

5 V SPST Depletion Switch with Negative Swing

■ Features

- SPST depletion switch
- Normally closed when $V_{DD} < 0.5\text{ V}$
- V_{SW} : -3.0 V to 5.5 V
- R_{ON} : 0.67 Ω (typ.)
- $R_{FLAT(ON)}$: 2 m Ω (typ.)
- THD+N: -105 dB (typ.)

■ Applications

- Smart phones
- Tablets, laptops
- Bluetooth headsets
- Adapters, cables
- Mobile accessories
- Computer accessories

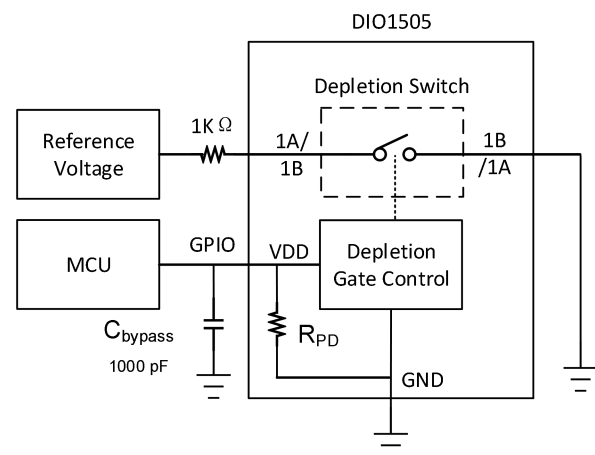
■ Package Information

Part Number	Package	Body Size
DIO1505	WLCSP-4	0.77mm × 0.77mm

■ Description

The DIO1505 is a high-performance single-pole single-throw (SPST) depletion switch. Depletion technology enables the device to conduct signals in the absence of V_{DD} and to isolate signals in the presence of V_{DD} . The DIO1505 can pass or isolate negative signal fluctuations as low as -3.0 V and is 5.5 V tolerable. The DIO1505's depletion gate control enables it to achieve exceptional THD+N performance while using very little power during signal conduction.

■ Simplified Schematic



■ Ordering Information

Ordering Part No.	Top Marking	MSL	RoHS	T _A	Package	
DIO1505WL4	WV5	1	Green	-40 to 85°C	WLCSP-4	Tape & Reel, 5000

If you encounter any issue in the process of using the device, please contact our customer service at marketing@dioo.com or phone us at (+86)-21-62116882. If you have any improvement suggestions regarding the datasheet, we encourage you to contact our technical writing team at docs@dioo.com. Your feedback is invaluable for us to provide a better user experience.

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1. Pin Assignment and Functions

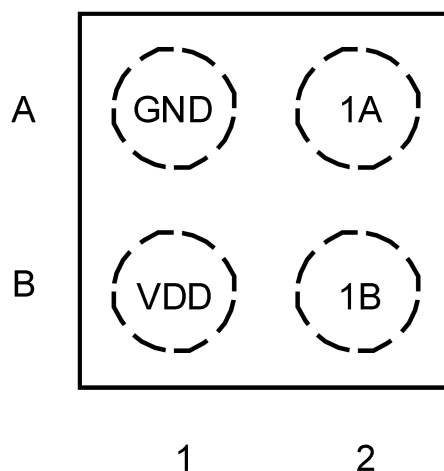


Figure 1. WLCSP-4 (Top view)

Pin No.	Name	Description
A1	GND	Ground
A2	1A	A-port of switch 1 (normally closed)
B1	VDD	Supply voltage (switch is closed when low)
B2	1B	B-port of switch 1 (normally closed)

2. Absolute Maximum Ratings

Exceeding the maximum ratings listed under Absolute Maximum Ratings when designing is likely to damage the device permanently. Do not design to the maximum limits because long-time exposure to them might impact the device's reliability. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

Symbol	Parameter		Rating	Unit
V_{DD}	Supply voltage		-0.5 to 6.0	V
$V_{SW(ON)}$	Switch voltage range	DC switch I/O voltage (switch conducting)	-3.6 (AC) to 6.0	V
$V_{SW(OFF)}$		DC switch I/O voltage (switch isolated)	-3.6 (AC) to 6.0	V
I_{SW}	Maximum DC switch I/O current		350	mA
I_{SWPEAK}	Maximum peak switch I/O current -pulsed at 1 ms duration, < 10% duty cycle		500	mA
T_J	Maximum Junction temperature		150	°C
T_{STG}	Storage temperature		-65 to 150	

