

INSTRUCTION MANUAL
FOR
MODEL RI-411A INFRARED CO₂ INDICATOR

RANGE : 0-4975ppm

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1. INTRODUCTION

The Model RI-411A represents a new approach to the problem of measuring carbon dioxide in low concentration up to 4975ppm. 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 applications.

1-1 Detection principle

The infrared analyzer uses the fact that each gas absorbs infrared energy of a characteristic frequency. In the gas analyzer, an infrared source (an electrically heated wire) emits a broad band of energy which is focused on a solid state detector through a narrow band filter selected to transmit only a certain range of frequencies which are selectively absorbed by CO₂. A sample gas to be detected flows through an enclosed chamber interposed between the infrared source and the detector.

The infrared beam is transmitted through this chamber. If the measuring chamber contains CO₂, the amount of energy passing through the chamber is decreased. The decreased amount of infrared beam is an indication of the concentration of carbon dioxide in the sample.

1-2 General Description

In the Model RI-411A, a small pump continuously draws a sample of the atmosphere to be tested, through a length of hose and a probe. The CO₂ content is continuously monitored and digitally displayed directly in volume percent unit to the nearest 25ppm. That is, readings of 25, 50, 75 ... up to 4975 are possible. The microprocessor control produces instructional and malfunction information as needed for easy interpretation of indication.

Since the atmosphere always contains some CO₂, and this amount is constantly shifting slightly, a separate averaging readout mode is provided.

When used, it will integrate and calculate the average total exposure to CO₂ over a preselected period, usually three minutes, and then display and hold that reading until needed.

1-3 Normal Operation

To place instrument into operation, turn selector switch from OFF to BAT CK and follow the instructions as indicated on the display. These are summarized in tabular form in Section 5 of this manual. The written instructions will appear on the dot-matrix display. The display is self illuminated in subdued light conditions under the control of a photo diode which senses ambient light level.

Once proper battery capacity is indicated by the display (the star on the display must be at one of the positions above E for empty), proceed to make adjustments and to take a reading. The best way to set the zero or "AIR CAL" reading is with a gas sample of known CO₂ content, such as a cylinder of nitrogen, which may be assumed to be CO₂ free. If such a cylinder is available, put the selector switch in the CAL position, which will stop the pump. Then admit nitrogen to probe inlet, being very careful not to pressurize the instrument by flowing too fast. A flow of 0.5 to 1.0 cfh is plenty. While flowing, set AIR CAL to bring reading on display to .00 or a little above.

If nitrogen is not available, then set reading to 0.0 in normal air, while operating in the CONT position. When doing this, be sure the air is in fact "normal" and not taken from a space where people have been working and breathing. Air from outdoors and away from traffic is best.

Once the zero is set, proceed to take instrument to the area to be tested and hold probe at point where sample is to be taken. Reading may be taken continuously, or the switch may be moved to AVG, upon which the display will read "COUNTING 180" etc, with the numerals representing the number of seconds to completion of the test. At the end of the time period, the display will show

and hold the average concentration for the preceding period as calculated by the microprocessor. To start another test, turn switch to CONT and back to AVG.

1-4 Alarms

The RI-411A has a small internal buzzer, which will sound under the following conditions:

- a) As a high gas alarm, whenever reading goes above 1250 or 2500ppm. The sound pattern is a short-short one.

In case of 2500ppm	Set an arrow of SW2 to 5
In case of 1250ppm	Set an arrow of SW2 to 6
In case of alarm "OFF"	Set an arrow of SW2 to 7

- b) As an indication that the average reading has been completed, the sound pattern is a long-long one.

- c) As a low battery alarm when battery voltage drops to the point below which reliable operation is not possible. This is a continuous tone:

1-5 Maintenance

The principal routine maintenance operations are:

- a) Calibration. Check the reading on a known calibrating sample often enough to insure dependable indications. See Section 4.C.
- b) Battery. If disposable batteries are in use, replace them whenever battery indication approaches E* for empty. To replace, take instrument from its

vinyl case, turn it over and lift the thumb tab which releases bottom plate. Snap batteries out of holder and re-install new ones in the same way. Ordinary carbon zinc D-size flashlight cells may be used for short periods, but alkaline type are recommended.

