



# STP21NM60N-STF21NM60N-STW21NM60N STB21NM60N - STB21NM60N-1

N-CHANNEL 600V - 0.19  $\Omega$  - 17 A TO-220/FP/D<sup>2</sup>/I<sup>2</sup>PAK/TO-247  
SECOND GENERATION MDmesh™ MOSFET

**Table 1: General Features**

TYPE	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>
STB21NM60N	660 V	< 0.24 $\Omega$	17 A
STB21NM60N-1	660 V	< 0.24 $\Omega$	17 A
STF21NM60N	660 V	< 0.24 $\Omega$	17 A (*)
STP21NM60N	660 V	< 0.24 $\Omega$	17 A
STW21NM60N	660 V	< 0.24 $\Omega$	17 A

- 100% AVALANCHE TESTED
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE

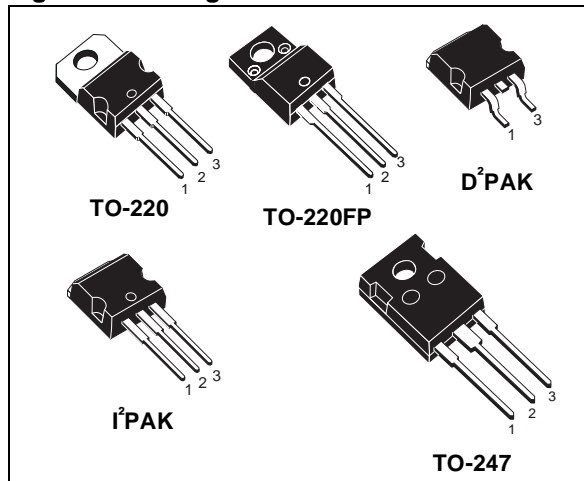
## DESCRIPTION

The **STx21NM60N** 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

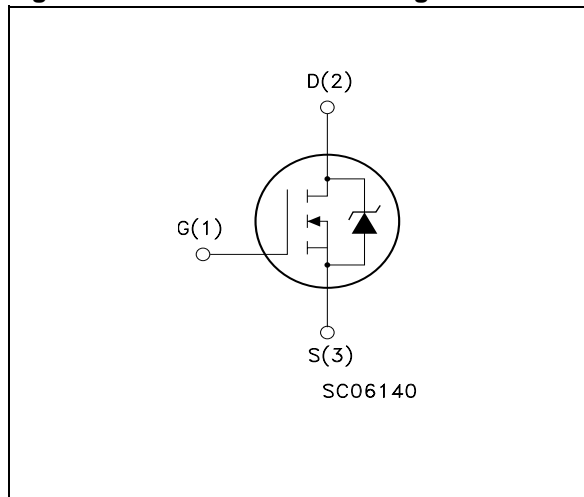
## APPLICATIONS

The MDmesh™ II family is very suitable for increasing power density of high voltage converters allowing system miniaturization and higher efficiencies.

**Figure 1: Package**



**Figure 2: Internal Schematic Diagram**



**Table 2: Order Codes**

SALES TYPE	MARKING	PACKAGE	PACKAGING
STB21NM60N	B21NM60N	D <sup>2</sup> PAK	TAPE & REEL
STB21NM60N-1	B21NM60N	I <sup>2</sup> PAK	TUBE
STF21NM60N	F21NM60N	TO-220FP	TUBE
STP21NM60N	P21NM60N	TO-220	TUBE
STW21NM60N	W21NM60N	TO-247	TUBE

**Table 3: 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>DGR</sub>	Drain-gate Voltage (R <sub>GS</sub> = 20 kΩ)	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	17	17 (*)	A
I <sub>D</sub>	Drain Current (continuous) at T <sub>C</sub> = 100°C	10	10 (*)	A
I <sub>DM</sub> (●)	Drain Current (pulsed)	64	64 (*)	A
P <sub>TOT</sub>	Total Dissipation at T <sub>C</sub> = 25°C	140	30	W
	Derating Factor	1.12	0.23	W/°C
dv/dt(1)	Peak Diode Recovery voltage slope	15		V/ns
V <sub>iso</sub>	Insulation Withstand Voltage (DC)	--	2500	V
T <sub>stg</sub>	Storage Temperature	-55 to 150 150		°C
T <sub>j</sub>	Max. Operating Junction Temperature			

(●) Pulse width limited by safe operating area

(\*) Limited only by maximum temperature allowed

(1) I<sub>SD</sub> ≤ 16 A, di/dt ≤ 400 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

**Table 4: Thermal Data**

		TO-220 / D <sup>2</sup> PAK / I <sup>2</sup> PAK / TO-247	TO-220FP	
R <sub>thj-case</sub>	Thermal Resistance Junction-case Max	0.89	4.21	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient Max	62.5		°C/W
T <sub>l</sub>	Maximum Lead Temperature For Soldering Purpose	300		°C

**Table 5: 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)	8.5	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> = 50 V)	610	mJ

