



# STB12NM50N, STD12NM50N, STI12NM50N STF12NM50N, STP12NM50N

N-channel 500 V, 0.29  $\Omega$ , 11 A MDmesh™ II Power MOSFET  
TO-220 - DPAK - D<sup>2</sup>PAK - I<sup>2</sup>PAK - TO-220FP

## Features

Type	V <sub>DSS</sub> (@T <sub>jmax</sub> )	R <sub>DS(on)</sub> max	I <sub>D</sub>
STB12NM50N	550 V	0.38 $\Omega$	11 A
STD12NM50N	550 V	0.38 $\Omega$	11 A
STI12NM50N	550 V	0.38 $\Omega$	11 A
STF12NM50N	550 V	0.38 $\Omega$	11 A <sup>(1)</sup>
STP12NM50N	550 V	0.38 $\Omega$	11 A

- 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 Power 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.

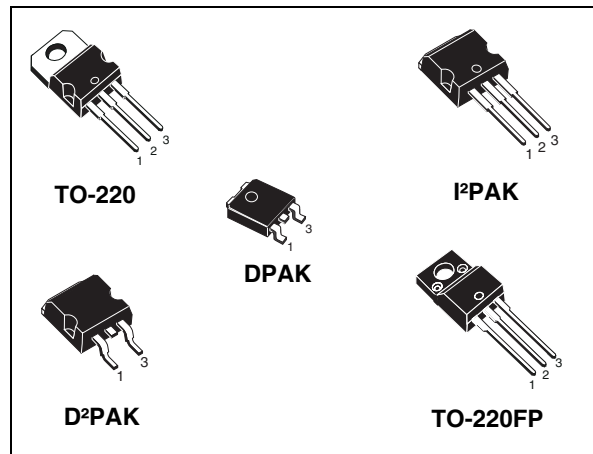


Figure 1. Internal schematic diagram

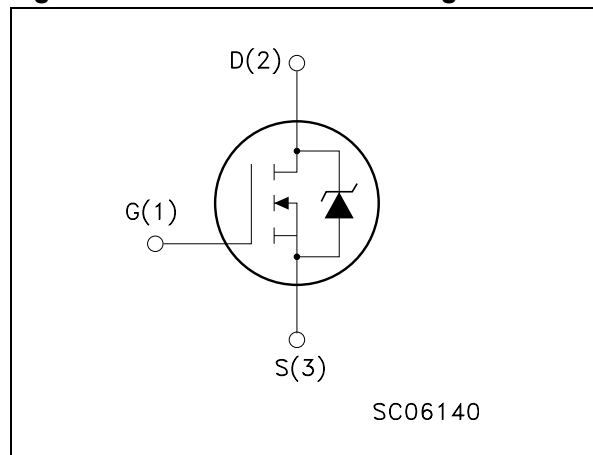


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB12NM50N	B12NM50N	D <sup>2</sup> PAK	Tape and reel
STD12NM50N	D12NM50N	DPAK	Tape and reel
STI12NM50N	I12NM50N	I <sup>2</sup> PAK	Tube
STF12NM50N	F12NM50N	TO-220FP	Tube
STP12NM50N	P12NM50N	TO-220	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220 / I <sup>2</sup> PAK D <sup>2</sup> PAK / DPAK	TO-220FP	
V <sub>DS</sub>	Drain-source voltage (V <sub>GS</sub> = 0)	500		V
V <sub>GS</sub>	Gate-source voltage	± 25		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	11	11 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> =100 °C	6.7	6.7 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	44	44 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	100	25	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>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> ≤ 11A, di/dt ≤ 400A/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	DPAK	D <sup>2</sup> PAK	TO-220FP	
R <sub>thj-case</sub>	Thermal resistance junction-case max	1.25			5	°C/W	
R <sub>thj-amb</sub>	Thermal resistance junction-amb max	62.5	--	--	62.5	°C/W	
R <sub>thj-pcb</sub>	Thermal resistance junction-pcb max	--	--	50	30	°C/W	
T <sub>l</sub>	Maximum lead temperature for soldering purposes	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)	5	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> =50V)	350	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	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	500			V
$dv/dt^{(1)}$	Peak diode recovery voltage slope	$V_{DD}=400\text{ V}$ , $I_D=11\text{ A}$ , $V_{GS}=10\text{ V}$		44		V/ns
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = \text{max rating}$ , $V_{DS} = \text{max rating}@125\text{ °C}$			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	$V_{GS} = 10\text{ V}$ , $I_D = 5.5\text{ A}$		0.29	0.38	$\Omega$

1. Characteristic value at turn off inductive load

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15\text{ V}$ , $I_D = 5.5\text{ A}$		8		S
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$		940		pF
$C_{oss}$	Output capacitance			100		pF
$C_{rss}$	Reverse transfer capacitance			10		pF
$C_{oss\ eq}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0$ , $V_{DS} = 0\text{ to }400\text{ V}$		130		pF
$Q_g$	Total gate charge	$V_{DD} = 400\text{ V}$ , $I_D = 11\text{ A}$ $V_{GS} = 10\text{ V}$ <i>(see Figure 17)</i>		30		nC
$Q_{gs}$	Gate-source charge			6		nC
$Q_{gd}$	Gate-drain charge			15		nC
$R_g$	Gate input resistance	$f = 1\text{ MHz}$ Gate DC Bias = 0 test signal level = 20 mV open drain		4.5		$\Omega$

