ORBBEC

DATASHEET
Document classification: Public

ORBBEC® 3D Camera
Gemini 2 Series

ORBBEC Inc.

Gemini 2 / Gemini 2 L

Revision History

Version	Date	Note
V1.0	2023.2.7	Initial release
V1.1	2023.3.24	● Modify product brief, product features, application scenarios, recommended system ● Modify product specification sheet ● Modify Figure 1-4-1 sensor arrangement ● Modify PS(PROXIMITY SENSOR) of 2.4.4 to LDP ● Modify the no blind area content of 3.4 and list it separately as 3.7 for detailed explanation ● Modify Table 3-6-1 and Table 3-6-2 resolution and frame rate ● Modify 3.8 Depth start point parameter ● Modify Table 3-12-1 to add typical scenarios ● Modify the fixed trigger of 3.12 to the specific trigger ● Modify the arbitrary frequency passive trigger of 3.13 to free trigger mode ● Modify 3.15 Multi-Camera Synchronization error data ● Modify Multi-Camera Synchronization description in Table 3-16-1 ● Add electronic performance parameters in Table 3-16-2 ● Modify resolution and FPS of Binned Sparse Default in Table 4-1-2
V1.2	2023.4.24	● Modify product lifetime description ● Modify Table 3-6-2 image format ● Modify 3.15 Muti-Camera Synchronization time error data ● Delete Image Mirroring and Dynamic Switching ● Modify 7.3 camera glass parameter description
V1.3	2023.6.26	● Add Gemini 2 L

Content

1 Description and Features

Orbbec Gemini 2 Series is a new generation depth camera product based on active stereo technology. This series of products provides a complete range of depth modules, RGB color modules, image signal processors, and depth computing engines. This cameras provide six-axis IMU/inertial data and high quality RGB images. This series also integrates the hardware depth image and color image spatial alignment function, which saves computing power of the host computer. The camera comes with a variety of depth operating modes to choose from to adapt to different application scenarios. It provides flexible and rich frame synchronization and multi-camera synchronization functions. It supports the Orbbec SDK, a unified development toolkit across platforms.

Usages / Markets	● Robot ● AVG / AMR ● 3D body/object scan ● Dimension ● Body tracking ● AR/VR ● Gesture control
System Requirements	**x86/x64** ● OS:Windows 10、Ubuntu18.04/20.04 ● Connector:USB 3.0/USB 2.0 ● CPU:qual-core, 2.9GHz ● RAM:4GB **ARM** ● OS:Ubuntu18.04/20.04、Android 7or above ● Connector:USB 3.0/USB 2.0 ● CPU:Jetson Nano or A311D(quad-core Cortex-A73,dual- core Cortex-A53) ● RAM:4GB ● Support LibUSB + LibUVC ● Support UVC
General Feature	● Hardware Align (Depth to Color) ● No Blind Zone ● Infrared (IR) Laser Projector ● Free Trigger Mode ● Multi-Camera Synchronization Function ● Depth Working Modes

Product Specification

		Gemini 2	Gemini 2 L
Feature	Name		
	Use Environment	Indoor/semi-outdoor	Indoor/semi-outdoor
	Depth Range[1]	0.15m - 10m	0.25m - 10m
	Ideal Range	0.2m - 5m	0.2m - 7m
	Camera Driver	UVC	UVC
	SDK	Orbbec SDK	Orbbec SDK
Depth	Depth Technology	Stereo Structure Light	Stereo Structure Light
	Baseline	50mm	100mm
	Depth Accuracy[2]	≤ 2% (1280 x 800 @ 2m & 81% ROI)	≤ 2% (1280 x 800 @ 4m & 81% ROI)
	Depth Working Mode	Unbinned Dense Default Unbinned Sparse Default Binned Sparse Default	Unbinned Dense Default Unbinned Sparse Default Binned Sparse Default Dimensioning
	Depth Output Resolution	1280 x 800@30fps 640 x 400@60fps[3]	1280 x 800@30fps 640 x 400@60fps[3]
	Depth Field of View FoV	H91° / V66° / D101° ± 3° @ 2m	H91° / V66° / D101° ± 3° @ 4m
	Shutter Type	Global shutter	Global shutter
IR	IR Image Output Resolution	1280 x 800@30fps 640 x 400@60fps[3]	1280 x 800@30fps 640 x 400@60fps[3]
	IR FoV	H93° / V66.5° / D102° ± 3°	H94° / V68° / D104° ± 3°
RGB	Color Image Output Resolution	1920 x 1080@30fps 1280 x 720@60fps[3]	1280 x 800@30fps 1280 x 720@60fps[3]
	RGB FoV	16:9 H86° / V55° / D94° ± 3° 4:3 H63° / V50° / D75° ± 3°	H94° / V68° / D104° ± 3°
	Shutter Type	Rolling shutter	Global shutter
Function	D2C Depth Image FoV	16:9 H86° / V55° / D94° ± 3° @2m 4:3 H63° / V50° / D75° ± 3° @2m	16:10 H91° / V66° / D101°±3° @4m 16:9 H91° / V60° / D98±3° @4m 4:3 H65°/ V52°/ D78±3° @4m
	LDP[4]	Wavelength 940nm Distance measuring range: 0mm - 400mm	Wavelength 940nm Distance measuring range: 0mm - 400mm
	IMU	6 axis	6 axis
	IR Image AE Function	Support	Support
	UVC RGB Function	Support	Support
	Data Connection	USB 3.0 & USB 2.0	USB 3.0 & USB 2.0
Electrical	Power	Typical average[5] < 2.5W Max peak value[6] < 7.0W	Typical average[5] < 3.0W Max peak value[6] < 10.0W

	Power Input	DC 5V ≥1.5A	DC 5V ≥2A
Physical	Ambient Temperature	0℃ - 40℃	0℃ - 40℃
	Working Humidity	＜ 95 %RH (non-condensing)	＜ 95 %RH (non-condensing)
	Storage Temperature	-20℃ - 60℃	-20℃ - 60℃
	Multi-Camera Connector	8-Pin	8-Pin
	Connector	Type-C	Type-C
	Size	90 x 25 x 30 mm ± 0.5mm	124 x 29 x 26 mm ± 0.5mm
	Weight	98g ± 2g	152g ± 2g
	IP Rating	Basic dust protection	Basic dust protection
	Mounting Mechanism	1 x 1/4-20 UNC thread mounting point 2 x M3 thread mounting points	1 x 1/4-20 UNC thread mounting point 2 x M3 thread mounting points
	Heat Dissipation	Passive heat transfer	Passive heat transfer
Others	Certification	Class 1、RoHS、FCC、CE、Reach、KC	Class 1、RoHS、FCC、CE、Reach、KC
	Lifetime[7]	3 years	3 years

Notes:

[1] Measure object reflectivity > 10%, up to 10m distance depth data, but the actual accuracy varies with the distance and the object to be measured.

[2] The test object is a reflectivity > 80% plane, and the reference range is 81% FoV (81% FoV is the remaining center 81% of the depth map area after cropping 5% of the top and bottom of the depth map). The root mean square of the distance sequence from all valid points in the area to the best-fit point of the fitted plane is calculated.

[3] 60* fps for depth images in Binned Sparse Default mode.

[4] The actual working range output value range of LDP is 1mm - 400mm in 1mm..

	Gemini 2	Gemini 2 L
Unbinned Dense Default	Depth:1280x800@30fps Y14 RGB:1920x1080@30fps MJPEG	Depth:1280x800@30fps Y14 RGB:1280x800@30fps MJPEG
Unbinned Sparse Default	Depth:1280x800@30fps Y14 RGB:1920x1080@3fps MJPEG	Depth:1280x800@30fps Y14 RGB:1280x800@30fps MJPEG
Binned Sparse Default	Depth:640x400@30fps Y14 RGB:1920x1080@30fps MJPEG	Depth:640x400@30fps Y14 RGB:1280x800@30fps MJPEG
Dimensioning	/	Depth:1280x800@30fps Y14 RGB:1280x800@30fps MJPEG

[5] Typical operating modes are:

[6] Maximum average for peak power consumption when depth mode is Unbinned Dense Default with both RGB and Depth data streams turned on:

	Gemini 2	Gemini 2 L
Depth Work Mode	Unbinned Dense Default	Unbinned Dense Default
RGB	1920x1080@30 fps MJPEG	1280x800@30 fps MJPEG
Depth	1280x800@30 fps RLE	1280x800@30 fps RLE
Exposure	5000us	3000us
Laser Energy Level	5	7

[7] Operating in typical working mode within the supported temperature(0-40℃) for up to 8 hours a day.

2 Introduction

2.1 Purpose

This document describes the specifications and some design details of ORBBEC® Gemini 2 Series depth camera products, as well as for developers to understand and use the related products.

2.2 Terminology

Table 2- 2-1 Terminology Description

Term	Description
Baseline	Distance between left and right infrared camera imaging centers
Depth	The depth video stream is basically the same as the color video stream, except that each pixel value represents the spatial depth of the observed object from the camera, rather than the color information in the color image.
FoV	Field of view, used to describe the angular range of the camera to observe a given scene, there are three main horizontal field of view (H FoV), vertical field of view (V FoV) and diagonal field of view (D FoV).
Depth Processor	Depth computation processor, a dedicated ASIC chip for implementing depth computation algorithms and outputting depth images, such as MX6600.
IR Camera	Infrared camera, or infrared camera.
LDMP/LDM	Laser modules, also known as IR projector, etc., for emitting structured light patterns.
Depth Camera	Only the depth imaging module and the external interface are included, where the depth imaging module generally consists of an infrared projector, an infrared camera and a depth computing processor.
PS	Proximity Sensor, a proximity sensor for laser safety protection.
ISP	Image signal processor for post-processing of images.
LDP	Proximity Sensor for laser safety protection and distance measurement.
IR Flood	IR floodlight, using infrared light to illuminate the environment, used to fill the infrared imaging light.
Lens	Lens sets for imaging in infrared cameras, color cameras, and for projection in laser diffuser.
MIPI	MIPI Alliance, the Mobile Industry Processor Interface (MIPI) Alliance, is an open standard and a specification for mobile application processors initiated by the MIPI Alliance.
SoC	System on Chip, also known as System on Chip, means that it is a product that is an integrated circuit with a dedicated target that contains a complete system with embedded software in its entirety.
ASIC	ASIC is considered to be an integrated circuit designed for a specific purpose. It is an integrated circuit designed and manufactured in response to specific user requirements and the needs of a specific electronic system. ASIC are characterized by being oriented to the needs of specific users. ASIC have the advantages of smaller size, lower power consumption, increased reliability, improved performance, enhanced confidentiality, and lower cost when compared to general-purpose integrated circuits in mass production. In this document, it mainly refers to MX6600.
PCBA	PCB(Printed Circuit Board) that carry deep computing processors, memories and other electronic devices.

TBD	TBD, information will be provided in a later revision.

2.3 Introduction to Active Stereo 3D Imaging Technology

Gemini 2 Series is a depth camera based on active stereo 3D imaging technology, which consists of IR Left and IR Right cameras, a laser projection module (LDM), and a depth computation processor (MX6600). The laser projection module is used to project structured light patterns (scatter patterns) to the target scene (Scene), the left IR camera and the right IR camera acquire the left IR structured light image and the right IR structured light scatter pattern respectively, and the depth computation processor receives the left IR structured light image and the right IR structured light image, then executes the depth computation algorithm and outputs the depth image of the target scene.

2.4 Depth Field of View at Distance(Depth Z)

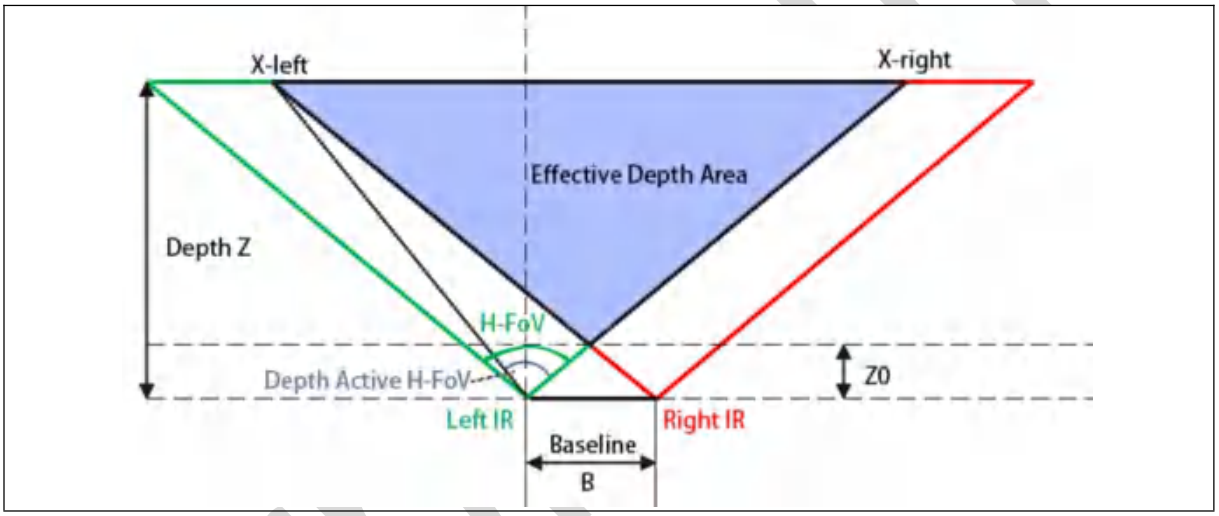


Figure2-4-1 Depth Field of View to Depth Map Illustration

Depth Field of View (Depth FOV) at any distance (Z) can be calculated using the following equation:

$$\text{Depth Active H-FoV} = \arctan\left(\frac{cx}{fx} - \frac{B}{Z}\right) + \arctan\frac{\text{width} - 1 - cx}{fx}$$

$$H-FoV = \arctan\frac{cx}{fx} + \arctan\frac{width - 1 - cx}{fx}$$

$$Z0 = \frac{B}{2\left(\tan\frac{H-FoV}{2}\right)}$$

Definitions:

1. cx = X-direction image coordinates of the main point of the depth image
2. fx = Depth camera focal length
3. width= Depth image width
4. H-FoV = IR H-FoV

Note:

1. cx, fx, and width parameters are obtained through the SDK Depth Intrinsic for the relevant camera parameters, and each depth camera parameters are not the same.

