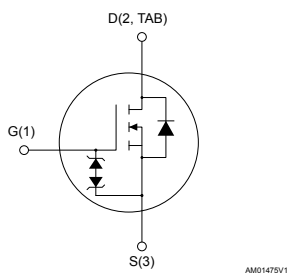
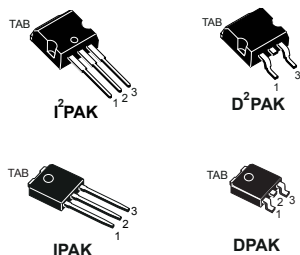


N-channel 600 V, 1.7 Ω typ., 4 A SuperMESH™ Power MOSFETs
in I²PAK, D²PAK, IPAK and DPAK packages



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.

Product status
STB4NK60Z-1
STB4NK60ZT4
STD4NK60Z-1
STD4NK60ZT4

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 $T_C = 25\text{ }^{\circ}\text{C}$	4	A
I_D	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	2.5	A
$I_{DM}^{(1)}$	Drain current (pulsed)	16	A
P_{TOT}	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	70	W
ESD	Gate-source human body model ($C=100\text{ pF}$, $R=1.5\text{ k}\Omega$)	3	kV
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4.5	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. $I_{SD} \leq 4\text{ A}$, $di/dt \leq 200\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$.

Table 2. Thermal data

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

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 $T_j = 25\text{ }^{\circ}\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$)	120	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	$V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$	600			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$ ⁽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	$V_{GS} = 10\text{ V}$, $I_D = 2\text{ A}$		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	$V_{DS} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	510		pF
C_{oss}	Output capacitance			67		
C_{rss}	Reverse transfer capacitance			13		
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0\text{ V}$, $V_{DS} = 0\text{ V to } 480\text{ V}$	-	38.5		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 2\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (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	$V_{DD} = 480\text{ V}$, $I_D = 4\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	12		ns
t_r	Fall time			12		
t_c	Cross-over time			19.5		
Q_g	Total gate charge	$V_{DD} = 480\text{ V}$, $I_D = 4\text{ A}$, $V_{GS} = 0\text{ to } 10\text{ V}$ (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. $C_{oss\text{ eq.}}$ 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. 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	$I_{SD} = 4\text{ A}$, $V_{GS} = 0\text{ V}$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 4\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$	-	400		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 24\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$	-	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	$I_{GS} = \pm 1\text{ mA}$, $I_D = 0\text{ A}$	± 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)

