



STB10NK60Z, STP10NK60Z STW10NK60Z

N-channel 650 V, 0.65 Ω , 10 A, SuperMESH™ Power MOSFET
Zener-protected I²PAK, D²PAK, TO-220, TO-220FP, TO-247

Features

Type	V _{DSS}	R _{DS(on) max}	I _D	P _w
STB10NK60Z-1	600 V	< 0.75 Ω	10 A	115 W
STB10NK60Z	600 V	< 0.75 Ω	10 A	115 W
STP10NK60Z	600 V	< 0.75 Ω	10 A	115 W
STP10NK60ZFP	600 V	< 0.75 Ω	10 A	35 W
STW10NK60Z	600 V	< 0.75 Ω	10 A	156 W

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very good manufacturing reliability

Application

- Switching applications

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, special care is taken to ensure a very good dv/dt capability for the most demanding applications.

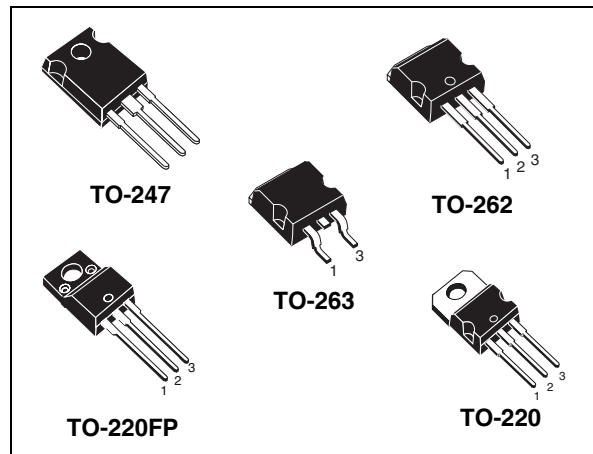


Figure 1. Internal schematic diagram

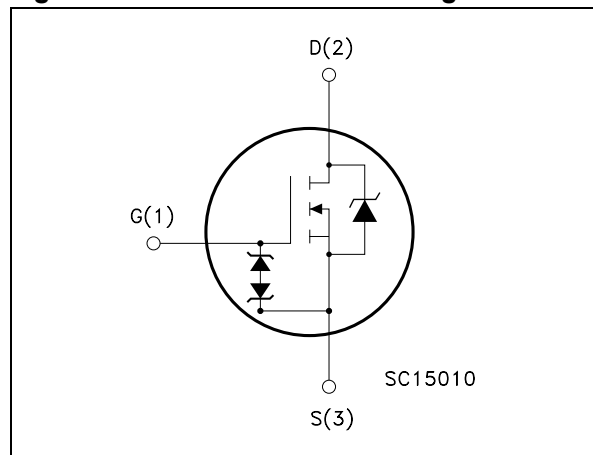


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB10NK60Z-1	B10NK60Z	I ² PAK	Tube
STB10NK60ZT4	B10NK60Z	D ² PAK	Tape & reel
STP10NK60ZFP	P10NK60ZFP	TO-220FP	Tube
STP10NK60Z	P10NK60Z	TO-220	Tube
STW10NK60Z	W10NK60Z	TO-247	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TO-220 D ² PAK, I ² PAK	TO-220FP	TO-247	
V _{DS}	Drain-source voltage (V _{GS} = 0)	600			V
V _{GS}	Gate-source voltage	± 30			V
I _D	Drain current (continuous) at T _C = 25 °C	10	10 ⁽¹⁾	10	A
I _D	Drain current (continuous) at T _C = 100 °C	5.7	5.7 ⁽¹⁾	5.7	A
I _{DM} ⁽²⁾	Drain current (pulsed)	36	36 ⁽¹⁾	36	A
P _{TOT}	Total dissipation at T _C = 25 °C	115	35	156	W
	Derating factor	0.92	0.28	1.25	W/°C
Vesd(G-S)	G-S ESD (HBM C=100 pF, R=1.5 kΩ)	4000			V
dv/dt ⁽³⁾	Peak diode recovery voltage slope	4.5			V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T _C =25 °C)	--	2500	--	V
T _j T _{stg}	Operating junction temperature Storage temperature	-55 to 150			°C

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I_{SD} < 10A, di/dt < 200A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		TO-220 I ² PAK	D ² PAK	TO-220FP	TO-247	
R _{thj-case}	Thermal resistance junction-case Max	1.09		3.6	0.8	°C/W
R _{thj-pcb}	Thermal resistance junction-pcb Max (when mounted on minimum footprint)		60			°C/W
R _{thj-amb}	Thermal resistance junction-amb Max	62.5			50	°C/W
T _l	Maximum lead temperature for soldering purpose	300				°C

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max)	9	A
E_{AS}	Single pulse avalanche energy (starting $T_j=25\text{ °C}$, $I_D=I_{AR}$, $V_{DD}=50\text{ V}$)	300	mJ
E_{AR}	Repetitive avalanche energy (pulse width limited by T_j max)	3.5	mJ

