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STB11NM60FD - STB11NM60FD-1 STP11NM60FD - STP11NM60FD-1

N-channel 600V - 0.40Ω - 11A - TO-220/TO-220FP/D²PAK/I²PAK
 FDmesh™ Power MOSFET (with fast diode)

General features

Type	V _{DSS}	R _{DS(on)}	I _D
STB11NM60FD	600V	<0.45Ω	11A
STB11NM60FD-1	600V	<0.45Ω	11A
STP11NM60FD	600V	<0.45Ω	11A
STP11NM60FD-1	600V	<0.45Ω	11A

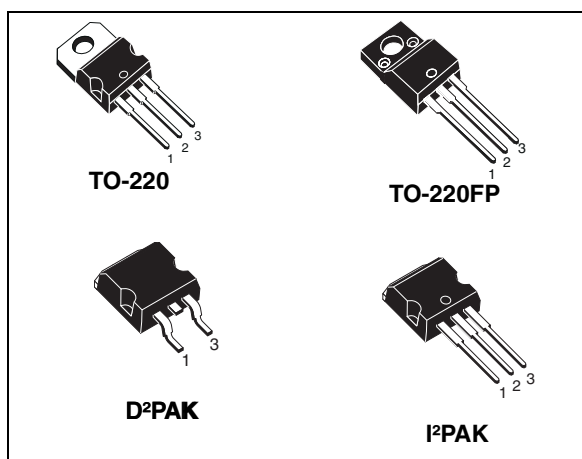
- 100% avalanche tested
- High dv/dt and avalanche capabilities
- Low input capacitance and gate charge
- Low gate input resistance
- Tight process control and high manufacturing yields

Description

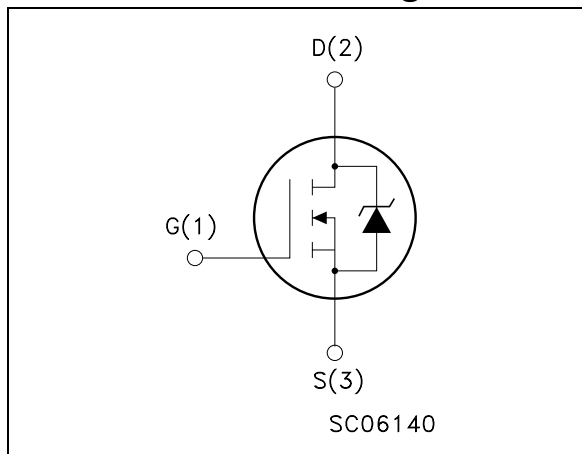
The FDmesh™ associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in particular ZVS phase-shift converters.

Applications

- Switching application



Internal schematic diagram



Order codes

Part number	Marking	Package	Packaging
STB11NM60FD	B11NM60FD	D ² PAK	Tape & reel
STB11NM60FD-1	B11NM60FD	I ² PAK	Tube
STP11NM60FD	P11NM60FD	TO-220	Tube
STP11NM60FD-1	P11NM60FD-1	TO-220FP	Tube

Contents

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STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP

Electrical ratings

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220/ D ² PAK/I ² PAK	TO-220FP	
V _{DS}	Drain-source voltage (v _{GS} = 0)	600		V
V _{DGR}	Drain-gate voltage (R _{GS} = 20 kΩ)	600		V
V _{GS}	Gate- source voltage	±30		V
I _D	Drain current (continuous) at T _C = 25°C	11	11 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100°C	7	7 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	44	44 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25°C	160	35	W
	Derating factor	0.88	0.28	W/°C
dv/dt ⁽³⁾	Peak diode recovery voltage slope	20		V/ns
V _{ISO}	Insulation withstand voltage (dc)	--	2500	V
T _{stg}	Storage temperature	-65 to 150		°C

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I_{SD} < 11A, di/dt < 400A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 2. Thermal resistance

Symbol	Parameter	Value		Unit
		TO-220 D ² PAK/I ² PAK	TO-220FP	
R _{thj-case}	Thermal resistance junction-case Max	0.78	3.57	°C/W
R _{thj-a}	Thermal resistance junction-ambient Max	62.5		°C/W
T _I	Maximum lead temperature for soldering purpose	300		°C

