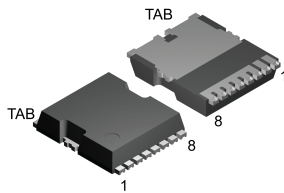
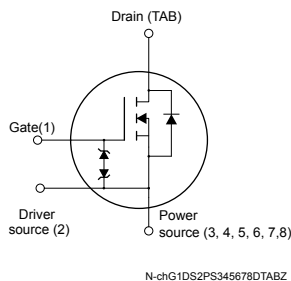


N-channel 600 V, 105 mΩ typ., 25 A, MDmesh M6 Power MOSFET in a TO-LL package



TO-LL type A



Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D
STO33N60M6	600 V	125 mΩ	25 A

- Reduced switching losses
- Lower $R_{DS(on)}$ per area vs previous generation
- Low gate input resistance
- 100% avalanche tested
- Zener-protected
- Excellent switching performance thanks to the extra driving source pin

Applications

- Switching applications
- LLC converters
- Boost PFC converters

Description

The new MDmesh M6 technology incorporates the most recent advancements to the well-known and consolidated MDmesh family of SJ MOSFETs. STMicroelectronics builds on the previous generation of MDmesh devices through its new M6 technology, which combines excellent $R_{DS(on)}$ per area improvement with one of the most effective switching behaviors available, as well as a user-friendly experience for maximum end-application efficiency.

Product status link

[STO33N60M6](#)

Product summary

Order code	STO33N60M6
Marking	33N60M6
Package	TO-LL type A
Packing	Tape and reel

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	± 25	V
I_D	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	25	A
	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	15.8	
$I_{DM}^{(1)}$	Drain current (pulsed)	78	A
P_{TOT}	Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$	230	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
$dv/dt^{(3)}$	MOSFET dv/dt ruggedness	100	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 limited by safe operating area.
2. $I_{SD} \leq 25\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$, $V_{DS}(\text{peak}) < V_{(BR)DSS}$, $V_{DD} = 400\text{ V}$.
3. $V_{DS} \leq 480\text{ V}$.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case	0.54	$^\circ\text{C}/\text{W}$
R_{thJB}	Thermal resistance, junction-to-board ⁽¹⁾	43	$^\circ\text{C}/\text{W}$
	Thermal resistance, junction-to-board ⁽²⁾	22	

1. When mounted on 1 inch² FR-4 pcb, standard footprint 2 Oz copper board.
2. When mounted on 40x40mm FR-4 pcb, 6 cm² 2 Oz copper board.

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or non-repetitive (pulse width limited by T_J max.)	4	A
E_{AS}	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$)	500	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	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$, $T_C = 125\text{ °C}^{(1)}$			100	
I_{GSS}	Gate-body leakage current	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 25\text{ V}$			± 5	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$	3.25	4.00	4.75	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$, $I_D = 12.5\text{ A}$		105	125	m Ω

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

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	1515	-	pF
C_{oss}	Output capacitance		-	128	-	
C_{rSS}	Reverse transfer capacitance		-	4.2	-	
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }480\text{ V}$, $V_{GS} = 0\text{ V}$	-	269	-	pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz}$, $I_D = 0\text{ A}$	-	1.5	-	Ω
Q_g	Total gate charge	$V_{DD} = 480\text{ V}$, $I_D = 25\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior)	-	33.4	-	nC
Q_{gs}	Gate-source charge		-	9.7	-	
Q_{gd}	Gate-drain charge		-	14	-	

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	$V_{DD} = 300\text{ V}$, $I_D = 12.5\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 13. Switching times test circuit for resistive load and Figure 18. Switching time waveform)	-	19.5	-	ns
t_r	Rise time		-	33	-	
$t_{d(off)}$	Turn-off delay time		-	38.5	-	
t_f	Fall time		-	7.5	-	

Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		25	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		78	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 25\text{ A}, V_{GS} = 0\text{ V}$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 25\text{ A}, di/dt = 100\text{ A}/\mu\text{s},$	-	265		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 60\text{ V}$	-	3.07		μC
I_{RRM}	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	23.2		A
t_{rr}	Reverse recovery time	$I_{SD} = 25\text{ A}, di/dt = 100\text{ A}/\mu\text{s},$	-	374		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 60\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	5.78		μC
I_{RRM}	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	30.9		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

