ORBBEC

Gemini 330 Series

Datasheet for USB Devices

Version 1.6

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Revision History

Version	Description	Revision Date
V1.0	● Initial release	2024-04-28
V1.1	● Add specifications for Gemini 336/336L	2024-06-05
V1.2	● Add RGB resolution by 10fps. ● Add frame rates of 6, 10, 15 for Depth 640x360 resolution under USB2.0 for Gemini 335/336 ● Add frame rates of 5, 10, 15 for Depth 640x360 resolution under USB2.0 for Gemini 335L/336L ● Add 90fps for RGB resolutions of 640x480 and below for Gemini 335L/336L. ● Add 10fps for all Depth/IR resolutions on the USB3.0 ● Add hardware D2C function ● Add disparity search ranges of 256 and 64 for Gemini 330L/335L/336L, See 4.7 for a detailed description. ● Add environmental certifications： TSCA, TPCH, and 94/62/EC. ● Update the 5.4 Ingress Protection ● Update the glossary of terms	2024-08-12
V1.3	● Update the datasheet templates ● Refine and improve the content of the datasheet.	2024-12-12
V1.4	● Update the firmware version to V1.4.00 and reduce the peak power consumption from 6.5W to 6.0W for Gemini 335L and Gemini 336L ● Add a depth resolution of 424x266 for the Gemini 330 series.	2025-01-24
V1.5	● Update section 3.4.8: Transmittance vs. Wavelength for Depth Camera	2025-02-11
V1.6	● Update the product images to remove the rubber feet from the Gemini 335/336 ● Update section 5.1.1	2025-04-10

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0.Glossary

Terms	Descriptions
AMR	Autonomous Mobile Robot（AMRs） refer to a type of robots that can navigate and perform tasks autonomously. Equipped with sensors and control systems, AMRs can move and operate in complex environments without human intervention
ASIC	Application-specific Integrated Circuit
Baseline	The distance between the optical centers of the two cameras used for depth calculation
D2C	Depth to Color maps each pixel on a depth map to the corresponding color image according to the intrinsic and extrinsic parameters of the depth camera and color camera
Depth	Depth video streams are similar to color video streams except each pixel has a value representing the distance away from the sensor instead of color information
Depth Camera	Includes depth imaging module and external interface, of which the former is generally composed of an infrared projector, infrared camera, and depth computing processor
FOV	Field of View describes the angular extent of a given scene that is captured by a camera, which can be measured in the horizontal, vertical, and diagonal
I2C	Refers to a simple bi-directional two-wire synchronous serial bus developed by Philips
IMU	Inertial measurement unit.
IR	Light in the infrared spectrum, which ranges from 700 nm and above
IR Camera	A camera capable of seeing light in the IR spectrum
ISP	Image signal processor, which is used for image post-processing
LDM	Laser Diode Module
LRM	Laser Ranging Module
MIPI	Mobile Industry Processor Interface (MIPI) Alliance. MIPI is an open standard and specification formulated by the MIPI Alliance for mobile application processors
PCBA	PCBA (Printed Circuit Board Assembly) refers to a fully assembled printed circuit board (PCB) that includes all the electronic

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	components mounted and soldered onto it.
Point Cloud	A discrete set of data points in space
RGBM/RGB Module	Color Camera
ROI	Region of Interest(ROI) in image processing refers to a specific area selected from the entire image
SOM	A System on Module (SoM) provides various core components of an embedded processing system on a single printed circuit board, including the processor core, communication interfaces, and memory modules. A typical example of this is the NVIDIA Jetson series products
SBC	A Single Board Computer (SBC) is a microcomputer where all the logic circuits, timing circuits, internal memory, and external interfaces are integrated onto a single printed circuit board. A typical example is the Raspberry Pi
SoC	System on Chip, an integrated circuit (IC) that integrates all components of a computing system
UVC	USB Video Class (UVC) is a protocol standard defined for USB video capture devices and has become one of the USB.org standards
VCSEL	Vertical-Cavity Surface-Emitting Laser (VCSEL) is a type of semiconductor laser where the laser light is emitted perpendicular to the surface of the device
DoF	Degree of Freedom, In an Inertial Measurement Unit(IMU), 6DoF means the device can measure all six degrees of freedom.
dToF	Direct Time-of-Flight(dToF) achieves high-precision distance measurement by directly tracking light pulse travel time.
TBD	To Be Determined. Information will be provided in a later revision.

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1. Product Brief

Integrating Orbbec's latest custom ASIC, the Gemini 330 series of Depth + RGB cameras combine active and passive stereo vision technologies for seamless operation in both indoor and outdoor conditions. The depth image computation and the depth to color spatial alignment functions are processed inside the camera providing for minimal latency and reduced dependency on expensive and power-hungry external compute. The cameras are programmable for a variety of depth operating modes to adapt to different application scenarios. A flexible and rich frame synchronization mechanism makes multi-camera operations simple and scalable.

The Gemini 330 series is easy to set up and operate with the **Orbbec SDK,** and the camera delivers extremely accurate and reliable data in various lighting conditions, ranging from pitch black to full sunshine.

- Wide field of view at 90° horizontal and 65° vertical
- High quality depth data output in both indoor and outdoor environments
- Up to 30 fps at 1280 x 800 depth resolution
- USB Type-C for power and data connectivity
- Multi-camera synchronization and IMU supported

Detailed Product Documentation: Gemini 330 series documentation

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2. Product Specifications

Parameter	Gemini 335/336	Gemini 335L/336L
Use Environment	Indoor & Outdoor	Indoor & Outdoor
Technology	Stereo Vision	Stereo Vision
Baseline	50mm	95mm
LDM Wavelength	850nm	850nm
Working Range[1]	0.1 - 20m+	0.17 -20m+
Ideal Range	0.3 - 3m	0.25 - 6m
Spatial Precision[2]	≤ 1.5% (1280 x 800 @ 2 m & 90% x 90% ROI)	≤ 0.8% (1280 x 800 @ 2 m & 90% x 90% ROI) ≤ 1.6% (1280 x 800 @ 4 m & 80% x 80% ROI)
Depth Resolution @ Frame Rate	Up to 1280 x 800 @ 30fps	Up to 1280 x 800 @ 30fps
Depth FOV	90° x 65° ± 3° @ 2m (1280 x 800)	90° x 65° ± 3° @ 2m (1280 x 800)
Depth Filter	All-Pass / IR-Pass	Visible + NIR-Pass / IR-Pass
Sensor Type	IR: Global Shutter Color: Rolling Shutter	IR: Global Shutter Color: Global Shutter
RGBM Resolution @ Frame Rate	Up to 1920 x 1080 @ 30fps	Up to 1280 x 800 @ 30fps
RGB Module FOV	Aspect Ratio 16:9 86° x 55° ± 3° Aspect Ratio 4:3 70° x 55° ± 3°	Aspect Ratio 16:10 94° x 68° ± 3° Aspect Ratio 16:9 94° x 62° ± 3° Aspect Ratio 4:3 82° x 66° ± 3°
IMU	6 DoF; Gyroscope/Accelerometer Sample range: 50 - 1,000Hz	
Depth Processing	In-camera processing using Orbbec MX6800 ASIC	
Data Connection	USB 3.0 & USB 2.0 Type-C for data and power	
HDR Depth	Supported	
ESD	Contact discharge: ±8KV, Air discharge : ±15KV Class A	
RE	≥6 dB	≥6 dB
Power Consumption	Average < 3.0W (Peak <6.5W)	Average < 3.0W (Peak <6.0W)
Operating Environment	-10℃ - 45℃ @ 15fps, -10℃ -40℃ @ 30/60fps, 5% ~ 90% RH (non-condensing)	-10℃ - 50℃ @ 15/30fps, -10℃ -45℃ @ 60fps, 5% ~ 90 % RH (non-condensing)

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Storage Environment	Short Term: -20℃ - 70℃,5%~90% RH (non-condensing) Long Term: 0℃ - 60℃, 5%~90% RH (non-condensing)	
Operating Backside Case Temperature	-10℃ - 55℃	-10℃ - 60℃
Protection	IP5X	IP65
Supported Functions	Hardware spatial alignment of depth to color Hardware Timestamps, Multi-camera Sync UVC camera	
Dimensions	90mm x 25mm x 30 mm / 90mm x 25mm x 30.7mm	124mm x 29mm x 27mm / 124mm x 29mm x 27.7mm
Weight	97g / 99g	133g / 135g
Installation	Bottom:1x 1/4-20 UNC, Max Torque: 4.0 N.m Back :2x M3,Max Torque:0.4 N.m	Bottom：1x 1/4-20 UNC, Max Torque: 4.0 N.m Back：2x M4,Max Torque: 0.4 N.m
Lifespan	5 Years: Default Operating Mode & Operating Environment	5 Years: Default Operating Mode &Operating Environment

Notes:

[1] Measure object reflectivity > 10%, up to 20m distance depth data. Theoretical maximum depth range up to 65 meters, but the actual accuracy varies with the distance and the object to be measured.

[2] The depth performance of each 3D camera is validated at the production line before shipping to customers. The metrics reflect the depth performance under typical conditions. External impact factors over 3D cameras' whole lifespan may have significant impacts on their depth performance. For more detailed depth performance metrics, please refer to section 5.1.2.

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3. Product Information

3.1 Product Pictures

Table 3-1-1 Product pictures for Gemini 335 & Gemini 336

Name	Gemini 335	Gemini 336
Front View		
Rear View		

Table 3-1-2 Product pictures for Gemini 335L & Gemini 336L

Name	Gemini 335L	Gemini 336L
Front View		
Rear View		

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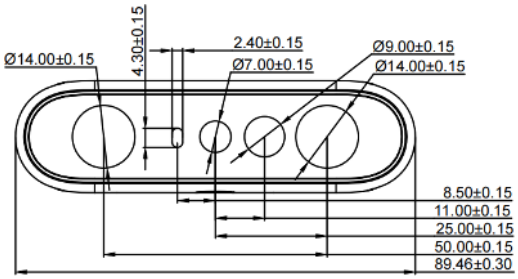
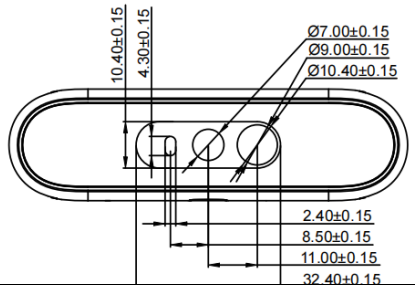
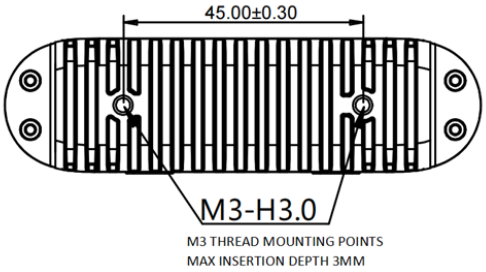
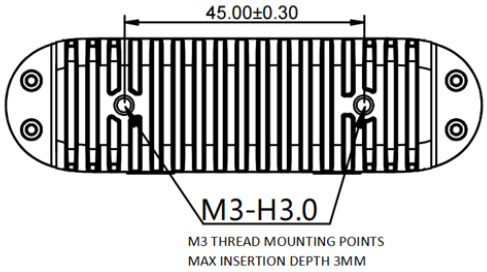
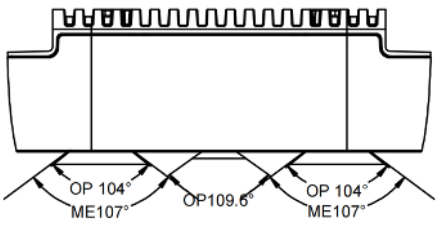
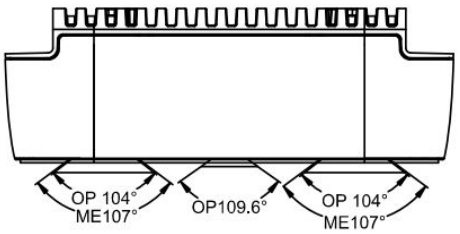
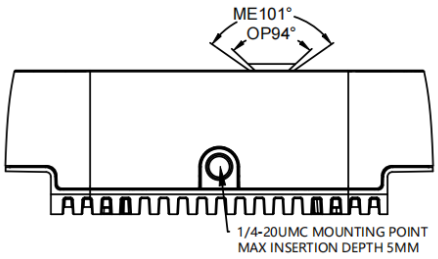
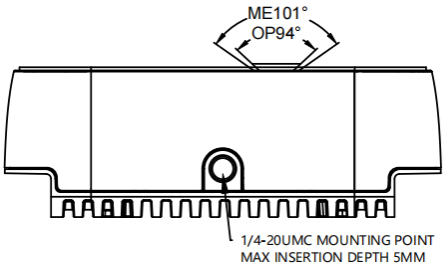
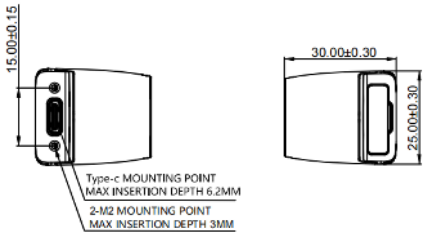
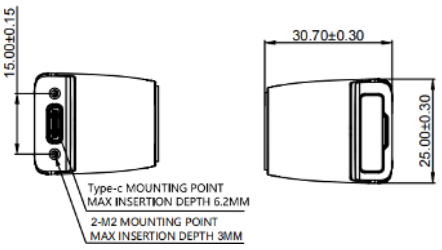
3.2 Product Drawings

3.2.1 Product Drawings for Gemini 335/336

Table 3-2-1 Product drawings for Gemini 335 & Gemini 336

Name	Gemini 335	Gemini 336
Front View		
Rear View		
Top View		
Bottom View		
Side View		

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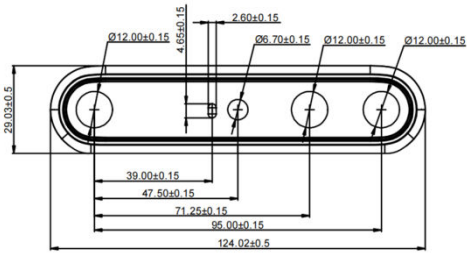
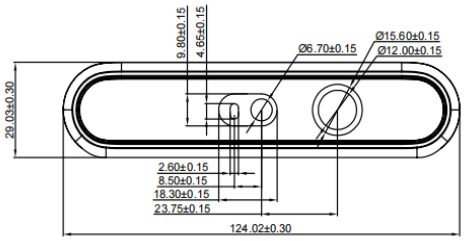
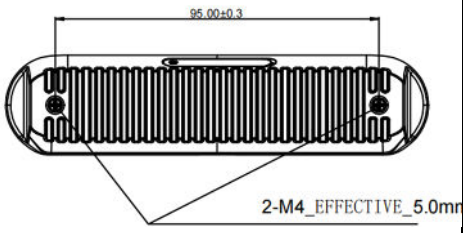
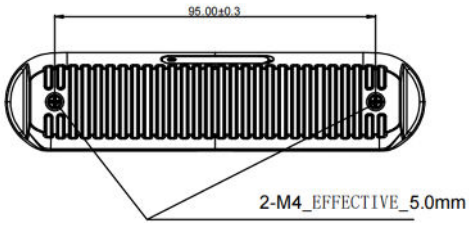
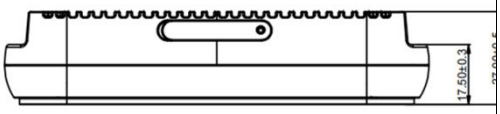
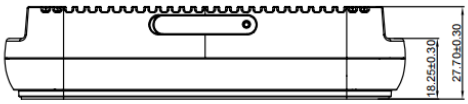
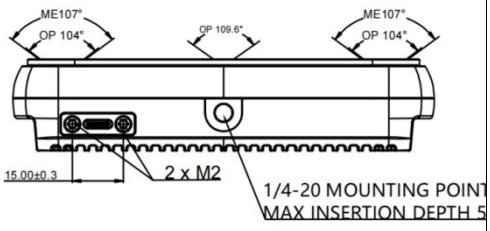
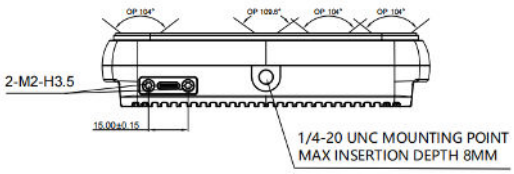
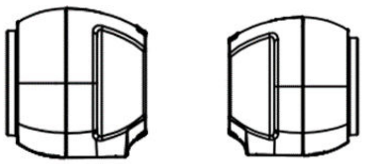
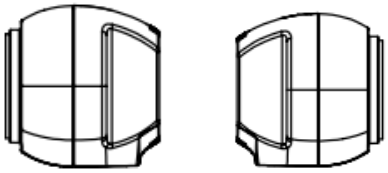
3.2.2 Product Drawings for Gemini 335L/336L

