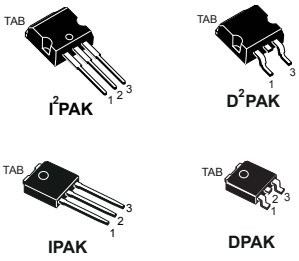
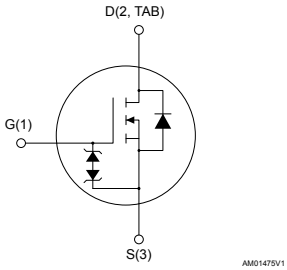
STB4NK60Z-1, STB4NK60ZT4
STD4NK60Z-1, STD4NK60ZT4

Datasheet

N-channel 600 V, 1.7 Ω typ., 4 A SuperMESH™ Power MOSFETs in I²PAK, D²PAK, IPAK and DPAK packages





Product status
STB4NK60Z-1
STB4NK60ZT4
STD4NK60Z-1
STD4NK60ZT4

Features

Order codes	V_{DS}	$R_{DS(on)}$ max.	P_{TOT}	I_D
STB4NK60Z-1	600 V	2 Ω	70 W	4 A
STB4NK60ZT4				
STD4NK60Z-1				
STD4NK60ZT4				

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- 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.

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{DS}	Drain-source voltage	600	V
V_{GS}	Gate-source voltage	±30	V
I_D	Drain current (continuous) at T_C = 25 °C	4	A
I_D	Drain current (continuous) at T_C = 100 °C	2.5	A
I_{DM} (1)	Drain current (pulsed)	16	A
P_{TOT}	Total dissipation at T_C = 25 °C	70	W
ESD	Gate-source human body model (C=100 pF, R=1.5 kΩ)	3	kV
dv/dt (2)	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. *Pulse width limited by safe operating area.*
2. *I_{SD} ≤ 4 A, di/dt ≤ 200 A/µs, V_{DD} ≤ $V_{(BR)DSS}$.*

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		I^2PAK, D^2PAK	IPAK, DPAK	
$R_{thj\text{-}case}$	Thermal resistance junction- case	1.79		°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient	62.5	100	°C/W

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max)	4	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	120	mJ

2 Electrical characteristics

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

Table 4. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	600			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 600 V			1	µA
		V_{GS} = 0 V, V_{DS} = 600 V, T_C = 125 °C (1)			50	µA
I_{GSS}	Gate-body leakage current	V_{DS} = 0 V, V_{GS} = ±20 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 50 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 10 V, I_D = 2 A		1.7	2	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 V, f = 1 MHz, V_{GS} = 0 V	-	510		pF
C_{oss}	Output capacitance			67		
C_{rss}	Reverse transfer capacitance			13		
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{GS} = 0 V, V_{DS} = 0 V to 480 V	-	38.5		
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 2 A,R_G = 4.7 Ω, V_{GS} = 10 V (see Figure 13. Test circuit for resistive load switching times)	-	12		ns
t_r	Rise time			9.5		
$t_{d(off)}$	Turn-off delay time			29		
t_f	Fall time			16.5		
$t_{r(Voff)}$	Off-voltage rise time	V_{DD} = 480 V, I_D = 4 A, R_G = 4.7 Ω, V_{GS} = 10 V) (see Figure 15. Test circuit for inductive load switching and diode recovery times)		12		
t_r	Fall time			12		
t_c	Cross-over time			19.5		
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 4 A, V_{GS} = 0 to 10 V (see Figure 14. Test circuit for gate charge behavior)	-	18.8	26	nC
Q_{gs}	Gate-source charge			3.8		
Q_{gd}	Gate-drain charge			9.8		

1. *$C_{oss\ eq.}$ 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. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		4	A
I_{SDM}	Source-drain current (pulsed)		-		16	
V_{SD}	Forward on voltage	I_{SD} = 4 A, V_{GS} = 0 V	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 4 A, di/dt = 100 A/µs	-	400		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 24 V, T_j = 150 °C	-	1.7		µC
I_{RRM}	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	8.5		A