**ELECTRICAL CHARACTERISTICS** ( $T_{CASE} = 25^{\circ}C$  UNLESS OTHERWISE SPECIFIED)

**Table 6: On/Off**

Symbol	Parameter	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{(BR)DSS}$	Drain-source Breakdown Voltage	$I_D = 1mA, V_{GS} = 0$	600			V
$dv/dt(2)$	Drain Source Voltage Slope	$V_{DD}=480V, I_D=17A, V_{GS}=10V$	48			V/ns
$I_{DSS}$	Zero Gate Voltage Drain Current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max Rating}$ $V_{DS} = \text{Max Rating}, T_C = 125^{\circ}C$			1 10	$\mu A$ $\mu A$
$I_{GSS}$	Gate-body Leakage Current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20V$			100	nA
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250 \mu A$	2	3	4	V
$R_{DS(on)}$	Static Drain-source On Resistance	$V_{GS} = 10V, I_D = 8.5 A$		0.190	0.24	$\Omega$

(2) Characteristic value at turn off on inductive load

**Table 7: Dynamic**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs} (1)$	Forward Transconductance	$V_{DS} = 15 V, I_D = 8 A$		12		S
$C_{iss}$ $C_{oss}$ $C_{rss}$	Input Capacitance Output Capacitance Reverse Transfer Capacitance	$V_{DS} = 25V, f = 1 MHz, V_{GS} = 0$		1950 508 38.4		pF pF pF
$C_{oss eq. (*)}$	Equivalent Output Capacitance	$V_{GS} = 0V, V_{DS} = 0V \text{ to } 400V$		282		pF
$t_{d(on)}$ $t_r$ $t_{d(off)}$ $t_f$	Turn-on Delay Time Rise Time Off-voltage Rise Time Fall Time	$V_{DD} = 300 V, I_D = 8.5 A$ $R_G = 4.7\Omega, V_{GS} = 10 V$ (see Figure 20)		22 15 84 31		ns ns ns ns
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total Gate Charge Gate-Source Charge Gate-Drain Charge	$V_{DD} = 480V, I_D = 17 A,$ $V_{GS} = 10V,$ (see Figure 23)		66.6 9.9 33		nC nC nC
$R_g$	Gate Input Resistance	$f=1MHz$ Gate DC Bias=0 Test Signal Level=20mV Open Drain		2		$\Omega$

(\*)  $C_{oss eq.}$  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 8: Source Drain Diode**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM}$	Source-drain Current Source-drain Current (pulsed)				16 64	A A
$V_{SD} (1)$	Forward On Voltage	$I_{SD} = 17 A, V_{GS} = 0$			1.3	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD} = 17 A, di/dt = 100 A/\mu s$ $V_{DD} = 100 V, T_j = 25^{\circ}C$ (see Figure 21)		372 4.6 25		ns $\mu C$ A
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD} = 17A, di/dt = 100 A/\mu s$ $V_{DD} = 100 V, T_j = 150^{\circ}C$ (see Figure 21)		486 6.3 26		ns $\mu C$ A

