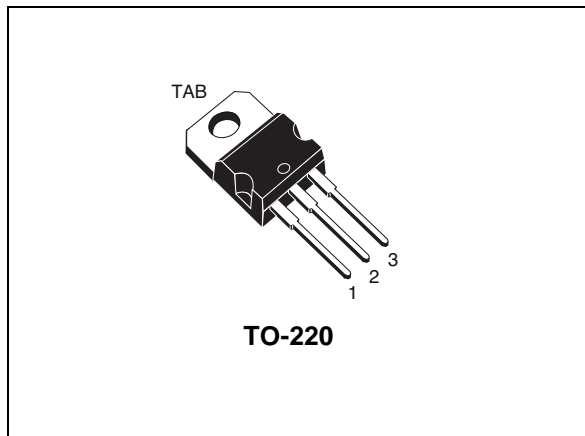
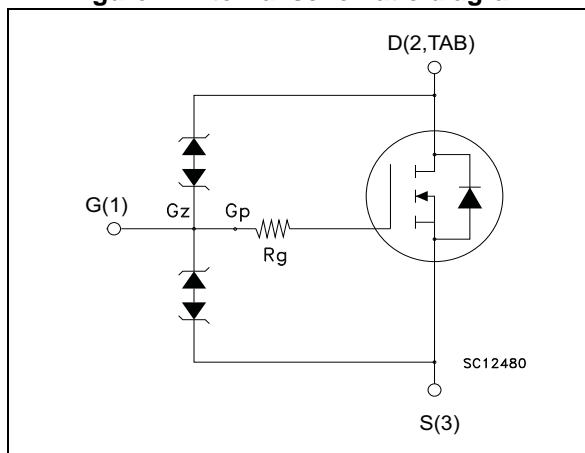


N-channel 40 V clamped 3.6 mΩ typ., 120 A  
fully protected SAFeFET™ Power MOSFET in a TO-220 package

Datasheet - production data



**Figure 1. Internal schematic diagram**



## Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STP180NS04ZC	40 V clamped	4.2 mΩ	120 A

- Low capacitance and gate charge
- 100% avalanche tested
- 175 °C maximum junction temperature

## Applications

- Switching and linear applications

## Description

This fully clamped Power MOSFET is manufactured using an advanced mesh overlay process which is based on an innovative strip layout. The benefits of this technology, coupled with the extra clamping capabilities render this device particularly suitable for the harshest operating conditions, such as those associated with the automotive environment. The device is also suitable for other applications that require a high degree of ruggedness.

**Table 1. Device summary**

Order code	Marking	Package	Packaging
STP180NS04ZC	P180NS04ZC	TO-220	Tube

Contents

1      **Electrical ratings** ..... 3

2      **Electrical characteristics** ..... 5

      2.1      Electrical characteristics (curves) ..... 7

3      **Test circuits** ..... 9

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	41 <sup>(1)</sup>	V
$V_{DG}$	Drain-gate voltage	33 <sup>(1)</sup>	V
$V_{GS}$	Gate-source voltage	$\pm 20$ <sup>(1)</sup>	V
$I_D$ <sup>(2)</sup>	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	120	A
$I_D$ <sup>(2)</sup>	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	120	A
$I_{DG}$	Drain gate current (continuous)	$\pm 50$	mA
$I_{GS}$	Gate-source current (continuous)	$\pm 50$	mA
$I_{DM}$ <sup>(3)</sup>	Drain current (pulsed)	480	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	330	W
	Derating factor	2.2	W/ $^\circ\text{C}$
ESD	Gate-source human body model ( $C = 100\text{ pF}$ , $R = 1.5\text{ k}\Omega$ )	$\pm 8$	kV
ESD	Gate-drain human body model ( $C = 100\text{ pF}$ , $R = 1.5\text{ k}\Omega$ )	$\pm 8$	kV
ESD	Drain-source human body model ( $C = 100\text{ pF}$ , $R = 1.5\text{ k}\Omega$ )	$\pm 8$	kV
$T_J$ $T_{stg}$	Operating junction temperature Storage temperature	-55 to 175	$^\circ\text{C}$

1. Voltage is limited by Zener diodes
2. Current limited by wire bonding
3. Pulse width limited by safe operating area

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.45	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5	$^\circ\text{C/W}$

