SONY

LiDAR Depth Sensor

User’s Guide

AS-DT1

Table of Contents

Overview

This unit is a LiDAR depth sensor that delivers high performance measurement accuracy, distance resolution, and distance measurement range*1 using the Direct Time of Flight (dToF) method*2.

*1 Able to recognize minute differences in the distance of multiple objects.

*2 Ranging method that calculates distance by measuring the time it takes for light to travel to an object, be reflected, and return.

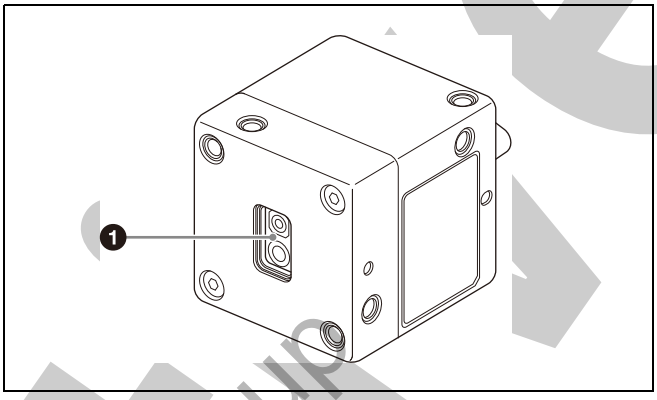
Features

The unit uses a proprietary dToF ranging module incorporating an SPAD (Single Photon Avalanche Diode)*1 sensor that uses multiple ranging points to accurately measure distances in three dimensions (vertical, horizontal, depth).
It can also measure the distance to low-contrast or low-reflectivity objects that are difficult to detect using other ranging methods. This makes it possible to accurately measure distances even in environments, such as stores, where there are likely to be various objects, including people and fixtures.
In addition to accurately measuring distances to objects in both indoor and outdoor environments, the sensor is small, lightweight, and has a robust metal housing, making it ideal for incorporation into a variety of devices, such as restaurant serving robots, autonomous transport robots in warehouses, and drones used for inspections and surveys.

*1 Electronic element (diode) that achieves high sensitivity by utilizing "avalanche multiplication," which amplifies electrons from a single incident photon like an avalanche.

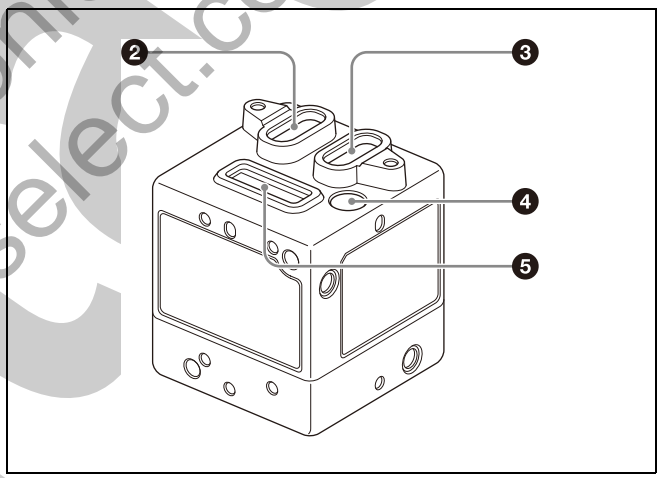
Name and Function of Parts

Front



❶ LiDAR depth sensor
The LiDAR depth sensor is housed within the ranging window. The sensor lens and sensor body are protected by a cover glass to protect against dust and water.

Rear



❷ USB upstream port
Used to connect the unit to a USB host device, such as a Windows PC, using a USB Type-C cable (commercially available).
This connector also supplies the power required to operate the unit.

❸ USB downstream port
Used to connect the unit to the following devices using a USB Type-C cable.
- Connecting another AS-DT1
  See *"Using multiple connected units" (page 7)*.
- Connecting a camera
  See *"Using with a connected camera" (page 8)*.

❹ Status LED

Indicates the status of the unit.

Color	Display	Status
–	Not lit	Off (power not supplied).
Green	Lit	Operating normally.
Orange	Lit	Obstacle is within obstacle detection range.*1
Orange	Flashing	Power on initialization
Red	Lit	Failure has occurred

*1 When the obstacle detection function is enabled

You can change status LED settings. Refer to the "API Manual."

For details about troubleshooting issues, see "If Trouble Occurs" (page 24).

❺ 8-pin connector

Used for the following functions.

- The unit can be operated from an external 12 V to 24 V power supply that is input using the GND and VCC pins (1 and 2) of the connector.

  For details about power supply input, see "Connecting an External Power Supply" (page 16).

- The unit can be connected to a PC or other host device via UART connection using the UART TX and UART RX pins (5 and 6) of the connector.

  For details about UART connection, see "Connecting via UART using the 8-Pin Connector" (page 14).

- The ranging timing of multiple AS-DT1 units can be synchronized using the Trigger In and Trigger Out pins (3 and 4) of the connector.

  For details about the external trigger function, see "Inputting a Trigger from an External Device" (page 15) and "Trigger Output" (page 15).

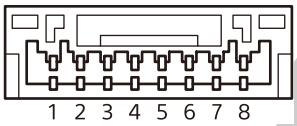
- The timestamp of the unit can be synchronized to other devices using the TS Clk input and TS Preset input pins (7 and 8) of the connector.

  For details about timestamps, see "Using the Timestamp Function" (page 15).

Note

This connector has a locking mechanism. Press the retaining latch on the plug to release the lock before removing the connector.

8-pin connector specifications



Pin number	Name	Input/ output	Function
1	GND	–	Ground
2	VCC	Input	External power supply
3	Trigger In	Input	Ranging start trigger pulse
4	Trigger Out	Output	Ranging pulse
5	UART TX	Output	UART transmitter
6	UART RX	Input	UART receiver
7	TS Clk	Input	Timestamp clock pulse
8	TS Preset	Input	Timestamp value set pulse

Mounting holes

The unit has the following mounting holes.

VCT-333I tripod adaptor screw hole

Used to attach the unit to the VCT-333I tripod adaptor (option).

For details about attaching to a tripod adaptor and tripod, see "Attaching to a Tripod" (page 16).

Device mounting screw holes

Used to attach the unit to a device (mounting in/on a device). There are 12 holes, two on each side.

For details about mounting, see "Attaching the Unit to a Mounting Point" (page 5).

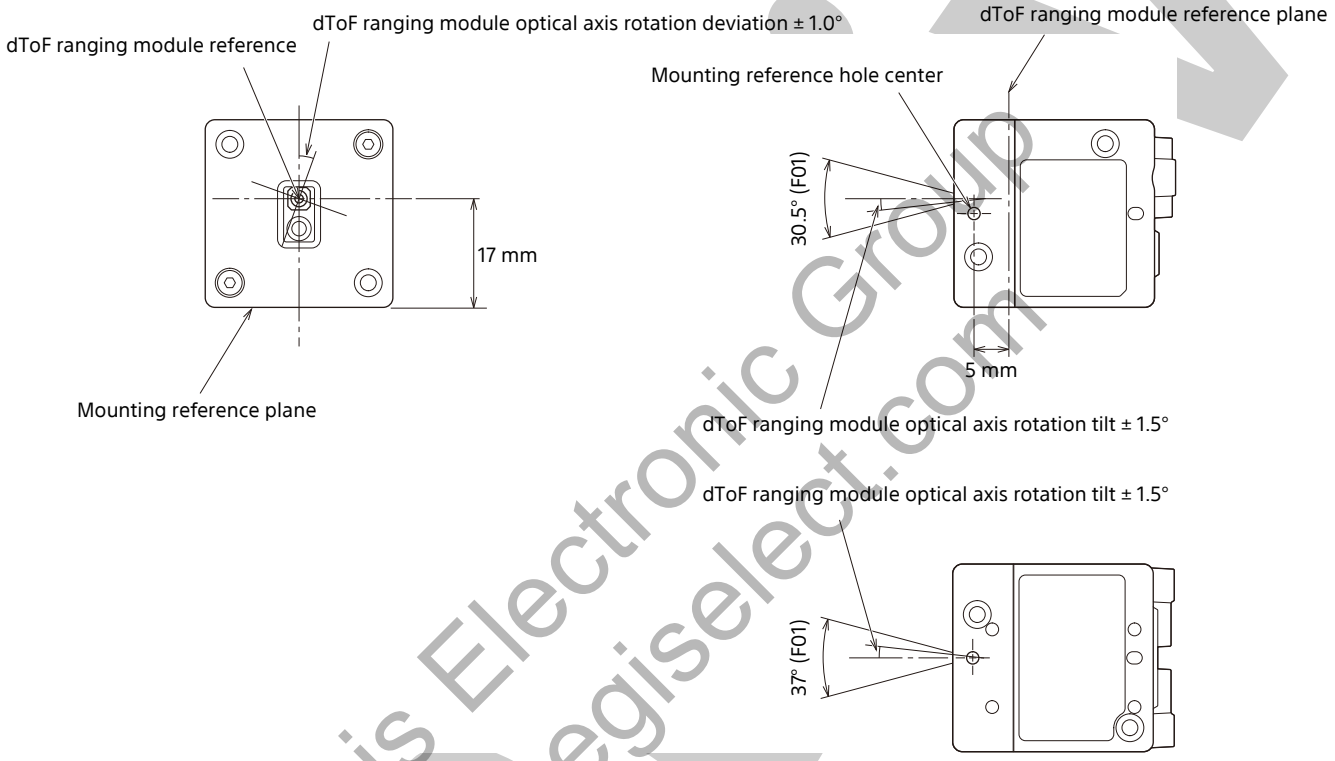
Preparation

Attaching the Unit to a Mounting Point

Attach the unit to the mounting point in/on a device using the mounting reference holes and device mounting screw holes. The X and Z directions are measured from the mounting reference hole on the bottom, and the Y direction is measured from the mounting reference plane, which is machined to the highest precision relative to the measurement origin point, allowing the unit to maximize the distance measurement performance.