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

Figure 3: Safe Operating Area For TO-220/  
I<sup>2</sup>PAK/D<sup>2</sup>PAK

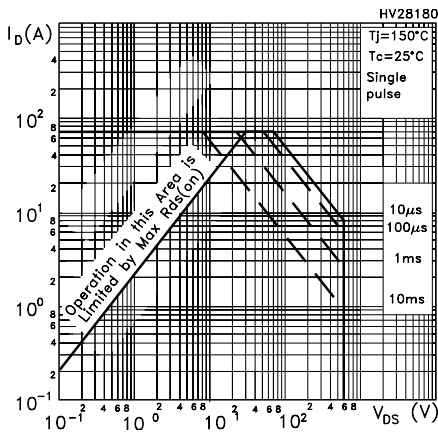


Figure 4: Safe Operating Area For TO-220FP

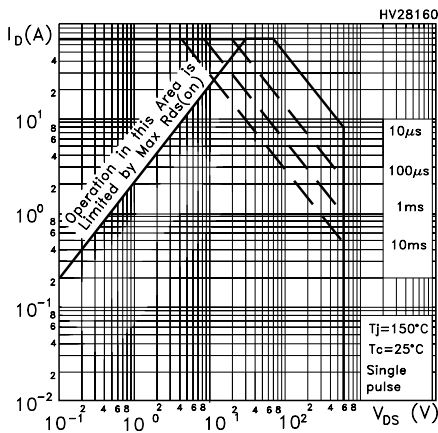


Figure 5: Safe Operating Area For TO-247

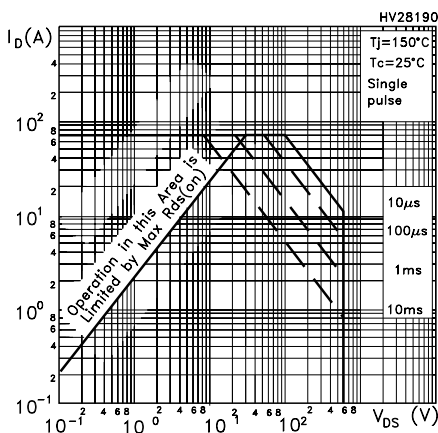


Figure 6: Thermal Impedance TO-220/I<sup>2</sup>PAK/  
D<sup>2</sup>PAK

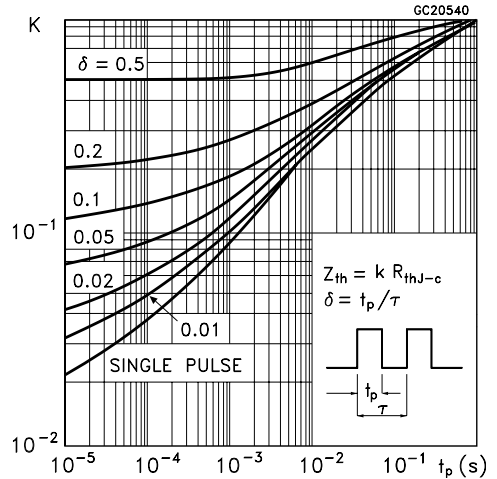


Figure 7: Thermal Impedance For TO-220FP

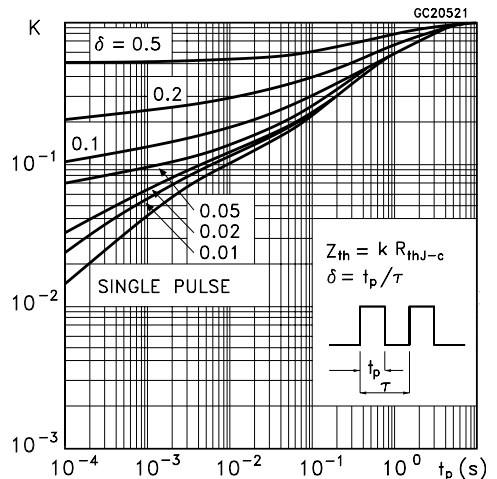


Figure 8: Thermal Impedance For TO-247

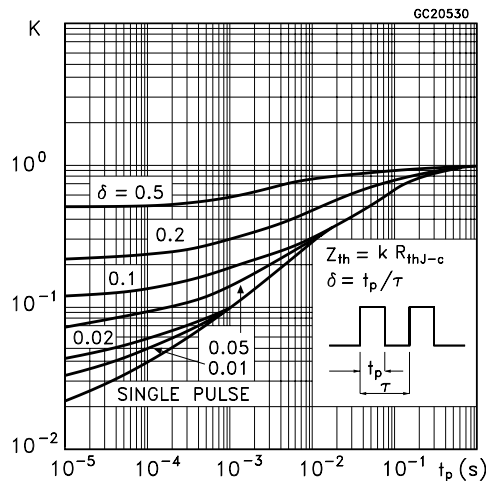


Figure 9: Output Characteristics  