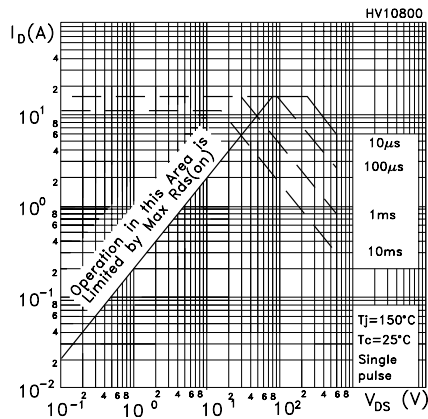
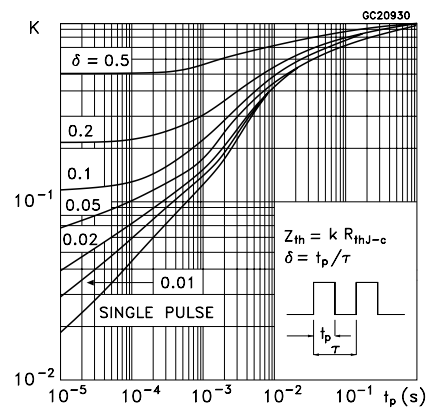
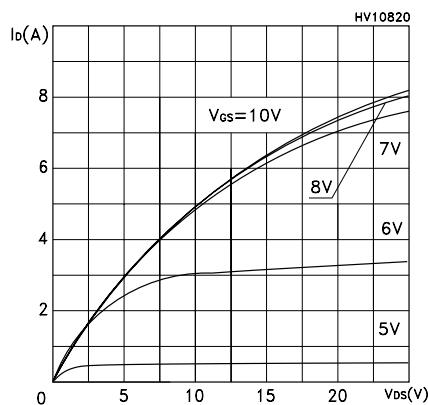
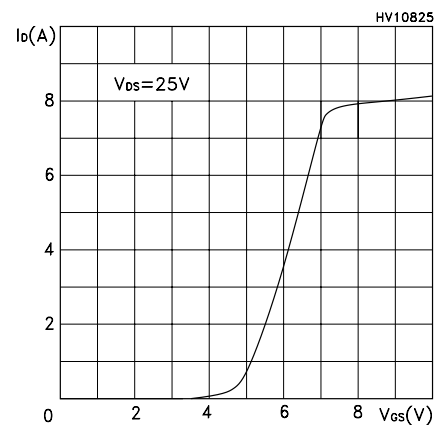
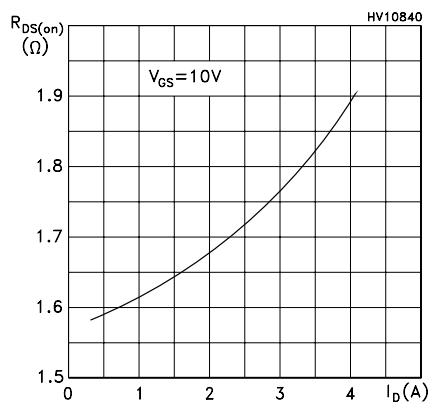
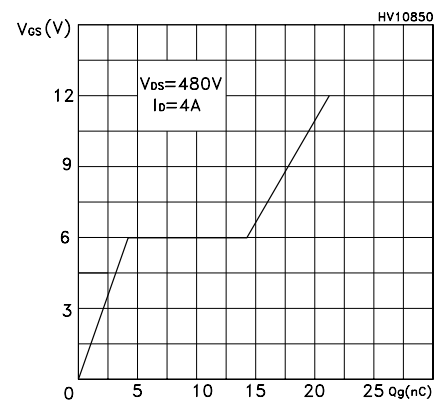
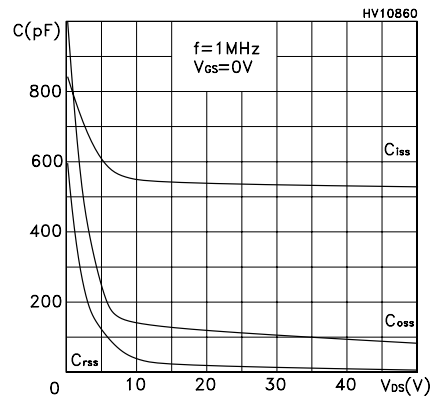
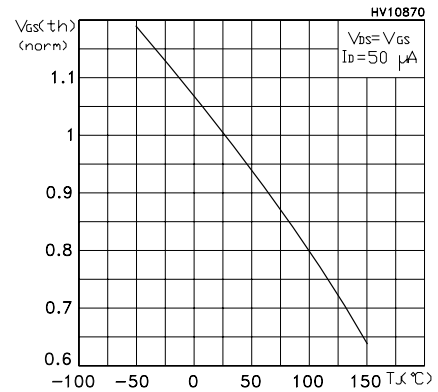
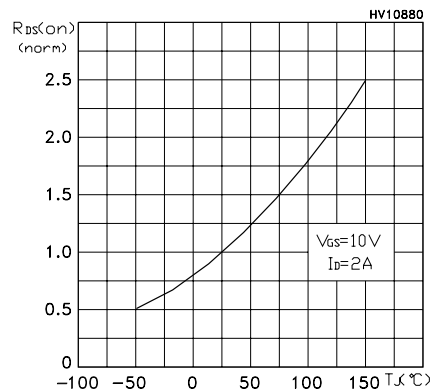
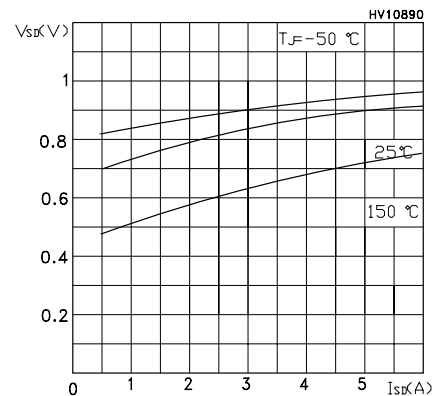
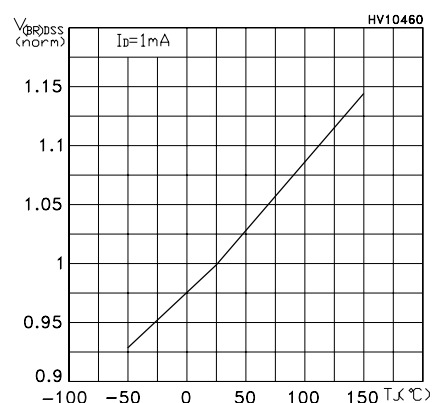
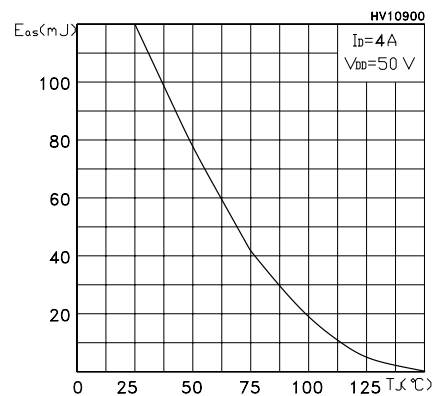
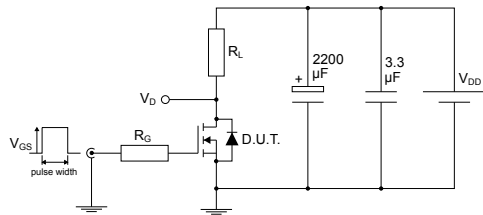
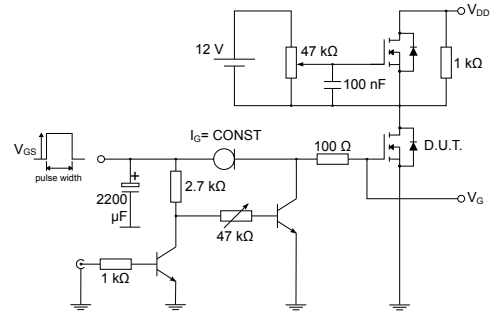
Figure 1. Safe operating area

Figure 2. Thermal impedance

Figure 3. Output characteristics

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


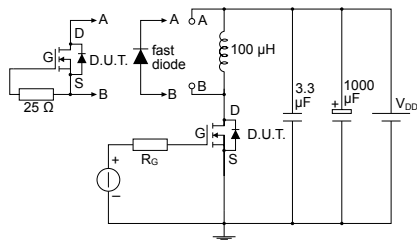
3 Test circuits

Figure 13. Test circuit for resistive load switching times


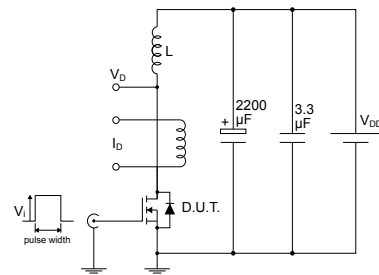
AM01468v1

Figure 14. Test circuit for gate charge behavior


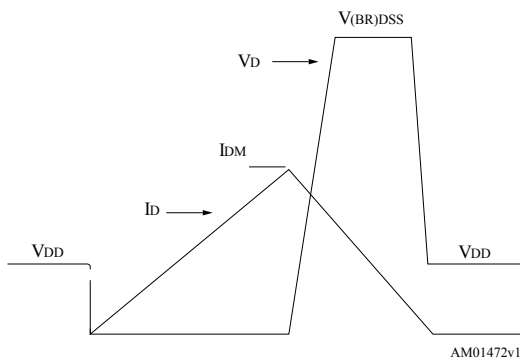
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Figure 15. Test circuit for inductive load switching and diode recovery times


