OMRON

3D TOF Sensor Module

B5L

Easy Setup Manual

E606-E1-01

Table of Contents

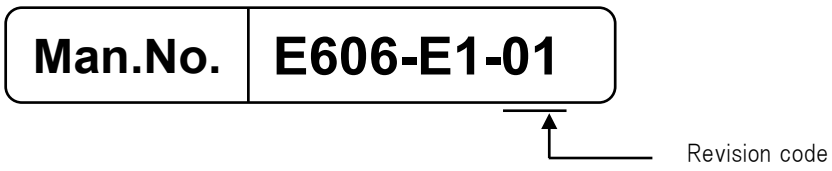
Definition of Terms

This section provides definitions of terms related to "this product."

TOF sensor	A sensor that measures the distance from a sensor to an object using the TOF method. TOF is an abbreviation for Time of Flight. The distance is measured by emitting light and measuring the phase difference between the emitted and reflected light.
Operation mode	- Normal mode: The HDR function is enabled and the distance is calculated based on two measurement results. - High-speed mode: The HDR function is disabled and the distance is calculated based on one measurement result. Note: HDR function: Function to make multiple measurements by changing the shutter speed.

Revision History

A manual revision code appears as a suffix to the catalog number on the front and back covers of the manual.



Revision Code	Revision Date	Revision Details & Pages
01	Mar. 2022	First edition

Chapter 1 - Connection

1-1 Introduction

(1) Intended readers

This manual is intended for the those who have knowledge of electrical systems and software.

(2) Applicable product

This manual covers the B5L, a 3D TOF Sensor Module. (hereinafter called "B5L")

(3) Operation environment

This application software has been tested in the following environment:

OS: Windows 10 Pro 64-bit

CPU: Intel® Core™ i5-7200U CPU @ 2.50 GHz

1-2 Preparations

(1) B5L

(2) Personal computer (OS: Windows 10)

*Administrator rights are necessary to perform software installation.
It is recommended to log in to the computer with the administrator account and perform operations.

(3) Evaluation software

This software can be downloaded from the following URL:
https://components.omron.com/us-en/products/sensors/displacement-sensors_ranging-sensors/3d-tof-sensors-module/b5l/software_lisense

(4) USB2.0 micro USB cable

*This product does not operate with any special cables for charging.

Use the power supply set provided in the evaluation kit.
If you have only a single B5L, prepare the power harness and a power supply of 24 VDC (72 W or higher) described in (5) below.
The product itself is not compatible with fire protection enclosures.
Therefore, during installation, use a power supply that meets the IEC 62368-1 LPS (limited power supply requirements).

(5) Power harness (requires assembly as shown below)

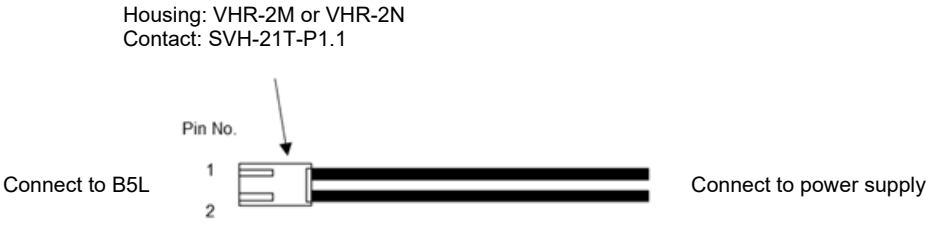
The recommended connector for B5L is as follows:

- Housing: VHR-2M or VHR-2N (J.S.T. Mfg. Co., Ltd.)
- Contact: SVH-21T-P1.1 (J.S.T. Mfg. Co., Ltd.)

Use AWG#18 wire lead.
Connect the cable end of the power harness to the output terminal of 24 VDC power supply.

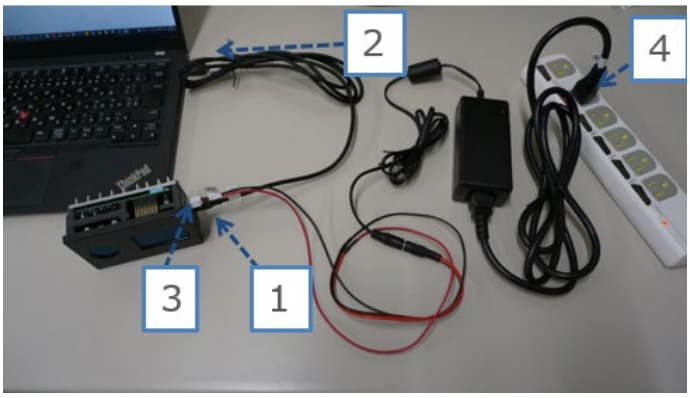
Pin No.	Signal	Description
1	Vcc	24 VDC power supply ±10%
2	GND	Ground (0V)

Fig.



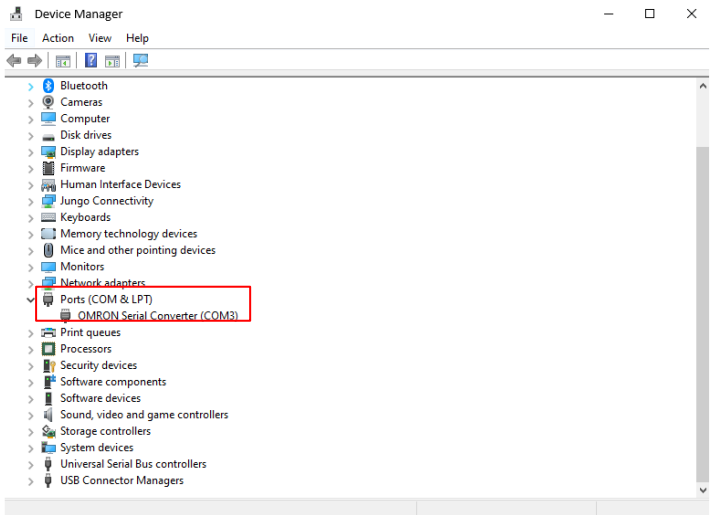
1-3 Connection Procedures

- Make connection using the following steps:
  (1) Plug the USB cable into B5L.
  (2) Plug the USB cable into the personal computer.
  (3) Connect the power supply harness to B5L.
  (4) Connect the cable to the AC outlet (Turn ON the power).
  *Perform these steps in the opposite order when turning OFF the power.
  (4→3→2→1)

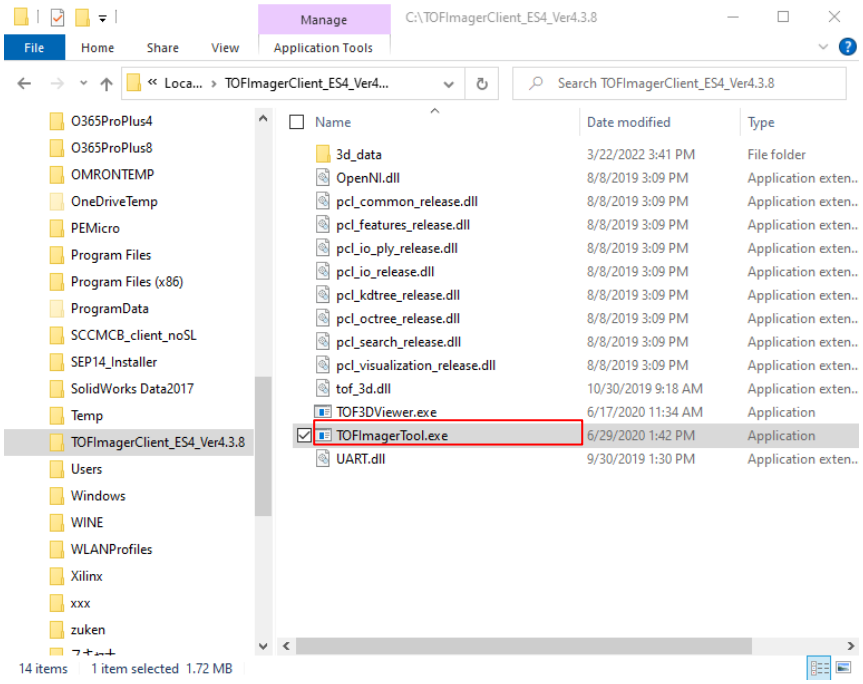


1-4 Evaluation Software

(1) Confirm the COM port
When step (4) of 1-3 Connection Procedures has finished, start up the Device Manager of the personal computer.
If B5L is connected correctly, the port is recognized and "USB serial device (COMxx)" is displayed.
Make a note of COMxx. (xx is assigned automatically.)
If it is not displayed, remove and insert the power cable and check again.



(2) Double-click TOFImageTool.exe to start up TOFImagerClient.



<Precautions>

Save TOFImagerClient directly below drive C.

