

FLUKE®

Biomedical

35040

Therapy Dosimeter

Operators Manual

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Section 1

General Information

1.1 Introduction

The Model 35040 Therapy Dosimeter is designed for calibration dosimetry of therapeutic radiation treatment machines including high-energy accelerators, ^{60}Co , and brachytherapy equipment. The instrument can be used for calibration, government compliance testing, installation and set-up of new equipment, and troubleshooting.

The Model 35040 Therapy Dosimeter is a reference grade instrument that exceeds calibration laboratories' 1993 recommendations for linearity, long-term stability, and zero drift. The instrument uses calibrated ion chambers to simultaneously measure and display dose and dose rate in the user specified radiological units. At the user's discretion, the reading may be corrected for air density by user entered ambient temperature and barometric pressure readings.

- The highly regulated, precision electronic bias is continuously monitored. The bias voltage may be selected from the front panel.
- The Model 35040 Therapy Dosimeter provides a timer for performing timed charge and dose measurements. A typical application of the timer is for measuring brachytherapy sources. The instrument supplies four timed measurement quantities, which may be added to any of the measurement displays with the Customization software
- Triaxial ion chamber input connectors are furnished on both the front and rear of the instrument to make it easier to set up and use.
- For the first time in a therapy dosimeter, the effective exposure time for ^{60}Co source is determined from a single exposure.

1.2 Features

- Low leakage current in the instrument.
- All front panel settings are stored at power down and recalled at power up.
- A wide variety of measurements are available simultaneously; including charge, dose, current, dose rate, accumulated charge, accumulated dose, and effective exposure time.
- Timer for performing timed charge, predicted time charge and corresponding dose measurements.
- The user may select one of 32 ion chamber calibration factors for direct readout of dose or dose rate units.
- Dose measurement values may be displayed in units of Roentgens, rads, Sieverts, or Grays. Dose rate measurement values may be displayed in dose units per second, minute or hour. For brachytherapy applications, the instrument may be configured to read in Curies, becquerles, or kerma.
- The user may enter ambient temperature and pressure for air density correction of dose and dose rate measurements. Air density correction may be turned on or off from the front panel.
- The user may select the dose rate time divisor from the front panel.

- The ion chamber bias voltage may be set to one of 11 user-customized settings. The display indicates the polarity of the central electrode and the actual measured output voltage generated by the ion chamber bias supply.
- Highly regulated, stable, electronic ion chamber bias supply.
- The level of the internal electronic bias supply is continuously monitored. Annunciators appear on the display if an abnormal bias voltage level is detected.
- Bright, clear, multi-line alphanumeric display.
- Simplified, uncluttered control panel.
- A wide AC line input range of 100 to 240 VAC and the use of an IEC 320/C13 style receptacle provide worldwide operation by use of the proper line cord.
- The system may be operated from either AC line power source or from its internal battery. The battery will be charged from AC line power during use.
- A high performance rechargeable battery system provides 8 hours of continuous operation from a 3-hour charge. A low battery annunciator indicates when 30 minutes or less of operation remains.
- Automatic power-down after a user-specified time period, when operating from battery power.

1.3 Before You Start - Safety Precautions

The Model 35040 Therapy Dosimeter should be used only by people who are:

- Aware of and understand the limitations of the device as they relate to the measurement of radiation output
- Knowledgeable about safety procedures observed when working with radiation sources, such as therapy radiation machines
- Aware of safety precautions required to avoid possible injury when using electrical/electronic equipment


NOTE


The Model 35040 Therapy Dosimeter is NOT approved for applications where the sensor or the dosimeter is in contact with the patient.

Please take the time to read this manual carefully before operating this instrument.

1.4 Safety Symbols And Terms

The following symbols and terms are found on the instrument and used in this manual.

The  symbol on the instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on the instrument shows that high voltage may be present on the terminal(s). Use standard safety precautions to avoid personal contact with these voltages.

The

WARNING

 heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The CAUTION heading used in this manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

1.5 Manual Addenda

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

1.6 Specifications

Charge Measurements

Range, Resolution and Repeatability:

Full Scale Range	Display Resolution	Repeatability (\pm counts)
200.00 pC	0.01 pC	5
2.0000 nC	0.0001 nC	1.5
20.000 nC	0.001 nC	2.5
200.00 nC	0.01 nC	1
2.0000 μ C	0.0001 μ C	1
20.000 μ C	0.001 μ C	1
200.00 μ C	0.01 μ C	1
2.0000 mC	0.0001 mC	1
20.000 mC	0.001 mC	1

Measurement Method: Charge flowing into the input is integrated using a capacitive feedback electrometer whose output is measured by means of a 20 bit bipolar A-D converter. A high-speed reset circuit removes the integrated charge on the feedback capacitor each time it reaches a level of 2 nC in either polarity. By monitoring both the number of 2 nC resets and the charge on the feedback capacitor, the total charge flowing into the input is determined.

Factory Calibration: Basic factory charge calibration is performed by injecting -1.90 nC and ± 19.0 nC via a precision standard air capacitor. This method is believed to provide a calibration accuracy of $\pm 0.05\%$ rdg ($\pm 0.05\%$ of reading) as detailed in the table below:

Factory Calibration Error Source	\pm (%rdg)
Charge Source Accuracy (Capacitor)	0.01
Charge Source Accuracy (Voltage Change)	0.01
Temperature Effects (21°C – 25°C)	0.02
Other	0.01
Maximum Error	0.05

The field adjustable current and charge scale factors are set to their nominal value of 1.000 during factory recalibration.

Measurement Accuracy: Charge measurement accuracy is warranted to be better than $\pm (0.20\%rdg + 2 \text{ counts})$ over the operating temperature range of 18°C to 28°C for 1 year.

Field Calibration: Field calibrations may be performed via a restricted distribution MS-DOS Calibration program. This program is available to the AAPM accredited calibration laboratories (or equivalent) and may be used to adjust the current and charge scale factors from their nominal factory setting of 1.000.

Timed Charge Measurements

Range and Resolution: Same as charge measurements.

Measurement Method: The timed charge measurement is derived by monitoring the charge integrated over a time interval that begins with the activation of the timer. The timer automatically stops when the elapsed time is equal to the timer interval setting or the exposure is over. Interpolation is used to determine the charge at an integral number of seconds.

Measurement Accuracy: Same as charge measurements assuming that the rate of charge delivery does not dramatically change within the interpolation window interval.

Current Measurements

Range, Resolution, and Noise:

Full Scale Range	Display Resolution	Noise (\pm counts)
200.0 pA	0.1 pA	2
2.000 nA	0.001 nA	2
20.00 nA	0.01 nA	1
200.0 nA	0.1 nA	1
1.000 μ A	0.001 μ A	1

Measurement Method: The basic current measurement is derived by monitoring the change in the integrated charge level over successive 1-second intervals. Dividing the change in integrated charge by the 1-second integration period interval yields the current value.

Measurement Accuracy: Current measurement accuracy is $\pm (0.20\%rdg + 2 \text{ counts})$ over the operating temperature range of 18°C to 28°C for 1 year. Since the current measurements are based directly upon charge measurements, an independent current calibration is not required.

Measurement Noise: Current measurement noise is typically 1 to 4 counts peak to peak (depending upon the range) when the input is supplied by a quiet DC current source. When using a 0.6 cc Farmer Probe to measure the output of a typical ⁶⁰Co source, noise in the current measurement may be on the order of 0.4 R/min peak to peak at 100 R/min. Normal variations in the output exposure rate produced by a linear accelerator may result in excessive noise on the current measurement.

Response Speed: The display of current measurement values will begin within 1 second of the start of the exposure and reach 99% of the final level within 2 seconds.

Average Current Measurements

Range and Resolution:

Full Scale Range	Display Resolution
200.00 pA	0.01 pA
2.0000 nA	0.0001 nA
20.000 nA	0.001 nA
200.00 nA	0.01 nA

1.0000 μA	0.0001 μA
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Measurement Method: Average current measurement is derived by monitoring the charge integrated over the time interval beginning 1.33 seconds after the detection of the start of the exposure, and ending 1.33 seconds prior to the detection of the end of the exposure. Dividing the charge integrated over this interval by duration of the time interval yields the average current value.

Measurement Accuracy: The accuracy of the average current value in %rdg is approximately equal to the accuracy of the integrated charge measurement value from which it is produced. This value may be calculated by converting the “counts” contribution to a %rdg and summing this value with the inherent 0.20%rdg base accuracy of the charge measurement. Since the average current measurements are based directly upon charge measurements, an independent current calibration is not required.

Measurement Noise: Average current measurement noise decreases as the integration time interval increases. Typically, the noise in the average current measurement after a 100 second integration interval will be 10 times less than is present in the current measurement.

Response Speed: The display of average current measurement values will begin within 4 seconds of the start of the exposure.

Effective Exposure Time Measurements

Range and Resolution:

Full Scale Range		Display Resolution
Seconds	Hours/Minutes/Seconds	
59.99 s	59.99 s	0.01 s
19,999.9 s	5 h 33 min 19.9 s	0.1 s

Measurement Method: The effective exposure time value is calculated as the quotient of the charge and average current measurement values. A minimum exposure duration of 3.5 seconds is required to produce an effective exposure time measurement value.

Measurement Accuracy: Although the accuracy of the effective exposure time measurement value is directly dependent upon the accuracy of the internal oscillator frequency (better than $\pm 0.01\%$), more important to the achievable accuracy of this measurement are the effects of linearity and noise in the exposure and average current measurement values upon which it is based. In practice, an upper limit of the error in the exposure time value in %rdg will be equal to the %rdg noise observed in the average current display values.

Response Speed: The display of effective exposure time values will begin within 4 seconds of the start of the exposure.

General Measurements

Dose Conversion: Dose measurement values are calculated by forming the product of the measured charge, ion chamber calibration factor, and the air density correction factor.

Dose Rate Conversion: Dose Rate measurement values are calculated by forming the product of the measured current, ion chamber calibration factor, air density correction factor, and time unit multiplier.

Measurement Non-Linearity: The maximum variation from a straight line is $\pm 0.1\%$ of range on all charge and current ranges.

Long Term Stability: Ultra high long-term stability on the order of 0.1% per 5 years for both charge and current measurements is expected. Long-term measurement stability is verified as a part of each factory recalibration using inputs of -1.90 nC and ± 19.0 nC for charge and 19.0 nA for current. Compliance to the warranted specifications is considered satisfied if the observed measurement errors (%rdg) meet the following equations:

Observed Charge Error $\leq [\sqrt{\text{Period}/5} \times 0.10\%] + 0.10\%$

and

Observed Current Error $\leq [\sqrt{\text{Period}/5} \times 0.10\%] + 0.15\%$

where “Period” is the time interval in years between calibrations.

Gain Temperature Stability: The maximum temperature effect is less than $\pm 0.05\%$ rdg for both charge and current measurements over operating range of 18°C to 28°C. Add an additional $\pm 0.05\%$ rdg for operation during and immediately following battery charging at the high rate. Add an additional $\pm 0.01\%$ rdg/°C for operation over the ranges of (8°C to 18°C) and (28°C to 38°C).

AC Line Gain Stability: The maximum AC line voltage effect is less than $\pm 0.02\%$ rdg over the full operating range of 100 to 240 VAC (47 - 63 Hz).

Maximum Input Current: To achieve the stated measurement accuracy, the instantaneous input current must be limited to less than ± 100 nA.

Input Protection: The electrometer input is protected by a 100 kW $\pm 10\%$ series resistor. The maximum input current level of 3 mA should never be exceeded. Currents above this level may damage the instrument.

Exposure Threshold: The start and end exposure thresholds are adjustable from the front panel over the range of 0.0 to 9.9 pA in 0.1 pA steps. Setting the start exposure threshold to 0.0 pA disables the automatic exposure detection system and turns off both the automatic reset and current leakage compensation features. When the start exposure threshold is set above 0.0 pA, the leakage compensation feature operates by automatically subtracting the leakage current value from the measured current throughout the duration of the exposure. Both the displayed current and charge values are thus compensated for leakage current effects. The leakage current value used in this compensation is derived by averaging the current over the 10 s period immediately prior to the start of the exposure.

Current Leakage: Dosimeter input leakage is warranted to be less than 10 fA over both the full operating temperature range of 8°C to 38°C and for humidities up to 80% R.H., but only for conditions in which the absolute humidity is ≤ 20 g/m³ (the equivalent R.H. is 75% at 25°C, 60% at 30°C, and 50% at 35°C).

Stabilization Time: The instrument is warranted to meet its measurement accuracy and current leakage specifications within 2 minutes of power up. A maximum of 2 minutes may be required for the leakage current to stabilize to below the 10 fA level following a change to the ion chamber bias voltage selection (exclusive of ion chamber and cable effects). The instrument is warranted to meet its measurement accuracy specifications within 1 hour of power up.

Input Connectors: Two female triaxial type mounted on front and rear panels and connected in parallel.

High Performance Power Supply and Battery Charger

AC Line Input Voltage Range: 100 to 240 VAC (47 - 63 Hz) without operator switching.

AC Line Input Receptacle: IEC 320/C13 style with integral fuse holder located on the rear panel.

AC Line Protection Fuse: 5 x 20 mm IEC type F1H250V fuses are used.

Battery Type and Capacity: Lead acid battery provides 8 hours of continuous operation.

Recharge Time: Fast recharge time less than 3 hours to the full charge level, even during operation.

Low Battery Annunciator: “LoBat” is displayed when the battery voltage drops below 5.9 V. To protect the battery from deep discharge, the unit automatically powers down when the battery voltage drops below the level of 5.4 V. The instrument will operate for approximately 30 minutes with the “LoBat” annunciator displayed before automatically powering down.

Automatic Power Down: The instrument may be customized by the user (via the supplied Customization program) to automatically power down after a preset period of inactivity (lack of a key press, RS-232

command, or exposure detection). The automatic power down feature applies only when the instrument is operating from battery power. In addition, all front panel settings are saved as part of the automatic power down sequence.

Internal Electronic High Voltage Ion Chamber Bias Supply

Voltage Range: A maximum of 11 output level settings in the range of -500 V to +500 V may be programmed during user customization. Once programmed, these output levels become available for use and may be selected from either the front panel or via the RS-232 interface.

Level Accuracy: Bias voltage is warranted to be within ± 0.3 V over the full operating temperature range for loads < 0.2 mA.

Internal Verification: The voltage level is continuously measured during operation and compared to the selected setting. A “LoBias” or “HiBias” annunciator is displayed if the measured level differs from the selected setting by more than 1 V.

Capacitive Loading: Maximum ion chamber cable capacitance is 5,000 pF from ground to guard or from guard to center. For a typical 100 pF per meter triaxial cable, the maximum cable length is therefore 50 meters.

Output Current Limit: The output current is limited to < 0.5 mA for operator safety.

General

RS-232 Interface: Single RJ-45 style jack mounted on rear panel. Interface operates at 9600 bps, with 8 bits, no parity, and one stop bit. Xon/Xoff handshaking is employed.

Display: 4 line by 20 character vacuum florescent type.

Environment

Operating: 8°C to 38°C with an absolute humidity of ≤ 20 g/m³ (the equivalent R.H. is 75% at 25°C, 60% at 30°C, 50% at 35°C).

Storage: -25°C to +65°C. For maximum battery life, always bring the batteries to a level of full charge prior to storage, and maintain the storage temperature at 25°C or below. Under these conditions the batteries should receive an annual maintenance recharge to compensate for the self-discharge effects. Decrease the time interval between maintenance recharges by one-half for each 10°C increase in storage temperature above the 25°C baseline.

Mechanical

Dimensions: 21.6 cm wide x 8.9 cm high x 26 cm deep (10 in. x 9.4 in. x 4 in.).

Weight: 4.5 kg (10 lbs.).

1.7 Unpacking and Inspection

The Model 35040 Therapy Dosimeter was carefully inspected before shipment. Upon receiving the Model 35040 Therapy Dosimeter, carefully unpack all items from the shipping carton and check for any obvious signs of physical damage that might have occurred during shipment. Report any damage to the shipping agent at once. Retain the original packing material in case reshipment becomes necessary. The following items are included with the Model 35040 Therapy Dosimeter:

Standard System Contents

- Model 35040 Therapy Dosimeter
- AC Line Cord – USA (CO-19)
- Customization Software Kit (37886)

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- CD, 35040 Standard Customization (37870CD)
- 9-pin connector adaptor (37616)
- 7 foot RJ-45 Cable (105-260)

Section 2

Theory of Operation

2.1 Introduction

The Model 35040 Therapy Dosimeter is a radiation measurement instrument intended for use in calibration procedures for high-energy accelerators, ^{60}Co , and brachytherapy. Basic theory of operation of the instrument is explained in the following paragraphs. For information on radiation dosimetry and ion chamber measurement theory, the reader should refer to one of the standard radiological physics texts.

2.2 Functional Description

The Model 35040 Therapy Dosimeter is a portable instrument that measures charge and current. Calibrated ion chamber factors convert charge and current to directly measure radiation dose and dose rate in the user specified radiological units. The reading may be corrected for air density by the user entering ambient temperature and barometric pressure readings. The electronic bias setting is selectable from the front panel.

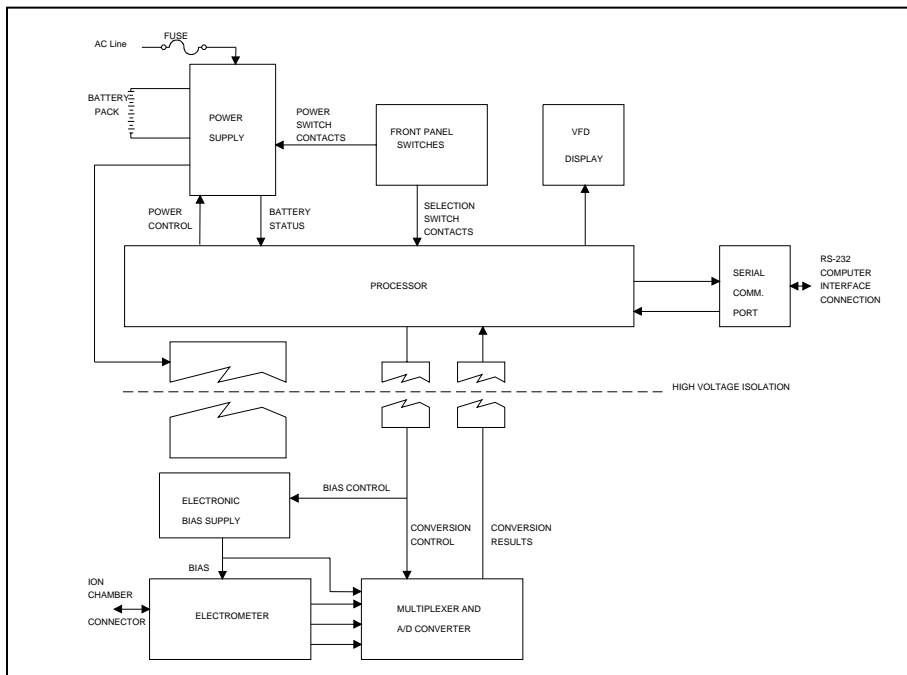


Figure 2-1. Hardware Block Diagram of the Model 35040 Therapy Dosimeter

2.2.1 Power Supply

During operation, the instrument may be powered by line voltage in the range of 100 to 240 VAC or from the internal 6 volt sealed lead acid battery for up to 8 hours. The power supply consists of a high performance charger that continuously charges the battery whenever the instrument is plugged in. The charger has three charging stages.

First stage: if the battery is fully discharged, the charger slowly recharges the battery until all cells in the battery have a minimum charge level on them. The instrument will not operate until the battery has more than the minimum charge on each cell. The first stage may be more than 18 hours depending on how severely discharged the battery is.

Second stage: the charger enters a high charge rate that can restore more than 80% of the charge in 2 to 3 hours - even during normal operation. The battery voltage will range from 5.5 to 8.5 volts. The battery current may be as high as 2.5 amps. After 3 hours of charging, the battery has enough charge for 8 hours of continuous operation.

Third stage: the charger enters a float charge stage that can be used indefinitely to maintain a full charge on the battery without harm. The battery voltage is approximately 7 volts. The current will range from 0.5 to 0.01 amps. The lower the current, the closer the battery is to full capacity. For additional information on care of the battery, see Section 3.8.

When operating from batteries, the battery current will be negative. The battery voltage will range from 6.5 volts to 5.4 volts. There are two automatic mechanisms to prevent excessive discharge of the battery. If the voltage drops below 5.9 volts, a low battery annunciator (LoBat) is displayed on the front panel. Less than 30 minutes of operating time are left. When the voltage drops to 5.4 volts, the firmware automatically turns off the instrument. The hardware will turn off the power if the voltage drops below 5.4 volts.

The AC Power Line is fused as it enters the instrument with two fuses. These external fuses may be replaced by the user (see Section 4.6 for details).

2.2.2 Front Panel

Pressing the power switch, an isolated, momentary-contact switch, once turns the power on. Pressing it again turns the power off. At least 5 seconds should elapse after turning the power off to let the internal parts reset before trying to turn power back on. The other keys, a matrix of 8 open contact membrane switches, are scanned when any key closure is detected. The key code is stored until it is used. The four line by twenty-character vacuum fluorescent display is easy to read over a wide range of lighting conditions.

2.2.3 MicroController

A Motorola processor controls the instrument. The operating program is stored in EPROM. RAM is used for volatile storage. Calibration parameters (gains and offsets) and customization parameters (ion chamber calibration factors, pressure, and temperature units, bias settings) are stored in EEPROM. Each time the instrument is turned off, all front panel settings are stored in a small portion of the EEPROM. The settings are restored when the instrument is turned on.

