FLUKE®
Biomedical

Victoreen® 06-526-5240 and 06-526-5242

RAD-CHECK® MICRO-R

Operators Manual

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Fluke Biomedical
Radiation Management Services

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Table of Contents

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Section 1
General Information

1.1 Product Description

The RAD CHECK MICRO-R is a battery operated, portable unit which measures the output radiation of diagnostic x-ray equipment. The exposure is displayed on a 3 ½ digit Liquid Crystal Display (LCD) as either:

1. Exposure, Roentgens (0.01 mR to 19.99 R) or SI units of milligrays (0.1 μGy to 199.9 mGy). (Refer to specifications for ranges.)
2. Rate, in Roentgens per minute (0.1 mR/min to 199.9 R/min.) or SI units of milligrays per minute (1 μGy/min to 1999.0 mGy/min). (Refer Section 1.2, Specifications, for ranges.)

Radiation is detected with an image intensifier ionization chamber P/N 06-524-3000 with a 15-foot cable assembly.

1.2 Specifications

Ranges:

Model 06-526-5240:

(Dose) Low Range	00.00 - 19.99 mR;	Resolution: 0.01 mR
(Dose) High Range	00.00 - 19.99 R;	Resolution: 0.01 R
(Rate) Low Range	000.0 - 199.9 mR/min;	Resolution: 0.1 mR/min
(Rate) High Range	000.0 - 199.9 R/min;	Resolution: 0.1 R/min

Model 06-526-5242:

(Dose) Low Range	000.0 - 199.9 μGy;	Resolution: 0.1 μGy
(Dose) High Range	000.0 - 199.9 mGy;	Resolution: 0.1 mGy
(Rate) Low Range	0000 - 1999 μGy/min;	Resolution: 1.0 μGy/min
(Rate) High Range	0000 - 1999 mGy/min;	Resolution: 1.0 mGy/min

Standard Cal.:	At 75 kVp with 4 mm Al filtration at 22°C and one atmosphere using Model 06-524-3000 chamber (chamber optional).
Reproducibility:	Within 2% short-term over 100 mR to 2 R range. (1 mGy to 20 mGy)
Electrometer Drift:	<2 digits in 5 minutes in exposure dose mode.
Maximum Exposure Rate:	Min. 90% collection at 20 R/sec.
Manual Reset:	Resets display to zero. (Dose Mode only)

Operating Conditions:	10-40°C max.; 90% relative humidity, non-condensing
Display:	3 ½ digit LCD, ½" high, low-battery indicator
Controls:	Display zero reset button, dose or dose rate output selector, and On/Off switch. Tilt stand to adjust unit visibility.
Power:	9 V Alkaline battery, Duracell MN1604 or equal >50 hour life
Size:	2.75" high x 6" wide x 6.25" deep. Net 18 oz. (7 cm x 15.25 cm x 15.9 cm, Net 0.51 kg)
Accessories Available:	
06-524-3000:	Image intensifier Ion Chamber, 100 cc volume, energy response: within 7% from 15 to 65 kVp (30 to 150 kVp); 15 ft. (4.5 meter) cable; 5.5 in. (14 cm) diameter x .72 in. (1.8 cm) thick. Nominal sensitivity: 30 nC/R.
89-525:	Carrying and Storage Case. Holds "RAD-CHECK MICRO-R" and accessories

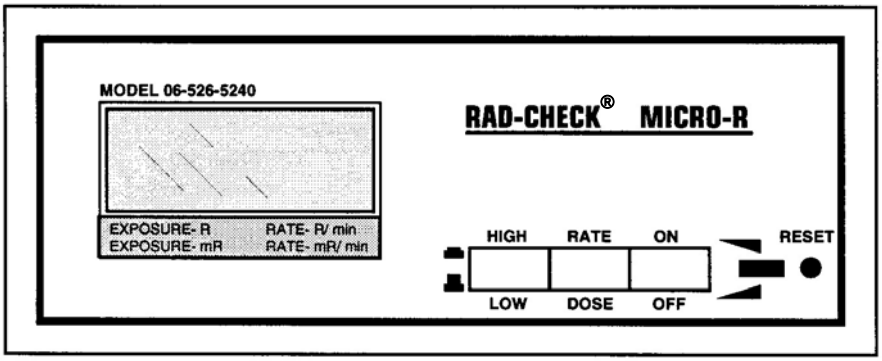


Figure 1-1. Model 06-526-5240 RAD-CHECK® MICRO-R

1.3 Receiving Inspection

Upon receipt of the package:

1. Inspect the cartons (s) and contents for damage. If damage is evident, file a claim with the carrier and notify Fluke Biomedical at 440.248.9300.
2. Remove the contents from the packing material.
3. Verify that all items listed on the packing list have been received and are in good order.