Table 7. Gate-source Zener diode

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

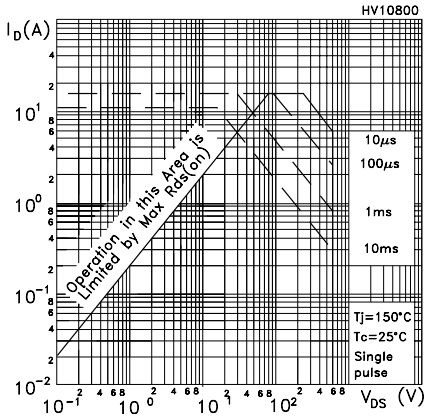


Figure 2. Thermal impedance

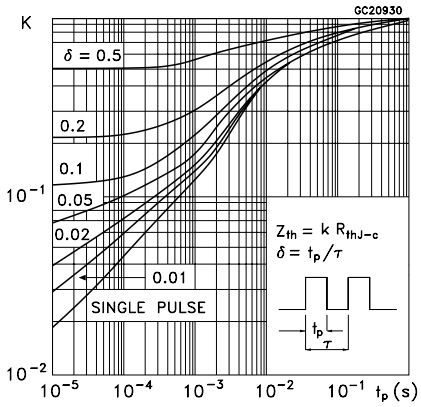


Figure 3. Output characterisics

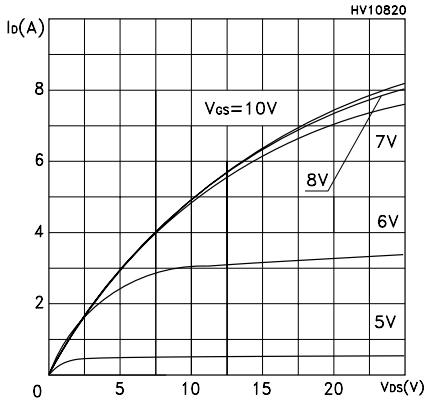


Figure 4. Transfer characteristics

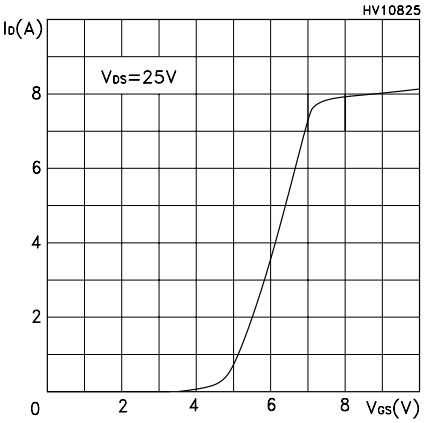


Figure 5. Static drain-source on-resistance

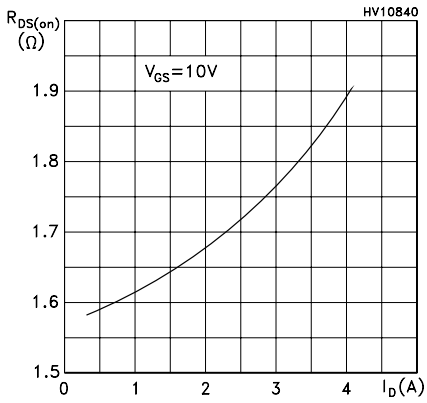


Figure 6. Gate charge vs gate-source voltage

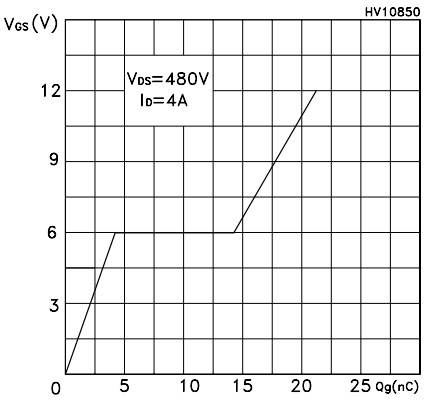


Figure 7. Capacitance variations

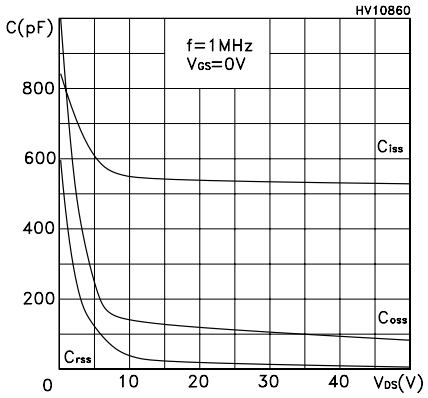


Figure 8. Normalized gate threshold voltage vs temperature

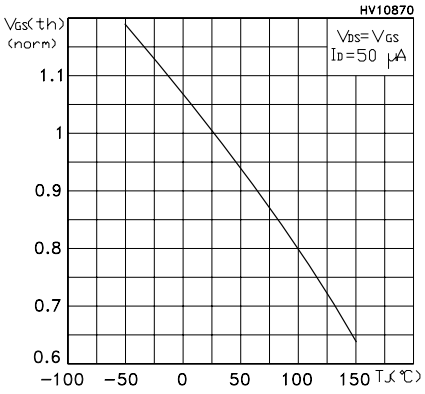


Figure 9. Normalized on-resistance vs temperature

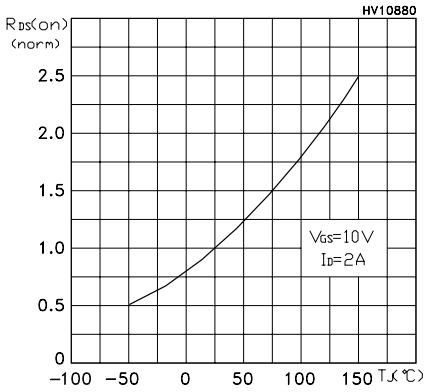


Figure 10. Source-drain diode forward characteristic

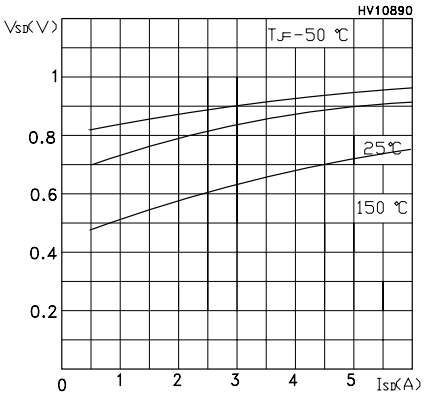


Figure 11. Normalized $V_{(BR)DSS}$ vs temperature

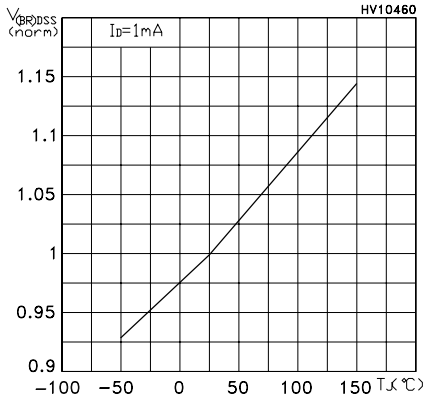
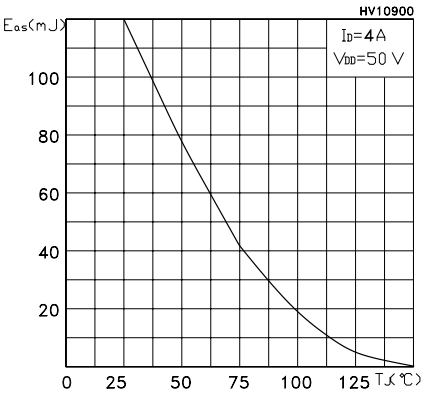


Figure 12. Maximum avalanche energy vs temperature



3 Test circuits

Figure 13. Test circuit for resistive load switching times

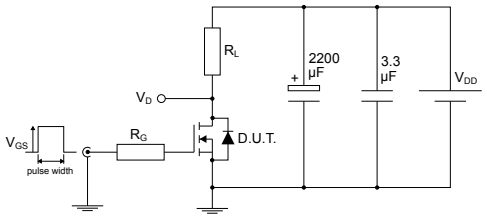


Figure 14. Test circuit for gate charge behavior

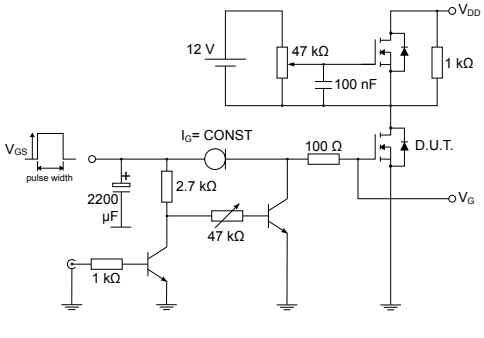


Figure 15. Test circuit for inductive load switching and diode recovery times

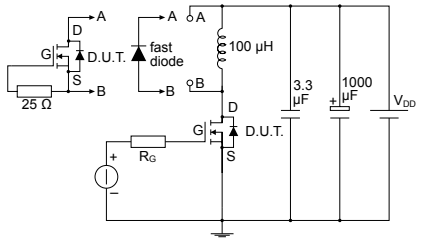


Figure 16. Unclamped inductive load test circuit

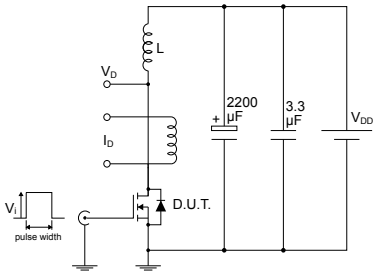


Figure 17. Unclamped inductive waveform

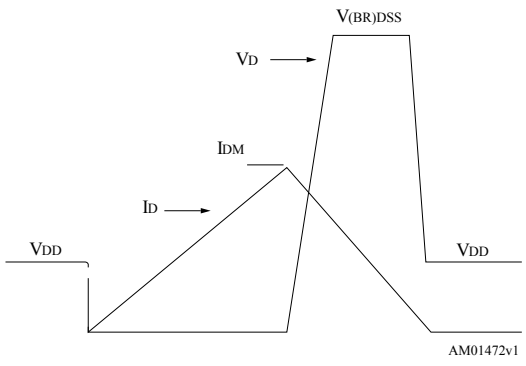
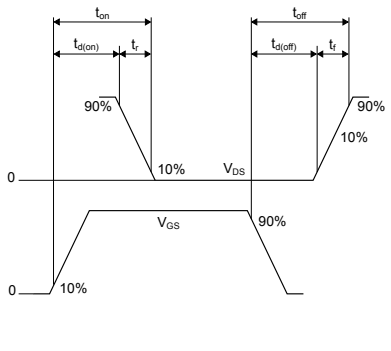