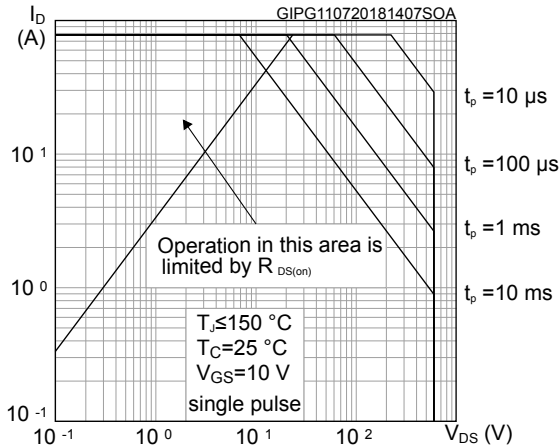


Figure 2. Thermal impedance

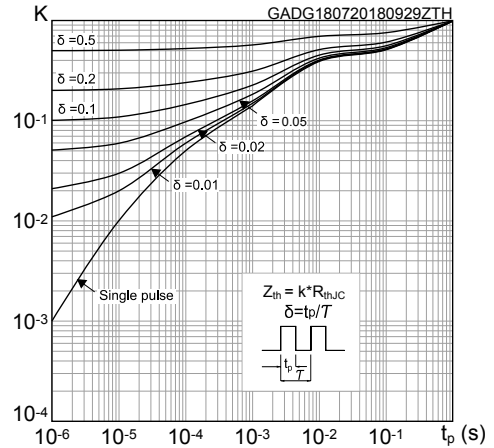


Figure 3. Output characteristics

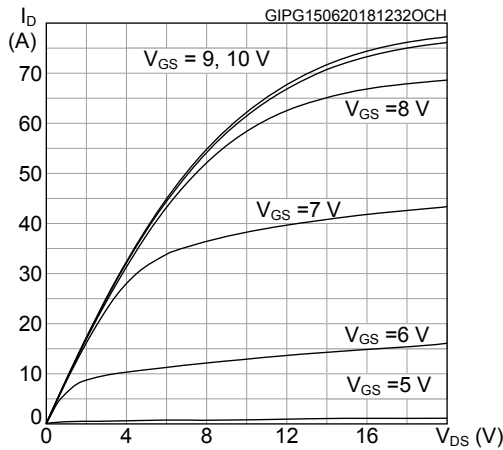


Figure 4. Transfer characteristics

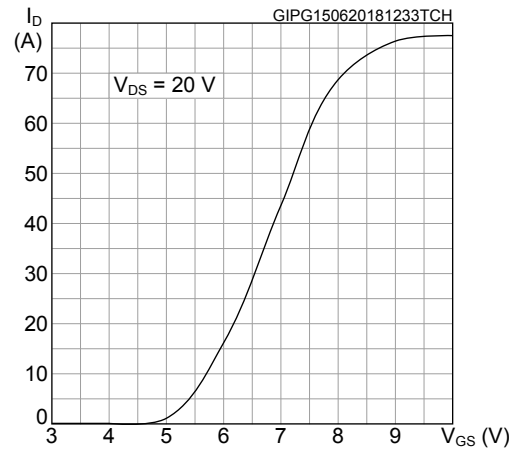


Figure 5. Gate charge vs gate-source voltage

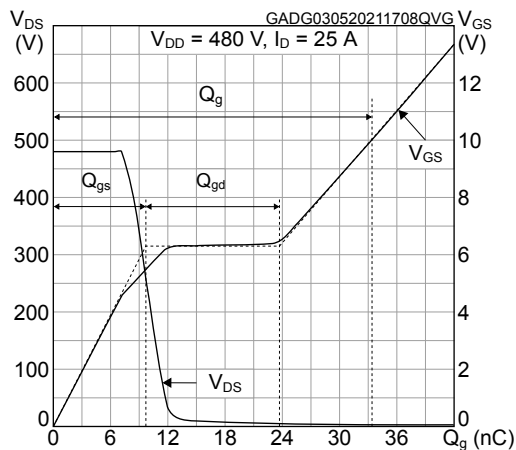


