RAM ION DigiLog Meters

For Wide Range Gamma, X-Ray and Beta Radiation Measurement

RAM ION
RAM ION-X

Operating & Maintenance Manual

Version 2.5 – November 2021

Document # PRIR43O9-2.5.DOC

Version / Revision Log: RAM ION / Operating & Maintenance Manual

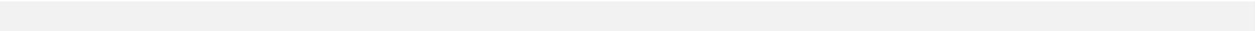| Ver./Rev.#	Date	Revised Pages	Comments
1.0	March 2000		Operating & Maintenance Manual, Document # PRIR43O9.DOC
2.1	Oct 2009		
2.2	Jan 2012		Updated Table of contents
2.3	July 2017		Corrected Paragraph 3.8 Push Button Function Table
2.4	Dec 2020		Changes in firmware and as a derivative additional mode of operation was added
2.5	Nov 2021		Silica gel status

ROTEM Industries Ltd. reserves the right to change specifications without advance notice.

Ref. PRIR43O9-2.5.DOC

Table of Contents

1. *The RAM ION Meter*

1.1. *General Description*

The **RAM ION Meter** is a portable ion chamber survey meter, designed for highly stable and accurate measurement of dose rates and integrated dose of gamma, x-ray and beta radiation. The meter covers a measuring range of 0.1 mR/h up to 50 R/h (1 μSv/h to 500 mSv/h) in the dose-rate mode and 1 μR up to 1000 R (0.01 μSv up to 10 Sv) in the integrated dose mode.

The RAM ION survey meter combines an ionization chamber vented to atmospheric pressure, electrometer card and a microcontroller, to offer optimal performances and special features. Two communication ports provide a very simple and reliable method to collect and store monitored data **on site** for later use, in addition to the RAM ION regular functions.

The RAM ION is a compact, battery operated, auto ranging, one hand held, lightweight and ruggedized meter, easy to use and maintain. It is ideal for use in facilities of: Nuclear power plants, nuclear medicine, radiography, radiotherapy, life science laboratories, nuclear research centers and for other industrial applications.

1.2. *Features*

- X-ray, Beta and Beta + Gamma radiation measurement.
- Auto ranging digital and analog display.
- Freeze mode to record the highest dose rate.
- Provision of dose rate and dose alarms.
- Sievert or Roentgen units.
- Display illumination for use in low light areas.
- Hot spot detection.
- Low battery, overflow, over threshold and detector fail alarms.
- Two communication ports.
- NV SRAM built-in memory to store measurements data.
- E²EPROM to save the meter parameters.
- ICRP-51 standard.
- RMV compatible.
- Computerized and/or manual calibration.
- X-Ray 50 nano Sec pulses dose measuring

1.3. *Ordering information*

RAM ION DIGILOG HR- BAK 1940
RAM ION DIGILOG LR -BAK 1950
RAM ION DIGILOG X LR - BAK 2010
RAM ION DIGILOG X HR - BAK 2000

---

2. *Specifications*

Measuring range	0.1 mR/h to 50 R/h (1 μSv/h to 500 mSv/h)
Accuracy	±10% of reading, within the measuring range
Gamma energy dependence (Cs-137)	Better than ±20 % at 20 keV to 1.3 MeV
Angular dependence (Cs-137)	Less than ±5 % (for ±120° of front direction)
Ion chamber volume	500 cc
Chamber wall & cover thickness	300 mg/cm^2
End window thickness	7 mg/cm^2
Response time	2 sec. for readings above 1 mR/h, 5 sec. for auto-ranging change, from Low Range to High Range (2 sec. + 3 additional seconds for auto-ranging delay).
Data logging	380 data records (1415 with extended memory)
Display	DigiLog (3 digits & 2 decades of analog bar-graph)
Power source	Two 1.5 Volt C-type cells 100 hours of continuous operation Automatic battery check
Temperature range	Operation: -10°C to +50°C (15°F to 122°F) Storage: -20°C to + 60°C (-5°F to 140°F)
Humidity range	Up to 95% RH (non condensing)
Casing Material	Splash proof plastic case
Dimensions	Width: 10 cm (3.9") Length: 25 cm (9.8") Height: 19 cm (7.5")
Weight	850 g (1.9 lb)

3. Operating Instructions

3.1. Preparation for Use

Remove the instrument from the shipping container and check for any physical damage. In the case of damage, report it immediately to the carrier.
Do not attempt to install or operate damaged equipment since safety and performance may be affected

3.2. Starting-up

Press the **ON/OFF** push-button. When the meter is turned on, it carries out a short self-test procedure indicated by displaying all the segments on the display, and emitting two beeps for a short period. After the self-test the meter enters to offset routine.
When the offset adjustment routine is active the **SET** LCDs and the 0.0mR/h reading blink on the display. The offset adjustment is carried out for 40 seconds. When offset adjustment is completed, the meter beeps twice. The meter is ready for use.
To turn the meter off press the **ON/OFF** push-button continuously for at least one second and then release. The actual turning off will be performed after the push-button is released.

3.3. General Functions

3.3.1. Recent Modifications

The RAM ION was modified to provide an instantaneous measurement of dose rate when subjected to pulsed radiation. When measuring pulsed radiation, the exposure duration is very short and the firmware of the instrument was adjusted to display the average dose rate during the pulsed X-ray exposure since the most recent timer reset. The displayed dose rate is based on accumulated dose divided by the integration time (since instrument's turn-on or since the timer reset).
The internal timer is reset either by pressing the "*RESET*" push button twice on the instruments panel or by a command transmitted to the instrument from the dedicated SW (RMVC), when the instrument is connected to the PC via the USB connector.

3.3.2. Measuring Modes

The meter has two measuring modes:
1. Auto-Range - 0.1 mR/h to 250 mR/h and 0.25R/h to 50R/h
2. High Range Only - 0.01 R/h to 50 R/h

Auto Range Mode

In this mode the meter's total measuring range is from 0.1 mR/h to 50 R/h.
For efficient measuring purposes, the total range is divided in two narrower ranges that are automatically switched:
Low Range: 0.1 mR/h to 250 mR/h
High Range: 0.25 R/h to 50 R/h
Switching from low range to high range is performed in a field of 250 mR/h.
Switching from high range to low range is performed in a field of 170 mR/h.
Response time in a field higher than 1 mR/h is 2 seconds

At the switching point from low range to high range there is a delay of 3 seconds.
When the meter is turned on, the default measuring mode is Auto Range. Switching to High Range Only is performed by a long press on the MODE push-button.

High Range Only

In this mode the meter's measuring range is from 0.01 R/h to 50 R/h. The meter resolution is 10 mR/h and there is neither switching between the range modes nor delay time. The meter's response time at any measuring range is 2 seconds.
Switching to Auto Range mode is performed by a long press on the MODE push-button.

3.3.3. Measuring Units

When the meter is turned on, the Dose Rate reading is displayed in mR/h or μSv/h units.
A short press on the MODE push-button switches between Dose reading, Dose Rate Pulsed and then Dose Rate and Dose reading display.

DOSE $\rightarrow$ **DOSE RATE pulsed** $\rightarrow$ **DOSE RATE continuous** $\rightarrow$ **DOSE**
μR, μSv   mR/h, μSv/h   mR/h, μSv/h   μR, μSv

Measuring range in **Dose Rate** mode:

Auto Range: 0.1 mR/h to 250 mR/h
                         0.25 R/h to 50 R/h
High Range Only: 0.01 R/h to 50 R/h

Measuring range in **Dose** mode:

                         0.01 μSv/h to 9.99 Sv
                         1 μR to 999 R

To reset the Dose reading, press two long successive pressings on the RESET push-button.
While the Dose reading is displayed, the digital display shows the Dose reading and the analog display shows the field tendency (Rate reading).

3.3.4. Dose Rate Display

Readings are displayed in digital and analog modes. The bar graph ranges are automatically changed and the displayed units correspond to both, the digital and analog display. The bar graph measuring response is quicker than the digital display response since the latter averages the readings.

3.3.5. Freeze & Reset Functions

Dose Rate mode - A short press on the RESET push-button enters the meter into the FREEZE mode for peak measuring. In the Freeze mode the measuring units (mR/h, μSv/h) blink on the display. An additional short press cancels the Freeze mode and performs a momentary reset of the Dose Rate reading.
The reset function provides a rapid means of discharging the Display reading and enables accurate measurement of low level Dose Rate.

Dose mode - The first short press on the RESET push-button causes the blinking of the measuring units, the second short press **within 4 seconds** resets the dose.

3.3.6. *Audible announcements*

Each push-button press is accompanied by an audible beep.
In case of threshold alarm or failure alarm, the audible alarm is activated and the SPK icon blinks on the display. To mute the audible alarms press the RESET push-button.
When no threshold exceeding or failure conditions are present the SPK icon is not displayed.

3.3.7. *Display Illumination*

A long press on the LIGHT push-button turns the display illumination on/off. If the light is on, it will turn off automatically after **two minutes** (option).

3.3.8. *Hot Spot Function*

When a rapid change in the radiation field is detected, the hot spot function is activated and a short beep is sounded. The meter's response time is shorter than one second and the display is immediately updated.

3.4. *Threshold Selection*

Note: The threshold value setting process is similar for Dose Rate and for Dose.

A threshold value can be selected from a series of 7 threshold values. The selected one is kept in the E²EPROM's memory. If the meter is turned off the selected threshold value does not change.

