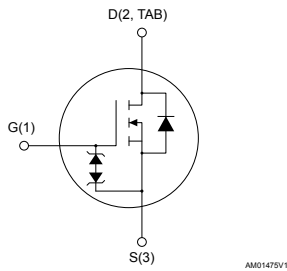
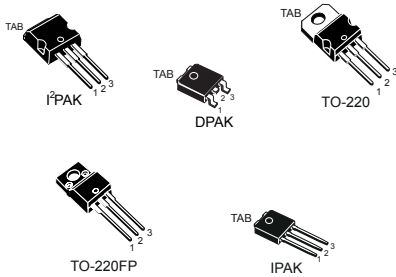




# THE DATASHEET OF STB5NK50ZT4



## N-channel 500 V, 1.22 $\Omega$ typ., 4.4 A SuperMESH™ Power MOSFETs in I<sup>2</sup>PAK, DPAK, TO-220, TO-220FP and IPAK packages



### Features

Order codes	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>	Package
STB5NK50Z-1	500 V	1.5 $\Omega$	4.4 A	I <sup>2</sup> PAK
STD5NK50ZT4				DPAK
STP5NK50Z				TO-220
STP5NK50ZFP				TO-220FP
STU5NK50Z				IPAK

- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance
- Zener-protected

### Applications

- Switching applications

### Description

These high-voltage devices are Zener-protected N-channel Power MOSFETs developed using the SuperMESH™ technology by STMicroelectronics, an optimization of the well-established PowerMESH™. In addition to a significant reduction in on-resistance, these devices are designed to ensure a high level of dv/dt capability for the most demanding applications.

#### Product status link

[STB5NK50Z-1](#)
[STD5NK50ZT4](#)
[STP5NK50Z](#)
[STP5NK50ZFP](#)
[STU5NK50Z](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		I <sup>2</sup> PAK, DPAK, TO-220, IPAK	TO-220FP	
V <sub>DS</sub>	Drain-source voltage	500		V
V <sub>GS</sub>	Gate-source voltage	±30		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	4.4	4.4 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	2.7	2.7 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	17.6	17.6 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	70	25	W
ESD	Gate-source human body model (R = 1.5 kΩ, C = 100 pF)	3		kV
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat-sink (t = 1 s, T <sub>C</sub> = 25 °C)		2.5	kV
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	4.5		V/ns
T <sub>j</sub>	Operating junction temperature range	-55 to 150		°C
T <sub>stg</sub>	Storage temperature range			

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3.  $I_{SD} \leq 4.4 \text{ A}$ ,  $di/dt \leq 200 \text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value				Unit
		I <sup>2</sup> PAK, TO-220	TO-220FP	DPAK	IPAK	
R <sub>thj-case</sub>	Thermal resistance junction-case	1.78	5	1.78		°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient	62.5			100	°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb			50		°C/W

1. When mounted on an 1-inch<sup>2</sup> FR-4, 2oz Cu board.

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> Max)	4.4	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	130	mJ

## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}, V_{GS} = 0\text{ V}$	500			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}, V_{DS} = 500\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}, V_{DS} = 500\text{ V}, T_C = 125\text{ °C}^{(1)}$			50	$\mu\text{A}$
$I_{GSS}$	Gate body leakage current	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	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	$V_{GS} = 10\text{ V}, I_D = 2.2\text{ A}$		1.22	1.5	$\Omega$

1. Defined by design, not subject to production test.

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}, V_{GS} = 0\text{ V}$	-	535		$\mu\text{F}$
$C_{oss}$	Output capacitance			75		
$C_{rSS}$	Reverse transfer capacitance			17		
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }400\text{ V}, V_{GS} = 0\text{ V}$	-	45		$\mu\text{F}$
$Q_g$	Total gate charge	$V_{DD} = 400\text{ V}, I_D = 4.4\text{ A}, V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 16. Test circuit for gate charge behavior)	-	20	28	nC
$Q_{gs}$	Gate-source charge			4		
$Q_{gd}$	Gate-drain charge			10		

1.  $C_{oss\text{ eq.}}$  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 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 250\text{ V}, I_D = 2.2\text{ A},$ $R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	15	-	ns
$t_r$	Rise time			10		
$t_{d(off)}$	Turn-off delay time			32		
$t_f$	Fall time			15		

**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	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 4.4 \text{ A}$ , $V_{GS} = 0 \text{ V}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 4.4 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$	-	310		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 30 \text{ V}$ , $T_j = 150^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching and diode recovery times)		1.425		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			9.2		A

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

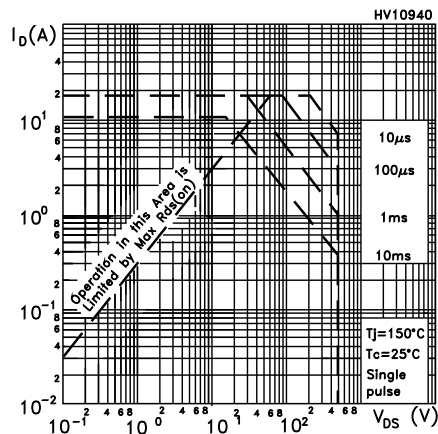
**Table 8. Gate-source Zener diode**

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

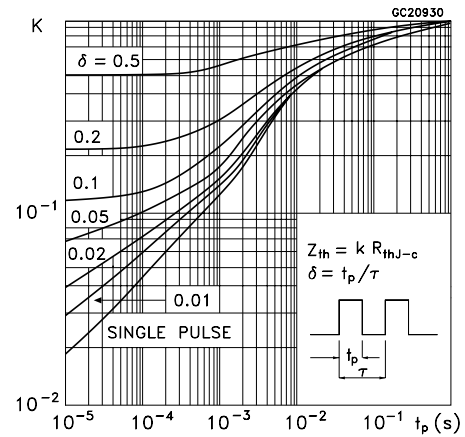
The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.1 Electrical characteristics curves

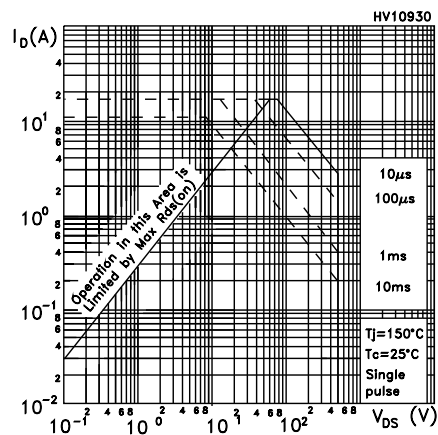
**Figure 1. Safe operating area for I<sup>2</sup>PAK, DPAK, TO-220, IPAK**



