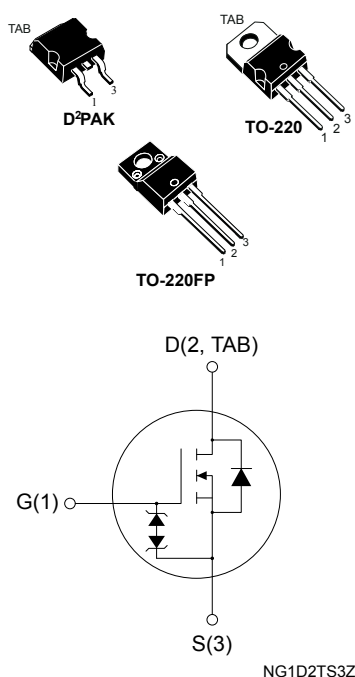


N-channel 400 V, 0.47 Ω typ., 9 A SuperMESH Power MOSFETs in a D²PAK, TO-220 and TO-220FP packages



Features

Order code	V _{DS}	R _{DS(on)} max.	I _D	Package
STB11NK40ZT4	400 V	0.55 Ω	9 A	D ² PAK
STP11NK40Z				TO-220
STP11NK40ZFP				TO-220FP

- 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

[STB11NK40ZT4](#)
[STP11NK40Z](#)
[STP11NK40ZFP](#)

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK, TO-220	TO-220FP	
V _{DS}	Drain-source voltage	400		V
V _{GS}	Gate-source voltage	±30		V
I _D	Drain current (continuous) at T _C = 25 °C	9	9 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	5.67	5.67 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	36	36 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	110	30	W
ESD	Gate-source human body model (C = 100 pF, R = 1.5 kΩ)	3.5		kV
dv/dt ⁽³⁾	Peak diode recovery voltage slope	4.5		V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C)		2.5	kV
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. $I_{SD} \leq 9\text{ A}$, $di/dt \leq 200\text{ A}/\mu\text{s}$, $V_{DD} = 80\% V_{(BR)DSS}$, $T_J \leq T_{JMAX}$.

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		D ² PAK	TO-220	TO-220FP	
R _{thj-case}	Thermal resistance junction-case	1.14		4.17	°C/W
R _{thj-amb}	Thermal resistance junction-ambient		62.5		°C/W
R _{thj-pcb} ⁽¹⁾	Thermal resistance junction-pcb	50			°C/W

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

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I _{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _J Max)	9	A
E _{AS}	Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	190	mJ

2 Electrical characteristics

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

Table 4. On/off states

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source Breakdown voltage	$I_D = 1\text{ mA}$, $V_{GS} = 0\text{ V}$	400			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 400\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 400\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}^{(1)}$			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	$V_{DS} = V_{GS}$, $I_D = 100\text{ }\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$, $I_D = 4.5\text{ A}$		0.47	0.55	Ω

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

Table 5. Dynamic

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	930	-	pF
C_{oss}	Output capacitance			140		
C_{rss}	Reverse transfer capacitance			30		
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }320\text{ V}$, $V_{GS} = 0\text{ V}$	-	78	-	pF
Q_g	Total gate charge	$V_{DD} = 320\text{ V}$, $I_D = 9\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 16. Test circuit for gate charge behavior)	-	32	-	nC
Q_{gs}	Gate-source charge			6		
Q_{gd}	Gate-drain charge			18.5		

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 condition	Min.	Typ.	Max.	Unit
t _{d(on)}	Turn-on delay time	V _{DD} = 200 V, I _D = 4.5 A,	-	20	-	ns
t _r	Rise time	R _G = 4.7 Ω, V _{GS} = 10 V (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)		20		
t _{d(off)}	Turn-off delay time			40		
t _f	Fall time			18		
t _{r(Voff)}	Off-voltage rise time	V _{DD} = 320 V, I _D = 9 A,		15		
t _f	Fall time	R _G = 4.7 Ω, V _{GS} = 10 V (see Figure 17. Test circuit for inductive load switching and diode recovery times)		17		
t _c	Cross-over time			30		

Table 7. Source drain diode

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		9	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				36	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 9\text{ A}$, $V_{GS} = 0\text{ V}$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 9\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 45\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching and diode recovery times)	-	225		ns
Q_{rr}	Reverse recovery charge			1.6		μC
I_{RRM}	Reverse recovery current			14		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