Table 3. Avalanche data

Symbol	Parameter	Value	Unit
I _{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _j max)	5.5	A
E _{AS}	Single pulse avalanche energy (starting T _j = 25°C, I _D = I _{AR} , V _{DD} = 35V)	350	mJ

Electrical characteristics STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FD-1

2 Electrical characteristics

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

Table 4. On/off states

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	$V_{DS} = \text{Max rating}$			1	μA
	Drain current ($V_{GS} = 0$)	$V_{DS} = \text{Max rating}, T_C = 125^{\circ}C$			100	μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 30V$			± 100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250 \mu A$	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10V, I_D = 5.5A$		0.40	0.45	W

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} > I_{D(on)} \times R_{DS(on)max}, I_D = 5.5A$		5.2		S
C_{iss}	Input capacitance	$V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$		900		pF
C_{oss}	Output capacitance			350		pF
C_{rss}	Reverse transfer capacitance			35		pF
$C_{oss eq}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0V, V_{DS} = 0V \text{ to } 400V$		100		pF
R_G	Gate input resistance	f=1 MHz Gate DC Bias= 0 test signal level = 20mV open drain		3		Ω
Q_g	Total gate charge	$V_{DD} = 400V, I_D = 11A, V_{GS} = 10V$ (see Figure 15)		28	40	nC
Q_{gs}	Gate-source charge			7.8		nC
Q_{gd}	Gate-drain charge			13		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% V_{DSS} .

STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP Electrical characteristics
Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 250V, I_D = 5.5A$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 14)		20		ns
t_r	Rise time			16		ns
$t_{r(Voff)}$	Off-voltage rise time	$V_{DD} = 400V, I_D = 11A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 16)		10		ns
t_f	Fall time			15		ns
t_c	Cross-over time			24		ns

Table 7. 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	$I_{SD} = 11A, V_{GS} = 0$			1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 11A, V_{DD} = 50V$ $di/dt = 100A/\mu s,$ (see Figure 19)		140		ns
Q_{rr}	Reverse recovery charge			680		nC
I_{RRM}	Reverse recovery current			A		A
t_{rr}	Reverse recovery time	$I_{SD} = 11A, V_{DD} = 50V$ $di/dt = 100A/\mu s,$ $T_j = 150^\circ C$ (see Figure 19)		260		ns
Q_{rr}	Reverse recovery charge			1600		nC
I_{RRM}	Reverse recovery current			13		A

1. Pulse width limited by safe operating area.

 2. Pulsed: Pulse duration = 300 μs , duty cycle 1.5 %

Electrical characteristics STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

