

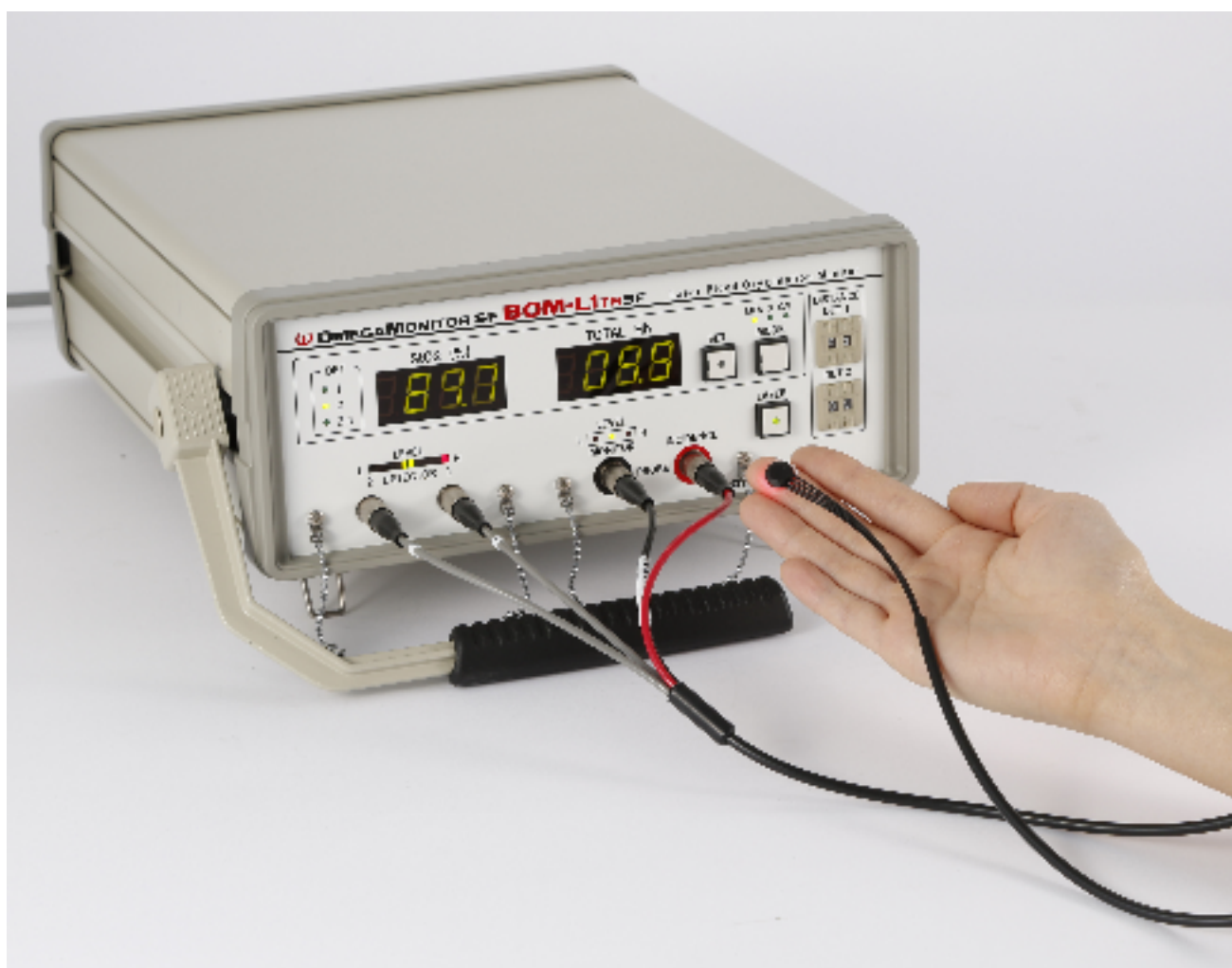
Laser Tissue Blood Oxygenation Monitor
OMEGAMONITOR BOM-L1 TR SF

BA4D9004-2

ω OMEGAMONITOR

BOM-L1 TR SF

USER'S MANUAL



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1. Summary

This laser tissue blood oxygenation monitor, OMEGAMONITOR BOM-L1 TRSF, is an useful instrument for measuring haemodynamics in a small portion of tissue, especially of brain, muscle and skin of a small animal.

BOM-L1 TRSF can measure tissue blood volume and its oxygenation continuously and noninvasively, and it is widely used from in fundermental research to in clinical applications.

