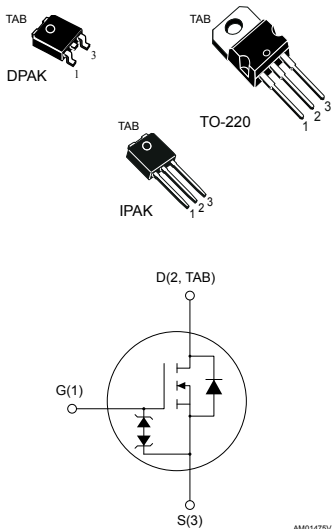


## N-channel 525 V, 2.1 $\Omega$ typ., 2.5 A MDmesh™ K3 Power MOSFETs in DPAK, TO-220 and IPAK packages



### Features

Order code	$V_{DS}$	$R_{DS(on)max.}$	$I_D$	Package
STD4N52K3	525 V	2.6 $\Omega$	2.5 A	DPAK
STP4N52K3			2.5 A	TO-220
STU4N52K3			2.5 A	IPAK

- 100% avalanche tested
- Extremely high dv/dt capability
- Very low intrinsic capacitance
- Improved diode reverse recovery characteristics
- Zener-protected

### Applications

- Switching applications

### Description

These MDmesh™ K3 Power MOSFETs are the result of improvements applied to STMicroelectronics' MDmesh™ technology, combined with a new optimized vertical structure. These devices boast an extremely low on-resistance, superior dynamic performance and high avalanche capability, rendering them suitable for the most demanding applications.

#### Product status link

[STD4N52K3](#)
[STP4N52K3](#)
[STU4N52K3](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	525	V
$V_{GS}$	Gate-source voltage	$\pm 30$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	2.5	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	2	A
$I_{DM}^{(1)}$	Drain current (pulsed)	10	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	45	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	12	V/ns
$T_j$	Operating junction temperature range	-55 to 150	$^\circ\text{C}$
$T_{stg}$	Storage temperature range		

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 2.5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DSpeak} \leq V_{(BR)DSS}$ .  $V_{DD} = 80\% V_{(BR)DSS}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value			Unit
		DPAK	TO-220	IPAK	
$R_{thj-case}$	Thermal resistance junction-case	2.78		2.78	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient		62.5	100	$^\circ\text{C}/\text{W}$
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb	50			$^\circ\text{C}/\text{W}$

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

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}^{(1)}$	Avalanche current, repetitive or not-repetitive	1.3	A
$E_{AS}^{(2)}$	Single pulse avalanche energy	110	mJ

1. Pulse width limited by  $T_j$  max.
2. Starting  $T_j = 25\text{ }^\circ\text{C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$ .

## 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	$I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$	525			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 525\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 525\text{ V}$ , $T_C = 125\text{ °C}$ <sup>(1)</sup>			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	$V_{GS} = 10\text{ V}$ , $I_D = 1.25\text{ A}$		2.1	2.6	$\Omega$

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

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	334	-	$\mu\text{F}$
$C_{oss}$	Output capacitance			28		
$C_{rss}$	Reverse transfer capacitance			5		
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }420\text{ V}$ , $V_{GS} = 0\text{ V}$	-	20	-	$\mu\text{F}$
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	4	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 420\text{ V}$ , $I_D = 2.5\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 16. Test circuit for gate charge behavior)	-	11	-	nC
$Q_{gs}$	Gate-source charge			2		
$Q_{gd}$	Gate-drain charge			7		

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 420 V.

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 260\text{ V}$ , $I_D = 1.25\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	8	-	ns
$t_r$	Rise time			7		
$t_{d(off)}$	Turn-off delay time			21		
$t_f$	Fall time			14		

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		2.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				10	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 2.5 \text{ A}$ , $V_{GS} = 0 \text{ V}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 2.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$	-	173		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60 \text{ V}$ (see Figure 17. Test circuit for inductive load switching and diode recovery times)		778		nC
$I_{RRM}$	Reverse recovery current			9		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 2.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$	-	196		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching and diode recovery times)		941		nC
$I_{RRM}$	Reverse recovery current			10		A