**Figure 2. Thermal impedance for I<sup>2</sup>PAK, DPAK, TO-220, IPAK**



**Figure 3. Safe operating area for TO-220FP**



**Figure 4. Thermal impedance for TO-220FP**

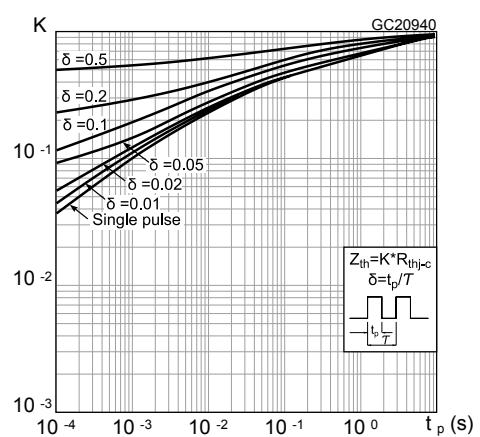


Figure 5. Output characteristics

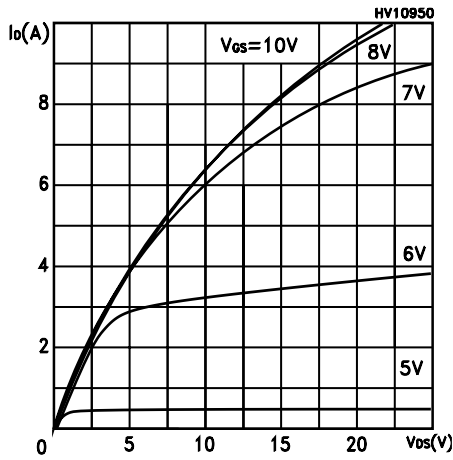


Figure 6. Transfer characteristics

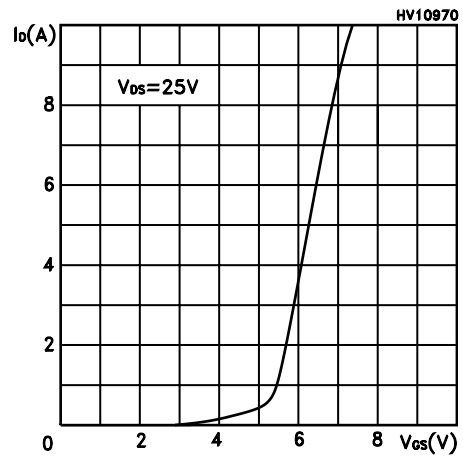


Figure 7. Static drain-source on resistance

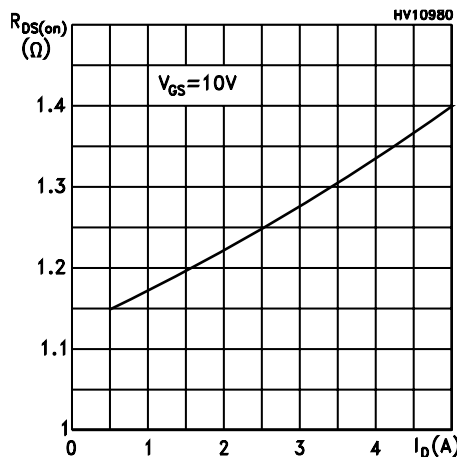


Figure 8. Gate charge vs gate-source voltage

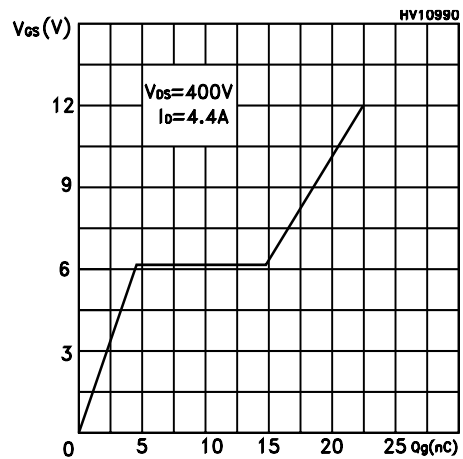


Figure 9. Capacitance variations

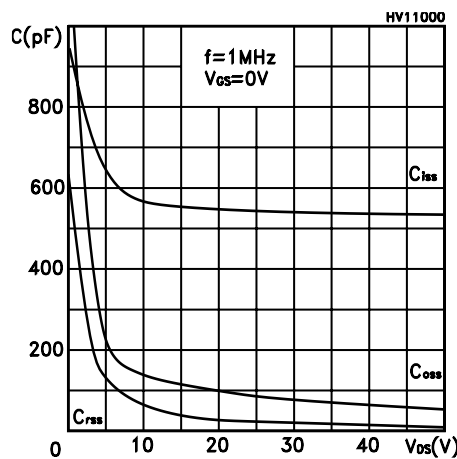


Figure 10. Normalized gate threshold voltage vs temperature

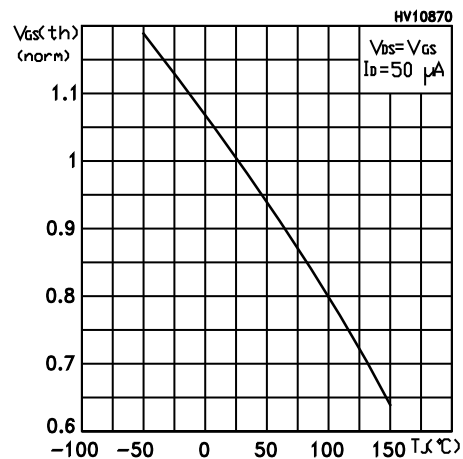


Figure 11. Normalized on resistance vs temperature

