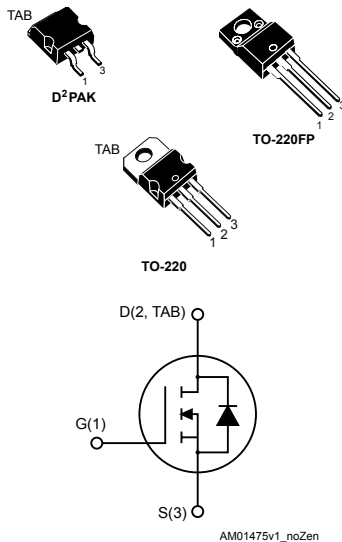


## N-channel 600 V, 0.20 $\Omega$ typ., 16 A MDmesh™ II Power MOSFETs in D<sup>2</sup>PAK, TO-220FP and TO-220 packages



### Features

Order code	$V_{DS}$ @ $T_{jmax.}$	$R_{DS(on)max.}$	$I_D$
STB22NM60N	650 V	0.22 $\Omega$	16 A
STF22NM60N			
STP22NM60N			

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

### Applications

- Switching applications

### Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

#### Product status

STB22NM60N

STF22NM60N

STP22NM60N

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		D <sup>2</sup> PAK	TO-220	TO-220FP	
V <sub>GS</sub>	Gate-source voltage	± 30			V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	16		16 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	10		10 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	64		64 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	125		30	W
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	15			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)			2500	V
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.
- $I_{SD} \leq 16$  A,  $di/dt \leq 400$  A/ $\mu$ s,  $V_{DSpeak} \leq V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .

**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		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	30			°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)	6	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)	300	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	$I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}^{(1)}$			100	$\mu\text{A}$
$I_{GSS}$	Gate body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 8\text{ A}$		0.20	0.22	$\Omega$

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

**Table 5. Dynamic**

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	1330	-	$\mu\text{F}$
$C_{oss}$	Output capacitance			84		
$C_{rss}$	Reverse transfer capacitance			4.6		
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$	-	181	-	$\mu\text{F}$
$R_g$	Gate input resistance	$f = 1\text{ MHz}$ open drain	-	4.7	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 16\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 15. Test circuit for gate charge behavior)	-	44	-	nC
$Q_{gs}$	Gate-source charge			6		
$Q_{gd}$	Gate-drain charge			25		

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**

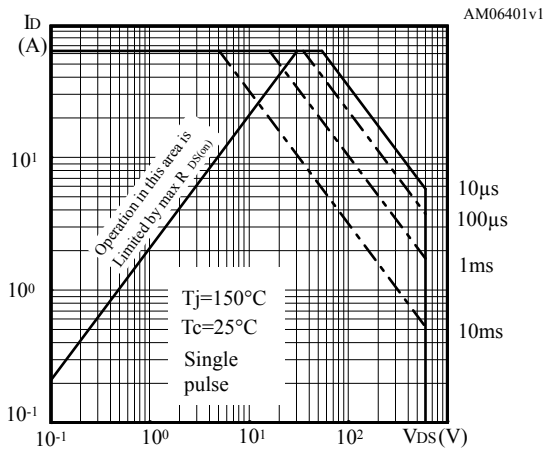
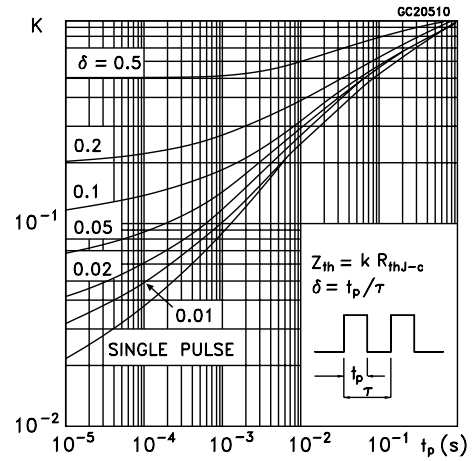
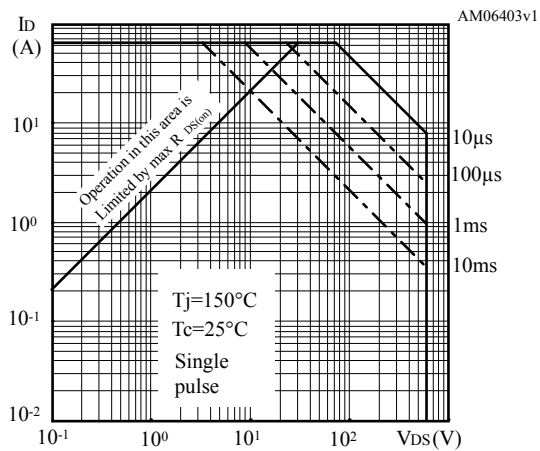
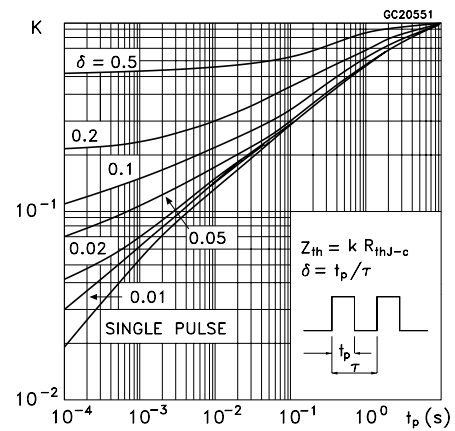
Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 8\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 14. Test circuit for resistive load switching times and Figure 19. Switching time waveform)	-	11	-	ns
$t_{r(v)}$	Voltage rise time			18		
$t_{d(off)}$	Turn-off delay time			74		
$t_{f(i)}$	Fall time			38		

