



# STD5N52K3, STF5N52K3 STP5N52K3, STU5N52K3

N-channel 525 V, 1.2  $\Omega$ , 4.4 A, DPAK, IPAK, TO-220, TO-220FP  
SuperMESH3™ Power MOSFET

Preliminary data

## Features

Type	V <sub>DSS</sub>	R <sub>DS(on) max</sub>	I <sub>D</sub>	P <sub>w</sub>
STD5N52K3	525 V	< 1.5 $\Omega$	4.4 A	70 W
STF5N52K3				25 W
STP5N52K3				70 W
STU5N52K3				

- 100% avalanche tested
- Extremely large avalanche performance
- Gate charge minimized
- Very low intrinsic capacitances
- Zener-protected

## Application

- Switching applications

## Description

The new SuperMESH3™ series of power MOSFETS is the result of the fine-tuning of ST's well-established strip-based PowerMESH™ layout with a new optimized vertical structure. The innovative design offer significantly reduced on-resistance, exceptional dynamic performance and very large avalanche capability, making the device suitable for the most demanding application.

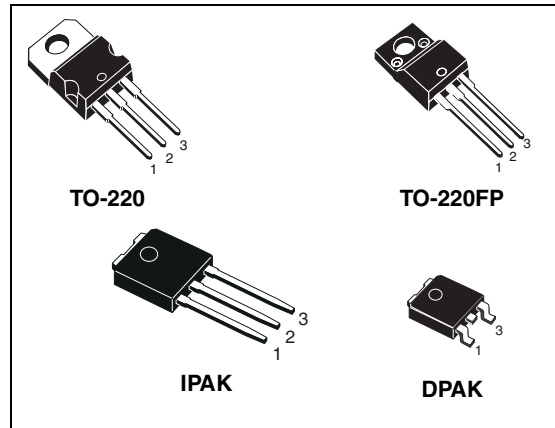


Figure 1. Internal schematic diagram

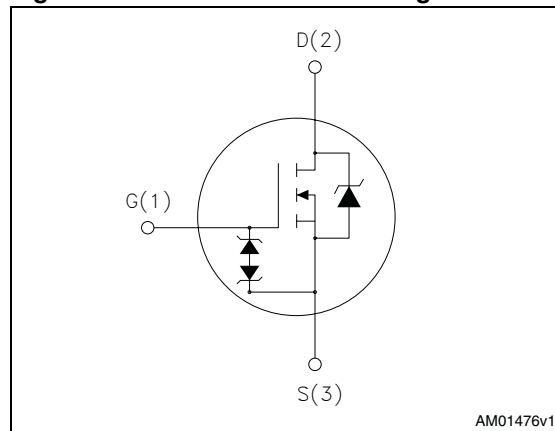


Table 1. Device summary

Order code	Marking	Package	Packaging
STD5N52K3	5N52K3	DPAK	Tape and reel
STF5N52K3		TO-220FP	Tube
STP5N52K3		TO-220	Tube
STU5N52K3		IPAK	Tube

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220 DPAK / IPAK	TO-220FP	
$V_{DS}$	Drain- source voltage	525		V
$V_{GS}$	Gate- source voltage	$\pm 30$		V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	4.4	4.4 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	3	3 <sup>(1)</sup>	A
$I_{DM}^{(2)}$	Drain current (pulsed)	17.6	17.6 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	70	25	W
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ max)	4.4		A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	TBD		mJ
$dv/dt^{(3)}$	Peak diode recovery voltage slope	12		V/ns
$dv/dt^{(3)}$	Diode reverse recovery current slope	200		A/ $\mu\text{s}$
$V_{ISO}$	Insulation withstand voltage (AC)		2500	
$T_J$ $T_{stg}$	Operating junction temperature Storage temperature	-55 to 150		$^\circ\text{C}$

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- $I_{SD} \leq 4.4\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ , peak  $V_{DS} \leq V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value				Unit
		TO-220	TO-220FP	IPAK	DPAK	
$R_{thj-case}$	Thermal resistance junction-case max	1.79	5	1.79		$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.50		100		$^\circ\text{C}/\text{W}$
$R_{thj-pcb}$	Thermal resistance junction-pcb max				50	$^\circ\text{C}/\text{W}$
$T_J$	Maximum lead temperature for soldering purpose	300				$^\circ\text{C}/\text{W}$

