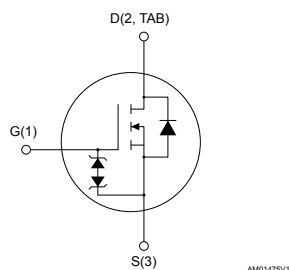
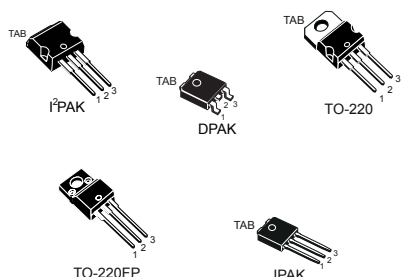


N-channel 500 V, 1.22 Ω typ., 4.4 A SuperMESH™ Power MOSFETs in I²PAK, DPAK, TO-220, TO-220FP and IPAK packages



AM01475V1

Features

Order codes	V _{DS}	R _{DS(on)} max.	I _D	Package
STB5NK50Z-1	500 V	1.5 Ω	4.4 A	I ² 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 ² PAK, DPAK, TO-220, IPAK	TO-220FP	
V _{DS}	Drain-source voltage	500		V
V _{GS}	Gate-source voltage	±30		V
I _D	Drain current (continuous) at T _C = 25 °C	4.4	4.4 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	2.7	2.7 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	17.6	17.6 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	70	25	W
ESD	Gate-source human body model (R = 1.5 kΩ, C = 100 pF)	3		kV
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat-sink (t = 1 s, T _C = 25 °C)		2.5	kV
dv/dt ⁽³⁾	Peak diode recovery voltage slope	4.5		V/ns
T _j	Operating junction temperature range	-55 to 150		°C
T _{stg}	Storage temperature range			

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

Table 2. Thermal data

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

1. When mounted on an 1-inch² FR-4, 2oz Cu board.

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
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 °C, I _D = I _{AR} , V _{DD} = 50 V)	130	mJ

2 Electrical characteristics

($T_{CASE} = 25\text{ }^{\circ}\text{C}$ 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	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 500\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$ ⁽¹⁾			50	μA
I_{GSS}	Gate body leakage current	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 20\text{ V}$			± 10	μA
$V_{GS(th)}$	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	Ω

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		μF
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		μF
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 A, V _{GS} = 0 V	-		1.6	V
t _{rr}	Reverse recovery time	I _{SD} = 4.4 A, di/dt = 100 A/μs V _{DD} = 30 V, T _j = 150°C (see Figure 17. Test circuit for inductive load switching and diode recovery times)	-	310		ns
Q _{rr}	Reverse recovery charge			1.425		μC
I _{RRM}	Reverse recovery current			9.2		A

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300 μs , 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 I²PAK, DPAK, TO-220, IPAK

