



STP5N120

N-channel 1200 V, 2.7 Ω , 4.7 A TO-220
Zener-protected SuperMESH™ Power MOSFET

Features

Type	V _{DSS}	R _{DS(on)}	I _D	P _W
STP5N120	1200 V	< 3.5 Ω	4.7 A	160 W

- 100% avalanche tested
- Extremely high dv/dt capability
- ESD improved capability
- New high voltage benchmark
- Gate charge minimized

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. Such series complements ST full range of high voltage Power MOSFETs.

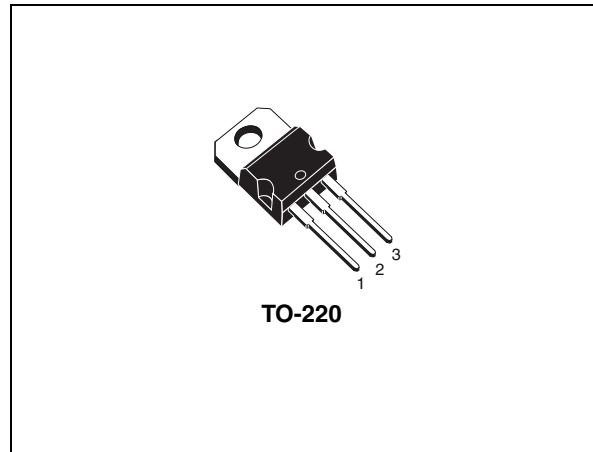


Figure 1. Internal schematic diagram

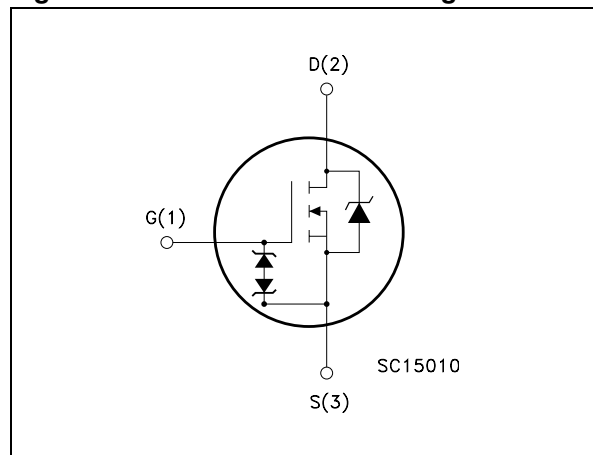


Table 1. Device summary

Order code	Marking	Package	Packaging
STP5N120	5N120	TO-220	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{DS}	Drain-source voltage ($V_{GS} = 0$)	1200	V
V_{GS}	Gate-source voltage	± 30	V
I_D	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	4.7	A
I_D	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	3	A
$I_{DM}^{(1)}$	Drain current (pulsed)	18.8	A
	Derating factor	1.28	W/ $^\circ\text{C}$
P_{TOT}	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	160	W
$V_{ESD(G-S)}$	Gate source ESD (HBM-C = 100 pF, R = 1.5 k Ω)	4000	V
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4	V/ns
T_j T_{stg}	Operating junction temperature Storage temperature	-55 to 150	$^\circ\text{C}$

1. Pulse width limited by safe operating area
2. $I_{SD} \leq 4.7\text{ A}$, $di/dt \leq 200\text{ A}/\mu\text{s}$, $V_{DD} \leq 80\% V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.78	$^\circ\text{C}/\text{W}$
$R_{thj-amb}^{(1)}$	Thermal resistance junction-amb max	62.5	$^\circ\text{C}/\text{W}$
T_l	Maximum lead temperature for soldering purpose	300	$^\circ\text{C}$

1. When mounted on 1inch² FR-4 board, 2 oz Cu

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max)	4.7	A
E_{AS}	Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$, $I_D = I_{AS}$, $V_{DD} = 50\text{ V}$)	400	mJ

