

ST350 Radiation Counter

Operating and Service Manual

November 1994

Model ST350 RADIATION COUNTER

The ST350 Radiation Counter brings new dimensions to Nuclear Science instruction and Health Physics training. By incorporating a specialized microcontroller, many of the features previously found only in multiple products are now combined in a single inexpensive instrument.

The classical nuclear scaler function has now been extended to include a timer, preset counter, digital ratemeter with alarm, computer interface and a battery option for field applications. When constant counting statistics are required, the preset count mode can be extremely useful and the digital ratemeter is ideal for contamination survey work. An alarm level may be set to any pre-selected value and if the count rate exceeds this level, the audible alarm is sounded warning of a high activity condition.

High voltage is fully variable from 0 to +1200 volts, allowing operation with many types of GM tubes. The supply is fully regulated and controlled by the processor for digital accuracy and readout on the display. Extra large LED's are used for the digital display for clear visual readout under widely differing ambient light conditions with leading zero suppression for clarity.

Classroom demonstrations and nuclear experiments may now be run directly from an IBM-PC compatible computer using the on-line serial DATALINK built into the ST350 and the standard RADEM emulation software. All functions of the Radiation Counter are accessible and may be controlled from the computer, including the high voltage setting for the GM tube using the optional LABLINK software. The Radiation Counter-PC software supplied produces computer screen displays of all functions including analog emulation of the ratemeter mode. Real-time data is automatically transferred to the computer and stored in spreadsheet compatible files. Data analysis and graphical presentation is now possible using many common spreadsheet programs bringing new techniques to Nuclear Science education.

Optional batteries may be installed in the ST350 making the instrument fully portable. An AC to DC line converter/charger is supplied for continuous benchtop operation with or without the batteries installed.

Specifications.

Input:	BNC connector. Accepts standard Geiger tubes.
High voltage:	0 to +1200 volts, digitally selectable in 25 volt increments.
Display:	6-decade LED, 1 in. numerals. Displays counts, preset counts, time, preset time, CPM, CPS, alarm level, and high voltage.
Modes:	Count for preset time, count for preset count, counts/min., counts/sec., set alarm level 0-999999 cps, set high voltage 0-1200v, and remote.
Audio:	Piezo alerter if countrate exceeds preset level.
Data Link:	DB-9 male connector accepts RS-232 serial cable.
Power:	Input 7.5 volt DC, at 500mA from AC line/charger. Specify 110-120, 220-240 VAC at time of order. Battery option requires installation of 4 x C size NiCd rechargeable batteries (not supplied).
Dimensions:	12 in. W, x 8 in. H, x 4.5 in. D.
Software supplied:	ST350 Radiation Counter-PC emulation software. DOS program runs on most IBM compatible PC's including CGA, EGA, VGA, SVGA, and Hercules graphics systems. Real-time display of simulated analog ratemeter with auto-ranging, digital ratemeter in CPM or CPS, count, elapsed time, preset count, preset time, high voltagesetting, acquisition time, and run number. Data is loaded into spreadsheet compatible files for transfer. Bi-directional LABLINK offers full control of all functions including preset count, preset time, countrate in CPM or CPS, alarm level, high voltage, start, stop, reset, and data transfer. Requires EGA or VGA graphics. All operations may be run directly from the computer with spreadsheet compatibility.

Operation.

CAUTION

Never operate the ST350 Radiation Counter with the GM probe disconnected. Dangerous voltages can exist at the probe connector so ensure the instrument is in the OFF position and the high voltage is set to zero before disconnecting or reconnecting the GM probe.

General.

The ST350 Radiation Counter may be operated with or without the optional rechargeable batteries installed by connecting the AC power supply/charger module supplied. If batteries are installed, it may be necessary to supply an initial overnight charge before operating away from the power source.

A LOW BATTERY indicator is included to alert the operator before the batteries become fully exhausted and the instrument ceases to function. If this indicator is illuminated, discontinue use until the unit has been reconnected to the charger. To maintain good battery life and condition, rechargeable batteries should be discharged and fully recharged periodically.

Detectors.

Geiger-Mueller tubes produce electrical pulses when ionizing radiation events occur within their sensitive volume. For proper operation, these detectors should be run at a predetermined operating voltage specified by the manufacturer or derived empirically. To improve sensitivity to alpha and beta particle radiation, many GM tubes have extremely thin entrance windows which require considerable care in handling. Do not remove protective caps unless necessary and never touch the window.

The ST350 is designed to accommodate many types of GM probes and includes a fully adjustable high voltage power supply to cover a wide range of applications. The high voltage level may be displayed on the digital readout by moving the FUNCTION switch to the HIGH VOLTAGE position. Adjustments to the high voltage may now be made using the UP/DOWN buttons in 25 volt increments.

Operating Modes and Controls.

Each mode may be selected by the DISPLAY FUNCTION switch.

DISPLAY OFF. Turns off the digital display to conserve power. Mainly used when operating on internal battery power. The ST350 continues to operate in the last mode selected.

