



# STB10NK60Z/-1 - STP10NK60Z/FP STW10NK60Z

N-CHANNEL 600V-0.65Ω-10A - TO220/FP-D<sup>2</sup>/I<sup>2</sup>PAK-TO-247  
Zener-Protected SuperMESH™ MOSFET

## General features

Type	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>w</sub>
STB10NK60Z	600 V	<0.75 Ω	10 A	115
STB10NK60Z-1	600 V	<0.75 Ω	10 A	115
STP10NK60ZFP	600 V	<0.75 Ω	10 A	35
STP10NK60Z	600 V	<0.75 Ω	10 A	115
STW10NK60Z	600 V	<0.75 Ω	10 A	156

- TYPICAL R<sub>DS(on)</sub> = 0.65 Ω
- EXTREMELY HIGH dv/dt CAPABILITY
- 100% AVALANCHE TESTED
- GATE CHARGE MINIMIZED
- VERY LOW INTRINSIC CAPACITANCES
- VERY GOOD MANUFACTURING REPEATABILITY

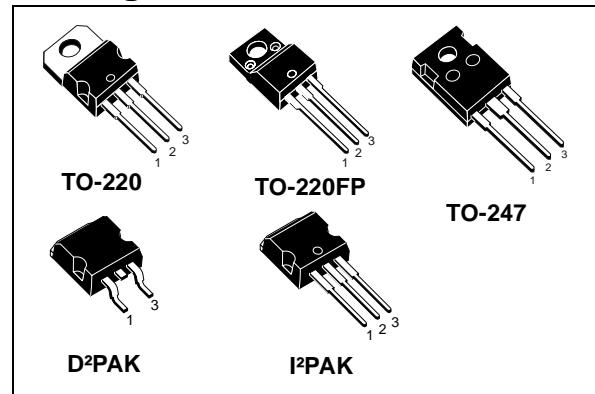
## Description

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. Such series complements ST full range of high voltage MOSFETs including revolutionary MDmesh™ products.

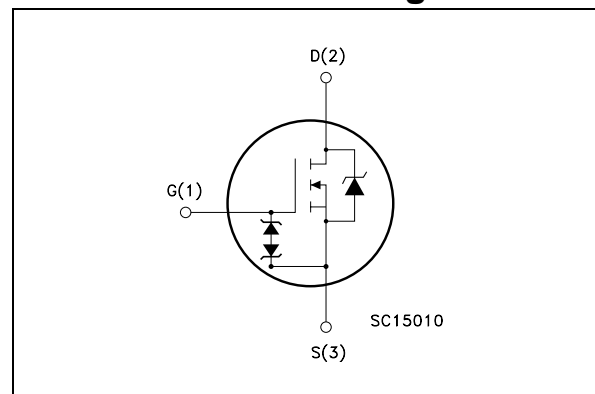
## Applications

- HIGH CURRENT, HIGH SPEED SWITCHING
- IDEAL FOR OFF-LINE POWER SUPPLIES, ADAPTOR AND PFC
- LIGHTING

## Package



## Internal schematic diagram



# 1 Absolute maximum ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		TO-220/D <sup>2</sup> I <sup>2</sup> PAK	TO-220FP	TO-247	
V <sub>DS</sub>	Drain-Source Voltage (V <sub>GS</sub> = 0)	600			V
V <sub>DGR</sub>	Drain-gate Voltage (R <sub>GS</sub> = 20kΩ)	600			V
V <sub>GS</sub>	Gate-Source Voltage	± 30			V
I <sub>D</sub>	Drain Current (continuous) at T <sub>C</sub> = 25°C	10	10 (Note 3)	10	A
I <sub>D</sub>	Drain Current (continuous) at T <sub>C</sub> = 100°C	5.7	5.7 (Note 3)	5.7	A
I <sub>DM</sub> Note 2	Drain Current (pulsed)	36	36 (Note 3)	36	A
P <sub>TOT</sub>	Total Dissipation at T <sub>C</sub> = 25°C	115	35	156	W
	Derating Factor	0.92	0.28	1.25	W/°C
Vesd(G-S)	G-S ESD (HBM C=100pF, R=1.5kΩ)	4000			V
dv/dt Note 1	Peak Diode Recovery voltage slope	4.5			V/ns
V <sub>ISO</sub>	Insulation Withstand Voltage (DC)	--	2500	--	V
T <sub>j</sub> T <sub>stg</sub>	Operating Junction Temperature Storage Temperature	-55 to 150			°C

