



# STx25NM60ND

N-channel 600 V, 0.13  $\Omega$ , 21 A FDmesh™ II Power MOSFET  
D<sup>2</sup>PAK, I<sup>2</sup>PAK, TO-220FP, TO-220, TO-247

## Features

Type	V <sub>DSS</sub> @ T <sub>JMAX</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STB25NM60ND	650 V	0.16 $\Omega$	21 A
STI25NM60ND			21 A
STF25NM60ND			21 A <sup>(1)</sup>
STP25NM60ND			21 A
STW25NM60ND			21 A

1. Limited only by maximum temperature allowed

- The worldwide best R<sub>DS(on)</sub>\*area amongst the fast recovery diode devices
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Extremely high dv/dt and avalanche capabilities

## Application

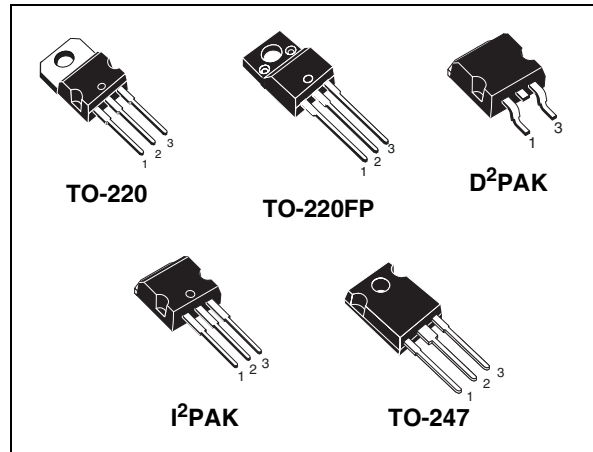
- Switching applications

## Description

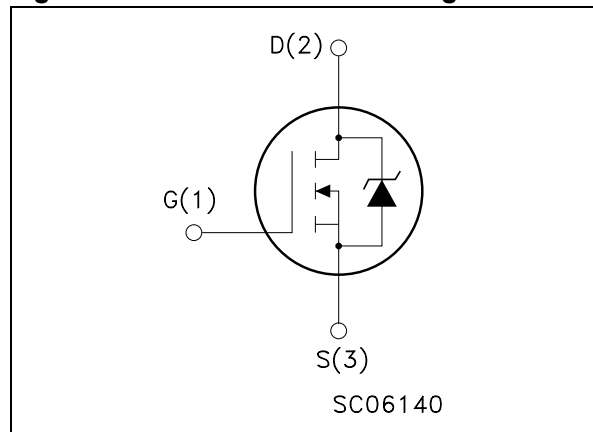
The FDmesh™ II series belongs to the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the company's strip layout and associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in ZVS phase-shift converters.

**Table 1. Device summary**

Order codes	Marking	Package	Packaging
STB25NM60ND	25NM60ND	D <sup>2</sup> PAK	Tape and reel
STI25NM60ND	25NM60ND	I <sup>2</sup> PAK	Tube
STF25NM60ND	25NM60ND	TO-220FP	Tube
STP25NM60ND	25NM60ND	TO-220	Tube
STW25NM60ND	25NM60ND	TO-247	Tube



**Figure 1. Internal schematic diagram**



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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220, D <sup>2</sup> PAK I <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(1)	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	160	40	W
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	40		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> ≤ 21 A, di/dt ≤ 600 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

Symbol	Parameter	TO-220	I <sup>2</sup> PAK	TO-247	D <sup>2</sup> PAK	TO-220FP	Unit
R <sub>thj-case</sub>	Thermal resistance junction-case max	0.78				3.1	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	62.5		50		62.5	°C/W
R <sub>thj-pcb</sub>	Thermal resistance junction-ambient max				30		°C/W
T <sub>l</sub>	Maximum lead temperature for soldering purpose	300					°C

**Table 4. Avalanche characteristics**

Symbol	Parameter	Max value	Unit
I <sub>AS</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>AS</sub> , V <sub>DD</sub> = 50 V)	850	mJ

## 2 Electrical characteristics

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

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{(BR)DSS}$	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 ( $V_{GS} = 0$ )	$V_{DS} = \text{Max rating}$ $V_{DS} = \text{Max rating @ } 125\text{ }^{\circ}\text{C}$			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	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}, I_D = 10.5\text{ A}$		0.13	0.16	$\Omega$

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	$V_{DS} = 15\text{ V}, I_D = 10.5\text{ A}$		17		S
$C_{iss}$ $C_{oss}$ $C_{rss}$	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 50\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$		2400 150 15		pF pF pF
$C_{oss\text{ eq.}}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0\text{ to } 480\text{ V}$		320		pF
$t_{d(on)}$ $t_r$ $t_{d(off)}$ $t_f$	Turn-on delay time Rise time Turn-off delay time Fall time	$V_{DD} = 300\text{ V}, I_D = 10.5\text{ A}$ $R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 23), (see Figure 18)		60 30 50 40		ns ns ns ns
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 480\text{ V}, I_D = 21\text{ A}, V_{GS} = 10\text{ V},$ (see Figure 19)		80 15 40		nC nC nC
$R_g$	Gate input resistance	$f=1\text{ MHz}$ 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%  $V_{DSS}$