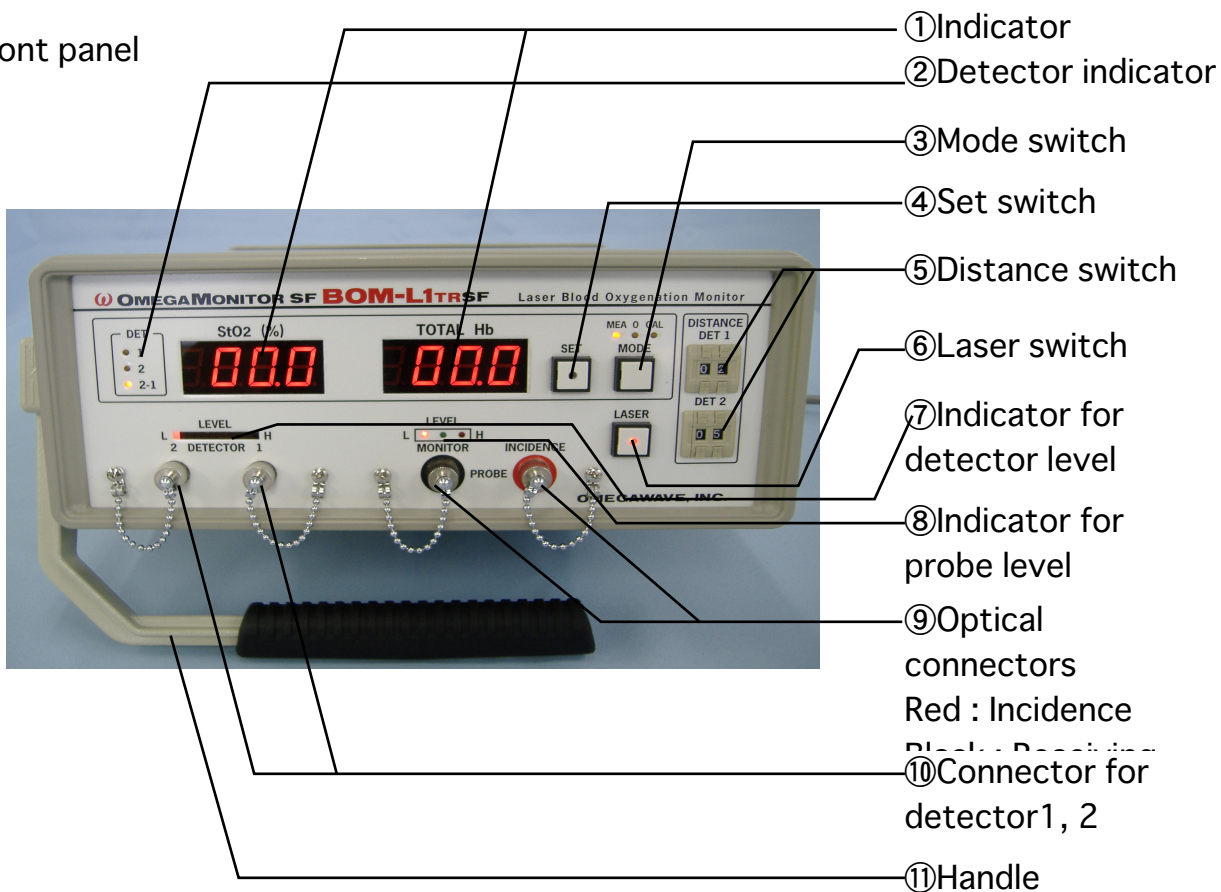
BOM-L1 TRSF uses 3 laser diodes and their width of wavelength is narrow, then it causes high S/N measurement. Also, our stabilizer system for the laser dioedes makes stable measurement possible, and fast change of haemodynamics can be observed. The probe is made from optical fibers, and it is not affected by electromagnetic noise.

The maximum measuring depth is almost the same length as the distance between the probe and detector although it is dependent on a kind of tissue.

