

LiDAR Depth Sensor

User's Guide

AS-DT1

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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 Distance measurement 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 distance measurement module incorporating an SPAD (Single Photon Avalanche Diode)*¹ sensor that uses multiple distance measurement points to accurately measure distances in three dimensions (vertical, horizontal, depth).

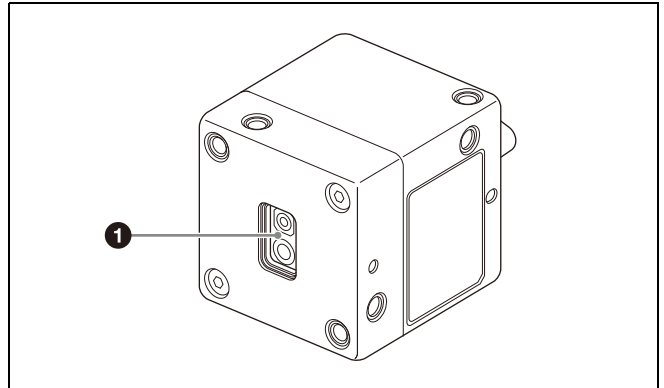
It can also measure the distance to low-contrast or low-reflectivity objects that are difficult to detect using other distance measurement methods. This makes it possible to accurately measure distances even in environments, such as stores, where there are likely to be various objects, including people 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

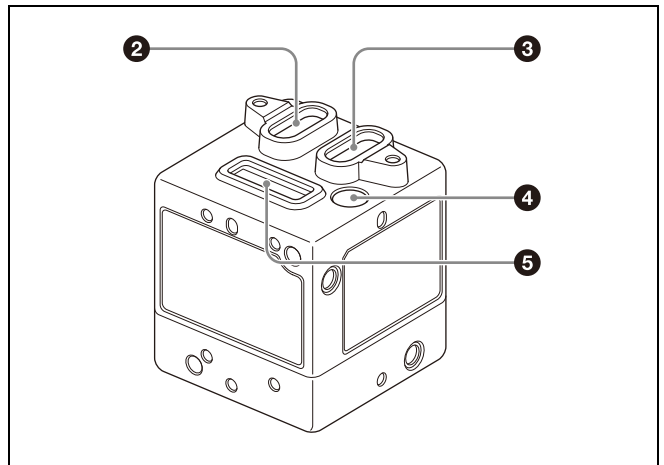
Front



① Distance measurement window / cover glass / dToF distance measurement module

The dToF distance measurement module is mounted behind a dustproof and waterproof cover glass.

Rear



② 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 port also supplies the power required to operate the unit.

③ 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 8).
- Connecting a camera
See "Using with a connected camera" (page 7).

④ Status LED

Indicates the status of the unit.

Color	Display	Status
–	Not lit	Off (power not supplied)
Green	Lit	Operating normally ^{*2}
Orange	Lit	Obstacle within obstacle detection range ^{*1 *2}
Orange	Flashing	Power on initialization ^{*2}
Red	Lit	Failure has occurred ^{*2 *3}

*1 When the obstacle detection function is enabled

*2 Flashes for a short moment when a serial command is received via the USB/UART interface and when conducting a distance measurement.

*3 The unit is malfunctioning. Request repairs.

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

⑤ 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 17).

- 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 15).

- The distance measurement 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 16) and "Trigger Output" (page 17).

- 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.

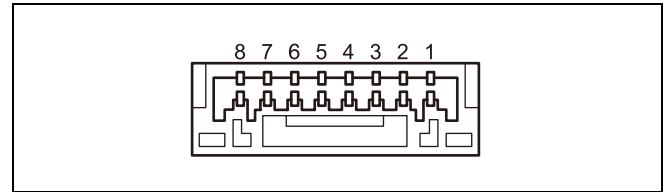
For details about timestamps, see "Using the Timestamp Function" (page 17).

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

Compatible connector: JST GHR-08V-S



Pin number	Name	Input/output	Function
1	GND	Input	Ground
2	VCC	Input	External power supply input
3	Trigger In	Input	Distance measurement start trigger pulse
4	Trigger Out	Output	Distance measurement 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 mounting 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 17).

Mounting screw holes

Used to attach the unit to an external device (mounting in/on the device). There are 10 holes, two on each side.

For details about mounting, see "Mounting the Unit" (page 5).

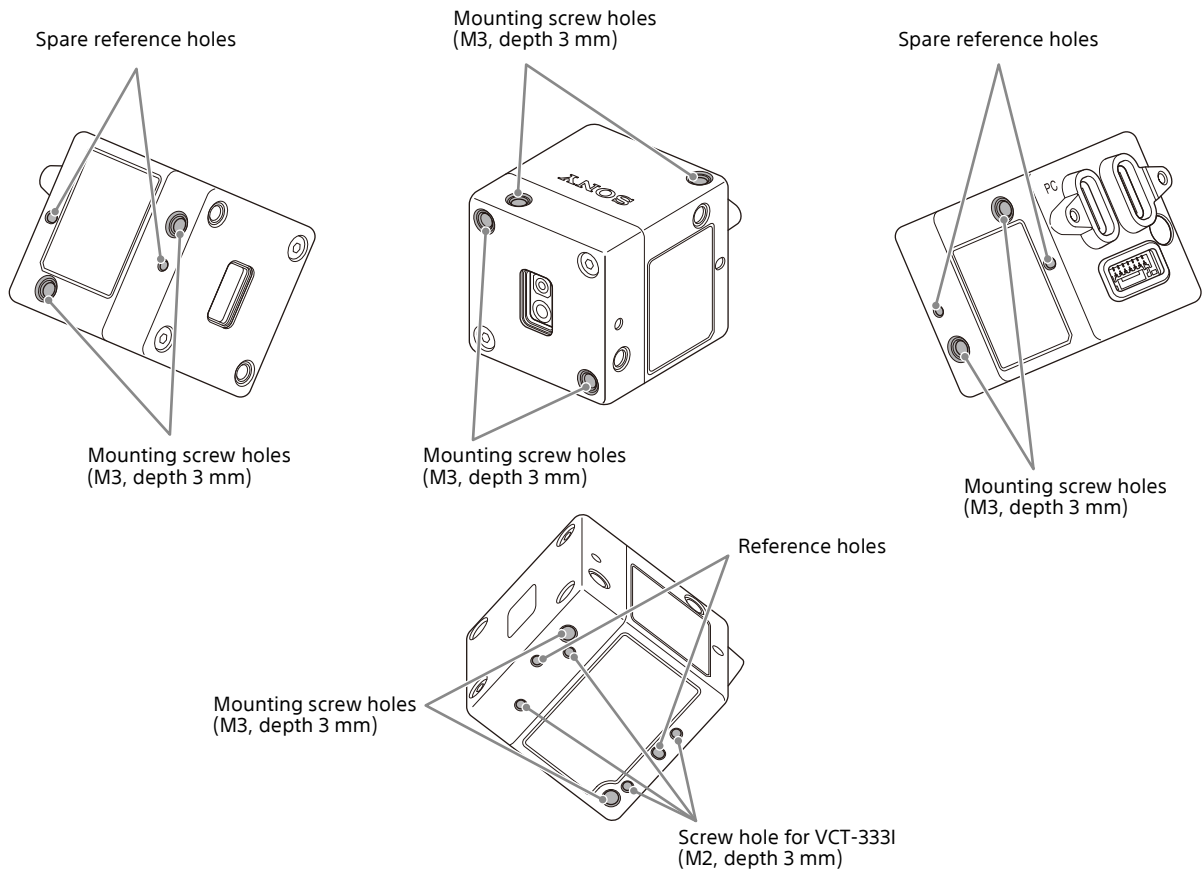
Preparation

Mounting the Unit

Mount the unit onto a fixed surface of an external device using the mounting reference holes and mounting screw holes. The mounting reference holes and mounting surface on the bottom are machined with the highest precision relative to the distance measurement origin point, maximizing the distance measurement performance of the unit.

