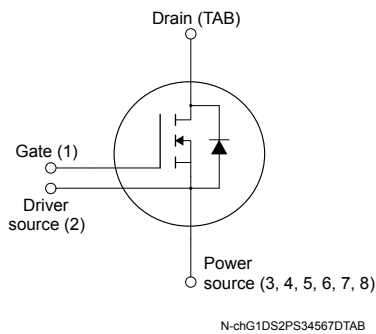
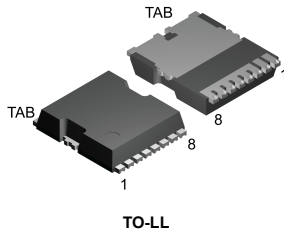


## Silicon carbide Power MOSFET 650 V, 40 mΩ typ., 35 A in a TO-LL package



### Product status link

[SCT040TO65G3](#)

### Product summary

<b>Order code</b>	SCT040TO65G3
<b>Marking</b>	040TO65G3
<b>Package</b>	TO-LL
<b>Packing</b>	Tape and reel

### Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> typ.	I <sub>D</sub>
SCT040TO65G3	650 V	40 mΩ	35 A

- Very fast and robust intrinsic body diode
- Very low R<sub>DS(on)</sub> over the entire temperature range
- High speed switching performances
- Source sensing pin for increased efficiency

### Applications

- Switching mode power supply
- DC-DC converters

### Description

This silicon carbide Power MOSFET device has been developed using ST's advanced and innovative 3<sup>rd</sup> generation SiC MOSFET technology. The device features a very low R<sub>DS(on)</sub> over the entire temperature range combined with low capacitances and very high switching operations, which improve application performance in frequency, energy efficiency, system size and weight reduction.

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage	650	V
$V_{GS}$	Gate-source voltage	-10 to 22	V
	Gate-source voltage (recommended operating values)	-5 to 18	
	Gate-source transient voltage, $t_p < 1 \mu s$ , $t \leq 10$ hours over lifetime	-11 to 25	
$I_D^{(1)}$	Drain current (continuous) at $T_C = 25 \text{ }^\circ\text{C}$	35	A
	Drain current (continuous) at $T_C = 100 \text{ }^\circ\text{C}$	35	
$I_{DM}^{(2)}$	Drain current (pulsed)	197	A
$P_{TOT}$	Total power dissipation at $T_C = 25 \text{ }^\circ\text{C}$	288	W
$T_{stg}$	Storage temperature range	-55 to 175	$^\circ\text{C}$
$T_J$	Operating junction temperature range		$^\circ\text{C}$

- $I_D$  is limited by package.
- Pulse width is limited by safe operating area.

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance, junction-to-case	0.52	$^\circ\text{C}/\text{W}$
$R_{thJA}$	Thermal resistance, junction-to-ambient	50	$^\circ\text{C}/\text{W}$

## 2 Electrical characteristics

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

**Table 3. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	650			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$			10	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = -10\text{ to }22\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 1\text{ mA}$	1.8	3.0	4.2	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 15\text{ V}$ , $I_D = 20\text{ A}$		47		m $\Omega$
		$V_{GS} = 18\text{ V}$ , $I_D = 20\text{ A}$		40	63	
		$V_{GS} = 18\text{ V}$ , $I_D = 20\text{ A}$ , $T_J = 175\text{ °C}$		52		

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 400\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	853	-	pF
$C_{oss}$	Output capacitance		-	89	-	pF
$C_{riss}$	Reverse transfer capacitance		-	13	-	pF
$Q_g$	Total gate charge	$V_{DD} = 400\text{ V}$ , $V_{GS} = -5\text{ to }18\text{ V}$ , $I_D = 20\text{ A}$	-	42.5	-	nC
$Q_{gs}$	Gate-source charge		-	12.9	-	nC
$Q_{gd}$	Gate-drain charge		-	15.8	-	nC
$R_g$	Gate input resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	1.4	-	$\Omega$

**Table 5. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}$	Turn-on switching energy	$V_{DD} = 400\text{ V}$ , $I_D = 20\text{ A}$ ,	-	76.4	-	$\mu\text{J}$
$E_{off}$	Turn-off switching energy	$R_G = 18\text{ }\Omega$ , $V_{GS} = -5\text{ V to }18\text{ V}$	-	74.9	-	$\mu\text{J}$

