

# 451B

Ion Chamber Survey Meter

Operators Manual

### **Warranty and Product Support**

Fluke Biomedical warrants this instrument against defects in materials and workmanship for one full year from the date of original purchase. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to Fluke Biomedical. This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by other than Fluke Biomedical. IN NO EVENT SHALL FLUKE BIOMEDICAL BE LIABLE FOR CONSEQUENTIAL DAMAGES.

Only serialized products and their accessory items (those products and items bearing a distinct serial number tag) are covered under this one-year warranty. PHYSICAL DAMAGE CAUSED BY MISUSE OR PHYSICAL ABUSE IS NOT COVERED UNDER THE WARRANTY. Items such as cables and nonserialized modules are not covered under this warranty.

Recalibration of instruments is not covered under the warranty.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state, province to province, or country to country. This warranty is limited to repairing the instrument to Fluke Biomedical's specifications.

## Notices

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### Copyright Release

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### Unpacking and Inspection

Follow standard receiving practices upon receipt of the instrument. Check the shipping carton for damage. If damage is found, stop unpacking the instrument. Notify the carrier and ask for an agent to be present while the instrument is unpacked. There are no special unpacking instructions, but be careful not to damage the instrument when unpacking it. Inspect the instrument for physical damage such as bent or broken parts, dents, or scratches.

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### Technical Support

For application support or answers to technical questions, either email [techservices@flukebiomedical.com](mailto:techservices@flukebiomedical.com) or call 1-800- 850-4608 or 1-440-248-9300. In Europe, email [techsupport.emea@flukebiomedical.com](mailto:techsupport.emea@flukebiomedical.com) or call +31-40-2965314.

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### Claims

Our routine method of shipment is via common carrier, FOB origin. Upon delivery, if physical damage is found, retain all packing materials in their original condition and contact the carrier immediately to file a claim. If the instrument is delivered in good physical condition but does not operate within specifications, or if there are any other problems not caused by shipping damage, please contact Fluke Biomedical or your local sales representative.

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### Returns and Repairs

#### Return Procedure

All items being returned (including all warranty-claim shipments) must be sent freight-prepaid to our factory location. When you return an instrument to Fluke Biomedical, we recommend using United Parcel Service, Federal Express, or Air Parcel Post. We also recommend that you insure your shipment for its actual replacement cost. Fluke Biomedical will not be responsible for lost shipments or instruments that are received in damaged condition due to improper packaging or handling.

Use the original carton and packaging material for shipment. If they are not available, we recommend the following guide for repackaging:

- Use a double-walled carton of sufficient strength for the weight being shipped.
- Use heavy paper or cardboard to protect all instrument surfaces. Use nonabrasive material around all projecting parts.
- Use at least four inches of tightly packed, industry-approved, shock-absorbent material around the instrument.

#### Returns for partial refund/credit:

Every product returned for refund/credit must be accompanied by a Return Material Authorization (RMA) number, obtained from our Order Entry Group at 1-440-498-2560.

#### Repair and calibration:

To find the nearest service center, go to [www.flukebiomedical.com/service](http://www.flukebiomedical.com/service) or

#### In the U.S.A.:

Cleveland Calibration Lab  
Tel: 1-800-850-4608 x2564  
Email: [globalcal@flukebiomedical.com](mailto:globalcal@flukebiomedical.com)

Everett Calibration Lab  
Tel: 1-888-99 FLUKE (1-888-993-5853)  
Email: [service.status@fluke.com](mailto:service.status@fluke.com)

#### In Europe, Middle East, and Africa:

Eindhoven Calibration Lab  
Tel: +31-40-2675300  
Email: [ServiceDesk@fluke.com](mailto:ServiceDesk@fluke.com)

#### In Asia:

Everett Calibration Lab  
Tel: +425-446-6945  
Email: [service.international@fluke.com](mailto:service.international@fluke.com)

To ensure the accuracy of the Product is maintained at a high level, Fluke Biomedical recommends the product be calibrated at least once every 12 months. Calibration must be done by qualified personnel. Contact your local Fluke Biomedical representative for calibration.

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### Certification

This instrument was thoroughly tested and inspected. It was found to meet Fluke Biomedical's manufacturing specifications when it was shipped from the factory. Calibration measurements are traceable to the National Institute of Standards and Technology (NIST). Devices for which there are no NIST calibration standards are measured against in-house performance standards using accepted test procedures.

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### WARNING

Unauthorized user modifications or application beyond the published specifications may result in electrical shock hazards or improper operation. Fluke Biomedical will not be responsible for any injuries sustained due to unauthorized equipment modifications.

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### Restrictions and Liabilities

Information in this document is subject to change and does not represent a commitment by Fluke Biomedical. Changes made to the information in this document will be incorporated in new editions of the publication. No responsibility is assumed by Fluke Biomedical for the use or reliability of software or equipment that is not supplied by Fluke Biomedical, or by its affiliated dealers.

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### Manufacturing Location

The 451B Ion Chamber Survey Meter is manufactured at Fluke Biomedical, 6920 Seaway Blvd., Everett, WA, U.S.A.