3. Recommended Operating Conditions

Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

Symbol	Parameter		Min	Max	Unit
V _{DD(OFF)}	Supply voltage	Isolating	2.5	5.5	V
V _{DD(ON)}		Conducting	0	0.5	V
V _{SW(OFF)}	Switch voltage range	Isolating	−3.0 (V _{pk} ; AC)	4.7	V
		Isolating (requires 1 kΩ (typ.) in series with source)	4.7	5.5	V
V _{SW(ON)}		Conducting	−3.0 (V _{pk} ; AC)	4.7	V
		Isolating (requires 1 kΩ (typ.) in series with source)	4.7	5.5	V
T _A	Ambient operating temperature		-40 to 85		°C

4. ESD Ratings

When a statically-charged person or object touches an electrostatic discharge sensitive device, the electrostatic charge might be drained through sensitive circuitry in the device. If the electrostatic discharge possesses sufficient energy, damage might occur to the device due to localized overheating.

Model	Condition	Value	Unit
HBM	Human-body model	±6000	V
CDM	Charged-device model	±2000	

5. Thermal Considerations

The thermal resistance determines the heat insulation property of a material. The higher the thermal resistance is, the lower the heat loss. Accumulation of heat energy degrades the performance of semiconductor components.

Symbol	Parameter	Value	Unit
R _{θJA}	Junction-to-ambient thermal resistance	77	°C/W

6. Switch Truth Table

VDD	Switch State
Low	ON (Conducting)
High	OFF (Isolating)

7. Electrical Characteristics

Unless otherwise specified, typical values are for $T_A = 25^\circ\text{C}$, $V_{DD} = 0\text{ V}$.

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
Switch DC characteristics							
I _{OFF}	Switch off leakage current	V _{DD} = 5 V, 1B = GND	1A = 5.5 V ⁽¹⁾		0.16	1	μA
			1A = −1.5 V		−1		μA
		V _{DD} = 3.3 V, 1B = GND	1A = 1.4V ⁽¹⁾		−0.25	1	μA
R _{ON}	Switch on resistance	I _{SW} = 100 mA, V _{SW} = −1.5 V to 1.5 V			0.67	1.1	Ω
		I _{SW} = 100 mA, V _{SW} = 0 V to 5.5 V			0.67	1.1	Ω
R _{FLAT(ON)}	On resistance flatness	I _{SW} = 100 mA, V _{SW} = −1.5 V to 1.5 V			2		mΩ
		I _{SW} = 100 mA, V _{SW} = 0 V to 5.5 V			2		mΩ
Switch AC characteristics							
THD+N	Total harmonic distortion plus noise	V _{SW} = 1 V _{RMS} , Ground centered R _L = 32 Ω , f = 1 kHz			−105		dB
OIRR	Off isolation rejection ratio	V _{SW} = 1 V _{RMS} , Ground centered R _L = 32 Ω	f = 1 kHz		−108		dB
			f = 20 kHz		−91		dB
BW	Bandwidth	R _L = 50 Ω, C _L = 0 pF			195		MHz
Supply currents							
I _{DDT}	Peak startup supply current	V _{DD} = 0 V to 5.5 V			1		mA
I _{DD}	Quiescent current	V _{DD} = 5.5 V ⁽¹⁾			25	35	μA
I _{DIS}	Disable current	V _{DD} ≤ 0.2 V ⁽¹⁾			0.05	0.5	μA
Control logic							
R _{PD}	V _{DD} pull-down resistance	V _{DD} ≤ 0.2 V			5.8		MΩ
V _{DDH}	V _{DD} high voltage			2.5			V
V _{DDL}	V _{DD} low voltage					0.5	V
Timing							
t _{OFF}	Switch turn-off time	R _L = 1 kΩ, C _L = 10 pF, V _{DD} = 0.0 V to 3.0 V, V _{SW} = 5.0 V			85		μs
t _{ON}	Switch turn-on time	R _L = 1 kΩ, C _L = 10 pF, V _{DD} = 3.0 V to 0 V, V _{SW} = 5.0 V			240		μs
Capacitance							
C _{ON}	On capacitance	V _{SW} = 0 dBm, f = 1 MHz			25		pF
C _{OFF}	Off capacitance	V _{SW} = 0 dBm, f = 1 MHz			41		pF
Oscillator frequency							
f _{OSC} ⁽²⁾	On-chip oscillator frequency	For reference only			400		kHz