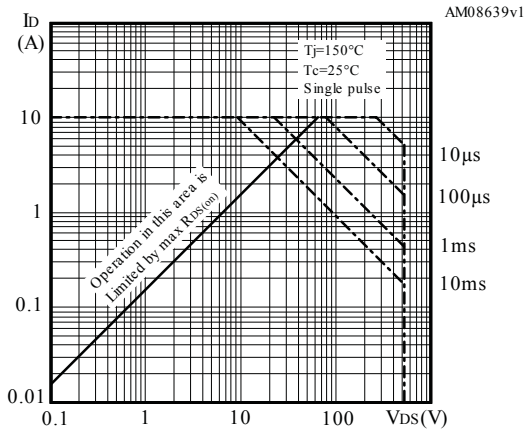
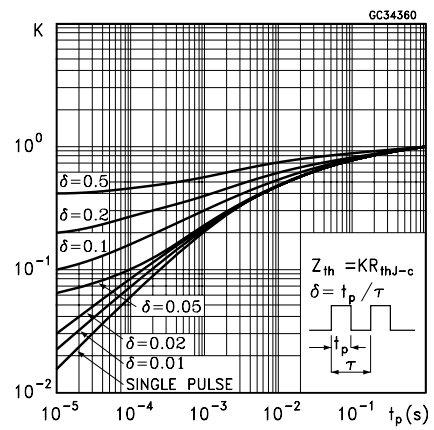
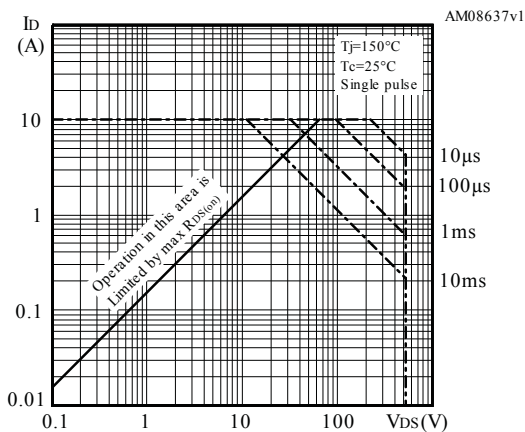
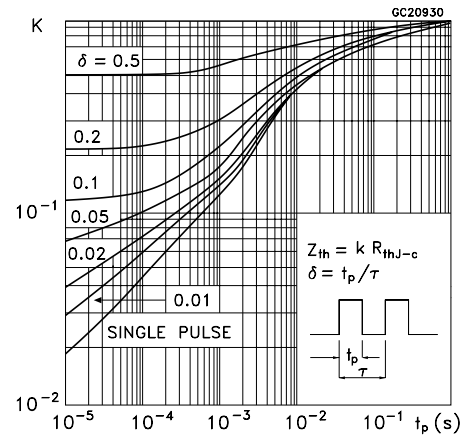
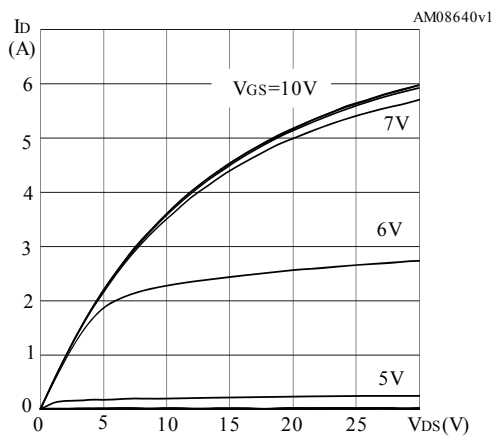
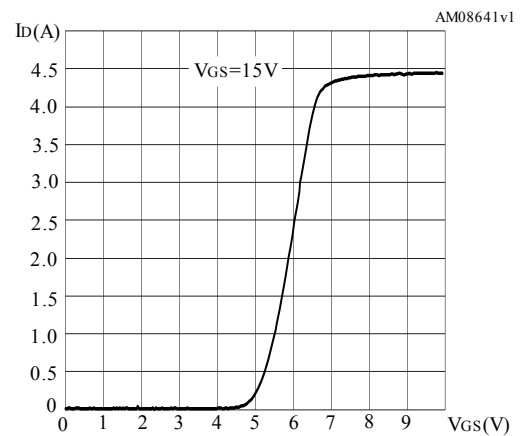
1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

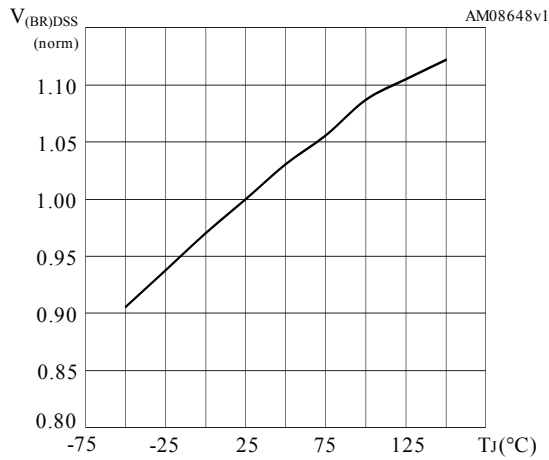
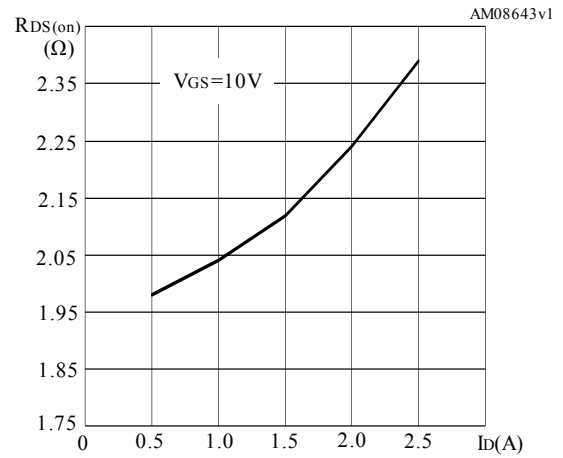
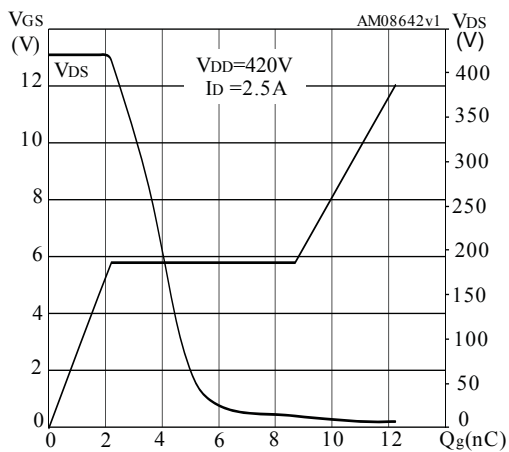
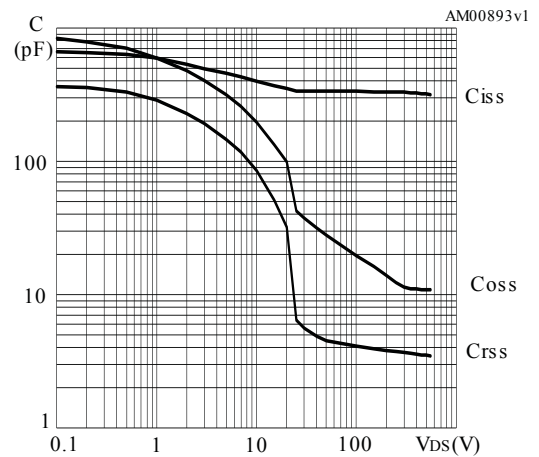
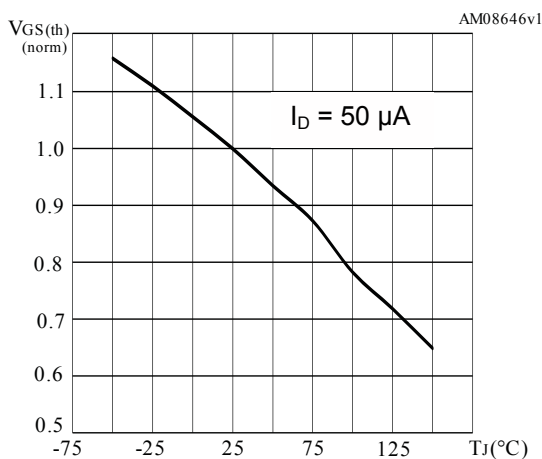
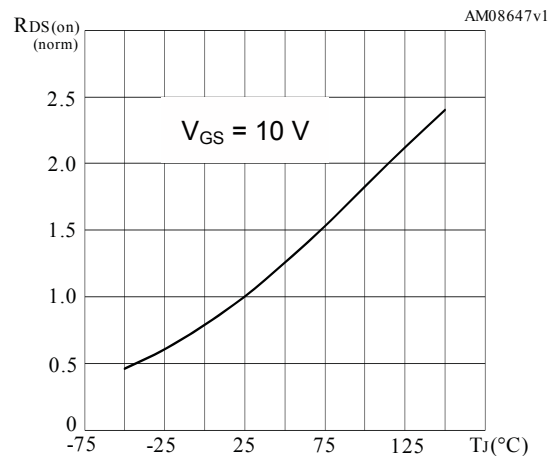
**Table 8. Gate-source Zener diode**