Table 3-2-2 Product drawings for Gemini 335L & Gemini 336L

Name	Gemini 335L	Gemini 336L
Front View		
Rear View		
Top View		
Bottom View		
Side View		

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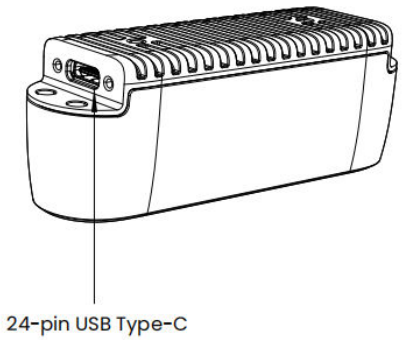
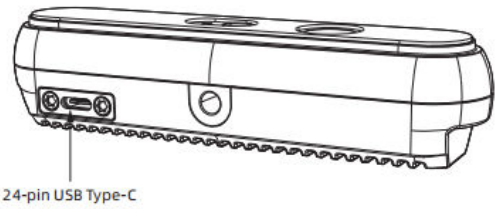
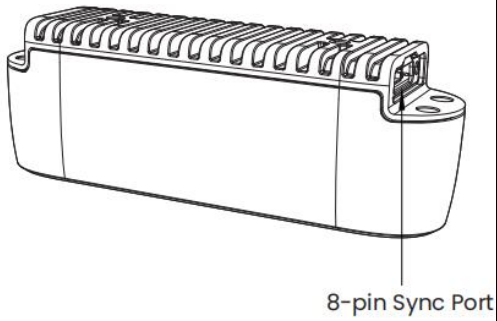
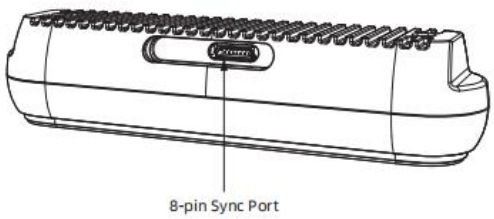
3.2.3 Product Dimensions & Weight for Gemini 330 series

Table 3-2-3 Product dimensions & weight for Gemini 330 series

Name	Gemini 335	Gemini 336	Gemini 335L	Gemini 336L
Width/mm	90		124	
Height/mm	25		29	
Depth/mm	30	30.7	27	27.7
N.W/g	97	99	133	135

3.3 Product Interfaces

Table 3-3-1 Product interfaces for Gemini 330seriese

Name	Gemini 335/336	Gemini 335L/336L
USB Type-C		
8-pin Sync Port		

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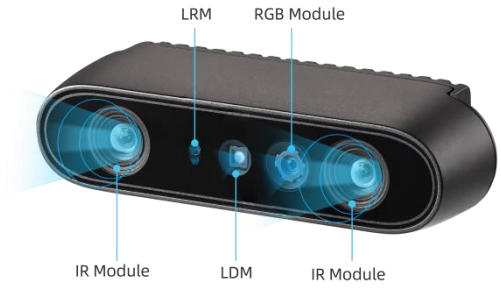
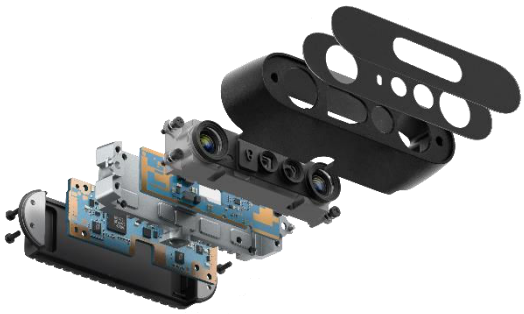
3.4 Product Components

3.4.1 Overview of Product Components for Gemini 335/336

Table 3-4-1 Overview of product components for Gemini 335/336

Gemini 335	Gemini 336
	
	

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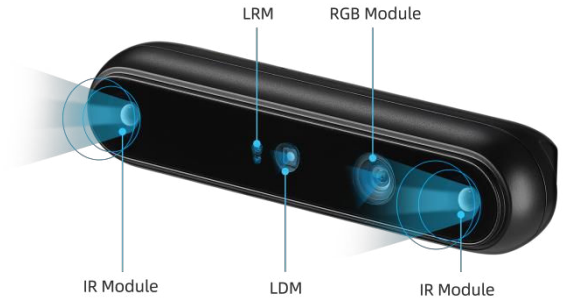
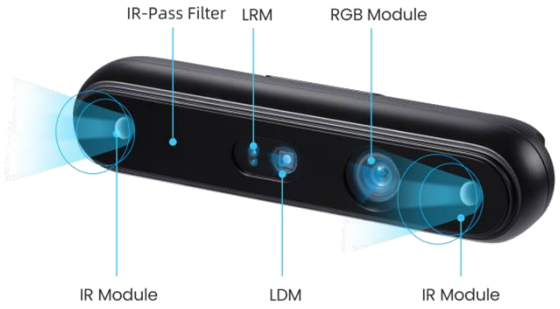
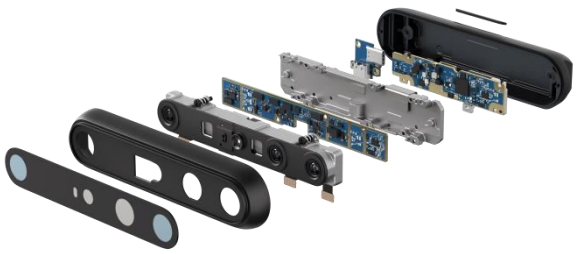
3.4.2 Overview of Product Components for Gemini 335L/336L

Table 3-4-2 Overview of product components for Gemini 335L/336L

Gemini 335L	Gemini 336L
	
	

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3.4.3 Laser Diode Module

The laser module (LDM) comprises an array of vertical cavity surface emitting lasers and other optic components. It enhances the depth camera system's ability to detect depth information by projecting static infrared patterns onto the scene, adding texture to low- texture scenes. The Gemini 330 Series laser module is a Class 1 Laser Product under normal conditions.

Table 3-4-3 LDM parameters

LDM	Gemini 335/336/335L/336L
Type	Infrared
Component	Vertical Cavity Surface Laser Emitter(VCSEL) + Optics
Laser Controller	Pulse
Wavelength	850nm ± 6nm
Laser Compliance*	Class 1, IEC 60825-1:2007 Edition 2, IEC 60825-1:2014 Edition 3 FDA number: 2420619-000
Laser Power-down Temperature*	73℃
Horizontal FOV	101°
Vertical FOV	72.5°
FOV tolerance	±3.0°

Note: * LDM is considered Class 1 when integrated into Orbbec's 3D Cameras.

* LDM will power down while the NTC tested temperature is ≥73℃.

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3.4.4 Infrared Module

Table 3-4-4 Infrared module parameters

IR Module	Gemini 335 /336/336L	Gemini 335L
Filter Type	All-pass Filter	Visible + NIR-pass Filter
Active Pixels	1280 x 800	1280 x 800
Sensor Aspect Ratio	16:10	16:10
Focus Type	Fixed	Fixed
Shutter Type	Global Shutter	Global Shutter
Horizontal FOV	94°	94°
Vertical FOV	68°	68°
Diagonal FOV	104°	104°
FOV tolerance	±3.0°	±3.0°
Distortion	<1.5%	<1.5%

3.4.5 RGB Module

Table 3-4-5 RGB module parameters

RGB Module	Gemini 335/336	Gemini 335L/336L
Filter Type	IR-cut	IR-cut
Active Pixels	1920 x 1080	1280 x 800
Sensor Aspect Ratio	16:9	16:10
Focus Type	Fixed	Fixed
Shutter Type	Rolling Shutter	Global Shutter
Horizontal FOV	86°	94°
Vertical FOV	55°	68°
Diagonal FOV	94°	104°
FOV tolerance	±3.0°	±3.0°
Distortion	<1.5%	<1.5%

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3.4.6 Laser Ranging Module

The Gemini 335/336 and 335L/336L 3D cameras come equipped with a single-point laser ranging module (LRM). Essentially, it is a single-point dToF (direct time-of-flight) sensor that calculates relative distance by measuring the time it takes for light to travel from emission to reception. It is used for close-range ranging, helping the 3D camera to fill in blind spots at short distances and enhances the overall ranging performance of the depth camera.

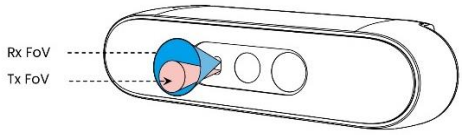
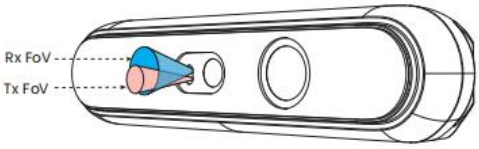
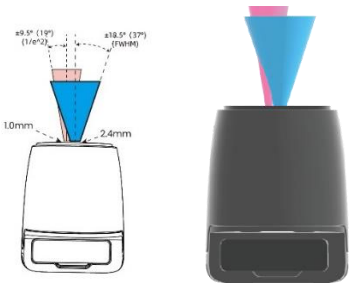
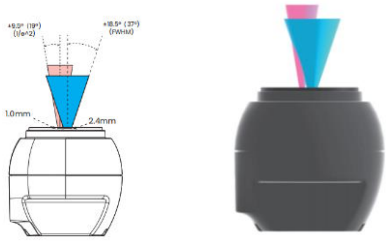
Table 3-4-6a LRM parameters

LRM	Gemini 330 series
Type	Infrared
Wavelength	940nm (Typical)
Tx DFOV	19°
Rx DFOV	37°
FOV tolerance	±2.0°

Table 3-4-6b LRM Ranging Accuracy Reference Value

	Distance	Value	Unit
LRM Accuracy	1mm — 100mm	±15	mm
	100mm — 200mm	±10	mm
	200 mm — 400mm	±5%	N/A

Table 3-4-6c LRM Ranging FOV

Name	Gemini 335/336	Gemini 335L/336L
Rear View		
Side View		

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3.4.7 IR-pass filter cover（Gemini 336 &336L cover glass）

The Gemini 336 adds an IR-Pass filter to the base model of the Gemini 335 and the Gemini 336L is also add an IR-Pass filter to the base model of the Gemini 335L. About the optical filter details introduction Please see Optical filters for stereo vision 3D cameras

3.4.8 Transmittance vs. Wavelength for Depth Camera

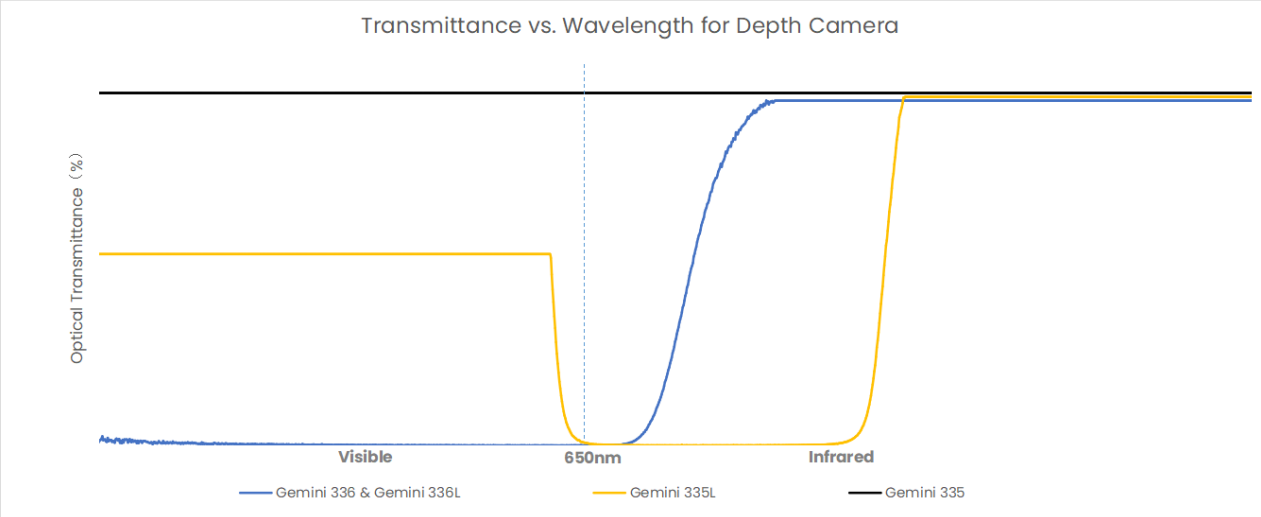

Figure 3-4-8 Transmittance vs. Wavelength for Depth Camera

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3.4.9 IMU

Table 3-4-9 Gemini 330series IMU Specifications

IMU Parameters		Specifications
Timestamp Unit		us (Same source hardware timestamp is used for IMU, IR, RGB and Depth stream)
Transmittance Protocol		I2C
X/Y/Z Axis		The X, Y, and Z axis point right, downward, and forward relative to the camera front
Gyroscope	Format	3 x 16-bit
	Range	±17.45 rad/s (1000dps)
	Frequency (Hz)	50/100/200/500/1000
Accelerometer	Format	3 x 16-bit
	Range	± 39.2m/s² (4g)
	Frequency (Hz)	50/100/200/500/1000
Temperature	Format	1 x 16-bit
	Range	-40 ~ 85℃
	Frequency (Hz)	Follows the gyroscope and accelerometer frequency

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4. Functional Specifications

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

Table 4-1-1 VID & PID table

Name	Gemini 335	Gemini 336	Gemini 335L	Gemini 336L
Model	G40155-170	G40155-180	G40055-170	G40055-180
PID	0x0800	0x0803	0x0804	0x0807
VID	0x2BC5			

4.2 Platform and System Requirements

Gemini 330 series connect to the host computer using USB, which is compatible with various platforms and system requirements.