2 Electrical characteristics

(T_{case} = 25 °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 = 250 μA, V _{GS} = 0	600			V
I _{DSS}	Zero gate voltage drain current (V _{GS} = 0)	V _{DS} = Max rating, V _{DS} = Max rating, T _j = 125 °C			1 50	μA μA
I _{GSS}	Gate body leakage current (V _{DS} = 0)	V _{GS} = ±20 V, V _{DS} = 0			±10	μA
V _{GS(th)}	Gate threshold voltage	V _{DS} = V _{GS} , I _D = 250 μA	3	3.75	4.5	V
R _{DS(on)}	Static drain-source on resistance	V _{GS} = 10 V, I _D = 4.5 A		0.65	0.75	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g _{fs} ⁽¹⁾	Forward transconductance	V _{DS} = 15 V, I _D = 4.5 A		7.8		S
C _{iss} C _{oss} C _{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V _{DS} = 25 V, f = 1 MHz, V _{GS} = 0		1370 156 37		pF pF pF
C _{oss eq} ⁽²⁾	Equivalent output capacitance	V _{GS} = 0, V _{DS} = 0 to 480 V		90		pF
Q _g Q _{gs} Q _{gd}	Total gate charge Gate-source charge Gate-drain charge	V _{DD} = 480 V, I _D = 8 A V _{GS} = 10 V (see Figure 20)		50 10 25	70	nC nC nC

1. Pulsed: pulse duration = 300 μs, 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%

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_{d(on)}$ t_r	Turn-on delay time Rise time	$V_{DD}=300\text{ V}$, $I_D=4\text{ A}$, $R_G=4.7\ \Omega$, $V_{GS}=10\text{ V}$ (see Figure 19)		20 20		ns ns
$t_{d(off)}$ t_f	Turn-off delay time Fall time	$V_{DD}=300\text{ V}$, $I_D=4\text{ A}$, $R_G=4.7\ \Omega$, $V_{GS}=10\text{ V}$ (see Figure 19)		55 30		ns ns

Table 8. 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)				36	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD}=10\text{ A}$, $V_{GS}=0$			1.6	V
t_{rr}	Reverse recovery time	$I_{SD}=8\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=40\text{ V}$, $T_j=150\text{ }^\circ\text{C}$		570		ns
Q_{rr}	Reverse recovery charge			4.3		μC
I_{RRM}	Reverse recovery current			15		A

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

Table 9. Gate-source Zener diode

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$BV_{GSO}^{(1)}$	Gate-source breakdown voltage	$I_{GS}=\pm 1\text{ mA}$ (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 2. Safe operating area for TO-220 / I²PAK / D²PAK

