V.1.1

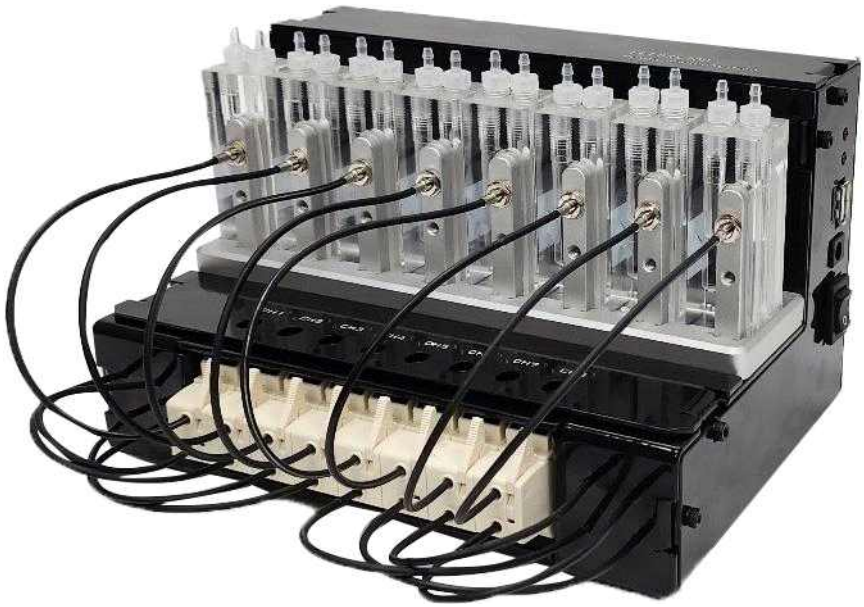
USER'S MANUAL

Biological Respirometric System (BRS)

- Aerobic/Anaerobic Respirometer -

Model | BRS-110, BRS-200, BRS-800

Revision 10 January 2024



EET Eco-Environmental Technology Inc.

http://www.eetech.co.kr eetech2011@daum.net

Don't discard the packaging box and silicon caps for plastic cells.
Save them if you need to return the product to the company for customer service

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Chapter I

Unboxing

CHAPTER I

01
Product lists (ordering information)

Product list for aerobic and anaerobic respirometer

(BRS-110, BRS-200, and BRS-800)

- A main respirometer unit with four cells(BRS-110 and BRS-200) and eight cells(BRS-800) attached
- A USB cable and power adapter
- A sheet for factor values for each cell
- USB driver program, BRS program, and User's manual in an USB flash drive
- Syringe (10 mL), Needles (20G), Fittings, Tubing, Stir bars
- Wheaton serum bottles (500 mL), caps, and septa
- Internal CO_2 trap
- Special oil for the cells (50 mL), Cell oil needle
- External CO_2 trap unit (Optional)
- Pure-oxygen Supply Unit (O_2 gas regulator, acrylic box, metering valve, SS tubing, tubing, fitting)

※ The oil characteristics are different for BRS-110, BRS-200, and BRS-800, so the oils are not interchangeable.

Products available

- Special oil for the cells (for BRS-110 AER, BRS-200 AER, and BRS-800 AER), Cell oil needle
- Tubing, Fitting
- Serum bottles (125, 250, 500, and 1,000 mL), caps, and septa
- Internal CO_2 trap (BOD or BMP test)
- Pure-oxygen Supply Unit (O_2 gas regulator, acrylic box, metering valve, SS tubing, tubing, fitting)
- Water bath with stir plate (for 4 channels or 8 channels)
- BOD incubator with stir plate (for 4 channels or 8 channels)
- External CO_2 trap unit
- Metering valve
- O_2 gas regulator
- Syringes, Needles, Stir bars

02
How to check if the device works

- Carefully remove the device from the packaging box and connect the power cable to the right side of the device.
- Use your hand and press the BRS plastic cell down to prevent it from moving to remove the silicon caps from the plastic cells.
- Keep the silicon caps and use them when sending the product to the headquarters for A/S.
- Insert the tubing supplied by the company directly into the left fitting (gas production) of the BRS cell for channel 1 to connect it.
- Turn on the power and slowly inject air through the tubing into the BRS cell using the syringe (5~10 mL) supplied by the company to create bubbles in the cell.
- Check if the two red LEDs on the optic sensors of channel 1 (right, left order) and the green LED on the right side of the device are blinking every time bubbles rise in the BRS cell (refer to the movie clip provided).
- Similarly, do the same things and check if the LEDs blink for channels 2, 3, and 4.
- If the LED does not blink, contact the company and refer to the manual to perform an optic sensor calibration (refer to the manual).
- If there is no problem, connect the device to the computer with the USB cable and install the BRS program.

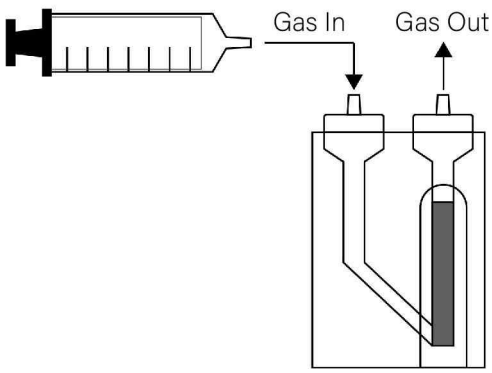


Fig. Connection with a syringe (5~10 mL) and the BRS cell

03
Program installation and operation flowchart

USB driver installation

▼

BRS program installation

▼

USB port setting for connection between the device and the BRS program

▼

Check if the BRS system works

▼

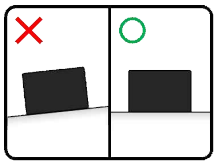
Connection between bioreactors and cells

▼

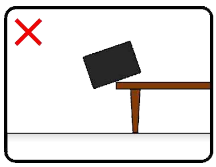
Start a measurement

04
Caution

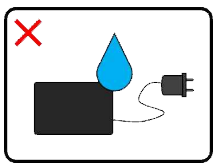
Device installation



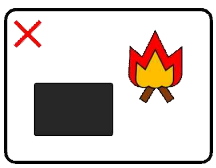
Install the device horizontally.



Be careful not to drop the device.

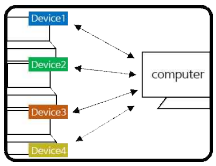


Make sure the device does not come into direct contact with water.

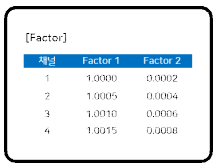


Do not place the device near flammable materials.

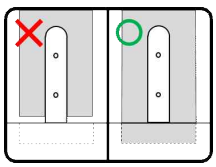
Before measurement



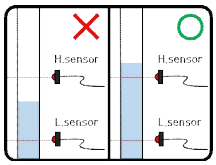
You can connect up to four devices to one computer, and each port number must be set for each device. Also, make sure to turn off the power-saving mode of the computer.



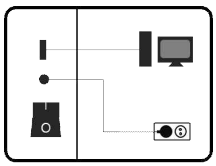
To obtain more accurate results, perform the experiment in a constant temperature chamber or incubator, while verifying that the factor values are accurately entered.



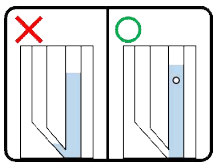
The BRS cells must be positioned exactly in the groove below. Do not switch the positions of the BRS cells.



Before starting the experiment, check if the BRS cells are filled with oil. After injecting air with a syringe into the BRS cell, the height of the oil level in the BRS cell should be higher than the H.sensor.

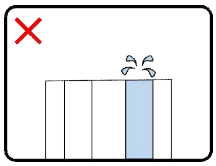


Make sure that the device's power or USB is properly connected. If the device's power or USB cable has been disconnected or if the port number of the option has been changed, be sure to restart the BRS program.

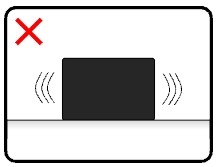


Before taking any measurements, confirm that when bubbles are generated using a syringe.

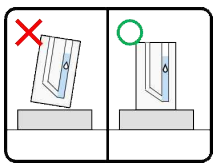
During measurement



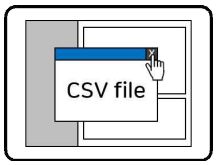
Be careful as oil inside the BRS cell may flow out when the end of the syringe needle inserted to the septum of the bioreactor is blocked by water and pressure build up.



Do not move or shake the device.



Do not switch the cells.



If a raw data file or cumulative data file is open, measurement will not be stop and data will not be saved. Therefore, be sure to close the file.

Chapter II

Respirometer Description

CHAPTER II

01
Principle of the respirometer

Theory

This product is a bubble-type microbial respiration measurement device that measures the amount and rate of gas generated (or consumed) in the reactor over time and displays it on graphs. The gas generated (or consumed) in the reactor rises in the form of bubbles in a BRS cell filled with oil and passes through two photo sensors located at the top and bottom of the BRS cell. The amount of gas generated (or consumed) over time can be measured in two modes 1) by counting the number of bubbles (fixed bubble volume mode) or 2) by measuring the bubble volume each time a bubble generated and adding these to calculate the total generated volume (bubble volume calculation mode).

BRS-110 and BRS-200 can be operated by fixed bubble volume mode and bubble volume calculation mode. BRS-800 can be operated by fixed bubble volume mode only.

Fixed Bubble Volume Mode: Generally, as the airflow rate to the BRS cell increases from 0.3 mL/min to 20 mL/min, the bubble volume increases by about 20%. However, if the airflow rate is as small as 0.1 mL/min, that is, 144 mL/day, there is little differences in the volume of the generated bubbles, so the total volume is measured

by counting the number of bubbles generated. This method is the fixed bubble volume mode.

Bubble Volume Calculation Mode: Bubble volume is measured each time a bubble is created. The bubble volume is measured using two optic sensors, specifically a low and a high sensor, with a travel distance. T1 is the times taken by the bubble to cross the high sensor and T2 is the time elapsed from when a bubble first touches the lower sensor until it touches the upper sensor. Using T1 and T2 the volume of the bubble can be calibrated by adding different air flow rates using a syringe pump.

