SPECTECH

ST160 Nuclear Lab Station

Operating and Service Manual

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Model ST160 Nuclear Lab Station

Introduction

The ST160 Nuclear Lab Station provides a self-contained unit that includes a versatile timer/counter, GM tube, sample stand, and an 11 piece absorber set. The unit comes complete with a serial interface to either Macintosh or IBM-compatible personal computers and also a Universal Serial Bus (USB) interface.

High voltage is keyboard or manually controlled by front panel pushbutton and fully variable from 0 to +800 volts. The supply is fully regulated and controlled by the processor for digital accuracy and readout on the computer monitor display. Extra large, 1" LEDs are used for the front panel 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 a Windows PC computer using the built in USB or serial RS-232 interface and the STX emulation software. Counting functions may be initiated from either the ST160 or the computer. The supplied software produces computer screen displays of all functions including analog and digital emulation of a ratemeter. Real-time data is automatically transferred to the computer and stored in spreadsheet-compatible files. Data analysis and graphical presentation are now possible using many common spreadsheet programs bringing new techniques to Nuclear Science education.

An AC to DC line converter is supplied for continuous benchtop operation.

Warranty

Spectrum Techniques warrants products of our manufacture against defects in workmanship or material for a period of one year from date of shipment. We will repair or replace, at our option, any instrument that is deemed to be defective during this period. This warranty fully covers all replacement parts and labor. The instrument must be returned to our factory prepaid and we in turn will pay the cost of return shipping .

This warranty does not cover damage caused by mishandling or misuse. GM tubes with broken windows are specifically excluded from this warranty.

Accessory items not manufactured by Spectrum Techniques but supplied as part of our systems will be subject to the original manufacturer's warranty.

Specifications

Input: Built in Geiger Mueller tube: 15 mm diameter, 1.5- 2 mg/cm.^{2} window, 500V operating voltage, approximately 150V plateau.

High voltage: 0 to +800 volts, digitally selectable in 20 volt increments.

Display: 6-decade LED, 1 in. numerals. Displays counts, time, and high voltage.

Modes: Count for preset time, set and view preset time, and set and view high voltage 0 to +800v.

Data Link: DB-9 male connector accepts RS-232 serial cable to IBM-PC compatible computers. USB Interface for Windows PCs.

Absorbers: 11 piece set, 6-7400 mg/cm^2.

Sample holder: 6 position, 1cm spacing.

Power: Input 9 volt DC, at 500mA from AC adapter. (Specify 110-120 or 220-240 VAC at time of order.)

Dimensions: 10 in. W, x 7.5 in. H, x 6.2 in. D.

Software supplied: **STX** - Windows PC application that controls the ST160 and the ST360. While active, the ST160's buttons will be disabled and will only accept software commands.

All software provides real-time display of simulated analog or digital ratemeter in CPM or CPS, counts, elapsed time, preset time, high voltage setting, acquisition time, and run number. Data is saved to spreadsheet-compatible files. Bi-directional control offers computer control of count start/stop and data transfer.

CAUTION

The detector window is extremely thin and fragile. If broken it cannot be repaired and will not be covered under the warranty. Never allow objects to touch the window.

Operation

General

The ST160 Radiation Counter may only be operated with the AC adapter provided or with one of

identical specifications. The sample holder provides six positions with 1 cm. separation between each for placement of radioactive sources and absorbers. 11 absorbers are provided for use in radiation absorption experiments. Absorbers may be placed in empty sample holder slots between the source and the detector.

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 allow any object to come in contact with the GM tube mounted in the top of the sample holder. The ST160 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 pressing the **H.V.** button once. Adjustments to the high voltage may then be made in 20 volt increments using the **UP/DOWN** buttons. To return to count display mode press **H.V.** button again.

Operating Modes and Controls

COUNT. 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 time may be entered using the **TIME** and **UP/DOWN** buttons. To begin the count interval press the **COUNT** button. Any existing count and elapsed time will be automatically cleared. If a preset time has been entered, the unit will count until the preset time is reached.

STOP. This button will stop the current count.

