

FLUKE®

Biomedical

35035

mA/mAs Meter

Operators Manual

February 2005
Manual No. 37549 Rev.5
©2004, 2005 Fluke Corporation, All rights reserved. Printed in U.S.A.
All product names are trademarks of their respective companies

**Fluke Biomedical
Radiation Management Services**

6045 Cochran Road
Cleveland, Ohio 44139
440.498.2564

www.flukebiomedical.com/rms

Table of Contents

Section 1:	General Information	1-1
1.1	Specifications.....	1-1
1.2	Introduction.....	1-2
1.3	Safety Precautions.....	1-2
Section 2:	Theory of Operation	2-1
2.1	Introduction.....	2-1
2.2	Instrument Features.....	2-2
2.3	Manual Addenda.....	2-3
Section 3:	Operation	3-1
3.1	Battery Installation.....	3-1
3.2	Operating Instructions.....	3-1
3.3	Signal Input Limits.....	3-2
Section 4:	Maintenance	4-1
4.1	General.....	4-1
4.2	Cleaning the Instrument.....	4-1
4.3	Test Equipment.....	4-2
4.4	Performance Tests.....	4-2
4.4.1	mA Performance Tests.....	4-2
4.4.2	mAs Performance Tests.....	4-2
4.5	Instrument Calibration.....	4-3
4.6	Battery Replacement.....	4-4
4.7	Fuse Replacement.....	4-5
4.8	Recalibration & Repair Information/Technical Assistance.....	4-5
4.9	Warranty Information.....	4-5

Section 1 General Information

1.1 Specifications

CURRENT (mA)			MILLIAMP SECONDS (mAs)			
Range	Resolution	Input Impedance*	Range	Resolution	Threshold Current	Input Impedance*
20 mA	0.01 mA	100 Ohms				
200 mA	0.1 mA	10 Ohms	200 mAs	0.1 mAs	3.2 mA	10 Ohms
2000 mA	1 mA	1 Ohm	2000 mAs	1 mAs	32 mA	1 Ohm

SIGNAL INPUT LIMITS					
Function	Range	Maximum Input Limit	Function	Range	Maximum Input Limit
mA	OFF	Input shorted -2.0 A max (fuse protected)	mAs	20	Input shorted -2.0 A max (fuse protected)
	20	250 mA for 30 sec*		200	1 A for 30 sec*
	200	1 A for 30 sec*		2000	2.0 A max (fuse protected)
	2000	2.0 A max (fuse protected)			

* Limit set by power dissipation rating of shunt resistors. Maximum common mode voltage is 500 V.

GENERAL	
Meter Accuracy: $\pm 1\%$ of rdg + 2d on all ranges	Input Jacks: touch - protected 4 mm banana
Battery Type: Eveready type 522 or equivalent	Fuse: 5 x 20 mm type F2AH250V fuse
Battery Life: Approximately 200 hours	Environmental: Operating Temperature: 5°C to 35°C Storage Temperature: -20°C to 50°C Humidity: 0 to 80%
Display: 3-1/2 digit LCD; low battery annunciator, 0.50 in high digits	Dimensions and Weight: 15 cm wide x 5.0 cm deep x 8.75 cm high (6 in x 2 in x 3-1/2 in); 0.35 kg (0.78 lb)
Test Leads: 91.4 cm (36 in.) safety set with finger guards on probes and shrouded banana plugs	

* Specifications subject to change without notice.

1.2 Introduction

The following safety precautions should be observed before and while operating the Model 35035. They must be observed in conjunction with those outlined in the manual for the x-ray generator to which the instrument is connected.

Circuit protection provisions are built into the Model 35035. However, they primarily protect the meter circuit itself. The x-ray generator must therefore contain voltage and current limiting components within its circuitry for its own protection as well as for the safety of the technician or operator making the connections to and performing the tests on the generator.

1.3 Safety Precautions


This instrument is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read this manual carefully before operating the Model 35035 mA/mAs Meter.

Exercise extreme caution when a shock hazard is present at the instrument's input. The American National Standards institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 V RMS or 42.4 V Peak are present. A good safety practice is to expect that a hazardous voltage is present in any unknown circuit before measuring.

Do not exceed 500 V peak between input low and earth ground.

