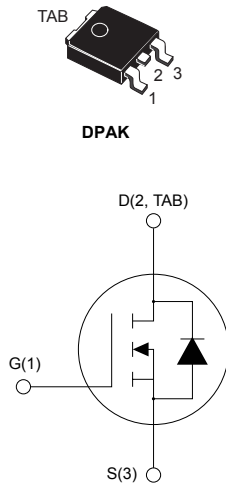


## N-channel 600 V, 325 mΩ typ., 11 A FDmesh II Power MOSFET in a DPAK package



AM01475v1\_noZen



### Features

Order code	$V_{DS}$ at $T_J$ max.	$R_{DS(on)}$ max.	$I_D$
STD13NM60ND	650 V	380 mΩ	11 A

- Fast-recovery body diode
- Low gate charge and input capacitance
- Low on-resistance  $R_{DS(on)}$
- 100% avalanche tested
- High dv/dt ruggedness

### Applications

- Switching applications

### Description

This FDmesh II Power MOSFET with fast-recovery body diode is produced using MDmesh II technology. Utilizing a new strip-layout vertical structure, this device features low on-resistance and superior switching performance. It is ideal for bridge topologies and ZVS phase-shift converters.

#### Product status link

[STD13NM60ND](#)

#### Product summary

<b>Order code</b>	STD13NM60ND
<b>Marking</b>	13NM60ND
<b>Package</b>	DPAK
<b>Packing</b>	Tape and reel

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	600	V
$V_{GS}$	Gate-source voltage	±25	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ °C}$	11	A
	Drain current (continuous) at $T_C = 100\text{ °C}$	6.93	
$I_{DM}^{(1)}$	Drain current (pulsed)	44	A
$P_{TOT}$	Total power dissipation at $T_C = 25\text{ °C}$	109	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	40	V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	40	V/ns
$T_{stg}$	Storage temperature range	-55 to 150	°C
$T_J$	Maximum operating junction temperature	150	°C

1. Pulse width is limited by safe operating area.
2.  $I_{SD} \leq 11\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS}(\text{peak}) < V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .
3.  $V_{DS} \leq 480\text{ V}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance, junction-to-case	1.15	°C/W
$R_{thJA}^{(1)}$	Thermal resistance, junction-to-ambient	50	°C/W

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

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AS}$	Avalanche current, repetitive or non-repetitive (pulse width limited by $T_J$ max.)	3	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ °C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ )	162	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	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$			$\pm 100$	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	$V_{GS} = 10\text{ V}$ , $I_D = 5.5\text{ A}$		325	380	m $\Omega$

1. Specified by design, not tested in production.

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	845	-	pF
$C_{oss}$	Output capacitance		-	47	-	pF
$C_{rss}$	Reverse transfer capacitance		-	2.5	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }480\text{ V}$	-	121	-	pF
$R_G$	Gate input resistance	$f = 1\text{ MHz}$ , Gate DC bias = 0 V, test signal level = 20 mV, open drain	-	4.3	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 13. Test circuit for gate charge behavior)	-	24.5	-	nC
$Q_{gs}$	Gate-source charge		-	4.8	-	nC
$Q_{gd}$	Gate-drain charge		-	17	-	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	$V_{DD} = 300\text{ V}$ , $I_D = 5.5\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$	-	46.5	-	ns
$t_r$	Rise time		-	10	-	ns
$t_{d(off)}$	Turn-off delay time	(see Figure 12. Test circuit for resistive load switching times and Figure 17. Switching time waveform)	-	9.6	-	ns
$t_f$	Fall time		-	15.4	-	ns

