

N-channel 600 V, 0.53  $\Omega$  typ., 10 A MDmesh™ II Power MOSFET  
in DPAK, TO-220FP, TO-220 and IPAK packages

Datasheet - production data

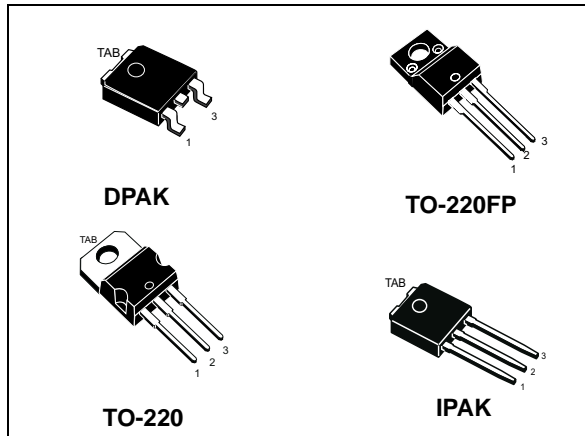
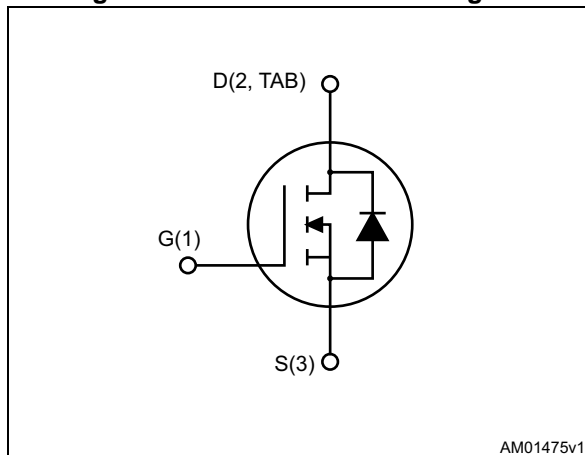


Figure 1. Internal schematic diagram



## Features

Order code	$V_{DS} @ T_J$ max.	$R_{DS(on)}$ max.	$I_D$	$P_{TOT}$
STD10NM60N	650 V	0.55 $\Omega$	10 A	70 W
STF10NM60N				25 W
STP10NM60N				70 W
STU10NM60N				

- 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.

Table 1. Device summary

Order code	Marking	Package	Packing
STD10NM60N	10NM60N	DPAK	Tape and reel
STF10NM60N	10NM60N	TO-220FP	Tube
STP10NM60N	10NM60N	TO-220	Tube
STU10NM60N	10NM60N	IPAK	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value				Unit
		TO-220	TO-220FP	IPAK	DPAK	
$V_{GS}$	Gate- source voltage	± 25				V
$I_D$	Drain current (continuous) at $T_C = 25\text{ °C}$	10	10 <sup>(1)</sup>	10		A
$I_D$	Drain current (continuous) at $T_C = 100\text{ °C}$	5	5 <sup>(1)</sup>	5		A
$I_{DM}^{(2)}$	Drain current (pulsed)	32	32 <sup>(1)</sup>	32		A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	70	25	70		W
$dv/dt^{(3)}$	Peak diode recovery voltage slope	15				V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; $T_C = 25\text{ °C}$ )		2500			V
$T_J$	Operating junction temperature	- 55 to 150				°C
$T_{stg}$	Storage temperature					

- Limited by maximum junction temperature.
- Pulse width limited by safe operating area.
- $I_{SD} \leq 10\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS\text{ peak}} \leq V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .

**Table 3. Thermal data**

Symbol	Parameter	Value				Unit
		TO-220	TO-220FP	IPAK	DPAK	
$R_{thj-case}$	Thermal resistance junction-case max.	1.79	5	1.79		°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max.	62.50		100		°C/W
$R_{thj-pcb}$	Thermal resistance junction-pcb max.				50	°C/W

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AS}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ max.)	4	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ °C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ )	200	mJ

## 2 Electrical characteristics

( $T_{\text{case}} = 25\text{ °C}$  unless otherwise specified)

**Table 5. On/off-states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}, V_{GS} = 0$	600			V
		$I_D = 1\text{ mA}, V_{GS} = 0,$ $T_C = 150\text{ °C}$		650		
$I_{DSS}$	Zero-gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 600\text{ V}, T_C = 125\text{ °C}$			100	
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25\text{ V}$			$\pm 100$	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	$V_{GS} = 10\text{ V}, I_D = 4\text{ A}$		0.53	0.55	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}, f = 1\text{ MHz},$ $V_{GS} = 0$	-	540	-	pF
$C_{oss}$	Output capacitance		-	44	-	pF
$C_{riss}$	Reverse transfer capacitance		-	1.2	-	pF
$C_{oss\text{ eq}}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }480\text{ V}, V_{GS} = 0$	-	110	-	pF
$R_g$	Gate input resistance	$f=1\text{ MHz open drain}$	-	6	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}, I_D = 8\text{ A},$ $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 17</a> )	-	19	-	nC
$Q_{gs}$	Gate-source charge		-	3	-	nC
$Q_{gd}$	Gate-drain charge		-	10	-	nC

1.  $C_{oss\text{ eq}}$  time related 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 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 4\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16</a> )	-	10	-	ns
$t_r$	Rise time		-	12	-	ns
$t_{d(off)}$	Turn-off-delay time		-	32	-	ns
$t_f$	Fall time		-	15	-	ns

**Table 8. Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		8	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				32	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 8\text{ A}$ , $V_{GS} = 0$	-		1.3	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 8\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	-	250		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$	-	2.12		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see <a href="#">Figure 18</a> )		17		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 8\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$	-	315		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$ $T_J = 150\text{ }^\circ\text{C}$		2.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see <a href="#">Figure 18</a> )		16.5		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 2. Safe operating area for TO-220