Figure 6. Static drain-source on-resistance

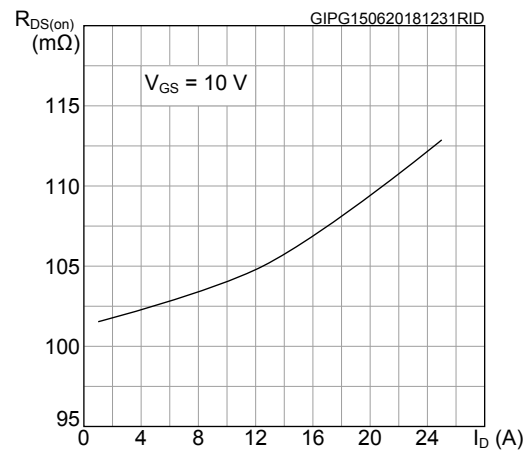


Figure 7. Capacitance variations

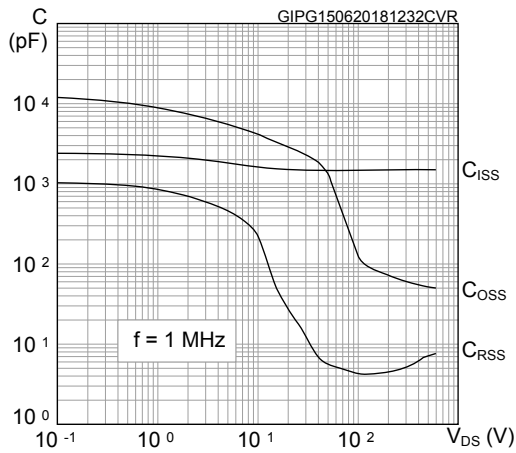


Figure 8. Normalized gate threshold voltage vs temperature

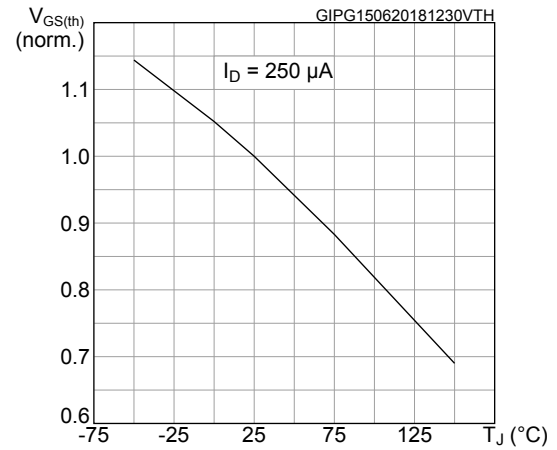


Figure 9. Normalized on-resistance vs temperature

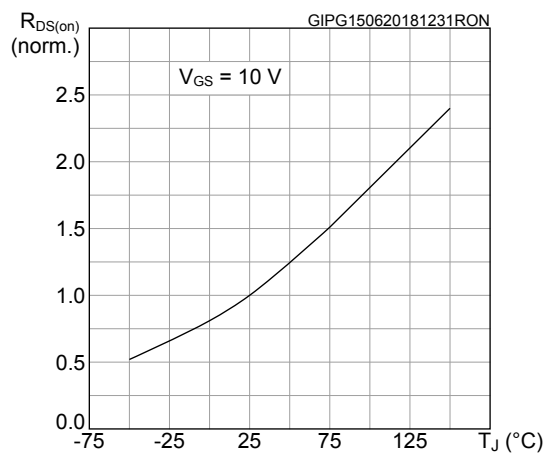