Mounting screw hole and reference hole positions

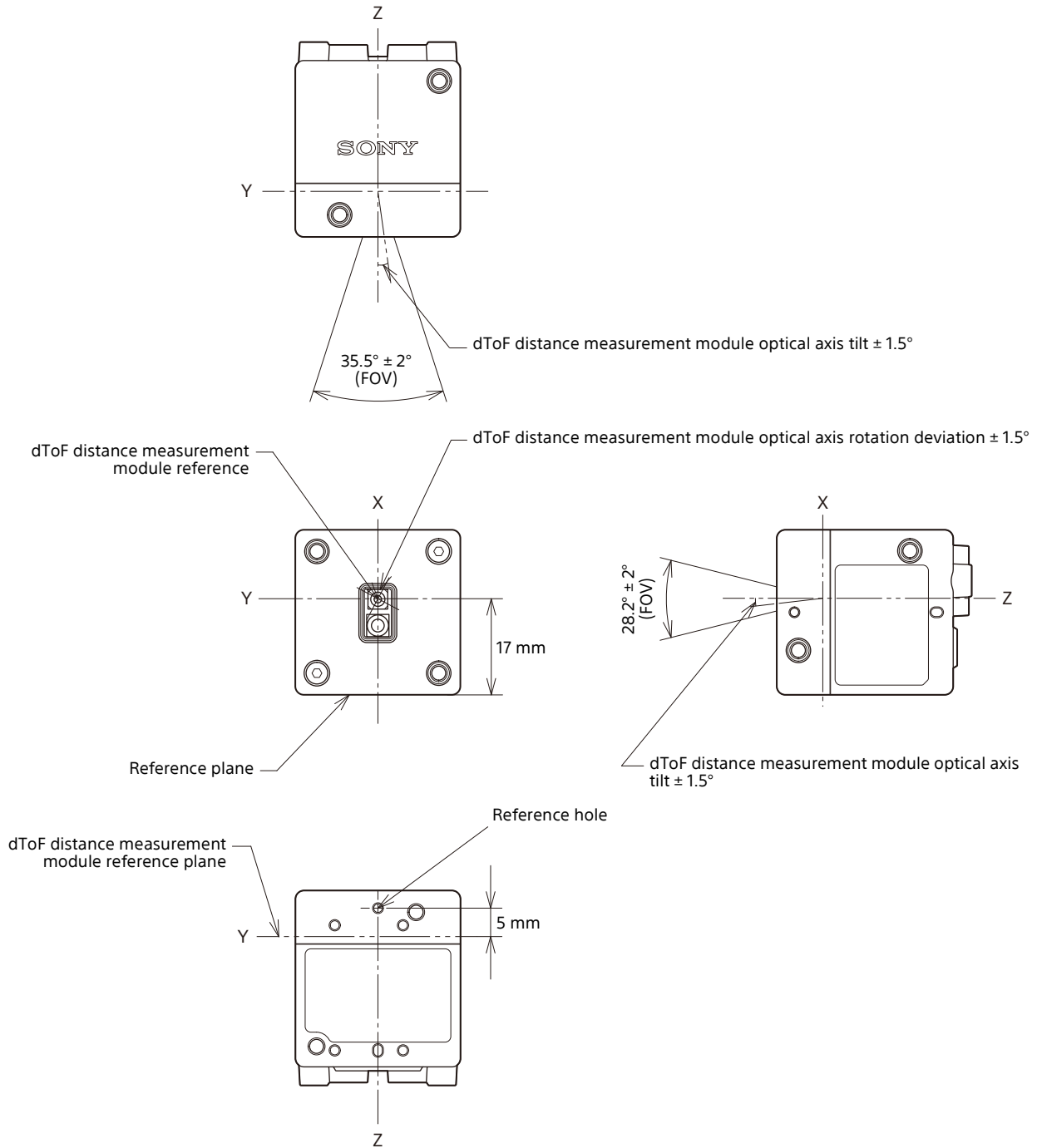
The following diagram shows the mounting screw hole and reference hole positions.



M3 screw recommended tightening torque: 0.6 N·m

Distance measurement reference of the unit

The distance measurement reference point ($X=0$, $Y=0$, $Z=0$) is defined as follows.



Mounting precautions

- Purchase commercially available mounting screws separately.
- Attach the unit securely using the reference hole and mounting screw holes.
- The distance measurement origin point is 5 mm from the mounting reference hole.
- Make sure that the threads of the mounting screws do not protrude further than 3 mm. This may damage the unit.

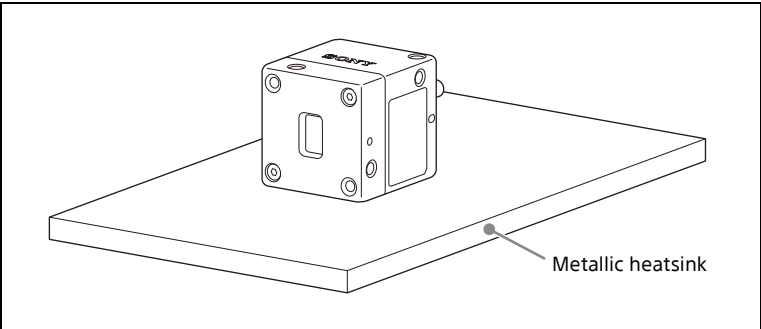
Usage temperature (using a heatsink)

Make sure that the readout value of the sensor temperature (*page 11*) of the unit 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 chassis of the surrounding equipment, to provide sufficient heat dissipation. For heat dissipation, a heatsink with the following parameters can be used.

Continued use at high temperatures may significantly shorten its lifespan.

Even in environments where the performance guarantee temperature is less than 40 °C (104 °F), the internal sensor temperature (*page 11*) readout value of the unit may exceed 70 °C (158 °F) if exposed to sunlight or depending on other installation and operating conditions.

Heatsink mounting



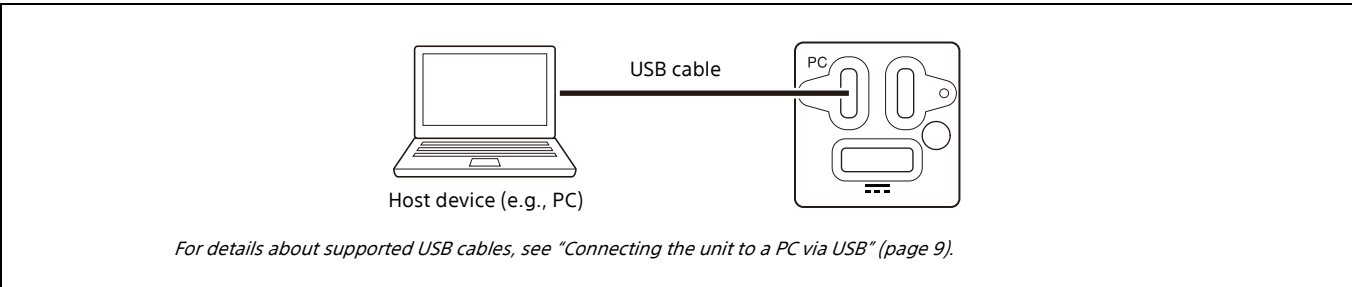
Heatsink size: 150 mm × 80 mm × thickness 10 mm (6 in × 3 1/4 in × 13/32 in) or larger
Heatsink thermal conductivity: 140 W/(m·K) or higher

System Configuration

The following show typical system configuration examples.

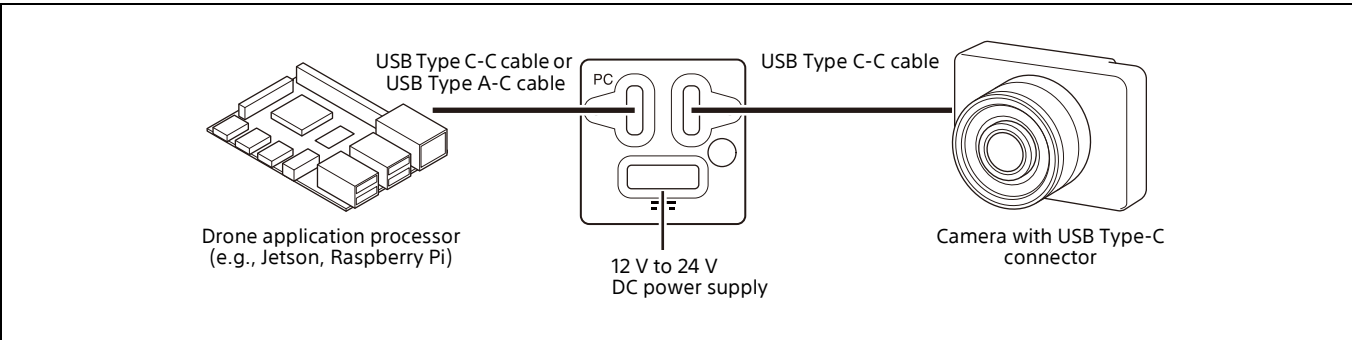
Using the unit as a standalone device

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



Using with a connected camera

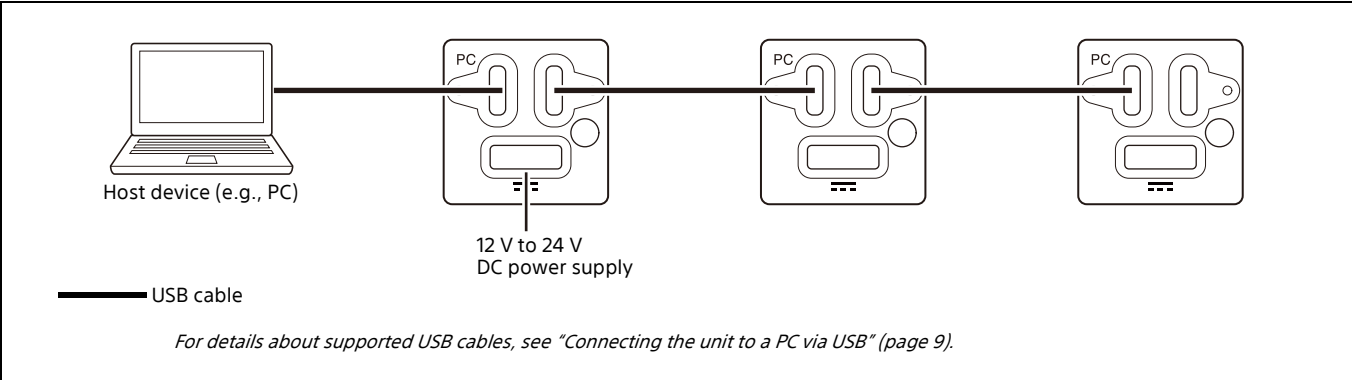
You can connect to a camera that has a USB Type-C connector using the USB downstream port. Whether or not the connected camera will be charged depends on the status of the power supply to the unit. If a device connected to the USB downstream port requires a large amount of power, such as for charging,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