Output Characteristics

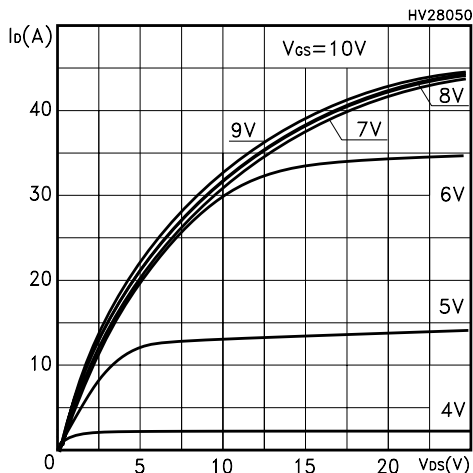


Figure 10: Transconductance

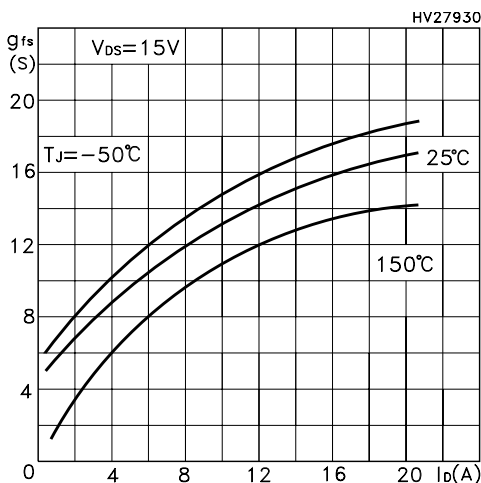


Figure 11: Gate Charge vs Gate-source Voltage

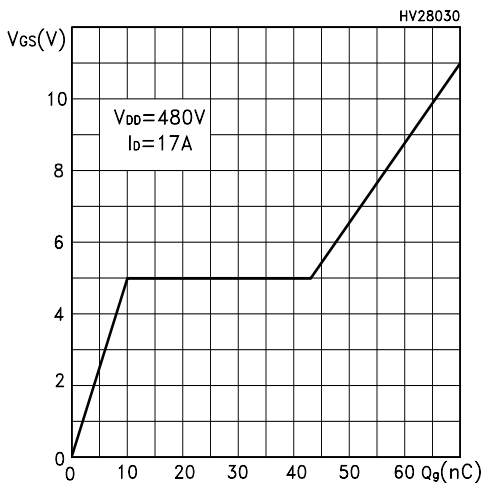


Figure 12: Transfer Characteristics

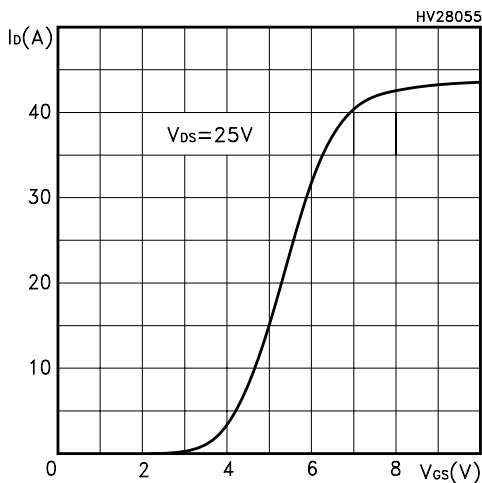


Figure 13: Static Drain-Source On Resistance

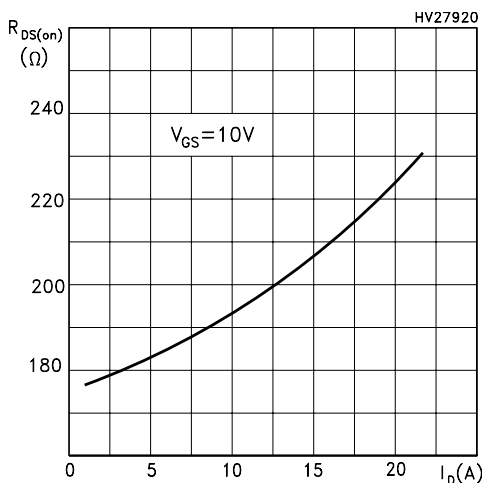


Figure 14: Capacitance Variations

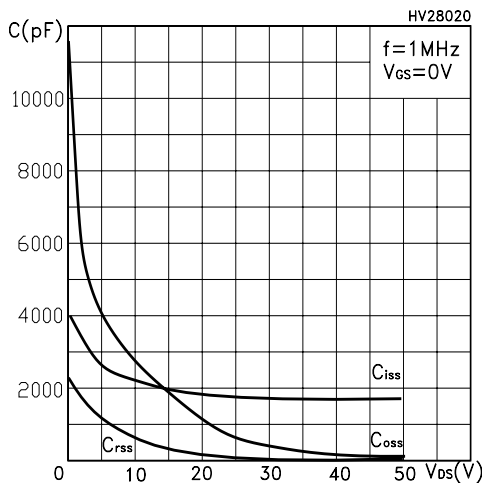


Figure 15: Normalized Gate Threshold Voltage vs Temperature

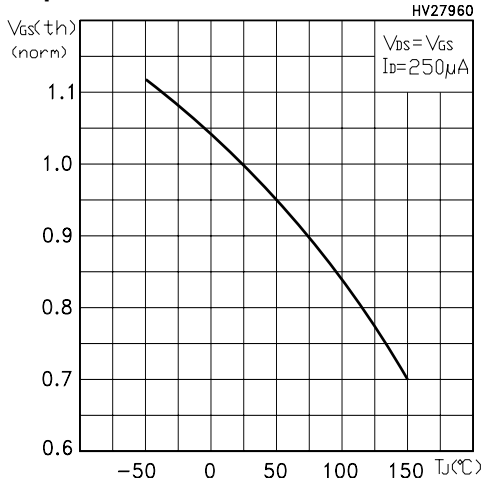


Figure 16: Source-Drain Forward Characteristics

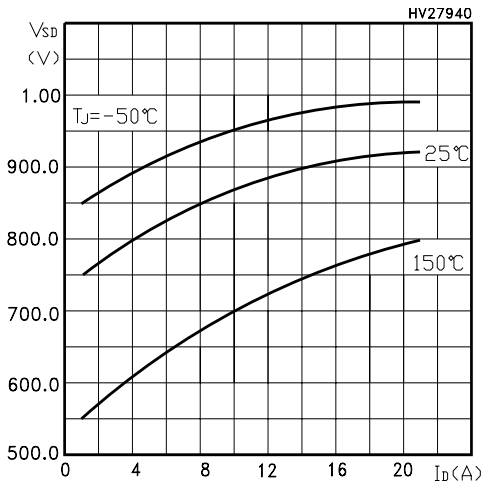