2. At different distances, the depth FoV is different. The farther the distance, the greater the depth FoV.

2.5 Depth Camera System Framework

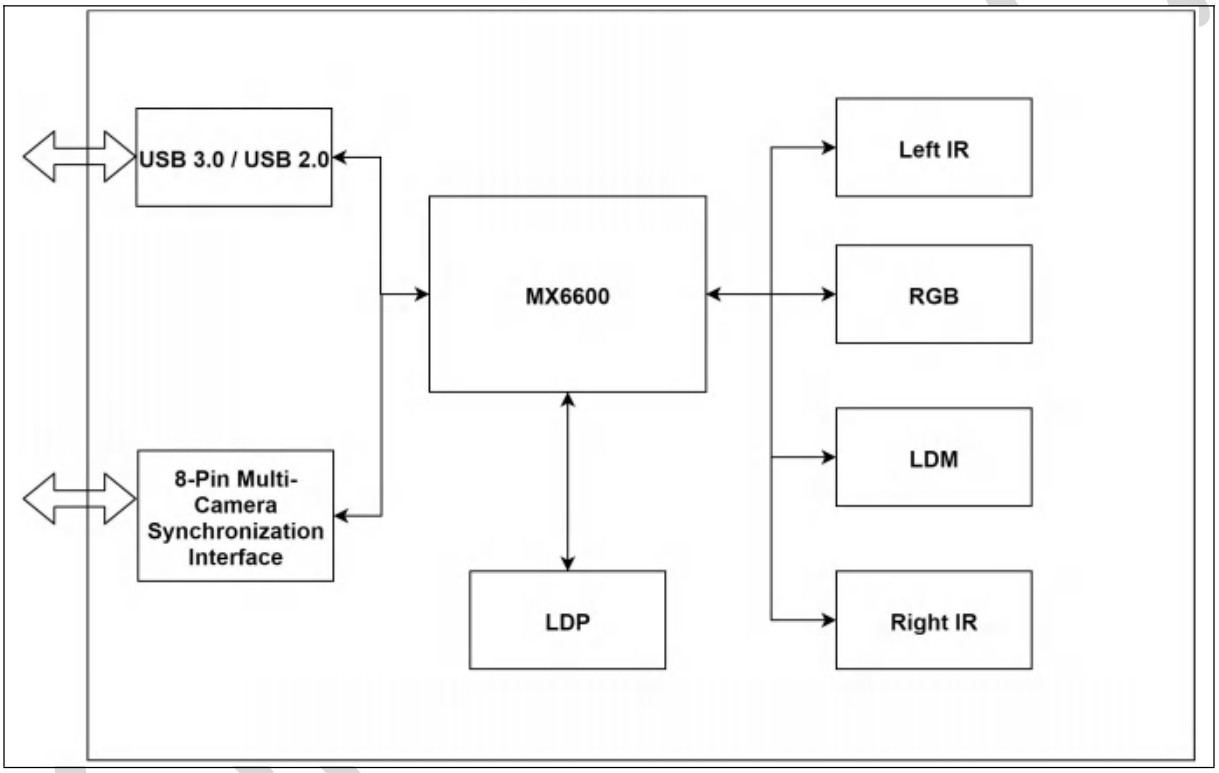


Figure 2-5-1 Gemini 2 Series System Framework Diagram

3 Product Composition

3.1 Component Composition

This section will introduce the basic structure of Gemini 2 Series depth camera. Structure size data and pictures may cause slight differences due to product specific configuration differences, please refer to the actual product.

3.1.1 Product Physical Picture

Figure 3-1-1 Gemini 2 Front View

Figure 3-1-2 Gemini 2 Rear View

Figure 3-1-3 Gemini 2 Top View

Figure 3-1-4 Gemini 2 L Front View

Figure 3-1-5 Gemini 2 L Rear View

Figure 3-1-6 Gemini 2 L Top View

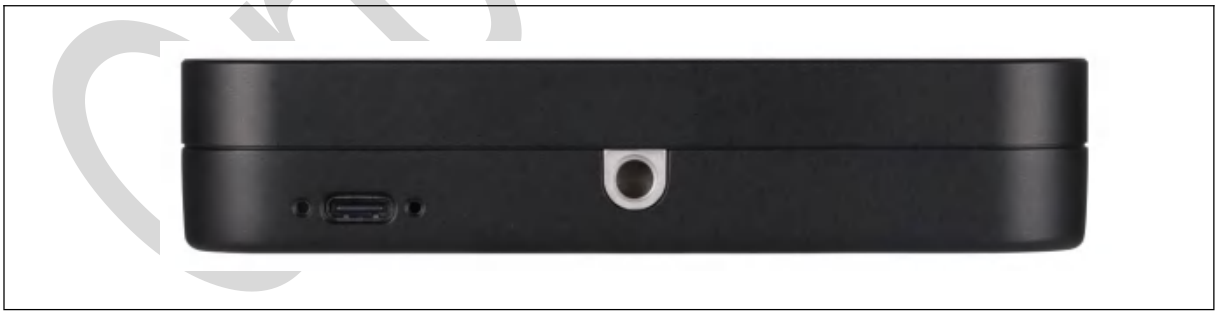


Figure 3-1-7 Gemini 2 L Bottom View

3.1.2 Camera Dimension

Table 3-1-1 Gemini 2 Dimension

Dimension	Nominal	Unit
Width	90	mm
Height	25	mm
Depth	30	mm

Gemini 2 dimension diagram:

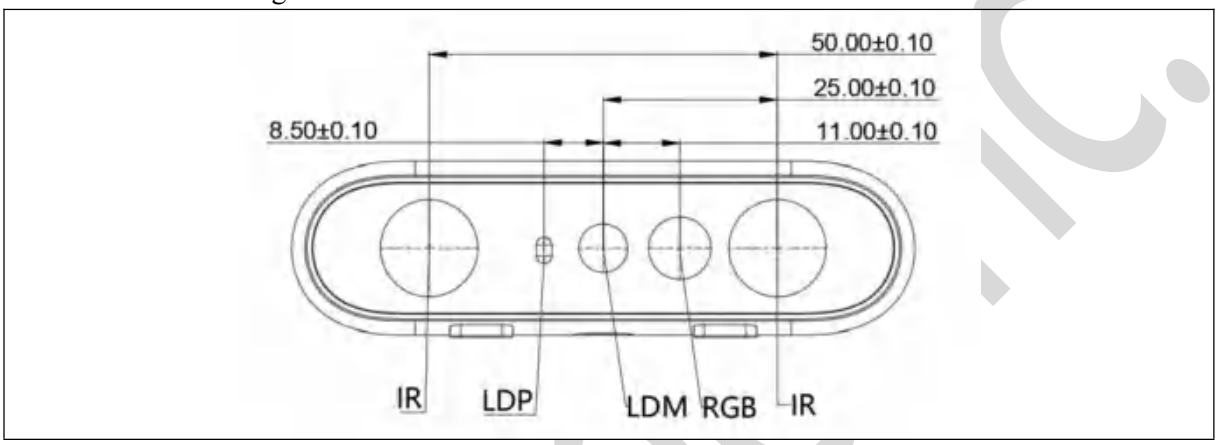


Figure 3-1-8 Front View

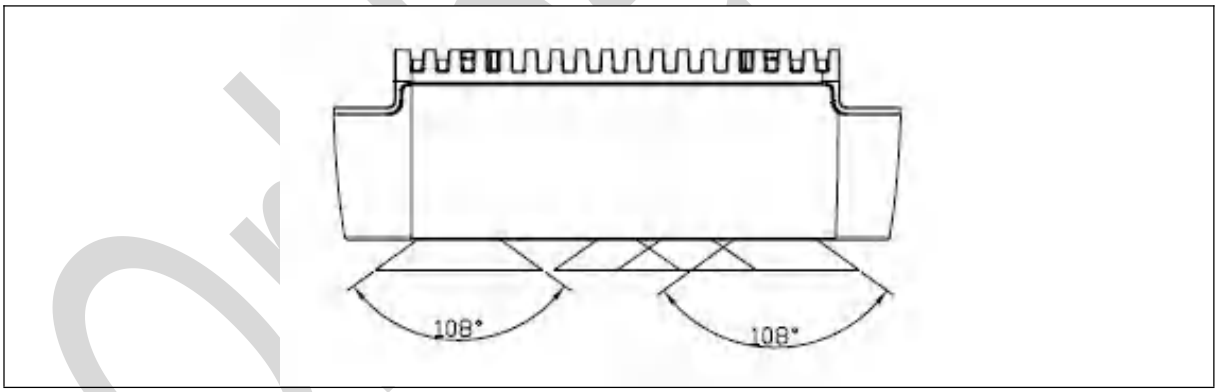


Figure 3-1-9 Top View

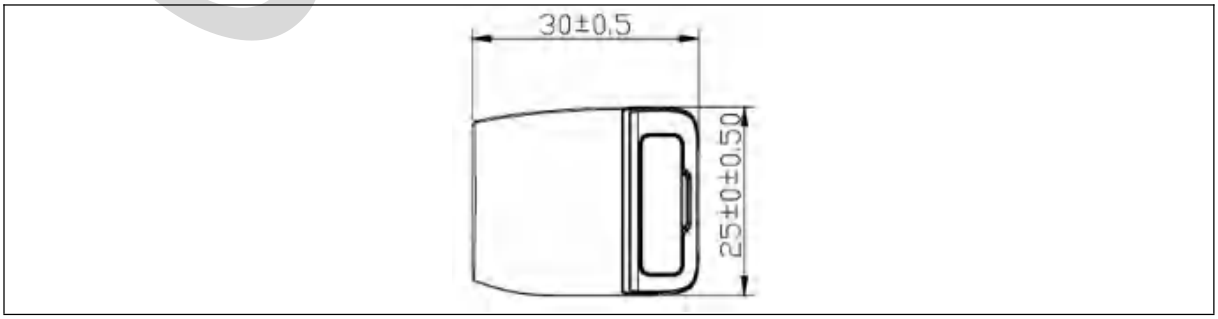


Figure 3-1-10 Right View

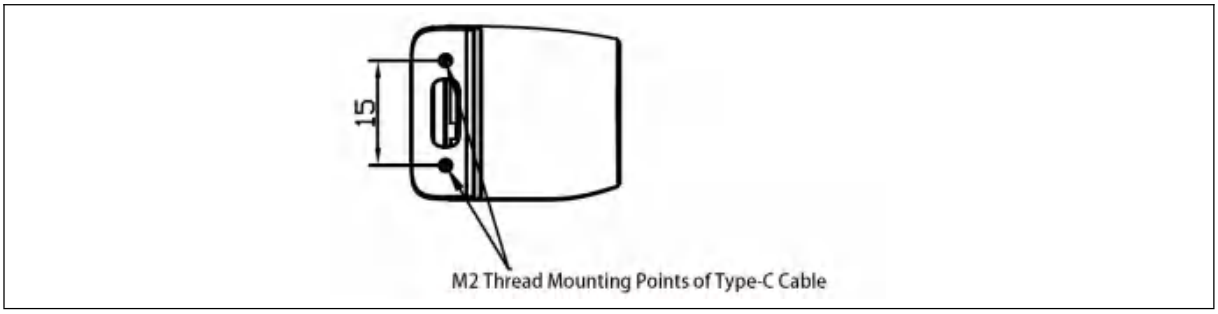


Figure 3-1-11 Left View

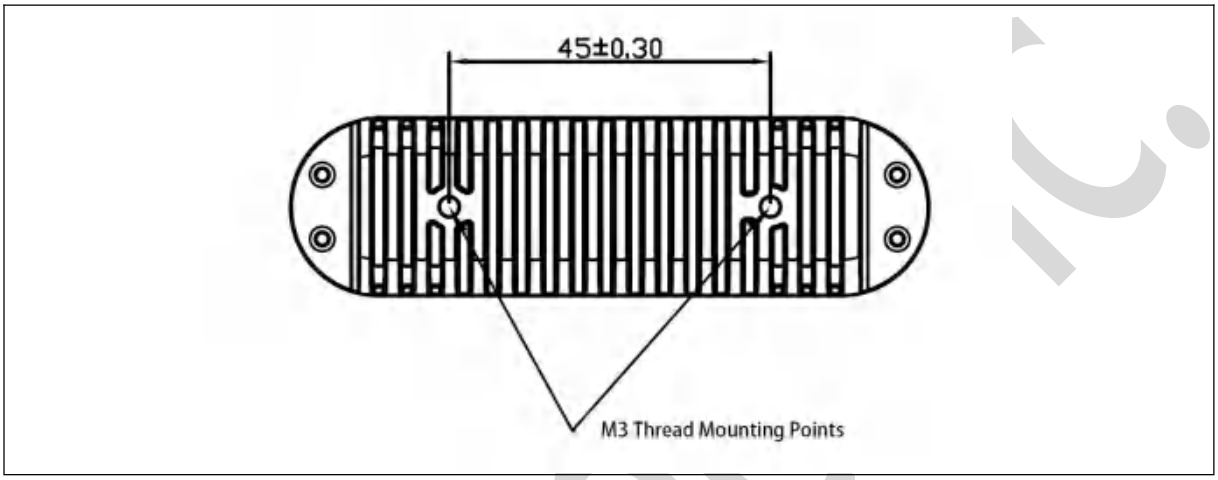


Figure 3-1-12 Rear View

Table 3-1-2 Gemini 2 L Dimension

Dimension	Nominal	Unit
Width	124	mm
Height	29	mm
Depth	26	mm

Gemini 2 L dimension diagram:

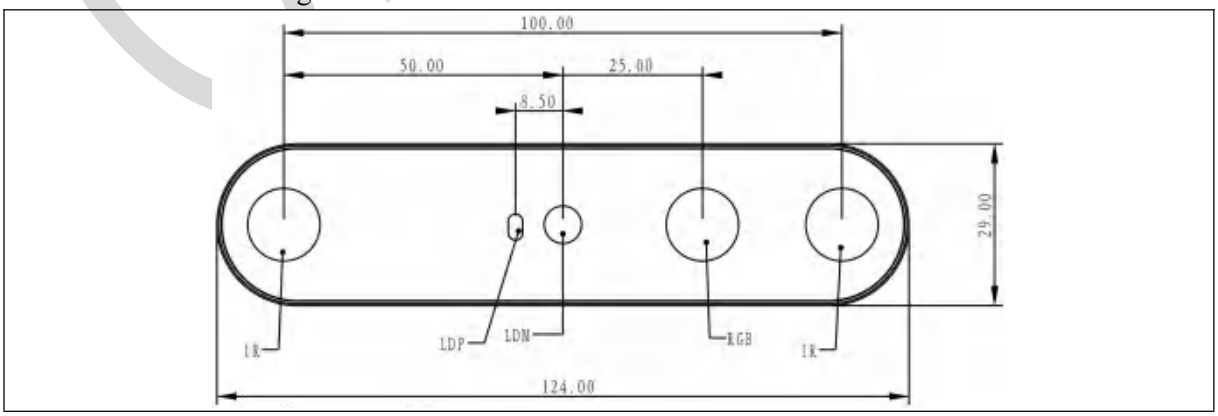


Figure 3-1-13 Front View

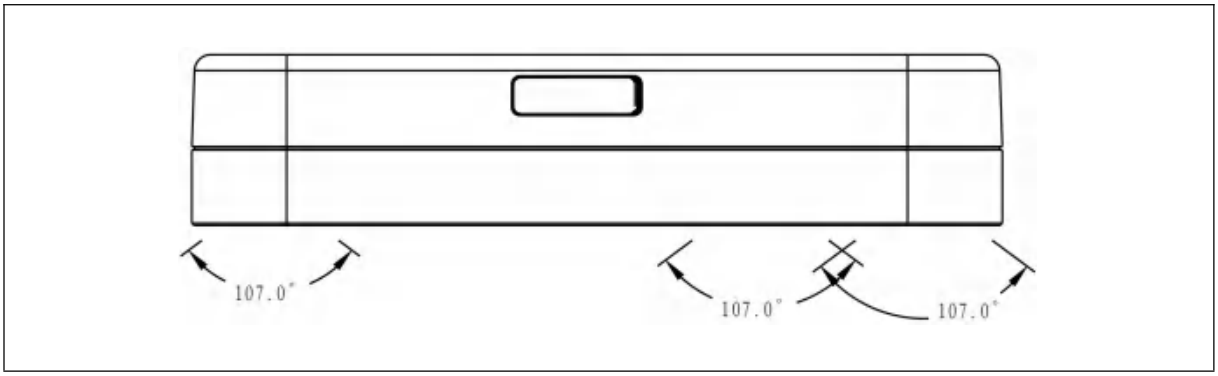


Figure 3-1-14 Top View

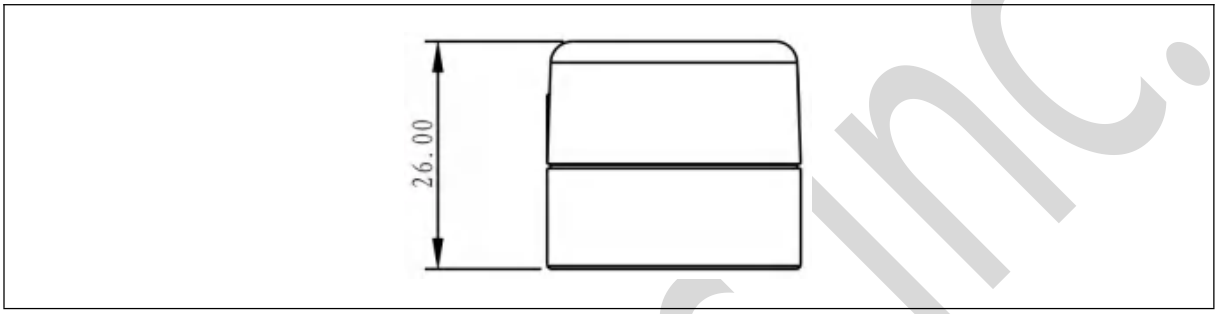


Figure 3-1-15 Side View

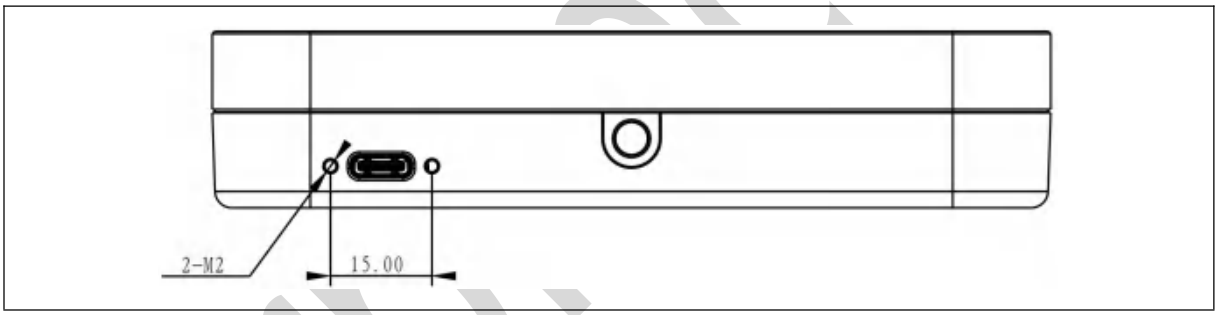


Figure 3-1-16 Bottom View

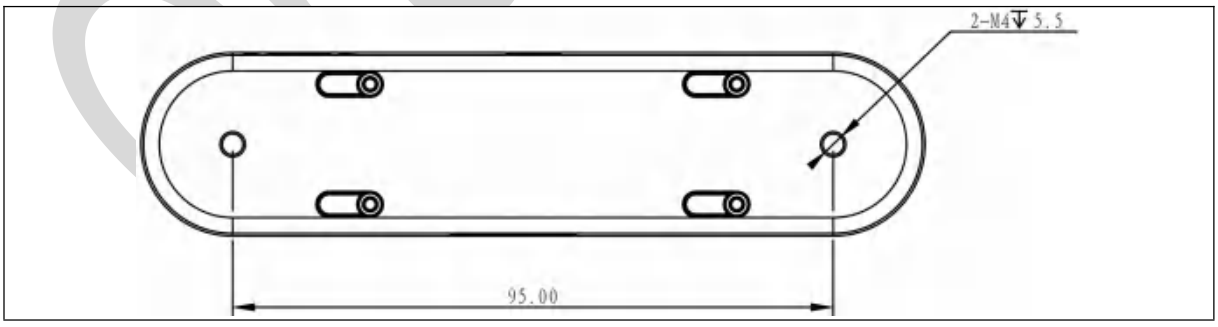


Figure 3-1-17 Rear View

3.2 Component Description

Figure 3-2-1 Gemini 2 Series Product Diagram

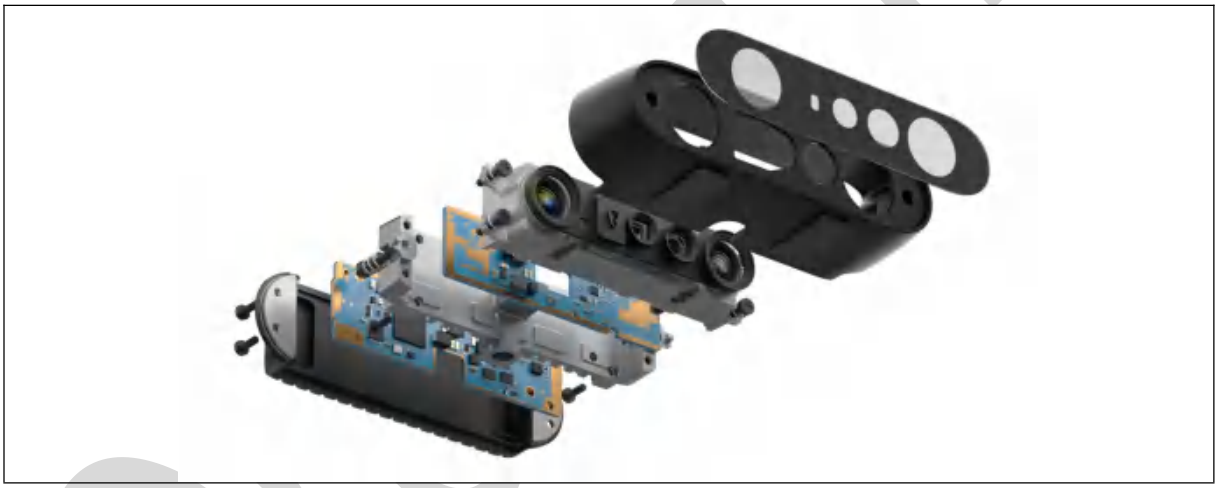


Figure 3-2-2 Exploded View

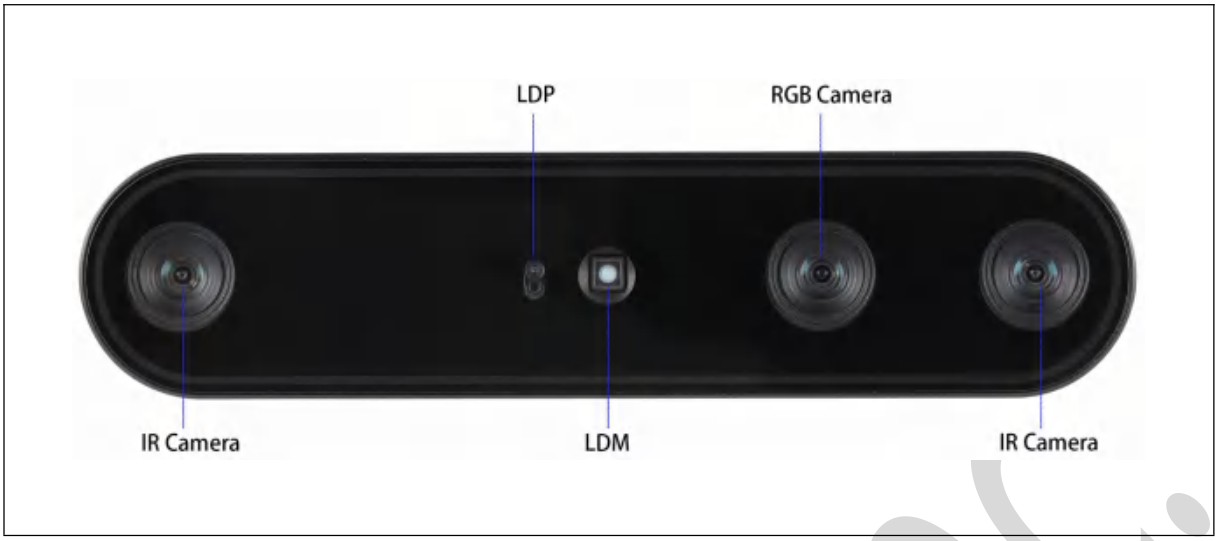


Figure 3-2-3 Gemini 2 L Product Diagram

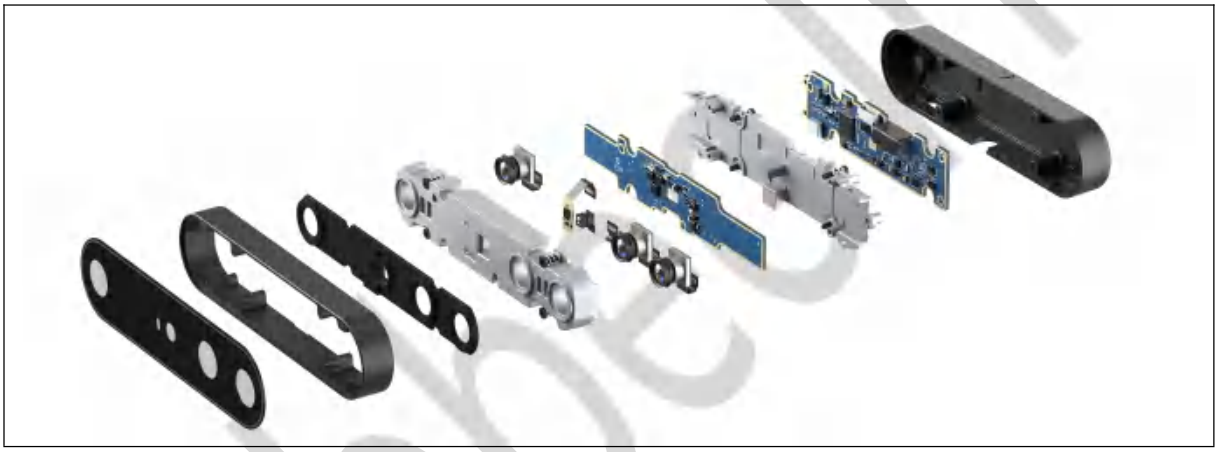


Figure 3-2-4 Gemini 2 L Exploded View

3.3 Depth Engine

The Depth Computing Processor MX6600 is primarily used to perform depth image calculations. The host computer communicates with the depth camera via Type-C and receives image data from the Depth Computing Processor.

3.4 Depth Camera Module

3.4.1 Infrared Camera

Table 3-4-1 Infrared Camera Parameter

Parameters	Gemini 2 / Gemini 2 L
Effective Pixels	1280 x 800
Aspect Ratio	16 : 10

Focal Length	Fixed focus
Shutter Type	Global shutter
Signal Interface	MIPI
Horizontal FoV	94°
Vertical FoV	68°
Diagonal FoV	104°
FoV Error	±3.0°

3.4.2 Laser Module

The laser module (LDM), consists of an array of vertical cavity surface emitting lasers and a spot diffuser. It improves the ability of the depth camera system to detect depth information by projecting static infrared patterns on the scene to add texture to low-quality scenes. Under normal conditions, the Gemini 2 Series laser module complies with Class 1 Laser Product.