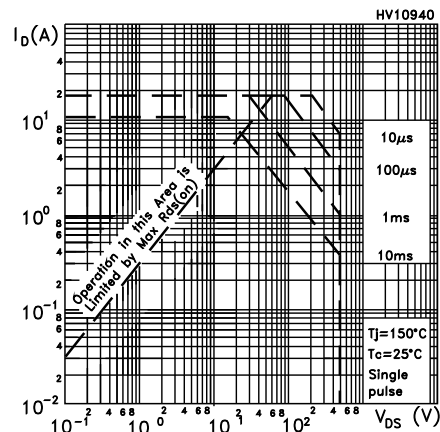


Figure 2. Thermal impedance for I²PAK, DPAK, TO-220, IPAK

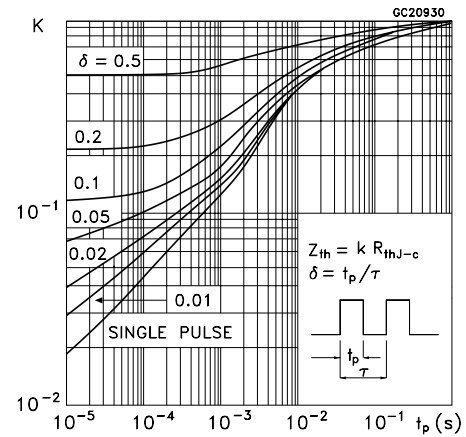


Figure 3. Safe operating area for TO-220FP

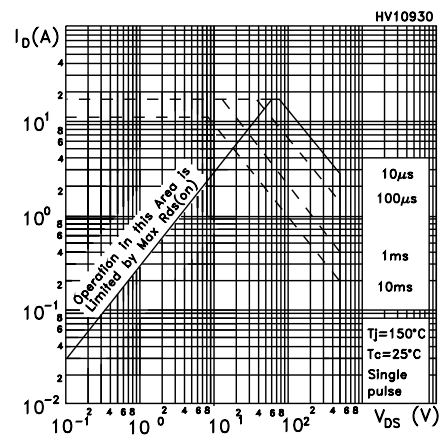


Figure 4. Thermal impedance for TO-220FP

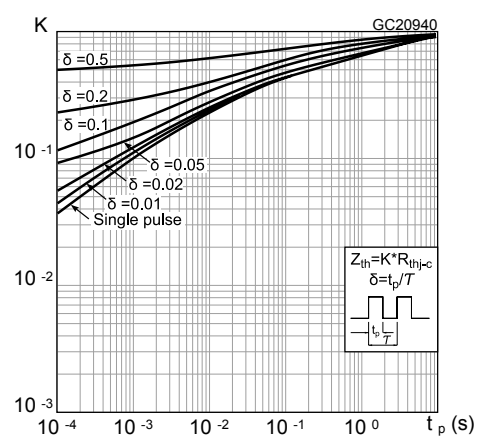


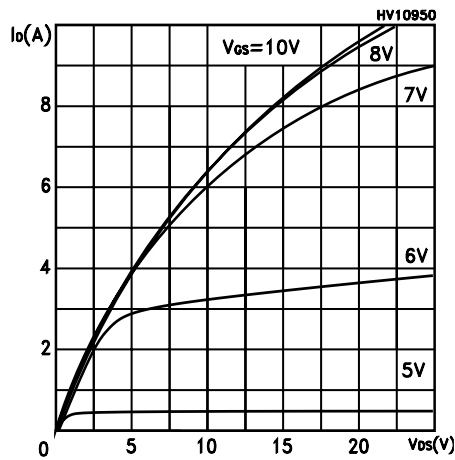
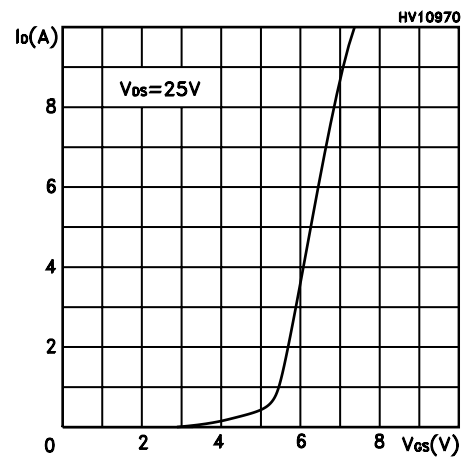
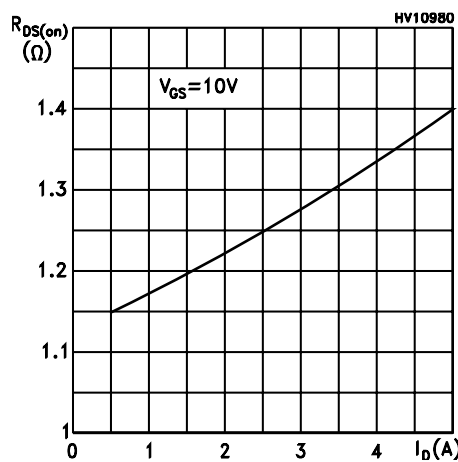
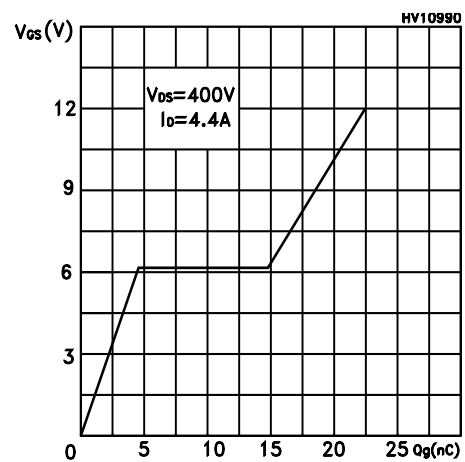
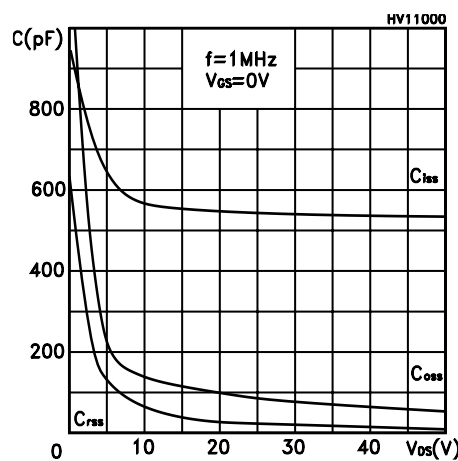
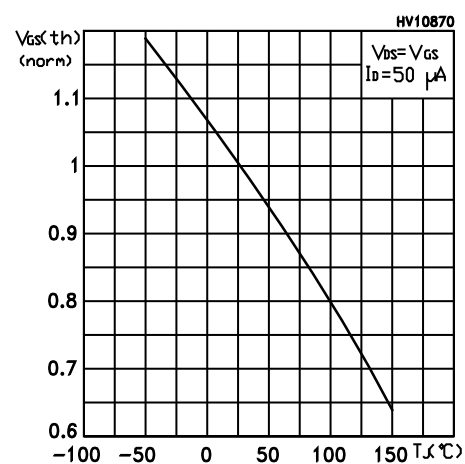
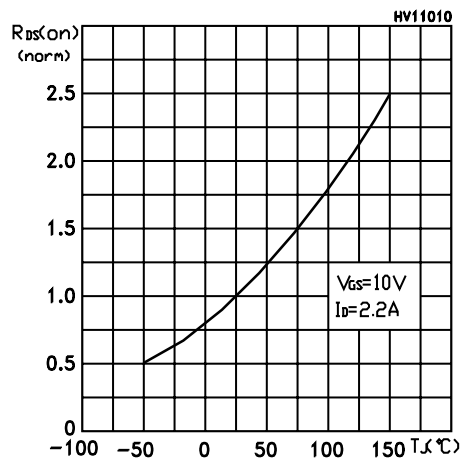
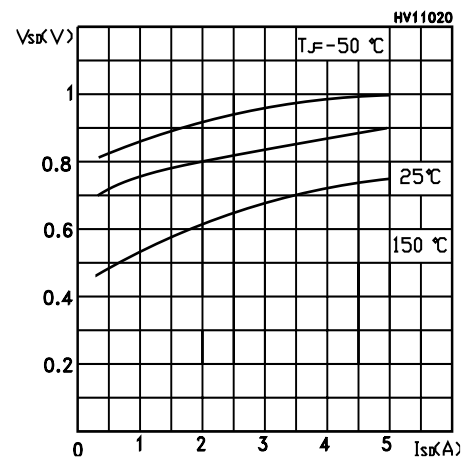
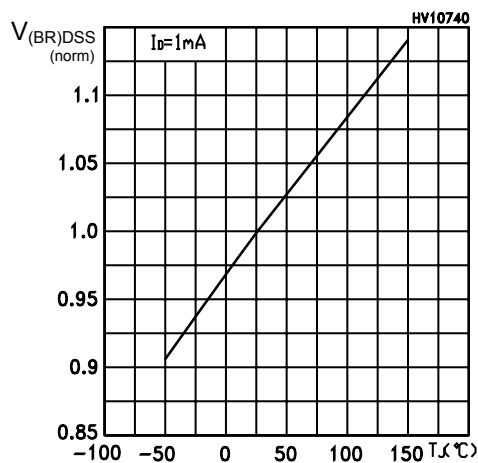
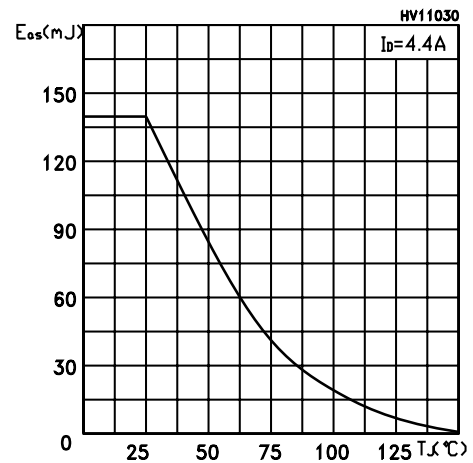
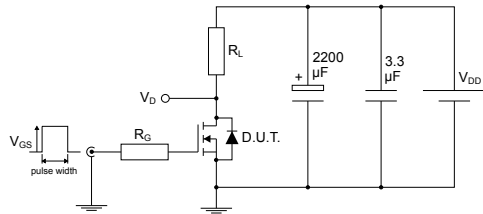
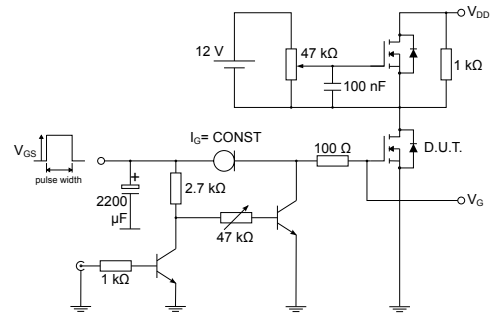
Figure 5. Output characteristics