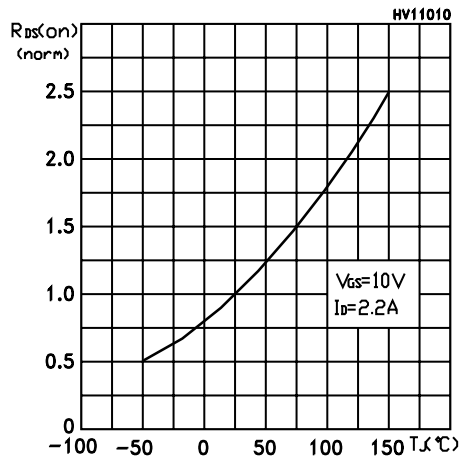


Figure 12. Source-drain diode forward characteristic

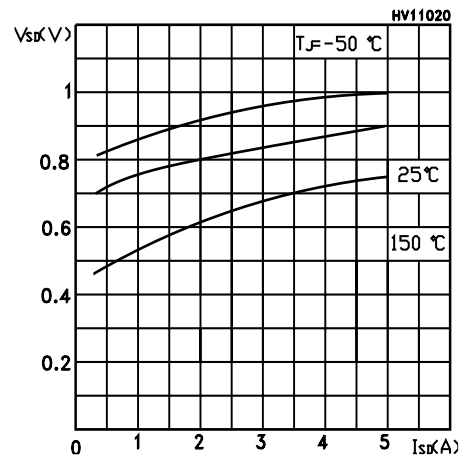


Figure 13. Normalized  $V_{(BR)DSS}$  vs temperature

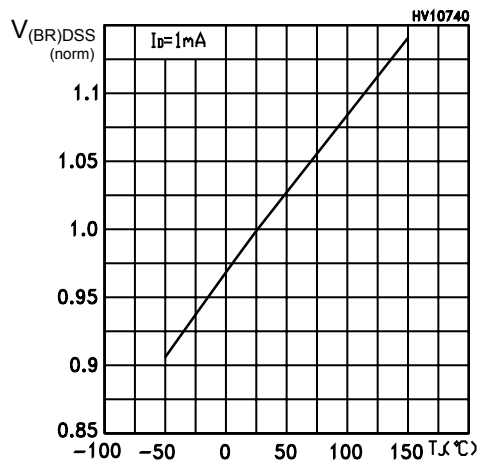
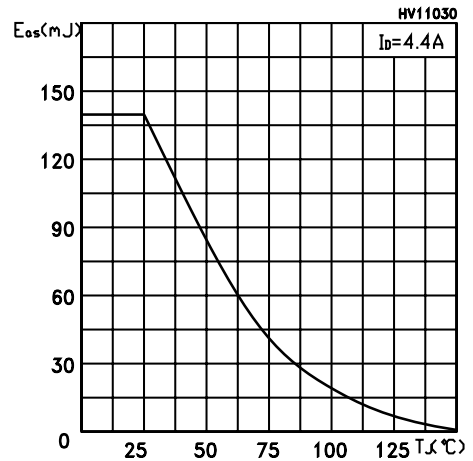
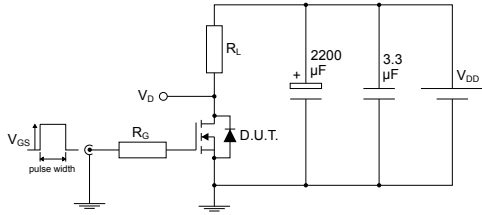


Figure 14. Maximum avalanche energy vs temperature



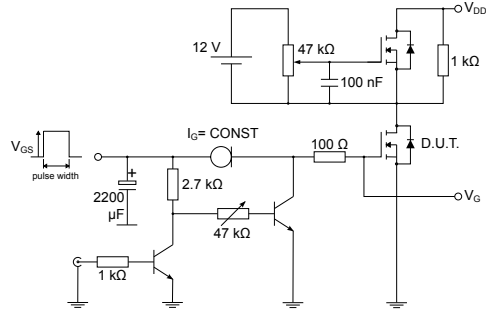
### 3 Test circuits

Figure 15. Test circuit for resistive load switching times



AM01468v1

Figure 16. Test circuit for gate charge behavior



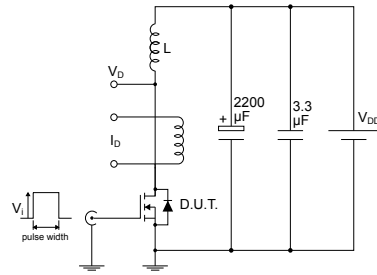
AM01469v1

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



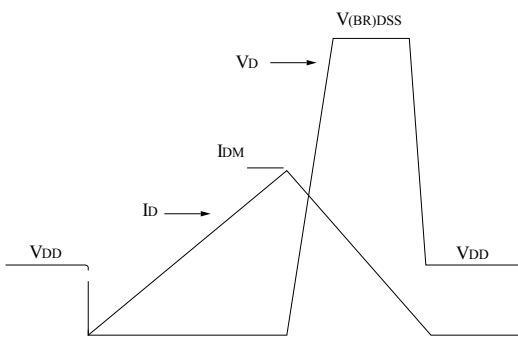
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Figure 18. Unclamped inductive load test circuit