Inspect the test leads for possible wear, cracks, or breaks before each use. If any defects are found, replace the test leads with ones that have a reputable measure of safety. For optimum safety, do not touch the test leads or the instrument while power is applied to the circuit under test. Turn the x-ray generator power off before connecting or disconnecting the instrument.

Do not exceed the instrument's maximum allowable input as defined in the Sections 1 and 3.

The symbol  on the instrument indicates that a potential shock hazard may exist during use. Always expect a shock hazard at the input terminals when the unit is connected to the x-ray generator and the generator is powered.

Do not make any contact with the unit during exposures. The voltage potential at the input could exceed the insulating capacity of the case and test leads under fault conditions.

Section 2

Theory Of Operation

2.1 Introduction

The purpose of this manual is to outline the operation and maintenance of the instrument. IT IS THE RESPONSIBILITY OF THE USER TO DETERMINE THE SUITABILITY OF THIS PRODUCT FOR HIS PARTICULAR MEASUREMENT CONDITIONS. The entire manual should be read before using the meter.

WARNING

Failure to observe all of the safety precautions presented in Sections 1.2 and 1.3 of this manual as well as those provided by the x-ray generator manufacturer may result in serious injury.

The Inovision Model 35035 mA/mAs Meter has two functions: an mA function with three (3) ranges that measures current in mA, and an mAs function with two (2) ranges that connects an integrator to read the product of current and time in mA-seconds. Both range and function are selected using rotary switches. Either DC or AC input mode is selected using a two-position rocker switch. The mAs function is reset by means of a momentary push-button switch.

Operation of the meter requires a standard 9 V alkaline battery. A low-battery warning appears in the display when the battery is nearly depleted (7.2 V). Polarity is displayed as well. Blanking of display digits indicates overrange.

A schematic of the input circuit of the Model 35035 is shown on the following page. R1, R2, and R3 are current shunt resistors for range scaling and changing the input current flow into a voltage. F1, R15, D2, and D3 are input protection devices that protect the shunt resistors and input circuit electronics from excessive current and voltage. F1 is a 2 A, 250 V fuse that limits the input current. R15 is a 140 V varistor that clamps high voltage pulses. D2 and D3 are 24 V zener diodes that clamp lower voltages.

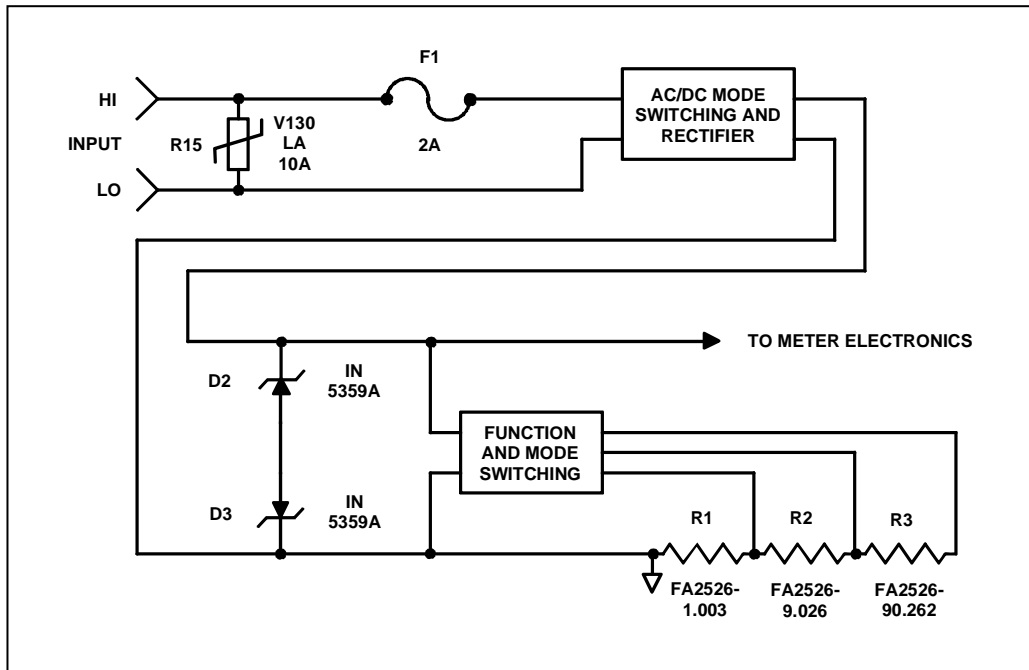


Figure 2-1. Input Circuit Schematic

2.2 Instrument Features

Figure 2-2 represents a front panel of the Model 35035 mA/mAs Meter and shows the location of its display, input jacks, fuse, switches, and trimmer adjustment controls. The functions of these features are described below.

