

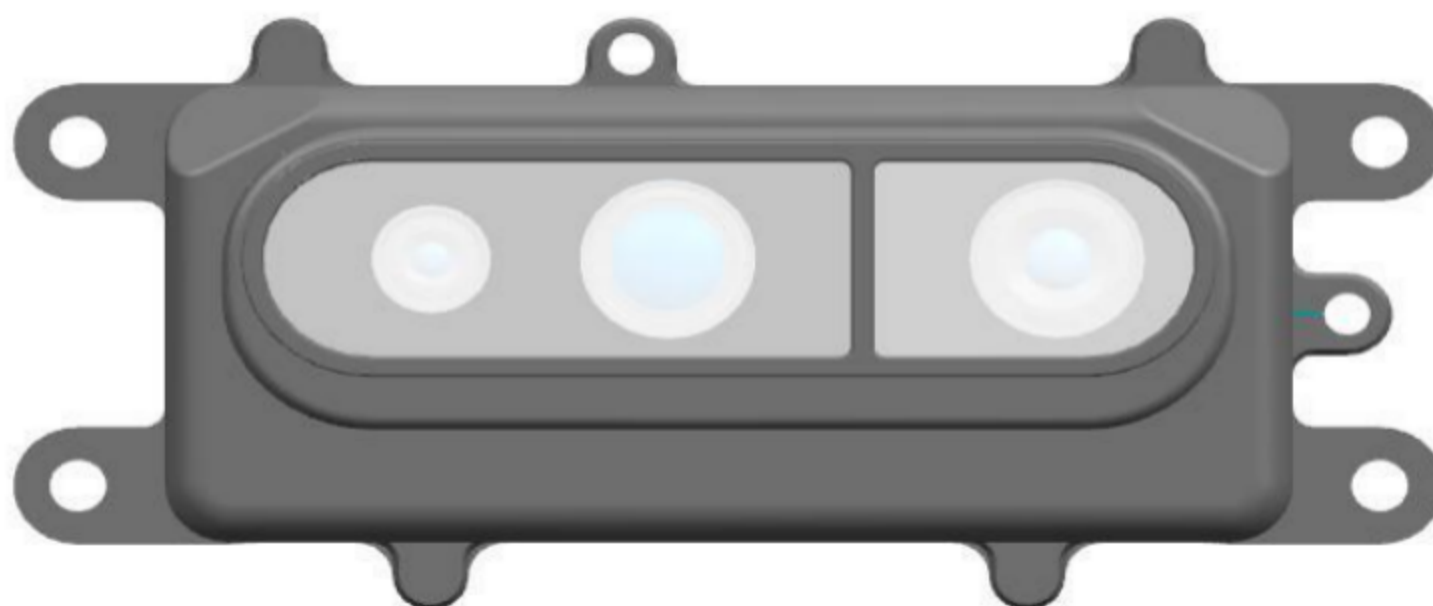
Deptrum® Nebula 411

Product Specification

V1.0 - 2026/09/30

1 Revision History

Version	Description	Date	Reviser
V1.0	Official release	2026/09/30	Hu Tao



Product Rendering (USB module, incl. mounting ears)

2 Product Overview

Product Introduction Deptrum® Nebula 411 series depth cameras use speckle-modulated ToF technology to capture the 3D structure of objects and spaces and, combined with a high-performance RGB camera, provide users with large-FOV, wide-range, high-precision depth sensing. The Nebula 411 USB camera is built on Deptrum's self-developed WFP photonic chip that modulates the projected light field, combined with the proprietary sToF and mToF algorithms that fuse structured light and ToF, effectively solving the multipath interference problem of conventional ToF and significantly improving depth accuracy.¹² System Requirements Supports Windows / Linux / Android; maximum computing requirement < 1 × A53@1.8GHz (MODE2).	Product Features • A single module covers both short-range obstacle avoidance and long-range SLAM depth requirements • Multipath interference resistance • Low motion blur • Large FOV (up to H98° × V72°) • Compatible with 3D SLAM algorithms • RGBD output (with built-in RGBD extrinsic calibration, supporting RGB and ToF hardware synchronization) Applications • Commercial service robots • Outdoor robots • Mobile robot chassis
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3 Core Specifications

Nebula 411 Product Specifications

¹sToF: StructureLight + iToF, a 3D algorithm suite that fuses the software-based structured-light reconstruction algorithm with the iToF 3D algorithm. Mainly used for short-range obstacle avoidance.