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 400\text{ V}$ , $I_D = 20\text{ A}$ , $R_G = 18\text{ }\Omega$ , $V_{GS} = -5\text{ to }18\text{ V}$	-	11	-	ns
$t_r$	Rise time		-	5	-	ns
$t_{d(off)}$	Turn-off delay time		-	36	-	ns
$t_f$	Fall time		-	16	-	ns

**Table 7. Reverse SiC diode characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}^{(1)}$	Continuous diode forward current	$T_C = 25\text{ °C}$	-		35	A
		$T_C = 100\text{ °C}$	-		35	
$V_{SD}$	Diode forward voltage	$I_{SD} = 20\text{ A}, V_{GS} = 0\text{ V}$	-	2.8		V
$t_{rr}$	Reverse recovery time	$I_{SD} = 20\text{ A}, 1\text{ kA}/\mu\text{s}, V_{DD} = 400\text{ V}$	-	14		ns
$Q_{rr}$	Reverse recovery charge		-	82		nC
$I_{RRM}$	Reverse recovery current		-	9.4		A

1.  $I_{SD}$  is limited by package.

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

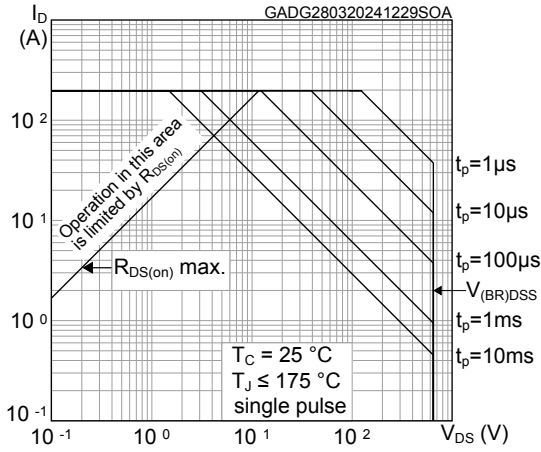


Figure 2. Maximum transient thermal impedance

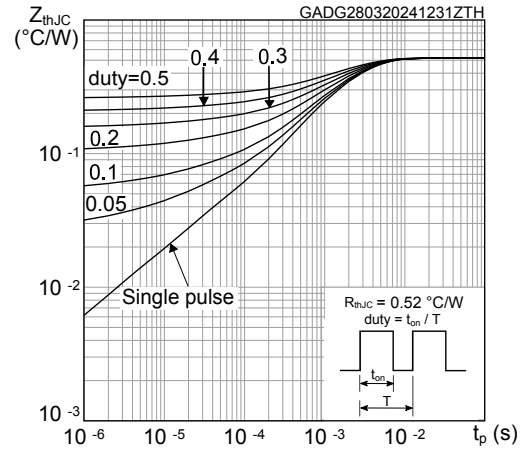


Figure 3. Typical output characteristics ( $T_J = 25\text{ °C}$ )

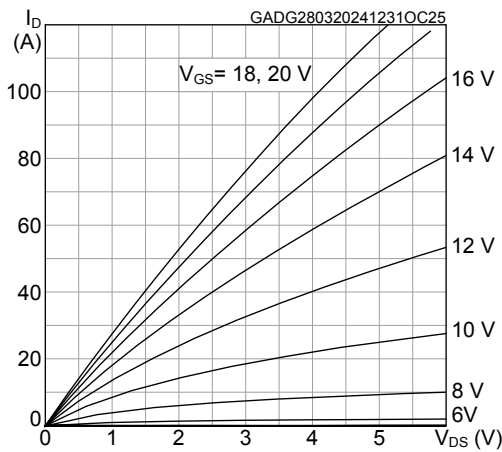


Figure 4. Typical output characteristics ( $T_J = 175\text{ °C}$ )