If rechargeable Ni-Cd cells are in use, plug in charger and let it run overnight, with switch off. CONFIRM NI-CD CELLS ARE INSTALLED BEFORE PLUGGING IN CHARGER.

- c) Filter. The internal optical system parts must be kept clean and dry for proper operation. Avoid drawing water into system, and keep the cotton filter element clean, replacing when it becomes necessary. This applies to the small primary filters in the handle of the probe and the main filter in the transparent housing strapped to the side of the instrument.
- d) Pump. Pump must draw sample at a satisfactory rate to produce readings in a reasonable time. Check time response by breathing out into the probe inlet and noting elapsed time before the meter responds with an increase in CO₂. Normal response is about 10 seconds. If it exceeds 20 seconds, the pump could need servicing.

To remove pump, first take off rear cover to expose sample and optical systems. Then remove one screw holding the pump retainer bracket, and slip off the two tubes at the nipples on head of pump. Unplug the connector at circuit board.

The pump can be returned for service on an exchange basis, or disassembled and cleaned. The usual cause of poor pump efficiency is dirt on valves.

- e) Other maintenance. Repair, overhaul and troubleshooting of the optical and electronic circuits are beyond the scope of this manual. For problems in these areas, return of the entire instrument to RIKEN KEIKI or our agent close by is recommended.

1-6 Optional water trap

For operation in very moist conditions, an optional water trap is available. It connects at the left hand (inlet) end of the dust filter chamber at rear of instrument. Its transparent body hangs downward and collects any water that may be carried in with the sample. This will prevent water saturation of the dust filter and may forestall accumulation of water in the optical system.

- a) If trap is in use, check it periodically for water accumulation. If water does build up in the bottom, it can be drawined out, while pump is off, by pushing up on the stem of the tire valve protruding from the bottom.
- b) Filter element is replaceable by unscrewing plastic body from trap assembly and then unscrewing element retainer.
- c) Do not use the trap when not needed, as it will add about 10 seconds to the response time.