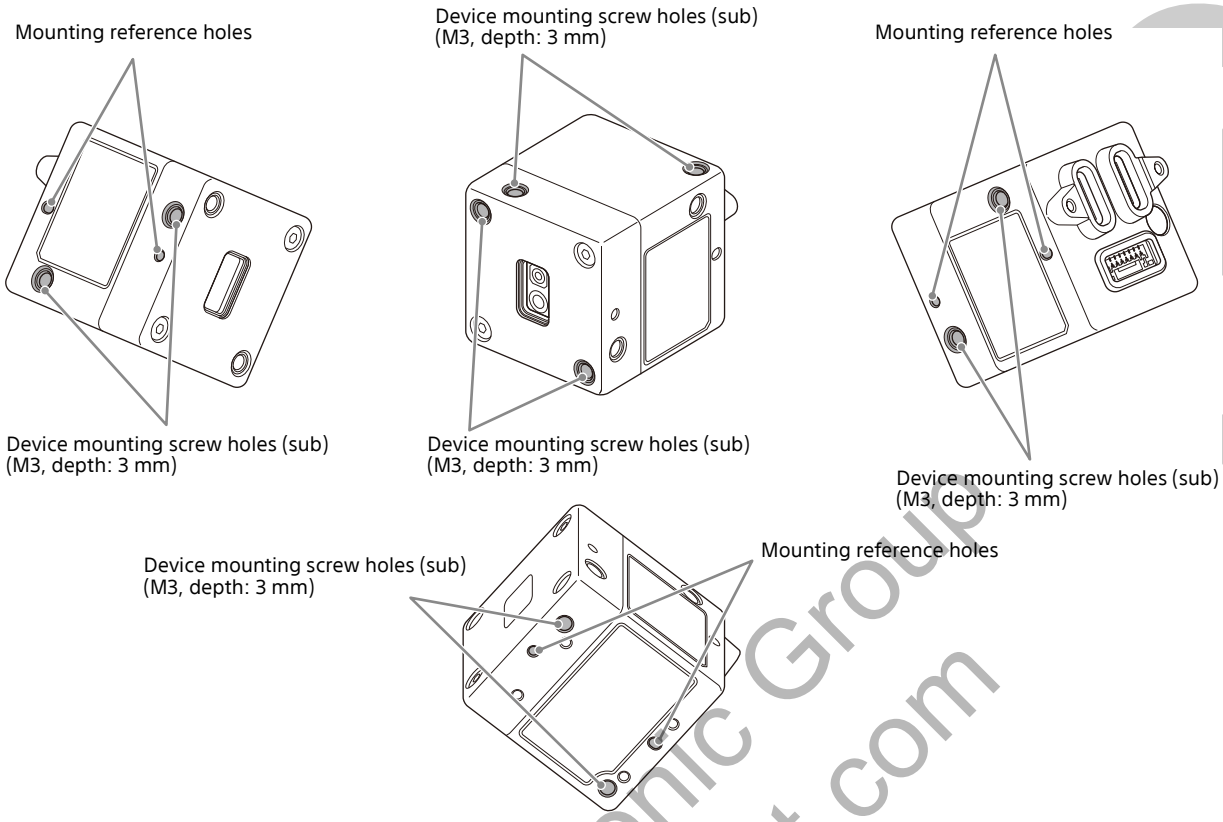
Mounting reference holes

Reference holes used for positioning when attaching the unit (Depth: 2 mm).



Device mounting screw hole locations

The screw hole locations and specifications are given below.



M3 screw recommended tightening torque: 0.6 N·m

Mounting precautions

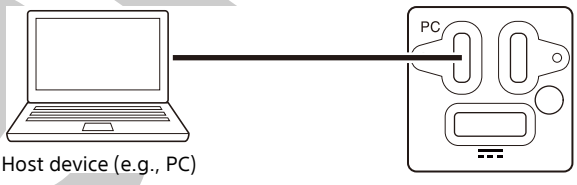
- Purchase commercially available mounting screws separately.
- Attach the unit securely to the device mounting point using the camera mounting reference screw holes and screws.
- The ranging origin point is 5 mm from the mounting reference holes.
- Do not use screws with thread depth exceeding 3 mm. This may damage the unit.

System Configuration

The following show typical system configuration examples.

Using the unit as a standalone device

This configuration example shows the unit connected to a PC or other host device via USB connection.

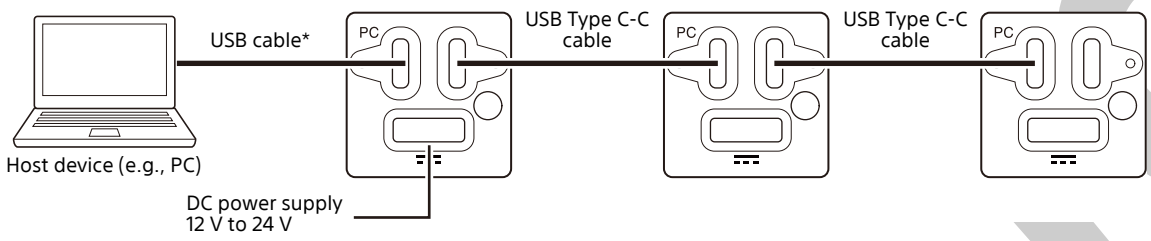


* For details about supported USB cables, see *"Connecting the unit to a PC via USB" (page 9)*.

Using multiple connected units

These configuration examples shown multiple AS-DT1 units connected using the USB downstream ports.

Connecting up to 3 units



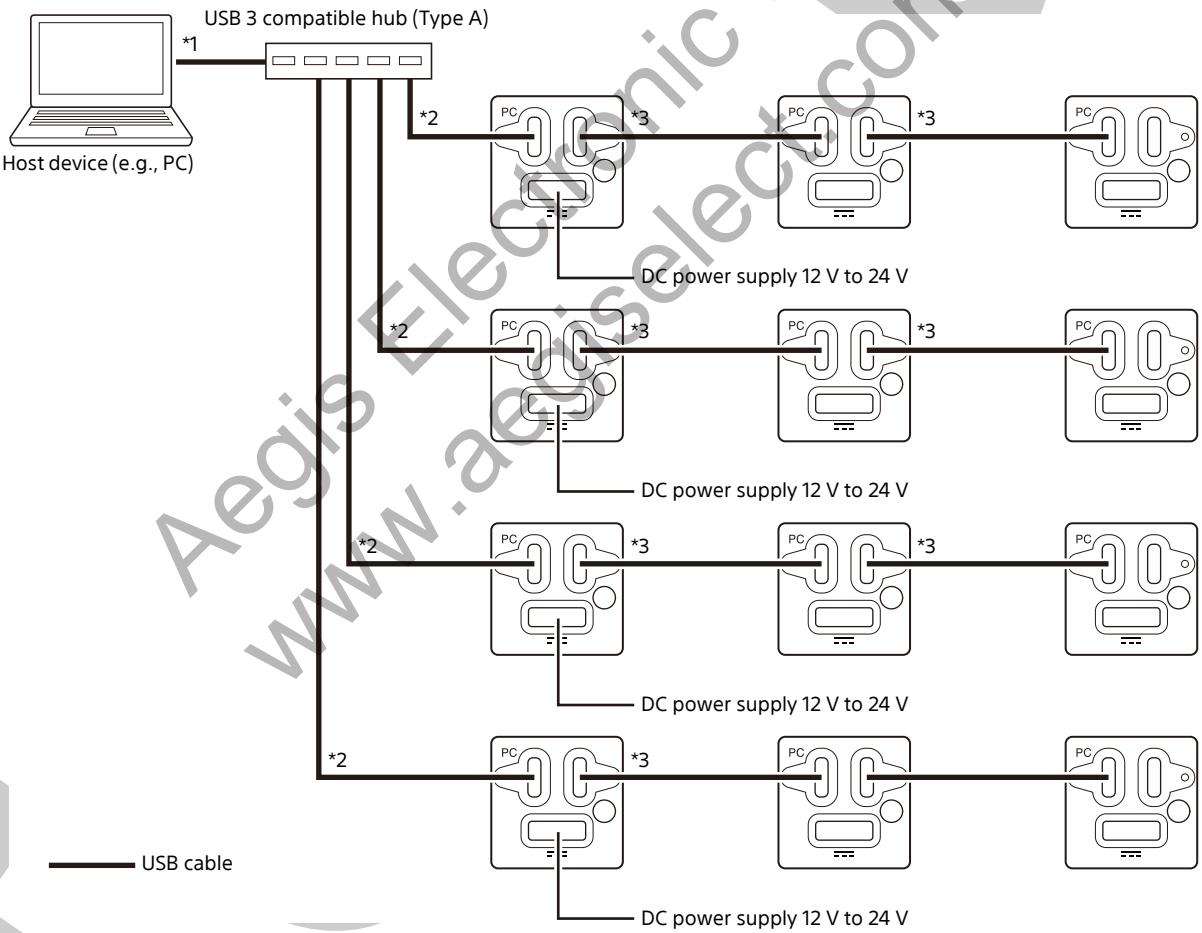
* If the host device (e.g., PC) uses USB Type-A, use a cable with Type-A and Type-C connectors.
If the host device (e.g., PC) uses USB Type-C, use a cable with Type-C connectors at both ends.

For details, see "Connecting the unit to a PC via USB" (page 9).

Supply power to the units using an external power supply or a host device capable of supplying USB-C power with current capacity of 3 A or higher.

Connecting 3 or more units

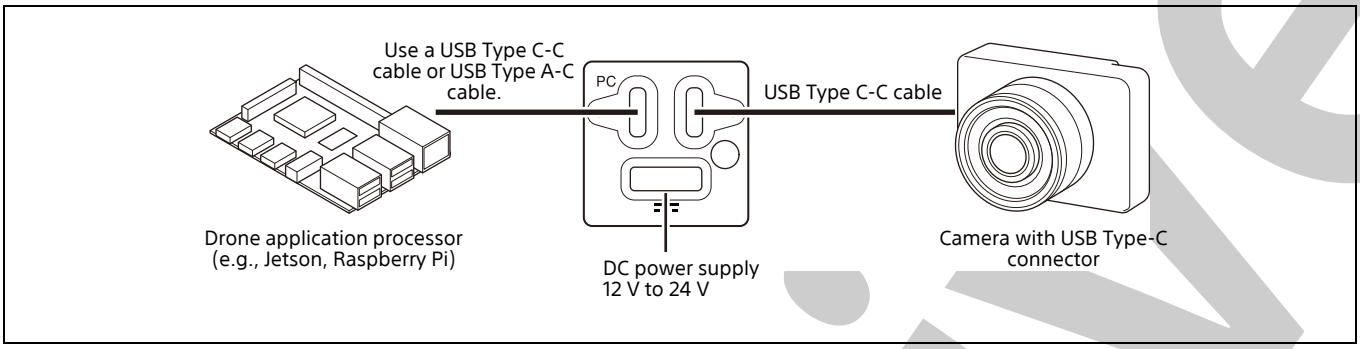
Up to 12 units can be connected using a hub or other device.



*1 Use a USB Type A-C cable or USB Type C-C cable.
*2 Use a USB Type A-C cable.
*3 Use a USB Type C-C cable.

Using with a connected camera

You can connect to a camera that has a USB Type-C connector using the USB downstream port.
Whether or not the connected camera will be charged depends on the status of the power supply to the unit. To use the device while charging, supply power from an external power source or use a host device that can supply USB-C power at 3 A or higher.