2.2.4 Serial Communications Port

The serial port is configured as an RS-232C data communications device (DCE) running at 9600 baud, 8 bits, no parity, and 1 stop bit. The protocol uses XON/XOFF handshaking. This port is used for factory calibration and testing, for calibration, for customization, and for remote control/data acquisition. Inadvertent changes of the calibration or customization parameters are prevented by use of a three-step sequence.

2.2.5 Electrometer

The electrometer is a single range, resettable, integrating amplifier. The high speed solid state reset is activated either by the operator pressing the RESET/MEASURE button or automatically when the instrument detects the end of an exposure. Errors resulting from temperature drift of the components and from dielectric absorption are dynamically corrected by the controlling firmware.

2.2.6 Bias Supply

The Model 35040 Therapy Dosimeter has a fully regulated electronic bias supply. The user may specify up to 11 settings within the range -500.0 to +500.0 volts, in any order, during customization of the instrument. Typical settings are +300.0, +150.0, 0, -150.0, and -300.0 volts, which conform to the recommendations of the American Association of Physicists in Medicine Task Group 21 (AAPM TG21). Other locality specific protocols can be accommodated within the 11 settings.

During operation, the bias supply output level is periodically measured by the A/D through a resistive divider. If the output is more than ± 1.0 volt from the set voltage, an error message (LoBias, or HiBias) will appear on the display. The bias supply has been designed to drive a capacitive load of less than 5000 pf.

CAUTION

Attaching a larger capacitance may create a potential shock hazard.

For operator safety, the output of the bias supply is energy and current limited. Before attempting to connect or disconnect an ion chamber, the operator should either set the bias voltage to 0 volts or turn off the instrument. Setting the bias voltage to 0 volts pulls the bias to a safe level within one second. The output of the bias supply is de-energized at power down. De-energizing may take 15 to 30 seconds.

2.2.7 Multiplexer and A/D Converter

The output of the electrometer is sampled at approximately 20 times per second by an analog to digital converter. The temperature of the electrometer is measured whenever the electrometer is reset. The program uses the temperature measurement to correct for temperature-induced drift in the electrometer components. The internal temperature may be different from the ambient temperature, especially during the battery high charge rate stage.

2.3 Basic Operating Equations

The instrument makes extensive use of the microcontroller's processing capabilities to directly implement the operating equations. The variables used in the equations are detailed in the table below. The equations in this section have measurement units enclosed in square brackets as a reminder of the required units, e.g. [C] for Coulombs.

Table 2-1. Description of Quantities

Quantity	Description	Units	Comments
ADCF	Air Density Correction Factor	None	Calculated by instrument and depends on front panel Temperature and Pressure settings.
QExposure	Charge during exposure	C	Electrical charge delivered to readout in response to radiation incident upon detector since the last exposure.
QAccum	Accumulated Charge	C	The sum of all charge accumulated due to exposures since the RESET/MEASURE button was last pressed.
QAccum_previous	Previous Accumulated Charge	C	The sum of all accumulated charge not including the current exposure since the RESET/MEASURE button was last pressed.
QElectrometer	Electrometer Charge	C	Factory calibrated electrical charge.
Q	Charge	C	Calibrated electrical charge.
QScaleFactor	Charge Scale Factor	C / C	Calibrates the charge measured by the electrometer. Viewed on a Test Function screen.
QOffset	Charge Leakage	C	The electrical charge measured when no incident radiation is present.
I	Current	A	Calibrated electrical current.
IAvg	Average Current	A	The constant electrical current required to accumulate charge Q over time TStart to T.
ICCF	Ion Chamber Calibration Factor	Ion Chamber Calibration Units / A or C	Values are field programmable via Customization Software.
ILeakage	Leakage Current	A	The electrical current measured when no incident radiation is present.
IScaleFactor	Current Scale Factor	A / A	Calibrates the current. Viewed on a Test Function screen.
RateMultiplier	Rate Units Multiplier	s	Specifies the number of seconds the rate divisor is equal to 1(s), 60(min), 3600(hr).
T	Q Sampling Time	s	The time corresponding to Q and I.
Time	Effective Time of Exposure	s	The time required to accumulate charge QExposure with a constant electrical current IAvg.
TOffset	QOffset Sampling Time	s	The time corresponding to QOffset and ILeakage.
QTimed	Timed Charge	C	The electrical charge delivered during the timer interval.
QTimed_Predicted	Predicted Timed Charge	C	The total amount of timed charge that should be accumulated at the completion of the timer interval, based on the observed delivery rate.

Charge and Current Measurements

The instrument's electrometer charge and current measurements are factory calibrated to a United States National Institute for Standards and Technology (NIST) traceable standard. Governing regulatory agencies or best of practice protocols may require that the instrument be calibrated by an independent calibration agency. The calibration agency may install the correction factors ($Q_{ScaleFactor}$, $I_{ScaleFactor}$) to make the instrument read out directly as calibrated. These factors are viewable by the operator but may not be changed or turned off. In almost all cases, the scaling factors will be nearly unity.

$$Q = Q_{Electrometer} [C] \times Q_{ScaleFactor} [C/C]$$

$$I = \left(\frac{Q(i) - Q(i-1)}{T(i) - T(i-1)} \right) [C/s] \times I_{ScaleFactor} [A/A]$$

$$T = \text{time of electrometer conversion} [s]$$

Leakage Measurements

Leakage measurements (Q_{Offset} , $I_{Leakage}$ and T_{Offset}) are only applicable when automatic leakage compensation is enabled.

The leakage current is defined as the current present between exposures. The displayed leakage current or dose rate value (3-1/2 digit) is updated at a rate of approximately one time per second and held during an exposure. Extrapolated charge due to leakage current is nulled from the measurement. In order to do this, a short-term history of the leakage current is necessary.

When an exposure is not in progress and the absolute value of the current is less than the start threshold, pressing the RESET/MEASURE button sets the leakage current $I_{Leakage}$ to zero and starts the acquisition of current measurements for determining $I_{Leakage}$. To get the "best" determination of $I_{Leakage}$ takes time, at least 10 seconds. The ion chamber, cables, and instrument should not be disturbed while making the leakage measurement.

$$Q_{Offset} = Q(T_{Offset}) [C]$$

$$I_{Leakage} = \frac{\sum_1^n I [A]}{n}$$

$$DoseRateLeakage = I_{Leakage} [A] \times ICCF [Units / C] \times ADCF \times RateMultiplier [s]$$

$$T_{Offset} = T [s]$$

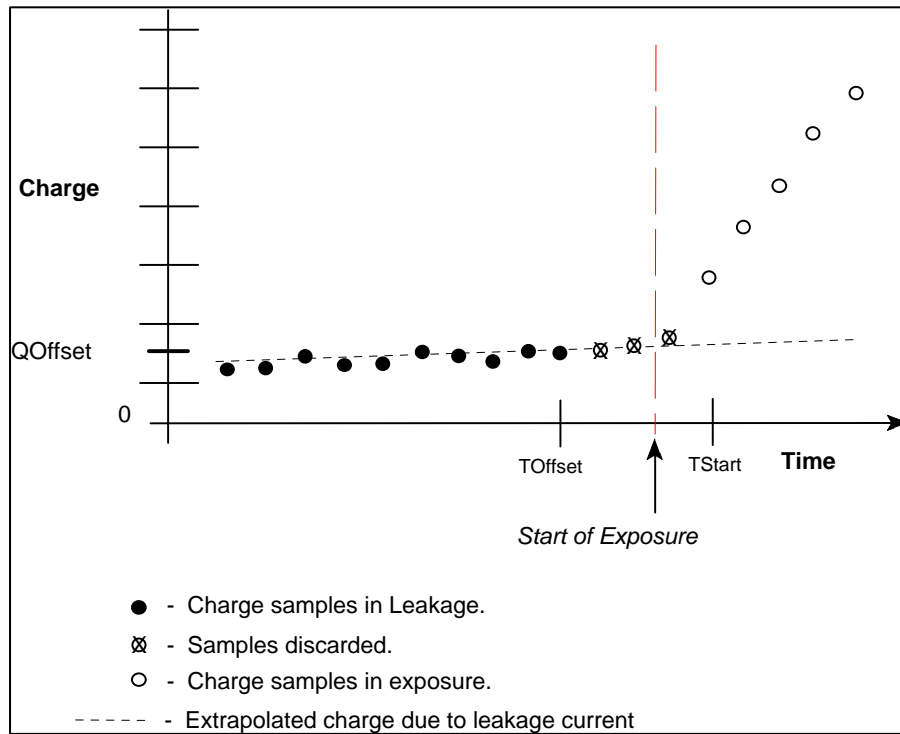


Figure 2-2. Leakage Current and Start of Exposure

When automatic exposure detection is disabled (start and stop threshold set to 0.0 pA), there is no correction for extrapolated charge due to leakage current. The dosimeter must be manually reset between exposures and the leakage current kept as low as possible for best results.

Exposure Charge and Dose

The charge on the electrometer during an exposure is due to the incident radiation plus the charge that was on the electrometer before the exposure plus the extrapolated charge due to any leakage currents in the ion chamber, cables, or electrometer. To obtain only the charge due to the exposure, the instrument employs the following equation:

$$Q_{Exposure} = Q [C] - Q_{Offset} [C] - (I_{Leakage} [A] \times (T [s] - T_{Offset} [s]))$$

$$Dose = Q_{Exposure} [C] \times ICCF [Units/C] \times ADCF$$

The exposure charge variable $Q_{Exposure}$ is set to zero at the start of an exposure either manually by pressing the RESET/MEASURE button or automatically if the start and stop thresholds are used. Over the duration of the exposure, $Q_{Exposure}$ and **Dose** are updated about once a second. The displayed measurement value (4-1/2 digit) is held following the exposure.

Timed Charge and Dose

This measurement accumulates charge only while the elapsed time is less than or equal to the timer interval setting. The displayed value is held following the completion of the timer interval.

$$Q_{Timed} = Q_2 [C] - Q_1 [C] - (I_{Leakage} [A] \times (T_2 [s] - T_1 [s]))$$

$$Dose_{Timed} = Q_{Timed} [C] \times ICCF [Units/C] \times ADCF$$

Q_1 represents the next sample of charge at time T_1 following the activation of the timer. Q_2 corresponds to the interpolated charge at time T_2 , where T_2 is an integral number of seconds that is restricted to times within the range: $T_1 < T_2 \leq (T_1 + \text{Timer Interval Setting})$.

Predicted Timed Charge and Dose

This measurement extrapolates the timed charge (Q_{Timed}) at the elapsed time (T_{Elapsed}) that should be accumulated at completion of the timer interval (i.e., $\text{TimerIntervalSetting}$) based on the rate of charge delivery.

$$Q_{\text{Timed_Predicted}} = \frac{Q_{\text{Timed}}[\text{C}]}{T_{\text{Elapsed}}[\text{s}]} \times \text{TimerIntervalSetting}[\text{s}]$$

$$\text{DoseTimed_Predicted} = Q_{\text{Timed_Predicted}} [\text{C}] \times \text{ICCF} [\text{Units/C}] \times \text{ADCF}$$

At the conclusion of the timer interval (i.e., T_{Elapsed} equals the $\text{TimerIntervalSetting}$), the predicted timed charge and dose are equal to the predicted timed charge and dose, respectively.

Accumulated Charge and Dose

This measurement accumulates charge across multiple exposures. The displayed value is updated during the exposure and held between exposures. It is reset to zero when the RESET/MEASURE button is pressed while viewing a measurement screen.

$$Q_{\text{Accum}} = Q_{\text{Accum_previous}} [\text{C}] + Q_{\text{Exposure}} [\text{C}]$$

$$\text{DoseAccum} = Q_{\text{Accum}} [\text{C}] \times \text{ICCF} [\text{Units/C}] \times \text{ADCF}$$

Exposure Current and Rate

The current (3-1/2 digit) and dose rate displayed when the exposure is in progress are updated once per second. The current and dose rate return to zero after the end of the exposure. The dose rate measurement is displayed using the selected time base (seconds, minutes, or hours). If the start and stop thresholds are set to zero, I_{Leakage} is zero.

$$I_{\text{Exposure}} = I [\text{A}] - I_{\text{Leakage}} [\text{A}]$$

$$\text{DoseRate} = I_{\text{Exposure}} [\text{A}] \times \text{ICCF} [\text{Units/C}] \times \text{ADCF} \times \text{RateMultiplier} [\text{s}]$$

Average Current and Rate

The average current is calculated using the charge accumulated ($Q/\Delta t$) during a portion of the exposure to eliminate noise effects. The displayed value (4-1/2 digit) is held following the exposure and reset at the

$$I_{\text{Avg}} = \left(\frac{Q_2 [\text{C}] - Q_1 [\text{C}]}{T_2 [\text{s}] - T_1 [\text{s}]} \right)$$

$$\text{DoseRateAvg} = I_{\text{Avg}} [\text{A}] \times \text{ICCF} [\text{Units/C}] \times \text{ADCF} \times \text{RateMultiplier} [\text{s}]$$

start of a subsequent exposure.

Q_1 and Q_2 are measured within the exposure at times T_1 and T_2 respectively. T_1 is 1.33 seconds after the start of exposure. T_2 is 1.33 seconds before the end of exposure (see Figure 2-3). The exposure must be more than 3 seconds long. I_{Avg} is 0 if the exposure is less than 3 seconds.

2.3.1 Setting Thresholds

The instrument has capability to automatically detect the start and end of an exposure when the current crosses given limits. Using automatic detection eliminates the sag in readings that occur due to leakage

or dielectric absorption. The start and stop thresholds are set independently, but the stop threshold must be less than the start threshold. The thresholds are settable in 0.1 pA increments from 0.0 pA to 9.9 pA. In some test setups, it may be necessary to raise the thresholds to reliably detect an exposure in the presence of a relatively large leakage current. Since the start threshold determines the minimum dose rate, it may be necessary to lower the thresholds for some exposures.

$$DoseRate = I[A] \times ICCF[Units/C] \times ADCF \times RateMultiplier [s]$$

The minimum dose rate is

where I[A] is the start threshold setting.

When the start and stop thresholds are set to 0.0 pA, the automatic detection of start and end of exposure is disabled. This effectively means that the instrument is measuring as if an exposure has been running continuously. In this mode of operation, leakage current is not measured, the average current is measured from the last time RESET/MEASURE was pressed, and charge will accumulate due to leakage current.

NOTE

Thresholds other than those used by the calibration agency may render inaccurate measurements.

2.3.2 Exposure Time

Historically, the determination of exposure time for ⁶⁰Co has involved multiple exposures to eliminate the effect of the shutter speed. By using the total charge and the average current for the exposure, the effective exposure time can be determined using a single exposure. If the average current varies by more than 10% during the exposure, this measurement is considered invalid and will be replaced by "INVALID."

$$I_{Avg} = \left(\frac{Q_2 [C] - Q_1 [C]}{T_2 [s] - T_1 [s]} \right) \quad Time = \left(\frac{Q [C]}{I_{Avg} [A]} \right)$$

The effective exposure time is derived from the total charge and the average current. In order to get enough data points to accurately calculate the time, the exposure must be a minimum of 3 seconds. To avoid artifacts at the start and end of exposure, the average current is calculated over the interval starting 1 1/3 seconds after the start is detected to 1 1/3 seconds before the end of exposure.

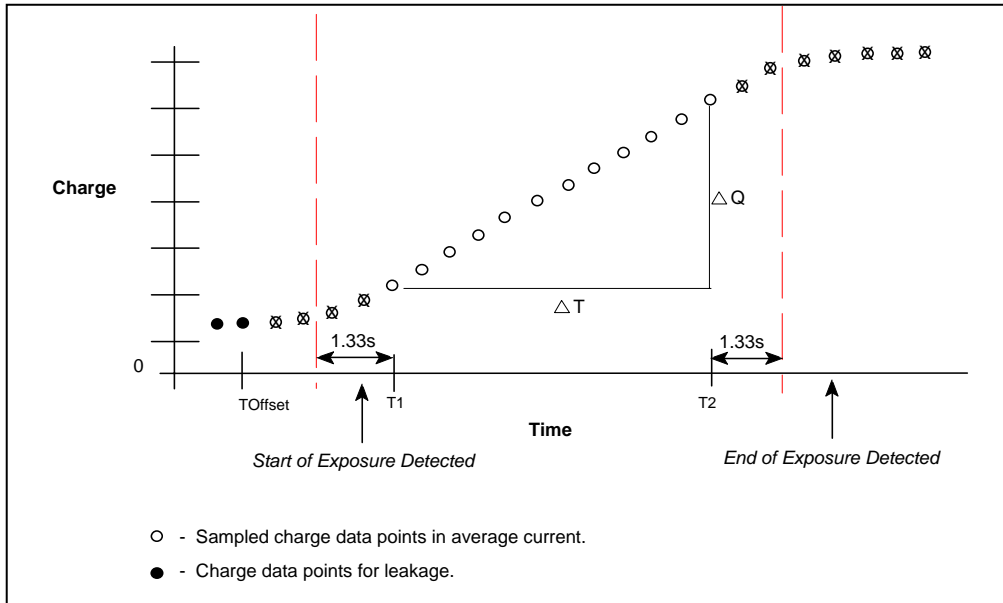


Figure 2-3. Average Current and Exposure Time

2.3.3 Air Density Correction Factor

$$ADCF = \left(\frac{760 \text{ mmHg}}{P} \right) \times \left(\frac{T}{T_c} \right)$$

The air density correction factor is used to correct dose and dose rate measurements for a vented ion chamber.

where the pressure “P” is expressed in mmHg, the temperature “T” is in Kelvin, and the calibration temperature “T_c” is in Kelvin. The calibration temperature is either 20°C (293.15 K) or 22°C (295.15 K), depending on that used by the calibration agency when calibrating the ion chamber. The calibration temperature must be specified during customization. The ADCF is displayed on the bottom line of the Air Density screen.

When the user has customized the Model 35040 Therapy Dosimeter to use other temperature and pressure units, the corresponding values entered by the user at the instrument’s front panel are automatically converted to mmHg and K before use in calculating the ADCF. The equations used for these conversions are listed below. The abbreviation FSL stands for “from sea level.”

$$\text{mm Hg} = \text{inch Hg} \times 25.4$$

$$\text{mm Hg} = 760 \times (54,041 - \text{feet FSL}) / (54,041 + \text{feet FSL})$$

$$\text{mm Hg} = 760 \times (16,472 - \text{meters FSL}) / (16,472 + \text{meters FSL})$$

$$\text{mmHg} = \text{mbar} \times 0.75006$$

$$\text{mmHg} = \text{hPa} \times 0.75006$$

$$K = (5 / 9) \times (F - 32) + 273.15$$

$$K = C + 273.15$$

Table 2-2. *Air Density Adjustment Ranges and Resolutions*

Units	Display	Minimum	Maximum	Standard	Resolution	% Error*
inches of mercury	inHg	20.55	31.30	29.90	0.05	0.12
millimeters of mercury	mmHg	522	795	760	1.0	0.10
altitude in feet	ft	-1200	10,000	0	25	0.07
altitude in meters	m	-360	3050	0	10	0.09
millibars	mbar	697	1060	1013	1.0	0.07
hectoPascals	hPa	697	1060	1013	1.0	0.07

Units	Display	Minimum	Maximum	Standard		Resolution	% Error*
Fahrenheit	F	32.0	122.0	71.6	68.0	0.5	0.05
Kelvin	K	273.0	323.0	295.2	293.2	0.5	0.09
Celsius	C	0.0	50.0	22.0	20.0	0.5	0.09

* The “% Error” column indicates the maximum amount of error that can occur due to the step resolution of the pressure or temperature units.

Section 3 Operation

3.1 Setup

Introduction

This section contains set-up and connection procedures for the Model 35040 Therapy Dosimeter.

The instrument is factory calibrated to measure charge (Coulombs) and current (Amperes). It is recommended that the user customize the Model 35040 Therapy Dosimeter prior to its first use. This customization may involve selecting the desired ion chamber calibration factor, temperature units, pressure units, and bias voltages. Procedures for carrying out the customization are covered in Section 3.10.

3.2 Front Panel Familiarization

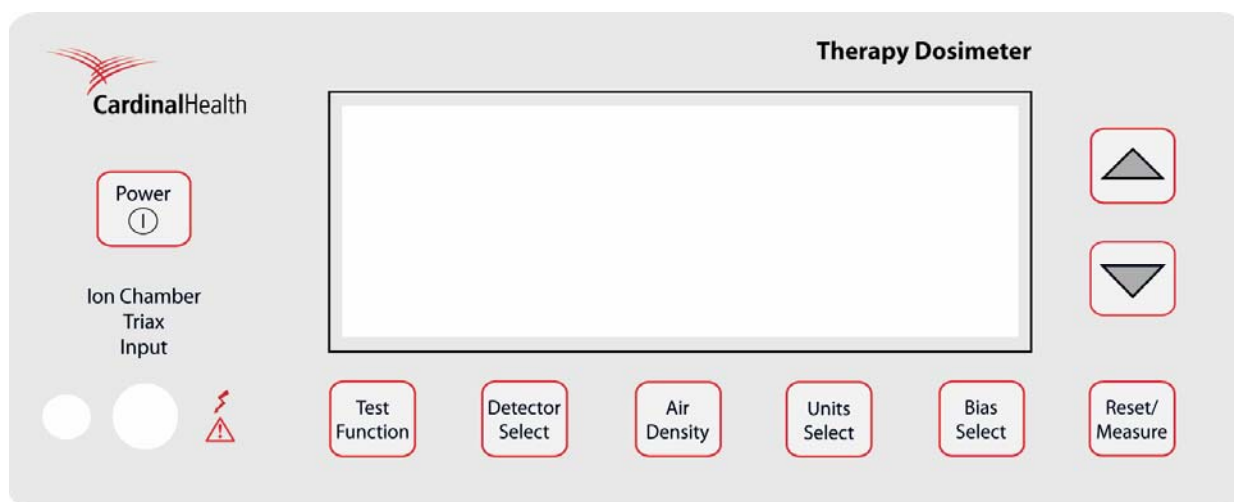


Figure 3-1. The Model 35040 Therapy Dosimeter Front Panel

Triaxial Ion Chamber Input: This input accepts the current line of ion chambers from Fluke Biomedical, various 0.6 cc, 0.3 cc, and 0.1 cc therapy ion chambers from other manufacturers, and Brachytherapy well chambers. The front panel ion chamber input is wired in parallel with the rear panel ion chamber input.