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## ***Introduction***

The Model 451B Ion Chamber Survey Meter (the Survey Meter) is a hand-held, battery operated meter designed to measure alpha above 7.5 MeV, beta above 100 keV, and gamma & x-ray radiation above 7 keV, using the latest CMOS and LCD technology. The Survey Meter case is constructed of high strength ABS plastic. A gasket and desiccant pack seal moisture out of the Survey Meter and provides a cushion for the internal components. The readout consists of a 2½ digit liquid crystal display and a 100 segment analog bar graph. The bar graph contains a zero segment and twenty groups of five segments each. A permanent scale is located on the display screen. The major divisions of the scale indicate the units corresponding to the range that the Survey Meter is measuring. The units of measurement show next to the 2 ½ digit display. LOW BAT and FREEZE appear on the display when the product is operating in these modes. External controls consist of an ON/OFF button and a MODE button. The Survey Meter is auto-ranging and auto-zeroing. The auto-on circuit for the backlight is enabled when twilight conditions occur. The Survey Meter has an audio alarm that can be set by the user. Two 9 volt batteries, located in the back of the Survey Meter, provide over 200 hours of continuous operation. A 440 mg/cm<sup>2</sup> phenolic shield is provided as a beta shield. The shield also serves as an equilibrium thickness for photon measurements & protects the Mylar window.

## ***Intended Use***

The 451B Ion Chamber Survey Meter is a hand-held, battery operated unit designed to measure beta radiation above 100 keV and gamma and x-ray radiation above 7 keV.

## Safety Information

A **Warning** identifies conditions and procedures that are dangerous to the user. A **Caution** identifies conditions and procedures that can cause damage to the Product or the equipment under test.

Table 1 is a list of symbols used on the product and in this manual.

Table 1. Symbols

Symbol	Description	Symbol	Description
	Hazardous voltage. Risk of electric shock.		Risk of Danger. Important information. See Manual.
	DC (Direct Current)		On/Off button
	This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as category 9 "Monitoring and Control Instrumentation" product. Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.		This product contains a Lithium-ion battery. Do not mix with solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler per local regulations. Contact your authorized Fluke Service Center for recycling information.
	Conforms to European Union directives		

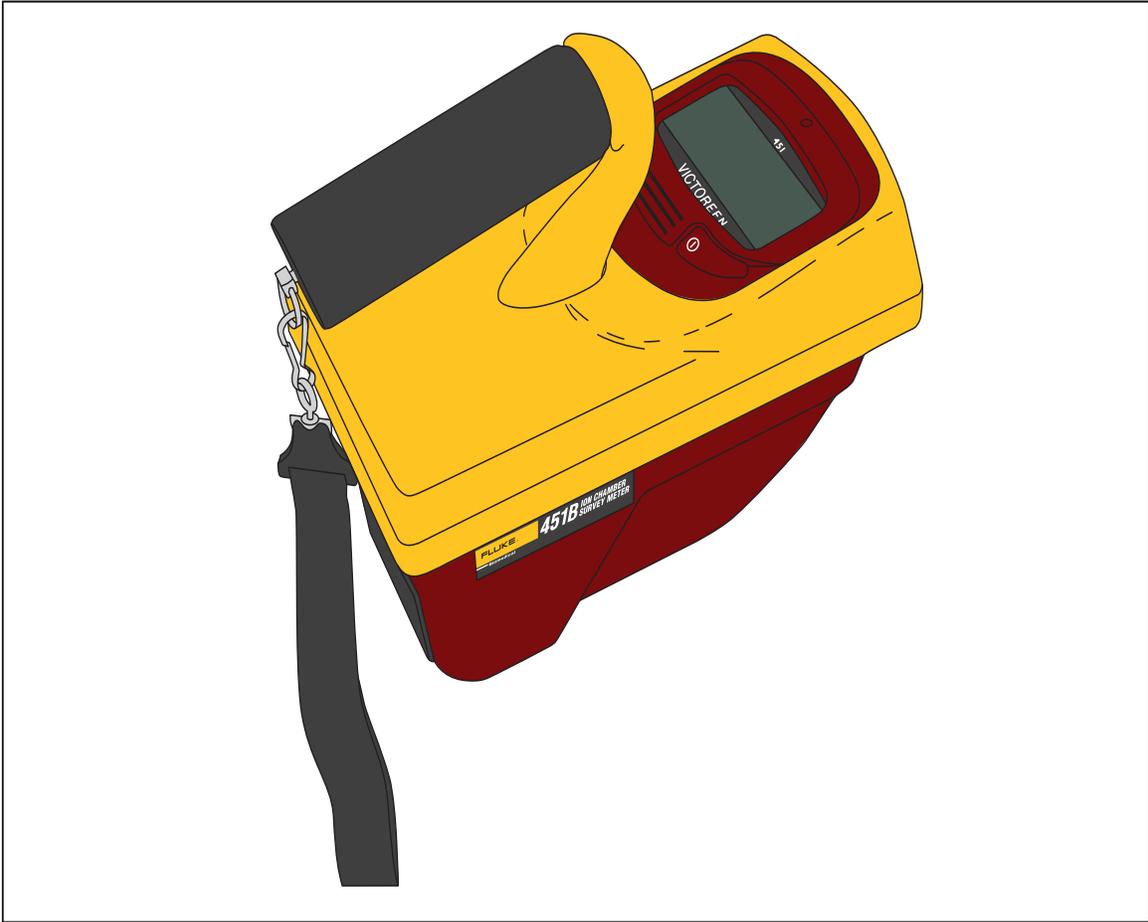
### Warning

To prevent possible electrical shock, fire, or personal injury:

- Read all safety information before you use the Product.
- Use the Product only as specified, or the protection supplied by the Product can be compromised.
- Remove the batteries if the Product is not used for an extended period of time, or if stored in temperatures above 50 °C. If the batteries are not removed, battery leakage can damage the Product.