2 Electrical characteristics

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

Table 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}, V_{GS} = 0$	1200			V
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = \text{Max rating},$ $V_{DS} = \text{Max rating}, T_c = 125\text{ °C}$			1 50	μA μA
I_{GSS}	Gate body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 20\text{ V}$			± 10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 100\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}, I_D = 2.3\text{ A}$		2.7	3.5	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15\text{ V}, I_D = 2.3\text{ A}$		5.8		S
C_{iss}	Input capacitance	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$		2004		pF
C_{oss}	Output capacitance			139	-	pF
C_{rss}	Reverse transfer capacitance			19		pF
$C_{oss\text{ eq.}}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0\text{ to }960\text{ V}$	-	89	-	pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz open drain}$	-	2.2	-	Ω
Q_g	Total gate charge	$V_{DD} = 960\text{ V}, I_D = 4.7\text{ A}$		57		nC
Q_{gs}	Gate-source charge	$V_{GS} = 10\text{ V}$	-	10	-	nC
Q_{gd}	Gate-drain charge	(see Figure 15)		31		nC

1. Pulsed: pulse duration=300 μs , 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. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 600\text{ V}, I_D = 2.3\text{ A},$ $R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 17)		18		ns	
t_r	Rise time			9		ns	
$t_{d(off)}$	Turn-off delay time				42		ns
t_f	Fall time				30		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		4.7	mA
I_{SDM}	Source-drain current (pulsed)		-		18.8	A
$V_{SD}^{(1)}$	Forward on voltage	$I_{SD}= 4.7\text{ A}, V_{GS}=0$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD}= 4.7\text{ A}, V_{DD}= 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, (see Figure 16)	-	760		ns
Q_{rr}	Reverse recovery charge		-	5		μC
I_{RRM}	Reverse recovery current		-	14		A
t_{rr}	Reverse recovery time	$I_{SD}= 4.7\text{ A}, V_{DD}= 60\text{ V}$ $di/dt=100\text{ A}/\mu\text{s}$, $T_J=150\text{ }^\circ\text{C}$ (see Figure 16)	-	880		ns
Q_{rr}	Reverse recovery charge		-	7		μC
I_{RRM}	Reverse recovery current		-	160		A

1. 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}	Gate-source breakdown voltage	$I_{gs} \pm 1\text{ mA}$, (open drain)	30			V

