INSTRUMENTS

# INSTRUCTION MANUAL
# MODEL RI-411

## PORTABLE MONITOR FOR CARBON DIOXIDE

The accompanying instrument is sold and serviced in the USA by RKI Instruments, Inc. Please contact RKI Instruments Inc. for any follow up service needs, including questions, warranty issues, repairs, and spare parts and sensors. Any reference in the attached manual to Riken Keiki may be read as RKI Instruments, Inc. Thank you for selecting this fine instrument for your use. With proper care and maintenance, it will provide you with many years of reliable service.

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## 1. INTRODUCTION

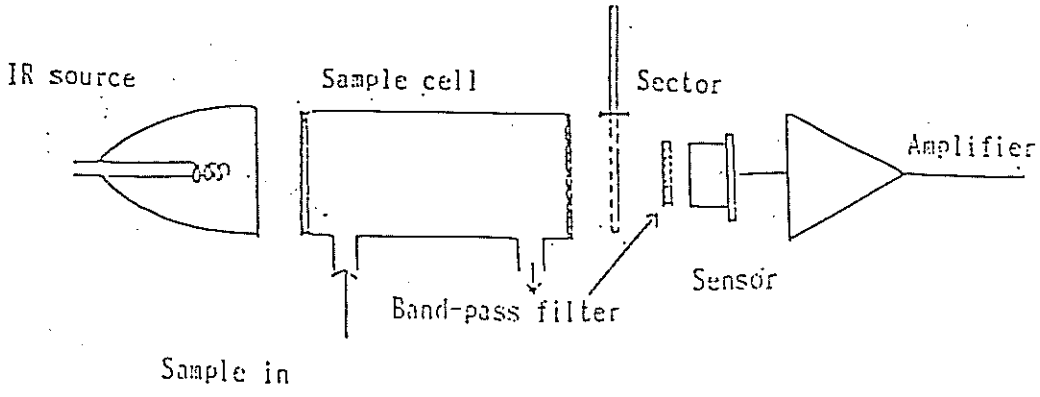
The Model RI-411A represents a new approach to the problem of measuring carbon dioxide in low concentration or high concentration. The versatility of the microprocessor coupled to the selectivity of the nondispersive infrared analyzer makes possible a portable gas analyzer small enough and inexpensive enough for daily use in industrial safety and atmospheric control application.

## 2. FEATURES

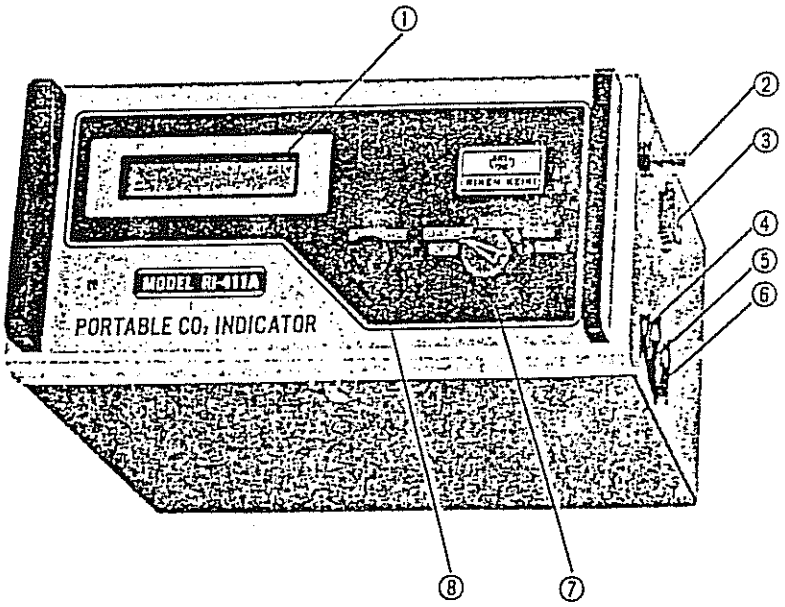
* Digital display
* Microprocessor controlled
* Time weighted average
* Adjustable alarm point at 0~full scale
  Available to stop the alarm
* Illuminated display
* Battery powered
* Light weight
* Fully portable

## 3. DETECTION PRINCIPLE

The infrared analyzer uses the fact that each gas absorbs infrared energy of a characteristic frequency. In the gas anlyzer, an infrared source (an electrically heated wire) emits a broad band of energy which is focued on a solid state detector through a narrow band filter selected to transmit only a certain range of frequencies which are selectively abosrbed by $CO_2$.
A sample gas to be detected flows through an enclosed chamber interposed between the infrared source and the detector.
The infrared beam is alternately trnasmitted through this chamber. If the measuring chamber contains $CO_2$, the amount of energy passing through the chamber is smaller than that of without $CO_2$. A comparison of the two levels of energy is an indication of the concentration of carbon dioxide in the sample gas.