- **The battery door must be closed and locked before you operate the Product.**
- **Replace the batteries when the low battery indicator shows to prevent incorrect measurements.**
- **Comply with local and national safety codes. Use personal protective equipment.**
- **Carefully read all instructions.**
- **Do not touch voltages > 30 V ac rms, 42 V ac peak, or 60 V dc.**
- **Do not use the Product around explosive gas, vapor, or in damp or wet environments.**
- **Do not use and disable the Product if it is damaged.**
- **Do not use the Product if it operates incorrectly.**
- **Examine the case before you use the Product. Look for cracks or missing plastic.**
- **Use this Product indoors only.**
- **Remove all accessories before the battery door is opened.**
- **Each person who uses a product that senses and measures ionizing radiation must:**
  - **Be approved to do work where there is radiation**
  - **Obey all applicable safety procedures and regulations**
  - **Be approved to correctly interpret the indications on the product**

**The user of this Product must read and strictly obey the instructions and precautions contained in the manuals. If you do not obey the instructions and precautions, there is a risk of injury. If you do not obey the instructions and precautions there is a risk that the Product will show incorrect indications. Before each use, do a battery check and other preoperational checks to make sure that the Product operates correctly.**



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**Figure 1. Fluke 451B Ion Chamber Survey Meter**

## **Features**

The following sections describe the features of the Survey Meter.

### **Overrange Rate**

If the instantaneous radiation rate measured by the Survey Meter exceeds 50 R/h (0.5 Sv/h), the 'R' in R/h or the 'Sv' in Sv/h displayed will blink to notify the user that the radiation field exceeds the measuring capability of the Survey Meter. Also, a potential error in the integrated radiation value may exist due to this condition. The blinking will stop when the integrated value is cleared.

### **Low Battery Indicator**

There are about 6 hours of operation remaining when the LOW BATTERY indicator first becomes visible. When the LOW BATTERY indicator blinks, there is less than 1 hour of operation remaining. These times are for two batteries installed and from the first occurrences of these indications. If the Survey Meter is turned off during a low battery condition, the batteries will recover somewhat, but time of operation remaining will be less.

### **Audio Alarm**

The audio alarm set points are set using the RS-232 COMM port connected to a computer along with the associated software. The audio alarm set point is set in increments of 1 % full scale. That is from 1 % to 100 % of full scale. The "A" command in the menu allows access to the scale and percent set point. The alarm will sound when readings reach or exceed the set point.

### **Integrate Mode**

The Integrate Mode allows the Survey Meter to display the integrated exposure. Exposures are accumulated up to 999 R (9.99 Sv).

### **Freeze Mode**

The Freeze Mode will move a "bar" on the bar graph display to show the user the peak value, and will lock on the maximum range. The Survey Meter will continue to read and display current readings.

### **Auto-On Backlight**

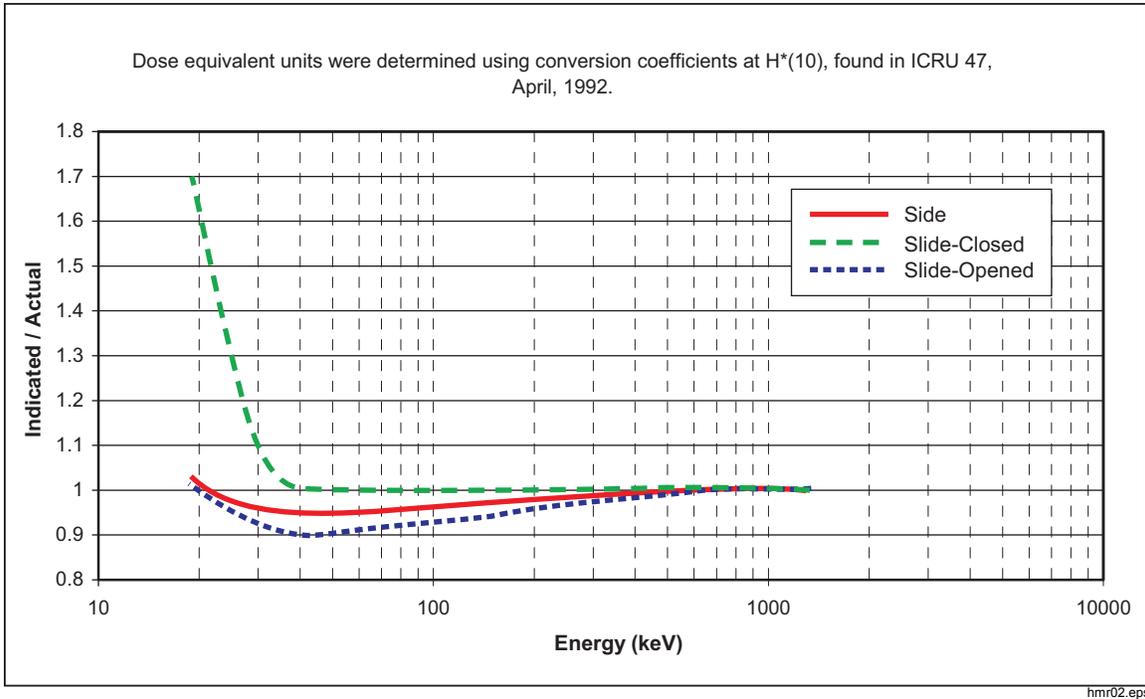
The Survey Meter is equipped with a backlight which automatically turns on when ambient light drops below a predetermined level. The backlight will turn off when the ambient light exceeds the predetermined level, which is factory set.

