取 A-0011-02

Multi-Exciter

Operation Manual

For Tour Safety Use

1. **Prior to use, read this manual carefully.**
2. **Unsuitable handling causes some accident.**
3. **Store this manual with caution.**

JFE Advantech Co., Ltd.

Contents

1. Introduction

The biomass of phytoplankton can be measured by conventional chlorophyll fluorometers. The in-situ fluorometers have been used as a tool for monitoring phytoplankton since 1970'. However, they cannot observe phytoplankton types or species.

The multi-excitation chlorophyll fluorometer (Multi-Exciter) automatically and continuously measures excitation spectra of chlorophyll fluorescence with 9-wavelength LEDs in the water. The spectra include the information of photosynthetic pigments related to phytoplankton classes so the classes/types such as diatoms, green algae, cyanobacteria, can be estimated with mathematical processing.

The instrument records chlorophyll fluorescence intensities of 9-wavelength excitation lights, turbidity, temperature and depth as a dataset with 13-channel. It has a mechanical wiper to prevent bio-fouling and debris before measuring so stable and accurate measuring is available for the deployment period.

2. Safety Instructions I

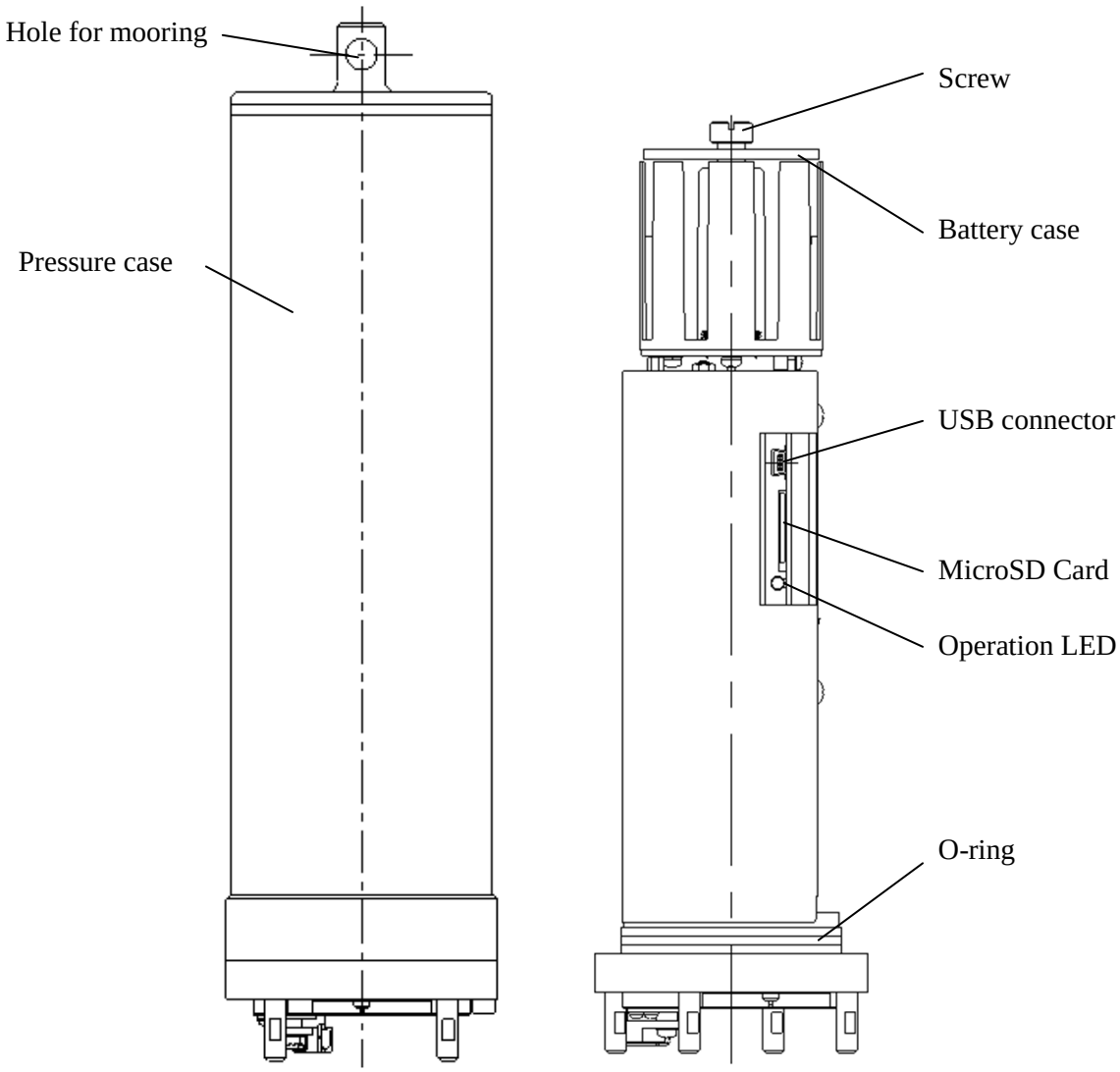
DANGER	Improper operations will result in serious personal injuries or death. and also when danger occurs, warning urgency (degree) is high and definite.
WARNING	Improper operations may result in serious personal injuries or death.
CAUTION	Improper operations may result in slight personal injuries or property damages only.