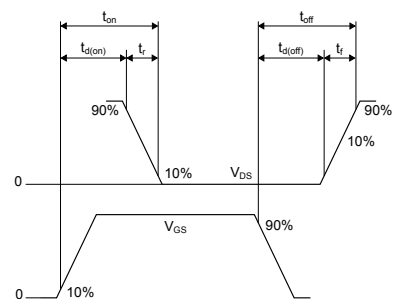
AM01470v1

Figure 16. Unclamped inductive load test circuit


AM01471v1

Figure 17. Unclamped inductive waveform


AM01472v1

Figure 18. Switching time waveform


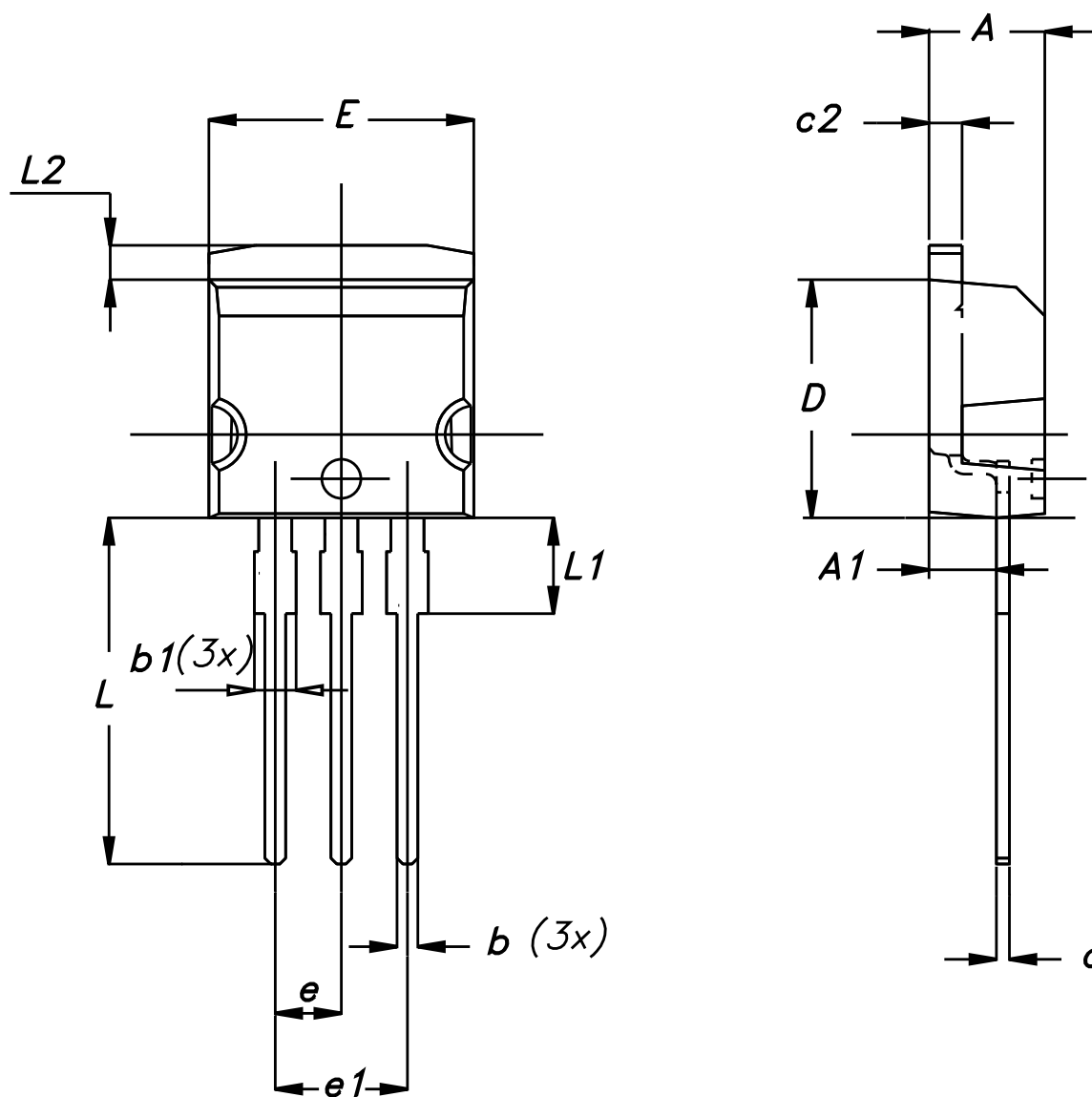
AM01473v1

