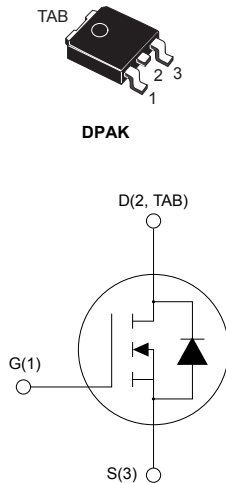


N-channel 600 V, 0.9 Ω typ., 5 A MDmesh Power MOSFET in a DPAK package



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Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D
STD5NM60T4	600 V	1.0 Ω	5 A

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

Applications

- Switching applications

Description

This N-channel Power MOSFET is developed using STMicroelectronics' revolutionary MDmesh technology, which associates the multiple drain process with the company's PowerMESH horizontal layout. This device offers extremely low on-resistance, high dv/dt , and excellent avalanche characteristics. Using STMicroelectronics's proprietary strip technique, this Power MOSFET boasts an overall dynamic performance that is superior to similar products on the market.

Product status link

[STD5NM60T4](#)

Product summary

Order code	STD5NM60T4
Marking	D5NM60
Package	DPAK
Packing	Tape and reel

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	± 30	V
I_D	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	5	A
	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	3.1	
$I_{DM}^{(1)}$	Drain current (pulsed)	20	A
P_{TOT}	Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$	96	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
T_{stg}	Storage temperature range	-55 to 150	$^\circ\text{C}$
T_J	Operating junction temperature range		$^\circ\text{C}$

1. Pulse width is limited by safe operating area.
2. $I_{SD} \leq 5\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$, $V_{DD} = 80\% V_{(BR)DSS}$.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case	1.3	$^\circ\text{C}/\text{W}$
$R_{thJA}^{(1)}$	Thermal resistance, junction-to-ambient	50	$^\circ\text{C}/\text{W}$

1. When mounted on 1 inch² 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.)	2.5	A
E_{AS}	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$, $I_D = I_{AS}$, $V_{DD} = 50\text{ V}$)	200	mJ

2 Electrical characteristics

$T_C = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Table 4. On/off states

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 250\ \mu\text{A}$, $V_{GS} = 0\ \text{V}$	600			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\ \text{V}$, $V_{DS} = 600\ \text{V}$			1	μA
		$V_{GS} = 0\ \text{V}$, $V_{DS} = 600\ \text{V}$, $T_C = 125\text{ }^\circ\text{C}^{(1)}$			10	
I_{GSS}	Gate body leakage current	$V_{DS} = 0\ \text{V}$, $V_{GS} = \pm 20\ \text{V}$			± 100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 250\ \mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\ \text{V}$, $I_D = 2.5\ \text{A}$		0.9	1.0	Ω

1. Specified by design, not tested in production.

Table 5. Dynamic

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 25\ \text{V}$, $f = 1\ \text{MHz}$, $V_{GS} = 0\ \text{V}$	-	400	-	pF
C_{oss}	Output capacitance		-	100	-	pF
C_{rss}	Reverse transfer capacitance		-	10	-	pF
$C_{oss\ eq.}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0\ \text{V}$, $V_{DS} = 0\ \text{to}\ 480\ \text{V}$	-	50	-	pF
Q_g	Total gate charge	$V_{DD} = 400\ \text{V}$, $I_D = 5\ \text{A}$, $V_{GS} = 0\ \text{to}\ 10\ \text{V}$ (see Figure 12. Test circuit for gate charge behavior)	-	13	-	nC
Q_{gs}	Gate-source charge		-	5	-	nC
Q_{gd}	Gate-drain charge		-	6	-	nC

