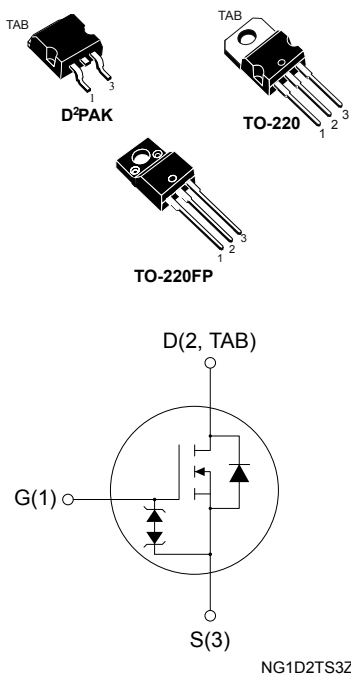


## N-channel 400 V, 0.47 $\Omega$ typ., 9 A SuperMESH Power MOSFETs in a D<sup>2</sup>PAK, TO-220 and TO-220FP packages



### Features

Order code	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$	Package
STB11NK40ZT4	400 V	0.55 $\Omega$	9 A	D <sup>2</sup> 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 <sup>2</sup> PAK, TO-220	TO-220FP	
V <sub>DS</sub>	Drain-source voltage	400		V
V <sub>GS</sub>	Gate-source voltage	±30		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	9	9 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	5.67	5.67 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	36	36 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	110	30	W
ESD	Gate-source human body model (C = 100 pF, R = 1.5 kΩ)	3.5		kV
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	4.5		V/ns
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T <sub>C</sub> = 25 °C)		2.5	kV
T <sub>J</sub>	Operating junction temperature range	-55 to 150		°C
T <sub>stg</sub>	Storage temperature range			

- Limited by maximum junction temperature.
- Pulse width limited by safe operating area.
- I<sub>SD</sub> ≤ 9 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>, T<sub>J</sub> ≤ T<sub>JMAX</sub>.

**Table 2. Thermal data**

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

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

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> Max)	9	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	190	mJ

## 2 Electrical characteristics

( $T_{CASE} = 25\text{ °C}$  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	$\mu\text{A}$
		$V_{GS} = 0\text{ V}, V_{DS} = 400\text{ V}, T_C = 125\text{ °C}^{(1)}$			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	$V_{DS} = V_{GS}, I_D = 100\text{ }\mu\text{A}$	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	$\Omega$

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	-	$\mu\text{F}$
$C_{oss}$	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	-	$\mu\text{F}$
$Q_g$	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	$V_{DD} = 200\text{ V}, I_D = 4.5\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	20	-	ns
$t_r$	Rise time			20		
$t_{d(off)}$	Turn-off delay time			40		
$t_f$	Fall time			18		
$t_{r(Voff)}$	Off-voltage rise time	$V_{DD} = 320\text{ V}, I_D = 9\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 17. Test circuit for inductive load switching and diode recovery times)		15		
$t_f$	Fall time			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 <a href="#">Figure 17. Test circuit for inductive load switching and diode recovery times</a> )	-	225		ns
$Q_{rr}$	Reverse recovery charge			1.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			14		A

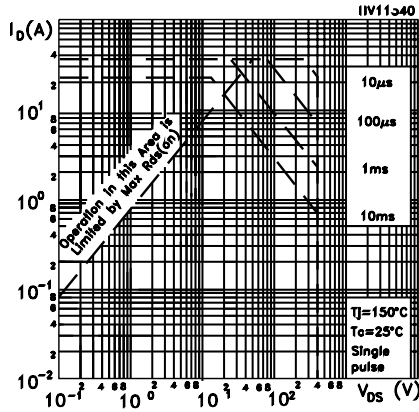
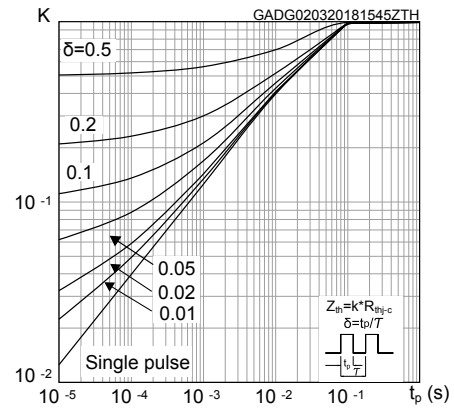
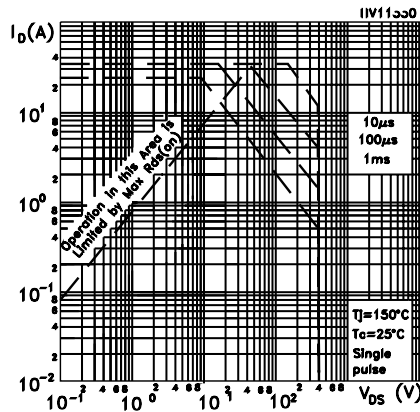
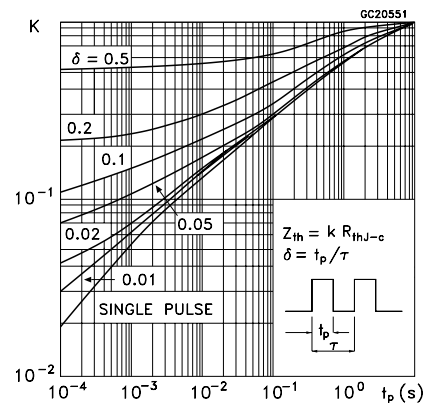
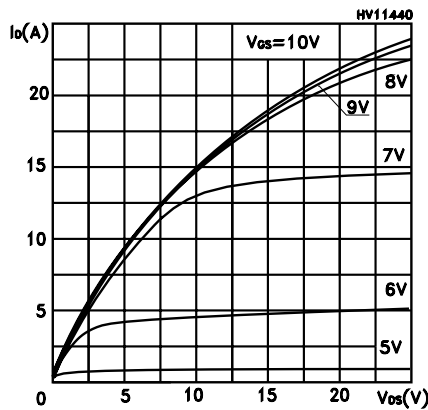
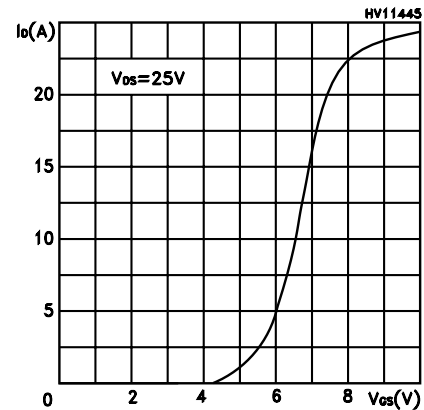
1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1\text{ mA}$ , $I_D = 0\text{ A}$	$\pm 30$	-	-	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, D<sup>2</sup>PAK**