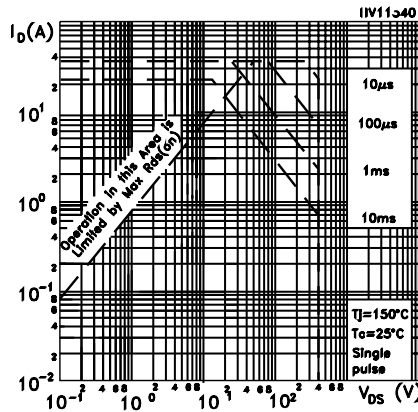
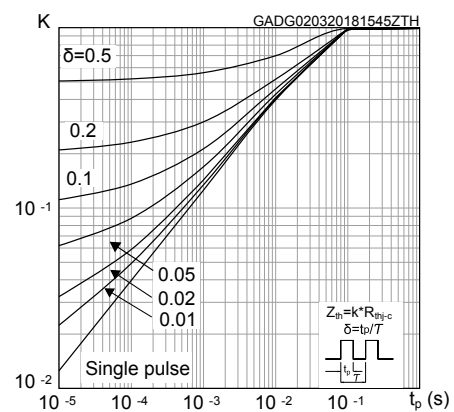
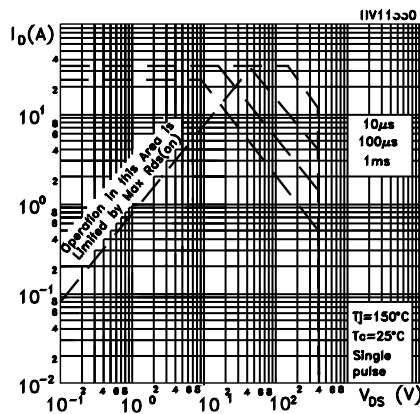
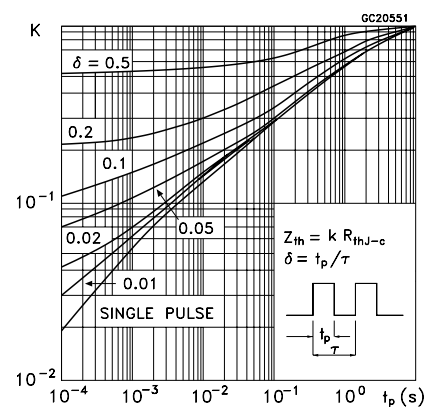
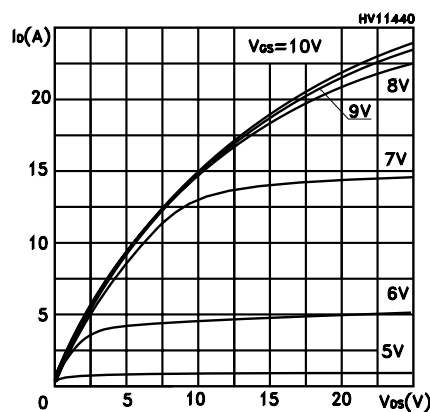
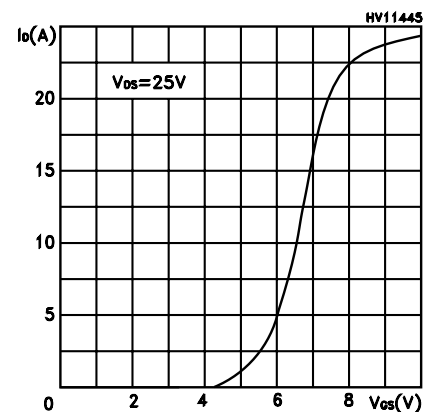
Figure 1. Safe operating area for TO-220, D²PAK