Figure 18. Switching time waveform



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 19. I²PAK package outline

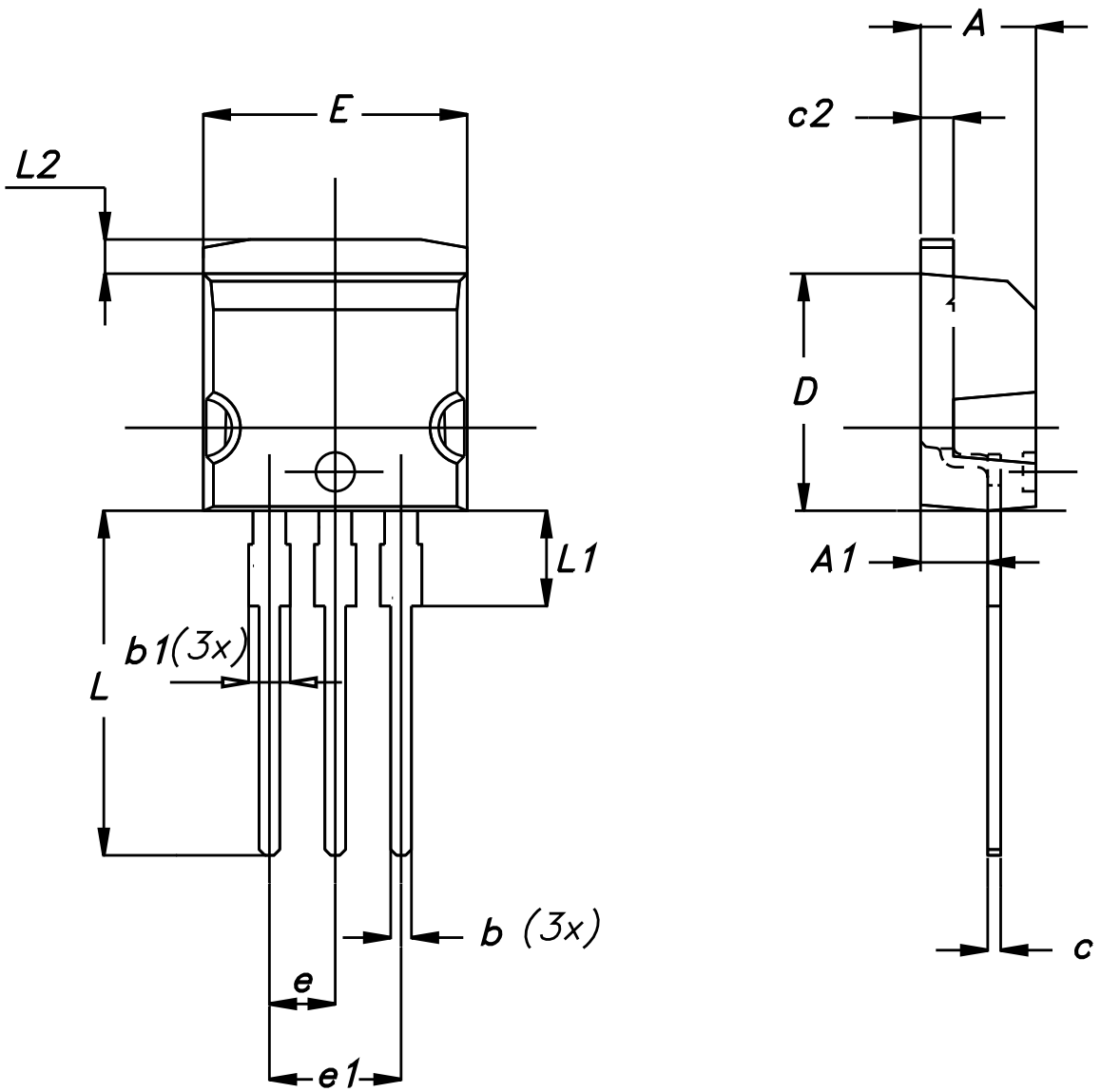


Table 8. **I²PAK package mechanical data**

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 D²PAK (TO-263) type A package information