Figure 17: Normalized On Resistance vs Temperature

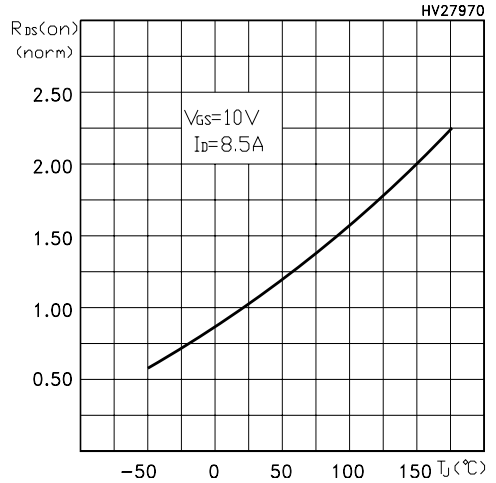


Figure 18: Normalized  $BV_{DSS}$  vs Temperature

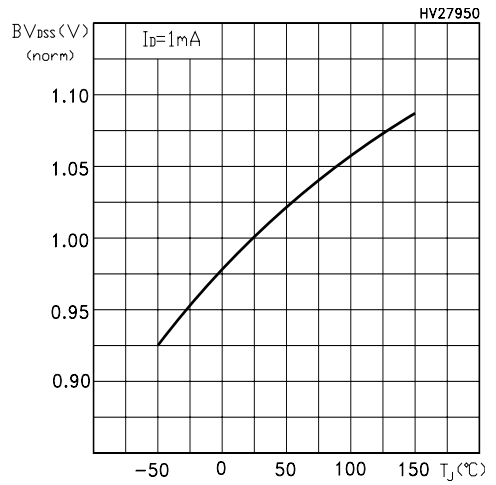


Figure 19: Unclamped Inductive Load Test Circuit

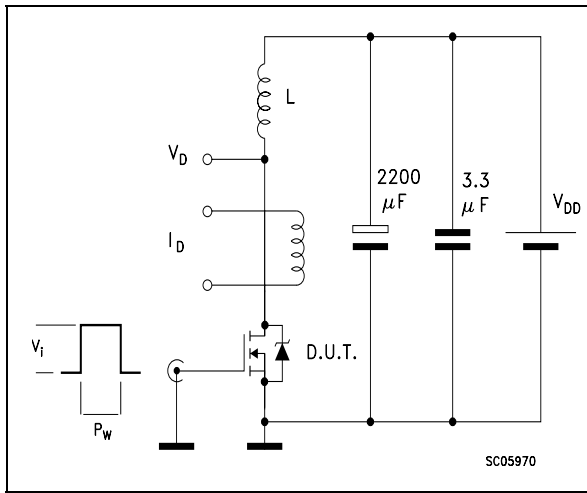


Figure 20: Switching Times Test Circuit For Resistive Load

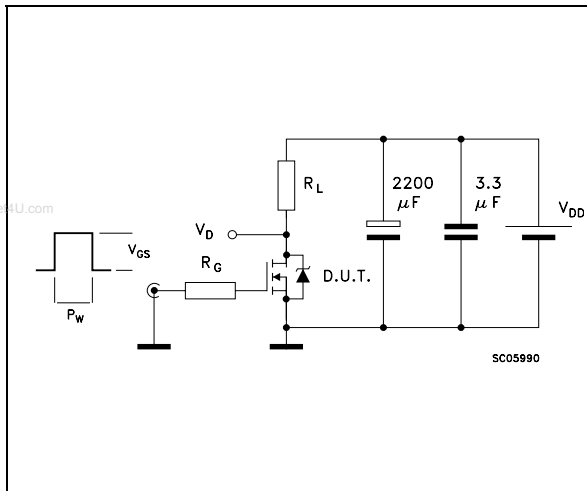


Figure 21: Test Circuit For Inductive Load Switching and Diode Recovery Times

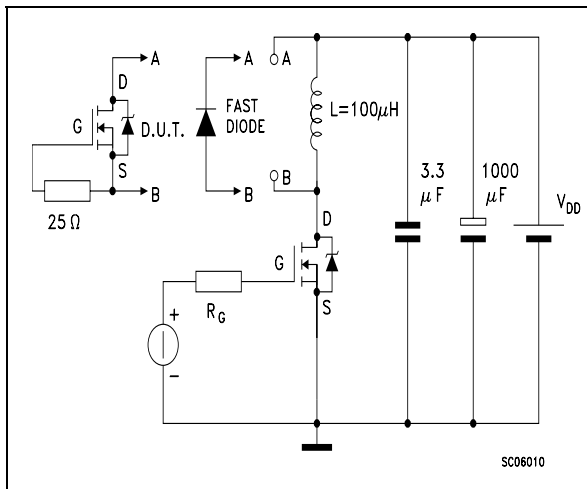


Figure 22: Unclamped Inductive Waferform

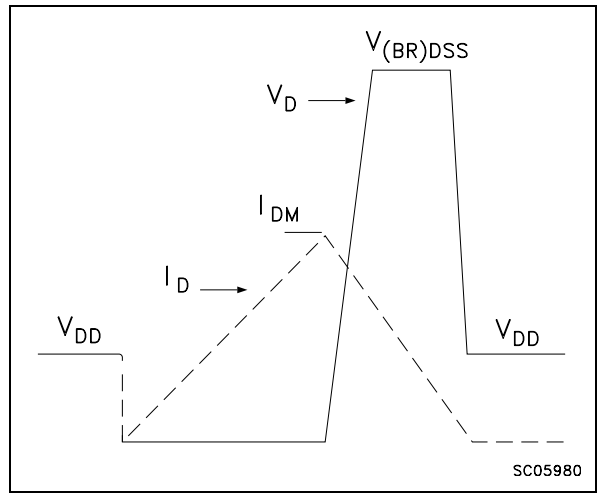
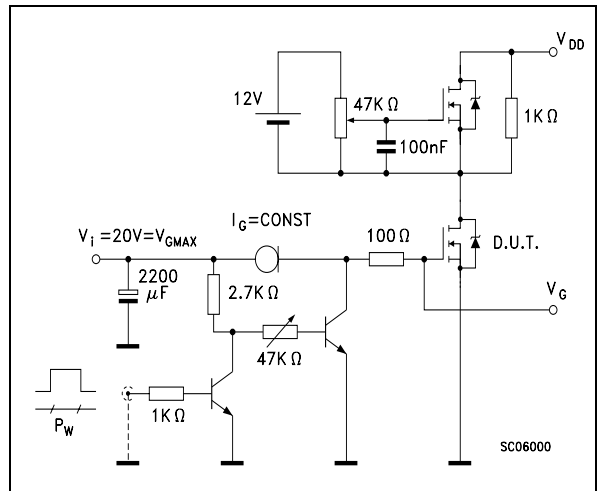