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

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD}=250\text{ V}$ , $I_D=5.5\text{ A}$ , $R_G=4.7\ \Omega$ , $V_{GS}=10\text{ V}$ <i>(see Figure 16)</i>		15		ns
$t_r$	Rise time			15		ns
$t_{d(off)}$	Turn-off delay time				60	ns
$t_f$	Fall time				14	ns

**Table 8. Source drain diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$	Source-drain current				11	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				44	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD}=11\text{ A}$ , $V_{GS}=0$			1.3	V
$t_{rr}$	Reverse recovery time	$I_{SD}=11\text{ A}$ , $V_{DD}=100\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ , <i>(see Figure 18)</i>		340		ns
$Q_{rr}$	Reverse recovery charge			3.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			20		A
$t_{rr}$	Reverse recovery time	$I_{SD}=11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD}=100\text{ V}$ , $T_J=150\text{ }^\circ\text{C}$ <i>(see Figure 18)</i>		420		ns
$Q_{rr}$	Reverse recovery charge			4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			20		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/ DPAK/ D<sup>2</sup>PAK / I<sup>2</sup>PAK

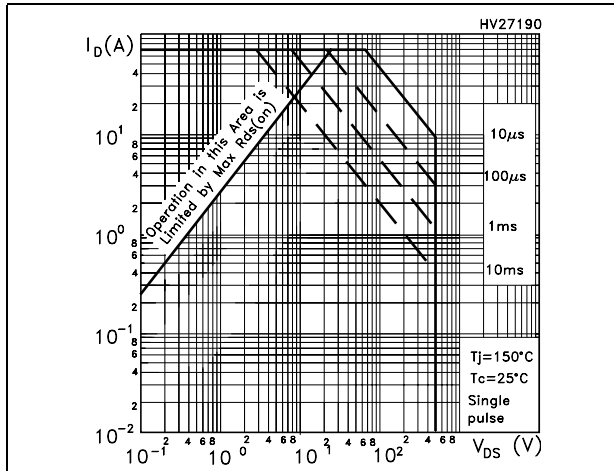


Figure 3. Thermal impedance for TO-220/ DPAK/ D<sup>2</sup>PAK / I<sup>2</sup>PAK