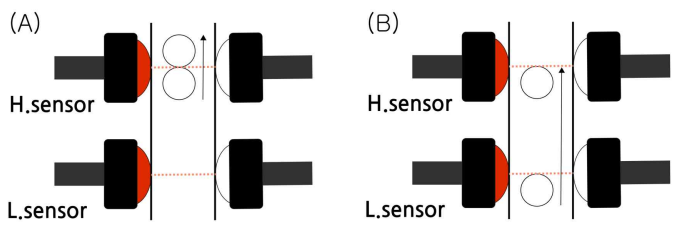


Fig. BRS cell depiction of (A) T1 and (B) T2

Applications

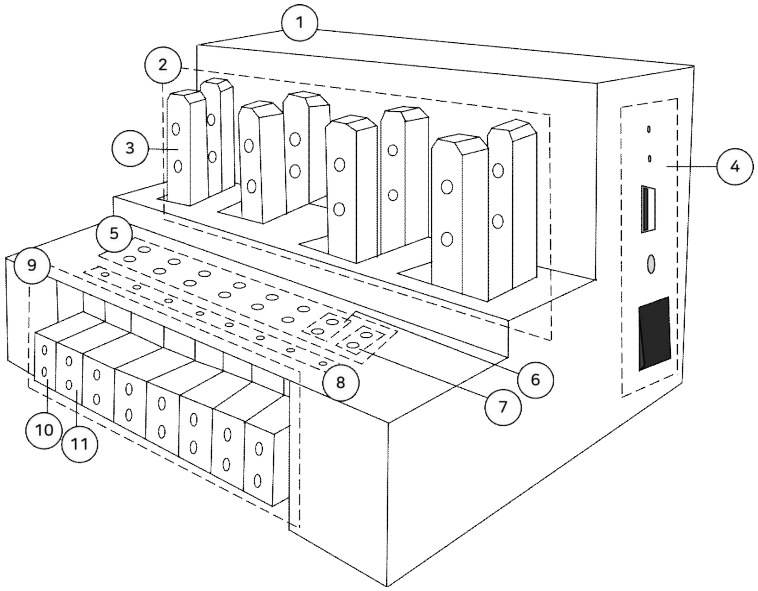
- Measurement of oxygen consumption
- Oxygen uptake rate (OUR)
- Toxicity screening
- Biodegradation test
- Treatability assessment
- Laboratory respiration studies
- Soil and compost respiration
- Biogas production
- Respiration of plants/animals
- BMP test
- Biochemical hydrogen potential
- Green energy studies

CHAPTER II

02
Respirometer configuration

Respirometer

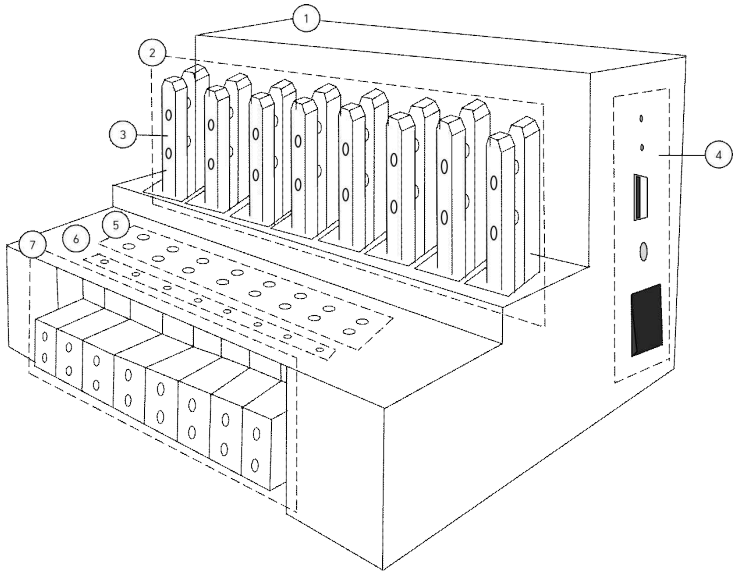
(BRS-110 and BRS-200)



① Main board
② BRS cells
③ Cell Support
④ Power and data output
⑤ Optic sensor adjustment
⑥ H.sensor adjustment
⑦ L.sensor adjustment
⑧ Red LEDs
⑨ Optic sensors
⑩ Optic sensors for high position (H.sensor)
⑪ Optic sensors for low position (L.sensor)

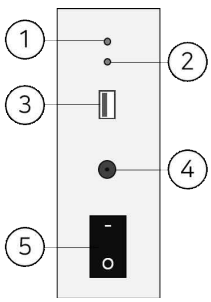
Respirometer

(BRS-800)



① Main board
② BRS cells
③ Cell Support
④ Power and data output
⑤ Optic sensor adjustment
⑥ Red LEDs
⑦ Optic sensors

Power and data output

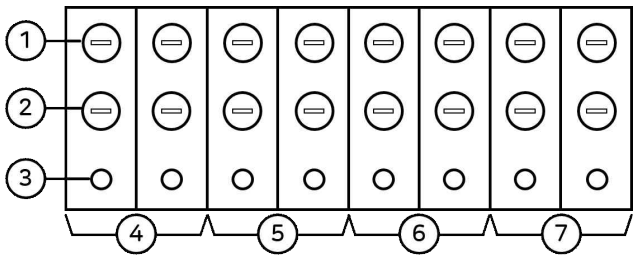


① Power LED
② Data output LED
③ USB cable connect
④ Power cable connect
⑤ Power button

Optic sensors

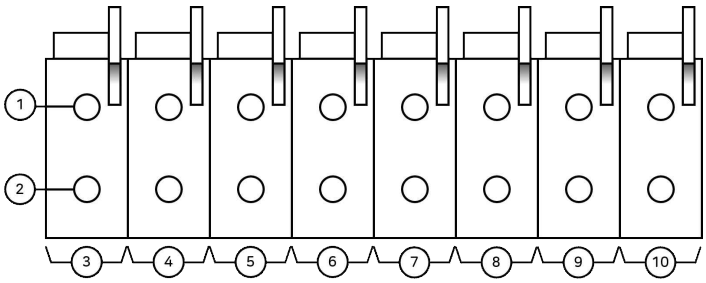
(BRS-110 and BRS-200)

<Parts for adjustment>



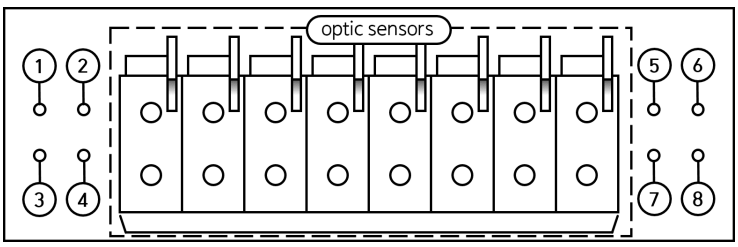
① Fine adjustment
② Coarse adjustment
③ Red LEDs
④ Ch.1
⑤ Ch.2
⑥ Ch.3
⑦ Ch.4

<Optic sensors>



① Light receive
② Light send
③ Ch.1 H.sensor
④ Ch.1 L.sensor
⑤ Ch.2 H.sensor
⑥ Ch.2 L.sensor
⑦ Ch.3 H.sensor
⑧ Ch.3 L.sensor
⑨ Ch.4 H.sensor
⑩ Ch.4 L.sensor

<Connection of optic cable to optic sensor>

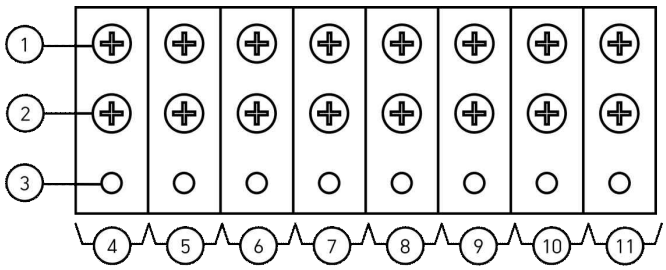


① Ch.1 H.sensor
② Ch.2 H.sensor
③ Ch.1 L.sensor
④ Ch.2 L.sensor
⑤ Ch.3 H.sensor
⑥ Ch.4 H.sensor
⑦ Ch.3 L.sensor
⑧ Ch.4 L.sensor

Optic sensors

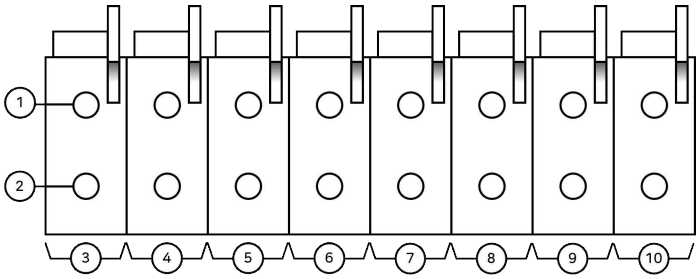
(BRS-800)

<Parts for adjustment>



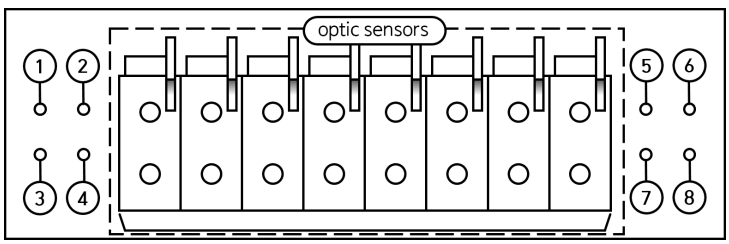
① Fine adjustment
② Coarse adjustment
③ Red LEDs
④ Ch.1
⑤ Ch.2
⑥ Ch.3
⑦ Ch.4
⑧ Ch.5
⑨ Ch.6
⑩ Ch.7
⑪ Ch.8

<Optic sensors>



① Light receive
② Light send
③ Ch.1 sensor
④ Ch.2 sensor
⑤ Ch.3 sensor
⑥ Ch.4 sensor
⑦ Ch.5 sensor
⑧ Ch.6 sensor
⑨ Ch.7 sensor
⑩ Ch.8 sensor

<Connection of optic cable to optic sensor>



① Ch.1 sensor
② Ch.2 sensor
③ Ch.3 sensor
④ Ch.4 sensor
⑤ Ch.5 sensor
⑥ Ch.6 sensor
⑦ Ch.7 sensor
⑧ Ch.8 sensor

CHAPTER II

03
BRS cells

BRS cells

	Measurable flow rate	Oil volume
BRS-110	0~1 mL/min	2.2 mL
BRS-200	1~5 mL/min	12.0 mL
BRS-800	0~0.2 mL/min	1.6 mL

Connection of a bioreactor and a BRS cell

- In the case of oxygen consumption, the bioreactor should be connected to the right top fitting using tubing (A) so that negative pressure in the headspace of the reactor will attract the oil, and oxygen gas from the pure oxygen supply unit will turn into gas bubbles in the oil.
- For measuring gas production from a bioreactor, the bioreactor should be connected to the left top fitting of a cell using tubing (B) as shown in the below figure. The generated gas will push out the oil in a cell, and the gas turns into gas bubbles in the oil.

