INFINITY-CT

Conductivity and temperature sensor

A7CT-CAR (RS-232C)

A7CT-CAD (RS-485)

Operation Manual

For the safe use of this instrument

- Use after thoroughly reading the operation manual.
- Improper handling may lead to an accident.
- Safely keep this manual in order not to lose it.

JFE Advantech Co., Ltd.

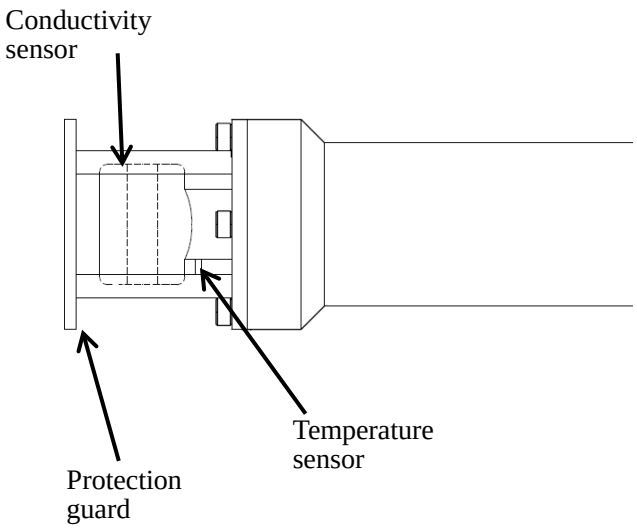
Introduction

INFINITY-CT is an accurate conductivity and temperature meter making use of 7-electrode sensor. This 7-electrode generates an electric current only inside of the conductivity cell, minimizing external influences and improving data quality. The compact design is suitable to be deployed/integrated with various sites/platforms. The instrument also has a robust and corrosion-resistant titanium pressure case and communicates using RS-232C or RS-485 communication protocols.

Contents

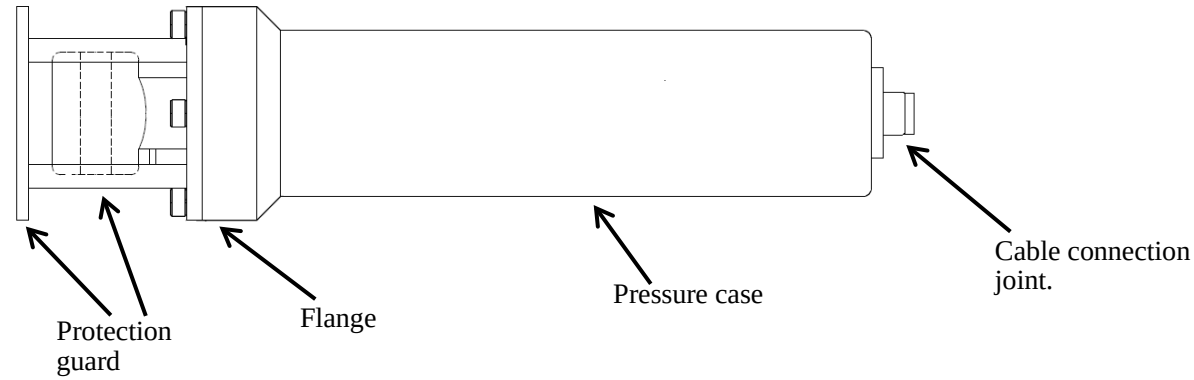
1. Sensors and part names

1.1 Sensor diagram

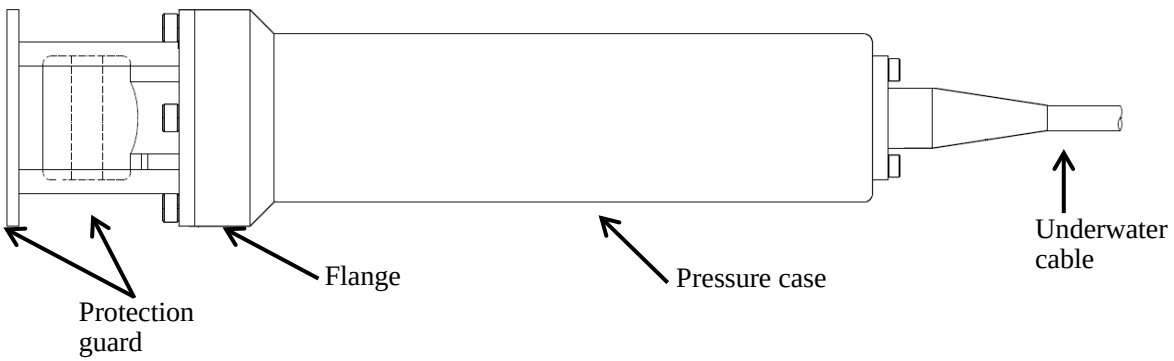


1.2 External diagram

(a) Detachable cable version

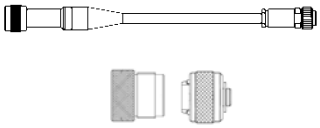


(b) Fixed cable version



2. Packing List

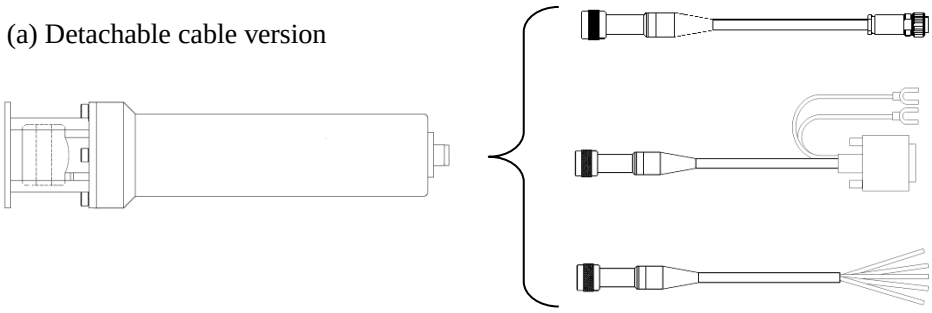
2.1 A7CT-CAR packing list [(1)]

No.	Name	Appearance[(2)]	Quantity
1	Main unit (A7CT-CAR)		1
2	Cable – 20 m (detachable or fixed) Connector cap		1 1
3	Maintenance kit - Plus screw driver - Sensor-cleaning brush		1 1
4	Calibration Sheet		1
5	Operation Manual (this manual)		1

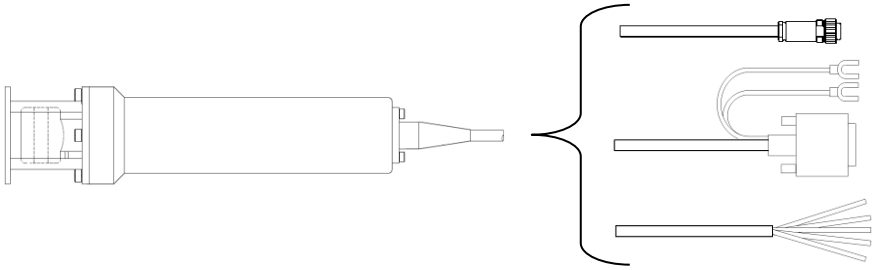
Note[(1)] This is the standard packing list. The contents may differ depending of what is being requested.
Note[(2)] Actual design may differ.

