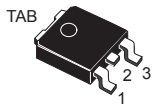
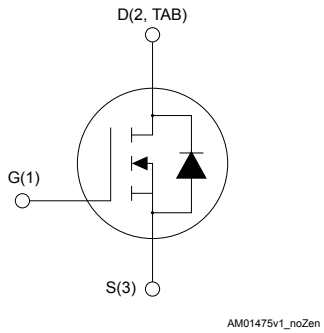
N-channel 600 V, 370 mΩ typ., 10 A FDmesh II Power MOSFET in a DPAK package



DPAK



Features

Order code	V_{DS} at T_J max.	$R_{DS(on)}$ max.	I_D
STD11NM60ND	650 V	450 mΩ	10 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
STD11NM60ND

Product summary	
Order code	STD11NM60ND
Marking	11NM60ND
Package	DPAK
Packing	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 °C	10	A
	Drain current (continuous) at T_C = 100 °C	6.3	
I_{DM}(1)	Drain current (pulsed)	40	A
P_{TOT}	Total power dissipation at T_C = 25 °C	90	W
dv/dt(2)	Peak diode recovery voltage slope	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} ≤ 10 A, di/dt ≤ 400 A/µs, V_{DS} (peak) < $V_{(BR)DSS}$, V_{DD} = 80% $V_{(BR)DSS}$.*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case	1.38	°C/W
R_{thJA}(1)	Thermal resistance, junction-to-ambient	50	°C/W

1. *When mounted on 1 inch^2 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.)	3.5	A
E_{AS}	Single pulse avalanche energy (starting T_J = 25 °C, I_D = I_{AS}, V_{DD} = 50 V)	200	mJ

2 Electrical characteristics

T_C = 25 °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 V, I_D = 1 mA	600			V
dv/dt(1)	Drain-source voltage slope	V_{DD} = 480 V, I_D = 10 A, V_{GS} = 10 V		45		V/ns
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 600 V			1	µA
		V_{GS} = 0 V, V_{DS} = 600 V, T_C = 125 °C(2)			100	
I_{GSS}	Gate-body leakage current	V_{DS} = 0 V, V_{GS} = ±20 V			±100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 5 A		370	450	mΩ

1. *Value measured at turn off under inductive load.*
2. *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 V, f = 1 MHz, V_{GS} = 0 V	-	850	-	pF
C_{oss}	Output capacitance		-	44	-	pF
C_{rss}	Reverse transfer capacitance		-	5	-	pF
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{GS} = 0 V, V_{DS} = 0 to 480 V	-	130	-	pF
R_G	Gate input resistance	f = 1 MHz, I_D = 0 A	-	3.7	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 10 A, V_{GS} = 0 to 10 V (see Figure 13. Test circuit for gate charge behavior)	-	30	-	nC
Q_{gs}	Gate-source charge		-	4	-	nC
Q_{gd}	Gate-drain charge		-	16	-	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 conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 10 A, R_G = 4.7 Ω, V_{GS} = 10 V (see Figure 12. Test circuit for resistive load switching times and Figure 17. Switching time waveform)	-	16	-	ns
t_r	Rise time		-	7	-	ns
$t_{d(off)}$	Turn-off delay time		-	50	-	ns
t_f	Fall time		-	9	-	ns

Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		10	A
I_{SDM}(1)	Source-drain current (pulsed)		-		40	A
V_{SD}(2)	Forward on voltage	I_{SD} = 10 A, V_{GS} = 0 V	-		1.3	V
t_{rr}	Reverse recovery time	I_{SD} = 10 A, di/dt = 100 A/µs, V_{DD} = 100 V (see Figure 14. Test circuit for inductive load switching and diode recovery times)	-	130		ns
Q_{rr}	Reverse recovery charge		-	0.69		µC
I_{RRM}	Reverse recovery current		-	11		A
t_{rr}	Reverse recovery time	I_{SD} = 10 A, di/dt = 100 A/µs, V_{DD} = 100 V, T_J = 150 °C (see Figure 14. Test circuit for inductive load switching and diode recovery times)	-	200		ns
Q_{rr}	Reverse recovery charge		-	1.2		µC
I_{RRM}	Reverse recovery current		-	12		A