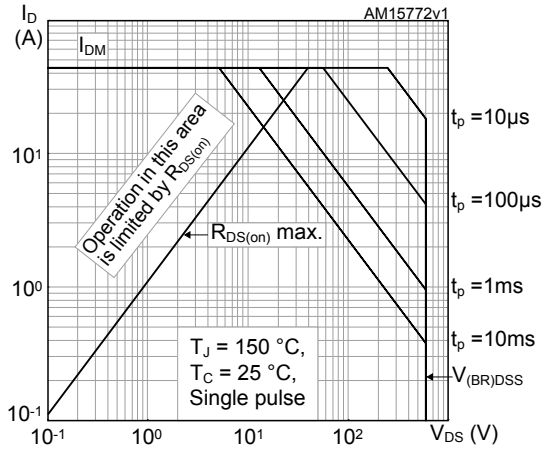
**Table 7. Source-drain diode**

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	$I_{SD} = 11\text{ A}$ , $V_{GS} = 0\text{ V}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	150		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100\text{ V}$	-	755		nC
$I_{RRM}$	Reverse recovery current	(see Figure 14. Test circuit for inductive load switching and diode recovery times)	-	12		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	187		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$	-	1271		nC
$I_{RRM}$	Reverse recovery current	(see Figure 14. Test circuit for inductive load switching and diode recovery times)	-	13.6		A

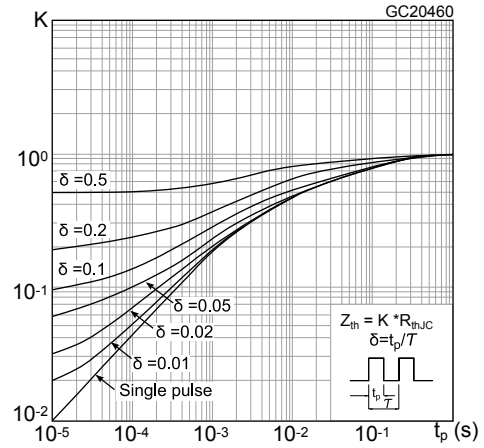
1. Pulse width is limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

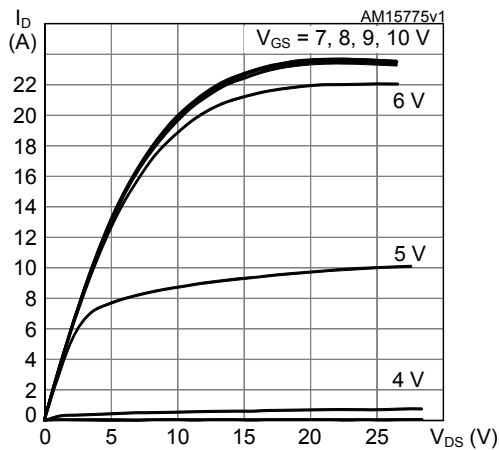
**Figure 1. Safe operating area**



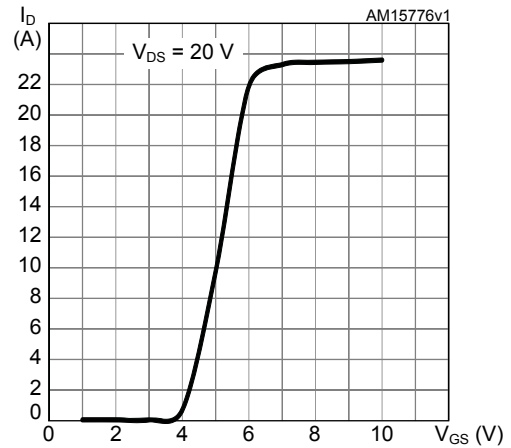
**Figure 2. Normalized transient thermal impedance**