● Combination of cable and connector

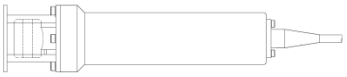
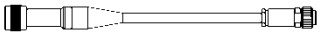
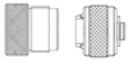
(a) Detachable cable version



(b) Fixed cable version



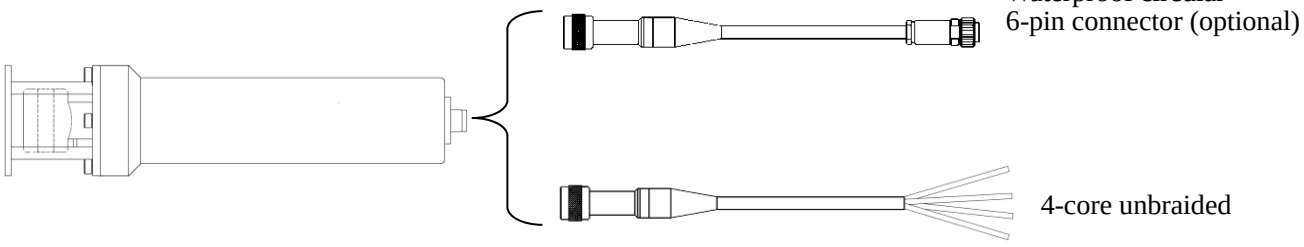
2.2 A7CT-CAD packing list[1]

No.	Name	Appearance[2]	Quantity
1	Main unit (A7CT-CAD)		1
2	Cable – 20 m (detachable or fixed) Connector cap	 	1 1
3	Maintenance kit - Plus screw driver - Sensor-cleaning brush		1 1
4	Calibration Sheet		1
5	Operation Manual (this manual)		1

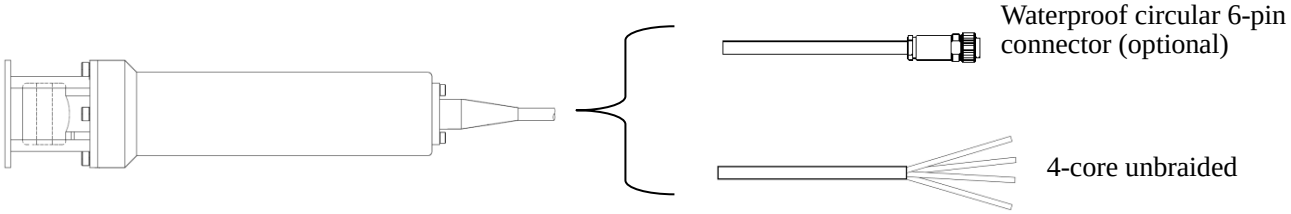
Note[1] This is the standard packing list. The contents may differ depending of what is being requested.
Note[2] Actual design may differ.

● Combination of cable and connector

(a) Detachable cable version



(b) Fixed cable version



3. Notes on use

Danger If you handle it incorrectly, the user is likely to be at risk of death or serious injury.

Warning If you handle it incorrectly, the user may be minor or seriously injured.

Caution If you handle it incorrectly, the instrument may be damaged and unrepairable.

Please read before using the instrument

Danger

- When working on water, please ensure the safety of working environment.

Warning

- Be careful not to hurt yourself when deploying and retrieving the instrument.
- Wear gloves while fixing the instrument in a wire or mooring to avoid being hurt by any burrs or ridges.
- Do not connect or disconnect cables with wet hands. It may cause an electrical shock.

Caution

- Do not repair or disassemble anything beyond of what is written in this manual.
- Make sure not to supply power with reverse-polarity.
- Avoid mechanical impacts on the instrument during deployment and retrieval.
- Touch grounded metal objects, before touching the instrument to avoid any static electricity discharges.
- Be careful not to allow water into the connector and its surroundings. It may result in rusting and communication failure.
- Do not store the instrument in a humid and/or dusty environment, and do not expose the instrument to direct sunlight or high temperatures exceeding 40 °C.
- Do not damage the cables and connectors.
- Do not use damaged or rusted cables.
- Be sure to check the communication with the input device in advance.
- Do not disconnect the cable while power is on, and/or do not turn off the instrument while communication is taking place.
- Make sure that there are no loose connectors.

3.1 Disposal

When disposing of this product, do so in the appropriate manner following all laws and regulations.

4. Sensor principle

4.1 Temperature sensor

The sensor is integrated with the conductivity sensor and uses a highly reliable thermistor with fast time response. The sensor is a very stable and measurements are not influenced by fouling. However, if the sensor is significantly dirty, the time response will slow down, and therefore, it should be cleaned periodically. The sensor is thin and care should be taken not to break it during cleaning.

4.2 Conductivity sensor

As shown in Fig. 1, our 7-electrode conductivity sensor has 2 sets of 4-electrode sensors, having a central electrode common to both sets, totalizing 7 electrodes inside a cell with an inner diameter of 8 mm. The electrodes are separated by ceramic material ensuring that the conductivity cell structure is stable and do not deform due to temperature or pressure variations. The basic principle of our conductivity sensor is the same as the one of 4-electrode conductivity cells that measures current and voltage simultaneously as shown in Fig.2. However, using only 4 electrodes, current will flow inside and outside the conductivity cell, which does not happen while using a 7-electrode conductivity cell. The conductivity sensor has both ends of the conductivity cell ending with same polarity, which results in no electric current flowing from the external side of the sensor and eliminates external influence.

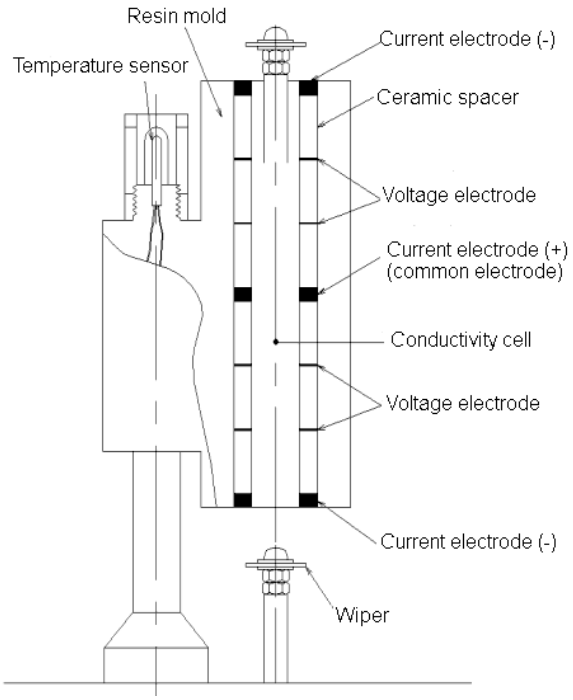


Figure 2. Scheme of the 4-electrode conductivity sensor. Note that wiper is not available for A7CT models.