Figure 20. D²PAK (TO-263) type A package outline

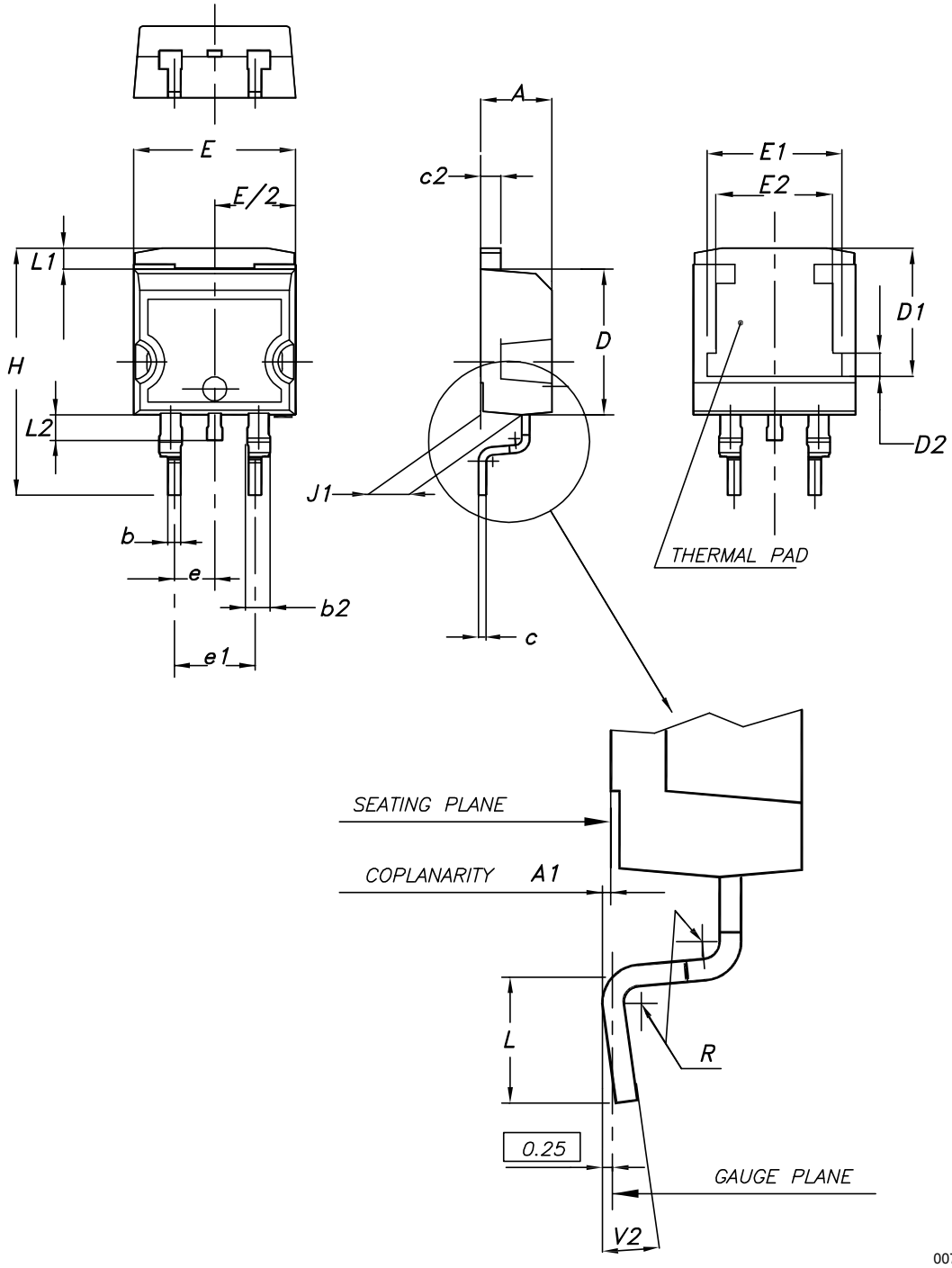


Table 9. D²PAK (TO-263) type A package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

4.3 D²PAK (TO-263) type B package information

Figure 21. D²PAK (TO-263) type B package outline

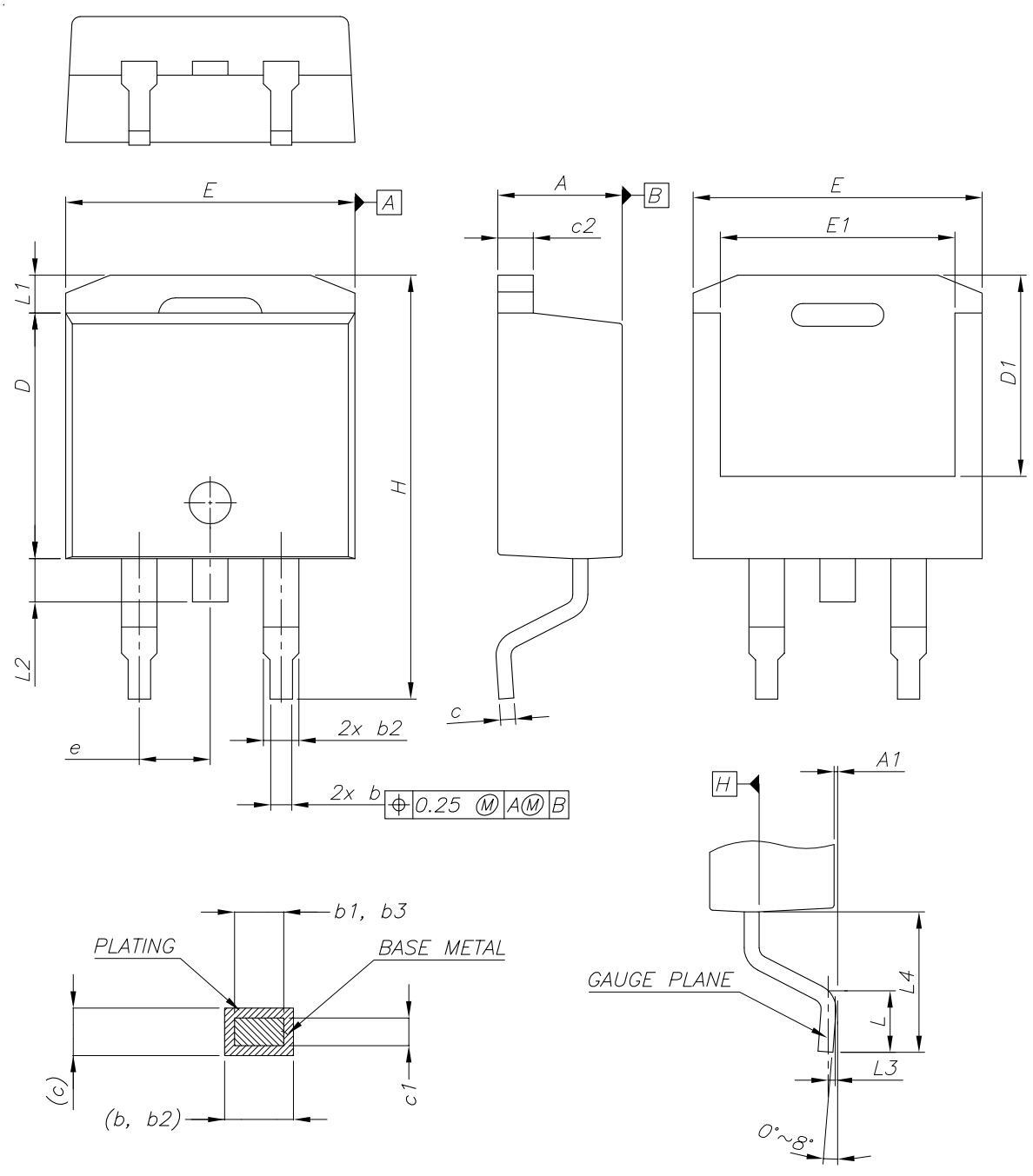


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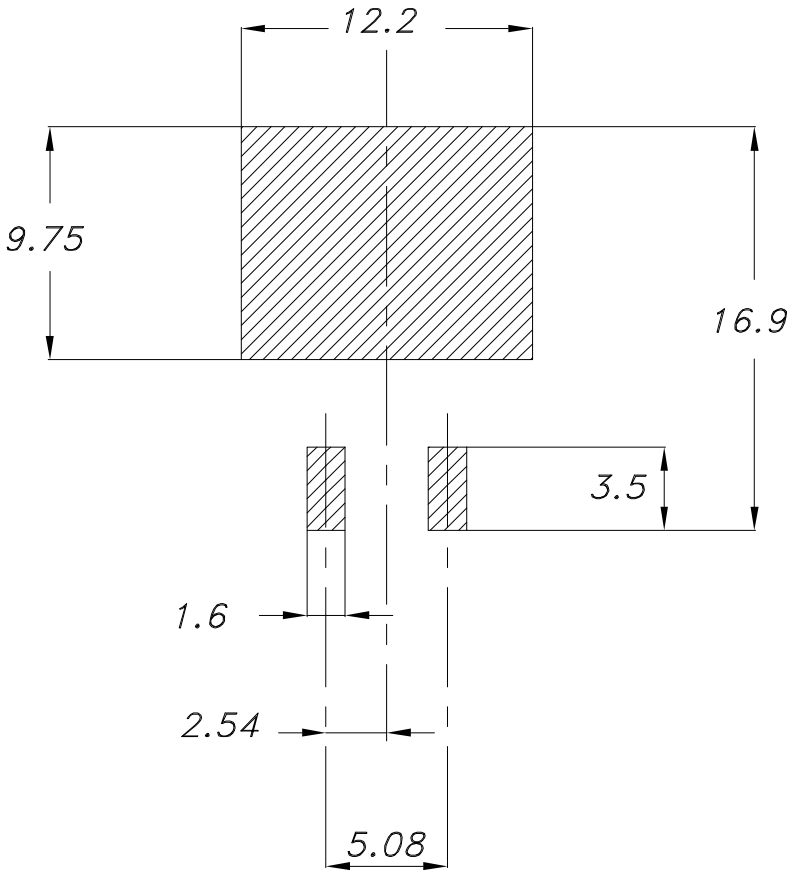
Table 10. **D²PAK (TO-263) type B mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.56
A1	0		0.25
b	0.70		0.90
b1	0.51		0.89
b2	1.17		1.37
b3	1.36		1.46
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.34
D	8.60		9.00
D1	6.90		7.50
E	10.15		10.55
E1	8.10		8.70
e		2.54 BSC	
H	15.00		15.60
L	1.90		2.50
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