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


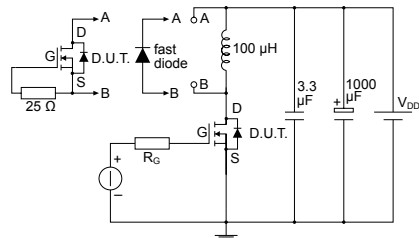
3 Test circuits

Figure 15. Test circuit for resistive load switching times


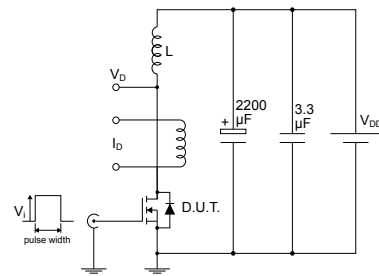
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Figure 16. Test circuit for gate charge behavior


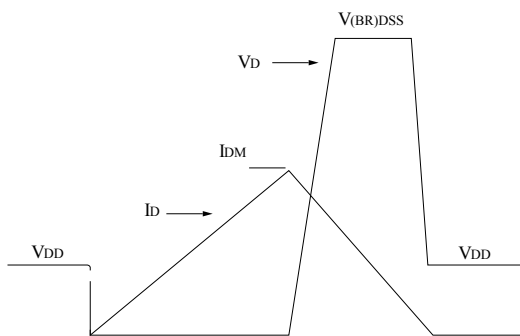
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Figure 17. Test circuit for inductive load switching and diode recovery times


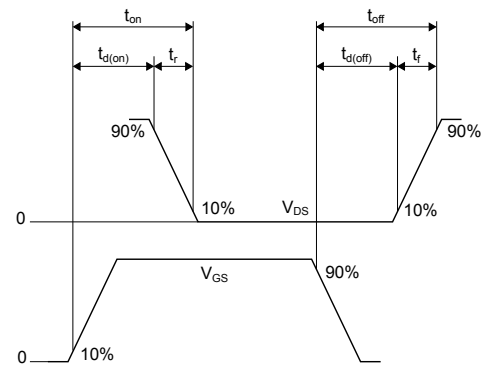
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Figure 18. Unclamped inductive load test circuit