**Table 2. Thermal data**

		TO-220 I <sup>2</sup> PAK	D <sup>2</sup> PAK	TO-220FP	TO-247	Unit
Rthj-case	Thermal Resistance Junction-case Max	1.09		3.6	0.8	°C/W
Rthj-pcb	Thermal Resistance Junction-pcb Max (when mounted on minimum Footprint)		60			°C/W
Rthj-amb	Thermal Resistance Junction-amb Max	62.5			50	°C/W
T <sub>l</sub>	Maximum Lead Temperature For Soldering Purpose	300				°C

**Table 3. 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 $T_j=25^\circ\text{C}$ , $I_D=I_{AR}$ , $V_{DD}=50\text{V}$ )	300	mJ
$E_{AR}$	Repetitive Avalanche Energy (pulse width limited by $T_j$ max)	3.5	mJ

**Table 4. Gate-source zener diode**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}$	Gate-Source Breakdown Voltage	$I_{gs}=\pm 1\text{mA}$ (Open Drain)	30			V

## 1.1 PROTECTION FEATURES OF GATE-TO-SOURCE ZENER DIODES

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 Electrical characteristics

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

**Table 5. On/Off**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	$I_D = 250\mu A, V_{GS} = 0$	600			V
$I_{DSS}$	Zero Gate Voltage Drain Current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max Rating,}$			1 50	$\mu A$
$I_{GSS}$	Gate Body Leakage Current ( $V_{DS} = 0$ )	$V_{GS} = \pm 15V, V_{DS} = 0$			$\pm 10$	$\mu A$
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\mu A$	3	3.75	4.5	V
$R_{DS(on)}$	Static Drain-Source On Resistance	$V_{GS} = 10V, I_D = 20A$		0.65	0.75	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs}$ <i>Note 4</i>	Forward Transconductance	$V_{DS} = 15V, I_D = 4.5A$		7.8		S
$C_{iss}$ $C_{oss}$ $C_{rss}$	Input Capacitance Output Capacitance Reverse Transfer Capacitance	$V_{DS} = 25V, f = 1\text{ MHz}, V_{GS} = 0$		1370 156 37		pF pF pF
$C_{oss\ eq.}$ <i>Note 5</i>	Equivalent Output Capacitance	$V_{GS} = 0, V_{DS} = 0V\text{ to }480V$		90		pF
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total Gate Charge Gate-Source Charge Gate-Drain Charge	$V_{DD} = 480V, I_D = 8A$ $V_{GS} = 10V$ (see Figure 19)		50 10 25	70	nC nC nC

**Table 7. Switching on/off**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$	Turn-on Delay Time Rise Time	$V_{DD} = 300V, I_D = 4A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 20)		20 20		ns ns
$t_{d(off)}$ $t_f$	Turn-off Delay Time Fall Time	$V_{DD} = 300V, I_D = 4A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 20)		55 30		ns ns
$t_r(V_{off})$ $t_f$ $t_c$	Off-voltage Rise Time Fall Time Cross-over Time	$V_{DD} = 480V, I_D = 8A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 20)		18 18 36		ns ns ns

Table 8. Source drain diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain Current				10	A
$I_{SDM}$ <i>Note 2</i>	Source-drain Current (pulsed)				36	A
$V_{SD}$ <i>Note 4</i>	Forward on Voltage	$I_{SD}=10A, V_{GS}=0$			1.6	V
$t_{rr}$	Reverse Recovery Time	$I_{SD}=8A, di/dt = 100A/\mu s,$ $V_{DD}=40 V, T_j=150^\circ C$		570		ns
$Q_{rr}$	Reverse Recovery Charge			4.3		$\mu C$
$I_{RRM}$	Reverse Recovery Current			15		A

(1)  $I_{SD} \leq 10A, di/dt \leq 200A/\mu s, V_{DD} \leq V_{(BR)DSS}, T_j \leq T_{JMAX}$

(2) Pulse width limited by safe operating area

(3) Limited only by maximum temperature allowed

(4) Pulsed: pulse duration = 300 $\mu s$ , duty cycle 1.5%

(5)  $C_{OSS\ eq}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{OSS}$  when  $V_{DS}$  increases from 0 to 80%