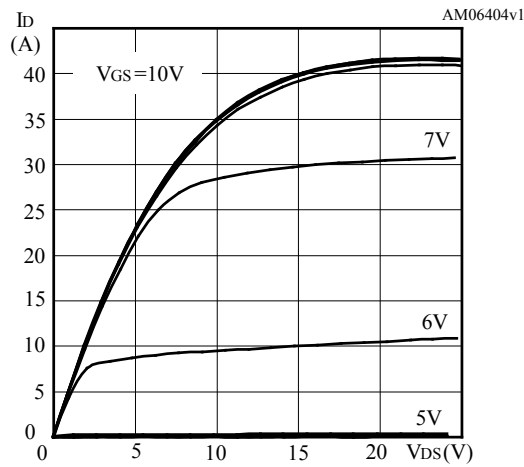
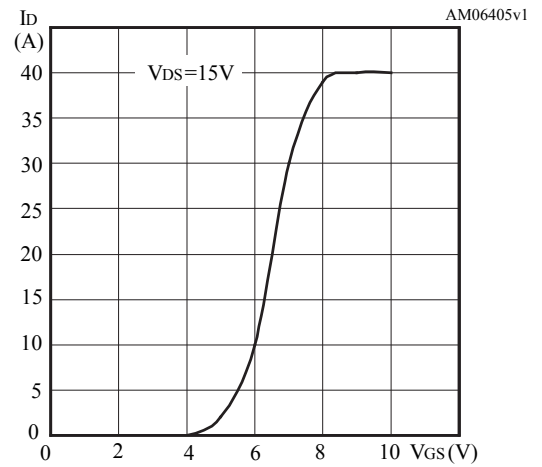
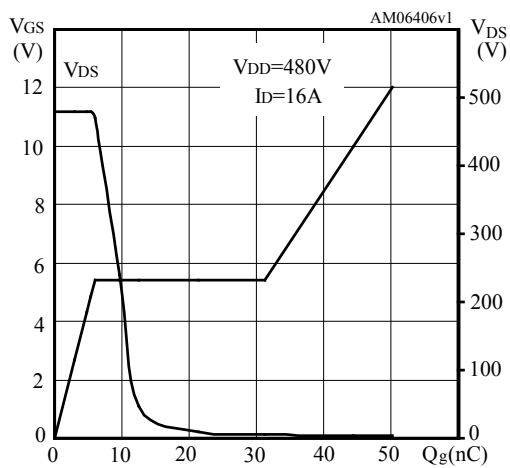
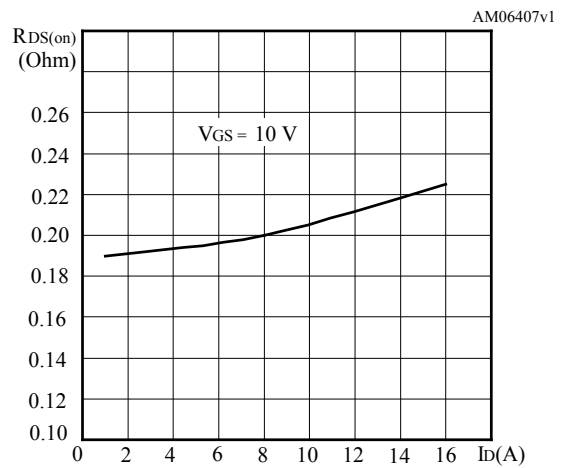
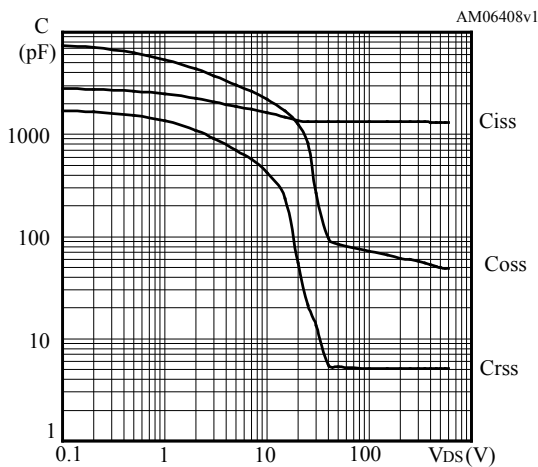
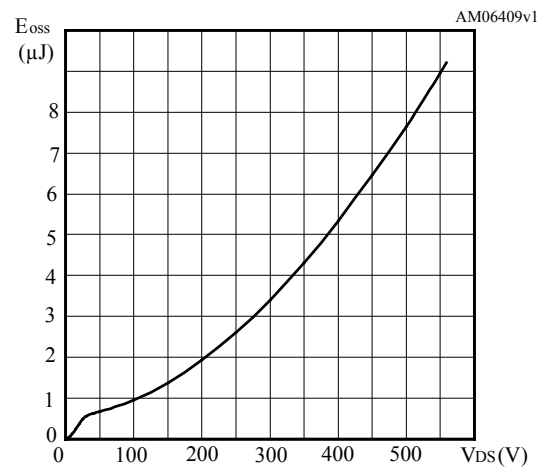
**Table 7. Source drain diode**