3.3 Rear Panel Familiarization

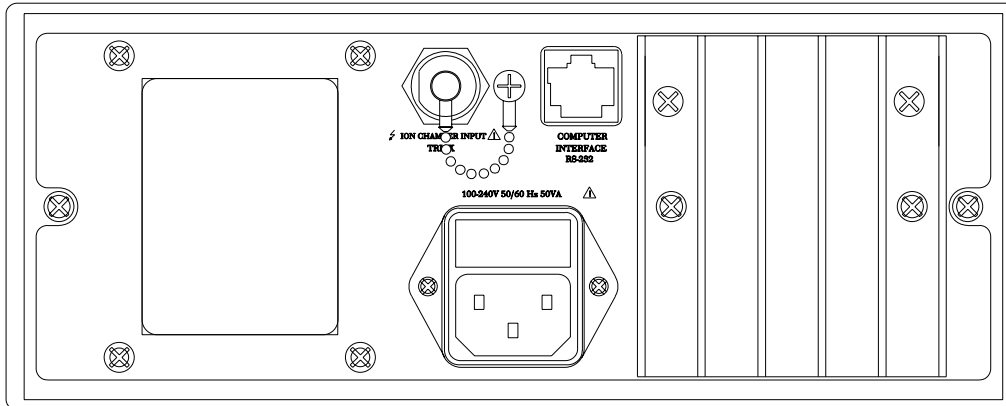


Figure 3-2. The Model 35040 Therapy Dosimeter Rear Panel

RS-232 Receptacle (RJ-45 Style): The RS-232 Computer Interface is used for computer controlled factory test, for calibration, for customization, and for remote control/data acquisition.

AC Line Power Receptacle: The AC line input range is 100 - 240 VAC (47 - 63 Hz). AC line voltage within the specified range has no effect on any dosimeter measurements. The IEC 320/C13 style receptacle permits worldwide operation by simply changing the line cord.

Triaxial Ion Chamber Input: This input is preferred in semi-permanent setups where the dosimeter is stationary at the treatment console. The rear triaxial is wired in parallel with front panel input.

NOTE

Do NOT attach ion chambers to both the front and rear connectors at the same time. The signals will be the summation of the two inputs and may result in erroneous readings.

3.4 Powering The System

The Model 35040 Therapy Dosimeter may be operated from either line or battery power. The line receptacle at the rear panel of the Model 35040 Therapy Dosimeter mates with a 3-wire line cord to provide a connection to line voltage (high, neutral and earth ground).

WARNING

When powering the Model 35040 Therapy Dosimeter from an AC line, always use a 3-wire grounding type line cord such as the one supplied with the dosimeter. In addition, only connect the Model 35040 Therapy Dosimeter to an AC power outlet employing a third wire safety ground. Failure to ground the Model 35040 Therapy Dosimeter may result in personal injury or death in the event of a short circuit or malfunction.

The Model 35040 Therapy Dosimeter operates on battery power for eight hours after a full charge. The dosimeter can be recharged quickly, usually in two to three hours, even during instrument operation. A low battery annunciator is displayed when 30 minutes or less of operation remains. When the battery pack is fully discharged, the instrument automatically shuts off and will not operate until AC line power is connected.

3.5 Power-Up Self-Test and Display Messages

When the instrument is powered up by pressing and releasing the POWER ON/OFF button, the following sequence of screens will be displayed:

1. The Pixel Test screen lights up all the pixels on the screen (2-10 seconds).
2. Calibration information showing the calibration agency and the calibration date (2 seconds).
3. Firmware revision date (2 seconds).
4. Instrument bias, leakage, and battery levels.

During this opening screen sequence, pressing a front panel button will have no effect. The instrument bias, leakage, and battery level screen will be the last screen displayed as shown below. At the completion of the sequence, other functions may be selected.

See Section 3.9.4 for an explanation of the contents of each screen.

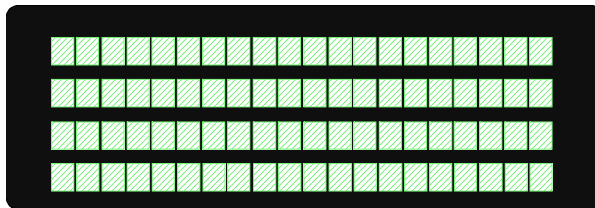


Figure 3-3. *The Pixel Test Screen*

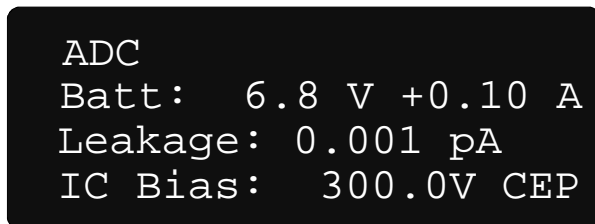


Figure 3-4. *The Bias, Leakage, and Battery Voltage and Current*

3.6 Ion Chamber Connector

CAUTION

Never connect a coaxial BNC type cable to the Model 35040 Therapy Dosimeter's triaxial ion chamber input connectors. Doing so will damage the ion chamber input connector.

WARNING

Mating and unmating to this connector (or to the other end of a cable already connected to it) should be done only when the bias is set to 0 volts, or when the instrument power is turned off. The central pin and inner shield shell of the triaxial connector are operated at the bias voltage above the outer shell and instrument case. Although the bias potential is energy and current limited, care should be taken to avoid unnecessary and possibly hazardous shocks.

The connector is a triaxial female with dust cap and chain. It connects to any low-noise triaxial male cables. The NE 2571A 0.6 cc Farmer Ion Chamber and other ion chambers may be operated with the Model 35040 Therapy Dosimeter.

The connector is mounted to avoid contaminating spills and dust. Putting its dust cap in place whenever a cable is not connected will help assure long service with minimum leakage problems.

3.7 Basic Measurement Techniques

3.7.1 General Considerations

The dosimeter must be placed on a solid, non-vibrating surface. Both the dosimeter and the operator must be outside the radiation field. Any cable movement will induce a current that may interfere with proper measurements. You should wait ten seconds or more after moving the ion chamber, triaxial cable, or disturbing another part of the high impedance circuit before taking a measurement.

3.7.2 Making Non-Timed Exposure Measurements

With Automatic Leakage Compensation Disabled

The instrument must be manually reset before each exposure when automatic leakage compensation is disabled.

Procedure

- Hold RESET/MEASURE for one second just before making the exposure to reset the instrument. Note that the instrument displays the "Rst" annunciator while the hardware is being reset.
- Wait for the reset to complete.
- Make the exposure.

The exposure measurements will be displayed but may drift due to leakage. Repeat this sequence for every exposure.

With Automatic Leakage Compensation Enabled

In addition to compensating measurements for leakage, the instrument holds the exposure measurements and automatically resets after each exposure when automatic leakage compensation is enabled.

Procedure:

- The annunciator line on the Measurement screen displays "WAIT System Not RDY" while the instrument is acquiring the minimum number of samples required for leakage compensation. Wait for this message to disappear.
- Wait for the leakage current to return to the nominal value.
- Make the exposure.

When the instrument senses that the exposure is over, it displays and holds the exposure measurements and then resets the electrometer (refer to Section 3.9.7 for information on configuring the start and stop thresholds). The exposure measurements are displayed until either the RESET/MEASURE button is held for one second, the bias voltage or threshold changed, or another exposure is started.

3.7.3 Making Timed Exposure Measurements

The timer is available when any of the measurement displays contains a timed measurement. Refer to Section 3.10 for information on customizing measurement displays.

Timer Setup

Procedure:

- Use the TEST FUNCTION button, along with the UP and DOWN arrows to display the Timer Setup screen.
- To modify the timer setup, press the TEST FUNCTION button to display the "▶" cursor at the timer interval field and use the UP and DOWN arrows to select a timer interval from the programmed list. (Refer to Section 3.10 for information on how to program the interval list.)
- Press the TEST FUNCTION button to advance the "▶" cursor to the timer count mode field and use the UP and DOWN arrow keys to select up (UP) or down (DOWN) for the count mode.
- Press the TEST FUNCTION button to advance the "▶" cursor to the timer decimal places field and use the UP and DOWN arrow keys to select zero (0) or one (1).
- Press the TEST FUNCTION button to hide the cursor and save any changes. Proceed to using the timer, which is discussed next.

Timer Use

Procedure:

- Press the RESET/MEASURE button to show the Measurement screen if it is not displayed.
- To start or manually stop the timer, press the RESET/MEASURE button while the instrument is updating other exposure measurements (e.g., charge and current). The instrument displays the "Tmr" annunciator when the timer is running.

NOTE

The instrument will not permit the timer to be started while leakage is being measured.

- Upon completion of the timer interval or if the instrument senses the exposure is over (applicable when automatic leakage compensation is enabled), the instrument ceases updating the timed measurements.

NOTE

Use the predicted timed charge or dose measurement to diagnose a problem at the onset of a timed measurement for sources that deliver at a constant exposure rate. If the predicted timed measurement is drastically different from the expected value, there is no reason to wait for the complete timer interval to expire before investigating the cause of the discrepancy.

NOTE

To differentiate the predicted and non-predicted timed measurements, the instrument alternates the display of time with a "PREDICT" indicator on the predicted timed measurement lines.

3.7.4 Using Other Ion Chambers

You may make measurements using electrical units of coulombs and amperes and manually calculate the radiological values from known ion chamber and air density factors. Or you may use the Customization software to add the new ion chamber's description and calibration factor to the list available for DETECTOR SELECT. See Section 3.10 for details.

3.8 Battery Care

To maximize both the life and the performance from the rechargeable battery, deep discharge should be avoided. The battery will maintain peak performance through out the life of the product if the following practices are adopted.

1. Store the instrument connected to the AC line power source if possible. This will maintain the batteries at their full charge level and insure that the instrument is ready to go anytime it is needed.
2. If the instrument cannot be connected to AC line power during storage, fully recharge the batteries at the beginning of the storage interval and store the instrument at 25°C or less if possible. For extended storage, fully recharge the batteries at least annually to compensate for their self-discharge characteristics. Decrease the time between maintenance recharges by one-half for each 10°C increase in the storage temperature above the 25°C baseline.
3. If possible, begin charging the batteries as soon as the "LoBat" annunciator appears and avoid setting the automatic power down interval to a value greater than 15 minutes so that the batteries will not become fully discharged if the instrument is left unattended.
4. Charge the batteries immediately if the instrument is allowed to operate to the 5.4 V automatic power down level. This will avoid self-discharge to levels below which an extended recovery period may be required.
5. If the instrument is used primarily from battery power, provide an extended charging period (24 hours or longer) for every 5 to 10 fast charge cycles.

The instrument will not operate when the battery voltage is below the 5.4 V automatic cutoff level. If the battery voltage level is allowed to drop below this level due to self-discharge, an extended charge period on the order of hours may be required to bring the voltage up to the 5.4 V level. During this period, the

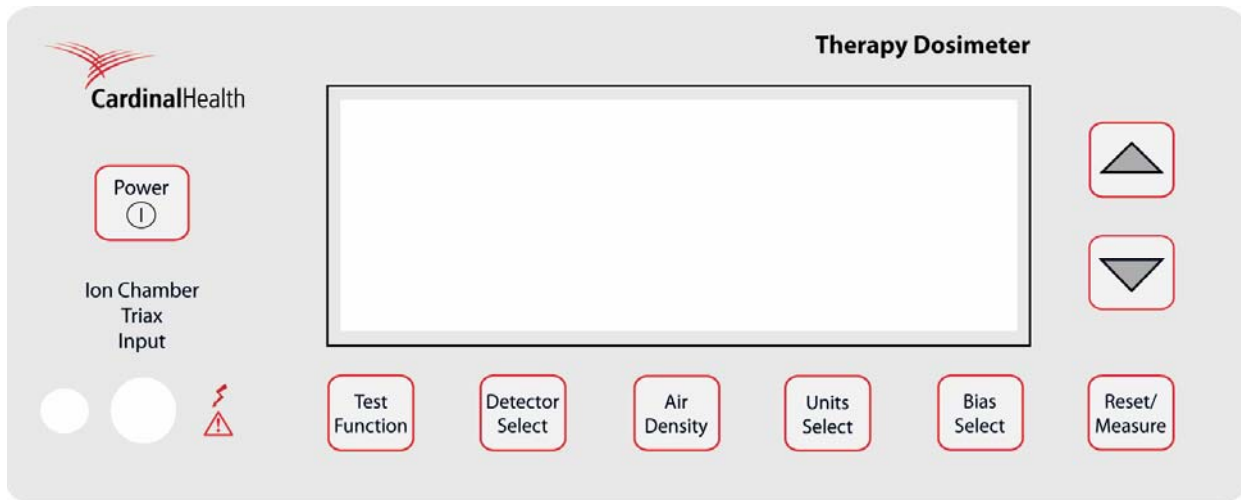
instrument will not be available for use. Depending upon the level of discharge, this period of unavailability may be on the order of days, and in extreme cases the battery will be permanently damaged.

3.9 Operation Instructions

This section contains detailed instructions on the front panel operation of the Model 35040 Therapy Dosimeter. Please note that the display examples shown here correspond to a particular customization set-up. Other customization set-ups will produce different results.

3.9.1 Front Panel Controls

Figure 3-5 shows the front panel of the Model 35040 Therapy Dosimeter. The front panel consists of a triax connector, control buttons and a display. The following paragraphs describe the operation of each



control button and the corresponding display screens.

Figure 3-5. The Model 35040 Therapy Dosimeter Front Panel

Power

The POWER button toggles the system power on and off.

Test Function

The TEST FUNCTION button displays the Test Function screens. It is also used in setting the start and stop exposure current thresholds.

- When the Test Function screen is not displayed, pressing the TEST FUNCTION button displays the Test Function screen and the information/settings that were last viewed since power-up.

NOTE

The TEST FUNCTION screen provides access to information and settings such as the firmware revision, charge and current scale factors, battery

and bias voltages, automatic leakage compensation settings, and timer settings.

- When the Test Function screen is displayed, pressing the TEST FUNCTION button displays a cursor that allows modification of the following settings:
 - Enabling or disabling automatic leakage compensation or setting of the start and stop exposure current thresholds
 - Selecting the timer interval, count mode, and decimal places
 - Specifying the effective exposure time presentation

Detector Select

The DETECTOR SELECT button displays the Detector Select screen.

Air Density

The AIR DENSITY button displays the Air Density screen. Subsequent presses advance the cursor through the temperature, pressure, and air density correction on/off fields.

Units Select

The UNITS SELECT button displays the Units Select screen for selecting the rate divisor.

Bias Select

The BIAS SELECT button displays the Bias Select screen.

Reset/Measure

- When the Measurement screen is not displayed, pressing the RESET/MEASURE button displays the Measurement screen and the Measurement display that was last viewed since power-up.
- When the Measurement screen is displayed:
 - And when the instrument is performing exposure measurements, pressing the RESET/MEASURE button toggles the timer
 - Pressing and holding the RESET/MEASURE button for one second zeroes all exposure measurements; the instrument also zeroes leakage measurements if leakage was being measured

Up (▲)

The function of the UP button depends on the screen displayed. It increases the temperature or pressure setting. It toggles the state of the air density correction annunciator. For the Test Function and Measurement screens, it displays the next information screen. It presents the next ion chamber for the Detector Select screens. It increases the dose rate unit's divisor. For setting the start and stop exposure current thresholds, it increases the setting.

Down (▼)

The function of the DOWN button depends on the screen displayed. It decreases the temperature or pressure setting. It toggles the state of the air density correction annunciator. For the Test Function and Measurement screens, it displays the previous screen. It presents the previous ion chamber for the Detector Select screen. It decreases the dose rate unit's divisor. For setting the start and stop exposure current thresholds, it decreases the setting.

3.9.2 Powering Up the Model 35040 Therapy Dosimeter

Pressing the POWER button turns on the instrument. Initially, the instrument runs self-tests, restores the ion chamber, temperature, pressure, air density correction status, exposure thresholds, and measurement units to their previous values, and waits for the bias supply to stabilize.

NOTE

When attempting to turn the instrument on, firmly press the POWER button and hold for approximately one second. Always allow several seconds between retries.

During this self-test period, the Model 35040 Therapy Dosimeter displays a sequence of screens. The first screen to appear after pressing the POWER button is the Pixel Test screen shown in Figure 3-6.

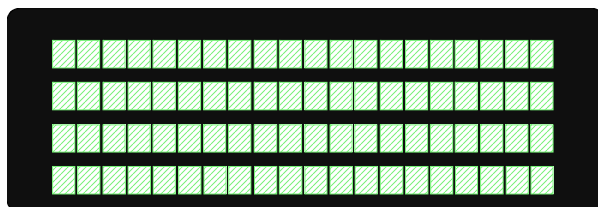


Figure 3-6. The Pixel Test Screen

The pixel test screen remains visible for two to ten seconds depending on the number of ion chamber calibration factors in the instrument. It will be followed by the Calibration Identification screen shown in Figure 3-11. After an additional two seconds, the display will change to the General Information Screen shown in Figure 3-7. After two more seconds, the display will advance to the Bias and Battery Voltage Test Screen shown in Figure 3-8. The bias voltage will take a few seconds to reach a stable value. When the bias voltage is stable, the instrument is ready for use. While measurements may be made immediately, the specified warm up time must elapse before specified accuracy is warranted.

3.9.3 Powering Down the Model 35040 Therapy Dosimeter

Pressing the POWER button turns the instrument off. As part of the power down sequence, the Model 35040 Therapy Dosimeter saves all of its front panel settings and is thus able to restore these settings during the next power up sequence.

3.9.4 Using the TEST FUNCTION Button

Press the TEST FUNCTION button to display the Test Function screens, see Figure 3-7 to 3-11. Use the UP and DOWN buttons to cycle through the Test Function screens. These screens contain information about the instrument's calibration, the calibration scale factors, firmware revision date, serial number, leakage current, bias and battery condition, and optional text lines.

The top line of the display, shown in Figure 3-7, has annunciators for air density correction applied (ADC), bias status (LoBias or HiBias), and battery status (LoBat). The firmware revision date, on the second line, indicates the revision level of the controlling program in the instrument. The two optional text lines can be customized using the Customization software.

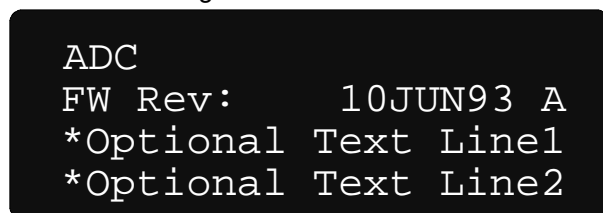


Figure 3-7. The Test Function Screen 1 - General Information

Figure 3-8 shows the ion chamber bias voltage (IC Bias), the system leakage current (Leakage), and the battery voltage and current. The bias voltage shown is 300.0 volts. The central electrode is positive (CEP). The leakage current is 0.001 picoamps. The battery current is a small positive number, thus the battery is charging and is almost fully charged.

```
ADC
Batt: 6.8 V +0.10 A
Leakage: 0.001 pA
IC Bias: 300.0 V CEP
```

Figure 3-8. The Test Function Screen 2 - Bias, Leakage, and Battery Voltage and Current

The battery current (shown in Figure 3-8), “+0.1 A”, is displayed to the right of the battery voltage, “6.8 V”. A positive current value of up to 2.5 amperes indicates that the battery is being charged from the AC line. As the battery approaches full charge, the current will decrease to near zero. A negative current value will be shown when the instrument is operated from battery power. A negative current indicates the actual current consumption of the instrument.

During a charging cycle, the battery voltage can range from 5.5 volts to 8.5 volts. After the battery reaches its full charge, the charging circuit switches to float charge stage with a corresponding voltage of approximately 7 volts. The unit will remain in the float charge stage as long as the instrument is attached to an AC line. When the instrument is operated from battery power, the voltage will read between 6.5 volts (battery fully charged) and 5.4 volts (low battery shutdown voltage).

The two scale factors that appear in Figure 3-9 are those determined by a calibration agency. QScaleFactor adjusts the charge. IScaleFactor adjusts the current. See Section 2.3 for details.

```
ADC
QScaleFactor=1.0000
IScaleFactor=1.0000
```

Figure 3-9. The Test Function Screen 3 - Calibration Scale Factors

Figure 3-10 shows the present settings for the start and stop threshold currents and the instantaneous current measurement. See Section 3.9.5 for details.

```
ADC
Start Thres: 1.0pA
Stop Thres: 0.9pA
Current: 0.0pA
```

Figure 3-10. The Test Function Screen 4 - Leakage Threshold Screen

Figure 3-11 shows the automatic leakage compensation settings, which consist of the ALC status, start and stop threshold currents, and the instantaneous current measurement. Refer to Section 3.9.5 for details.

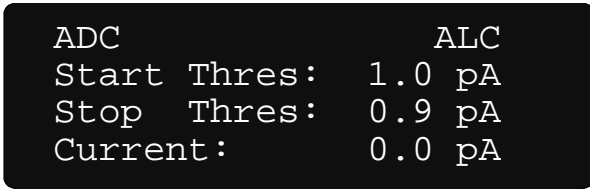


Figure 3-11. The Test Function Screen Showing the Automatic Leakage Compensation Settings

Figure 3-12 displays the settings for the timer interval, count mode, and decimal places. Refer to Section 3.9.6 for details.