COUNTS. This is the normal operating mode where the display registers the number of radiation events detected by the GM tube. Before starting a count, a preset count value or preset time may be entered using the UP/DOWN buttons. If this feature is selected, once started the unit will continue to count until the preset count or preset time level is reached. Preset count mode can be very useful when constant counting statistics are required.

TIME. If the operator wishes to count radiation events for a predetermined time, select this position and with the unit in the STOP mode enter the required counting time in seconds using the UP/DOWN buttons. When a preset time is entered the preset count mode is reset and disabled

RATEMETER. This mode provides a digital display of the instantaneous count rate. It can be very useful for survey applications particularly when used in conjunction with the ALARM feature.

ALARM SET. An alarm level in counts per second may be preloaded into the ST350. Whenever the incoming count rate exceeds this level, an audible alarm will sound. To select this feature set the FUNCTION switch to ALARM SET and enter the required level using the UP/DOWN buttons. The ST350 may now be set to other modes with the alarm level retained.

HIGH VOLTAGE. This position of the function switch displays the value of the high voltage setting for the GM tube. The high voltage may be adjusted in 25 volt increments using the UP/DOWN buttons between 0 and 1200 volts.

REMOTE. The REMOTE feature is used with the optional LABLINK computer control software. In this mode all front panel control is transferred to the computer screen. The LED indicators and numerical display will continue to show mode information being selected by the computer. When using the standard RADEM emulator software supplied with the ST350, the function switch may be set to any position.

Operation.

Basic operation of the model ST350 Radiation Counter is straightforward and intuitive.

First set the high voltage to the recommended value for the GM tube using the HIGH VOLTAGE function and the PRESETS buttons.

If no other presets are required, return the function switch to the COUNT position. Operation may now be controlled with the START, STOP, and RESET buttons. Setting the function switch to COUNTS will display the number of radiation events detected by the GM tube, or selecting TIME will display the acquisition time in seconds.

To count for a preset time, select TIME on the function switch and enter the required counting time in seconds using the UP/DOWN buttons. Once set this time will remain until changed with the PRESET. Set the function switch to COUNTS, press RESET and start the count with the COUNT button. The count may be interrupted before the preset time is reached by pressing the STOP button and continued with the COUNT button. Once the preset time is reached the counter will stop accumulating data. At this point it is only necessary to press COUNT to restart the next cycle as the preset will automatically be restored and the count register reset to zero.

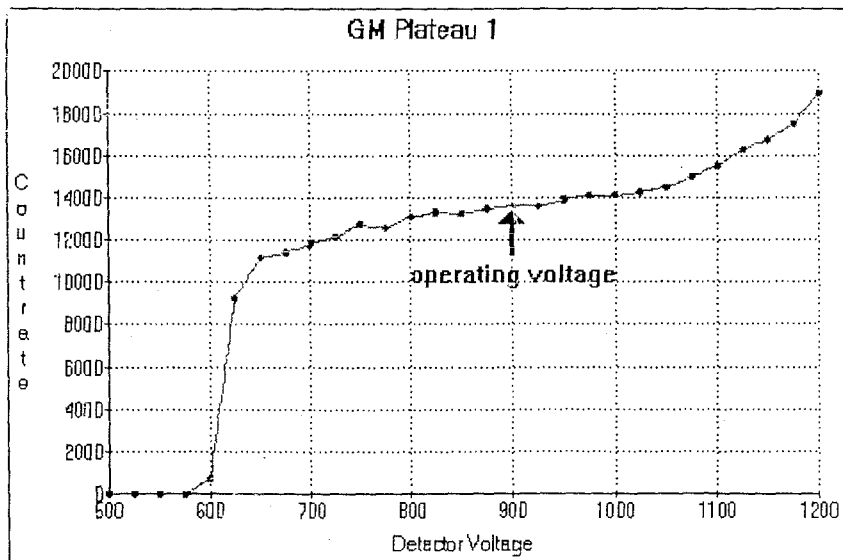
Using the preset count mode is similar to the preset time. Set the function switch to COUNTS and load the preset count value with the UP/DOWN buttons and press COUNT to start accumulating events. The acquisition time or the event register may be selected for display using the function switch. The STOP button may be used to interrupt a count without losing current data. Once the preset value has been reached, counting will stop automatically. To recycle simply press COUNT.

In the RATEMETER mode CPS or CPM may be selected using the UP/DOWN buttons.

Convenient indicator lights show the currently selected mode to assist operation. An ACTIVITY indicator is also included which monitors incoming events independent of the selected mode even in the stopped condition.

GM Plateau.

The correct operating voltage for the Geiger-Mueller tube may be determined experimentally using a small radioactive source such as Cs-137 or Co-60. A properly functioning tube will exhibit a "plateau" effect, where the counting rate remains nearly constant over a range of applied voltage. Place the radioactive source close to the window of the GM probe and slowly increase the high voltage until radiation events just begin to be detected. Now increase the voltage in 25 volt steps recording the counting rate at each increment. The rate should remain fairly constant over a range of voltage and then increase rapidly as the high voltage is further raised indicating that the tube is entering the breakdown region. Do not continue to operate the tube in this breakdown condition but reduce the high voltage and make a plot of the counting rate versus the applied voltage. The recommended operating voltage may now be determined as the center of the plateau region.