1. *Pulse width is 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

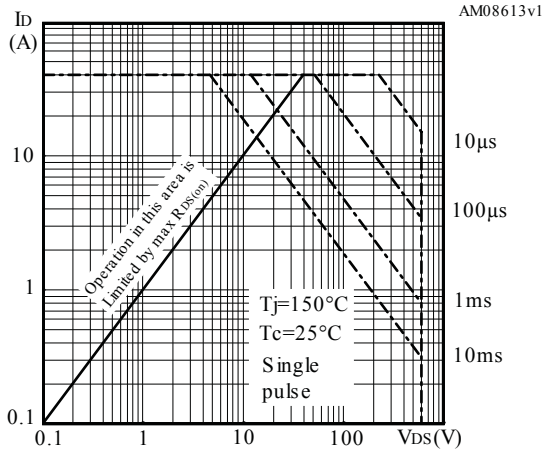


Figure 2. Normalized transient thermal impedance

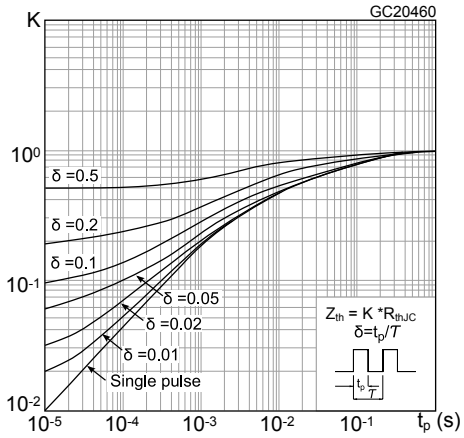


Figure 3. Typical drain-source on-resistance

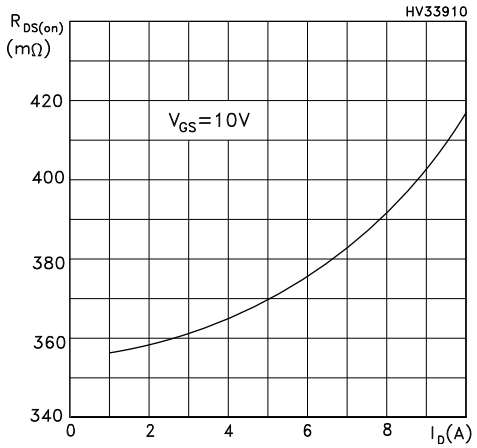


Figure 4. Typical output characteristics

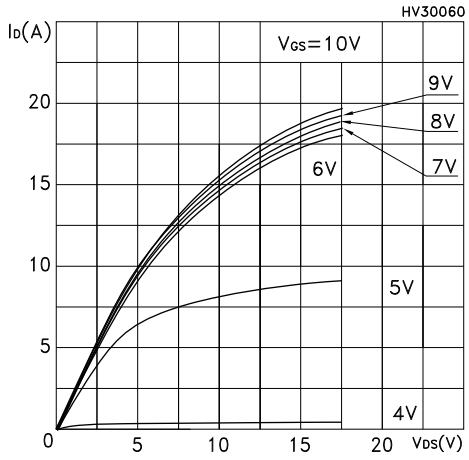


Figure 5. Typical transfer characteristics

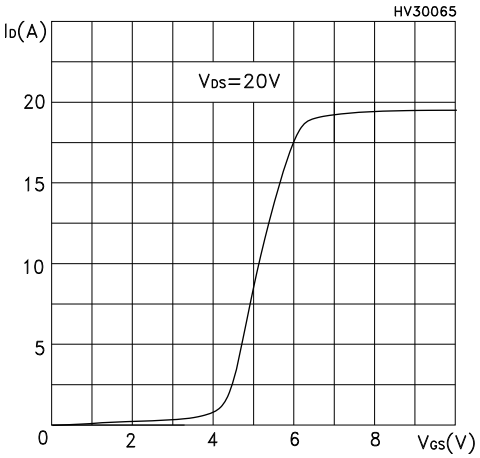