Dose Rate threshold values:

0.75 mR/h, 2.50 mR/h, 10.0 mR/h, 100 mR/h, 200 mR/h, 0.50 R/h, 50.0 R/h

7.5 μSv/h, 25.0 μSv/h, 100 μSv/h, 1.00 mSv/h, 2.00 mSv/h, 5.00 mSv/h, 500 mSv/h

Dose threshold values:

750 μR, 2.50 mR, 10.0 mR, 100 mR, 200 mR, 500 mR, 999 R

7.50 μSv, 25.0 μSv, 100 μSv, 1.00 mSv, 2.00 mSv, 5.00 mSv, 9.99 Sv

To choose the required threshold value, proceed with the following steps:

3.4.1. Enter threshold mode by pressing the MODE and RESET push-buttons simultaneously. The threshold readings, SET LCDs, RATE LCDs and SPK icon will be displayed.

3.4.2. Each short press on the RESET push-button advances the display to the next threshold value, according to the order described above.

3.4.3. To exit Set Threshold mode, save and set the new threshold value, press the MODE & RESET push-buttons simultaneously. Saving will be verified by an audible beep.

3.4.4. The MODE push-button is used to switch between SET DOSE ALARM and SET DOSE RATE ALARM.

3.5. *Alarms*

a. Detector alarm

The **Err.** LCDs and **SPK icon** will blink on the display in three cases:
  1. Electrometer circuit is defective.
  2. High voltage power supply is defective.

---

3. Ion chamber is defective.

To mute the audible alarm, press the RESET push-button.

b. Battery alarm

If battery voltage decreases below 2.2V, the **battery** and **SPK** icons will blink on the display, and an interrupted audible alarm will be activated.
To mute the audible alarm, press the RESET push-button.
If a **low battery** alarm is activated while the meter is on, it will continue the operation during at least eight additional hours.

c. Overflow alarm

If the displayed DOSE RATE is over 50 R/h, the **O.F.** LCDs and **SPK** icon will blink on the display and an interrupted audible alarm will be activated. To mute the audible alarm, press RESET push-button.

d. Threshold alarm for Dose Rate and Dose

If the Dose Rate reading exceeds threshold value, the **DOSE RATE** LCDs and **SPK** icon will blink on the display, and an audible alarm will be activated.
Pressing the RESET push-button mutes the audible alarm, but the **RATE** LCDs and the **SPK** icon continue blinking, until the reading decreases to 75% of threshold value. In case the reading exceeds threshold value and then decreases to below 75% of the threshold value, the **RATE** LCDs, the **SPK** icon and the beep sound will automatically cancel, even though the RESET push-button has not been pressed.
If the **DOSE** reading exceeds dose threshold value, the **DOSE** LCDs and **SPK** icon will blink on the display, accompanied by an audible alarm.
Pressing the RESET push-button mutes the audible alarm but the **DOSE** LCDs and **SPK** icon continue blinking on the display.
The exceeding threshold message in the dose mode will be cancelled only after dose reading reset.
The meter alarms dose threshold exceeding also in the rate measuring mode.
The meter alarms rate threshold exceeding also in the dose measuring mode.

3.6. *Gamma and Beta Radiation Measurement*

The meter can measure gamma and beta & gamma radiation fields.
In case of the beta cover is on the Ion chamber, the meter measures gamma radiation.
When the beta cover is off the Ion chamber, the meter measures beta & gamma radiation.
Decreasing the gamma reading from the beta & gamma reading gives the beta radiation reading.

3.7. *Data Storage in the Internal Memory*

a) A short press on the STORE push-button enables to store data records in the built-in NV SRAM. When data is stored, the number of available memory entries is displayed by three digits and the **m** segment (e.g. 345 m). Maximum memory space is 380 Memory record.

   The stored data includes:
   - ID number (up-to 12 characters)
   - Date (month, day, year)
   - Time (hour, minutes)
   - Measurement
   - Unit
   - Comments

b) A long press (for 2 sec.) on the LIGHT push-button turns the light on/off.

c) To transfer the saved records from the RAM ION meter to the PC, the supplied cable should be used. The RMV software in the PC are used to receive the meter's data. RAM ION communication protocol is adequate to RMV software.

d) The stored data in the meter's memory is cleared in two way:

   - After it is transferred to the PC.

   - Two sequential long pressings (for 10 sec.) on the B.CODE push-button.

3.8. *Push-buttons Function*

Definitions:

Short press - Press a push-button and release within 2 seconds.

**Long press -** Press a push-button and hold at least for 2 seconds

Each press is accompanied by an audible beep.

Function	Pressing mode	Push-buttons
Meter on/off .Display 0.0 uSv/h and SET during calculate offset (about 40sec)	Short	ON/OFF
Switch between dose and rate measuring units. Switch between dose (0.00 uSv) to dose rate (0.00 uSv/h & DOSE RATE) to rate (0.0 uSv/h)	Short	MODE
Switch between Auto Range and High Range Only. Switch between high gain and low gain. high gain(uSv, uSv/h, uSv/h), low gain (uSv u blink, mSv/h, mSv/h)	Long	MODE
In case of an alarm condition (threshold or malfunction) the beeper is activated. Pressing the RESET push-button turns the beeper off. In Dose Rate mode, the first press enters to the Freeze mode, the second press returns to Dose Rate mode and resets the reading. In DOSE mode the first press on the RESET push-button causes the blinking of the measuring units, the second press **within 4 seconds** resets the dose.	Short	B.CODE RESET
Stores the reading value. Displays the available memory space.	Short	STORE LIGHT
Displays back light illumination on/off.	Long	STORE LIGHT
Switching between measurement mode and Threshold Set mode.	Simultaneously	MODE & RESET
Selects threshold value. In case of alarm mutes the speaker. First press go to freeze and enable set to zero dose and rate. (uSv, uSv/h, uSv/h and F blink)	Short	RESET

Second press within 10 secs after first press (while the measurement is blinking) sets the dose rate to zero and cancels the freeze mode. To Exit from Freeze, mode click with a short press on FREEZE during freeze mode press short reset exit from freeze		
Clear data from the meter's internal memory. (About 10 sec) first press display space memory available. Second press clear space memory to 346 maximum record.	Two sequential long presses (10 sec)	B.CODE RESET

3.9. Batteries Replacement

3.9.1. Open the batteries compartment by inserting a coin in the cover slot and turning counter clockwise

3.9.2. Insert two 1.5V C-type cells into the batteries compartment. Ensure to insert the (+) polarity towards the cover direction.
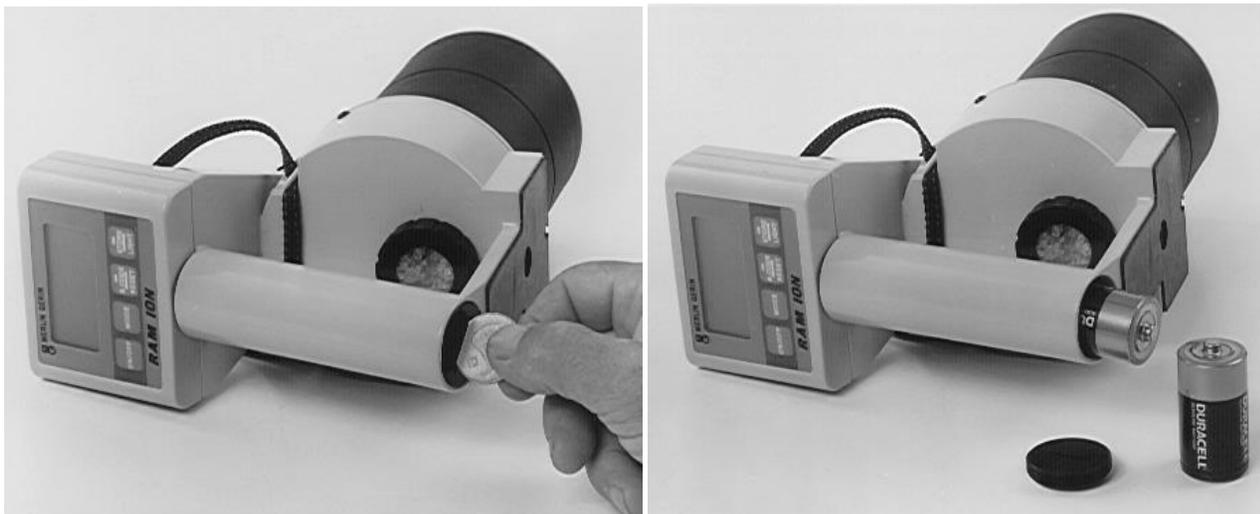
3.10. Silica Gel Cartridge

If the silica gels color changes from blue to pink which means that the hygroscopic material is saturated and cannot absorb more humidity), replace it with new material (blue color).

Blue – Silica Gel is dry and good.

Pink – Silica Gel is wet and should be dried or replaced.

4. Communication

4.1. General

The RAM ION DigiLog Meters include two communication channels:

COMM-1 – D-type connector, 9 pin

COMM-2 – internal Molex connector

COMM-1 is used for:
-Communication between meter and built-in bar code reader (internal connection).
-Communication between meter and PC, to download records from the meter to SMARTS or RMV software on PC.
-Communication between meter and PC to perform computerized calibration to the meter using RMC software.

COMM-2 is used for:
-Communication between meter and WRM2 wireless transmitter
-Communication between meter and WRM transmitter to integrate with the data acquisition system WRM.