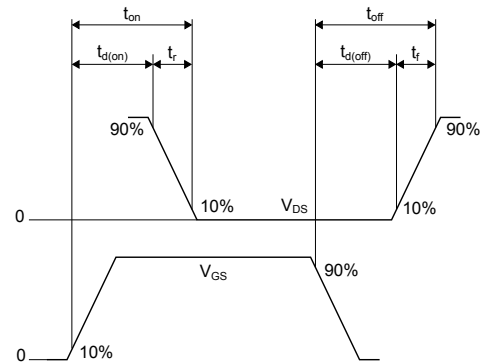
AM01471v1

Figure 19. Unclamped inductive waveform



AM01472v1

Figure 20. Switching time waveform



AM01473v1



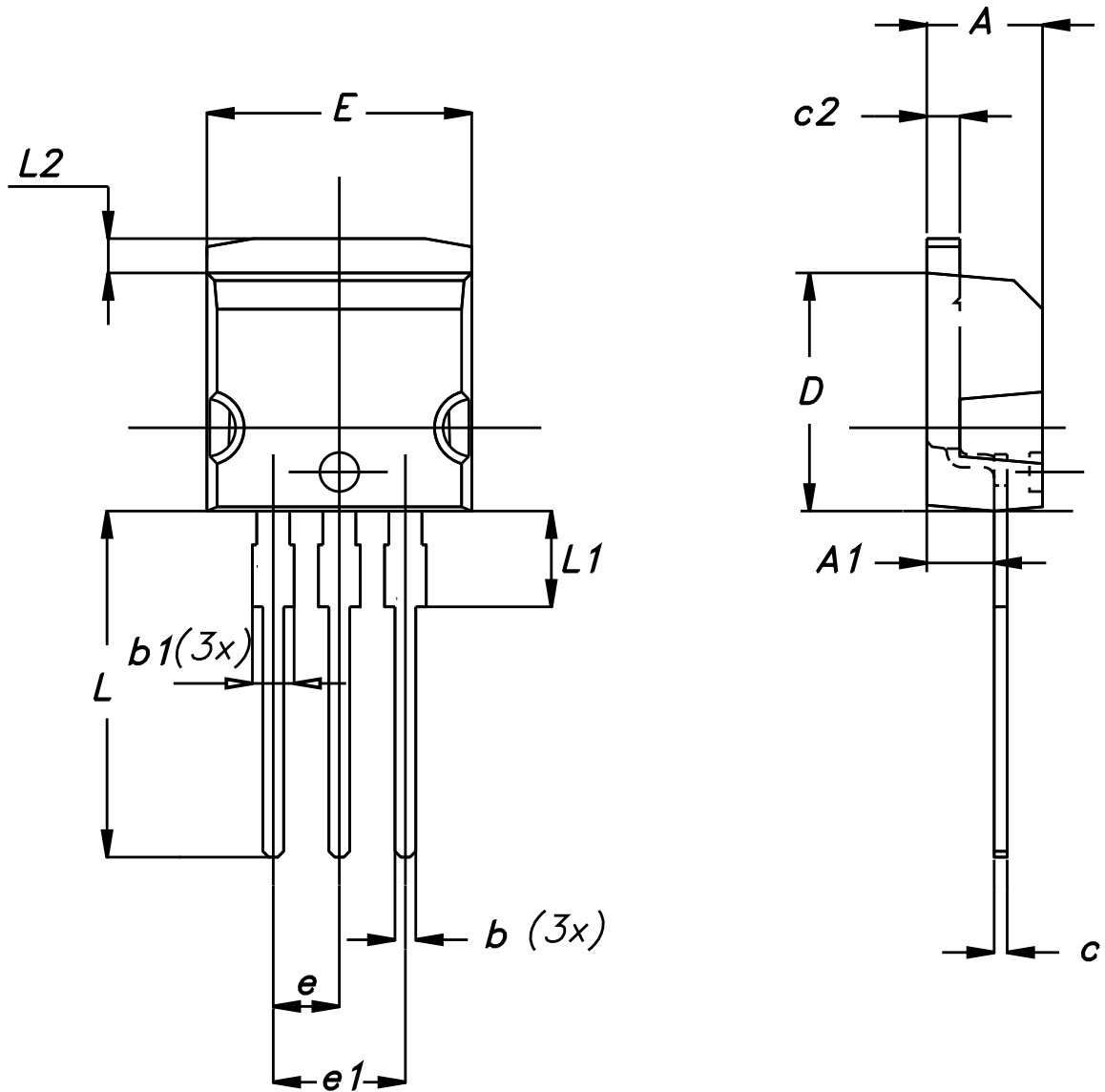
## 4 Package information

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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](http://www.st.com). ECOPACK® is an ST trademark.

#### 4.1 I<sup>2</sup>PAK package information

Figure 21. I<sup>2</sup>PAK package outline



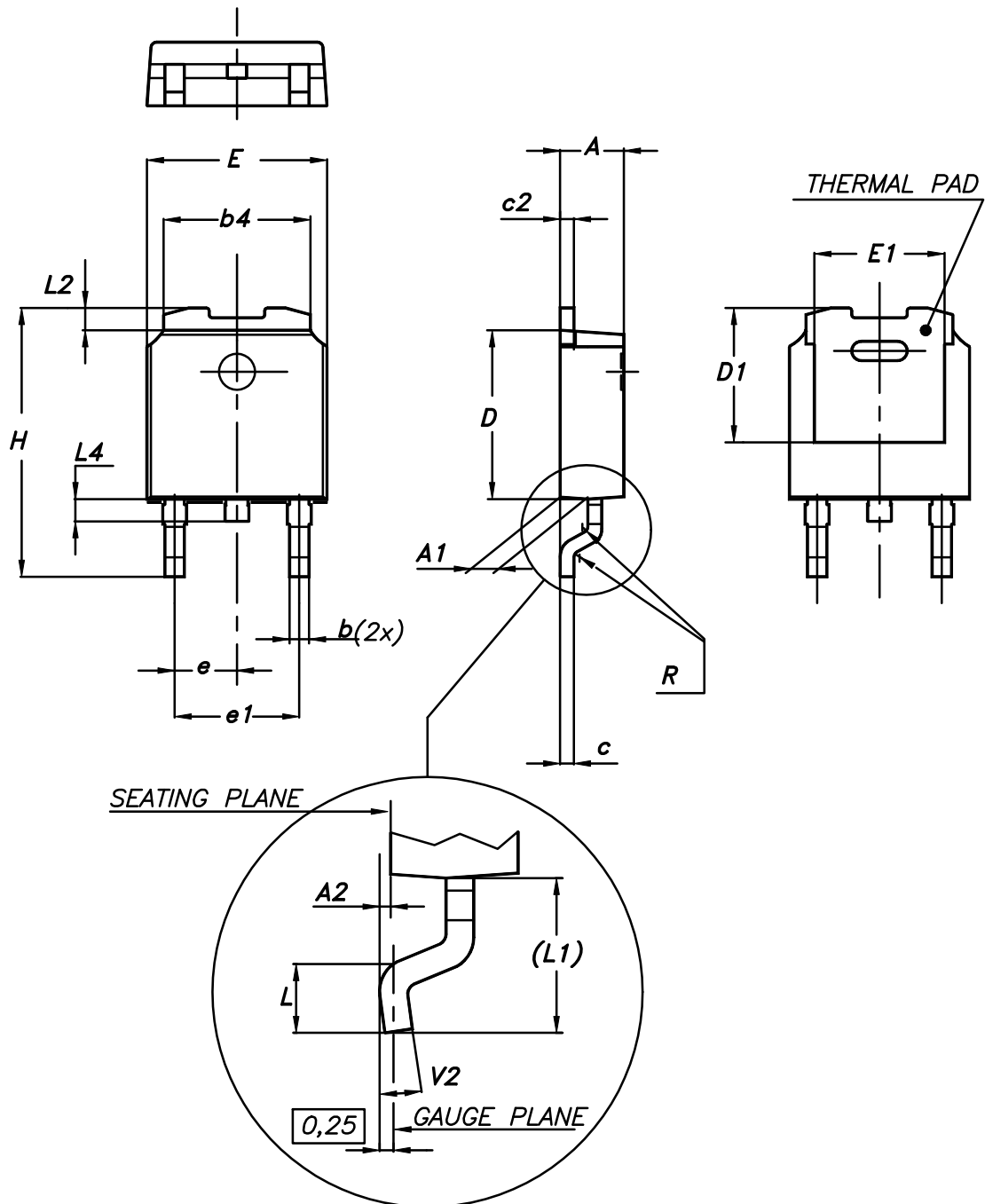
0004982\_Rev\_H

**Table 9. I<sup>2</sup>PAK package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40	-	4.60
A1	2.40	-	2.72
b	0.61	-	0.88
b1	1.14	-	1.70
c	0.49	-	0.70
c2	1.23	-	1.32
D	8.95	-	9.35
e	2.40	-	2.70
e1	4.95	-	5.15
E	10	-	10.40
L	13	-	14
L1	3.50	-	3.93
L2	1.27	-	1.40