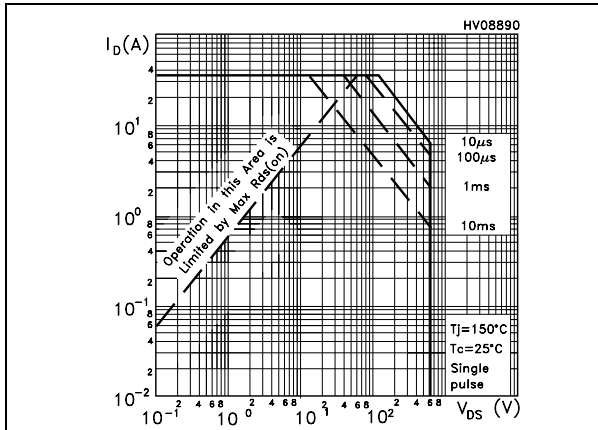


Figure 3. Thermal impedance for TO-220 / I²PAK / D²PAK

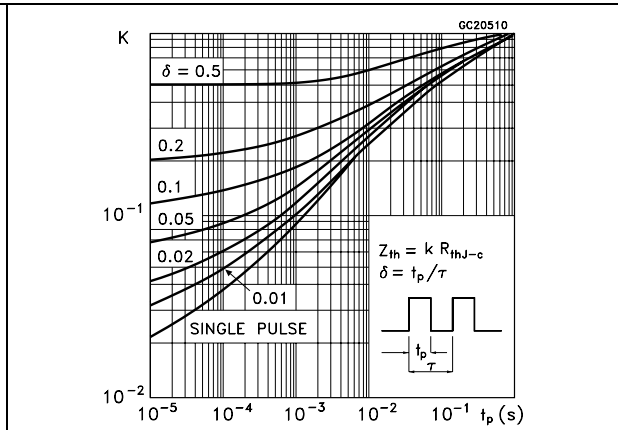


Figure 4. Safe operating area for TO-247

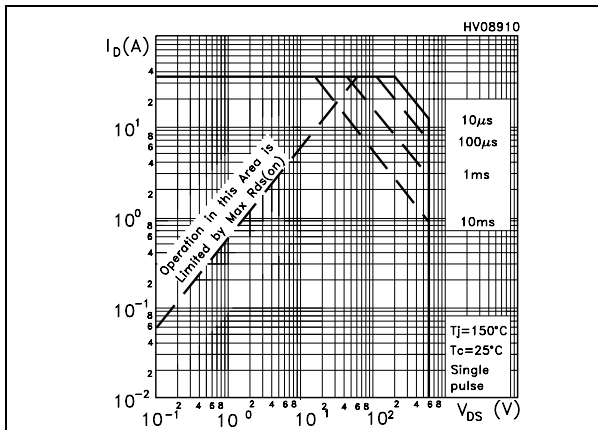


Figure 5. Thermal impedance for TO-247

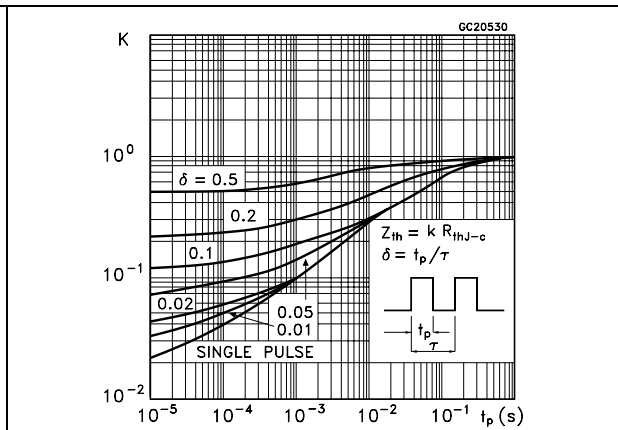


Figure 6. Safe operating area for TO-220FP

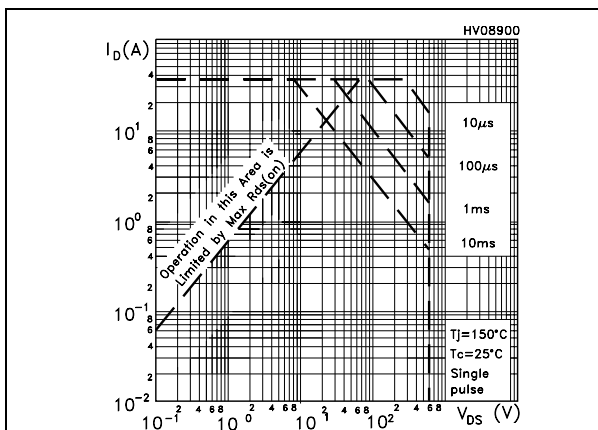


Figure 7. Thermal impedance for TO-220FP

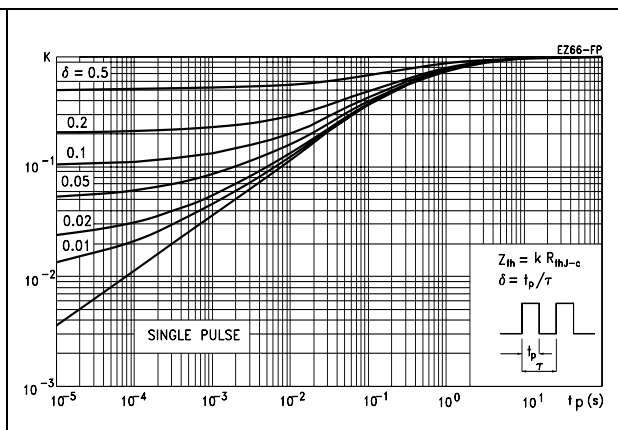