Using multiple connected units

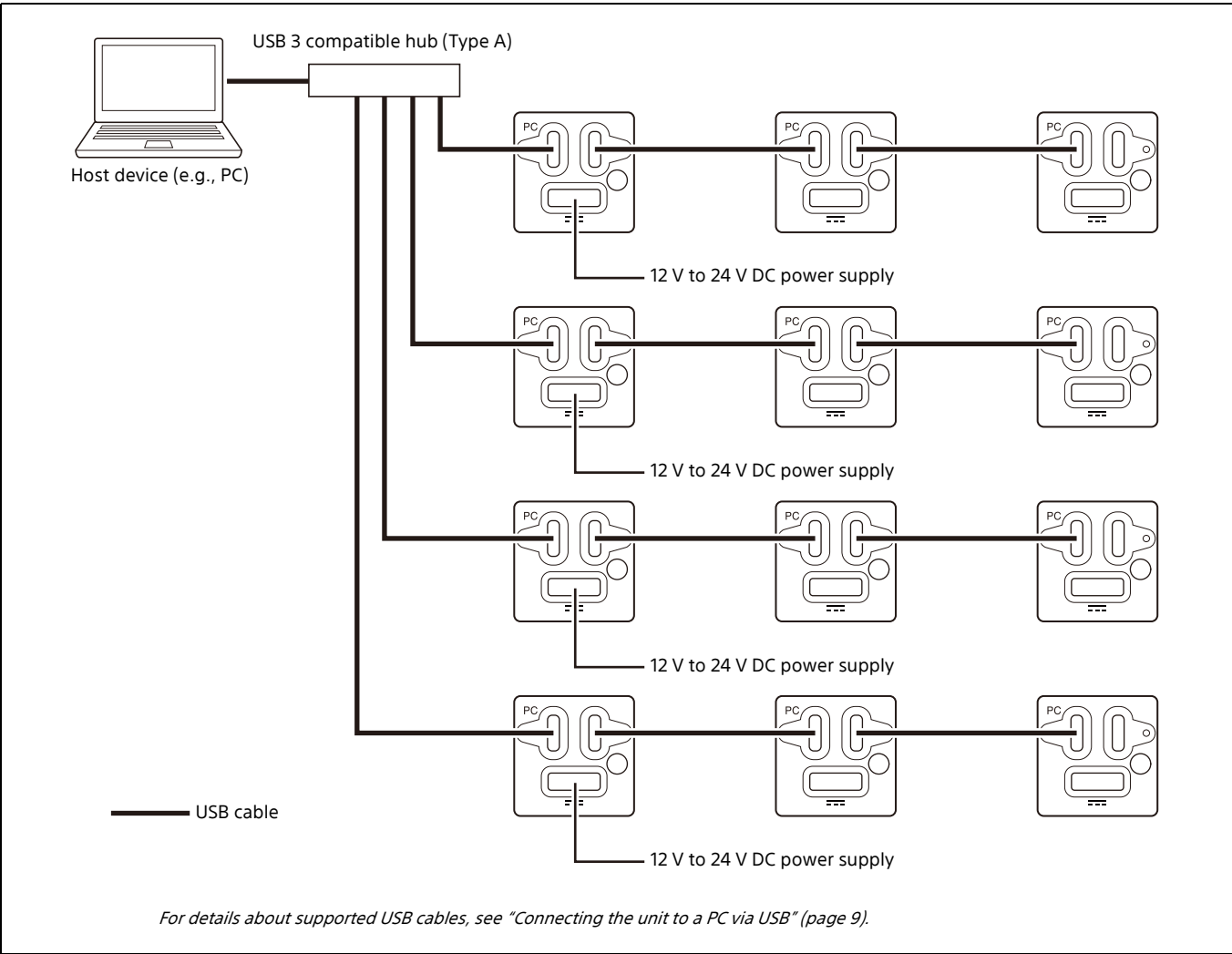
These configuration examples show multiple AS-DT1 units connected using the USB downstream ports.

Connecting up to 3 units



Connecting 4 or more units

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

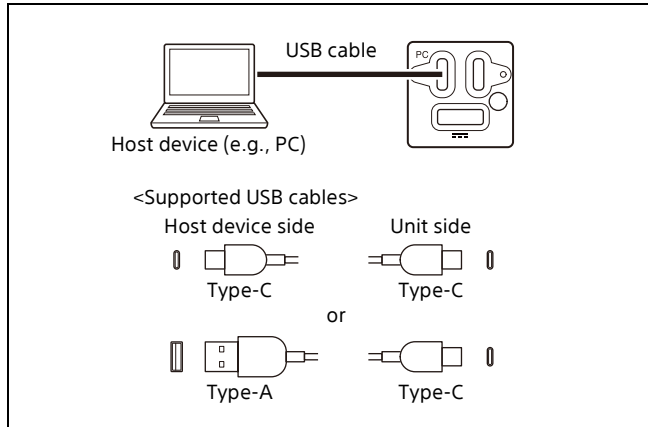


Running Sample Programs

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

Connecting the unit to a PC via USB

Connect the unit and PC using a USB cable.

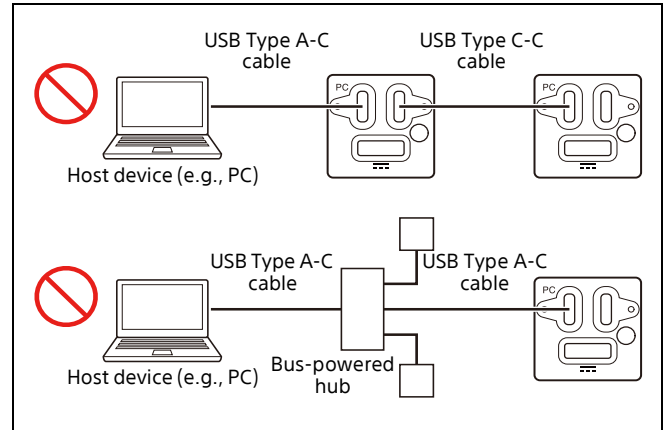


Use a cable with USB Type-C connectors on both ends or a cable with USB Type-A on the host side and USB Type-C on the unit side depending on the shape of connector on the host device.

- 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. Note that some USB Type-C cables can only connect via USB 2.0.
- 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 USB cable with USB certification logo is recommended.

Notes

- When using the unit as a standalone device, USB default power supply (500 mA) or larger is required.
- If a bus-powered 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).
- The unit does not support LPM as defined by the USB standard. Even if a transition to Suspend or U1, U2, or U3 is specified, the unit will not enter a low-power consumption state.
- Even if the unit is connected with a USB Type A-C cable and is operating as bus-powered, the USB descriptor of the built-in hub of the unit will be reported to the host device as self-powered and consuming 0 mA of current. It is the responsibility of the user to deal with power supply insufficiencies.
- To ensure stable operation of this unit, make sure the VBUS voltage at the upstream port is 4 V or higher. If the voltage falls below 4 V, USB communication may stop whether the device is bus-powered or self-powered.



Checking the usage environment for the sample programs and sample application

The sample programs 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)

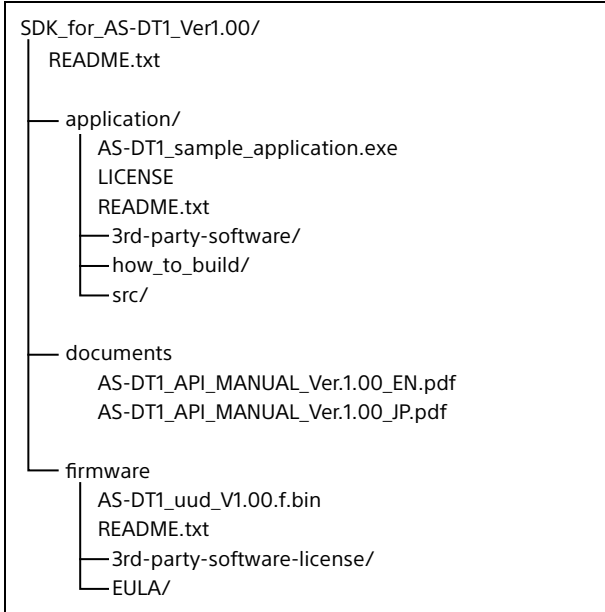
Notes

- 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.
- For details about usage in environments other than Windows 11, refer to the "API Manual."

Obtaining the SDK and uncompressing on a PC

- 1 Obtain the "SDK_for_AS-DT1_Ver.1.00.zip" file.
For details about obtaining the "SDK_for_AS-DT1_Ver.1.00.zip" file, contact your Sony sales representative.

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



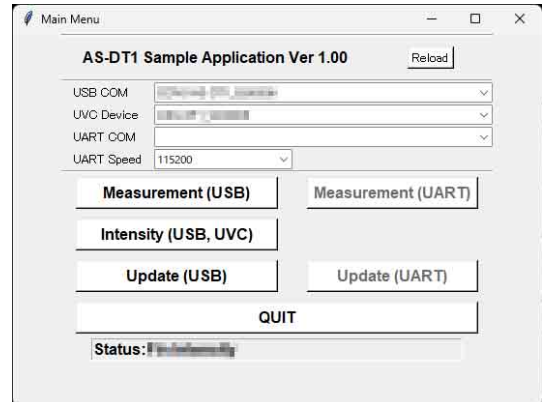
- 3 Open the “SDK_for_AS-DT1_Ver1.00” folder.**
- 4 Open the “application” folder.**
Check that “AS-DT1_sample_application.exe” is in the folder.

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_application.exe” in the “application” folder obtained by uncompressing the “SDK_for_AS-DT1_Ver1.00.zip” file.
The [Main Menu] screen appears.



The following table shows the buttons and their functions supported by the sample application. When you click a button other than the [QUIT] button, the distance measurement mode changes to the mode indicated on the button, and the screen switches to the corresponding mode.

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 an SPAD sensor used for distance measurement.
[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 application.

Configuring the Connection

The required setup items vary depending on the selected button.