Table 7. 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	$I_{SD} = 21 \text{ A}, V_{DD} = 60 \text{ V}$ $di/dt = 100 \text{ A}/\mu\text{s}$ <i>(see Figure 20)</i>		160		ns
$Q_{rr}$	Reverse recovery charge			1		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			15		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 21 \text{ A}, V_{DD} = 60 \text{ V}$ $di/dt = 100 \text{ A}/\mu\text{s}$ , $T_J = 150 \text{ }^\circ\text{C}$ <i>(see Figure 20)</i>		230		ns
$Q_{rr}$	Reverse recovery charge			2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			19		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

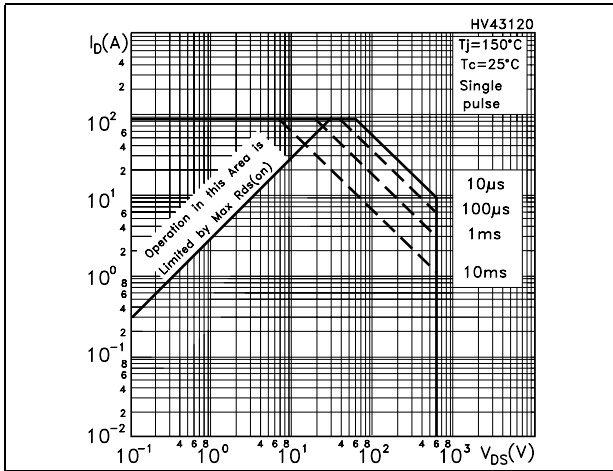