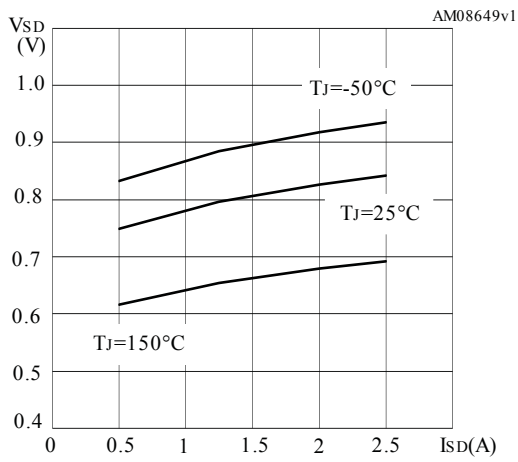
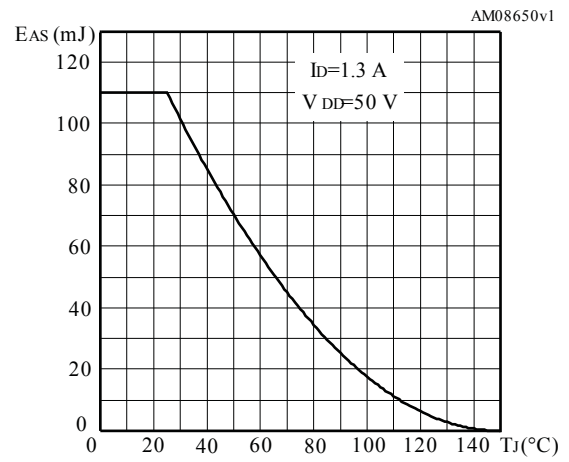
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1 \text{ mA}$ , $I_D = 0 \text{ A}$	30	-	-	V

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 DPAK/IPAK**

**Figure 2. Thermal impedance for DPAK/IPAK**

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

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

**Figure 5. Output characteristics**

**Figure 6. Transfer characteristics**


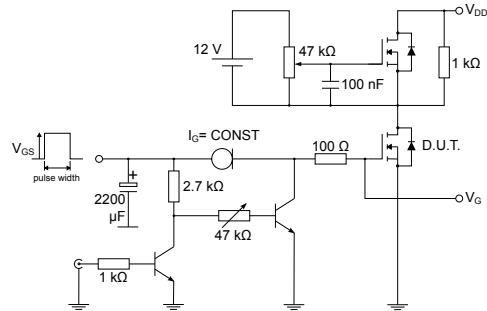
**Figure 7. Normalized  $V_{(BR)DSS}$  vs temperature**

**Figure 8. Static drain-source on-resistance**

**Figure 9. Gate charge vs gate-source voltage**

**Figure 10. Capacitance variations**

**Figure 11. Normalized gate threshold voltage vs temperature**

**Figure 12. Normalized on-resistance vs temperature**


**Figure 13. Source-drain diode forward characteristics**

**Figure 14. Maximum avalanche energy vs temperature**


### 3 Test circuits

**Figure 15. Test circuit for resistive load switching times**

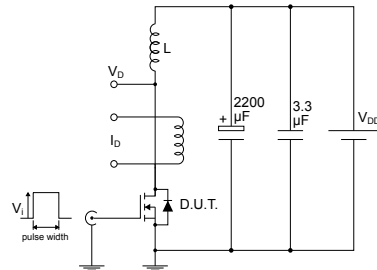

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**Figure 16. Test circuit for gate charge behavior**