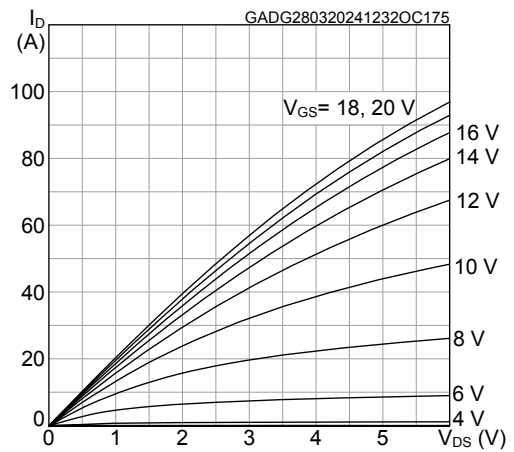


Figure 5. Typical transfer characteristics

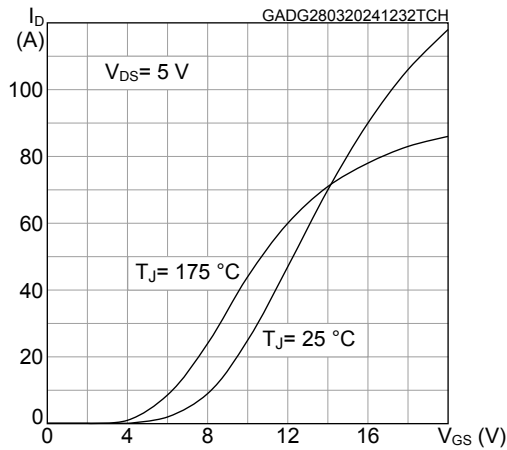


Figure 6. Total power dissipation

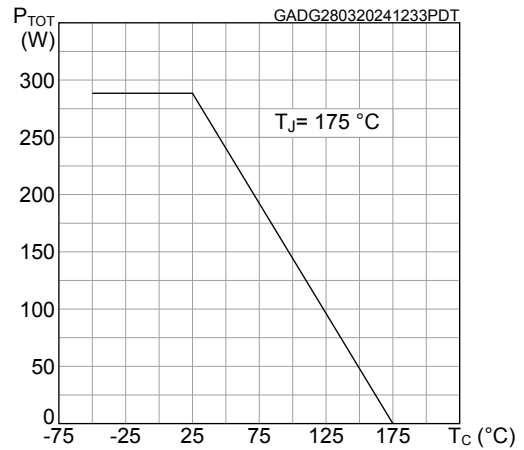


Figure 7. Typical gate charge characteristics

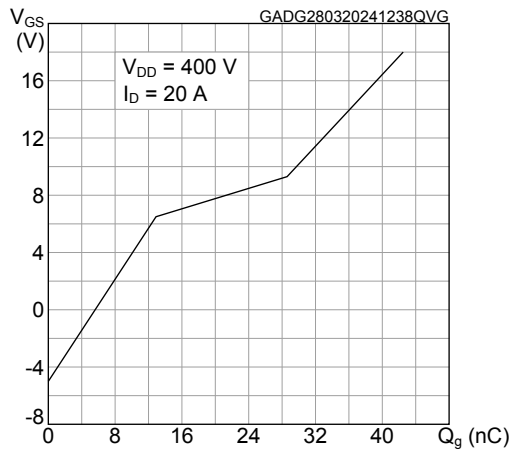


Figure 8. Typical capacitance characteristics

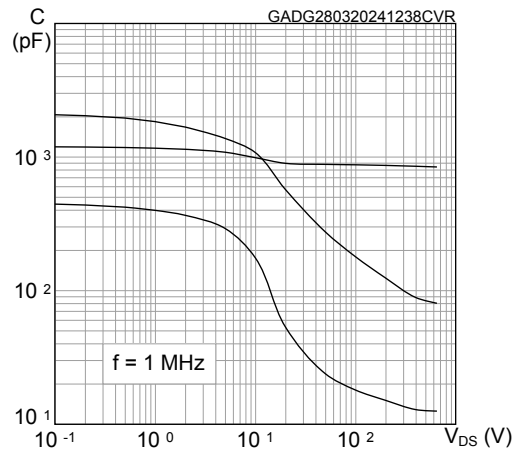


Figure 9. Typical switching energy vs drain current