Button	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]

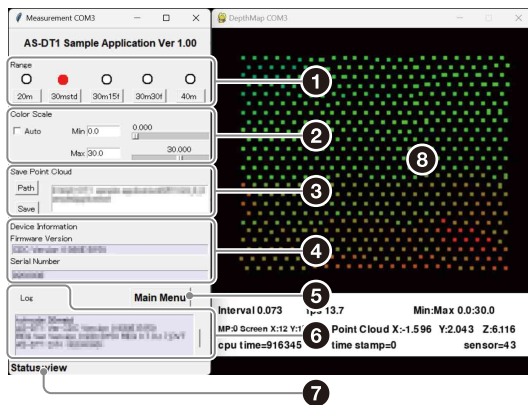
Set the port and device number connected to the unit with the serial number you want to use for the required items corresponding to each button.

Clicking the [Reload] button updates the [USB COM], [UVC Device], and [UART COM] information. Use this if the connection is changed after launching the sample 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 Distance Measurement Mode [Measurement (USB)]

In [USB COM] on the [Main Menu] screen, select the unit you want to use for distance measurement. Then, click the [Measurement (USB)] button. The following screen appears.



① [Range]

The lamp for the current distance measurement mode is lit red.

You can change the distance measurement mode by clicking a distance measurement mode selector button. The indicators light up orange in sequence until the distance measurement has been determined.

For the distance measurement range specifications, see "Distance Measurement Range" (page 22).

② [Color Scale]

Set the colorization of the image displayed on the right side ⑧ 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 measurement 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.

③ [Save Point Cloud]

Specify the save destination for distance measurement results data by clicking the [Path] button. When you click the [Save] button, the distance measurement 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 four types of files are saved.

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

④ [Device Information]

Displays the firmware version and serial number of the connected unit.

⑤ [Main Menu] button

Exits distance measurement and returns to the [Main Menu] screen.

⑥ [Log] window

Displays the self-diagnostics information and operating log information of the unit. You can use this to resolve issues or problems with the unit.

⑦ [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 [Main Menu] screen.

⑧ Distance measurement results display

Displays the distance measurement results for the specified distance measurement mode on the unit. When you click a distance measurement point using a mouse, the distance measurement information for that point is displayed in "Point Cloud" at the bottom of the screen.

<Display example>

Interval 0.073	fps 13.7	Min:Max 0.0:30.0
MP:0 Screen X:12 Y:15	Point Cloud X:-1.596 Y:2.043 Z:6.116	
cpu time=916345	time stamp=0	sensor=43

Item	Meaning
Interval	Distance measurement time interval (unit: second)
fps	Frame rate (frames/second) * The application has a frame rate limit of 30 fps.
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: Distance measurement point number

Item	Meaning
Screen X,Y	X: X-coordinate within the screen (0 to 169) Y: Y-coordinate within the screen (0 to 139)
Point Cloud X,Y,Z	Distance measurement information expressed as a point cloud (unit: m)
cpu time	Timestamp information within the unit (unit: ms)
time stamp	External synchronization timestamp count
sensor	Sensor temperature within the unit (unit: °C)

Intensity Mode [Intensity (USB, UVC)]

In [USB COM] and [UVC Device] on the [Main Menu] screen, select the unit for which you want to display an intensity image.

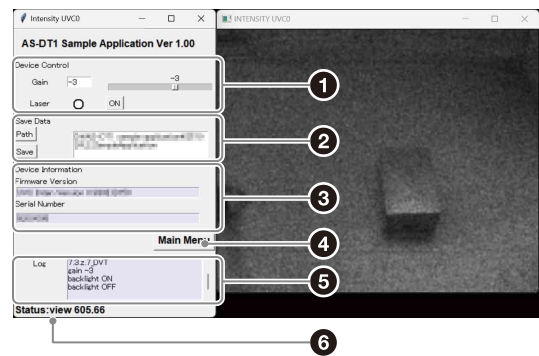
Then, click the [Intensity (USB, UVC)] button.

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 [Main Menu] 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 with a camera used in conjunction with the distance measurement sensor.

① [Device Control]

You can control the gain of the infrared image using the [Gain] box.

The dynamic range of the SPAD sensor is 18 bits. In intensity mode, the 18-bit SPAD sensor output is converted to 8-bit for output and display. The position of the 8 bits in the 18-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.

Typical SPAD sensor output (18-bit) and UVC output (8-bit) combinations

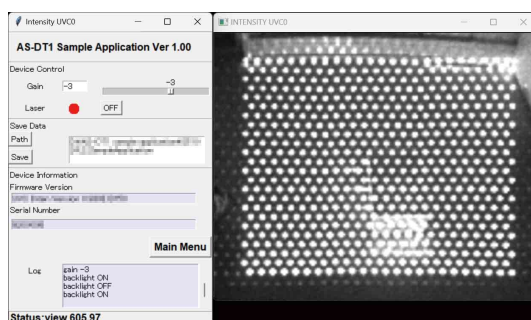
SPAD value		17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
UVC value (Gain value)	-10	7	6	5	4	3	2	1	0										
	-6					7	6	5	4	3	2	1	0						
	0											7	6	5	4	3	2	1	0
	4*1															7	6	5	4

*1 Bit 3, 2, 1, and 0 are always 0.

The [Laser] lamp and [ON]/ [OFF] button function to emit a laser for distance measurement.

During laser emission, the lamp is lit red.

When the laser is emitted, the following screen appears.



② [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 distance measurement results data 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 three types of files are saved.

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

③ [Device Information]

Displays the firmware version and serial number of the connected unit.

④ [Main Menu] button

Exits intensity mode and returns to the [Main Menu] screen.

5 [Log] window

Displays the self-diagnostics information and operating log information of the unit.

You can use this to resolve issues or problems with the unit.

6 [Status]

Displays the current operating status.

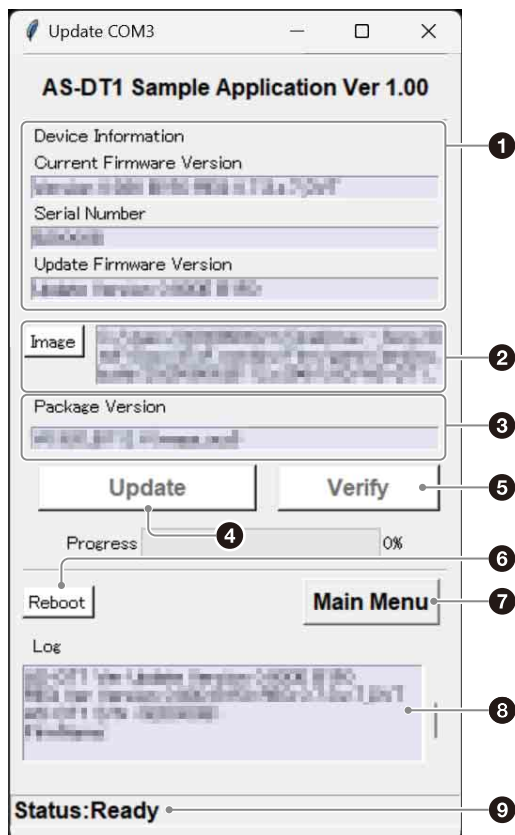
"open fail" is displayed if the connection with the unit is lost. If this occurs, exit the program, check the connection with the unit, and reconfigure settings on the [Main Menu] screen.

Update Mode [Update (USB)]

In [USB COM] on the [Main Menu] screen, select the unit for which you want to update the firmware.

Then, click the [Update (USB)] button.

The following screen appears.



1 [Device Information]

Displays the firmware version, serial number, and the version of the firmware update written at the factory of the unit connected to the PC.

Note

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

2 [Image] button

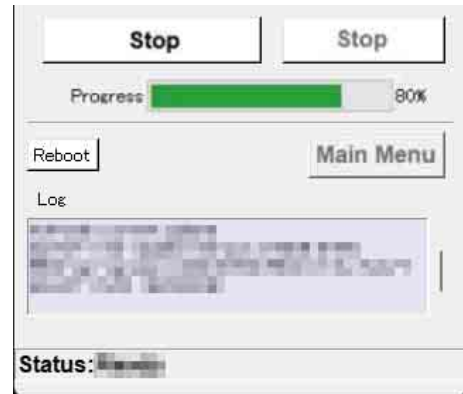
Click the button and select an update package for the unit (".f.bin" extension).

3 [Package Version]

Displays the update package version when a valid update package is selected.

4 [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%.

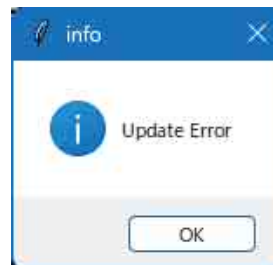


When completed, the following dialog appears.

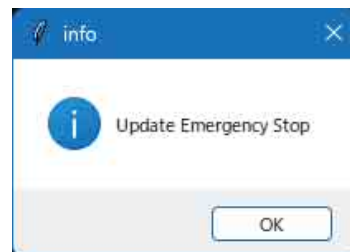
- "Update Finish" is displayed if successful.



- "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, execute the update again. If you do not update the firmware, some functions may not be available or other problems may occur.

After updating, check that [Current Firmware 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.

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

⑤ [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 Error" is displayed in the status display.

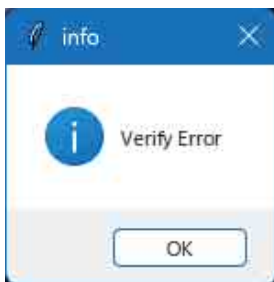
You can recover by executing the update again.

When completed, the following dialog appears.

- "Verify Finish" is displayed if successful.



- "Verify Error" is displayed if unsuccessful.