Table 4. Avalanche data

Symbol	Parameter	Value	Unit
$I_{AS}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ $\delta < 1\%$ )	80	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j=25\text{ }^{\circ}\text{C}$ , $I_D=I_{AS}$ , $V_{DD}=21\text{ V}$ ) (see <a href="#">Figure 17</a> , <a href="#">Figure 14.</a> )	1000	mJ

## 2 Electrical characteristics

(T<sub>CASE</sub>=25°C unless otherwise specified)

Table 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DG</sub>	Clamped voltage	I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0 -40 < T <sub>j</sub> < 175 °C	33		41	V
V <sub>DSR(CL)</sub>	Drain-source clamping voltage (DC)	I <sub>GS(CL)</sub> = -2 mA, I <sub>D</sub> = 1 A		41		V
I <sub>DSS</sub>	Zero gate voltage drain current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = 16 V V <sub>DS</sub> = 16 V, T <sub>j</sub> = 150 °C V <sub>DS</sub> = 16 V, T <sub>j</sub> = 175 °C			1 50 100	μA μA μA
I <sub>GSS</sub> <sup>(1)</sup>	Gate-body leakage current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ±10 V V <sub>GS</sub> = ±10 V, T <sub>j</sub> = 175 °C V <sub>GS</sub> = ±16 V, T <sub>j</sub> = 175 °C			±2 ±50 ±150	μA μA μA
V <sub>GSS</sub>	Gate-source breakdown voltage	I <sub>GS</sub> = ±100 μA	18		25	V
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1 mA	2	3	4	V
R <sub>DS(on)</sub>	Static drain-source on-resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 40 A		3.6	4.2	mΩ
R <sub>G</sub>	Internal gate resistor			14		Ω

1. Gate Oxide, without zener diodes, tested at wafer sorting (I<sub>GSS</sub> < ± 100 nA @ ± 20 V T<sub>j</sub>=25 °C).

*Figure 17: Unclamped inductive load test circuit* for electrical schematics

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C <sub>iss</sub>	Input capacitance	V <sub>DS</sub> = 25 V, f = 1 MHz, V <sub>GS</sub> = 0	-	4500	-	pF
C <sub>oss</sub>	Output capacitance		-	1700	-	pF
C <sub>rss</sub>	Reverse transfer capacitance		-	500	-	pF
t <sub>r(Voff)</sub>	Off voltage rise time	V <sub>CLAMP</sub> = 30 V, I <sub>D</sub> = 80 A, V <sub>GS</sub> = 10 V, R <sub>G</sub> = 4.7 Ω	-	250	-	ns
t <sub>f</sub>	Fall time	(see <i>Figure 14</i> )	-	115	-	ns
t <sub>c</sub>	Cross-over time		-	290	-	ns
Q <sub>g</sub>	Total gate charge	V <sub>DD</sub> = 20 V, I <sub>D</sub> = 120 A	-	110	-	nC
Q <sub>gs</sub>	Gate-source charge	V <sub>GS</sub> = 10 V	-	25	-	nC
Q <sub>gd</sub>	Gate-drain charge	(see <i>Figure 15</i> )	-	45	-	nC

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		120	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				480	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD}=120\text{ A}$ , $V_{GS}=0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD}=120\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD}= 32\text{ V}$ , $T_j=150\text{ }^\circ\text{C}$ (see <a href="#">Figure 16</a> )	-	56		ns
$Q_{rr}$	Reverse recovery charge		-	70		nC
$I_{RRM}$	Reverse recovery current		-	12		A

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration=300  $\mu\text{s}$ , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