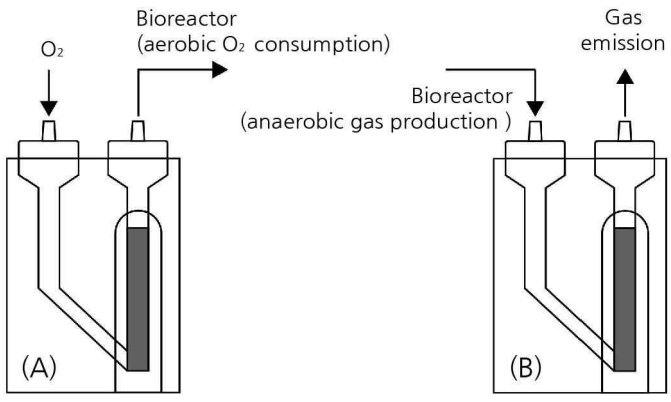


Fig. Connection of a bioreactor and a BRS cell for
(A) aerobic O_2 consumption (B) anaerobic gas production

CHAPTER II

04
Selection of the measurement mode

Bubble vol. calculation mode

- Calculate volumes of bubbles every time bubbles are generated.
- Use when the gas generation rate is more than 0.1 mL/min.
- Input the factor values according to the temperature and the minimum/maximum reference bubble volume in the settings at the BRS program.
- BRS-110 and BRS-200 can use in this mode.

Fixed bubble vol. mode

- When the gas generation rate is small (within 0.1 mL/min), there is little difference in bubble volumes. In this case, calculate the total amount of generation/consumption by fixing the bubble volume and multiplying by the number of bubbles.
- Enter the fixed bubble volume value according to the temperature in the settings at the BRS program.
- BRS-110, BRS-200, and BRS-800 can use in this mode.

	Bubble Volume Calculation Mode	Fixed Bubble Volume Mode
Definition	▫ Calculate volumes of bubbles every time bubbles are generated. ▫ Bubble volume will increase as the gas flow rate increases to over 0.1 mL/min	▫ When the gas flow rate is less than 0.1 mL/min, bubble volumes are almost the same. The bubble volume can be fixed
Advantage	▫ It is possible to measure the bubble volume every time a bubble is generated, so errors will be small	▫ Fixed bubble volume mode eliminates the need for periodic calibration.
Disadvantage	▫ It is necessary to periodically inject a fixed amount of gas manually and determine whether the equipment needs calibration (F3 calibration is possible in the laboratory if necessary)	▫ To measure gas flow rate above 0.1 mL/min, the bubble vol. calc. mode should be used.

Mode selection	□ Choose this mode when the gas flow rate is higher than 0.1 mL/min (the bubble generation rate is such that one bubble is generated and another bubble is generated within 1 to 5 seconds	□ Choose this mode when the gas flow rate is lower than 0.1 mL/min (the bubble generation rate is such that one bubble is generated, and after waiting about 5 seconds or more, another bubble is generated

CHAPTER II

05
Connection of a bioreactor and a BRS cell

Connection of bioreactor and a BRS cell

<Gas production>

① Install the BRS respirometer in an incubator set at the desired temperature.

② Place the medium and stir bars in the uninoculated bioreactors, and sparge for 5-10 minutes with N_2 gas to remove dissolved oxygen. Cover the reactors with sealed caps, each containing a septum.

③ Place the bioreactors in a water bath to adjust medium temperature to the desired experimental temperature quickly.

④ After the medium temperature of the bioreactors has increased, move them to the incubator and place them on a stirrer, then add microorganisms using a syringe with a needle.

⑤ When microorganisms are added, pressure is created in the headspace, so after adding the microorganisms, insert a needle into the septum to release the pressure; then, remove the needle after a few seconds.

⑥ To connect the bioreactors to the BRS cells, insert a needle connected at the end of the tubing into the septum as shown in the following figure.

⑦ Add N_2 gas (1~2 mL) to the reactor headspace through the septum using another syringe with a needle slowly and check for formation of bubbles in the cell. Confirm that data is being transmitted to the computer, and start measurement.

<Oxygen consumption>

Pure-oxygen Supply Unit
It is designed to keep oxygen in a state of atmospheric pressure inside the acrylic box unit supplying a continuous source of oxygen to be used in a biological reaction

① Place the BRS respirometer in an incubator set at the desired temperature.

② Place the medium, stir bars, and carbon dioxide absorption tubes (CO_2 trap with

5 M KOH solution (280.5 g KOH/L) or 30% KOH) in the uninoculated bioreactors, and cover the reactors with sealed caps, each having a septum. In this scenario, the headspace oxygen concentration will be 21% and nitrogen concentration 79%.

③ Adjust the medium temperature to the experimental temperature by placing them in a water bath.

④ After the temperature of the medium has increased, move the bioreactors to the incubator and place them on a stirrer, and then add microorganisms using a syringe with a needle.

⑤ When microorganisms are added, pressure is created in the headspace, so insert a needle into the septum to release the pressure; then, remove the needle after a few seconds.

⑥ To connect the bioreactors to the BRS cells, use a needle at the end of the tubing. Follow the diagram to connect the BRS cells and the pure-oxygen supply unit.

⑦ Withdraw gas (1~2 mL) from the reactor headspace through the septum using another syringe with a needle slowly and check for the formation of bubbles in the cell. Confirm that data is being transmitted to the computer, and start measurement.

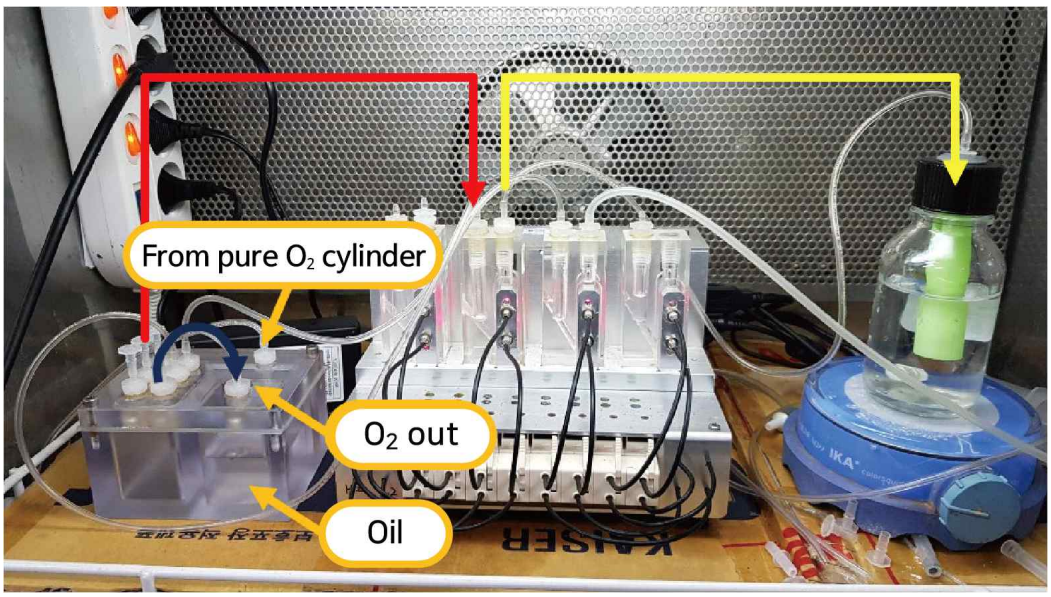


Fig. Connection of Pure-oxygen supply unit, the respirometer, and a bioreactor

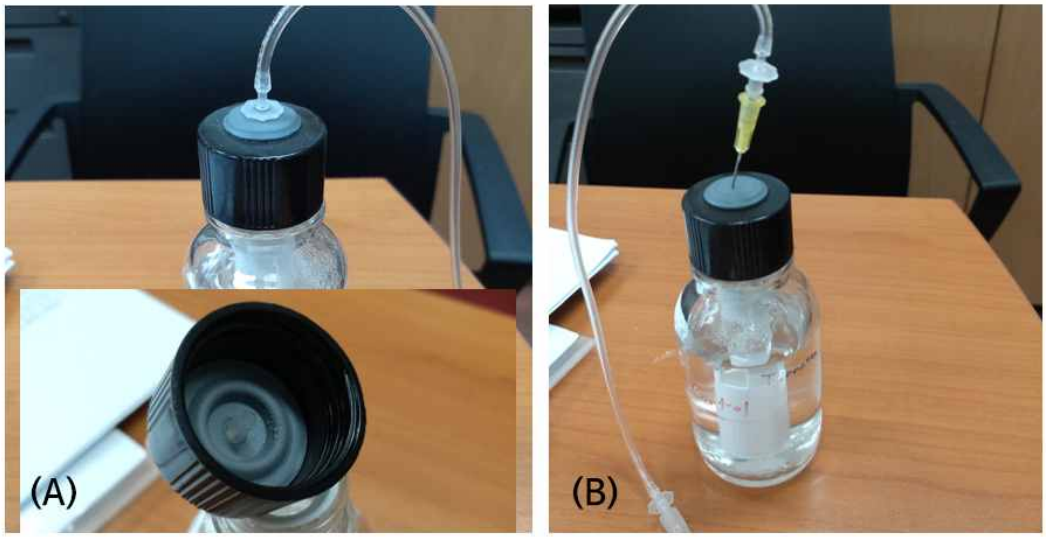


Fig. Examples of connection between bioreactor and tubing from a BRS cell using septum with fitting (A) and a needle (B)

Information for connecting of bioreactor and a cell

① It is important to use the same type of stir bar in each reactor and ensure that the stirring speed is uniform and sufficiently fast since the rate at which oxygen gas dissolves in the solution can very depending on the stirring speed.