Figure 3. Thermal impedance for TO-220, D<sup>2</sup>PAK, I<sup>2</sup>PAK

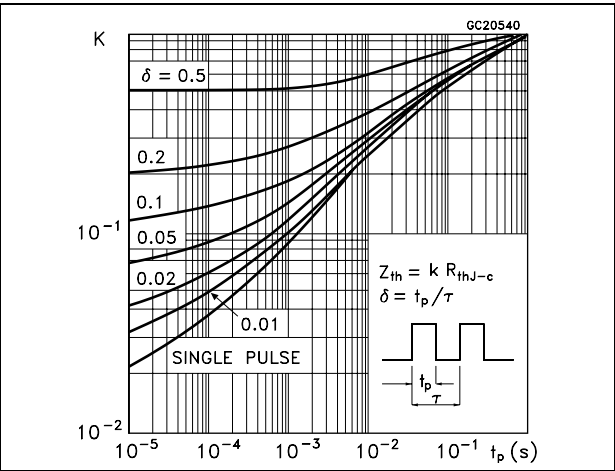


Figure 4. Safe operating area for TO-220FP

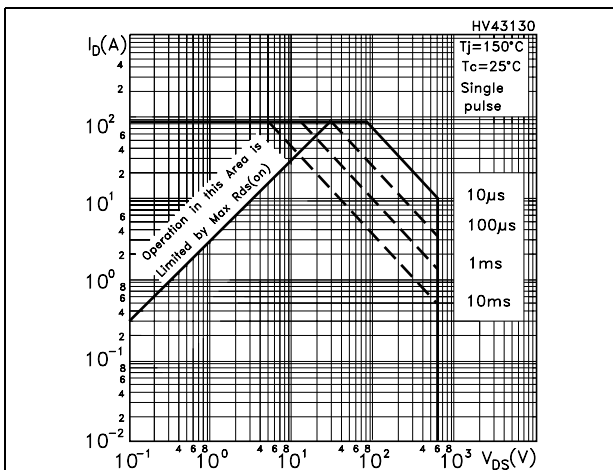


Figure 5. Thermal impedance for TO-220FP

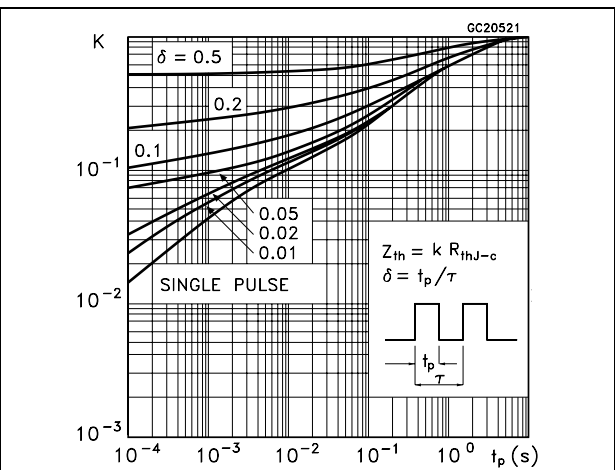


Figure 6. Safe operating area for TO-247

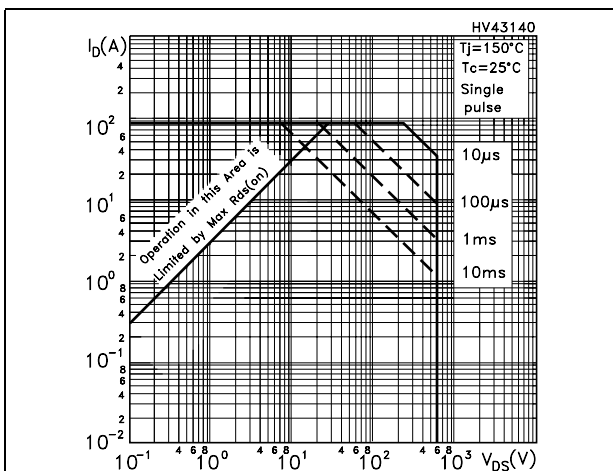


Figure 7. Thermal impedance for TO-247

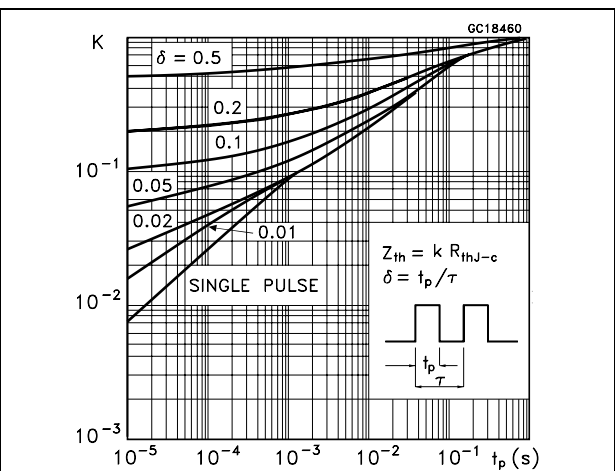


Figure 8. Output characteristics

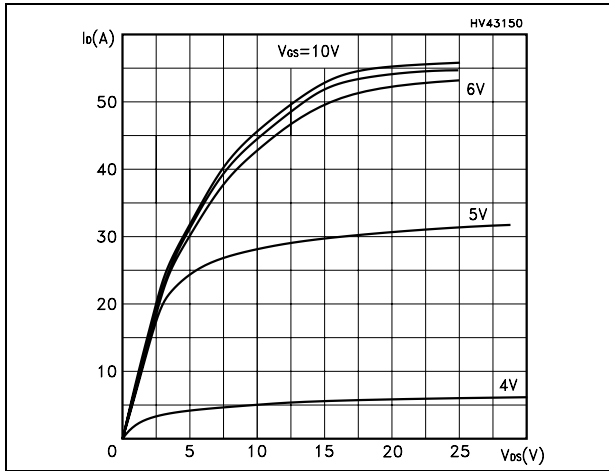


Figure 9. Transfer characteristics

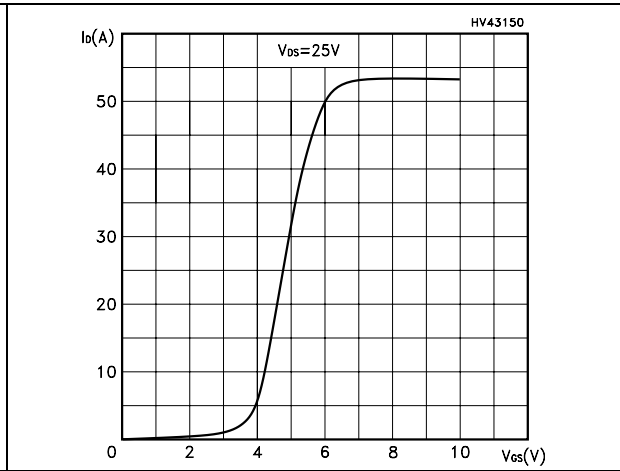


Figure 10. Transconductance