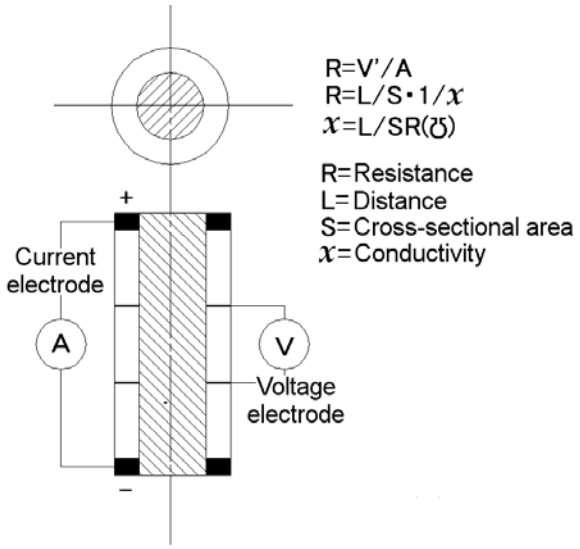
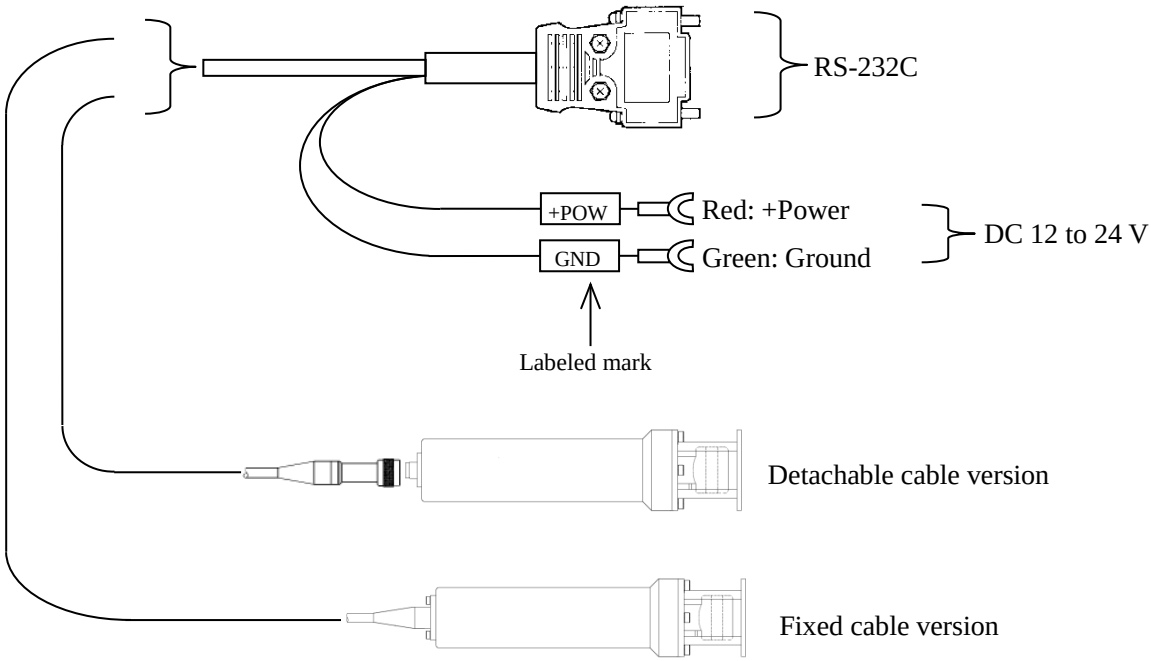


Figure 1. Scheme of the 7-electrode conductivity sensor.