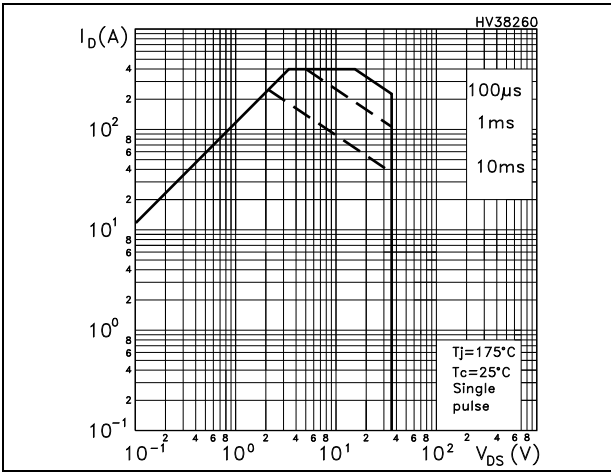


Figure 3. Thermal impedance

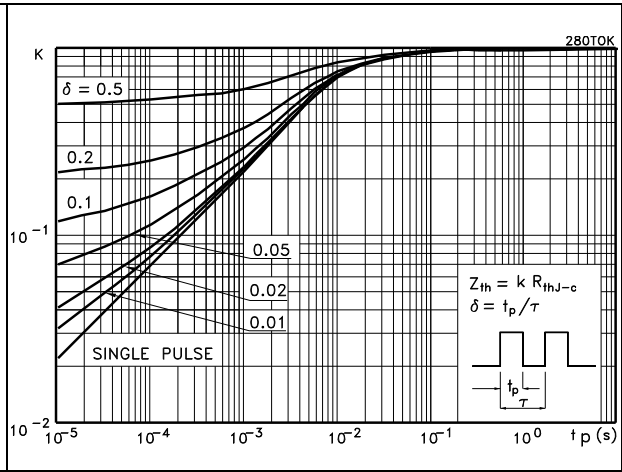


Figure 4. Output characteristics

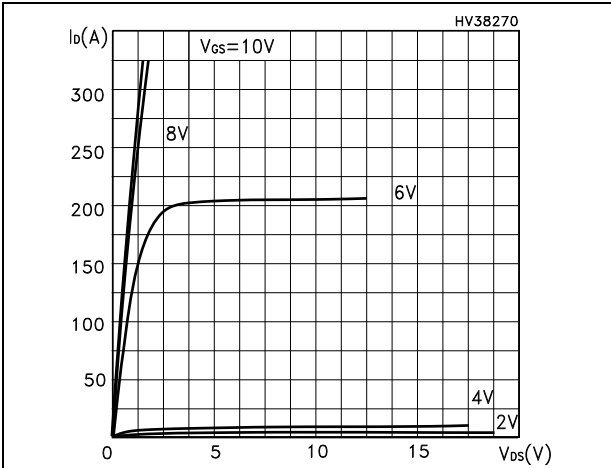


Figure 5. Transfer characteristics

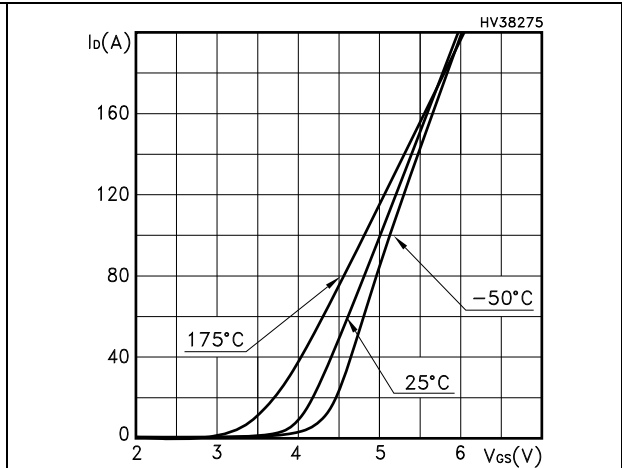


Figure 6. Transconductance