Note:

- (1) Maximum is guaranteed at 25°C .
- (2) Guaranteed by design.
- (3) Specifications subject to change without notice.
- (4) Performance guaranteed over the indicated operating temperature range by design and/or characterization tested at $T_J = T_A = 25^\circ\text{C}$.

8. Typical Characteristics

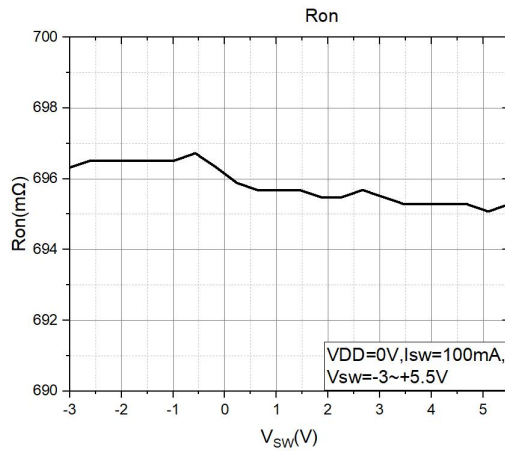


Figure 2. R_{ON} vs. V_{SW}

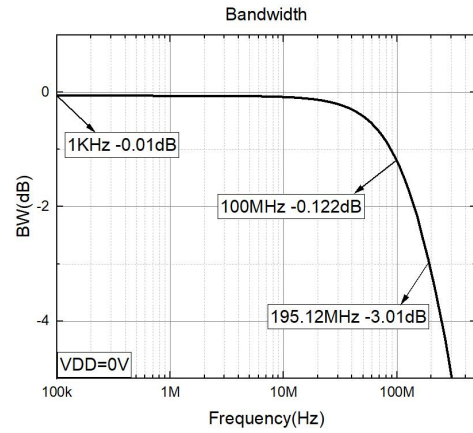


Figure 3. Bandwidth vs. Frequency

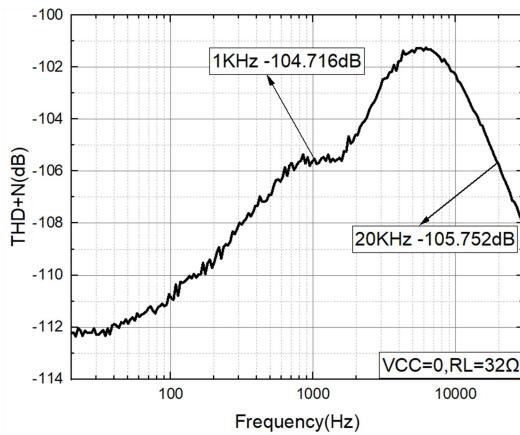


Figure 4. THD + N vs. Frequency

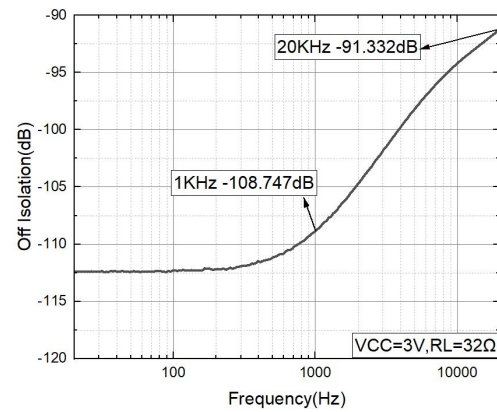


Figure 5. Off-isolation vs. Frequency

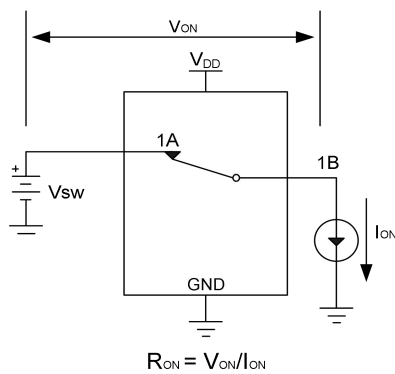


Figure 6. Switch on resistor

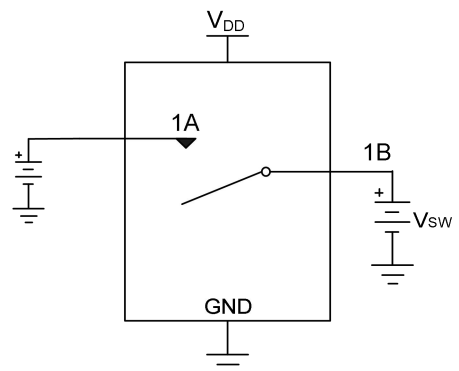


Figure 7. Switch off leakage