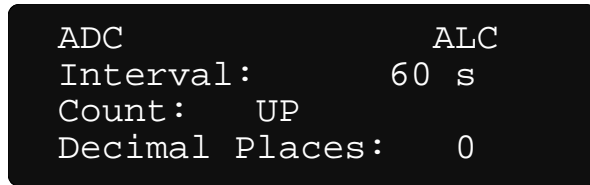


Figure 3-12. The Test Function Screen Showing the Timer Settings

Figure 3-13 shows the display format setting for the effective exposure time, which determines the presentation of the effective time on the Measurement screen.



Figure 3-13. The Test Function Screen Showing the Effective Exposure Time Display Setting

To change the effective time format setting, press the TEST FUNCTION button to show the "►" cursor and use the UP and DOWN arrow buttons to select either seconds (SECONDS) or hours/minutes/seconds (HR/MIN/SEC). Press the TEST FUNCTION button again to hide the cursor and save the selection.

3.9.5 Automatic Leakage Compensation

Automatic compensation for leakage currents can be enabled and disabled from the front panel. Automatic leakage compensation allows the instrument to “detect” when an exposure is in progress and hold the final exposure measurement values between exposures.

The start threshold specifies the current necessary for the instrument to begin updating the exposure measurements. The stop threshold must be smaller than the start threshold, and it indicates the minimum current required for the exposure measurements to be updated once an exposure is detected. That is, the instrument will cease updating the exposure measurements when the current drops below the stop threshold and will return to measuring leakage.

NOTE

The instrument uses the start and stop threshold settings to sense when an exposure is in progress.

With the automatic leakage compensation settings displayed (Figure 3-14), press the TEST FUNCTION button. The "▶" cursor will appear to the left of the ALC annunciator. Use the UP and DOWN arrow buttons to toggle the setting between on (ALC) and off (OFF).

With automatic leakage compensation enabled, press the TEST FUNCTION button to advance the "▶" cursor to the next field or exit Edit mode. When the cursor points to a threshold setting, use the UP and DOWN arrow buttons to increment and decrement the value, respectively. Nominal values for the start and stop thresholds are 1.3 and 1.2 pA, respectively. However, depending on the system leakage, other values may be necessary.

When automatic leakage compensation is disabled, the annunciator displays off (OFF) (Figure 3-15), the start and stop threshold settings cannot be changed and display Not Available (NA), as do the leakage measurements.

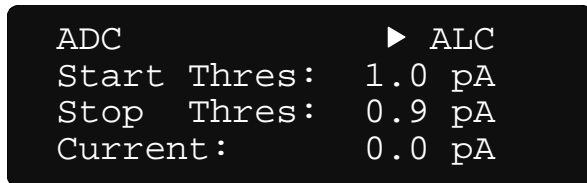


Figure 3-14. Automatic Leakage Compensation Enabled

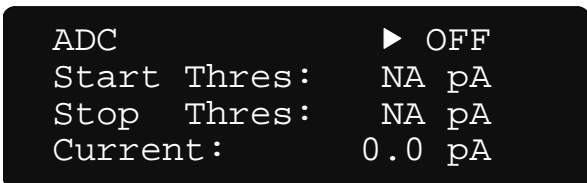


Figure 3-15. Automatic Leakage Compensation Disabled

NOTE

The instrument may reset all measurements when the automatic leakage compensation parameters are changed.

NOTE

Disabling automatic leakage compensation prevents automatic exposure detection and the measurement of leakage current, and leakage measurements will display Not Available (NA).

Figure 3-16 shows the name of the calibration agency and the date the instrument was calibrated. The bottom three lines may be different on your instrument depending on what the calibration agency puts here.

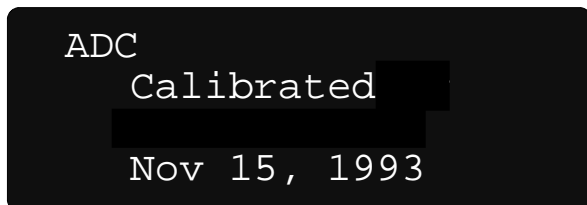


Figure 3-16. The Test Function Screen 5 - Calibration Identification

3.9.6 Timer Setup

The Test Function screen provides for configuring the timer interval, count mode, and decimal places (see Figure 3-17).

With the timer settings displayed, press the TEST FUNCTION button. The "▶" cursor will appear to the left of the timer interval setting. Use the UP and DOWN arrow buttons to select a value from the user customizable list. Refer to Section 3-10 for details on programming the timer intervals.



Figure 3-17. The Test Function Screen Showing the Timer Settings

Press the TEST FUNCTION button to advance the "▶" cursor to the timer count mode field. Use the UP and DOWN arrow buttons to toggle the setting between up (UP) and down (DOWN). For the up count mode, the timer starts at zero (0) seconds and increments up to the timer interval setting. The down count mode displays time starting from the timer interval setting and decrements to zero (0) seconds.

Press the TEST FUNCTION button to advance the "▶" cursor to the timer decimal places setting. Use the UP and DOWN arrow buttons to toggle the setting between zero (0) and one (1). Zero decimal places displays time in whole seconds, while one decimal place displays time to a tenths of a second.

NOTE

Presently, the timer counts only in whole seconds.

3.9.7 Setting Thresholds

The automatic exposure detection start and stop threshold currents can be set from the front panel. When the thresholds screen is displayed (Figure 3-10), press the TEST FUNCTION button. The "▶" cursor will appear to the left of the start threshold. Use the UP and DOWN arrow buttons to change the setting. Press the TEST FUNCTION button to move the "▶" cursor to the stop threshold setting. Use the UP and DOWN arrow buttons to change the setting. Press the TEST FUNCTION button a third time to return to viewing the rest of the test screens. It is recommended that the start threshold be set to 1.3 pA and the stop threshold be set to 1.2 pA. Depending on the system leakage, other settings may be necessary. See Section 2.3.1 for more details.

NOTE

Changing the thresholds automatically zeroes all measurements.

NOTE

Setting the thresholds to 0.0 pA disables the automatic exposure detection. This setting prevents the measurement of leakage current. "Leakage NA pA" on the display indicates the leakage measurement is not available.

3.9.8 Using the DETECTOR SELECT Button

Pressing the DETECTOR SELECT button displays the Detector Select screen, see Figure 3-18. This screen displays information about the selected ion chamber calibration factor. An ion chamber consists of two text lines and an ion chamber calibration factor (ICCF) with units. All ion chambers are entered and can be modified via the Customization Software.

The “▶” cursor points to the first description string of the selected chamber. Use the UP arrow to select the next ion chamber and the DOWN arrow to select the previous ion chamber.

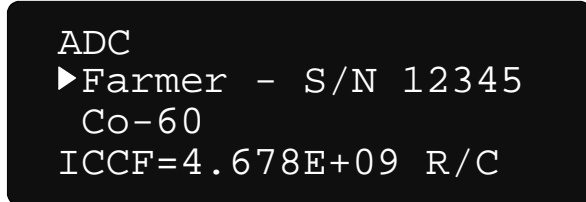


Figure 3-18. The Detector Select Screen

The ion chamber calibration unit (R/C shown here) includes the radiological measurement unit (R). This is the radiological unit that appears on the Measurement screens.

NOTE

The ion chamber’s calibration unit includes the radiological measurement unit.

If you want radiological units that are not available, use the Customization software (see Section 3.10) to enter a new ICCF with the appropriate units.

The descriptive text should contain enough information to let the operator correctly select an ICCF that is appropriate for the measurement desired, e.g. energy, modality, build up, etc.

3.9.9 Using the AIR DENSITY Button

Pressing the AIR DENSITY button displays the Air Density screen, see Figures 3-19 and 3-20. This screen contains the temperature value, pressure value, and Air Density Correction Factor (ADCF). Press the AIR DENSITY button to advance the “▶” cursor to the next field. To change the value or state of an item at the “▶” cursor, use the UP and DOWN arrows. The Model 35040 Therapy Dosimeter displays the Air Density Correction (ADC) annunciator in the upper left-hand corner of all screens if the air density correction is enabled, see Figure 3-19.

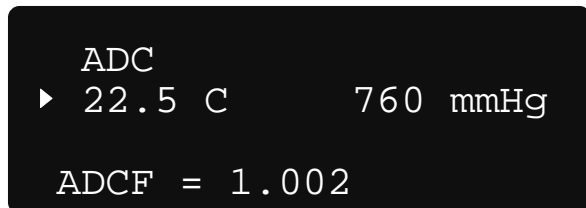


Figure 3-19. The Air Density Screen With Air Density Corrections Enabled

To disable the air density correction, advance the “▶” cursor to the ADC annunciator at the upper left of the display. With the “▶” cursor at this position, pressing the UP and DOWN keys will toggle the air density correction on (ADC) and off (OFF).

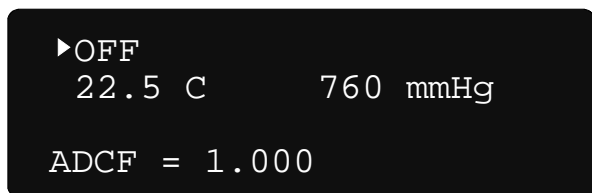


Figure 3-20. The Air Density Screen With Air Density Corrections Disabled

Air density correction is only applied to dose or dose rate measurements such as, Roentgens, rads, Grays, Sieverts, etc. These measures are dependent on correctly compensating for the mass of air in the ion chamber. Electrical units (coulombs and amperes) are, by definition, insensitive to the mass of air in the ion chamber.

3.9.10 Using the UNITS SELECT Button

Pressing the UNITS SELECT button displays the Units Select screen, see Figure 3-21. The radiological units shown on the Units Select screen appear on the Measurement screens when displaying dose, dose rate, accumulated dose, and average dose rate. This screen allows the radiological rate divisor (hr, min, s) to be specified. The “▶” cursor points to the radiological rate measurement unit. Press the UP arrow to increase the rate divisor, and press the DOWN arrow to decrease the rate divisor.

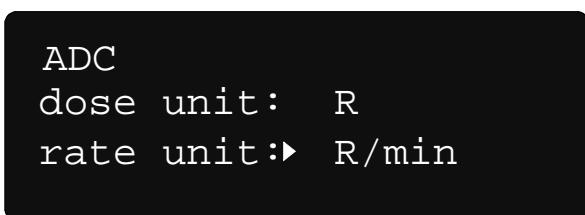


Figure 3-21. The Units Select Screen for an Ion Chamber Calibrated for Dose Measurements

Ion chambers having dose rate calibration units will not have a rate divisor, e.g. Curies (Ci), becquerles (Bq), or kerma (Sk). The dose rate units will be multiplied by seconds to produce an equivalent dose unit, see Figure 3-22.

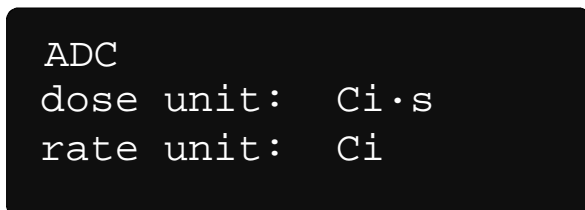


Figure 3-22. The Units Select Screen for an Ion Chamber Calibrated for Dose Rate Measurements

3.9.11 Using the BIAS SELECT Button

Pressing the BIAS SELECT button displays the Bias Select screen, see Figures 3-23 through 3-24. This screen displays the bias setting and the bias voltage measured by the Model 35040 Therapy Dosimeter. The “▶” cursor points to the bias setting, expressed both as a voltage and as a percent of the maximum voltage setting. The line below the bias setting indicates the bias polarity. The bottom line displays the bias voltage measured by the instrument, and three letters to signify the bias polarity. When the central electrode is positive, CEP is displayed to the right of the measured voltage. When the central electrode is negative, CEN is displayed to the right of the measured voltage. **(NOTE:** The bias settings are user customizable; see Section 3-10.)

```
ADC
Set: ▶ 300.0 V 100%
Central Electrde Pos
IC Bias: 300.0 V CEP
```

Figure 3-23. The Bias Select Screen With the Bias Set to a Positive Voltage

```
ADC
Set: ▶ 0.0 V 0%
      Bias Off
IC Bias: 0.0 V OFF
```

Figure 3-24. The Bias Select Screen With the Bias Turned Off

```
ADC
Set: ▶ -150.0 V -50%
Central Electrde Neg
IC Bias: -150.0 V CEN
```

Figure 3-25. The Bias Select Screen With the Bias Set to a Negative Voltage

In the example of Figures 3-23 to 3-25, the maximum voltage setting is 300.0 V. Thus, 300.0 V is 100% of 300.0 V and -150.0 V is -50% of 300.0 V.

Use the UP and DOWN buttons to scroll through the customized bias settings. When the bias setting is selected, wait for the bias voltage to match the selection before pressing the RESET/MEASURE button. The top line of the display will read "WAIT Bias Not Ready" until the measured voltage matches the selection. If the RESET/MEASURE button is pressed while the bias voltage is changing, the bias may be set to the wrong voltage. While the bias voltage is changing, a current is produced that may cause an "Internal Reset Error", see Section 3.9.12.

NOTE

Changing the bias setting automatically zeroes all measurement readings.

WARNING

To prevent an electrical shock, the Model 35040 Therapy Dosimeter bias should always be set to 0 volts or the instrument turned off when connecting or disconnecting an ion chamber or triaxial cable.

3.9.12 Using the RESET/MEASURE Button

The RESET/MEASURE button has dual functionality. If no Measurement screen is displayed, pressing the RESET / MEASURE button displays one. When a Measurement Screen is displayed, pressing the RESET/MEASURE button zeroes all measurement readings and causes the Model 35040 Therapy Dosimeter to restart the measurement process.

Press the UP arrow to display the next Measurement screen. Press the DOWN arrow to display the previous Measurement screen. The Measurement screens are user customizable via the Customization software (see Section 3-10).

The Model 35040 Therapy Dosimeter is always collecting charge from the ion chamber, even when a Measurement screen is not displayed.

The operator may view the Detector Select screen, the Air Density screen, the Test Function screen, or the Units Select screen, make changes, and return to the Measurement screen to see the results. Changing the bias voltage, the start threshold, or the stop threshold, automatically zeros all measurement readings.

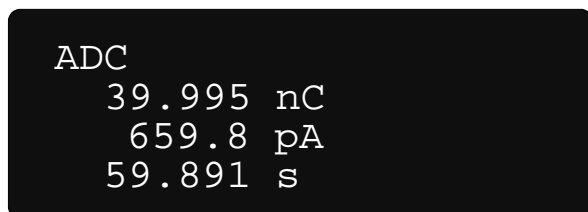


Figure 3-26. The Measurement Screen

NOTE

Press RESET/MEASURE from the Measurement screen to restart the leakage measurement process after moving the triax cable connected to the Model 35040 Therapy Dosimeter.

The measurements have different visual cues to assist the operator in understanding the measurement. If the instrument is trying to acquire enough data to make a measurement, the display area will be filled with dashes. If the measurement is being actively updated, the decimal point will flash. When there was inadequate time to get enough data for leakage compensation, a question mark is displayed to the left of the measurement. If the measurement cannot be made due to the selected settings, the measurement is replaced by “NA.” If the measurement has too much variation to be reliable, “INVALID” is substituted.

3.9.13 Overranging Conditions

The Model 35040 Therapy Dosimeter displays an overrange indicator (“OVER”) when the electrometer’s maximum limit has been exceeded (see Figure 3-27).

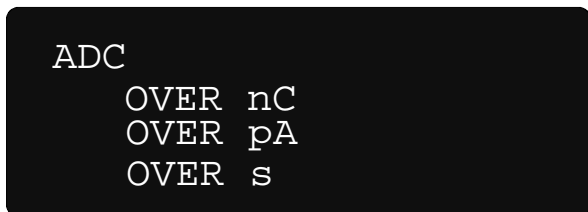


Figure 3-27. The Measurement Screen With the Charge and Current Limits Exceeded Within the First 60 Seconds

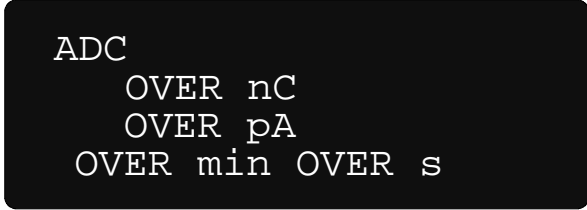


Figure 3-28. The Measurement Screen With the Charge and Current Limits Exceeded After the First 60 Seconds

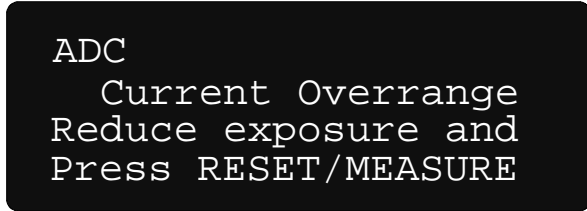


Figure 3-29. The Measurement Overage Screen

Table 3-1 specifies the conditions that cause the Model 35040 Therapy Dosimeter to display the overrange indicator for a measurement.

Table 3-1. Overage Conditions

Condition	Values Overage
charge > 2.4 μ C	charge, accumulated charge, dose, accumulated dose, average current, average dose rate, effective exposure time
accumulated charge > 1.0000 C	accumulated charge, accumulated dose
current > 100.0 nA	all except leakage
time > 59 min 59 s	effective exposure time

3.9.14 Reset Error

Pressing the RESET /MEASURE button while on the Measurement Screen causes the Model 35040 Therapy Dosimeter to reset the electrometer, zero all readings, and restart the measurement process. If an exposure starts during the reset operation, the instrument displays the reset error message (see Figure 3-30).

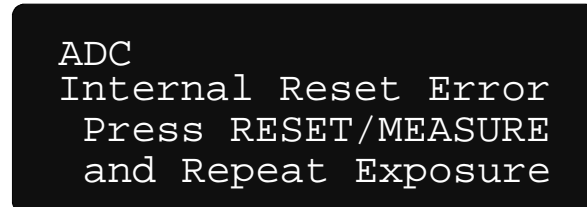


Figure 3-30. The Measurement Screen Showing a Reset Error

To remove the error condition, end the exposure, and press the RESET/MEASURE button. Wait a few seconds and repeat the exposure.

A reset error will not occur for ion chambers calibrated in dose rate units (i.e. Brachytherapy chambers) since the measurement is primarily concerned with amps or dose rate.

3.9.15 Reset Error (With Automatic Leakage Compensation Enabled)

The following discussion is only applicable when automatic leakage compensation is enabled and the ion chamber is calibrated in Coulombs.

Holding the RESET/MEASURE button while on the Measurement screen causes the Model 35040 Therapy Dosimeter to reset the electrometer, zero all readings, and restart the measurement process. When an exposure is detected immediately following the reset that was not present prior to the reset, the instrument displays the reset error message shown in Figure 3-31.



Figure 3-31. The Measurement screen showing the Reset Error message

To remove the error message, end the exposure and hold the RESET/MEASURE button. Wait a few seconds for the instrument to complete the reset and repeat the exposure.

3.9.16 Annunciators

The top line of the display is dedicated to status annunciators. The Model 35040 Therapy Dosimeter continuously monitors the ion chamber bias and battery voltages. If either one of these values is outside the specified range, the Model 35040 displays an annunciator to indicate the error. Table 3-2 specifies these annunciators and specifies the annunciators that may appear on the top line of the display.

Table 3-2. Annunciators

Annunciator	Condition
??Bias	No bias measurement possible since the electrometer is not ready
ADC	Air density correction in use (only applicable to radiological measurements)
ALC	Automatic leakage compensation enabled
LoBat	Low Battery voltage
LoBias	Low Bias voltage
HiBias	High Bias voltage
OvAmps	Overranged current
Rst	Resetting electrometer
Tmr	Timer in use
WAIT Bias Not Ready	The dosimeter is setting the bias
WAIT System Not Rdy	The dosimeter is resetting the electrometer (only applicable when automatic leakage compensation is enabled)

Figure 3-32 illustrates the locations of some annunciators. The battery, bias, and overranged current annunciators appear at the same location, and the instrument alternates the displaying of each annunciator when more than one is applicable.

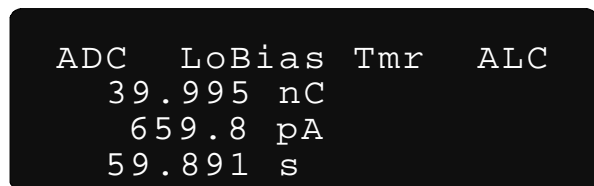


Figure 3-32. Annunciator positions

Table 3-2 lists the indicators the instrument uses to signal that a measurement quantity has not been compensated for leakage or is not available due to the specified condition.

Table 3-2. Measurement Indicators and Conditions

Indicator	Measurement	Condition
? (left of value)	All Non-leakage ¹	Automatic leakage compensation is enabled, but the exposure started before a leakage measurement was available.
-.---	Leakage	Automatic leakage compensation is enabled, but the exposure started before a leakage measurement was available.
INVALID	Effective Time	The calculated effective time is longer than the actual exposure. This condition occurs when a large amount of charge is injected at the beginning of the exposure.
NA	Leakage	The leakage measurement is not available since automatic leakage compensation is disabled.
OVER	Non-leakage ¹	The quantity or one of its dependents has exceeded the maximum value. Refer to Table 3-3 for more information.

¹ All non-leakage measurements (e.g., charge, current, dose, rate, effective time, etc.)

Table 3-3 specifies the conditions that cause the Model 35040 Therapy Dosimeter to display an overrange indicator (OVER) for a measurement quantity.