**Figure 2. Thermal impedance for TO-220, D<sup>2</sup>PAK**

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

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

**Figure 5. Output characteristics**

**Figure 6. Transfer characteristics**


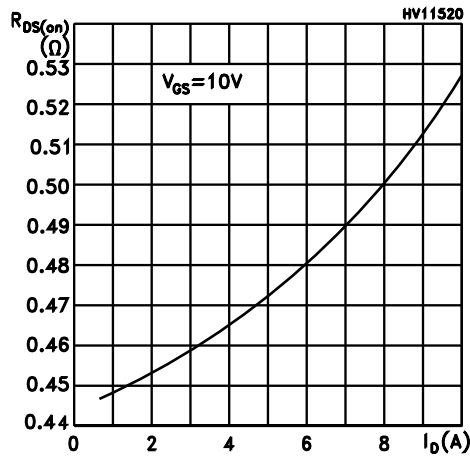
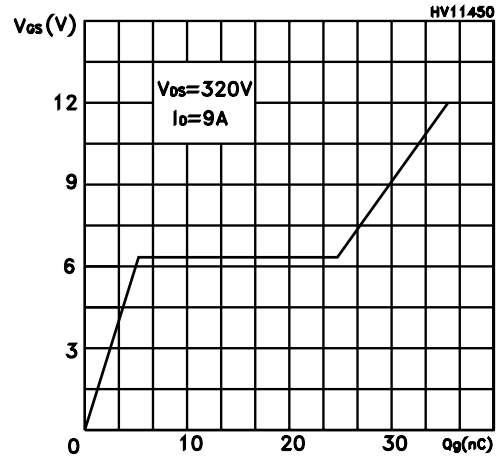
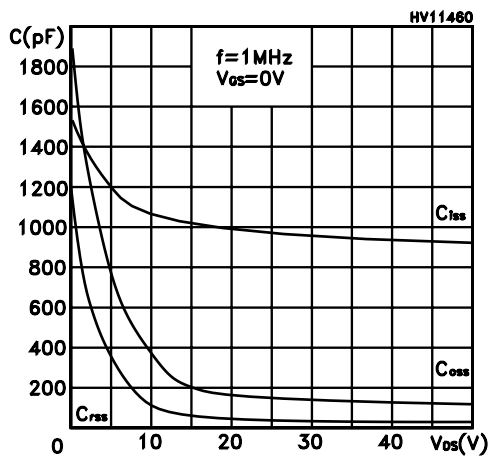
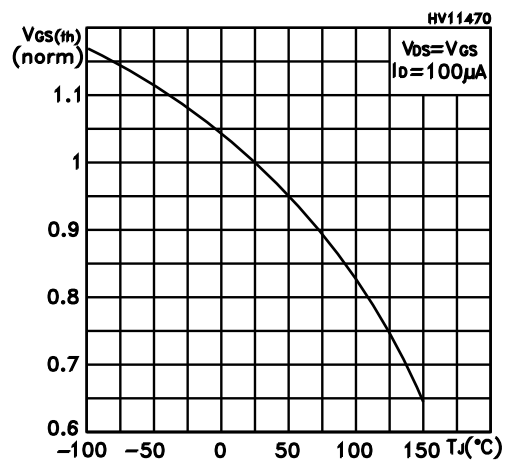
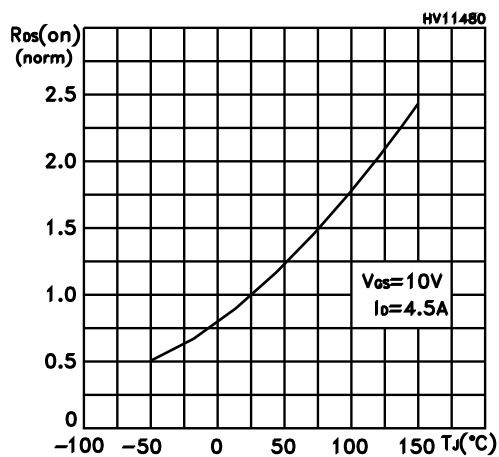
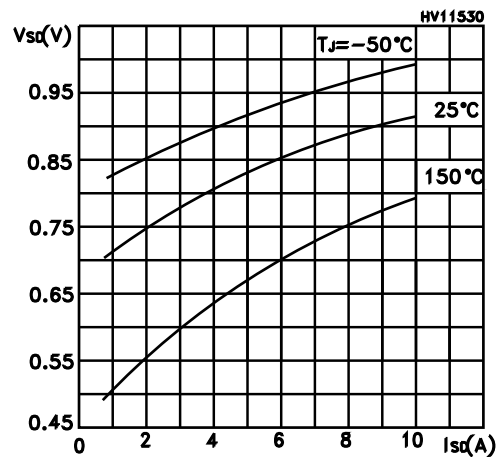
**Figure 7. Static drain-source on resistance**