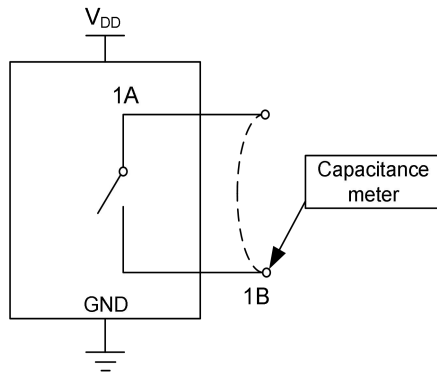


Figure 8. Channel on / off capacitance

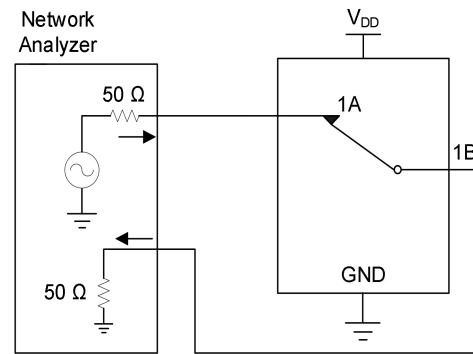


Figure 9. Bandwidth

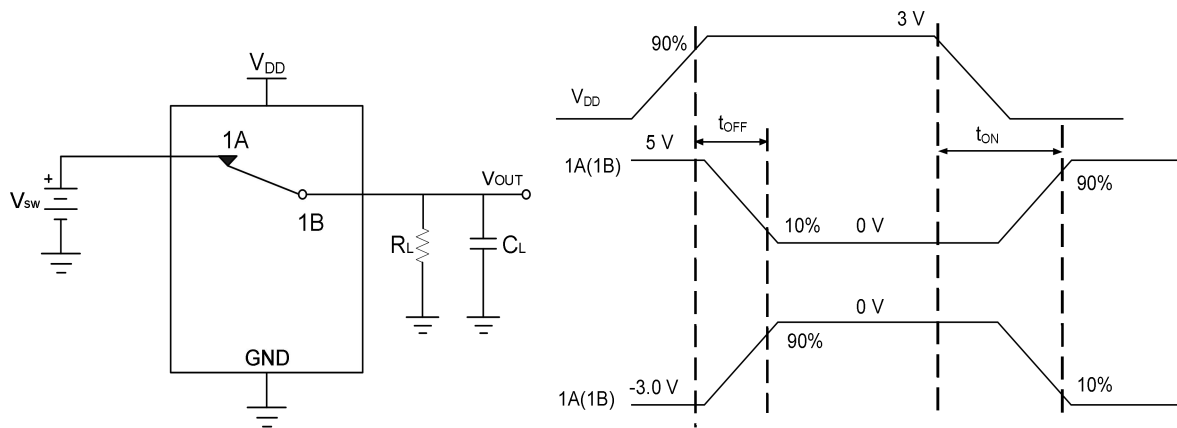


Figure 10. Turn-on / Turn-off

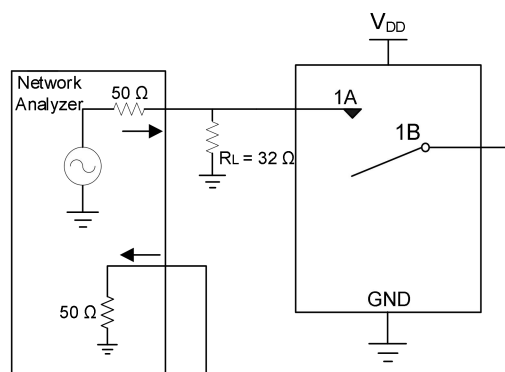


Figure 11. Off-isolation

9. Function Description

When there is no power supply, because of the characteristic that the threshold voltage of depletion switch is negative, the gate voltage is equal to the input voltage and the switch tube is on to achieve the high-performance signal connection; When a power source is present, the gate voltage is lowered by auxiliary circuits, such as negative charge pump, and the switch tube is off to stop the signal transmission.