Figure 10. Normalized V_(BR)DSS vs temperature

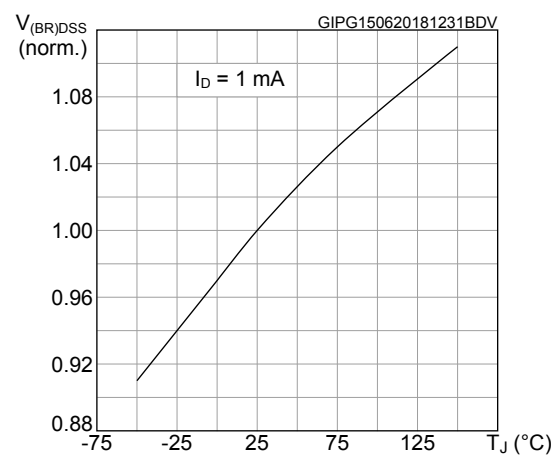


Figure 11. Output capacitance stored energy

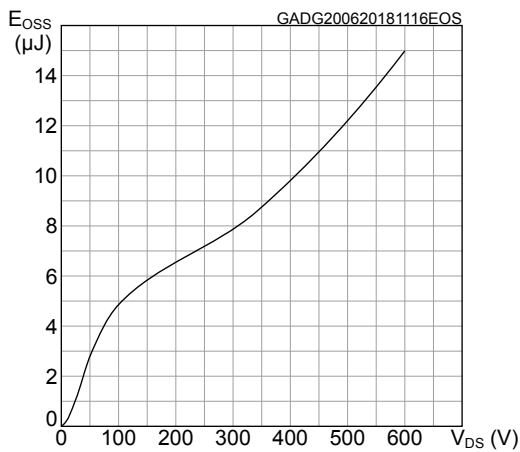
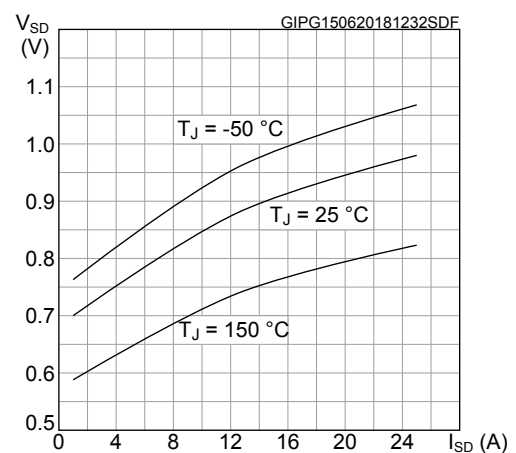
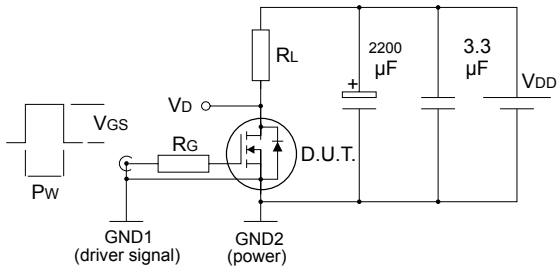


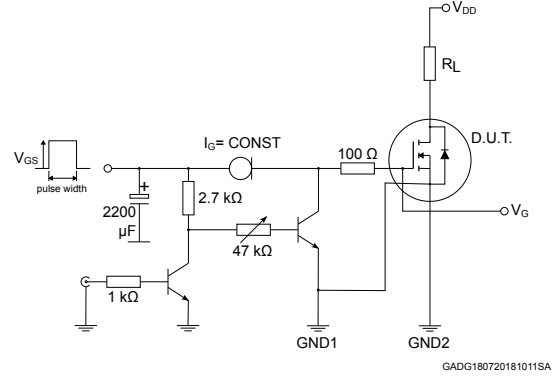
Figure 12. Source-drain diode forward characteristics