**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

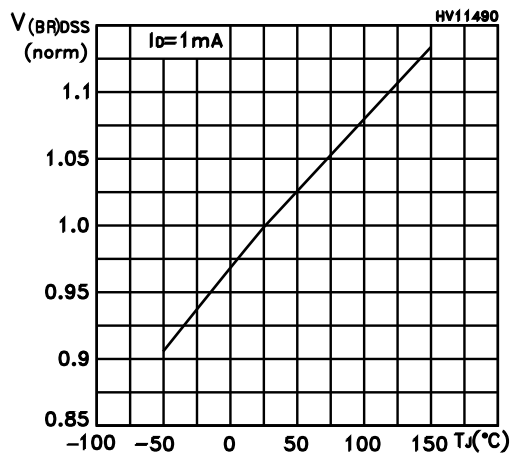
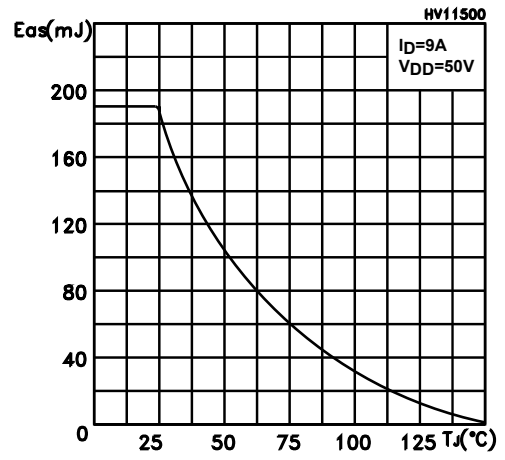
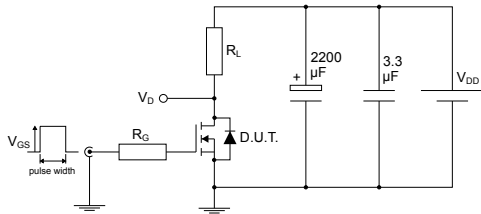


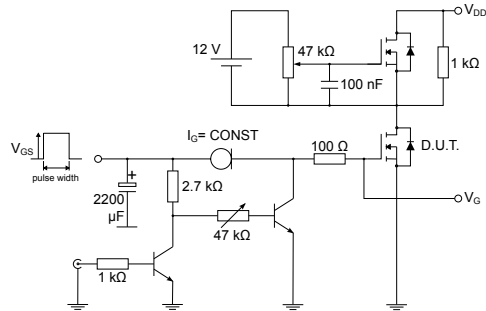
Figure 14. Maximum avalanche energy vs temperature