## 4. PART IDENTIFICATIONS




① LCD display (LCD)
② Sample inlet (INLET) (and CAL gas inlet)
③ Charger jack (CHG)
④ Calibration adjustment V.R (SPAN)
⑤ External output (REC 0～100mV)
⑥ Continuous operation AC adaptor connection (DC8V) (CHG)
⑦ Selector switch
　　BAT-CK (Voltage check)
　　CONT　(Continuous measurement)
　　AVG　(Measurement of average value
　　CAL　(Calibration pump stop)
⑧ Zero knob (AIR.CAL)

## 5. SPECIFICATIONS

| | |
|---|---|
| Detection principle | Non-dispersive infrared absorbtion (NDIR) |
| Measuring gas | Carbon Dioxide ($CO_2$) in air |
| Measuring range | a) 0～ 4,975ppm(25ppm/digit) ⟶(Standard range)<br>b) 0～ 9,950ppm(50ppm/digit) ⟶(Standard range)<br>c) 0～ 1.990 % (0.01%/digit)<br>d) 0～ 4.975 % (0.025%/digit)<br>e) 0～ 9.95 % (0.05%/digit)<br>f) 0～ 19.9 % (0.1%/digit)<br>Please specify one of your desired measuring range when ordering |
| Readout method | Dot-matrix digital display, illuminated |
| Indication method | Continuous ... Digital LCD display of instantaneous concentration<br>Average ..... Digital LCD display of average concentration over 1,3 or 15 minutes<br>Battery ..... Battery capacity remaining |
| Alarms | Audible for... Gas alarm (Short pulse)<br>..... End of averaging period (Long tone)<br>..... Low battery (Continuous tone) |
| Linearity | Within ± (2% FS + 1 digit) at same environmental condition [In case of measuring range 0 ～ 19.9%, within± (5% FS + 1 digit)] |
| Response time | Approx. 10 seconds to get 90% indication |
| Sampling method | Motor-driven diaphragm pump |
| Calibration | SPAN ... Calibration on known cylinder of $CO_2$ in air or $N_2$ (span gas) |
| Ambient temperature & humidity | −10℃ ～ +40℃, 10% ～ 95% RH |
| Continuous operating hours | Approx. 4 hours<br>(based on use of alkaline dry cell at 25℃) |
| Power supply | Alkaline, Carbon-zinc or Nickel-cadmium battery.<br>Optional charger available for charging or continuous operation on AC220V (or AC100V,117V,240V) |
| Recorder | 0 ～ 100mV DC (Linear) |
| Dimensions & Weight | 230 (W) x 190 (H) x 113 (D) mm,<br>Approx. 2.4kg (Instrument only) |

## 6-1. Preparation

1) After connection of gas sampling probe and sampling tube, connect the other end of sampling tube to the gas inlet (2) (described as "INLET") on the right side of monitor.

2) As the knurling part on the end of sampling tube is coupler-quick fit type, connect it according to the following drawings

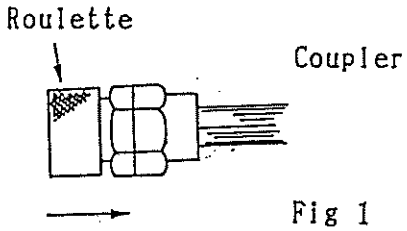
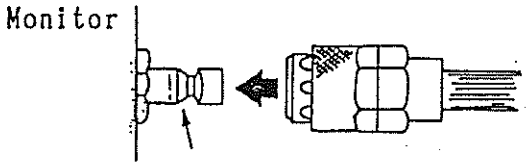



Fig 1

① Pull the knurlings part on the end of gas sampling tube toward arrow mark by holding it with fingers. (Refer to figl)