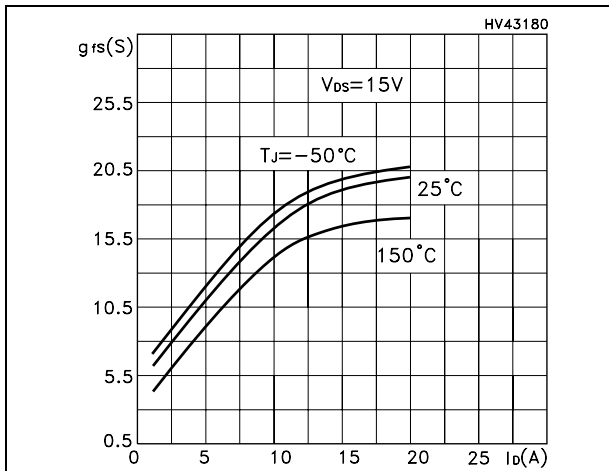


Figure 11. Static drain-source on resistance

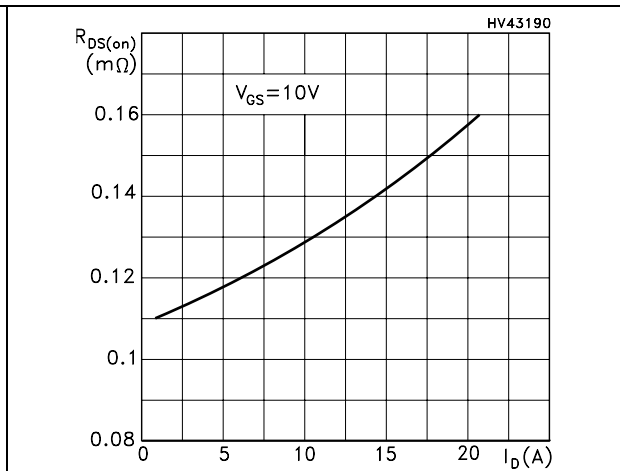


Figure 12. Gate charge vs gate-source voltage Figure 13. Capacitance variations

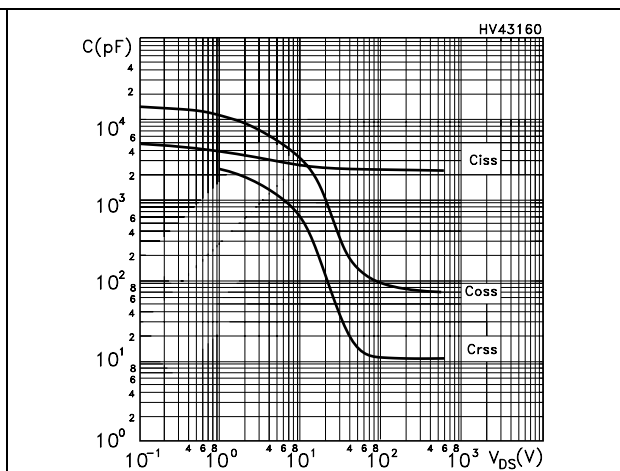
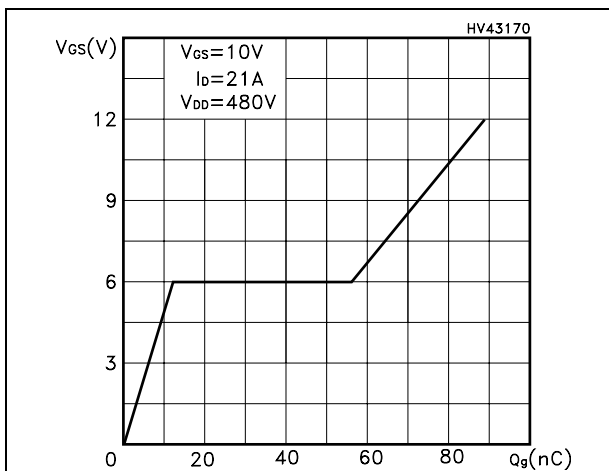


Figure 14. Normalized gate threshold voltage vs temperature

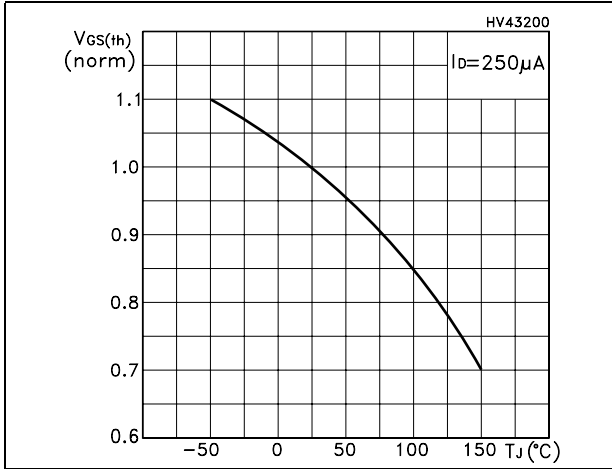


Figure 15. Normalized on resistance vs temperature

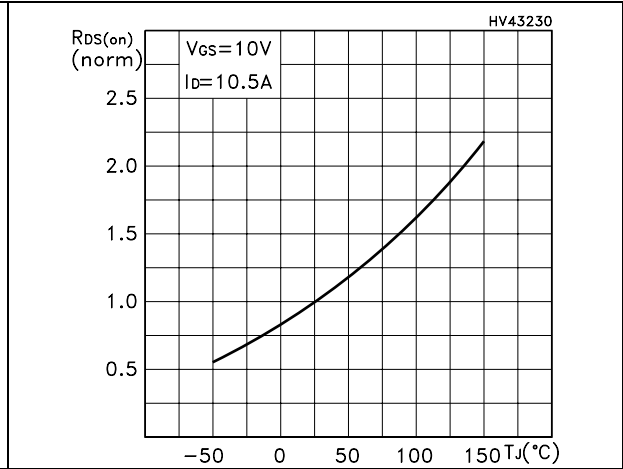


Figure 16. Source-drain diode forward characteristics

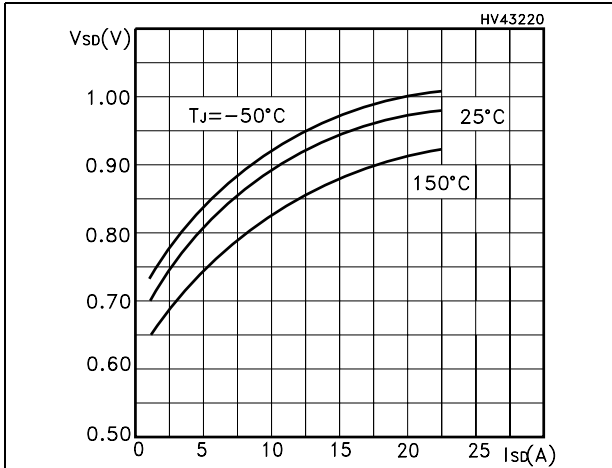
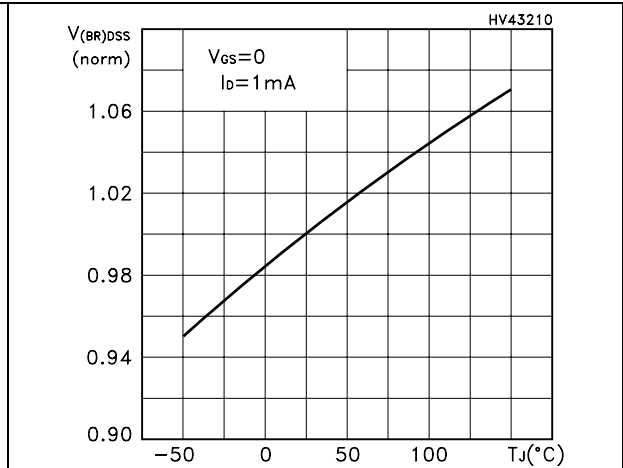