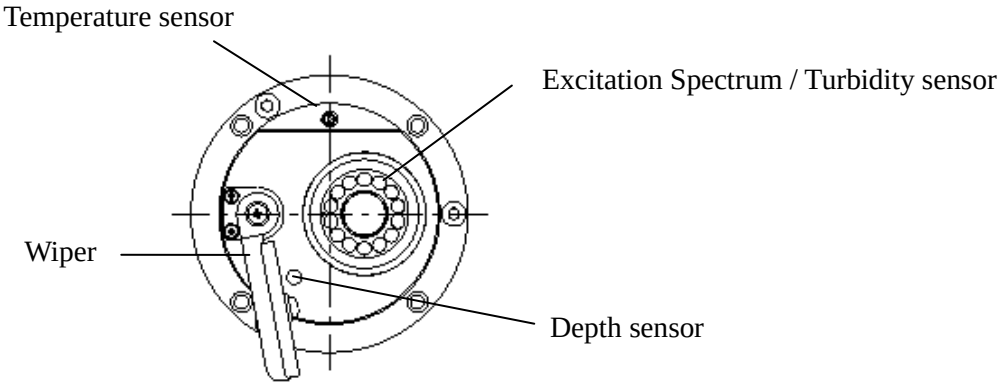
3. Safety Instructions II

DANGER	● When operating in the field, adequate safety in the working environment must be secured to prevent a fall.
WARNING	● Care should be taken not to injure your waist, etc. in an uncomfortable position when installing and collecting the instrument. ● When mooring with wires, wear gloves or the like not to injure your hands with cable burr and protrusion. ● When putting the internal unit into the pressure resisting case, care should be taken not to squeeze your fingers and hands there.
CAUTION	● Be sure to use a new battery, and after attaching of batteries, attach a battery pressing cover securely. ● Check the O-ring if it has any scratches and/or debris. Change or Clean the O-ring if there are any scratches and/or debris. ● When opening, take care not to allow any waterdrops to enter. If water enters the circuit section, a trouble will be caused. ● Don't provide excessive shock to the instrument. ● Be careful of the temperature sensor. Measuring might be not available if the temperature sensor has any damages. ● Be careful of the mooring. Don't touch objects around the instrument. ● Don't fall the instrument when the pressure case is removed. ● Gently insert and remove the USB cable from ● Don't touch the terminal of the microSD card. Wipe the water drops and debris if they are on it.
	● Insert the microSD card to the instrument before using the processing software. ● Use the special microSD card for measuring. Format the microSD card if you use the card with other data. Don't remove a part of the data file after using the card for measuring. ● About disposal of the instrument and Li-batteries. ➢ Comply with the regulations.