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 19. I²PAK package outline



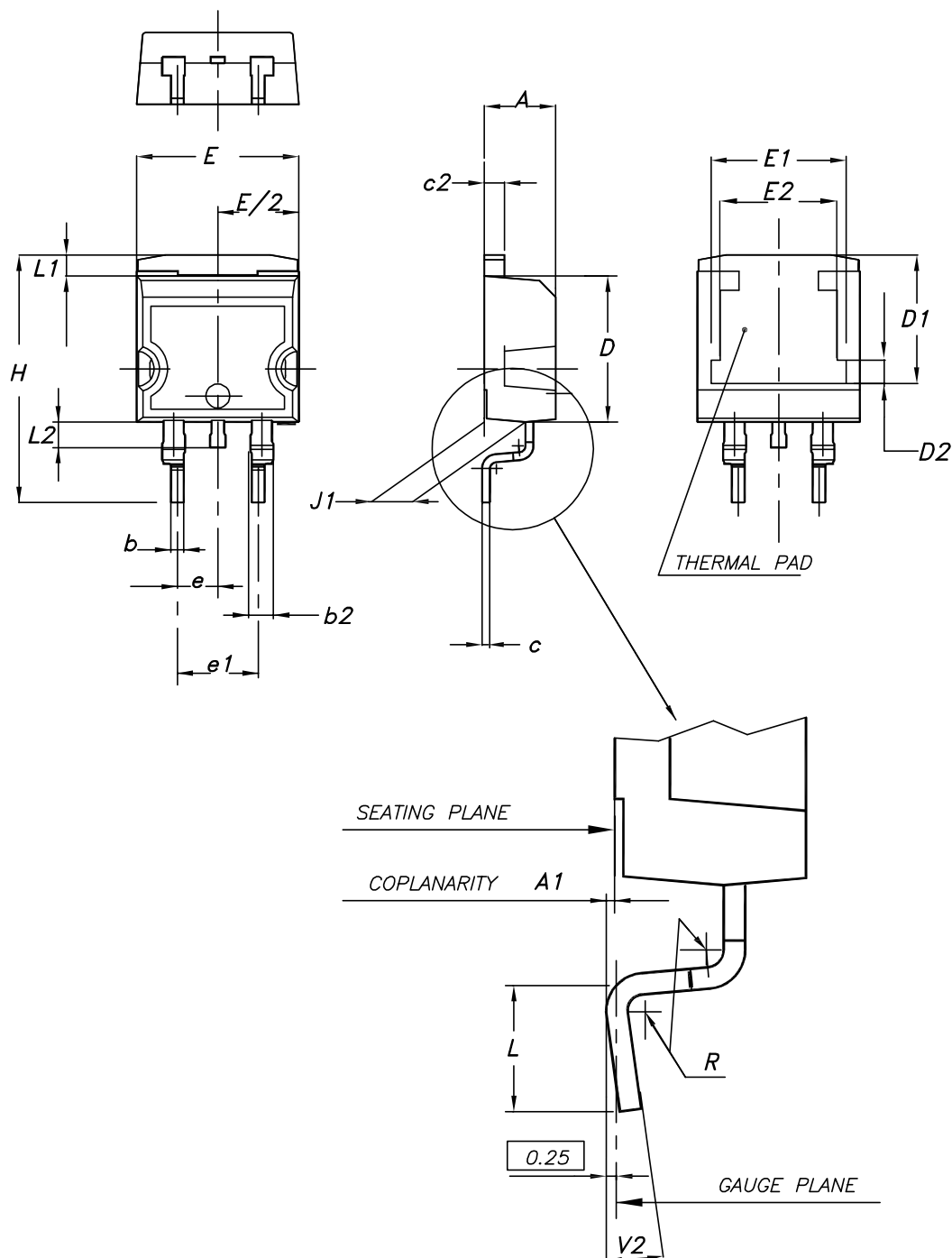
0004982_Rev_H

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



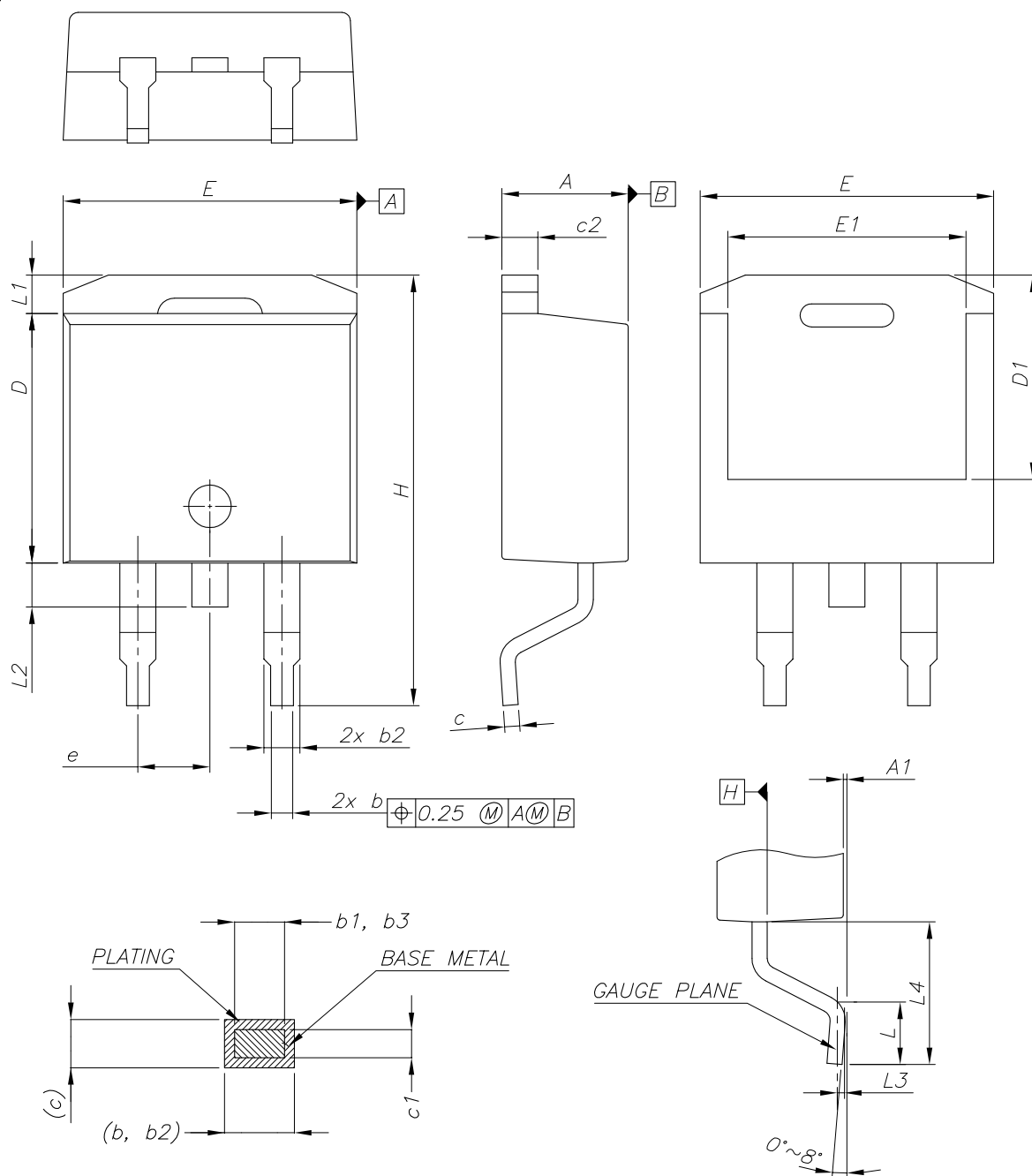
0079457_24