1-7 Operation in CO2 background

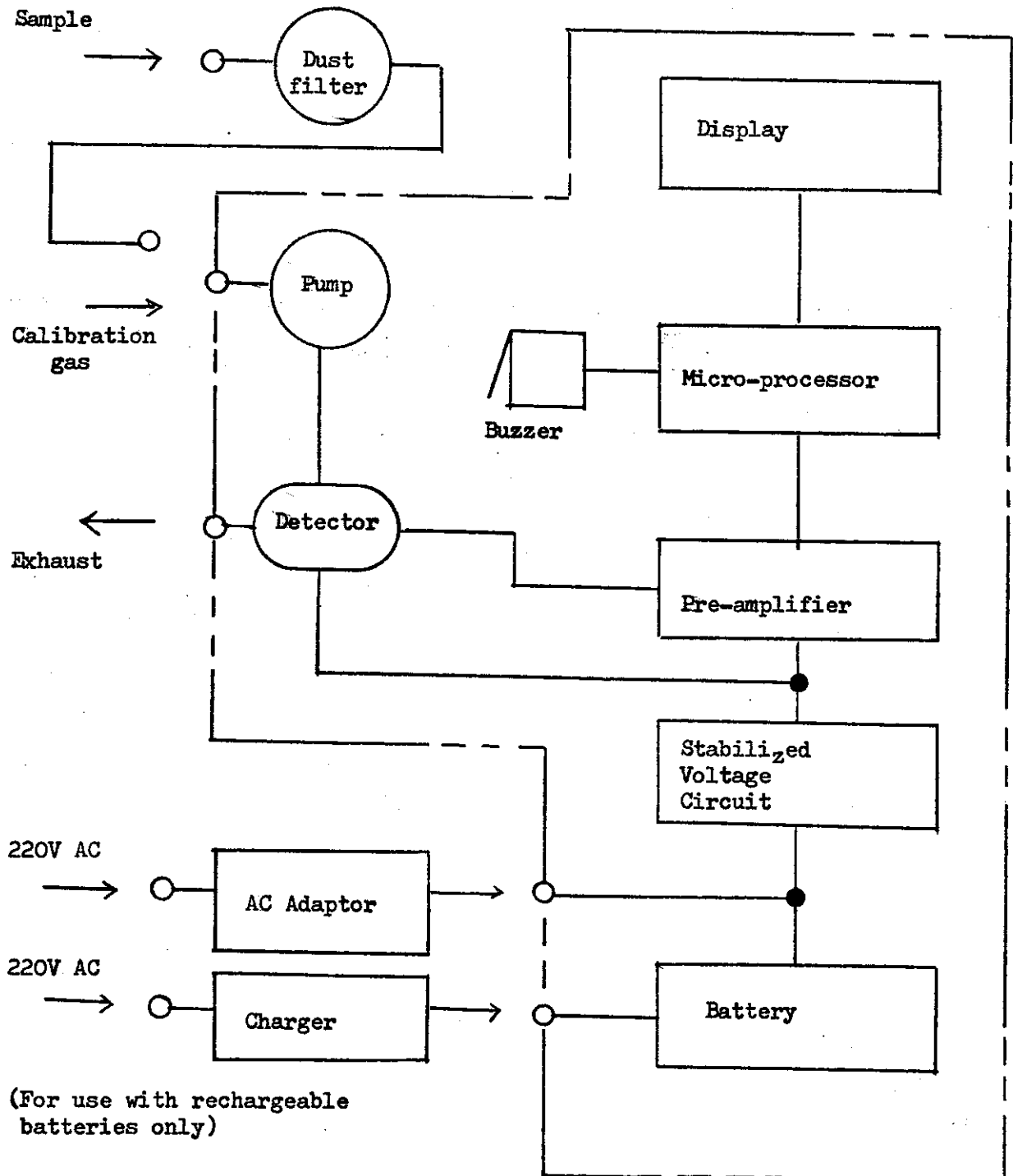
The model RI-411A is designed primarily for use with the instrument and the operator in a normal atmosphere having about 500ppm CO2. The space being tested is connected to the instrument by means of the probe and hose.

To avoid false low or varying readings from this cause, try to keep the instrument in a ventilated or normal CO2 environment, and periodically take it back to a known fresh air location to allow it to recover. When in doubt as to validity of readings at any time, make a calibration recheck

