

## N-channel 500 V, 2.8 $\Omega$ typ., 2.3 A Zener-protected SuperMESH™ Power MOSFET in a TO-220 package

Datasheet - production data

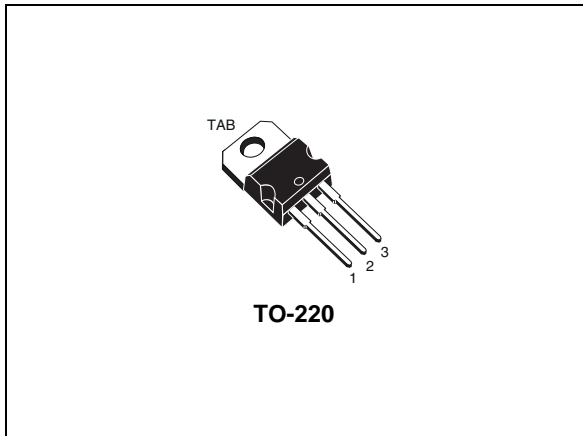
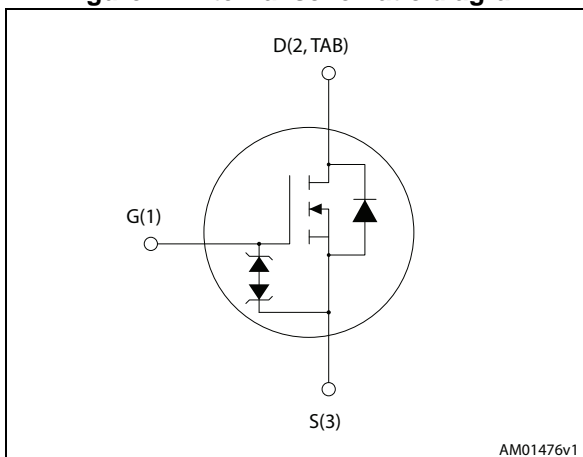


Figure 1. Internal schematic diagram



### Features

Order code	$V_{DS}$	$R_{DS(on)max.}$	$I_D$	$P_{TOT}$
STP3NK50Z	500 V	3.3 $\Omega$	2.3 A	45 W

- Extremely high dv/dt capability
- ESD improved capability
- 100% avalanche tested
- Gate charge minimized
- Zener-protected

### Applications

- Switching applications

### Description

This device is an N-channel Zener-protected Power MOSFET developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

Table 1. Device summary

Order code	Marking	Packages	Packaging
STP3NK50Z	P3NK50Z	TO-220	Tube

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	500	V
$V_{DGR}$	Drain-gate voltage ( $R_{GS}=20\text{ k}\Omega$ )	500	V
$V_{GS}$	Gate-source voltage	$\pm 30$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	2.3	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	1.45	A
$I_{DM}^{(1)}$	Drain current (pulsed)	9.2	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	45	W
	Derating factor	0.36	W/ $^\circ\text{C}$
ESD	Gate-source human body model ( $C = 100\text{ pF}$ , $R = 1.5\text{ k}\Omega$ )	2	kV
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4.5	V/ns
$T_{stg}$	Storage temperature	-55 to 150	$^\circ\text{C}$
$T_j$	Operating junction temperature		$^\circ\text{C}$

1. Pulse width limited by safe operating area.

2.  $I_D \leq 2\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	2.78	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5	$^\circ\text{C}/\text{W}$