AM01469v1

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

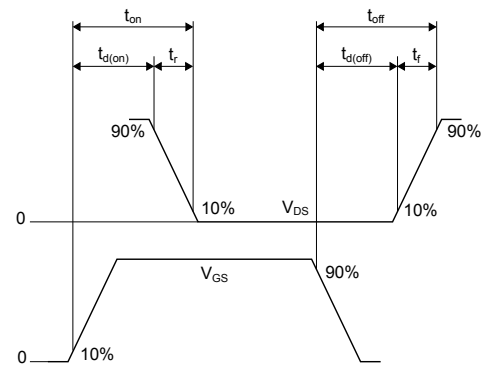

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**Figure 18. Unclamped inductive load test circuit**


AM01471v1

**Figure 19. Unclamped inductive waveform**


AM01472v1

**Figure 20. Switching time waveform**


AM01473v1



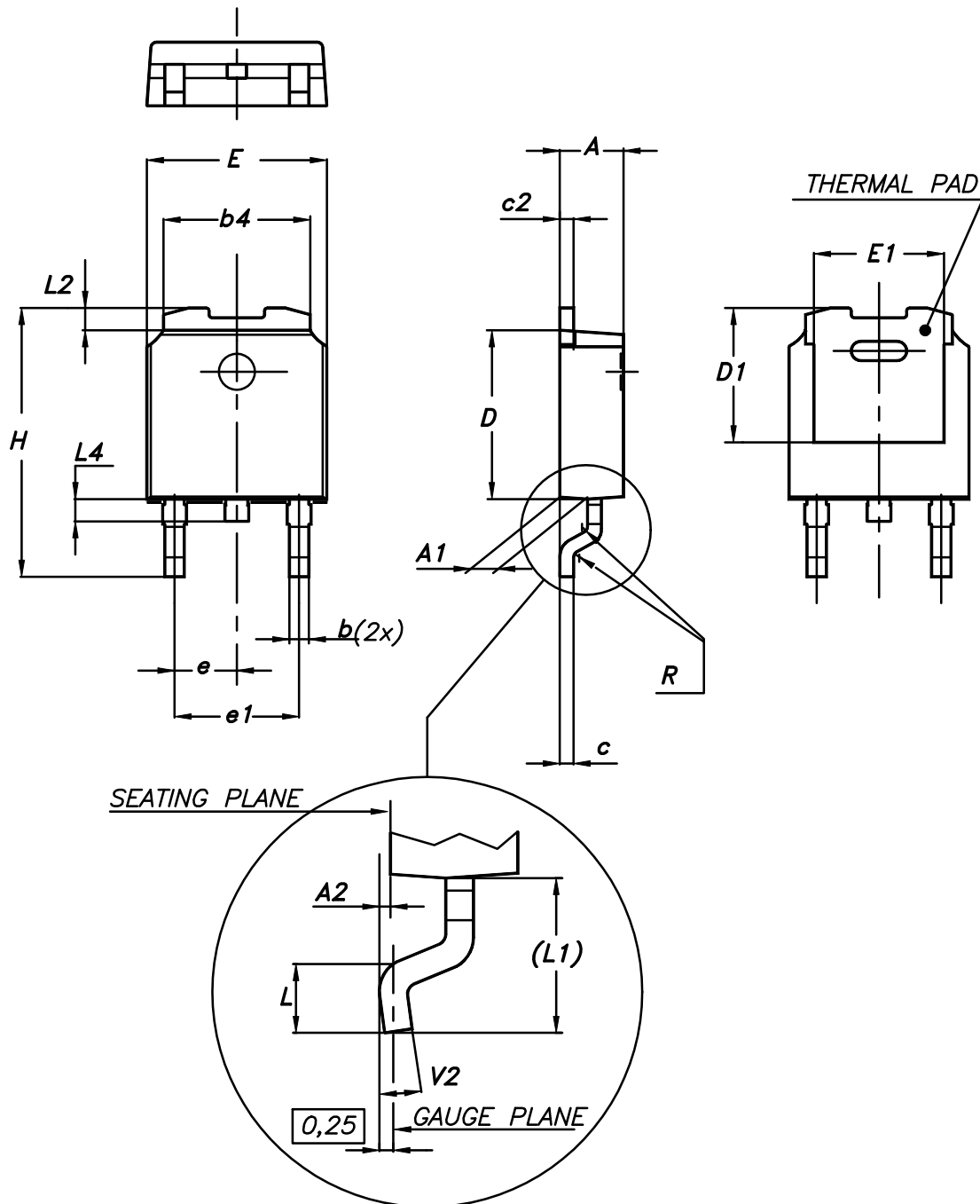
## **4 Package information**

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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 DPAK (TO-252) type A package information