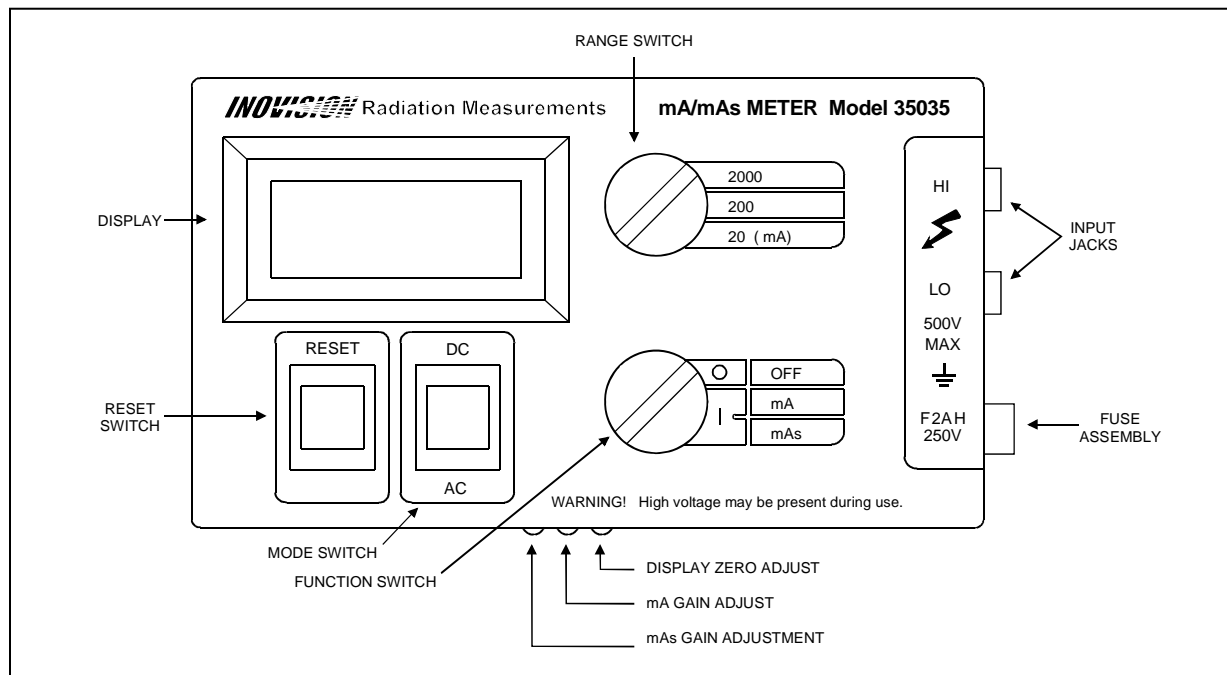


Figure 2-2. Model 35035 mA/mAs Meter Front Panel

INPUT JACKS

Touch-protected 4mm laboratory banana jacks for the use of safety laboratory leads and all spring-loaded 4mm banana plugs.

FUSE ASSEMBLY

Allows field replacement of the input current protection fuse with a small flat-blade screwdriver.

DISPLAY

3-1/2 digit liquid crystal display indicates the measured value of the signal applied to the input in mA or mAs.

RESET SWITCH

Resets the display to zero after a mAs measurement has been made and the display reading has been recorded.

MODE SWITCH

Selects either AC or DC measurement mode. The position of this switch depends upon the type of current signal from the x-ray generator to be measured.

FUNCTION SWITCH

Turns the Model 35035 mA/mAs Meter power ON and selects the desired measurement function (mA or mAs).

RANGE SWITCH

Selects the full-scale measurement range of the Model 35035 (20, 200, or 2000). All three ranges operate in the mA function. Only the 200 and 2000 ranges operate in the mAs function.

DISPLAY ZERO ADJUST

Trimmer potentiometer (R33) provides adjustment for a zero display reading with no signal applied to the input jacks.

MA GAIN ADJUST

Trimmer potentiometer (R10) provides calibration adjustment of the mA function.