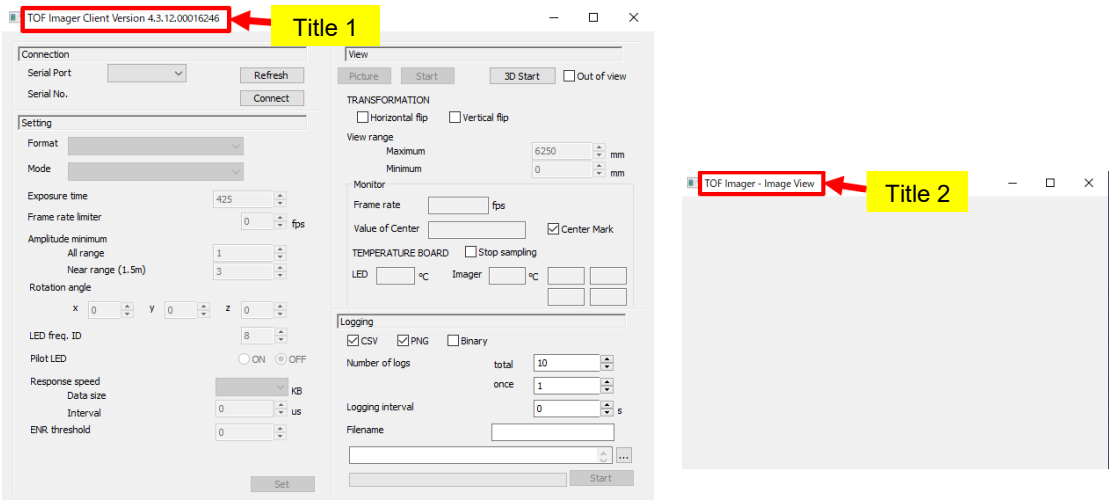
(3) Two windows appear.

Title 1: TOF Imager Client Version xxxx (xxxx is the version number.)

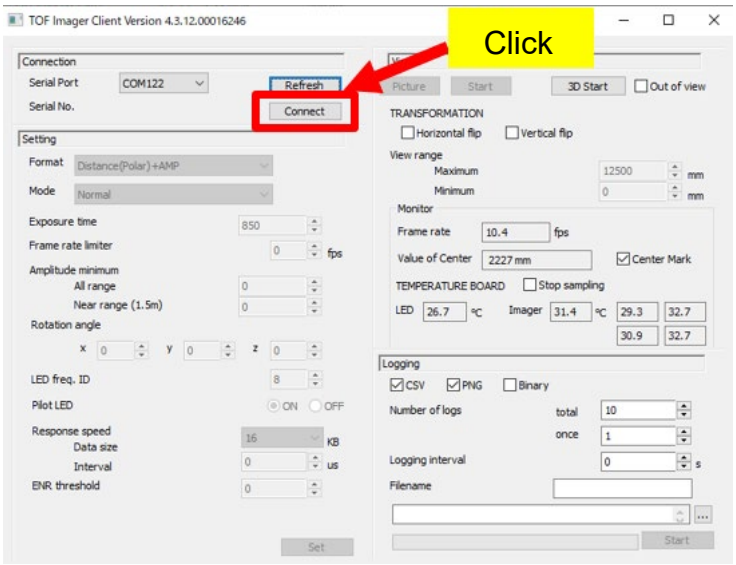
This tool is used to set up B5L.

Title 2: TOF Imager - Image View

This tool is used to visualize the image of the measurement results of B5L.

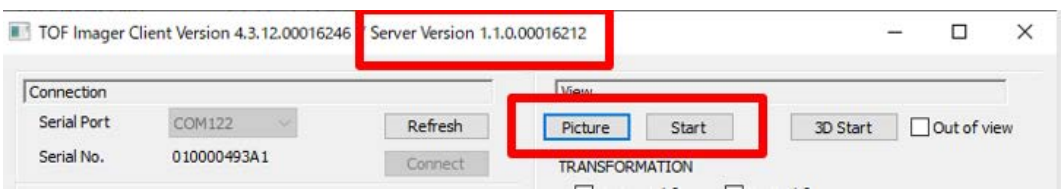


(4) Select the same COM number that you wrote down when checking the COM port, and click the Connect button. B5L connects to TOFImagerClient.

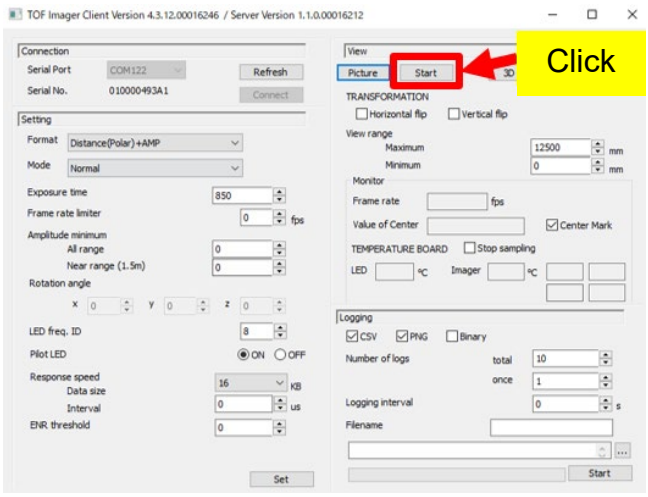


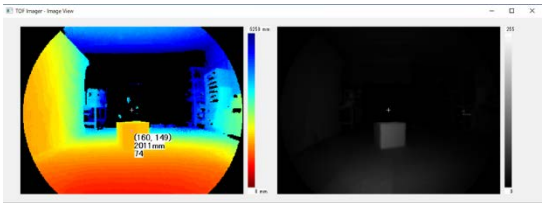
<Spot Advice>

When B5L is connected, Server Version (the version of the B5L firmware) is displayed beside the title. The Picture and Start buttons (described later) are also enabled.



(5) Click the Start button. The measurement image is displayed on Image View.





The measurement image is displayed.

<Image View>

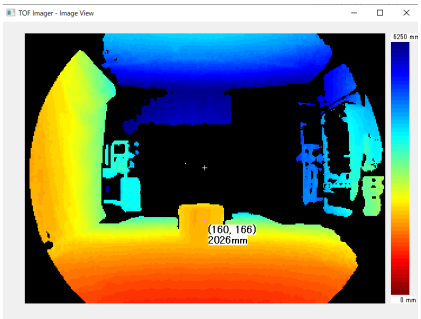
Total pixels: 320 x 240

Image View displayed images in three patterns depending on the Format setting.

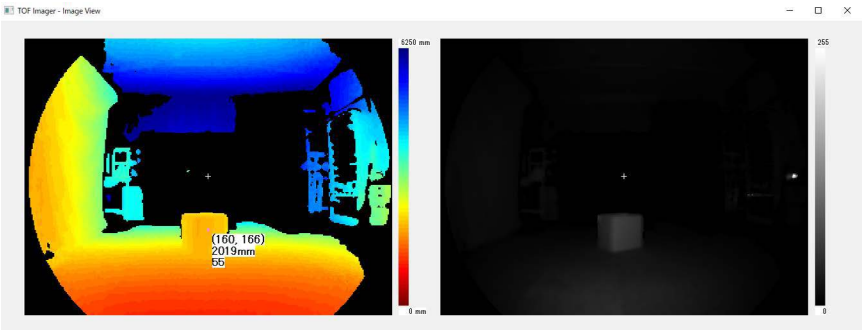
Select Amplitude (amplitude of receiving light intensity) if you want to display a monochrome image, or select Distance if you want to display the difference in distance.

① When choosing Amplitude: Only the view of Amplitude is displayed.

② When choosing Distance (xxx): Only the view of Distance (mm) is displayed.



③ When choosing Distance(xxx) & AMP: The view of Distance is displayed to the left and the view of Amplitude is to the right.

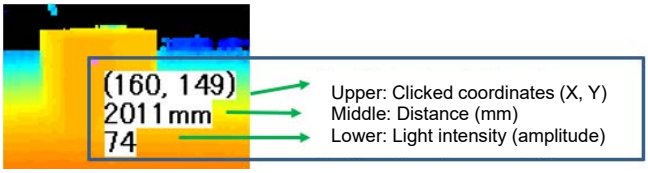


By clicking on the screen of Image View, the information on that pixel is displayed.

① Coordinates/light intensity

② Coordinates/distance

③ Coordinates/distance/light intensity



Each output value of the Image View display

- Amplitude
  - Normal value: 0-255 LSB
  - Abnormal value: --
- Distance: mm
  - Normal value: 0-12500 mm
  - Abnormal value: -- mm

The evaluation software can set up the personal computer's screen display and data logging in addition to the setup of B5L. However, only the major functions of B5L configuration are described hereafter. For the content not described in this manual, refer to "3D TOF Sensor Module B5L Uer’s Manual". This manual is a document downloadable from the homepage together with the evaluation software.

Chapter 2 - Configuration

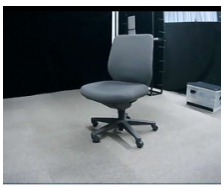
2-1 Optimization of B5L Configuration

Check the following items in order and clear them all to optimize the settings.

2-2 Installation
2-3 Saturation
2-4 Weak light
2-5 Due to Emphasizing edges
2-6 Mutual interference due to operating multiple B5L
2-7 Measurement impossible in principle
2-8 Precautions

<Photos of measurement environment>

Cardboard box



Chair

B/W board

2-2 Installation

(1) Symptom and influence

If the table shows within the viewing angle due to putting B5L on a surface (such as a table), the output from B5L is saturated by the reflected light from the table, so the measured distance value changes as if the entire image gets closer to that position.