Figure 21. DPAK (TO-252) type A package outline



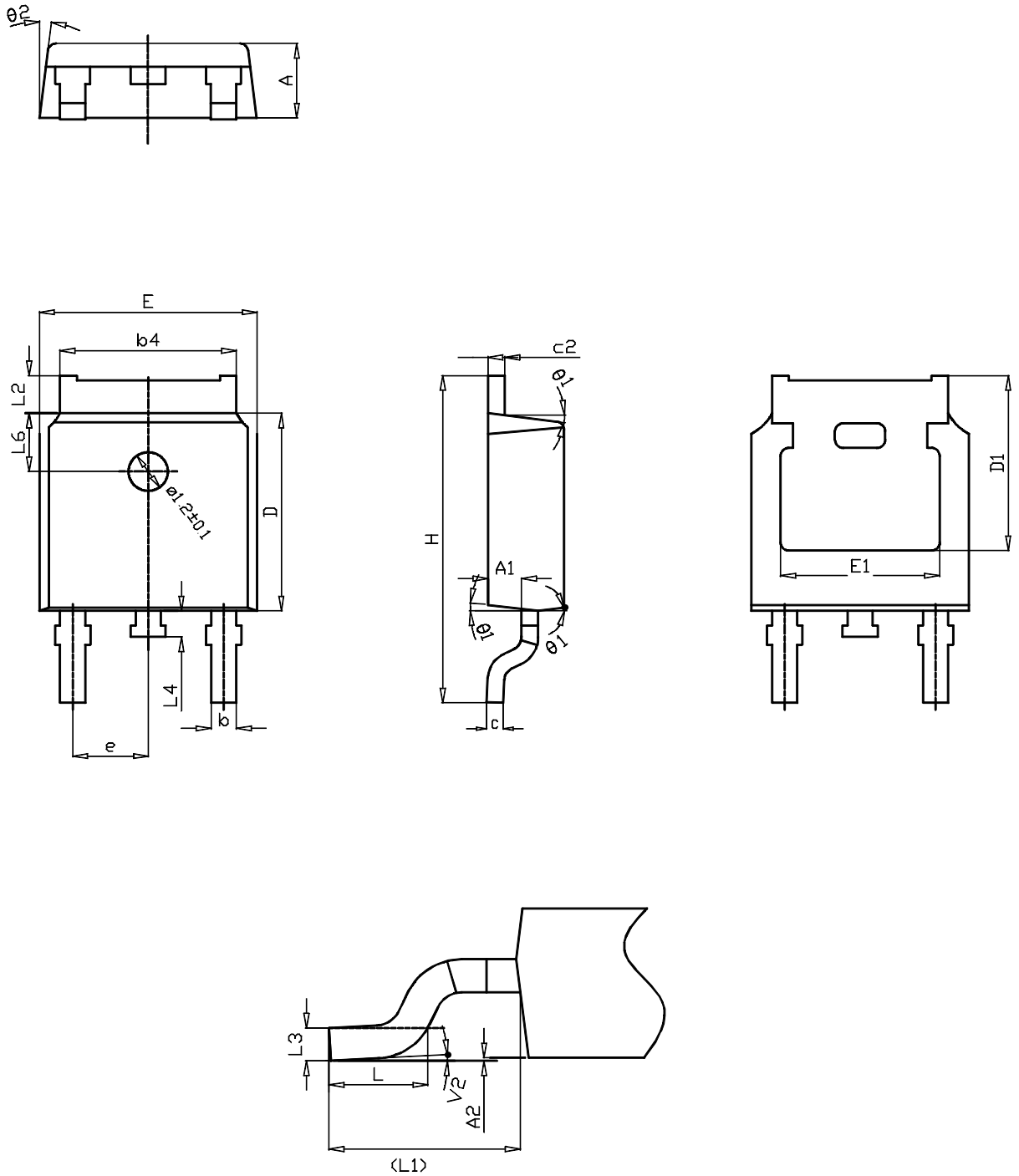
0068772\_A\_25

**Table 9. 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°

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

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



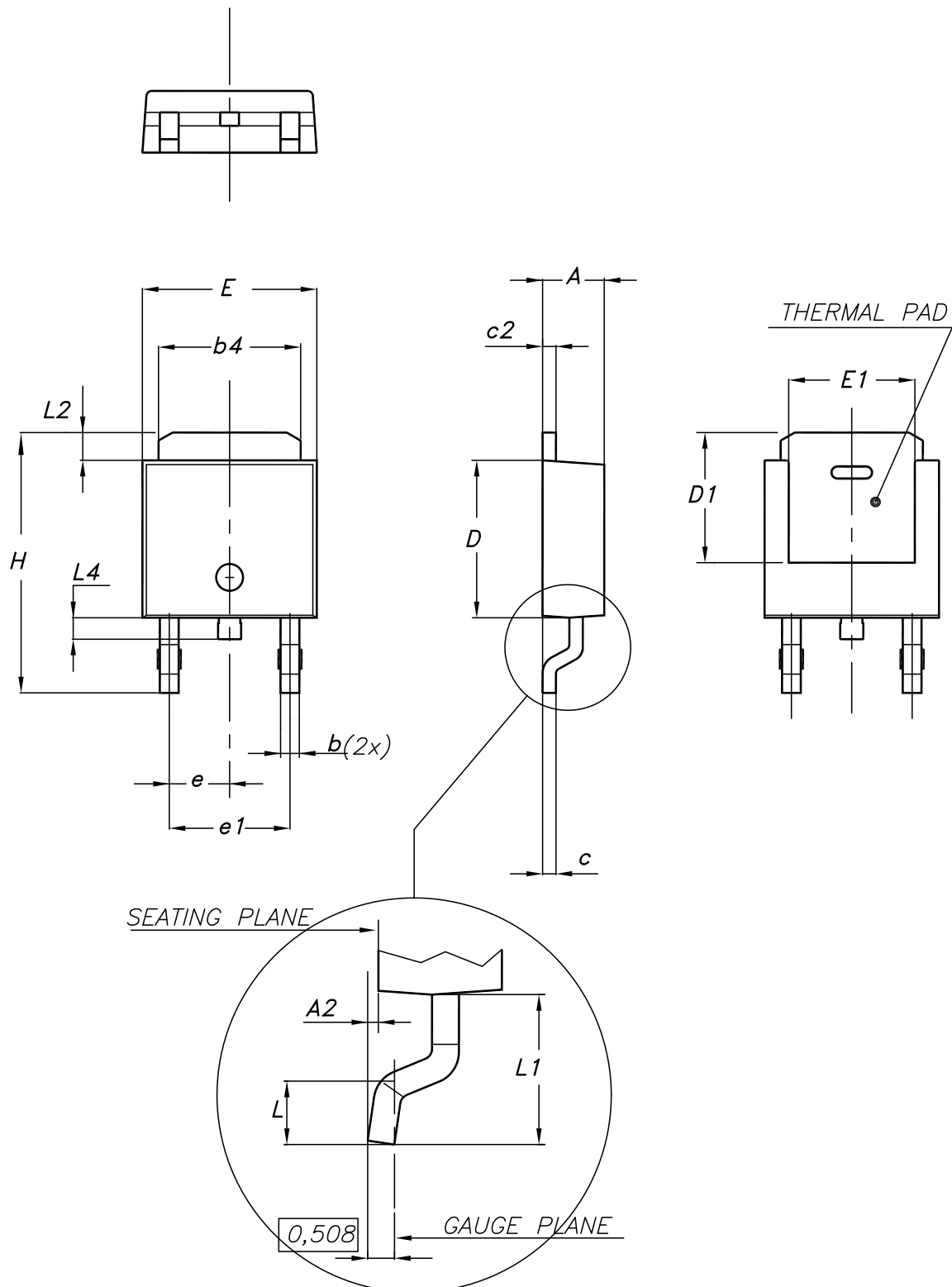
0068772\_C\_25

**Table 10. DPAK (TO-252) type C mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.38
A1	0.90	1.01	1.10
A2	0.00		0.10
b	0.72		0.85
b4	5.13	5.33	5.46