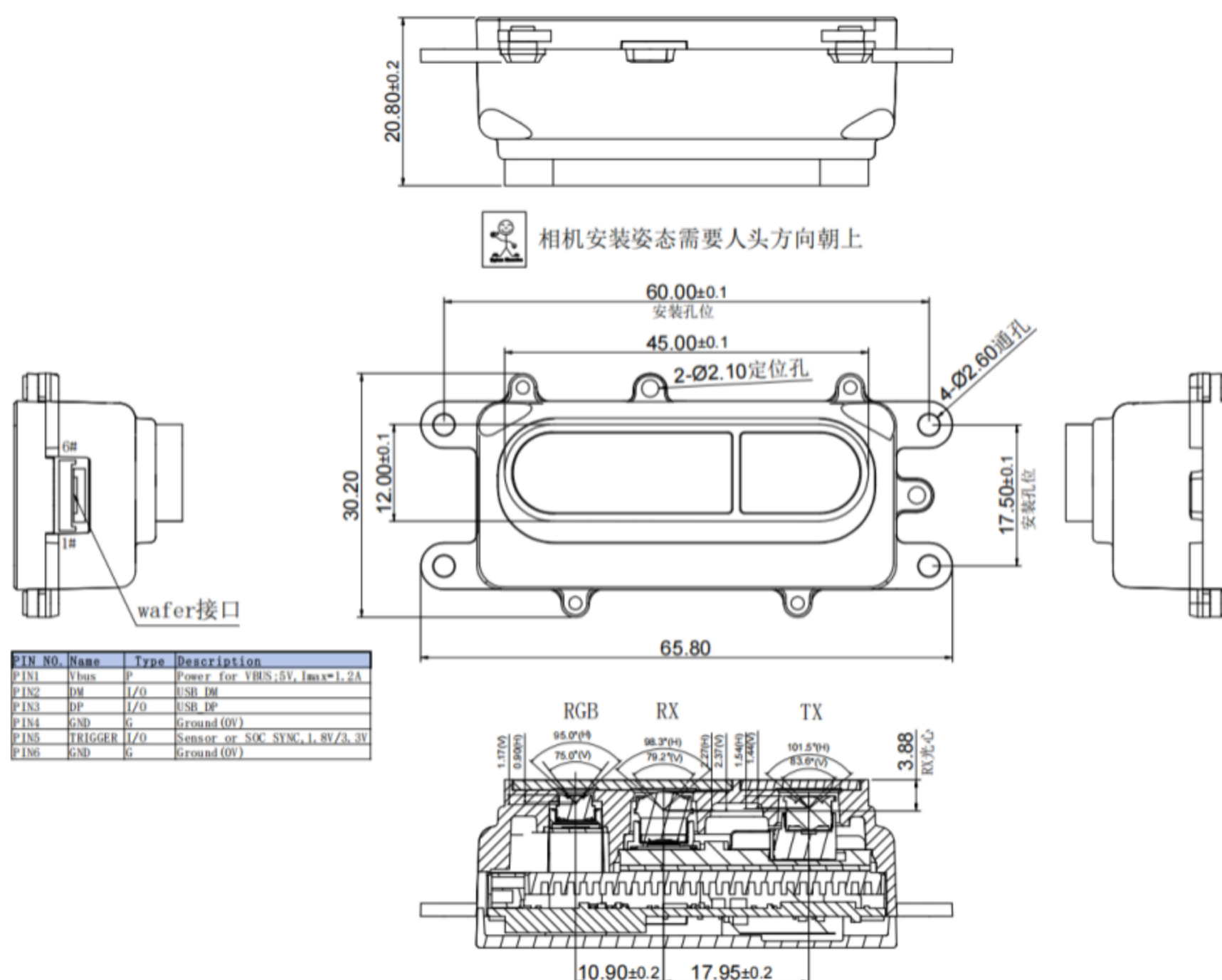
²mToF: modulated ToF, a speckle-based iToF technology implemented by modulating the projected light field with the WFP photonic chip; mainly used for long-range SLAM.

