EG&G ORTEC

# Model 487
# Spectrum Scanner
# Operating and Service Manual

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This manual applies to instruments
"Rev 05" on rear panel

Printed in U.S.A.

0696 0.50C 0279

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### QUALITY CONTROL

Before being approved for shipment, each EG&G ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design improvements.

### REPAIR SERVICE

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, EG&G ORTEC must be informed, either in writing or by telephone [(615) 482-4411], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The EG&G ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped **PREPAID** via Air Parcel Post or United Parcel Service to the nearest EG&G ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty will be repaired at the standard charge unless they have been grossly misused or mishandled, in which case the user will be notified prior to the repair being done. A quotation will be sent with the notification.

### DAMAGE IN TRANSIT

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify EG&G ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment if necessary.

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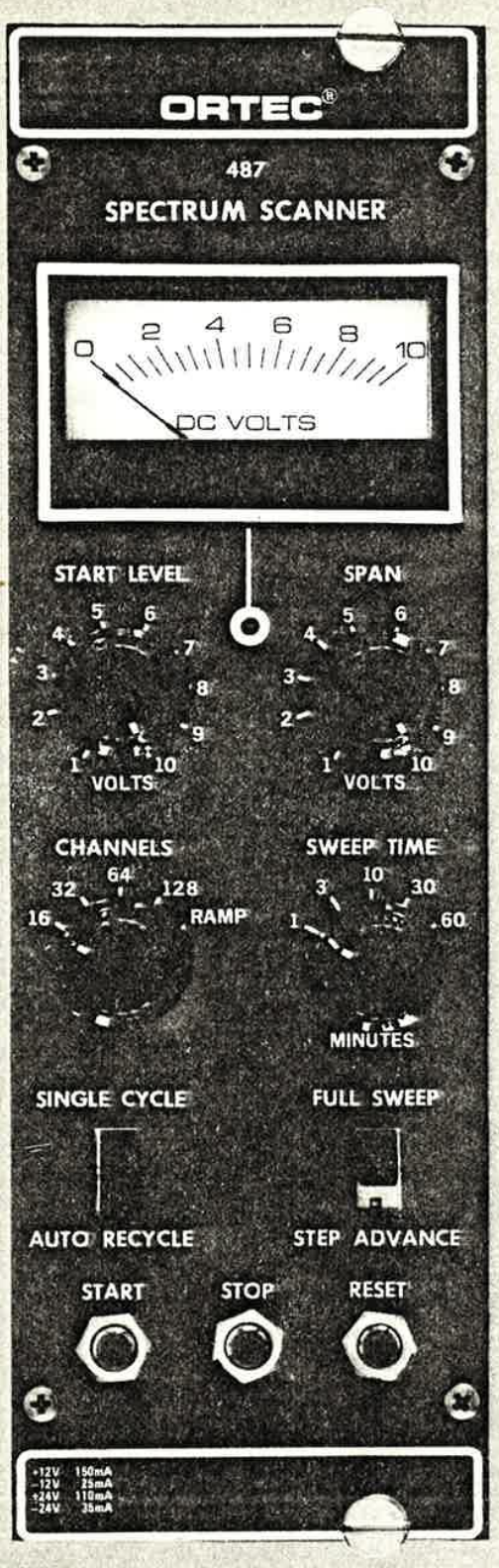
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START
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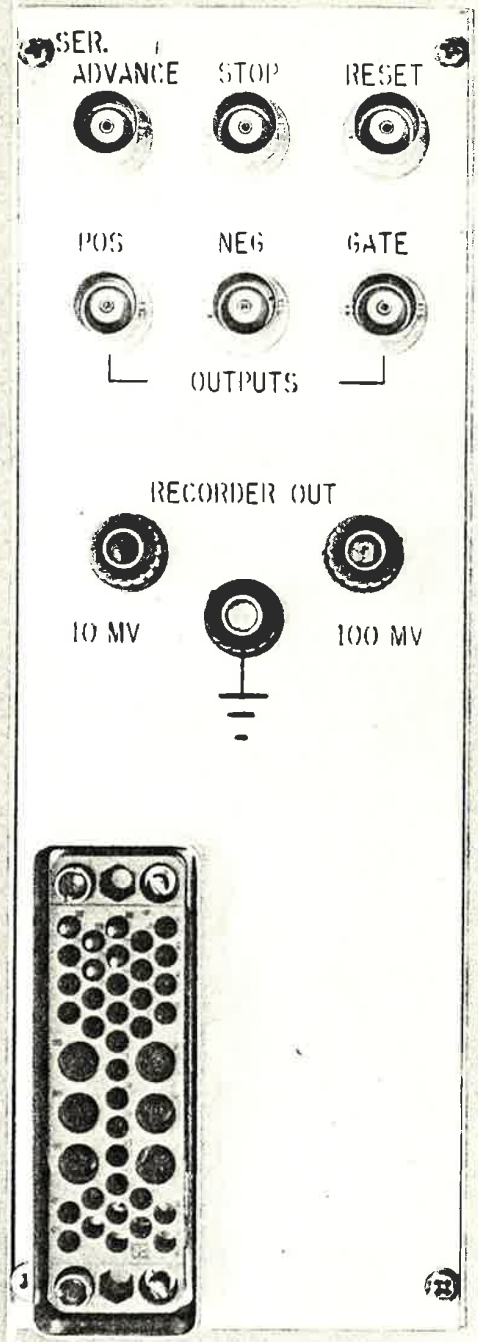
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# ORTEC 487 SPECTRUM SCANNER