Figure 22. D²PAK (TO-263) recommended footprint (dimensions are in mm)



Footprint

4.4 IPAK (TO-251) type A package information

Figure 23. **IPAK (TO-251) type A package outline**

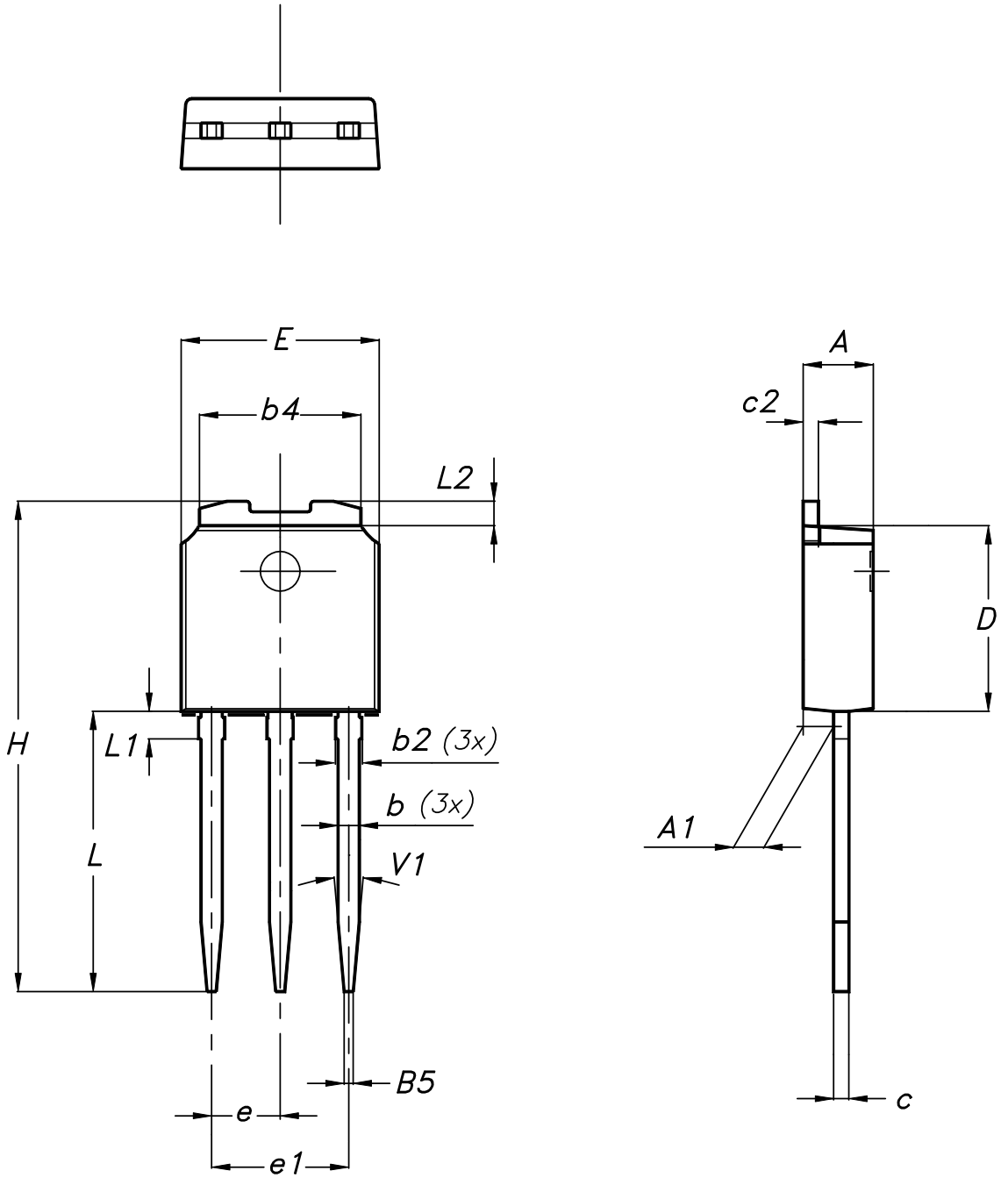


Table 11. **IPAK (TO-251) type A package mechanical data**

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°	

4.5 IPAK (TO-251) type C package information

Figure 24. **IPAK (TO-251) type C package outline**

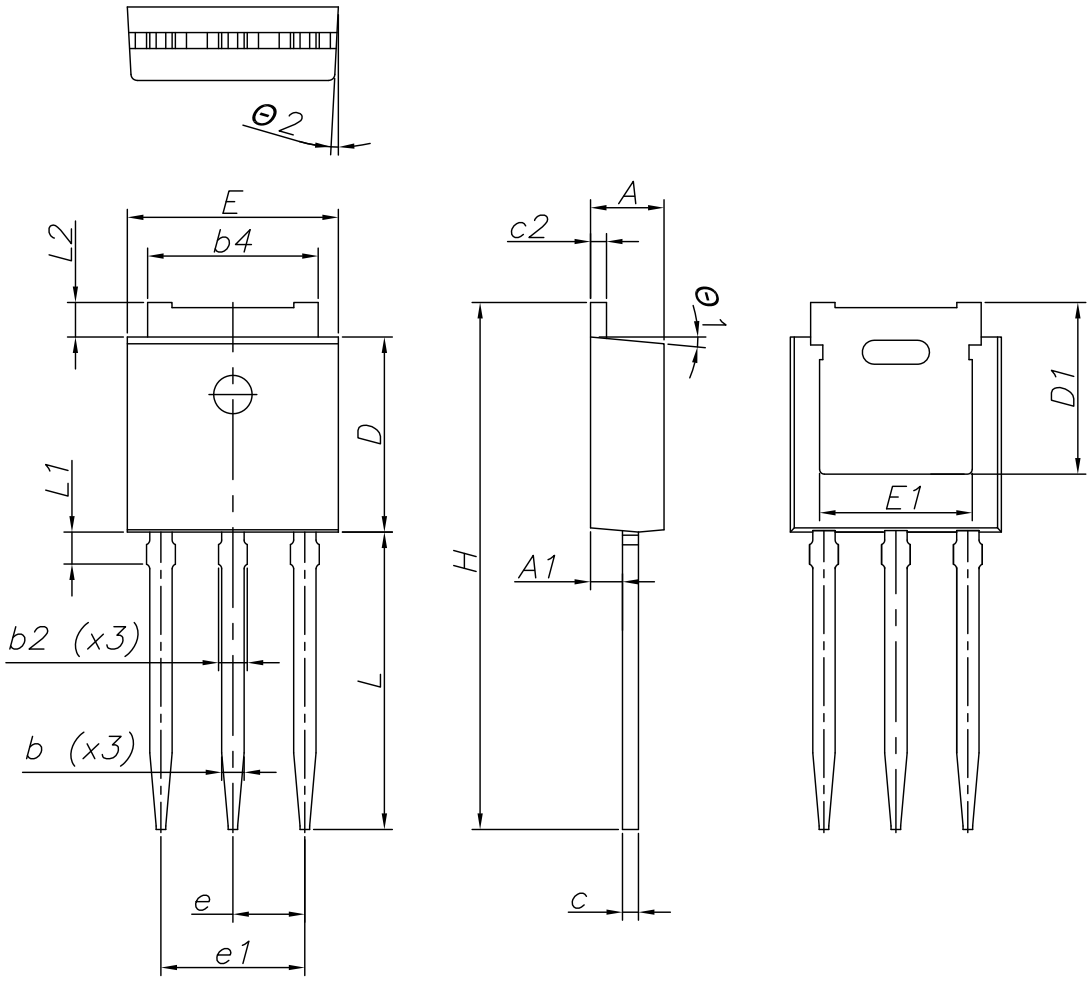