Table 3-3. Overage Conditions

Condition	OVERRANGED MEASUREMENT ¹
charge > 19.999 mC	<ul style="list-style-type: none"> • charge • average current • accumulated charge • effective exposure time
accumulated charge > 1.0000 C	<ul style="list-style-type: none"> • accumulated charge
current > 1.000 μ A	<ul style="list-style-type: none"> • current
current > 1.200 μ A	<ul style="list-style-type: none"> • all non-leakage
time > 19,999.9 s	<ul style="list-style-type: none"> • effective exposure time

¹ Includes radiological measurements derived from electrical measurements.

3.10 Customization

3.10.1 Introduction

The Model 35040 Therapy Dosimeter is shipped with valid settings allowing you to make measurements immediately. Should the need arise to change or modify any of the items described below, the Customization software provides for customizing the Model 35040 Therapy Dosimeter to meet your needs.

The basic features of the Customization software are its ease of use, on-screen help text, printer support, and full customization capability for the Model 35040 Therapy Dosimeter.

The screens shown in this section represent the appearance of the Customization software running Microsoft® Windows® 95/98 or later.

The Customization software has the following requirements:

- IBM Personal Computer or compatible
- EGA or VGA display
- CD drive
- Microsoft® Windows® 95/98 or later
- One serial port (COM1 thru COM4)
- One printer - recommended for printing out 35040 Customization reports

3.10.2 Installing/Uninstalling Customization Software

To install the 35040 Customization Software, insert the CD into your CD drive. The installation should automatically start. If it does not, run setup.exe to start the installation. Administrator rights are required to install the 35040 Customization Software on a Windows NT, Windows 2000 and Windows XP.

To remove the 35040 Customization Software from your hard disk, double click on "Add/Remove Programs" in the Control Panel. On the "Install/Uninstall" tab, select "35040 Customization" in the list of programs and click the "Add/Remove..." button. You will have to manually delete any "Dosimeter Settings" text files (*.TXT) that you saved while using the Customization Software.

Refer to "Readme.txt" on the CD for the most current information on the 35040 Customization Software.

3.10.3 Connection to the Computer

To prepare the Model 35040 Therapy Dosimeter for customizing, insert the RS-232 cable into the instrument. Connect the other end of the RS-232 cable to the computer serial port. Personal computers have serial ports that are either 9 or 25-pin. Determine which you have and use the appropriate adapter included with your Model 35040 Therapy Dosimeter. Use COM1 if it is available, otherwise use COM2, COM3, or COM4. Turn on the Model 35040. Wait approximately five seconds and then start the Customization software as described in Section 3.10.4.

3.10.4 Starting the Customization Software

Start the Customization software by selecting:

START | PROGRAMS | 35040 CUSTOMIZATION | 35040 CUSTOMIZATION

Refer to Fig. 3.10.33. The first time that the 35040 Customization Software is started, communication with the Dosimeter will be tried over COM1. If COM1 is not available, an error message will be displayed and the COM PORT indicator will turn red. If this is the case, use the COM PORT drop down list to select the correct serial port. Subsequent startups will automatically connect to the serial port that you have selected. If the customization forms have not been filled in with Dosimeter settings after starting the

35040 Customization Software, verify that COM PORT indicator is green, and click on the UPLOAD button.

We recommend that you print a copy of the customization report (Print) as your first step in the customization process. This report contains all of the customization values and thus serves as a guide for returning to the original settings should an operator keyboard error occur during the process. Additionally, print a copy of the customization report as the final step in the customization process. Use this final report to verify the new customization parameter values, and then save it in a safe place for future reference. Reports can also be generated and saved as text files. Refer to Section 3.10.7, FILE | SAVE AS and FILE | PRINT.

3.10.5 Downloading

The Customization software sends (downloads) information through the RS-232 link to the Model 35040 Therapy Dosimeter. This action happens automatically after you confirm the changes that you make to any parameter. After downloading, the instrument sends back the information it received. The Customization software compares the reply to what it sent down in order to verify that the screen display and instrument contents are the same. In some cases, the downloading process may last several seconds.

3.10.6 Menu Items and Controls

Refer to Figure 3-33 for the Menu Items and Controls that are at the top of each Customization form. The operation of the controls is the same for all forms.

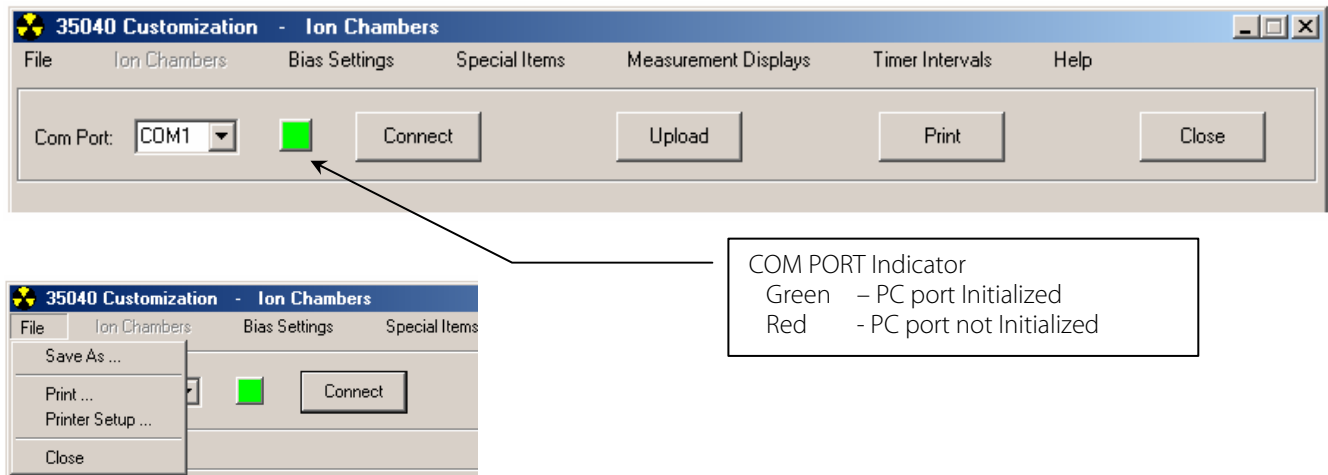


Figure 3-33. Menu Items and Controls

Ion Chambers, Bias Settings, Special Items, Measurement Displays, or Timer Intervals

Selection of one of these five (5) menu items will bring up different forms for customizing the 35040 Dosimeter's settings. Refer to the appropriate section below for a detailed description of each of the forms and programming the Dosimeter's settings.

COM PORT Drop Down List

Use the COM PORT drop down list to select the computer's serial port used to communicate with the 35040 Dosimeter. To select a different serial port, click on the DOWN arrow key and select another port from the drop down list by clicking on it. After the selection has been made, the serial port will be initialized. If initialization is successful, the indicator to the right of the Com Port selection will turn GREEN. If not, an error message will be displayed and the indicator will turn RED.

CONNECT

Select CONNECT to force an initialization the computer's serial port for use with the 35040 Customization Software. Normally initialization is done automatically at the start of the 35040 Customization Software or by selecting the serial port from the Com Port drop down list.

UPLOAD

Select UPLOAD to request the Dosimeter to send a listing of all the Customization Settings. When depressed, all Customization forms are cleared and the Dosimeter's latest settings are written to the forms.

PRINT

Select PRINT to create a printed report of the customization items. The report will contain the current state of all customization items within the Model 35040 Therapy Dosimeter. The report includes:

- All Ion Chambers including Title, Description, Calibration Factor, and Calibration Units
- All Special Items (Power Down Interval, Temperature and Pressure Units, Calibration Temperature, and Optional Text Lines)
- All Measurement Displays printed as they would appear on the instrument's front panel
- The Calibration Factors and Calibration Identification
- All the Bias Settings

CLOSE or FILE | CLOSE

Select CLOSE to terminate the Customization program. The program verifies the choice of Close before terminating the program. Select "Yes" to exit; select "No" to return to the Customization program.

FILE | SAVE AS and FILE | PRINT

Select FILE | SAVE AS to generate a customization report and save it as a text file on the computer. A standard Windows dialog box will be shown for naming the text file. Use FILE | PRINT to select a customization report and then print it.

FILE | PRINT SETUP

Select FILE | PRINT SETUP to select a printer for printing the customization reports.

3.10.7 Ion Chambers

Figure 3-34 shows the Ion Chambers form. This form contains a List Box listing all of the ion chambers available in the Model 35040 Therapy Dosimeter and a Parameter Display (titled Ion Chamber Parameters) that displays the parameters for the selected ion chamber. At the bottom, there are four buttons labeled APPEND, INSERT, DELETE, and STORE. Finally, a brief explanation of the controls on the Ion Chamber's form appears at the lower right. Use the vertical scroll bar to view the complete description of the controls.

Within this form you may edit or remove any ion chamber in the instrument's list. Also, you may add or insert an ion chamber into the list.

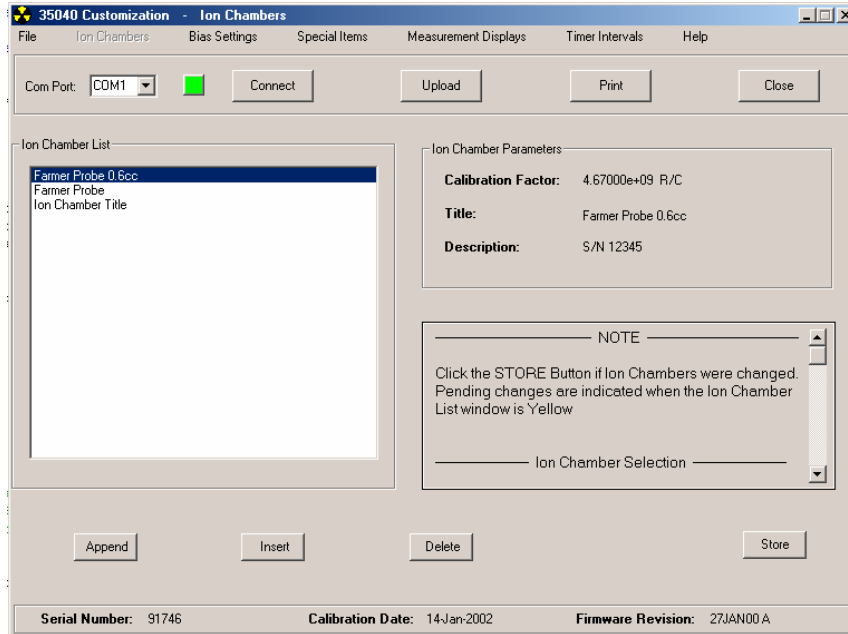


Figure 3-34. The Ion Chambers Form

EDIT

To modify existing ion chamber parameters, click twice with the mouse on a title within the Ion Chamber List Box. A form titled “Program Ion Chamber” appears with the parameters of the selected Ion Chamber and two buttons: OK and CANCEL. Refer to Figure 3-35. The following description of the Parameter Editor may be followed when editing, appending, or inserting ion chamber parameters.

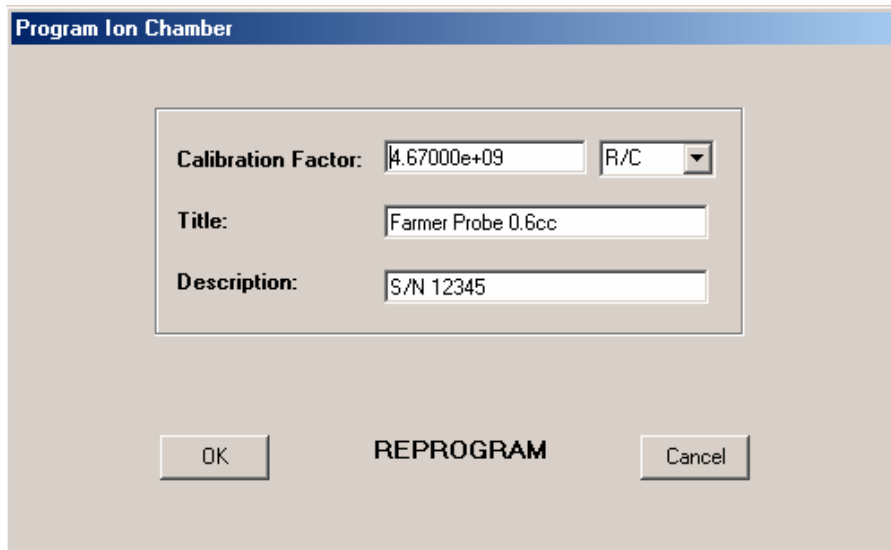


Figure 3-35. The Program Ion Chamber Form

To modify the Title, Description, or Calibration Factor, click on the desired text box and type in the new text from the keyboard. To select different Calibration Units, click on the DOWN arrow key and select another item from the drop down list by clicking on it.

OK and CANCEL

When you complete your editing of ion chamber parameters, you may use OK or CANCEL to exit the Parameter Editor. If you select CANCEL, all modifications are discarded and the original parameter settings of the ion chamber remain. If you select OK, the ion chamber parameters (modified or not) are sent to the instrument where they are stored for use during measurement modes.

NOTE

When Ion Chambers are edited, deleted, inserted, or appended the List box background color will change from 'white' to 'yellow' indicating that the Dosimeter's settings have been modified. Permanent storage in the Dosimeter's memory is made only after depressing the STORE button or by selecting one of the following menu items: BIAS SETTINGS, SPECIAL ITEMS, MEASUREMENT DISPLAYS, or TIMER INTERVALS. Storage in memory may take up to 70 seconds.

APPEND

If you want to add an ion chamber to the end of the list of ion chambers, click on APPEND. The Program Ion Chamber Form appears with the default text and values. Change the text and values to match those of the ion chamber you are adding. Select OK to send the new ion chamber to the Model 35040 Therapy Dosimeter; select CANCEL to discard the ion chamber and stop the append operation.

DELETE

If you want to delete an ion chamber, select it from the List Box. When you click on DELETE, you are asked to confirm the deletion. Select YES to delete the ion chamber; select NO to stop the delete operation.

INSERT

If you want to insert an ion chamber, select a position in the List Box ahead of which to insert a new ion chamber. Click on INSERT. The Program Ion Chamber Form appears with the default text and values. Change the text and values to match those of the ion chamber you are adding. Select OK to send the new ion chamber to the Model 35040 Therapy Dosimeter; select CANCEL to discard the ion chamber and stop the insert operation.

STORE

Click on STORE so that changes made to the instrument's ion chamber list are stored permanently. This process may last 70 seconds.

NOTE

If changes were made to the ion chamber list and not stored permanently with the STORE button, they are permanently stored when another customization form is selected.

3.10.8 Special Items

Figure 3-36 shows the Special Items Form. This form contains the Power Down Interval, Temperature and Pressure Units, Calibration Temperature, and two Optional Text lines. At the bottom, there are two buttons labeled DOWNLOAD and CANCEL. At the right, a brief explanation of the focused item appears.

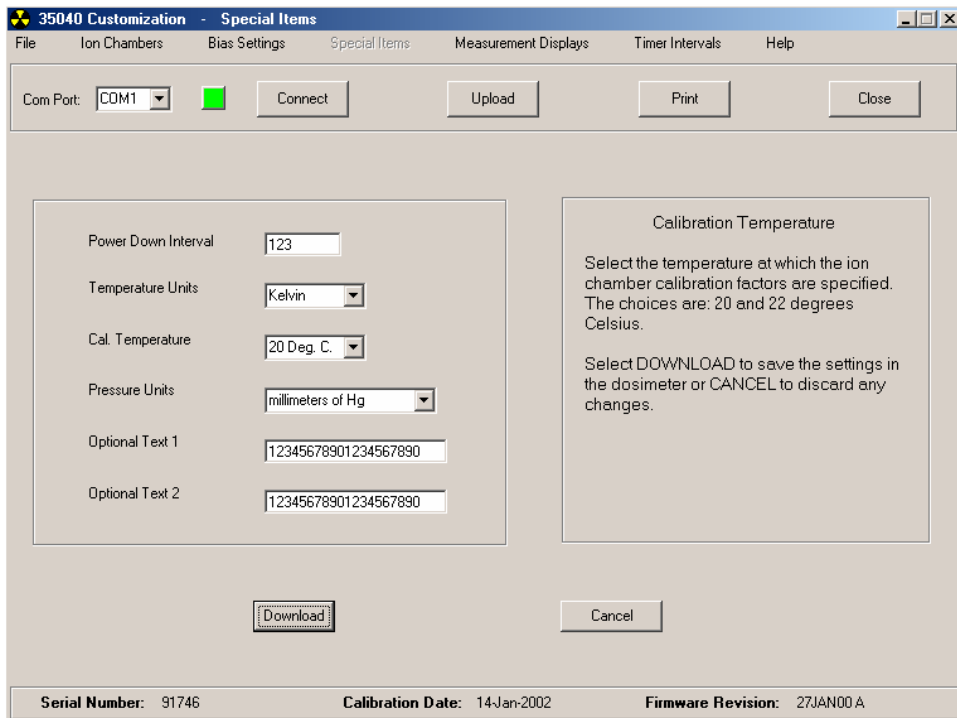


Figure 3-36. The Special Items Menu (Calibration Temperature has focus)

To modify the Power Down Interval or Optional Text, click on the desired text box and type in the new text from the keyboard.

To select the Calibration Temperature, or different Temperature or Pressure Units, click on the DOWN arrow key and select another item from the drop down list by clicking on it.

NOTE

When a Special Item has been edited or changed, its text box background color will change from 'white' to 'yellow'. Permanent storage in the Dosimeter's memory is made only after depressing the DOWNLOAD button.

DOWNLOAD and CANCEL

When you complete your editing of the Special Items, you may select DOWNLOAD or CANCEL. If you select CANCEL, all modifications are discarded and the original settings of the Special Items return. If you select DOWNLOAD, the Special Items (if modified) are sent to the instrument where they are stored and used.

3.10.9 Measurement Displays

The Model 35040 Therapy Dosimeter can contain up to sixteen (16) measurement displays, which are viewed from the Measurement Displays Form. With this form you may customize the appearance of any of the measurement displays. All screens must show an Annunciators Status Line (see Section 3.9.13) on the first line of the display. You may choose what appears on the other three lines. Figure 3-37 shows the Measurement Displays Form.

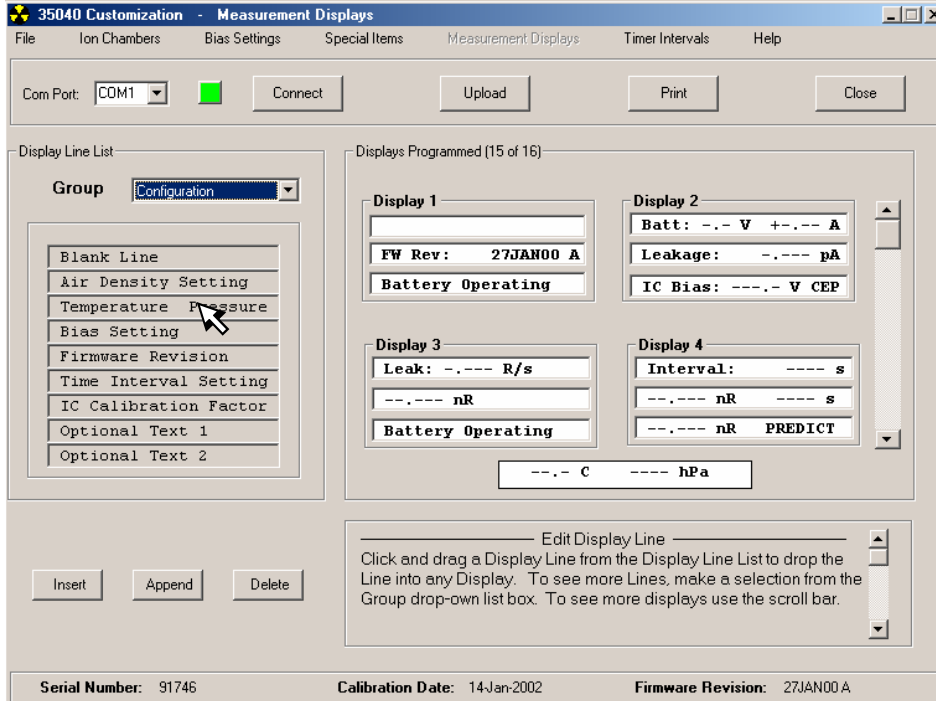


Figure 3-37. The Measurement Displays Form (right click the mouse on an item in the Display Line List to show the format of the Display Line)

The display lines are grouped according to their function. The four groups are [Configuration] [Amps, Coulombs, Volts] [Dose, Rate] and [Time]. Table 3-4 provides a listing of all the display lines available for each group, along with a representation of the display line's appearance on a measurement display.

Right click mouse on the Title of a Display Line (in the Display Line List) to view the format or Appearance of the Measurement Display. Refer to Figure 3-37.

Table 3-4. Available Display Lines

Group	Display Line	
	Title	Appearance (on a Measurement Display)
Configuration	Blank Line	
	Air Density Setting	ADCF = -.-
	Temperature Pressure	--. C ---- hPa
	Bias Setting	Set: >+----. V +----%
	Firmware Revision	FW Rev: 15OCT92 A
	Time Interval Setting	Interval: ---- s
	IC Calibration Factor	ICCF=1.234E+08 R/C
	Optional Text 1	Optional Text Line 1
	Optional Text 2	Optional Text Line 2
Amps, Coulombs, Volts	Battery Voltage	Batt: -. V +.-.A
	Leakage Current	Leakage: -.--- pA
	Bias Voltage	IC Bias: ---. V CEP
	Charge	--.--- nC
	Current	---. pA
	Accumulated Charge	--.--- nC ACCUM
	Average Current	---. pA AVG
	Timed Charge	--.--- nC ---- s
	Predicted Timed Charge	--.--- nC PREDICT
Dose, Rate	Leakage Rate	Leak: -.--- R/s
	Dose	--.--- nR
	Rate	---. pR/s
	Accumulated Dose	--.--- nR ACCUM
	Average Rate	---. pR/min AVG
	Timed Dose	--.--- nR ---- s
	Predicted Timed Dose	--.--- nR PREDICT
Time	Time Interval Setting	Interval: ---- s
	Timed Charge	--.--- nC ---- s
	Predicted Time Chrg	--.--- nC PREDICT
	Timed Dose	--.--- nR ---- s
	Predicted Timed Dose	--.--- nR PREDICT
	Effective Exp. Time	--. s

Display Line Group Selection

Click on the Group's DOWN arrow key and select another group from the drop down list by clicking on it. Each group on the drop down list will bring up a different Display Line List. Refer to Table 3-4.