1. $C_{oss\ eq.}$ 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	$V_{DD} = 300\ \text{V}$, $I_D = 2.5\ \text{A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\ \text{V}$	-	14	-	ns
t_r	Rise time		-	10	-	ns
$t_{d(off)}$	Turn-off delay time	(see Figure 11. Test circuit for resistive load switching times and Figure 16. Switching time waveform)	-	23	-	ns
t_f	Fall time		-	10	-	ns
$t_{r(voff)}$	Off-voltage rise time	$V_{DD} = 480\ \text{V}$, $I_D = 5\ \text{A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\ \text{V}$	-	7	-	ns
t_f	Fall time		-	10	-	ns
t_c	Cross-over time	(see Figure 13. Test circuit for inductive load switching and diode recovery times)	-	17	-	ns

Table 7. Source-drain diode

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		20	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 5 \text{ A}$, $V_{GS} = 0 \text{ V}$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 5 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$,	-	300		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100 \text{ V}$	-	1.95		μC
I_{RRM}	Reverse recovery current	(see Figure 13. Test circuit for inductive load switching and diode recovery times)	-	13		A
t_{rr}	Reverse recovery time	$I_{SD} = 5 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$,	-	445		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100 \text{ V}$, $T_J = 150 \text{ }^\circ\text{C}$	-	3		μC
I_{RRM}	Reverse recovery current	(see Figure 13. Test circuit for inductive load switching and diode recovery times)	-	13.5		A

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%.

