User's Guide

IVD Solutions™

Model 1136 rf-IVD^2 Model 1137 IVD^2

SUN NUCLEAR
corporation

User's Guide, IVD Solutions™

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This guide is written for:

Control Module firmware:	version 2.00.00
Base/Pod firmware:	version 2.00.00
PC software:	version 2.00.00

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NOTICE: Model 1136 rf-IVD^2™ complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. FCC ID: G6P1136

CAUTION: Recommended separation distance between rf-IVD^2™ and portable and mobile RF communications equipment (such as Bluetooth, cell phones, etc.) is 0.5 meter (20 inches).

CAUTION: Any changes or modifications not expressly approved by Sun Nuclear Corporation could void the user's authority to operate this equipment.

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1 Introduction

About IVD Solutions

IVD Solutions™ is a measurement system for *In Vivo Dosimetry*—the real time measurement of radiation dose administered to a patient during therapy.

The equipment consists of two models (Figure 1-1):

- Model 1136, wireless rf-IVD^2—connected by a wireless link within the treatment vault. This eliminates cable tangle on the floor of the treatment room, providing a neater, safer environment.
- Model 1137, wired IVD^2—connected with a cable.

Figure 1-1. Model 1136 wireless and model 1137 wired detector pods

The two models are identical except for the wireless circuits and a battery in the Model 1136.

You can connect up to four diode detectors to each Pod with snap-on LEMO connectors. For example, you might have a 1-4 MV detector on channel A, a 6-12 MV diode on channel B, a 15- 25 MV diode on channel C, and an electron diode on channel D. This would allow you to use a single Pod to cover most treatment ranges. Or you could set up another Pod to measure multiple points simultaneously, such as entrance and exit doses.

Each Pod contains a complete measurement system, including electrometer, calibration memory, and communication circuits. The other parts of the system are common to all models. For example, cables, power supply, Control Module, and PC application software, are common and can be used with either model. See "Parts and accessories for the IVD Solutions" on page 9.

NOTE: Components of Models 1133/1135 can be intermixed with components of Model 1136/1137 with minor changes to hardware, software, and firmware. see "Using Model 1133/1135 components" on page 83.

Control devices

Control devices include the following:

- Control Module—desktop operating device with keypad and display
- Computer—special IVD application software on your computer

You can use either device and you can switch back and forth between them.

Control module

A Control Module is part of every system. You control the system directly with push buttons on the Control Module, and you see the results of measurements on the built-in display.

Figure 1-2. Control module

The Control Module can control one measurement Pod at a time. You can print reports on the optional thermal printer.

PC software

You can also control the system from your personal computer (PC) using the Windows software included with your system. The program collects dose measurements from the Pods and displays the dose results on the screen. You operate the system by clicking buttons on the PC screen (Figure 1-3).

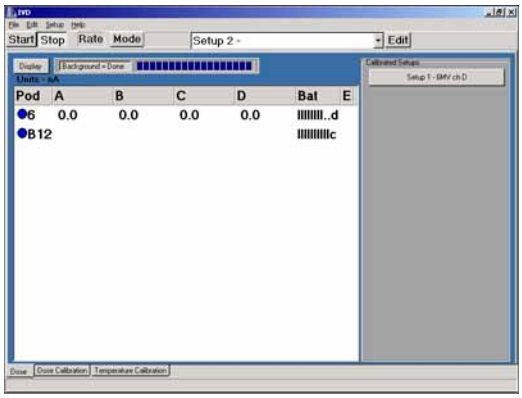


Figure 1-3. PC software control display

The software is provided on a CD and can be installed on any computer (Windows 95 or higher). Reports can be printed on any printer connected to the computer or network.

If you want to use more than one Pod (more than 4 diodes) at the same time, you MUST use the PC software. Updated software can be found on the Sun Nuclear Corporation web site.

See "Software operation" on page 41.

Applications

Features

- Wireless connection—in model 1136, the wireless connection between patient and the control station eliminates cable tangle on the treatment room floor.
- Wired connection—the system can be instantly changed to a wired connection by connecting the cables. Either wireless detector Pods or wired detector Pods can be connected. Patient safety is preserved by using a medically-approved power supply.
- Simple operation—push button energy selection makes daily operation simple.
- PIN protection—a user-furnished PIN number protects setup and calibration factors from accidental change.
- Redundancy—transceiver units are interchangeable and can be used in wireless or wired configurations. Wired and wireless Pods can be used together in a wired configuration.
- Flexible mounting and connection—small size and flexible connections allow the system to be adapted to almost any treatment room.

Dose verification

The IVD Systems equipment verifies the actual dose administered to a patient. Typically, the system is the final check of radiation administered as a part of an overall quality assurance system in a treatment facility.

Although errors due to planning, setup, calibration, and accelerator settings are extremely rare, they have occurred in the past, and it is reasonable to assume they could occur in the future.

To use the system, the technician tapes one or more diodes to the patient's skin in the area to be irradiated (Figure 1-4), then administers the treatment dose. Dose values are immediately displayed on the Control Module display or computer monitor, and a report can be printed.

Figure 1-4. Taping a QED™ diode in place on the patient

For recommendations on the use this type of system for In Vivo Dosimetry, refer to AAPM Report 87, "Diode in vivo dosimetry for patients receiving external beam radiation therapy," ISBN 1-888340-50-9, (2005), Radiation Therapy Committee, Task Group #62.

Total body irradiation (TBI)

You can also use the IVD systems equipment to verify dose administered to patients undergoing Total Body Irradiation.

With the Control Module, you can make up to 4 measurements simultaneously. The diodes can be positioned anywhere on the patient's body. Using the Control Module can control one measurement Pod with up to 4 diodes connected.

By using the IVD application software and up to seven detector Pods, you can make up to 28 measurements simultaneously. The application software allows you to log data to transfer to spreadsheets, print a report with all 28 measurements showing, and print a report with multiple exposures on a single report. See "TBI measurements with multiple pods" on page 68.

Diode selection and use

You can use a variety of diodes with the system. Diodes should be selected for the beam energy range and the type of irradiation—photon or electron.

Each diode must be calibrated before use. Diode calibration factors are stored in non-volatile memory in the Pod for the specific channel for which the diode was calibrated. Once having connected and calibrated a diode, you should leave it in that position. Each diode should be marked with a label to show where it was calibrated, and the Control Module should be similarly marked.

Sun Nuclear Corporation manufactures two types of diodes, the flat QED™ diodes and the omnidirectional IsoRad-III™ diode. Typical Sun Nuclear Diodes are listed in the table below.

Table 1-1. Sun Nuclear diode detectors suitable for use with IVD Solutions

Type	Model	Application	Output	Color
QED	1114000-0	1-4 MV	negative	Blue
	1114000-1	1-4 MV	positive	Blue
	1115000-0	6-12 MV	negative	Gold
	1115000-1	6-12 MV	positive	Gold
	1116000-0	15-25 MV	negative	Red
	1116000-1	15-25 MV	positive	Red
	1112000-0	Electron	negative	Silver
	1112000-1	Electron	positive	Silver
	1113000-0	Skin	negative	Black
	1113000-1	Skin	positive	Black
IsoRad-III	1162000-0	1-4 MV	negative	Blue
	1162000-1	1-4 MV	positive	Blue
	1163000-0	6-12 MV	negative	Gold
	1163000-1	6-12 MV	positive	Gold
	1164000-0	15-25 MV	negative	Red
	1164000-1	15-25 MV	positive	Red

Current Sun Nuclear Corporation diodes are fitted with LEMO coaxial connectors instead of BNC coaxial connectors. The LEMO connectors have smaller size and superior strength. You can still use other diodes having BNC connectors with Model 1136 or 1137 systems if you use the optional BNC to LEMO adaptor.

Figure 1-5. Using the BNC to LEMO adaptor

Specifications

Table 1-2. Specifications for IVD solutions

Category	Characteristic	Specification
Diode detector inputs	Quantity	Four channels; connection to 4 diodes
	Connector type	LEMO (BNC-LEMO adaptor available)
	Detector temperature Compensation	Auto, within 0.1 °C (negative detector current only)
	Calibration	User calibrated against ion chamber standard
	Repeatability	± 0.2% or ± 0.1 cGy
	Detector requirements	n or p type diodes responding between 5 to 100 nC/Gy
	Polarity	Bipolar, i.e., measures positive or negative detector current
	Current limit	± 40 nA average radiation current or 1.0 nC per radiation pulse
	Leakage	Auto compensation
	Warm-up time	< 30 seconds
	Environmental Temperature	15 °C to 32 °C
	Relative humidity	10% to 90% rh, non-condensing
Component definitions, size and weight	Detector Pod	Measure dose received by diode detectors, 4 diodes per Pod; 7x12x3 cm, 340 gm
	Base station	Data relay between wireless Detector Pod and Control Module; 7x12x3 cm, 340 gm
	Display	Control Module with keypad for start and display of dosimetry measurements; 14x16x3.5 cm, 780 gm
	Printer	Seiko thermal printer, model DPU-414, serial port to display, 9x320 dots/line, 40 column=9 cm; 16x17x6.6 cm, 580 gm
	Cable	Control Module to base station (located in treatment room) via 6 pin modular connector/cable, 25 m.
	Frequency	916.5 MHz for USA, 868.35 MHz for European Union
Power	Detector Pod	Rechargeable NiMH battery, 12 hour on full charge
	Control Module	Medically-approved power supply operating on 100-240 VAC, 47-63 Hz mains, providing 18 VDC output
	Electrical isolation	• Wireless—through radio frequency communication, Amplifier Sequenced Hybrid (ASH), On-Off Keyed (OOK), Manchester encoded • Hardwired—through medically approved power supply

Table 1-2. Specifications for IVD solutions (Continued)

Category	Characteristic	Specification
Control module	Dose range	0 to 99.999 Gy; 0 to 9999.9 cGy; 0 to 9999.9 R
	Display	LCD, 2 line, 16 character/line, 8 mm character height, adjustable backlight and contrast
	Functions	Dose measurement, calibration of dose and temperature coefficient, PIN protection, self diagnostics
	Measurement	2 key stroke, select energy key to start measuring, select STOP when finished.
	Software	Field updateable
	Control buttons	INCrement, PRINT, STOP, ENTER, MENU
	Keypad	12 energy keys (also serve as numeric key entry)
	Connectors	• PRINTER PWR OUT: +18 VDC out to thermal printer (if power supply connected) • +18VDC: Power input from medical power supply • PRINTER: Serial data to thermal printer • TO INST: Data and power connection to Pod • COM: Serial data to/from PC • USB: Universal serial bus data to/from PC
Pod	Functions, rf	• a) As detector Pod, measure detector current and transmit data to the base station via rf communication • b) As base station, relay data and commands between detector Pod and Control Module via wire
	Functions, wired	• Measure detector current and transmit data to Control Module
	Software	Field updateable
	End panel 1	• A, B, C, D: LEMO input connectors for diode detectors (BNC adapter available) • DS1: Green LED – battery charge status • DS2: Green LED – operational error status

	End panel 2	• J5 and J6: 6-pin modular power/data connector
		  • a) to base station when used as detector Pod (For detector Pod battery charging only)
		  • b) to detector Pod when used as Base Station (For detector Pod battery charging only)
		  • c) to 2nd detector Pod when daisy chaining when not communicating by rf
		• DC +15V: Power input, +9 to +20 VDC, barrel type connector (For battery charging only)
		• BAT 0-1: battery switch; 0=OFF, 1=ON, must be on in order to charge the battery
		• DS3: green LED transmit status
		• DS4: green LED receive status

RF transceiver specification	Frequency	Fixed frequency; 916.5MHz, ± 0.2MHz for USA; 433.92 ± 0.2MHz for European Union.
	Power	94 dBuV/m. (0.1 milliwatt)
	Modulation	On/Off keyed.
	Baud rate	4630 bits/sec.
	Antenna	50 Ohm, ¼ wave, helical whip. Mounts via “reverse SMA” connector.
	Duty cycle	approximately 20%
	Encoding	Manchester
	Filtering	SAW filtering in compliance with ETSI-ETS 300 220-1
	Interference outside shielded treatment room	none

Table 1-2. Specifications for IVD solutions (Continued)

Category	Characteristic	Specification
Windows Software Functions	Operating system	Windows 95 and higher
	Installation	Installed with CD
	START/STOP	Start or stop data acquisition of profile.
	RATE/DOSE	Display profile scale in units of rate (cGy/sec) or accumulated dose. Real time display (one update per second) allows instant feedback on machine adjustments.
	Dose view	• Calibrated setup "buttons"—provide 1-button operation. • Complete system status shown at all times. • Dose values displayed on screen immediately after exposure. • Printed report with header data
	Dose calibration view	• Hierarchical list shows all data about setup. • Complete calibration steps shown on-screen. • Complete report
	Temperature calibration view	• Hierarchical list shows all data about setup. • Complete temperature calibration steps shown on-screen.

How to use this guide

Table 1-3 summarizes the use of the various parts of this guide. The procedures are arranged sequentially.

Table 1-3. Installation, setup, and operational procedures

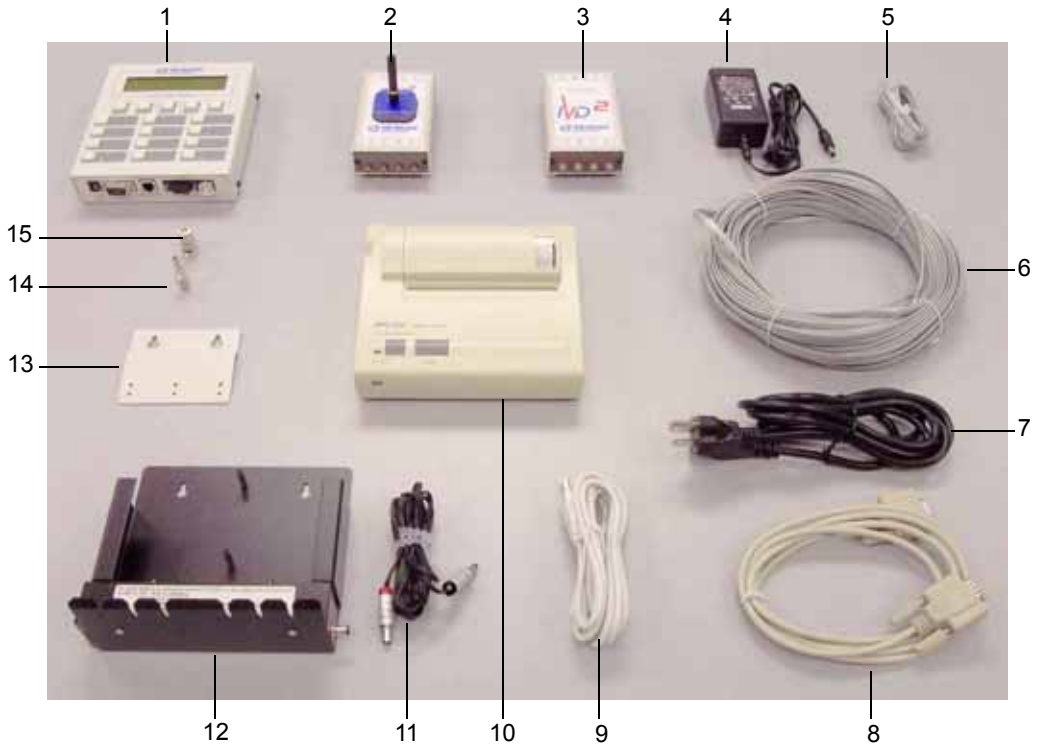
If you want to…	Perform these steps:	See	Time*	When
Install the system	• Unpack and check the hardware. • Identify and learn about the components.	"Installation" on page 9	10 to 30 min.	First time use
Connect a system	• Connect a wireless system. • Connect a wired system.	"Connections" on page 10	20 to 60 min.	First time use
Install and operate the Control Module	• Install Control Module. • Learn operation of module.	"Control module buttons and display" on page 14	10 to 120 min.	First time use
Set up a system for use with Control Module	• Start up. • Enter PIN, date and time. • Set unit and system identification numbers.	"Setup with control module" on page 18	10 to 60 min.	First time use
Calibrate a system with Control Module	• Calibrate beam energies. • Correct diodes for temperature.	"Calibration with control module" on page 24	30 min.	First time use
Make daily measurements with Control Module	• Start up. • Perform treatment. • View dose.	"Control module operation" on page 17	1 min.	Daily
Print reports with Control Module	• Select type of report. • Print reports.	"Reports from control module" on page 34	1 min.	As desired
Install and use PC software	• Install PC software. • Learn operation of software.	"To install the software" on page 41	10 to 120 min.	First time use
Set up a system for use with PC software	• Start up. • Select serial port (if required). • Enter PIN, date and time.	"Setup for PC software" on page 47	10 to 60 min.	First time use
Calibrate a system with PC software	• Calibrate beam energies. • Correct diodes for temperature.	"Calibration with PC software" on page 59	30 min.	First time use
Make daily measurements with PC software	• Start up. • Perform treatment. • View dose.	"Measurements with PC software" on page 65	1 min.	Daily
Print reports with PC software	• Select type of report. • Print reports.	"PC software reports" on page 68	1 min.	As desired

*Estimated time to completion under average conditions.

2 Installation

Unpacking

After unpacking, identify the parts and accessories in your system (Figure 2-1).



No.	Part Number	Description	Model Number	
			1136	1137
1	1136400	Control Module	1	1
2	1136300	Module, Pod/Base Station, wireless, Model 1136 rf-IVD^2	2	-
3	1137300	Module, Pod, wired, Model 1137 IVD^2	-	1
4	741008	Power supply, medical, 18 vdc, (black plug)	1	1
5	1133560	Cable, modular, phone, 6-conductor, 1 m (test cable)	1	1
6	1133550	Cable, modular, phone, 6-conductor, 25 m	1	1
7	801008	Cable, power, detachable, 6 ft, 125 V, 10 A	1	1
8	801032	Cable, serial (RS-232), DB9M to DB9F, 6 ft (printer/computer)	1	1
9	801041	Cable, USB (universal serial bus), 2 m	1	1
10	850040	Printer, thermal, control module (includes 850043 paper roll)	1	1
11	1136030	Cable, power, thermal printer, 2.5 mm plug (red), 2.1 mm plug (black)	1	1
12	1133210	Wall bracket, transceiver charging	1	-
13	113149	Wall bracket, control module	1	1
14	781048	Adapter, LEMO diode to BNC Pod connector (optional)	-	-
15	781050	Adapter, BNC diode to LEMO Pod connector (optional)	-	-
16	023000	Compact disk, SNC software and manuals (not shown)	1	1
17	1136012	*Getting Started* booklet (not shown)	1	1

Figure 2-1. Parts and accessories for the IVD Solutions

Connections

Types of connections

You have several choices for connecting the Model 1136/1137 IVD Solutions system:

- Control device—Control Module or PC.
- Communication path—wireless or wired. The Model 1136 detector Pod can communicate via a wireless link or directly if connected to a cable.

The standard control device is the Control Module, although you can also use a personal computer (PC). Either control will work with the same Pods and cables, but there are differences in the connections.

Figure 2-2 shows a typical wireless connection using a Control Module. System power connects to the power supply, which connects to the Control Module. The Control Module connects to the Base Station via a 25-meter cable that is routed through the cable conduit between the control room and the treatment room. The Base Station and Pod can operate on rechargeable batteries.

Figure 2-2. Typical wireless system connection with control module

Wireless connections

In a normal wireless connection (Figure 2-3), you pull the 25-meter cable (P/N 1133550) through the conduit between the control room and the shielded treatment vault. One end of the long cable plugs into the Model 1136 base station which is placed in the charging wall bracket (P/N 1133210). The other end of the cable plugs into the Control Module.

NOTE: Base station and pods are identical and interchangeable during setup.

The medical power supply (P/N 741008) connects to the Control Module and furnishes power for the Control Module, the printer, and the charging wall bracket. To apply power, plug the medical power supply into any wall outlet with 110 to 230 VAC, 50 to 60 Hz power. The power supply is auto-switching.

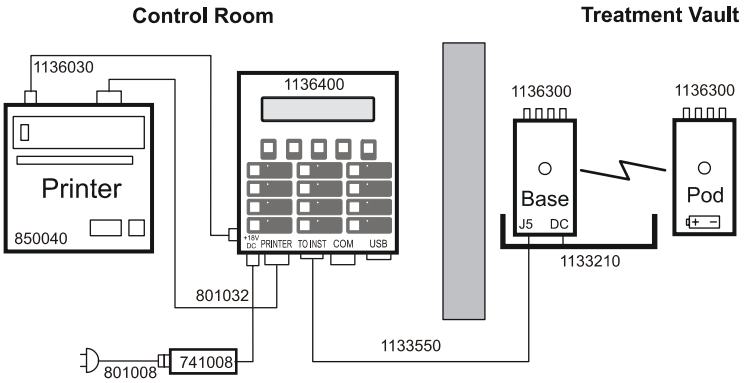


Figure 2-3. Wireless connection with control module

NOTE: To identify part numbers shown in connection diagrams, See Figure 2-1.

When the Pod is removed from the charging wall bracket for use, it operates on battery, providing patient isolation. After use, the battery is recharged in the wall bracket.

You can also connect a personal computer (Figure 2-4) to control the system. In this connection, the computer controls operation instead of the Control Module. You can connect to the computer via either a COM (serial) port or a USB port.

While the PC is controlling the system, the Control Module's functions are locked out. The Control Module screen displays "System under PC Control. 30." Pushing any buttons results in just a beep. The "30" (seconds) will start counting down (at one count per second) if the PC software is closed or disconnected. If the countdown reaches zero, the Control Module resumes stand-alone operation.

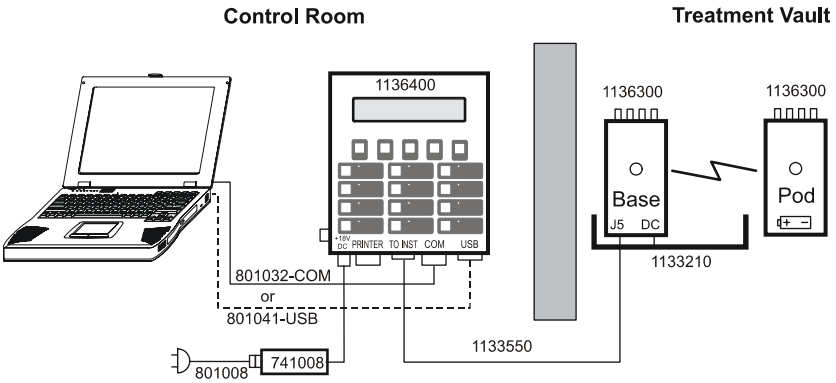


Figure 2-4. Wireless connection with PC

Wired connections

The normal wired connection (Figure 2-5) is identical to the wireless connection except that the diodes are connected directly to the Pod which is wired to the Control Module. You pull the 25-meter cable (P/N 1133550) through the conduit between the control room and the shielded treatment vault. One end of the long cable plugs into the Model 1137 Pod. The other end of the cable plugs into the Control Module. The Model 1137 Pod does not have a battery since it operates on cable power. The medical power supply provides patient isolation.

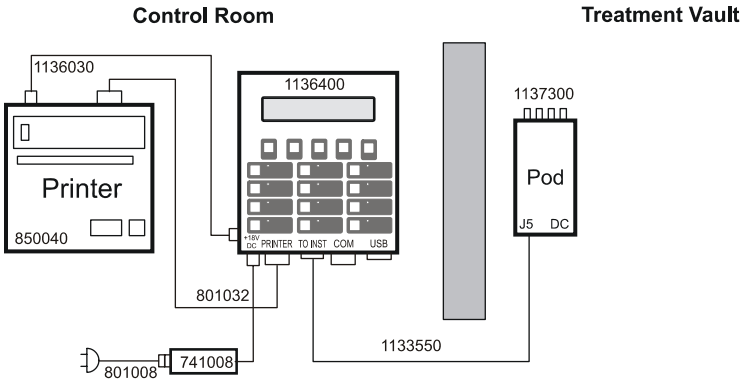


Figure 2-5. Wired connection with control module

A wired connection with a computer (Figure 2-6) is almost the same as with the Control Module. You can connect to the computer's COM (serial) or USB port.

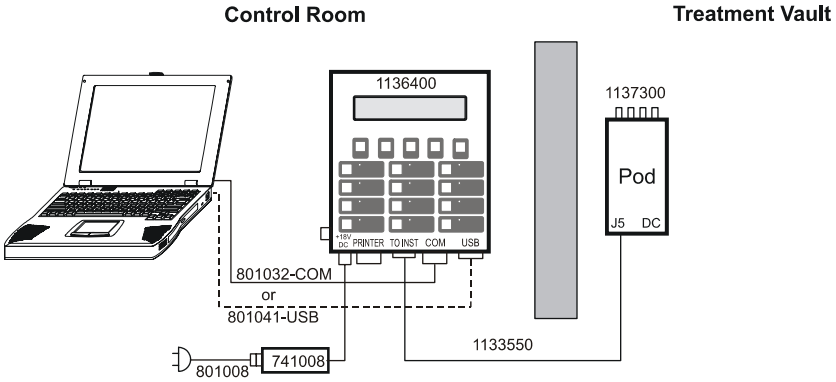


Figure 2-6. Wired connection with PC

NOTE: Wired connections can also be used with a Model 1136 rf-IVD pod if one pod is damaged or the battery is discharged.

Connections with multiple pods

Multiple Pods are only possible when using the PC software. If you use the Control Module, only a single Pod can be used.