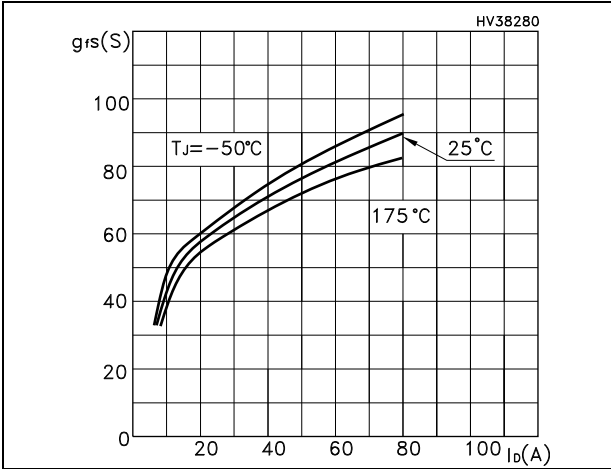


Figure 7. Static drain-source on-resistance

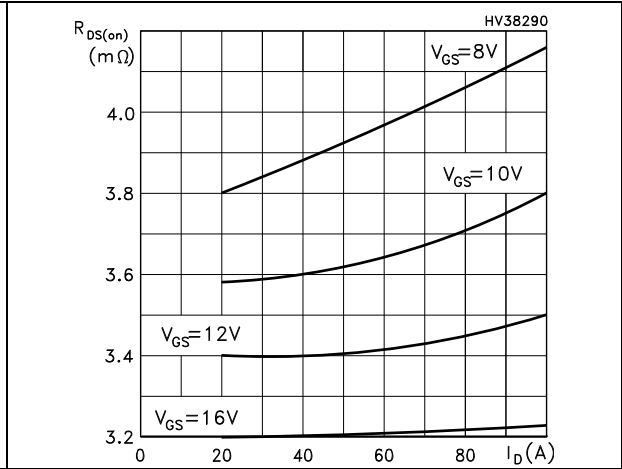


Figure 8. Gate charge vs gate-source voltage

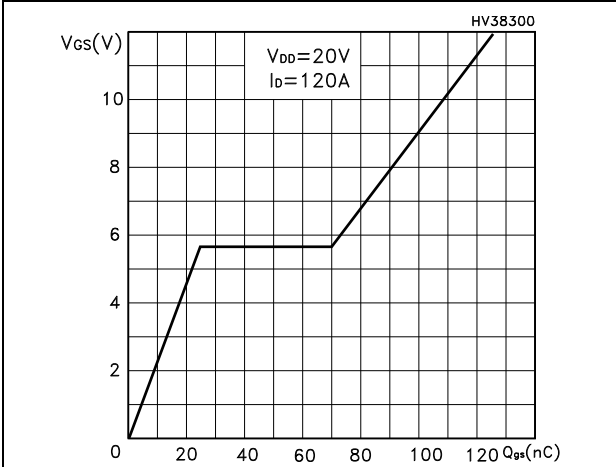


Figure 9. Capacitance variations

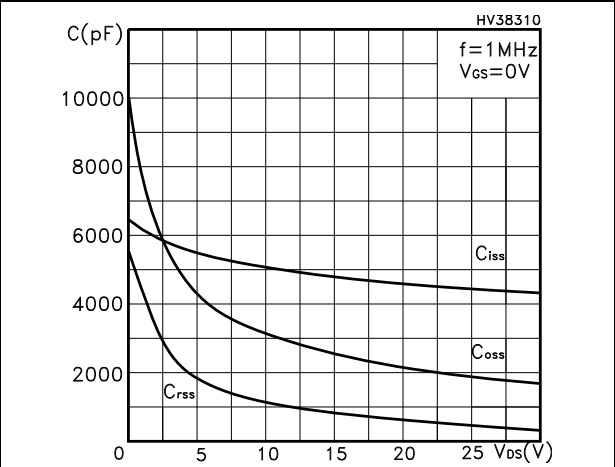