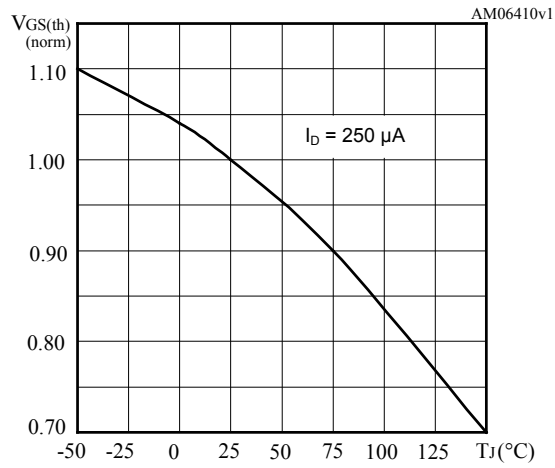
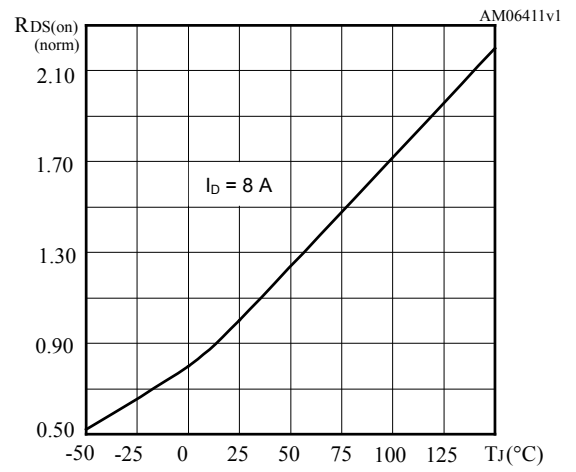
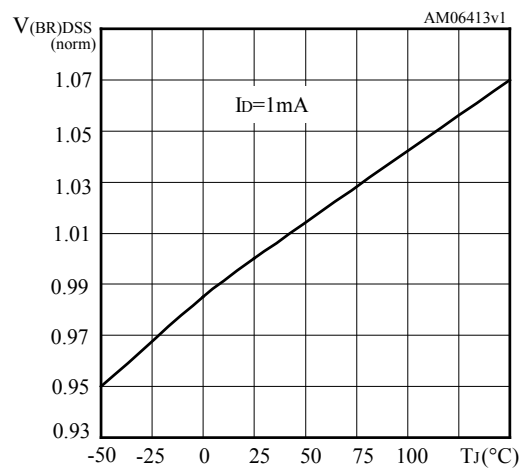
Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		16	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				64	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 16\text{ A}$ , $V_{GS} = 0\text{ V}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 16\text{ A}$ , $di/dt = 100\text{ V}$	-	296		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 16. Test circuit for inductive load switching and diode recovery times</a> )		4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			26.8		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 16\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	-	350		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 16. Test circuit for inductive load switching and diode recovery times</a> )		4.7		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			27		A

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

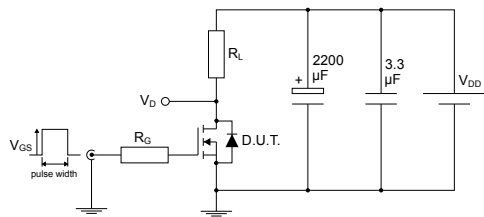
## 2.1 Electrical characteristics curves

