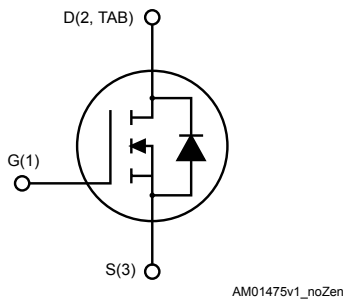
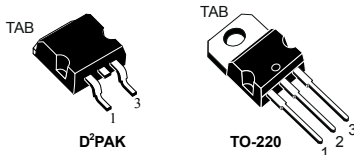


# N-channel 600 V, 0.4 Ω typ., 11 A, MDmesh™ II Power MOSFETs in D<sup>2</sup>PAK and TO-220 packages



## Features

Order codes	V <sub>DSS</sub> (@ T <sub>Jmax</sub> )	R <sub>DS(on)</sub> max.	I <sub>D</sub>	Package
STB11NM60T4	650 V	0.45 Ω	11 A	D <sup>2</sup> PAK
STP11NM60				TO-220

- 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. These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high-efficiency converters.

### Product status link

[STB11NM60T4](#)

[STP11NM60](#)

### Product summary

Order code	STB11NM60T4
Marking	B11NM60
Package	D <sup>2</sup> PAK
Packing	Tape and reel
Order code	STP11NM60
Marking	P11NM60
Package	TO-220
Packing	Tube

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Gate-source voltage	600	V
$V_{GS}$	Gate- source voltage	±30	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ °C}$	11	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ °C}$	7	
$I_{DM}^{(1)}$	Drain current (pulsed)	44	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	160	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
$T_{stg}$	Storage temperature range	-65 to 150	°C
$T_j$	Operating junction temperature range		

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 11\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK	TO-220	
$R_{thj-case}$	Thermal resistance junction-case	0.78		°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient		62.5	
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb	35		

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

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or non-repetitive (pulse width limited by $T_{jmax}$ )	5.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	350	mJ

## 2 Electrical characteristics

( $T_C = 25\text{ °C}$  unless otherwise specified).

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$			10	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 30\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 5.5\text{ A}$		0.4	0.45	$\Omega$

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

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance		-	1000	-	pF
$C_{oss}$	Output capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	230	-	pF
$C_{rss}$	Reverse transfer capacitance		-	25	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ V to } 480\text{ V}$ , $V_{GS} = 0\text{ V}$	-	100	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	1.6	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ , $V_{GS} = 0\text{ to } 10\text{ V}$ (see Figure 12. Test circuit for gate charge behavior)	-	30	-	nC
$Q_{gs}$	Gate-source charge		-	10	-	nC
$Q_{gd}$	Gate-drain charge		-	15	-	nC

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%  $V_{DSS}$

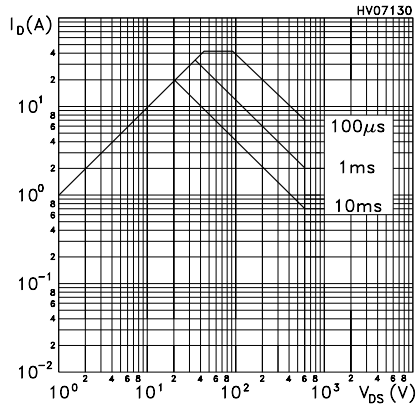
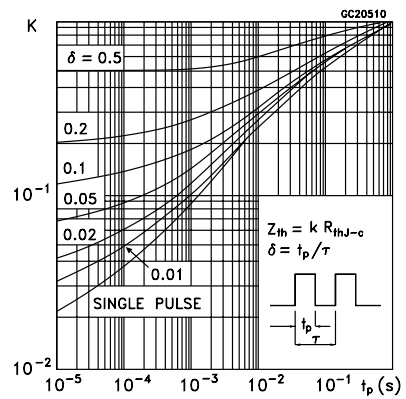
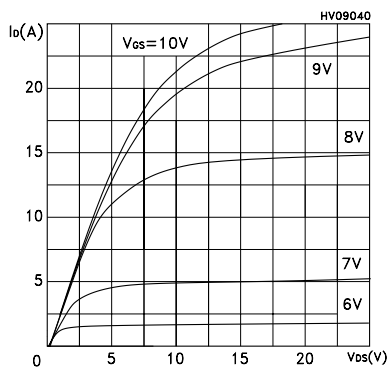
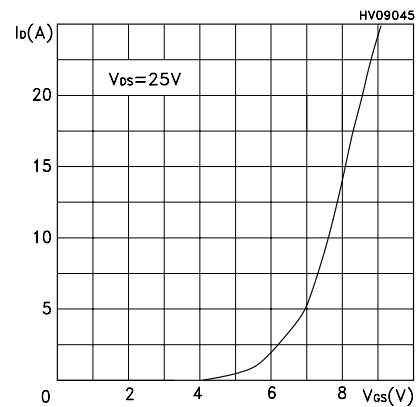
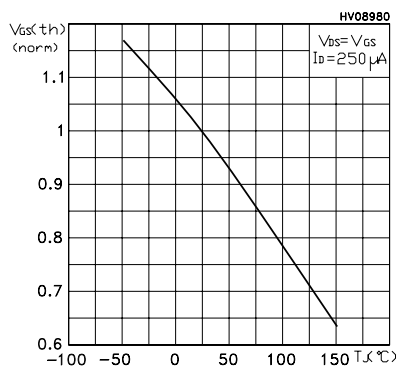
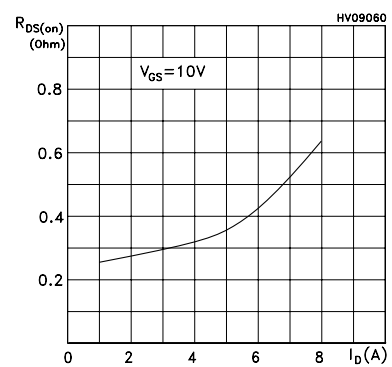
**Table 6. Switching times**