Selecting an Item and Placing It

Use the mouse to move an item from the Display Line List to a Display. With the mouse, place the mouse cursor on the item. Press and hold the left key down. The item is now "grabbed" as indicated by the rectangle shown around the display line. Drag the item using the mouse. When you have moved it to display line you want, drop it by releasing the mouse button.

Changing a Line on a Display

To change a line on a Display, use the select and move operations described above to place an item on a Display.

When an item replaces a line on a Display, the Customization software immediately sends the information to the Model 35040 Therapy Dosimeter. In this manner, the Customization software always reflects the current appearance of the Displays. Any line on any display may be changed as often as required.

Using the APPEND, DELETE, and INSERT Buttons

Within the Measurement Displays Form you may remove any Display in the instrument. Also, you may add or insert a Display in the instrument. During these operations, different Displays will appear. A maximum of four (4) displays can be viewed at any time. To see other Displays, use the vertical scroll bar in the Display Frame to scroll up and down the Display list.

APPEND

If you want to add a Display to the end of the Displays, click on APPEND button. The Displays area of the dialog box shows the new Display. You may customize the lines as described above. Append adds one Display only.

NOTE

Upon selecting Append, the Customization software tells the Model 35040 Therapy Dosimeter to append a display with, initially, two Blank Lines and a Charge measurement.

DELETE

If you want to remove a Display, click on the DELETE button. The Customization software prompts you for the Display's number. Enter a valid Display number and press OK (if you make an invalid entry, the program beeps). The Display is removed. To abort the Delete operation, press CANCEL.

NOTE

Upon completing the deletion, the Customization software tells the Model 35040 Therapy Dosimeter to delete the Display you specified.

INSERT

If you want to insert a Display, click on the INSERT button. The Customization software prompts you for the Display's number ahead of which to insert a new Display. Enter a valid Display number and press OK (if you make an invalid entry, the program beeps). The Display is inserted. You may customize the lines as described above. To abort the Insert operation, press CANCEL.

NOTE

Upon completing the insertion, the Customization software tells the Model 35040 Therapy Dosimeter to insert the Display you specified. Initially, the inserted Display has two Blank Lines and a Charge measurement.

3.10.10 Timer Intervals

The Model 35040 Therapy Dosimeter can contain up to twenty (20) timer interval settings, which are programmed from the Timer Intervals Form.

Figure 3-38 shows the measurement Timer Intervals Form that contains the timer interval settings, general editing information, and DOWNLOAD and CANCEL buttons.

Interval	Value
Interval 1	5
Interval 2	10
Interval 3	30
Interval 4	60
Interval 5	120
Interval 6	600
Interval 7	0
Interval 8	0
Interval 9	0
Interval 10	0
Interval 11	0
Interval 12	0
Interval 13	0
Interval 14	0
Interval 15	0
Interval 16	0
Interval 17	0
Interval 18	0
Interval 19	0
Interval 20	0

Figure 3-38. The Timer Intervals Form

Select a field by clicking on it with the mouse. Enter an integral number of seconds for the timer interval setting. When you select DOWNLOAD, the Customization software sends the timer interval settings to the instrument. Select CANCEL to discard any changes and return to the Measurement menu.

NOTE

When a Timer Interval has been edited, its text box background color will change from 'white' to 'yellow'. Permanent storage in the Dosimeter's memory is made only after depressing the DOWNLOAD button.

The Model 35040 Therapy Dosimeter displays the timer intervals in the same order they are entered. That is, it does not sort the timer interval settings. The UP arrow key displays the timer interval settings in an increasing interval number order (e.g., *Interval 1*, *Interval 2* ... *Interval 20*), while the DOWN arrow key presents the timer interval settings in a decreasing order. The instrument automatically skips any settings that have a value of zero (0).

3.10.11 Bias Settings

To customize the bias voltage settings for your Model 35040 Therapy Dosimeter, select Bias Settings. Figure 3-39 shows the Bias Settings that contains 11 bias setting fields, general editing information, and DOWNLOAD and CANCEL buttons.

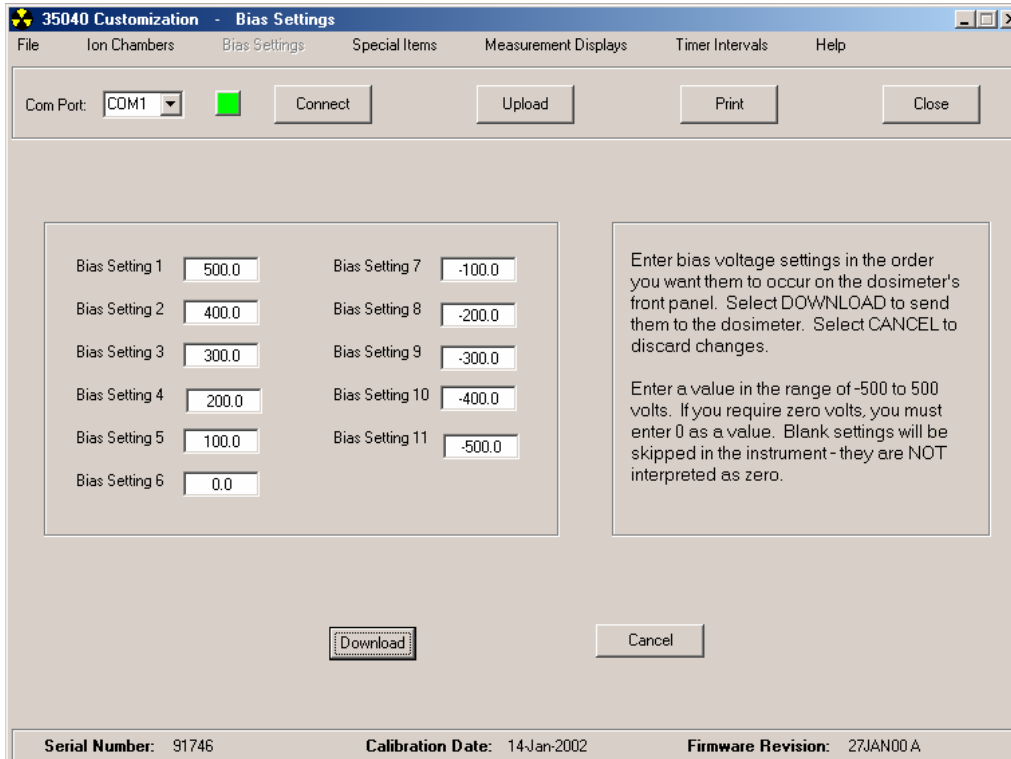


Figure 3-39. The Bias Settings Form

Select a field by clicking on it with the mouse. Enter a bias voltage setting between -500 and +500 V. If you require zero (0) volts, you must enter 0 as a value. Blank settings are skipped in the instrument – they are NOT interpreted as zero. When you select DOWNLOAD, the Customization software sends the bias settings to the instrument. Select CANCEL to discard any change. Not all fields must have an entry; the Model 35040 Therapy Dosimeter ignores blank fields. Bias settings may be entered in any order and may be repeated.

NOTE

When a Bias Setting has been edited, its text box background color will change from 'white' to 'yellow'. Permanent storage in the Dosimeter's memory is made only after depressing the DOWNLOAD button.

When you press Bias Select on the Model 35040 Therapy Dosimeter front panel, the UP & DOWN keys allow you to select the bias settings in the order you entered them in the Bias Settings dialog box.

3.10.12 Examples

The following examples describe many functions of the Customization program.

Editing an Ion Chamber

To change an ion chamber's parameters, first select Ion Chambers from the menu.

1. Click twice on the ion chamber you want to modify.
2. Keyboard: To edit the Title, Description, or Calibration factor, start typing. The program places the text into the focused area. Also, a blinking cursor indicates the position of the next character. To select another parameter to edit, use the mouse to move the focus. To select different units, press the DOWN arrow key to drop the list and to make a selection. Press OK to accept the new settings; press CANCEL to retain the original settings.

Appending or Inserting an Ion Chamber

You may add or insert an ion chamber into the list of ion chambers by selecting APPEND or INSERT. Append adds an ion chamber to the end of the list. Insert inserts an ion chamber ahead of the one highlighted on the list.

APPEND

1. Click on the APPEND button.
2. The program enters the Edit mode where you may change the parameters as described in the first example. Select OK to complete the APPEND operation; select CANCEL to abort it.

INSERT

1. Click on an ion chamber ahead of which to insert a new ion chamber.
2. Click on the INSERT button.
3. The program enters the Edit mode where you may change the parameters as described in the first example. Select OK to complete the INSERT operation; select CANCEL to abort it.

To abort the Append or Insert operation, select CANCEL. If you select OK, the program sends the information to the instrument along with instructions to append or insert the ion chamber information.

Deleting an Ion Chamber

Select DELETE to remove the highlighted ion chamber from the list. When you click on DELETE, you are asked to confirm the deletion. Select YES to delete the ion chamber; select NO to stop the delete operation.

Storing the Modified Ion Chamber Settings in the Dosimeter

Click on STORE so that changes made to the instrument's ion chamber list are stored permanently. This process may last 70 seconds.

NOTE

If changes were made to the ion chamber list and not stored permanently with the STORE button, they are permanently stored when another customization form is selected.

Changing the Power Down Interval

To change the Power Down Interval, select Special Items from the Main menu. This example changes the Power Down Interval to 15 minutes.

1. Clicking on the Power Down Interval places the input focus there.
2. Keyboard: Enter 15 into the Edit Box.
2. Click on DOWNLOAD. The Customization software downloads the new Power Down Interval to the model 35040 Therapy Dosimeter.

Changing the Pressure Units

To change the Pressure Units, select Special Items from the Main menu. This example changes the Pressure Units to millibars.

1. Click on the DOWN arrow symbol of the Pressure Units Drop List.
2. Click on millibars.
3. Click on DOWNLOAD. The Customization software downloads the new Pressure Units to the model 35040 Therapy Dosimeter.

Customizing a Measurement Display

To customize a Measurement Display, select Measurement Displays from the Main menu. This example places the Battery Voltage readout on the third line of the second Display (Display 2).

1. Click on the down arrow symbol of the GROUP drop down list.
2. Click on "Amps, Coulombs, Volts".
3. Move the mouse icon over "Battery Voltage" in the Display Line List box.
4. Press and hold the left key of the mouse and drag the 'blank text box' to the third line of Display 2. Release the mouse button. The Customization software drops the Battery Voltage display text into the third line of Display 2 and downloads the new contents of Display 2 to the Model 35040 Therapy Dosimeter.

To preview the display text, place the mouse icon over a display line description in the Display Line List box and press and hold the right key of the mouse. The display text will appear on the bottom of the Displays Programmed List box.

Appending a Display

This example shows how to add a Display to the end of all the Displays.

1. Click on the button labeled APPEND.

The Customization software appends a new Display and assigns it the next highest number. It also downloads the append operation to the instrument. The new Display contains two Blank Lines and a Charge measurement as a default. The Display appears immediately and you may add lines to it as described in the first example.

Deleting a Display

This example shows how to remove Display 2 from the list of Displays.

1. Click on the button labeled DELETE.
2. The Customization software prompts you for the number of the Display to delete. Type 2 and press OK. If CANCEL is selected, no display is deleted.

The Customization software deletes Display 2. All the Displays behind Display 2 move up in order. The Customization software downloads the delete operation to the instrument.

Inserting a Display

This example shows how to insert a Display before Display 3.

1. Click on the button labeled INSERT.

2. The Customization software prompts you to enter a Display number ahead of which to insert a new Display. Type 3 and press ENTER.

The Customization software inserts a new Display ahead of Display 3. The Customization software downloads the insert operation to the instrument. The new Display contains two Blank Lines and a Charge measurement as a default. All the Displays behind Display 3 move down in order.

Changing a Bias Setting

To customize a Bias Setting, select Bias Settings from the Main menu. This example customizes the second Bias Setting to 150 V.

1. Click on the Edit Box to the right of the Bias Setting 2 title.
2. Keyboard: Enter 150.
3. Click on DOWNLOAD. The Customization software downloads the new Bias Voltage Setting to the model 35040 Therapy Dosimeter.

3.10.13 Errors

This section describes the error messages that may appear during the program's operation. If an error message appears, follow the instructions below to resolve the error. To remove the error message, use the mouse or press a key. If you press a key and it has an associated operation, the operation executes.

Printing Error

A Printing Error occurs if the Customization software cannot initialize the printer. Check the computer connection to the printer and try printing again.

Com Initialization Error

The selected serial COM port could not be initialized. Verify that the port selected is available and that it is not being used by another program.

Serial Link Error

A Link Error occurs when the Customization software starts and cannot establish communication with the instrument. If this happens, first verify that the Com Port Indicator is green signifying that the PC port has been initialized. Next, verify that the serial port cable is connected from the PC to the 35040 Dosimeter and that the Dosimeter is powered up.

Also try, cycling Dosimeter power, wait five (5) seconds, and click on the UPLOAD button.

Download Errors

When new customization settings are downloaded to the 35040 Dosimeter, the Dosimeter will send back the new settings to verify that the data was properly received. The Customization software will verify that the returned settings match what was transmitted to the instrument. If the match is correct, all data field background colors that were yellow (indicating a changed parameter) will be changed back to white. If there was a mismatch, the data field background color will remain yellow and an error message may also be displayed. Repeat the download procedure if there was an error.

Section 4

Troubleshooting and Service

NOTE

The Model 35040 Therapy Dosimeter contains no internal operator serviceable parts. Disassembly of the unit could result in electrical shock.

Always select 0 volts bias or turn off the Model 35040 Therapy Dosimeter prior to connecting or disconnecting the ion chamber. Failure to do so may result in an electrical shock.

When powering the Model 35040 Therapy Dosimeter from an AC line, always use a 3-wire grounding type line cord such as the one supplied with the dosimeter. In addition, only connect the Model 35040 Therapy Dosimeter to an AC power outlet employing a third wire safety ground.

4.1 Introduction

This section outlines steps that the operator may take to identify and correct problems. It also gives instructions on how to order replacement parts or arrange for service if necessary.

For the purpose of troubleshooting, some problems can be resolved by the operator in the field, even though the Model 35040 Therapy Dosimeter contains no internal operator serviceable parts.

4.2 Troubleshooting

The dosimeter provides information that can be used in troubleshooting by the user. Troubleshooting has been split into a list of symptoms and a set of decisions. The first section covers broad categories of errors. It is organized as symptom, cause, and action blocks. The second section is organized as decision trees.

A symptom is something that can be seen, heard, or felt. The most likely cause is stated, followed by what action should be taken to correct the problem or isolate it. The last part of each block is a detailed explanation.

The decision trees of the second part are presented in text format. To use the decision tree, start with statement number 1. The text may state one or more actions to be completed followed by a question. Choose the most appropriate answer. Use the number after the answer to find the next statement. Eventually, you will come to a statement that has an action and no question. This may refer you to another section or provide a conclusion to the problem.

When “PROBLEM”: is the first part of the action, the problem has been identified. The exact wording of the phrase should be used when reporting the problem to Fluke Biomedical’s Repair Coordinator.

Let’s walk through a likely problem. The instrument is running from the battery. The phrase “LoBat” is blinking on the top line of the display. Look through the list of symptoms for the phrase “LoBat”. The symptom-cause-action block states that the most likely cause is the battery voltage is less than 5.9 volts. Many times the information in the cause may be enough to take corrective action. In this case though, you are going to follow the suggested action. Turn to the decision tree titled *Low Battery* (see Section 4.4). The first statement asks if the instrument is plugged in. The instrument is not, so the answer is NO. Proceed to statement 6. Statement 6 says to plug the instrument in and asks if the current is positive. All parts of the instrument are operating normally, so the answer is YES. You proceed to statement 7. Statement 7 states that the battery is charging. Since there is no question, you are done.

Symptom: Display does not light up when POWER is pressed.

Cause: The battery voltage may be very low.

Action: See Section 4.3.

Explanation: The instrument will not operate if the battery voltage is less than 5.4 volts. The battery must be slowly charged to the 5.4 volt level by plugging the instrument in for up to 24 hours.

Symptom: “??Bias” annunciator displayed.

Cause: Signals from the high voltage side of the instrument are not valid.

Action: See Section 4.5.

Explanation: The electrometer has not been initialized properly or the data transfer across the high voltage isolation has been interrupted. If the bias voltage is shorted by connecting or disconnecting a cable while the bias is on, a high voltage spark may be generated which can turn off some or all of the logic on the high voltage side of the instrument.

Symptom: “HiBias” annunciator displayed.

Cause: Bias is higher than the selected voltage by more than 1 volt.

Action: See Section 4.5.

Explanation: HiBias is a normal momentary indication when changing from one bias selection to the next. It should only persist for a few seconds. This display is triggered when the magnitude of the measured bias voltage exceeds the set point by more than 1 volt.

Symptom: “LoBias” annunciator displayed.

Cause: Bias is lower than the set point by more than 1 volt.

Action: See Section 4.5.

Explanation: LoBias is a normal momentary indication when changing from one bias setting to the next. It should only persist for a few seconds. This display is triggered when the magnitude of the measured bias voltage is less than the set point by more than 1 volt.

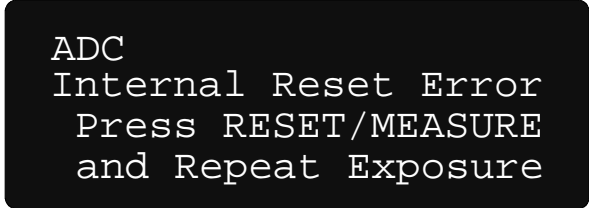
Symptom: “LoBat” annunciator displayed.

Cause: The battery voltage is 5.9 volts or less.

Action: See Section 4.4.

Explanation: The low battery annunciator is a reminder that while running on the battery, there is a finite amount of energy available. For the battery in this instrument and the energy consumption of the instrument, when the battery voltage drops below 5.9 volts there is less than 30 minutes of operating time left.

Symptom: “Internal Reset Error” displayed.

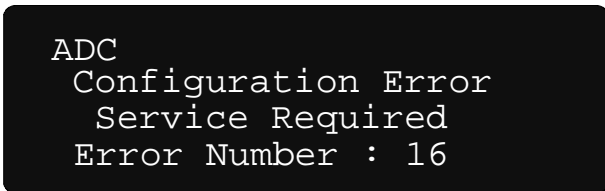


Cause: Start of exposure detected during reset process.

Action: Stop the exposure. Press the RESET/MEASURE button. Wait for the “System Not RDY” annunciator to extinguish. Start the exposure.

Explanation: The instrument measured a current above the start threshold while resetting the electrometer. It is assumed that the exposure was started while the reset was occurring. If the exposure did start during the reset, some unknown amount of charge was lost. The lost charge would lead to an incorrect reading.

Symptom: “Configuration Error” displayed.



Cause: The instrument has lost the calibration or customization data.

Action: Convert the configuration error number to a binary value using a program such as the Windows® Calculator and use the table below to determine the extent of the problem. For example, a configuration error of “18” corresponds to a binary value of “10010” (bits 5 and 2 set), which indicates that the customization for both the ion chamber and settings are invalid.

Bit	Description	Action
1	Operator settings are invalid.	Select the proper settings from the front panel.
2	Customization settings are invalid.	Reinstall settings using the Customization software.
3	Electrometer calibration settings are invalid.	Do NOT make measurements. Return instrument for repair.
4	Bias calibration settings are invalid.	Do NOT make measurements. Return instrument for repair.
5	Ion chamber customization settings are invalid.	Reinstall ion chambers using the Customization software.
6	Ion chambers cannot be read.	Return instrument for repair to correct problem.

7	Additional operator settings are invalid.	Select the proper settings from the front panel.
8	Timer interval customization settings are invalid.	Reinstall settings using the Customization software.
9	Additional calibration settings are invalid.	Do NOT make measurements. Return instrument for repair.

Explanation: The instrument detects whether the stored parameters are valid at power-up. If the parameters are invalid, it will affect one or more of the measurements. The operator may restore some of the information either by selecting options from the front panel or by running the customization software. Invalid calibration settings require a new calibration. Follow the recommendations in the above table.

Symptom:
displayed.

"Current Overage"

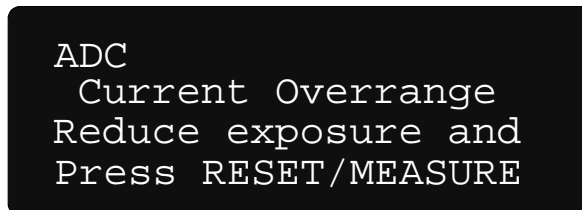


Cause: The input current has exceeded the 1.200 uA limit.

Action: Stop the exposure. Change the setup to reduce the current.

Explanation: The instrument has a 1.000 uA limit on measurable current and will continue to measure charge for currents up to 1.200 uA. The instrument can accept an input current up to 3 mA without damage to the instrument.

Symptom: "Current Overage" displayed.



Cause: The input current has exceeded the 100 nA limit.

Action: Stop the exposure. Change the setup to reduce the current.

Explanation: The instrument has a 100 nA limit on measurable current. The instrument can accept an input current up to 3 mA without damage to the instrument.