Figure 2. Thermal impedance for TO-220, D²PAK

Figure 3. Safe operating area for TO-220FP

Figure 4. Thermal impedance for TO-220FP

Figure 5. Output characteristics

Figure 6. Transfer characteristics


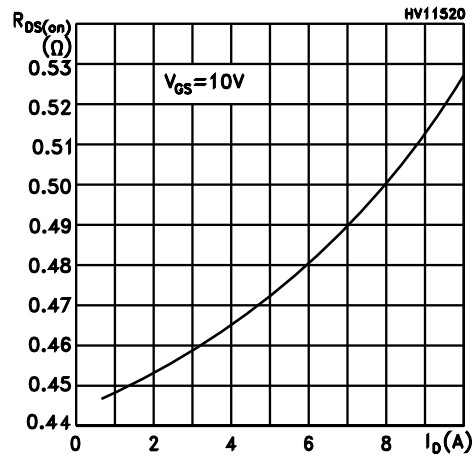
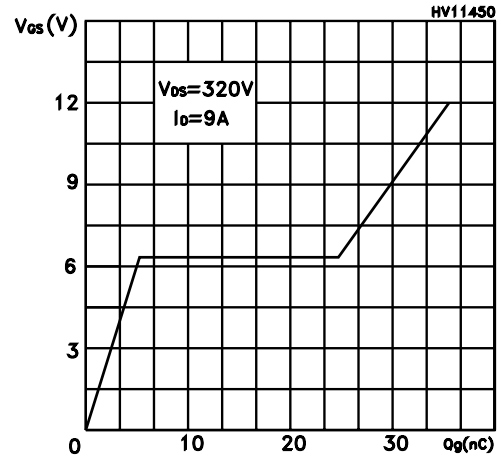
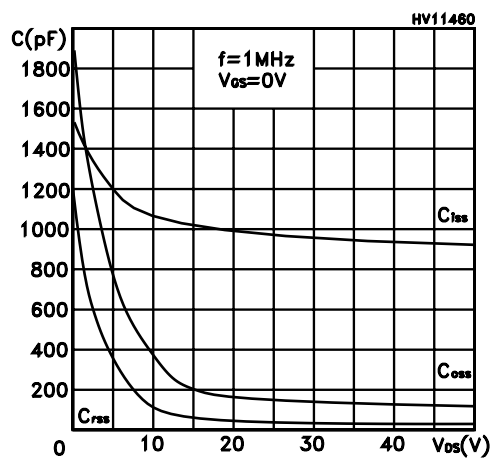
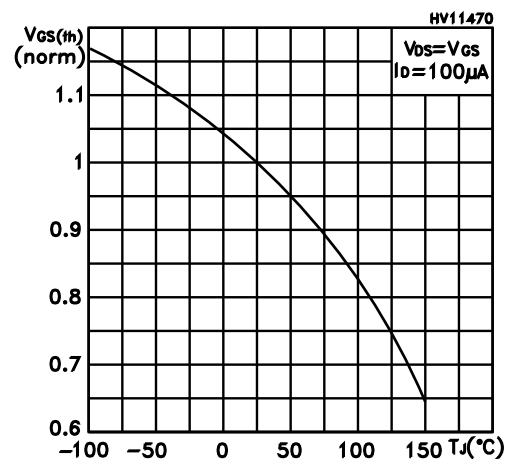
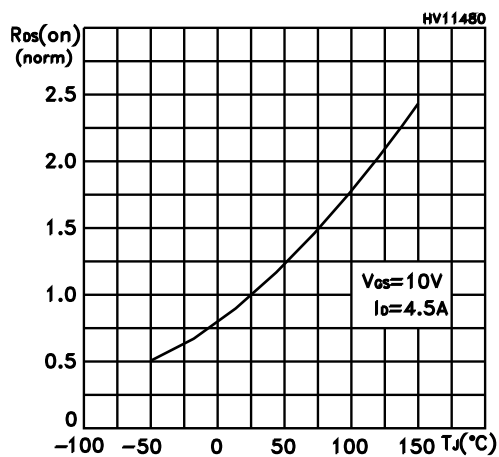
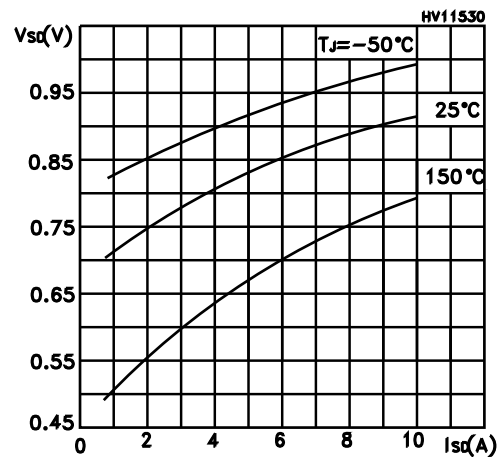
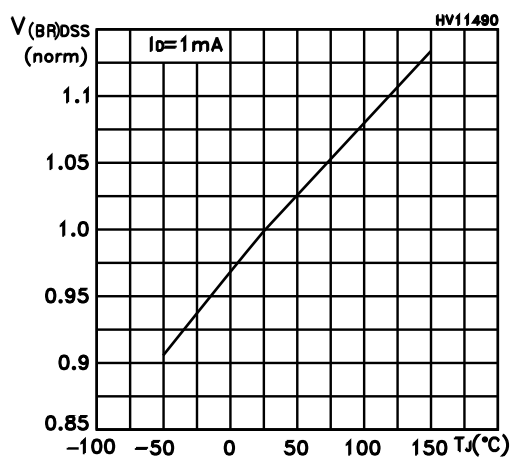
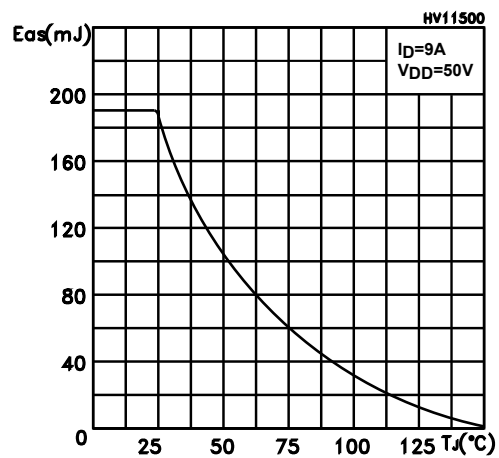
Figure 7. Static drain-source on resistance