### 3 Test circuits

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


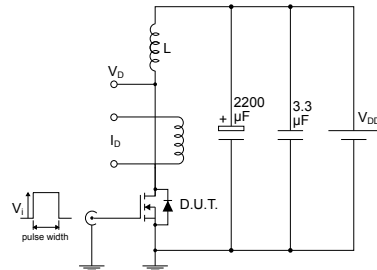
AM01468v1

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


AM01469v1

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

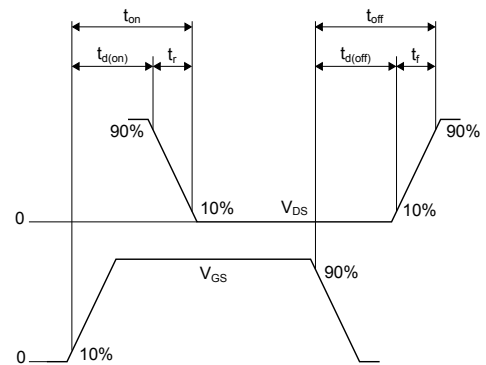

AM01470v1

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


AM01471v1

**Figure 19. Unclamped inductive waveform**


AM01472v1

**Figure 20. Switching time waveform**


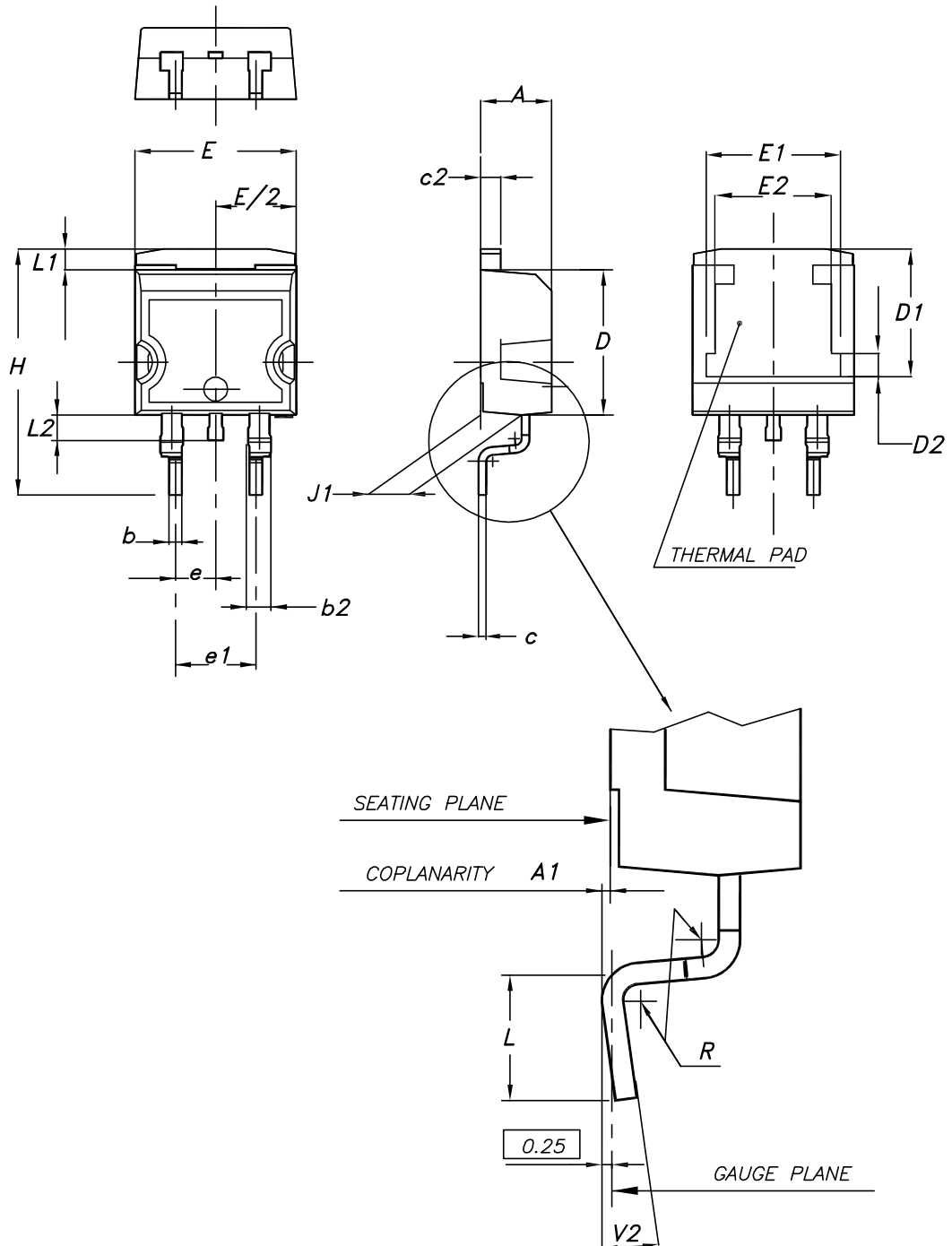
AM01473v1



## 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 D<sup>2</sup>PAK (TO-263) type A package information**
**Figure 21. D<sup>2</sup>PAK (TO-263) type A package outline**