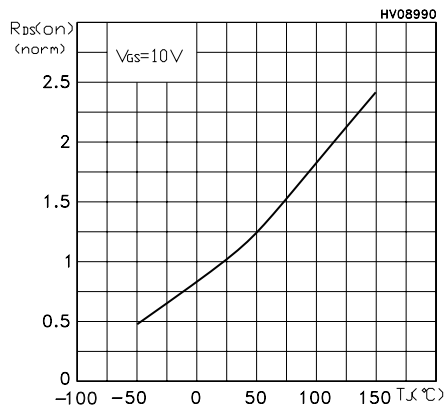
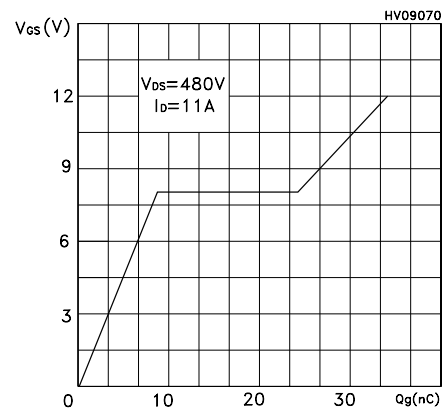
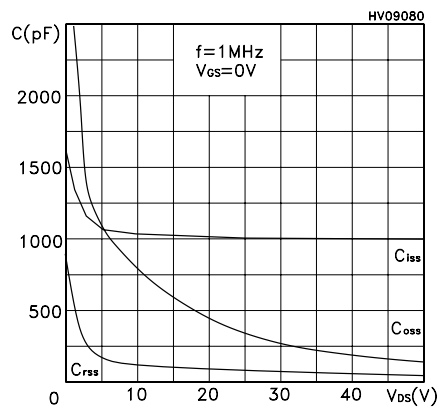
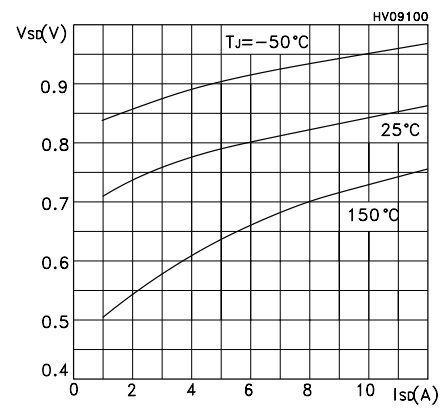
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 5.5\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 11. Test circuit for resistive load switching times and Figure 16. Switching time waveform)	-	20	-	ns
$t_r$	Rise time		-	20	-	ns
$t_{r(Voff)}$	Off-voltage rise time	$V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 13. Test circuit for inductive load switching and diode recovery times and Figure 16. Switching time waveform)	-	6	-	ns
$t_f$	Fall time		-	11	-	ns
$t_c$	Cross-over time		-	19	-	ns

**Table 7. Source drain diode**

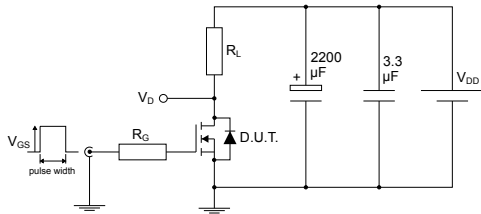
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		11	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		44	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 11\text{ A}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 100\text{ V}$	-	390		ns
$Q_{rr}$	Reverse recovery charge		-	3.8		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 13. Test circuit for inductive load switching and diode recovery times)	-	19.5		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$	-	570		ns
$Q_{rr}$	Reverse recovery charge		-	5.7		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		(see Figure 13. Test circuit for inductive load switching and diode recovery times)	-	20	