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 characteristics


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

Figure 14. Maximum avalanche energy vs temperature


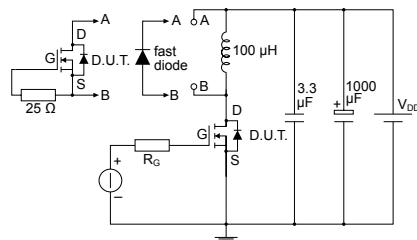
3 Test circuits

Figure 15. Test circuit for resistive load switching times

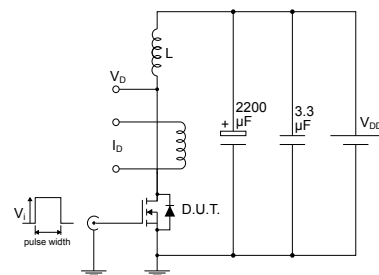

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Figure 16. Test circuit for gate charge behavior

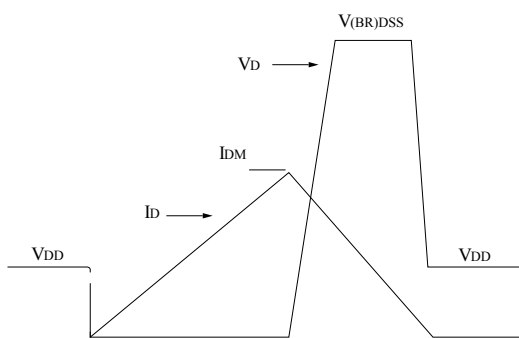

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Figure 17. Test circuit for inductive load switching and diode recovery times


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Figure 18. Unclamped inductive load test circuit


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Figure 19. Unclamped inductive waveform


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Figure 20. Switching time waveform

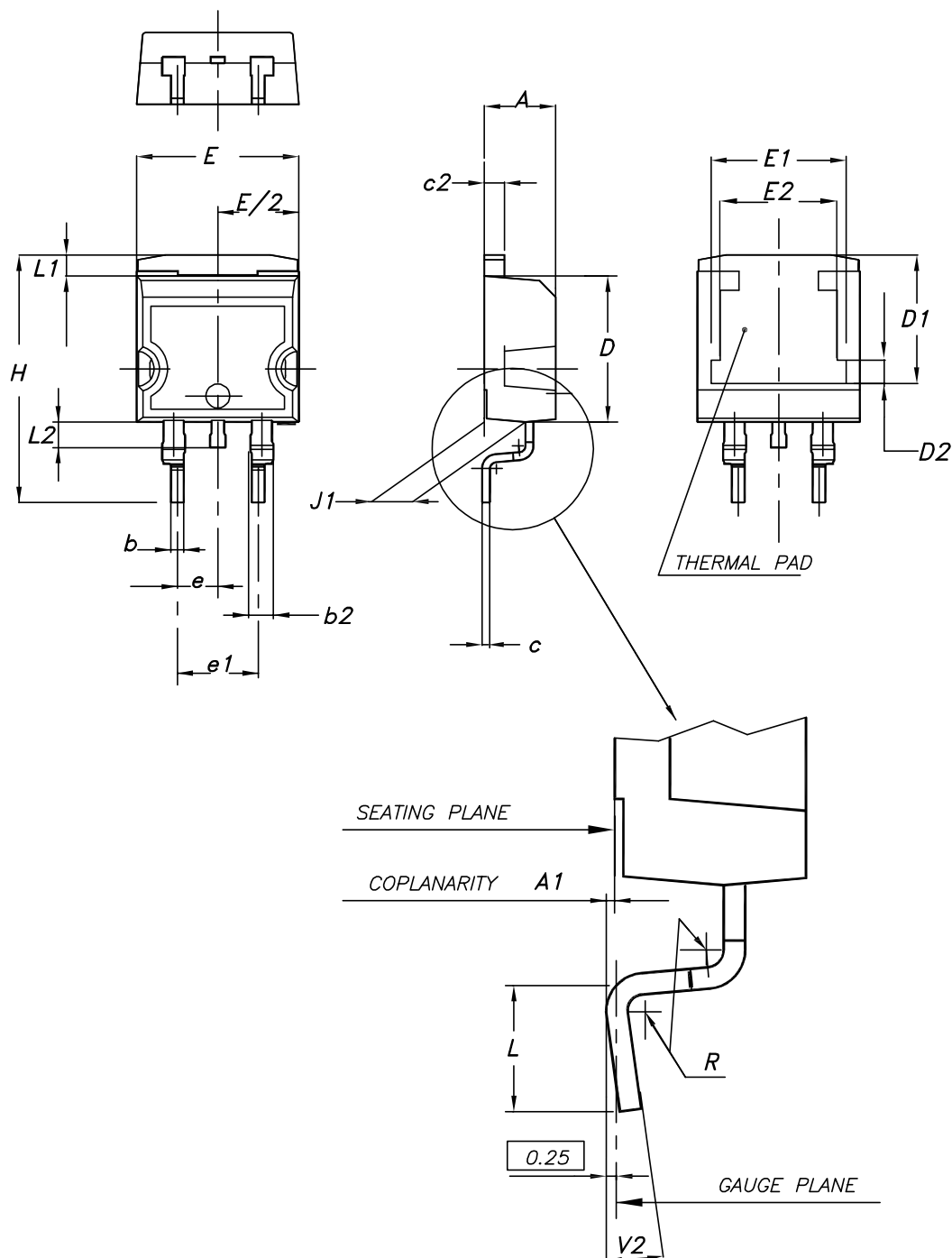

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4 Package information

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 D²PAK (TO-263) type A package information