c	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.25		
E	6.50	6.60	6.70
E1	4.70		
e	2.186	2.286	2.386
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.90		1.25
L3	0.51 BSC		
L4	0.60	0.80	1.00
L6	1.80 BSC		
θ1	5°	7°	9°
θ2	5°	7°	9°
V2	0°		8°

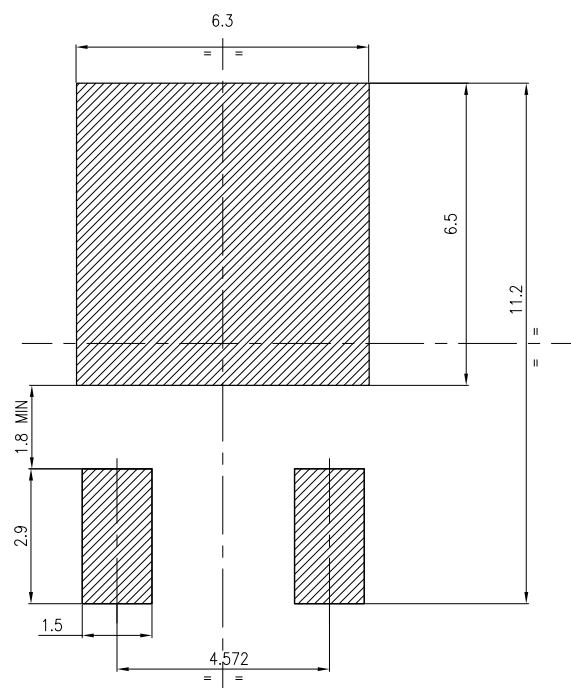
### 4.3 DPAK (TO-252) type E package information

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)**


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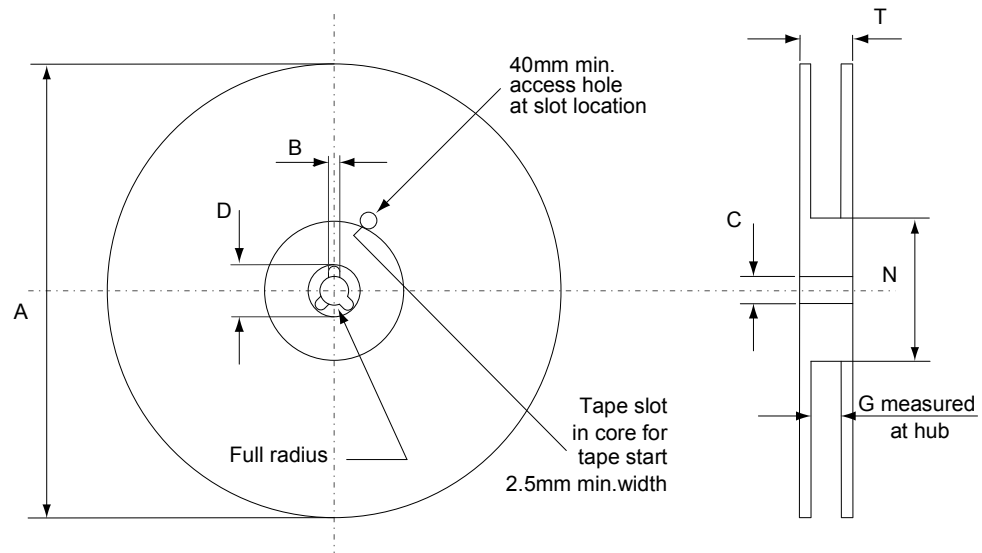
### 4.4 DPAK (TO-252) packing information