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

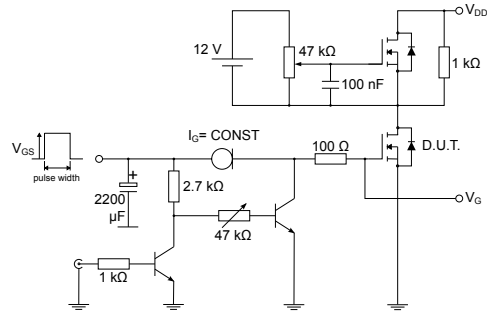
**2.1 Electrical characteristics (curves)**
**Figure 1. Safe operating area**

**Figure 2. Thermal impedance**

**Figure 3. Output characteristics**

**Figure 4. Transfer characteristics**

**Figure 5. Normalized gate threshold voltage vs temperature**

**Figure 6. Static drain-source on-resistance**


**Figure 7. Normalized on-resistance vs temperature**

**Figure 8. Gate charge vs gate-source voltage**

**Figure 9. Capacitance variations**

**Figure 10. Source-drain diode forward characteristics**


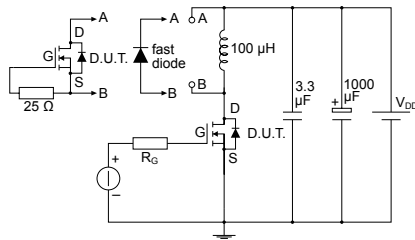
### 3 Test circuits

**Figure 11. Test circuit for resistive load switching times**


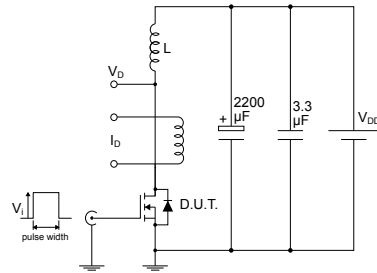
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**Figure 12. Test circuit for gate charge behavior**


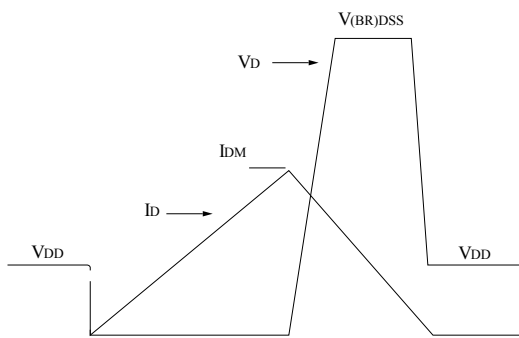
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**Figure 13. Test circuit for inductive load switching and diode recovery times**


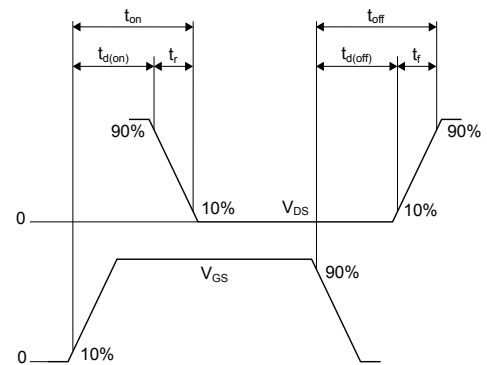
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**Figure 14. Unclamped inductive load test circuit**


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**Figure 15. Unclamped inductive waveform**