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



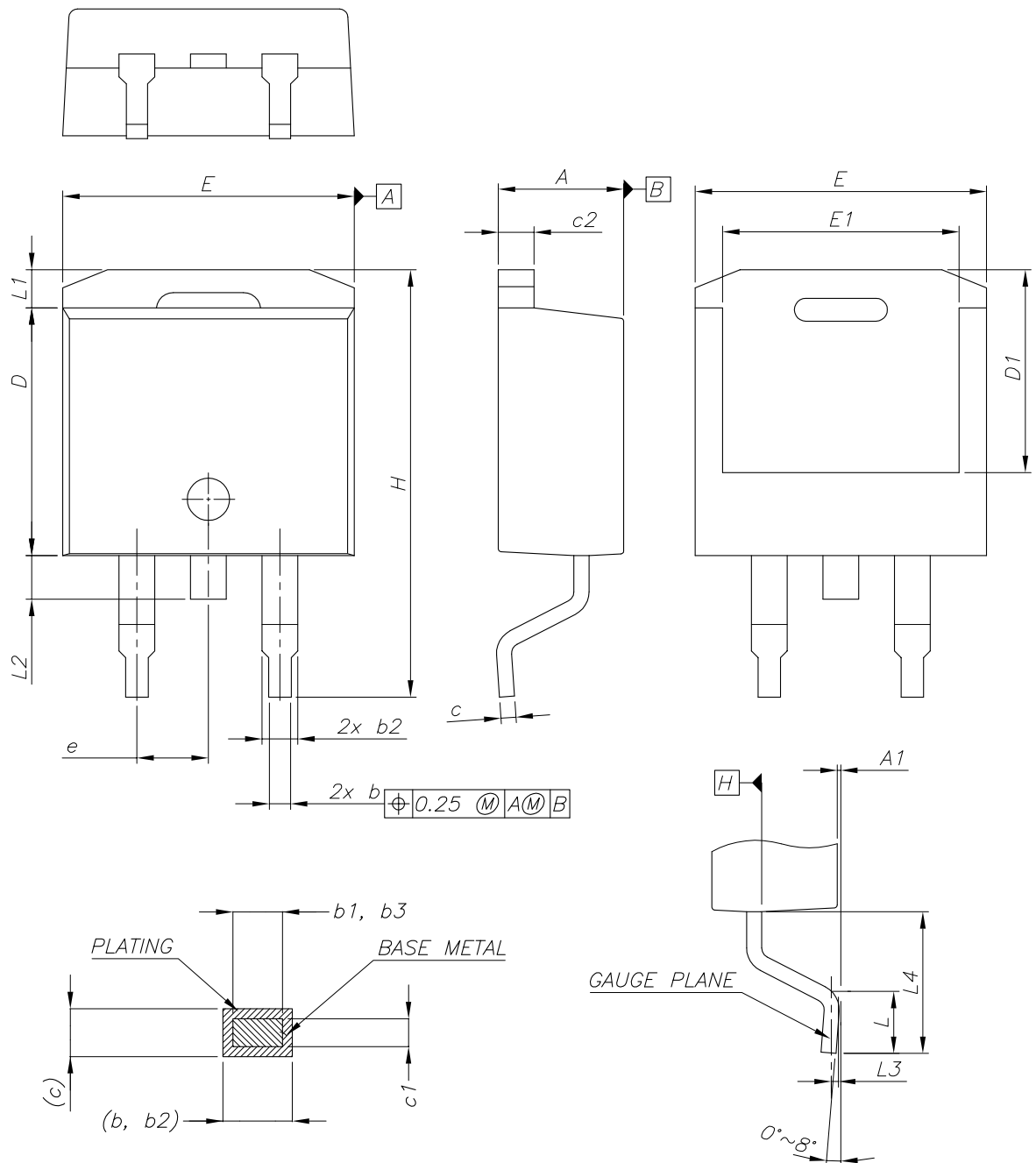
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Table 9. D²PAK (TO-263) type A package mechanical data

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	8.30	8.50	8.70
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°