For specialized measurements, you can connect up to 7 wired Pods in a single setup using the PC software. The Pods can be connected by connecting a 6-conductor cable, daisy-chained via the J5 and J6 ports (Figure 2-7). Since each Pod can accommodate 4 diodes, you can record up to 28 measurements during a single exposure.

You can connect up to 13 wireless Pods in a single setup using the PC software. This allows up to 52 measurements to made during a single exposure.

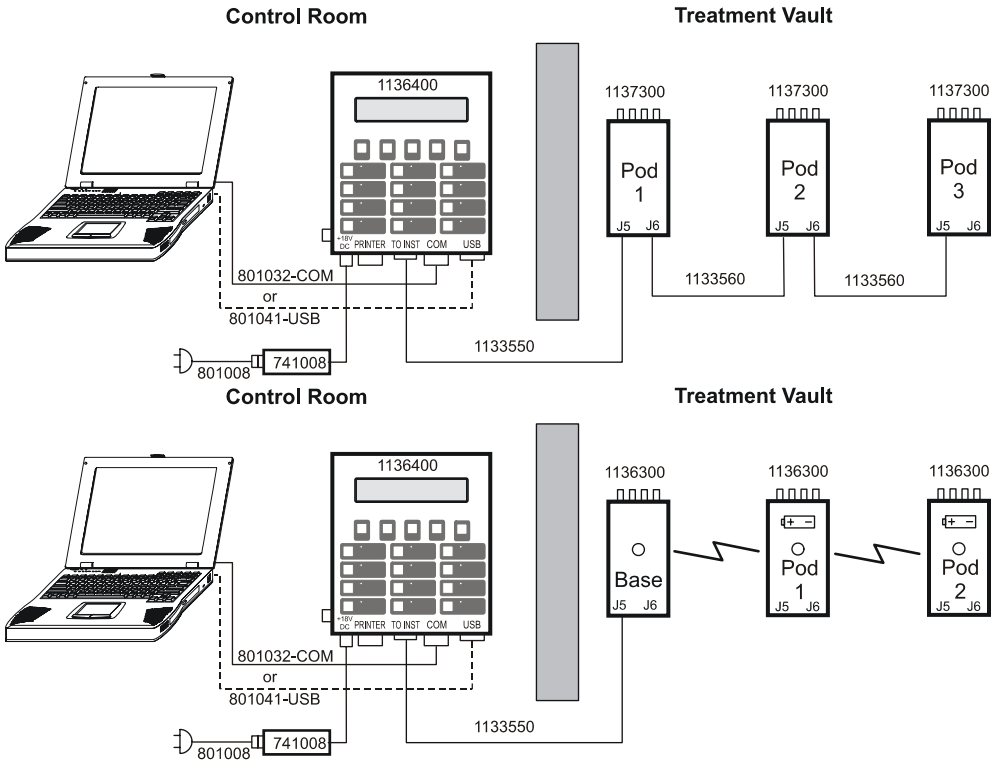


Figure 2-7. Connections with multiple wired and wireless pods

Wall brackets

Two types of wall brackets are furnished:

- The charging wall bracket (P/N 1133210) is mounted on the treatment room wall and contains powered mounting slots for the Base Station and the Detector Pod (Figure 2-8). DC power is supplied to the wall bracket. When the Pod is removed for daily use, it becomes battery powered. At the end of a patient session and at the end of the day, the Pod is returned to its slot in the wall bracket to be charged to full capacity overnight.
  - Attach the charging wall bracket to the treatment room wall with two suitable screws to fit the slotted holes in the back of the wall hanger.
  - Feed the 6-conductor flat cable from the Control Module through the hole in the left side and connect to the Base Station.
  - Place the Base Station on left side of the wall bracket. Charging power is provided via the 6-conductor flat cable from the Control Module.
  - Place the Pod in the right side of the wall bracket. If desired, diode leads can be left attached to the Pod, and the diodes can be inserted in the slots on the front of the wall bracket.

Figure 2-8. Wall bracket stores pod and diodes while charging battery

- If you are using multiple Pods, you can daisy-chain the wall brackets together (Figure 2-9). The connector on the bottom right of the first fits into a receptacle on the bottom left to the next bracket.

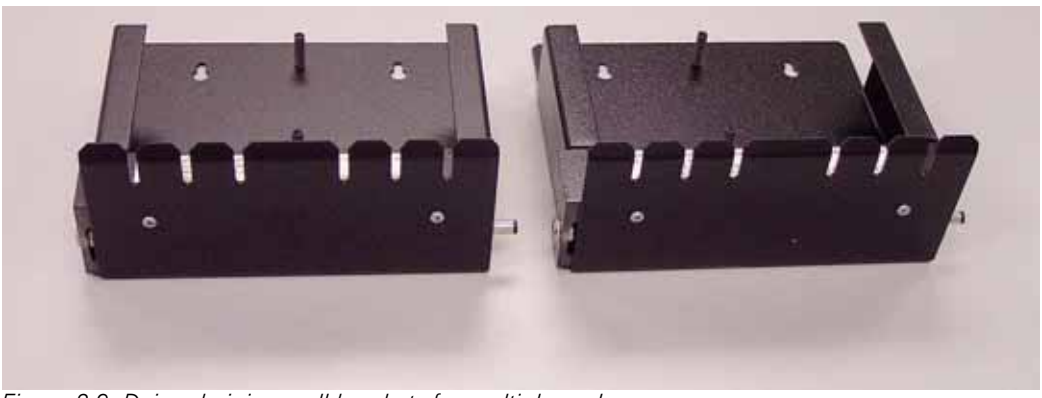


Figure 2-9. Daisy-chaining wall brackets for multiple pods

- The Control Module wall bracket (P/N 113149) lets you mount the Control Module on the wall at the control station to allow more space on the desktop. The Control Module wall bracket is attached to the back of the Control Module with three, 6-32 x 3/16 pan head screws. To use the wall hanger, insert two suitable screws into the wall to fit the slotted holes in the back of the wall hanger.

Control module buttons and display

Control module front panel

The Control Module front panel (Figure 2-10) consists of a 2-line, 16-character liquid crystal display, Status LEDs, Function buttons, and Energy keys/keypad. The display shows measurements as well as abbreviated instructions to prompt you during special modes.

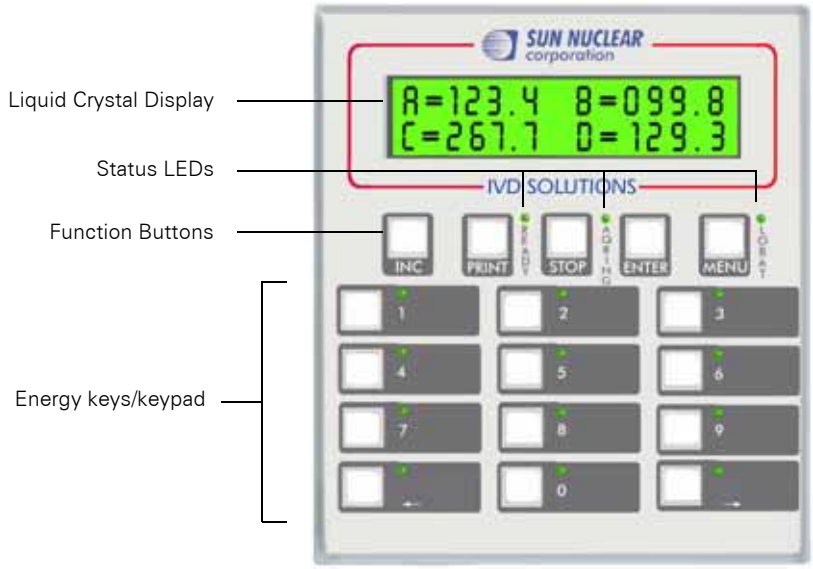


Figure 2-10. Control module front panel

Primary and alternate screens

The display consists of two types of screens: primary and alternate. The primary screen provides information or measurements for you; the alternate screens are hints or instructions that tell you what to do next.

The primary screen appears when you select a menu item, initiate an action, or complete a measurement. The alternate screen appears a few seconds later if you haven't made an input or selected another activity. The alternate screen gives suggestions on what you should do next. If there is still no activity for a few seconds, the alternate screen switches back to the main screen. The two screens will switch back and forth until you take some action.

For example,

- After the initialization, the Main screen appears. This Primary screen requests you to press an Energy key to start measuring:

```
ENERGY KEY to
Start measuring
```

- If you don't press an energy key within a few seconds, an Alternate screen offers a suggestion:

```
MENU for more
options
```

LEDs

- READY—on when the system is ready to make a measurement.
- AQRING—on during a measurement.
- LOW BAT—on if the Base Station or Pod battery is discharging and the running time for any of these units is less than 30 minutes.

Function buttons

- INC—increments through the displayed calibration factors.
- PRINT—sends data to the optional printer.
- STOP—stops an acquisition; enters spaces for numeric entry; cancels any of the menu modes.
- ENTER—accepts the action.
- MENU—displays a list of menu items.

Energy buttons/keypad

These buttons are used for starting acquisition and entering numbers. The energy button's LED is lit when its button has been calibrated. An energy button's LED blinks when it is the active button while acquiring, or when there is a displayed measurement from a previous acquisition.

Each energy button has an alternate keypad number or entry arrow function associated with it.

When the cursor is blinking on a screen location, a numeric entry is expected at that location. Numeric entries are left justified. When the numeric key is pressed, the screen location updates with that entry, and the cursor location automatically advances to the next location. The STOP button will enter a blank.

The left and right arrow keys on the keypad can be used to move the cursor without a numeric entry. If the cursor is on the top line in a numeric entry location and the right cursor is pressed to the end of the numeric field, then the next press will advance to the first numeric location on the bottom line. Advancement will continue to the right until the last numeric field location and then jump back up to the top left.

Software installation

You can operate the system directly from your PC by installing special application software.

See "Software operation" on page 41.

3 Control module operation

Planning to use IVD Solutions

Energy keys

The system is designed for one-button setup when using the Control Module:

- Tape the diode(s) to the patient
- Press a single "Energy Key" to select a setup and start collection
- Deliver the dose
- Press the Stop button to stop collection
- Read the measured dose on the display
- Print a report on the thermal printer

This sequence can be repeated over and over throughout the day's treatments with minimal effort by the technician.

The 12 "Energy Keys" on the front of the Control Module correspond to 12 memory locations in the connected Pod. Each key or memory location represents a stored setup, including energy, diode serial numbers, channels assigned, calibration values for each diode, and temperature correction factors.

Examples of system setup

Before use, the physicist should decide what measurements are to be made, select and calibrate the appropriate diodes, store the setup and calibration data in the memory locations, and label the energy keys on the Control Module.

Example 1

The physicist decides to set up four single measurements for the normal energy types using a single Pod. The physicist selects four QED diodes, connects them to channels A through D, enters the data into the Pod's memory locations 1 through 4, and sets up buttons 1 through 4 as shown in the following table.

Table 3-1. Example setup of four diodes to be used singly for different ranges

Channel	Diode	Serial No.	Energy Range	Energy Key	Technician Action
A	QED	000021	1-4 MV (blue)	1	Tape blue diode to patient, press 1, administer 1-4 MV photon dose, read value, print report. The other 3 diodes are not used.
B	QED	000022	6-12 MV (gold)	2	Tape gold diode to patient, press 2, administer 6-12 MV photon dose, read value, print report. The other 3 diodes are not used.
C	QED	000023	15-25 MV (red)	3	Tape red diode to patient, press 3, administer 15-25 MV photon dose, read value, print report. The other 3 diodes are not used.
D	QED	000024	electron (silver)	4	Tape silver diode to patient, press 4, administer electron dose, read value, print report. The other 3 diodes are not used.

Example 2

The physicist wants another setup in which two diodes simultaneously measure entrance and exit dose in the 6-12 MV range. The physicist selects the gold QED diode which remains connected to channel B and replaces the channel D diode with a skin diode. Thus the new setup is as shown in the following table.

Table 3-2. Example setup of two diodes to be used in combination

Channel	Diode	Serial No.	Energy Range	Energy Key	Technician Action
B	QED	000022	6-12 MV (gold)	5	Tape gold diode to top surface of patient, tape black diode (000025) beneath patient press energy key 5, administer dose, read values, print report.
D	QED	000025	scatter (black)		

In the above example, the physicist can simply transfer the calibration for gold diode 000022 to memory location 5, but the skin diode, 000025, must be newly calibrated for this setup. The data for both diodes is stored in memory location 5. To shift from example 1 to this setup, the technician must know that electron diode must be removed from channel D and the scatter diode installed in its place. There are no copy or edit functions for calibration factors in the Control Module. There is only recalibration.

Setup with control module

Initializing

1 Connect cables and power as described in Section 2. See "Connections" on page 10.

CAUTION: To obtain a valid background measurement, the diodes must be connected to the detector Pod before applying power to the Control Module.

2 Connect the correct diodes to the Detector Pod. (They can remain connected.)

- The same diodes used for calibration must be connected to the same terminals that were used during calibration.
- Diodes must be connected before powering the Control Module to get a valid background measurement.

3 Verify that the correct Pod is connected.

- Calibration factors are stored in the Pod's memory.

4 Apply power to the Control Module. When power is applied to the Control Module, the display powers up and shows the "Initializing" message.

```
  Initializing
||||||||||||
```

- Then the system looks for system components and displays "Finding Pod #NN," the last-used Pod number.
- If a different Pod is found, the message "Found Pod #NN" is displayed. This means that the Pod being sought is switched off or the connection has changed. If you have deliberately changed connections and want to use a different Pod, press ENTER to select the new Pod. See "System select" on page 20.

5 If all the hardware for this system is found, the Background collection screen appears.

```
Measuring
BACKGROUND... 20
```

- This is the initial background collection screen before data acquisition.
- Background measurement takes about 20 seconds. During this time the alternate screen displays "Please wait" and numbers in the lower right hand corner count down from 20.

```
Please wait
                15
```

6 The Control Module displays the "Main screen." After initialization, the Control Module can be left on indefinitely. There is no ON/Off switch.

7 If you are using an rf-IVD[2] system, perform a battery check (see "Battery check" on page 20). If the battery check shows B=N/A, you have set the system up as a wired system. See Figure 2-3 or Figure 2-4.

"Main" screen

Once the initialization, system check, and background acquisition are complete, the "Main screen" will be displayed.

- With this message displayed, the system is ready to make a measurement. The energy keys that have calibration values for connected detectors will have their corresponding LEDs lighted.

```
ENERGY KEY to
Start measuring
```

- Once an acquisition has been completed, the Main screen will be displayed while background collection is done.
- The alternate screen for the Main screen reminds you that more options are available by pressing the MENU button.

```
MENU for more
options
```

When the Main screen is displayed, the system is ready for a measurement.

After the first measurement, the Main screen shows the results of the last measurement taken.

```
A=99.8   B=102.1
C=98.4   D=99.6
```

Menu functions

Menu items below are used for system setup and calibration.

Table 3-3. Control module menu functions

Menu Item	What it does	Comments	Page
Battery Check	Shows battery charge for all units		20
System Select	Selects the Pod number		20
Display Adjust	Controls brightness and contrast		21
Time and Date	Sets time and date		21
Software Version	Displays software version for each unit in system		21
Dose Calibration	Sets calibration for an energy button	PIN required	22
View Calibration	Displays calibration results for an energy button	PIN required	22
Temperature Coef	Determines temperature correction coefficient	PIN required	22
Dose Unit Setup	Selects dose unit for display		22
Device ID Setup	Sets ID number for each unit	PIN required	22
PIN Setup	Enters or changes PIN	PIN required	23
Physics Mode	Switches to Physics Mode for testing, calibration, or setup	PIN required	23
Institution Name	Sets optional institution name to be printed on reports		24

NOTE: Once you have opened the menu, you can use the arrow keys to scroll through the menu.

Menu operation

The menu is accessible from the Main screen when acquisition is not going on. Each menu item has a normal screen.

1. Press MENU button. The first menu item appears.
2. After a few seconds, the alternate screen appears.
3. Continue pressing MENU button (or press the arrow keys) to scroll through the menu items.

```
Press MENU for
next item
```

4. At any time while stepping through the menu, the STOP button can be used to leave the menu and return to the Main screen.

Initial settings

For first-time use, select the preferences you want from the menu:

1. If you want to enter an administrator PIN (personal identification number) see "PIN setup" on page 23. Using a PIN forces you to enter the PIN prior to making important settings. This prevents accidental or inadvertent changes when several people are using the system. If you don't want to use a PIN, do not enter a PIN initially, or if there is already a PIN, change the existing PIN to 0000.
2. To adjust the display brightness and contrast, see "Display adjust" on page 21.
3. To check and change the time and date, see "Time and date" on page 21.
4. The default dose unit for display is cGy. To change to Gy or Rad, see "Dose unit setup" on page 22.
5. Each unit is assigned a number. To change a device ID, see "Device ID setup" on page 22.
6. You can enter an optional Institution Name to be printed at the top of each printed report. See "Institution name" on page 24.

Battery check

This menu item is used to check the remaining battery life and the state of each battery (Model 1136 only). Administrator pin is not needed.

NOTE: Battery check shows "predicted" battery life, which may differ from actual battery life. See "About predicted battery life" on page 87.

1. Press MENU button. The first menu item appears, which is "Battery Check."

```
Battery Check
Press ENTER
```

2. Press ENTER. The status of each battery is shown.
   - Unit Name.
   - Bar scale shows the measurement time left. A full bar scale is equivalent to 10 to 12 hours of normal operation, enough to complete an 8-hour shift.

```
Base: |||||| chg
 Pod: ||||   dch
```

   - Status: chg=charging (battery is discharged and is charging at maximum rate), trc=trickle charging (a full charge is being maintained with a trickle of power), dch=discharging, off= battery switch is off, ???????=unit not found, N/A=system selected has no base station. If a base station is desired, change system select.
   - A battery can show "off" when fully charged.
   - "N/A" means that the wireless system selected has no base station or has the wrong Pod selected in the System Select. See "System select" below.
3. Press STOP to exit and return to Main screen.

System select

This menu item selects the present configuration by selecting a unit and designating it as the Pod. This ensures that all the correct units are connected and communicating, and that the correct calibration factors (stored in the Pod) are used. Administrator PIN is not needed.

1. Press MENU button. The first menu item appears.
2. Continue pressing MENU button until "System Select" screen appears.

```
System Select
Press ENTER
```

3. Press ENTER.
4. The current Pod identification number is shown. Use the arrow keys to increment or decrement the Pod identification (ID) number.

```
Use ARROWS to
select Pod ID=02
```

   - Each Pod is assigned a unique number from 02 to 15.

- A wired system (model 1137) has one or more measurement Pods. If a wireless system (model 1136) is being used, a Base Station is also required.

5 Press ENTER to confirm and save the Pod number or STOP to abort.

```
ENTER= Accept
STOP = Exit
```

- Accepting a new number causes the system to re-initialize with the new Pod number.
- STOP returns to Main screen.

Display adjust

This menu item is used to adjust the brightness and contrast of the screen. Administrator pin is not needed.

1 Press MENU button. The first menu item appears.

2 Continue pressing MENU button until “Display Adjust” screen appears.

3 Press ENTER. Then press the arrow keys on the keypad to adjust the screen brightness. Continue pressing arrow keys until the brightness is at the desired level.

```
Use < > to
set brightness
```

4 Press ENTER to save the selected level of brightness and continue to the contrast screen.

5 Use the arrows to select the desired contrast. Continue pressing to increase or decrease the contrast.

```
Use < > to
set contrast
```

6 Press ENTER to select the contrast and exit this menu item. The display returns to the Main screen.

Time and date

This menu item is used to set the display's internal clock. Administrator pin is not needed.

1 Press MENU button. The first menu item appears.

2 Continue pressing MENU button until “Time and Date” screen appears.

```
Time and Date
Press ENTER
```

3 Press ENTER. The display shows the current time as hours: minutes: seconds and the date as day/month/year.

- A cursor bar appears under the character to be changed.
- Use arrow keys to move cursor around.
- Use number keys to enter the time in HHMMSS format (hours, minutes, seconds) and date as DDMMYY (day, month, year).

```
HHMMSS: 15:27:59
DDMMYY: 18/04/05
```

- When a digit is changed, the change is written to the internal clock.

4 Press ENTER to leave the menu item, and return to the Main screen.

Software version

This menu item is used to display the embedded firmware versions of all the units. Administrator pin is not needed.

You may need to check the software version when speaking to Sun Nuclear Corporation Technical Support and to check that the Base Station and Pod have the same version.

1 Press MENU button. The first menu item appears.

2 Continue pressing MENU button until “Software Version” screen appears.

```
Software Version
Press ENTER
```

3 Press ENTER. The software versions appear on the display. Units are identified by letters:

D=Display; B=Base Station; P=Pod

```
D=10200 B=10000
P=10000
```

4 Press ENTER or STOP to return to the Main screen.

NOTE: Base and Pod software versions should be the same.

Dose calibration

This menu item is described in the calibration procedure. See "Dose calibration" on page 24.

View calibration

This menu item is described in the calibration procedure. See "View calibration" on page 26.

Temperature coef

This menu item is described in the calibration procedure. See "Temperature coefficient (Tc)" on page 27.

Dose unit setup

This menu item is used to select the dose units that are displayed and printed. Administrator PIN is not needed.

1 Press MENU button.

2 Continue pressing MENU button until the "Dose Unit" screen appears.

```
Dose Unit
Press ENTER
```

3 Press ENTER button.

4 Press the arrow keys to cycle through the list of units.
   - Units are cGy (centigray), Gy (gray), Rads (rad).

```
< > select dose
unit: cGy
```

5 Press ENTER button to confirm or STOP button to abort the change.

6 An alternate screen prompts this change.

```
ENTER= Confirm
STOP = Abort
```

7 At any time during the process:
   - Pushing the ENTER button selects that unit of measurement, leaves the menu item, and goes back to the Main screen.
   - Pushing the STOP button leaves this menu item and goes back to the Main screen.

Device ID setup

Device ID numbers are assigned at the factory. You can use this menu item to change the Identification code (ID) of a Pod. Normally they will not be changed throughout their life. However, if you happen to purchase additional Pods, exchange Pods from another treatment room, or are using Pods from two different systems, you may need to change a device ID number to prevent having duplicate numbers. Administrator pin is needed.

1 Press MENU button. The first menu item appears.

2 Continue pressing MENU button until "Device ID Edit" screen appears.

```
Device ID Setup
Press ENTER
```

3 Press ENTER.

4 Key in the 4-digit Administrator PIN number, and press ENTER.

5 Use the arrow keys to increment or decrement the ID number or use number keys to enter the ID.
   - The ID that is displayed will be the current ID.
   - The ID is a number from 02-15.

```
< > Change ID:02
```

6 Press ENTER button to select the new ID or STOP to keep the old ID.
   - After changing the Pod's ID, you will be prompted to Select system. See "System select" on page 20. After selecting the new Pod, the system will re-initialize.

```
ENTER = Confirm
STOP = Abort
```

- If the Pod number is unchanged or STOP is pressed, the display returns to the Main screen.

PIN setup

This menu item is used to set up a PIN (Personal Identification Number). The administrator PIN avoids accidental changes to setup and calibration. Default for the "Pin Setup" screen is 0000, which is No PIN.

1. Press MENU button. The first menu item appears.
2. Continue pressing MENU button until "PIN Setup" screen appears.
3. Press ENTER.
4. Key in the 4-digit Administrator PIN number, and press ENTER. If no PIN is set, enter 0000.

```
Key in pin#____
then ENTER
```

NOTE: If the PIN is lost or forgotten, the physicist can key in "911" to display the stored PIN. After 911 is entered, fill in the stored PIN and press ENTER to continue. Then the existing PIN can be used, or the PIN can be changed.

5. The "Key in new PIN #" screen appears.

```
Key in new PIN #
9999  Then ENTER
```

6. Use the number keys to enter a 4-digit PIN. When entering the numbers:
   - The arrow keys can be used to scroll left or right.
   - The un-initialized value is all 0's and is invalid for a PIN.
   - All 4 digits must be used.
   - To remove a PIN, enter four zeros when prompted.
7. Press ENTER to confirm or STOP to abort without change. The display returns to the Main screen.

```
ENTER= Confirm
STOP = Abort
```

Physics mode

Physics Mode is a special mode for the physicist to test and calibrate equipment. Administrator pin is needed. Physics Mode allows the physicist to set up a variety of configurations for testing and calibration.

To use Physics Mode:

1. Press MENU button. The first menu item appears.
2. Continue pressing MENU button until "Physics Mode" screen appears.

```
Physics Mode
Press ENTER
```

3. Press ENTER.
4. Key in the 4-digit Administrator PIN number, and press ENTER.
5. Pressing the ENTER button turns ON Physics Mode and momentarily displays the message "Physics mode is now on."

```
ENTER= Mode ON
STOP = Mode OFF
```

   - The display returns to the Main screen in Physics Mode.
   - If the system is powered down while in the Physics Mode, it will automatically switch back to normal mode when powered up again.
   - If the Physics Mode is inactive for 1 hour, the system will automatically revert back to standard mode.

NOTE: When Physics Mode is active, the letter 'P' appears in the lower right hand corner of the dose display.

```
A=9.9    B=9.9
C=9.9    cGy     P
```

6. Pressing STOP turns the Physics mode OFF and momentarily displays the message "Physics mode is now off."
   - To turn off Physics mode, press MENU, scroll to Physics Mode, enter PIN, and press STOP; or, power down the system.