The built-in-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

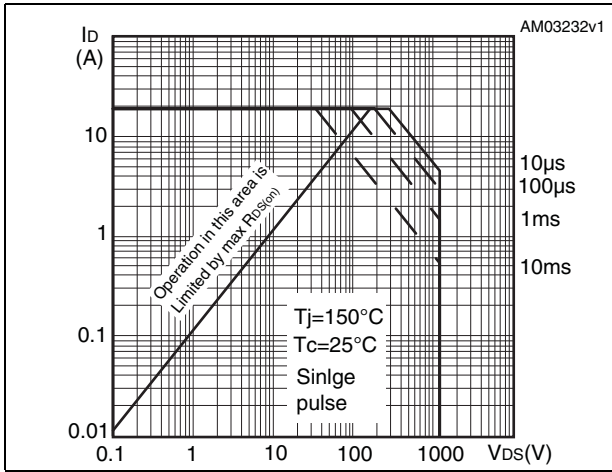


Figure 3. Thermal impedance

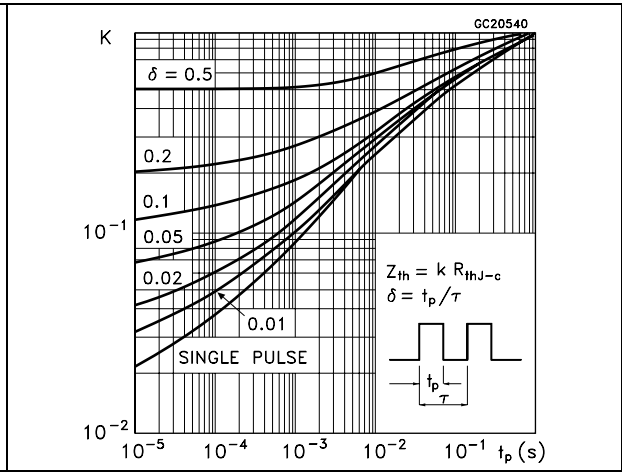


Figure 4. Output characteristics

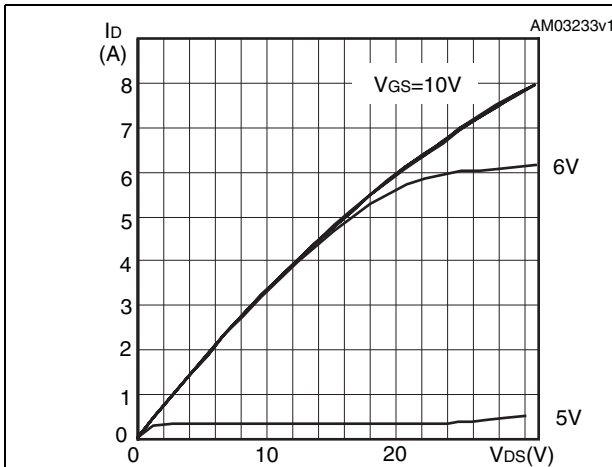


Figure 5. Transfer characteristics

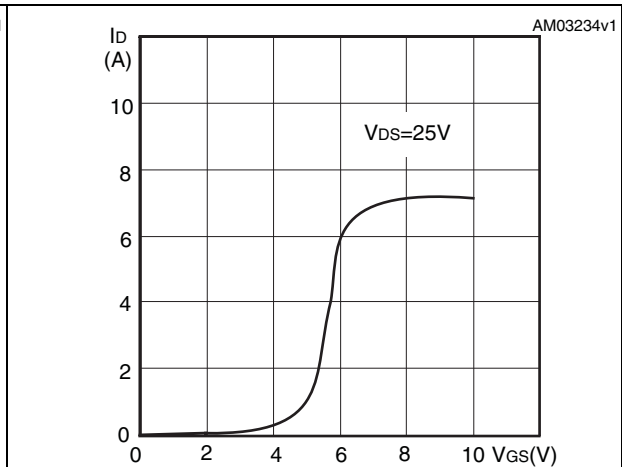


Figure 6. Normalized $B_{V_{DSS}}$ vs temperature