Figure 23: Gate Charge Test Circuit



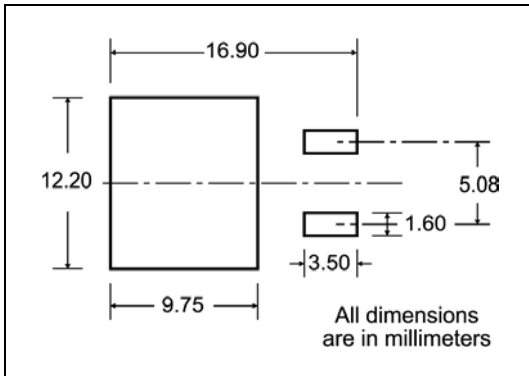
## **STP21NM60N - STF21NM60N - STB21NM60N - STB21NM60N-1 - STW21NM60N**

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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)



### 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

**Carrier Diagram Labels:** TOP COVER TAPE, K<sub>0</sub>, D, P<sub>2</sub>, P<sub>0</sub>, E, B<sub>0</sub>, D<sub>1</sub>, A<sub>0</sub>, P<sub>1</sub>, W, f. 10 pitches cumulative tolerance on tape +/- 0.2 mm. Center line of cavity.

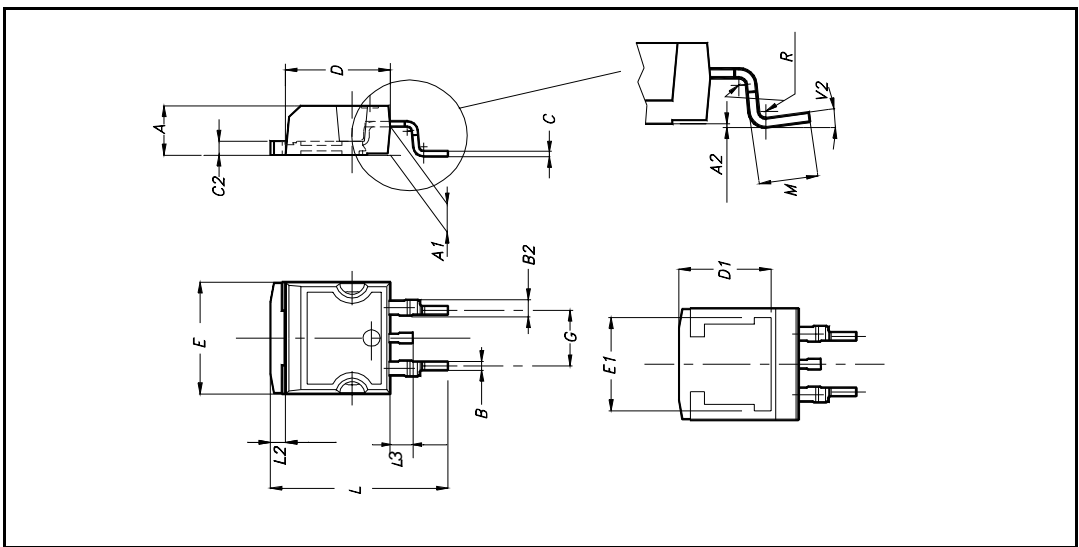
**Feeding and Bending Diagrams:** TRL, FEED DIRECTION, Bending radius R min.