**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**


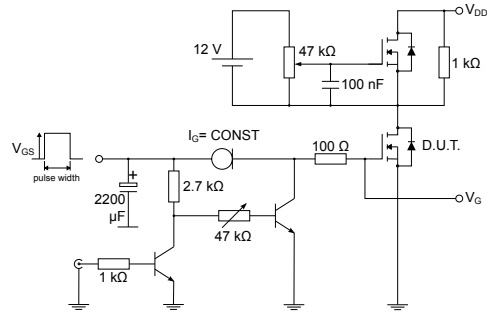
**Figure 5. Output characteristics**

**Figure 6. Transfer characteristics**

**Figure 7. Gate charge vs gate-source voltage**

**Figure 8. Static drain-source on resistance**

**Figure 9. Capacitance variations**

**Figure 10. Output capacitance stored energy**


**Figure 11. Normalized gate threshold voltage vs temperature**

**Figure 12. Normalized on resistance vs temperature**

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


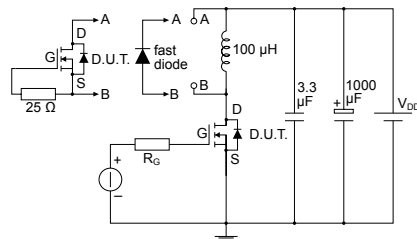
### 3 Test circuits

**Figure 14. Test circuit for resistive load switching times**


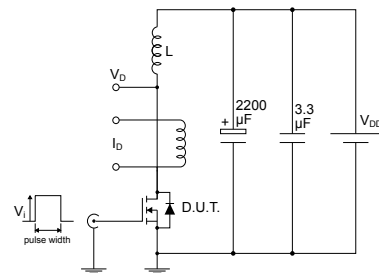
AM01468v1

**Figure 15. Test circuit for gate charge behavior**


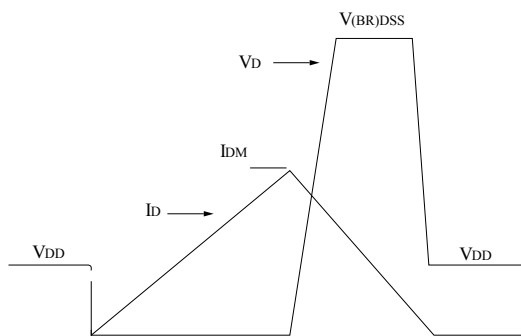
AM01469v1

**Figure 16. Test circuit for inductive load switching and diode recovery times**


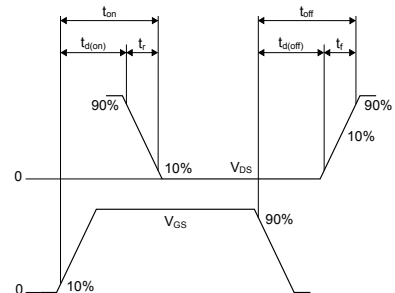
AM01470v1

**Figure 17. Unclamped inductive load test circuit**


AM01471v1

**Figure 18. Unclamped inductive waveform**


AM01472v1

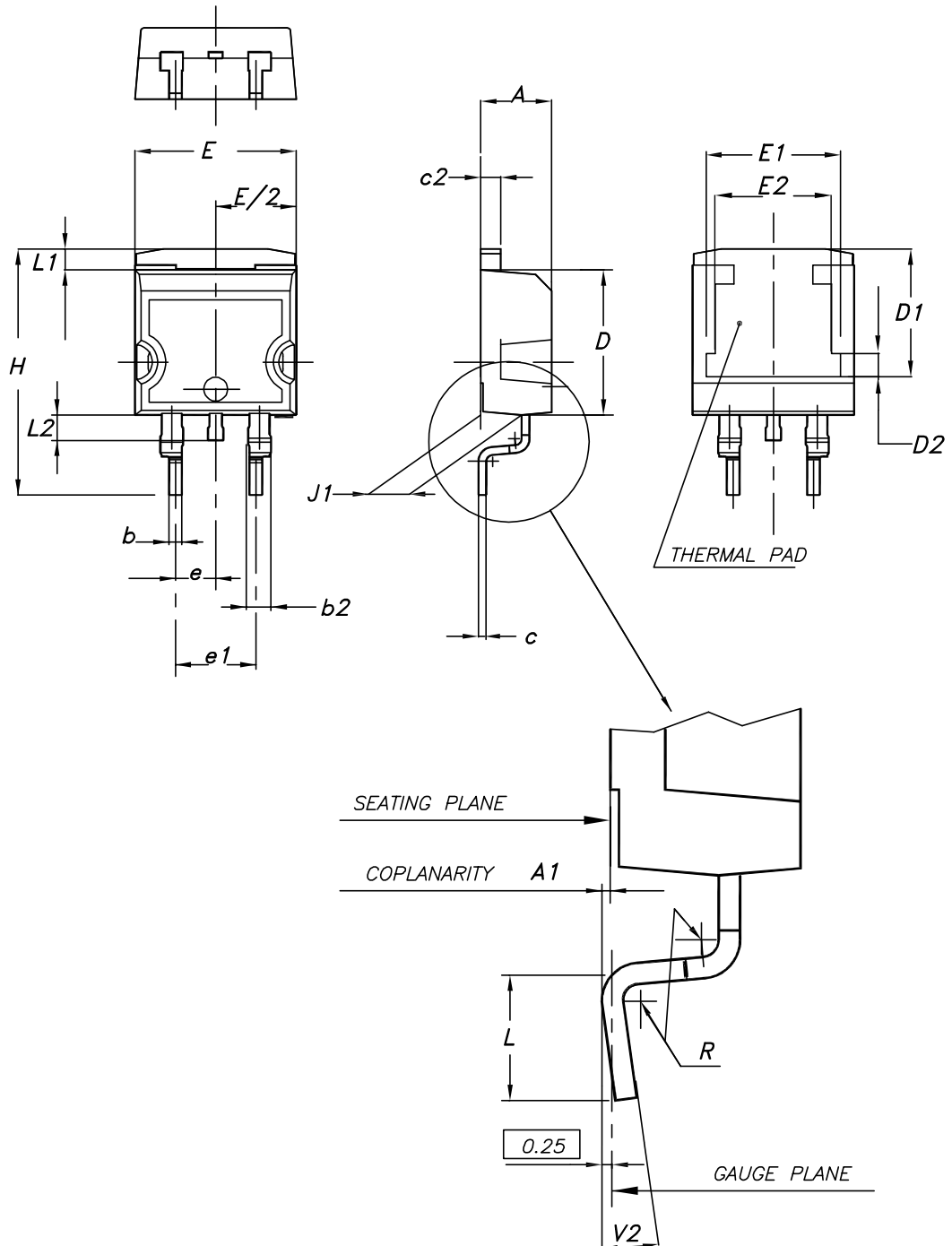
**Figure 19. Switching time waveform**


AM01473v1

## **4 Package information**

---

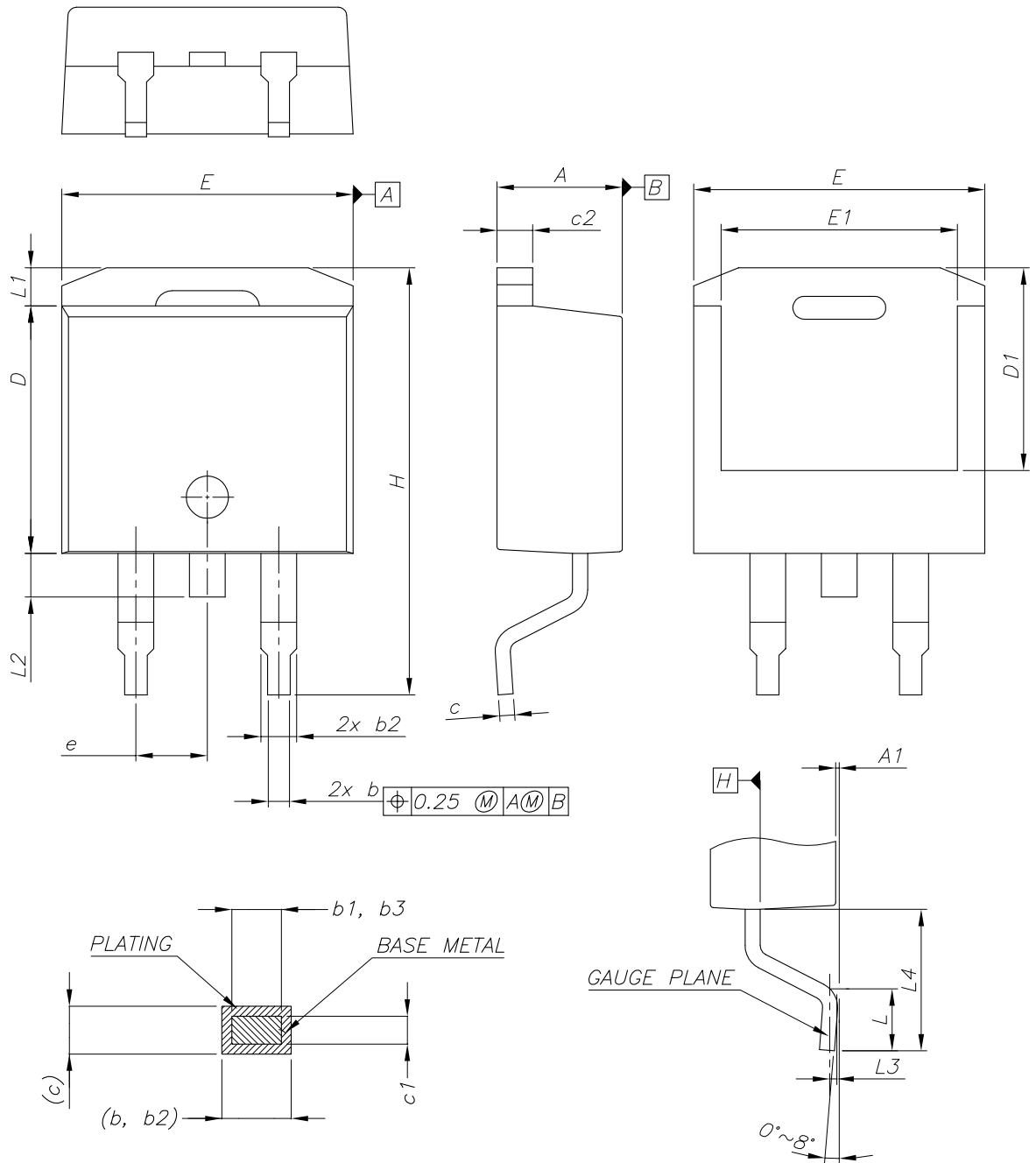
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