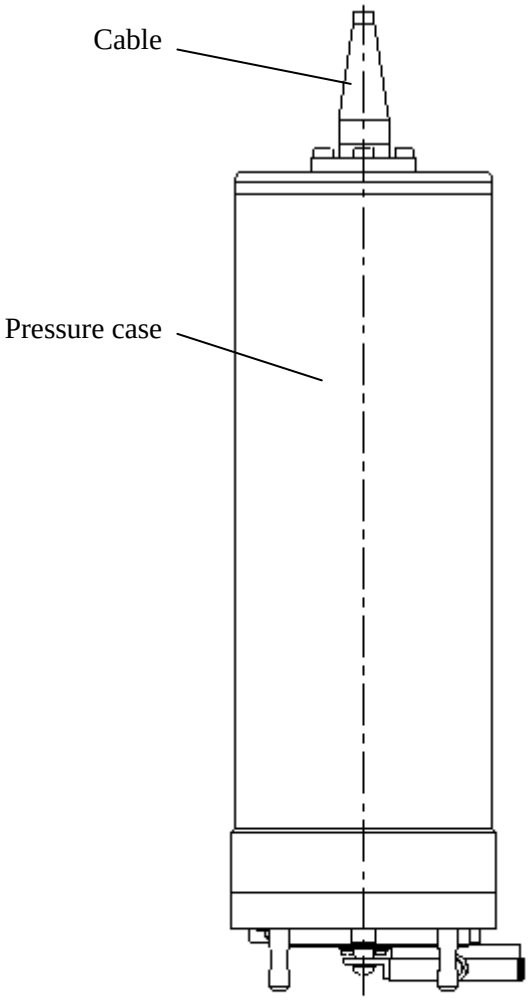
4. Instrument Overview

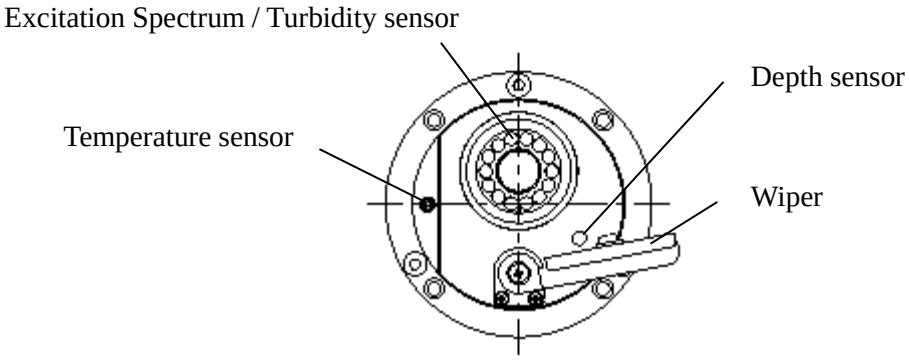
4.1. Memory type





4.2. Cable type





5. Operations

5.1. Memory type

5.1.1. How to open the pressure case

(1) Perfectly remove water drops around the instrument.
(2) Remove the hex bolts which fix the instrument and the pressure case.
(3) Put the instrument laterally. And then, remove the instrument at the position where you can see the O-ring.
(4) Blow up any water drops around the O-ring.
(5) Gently, remove the instrument from the pressure case.

CAUTION

- **Don't work with wet hands.**
- **Be careful of water drops. Don't moisten the electric board inside the pressure case.**
- **Be careful when the instrument is removed from the pressure case. The pressure case might be shot out, depending on the pressure gap between atmosphere and the inside.**

5.1.2. Battery replacement

(1) Loosen the mounting screws and remove the battery retaining cover.
(2) Change the battery and then set the battery case with the screws.

CAUTION

- **Must use new batteries if the long-term deployment is carried out.**
- **Don't strongly screw the hex bolts without batteries.**

5.1.3. USB Connection

(1) Insert the USB cable up to its root.
(2) The operating LED is illuminated when the cable is connected.

CAUTION

- **Don't pull out the cable until the setting is completed.**
- **The measurement is not interrupted, even if the cable is inserted "during the measurement".**

5.1.4. Instruction for removal/insertion of microSD card

(1) Removal: The microSD card attached is removed by finger-push operation.
(2) Insertion: The microSD card must be inserted completely.

5.1.5. Closing of Pressure Case Instruction

(1) Check if there are any scratches and/or debris on the O-ring. (**Caution:** They cause immersion inside the instrument.)

(2) Apply a thin coat with silicone grease. (**Caution:** Don't use any paper to coat the grease. Coat it with a finger.)

(3) Insert the instrument into the pressure case. (**Caution:** Don't insert the instrument perfectly. Leave a gap slightly.)

(4) Charge the dew condensation preventive gas.

(5) Insert the instrument into the pressure case perfectly.

(6) Fix the instrument with the hex screws.

CAUTION

- **Carefully check the O-ring if there are any scratches and/or debris on it.**
- **Don't apply a thick coat with silicone grease.**
- **Be careful of the O-ring when the instrument is inserted into the case.**
- **Screw up the hex bolts fairly.**
- **Don't over-crew up the bolts. They might be broken.**