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



⑥ [Reboot] button

Click the button to reboot the unit. The button cannot be clicked during the update or verification processes.

⑦ [Main Menu] button

Exits update mode and returns to the [Main Menu] screen.

⑧ [Log] window

Displays update and verification log information.

You can use this to resolve issues or problems with the unit.

⑨ [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 [Main Menu] 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 [Main Menu] screen.

Connecting Peripheral Devices

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

Using the USB Downstream Port

The downstream port of the unit conforms to the USB Type-C standard. The unit also has a built-in USB hub function that supports connection of additional AS-DT1 units and USB 3.2 compatible devices to the downstream port via USB 3.2 Gen 1. USB 2.0 compatible devices can also be connected to the downstream port.

To prevent disconnection of the USB Type-C cable, use a cable that supports the single screw USB Type-C locking plug standard.

Use of a USB 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 (only 5 V, 0 mA self-powered devices can be connected)

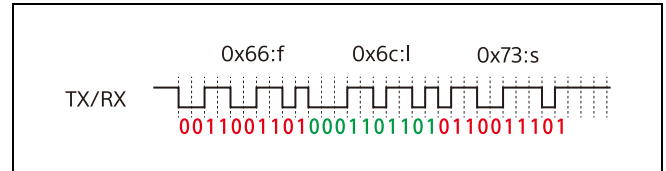
Notes

- 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 pin and RX pin. The UART interface is used when the distance measurement mode of the unit is set to [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.



Input/output voltage levels

Item		Voltage level
TX	V _{OH} min	2.4 V
	V _{OL} max	0.1 V
RX	V _{IH} min	2.3 V (5 V tolerant)
	V _{IL} max	0.99 V

The communications standard supported via UART is listed below.

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

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

Notes

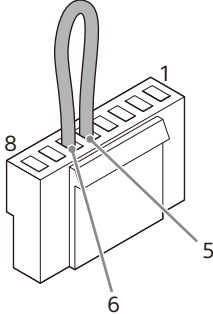
- The UART RX port of the unit has a 5 V tolerant input. Driving at voltages exceeding 5 V may cause device failure.
- The UART ports cannot be connected directly to an RS-232 or RS-422 interface. Use only with a level conversion circuit or interface circuit attached externally.
- The UART ports of the unit are non-isolated ports. When connecting to a system with a large potential difference or transmitting over long distances exceeding 1 m, isolation and buffering should be performed externally to the unit.
- The frame rate may be slow or some frames may be dropped if [UART SPEED] is set to 115200 bps or 230400 bps or if the PC or other host device has low performance, and the distance measurement result output format setting is set to ascii or binary.
- The UART port achieves high speed communication by performing 16-byte buffering. Accordingly, when sending a serial command to the unit, add space characters (0x20) as required so that the entire command is a multiple of 16 bytes, as shown below.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
f	l	s	t	a	r	t	SP	c	d	c	SP	SP	SP	CR
66	6C	73	74	61	72	74	20	63	64	63	20	20	20	0d

If the mode is accidentally set to use the UART interface

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 back of the unit is flashing green periodically.**
- 4 **Disconnect the USB cable and 8-pin connector, and turn off the power supply.**
- 5 **Reconnect the PC or other host device and the unit using a USB cable, then turn on the power supply.** The mode will now be recognized as [Update (USB)] mode.

Distance Measurement Trigger

The unit can start distance measurement using multiple methods according to the use case of the unit.

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

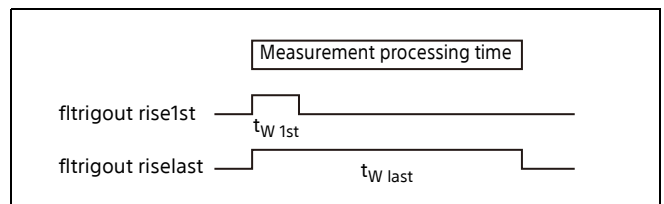
For details about the configuration and limitations of each trigger, refer to the "API Manual."

Notes

- The minimum distance measurement time interval is determined by the distance measurement range.
For details about the minimum distance measurement time interval, see "Minimum Distance Measurement Time Interval" (page 23).
- If a trigger occurs within the minimum distance measurement time interval, the trigger is ignored and distance measurement is not performed.
- When using the USB interface and an internal trigger to control distance measurement, the distance measurement time interval may automatically increase beyond the specified time interval, as required, to prevent abnormal operation if the performance of the host device is low.

Inputting a Trigger from an External Device

You can start distance measurement 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.



The pulse width varies with the distance measurement range setting.

Setting	t_{W1st}	t_{Wlast}
30MSTD	Approx. 4 ms	Approx. 31 ms
30M15F	Approx. 7 ms	Approx. 64 ms
30M30F	Approx. 7 ms	Approx. 31 ms
20M	Approx. 3 ms	Approx. 32 ms
40M	Approx. 7 ms	Approx. 64 ms

You can set whether to start distance measurement on the rising edge or falling edge using a command.

You can also disable the external trigger.

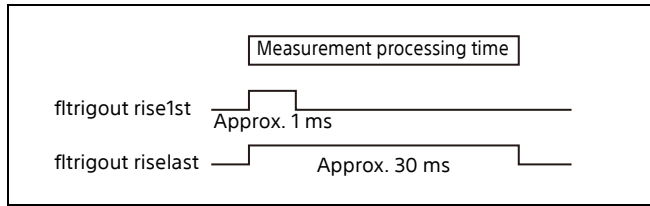
For details about the minimum distance measurement time interval (t_{CY}), see "Minimum Distance Measurement Time Interval" (page 23).

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 1 m, isolation and buffering should be performed externally to the unit.

Trigger Output

You can output a pulse in sync with the distance measurement 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.



Item	Voltage level
V_{OH} min	2.3 V
V_{OL} max	0.55 V
I_{OH} max	-24 mA
I_{OL} max	24 mA

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

Note

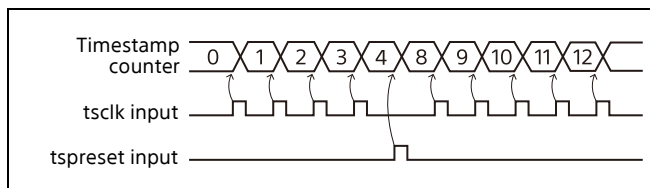
A short time pulse is output when the unit is turned on.

Using the Timestamp Function

You can generate a 32-bit timestamp within the unit that is synchronized to an external device using the TS Clk and TS Preset pins of the 8-pin connector of the unit, and add that data to the distance measurement data for output. The timestamp counter is output at the start of the distance measurement data.

The following diagram shows the input voltage level of the TS Clk pin and TS Preset pin.

fltsclk rise, fltspreset rise, ts 8 settings example



Item		Voltage level
tsclk	V_{IH} min	2.3 V (5 V tolerant)
	V_{IL} max	0.99 V
tspreset	V_{IH} min	2.3 V (5 V tolerant)
	V_{IL} max	0.99 V

The TS Clk maximum frequency is 1 kHz. Set the TS Preset signal pulse width to 1 μ s or longer.

Connecting an External Power Supply

You can supply power to 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 upstream port 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.

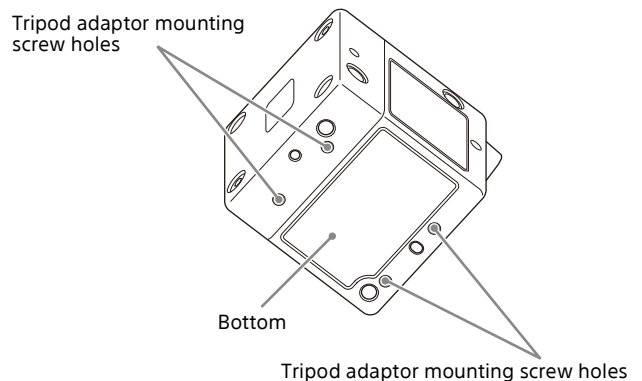
Downstream port load current	Current capacity required for power supply device connected to pins	
	Supply voltage 12 V	Supply voltage 24 V
Not used	0.19 A	0.11 A
500 mA	0.48 A	0.25 A
1.5 A	1.03 A	0.54 A

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.

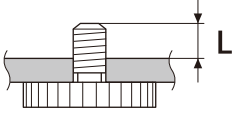


M2 screw recommended tightening torque: 0.18 N·m

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 they don't become loose. Using a tripod screw that protrudes 5.5 mm or more may damage the unit or prevent the unit from being attached securely.



Protrusion length (L): 4.5 mm to 5.5 mm

- The M2 screw holes on the bottom of the unit are dedicated screw holes for attaching a tripod adaptor. Do not use for any other purpose. This may damage the unit.
- The tripod adaptor does not have a heatsink function. When using an adaptor, make sure that the sensor temperature (*page 11*) within the unit does not exceed 70 °C (158 °F) and use a heatsink (*page 6*), as required.

Cleaning

Cleaning the Cover Glass

Do not directly touch the surface of the cover glass during use. If the cover glass becomes dirty, accurate distance measurement may not be 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.

Note

If the cover glass is broken or has fallen off, immediately stop using the unit and have it repaired.

Using Commands

You can configure preferences and control the unit using serial commands from terminal software that supports serial communication.

When using a USB connection, the unit is connected via USB CDC and is recognized as a COM port on a Windows PC.

When using the UART connection of the 8-pin connector (see page 15), use the connected COM port.

Configuring Serial Port Communication

When using a USB CDC connection, configuration of the bit rate, start/stop bits, and other settings for 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 the UART connection (see page 15) of the 8-pin connector is listed below.

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

Frequently Used Commands

This section describes frequently used commands.