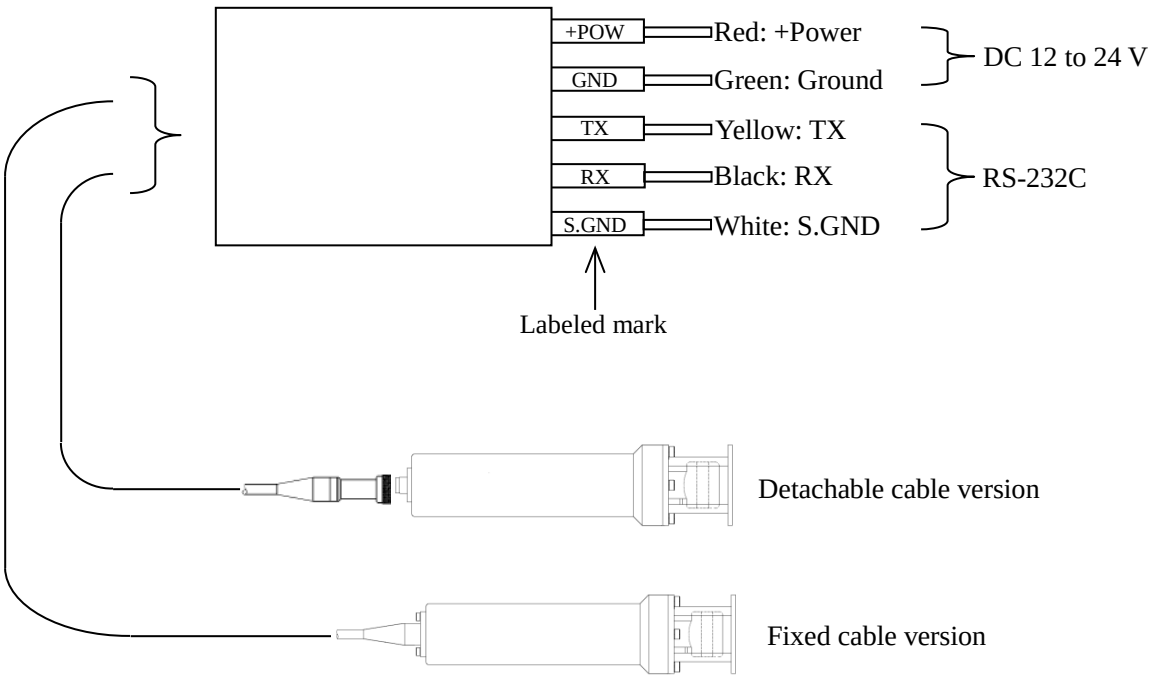
5. Connection Outline

5.1 RS-232C

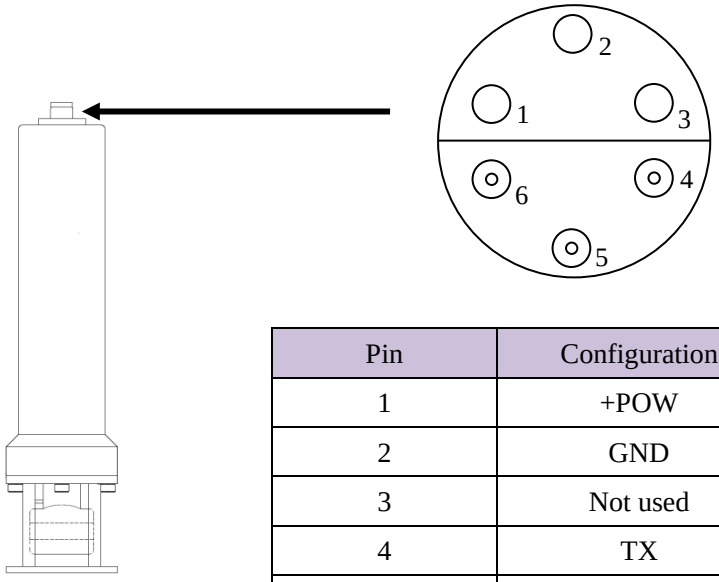
(1) D-SUB 9-pin



(2) 5-core unbraided



(3) Wiring pin-out

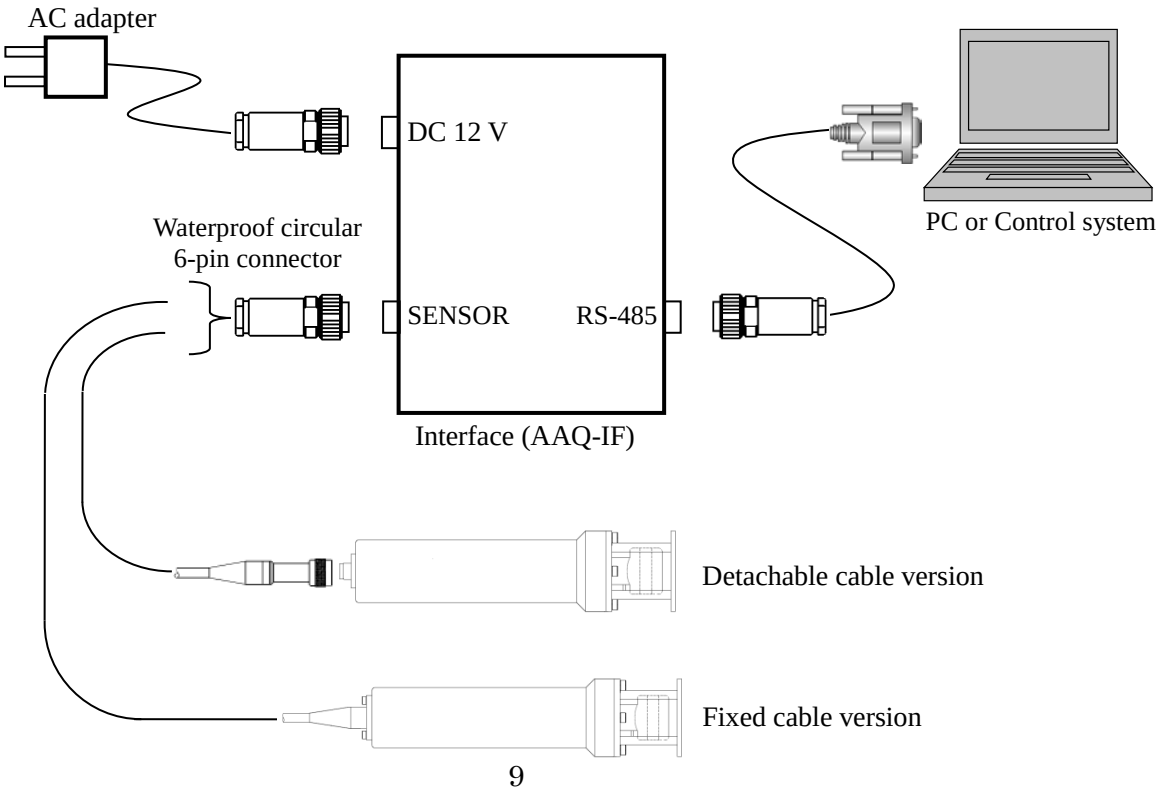


Pin	Configuration
1	+POW
2	GND
3	Not used
4	TX
5	RX
6	S.GND

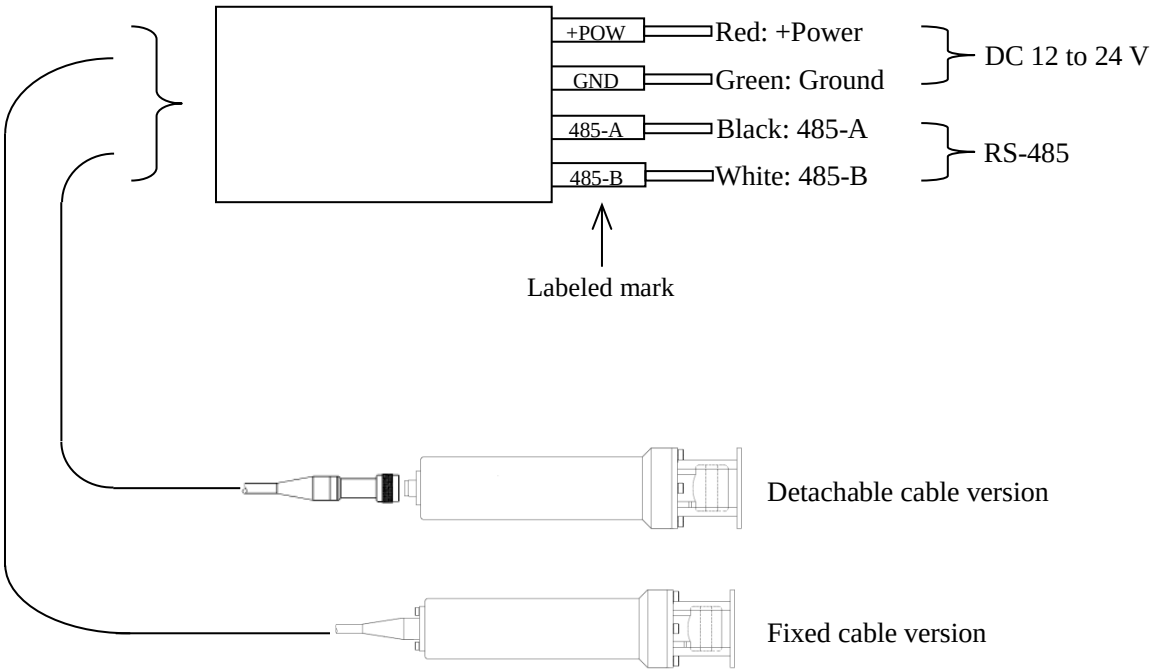
5.2 RS-485

(1) Waterproof circular 6-pin connector.