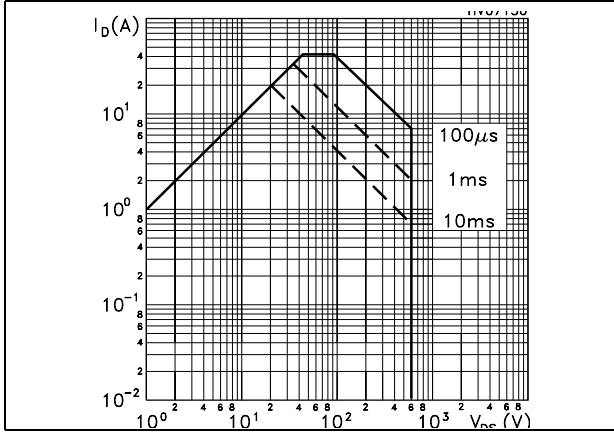


Figure 2. Thermal impedance

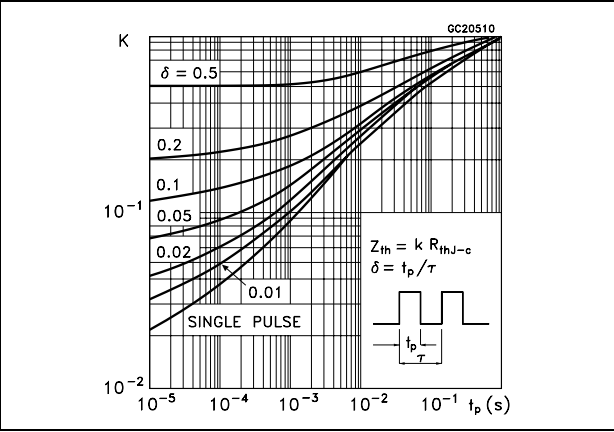


Figure 3. Safe operating area for TO-220FP

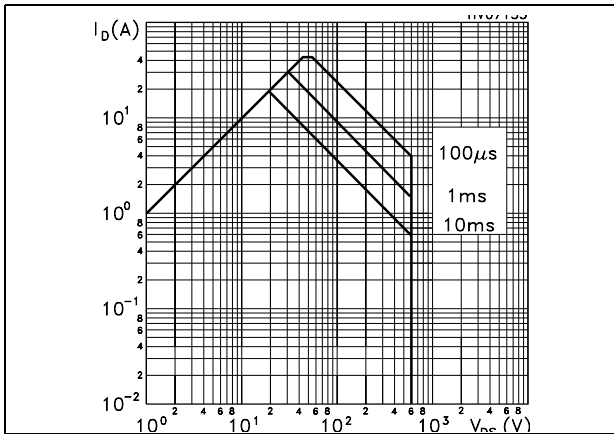


Figure 4. Thermal impedance for TO-220FP

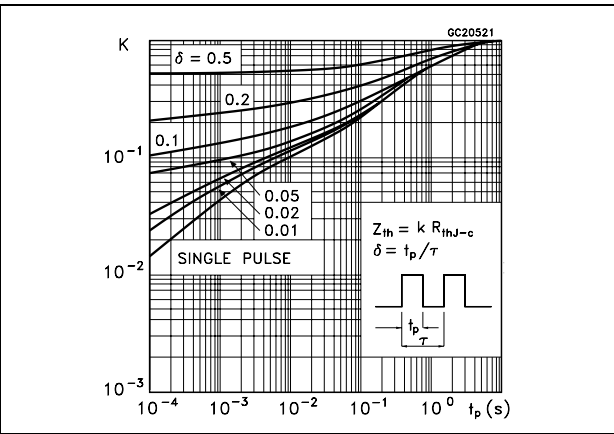


Figure 5. Output characteristics

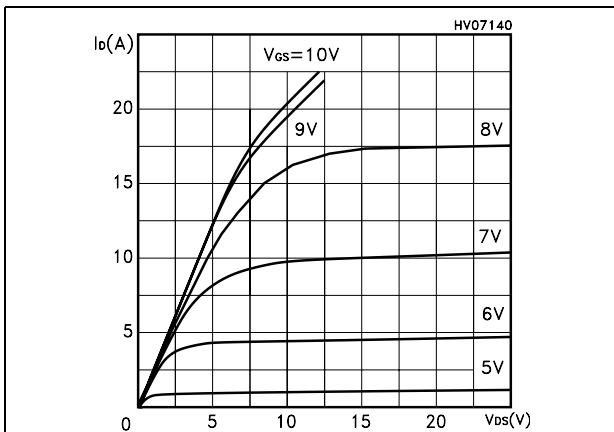
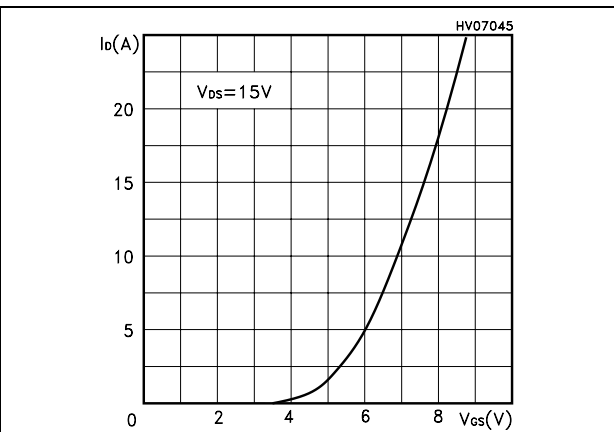


Figure 6. Transfer characteristics



STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP Electrical characteristics