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Max current during repetitive or single pulse avalanche (pulse width limited by $T_{jmax}$ )	2.3	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D=I_{AS}$ , $V_{DD}=50\text{ V}$ )	120	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 ( $V_{GS} = 0$ )	$I_D = 1\text{ mA}$	500			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 500\text{ V}$ $V_{DS} = 500\text{ V}, T_c = 125\text{ °C}$			1 50	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{ V}$			$\pm 10$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 50\text{ }\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}, I_D = 1.15\text{ A}$		2.8	3.3	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g^{(1)}$	Forward transconductance	$V_{DS} = 15\text{ V}, I_D = 1.15\text{ A}$	-	1.5		S
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$	-	280		pF
$C_{oss}$	Output capacitance		-	42		pF
$C_{rss}$	Reverse transfer capacitance		-	8		pF
$C_{oss\text{ eq.}}^{(2)}$	Equivalent capacitance time related	$V_{GS} = 0, V_{DS} = 0\text{ to }400\text{ V}$	-	27.5		pF
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 250\text{ V}, I_D = 1.15\text{ A},$ $R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see <a href="#">Figure 19</a> and <a href="#">15</a> )	-	8		ns
$t_r$	Rise time		-	13		ns
$t_{d(off)}$	Turn-off delay time		-	24		ns
$t_f$	Fall time		-	14		ns
$Q_g$	Total gate charge	$V_{DD} = 400\text{ V}, I_D = 2.3\text{ A}$ $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16</a> )	-	11	15	nC
$Q_{gs}$	Gate-source charge		-	2.5		nC
$Q_{gd}$	Gate-drain charge		-	5.6		nC

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , 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. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		2.3	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		9.2	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD}= 2.3 \text{ A}, V_{GS}=0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD}= 2.3 \text{ A}, V_{DD}= 40 \text{ V}$ $di/dt = 100 \text{ A}/\mu\text{s}$ , (see <a href="#">Figure 17</a> )	-	250		ns
$Q_{rr}$	Reverse recovery charge		-	745		nC
$I_{RRM}$	Reverse recovery current		-	6		A
$t_{rr}$	Reverse recovery time	$I_{SD}= 12 \text{ A}, V_{DD}= 40 \text{ V}$ $di/dt=100 \text{ A}/\mu\text{s}$ , $T_J=150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 17</a> )	-	300		ns
$Q_{rr}$	Reverse recovery charge		-	960		nC
$I_{RRM}$	Reverse recovery current		-	6.2		A

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%
2. Pulse width limited by safe operating area

Table 8. Gate-source Zener diode

Symbol	Parameter	Test conditions	Min	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1 \text{ mA}, I_D=0$	30	-	-	V

The built-in back-to-back Zener diodes have been specifically designed to enhance not only the device's ESD capability, but also to make them capable of safely absorbing any voltage transients that may occasionally be applied from gate to source. In this respect, the Zener voltage is appropriate to achieve efficient and cost-effective protection of device integrity. The integrated Zener diodes thus eliminate the need for external components.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