## Specifications

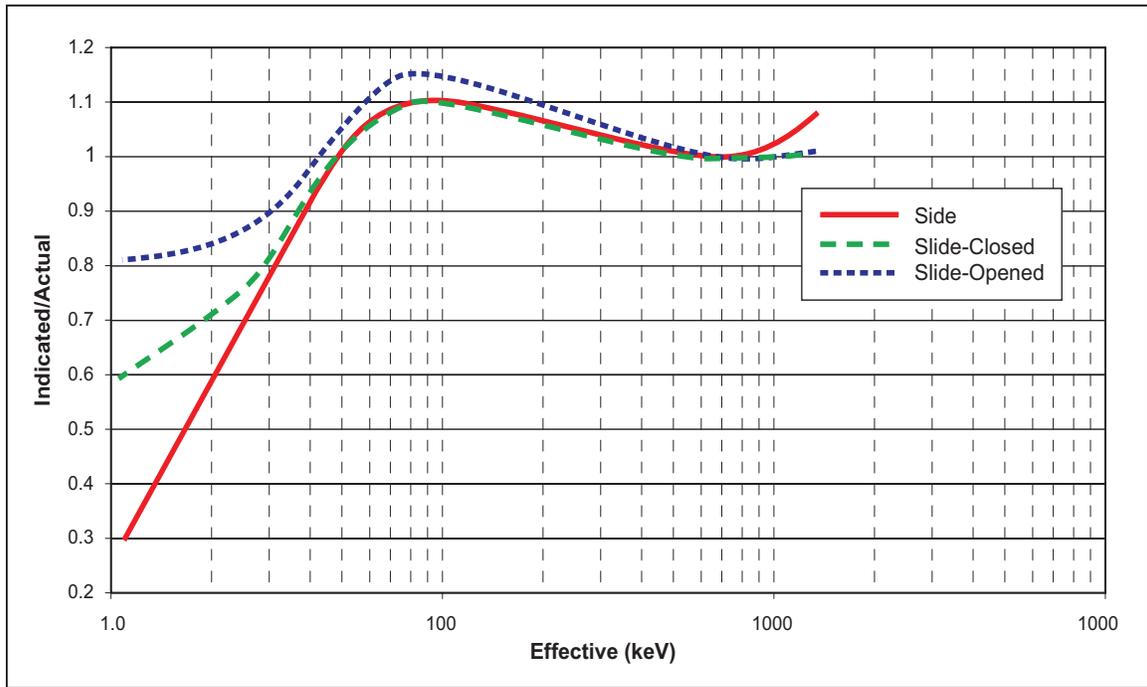
<b>Radiation Detected</b> .....	Alpha above 7.5 MeV, beta above 100 keV, gamma above 7 keV
<b>Operating Ranges</b> .....	451: 0 mR/h to 5 mR/h, 0 mR/h to 50 mR/h, 0 mR/h to 500 mR/h, 0 R/h to 5 R/h, 0 R/h to 50 R/h  451-DE-SI: 0 $\mu$ Sv/h to 50 $\mu$ Sv/h, 0 $\mu$ Sv/h to 500 $\mu$ Sv/h, 0 mSv/h to 5 mSv/h, 0 mSv/h to 50 mSv/h, 0 mSv/h to 500 mSv/h
<b>Accuracy</b> .....	$\pm$ 10 % of reading between 10 % and 100 % of full-scale indication on any range, exclusive of energy response (Calibration source is 137 Cs)
<b>Detector</b> .....	349 cc volume air ionization chamber; phenolic chamber wall 246 mg/cm <sup>2</sup> . Chamber window is composed of 6.6 mg/cm <sup>2</sup> Mylar. A coating of graphite has been applied to the walls to make them conductive. The collection potential is -63 Volts. The Chamber is vented through the desiccant  451B-DE-SI: In order to achieve energy response consistent with measurements of H*(10) as required by ICR4-47, aluminum has been added to the back wall, 38 % of the side wall area, and to the beta slide. With the Beta Shield open, the 451B can measure skin dose at H* (0.07), and Deep Dose H* (10) with the Beta shield closed.
<b>Warm-Up Time</b> .....	Less than one minute for initial operation
<b>Response Time</b> .....	Time measured from 10 % to 90 % of final value for a step increase/decrease in radiation rate such that a range change does not occur:  451B: 0 mR/h to 5 mR/h, range: 8 seconds. 0 mR/h to 50 mR/h, range: 2.5 seconds. 0 mR/h to 500 mR/h range: 2 seconds. 0 R/h to 5 R/h, range: 2 seconds. 0 R/h to 50 R/h, range: 2 seconds  451B-DE-SI: 0 $\mu$ Sv/h to 50 $\mu$ Sv/h, range: 8 seconds. 0 $\mu$ Sv/h to 500 $\mu$ Sv/h, range: 2.5 seconds. 0 mSv/h to 5 mSv/h, range: 2 seconds. 0 mSv/h to 50 mSv/h, range: 2 seconds. 0 mSv/h to 500 mSv/h range: 2 seconds  NOTE: Instantaneous exposure rate is limited to 50 R/h (0.5 Sv/h), including but not limited to a pulsed field.
<b>Precision</b> .....	Within 10 % of reading
<b>Readout</b> .....	Liquid Crystal Display: Contains an analog bar graph with a permanent scale on the display and a 2 ½ digit display. Analog Display: The bar graph consists of 100 segments, 2 ½ inches long; the scale has five major divisions; the appropriate value for the operating range of the instrument will appear below the scale. Digital Display: The digital display is 2 ½ digits followed by a significant zero digit depending on the operating range of the instrument. The leading ½ digit is blank, or a "1" or a "0" for clarity. Units of measure appear to the right of the digital display. Appropriate multipliers also appear on the display units: As indicated under Range, programmable in R/h or Sv/h
<b>External Controls</b> .....	ON/OFF button, MODE button.
<b>Automatic Features</b> .....	Ranging and zeroing are fully automatic.