Figure 25. DPAK (TO-252) tape outline



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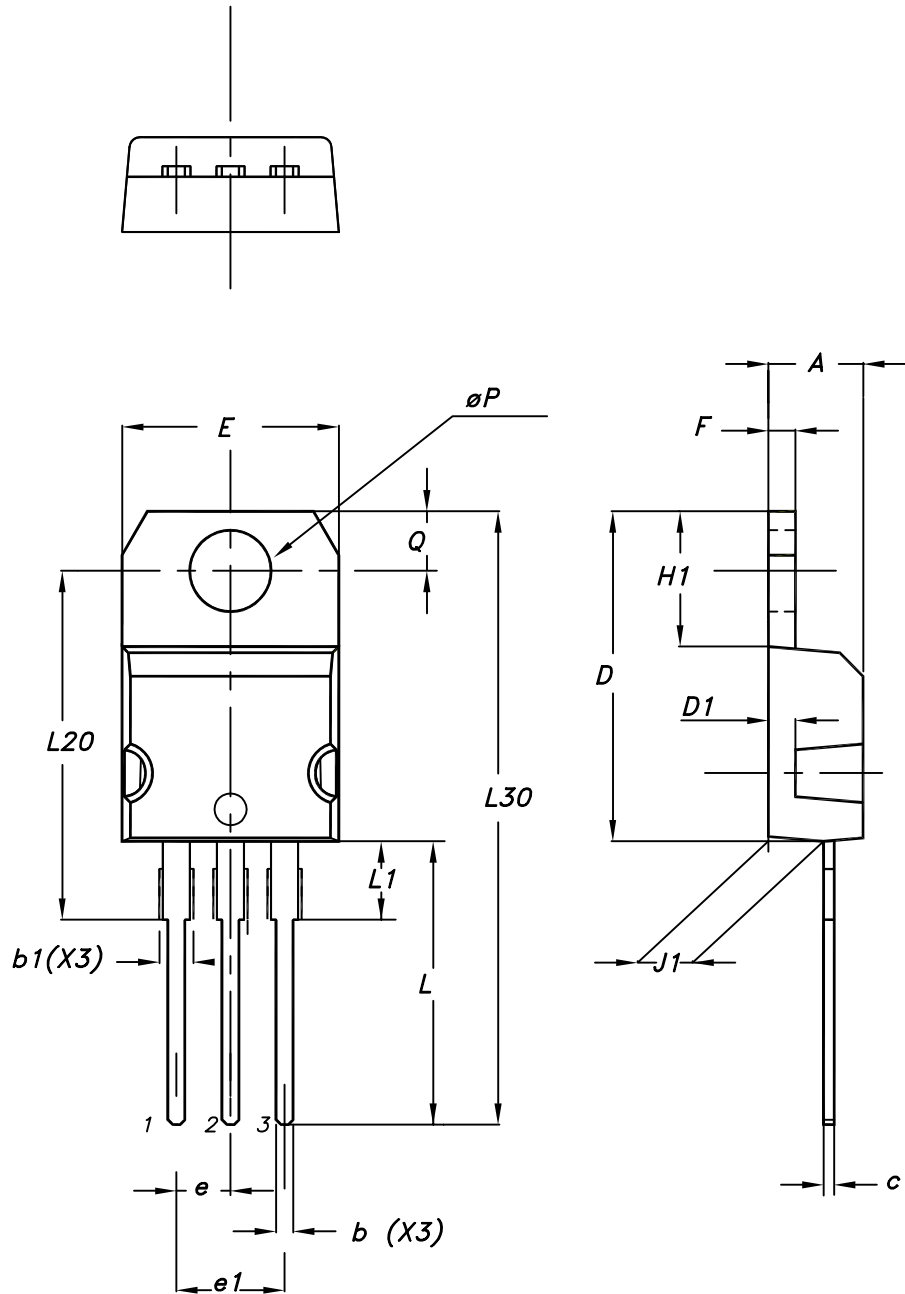