5.1.6. How to moor and deploy

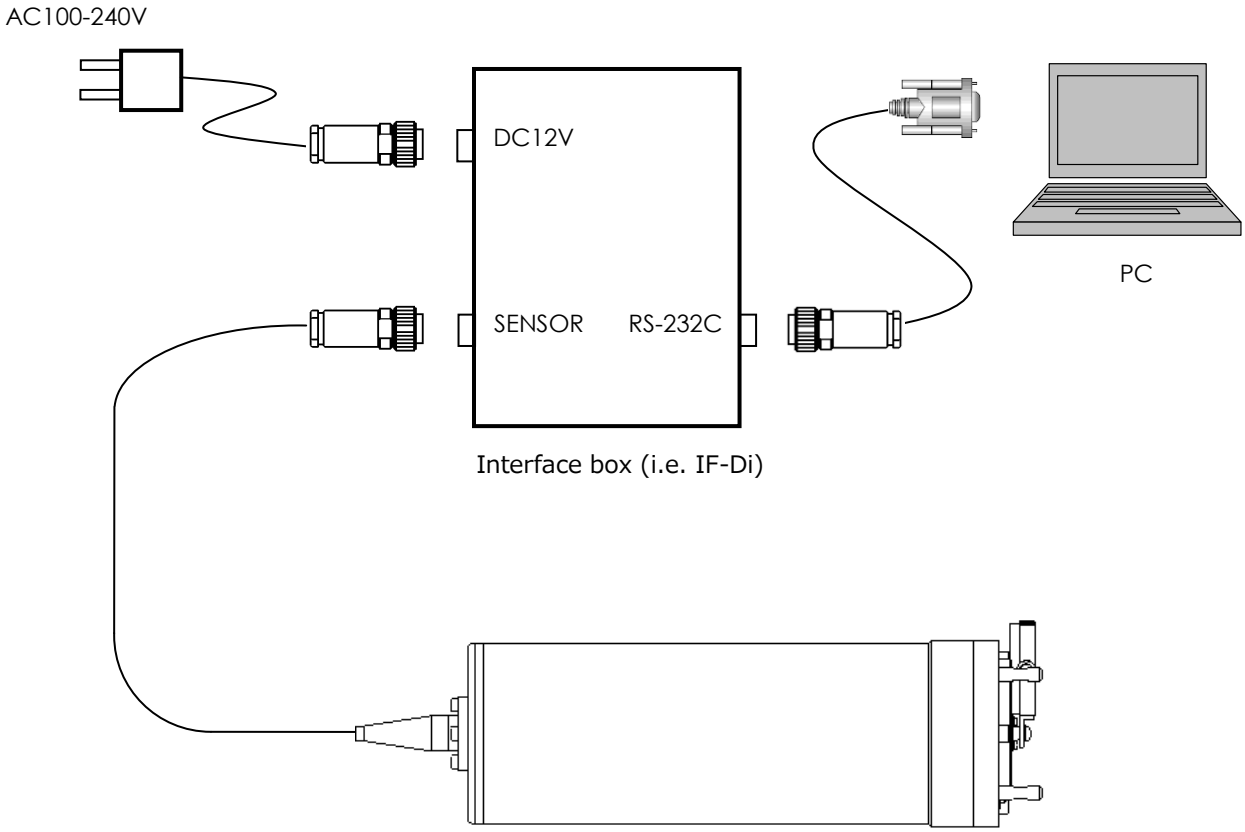
(1) Connected the cable at the hole for mooring perfectly (e.g. Using a shackle).
(2) Don't hit the instrument to any objects (e.g. Rocks, ships) when deployed.

CAUTION

- **Check if the shackle is perfectly connected at the hole and there are any scratches on the cable.**