Figure 8. Output characteristics

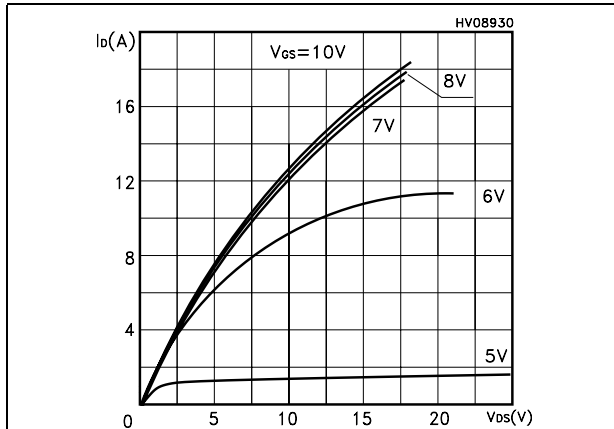


Figure 9. Transfer characteristics

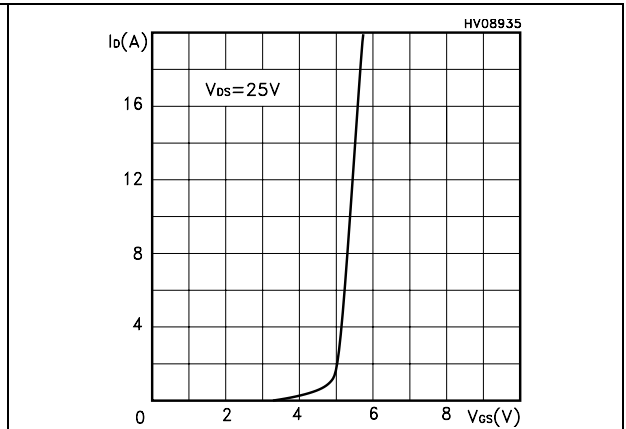


Figure 10. Transconductance

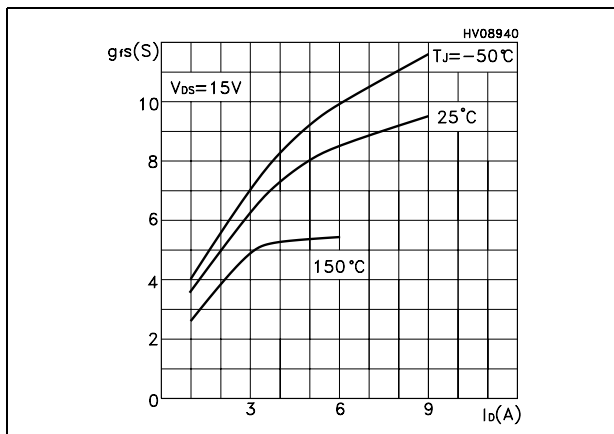


Figure 11. Static drain-source on resistance

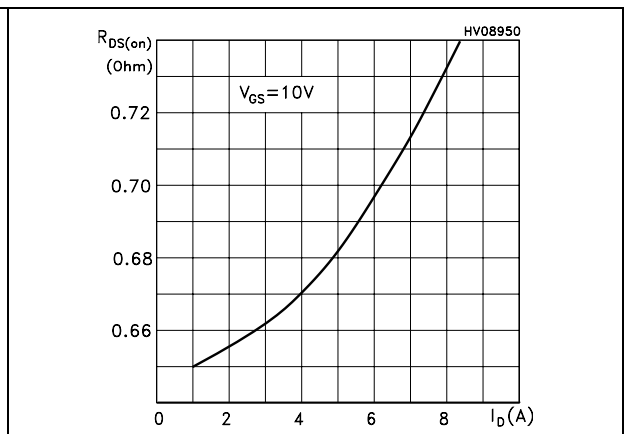


Figure 12. Gate charge vs gate-source voltage

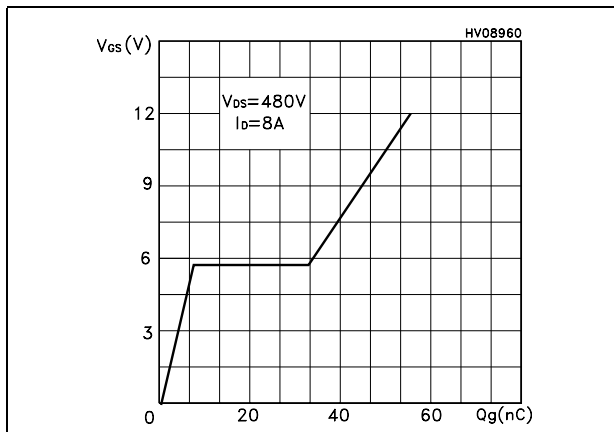


Figure 13. Capacitance variations