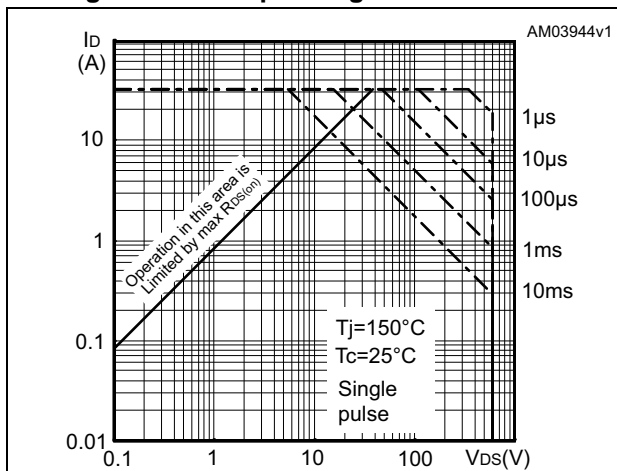


Figure 3. Thermal impedance for TO-220

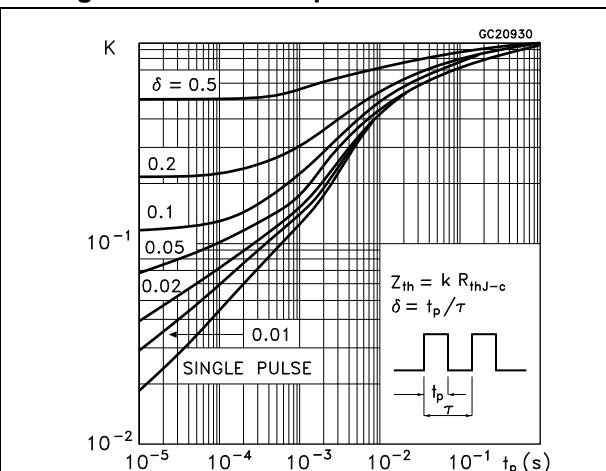


Figure 4. Safe operating area for TO-220FP

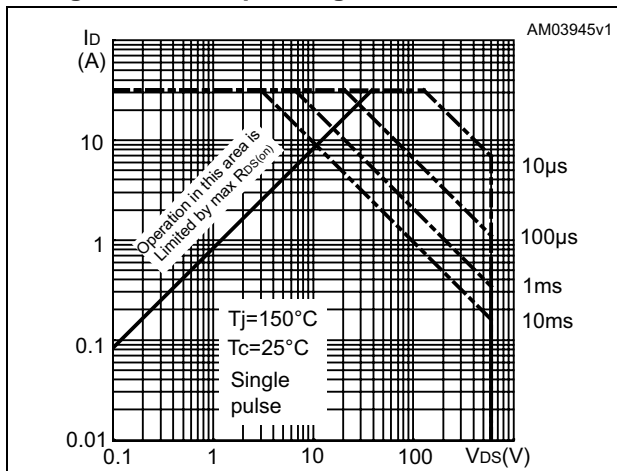


Figure 5. Thermal impedance for TO-220FP

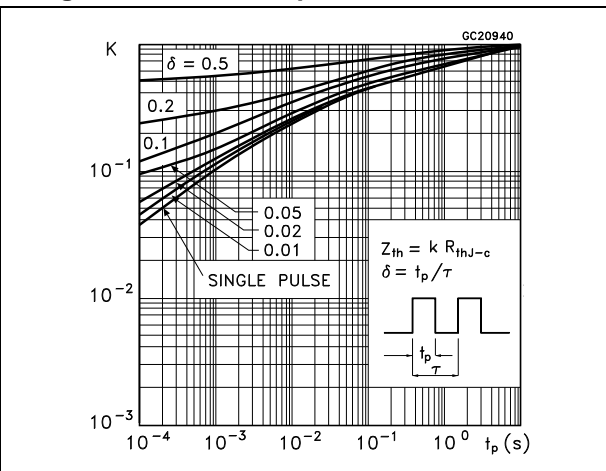


Figure 6. Safe operating area for DPAK, IPAK

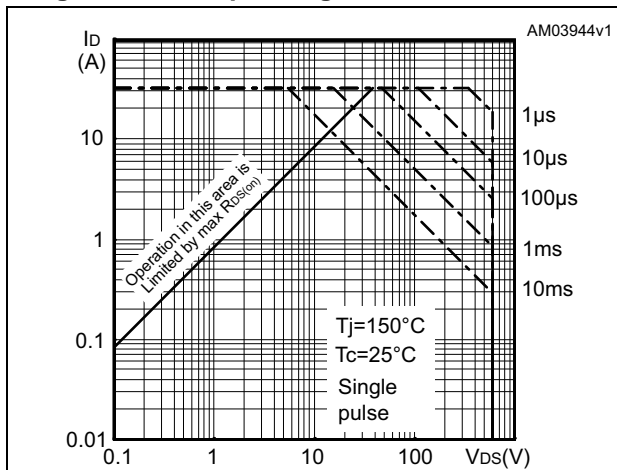


Figure 7. Thermal impedance for DPAK, IPAK

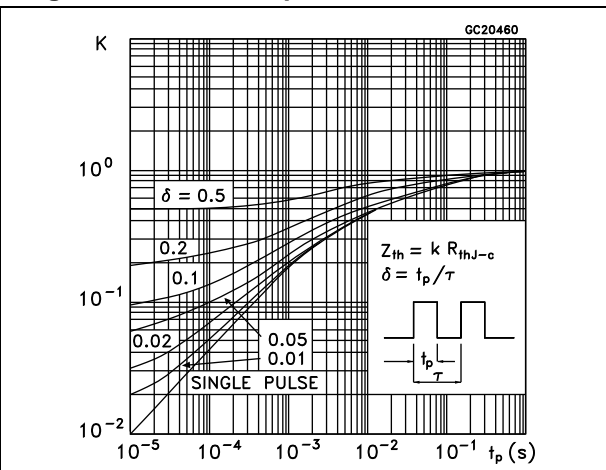


Figure 8. Output characteristics

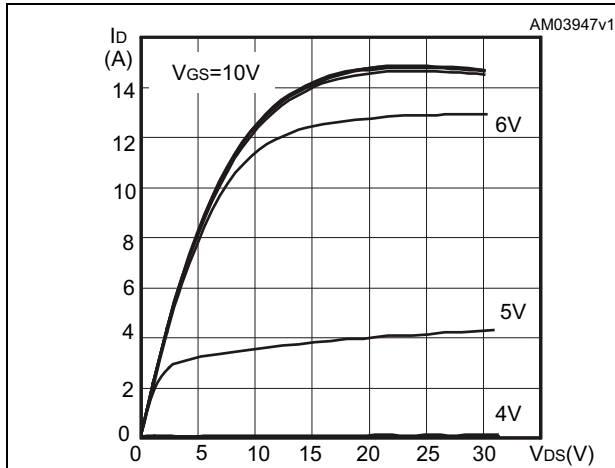