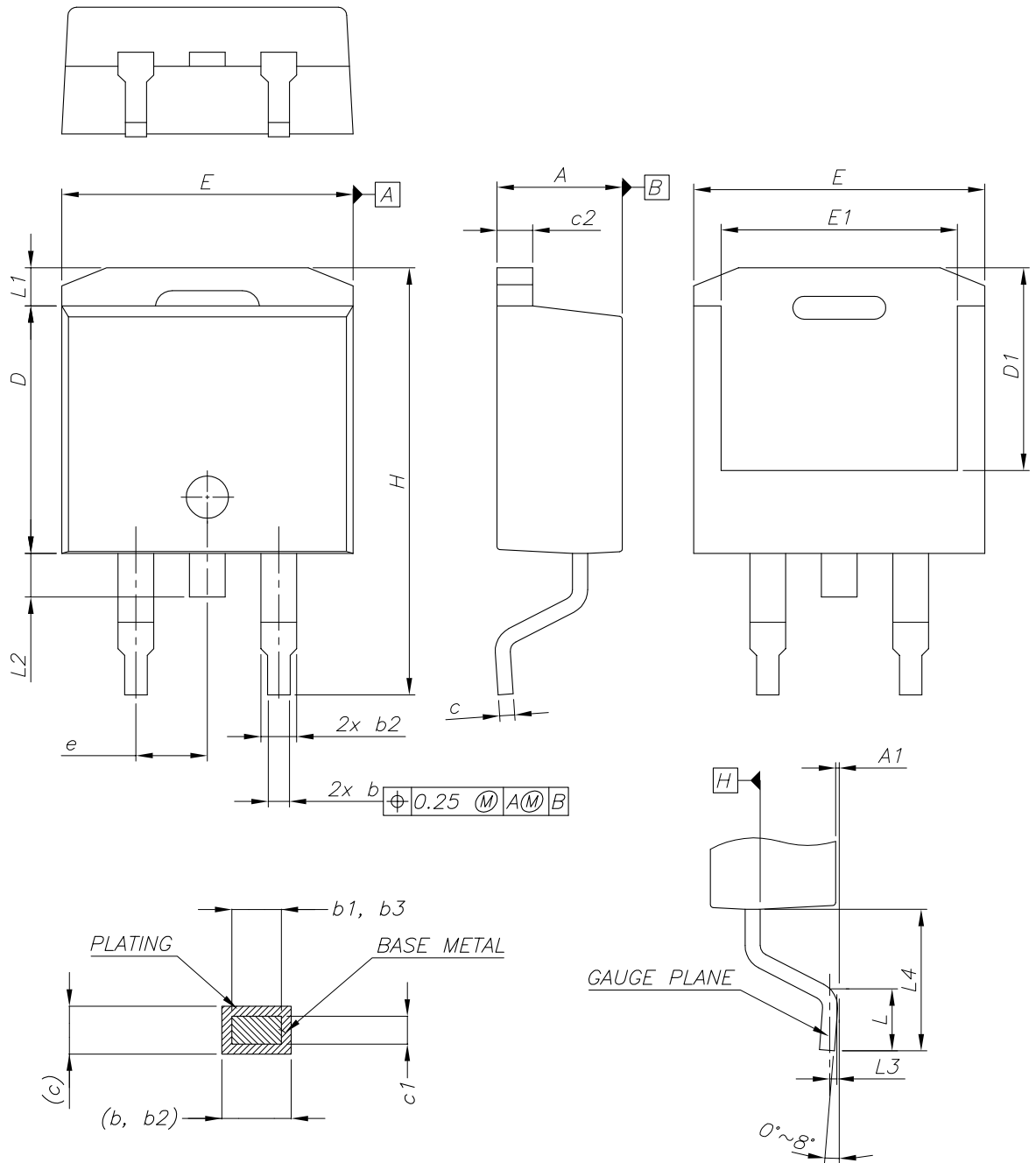
0079457\_25

**Table 9. D<sup>2</sup>PAK (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 D<sup>2</sup>PAK (TO-263) type B package information