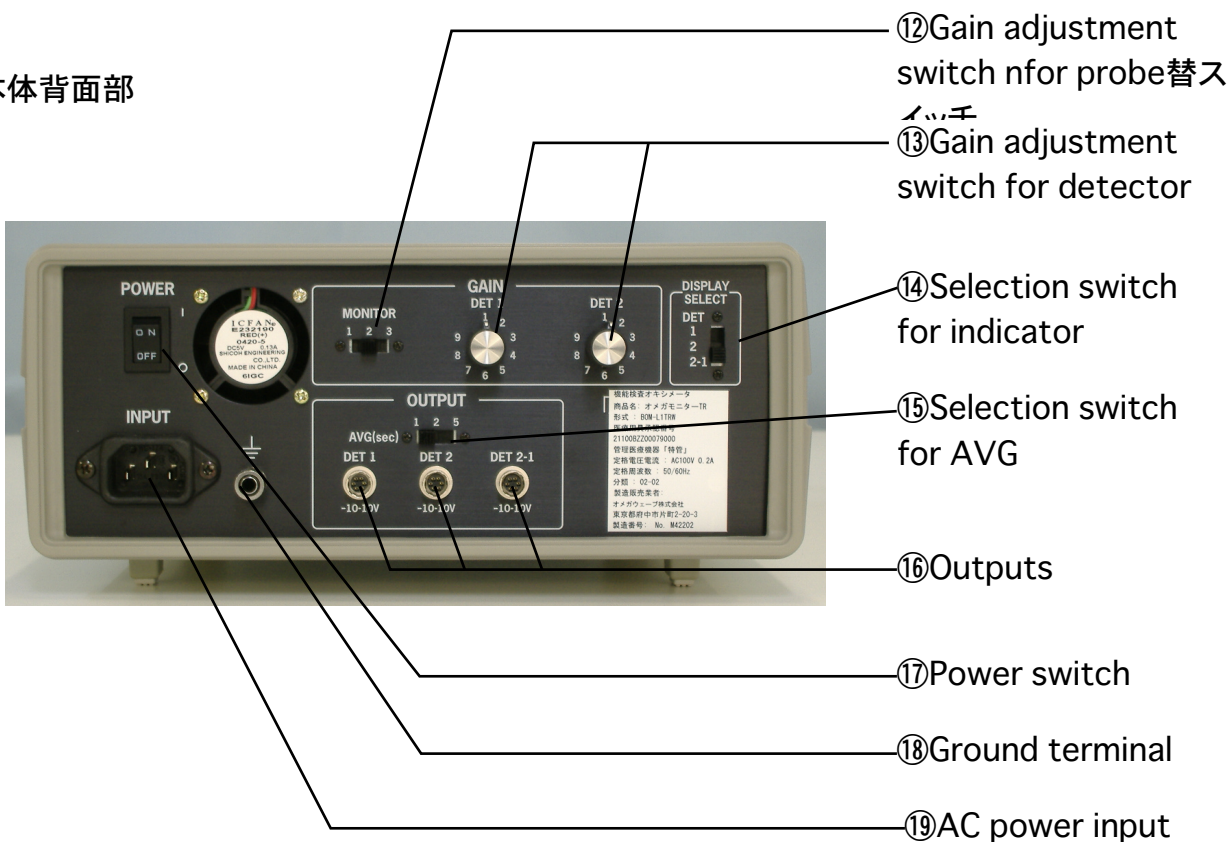
2. Part names and Functions

1)Part names

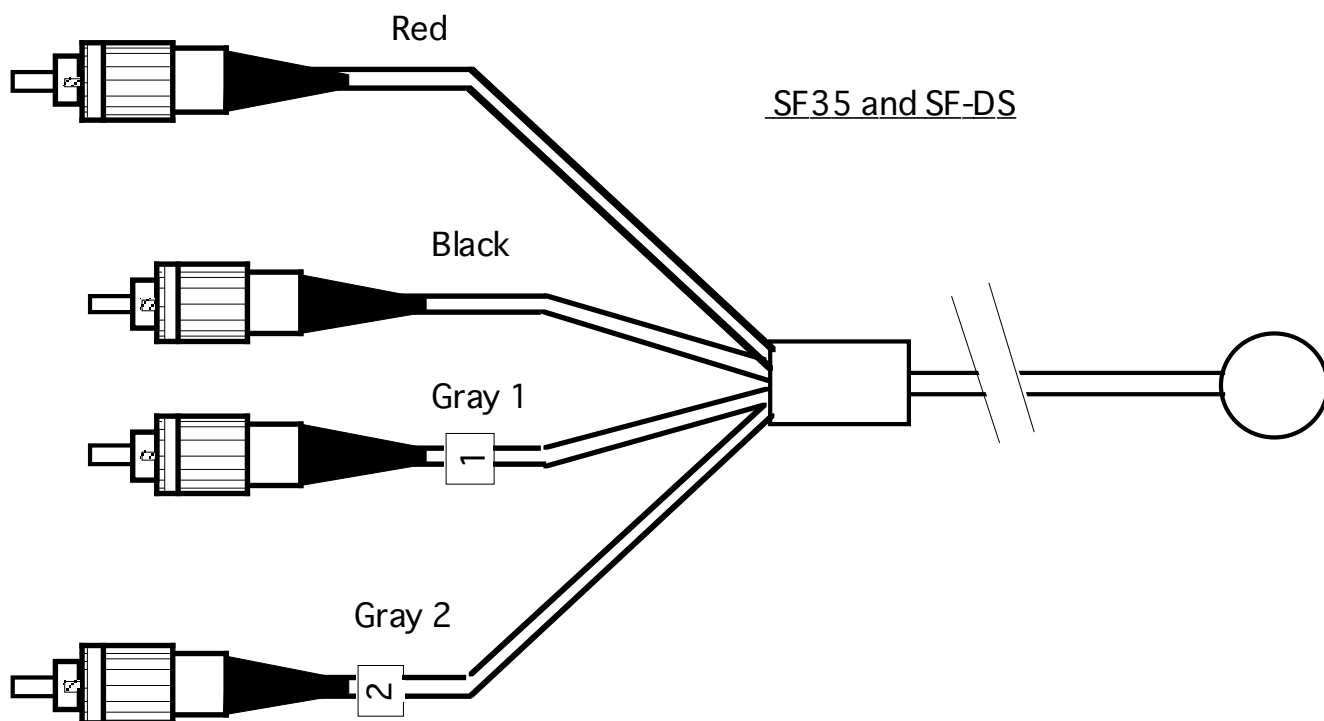
Front panel



本体背面部



①9Probe



2) Functions

① Indicator

This indicator shows the measurement value of tissue blood oxygenation ratio and total Hb volume.

The tissue blood oxygenation ratio, StO₂, is showed as persantage, and total Hb volume, TOTAL Hb, is showed as 0~100.0.

The oxy-Hb volume, OXY HB, and deoxy-Hb volume, DEDOXY Hb, are not showed in this indicator, but all of StO₂, Total Hb, OXY Hb and DEOXY Hb are obtained from the output on the rear panel.