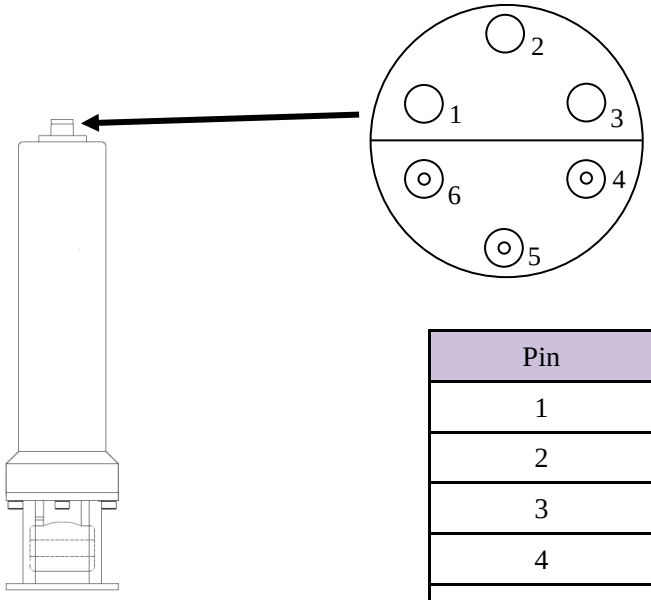
The sensor can be connected to our interface (optional and sold separately).



(2) 4-core unbraided



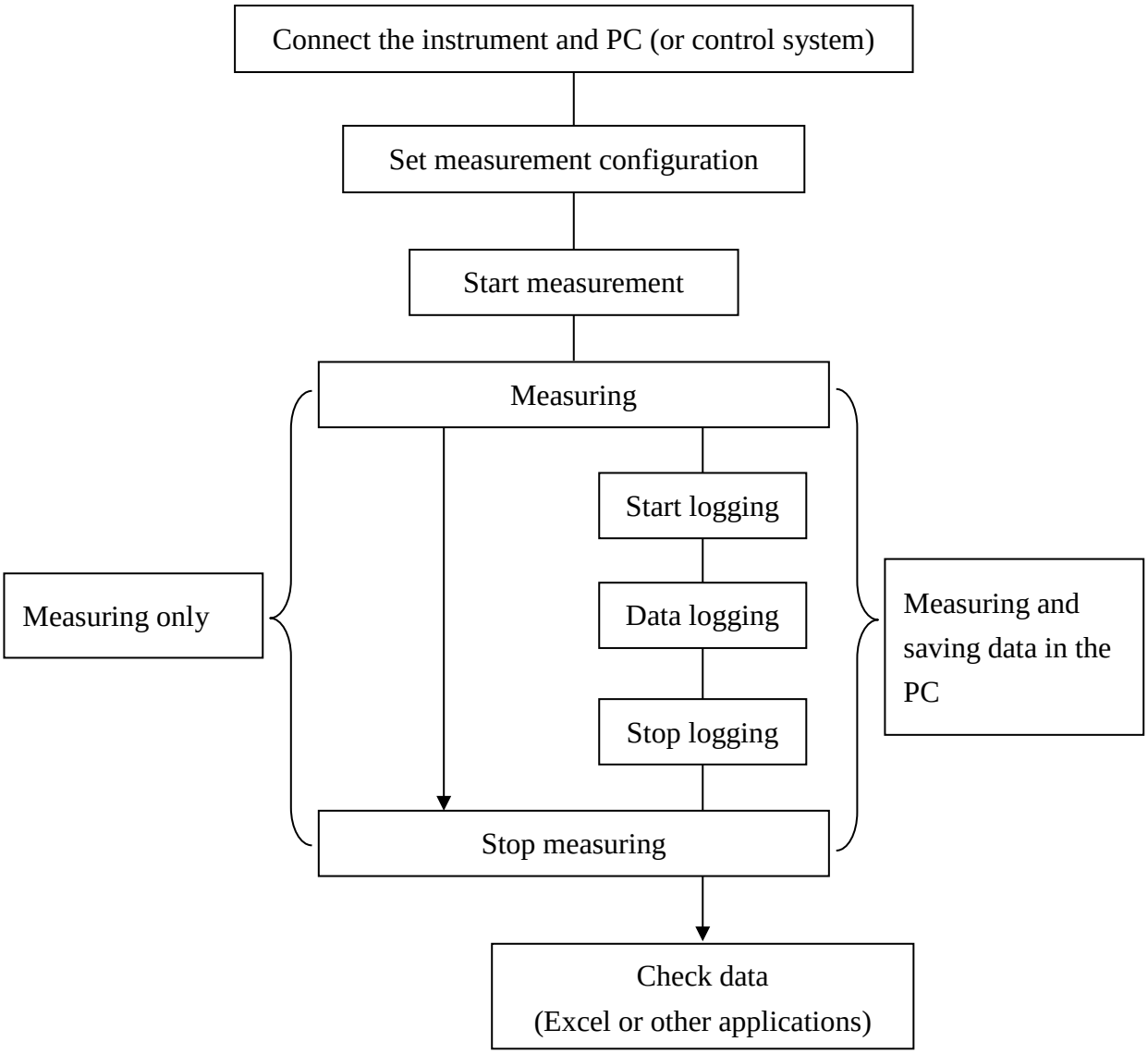
(4) Wiring pin-out



Pin	Configuration
1	+POW
2	GND
3	Not used
4	485-A
5	485-B
6	Not used

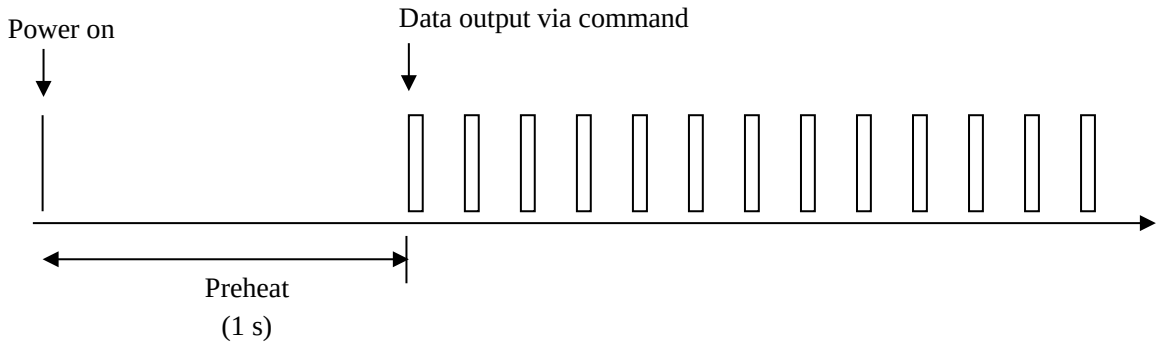
6. Measurement Flowchart

The measurement flowchart is shown below. Connect the instrument to power supply and to PC (or control system) with RS-232C (or RS-485) before measurement.