## 4.2 DPAK (TO-252) type A package information

Figure 22. DPAK (TO-252) type A package outline



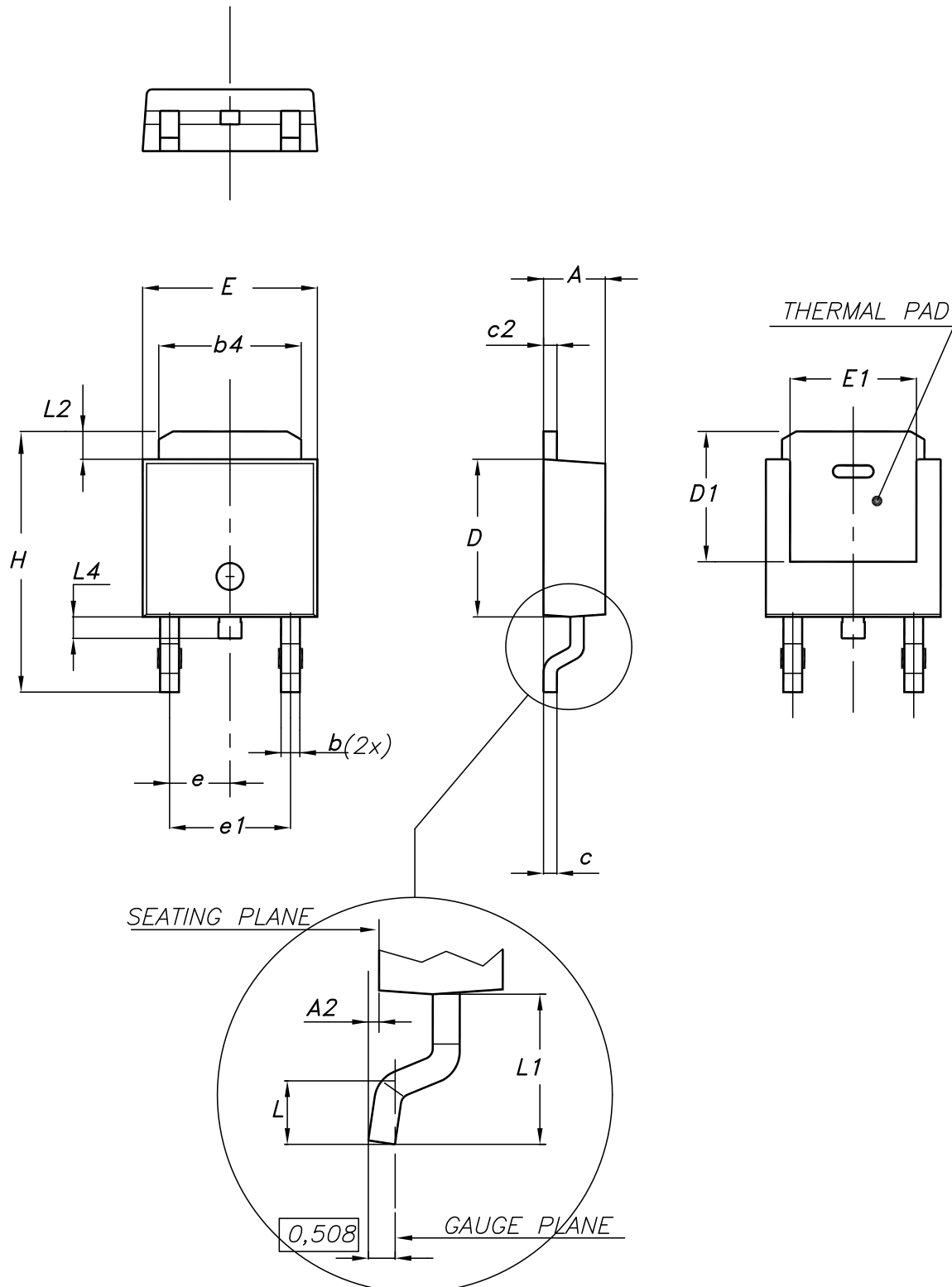
0068772\_A\_25

**Table 10. DPAK (TO-252) type A 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	4.95	5.10	5.25
E	6.40		6.60
E1	4.60	4.70	4.80
e	2.159	2.286	2.413
e1	4.445	4.572	4.699
H	9.35		10.10
L	1.00		1.50
(L1)	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

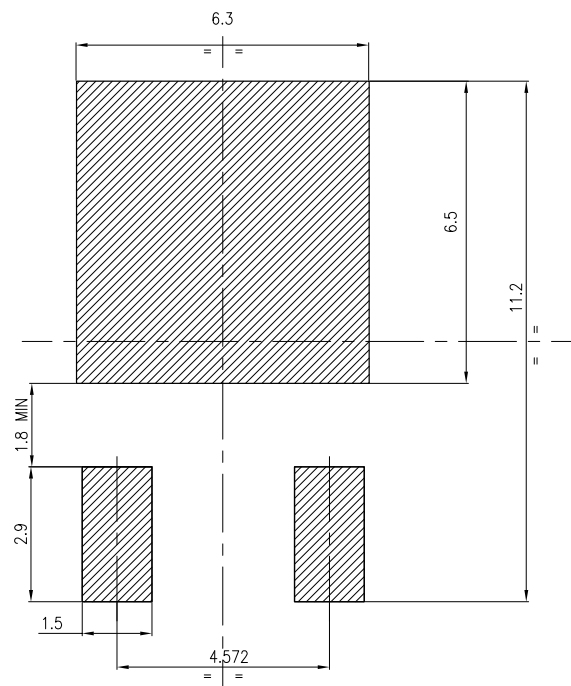
### 4.3 DPAK (TO-252) type E package information

Figure 23. DPAK (TO-252) type E package outline



**Table 11. DPAK (TO-252) type E mechanical data**

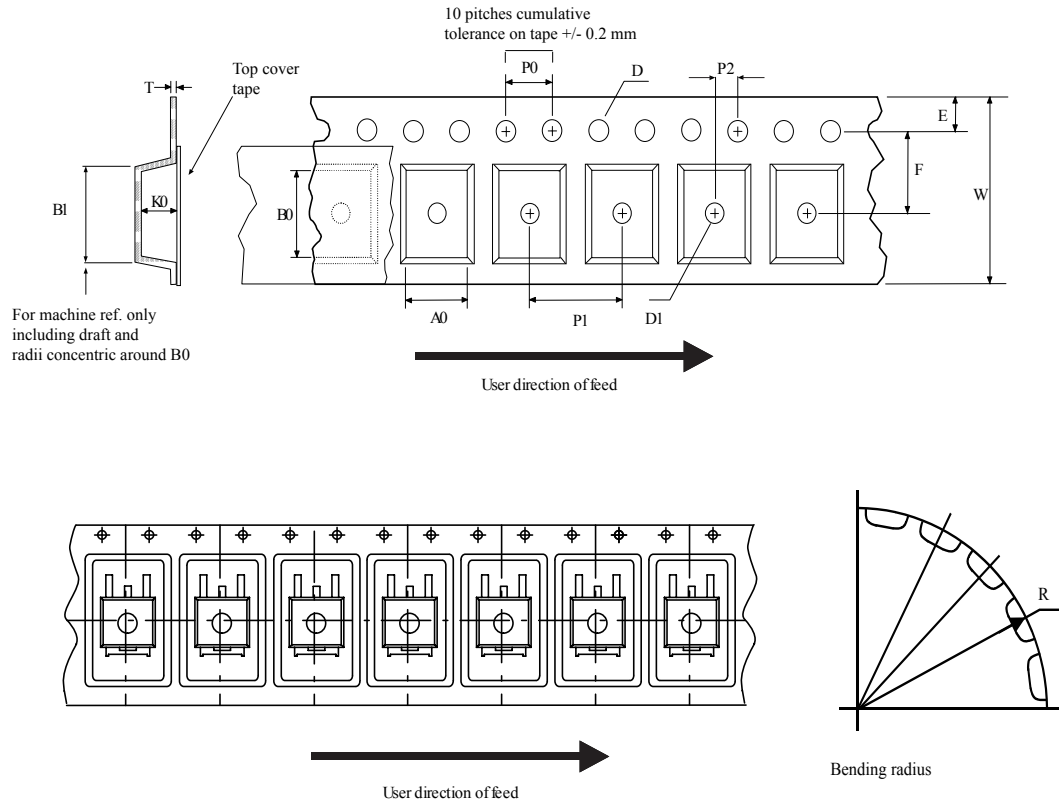
Dim.	mm		
	Min.	Typ.	Max.
A	2.18		2.39
A2			0.13
b	0.65		0.884
b4	4.95		5.46
c	0.46		0.61
c2	0.46		0.60
D	5.97		6.22
D1	5.21		
E	6.35		6.73
E1	4.32		
e		2.286	
e1		4.572	
H	9.94		10.34
L	1.50		1.78
L1		2.74	
L2	0.89		1.27
L4			1.02

