INSTRUCTION MANUAL
TC 256/TC257
ALPHA SPECTROMETER

N256/257MT00F02

WARRANTY

Oxford Instruments Inc warrants that the products or components manufactured by it shall be free from defects in material or workmanship for a period of one year from the date of delivery to purchaser. If such product or component is determined to be defective by Oxford Instruments Inc, its sole warranty obligation shall be limited to either replacing or repairing such defective product or component or allowing credit therefor, at Oxford's option. Such warranty is further conditional upon the purchaser giving prompt notice of any such defect and satisfactory proof thereof to Oxford's Customer Service Manager, thereafter upon Oxford's approval, the purchaser shall return such defective product or component to Oxford's factory at Oak Ridge, Tennessee, all transportation charges prepaid. Oxford shall be responsible only for transportation charges incurred in returning such product or component to purchaser. All customs, brokerage and duty charges shall be at the expense of the purchaser. Damage in transit due to inadequate packaging will be repaired at the purchaser's expense. Any repairs or replacements by the purchaser without Oxford's approval, any willful abuse or any evidence that the product or component was not properly used and maintained would automatically void this warranty.

Oxford Instruments Inc makes no warranty whatsoever in respect to products or components not manufactured by it, but instead, the applicable warranties, if any, of the respective manufacture thereof shall apply. Likewise fuses, batteries, and input transistors in low-noise preamplifiers are specifically excluded from this warranty.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS.

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1.0 INTRODUCTION

The TENNELEC Models TC 256 and TC 257 are a complete alpha spectrometer packaged in a standard NIM module. The TC 256 is a double-width NIM module and accommodates samples up to 1.75 inches in diameter, while the TC 257 is a triple-width NIM module and accommodates samples up to 2.25 inches in diameter. The TC 256/TC 257 is specifically designed for either surface barrier or diffused junction silicon detector operation and includes a vacuum chamber, charge sensitive preamplifier, linear amplifier, discriminator, biased amplifier, variable detector bias supply and variable test pulser. The TC 256/TC 257 combined with a multichannel analyzer and vacuum pump provides a complete alpha spectroscopy system. Multiple-spectrometer energy analysis systems can be easily configured utilizing a TENNELEC Model TC 306 ROUTER/MULTIPLEXER.

An ENERGY RANGE switch selects specific energy ranges for the ENERGY output. The ranges provided are 3 to 8 MeV, 4 to 7 MeV, 3 to 5 MeV, 4 to 6 MeV, 5 to 7 MeV and 6 to 8 MeV. A calibrated ENERGY MARKER test pulser allows the user to inject an artificial alpha peak within the range of energies from 0 to 10 MeV.

Two additional outputs are provided: COUNTS and LINEAR AMP. The COUNTS output is a NIM-standard positive logic pulse for gross alpha counting and/or signal routing. The LINEAR AMP output is a 0 to 10 V positive pulse representing an energy span of 0 to 10 MeV.

Operational setup of the TC 256/TC 257 has been simplified by the addition of front-panel screwdriver-adjustable calibration controls.

2.0 SPECIFICATIONS

2.1 PERFORMANCE

SYSTEM NOISE Dependent on detector load capacitance (See Fig. 2.1) and leakage current; 14 keV FWHM typical for a 450 mm^2 surface barrier silicon detector.

SAMPLE SIZE

TC 256	Up to 1.75 inch (44.5 mm) diameter.
TC 257	Up to 2.25 inch (57.2 mm) diameter.

SAMPLE SPACING Adjustable from 1 to 53 mm from detector in steps of 4 mm.

ENERGY RANGES 3 to 8 MeV, 4 to 7 MeV, 3 to 5 MeV, 4 to 6 MeV, 5 to 7 MeV and 6 to 8 MeV.

NONLINEARITY Less than 0.1% of full-scale for selected energy range.

DETECTOR VOLTAGE Variable from 0 to $\pm$ 150 V. Polarity selected by internally mounted switches.

OPERATING TEMPERATURE +0 TO 50°C.