7. Measurement Mode

The observation interval depends on the data output command.



8. Communication

8.1 Specifications

Communication specifications

Item	Specification
Baudrate	Default: 38400 (configurable to 4800,9600,19200 or 38400 at the factory and before shipment)
Character length	8bit, fixed
Stop bit	1, fixed
Parity	None, fixed
Interface	RS-232C (A7CT-CAR), RS-485 (A7CT-CAD)
Busy control	none

Control codes

Notation	Code
<d1>	11h (ASCII control code DC1)
<cr>	0Dh

All characters are ASCII.

PC means a personal computer or a control system.

8.2 A7CT-CAR (RS-232C communication protocol) – command list

All characters are ASCII.

Header	Command	,	SUB command	,	Termination
<d1><d1>					<cr>

Example:

PC → instrument <d1><d1>date?<cr>

PC ← instrument <d1><d1>date,2015,01,15,<cr>

(1) Header

First characters in the command line.

<d1>: 11h（ASCII Control code）

(2) Command

Instruction to be sent to the instrument.

(3) SUB command

Instrument response to the command. Shows data or logged data being outputted by the instrument (some commands may not have a SUB command.)

(4) Termination

End of the command line.

<cr>：0Dh (ASCII control code)

(1) Setting date and time:

- When the date information is not required, it's not necessary to setup.
- Clock information is lost every time the instrument's power is turned off.
- Send "go" command after each command (data or time). No data is overwritten by sending date or time command only. New date and time become effective after sending the "go" command.

(a) Date Setup

PC→instrument <d1><d1>date,YEAR,MONTH,DAY,<cr>

PC←instrument <d1><d1>ak,date,YEAR,MONTH,DAY,<cr>

PC→instrument <d1><d1>go,<cr>

PC←instrument <d1><d1>ok,<cr>

In case of error:

PC←instrument <d1><d1>er,date,3456,13,45,<cr>

(b) Time Setup

PC→instrument `<d1><d1>time,HOUR,MINUTE,SECOND,<cr>`

PC←instrument `<d1><d1>ak,time,HOUR,MINUTE,SECOND,<cr>`

PC→instrument `<d1><d1>go,<cr>`

PC←instrument `<d1><d1>ok,<cr>`

In case of error:

PC←instrument `<d1><d1>er,time,45,13,45,<cr>`

(2) Obtaining clock information:

(a) Date

PC→instrument `<d1><d1>date?,<cr>`

PC←instrument `<d1><d1>date,YEAR,MONTH,DAY,<cr>`

e.g.) PC→instrument `<d1><d1>date?,<cr>`

PC←instrument `<d1><d1>date,2019,10,17,<cr>`

(b) Time

PC→instrument `<d1><d1>time?,<cr>`

PC←instrument `<d1><d1>time,HOUR,MINUTE,SECOND,<cr>`

e.g.) PC→instrument `<d1><d1>time?,<cr>`

PC←instrument `<d1><d1>time,23,59,00,<cr>`

(3) Obtaining header information

- Header information contains serial No., preheat time (in milliseconds), calibration coefficients (Ch1: temperature, Ch2: conductivity, Ch4: power supply voltage; the remaining channels are not used and defined here as "<NotUsed>").
- Calibration coefficients in the "Header information 1" are from A to D for Ch1, Ch2 and Ch3, and calibration coefficients in the "Header information 2" are from E to H for Ch1, Ch2 and Ch3.

(a) Header information 1

PC→instrument `<d1><d1>head1?,<cr>`

PC←instrument `<d1><d1>TYPE,SERIAL,VERSION,<NotUsed>,<NotUsed>,<NotUsed>,`
`<NotUsed>,<NotUsed>,<NotUsed>,<NotUsed>,<NotUsed>,<NotUsed>,`
`<NotUsed>,<NotUsed>,PREHEAT[millisecond],<NotUsed>,Ch1A,Ch1B`
`,Ch1C,Ch1D,Ch2A,Ch2B,Ch2C,Ch2D,…,Ch4A,Ch4B,Ch4C,Ch4D,…,<cr>`

(b) Header information 2

PC→instrument `<d1><d1>head2?,<cr>`

PC←instrument `<d1><d1>TYPE,SERIAL,VERSION,<NotUsed>,<NotUsed>,<NotUsed>,`
`<NotUsed>,<NotUsed>,<NotUsed>,<NotUsed>,<NotUsed>,<NotUsed>,`
`<NotUsed>,<NotUsed>,PREHEAT[millisecond],<NotUsed>,Ch1E,Ch1F`
`,Ch1G,Ch1H,Ch2E,Ch2F,Ch2G,Ch2H,…,Ch4E,Ch4F,Ch4G,Ch4H,…,<cr>`

Note1: … represents the remaining channels that are not used.

Note 2: CH1A to CH1F are the coefficients for the temperature sensor; CH2A to CH2C are the coefficients for the conductivity sensor; CH4B is the coefficient for the power supply voltage.

There are other commands that allow checking calibration coefficients, instrument serial number and firmware version separately. See below:

(c) Checking calibration coefficients

Temperature calibration coefficients:

PC→instrument `<d1><d1>headR,30,CH1,<cr>`

PC←instrument `<d1><d1>CH1,CH1a,CH1b,CH1c,CH1d,CH1e,CH1f,CH1g,`
`CH1h,<NotUsed>,<cr>`

Conductivity calibration coefficients:

PC→instrument `<d1><d1>headR,31,CH2,<cr>`

PC←instrument `<d1><d1>CH2,CH2a,CH2b,CH2c,CH2d,CH2e,CH2f,CH2g,`
`CH2h,<NotUsed>,<cr>`

Voltage calibration coefficients:

PC→instrument `<d1><d1>headR,33,CH4,<cr>`

PC←instrument `<d1><d1>CH4,CH4a,CH4b,CH4c,CH4d,CH4e,CH4f,CH4g,`
`CH4h,<NotUsed>,<cr>`

The equations, in which `a, b, c, d, e, f, g` and `h` coefficients are applied, can be found in the calibration certificate of the instrument.