(2) Countermeasure

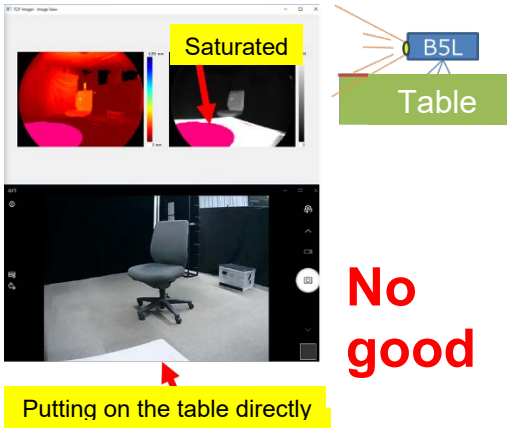
Move the table out of the viewing angle of B5L.

The following two ways are the concrete examples:

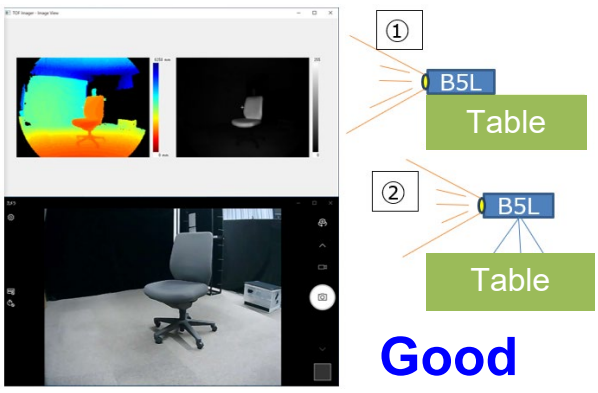
① Install B5L in a position that the table does not show in the viewing angle.

② Mount B5L on a tall tripod.

*It is impossible to insert the screws of the tripod into the screw holes on the bottom of the B5L main body. So, it is necessary to separately prepare an arm to clamp B5L and fix it onto the tripod.



Installation no good: The surface (table) is within the viewing angle



Installation good: Countermeasured by method ① or ②

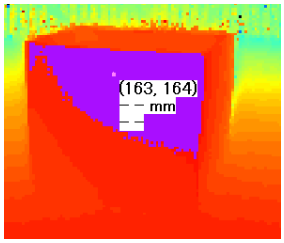
2-3 Saturation

(1) How to discriminate where it is saturated on the screen

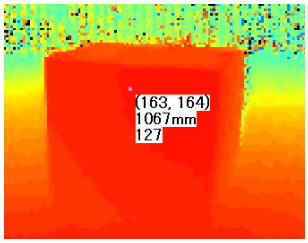
The saturated part is colored in violet or pink on the Distance image of Image View.

(2) Symptoms and influence

The reflected light from the object is too intense for B5L to measure and display distance.



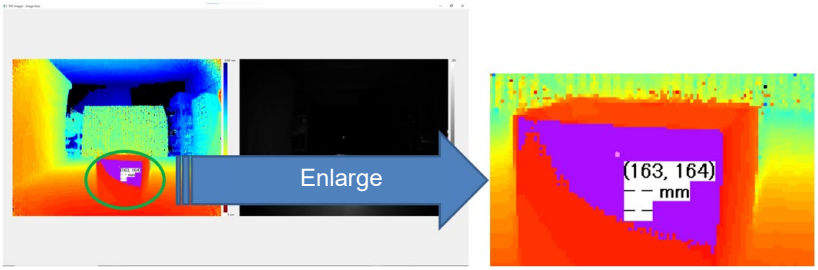
Saturated



Not saturated

<Important matter>

Click the saturated spot. "--mm" (meaning an abnormal value) is displayed.



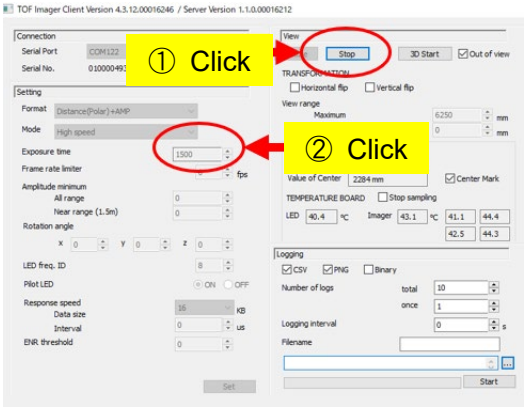
(3) Countermeasure

Reduce the intensity of the light from B5L.

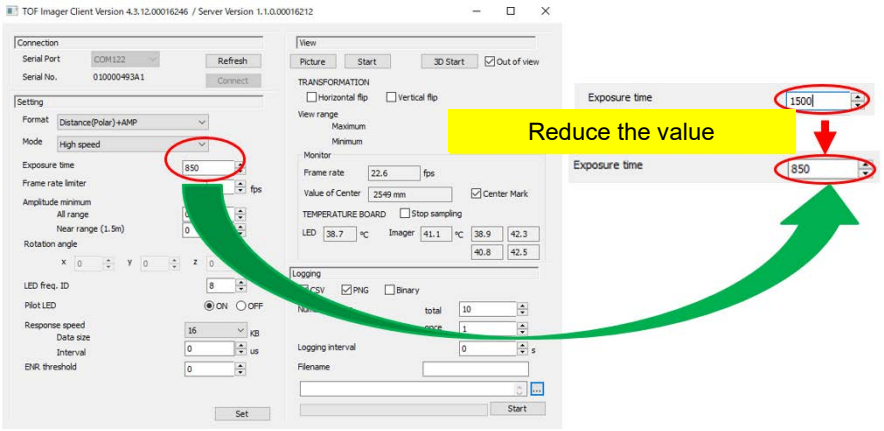
(4) Procedures

① Click Stop. (Stop the operation of B5L so that configuration can be changed.)

② Click the value of Exposure time.

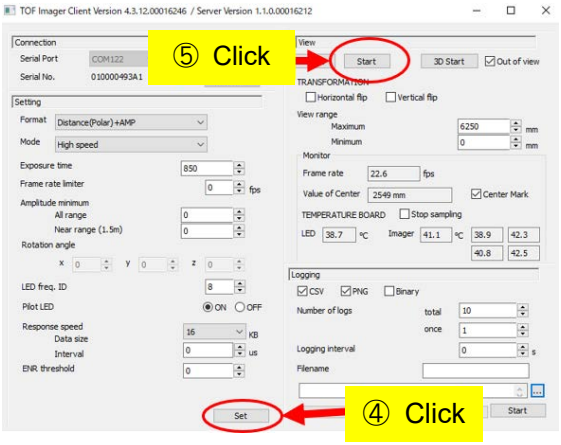


③ Reduce the value originally entered in the "Exposure time" box (to reduce light intensity).

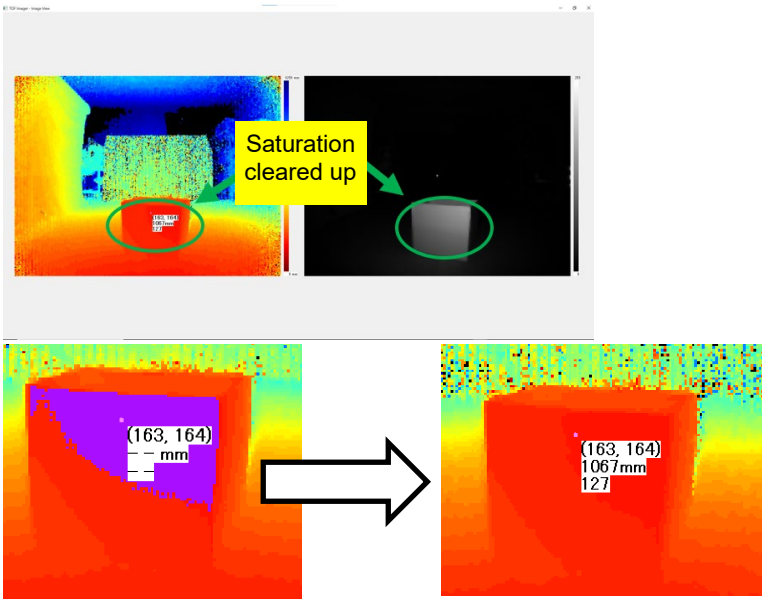


④ Click the Set button (to save the configured data).

⑤ Click the Start button (to start operation).



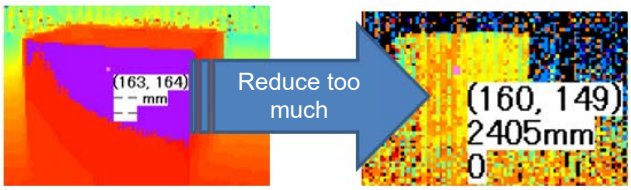
⑥ Check if saturation has not remained on the distance image.
The saturation problem is cleared up if there is no display colored in violet or pink.
If still there is any such display, these steps must be repeated from ①.



Saturated Cleared up

<Precautions>

If reducing exposure time too much in performing step ③, light intensity gets too low. Such a state is likely to occur especially when the object is far or the reflectance of the object is low. Check if the state of the image is applicable to the above state in Section 2-3 Too Weak Light.