Module Parameters	Module Dimensions	66 mm × 30.2 mm × 20.8 mm (excl. wafer cable)
	Baseline	17.95 mm
	Operating Temperature	-10°C ~ +45°C
	Operating Humidity	0% ~ 95% RH, non-condensing
	Average Power Consumption (10 fps)	≤ 1.7 W (MODE1 / MODE2, RGBD output); ≤ 1.4 W (MODE0, RGBD output) ³
	Power Supply Requirement	≥ 1.5 A @ 5 V DC; 2 A supply current capability recommended
	Communication Protocol & Interface	USB 2.0 (6 pin Wafer)
Depth Image Performance (white-wall test, MODE1)⁴	Operating Distance	3 cm ~ 8 m
	Operating Illuminance	0 ~ 100,000 lux @ 2.5 m
	Resolution / Frame Rate	≥ 248 × 180 @ 10 fps
	Depth Accuracy	< 5 mm @ [3 cm ~ 30 cm]; < 1.5% @ (30 cm ~ 60 cm]; < 1% @ (60 cm ~ 8 m]
	Depth Trueness	< 1 cm @ [3 cm ~ 35 cm]; < 1.5% @ (35 cm ~ 60 cm];

³Different modes have different SDK configurations; the mode can be selected in the SDK for depth computation, and CPU usage and depth-scene adaptability differ. The modes differ in depth performance and CPU usage. MODE0: mToF AE mode only, featuring low USB data bandwidth and the lowest compute consumption, sparse point cloud across the full range, but no structured-light or HDR support; MODE1: higher compute consumption, supports structured-light and ToF fusion as well as HDR, dense depth at close range and sparse depth at medium-to-long range; MODE2: moderate compute consumption, supports mToF HDR mode, does not include structured-light reconstruction, sparse point cloud across the full range;

		$< 1\% @ (60\text{ cm} \sim 8\text{ m})$
	FOV	Max FOV: $H98^\circ \times V72^\circ (\pm 3^\circ)$
	Spatial Angular Resolution	$\leq 2.5^\circ @ 6\text{ m}$, 90% reflectivity white wall ⁵
RGB Image Performance	Resolution / Frame Rate	$\geq 800 \times 600 @ 10\text{ fps}$
	Native FOV	$H95^\circ \times V75^\circ (\pm 3^\circ)$; it is recommended to keep this FOV unobstructed in structural design
	FOV After Distortion Correction	$H89^\circ \times V73^\circ (\pm 3^\circ)$
RGBD Alignment	RGBD Alignment	Built-in RGBD extrinsic calibration; supports RGB and ToF hardware synchronization
Synchronization & Fusion	Synchronization	Supports multi-camera master-slave mode
	Mode Support	MODE0 supports mToF AE mode; MODE1 supports sToF / mToF fusion HDR mode; MODE2 supports mToF HDR mode
System & Algorithms	System Compatibility	Supports Arm Linux
	Application Algorithm	Supports 3D SLAM algorithms based on area-array point clouds when paired with the Nebula 411