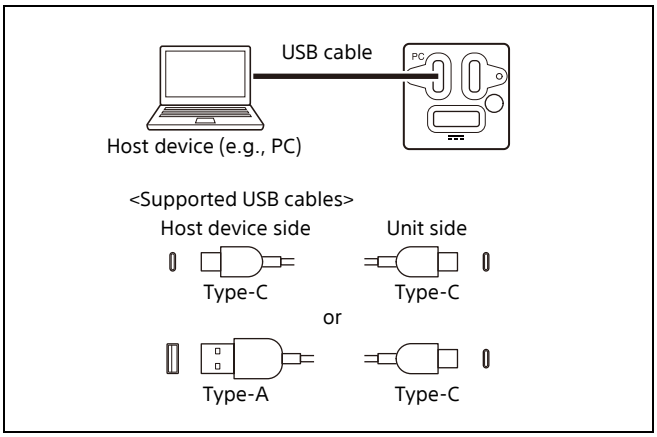


Running the Sample Program

This section describes the preparation for checking operation by running the sample program using a PC running Windows 11.

Connecting the unit to a PC via USB

Connect the unit and PC using a USB cable.

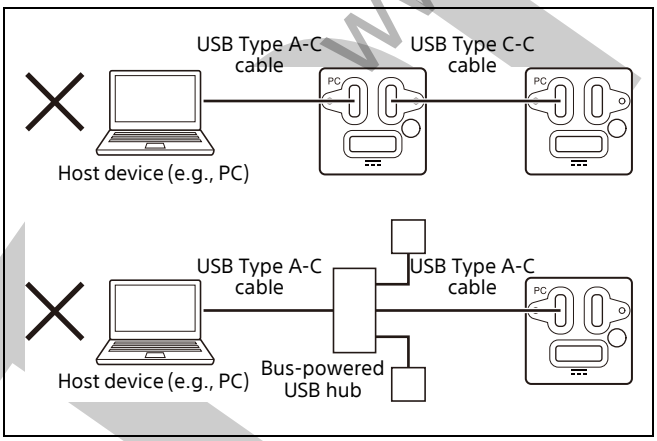


Use a cable with USB Type-C connectors on both ends or a cable with USB Type-A on the host side and USB Type-C on the unit side depending on the shape of connector on the host device.

- A connection via USB 3.2 Gen 1 or USB 2.0 may be established depending on the type of USB connector on the host side and the type of USB cable. To connect via USB 3.2 Gen 1, use a USB 3.2 Gen 1 compatible cable.
- To prevent disconnection of the USB Type-C cable, use a cable that complies with the single screw USB Type-C locking plug standard.
- Use of a cable with USB certification logo is recommended.

Notes

- When using the unit as a standalone device, USB default power supply (500 mA) is required.
- If a bus-powered USB hub or similar device is placed between the unit and the host device that is supplying power, unit operation may become unstable or stop due to insufficient power.
- The unit does not support USB PD (USB Power Delivery).



Checking the usage environment for the sample program and sample application

The sample program and sample application can be used in the following PC environment.

- OS: Windows 11
- CPU: 8th generation Intel Core i-series or later
- RAM: 8 GB or higher
- Free disk space: 200 MB or higher
- Display: XGA (1024×768) or higher
- USB connector: USB 3.2 Gen 1 or USB 2.0 ×1

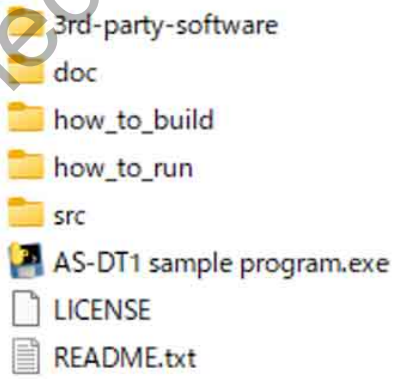
Notes

- If other applications are running and your CPU performance is insufficient, or if you have an antivirus application or similar installed, the frame rate may decrease.
- When connected via USB FS (12 Mbps) or USB LS (1.5 Mbps), only USB COM ports are recognized. Connection via UVC is not available.

Downloading the sample program to a PC

1 **Access the following URL and download "AS-DT1 sample program and development library.zip" to the PC.**
https://www.sony.co.jp/Products/ISP/download/software.html

2 **Uncompress the downloaded zip file.**
When the zip file is uncompressed, the following folders and files are displayed.

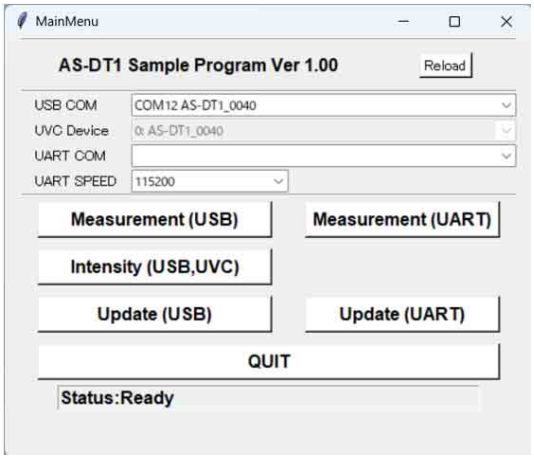


Basic Usage Method

This section describes the basic usage method of the unit and how to check the operation.

Launching the Sample Application

Launch “AS-DT1 sample program.exe” in the folder from the uncompressed “AS-DT1 sample program and development library.zip” file.
The [MainMenu] screen appears.



The following table shows the operating modes and their functions supported by the sample application.

Button	Function
[Measurement (USB)]	Measures distances using the USB interface and displays results.
[Measurement (UART)]	Measures distances using the UART port of the 8-pin connector and displays results.
[Intensity (USB,UVC)]	Displays an infrared image using the SPAD sensor.
[Update (USB)]	Updates the firmware of the unit using the USB interface.
[Update (UART)]	Updates the firmware of the unit using the UART port of the 8-pin connector.
[QUIT]	Exits the sample program.

Configuring the Connection

The required setup items vary depending on the ranging mode of the unit.

Ranging mode	Required setup items
[Measurement (USB)]	[USB COM]
[Measurement (UART)]	[UART COM], [UART SPEED]
[Intensity (USB,UVC)]	[USB COM], [UVC Device]
[Update (USB)]	[USB COM]
[Update (UART)]	[UART COM], [UART SPEED]

Set the port and device number connected to the unit with the serial number you want to use for the items corresponding to each ranging mode.

Clicking the [Reload] button updates the COM port and device information. Use this if the connection is changed after launching the sample program application.

If the communication method is changed from USB to UART, set [USB COM], [UART COM], and [UART Speed], then click the [Measurement (UART)] or [Update (UART)] button.
If the communication method is changed from UART to USB, set [UART COM] and [UART Speed], then click the [Measurement (USB)] or [Update (USB)] button.

USB Ranging Mode (Measurement)

On the [MainMenu] screen, set the COM port to which the unit used for ranging is connected in [USB COM] and click the [Measurement (USB)] button.
The following screen appears.

❶ [mode]
The lamp for the current ranging mode is lit red.
You can change the ranging mode by pressing a ranging mode selector button

For the distance measurement range specifications, see “Distance Measurement Range” (page 20).

❷ [Color Scale]
Set the colorization of the image displayed on the right side ❽ of the screen.
The colorization is based on the distances (unit: m) set in the [Min] box and [Max] box.
As the distance varies from close to far, the color changes from red to green and from green to blue. Distance points that cannot be measured are displayed in gray.

When a check mark is placed in [Auto], colorization is based on the maximum and minimum distance measurement results for the whole screen. The maximum and minimum distance values are reflected in the [Min] box and [Max] box, respectively.
When the check mark is cleared from [Auto], you can set the minimum and maximum using the sliders on the right side.

❸ [Save Point Cloud]
Specify the save destination for distance measurement results data by clicking the [Path] button.
When you click the [Save] button, the results data is saved in the location displayed in the box with file names in “as_dt1_YYYYMMDD_HHMMSS_MICROS.ext” format (for example, as_dt1_20250805_162444_166336.ply).

The following three types of files are saved.

Extension	Description
.ply	PLY format point cloud file
.jpg	Saved display screen file
.json	Setup information file

❹ [Device Information]
Displays the firmware version and serial number of the connected unit.

❺ [MainMenu] button
Exits distance measurement and returns to the [MainMenu] screen.

❻ [Log] window
Displays the status of communications with the unit.

❼ [Status]
Displays the current operating status of the unit.
"open fail" is displayed if the connection with the unit is lost. If this occurs, exit the program, check the connection with the unit, and reconfigure settings on the [MainMenu] screen.

❽ Distance measurement results display
Displays the distance measurement results for the specified ranging mode on the unit.
When you click a distance measurement point using a mouse, the distance measurement result for that point is displayed as PCD (point cloud data) at the bottom of the screen.
<Display example>

```
Interval 0.109                    Min:Max 1.0:14.0
MP:552 Screen X:18 Y:126 PointCloud X:-0.767 Y:-0.683 Z:2.642
cputime=735528 timestamp=0 sensortemp=34
```

Item	Meaning
Interval	Measurement interval (unit: sec)
Min:Max	Minimum value and maximum value of distance measurement results (unit: m)
MP	Information for the distance measurement point clicked using a mouse • MP suffix number: Distance measurement point number (552 in this example) • Screen X: X coordinate within the screen (0 to 169) • Y: Y coordinate within the screen (0 to 139)
PointCloud X, Y, Z	Distance measurement information expressed as a point cloud (unit: m)
cputime	Timestamp information within the unit (unit: ms)
time stamp	External synchronization timestamp count
sensor temp	Sensor temperature within the unit (unit: °C)

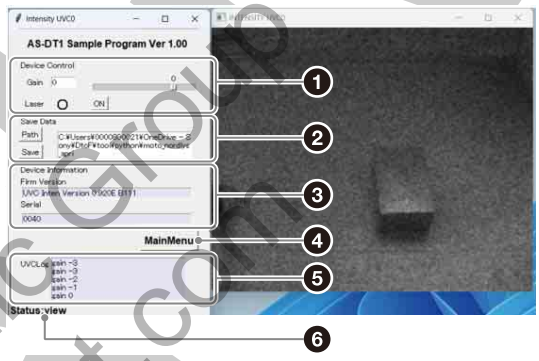
Intensity Mode (Intensity)

On the [MainMenu] screen, set [USB COM] and [UVC Device] for the device connected to the unit that you want to display in the intensity image table, then click the [Intensity (USB,UVC)] button.

Note

If using a Windows PC with multiple UVC devices, there may be a discrepancy in the recognition of the UVC devices which results in the display of incorrect serial numbers. This can occur if the camera recognition does not match the Windows recognition.
If this occurs, designate a camera from the image and select a different UVC device in [UVC Device] on the [MainMenu] screen.

The following screen appears.