Table 4-2-1 Gemini 330 series Recommended Platforms and Systems

Chip	x86/x64		ARM	
OS	Windows 10/11	Ubuntu 20.04 / 22.04	Android OS 8 and above	Ubuntu 20.04 / 22.04
USB	USB 3.0	USB 3.0	USB 3.0	USB 3.0
CPU	Quad-core, 2.9GHz	Quad-core, 2.9GHz	Quad-core Cortex-A73, dual-core Cortex-A53	Quad-core, A57
Reference model	Intel i3 10100 / Intel i5 8400	Intel i3 10100 / Intel i5 8400	Qualcomm Snapdragon RB5	NVIDIA Jetson Orin Nano / Raspberry Pi 5
RAM	8GB RAM and above	4GB RAM and above	4GB RAM and above	4GB RAM and above

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4.3 Camera system Framework

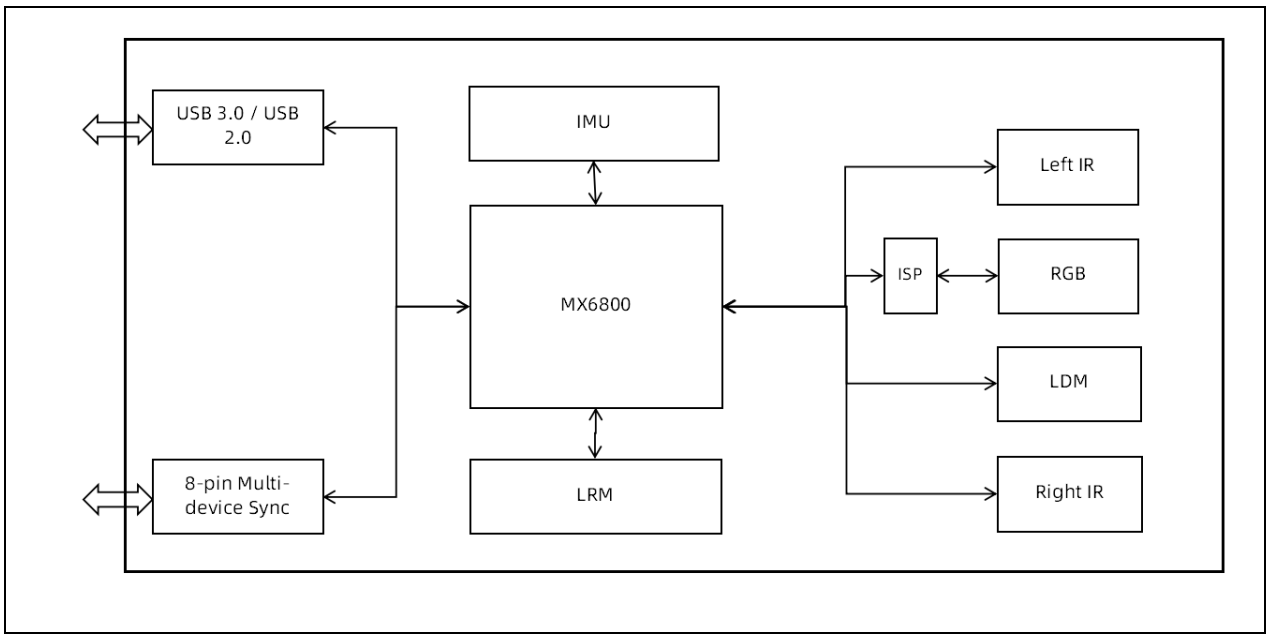

Figure 4-3-1 Gemini 330 Series System Framework Diagram

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4.4 Image Data Stream

The Gemini 330 series provide high-quality, multi-resolution depth stream data, as well as high-definition color stream data. The camera outputs depth stream data in Y16 format. The color stream data output by the camera is in MJPEG/YUYV format. The SDK supports output in MJPEG / YUYV / RGB8 / BGR8 / RGBA8 / BGRA8 / Y16 formats. The camera outputs IR image data in Y8 format, and the SDK also supports outputting data in Y16/Y12 formats at maximum resolution.

Table 4-4-1 Output data streams (USB3.0)-Gemini 335/336

Gemini 335/336 (USB 3.0)	Data Format	Aspect Ratio	Resolution	Frame Rate
Depth	Y16	16:10	1280 x 800	6, 10, 15, 30
			640 x 400	6, 10, 15, 30
			424 x 266	6, 10, 15, 30
		16:9	1280 x 720	6, 10, 15, 30
			848 x 480	6, 10, 15, 30, 60
			640 x 360	6, 10, 15, 30, 60,90
			480 x 270	6, 10, 15, 30, 60,90
			424 x 240	6, 10, 15, 30, 60,90
		4:3	640 x 480	6, 10, 15, 30, 60,90
		Other	848 x 100	100
IR	Y8	16:10	1280 x 800	6, 10, 15, 30
			640 x 400	6, 10, 15, 30
			424 x 266	6, 10, 15, 30
		16:9	1280 x 720	6, 10, 15, 30
			848 x 480	6, 10, 15, 30, 60
			640 x 360	6, 10, 15, 30, 60,90
			480 x 270	6, 10, 15, 30, 60,90
			424 x 240	6, 10, 15, 30, 60,90
		4:3	640 x 480	6, 10, 15, 30, 60,90
		Other	848 x 100	100
RGB	MJPEG & YUYV	16:9	1920 x 1080	6, 10, 15, 30
			1280 x 720	6, 10, 15, 30, 60
			960 x 540	6, 10, 15, 30, 60
			848 x 480	6, 10, 15, 30, 60
			640 x 360	6, 10, 15, 30, 60
			424 x 240	6, 10, 15, 30, 60
			320 x 180	6, 30, 60
		4:3	640 x 480	6, 10, 15, 30, 60
			320 x 240	6, 30, 60

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Table 4-4-2 Output data streams (USB2.0)-Gemini 335/336

Gemini 335/336 (USB 2.0)	Data Format	Aspect Ratio	Resolution	Frame Rate
Depth	Y16	16:10	1280 x 800	6
			640 x 400	6, 10, 15, 30
			424 x 266	6, 10, 15, 30
		16:9	1280 x 720	6
			848 x 480	6, 8, 10
			640 x 360	6, 10, 15, 30
			480 x 270	6, 10, 15, 30, 60
		4:3	640 x 360	6, 10, 15, 30
IR	Y8	16:10	1280 x 800	6
			640 x 400	6, 10, 15, 30
			424 x 266	6, 10, 15, 30
		16:9	1280 x 720	6
			848 x 480	6, 8, 10
			640 x 360	6, 10, 15, 30
			480 x 270	6, 10, 15, 30, 60
		4:3	640 x 480	6, 10, 15, 30
RGB	MJPEG	16:9	1920 x 1080	8
			1280 x 720	6, 10, 15
	MJPEG & YUYV	16:9	424 x 240	6, 15, 30, 60
		4:3	640 x 480	6, 15, 30

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Table 4-4-3 Output data streams (USB3.0)-Gemini 335L/336L

Gemini 335L /336L (USB 3.0)	Data Format	Aspect Ratio	Resolution	Frame Rate
Depth	Y16	16:10	1280 x 800	5, 10, 15, 30
			640 x 400	5, 10, 15, 30
			424 x 266	5, 10, 15, 30
		16:9	1280 x 720	5, 10, 15, 30
			848 x 480	5, 10, 15, 30, 60
			640 x 360	5, 10, 15, 30, 60, 90
			480 x 270	5, 10, 15, 30, 60, 90
			424 x 240	5, 10, 15, 30, 60, 90
		4:3	640 x 480	5, 10, 15, 30, 60, 90
		other	848 x 100	100
IR	Y8	16:10	1280 x 800	5, 10, 15, 30
			640 x 400	5, 10, 15, 30
			424 x 266	5, 10, 15, 30
		16:9	1280 x 720	5, 10, 15, 30
			848 x 480	5, 10, 15, 30, 60
			640 x 360	5, 10, 15, 30, 60, 90
			480 x 270	5, 10, 15, 30, 60, 90
			424 x 240	5, 10, 15, 30, 60, 90
		4:3	640 x 480	5, 10, 15, 30, 60, 90
		other	848 x 100	100
RGB	MJPEG & YUYV	16:10	1280 x 800	5, 10, 15, 30, 60
			640 x 400	5, 10, 15, 30, 60, 90
		16:9	1280 x 720	5, 10, 15, 30, 60
			848 x 480	5, 10, 15, 30, 60
			640 x 360	5, 10, 15, 30, 60, 90
			480 x 270	5, 10, 15, 30, 60, 90
			424 x 240	5, 10, 15, 30, 60, 90
		4:3	640 x 480	5, 10, 15, 30, 60, 90

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Table 4-4-4 Output data streams (USB2.0)-Gemini 335L/336L

Gemini 335L / 336L (USB 2.0)	Data Format	Aspect Ratio	Resolution	Frame Rate
Depth	Y16	16:10	1280 x 800	5
			640 x 400	5, 10, 15, 30
			424 x 266	5, 10, 15, 30
		16:9	1280 x 720	5
			848 x 480	5, 10
			640 x 360	5, 10, 15, 30
			480 x 270	5, 10, 15, 30, 60
		4:3	640 x 480	5, 10, 15, 30
IR	Y8	16:10	1280 x 800	5
			640 x 400	5, 10, 15, 30
			424 x 266	5, 10, 15, 30
		16:9	1280 x 720	5
			848 x 480	5, 10
			640 x 360	5, 10, 15, 30
			480 x 270	5, 10, 15, 30, 60
		4:3	640 x 480	5, 10, 15, 30
RGB	MJPEG	16:10	1280 x 800	8
		16:9	1280 x 720	5, 10, 15
	MJPEG & YUYV	16:10	640 x 400	5, 10, 15, 30
		16:9	424 x 240	5, 10, 15, 30, 60
		4:3	640 x 480	5, 10, 15, 30

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4.5 Field of View

4.5.1 Definition of Depth Field of View

The image below shows the depth camera field-of-view, or the angles that the sensors "see". We use the IR cameras for illustration.

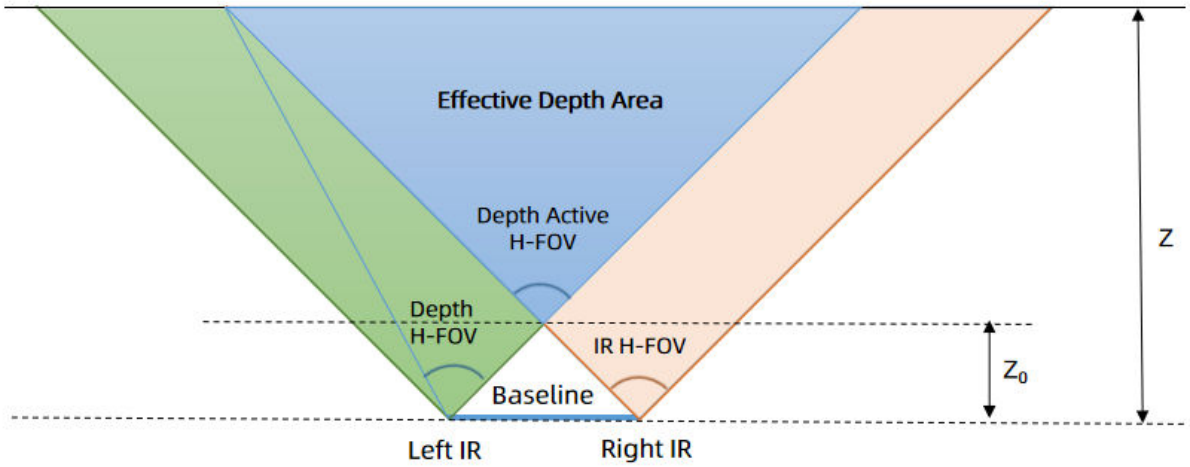

Figure 4-5-1 Depth Field of View to Depth Map illustration

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

Table 4-5-1 Depth FOV calculation formulas

Calculation Formulas	Definitions
$\text{Depth H}-\text{FOV} = \arctan\left(\frac{cx}{fx}-\frac{B}{Z}\right)+\arctan\frac{width-1-cx}{fx}$	1. cx = X-direction image coordinates of the principle point of the depth image 2. fx= Depth camera focal length 3. cy= Y-direction image coordinates of the principle point of the depth image 4. fy=Depth camera focal length 5. width= Depth image width 6. Height=Depth image height 7. Depth active H-FOV =Left IR H-FOV
$\text{Depth Active H}-\text{FoV} = \arctan\frac{cx}{fx}+\arctan\frac{width-1-cx}{fx}$	
$Z_0 = \frac{\text{B}}{2*\tan(\frac{\text{Depth Active H}-\text{FOV}}{2})}$	
$\text{Depth V - FOV} = \arctan\left(\frac{\text{cy}}{fy}\right)+\arctan\frac{height\text{-}1\text{-}cy}{fy}$	

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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 depth values, the depth FOV is different. The farther the depth, the greater the depth FOV.

4.5.2 Typical Depth Intrinsics

Table 4-5-2 Typical Depth Intrinsics of Gemini 330series

Baseline/mm	Resolution：Width x Height		cx/pixel	cy /pixel	Fx & fy/pixel
	Width/pixel	Height/pixel			
Gemini335: 50mm	1280	800	640	400	620.0 & 620.0
	1280	720	640	360	620.0 & 620.0
Gemini 336: 50mm	848	480	424	240	410.7 & 410.7
	848	100	424	50	410.7 & 410.7
Gemini 335L: 95mm	640	480	320	200	372.0 & 372.0
	640	400	320	200	310.0 & 310.0
	640	360	320	180	310.0 & 310.0
Gemini 336L: 95mm	480	270	240	135	232.5 & 232.5
	424	240	212	120	205.4 & 205.4

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4.5.3 Overview of Stream FOV

Table 4-5-3 Stream FOV for Gemini 330 Series

FOV	Aspect Ratio	Gemini 335/336	Gemini 335L/336L
Depth @ 2m	16:10	H 90° V 65°	H 90° V 65°
	16:9	H 90° V 60°	H 90° V 60°
	4:3	H 81° V 65°	H 81° V 65°
	Other(848x100)	H 90° V 14°	H 90° V 14°
IR	16:10	H 91° V 65°	H 91° V 65°
	16:9	H 91° V 60°	H 91° V 60°
	4:3	H 81° V 65°	H 81° V 65°
	Other(848x100)	H 91° V 14°	H 91° V 14°
RGB	16:10	N/A	H 94° V 68°
	16:9	H 86° V 55°	H 94° V 62°
	4:3	H 70° V 55°	H 82° V 68°
D2C FOV @ 2m	16:10	N/A	H 90° V 65°
	16:9	H 86° V 55°	H 90° V 60°
	4:3	H 70° V 55°	H 81° V 65°

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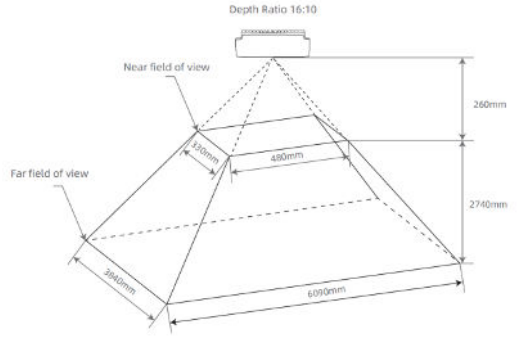
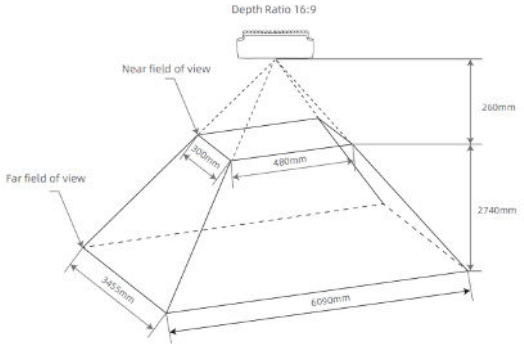
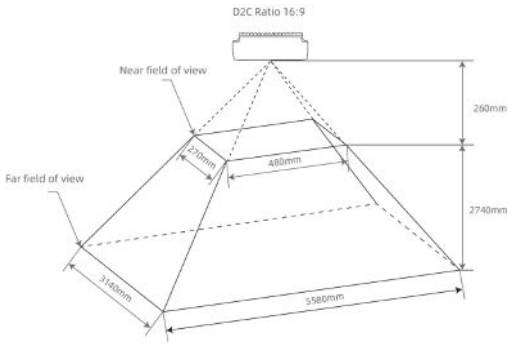
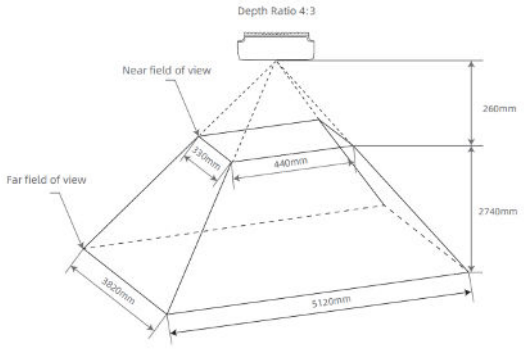
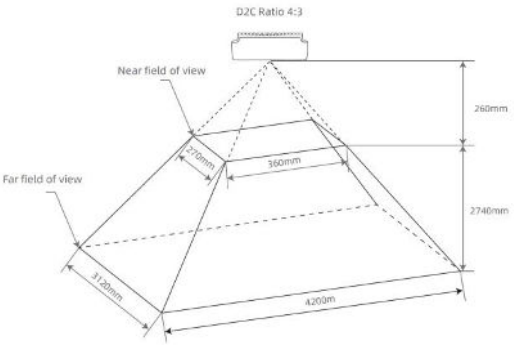
4.5.4 FOV Illustrations for Gemini 335/336