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

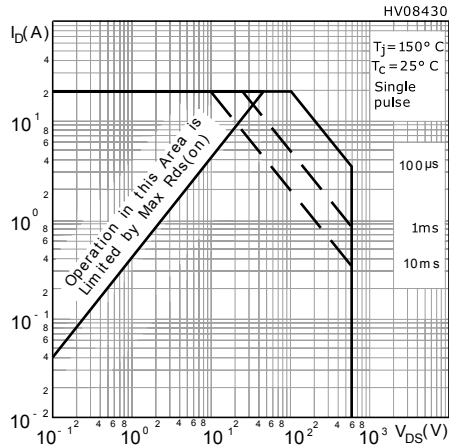


Figure 2. Thermal impedance

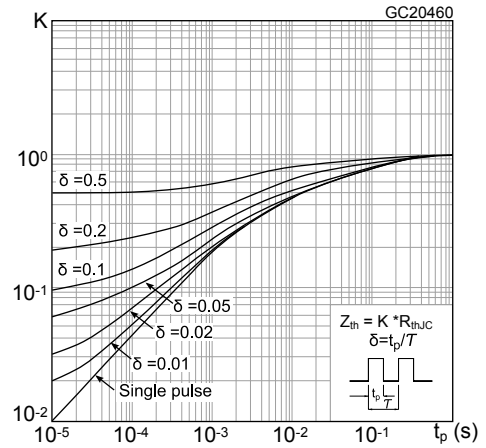


Figure 3. Output characteristics

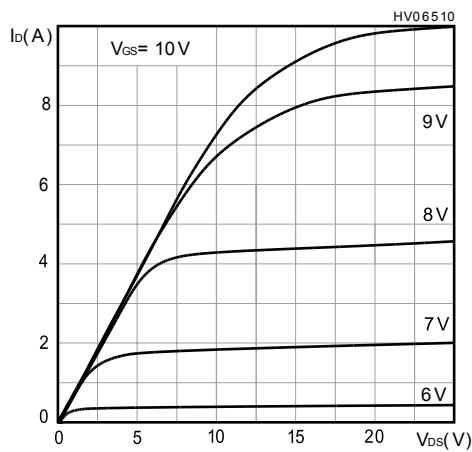


Figure 4. Transfer characteristics

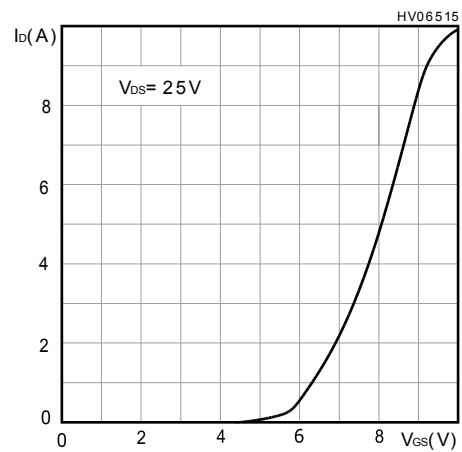


Figure 5. Static drain-source on-resistance

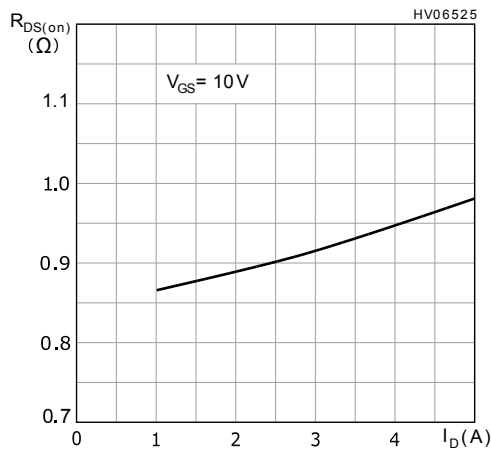


Figure 6. Gate charge vs gate-source voltage

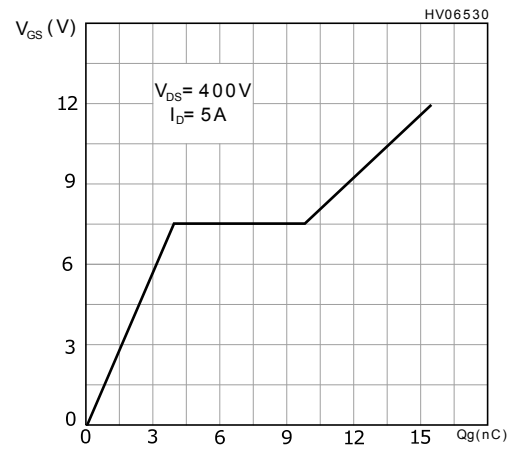


Figure 7. Capacitance variations

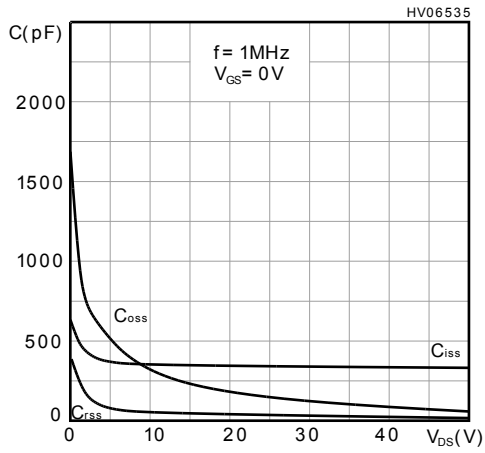


Figure 8. Normalized gate threshold voltage vs temperature

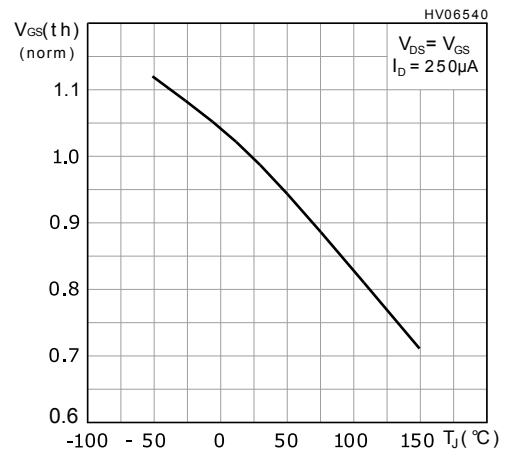