Figure 6. Normalized gate threshold vs temperature

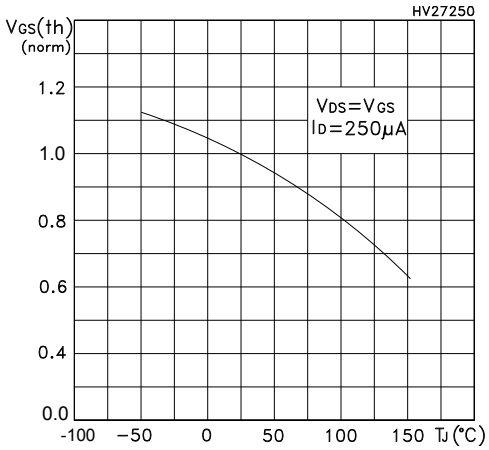


Figure 7. Normalized breakdown voltage vs temperature

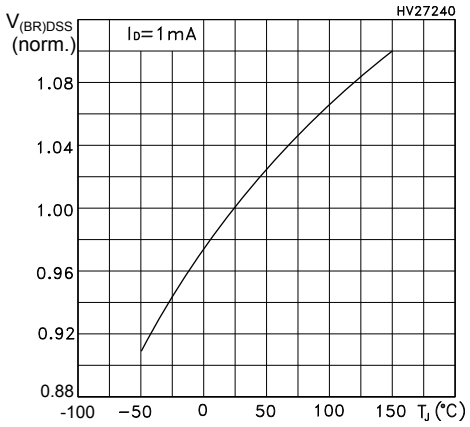


Figure 8. Normalized on-resistance vs temperature

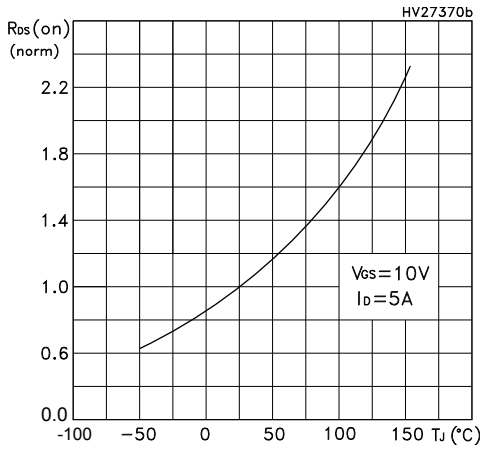


Figure 9. Typical gate charge characteristics

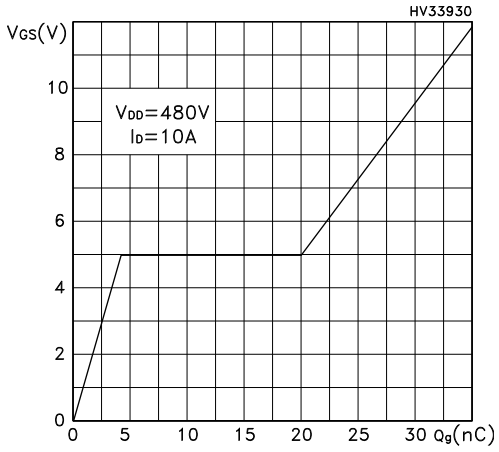


Figure 10. Typical capacitance characteristics

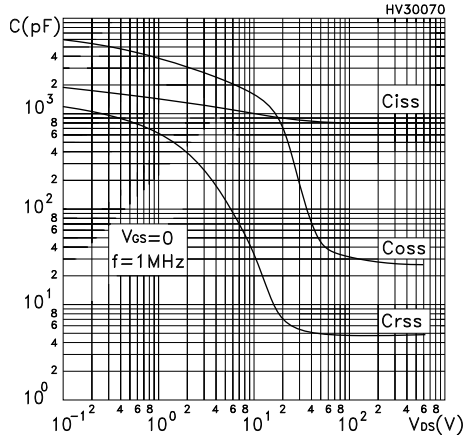
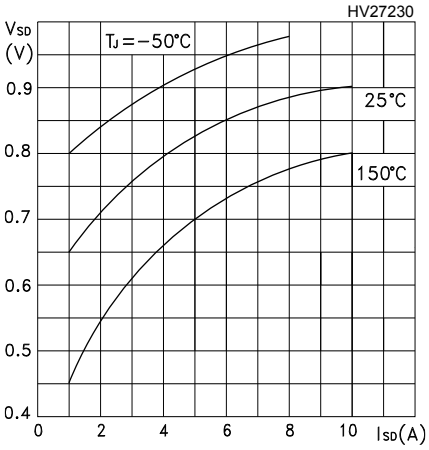