Output mode has three modes. "MEA" mode is for measurement, "0" mode shows 0 (zero) on this indicator and sets the output to 0 (V), and "CAL" mode shows calibration value and outputs its voltage. The calibration value of StO₂ on the indicator is 10.0 and the value of TOTAL Hb is 20.0. The calibration voltage of the output of OXY Hb, DEOXY HB and StO₂ are 1.0 (V) respectively, and the voltaage of TOTAL HB is 2.0(V).

TOTAL Hb = OXY Hb + DEOXY Hb

② Mode switch

The output mode of "MEA", "0" and "CAL" is selected by this switch.

③ Set switch

This switch is used for measuring the value of change from a point. When this switch is pushed, OXY-Hb, DEOXY-HB and TOTAL-Hb become zero. Then just the volume change is obtained. However, StO₂ is not affected by this switch. The red light shows "ON".

This switch is controlled when Mode switch shows "MEA", Laser switch is "ON", Detector level shows green light and Probe level shows green light.

④ Distance switch

This switch is for normalizing the distance between Probe and Detector on tissue. Input the distance as the unit of "mm".

⑤ Laser switch

Laser power is operated by this switch. Press this switch for ON and the red light glows.

⑥ Indicator for detector level

This indicator shows the level of detected light intensity detected by the detector. The haemodynamic values are obtained when this indicator shows green. When it shows red at L or H level, adjust the detection level using "⑫Gain adjusting switch for detector" to become green. L level means low detected light intensity, and H level does high intensity for processing the signal.

The larger number of switch means higher gain.

⑦ Indicator for monitor level

This indicator shows the level of detected light intensity detected by the optical fiber for monitor. This light intensity is used to compensate the output laser power on tissue and absorption by pigment in the tissue. The haemodynamic values are obtained when this indicator shows green. When it shows red at L or H level, adjust the detection level using "⑪Gain adjusting switch for probe" to become green. L level means low detected light intensity, and H level does high intensity for processing the signal.

The larger number of switch means higher gain.

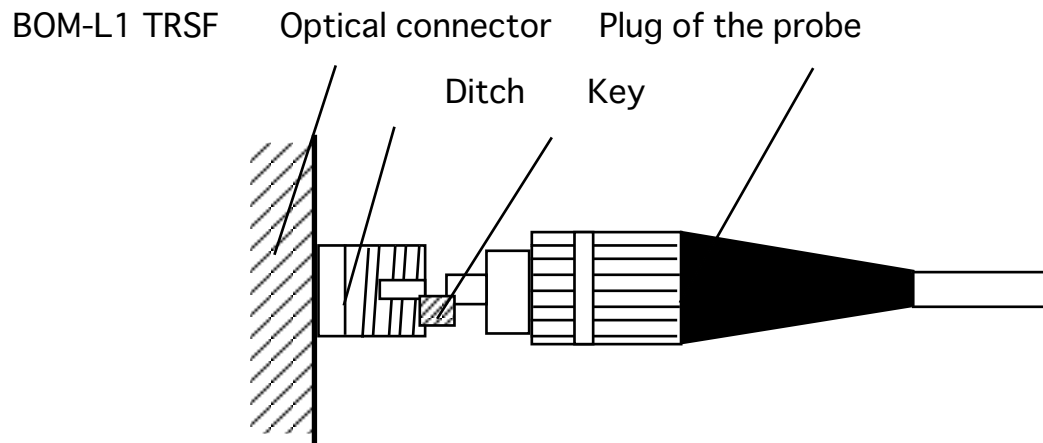
⑧ Optical connectors for incidence and monitor

Optical connectors to connect the probe. The plugs of standard probes are specified by RED and BLACK. Match the key of the plug of the probe with the dich of the connector, and push and screw the plug.

⑨ Optical connectors for detection

Optical connectors to connect the probe. The plugs of standard probes are specified by 1 and 2. Match the key of the plug of the probe with the ditch of the connector, and push and screw the plug.

Top View



⑩ Handle

Use this handle for carrying BOM-L1 TR SF.

⑪ Gain adjustment switch for monitor

This selection switch is used to adjust the detected light intensity level of the probe. Usually the position of "2" is widely used for many tissue. When dark tissue is measured and the indicator shows red at L, set to "3".

When white tissue is measured and the indicator shows red at H, set to "1".

⑫ Gain adjustment switch for detector

This selection switch is used to adjust the detected light intensity level of the detection. The detected light intensity is affected by the distance between the incidence and the detection. When the indicator shows red at L, turn this switch to higher number. When the indicator shows red at H, turn this switch to lower number.

BOM-L1 TRTSF uses two point detection system, and each detection is adjusted by each switch. DETECTOR 1 is the shorter point from the incidence.

⑬ Selection switch for AVG

The average of the output voltage can be set by this switch. The averaging time is 1, 2 or 5 sec.

⑭ Selection switch for detection

The detection point can be selected using this switch.

The selectable detection points are "1", "2" and "2-1".

The detection point "1" is for shallow part, "2" is for deeper part from the surface.

"2-1" measures haemodynamics of only deep part.