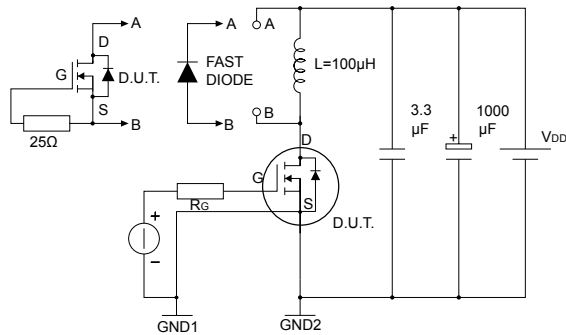
3 Test circuits

Figure 13. Switching times test circuit for resistive load


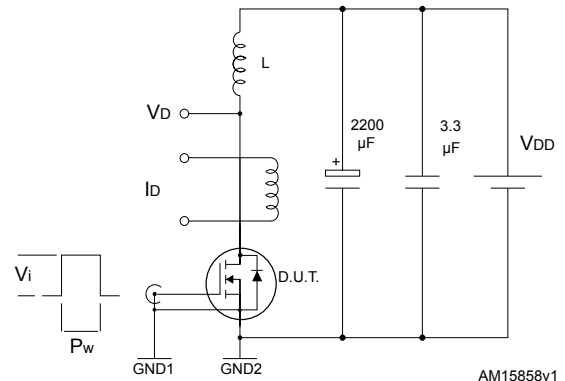
AM15855v1

Figure 14. Test circuit for gate charge behavior


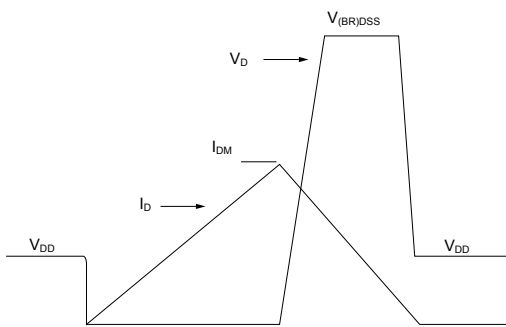
GADG180720181011SA

Figure 15. Test circuit for inductive load switching and diode recovery times


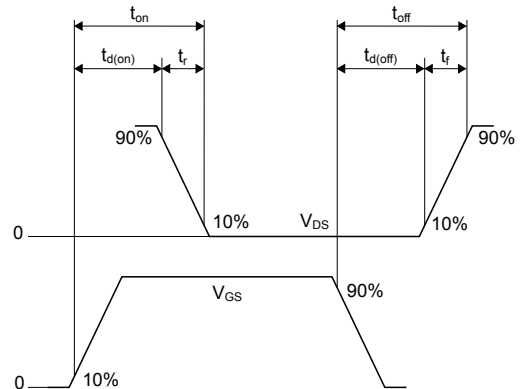
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Figure 16. Unclamped inductive load test circuit