(d) Checking serial number and firmware version:

PC→instrument `<d1><d1>card?,<cr>`

PC←instrument `<d1><d1>card,<NotUsed>,<NotUsed>,<NotUsed>,<version>,`
`A7CT-CAR,<SerialNumber>,<cr>`

- `<version>` shows the firmware version.
- `<SerialNumber>` shows the serial number of the instrument.

(4) Data output

(a) Physical data

- Physical data is the data into which the raw output data is converted by using the calibration coefficients.
- The number of decimal places is three and the number of display digits of integer is variable.
- <stat> shows the instrument status

PC→instrument <d1><d1>pval,<cr>

PC←instrument <d1><d1>pval,conductivity (mS cm^{-1}), temperature (ºC), salinity, Voltage(V),<stat>,<cr>

e.g.) PC→instrument <d1><d1>pval,<cr>

PC←instrument <d1><d1>pval,42.914,15.000,35.000,12.452,0,<cr>

(b) N-value data

- N-value is the raw output data of the instrument (16bit A/D conversion).
- <stat> shows the status of the instrument

PC→instrument <d1><d1>real,<cr>

PC←instrument <d1><d1>real,Temperature,Conductivity,Voltage,<stat>,<cr>

e.g.) PC→instrument <d1><d1>real,<cr>

PC←instrument <d1><d1>real,12345,23456,34567,0,<cr>

8.3 A7CT-CAD (RS-485 communication protocol) – command list

All characters are ASCII.

Main instruction	ID	,	Command	,	SUB command	,	End
? : read ! : write = : response	Instrument ID from 00 to 99 (00 is the common ID)						<cr>

(1) Setup

(a) Updating the instrument ID

PC→instrument `!ID,HEAW,87,ID,<ID>,1,<cr>`

PC←instrument `=ID,HEAW,87,ID,<ID>,1,<cr>`

<ID> number should be a number between 01 and 99.

e.g.) Changing the ID from 01 to 03

PC→instrument `!01,HEAW,87,ID,03,1,<cr>`

PC←instrument `=01,HEAW,87,ID,03,1,<cr>`

(b) Checking the instrument ID

PC→instrument `?ID,HEAR,87,<cr>`

PC←instrument `=ID,HEAR,ID,<ID>,1,<cr>`

e.g.) PC→instrument `?00,HEAR,87,<cr>`

PC←instrument `=00,HEAR,ID,03,1,<cr>`

- ID:00 is a wildcard.

(2) Setting date and time

(a) Updating date and time

PC→instrument `!ID,DATE,<year><month><day><hour><minute><second>,<cr>`

PC←instrument `=ID,DATE,<year><month><day><hour><minute><second>,<cr>`

`<year>` → yyyy (4 digits)

`<month>` → mm (2 digits)

`<day>` → dd (2 digits)

`<hour>` → hh (2 digits)

`<minute>` → mm (2 digits)

`<second>` → ss (2 digits)

e.g.) October `17, 2019 3:30` PM

PC→instrument `!01,DATE,20191017153000,<cr>`

PC←instrument `=01,DATE,20191017153000,<cr>`

(b) Checking clock information

PC→instrument `?ID,DATE,<cr>`

PC←instrument `=ID,DATE,<year><month><day><hour><minute><second>,<cr>`

e.g.) PC→instrument `?01,DATE,<cr>`

PC←instrument `=01,DATE,20191017153000,<cr>`

(3) Checking the number of channels

PC→instrument `?ID,CHAN,<cr>`

PC←instrument `=ID,CHAN,<Ch-number>,<cr>`

`<Ch-number>` → ccccc (5 digits). The length is fixed and goes from 00000 to 00016.

The A7CT-CAD has 4 channels and `<Ch-number>` should show `00004`. See below.

e.g.) PC→instrument `?01,CHAN,<cr>`

PC←instrument `=01,CHAN,00004,<cr>`

(4) Checking the serial number

PC→instrument `?ID,SERI,<cr>`
PC←instrument `=ID,SERI,<S-No>,<cr>`

e.g.) PC→instrument `?01,SERI,<cr>`
PC←instrument `=01,SERI,0001,<cr>`

(5) Checking calibration coefficients

There are 4 channels (Ch1: temperature, Ch2: conductivity, Ch3: not used ("<NotUsed>") and Ch4: voltage) with 8 calibration coefficients each (A, B, C, D, E, F, G, H).

PC→instrument `?ID,COFE,<cr>`
PC←instrument `=ID,COFE,Ch1A,Ch1B,Ch1C,Ch1D,Ch1E,Ch1F,Ch1G,Ch1H,`
`Ch2A,Ch2B,Ch2C,Ch2D,Ch2E,Ch2F,Ch2G,Ch2H,Ch3A,Ch3B`
`Ch3C,Ch3D,Ch3E,Ch3F,Ch3G,Ch3H,Ch4A,Ch4B,Ch4C,Ch4D,`
`Ch4E,Ch4F,Ch4G,Ch4H,<cr>`

(6) Checking the firmware version

PC→instrument `?ID,VERS,<cr>`
PC←instrument `=ID,VERS,<F-ver>,<cr>`

`<F-ver>`: shows the firmware version.

e.g.) PC→instrument `?01,VERS,<cr>`
PC←instrument `=01,VERS,Ver0.05,<cr>`

(7) Data output

(a) Physical data

- Physical data is the data into which the raw output data is converted by using the calibration coefficients.
- The number of decimal places is three and the number of display digits of integer is variable.
- `<stat>` shows the instrument status

PC→instrument `?ID,PVAL,<cr>`
PC←instrument `=ID,PVAL, conductivity (mS cm`$^{-1}$`), temperature (ºC), salinity,`
`Voltage(V),<stat>,<cr>`

e.g.) PC→instrument `?01,PVAL,<cr>`

PC←instrument `=01,PVAL,42.914,15.000,35.000,0,<cr>`

(b) N-value data

- N-value is the raw output data of the instrument (16bit A/D conversion).
- `<stat>` shows the status of the instrument.

PC→instrument `?ID,NVAL,<cr>`

PC←instrument `=ID,NVAL,Temperature,Conductivity,Voltage,<stat>,<cr>`

e.g.) PC→instrument `?01,NVAL,<cr>`

PC←instrument `=01,NVAL,12345,23456,34567,0,<cr>`

9. Maintenance

10.1 Before deployment

Check if the instrument is operating properly by testing communication and cables.

10.2 Maintenance after deployment

(1) Use the brush included in the accessories to carefully clean the conductivity cell.

(2) Confirm that there is no visible damage in the sensor or cable. If any damage is identified, we recommend contacting us immediately. The instrument may need to be serviced and repaired.

(3) Do not deploy an instrument that is damaged. This may aggravate the damage and make the instrument irreparable.