Figure 22. D<sup>2</sup>PAK (TO-263) type B package outline

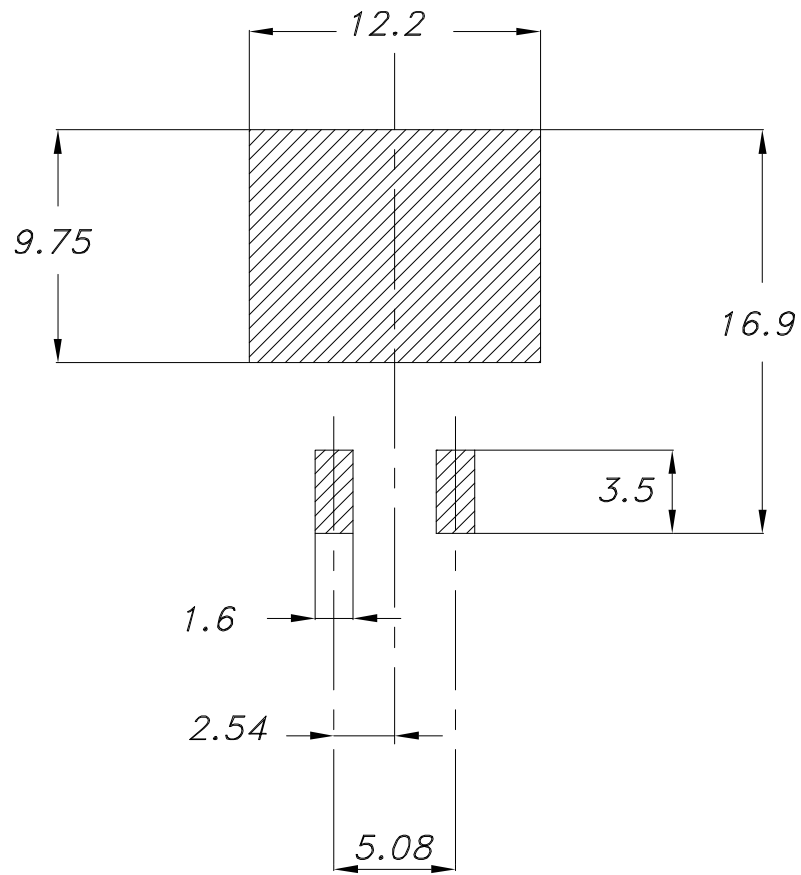


0079457\_25\_B

**Table 10. D<sup>2</sup>PAK (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

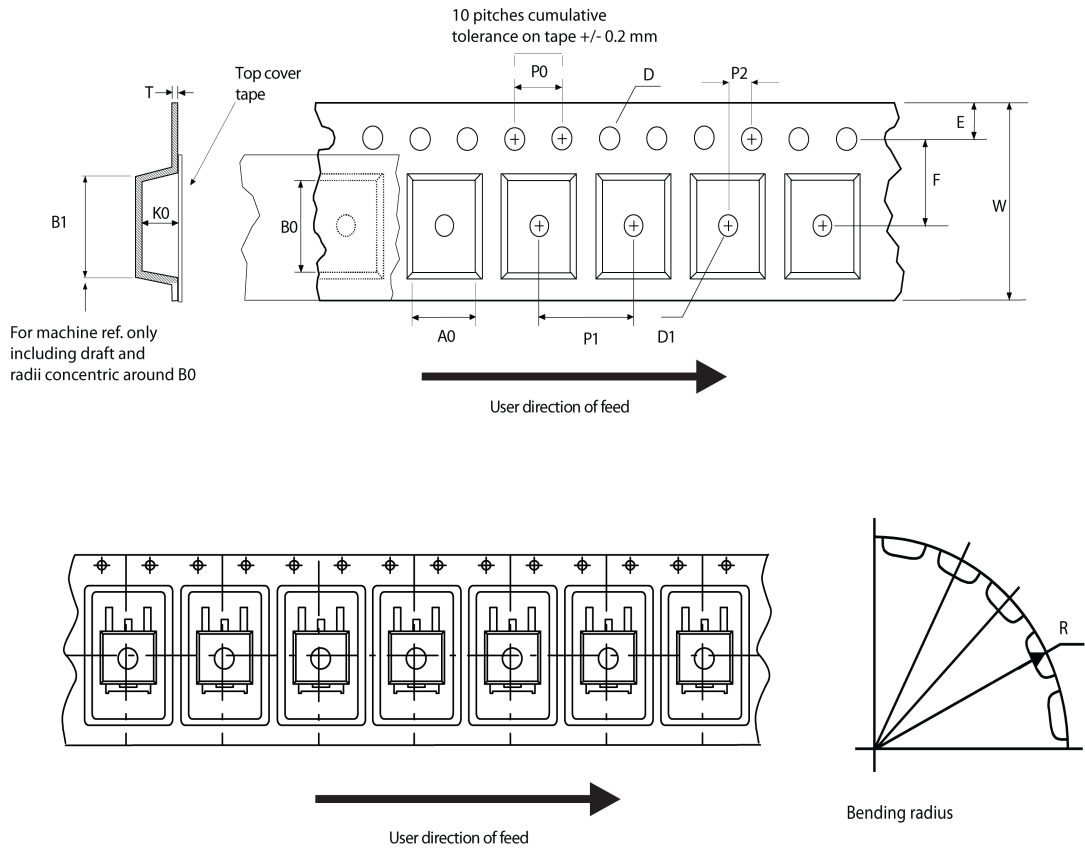
Figure 23. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)



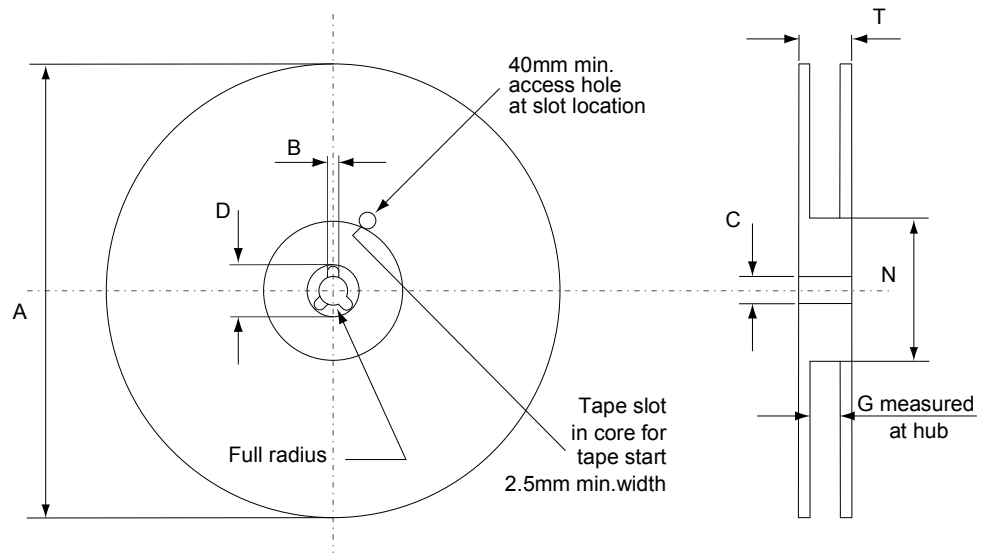
Footprint

### 4.3 D<sup>2</sup>PAK packing information

Figure 24. D<sup>2</sup>PAK tape outline



AM08852v1

**Figure 25. D<sup>2</sup>PAK reel outline**


AM06038v1

**Table 11. D<sup>2</sup>PAK 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		
P1	11.9	12.1			
P2	1.9	2.1	Bulk quantity		
R	50				
T	0.25	0.35			
W	23.7	24.3			