## 2 Electrical characteristics

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

**Table 4. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0	525			V
I <sub>DSS</sub>	Zero gate voltage drain current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = Max rating V <sub>DS</sub> = Max rating, T <sub>C</sub> = 125 °C			1 50	μA μA
I <sub>GSS</sub>	Gate-body leakage current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ± 20 V; V <sub>DS</sub> = 0			±10	μA
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 50 μA	3	3.75	4.5	V
R <sub>DS(on)</sub>	Static drain-source on resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 2.2 A		1.2	1.5	Ω

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g <sub>fs</sub> <sup>(1)</sup>	Forward transconductance	V <sub>DS</sub> = 15 V, I <sub>D</sub> = 2.2 A	-	TBD	-	S
C <sub>iss</sub> C <sub>oss</sub> C <sub>rss</sub>	Input capacitance Output capacitance Reverse transfer capacitance	V <sub>DS</sub> = 100 V, f = 1 MHz, V <sub>GS</sub> = 0	-	450 40 10	-	pF pF pF
C <sub>o(tr)</sub> <sup>(2)</sup>	Equivalent capacitance time related	V <sub>DS</sub> = 0 to 520 V, V <sub>GS</sub> = 0	-	TBD	-	pF
C <sub>o(er)</sub> <sup>(3)</sup>	Equivalent capacitance energy related	V <sub>DS</sub> = 0 to 520 V, V <sub>GS</sub> = 0	-	TBD	-	pF
R <sub>g</sub>	Gate input resistance	f = 1 MHz open drain	-	TBD	-	Ω
Q <sub>g</sub> Q <sub>gs</sub> Q <sub>gd</sub>	Total gate charge Gate-source charge Gate-drain charge	V <sub>DD</sub> = 400 V, I <sub>D</sub> = 4.4 A, V <sub>GS</sub> = 10 V (see Figure 3)	-	14 TBD TBD	-	nC nC nC

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

2. C<sub>oss eq.</sub> time related is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>

3. C<sub>oss eq.</sub> energy related is defined as a constant equivalent capacitance giving the same stored energy as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 260 \text{ V}$ , $I_D = 4.4 \text{ A}$ , $R_G = 4.7 \Omega$ , $V_{GS} = 10 \text{ V}$ (see Figure 2)	-	TBD	-	ns
$t_r$	Rise time			TBD		ns
$t_{d(off)}$	Turn-off-delay time			TBD		ns
$t_f$	Fall time			TBD		ns

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$I_{SD}$	Source-drain current		-		4.4	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				17.6	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 4.4 \text{ A}$ , $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 4.4 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see Figure 4)	-	TBD		ns
$Q_{rr}$	Reverse recovery charge			TBD		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			TBD		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 4.4 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ , $T_J = 150 \text{ }^\circ\text{C}$ (see Figure 4)	-	TBD		ns
$Q_{rr}$	Reverse recovery charge			TBD		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			TBD		A

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

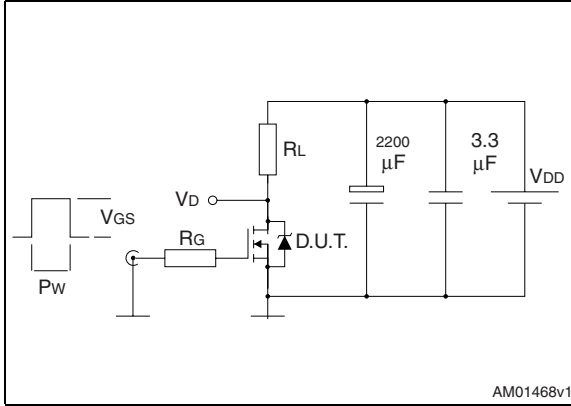
**Table 8. Gate-source Zener diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}$	Gate-source breakdown voltage	$I_{gs} = \pm 1 \text{ mA}$ (open drain)	30	-	-	V

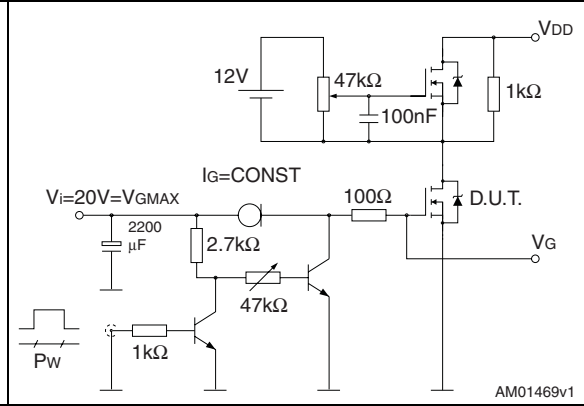
The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