AM01472v1

**Figure 16. Switching time waveform**


AM01473v1

## **4 Package information**

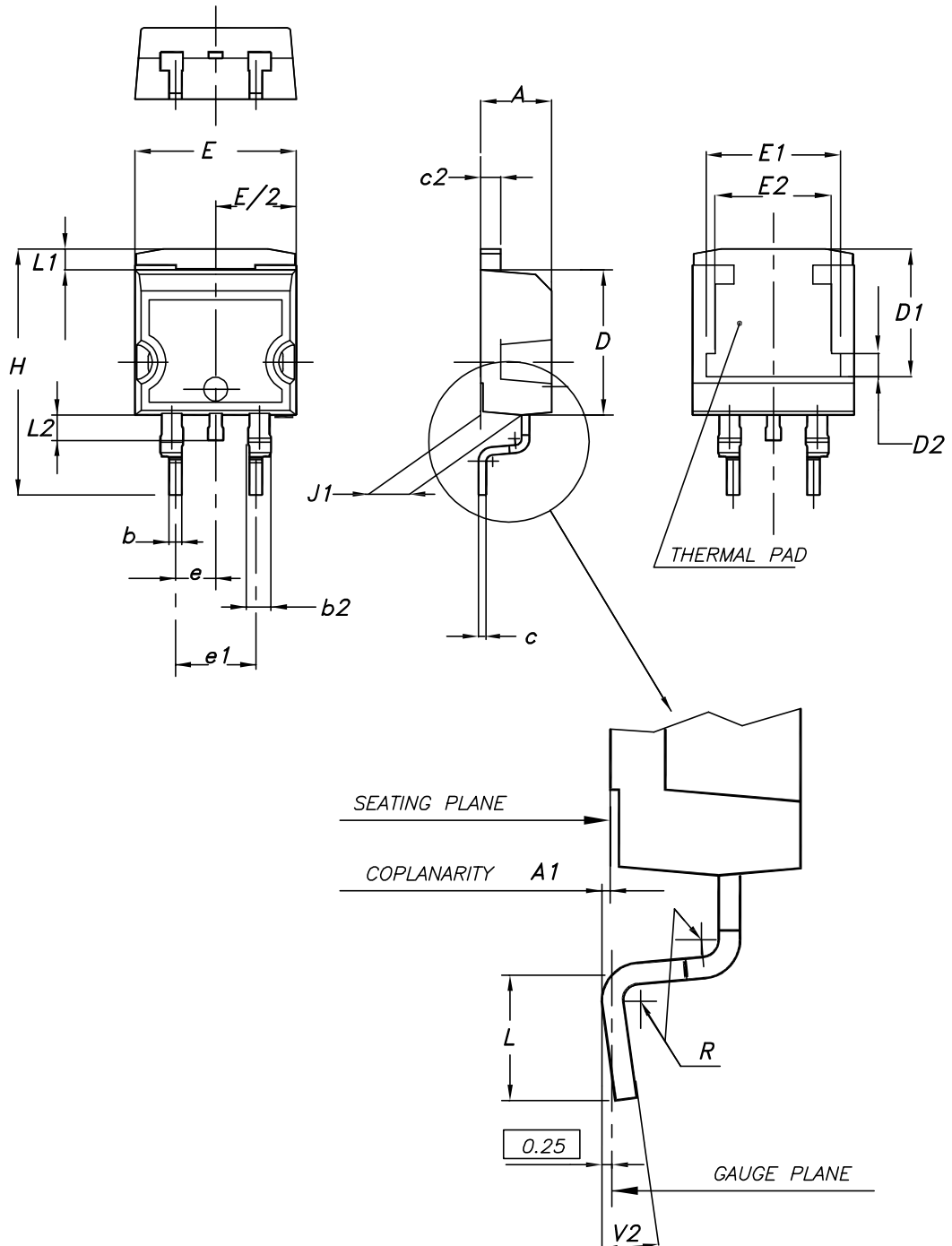
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In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com).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



#### 4.1 D<sup>2</sup>PAK (TO-263) type A package information

Figure 17. D<sup>2</sup>PAK (TO-263) type A package outline



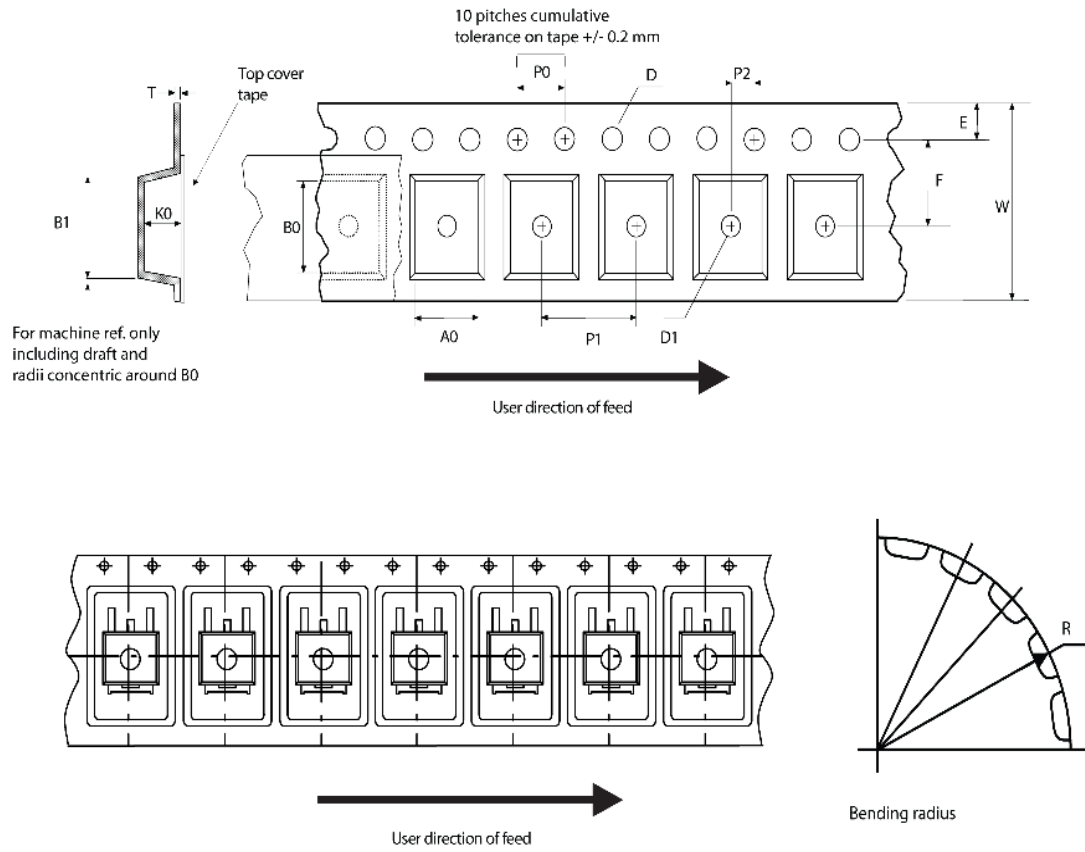
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**Table 8. D<sup>2</sup>PAK (TO-263) type A package mechanical data**