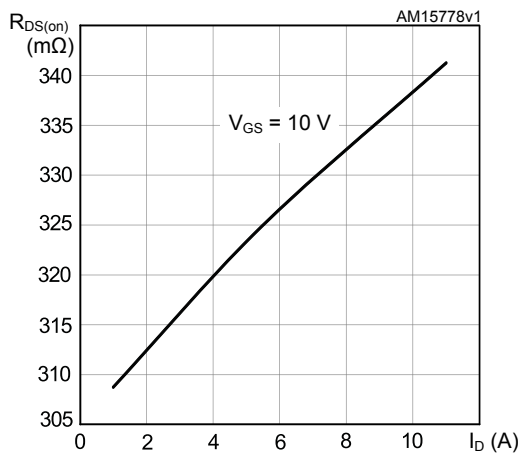
**Figure 3. Output characteristics**



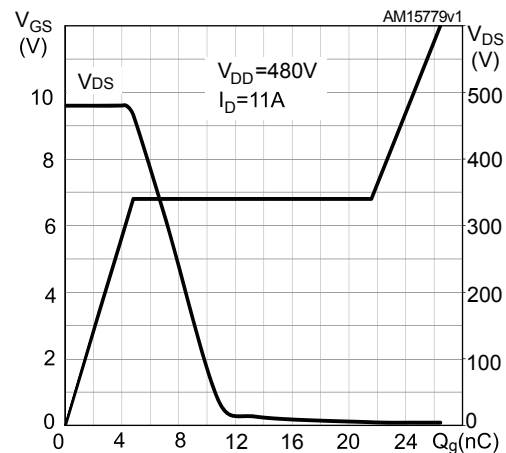
**Figure 4. Transfer characteristics**



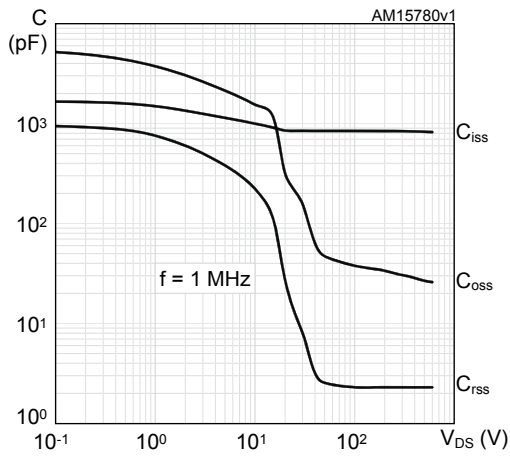
**Figure 5. Static drain-source on resistance**



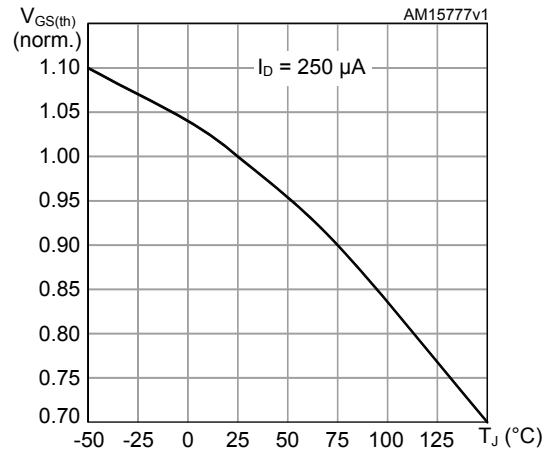
**Figure 6. Gate charge vs gate-source voltage**



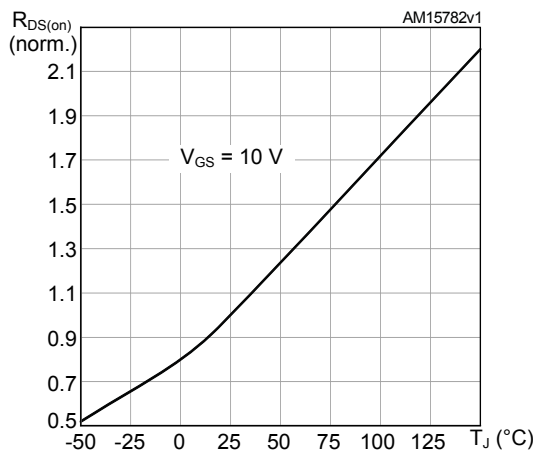
**Figure 7. Capacitance variations**



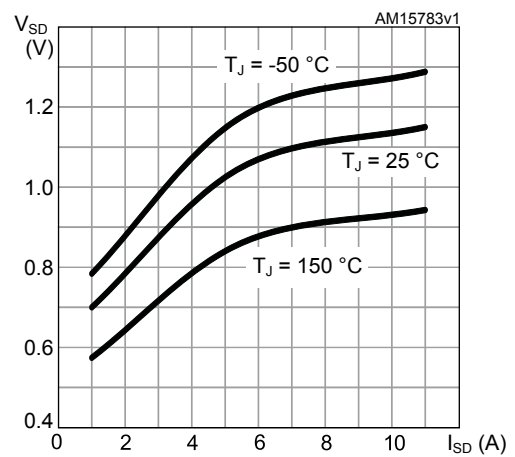
**Figure 8. Normalized gate threshold voltage vs temperature**