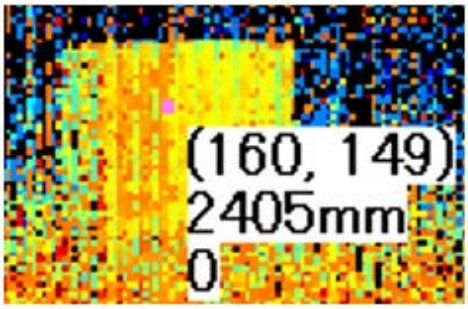
2-4 Weak Light

(1) How to distinguish where has too weak light on the screen

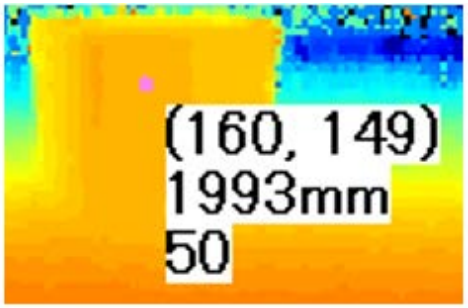
On the image of too weak light, the object is displayed like a dappled pattern. The image in the normal state is displayed as a stable image with no dappled pattern.

(2) Symptoms and influence

The reflected light from the object is too weak for B5L to measure distance correctly.



Too weak light

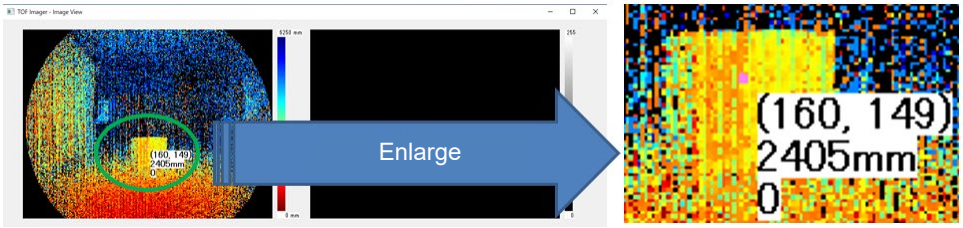


Normal state

(3) Countermeasure: Raise the intensity of the light from B5L.

<Important matter>

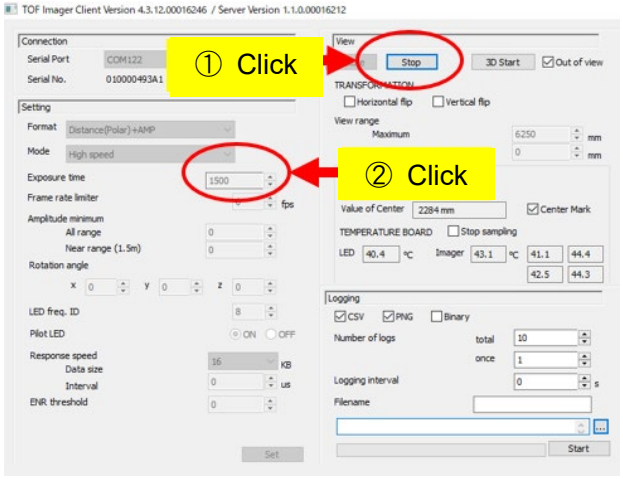
Click the object to confirm that the bottom line (amplitude value) is zero.



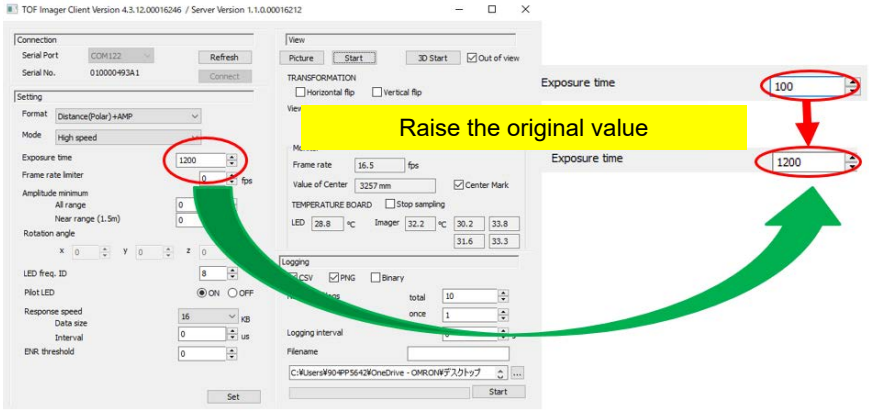
(4) Procedures

① Click Stop. (Stop the operation of B5L so that the configuration can be changed.)

② Click the value of Exposure time.

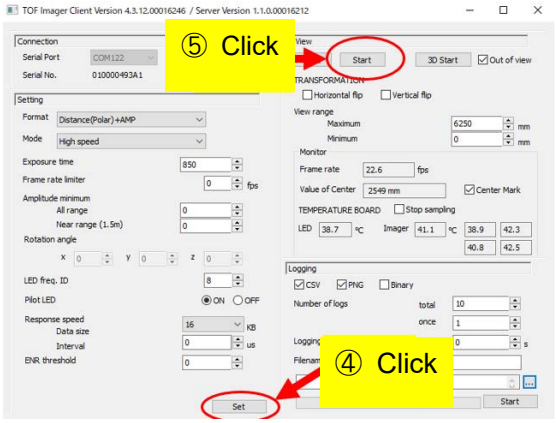


③ Raise the value originally entered in the "Exposure time" box (to raise light intensity).

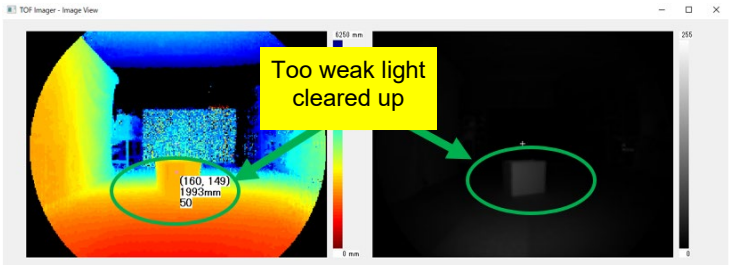


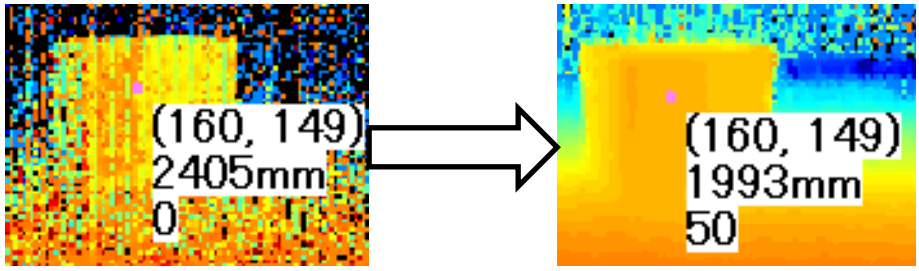
④ Click the Set button (to save the configured data).

⑤ Click the Start button (to start operation).



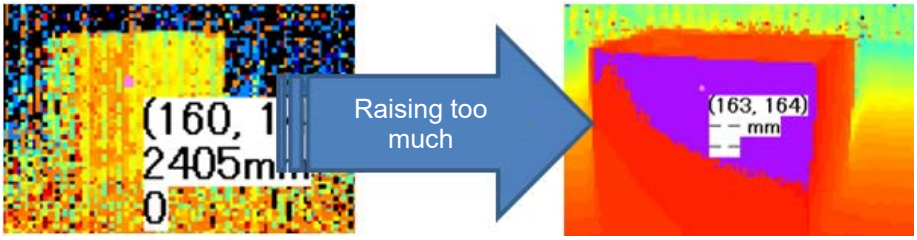
⑥ Check if the problem of too weak light has been cleared up.
Click the object displayed on Image View. If the Amplitude value is greater than or equal to 1 when you click an object displayed in Image View, the problem is solved. If that value is still zero, these steps must be repeated from ①.





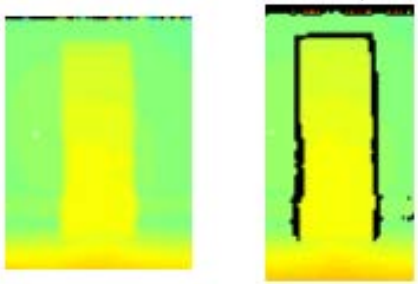
Too weak light　　Normal state

<Precautions>
If raising exposure time too much in performing step ③, light gets saturated.
Check if the state of the image is applicable to this state in Section 2-2 Saturation.



2-5 Due to Emphasizing Edges

(1) State that edges are not emphasized
Edges mean the boundaries between an object and another one.
(2) Symptoms and influence
The object on Image View seems to be assimilated with the background.
This is the state in which the edges are difficult to discriminate so the shape of the object cannot be identified easily.
(3) Countermeasure
Make a setup to emphasize the edges.