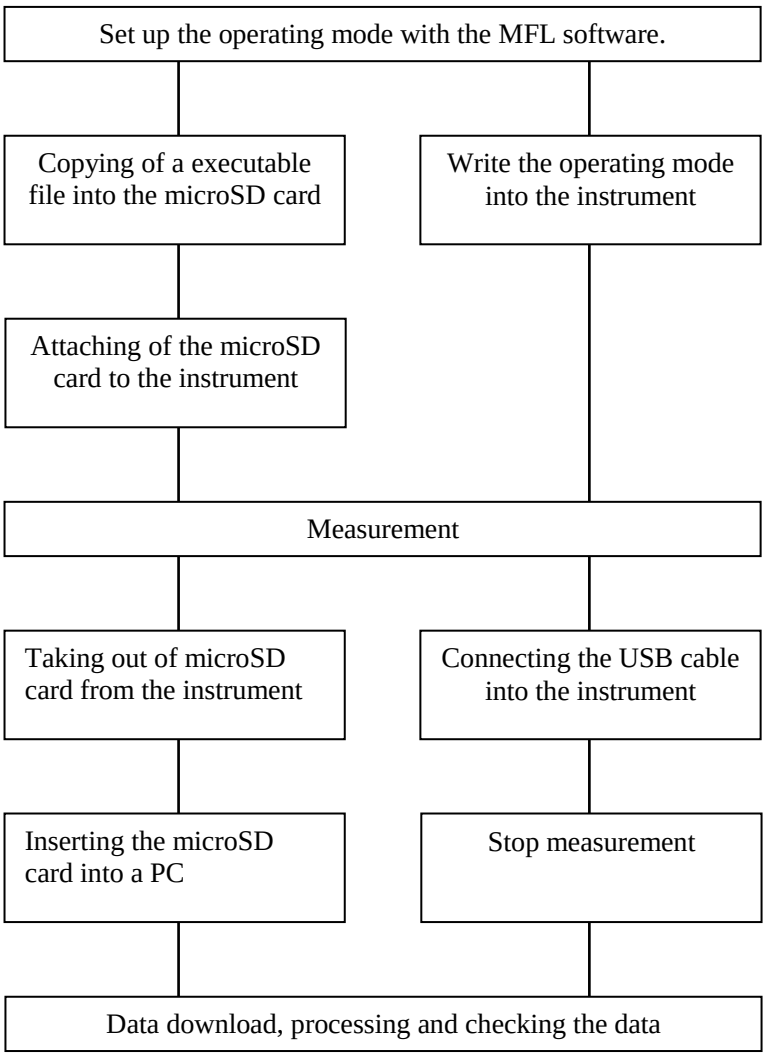
5.2. Cable type

5.2.1. Wiring overview

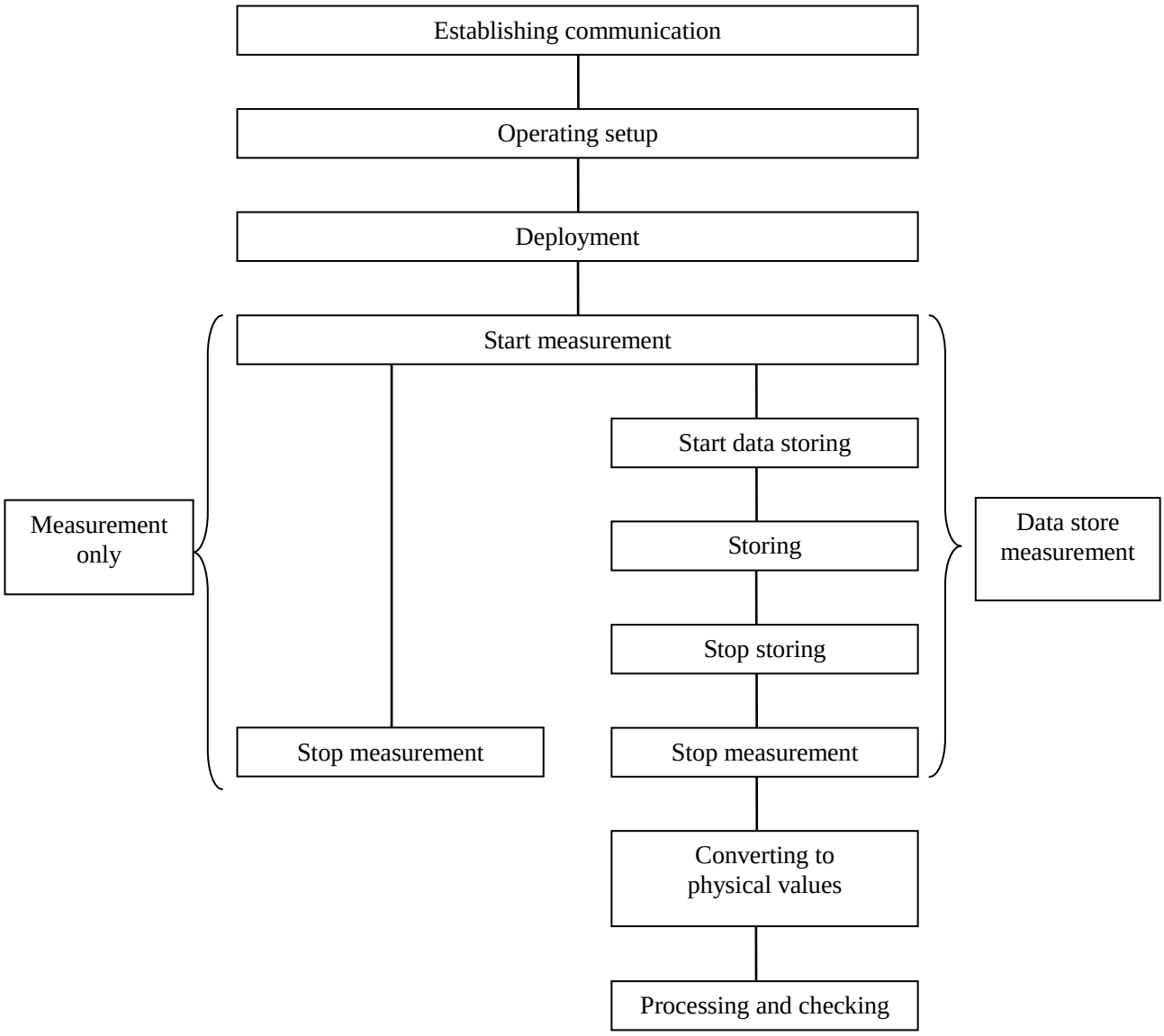


6. Measurement

6.1. Flow chart of the measurement (Memory type)



6.2. Flow chart of the measurement (Cable type)



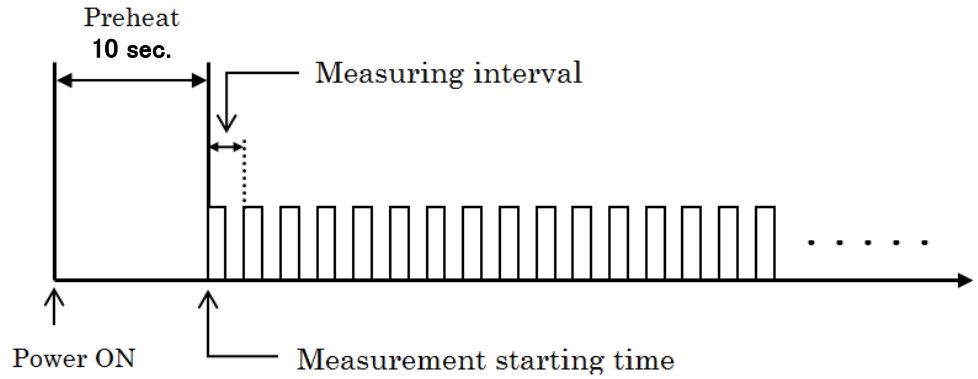
6.3. Operating mode

There are two operating mode for the instrument.

- Continuous mode
- Burst mode (Mainly use this mode for the long-term deployment)

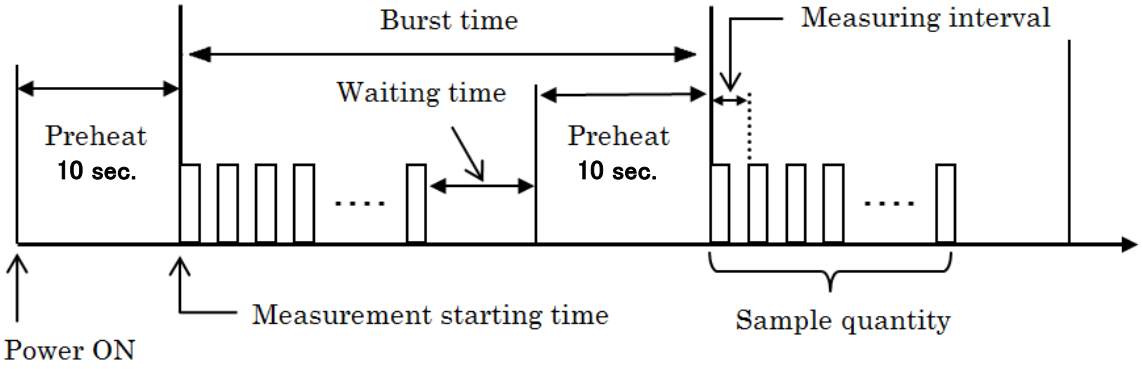
6.4. Continuous mode

Set up the starting time and sampling interval.
The measurement will be started with the interval from the starting time.



6.5. Burst Mode

Set up the starting time, the burst time, the sampling interval and the sampling numbers.
The measurement starts operating with the setup parameters.



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Maintenance

7.1. Maintenance after deployments

(1) Wash the instrument with water and then wipe it perfectly.
(2) Wash the optical sensors with water and then wipe it with a soft closes, gently.
(3) Check if there are any scratches and damages on the sensors.
(4) Store the instrument under room temperature and moisture (i.e. Don't store it under high temperature and moisture environment).

Caution

- **Don't use any organic solvent to clean the optical sensor (e.g. thinner, ethanol, acetone).**
- **Please contact to the factory if there are any scratches and/or damages on the sensors.**
- **Remove the batteries if the instrument is not use for a long-term.**

7.2. Regular maintenance

We recommend the overhaul (check and calibration) once a year.

8. Trouble-Shooting

No	Situation	Solution
1	No communication with a PC	Re-start the PC and try to re-communicate with the software. If communicating is still in trouble, re-install the driver (Refer to the software manual).
2	No starting of measuring	Check the recorded starting time with the software. Check the batteries. If the remaining power of batteries is little, the instrument cannot be operated normally.
3	Cannot insert the batteries	Use the specified batteries. Further, check if the direction of the batteries is correct.
4	Damaged the temperature sensor	The temperature data is not accurate. Please send the instrument back to the factory.