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Table 12. **IPAK (TO-251) type C package mechanical data**

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°

4.6 DPAK (TO-252) type A2 package information

Figure 25. **DPAK (TO-252) type A2 package outline**

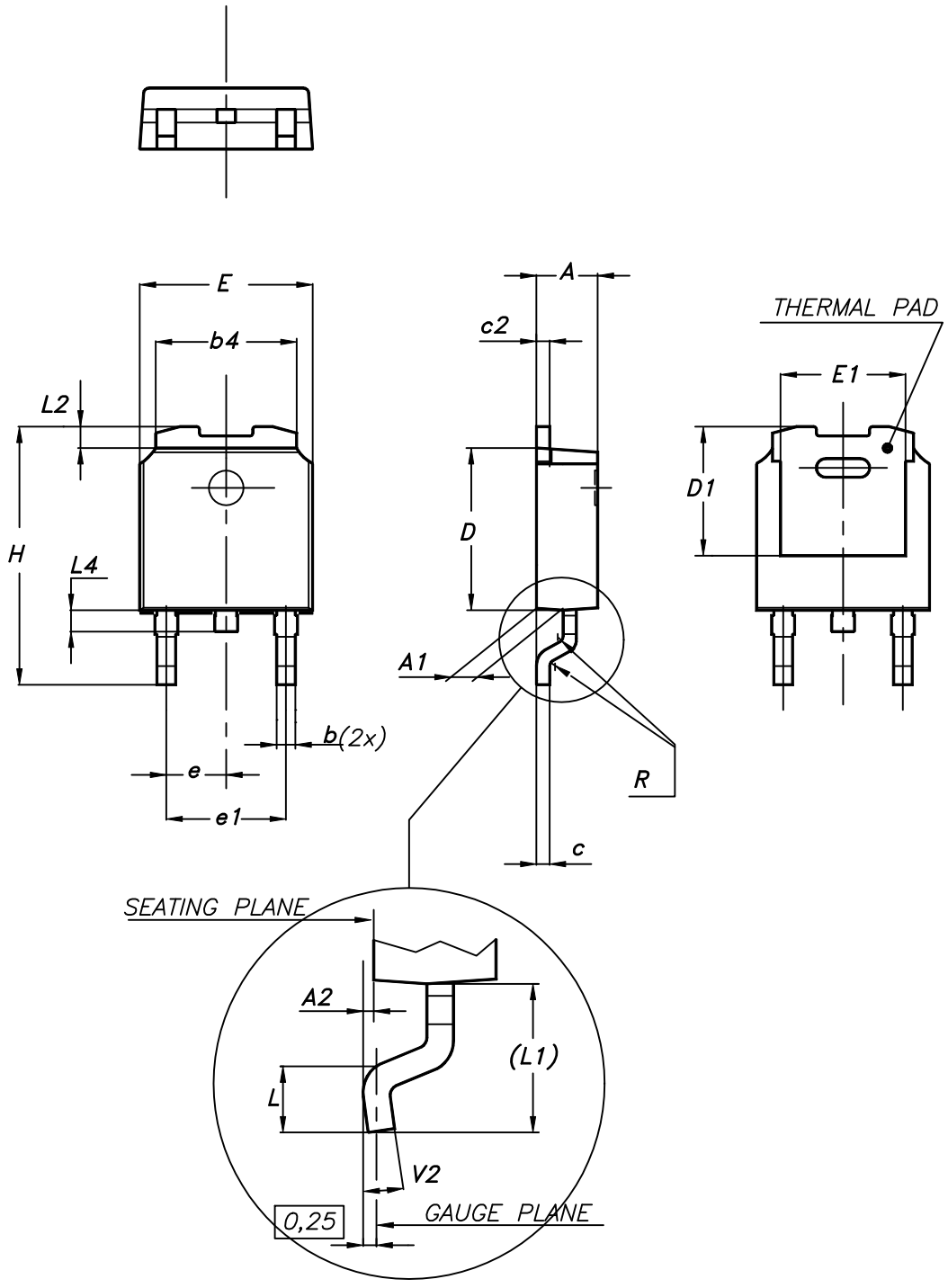

Table 13. **DPAK (TO-252) type A2 mechanical data**

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	5.10	5.20	5.30
e	2.16	2.28	2.40
e1	4.40		4.60
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°

