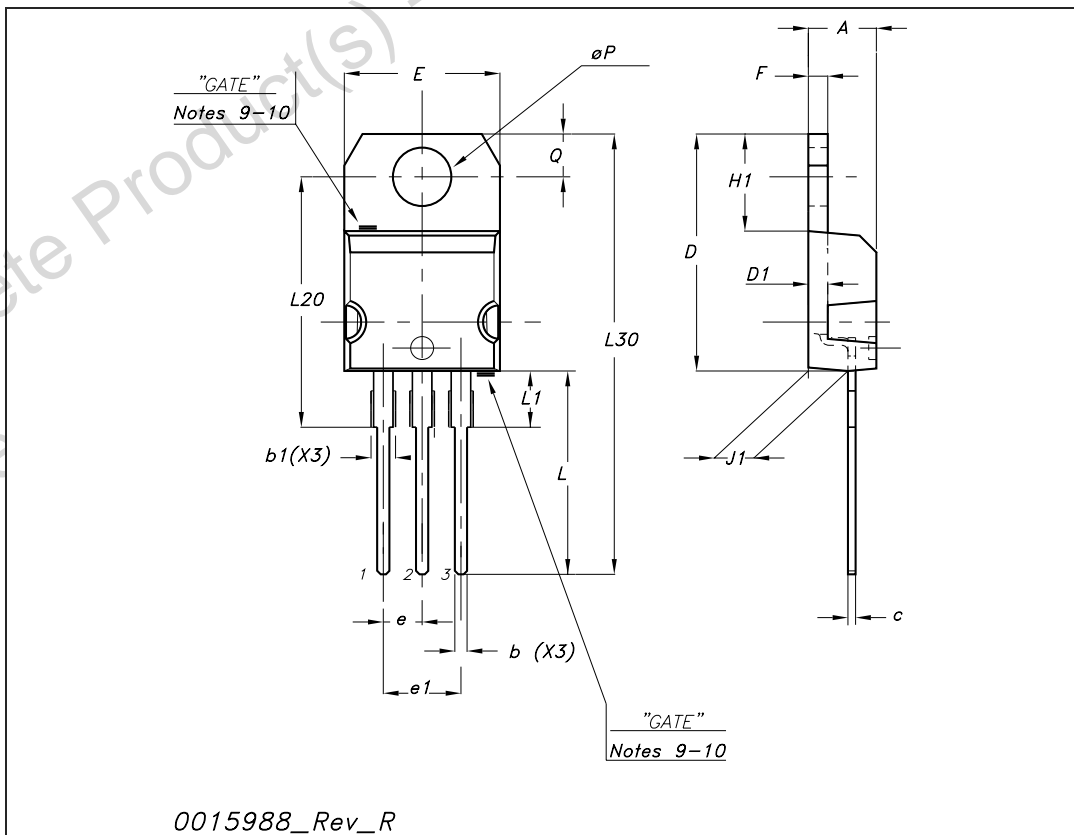
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in 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)

Obsolete Product(s) - Obsolete Product(s)  
Obsolete Product(s) - Obsolete Product(s)