Table 4-5-4 Gemini 335/336 Depth FOV

Aspect ratio	Depth FoV Before D2C	Depth FOV After D2C
16:10		**N/A**
16:9		
4:3		

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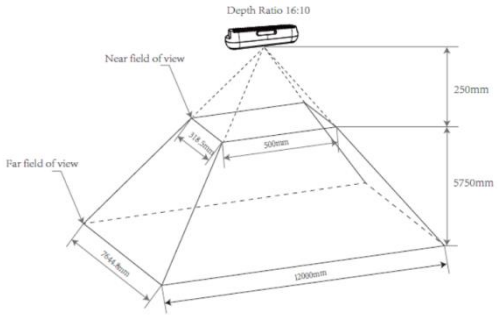
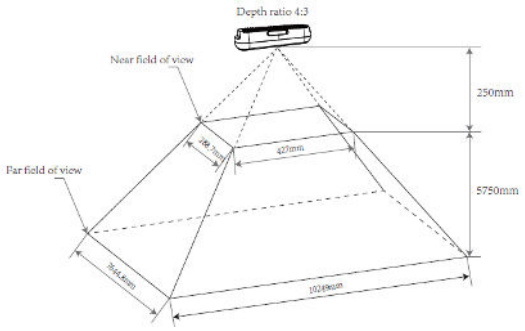
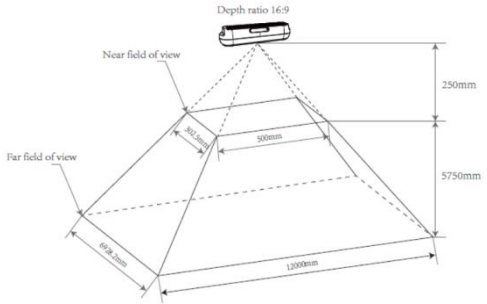
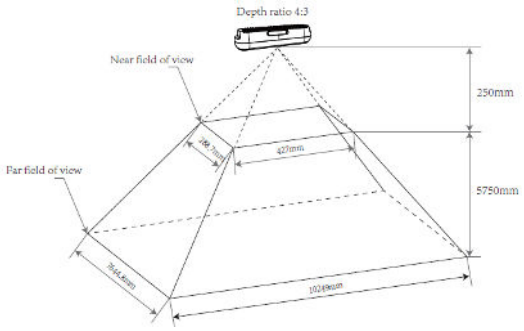
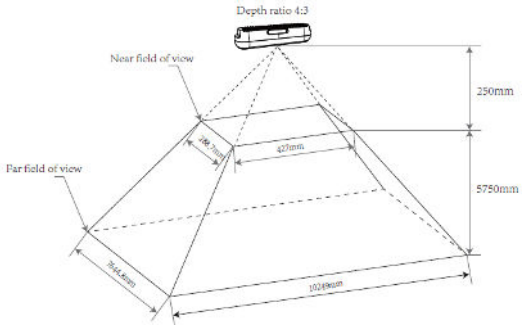
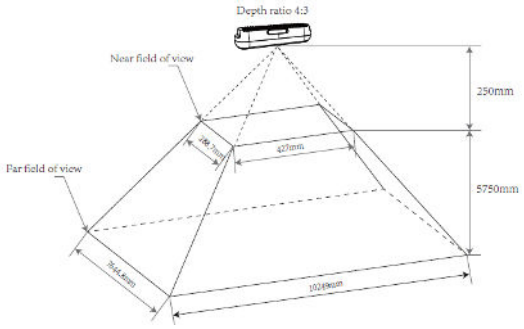
4.5.5 FOV Illustrations for Gemini 335L/336L

Table 4-5-5 Gemini 335L/336L Depth FOV

Aspect ratio	Depth FoV Before D2C	Depth FOV After D2C
16:10		
16:9		
4:3		

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4.6 Depth to Color Alignment

Depth to Color, a pixel-by-pixel geometric transformation of a depth image, results in the spatial alignment of a depth image with its corresponding color image through the D2C transformation, allowing us to locate any pixel of a color image by its image coordinates in the depth image after D2C by the same image coordinates. The depth information of the color pixel can be located in the depth image after D2C by using the same image coordinates. We generate a depth image of the same size as the target color image after D2C, and the image content is the depth data in the color camera coordinate system. In other words, a depth image is reconstructed that is "taken" using the origin and size of the color camera, where each pixel matches the coordinates of the corresponding pixel of the color camera.

Table 4-6-1 Gemini 335 & Gemini 336 Depth to Color Alignment by software

Depth Image before D2C	Color Image	Depth Image After D2C	Aspect Ratio
1280 x 800 / 1280 x 720 / 848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	1920 x 1080	1920 x 1080	16:9
	1280 x 720	1280 x 720	
	960 x 540	960 x 540	
	848 x 480	848 x 480	
	640 x 360	640 x 360	
	424 x 240	424 x 240	
	320 x 180	320 x 180	
1280 x 800 / 1280 x 720 / 848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	640 x 480	640 x 480	4:3
	320 x 240	320 x 240	

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Table 4-6-2 Gemini 335 & Gemini 336 Depth to Color Alignment by hardware

Depth Image before D2C	Color Image	Depth Image After D2C	Aspect Ratio
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360	640 x 360	640 x 360	16:9
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	424 x 240	424 x 240	
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	320 x 180	320 x 180	
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360	640 x 480	640 x 480	4:3
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	320 x 240	320 x 240	
*The depth resolution of 640x400/424x266 only supports color alignment at 30fps or lower.			

Table 4-6-3 Gemini 335L & Gemini 336L Depth to Color Alignment by software

Depth Image before D2C	Color Image	Depth Image After D2C	Aspect Ratio
1280 x 800 / 1280 x 720 / 848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	1280 x 800	1280 x 800	16:10
	640 x 400	640 x 400	
1280 x 800 / 1280 x 720 / 848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	1280 x 720	1280 x 720	16:9
	848 x 480	848 x 480	
	640 x 360	640 x 360	
	480 x 270	480 x 270	
	424 x 240	424 x 240	
	320 x 180	320 x 180	
1280 x 800 /1280 x 720 / 848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	640 x 480	640 x 480	4:3

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Table 4-6-4 Gemini 335L & Gemini 336L Depth to Color Alignment by hardware

Depth Image before D2C	Color Image	Depth Image After D2C	Aspect Ratio
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	640 x 400	640 x 400	16:10
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360	640 x 360	640 x 360	16:9
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	480 x 270	480 x 270	
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	424 x 240	424 x 240	
848 x 480 / 640 x 480 / 640 x 400 / 640 x 360 / 480 x 270 / 424 x 266 / 424 x 240	640 x 480	640 x 480	4:3
*1. The depth resolution of 848x480 only supports color alignment at 60fps or lower. *2. The depth resolution of 640x400/424x266 only supports color alignment at 30fps or lower.			

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4.7 Minimum-Z Depth

The Minimum-Z Depth is the minimum distance from the depth camera to the scene.

Table 4-6-1 Minimum-Z Depth for Gemini 330series

Cameras		Gemini 335/336	Gemini 335L/336L		
Disparity search range		128	256	128	64
H / V-FOV: 90° / 65°	1280 x 800	0.26m	0.25m	0.5m	1m
	640 x 400				
	424 x 266				
H / V-FOV: 90° / 60°	1280 x 720	0.26m	0.25m	0.5m	1m
	848 x 480	0.18m	N/A	0.34m	N/A
	640 x 360	0.14m	N/A	0.26m	N/A
	480 x 270	0.11m	N/A	0.19m	N/A
	424 x 240	0.1m	N/A	0.17m	N/A
H / V-FOV: 81° / 65°	640 x 480	0.17m	N/A	0.3m	N/A
H / V-FOV: 90° / 14°	848 x 100	0.18m	N/A	0.34m	N/A

Note: The larger the disparity search range, the closer the minimum working distance becomes, and the higher the power consumption. Conversely, the smaller the disparity search range, the farther the minimum working distance extends, the lower the camera's power consumption, and the higher the ambient temperature it can withstand.

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4.8 Coordinate System

For the Gemini 330 series 3D camera, the plane where the 1/4 screw hole is located is defined as the bottom side, the glass cover surface is the front side, and the RGB module is positioned to the left of the LDM module.

The origin of the IMU coordinate system is situated at the physical sensor center point. The accelerometer and gyroscope coordinate systems are located at the back of the left IR. The positive X-axis of the coordinate system points to the right, the positive Y-axis points downwards, and the positive Z-axis points forwards.

The origin of the depth image coordinate system is at the optical center of the left IR module, while the origin of the color image coordinate system is at the optical center of the RGB module. The direction of the coordinate systems is the same: the positive X-axis points to the right, the positive Y-axis points downward, and the positive Z-axis points forward. The depth camera coordinate system origin is the default origin of the 3D camera, with coordinates (0,0,0). The reference positions of the depth origin, color origin, and IMU origin in the 3D camera coordinate system are shown in the chart below:

Table 4-8-1 Gemini 330 series Coordinate System Position Reference

Camera	Coordinate System	Position in the 3D camera coordinate system		
		X（mm）	Y（mm）	Z(mm)
Gemini 335/336	Depth	0	0	0
	Color	14.00	0	2.02
	IMU	-0.246	-0.065	-16.948
Gemini 335L & Gemini 336L	Depth	0	0	0
	Color	23.75	0	0
	IMU	7.866	1.068	-14.248

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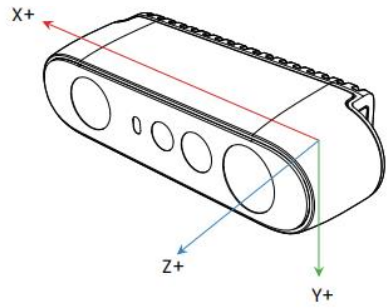
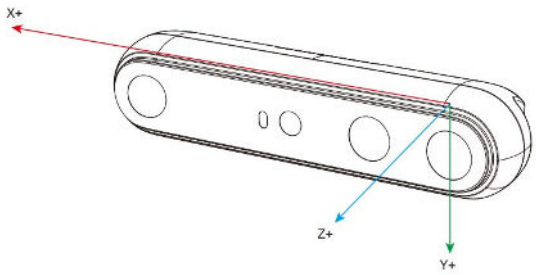
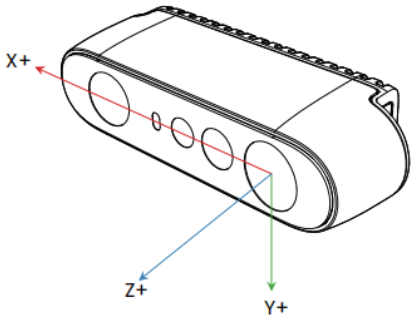
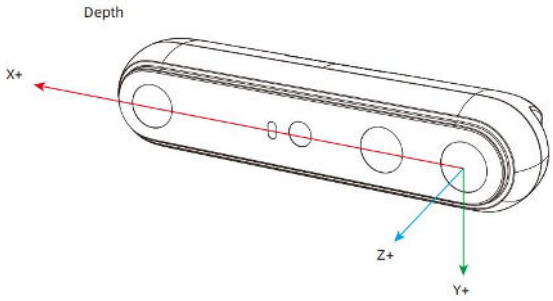
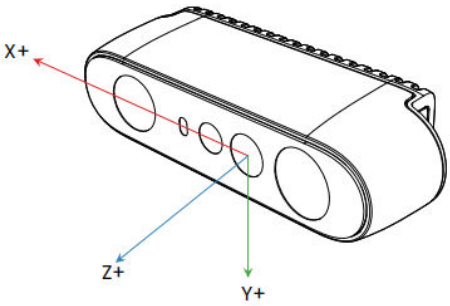
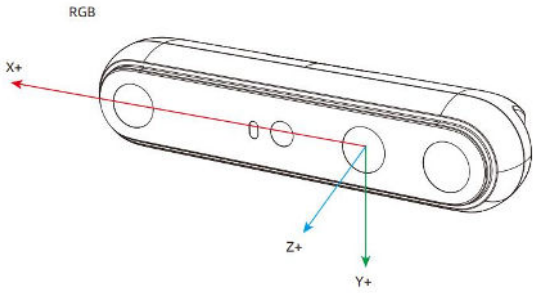
Table 4-8-2 Gemini 330 Series Coordinate System Schematic

	Gemini 335/336	Gemini 335L/336L
IMU		
Depth		
RGB		

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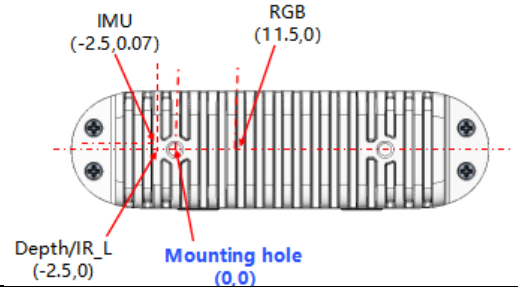
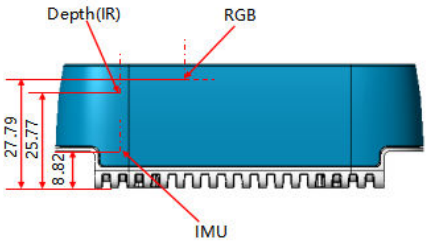
The relative coordinate system relationship between the installation positions and Depth/Color/IMU of Gemini 335/336.

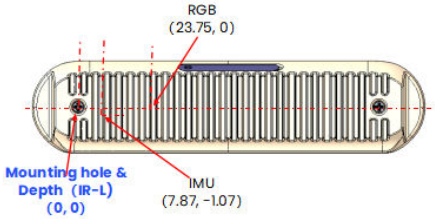
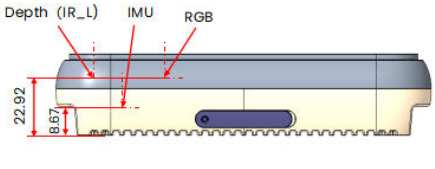
Table 4-8-3 Gemini 335/336 Coordinate System Position Reference

Camera	Coordinate System	Position in the 3D camera coordinate system		
		X（mm）	Y（mm）	Z(mm)
Gemini 335/336	Mounting hole	0	0	0
	Depth	-2.5	0	25.77
	Color	11.5	0	27.79
	IMU	-2.5	0.07	8.82
				

Note：All reference points are at the centers of the components or positions.

The relative coordinate system relationship between the installation positions and Depth/Color/IMU of Gemini 335L/336L.