2. SPECIFICATIONS

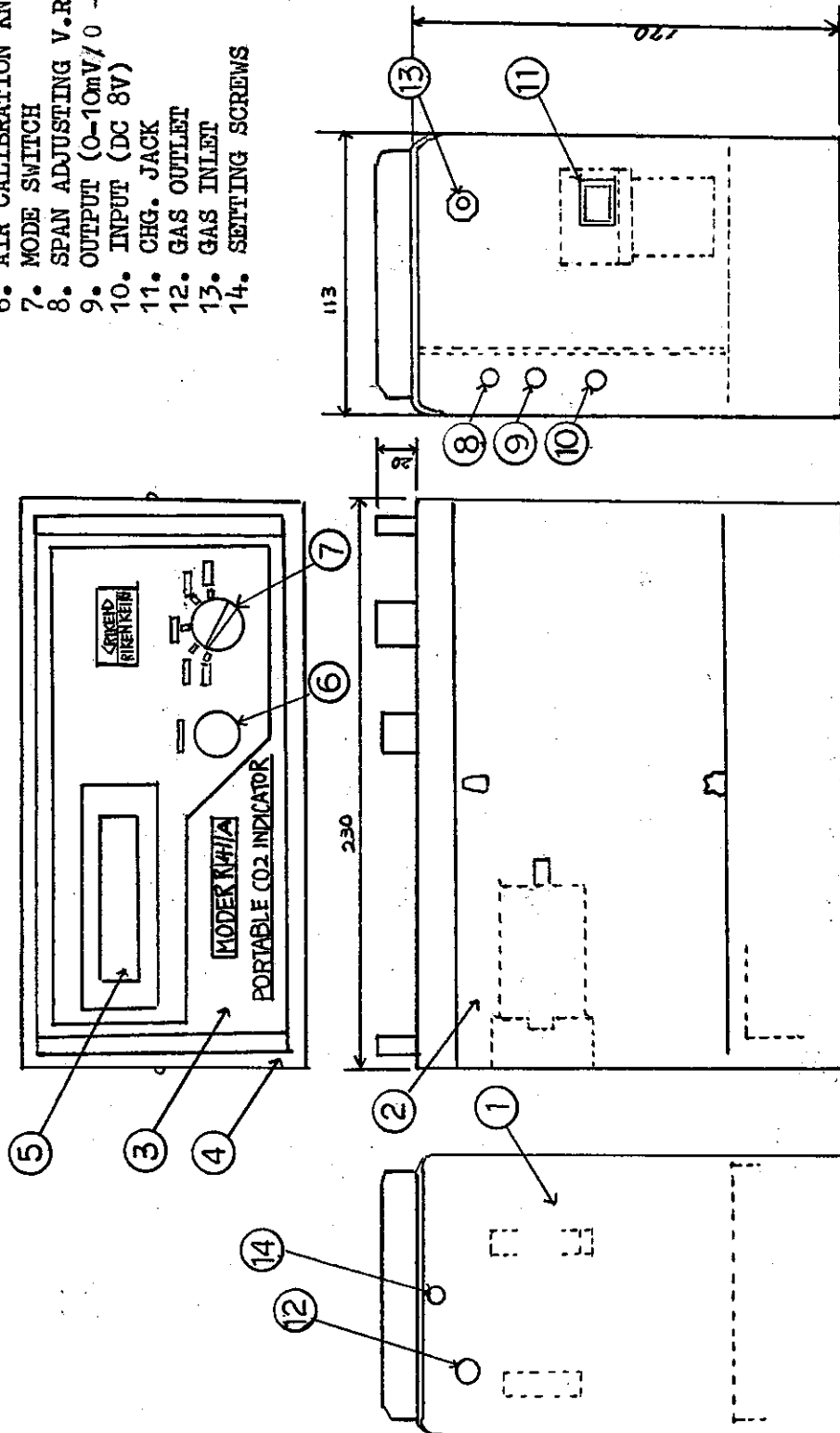
Model	RI-411A (0-4975ppm range)
Measuring principle	Non-dispersive infrared absorption (NDIR)
Measuring gas	Carbon dioxide (CO ₂) in air
Measuring range	0 ~ 4975ppm (25ppm/digit)
Indication method	Continuous .. Digital LCD display of instantaneous concentration Average..... Digital LCD display of average concentration over 1, 3 or 15 minutes.
Terminal-based Linearity	0.1% (1000 ppm) CO ₂
Response time	10 seconds to 90% indication
Sampling method	Motor-driven diaphragm pump
Calibration	AIR CAL Set zero on CO ₂ -free air SPAN Calibrate on known cylinder of CO ₂ in air or N ₂ (Span gas)
Ambient temperature	-10~+40°C (14~104 degree Fahrenheit)
Recorder output	0 ~ 10mV / 0 - 100mV DC
Power supply	6 pcs of D size cells Alkaline dry cell .. Approx. 7 hr. in continuous operation at 23 °C
Dimensions	230 (W) x 190 (H) x 113 (D) mm (9.8 x 7.5 x 4.3 inches)
Weight	Approx 2.4Kg

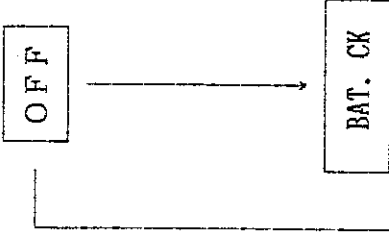
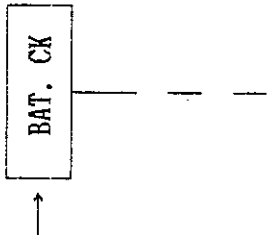
3. BLOCK DIAGRAM