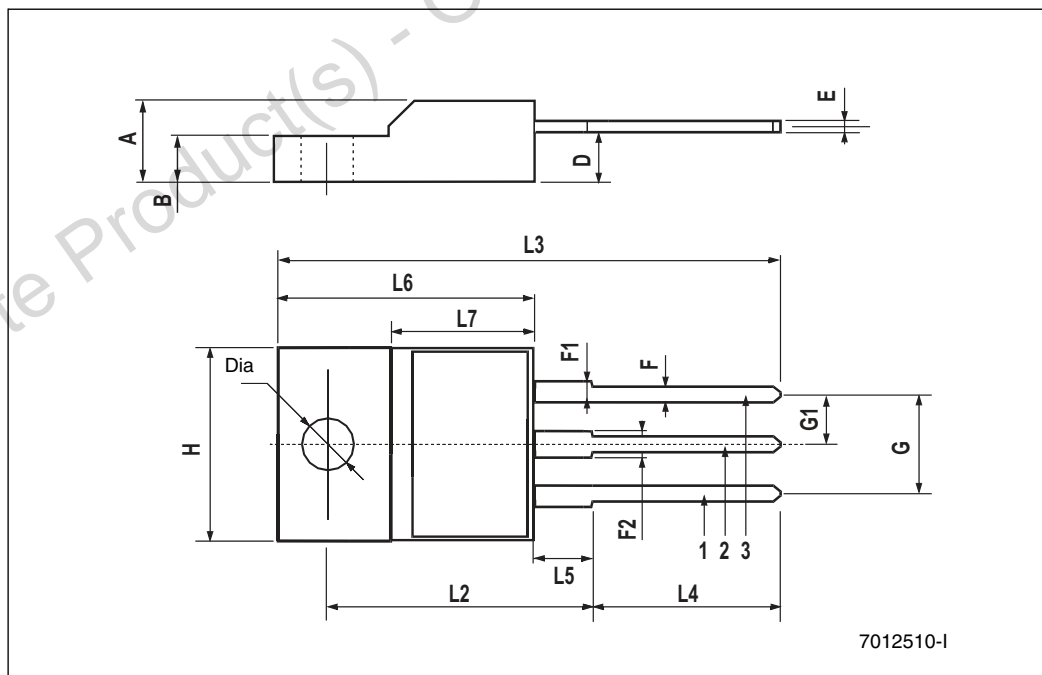
TO-220 mechanical data

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



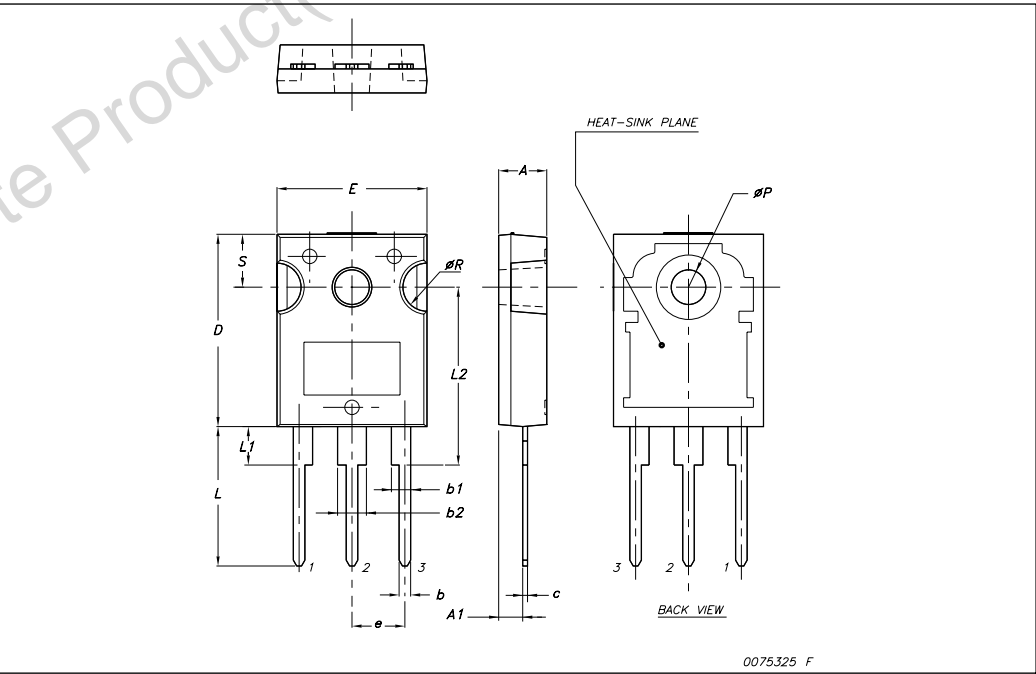
**TO-220FP mechanical data**

Dim.	mm.			inch		
	Min.	Typ	Max.	Min.	Typ.	Max.
A	4.40		4.60	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		0.70	0.017		0.027
F	0.75		1.00	0.030		0.039
F1	1.15		1.50	0.045		0.067
F2	1.15		1.50	0.045		0.067
G	4.95		5.20	0.195		0.204
G1	2.40		2.70	0.094		0.106