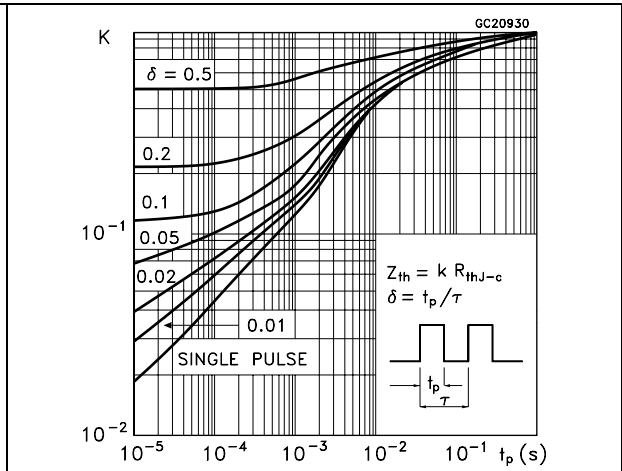


Figure 4. Safe operating area for TO-220FP

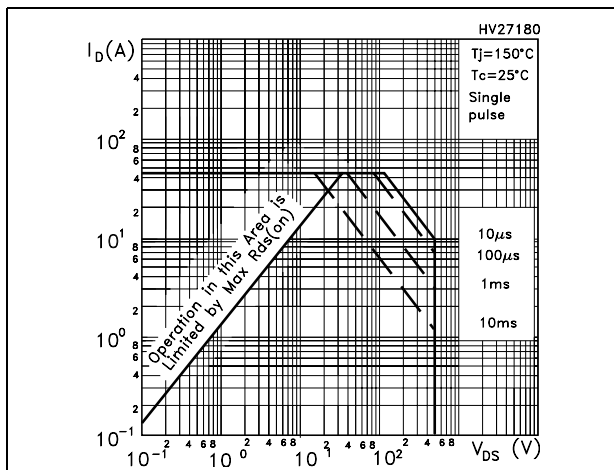


Figure 5. Thermal impedance for TO-220FP

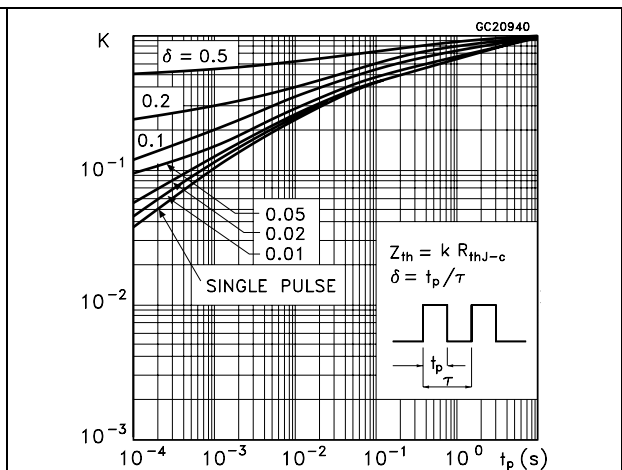


Figure 6. Output characteristics

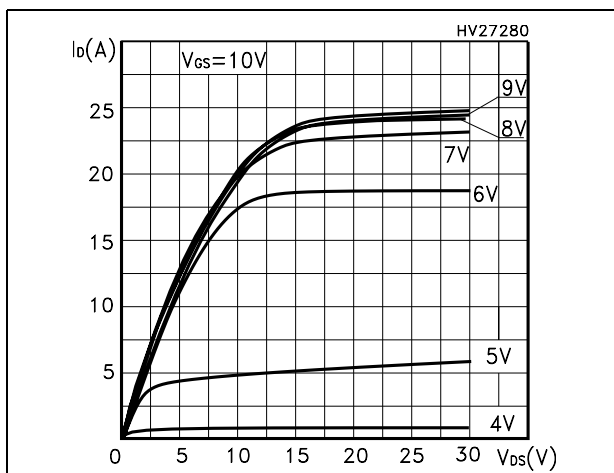


Figure 7. Transfer characteristics

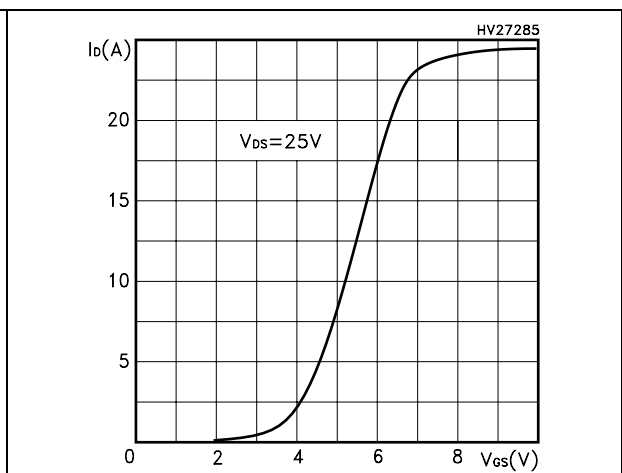


Figure 8. Transconductance

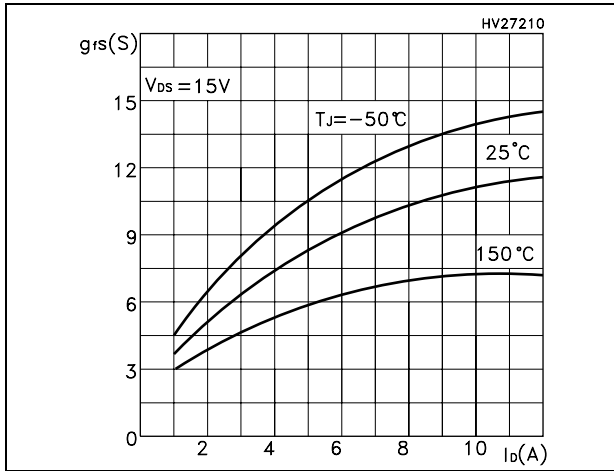


Figure 9. Static drain-source on resistance

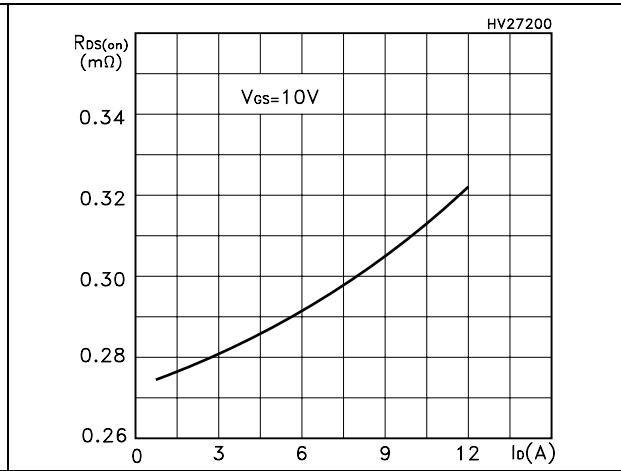