AM01471v1

Figure 19. Unclamped inductive waveform


AM01472v1

Figure 20. Switching time waveform


AM01473v1

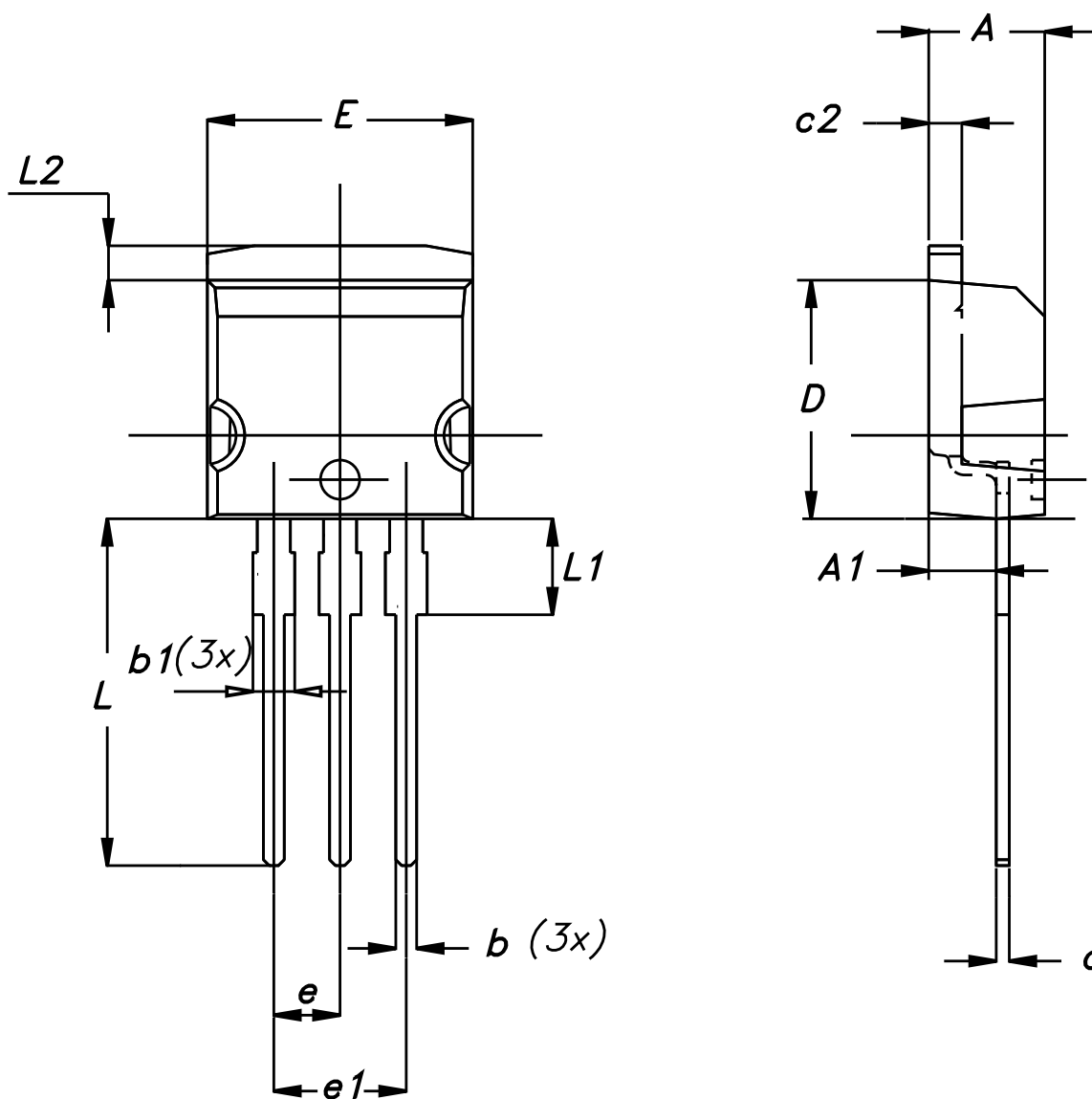


4 Package information

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. ECOPACK® is an ST trademark.