Figure 7. Transconductance

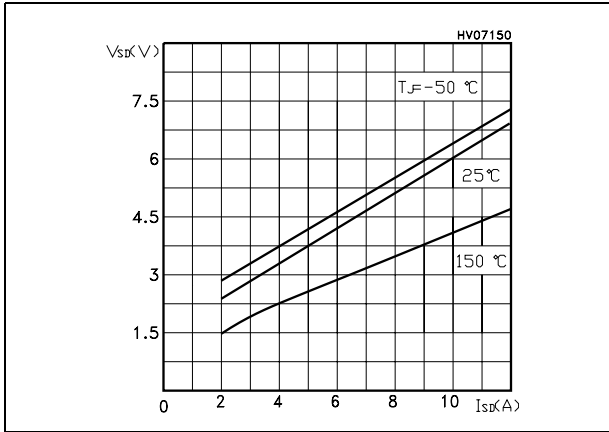


Figure 8. Static drain-source on resistance

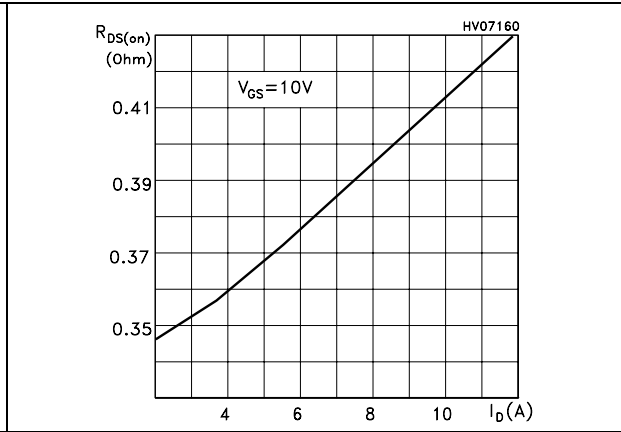


Figure 9. Gate charge vs gate-source voltage **Figure 10. Capacitance variations**

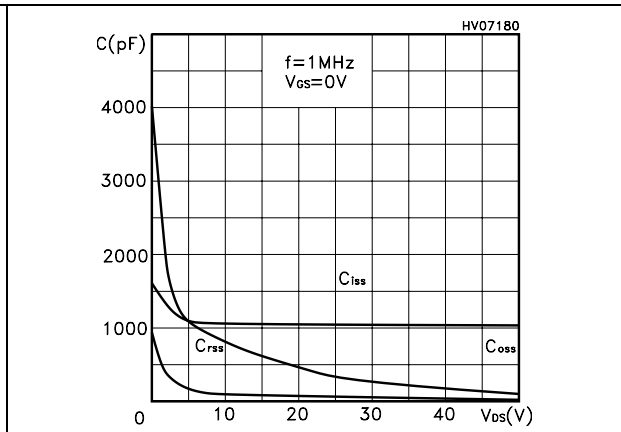
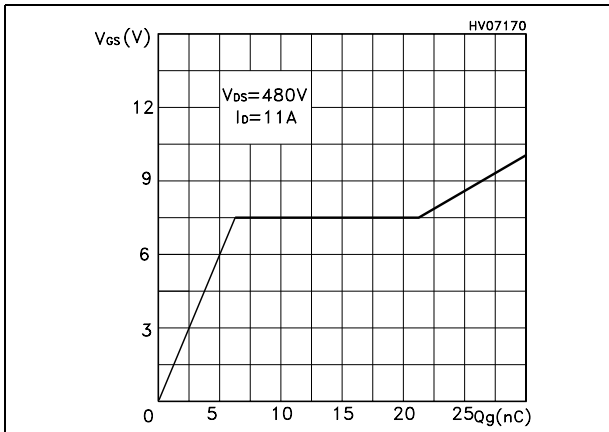