4.7 DPAK (TO-252) type C2 package information

Figure 26. **DPAK (TO-252) type C2 package outline**

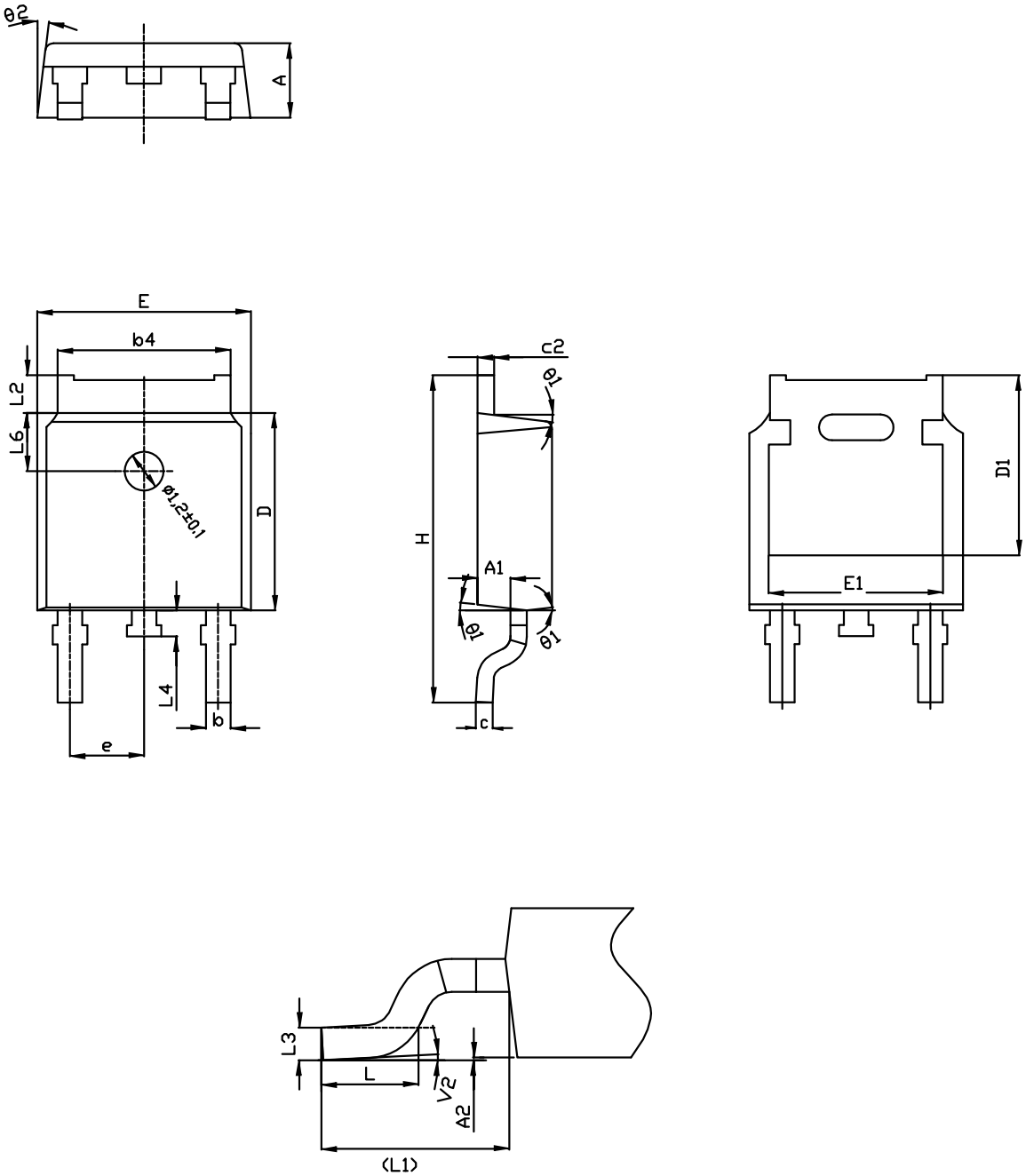

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Table 14. **DPAK (TO-252) type C2 mechanical data**

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	5.10		5.60
E	6.50	6.60	6.70
E1	5.20		5.50
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°

4.8 DPAK (TO-252) type E package information

Figure 27. **DPAK (TO-252) type E package outline**

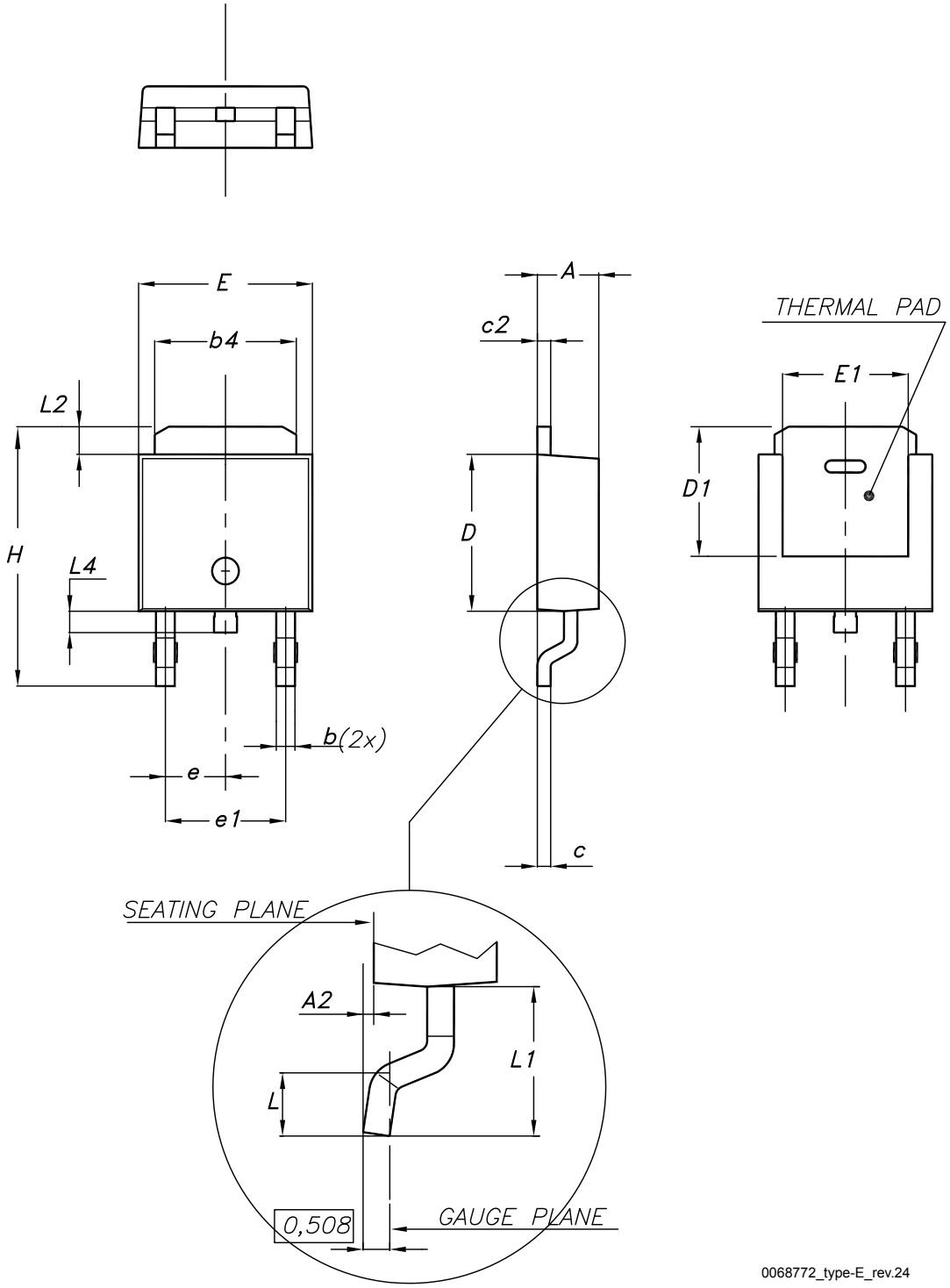
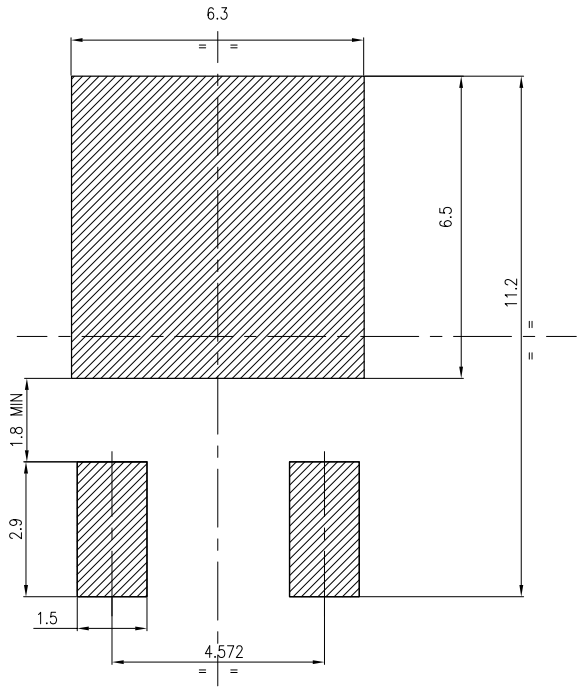