Hardware   Communication Cable

COMM - 1

3	→	Tx
2	←	Rx
7	—	GND
9		
1	—	PC connection
6	—	acknowledge

D-type 9-Pin
Female on Meter

3	Tx	2
2	Rx	3
7	GND	5
9		
1		
6		

DB - 9 Male   DB - 9 Female
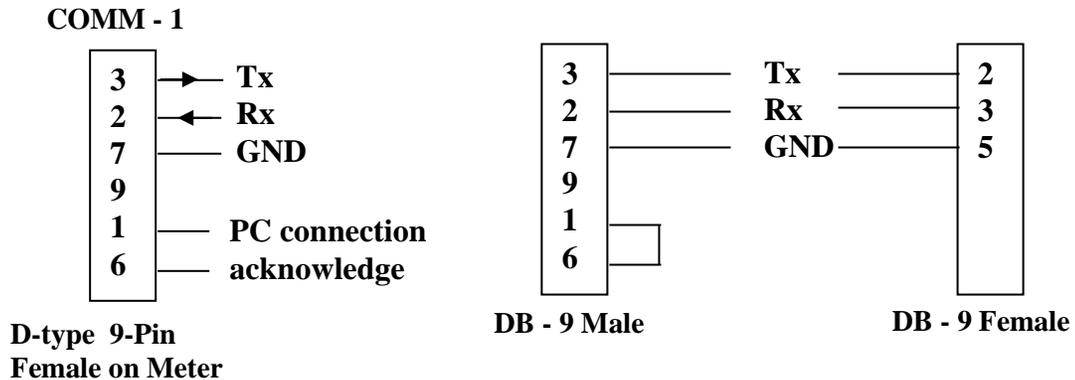
5. RAM ION-X

5.1. General Description

The RAM ION X is similar to the basic RAM ION meter but differs only in the EPROM software. The RAM ION X meter has been designed to measure the scattered leakage radiation of X-ray machines.

The RAM ION X meter is the best solution for routine checks of gamma and X-ray radiation, in facilities like nuclear medicine radiotherapy, radiochemistry, radiography, research centers and other health physics applications.

In the Dose mode the meter can measure narrow radiation pulses (50 Nano sec. minimum). Two optional measuring ranges are available in the Dose mode:

a. Measuring Dose in a Low Range radiation field from 1 μSv/h to 2.5 mSv/h (0.1 mR/h to 250 mR/h).

b. Measuring Dose in a High Range from 0.0 mSv/h to 500 mSv/h (0.01 to 50 R/h)

5.2. Basic Modes

Offset Adjustment – is performed during the first 40 seconds each time the meter is turned on (the same as the basic RAM ION).

Measuring Dose in Low Range Radiation Field – The meter enters this mode after offset adjustment. Dose is measured from 0.01 μSv (1 μR) in condition that the radiation field ranges from 0.1 mR/h to 250 mR/h.

To reset Dose measuring and starting a new count perform by a long press (2 sec.) on the RESET push-button. If the radiation field is higher than 250 mR/h, the meter will alarm overflow, the **O.F** LCDs, the RATE segment will blink on the display and an audible alarm is activated. A short press on the RESET push-button mutes the audible alarm. If the radiation field decreases below 250 mR/h, the audible alarm will be automatically stopped (even if the RESET push-button has not been pressed). The Dose measured reading and the O.F. & RATE segments will be displayed alternately. This result indicates that the count reading is not accurate since the meter has been in a radiation field higher than the meter range. A short press on the RESET push-button cancels the O.F. & RATE segments and resets the Dose value.

A short press on the MODE push-button switches the meter to measure Dose in High Range radiation field mode.

A long press on the MODE push-button switches the meter to measure Dose Rate in Auto Range mode.

Measuring Dose in High Range Radiation Field – Dose is measured from 0.01 μSv   (1 μR) in condition that the radiation field ranges from 0.01 R/h to 50 R/h. In this mode the units μSv (μR) blink on the display.

To reset Dose measuring and starting a new count perform by a long press (2 sec.) on the RESET push-button. If the radiation field is higher than 50 R/h, the meter will alarm overflow, the **O.F** LCDs, the RATE segment will blink on the display and an audible alarm is activated. A short press on the RESET push-button mutes the audible alarm. If the radiation field decreases below 50 R/h, the audible alarm will be automatically stopped (even if the RESET push-button has not been pressed). The Dose measured reading and the O.F. & RATE segments will be displayed alternately. This result indicates that the count reading is not accurate since the meter has been in a radiation field higher than the meter range. A short press on the RESET push-button cancels the O.F. & RATE segments and resets the Dose value.

A short press on the MODE push-button switches the meter to measure Dose in Low Range radiation field mode.

A long press on the MODE push-button switches the meter to measure Dose Rate in High Range Only mode.

Measuring Dose Rate in Auto Range - is manually performed by a short press on the MODE push-button in the dose rate high range mode, or by a long press on the MODE push-button in the dose high range mode. All the other functions are the same as in the basic RAM ION.

Measuring Dose Rate in High Range Only (R/h) – is automatically performed when in the Auto range the reading exceeds 250 mR/h (2.5 mS/h), or manually performed by a long press on the MODE push-button in the dose rate low range mode. All the other functions are the same as in the basic RAM ION.
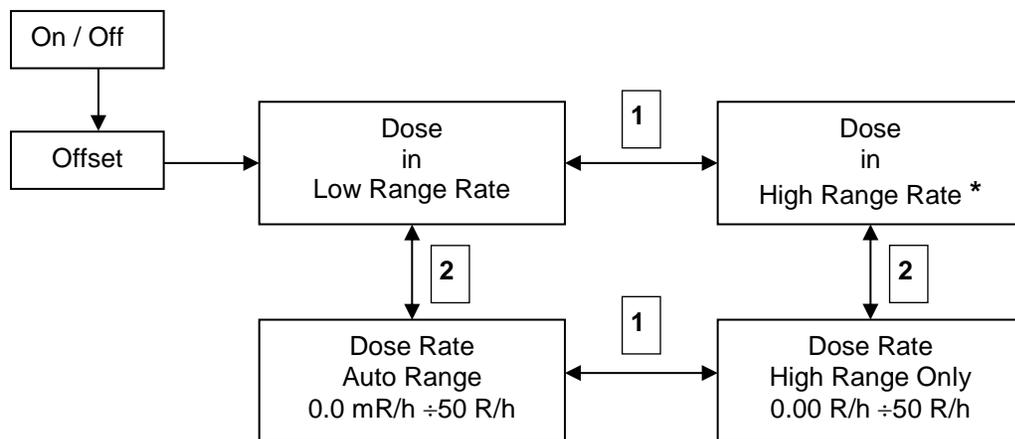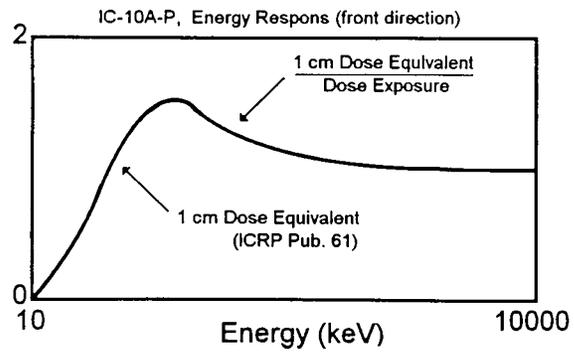

Reading:
* In Dose measuring in High Range Rate the units icons blink.

| 1 | Short press on MODE push-button. |

| 2 | Long press on MODE push-button. |

6. ICRP-51

The RAM ION ICRP-51 meets the ICRP 51 publication recommendation for ambient dose equivalent H*(10).

IC-10A-P, Energy Respons (front direction)

7. Calibration Instructions

7.1. Electronic Calibration *(Perform in an electronic lab by authorized engineer)*

7.1.1. Unscrew the three Philips screws located around the cylindrical part of the plastic mould electronic housing.

7.1.2. Disassemble RAM ION electronic housing.

7.1.3. Disconnect JMP1 on the electrometer board and connect a reference voltage of -20 Volts between R10 (JMP1 side) and common (GND).

7.1.4. Turn the RAM ION on.

7.1.5. Adjust the output frequency on U2/1 (R13) by TR11 to obtain 81.0 KHz.

7.1.6. Disconnect the reference power supply (-20.00 Volts) and check that the output frequency is within 500 ±150Hz. If this result is not obtained, replace the board.

7.2. Manual Radiation Calibration

7.2.1. Place the RAM ION is a homogenous gamma radiation field of about 200 mR/h (2.00mSv/h), at a distance of at least one meter from the source. The meter should be in the auto range, the default mode when turning on.

7.2.2. Verify the meter's reading fits the radiation field.

7.2.3. In case the meter's reading differs more than 5% from the true radiation field, adjust TR11 to obtain the required reading, each clockwise full turn increases the reading by 1.5%. TR11 can be accessible by unscrewing the silica-gel cartridge.

7.2.4. Check the linearity response.
ROTEM labs checked RAM ION linearity response in the following radiation levels:

> 2.6 mR/h   (26 μSv/h)
> 25 mR/h (250 μSv/h)
> 218.2 mR/h (2182 μSv/h)
> 282.4 mR/h 2.824 (mSv/h) - Calibration point
> 2.325 R/h (23.25 mS/h)
> 46.21 R/h (462.1 mSv/h)
> 50 R/h   (500 mSv/h) - Overload check
> 500 R/h (5 Sv/h) - Overload check

The above radiation levels are only typical values. The exact values are determined according to the precise source radiation level.
For acquiring the precise values, please check the specific calibration certificate attached to each RAM ION instrument.

7.3. Computerized calibration ROTEM Meter Calibration – RMC

7.3.1. General Description

The computerized calibration program enables to calibrate the ROTEM Meter with a very efficient and easy process, via RS-232 communication.

The ROTEM Meters using the RMC software are: RAM ION, RAM ION DigiLog, TelePole HR, TelePole WR, TelePole Internal Detector.