10. Application Information

Important notice: Validation and testing are the most reliable ways to confirm system functionality. The application information is not part of the specification and is for reference purposes only.

10.1. Bluetooth noise reduction headphones

The DIO1505 is a high-performance single-pole single-throw (SPST) depletion switch. The depletion switch can be conducted without a power source. It is widely used in bluetooth noise reduction headphones (See Figure 12). When the batteries is ran down, two single-channel SPST depletion analog switches can be used directly to realize the closed conduction without power supply.

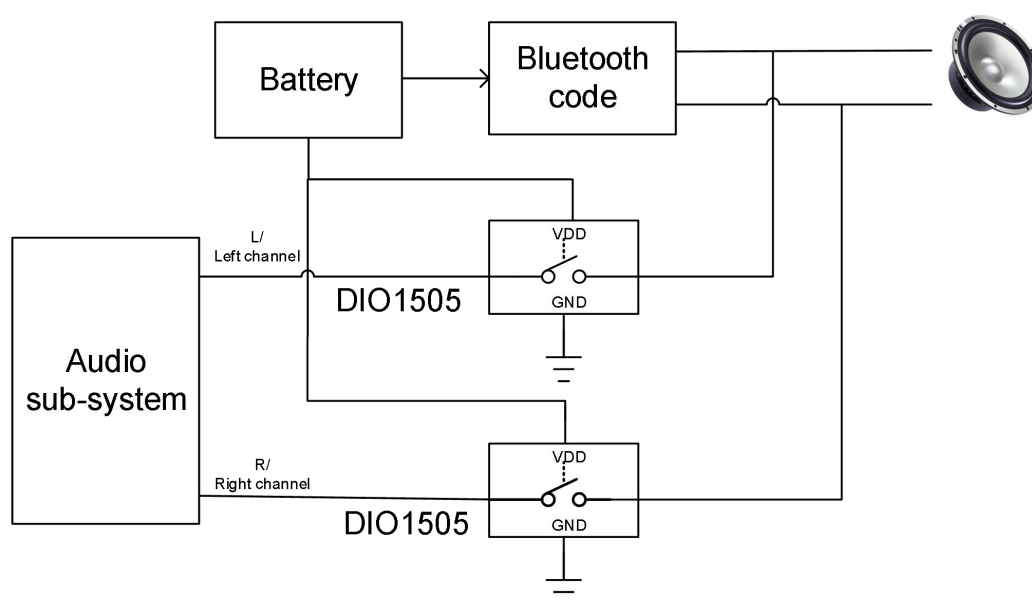


Figure 12. Application diagram

10.2. Type-C accessory with R_a resistor isolated after detection

The DIO1505 can be applied to connect mobile devices to the powered accessories via USB Type C. As soon as the accessory is attached and powered by V_{CONN} , the current still flows through the grounded R_a in the accessory (See Figure 13). For 5 V V_{CONN} and 1 k Ω R_a , mobile devices need to supply 5 mA of DC current. However, for accessories that use a micro-controller or similar devices, a single-channel SPST depletion-mode analog switch on the accessory device in series with a R_a resistor provides the ability to isolate the R_a resistor ground path after USB Type C detection is complete. By using GPIO and some firmware coding on the accessory controller to power the VDD pin of the depletion switch after successful detection, the increased current consumption can be reduced from 5 mA to the quiescent power dissipation of the depletion switch while connected.