Figure 9. Transfer characteristics

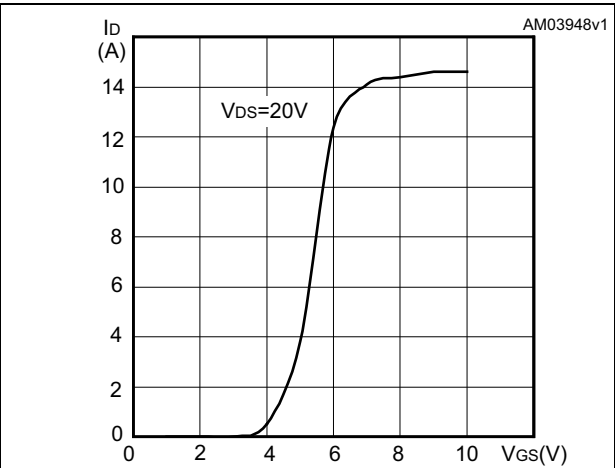


Figure 10. Normalized  $V_{DS}$  vs. temperature

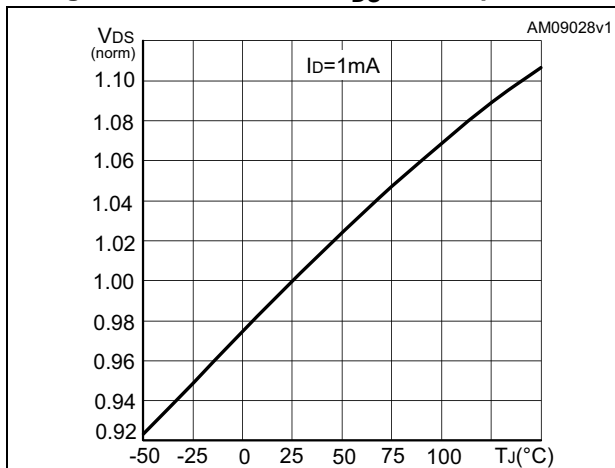


Figure 11. Static drain-source on-resistance

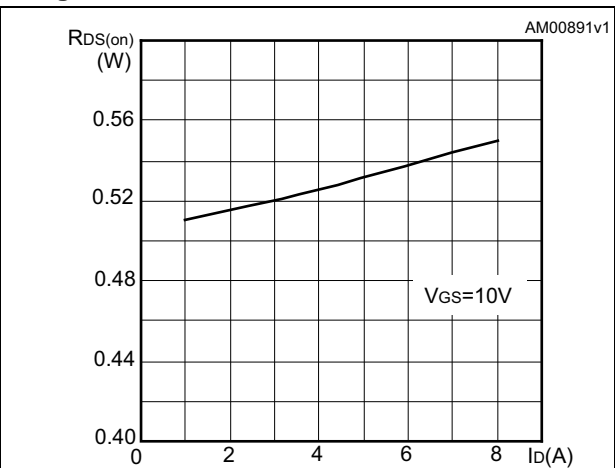


Figure 12. Gate charge vs. gate-source voltage

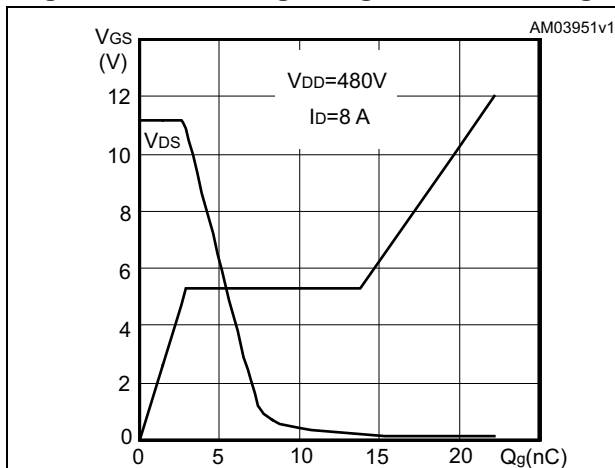


Figure 13. Capacitance variations

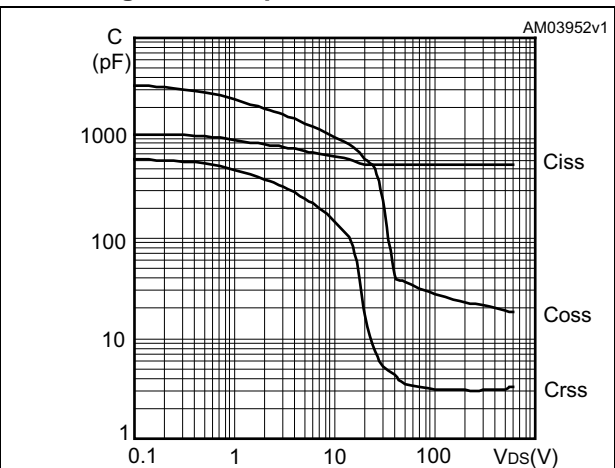


Figure 14. Normalized gate threshold voltage vs. temperature

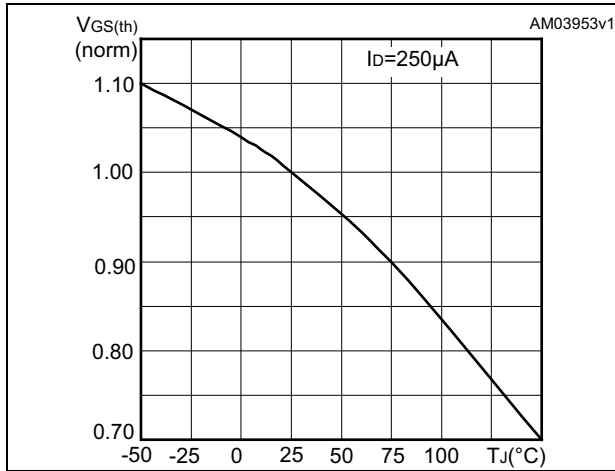
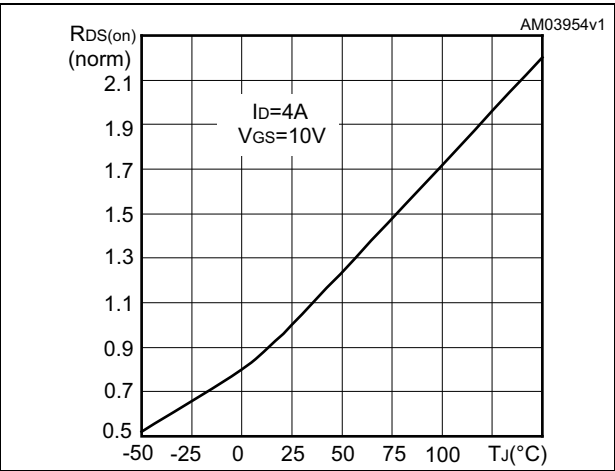