Figure 9. Normalized on-resistance vs temperature

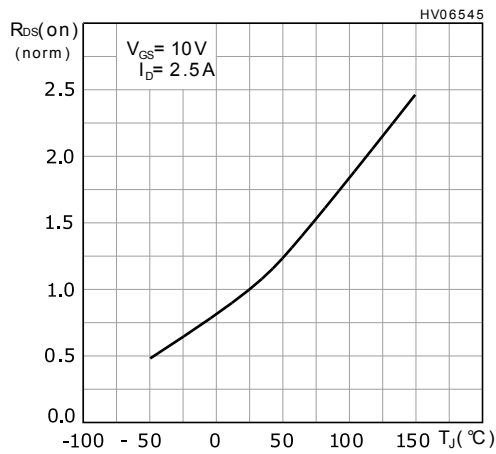
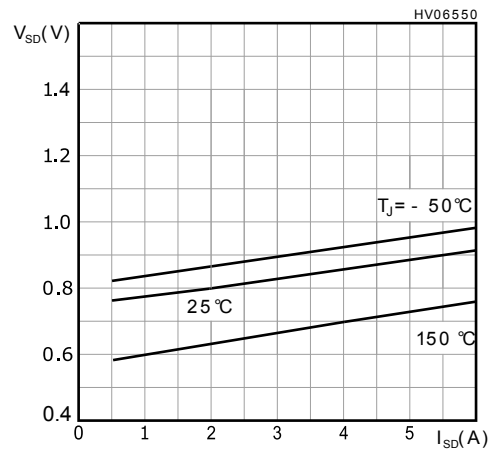


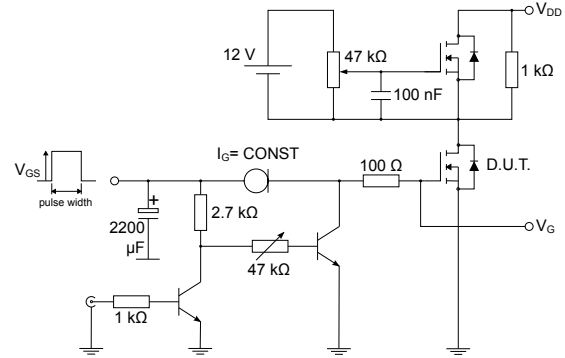
Figure 10. Source-drain diode forward characteristics



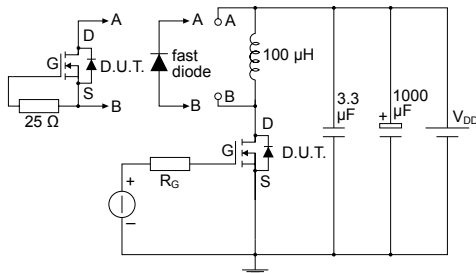
3 Test circuits

Figure 11. Test circuit for resistive load switching times

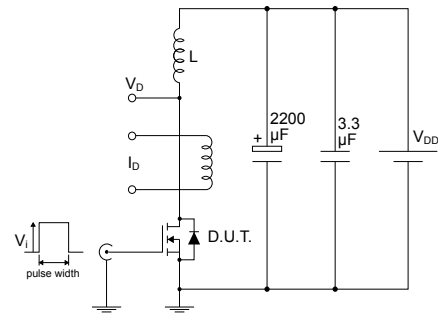

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Figure 12. Test circuit for gate charge behavior


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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


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Figure 16. Switching time waveform