Figure 11. Typical reverse diode forward characteristics



3 Test circuits

Figure 12. Test circuit for resistive load switching times

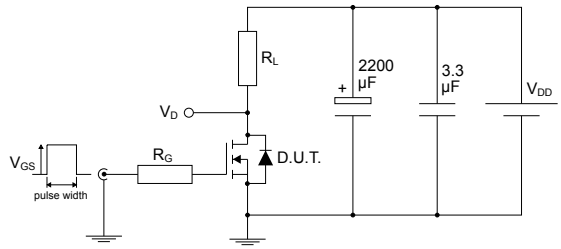


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Figure 13. Test circuit for gate charge behavior

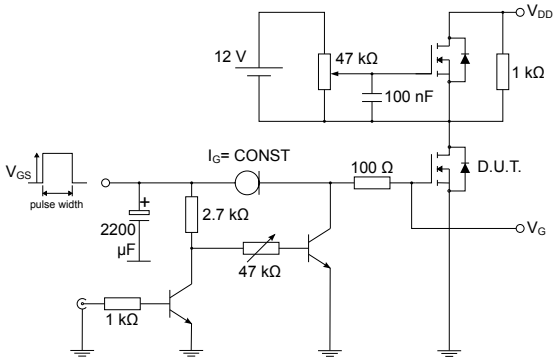

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Figure 14. Test circuit for inductive load switching and diode recovery times

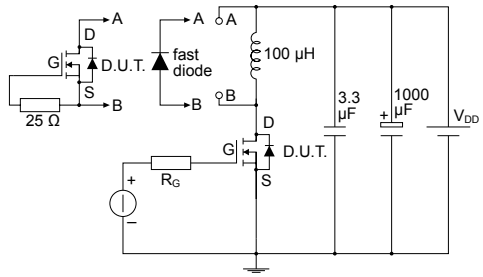

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Figure 15. Unclamped inductive load test circuit

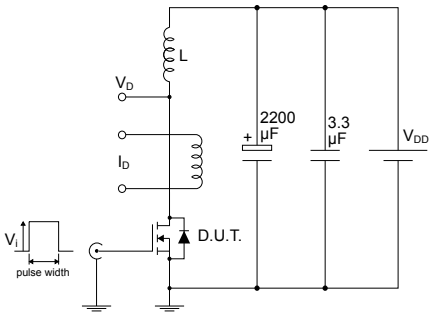

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Figure 16. Unclamped inductive waveform

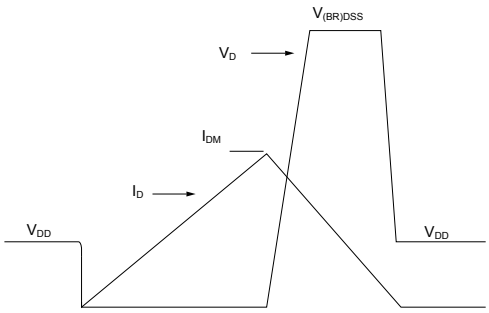

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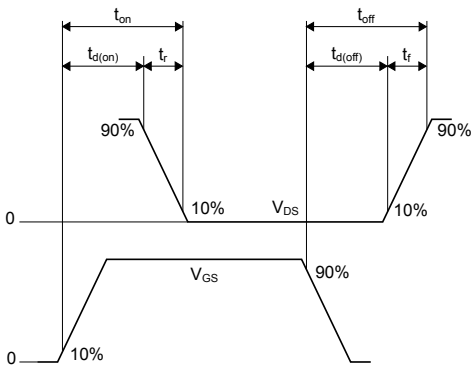
Figure 17. Switching time waveform



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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. ECOPACK is an ST trademark.