Table 15. **DPAK (TO-252) type E mechanical data**

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



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4.9 D²PAK and DPAK packing information

Figure 29. **Tape outline**

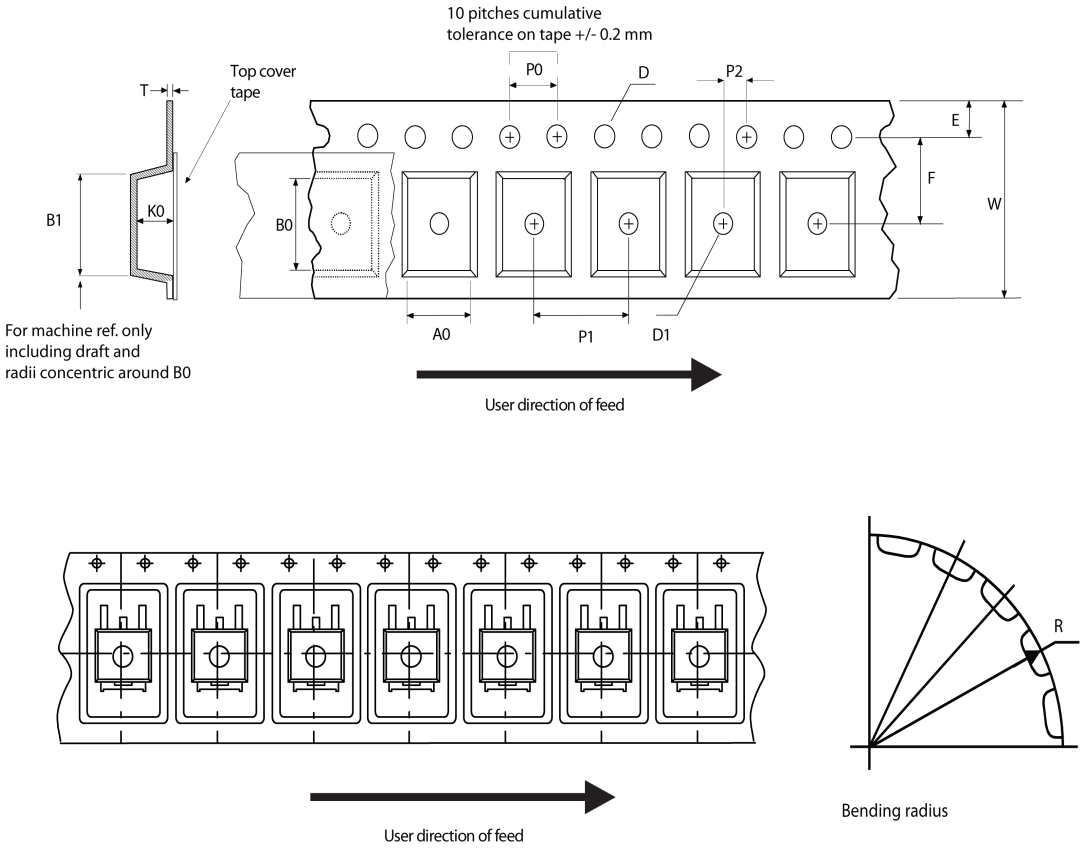

Figure 30. **Reel outline**

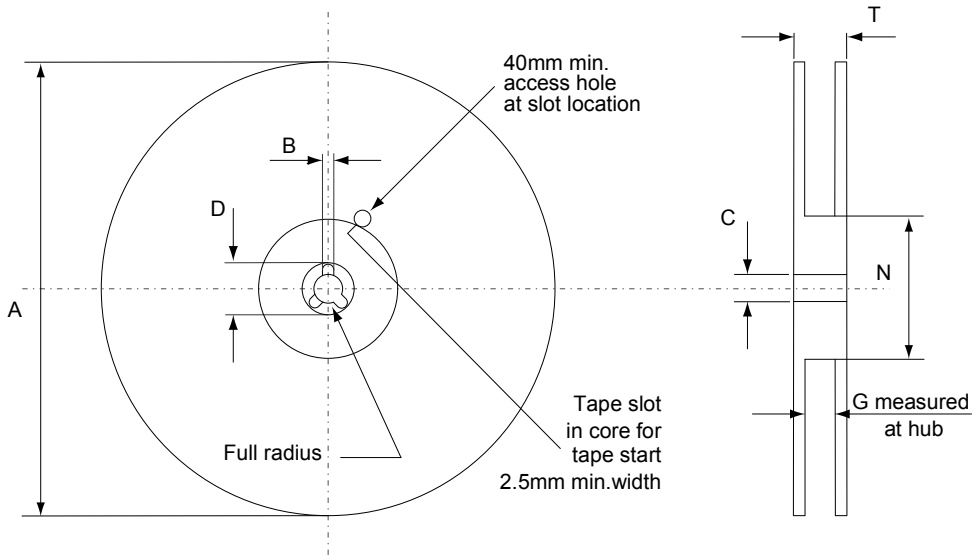

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Table 16. **D²PAK tape and reel mechanical data**

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Table 17. **DPAK 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			

5 Ordering information

Table 18. **Order codes**

Order code	Marking	Package	Packing
STB4NK60Z-1	B4NK60Z	I^2PAK	Tube
STB4NK60ZT4		D^2PAK	Tape and reel
STD4NK60Z-1	D4NK60Z	IPAK	Tube
STD4NK60ZT4		DPAK	Tape and reel

Revision history

Table 19. **Document revision history**

Date	Version	Changes
25-Oct-2006	4	Document reformatted no content change.
04-Mar-2008	5	Modified TO-220 and TO-220FP mechanical data.
16-Apr-2008	6	Minor text changes to improve readability.
11-Jul-2011	7	Updated package mechanical data *Section 4* and packaging mechanical data *Section 4*.
18-Jul-2013	8	– Minor text changes – The part numbers STP4NK60Z and STP4NK60ZFP have been moved to a separate datasheet – Updated: *Section 4: Package mechanical data* and *Section 4: Package mechanical data*
05-Apr-2018	9	Removed maturity status indication from cover page. The document status is production data. Updated part numbers. Updated Table 1. Absolute maximum ratings, Table 4. On/off states, Table 5. Dynamic, Table 6. Source-drain diode and Table 7. Gate-source Zener diode. Updated Section 2.1 Electrical characteristics (curves) and Section 4 Package information. Minor text changes.

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