Figure 15. Normalized on-resistance vs. temperature





### 3 Test circuits

Figure 16. Switching times test circuit for resistive load

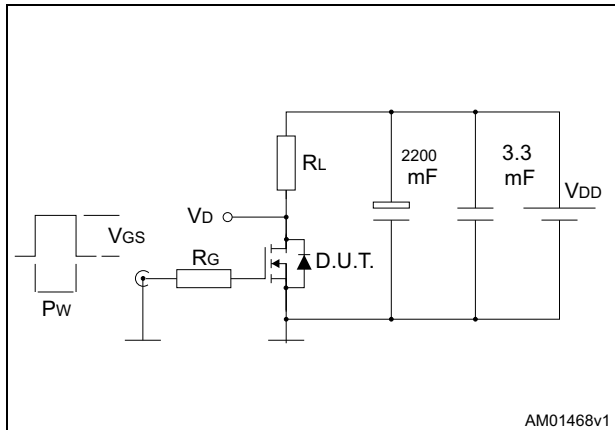


Figure 17. Gate charge test circuit

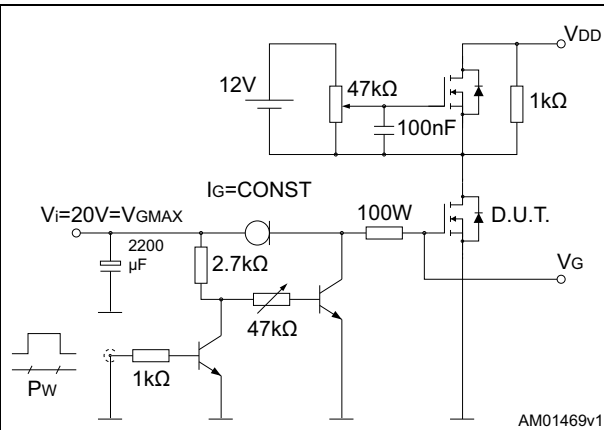


Figure 18. Test circuit for inductive load switching and diode recovery times

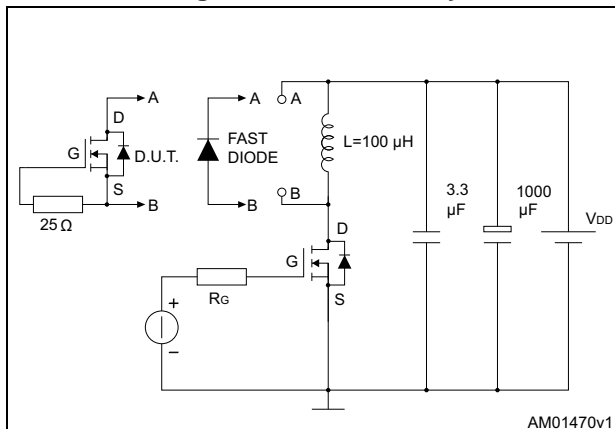


Figure 19. Unclamped inductive load test circuit

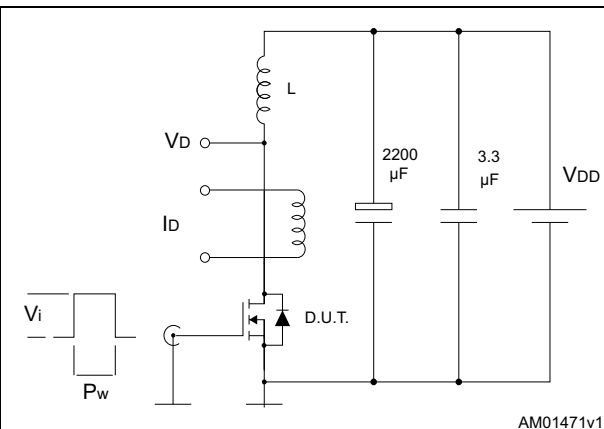


Figure 20. Unclamped inductive waveform

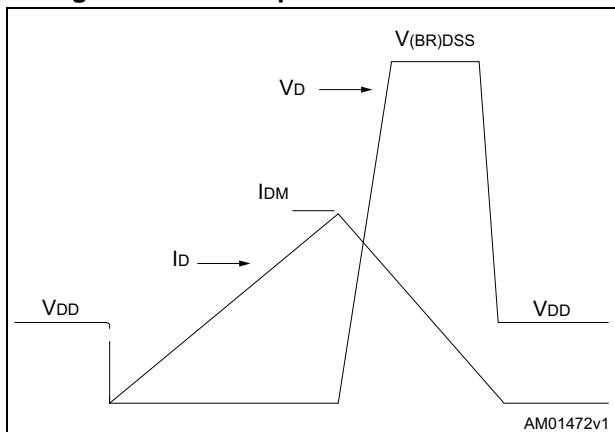
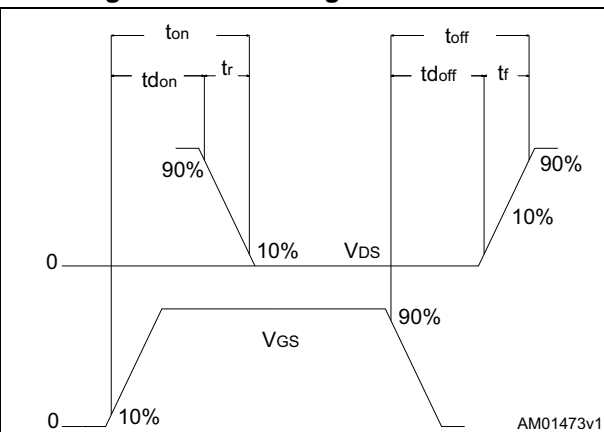


Figure 21. Switching time waveform



## 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 STD10NM60N, DPAK (TO-252) package information

Figure 22. DPAK (TO-252) type A package outline

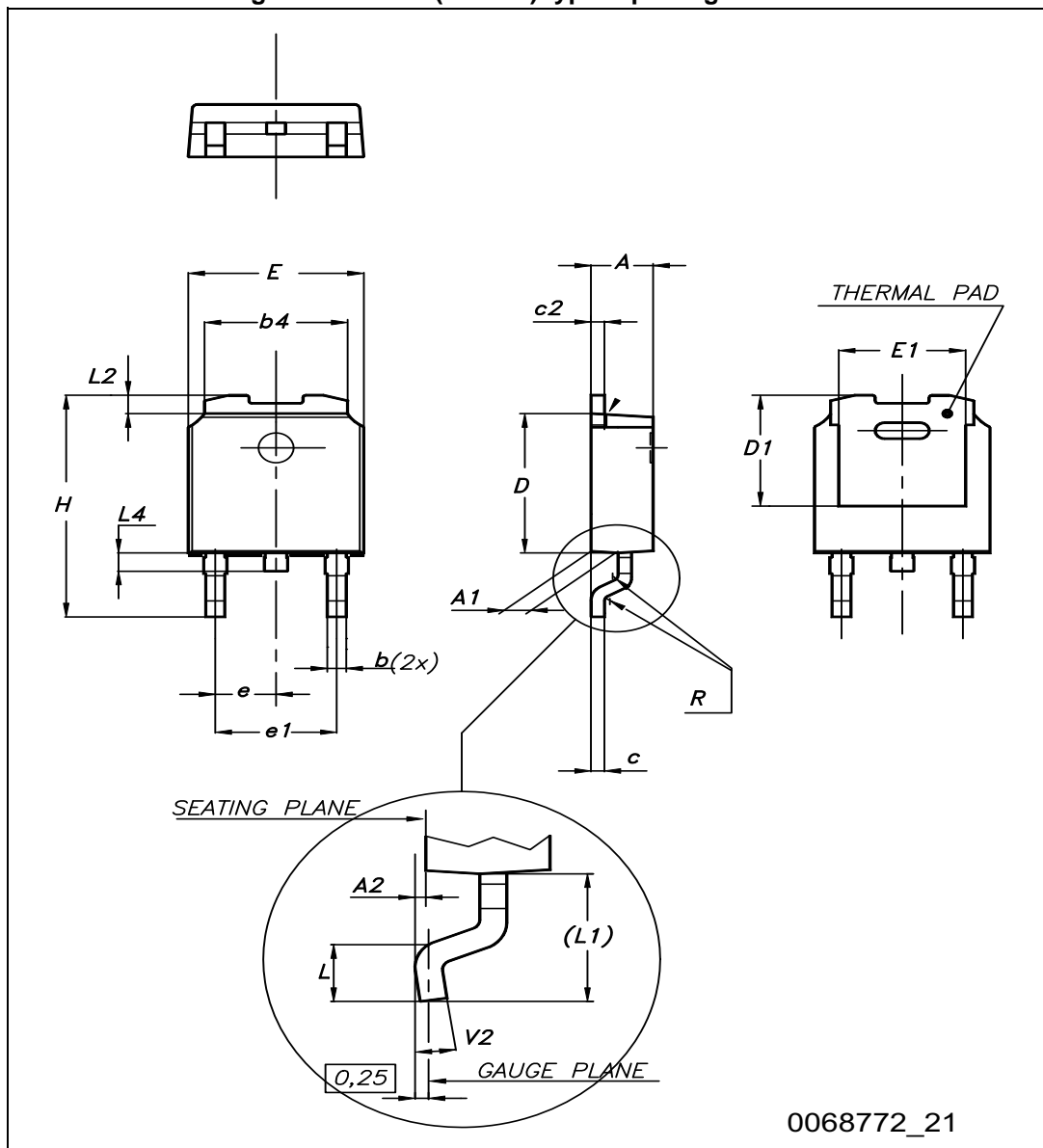


Table 9. DPAK (TO-252) type A mechanical data

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	4.60	4.70	4.80
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°