9. Specification

9.1. Sensors

Parameter	Excitation Spectrum	Turbidity	Temperature	Pressure
Measurement principle	Back-scattered Chl fluorescence	Near-infrared Backscattering	Thermistor	Semiconductor
Excitation light Wavelength [nm]	375, 400, 420, 430, 470, 505, 525, 570, 590	880		
Range	0 to 400ppb (calibrated against Rhodamine-WH solutions)*1	0 to 1000 FTU (calibrated against Formazin solutions)	-5 degC to 40 degC	0 to 500m*3
Accuracy (Reproducibility)	± 2% FS (0 to 100 ppb)	± 5 %FS	± 0.02 degC*2	0.3% FS

*1. The 570nm output in 100 ppb Rhodamine-WT solution is defined as '100'. Other channels are normalized by fluorescence excitation characteristics of the Rhodamine-WT.

*2. Calibrated temperature range: 3 to 31 degC.

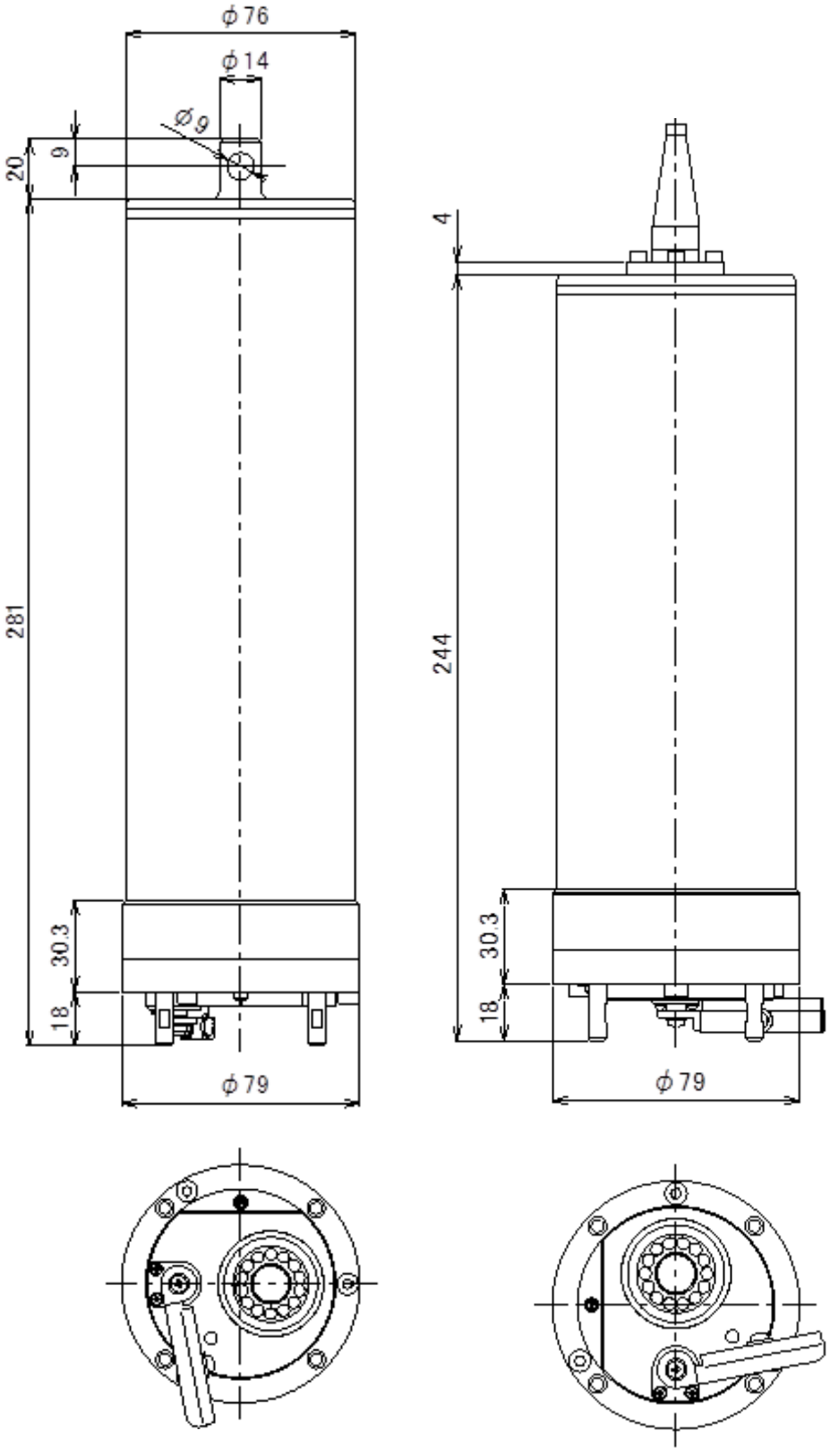
9.2. Instrument

Type			Memory Type			Cable Type	
Depth Range			0 to 50 m	0 to 100 m	0 to 500m	0 to 50 m	0 to 100 m
Model			MFL05W-USB	MFL10W-USB	MFL50W-USB	MFL05W-CAD	MFL10W-CAD
Communication Interface			USB			RS-485	
Memory Medium			micro SD Card			depend on external devices	
Measurement Mode			Continuous mode, Burst mode				
Measurement Conditions	**Cont. Mode**	**Sampling Intervals**	0.1 to 600 seconds			0.5/1/2/5/10/15/20/30 seconds	
	Burst Mode	**Sampling Intervals**					
		Burst Sampling Intervals	1 to 1440 minutes (1 min increments)				
		Number of Samples per Burst	1 to 18,000 samples			1/10/15/20/30/60/ 120/180/240/300 /600/1,200 samples	
Operating Voltage			3 V (Lithium battery, CR-V3)			12 to 24 DCV	
Power Consumption			Approx. 300 mA			Approx. 900 mW	
Dimensions			79 mm dia. x 301 mm			79 mm dia. x 244 mm	
Weight			1.8 kg			1.6kg	
Materials			Housing: Titanium, Optical window: Epoxy-acrylic resin				
Depth Rating			500 m				

*3. Capacity: 3.3Ah, Maximum number of batter: 4.

*4. Except a pressure sensor. The depth rating of pressures is a depth range for each type.

10. Drawing



Appendix-A　Measuring the chlorophyll specific spectra

A-1. Introduction

We define the spectra normalized by the chlorophyll-a concentrations as chlorophyll specific spectra. The software uses these spectra to estimate phytoplankton community structures (phytoplankton class compositions). With an assumption, the excitation spectra measured by the fluorometer is constructed as follows:

$$F(\lambda) = \sum_{i=1}^{4} a_i \cdot Fn_i$$

Where F(λ), a and Fn show the excitation spectra observed by the fluorometer, the chlorophyll-a concentration and the chlorophyll specific spectrum. The subscript, i. indicates the phytoplankton class. The above equation is expressed with the assumption that the 4-type phytoplankton classes [A group with carotenes as marker pigments (e.g. Diatoms, dinoflagellates), green algae, cyanobacteria, cryptophyta] are dominated in the water.