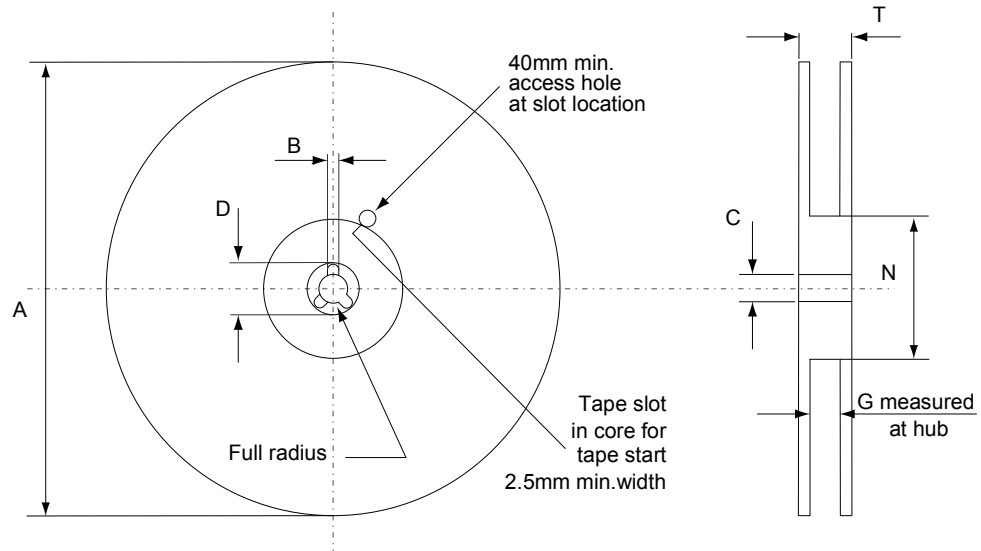
Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.30	8.50	8.70
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R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