Figure 10. Gate charge vs gate-source voltage

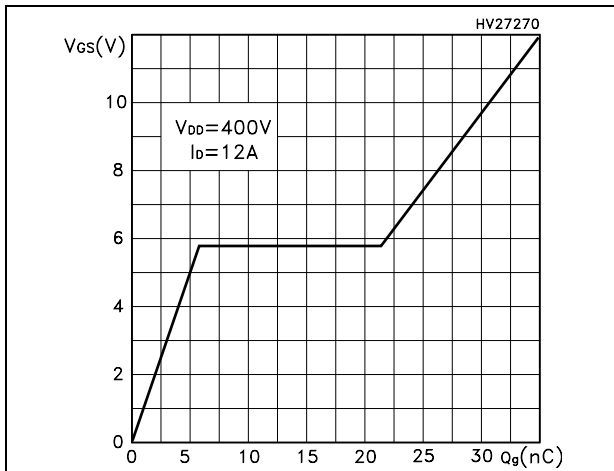


Figure 11. Capacitance variations

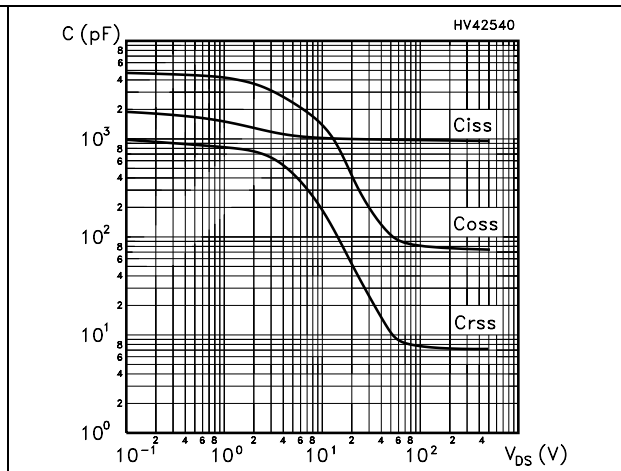


Figure 12. Normalized gate threshold voltage vs temperature

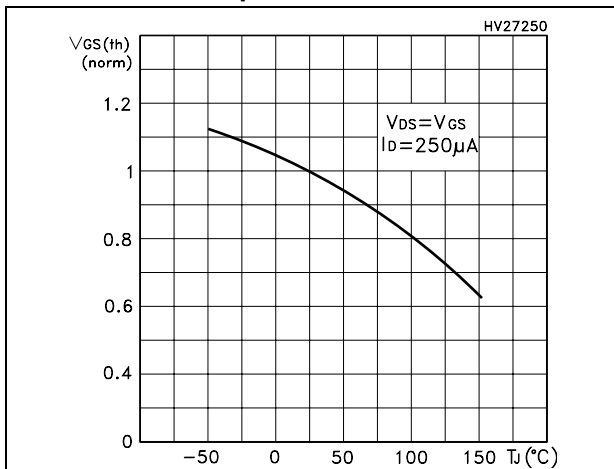


Figure 13. Normalized on resistance vs temperature

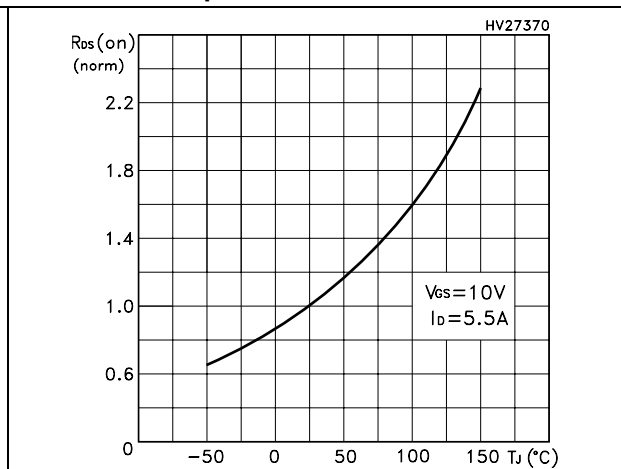


Figure 14. Source-drain diode forward characteristics

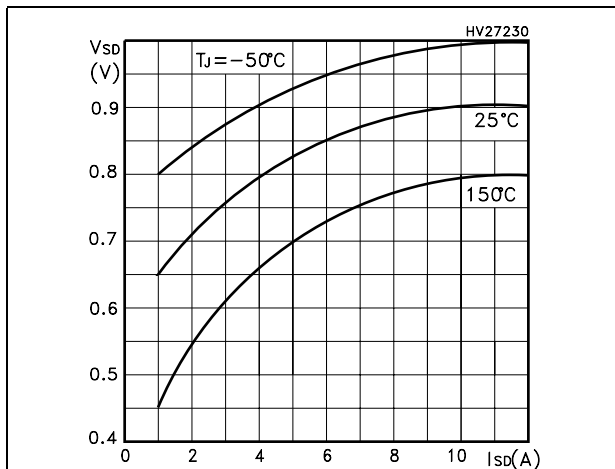
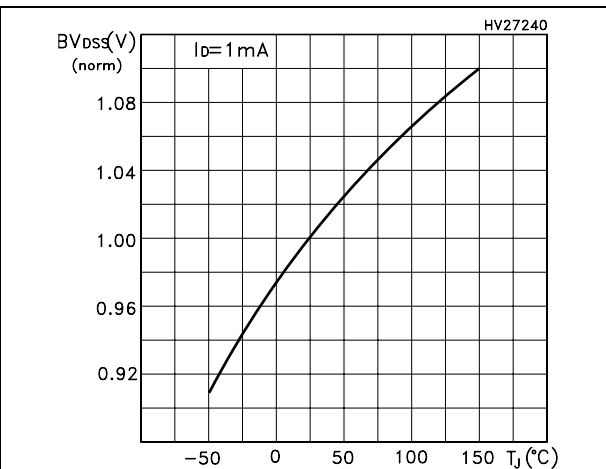