Table 4-8-4 Gemini 335L/336L Coordinate System Position Reference

Camera	Coordinate System	Position in the 3D camera coordinate system		
		X（mm）	Y（mm）	Z(mm)
Gemini 335L/336L	Mounting hole	0	0	0
	Depth	0	0	22.92
	Color	23.75	0	22.92
	IMU	7.87	-1.07	8.67
				

Note：All reference points are at the centers of the components or positions.

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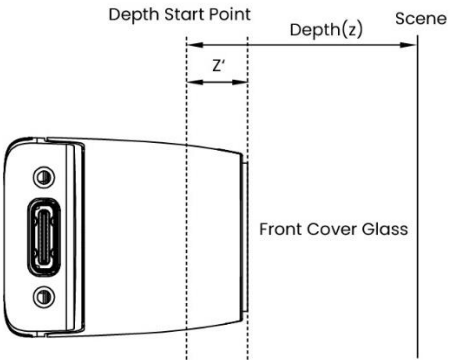
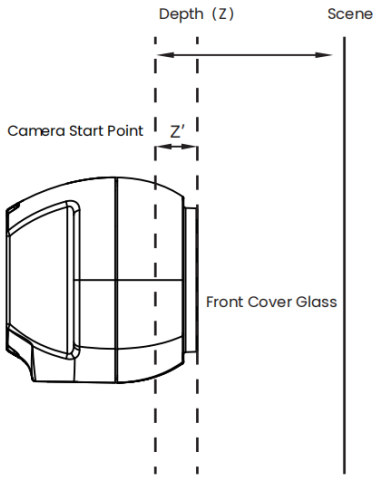
4.9 Camera Start Point Reference

The camera start point, or ground zero datum can be described as a start point or plane with depth = 0. For the Gemini 330 series 3D camera, the distance of the depth/RGB/LRM zero point relative to the front cover glass of the camera are listed in the table below.

Table 4-9-1 Camera Start Point Illustrations

Camera	Gemini 335	Gemini 336	Gemini 335L	Gemini 336L
Depth (Z')	4.230mm	4.930mm	4.080mm	4.780mm
RGB (Z')	2.210mm	2.910mm	4.080mm	4.780mm
LRM (Z')	0mm	0.7mm	0mm	0.7mm
Camera Start Point				

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4.10 Streaming Mode

The Gemini 330 Series offers users flexible methods for acquiring IR, Depth, and RGB image data, with the most common being the specific frame rate streaming mode. In this mode, users set a target frame rate, resolution, and image format for each type of data, and then activate the corresponding data streams in sequence. The camera captures and outputs image data at the user-defined target frame rate, resolution, and image format. The user can select a specific frame rate for the current scene from predefined fixed frame rate values of 5fps/6fps, 10fps, 15fps, 30fps, 60fps, 90fps and 100fps depending on the camera's currently configured depth mode and resolution, and capture image data at that frame rate.

4.11 Triggering Mode

The Gemini 330 Series supports image data acquisition methods based on specific frame rates, as well as a free triggering mode that supports arbitrary frequencies. In this mode, the camera waits for an external input trigger signal and only completes an image data acquisition after receiving a valid external trigger signal, as configured by the camera. The camera then continues to wait for the next external trigger signal. As there is no set 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 desired frequency. This allows for passive acquisition of image data. The camera can be triggered through a soft signal sent by the host computer via USB command or an external device through the 8-Pin synchronous interface. This allows for passive triggering mode at any frequency.

In free triggering mode, the camera's IR, Depth, and RGB fixed frame rates must be set to a uniform value of 5fps/6fps, 10fps, 15fps, 30fps, 60fps, or 90fps upon request. This is necessary to determine the minimum time interval between two consecutive active triggers. Table 4-11-1 shows the relationship between the fixed frame rate, the minimum time interval, and the upper frequency limit for passive triggering. In summary, the camera will only respond to trigger signals within the allowable range. This means that the trigger frequency can be any value within the valid frequency range for passive triggering.

Table 4-11-1 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)
90	≥22.3	0 - 45
60	≥33.4	0 - 30
30	≥ 66.7	0 - 15
15	≥ 133.4	0 - 7.5
10	≥200	0 – 5
6	≥333.4	0 - 3
5	≥ 400	0 – 2.5

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4.12 Multi-Camera Synchronization

For a multi-camera use case, one camera can be initialized as primary, and the rest configured as secondary. Alternatively, an external signal generator can also be used as the primary trigger with all cameras set to secondary mode. When applying an external sync pulse, the HW SYNC input requires a 100-microsecond positive pulse at the nominal camera frame rate, e.g. 33.33 ms for a 30 Hz frame rate. Inputs are high impedance, 1.8V CMOS voltage levels. However, it is important to make sure to use a high-resolution signal generator. The frequency of the signal generator needs to exactly match the sensor frame rate. For example, if the sensor is set up as 30 FPS, the real frame rate may be 30.015 FPS. You may need to use an oscilloscope to measure the real frame rate and configure the signal generator to the same frequency. For this reason, it may be better to just use one additional camera as the primary sync signal generator.

Advantages of multi-camera setup：

- Increase camera coverage in a given space and fill in the occlusions where a single camera may have blind spots
- Capture multiple images of the same scene and scan objects from different angles
- Increase the effective frame rate to greater than 30 FPS

Using an 8-pin connector and matching cable, a multi-camera and multi-sensor network can be designed. (Please follow the instructions in the SDK).

Multi-camera frame synchronization in two topologies is supported, including depth image synchronization and RGB image synchronization (time difference ≤ 5ms, when auto exposure off), using the multi-camera synchronization function.

Table 4-12-1 Topologies schematic diagram

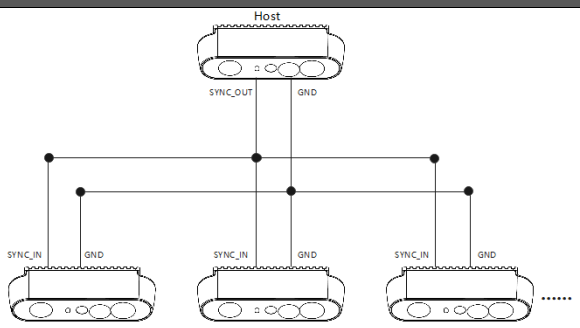
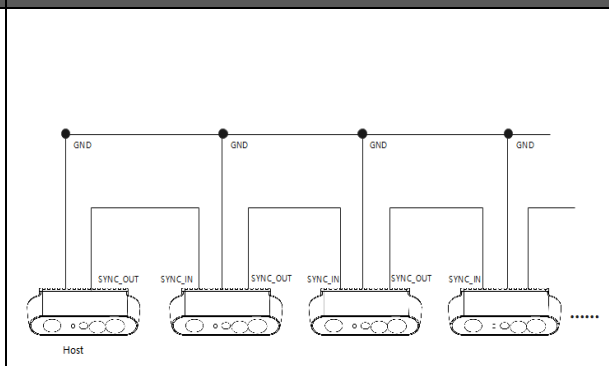
Star Topology	Daisy-chain Topology
	

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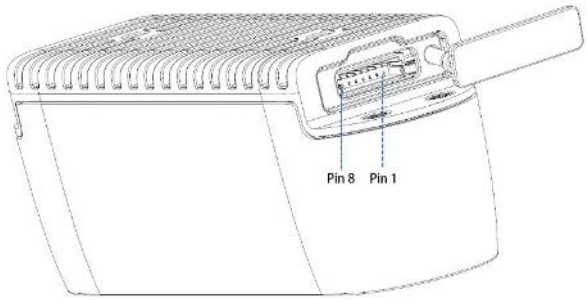
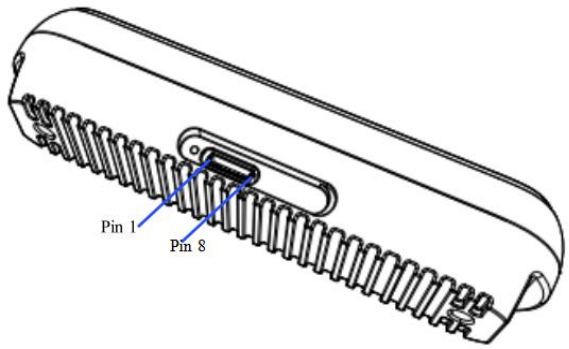
Table 4-12-2 Synchronization Interfaces of Gemini 330 Series

Pin	Definitions	Description
Pin_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.
Pin_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.
Pin_3	VSYNC_OUT	Synchronous trigger signal: Active high. The high level provides the triggering signal for the secondary devices.
Pin_4	TIMER_SYNC_OUT	Pulse signal source, reset hardware timestamp of secondary devices.
Pin_5	RESET_IN	Hardware reset signal: Triggers the camera to power down and automatically power up and reset. Detect the input signal: 20 Hz / 50% duty cycle / more than 5 consecutive cycles, that is, judged as normal input signal, other signals filtered out; allowed fluctuations for frequency ± 1 Hz, duty cycle ± 2%.
Pin_6	VSYNC_IN	Synchronous trigger signal: Active high, used for the triggering/sync signal from primary device, with a duration of 1 ms.
Pin_7	TIMER_SYNC_IN	Hardware timestamp reset signal input, hardware timestamp clearing.
Pin_8	GND	Ground

Table 4-12-3 Gemini 330 series Multi-camera Synchronization Pin Placement

Gemini 335/336	Gemini 335L/336L
	

Detailed operating instructions for multi-camera synchronization, please refer the document of [Set up cameras for external synchronization]

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4.13 Camera Functions

4.13.1 Depth Camera Functions

Gemini 330 series expose the following Depth image settings.

Table 4-13-1 Depth camera control

Control	Description	Settings	Default Setting
Mirror	Image mirror is an image processing technique that creates a symmetrical effect by flipping the image along a specific axis (usually vertical or horizontal).	Disable, Enable	Enable
Flip	Inverting images or data, such as flipping an image horizontally or vertically.	Disable, Enable	Enable
Rotate	Turning an image by a specific angle.	0°,90°,180°,270°	0°
Laser Power Level		0,1,2,3,4,5,6	6
Laser Status	Laser control on or off and Laser On-Off pattern On-Off ,Off-On, Off	Laser On, Laser Off, Laser On-Off, Off-On, Off	Laser on
Auto Exposure	Auto Exposure Mode. When Auto Exposure is enabled, Exposure and Gain are set based on the environment condition.	Disable, Enable	Enable
AE Max Exposure(us)	AE Max Exposure	Gemini 335/336: 1 - 165000 Gemini 335L/336L: 1 - 199000	30458(30fps)
Mean Intensity Set Point	Mean Intensity Set Point for Gemini	0 - 255	Gemini 335: 70 Gemini 336 / 335L/336L : 60
AE ROI	Perform Auto Exposure on a selected ROI	T:0 - 799, B:0 -799 L:0 - 1279, R:0 -1279 (Resolution:1280 x 800)	T:0, B:479 L:0, R:847 (Resolution: 848 x 480)
Manual Exposure(1) (us)	Sets the absolute exposure time when auto-exposure is disabled	Gemini 335/336: 1 - 165000 Gemini 335L/336L: 1 - 199000	3000
Gain(Gain 1.0=16)	Control sensor digital gain	16 -248	16
Depth Unit(millimeter)	Depth Measurement Standard Units	0.001 - 10	1
HDR	High Dynamic Range	Disable, Enable	Disable
Disparity to Depth	Disable, Hardware, Software	Disable, Hardware, Software	Hardware
Post Processing	post-processing filters to enhance the quality of depth data and reduce noise levels	Disable, Enable	Enable

Note: (1) Not supported in Auto Exposure Mode

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Definitions: T = Top, L = Left, B = Bottom, R = Right

4.13.2 Color Camera Functions

Gemini 330 series expose the following Color image settings.

Table 4-13-2 Color camera control

Control	Description	Settings	Default setting
Mirror (Except MJPEG)	Image mirror is an image processing technique that creates a symmetrical effect by flipping the image along a specific axis (usually vertical or horizontal).	Disable, Enable	Disable
Flip (Except MJPEG)	Inverting images or data, such as flipping an image horizontally or vertically.	Disable, Enable	Disable
Rotate (Except MJPEG)	Turning an image by a specific angle.	0°, 90°, 180°, 270°	0°
Auto Exposure Priority		Disable, Enable	Enable
Auto Exposure	Automatically sets the exposure time and gain for the frame	Disable, Enable	Enable
AE Max Exposure (100us)	Maximum correction value for AE exposure that limits the corresponding frame rate	Gemini 335/336: 1 – 1665 Gemini 335L/336L:1 - 1999	332(30fps)
AE ROI	Perform Auto Exposure on a selected ROI for Gemini 335/336	T:0 - 1079, B:0 -1079 L:0 - 1919, R:0 -1919 (Resolution:1920 x 1080)	T:0, B:719 L:0, R:1279 (Resolution:1280 x 720)
AE ROI	Perform Auto Exposure on a selected ROI for Gemini 335L/336L	T:0 - 779, B:0 -779 L:0 - 1279, R:0 -1279 (Resolution:1280 x 800)	T:0, B:719 L:0, R:1279 (Resolution:1280 x 720)
Manual Exposure(1) (100us)	Sets the absolute exposure time when auto-exposure is disabled	Gemini 335/336: 1 – 1665 Gemini 335L/336L:1 - 1999	156
Gain	Sets the amount of gain applied to the frame if auto-exposure is disabled	0 – 128	16
Brightness	Sets the amount of brightness applied when auto-exposure is enabled	-64 – 64	0
Auto White Balance	Enables or disables the AWB algorithm	Disable, Enable	Disable
White Balance/ K	Sets the white balance when AWB is disabled	2800 – 6500	4600
Sharpness	Sets the amount of sharpening adjustment applied to the frame	0 – 100	50

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Gamma	Sets amount of gamma correction applied to the frame	100 - 500	300
Saturation	Sets the amount of saturation adjustment applied to the frame	0 - 100	64
Contrast	Sets the amount of contrast based on the brightness of the scene	0 - 100	50
Hue	Sets the amount of hue adjustment applied to the frame	-180 – 180	0
Backlight Compensation	Sets a weighting amount based on brightness to the frame	Disable, Enable	Disable
Powerline Frequency	Specified based on the local power line frequency for flicker avoidance	Auto, 50, 60, Disabled	Auto

Note: (1) Not supported in Auto Exposure Mode

Definitions: T = Top, L = Left, B = Bottom, R = Right

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5. Performance

5.1 Depth Performance

5.1.1 Depth Quality Assessment

Calculation of Depth Accuracy (Z-accuracy):
Depth accuracy (Z-accuracy) measures the per-pixel depth accuracy relative to the GT in a single frame depth image, excluding errors due to camera placement. GT is obtained by measuring the distance from depth origin to the reference target. Depth accuracy can be calculated using the following formula:
Depth_accuracy_Signed = Median (CP_Length – GT + PP_Dist)
where CP_Length represents the actual length between the depth origin and a fitted plane along the GT measuring direction, and PP_Dist denotes the per-pixel distance of the point cloud to the fitted plane.

Calculation of Spatial Precision:
The spatial precision is calculated as the percentage of the root mean square error (RMS Error) between each valid pixel and the optimal fitting plane compared to the true value (GT).

Calculation of Temporal Precision:

The temporal precision measures the variation in depth values over time within a ROI. The quality of a depth image can be assessed based on its temporal consistency, high-quality depth images should exhibit smooth and stable over time. This method is defined as the STD of depth values across a specific number of frames (for example, 30). The quantification of temporal noise is carried out on a per-pixel basis, followed by calculating the STD of each pixel over a specified time.

Depth Fill Rate Calculation:
The fill rate is used to calculate the proportion of valid pixels to total pixels within the target area (ROI region), primarily used to measure the completeness of depth.

Detailed calculation principle can be found in document "**Depth Quality Metrics**".