Figure 17. Normalized B<sub>VDSS</sub> vs temperature





### 3 Test circuits

Figure 18. Switching times test circuit for resistive load

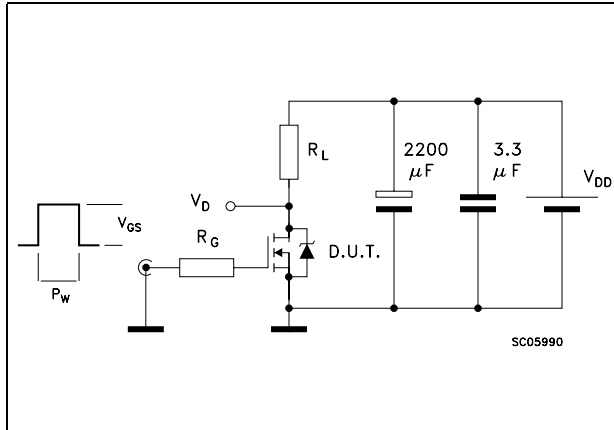


Figure 19. Gate charge test circuit

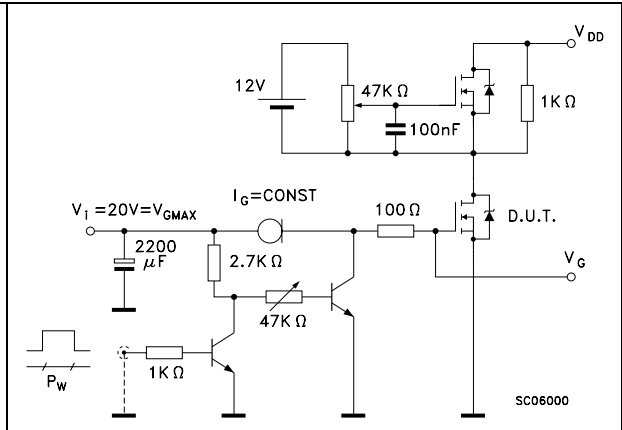


Figure 20. Test circuit for inductive load switching and diode recovery times

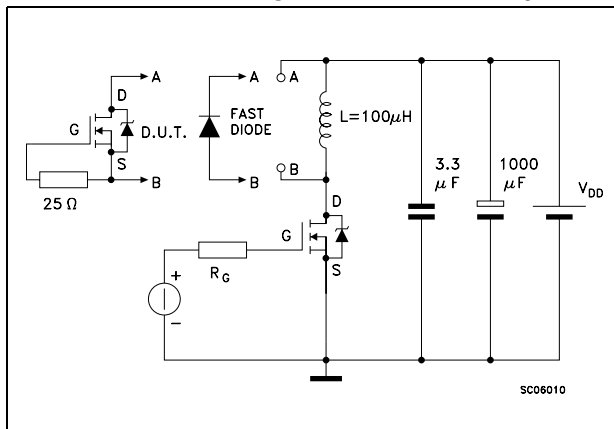


Figure 21. Unclamped inductive load test circuit

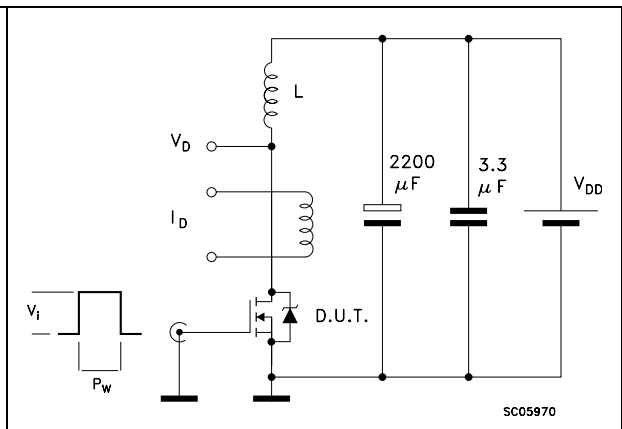


Figure 22. Unclamped inductive waveform

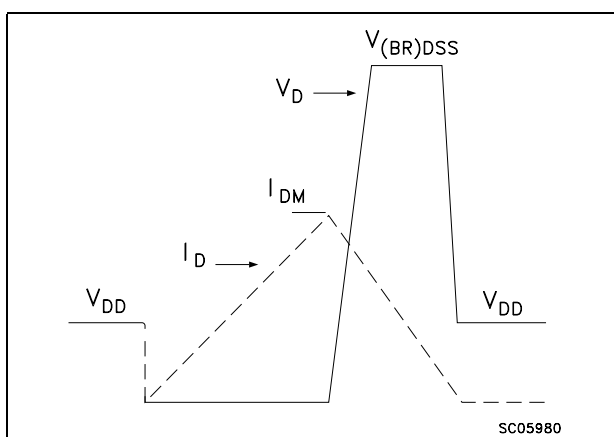
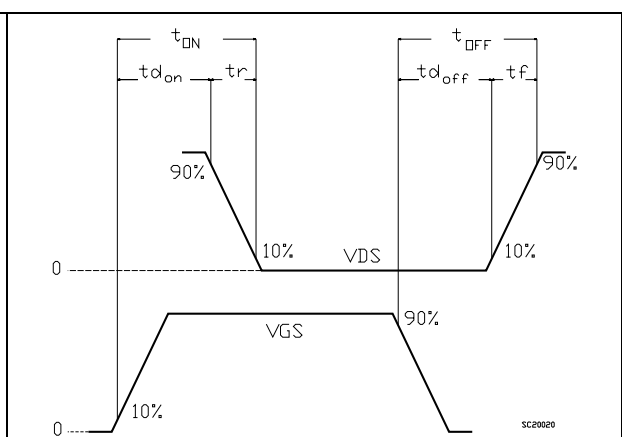