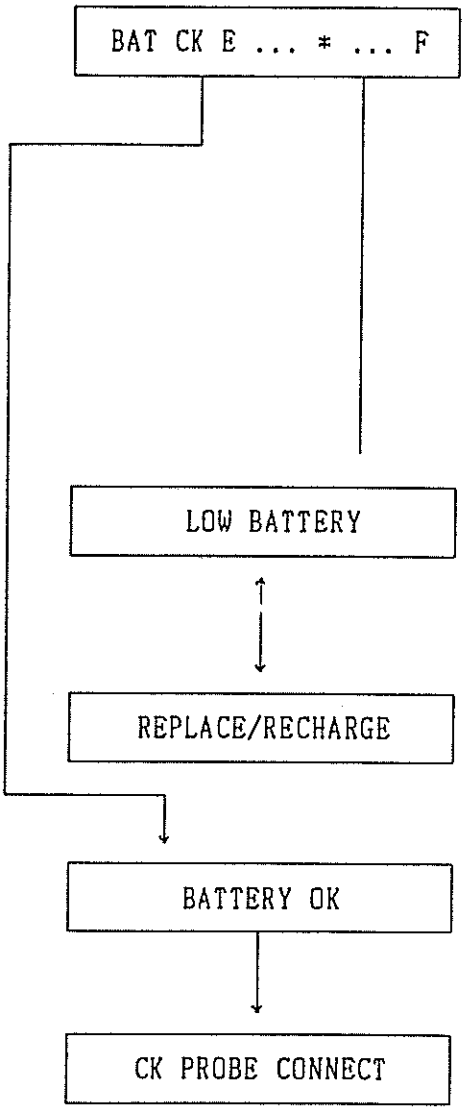
② When it is pushed into the depth of gas inlet with the knurling part pulled, it will click. Then when release the fingers holding it, it will be locked to the monitor. (Refer to fig 2)

Fig 2




③ When gas sampling tube should be taken off from monitor gas sampling tube will be taken off from monitor easily by making reverse procedure of above.

6-2-1. Battery check




1) After the connection of sampling tube, turn the selector switch ⑦ to "BAT CK". The measuring range will appear on the display.

2) After a few seconds, the indication on display will change to [BAT CK E ... * ... F], the suction pump will operate.
Battery capacity is indicated with "*" mark. This mark will move from F to E depending upon operation hours.

When "*" mark is moved until E position(When battery capacity is dropped), the indication will appear to [REPLACE/RECHARGE] and the buzzer will sound.

In this case, replace the battery with new one (in case of usage of dry battery) or charge (in case of usage of optional Ni-Cd battery)

When the battery capacity is OK, confirm the connection of sampling tube

3) After check of battery, make warming up for approx. 15 minutes as it is. To make an accurate measurement, turn the selector switch ⑦ to other position within one minute after the power switch "ON".
The indication on display will appear [WARM UP] and will appear the gas concentration.

6-3. Normal measurement (Continuous measurement)

6-3-1 When this monitor is used firstly or when this monitor is not used for a long period, it is necessary to make the zero and span calibration before the measurement. Carry out the zero and span calibration in accordance with item 7 "Calibration method".

6-3-2 When the monitor is used always

① After the check of battery and calibration, turn the selector switch ⑦ to "CONT" position. The indication of higher concentration will appear on the display immediately and will move to the lower concentration gradually. After that, the indication is became to stable with constant concentration (This time is approx 20 seconds).
The indication of concentration on the display is not returned to zero(0) and is shown the some hundred PPM always. This is not caused the trouble on the monitor. The monitor is measured $CO_2$ in a normal atmosphere. The concentration of $CO_2$ in normal atmosphere is different depend upon the place. In usual, the concentration of $CO_2$ is existed in normal atmosphere as following;

$CO_2$ concentration in normal atmosphere

| | $CO_2$ concentration |
|---|---|
| Out-of-door | 300 ～ 400ppm |
| Inside of a house | 500 ～ 1,000ppm |
| Human expiration | Max. 5% |

② After stable indication, make the measurement by appoaching the sampling probe to the measuring place.

③ When the measuring gas concentration value is exceeded the alarm setting valve, the buzzer will sound intermittently. When the gas concentration value is below the alarm setting value, the buzzer will stop. It is possible to stop the alarm buzzer by inside selector switch. Please refer to item 8 for stop of alarm buzzer.

③ When the gas concentration value is exceeded the measuring range, the indication on display will appear OVER SCALE .
In this case, stop the measurement immediately and introduce the fresh air to the monitor in some clean place.

## 6-4. Measurement of average value

This monitor can be measured the average value of time for 1 minute, 3 minutes and 15 minutes in addition to continuous measurement. Carry out the setting of average time in accordance with following procedure.