<b>Environmental</b> .....	Operating Temperature Range: -20 °C to 50 °C Relative Humidity Range: 0 % to 95 % non-condensing Geotropism: less than 1 % Altitude 2000 m For Indoor use
<b>Dimensions (L x W x H)</b> .....	8 ½ in x 4 ½ in x 8 in (21.6 cm x 11.3 cm x 20 cm)
<b>Weight</b> .....	Approximately 2 lb, 9 oz (1.16 kg)
<b>Batteries</b> .....	Two 9 volt batteries (NEDA 1604A or 6LR61 or 6AM6) provide over 200 hours continuous operation. Three lithium cells provide chamber bias voltage of 63 V (10-year life expectancy)
<b>Audio Alarm</b> .....	Set through communication programs. Setting at 1 % increments, 1 % to 100 % full scale
<b>Temperature Sensor</b> .....	A temperature sensor in the 451B-DE-SI is used to adjust for offset drift due to temperature. Readings are not corrected for changes in air density due to pressure and temperature
<b>Check Source</b> .....	Model 450UCS (item number 3267644), allows user to check for proper instrument operation. Gives a nominal reading of 0.4 mR/h (4 µSv/h)
<b>IP Rating</b> .....	IEC 60529: IP40
<b>Safety</b> .....	IEC 61010-1: Pollution Degree 2
<b>Electromagnetic Environment</b> .....	IEC 61326-1: Portable
<b>Emissions Classification</b> .....	IEC CISPR 11: Group 1, Class A.  <i>Group 1 ISM equipment:</i> group 1 contains all ISM equipment in which there is intentionally generated and/or used conductively coupled radio-frequency energy which is necessary for the internal functioning of the equipment itself. <i>Class A equipment</i> is equipment suitable for use in all establishments other than domestic and those directly connected to a low voltage power-supply network which supplies buildings used for domestic purposes.

\* Specifications are subject to change without notice.



**Figure 2. Model 451B-DE-SI Typical Energy Dependence**



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Figure 3. Model 451B Typical Energy Dependence

### Receiving Inspection

Upon receipt of the Survey Meter:

1. Check the shipping cartons(s) and their contents for in-shipment damage.
2. Check that all items listed on the packing slip are present and in good condition.

If damage is evident, make a claim with the carrier and contact Fluke immediately. If items are missing, contact Fluke. See the How to Contact Fluke section in this manual.

## Operation

The following sections describe the operation of the Survey Meter.

### **Warning**

**To prevent possible electrical shock, fire, or personal injury, do not put metal objects into connectors.**

### External Controls

There are two external controls on the Survey Meter: an ON/OFF button and a MODE button.

#### ON/OFF Button

Press the ON/OFF button to turn on the product. All the elements in the display turn on and the microprocessor runs through an initialization procedure. Part of the procedure includes reading the calibration coefficients stored in EEPROM. If an EEPROM read error occurs, an error code (E1) displays at power-on and unity calibration coefficients are used.

The bar graph and digital display will show a reading that decreases as the Survey Meter stabilizes. The initial reading usually starts in the 50 R/h (50 mSv/h) range and decreases through the lower ranges to a reading of less than 0.5 mR/h (5  $\mu$ Sv/h) within 40 seconds. When the elements in the display turn off, with the exception of those necessary for normal operation, the user can begin the measurement process.

#### Note

*Background fluctuations may occur (less than 0.5 mR/h (5  $\mu$ Sv/h)) returning to the original reading typically in less than 3 seconds.*

#### Mode Button

To configure the MODE button to the opposite function without the RS-232 connection, use the following procedure:

1. Turn off the Survey Meter.
2. Press the MODE button.
3. Turn on the Survey Meter while continuing to press the MODE button.
4. Release the MODE button when the display is in the "all elements on" condition.
5. Use the MODE button to toggle the Survey Meter between the rate mode and the newly selected Freeze or Integrate mode.