### 3 Test circuits

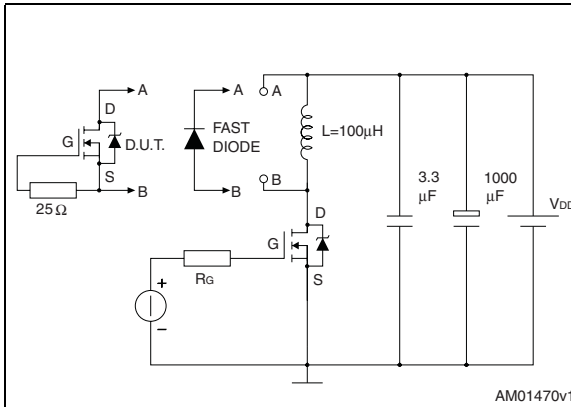
**Figure 2. Switching times test circuit for resistive load**



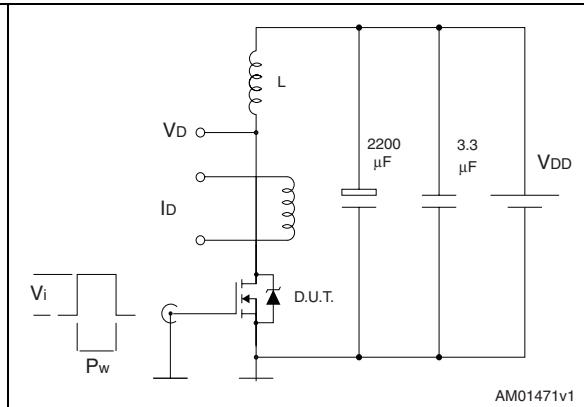
**Figure 3. Gate charge test circuit**



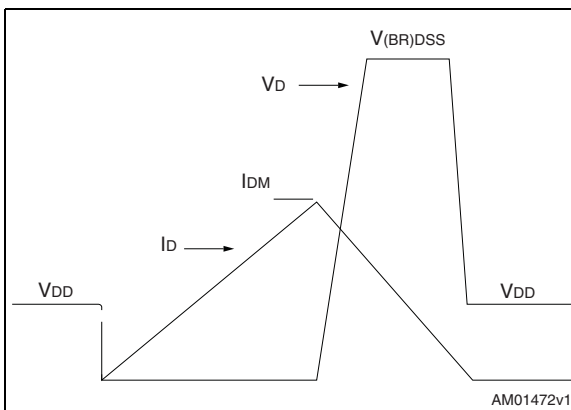
**Figure 4. Test circuit for inductive load switching and diode recovery times**



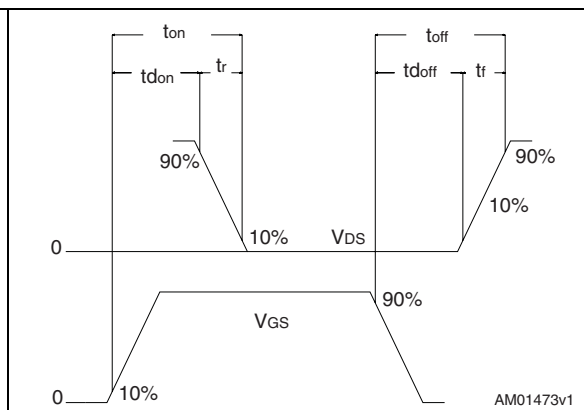
**Figure 5. Unclamped inductive load test circuit**