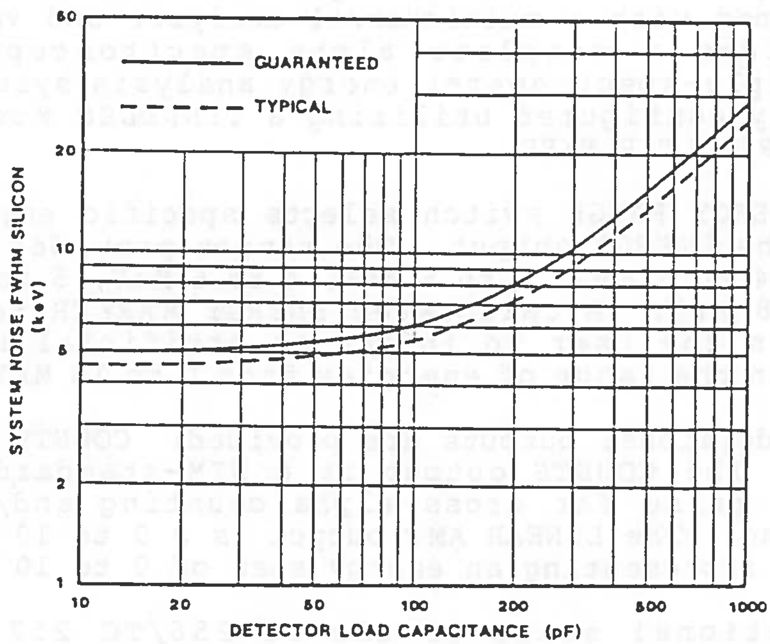

Fig. 2.1 TC 256/TC 257 System Resolution

2.2 CONTROLS

2.2.1 FRONT-PANEL CONTROLS

MARKER/BIAS/OFF A three-position locking toggle switch controls both the ENERGY MARKER (internal test pulser) and detector HIGH VOLTAGE BIAS. In the MARKER position both the ENERGY MARKER and the detector HIGH VOLTAGE BIAS are active. In the BIAS position only the detector HIGH VOLTAGE BIAS is active. An OFF position is provided which disables both functions. A front-panel BIAS indicator illuminates whenever the HIGH VOLTAGE is active.

ENERGY RANGE A six-position rotary switch selects the desired ENERGY RANGE (3 to 8 MeV, 4 to 7 MeV, 3 to 5 MeV, 4 to 6 MeV, 5 to 7 MeV or 6 to 8 MeV) of the ENERGY output. The ENERGY output voltage span corresponds to the span of the selected ENERGY RANGE.

VENT/HOLD/PUMP A three-position rotary vacuum valve controls internal vacuum routing. In the VENT position the module vacuum chamber is at atmospheric pressure while the rear-panel VACUUM connector is isolated and sealed off. In the HOLD position both the module vacuum chamber and the rear-panel VACUUM connector are isolated and sealed off. In the PUMP position a path is established between the rear-panel VACUUM connector and the module vacuum chamber.

ENERGY MARKER A 10-turn potentiometer with a direct reading calibrated dial sets the equivalent energy of the internal test pulser. The ENERGY MARKER is continuously variable over the energy range of 0 to 10 MeV. The ENERGY MARKER is active only when the MARKER/BIAS/OFF switch is in the MARKER position.

DC ZERO A 25-turn screwdriver adjustable control allows the dc-baseline of the ENERGY output to be adjusted over the range of ± 75 mV. A front-panel test point is furnished to monitor this voltage.

E BIAS A 25-turn screwdriver-adjustable control allows the ENERGY output bias point (lower energy of the selected ENERGY RANGE) to be varied by ±10% for ease of setup with the multichannel analyzer.

ΔE GAIN A 25-turn screwdriver-adjustable control allows the maximum output voltage of the ENERGY output to be varied from +7.75 to +10.25 V for ease of setup with the multichannel analyzer.

2.2.2 REAR-PANEL CONTROL

HIGH VOLTAGE A single-turn control with locking nut sets the bias applied to the detector. The HIGH VOLTAGE is continuously variable from 0 to 150 V with polarity selected by internal slide switches.

2.2.3 INTERNAL CONTROLS

POLARITY Two internally mounted slide switches (See Fig. 6.1) select the high voltage polarity required for the detector (NOTE: Both switches should be set for the same polarity).

GAIN A 20-turn control allows the gain of the linear amplifier to be varied by ±50% for a 1V/MeV calibration of the LINEAR AMP output. This control is factory calibrated and does not require user calibration for general applications. GAIN calibration is covered in Sec. 6.0.

PULSER CAL A 20-turn control calibrates the ENERGY MARKER control for the specific detector in operation. This control is factory calibrated and does not require user calibration for general applications. PULSER CAL calibration is covered in Sec. 6.0.

2.3 CONNECTORS

2.3.1 REAR-PANEL OUTPUTS

COUNTS A BNC connector provides a TTL compatible NIM-standard positive logic pulse 3.5 usec wide for each event with equivalent energy of 2.5 MeV or greater. The output impedance is 50 ohms, dc-coupled. Note that this output guard-bands the ENERGY output for signal routing (See Fig. 4.1).