10.3 Storage

(1) Wash the instrument with freshwater abundantly to remove residual seawater.

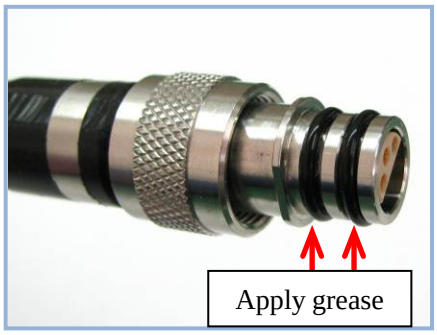
(2) After washing the instrument, wipe off the moisture on the instrument before storing it.

(3) When storing the instrument, avoid locations with high temperatures, high humidity, and that are exposed to direct sunlight.

10.4 Periodic maintenance

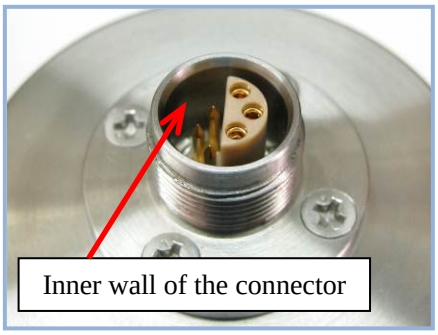
(1) In order to maintain the initial accuracy of the instrument, we recommend to a periodical overhaul of the instrument, in which component inspection, maintenance and sensor recalibration are performed at our factory at least once a year.

10.5 Attaching and detaching the waterproof connector



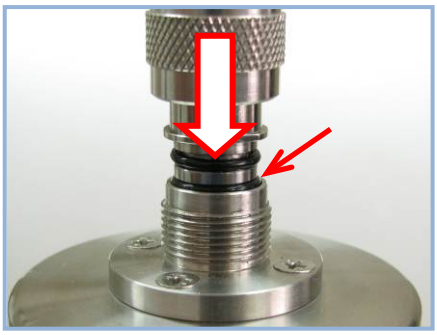
(1) Communication cable (in the connector end)

- Check if there is no dust or anything else adhered to the o-rings.
- Apply a small portion of silicon grease on the o-rings. If too much silicon grease is applied, there is a risk that dust or any other particle gets adhered to the o-rings more easily.



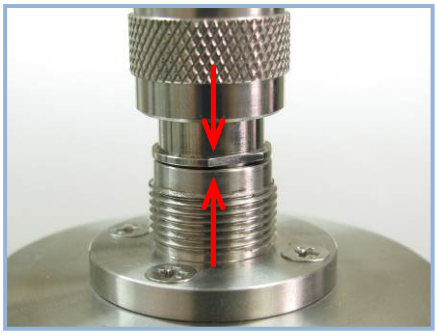
(2) Inner wall of the connector in the instrument

- Check if there is no dust or any kind of particles adhered to the wall.



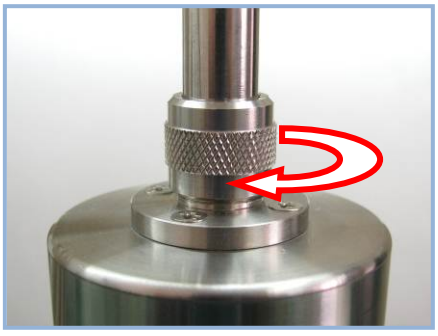
(3) Connecting the cable to the instrument.

- Adjust a position ensuring that male and female connectors fit correctly.
- Insert the cable straightly to the instrument.



(4) Insert the cable connector firmly

- Insert firmly until all o-rings are completely covered.



(5) Tighten the connector nut firmly until the end of the screw thread.

Note: After detaching the cable from the instrument, do not let the instrument and cable connectors without the protection cap. The protection cap helps to keep the

10. Troubleshooting

No.	Problem	Action
1	Unable to establish communication with PC (or control system).	Check the power supply and the connecting port number.
2	Unable to start measuring.	Check the power supply voltage and connection.
3	Missing data	Data is not obtained during preheating. Check preheating time.
4	The conductivity cell seems to be damaged.	The sensor may not work properly and data should not be trusted. Contact us for a better assessment [(1)].
5	Observed values are way out of range.	Contact us for a better assessment [(1)].
6	Temperature sensor is damaged.	The sensor may not work properly and data should not be trusted. Contact us for a better assessment [(1)].

Note(1) Please let us know model name, serial number, place of measurement, measuring conditions, etc.

11. Specifications

(1) Sensor specifications

	Temperature	Conductivity
Principle	Thermistor	7-electrode
Range	-3 to 45 ºC	0.5 to 70 mS cm^{-1}*
Resolution	0.001 ºC	0.001 mS cm^{-1}
Accuracy(4)	±0.01 ºC (0 to 35 ºC)	±0.01 mS cm^{-1}* (28 to 65 mS cm^{-1})

* Please contact us for fresh water conductivity measurements.

(2) Instrument specifications

Model	A7CT-CAR	A7CT-CAD
Communication	RS-232C	RS-485
A/D converter	16-bit digital conversion	
Communication interval	0.5 s or above	
Preheating time	15 s	
Operating voltage	DC 12 to 24 V	
Power consumption	60 mA	
Material	Titanium (grade 2)	
Dimensions	Φ54 × 217 mm	
Weight	Approx. 0.6 kg in air, 0.3 kg in water	
Depth rating	1000m depth equivalent	
Cable length	20m (standard)	

12. Warranty

The warranty period shall be one (1) year from the date of shipment from our factory, and will be repaired or replaced against any malfunctions attributed to its design, manufacturing, or malfunction occurred with proper use within the warranty period.
However, this warranty will NOT be applied to the following cases:

(1) This warranty will not be applied to any accessories, consumables, packing, scratches unrelated to its functions, grime, rust and others.

(2) Damaged caused when integrating, mooring, observing or storing.

(3) Malfunction or damage caused by incorrect operation or carelessness.

(4) Malfunction or damage caused by unwarrantable repair or modification, which was not performed by JFE Advantech Co., Ltd.

(5) Malfunction or damage caused by transporting, dropping, or applying impact after its purchase.

(6) Malfunction or damage caused by external factors such as fire, earthquake, flood, lighting, or any other natural disaster, including pollution, abnormal voltage or others.

(7) Malfunction or damage caused by connecting to defective equipment.

(8) Malfunction and damage resulted from damaged consumables that were not replaced.

(9) JFE Advantech will not be responsible for any damage, lost earnings using this instrument, or any claim from a third party.

(10) Malfunction or damage resulted from installation or deployment. The end-user should consider purchasing appropriate insurance when there is a risk of damaging the instrument.

For repairs done by JFE Advantech Co., Ltd. is given guarantee for none defects in material and workmanship for six months from the date such repair was made. This warranty is limited only to the replaced part.

Manufacturer

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