Calibration parameters stored in the meter's EEPROM memory:
- Meter serial number (up to 8 characters)
- Calibration factor
- Name of the operator (up to 12 characters)
- Calibration date
- Calibration due date

Parameters transferred to the SMARTS (Survey Mapping Automatic Radiation Tracking System) software and RMV (ROTEM Meter View) software:
- Meter serial number
- Name of the operator (up to 12 characters)
- Calibration factor
- Calibration due date

7.3.2. Installation Instructions

The calibration software is operated under MS-Windows 95 or later versions.
  a. Insert the installation diskette in the floppy drive.
  b. Run the install.bat file. The RMC directory will be created.
  c. Create an icon for the RMC.EXE file in the Program Manager.

7.3.3. Operation Instructions

Run the calibration program via the RMC.EXE file (or icon).
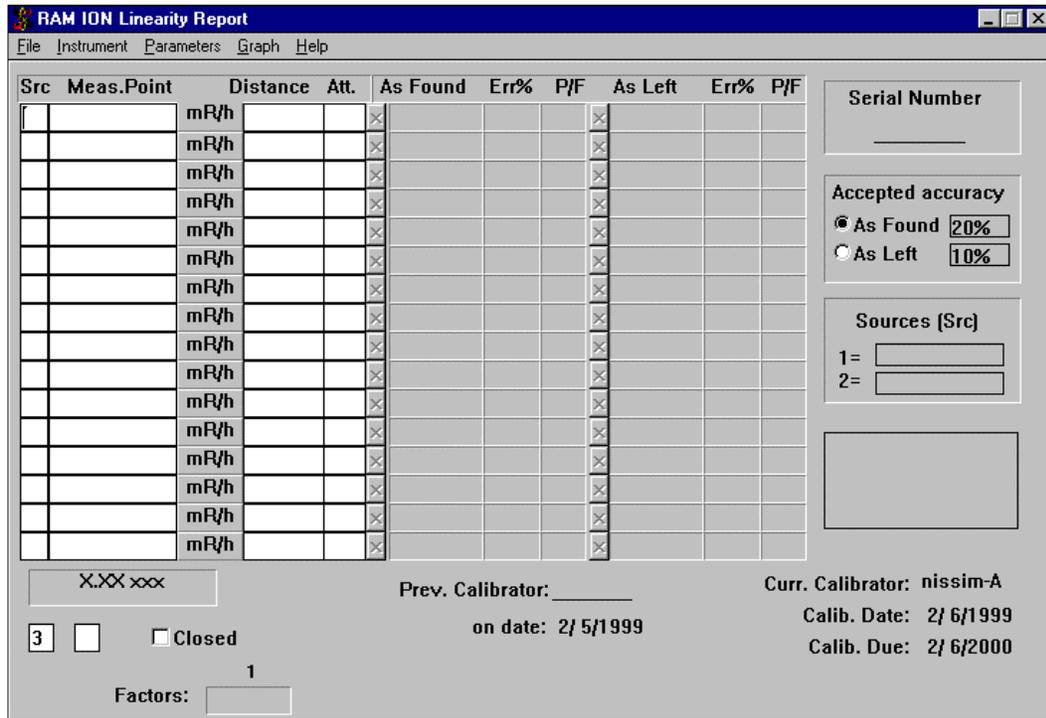
Enter **Login name -** up to 12 characters

Enter **Password** - ram in small letters.

7.3.4. Click OK, the program enters the main window.

The main window displays the previous template. In the displayed template the operator executes the required missions to complete calibration and linearity.

To create a new template or change parameters refer to section 3.2.

7.3.5. *New Template & Parameters Setup*

The template includes setup parameters, instrument parameters and readings.
To create a new template proceeds as follows:

7.3.6. Fill the following parameters in the displayed template*: Src (source), Measuring* **Point** including units**, Distance**, and **Attenuators.** To select between mR/h and R/h, or cps and Kcps, or cpm and Kcpm, click the units column*.*

7.3.7. Select **Parameters / Setup** from the pull down menu. Fill the following:

Customer - Enter header (up to 4 lines) for the calibration & linearity certificate.
Accepted accuracy: As Left - Enter maximum allowed deviation
                         As Found - Enter maximum allowed deviation
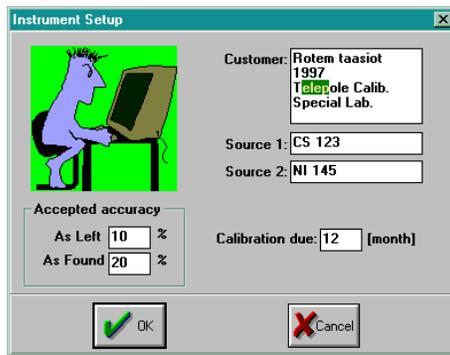**Source 1** - Enter source type used in the calibration facility.
Source 2 - Enter source type used in the calibration facility.
Calibration due - Set the calibration interval.
Click **OK** to save data and quit.
Click **Cancel** to cancel data changes and quit.

7.3.8. Select **Parameters / Template** from the pull down menu**.**

In the **Template Settings** window perform the following:

Template name - Fill new template name.

Instrument - Select instrument type/ name.

Units - Select units to be used in this template.

New template - Save current template settings into a new file.

Open template file - Select existing template without changing it.
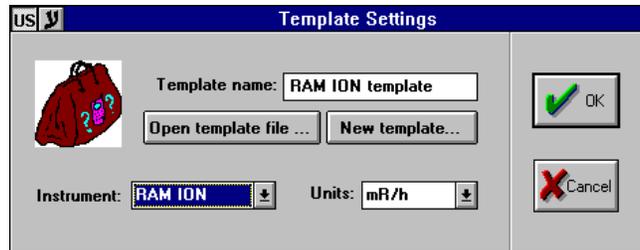
7.3.9. Select **Parameters / Instrument** from the pull down menu**.**

To change the instrument **Serial Number** type the new serial number and click **Send.**
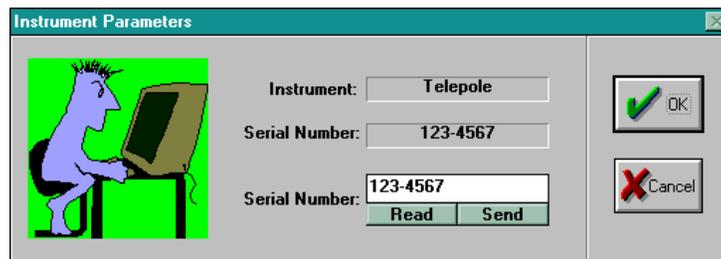
7.3.10. Select **Parameters / Communication** from the pull down menu**.**

Set the **Comm. port** connected to the meter.

Set **Baud rate** to 19200.
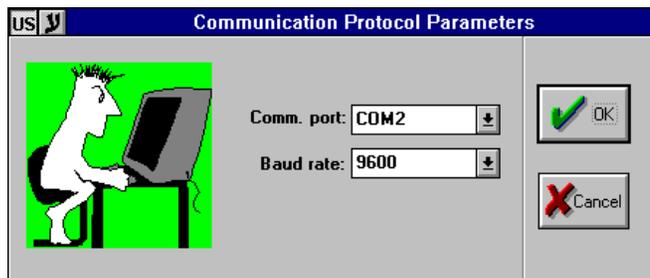
7.4. Starting up Calibration & Linearity Process

a) Connect the meter to the computer via the appropriate **Comm. port** (according to the selected port in the set up program), using the customized communication cable.

b) Turn the meter on.

c) Execute the RMC file.

d) Enter **User name** up to 12 characters.

e) Enter **Password,** type **ram** (in small letters).

f) To check and calibrate the instrument, first enter **Linearity** and check **As Found**. Then enter from the pull down menu to **Instrument/ Calibration.** After calibration is performed, return to **Linearity** and check **As Left**.

Note: In case of computer/instrument communication failure or disconnection, the **Bad Communication Message** is displayed in the computer's display. Check the communication cable and/or Comm. port.

7.5. *Calibration*

Select **Instrument/Calibration** from the pull down menu. The calibration menu will be displayed as seen in the figure.

(1) ——
(2) ——
(3) ——
(4) ——
(5) ——
(6) ——
(7) ——
(8) ——
(9) ——

(1) Instrument reading

(2) Factor number for calibration.

Instrument Type	Cal. Factors*	Factors Description
RAM ION	one	**F1**
TelePole WR	five	**F1** if the probe head is in a field higher than 10 mR/h and lower than 100 mR/h.
		F2 if the probe head is in a field higher than 100 mR/h and lower than 800 mR/h.
		F3 if the probe head is in a field higher than 800 mR/h and lower than 50 R/h.
		F4 if the probe head is in a field higher than 50 R/h and lower than 350 R/h.
		F5 if the probe head is in a field higher than 350 R/h
TelePole HR	three	**F 1** if the probe head is in a field higher than 10 mR/h and lower than 50 R/h.
		F2 if the probe head is in a field higher than 50 R/h and lower than 350 R/h.
		F3 if the probe head is in a field higher than 350 R/h
Internal Detector for TelePole	two	**F1** if the probe head is in a field higher than 10 mR/h and lower than 100 mR/h.
		F2 if the probe head is in a field higher than 100 mR/h and lower than 1000 mR/h.

* **Note:** The calibration factors are selected according to the detector's radiation field location. Only the displayed factor can be changed.

(3) Previous calibration factor as saved (stored) in the instrument memory.

(4) Factor can be changed in two modes:
- **a.** Type the measured field. The computer will calculate the new factor dependant on the radiation field and the old factor. The new factor value will be displayed on the **New Factor** box**.**
- **b.** Using the ± boxes.

Instrument	Factors	Calibration Mode
RAM ION	1	a
TelePole WR	1, 3	a
	2, 4, 5	b
TelePole HR	1	a
	2, 3	b
Internal detector for TelePole	1	a
	2	b

(5) In case the operator wants to force the calibration factor to 1.00 select **Force.**
If the calculated factor value is lower than 0.6 or higher than 1.4, calibration will be not performed.
It is recommended to perform the instruments' calibration according to the following table:

(6) After the factor changing, press **Update Factor**.
Ensure to obtain the status: **Factor Accepted**.