Figure 15. Normalized  $B_{V_{DSS}}$  vs temperature





### 3 Test circuit

Figure 16. Switching times test circuit for resistive load

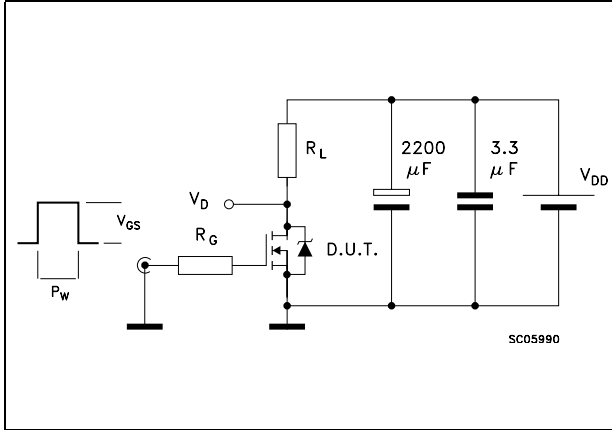


Figure 17. Gate charge test circuit

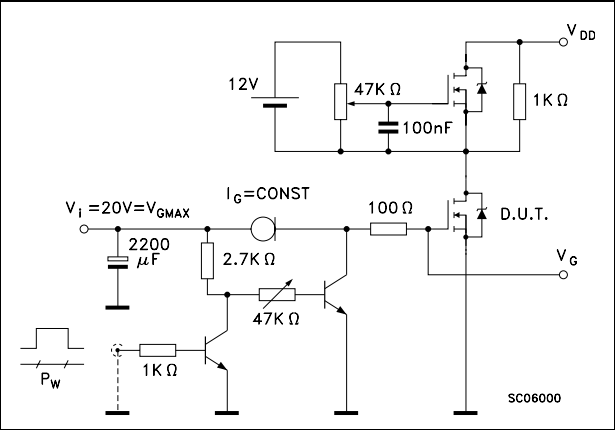


Figure 18. Test circuit for inductive load switching and diode recovery times

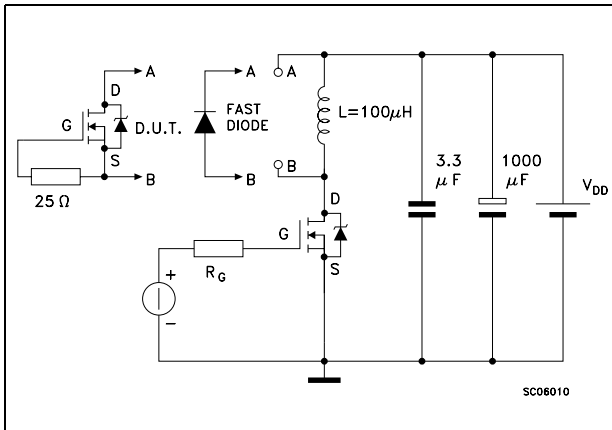


Figure 19. Unclamped Inductive load test circuit

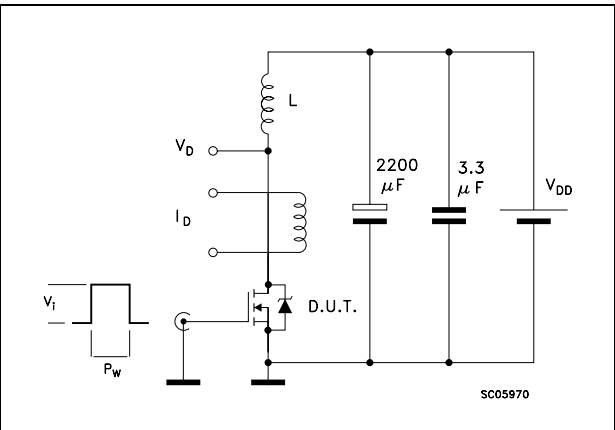


Figure 20. Unclamped inductive waveform

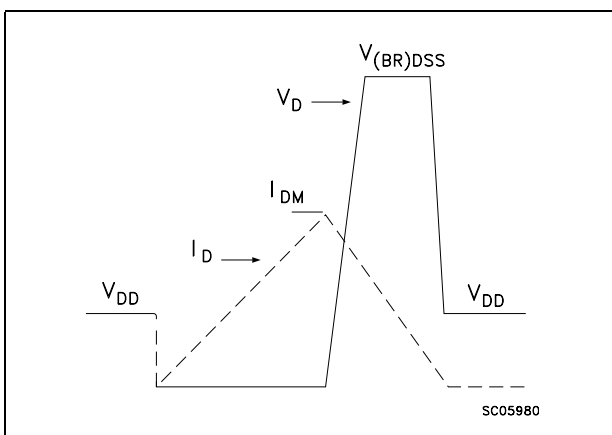
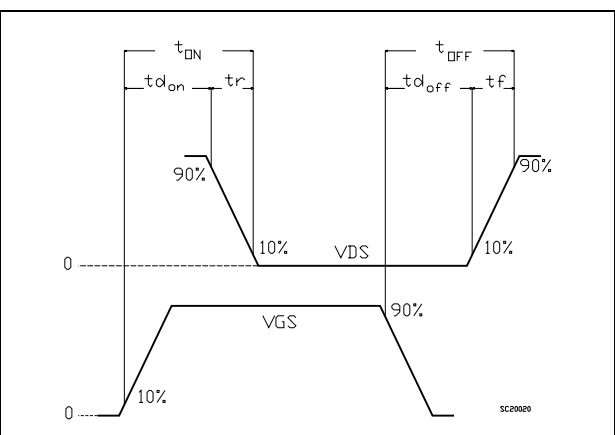