Table 3-4-2 Laser Module Parameters

Parameters	Gemini 2 / Gemini 2 L
Type	Infrared
Lighting Component	Vertical Cavity Surface Laser Emitter(VCSEL) + Optics
Laser Controller	Pulse
Wavelength	850nm
Horizontal FoV	101°
Vertical FoV	72.5°
FoV Error	±3.0°

3.4.3 Color Camera

Table 3-4-3 Color Camera Parameters

Parameters	Gemini 2	Gemini 2 L
Effective Pixels	1920 x 1080	1280 x 800
Aspect Ratio	16:9	16:10
Format	MJPEG & YUYV	MJPEG & YUYV
Focal Length	Fixed focus	Fixed focus
Shutter Type	rolling shutter	rolling shutter
Signal Interface	MIPI	MIPI

Horizontal FoV	86.2°	94°
Vertical FoV	55.2°	68°
Diagonal FoV	94.2°	104°
FoV Error	±3.0°	±3.0°

3.4.4 Proximity Sensors(LDP)

Gemini 2 Series supports LDP, which detects objects in close proximity and is used to enable laser safety protection.

Gemini 2: LDP protection standard is ≤ 10cm.

Gemini 2 L: LDP protection standard is ≤ 15cm.

The LDP function is tested as follows.

Camera system will decrease or even turn off the power supply and IR image brightness as the object is moving close to the camera, this is because of the laser safety protection Triggered,During this stage,IR image brightness value will reducing below the origin value.then when the object is going far away from the camera, what happened above that are being restored and laser safety protection turned off at the end.

Table 3-4-4 LDP Test Distance Data

Depth Mode:Unbinned Dense Default					
Laser State	Laser protection range / mm（Typical measurements）				
	Wall	Plank	Skin on the back of the hand	Brown leather	Cardboard box
Laser ON (Test object from near to far from the module)	102	100	104	101	101
Laser OFF (Test object from near to far from the module)	100	100	100	100	101

3.4.5 Gemini 2 Series Interface

Gemini 2 support Type-C and 8-Pin multi-camera synchronization :

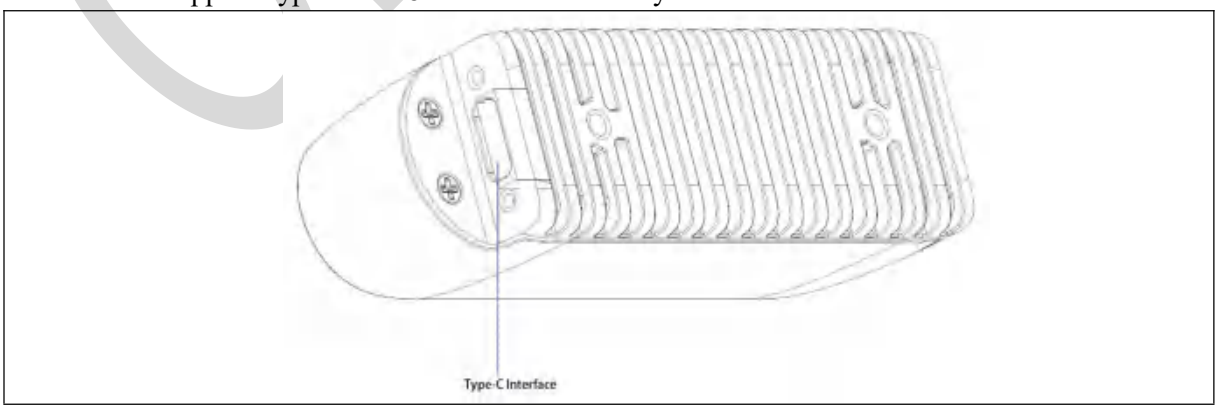


Figure 3-4-1 Type-C Interface

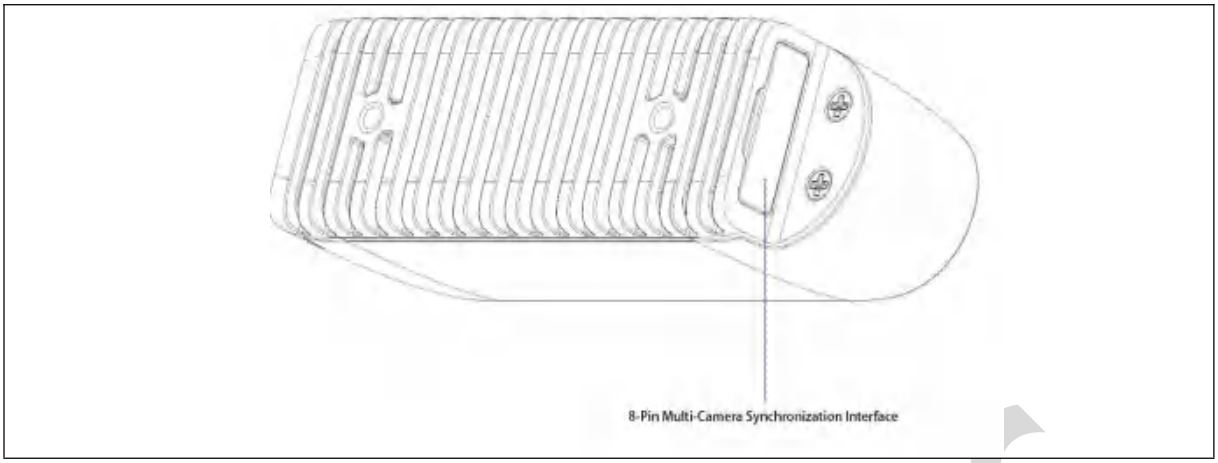


Figure 3-4-2 8-Pin Multi-Camera Synchronization Interface

Gemini 2 L support Type-C and 8-Pin multi-camera synchronization :

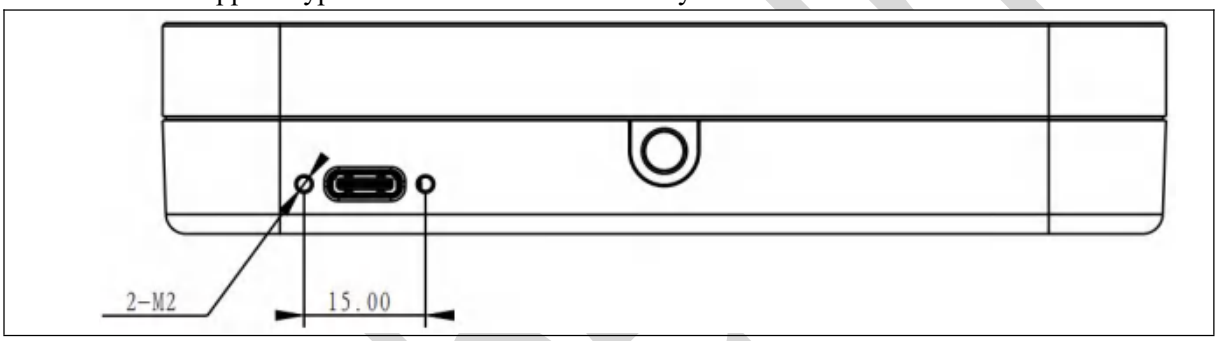


Figure 3-4-3 Type-C Interface

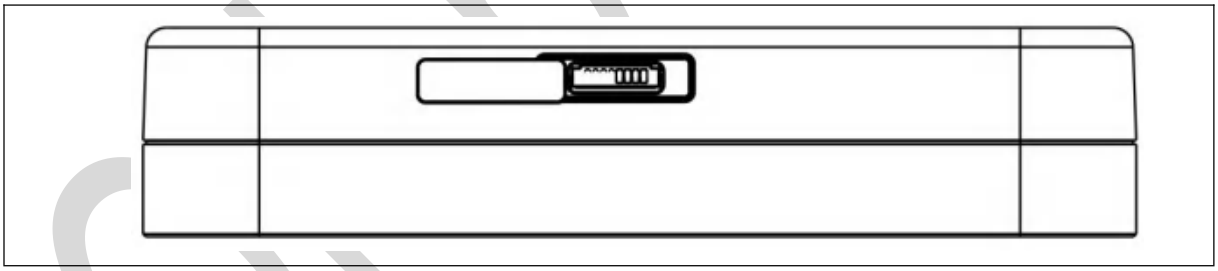


Figure 3-4-4 8-Pin Multi-Camera Synchronization Interface

4 Functional Specification

4.1 Vendor Identification(VID) and Product Identification(PID)

Table 4-1-1 Gemini 2 Series VID and PID

Name	Model	VID	PID
Gemini 2	G20155-15	0x2BC5	0x0670
Gemini 2 L	G20055-15	0x2BC5	0x0673

4.2 Platform and System Requirements

This product connects to the host computer via Type-C, for different platforms and systems requirements.

Table 4-2-1 Gemini 2 Series Platforms and Systems

Chip	x86 / x64		ARM		
OS	Windows 10	Ubuntu 18.04/20.04	Android 8/9/10	Ubuntu 18.04/20.04	ROS / ROS2
USB	USB 3.0 & USB 2.0	USB 3.0 & USB 2.0	USB 3.0 & USB 2.0(support host)	USB 3.0 & USB 2.0(support host)	USB 3.0 & USB 2.0(support host)
CPU	Quad-core, 2.9GHz	Quad-core, 2.9GHz	Quad-core Cortex-A73, dual-core Cortex-A53	Quad-core Cortex-A73, dual-core Cortex-A53	Quad-core Cortex-A73, dual-core Cortex-A53
RAM	8GB	4GB	4GB	4GB	4GB

4.3 Depth Image of FoV

The following table shows the values of the depth FoV for Gemini 2 Series, including horizontal FoV, vertical FoV, diagonal FoV and FoV error.

Table 4-3-1 Gemini 2 / Gemini 2 L Depth Image of FoV

Parameters	Gemini 2 / Gemini 2 L
Horizontal FoV	91°
Vertical FoV	66°
Diagonal FoV	101°
FoV error	±3.0°

4.4 Depth Data Streams

Gemini 2 Series can output depth data streams., depth image data is generated via active stereo technology, which can acquire and output depth data of objects between 0.15m - 10m. The format of the depth stream output is Y14/RLE.

4.5 Color Image Data Streams (UVC)

The Gemini 2 Series can output depth data, as well as color image data. The color camera supports capturing and outputting color image data of objects. The format of the color image output is MJPEG and YUYV.

4.6 Depth and Color Image Data Stream Formats

Gemini 2 Series provides high quality, multi-resolution depth image data, as well as high definition color image data. The camera outputs depth image data in Y14/RLE as the camera output format (different data formats affect USB bandwidth usage), and the upper computer SDK outputs in Y16. The camera outputs color image data in MJPEG/YUYV format, and the SDK supports output in MJEPG/YUYV/RGB888 format.

Table 4-6-1 Gemini 2 (USB 3.0) Image Formats

Format	Resolution	Frame Rate(FPS)	Comment
Y14H14	1280 x 800	5, 10, 15, 30	Depth
	640 x 400	5, 10, 15, 30, 60*	
	320 x 200	5, 10, 15, 30, 60*	
RLE	1280 x 800	5, 10, 15, 30	
	640 x 400	5, 10, 15, 30, 60*	
	320 x 200	5, 10, 15, 30, 60*	
Y8H8	1280 x 800	5, 10, 15, 30	IR
	640 x 400	5, 10, 15, 30, 60*	
	320 x 200	5, 10, 15, 30, 60*	
MJPEG	1280 x 800	5, 10, 15, 30	
	640 x 400	5, 10, 15, 30, 60*	
	320 x 200	5, 10, 15, 30, 60*	
YUYV	1920 x 1080	5, 10, 15, 30	Color
	1280 x 720	5, 10, 15, 30, 60*	
	640 x 480	5, 10, 15, 30, 60*	
	640 x 360	5, 10, 15, 30, 60*	
MJPEG	1920 x 1080	5, 10, 15, 30	
	1280 x 720	5, 10, 15, 30, 60*	
	640 x 480	5, 10, 15, 30, 60*	
	640 x 360	5, 10, 15, 30, 60*	

Note: 60* fps is used in Binned Sparse Default

Table 4-6-2 Gemini 2 (USB 2.0) Image Formats

Format	Resolution	Frame Rate (FPS)	Comment
Y14H14	1280 x 800	5, 10	Depth
	640 x 400	5, 10, 15, 30	
	320 x 200	5, 10, 15, 30	

RLE	1280 x 800	5, 10	
	640 x 400	5, 10, 15, 30	
	320 x 200	5, 10, 15, 30	
Y8H8	1280 x 800	5, 10	IR
	640 x 400	5, 10, 15, 30	
	320 x 200	5, 10, 15, 30	
MJPEG	1280 x 800	5, 10	
	640 x 400	5, 10, 15, 30	
	320 x 200	5, 10, 15, 30	
YUYV	640 x 480	5, 10, 15, 30	Color
	640 x 360	5, 10, 15, 30	
MJPEG	1920 x 1080	5, 10, 15, 30	
	1280 x 720	5, 10, 15, 30	
	640 x 480	5, 10, 15, 30	
	640 x 360	5, 10, 15, 30	

Note: Single output video streams can meet all resolutions and frame rates, for two or three output depth and color video streams, limited by the actual bandwidth of USB2.0 and the performance of the host computer, some combinations are not supported..