⑮ Output 1

This output is for OXY Hb, DEOXY Hb and TOTAL Hb.

The range of the voltage is 0~10(V). When the set switch shows "ON", the range is -10~+10(V).

0 (zero) (V) is generated on each parameter on "0" mode.

1(V) is obtained for OXY Hb and DEOXY Hb on "CAL" mode.

2(V) is obtained for TOTAL Hb on "CAL" mode.

⑯ Output 2

This output is for StO₂.

The range of the voltage is 0-10(V).

0 (zero) (V) is generated on "0" mode.

1(V) is obtained on "CAL" mode.

⑰ Power switch

This switch is used for "ON-OFF".

⑮ AC power input

Insert 3P power cord.

⑯ Probe

This is connected to the optical connector on BOM-L1 TRSF.

Match the key of the plug of the probe with the dich of the connector, and push and screw the plug.

3. Connection to Recorder and Operation

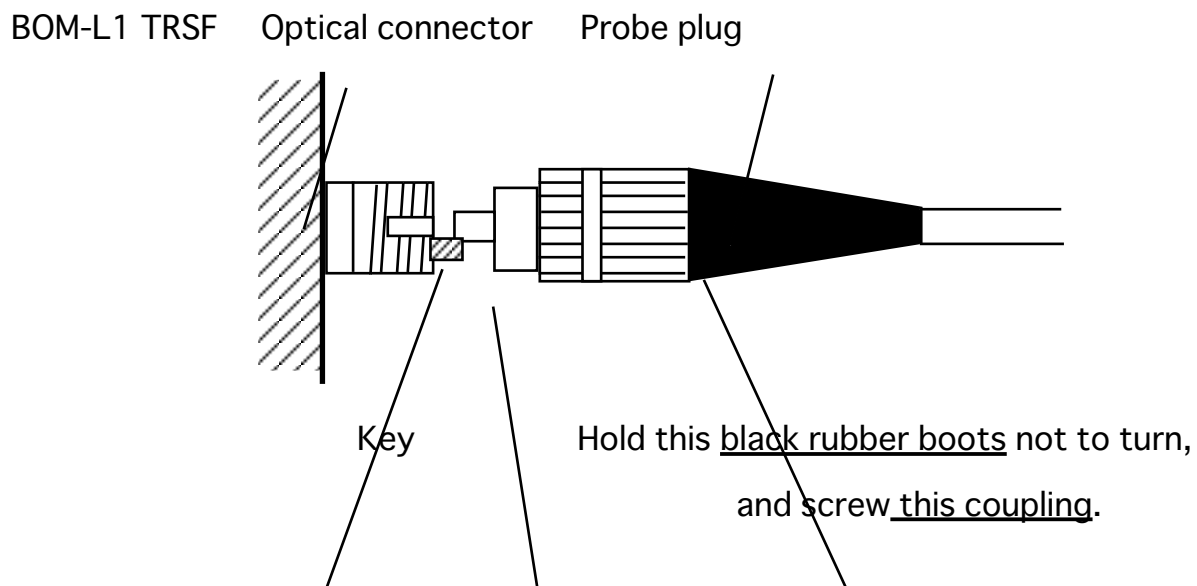
1) Connection to a recorder

- (1) Connect the output of BOM-L1 TRSF to the inputs of a recorder using the signal cable having three black and red banana jacks. Black banana jacks are grounds and red ones are signals for each haemodynamic parameters.
- (2) Put the power source cord into the "AC power input" of BOM-L1 TRSF and connect to a power source.

2) Operation

- (1) Insert the plugs of a probe into the optical connectors of BOM-L1 TRSF and screw the coupling of the plugs to the right by one hand holding the black rubber boots not to turn by the other. Insert the plugs slowly and in a straight line. Do not insert the plugs slantwise by force.

Top view

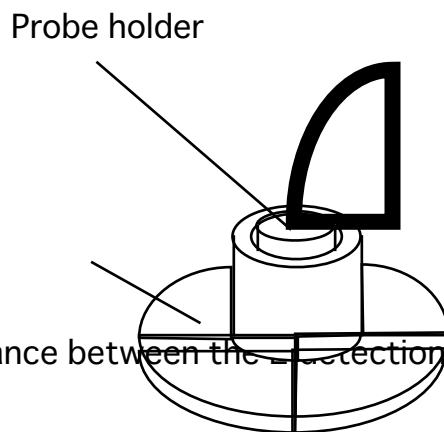


BOM-L1 TRSF has 4 optical connectors for laser incidence, receiving, detection 1 and detection2 . Insert the red plug of the probe into the red mark connector, the black

plug into the black connector, detection 1 in to 1 connector and detection 2 into 2 connector.

- (2) Put the probe and the detector on the tissue under study. To avoid the light from outside, use the optional probe holder, a black rubber sheet or vinyl tape over them.

Probe (SF35)



- (3) Input the distance between the detection points in the distance switch. The unit is "mm".

- (4) Turn on BOM-L1 TRSF and the recorder by the power switches.

- (5) Turn "LASER" switch on. The red lamp is lighted. Confirm the green light on both the detector level and probe level. When they show red, adjust the gain adjustment switch for the detector and probe on the rear panel.