In intensity mode, infrared images are acquired using an SPAD sensor for distance measurement as a 170×140 pixel infrared detector. The distance measurement point can also be confirmed visually by emitting a laser used for distance measurement.
You can align the optical axis and angle of view of a camera used in conjunction with the distance measurement sensor.

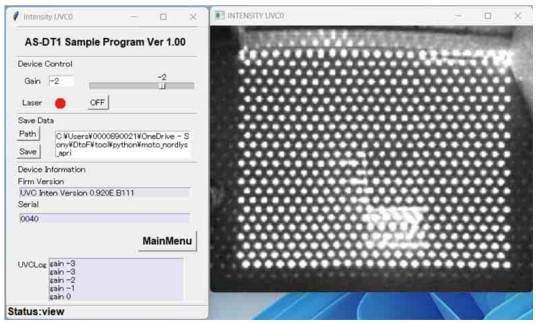
❶ [Device Control]
You can control the gain of the infrared image using the [Gain] box.
The dynamic range of the SPAD sensor is 24 bits. In intensity mode, the 24-bit SPAD sensor output is converted to 8-bit for output and display. The position of the 8 bits in the 24-bit data that are output and displayed is determined by the gain.
The gain can be set in the range –16 to +4.
The following table shows the supported combinations of the SPAD sensor output and UVC output.

SPAD sensor output (24-bit) and UVC output (8-bit) combinations

SPAD value		23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
UVC value (Gain value)	–16	7	6	5	4	3	2	1	0																
	–6											7	6	5	4	3	2	1	0						
	0																	7	6	5	4	3	2	1	0
	3*1																				7	6	5	4	3

*1 Bit 2, 1, and 0 are always 0.

The [Laser] lamp, [ON] button, and [OFF] button function to emit a laser for ranging.
During laser emission, the lamp is lit red.
When the laser is emitted, the following screen appears.



❷ [Save Data]
Saves the displayed intensity image to a png-format file.
Click the [Path] button and set a save destination directory.
When you click the [Save] button, the intensity image is saved in the save destination directory with file names in "as_dt1_YYYYMMDD_HHMMSS_MICROS.ext" format (for example, as_dt1_20250805_162444_166336.png).
The following two types of files are saved.

Extension	Description
.png	Saved display screen file
.json	Setup information file

❸ [Device Information]
Displays the firmware version and serial number of the connected unit.

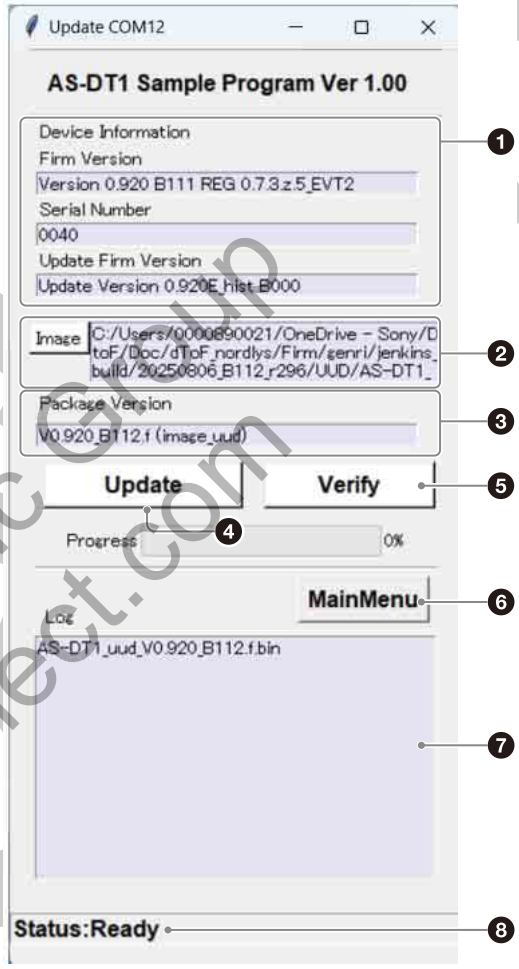
❹ [MainMenu] button
Exits intensity mode and returns to the [MainMenu] screen.

❺ [UVCLog]
Displays the status of communications with the unit.

❻ [Status]
Displays the current operating status.
"open fail" is displayed if the connection with the unit is lost. If this occurs, exit the program, check the connection with the unit, and reconfigure settings on the [MainMenu] screen.

Update Mode

On the [MainMenu] screen, set the COM port to which the unit whose firmware you want to update is connected in [USB COM] and click the [Update (USB)] button.
The following screen appears.



❶ [Device Information]
Displays the firmware version, serial number, and the version of the firmware update written at the factory of the unit connected to a PC.

Note
[Update Firm Version] is not updated by a normal update package. The version when shipped from the factory is displayed.

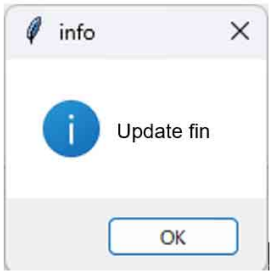
❷ [Image] button
Click the button and select an update package for the unit (".f.bin" extension).

❸ [Package Version]
Displays the update package version when a valid update package is selected.

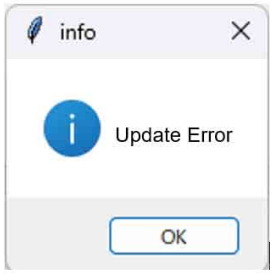
❹ [Update] button
Click the button to write the selected update package to the unit. A progress bar and percentage indicator are displayed during the update process. The update is completed when the indicator reaches 100%.

When completed, the following dialog appears.

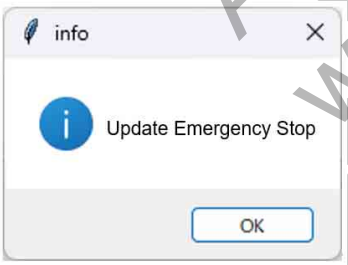
- "Update fin" is displayed if successful.



- "Update Error" is displayed if unsuccessful.



- "Update Emergency Stop" is displayed if you click the [Stop] button during the update process.



Note

If the update fails or is stopped midway, some functions will not work. Execute the update again.

After updating, check that [Firm Version] in [Device Information] displays the version of the update package. The [Update] button becomes a [Stop] button during the update process. If the update stops midway for any reason, you can forcibly stop the update process by clicking the [Stop] button.

Notes

- When updated, all settings are returned to the factory default state. Configure the settings again, as required.
- Do not do any of the following during the write process. Doing so may corrupt the firmware and make the unit unusable.
  - Turning the unit or PC off
  - Connecting/disconnecting USB cables
  - Turning the DC power supply on/off
  - Exiting the sample application
  - Forcibly stopping the update using the [Stop] button

  If doing so was unavoidable, you may be able to recover by executing the update again.

❺ [Verify] button

Click the button to verify (compare) the firmware written to the unit with the update package.
A progress bar and percentage indicator are displayed during the verification process. The process is completed when the indicator reaches 100%.
The [Verify] button becomes a [Stop] button during the verification process.
You can forcibly stop the verification process by clicking the [Stop] button.
If there is a mismatch between the update package and the firmware, "Verify Err" is displayed in the status display. You can recover by executing the update again.

❻ [MainMenu] button

Exits update mode and returns to the [MainMenu] screen.

❼ [Log]

Displays the status of communications with the unit.

❽ [Status]

Displays the current status.
"Update Error" is displayed if the update fails. Check the connection with the unit and perform the update process again from the [MainMenu] screen.
"Verify Error" is displayed if verification fails. Check the connection with the unit and perform the verification process or update process again from the [MainMenu] screen.

Connecting Peripheral Devices

This section describes how to connect peripheral devices using the interfaces of the unit.

Using the USB Downstream Port

The unit has a downstream-facing port (DFP) USB Type-C connector, with a built-in USB hub function that allows you to connect devices that support the USB standard.
This unit supports the connection of devices that comply with the USB 3.2 standard to the downstream port using the USB 3.2 Gen 1 standard.
This unit supports the connection of devices that comply with the USB 2.0 standard to the downstream port.
To prevent disconnection of the USB Type-C cable, use a cable that complies with the single screw USB Type-C locking plug standard.
Use of a cable with USB certification logo is recommended.
The power that can be supplied from the downstream port of the unit depends on the status of the DC power supply and the status of the power supply from the host device connected to a PC, as shown in the following table.

Power supply to the unit	Power supply capacity from downstream port
External power supply	5 V, 1.5 A (max)
USB (5 V, 3 A)	5 V, 1.5 A (max)
USB (5 V, 1.5 A)	Default USB power (5 V, 900 mA)
Default USB power	Default USB power

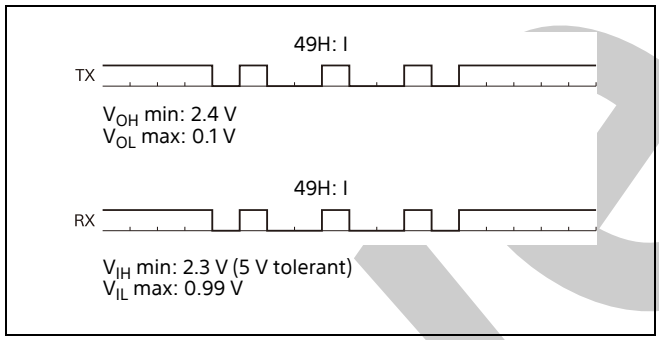
Notes

- The unit does not support USB PD. The supply voltage from the USB downstream port is 5 V only.
- If a host device supports only default USB power, the unit may stop working or its operation may become unstable, depending on the power consumption of the device connected to the downstream port.
- If multiple units are in a daisy-chain connection, make sure the power supply has sufficient capacity.

Connecting via UART using the 8-Pin Connector

The unit has an 8-pin connector with UART TX/RX pins. The operating modes available when using UART are [Measurement(UART)], and [Update (USB)] or [Update (UART)].
UART uses an asynchronous, serial communications standard for communication.

The signal format and input/output voltage levels are shown in the following diagram.



The communications standard supported via UART is listed below.

- Bit rate: 115200 (default), 230400, 460800, 921600
- Bit length: 8 bits
- Start bit: Bit 1
- Stop bit: Bit 1
- Parity bit: None
- Flow control: None

After setting [UART COM] and [UART SPEED] on the [MainMenu] screen of the sample application, you can click the [Measurement (UART)] button to display distance measurements via the UART connection.

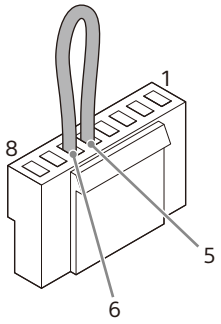
Notes

- The UART RX port of the unit has a 5 V tolerant input. Driving at voltages exceeding 5 V may cause device failure.
- The UART ports cannot be connected directly to an RS-232 or RS-422 interface. Use only with an level conversion circuit or interface circuit attached externally.
- The UART ports of the unit are non-isolated ports. When connecting to a system with a large potential difference or transmitting over long distances exceeding 3 m, isolation and buffering should be performed externally to the unit.
- The maximum frame rate may be slow if [UART SPEED] is set to 115200 bps/230400 bps or if the PC or other host device has low performance.