**Figure 6. Unclamped inductive waveform**



**Figure 7. Switching time waveform**

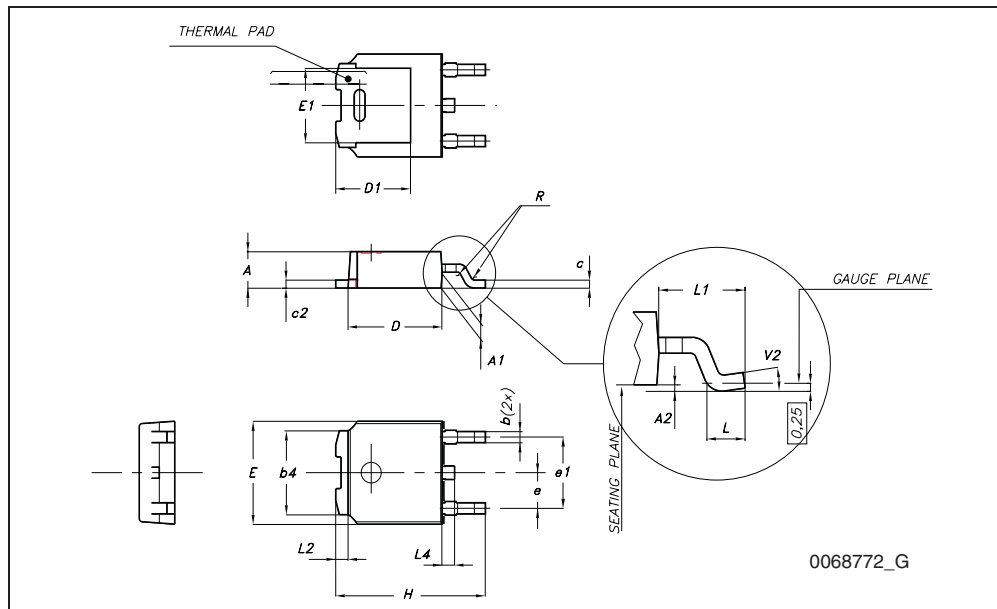


## 4 Package mechanical data

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 is an ST trademark.

TO-252 (DPAK) mechanical data

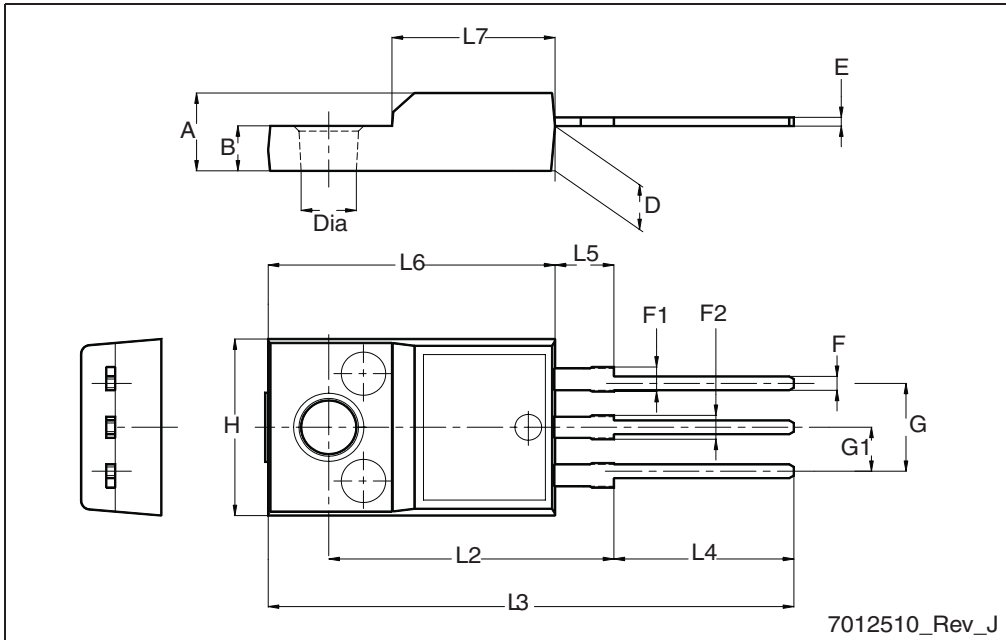
DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°