4. PART IDENTIFICATION

1. INSTRUMENT CASE
2. SIDE COVER
3. PANEL PLATE
4. TOP PANEL
5. DISPLAY (L.C.D.)
6. AIR CALIBRATION KNOB
7. MODE SWITCH
8. SPAN ADJUSTING V.R.
9. OUTPUT (0-10mV/0 - 100mV)
10. INPUT (DC 8V)
11. CHG. JACK
12. GAS OUTLET
13. GAS INLET
14. SETTING SCREWS



	Rotary switch	Display by LCD	Operation
Preparation		<p>RANGE 4975 PPM ↓ BAT CK E-***-F ↓ BATTERY OK ↓ CK PROBE CONNECT ↓ TURN TO CONT/AVG</p>	<ul style="list-style-type: none"> * 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 sampling probe to the sampling hose, sampling hose to the dust filter and the dust filter to the gas inlet of instrument. * This indicates the full scale range of concentration. * The voltage of the battery is displayed on the indicator by the position of the mark (*). An indication close to E (empty) indicates the batteries need charging or exchange. * Check that sampling probe, sampling hose and dust filter are connected properly. * Select either "Continuous" or "Average" measurement.
		<p>RANGE 4975 PPM ↓ LOW BATTERY ↓ REPLACE/RECHARGE</p>	<ul style="list-style-type: none"> * This indicates the full scale range of concentration. * This shows that the battery voltage is too low for proper operation. * If dry batteries are in use, replace them. If rechargeable Ni-Cd batteries are used, recharge them.

Measurement	Rotary switch	Display by LCD	Operation
	<div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 10px;">CONT</div> <div style="text-align: center; margin: 0 20px;">↓</div> <div style="border: 1px solid black; padding: 5px; display: inline-block;">AVG</div>	<p>WARM UP ↓ CONTINUOUS MEAS ↓ ADJ 300 PPM AIR ↓ CONT 300 PPM ↓ CONT PPM ↓ COUNTING SEC ↓ AVG PPM</p>	<ul style="list-style-type: none"> * After the power turned on, this indication will be displayed for approx. 1 minute. * While clean air with normal average CO2 content is drawn through into the instrument, adjust the indicator to 300ppm by turning ZERO knob. * When sampling an unknown sample with the sampling probe, the CO2 concentration will be displayed on the indicator within 10 seconds. * 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.) * 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	<div data-bbox="316 1458 379 1630" style="border: 1px solid black; padding: 2px; text-align: center;"> ↓ CAL </div>	<div data-bbox="272 1160 592 1391" style="text-align: center;"> ↓ CALIBRATION ↓ TAKE PROBE OFF ↓ SUPPLY CAL GAS ↓ CAL PPM </div>	<div data-bbox="309 421 692 1043" style="text-align: left;"> <ul style="list-style-type: none"> * Pump stops. * Remove sampling hose from the instrument. * Connect span gas outlet to the inlet fitting of instrument and allow the span gas to flow slowly through into the detector. * Observe highest reading. If it differs from the known concentration, adjust it to the span gas concentration by turning CAL control with a small screwdriver. (See below.) </div> <div data-bbox="687 232 975 797" style="text-align: center;"> </div> <div data-bbox="986 232 1469 1043" style="text-align: left;"> <p>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".</p> <p>(2) When an accurate zero adjusting by turning the "AIR CAL" knob on top panel is not controllable, make zero adjustment by turning VR-8 for zero coarse adjustment of inside of monitor.</p> <p>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.</p> <p>② Adjust the display to 0ppm by turning the VR-8 for zero coarse adjustment of P.C.R.</p> </div>

6. ACCESSORIES

STANDARD ACCESSORIES

1. Carrying case with shoulder strap 1 pce.
2. Gas sampling probe 1 pce.
3. Gas sampling hose 1 pce.
4. Alkaline dry battery 6 pcs.
5. Canned span gas 1 pce.

OPTIONAL ACCESSORIES

1. Charger 1 pce.
2. AC adaptor 1 pce.
3. Ni-Cd battery (3 pcs/set in series) 2 sets