Institution name

An optional Institutional name can be entered via the menu that will appear at the top of every printed report. The Institution name can be a maximum of 32 characters and will be centered on the top text line of each printed report. Administrator PIN is not needed.

1. Press MENU button. The first menu item appears.
2. Continue pressing MENU button until "Institution Name" appears.

```
Institution Name
Press ENTER
```

3. Press ENTER to continue. A blank screen appears. The cursor appears in the upper left space on the screen.
4. To enter the first character, press the INC key to scroll through a list of characters. Available characters are 0-9, A-Z,. :, &.
5. To move the cursor, press the arrow keys.
6. When finished entering the institution name, press ENTER to accept or STOP to abort.

Calibration with control module

Calibration overview

Before using the IVD, you must calibrate the system for beam energies and temperature response (negative diodes only). Both of these calibration factors are stored in non-volatile memory in the Detector Pod on which the calibration was performed.

Beam energy calibration is assigned to a specific button; temperature correction factor is assigned to all buttons using the diode serial number and exposure parameters to which the temperature correction factor applies.

In daily operation, pressing a single calibrated energy button prepares the system for measurement. One-button operation simplifies the therapist's daily work.

To standardize setup and prevent mistakes in operation, the physicist should consider the following suggestions:

- Select one of the connection methods appropriate to your needs and stick with it.
- Mark each Pod and Base Station with its unit number. Remember, correction factors are stored in each Pod, not the Control Module.
- Place an adhesive label next to each energy button calibrated, and mark the parameters to which the button was calibrated.
- If you have multiple Pods, use a consistent method for assigning buttons to beam energies. Example: button 1=6 Mev, button 2=18 Mev, etc. on all Pods.
- Use consistent placement of diodes on Pod connectors A, B, C, and D.

Dose calibration

This menu item is used to complete dose calibration on a per-button basis. Administrator pin is needed.

1. Press MENU button. The first menu item appears.
2. Continue pressing MENU button until "Dose Calibration" screen appears.

```
Dose Calibration
Press ENTER
```

3. Press ENTER.
4. Key in the 4-digit Administrator PIN number, and press ENTER.
5. Fill in the blank spaces in front of either "Xray" or "Electron" with the value of the beam energy you will use during calibration.

```
Key in MV or MeV
__Xray__Electron
```

   - Only one field may contain a numeric entry. If you attempt to enter numbers for both X-ray and Electron, an error message appears.

- If a numeric entry starts in the other field, clear the old field by entering zeros in it.

6 After keying in the beam energy, press ENTER.

7 Key in the serial numbers (s/n's) of the detectors connected to the A, B, C, and D connectors (type over the "s/n" characters).

```
A s/n    B s/n
C s/n    D s/n
```

- To edit a serial number after entry, move the cursor (using the arrow keys) to the required location and key in the appropriate numeric value. Example: If a number such as 1376027 is to be replaced with a number 3487, then start at the left cursor position and enter 0 0 0 3 4 8 7.
- Serial numbers will be from 1 to 9999999.
- No spaces are allowed.
- If no serial number is entered, the serial number will be saved as 0.
- Duplicate serial numbers on multiple channels are not allowed.

```
Error, duplicate
s/n's not valid
```

- Serial numbers are left justified.
- If intermediate blanks occur in a serial number or if two channels have the same serial number when ENTER is pressed, the system will assume that the serial numbers are invalid.
- The serial number can be cleared by entering 0 for all digits.

8 Press ENTER.

9 Set up the machine to deliver the specified dose that you wish to calibrate.

10 Press the energy key which is to be calibrated.

```
Press ENERGY KEY
to start
```

- The LED is out for un-calibrated energy keys. The LED is on if a key has already been calibrated.
- If you select a key that was previously calibrated, the new calibration will overwrite the old calibration.
- An alternate screen may appear with additional instructions.

```
Select key for
CALIBRATION
```

11 After the energy key has been pressed, its corresponding LED blinks, the AQRING LED turns on, and the message "Starting..." is briefly displayed.

12 Counts are displayed for connected diodes.

```
A±       B±
C±       D±
```

13 Within a few seconds, the alternate screen will instruct you to "Turn on beam."

14 Turn beam on. The alternate screen will change to "Measuring, please wait."

15 The primary screen will show the changing counts.

- Counts are background-compensated just as in a typical dose measurement.
- Both negative and positive numbers can be displayed.
- A lower case channel letter will be used and a '~' will be displayed in the '=' sign position to let you know when a bad background was collected. i.e. accelerator was on, or excessive leakage.

16 When the beam turns off, press STOP.

- The message "Stop when done" will display when the beam turns off.
- The message "Stopping..." will briefly appear.
- The number of counts will be shown.
- The measurement Pod will automatically detect when the beam turns off and will make a temperature measurement (negative output diodes only).

17 After Stop is pressed, key in the dose delivered.

```
Key in dose
0000.00 cGy
```

- Use keypad to enter numbers, arrows to move cursor. Typical entries will be in hundreds of cGy, example: 100.0 cGy
- Units can be changed to either cGy, Gy, or Rad in the "Dose Unit" menu item. If the units are changed after calibration, the display will compensate with the decimal shift in Gy (1 Rad = 1 cGy, 1 Gy = 100 cGy).

18 After the dose value has been keyed in and ENTER pressed, the first calibration factor will be shown.

```
A Cf=-0.9999999
Sn=9999999 99MeV
```

- A, B, C=diode terminal; Cf = the calculated calibration factor; Sn=serial number of diode
- The Calibration Factors will always be less than 1.
- The Cf can be positive or negative, depending upon the sign of the measured current.
- Calibration factors are stored in the Pod, not Display. Each Pod contains its unique calibration factors.

19 Press INC to scroll, in a continuous loop, through the calibration factors for A, B, C, and D.

```
INC=Scroll ENTER
=Save STOP=Abort
```

20 Pressing PRINT will print a report for this calibration. For printout details, see "Dose calibration report" on page 75.

21 Press ENTER to save the calibration or press STOP to abort.

- Pressing ENTER saves the calibration factors to the measurement Pod, displays the brief message "Saving...," leaves the calibration menu item, and returns to the Main screen.
- Pressing STOP exits the procedure without saving the calibration factors and returns the display to the Main screen.

CAUTION: Validate after calibration!

---

22 Immediately after calibration, the diode calibration should be validated at the same reference conditions used during calibration. This measurement should be performed in the same manner as will be used for patient dosimetry. (See "Control module operation" on page 17.) These results should be recorded for future reference and repeated at least monthly for trend analysis.

View calibration

This menu item is used to display, print, and delete the calibration factors for the selected button. Administrator pin is needed.

To view calibration

1 Press MENU button. The first menu item appears.

2 Continue pressing MENU button until "View Calibration" screen appears.

```
View Calibration
Press ENTER
```

3 Press ENTER.

4 Key in the 4-digit administrator PIN number, and press ENTER.

5 A new screen appears. Press the energy key whose calibration you want to view.

```
ENERGY KEY to
select Cal
```

- The LED for the energy button being reviewed will blink.

6 The first calibration factor (diode A) appears along with the diode serial number and beam energy for the calibration.

```
A Cf=-0.9999999
Sn=9999999 99MeV
```

7 Press INC to scroll to the other diodes.

```
INC=Scroll ENTER
=More STOP=Abort
```

- Continue Pressing INC to scroll through the calibration factors in a continuous loop.
- Press ENTER to go back to "Energy key to select Cal" screen and select another button to review.
- Press STOP to exit.

Print calibration

8 Press PRINT to print out a report for this calibration. For printout details, see "Reports from control module" on page 34.

Delete calibration

9 To delete the button's calibration factors, press both arrow keys at the same time.

10 Verify you want to clear the calibration factor that is being reviewed.

```
Delete Cal?
ENTER=Y STOP=N
```

- If the ENTER is pressed, the message "Deleting..." will be briefly displayed, the calibration factors for the button will be permanently deleted, and the LED will turn off.
- If STOP is pressed, the calibration factors will not be deleted.

11 Display returns to the "ENERGY KEY to select cal" screen. Press another button to view another calibration or press STOP to return to the Main screen.

Temperature coefficient (Tc)

The dose response of diodes varies with changes in temperature. The "Temperature coefficient" (Tc) is the fractional change in response per unit of junction voltage across the diode. The junction voltage varies inversely with the temperature, and is measured with a 12-bit analog-to-digital converter. For most diodes, a change of approximately 10 analog-to-digital units is equivalent to a change of 1 degree Celsius.

In models 1136 and 1137, you must determine your own temperature coefficient by either:

- Using a lookup table and entering a value (see below)
- Measuring temperature coefficient (see "Temperature coefficient measurement" on page 28)

Temperature coefficient table

The temperature coefficient table provides reasonably accurate temperature coefficients based on the model number, serial number, and manufacturer of the diode you are using.

Table 3-4. Nominal temperature coefficients of commercial diode detectors

Detector name	Manufacturer	Temperature coefficient (%/°C)	V' (mV/°C)
Isorad	Sun Nuclear	0.3 ± 0.1	-2.2 ± 0.1
Isorad-p QED (p-type) (S/N below 3323601)	Sun Nuclear	0.3 ± 0.1	-2.4 ± 0.1
Isorad-III	Sun Nuclear	0.5 ± 0.1	-2.1 ± 0.1
QED (n-type) (S/N 3323601 and up)	Sun Nuclear	0.6 ± 0.1	-2.0 ± 0.1
Hi-*p*Si	Scanditronix	0.4	N/A
3G-*p*Si	Scanditronix	0.25	-2.0 ± 0.1
Veridose	Nuclear Associates	0.5	N/A
In-vivo Semi-Conductor probes	PTW	0.15	N/A

NOTE: For detectors not manufactured by Sun Nuclear Corp., the data may not be updated. Please contact the manufacturer for the updated information.

To enter Tc and V' from table

1 Press MENU button. The first item appears.

2 Continue pressing MENU button until "Temperature Coef" screen appears.

3 Press ENTER.

4 Key in the 4-digit administrator PIN number, and press ENTER.

5 Enter the serial numbers (s/n's) of the detectors connected to the A, B, C, and D connectors and press ENTER. The display shows "Please wait..."

```
A s/n    B s/n
C s/n    D s/n
```

6 Select the energy keys on which these serial numbers are calibrated and press ENTER.

- This assigns temperature coefficients to the detectors with the same serial numbers calibrated for these keys.
- Only keys calibrated with these serial number diodes will be lighted.
- When selected, the LEDs will blink.

7 Select the data source for the temperature coefficient as "Table" by pressing the arrow keys.

```
Select Data
Source:Table  <>
```

8 Press ENTER.

9 Key in the value(s) for V' from Table 3-4 for the diode serial numbers you previously entered, and press ENTER.

```
AV'=-0.0BV'=-0.0
CV'=-0.0DV'=-0.0
```

10 Key in the values of Tc from Table 3-4 for the diode serial numbers you entered, and press ENTER. The screen shows "Saving..." then returns to the Main screen.

```
Atc= 0.0Btc= 0.0
Ctc= 0.0Dtc= 0.0
```

NOTE: You can check that you entered the correct values with the "View Calibration" menu item.

Temperature coefficient measurement

If you want to determine temperature coefficients experimentally, you can do so using the following procedure.

Preparation

This procedure is used to perform temperature coefficient measurement for a Detector Pod and diode combination. Administrator pin is needed.

NOTE: Only negative diodes can be measured for a temperature coefficient.

To perform this procedure, you will need the following additional equipment:

- standard microwave oven
- a small water-filled bag, such as a locking sandwich or freezer bag

It is assumed that treatment room ambient temperature is about 22 °C (72 °F) and that the water bag will be heated in the microwave oven to about 38 °C (100 °F). First, a measurement is taken at ambient temperature. Then the bag is heated and placed over the diodes and another measurement is taken. The temperature coefficient is calculated from the two measurements.

For calculation details, see "Calculations" on page 77.

Application of temperature coefficients

A calculated temperature coefficient only applies to a single diode serial number. The same temperature coefficient can be applied wherever that same diode serial number is used, as long as the instantaneous dose rate is within an order of magnitude. (Some diodes have been found to have a different temperature coefficient with Co-60 beams than with accelerator beams.)

Generally, a group of diodes from the same manufacturing lot will have nearly the same temperature coefficient, but for best results, it is better to determine the temperature coefficient for each diode.

In accelerator beams, the instantaneous dose rate within the pulse of radiation is on the order of 10,000 cGy/s. In Co-60 beams, the instantaneous dose rate is on the order of 5 cGy/s. So, even though both beams have an average dose rates of about 300 cGy/min, there can be a significant difference in the temperature coefficient for a diode in these two beams.

In TBI beams where the SSD is 300 to 400 cm, the instantaneous dose rate will be 1/10 of that at 100 cm. Here also, it may be advisable to remeasure the temperature coefficient for TBI applications. In different beam energies, the instantaneous dose rate within a pulse is typically within a factor of 2 or 3 and should not contribute to measurable changes of temperature coefficient.

Temperature coefficient measurement example

For example, a physicist has a 6 MV diode (SN 666), an 18 MV diode (SN 1818) and an electron diode (SN 5555). The physicist has calibrated for 5 procedures: 6 MV on button 1, 15 MV on button 2, 6 MeV on button 3, 9 MeV on button 4, and 12 MeV on button 5. All these are at 100 cm SSD.

The physicist wishes to do temperature compensation for all three diodes. The physicist would choose to do one Temperature Coefficient Measurement at 6 MV, using diode SN 666, then another one at 15 MV, using diode SN 1818, and finally, another one for all three electron energies using diode SN 5555. The electron Temperature Coefficient Measurement can be measured using any one of the electron energies (the physicist chooses, say, 9 MeV) and all three electron energy buttons are selected on step 7 of the Temperature Coefficient Measurement procedure.

Once all the Temperature Coefficients are entered, the physicist then verifies that they are correct for all energies by taking a measurement at room temperature, and then another measurement after two minutes under a hot heat pack. If the measurements are within 1-2%, then the coefficient is correct. If however, the measurements do not agree for a particular energy, then the physicist can perform the Temperature Measurement coefficient procedure for that energy.

Temperature coefficient measurement procedure

1. Tape a thermometer and the diodes on a room-temperature, 3 cm thick, acrylic phantom (Figure 3-1). The phantom provides a thermal mass during the test.
2. Place the water bag over the diodes and the thermometer. The diodes should be under the bag during exposure and measurement.
3. Press MENU button. The first menu item appears.
4. Continue pressing MENU button until “Temperature Coef” screen appears.

```
Temperature Coef
Press ENTER
```

5. Press ENTER.
6. Key in the administrator PIN number and press ENTER.

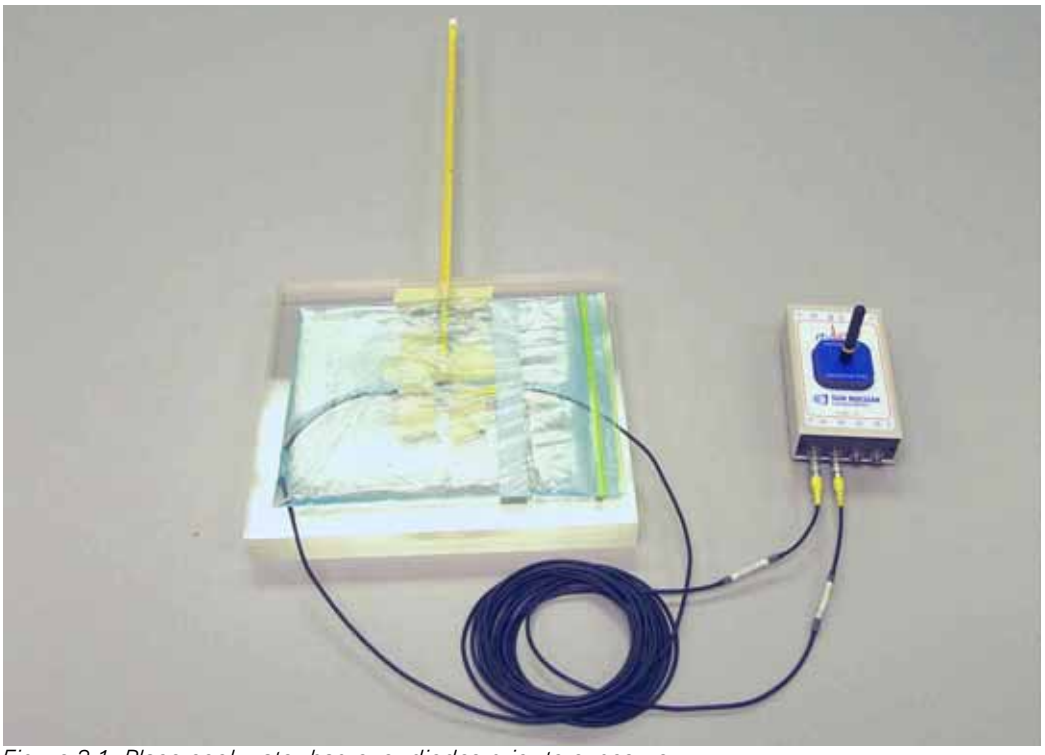


Figure 3-1. Place cool water bag over diodes prior to exposure

7 Key in the serial numbers of the detectors which will have their temperature coefficient measured.

```
A s/n    B s/n
C s/n    D s/n
```

- The combination of a detector serial number and a connector (A,B,C,D) must match at least one of the combinations in the Energy Key calibration table.
- Once the detector serial numbers are keyed in, the LEDs for all energy buttons will go off unless they have calibrations using these same serial numbers.
- The detectors do not need to be the same energy.
- The detectors do not need to co-exist on the same Energy Key.
- All detectors can be tested for temperature coefficient in the same beam, as long as the dose per pulse (or instantaneous dose rate) is nominally within one order of magnitude of their intended beam use.
- To change a serial number, move the cursor to the required location and key in the correct numeric value.

8 After the serial numbers are entered, press ENTER.

- The message "Please wait..." appears while the system looks for energy keys calibrated with the selected diode serial numbers. The LEDs for all other energy keys go out. LEDs for keys using the selected diode numbers remain lighted.
- A screen appears that instructs you to press the energy keys for which the temperature coefficients will be measured and then assigned to.

```
Select Energy
Keys, then ENTER
```

- The alternate screen describes the purpose of the selection.

```
Assigns tmp coef
to keys
```

9 Press keys to select for storage of measured temperature coefficients; the LEDs will begin flashing.

10 Press ENTER.

11 Select the data source for the temperature coefficient as "Measure" by pressing the arrow keys and Press ENTER.

```
Select Data
Source:Measure<>
```

12 Make a heat pack (water-filled sandwich or freezer bag) by filling the bag with cold (ambient temperature) water (approximate temperature 22 °C (72 °F). Remove any large air bubbles.

13 Place the cold water bag over the diodes (Figure 3-1).

14 Press ENTER to continue.

```
Apply cold bag
to diodes
```

15 Wait for 7 minutes to allow the temperature of the diodes and the phantom to stabilize.

```
Please Wait 7
Minute(s).
```

- The display will count down and show the remaining minutes.
- When the 7 minutes has elapsed, the display will beep and a temperature entry screen appears.

16 Read the thermometer and key in the temperature that you read on the thermometer.

```
Enter meas temp
__._ °C
```

17 Press ENTER to continue. The message "Starting..." appears briefly. The alt-screen displays "Deliver dose at desired energy."

18 Turn on the beam and deliver 100 MU dose to the diodes. During exposure, the screen will display "Measuring, please wait."

```
Measuring,
please wait
```

19 When the beam turns off, press STOP.

20 The alternate screen shows the diode junction voltage measurement.

```
A=9999  B=9999
C=9999  D=9999
```

21 Place the water bag in a microwave oven and turn on the oven for about 40 seconds. The heat pack should heat up to approximately normal body temperature of about 38 °C (100 °F), warm to the touch.

22 Place the hot water bag over the diodes (Figure 3-1).

23 Press ENTER to continue.

```
Apply hot bag
to diodes
```

24 Wait for 7 minutes to allow the diodes and the phantom to stabilize.

```
Please wait 7
minutes.
```

- The display will count down and show the remaining minutes.
- When the 7 minutes has elapsed, the display will beep and a temperature entry screen appears.

25 Read the thermometer and key in the temperature that you read on the thermometer.

```
Enter meas temp
__._ °C
```

26 Press ENTER to continue.

27 Turn on the beam and deliver 100 MU dose to the diodes. During exposure, the screen will display "Measuring, please wait."

```
Measuring,
please wait
```

28 The alternate screen shows the measured dose in counts.

```
A=9999  B=9999
C=9999  D=9999
```

29 When the beam turns off, press STOP.

30 After the two exposures described above are recorded, the display unit will calculate the temperature coefficients and display them.

```
A  tc=-0.9999999
B  tc=-0.9999999
```

- Press the INC button to scroll through the inputs in a continuous circle.

```
INC=Scroll ENTER
=Save STOP=Abort
```

- Typical temperature coefficient values will be negative and have an approximate value of –0.0004 ±0.0002. See Note after step 29.
- Pressing ENTER will save the temperature coefficients to the measurement Pod and exit the Tc function.
- Pressing STOP will exit the calibration function without saving the calibration factors.
- For calculation details, see "Calculations" on page 77.

31 To print the temperature coefficients, print a dose calibration report. The Dose Calibration will print on the optional printer, showing the temperature coefficients for the diodes. See "Dose calibration report" on page 39.

NOTE: The displayed temperature coefficients are in terms of fractional response change to a junction voltage change of the diode. The junction voltage is a linear function of temperature (percent per degree C).

32 Validate the application of the temperature coefficients as follows:

a. Position detectors on room temperature buildup and make a measurement under calibrated conditions. This result should be reasonably accurate.

b. After that measurement, place the warmed water bag on the detector for about 2 minutes, remove the bag, and repeat the measurement.

c. The second measurement should agree with the first room temperature measurement within 1 or 2 percent.

Measurements with control module

Daily preparation (Model 1136)

1 Allow the batteries to charge overnight. This will ensure you have enough reserve power for a full day's dosimetry measurements.

2 Check that all batteries are fully charged and the battery switches are on. Battery status can be checked on the Control Module from the menu. See "Battery check" on page 20.

Measurement

WARNING: To maintain hygienic safety and prevent cross-infection, disinfect diode before placing it on a patient.

1 Wipe the diode(s) with a pad moistened with an antiseptic solution.

2 Tape the diode(s) in place on the patient.

CAUTION: Never place the Detector Pod or Base Station in the direct beam. You may damage it.

3 Press a calibrated energy key for the dose to be administered.

- When pressing the key, the Main screen must be visible on the Control Module ("Energy Key to Start measuring" or last values) and that the READY LED is on.

```
ENERGY KEY to
Start measuring
```

- Calibrated energy keys have lighted LEDs. If LED next to key is out, that key has not been calibrated.
- LED for selected energy key will be blinking during acquisition.
- The message "Starting..." appears briefly.

- The AQRING LED will light, and the READY LED will go out.

4 Administer the prescribed radiation dose to the patient.

- During administration of the dose, the screen will display "Measuring, please wait."

```
Measuring,please
wait
```

- To print Interim Dose reports, press PRINT after the beam turns off. You can then continue treatment with another field and the measurement will continue to accumulate. See "Intermediate dose report" on page 70.

5 When the beam has turned off, press STOP button on the Control Module.

- AQRING LED will go out, READY LED will go on, and the energy key LED will stop blinking.
- If beam was still on when the STOP button was pushed, the "Beam is On" message will be displayed to let you know that the dose was not finished.

```
BEAM is ON  STOP
or ENTER to Cont
```

  - Push the STOP button to stop acquisition, display final dose, and return to collecting background.
  - Push the ENTER button to continue the measurement.
- The measured dose for diodes A, B, C, and D will be displayed. The values will stay on the screen until the next measurement.

```
A=9.9    B=9.9
C=9.9    D=9.9
```

- If an un-calibrated button is pushed, the display will show nominal charge in nC (nanocoulomb).
- When not acquiring, background is being collected.
- A lower case channel letter will be used and a '~' will be displayed in the '=' sign position to let you know when a bad background was collected. i.e. accelerator was on, or excessive leakage.
- If Base Station or Pod battery is discharging and the running time is <30 minutes, the "Low Battery..." alternate screen appears. Unit Name P= Pod, B= Base Station.

```
LOW Battery:
B||||| P||
```

6 Press PRINT button to print the Dose report. See "Reports from control module" on page 34.

- Fill in the blanks, sign the report, and file with patient records in accordance with the applicable policies of your treatment center.

7 Remove the diodes from the patient, and repeat the process for the next patient.

Data interpretation

If the dose measured by the IVD does not agree with the calculated dose, then an investigation of the cause will reveal one of the following:

1 There is an error in the treatment plan calculation.

2 There is an error in the machine or patient setup.

3 The treatment machine is out of calibration.

4 The IVD is improperly calibrated.

5 A failure in the IVD.

In this event, the plan and setup should be reviewed by the physicist. If this does not reveal the error, the calibration of the machine output and the IVD should be tested. If this does not reveal the error, then either the error is the result of a non-reproducible setup or an IVD failure. Under such a condition, the IVD should be used to make another measurement of the treatment dose at the next treatment session. Report any evidence of software faults to the manufacturer by telephone, fax, or E-mail.

WARNING: Under no conditions should the treatment plan be modified based solely upon the measurements of the IVD without corroborating evidence of an error resulting from situations 1, 2, or 3 as described above.