If the mode is accidentally set to UART mode

If you accidentally set the unit to UART mode when no UART connection is available, you can change the mode to use the USB interface using the following procedure.

1 Make a cable that short-circuits pins 5 and 6 of the 8-pin connector and connect it to the 8-pin connector of the unit as shown below.



2 Connect a PC or other host device and the unit using a USB cable and turn on the unit.

3 **Check that the status LED on the rear of the unit is lit green and disconnect the USB cable and 8-pin connector.**

4 **Reconnect the PC or other host device and the unit using a USB cable.**
The mode will now be recognized as [Update (USB)] mode.

Ranging Trigger

The unit can start ranging using multiple trigger methods according to the scene in which it is being used.

Trigger method	Description
Command trigger	You can start ranging by sending the “t” trigger command via the USB or UART interface. Used for software-based ranging timing management. The sample application uses this method for ranging.
Internal trigger	Use the “fsync” command for repeated distance measurement at intervals specified by the argument to the command (unit: 0.01 ms). Use for repeated distance measurements based on the clock of the unit.
External trigger	Use the “fltrgin” command to configure settings and trigger ranging when an input pulse occurs on the Trigger In pin of the 8-pin connector.

For details about the configuration and limitations of each trigger, refer to the “API Manual.”

Notes

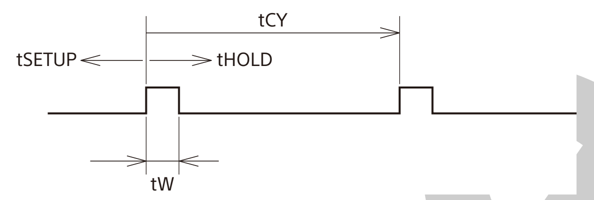
- The minimum distance measurement time interval is determined by the distance measurement range.

  For details about the minimum distance measurement time interval, see “Ranging Performance” (page 22).

- If a trigger occurs within the minimum distance measurement time interval, the trigger is ignored and ranging is not performed.

Inputting a Trigger from an External Device

You can start ranging by inputting a pulse on the Trigger In pin of the 8-pin connector of the unit.
The signal format and input/output voltage levels are shown in the following diagram.



tSETUP: 10 µs
tHOLD: 10 µs
tW: 1 µs
tCY: 33.34 ms @ 30 fps mode
66.67 ms @ 15 fps mode
V_{IH} min: 2.3 V (5 V tolerant)
V_{OL} max: 0.99 V

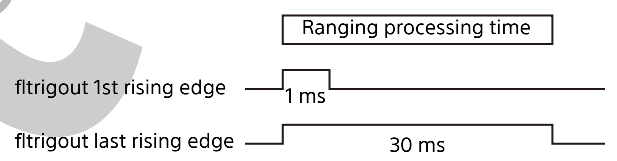
You can set whether to start ranging on the rising edge or falling edge using a command.
You can also disable the external trigger.

Notes

- The trigger input pin of the unit has a 5 V tolerant input. Driving at voltages exceeding 5 V may cause device failure.
- The trigger input pin of the unit is a non-isolated port. When connecting to a system with a large potential difference or transmitting over long distances exceeding 3 m, isolation and buffering should be performed externally to the unit.

Trigger Output

You can output a pulse in sync with the ranging from the Trigger Out pin of the 8-pin connector of the unit.
The signal format and output voltage levels are shown in the following diagram.



V_{OH} min: 3.0 V
V_{OL} max: 0.99 V

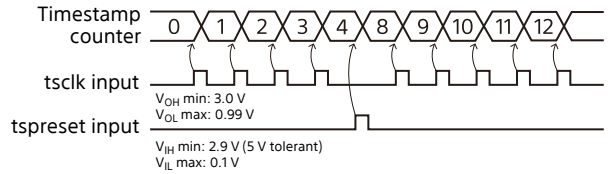
For details about the configuration and limitations of the trigger output, refer to the “API Manual.”

Note

A short time pulse is output when the unit is turned on.

Using the Timestamp Function

You can generate a 32-bit timestamp within the unit that is synchronized to an external device using the TS Clock and TS Preset pins of the 8-pin connector of the unit, and add that data to the distance measurement data for output.
The following diagram shows the input voltage level of the TS Clock and TS Preset pins.



If the rising edge of fltsclk pulses and fltspreset are set to timestamp 8 (ts 8), the timestamp counter will be output at the start of the distance measurement data.

The TS Clock maximum frequency is 1 kHz.
Set the TS Preset signal pulse width to 1 µs or longer.

Connecting an External Power Supply

You can operate the unit by connecting a 12 V to 24 V power supply between the power supply VCC pin (pin 2) and GND pin (pin 1) of the 8-pin connector.
When the power supply is input on these pins, this power supply takes precedence, and any power supply from the USB Type-C connector is not used.
If power is supplied to these pins while power is being supplied via USB, the power supply switches over and the unit is restarted.
The current capacity required for the power supply device connected to these pins varies depending on the load current of the USB downstream port. Use a power supply device that satisfies the load current being used.

Downstream port load current	Supply voltage	
	12 V	24 V
Not used	0.19 A	0.11 A
500 mA	0.48 A	0.25 A
1.5 A	1.03 A	0.54 A

Note

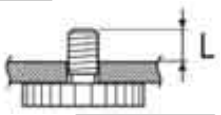
Applying voltages exceeding 24 V may cause device failure.
At voltages lower than 12 V, unit operation may become unstable.

Attaching to a Tripod

You can mount the unit on a tripod by attaching the VCT-333I tripod adaptor (option) to the bottom of the unit.
M2 screw recommended tightening torque: 0.18 N·m

Notes

- When attaching the VCT-333I tripod adaptor (option), use the supplied screw.
- When attaching to a tripod, use a screw with the following protrusion length (L) from the mounting surface and tighten securely so that it doesn't become loose.
  Protrusion length (L): 4.5 mm to 5.5 mm (max)



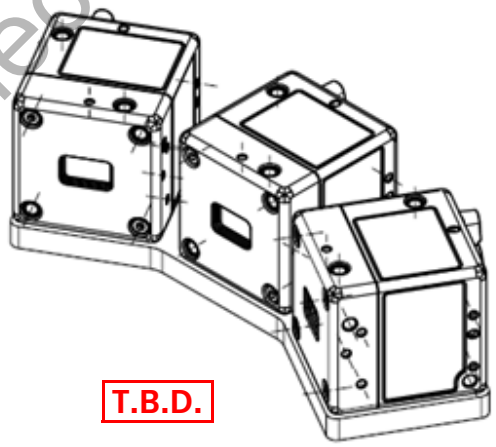
- Using a tripod screw longer than the maximum length may damage the unit or prevent the unit from being attached securely.

Attaching to a Triple Mount Bracket

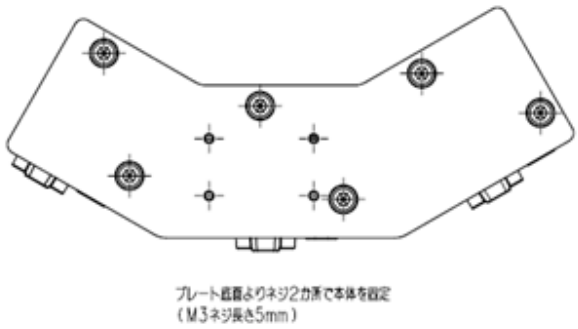
When you want to measure an area that cannot be covered by a single unit, you can use three units ranging simultaneously, expanding the measurement range.
The field of view of each unit is approximately 30 degrees, so by mounting additional units at an angle of 30 degrees, you can measure distances over a range of approximately 90 degrees. You can combine the point clouds acquired from three units by rotating the units and merging the distance measurement results during subsequent computation processing.
To make cable management easier and to position the ranging origin point of each unit as close as possible, the layout shown in the following diagram is recommended.
To maximize performance, rotate the units 90 degrees during use. The ranging sequence of the units is optimized to reduce interference between the three sensors. When the optical axes cross over in this way, no direct interference occurs.

For details about how to combine the three sensors and how to perform point cloud computation processing, refer to the "API Manual."

Prepare a plate with optimized relative installation positions for the three units.
For installation reference, 3D data is available for download from the following website.
3D CAD data download link (add URL)
* This layout is not a guarantee of sufficient heat dissipation.



T.B.D.



Using Commands

You can configure preferences and control the unit using commands from terminal software that supports serial communication.
When using USB connection, the unit is connected via USB CDC and is recognized as a COM port on a Windows PC.
When using UART connection, use the connected COM port.

Configuring Serial Port Communication

When using USB connection, configuration of the bit rate, start/stop bits, and other settings as a serial port is not required. Communication operates at the maximum speed specified by the USB standard and the PC driver.
The communications standard supported via UART connection is listed below.

- Bit rate: 115200 (default), 230400, 460800, 921600
- Bit length: 8 bits
- Start bit: Bit 1
- Stop bit: Bit 1
- Parity bit: None
- Flow control: None

Commands for Troubleshooting

This section describes useful commands for troubleshooting.

For details about the use of all commands, refer to the "API Manual."