(7) Press **Update Details**.

(8) Ensure to obtain **Status: Details Accepted**.

(9) To quit the calibration function and return to the main menu, click **End Calibration.**

7.6. Linearity

The **Linearity Report** includes the **As Left** and **As Found** columns. Before calibration and linearity checking, perform the following steps in this order:

a) Check linearity in **As Found** column.

b) If linearity fail is obtained, the instrument is defected and cannot be calibrated (**P/F - fail**).

c) If linearity As Found is ok, calibrate the instrument.

d) Check linearity in As Left column.

Src	Meas.Point		Distance	Att.		As Found	Err%	P/F		As Left	Err%	P/F
1	26	uSv/h	70*7	80	x				x	27.10 uSv/	4.2	Pass
1	250	uSv/h	70*7	8	x				x	257.00 uSv	2.8	Pass
1	2182	uSv/h	70*7	0	x				x	2.26 mSv/l	3.6	Pass
2	2824	uSv/h	70*7Cal	4000	x				x	2.85 mSv/l	0.9	Pass
2	23.25	mSv/h	70*7	400	x				x	23.60 mSv	1.5	Pass
2	118.6	mSv/h	70*7	80	x				x	112.00 mS	-5.6	Pass
2	226.3	mSv/h	70*7	40	x				x	212.00 mS	-6.3	Pass
2	462.1	mSv/h	70*7	20	x				x	440.00 mS	-4.8	Pass
2	550	mSv/h	70*7	10	x				x	Overflow	-	Pass
2	5000	mSv/h	70*7	0	x				x	Overflow	-	Pass
		mSv/h			x				x			
		mSv/h			x				x			
		mSv/h			x				x			
		mSv/h			x				x			
		uSv/h			x				x			
		uSv/h			x				x			

Serial Number
2213-028

Accepted accuracy
○ As Found **20%**
● As Left **10%**

Sources (Src)
1= **Cs137-300m(**
2= **Cs137-1770C**

RAM ION Sv\h

0.00 uSv/h

Prev. Calibrator: **motti**
on date: **26/12/2017**

Curr. Calibrator: **motti**
Calib. Date: **26/12/2017**
Calib. Due: **26/12/2018**

[1] [/] ☐ Closed ☐ MGP

Factors: **0.97**

(1) (2) (3)

Note: On the first time the instrument linearity is checked, the program forces to save the linearity file.

Linearity Report Window

Src - Source type by which calibration and linearity were performed. Defined in the set-up parameters.

Meas.Point - Radiation field where linearity tests are performed.

Unit - Measurement units.

Distance and **Att. -** Distance between detector and source and attenuator number.

As Found - Instrument reading prior to calibration.

As Left - Instrument reading after calibration.

Err. - Reading deviation % between measuring point (calculated value) and meter reading.

P/F - Notifies that linearity checking is correct.

Serial Number - Instrument number, may be changed in **Parameters / Instrument**.

Accepted accuracy - Permitted deviation in % between the instrument reading and radiation. Defined in the **Parameters / Set up**.

Sources [Src] - Source type by which calibration and linearity were performed. Defined in the set-up parameters.

Rotem Ind.- Customer: Enter header (up to 4 lines) for the calibration & linearity certificate.

Curr. Calibrator - Present calibrator's name and calibration date.

Prev. Calibrator - Former calibrator's name and calibration date.

(1) ☐ ☐ - Checking adequate connection between instrument and computer. If after the fifth time there is no communication, an alarm message is displayed.

(2) 0.00 mR/h - Instrument reading is up dated every second.

(3) ☐ **Closed** - After finishing the linearity checking:

> When marked (3) it means the file is "read only"*,
> When not marked the file is "read & write".
> *Note:* * In order to make the file "read only" it is necessary in addition to perform **File / Safe.**

Factors - Factors' value**.**

In order to perform linearity and calibration to another instrument, select **File / New report** on the pull down menu.

7.7. *Save, Load and Print Calibration and Linearity Certificate*

7.7.1. *Save and Print Current Calibration and Linearity Certificate*
   a) Click **File / Save** for saving the Calibration and Linearity Certificate in a file.
   b) Click **File / Print** for Calibration and Linearity Certificate printout.
   c) Click **Graph** to display Linearity graph.
   d) Click **Plot** and select **Linearity** or **Relative Error** graph.
   e) Click **File / Print** for Linearity graph printout.

7.7.2. *Load and Print Previous Calibration and Linearity Certificate*
To load a previous Calibration and Linearity Certificate click **File/ Open**.

Double click to select the appropriate drive.

Double click to select the appropriate file.

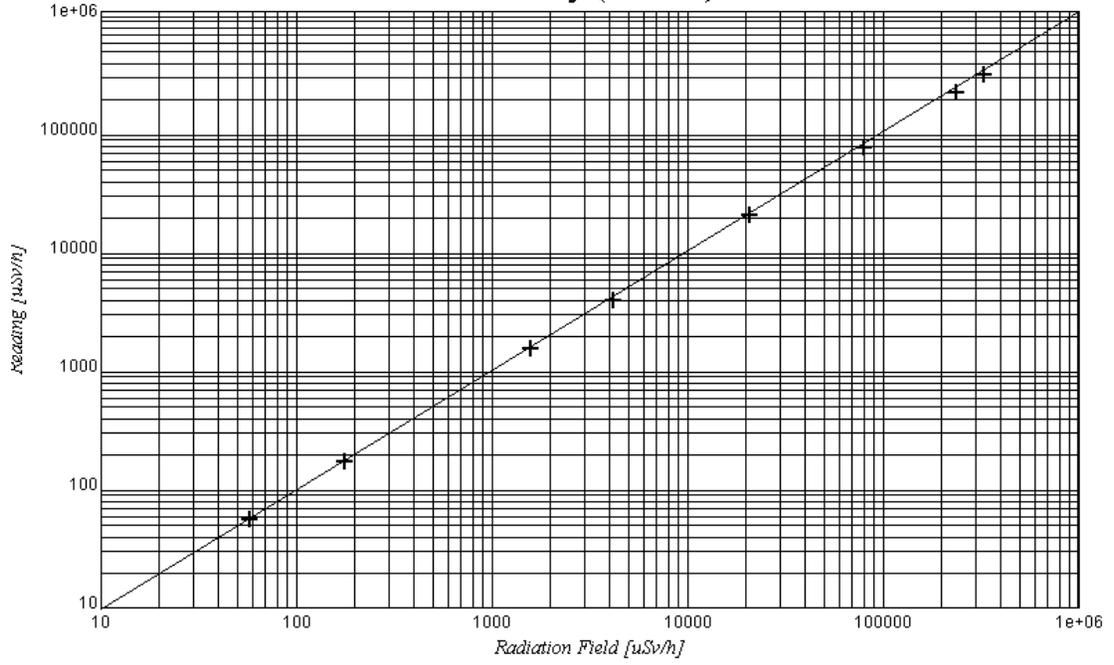Click **File / Print** for Calibration and Linearity Certificate printout.

Click Graph to display Linearity graph.

Click Plot and select Linearity or Relative Error graph.

Click File / Print for Linearity graph printout.

Linearity (As Left)
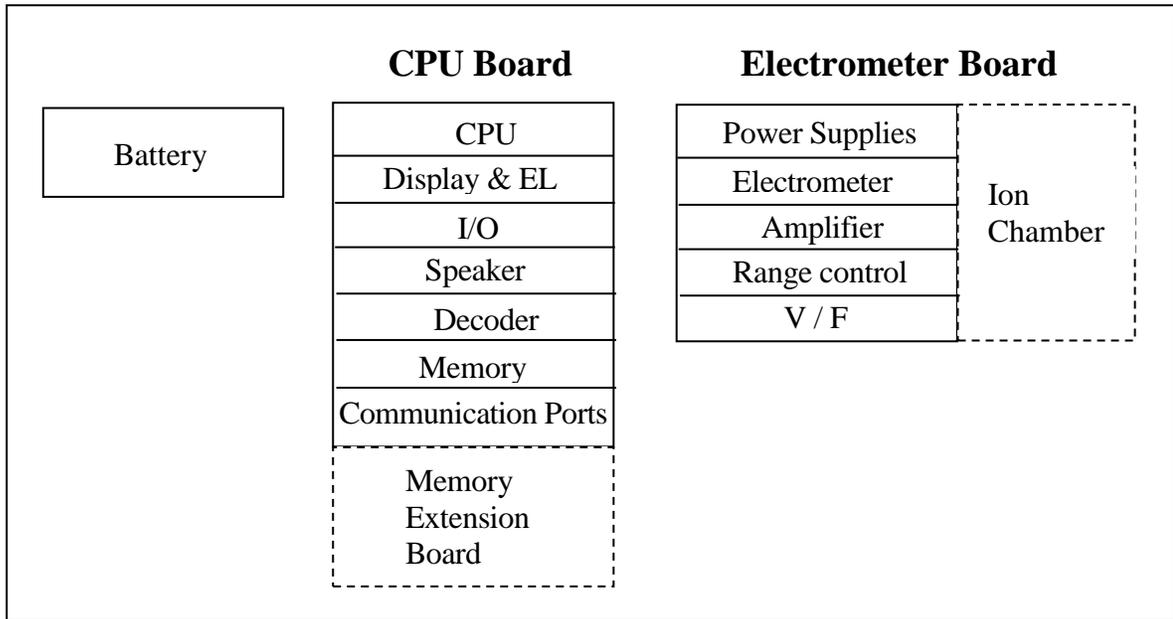
S/N :2099-018
Date :19/ 5/2019

8. *Electronic Block Diagrams Description*

8.1. *Overall Block Diagram of RAM ION Meter*

	CPU Board	Electrometer Board

Battery		CPU		Power Supplies	
		Display & EL		Electrometer	Ion Chamber
		I/O		Amplifier	
		Speaker		Range control	
		Decoder		V / F	
		Memory			
		Communication Ports			
		Memory Extension Board			

8.2. *Electrometer Board*

8.2.1. *Electrometer Board Block Diagram*

-5V   -25V   H.V.