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

? command

Displays a list of the serial commands with brief descriptions.

flstart command

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

```
> flstart cdc
> reboot
```

List of distance measurement modes configurable using flstart

Parameter	Distance measurement mode
update	Update mode
cdc	USB distance measurement mode
extuart	UART distance measurement mode
hist	Histogram mode
inten	Intensity mode

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

t command

Starts distance measurement using the USB CDC or UART interface.

Note

This command is ignored if issued while distance measurement is already in progress.

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

reboot command

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

Note

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

factorydefault command

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

Commands for Troubleshooting

This section describes useful commands for troubleshooting.

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

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
model:AS-DT1 serial:1000001
ope:19.2(H) shot:2779(k)
```

sensorinfo command

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

```
> sensorinfo
model:AS-DT1 serial:1000001
S/N=xxxxxxxxxxxxxxxxxx
FMTVER=x.x
modelName=xxxxxxx
manufacturing date=2025xxxx xxxx
facility date=2025xxxx
equipment ver=xxxxxxxxxxxxxxxxxx
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. If a "Diag NG" response occurs after running this command, the unit is deemed to be malfunctioning, and you should request repairs.

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)
```

flshow command

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

Execution example

```
> flshow  
flstart update  
flmode 30mstd  
flfsync 0  
flhistfsync 500  
flformat ascii  
fluart 115200  
fltrgin disable  
fltrgout disable  
fltsclk rise  
fltspreset rise  
flobs 0 0  
flbank 1  
filed on
```

Note

When the flshow command is used in update mode, only the factory default settings are displayed. To see all settings, switch the distance measurement mode to cdc or extuart and run the flshow command.

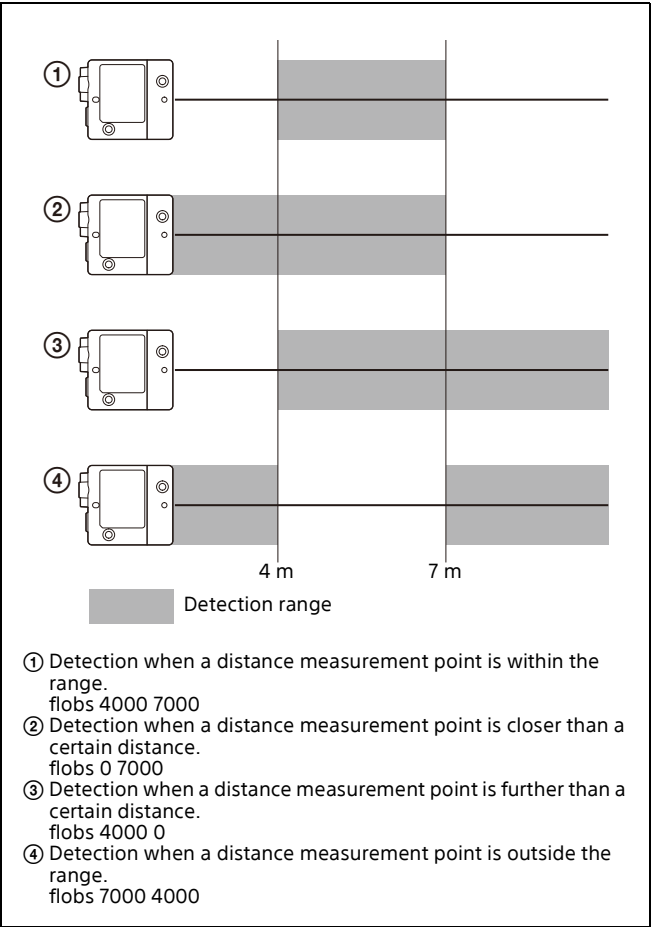
Other Functions

This section describes other functions of the unit.

Obstacle Detection Function

When operating in cdc mode or extuart mode, this function detects the presence of distance measurement points at distances within a set range of the distance measurement result data.

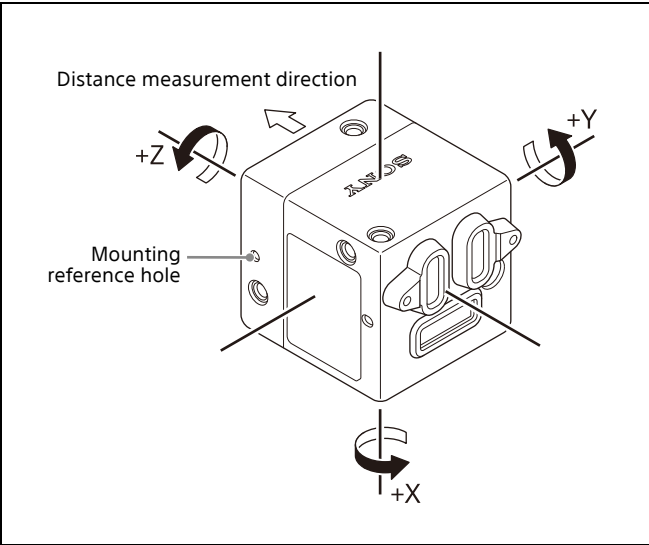
The detection result is output on the Trigger Out pin of the 8-pin connector, and the status LED of the unit lights up orange to indicate that an obstacle has been detected. The detection range is set by two values (longest distance and shortest distance) and detection occurs as follows.



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 distance measurement data output, IMU measurement result data and distance measurement timing flags can also be output. The acceleration range is $\pm 4G$, 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.

Histogram Mode

This mode outputs all output data from the distance measurement module of the unit via USB UVC. The output data includes not just distance measurement results, but also the ToF data used for distance measurement, the total amount of reflected light, and other data. 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.”

Distance Measurement Specifications

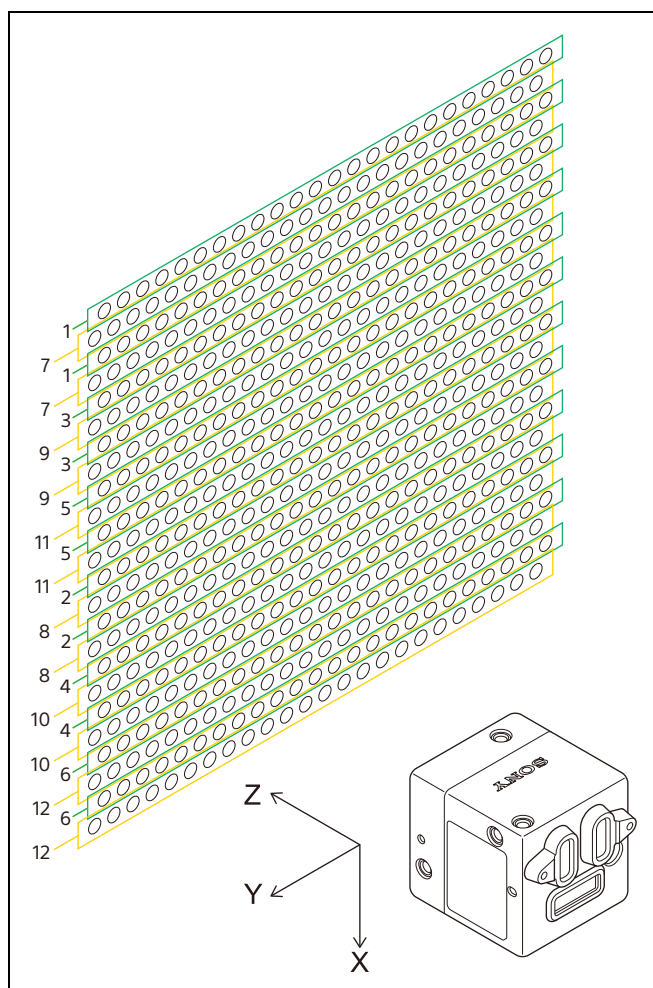
This section describes the distance measurement specifications of the unit.

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 mounting reference hole on the bottom as reference points.

The coordinates of the point cloud output are expressed relative to these reference points.



When the 30M30F distance measurement range is selected, the total number of distance measurement points is halved to 288, and light is emitted only for points 1 to 6 shown in green. In other distance measurement range settings, light is emitted for all the points shown in green and yellow.

Distance Measurement Range

This section describes the features of the distance measurement range settings.

The unit performs distance measurement 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 number of distance measurement points, the number of ToF measurements per scan, and the time measurement resolution vary between distance measurement ranges, providing distinctive characteristics.

30MSTD distance measurement range

This is the standard range for measuring distances up to 30 m. It supports distance measurement of 576 distance measurement points at time intervals of 33.33 ms (min). It features well-balanced distance measurement performance with stable distance measurement from short to long distances.

30M15F distance measurement range

This range setting is suitable for outdoor distance measurement, measuring distances up to 30 m at time intervals of 66.66 ms (min). It supports distance measurement of 576 distance measurement points at time intervals of 66.66 ms (min). By lowering the distance measurement 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 distance measurement, measuring distances up to 30 m. It supports distance measurement at time intervals of 33.33 ms (min), increases the number of ToF measurements per distance measurement point, but reduces the number of distance measurement points to 288, allowing 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 distance measurement of 576 distance measurement points at time intervals of 33.33 ms (min). Compared to other modes, it provides higher distance measurement accuracy at close ranges of 5 m or lower, but with maximum range limited to 20 m.

40M distance measurement range

This range setting is suitable for indoor distance measurement, measuring distances up to 40 m. It supports distance measurement of 576 distance measurement points at time intervals of 66.66 ms (min). Compared to other range settings, it provides long-distance distance measurement by increasing the maximum ToF measurement time.

In long-distance distance measurement, accuracy may deteriorate due to dispersion of laser power, especially in situations with strong ambient light, such as outdoors, or for distance measurement objects with low reflectance.

Minimum Distance Measurement Time Interval

The minimum distance measurement time interval is determined by the distance measurement range. If you attempt to measure distance at a time interval shorter than the minimum distance measurement time interval, the next measurement will not be performed until the first measurement has been completed.

Distance measurement range and minimum distance measurement time interval

Minimum distance measurement time interval [ms]				
20M	30MSTD	30M15F	30M30F	40M
33.33	33.33	66.66	33.33	66.66

Distance Measurement Performance

Distance measurement performance is expressed in terms of accuracy and precision.

Accuracy: Indicates the error in mm between the average value of multiple distance measurements when the same target is measured multiple times with the target in a fixed position and the true distance.

Precision: Indicates the variation (σ) in mm between the distance measurement 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 distance measurement, the results are from distance measurements taken in an environment with a background light brightness of 1000 lx or lower. For outdoor distance measurement, the results are from distance measurements taken in an environment with a background light brightness of 40000 lx or lower.

However, these are under conditions where the background light reflected from the objects does not enter the unit due to total reflection.

The distance measurement performance depends on the following factors.

- Distance measurement range
- Ambient light intensity
- Distance to an object
- Infrared reflectance of an object
- Infrared specular reflectance of an object
- Sensor temperature within the unit

Notes