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5.1.2 Typical depth performance for Gemini 330 Series

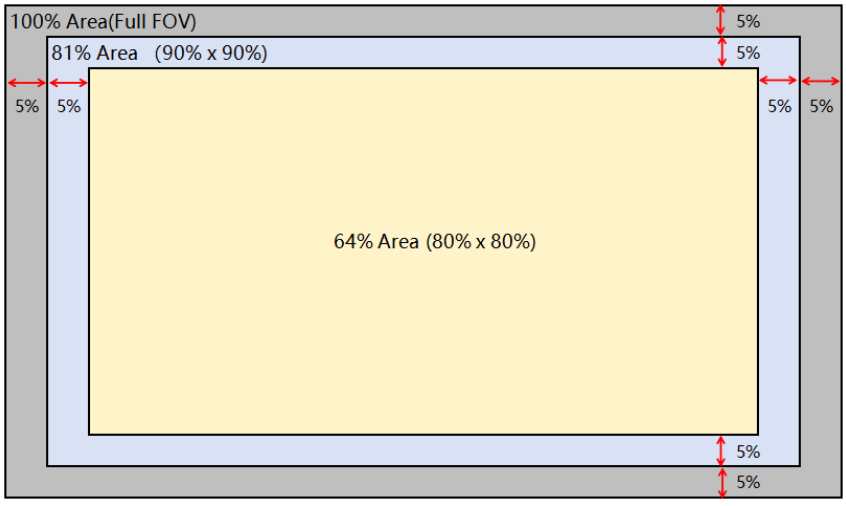
Typical depth performance for Gemini 330 series is shown in the table below:

Table 5-1-1 Typical Depth Performance for Gemini 330 Series

Depth Performance	Gemini 335/336	Gemini 335L/336L
Depth Accuracy	**≤±2%** (1280 x 800 @ 2 m & 90% x 90% ROI)	**≤±1%** (1280 x 800 @ 2 m & 90% x 90% ROI) **≤±2%** (1280 x 800 @ 4 m & 80% x 80% ROI)
Spatial Precision	**≤ 1.5%** (1280 x 800 @ 2 m & 90% x 90% ROI)	**≤ 0.8%** (1280 x 800 @ 2 m & 90% x 90% ROI) **≤ 1.6%** (1280 x 800 @ 4 m & 80% x 80% ROI)
Temporal Precision	**≤ 0.9%** @2m	**≤ 0.4%** @2m
Fill Rate	**≥99.5%** (1280 x 800 @ 2 m & 90% x 90% ROI)	**≥99.5%** (1280 x 800 @ 2 m & 90% x 90% ROI)

Note:

1. The actual working range and accuracy may vary with the ambient illumination and the objects being 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% from the top, bottom, left and right of the depth map) or 64% FOV (64% = 80% x 80% and of a similar definition).



3. The depth performance of each 3D camera is validated at the production line before shipping to customers. The metrics reflect the depth performance under typical conditions. External impact factors over 3D cameras' whole lifespan may have significant impacts on their depth performance.

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- **Spatial Precision performance reference vs. Distance**

Typical Depth performance reference of spatial precision for Gemini 335/336

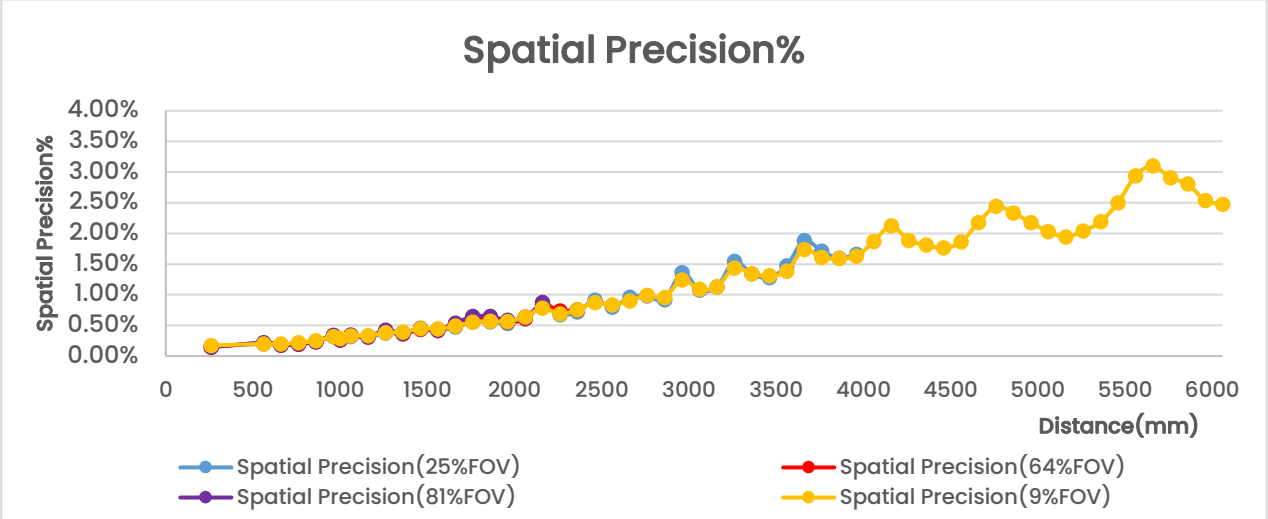

Figure 5-1-3 Spatial Precision chart of Gemini 335/336

Typical Depth performance reference of spatial precision for Gemini 335L/336L

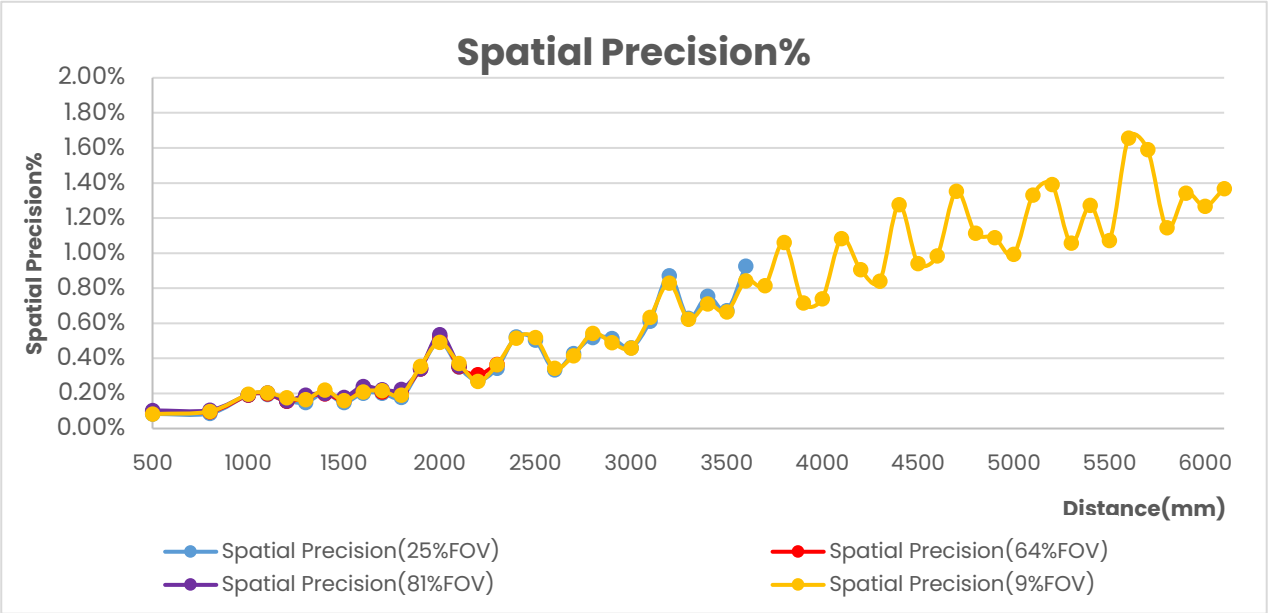

Figure 5-1-4 Spatial Precision chart of Gemini 335L/336L

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- **Temporal Precision performance reference vs. Time**

Typical Depth performance reference of temporal precision for Gemini 335

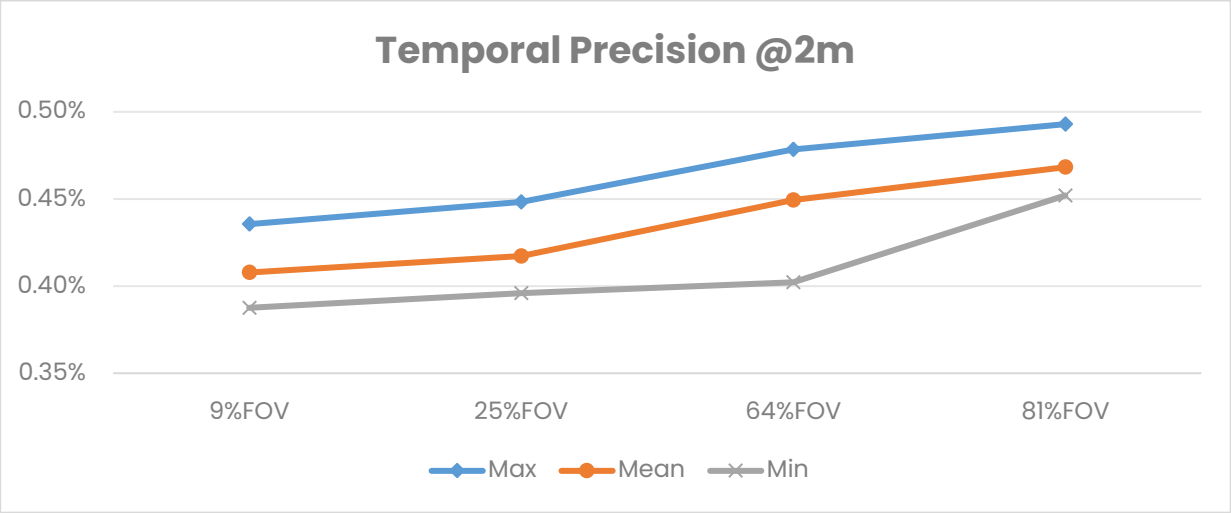

Figure 5-1-5 Temporal Precision chart of Gemini 335

Typical Depth performance reference of temporal precision for Gemini 335L

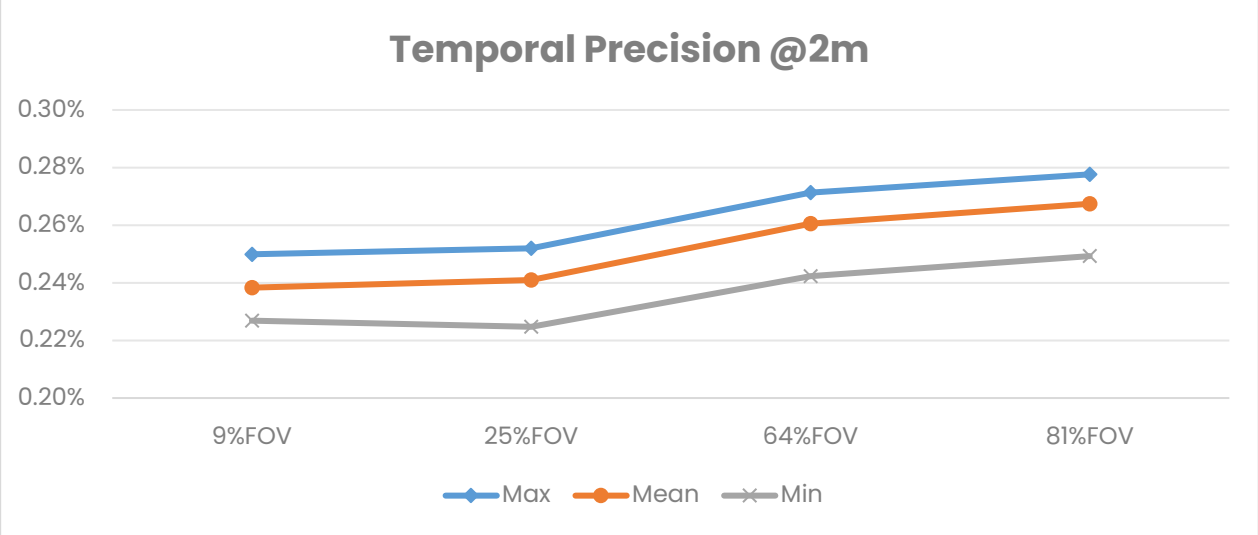

Figure 5-1-6 Temporal Precision chart of Gemini 335L

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- **Fill Rate performance reference vs. Distance:**

Typical Depth performance reference of fill rate for Gemini 335/336

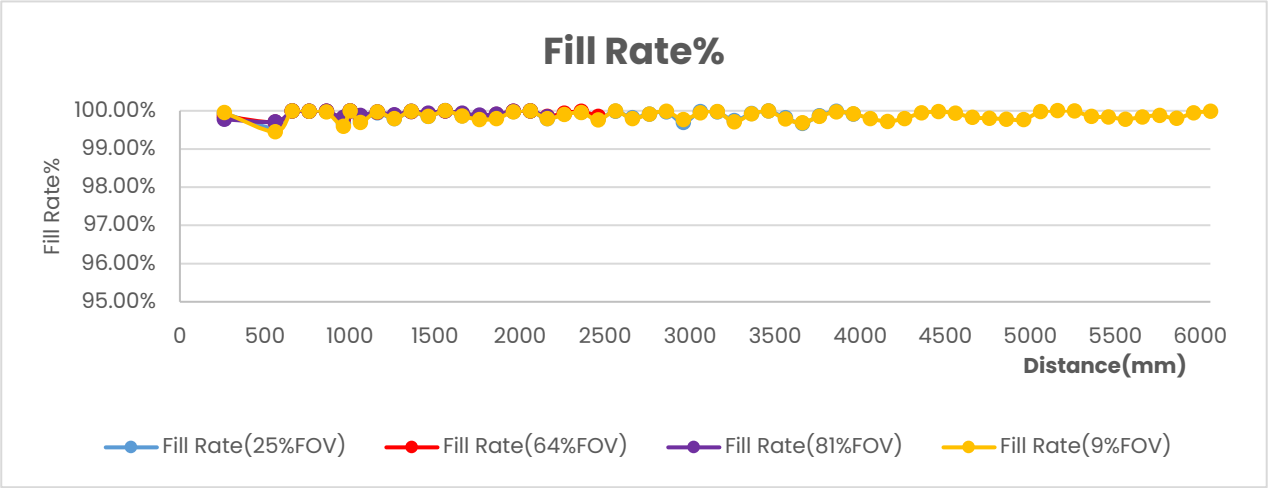

Figure 5-1-7 Fill Rate chart of Gemini 335/336

Typical Depth performance reference of fill rate for Gemini 335L/336L

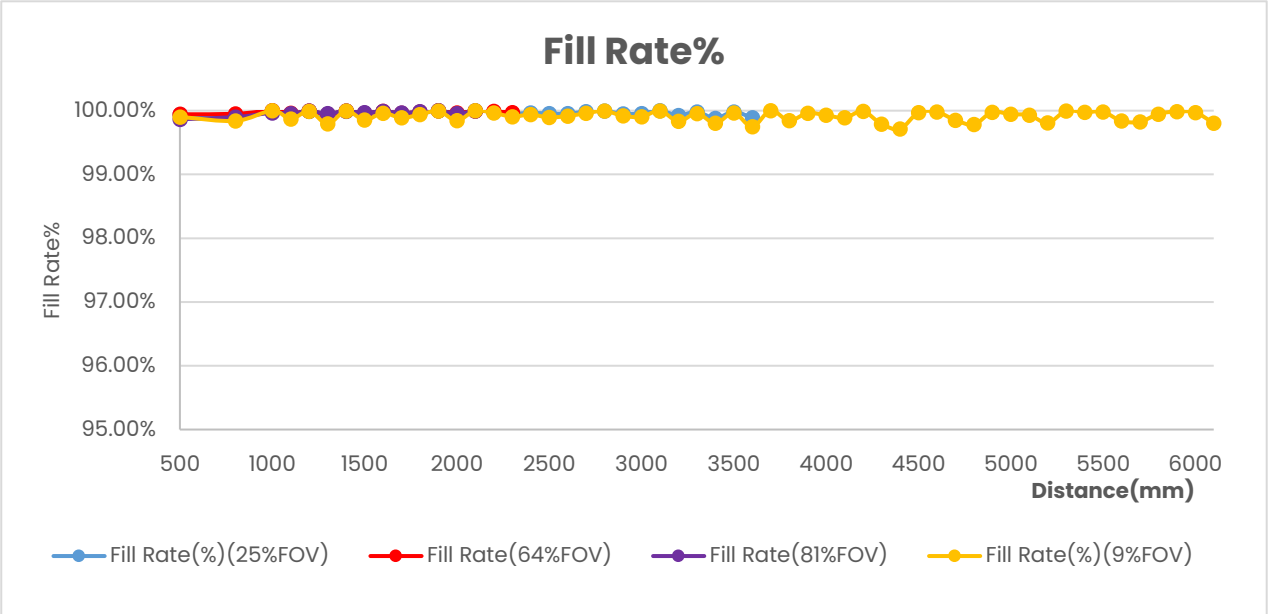

Figure 5-1-8 Fill Rate chart of Gemini 335L/336L

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5.2 Electrical Performance

5.2.1 Power Supply

The Gemini 330 Series requires Type-C power and it is important to ensure that the power output is standard and that the maximum current of the Type-C power port is 1.5A or higher.