MAS GAIN ADJUST

Trimmer potentiometer (R7) provides calibration adjustment of the mAs function.

2.3 Manual Addenda

Any improvements or changes concerning the instrument or manual will be explained in an addenda included with the manual. Be sure to note these changes and incorporate them into the manual.

Section 3 Operation

3.1 Battery Installation

The Model 35035 mA/mAs Meter is shipped from the factory with the battery separate from the unit. Remove the battery compartment cover on the bottom of the unit to install the battery. Make certain that the battery's clip end is inserted at the end of the compartment where the clip wires come out from the case and that the wires get looped around the top of the battery. This method will aid the user in replacing the battery when its life has been depleted.

3.2 Operating Instructions

1. Before making any connections to the x-ray generator, **MAKE CERTAIN THAT THE GENERATOR'S POWER IS TURNED OFF**. Connect the Model 35035 to the x-ray generator under test. Ensure that the test leads have no defects and the connections are secure.

WARNING

Failure to observe all of the safety precautions presented in Sections 1.2 and 1.3 of this manual as well as those provided by the x-ray generator manufacturer may result in serious injury.

2. Select either the AC or DC measurement mode on the Model 35035 using the MODE rocker switch depending upon the type of input signal expected from the x-ray generator. Again, knowledge of the signal from a specific generator is the responsibility of the technician.
3. Select the desired measurement function (mA or mAs) on the Model 35035 with the FUNCTION rotary switch. This switch turns the unit's power ON as well.
4. Select the desired range of the Model 35035 with the RANGE rotary switch. For greatest accuracy in the mA function, select the range that provides the most resolution on the unit's display. (Make certain that the signal input limits specified for that particular range are not exceeded.)

For mAs readings, select either the 200 range or the 2000 range (the 20 range is for mA only) and when necessary, reset the Model 35035 integrator by depressing the RESET button. Since noise comparators are built into the Model 35035 mAs circuitry, a minimum current of approximately 3.2 mA on the 200 mAs range or 32 mA on the 2000 mAs range is required before the signal registers on the display.

For greatest accuracy in the mAs function, use as high a current as possible within the proper signal limits for the selected range. The duration of the current pulse should be correspondingly short. This is especially important when measuring mAs in AC mode for single-phase x-ray generators.

5. Turn the x-ray generator power ON and proceed to take measurements with the Model 35035. It is mandatory to **OBSERVE ALL SAFETY PRECAUTIONS** contained in Section 1 of this manual.
6. Turn the x-ray generator power OFF after the measurements are complete.
7. Turn the Model 35035 power OFF and disconnect the test leads.

3.3 Signal Input Limits

WARNING

Exceeding the maximum input overload limits may result in fuse or other component failure. Such failure can result in the generation of dangerously high voltage at the input.

Function	Ranges	Maximum Input Limit
	OFF	Input shorted 2 A max (fuse protected)
mA	20	250 mA for 30 sec*
	200	1 A for 30 sec*
	2000	2 A max (fuse protected)
mAs	20	Input shorted 2 A max (fuse protected)
	200	1 A for 30 sec*
	2000	2 A max (fuse protected)

*Limit set by power dissipation rating of current range shunt resistors.

WARNING

A possible electrical shock hazard may occur if either input terminal is connected to a source of more than 500V DC or RMS AC above earth ground.

Section 4

Maintenance

4.1 General

The Inovision Model 35035 mA/mAs Meter is designed to perform with an accuracy of 1%. The performance of the meter should be checked periodically to ensure accurate, reliable operation. Under normal operating conditions, this instrument will perform to specifications for a period of at least one (1) year after calibration. The calibration cycle is, therefore, one (1) year. Any major, abrupt changes in performance indicate that the meter might not be operating properly. The unit should then be returned to the factory for calibration and repair. There are no user-serviceable parts within the meter. See Section 4.8 for calibration and repair information.

The calibration procedure for a normal operating unit does not require any disassembly of the instrument. Adjustments are all accessible from the enclosure exterior. They are set using a small flat-blade screwdriver with an insulated handle or an adjustment tool specifically designed for trimmer potentiometer adjustment purposes. Refer to Figure 2-2 for the exact location of the trimmer potentiometer access holes.