Figure 10. Normalized gate threshold voltage vs temperature

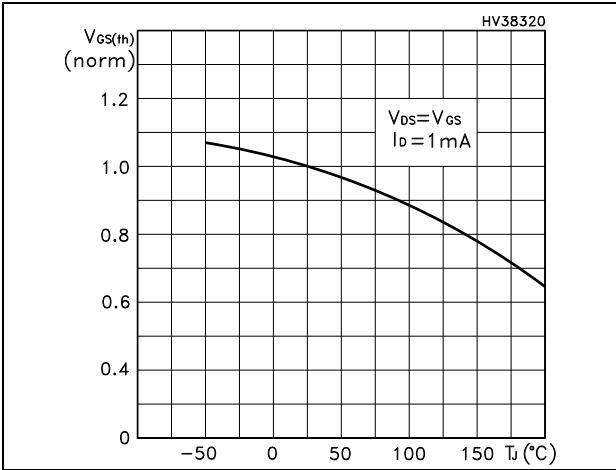


Figure 11. Normalized on-resistance vs temperature

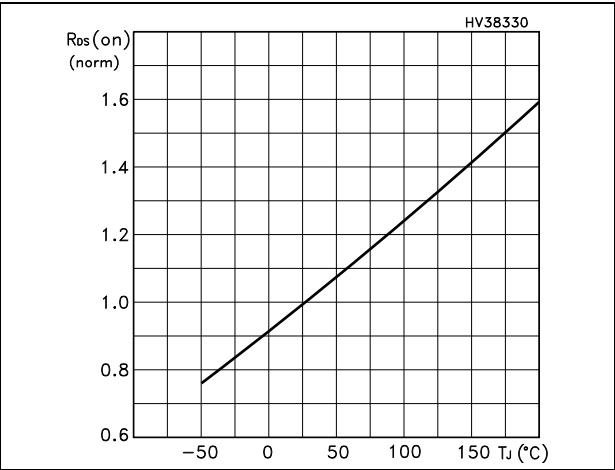


Figure 12. Source-drain diode forward characteristics

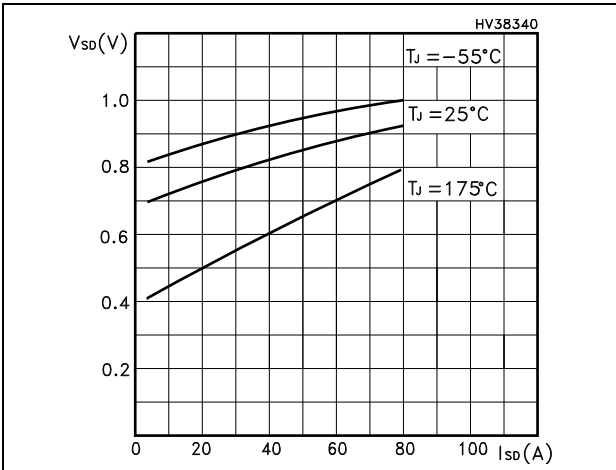
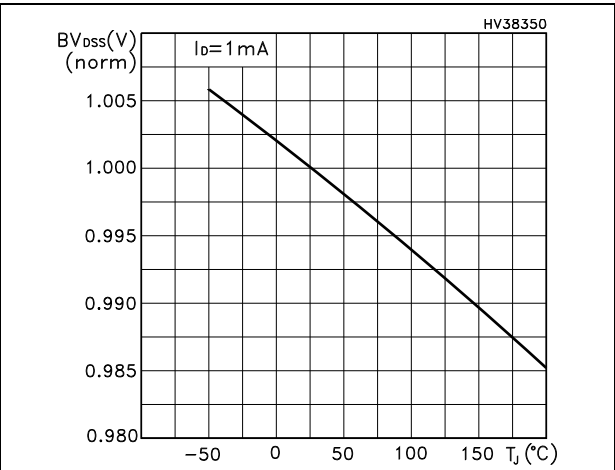