? command

Displays a list of the serial commands with brief descriptions.

ver command

Displays the version, serial number, and hours meter of the unit.

```
> ver
dToF CDC Version 1.000 B999
setting Version 1.000 B999 REG Ver1.00 1.0.0.z.1r1
model:AS-DT1 serial:9200067
ope:19.2(H) shot:2779(k)
```

flstart command

Writes the ranging mode to use at next startup to non-volatile memory. The unit will start up in the specified ranging mode when the unit is restarted using the reboot command or when turned off and on again.

```
> flstart cdc
> reboot
```

List of ranging modes configurable using flstart

Parameter	Ranging mode
update	Update mode
cdc	USB ranging mode
extuart	UART ranging mode
hist	Histogram mode
inten	Intensity mode

For details about usage, refer to the "API Manual."

sensor i command

Displays the serial number and module ID of the installed sensor module.

```
> sensor i
model:AS-DT1 serial:9100001
S/N=xxxxxxxxxxxxxxxx
FMTVER=x.x
modelname=xxxxxxxx
manufacturing date=2025xxxx xxxx
facility date=2025xxxx
equipment ver=xxxxxxxxxxxxxxx
facility num=xxxxxx
laser lot=xxxxx
```

ustatus command

Displays the operating status of the internal USB hub.

```
> ustatus
SS
SelfPwr
Hub UCur Default
Hub DCur 1.5A
```

diag command

Runs self-diagnostics on the unit and displays the result.

```
Execution example (normal)
> diag
Diag OK

Execution example (error)
> diag
Diag NG
FLASH xx
IMU xx
SENSOR xx
EEPROM xx
```

errinfo command

Displays the record of error conditions stored within the unit.

```
Execution example (normal)
> errinfo
--- Error info ---
No Error Info
--- MIPI error ---
No MIPI Error
--- MIPI status ---
MipicsiGetErr 0
Ctrl Err(IncorrectLineStateSeq) Cnt 0
Unrec SyncByteErr Cnt 0
CrcErrCnt 0
MultiDataLane Sync ByteErrCnt 0
Framing Err Cnt 0
Unsup Pkt ID Err Cnt 0
Recov Pkt Hdr Err Cnt 0
Unrec Pkt Hdr Err Cnt 0
Recov SyncByteErr Cnt 0
--- Sensor overheat info ---
T>70degC:0(Sec)
maxT:50(degC)

Execution example (error)
> errinfo
--- Error info ---
Boot Error
LDD NG
PMIC NG
--- MIPI error ---
Measure Err mipi:19 peak:7
--- MIPI status ---
MipicsiGetErr 0
Ctrl Err(IncorrectLineStateSeq) Cnt 255
Unrec SyncByteErr Cnt 0
CrcErrCnt 0
MultiDataLane Sync ByteErrCnt 0
Framing Err Cnt 0
Unsup Pkt ID Err Cnt 0
Recov Pkt Hdr Err Cnt 0
Unrec Pkt Hdr Err Cnt 0
Recov SyncByteErr Cnt 0
--- Sensor overheat info ---
T>70degC:0(Sec)
maxT:50(degC)
```

reboot command

Reboots the unit and reloads the ranging mode, distance measurement range, and other non-volatile information.

Note

When the reboot command is executed, the USB connection with the host system will be temporarily lost.

flshow command

Displays a list of the settings written to non-volatile memory for next startup.

```
Execution example
> flshow
flstart:update
flmode:30mstd
flfsync:500
flcdc:ascii imuoff
fluart:115200
fltrgin:disable
fltrgout:disable
fltsclk:rise
fltspreset:rise
flobs:low:0 high:0
flbank:12
flled:on
```

Note

When the flshow command is used in update mode, only the factory default settings are displayed. To see all settings, run the flshow command in USB ranging mode or UART ranging mode.

factorydefault command

Resets the whole non-volatile memory to the factory default state. The ranging mode is set to update mode.

Other Functions

This section describes other functions of the unit.

Histogram Mode

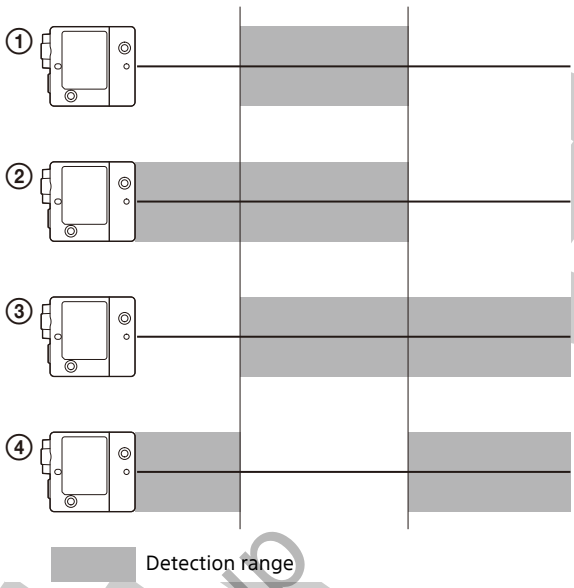
This mode outputs all output data from the built-in SPAD sensor of the unit via USB UVC. The output data includes not just distance measurement results, but also the ToF data used for ranging and the total amount of reflected light. The output data is output as image data in the following sizes, depending on the distance measurement range.

Distance measurement range	Output resolution
20M	800×504
30MSTD	800×252
30M15F	800×252
30M30F	800×126
40M	800×252

For details about usage, refer to the "API Manual."

Obstacle Detection Function

When operating in a ranging mode, this function detects the presence of obstacles at distance measurement points within the range of distance measurement result data. The detection result is output on the Trigger Out pin of the 8-pin connector, and the status LED of the unit lights up orange to indicate that an obstacle has been detected. The detection range is set by two values (longest distance and shortest distance) and detection occurs as follows.

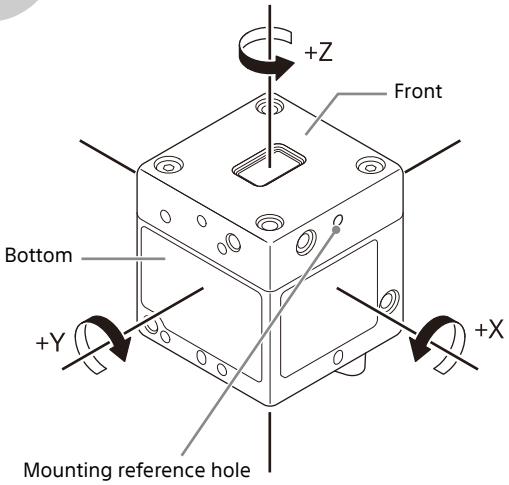


① Detection when a distance measurement point is within the range.
flobs 4000 7000
② Detection when a distance measurement point is closer than a certain distance.
flobs 0 7000
③ Detection when a distance measurement point is further than a certain distance.
flobs 7000 0
④ Detection when a distance measurement point is outside the range.
flobs 7000 4000

For details about usage, refer to the "API Manual."

IMU Function

The unit is equipped with an inertial measurement unit (IMU) that can measure acceleration and angular velocity. The IMU measures acceleration and angular velocity in the directions shown in the following diagram.



Measurements are conducted at intervals of about 10 ms controlled by an independent clock inside the IMU.
In addition to the ranging data output, IMU measurement result data and ranging timing flags can also be output.
The acceleration range is ±4G, and the angular velocity range is ±500 dps.

For details about usage, refer to the "API Manual."

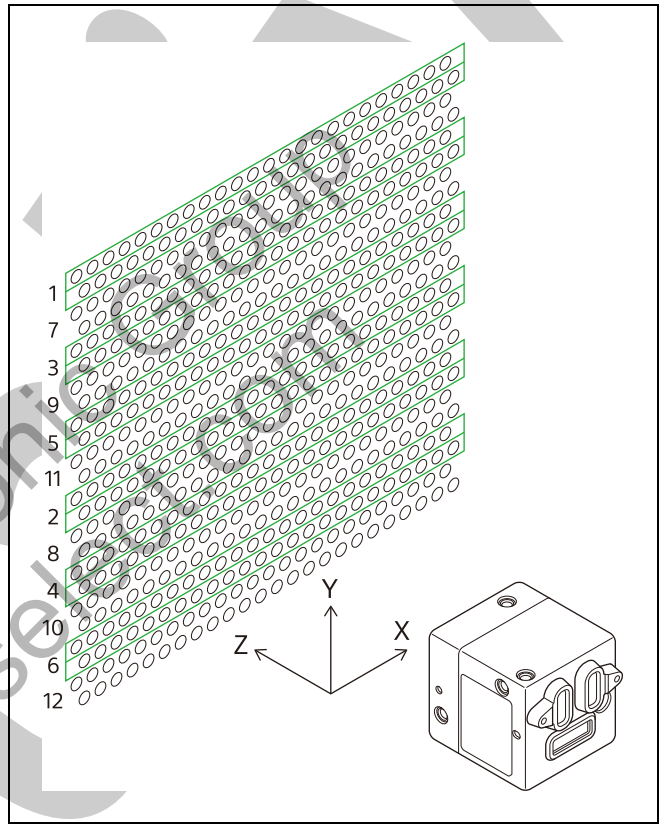
Note

The output data is the raw data from the built-in IMU.
Perform the calibration on the user side, as required.

Ranging Specifications

Point Cloud Coordinate System

This section describes the point cloud coordinate system of the unit.
Distance measurements by the unit are performed using the bottom surface and the reference hole on the bottom as reference points.
The coordinates of the point cloud output are expressed relative to these reference points.



Distance Measurement Range

This section describes the features of the distance measurement range setting.
The unit performs ranging using the dToF method. The dToF method measures the distance to a target object by measuring the round-trip time of laser light.
The unit irradiates objects at 576 points using an infrared (940 nm) laser (Class 1) and receives the reflected light with a high-sensitivity SPAD sensor to measure distances that are less affected by the condition of the object.
The unit achieves highly accurate distance measurements that are resistant to external disturbances by repeatedly performing ToF measurements tens of thousands of times per scan.
The performance and accuracy of ranging depends on the following factors.

- Distance measurement range
- Ambient light intensity
- Reflectance of the target
- Total reflection and diffuse reflection status of the target object surface

- Temperature of the unit

Notes

- Because the SPAD sensor features high sensitivity, excessive reflected light from objects with high reflectance at close range can cause overflow when ranging at long distance measurement range, reducing distance measurement accuracy.
- When measuring long distances, ambient light may reduce the accuracy of the measurement.

30MSTD distance measurement range

This is the standard range for measuring distances up to 30 m. It supports ranging of 576 distance measurement points at rates up to 30 fps. It features well-balanced ranging performance with stable distance measurement from short to long distances.

30M15F distance measurement range

This range setting is suitable for outdoor ranging, measuring distances up to 30 m at 15 fps. It supports ranging of 576 distance measurement points at rates up to 15 fps. By lowering the ranging frame rate and increasing the number of ToF measurements per distance measuring point, accurate measurement of distance is possible even when the object is affected by ambient light outdoors or has low reflectance.

30M30F distance measurement range

This range setting is suitable for outdoor ranging, measuring distances up to 30 m. By ranging at a frame rate of 30 fps and increasing the number of ToF measurements per distance measuring point but reducing the number to 288 distance measurement points, it supports high-speed accurate measurement of distance even when the object is affected by ambient light outdoors or has low reflectance.

20M distance measurement range

This range setting is suitable for short distances, measuring distances up to 20 m.
It supports ranging of 576 distance measurement points at rates up to 30 fps.
Compared to other modes, it provides higher ranging accuracy at close ranges of less than 5 m, but with maximum range limited to 20 m.

40M distance measurement range

This range setting is suitable for outdoor ranging, measuring distances up to 40 m. It supports ranging of 576 distance measurement points at rates up to 15 fps.
Compared to other range settings, it provides long-distance ranging by increasing the maximum ToF measurement time.
When ranging long distances, accuracy may deteriorate due to dispersion of laser power, especially in situations with strong ambient light, such as outdoors, or when ranging objects with low reflectance.