Table 4-6-3 Gemini 2 L (USB 3.0) Image Formats

Format	Resolution	Frame Rate (FPS)	Comment
Y14H14	1280 x 800	5, 10, 15, 30	Depth
	640 x 400	5, 10, 15, 30, 60*	
	320 x 200	5, 10, 15, 30, 60*	
RLE	1280 x 800	5, 10, 15, 30	
	640 x 400	5, 10, 15, 30, 60*	
	320 x 200	5, 10, 15, 30, 60*	
Y8H8	1280 x 800	5, 10, 15, 30	IR
	640 x 400	5, 10, 15, 30, 60*	
	320 x 200	5, 10, 15, 30, 60*	
MJPEG	1280 x 800	5, 10, 15, 30	
	640 x 400	5, 10, 15, 30, 60*	
	320 x 200	5, 10, 15, 30, 60*	
YUYV	1280 x 800	5, 10, 15, 30	Color
	640 x 400	5, 10, 15, 30, 60*	
	320 x 200	5, 10, 15, 30, 60*	
MJPEG	1280 x 800	5, 10, 15, 30	
	1280 x 720	5, 10, 15, 30, 60*	
	800 x 600	5, 10, 15, 30, 60*	
	640 x 400	5, 10, 15, 30, 60*	
	640 x 360	5, 10, 15, 30, 60*	

Note: 60* fps is used in Binned Sparse Default

Table 4-6-4 Gemini 2 L (USB 2.0) Image Formats

Format	Resolution	Frame Rate (FPS)	Comment
Y14H14	1280 x 800	5, 10	Depth
	640 x 400	5, 10, 15, 30	
	320 x 200	5, 10, 15, 30	
RLE	1280 x 800	5, 10	
	640 x 400	5, 10, 15, 30	
	320 x 200	5, 10, 15, 30	
Y8H8	1280 x 800	5, 10	IR
	640 x 400	5, 10, 15, 30	
	320 x 200	5, 10, 15, 30	
MJPEG	1280 x 800	5, 10	
	640 x 400	5, 10, 15, 30	

	320 x 200	5, 10, 15, 30	
YUYV	800 x 600	5, 10, 15	Color
	640 x 400	5, 10, 15, 30	
	640 x 360	5, 10, 15, 30	
MJPEG	1280 x 800	5, 10, 15, 30	
	1280 x 720	5, 10, 15, 30	
	800 x 600	5, 10, 15, 30	
	640 x 400	5, 10, 15, 30	
	640 x 360	5, 10, 15, 30	

Note: Single output video streams can meet all resolutions and frame rates, for two or three output depth and color video streams, limited by the actual bandwidth of USB2.0 and the performance of the host computer, some combinations are not supported..

4.7 No-Blind Zone Depth Data

In addition to generating depth maps and outputting depth data through stereo structured light technology, Gemini 2 Series can realize the no-blind zone detection within 0 - 10 meters by using LDP module which has the function of single-point ranging. When the value of LDP is 0, it means the distance is infinite. When the value of LDP is 0, it means long range or no reliable measurement value.

The following table gives reference values for the LDP ranging accuracy of the Gemini 2 Series.

Table 4-7-1 Gemini 2 Series LDP Ranging Accuracy Reference Values

	Distance	Value	Unit
LDP Distance Measurement Accuracy	≥ 200mm	±5	%
	100mm – 200mm	±15	mm
	20mm – 100mm	±15	mm

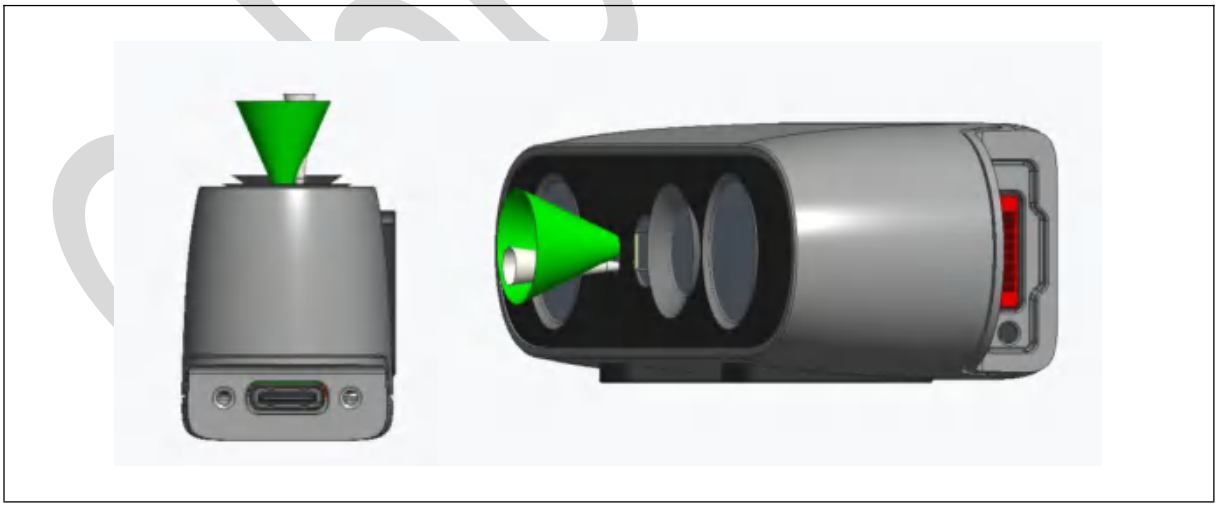


Figure 4-7-1 3D Schematic of Gemini 2 LDP FoV

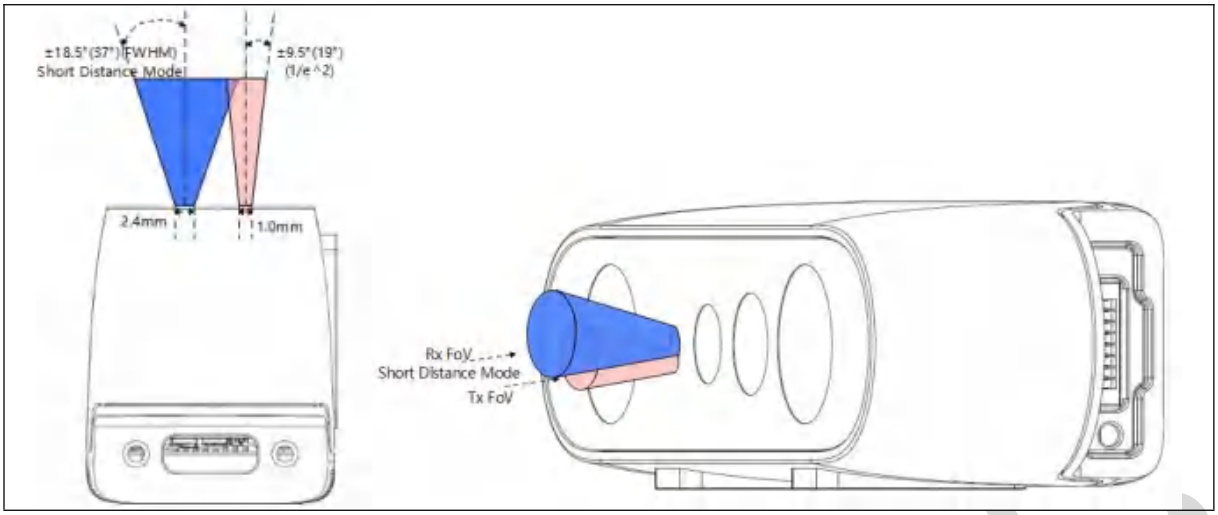


Figure 4-7-2 Gemini 2 LDP FoV Data

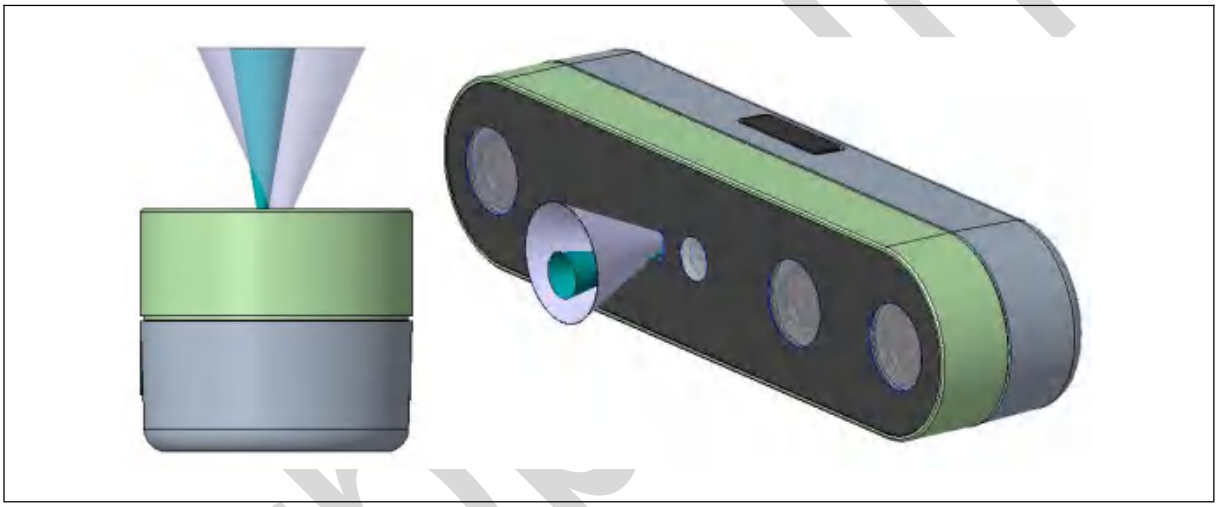


Figure 4-7-3 3D Schematic of Gemini 2 L LDP FoV

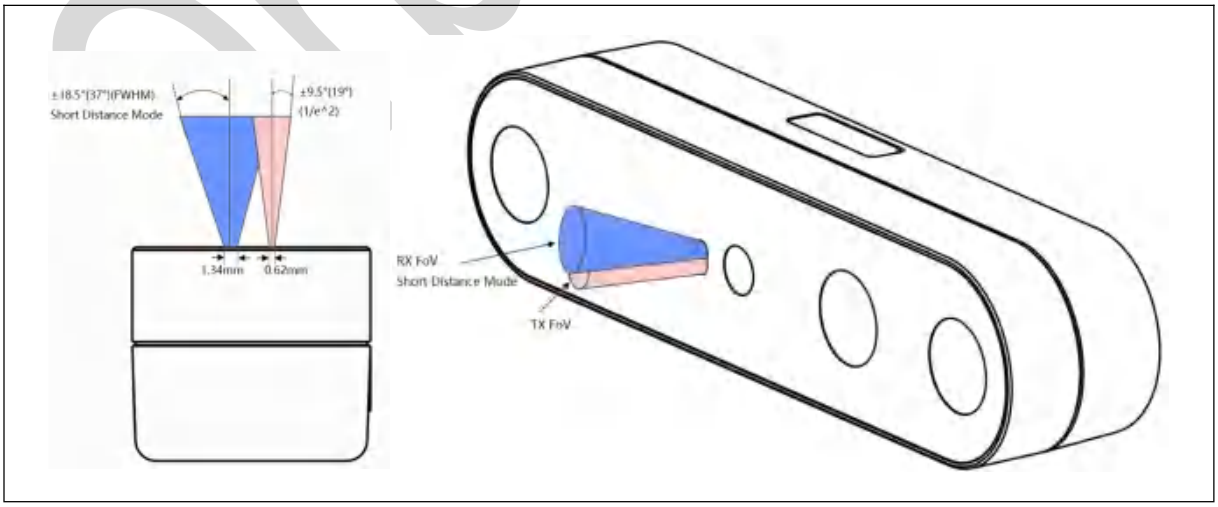


Figure 4-7-4 Gemini 2 L LDP FoV Data

4.8 Depth Start Point Reference

The depth start point or ground zero datum can be described as a start point or plane with depth = 0. For the depth camera Gemini 2 Series, the distance of the depth zero point relative to the front face of the module in tables.

Camera	Front Cover Glass of Thickness	Start Point Distance（Z'）
Gemini 2	0.7mm	4.23mm
Gemini 2 L	1.1mm	4.4mm

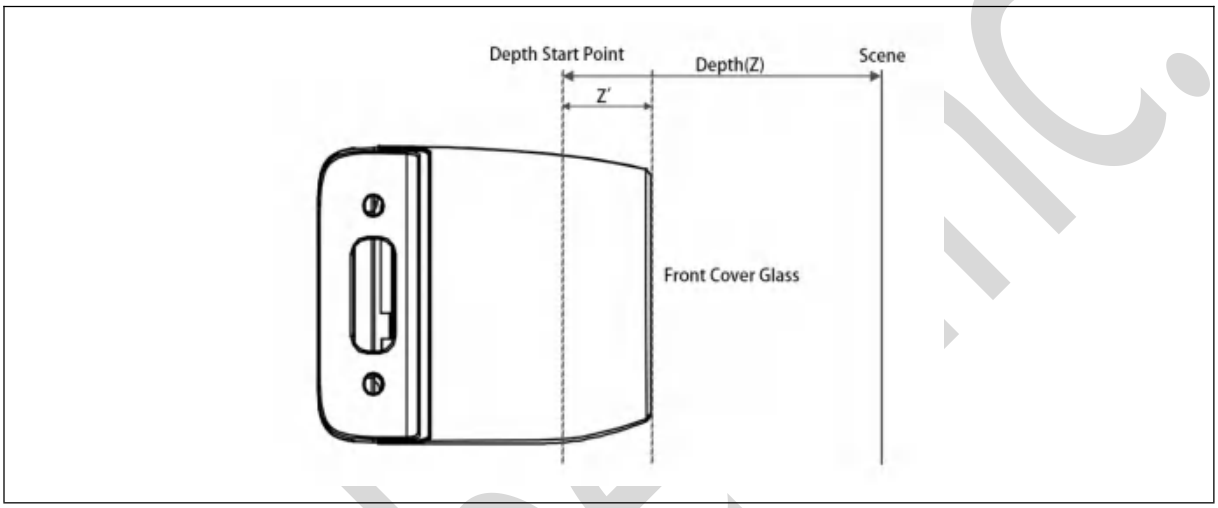


Figure 4-8-1 Schematic of Gemini 2 Depth Start Point

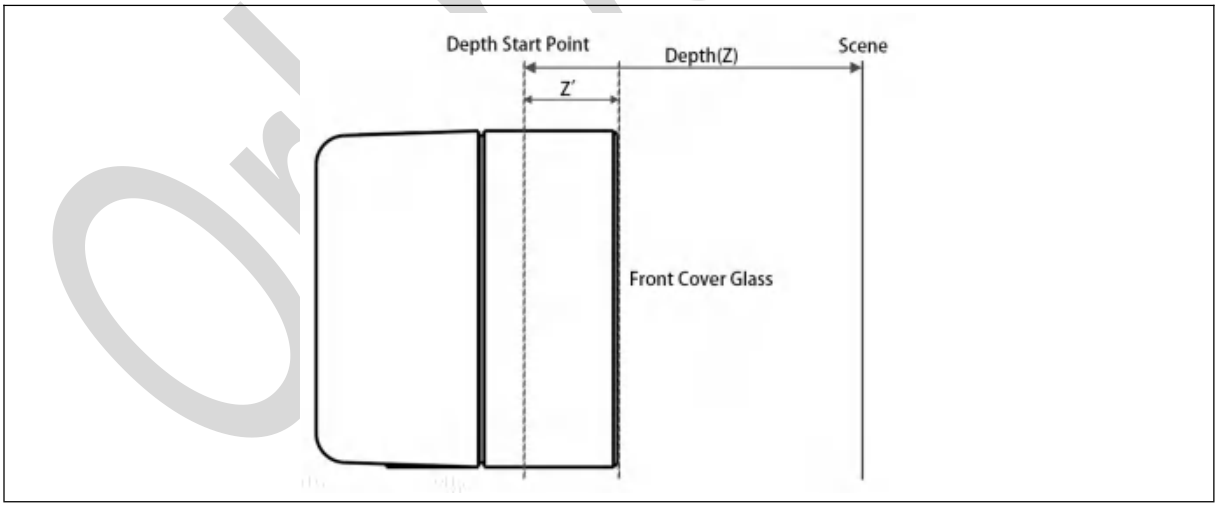


Figure 4-8-2 Schematic of Gemini 2 L Depth Start Point

4.9 Depth to Color Alignment

Gemini 2 Series supports simultaneous output of D2C (Depth To Color), which maps each pixel point on the depth map to the corresponding position on the color image based on the internal and external parameters of the depth and color cameras, resulting in an RGBD map.