NOTE: Additional information is available in AAPM Report 87, "Diode in vivo dosimetry for patients receiving external beam radiation therapy," Radiation Therapy Committee, Task Group #62, ISBN 1-888340-50-9, (2005). The report covers the calibration and use of diodes, as well as the interpretation of results.

Solving operator problems

Table 3-5. Common solutions to operator problems

Problem	Remedy
System can't find desired Pod at startup.	• Turn on battery switch on wireless Pod. • Recharge battery on wireless Pod. • Swap Base Station and Pod. • Change Pod number in System Select. See "System select" on page 20. • Move the Pod around to a more desirable position for radio transmission. Moving the Pod a few feet may make a difference in the transmission or reception.
System finds Pods from another system	• Move the system inside the treatment vault. • Turn off the interfering system.
Message "Nothing found" is displayed on startup.	• Connect power or turn on battery. • Reconnect Control Module properly.
Message "Low Battery" and a beep sounds. Display shows which battery is low.	• Complete existing operation (you have 30 minutes grace time) and recharge battery.
LED DS2 on Pod is blinking rapidly.	• Check error code. See "Error codes" on page 80. • Power down, then power back up. Repeat the procedure that caused the problem. • If problem continues, call Sun Nuclear Customer Service.
Display shows 0 cGy when the beam is measured.	• Reset System select to the correct Pod. • Connect a diode to the Pod. • Replace a damaged or non-functioning diode. • Place the diode(s) properly on the patient in the beam

Post operational checks (Model 1136)

At the completion of daily operation:

1. Verify that the Base Station is still connected to battery charging power and is charging.
2. Reconnect the Detector Pod to battery charging power.
   - Whenever charging power is connected to the Pod, a beep will sound and the message "Pod on External Power" appears.
3. Verify that all batteries are charging (blinking DS1 LED on Pods). Leave the Control Module on (powered). If any units were switched or reconnected, return the setup to its original configuration.

Reports from control module

About reports

You can print five types of reports.

- The first two reports are printed by the therapist during daily use:
  - Intermediate Dose Report
  - Dose Report
- The remaining three reports are available for the physicist:
  - Intermediate Charge Report
  - Charge Report

- Dose Calibration Report

The type of report printed will depend on the operation that was in progress or just completed when the PRINT button was pressed.

Using the printer

The optional Seiko DPU-414 thermal printer (Figure 3-2) is used to print reports generated by the Control Module.

Figure 3-2. Optional thermal printer

The printer has been set up at the factory. Do not change the internal DIP switch settings. Refer to the separate printer Operation Manual for instructions for installing a new paper roll (replacement part number 850043).

To connect and turn on the printer

1. Connect the printer to the Control Module with the serial cable.
2. Connect the printer power cord (black plug) to the printer. Connect the power cord (red plug) to the receptacle on the side of the Control Module.
3. Slide the POWER switch on the left side of the printer to the ON position. The Power lamp will come on.
4. If necessary, press the ONLINE button, the ONLINE lamp will come on.
5. To feed blank paper, press the FEED button on the printer.

To print a report

1. Press PRINT button on the Control Module. The "Printing..." message is displayed for 2 seconds after the PRINT button is pushed.

```
Printing...
```

2. The report will scroll out of the printer.
3. If you press PRINT when no data is available for print, the screen will display "Nothing to print."

The five types of reports are described in the following paragraphs.

Intermediate dose report

An Intermediate dose report is printed by pressing the PRINT button while the Active LED is turned on. It provides an opportunity to print one or more treatment fields before STOP is pressed. Each intermediate dose report will contain the accumulated total since the energy key is pressed.

```
****************************************
      INSTITUTION NAME (OPTIONAL)
        INTERMEDIATE DOSE REPORT
****************************************
HHMMSS: 08:52:38        DDMMYY: 20/09/00

Patient Name:____________________________
Patient ID:______________________________
Field:_______________ Machine:___________
Energy:________ MU:________ SSD:________

BASESTATION 03, POD O4, KEY 1 (06 MV)

Therapist:_____________________________

DOSE:
Channel A= 12.0    cGy   (s/n: 1615126)
Channel B= -0.0    cGy   (s/n: 1615125)
Channel C= 11.6    cGy   (s/n: 1615124)

HHMMSS: 08:52:59
Channel A= 22.1    cGy   (s/n: 1615126)
Channel B= -0.0    cGy   (s/n: 1615125)
Channel C= 21.5    cGy   (s/n: 1615124)

HHMMSS: 08:53:15
Channel A= 42.3    cGy   (s/n: 1615126)
Channel B= -0.1    cGy   (s/n: 1615125)
Channel C= 41.6    cGy   (s/n: 1615124)
```

Figure 3-3. Intermediate dose report

- The date and time on Intermediate dose report will be the date and time of the printout.
- Print this report when collecting Dose with calibrated inputs.
- Signed by the therapist.

Dose report

The Dose Report is the final report printed after treatment. After STOP is pressed, this report will be printed when PRINT button is pressed.

```
****************************************
       INSTITUTION NAME (OPTIONAL)
              DOSE REPORT
****************************************
HHMMSS: 08:52:38    DDMMYY: 20/09/00

Patient Name:_____________________________
Patient ID:_______________________________
Field:_________________ Machine:____________
Energy:_________ MU:_________ SSD:_________

BASESTATION 03, POD 04, kEY 1 (06 MV)

DOSE:
Channel A= 150.0  cGy   (s/n: 1615126)
Channel B= -0.0   cGy   (s/n: 1615125)
Channel C= 106.6  cGy   (s/n: 1615124)

TEMPERATURES:
Channel A= 9999 cts
Channel B= 9999 cts
Channel C= 9999 cts

Therapist:_________________________________
****************************************
```

Figure 3-4. Dose report

- The date and time on the Dose report will be the date and time the STOP button was pressed at the end of the acquisition.
- Print this report after collecting Dose with calibrated inputs.
- Blank fields should be filled in according to organization policies.
- Signed by therapist.

Intermediate charge report

This report is the same as the Intermediate Dose Report except that it is printed out if an un-calibrated energy button is selected.

```
****************************************
      INSTITUTION NAME (OPTIONAL)
      INTERMEDIATE CHARGE REPORT
****************************************
HHMMSS: 08:52:38        DDMMYY: 20/09/00

BASESTATION 03, BOD 04, KEY 1

Therapist:_____________________________

DOSE:
Channel A= 22.1     nC
Channel B= 32.4     nC
Channel C= 9.4      nC


HHMMSS: 08:53:21
Channel A= 33.5     nC
Channel B= 51.1     nC
Channel C= 12.7     nC


HHMMSS: 08:54:25
Channel A= 45.7     nC
Channel B= 72.4     nC
Channel C= 18.4     nC
```

Figure 3-5. Intermediate charge report

- The date and time on the Intermediate Charge report will be the date and time of the printout.
- Print this report while collecting charge with un-calibrated inputs.
- Signed by the therapist or physicist.

Charge report

This report is similar to the Dose Report except that it is printed if an un-calibrated energy button is selected.

```
****************************************
       INSTITUTION NAME (OPTIONAL)
             CHARGE REPORT
****************************************
HHMMSS: 08:52:38        DDMMYY: 20/09/00

BASESTATION 03, POD 04, KEY 1

DOSE:
Channel A= 45.7     nC
Channel B= 72.4     nC
Channel C= 18.4     nC

Therapist:_______________________________
****************************************
```

Figure 3-6. Charge report

- The date and time on the Charge report will be the end date and time of the acquisition.
- Print this report after collecting charge with un-calibrated inputs.
- Signed by the therapist or physicist.

Dose calibration report

This report shows the calibration details for a calibrated energy button.

```
****************************************
      INSTITUTION NAME (OPTIONAL)
          CALIBRATION REPORT
****************************************
HHMMSS: 08:52:38     DDMMYY: 20/09/00

Field:_________________Machine:_________
Energy:___________MU:________SSD:________

BASESTATION 03, POD 04, KEY 1 (06 MeV)

CALIBRATION FACTORS:
Channel A= -0.0021892 (s/n: 1615126)
Channel B= -0.0022169 (s/n: 1615125)
Channel C= -0.0021944 (s/n: 1615124)

TEMPERATURE:
Channel A= 2495 cts
Channel B= 2503 cts
Channel C= 2417 cts

TEMPERATURE COEFFICIENTS:
Channel A= -0.0004219
Channel B= -0.0002975
Channel C= -0.0003785

Physicist:_______________________________
****************************************
```

Figure 3-7. Dose calibration report

- The date and time on the Dose Calibration report will be the date and time of calibration.
- Temperature is only shown if the calibration factor is negative.
- The temperature coefficients show 0.0 if temperature coefficient measurement has not been done.
- This report will be printed when the calibration coefficients are displayed in dose calibration or from View Calibration with a button selected.
- Signed by the physicist.

4 Software operation

About the PC software

The PC software is included on the compact disk (CD) with each system. The PC software lets you operate the system with your personal computer. The software operates on any PC with Windows 95 and higher.

When using a computer, the buttons and display on the Control Module are inactive. You can control the system with either the computer or the Control Module, but you can't use them simultaneously.

When the Control Module senses that the PC software is active and connected, the Control Module display shows "System under PC Control. 30" If the PC software is switched off or loses connection, the Control Module counts down from 30 seconds before resuming control.

To print reports when using the computer, connect any standard computer printer to your computer. When using PC software, the thermal printer is not used. You can also use a printer on your network. Computer reports are full page and have a different format and appearance than the Control Module reports. An additional feature of the computer is the ability to print multiple exposures in a single report.

NOTE: To measure with multiple Pods, you must use the PC software. You cannot use the Control Module with more than one detector pod (up to 4 diodes).

To install the software

1. To install the software on your PC, place the CD in the CD drive and wait for the opening screen to appear.
2. If autorun is not enabled on your CD drive, navigate to the CD drive and double-click on the file "SunNuclearCorp.exe" to open the menu.
3. From the menu, select the option to install software for the IVD.

NOTE: The CD also contains software and documentation for other Sun Nuclear Corporation products.

4. Follow the on-screen directions.

To launch and close the software

To launch the software

1. To launch the IVD software, double-click the IVD icon on the desktop.
2. If the desktop icon is missing, select Start > Programs > SNC Group >IVD.

To close the software

To close the software, click on the "X" in the upper right corner or select Exit from the File menu.

To remove the software

1. To remove the IVD software, select Start > Settings > Control Panel > Add or Remove Programs.
2. Select IVD Version (version no.) from the list of programs, and click Remove.
3. Follow the on-screen directions.

Opening view

Once the initialization and system check are complete, the Dose view will be displayed.

- The system always powers up in the Dose view.
- In the Dose view, the system is ready to make a measurement.
- The energy keys that have calibration values for connected detectors will have their corresponding buttons shown on the right side of the screen.

After the first measurement, the Dose view shows the results of the last measurement taken.

Screen elements

The IVD software uses typical Windows screen elements (Figure 4-1) described below. While there may be minor differences in the appearance of the screen under different versions of Windows, the results are the same.

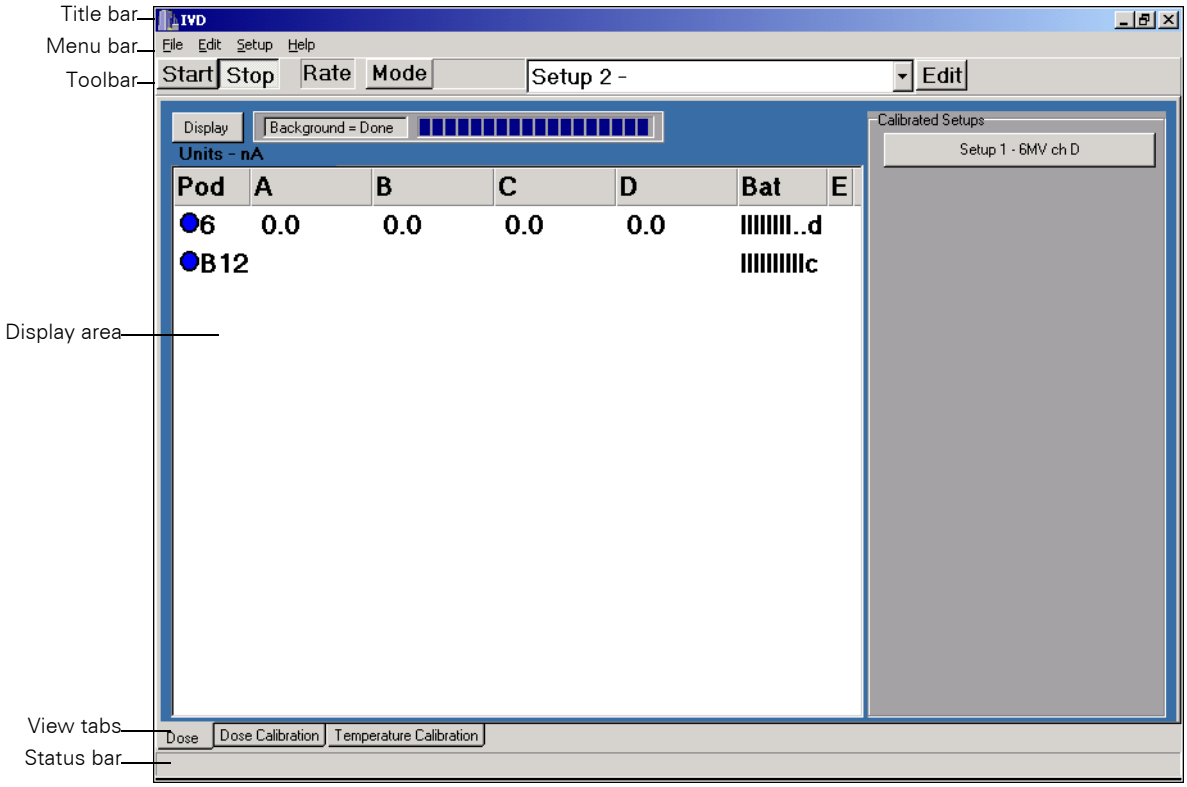


Figure 4-1. Screen elements

Title bar

The Title bar shows the name of the program and contains the standard Windows control buttons: Minimize, Maximize, and Close.

Menu bar

The menu bar lists the menu commands in groups under the headings: File, Edit, Setup, and Help. When you click on a menu item, a drop-down list of commands appears. Table 4-1 lists the menu commands available and describes their functions.

Table 4-1. PC software menu functions

Menu	Menu Item	What it does	Pin
File	Log Data	Click to select or clear the log data option. When a check mark appears next to Log Data, the program creates a text file with measurements taken every second.	No
	Load Pod's Calibration from File	Causes the data in a calibration file that has been saved to be loaded to the Pod.	Yes
	Save Pod's Calibration to File	Saves a Pod's calibration data to a file.	Yes
	Print...	In Dose view, prints a dose delivered report. The type of report printed will depend on the type of measurement made. In Dose Calibration view, prints the opened calibration report for this setup.	No
	Collect for Multi-Acquisition Print	Sets the system to begin collecting data for multiple acquisitions to be printed in a single report.	No
	Review Multi Acquisition Print	Opens a dialog box to let you review and print the Multi Acquisition data.	No
	End and Print Multi Acquisition	Ends the acquisition of multiple exposures and begins the printing of the multi-acquisition report.	
	Exit	Exits the application after checking for any unsaved files.	No
Edit	Copy Dose Screen Data	Copies Dose screen data to the Windows clipboard. Then you can paste the information into a spreadsheet or word processor.	No
Setup	Physics Mode	Selects and deselects Physics Mode.	Yes
	Parameter Setup	Sets up parameters, including PIN, measurement units, options, and institution name.	Yes
	Log Active Pods	Initiates communications between all active Pods and the Base Station.	No
	Select Serial Port	Selects serial port to communicate with the Control Module.	No
Help	IVD help contents	Opens program help.	No
	About	Displays software version and manufacturer.	No

Toolbar

The toolbar is a row of buttons and drop-down lists just below the menu bar. The items on the toolbar, from left to right, are listed below:

- Start button—starts the dose counter for an exposure.
- Stop button—stops the dose counter after an exposure is complete.
- Dose/Rate display—shows which mode is selected, Dose mode or Rate mode. In Dose mode, the value displayed for each diode detector is the accumulated dose. In the Rate mode, the value displayed for each diode detector is the dose Rate in the selected units per second.
- Mode button—toggles between Dose display mode and Rate display mode.
- Setup list—This pull-down list selects the calibrated or uncalibrated memory positions available for calibration storage.
- Edit button—allows editing of the description of the calibrations on the list and the corresponding buttons.

Display area

The display area is the central part of the window that contains information and controls for the selected views.

View tabs

You select a view by clicking one of the three tabs at the bottom of the screen:

- Dose—the technician uses the Dose View for daily In Vivo Dosimetry. The program always starts up in this view.
- Dose Calibration—the physicist uses this view for calibrating each of the 12 available memory slots. This view is password-protected.
- Temperature Calibration—the physicist uses this view for entering the temperature calibration factors for SNC detectors or determining a temperature correction factor to be applied to dose calibration on non SNC diodes. This view is also password-protected.

Status bar

The status bar at the bottom of the window shows messages and status information when applicable.

Main views

Dose view

Dose view (Figure 4-2) is the normal operating view used by the technician for daily In Vivo Dosimetry.

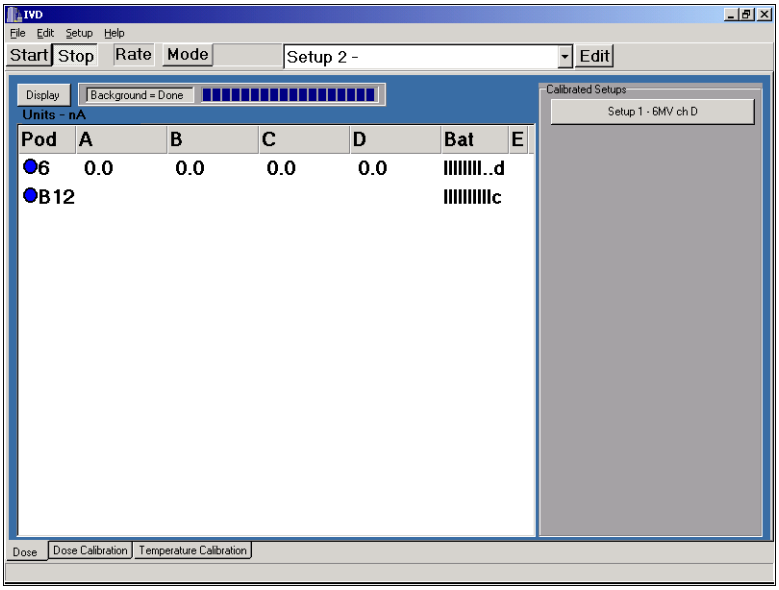


Figure 4-2. Dose view—multiple pod display

- Display button—toggles between the multiple Pod display (Figure 4-2) and the single Pod display (Figure 4-3).

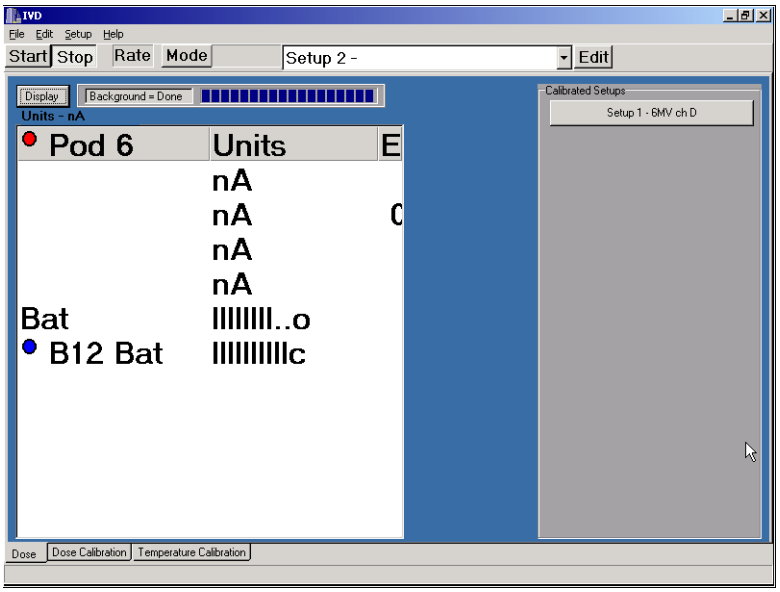


Figure 4-3. Dose view—single pod display

- The body of the display shows the following:
  - A color-coded "LED" next to the Pod number. The color shows Pod status:
    - Green = acquiring.
    - Red = no communication between that unit and the computer.
    - Blue = a recurring background measurement is underway.
  - ID Number of the Pod(s) connected for this setup. The letter "B" in an 1136 installation indicates that the Pod is being used as a base station.
  - Diode connections A, B, C, and D for each Pod. The dose or dose rate value for each diode is displayed.
  - Units selected. You can select between Gy, cGy, and Rads. See "To change dose units" on page 56.
  - Bat (battery). Three choices are selectable in the parameter setup screen: (1) Percent remaining bar, (2) percent remaining text, and (3) Hours:minutes remaining. Letters show status: d = discharging, c = charging, t = trickle charging (fully charged)

  NOTE: Battery check shows "predicted" battery life, which may differ from actual battery life. See "About predicted battery life" on page 87.

  - E = error status. If an error condition is present, an "E" will be displayed in this column. Right-clicking on the "E" will display the error message. See "Error codes" on page 80.
- Calibrated Setup buttons—clicking these buttons activate the calibrated setups for measurement. Each button represents a calibration factor stored in the selected Pod. By right clicking on the button, you can edit the labels for the setups so you can remember the setup conditions for the exposure. These calibrations are the same as the Setups in the pull-down list above.

NOTE: The Calibrated Setup "buttons" are the same as the "Energy Keys" on the front panel of the Control Module. Clicking a single "button" enables the system to take a measurement using the selected calibration.

Dose calibration view

Dose Calibration view (Figure 4-4) is used by the physicist for calibrating the dose for each Pod. see "Calibration with PC software" on page 59 for steps in completing calibration.

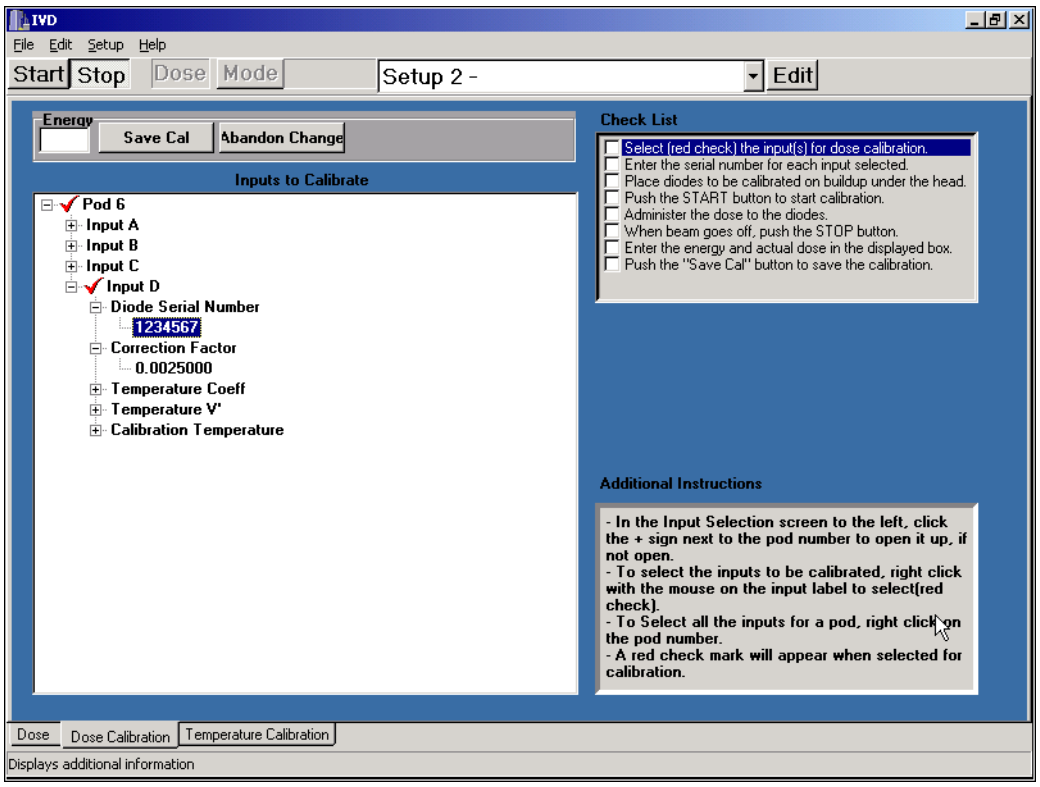


Figure 4-4. Dose calibration view

- Energy box—displays the energy setting that was used on the accelerator for this calibration.
- Save Cal button—saves the current calibration value (Red Check value) to the Pod.
- Cancel Cal button—cancels the current calibration session.
- Inputs to Calibrate—lists the inputs to be calibrated. To select an input for calibration, right-click the input. A RED CHECK MARK WILL APPEAR NEXT TO THE SELECTED INPUT. The diode serial number must be entered for that input.

NOTE: Red check marks appear next to the input for it to be selected!

- Checklist—lists the steps and the sequence of operation for a calibration. This is your list of steps to perform a single calibration. During calibration, you click on each task when it is completed. A check mark appears in the box to identify the completed items. You must complete the checklist in the correct order from top to bottom.
- Additional Instructions—lists additional instructions for the step to be completed. Inputs can be edited by right clicking on the calibration factor and changing it.