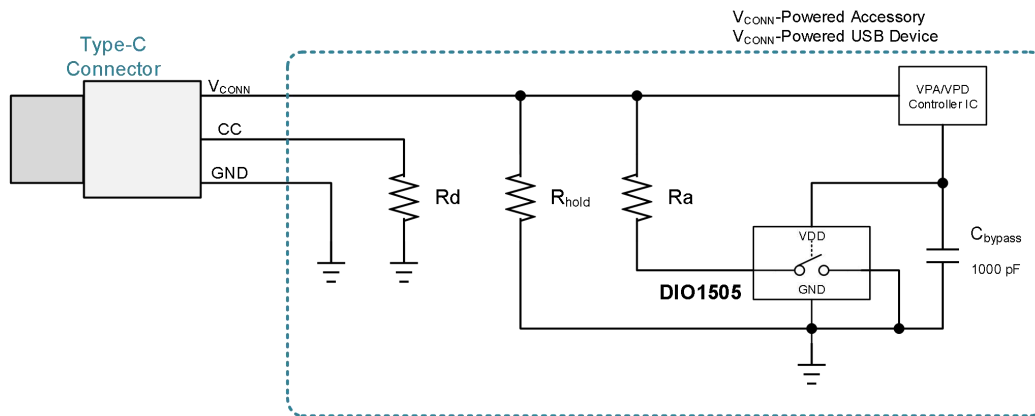
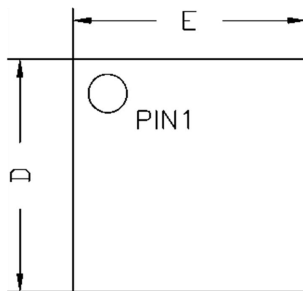
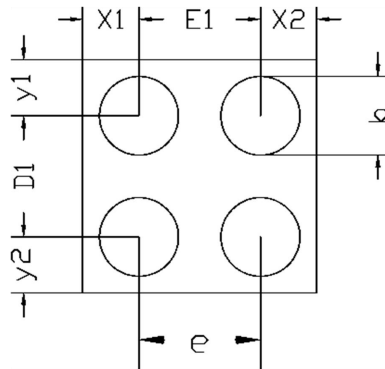


Figure 13. Type-C accessory with R_a resistor isolated after detection

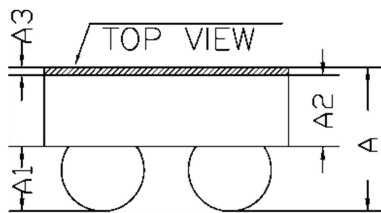
11. Physical Dimensions: WLCSP-4



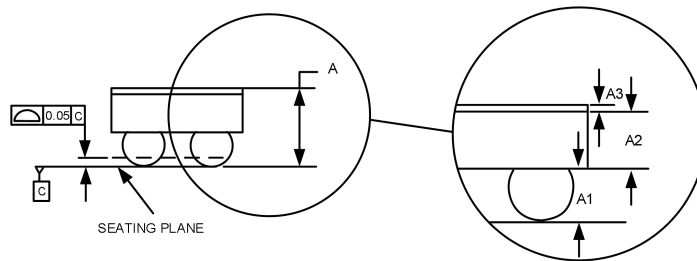
25 μ m Backside Tape
(MARK SIDE)



BOTTOM VIEW
(BALL SIDE)



SIDE VIEW

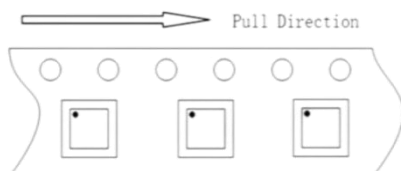


Common Dimensions (Units of measure = Millimeter)			
Symbol	Min	Nom	Max
A	0.419	0.457	0.495
A1	0.183	0.203	0.223
A2	0.211	0.229	0.247
A3	0.025 REF		
D	0.740	0.770	0.800
D1	0.400 BSC		
E	0.740	0.770	0.800
E1	0.400 BSC		
b	0.240	0.260	0.280
e	0.400 BSC		
x1	0.185 REF		
x2	0.185 REF		
y1	0.185 REF		
y2	0.185 REF		