② When bubbles pass through the H.sensor and L.sensor, the LED (red) in the optical sensor blinks and the data is transmitted to the BRS program, checking that the LED (green) on the right side of the device is blinking.

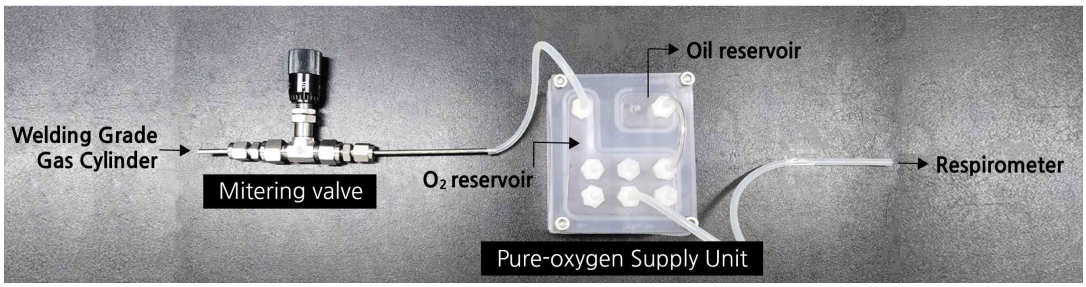
③ The CO_2 generated by the biological reaction can be removed in the from of CO_3^{2-} through 5 M KOH (280.5 g KOH/L) or 30% KOH in the CO_2 trap.

CHAPTER II

06
Pure-oxygen supply unit

Pure-oxygen supply unit

- Used to measure oxygen consumption in aerobic experiments.
- The pure oxygen supply unit consists of an oxygen gas reservoir and an oil reservoir.
- The oxygen pressure in the oxygen gas reservoir within the unit is maintained at 1 atm.
- When aerobic bacteria consume oxygen in the bioreactor headspace, negative pressure is created and causes oxygen gas to flow from the pure-oxygen supply unit through the BRS cell to the bioreactor maintaining 21% oxygen in the bioreactor headspace throughout the experiment.



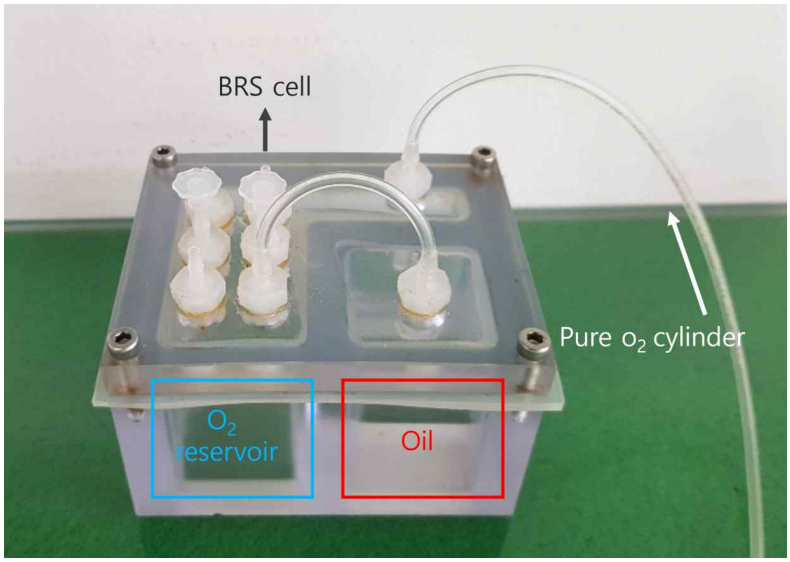


Fig. Pure-oxygen supply unit

How to assemble the pure O_2 supply unit

① Add 9.5 mL of BRS oil to the oil reservoir of the pure oxygen supply unit.

② Clean the gasket and place it on top, then cover it with the lid and tighten the four hex bolts.

③ Connect the pure oxygen gas cylinder to the pure oxygen supply unit with tubing as shown in the above figure, and also connect tubing between the oxygen reservoir and the oil reservoir.

④ Supply oxygen by slowly opening a metering valve and check if bubbles are generated in the oil reservoir, then continue to supply oxygen at a fast rate for a certain period of time (appx. 1 min) to replace the air in the oxygen reservoir with pure oxygen.

⑤ Then reduce the oxygen supply rate to around 1 mL/min. The oxygen supply rate from the gas cylinder should be higher than the oxygen consumption rate in the reactors. There should be the generation of gas bubbles in the oil reservoir throughout the experiment.

⑥ To supply O_2 to a bioreactor, remove one of silicon caps among the five fittings of the unit and connect it to the BRS cell.

Chapter III

BRS program

CHAPTER III

01
USB driver installation

USB driver installation

<Install only when connecting the device to the computer for the first time>

① Connect the USB cable to the device and the computer

② Unzip the separately attached CP210.zip

③ Open Device manager on control panel

④ Confirm that Silicon Labs CP210x CP2102 USB to UART Bridge Controller(hereinafter "CP210x") is created in the "Port (COM and LPT)" item

⑤ CP210x-(Right)-Click [Properties]

⑥ Click on Driver-Update Driver

⑦ Click Find Driver Software on your computer

⑧ After clicking [Browse], select the extracted folder, and then proceed to complete installation

USB port setting and check

① Make sure that the BRS-110 AER's power is on and that the USB cable is connected.

② Click [Port (COM and LPT)] in [Device Manager], and then click CP210x (COM1).

③ Set “bit 38400, data bit 8, no parity, stop bit 1, no flow control” in “port setting”.

④ Click the "Advanced" button to check the COM port number.

⑤ Click the [OK] button to close the setting window

CHAPTER III

02
BRS program installation and connection

BRS program installation

① Unzip the BRS setup file

② Click "BRS setup.exe"to install a program

③ Default installed folder is C:₩EET₩BRS₩

④ Be sure to turn off computer sleep mode after the installation is complete

BRS program uninstall

① Close the BRS program

② If a Raw or Data file is open, the BRS program may not be properly uninstalled

③Therefore, if any of these files are open, please close them before attempting to uninstall the BRS program

④ Uninstall the BRS program from Apps or click the unins000.exe file on C:₩EET₩BRS₩

⑤ Raw folder and Data folder are not deleted by uninstalling the program; if necessary manually delete the two folders with data

Connection of a device and a program

① Launching the BRS program, click on Menu - Option - Option

② Activate the "Use" button according to the number of devices being used

③ Check the port number in the BRS port setting

④ Open the Device Manager to check the port number from Port(COM&LPT)

⑤ If the port number in the BRS program and port number in the Device Manager are different, adjust the port number in the Device Manager to match the BRS port number

⑥ Click the OK button to close and restart the BRS program

⑦ If the port number in the BRS program and port number in the Device Manager are the same, click the Cancel button to close the option window

⑧ The port numbers of all installed BRS programs must be different

CHAPTER III

03
BRS program operation

BRS program operation

① Run the BRS program by clicking on the BRS shortcut on the desktop.

② To connect the respirometer and the BRS program, match the COM port number with the port number in the BRS port setting, and restart the BRS program.

③ If the connection fails even after restarting the BRS program, reboot the computer and then run the BRS program again.

④ Check the connection in the lower left corner of the program based on the yellow color of the figures ①~④.

Settings

① Click on the menu "Settings"

② Choose the experiment mode (variable bubble vol. mode or fixed bubble vol. mode)

③ Enter the settings value provided by company

④ Input the actual operating temperature that the user is experimenting with, and change the Time interval, Save interval of cumulative data, or Save interval of raw data according to the user's convenience

⑤ If the provided values are not entered correctly, accurate measurement results may not be obtained. Make sure to enter them correctly

Start measurement

① After clicking on the "Measurement" menu, check if channels 1 to 4 are all in waiting mode

② Select the channels to be measured and click the "Start measurement" button

③ Multiple channels can be started simultaneously

④ Confirm that the channels that started the measurement has changed to "Measuring" in the channel information

Check the data

To view cumulative data find the desired file in the corresponding data folder shown below and load it into an Excel program. The data is represented as shown in the figure below.