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

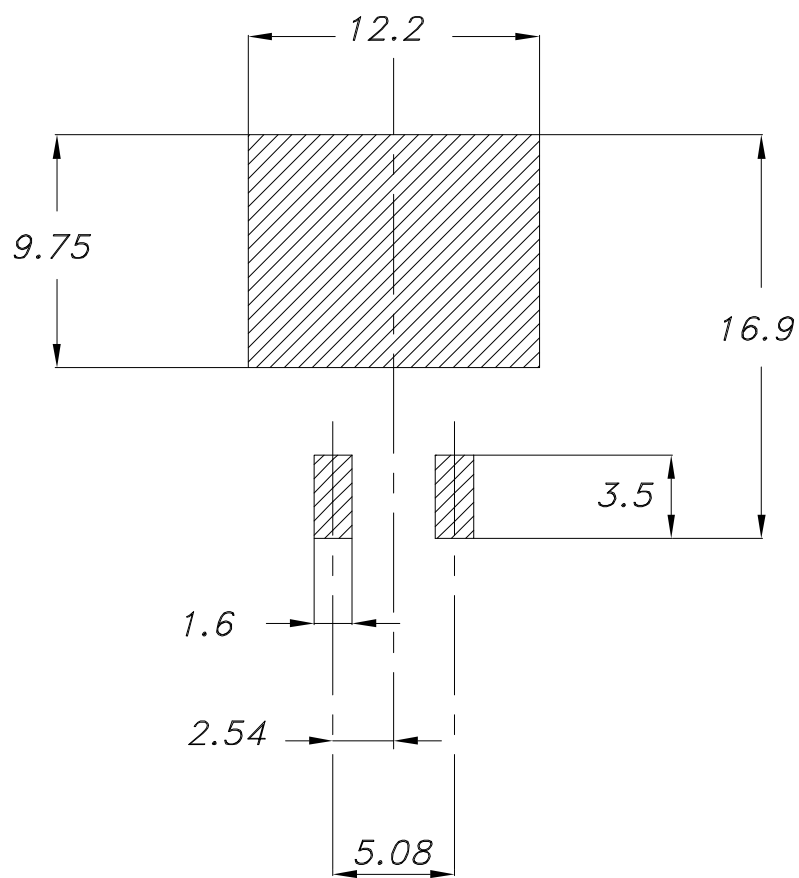


0079457_24_B

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

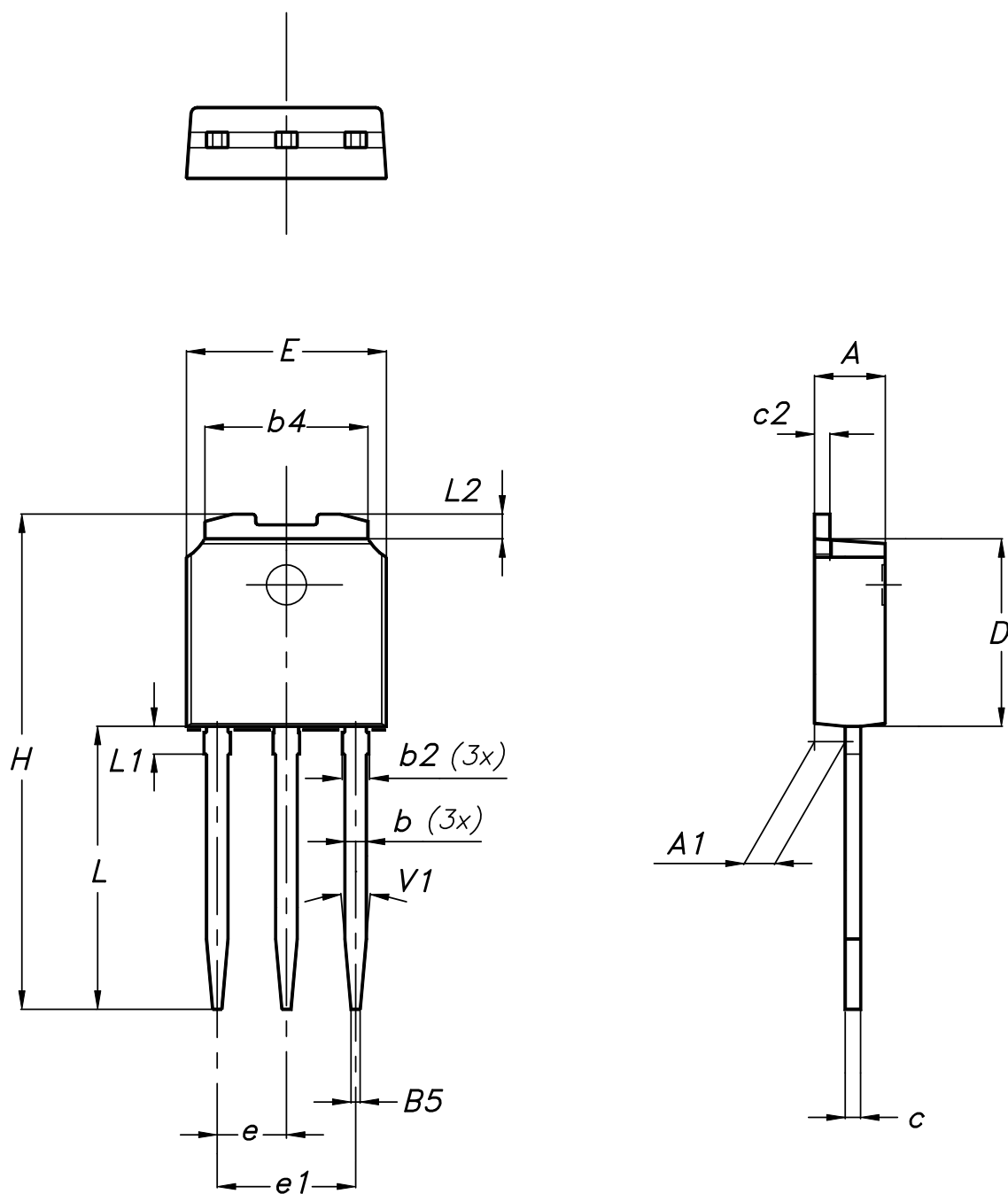
Figure 22. D²PAK (TO-263) recommended footprint (dimensions are in mm)