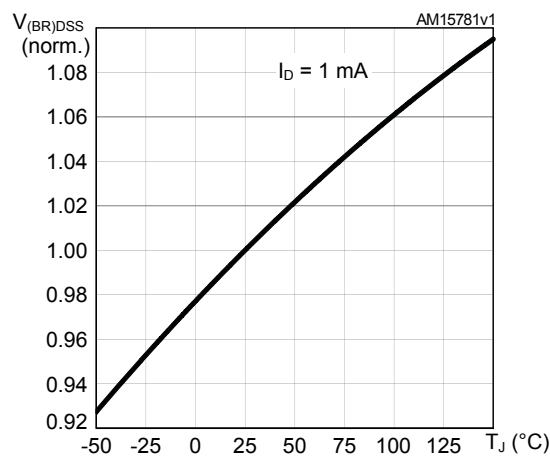
**Figure 9. Normalized on resistance vs temperature**



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



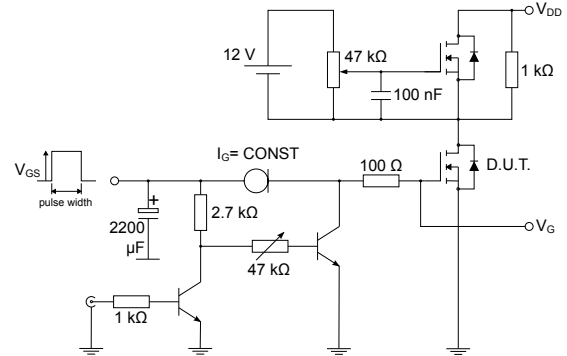
**Figure 11. Normalized breakdown voltage vs temperature**



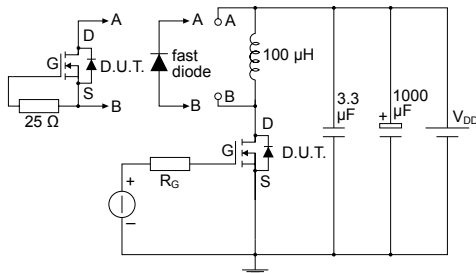
### 3 Test circuits

**Figure 12. Test circuit for resistive load switching times**

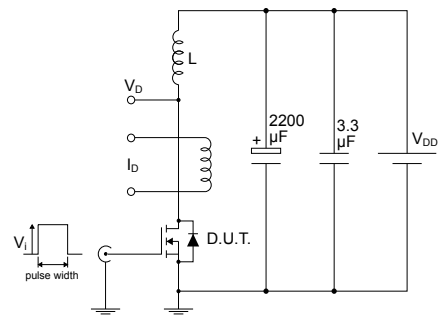

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**Figure 13. Test circuit for gate charge behavior**


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**Figure 14. Test circuit for inductive load switching and diode recovery times**


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**Figure 15. Unclamped inductive load test circuit**


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**Figure 16. Unclamped inductive waveform**