Figure 11. Normalized gate threshold voltage vs temperature

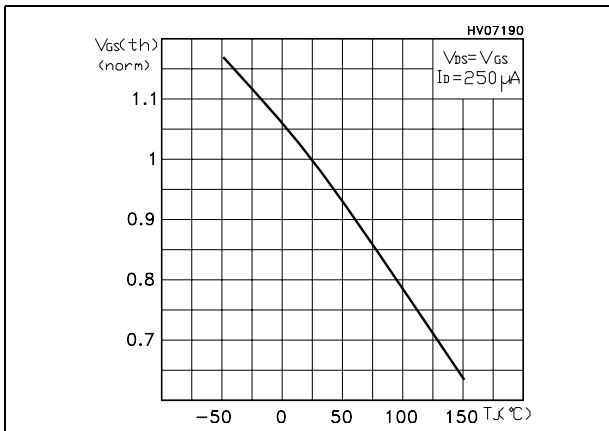
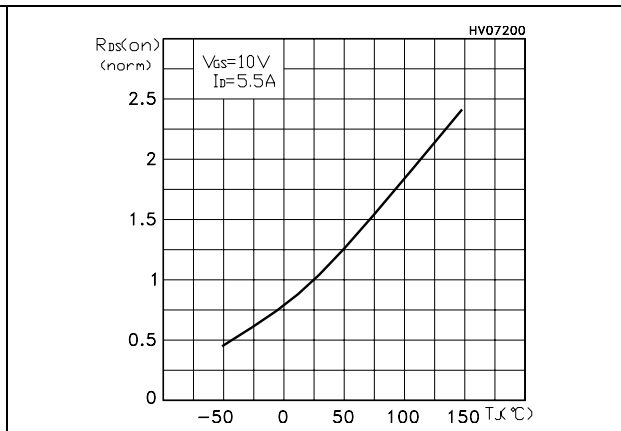
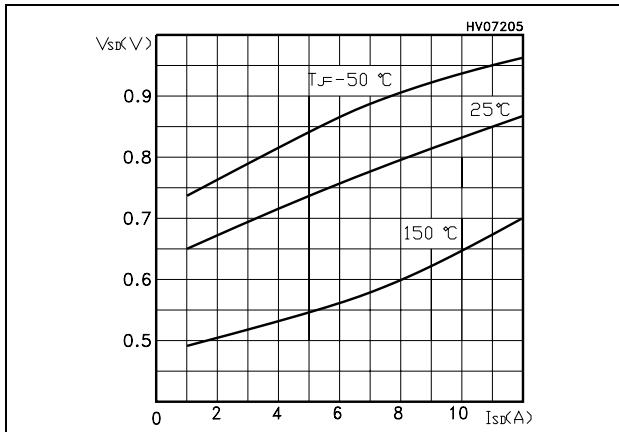


Figure 12. Normalized on resistance vs temperature



Electrical characteristics STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FD-1