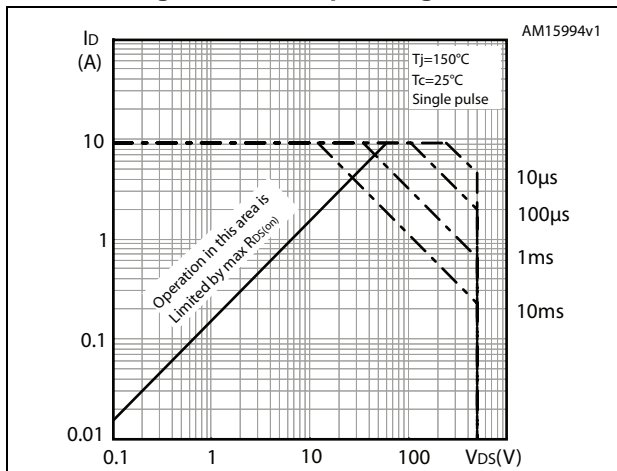


Figure 3. Thermal impedance

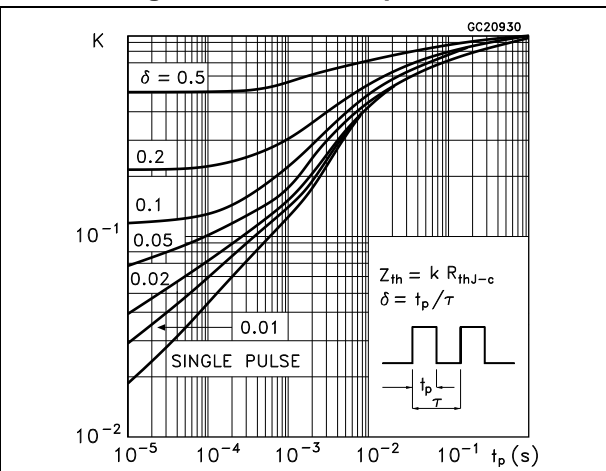


Figure 4. Output characteristics

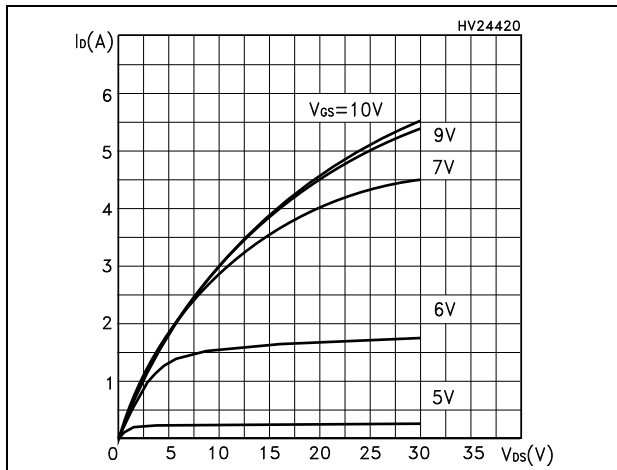


Figure 5. Transfer characteristics

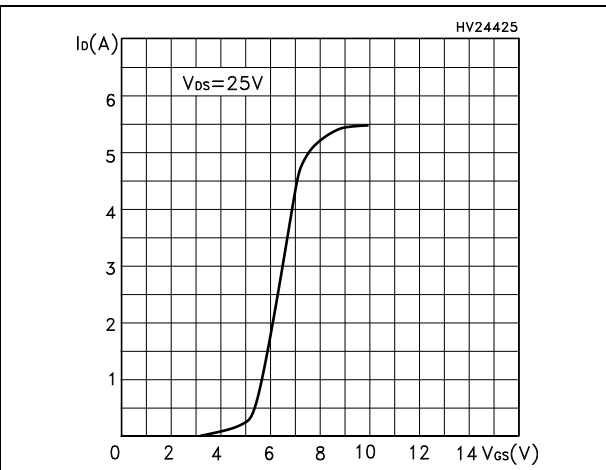


Figure 6. Transconductance

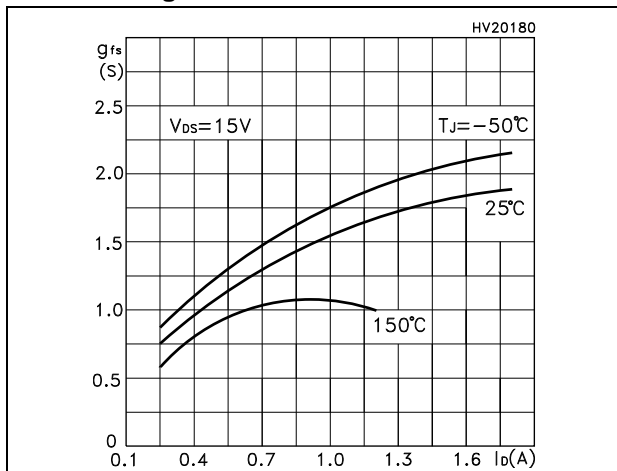