4.2 D²PAK (TO-263) type B package information

Figure 22. D²PAK (TO-263) type B package outline

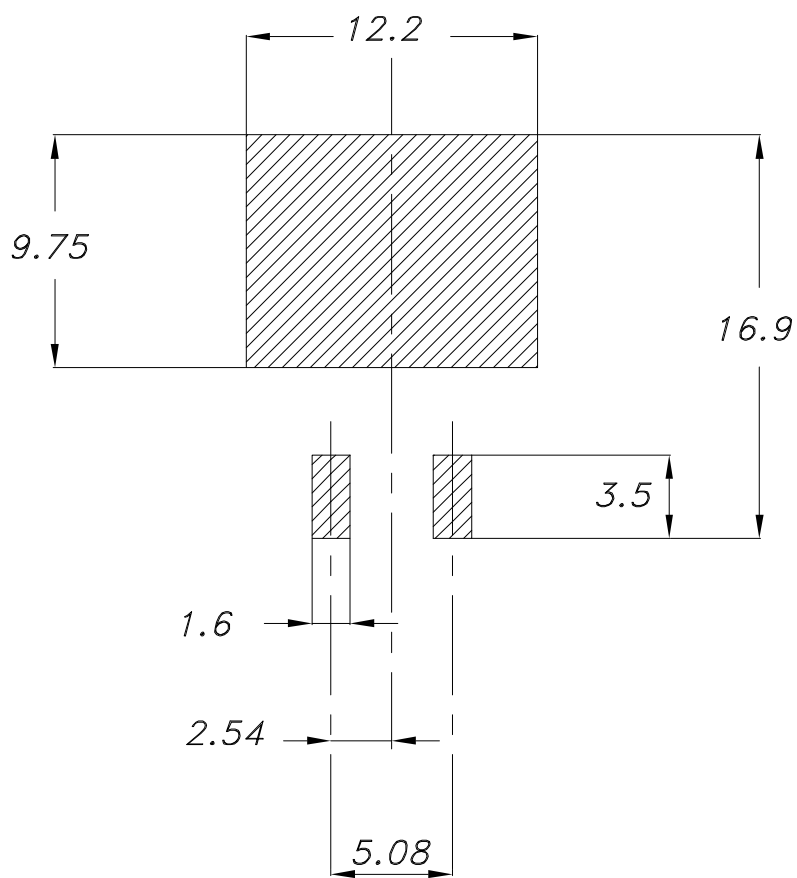


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Table 10. D²PAK (TO-263) type B mechanical data

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

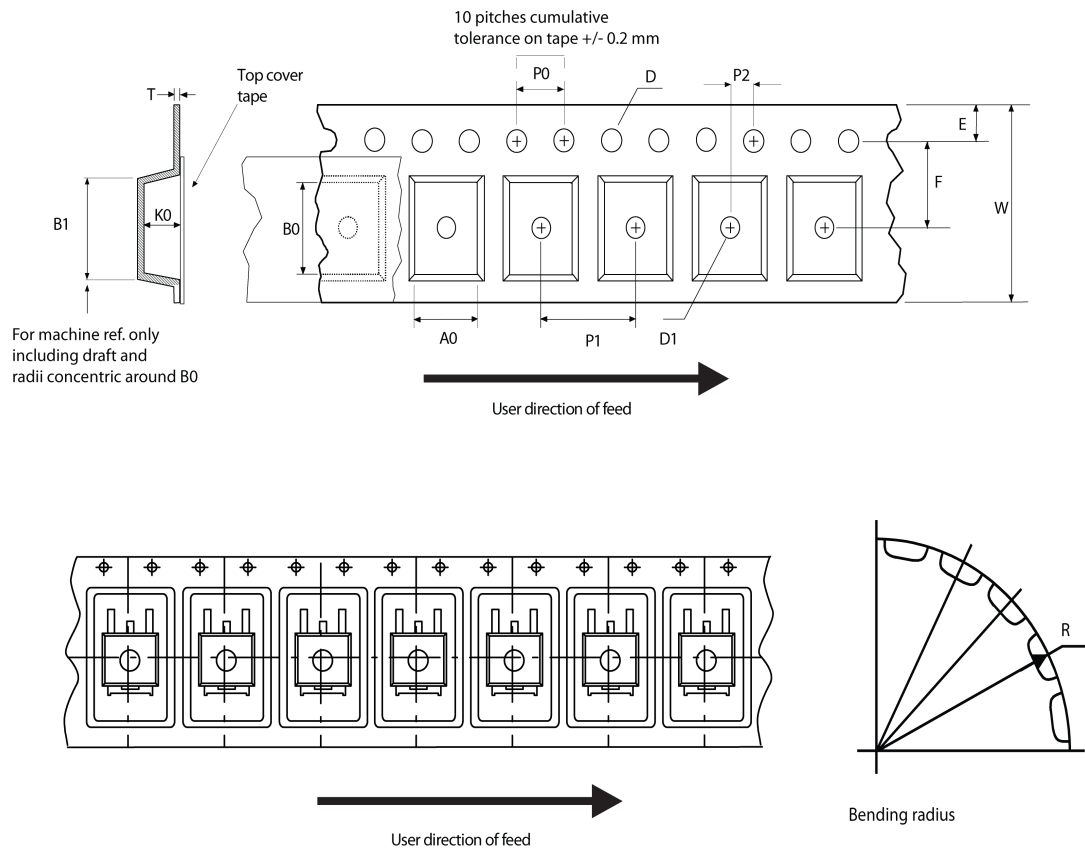
Figure 23. D²PAK (TO-263) recommended footprint (dimensions are in mm)