5.2.2 Power Consumption

Power consumption varies depending on the selected working mode.

Table 5-1-1 Gemini 330series typical configuration & tested power consumption Reference

Name	Gemini 335 & Gemini 336	Gemini 335L & Gemini 336L
Typical configuration	Laser power level: 6 Disparity search range：128 D2C：off Depth：1280 x 800 @ 30 fps Y16 AE On RGB: 1920 x 1080 @ 30 fps MJPEG AE On IR: Off IMU ODR (output data rate): 200Hz	Laser power level: 6 Disparity search range：256 D2C：off Depth：1280 x 800 @ 30 fps Y16 AE On RGB: 1280 x 720 @ 30 fps MJPEG AE On IR: Off IMU ODR (output data rate): 200Hz
Average power consumption	2.3 W	2.5W

Table 5-1-2 Gemini 330series Max Power Configuration & tested power consumption Reference

Name	Gemini 335 & Gemini 336	Gemini 335L & Gemini 336L
Max Power Configuration	Laser power level: 6 Disparity search range：128 D2C：off Depth：1280 x 800 @ 30 fps Y16 & exposure:32ms RGB: 1920 x 1080 @ 30 fps MJPEG AE On IR: 1280 x 800 @ 30 fps Y8 & exposure:32ms IMU ODR (output data rate): 1000Hz	Laser power level: 6 Disparity search range：256 D2C：off Depth：1280 x 800 @ 30 fps Y16 & exposure:32ms RGB: 1280 x 720 @ 30 fps MJPEG AE On IR:1280 x 800 @ 30 fps Y16 & exposure:32ms IMU ODR (output data rate): 1000Hz
Average power consumption	3.0 W	3.0 W

*Note: The data in the above table are laboratory measurements and are for design reference only.

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5.2.3 Storage and Powered Conditions

Table 5-1-3 Gemini 330 Series Storage and Powered Conditions

Condition	Description	Min	Max	Unit
Storage (Ambient), Not Powered	Long term storage	0	50	℃
	Short exposure represents temporary max limits acceptable for transportation conditions	-20	60	℃
	Humidity	Temperature / RH: 60℃ / 95%		
Ambient, Powered	The camera ambient temperature when powered (Gemini 335/336) [1]	-10	45	℃
	The camera ambient temperature when powered (Gemini 335L/336L) [2]	-10	50	℃
LDM Protect Temperature	The LDM temperature when powered	N/A	73	℃
Backside Case Temperature, Powered	The maximum temperature of the backside case occurs when the camera is operated in an ambient temperature of 45°C (Gemini 335/336)	0	60	℃
	The maximum temperature of the backside case occurs when the camera is operated in an ambient temperature of 50°C (Gemini 335L/336L)	0	60	℃

Notes:

[1] For Gemini 335/336, the camera can operate at any resolution combination at 15fps within the temperature range of -10°C to 45°C. When the camera is configured for high-resolution image output at 30fps and 60fps, due to the significant increase in power consumption, the operating temperature range will be reduced to -10°C to 40°C.

[2] For Gemini 335L/336L, the camera can operate at any resolution combination at 15fps and 30 fps within the temperature range of -10°C to 50°C. When the camera is configured for high-resolution image output at 60fps, due to the significant increase in power consumption, the operating temperature range will be reduced to -10°C to 45°C.

[3] If users require operation over a wider temperature range, additional thermal management measures need to be evaluated.

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5.2.4 ESD Performance

Table 5-2-3 Gemini 335/336/335L/336L ESD Performance

Conditions	Powered-On	Powered-Off	Certification Standards
Contact Discharge	±8KV Class A	±8KV Class A	EN 61000-6-2
Air Discharge	±15KV Class A	±15KV Class A	

5.3 Physical Performance

5.3.1 Ingress Protection

Gemini 335/336 & 335L/336L Ingress Protection Information

Camera	IP Rating	Protection Ability	Conditions	Reference Standard
Gemini 335/336	IP5X	① Prevents solid objects from entering the camera. ② Cannot completely prevent dust from entering the inside of the camera, but the dust that does enter does not affect normal operation.	① Insert the Type-C cable and tighten the screws. ② Multi-camera sync 8-pin interface not in use.	IEC 60529:2013
Gemini 335L/336L	IP65 (USB Type-C Connector: IP67)	① Completely prevents dust from entering the camera ② Prevents low-pressure liquid spray from entering the camera	① Multi-camera sync 8-pin interface not in use.	IEC 60529:2013

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6. Firmware

6.1 Firmware Update & Cautions

Gemini 330series supports update the firmware via online or location, you can upgrade or downgrade as needed. To get the firmware and changelog: **Firmware Release**

Please note the following considerations:

1. You can update the firmware in any working mode or preset;
2. All data streams must be closed when update the firmware;
3. During the firmware update, please ensure that the power supply and data transmission cable connections are stable;
4. The camera will automatically restart after the firmware update is completed. You can also re-plug the cable after completion and restart it manually;

6.2 How to Update Firmware

The simplest way to update the firmware is through the Orbbec Viewer tool, which supports both manual updates and online updates. For detailed instructions, please refer to the documentation: **Update firmware**

6.3 Recovery

Ensure the stability of cable during the update process to avoid upgrade failure. If the update process fails, disconnect the cable, re-insert it, and burn the product again. If re-burning is unsuccessful, the product may be damaged. Orbbec assumes no liability for any damages or losses resulting from the use of this product.

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7. SDK

Orbbec SDK is a flexible and modular platform for easy camera setup and runs on multiple platforms with a rich set of APIs. It supports camera access, device setup and configuration, data stream reading, processing, and viewing, RGB-D registration, and frame synchronization.

Its functions include:

- Access and control of camera devices
- Control of frame synchronization and alignment
- Acquisition of point cloud data
- Orbbec Viewer for camera testing and evaluation

Please visit **Orbbec SDK** for the latest SDK.

7.1 Temperature Sensor and Recording

The temperature of camera core components can be obtained, including laser temperature, IR sensor temperature, and IMU sensor temperature, through API commands.

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8. Use Guidance

8.1 Packing List

Table 8-1-1 Gemini 330 Series Package List

Package Type	Package List	Gemini 335/336	Gemini 335L/336L	Notes
Bulk	Camera			Minimum batch packaging quantity: 100pcs
Box	Camera			Minimum batch packaging quantity: 20pcs
	1x Tripod			
	1x Tripod Head			
	1x USB Cable(1m)			
	1x Quick Start Guide			

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8.2 Initialization and Operation

- Connect Gemini 335/336/335L/336L via the USB cable to the host PC
- Download Orbbec SDK from **Orbbec SDK**
- Use Orbbec Viewer to validate that images can be streamed from all sensors with the following settings:
    - Depth stream: 848 x 480(default configuration)
    - Color stream: 1280 x 720(default configuration)
    - IMU enabled

The detailed quick start guide refers to the documentation: **Gemini 330 Series Quick Start Guide**

- If for any reason that the camera is not responding or not being detected, please unplug all cables from the camera and replug the cable into the host PC for resetting the camera state.

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9. Regulatory Compliance

These products are certified as follows:

9.1 Laser Safety certification

Class 1 Laser Product under the EN/IEC 60825-1:2014	U.S. FDA Accession Number: 2420619-000
CLASS 1 LASER PRODUCT	FDA

9.2 EMC Regulatory Compliance

CE-Declaration	FCC part 15 Declaration of Conformity	KC
CE	FC	KC
UKCA	**IC**	**RCM**
UKCA	IC	RCM

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9.3 Environment Regulatory Compliance

RoHS 2.0, REACH, WEEE, TSCA, TPCH, 94/62/EC

RoHS	REACH	WEEE
		
TSCA	**TPCH**	**94/62/EC**
	PASS	PASS

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10. System Integration Guide

Use outside of the specified conditions could cause the device to fail and/or function incorrectly. These conditions are applicable for the environment immediately around the device under all operational conditions. When used with an external enclosure, active temperature control and/or other cooling solutions are recommended to ensure the device is maintained within these ranges.

10.1 Installation Recommendations

1. When using external housing around the camera for dust proofing, use foam inserts or rubber gaskets between the front of the camera and the external housing.
2. Avoid external forces applied to the camera chassis during installation process.
3. Disassembling chassis will void the warranty.
4. For the detailed installation reference solution, please refer to Document **Reference solution & best practice - mounting**

10.2 Heat Dissipation

1. Avoid direct heat source around the camera.
2. Maximizing the space inside the external housing may help lower operating temperature.
3. For the detailed heat dissipation reference solution, please refer to Document **Reference solution & best practice - thermal**

10.3 Cable Design Guide

1. It is recommended to use the included USB Type-C cable. If there is a need for longer cable, please select a USB-IF certified cable that supports both power and data (< = 3.0 m length is recommended).
2. For the detailed cable design guide reference solution, please refer to Document **Reference design & best practice - cable**

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11. Cautions

1. Follow the instructions carefully when operating the camera. Improper handling may lead to damage to the internal components.
2. Do not drop the camera or expose the camera to mechanical stress.
3. Do not attempt to modify the camera as such modifications may cause permanent damage or performance degradation.
4. The temperature of the camera may rise during long periods of use.
5. Do not touch the lens. Fingerprints on the lens may affect image quality.
6. Keep the product beyond the reach of children or animals to avoid accidents.
7. If the computer does not recognize the camera, verify that the cable meets the power and data transfer requirements, then replug it into the USB port to reconnect.
8. This product is classified as a Class 1 Laser Product under the international standard EN/IEC 60825-1, Edition 3 (2014). Using controls, adjustments, or procedures other than those specified herein may result in hazardous radiation exposure.

Safety and Handling Instructions:

●Avoid powering on the product if any external damage was observed.

●Do not attempt to open any portion of this product. There are no user serviceable parts.

●Be cautious of invisible laser radiation. Avoid direct exposure to the beam.

●To maintain compliance and safety standards, do not modify or service the product. Unauthorized modifications or servicing could result in emissions surpassing the Class 1 safety level.

●Only update the camera firmware with official releases that match the specific module SKU and revision to ensure proper functionality and safety.

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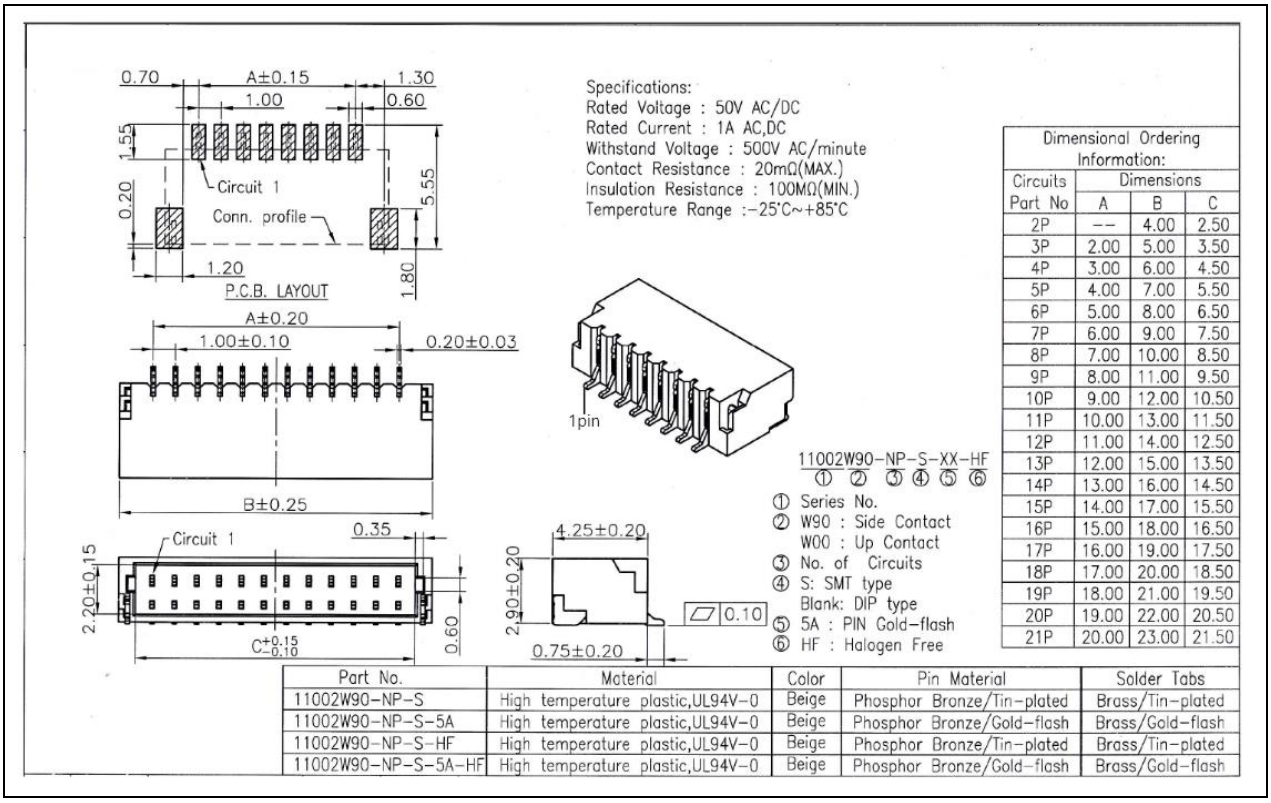
Appendix A Multi-Camera Sync Interface Mechanical Diagram



Dimensional Ordering Information:			
Circuits Part No	Dimensions A	B	C
2P	--	4.00	2.50
3P	2.00	5.00	3.50
4P	3.00	6.00	4.50
5P	4.00	7.00	5.50
6P	5.00	8.00	6.50
7P	6.00	9.00	7.50
8P	7.00	10.00	8.50
9P	8.00	11.00	9.50
10P	9.00	12.00	10.50
11P	10.00	13.00	11.50
12P	11.00	14.00	12.50
13P	12.00	15.00	13.50
14P	13.00	16.00	14.50
15P	14.00	17.00	15.50
16P	15.00	18.00	16.50
17P	16.00	19.00	17.50
18P	17.00	20.00	18.50
19P	18.00	21.00	19.50
20P	19.00	22.00	20.50
21P	20.00	23.00	21.50