ENERGY A BNC connector furnishes a 0 to 10 volt positive linear signal with amplitude corresponding to an energy within the selected ENERGY RANGE. The output is shaped to a nearly rectangular pulse with 0.5 usec rise and fall time, 2 usec FWHM, for optimum acceptance by the ADC of the multichannel analyzer. The output impedance is 50 ohms, dc-coupled.

LINEAR AMP A BNC connector provides a 0 to 10 volt positive linear signal with amplitude corresponding to an energy range of 0 to 10 MeV (i.e., an output signal of 1V/MeV). The output baseline is dc-restored (0 ±5 mV) by the baseline restorer (BLR) and the output impedance is 50 ohms, dc-coupled.

BUSY A BNC connector furnishes a TTL compatible NIM-standard positive logic pulse having a width which is the "OR" of the module's internal signal processing time and the BUSY input. The output impedance is 50 ohms, dc-coupled.

TRIGGER A BNC connector provides both positive and negative 1.5 volt pulses for externally triggering an oscilloscope during system test. The external trigger polarity of the oscilloscope should be set opposite to that of the internal HIGH VOLTAGE POLARITY switches. The TRIGGER output is active only when the MARKER/BIAS/OFF switch is in the MARKER position. The output impedance is 100 ohms, dc-coupled.

2.3.2 REAR-PANEL INPUTS

BUSY A BNC connector accepts NIM-standard positive logic pulses which are "ORed" with the module's internal signal processing time providing an overall BUSY output. The input impedance is 10k ohms, dc-coupled.

EXT PULSER A BNC connector accepts pulses from an external signal generator for energy markers. The input impedance is 50 ohms, dc-coupled with a sensitivity of 25 MeV/V.

2.3.3 REAR-PANEL TEST POINTS

DET/HV/GND Three test points are furnished for monitoring both detector load current and bias voltage. It is recommended that a 10 Mohm input-impedance, battery-operated digital Multimeter (such as FLUKE Model 8010A or equivalent) be used for these measurements. The detector bias current is monitored by connecting the Digital Multimeter (DMM) to the HV and DET test points. Setting the DMM to the 2 Volt full-scale range will result in the meter displaying the detector load current directly in microamperes. The detector bias voltage is monitored by connecting the DMM to the HV and GND test points. The detector bias voltage, measured between the HV and GND test points, should be increased to compensate for voltage losses in the bias network. This voltage loss can be computed from the formula V = 12 I where V is in volts and I in the detector load current in microamperes.

2.3.4 REAR-PANEL VACUUM CONNECTOR

VACUUM A Swagelok connector for 0.25 inch OD tubing is used for connecting the module to the vacuum pump. The pump should be capable of providing an oil-free vacuum of less than 100 microns of mercury to assure good system resolution.

2.4 POWER REQUIREMENTS:

+24 V, 125 mA; +12 V, 125 mA
-24 V, 125 mA; -12 V, 35 mA

2.5 OTHER INFORMATION

WEIGHT:	TC 256	TC 257
SHIPPING	8.5 lbs (3.95 Kg)	10.0 lbs (4.65 Kg)
NET	6.4 lbs (2.9 Kg)	8.0 lbs (3.75 Kg)

DIMENSIONS:

TC 256 Standard double-width NIM Module (2.70 x 8.714) per TID 20893 (Rev.).

TC 257 Standard triple-width NIM module (4.05 x 8.714) per TID 20893 (Rev.).

ACCESSORIES INCLUDED:

1 each Instruction Manual
1 each Sample Holder Rack
1 each Sample Holder

WARRANTY One year.

3.0 INSTALLATION

3.1 DETECTOR INSTALLATION

Remove the sample holder rack and the sample holder from the vacuum chamber. Invert the TC 256/TC 257 and hold the vacuum chamber door open. Carefully grasp the detector along the outer rim and position it above the vacuum chamber's Microdot connector. Screw the detector into the Microdot connector being careful not to touch the active surface of the detector. Return the module to its upright position and reinstall the sample holder rack and sample holder. Remove the module's left side shield and set both POLARITY slide switches for the high voltage polarity required for the detector (See Fig. 6.1). Reinstall the module's left side shield.

3.2 CONNECTION TO POWER

The TC 256/TC 257 Alpha Spectrometer requires a NIM-standard bin and power supply, such as the TENNELEC TB3/TC911, for operation. The bin provides mechanical mounting and power supply distribution. Always turn OFF the bin power supply when inserting or removing any modules.

The TENNELEC NIM modules are designed so that it is not possible to overload the power supply, even with a full complement of modules in the bin. Since this may not be true when the bin contains modules other than those of TENNELEC design, the power supply voltages should be checked after all modules have been inserted. The TENNELEC TB3/TC911 Bin and Power Supply provides power supply test points on the bin control panel for monitoring the dc voltage levels.