A-2. How to measure

In order to estimate the community structure from excitation spectra measured by the fluorometer, the software requires inputting the chlorophyll specific excitation spectra of the above 4-type phytoplankton. To obtain the chlorophyll specific spectra, with the each pure phytoplankton culture of 4-types, 1) measuring the excitation spectra by the multi-excitation fluorometer and　2) analyze the chlorophyll-a concentration by chemical analysis (e.g. HPLC, fluorescence or absorbance technique) are required.

（1）How to measure the excitation spectra

(A) Prepare the 4L pure culture solutions diluted by distilled water or filtered sea water. The pure culture solution filled up into the black bucket packaged as one of the standard accessories.
(B) The solution filled up in the bucket should be fully stirred before the measurement.
(C) The fluorometer is set in the bucket and then started measuring the excitation spectrum. We recommend measuring the spectrum for 30 seconds. **Caution:** The optical sensors must be separated from the bottom of the bucket.

With these procedures, please measure the excitation spectra of 4-type phytoplankton each. Caution: Without interferences of the illuminations to the detector, we recommend to measure them under the dark condition. Remove bubbles on the optical sensor before measuring.

(2) Chla concentration

The first, filter the pure culture solutions onto the glass fiber filter (e.g. Whatmann GF/F filter). After the filtration, immediately input the sample filter into the organic solvent　(DMF, Acetone, Methanol)　and store it under the freezer for 24-hour. After that, measure the chlorophyll-a concentration with one of standard techniques. According to your facility, please choose one of techniques for the measurement of chlorophyll-a concentration.

(3)　Calculations of the chlorophyll-a specific spectra

With a spreadsheet software, average the excitation spectra measured for 30-second. Then, divide the spectra by the chlorophyll-a concentration each.

Note

The classification error depends on if the chlorophyll specific spectra using the calculations are represented or not in the field. Please measure the spectra of the dominant species in the field if you know them. We recommend to input the chlorophyll specific spectra in the software when the community structures are estimated.

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Manufacturer

JFE Advantech Co., Ltd.

3-48, Takahata-cho,　Nishinomiya,　Hyogo 663-8202 Japan
Tel: +81-798-66-1783　　Fax: +81-798-66-1654
URL : http://www.jfe-advantech.co.jp/
E-mail: ocean@jfe-advantech.co.jp