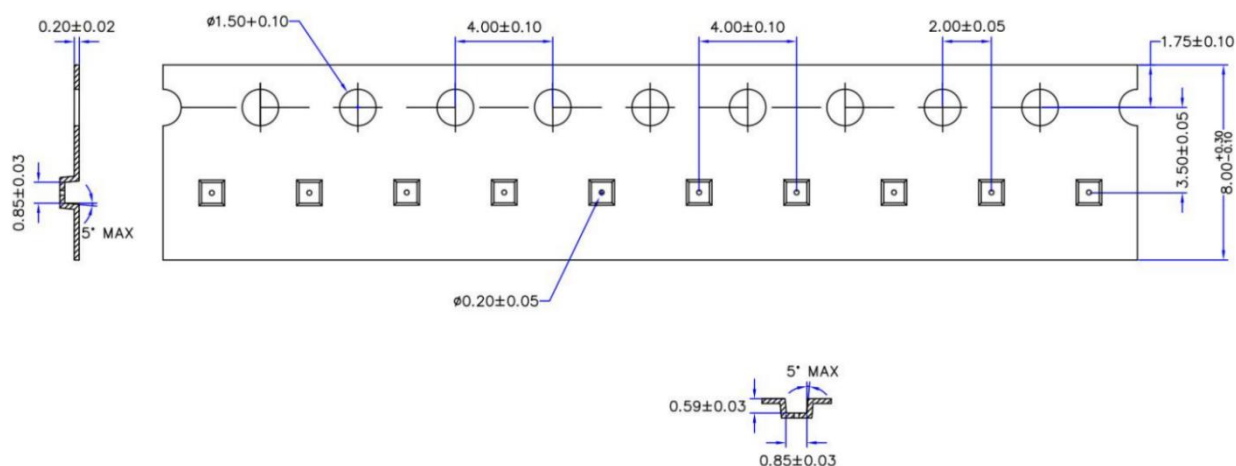
12.DIO1505WL4 packing instructions

Package: Tape & Reel + Moisture Barrier Bag + Vacuum

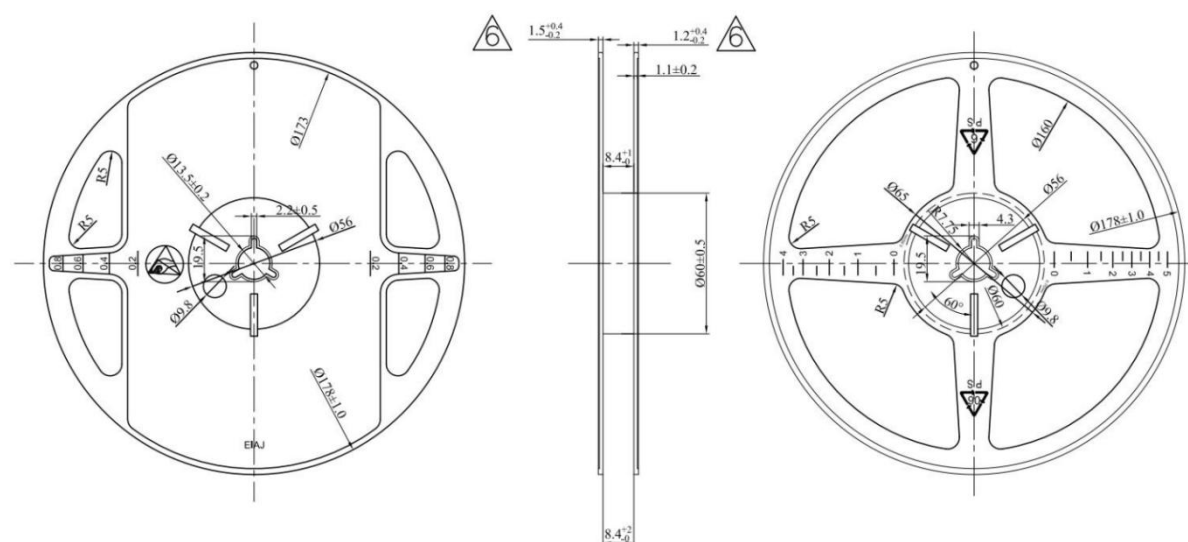
(1) Tape & Reel orientation



(2) Tape dimensions



(3) Reel dimensions (7 inches)



(4) Packing Specification

PKG	Pcs / Reel	Gram / Reel	Reel / Box	Pcs / Box	Box / Carton	Pcs / Carton
WLCSP-4	5000	112.5	4	20000	12	240000

Disclaimer

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