### 6-4-1 Setting method of measuring time for average value

① Confirm that the selector switch ⑦ is "OFF".

② Take out the sampling tube from the monitor.

③ Remove the monitor from carrying case.

④ Remove the front panel.

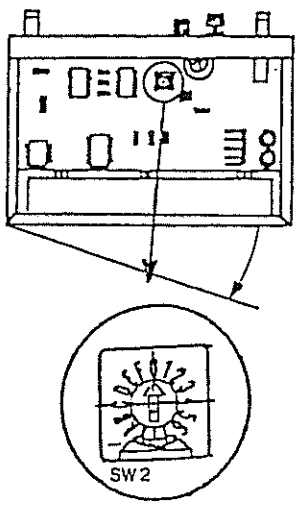
⑤ When the front panel is removed, the printed circuit board is fixed. Set the desired average time by turning SW2 with minus driver.

Note : SW2 is set to "1" position at Riken factory.
(The alarm setting is setting value of high concentration side and the measurement of average value is 1 minutes)

Average time

| | |
|---|---|
| 1 minutes | Set the arrow position to "5" |
| 3 minutes | Set the arrow position to "6" |
| 15 minutes | Set the arrow position to "7" |

After the finishment of time setting, close the panel.

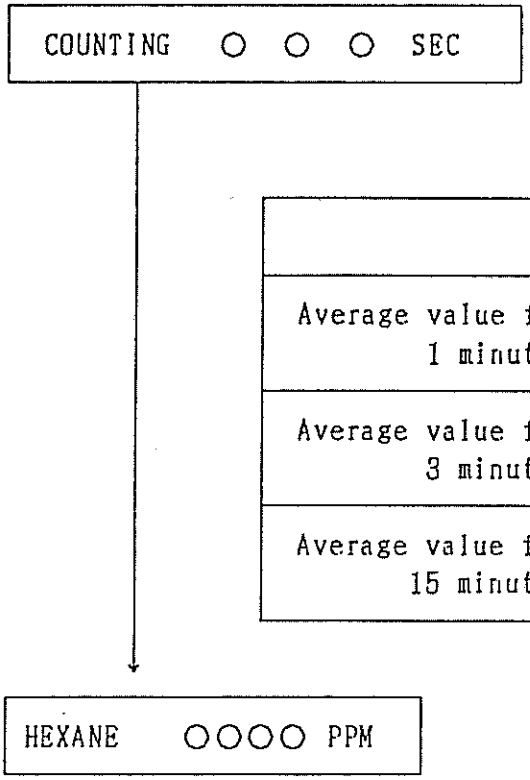


6-4-2 Measuring method of average value

① Carry out the adjustment in accordance with item 6-1 "Preparation", 6-2-1 "Battery check" and 6-3"Normal measurement (continuous measurement)".

② Turn the selector switch ⑦ to "AVG"

③ The indication will appear on the display as COUNTING ○○○ SEC
When swich is turned, the remaining time is indicated as following.




| | Count indication of remaining time |
|---|---|
| Average value for 1 minute | Remaining time is indicated at 1 sec. interval |
| Average value for 3 minutes | Remaining time is indicated at 5 sec. interval |
| Average value for 15 minutes | Remaining time is indicated at 5 sec. interval |

④ After the finishement of measurement for average value, the buzzer will sound with intermittent. The average value is indicated as HEXANE ○○○○ PPM

Note) After the finishment of measurement for average value, the buzzer will sound with intermittent. Then, when the reading of gas concentration is finished, turn the selector switch⑦ to "CONT" position immediately. The buzzer will stop.

⑤ When the average value is measured again, turn the selector switch ⑦ to "AVG" position.

## 7. CALIBRATION METHOD

When this monitor is used firstly or when this monitor is not used for a long time and also, when calibration check is made with regular check, carry out the calibration in accordance with following procedure.

### 7-1. Calibration procedure

1) Carry out the battery check in accordance with item 6-2-1 "Battery check".
2) Turn the selector switch ⑦ to "CAL" position.
3) Take out the sampling tube and sampling probe from the monitor. (Please refer to item 6-1, "Preparation") The pump will stop and the indication display will appear [ZERO/SPAN CAL] and will change to [CALOOOO] PPM after a few seconds.

### 7-2. Zero/span adjustment

1) Insert the nozzle of span gas can for zero adjustment to sample inlet② as following fig 4 and introduce the gas to the detector by pushing the span gas can for 2～3 times in a moment.