4.1 I²PAK package information

Figure 21. I²PAK package outline



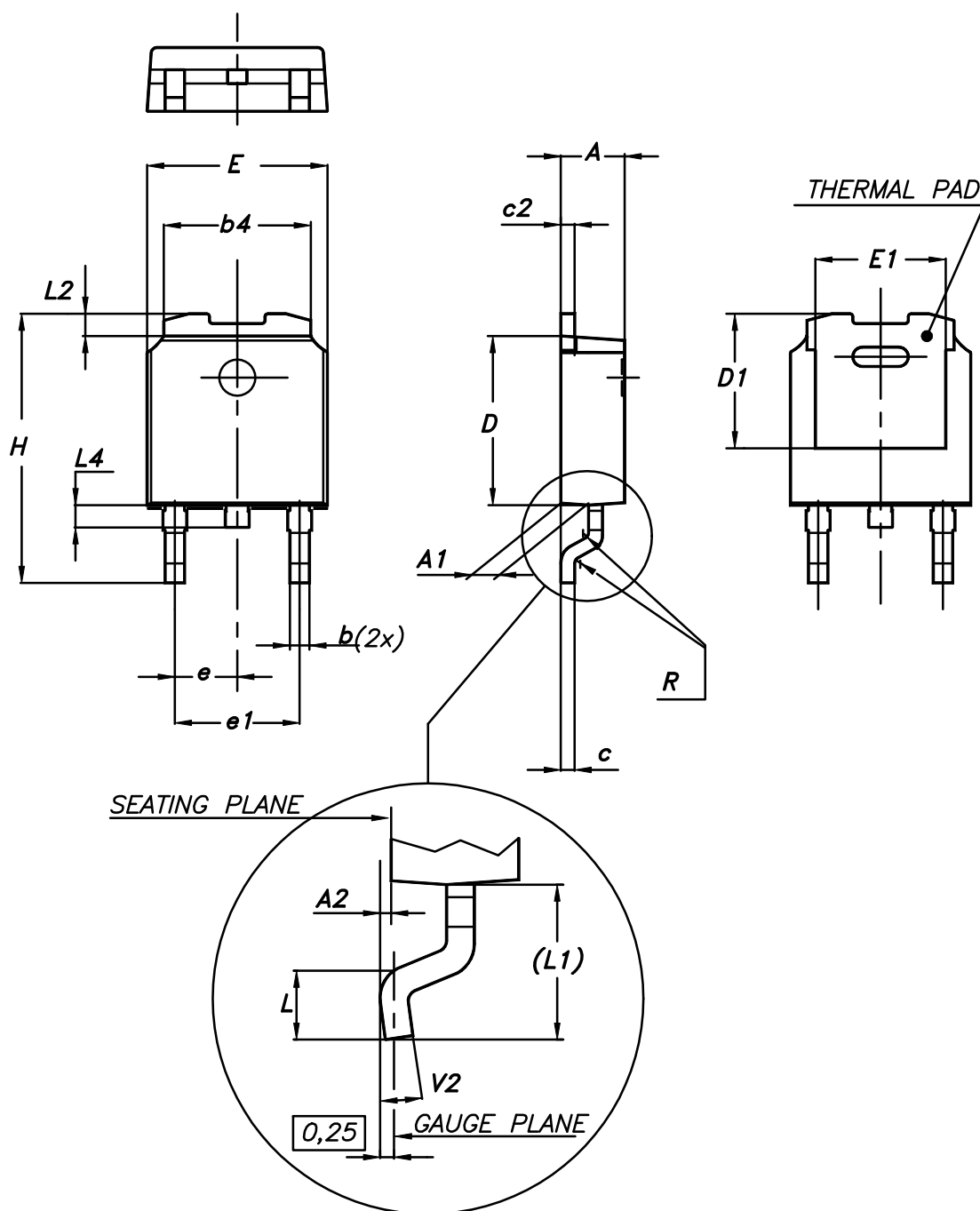
0004982_Rev_H

Table 9. I²PAK 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

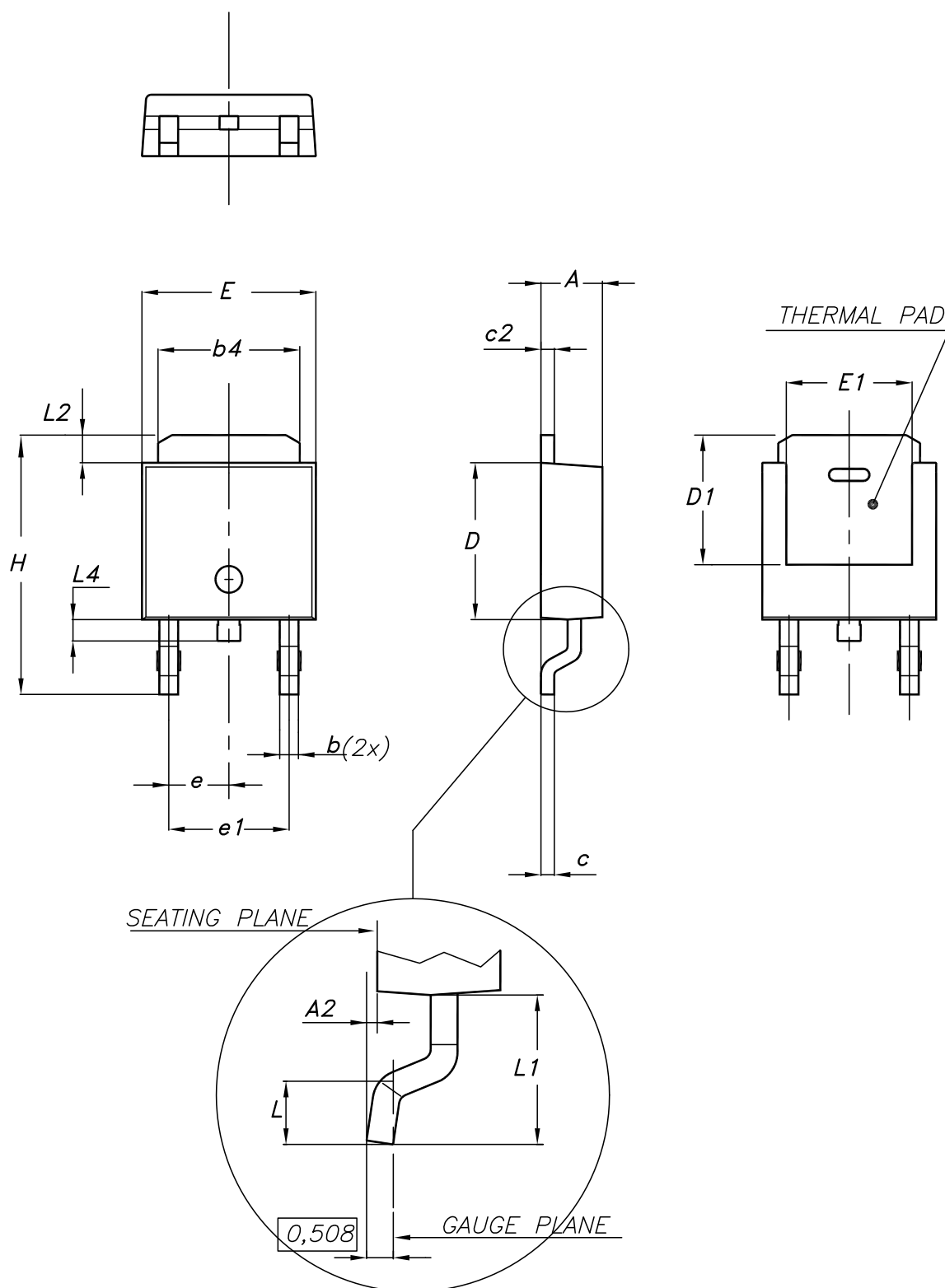
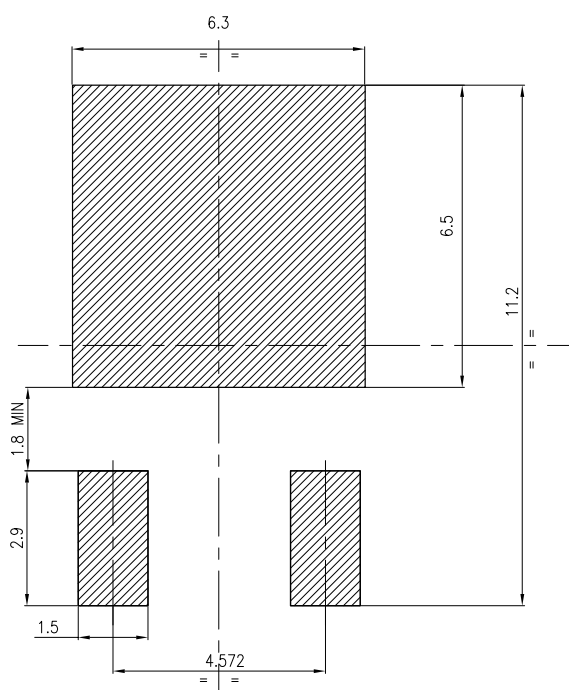