Data folder

<Location>

BRS I : C:₩EET₩BRS₩BRS1₩Data
BRS II : C:₩EET₩BRS₩BRS2₩Data
BRS III : C:₩EET₩BRS₩BRS3₩Data
BRS IV : C:₩EET₩BRS₩BRS4₩Data

<File name>

BRS no._Data_Date_Time_No. of start
ex) B1_Data_20221221_160000_1
ex) B2_Data_20221221_170000_1

Start time	3/13/2023 16:26:22	3/13/2023 16:26:22	3/13/2023 16:26:22	3/13/2023 16:26:22
Product no	Test_BRS			
Test name	Test1	Test2	Test3	Test4
Factor1	2.1816	2.1284	2.0054	1.9241
Factor2	0.0092	0.0073	0.0025	0.0031
Factor3	1	1	1	1
Minutes	Ch 1	Ch 2	Ch 3	Ch 4
0	0	0	0	0
1	0.0897	0.0888	0.0897	0.0926
2	0.1794	0.1776	0.1794	0.1812
3	0.2995	0.2962	0.2983	0.3001

Fig. An example of data file in excel (BRS-110 and BRS-200)

Start time	3/13/2023 16:26:22	3/13/2023 16:26:22	3/13/2023 16:26:22	3/13/2023 16:26:22	3/13/2023 16:26:22	3/13/2023 16:26:22	3/13/2023 16:26:22	3/13/2023 16:26:22
Product no	Test_BRS							
Test name	Test1	Test2	Test3	Test4	Test5	Test6	Test7	Test8
Factor1	2.1816	2.1284	2.0054	1.9241	2.1816	2.1284	2.0054	1.9241
Factor2	0.0092	0.0073	0.0025	0.0031	0.0092	0.0073	0.0025	0.0031
Factor3	1	1	1	1	1	1	1	1
Minutes	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8
0	0	0	0	0	0	0	0	0
1	0.0897	0.0888	0.0897	0.0926	0.0897	0.0888	0.0897	0.0926
2	0.1794	0.1776	0.1794	0.1812	0.1794	0.1776	0.1794	0.1812
3	0.2995	0.2962	0.2983	0.3001	0.2995	0.2962	0.2983	0.3001

Fig. An example of data file in excel (BRS-800)

<If a raw file or cumulative data file is open, automatic saving and stopping measurement may not be executed, so the opened file (raw file and/or cumulative data file) must be closed>

<If you need to check the data value during the experiment, press the small save button just next to "Save interval of cumulative data" or "Save interval of raw data" to update to the latest data. Then, copy the raw or data file you want to view, paste it into another folder, and open the file to check>

<When the "Start measurement" is clicked, a data and raw file will be created automatically in the folder>

Raw folder

<Location>

BRS I : C:₩EET₩BRS₩BRS1₩Raw
BRS II : C:₩EET₩BRS₩BRS2₩Raw
BRS III : C:₩EET₩BRS₩BRS3₩Raw
BRS IV : C:₩EET₩BRS₩BRS4₩Raw

<File name>

BRS no._Raw Ch no._Date_Time_Test name
ex) B1_Raw1_20221221_160000_Test1

ex) B2_Raw2_20221221_170000_N2

Time	T1	T2	Ch 1
3/13/2023 20:00	100.1	204.8	0.05
3/13/2023 20:14	100.9	203.9	0.05
3/13/2023 21:22	100.8	204.1	0.05
3/13/2023 21:25	100.5	204.6	0.05

Fig. An example of raw file in excel

Data convert

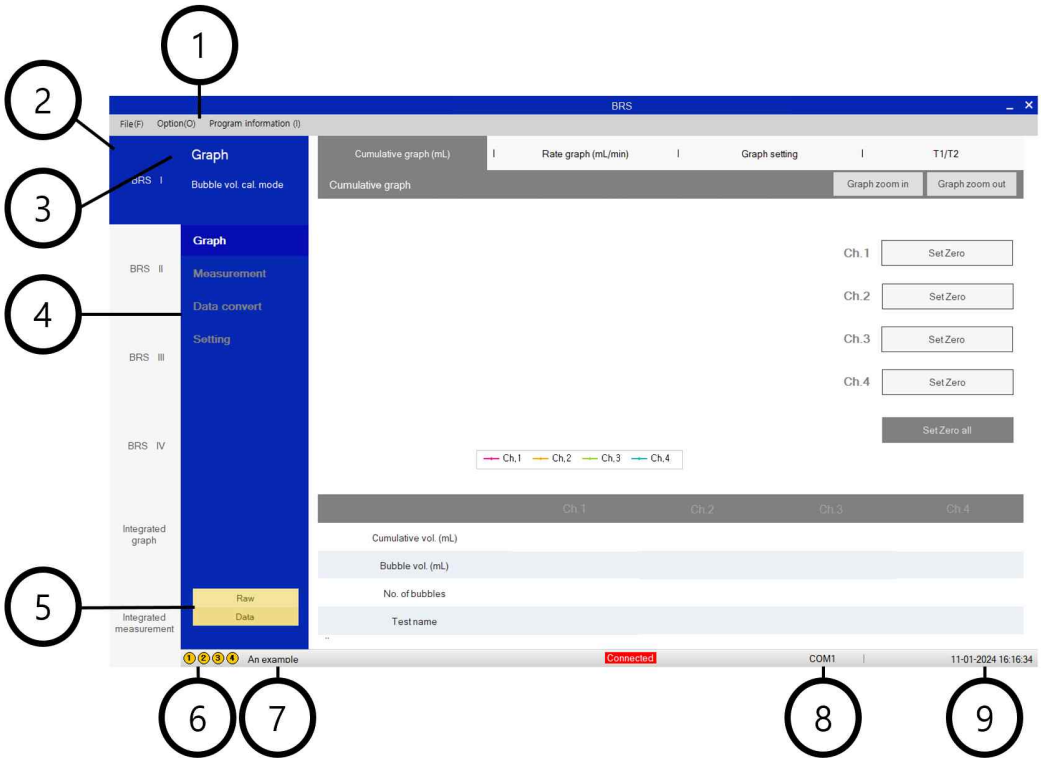
◦ Time interval in the data file can be changed using raw files in the "Data convert" menu, for example, time interval 1 hour to 10 min interval.

- In the "Data convert" menu, four raw files can be chosen by clicking files in the file list
- After choosing files, change cumulative time (time interval) and click "Apply"
- Then, data having changed time intervals can be obtained

04
BRS program screen

Common information

(BRS-110, BRS-200, and BRS-800)



① Menu

- File (F) : Time calculator (Ctrl+T), Exit (Alt+X)
- Option (O) : Option (Ctrl+O), Device manager (Ctrl+D),
- Program information (I) : Product no. registration (Ctrl+R), Update list (Ctrl+U), Program information (Ctrl+I)

② BRS selection

- This program can control 4 BRS respirometers simultaneously

③ Sub-menu and current operation mode

- Check the bubble vol. calc. mode or fixed bubble vol. mode(BRS-110 and

BRS-200)

- Fixed bubble vol. mode is fixed in BRS-800

④ Menu

- Graph, Measurement, Data convert, Setting

⑤ Button for opening Raw folder or Data folder

⑥ Device connection status

- Measuring (green), Waiting (yellow), Disconnected (black)

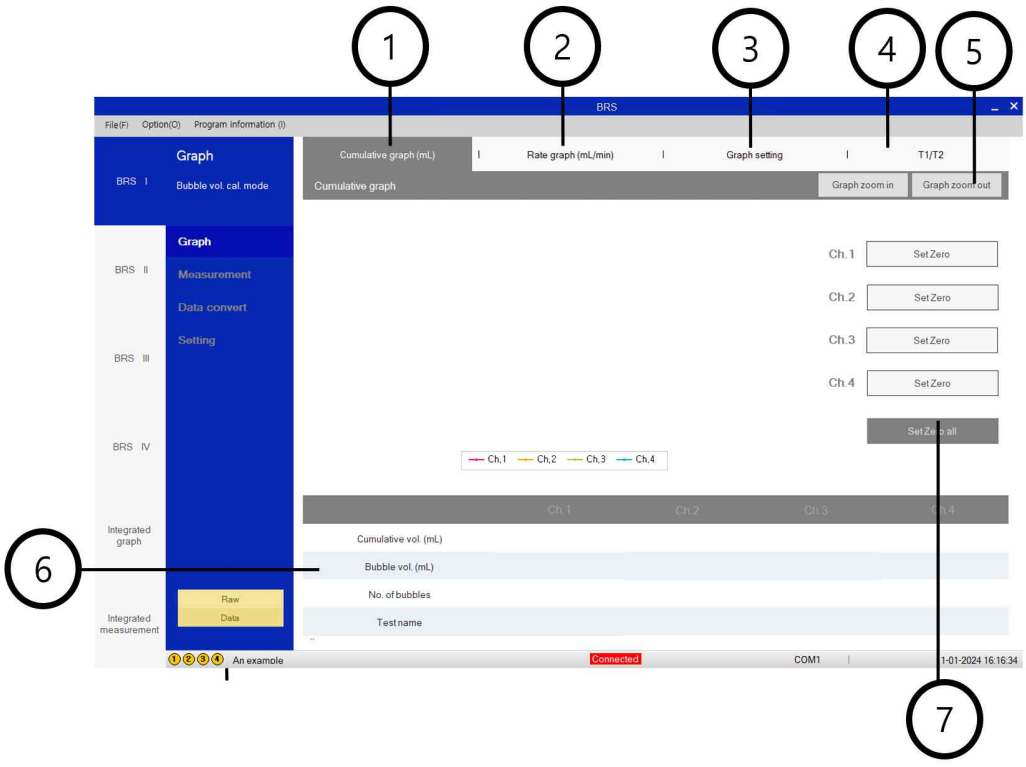
⑦ Product no.

⑧ Port no.