### Freeze Mode

When configured to select the Freeze mode, the MODE button acts as a toggle switch. Press the button until FREEZE appears on the display. Operation in the Freeze mode gives the user a constant reference of the highest exposure rate obtained from the time the freeze function is initialized. The highest reading appears as a single bar on the bar graph. The current reading continues to display on the digital display and the bar graph. If a measurement is obtained which exceeds the freeze bar reading, the freeze bar moves to the higher measurement point. The operating range of the Survey Meter remains locked on the highest range attained during the Freeze mode so that the scale and the multiplier remain the same.

For example, assume the scale units appear as 10, 20, 30, 40, 50, and the freeze bar is at 47 mR/h on the bar graph. If the Survey Meter then measures a radiation field of 120 mR/h, the scale units will change to 100, 200, 300, 400, 500, and the freeze bar appears on the graph at 120 mR/h. If the Survey Meter measurement goes below 100 mR/h, the units on the scale will not change until the survey meter is taken out of the Freeze mode. However, the digital display continues to show the current reading. The Survey Meter operates in the Freeze mode until the user toggles the MODE button to return to the normal operating mode.

#### Note

*If a measurement is obtained which causes a range change higher than the alarm set point range, the alarm will sound and continue to sound until the Freeze mode is disabled.*

### Integrate Mode

The Integrate mode is operational 30 seconds after the Survey Meter is turned on and all of the time after that. However the integrated exposure can only be displayed when the MODE button has been configured as a toggle to display exposure rate/integrated exposure. If the MODE button is pressed within the 30 second initialization period of the Survey Meter, the display will read "0."

When integration starts, "0  $\mu$ R (0  $\mu$ Sv)" displays. Toggle MODE to read exposure rate as required.

To reset the integration display, toggle the display from the Rate mode to the Integrate mode. Keep the MODE button pressed for about 5 seconds. The display will clear, and then read "0  $\mu$ R (0  $\mu$ Sv)." Exposures are accumulated up to 999 R (9.99 Sv).

### **Self-Test**

When the Survey Meter is first turned on, it runs through a functional self-test procedure. During this self-test, the firmware version of the Survey Meter is displayed, along with the HI or LO chamber bias.

#### **Warning**

**For safe operation and maintenance of the product, note the chamber bias from the self-test. If chamber bias is LO, the Product cannot measure high radiation rates accurately. The Product requires service, contact Fluke.**

If the Survey Meter passes the self-test, it goes into the normal operating mode. If the Survey Meter fails the self-test it remains locked with the firmware revision displayed. Contact Fluke for corrective action. See the How to Contact Fluke section in this manual.

### **Installation**

The Survey Meter periodically tests for mark signal at its RS-232 port. When an RS-232 signal is detected, the Survey Meter sends test signals using its sending device and, if RS-232 is present and operational, the Survey Meter enters into the communications mode. The display clears and the letters “CO” display as an indication that the Survey Meter is in the communications mode.

The Survey Meter is compatible with a CRT or printing terminal that has a standard RS-232 connector and a 1200-baud rate. A computer with a modem or terminal emulator can be used in place of the terminal. Set up the terminal or computer for 1200 baud, 7 data bits, no parity bit, and 1 stop bit.

1. Connect the 9-pin female connector to an active communication serial port.
2. When “CO” appears on the Survey Meter display, press the computer or terminal space bar twice.

If the Survey Meter displays the “CO” message but there is no response at the terminal after pressing the space bar twice, perform the following tests:

- Be sure that the Survey Meter and terminal are properly connected via the RS-232 cable.

If there is still a problem, consult Fluke for further instructions. See the How to Contact Fluke section in this manual.