Figure 21. Switching time waveform

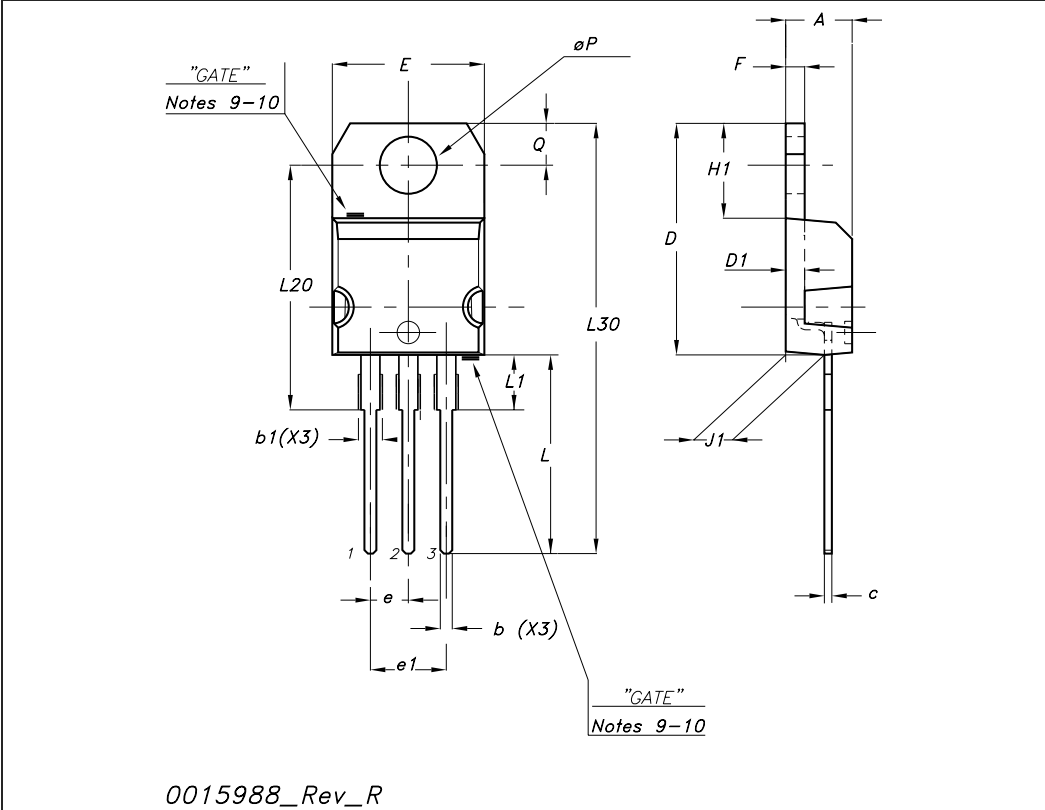


## 4 Package mechanical data

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)

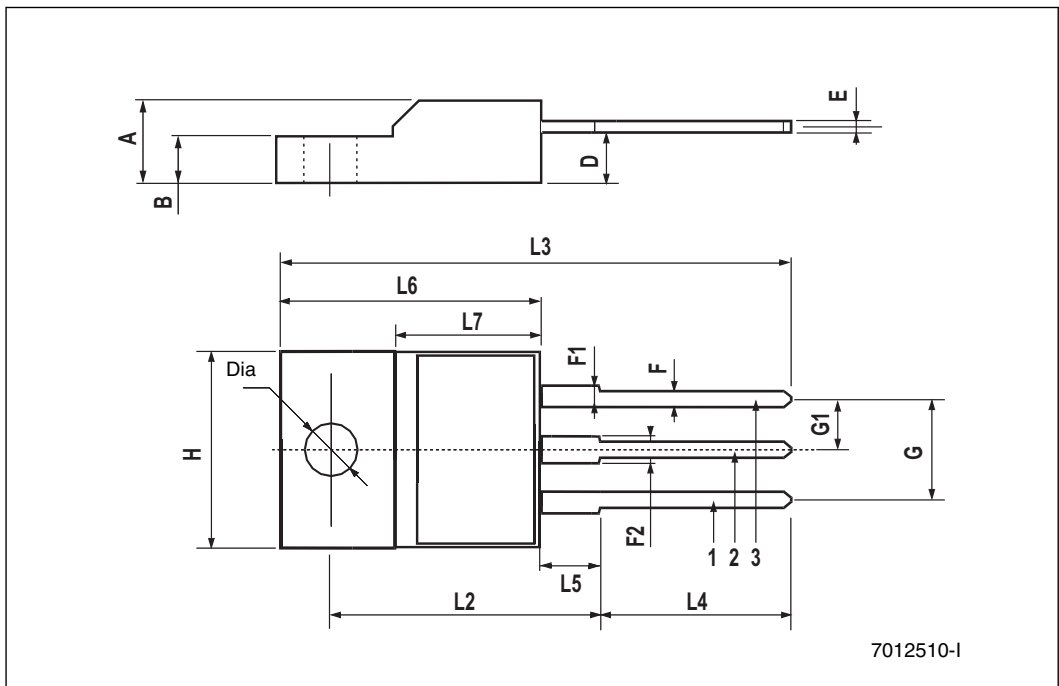
TO-220 mechanical data

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	1.14		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