Figure 13. Source-drain diode forward characteristics



STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP

Test circuit

3 Test circuit

Figure 14. Switching times test circuit for resistive load

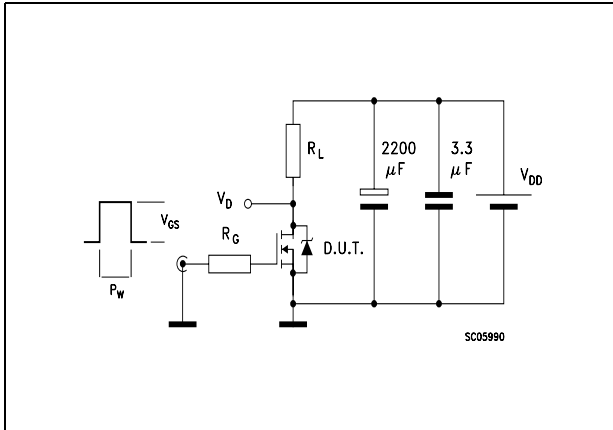


Figure 15. Gate charge test circuit

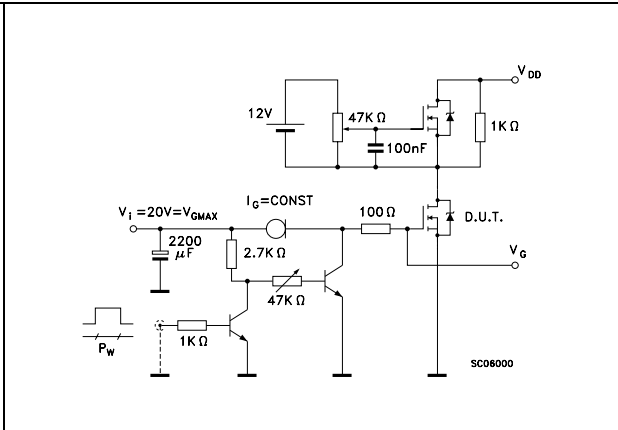


Figure 16. Test circuit for inductive load switching and diode recovery times

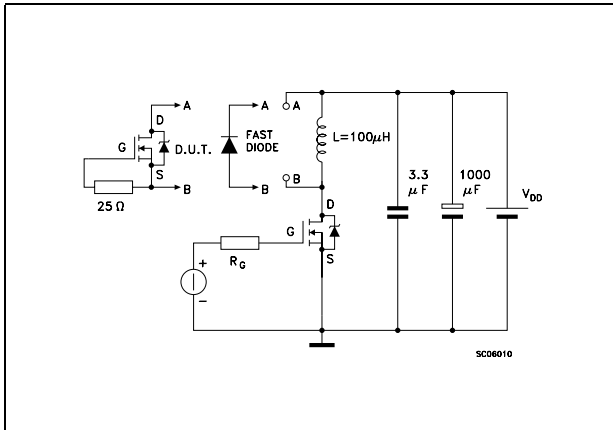


Figure 17. Unclamped Inductive load test circuit

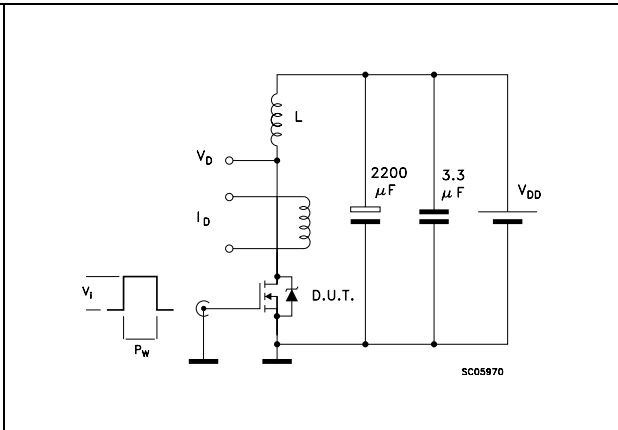


Figure 18. Unclamped inductive waveform

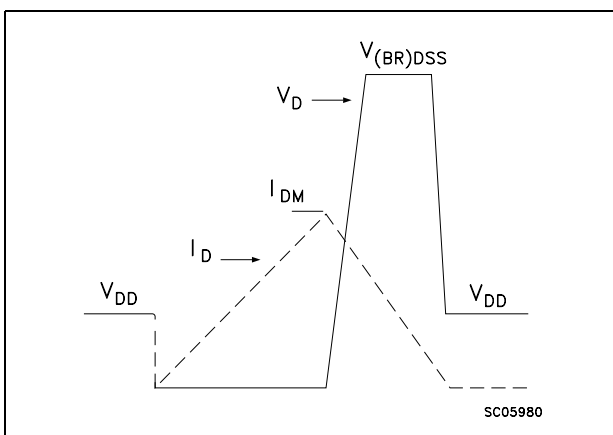
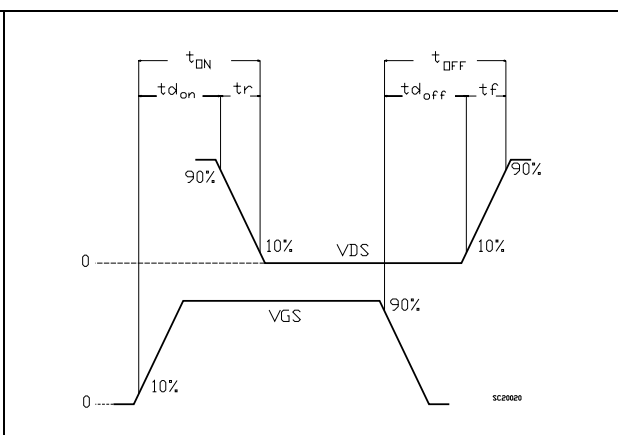