Table 11. DPAK (TO-252) type E mechanical data

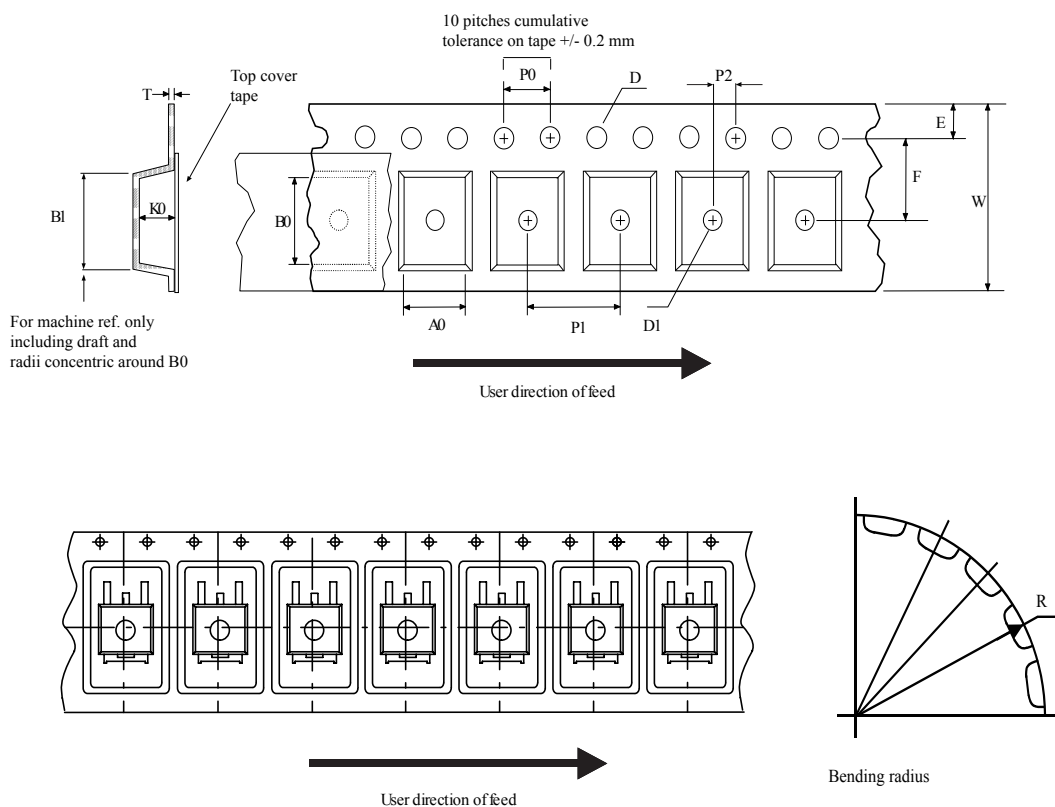
Dim.	mm		
	Min.	Typ.	Max.
A	2.18		2.39
A2			0.13
b	0.65		0.884
b4	4.95		5.46
c	0.46		0.61
c2	0.46		0.60
D	5.97		6.22
D1	5.21		
E	6.35		6.73
E1	4.32		
e		2.286	
e1		4.572	
H	9.94		10.34
L	1.50		1.78
L1		2.74	
L2	0.89		1.27
L4			1.02