Figure 23. DPAK (TO-252) type C2 outline

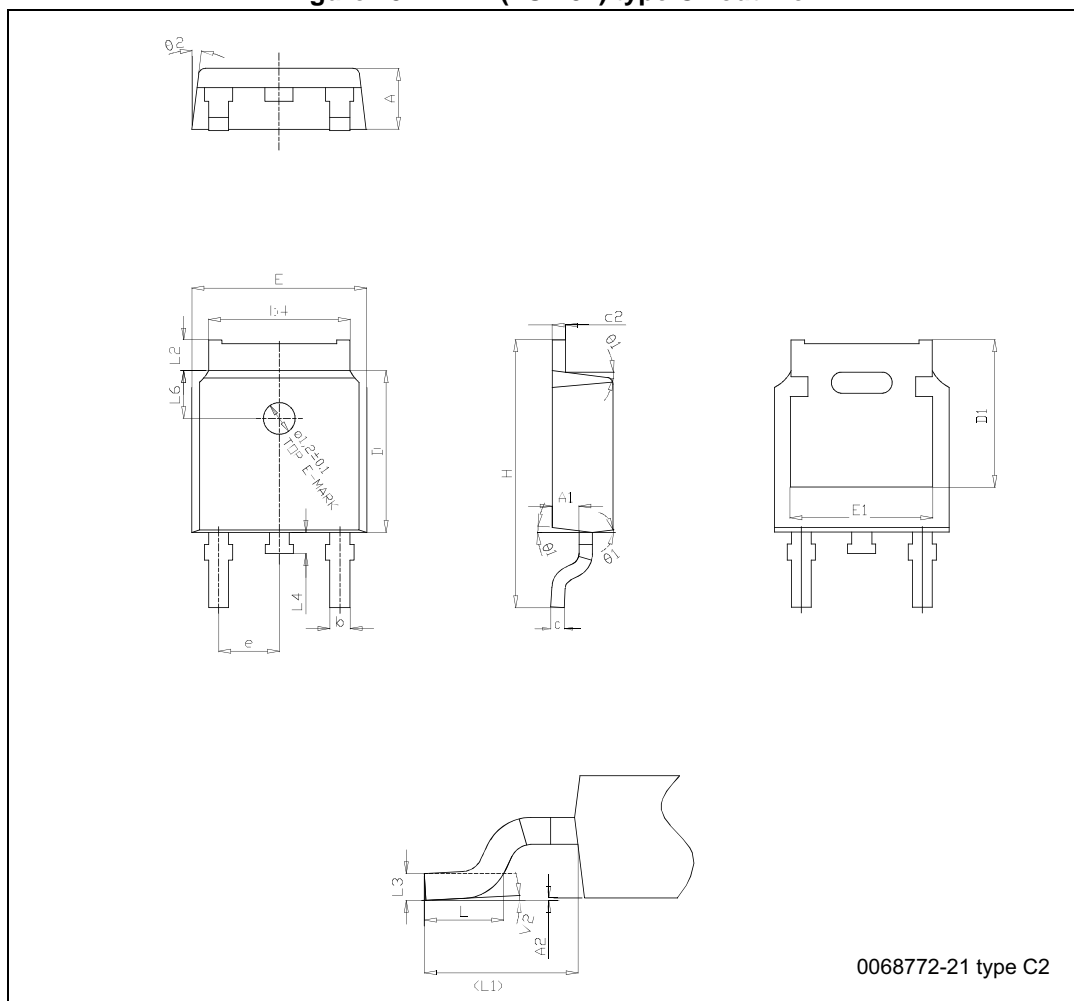


Table 10. DPAK (TO-252) type C2 package mechanical data

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°

Figure 24. DPAK (TO-252) type E package outline

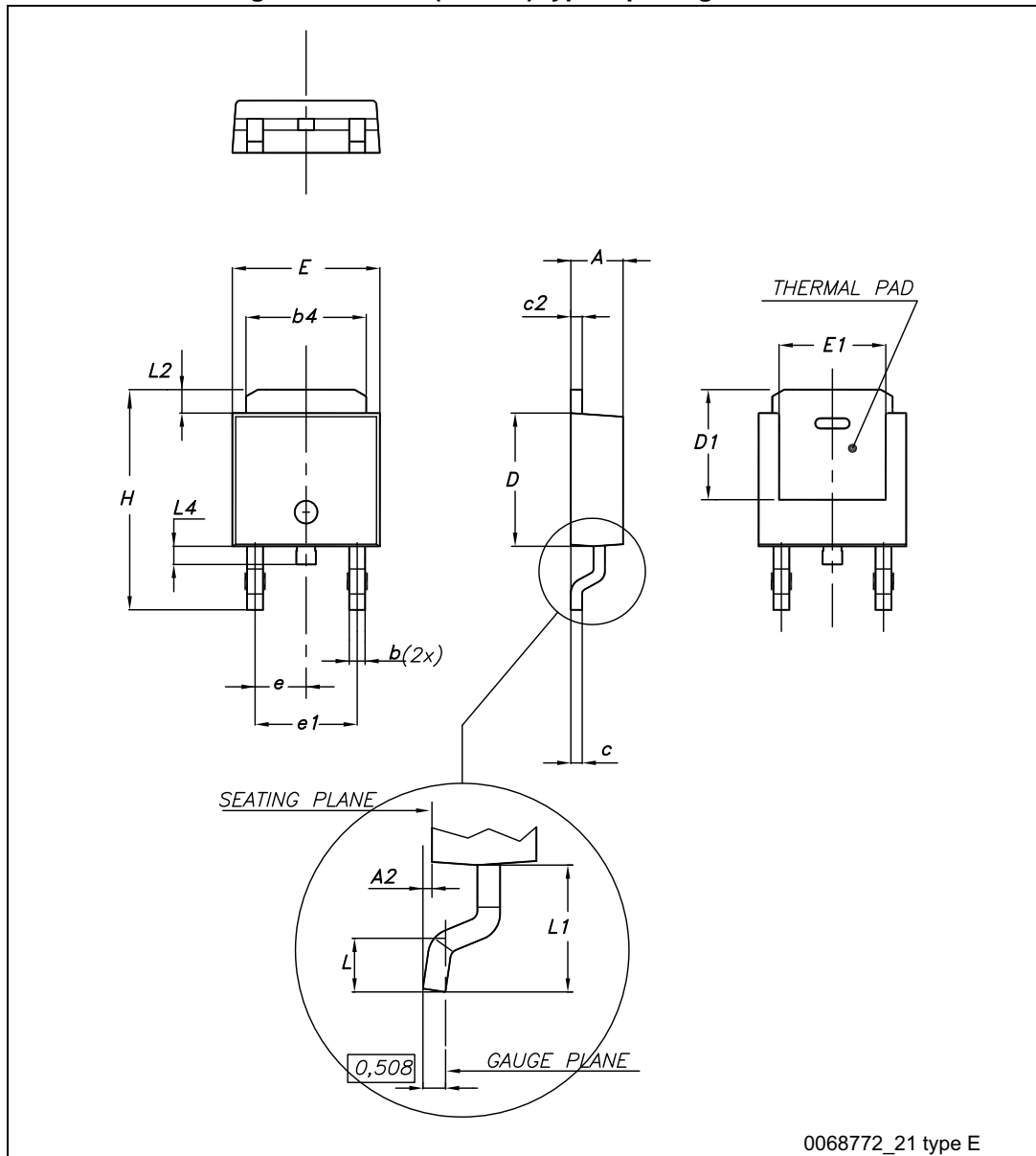
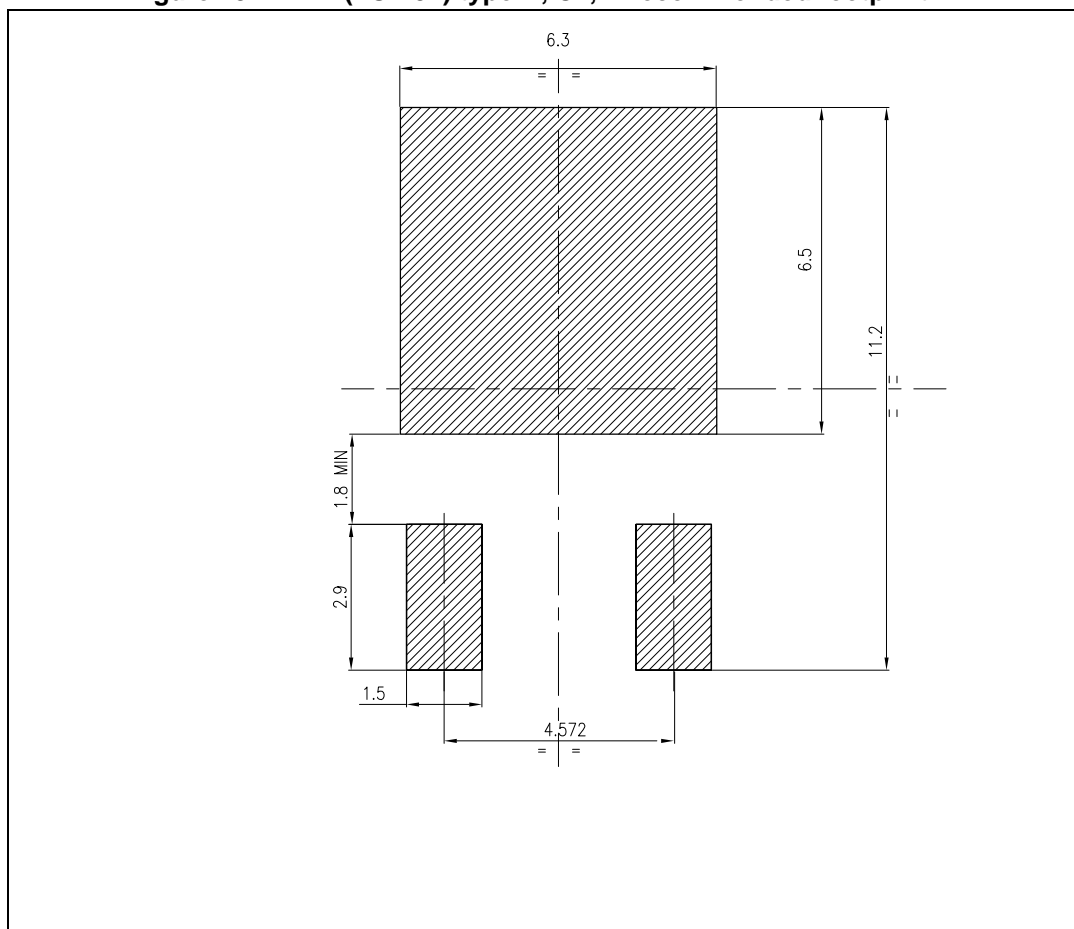