**Figure 24. DPAK (TO-252) recommended footprint (dimensions are in mm)**


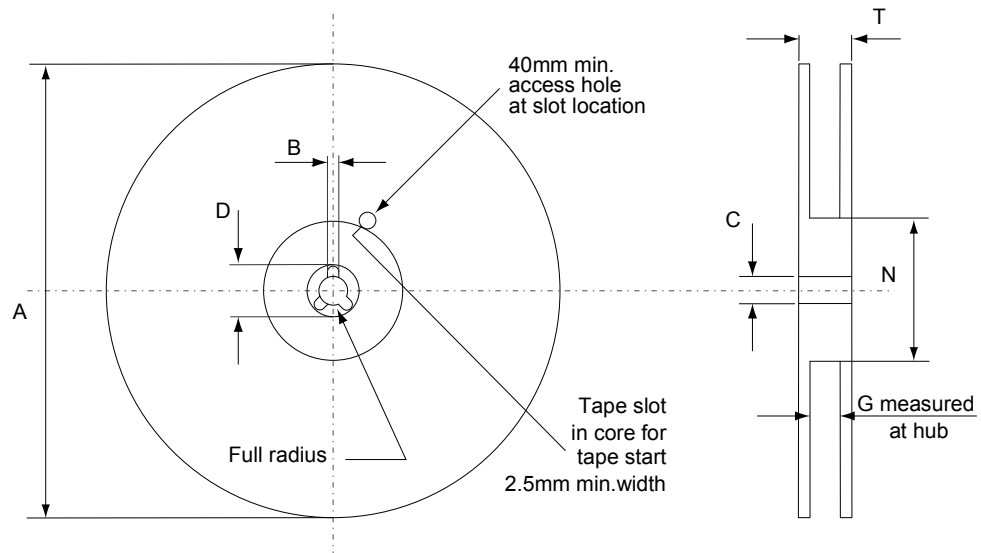
FP\_0068772\_25

#### 4.4 DPAK (TO-252) packing information

Figure 25. DPAK (TO-252) tape outline



AM08852v1

**Figure 26. DPAK (TO-252) reel outline**


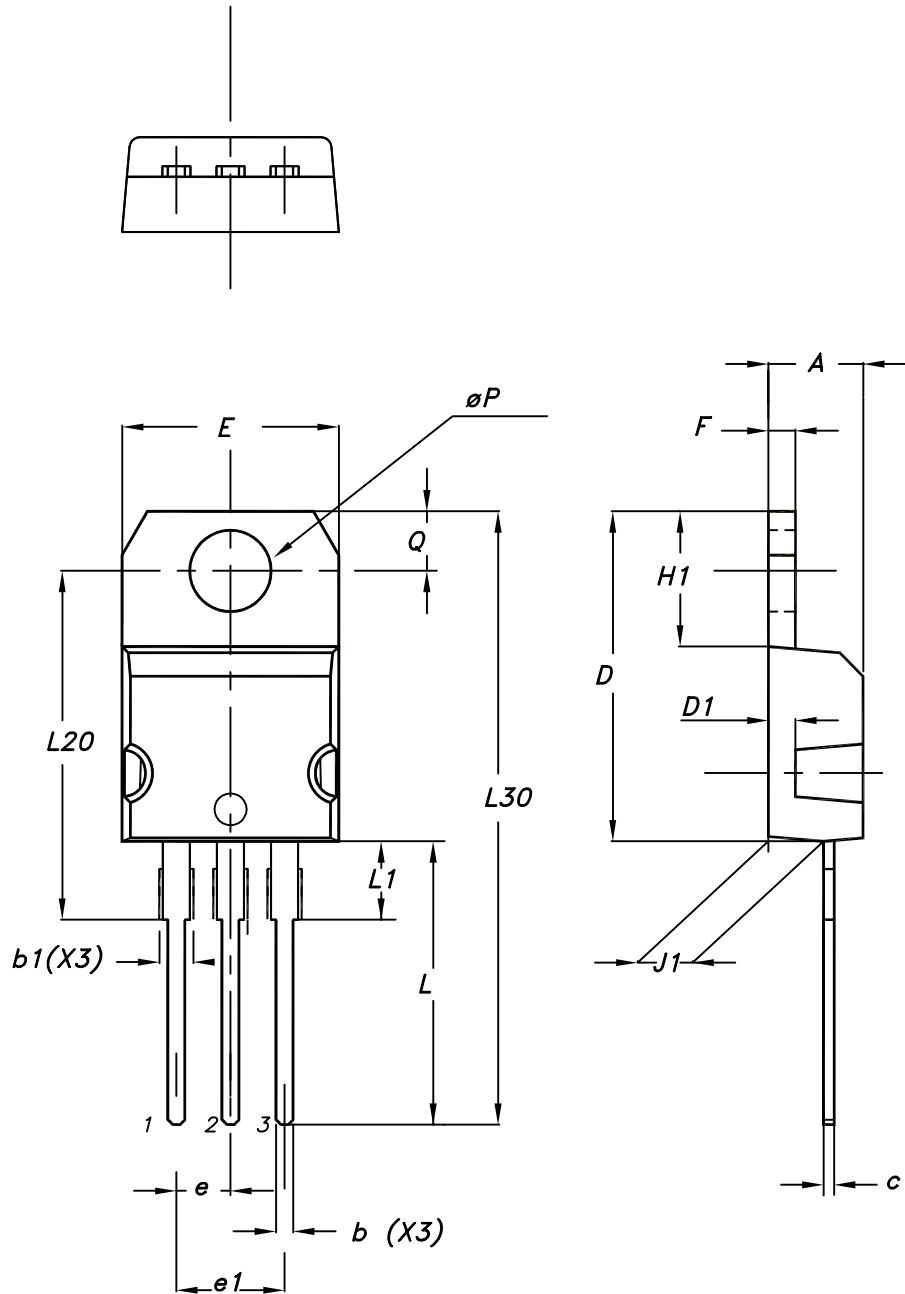
AM06038v1

**Table 12. DPAK (TO-252) tape and reel mechanical data**

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

### 4.5 TO-220 type A package information

Figure 27. TO-220 type A package outline



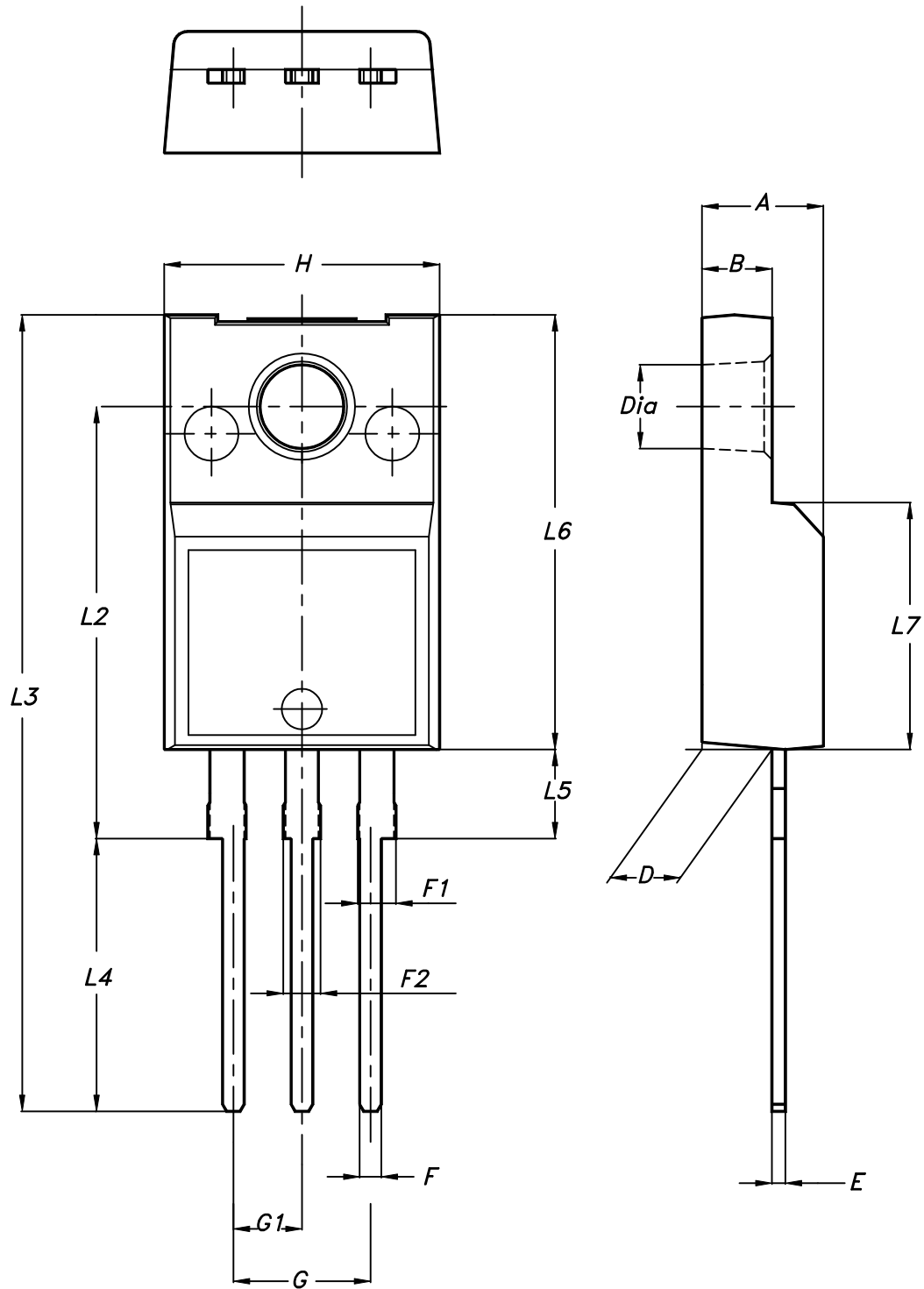
0015988\_typeA\_Rev\_21

**Table 13. TO-220 type A package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øP	3.75		3.85
Q	2.65		2.95

4.6 TO-220FP package information

Figure 28. TO-220FP package outline



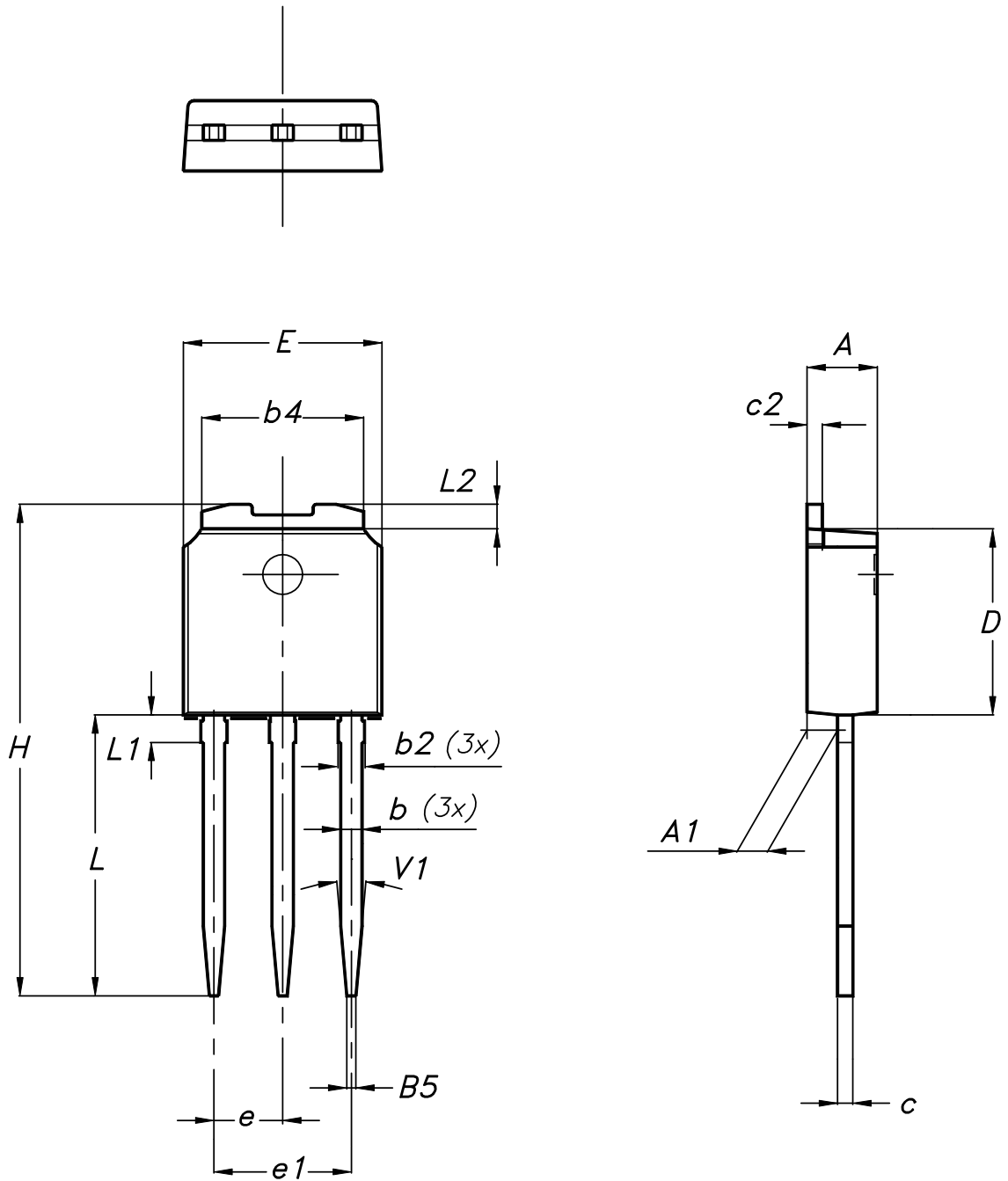
7012510\_Rev\_12\_B