Ranging Performance

This section shows the typical ranging performance of the unit. Ranging performance is expressed in terms of accuracy and precision.
Accuracy: Indicates the variation in mm between the distance measurement result and the true value.
Precision: Indicates the variation (α) between the values obtained when the same target is measured multiple times with the target in a fixed position.
The object used for performance measurement is a flat plate with an infrared (940 nm) reflectance of 10%/50%/80%.
Measurements are taken with the unit facing directly at the flat plate with the distance measurement point in the center of the screen.
For indoor ranging, the results are from distance measurements taken in an environment with a background light brightness of 1000 lux. For outdoor ranging, the results are from distance measurements taken in an environment with a background light brightness of 40000 lux (where the background light reflected from the objects does not enter the unit due to total reflection).
High-reflectance objects may be measured as shorter distances as they appear closer.
In conditions with strong background light or objects with low reflectance, the precision decreases as the distance increases.

Accuracy indoors (1000 lx)

Distance [m]	Accuracy (Indoor) [mm]				
	20M	30MSTD	30M15F	30M30F	40M
0.5	+30/–80	+50/–150	+50/–150	+50/–150	+70/–230
1	+30/–80	+50/–150	+50/–150	+50/–150	+70/–230
2	+30/–30	+10/–150	+10/–150	+10/–150	+25/–230
5	+10/–60	+20/–100	+20/–100	+20/–100	+40/–140
10	+10/–25	+20/–30	+20/–40	+20/–40	+45/–55
15	+10/–25	+20/–40	+20/–40	+20/–40	+60/–55
20	+10/–25	+20/–40	+20/–40	+20/–40	+60/–55
25	–	+20/–40	+20/–40	+20/–40	+60/–55
30	–	+20/–40	+20/–40	+20/–40	+60/–55
35	–	–	–	–	+60/–55
40	–	–	–	–	+60/–55

Precision indoors (1000 lx)

Distance [m]	Precision (Indoor) [mm]				
	20M	30M STD	30M 15F	30M 30F	40M
0.5	4	4	4	4	4
1	4	4	4	4	4
2	4	4	4	4	4
5	2.5	2.5	2.5	2.5	2.5
10	5	5	5	5	5
15	7.5	7.5	7.5	7.5	7.5
20	10	10	10	10	10
25	–	12.5	12.5	12.5	12.5
30	–	15	15	15	15
35	–	–	–	–	17.5
40	–	–	–	–	20

Accuracy outdoors (40000 lx)

Distance [m]	Accuracy (Outdoor) [mm]				
	20M	30M STD	30M 15F	30M 30F	40M
0.5	+35/–120	+25/–170	+25/–170	+25/–170	+60/–230
1	+35/–120	+25/–170	+25/–170	+25/–170	+60/–230
2	+35/–100	+25/–170	+25/–170	+25/–170	+30/–230
5	+35/–100	+30/–100	+30/–100	+30/–100	+50/–120
10	+35/–70	+30/–100	+100/–110	+100/–110	+50/–120
15	+45/–70	+30/–100	+100/–110	+100/–110	+50/–120
20	+45/–70	+30/–100	+100/–110	+100/–110	+120/–120
25	–	+30/–100	+100/–110	+100/–110	+120/–120
30	–	+30/–100	+100/–110	+100/–110	+120/–120
35	–	–	–	–	+120/–120
40	–	–	–	–	+120/–120

Precision outdoors (40000 lx)

Distance [m]	Precision (Outdoor) [mm]				
	20M	30M STD	30M 15F	30M 30F	40M
0.5	25	10	10	10	15
1	25	10	10	10	20
2	25	10	10	10	20
5	10	10	10	10	20
10	20	25	20	20	40
15	30	37.5	30	30	60
20	40	50	40	40	80
25	–	62.5	50	50	100
30	–	75	60	60	120
35	–	–	–	–	140
40	–	–	–	–	160

If Trouble Occurs

Initial Checks

The following symptoms may not indicate a malfunction. Check these before contacting support.

- Ranging is not possible with certain objects or ranging accuracy is poor.
  Ranging may not be possible with objects that do not reflect infrared light with a sufficient reflectance. The following objects and natural environments may prevent normal ranging.
  - Objects with low infrared reflectance (objects that easily absorb infrared rays) and targets with high infrared reflectivity (transparent glass, water, non-reflective objects, mirrors, reflective tape, etc.)
  - Surface or bottom of liquid bodies (including ponds, lakes, seas, rivers, swamps, and other liquids)
  - Deep water, such as rivers and seas
- Ranging short distances less than 1 m is not possible.
  It may not be possible to measure the distance to high-reflectance objects at close range.
- The unit does not turn on if the voltage of the power supply is too high or too low.
  The unit will not operate normally at voltages outside the specified range. The unit may become damaged if used at voltages outside the specified range.
- The power supply capacity of the USB port may be insufficient, causing unstable operation.
  Connect the unit to a USB port that can supply enough power to drive the unit and all devices connected to its downstream port, or use an external power supply.
- The temperature of the unit is too high or too low.
  The guaranteed operating temperature range of the unit is 0 °C to 40 °C (32 °F to 104 °F). If outside this range, adjust the environment temperature where possible.
- The temperature of the sensor is too high.
  If the sensor temperature, which is taken into account in the ranging result, exceeds 70 °C (158 °F), ranging accuracy may be reduced. Allow the unit to cool down so that it runs at temperatures below 70 °C (158 °F).
  Even when the ambient temperature is below the guaranteed operating temperature of 40 °C (104 °F), the temperature sensor reading may exceed 70 °C (158 °F) depending on the usage environment.
- Intervals between distance measurement points are not uniform.
  The intervals between distance measurement points may be uneven due to the tolerances in the optical system. The ranging result point cloud is output taking this into consideration.

When Contacting Support

Provide the following information when contacting support.

- Symptoms and problems
- The serial number printed on the nameplate of the unit.
- Power supply method if reporting a malfunction (USB or external power supply)
- Connection method if reporting a malfunction (USB or UART)
- If you can connect using serial commands, provide the response of running the following commands.
  - ver command
  - sensor i command
  - ustatus command
  - errinfo command
  - diag command
  - flshow command

Troubleshooting Issues

This section describes the symptoms and measures to take if trouble occurs.

Symptom	Cause	Solution
Unit does not power on.	Power is not being supplied from a PC or other host device connected to the upstream port.	• Check that the power supply of the host device is turned on.
	There may be a problem with the connection or condition of the USB cable.	• Check that the unit and host device are connected correctly using a USB cable. • Check the specifications of the USB cable. *See "Connecting the unit to a PC via USB" (page 9).*
	Abnormal voltage from the DC power supply connected to the 8-pin connector.	• Check that the supplied voltage is within the specified power supply range of the unit. • Check the polarity of the power supply. • Check the pin layout of the connector. *See "Connecting an External Power Supply" (page 16).* **Note** If an overvoltage is applied, the internal fuse may blow preventing the power from turning on. In this case, repairs will be charged even if the product is within the warranty period.
The unit is not recognized from a PC or other USB host device.	Power is not being supplied to the unit.	*See the "Solution" column for the "Unit does not power on" symptom in this table.*
	There may be a problem with the connection or condition of the USB cable.	• Check that the unit and host device are connected correctly using a USB cable. • Check that USB cable is not damaged or broken. • Check the specifications of the USB cable (due to use of a communications compatible USB cable, for example). **Notes** • The USB cable may not be recognized if you plug and unplug the cable quickly. • Connection may not be established or instability may arise due to insufficient power supply capacity, depending on the state of the USB connection.
USB device connected to the USB downstream port cannot be recognized.	Power is not being supplied to the unit.	• Check that the power supply of the connected USB device is turned on.
	There may be a problem with the connection or condition of the USB cable.	• Check that USB cable is not damaged or broken. • Power is not being supplied from the 8-pin connector? *See "Connecting an External Power Supply" (page 16).*
	Power capacity is insufficient when multiple units are connected in a daisy-chain.	*See the "Solution" column for the "Some devices in a cascade connection are not recognized, do not work, or are unstable." symptom in this table.*
	Driver for connected USB device is not installed on the host PC.	• Install the driver for the connected USB device on the host PC.
Some devices in a cascade connection are not recognized, do not work, or are unstable.	Capacity of the power supply is insufficient.	• In the case of a cascade connection, power is supplied in order from a PC or other host device. This phenomenon can arise if the capacity of the power supply is insufficient. Use a USB host device with large power supply capacity or use an external DC power supply. *See "Using multiple connected units" (page 7).*

Symptom	Cause	Solution
Ranging is not possible. Ranging accuracy is extremely poor.	The cover glass is dirty.	• Check that the cover glass that protects the LiDAR depth sensor is not dirty. *If the cover glass is dirty, wipe it clean as described in "Cleaning the cover glass" (page 28).*
	The sensor temperature is too low or too high.	• Check that the unit temperature and sensor temperature are not too high or too low. → Use within the guaranteed operating temperature range of 0 °C to 40 °C (32 °F to 104 °F).
	The settings are incorrect.	• Check the settings. • If the problem persists, reset the unit to the factory default status using the factorydefault command. *For details about the factorydefault command, refer to the "API Manual."*
	Object is difficult to measure.	• The target object may be difficult to measure. This case does not indicate a malfunction. *For details about objects difficult to measure, see "Initial Checks" (page 24).*
Status LED turns on at startup but then turns off.	The LED is turned off.	• When the LED is set to be turned off, the LED turns off once the startup process has been completed. The LED off setting is also retained after the unit is turned off. → Reset the unit to the factory default status using the factorydefault command. *For details about the LED off setting and the factorydefault command, refer to the "API Manual."*
Various signals are not being sent or received properly from the 8-pin connector.	Signal specifications mismatch.	• Check the input/output voltage levels of connected devices and their cable lengths. *For details about usage settings, input/output voltage levels, and signal specifications, see "Connecting via UART using the 8-Pin Connector" (page 14), "Inputting a Trigger from an External Device" (page 15), "Trigger Output" (page 15), and "Using the Timestamp Function" (page 15).*
	The signal quality is poor.	
The ranging mode was accidentally changed to UART in a non-UART connection configuration and the unit does not operate normally.	Erroneous operation.	*Change the ranging mode as described in "If the mode is accidentally set to UART mode" (page 14).*
UVC devices are not recognized in intensity mode and histogram mode.	USB standards mismatch.	• UVC devices are not supported using USB FS (12 Mbps) or USB LS (1.5 Mbps). Connect via USB HS (480 Mbps) or USB SS (5 Gbps).