Figure 7. Capacitance variations

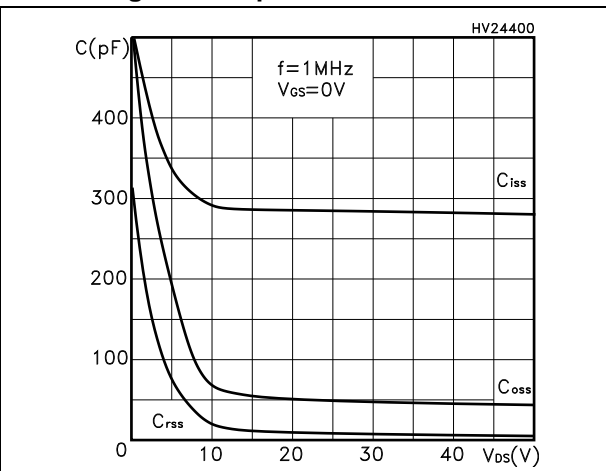


Figure 8. Gate charge vs gate-source voltage

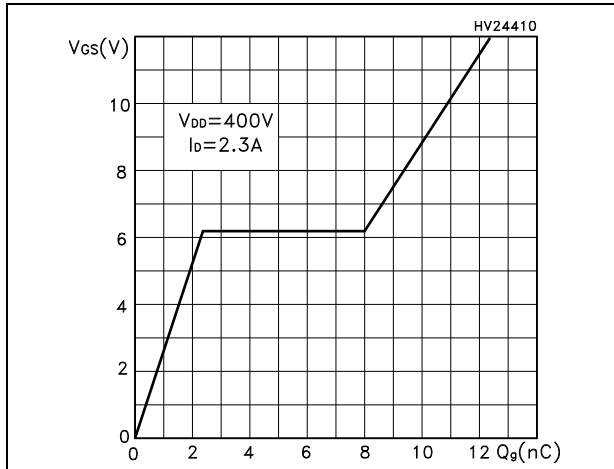


Figure 9. Normalized gate threshold voltage vs temperature

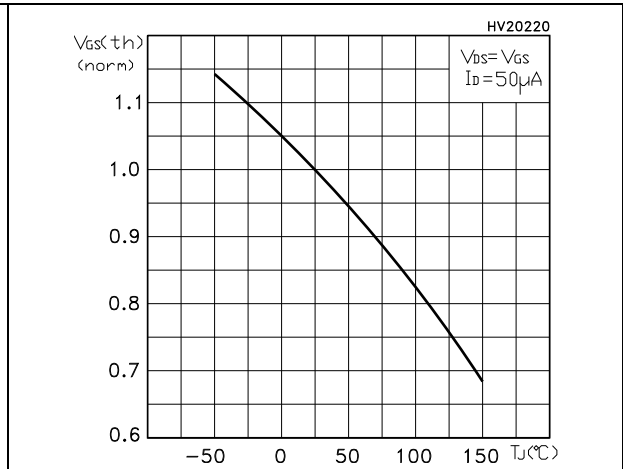


Figure 10. Static drain-source on-resistance

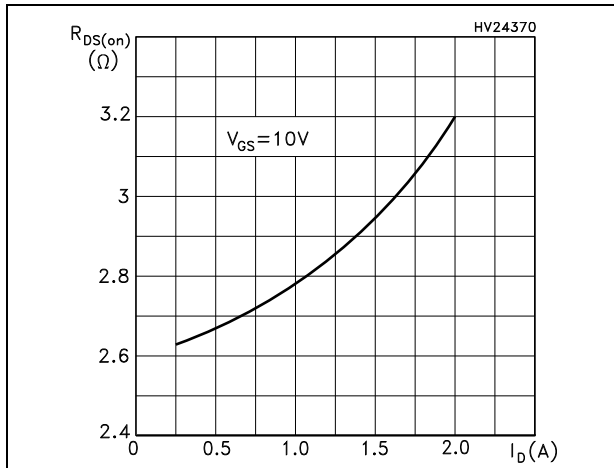