Temperature calibration view

Temperature Calibration view (Figure 4-5) is used by the physicist to measure the temperature coefficient of the detector response that will allow compensation during measurement. see "Temperature coefficient measurement" on page 63 for the steps in completing temperature calibration.

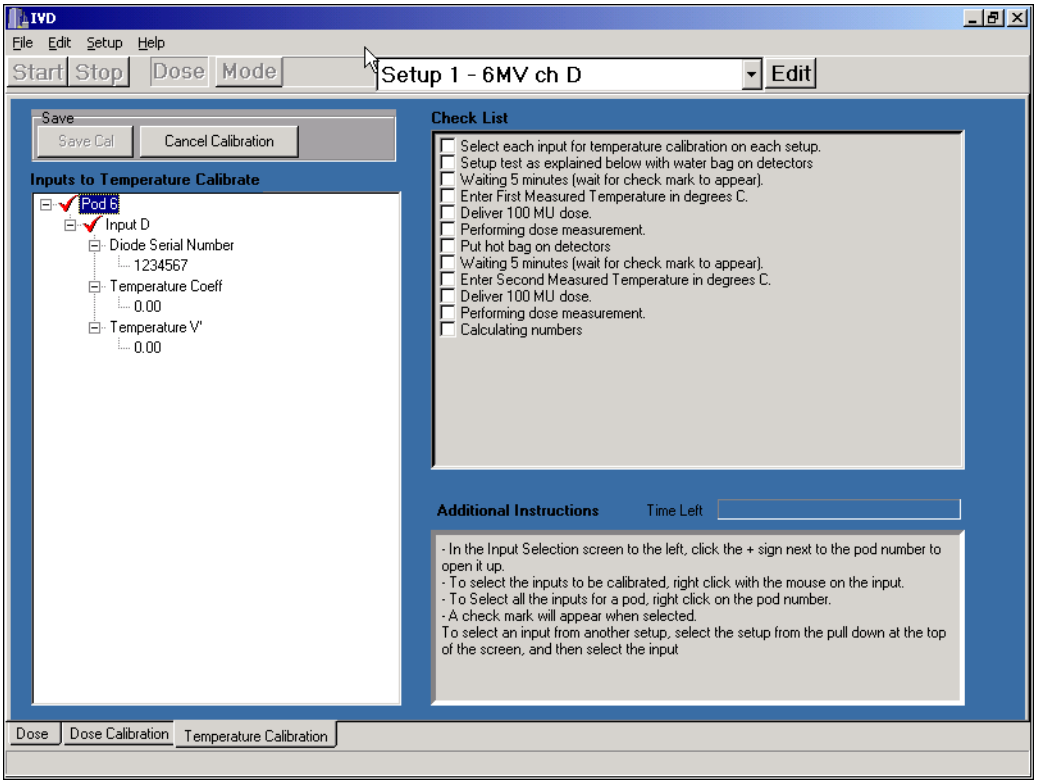


Figure 4-5. Temperature calibration view

- Save Cal button—saves the entered/completed temperature calibration to the Pod.
- Cancel Temperature Cal button—cancels the current temperature calibration (if the input is selected (Red Check mark).
- Inputs to Temperature Calibrate—lists the diode serial numbers and previous temperature coefficients. To select an input for calibration, right-click the input. Once selected, a check mark appears next to the selected input. The diode serial numbers are carried over from the dose calibration, which has to be completed before temperature calibration can be done.
- Temperature factors can be entered directly from a chart for SNC detectors and certain other manufacturers. If this method is used, the temperature calibration does not have to be done which greatly simplifies this process. See "Temperature coefficient (Tc)" on page 62.
- Checklist—lists the steps and the sequence of operation for a temperature calibration. This is your list of steps to perform a single calibration. During calibration, you click on each task when it is completed. A check mark appears in the box to identify the completed items. You must complete the checklist in the correct order from top to bottom.
- Additional Instructions—lists additional instructions for the step to be completed.

Setup for PC software

COM (serial) connection

1. Connect the serial cable between the PC's serial port and the COM port on the Control Module (Figure 4-6).

NOTE: You can permanently install the 25-meter data cable in a conduit between the two rooms. For multiple rooms, additional 25-meter data cables can be purchased separately and installed in all conduits and control rooms. This will reduce setup time when moving the system from room to room.

2. Connect the instrument to the Control Module with the power/data cable.
3. Plug the power converter into an outlet with 110 to 240 VAC, single phase, 50-60 Hz power.
4. Connect the power converter to the Control Module.

Figure 4-6. Typical serial port connection

Serial port alternatives

IVD Solutions operates with either a standard serial port or a USB port. If your computer has neither port, several alternatives may allow you to connect to IVD Solutions. You can obtain the necessary equipment from computer stores, catalogs, and on-line merchants.

- Serial port card—If your computer is a desktop, you may be able to install a serial port card in an empty PCI slot.
- PCMCIA card to serial port adapter—if your computer is a laptop, you may be able to install a PCMCIA card to serial port adapter in the card slot.

To use these adaptors, follow the manufacturer's instructions and observe the following steps:

1. Set up the adaptor per manufacturer's instruction.
2. In the setup, identify the serial port as COM 1 through COM 9 (higher numbers are not supported).
3. Connect the serial cable between Control Module and the serial port adaptor.
4. Power up normally.

   NOTE: Sun Nuclear Corporation recommends using a standard serial port or USB port. Although many adaptors may work, Sun Nuclear Corporation assumes no responsibility for the proper operation of your serial port or serial port adaptor.

USB connection

The Control Module contains a high-speed, USB to Serial converter port. This port allows a serial connection through a USB cable.

The converter operates with Windows 98SE (Second Edition) or higher if the proper USB drivers are installed. The converter does not operate in USB mode with Windows 95, 98, or NT 4.0.

Drivers are included with IVD software.

NOTE: Check your software version by clicking Help > About on the application software menu. To obtain latest software, check the web site.

When you install the correct version of the application software, USB drivers are copied to your hard drive. The first time you connect your computer to the USB port on the Control Module, you are prompted to install the drivers.

1. With the computer off, connect the cables as shown (Figure 4-7), except DO NOT PLUG THE USB CABLE INTO THE PC.

Figure 4-7. Typical USB port connection

2 Plug the power converter cord into a 110 to 240 VAC, 1-phase, 50-60 Hz power source.

To power up the system

1 Connect cables and power as described in Section 2. See “Connections” on page 10.

CAUTION: To obtain a valid background measurement, the diodes must be connected to the Detector Pod before launching the software.

2 Connect the correct diodes to the detector Pod. (They can remain connected.)

- Make a note of the serial numbers of the diodes and the channels to which they are connected.
- The same diodes used for calibration must be connected to the same terminals that were used during calibration.
- Diodes must be connected before you launch the software in order to get a valid background measurement.

3 Verify that the correct Pod is connected.

- Calibration factors are stored in the Pod’s memory.

4 Turn on power to the Pod(s).

5 Launch the software. When the software launches, the Dose View will be displayed.

6 From the Setup menu, select Log Active Pods. The system will show the active Pods in the center of the screen.

7 Check to make sure the “LED” next to the Pod number is blue, indicating a recurring background reading is being collected.

8 If all the hardware for this system is found, the Background message appears next to the Display button. This indicates that a background measurement is being taken.

- This is the initial background collection screen before data acquisition.
- Background measurement takes about 30 seconds.
- After a measurement, the background will count down again. If a measurement is taken before the count-down is finished, the previous background value will be used.

9 After initialization, the PC monitor displays the Dose view.

To set up initial parameters

For first-time use, you should select the initial parameter from Setup > Parameter Setup on the menu:

1. If you want to enter an administrator PIN (personal identification number) see "To set or change a PIN" on page 55. Using a PIN forces the operator to enter the PIN prior to making important settings. This prevents accidental or inadvertent changes when several people are using the system. If you don't want to use a PIN, enter 0000, or if there is already a PIN, change the existing PIN to 0000.
2. The default dose unit for display is cGy. To change to Gy or Rad, see "To change dose units" on page 56.
3. Each unit is assigned a number. To change a device ID, see "To set or change a device ID" on page 59.
4. You can enter an optional Institution Name to be printed at the top of each printed report. See "To enter an institution name" on page 56.

To set up a serial connection

If COM 1 is free and is working properly, the serial port will connect and operate automatically. You don't need to do anything.

The IVD software defaults to COM port 1. If the port is not working, no Pods will be found when you attempt the Log Active Pods command.

To find a COM port

If the computer does not automatically find the COM port of the Control Module, perform the following steps:

1. Click Setup > Select Serial Port. The Select Port dialog opens (Figure 4-8).

Figure 4-8. Serial port setup

2. Click the Find button. The computer will automatically locate the Control Module and assign a port.

To change the COM port

If you know what the COM port is, you can assign it:

1. Select Serial Port from the Setup menu. The Select Serial Port dialog box opens (Figure 4-8).
2. Select the desired COM port and click OK.

NOTE: Only available COM ports will be displayed.

3. Click OK to close the messages.
4. Close the IVD Windows application program and then re-launch it.
5. The connect messages appear.

Serial port troubleshooting

If you can't connect on any port, see "Before requesting help" on page 89. Or contact Sun Nuclear Technical Support by phone, 321-259-6862, or via email, techsupport@sunnuclear.com.

To set up a USB connection

Use this procedure if you are connecting via the USB port. If using the serial port, see “COM (serial) connection” on page 47.

To Install USB drivers for Windows XP

When you previously installed the software, the USB drivers were automatically loaded on your hard drive

1. Turn on the computer and boot Windows.
2. Plug the USB cable into the computer. Windows will automatically detect new hardware.
3. If connected to the Internet and the Windows Automatic Update feature is turned ON, wait while the operating system automatically downloads and installs the proper drivers. A status icon appears in the system tray as the operating system goes through this process. Afterward, see “Verifying installation of USB drivers” on page 54.
4. If the computer is NOT connected to the Internet OR the Windows Automatic Update feature is turned off, Windows will pop up a “Found New Hardware” flag on the system tray, and open the Found New Hardware Wizard (Figure 4-9).

Figure 4-9. Found new hardware wizard

5. Select “Install from a list or specific location (Advanced)” and click Next. A dialog appears (Figure 4-10).

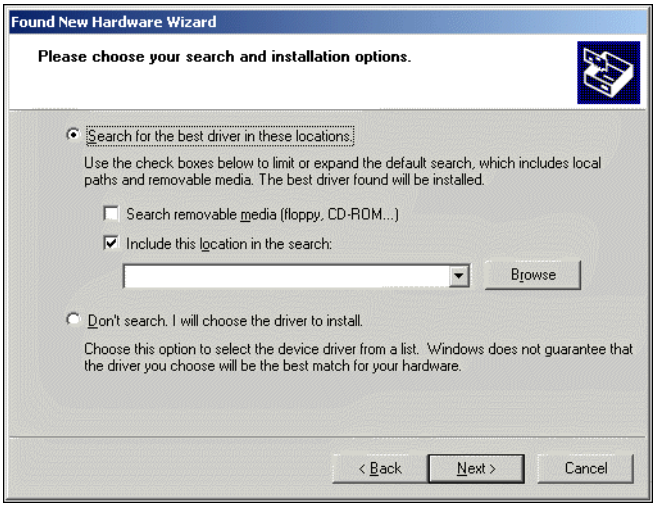


Figure 4-10. Choose search and installation options

6 Click “Search for the best driver in these locations” and check “Include these locations in the search.” The location of the drivers that were installed with the current version of the instrument software are displayed.

7 Click Next. A security warning may appear (Figure 4-11).

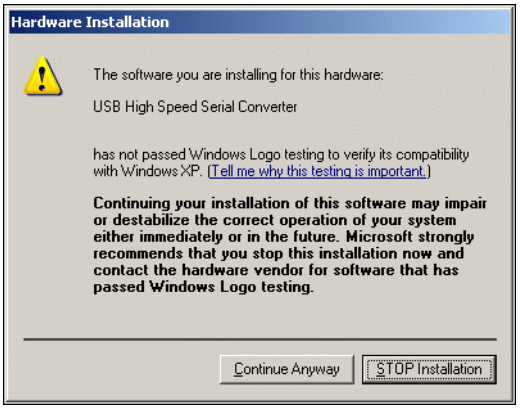


Figure 4-11. Install hardware drivers dialog box

8 Click “Continue Anyway.” A dialog box appears when finished (Figure 4-12).

Figure 4-12. Install hardware drivers dialog box

9 Click Finish to complete the installation. The Found New Hardware Wizard will open again (there is another driver to install).

10 Repeat steps 2 through 6 to install the second driver. When completely finished, a pop-up flag on the icon tray will say “Found New Hardware. Your new hardware is installed and ready to use.” This completes installation of the drivers.

11 Launch the IVD application software.

To install USB drivers for Windows 2000

1 Turn on the computer and wait for Windows to boot. Windows will automatically detect the USB device and display a “New Hardware Detected” message, The Found New Hardware Wizard opens (Figure 4-9).

Figure 4-13. Found new hardware wizard

2 Click Next. The Install Hardware Device Drivers dialog appears (Figure 4-10).

Figure 4-14. Install hardware drivers dialog box

3 Select "Search for suitable driver…" and click Next. The Locate Driver Files dialog box appears (Figure 4-11).

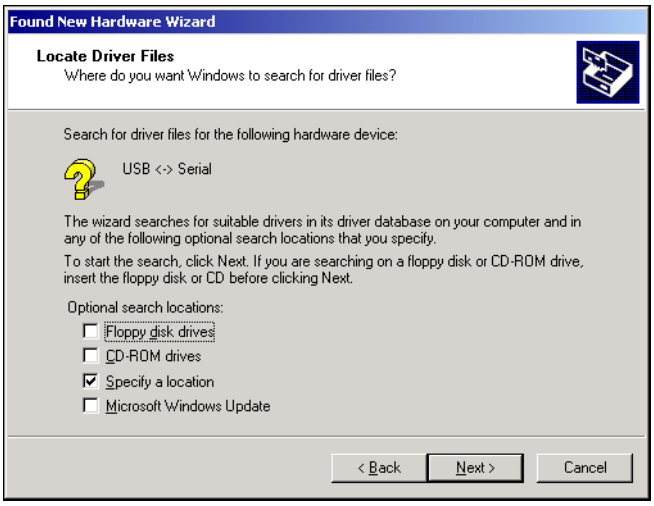


Figure 4-15. Install hardware drivers dialog box

4. Select "Specify a location," clear any other check boxes, and click Next. The computer will search for a driver, install it, and display the results (Figure 4-16).
5. Click Next to install the ftdibus.inf driver.
6. Repeat steps 2 through 6 to install the ftdiport.inf driver. This completes the driver installation
7. Launch the application software.

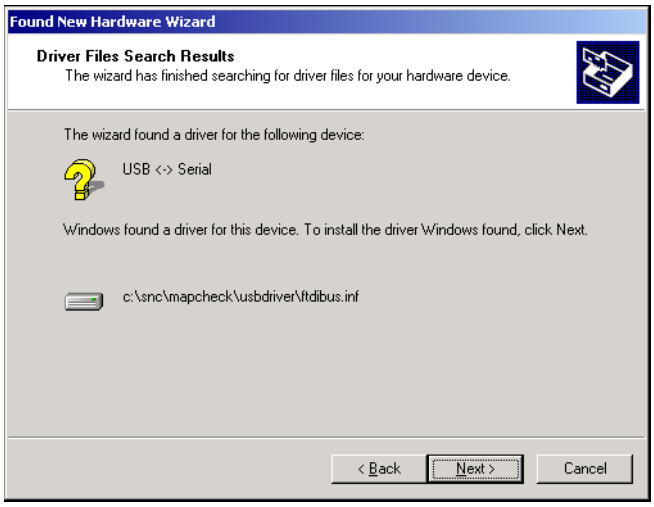


Figure 4-16. Install hardware drivers dialog box

Installing USB drivers for Windows 98SE and ME

Installation for Windows 98SE and ME is similar to Windows 2000, except that the screens have a slightly different appearance, and you must manually enter the location of the drivers.

Drivers are located in the following directory:

- C:\Program Files\SNC\IVD2\USBDriver

  NOTE: Pull down the list in "Include this location in the search" in the Found New Hardware Wizard to find the location of the drivers.

Verifying installation of USB drivers

If you want to verify the installation, select Control Panel > System > Hardware > Device Manager > View > Devices by type. In the Device Manager window, expand the Ports (COM/LPT) to show "USB Serial Port (COM n)" where n is the port number assigned (Figure 4-17).

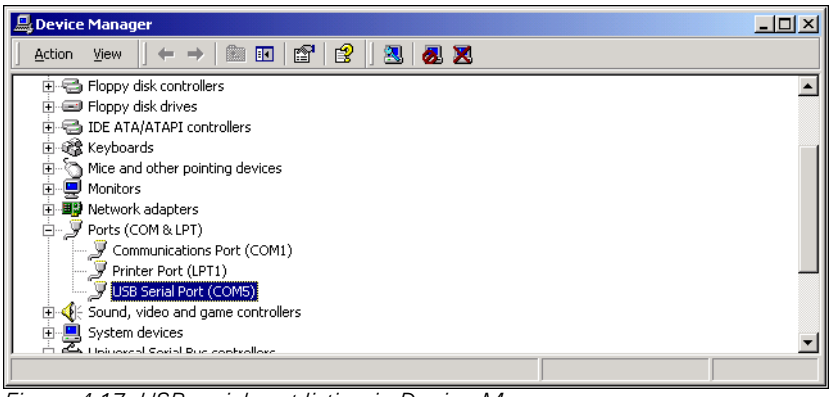


Figure 4-17. USB serial port listing in Device Manager

Using the USB connection

Use the USB connection the same as you would the serial connection.

NOTE: Do not disconnect the USB cable until after you have closed the application software to prevent loss of data.

Connecting multiple instruments to USB

If you use multiple instruments with one computer (for example, an IVD and a DQAC) each installation is assigned a different serial port number. You must know which serial port is assigned to each instrument and select only that port when running that instrument. Or you can use the "Detect" or "Find Port" commands to detect the instrument.

Removing the USB drivers

To remove the USB drivers, open Control Panel (Start > Settings > Control Panel) and double click on Add/Remove Programs. In the Add/Remove Programs dialog box, select "FTDI USB Serial Converter Drivers" and click Change/Remove. Follow the on-screen directions.

Parameter setup

The Parameter Setup item on the Setup menu lets you

- enter or change the PIN (Personal Identification Number),
- select the printout characteristics
- select the type of display for battery status,
- select the type of dose units to be displayed,
- set the RV Portal Software to run at start,
- suppress background subtraction for uncalibrated inputs, and
- enter an Institution Name that will be printed at the top of the printed reports.

To set or change a PIN

The administrator PIN protects patient safety by preventing unsafe connections. In addition, the PIN avoids accidental changes to setup and calibration. To use no PIN, enter 0000.

1. Select Parameter Setup from the Setup menu. This opens the Setup Parameters dialog box (Figure 4-18).

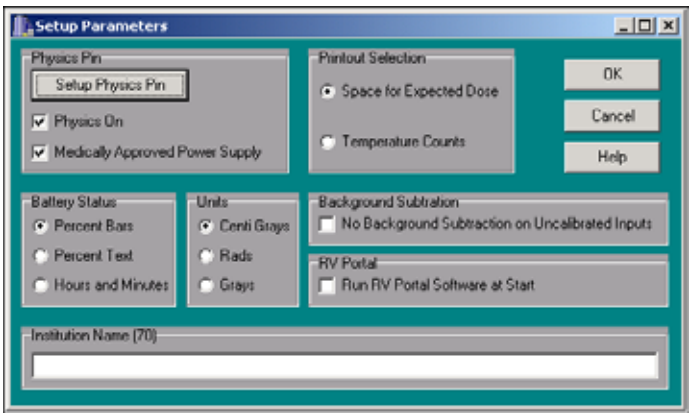


Figure 4-18. Setup parameters dialog box

2. Click the Setup Physics Pin button to open the Password dialog box.
3. In the Password dialog box, enter the PIN once, then enter it again to confirm.
4. Click OK.

NOTE: If the PIN is lost or forgotten, the physicist can key in "0911" to display the stored PIN. After 0911 is entered, fill in the stored PIN and press ENTER to continue. Then the existing PIN can be used, or the PIN can be changed.

About the medical power supply

The medical power supply, P/N 741008, is required for use with the Models 1136 and 1137. The medical power supply can be identified by the label "Medical Power Supply" on the top surface.

When the medical power supply is used, the Medically Approved Power Supply box should be checked. If the box is cleared, the software will force you into Physics Mode whenever a wired connection to a Pod is detected.

To remove a PIN

- To remove a PIN, enter four zeros when prompted.

To make printout selection

This setup option lets you select one of two options to change the appearance of reports:

- Space for Expected Dose—causes a blank to appear with the heading "Exp Dose" so that the therapist can write in the expected dose (from plan) next to the actual dose (measured).
- Temperature Counts—causes the junction voltage counts to appear with the heading "Temp Cnts" next to the actual dose. Temperature counts allow you to independently verify temperature calibration by calculation.

To select battery status display

You can change the battery status display to show three different types of remaining battery life with an accuracy of about ±10%:

- Percent Bars—a horizontal bar that shows the approximate battery life remaining.
- Percent Text—a text display of percent battery life remaining.
- Hours and Minutes—hours and minutes of remaining battery life assuming continuous beam on measurement. Actual operating time with intermittent measurement is about twice as long.

See "About predicted battery life" on page 87 for more information about predicted battery life.

To change dose units

This option is used to select the dose units that are displayed and printed. Administrator PIN is needed.

1. Select Parameter Setup from the Setup menu.
2. Enter your PIN and click OK. This opens the Setup Parameters dialog box (Figure 4-18).
3. Click the button next to the units you want to display.
   - Units are cGy (centigray), Gy (gray), Rads (rad).
4. Click OK.

To run RV Portal software

Normally, this option is not checked. However, if you have installed Sun Nuclear's Record and Verify Portal software, check this box to run the software at startup.

NOTE: Record and Verify Portal Software operates as a bridge to provide data to Nucletron Oncentra RV/VISIR Record and Verify software. For additional information, refer to Oncentra documentation, the Sun Nuclear Record and Verify Portal Software manual, or contact Sun Nuclear Corporation Sales Department.

To suppress background subtraction for uncalibrated inputs

Normally, this option is not checked. However, for troubleshooting, this option allows you to suppress background subtraction for un-calibrated inputs. Thus, the uncorrected values can be displayed.

To enter an institution name

An optional Institutional name can be entered via the dialog box so that the Institution's name appears at the top of every printed report. The Institution name can be a maximum of 70 characters and will be centered on the top text line of each printed report. Administrator PIN is needed.

1. Select Parameter Setup from the Setup menu.

2 Enter your PIN and click OK. This opens the Setup Parameters dialog box.

3 Type the desired institution name in the space provided and press OK to accept or Cancel to abort.

To log active pods

When the system is powered up, the connected Pods are not communicating with the software. To establish communication, you must activate the Log Active Pods command on the Setup menu.

1 Connect and power-up the system.

2 Select Setup > Log Active Pods.

3 Wait approximately 15 seconds for the connected Pods to appear on the main screen.

NOTE: If the Pods do not appear, check to be sure the battery switches are on.

To check the battery

NOTE: Only Model 1136 rf-IVD^2 wireless Pods have batteries.

You can check the remaining battery life and the state of each battery from the display on the Dose view (Figure 4-19).

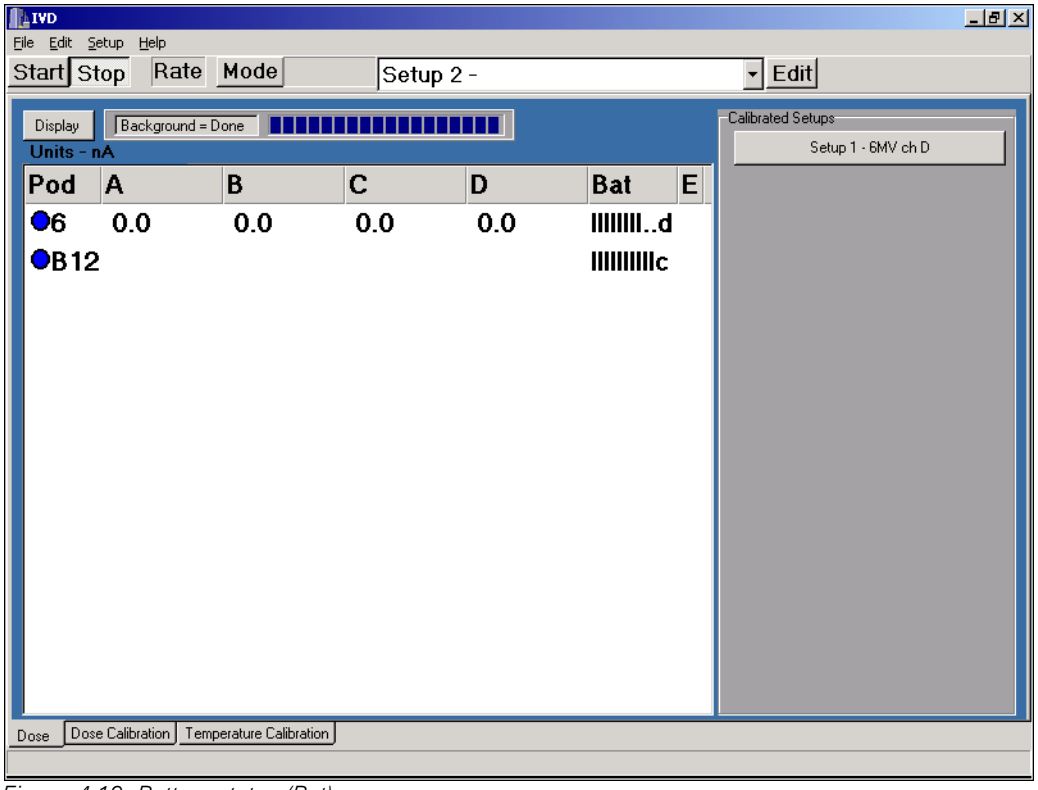


Figure 4-19. Battery status (Bat)

- Battery status is shown as follows:
  - Three choices are selectable in parameter setup screen: (1) Percent remaining Bar, (2) Percent remaining Text, and (3) Hours:minutes remaining
  - If hours and minutes are shown, the numbers displayed are predicted hours and minutes of measurement time left (not including a 30-minute safety factor). If the system is idle (not measuring), the batteries will last about twice as long as shown on the display. See "About predicted battery life" on page 87.
  - Status: c = charging (battery is discharged and is charging at maximum rate), t = trickle charging (a full charge is being maintained with a trickle of power), d = discharging, o = battery switch is off.
  - A battery can show "off" when fully charged.