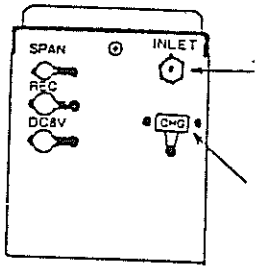



fig 4

After the stable indication, adjust the indication to [ O PPM ] by turning the Zero knob ⑧. In this case, turn the Zero knob ⑧ by lifting to up side.

2) After the zero adjustmen, insert the span gas for span adjustment and introduce the gas to the detector by pushing the span gas can for 2～3 times in a moment. The gas concentration value of monitor is almost same as gas concentration value described on the label of span gas can. When the indication on display is became to stable afer introduction of span gas, adjust the indication of gas concentration value described on the label of span gas can by inserting the small minus driver to span adjustment V.R (SPAN) (Refer to fig 5)

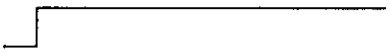
3) After the calibration, remove the gas existing in detector by turning the selector switch⑦ from "CAL" position to "CONT" position.

Note) When the span gas is introduced to the detector, don't push the span gas for a long time (One time/one second)

## 8. ALARM

### 8-1. Alarm function and alarm pattern

It is possible to judge the following alarm function depending upon the alarm buzzer pattern.

| Alarm function | Alarm pattern |
|---|---|
| Alarm of gas concentration |  |
| Low battery |  |
| Finishment of calculation (Finishment of measurement for average value) |  |

### 8-3. Alternation method of alarm point

It is possible to change the alarm point either low concentration side or high concentration side and to make the ON/OFF on alarm function.
The alarm will sound at the "CONT" position by turning the selector switch⑦. It means normal measurement only.
When the gas concentration value is exceeded the alarm setting value in the measurement of average value, the alarm is not sounded.
(The alarm setting value depends upon the measuring range. Please refer to the specifications)

1) Alternation method

Carry out the change of alarm with SW2 on printed circuit board.
This SW2 is switch to use the setting of measurement of average value. Set the alarm point in accordance with 6-4-1, Setting method of average value time by openning the panel.

2) Gas concentration alarm

| | |
|---|---|
| In case of high concentration side | Set the alarm of SW2 to "5" |
| In case of low concentration side | Set the alarm of SW2 to "6" |
| In case of alarm "OFF" | Set the alarm of SW2 to "7" |

Note: SW2 is used for both alarm setting and measurement of average value. Take care this point.

| Position of SW2 | Position of selector switch on panel | |
|---|---|---|
| | CONT | AVG |
| 5 | Alarm setting of higher concentration side | Measurement of average value for 1 minute |
| 6 | Alarm setting of lower concentration side | Measurement of average value for 3 minutes |
| 7 | Alarm "OFF" | Measurement of average value for 15 minutes |

* For example

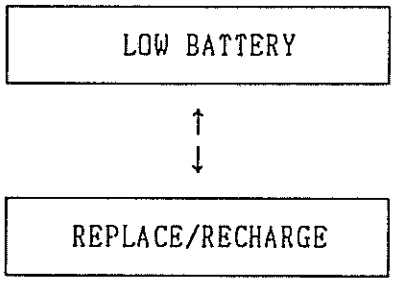
When the selector switch is turned to average value after operation with alarm OFF (position "7" of SW2) in normal measurement, it is became to the measurement of average value for 15 minutes automatically.
And also, after measuremenet of average value by changing the measurement of average value for 1 minute (change the arrow of SW2 to "5") the alarm setting value is became to the alarm for higher concentration side automatically by turning the selector switch⑦ to "CONT".

Note: It is possible to change the position of SW2 to "0, 1, 2, ... ....8, 9, A, B ..... E, F.
When the position of SW2 is placed to other position except 5, 6 and 7,. it is impossible to use this monitor for normal measurement.

## 9. POWER SUPPLY

This monitor is available to use the dry battery (standard), Ni-Cd battery (Option) and AC adaptor (Option).

### 9-1. Replacement of battery (in case of usage of dry battery)




When the dry battery is used, the indicattion will appear on display as REPLACE/RECHARGE above fig. And also, when the alarm for low battery is sounded, replace the battery with new one in accordance with following procedure.

1) Take off the monitor from carrying case.

2) Confirm that the power supply is "OFF"

3) Remove the battery cover.