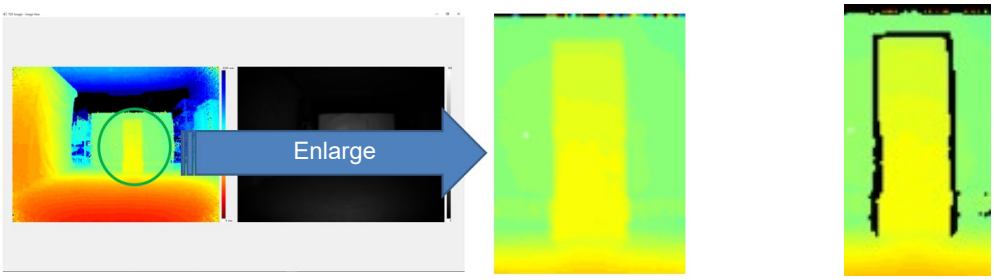
Edge not emphasized　　Edge emphasized

<Important matter>

When looking at an object, if the background is close to the object, it will be difficult to identify the edge because the color display is similar.

Edges can be discriminated easily by making configuration.

(Left-hand figure: Before configuration　Right-hand figure: After configuration)



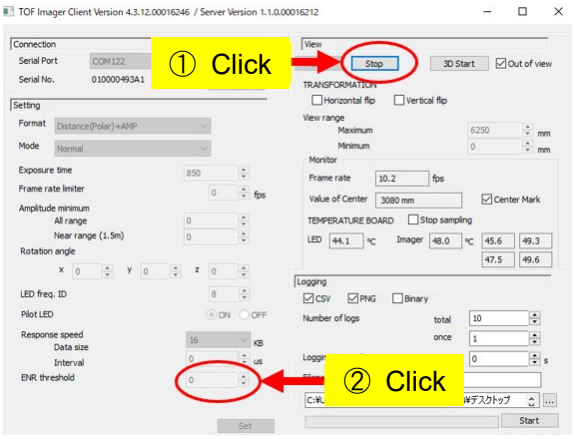
Before configuration　　After configuration

(4) Procedures to emphasize edges

① Click Stop. (Stop the operation of B5L so that configuration can be changed.)

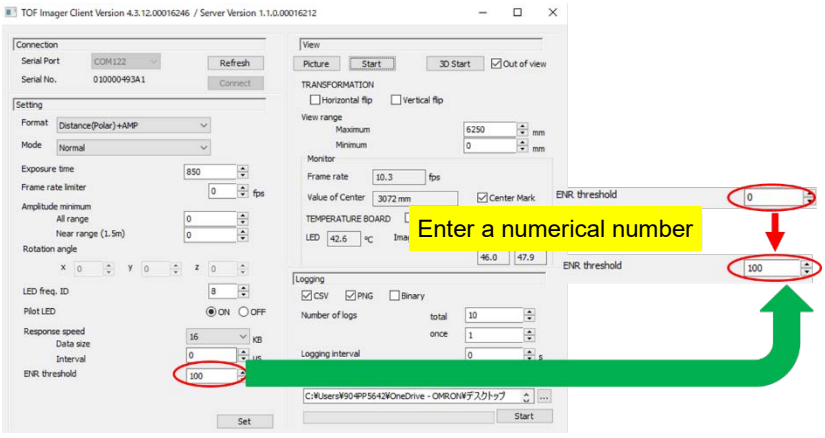
② Click the "ENR threshold" box.

*ENR is an abbreviation of Edge Noise Reduction.



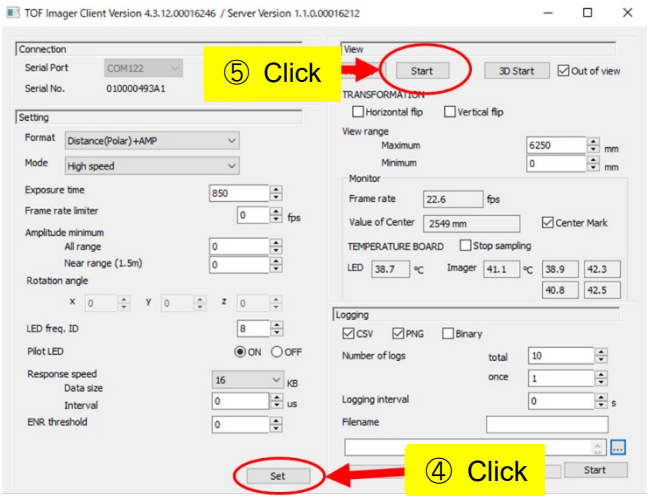
③ Fill in the ENR threshold box with a numerical value. (If the distance between adjacent pixels is equal to or greater than the configured value, it is recognized as an edge and colored in black.)

Numbers in a range of 0-12,499 can be set. If zero is set, the ENR function is disabled.

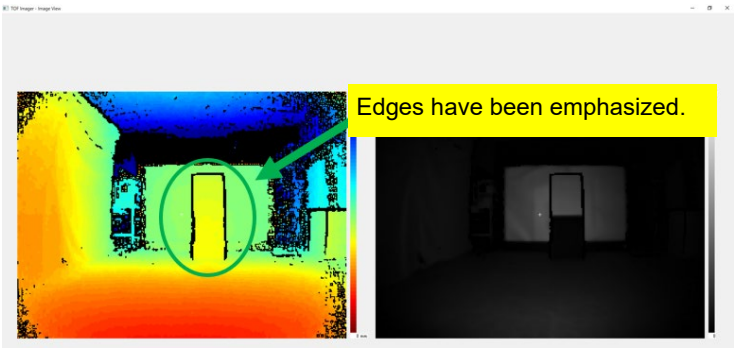


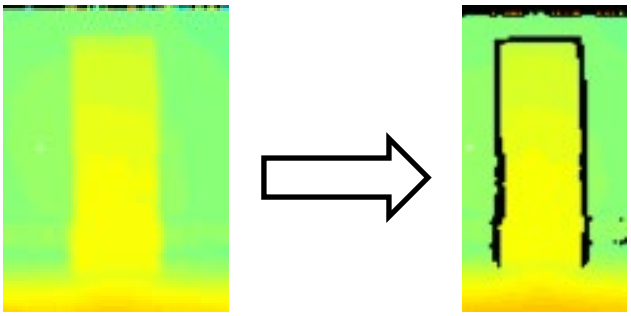
④ Click the Set button (to save the configured data).

⑤ Click the Start button (to start operation).



⑥ Check if the shape of the object can be identified.
Edges are displayed in black.
If you can recognize the shape, those edges have been emphasized.
If the shape is assimilated with the background, these steps must be repeated from ①.





Edge not emphasized　　Edge emphasized

2-6 Mutual Interference due to Operating Multiple B5Ls

(1) How to distinguish mutual interference

The display color of Image View varies greatly and irregularly in measurement.

(2) Symptoms and influence

If multiple sets of B5L are operated simultaneously, emitted light might interfere with each other and lead to incorrect measurement results.

(3) Countermeasure

How to countermeasure in using two sets of B5L simultaneously is described (Up to 17 sets are configurable).

*It is not allowed to start up more than one suit of TOF Image Client (evaluation software) simultaneously. If testing two or more sets of B5L simultaneously using the evaluation software, one personal computer is necessary for each set of B5L.

Now two sets of B5L are called as individual A and Individual B, respectively.

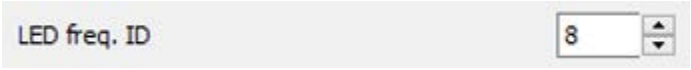
Shift the value of LED freq ID (the ID of the LED's emitting frequency) of individual A.

<Important matter>

Check the LED's emitting frequency ID of the TOF Image Client.

If the LED freq ID is equal to each other like below, interference occurs.

B5L Individual A



B5L Individual B

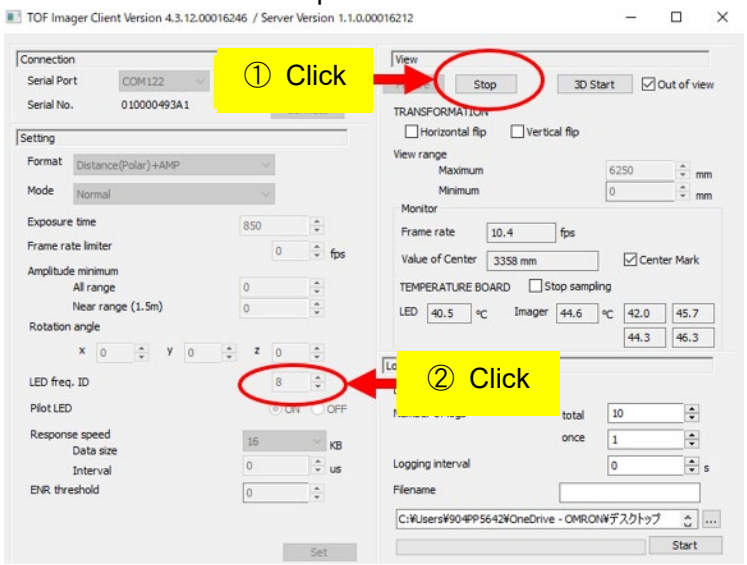
A movie to introduce mutual interference is available on the homepage below.

https://www.youtube.com/embed/66pQ5iYqaTw?rel=0&autoplay=1

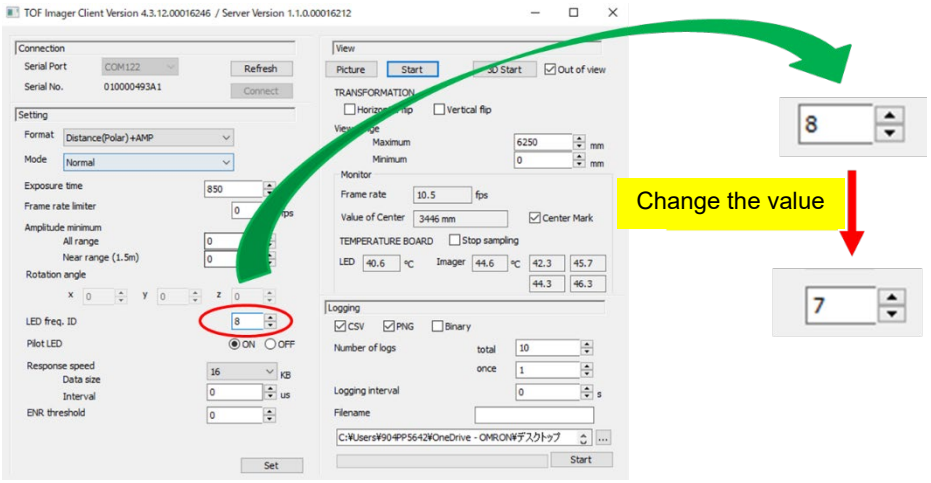
(4) Procedures

① Click Stop. (Stop the operation of B5L so that the configuration can be changed.)