\* on sales type

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

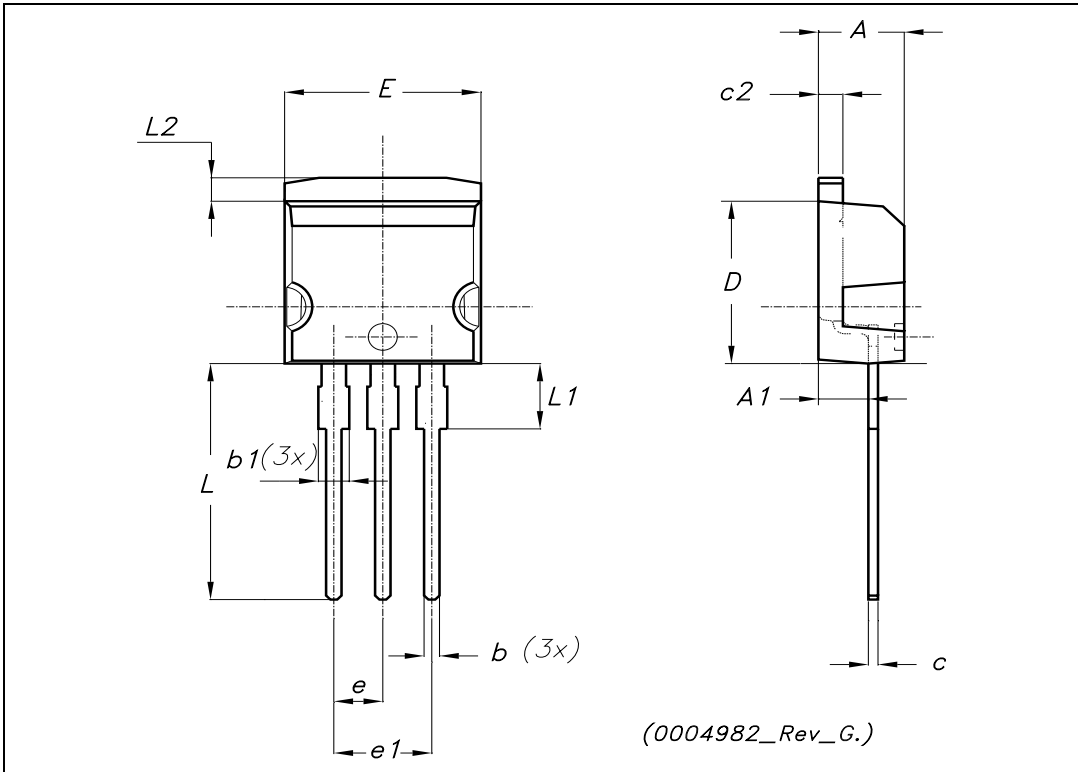
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
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°			

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**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