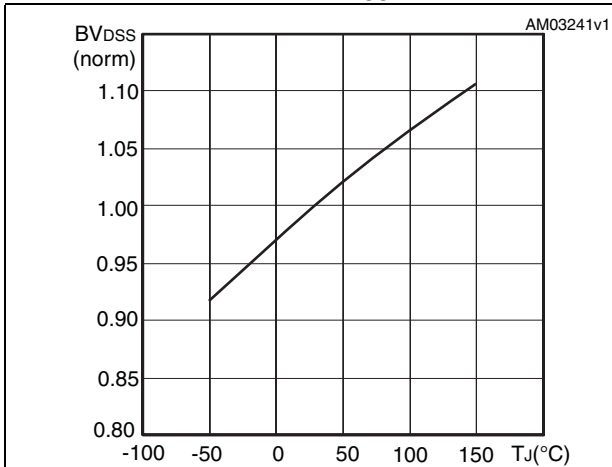


Figure 7. Static drain-source on resistance

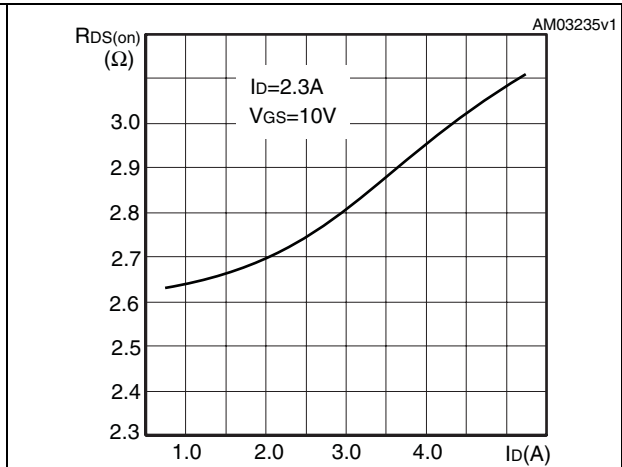


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

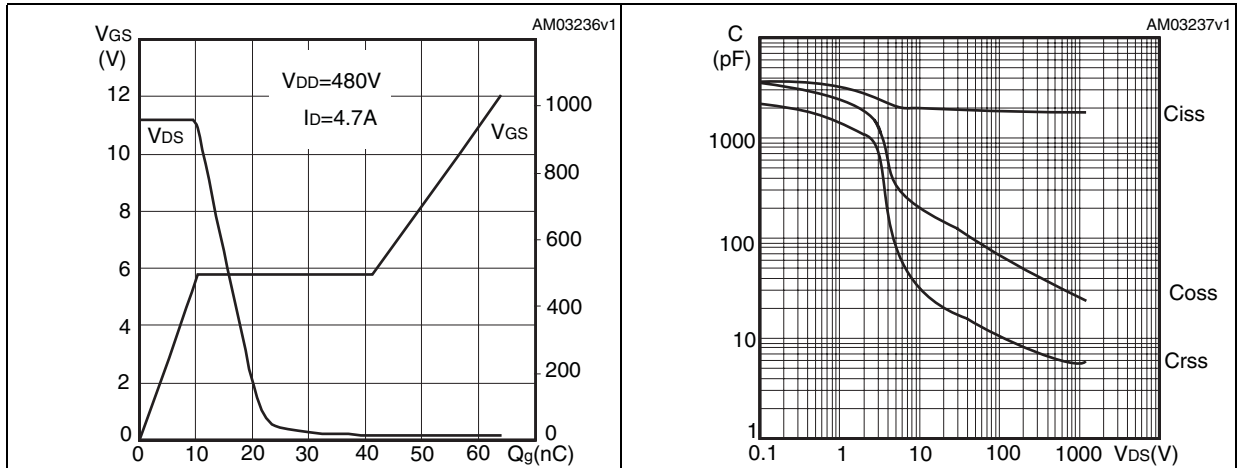


Figure 10. Normalized gate threshold voltage vs temperature Figure 11. Normalized on resistance vs temperature