4) Remove the older battery and put new battery into the battery holder. (Don't mistake the polarity of battery)

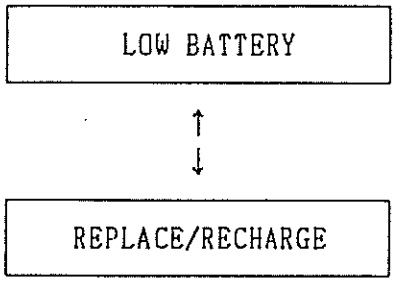
5) After the finishment of battery replacement, close the battery cover.

Note: 1) When the dry battery is replaced with new one, don't mix new battery and used battery.

2) When the dry battery is used, apply the dry battery of same type and same manufacturer.

3) When the dry battery is used, don't connect it to the charger absolutely. (This is for protection of electrolyte leakage and damage of dry battery)

9-2. Charging (The Ni-Cd battery and charger is option)




When the Ni-Cd battery is used, the indication is appeared on the display as REPLACE/RECHARGE and also, when the alarm for low battery is sounded, make the charging as following procedure.

1) Confirm that the selector switch ⑦ is "OFF" position.

2) Connect the charger to "CHG" position by removing the rubber cap for "CHG" of side panel and make the charging. (Refer to fig 5)

3) The charging time is approx 15 hours.

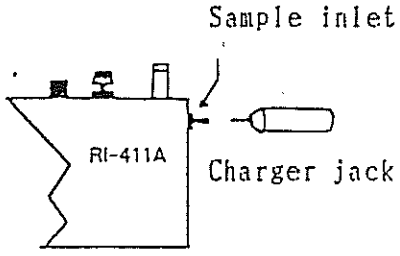



fig 5

Note: 1) Don't use the monitor during charging.

2) When the Ni-Cd battery is used, apply an exclusive battery and charger (This is option).

3) When the battery capacity is dropped, carry out the charging with charger. When it is necessary to use the monitor during charging, it is possible to use the monitor even if during charging by connecting the AC adaptor.

9-3. How to use the AC adaptor (option)

The monitor can be measured continuously by using the AC adaptor.
In this case, put the jack of AC adaptor to the socket of "DC 8V".
When this monitor is used with continuous measurement, take care the following points.

1) When the variation of environmental temperature is remarkable large during operation for a long time, make the zero and span calibration.

2) The durable times of suction pump depends upon the operation condition. when the monitor is used with continuous measurement for a long time, make the confirmation for pump suction regularly. When the pump is sucked the air, replace it with new one. check the suction of pump by touching on the gas inlet by finger.

3) When the AC adaptor is used for monitor, apply the power source which is not influenced from the noise.

4) When AC adaptor is necessary, apply an exclusive charger.

## 10. NOTICE OF HANDLING

To maintain the function of this monitor, take care the following points on handling.

1) Don't drop or shock

2) Protect the monitor from a waterdrop

3) When the monitor is given with excessive electric noise from outside and strong shock during operation, abnormal indication is appeared in display. In this case, turn the selector switch ⑦ to "OFF" and again, turn the selector switch to "ON".

4) When the selector switch ⑦ is turned to "OFF", turn the selector switch ⑦ to "ON" after more than 3 seconds.

5) When this monitor is used at higher humidity, moisture and dust places, confirm whether filter of sampling probe is dirt or not at regular. If this filter is dirty, replace with new one.

## 11. CHECK OF MONITOR IN ABNORMAL CONDITION

When the monitor is abnormal during operation, check the monior as following procedure. (Refer to fig 6)

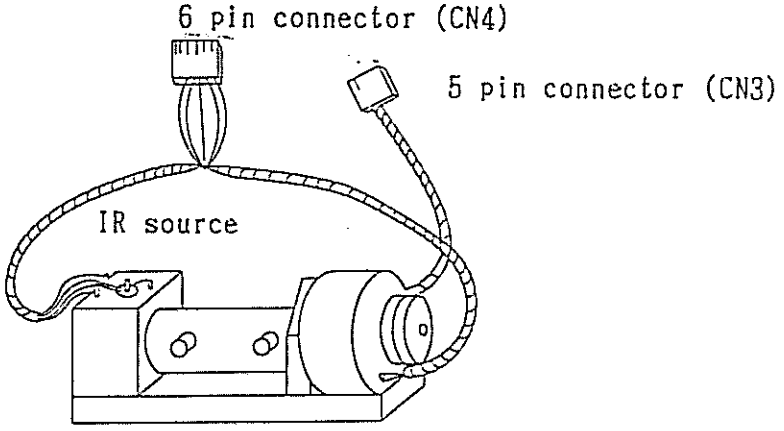



fig 6

11-1.