Figure 11. Source-drain forward characteristics

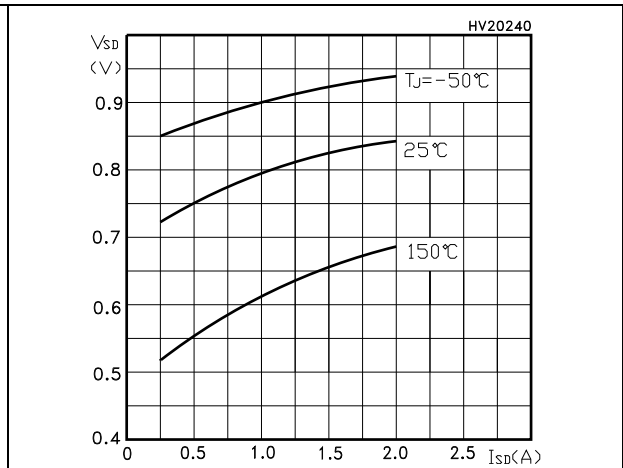


Figure 12. Maximum avalanche energy vs temperature

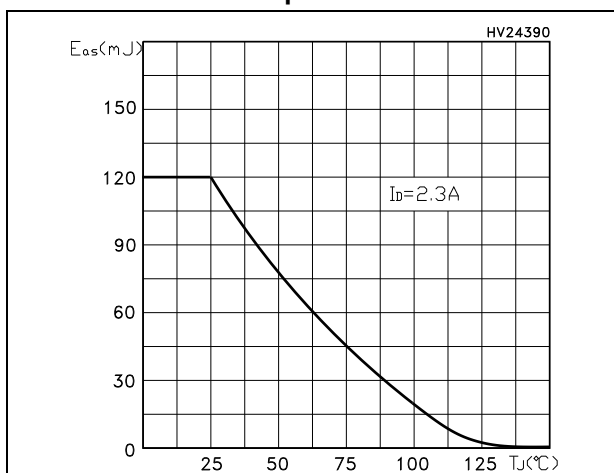


Figure 13. Normalized BV<sub>DSS</sub> vs temperature

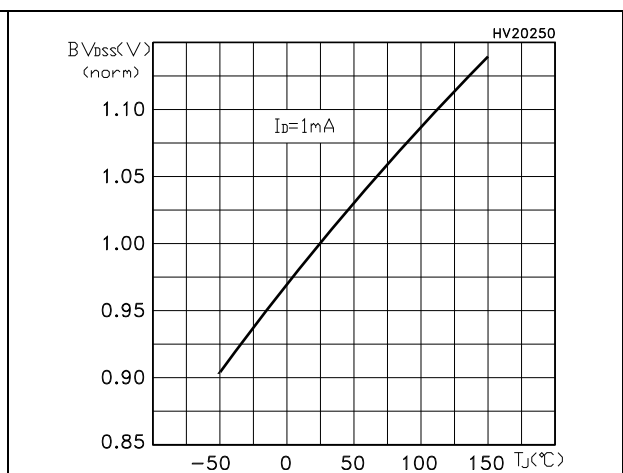
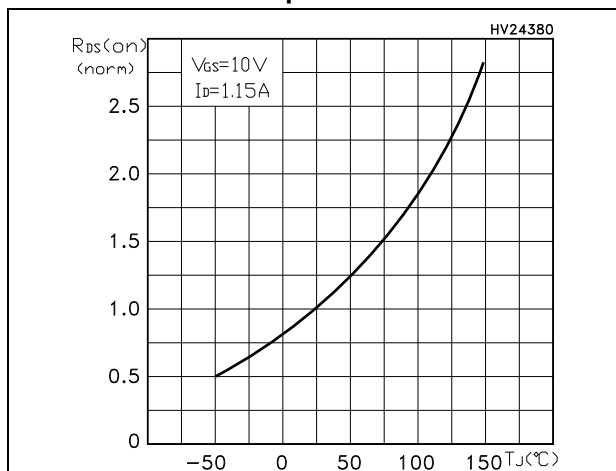