Symptom: Dashes displayed instead of digits.

Cause: No meaningful measurement could be obtained.

Action: Press the RESET/MEASURE button to reset the measurements.

Explanation: ICBias —.- V : the bias voltage measurement is unavailable due to invalid signals within the instrument. This is a normal momentary condition when the instrument is powered up.

Symptom: The bias voltage measurement changes by one digit.

Example: 299.9 to 300.0

Cause: Rounding error in measurement.

Action: None.

Explanation: The bias voltage is not actually changing. The control for the bias is in discrete steps. The measurement is also in discrete steps. The control program may select a setting that causes the measurement to be very near the transition between one measurement step and the next.

4.3 Display Will Not Light

			Go to line:
1.	Is the instrument connected to line voltage?	YES NO	2 4
2.	Disconnect the line cord. Check the fuse. (See Section 4.6.) Is the fuse filament intact?	YES NO	3 11
3.	Attach known operational appliance to outlet. Does the appliance work?	YES NO	4 12
4.	Connect instrument to AC line. Press the Power button. Did the display light up?	YES NO	5 7
5.	Is the battery current between +0.10 A and +3.00 A?	YES NO	6 13
6.	The fault has been cleared. The battery is charging. Leave the instrument plugged in for at least 2 hours. When the battery is less than 5.4 volts and the instrument is running on battery, the instrument will turn itself off. This is to protect the battery from becoming severely discharged.		
7.	Replace cord with known good cord or establish that the line cord is good. Is line cord good?	YES NO	8 14
8.	Was the battery low the last time the instrument was stored?	YES NO	9 16
9.	Has the instrument been plugged in for more than 24 hours?	YES NO	10 15
10.	PROBLEM: Instrument will not power up after 24 hours. See Section 4.10.		
11.	See Section 4.6.		
12.	Faulty Outlet. Use a different outlet.		
13.	See Section 4.2 to isolate problem.		
14.	ORDER: Proper line cord. See Section 4.9.		
15.	The battery may take more than 18 hours to recharge if the battery was in the low battery condition and was not recharged before storage. Leave the instrument plugged in and try again in 18-24 hours.		
16.	PROBLEM: Instrument will not power up. See Section 4.10.		

4.4 Low Battery

			Go to line:
1.	Is the instrument connected to line voltage? Is the instrument connected to line voltage?	YES NO	2 6
2.	Turn the instrument off. Wait a few seconds. Turn the instrument on. A sequence of screens will appear. On the last screen, the battery voltage and current are displayed. Is the battery current between +0.10 A and +3.00 A?	YES NO	3 8
3.	The battery is charging. Has the instrument been plugged in for more than 8 hours?	YES NO	4 --
4.	Is the battery voltage greater than 5.9 volts?	YES NO	5 --
5.	PROBLEM: False battery low indication. See Section 4.10.		
6.	Connect AC line cord. If the display goes blank or stops updating, turn the instrument off. Wait a few seconds. Turn the instrument on. Is the battery current between +0.10 A and +3.00 A?	YES NO	7 8
7.	The battery is charging. "LoBat" indicator will turn off when the battery voltage is above 5.9 volts.		
8.	Is the battery current between -1.00 A and -0.10 A?	YES NO	9 18
9.	Disconnect AC line cord from rear panel. Remove line fuses from rear panel fuse holder. Test the fuses with an ohmmeter. Are the fuses open circuited?	YES NO	10 11
10.	See Section 4.6.		
11.	Reinstall fuses. Reconnect AC line cord. Is the battery current between +0.10 A and +3.00 A?	YES NO	12 13
12.	The battery is charging.		
13.	Attach known operational appliance to outlet. Does the appliance work?	YES NO	14 16
14.	Instrument or line cord is faulty. Replace cord with known good cord or establish that the line cord is good. Is line cord good?	YES NO	15 17
15.	PROBLEM: Battery charger inoperative. See Section 4.10.		
16.	Outlet is faulty.		
17.	See Section 4.9. Order proper line cord.		
18.	PROBLEM: Low battery during trickle charge. Call Fluke Biomedical for Service.		

4.5 Bias Error

			Go to line:
1.	Is "??Bias" displayed?	YES NO	2 6
2.	Has the instrument been on for more than one minute?	YES NO	3 8
3.	Turn off the power. Wait 10 seconds. Turn on the power. Wait 1 minute. Is "??Bias" displayed?	YES NO	4 --
4.	PROBLEM: Electrometer fault. See Section 4.10.	YES NO	5 --
5.	Change the bias voltage to a different setting and then change back. Wait about 10 seconds. Is the error on the display?		
6.	Change the bias voltage to 0.0 V. Disconnect all triax cables. Cap the connectors. Change bias voltage to desired setting. Wait about 10 seconds. Is the error on the display?	YES NO	7 8
7.	Change the bias voltage to 0.0 V. Examine the triax connectors on the instrument, both front and rear, for foreign matter. Is foreign matter present?		
8.	See Section 4.7.	YES NO	9 18
9.	Normal operation established.	YES NO	10 11
10.	Do you use a separate cable to connect the ion chamber to the instrument?		
11.	Change the bias voltage to 0.0 V. Connect only the cable to the instrument. Change the bias voltage to the desired setting. Wait about 10 seconds. Is the error on the display?	YES NO	12 13
12.	PROBLEM: Bias fault in cable. See Section 4.10.		
13.	Change the bias voltage to 0.0 V. Connect the ion chamber. Change the bias voltage to the desired setting. Wait about 10 seconds. Is the error on the display?	YES NO	14 16
14.	PROBLEM: Bias fault in instrument. See Section 4.10.	YES NO	15 17
15.	PROBLEM: Bias fault in ion chamber. See Section 4.10.		
16.	This message is displayed until the signals from the isolated side are valid.		

4.6 Line Fuse Replacement

NOTE

Disconnect the Model 35040 Therapy Dosimeter from other equipment along with the AC line power and turn off power before continuing with this section.

1. Position the instrument on its display face.

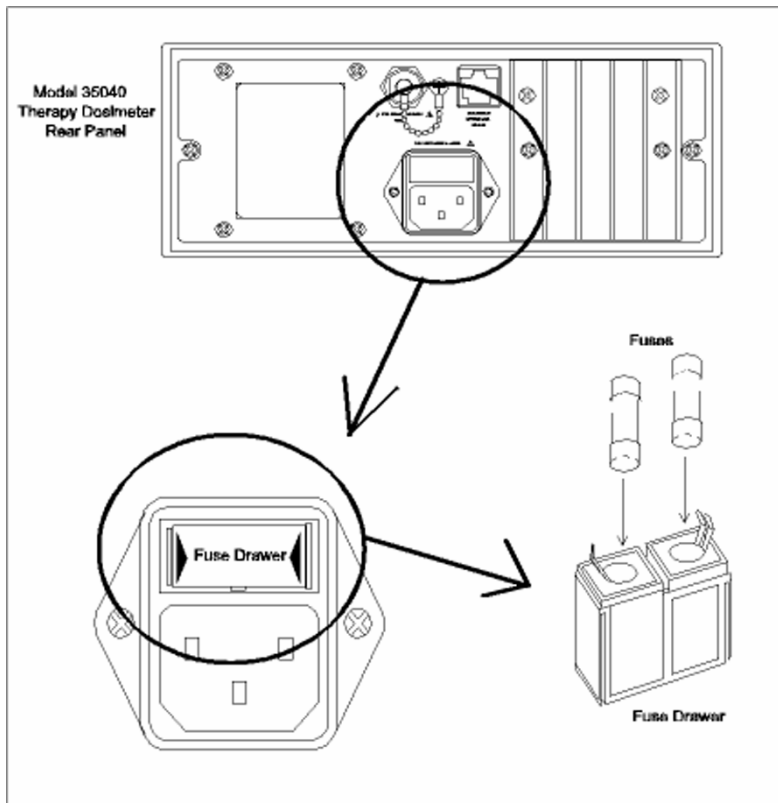


Figure 4-1. Model 35040 Therapy Dosimeter Fuse Replacement

2. Remove the fuse drawer. With your fingernails, squeeze together the two ends of the fuse drawer and pull it out of its slot.
3. Replace the fuses with P/N 38476.

WARNING

The use of different fuses may result in fire or electrical shock in case of an internal fault.

4. Place the fuse drawer back into its slot. Press on the fuse drawer firmly until it snaps back into place. Both sides of the fuse drawer should snap into place.

NOTE

If fuses continue to fail - return the instrument for repair.

4.7 Interface Connector Cleaning

WARNING

Select 0.0 V bias setting **AND** turn off the Model 35040 Therapy Dosimeter prior to cleaning the interface connectors. Failure to do so may result in an electrical shock.

The presence of dust or lint at the interface connectors can produce leakage currents that may have a detrimental affect upon the accuracy of radiation measurements.

The ends of the interface cable may pick up dust and lint as the cable touches the floor during packing and unpacking. Dirt may later be transferred to the interface connectors located on the Model 35040 Therapy Dosimeter during mating with the interface cable.

In some cases, the offending foreign matter may be removed by gently blowing across the connector with dry air. Air containing moisture or other contaminants should be avoided. A suitable source of dry air is available where camera accessories are sold. They are intended for use in cleaning fine and delicate camera equipment. If this cleaning method fails to produce satisfactory results, then service will be required.

A procedure for troubleshooting excessive leakage is given earlier in this section.

4.8 Cleaning The Instrument

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

1. Turn off the instrument and disconnect all input connectors.
2. Place the caps on both triax connectors.
3. 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.

4. Use the moistened cloth to wipe the instrument's exterior cover.
5. Let the instrument dry completely before using.

4.9 Replaceable Parts Information

Fluke Biomedical maintains a complete inventory of all normal replaceable parts (see Table 4-1). To place an order, or to obtain information concerning replaceable parts, contact Fluke Biomedical at 440.248.9300.

Table 4-1. *Replaceable Parts List*

Description	Part Number
AC Line Cord (USA)	CO-19
AC Line Cord (Europe CEE 7/7)	86512060
AC Line Cord (UK & Ireland)	86583000
AC Line Cord (Denmark)	86536041
AC Line Cord (Italy)	86531031
AC Line Cord (Switzerland)	86515050
Carrying Case	37777
Customization Kit	37886
DB-9 Female Connector	37616
7 foot RJ-45 Cable	105-260
Customization Software Disk 3.5"	37888
Handle	38439
Mounting Ear (Right)	428-328E
Mounting Ear (Left)	428-338B
Rubber Foot (Front)	070-80
Rear Foot	38600
Rubber Foot (Rear)	FE-6
Dust Cap and Chain (BNC)	878-11-63
Dust Cap and Chain (TNC Optional)	414910-2
Fuse	38476
Fuse Drawer	018-304

4.10 Recalibration, Repair Information & Technical Assistance

If your instrument needs recalibration or repair, we request that you contact Fluke Biomedical at 440.248.9300.

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

4.11 Warranty Information

Should your instrument require warranty service, contact Fluke Biomedical at 440.248.9300.

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Appendix A

Sample Customization Reports

A.1 Sample Documents

This section contains sample documents that the Customization Software can produce. It produced these documents on a HP LaserJet®. All of them contain the header “35040 THERAPY DOSIMETER”.

3 5 0 4 0 T H E R A P Y D O S I M E T E R
Customization Report

Serial Number: 91746

12 Jul 04

----- Measurement Displays -----

Display 1
=====

Annunciators
FW Rev: 27JAN00 A
Property of
City Medical Center

=====

Display 2
=====

Annunciators
--.-- nC
--.-- nR

=====

Display 3
=====

Annunciators
---- pA
---- pR/s

=====

Display 4
=====

Annunciators
--.-- nC
--.-- nC ACCUM

=====

Display 5
=====

Annunciators
---- pA
---- pA AVG

=====

Display 6
=====

Annunciators
--.-- nR
--.-- nR ACCUM

=====

Display 7
=====

Annunciators
---- pR/s
---- pR/min AVG

=====

Display 8
=====

Annunciators
--.-- nC
--.-- s

=====

Display 9
=====

Annunciators
---- nR
---- pR/s
---- s

=====

Display 10
=====

Annunciators
---- pR/s
---- pR/min AVG
---- s

=====

Display 11
=====

Annunciators
Leakage: ---- pA
Leak: ---- R/s
IC Bias: ---- V CEP

=====

Display 12
=====

Annunciators
IC Bias: ---- V CEP

=====

Display 13
=====

Annunciators
--- C ---- hPa
ICCF=1.234E+08 R/C

=====

Display 14
=====

Annunciators
Set: >+---- V +---%
ADCF = -.--

=====

Display 15
=====

Annunciators
Batt: -- V +--- A

=====

Display 16
=====

Annunciators
---- nR
---- pR/s
ICCF=1.234E+08 R/C

=====

3 5 0 4 0 T H E R A P Y D O S I M E T E R
Customization Report

Serial Number: 91746

12 Jul 04

----- Special Items -----

Power Down Interval 123 Minutes
Temperature Units Kelvin
Calibration Temperature 22 Deg. C.
Pressure Units millimeters of Hg
Optional Text 1 Property of
Optional Text 2 City Medical Center

----- Bias Settings (VDC) -----

Bias Setting 1 500.0
Bias Setting 2 400.0
Bias Setting 3 300.0
Bias Setting 4 200.0
Bias Setting 5 100.0
Bias Setting 6 0.0
Bias Setting 7 -100.0
Bias Setting 8 -200.0
Bias Setting 9 -300.0
Bias Setting 10 -400.0
Bias Setting 11 -500.0

----- Timer Intervals (Sec.) -----

Timer Interval 1 5
Timer Interval 2 10
Timer Interval 3 30
Timer Interval 4 60
Timer Interval 5 120
Timer Interval 6 600
Timer Interval 7 0
Timer Interval 8 0
Timer Interval 9 0
Timer Interval 10 0
Timer Interval 11 0
Timer Interval 12 0
Timer Interval 13 0
Timer Interval 14 0
Timer Interval 15 0
Timer Interval 16 0
Timer Interval 17 0
Timer Interval 18 0
Timer Interval 19 0
Timer Interval 20 0

3 5 0 4 0 T H E R A P Y D O S I M E T E R
Customization Report

Serial Number: 91746

12 Jul 04

----- Ion Chambers -----

Ion Chamber 1

```
=====
Annunciators
Farmer Probe 0.6cc
S/N 12345
4.67000e+08 R/C
=====
```

Ion Chamber 2

```
=====
Annunciators
Farmer Probe
S/N 23456
4.08100e+07 Gy/C
=====
```

Ion Chamber 3

```
=====
Annunciators
Farmer IC
S/N 34567
4.67800e+08 R/C
=====
```

3 5 0 4 0 T H E R A P Y D O S I M E T E R
Customization Report
Serial Number: 91746 12 Jul 04

----- Calibration -----

Electrometer Charge Scale Factor 1.0000
Electrometer Current Scale Factor 1.0000

Calibration ID
=====

Annunciators Calibrated by Inovision RM LLC 14-Jan-2002
--

=====

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Appendix B

Features of Firmware Version "27JAN00" or Later

B.1 Introduction

This addendum updates information provided in the *Model 35040 Therapy Dosimeter Instruction Manual*. Particularly, the instrument now supports a measurement timer and extended charge and current ranges.

B.2 New Features

B.2.1 Overview

- Added timed charge, predicted timed charge, and the corresponding dose measurements
- Twenty (20) interval settings (1 to 9,999 s) selectable from the instrument's front panel and user programmable via the Customization software
- Ability to select the timer's count mode and decimal places from the front panel
- Increased maximum charge from 2.4 μC to 19.999 mC
- Increased maximum current from 100 nA to 1.000 μA and auto-recovery for currents less than 1.200 μA
- ALC annunciator simplifies toggling of the automatic leakage compensation status and promotes easy recognition of leakage compensation status
- Increased maximum effective time from "59 min 59.9 s" (3,599.9 s) to "5 h 33 min 19.9 s" (19,999.9 s)

B.2.2 Timed Measurements

The Model 35040 Therapy Dosimeter provides a timer for performing timed charge and dose measurements. A typical application of the timer is for measuring brachytherapy sources. The instrument supplies four timed measurement quantities, which may be added to any of the measurement displays with the Customization software (refer to Section B.7).

While competing instruments may provide measurements similar to the timed charge or dose, the Model 35040 offers predicted timed measurements for superior diagnostic capabilities while measuring sources delivering at a constant exposure rate (e.g., brachytherapy). The predicted timed measurements extrapolate the amount of timed charge that should be collected at the completion of the interval, which can reveal problems early in the measurement process versus waiting for the complete interval to expire.

Refer to the following sections for details on the timed measurements:

- Section B.3.2, Making Timed Exposure Measurements, presents an overview on configuring and using the timer.
- Section B.4.1, Front Panel Controls: RESET/MEASURE, discusses how to start and stop the timer as well as zero measurements.
- Section B.4.4, Timer Setup, provides details on the timer configuration.
- Section B.5, THEORY OF OPERATION, specifies how the instrument performs timed measurements.
- Section B.7, CUSTOMIZATION, provides information on customizing the measurement displays and timer intervals.

B.2.3 Specifications Update

This section lists the specification changes with respect to the *Model 35040 Therapy Dosimeter Instruction Manual*.

Charge Measurements

Range, Resolution, and Repeatability:

Full Scale Range	Display Resolution	Repeatability (± counts)
200.00 pC	0.01 pC	5
2.0000 nC	0.0001 nC	1.5
20.000 nC	0.001 nC	2.5
200.00 nC	0.01 nC	1
2.0000 μC	0.0001 μC	1
20.000 μC	0.001 μC	1
200.00 μC	0.01 μC	1
2.0000 mC	0.0001 mC	1
20.000 mC	0.001 mC	1

Timed Charge Measurements

Range and Resolution: Same as charge measurements.

Measurement Method: The timed charge measurement is derived by monitoring the charge integrated over a time interval that begins with the activation of the timer. The timer automatically stops when the elapsed time is equal to the timer interval setting or the exposure is over. Interpolation is used to determine the charge at an integral number of seconds.

Measurement Accuracy: Same as charge measurements assuming that the rate of charge delivery does not dramatically change within the interpolation window interval. Refer to Section B.5 for calculation details.

Current Measurements

Range, Resolution, and Noise:

Full Scale Range	Display Resolution	Noise (± counts)
200.0 pA	0.1 pA	2
2.000 nA	0.001 nA	2
20.00 nA	0.01 nA	1
200.0 nA	0.1 nA	1

1.000 μ A	0.001 μ A	1
---------------	---------------	---

Average Current Measurements

Range and Resolution:

Full Scale Range	Display Resolution
200.00 pA	0.01 pA
2.0000 nA	0.0001 nA
20.000 nA	0.001 nA
200.00 nA	0.01 nA
1.0000 μ A	0.0001 μ A

Effective Exposure Time Measurements

Range and Resolution:

Full Scale Range		Display Resolution
Seconds	Hours/Minutes/Seconds	
59.99 s	59.99 s	0.01 s
19,999.9 s	5 h 33 min 19.9 s	0.1 s

Measurement Method: The effective exposure time value is calculated as the quotient of the charge and average current measurement values. A minimum exposure duration of 3.5 seconds is required to produce an effective exposure time measurement value.

B.3 SETUP

B.3.1 Making Non-Timed Exposure Measurements

With Automatic Leakage Compensation Disabled

The instrument must be manually reset before each exposure when automatic leakage compensation is disabled.

Procedure

- Hold RESET/MEASURE for one second just before making the exposure to reset the instrument. Note that the instrument displays the “Rst” annunciator while the hardware is being reset.
- Wait for the reset to complete.
- Make the exposure.

The exposure measurements will be displayed but may drift due to leakage. Repeat this sequence for every exposure.

With Automatic Leakage Compensation Enabled

In addition to compensating measurements for leakage, the instrument holds the exposure measurements and automatically resets after each exposure when automatic leakage compensation is enabled.

Procedure

- The annunciator line on the Measurement screen displays "WAIT System Not RDY" while the instrument is acquiring the minimum number of samples required for leakage compensation. Wait for this message to disappear.
- Wait for the leakage current to return to the nominal value.
- Make the exposure.

When the instrument senses that the exposure is over, it displays and holds the exposure measurements and then resets the electrometer (refer to Section B.4.3 for information on configuring the start and stop thresholds). The exposure measurements are displayed until either the RESET/MEASURE button is held for one second, the bias voltage or threshold changed, or another exposure is started.

B.3.2 Making Timed Exposure Measurements

The timer is available when any of the measurement displays contains a timed measurement. Refer to Section B.7 for information on customizing measurement displays.

Timer Setup

Procedure

- Use the TEST FUNCTION button, along with the UP and DOWN arrows to display the Timer Setup screen.
- To modify the timer setup, press the TEST FUNCTION button to display the "▶" cursor at the timer interval field and use the UP and DOWN arrows to select a timer interval from the programmed list. (Refer to Section B.7 for information on how to program the interval list.)
- Press the TEST FUNCTION button to advance the "▶" cursor to the timer count mode field and use the UP and DOWN arrow keys to select up (UP) or down (DOWN) for the count mode.
- Press the TEST FUNCTION button to advance the "▶" cursor to the timer decimal places field and use the UP and DOWN arrow keys to select zero (0) or one (1).
- Press the TEST FUNCTION button to hide the cursor and save any changes. Proceed to using the timer, which is discussed next.

Timer Use

Procedure

- Press the RESET/MEASURE button to show the Measurement screen if it is not displayed.
- To start or manually stop the timer, press the RESET/MEASURE button while the instrument is updating other exposure measurements (e.g., charge and current). The instrument displays the "Tmr" annunciator when the timer is running.

NOTE

The instrument will not permit the timer to be started while leakage is being measured.

- Upon completion of the timer interval or if the instrument senses the exposure is over (applicable when automatic leakage compensation is enabled), the instrument ceases updating the timed measurements.