Figure 13. Normalized  $BV_{DSS}$  vs temperature





### 3 Test circuits

Figure 14. Switching times test circuit for resistive load

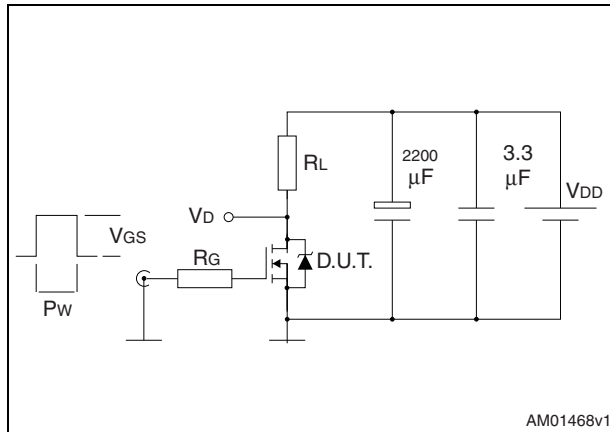


Figure 15. Gate charge test circuit

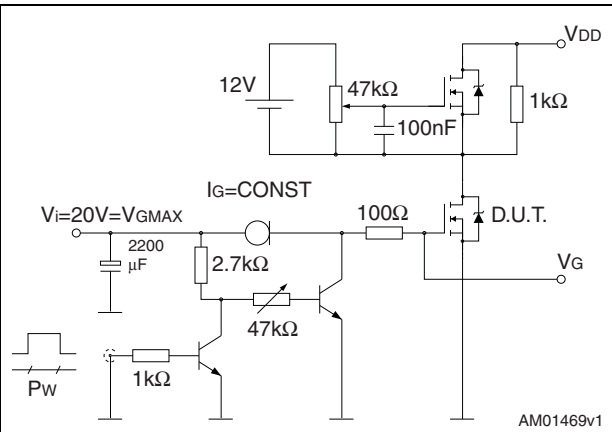


Figure 16. Test circuit for inductive load switching and diode recovery times

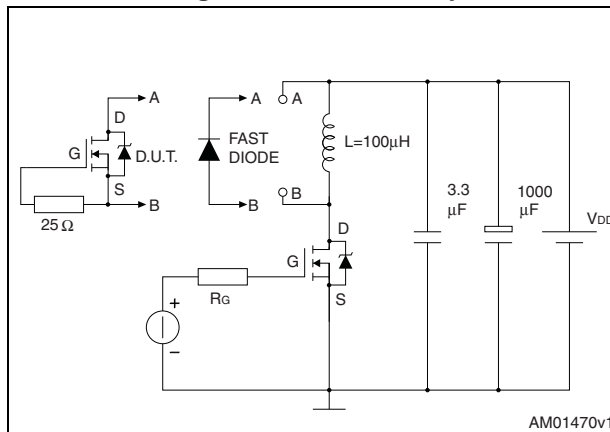


Figure 17. Unclamped inductive load test circuit

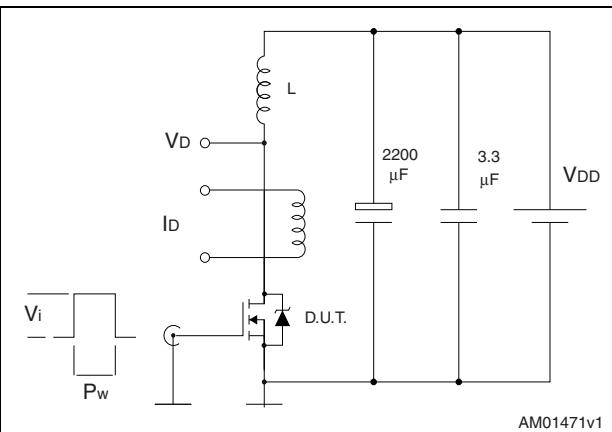


Figure 18. Unclamped inductive waveform

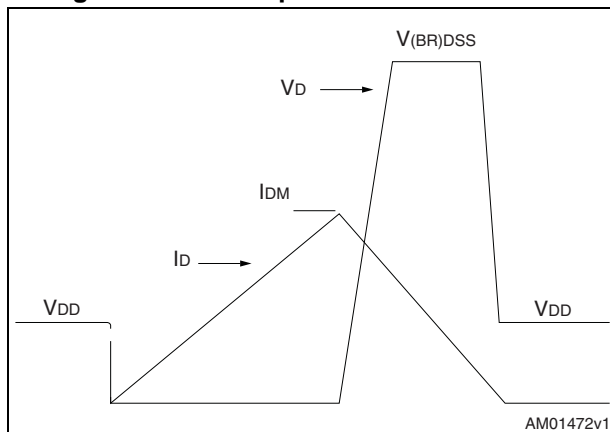
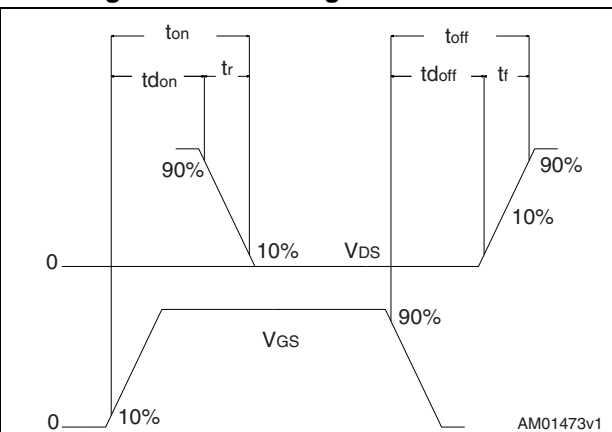