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


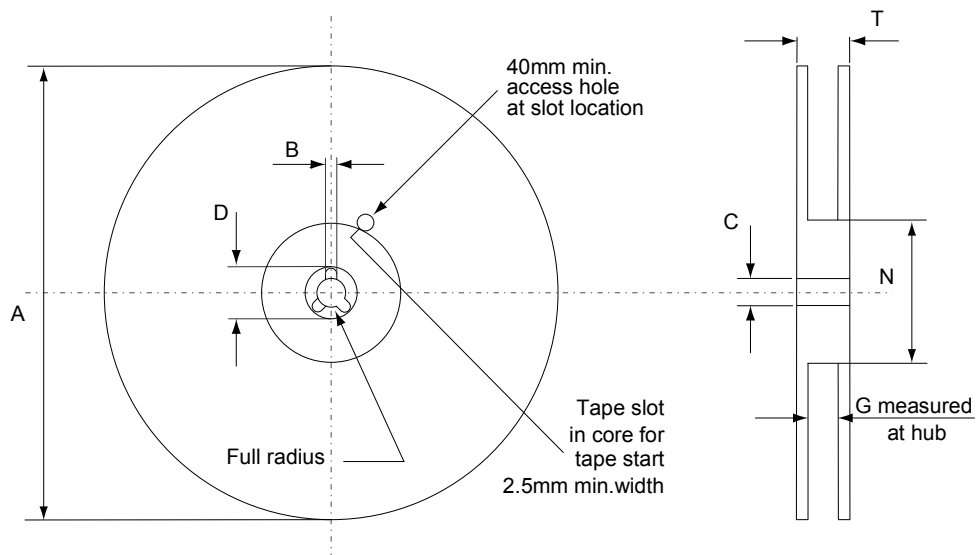
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4.4 DPAK (TO-252) packing information

Figure 25. DPAK (TO-252) tape outline



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Figure 26. DPAK (TO-252) reel outline


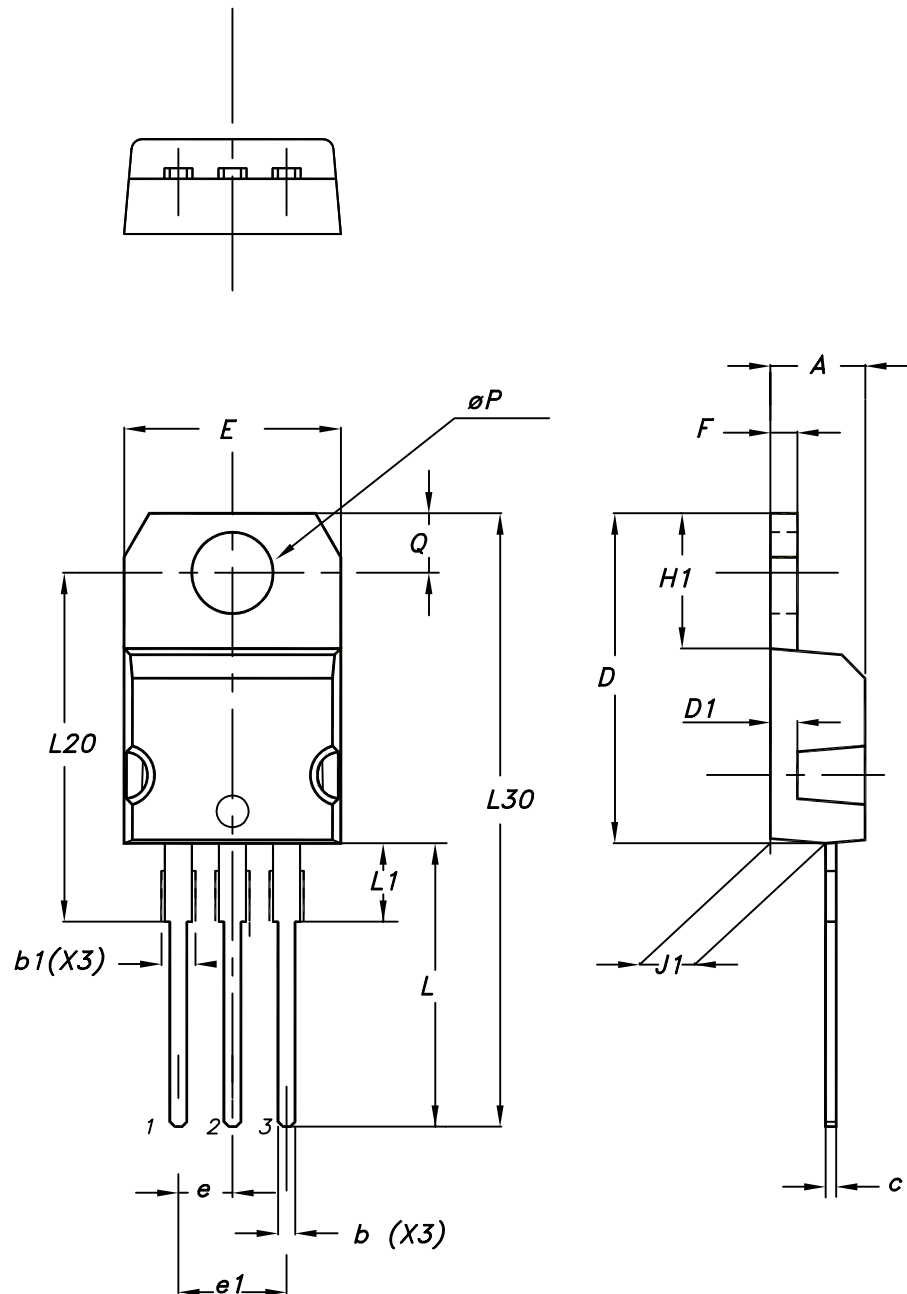
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Table 12. DPAK (TO-252) tape and reel mechanical data