- A fully-charged battery will indicate 5 to 7 hours on trickle charge.

To view the software version

You may need to check the software version when speaking to Sun Nuclear Corporation Technical Support.

1. Click About on the Help menu.
2. A dialog box opens showing the current software version.
3. Click OK to return to the main window.

To view firmware versions of pods

You may need to check the firmware versions when speaking to Sun Nuclear Corporation Technical Support and to check that the Base Station and Pod have the same version.

1. Power up the system and select Log Active Pods from the Setup menu.
2. Select the multiple Pod display by toggling the Display button.
3. Place the cursor over the Pod or Base Station number you want to check and right-click the mouse.
4. A pop-up box will show the firmware version for the selected unit (Figure 4-20).

CAUTION: In a given setup, all Pod and Base Station firmware versions should be the same.

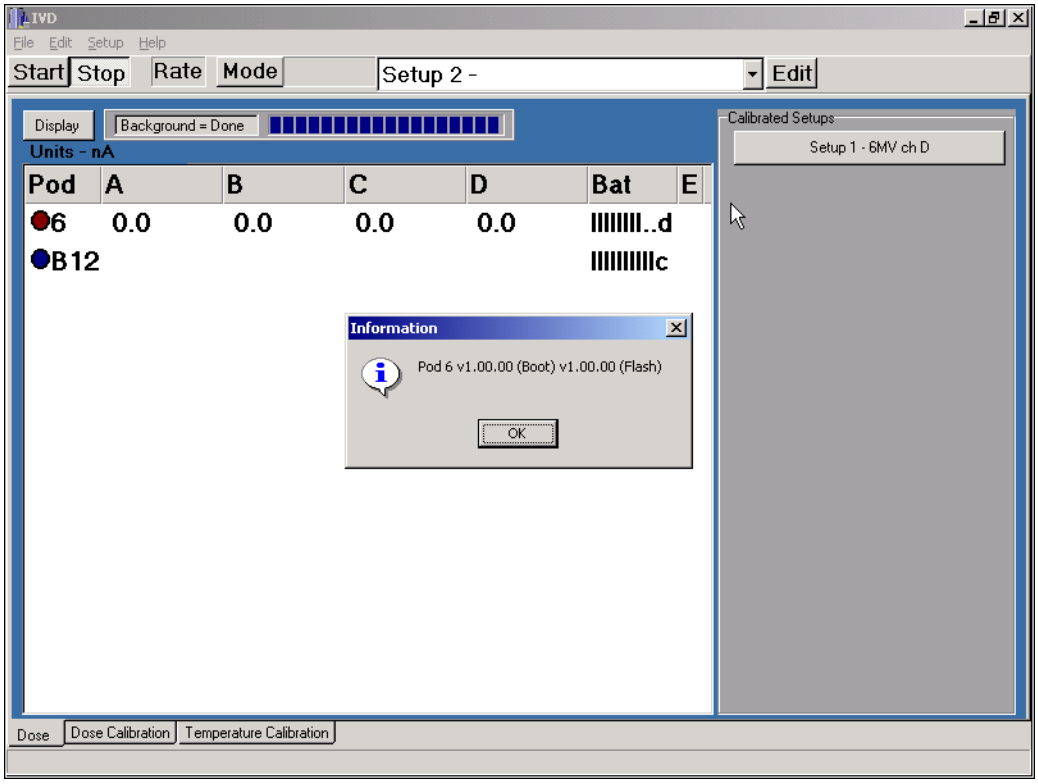


Figure 4-20. Firmware version display

To copy, edit, and paste calibration data

You can copy, edit, and paste correction factors, temperature coefficients, serial numbers, etc. using the standard Windows Copy and Paste function by right-clicking in the edit box.

CAUTION: Pasting or editing overrides the calibration procedures and may result in inaccurate data.

1. Open the Dose Calibration View and expand the listing to include the desired source of the coefficient.

2 Right-click the coefficient to be copied. The coefficient will be highlighted.

3 Right-click to open the context menu (Figure 4-21) and select Copy.

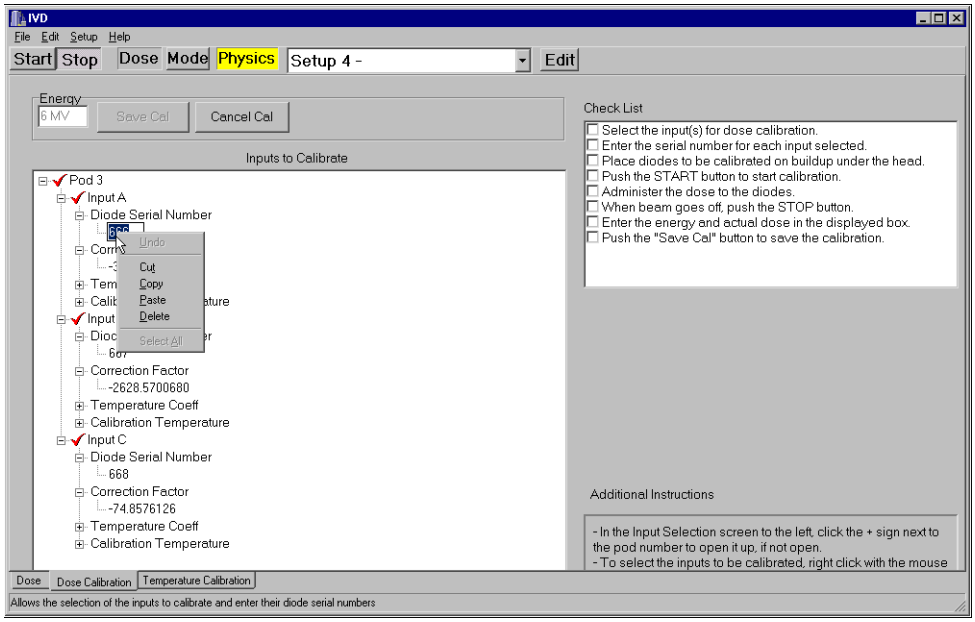


Figure 4-21. Context menu

4 Navigate through the listing to open the destination for the coefficient.

5 Place the cursor where you want to paste the coefficient.

6 Right-click to again open the context menu and select Paste. The coefficient will be copied to the new position.

Or...

Highlight a box and edit the value.

7 Click the Save Cal button to save the copied coefficient to the Pod or click the Cancel Cal button to exit without saving.

To set or change a device ID

Device ID numbers are assigned at the factory. Normally they will not be changed throughout their life. However, if you happen to purchase additional Pods, exchange Pods from another treatment room, or are using Pods from two different systems, you may need to change a device ID number to prevent having duplicate numbers.

You can change the device ID number by using the SNCutility.exe program used for downloading new firmware into your Pod. This program is located on the distribution CD.

Prior to changing the device ID number, please call Sun Nuclear Customer Support for assistance. A representative will guide you through the process.

CAUTION: Improper use of the SNC utility program may erase the embedded firmware and all calibration factors in the Pod rendering it unusable.

Calibration with PC software

Calibration overview

Before using the IVD equipment, you must calibrate the system for different beam energies. Temperature calibration (negative diodes only) is optional. Both of these calibration factors are stored in non-volatile memory in the Detector Pod on which the calibration was performed.

Beam energy calibration is assigned to a specific button; temperature correction factor is assigned to all buttons using the diode serial number and exposure parameters to which the temperature correction factor applies.

In daily operation, clicking a single calibrated energy button prepares the system for measurement. One-button operation simplifies the therapist's daily work.

To standardize setup and prevent mistakes in operation, the physicist should consider the following suggestions:

- Select one of the connection methods appropriate to your needs and stick with it.
- Mark each Pod and Base Station with its unit number. Remember, correction factors are stored in each Pod, not the Control Module or PC.
- Edit the setup description for each energy setup or "button" calibrated, including the parameters to which the button was calibrated.
- If you have multiple Pods, use a consistent method for assigning buttons to beam energies. Example: button 1=6 MV, button 2=18 MV, etc. on all Pods.
- Use consistent placement of diodes on Pod connectors A, B, C, and D.

To calibrate a "button"

When you perform a Dose Calibration, you are setting up a "button" that invokes correction factors specific to the beam energy, diode, and hardware for a specific input. The "buttons" appear in the Dose view only after they have been calibrated.

The button setups are listed in the Setup pull-down list on the Toolbar. You can perform up to 12 calibrations, identified as "Setup 1" through "Setup 12."

To calibrate a button, use the following procedure.

1. Connect and energize the Pod(s) you want to calibrate.
2. Click the Dose Calibration tab at the bottom of the screen. The Password dialog box appears.
3. Enter your PIN and click OK.
4. Select the Setup Number to calibrate.
5. Now follow the on-screen "Check List" (Figure 4-22).

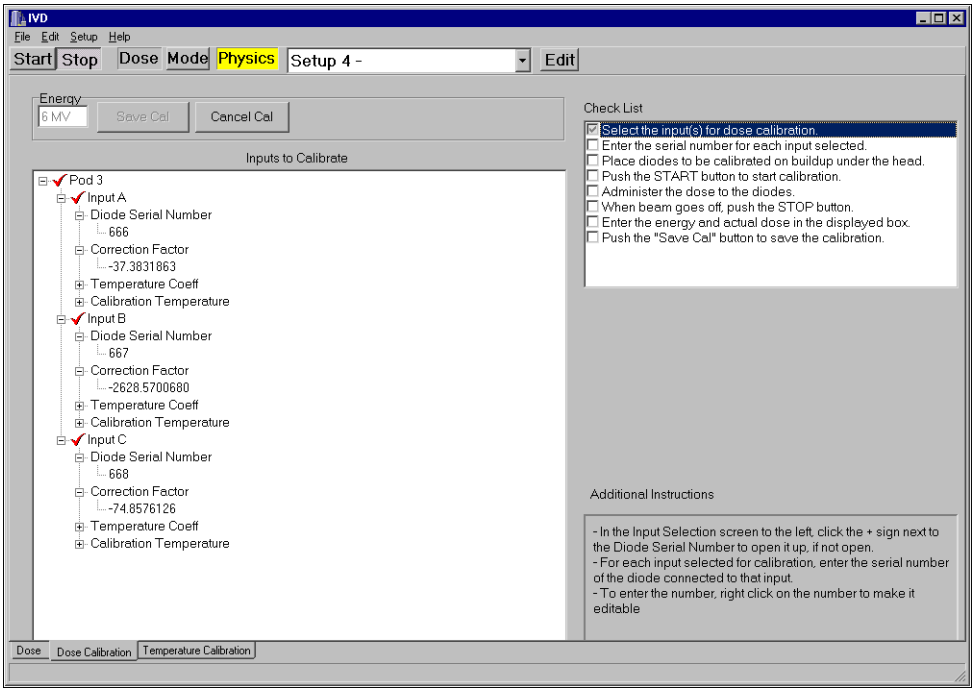


Figure 4-22. Using the check list to calibrate diodes

- The Check List is in the upper right corner of the Dose Calibration view.
- Starting at the top, complete each item.
- For each item on the Check List, there may be Additional Instructions below.
- When an item on the Check List is completed, click the check box and go to the next item.
- Continue through the entire check list.

CAUTION: Be sure the input(s) to be calibrated are selected with a RED CHECK.

6. After the beam goes off and the Stop button is clicked, you will be asked for the administered dose and energy. Enter the correct values in the dialog box.
7. After a few seconds, the display shows the calculated correction factors for each diode. You should review the calibration factors to verify that they are reasonable.
8. Pressing PRINT will print a report for this calibration. For printout details, see "Dose calibration report" on page 75.
9. If correct, save the calibration factors by clicking the Save Cal button. The calibration factors will be saved to the selected Pod location.

CAUTION: Validate after calibration!

Immediately after calibration, the diode calibration should be validated at the same reference conditions used during calibration. This measurement should be performed in the same manner as will be used for patient dosimetry. These results should be recorded for future reference and repeated at least monthly for trend analysis.

To review and print calibration

You can display and print the calibration factors for the selected button at any time. Administrator pin is needed.

To view calibration

1. Click the Dose Calibration tab at the bottom of the screen.
2. When prompted, key in your 4-digit administrator PIN number, and press Enter.
3. In the display area of the screen, select the Pod containing the calibration factors to be viewed.
4. Select the Setup number from the pull-down list.
5. Expand the Inputs to Calibrate list to see the correction factors.
6. To exit, click on the Dose tab at the bottom of the screen.

To print calibration

1. To print out a report for a calibration, first view the calibration.
2. While the calibration factors are on the screen, select Print from the File menu.
3. Change the number of copies or other items in the Print dialog box.
4. Click OK.

For printout details, see "Dose calibration report" on page 75.

To delete calibration

1. To delete the button's calibration factors, first select and open the calibration factors for viewing. See "To view calibration" on page 61.
2. Right-click to highlight the serial number of the diode whose calibration factor is to be deleted.
3. Enter a zero in the serial number box for each calibration you want to delete.

NOTE: Be sure a red check mark appears in front of the edited calibration factors before saving. The red check marks must be visible in order to save the edited calibration factors.

4. When all the calibrations have had their serial numbers zeroed for this setup, click the Save Cal button.
5. The correction factors stored in the Pod are deleted, and a confirmation message appears on the screen.

Saving and reloading a pod's calibration file

Calibration information is stored in the Pod's memory. However, you can save a Pod's calibration data to a file and then re-load it in the Pod at a later time.

This lets you alternate the use of different sets of detectors and their calibration factors with a single Pod.

Saving a pod's calibration file

1. Connect the diode(s) to the desire channel(s).
2. Enter the temperature coefficients and V' or determine them experimentally.
3. Perform the calibration of the diodes at the energy levels desired.
4. Click File > Select Save Pod's Calibration to File. A Save file dialog box appears.
5. Change location as necessary (you can store it wherever you want) and enter a descriptive file name.
6. Click OK to save the calibration data to a file.

Loading a pod's calibration file

1. Connect the diodes to the channels on which they were calibrated.

CAUTION: Be sure you connect the same diodes to the same channel on which they were calibrated. Be sure you are loading the calibration file into the correct Pod number.

2. Click File > Load Pod's Calibration from File.
3. Navigate to the location of your calibration files and select the desired file.
4. Click OK. The data from the file overwrites the contents of the Pod's memory.

Temperature coefficient (Tc)

The dose response of diodes varies with changes in temperature. The "Temperature coefficient" (Tc) is the fractional change in response per unit of junction voltage across the diode. The junction voltage varies inversely with the temperature, and is measured with a 12-bit analog-to-digital converter. For most diodes, a change of approximately 10 analog-to-digital units is equivalent to a change of 1 degree Celsius.

In models 1136 and 1137, you must determine your own temperature coefficient by either:

- Using a lookup table and entering a value (see below)
- Measuring temperature coefficient (see "Temperature coefficient measurement" on page 63)

To enter Tc and V' from table

The temperature coefficient table provides reasonably accurate temperature coefficients based on the model number, serial number, and manufacturer of the diode you are using.

Table 4-2. Nominal temperature coefficients of commercial diode detectors

Detector name	Manufacturer	Temperature coefficient (%/°C)	V' (mV/°C)
Isorad	Sun Nuclear	0.3 ± 0.1	-2.2 ± 0.1
Isorad-p QED (p-type) (S/N below 3323601)	Sun Nuclear	0.3 ± 0.1	-2.4 ± 0.1
Isorad-III	Sun Nuclear	0.5 ± 0.1	-2.1 ± 0.1
QED (n-type) (S/N 3323601 and up)	Sun Nuclear	0.6 ± 0.1	-2.0 ± 0.1
Hi-*p*Si	Scanditronix	0.4	N/A
3G-*p*Si	Scanditronix	0.25	-2.0 ± 0.1
Veridose	Nuclear Associates	0.5	N/A
In-vivo Semi-Conductor probes	PTW	0.15	N/A

NOTE: For detectors not manufactured by Sun Nuclear Corp., the data may not be updated. Please contact the manufacturer for the updated information.

To enter Tc and V' from table, perform the following steps

1. Click the Dose Calibration tab at the bottom of the screen.
2. Expand and select the diodes for which you want to add the Tc and V' data from the table.
3. Type the values directly into the furnished spaces.

Temperature coefficient measurement

If you want to determine temperature coefficients experimentally, you can do so using the following procedure.

Preparation

This procedure is used to perform temperature coefficient measurement for a Detector Pod and diode combination. Administrator pin is needed.

NOTE: Only negative diodes can be measured for a temperature coefficient.

To perform this procedure, you will need the following additional equipment:

- standard microwave oven
- a small water-filled bag, such as a locking sandwich or freezer bag

It is assumed that treatment room ambient temperature is about 22 °C (72 °F) and that the water bag will be heated in the microwave oven to about 38 °C (100 °F). First, a measurement is taken at ambient temperature. Then the bag is heated and placed over the diodes and another measurement is taken. The temperature coefficient is calculated from the two measurements.

For calculation details, see “Calculations” on page 77.

Application of temperature coefficients

A calculated temperature coefficient only applies to a single diode serial number. The same temperature coefficient can be applied wherever that same diode serial number is used, as long as the instantaneous dose rate is within an order of magnitude. (Some diodes have been found to have a different temperature coefficient with Co-60 beams than with accelerator beams.)

Generally, a group of diodes from the same manufacturing lot will have nearly the same temperature coefficient, but for best results, it is better to determine the temperature coefficient for each diode.

In accelerator beams, the instantaneous dose rate within the pulse of radiation is on the order of 10,000 cGy/s. In Co-60 beams, the instantaneous dose rate is on the order of 5 cGy/s. So, even though both beams have an average dose rates of about 300 cGy/min, there can be a significant difference in the temperature coefficient for a diode in these two beams.

In TBI beams where the SSD is 300 to 400 cm, the instantaneous dose rate will be 1/10 of that at 100 cm. Here also, it may be advisable to remeasure the temperature coefficient for TBI applications. In different beam energies, the instantaneous dose rate within a pulse is typically within a factor of 2 or 3 and should not contribute to measurable changes of temperature coefficient.

To measure temperature coefficient

1. Position the diodes on a room-temperature phantom, in the same manner as used for dose calibration. The phantom is required as a thermal mass during the test. See Figure 4-23 for diode spacing.

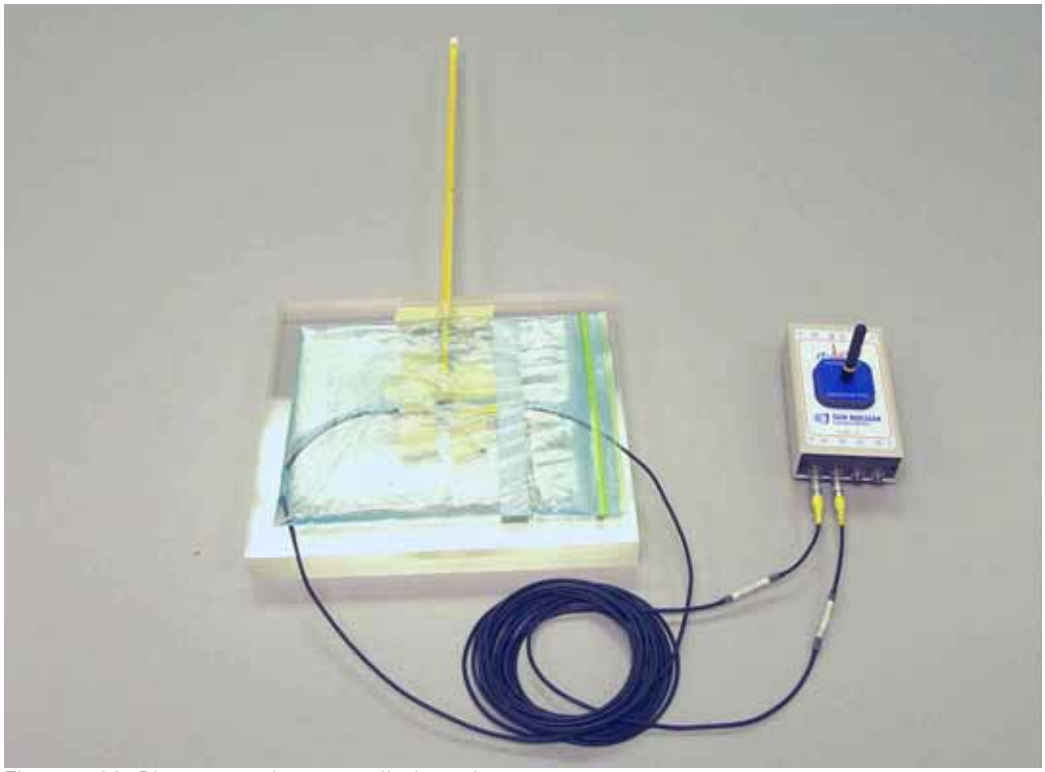


Figure 4-23. Place water bag over diodes prior to exposure

2. Connect and energize the Pod(s) you want to calibrate.
3. Click the Temperature Calibration view tab at the bottom of the screen. The Password dialog box opens.
4. Enter your PIN and click OK.
5. Now follow the on-screen "Check List" (Figure 4-24).
   - The Check List is in the upper right corner of the Temperature Calibration view.
   - Starting at the top, complete each item.
   - If a diode is being used on multiple setups, the same temperature calibration can be applied to all setups by selecting each setup using that diode and selecting its input for temperature calibration.
   - For each item on the Check List, there may be Additional Instructions below.
   - When an item on the Check List is completed, click the check box and go to the next item.
   - Continue through the entire check list.

NOTE: The displayed temperature coefficients are in terms of fractional response change to a junction voltage change of the diode. The junction voltage is a linear function of temperature. The junction voltage is measured with an analog to digital counter, displayed in "A2D" counts. Therefore, the displayed temperature coefficient is not a very recognizable quantity.

6. Validate the application of the temperature coefficients as follows:

a. Position detectors on room temperature buildup and make a measurement under calibrated conditions. This result should be reasonably accurate.

b. After that measurement, place the warmed water bag on the detector for about 2 minutes, remove the bag, and repeat the measurement.

c. The second measurement should agree with the first room temperature measurement within 1 or 2 percent.

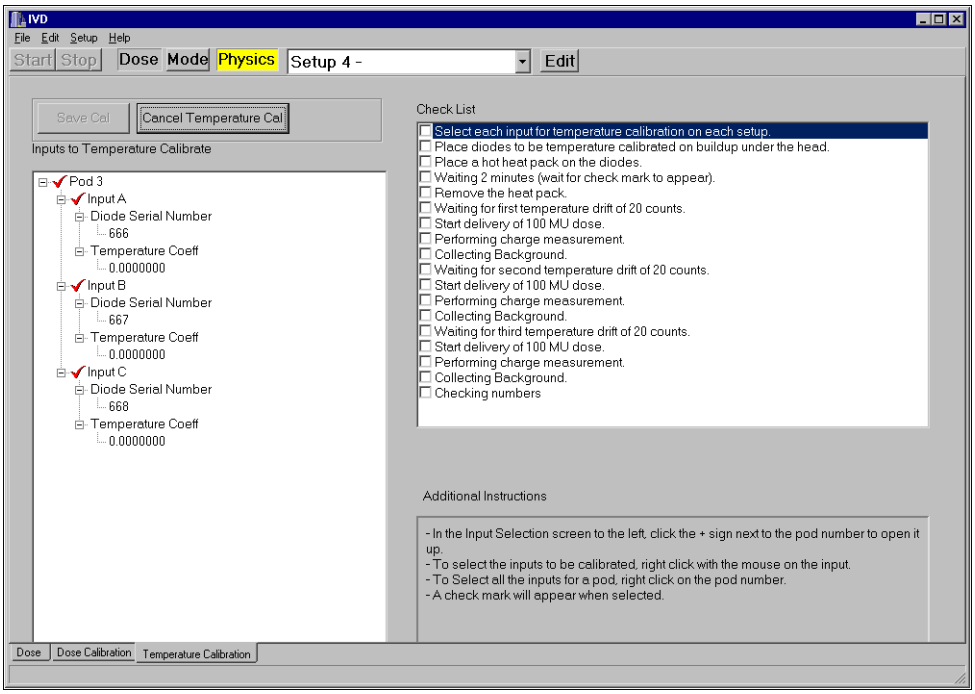


Figure 4-24. Temperature calibration view

Copying temperature coefficients

Whenever you have setups using the same diode on the same channel in the same Pod, you can copy the temperature coefficient from the first temperature calibration to the other setups. You do not have to perform the calibration for each instance of the diode serial number. You only have to do it once. See "To copy, edit, and paste calibration data" on page 58.