Figure 23. Switching time waveform

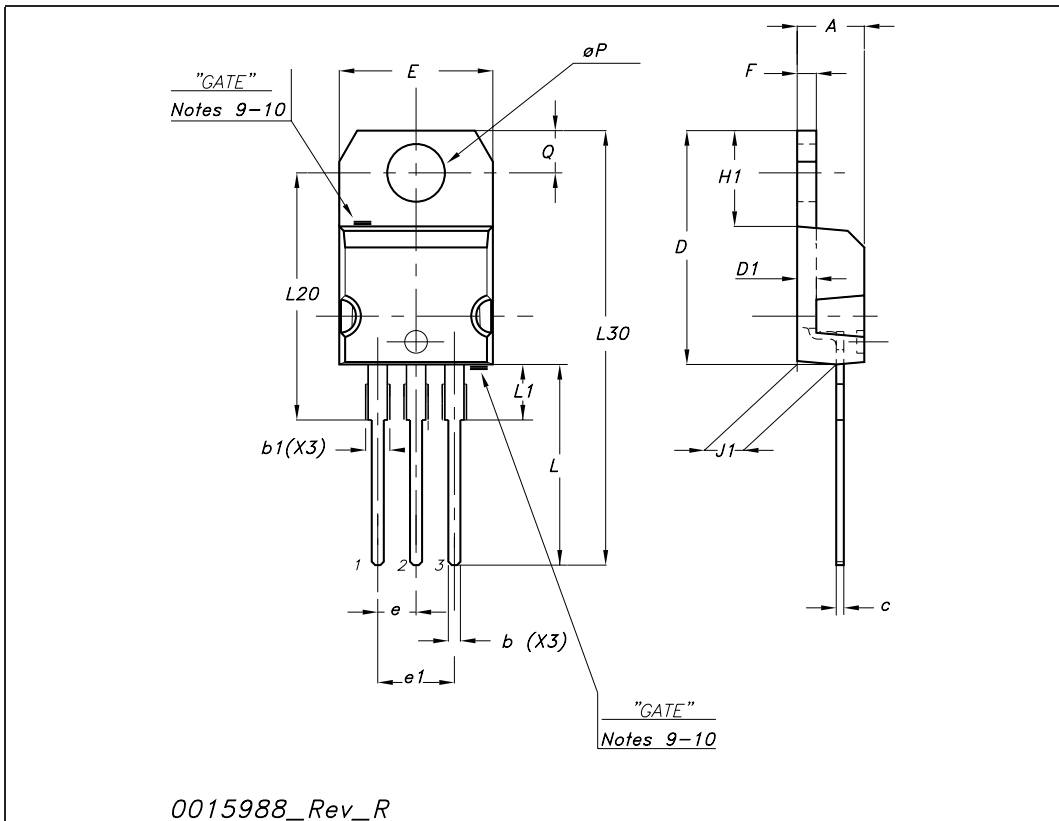


## 4 Package mechanical data

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

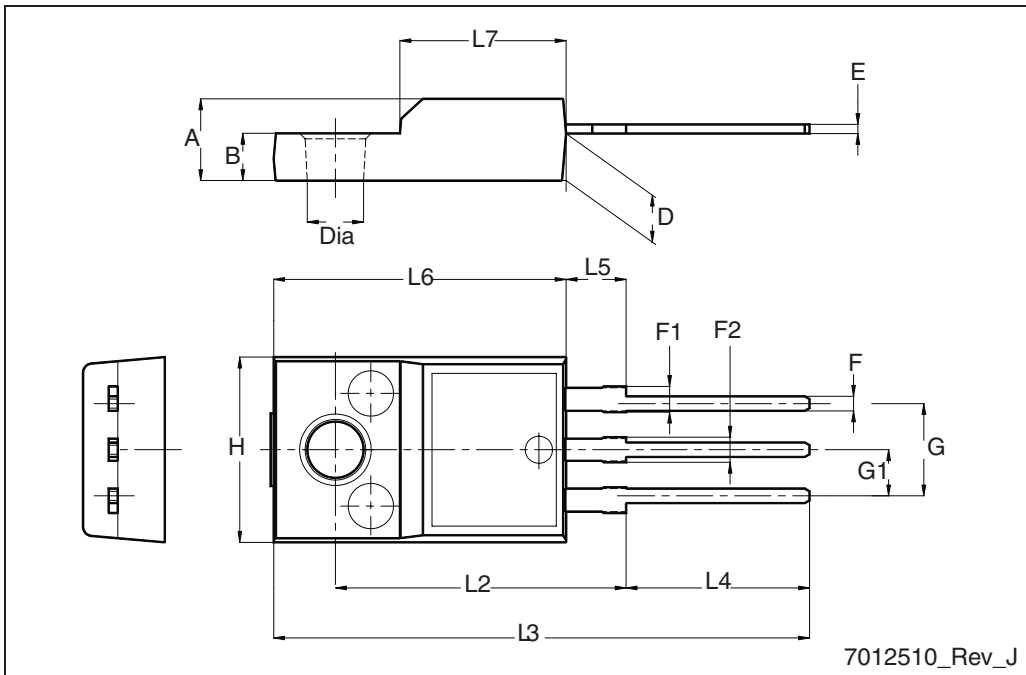
TO-220 mechanical data

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



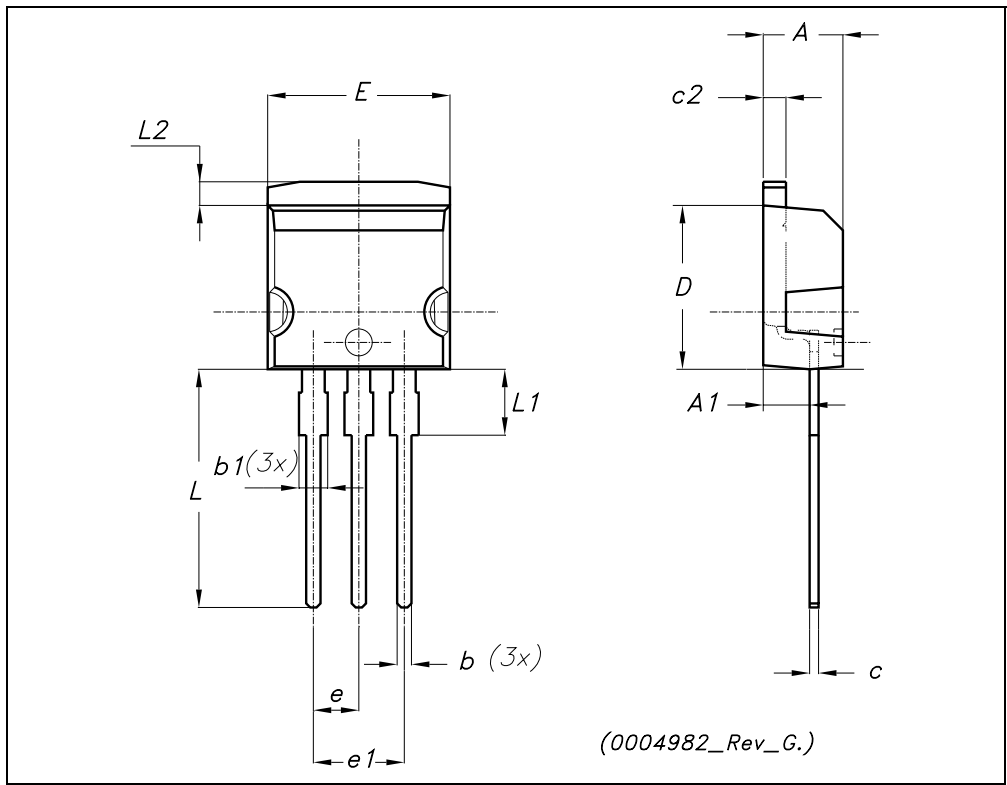
TO-220FP mechanical data

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



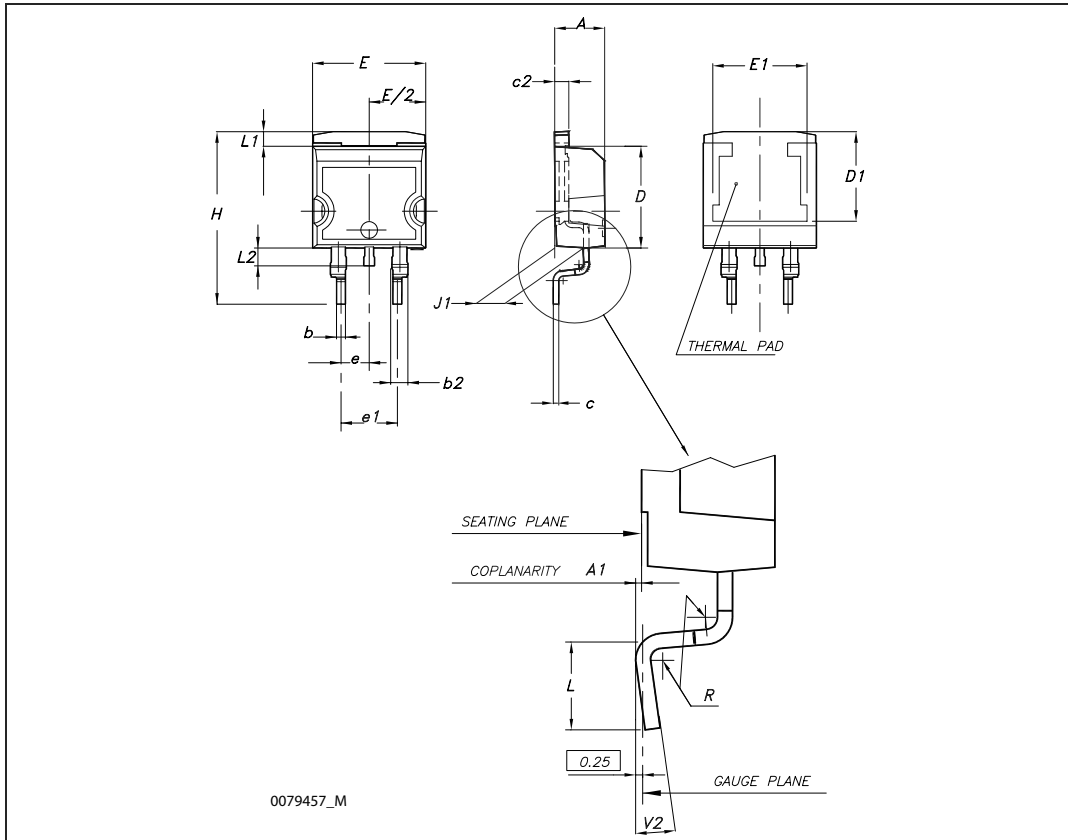