3.3 VACUUM CONNECTION

The TC 256/TC 257 vacuum chamber requires a clean, dry, oil-free vacuum of less than 100 microns of mercury for proper operation. The vacuum source should be connected to the VACUUM connector on the rear panel of the TC 256/TC 257 using 0.25 inch OD tubing and Swagelok fittings. The VENT/HOLD/PUMP control should be set to the VENT or HOLD position to isolate the vacuum source from atmospheric pressure.

4.0 OPERATING PROCEDURES

4.1 FIRST-TIME OPERATION

Users will find it helpful to familiarize themselves with the TC 256/TC 257 Alpha Spectrometer by conducting a few simple tests.

4.1.1 EQUIPMENT REQUIRED

1. NIM bin and power supply (TENNELEC TB3/TC911 or equivalent).
2. Oscilloscope (TEKTRONIX 465 or equivalent).
3. Digital Multimeter (FLUKE 8010A or equivalent).
4. Vacuum Source.
5. Shielded cables with BNC connectors.

4.1.2 TEST SYSTEM SET-UP

Install the detector in the TC 256/TC 257 module (See Sec. 3.1).

Insert the TC 256/TC 257 into the NIM bin and connect the vacuum source (See Sec. 3.3).

Set the TC 256/TC 257 controls as follows:

MARKER/BIAS/OFF	OFF
ENERGY RANGE	3 - 8 MeV
VENT/HOLD/PUMP	VENT
ENERGY MARKER	5.00 MeV
HIGH VOLTAGE	0 V

Set the Oscilloscope controls as follows:

CH A VERT SENS	2 Volts/Div (dc-coupled)
CH B VERT SENS	2 Volts/Div (dc-coupled)
HORIZ SWEEP	1 usec/Div
TRIGGERING	NEG EXTERNAL for POS high voltage POLARITY. POS EXTERNAL for NEG high voltage POLARITY.

Connect the TRIGGER output of the TC 256/TC 257 to the external trigger input of the oscilloscope. Connect the LINEAR AMP output of the TC 256/TC 257 to the channel A input of the oscilloscope. Plug the negative lead of the Digital Multimeter (DMM) into the GND test point of the TC 256/TC 257 and the positive lead into the HV test point. Set the DMM for 200 volts dc full-scale.

4.1.3 TEST SYSTEM OPERATION

Turn the vacuum source on and apply power to the NIM bin. Close the vacuum chamber door of the TC 256/TC 257 and turn the VENT/HOLD/PUMP control to the PUMP position. After several minutes move the MARKER/BIAS/OFF control to the MARKER position.

<u>WARNING</u>

To prevent detector damage always turn the MARKER/BIAS/OFF control to the OFF position before evacuating or venting the vacuum chamber.

Adjust the trigger control of the oscilloscope for a stable dis lay; a + 5 volt unipolar pulse with several volts of noise should be present. Slowly increase the HIGH VOLTAGE control. After several volts of high voltage is applied, the noise should suddenly decrease. Increase the Channel A sensitivity of the oscilloscope to 0.1 Volt/Div. Continue increasing the HIGH VOLTAGE control until either the detector's rated high voltage is reached, as monitored by the DMM, or there is an apparent increase in the noise level as displayed by the oscilloscope. Return the Channel A sensitivity of the oscilloscope to 2 Volts/Div.

Connect the ENERGY output of the TC 256/TC 257 to the channel B input of the oscilloscope. A nearly rectangular, + 4 volt pulse should be present (See Fig. 4.1). This signal is normally connected to the ADC input of a multichannel analyzer for energy spectroscopy measurements.

Move the cable from the ENERGY output to the COUNTS output. A rectangular, + 4 volt logic pulse, 3.5 usec wide should be present. This signal is normally connected to the positive input of a timer and counter module for gross alpha-rate measurements. This signal can also be used for signal routing in special system configurations.

Move the cable from the COUNTS output to the BUSY output. A rectangular, + 4 volt logic pulse, 5.5 usec wide should be present. This signal is normally connected to the TIME GATE input of a timer and counter module when making gross alpha-rate measurements, thus providing deadtime correction for the timer.

Return the cable from the BUSY output to the ENERGY output. Decrease the ENERGY MARKER control while watching the amplitude relationship of the LINEAR AMP (Channel A) and ENERGY (Channel B) outputs on the oscilloscope. Note that the ENERGY output signal disappears for ENERGY MARKER settings below 3 MeV. Increase the ENERGY MARKER control and note that the ENERGY output amplitude remains constant for ENERGY MARKER settings above 8 MeV. This energy range expansion is the result of the biased amplifier.