TIME. If the operator wishes to count radiation events for a predetermined time, a preset time may be entered by pressing **TIME** and entering the required counting time in seconds using the **UP/DOWN** buttons. To return to count display mode press **TIME** again.

HIGH VOLTAGE. The high voltage setting on the GM tube may be set by pressing the **H.V.** button. The current setting will be displayed. The high voltage may be adjusted in 20 volt increments using the **UP/DOWN** buttons between 0 and +800 volts. To return to count display mode press **H.V.** again.

Operation

Basic operation of the model ST160 Radiation Counter is straightforward and intuitive.

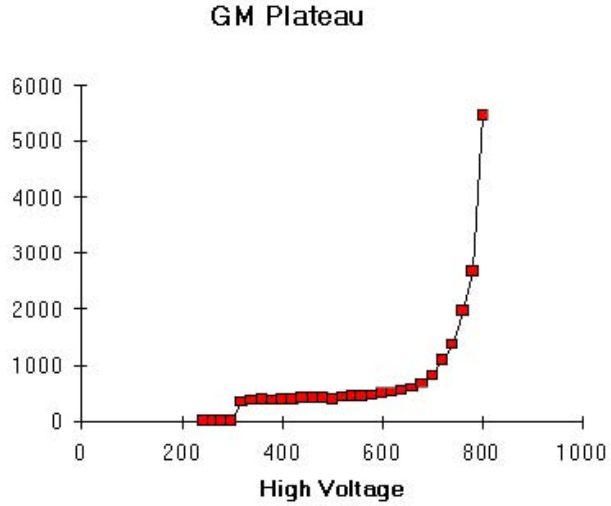
First, set the high voltage to the recommended value for the GM tube using the **H.V.** and **UP/DOWN** buttons. Then, if no other presets are required, press **H.V.** again to return to the count display mode.

Operation may now be controlled with the **START** and **STOP** buttons. Pressing **TIME** will display the acquisition time in seconds.

To count for a preset time, press the **TIME** button and enter the required counting time in seconds using the **UP/DOWN** buttons. Once set, the preset time will remain unchanged unless the **UP/DOWN** buttons are pressed again. Start the count with the **COUNT** button. The count may be stopped before the preset time is reached by pressing the **STOP** 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. If the ST160 is linked to a computer running the STX software, data will be automatically transferred to the computer whenever a count stops either by reaching the preset time or pressing the **STOP** button. If, however, the count is stopped by remote control from the computer the data is NOT automatically transferred. This allows a single run in a multiple run experiment to be repeated before it is stored.

GM Plateau

The correct operating voltage for the Geiger-Mueller tube may be determined experimentally using a small radioactive source such as a 1 microCurie 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 20 volt steps, recording the count 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 count rate versus the applied voltage. The recommended operating voltage may now be determined as the center of the plateau region. In the example below note that the plateau extends from approximately 350V to 600V. A reasonable operating voltage in this case would be 500V.



Resolving Time

Geiger-Mueller tubes 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, n, 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, *T*, is given by

$$T = \frac{R(a) + R(b) - R(a+b)}{2R(a) \times R(b)}$$

The resolving time of the ST160 Nuclear Lab Station is very short and is not a significant factor compared to that of the GM tube.

Applications

The ST160 may be used for a variety of applications some of which are listed below:

- Surface contamination measurement.
- Plotting a GM plateau.
- Radiation background measurement.
- Natural radioactivity.
- GM resolving time.
- Detector efficiency.
- Radiation absorption studies.
- Backscattering.
- Inverse square law.
- Isotope half-life.
- Radiation properties.
- Counting statistics.

Maintenance

CAUTION

Dangerous voltages can exist inside the ST160 from the high voltage power supply. Before removing the cover ensure the instrument is in the OFF position and the high voltage is set to zero. Only qualified technicians should attempt any repairs.

Your ST160 has been built with care using quality parts and should not require any routine service. In the unlikely event of a malfunction, the unit may be returned to the factory for repair. We will gladly supply a cost estimate if the warranty period has expired.

Software

An extensive help guide for the **STX** software can be found under the Help -> Contents menu of the software.

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