AM01472v1

**Figure 17. Switching time waveform**

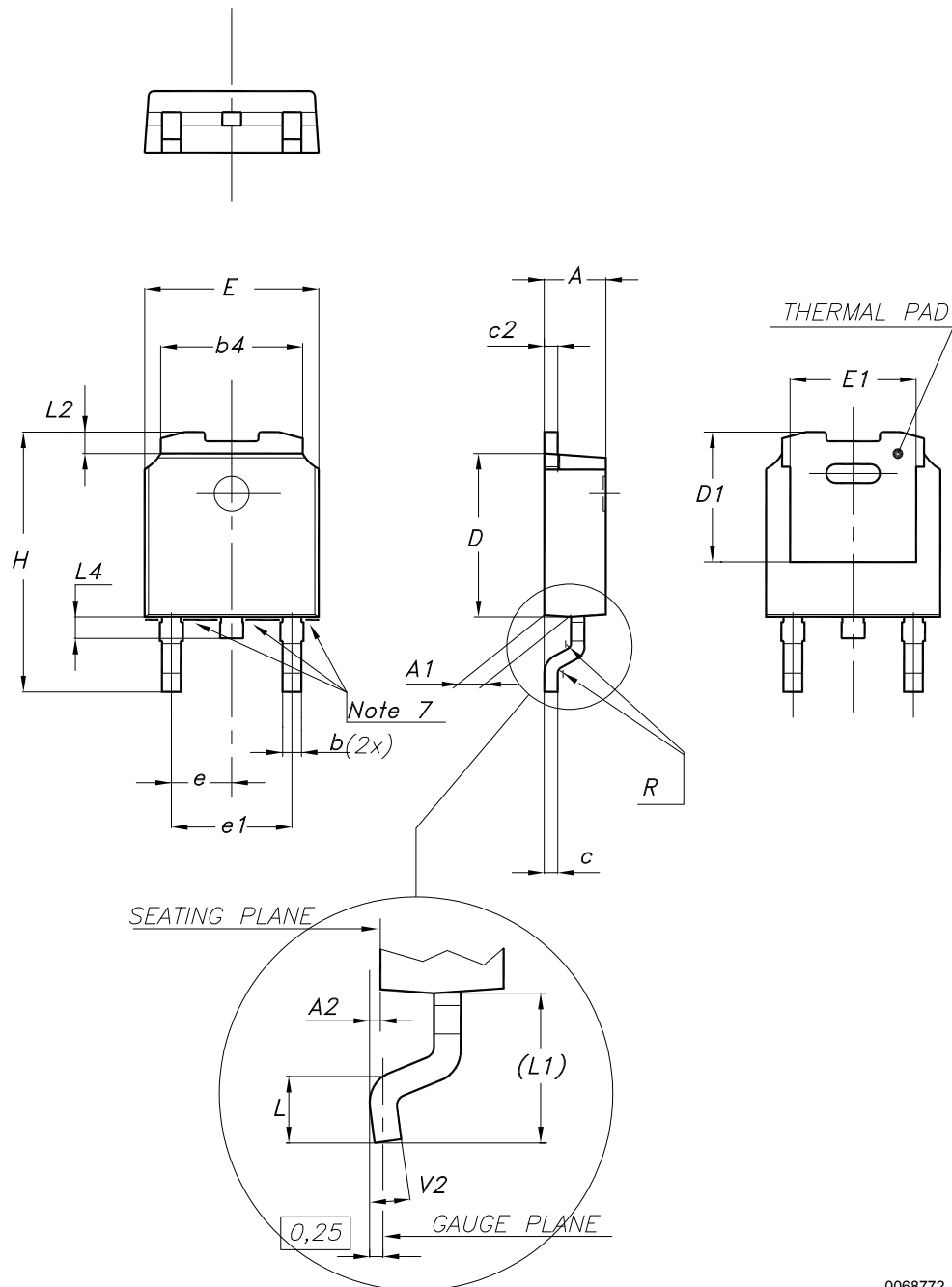

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## 4 Package information

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](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 DPAK (TO-252) type A2 package information