Figure 14. Normalized on-resistance vs temperature





### 3 Test circuits

Figure 15. Switching times test circuit for resistive load



Figure 16. Gate charge test circuit



Figure 17. Test circuit for inductive load switching and diode recovery times



Figure 18. Unclamped inductive load test circuit



Figure 19. Unclamped inductive waveform



Figure 20. Switching time waveform



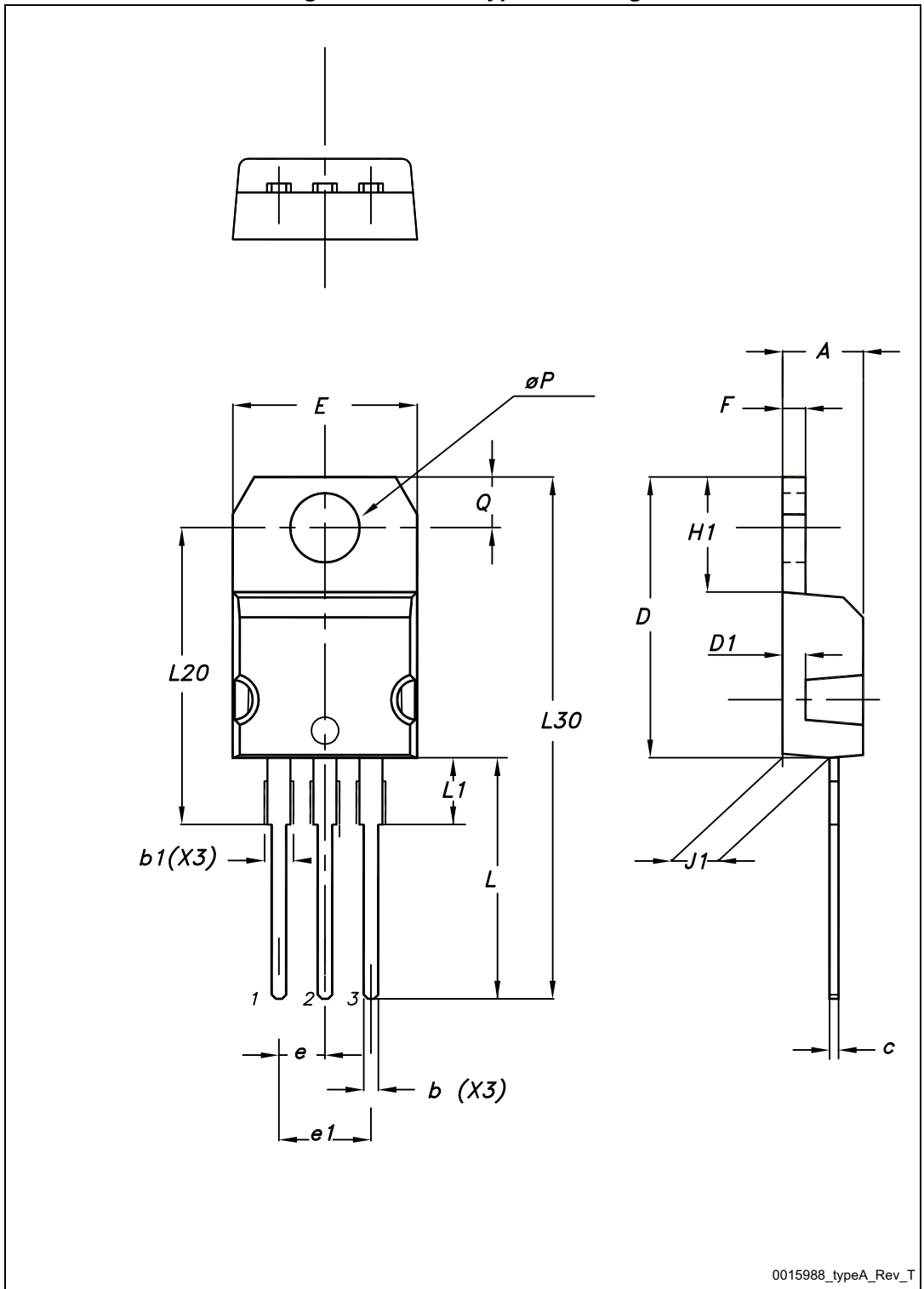
## 4 Package mechanical data

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 9. 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 21. TO-220 type A drawing



## 5 Revision history

Table 10. Document revision history

Date	Revision	Changes
13-Aug-2013	1	First release.

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