4.1 DPAK (TO-252) type A2 package information

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

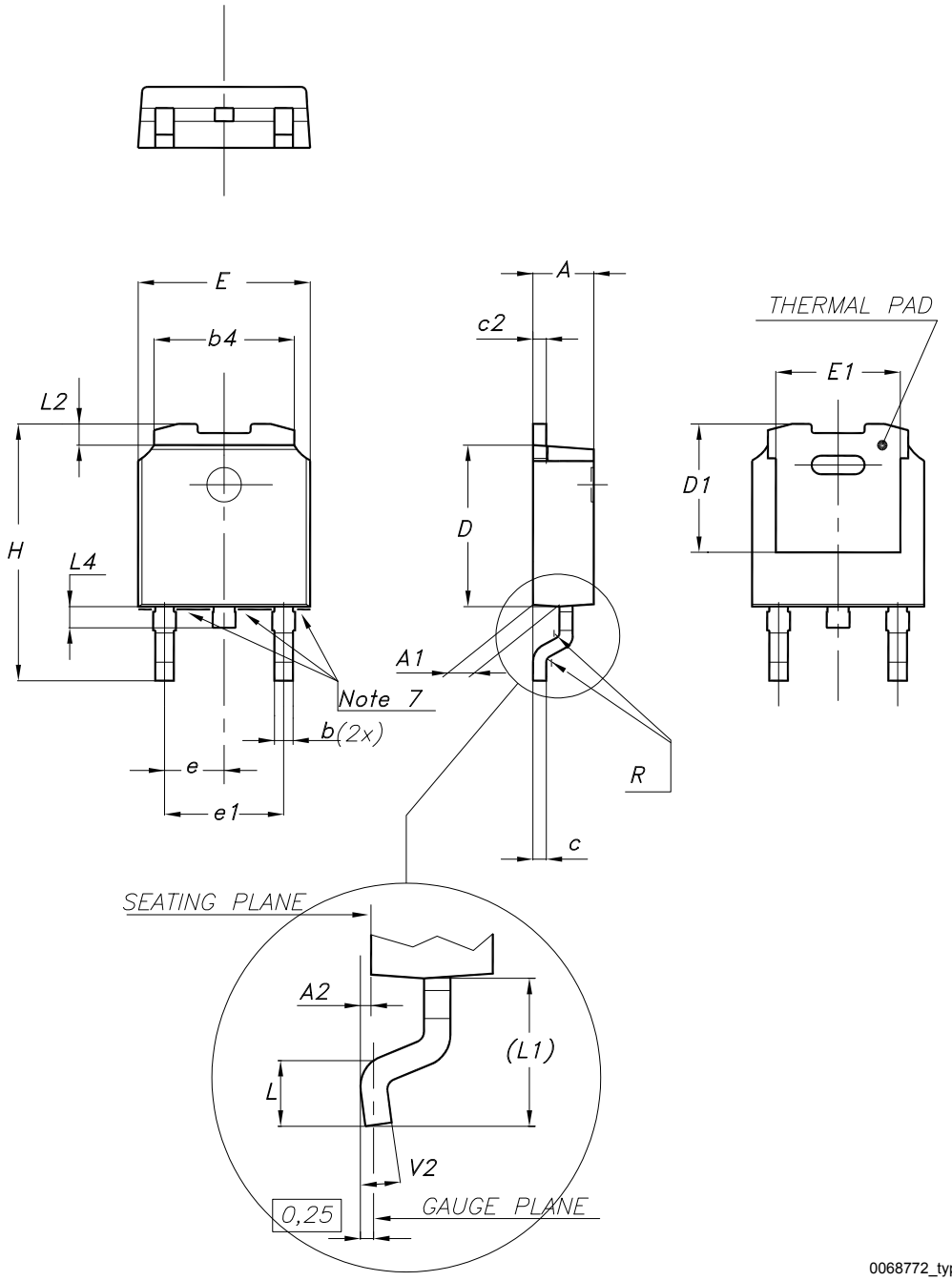