AM15858v1

Figure 17. Unclamped inductive waveform


AM01472v1

Figure 18. Switching time waveform


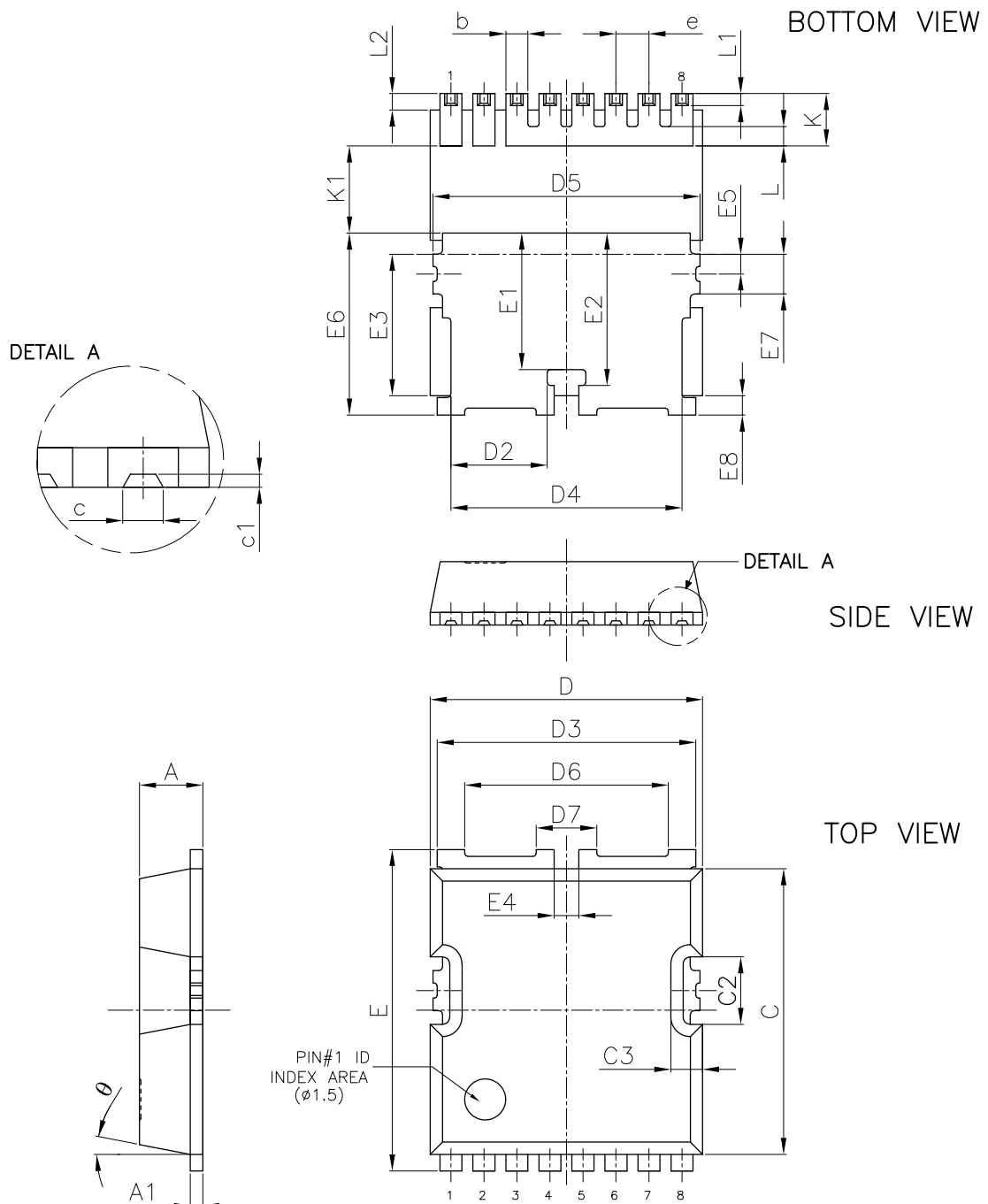
AM01473v1

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 TO-LL type A package information

Figure 19. TO-LL type A package outline

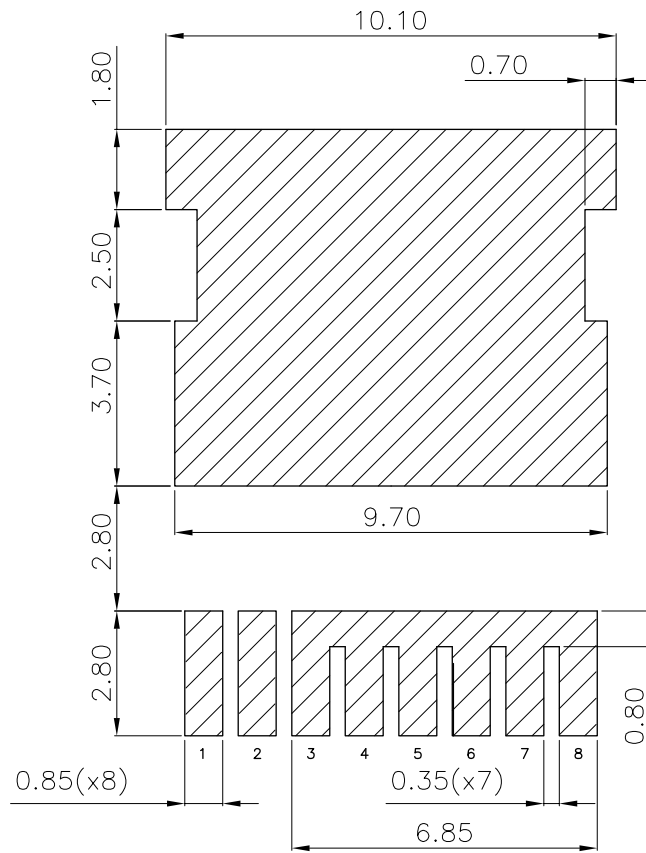


DM00276569_5_type_A

Table 8. TO-LL type A package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.40
A1	0.40	0.48	0.60
b	0.70	0.80	0.90
c		0.46	
c1		0.15	
C	10.28	10.38	10.48
C2	2.35	2.45	2.55
C3		1.16	
D	9.80	9.90	10.00
D2	3.30	3.50	3.70
D3	9.30	9.40	9.50
D4	8.20	8.40	8.60
D5	9.50	9.70	9.90
D6		7.40	
D7		2.20	
e		1.20	
E	11.48	11.68	11.88
E1		4.96	
E2		5.54	
E3		5.14	
E4		0.90	
E5		0.72	
E6	6.41	6.61	6.81
E7		1.44	
E8	0.50	0.70	0.90
K	1.70	1.90	2.10
K1	2.70		
L		0.70	
L1		0.44	
L2	0.40	0.60	0.80
θ		11°	

Figure 20. TO-LL type A recommended footprint (dimensions are in mm)