Phenomenon : * When the indication is not moved above "0 ppm" by turning the zero knob to clockwise fully.

Check point : * Check whether connector(6 pin/CN4) of detector is removed or not.
* Check whether contact point is normal or not.
* Check whether the IR source of detector is cold by touching with hand or not.

Treatment : * Check the connector(CN4)
* Check the IR source of detector is cold, it is necessary to replace the detector with new one so that IR source may be disconnected.

11-2.

Phenomenon : * The indication is adjutable by turning the zero knob. However, even though the calibration gas is introduced to the monitor, the indicator is not changed.

Check point : * Check whether the connector (5/pin.CN3) of detctor is removed.
* Check whether the connector of detector is defective contact.
* Check whether the light source of detector is cold.
* Check whether the installation of gas sampling probe and gas sampling tube is normal (Leakage check).

Treatment : * Check the CN3 connector
* Check the CN5 connector
* When the light source of detector is cold, the light source of detector is disconnected. It is necessary to replace.
* Check the gas sampling probe, gas sampling tube and inside sampling tube.

Phenomenon : * The display is not appeared after the power switch to "ON" and is appeared with abnormal indication.

Check point : * Check whether the battery is installed in normal.
* Check whether the battery is defective contact with the leakage of battery electrolyte.
* Check whether the connector of printed circuit board is loosen.

Treatment : * Replace the batteries with new one.
* Polish the battery socket with a alcohol.

11-4. When the water is absorbed into the detector through sampling probe and sampling tube, turn the selector switch ⑦ to "OFF" immediately and replace the filter with new one. Make the operation for approx. 10 minutes by turning the selector switch ⑦ to "BAT.CK" position. After that, make the ZERO adjustment and calibration certainly.

## 12. FUNCTION OF SOME PARTS

This monitor has following functions.

1) Output for recorder

When this monitor is used with connection of recorder, connect the recorder to external outlet of "REC 0～100mV".
Please use an exclusive plug for connection (cable with 1m).

2) Automatic illumination in dark place

This monitor will illuminate automatically when the surrounding is dark.
This monitor can be read the indication value at dark place.
The illumination will vanish automatically when the surroundings will bright.

## 13. ACCESSORIES

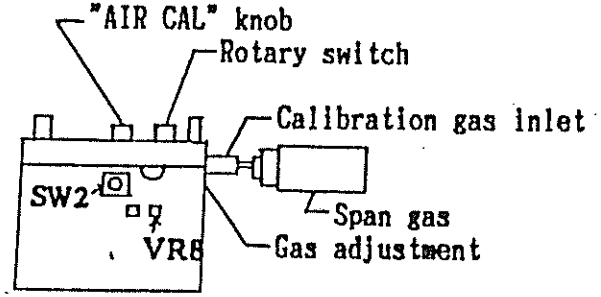
Standard accessories

1. Carrying case with shoulderstrap .... 1 pce,
2. Sampling probe ..... 1 pce,
3. Sampling tube (1m) .... 1 pce,
4. Alkaline dry cell ..... 6 pcs
5. Span gas can for zero ... 1 pce
6. Span gas can for span ... 1 pce
7. Instruction manual ..... 1 sheet

OPERATION PROCEDURE ( Example for 0 - 4.975 ppm )

| | Rotary switch | Display by LCD | Operation |
|---|---|---|---|
| Preparation | OFF | | * Check the condition of dust filters and replace them when they get visibly dirty. There are two filters, a small one in the handle of probe and a large one in a chamber head of sample inlet. |
| | | | * Connect the samping probe to the sampling hose, sampling hose to the dust filter and the dust filter to the gas inlet of instrument. |
| | BAT. CK | RANGE 4975 PPM | * This indicates the full scale range of concentration. |
| | | BAT CK E-*---F | * The voltage of the battery is displyed on the indicator by the position of the mark (*). An indication close to E (empty) indicates the batteries need charging or exchange. |
| | | BATTERY OK | |
| | | CK PROBE CONNECT | * Check that sampling probe, sampling hose and dust filter are connected properly. |
| | | TURN TO CONT/AVG | * Select either "Continuous" or "Average" measurement. |
| | BAT. CK | RANGE 4975 PPM | * This indicates the full scale range of concentration. |
| | | LOW BATTERY | * This shows that the battery voltage is too low for proper operation. |
| | | REPLACE/RECHARGE | * If dry batteries are in use, replace them. If rechargeable Ni-Cd batteries are used, recharge them. |