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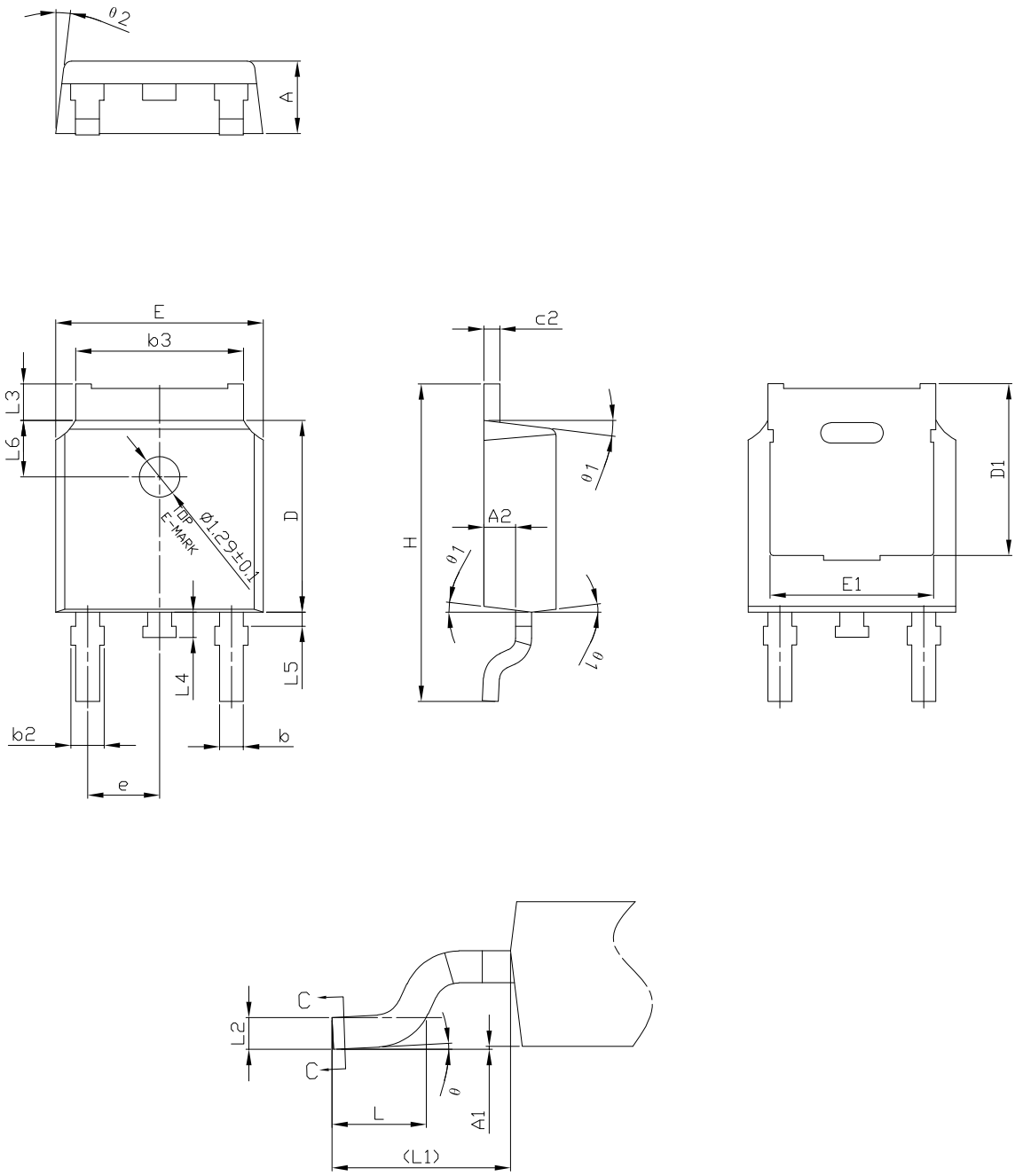
Table 8. **DPAK (TO-252) type A2 mechanical data**