Table 11. DPAK (TO-252) type E mechanical data

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

Figure 25. DPAK (TO-252) type A, C2, E recommended footprint (a)

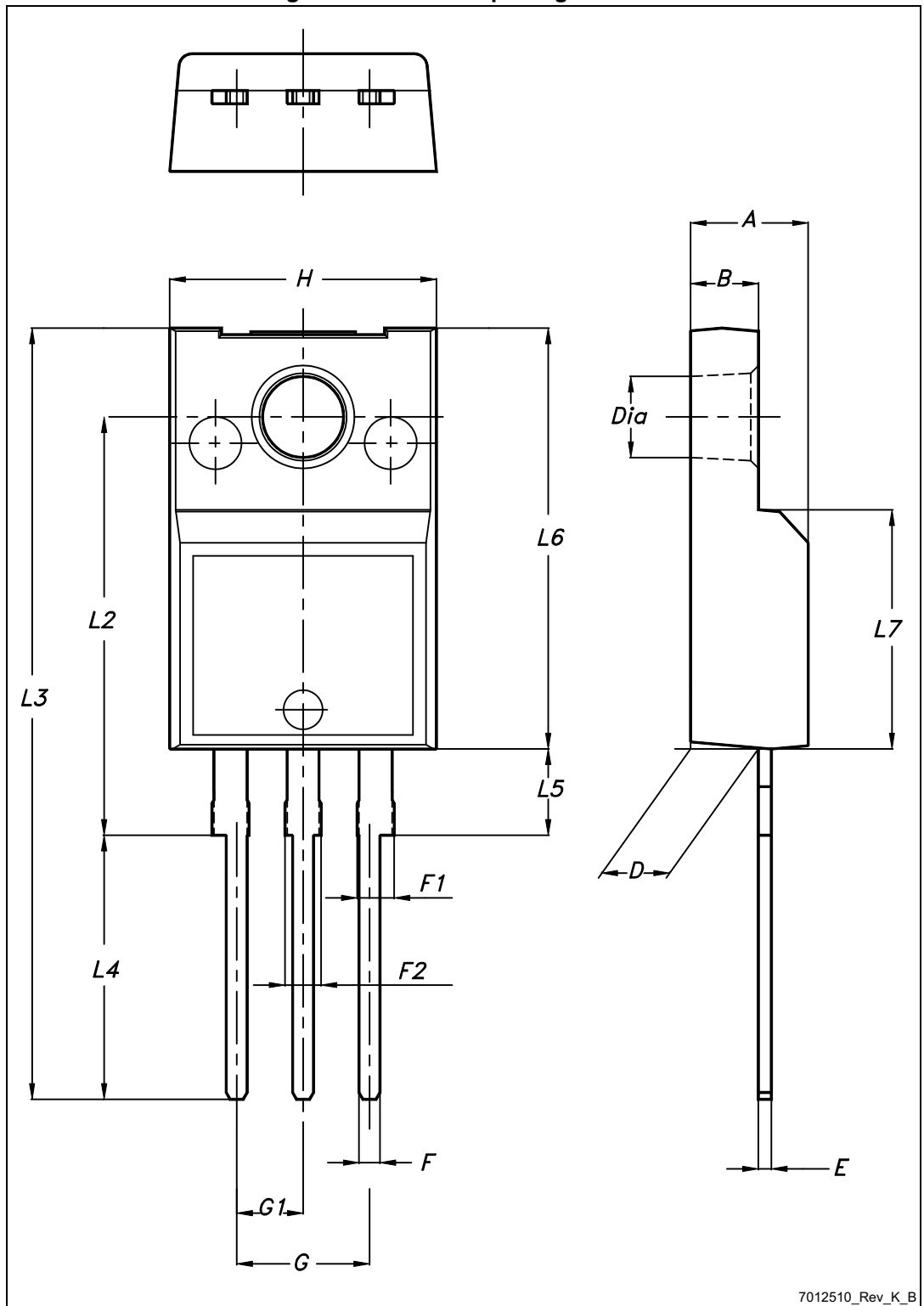


a. All dimensions are in millimeters



### 4.2 STF10NM60N, TO-220FP package information

Figure 26. TO-220FP package outline



7012510\_Rev\_K\_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