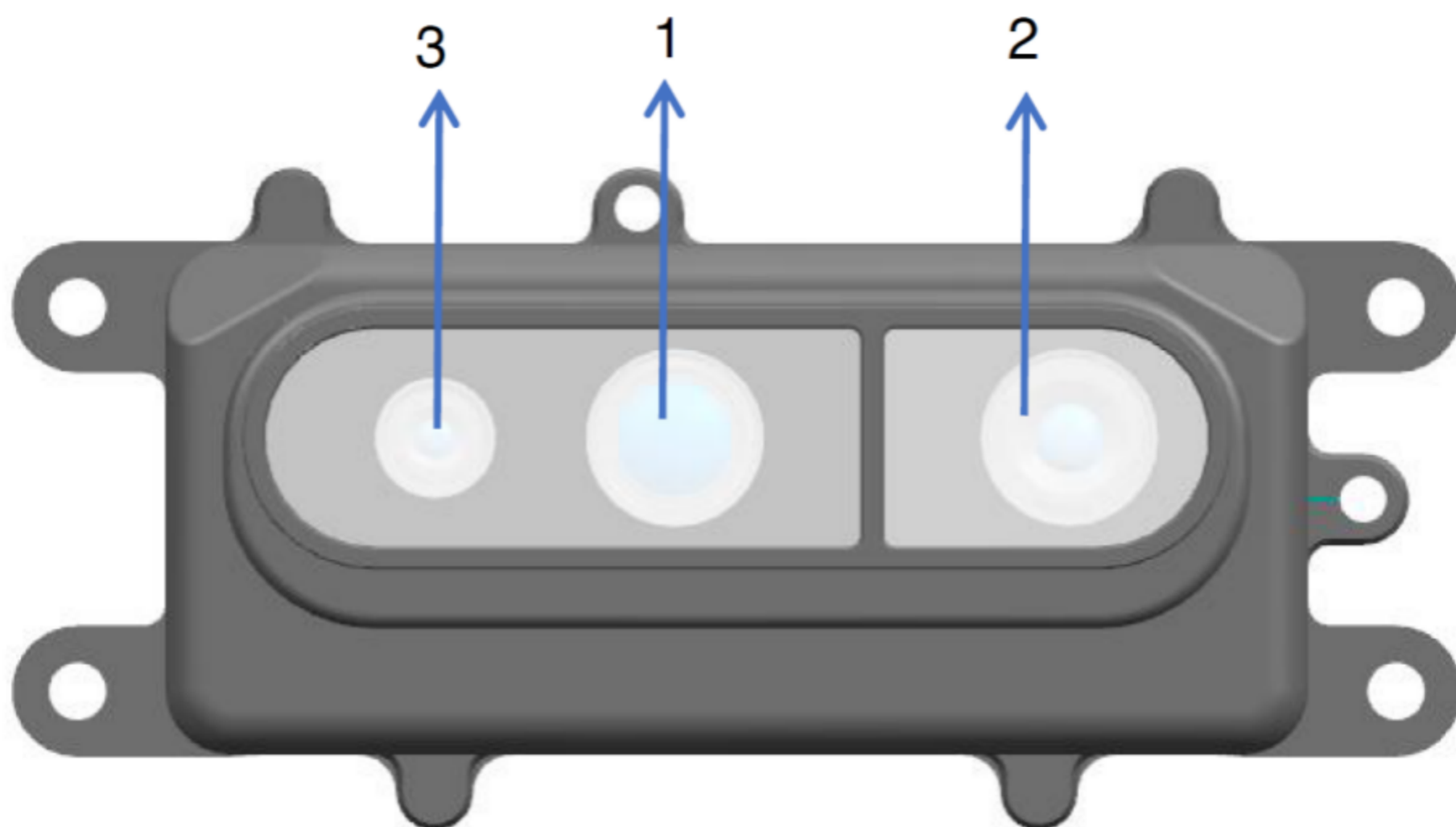
4 Module Dimensions & Structure



4.1 Module Description

The Nebula 411 optical module consists of a ToF Camera (No. 1), a Dot Projector (No. 2), and an RGB Camera (No. 3), and is equipped with mounting ears and a wafer connector. The module measures 65.8 mm × 30.2 mm × 20.8 mm with a 17.95 mm baseline; The mounting hole dimensions specified in the structural drawing are 45.00 mm ± 0.1 / 12.00 mm ± 0.1. Locate the camera at through-hole 2 (Ø2.10 mm), and secure the camera with an M2.5 screw at through-hole 4 (Ø2.60 mm). Avoid structural deformation when installing the optical module, as it will degrade short-range depth accuracy. Dimensional data and images may differ slightly depending on the specific product configuration; please refer to the actual product. The product 3D drawing includes the safety FOV; refer to the camera 3D drawing for

stacking design.



Module Layout Diagram (numbers correspond to the System Components table)

System Components	No.
ToF Camera (ToF receiving camera)	1
Dot Projector	2
RGB Camera	3