Table 4-9-1 Gemini 2 Depth to Color

Pre-D2C Depth Image	Color Image	Post D2C Depth Image
1280 x 800@5/10/15/30fps	1920 x 1080@5/10/15/30fps	1920 x 1080@5/10/15/30fps
1280 x 800@5/10/15/30fps	1280 x 720@5/10/15/30fps	1280 x 720@5/10/15/30fps
640 x 400@5/10/15/30fps	1920 x 1080@5/10/15/30fps	1920 x 1080@5/10/15/30fps
640 x 400@5/10/15/30fps	1280 x 720@5/10/15/30fps	1280 x 720@5/10/15/30fps
640 x 400@5/10/15/30/60fps	640 x 480@5/10/15/30/60fps	640 x 480@5/10/15/30/60fps
640 x 400@5/10/15/30/60fps	640 x 360@5/10/15/30/60fps	640 x 360@5/10/15/30/60fps
320 x 200@5/10/15/30/60fps	1920 x 1080@5/10/15/30fps	1920 x 1080@5/10/15/30fps
320 x 200@5/10/15/30/60fps	1280 x 720@5/10/15/30fps	1280 x 720@5/10/15/30fps
320 x 200@5/10/15/30/60fps	640 x 480@5/10/15/30/60fps	640 x 480@5/10/15/30/60fps
320 x 200@5/10/15/30/60fps	640 x 360@5/10/15/30/60fps	640 x 360@5/10/15/30/60fps

Table 4-9-2 Gemini 2 L Depth to Color

Pre-D2C Depth Image	Color Image	Post D2C Depth Image
1280 x 800@5/10/15/30fps	1280 x 800@5/10/15/30fps	1280 x 800@5/10/15/30fps
1280 x 800@5/10/15/30fps	1280 x 720@5/10/15/30fps	1280 x 720@5/10/15/30fps
1280 x 800@5/10/15/30fps	800 x 600@5/10/15/30fps	800 x 600@5/10/15/30fps
640 x 400@5/10/15/30fps	1280 x 800@5/10/15/30fps	1280 x 800@5/10/15/30fps
640 x 400@5/10/15/30fps	1280 x 720@5/10/15/30fps	1280 x 720@5/10/15/30fps
640 x 400@5/10/15/30/60fps	800 x 600@5/10/15/30fps	800 x 600@5/10/15/30fps
640 x 400@5/10/15/30/60fps	640 x 400@5/10/15/30/60fps	640 x 400@5/10/15/30/60fps
640 x 400@5/10/15/30/60fps	640 x 360@5/10/15/30/60fps	640 x 360@5/10/15/30/60fps
320 x 200@5/10/15/30/60fps	1280 x 800@5/10/15/30fps	1280 x 800@5/10/15/30fps
320 x 200@5/10/15/30/60fps	1280 x 720@5/10/15/30fps	1280 x 720@5/10/15/30fps
320 x 200@5/10/15/30/60fps	800 x 600@5/10/15/30fps	800 x 600@5/10/15/30fps

320 x 200@5/10/15/30/60fps	640 x 400@5/10/15/30/60fps	640 x 400@5/10/15/30/60fps
320 x 200@5/10/15/30/60fps	640 x 360@5/10/15/30/60fps	640 x 360@5/10/15/30/60fps

4.10 IMU Specification

4.10.1 IMU Specification Description

Table 4-10-1 Gemini 2 Series IMU Specification Description

	Parameters		Gemini 2 Series
IMU	Timestamp		Timestamp synchronization (us) with IR, depth and RGB data all using the same time reference and clock frequency
	X/Y/Z axis orientation		X-axis in line with depth, pointing to the left of the camera Y-axis in line with depth, pointing below the camera Z-axis in line with depth, pointing in front of the camera
	Gyroscope	Format	3x16-bit
		Measurement Range	±17.45rad/s(1000dps)
		Output Frequency (Hz)	100/200/500/1000
	Accelerometer	Format	3x16-bit
		Measurement Range	± 39.2m/s²(4g)
		Output Frequency (Hz)	100/200/500/1000
	Temperature	Format	1x16-bit
		Measurement Range	-40~85°C
		Output Frequency (Hz)	Follows gyroscope and accelerometer frequencies

4.10.2 IMU Coordinate System

The IMU coordinate system origin is in the same position as the physical sensor center point. The coordinate axis direction is aligned with the depth direction.

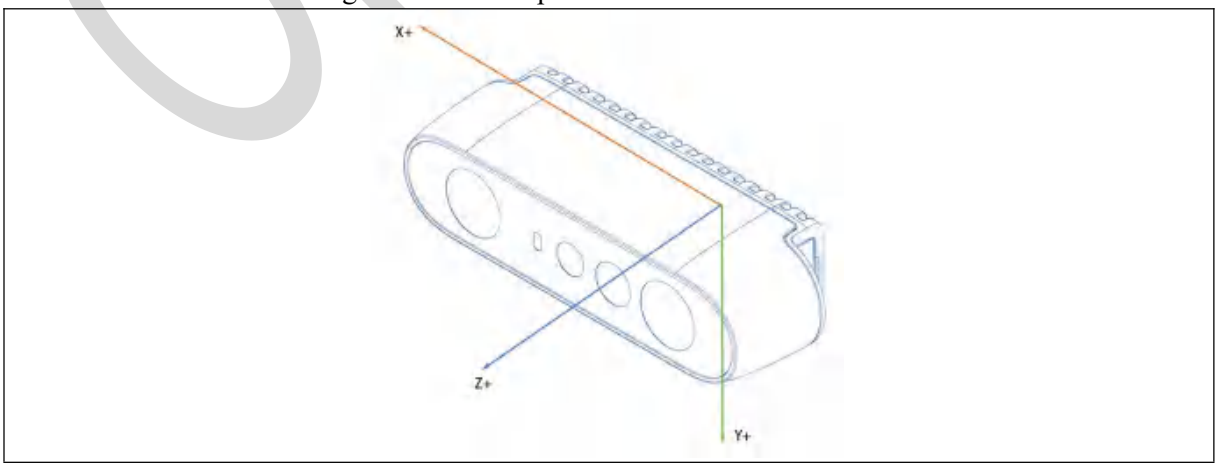


Figure 4-10-1 Gemini 2 IMU Coordinate System

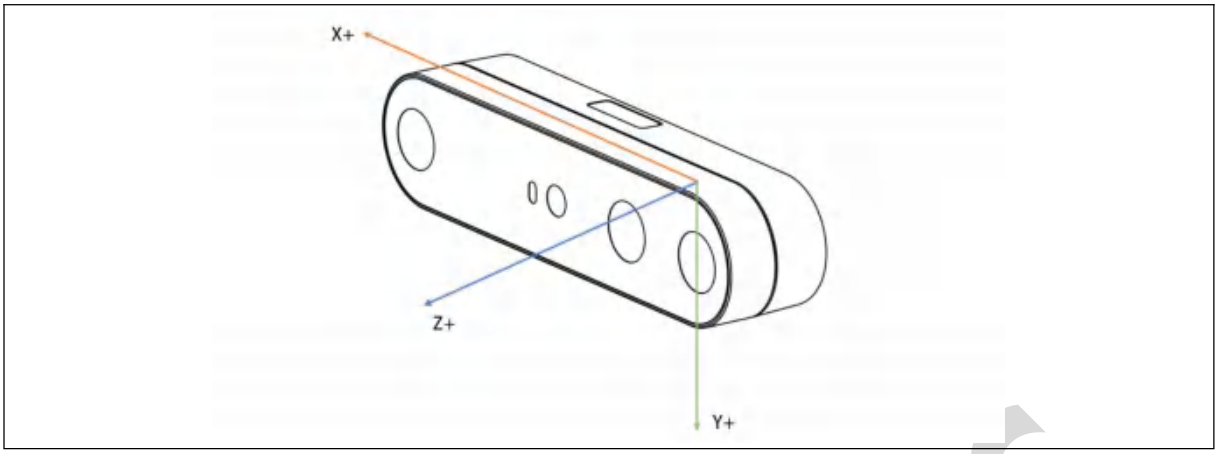


Figure 4-10-2 Gemini 2 L IMU Coordinate System

4.11 Depth Mode

Table 4-11-1 Gemini 2 Series Depth Mode

	Unbinned Dense Default	Unbinned Sparse Default	Binned Sparse Default	Dimensioning
Ideal Range (Gemini 2)	0.20m - 5.0m	0.20m - 5.0m	0.15m - 2.5m	/
Ideal Range (Gemini 2 L)	0.30m - 7.0m	0.30m - 7.0m	0.25m - 5.0m	0.30m - 4.0m
Accuracy	High	Medium	Low	High
Resolution (Gemini 2)	1280x800@5/10/15/30fps 640x400@5/10/15/30fps 320x200@5/10/15/30fps	1280 x800@5/10/15/30fps 640x400@5/10/15/30fps 320x200@5/10/15/30fps	640x400@5/10/15/30/60fps 320x200@5/10/15/30/60fps	/
Resolution (Gemini 2 L)	1280x800@5/10/15/30fps 640x400@5/10/15/30fps 320x200@5/10/15/30fps	1280x800@5/10/15/30fps 640x400@5/10/15/30fps 320x200@5/10/15/30fps	640x400@5/10/15/30/60fps 320x200@5/10/15/30/60fps	1280x800@5/10/15/30fps 640x400@5/10/15/30fps 320x200@5/10/15/30fps
Power	High	Medium	Low	High
Feature	High accuracy and High quality depth data	Balancing depth accuracy and power & Optimizing for low inversion and semi-outdoor	Low power & Support 60fps & Small blind zone	High accuracy and High quality depth data
Typical Usages	Robots / Body Tracking	Robots / Gesture Control	Robots / Sports	Dimension / 3D Scan

4.12 Specific Frame Rate Trigger Mode

Gemini 2 Series provides users with flexible IR, Depth and RGB image data acquisition methods, the most common of which is the specific frame rate trigger mode. In this mode, users configure a specific target frame rate, resolution and image format for IR, Depth and RGB respectively, and then turn on the corresponding data streams in turn. The camera acquires and outputs image data at the user-configured target frame rate, resolution, and image format. Depending on the camera's currently configured depth mode and resolution, the user can select a specific frame rate for the current scene from predefined fixed frame rate values of 5fps, 10fps, 15fps, 30fps, and 60fps, and capture image data at that frame rate.

4.13 Free Trigger Mode

In addition to supporting image data acquisition methods based on specific frame rates, Gemini 2 Series also offers a free trigger mode that supports arbitrary frequencies. In this mode, the camera always waits for an external input trigger signal, and only after receiving a valid external trigger signal will it complete an image data acquisition as configured by the camera, and then continue to wait for the next external trigger signal. Since there is no specific time limit between two consecutive triggers, but only a single acquisition time greater than that of the camera, it is possible to control the time interval between two consecutive triggers to achieve any frequency, passive trigger image data acquisition function. The camera supports a soft trigger signal sent by the host computer via USB command or a trigger signal input by an external device through the 8-Pin synchronous interface to achieve any frequency of passive trigger mode.

In the free trigger mode, the IR, Depth, and RGB fixed frame rates of the camera need to be set to the same specific value on demand, specifically to a uniform value of 5fps, 10fps, 15fps, 30fps, or 60fps to determine the minimum time interval for two consecutive active triggers. The relationship between the fixed frame rate and the minimum time interval, as well as the upper frequency limit for passive triggering, is shown in Table 3-14-1. In other words, once a trigger is received, the camera will ignore any other trigger signals that are outside the allowable range, which means that the trigger frequency can be any value within the range of valid frequencies for passive triggering.

Table 4-13-1 Table of Arbitrary Frame Rates Allowed to be Passively Triggered

Set The Camera's Fixed Frame Rate(fps)	Supportable Passive Trigger Interval(ms)	Supportable Passive Trigger Frequency(Hz)
60	≥ 250	0 - 4
30	≥ 250	0 - 4
15	≥ 500	0 - 2
10	≥ 750	0 – 1.33
5	≥ 1500	0 – 0.66

Table 4-13-2 Table of Arbitrary Frame Rates Allowed to be Passively Triggered

Set The Camera's Fixed Frame Rate(fps)	Supportable Passive Trigger Interval(ms)	Supportable Passive Trigger Frequency(Hz)
60	≥ 40	0 - 24
30	≥ 80	0 - 12
15	≥ 160	0 - 6

10	≥ 240	0 – 4
5	≥ 480	0 – 2

4.14 Multi-Camera Synchronization Function

4.14.1 Specification Description

Each Depth camera device is equipped with a synchronization interface that enables multiple camera connections. The use of multiple depth camera devices allows for a wider range of needs, including:

- Filling the masked area: Since the depth and RGB cameras on depth camera actually maintain a small distance between them. This offset makes occlusion possible. This occlusion is the foreground object that blocks part of the view of the background object from one of the two cameras on the device. In the resulting color image, the foreground object looks like it is casting a shadow on the background object.
- Better scanning of 3D objects.
- Increasing the spatial coverage of the camera.
- Increase the effective frame rate to a value above 30 frames per second (FPS).
- Capturing multiple color images of the same scene.
- The use of multi-camera synchronization can be better applied in scenarios such as shooting volumetric video and needing a large field of view.