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

**Figure 18. D<sup>2</sup>PAK tape outline**



AM08852v1

**Figure 19. D<sup>2</sup>PAK reel outline**


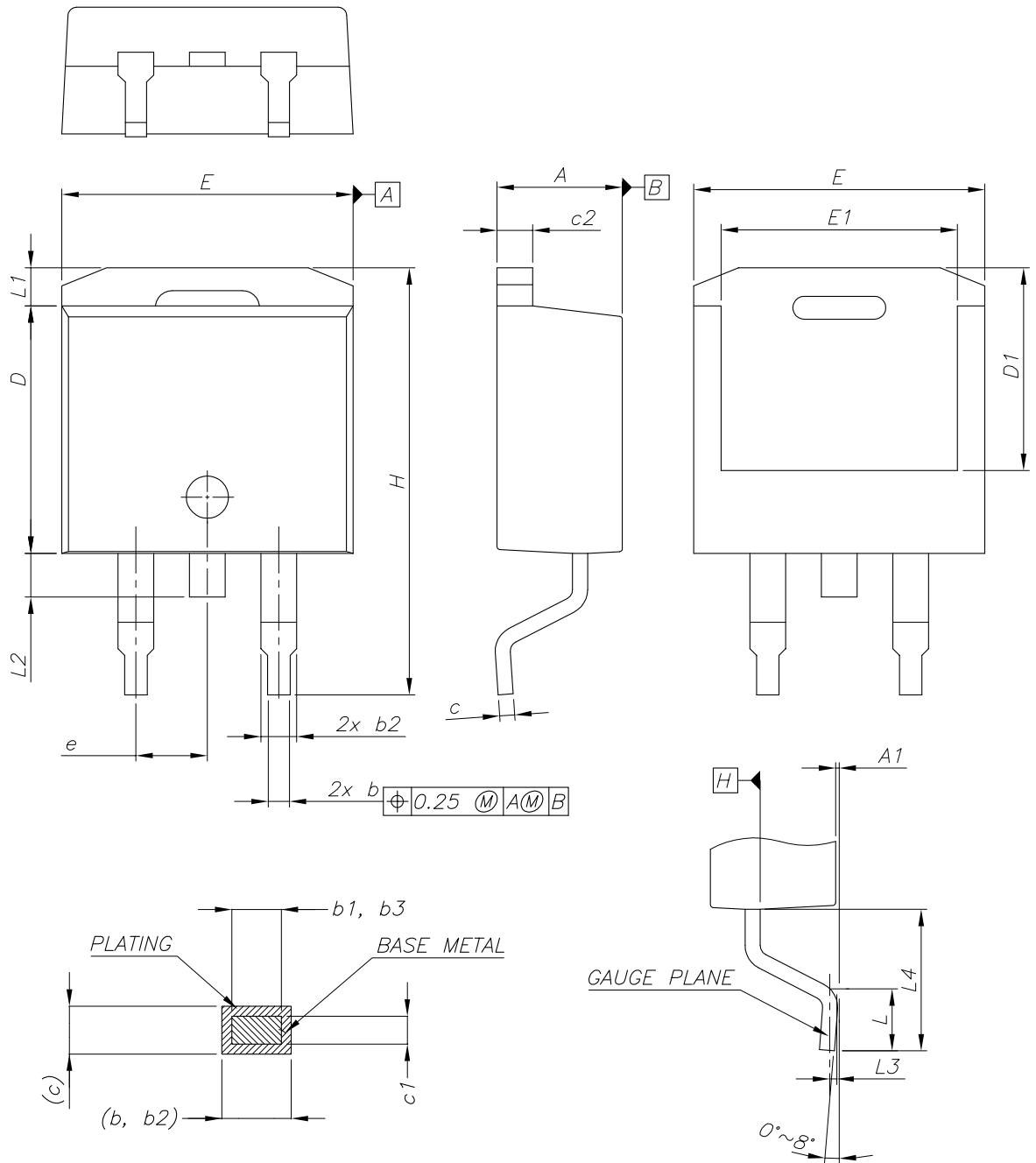
AM06038v1

**Table 9. 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				

### 4.3 D<sup>2</sup>PAK (TO-263) type B package information

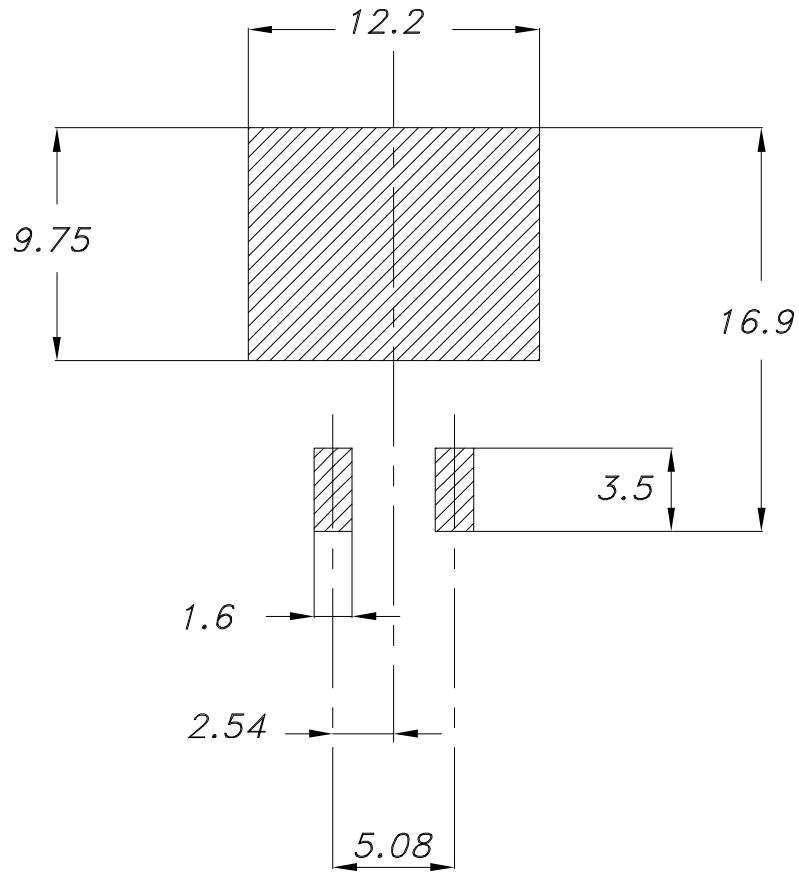
Figure 20. D<sup>2</sup>PAK (TO-263) type B package outline