(6) Calibration

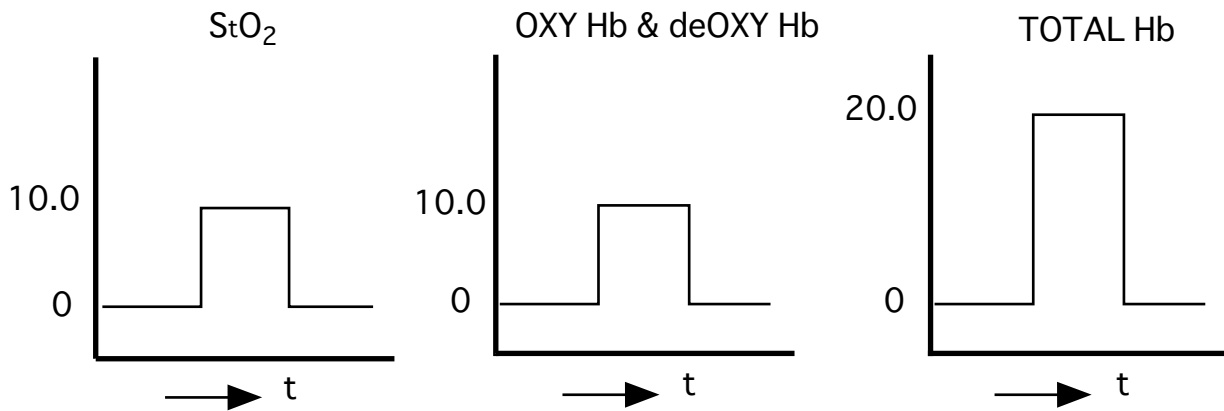
- ① Set the full scale of a recorder at 10 (V) using the range dial of the recorder.
- ② Press "MODE" switch and set at "0".
- ③ Set the pen of the recorder at zero line using the zero null dial of the recorder.
- ④ Press "MODE" switch again and set at "CAL".

OXY Hb : 10.0 , DEOXY Hb : 10.0 , TOTAL Hb : 20.0, StO₂ : 10.0

are obtained from the output of BOM-L1 TR. The each voltage is 1 (V) for OXY Hb, DEOXY Hb and StO₂, and 2(V) for TOTAL Hb.

Set the pen of the recorder at an adequate point.

- ⑤ Run the chart paper and make the calibration form showed below operating
① to ④ again.



- (7) Press "MODE" switch to set at "MEA" . Measurement starts.
 - (8) Raise the gain of the recorder if the measuring wave is too small.
 - (9) Chose the AVG switch on the rear panel. To obtaine averaged measuring wave, choose longer time-constant.
- Once the recorder is adjusted, this "Calibration" section will not be needed.

3) Stop Operating

- (1) Stop the chart of the recorder, and turn off "LASER" switch.
- (2) Turn off the power switch of BOM-L1 TRSF.
- (3) Remove the probe from BOM-L1 TRSF slowly. Do not pull the plugs out slantwise by force.
- (4) Cap the optical connectors.
- (5) Cap the plugs of the probe and keep it in the probe case.

3. Theory

1) Spectrophotometry

The absorption spectrum of light by oxygenated haemoglobin and deoxygenated haemoglobin are different. Three kinds of laser lights illuminate tissue and the scattered light is detected at the point separated 1-8 mm from the incident point. As tissues are highly scattering materials in the wavelength range between 500 and 900 nm, photons are scattered many times in tissue, and some of them are absorbed by haemoglobin in erythrocytes. The absorption coefficient of haemoglobin depends on wavelength, and the detected light intensity can be expressed as

$$I = \eta I_0 \exp [(-\alpha V_o - \beta V_d - \mu) L]. \quad (1)$$

Here,

I : detected light intensity

I_0 : incident light intensity

η : the coefficient of measurement system

α : absorption coefficient of oxy-haemoglobin

β : absorption coefficient of deoxy- haemoglobin

V_o : volume fraction of oxygenated blood(haemoglobin) in tissue

V_d : volume fraction of deoxygenated blood(haemoglobin) in tissue

μ : attenuation(scattering + absorption) coefficient of tissue

L : optode, the distance between the incident point and the detected point.

Using three laser lights, we can obtain the volume fraction of oxygenated and deoxygenated blood in the tissue as

$$V_o \cdot L = A \cdot [\ln (I_1/I_{10}) - \ln (I_2/I_{20})] + B \cdot [\ln (I_2/I_{20}) - \ln (I_3/I_{30})] \quad (2)$$

and

$$V_d \cdot L = C \cdot [\ln (I_1/I_{10}) - \ln (I_2/I_{20})] + D \cdot [\ln (I_2/I_{20}) - \ln (I_3/I_{30})]. \quad (3)$$

Here,

I_1 , I_2 and I_3 are the detected light intensity of the three laser wavelengths

1, 2, and 3 respectively,

I_{10} , I_{20} and I_{30} are the incident light intensity of the three laser light,

A, B, C and D are the coefficients obtained from α_1 , α_2 , α_3 , β_1 , β_2 , and β_3 ,

α_1 , α_2 and α_3 are the absorption coefficient of oxy- haemoglobin at the

three laser wavelengths, and

β_1 , β_2 , and β_3 are the absorption coefficients of deoxy-haemoglobin at

the three laser wavelengths.