The synchronization function can be implemented through two types of connections respectively:

Star Topology:

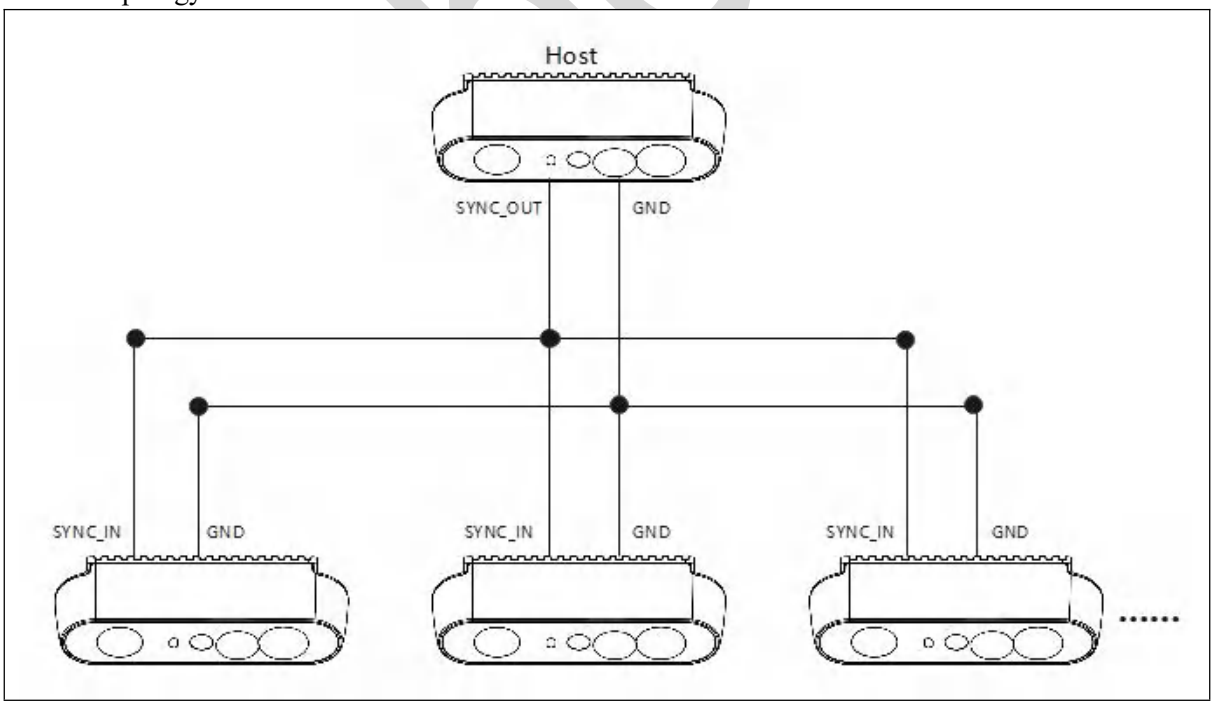


Figure 4-14-1 Star Topology Diagram

Chain Topology:

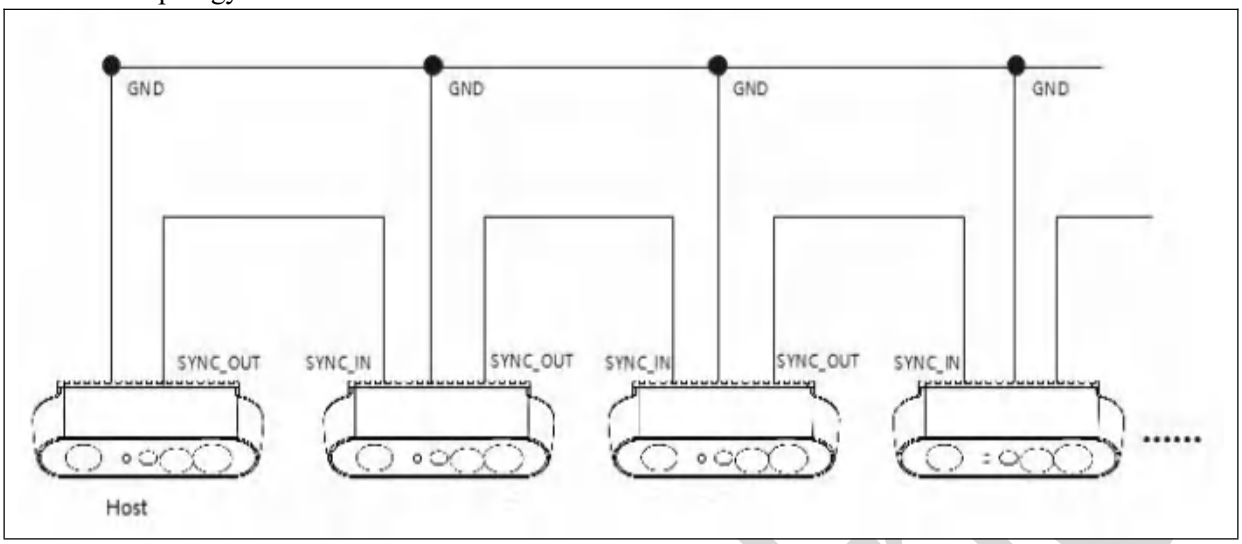


Figure 4-14-2 Chain Topology Diagram

Multi-camera frame synchronization in two topologies, including depth image synchronization and RGB image synchronization (time difference ≤ 3ms, when auto exposure off), using the multi-camera synchronization function.

4.14.2 Multi-Camera Synchronization Interface

The following table describes the definition of the multi-camera synchronization interface for Gemini 2 Series.

Table 4-14-1 Gemini 2 Series Multi-Camera Synchronization Interface Definitions

Pin	Definitions	Description
1	VCC	The default electrical level setting is 1.8V; when 3.3V or 5V drive voltage is provided on the VCC interface, the I/O level setting can be adjusted to 3.3V or 5V as required
2	GPIO_OUT	Synchronization drive signal: Active high. The high-level interval coincides with the IR exposure time. Typical application is to drive external fill light.
3	VSYNC_OUT	Synchronous trigger signal: Active high. The high level provides the triggering signal for the secondary devices.
4	TIMER_SYNC_OUT	Pulse signal source, reset hardware timestamp of secondary devices.
5	RESET_IN	Hardware reset signal: Triggers the camera to power down and automatically power up and reset. Detect the input signal: 20Hz / 50% duty cycle / more than 5 consecutive cycles, that is, judged as normal input signal, other signals filtered out; allowed fluctuations for frequency ± 1Hz, duty cycle ± 2%.
6	VSYNC_IN	Synchronous trigger signal: Active high, used for the triggering/sync signal from primary device, with a duration of 1MS
7	TIMER_SYNC_IN	Hardware timestamp reset signal input, hardware timestamp clearing
8	GND	Ground

Table 4-14-2 Gemini 2 Series Multi-Camera Synchronization Interface Electronic Performance Parameters

Pin	Definitions	Electronic Performance Parameters
1	VCC	Input voltage: min: 1.75V, max: 5.25V, typical:1.8V/3.3V/5.0V, default:1.8V Input current: ≧100mA Power ripple: ≦50mV/AC
2	GPIO_OUT	Output voltage: =VCC

		Output current: 1.8V@4mA, 3.3V@24mA, 5.0V@32mA Rise/Fall: 1.8V@≦20ns/V, 3.3V@≦10ns/V, 5.0V@≦6ns/V
3	VSYNC_OUT	Output voltage: =VCC Output current: 1.8V@4mA, 3.3V@24mA, 5.0V@32mA Rise/Fall: 1.8V@≦20ns/V, 3.3V@≦10ns/V, 5.0V@≦6ns/V
4	TIMER_SYNC_OUT	Output voltage: =VCC Output current: 1.8V@4mA, 3.3V@24mA, 5.0V@32mA Rise/Fall: 1.8V@≦20ns/V, 3.3V@≦10ns/V, 5.0V@≦6ns/V
5	RESET_IN	Input voltage: =VCC Input current: VIH:VCC×0.65,VIL:≦0.7V Input current: 1.8V~5.0V @≧4mA Rise:1.8V@≦30ns/V, 3.3V@≦20ns/V, 5.0V@≦8ns/V Fall:1.8V@≦90ns/V, 3.3V@≦90ns/V, 5.0V@≦50ns/V Signal: Freq 20Hz±1Hz, duty cycle 50%±2%, cycle≧8T
6	VSYNC_IN	Input voltage: =VCC Input current: VIH:VCC×0.65,VIL:≦0.7V Input current: 1.8V~5.0V @≧4mA Rise:1.8V@≦30ns/V, 3.3V@≦20ns/V, 5.0V@≦8ns/V Fall:1.8V@≦90ns/V, 3.3V@≦90ns/V, 5.0V@≦50ns/V Rise edge trigger & Single pulse triggering
7	TIMER_SYNC_IN	Input voltage: =VCC Input current: VIH:VCC×0.65,VIL:≦0.7V Input current: 1.8V~5.0V @≧4mA Rise:1.8V@≦30ns/V, 3.3V@≦20ns/V, 5.0V@≦8ns/V Fall:1.8V@≦90ns/V, 3.3V@≦90ns/V, 5.0V@≦50ns/V Rise edge trigger & Single pulse triggering
8	GND	Ground

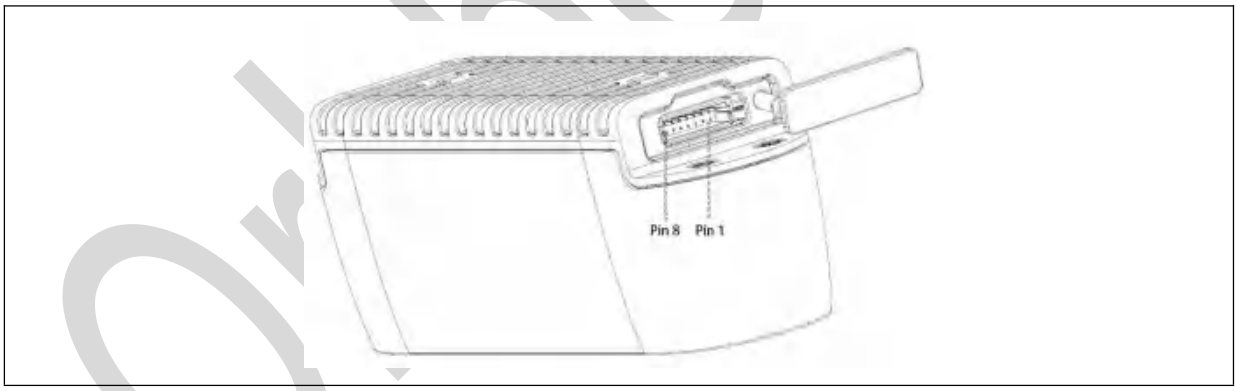


Figure 4-14-3 Gemini 2 Multi-Camera Synchronization Interface Diagram

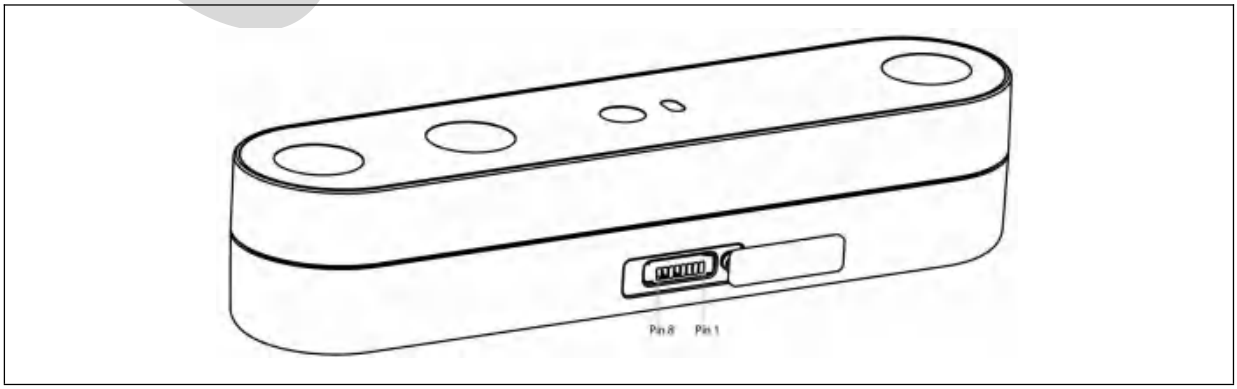


Figure 4-14-4 Gemini 2 L Multi-Camera Synchronization Interface Diagram

5 Performance

5.1 Electrical Performance

5.1.1 Power Supply

Gemini 2 Series is Type-C powered and needs to ensure that Type-C is the standard power output and the maximum current of the Type-C power port needs to be 1.5A or above.

5.1.2 Power

The power consumption differs for different working modes.