Part No.	Material	Color	Pin Material	Solder Tabs
11002W90-NP-S	High temperature plastic,UL94V-0	Beige	Phosphor Bronze/Tin-plated	Brass/Tin-plated
11002W90-NP-S-5A	High temperature plastic,UL94V-0	Beige	Phosphor Bronze/Gold-flash	Brass/Gold-flash
11002W90-NP-S-HF	High temperature plastic,UL94V-0	Beige	Phosphor Bronze/Tin-plated	Brass/Tin-plated
11002W90-NP-S-5A-HF	High temperature plastic,UL94V-0	Beige	Phosphor Bronze/Gold-flash	Brass/Gold-flash

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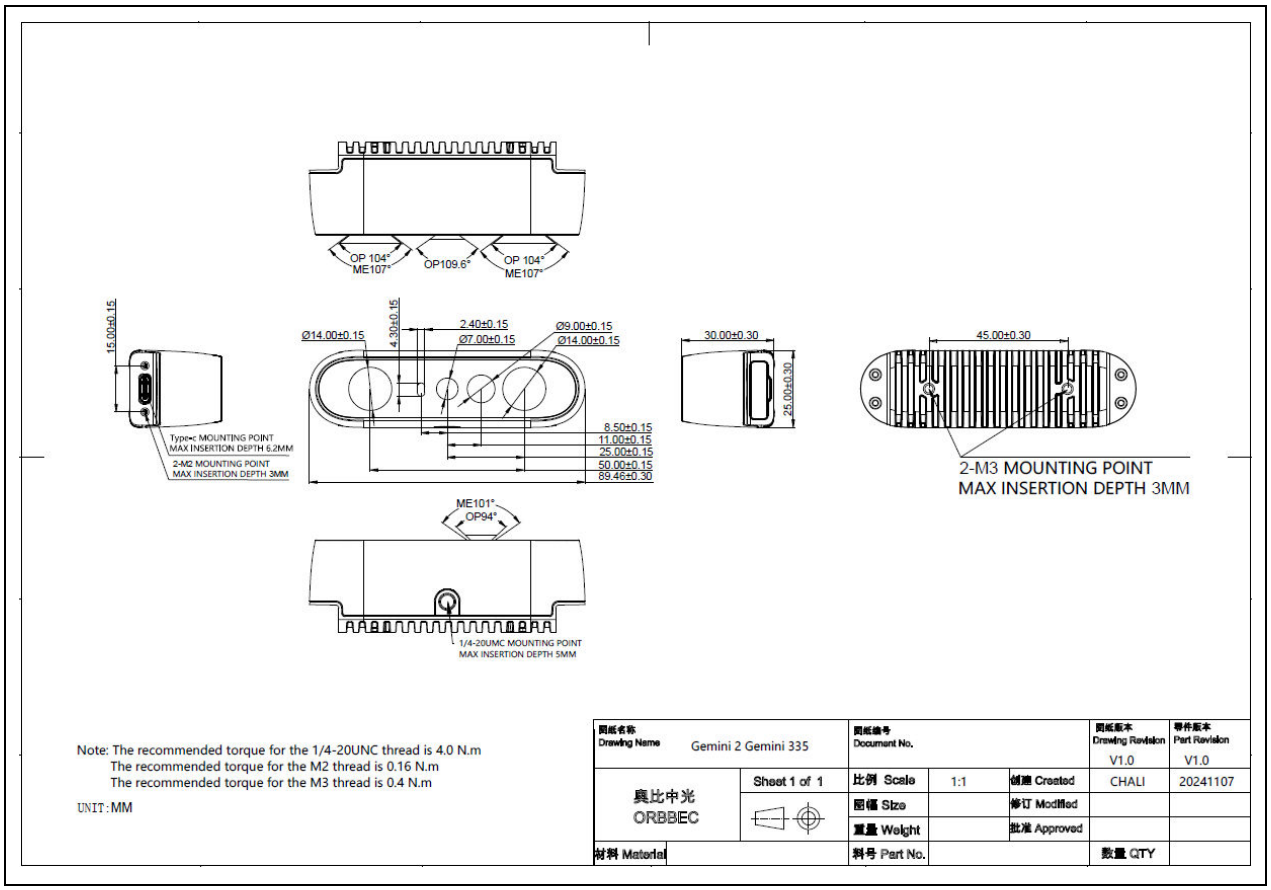
Appendix B Gemini 335 2D Mechanical Diagram



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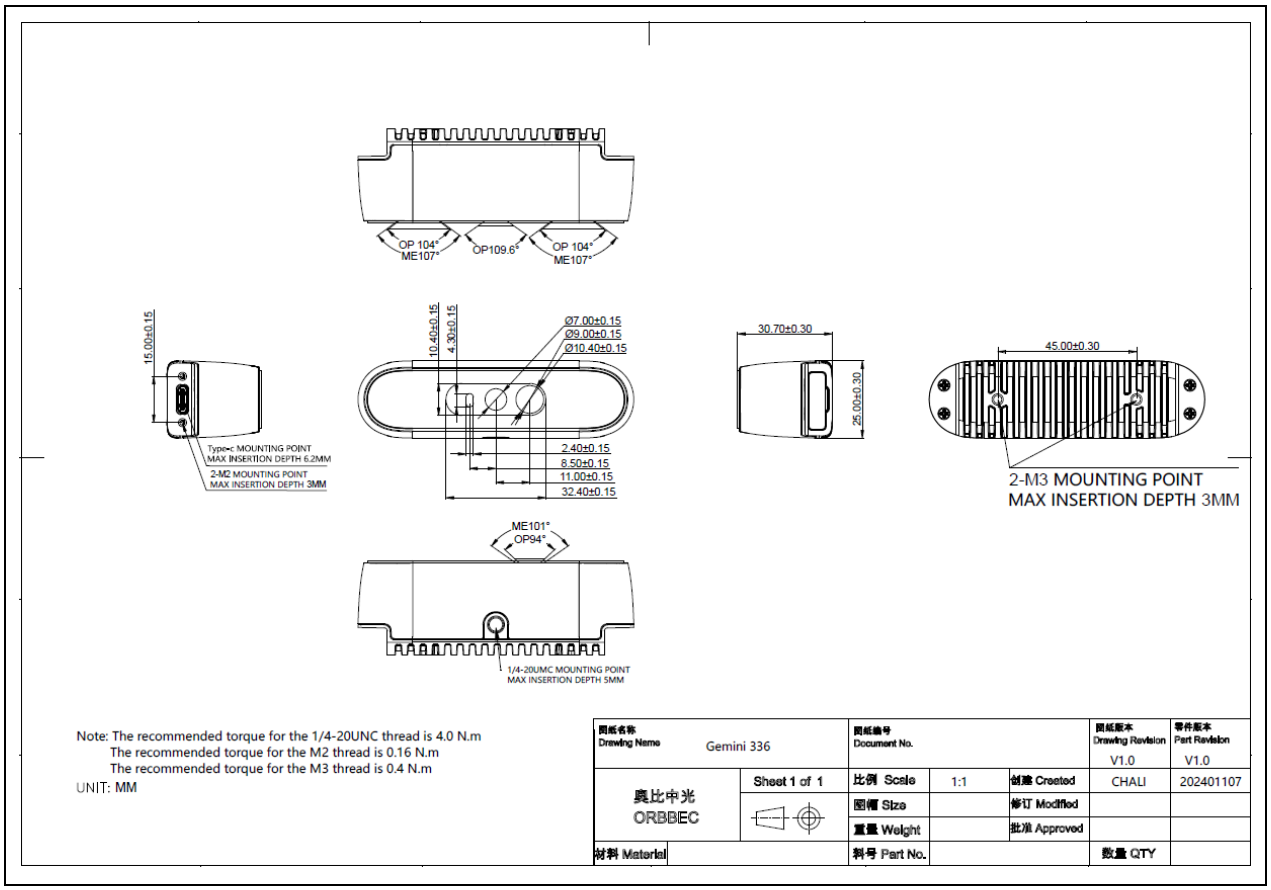
Appendix C Gemini 336 2D Mechanical Diagram



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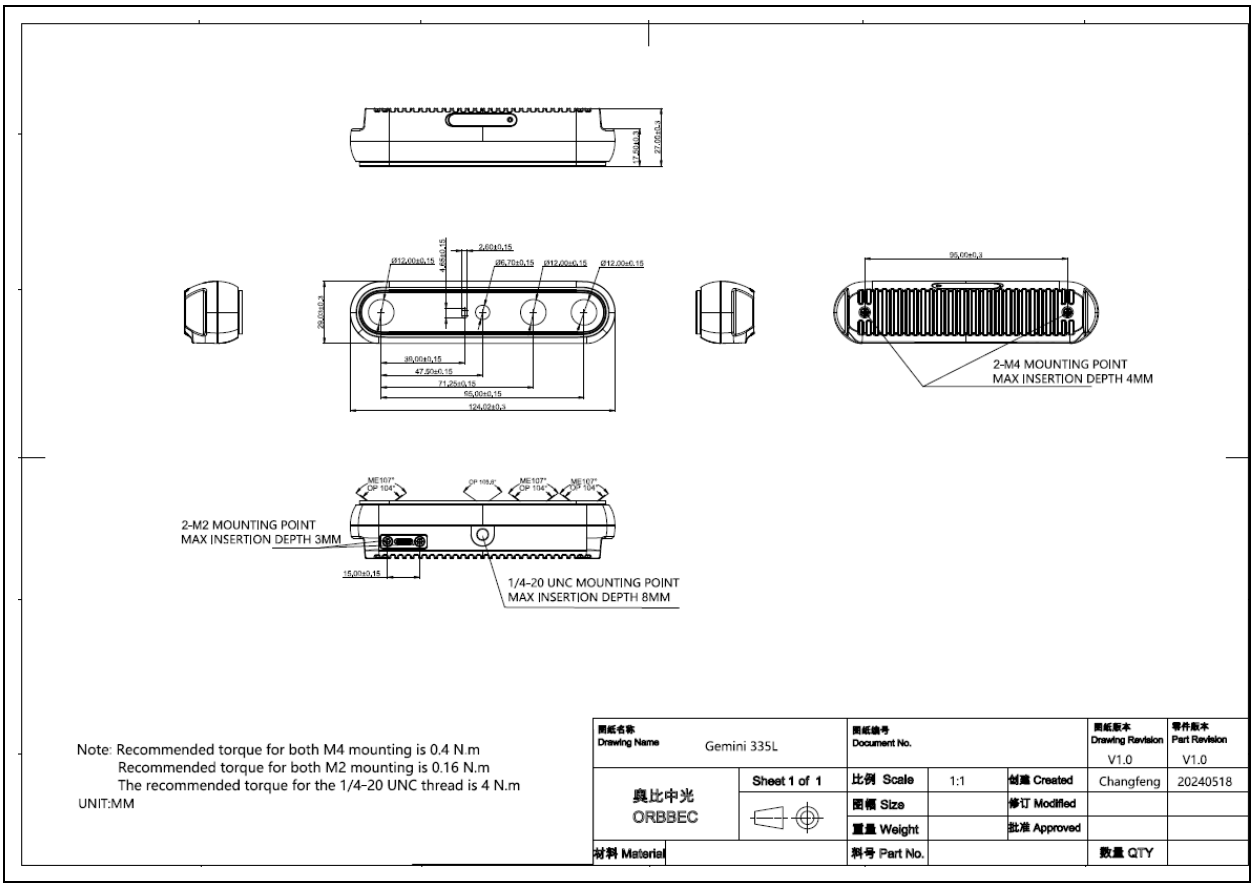
Appendix D Gemini 335L 2D Mechanical Diagram



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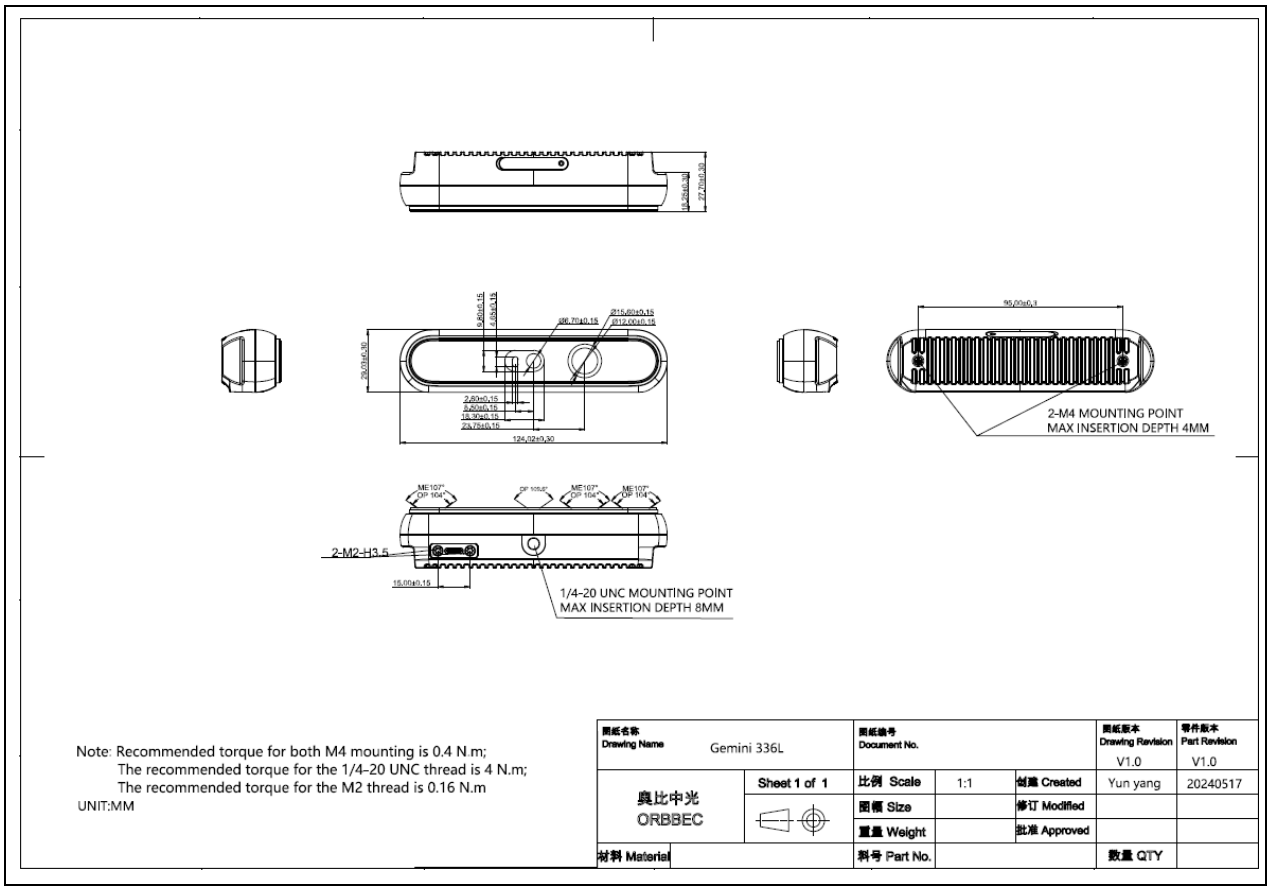
Appendix E Gemini 336L 2D Mechanical Diagram



Note: Recommended torque for both M4 mounting is 0.4 N.m;
The recommended torque for the 1/4-20 UNC thread is 4 N.m;
The recommended torque for the M2 thread is 0.16 N.m
UNIT:MM

图纸名称 Drawing Name	Gemini 336L		图纸编号 Document No.			图纸版本 Drawing Revision	零件版本 Part Revision
						V1.0	V1.0
奥比中光 ORBBEC	Sheet 1 of 1		比例 Scale	1:1	创建 Created	Yun yang	20240517
			图幅 Size		修订 Modified		
			重量 Weight		批准 Approved		
材料 Material			料号 Part No.			数量 QTY	

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