NOTE

Use the predicted timed charge or dose measurement to diagnose a problem at the onset of

a timed measurement for sources that deliver at a constant exposure rate. If the predicted timed measurement is drastically different from the expected value, there is no reason to wait for the complete timer interval to expire before investigating the cause of the discrepancy.

NOTE

To differentiate the predicted and non-predicted timed measurements, the instrument alternates the display of time with a “PREDICT” indicator on the predicted timed measurement lines.

B.4 Operation Instructions

B.4.1 Front Panel Controls

Test Function

- When the Test Function screen is not displayed, pressing the TEST FUNCTION button displays the Test Function screen and the information/settings that were last viewed since power-up.

NOTE

The TEST FUNCTION screen provides access to information and settings such as the firmware revision, charge and current scale factors, battery and bias voltages, automatic leakage compensation settings, and timer settings.

- When the Test Function screen is displayed, pressing the TEST FUNCTION button displays a cursor that allows modification of the following settings:
 - Enabling or disabling automatic leakage compensation or setting of the start and stop exposure current thresholds
 - Selecting the timer interval, count mode, and decimal places
 - Specifying the effective exposure time presentation

RESET/MEASURE

- When the Measurement screen is not displayed, pressing the RESET/MEASURE button displays the Measurement screen and the Measurement display that was last viewed since power-up.
- When the Measurement screen is displayed:
 - And when the instrument is performing exposure measurements, pressing the RESET/MEASURE button toggles the timer
 - Pressing and holding the RESET/MEASURE button for one second zeroes all exposure measurements; the instrument also zeroes leakage measurements if leakage was being measured

B.4.2 Using the Test Function Button

Figure B.1 shows the automatic leakage compensation settings, which consist of the ALC status, start and stop threshold currents, and the instantaneous current measurement. Refer to Section B.4.3 for details.

```
ADC          ALC
Start Thres: 1.0 pA
Stop  Thres: 0.9 pA
Current:     0.0 pA
```

Figure B-1. The Test Function screen showing the automatic leakage compensation settings

Figure B-2 displays the settings for the timer interval, count mode, and decimal places. Refer to Section B.4.4 for details.

```
ADC          ALC
Interval:    60 s
Count:       UP
Decimal Places: 0
```

Figure B-2. The Test Function screen showing the timer settings

Figure B-3 shows the display format setting for the effective exposure time, which determines the

```
ADC          ALC
Exp Time:    HR/MIN/SEC
```

presentation of the effective time on the Measurement screen.

Figure B-3. The Test Function screen showing the effective exposure time display setting

To change the effective time format setting, press the TEST FUNCTION button to show the "▶" cursor and use the UP and DOWN arrow buttons to select either seconds (SECONDS) or hours/minutes/seconds (HR/MIN/SEC). Press the TEST FUNCTION button again to hide the cursor and save the selection.

B.4.3 Automatic Leakage Compensation

Automatic compensation for leakage currents can be enabled and disabled from the front panel. Automatic leakage compensation allows the instrument to "detect" when an exposure is in progress and hold the final exposure measurement values between exposures.

The start threshold specifies the current necessary for the instrument to begin updating the exposure measurements. The stop threshold must be smaller than the start threshold, and it indicates the minimum current required for the exposure measurements to be updated once an exposure is detected. That is,

the instrument will cease updating the exposure measurements when the current drops below the stop threshold and will return to measuring leakage.

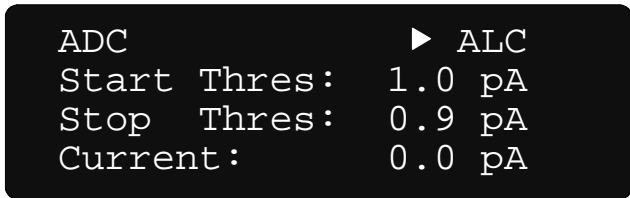
NOTE

The instrument uses the start and stop threshold settings to sense when an exposure is in progress.

With the automatic leakage compensation settings displayed (Figure B-4), press the TEST FUNCTION button. The "▶" cursor will appear to the left of the ALC annunciator. Use the UP and DOWN arrow buttons to toggle the setting between on (ALC) and off (OFF).

With automatic leakage compensation enabled, press the TEST FUNCTION button to advance the "▶" cursor to the next field or exit Edit mode. When the cursor points to a threshold setting, use the UP and DOWN arrow buttons to increment and decrement the value, respectively. Nominal values for the start and stop thresholds are 1.3 and 1.2 pA, respectively. However, depending on the system leakage, other values may be necessary.

When automatic leakage compensation is disabled, the annunciator displays off (OFF) (Figure B-5), the start and stop threshold settings cannot be changed and display Not Available (NA), as do the leakage



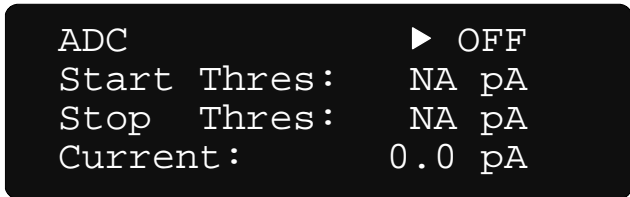
measurements.

Figure B-4. Automatic Leakage Compensation Enabled

Figure B-5. Automatic Leakage Compensation Disabled

NOTE

The instrument may reset all measurements when



the automatic leakage compensation parameters are changed.

NOTE

Disabling automatic leakage compensation prevents automatic exposure detection and the measurement of leakage current, and leakage measurements will display Not Available (NA).

B.4.4 Timer Setup

The Test Function screen provides for configuring the timer interval, count mode, and decimal places (see Figure B-6).

With the timer settings displayed, press the TEST FUNCTION button. The "▶" cursor will appear to the left of the timer interval setting. Use the UP and DOWN arrow buttons to select a value from the user customizable list. Refer to Section B.7 for details on programming the timer intervals.



Figure B-6. The Test Function Screen Showing the Timer Settings

Press the TEST FUNCTION button to advance the "▶" cursor to the timer count mode field. Use the UP and DOWN arrow buttons to toggle the setting between up (UP) and down (DOWN). For the up count mode, the timer starts at zero (0) seconds and increments up to the timer interval setting. The down count mode displays time starting from the timer interval setting and decrements to zero (0) seconds.

Press the TEST FUNCTION button to advance the "▶" cursor to the timer decimal places setting. Use the UP and DOWN arrow buttons to toggle the setting between zero (0) and one (1). Zero decimal places displays time in whole seconds, while one decimal place displays time to a tenth of a second.

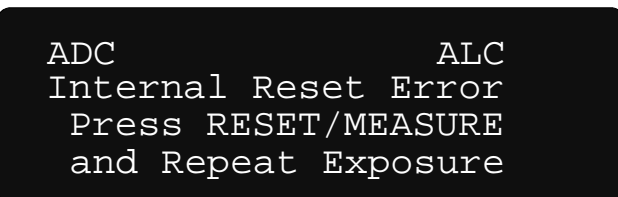
NOTE

Presently, the timer counts only in whole seconds.

B.4.5 Reset Error (with Automatic Leakage Compensation Enabled)

The following discussion is only applicable when automatic leakage compensation is enabled and the ion chamber is calibrated in Coulombs.

Holding the RESET/MEASURE button while on the Measurement screen causes the Model 35040 Therapy Dosimeter to reset the electrometer, zero all readings, and restart the measurement process. When an exposure is detected immediately following the reset that was not present prior to the reset, the



instrument displays the reset error message shown in Figure B-7.

Figure B-7. The Measurement Screen Showing the Reset Error Message

To remove the error message, end the exposure and hold the RESET/MEASURE button. Wait a few seconds for the instrument to complete the reset and repeat the exposure.

B.4.6 Annunciators, Indicators, and Overrange Conditions

Table B-1 specifies the annunciators that may appear on the top line of the display.

Table B-1. Annunciators

Annunciator	Condition
??Bias	No bias measurement possible since the electrometer is not ready
ADC	Air density correction in use (only applicable to radiological measurements)
ALC	Automatic leakage compensation enabled
LoBat	Low Battery voltage
LoBias	Low Bias voltage
HiBias	High Bias voltage
OvAmps	Overranged current
Rst	Resetting electrometer
Tmr	Timer in use
WAIT Bias Not Ready	The dosimeter is setting the bias
WAIT System Not Rdy	The dosimeter is resetting the electrometer (only applicable when automatic leakage compensation is enabled)

Figure B-8 illustrates the locations of some annunciators. The battery, bias, and overranged current annunciators appear at the same location, and the instrument alternates the displaying of each annunciator when more than one is applicable.

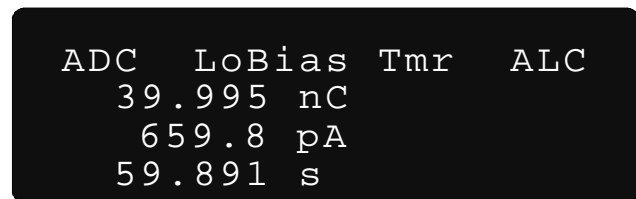


Figure B-8. Annunciator Positions

Table B-2 lists the indicators the instrument uses to signal that a measurement quantity has not been compensated for leakage or is not available due to the specified condition.

Table B-2. Measurement Indicators and Conditions

Indicator	Measurement	Condition
? (left of value)	All Non-leakage ¹	Automatic leakage compensation is enabled, but the exposure started before a leakage measurement was available.
-.---	Leakage	Automatic leakage compensation is enabled, but the exposure started before a leakage measurement was available.
INVALID	Effective Time	The calculated effective time is longer than the actual exposure. This condition occurs when a large amount of charge is injected at the beginning of the exposure.
NA	Leakage	The leakage measurement is not available since automatic leakage compensation is disabled.
OVER	Non-leakage ¹	The quantity or one of its dependents has exceeded the maximum value. Refer to Table B-3 for more information.

¹ All non-leakage measurements (e.g., charge, current, dose, rate, effective time, etc.)

Table B-3 specifies the conditions that cause the Model 35040 Therapy Dosimeter to display an overrange indicator (OVER) for a measurement quantity.

Table B-3. Overage Conditions

Condition	Overranged Measurement¹
charge > 19.999 mC	charge average current accumulated charge effective exposure time
accumulated charge > 1.0000 C	accumulated charge
current > 1.000 μ A	current
current > 1.200 μ A	all non-leakage
time > 19,999.9 s	effective exposure time

¹ Includes radiological measurements derived from electrical measurements.

B.5 Theory Of Operation

Basic Operating Equations

Quantity	Description	Units	Comments
Q_{Timed}	Timed Charge	C	The electrical charge delivered during the timer interval.
$Q_{Timed_Predicted}$	Predicted Timed Charge	C	The total amount of timed charge that should be accumulated at the completion of the timer interval, based on the observed delivery rate.

Leakage Measurements

Leakage measurements (Q_{Offset} , $I_{Leakage}$ and T_{Offset}) are only applicable when automatic leakage compensation is enabled.

Timed Charge and Dose

This measurement accumulates charge only while the elapsed time is less than or equal to the timer interval setting. The displayed value is held following the completion of the timer interval.

$$Q_{Timed} = Q_2[C] - Q_1[C] - (I_{Leakage} [A] \times (T_2 [s] - T_1 [s]))$$

$$Dose_{Timed} = Q_{Timed} [C] \times ICCF [Units/C] \times ADCF$$

Q_1 represents the next sample of charge at time T_1 following the activation of the timer. Q_2 corresponds to the interpolated charge at time T_2 , where T_2 is an integral number of seconds that is restricted to times within the range: $T_1 < T_2 \leq (T_1 + \text{Timer Interval Setting})$.

Predicted Timed Charge and Dose

This measurement extrapolates the timed charge (Q_{Timed}) at the elapsed time ($T_{Elapsed}$) that should be accumulated at completion of the timer interval (i.e., $\text{TimerIntervalSetting}$) based on the rate of charge delivery.

$$Q_{Timed_Predicted} = \frac{Q_{Timed}[C]}{T_{Elapsed}[s]} \times \text{TimerIntervalSetting}[s]$$

$$Dose_{Timed_Predicted} = Q_{Timed_Predicted} [C] \times ICCF [Units/C] \times ADCF$$

At the conclusion of the timer interval (i.e., $T_{Elapsed}$ equals the $\text{TimerIntervalSetting}$), the predicted timed charge and dose are equal to the predicted timed charge and dose, respectively.

B.6 Troubleshooting

This section outlines steps that the operator may take to identify and correct problems.

Symptom: "Configuration Error" displayed.

```
ADC
Configuration Error
Service Required
Error Number : 16
```

Cause: The instrument has lost the calibration or customization data.

Action: Convert the configuration error number to a binary value using a program such as the Windows[®] Calculator and use the table below to determine the extent of the problem. For example, a configuration error of "18" corresponds to a binary value of "10010" (bits 5 and 2 set), which indicates that the customization for both the ion chamber and settings are invalid.

Bit	Description	Action
1	Operator settings are invalid.	Select the proper settings from the front panel.
2	Customization settings are invalid.	Reinstall settings using the Customization software.
3	Electrometer calibration settings are invalid.	Do NOT make measurements. Return instrument for repair.
4	Bias calibration settings are invalid.	Do NOT make measurements. Return instrument for repair.
5	Ion chamber customization settings are invalid.	Reinstall ion chambers using the Customization software.
6	Ion chambers cannot be read.	Return instrument for repair to correct problem.
7	Additional operator settings are invalid.	Select the proper settings from the front panel.
8	Timer interval customization settings are invalid.	Reinstall settings using the Customization software.
9	Additional calibration settings are invalid.	Do NOT make measurements. Return instrument for repair.

Explanation: The instrument detects whether the stored parameters are valid at power-up. If the parameters are invalid, it will affect one or more of the measurements. The operator may restore some of the information either by selecting options from the front panel or by running the customization software. Invalid calibration settings require a new calibration. Follow the recommendations in the above table.

Symptom: "Current Overrange" displayed.

ADC
Current Overage
Reduce exposure and
Press RESET/MEASURE

Cause: The input current has exceeded the 1.200 uA limit.

Action: Stop the exposure. Change the setup to reduce the current.

Explanation: The instrument has a 1.000 uA limit on measurable current and will continue to measure charge for currents up to 1.200 uA. The instrument can accept an input current up to 3 mA without damage to the instrument.

B.7 Customization

The screens shown in this section represent the appearance of the Customization software running within a MS-DOS® window running on Windows® 95/98.

B.7.1 The Main Menu

The Main menu appears after customization information has been received from the Model 35040 Therapy Dosimeter. The menu items are *Ion Chambers*, *Special Items*, *Measurement*, *Bias Settings*, *Print*, and *Exit*.

B.7.2 The Measurement Menu

The Measurement menu provides items *Displays*, *Timer Intervals*, and *Quit*. Select *Displays* to view the Measurement Displays, *Timer Intervals* to view the Measurement Timer Intervals, or *Quit* to return to the Main menu.

Measurement Displays

The Model 35040 Therapy Dosimeter can contain up to sixteen (16) measurement displays, which are viewed from the Measurement screen. From the Measurement Displays section of the Customization software, you may customize the appearance of any of the measurement displays. All measurement displays must show the annunciators on the first line. You may choose what appears on the other three lines

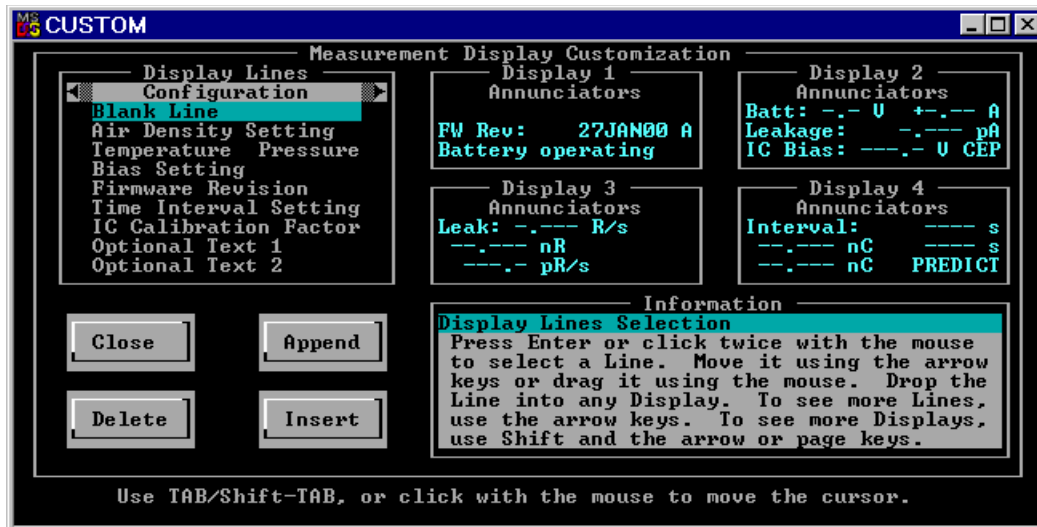


Figure B-9 shows the *Measurement Displays dialog box*.

Figure B-9. The Measurement Displays Dialog Box (shown with the rotating rack having focus)

The display lines are grouped within the Rotating Rack according to their function. The groups consist of "Configuration," "Amps, Coulombs, Volts," "Dose, Rate," and "Time." Table B-4 provides a listing of all the display lines available for each group, along with a representation of the display line's appearance on a measurement display. Refer to the *Model 35040 Therapy Dosimeter Instruction Manual* for general information on how to use the CLOSE, APPEND, DELETE, and INSERT buttons and move a display line to a measurement display.

Table B-4. Available Display Lines

Display Line		
Group (on the Rotating Rack)	Title (on the Rotating Rack)	Appearance (on a Measurement Display)
Configuration	Blank Line	
	Air Density Setting	ADCF = -.----
	Temperature Pressure	--. C ---- hPa
	Bias Setting	Set: >+----. V +----%
	Firmware Revision	FW Rev: 15OCT92 A
	Time Interval Setting	Interval: ---- s
	IC Calibration Factor	ICCF=1.234E+08 R/C
	Optional Text 1	Optional Text Line 1
	Optional Text 2	Optional Text Line 2
Amps, Coulombs, Volts	Battery Voltage	Batt: -. V +-.—A
	Leakage Current	Leakage: -.---- pA
	Bias Voltage	IC Bias: ---. V CEP
	Charge	--.---- nC
	Current	---. pA
	Accumulated Charge	--.---- nC ACCUM
	Average Current	---.— pA AVG
	Timed Charge	--.---- nC ---- s
	Predicted Timed Charge	--.---- nC PREDICT
Dose, Rate	Leakage Rate	Leak: -.---- R/s
	Dose	--.---- nR
	Rate	---. pR/s
	Accumulated Dose	--.---- nR ACCUM
	Average Rate	---. pR/min AVG
	Timed Dose	--.---- nR ---- s
	Predicted Timed Dose	--.---- nR PREDICT
Time	Time Interval Setting	Interval: ---- s
	Timed Charge	--.---- nC ---- s
	Predicted Time Chrg	--.---- nC PREDICT
	Timed Dose	--.---- nR ---- s
	Predicted Timed Dose	--.---- nR PREDICT
	Effective Exp. Time	--. s

Timer Intervals

The Model 35040 Therapy Dosimeter can contain up to twenty (20) timer interval settings, which interval settings, general editing information, and OK and CANCEL buttons.

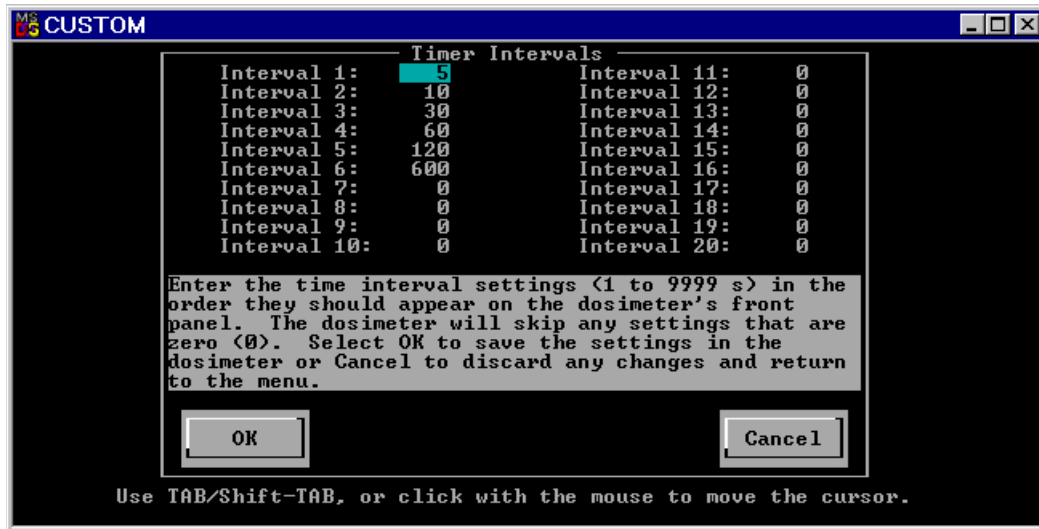


Figure B-10. The Timer Intervals dialog box

Select a field by pressing TAB until it is highlighted, or click on it with the mouse. Enter an integral number of seconds for the timer interval setting. When you select OK, the Customization software sends the timer interval settings to the instrument and returns the program to the Measurement menu. Select CANCEL or press ESC to discard any changes and return to the Measurement menu.

The Model 35040 Therapy Dosimeter displays the timer intervals in the same order they are entered. That is, it does not sort the timer interval settings. The UP arrow key displays the timer interval settings in an increasing interval number order (e.g., *Interval 1*, *Interval 2* ... *Interval 20*), while the DOWN arrow key presents the timer interval settings in a decreasing order. The instrument automatically skips any settings that have a value of zero (0).

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