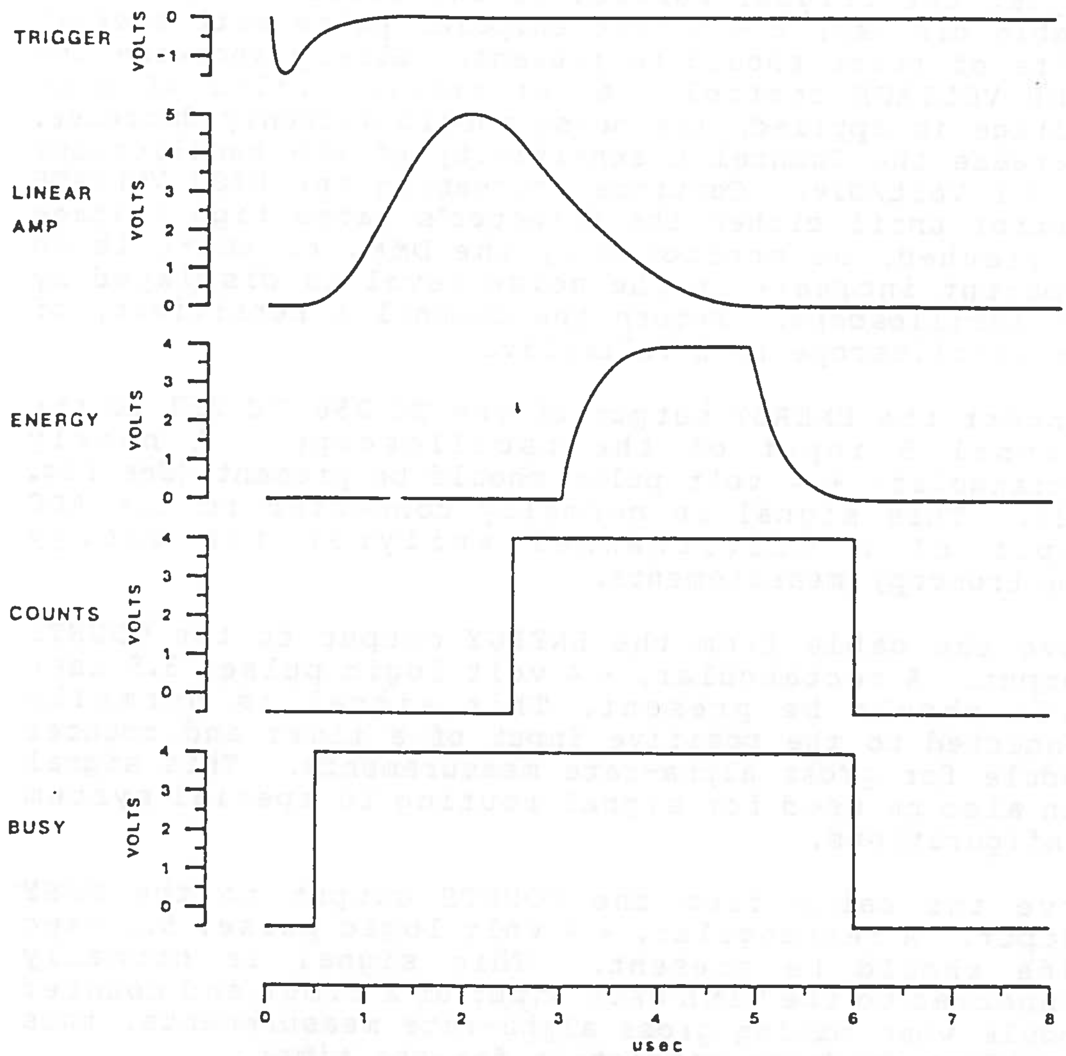

Fig. 4.1 Typical Output Waveforms

4.2 OPERATION IN A GROSS ALPHA COUNTING SYSTEM

4.2.1 SINGLE CHANNEL COUNTING SYSTEM

A single channel gross alpha-rate counting system can be configured as shown in Fig. 4.2. The COUNTS output of the TC 256/TC 257 is connected to the positive input of the Counter and Timer. The positive discriminator of the Counter and Timer should be set to 2 volts. System deadtime correction can be provided by connecting the BUSY output of the TC 256/TC 257 to the TIME GATE input of the Counter and Timer.

FIG. 4.2 Single Channel Counting System

The addition of a TC 576L BUFFERED PRINTER will provide a hardcopy print-out of sample number, counting time, gross alpha counts, alpha counts per unit time (either in cps or cpm as selected by the TC 534 COUNTER AND TIMER) and a 2-sigma standard deviations (percent).

Refer to Secs. 4.1.2 and 4.1.3 for set-up and operation of the TC 256/TC 257.