**Figure 26. DPAK (TO-252) reel outline**


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**


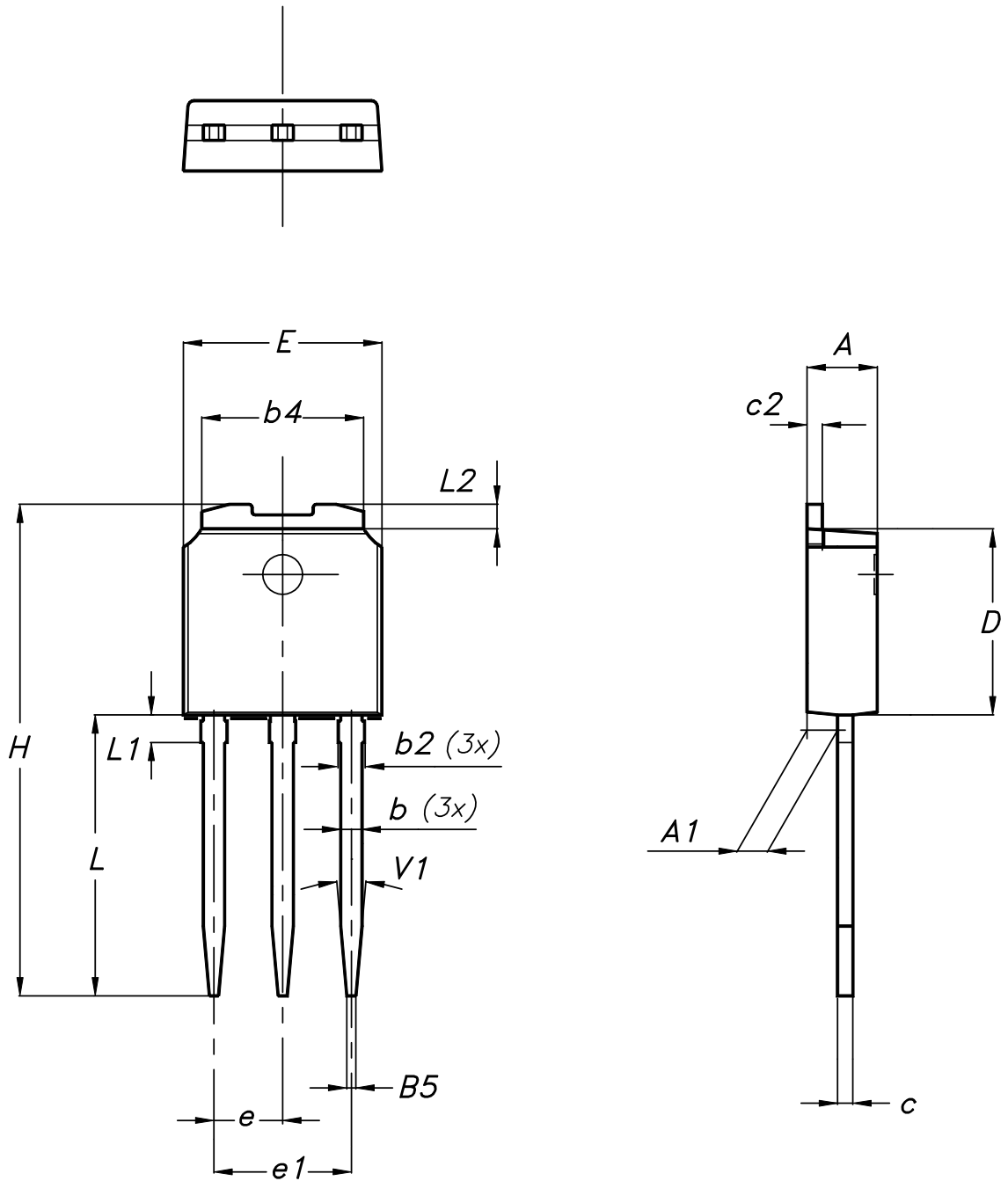
0015988\_typeA\_Rev\_21

**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 IPAk (TO-251) type A package information

Figure 28. IPAk (TO-251) type A package outline



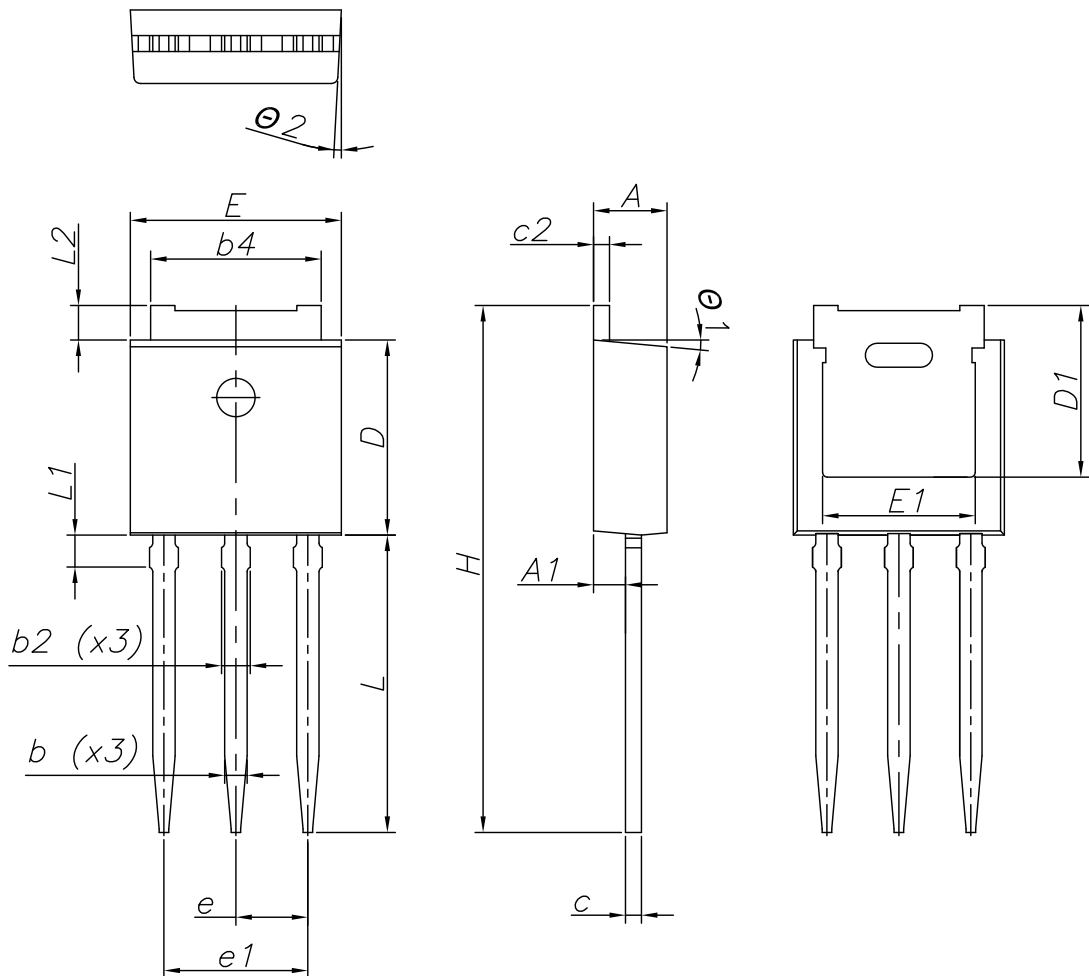
0068771\_IK\_typeA\_rev14

**Table 14. 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°	

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

Figure 29. IPAK (TO-251) type C package outline



0068771\_IK\_typeC\_rev14

**Table 15. 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 16. Order codes

Order code	Marking	Package	Packing
STD4N52K3	4N52K3	DPAK	Tape and reel
STP4N52K3		TO-220	Tube
STU4N52K3		IPAK	Tube



## Revision history

**Table 17. Document revision history**

Date	Version	Changes
09-Nov-2010	1	First release
19-Feb-2013	2	<p>Updated packages order in Table 1: Device summary.</p> <p>Updated Table 4: Package mechanical data and Table 5: Packaging mechanical data.</p> <p>Minor text changes on the cover page.</p>
20-Aug-2018	3	<p>The part number STF4N52K3 has been moved to a separate datasheet.</p> <p>Removed maturity status indication from cover page. The document status is production data.</p> <p>Updated title and features in cover page.</p> <p>Updated <a href="#">Section 1 Electrical ratings</a>, <a href="#">Section 2 Electrical characteristics</a> and <a href="#">Section 2.1 Electrical characteristics curves</a>.</p> <p>Added <a href="#">Section 5 Ordering information</a>.</p> <p>Minor text changes.</p>

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