1.4 Storage

If the unit is to be stored prior to use, pack it in the original container if possible, and store in an environment free of corrosive materials, fluctuations in temperature, humidity, vibration and shock. Remove batteries prior to storage. Refer to Section 2.11, Battery Voltage, for further details.

1.5 Routine Cleaning

Do not immerse the RAD-CHECK. The unit is not waterproof. Liquid could damage the circuits. The unit should be kept clean and free from dirt and contamination. The unit may be cleaned by wiping with a damp cloth, using any commercially available cleaning or decontaminating agent.

1.6 Procedures, Warnings and Cautions

WARNING

Extreme caution should be used when making connections with the chamber and rear panel, an electrical shock hazard exists on the ion chamber bias connector (HV out).

NOTE

In the event of a transient induced lockup of the unit. It is necessary to reset the unit by cycling the power (turning the unit off and back on). After power-up, the unit will be in its normal operating mode.

The equipment described in this manual is intended to be used for the detection and measurement of ionizing radiation. It should be used only by persons who have been trained in the proper interpretation of its readings and the appropriate safety procedures to be followed in the presence of ionizing radiation.

Although the equipment described in this manual is designed and manufactured in compliance with all applicable safety standards, certain hazards are inherent in the use of electronic and radiometric equipment.

WARNINGS and **CAUTIONS** are presented throughout this document to alert the user to potentially hazardous situations. A **WARNING** is a precautionary message preceding an operation which has the potential to cause personal injury or death. A **CAUTION** is a precautionary message preceding an operation which has the potential to cause permanent damage to the equipment and/or loss of data. Failure to comply with **WARNINGS** and **CAUTIONS** is at the user's own risk and is sufficient cause to terminate the warranty agreement between Fluke Biomedical, Radiation Management Services and the customer.

Adequate warnings are included in this manual and on the product itself to cover hazards that may be encountered in normal use and servicing of this equipment. No other procedures are warranted by Fluke Biomedical. It shall be the owner's or user's responsibility to see to it that the procedures described here are meticulously followed, and especially that **WARNINGS** and **CAUTIONS** are heeded. Failure on the part of the owner or user in any way to follow the prescribed procedures shall absolve Fluke Biomedical and its agents from any resulting liability.

Indicated battery and other operational tests must be performed prior to each use to assure that the instrument is functioning properly. If applicable, failure to conduct periodic performance tests in

accordance with ANSI N323-1978 (R1983) Radiation Protection Instrumentation Test and Calibration, paragraphs 4.6 and 5.4, and to keep records thereof in accordance with paragraph 4.5 of the same standard, could result in erroneous readings or potential danger. ANSI N323-1978 becomes, by this reference, a part of this operating procedure.

Section 2
Operation

WARNING

Extreme caution should be used when making connections with the chamber and rear panel, an electrical shock hazard exists on the ion chamber bias connector (HV out).

2.1 Connecting the Chamber

1. Connect the cable of the chamber to the rear panel connectors.
   a. The coaxial BNC on the rear panel is the signal input.
   b. The recessed banana plug is the high voltage connection for the chamber bias.

2.2 Applying Power

NOTE

RAD-CHECK MICRO-R performs to specifications immediately on application of power. However, a five-minute warm-up period is suggested to minimize the drift associated with surface charge distribution.

1. Turn the power switch to the ON position.
   a. If "**LOW BAT**" appears in the upper left corner of the display, the battery voltage is low. Refer to Section 2.11, Battery Voltage, for battery replacement procedures.
   b. If no display is present, the battery may be fully discharged. Refer to Section 2.11, Battery Voltage, for battery replacement procedures.