② Click the box of LED freq ID.

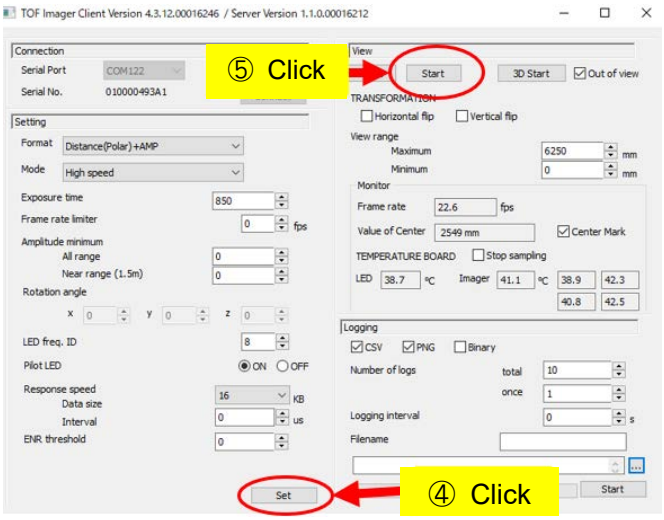


③ Change the numerical value of LED freq ID to not be equal to that of individual B of B5L.
The LED freq ID of individual B is eight this time, so change the value to other than eight.

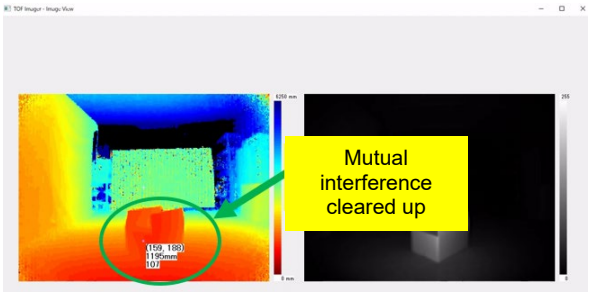


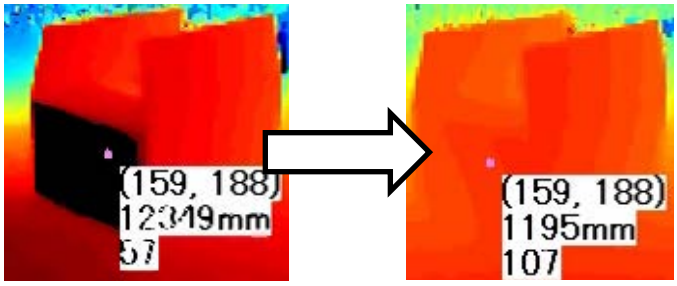
④ Click the Set button (to save the configured data).

⑤ Click the Start button (to start operation).



⑥ Check if the display of the distance image is stable.
If it is stable, the problem occurring in the multiple use has been cleared up.
When using three or more sets of B5L, it is necessary to set a different LED freq ID value for each B5L.





LED freq IDs duplicated LED freq IDs changed

2-7 Measurement Impossible in Principle

(1) The following items and cases cannot be countermeasured in principle.

① Multipath

①-(1): Measurement in a position close to a wall

①-(2): Measurement above a mirror-like floor

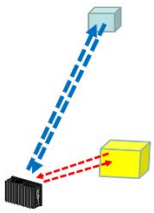
② Measurement of the back of a clear object such as transparent glass

③ Mirror measurement (measuring the reflecting object itself): Measurement of a mirror or a transparent glass

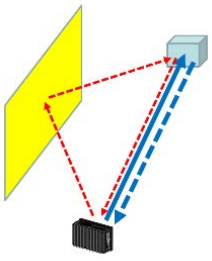
④ The far object is measured as a shorter distance.

(2) Multipath means the symptoms of the two pattens below:

Pattern 1: If there is an obstacle closer to the sensor than the measurement target, strong reflected light strays inside the lens, so that the object is measured as a shorter distance.



Pattern 2: If there is a large-size object of high reflectance such as a floor or a wall, the object is measured as a longer distance.



(3) Description on the cases of measurement impossible in principle

①-(1) Multipath Measurement in a position closer to a wall

(a) Symptom

The light emitted from B5L is returned from the object via the wall.

(b) What error occurs

The output value via the wall is added to the original output value to the object.

(c) Countermeasure

Enlarge the distance from the wall.

<An example>

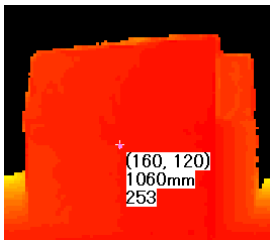
Condition: Distance to the object: 1000 mm

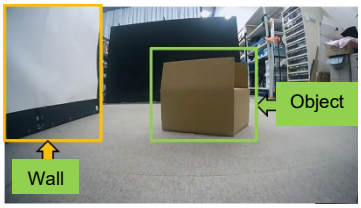
Object: A carboard box

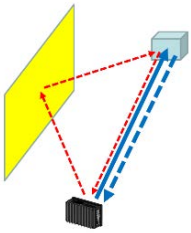
- Multipath has occurred

Condition: Distance between the wall and object: 1000 mm

Result: output value from B5L: 1060 mm



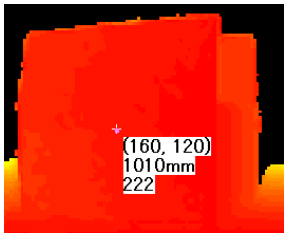


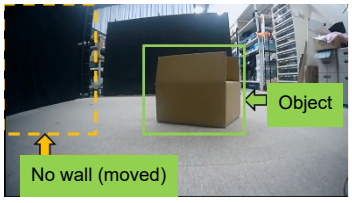


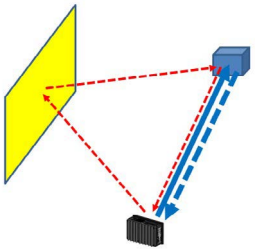
- Multipath has been cleared up

Condition: Enlarge the distance between the wall and object.

Result: output value from B5L: 1010 mm







①-(2) Multipath Measurement above a mirror-like floor

(a) Symptom

The light emitted from B5L is returned from the object via the floor.

(b) What error occurs

The output value via the floor is added to the original output value to the object.

(c) Countermeasure

1. Put a covering on the mirror-like floor, or
2. Enlarge the distance between the sensor and the floor.

This section describes an actual example that the problem is cleared up by method 1.

<An example>

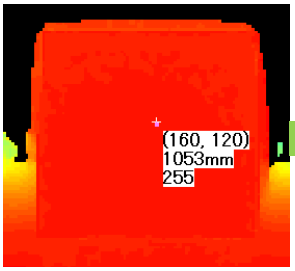
Condition: Distance to the object: 1000 mm

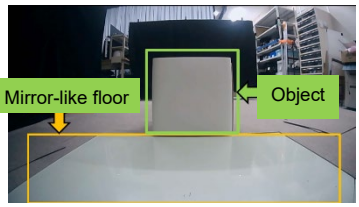
Object: White paper

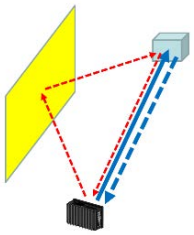
- Multipath has occurred

Floor: Being like a mirror

Result: 1053 mm



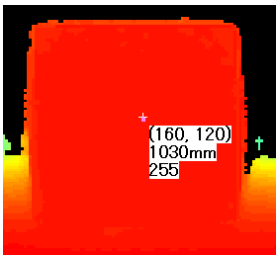


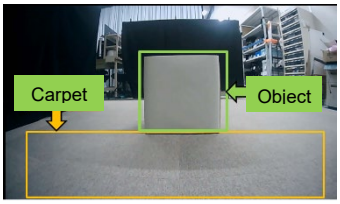


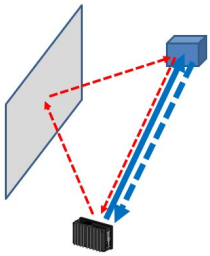
- Multipath has been cleared up

Floor: Carpet

Result: 1030 mm







② Measurement of the back of a clear object

(a) Symptom

When looking at the measurement target, there is a clear object on the way to that object.