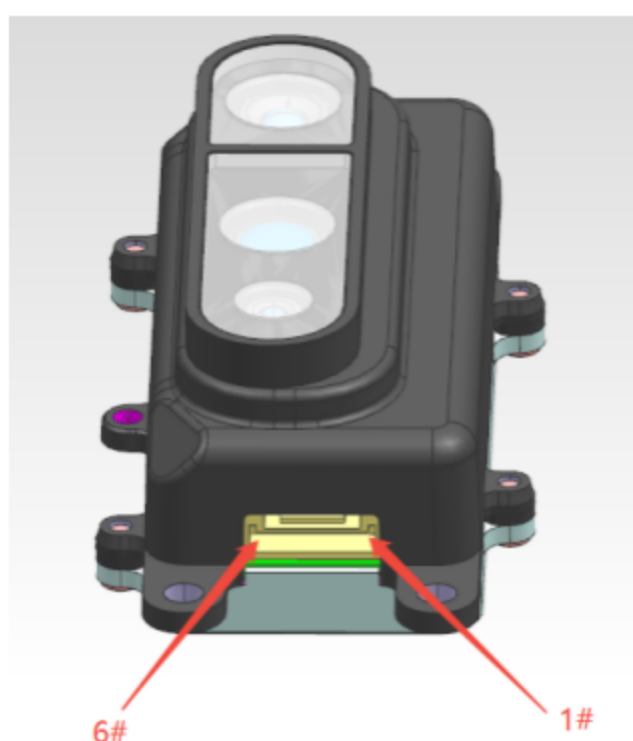
5 Key Component Specifications

Item	Key Parameter	Specification
ToF Sensor	Active Array Size	240 × 180
ToF Sensor	Pixel Size	10 × 10 μm
ToF Sensor	QE @ 940 nm	30%
ToF Sensor	Operating temperature range	-20°C ~ +85°C

ToF Lens	F/NO	1.4
ToF Lens	FOV	98.3°(H) × 79.2°(V) × 115.6°(D)
ToF Lens	EFL	1.09 mm
ToF Lens	TTL	7 mm
TX	Optical Power	700 mW
TX	Center Wavelength	940 nm
TX	Eye Safety	Class I
TX	F/NO	2.4
TX Lens	FOV	101.1°(H) × 83.6°(V) × 117.3°(D)
TX Lens	EFL	0.695 mm
TX Lens	TTL	4.8 mm
RGB Sensor	Active Array Size	1600 × 1200
RGB Lens	FOV	95°(H) × 75°(V)

6 Module Electrical Requirements

6.1 PIN Definition



PIN NO.	Name	Type	Description
1	VBUS	Power	5 V power supply, ≥ 1.5 A, 2 A recommended
2	DM	I/O	Data line negative (differential, USB_D-)
3	DP	I/O	Data line positive (differential, USB_D+)
4	GND	G	Ground (GND)
5	TRIGGER ⁶	I/O	Sync signal Trg (1.8V, 5 mA)
6	GND	G	Ground (GND)

7 Environment & Reliability

Item	Parameter	Specification
Operating Environment	Temperature	-10°C ~ +45°C
	Humidity	0% ~ 95% RH, non-condensing
	Illuminance	0 ~ 40,000 lux (indoor / outdoor)
Storage Environment	Temperature	-40°C ~ +65°C
	Humidity	10% ~ 90% RH, non-condensing

8 Certification

Item	Specification
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Laser Eye Safety	Class 1 laser safety
Environmental Certification	RoHS 2.0

9 Software Development

Customers can use the Deptrum Stream SDK for secondary development to obtain point cloud data. The SDK supports Windows / Linux / Android platforms and x86_64 and ARMv7 / ARMv8 architectures, with specific performance optimizations for embedded architectures. For detailed usage, refer to the documentation included with the SDK.

10 Disclaimer

The device application information and similar content described in this publication are provided for your convenience only and may be superseded by updated information. It is your responsibility to ensure that your application complies with the applicable technical specifications. Shenzhen Deptrum Technology Co., Ltd. makes no representations or warranties of any kind, express or implied, written or oral, statutory or otherwise, including but not limited to representations or warranties regarding use, quality, performance, merchantability, or fitness for a particular purpose. Deptrum assumes no liability arising from this information or its use. Deptrum products shall not be used as critical components in life support systems without the written approval of Shenzhen Deptrum Technology Co., Ltd. No license is conveyed, implicitly or otherwise, under any Deptrum intellectual property rights.

11 Technical Support

You can obtain support through the following channels:

- Email support: please send specific questions to support@deptrum.com
- FAE support: please contact our sales team for FAE support access

12 Precautions

- Do not heat this product with any other heat source.
- Do not drop or strike this product, as this may damage internal components and degrade accuracy; improper handling may damage internal elements.
- Do not attempt to modify or disassemble this device in any way, as this may damage the module and degrade accuracy.
- The module heats up after a period of use, which is normal; heat dissipation may be applied to the back of the module.
- Do not store the module in a high-temperature, high-humidity environment, as this may degrade module accuracy or cause depth reconstruction failure.