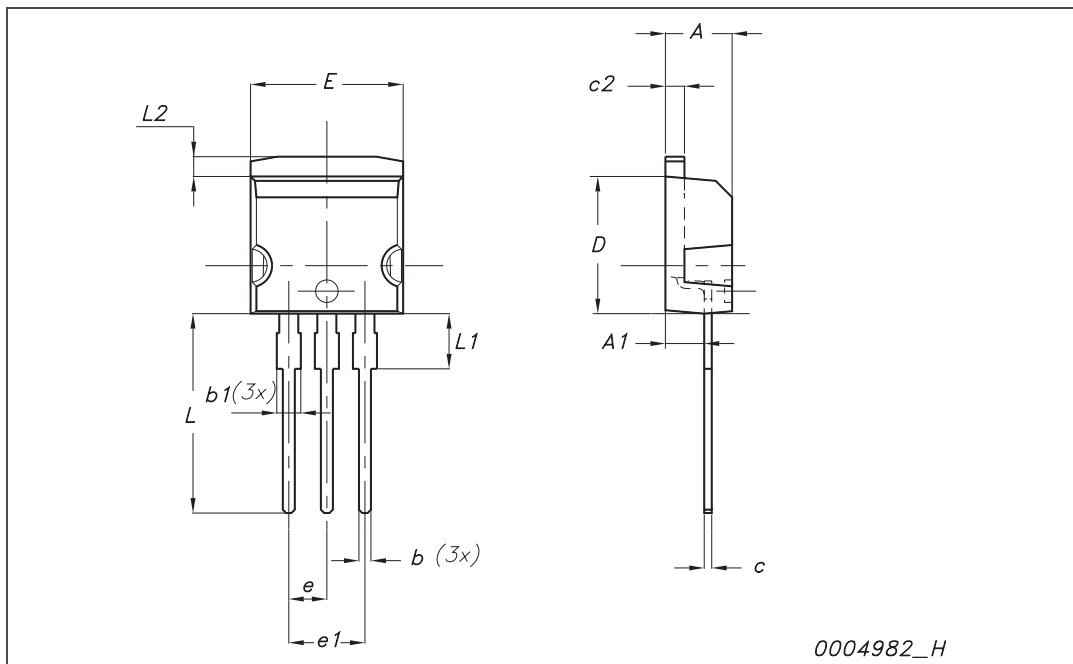
**TO-220FP mechanical data**

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



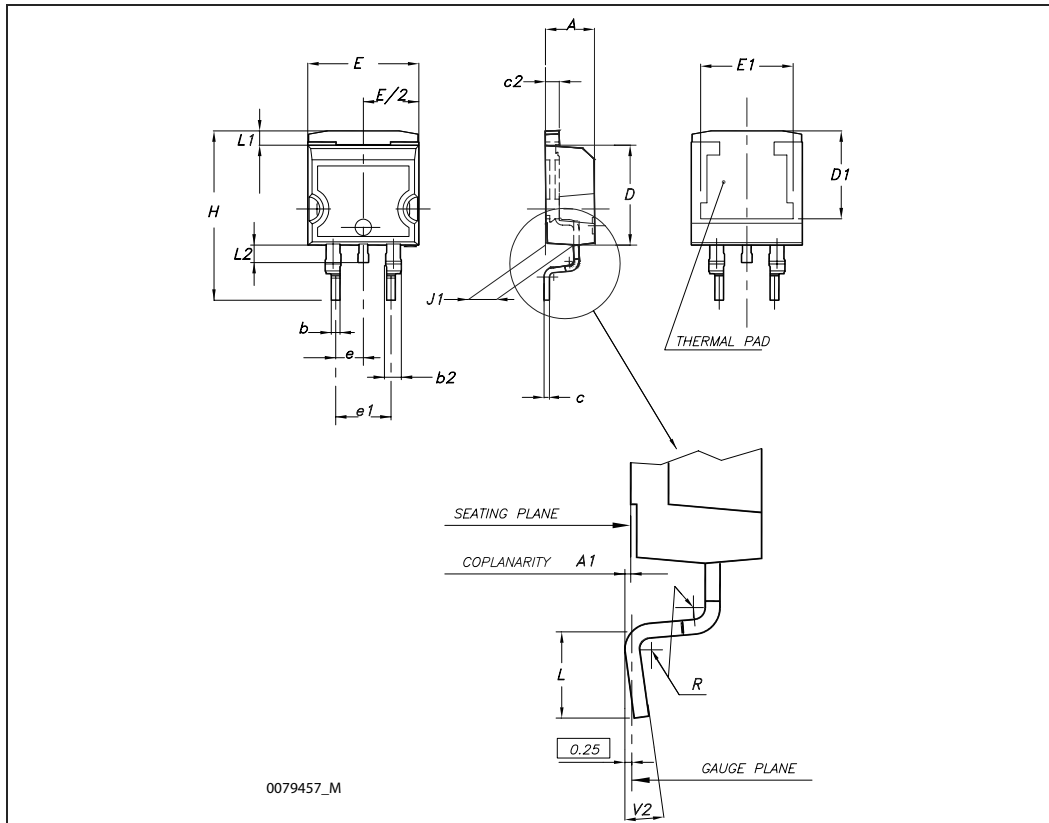
I<sup>2</sup>PAK (TO-262) mechanical data