4.2 Cleaning the Instrument

To clean the exterior of the instrument, follow these steps:

1. Turn off the instrument and disconnect all input connectors.
2. Moisten a soft cleaning cloth with a solution of three parts water and one part liquid dishwashing detergent.
Do not soak the cloth in the solution; you must not let the solution drip inside the instrument.
3. Use the moistened cloth to wipe the instrument's exterior cover.
4. Let the instrument dry completely before using.

4.3 Test Equipment

A calibrated DC current source is required to properly calibrate the Model 35035 mA/mAs Meter. Its dwell time should be adjustable from 100 mS to 10 s and accurate to within 0.5%. Its current output should be adjustable from 1 mA to 2 A and accurate to within 0.5%. Finally, its compliance (burden) voltage should be adjustable to 25 volts DC.

In addition, a precision digital multimeter (0.25% accuracy in DC Amps) can be in the circuit to monitor the output of the current source.

4.4 Performance Tests

Connect the Model 35035 to the current source with appropriate test leads. Place its mode switch in the DC position. For the mA performance tests, apply the current listed and verify that the Model 35035 display reads within the limits specified. For the mAs performance tests, apply the current for the dwell

time specified and verify that the Model 35035 display reads within the limits listed. Reversing the polarity of the current source signal should reverse the polarity indicated on the Model 35035 display without significantly altering the numeric value for either mA or mAs. On mAs, the reading generated by a 50 mA, 5 s pulse should be effectively nulled out by an equal pulse of reverse polarity. (Note that except when performing the mAs tracking test, the RESET button must be depressed after each measurement reading.)

4.4.1 MA Performance Tests

35035 Range Setting	Current Source Output	35035 Display Reading
20	5 mA	4.95 - 5.05
20	15 mA	14.85 - 15.15
200	50 mA	49.5 - 50.5
200	150 mA	148.5 - 151.5
2000	500 mA	495 - 505
2000	1500 mA	1485 - 1515

4.4.2 MAS Performance Tests

35035 Range Setting	Current Source Output	Current Source Dwell Time	35035 Display Reading
20	15 mA	1 s	0
200	50 mA	1 s	49.5 - 50.5
200	500 mA	.1 s	49.5 - 50.5
200	1500 mA	.1 s	148.5 - 151.5
2000	50 mA	5 s	248 - 253
2000	500 mA	1 s	495 - 505
2000	1500 mA	1 s	1485 - 1515

NOTE

The following test will verify the mAs tracking performance. Do not depress the RESET button between applied current pulses.

2000	50 mA	5 s	DO NOT RESET!
2000	-50 mA	5 s	LESS THAN ± 005

4.5 Instrument Calibration*

A thorough checkout and adjustment of the Inovision Model 35035 mA/mAs Meter should be performed on a yearly basis*. Three (3) trimmer potentiometers (accessible from the front side of the enclosure) are the only adjustments necessary to calibrate a properly functioning unit. The following 28 steps outline the calibration procedure:


NOTE

* It is recommended that the unit be returned to Fluke Biomedical, Radiation Management Services for calibration. Removing the tamper-proof seal will void the Fluke Biomedical, Radiation Management Services warranty pertaining to the calibration.

1. With a fresh battery installed, remove the tamper-proof seal covering the three (3) trimmer potentiometers. Remove any connections to the input terminals. Turn the Model 35035 FUNCTION switch to the mA position, the RANGE switch to the 200 position, and the MODE switch to the DC position.
2. Adjust the display zero trimmer potentiometer (R33) for a stable 00.0 display reading. The “-” polarity indicator on the display should flicker on and off.
3. Turn the Model 35035 FUNCTION switch to the mAs position, depress the mAs RESET button, and, if necessary, re-adjust the display zero trimmer potentiometer (R33) for a stable 00.0 display reading.
4. While alternately turning the FUNCTION switch between the mAs and mA positions, re-adjust the display zero trimmer potentiometer (R33) once again so that equal flicker of the “-” polarity indicator on the display is maintained between the two functions.
5. Connect the current source output to the Model 35035 input terminals.
6. Turn the Model 35035 FUNCTION switch to the mA position and ensure that the RANGE switch is set to the 200 position.
7. Alternately apply +190.0 mA and -190.0 mA to the Model 35035 input and adjust the mA gain trimmer potentiometer (R10) for equal readings on either side of 190.0 on the display.
8. Turn the Model 35035 RANGE switch to the 20 position.
9. Alternately apply +19.00 mA and -19.00 mA to the Model 35035 input and verify that its display reads between 18.95 and 19.05 and that the correct polarity is indicated.
10. Turn the Model 35035 RANGE switch to the 2000 position.
11. Alternately apply +1900 mA and -1900 mA to the Model 35035 input and verify that its display reads between 1895 and 1905 and that the correct polarity is indicated.
12. Turn the Model 35035 FUNCTION switch to the mAs position and the RANGE switch to the 200 position.
13. Depress the Model 35035 RESET button.
14. Apply +100.0 mA for 1.9 seconds to the Model 35035 input and immediately adjust the mAs gain trimmer potentiometer (R7) for a reading of 190.0 on the display.
15. Depress the RESET button.
16. Apply -100.0 mA for 1.9 seconds to the Model 35035 input and immediately re-adjust the mAs gain potentiometer (R7) for a reading of -190.0 on the display.
17. Depress the RESET button.