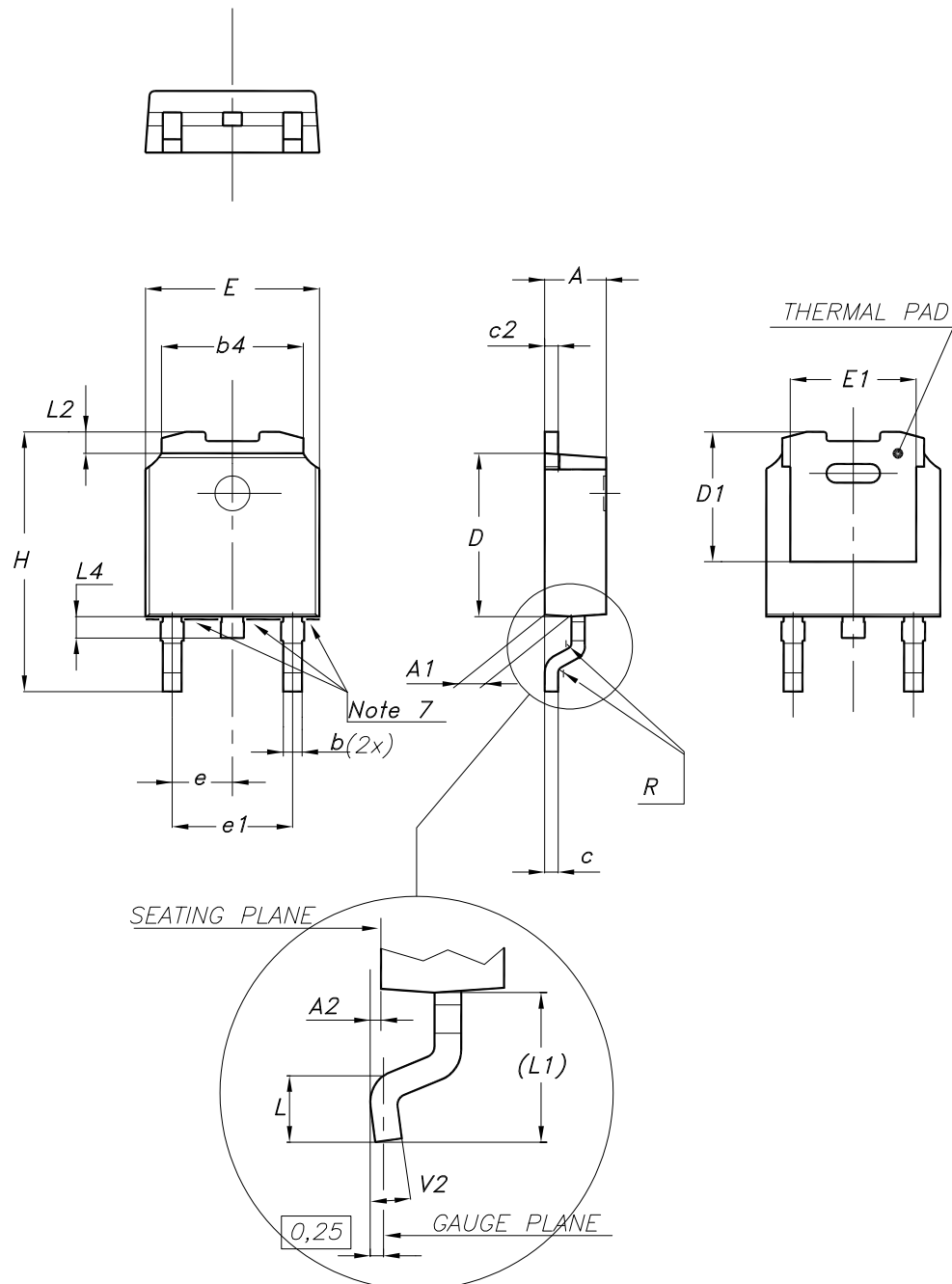

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4 Package information

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. ECOPACK is an ST trademark.