4.2.2 MULTIPLE CHANNEL COUNTING SYSTEM

A multiple channel gross alpha-rate counting system can be configured as shown in Fig. 4.3. The COUNTS output of each TC 256/TC 257 is connected to a positive input channel of the Multi-Counter and Timer. Each channel's positive discriminator of the Multi-Counter and Timer should be set to 2 volts. Deadtime correction should not be applied in a system with a single timer and multiple counter channels as improper deadtime compensation will result.

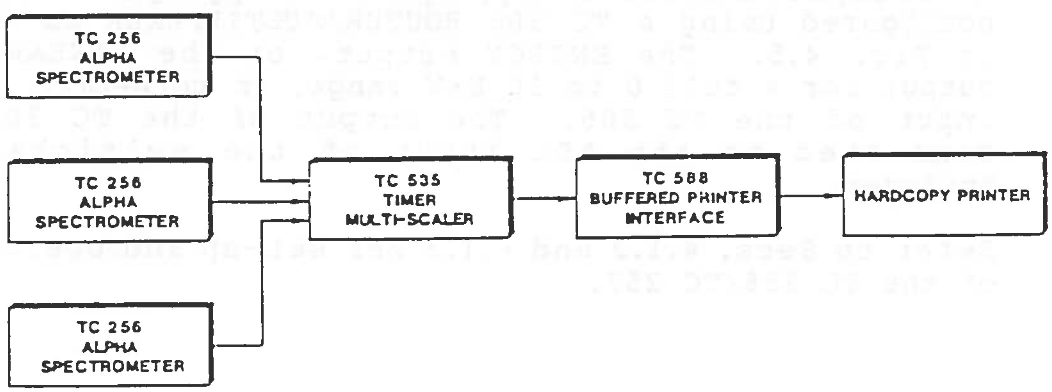

FIG 4.3 Multiple Channel Counting System

A hardcopy printout of counting time and gross counts for each channel is provided with the addition of a TC 588 BUFFERED PRINTER INTERFACE and printer.

Refer to Secs. 4.1.2 and 4.1.3 for set-up and operation of the TC 256/TC 257.

4.3 OPERATION IN AN ENERGY SPECTROSCOPY SYSTEM

4.3.1 SINGLE CHANNEL SPECTROSCOPY SYSTEM

A single channel energy spectroscopy system can be configured as shown in Fig. 4.4. The ENERGY output, or LINEAR AMP output for a full 0 to 10 MeV range, is connected to the ADC input of the multichannel analyzer.

Refer to Secs. 4.1.2 and 4.1.3 for set-up and operation of the TC 256/TC 257.

FIG. 4.4 Single Channel Spectroscopy System

4.3.2 MULTIPLE CHANNEL SPECTROSCOPY SYSTEM

A multiple channel energy spectroscopy system can be configured using a TC 306 ROUTER/MULTIPLEXER as shown in Fig. 4.5. The ENERGY output, or the LINEAR AMP output for a full 0 to 10 MeV range, is connected to an input of the TC 306. The output of the TC 306 is connected to the ADC input of the multichannel analyzer.

Refer to Secs. 4.1.2 and 4.1.3 for set-up and operation of the TC 256/TC 257.

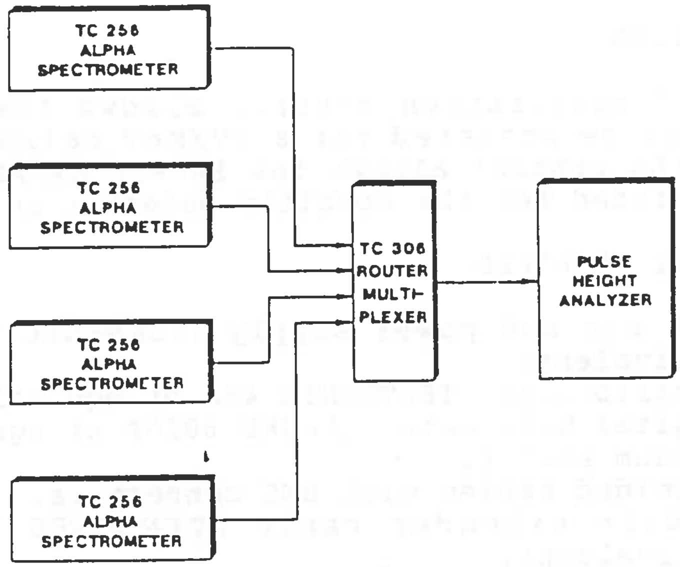

FIG. 4.5 Multiple Channel Spectroscopy System

5.0 DECONTAMINATION

An increase in the background count rate may indicate that the vacuum chamber and/or detector has become contaminated by residual deposits of alpha-emitting materials.