**4.1 D<sup>2</sup>PAK (TO-263) type A package information**
**Figure 20. D<sup>2</sup>PAK (TO-263) type A package outline**


0079457\_25

**Table 8. D<sup>2</sup>PAK (TO-263) type A package mechanical data**

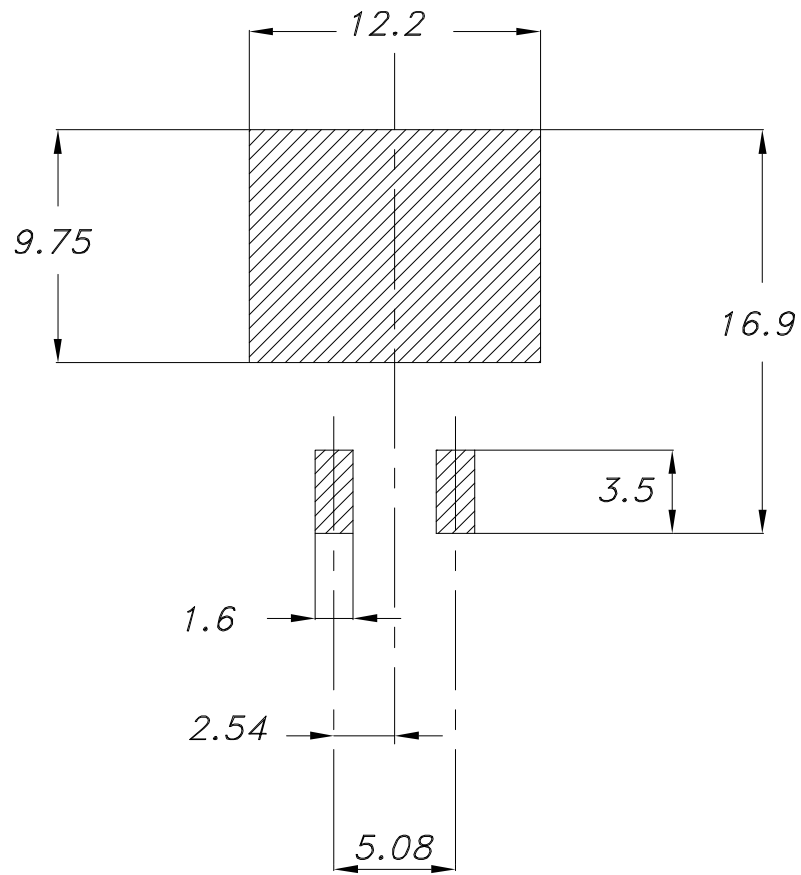
Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.30	8.50	8.70
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