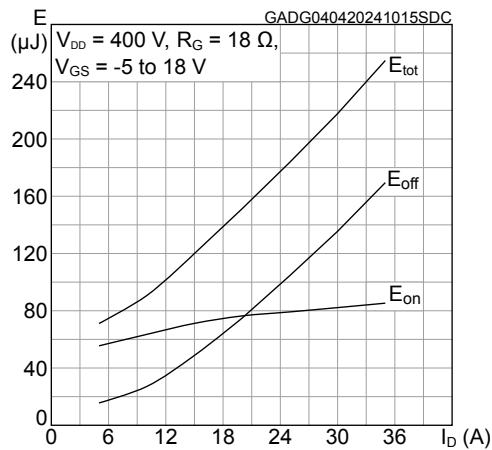


Figure 10. Typical switching energy vs gate resistance

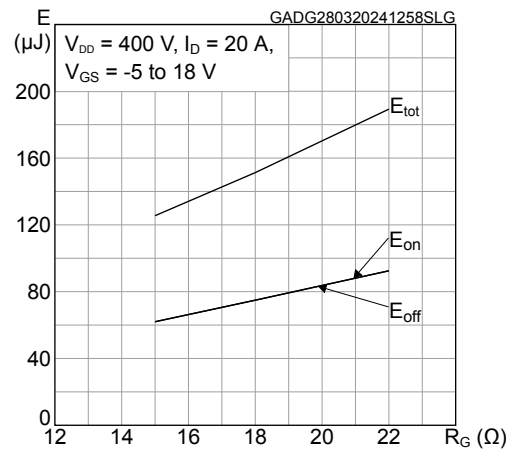


Figure 11. Typical switching energy vs supply voltage

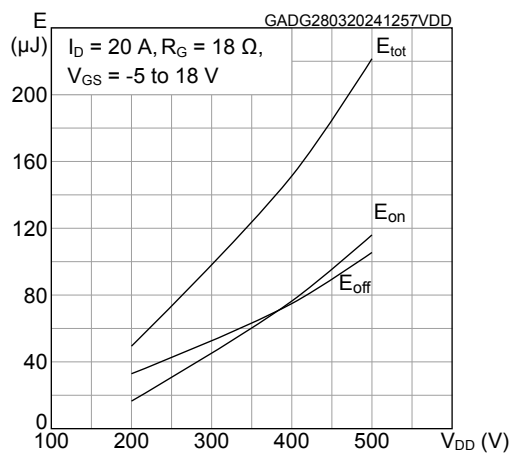


Figure 12. Typical switching energy vs temperature

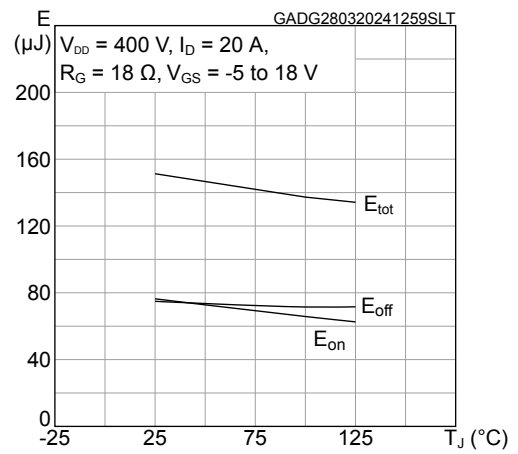


Figure 13. Normalized breakdown voltage vs temperature

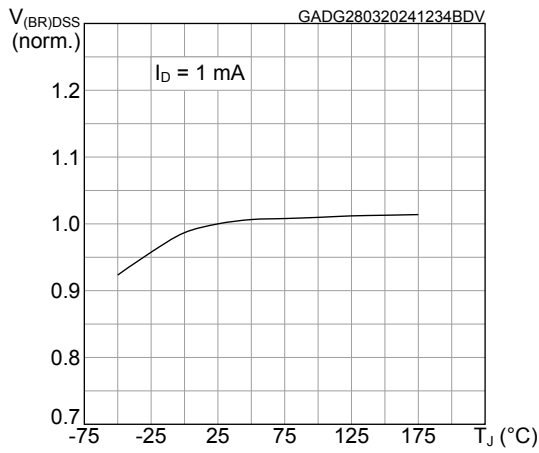