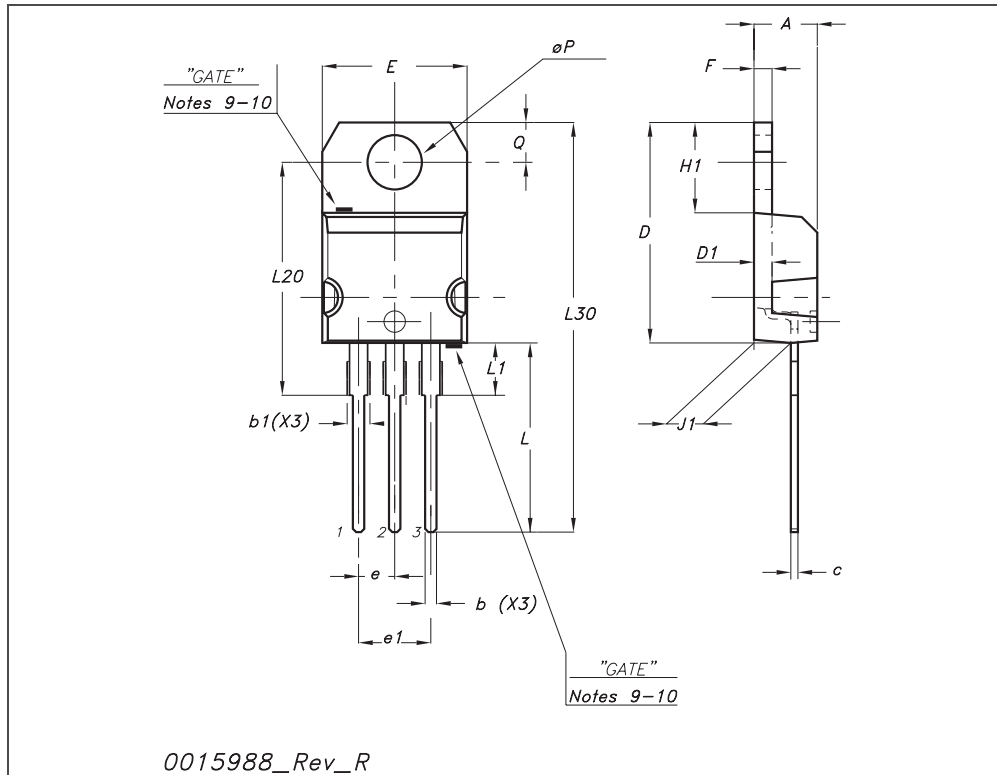
TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.5
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2



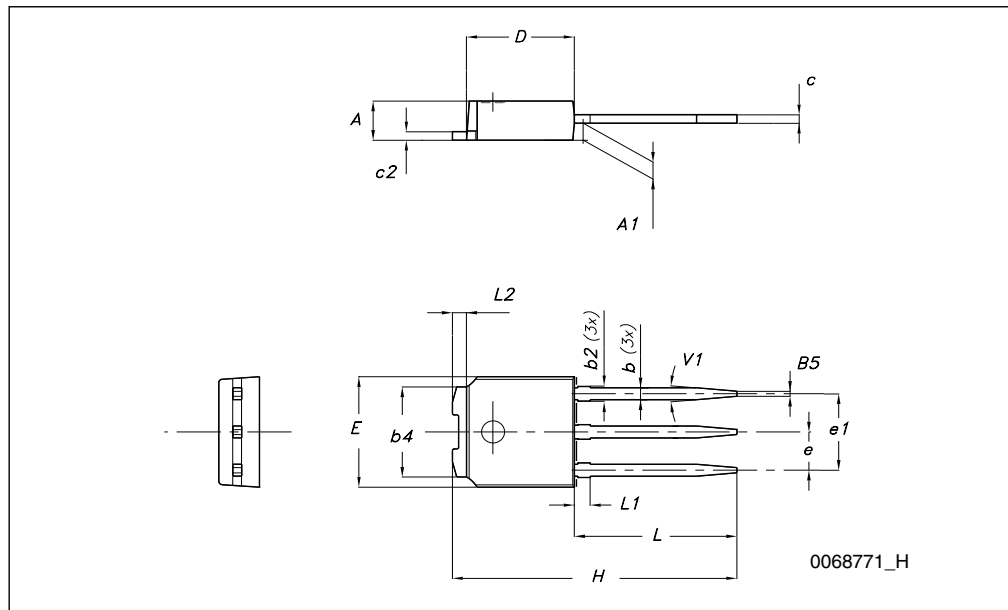
TO-220 mechanical data

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	1.14		1.70	0.044		0.066
c	0.48		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
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		0.051
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	
∅P	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



TO-251 (IPAK) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
(L1)	0.80		1.20
L2		0.80	
V1		10°	



## 5 Revision history

Table 9. Document revision history

Date	Revision	Changes
05-Jan-2010	1	First release.

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