0079457\_25\_B

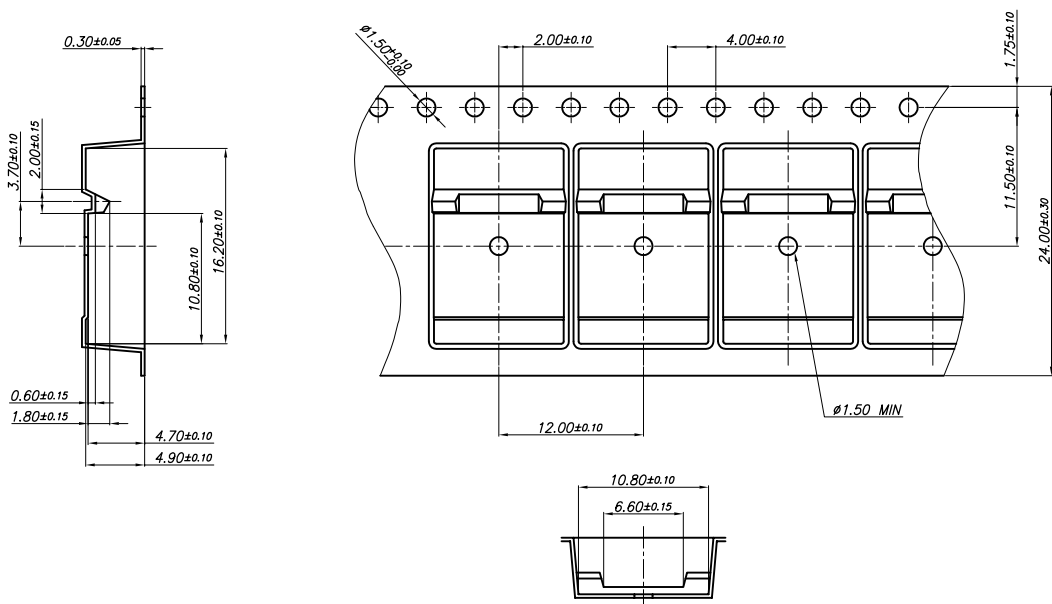
**Table 10. D<sup>2</sup>PAK (TO-263) type B mechanical data**

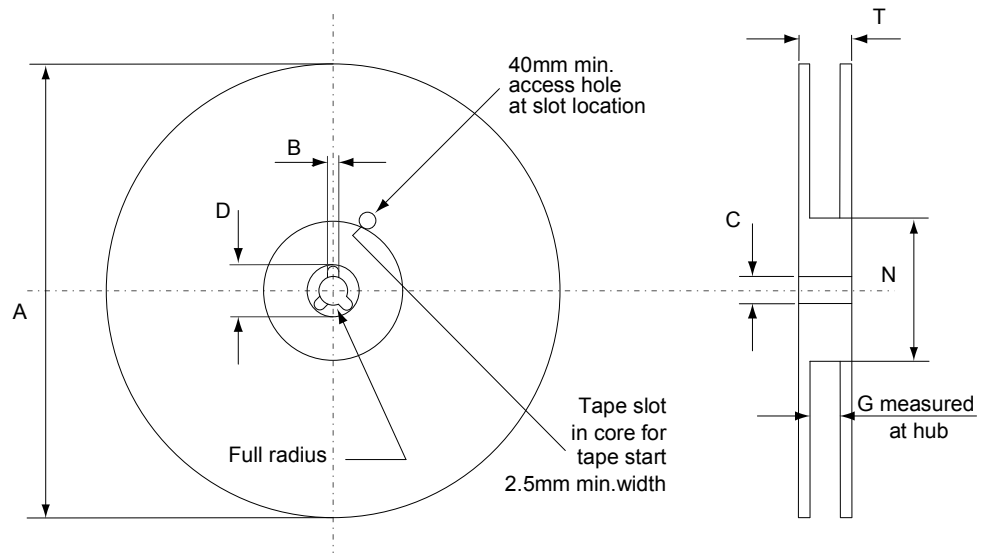
Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.56
A1	0		0.25
b	0.70		0.90
b1	0.51		0.89
b2	1.17		1.37
b3	1.36		1.46
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.34
D	8.60		9.00
D1	6.90		7.50
E	10.15		10.55
E1	8.10		8.70
e	2.54 BSC		
H	15.00		15.60
L	1.90		2.50
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