Figure 14. Normalized gate threshold vs temperature

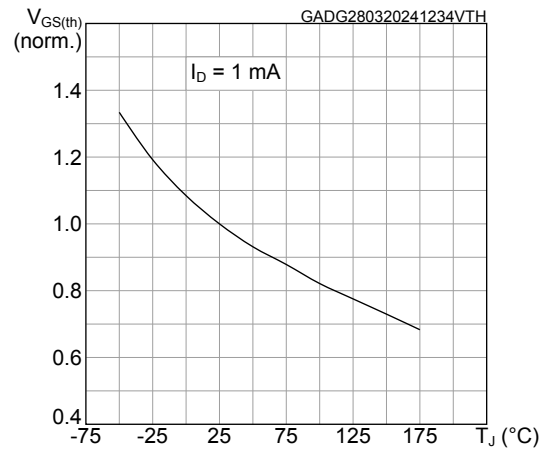


Figure 15. Normalized on-resistance vs temperature

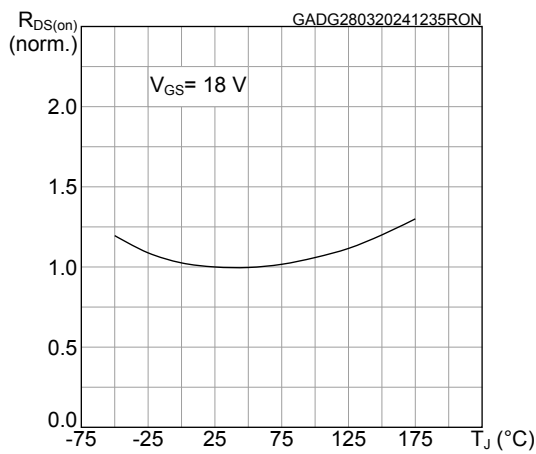


Figure 16. Typical reverse conduction characteristics ( $T_J = 25^\circ\text{C}$ )

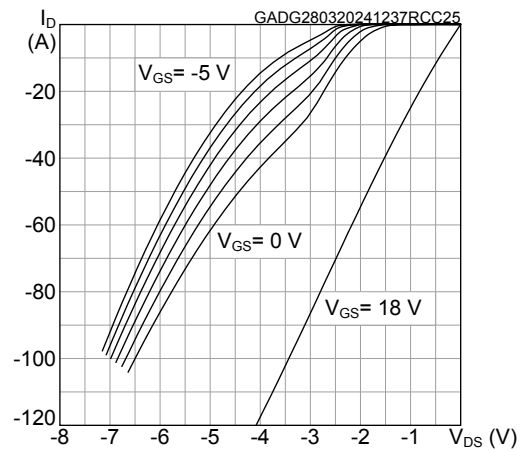
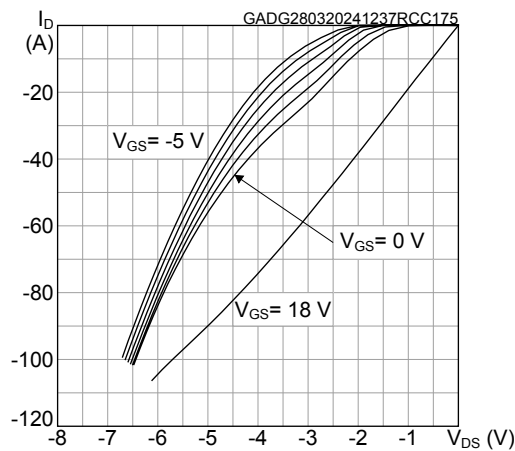


Figure 17. Typical reverse conduction characteristics ( $T_J = 175^\circ\text{C}$ )