**Table 14. TO-220FP package 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		1.70
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

#### 4.7 IPAk (TO-251) type A package information

Figure 29. IPAk (TO-251) type A package outline



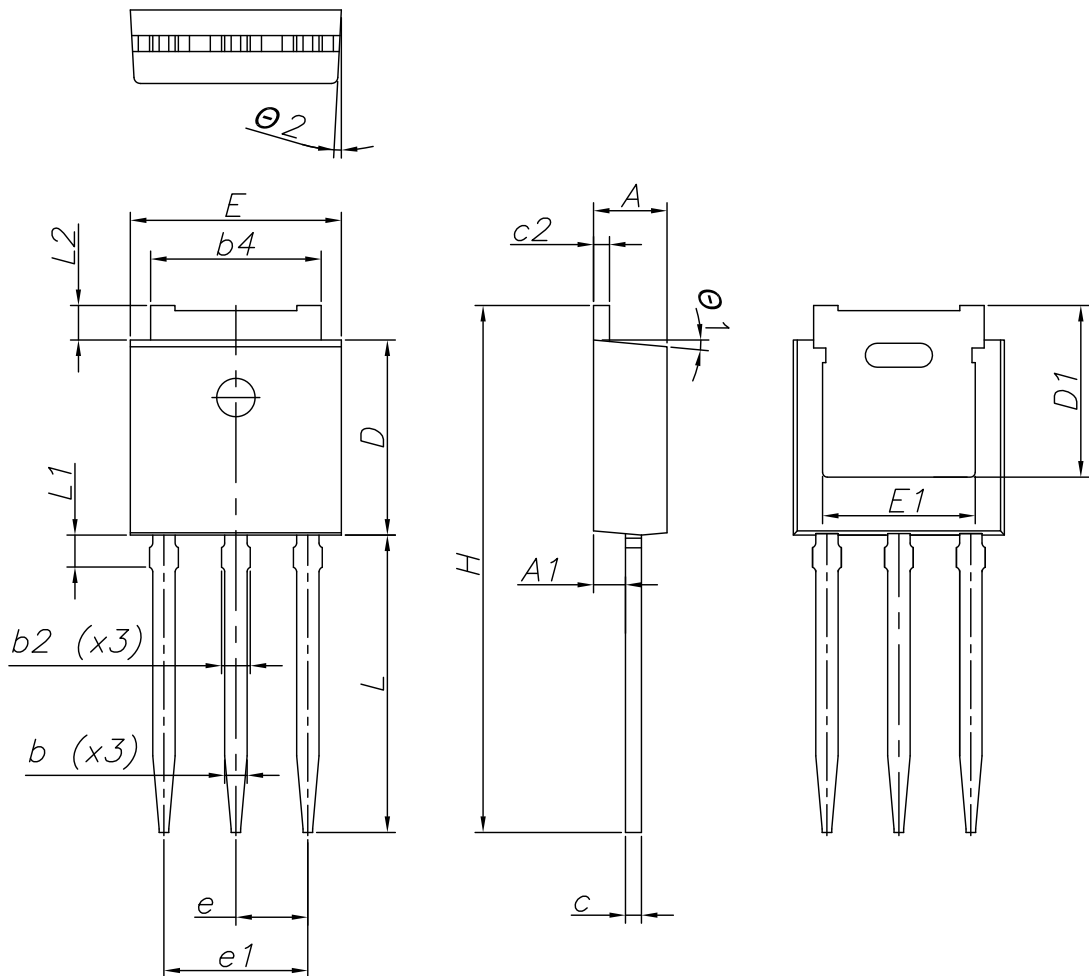
0068771\_IK\_typeA\_rev14

**Table 15. IPAK (TO-251) type A package 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
B5		0.30	
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	1.00
V1		10°	

### 4.8 IPAK (TO-251) type C package information

Figure 30. IPAK (TO-251) type C package outline



0068771\_IK\_typeC\_rev14

**Table 16. IPAK (TO-251) type C package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.35
A1	0.90	1.00	1.10
b	0.66		0.79
b2			0.90
b4	5.23	5.33	5.43
c	0.46		0.59
c2	0.46		0.59
D	6.00	6.10	6.20
D1	5.20	5.37	5.55
E	6.50	6.60	6.70
E1	4.60	4.78	4.95
e	2.20	2.25	2.30
e1	4.40	4.50	4.60
H	16.18	16.48	16.78
L	9.00	9.30	9.60
L1	0.80	1.00	1.20
L2	0.90	1.08	1.25
θ1	3°	5°	7°
θ2	1°	3°	5°

## 5 Ordering information

**Table 17. Order codes**

Order code	Marking	Package	Packing
STB5NK50Z-1	B5NK50Z	I <sup>2</sup> PAK	Tube
STD5NK50ZT4	D5NK50Z	DPAK	Tape and reel
STP5NK50Z	P5NK50Z	TO-220	Tube
STP5NK50ZFP	P5NK50ZFP	TO-220FP	Tube
STU5NK50Z	5NK50Z	IPAK	Tube

## Revision history

**Table 18. Document revision history**

Date	Version	Changes
16-Jun-2004	4	D <sup>2</sup> PAK Included. New Stylesheet.
06-Sep-2005	5	Inserted Ecopack indication
18-Sep-2018	6	The part number STB5NK50Z has been moved to a separate datasheet. Added part number STU5NK50Z. Updated <a href="#">Section 4 Package information</a> .

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