However, if you use the same diode on a different channel, or different Pod, you should repeat the temperature calibration.

Measurements with PC software

To prepare for daily operation

1. Allow the batteries to charge overnight. This will ensure you have enough reserve power for a full day's dosimetry measurements.
2. Check that all batteries are fully charged and the battery switches are on. Battery status can be checked on screen in the Dose view.
3. Power up the computer and launch the software.
4. Click Setup > Log Active Pods to activate communication with the Pods.

To make a daily measurement

WARNING: To maintain hygienic safety and prevent cross-infection, disinfect diode before placing it on a patient.

1. Wipe the diode(s) with a pad moistened with an antiseptic solution.

2 Tape the diode(s) in place on the patient.

CAUTION: Never place the Detector Pod or Base Station in the direct beam. You may damage it.

3 Click a Calibrated Setup button in Dose view to prepare the IVD for dose measurement. (The Start button is automatically initiated.)

4 Administer the prescribed radiation dose to the patient.
- During administration of the dose, the simulated LED(s) next to the measuring Pod(s) will be blinking green.

5 When the beam turns off, press Stop button.
- If beam was still on when the Stop button was pushed, the "Beam is On" message will be displayed to let you know that the dose was not finished.
  - Click the OK button to stop acquisition, display final dose, and return to collecting background. (If you continue to Stop with the beam on, the background collected will not be accurate.)
  - Click the Abort button to continue the measurement.
- The measured dose for diodes A, B, C, and D will be displayed. The values will stay on the screen until the next measurement.
- When not acquiring, background is being collected.
- A lower case channel letter will be used and a '~' will appear next to the displayed dose to let you know when a bad background was collected. i.e. accelerator was on, or excessive leakage.
- To print Interim Dose reports, press PRINT after the beam turns off (do not press STOP). You can then continue treatment with another field and the measurement will continue to accumulate. See "Intermediate dose report" on page 70.

6 Click Print on the File menu to print the Dose report. See "Dose report" on page 71.
- Fill in the blanks, sign the report, and file with patient records in accordance with the policies of your treatment center.

7 Remove the diodes from the patient, and repeat the process for the next patient.

WARNING: To maintain hygienic safety and prevent cross-infection, diodes should be cleaned with an antiseptic solution or equivalent before placing them on another patient.

Data interpretation

If the dose measured by the IVD does not agree with the calculated dose, then an investigation of the cause will reveal one of the following:

1 There is an error in the treatment plan calculation.

2 There is an error in the machine or patient setup.

3 The treatment machine is out of calibration.

4 The IVD is improperly calibrated.

5 A failure in the IVD.

In this event, the plan and setup should be reviewed by the physicist. If this does not reveal the error, the calibration of the machine output and the IVD should be tested. If this does not reveal the error, then either the error is the result of a non-reproducible setup or an IVD failure. Under such a condition, the IVD should be used to make another measurement of the treatment dose at the next treatment session. Report any evidence of software faults to the manufacturer by telephone, fax, or E-mail.

WARNING: Under no conditions should the treatment plan be modified based solely upon the measurements of the IVD without corroborating evidence of an error resulting from situations 1, 2, or 3 as described above.

The American Association of Physicists in Medicine (AAPM) has issued Report 87, "Diode in vivo dosimetry for patients receiving external beam radiation therapy," ISBN 1-888340-50-9, (2005), Radiation Therapy Committee, Task Group #62. This report covers the calibration, use, and interpretation of results.

Solving operator problems

Table 4-3. Common solutions to operator problems

Problem	Remedy
Pod not shown at startup.	• Find Pod using Setup > Log Active Pods command on menu. • Turn on battery switch on wireless Pod. • Recharge battery on wireless Pod. • Swap Base Station and Pod. • Move the Pod around to a more desirable position for radio transmission. Moving the Pod a few feet may make a difference in the transmission.
Control Module not shown at startup.	• Connect power or turn on Control Module. • Reconnect Control Module properly.
Message "Low Battery" and a beep sounds. Display shows which battery is low.	• Complete existing operation (you have 30 minutes grace time) and recharge battery.
LED DS2 on Pod is blinking rapidly.	• Check error code shown in error message. Right-click on the "E" column next to the Pod in the Dose screen. See "Error codes" on page 80. • Power Pod down, then power back up. Repeat the procedure that caused the problem. • If problem continues, call Sun Nuclear Customer Service.

To perform post operational checks (Model 1136)

At the completion of daily operation:

1. Verify that the Base Station and Pod are connected to battery charging power and are charging.
2. Reconnect the Detector Pod to battery charging power.
3. Verify that all batteries are charging (blinking DS1 LED on Pods). If any units were switched or reconnected, return the setup to its original configuration.

To log data

A data logging function is available for troubleshooting or special studies. By checking the Log Data command on the File menu, you can cause a data log text file to be written to disk for every measurement.

When the menu is checked, the program writes data to C:\Program Files\SNC\IVD\data.txt once per second during the measurement. The tab-separated "data.txt" file can be viewed with a spreadsheet or other text editor.

NOTE: Subsequent measurements overwrite the "data.txt" file.

To make "multi acquisition" measurements

This option lets you make multiple measurements but accumulate all measurements on one report.

Collect for multi acquisition print

1. Click File > Collect for Multi Acquisition Print. The header dialog box opens.
2. Fill in the header dialog box with the data pertinent to the exposure.
3. Click OK.
4. Make the exposure.
5. If desired, review the data (see below)
6. Repeat steps 1-5 for all subsequent exposures.

Review multi acquisition print

1. Click File > Review Multi Acquisition Print. The review dialog opens.
2. Check the exposures.
3. Continue collecting exposures or end and print multi acquisition.

End and print multi acquisition

When finished with all exposures for the printout, click File > End and Print Multi Acquisition. All of the stored exposures will print on a single report.

TBI measurements with multiple pods

If you use the IVD application software, you can connect multiple Pods for Total Body Irradiation (TBI) measurements. You can perform up to 28 simultaneous measurements if you use up to 7 wired detector Pods. Or you can perform up to 52 simultaneous measurements if you use up to 13 wireless Pods.

1. Before treatment, perform the following tasks:
   a. Set up and identify the Pods.
   b. Connect and calibrate all the diodes.
2. Tape the diodes to the patient according to the measurement plan. Write down the location each diode on the patient along with the diode letter and Pod number at the corresponding location.
3. Open the Application software, verify all Pods are present and diodes listed.
4. Click Start.
5. Irradiate the patient.
6. After the accelerator turns off, click Stop.
7. If desired, copy and paste the measurement values from the screen of the IVD application software into a spreadsheet.
8. If desired, print a report. See “PC software reports” below.

PC software reports

About reports

The following reports are available for therapist use to record daily testing:

- Intermediate Dose Report can be printed to show the accumulated dose up to that point when making multiple exposures.
- Dose Report can be printed at the completion of a dose.
- Multi-acquisition Report contains a series of dose measurements in a single report.

In addition, the physicist may find the following reports useful:

- Intermediate Charge Report can be printed to show the accumulated dose up to that point when making multiple exposures using an un-calibrated energy key.
- Charge Report can be printed at the completion of a dose when using un-calibrated energy key.
- Calibration Report can be printed to show details of a calibration.

The type of report printed will depend on the operation that was in progress or just completed when the PRINT button was pressed.

The time and date shown on each report is derived from the PC system clock. You can select any system printer that is connected to your PC.

To print a report

1. Be sure the selected system printer is properly connected and turned on.
2. Complete the procedure for which you want a report.
3. Select the view appropriate to what you are doing.
4. Select Print from the File menu.
5. To change printer or printer settings, click Properties and make the necessary changes in the Windows printer setup dialog box.
6. Click OK. A header dialog box appears (Figure 4-25).

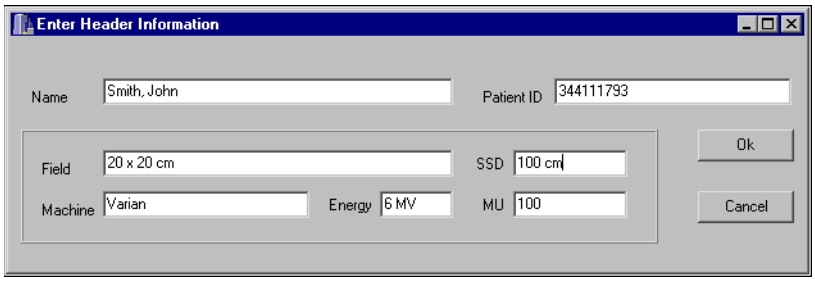


Figure 4-25. Print header dialog box

7. Enter the appropriate report header information and click OK.
8. The report will be printed on the selected system printer.

Intermediate dose report

An Intermediate dose report is printed by pressing the PRINT button while the Active LED is turned on. It provides an opportunity to print one or more treatment fields before STOP is pressed. Each intermediate dose report will contain the accumulated total since the energy key is pressed.

Community Hospital Oncology Department
Intermediate Dose Report

Time: 01:10:03 pm Date: 7/2/2005

Name: John Smith Patient ID: 1234567

Field: 10 x 10 cm SSD: 100 cm

Machine: Clinac 2100 Energy: 11 MV MU: 100

Setup 2 -

Pod	Input-A Serial	Temp Cts	Dose cGy	Input-B Serial	Temp Cts	Dose cGy	Input-C Serial	Temp Cts	Dose cGy	Input-D Serial	Temp Cts	Dose cGy
5	1111111	2222	1027.9									

Therapist: _____ Physicist: _____ Doctor: _____

Figure 4-26. Intermediate dose report

- The date and time on Intermediate dose report will be the date and time of the printout as determined by the PC system clock.
- Print this report when collecting Dose with calibrated inputs.
- Signature space for therapist, physicist, and doctor.

Dose report

The Dose Report is the final report printed after treatment. After STOP is pressed, this report will be printed when PRINT button is pressed.

Community Hospital Oncology Department
Dose Report

Time: 01:05:39 pm Date: 7/2/2005

Name: John Smith Patient ID: 1234567

Field: 10 x 10 cm SSD: 100 cm

Machine: Clinac 2100 Energy: 6 MV MU: 100

Setup 1 - Collection Date and Time: 7/2/2005 01:04:24 pm

Pod	Input-A Serial	Temp Cts	Dose cGy	Input-B Serial	Temp Cts	Dose cGy	Input-C Serial	Temp Cts	Dose cGy	Input-D Serial	Temp Cts	Dose cGy
5	1111111	2222	629.9									

Therapist: _____ Physicist: _____ Doctor: _____

Figure 4-27. Dose report

- The date and time on the Dose report will be the date and time the STOP button was pressed at the end of the acquisition as determined by the PC system clock.
- Print this report after collecting Dose with calibrated inputs.
- Blank fields should be filled in according to organization policies.
- Signature space for therapist, physicist, and doctor.

Multiple acquisition report

You can collect a series of up to 20 sequential measurements and print them in a single report (Figure 4-28).

For example, you may want to make measurements throughout a patient's treatment session, but print them on a single report. This feature lets you print up to 20 measurements on a report with a single header.

Community Hospital Oncology Department
Dose Report

Time: 01:43:38 pm Date: 7/2/2005

Name: Joe Jones Patient ID: 1234568

Setup 1 - Collection Date and Time: 7/2/2005
Field: 10 x 10 cm SSD: 100
Machine: Clinac 2100C Energy: 11 MV MU: 100

Pod	Input-A Serial	Exp Dose	Dose cGy	Input-B Serial	Exp Dose	Dose cGy	Input-C Serial	Exp Dose	Dose cGy	Input-D Serial	Exp Dose	Dose cGy
5	1111111	_____	0.0	0	_____		0	_____		0	_____	

Setup 1 - Collection Date and Time: 7/2/2005
Field: 10 x 10 cm SSD: 100
Machine: Clinac 2100C Energy: 11 MV MU: 100

Pod	Input-A Serial	Exp Dose	Dose cGy	Input-B Serial	Exp Dose	Dose cGy	Input-C Serial	Exp Dose	Dose cGy	Input-D Serial	Exp Dose	Dose cGy
5	1111111	_____	0.0	0	_____		0	_____		0	_____	

Therapist: _____ Physicist: _____ Doctor: _____

Page 1

Figure 4-28. Multiple acquisition report

1. Click the Start button and begin the first exposure.
2. Click Stop button when the exposure is done.
3. Click File > Collect for Multi-acquisition Print for each acquisition to log the data for printing. The Header dialog box opens.
4. Enter the Header information in the dialog box for this exposure.
5. When you have completed the series of exposures, you can chose Click File > Review Multi-acquisition Print to review all the exposures taken and choose to not print one or more exposures if necessary.
6. Then click File > End and Print Multiple Acquisition. The print dialog opens.

7 Select and set up the printer and click OK. The multiple acquisition Dose Report prints on the selected printer.

NOTE: Once you click the End and Print Multiple Acquisition, the data will be cleared from memory the next time Start is pushed. You can reprint the report again if you have not clicked Start. When you click start for the next measurement, the previous values are cleared from memory. and a new session will be started.

NOTE: These values are not retained once the program closes.

Intermediate charge report

This report is the same as the Intermediate Dose Report except that it is printed out if an un-calibrated energy button is selected.

Community Hospital Oncology Department
Intermediate Charge Report

Time: 01:11:52 pm Date: 7/2/2005

Name: John Smith Patient ID: 1234567

Field: 10 x 10 cm SSD: 100 cm

Machine: Clinac 2100 Energy: 11 MV MU: 100

Setup 9 -

Pod	Input-A Serial	Temp Cts	Chrg nC	Input-B Serial	Temp Cts	Chrg nC	Input-C Serial	Temp Cts	Chrg nC	Input-D Serial	Temp Cts	Chrg nC
5			-23.3			-23.5			-23.2			-23.5
10			0.0			0.0			0.0			0.0

Therapist: _____ Physicist: _____ Doctor: _____

Figure 4-29. Intermediate charge report

- The date and time on the Intermediate Charge report will be the date and time of the printout as determined by the PC system clock.
- Print this report while collecting charge with un-calibrated inputs.
- Signature space for therapist, physicist, and doctor.

Charge report

This report is similar to the Dose Report except that it is printed if an un-calibrated energy button is selected.

Community Hospital Oncology Department
Charge Report

Time: 01:47:14 pm Date: 7/2/2005

Name: Joe Jones Patient ID: 1234568

Field: 10 x 10 cm SSD: 100

Machine: Clinac 2100CEnergy: 11 MV MU: 100

Setup 9 - Collection Date and Time: 7/2/2005 01:46:52 pm

Pod	Input-A Serial	Exp Dose	Chrg nC	Input-B Serial	Exp Dose	Chrg nC	Input-C Serial	Exp Dose	Chrg nC	Input-D Serial	Exp Dose	Chrg nC
5			-9.3			-9.4			0.0			0.0
10			-9.3			-9.2			0.0			0.0

Therapist: _____ Physicist: _____ Doctor: _____

Figure 4-30. Charge report

- The date and time on the Charge report will be the end date and time of the acquisition as determined by the PC system clock.
- Print this report after collecting charge with un-calibrated inputs.
- Signature space for therapist, physicist, and doctor.

Dose calibration report

This report shows the calibration details for a calibrated energy button.

Community Hospital Oncology Department
Calibration Factor Report

Time: 02:01:40 pm Date: 7/2/2005

Setup 12 -

Pod	Input	Energy	Cal Date/Time	Serial	Temp Cts	Cal	Temp Coef	
5	A	6 MV	7/2/2005 02:00:36 pm	22222222	2218	-0.0731215	0.00	0.00
5	B	6 MV	7/2/2005 02:00:36 pm	33333333	2219	-0.0731722	0.00	0.00
5	C		No Calibration					
5	D		No Calibration					

Phyicist: _____

Figure 4-31. Dose calibration report

- The date and time on the Dose Calibration report will be the date and time of calibration as determined by the PC system clock.
- Temperature is only shown if the calibration factor is negative.
- The temperature coefficients show 0.0 if temperature coefficient measurement has not been done.
- This report will be printed when the calibration coefficients are displayed in dose calibration.
- Signature space for physicist.

5 Reference information

Calculations

This section describes calculations performed by the display unit on the raw data obtained from the detector diodes and is provided as reference information for the radiation physicist.

Background

Display builds a FIFO array with the counter data from the POD and a time value (in seconds) from the 16 millisecond clock on the Pod. This array is cleared each time an energy key or Stop is pressed.

The array looks like:

```
A(1,1)=T(1),   A(1,2)=A(1), A(1,3)=B(1), A(1,4)=C(1),   A(1,5)=D(1);
A(2,1)=T(2),   A(2,2)=A(2), A(2,3)=B(2), A(2,4)=C(2),   A(2,5)=D(2);
…;
A(32,1)=T(32), A(32,2)=A(32),A(32,3)=B(32),A(32,4)=C(32),A(32,5)=D(32).
```

Where: T(n) = time stamp of the nth counter values for channels A, B, C, D, with T(1) being the most recent and T(32) being the oldest.

When a calibrated energy key is pressed, calculate the background rates **before** clearing the array.

CAUTION: Note conditions below.

Find first subscript n such that A(n,1) – A(1,1) $\geq$ 20, i.e., calculate the background from the most recent 20 seconds of data.

$$BKGA = \frac{A_{n,2} - A_{1,2}}{A_{n,1} - A_{1,1}} \quad BKGB = \frac{A_{n,3} - A_{1,3}}{A_{n,1} - A_{1,1}} \quad BKGC = \frac{A_{n,4} - A_{1,4}}{A_{n,1} - A_{1,1}} \quad BKGD = \frac{A_{n,5} - A_{1,5}}{A_{n,1} - A_{1,1}}$$

where BKGA, BKGB, BKGC, BKGD are the background counting rates for channels A, B, C, D.

Background calculation conditions:

- Recalculate BKGA, BKGB, BKGC, BKGD after an energy key is pressed only if A(1,1)-A(oldest,1) ≥ 20. i.e. we have collected a full 20 seconds worth of background again, otherwise use the prior values of BKGA, BKGB, BKGC, BKGD previous to the energy key being pressed.
- If new BKGA, BKGB, BKGC, BKGD is < 10 (25 pA), replace previous value with the new value.
- If new BKGA, BKGB, BKGC, BKGD is ≥ 10, replace previous value with 0. Display '~' next to the dose results in the Dose screen, and display lower case a, b, c, when displaying charge results.
- Example: Old BKGA = 3.53, BKGB = 2.88, BKGC = 4.34, BKGD = 3.21
  a. A(20,1) – A(1,1) = 20, 1st condition passes, calculate new backgrounds
  b. New BKGA = 4.39, BKGB = 2.58, BKGC = 11.34, BKGD = 3.56
  c. Replace backgrounds as BKGA = 4.39, BKGB = 2.58, BKGC = 0, BKCD = 3.56
  d. Something failed in channel C, but A,B, and D are OK.
- Example: Old BKGA = 3.53, BKGB = 2.88, BKGC = 4.34, BDGD = 3.21
  a. A(19,1) – A(1,1) = 19, 1st condition fails, do not calculate new backgrounds
- Note that it is possible, if we miss a communication, that the A(n,1) – A(1,1) > n.

Data collection

At the beginning of the measurement, when the Pod is told to start measuring, the 16 millisecond counter is zeroed. During Measurement, calculate the Dose and Rate from the FIFO array as follows:

Dose:

$$DA = [A_{1,2} - A_{1,1} \cdot BKGA] \cdot CF_{btn,A} \cdot (Tempcf)_{btn,A}$$
$$DB = [A_{1,3} - A_{1,1} \cdot BKGB] \cdot CF_{btn,B} \cdot (Tempcf)_{btn,B}$$
$$DC = [A_{1,4} - A_{1,1} \cdot BKGC] \cdot CF_{btn,C} \cdot (Tempcf)_{btn,C}$$
$$DD = [A_{1,5} - A_{1,1} \cdot BKGD] \cdot CF_{btn,D} \cdot (Tempcf)_{btn,D}$$

where DA, DB, DC, DD are the dose values for channels A, B, C, D and $CF_{btn,A}$, $CF_{btn,B}$, $CF_{btn,C}$, $CF_{btn,D}$, are the Calibration Factors for channels A, B, C, D on energy button 'btn.' $(Tempcf)_{btn,cnr}$ is defined below, cn_r being A, B, C, D. This assumes that the timer counter was zeroed, i.e., A1,1 is the true elapsed time since pressing the energy key.

Rate:

$$RA = [(A_{1,2} - A_{2,2}) - (A_{1,1} - A_{2,1}) \cdot BKGA] \cdot CF_{btn,A} \cdot (Tempcf)_{btn,A}$$
$$RB = [(A_{1,3} - A_{2,3}) - (A_{1,1} - A_{2,1}) \cdot BKGB] \cdot CF_{btn,B} \cdot (Tempcf)_{btn,B}$$
$$RC = [(A_{1,4} - A_{2,4}) - (A_{1,1} - A_{2,1}) \cdot BKGC] \cdot CF_{btn,C} \cdot (Tempcf)_{btn,C}$$
$$RD = [(A_{1,5} - A_{2,5}) - (A_{1,1} - A_{2,1}) \cdot BKGD] \cdot CF_{btn,D} \cdot (Tempcf)_{btn,D}$$

where the RA, RB, RC, RD are the dose rate values for channels A, B, C, D during the past time interval of $A_{1,1}$ to $A_{2,1}$.

Temperature correction factor

This section describes how the IVD Control Module allows users to set up temperature compensation for their diodes.

The routines are accessed from the "Temperature Coef" item from the main menu. A PIN code is required to proceed, followed by 1 to 4 serial numbers. After the serial numbers are selected and enter is pressed, the display then scans the active Pod's calibration files, flagging as selectable those which contain any of the chosen serial numbers. You can then choose which calibration(s) are to be adjusted.

Two coefficients are associated with each diode pertaining to temperature: Tc and V'. Tc is the diode's change in sensitivity with respect to temperature. Its label is percent per degree Celsius. A typical value for this is 0.5%/deg, which is stored internally as 50. V' is a factor which allows the IVD display to determine relative diode temperature from the diode's junction voltage. Its units are millivolts per degree Celsius (typical value, -2.0mV/deg, which is stored as 200). Formulae for Tc and V' are provided below.

After you select your calibrations, you are presented with the option of either entering Tc and V' manually for each detector, or finding the coefficients through an experiment. If they are entered manually, the values are simply stored in the selected calibrations for the selected detectors, and the setup is complete.

For diodes with unknown coefficients, or to verify a coefficient, the IVD allows for an experiment instead of manual entry.

Materials required for the experiment:

- An IVD system with diodes connected
- A 3 cm thick acrylic or solid water phantom
- A laboratory thermometer with 0.1 degree C resolution

- A Zip-Loc (or equivalent) sandwich bag. (7x8")
- Adhesive tape
- Water

Mount the thermometer to the buildup with tape, and mount the detectors face-down to the buildup. For maximum of 8 detectors, place the detectors and the thermometer uniformly along a 5 cm circle in a 20x20 cm^2 field at 100 cm SSD.

Fill the bag with 400mL of cold tap water, enough water that the bag is roughly 2 cm thick when sealed and laid flat. Try to avoid sealing in any large bubbles.

The first step on the IVD display after choosing the experimental route is "Apply cold bag to diodes."

Lay the bag flat over the diodes, and then press ENTER. The display will begin a 7-minute countdown. This delay is to allow the system to reach thermal equilibrium. The countdown can be stopped early by pressing both the left arrow and the right arrow at the same time, but this is not recommended unless the bag really has been applied for at least 7 minutes.

After the delay, the system beeps and asks you for a temperature in degrees (from the thermometer). Immediately after the temperature is entered, the diodes' junction voltages are read and stored along with the entered temperature. These numbers will be used to find the V primes.

Then, A 15-second background measurement is made, a beep is sounded, and you are presented with a dose-counting screen, with dosages in counts and an alternate message asking you to turn on the beam. Deliver a dose of 100 monitor units at any energy. When this is done, the dose is stored, along with the final junction voltage measurement after the dose measurement. These numbers will be used to find the Tc's.

The next step on the IVD display is to "Apply hot bag to diodes," and press Enter. The steps are the same as above except that now the bag is to be heated for 45 seconds in the microwave before application.

After the dose is delivered, you can use the hot and cold data sets to calculate all of your coefficients for each channel:

$$V' = (\text{ThotCts} - \text{TcoldCts}) * 0.2265 / (\text{ThotDeg} - \text{TcoldDeg})$$

Where **ThotCts** is the second junction voltage in counts measured after you enter the temperature, **TcoldCts** is the first junction voltage in counts, **ThotDeg** is the second temperature you enter, and **TcoldDeg** is the first temperature you enter. The 0.2265 is the factor to convert junction voltage counts into milliVolts.

$$\text{Tc} = 100.0 * (\text{DoseHot} - \text{DoseCold}) / (\text{DoseCold} * (\text{Thot} - \text{Tcold}) * 0.2265/V')$$

Where **DoseHot** is the second measured dose for a channel in background-compensated counts, **DoseCold** is the first measured dose, **Thot** is the junction voltage (in counts) following the second dose measurement, **Tcold** is the first junction voltage. **V'** is the V' described above.

Internally, these numbers are stored as unsigned short integers. For this reason, V' is kept multiplied by –100 (i.e. –2.0 would be stored as 200) and Tc is kept multiplied by 100. (0.6 would be stored as 60.)