#### 4.4 D<sup>2</sup>PAK type B packing information

Figure 26. D<sup>2</sup>PAK type B tape outline

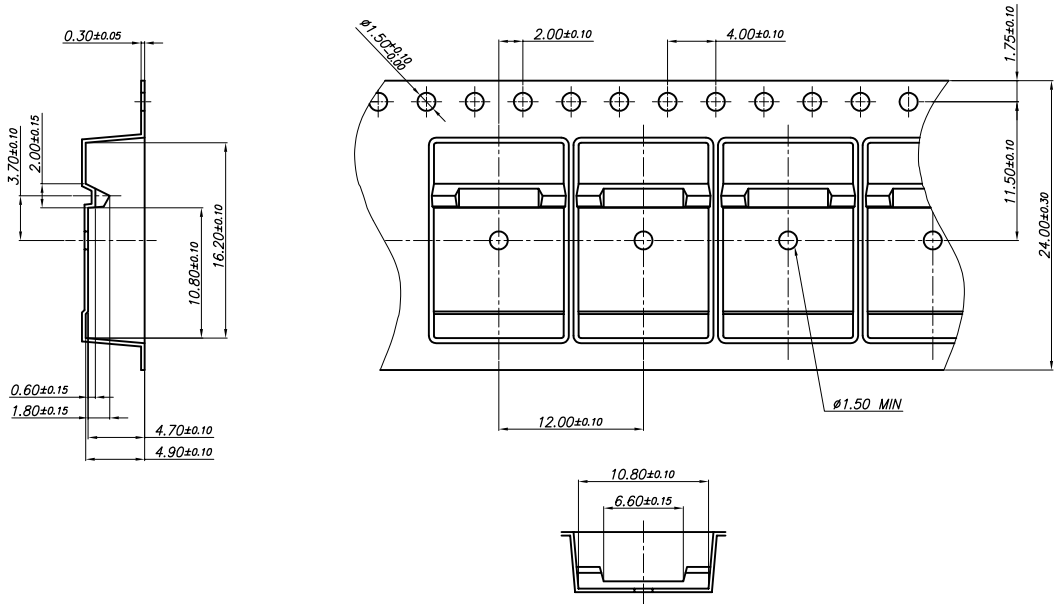
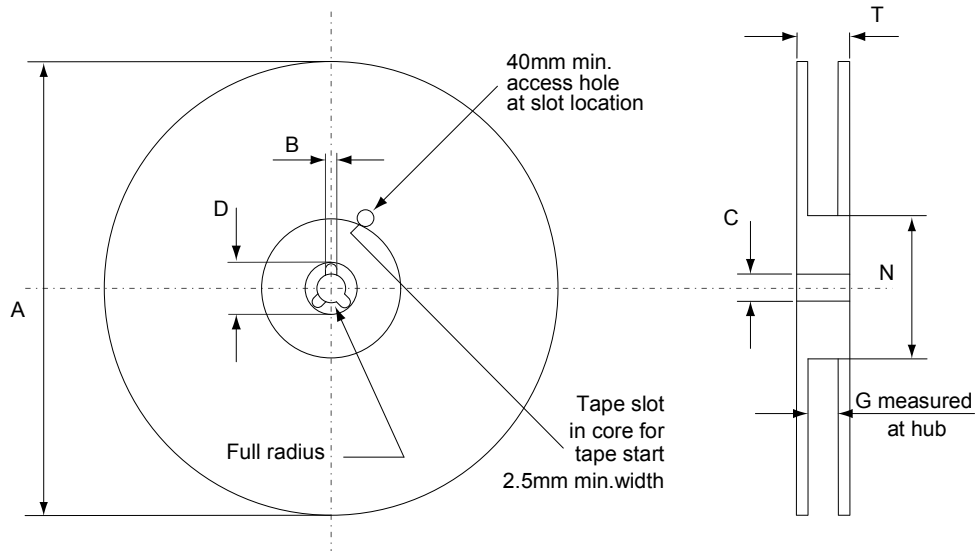