Vin Batteries	Power Supply +5V DC	Power Supply -5V DC	Low Battery Identification	Power Supply H.V.
			Power Supply -25V DC	

+5V

Offset Relay

Range Change Relay

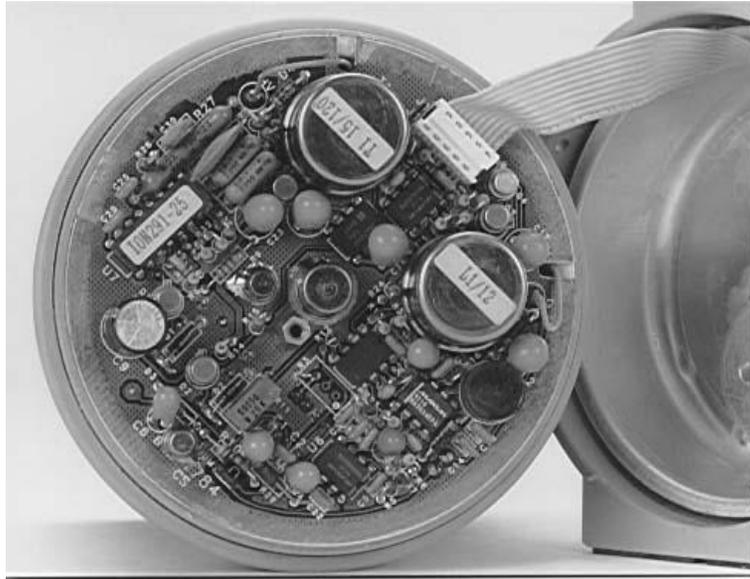| Detector	Electrometer	Amplifier X 10	V / F Converter	→ To CPU
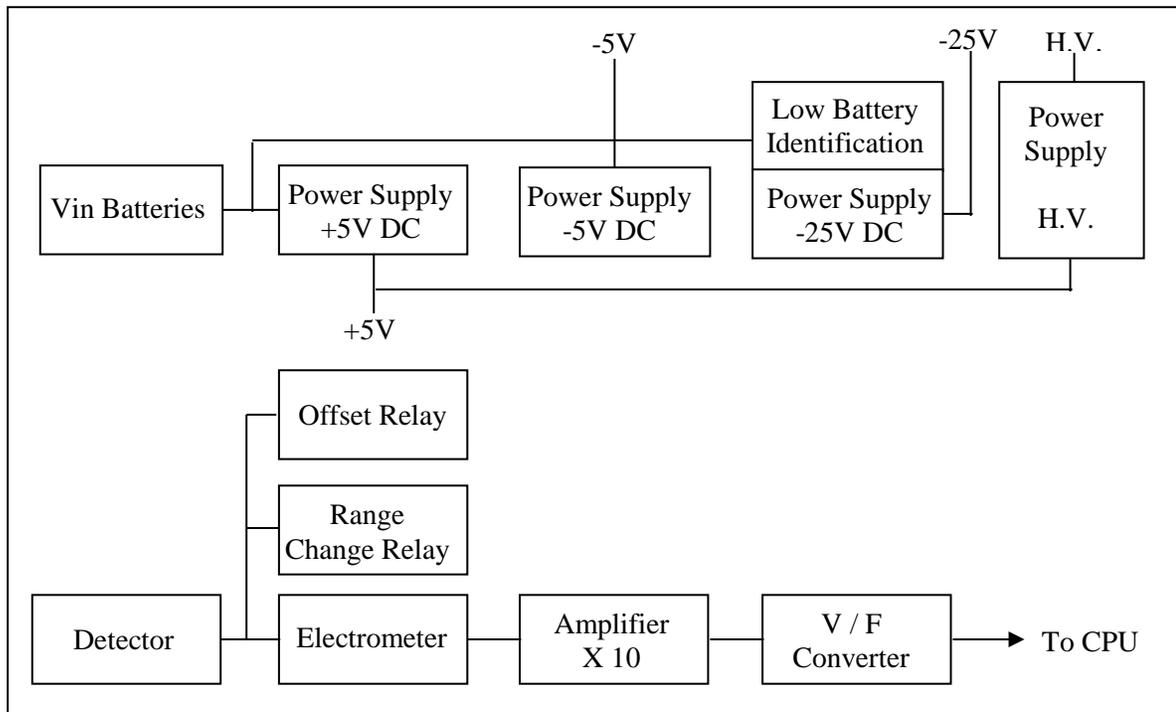
Figure 12-1. Electrometer Board, Components side

8.2.2. Electrometer Board Description

The following section describes the Electrometer Board block diagram, (DRW #11730-7, PC #1784).

+5V DC Power Supply (U4)
The +5V power supply is a dc/dc switching regulator. It provides dc power voltage to all the system circuits.
Input voltage: 1.7V ÷ 3V dc
Output voltage: +5V dc ±0.15
Ripple: lower than 50 mVpp

-5V DC Power Supply (U5)
The -5V power supply is a dc/dc switching regulator, which converts positive input voltage to negative of similar value. It supplies dc power voltage to the electrometer amplifier (U1).
Output voltage: -5V dc ±0.2
Ripple: lower than 50 mVpp

-25V DC Power Supply (U3)
The -25V power supply is a dc/dc switching regulator. It supplies dc power voltage to the amplifier (U6).
Output voltage: -25V dc ±1
Ripple: lower than 30 mVpp

High Voltage Power Supply (U7+T1)
The HV power supply is a dc/dc switching regulator.
Output voltage: 200V dc ±10
Ripple: lower than 0.5 mVpp

Low Battery Identification
When batteries voltage reduces below 2.2V, the identification circuit (U3) decreases voltage from +5V to 0V on U3/2.

Electrometer Circuit (U1)
The electrometer circuit converts the Ion chamber output current to negative voltage.

Amplifier X10 (U6)
The amplifier circuit amplifies the output voltage of the electrometer circuit.
Output voltage: $0V \div -24V$ dc

Offset Relay (RL1)
The offset relay cancels the amplified current for measuring the offset voltage of U1.

Range Change Relay (RL2)
This relay increases the measuring range of the instrument by reducing the gain of U1 in a factor of 100.

V/F Converter (U2)
The V/F converter converts voltage in the range of $0 \div -20V$ dc to frequency.
"0" reading equals approximately 500Hz ±150.
-20V dc equals to 81KHz.
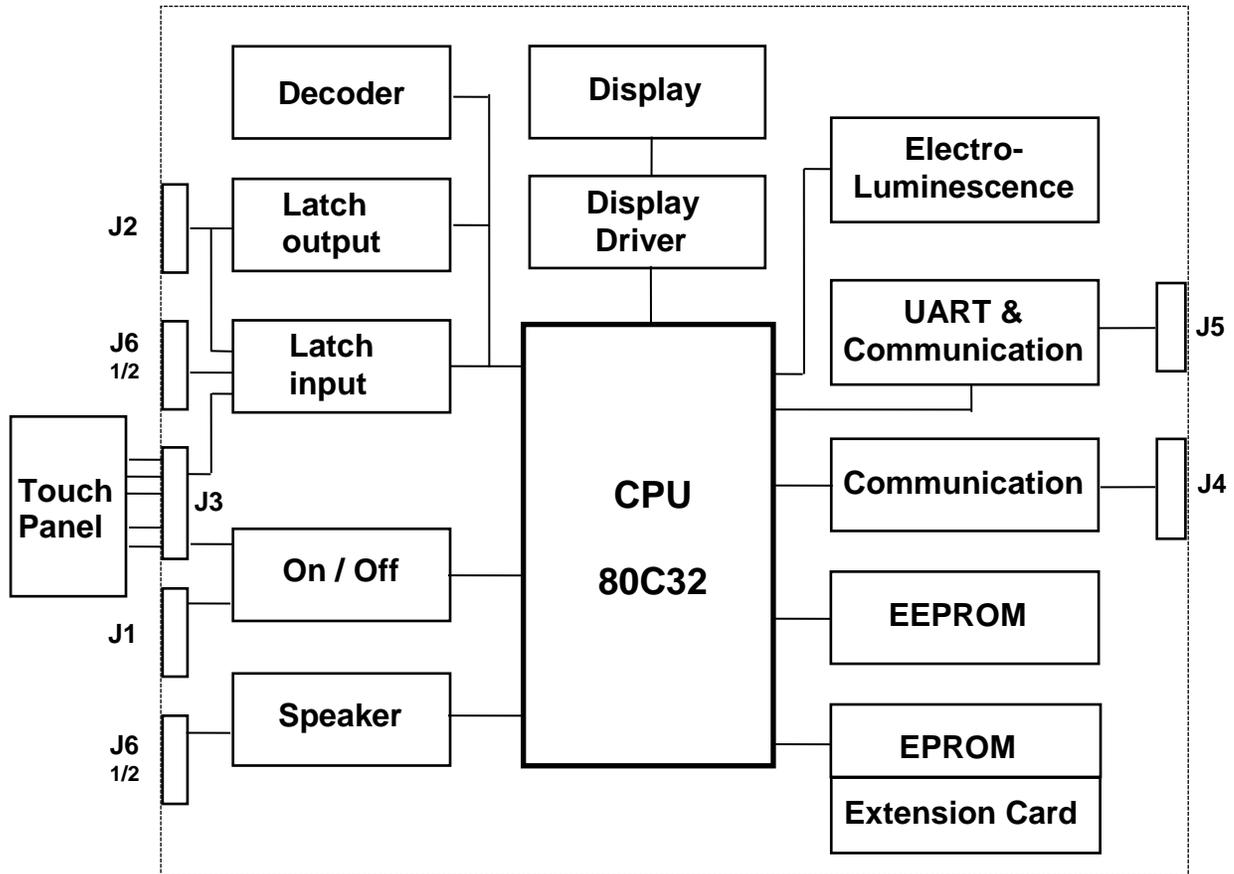The relation between field reading output voltage and output frequency is as follows:
Reading up to 250 mR/h: 1mR/h = 172Hz = 43mV.
Reading higher than 250 mR/h: 1mR/h = 1.72Hz = 0.43mV.