## 2.1 Typical characteristics

Figure 1. Safe Operating Area for TO-220/D<sup>2</sup>/I<sup>2</sup>PAK

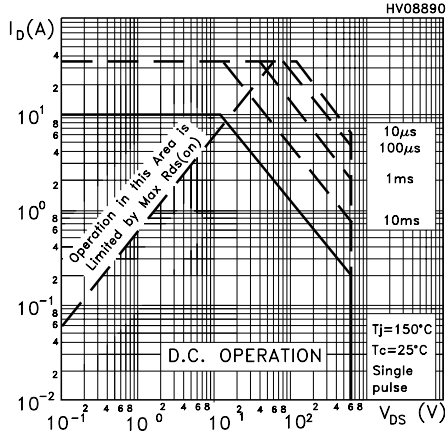


Figure 2. Thermal Impedance for TO-220/D<sup>2</sup>/I<sup>2</sup>PAK

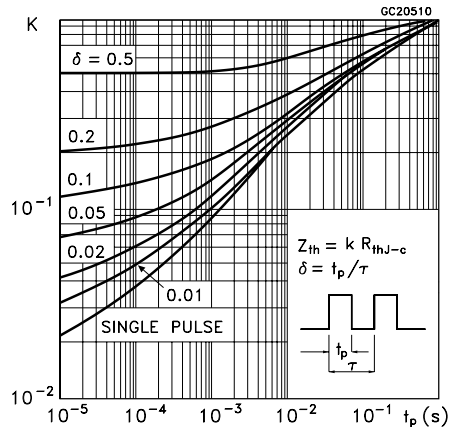


Figure 3. Safe Operating Area for TO-220FP

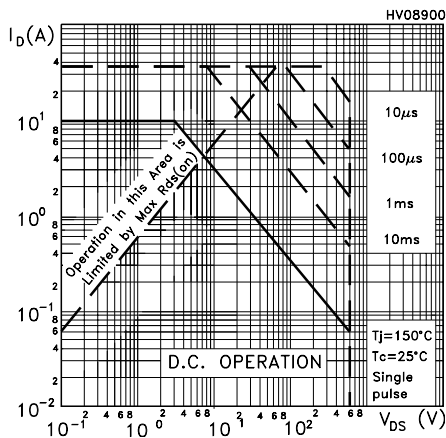


Figure 4. Thermal Impedance for TO-220FP

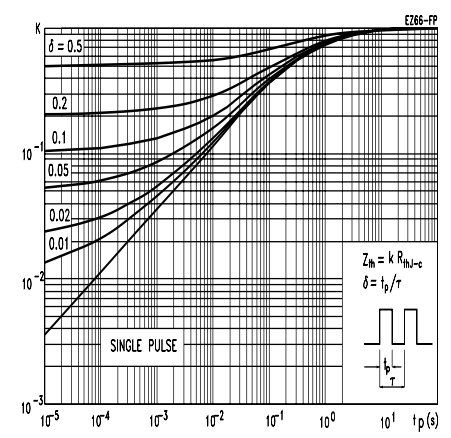


Figure 5. Safe Operating Area for TO-247

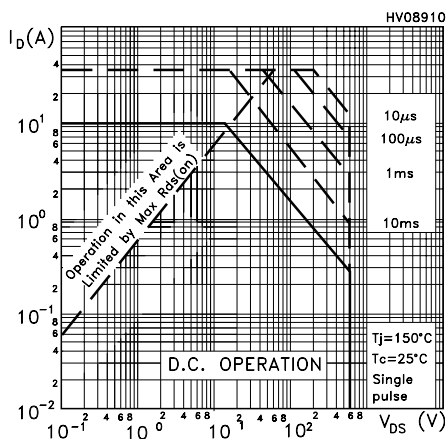


Figure 6. Thermal Impedance for TO-247

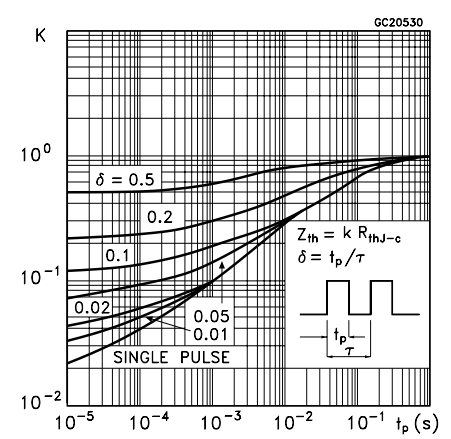