Footprint

4.4 IPAK (TO-251) type A package information

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



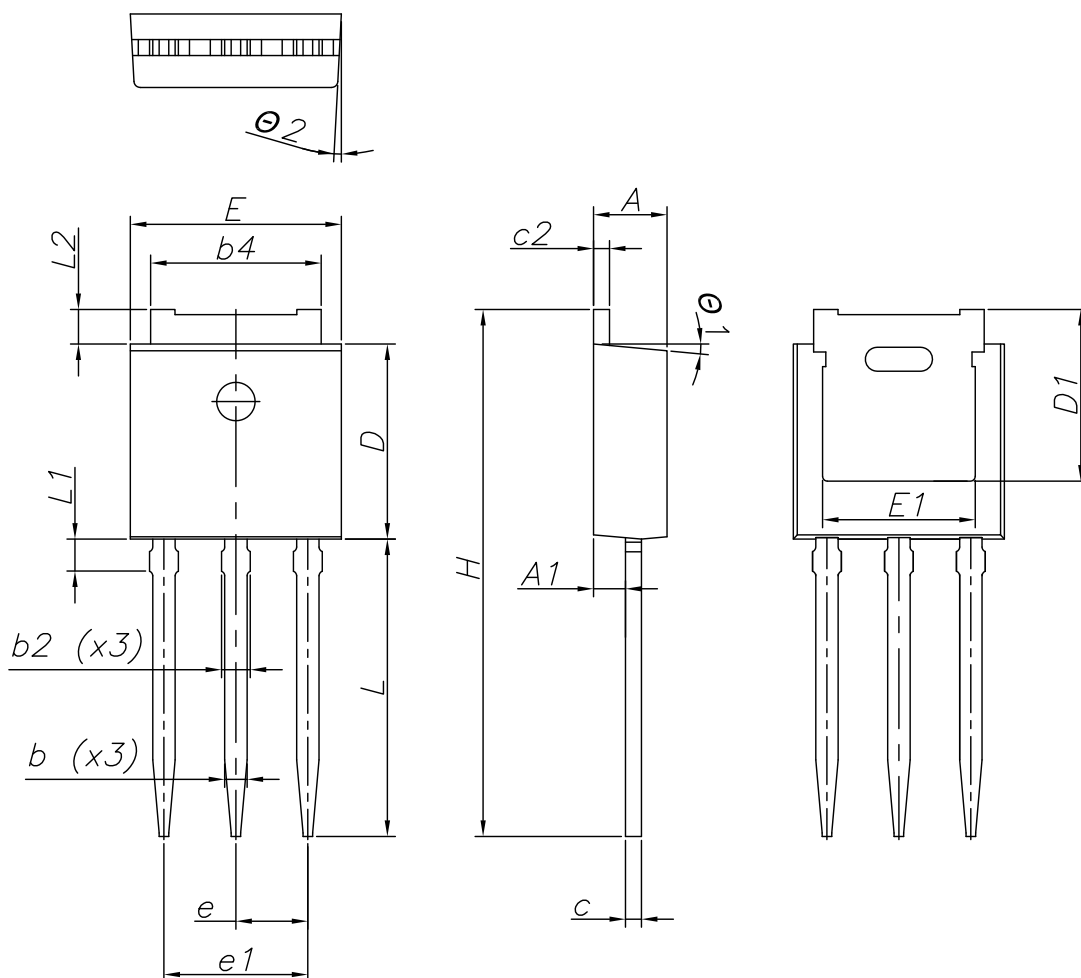
0068771_IK_typeA_rev14

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



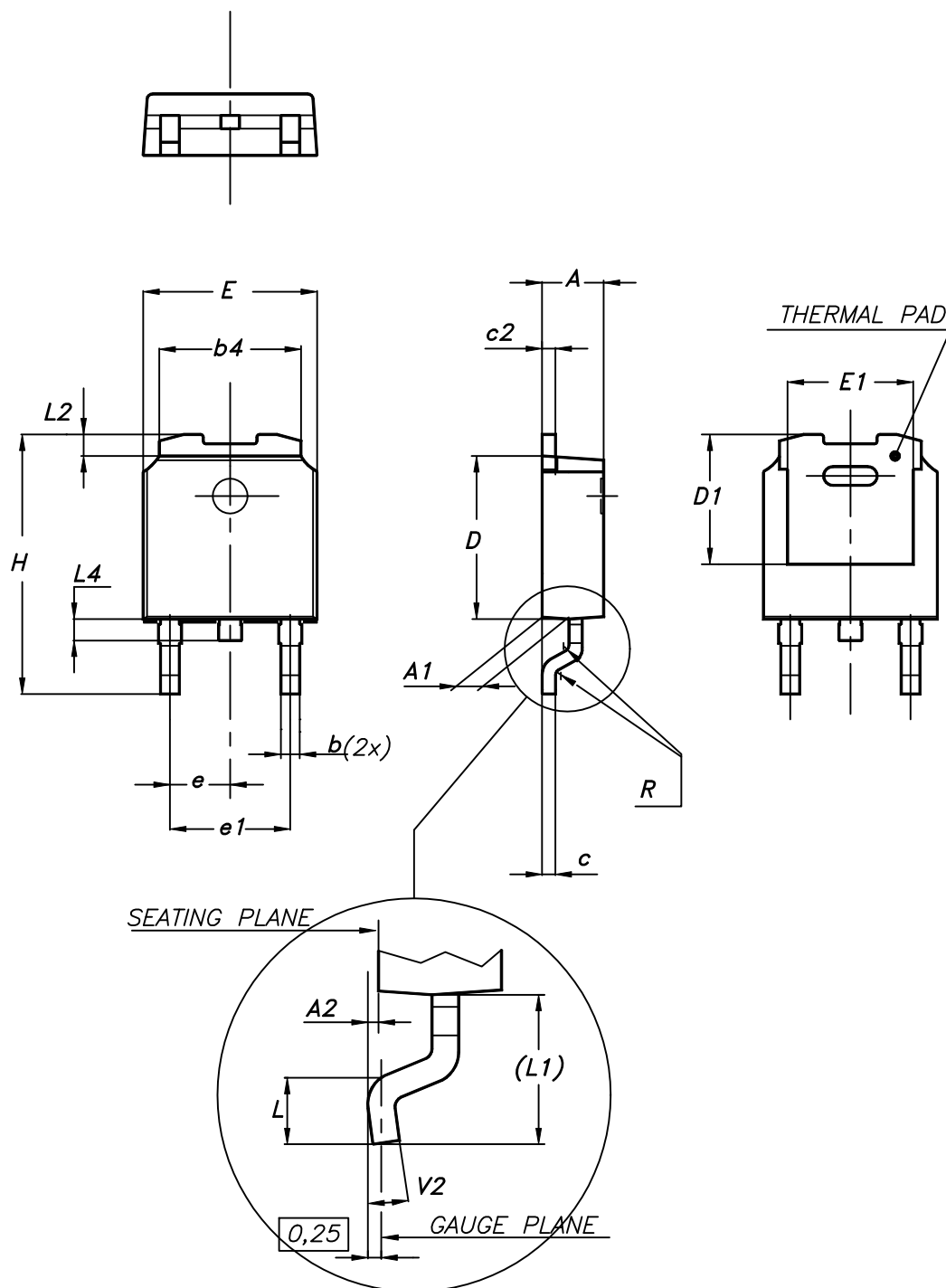
0068771_IK_typeC_rev14

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



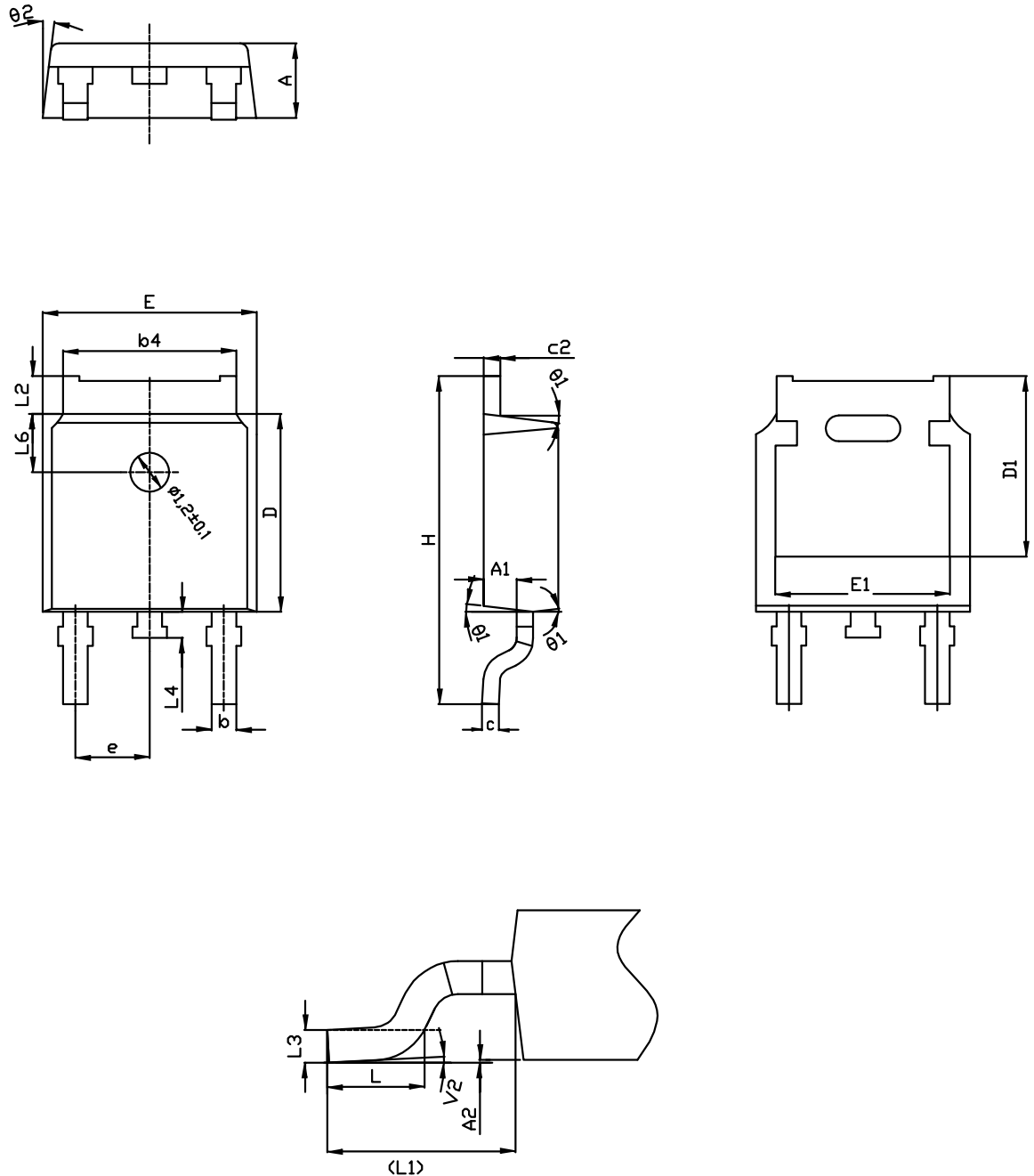
0068772_type-A2_rev24

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



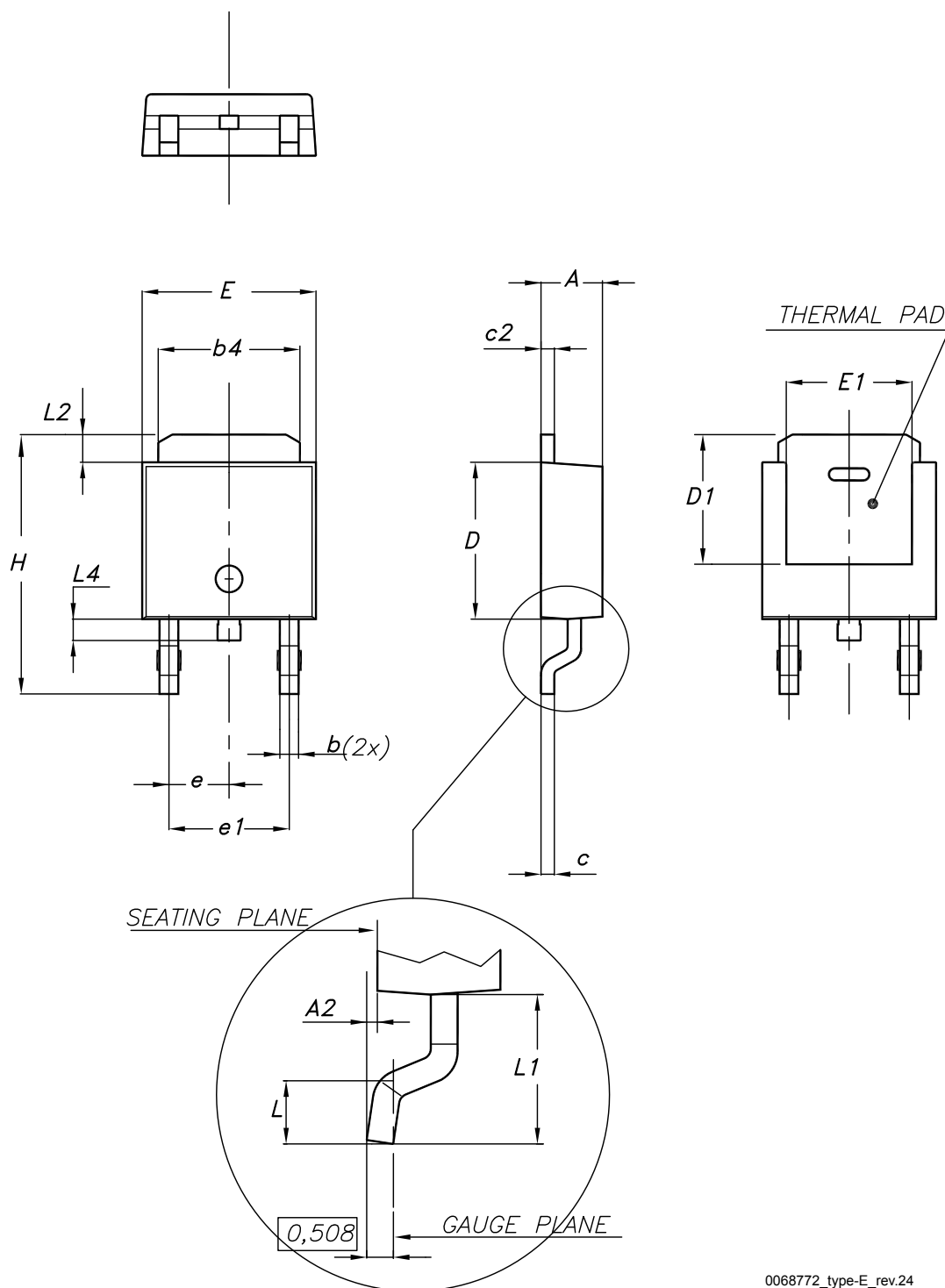
0068772_C2_24

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



0068772_type-E_rev.24