8.3. Meter

8.3.1. CPU Board Description

DRW #12850-40-00, PC #1942.

CPU Board Block Diagram

On /Off Circuit (Q3, Q4, Q5)

A momentary short between pin J3/1 and J3/2 switches Q3 and Q4 on.
The battery voltage powers the power supply circuit.
U5/5 is set to "1" (in software), Q3 is switched on, and as a result the meter is turned on.
An additional momentary short between J3/1 and J3/2 sets U5/6 to "0" through Q5. U5/5 is set to "0" and the meter is turned off.

Speaker Circuit (U13)

The speaker circuit is activated in the following cases:
a. Threshold level exceeding.
b. Malfunction.
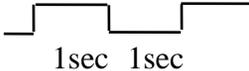c. Push-button press approval.

A 3 KHz signal on pin U13/3 activates the speaker. Two ports control the speaker:
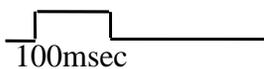Port 1 - alarm, pin U3/9
Port 2 - speaker on, pin U3/19

For threshold level exceeding and malfunction:
U3/9 - "0"
U3/19 -

1sec   1sec

For push-button press approval:
U3/9 - "0"
U3/19 -

100msec

To mute the speaker:
U3/9 - "0".
U3/19 - "1"

Input & Output Latch

Two **74HC373** IC's are used for the input/output signals. The IC's are connected to the CPU BUS.
Input signals   - **U9,** address - 8200H
Output signals - **U3,** address - 8100H

Output Signals

0 - U3/2   remote/internal detector (optional)
1 - U3/5   low range / high range Geiger (optional)
2 - U3/6   electro-luminescence
3 - U3/9   speaker alarm
4 - U3/12 not in use
5 - U3/15 not in use
6 - U3/16 enables VCC for barcode laser reader
7 - U3/19 speaker on

Input Signals

0 -   U9/3   MODE push-button
1 -   U9/4   RESET push-button
2 - U9/7   LIGHT push-button
3 -   U9/8   low battery
4 -   U9/13 not in use
5 -   U9/14 calibration mode
6 -   U9/17 internal Geiger (optional)
7 -   U9/18 PC communication

Touch Panel

The touch panel push buttons are connected to the micro-controller chip in the CPU board via input latch, except the on/off push-button that is connected to the on-off circuit.

Display (U17, U18)

DRW # 12850-40-00 sheet 2.

The display shows the meter readings and messages.

The display driver (U17) receives clock and serial data from the CPU and transmits it in parallel to the display in three back planes.

U18 - Rotem's custom display especially designed for the RAM ION and RAM ION meters. The display includes: 3-character 7-segment, 2 decimal points, bar graph and data segments.

Electro-luminescence (EL, T1, Q1, Q6)

Pressing the LIGHT push-button turns on the display illumination.

U3/6 is set to "1" and activates T1 that supplies 100V AC.

EPROM Circuit (U2, U5) & Extension Card

U2 - 74HC 373, Address A_0 - A_7, latch from AD_0 - AD_7 .

U5 - 27C 256, EPROM contains software code.

The extension card, DRW # 12850-41-00, is installed on the EPROM socket.

The extension card includes: EPROM, NOVRAM, Reset and Watchdog circuit.

U2 - NOVRAM: DS1243 8K byte, or DS1244, 32K byte.

The NOVRAM contains: SRAM, clock, calendar and battery backup, used for storing the SMARTS data.

U3 - MAX1232, watchdog and reset circuit. The micro-controller receives a reset signal in two cases:

a. When the meter is turned on.

b. In case of software failure.

Pulses are sent from U6/2 to U3/7 as long as operation runs ok. In case of a fault detection in software, the pulses stop and a reset signal is obtained on U3/6.

CPU Circuit (U6)

The micro-controller circuit manages all the meter activities.

EEPROM Back up Memory (U1)

The X2C04 is a 512-byte serial EEPROM (Electrically Erasable Prom).

The EEPROM stores threshold values, ID number and calibration factors values.

Communication Circuit

The CPU board contains two separate communication ports. One is the micro-controller communication port used for the SMARTS communication:

J4/1 TxD - This is the serial data line transmitted from the meter. The logic level swings are 0 to 5 Volts, and can be described as RS-232 TTL level. This circuit is able to drive TTL, LSTTL, and CMOS inputs.

J4/2 RxD - This is the serial data line received in the meter. The meter accepts serial data either in RS-232 signal levels (low: -3 to -15 Volts, high: +3 to 15 Volts) or TTL levels (low: 0.8 Volts, high: 2.0 Volts).

J4/3, 6 - ground

J4/4 - + 5V

UART & Communication

The other communication port is used for the WRM system or COMBO system.
U12 - 82510 is connected to the CPU BUS, address 8700H.

J5/1 TxD - This is the serial data line transmitted from the meter. The logic level swings are 0 to 5 Volts, and can be described as RS-232 TTL level. This circuit is able to drive TTL, LSTTL, and CMOS inputs.
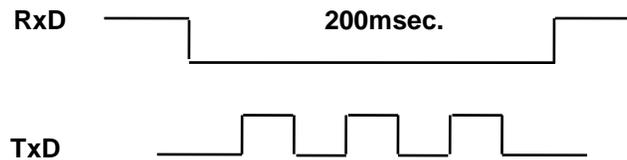
J5/2 RxD - This is the serial data line received in the meter. The meter accepts serial data either in RS-232 signal levels (low: -3 to -15 Volts, high: +3 to 15 Volts) or TTL levels (low: 0.8 Volts, high: 2.0 Volts).

J5/3 - ground
J5/6 - + 5V
J5/7 - trigger from the WRM transmitter

The communication port receives a trigger from the WRM transmitter and transmits the data to the WRM system.

Decoder

U11 - 74HC138, sets addresses for the input/output IC's and UART IC.
Address ranges from 8000H to 8700H.
Three addresses are used:
8100 - input latch U3
8200 - output latch U9
8700 - UART 82510 U12

Jumpers

CPU card, PC #1942
E1 – Short for speaker
E3 – Open for µSv/h units, short for mR/h units.

Memory card, PC #1944
E1, E2 – Short for DS 1244
E1, E2 – Open for DS 1243
E3 – (1-2) – Short for 27C512
E3 – (1-3) – Short for 27C256

9. Electrometer Board Testing with Standard Measurement Devices

DRW #11730-7, PC #1784

Note: The following procedures should be performed by an authorized person only.

9.1. Power Supplies Test

9.1.1. Connect a 3V dc power supply to J1 (J1/2 +3V, J1/3 ground) on the CPU board.

9.1.2. Turn the RAM ION on.

9.1.3. Check the presence of the following voltages: +5V ±0.1 - on D6 cathode, -25V ±0.5 - on D5 anode, - 5V ±0.1 - on U5/5 (7660).
Check with an HV probe the presence of 200V ±10 at TP. F.

9.1.4. Ensure output voltages (sub-sec. 13.1.3) are stable for input power from 2 to 3.2V dc.

9.2. Low Battery Circuit Test

9.2.1. Reduce power supply below 2.1V ±0.1.

9.2.2. Check if the "BAT. ALARM" element flashes on the meter display. If not Check 0V on J1/10 or on U3/2 (in the electrometer board).