Specifications

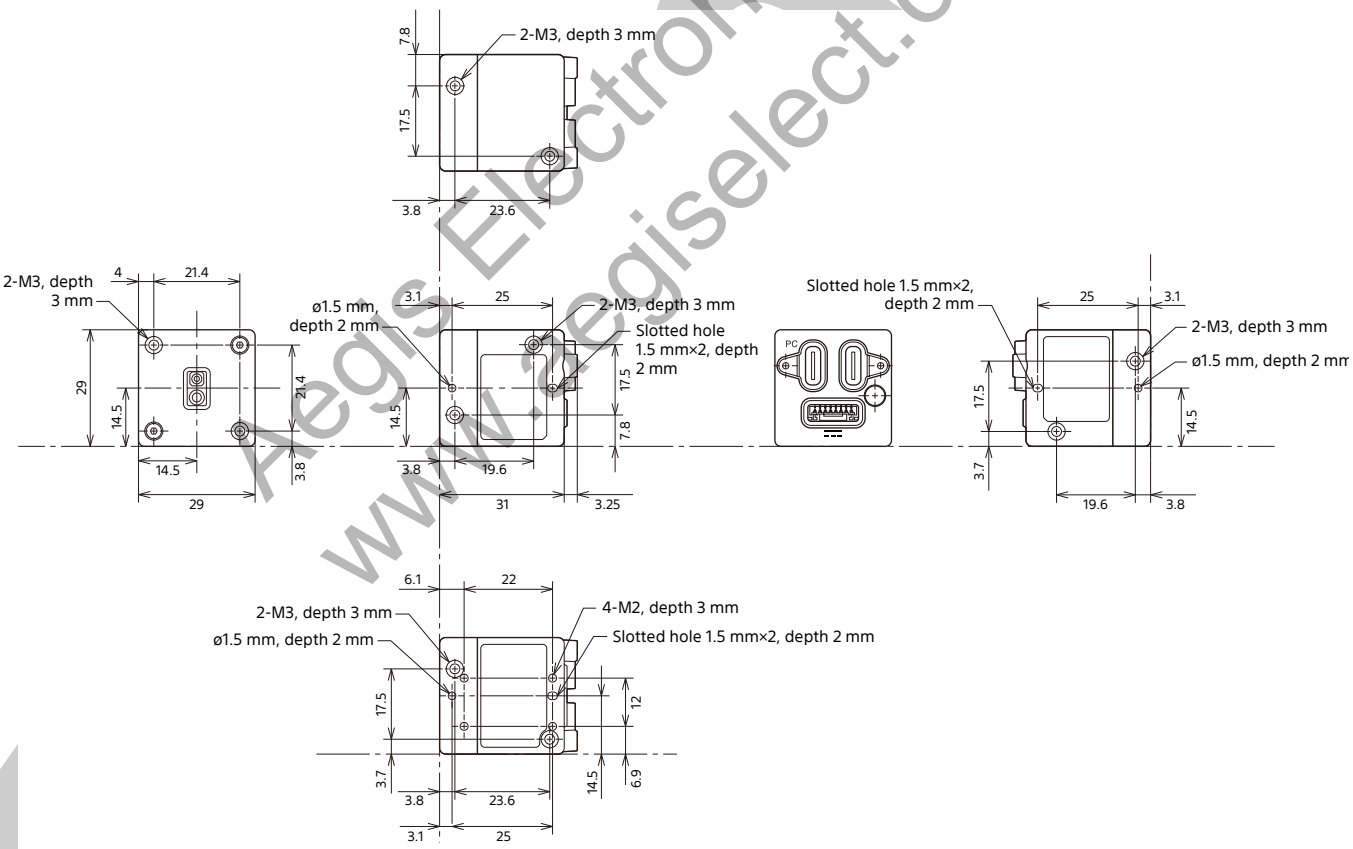
Main Specifications

HFoV 30° or higher
Maximum ranging distance
Outdoor: 40 m (40M distance measurement range, 50% target reflectance, center front of sensor)
Outdoor: 30 m (30MSTD distance measurement range, 50% target reflectance, center front of sensor)
Measurement accuracy
±50 mm at 10 m measurement distance indoors and outdoors
Distance resolution
0.25 mm
Frame rate 30 fps, 15 fps (maximum measurement distance range)
Number of distance measurement points
576 (24×24)
Laser wavelength 940 nm
Power supply DC 12 V to 24 V from USB power or 8-pin connector (8-pin connector has precedence)
Power consumption
2.5 W (max)
Guaranteed performance temperature range
0 °C to 40 °C (32 °F to 104 °F)
Operating temperature range
–5 °C to +45 °C (23 °F to 113 °F)
Storage temperature range
–30 °C to +60 °C (–22 °F to +140 °F)
Operating humidity
20% to 80% (no condensation)
Storage humidity 20% to 80% (no condensation)
Shock resistance 200G (7 ms to 8 ms)
Dimensions 29 mm × 29 mm × 31 mm ($1\ ^3/_{16}$ in × $1\ ^3/_{16}$ in × $1\ ^1/_4$ in) (width / height / depth)
Excluding protrusions
For details, see "External Dimensions."
Mass 50 g (1.8 oz) or lower

Design and specifications are subject to change without notice.

External Dimensions

Unit: mm



Appendix

Usage Precautions

Read this section in conjunction with the information provided in the supplied “Before Using This Unit” document.

Use and storage

Avoid using or storing the unit in the following places.

- In excessive heat or cold
- Locations with oil smoke, humidity, or dust
- Locations exposed to rain
- Locations with high concentrations of corrosive gases (hot springs, near volcanoes, etc.)
- Locations subject to violent vibration
- Near strong magnetic fields
- Close to radio or TV transmitters producing strong electromagnetic fields.
- In direct sunlight or close to heaters for extended periods

To prevent electromagnetic interference from portable communications devices

The use of portable telephones and other communications devices near this unit can result in malfunctions and interference with distance measurement results.
It is recommended that the portable communications devices near this unit be powered off.

About the laser

The unit includes a Class 1 laser. Observe the following points when using the unit.

- Do not intentionally look directly at the laser beam continuously or shine it on your fingers near the distance measurement window (the laser on this device is infrared and cannot be sensed as light by the naked eye).
- Under ideal operating conditions, the laser light source output will gradually decrease with the accumulated light emission time. The maximum measuring distance may decrease due to the reduction in output. This does not indicate a malfunction.

Condensation

If the unit is suddenly taken from a cold to a warm location, or if ambient temperature suddenly rises, moisture may form on the outer surface of the unit and/or inside of the unit. This is known as condensation. If condensation occurs, turn off the unit and wait until the condensation clears before operating the unit. Operating the unit while condensation is present may damage the unit.

Direct sunlight

Avoid pointing the distance measurement sensor window directly at the sun. The lens and sensor temperature may rise, resulting in reduced measurement accuracy or unit malfunction.

Cleaning the cover glass

Do not directly touch the surface of the cover glass.
If the cover glass of the unit becomes dirty, accurate ranging is not possible.
If it gets dirty, wipe it off thoroughly with a cotton swab or similar.
Never use organic solvents, such as alcohol, thinner, or benzene. This may damage the unit.

Usage temperature

The unit is equipped with a built-in temperature sensor. Make sure that the temperature sensor reading does not exceed 70 °C (158 °F). If the temperature exceeds this, attach the unit to a heatsink or other metal plate, such as the housing of the surrounding equipment, to provide sufficient heat dissipation. Continued use at high temperatures may significantly shorten its lifespan.
Even when the ambient temperature is below the guaranteed operating temperature of 40 °C (104 °F), the temperature sensor reading may exceed 70 °C (158 °F) depending on the ambient conditions, such as direct exposure to sunlight or the operating load conditions.

Dust and water resistance

The connectors on the rear of the unit are not dustproof or water-resistant. If the unit is used in an environment where it may be exposed to liquid splashes or excessive dust, seal any gaps in the connectors and any unused connector openings with tape or other packing to prevent the intrusion of liquids and dust.

Use in systems that require special product quality and reliability

Note that Sony cannot be held responsible for any damages incurred as a result of using the product in systems that require special quality and reliability, such as nuclear control systems, operation and control systems for transportation equipment (automobiles, trains, ships, aircraft, etc.), or medical control systems related to life support, which could result in a threat to life or physical safety, significant property damage, or large-scale system outages due to the product becoming unable to be used.

List of Supported Commands

The following table shows the list of commands supported by the unit. For details about the use of commands, refer to the "API Manual."
○: Supported. (Blank): Not supported.

Command name	update	cdc	UART	Histogram	Intensity	Function
ver	○	○	○	○	○	Display information about the model, such as firmware version.
ustatus	○	○	○	○	○	Display the connection status of the internal USB hub.
cstatus	○	○	○	○	○	Display the communication method and speed with the ranging device.
reboot	○	○	○	○	○	Reboot the ranging device.
serial	○					Display/set the serial number.
hrs	○					Display/set the hours meter and laser usage count.
cdcmode		○	○			Set the ranging result output format.
flshow	○	○	○	○	○	Display the list of non-volatile settings.
factorydefault	○	○	○	○	○	Reset the non-volatile settings to the factory default state.
flstart	○	○	○	○	○	Set the operating mode at startup.
flmode	○	○	○	○	○	Set the ranging mode at startup.
flfsync	○	○	○	○	○	Set automatic ranging at specified intervals at startup.
flcdc	○	○	○	○	○	Set the ranging result output format at startup.
fluart	○	○	○	○	○	Set the bit rate for UART connections at startup.
fltrgin	○	○	○	○	○	Set the Trigger In connector function at startup.
fltrgout	○	○	○	○	○	Set the Trigger Out connector function at startup.
fltsclk	○	○	○	○	○	Set the TS Clk connector function at startup.
fltspreset	○	○	○	○	○	Set the TS Preset connector function at startup.
flobs	○	○	○	○	○	Set obstacle detection at startup.
flbank	○	○	○	○	○	Set the number of banks per frame (histogram mode only).
flled	○	○	○	○	○	Set to show/not show status LED at startup.
flwp	○					Write protect flash memory (for service personnel).
erase	○					Erase memory area (for service personnel).
wrt	○					Write update to flash memory.
vfy	○					Verify update in flash memory.
erser	○					Erase serial settings.
imuval		○	○	○	○	Read out IMU measurement value.
sensor	○	○	○	○	○	Display sensor information.
lddlout					○	Set the laser light intensity for intensity mode.
fsync		○	○	○	○	Set automatic ranging at specified intervals.
t		○	○	○	○	Execute one ranging scan by command.
trgout	○	○	○	○		Set trigger output setting.
ts		○	○	○		Set timestamp and preset register.
obs		○	○			Set obstacle detection.
userrd	○	○	○	○	○	Read from user memory.
userwr	○	○	○	○	○	Write to user memory.
diag	○	○	○	○	○	Run self-diagnostics and display result.
gain					○	Adjust display gain of SPAD output in intensity mode.
errinfo	○	○	○	○	○	Display error history log.

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iconv (Charset Conversion Library) v2.0

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strcmp (included in newlib 2.0.0)

strcpy (included in newlib 2.0.0)
strlen (included in newlib 2.0.0)

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