DM00276569_5_type_A_FP

4.2 TO-LL packing information

Figure 21. Carrier tape outline and dimensions

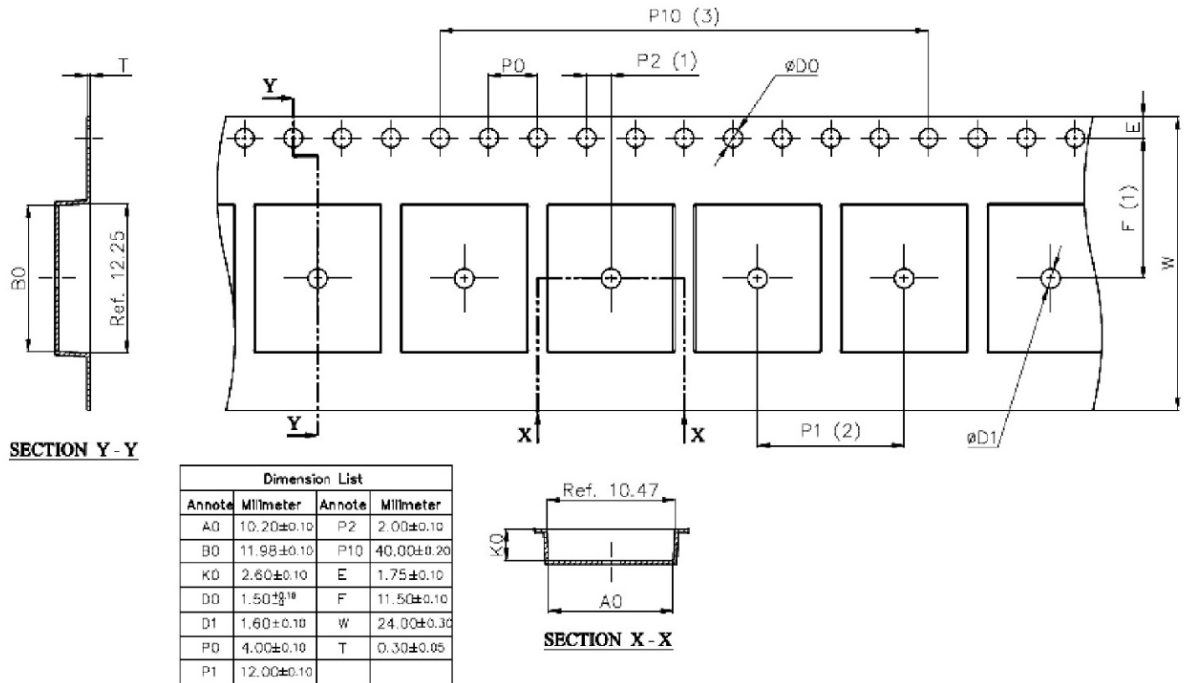


Figure 22. Reel outline and dimensions

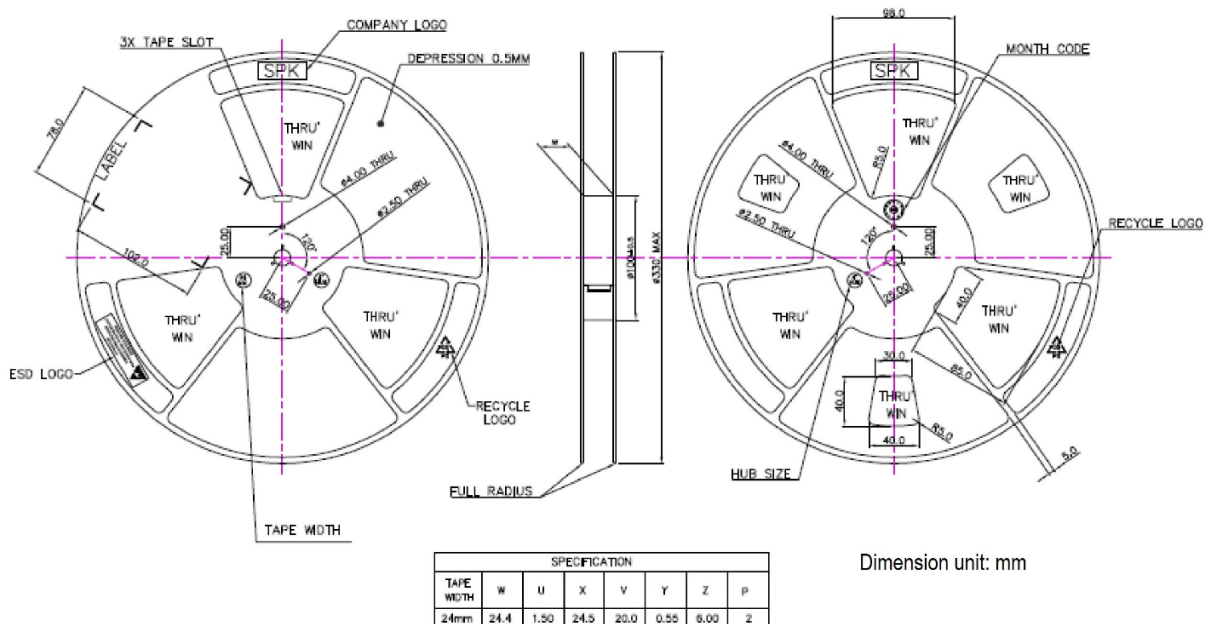
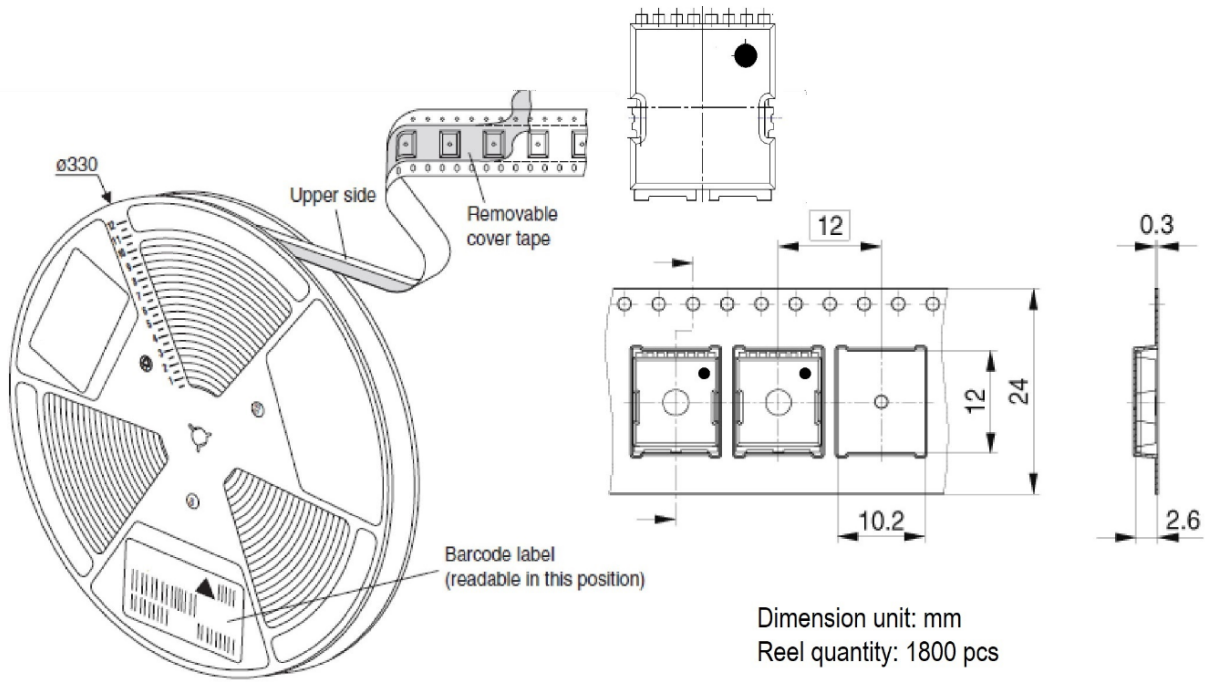


Figure 23. TO-LL orientation in tape pocket



Revision history

Table 9. Document revision history

Date	Version	Changes
11-Jul-2018	1	Initial release.
05-May-2021	2	Updated title and Device summary in cover page. Updated Table 1. Absolute maximum ratings and Table 2. Thermal data. Updated Table 5. Dynamic. Updated Figure 5. Gate charge vs gate-source voltage. Updated Section 4 Package information. Minor text changes.

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