Consult the detector manufacturer's instruction manual for recommended detector cleaning procedures.

The TC 256/TC 257 vacuum chamber may be cleaned using a clean, white cotton cloth or cotton swab and methanol. Remove the sample holder rack, sample holder and detector. Remove the O-ring seal from the vacuum chamber door. Carefully clean the vacuum chamber and vacuum chamber door, then rinse with methanol and blow dry with clean. dry air or dry nitrogen. Clean and dry the sample holder rack and sample holder. Clean and dry the O-ring seal with methanol.

Apply a thin coating of vacuum grease to the O-ring and reinstall it. Reinstall the detector, sample holder rack and sample holder.

6.0 CALIBRATION

The GAIN calibration control allows the LINEAR AMP output to be adjusted for a 1V/MeV calibration. The PULSER CAL control allows the ENERGY MARKER control to be calibrated for the specific detector in operation.

6.1 EQUIPMENT REQUIRED

1. NIM bin and power supply (TENNELEC TB3/TC911 or equivalent).
2. Oscilloscope (TEKTRONIX 465 or equivalent).
3. Digital Multimeter (FLUKE 8010A or equivalent).
4. Vacuum source.
5. Shielded cables with BNC connectors.
6. Module extender cable (TENNELEC NC-EXC-4 or equivalent).
7. High resolution $^{210}P_o$ source (approximately 0.1 uC).

6.2 CALIBRATION SYSTEM SET-UP

Install the detector in the TC 256/TC 257 module (See Sec. 3.1). Remove the left module side shield. Connect the TC 256/TC 257 to the NIM bin using the module extender cable. Connect the vacuum source (See Sec. 3.3).

Set the TC 256/TC 257 controls as follows:

MARKER/BIAS/OFF	OFF
VENT/HOLD/PUMP	VENT
HIGH VOLTAGE	0 V

Set the Oscilloscope controls as follows:

CH A VERT SENS	1 Volt/Div (dc-coupled)
HORIZ SWEEP	1 usec/Div
TRIGGERING	INTERNAL CHANNEL A POS

Connect the LINEAR AMP output of the TC 256/TC 257 to the Channel A input of the oscilloscope. Plug the negative lead of the Digital Multimeter (DMM) into the GND test point of the TC 256/TC 257 and the positive lead into the HV test point. Set the DMM for 200 volts dc full-scale.

Turn the vacuum source on and apply power to the NIM bin. Place the $^{210}P_o$ source on the sample rack, close the vacuum chamber door and turn the VENT/HOLD/PUMP control to the PUMP position. After several minutes move the MARKER/BIAS/OFF control to the BIAS position.

<u>WARNING</u>

> To prevent detector damage always turn the MARKER/BIAS/OFF control to the OFF position before evacuating or venting the vacuum chamber.

Increase the HIGH VOLTAGE control until the detector's rated high voltage is reached as monitored by the DMM. Adjust the trigger control of the oscilloscope for a stable display.

6.3 CALIBRATION PROCEDURES

6.3.1 GAIN

Adjust the internal GAIN control (See Fig. 6.1) of the TC 256/TC 257 for a LINEAR AMP output signal of exactly 5.3 volts as displayed on the oscilloscope.

6.3.2 PULSER CAL

Move the MARKER/BIAS/OFF switch to the MARKER position and set the ENERGY MARKER control to 5.305 MeV. Adjust the internal PULSER CAL control (See Fig. 6.1) of the TC 256/TC 257 so that the pulser signal exactly coincides in amplitude with the ^{210}Po signal.

7.0 SHIPPING DAMAGE

Upon receipt of the instrument, examine it for shipping damage. Damage claims should be filed with the carrier. The claims agent should receive a full report: a copy of that report should be sent to TENNELEC, Inc., P.O. Box 2560, Oak Ridge, Tennessee 37830-2560. The model number and serial number of the instrument must be included in the report. Any remedial action taken by TENNELEC, Inc., will be based on the information contained in this report.

8.0 SERVICING

In the event of a component failure, replacement may be done in the field or the instrument may be returned to our plant for repair. There will be no charge for repairs that fall within the warranty.

9.0 WARRANTY

In connection with TENNELEC's warranty (inside front cover), TENNELEC suggests that if a fault develops, the customer should immediately notify the TENNELEC Customer Service Manager. He may be able to prescribe repairs and send replacement parts which will enable you to get the instrument operating sooner and at less expense than if you returned it.