**Figure 21. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)**


Footprint

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

**Figure 22. D<sup>2</sup>PAK type B tape outline**


**Figure 23. D<sup>2</sup>PAK type B reel outline**


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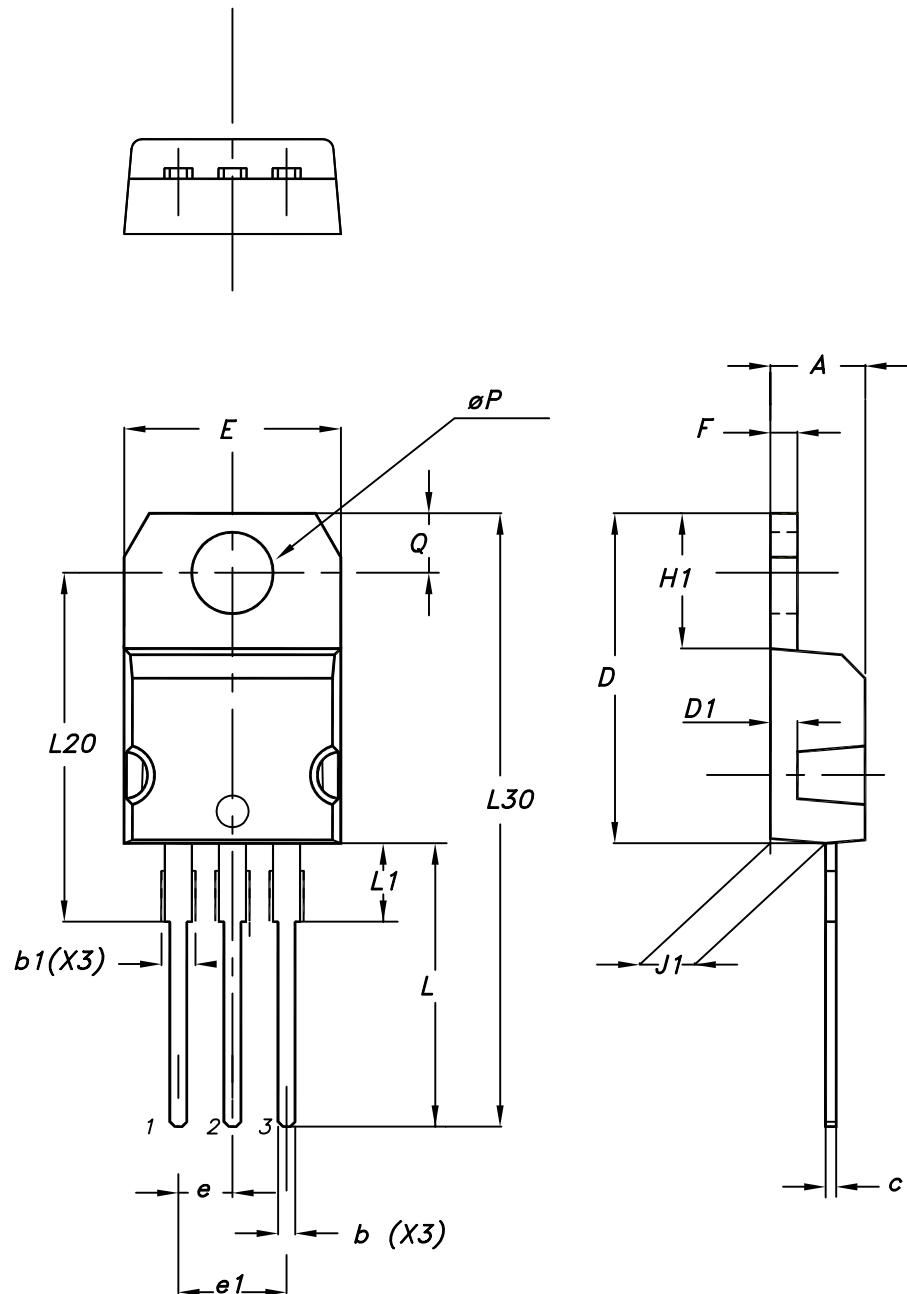
**Table 11. D<sup>2</sup>PAK type B reel mechanical data**

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-220 type A package information

Figure 24. TO-220 type A package outline



0015988\_typeA\_Rev\_21

**Table 12. 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

## Revision history

**Table 13. Document revision history**

Date	Version	Changes
09-Sep-2004	1	First release
10-Jun-2005	2	Typing error, wrong description
26-Jul-2006	3	The document has been reformatted, no content change
31-Aug-2006	4	Typo mistake on order code
21-Dec-2006	5	Various changes on " <i>Test conditions</i> " for <i>Table 5.</i> and <i>Table 6.</i>
12-Jan-2007	6	Order code has been corrected
01-Oct-2018	7	<p>The part numbers STB11NM60-1 and STP11NM60FP have been moved to a separate datasheet and the document has been updated accordingly.</p> <p>Modified <a href="#">Table 1. Absolute maximum ratings</a>, <a href="#">Table 2. Thermal data</a> and <a href="#">Table 5. Dynamic</a>.</p> <p>Modified <a href="#">Section 2.1 Electrical characteristics (curves)</a>.</p> <p>Updated <a href="#">Section 4 Package information</a>.</p> <p>Minor text changes.</p>

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