4.1 DPAK (TO-252) type A package information

Figure 17. DPAK (TO-252) type A package outline



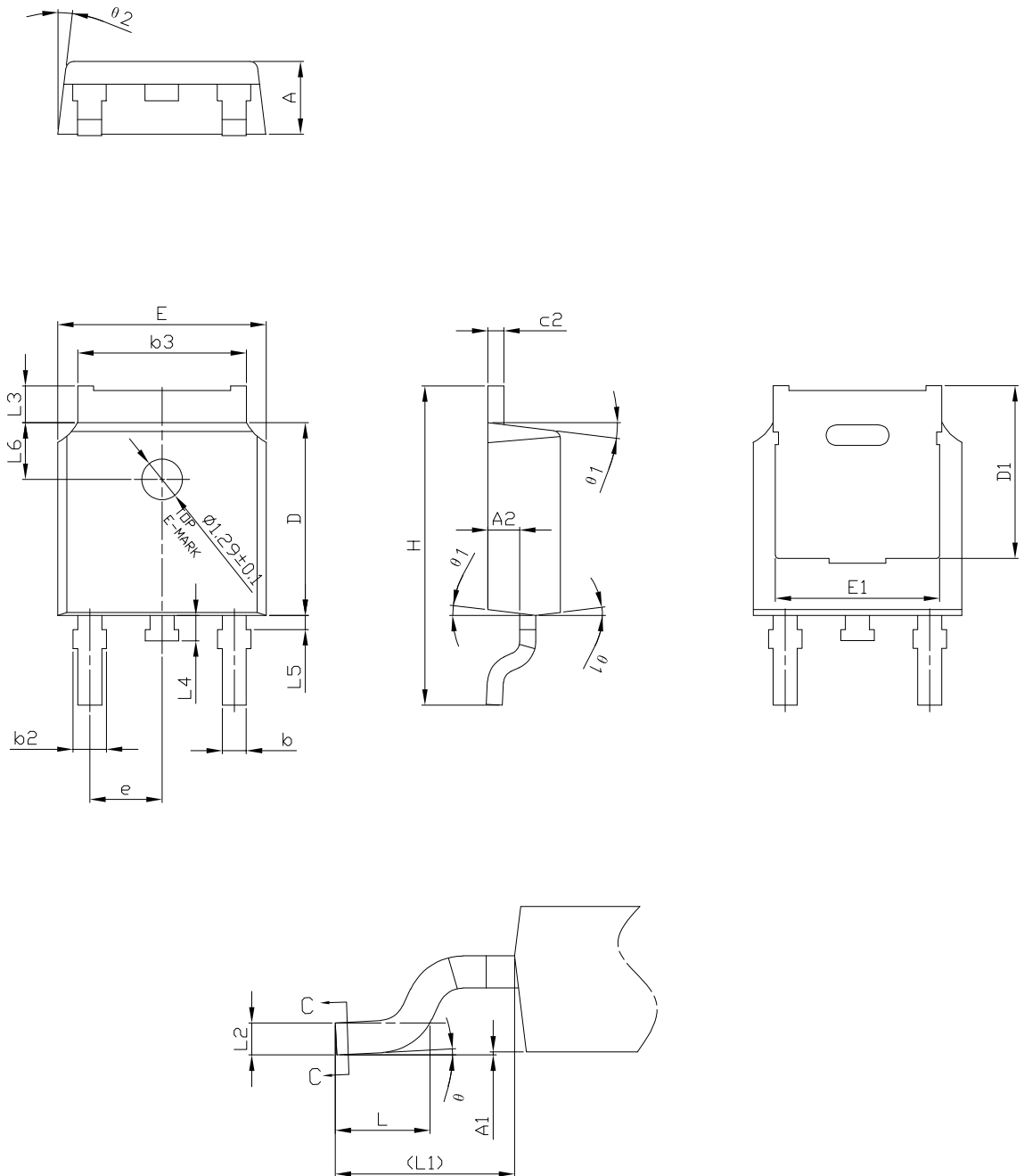
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Table 8. DPAK (TO-252) type A mechanical data

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	2.159	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 18. DPAK (TO-252) type C3 package outline