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


0079457\_25\_B

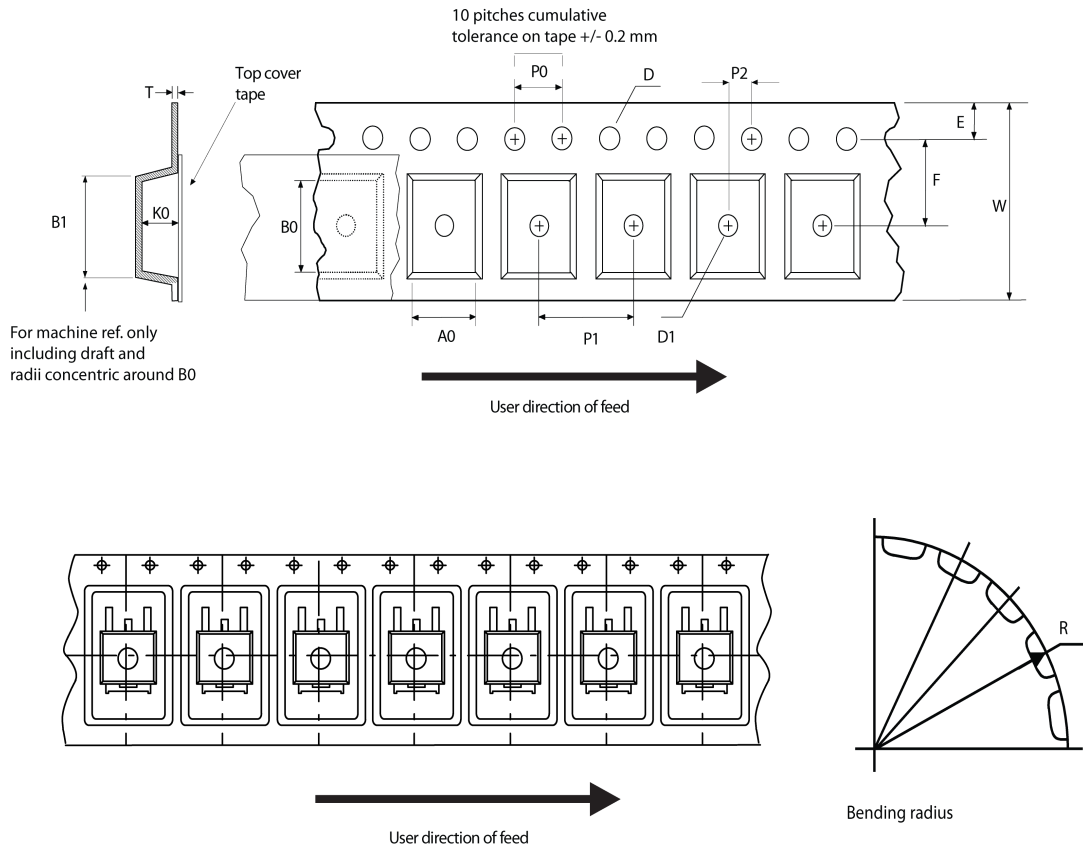
**Table 9. D<sup>2</sup>PAK (TO-263) type B mechanical data**

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

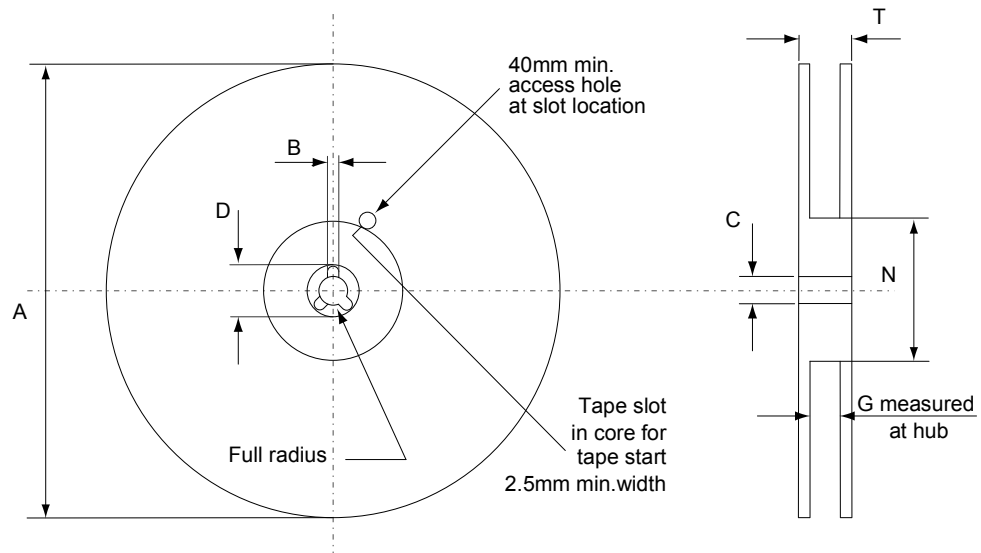
**Figure 22. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)**


Footprint

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

**Figure 23. D<sup>2</sup>PAK tape outline**


AM08852v1

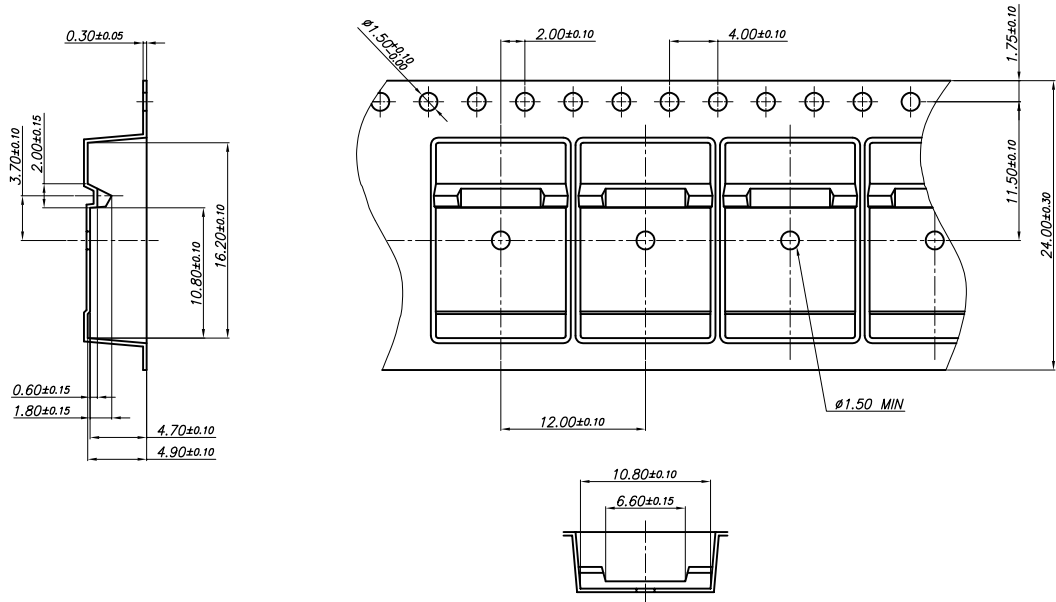
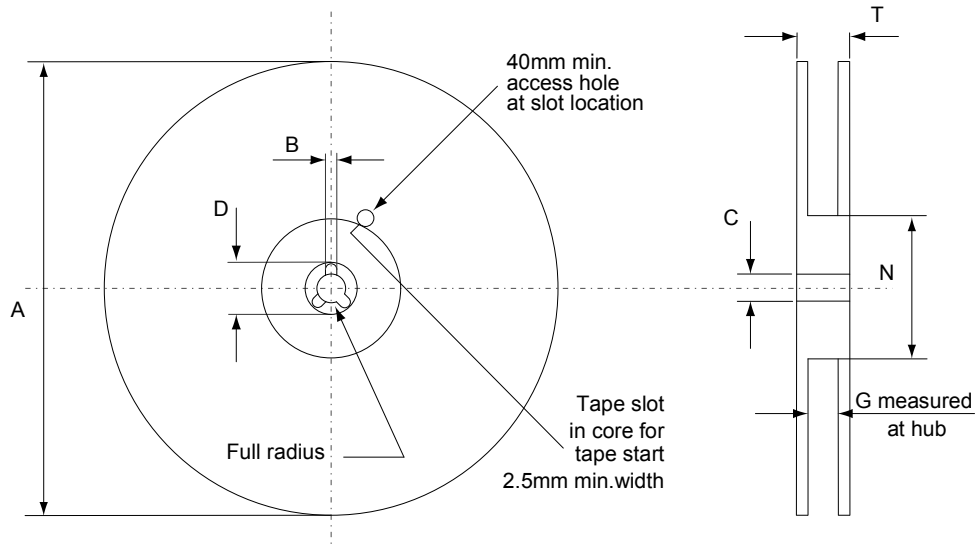
**Figure 24. D<sup>2</sup>PAK reel outline**