2.3 Exposure Mode

1. Set the front panel selector switch to **DOSE**. (Button is in the **OUT** position.)
2. Select High Exposure (19.99 R Max) or Low Exposure (19.99 mR Max.).
3. Using the collimator light field, adjust the field size so that the entire chamber is in the field.
4. Position the image intensifier ion chamber, Model 06-524-3000, so that the primary beam is centered on, and perpendicular to, the chamber.
5. Press the RESET button to zero the display; make the x-ray exposure.
6. Read the exposure in roentgens (R), high exposure, or in roentgens (μR), low "exposure. To minimize drift effects, readings should be recorded immediately.

WARNING

Extreme caution should be used when making connections with the chamber and rear panel, an electrical shock hazard exists on the ion chamber bias connector (HV out).

7. When finished, turn the unit OFF before disconnecting the cables to the chamber.

2.4 Exposure Rate Mode

1. Perform 2.1 and 2.2.
2. Set the front panel selector switch to **RATE** (Button is in the **IN** position.).
3. Select High Exposure (button **IN**) or Low Exposure (button **OUT**).
4. Using the collimator light field, adjust the field size so that the entire chamber is in the field.
5. Position the chamber so that the primary beam is centered on, and perpendicular to the chamber.
6. The RESET button has no effect on the zero. Zero the instrument from the rear if necessary; make the x-ray exposure.
7. Read the exposure rate (R/min or mR/min).

WARNING

Extreme caution should be used when making connections with the chamber and rear panel, an electrical shock hazard exists on the ion chamber bias connector (HV out).

8. When finished, turn the unit OFF before disconnecting the cables to the chamber.

2.5 Applications

The RAD-CHECK MICRO-R can be used to measure radiation output of diagnostic x-ray equipment. Several applications are discussed in the following paragraphs.

In each of these applications, it is important that all data pertaining to tests performed be recorded for later comparison. Records should include the date, technique factors used, and readings obtained.

2.5.1 Radiographic Output (mR/mAs) Dose Measurements

1. Set up x-ray field as follows:
   a. Using the collimator light field, adjust the field size so that the entire chamber is in the field.
   b. Position the chamber so that the primary beam is centered on, and perpendicular to the chamber.
2. Select the desired x-ray technique (kVp, mA, and time).
3. Make an exposure per Section 2.3, Exposure Mode, of this manual.
4. Record the reading in R or mR.
5. Calculate the mR/mAs value.

6. Record the data calculated above and the technique factors selected in Step 2 (referenced at a later date).

2.5.2 Determining Minimum Filtration Requirements (Beam Quality - HVL)

1. Select a tube potential which is commonly used and is in the highest kVp range of the x-ray machine.
2. Position the x-ray tube to the center of the chamber.
3. With no added filtration in the beam, make an exposure per Section 2.3, Exposure Mode, of this manual and record the reading.
4. Using the optional P/N 07 -436 Half-Value Layer Kit (or equivalent), tape the increments of filtration to the face of the collimator.
5. Make an exposure and record the reading for each total thickness of filtration as indicated in Table 2-1.

NOTE

The information contained in Table 2-1 was extracted from DHEW Publication (FDA) 76-8014 "Suggested Optimum Survey Procedures for Diagnostic X-Ray Equipment.

6. Plot the exposure reading (log scale) versus the total added filtration thickness on semilog paper.
7. Determine the exposure value which is 50% of the reading recorded in Step 3. The corresponding thickness is the HVL value. Refer to Section 2-1 for the minimum HVL values required for that particular kVp.

To check the minimum filtration requirement at a particular kVp:

1. At a pre-selected kVp, record an exposure reading and an exposure reading with no filtration.
2. Record an exposure reading with the minimum filtration requirement taped to the collimator.

The minimum filtration requirement has been met if the second exposure is less than or equal to one-half of the first reading.

Table 2-1. Minimum Filtration Requirements

kVp Range	Total Added Filtration Steps	Measured	kVp HVL (mm AL*)
Below 50	0.5, 1.0, 1.5, 2.0	30	0.3
		40	0.4
		49	0.5
50 to 70	1.0, 1.5, 2.5, 3.5	50	1.2
		60	1.3
		70	1.5
Above 70	1.5, 2.5, 3.5, 4.5	70	2.1
		80	2.3
		90	2.5
		100	2.7
		110	3.0

		120	3.2
		130	3.5
		140	3.8
		150	4.1

*Type 1100 aluminum alloy as give in "Aluminum Standards and Data."