Figure 7. Output Characteristics

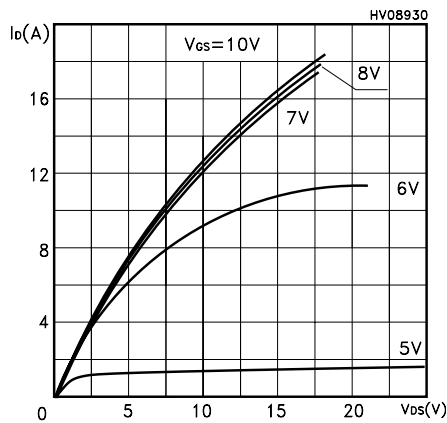


Figure 8. Transfer Characteristics

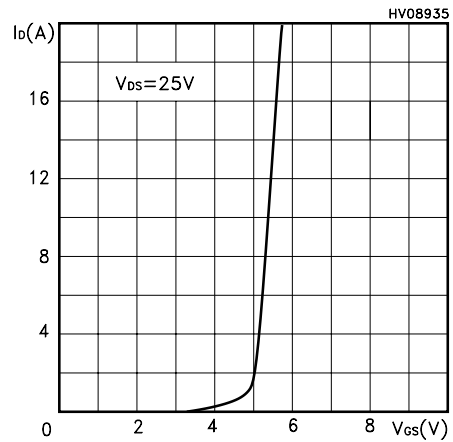


Figure 9. Transconductance

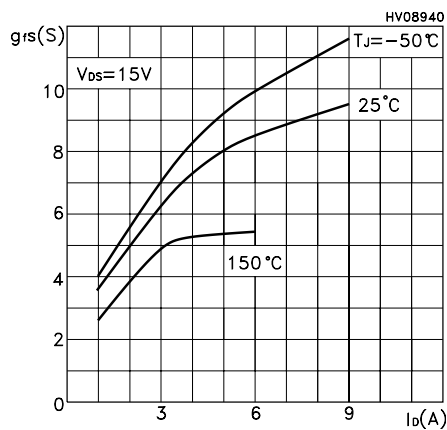


Figure 10. Static Drain-Source on Resistance

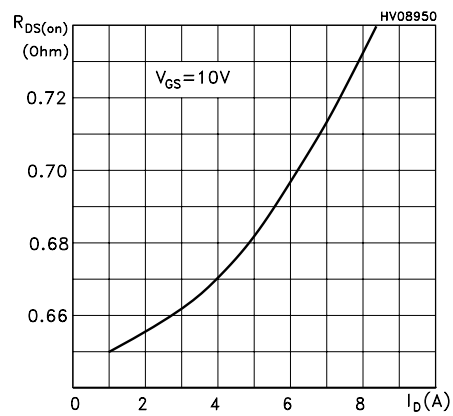


Figure 11. Gate Charge vs Gate -Source Voltage

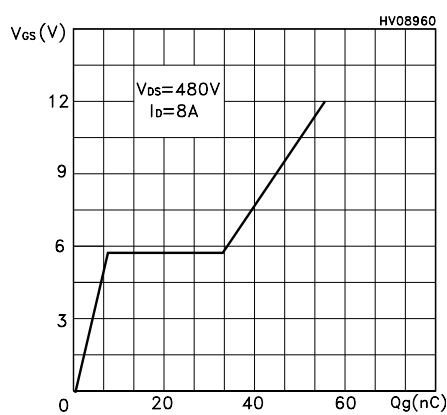


Figure 12. Capacitance Variations

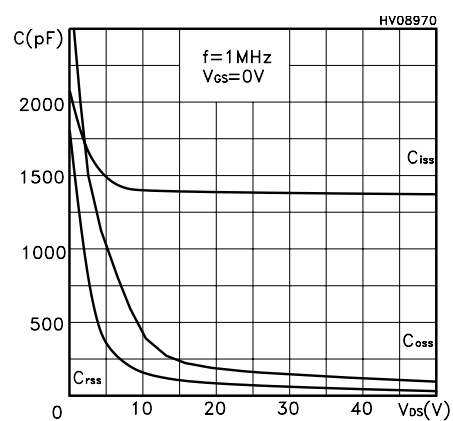


Figure 13. Normalized Gate Threshold Voltage vs Temperature

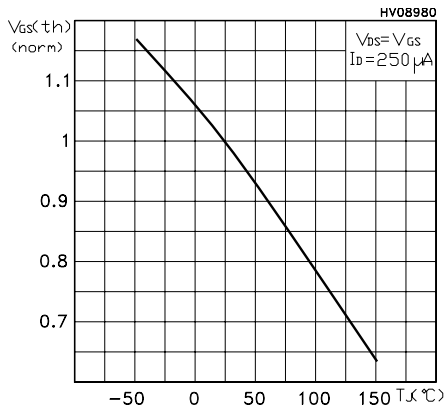