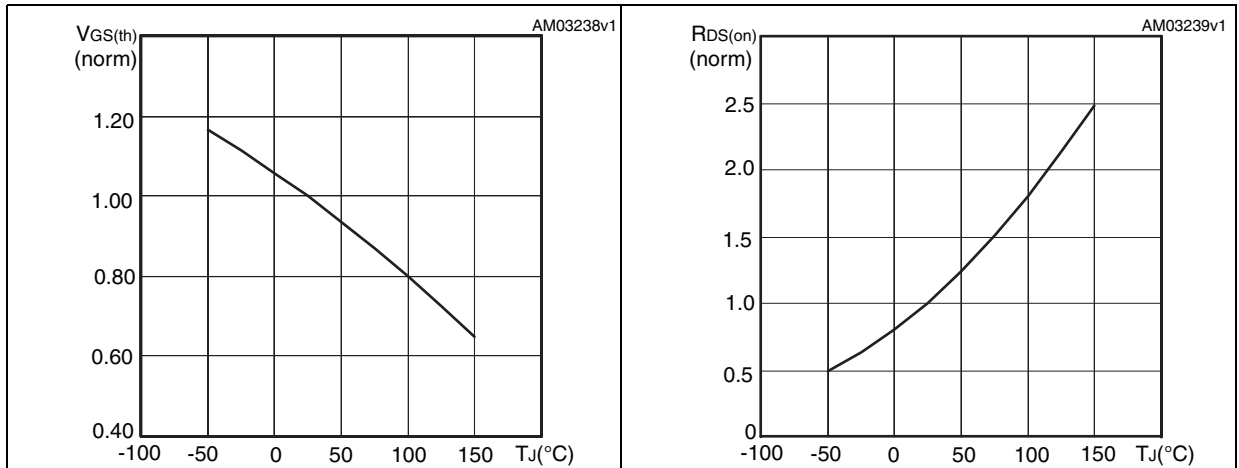
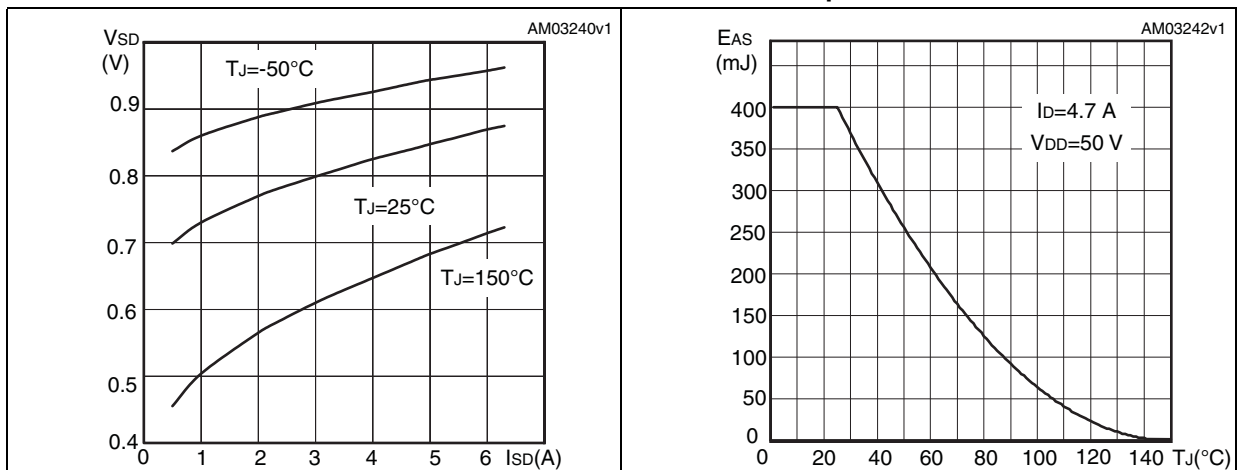


Figure 12. Source-drain diode forward characteristics Figure 13. Maximum avalanche energy vs temperature