Usually, the assumption that the scattering coefficient of tissue itself are the same for each wavelength if the wavelengths are close enough to each other.

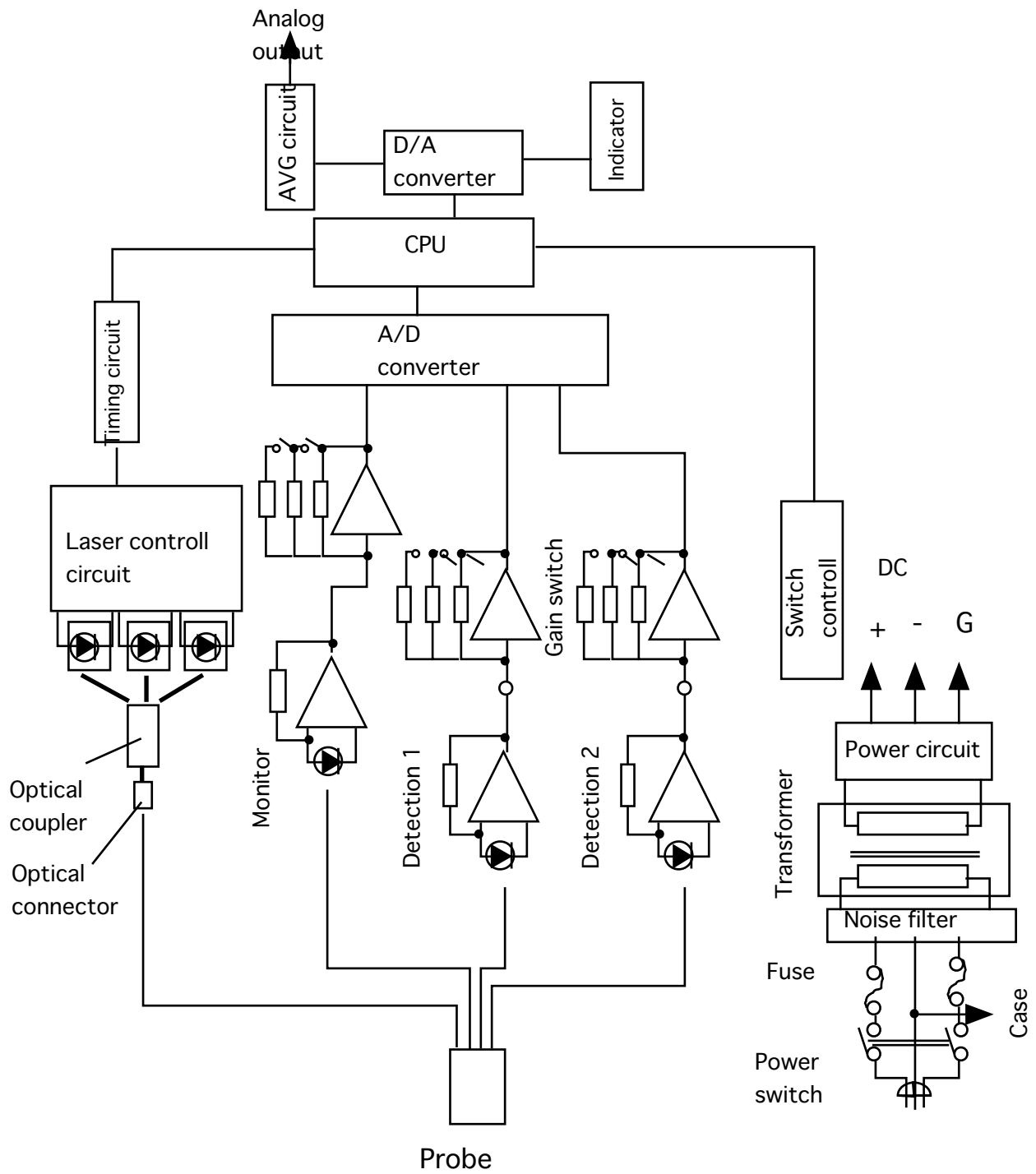
The oxygenation of the blood, StO₂, is calculated as

$$\text{StO}_2 = V_o / (V_o + V_d). \quad (4)$$

2) Unit and Indication

The indication of 1.0 and output of 0.1 (V) for OXY Hb, DEOXY Hb and TOTAL Hb is equivalent to about $1 \times 10^4 [\text{N/mm}^3]$ of the density of erythrocyte in tissue on the condition that the actual optical pass length in tissue is assumed 4 times of the distance between the laser incidence and receiving.

As the volumer of haemoglobin, $1 [\mu\text{mol}/100\text{mL}] \cong 2.2 \times 10^4 [\text{N/mm}^3]$.



5. Handling and Cautions

1) Pay attention to the next matters.