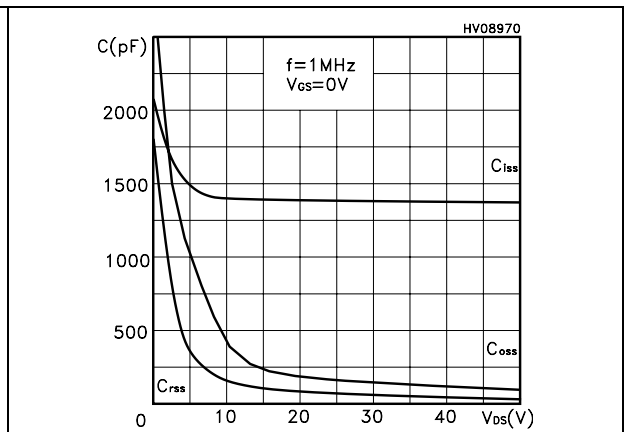


Figure 14. Normalized gate threshold voltage vs temperature

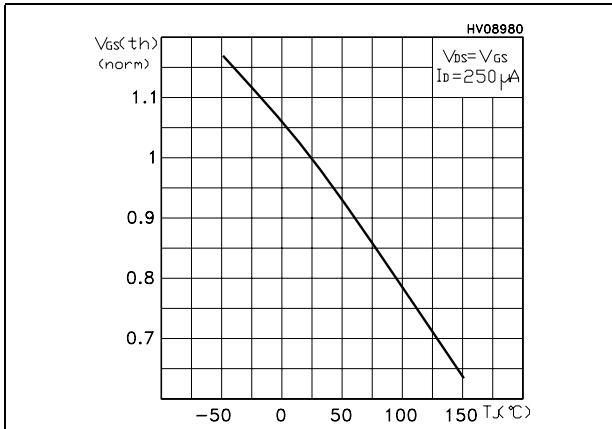


Figure 15. Normalized on resistance vs temperature

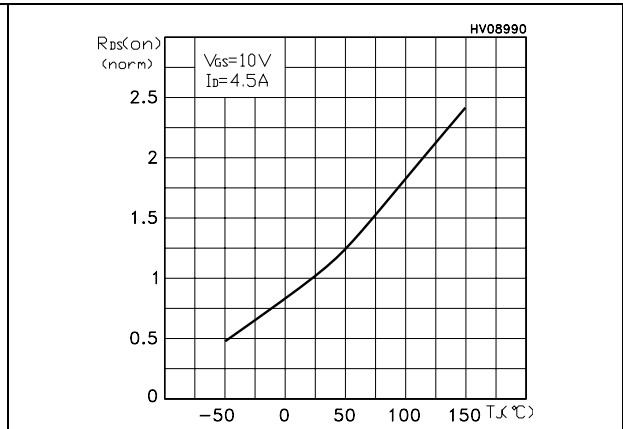


Figure 16. Source-drain diode forward characteristics

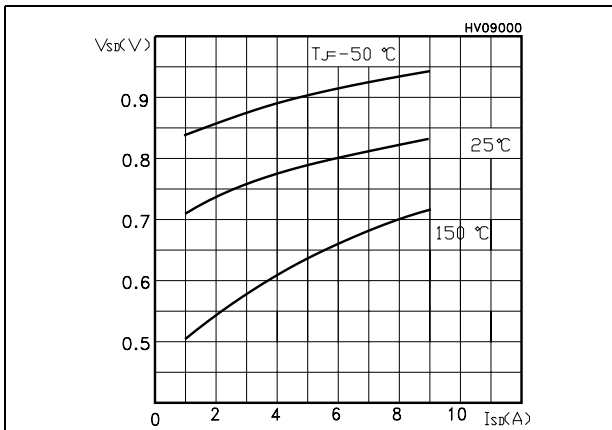


Figure 17. Maximum avalanche energy vs temperature

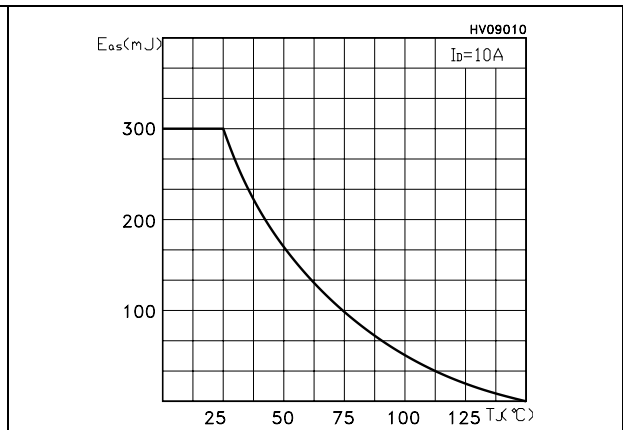
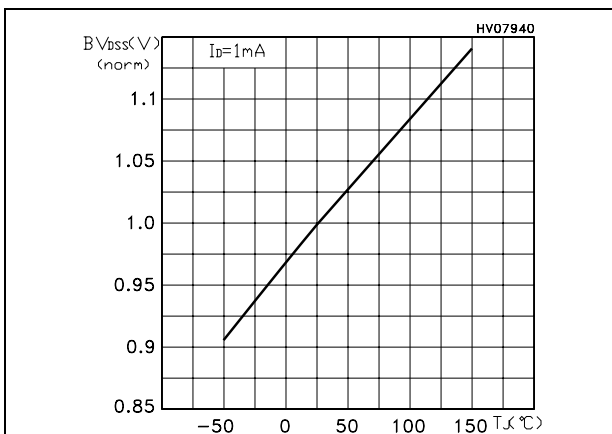