(b) What error occurs

Reflection from the clear object overlaps reflection from the measurement target.

(c) Illustration

(d) Countermeasure

Remove the clear object.

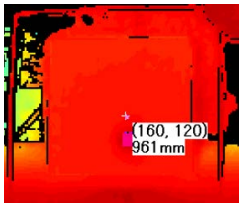
<An example>

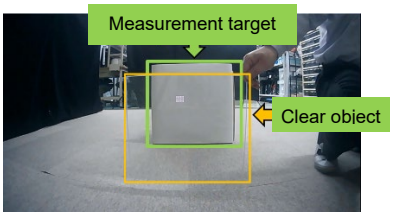
Condition: Distance to the object: 1000 mm

Object: White paper

- Putting a clear object on the way to the measurement target

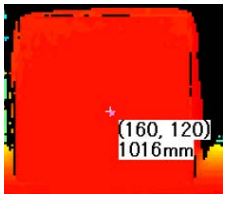
Result: 961 mm

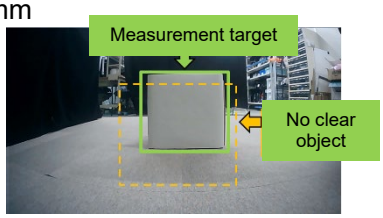




- There is no clear object

Result: 1016 mm





③ Measurement of a mirror (reflecting object itself)

(a) Symptom

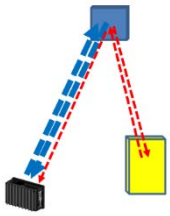
The measurement target is a mirror.

(b) What error occurs

When measuring a mirror from the front, light gets saturated because the light output from B5L returns as regular reflection.

When measuring it from an angle, light does not return directly but returns after reflected by the object shown on the mirror, so distance gets longer.

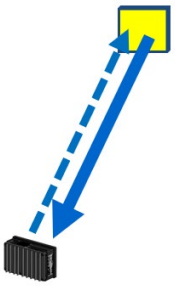
(c) Illustration



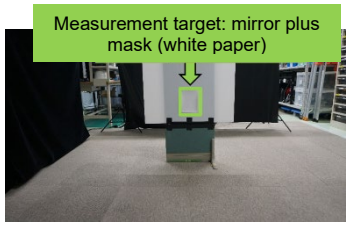
(d) Countermeasure: Shield the mirror so that the reflecting object does not show.

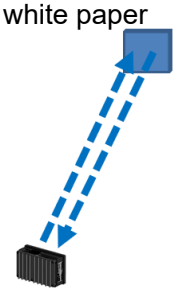
<An example>
Condition: Distance to the measurement target: 2000 mm
Target: Mirror

- Measuring the distance to the mirror
Result: 2719 mm



- Shielding the mirror so that no object shows
Target: Cover the entire surface of the mirror with a piece of white paper
Result: 2030 mm

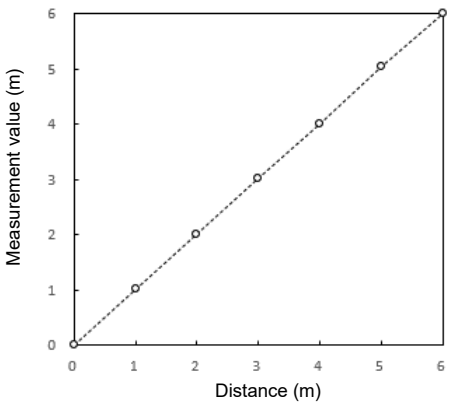




④ A far object is measured as nearer

(a) Symptom
A measurement target put far from the sensor may be measured incorrectly as a near object. This symptom occurs when an object more than 12.5 m far from the sensor is displayed, which is the upper limit of the display by B5L.

(b) Illustration
Distance values are displayed as below.
Up to 12.5 m, distance (m) and measured value (m) are output as the same numerical value.



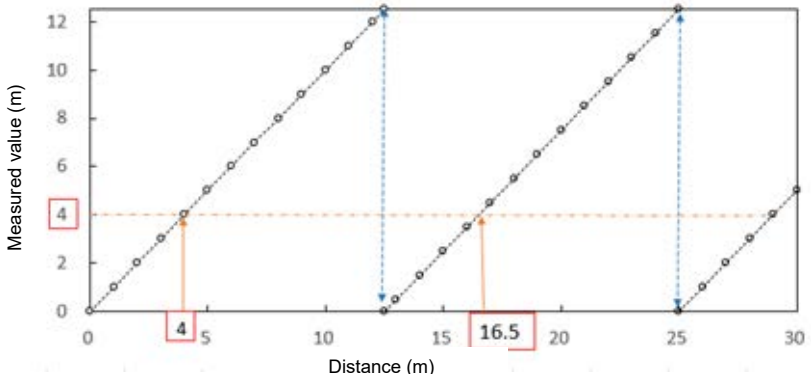
Condition
LED freq ID: 8
View range: 0-6500 mm
Color display:
Red to blue for output value 0-6500
Black for 6500-12499 mm
Horizontal axis:
Distance (m): Actual distance from B5L to the object
Vertical axis:
Measurement value (m): Distance output by B5L

Distance (m) of 12.5 m or longer is displayed as a value of the actual distance minus 12.5 m. The subtracted value doubles at 12.5 m intervals.

<An example>
If distance (m) is 4 m, the measured value is 4 m.

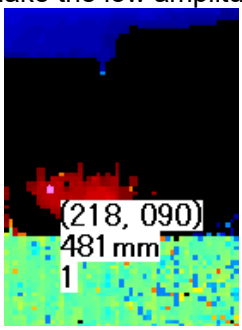
If distance (m) is 16.5 m, the measured value is 4 m.
Now, the real distance is calculated like:

12.5 m + measured value: 4 m = 16.5 m

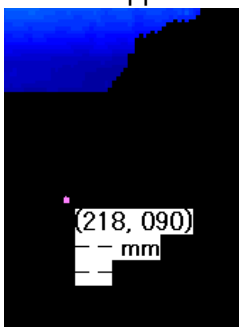


(c) Countermeasure

Make the low amplitude value to not appear on the display.



Abnormal state

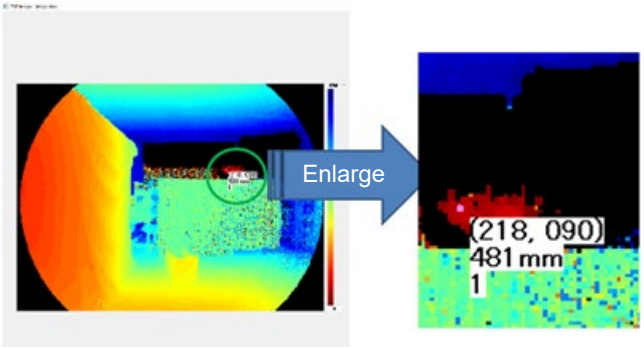


Normal state

<Important matter>

By clicking the image to display the distance, you can tell that the far measurement target is wrongly measured as a nearer object.

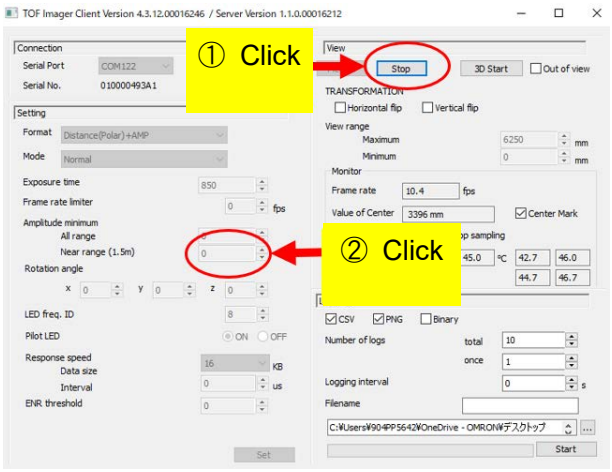
Although the displayed distance is 481 mm and the amplitude value is 1, the real distance is 12500 + 481 = 12981 mm because the object is positioned over 12.5 m afar.



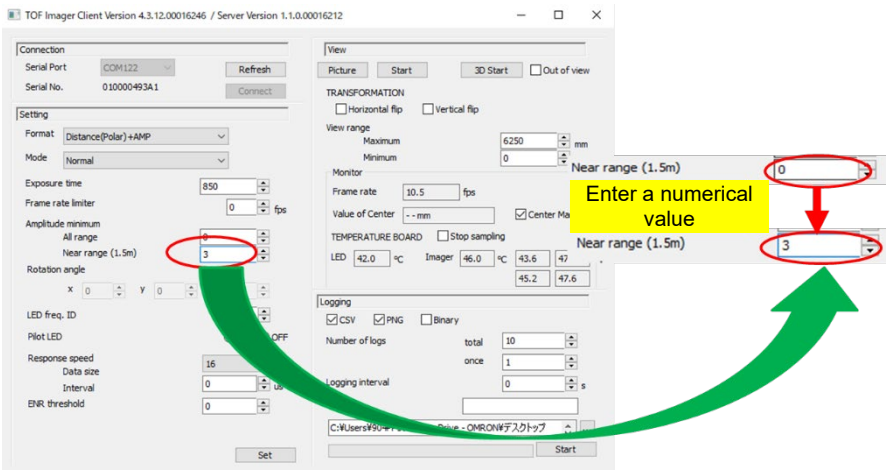
(d) Procedures

① Click Stop. (Stop the operation of B5L so that configuration can be changed.)