⑨ Date and time

Graph

<Graph>



① Cumulative graph

② Rate graph

③ Graph setting

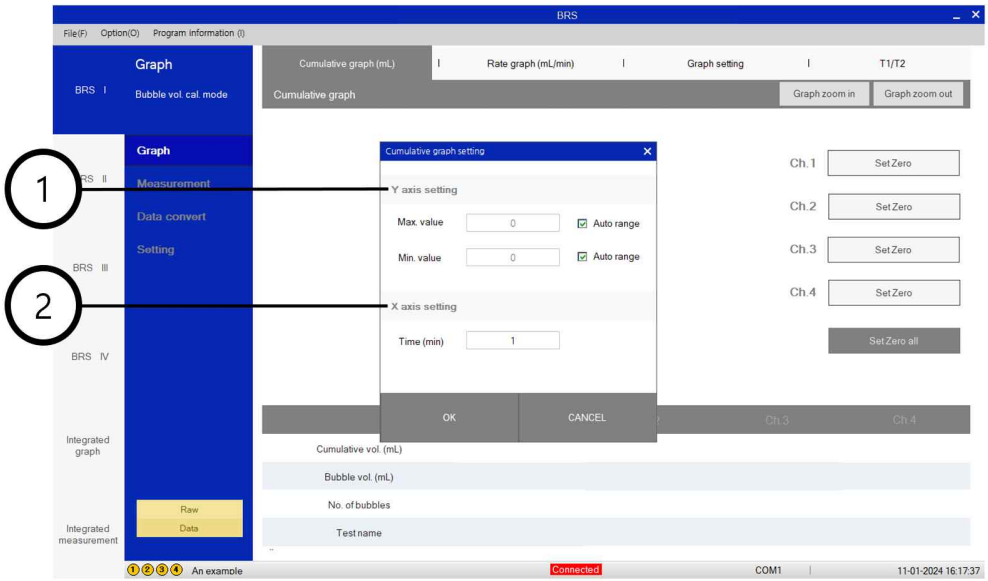
④ T1, T2

⑤ Zoom in and zoom out of graph

⑥ Data table

⑦ Buttons for semi-continuous operation

<Graph setting>



① Y axis setting

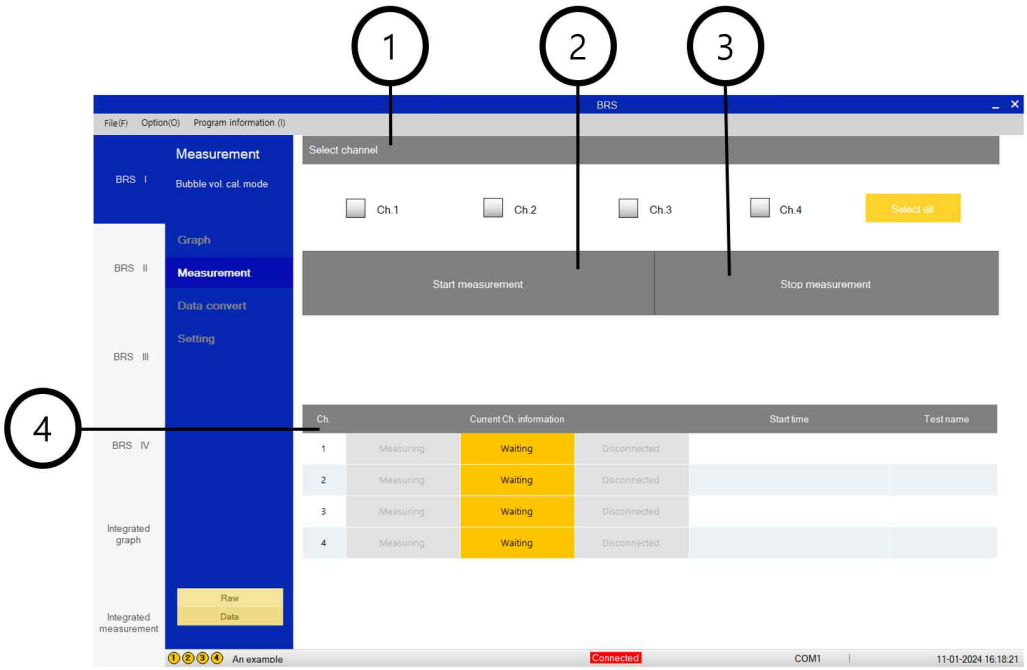
- Max. and min. values for Y axis

② X axis setting

- Time interval for zoom in and zoom out

Measurement

(BRS-110 and BRS-200)



① Select channel

- Select each channel to start or stop
- By clicking Select all button, all channels are selected to start or stop measurement

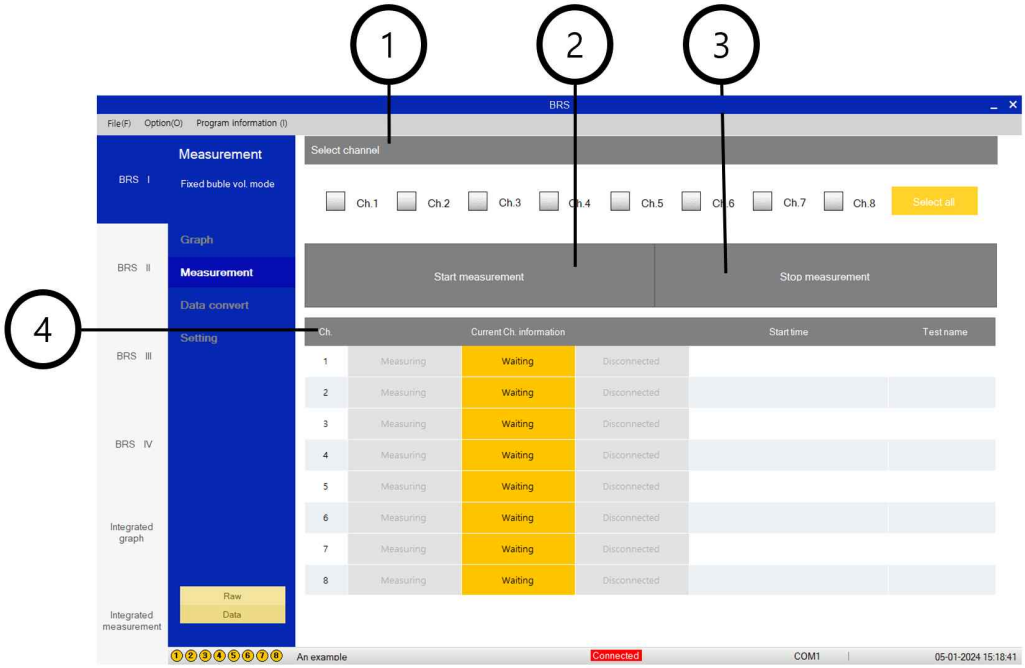
② Start measurement

③ Stop measurement

④ Current status

- It is possible to check the current status, measurement start time, and experiment name for each channel
- Measuring (green), Waiting (yellow), Disconnected (black)

(BRS-800)



① Select channel

- Select each channel to start or stop
- By clicking Select all button, all channels are selected to start or stop measurement

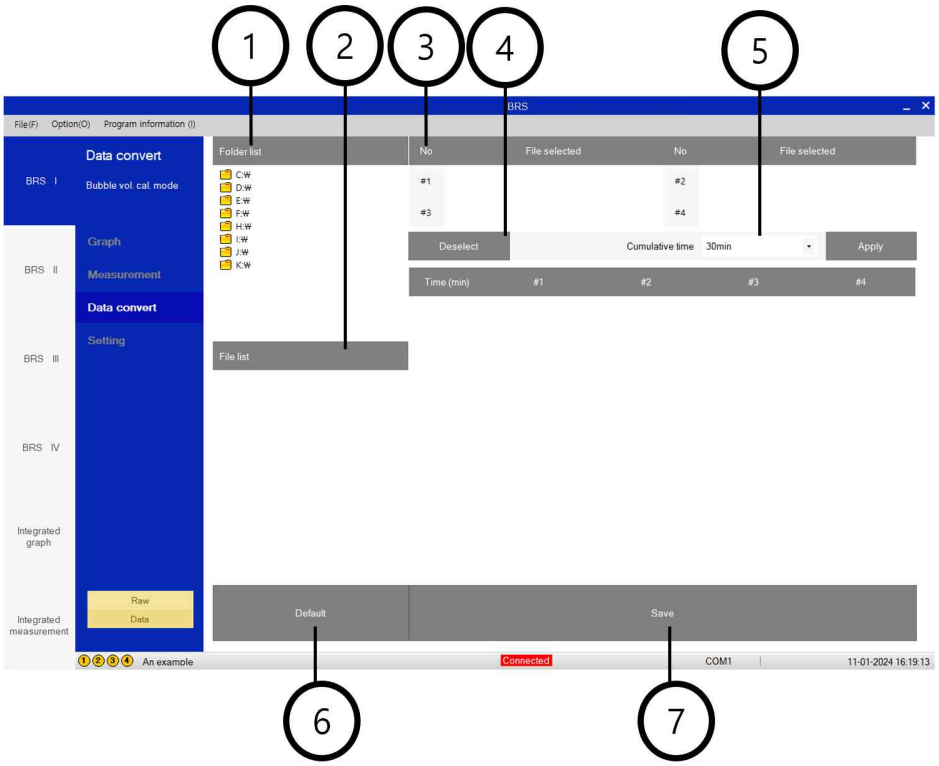
② Start measurement

③ Stop measurement

④ Current status

- It is possible to check the current status, measurement start time, and experiment name for each channel
- Measuring (green), Waiting (yellow), Disconnected (black)

Data convert



① Folder list

② File list

③ Selected file

④ Deselect

⑤ Cumulative time

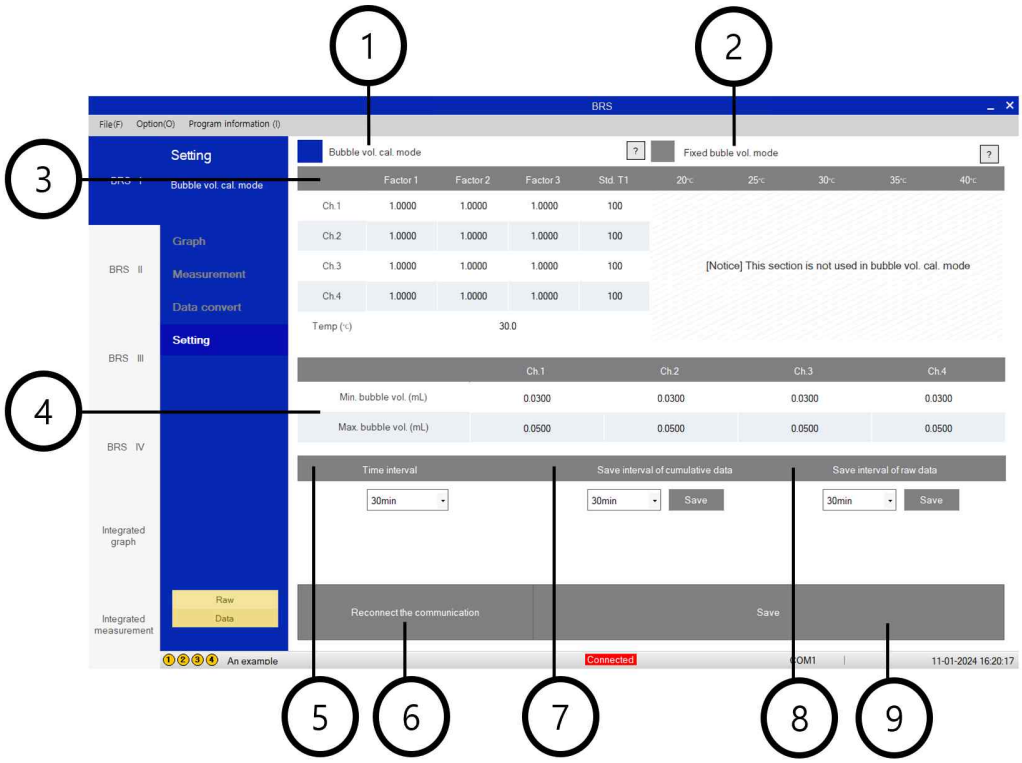
⑥ Reset

⑦ Save converted file

Setting

(BRS-110 and BRS-200)