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



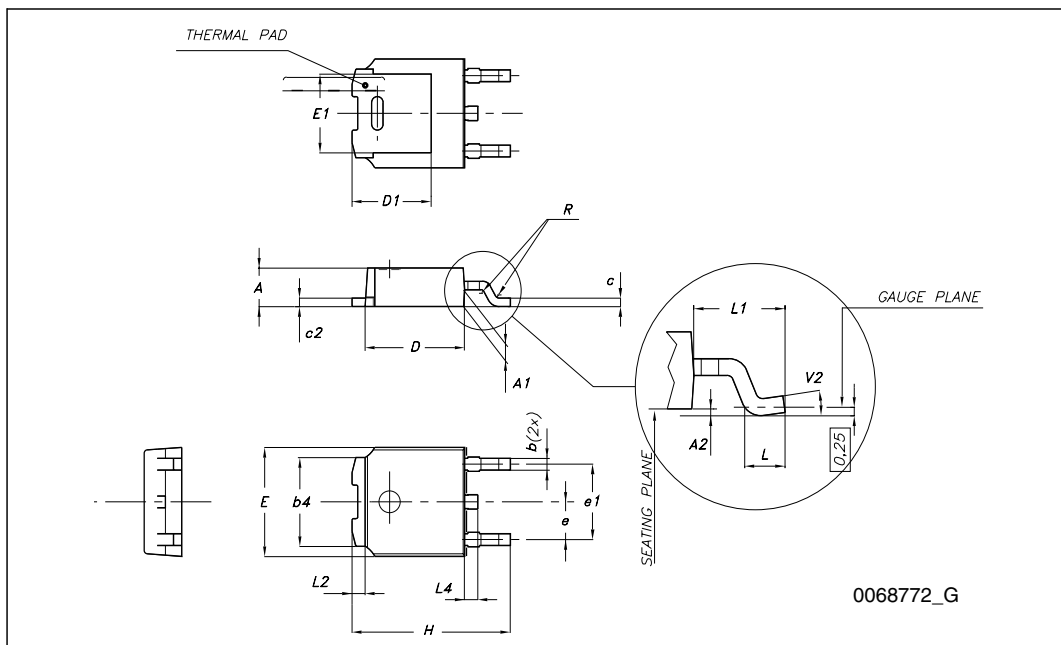
D<sup>2</sup>PAK (TO-263) mechanical data

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°



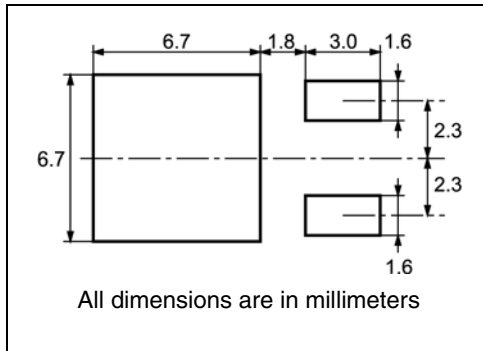
**TO-252 (DPAK) mechanical data**

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		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°



# 5 Packaging mechanical data

## DPAK 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

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

BASE QTY	BULK QTY
2500	2500

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

TOP COVER TAPE

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

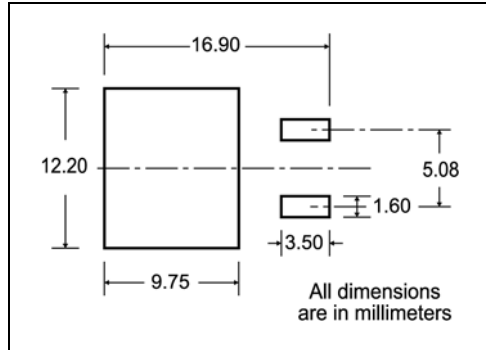
Bending radius

R min.

For machine ref. only including draft and radii concentric around B0



**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

**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

**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

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius R min.

\* on sales type

## 6 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
24-May-2005	1	Initial release
10-Jun-2005	2	Inserted new row in <a href="#">Table 7.: Switching times</a>
28-Sep-2005	3	Document status promoted from preliminary data to datasheet.
14-Oct-2005	4	Modified <a href="#">Figure 6</a> , <a href="#">Figure 9</a>
06-Mar-2006	5	Modified <a href="#">Figure 8</a>
29-Mar-2006	6	Modified value on <a href="#">Table 5</a> .
14-Nov-2006	7	Document reformatted no content change
24-Jul-2008	8	<ul style="list-style-type: none"><li>– Added I<sup>2</sup>PAK;</li><li>– <a href="#">Table 3: Thermal data</a> has been updated;</li><li>– <a href="#">Figure 11: Capacitance variations</a> changed.</li></ul>

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