Figure 14. Normalized on Resistance vs Temperature

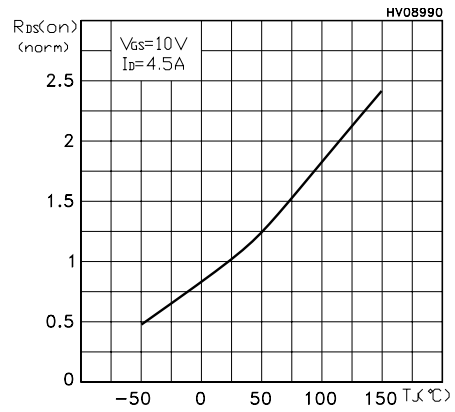


Figure 15. Source-drain Diode Forward Characteristics

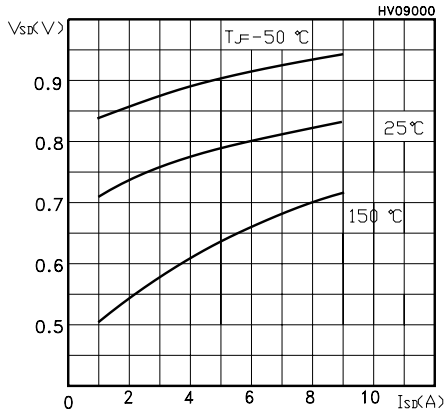


Figure 16. Normalized BVDSS vs Temperature

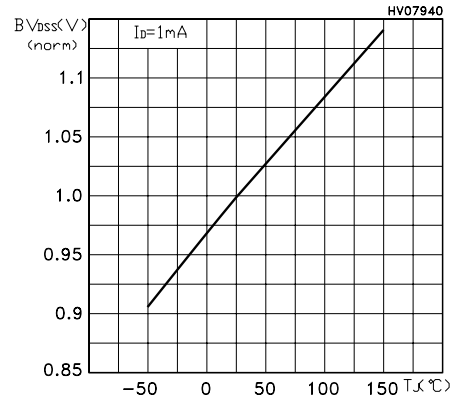
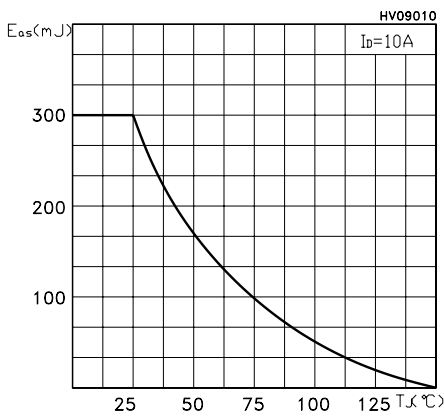


Figure 17. Maximum Avalanche Energy vs Temperature





### 3 Test circuits

Figure 18. Switching Times Test Circuit For Resistive Load

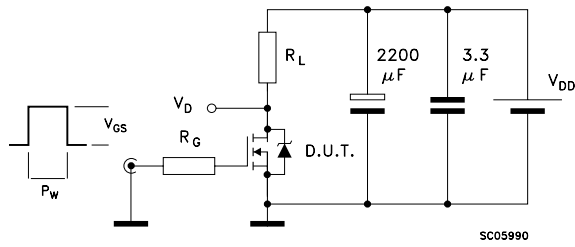


Figure 19. Gate Charge Test Circuit

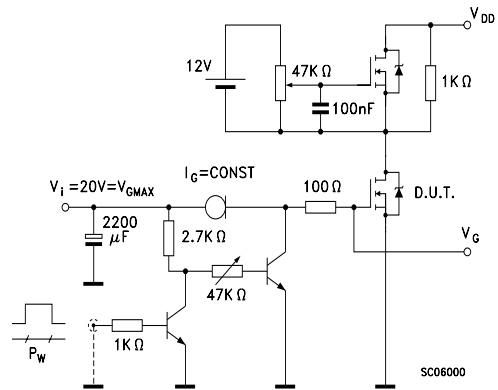
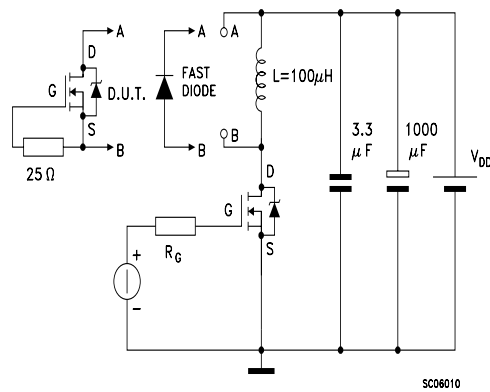