Footprint

4.3 D²PAK packing information

Figure 24. D²PAK tape outline



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Figure 25. D²PAK reel outline


AM06038v1

Table 11. 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			

4.4 D²PAK type B packing information

Figure 26. D²PAK type B tape outline

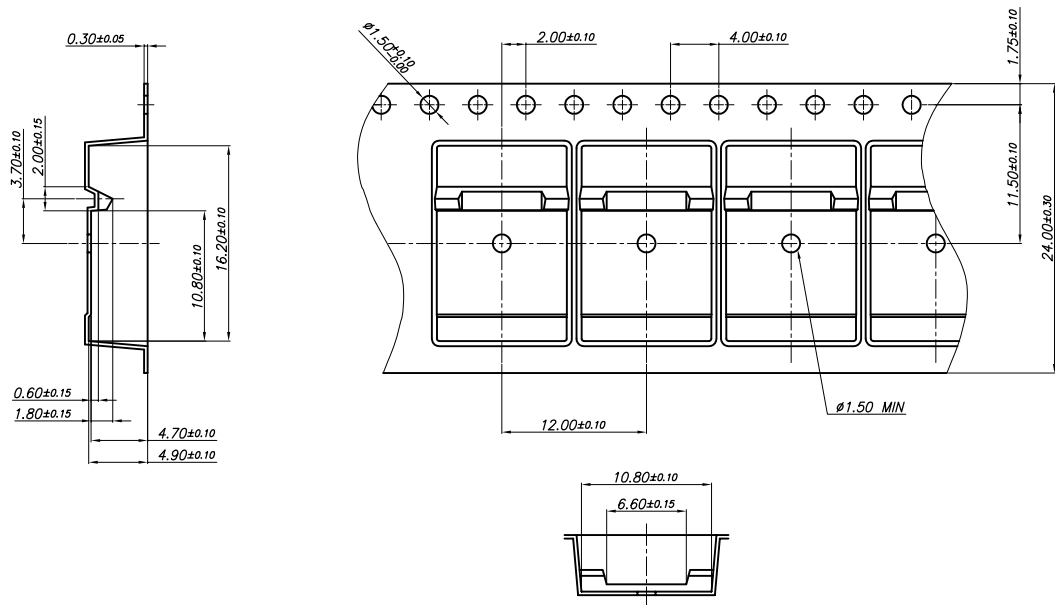
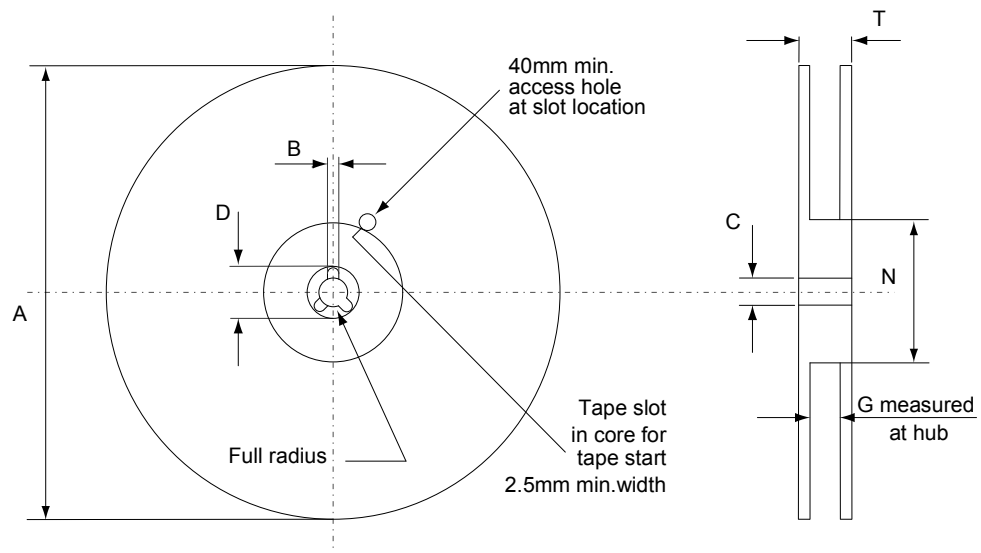


Figure 27. D²PAK type B reel outline



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Table 12. D²PAK type B reel mechanical data