3 Test circuits

Figure 14. Switching times test circuit for resistive load

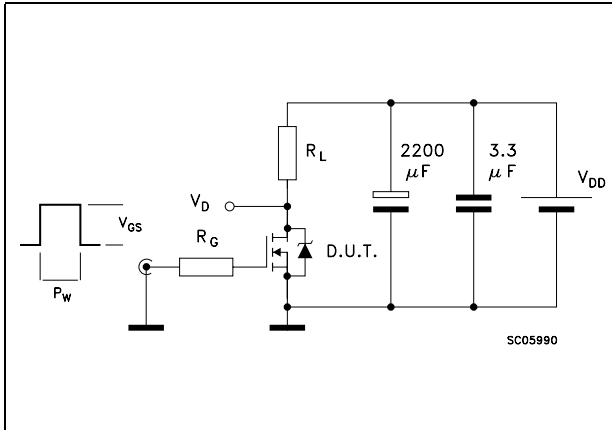


Figure 15. Gate charge test circuit

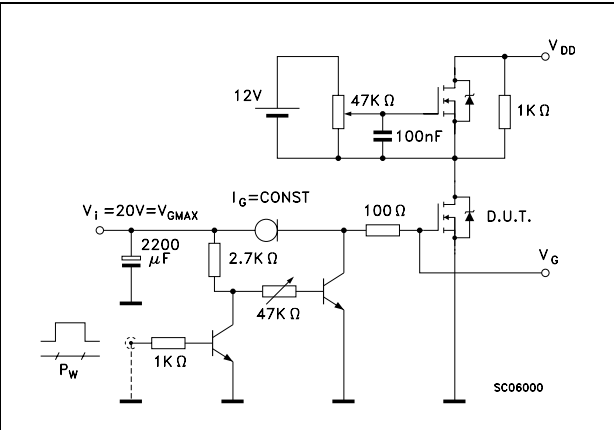


Figure 16. Test circuit for inductive load switching and diode recovery times

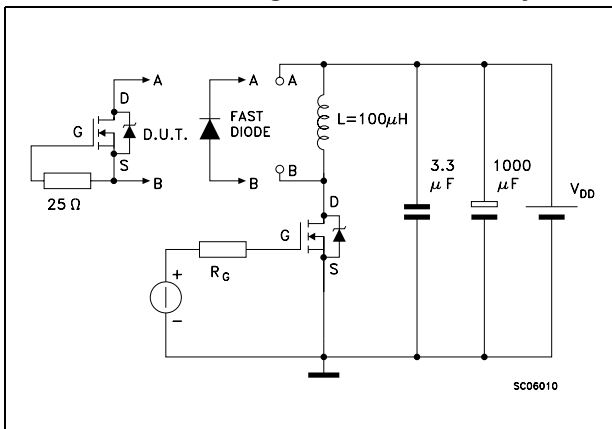


Figure 17. Unclamped inductive load test circuit

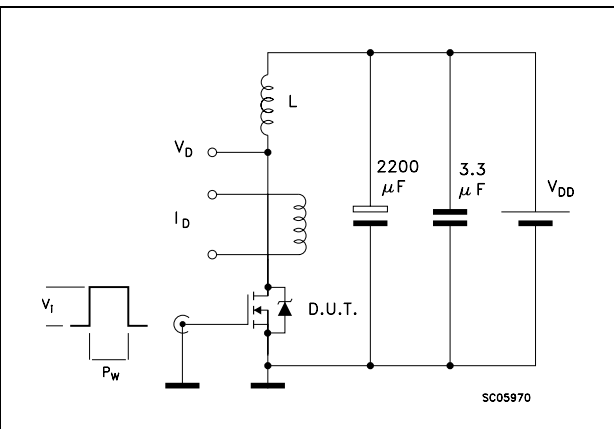


Figure 18. Unclamped inductive waveform

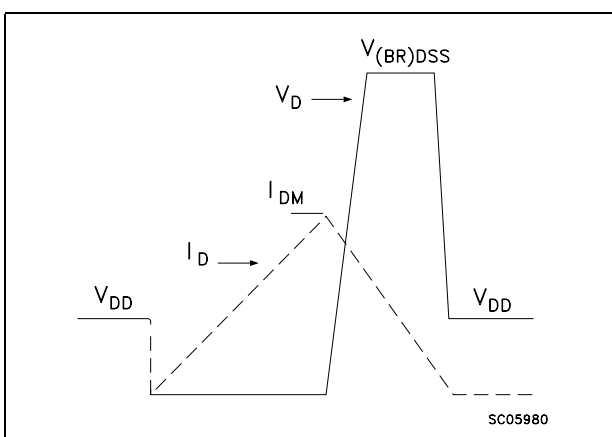
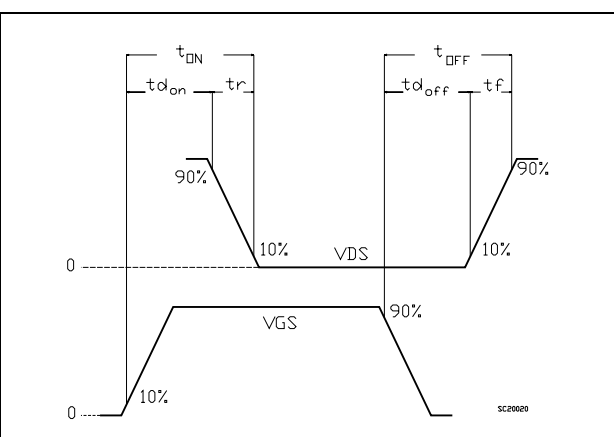