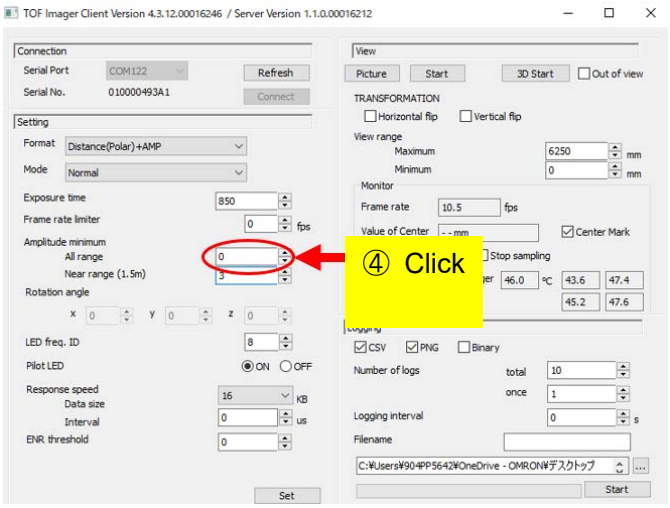
② Click the value of Exposure time.



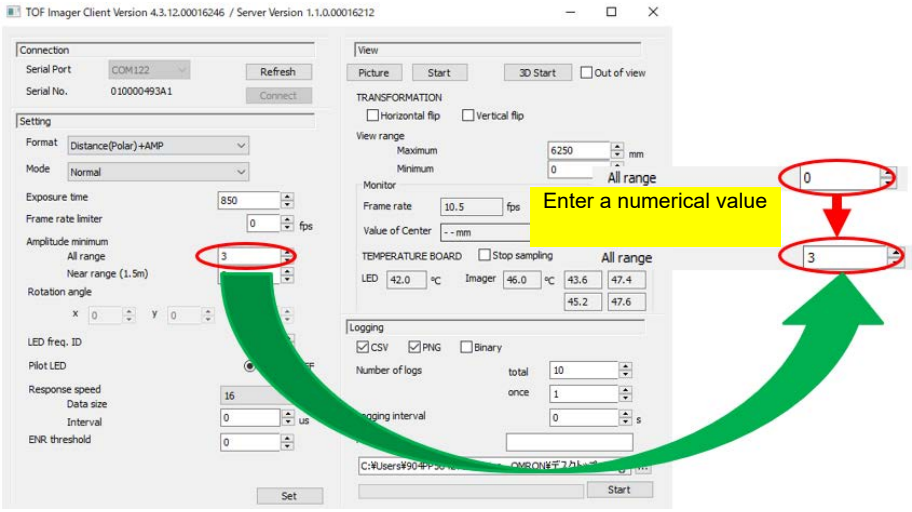
③ Fill in the "Near range" box of the "Amplitude minimum" item with a numerical number. This operation makes the object of a distance value of 1.5 m or smaller and an amplitude value of the configured value or smaller displaying in black.



④ Click the "All range" box of the Amplitude minimum item.

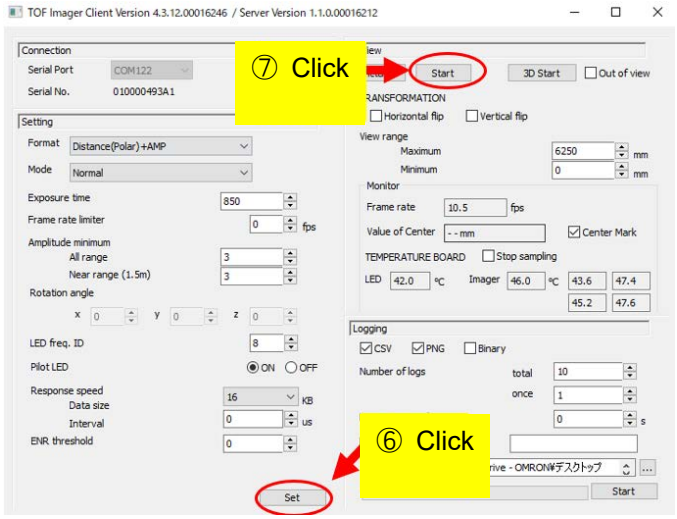


⑤ Fill in the "All range" box of the "Amplitude minimum" item. In the "all range" of distance values, an amplitude value below the set value is displayed in black.



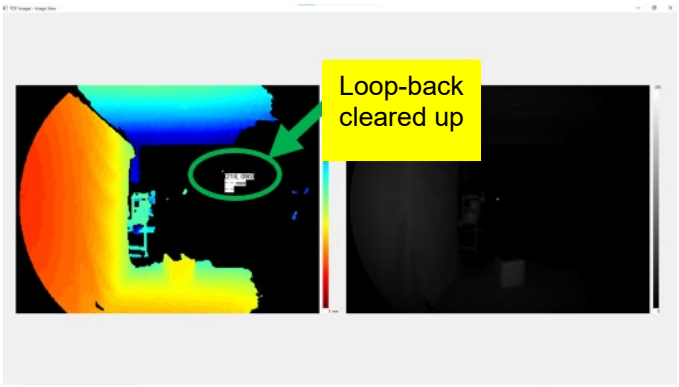
⑥ Click the Set button (to save the configured values).

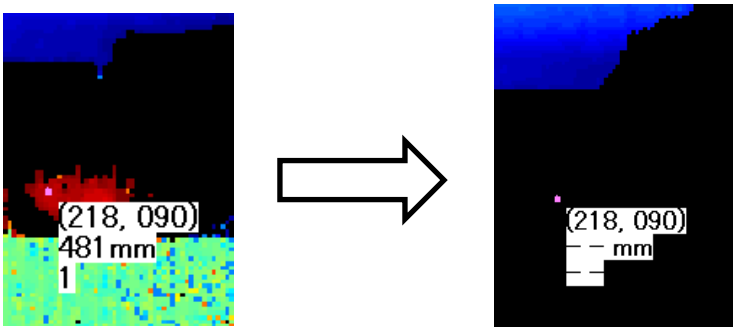
⑦ Click the Start button (to start operation).



⑧ Check if there is not any color display of close range in the back of the blue or black color display on the distance image.

If there is no color display of close range, the problem that a long range is measured as a close range has been cleared up. If still there is a color display of close range, repeat these steps from ①. When doing so, confirm the amplitude value of the color display of close range and set a value larger than that value.





Amplitude not minimized　　Amplitude minimized

<Precautions>
Setting of amplitude minimum blackens the amplitude value below the specified numerical value, so that the image gets blackened depending on the amplitude value of the measurement target.
Make an adjustment as checking the amplitude of the necessary part.

2-8 Precautions

(1) Problem of frame rate

Attention must be paid to frame rate because it varies depending on the configured mode or exposure time.

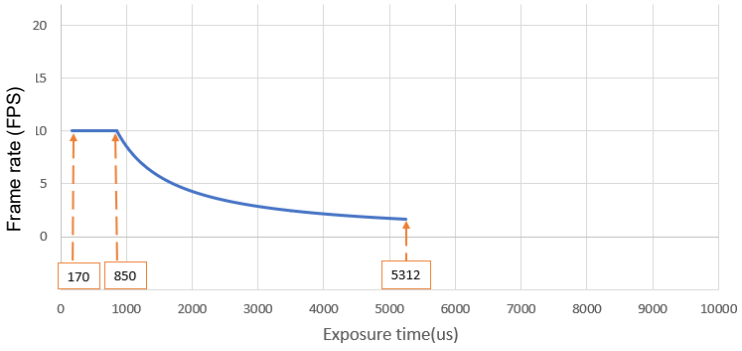
*There are two types of modes available, Normal and High-speed. In normal mode, measurement is performed twice, so a broader area can be measured. In High-speed mode, measurement is performed only once, so frame rate increases but the measurement area gets narrower.

For the setup method of Mode, refer to 3D TOF Sensor Module B5L Evaluation Software Manual.

A standard of frame rate is:

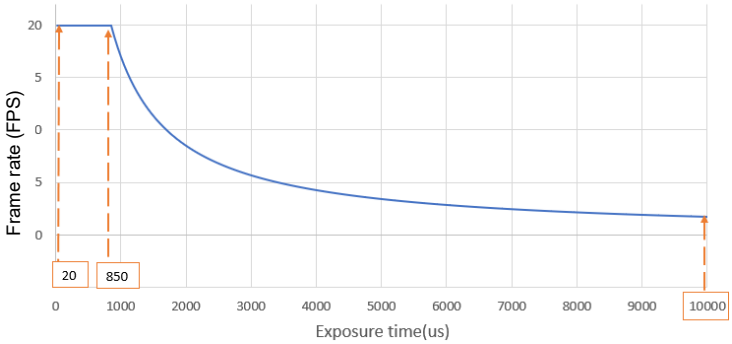
Like below in Normal mode.

Setting range of exposure time: 170-5312 us



Like below in High-speed mode.

Setting range of exposure time: 20-10000 us



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