Resolving Time.

Geiger-Mueller tube exhibit dead time effects due to the recombination time of the internal gas ions after the occurrence of an ionizing event. The actual dead time depends on several factors including the active volume and shape of the detector and can range from a few microseconds for miniature tubes, to over 1000 microseconds for large volume devices.

When making absolute measurements it is important to compensate for dead time losses at higher counting rates. If the resolving time of the detector is known, the true counting rate may be calculated from the measured rate using the following expression:

$$n = m / (1 - mt)$$

where n is the true counting rate, m the measured rate, and t the detector resolving time.

If the detector resolving time is unknown, it may be determined experimentally using two radioactive sources. Maintaining constant counting geometry is important throughout the experiment. A special source split into two halves is available for making the measurement, but good results may be obtained by careful positioning of two standard check sources. With the high voltage correctly set for the GM tube, position the two sources ($a+b$) side by side to obtain a count rate of at least 10,000 CPM. Accurately record the countrate as $R_{(a+b)}$. Remove source (b) and record the count rate as $R_{(a)}$. Carefully replace source (b) to its original position, remove source (a) and record the count rate of source (b) as $R_{(b)}$. The resolving time is given by

$$T = \frac{R_{(a)} + R_{(b)} - R_{(a+b)}}{2R_{(a)} \cdot R_{(b)}} \quad \frac{\text{Count/min}}{\text{Count/min}^2}$$

The resolving time of the ST350 RADIATION COUNTER is very short and is not a significant factor compared to that of the GM tube.

Serial Data Link.

Your ST350 Radiation Counter contains a unique Data Link making it possible to connect the instrument to a personal computer for recording events. Data transfers are via a RS-232C serial link and requires connection through a standard 9-pin cable to the computer COM 1 or COM 2 port. The ST350 RADEM Emulation Software may be run directly from the floppy disk supplied, or copied onto a hard drive if preferred.

To run the software, enter the command line **RADEM.EXE**. The program will self configure to the graphics system in use. Select the appropriate COM port.

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Choose a COM port:
COM1
COM2
  
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Your system will now be configured for 9600 Baud data transfer and ready for use.

Software Emulator.

The ST350 software emulator greatly expands the capability of the counter by providing large screen displays combined with multi-mode operation. Three basic modes are included.

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Choose:
Analog Rate Meter
Digital Ratemeter
Scaler
  
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Operation of the software is straightforward and requires little explanation.

The analog ratemeter mode provides a large screen display of the instrument meter which can be very useful for classroom demonstrations of basic radioactivity. Use the spacebar to switch the display between CPM and CPS, and the up/down arrows to change the range. For more precise readings, the digital ratemeter mode may be preferred for some measurements.

When operating in the scaler mode, all radiation events detected by the GM tube will be recorded during the pre-selected time. Use F1 to initialize the PRESET TIME mode and enter the required counting time in seconds. Entering zero or blank will allow the unit to operate in a manual mode. The scaler is started and stopped using the return key and the elapsed counting time is displayed in seconds.

At the completion of a preset time, the counting data together with elapsed time and the computer time of day clock is automatically stored in a data file which is displayed on the screen as a table. A new count may be restarted by simply pressing the return key, at which time the data register and elapsed time will automatically be reset, and the next run started. The counting may be interrupted at any time and resumed using the return key without loss of data providing the data is not stored in the data file. To store data in the manual mode, stop the counting and press the space bar. This action will cause the registers to reset when counting is restarted.

The ST350 software includes a recycle mode which can be very useful when performing radioactive decay such as half life experiments or absorption studies. Use the F1 key to select the required time for each count and the F2 key to set the number of measurements. Once started, the ST350 will now automatically store the data at the completion of each counting sequence, reset the registers, and continue for the number of runs selected.

Data File is a unique and powerful feature of SPECTECH products. Count and time data is stored in a tab separated temporary file which is displayed as a table. This may be stored as a .TSV file on the disk at the completion of a series of measurements. The file is compatible with many popular spreadsheet programs and may be directly transferred in the spreadsheet for analysis and viewing. At the end of a series of measurements use the ESC. key to prompt for file storage. If no filename extension is given the system will default to .TSV. To simply print the contents of the temporary data file, use the ALT_P keyboard command.

Run	Voltage	Count	Elapsed	Time Of Day
1	500	0	30	4:55:21 PM
2	525	0	30	4:55:52 PM
3	550	0	30	4:56:22 PM
4	575	0	30	4:56:53 PM
5	600	442	30	4:57:23 PM
6	625	3949	30	4:57:54 PM
7	650	4305	30	4:58:25 PM
8	675	4332	30	4:58:55 PM
9	700	4539	30	4:59:26 PM
10	725	4694	30	4:59:57 PM
11	750	4681	30	5:00:28 PM
12	775	4833	30	5:00:59 PM
13	800	4927	30	5:01:30 PM