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



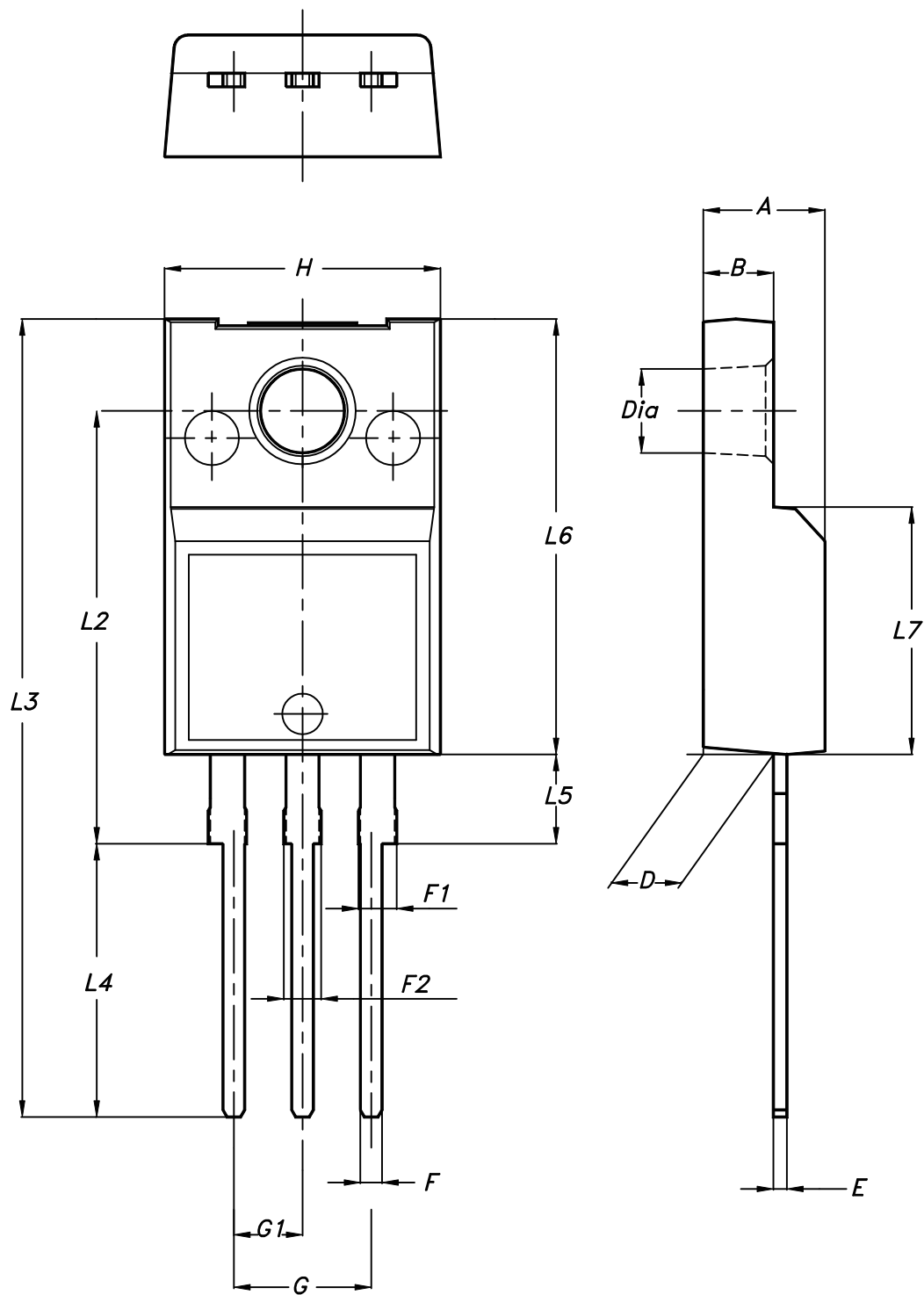
0015988_typeA_Rev_21

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



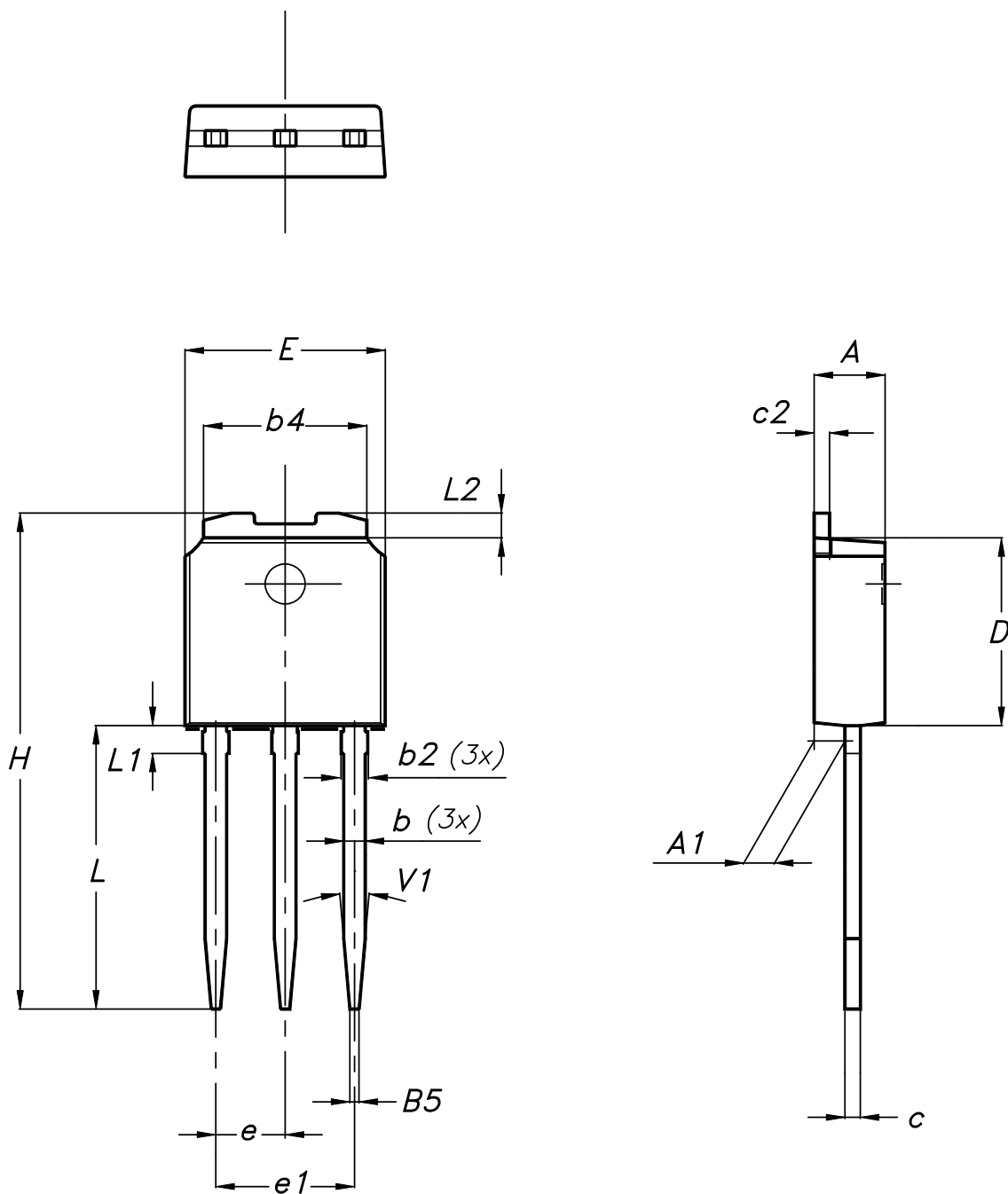
7012510_Rev_12_B

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



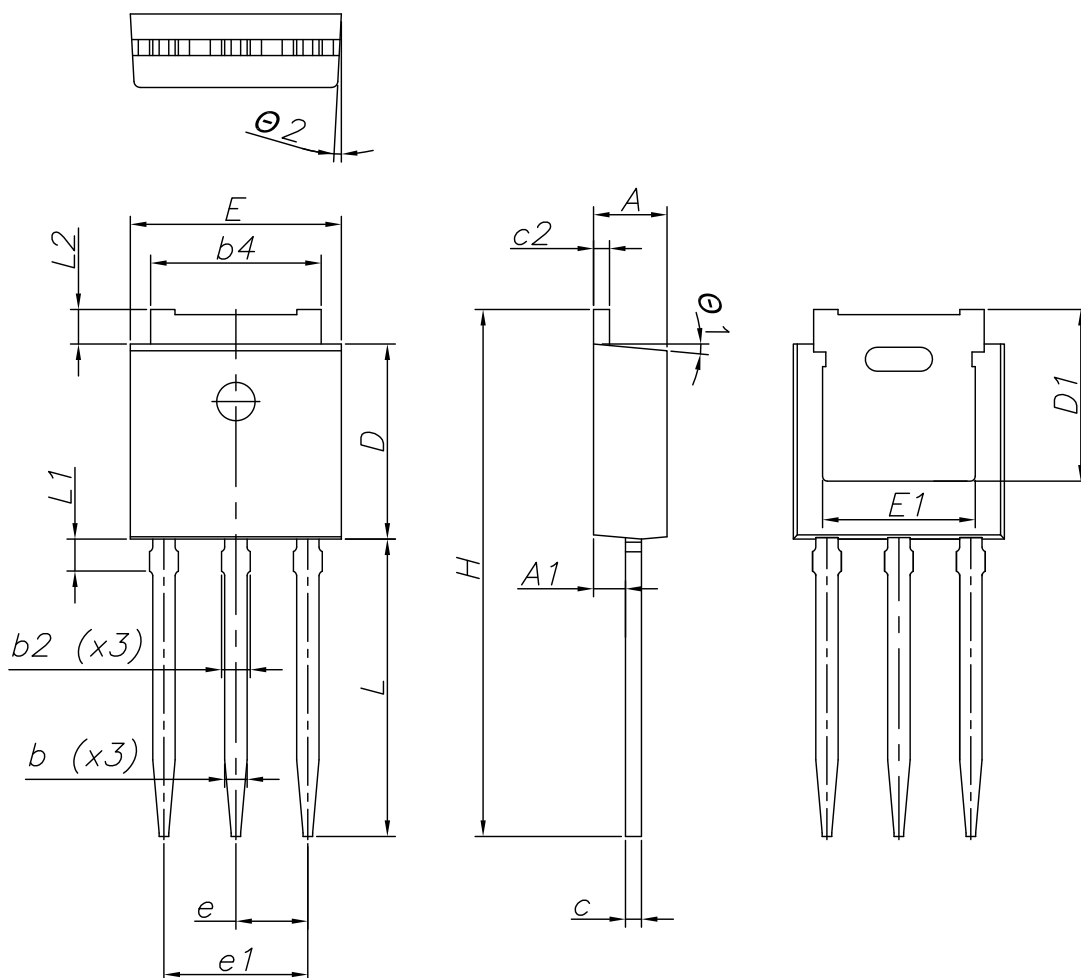
0068771_IK_typeA_rev14

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 ² 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 ² 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 Section 4 Package information .

Contents

1	Electrical ratings	2
2	Electrical characteristics	3
2.1	Electrical characteristics curves	5
3	Test circuits	8
4	Package information	9
4.1	I ² PAK package information	9
4.2	DPAK (TO-252) type A package information	11
4.3	DPAK (TO-252) type E package information	13
4.4	DPAK (TO-252) packing information	15
4.5	TO-220 type A package information	17
4.6	TO-220FP package information	19
4.7	IPAK (TO-251) type A package information	21
4.8	IPAK (TO-251) type C package information	23
5	Ordering information	26
	Revision history	27



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