<Bubble vol. calc. mode>



① Bubble vol. calc. mode

② Fixed bubble vol. mode

③ Input calibrating values for bubble vol. calc. mode

④ Min. and Max. bubble vol. (bubble vol. calc. mode only)

⑤ Time interval

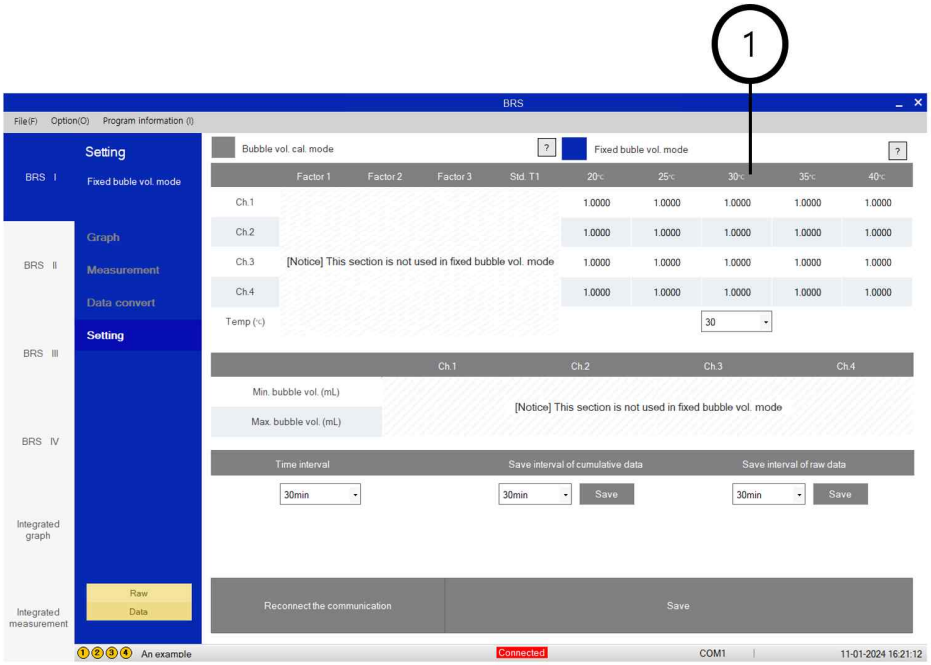
⑥ Reconnect the communication

⑦ Save interval of cumulative data

⑧ Save interval of raw data

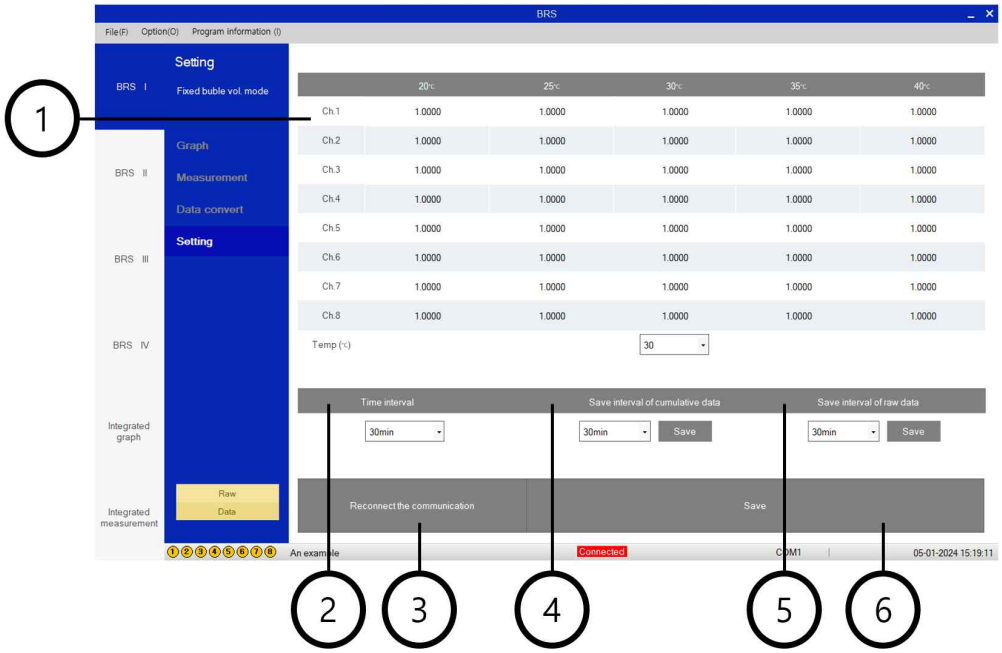
⑨ Save the setting

<Fixed bubble vol. mode>



① Input bubble volumes at different temperatures in each cell in the fixed bubble vol. mode

(BRS-800)