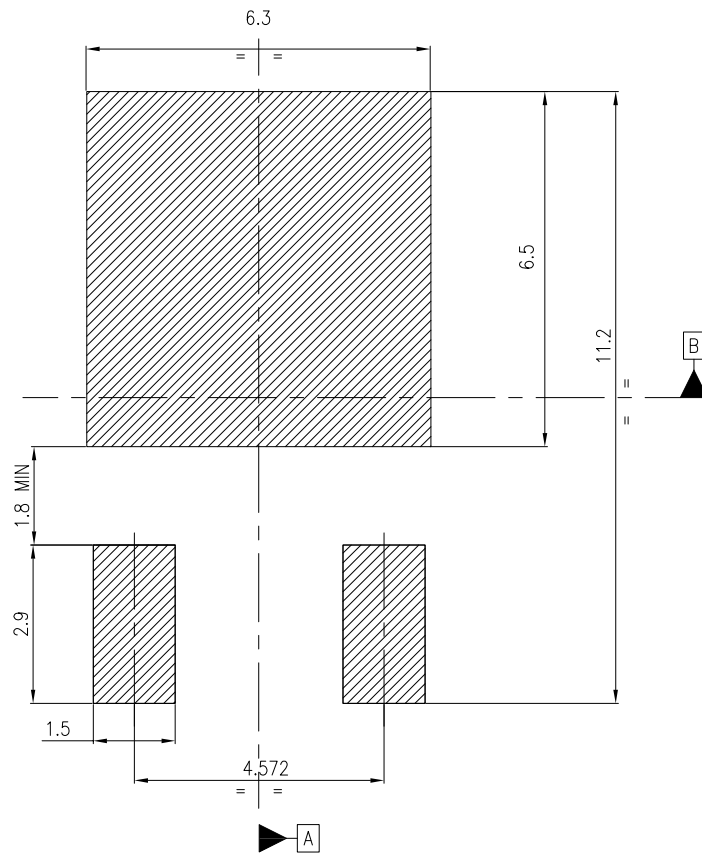


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Table 9. DPAK (TO-252) type C3 mechanical data

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



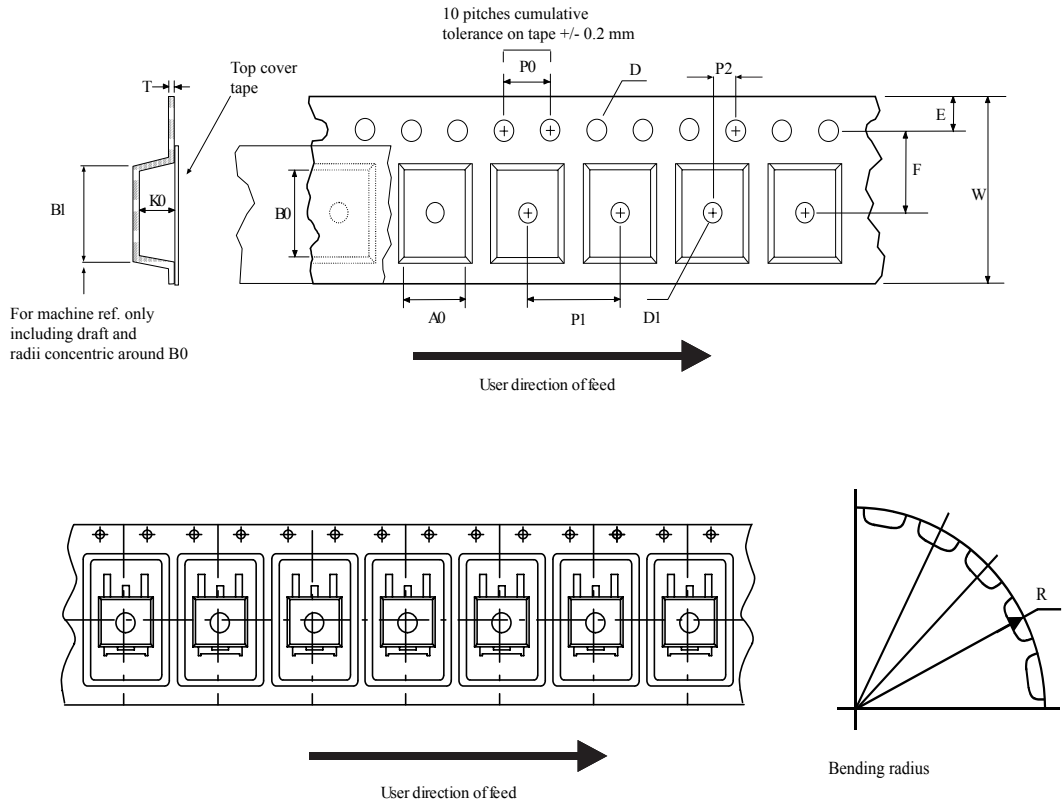
Notes:

- 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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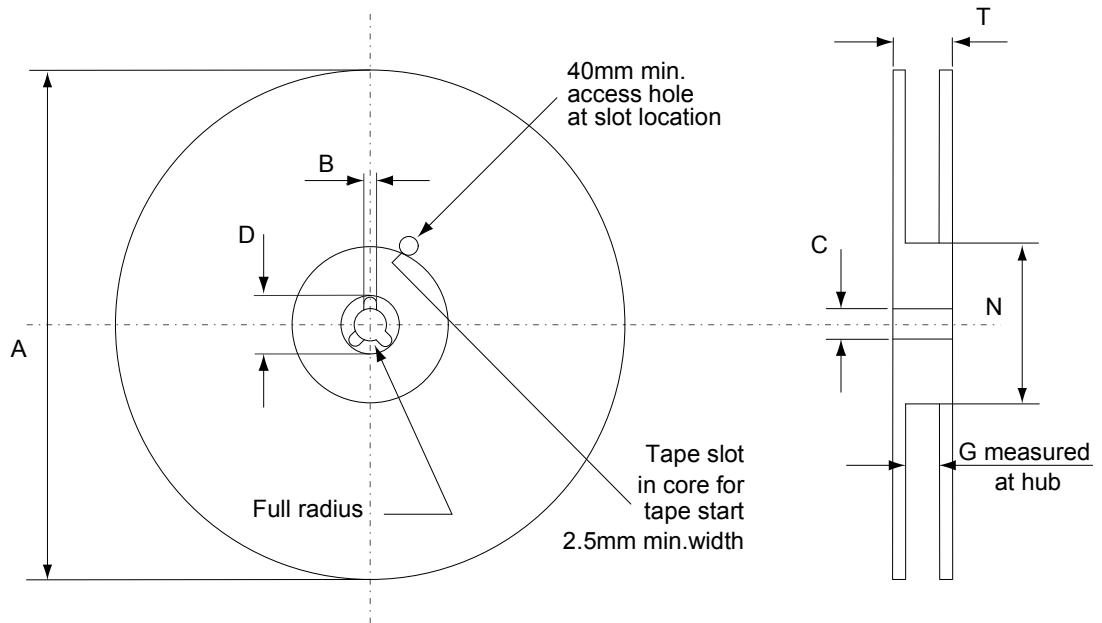
4.3 DPAK (TO-252) packing information

Figure 20. DPAK (TO-252) tape outline



AM08852v1

Figure 21. 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
14-Apr-2004	11	Title changed.
11-Apr-2005	12	Inserted D ² PAK.
21-Feb-2006	13	New template.
08-Sep-2006	14	Modified order codes.
14-Sep-2006	15	Corrected <i>Figure 6.: Safe operating area for DPAK/IPAK.</i>
09-Jul-2007	16	Qrr value in <i>Table 7.: Source drain diode has been updated.</i>
01-Oct-2008	17	<i>4: Package mechanical data updated.</i>
15-Jun-2023	18	<p>The part numbers STB8NM60T4, STD5NM60-1, STP8NM60 and STP8NM60FP have been moved to a separate datasheet and the document has been updated accordingly.</p> <p>Updated title, Internal schematic and Features on cover page.</p> <p>Updated Table 1. Absolute maximum ratings and Table 2. Thermal data.</p> <p>Updated Table 5. Dynamic, Table 7. Source-drain diode and removed "Figure 10. Transconductance".</p> <p>Updated Section 4.1 DPAK (TO-252) type A package information and added Section 4.2 DPAK (TO-252) type C3 package information.</p> <p>Minor text changes.</p>

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