Should return prove necessary, the TENNELEC Customer Service Manager must be informed in WRITING, BY CABLE or TWX of the nature of the fault and the model number and serial number of the instrument. Pack the instrument well and ship PREPAID and INSURED to TENNELEC, Inc., 601 Oak Ridge Turnpike, Oak Ridge, Tennessee 37830-2560. As stated in the warranty DAMAGE IN TRANSIT WILL BE REPAIRED AT THE SENDER's EXPENSE as will damage that obviously resulted from abuse or misuse of the instrument.

* *

TENNELEC'S Quality Assurance Program requires that each and every instrument be fully aged, vibrated, and electronically checked.

Should the user require a copy of the Quality Control Procedure and Test Record, please call the Customer Service Department of TENNELEC. Both model number and Serial number are required.

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MANUAL REV. 2

12/83 - Engineering and component improvements may be made after date of printing.

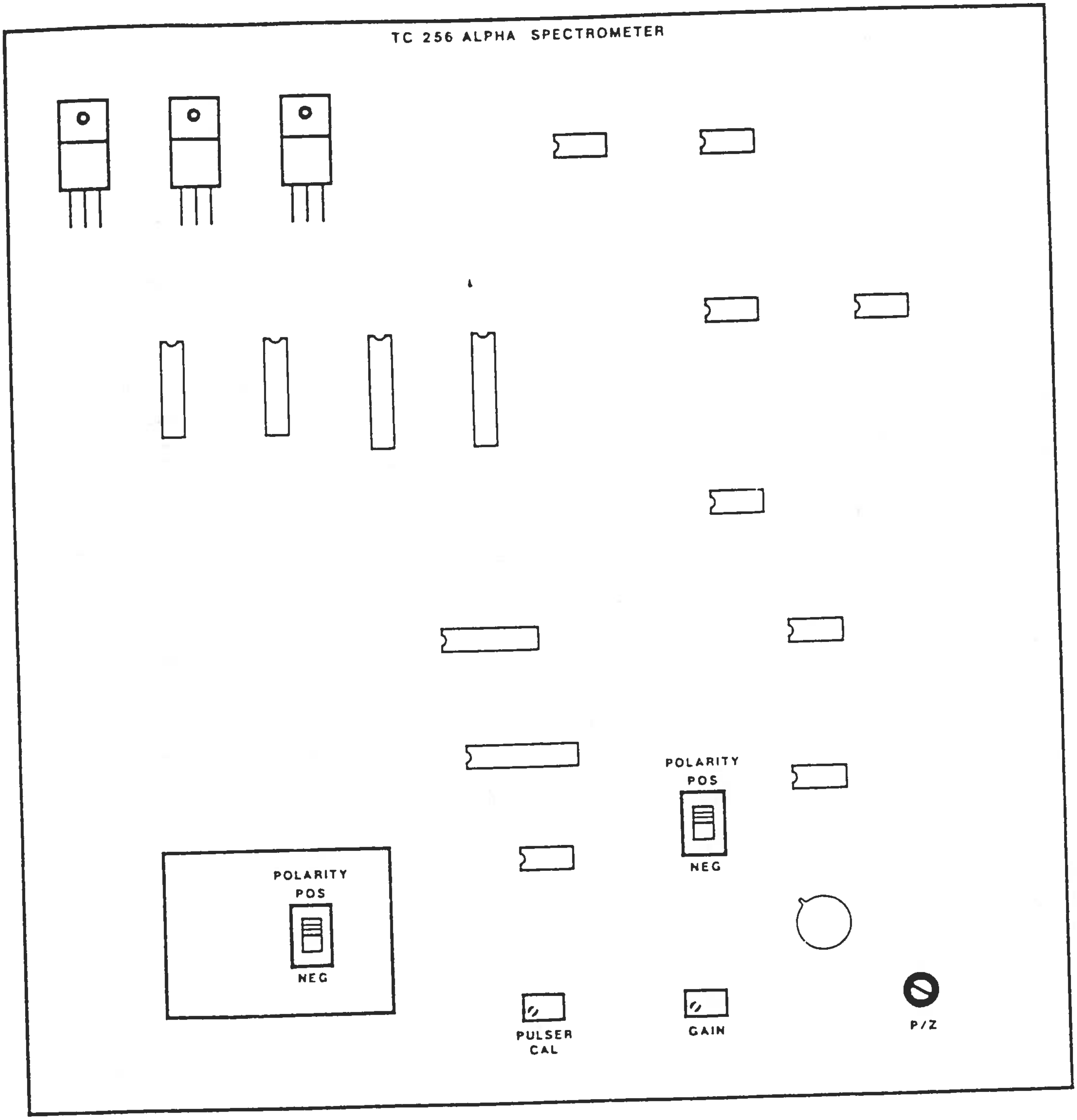

Fig. 6.1 Internal Controls And Adjustments