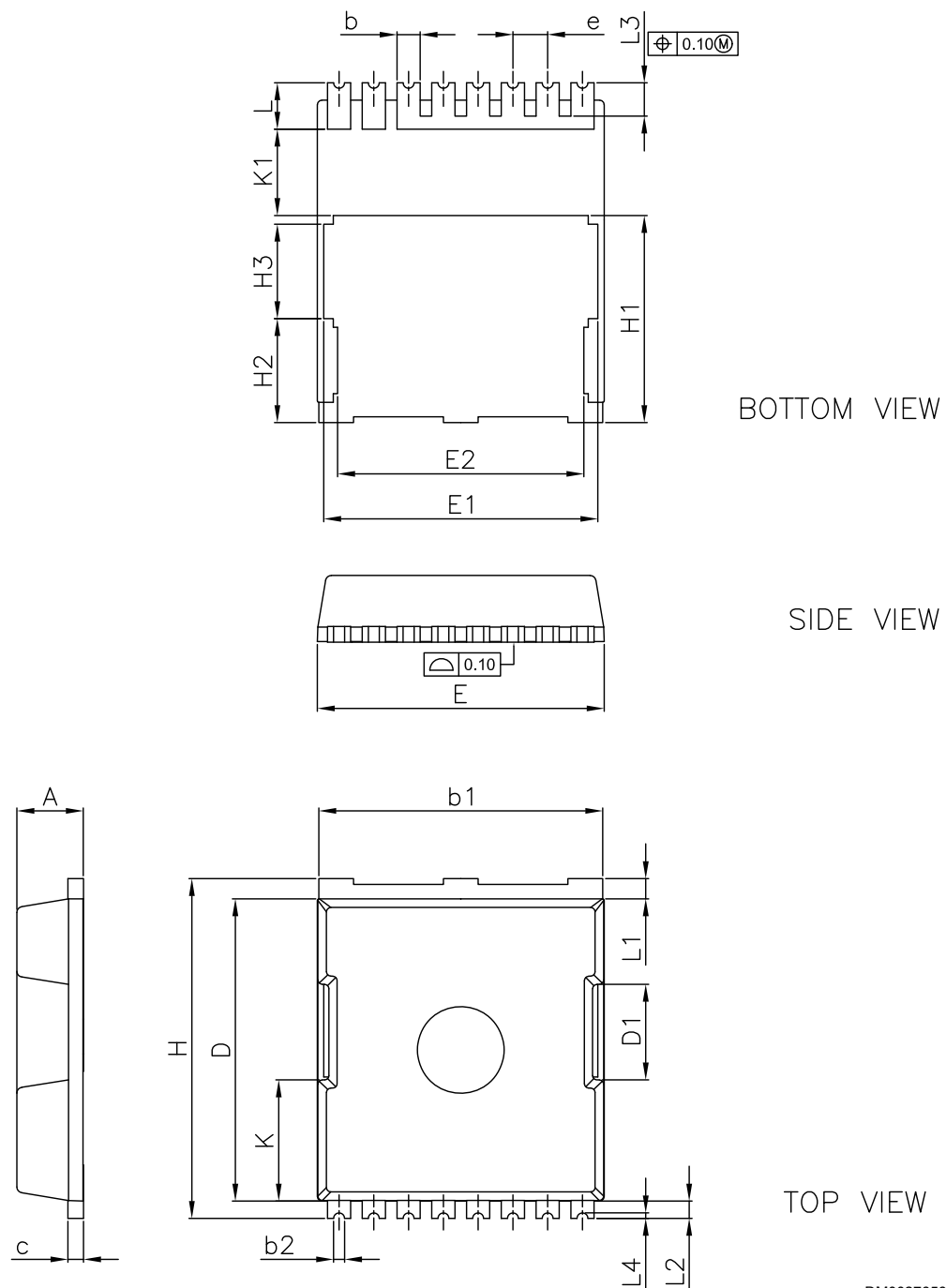


### 3 Package information

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.

#### 3.1 TO-LL package information

Figure 18. TO-LL package outline



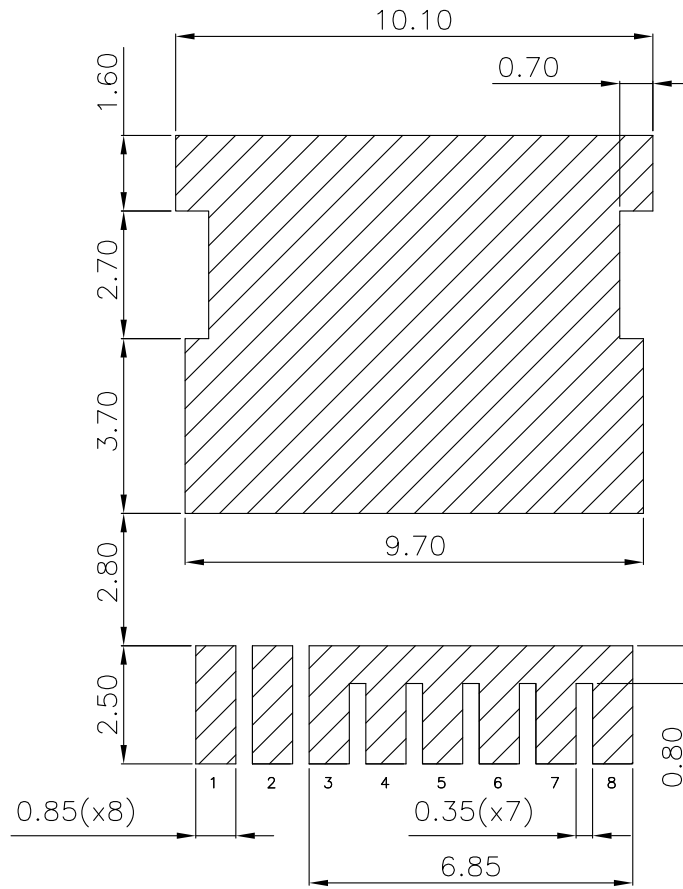
DM00276569\_SiC\_Rev\_6



**Table 8. TO-LL package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.40
b	0.60	0.80	0.90
b1	9.70	9.80	9.90
b2	0.20		0.50
c	0.40	0.50	0.60
D	10.28	10.43	10.58
D1	3.15	3.30	3.45
E	9.70	9.90	10.10
E1	9.31	9.46	9.61
E2	8.35	8.50	8.65
e	1.10	1.20	1.30
H	11.48	11.73	11.88
H1	7.00	7.15	7.30
H2	3.34	3.59	3.84
H3	3.11	3.26	3.41
K	4.03	4.18	4.33
K1	2.70		
L	1.45	1.60	1.75
L1	0.55	0.70	0.85
L2	0.45	0.60	0.75
L3	1.00	1.15	1.30
L4	0.05		0.40