Figure 18. DPAK (TO-252) type A2 package outline



0068772\_type-A2\_rev34

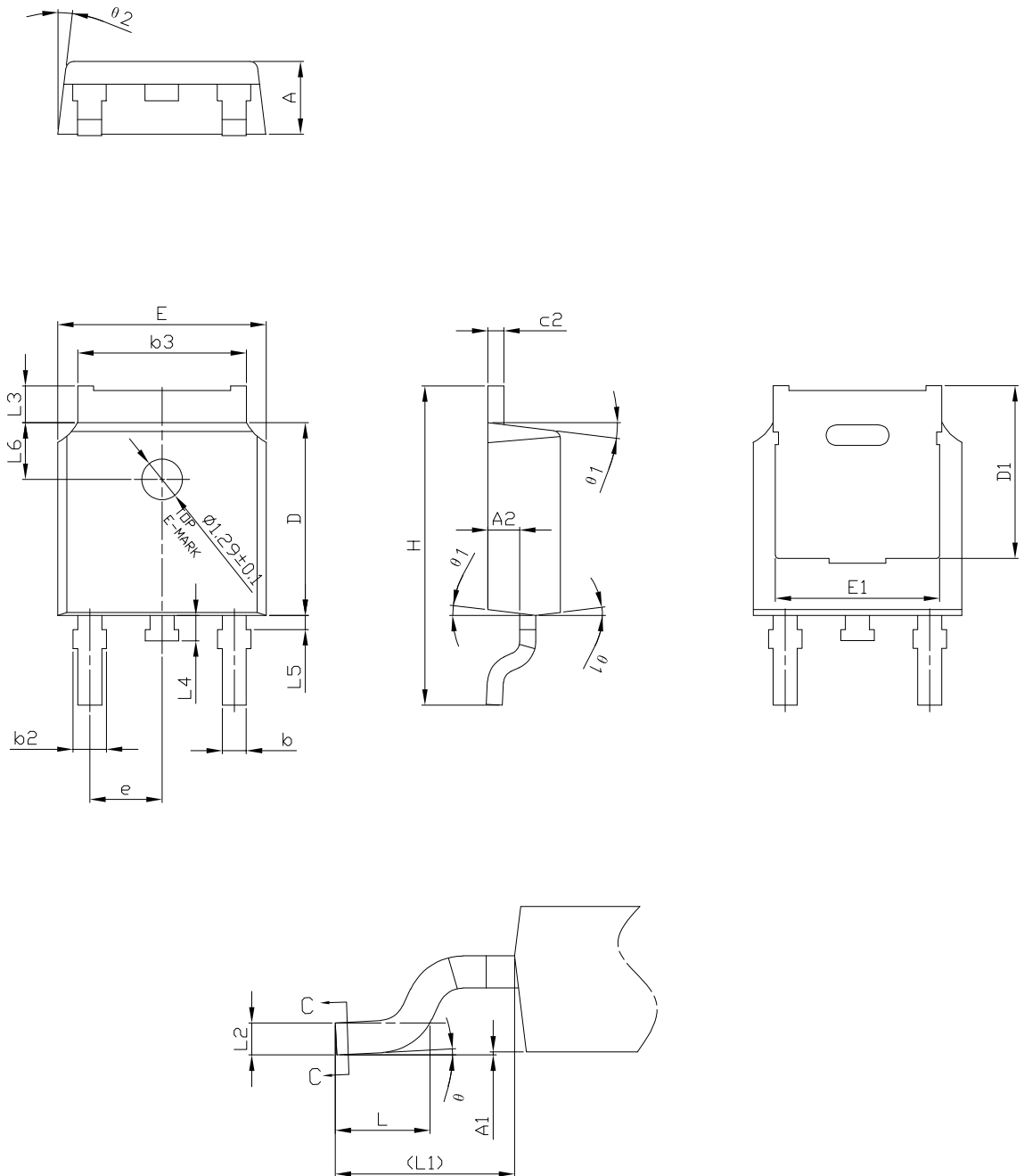


**Table 8. DPAK (TO-252) type A2 mechanical data**

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	5.10	5.20	5.30
e	2.159	2.286	2.413
e1	4.445	4.572	4.699
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°