Figure 19. Switching time waveform



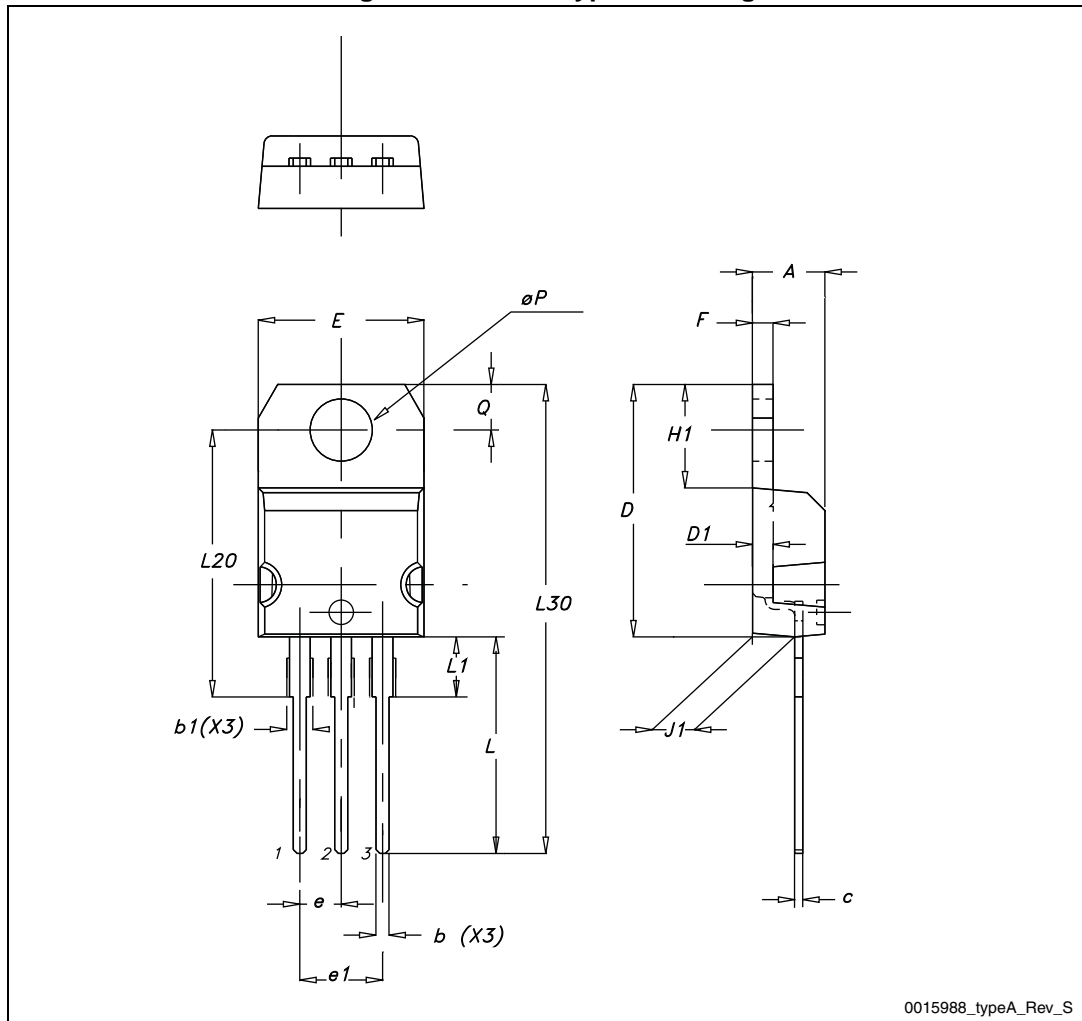
## 4 Package mechanical data

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

Table 8. 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	
ØP	3.75		3.85
Q	2.65		2.95

Figure 20. TO-220 type A drawing



## 5 Revision history

Table 9. Document revision history

Date	Revision	Changes
03-Apr-2008	1	First release.
21-Mar-2013	2	<ul style="list-style-type: none"><li>– <a href="#">Table 1: Device summary</a>, <a href="#">Table 2: Absolute maximum ratings</a>, <a href="#">Table 3: Thermal data</a>, <a href="#">Table 6: Dynamic</a> have been corrected.</li><li>– Minor text changes.</li><li>– Modified: <a href="#">Applications</a> section on the cover page.</li></ul>

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