Figure 27. D<sup>2</sup>PAK type B reel outline



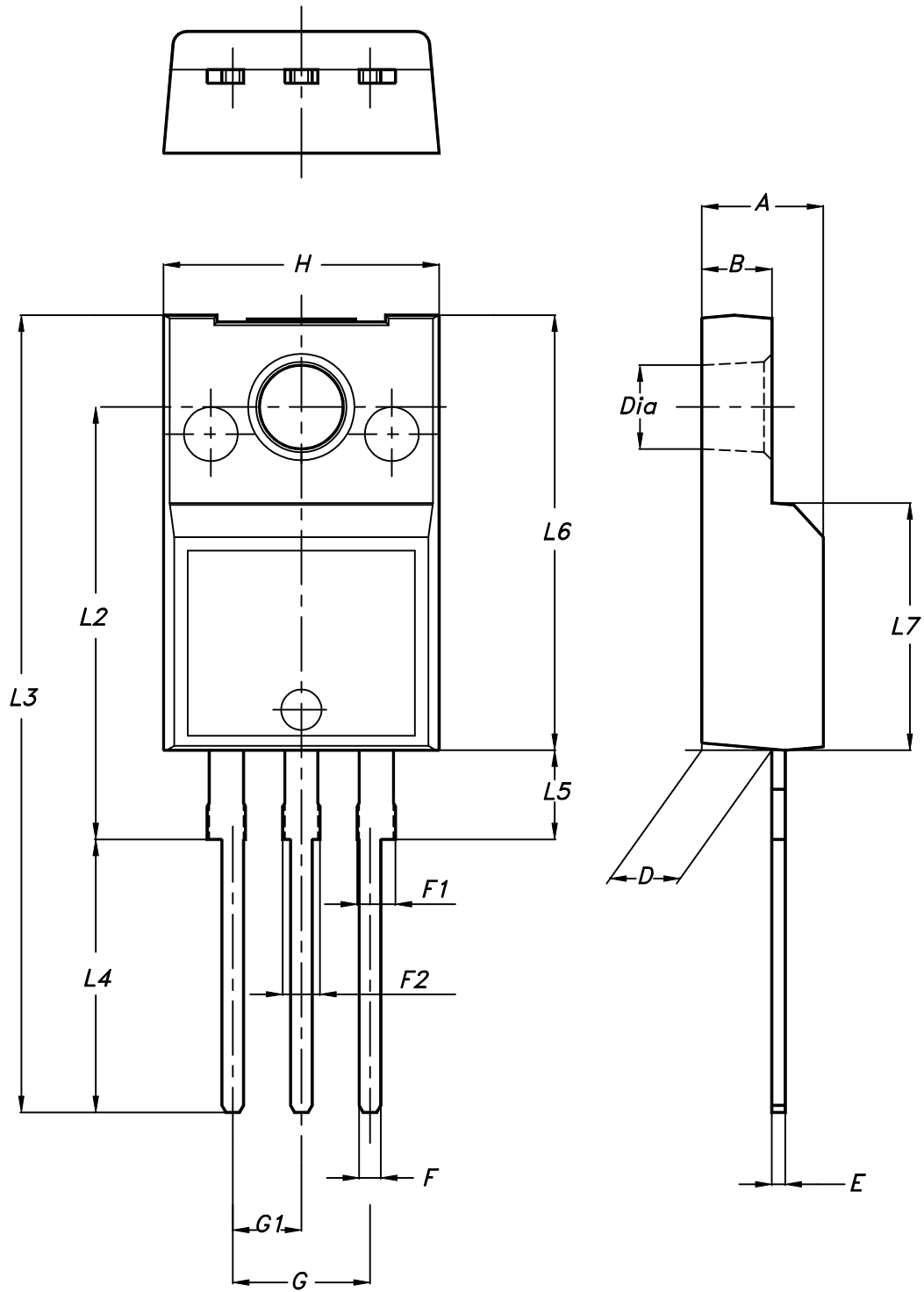
AM06038v1

**Table 12. D<sup>2</sup>PAK 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

4.5 TO-220FP package information

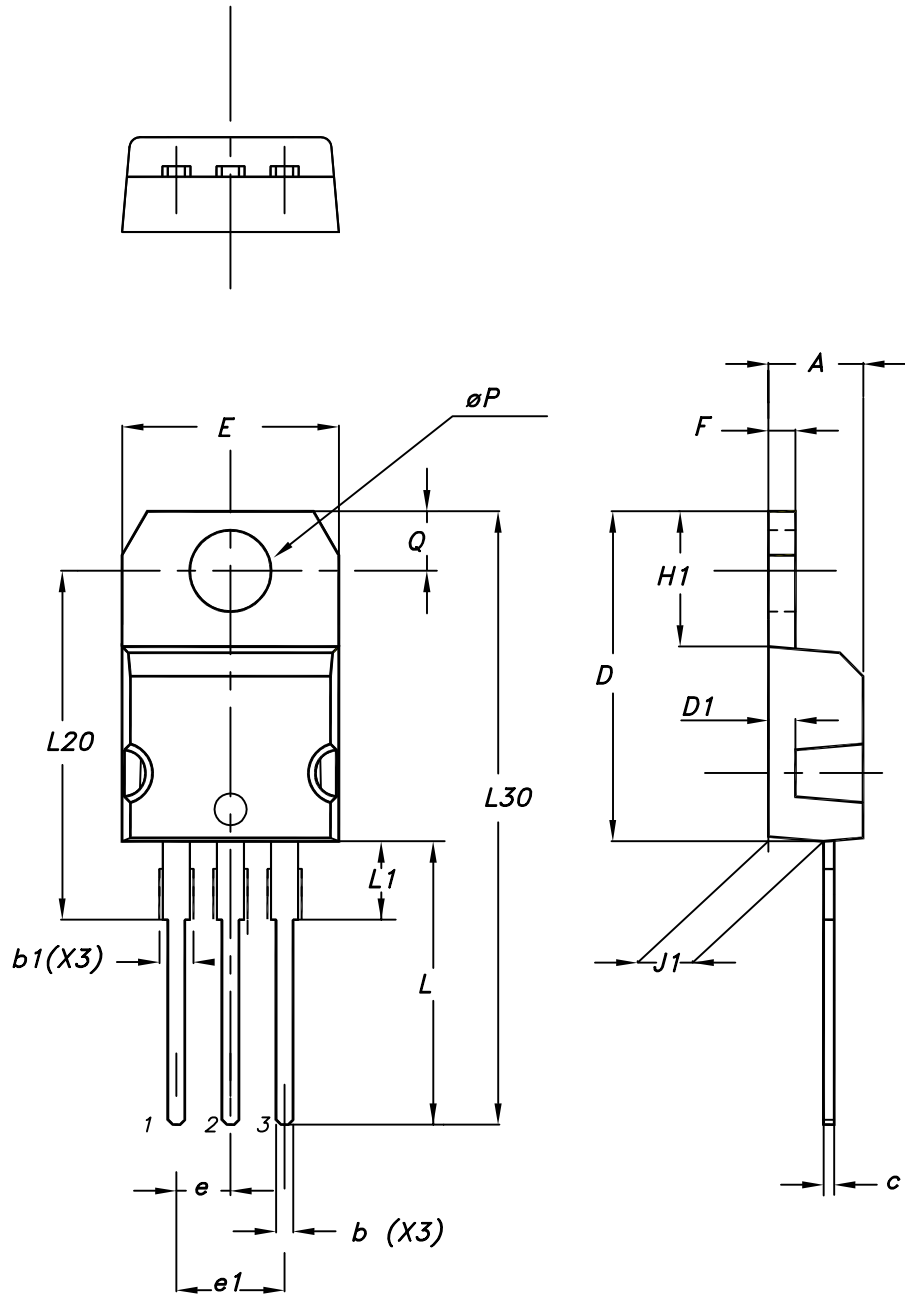
Figure 28. TO-220FP package outline



7012510\_Rev\_12\_B

**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 <sup>2</sup> 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 <a href="#">Section 4 Package information</a> . Minor text changes.



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