AM06038v1

**Table 10. 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 Bulk quantity			
P1	11.9	12.1				1000
P2	1.9	2.1				1000
R	50					
T	0.25	0.35				
W	23.7	24.3				

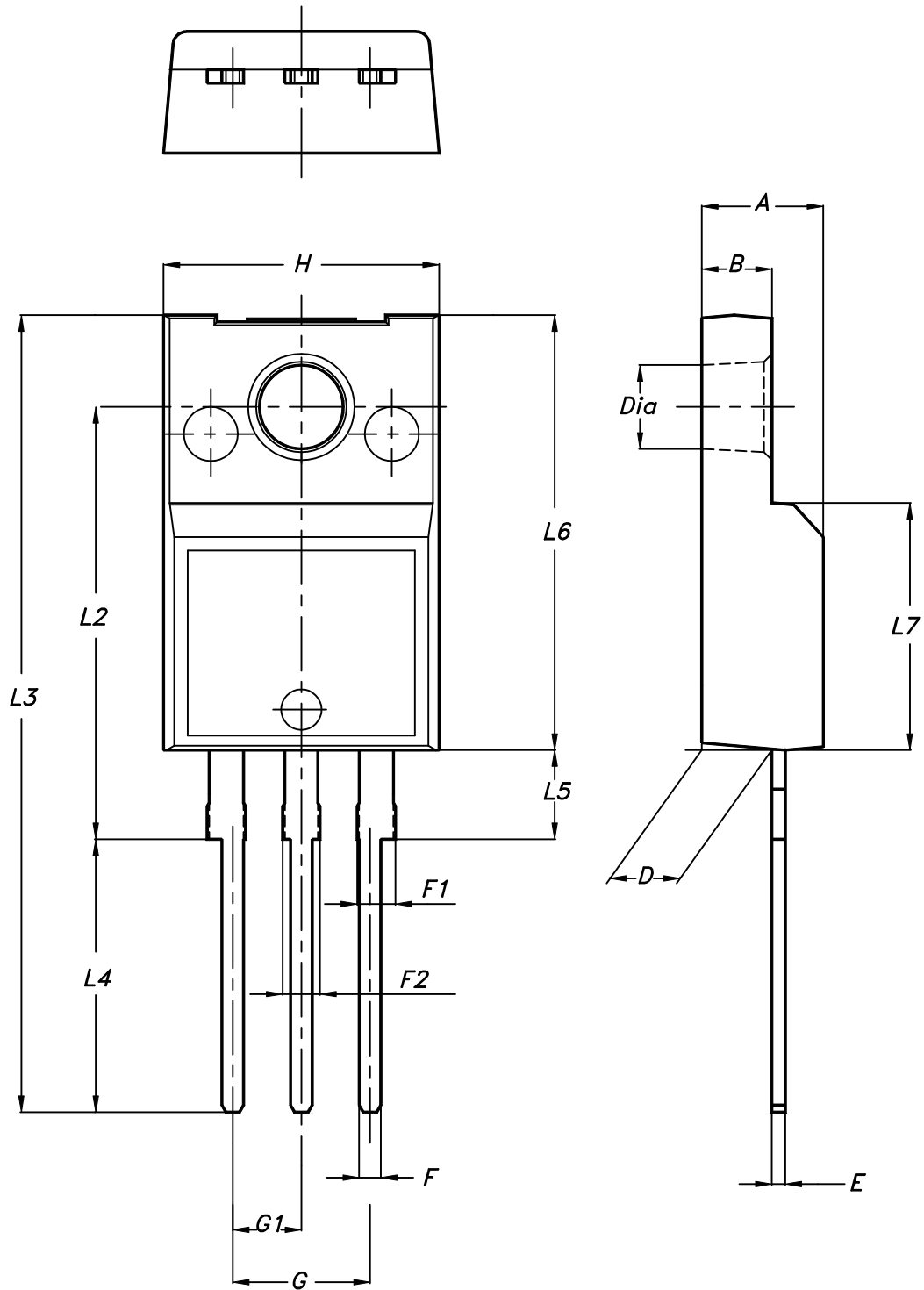
#### 4.4 D<sup>2</sup>PAK type B packing information