- Because the SPAD sensor features high sensitivity, excessive reflected light from objects with high reflectance at close range can cause overflow, reducing distance measurement accuracy.
- If there is strong ambient light, distance measurement performance may be reduced.

Accuracy indoors (1000 lx or lower)

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

Distance [m]	Precision (Indoor) [mm]				
	20M	30M STD	30M 15F	30M 30F	40M
0.5	4	4	4	4	4
1	2.5	2.5	2.5	2.5	2.5
2	2.5	2.5	2.5	2.5	2.5
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 or lower)

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/-70	+30/-100	+30/-100	+30/-100	+50/-120
10	+35/-70	+30/-100	+30/-100	+30/-100	+50/-120
15	+45/-70 ^{*1}	+30/-110	+100/-110	+100/-110	+120/-120
20	+45/-70 ^{*1}	+30/-110 ^{*1}	+100/-110	+100/-110	+120/-120
25	–	+30/-110 ^{*1}	+100/-110 ^{*1}	+100/-110 ^{*1}	+120/-120 ^{*1}
30	–	–	+100/-110 ^{*1}	+100/-110 ^{*1}	+120/-120 ^{*1}
35	–	–	–	–	–
40	–	–	–	–	–

Precision outdoors (40000 lx or lower)

Distance [m]	Precision (Outdoor) [mm]				
	20M	30M STD	30M 15F	30M 30F	40M
0.5	25	10	10	10	15
1	10	10	10	10	20
2	10	10	10	10	20
5	10	12.5	10	10	20
10	20	25	20	20	40
15	30 ^{*1}	37.5	30	30	60
20	40 ^{*1}	50 ^{*1}	40	40	80
25	–	62.5 ^{*1}	50 ^{*1}	50 ^{*1}	100 ^{*1}
30	–	–	60 ^{*1}	60 ^{*1}	120 ^{*1}
35	–	–	–	–	–
40	–	–	–	–	–

*1 Performance at infrared reflectance of 50%/80%

Troubleshooting

Initial Checks

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

- Distance measurement is not possible with certain objects or distance measurement accuracy is poor. Distance measurement 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 distance measurement.
 - Objects with low infrared reflectance (objects that easily absorb infrared rays), objects with high infrared reflectance, 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
- Distance measurement of short distances is not possible. It may not be possible to measure the distance to high-reflectance objects within 1 m.
- Unit does not power on.

The unit will not operate normally if the supply voltage supplied from the 8-pin connector is outside the operating range. The unit may become damaged if used at voltages outside the specified range.
- Operation is unstable (unit reboots).

The power supply capacity of the USB port is insufficient, causing a drop in voltage or power supply cutoff. 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 connect an external power supply that can supply enough power to the 8-pin connector.
- The temperature of the unit is too high or too low.

The guaranteed performance temperature range of the unit is 0 °C to +40 °C (32 °F to 104 °F), and the operating temperature range is –5 °C to +45 °C (23 °F to 113 °F). Insulate the unit or provide sufficient cooling, as required, to keep within the temperature range.
- The temperature is too high.

If the sensor temperature (*page 11*) within the unit exceeds 70 °C (158 °F), distance measurement 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 may exceed 70 °C (158 °F) depending on the usage method.
- Intervals between distance measurement points are not uniform in some areas.

The intervals between distance measurement points may be uneven in some areas due to the tolerances in the optical system. The distance measurement result point cloud coordinates are output taking this into consideration.

When Contacting Support

Provide the following information when contacting support.

- Symptoms and problems
- 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)
- The [Log] window of the sample application displays the results of executing the `ver`, `sensorinfo`, `ustatus`, `errinfo`, `diag`, and `flshow` commands (same information obtained by the serial commands). You can obtain information from the sample application by copying the displayed text.
- If you can connect using serial commands, provide the response of running the following commands.
 - `ver` command
 - `sensorinfo` command
 - `ustatus` command
 - `errinfo` command
 - `diag` command
 - `flshow` command

Troubleshooting Issues

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

Symptom	Cause	Solution
Unit does not power on. Status LED does not turn on.	Power is not being supplied from a PC or other host device connected to the USB 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 to the USB upstream port using a USB cable. - Check the specifications of the USB cable. <i>See "Connecting the unit to a PC via USB" (page 9).</i>
	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. <i>See "Connecting an External Power Supply" (page 17).</i>
	The LED is configured to turn off.	- If the status LED lights up during startup but then turns off, the LED may have been configured to turn off. 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 so that the status LED stays lit. <i>For details about the LED on/off setting and the factorydefault command, refer to the "API Manual."</i>
The unit is not recognized from a PC or other USB host device.	Power is not being supplied to the unit.	<i>See the "Solution" column for the "Unit does not power on" symptom in this table.</i>
	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 (use of a communications compatible USB cable, for example).
USB device connected to the USB downstream port cannot be recognized.	Power is not being supplied to the unit.	<i>See the "Solution" column for the "Unit does not power on" symptom in this table.</i>
	There may be a problem with the connection or condition of the USB cable.	- Check that USB cable is not damaged or broken. - Check that a USB device is connected to the USB downstream port. - Check that the host device is connected to the USB upstream port and that the power is turned on. <i>See "Connecting an External Power Supply" (page 17).</i>
	Power capacity is insufficient when multiple units are connected in a daisy-chain.	<i>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</i>
	Driver for connected USB device is not installed on the host PC.	Install the driver for the connected USB device on the host PC.
	A host device is not connected to the USB upstream port or the supply voltage of the host device is turned off.	The USB downstream port can only be used when a host device is connected to the USB upstream port. A device connected to downstream port cannot be used from the 8-pin connector.
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 sequence 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. <i>See "Using multiple connected units" (page 8).</i>
	The number of devices that can be connected is limited by the host device.	Some operating systems may limit the number of CDC devices and UVC devices that can be connected. Review the operating system settings according to the procedures for each operating system.

Symptom	Cause	Solution
Distance measurement is not possible. Distance measurement accuracy is extremely poor.	The cover glass is dirty.	Check that the cover glass that protects the dToF distance measurement module is not dirty or broken. <i>If the cover glass is dirty, wipe it clean as described in "Cleaning" (page 18). If the cover glass is broken, stop using the unit and have it repaired.</i>
	Temperature is out of range.	- Make sure that the sensor temperature (page 11) within the unit does not exceed 70 °C (158 °F). - Check that the temperature of the unit is not too high or too low. The guaranteed performance temperature range of the unit is 0 °C to +40 °C (32 °F to 104 °F), and the operating temperature range is -5 °C to +45 °C (23 °F to 113 °F). Use the unit within these temperature ranges.
	The settings are incorrect.	- Check the settings. - If the problem persists, reset the unit to the factory default status using the factorydefault command. <i>For details about the factorydefault command, refer to the "API Manual."</i>
	Object is difficult to measure.	The target object may be difficult to measure. This case does not indicate a malfunction. <i>For details about objects difficult to measure, see "Initial Checks" (page 26).</i>