Figure 19. Switching time waveform



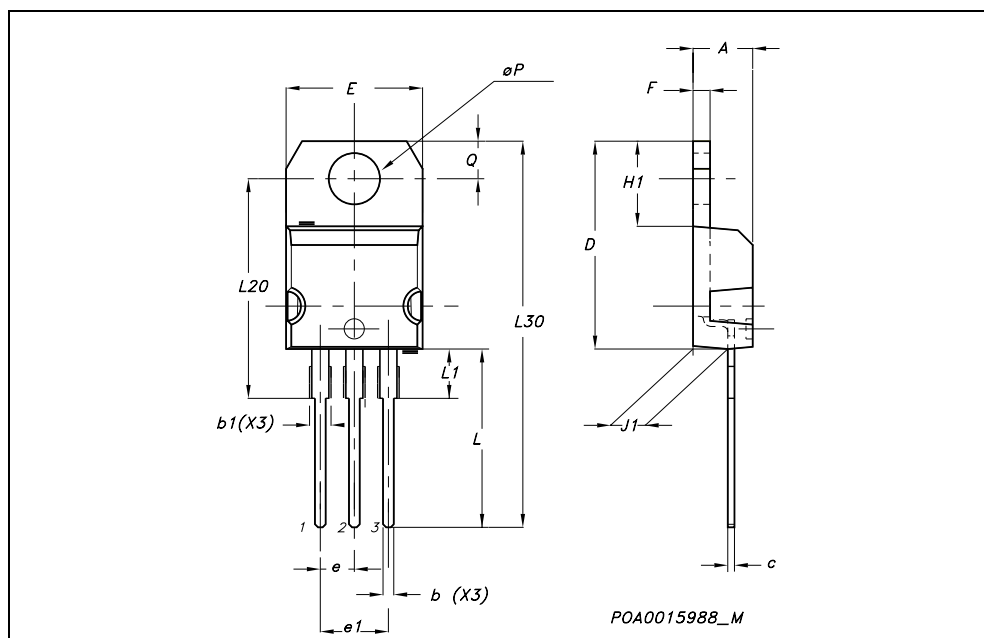
Package mechanical data STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP

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

STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP Package mechanical data

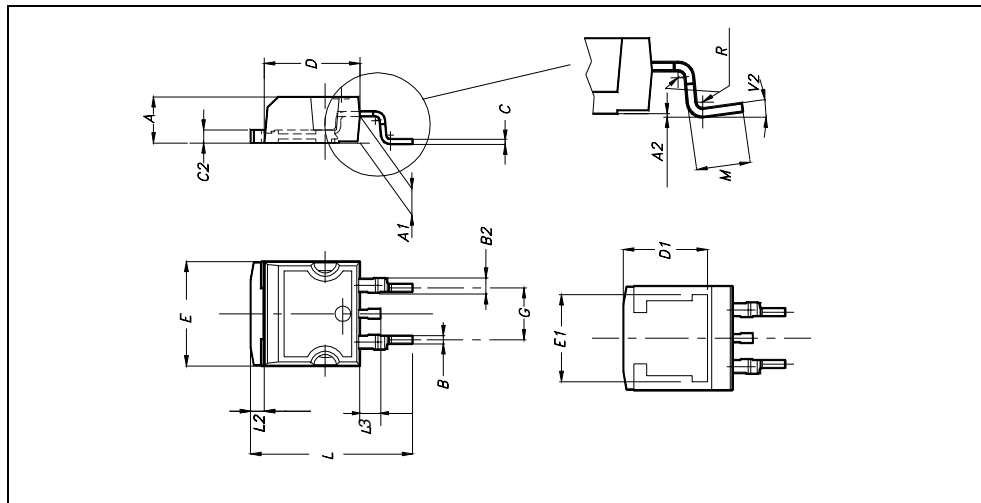
TO-220 MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	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



Package mechanical data STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP

D²PAK MECHANICAL DATA

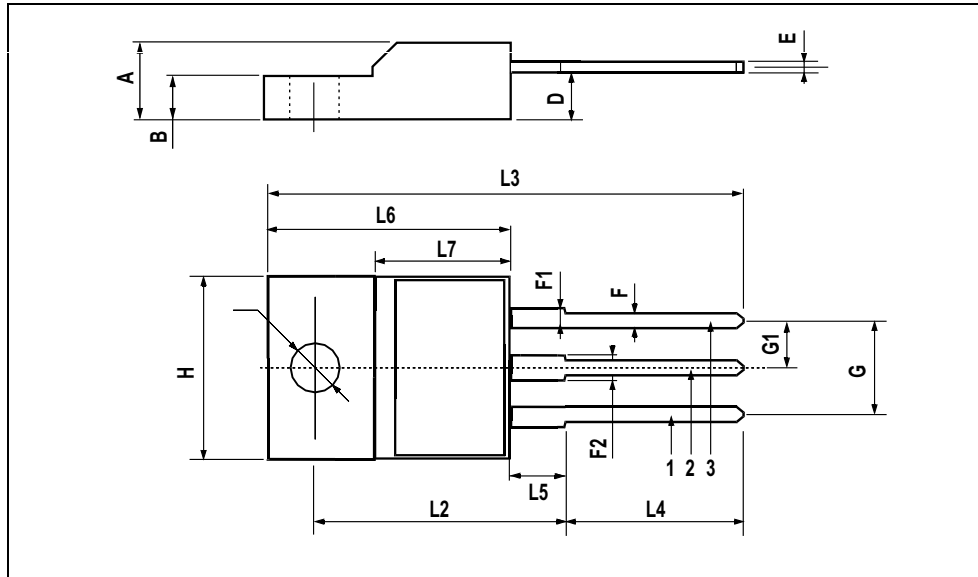
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334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



STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FD-1 Package mechanical data

TO-220FP MECHANICAL DATA

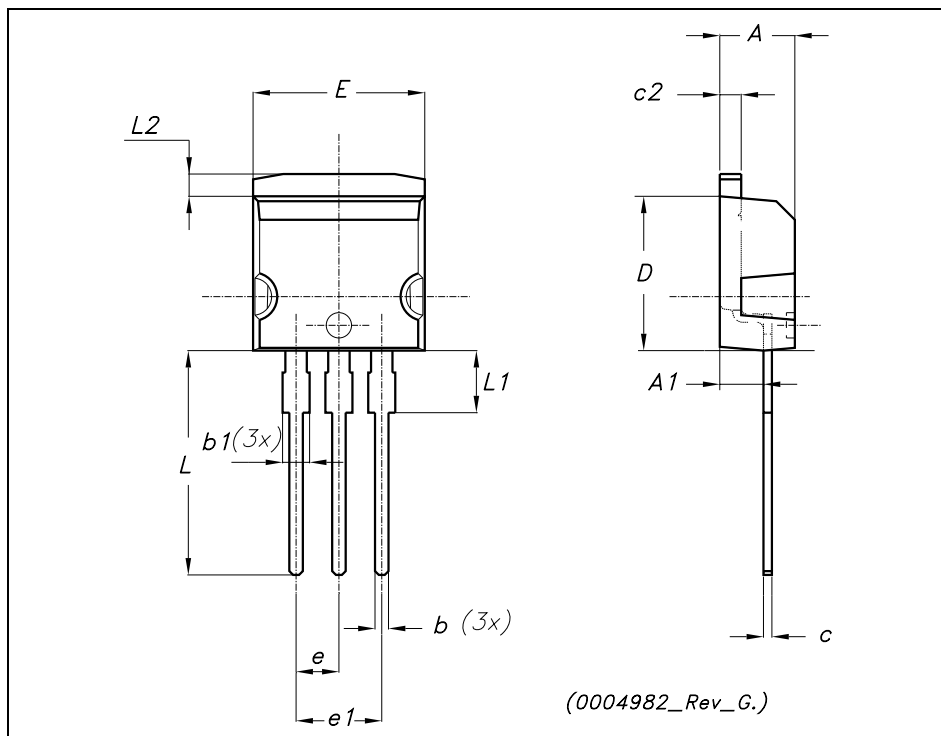
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16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



Package mechanical data STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP

TO-262 (I²PAK) MECHANICAL DATA

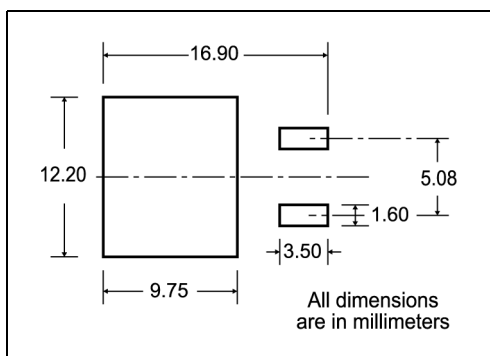
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
A1	2.40		2.72	0.094		0.107
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.49		0.70	0.019		0.027
c2	1.23		1.32	0.048		0.052
D	8.95		9.35	0.352		0.368
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
E	10		10.40	0.393		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



STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP Packaging mechanical

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

10 pitches cumulative tolerance on tape +/- 0.2 mm

User Direction of Feed

FEED DIRECTION

Bending radius R min.

* on sales type

6 Revision history

Table 8. Revision history

Date	Revision	Changes
09-Sep-2004	6	Preliminary version
08-May-2006	7	D ² PAK package inserted
22-May-2006	8	Updated values Table 5: Dynamic
26-Jul-2006	9	New template, no content change

STB11NM60FD - STB11NM60FD-1 - STP11NM60FD - STP11NM60FDFP

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