Figure 20. Test Circuit For Inductive Load Switching and Diode Recovery Times

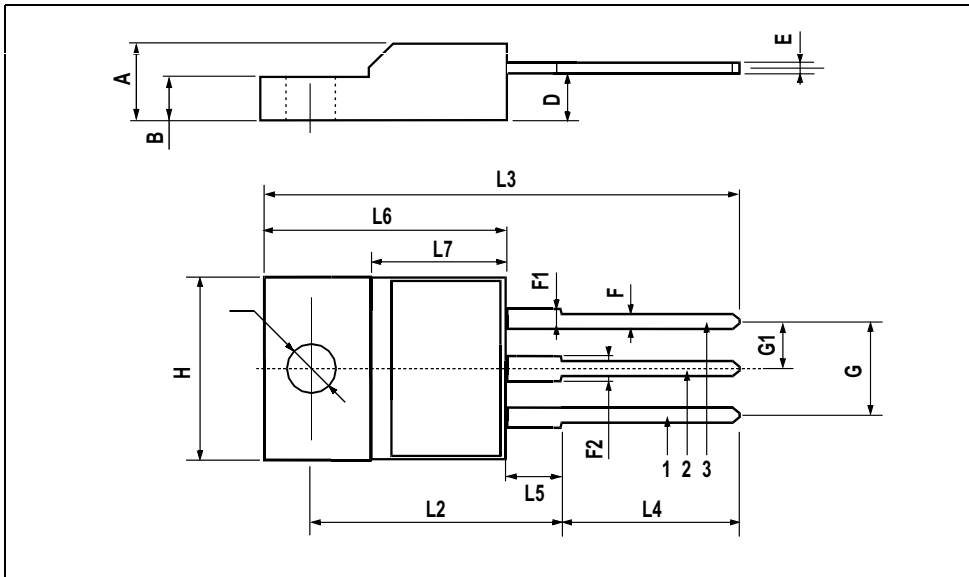


## 4 Package mechanical data

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)

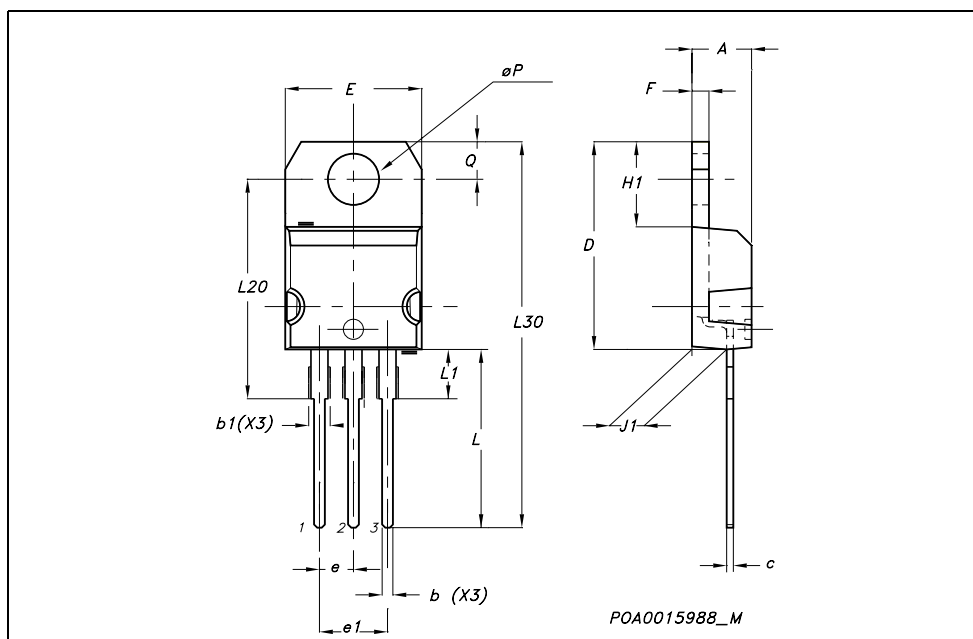
**TO-220FP MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	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		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	.0385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
Ø	3		3.2	0.118		0.126