Figure 18. Normalized B_VDSS vs temperature



3 Test circuits

Figure 19. Switching times test circuit for resistive load

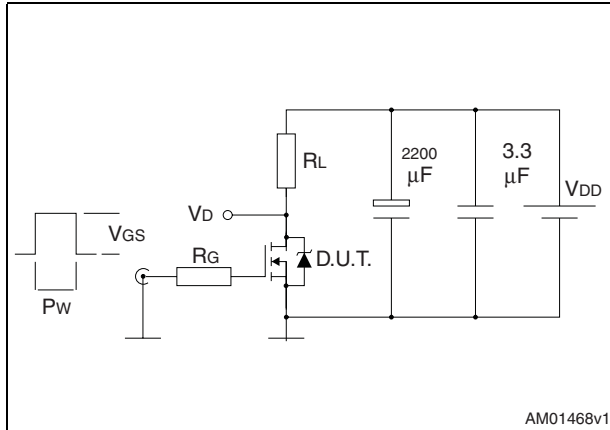


Figure 20. Gate charge test circuit

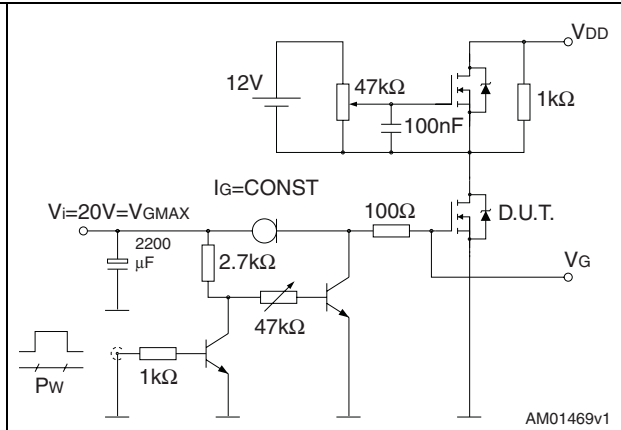


Figure 21. Test circuit for inductive load switching and diode recovery times

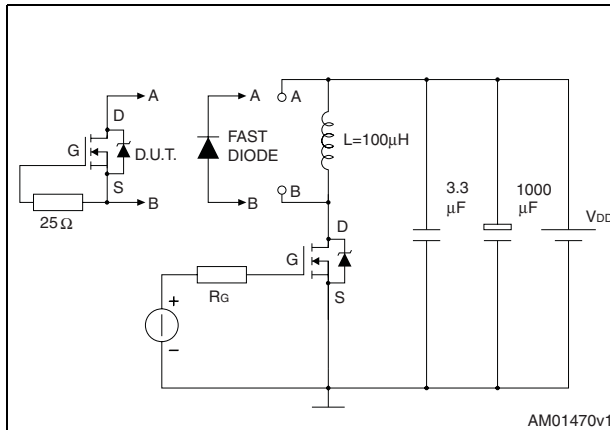


Figure 22. Unclamped inductive load test circuit

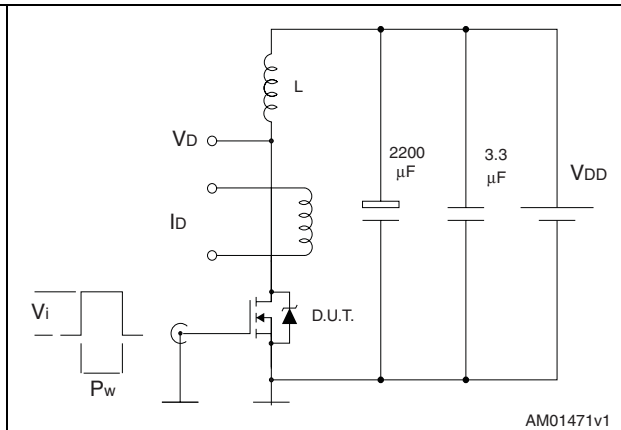


Figure 23. Unclamped inductive waveform

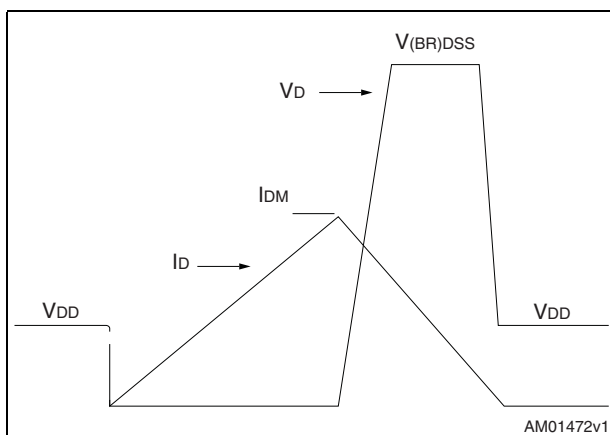
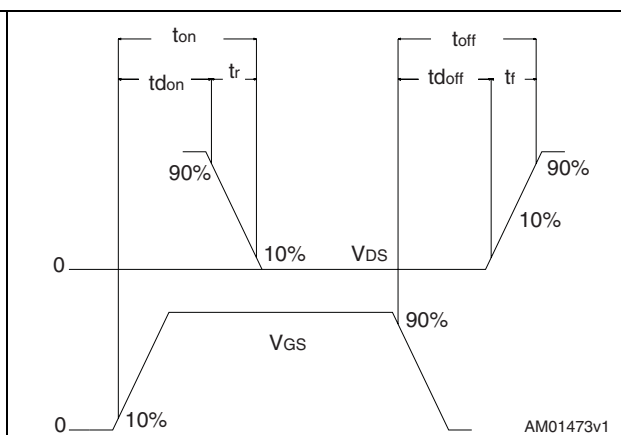