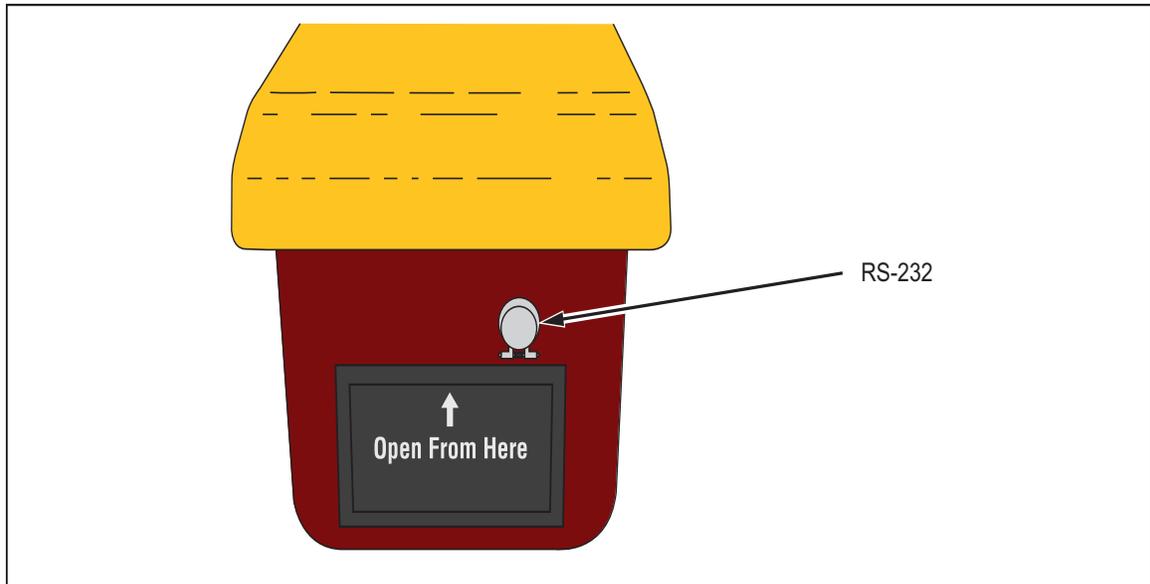


Figure 4. Location of RS-232 port

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### **Operational check**

Fluke recommends an operational check upon receipt of the Survey Meter and before each use. Monitor the start sequence. These results indicate the device is operating correctly:

- There are no error messages in the startup sequence.
- The display does not freeze (showing only the firmware number).
- The device gets to the background level within 2 minutes.

### **Optional Check Source Use**

#### **⚠ Warning**

**To prevent personal injury, use care in the handling and storage of the check source. The check source contains radioactive materials used for the verification of the Product operation.**

For more testing use the check source Model 450UCS (Fluke part number: 3267644), a radioactive button source that provides a nominal reading of 0.4 mR/h (4  $\mu$ Sv/h).

To check the device, do the following:

1. Turn on and initialize the Survey Meter.
2. After the self-test completes, wait for 2 minutes.
3. Open the beta shield.
4. Place the check source flat against the end window.
5. Check for a nominal reading of 0.4 mR/h (4  $\mu$ Sv/h).

### **Theory of Operation**

#### **⚠ Warning**

**To prevent personal injury, use care in handling this assembly during removal and installation. This Product contains lithium cells with a potential voltage of 63 V on the battery assembly.**

#### **⚠ Caution**

**To prevent damage to the Product, do not open or disassemble the Product. The high impedance circuits of the ion chamber are easily contaminated with grease and dirt that produce electrical leakage.**

The Survey Meter is an air ionization chamber meter calibrated in exposure rate units of roentgens/hour (or Sieverts/hour) for gamma and x-ray in the energy range of 20 keV to 2 MeV through the sliding Phenolic shield. It can also be used for x-ray in the energy range of 7 keV to 30 keV with the sliding shield open. The Survey Meter responds to, but is not calibrated for, beta radiation, with the slide open. Beta energies that can be measured are above 100 keV. The two thin Mylar windows have a combined density thickness of 6.6 mg/cm<sup>2</sup>. The Survey Meter also responds to alpha radiation above 7.5 MeV.

The liquid crystal display shows the radiation rate in digital and analog form with the range multiplier values also showing on the scale. It is a lightweight electronic device that requires the computational capabilities of a microprocessor to make it operate. It functions in a multiplex mode called quadruplex. This mode uses four backplanes to accommodate the 128 elements of the display.

The microprocessor performs data collection, averaging, and multiplication by stored calibration factors, range changing, and battery check functions, in addition to driving the LCD. Between computational periods, it “sleeps” in a low power mode to conserve battery power. The microprocessor reads stored information from an electrically erasable memory, EEPROM, which is used by the program for calibration and display units. The EEPROM will retain stored data when the Survey Meter is OFF or when the batteries are removed. Data can be entered into the EEPROM using the RS-232 port.

63 V collection voltage for the ion chamber is obtained from lithium cells that have a 10 year life. All internal power for the Survey Meter is supplied by the 9 V batteries, accessible from the rear of the Survey Meter.

The digital and bar graph displays read directly. The bar graph display update periods are listed in Table 2. The digital display updates at 1 second intervals nearest the current bar display update. The bar graph and digits display do not always show the same reading because the bar graph is faster than the digital update. It is more convenient to watch the bar graph when the reading is changing quickly and to read the value of a slowly changing or static reading by looking at the digital display.

The bar graph display is a digital presentation, programmed to appear as a linear analog meter display. It is also referred to as the analog display throughout this manual.

**Table 2. Bar Graph Display Update Periods**

<b>Range</b>	<b>Update Period</b>
50 R/h (500 mSv/h)	0.05 second
5 R/h (50 mSv/h)	0.1 second
500 mR/h (5 mSv/h)	0.1 second
50 mR/h (500 $\mu$ Sv/h)	0.15 second
5 mR/h (50 $\mu$ Sv/h)	0.25 second

There are 20 bars between each major division. The numerical values of the five major divisions change appropriately for the range in which the Survey Meter is operating. For instance, the first major division would have the numeric value of 1, 10, or 100. The minor divisions are worth 0.05, 0.5 or 5. The incremental nature of both the digital reading and the analog bar graph provide greater accuracy for reading in different portions of the scale. For example, on the 0 mR/h to 5 mR/h (0  $\mu$ Sv/h to 50  $\mu$ Sv/h) range, with a digital reading of 2.0 and above, the analog bar graph can be read more accurately than the digital display. Below a digital reading of 2.0, the digital display is more accurate because it consists of three significant digits. The stated precision of the digital display is accurate only above a reading of 0.20 on the 0 mR to 5 mR (0 Sv to 50 Sv) scale.