H	10		10.40	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.80		10.60	0.385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.90		16.40	0.626		0.645
L7	9		9.30	0.354		0.366
Dia	3		3.2	0.118		0.126



**TO-247 Mechanical data**

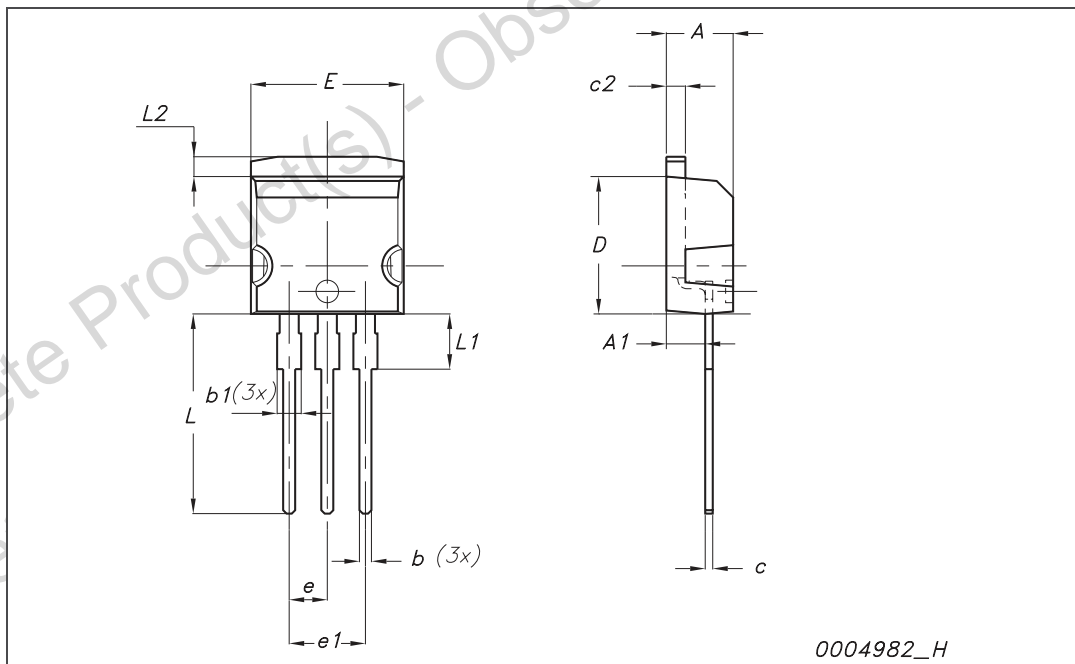
Dim.	mm.		
	Min.	Typ	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e		5.45	
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
øP	3.55		3.65
øR	4.50		5.50
S		5.50	