Figure 19. Switching time waveform

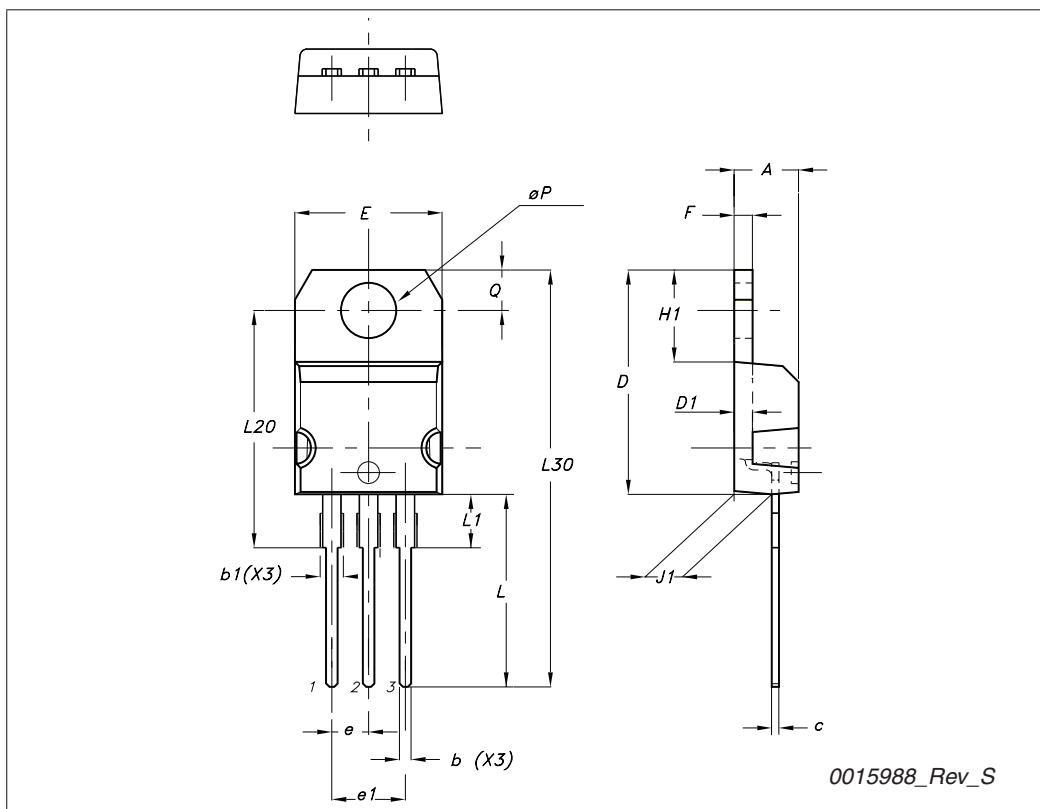


4 Package mechanical data

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

TO-220 type A mechanical data

Dim	mm		
	Min	Typ	Max
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95



5 Revision history

Table 10. Revision history

Date	Revision	Changes
21-May-2007	1	First release
02-Nov-2009	2	Document status promoted from preliminary data to datasheet. Updated mechanical data.

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