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**

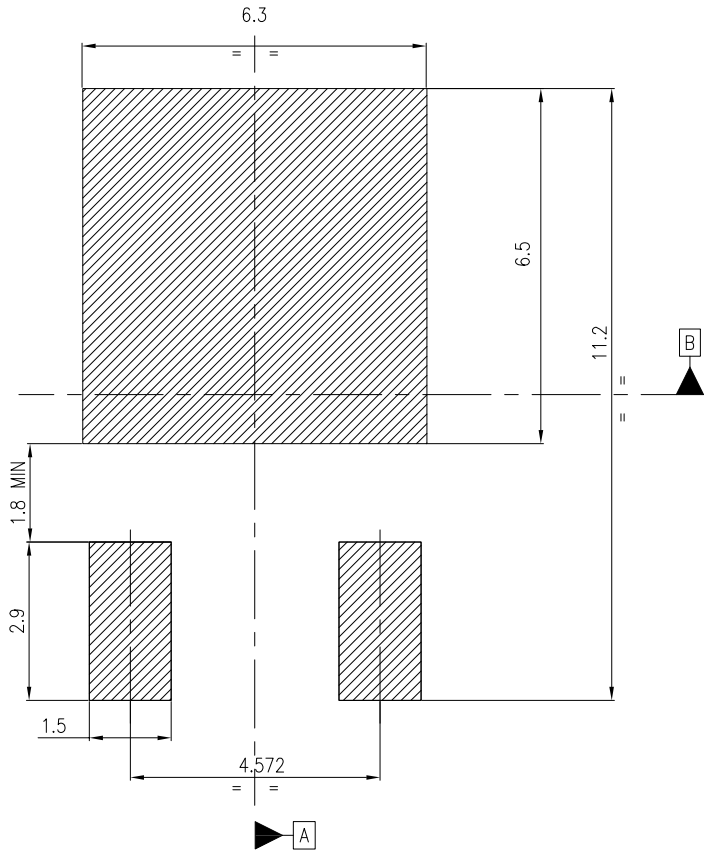


0068772_type-C3_rev34

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 ⌖ 0.05 A B

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4.3 DPAK (TO-252) packing information