Figure 19. TO-LL recommended footprint (dimensions are in mm)



DM00276569\_6\_SIC\_FP

### 3.2 TO-LL packing information

Figure 20. Carrier tape outline and dimensions

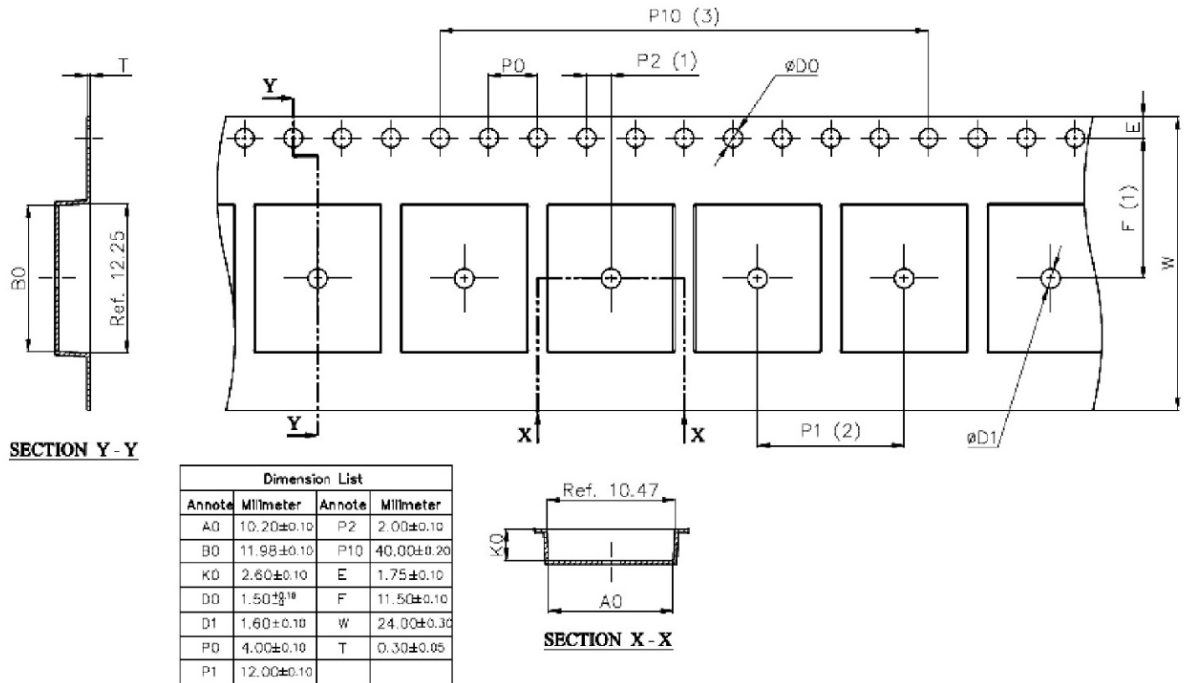
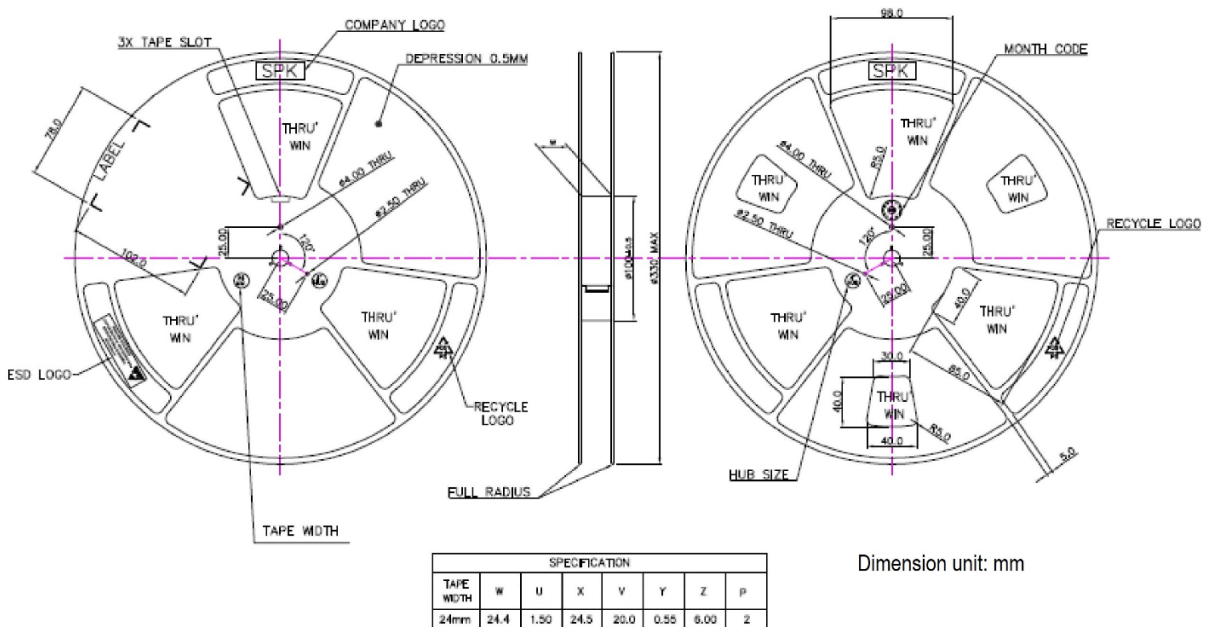
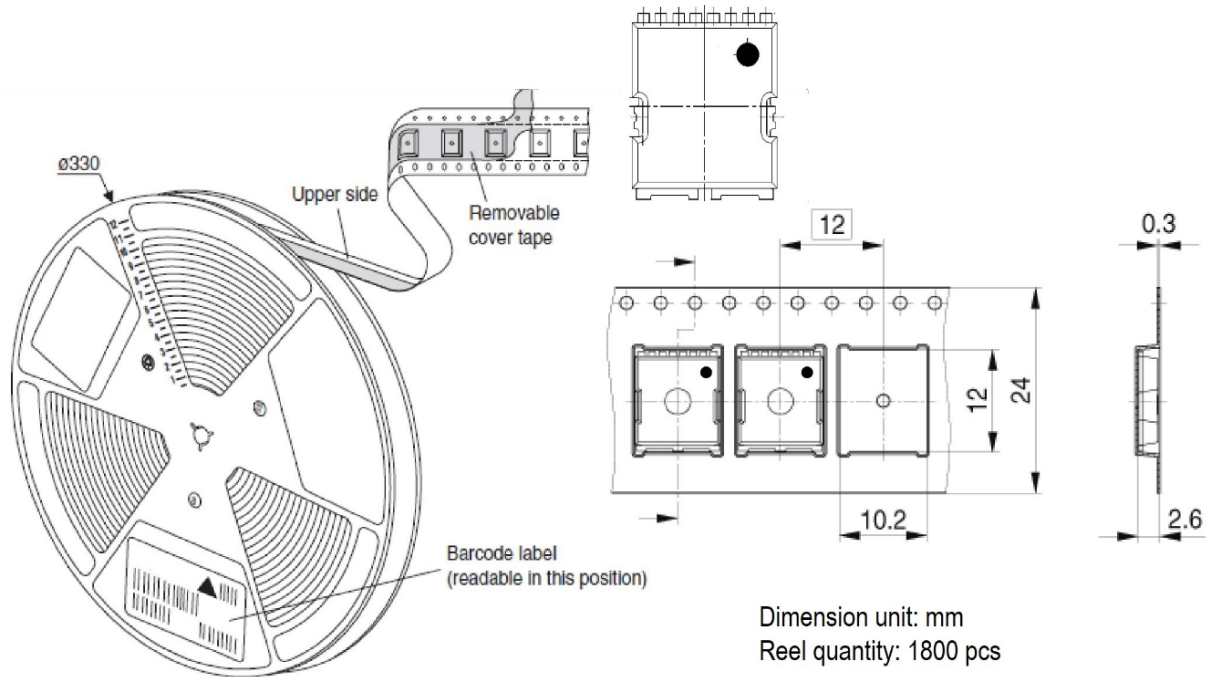


Figure 21. Reel outline and dimensions



**Figure 22. TO-LL orientation in tape pocket**



## Revision history

Table 9. Document revision history

Date	Revision	Changes
04-Apr-2024	1	First release.

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