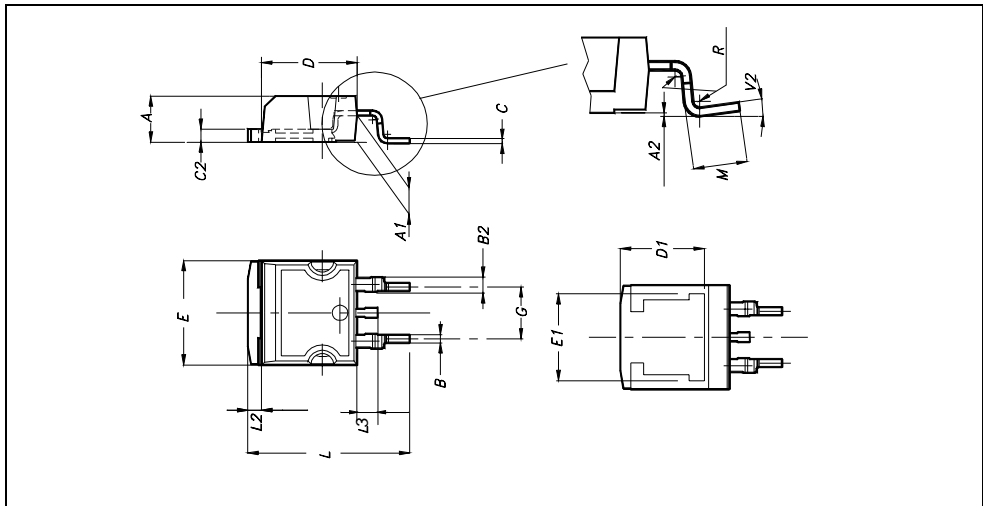
## TO-220 MECHANICAL DATA

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	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
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		0.052
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	
øP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



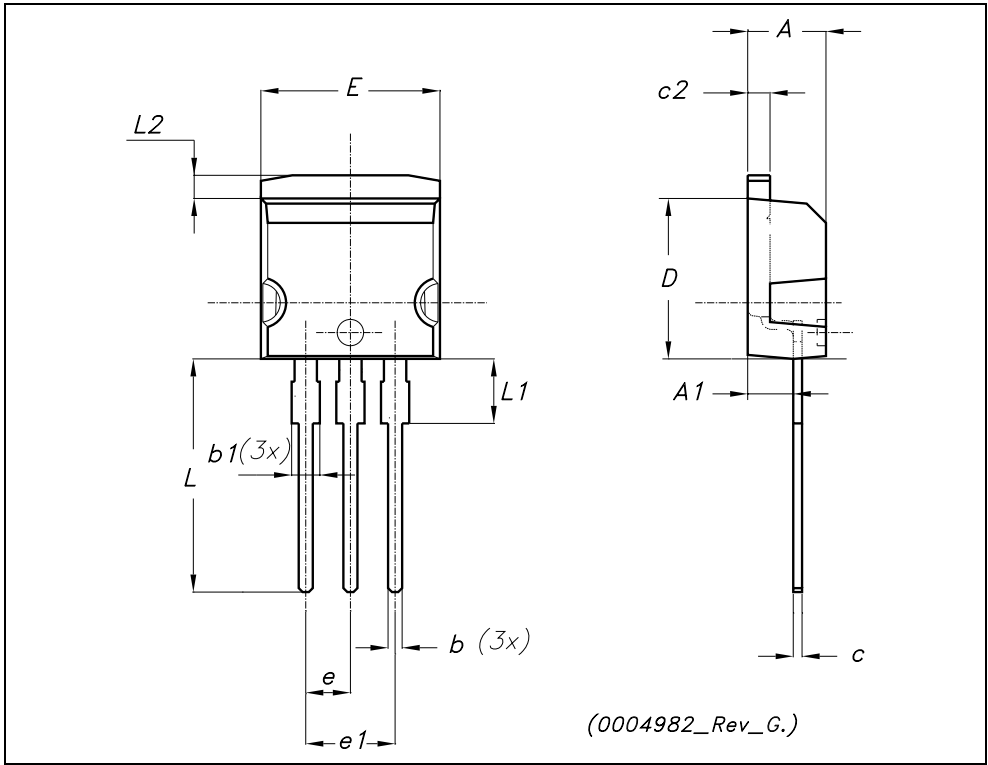
**D<sup>2</sup>PAK MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.625
L2	1.27		1.4	0.050		0.055
L3	1.4		1.75	0.055		0.068
M	2.4		3.2	0.094		0.126
R		0.4			0.015	
V2	0°		4°			