Figure 21. **DPAK (TO-252) tape outline**

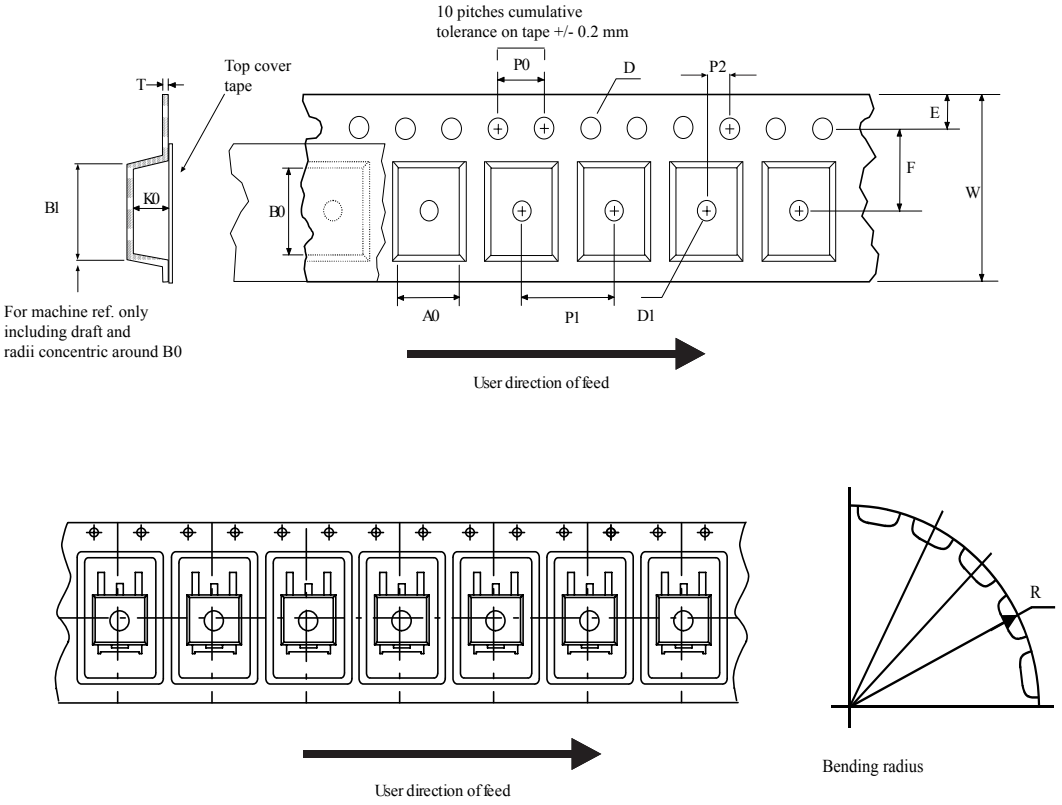

Figure 22. **DPAK (TO-252) reel outline**

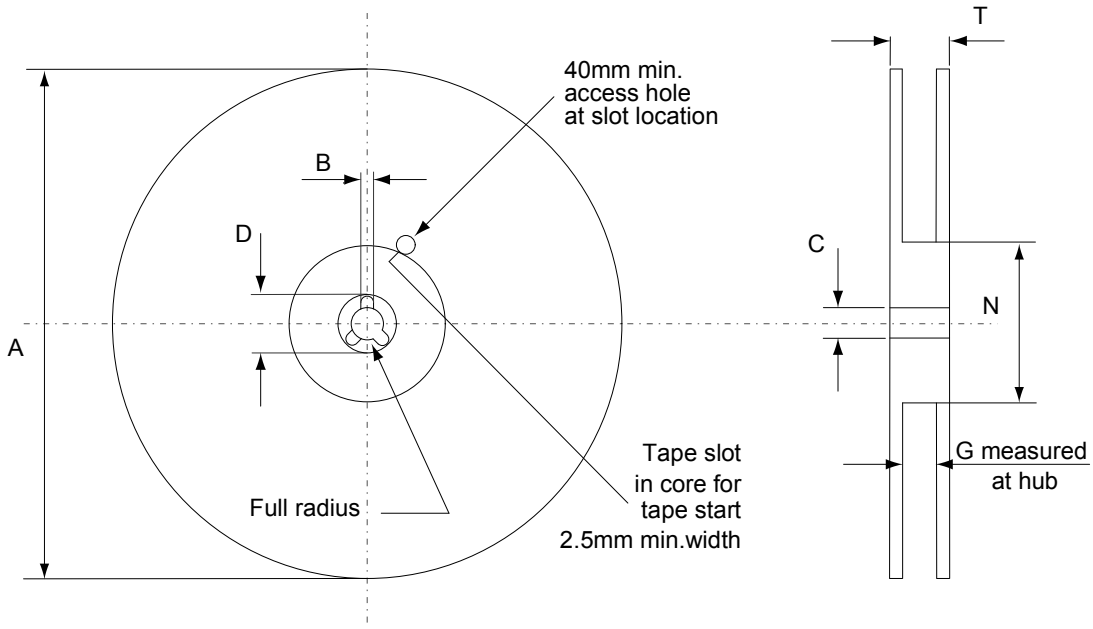

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Table 10. **DPAK (TO-252) tape and reel mechanical data**

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 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
23-Apr-2008	1	First release.
25-Oct-2010	2	– Corrected *Figure 2: Safe operating area for TO-220, I²PAK* – Corrected *Figure 4: Safe operating area for TO-220FP* – Corrected *Figure 6: Safe operating area for DPAK, IPAK*
20-Jun-2023	3	The part numbers STF11NM60ND, STI11NM60ND, STP11NM60ND, STU11NM60ND have been moved to separate datasheets and the documents have been updated accordingly. Modified the entire Section 4 Package information. Minor text changes.

Contents