2.5.3 mAs Reciprocity

At any given kVp, combinations of time and mA that yield equal mA values should produce equal exposure (output) values.

1. Make an exposure at each mA station, varying the time to maintain mAs constant.

Variations exceeding the 10% average value may indicate the need for equipment recalibration.

2.5.4 Fluoroscopic Exposure Rate

1. Position the chamber so that the center of the chamber is centered to the central beam.
2. Using the optional P/N 07-706 Patient Phantom (or equivalent), place two ¾ inch aluminum attenuators between the chamber and the image intensifier.
3. Center the detector in the fluoroscopic beam as follows:
   a. Turn on the x-ray beam at a low mA setting.
   b. Use the image intensifier to view the image intensifier ion chamber image.
   c. Press the rate button on the RAD-CHECK MICRO- R front panel. (Select High or Low).
   d. Turn the fluoroscope on and read the display.

CAUTION

To prevent damage to the image intensifier, the aluminum attenuators must be in place while making an exposure.

4. Place a 1/8 inch lead beam stop plate (also included in the 07-706 Patient Phantom) or equivalent (folded lead apron) between the MICRO chamber and the image intensifier tube. This drives the automatic brightness control to maximum output.

NOTE

On equipment without automatic brightness controls, select maximum output settings. 21 cfr 1020 requires that the maximum exposure rate be less than 10 R/min (Cg/min).

2.6 Accuracy Considerations

Electrometer Drift

Each instrument has a constant drift which can be measured in a zero radiation field. Drift is expressed as mR/min and has a typical value of 10 mR/min or less. By recording the drift rate (see Table 2-2), this error can be corrected.

Table 2-2. Periodic Drift Rate Record

Date	Drift (mR)	Time (Min)	Rate (mR/Min)
* / /			

* The first reading is performed at the factory for future reference over the lift of the instrument.

Air Density Corrections

Temperature and pressure have a definite effect on the response on the ion chamber; they determine the number and density of molecules present for ionization. Figure 2-1 shows the correction factors used for changes in temperature and altitude (from 22°C and sea level). To achieve maximum accuracy, use the following equation:

Corrected Exposure =
(Measured Exposure - Drift x Exposure Time) (CF_T) (CF_P)

Where (CF_T) and (CF_P) are the correction factors for temperature and pressure respectively. Note that no more than 2% errors result over the temperature range of 16°C to 28°C (60°F to 82°F), so that the temperature correction can normally be disregarded.

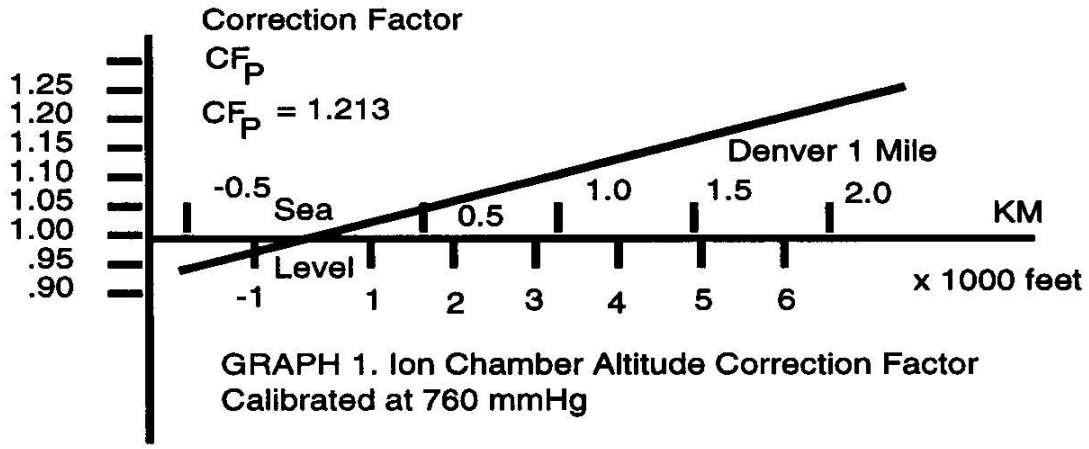
In the above equation, (CF_T) and (CF_P) can be calculated (rather than approximating using Figure 2-1).