Table 5-1-1 Gemini 2 Max Power Mode Configuration

Mode	Max Power Mode Configuration									
	Depth Parameter							RGB Parameter		
	Resolution	Format	Hardware D2C	AE	Exposure (us)	Gain	Laser energy level	Resolution	Format	AE
Unbinned Dense Default	1280x800 @30fps	RLE	on	off	5000	1000	5	1920x1080 @30fps	MJPEG	on
Unbinned Sparse Default	1280x800 @30fps	RLE	on	off	5000	1000	5	1920x1080 @30fps	MJPEG	on
Binned Sparse Default	640x400 @60fps	RLE	on	off	1500	1000	5	1280x720 @60fps	MJPEG	on
Note	1. In order to test the maximum power consumption of RGB, it is necessary to maintain a dark environment, so that the RGB exposure time is stretched 2. No obstacles within 30cm in front of the camera to avoid triggering the laser protection function 3. IMU ODR(output data register) is 1000Hz									

Table 5-1-2 Gemini 2 Typical Average and Peak Configuration

Scenes	Mode	Peak Current (mA)	Min Current (mA)	Average Current (mA)	Average Current (V)	Peak Power (mW)	Average Power (mW)
Max Power	Unbinned Dense Default	1240	220	426	5.17	6410.8	2202.42
	Unbinned Sparse Default	1300	220	439	5.16	6708	2265.24
	Binned Sparse Default	1030	228	376	5.17	5325.1	1943.92
Standby	Standby (IR Steam On and then IR Steam Off)	270	98	166	5.05	1363.5	838.3

Table 5-1-3 Gemini 2 L Max Power Mode Configuration

Mode	Max Power Mode Configuration									
	Depth Parameter							RGB Parameter		
	Resolution	Format	Hardware D2C	AE	Exposure (us)	Gain	Laser energy level	Resolution	Format	AE
Unbinned Dense Default	1280x800 @30fps	RLE	on	off	10000	1000	5	1280x800 @30fps	MJPEG	on
Unbinned Sparse Default	1280x800 @30fps	RLE	on	off	6000	1000	5	1280x800 @30fps	MJPEG	on
Binned Sparse Default	640x400 @60fps	RLE	on	off	5000	1000	5	1280x720 @60fps	MJPEG	on
Note	1. In order to test the maximum power consumption of RGB, it is necessary to maintain a dark environment, so that the RGB exposure time is stretched 2. No obstacles within 30cm in front of the camera to avoid triggering the laser protection function 3. IMU ODR(output data register) is 1000Hz									

Table 5-1-4 Gemini 2 L Typical Average and Peak Configuration

Scenes	Mode	Peak Current (mA)	Min Current (mA)	Average Current (mA)	Average Current (V)	Peak Power (mW)	Average Power (mW)
Max Power	Unbinned Dense Default	1270	236	536	5.01	6362.7	2685.36
	Unbinned Sparse Default	1360	230	466	5.04	6854.4	2348.64
	Binned Sparse Default	1020	240	461	5.04	5140.8	2323.44
Standby	Standby (IR Steam On and then IR Steam Off)	204	150	174	5.13	1046.5	892.6

6 Firmware

6.1 Update

1. Firmware upgrades do not require access to a specific mode
2. When upgrading the firmware, please make sure all camera streams are turned off
3. The upgrade tool currently does not check the current firmware version of the device, so there is a possibility of upgrading the version or downgrading the version
4. Please check if you need to "upgrade"

6.2 Update Restrictions

After a successful upgrade, the device can be reboot in the following:

1. Disconnect the USB cable and plug it in again for the new firmware version to take effect (you can also make sure the device USB is disconnected).

2. Reboot the device via software interface (SDK).

6.3 Recovery

Check the upgrade process to ensure that the USB cable is stable, otherwise it may lead to upgrade failure, after failure, please disconnect the USB, re-insert it and burn it again. If the re-burning is invalid, the product may be damaged. Orbbec does not assume any liability for damages or any losses resulting from the use of this product.

7 SDK

7.1 SDK Description

Orbbec SDK is a cross-platform (Windows, Android, Linux) software development kit that provides device parameter configuration, data stream reading and stream processing for depth cameras such as Orbbec Structured Light, Stereo and iToF. It offers various features, including:

1. Access and control of hardware devices
2. Access, control, and data acquisition of sensors in the device
3. Control of frame synchronization and alignment
4. Point cloud data acquisition
5. Provides algorithmic capabilities such as filtering
6. Different systems and Wrapper support

For SDK downloads and updates, please visit https://www.orbbec3d.com/

8 Use Instructions

8.1 Mounting / Fixing Solutions

1. Depth camera and the housing between the use of foam or Rubber sealing, to do dust-proof.
2. Do not apply external force to the depth camera mount during installation.
3. During installation, do not remove the screws between the depth camera bracket and the bridging steel plate.

8.2 Heat Dissipation Recommendations

1. Avoid direct heat source around the camera.
2. Maximize the space inside the external housing may help lowering operating temperature.

Note: For further support of housing design information, please contact Orbbec 3D at info@orbbec3d.com.

8.3 Camera Front Cover Glass Lens Parameters Description

The current light transmission of the Gemini 2 Series front cover glass lens is as follows:

1. RGB(420~650nm)transmittance rate ≥91%
2. IR、LDM (858 ±20nm) transmittance rate ≥91%
3. LDP (940nm±30) transmittance rate ≥91%

The camera has a front cover glass, if a new transparent media is added in front of the front glass lens of the camera cover, may affect the accuracy and imaging effect, for details, please contact our technical support.

9 Regulatory Compliance

The products is certified as follows:

1. RoHS Certification
2. Reach Certification
3. Class 1 Laser Product under the EN/IEC 60825-1:2014

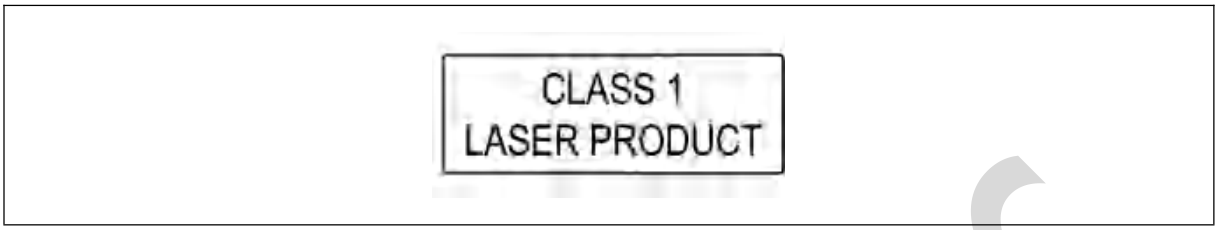


Figure 9-1 Class 1

4. CE Certification

Figure 9-2 CE Certification

5. FCC Certification

Figure 9-3 FCC Certification

6. KC Certification

Figure 9-4 KC Certification

10 System Integration Guide

Before choosing Gemini 2 Series for development, users should contact Orbbec sales staff to obtain the user manual and apply for the SDK development kit; through evaluation, debugging and verification steps to confirm whether the solution meets the mass production requirements.

We provide SDK for Gemini 2 Series for various software platforms, you need the SDK for the corresponding platform to develop and use the hardware device. Users can get the depth map through the depth camera, and can use the corresponding API interface to convert the original depth to point cloud data. By using the driver and SDK package, users can develop application layer for the product.

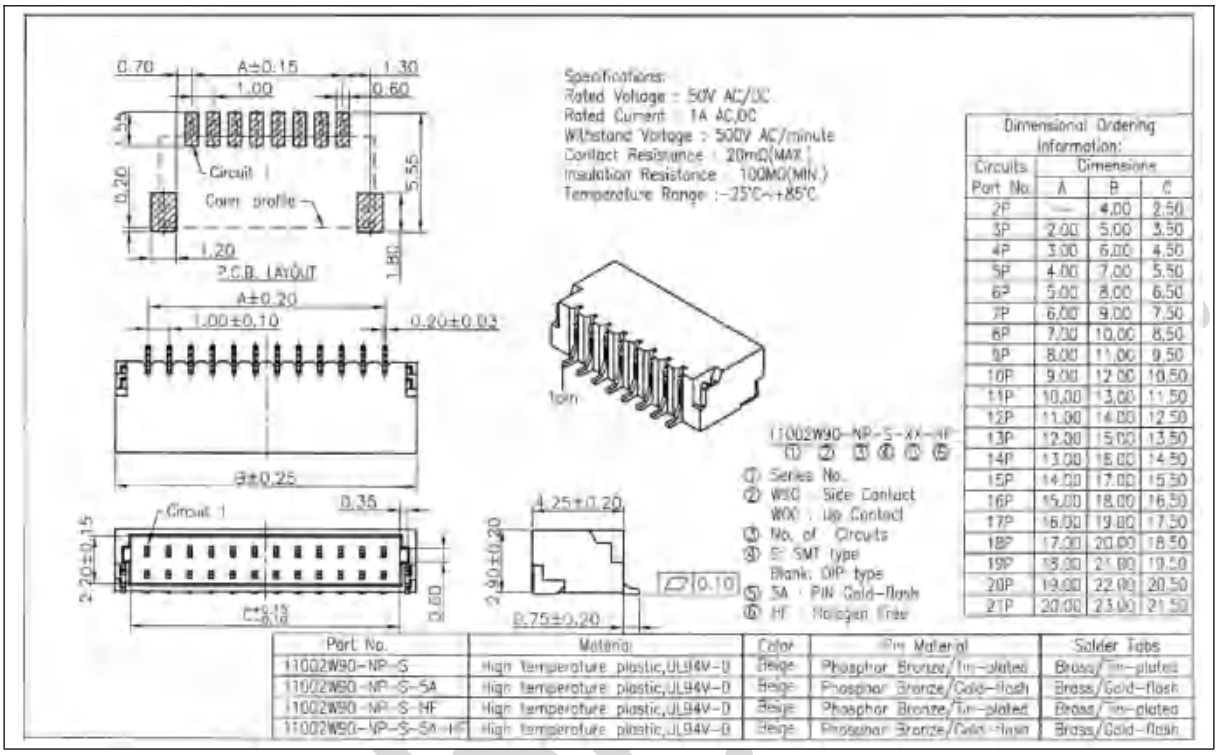
Suggested Process:

1. Read the product specification
2. Buy the product from the WEB store online
3. Before development, you should get in touch with the sales staff of Orbbec to obtain the user manual and apply for the SDK development kit.
4. Choose the right development platform
5. According to the function of product development, encounter technical problems, please contact with Orbbec staff in time
6. Confirm the mass production plan of the product
7. Mass production of the products according to mass production plan

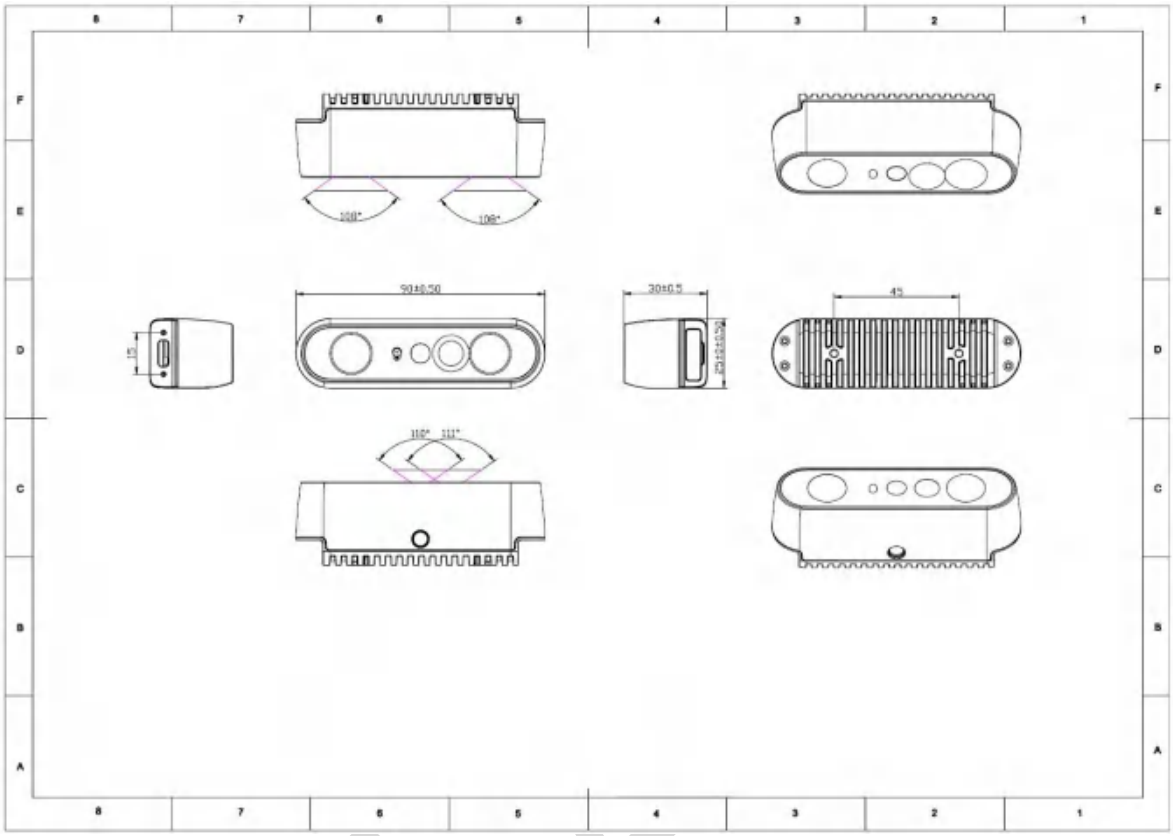
11 Cautions

1. Please follow the guidelines to operate the device correctly, such as illegal operation may lead to damage to internal components.
2. Do not drop or hit this product to prevent damage to the internal components and loss of accuracy.
3. Do not attempt to modify or disassemble this product in any way during assembly and use, as this may cause damage to the depth camera and loss of accuracy.
4. The product temperature rises after a period of use, which is a normal phenomenon.
5. Please do not touch the lens, so as not to leave a foreign body and thus affect the effect of taking picture.
6. Do not place the product in a place where children or animals can touch it to avoid accidents.
7. If you can't recognize the camera, please check whether the cable meets the power supply requirements and re-plug the USB to check.
8. Although this product uses a Class 1 laser (a harmless, control-free laser), we do not recommend looking directly at the laser emitter for more than 20 seconds to avoid discomfort.

Appendix I Multi-Camera Synchronization Interface Structure Diagram



Appendix II Gemini 2 2D Structure Diagram



Appendix III Gemini 2 L 2D Structure Diagram