9.3. Range Change Check

9.3.1. Disconnect JMP1 in the electrometer card.

9.3.2. Place a calibration source near the ion chamber and operate the RAM ION

9.3.3. Check the voltage on JMP1 (e.g. for a field of 10 mR/h voltage must be 430mV).

9.3.4. Press MODE push-button on RAM ION for at least 2 seconds.

9.3.5. Check if the voltage on JMP1 is 1/100 from the result (13.3.3).

9.4. V/F Test

9.4.1. Disconnect JMP1 in the electrometer card.

9.4.2. Connect a negative voltage to JMP1 and check the signal frequency on U2/1 according to the following table:

V	F
0 mV	500 Hz ±25
-500 mV	2500 Hz ±25
-20 V	81 KHz

9.5. *Offset Test*

9.5.1. Disconnect the short on JMP1.

9.5.2. Short J1/3 to J1/2. Ensure the presence of +0 mV ±1 mV on U6/6.

9.5.3. Cancel short between J1/2 and J1/3, and connect back JMP1.

9.6. *Electrometer Installation and Calibration (U1)*

9.6.1. Bend the electrometer pin #2 outward and insert it in its socket.

9.6.2. Solder pin #2 to the Teflon isolated pin "A". Be sure leg 2 isn't touching anything except for pin "A".

10. *Electrometer Board Testing with Electrometer Tester*

DRW #11730-7, PC #1784

Note: The following tests should be performed with an Electrometer Tester Model #11736/4-0049.
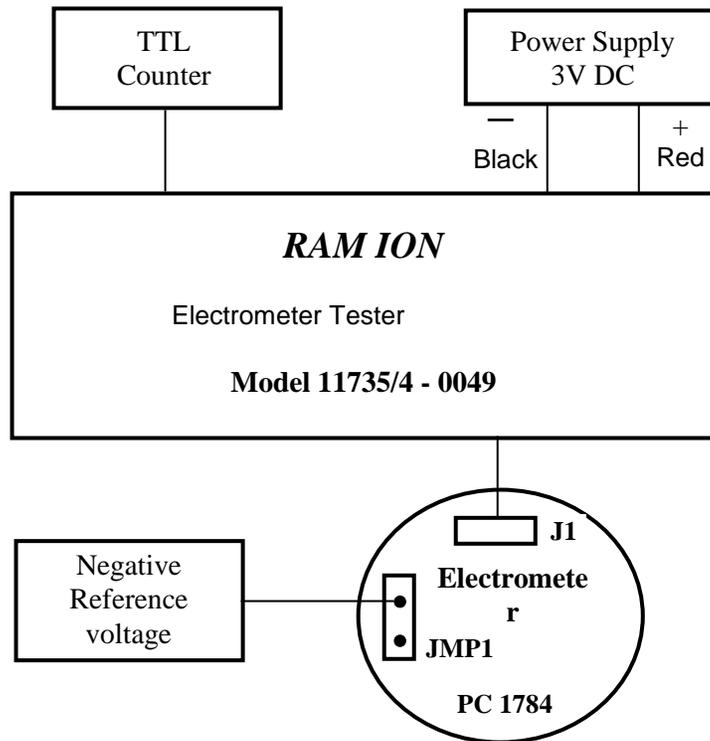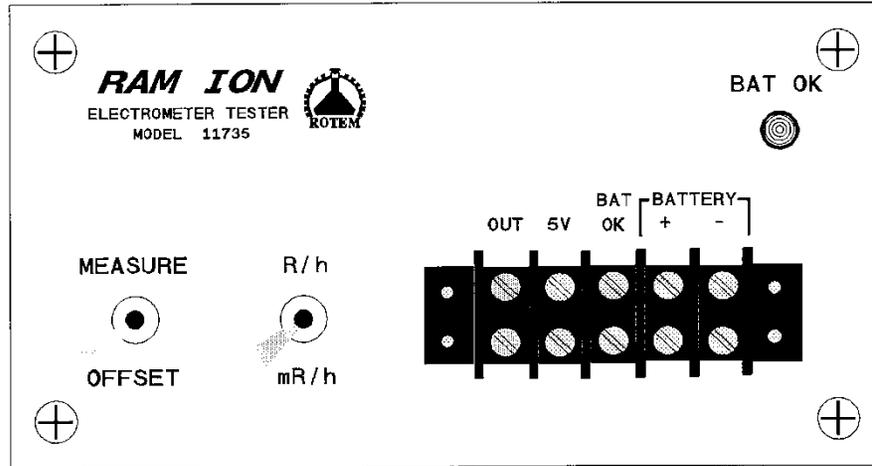

Figure14-1. RAM ION Electrometer

Note: The following procedures should be performed by an authorized person only.

10.1. Preparation for Testing

10.1.1. Disassemble RAM ION Meter.

10.1.2. Connect the Electrometer Tester flat cable J1 to the Electrometer board.

10.1.3. Connect the Electrometer Tester Vin (red and black wires) to the power supply.

10.1.4. Connect the Electrometer Tester BNC connector to the TTL counter.

10.1.5. Set power supply to 3V.

10.1.6. Turn the power supply and TTL counter on.

10.2. Power Supplies Test

10.2.1. Check the presence of the following voltages:

+5V ±0.1 - on points 5V and battery (-), on the electrometer tester front panel.

-25V ±0.5 - on D5 anode

- 5V ±0.1 - on U5/5 (7660)

Check with an HV probe the presence of 200V ±10 at TP. F.

10.2.2. Ensure the output voltages (sec. 13.1.3) are stable for input power from 2 to 3.2V dc.

10.3. Low Battery Circuit Test

10.3.1. Reduce power supply below 2.1V ±0.1.

10.3.2. Check if the BAT. OK green LED is turned off.

10.4. Offset Test

10.4.1. Set MEASURE / OFFSET switch to measure mode.

10.4.2. Set R/h – mR/h switch to mR/h mode.

10.4.3. Place a calibration source near the ion chamber.

10.4.4. Check the result in the TTL counter.

10.4.5. Set MEASURE / OFFSET switch to offset mode.

10.4.6. TTL counter result must be 500 ±150 Hz regardless the source location.

10.5. Range Change Check

10.5.1. Set MEASURE / OFFSET switch to measure mode.

10.5.2. Set R/h – mR/h switch to mR/h mode.

10.5.3. Place a calibration source near the ion chamber.

10.5.4. Check the result in the TTL counter. For a field of 10 mR/h the TTL counter reading must be 1700 Hz + offset frequency.

10.5.5. Set R/h – mR/h switch to R/h mode.

10.5.6. Check the result in the TTL counter/ For a reading of 10 mR/h the TTL counter reading must be 17 Hz + offset frequency.

10.6. V/F Test

10.6.1. Disconnect JMP1 in the electrometer board.

10.6.2. Connect a negative voltage to JMP1 and check the signal frequency on TTL counter, according to the following table:

V	F
0 mV	500 Hz ±25
-500 mV	2500 Hz ±25
-20 V	81 KHz

10.6.3. Connect JMP1 back to the electrometer board.

11. Assembly & Disassembly Instructions

11.1. Opening the Display Compartment

11.1.1. Open the batteries compartment by inserting a coin in the cover slot and turning counter clockwise.

11.1.2. To disassemble the RAM ION front panel unscrew the four screws using a Philips screw-driver: two screws are located inside holes on both sides (upper corners) of the laser scanner housing (Fig. 15-1), two additional screws are located at the bottom of the front panel.

11.2. CPU Board Removal (PC #1942)

11.2.1. Disconnect the four connectors: communication, ion-chamber, and batteries supply.

11.2.2. Remove the 3 screws and the spacer screw fastening the CPU board to the display compartment, and then lift out the board.

11.3. Display Compartment Assembly

11.3.1. Re-install the CPU board using the four fastening screws. Ensure the presence of an isolation disc under each screw.

11.3.2. To install the memory extension board, remove the EPROM from the CPU board (if present). Insert the extension board into the EPROM socket. Screw back into the spacer screw.

11.3.3. Re-connect the three connectors: communication, ion-chamber, and batteries supply. Beware of the connector's polarity, the dot on the communication and batteries supply connectors marks pin #1.

11.3.4. Before installing the display compartment cover, beware to guide the wires in a way that they will not be pressed by the electronic components,

particularly the transformer. Insert the Ion-chamber wire in the vacuum existing on the display compartment interior at the bottom; and the batteries supply wire between the transformer and the supply connector socket.

11.3.5. Return the display compartment cover, first pressing the lower left part and then the lower right part. Ensure wires are not being pressed.

11.3.6. Tighten both screws on the display compartment back*.*

11.4. Ion Chamber Cover Disassembly

11.4.1. Disassembly is usually performed when the cover is contaminated and need to be replaced.

11.4.2. Remove the 3 plastic screws that fasten the chamber cover to the plastic body.

11.4.3. Pull the chamber out of the instrument*.*

11.5. Ion Chamber Disassembly (including Electrometer Board)

11.5.1. Remove the silica-gel cartridge by turning it counter clockwise.

11.5.2. Remove the screw which fastens the shielding plate to the electronic board, inside the silica-gel housing.

11.5.3. Remove the three encircling metal screws which fasten the Ion-chamber to the instrument body.

11.5.4. Detach gently the Ion chamber from the instrument body in slight movements, left and right, up and down, and no turning.

11.5.5. Beware not to detach the Ion-chamber with turning (circling) movements since it is mounted on an o-ring which can be damaged.

11.5.6. Disconnect J1 which links between the Electrometer board (PC #1784) and the instrument body*.*

11.6. Electrometer Board Removal

11.6.1. Unsolder the HV & Guard wires on the electrometer board opposite edges, which are coming from the Ion chamber.

11.6.2. Unsolder the shielding cup located on the electronic board center.

11.6.3. Turn the screw located in the electrometer board center counter clockwise, to detach the board from the Ion chamber.

11.6.4. When lifting-up the electronic board, beware to keep the tiny parts (Teflon isolators, discs, screws)*.*

11.7. Electrometer Board Assembly

11.7.1. Ensure re-installing the isolators, discs, and central screw back on the board. See RAM ION Assembly Chamber Scheme.

11.7.2. Place the electronic board; insert wires coming from the Ion chamber in the respective holes; ensure inserting the direction (driving) pin in its slot on the board circle.

11.7.3. Turn the central screw fully clockwise to fasten the board.

11.7.4. Solder the shielding cup over the fastening screw.

11.7.5. Solder HV and Guard wires, coming from the Ion Chamber, to the electronic board.

11.8. Ion Chamber Assembly

11.8.1. Ensure that the shielding plate is correctly located inside the instrument body.

11.8.2. Re-connect J1 on the Electrometer board.

11.8.3. Join and match the instrument body into the Ion chamber properly so that it will be possible to tighten the fastening screw. The spacer on the Electrometer board should be in front of the hole in the shielding plate.

11.8.4. Insert but do not yet fully tighten the fastening screw, which links the shielding plate to the electrometer board, in to the silica-gel housing.

11.8.5. Turn the instrument body gently in the Ion chamber, so that the location of the three cycling screw holes will match in both parts.

11.8.6. Tighten the three fastening screws.

11.8.7. Tighten the screw in the silica-gel housing.