0075.325 F

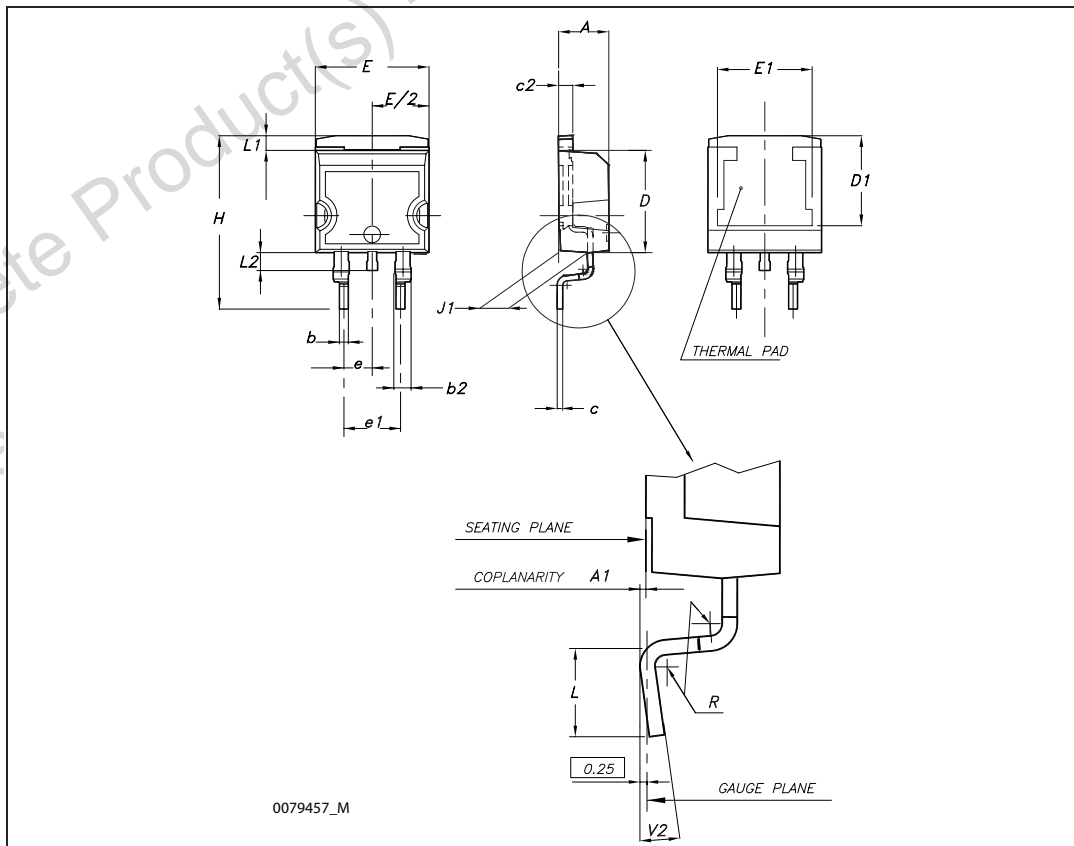
I<sup>2</sup>PAK (TO-262) mechanical data

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



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		0.368
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	0.099		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

### D<sup>2</sup>PAK FOOTPRINT



### TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

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

G measured at hub

#### REEL 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

TOP COVER TAPE

Center line of cavity

User Direction of Feed

TRL

FEED DIRECTION

Bending radius R min.

\* on sales type



## 6 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
30-Nov-2004	1	First release.
22-Mar-2005	2	Modified title
23-May-2005	3	Inserted some values in <a href="#">Table 7</a>
08-Jun-2005	4	Inserted new row in <a href="#">Table 6</a>
08-Sep-2005	5	New value for $C_{oss\ eq}$ in <a href="#">Table 6</a>
28-Sep-2005	6	Added curves
26-Oct-2005	7	Complete version
23-Jun-2006	8	New template, new value on <a href="#">Absolute maximum ratings</a>
25-Aug-2006	9	Wrong title on first page
14-Nov-2006	10	Modified <a href="#">Avalanche characteristics</a>
19-Jan-2007	11	Typo mistake on <a href="#">Table 7</a>
11-Jun-2008	12	<ul style="list-style-type: none"> <li>– Updated <math>R_{DS(on)}</math> max value in <a href="#">Table 5</a></li> <li>– Corrected capacitance value in <a href="#">Table 6</a></li> <li>– Update <a href="#">Figure 13: Capacitance variations</a></li> </ul>

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