### 4.3 STP10NM60N, TO-220 package information

Figure 27. TO-220 type A package outline

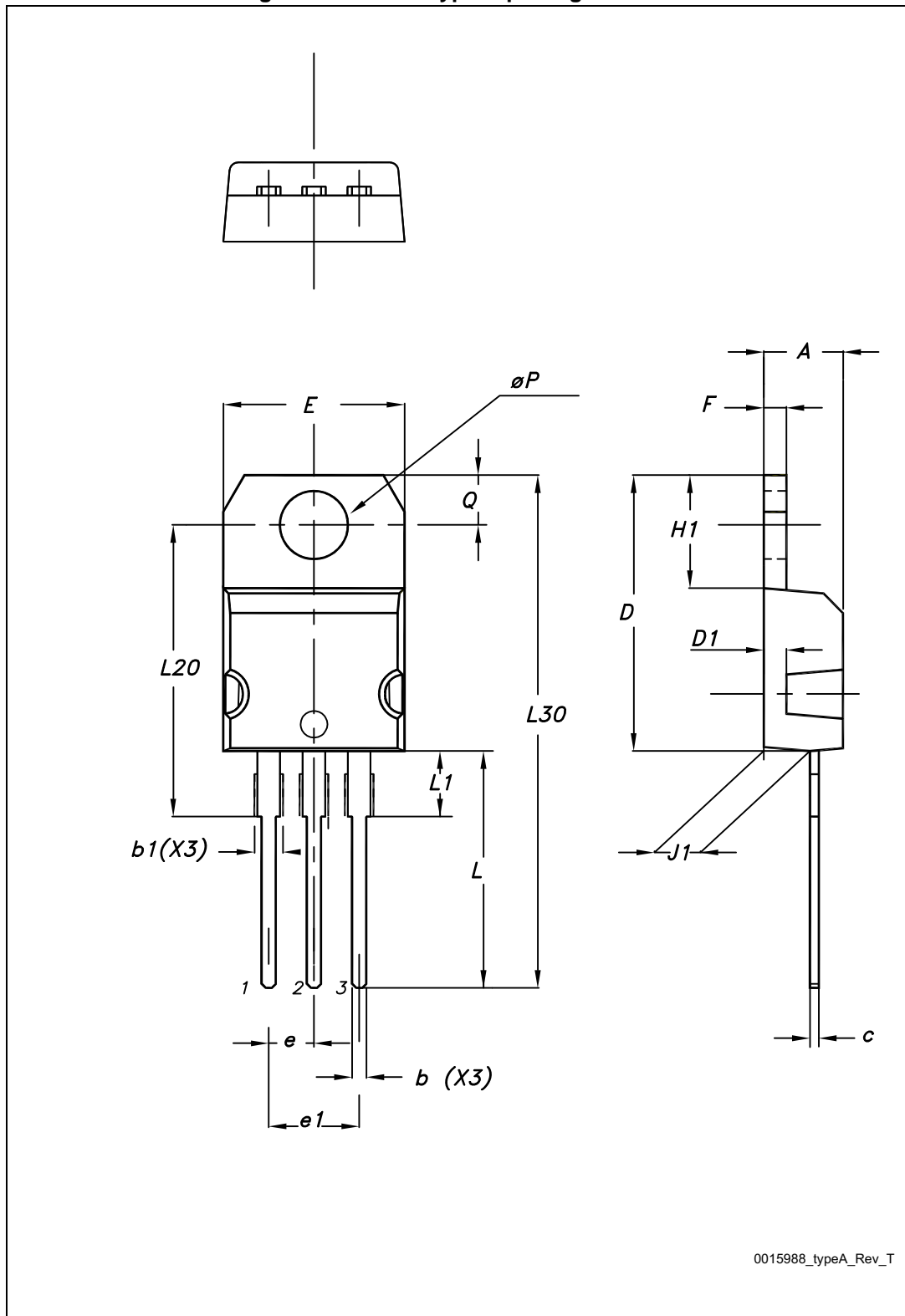


Table 13. TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		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		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
øP	3.75		3.85
Q	2.65		2.95

### 4.4 STU10NM60N, IPAK (TO-251)

Figure 28. IPAK (TO-251) type A outline

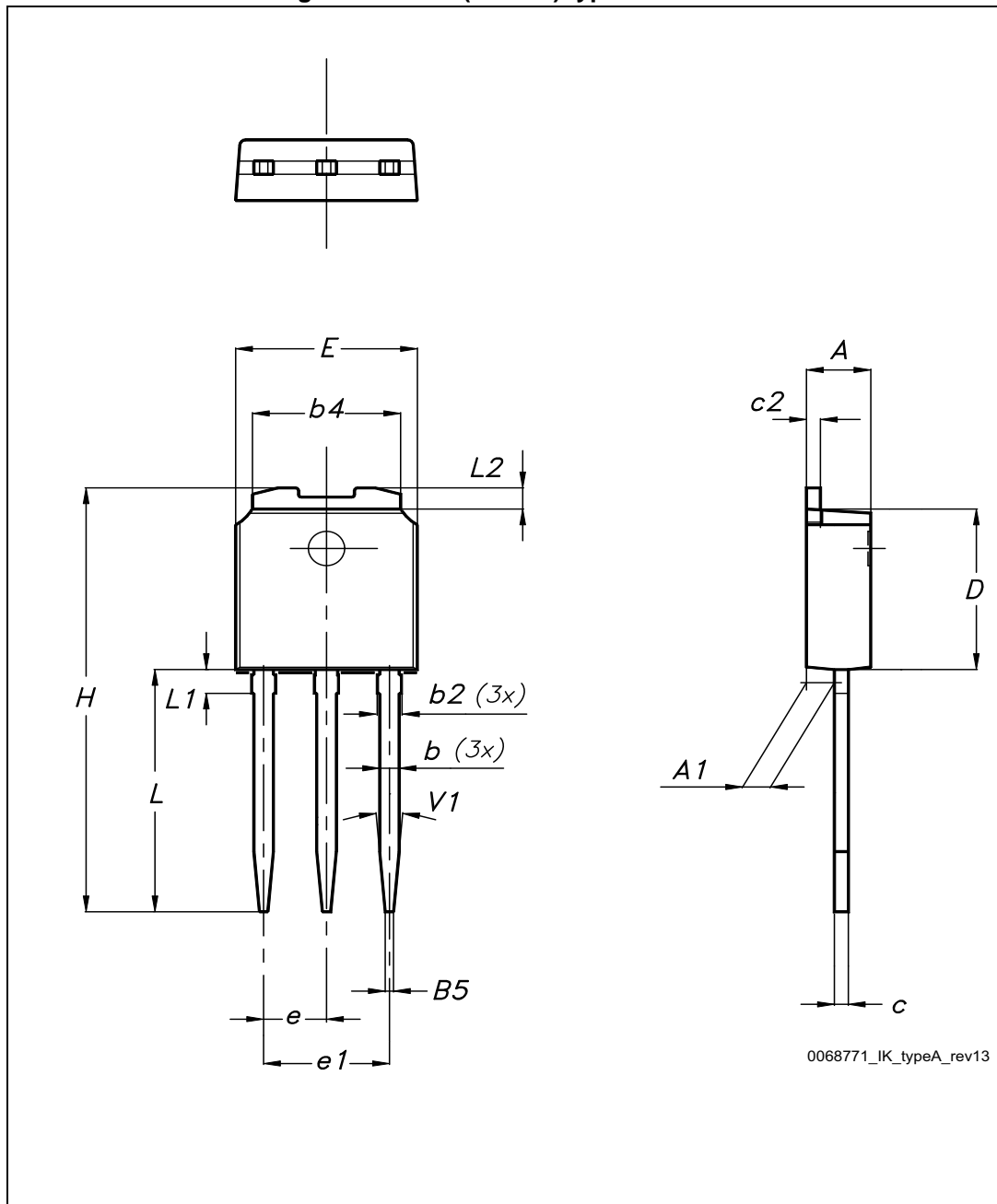
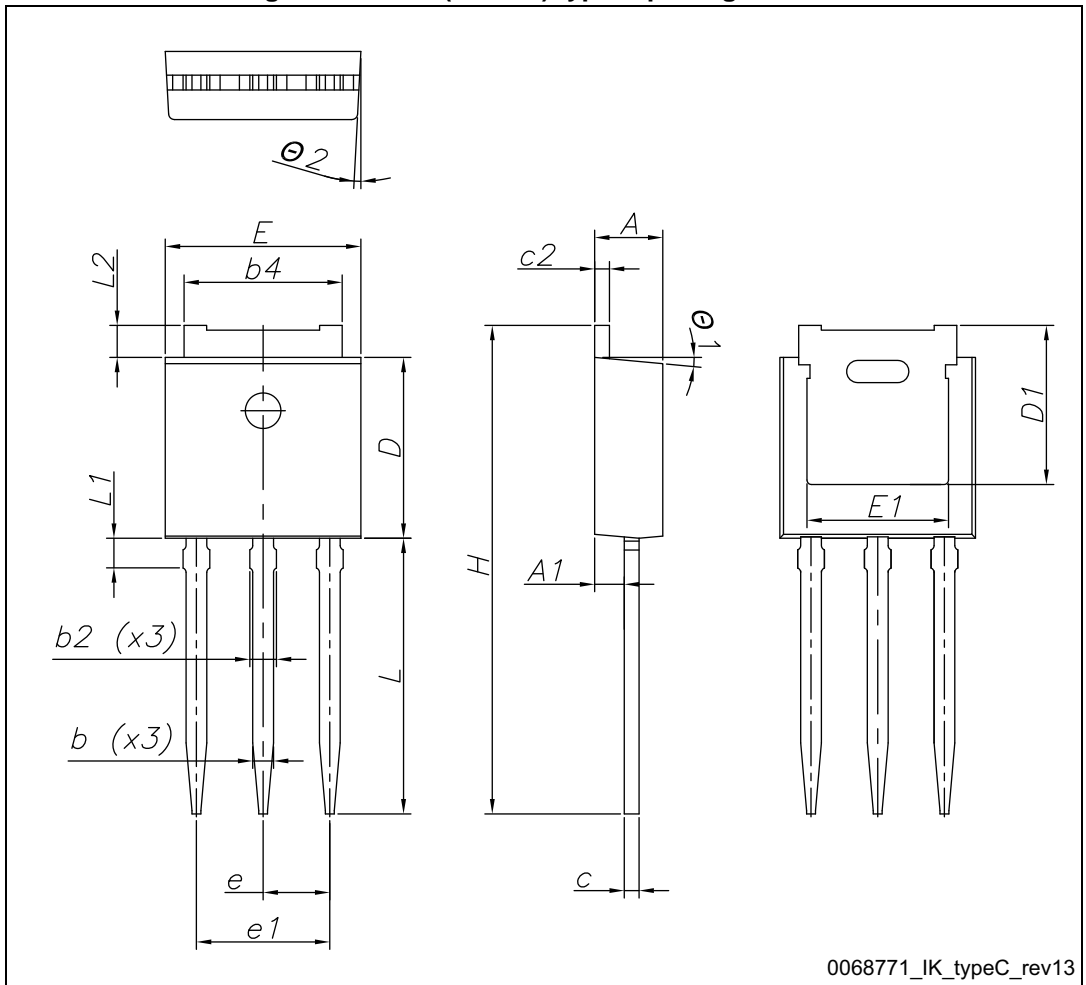