$$CF_T = \frac{T(°C)+273}{295}$$

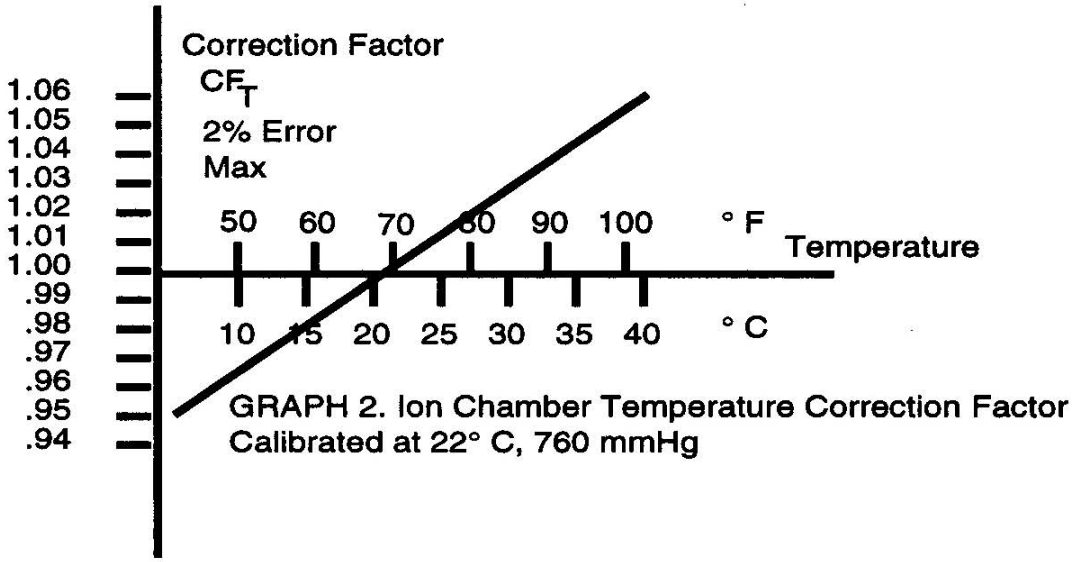
$$CF_P = \frac{760}{P(mmHg)}$$

Where:

T (°C) = temperature measured in degrees C, and P (mmHg) = pressure measured in mm Hg.



GRAPH 1. Ion Chamber Altitude Correction Factor
Calibrated at 760 mmHg



GRAPH 2. Ion Chamber Temperature Correction Factor
Calibrated at 22° C, 760 mmHg

Figure 2-1 Temperature Altitude Correction Graphs

2.7 Sources of Error

If an incorrect measurement is suspected, check the items listed below as they are potential sources of error:

1. Low battery voltage.
2. Failure to properly zero the unit before/between measurements.
3. Uncorrected drift error over long exposure times.
4. Unusual atmospheric conditions requiring a correction factor.
5. Extended low energy backscatter.
6. Capacitive effects (Refer to Section 2.8, Precautions).
7. Static discharge (Refer to Section 2.8, Precautions).
8. A damaged cable or connector on the chamber.
9. Operating the unit beyond specified limits of temperature, x-ray energy, etc.

2.8 Precautions

WARNING

Extreme caution should be used when making connections with the chamber and rear panel, an electrical shock hazard exists on the ion chamber bias connector (HV out).

1. Due to the high voltage inside the ion chamber and its delicate nature, puncturing or removing the chamber cover may result in damage to the unit or a change in calibration.
2. If a large amount of static electricity is present, small-to-moderate absolute errors may occur as a result of touching the exposed window. This is most likely to occur when the ambient humidity is very low.
3. Because of the highly sensitive nature of the electrometer input circuit, changing the position of the instrument can cause small changes in the reading due to capacitive effects. This is a reversible error and can be corrected by returning the unit to its original position or manually resetting the unit.

2.9 Operational Checks

Regular monitoring of the instrument's performance is necessary to achieve maximum accuracy.

2.10 Drift Rate

Periodic measurements of the drift rate should be recorded for reference when long exposure periods are used (Table 3-1).

2.11 Battery Voltage

Correct battery voltage is important for the proper operation of the unit. Installation and replacement of the battery requires the removal of the rear access panel. A MN1604 alkaline battery (P/N 16-29 or

equivalent) is recommended. However, any standard 9 V transistor battery will work, but with shorter life. The battery should be replaced after a maximum of one year's use.