## 4.2 DPAK (TO-252) type C3 package information

Figure 19. DPAK (TO-252) type C3 package outline

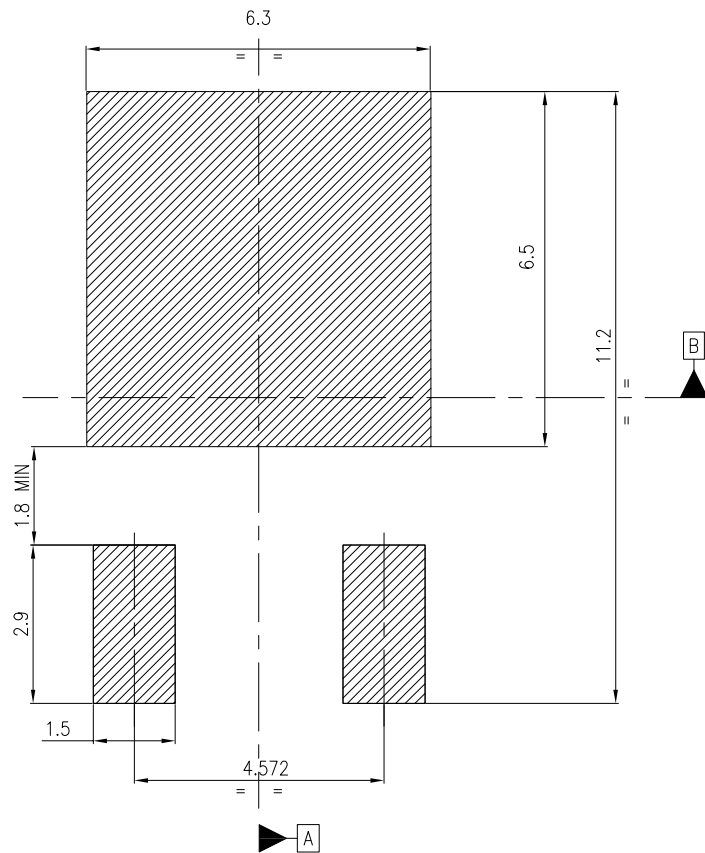


0068772\_type-C3\_rev34

**Table 9. DPAK (TO-252) type C3 mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.38
A1	0.00		0.10
A2	0.90	1.01	1.10
b	0.72		0.85
b2	0.72		1.10
b3	5.13	5.33	5.46
c	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.20	5.45	5.70
E	6.50	6.60	6.70
E1	5.00	5.20	5.40
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	0.51 BSC		
L3	0.90		1.25
L4	0.60	0.80	1.00
L5	0.15		0.75
L6	1.80 REF		
θ	0°		8°
θ1	5°	7°	9°
θ2	5°	7°	9°

Figure 20. DPAK (TO-252) recommended footprint (dimensions are in mm)



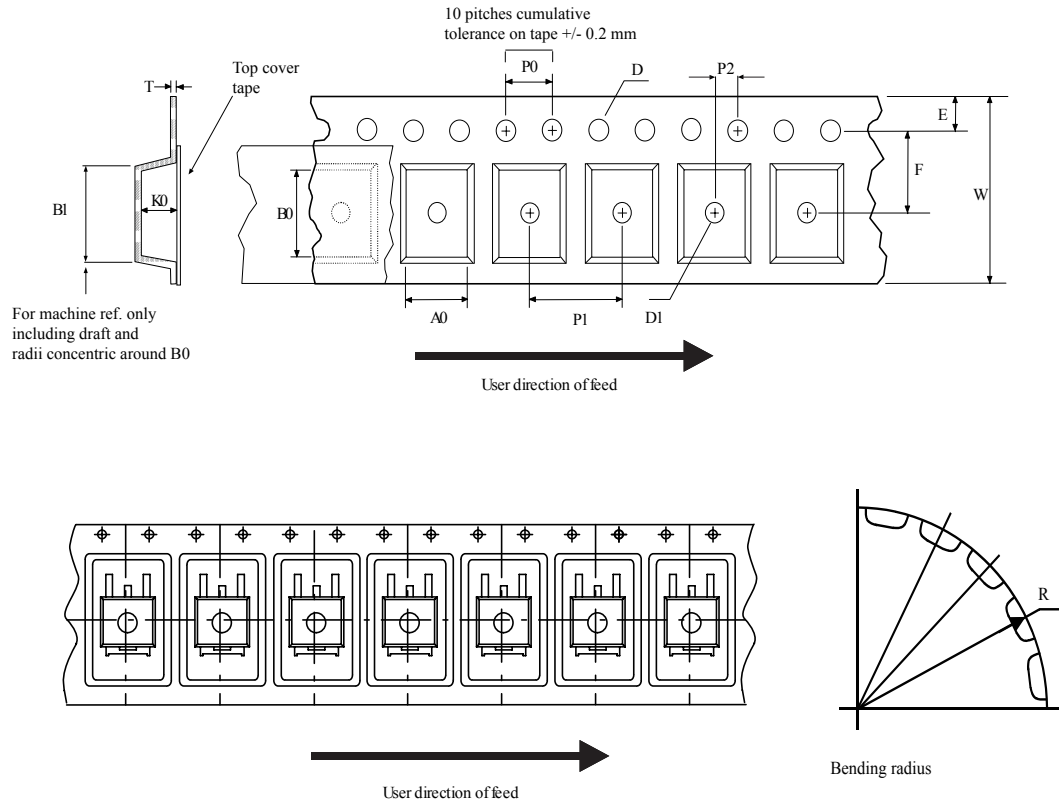
Notes:

- 1) This footprint is able to ensure insulation up to 630 Vrms (according to CEI IEC 664-1)
- 2) The device must be positioned within  $\boxed{\oplus 0.05 \text{ A B}}$

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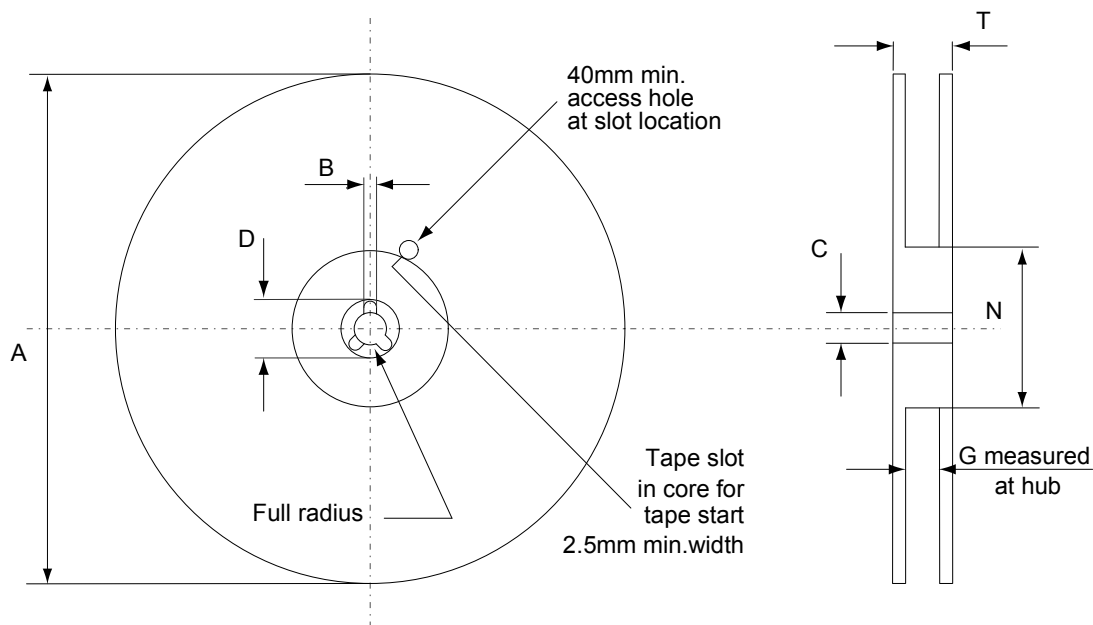
### 4.3 DPAK (TO-252) packing information

Figure 21. DPAK (TO-252) tape outline



AM08852v1

**Figure 22. DPAK (TO-252) reel outline**



AM06038v1

**Table 10. DPAK (TO-252) tape and reel mechanical data**

Dim.	Tape		Dim.	Reel	
	mm			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 qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

## Revision history

**Table 11. Document revision history**

Date	Revision	Changes
15-May-2013	1	First release.
08-May-2023	2	The part numbers STF13NM60ND and STP13NM60ND have been moved to a separate datasheet and the document has been updated accordingly. Updated <i>Section 4.1 DPAK (TO-252) type A2 package information</i> and added <i>Section 4.2 DPAK (TO-252) type C3 package information</i> . Minor text changes.
24-May-2023	3	Updated <a href="#">Table 4. On/off states</a> .

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