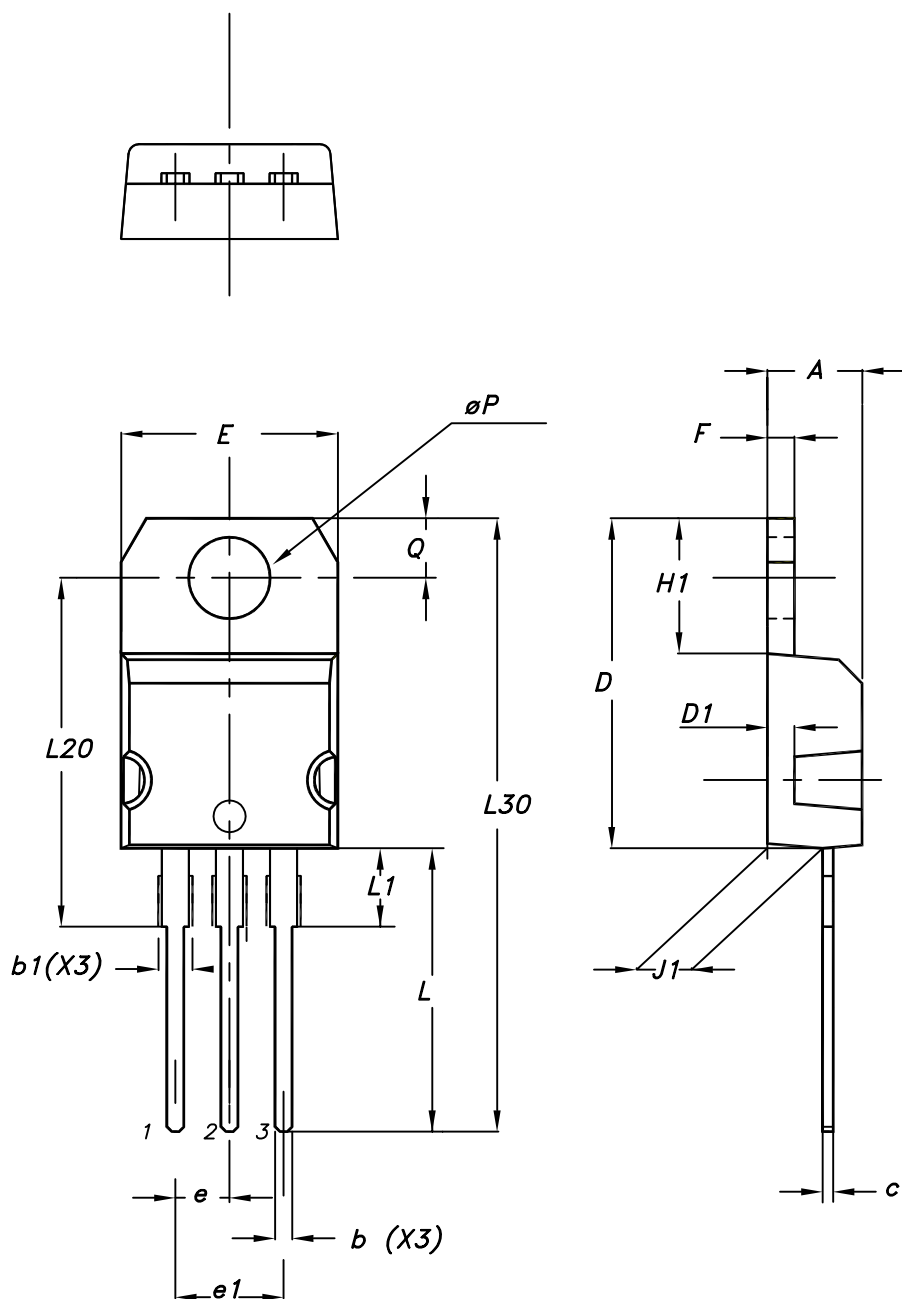
Dim.	mm	
	Min.	Max.
A		330
B	1.5	
C	12.8	13.2
D	20.2	
G	24.4	26.4
N	100	
T		30.4

Table 13. 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

4.6 TO-220 type A package information

Figure 29. TO-220 type A package outline



0015988_typeA_Rev_21

Table 14. 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

5 Ordering information

Table 15. Order codes

Order code	Marking	Package	Packing
STB11NK40ZT4	B11NK40Z	D ² PAK	Tape and reel
STP11NK40Z	P11NK40Z	TO-220	Tube
STP11NK40ZFP	P11NK40ZFP	TO-220FP	

Revision history

Table 16. Document revision history

Date	Version	Changes
23-Aug-2005	2	Preliminary version
28-Oct-2005	3	Complete version
26-Jul-2006	4	New template, no content change
22-Nov-2006	5	Corrected unit on <i>Table 5.: On/off states</i>
18-Jan-2007	6	Typo mistakes on page 1
20-Apr-2009	7	Updated mechanical data
02-Oct-2018	8	Updated Section 4 Package information . Minor text changes.

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