WARNING

Extreme caution should be used when making battery changes. An electrical shock hazard exists on the ion chamber bias connector (HV out).

NOTE

Turn off power before replacing the battery.

2.12 Zero Set

Due to aging of circuit components, small changes in the zero reading can be expected over the lifetime of the unit. A Zero Adjustment, located on the rear panel, is provided to permit field adjustment as follows:

1. Turn the unit ON.
2. Wait five minutes.
3. Set the front panel switch to DOSE.
4. Press RESET.
5. Adjust ZERO if necessary so that the display shows 0.000.

Section 3
Service Information

WARNING

Extreme caution should be used when making connections with the chamber and rear panel, an electrical shock hazard exists on the ion chamber bias connector (HV out).

3.1 General

The RAD-CHECK MICRO-R contains two functional elements: the electrometer circuit and the Voltage Ratio Module (VRM).

The external ion chamber consists of electrically charged plates enclosing a constant volume. Under operation (no radiation), no free ions exist in this volume. When exposed to an ionization source, ions are created in direct relationship to field strength. The ions are collected, producing an output current.

3.2 Circuit Description

The electrometer circuit is either a charge integration circuit or a current to voltage circuit depending on the selection of DOSE or RATE respectively.

The DOSE or RATE mode is selectable using the front panel switch. When operating in the DOSE mode, the electrometer circuit is a charge integration circuit. When operating in the RATE mode, the electrometer circuit is a current to voltage converter.

The input is a high impedance operational amplifier which provides minimum drift when used as an integrator. The charge from the ion chamber is collected by the electrometer amplifier producing a voltage across a capacitor. This voltage is a variable percentage of the operational amplifier output. A dose calibration potentiometer is used to calibrate the unit to give a direct radiation reading represented by this voltage.

The front panel RESET switch closes a relay, which shorts the charge across a capacitor, resetting the operational amplifier to 0. The zero offset adjustment potentiometer is used to adjust the electrometer input. It can be found on the rear panel.

3.3 Calibration and Adjustments

Standard Calibration: Calibrated @ Technique M75

NOTE

The user should be aware that changes in altitude and temperature will affect the reading (Refer Air Density Corrections in Section 2.6).

The voltages listed below should be checked before continuing with adjustments or calibration.

1. TP8 - TP12 = +7 to +9 V
2. TP9 – TP12 = +5 V ± 5%
3 TP10 - TP12 = -270 V ± 10% (Use an electrostatic voltmeter).
4. TP4 - TP6 = 1.1 V ± 0.2 V

Zero Adjustment

This adjustment eliminates offset and aging errors common to operational amplifiers.

1. Set the front panel switch to DOSE.
2. Reset the display, observe for several minutes, and adjust the zero adjustment located on the rear panel as required.

Offset (R30, U3)

WARNING

se care, 270 Vdc is present inside the unit.

1. With the cover on the unit, set the front panel switch to DOSE.
2. Press the RESET button on the front panel. The display should read 0.00.
3. If necessary, adjust R30, located on the printed circuit board, to display a 0.00 reading.

NOTE

Use a voltmeter between TP5 and TP12 for accuracy.

Section 4
Troubleshooting

4.1 Precautions

WARNING

Extreme caution should be used when making connections with the chamber and rear panel, an electrical shock hazard exists on the ion chamber bias connector (HV out).

CAUTION

Many components on the printed circuit board are static sensitive. ESD precautions should be observed when handling the printed circuit board assembly.

4.2 Troubleshooting

If there is a problem with the unit, refer to the table below for possible causes and corrective actions.

Symptom	**Possible Cause**	**Corrective Action**
No display	Dead Battery	Replace battery (See 2.11)
& No Reset Light	Broken battery snap lead	Replace lead
	Defective ON/OFF switch	Replace switch
Inaccurate Readings zero	Does not zero	Adjust rear panel (see ZERO SET)
	Low battery voltage	Replace battery (See 2.11)
	Defective/damaged ion chamber	Recalibrate chamber
		Return unit to factory for chamber repair/replacement

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Appendix A
Replacement Parts

A.1 Replacement Parts

There are no user replaceable parts on the RAD-CHECK MICRO-R circuit board. If a part is suspected of being faulty, contact Fluke Biomedical at 440.248.9300.

Fluke Biomedical
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