Status LED turns on at startup but then turns off.	The LED is configured to turn off.	- If the status LED lights up during startup but then turns off, the LED may have been configured to turn off. 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 so that the status LED stays lit. <i>For details about the LED off setting and the factorydefault command, refer to the "API Manual."</i>
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. <i>For details about usage settings, input/output voltage levels, and signal specifications, see "Connecting via UART using the 8-Pin Connector" (page 15), "Inputting a Trigger from an External Device" (page 16), "Trigger Output" (page 17), and "Using the Timestamp Function" (page 17).</i>
	The signal quality is poor.	
The distance measurement mode was accidentally changed to UART in a non-UART connection configuration and the unit does not operate normally.	Erroneous operation.	<i>Change the distance measurement mode as described in "If the mode is accidentally set to use the UART interface" (page 16).</i>
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).
Image acquisition and capture operations are unstable in intensity mode or histogram mode.	- The data transfer rate is insufficient. - The performance of the host device is insufficient. - A USB 2.0 cable is being used.	- If using a USB HS (480 Mbps) or slow host device, the data transfer rate may be insufficient, which may result in failure to obtain UVC data. Connect via USB SS or use a host device that can process USB data at high speed. - Depending on the USB cable you use, even when using a USB Type-C cable, the cable may be recognized as USB HS (USB 2.0), which may cause problems with data transfer. - Increase the capture interval in histogram mode. - If operation is unstable with USB HS (480 Mbps), connect using USB SS (5 Gbps).
Image displayed in intensity mode is dark.	- Lighting (for example, LED lighting) that does not emit infrared is being used. - The environment is dark in the infrared region.	Use lighting that contains 940 nm infrared light, such as incandescent bulbs or sunlight. LED bulbs do not emit infrared light and therefore appear very dark.
In USB distance measurement mode, data is not output at the time interval specified by the fsync command, and the time interval becomes longer after a while.	The performance of the connected host device (e.g., PC) is insufficient, the software used on the host device is slow, or the USB communication speed is slow.	When connected via the USB interface, the unit will perform repeated distance measurement at time intervals longer than the value set by the fsync command, to prevent overflow or hang-ups, if the host device is unable to receive all of the distance measurement results within the time interval specified by the fsync command.

Specifications

Main Specifications

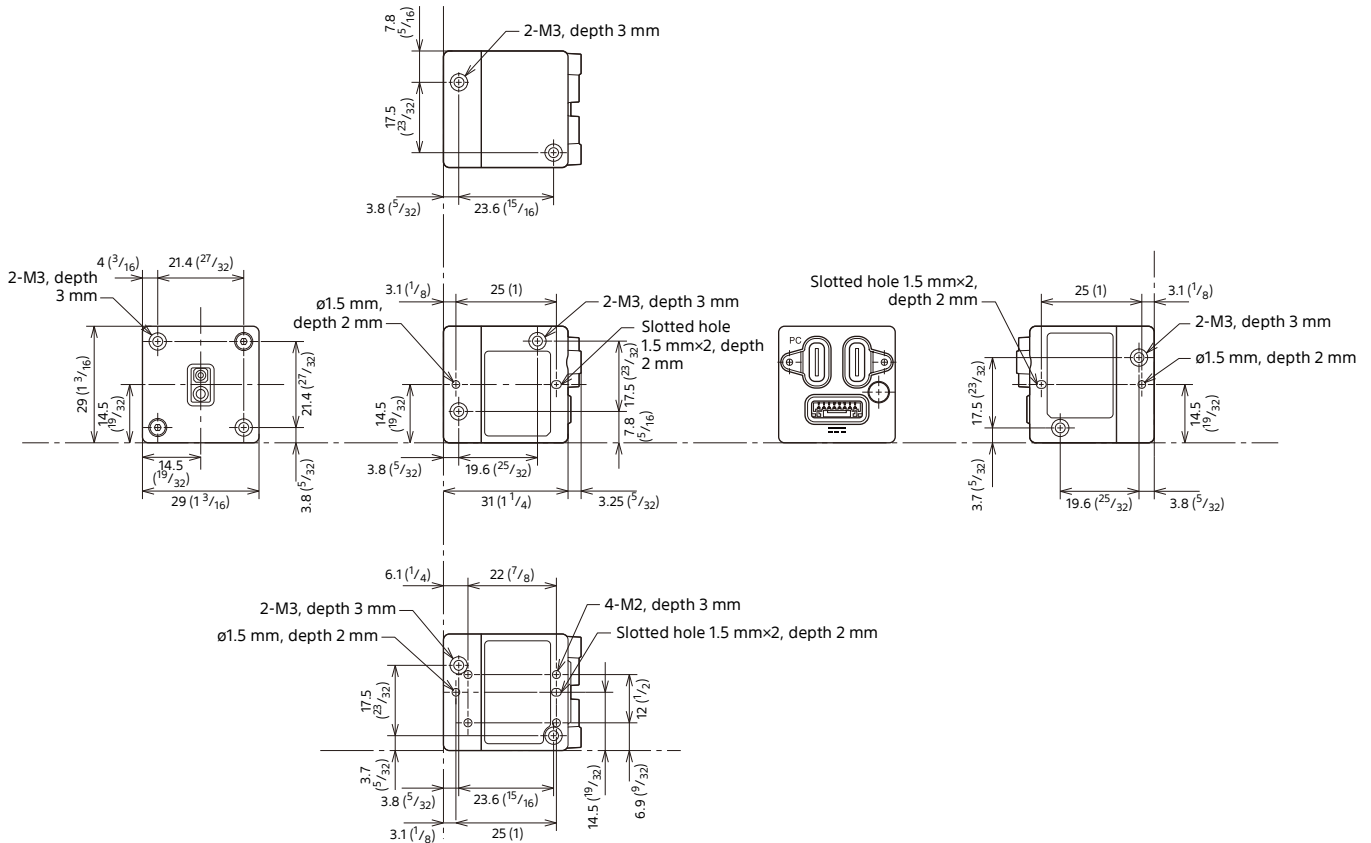
HFoV	35.5° ± 2°
VFoV	28.2° ± 2°
Maximum distance measurement	
Indoor: 40 m (40M distance measurement range, 50% target reflectance, center front of unit)	
Outdoor: 30 m (30M15F distance measurement range, 50% target reflectance, center front of unit)	
Measurement accuracy	
±50 mm at 10 m distance measurement indoors and outdoors	
Distance resolution	0.25 mm
Frame rate	30 fps, 15 fps (maximum distance measurement range)
Number of distance measurement points	576 (24×24)
Laser wavelength	940 nm
Class 1 laser product	

Supply voltage	USB: DC 5 V
	8-pin connector: DC 12 V to 24 V
	(8-pin connector has precedence)
Power consumption	2.5 W (max)
Guaranteed performance temperature	0 °C to 40 °C (32 °F to 104 °F) (with sensor temperature of 70 °C (158 °F) or lower)
Operating temperature	-5 °C to +45 °C (23 °F to 113 °F) (with sensor temperature of 70 °C (158 °F) or lower)
Storage temperature	-30 °C to +60 °C (-22 °F to +140 °F)
Operating humidity	20% to 80% (no condensation)
Storage humidity	20% to 80% (no condensation)
MTBF	Approx. 10.9 years (excluding exterior case)
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	Approx. 46 g (1.6 oz)

Design and specifications are subject to change without notice.

External Dimensions

Unit: mm (inches)



Appendix

Usage Precautions

Read this section in conjunction with the information provided in the supplied "Safety Regulations" 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).
- Even 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 window directly at the sun. The lens and sensor temperature may rise, resulting in reduced measurement accuracy or unit malfunction.

Dust and splash proof

The connectors on the rear of the unit are not dustproof or splash proof. 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

This Product is not designed, manufactured or intended for use in applications that require a high degree of safety, in which the use or failure of the Product could lead to death, personal injury, or severe physical or environmental damage (including, but not limited to, nuclear facilities, aviation, or life support machines). Furthermore, the Product may not be used for military purposes (e.g. the design, development, manufacture, sale, or supply of military systems, arms or weapons). SONY SHALL NOT BE LIABLE FOR ANY LOSSES OR DAMAGES ARISING FROM THE USE OF THE PRODUCT IN THE FOREGOING APPLICATIONS.

List of Supported Commands

The following table shows the list of serial 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	extuart	hist	Inten	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 of the unit.
reboot	○	○	○	○	○	Reboot the unit.
serial	○					Display/set the serial number.
hrs	○					Display/set the hours meter and laser usage count.
format		○	○		○	Set the distance measurement result output format.
findprg	○					Display information about firmware written to the unit.
flshow	○	○	○	○	○	Display the list of non-volatile settings.
factorydefault	○	○	○	○	○	Reset the non-volatile settings to the factory default state.
flstart	○	○	○	○	○	Set the distance measurement mode at startup.
flmode	○	○	○	○	○	Set the distance measurement range at startup.
flfsync	○	○	○	○	○	Set automatic distance measurement at specified time intervals at cdc and extuart startup.
flhistfsync	○	○	○	○	○	Specify the distance measurement time interval in histogram mode.
flformat	○	○	○	○	○	Set the distance measurement result output format at startup.
fluart	○	○	○	○	○	Set the bit rate for UART connections at startup.
fltrgin	○	○	○	○	○	Set the Trigger In pin function at startup.
fltrgout	○	○	○	○	○	Set the Trigger Out pin function at startup.
fltsclk	○	○	○	○	○	Set the TS Clk pin function at startup.
fltspreset	○	○	○	○	○	Set the TS Preset pin function at startup.
flobs	○	○	○	○	○	Set obstacle detection at startup.
flbank	○	○	○	○	○	Set the number of frame divisions in histogram mode.
flled	○	○	○	○	○	Set to show/hide status LED after startup.
flwp	○					Write protect flash memory (for service personnel).
erase	○					Erase area of flash memory for version update.
wrt	○					Write update to flash memory.
vfy	○					Verify update in flash memory.
erсер	○					Erase the serial number setting of the unit (for service personnel).
imuval		○	○	○	○	Read out IMU measurement value.
sensorinfo	○	○	○	○	○	Display sensor information.
mpinfo		○	○	○	○	Return distance measurement point layout information.
svminfo		○	○	○	○	Return distance measurement direction information for each distance measurement point.
lddlout					○	Set the laser light intensity for intensity mode.
fsync		○	○	○		Set automatic distance measurement at specified intervals.
t		○	○			Execute a single distance measurement scan.
trgin		○	○			Set the Trigger In pin function.
trgout	○	○	○	○		Set the Trigger Out output.
ts		○	○	○		Set timestamp and preset register.
obs		○	○			Set obstacle detection.
userrd	○	○	○	○	○	Read user settings from the non-volatile area.

Command name	update	cdc	extuart	hist	Inten	Function
userwr	☐	☐	☐	☐	☐	Write user settings to the non-volatile area.
diag		☐	☐	☐	☐	Run self-diagnostics and display result.
gain					☐	Adjust display gain of SPAD output in intensity mode.
errinfo	☐	☐	☐	☐	☐	Display error history log.
license	☐					Display the software license.

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