**TO-262 (I<sup>2</sup>PAK) mechanical data**

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



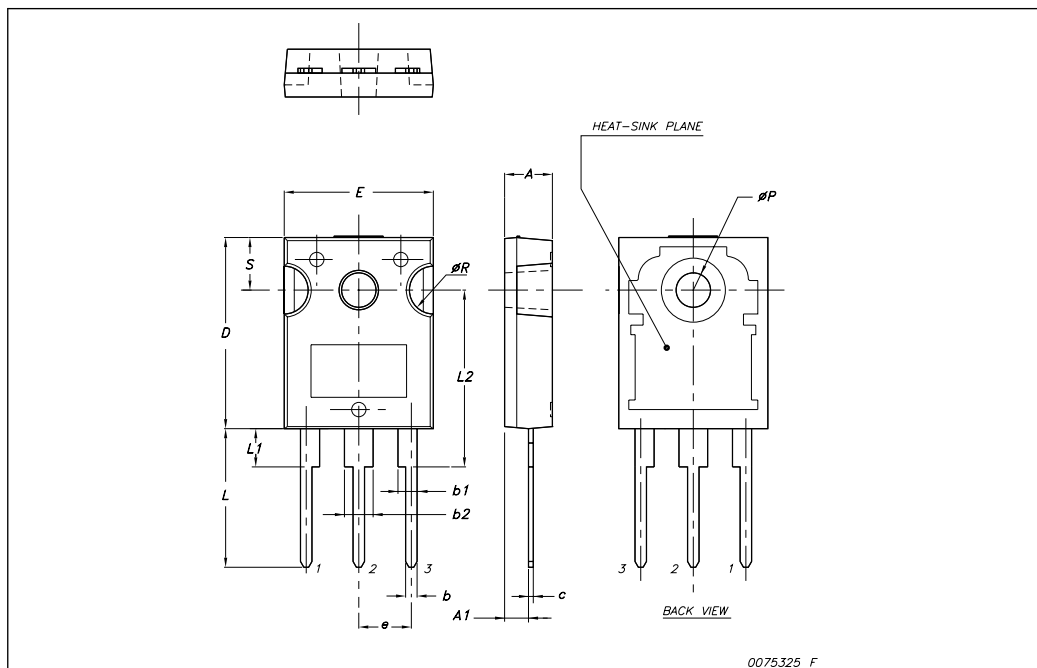
**D<sup>2</sup>PAK (TO-263) mechanical data**

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°



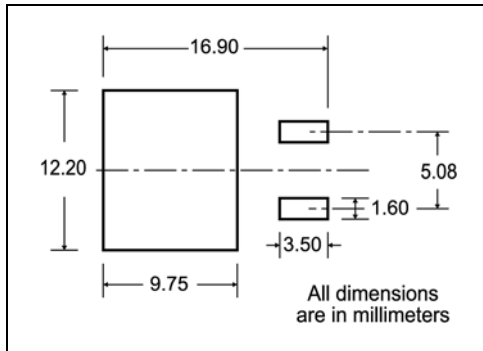
## TO-247 Mechanical data

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	



# 5 Packing mechanical data

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



## TAPE AND REEL SHIPMENT

**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

\* on sales type



## 6 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
15-Nov-2007	1	First release.
22-Jan-2008	2	Document status promoted from target specification to preliminary data.
08-Apr-2008	3	– Updated <a href="#">Table 3: Thermal data on page 3</a> ; – Document status promoted from preliminary data to datasheet.
03-Mar-2009	4	Q <sub>g</sub> value has been updated.

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