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

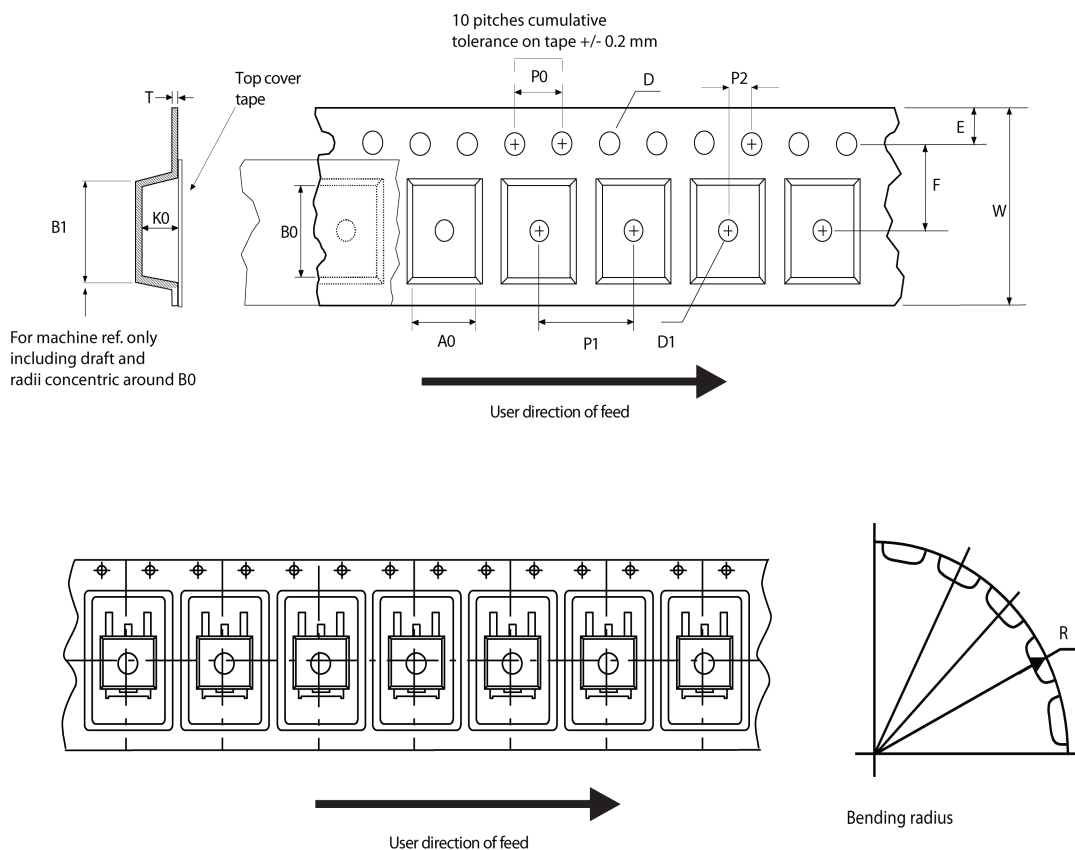
Technical drawing of a mechanical part with the following dimensions:

- Overall width: 6.3
- Overall height: 11.2
- Height of the upper section: 6.5
- Height of the lower section: 1.8 MIN
- Width of the lower section: 2.9
- Width of the lower section (inner): 1.5
- Width of the lower section (outer): 4.572

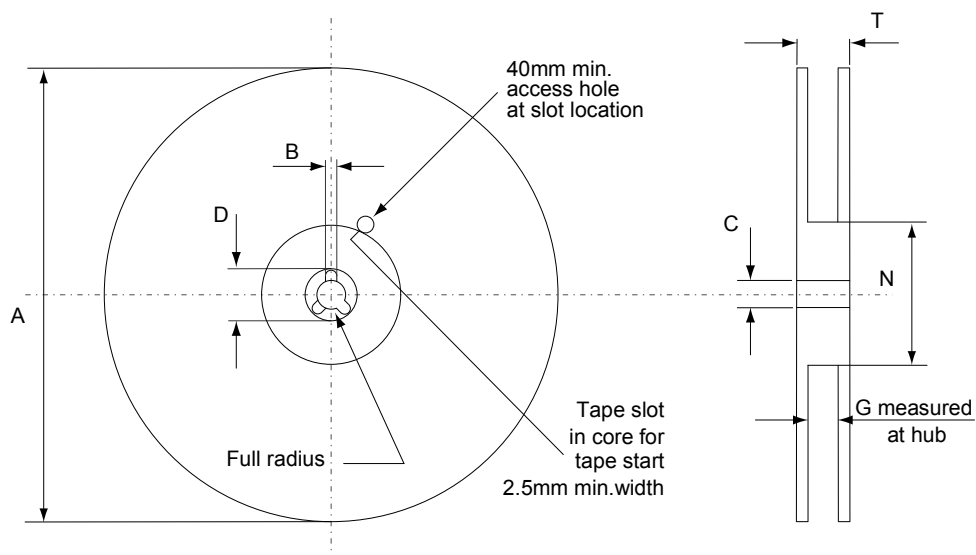
page 25/32

4.9 D²PAK and DPAK packing information

Figure 29. Tape outline



AM08852v1

Figure 30. Reel outline


AM06038v1

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	Base quantity Bulk quantity		
P1	11.9	12.1			
P2	1.9	2.1			
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 ² PAK	Tube
STB4NK60ZT4		D ² PAK	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 <i>Section 4</i> and packaging mechanical data <i>Section 4</i> .
18-Jul-2013	8	– Minor text changes – The part numbers STP4NK60Z and STP4NK60ZFP have been moved to a separate datasheet – Updated: <i>Section 4: Package mechanical data</i> and <i>Section 4: Package mechanical data</i>
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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