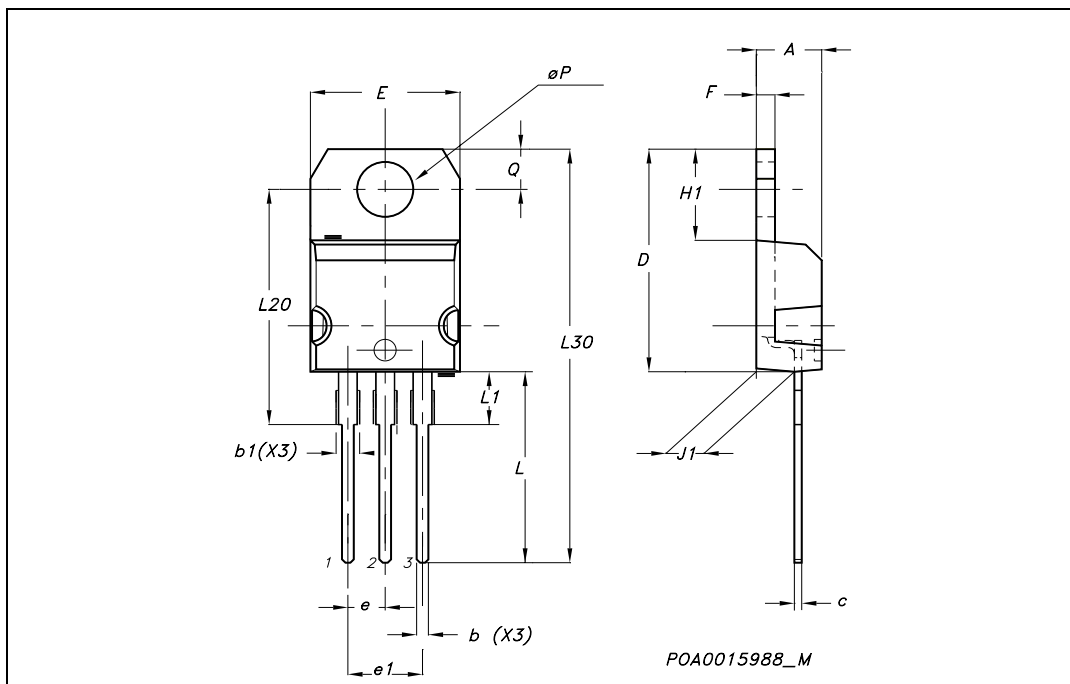


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**TO-220 MECHANICAL DATA**

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

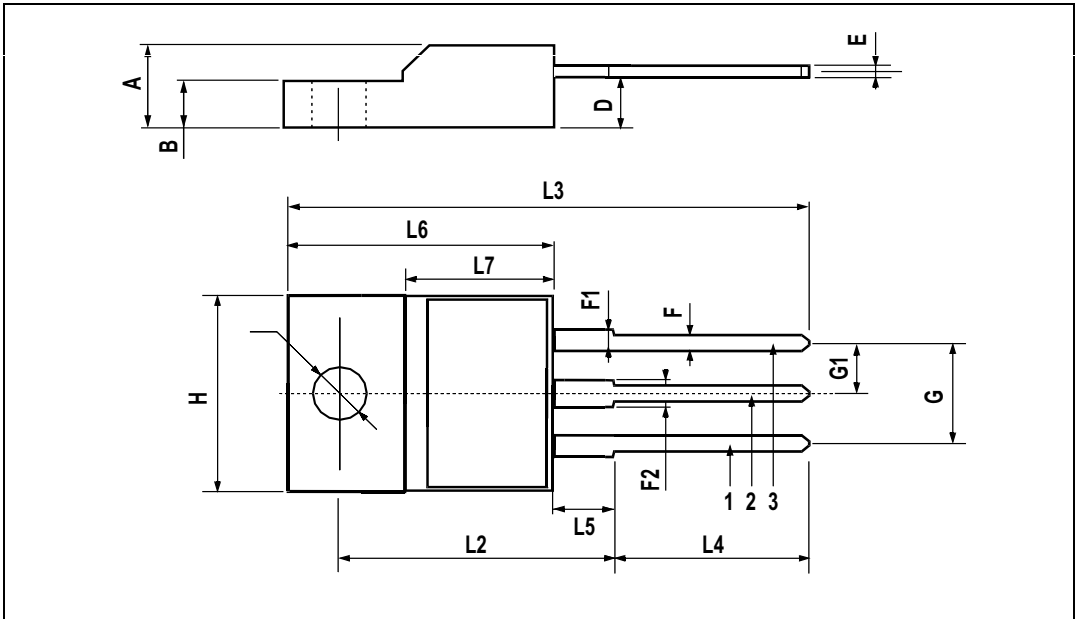
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**TO-220FP MECHANICAL DATA**

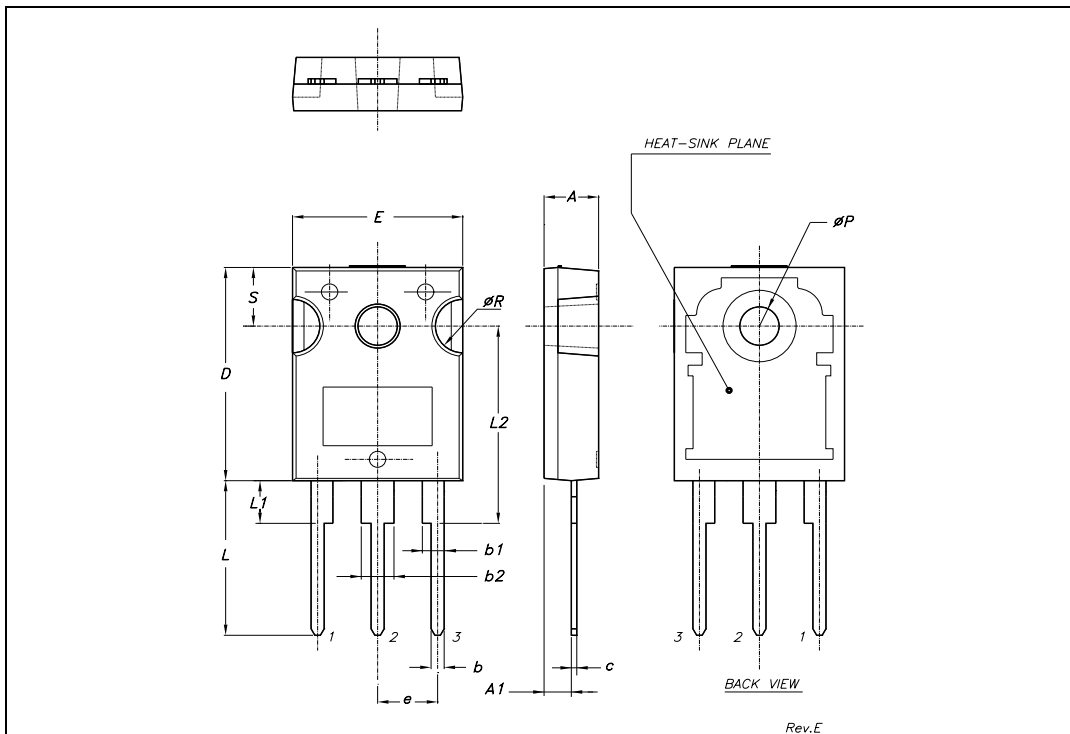
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			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
∅	3		3.2	0.118		0.126

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**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	



**Table 9: Revision History**

<b>Date</b>	<b>Revision</b>	<b>Description of Changes</b>
22-Sep-2005	1	First Release.
05-Oct-2005	2	Modified curves 9-12
26-Oct-2005	3	Complete version

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