① Input calibrating values for fixed bubble vol. mode

② Time interval

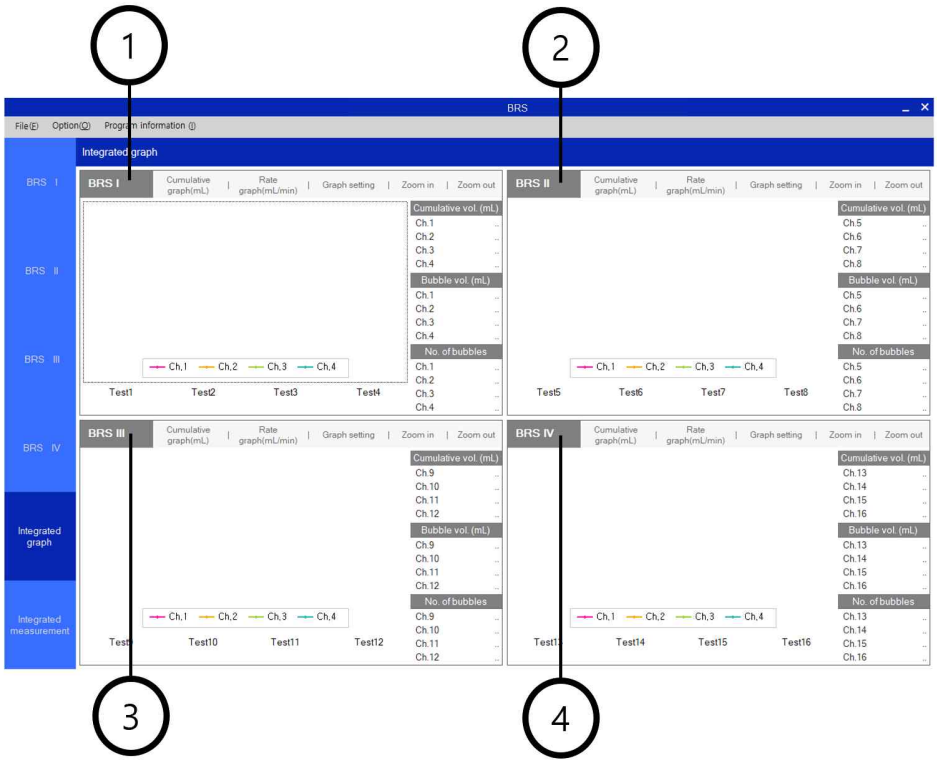
③ Reconnect the communication

④ Save interval of cumulative data

⑤ Save interval of raw data

⑥ Save the setting

Integrated graph



① BRS I graph

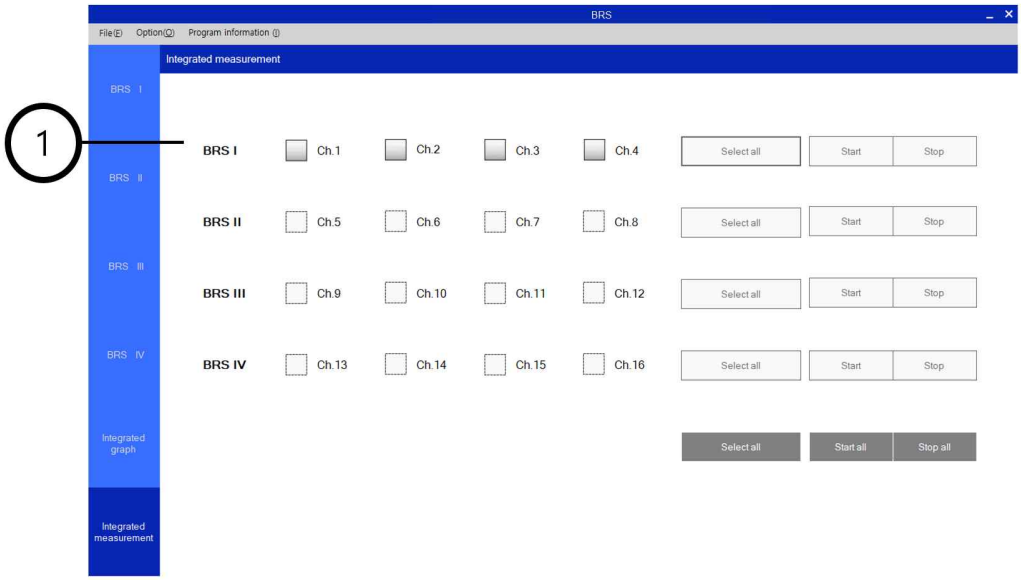
② BRS II graph

③ BRS III graph

④ BRS IV graph

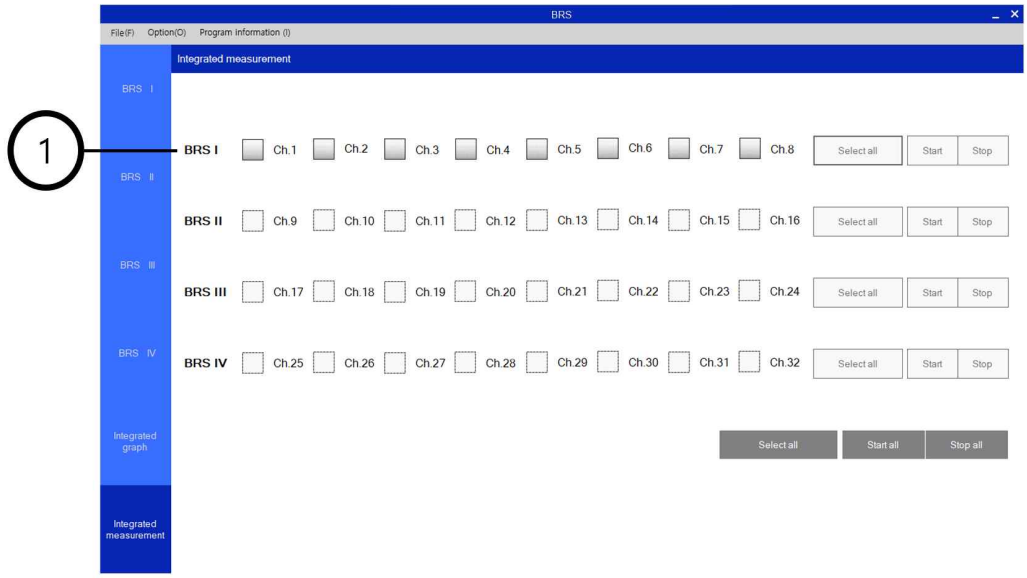
Integrated measurement

(BRS-110 and BRS-200)



① Select the channels and start/stop measurement for the integrated measurement

(BRS-800)



① Select the channels and start/stop measurement for the integrated measurement

Chapter IV

Trouble shooting and maintenance

CHAPTER IV

01
How to calibrate BRS cells for fixed bubble vol. mode

Equipment preparation

- Syringe pump
- Gas tight syringe (10 mL)
- Incubator

Calibration method

① Place the BRS device and a syringe pump in an incubator where the desired temperature is maintained, and leave them for more than 30 minutes to match the temperature of the oil in the BRS cell with the incubator temperature(as the temperature increases, the volume per bubble decreases)

② Connect the syringe in the syringe pump to the BRS cell of the device with tubing, and run the BRS program

③ Set the flow rate of the syringe pump at 2 mL/min, inject it for about 30 seconds, and check if bubbles are generated in the BRS cell

④ Change the flow rate of the syringe pump at 0.1 mL/min, and inject 8 mL (using a 10 mL gas tight syringe) to check the number of bubbles (repeat three times and use the average value. If there is a large variation in the number of bubbles, carefully repeat this step)

⑤ Calculate the volume per a bubble (the total volume of the injected volume/bubble numbers) and enter it into the program

⑥ Calibration is required for each BRS cell and must be entered into the program

CHAPTER IV

02
Optic sensor adjustment

If a channel is not working or the red LED blinking of the optic sensor is not clear, the high and low optic sensors for the channel should be adjusted. Our respirometer device consists of a total of 4 channels, and two optic sensors are used for each channel (total of eight optic sensors). The optic sensor on the left side of each channel is for the high sensor; the optic sensor on the right side is for the low sensor (BRS-110 and BRS-200).

- When adjusting the optic sensor, use a flat-blade screwdriver and set the COARSE at MIN and set the FINE at 3 o'clock
- Add air to the BRS cell and make bubbles. If the red LED of the optic sensor is blinking, turn the FINE adjuster to the left or right and set it where the red LED blinks clearly.
- If the red LED is not blinking, turn the COARSE to the right and set it where the red LED blinks and turn the FINE to the left or right and set it where the red LED blinks clearly

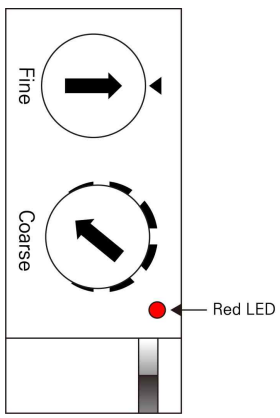
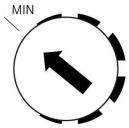
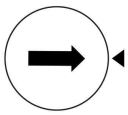
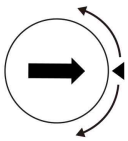
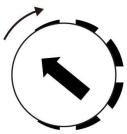
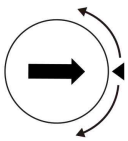


Fig. Fine and Coarse of optic sensor

How to adjust the optic sensor

	Adjustment methods	Coarse	Fine
Initial	Set the COASE adjuster at MIN and set the FINE adjuster at 3 o'clock		
If the LED is blinking	Turn the FINE adjuster to the left or right and set it where the red LED blinks clearly.	not need	
If the LED is not blinking	Turn the COARSE to the right and set it where the red LED blinks and turn the FINE to the left or right and set it where the red LED blinks clearly		

CHAPTER IV

03 Troubleshooting

When the graph is displayed in a step-like manner

- Due to blockages of needles, fittings, and tubing caused by water or small particles, the headspace pressure accumulates inside the bioreactor as gas produces over time, and when the blocked part is suddenly released due to pressure, a large amount of gas is released at once.
- If a water droplet forms at the tip of the needle inserted into the septum of the bioreactor, lightly tapping the needle with a finger can remove the water droplet.
- After separating needles, fittings, and tubing from the bioreactor, remove foreign substances by injecting air quickly using a syringe
- Replace any faulty needles, fittings, or tubings with new ones. If water droplets frequently form at the tip of a needle, consider using an alternative type of connection between the bioreactor and BRS cell

If bubble generation is confirmed but the value is not displayed in the BRS program

- The power of the BRS device is not turned on or the USB is not properly connected
  → Check the power and USB connection of the BRS respirometer
- If the oil level in the measurement cell is not higher than the H.sensor when bubbles are generated
  → Remove the oil in the measurement cell, inject 2.2 mL (for BRS-110) or 12 mL (for BRS-200) or 1.6 mL (for BRS-800) of new oil
- Optic sensor adjustment is needed

How to change oil in a BRS cell

When the BRS system is used, the oil in cells may be contaminated with water or particles from the outside. The oil should be changed.

- Slowly turn the right top fitting of the corresponding cell counterclockwise using a wrench and remove it.
- Remove the oil inside the cell with a disposable plastic dropper, etc., and then

use a cotton swab or a small piece of laboratory tissue to remove all remaining oil. To clean the cell, add some oil and do the same thing as described above. If possible, compressed air should then be injected into the cell to remove any remaining oil or unknown particles.

- After cleaning the cell, use a syringe to carefully inject right amount of BRS oil into the cell. Bubble generation should be checked by adding air into the cell using a syringe. If particles are present in the path in the BRS cell, the bubbles formed will be deflected, and the bubble size will be smaller.
- When everything is OK, join the disassembled fitting to the cell. After completing this oil change, it is necessary to calibrate the device. However, if the fixed bubble volume mode and the same amount of the same oil are used, recalibration should not be needed (BRS oil is a special oil made for the respirometer and can be purchased through the company).
- The characteristics of oils are different for BRS-110, BRS-200, and BRS-800).

04
Disabling power saving mode

Disable power saving mode

◦ If power saving mode is enabled on the PC or laptop where BRS is installed, data communication may not be available

<For Windows 7>

[Control Panel] > [Power Options] > [Change when the computer sleeps]

- Change "Put the computer to sleep" to "Never"

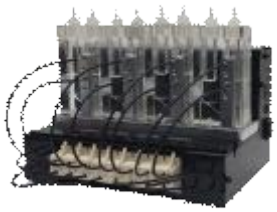
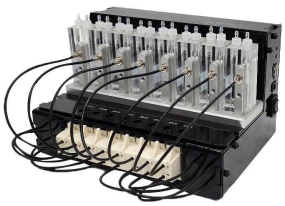
<For Windows 10>

[Windows Settings] > [System] > [Power & sleep]

- Turn off the following options: "Sleep" and "Turn off the display"

CHAPTER IV

05
Specifications

	BRS-110	BRS-200	BRS-800
			
No. of channels	4 (expandable 16 in a computer)	4 (expandable 16 in a computer)	8 (expandable 32 in a computer)
Flow rate	0~1 mL/min	1~5 mL/min	0~0.2 mL/min
Measuring resolution	Approx. 0.03 mL	Approx. 0.15 mL	Approx. 0.03 mL
Measuring interval	1 sec~10 hours(changeable)		
Gases	O_2 (OUR), CO_2, CH_4, H_2, and N_2		
Calibration error	≤1%		
Data output	USB		
Power input	DC 12V, 3.5A		
Weight	1.5 kg	1.9 kg	1.7 kg
Size	190(W)*130(D)*110*H), mm	200(W)*140(D)*120*H), mm	200(W)*140(D)*120*H), mm
Temperature	0~50℃		
Humiity	≤95%		
Material	Aluminum and acrylic		

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USER'S MANUAL

Biological Respirometric System (BRS)

- Aerobic/Anaerobic Respirometer -