**Figure 25. D<sup>2</sup>PAK type B tape outline**

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


AM06038v1

**Table 11. D<sup>2</sup>PAK type B reel mechanical data**

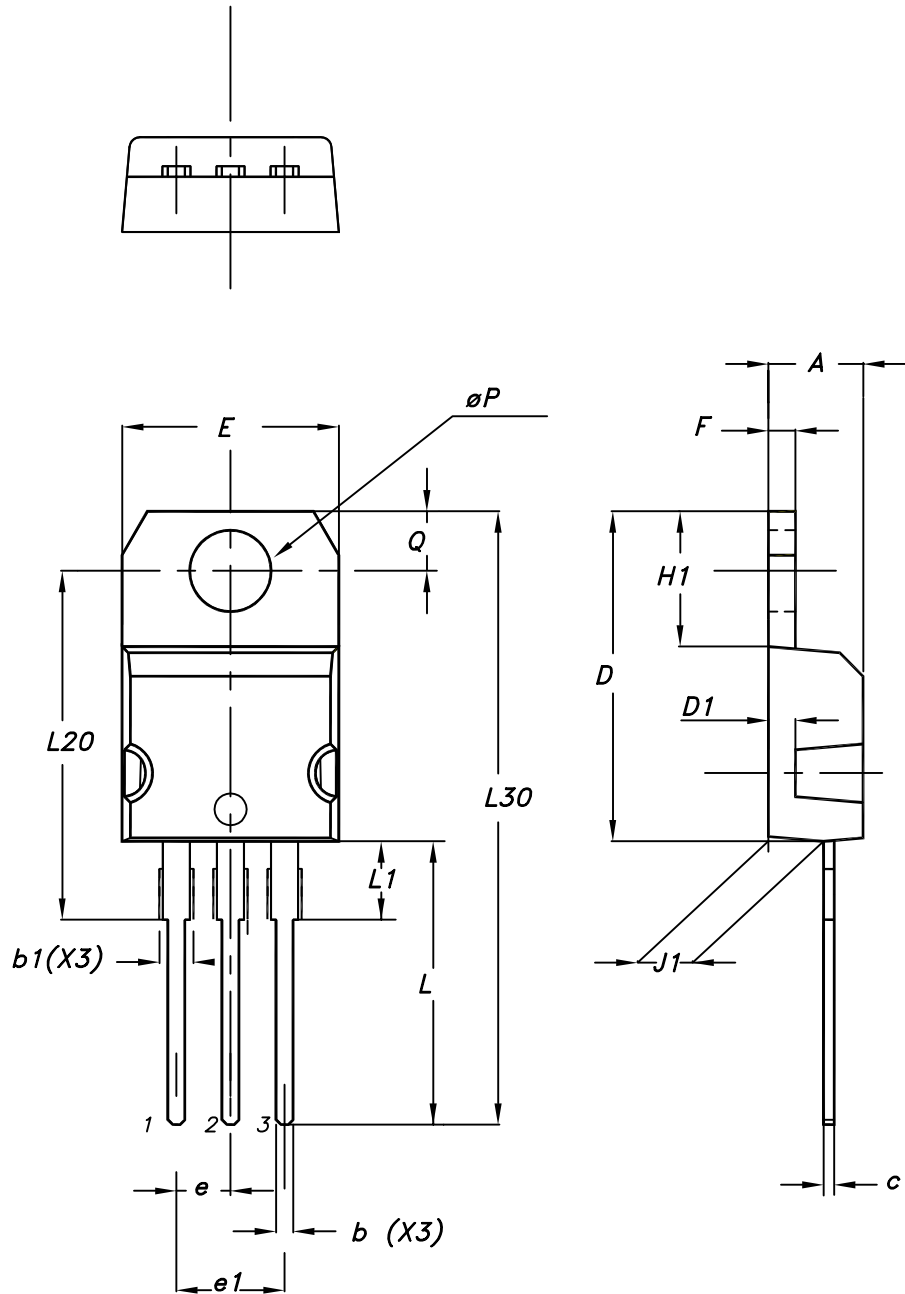
Dim.	mm	
	Min.	Max.
A		330
B	1.5	
C	12.8	13.2
D	20.2	
G	24.4	26.4
N	100	
T		30.4

**4.5 TO-220FP package information**
**Figure 27. TO-220FP package outline**


7012510\_Rev\_12\_B

**Table 12. 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 28. 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

## 5 Ordering information

**Table 14. Order codes**

Order code	Marking	Package	Packing
STB22NM60N	22NM60N	D <sup>2</sup> PAK	Tape and reel
STF22NM60N		TO-220FP	Tube
STP22NM60N		TO-220	

## Revision history

**Table 15. Document revision history**

Date	Version	Changes
02-Jul-2009	1	First release.
18-Feb-2010	2	Document status promoted from preliminary data to datasheet.
27-Aug-2010	3	New package, mechanical data has been inserted: I <sup>2</sup> PAK.
05-Nov-2011	4	Some value changed in <i>Table 5: On /off states</i> .
02-May-2018	5	<p>The part numbers STI22NM60N and STW22NM60N have been moved to a separate datasheet.</p> <p>Removed maturity status indication from cover page. The document status is production data</p> <p>Updated title and features in cover page.</p> <p>Updated <a href="#">Section 1 Electrical ratings</a>, <a href="#">Section 2 Electrical characteristics</a>, <a href="#">Section 2.1 Electrical characteristics curves</a> and <a href="#">Section 4 Package information</a>.</p> <p>Minor text changes.</p>

**IMPORTANT NOTICE – PLEASE READ CAREFULLY**

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2018 STMicroelectronics – All rights reserved

# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[STMicroelectronics:](#)

[STB22NM60N](#) [STF22NM60N](#) [STP22NM60N](#)