Table 14. IPAK (TO-251) type A mechanical data

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°	

Figure 29. IPAK (TO-251) type C package outline



0068771\_IK\_typeC\_rev13

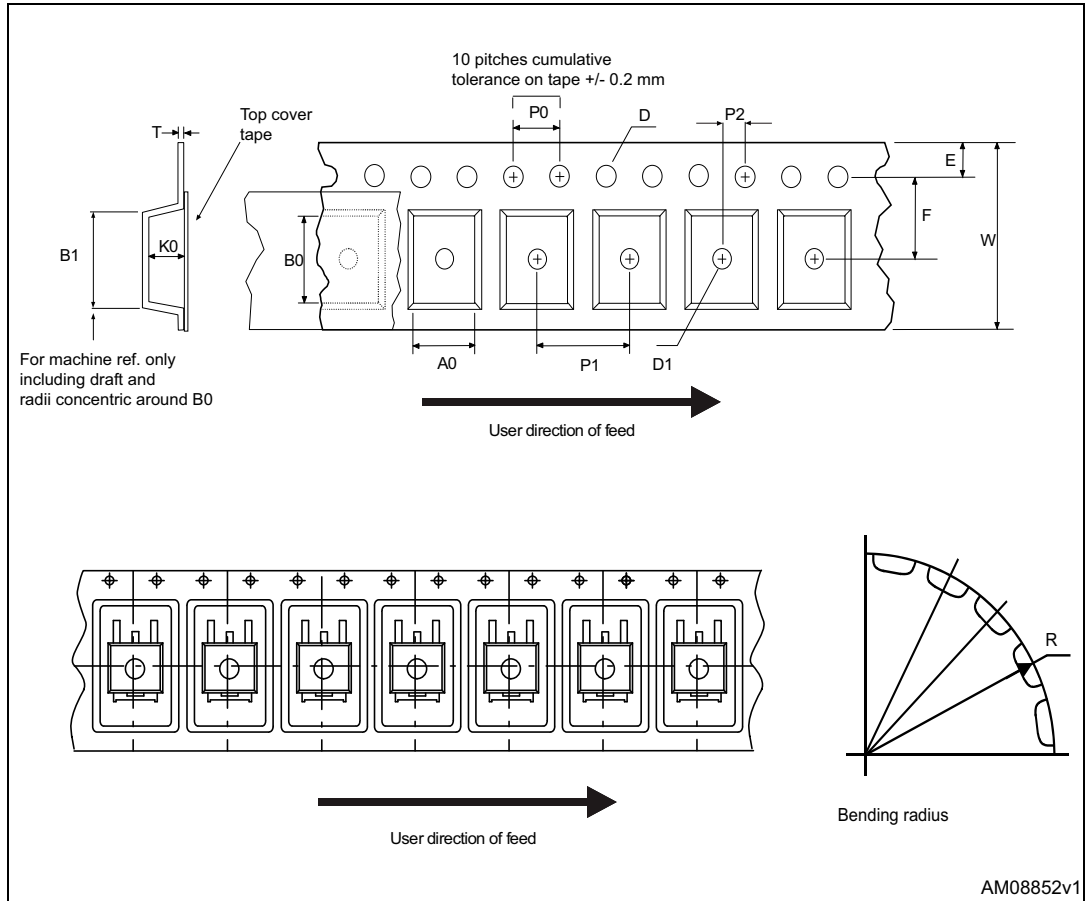
Table 15. IPAK (TO-251) type C package mechanical data

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	0.90	1.00	1.20
L2	0.90	1.08	1.25
θ1	3°	5°	7°
θ2	1°	3°	5°



# 5 Packing information

Figure 30. Tape for DPAK (TO-252)



AM08852v1

Figure 31. Reel for DPAK (TO-252)

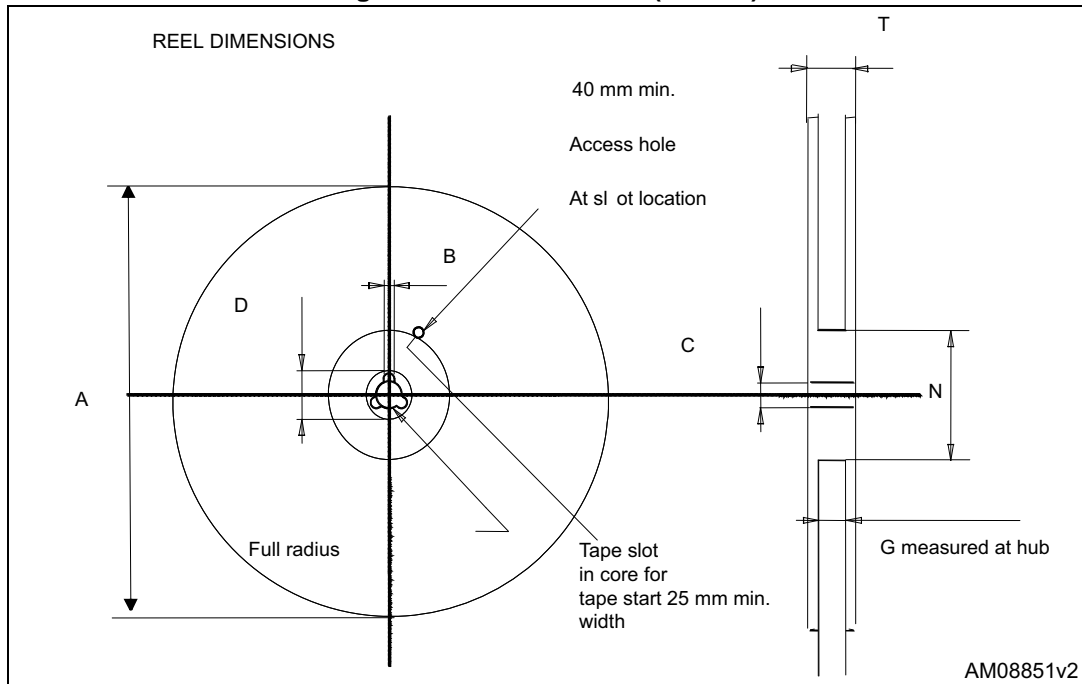


Table 16. DPAK (TO-252) tape and reel mechanical data

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 quantity		2500
P1	7.9	8.1	Bulk quantity		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

## 6 Revision history

**Table 17. Document revision history**

Date	Revision	Changes
04-Dec-2015	1	First release. Part numbers previously included in the datasheet with DocID15764.

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