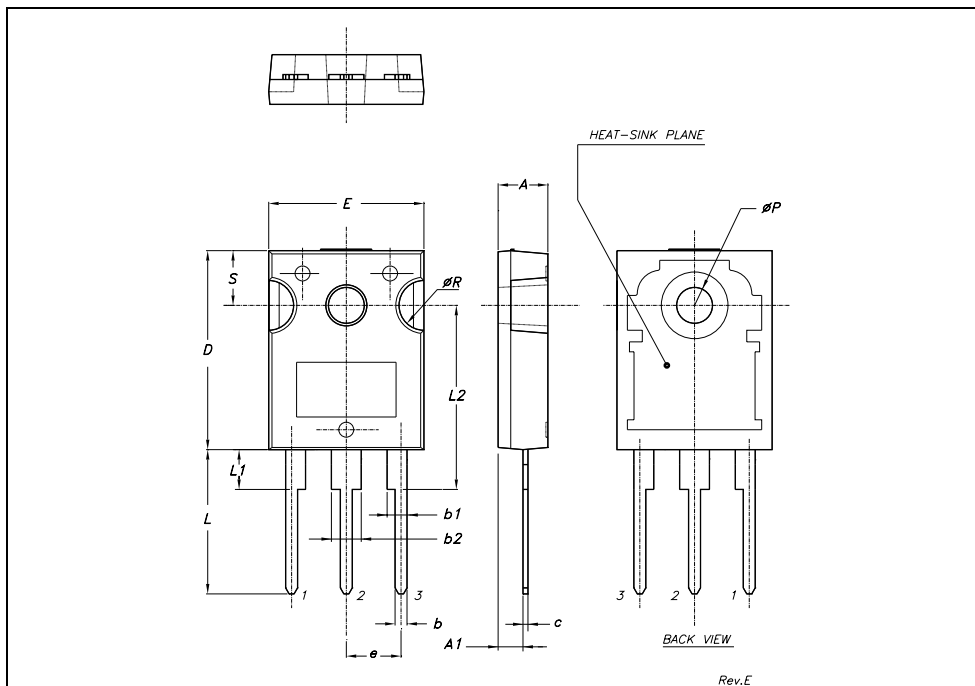
**TO-262 (I<sup>2</sup>PAK) MECHANICAL DATA**

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



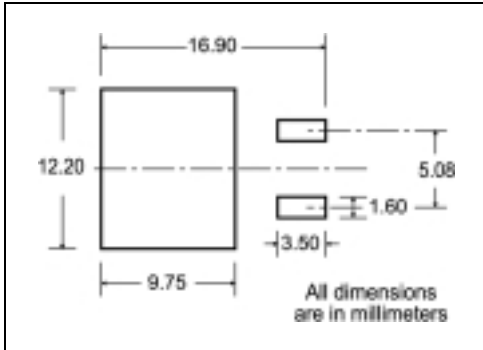
**TO-247 MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.85		5.15	0.19		0.20
A1	2.20		2.60	0.086		0.102
b	1.0		1.40	0.039		0.055
b1	2.0		2.40	0.079		0.094
b2	3.0		3.40	0.118		0.134
c	0.40		0.80	0.015		0.03
D	19.85		20.15	0.781		0.793
E	15.45		15.75	0.608		0.620
e		5.45			0.214	
L	14.20		14.80	0.560		0.582
L1	3.70		4.30	0.14		0.17
L2		18.50			0.728	
øP	3.55		3.65	0.140		0.143
øR	4.50		5.50	0.177		0.216
S		5.50			0.216	



# 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

\* on sales type



## 6 Order codes

Sales Type	Marking	Package	Packaging
STB10NK60Z-1	B10NK60Z-1	I <sup>2</sup> PAK	TUBE
STB10NK60ZT4	B10NK60Z	D <sup>2</sup> PAK	TAPE & REEL
STP10NK60ZFP	P10NK60ZFP	TO-220FP	TUBE
STP10NK60Z	P10NK60Z	TO-220	TUBE
STW10NK60Z	W10NK60Z	TO-247	TUBE

## 7 Revision History

Date	Revision	Changes
26-Jul-2005	2	Inserted Ecopack indication

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