18. Repeat steps 13 through 17 until equal readings on either side of 190.0 are attained on the Model 35035 display.
19. Turn the Model 35035 RANGE switch to the 2000 position.
20. Apply +1000 mA for 1.9 seconds to the Model 35035 input and verify that the display reads between 1895 and 1905.
21. Depress the RESET button.
22. Apply -1000 mA for 1.9 seconds to the Model 35035 input and verify that the display reads between -1895 and -1905. Before depressing the RESET button, verify that the display drifts no more than 5 display counts over a period of one minute.
23. Depress the RESET button.
24. Place the MODE switch in the AC position.
25. Again apply -1000 mA for 1.9 seconds to the Model 35035 input and verify that the display now reads between 1895 and 1905. This verifies correct operation of the front-end rectifier circuit in the Model 35035.
26. Depress the RESET button, place the MODE switch back in the DC position, and turn the RANGE switch to the 20 position.
27. With the Model 35035 FUNCTION switch still in the mAs position, apply +100.0 mA to for 1.9 seconds to the input and verify that the display reads 0.00. This verifies lockout of the 20 range in the mAs function.
28. Turn the RANGE switch of the Model 35035 to the 2000 position and the FUNCTION switch to the OFF position. With the current source output turned off, remove the test leads from the Model 35035 input terminals. This concludes the adjustment and operational checkout of the meter.

4.6 Battery Replacement

The Model 35035 meter operates on a standard 9 V alkaline battery such as the Eveready 522. A  appears in the display when the battery voltage reaches 7.2 V, indicating the battery needs to be replaced. The use of a battery type other than alkaline is not recommended.

WARNING

To avoid electrical shock, the instrument must be disconnected from the x-ray generator.

1. Turn the meter OFF and remove the test leads.
2. Turn the instrument over and remove the battery compartment cover.
3. Grasp the battery clip leads near the clip, gently lift the battery out of the compartment, and remove the old battery from the clip.
4. Install the new battery. Be certain that the clip end of the battery is inserted at the end of the compartment where the clip wires come out from the case and that the wires get looped around the top of the battery. This will aid the user the next time the battery needs to be replaced.
5. Re-install the battery compartment cover.

4.7 Fuse Replacement

The fuse is a 5 x 20 mm type F2AH250V. Do not use fuses of a different type or rating.

WARNING

If the fuse has blown, the meter operation should be checked to ensure other damage has not occurred.

1. Turn the meter OFF and remove the test leads.
2. Place the end of a flat-blade screwdriver into the slot in the fuse holder. Press inward slightly and rotate the fuse carrier one-quarter turn counterclockwise. Release pressure and extract the fuse carrier and the fuse.
3. Remove the defective fuse and replace it with the new fuse.
4. Re-install the fuse carrier with the new fuse turning the carrier one-quarter turn clockwise into its holder.

4.8 Recalibration & Repair Information / Technical Assistance

If your instrument needs recalibration or repair, we request that you consult Fluke Biomedical, Radiation Management Services at 800.850.4606, 440.498.2564, or by Fax at 440.542.3682.

More information concerning the operation, application, or service of your instrument may be obtained from the applications engineer at the above office.

4.9 Warranty Information

Should your instrument require warranty service, consult Fluke Biomedical, Radiation Management Services at 800.850.4606, 440.498.2564, or by Fax 440.542.3682.

**Fluke Biomedical
Radiation Management Services**

6045 Cochran Road
Cleveland, Ohio 44139
440.498.2564

www.flukebiomedical.com/rms