- (1) Keep BOM-L1 TRSF out of water.
- (2) Set BOM-L1 TRSF on the place where air pressure, temperature, humidity, wind, sunlight, dust, and air containing salt and sulfur do not cause bad condition.
- (3) Pay attention to inclination, vibration and shock.
- (4) Keep BOM-L1 TRSF out of a storeroom of chemicals and the place where gas generates.
- (5) Pay attention to the voltage, frequency and power of the power source which BOM-L1 TRSF is connected to.
- (6) Connect the ground correctly.

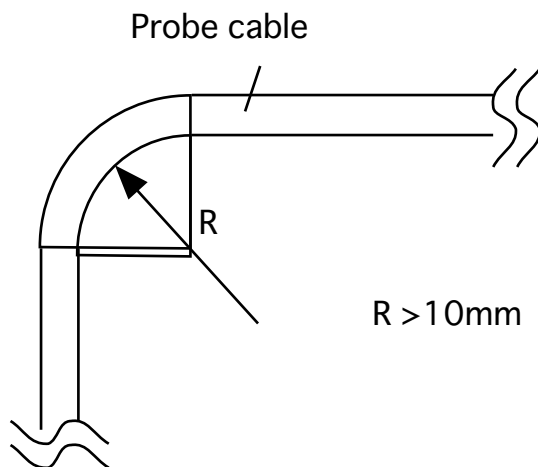
2) Pay attention to the next matters before using BOM-L1 TRSF.

- (1) Examine switch workings and meters, and confirm BOM-L1 TRSF working.
- (2) Confirm the ground being completely connected.
- (3) Confirm all the cables being connected correctly and completely.
- (4) Pay attention to using another instruments together.

3) Pay attention to the next matters in use of BOM-L1 TRSF.

- (1) Do not use over the time for diagnosis and medical treatment.
- (2) Always keep watch on BOM-L1 TRSF and a patient being not unusual.
- (3) Take proper measures, like turning off BOM-L1 TRSF, if something is unusual on BOM-L1 TRSF and a patient
- (4) Keep patients out from BOM-L1 TRSF.
- (5) Do not look at the laser light generated from BOM-L1 TRSF directly and through a lens .
- (6) Probes are made from glass fibers, and they are hardly repaired. Pay attention to the next matters for probes.
 - ① Do not scrub the tip of probes.

- ② Do not bend into a circle of under 10 mm radius.



- ③ Do not step on probes.
④ Keep the tip and plugs clean.
⑤ Do not insert and pull the plugs slantwise by force.
⑥ Use under 60°C sterilization.

4) Pay attention to the next matters after using BOM-L1 TRSF

- (1) Turn off the power switch after restoring the condition of before using BOM-L1 TRSF along the process.
- (2) Do not pull the cables by force.
- (3) Pay attention to keeping.
- ① Keep BOM-L1 TRSF out of water.
- ② Set BOM-L1 TRSF on the place where air pressure, temperature, humidity, wind, sunlight, dust, and air containing salt and sulfur do not cause bad condition.
- ③ Pay attention to inclination, vibration and shock.
- ④ Keep BOM-L1 TRSF out of a storeroom of chemicals and the place where gas generates.
- (4) Put belongings, cables and probes in order after cleaning.
- (5) Clean BOM-L1 TRSF for the next using.

5) When BOM-L1 TR SF is out of order, do not handle. Leave it to a specialist.

6) Do not remodel BOM-L1 TRSF.

7) Maintenance

(1) Inspect BOM-L1 TRSF regularly.

(2) Confirm BOM-L1 TRSF being in order before using it having not used for a long time.

6. Specifications

Laser for Measurement : Semiconductor lasers、

Wavelength : 635nm, 655nm, and 690nm

Under 3mW at the probe end

Probe : Optical fibers

Measuring parameters

1) Tissue oxygenated blood volume(OXY Hb) : 0~+100.0、 or change
-100.0~+100.0

2) Tissue deoxygenated blood volume(DEOXY Hb) : 0~+100.0、 or change
-100.0~+100.0

3) Tissue total blood volume(TOTAL Hb) : 0~+100.0、 or change
-100.0~+100.0

4) Oxygenation ratio (StO₂) : 0 ~ 100.0 %

Indication : StO₂ and TOTAL Hb

Analog output

1) OXY Hb : 0~10V、 or -10~+10V

2) DEOXY Hb : 0~10V、 or -10~+10V

3) TOTAL Hb : 0~10V、 or -10~+10V

4) S_tO₂ : 0~10V

AVG : 1, 2 and 5 sec

Power source : AC110±10V, 50/60Hz, 25VA

Weight: 5.5kg

Size : W257、 H100、 D322 (mm) without the handle

Operation circumstance : Temperature : 5-40℃, Humidity : 0-90%

7. Guarantee

1) BOM-L1 TR SF

Repairs are free within one year after the purchase of BOM-L1 TR except the next cases.

(1) Malfunction and damage due to incorrect using and inattention.

(2) Malfunction and damage due to a nature calamity and a fire.

2) Probes and Detectors

Probes are treated as like consumption articles, and repairs are according to the table below at the first time.

after purchase	cost of repair
within 6 months	under 50% of the purchase price
within one year	under 70% of the purchase price
after one year	not provided

OMEGAWAVE, INC
2-20-3 KATAMACHI
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No.