Figure 24. Switching time waveform

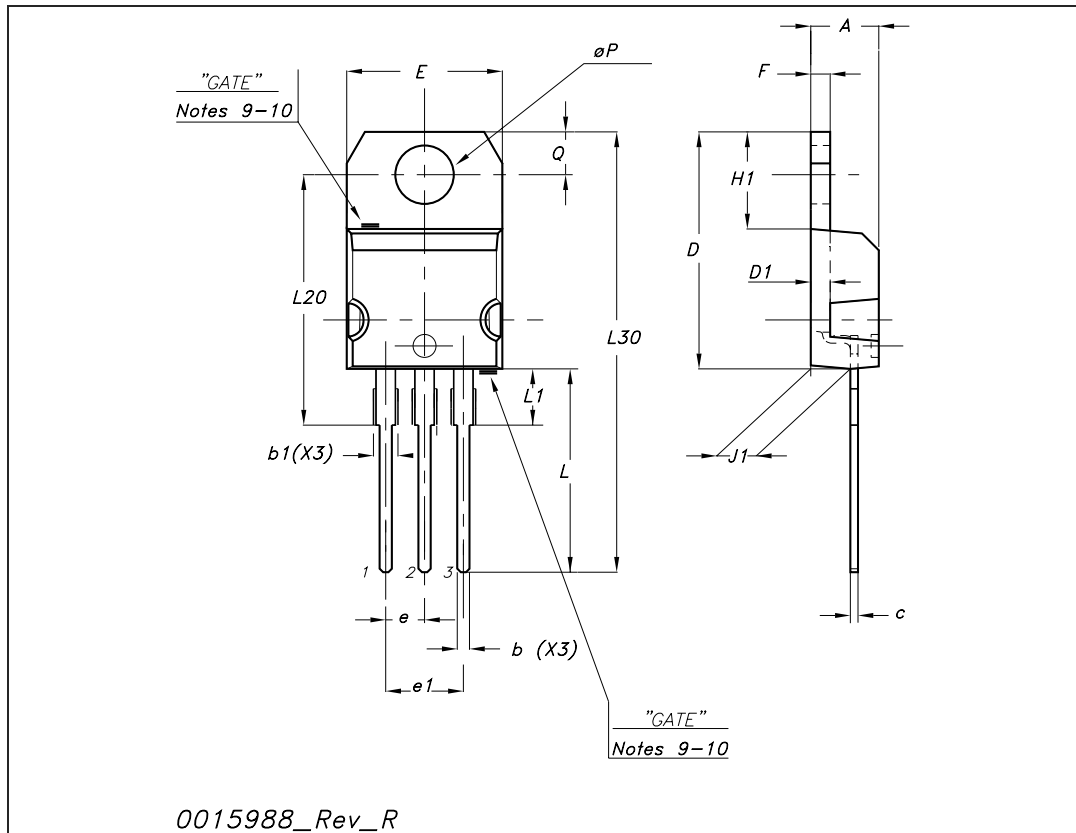


4 Package mechanical data

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

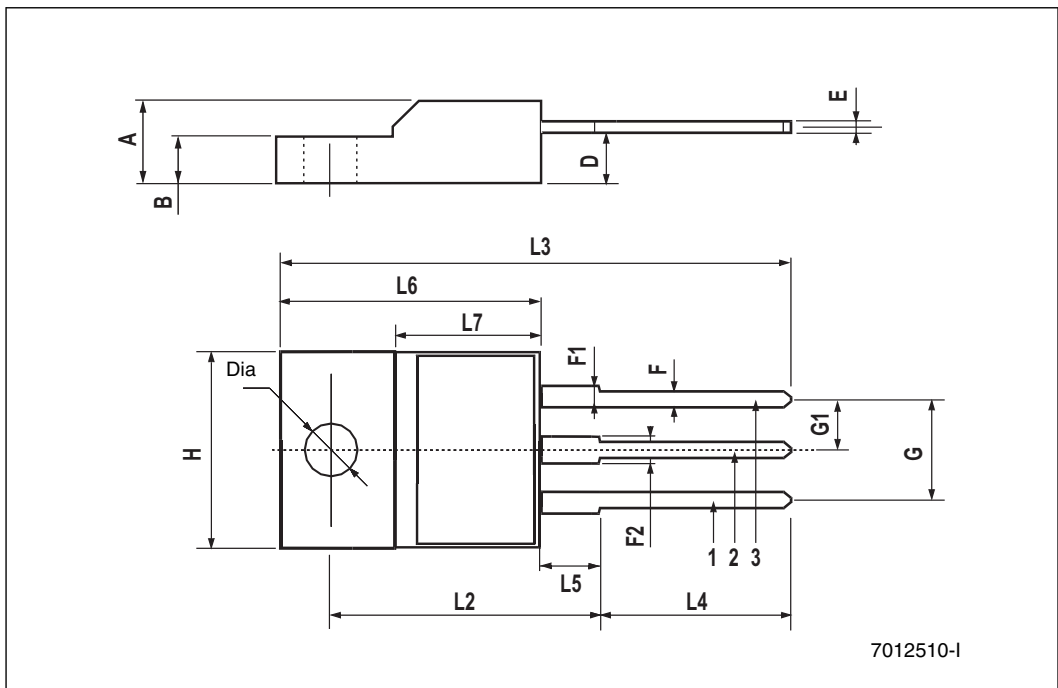
TO-220 mechanical data

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



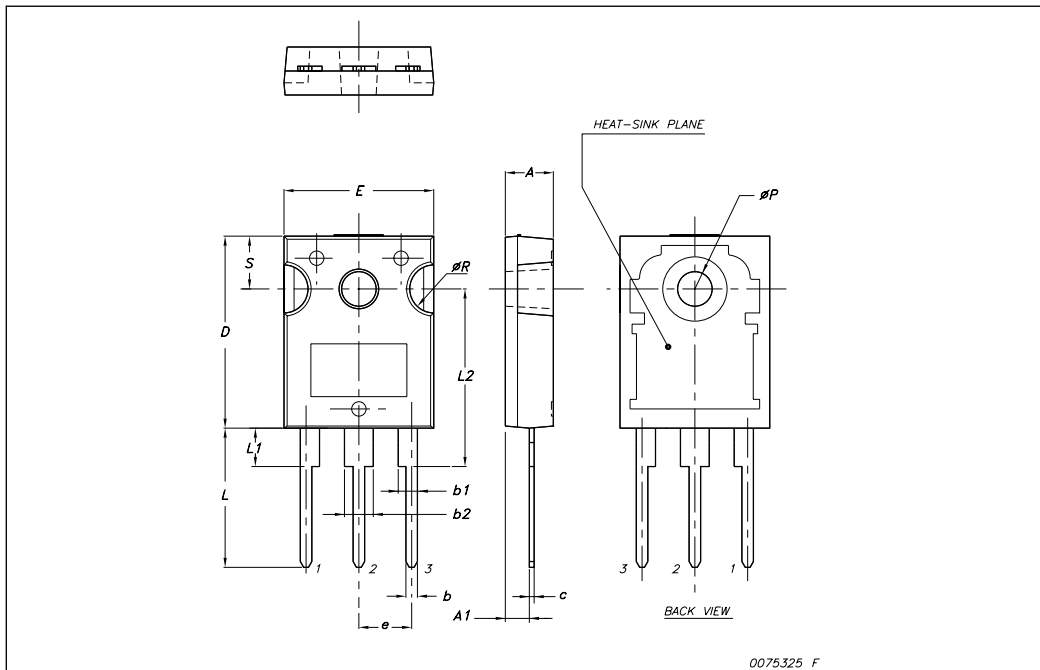
TO-220FP mechanical data

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



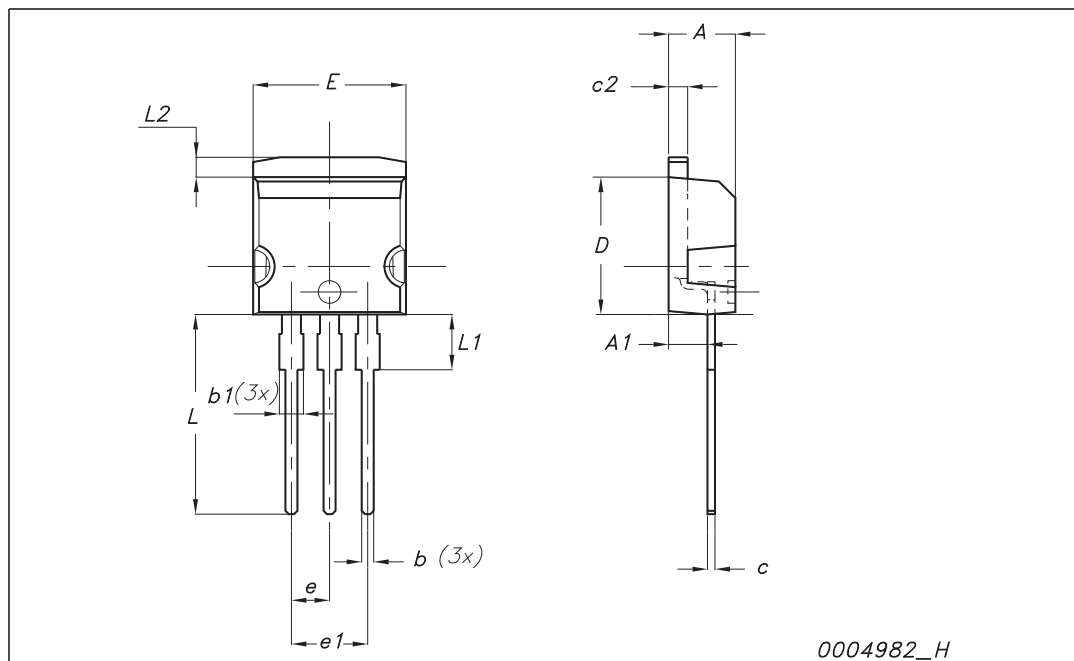
TO-247 Mechanical data

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	



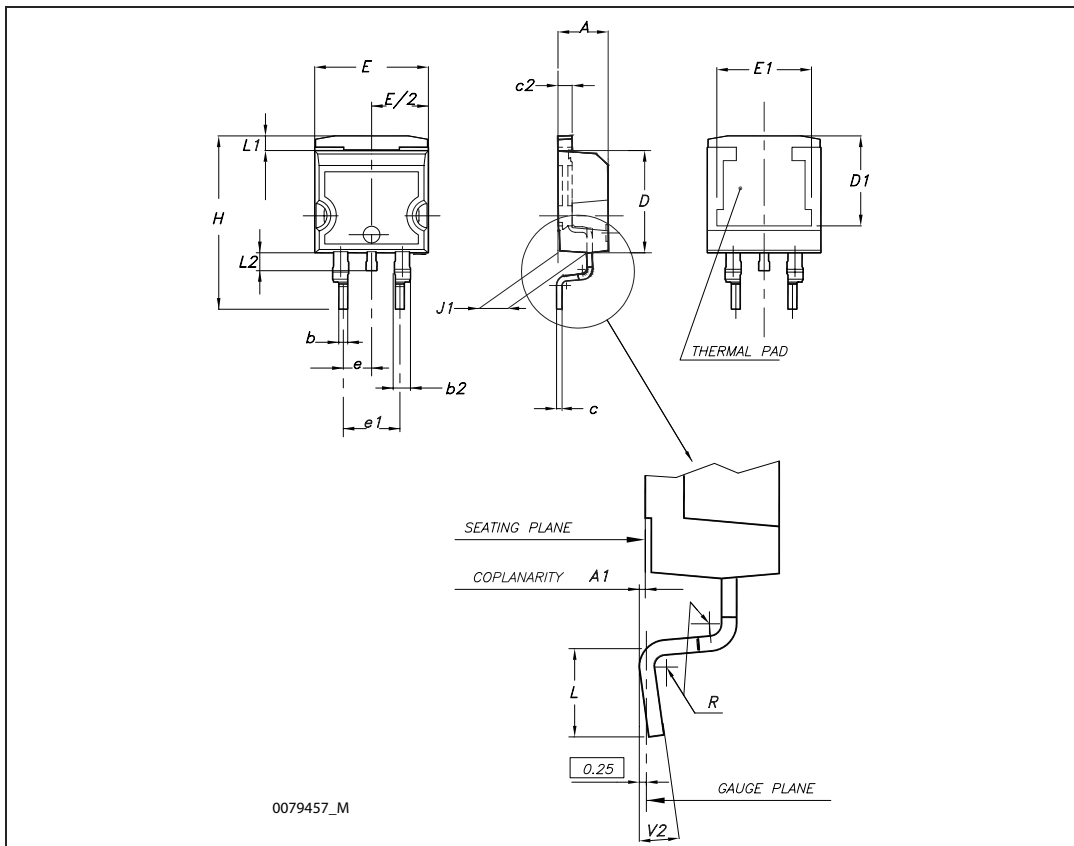
I²PAK (TO-262) mechanical data

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



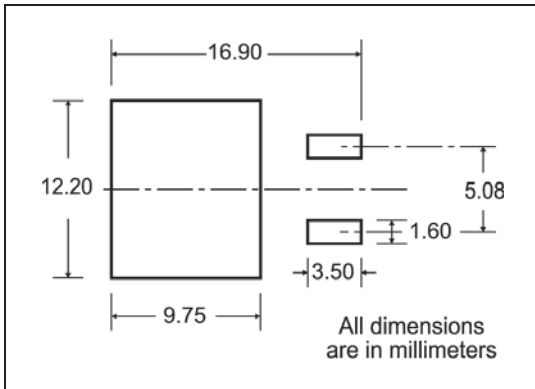
D²PAK (TO-263) mechanical data

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

D²PAK 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

6 Revision history

Table 10. Revision history

Date	Revision	Changes
29-Sep-2005	6	Inserted ecopack indication
29-Oct-2005	7	New value inserted in Table 6
11-Apr-2006	8	New template
19-Sep-2006	9	Unit changed in Table 5
17-Nov-2008	10	Updated Section 4: Package mechanical data

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