*Note*

*The same analysis applies to the all the other ranges because the number of significant digits or active bar elements are independent of the position of the decimal point or the units multiplier.*

There is a small hysteresis built into the range changing circuit so that the Survey Meter does not keep changing scales if the reading is at the threshold of range change. It is important when calibrating the Survey Meter that the calibration coefficients track from range to range because an oscillatory condition can occur if the calibration on a given range is low and the coefficient for the next more sensitive range is high.

In addition to FREEZE, the other message that can appear on the display is LOW BAT. When the LOW BAT message appears, the batteries should be changed within 1 hour.

The display will indicate HI for good chamber voltage bias condition.

The program in the Survey Meter ROM is proprietary to Fluke. The firmware version appears in the digital part of the LCD display (prior to the "all elements on" display) when the Survey Meter is turned on. The firmware program consists of three main parts: operation, communication, and monitoring.

The operation portion of the firmware performs all of the control functions needed to read and control the electrometer and range change amplifier, calculate radiation rate, and display the calculated values on the LCD Display. In addition, the measured data are smoothed and displayed in an exponential manner with time that simulates the rise and fall time of an ordinary meter display. Range changing is performed automatically. If a large increase in signal is detected, the range changing skips to higher ranges bypassing exponential rise with time to get to the new reading quickly. The Survey Meter continually integrates the detected radiation signal and saves the accumulated amount that may be read by the operator at any time. The operator may also reset the integration process.

## Maintenance

Very little maintenance is required for the Survey Meter, but some periodic attention may be necessary, especially if the Survey Meter is used in harsh industrial conditions.

### Warnings

To prevent possible electrical shock, fire, or personal injury:

- Do not operate the Product with covers removed or the case open. Hazardous voltage exposure is possible.
- Use only specified replacement parts.
- Have an approved technician repair the Product.
- Use care when handling, the surface below the High Voltage Board is conductive!
- Many components on the printed circuit board are static sensitive. Obey all ESD precautions when you touch the printed circuit board assembly.

### Preventive Maintenance

The desiccant must be renewed and replaced periodically. See the How to Contact Fluke section.

#### Note

*Install fresh batteries prior to performing any calibration on the Survey Meter.*

### Routine Cleaning

Do not immerse the Survey Meter. The Survey Meter is not waterproof; liquid could damage the circuits. The Survey Meter should be kept clean and free from dirt and contamination. To clean the Survey Meter, wipe with a damp cloth using any commercially available cleaning or decontaminating agent.

### Storage

If the Survey Meter 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 and humidity, vibration or shock. Store the Survey Meter with the two 9 volt batteries removed.

## **Battery Replacement**

### **Warning**

To prevent possible electrical shock, fire, or personal injury:

- **Batteries contain hazardous chemicals that can cause burns or explode. If exposure to chemicals occurs, clean with water and get medical aid.**
- **Do not disassemble the battery.**
- **Repair the Product before use if the battery leaks.**
- **Be sure that the battery polarity is correct to prevent battery leakage.**
- **Do not short the battery terminals together.**
- **Do not disassemble or crush battery cells and battery packs.**
- **Do not keep cells or batteries in a container where the terminals can be shorted.**
- **Do not put battery cells and battery packs near heat or fire. Do not put in sunlight.**

The LOW BAT message will appear on the display approximately 6 hours prior to the Survey Meter becoming inoperable. To ensure that the Survey Meter operates to specification, change the batteries within 1 hour after the LOW BAT message appears. The Survey Meter will function on one battery for approximately 100 hours, allowing replacement of one battery at a time if the Survey Meter must remain operational during battery changeover. Use either regular or alkaline batteries for replacement purposes.

Batteries are accessible from the rear of the Survey Meter.



hms02.eps

Figure 5. Battery Access

**Replaceable Parts Information**

Fluke maintains a complete inventory of all normal replaceable parts. To place an order, or to obtain information concerning replaceable parts, contact Fluke. See the How to Contact Fluke section in this manual.

**Table 3. Replaceable Parts List**

<b>Part Number</b>	<b>Description</b>
3567871	Underlay, 451
3567752	Keypad Overlay, Red
3567765	Handle, Yellow
3567776	Handle, Foam Grip, Black
3267644	Check Source, Model 450UCS
3569067	Wrist Strap
3567803	Cover Battery Box
3568830	Grill
614487	Battery, 9 V, Alkaline

**Recalibration and Service Information**

If your Survey Meter needs recalibration or repair, we request that you contact Fluke. See the How to Contact Fluke section.

More information concerning the operation, application, or service of your Survey Meter can be obtained from the applications engineer at the numbers listed above.

## Troubleshooting

### Caution

For safe operation and maintenance of the Product, use caution when working on this Product. If the device indicates a relatively high radiation rate, there is a possibility that the Product has been contaminated. High rates can quickly cause the operator's cumulative exposure to increase with the potential for injury.

### Note

*Install fresh batteries prior to performing any calibration on this product.*

### Self-Test Failure

If the Survey Meter fails self-test, it remains locked on the firmware revision number. See the How to Contact Fluke section.

### High Background Readings

The desiccant must be renewed and replaced periodically. See the How to Contact Fluke section.

### Erratic Readings

Check for broken ion chamber window or loose collector. Check for loose chamber bias connector.