To apply these coefficients to correct a dose measurement, the formula is as follows:

$$\text{DoseCorrect} = \text{DoseMeasured} / (1 + (\text{Tc} / 100) * (\text{Tmeas} - \text{Tcal}) * 0.2265/V')$$

Where **DoseMeasured** is a background compensated and calibrated dose reading in Gy, cGy, etc., **Tc** is the Tc from above, **Tmeas** is the junction voltage following the dose measurement (counts), **Tcal** is the junction voltage following calibration, and **V'** is the V' from above.

Keep in mind that because **Tc** and **V'** are stored as positive integers they will need to be divided by 100 and –100 respectively, before inserting them into the above equation.

Computing dose calibration factor for energy button 'btn'

Calculate CF as follows:

$$CF_{btn,A} = \frac{DA}{[A_{1,2} - A_{1,1} \cdot BKGA]}$$

$$CF_{btn,B} = \frac{DB}{[A_{1,3} - A_{1,1} \cdot BKGB]}$$

$$CF_{btn,C} = \frac{DC}{[A_{1,4} - A_{1,1} \cdot BKGC]}$$

$$CF_{btn,D} = \frac{DD}{[A_{1,5} - A_{1,1} \cdot BKGD]}$$

DA, DB, DC, DDare all equal since they are all the same dose, you enter after the calibration beam turns off.

There is no temperature correction because the calibration is at the temperature during calibration. That is, in the expression for Tempcf, the difference TMP_{cnr} –$TCAL_{btn,cnr}$ during calibration is zero and $TCAL_{btn,cnr}$ gets saved with the calibration.

Error codes

Error codes allow Sun Nuclear technicians to quickly identify internal errors that could occur in the IVD system. When requesting customer service, you may be asked to display any error codes and report them. This information will allow the Sun Nuclear technician to evaluate the problem and find a solution. The intent of the error display is to aid the technician in troubleshooting.

Displaying error codes on the PC

When an error occurs, the letter “E” appears in the E column in Dose view. To view the meaning of the errors, right-click the “E” for the unit that is displaying it. An explanation of the error appears in a pop-up box (Figure 5-1).

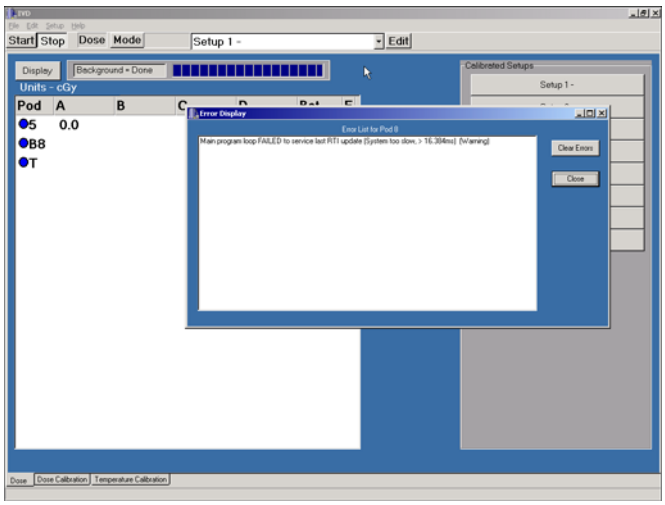


Figure 5-1. PC error code display

Displaying error codes on display module

1. Be sure the system is properly connected and powered up.
2. On the Control Module, select the Software Version menu. See “To view the software version” on page 58.
3. Key in the number “412” on the keypad. The error codes appear. It is possible that more than one error is displayed.

```
Error
0000000000000000
```

4 View and record the 16 digits that appear on the bottom row of the LCD screen.

5 To clear the error display, press ENTER. To leave, press STOP.

Reading error codes on the display module

Each Pod's internal memory contains an ERROR CODE ARRAY (g_errs[8]) consisting of 8 bytes. Each byte represents an error "module," and each module represents a group of functionally related errors. Each bit of the 8 bits in a module represents an error, for a total of 64 possible errors.

The errors are displayed, in hexadecimal format, in a row of 16 characters. The characters, from left to right, are in groups of two digits, designated A & B, and are associated to an error module group, designated Module_0 to Module_7 (Table 5-1).

Table 5-1. Arrangement of modules and A and B characters in the display

Module_0		Module_1		Module_2		Module_3		Module_4		Module_5		Module_6		Module_7	
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B

To decode the displayed errors:

1 Read the hexadecimal value of a non-zero character. From its position, determine the module and whether it is "A" or "B."

2 Using Table 5-2, read across for the hexadecimal character and determine which Error Bits are set, as indicated by the "X" in the column.

Table 5-2. Bit errors set

hex	A Error Bits Set				hex	B Error Bits Set			
	BIT 7	BIT 6	BIT 5	BIT 4		BIT 3	BIT 2	BIT 1	BIT 0
0					0				
1				X	1				X
2			X		2			X	
3			X	X	3			X	X
4		X			4		X		
5		X		X	5		X		X
6		X	X		6		X	X	
7		X	X	X	7		X	X	X
8	X				8	X			
9	X			X	9	X			X
A	X		X		A	X		X	
B	X		X	X	B	X		X	X
C	X	X			C	X	X		
D	X	X		X	D	X	X		X
E	X	X	X		E	X	X	X	
F	X	X	X	X	F	X	X	X	X

3 Using the Error Bits that were set from Table 5-2, find the corresponding errors in Table 5-3 for the Module group associated with the A-B combination.

Table 5-3. Error Codes

Error	Mask	Bit	Comment
MODULE_0: SYSTEM INITIALIZATION (BYTE 0x0B2C)			
ERR 1		BIT 0	BEEP - Battery Data Group is Corrupt (will attempt to use last group)
ERR 2	X	BIT 1	BEEP - Both Battery Data Segment checksums are bad, using Defaults
ERR 3	X	BIT 2	BEEP – Store Battery Data Failed
ERR 4	X	BIT 3	BEEP - System Data Checksum/Data is bad, using Defaults

Table 5-3. Error Codes (Continued)

Error	Mask	Bit	Comment
ERR 5	X	BIT 4	BEEP – Initialize Error Mask defaults Failed
ERR 6	X	BIT 5	BEEP – Initialize System Data Defaults Failed
ERR 7	X	BIT 6	BEEP – Clear old battery group data Failed
ERR 8		BIT 7	
MODULE_1: SYSTEM (BYTE 0x0B2D)			
ERR 9		BIT 0	Main program loop FAILED to service last RTI update (System too slow, > 16.384ms) (Warning)
ERR 10		BIT 1	Battery capacity <90% of last capacity??? (Warning)
ERR 11		BIT 2	Battery capacity >110% of last capacity??? (Warning)
ERR 12		BIT 3	BEAM ON was detected in Background Mode
ERR 13			(not used)
ERR 14	X	BIT 5	Could not AUTO Clear Caps (Electrometer problem?)
ERR 15		BIT 6	Background too high (channel a, b, c, d)
ERR 16		BIT 7	Battery Charge Problem?
MODULE_2: SYSTEM (BYTE 0x0B2E)			
ERR 17		BIT 0	(not used)
ERR 18		BIT 1	(not used)
ERR 19		BIT 2	(not used)
ERR 20		BIT 3	(not used)
ERR 21		BIT 4	
ERR 22		BIT 5	
ERR 23		BIT 6	
ERR 24		BIT 7	
MODULE_3: SYSTEM (BYTE 0x0B2F)			
ERR 25	X	BIT 0	Channel "D" (ATD0) Counter Overflow occurred in current mode, BKGND or ACQ
ERR 26	X	BIT 1	Channel "C" (ATD1) Counter Overflow occurred in current mode, BKGND or ACQ
ERR 27	X	BIT 2	Channel "B" (ATD2) Counter Overflow occurred in current mode, BKGND or ACQ
ERR 28		BIT 3	Channel "A" (ATD3) Counter Overflow occurred in current mode, BKGND or ACQ
ERR 29	X	BIT 4	Diode Channel "D" (ATD0) Rate Over Range was detected
ERR 30	X	BIT 5	Diode Channel "C" (ATD1) Rate Over Range was detected
ERR 31	X	BIT 6	Diode Channel "B" (ATD2) Rate Over Range was detected
ERR 32	X	BIT 7	Diode Channel "A" (ATD3) Rate Over Range was detected
MODULE_4: SYSTEM (BYTE 0x0B30)			
ERR 33		BIT 0	
ERR 34		BIT 1	
ERR 35		BIT 2	
ERR 36		BIT 3	
ERR 37		BIT 4	
ERR 38		BIT 5	
ERR 39		BIT 6	
ERR 40		BIT 7	
MODULE_5: SPI / SPI_AD (BYTE 0x0B31)			
ERR 41		BIT 0	SPI Status Flag did not set
ERR 42		BIT 1	SPI Write Collision, SP0DR WCOL bit 6 set
ERR 43		BIT 2	SPI Mode Error interrupt, SP0DR MODF bit 4 set
ERR 44		BIT 3	SPI AD Converter Command not valid
ERR 45		BIT 4	SPI A/D select error
ERR 46		BIT 5	
ERR 47		BIT 6	
ERR 48		BIT 7	
MODULE_6: SPI SERIAL EEPROM (BYTE 0x0B32)			

Table 5-3. Error Codes (Continued)

Error	Mask	Bit	Comment
ERR 49		BIT 0	SEEP Command not valid
ERR 50		BIT 1	SEEP Byte count not valid
ERR 51		BIT 2	SEEP Address not valid
ERR 52	X	BIT 3	SEEP Write Verify failed
ERR 53		BIT 4	
ERR 54		BIT 5	SEEP Write Enable Latch bit did not set
ERR 55		BIT 6	SEEP Status Register write failed
ERR 56		BIT 7	SEEP Write In Process timeout
MODULE_7: RAM, BYTE EEPROM, FLASH (BYTE 0x0B33)			
ERR 57		BIT 0	BYTE EEPROM Erase Failed
ERR 58	X	BIT 1	BYTE EEPROM Write Verify Failed
ERR 59		BIT 2	BYTE EEPROM Command not valid
ERR 60		BIT 3	
ERR 61		BIT 4	Memory address not valid
ERR 62		BIT 5	Memory data count not valid
ERR 63		BIT 6	Word is misaligned
ERR 64		BIT 7	

Each Error bit set represents a single error. There could be multiple errors occurring simultaneously

NOTE: Not all module groups or bit ID's have errors assigned. Some unassigned errors may be associated with future product changes.

Errors that are marked with an "X" in the Mask column are errors that allow the System Error Flag to be set. This will cause the Operation LED, DS2, to flash rapidly. This indicates a System Error caused by hardware or a condition that may cause data corruption.

Examples

0100000000000000 = ERR 1, Module_0, Battery group is corrupt

2000000000000000 = ERR 6, Module_0, Initialize error mask defaults failed

2100000000000000 = ERR 1 and ERR 6, Module_0

000100FF00000000 = ERR 9 Module_1, and ERR 25—32, Module_3

Using Model 1133/1135 components

You can mix different components from the IVD Solutions Models 1133/1135 (rf-IVD/wired IVD) and the IVD Solutions Models 1136/1137 (rf-IVD^2 and IVD^2). Although models 1133/1135 are no longer manufactured, you can use some parts of the Model 1136/1137 as replacements or to add to your existing installation as follows:

- Add or replace Pods in your 1133/1135 system if you use PC control
- Use 1133/1135 Pods with your 1136/1137 system
- Upgrade your 1133/1135 system with PC control to use new software and a medical power supply

Differences between systems

The following differences between these systems will help you understand the possibilities.

Pods

- Model 1133/1135 Pods have 3 channels (labeled A, B, and C) and use coaxial, 2-lug BNC connectors.

- Model 1136/1137 Pods have 4 channels (labeled A, B, C, and D) and use coaxial, snap-on LEMO connectors.
- The electrometer inside the Pod is functionally the same for all models.
- The radio frequencies and encoding are the same for Models 1133 and 1136.

Diode detectors

Diodes are the same except for connectors and can be used interchangeably. Older Isorad and QED diode detectors have the coaxial, 2-lug BNC plugs which mate with the BNC jacks on the model 1133 or 1135 Pods. Newer diodes have LEMO connectors.

Adapters are available to interconnect any diode to any Pod. See Figure 2-1 for part numbers.

Power source

Models 1133/1135 use a standard DC power supply and rely on batteries to comply with FDA regulations prohibiting direct connection to patients. If power is inadvertently applied when the user is connected to a patient, software or firmware blocks operation and requires switching to a protected mode called "Physics Mode."

Model 1136/1137 uses a medical power supply, consequently,

- Physics Mode is not needed.
- The Model 1137 wired Pod has no battery. The switch is not connected.
- You don't use the battery in the Model 1135 wired Pod, but leave the switch on.

Control module and turtle

- A turtle (communications module) is not required with the 1136400 Control Module. It is built in.
- The 1136400 Control Module contains both serial and USB ports; you can connect a computer via either port.

Software

Software for the 1136/1137 system includes support for four channels, an improved temperature calibration technique, multi-acquisition reports, and drivers for connection via USB.

The 1136/1137 software can also be used with the 1133/1135 system when PC controlled.

Add or replace pods in 1133/1135 system

Although 1133/1135 Pods are no longed manufactured, you can use 1136/1137 Pods with your existing 1133/1135 Pods if you need add or replace Pods. However, you must upgrade your PC software to do this. See "Upgrade 1133/1135 system (only with PC control)" below.

Use 1133/1135 pods with 1136/1137 system

You can use 1133/1135 Pods directly with the 1136/1137 system. Please note the following differences:

- Energy calibration factors (Cf) are unchanged.
- When the software senses an 1133 or 1135 Pod, it will ask if you want to change the calibration table to the new format.
  - If you say yes, the calibration table format in the Pod is changed to the new format and the temperature calibration is set to zero.
  - If you say no, the table format is unchanged and the temperature calibration is left intact although it is not used. If you select no, the software will continue asking if you want to change the calibration table to the new format every time you connect the Pod.
- Temperature calibration for diodes connected to 1133/1135 Pods must be recalibrated using temperature calibration procedures for 1136/1137.
- If you perform a temperature calibration, the calibration table is reformatted.
- You don't use the batteries for 1135 wired Pods in an 1136 system, since the system is powered by a medical power supply. However, battery switches should be left on.

NOTE: Always leave battery switches on Model 1135 pods in the ON position.

- Diodes with BNC and LEMO connector can be interchanged using the adaptors as long as each diode is calibrated on the Pod with which it is used. (Calibration factors are stored in the Pod.)

Upgrade 1133/1135 system (only with PC control)

Overview

You can upgrade your 1133/1135 system to use 1136/1137 Pods and to include new features in the software. To upgrade, you need to do the following:

- Purchase a new medical power supply, P/N 741008.
- Install new Model 1133/1135 software if you are using software control.

Medical power supply

The medical power supply, P/N 741008, replaces the original power supply, P/N 022000, which should be discarded.

WARNING: If you upgrade your system to use the new software on model 1133/1135, you must use the new medical power supply to comply with patient safety regulations.

New software

The new model 1133/1135 software adds the following functions:

- Lets you perform 4-channel measurement when using 1136/1137 Pods.
- Permits multi-acquisition report printing.
- Lets you enter temperature correction factors from a chart.
- Provides an improved method of temperature calibration.

If you are using computer control, you must install the new software. See “To install the software” on page 41.

Temperature calibration

If you are using the 1136 PC software, you must update the temperature calibration for 1133/1135 Pods.

See “Temperature coefficient (Tc)” on page 62.

6 Service instructions

Repairs

User service

There are no user-serviceable parts in the IVD system components. If repairs are required, return the units to Sun Nuclear Corporation for repair.

Parts and supplies

See "Parts and accessories for the IVD Solutions" on page 9 for a list of components and part numbers.

To reorder rolls of thermal paper for the printer, order P/N 850043.

Battery maintenance

Detector pod battery charging

The rf-IVD2 Detector Pods contain an internal, rechargeable, NiMH battery. A new, fully-charged battery will operate continuously for about 350-400 minutes (5 to 7 hours). However, due to the intermittent duty cycle of the electronics, this charge will actually last for up to 12 hours of normal patient measurements.

You should always begin each shift with a full charge. Battery charge status can be checked on the Control Module (see "Battery check" on page 20) or computer screen (see "To check the battery" on page 57). You should always recharge the batteries at the end of each shift and leave them on trickle charge when not in use.

To charge a battery

1. Place the battery switch in the ON position.

CAUTION: Battery Switch must be ON in order to charge the battery! (1=ON)

2. Connect charging power using any of the following methods:
   a. Place the Pod or Base in the powered wall bracket.
   b. Connect the 25-meter cable P/N 1133550 from the powered Control Module to J5 on the Pod or base station.
   c. Connect the 1-meter cable P/N 1133560 from J6 on the charging base station to J5 on the Pod.
3. It is a good practice, when not using the Detector Pod, to always keep charging power on all batteries.
   - It is not necessary to fully discharge the batteries for charging. There is special battery charging software that optimizes the battery charging. However, you may want to discharge them to reset predicted battery life. See below.
   - For a summary of possible connections, see "Connections" on page 10.
4. Verify batteries are actually charging. For detector Pods and Base Station, DS1 should be on blinking slowly for active charging, or on steady for trickle charge.

About predicted battery life

Since actual battery capacity cannot be measured directly, the Pod firmware uses an indirect calculation to predict battery life. Both the Control Module and the software show the predicted

battery life. This is the remaining life that the Pod firmware predicts that the battery has when in operation.

The predicted life of the battery assumes you are operating continuously, constantly reading and posting values. In practice, this rarely happens because a reasonable operating pace requires that you stop measuring during setup, changes of patients, etc. During this standby time, the Pod may be on, but no data is being collected. During standby, power consumption drops considerably. Assuming a reasonable duty cycle, a fully charged battery in good condition will have enough power for approximately 12 hours of treatment. Under these conditions, you would expect to begin the day with your predicted battery life at 6 hours, then, at the conclusion of an 8-hour shift, having used about 2/3 of the available battery power, your battery life should show 2 hours remaining.

However, over time, errors can creep into the predicted value so that predicted life is different than the actual life. To obtain predicted battery life, display software divides the estimated charge capacity of the battery at the present time by the nominal operating current of the Pod. Since no two batteries or circuits are exactly identical, the resulting battery life is only an estimate. The actual battery life will vary from to Pod to Pod. Over time, actual battery life will decline slowly.

By fully discharging the battery, you can reset the battery capacity. However, since the firmware limits the reset value to 10% of the predicted value, you may have to repeat the process several times to display an accurate battery life. To keep the predicted battery life equal to the actual battery life, you should perform a full discharge and recharge of the battery at least once a month. See "To reset battery predicted life" below.

To reset battery predicted life

Occasionally, NiMH batteries appear to have different capacity than they actually do. In other words, the predicted battery life is more or less that the actual battery life.

Reset the battery predicted life to agree with the actual battery life as follows:

1. After working hours, turn the system on, turn on all batteries, press or click the Start button, and completely discharge the batteries (about 8 hours).
2. Charge the batteries fully (about 6 hours).
   NOTE: You can automate the charging and discharging cycle overnight with a timer.
3. Resume normal operation.
4. If the battery is not restored to actual capacity, repeat steps 1 and 2 several times until actual and predicted battery life agree. On each discharge cycle, predicted battery capacity is adjusted about ±10% of the predicted life.

Software and firmware updates

Updating your software

Occasionally, updated IVD PC software may be made available on the Sun Nuclear web site. You can download the new software and install it in place of your existing software. Before downloading, check the version numbers to be sure the software posted on the website is a later version than the one you have. See "To view the software version" on page 58.

Updating your firmware

The IVD components contain firmware which is installed in non-volatile memory. During operation, the firmware installed in each component is executed by the on-board microprocessor to control the component and communicate with other components in the system.

Firmware can be updated when a new release is available. Generally, new releases are posted on the SNC website.

Installing new firmware

To install new firmware:

1. Verify that the firmware version to be installed is more recent than the firmware installed in your instrument. If using a PC as a control device, see "To view the software version" on page 58. If using the Control Module as a control device, see "Software version" on page 21.
2. Download the upgrade Installer from the SNC website (or run it from a SNC-supplied disk). Make a note of the directory in which you placed the software upgrade Installer.
3. Open Explorer, navigate to the directory containing the Installer, and run the Installer by double-clicking its icon.
   - The installer will, by default, install the programs to the directory "C:\Program Files\SNC\SNCutility\IVD." If you wish to install to a different directory, you may do so.
   - The Installer will be located in the Start > Programs > SNC Group > IVD Solutions menu.
4. Run the program called "Download to Control Module" by double-clicking its icon.
5. A window entitled "SNC Utilities" appears. The lower half of this window contains directions on how to connect the computer and go through the download process. Follow these instructions exactly and in order.

CAUTION: Failure to follow the instructions exactly can result in an unusable instrument.

6. After downloading the Control Module firmware, close the program. Run the "Download to Detector Pod" software, which is also located on the menu.
   - Make sure you have the correct unit connected when using a particular Downloader.
   - Don't forget to download the new firmware to all of your Detector Pods and Base Stations!
7. After all firmware downloads are complete, either discard the software upgrade installer or save for your records. Do not confuse different versions of the software upgrade installer. When newer upgrade installers are installed, the old one will be overwritten so you always have the latest one installed.

Before requesting help

- Operator problems—Before requesting help from customer service, check to see if any of the following will solve your problem.

Table 6-1. Solutions to operator problems

Problem	Remedy
System does not operate.	• Be sure main power supply is connected to the Control Module or computer. • Recharge batteries. • Turn on switches on Pod and Base. • Recheck all connections to be sure they are properly set up. See "Connections" on page 10.
System will not find correct units.	• Units from other systems may be operating within radio range. Turn off all other units that are not part of this system or move the transceivers in this system into the treatment room and remove all others from this treatment room.
All four LEDS (DS1-4) blinking rapidly.	• Internal problem. Cycle power switch off and then back on to reset the software. If problem persists, contact customer service.

- Error messages—If you are getting error messages, see "Error codes" on page 80 for an explanation.

Contacting customer service

For customer service, contact:

Sun Nuclear Corporation

425-A Pineda Court

Melbourne, Florida 32940-7508

telephone 321-259-6862, fax 321-259-7979

e-mail Mail@sunnuclear.com or techsupport@sunnuclear.com

http://www.sunnuclear.com

Contact Sun Nuclear Corporation for the latest software revisions via e-mail to techsupport@sunnuclear.com.

Web site information

Additional service information is available on the SNC web site:

http://www.sunnuclear.com/

The web site contains information about the IVD as well as other SNC products.

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Warranty

1 INSTRUMENTATION

a. This instrument and its accessories, excluding those listed in 1.D. below, are warranted by SUN NUCLEAR CORPORATION, against defects in materials and workmanship for a period of one year from the date of original purchase from SUN NUCLEAR CORPORATION. During the warranty period, SUN NUCLEAR CORPORATION will repair, or at its option, replace an instrument found to have such defect, at no charge to the customer.

THERE ARE NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OF FITNESS, WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. THIS EXPRESSED WARRANTY EXCLUDES COVERAGE OF AND DOES NOT PROVIDE RELIEF FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND OR NATURE, INCLUDING BUT NOT LIMITED TO LOSS OF USE, LOSS OF SALES OR INCONVENIENCE. THE EXCLUSIVE REMEDY OF THE PURCHASER IS LIMITED TO REPAIR, RECALIBRATION OR REPLACEMENT OF THE INSTRUMENT AT THE OPTION OF SUN NUCLEAR CORPORATION.

b. This warranty does not apply if the product, as determined by SUN NUCLEAR CORPORATION, is defective due to either abuse, misuse, or modification or service performed by someone other than a SUN NUCLEAR CORPORATION authorized repair and calibration facility. Misuse and abuse include, but are not limited to, subjecting the instrument to environmental conditions outside the specified limits or allowing the instrument to become contaminated by radioactive materials.

c. In order to obtain warranty repair service, the instrument must be returned, freight prepaid, to the facility cited in 3.B. below. The purchase date, vendor invoice or customer purchase order should be included, along with a statement of the problem. Instruments will be returned transportation prepaid to points within the United States.

d. Because the original manufacturer's warranty applies, the following items are specifically excluded from this warranty: photomultiplier, Geiger-Mueller, and proportional tubes; batteries; ancillary devices, including, but not limited to, printers, computers, display devices, etc.; and other components as may be specified in this manual.

2 CALIBRATION

a. This instrument is warranted to be within its specified accuracy at the time of shipment. If a question arises and SUN NUCLEAR CORPORATION determines that the initial calibration is in error, the instrument will be re-calibrated by SUN NUCLEAR CORPORATION at no charge. SUN NUCLEAR CORPORATION is not responsible for calibrations performed by independent laboratories, nor any calibration fees incurred prior to or subsequent to SUN NUCLEAR CORPORATION warranty service.

b. The return policy is as stated in 1.C. above.

3 NON-WARRANTY SERVICE

a. Repairs and/or replacements not covered by this warranty may be performed by SUN NUCLEAR CORPORATION or a factory authorized service location. Estimates of repair charges may be requested, however, a charge for estimate preparation may apply if the repair is later not authorized by the customer.

b. The cost of transportation into and out of the service location will be the responsibility of the customer. The instrument should be shipped to:

SUN NUCLEAR CORPORATION
425-A Pineda Court
Melbourne, FL 32940 U.S.A
Phone (321) 259-6862
Fax (321) 259-7979

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5 July 2005

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