| | Rotary switch | Display by LCD | Operation |
|---|---|---|---|
| Measurement | CONT<br>↓<br>AVG | WARM UP<br>↓<br>CONTINUOUS MEAS<br>↓<br>ADJ 300 PPM AIR<br>↓<br>CONT 300 PPM<br>↓<br>CONT □□□□ PPM<br>↓<br>CUNTING □□□ SEC<br>↓<br>AVG □□□□ PPM | * After the power turned on, this indication will be displayed for approx. 1 minute.<br>* While clean air with normal average CO2 content is drawn through into the instrument, adjust the indicator to 300ppm by turning ZERO knob.<br>* When sampling an unknow sample with the sampling probe, the CO2 concentration will be displayed on the indicator within 10 seconds.<br>* The average CO2 concentration during the 1 minute period after changing over the switch will be displayed on the indicator (3 or 15 minutes average concentration is available. See below.)<br>* Average CO2 concentration is displayed and held until switch is transferred. To repeat, turn to CONT and then back to AVG. |

| | Rotary switch | Display by LCD | Operation |
|---|---|---|---|
| Calibration | ↓<br>CAL | ↓<br>CALIBRATION<br>↓<br>TAKE PROBE OFF<br>↓<br>SUPPLY CAL GAS<br>↓<br>CAL □□□□ PPM | * Pump stops.<br>* Remove sampling hose from the instrument.<br>* Connect span gas outlet to the inlet fitting of instrument and allow the span gas to flow slowly through into the detector.<br>* Observe highest reading. If it differes from the known concentration, adjust it to the span gas concentration by turning CAL control with a small screwdriver. (See below.)<br>  <br><br>Note: (1) To make an accurate zero adjustment with zero gas (e.g. N2 99.999% which is free from CO2), adjust the indicator to "0" ppm by admitting zero gas to the gas inlet using the same procedure as shown for the span gas, and turning the ZERO knob. Set to "000" instead of "300".<br>(2) When an accurate zero adjusting by turning the "AIR CAL" knob on top panel is not controlable, make zero adjustment by turning VR-8 for zero coarse adjustment of inside of monitor.<br>① Turn VR-3 for "AIR CAL" knob on top panel to clockwise fully until stopped. Turn 2.5 times to counterclockwise from the stopped position.<br>② Adjust the display to 0ppm by turning the VR-8 for zero coarse adjustment of P.C.B. |



Range:4975ppm

## PRODUCT WARRANTY

RKI Instruments, Inc. warranties gas alarm equipment sold by us to be free from defects in materials, workmanship, and performance for a period of one year from the date of shipment from RKI Instruments, Inc. Any parts found defective within that period will be repaired or replaced, at our option, free of charge. This warranty does not apply to those items which by their nature are subject to deterioration or consumption in normal service, and which must be cleaned, repaired or replaced on a routine basis. Examples of such items are:

a) Absorbent cartridges
b) Pump diaphragms and valves
c) Fuses
d) Batteries
e) Filter elements

Warranty is voided by abuse including mechanical damage, alteration, rough handling, or repair procedures not in accordance with instruction manual. This warranty indicates the full extend of our liability, and we are not responsible for removal or replacement costs, local repair costs, transportation costs, or contingent expenses incurred without our prior approval.

*THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY AND ALL OTHER WARRANTIES AND REPRESENTATIONS, EXPRESSED OR IMPLIED, AND ALL OTHER OBLIGATIONS OR LIABILITIES ON THE PART OF RKI INSTRUMENTS, INC. INCLUDING BUT NOT LIMITED TO, THE WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL RKI INSTRUMENTS, INC. BE LIABLE FOR INDIRECT, INCIDENTAL OR CONSEQUENTIAL LOSS OR DAMAGE OF ANY KIND CONNECTED WITH THE USE OF ITS PRODUCTS OR FAILURE OF ITS PRODUCTS TO FUNCTION OR OPERATE PROPERLY.*

This warranty covers instruments and parts sold to users only by authorized distributors, dealers and representatives as appointed by RKI Instruments, Inc.

We do not assume indemnification for any accident or damage caused by the operation of this gas monitor and our warranty is limited to the replacement of parts or our complete goods.