## 1. DESCRIPTION

The ORTEC 487 Spectrum Scanner is a program-controlled baseline sweep generator designed as an accessory to an ORTEC single-channel pulse height analyzer. It furnishes the external baseline for the analyzer and controls a program by which the analyzer window can be swept through an energy spectrum. The 487 can be included as an integral part of a data acquisition system to obtain count rate versus energy level information.

The lower level threshold, or baseline, of the analyzer is stepped through an adjusted span within the total dynamic range of an amplifier analog output for x-ray and nuclear applications. The starting level span, number of steps, and dwell time at each step are all separately adjustable on the front panel. Both positive and negative bias polarities are available simultaneously to permit universal application to other instruments.

The automatic program identifies a cycle as one complete series of steps of the output baseline level, starting at an adjusted level of between 1 and 10 V and stepping toward zero volts, with a reset to the start level after the selected number of steps, or channels, has been generated. The 487 can be set for a single cycle of automatic programming or for automatic recycling. When it is set for full-sweep operation, the automatic program includes an adjusted dwell time per channel which results in 16 to 1024 equal time increments within the selected total-sweep time, 1 to 60 min. When it is set for step advance, dwell time is exclusively a function of the interval between advance pulses through a rear-panel connector, and this permits the system to be used for studies of correlation with mechanical movements or other conditions which can require aperiodic stepping.

A cycle, once it has been started, can be stopped manually or electronically and can be restarted from the point of interruption or can be reset to the start level.

A recorder output, included on the rear panel to monitor the baseline output level, is furnished in addition to a front-panel meter and a convenient test point. The test point can be used for critical adjustments of both start level and span. The recorder output can be used as the X drive in an X-Y recorder; it is not required for a strip chart recorder.

A rear-panel gate output may be used to control other instruments in the counting system according to the scanning and nonscanning intervals programmed in the 487.

## 2. SPECIFICATIONS

### PERFORMANCE

**SWEEP TIME ACCURACY** ±5%.

**OUTPUT NONLINEARITY** Integral nonlinearity ⩽ 0.05% for Pos, Neg, and Recorder outputs.

### CONTROLS

**START LEVEL** Potentiometer selects voltage level at which a sweep begins; range 1 to 10 V.

**SPAN** Potentiometer selects range, from start level toward zero, through which the output will be swept during a cycle; range 1 to 10 V, but limited to not more than the selected start level.

**CHANNELS** Switch selects the number of steps in a cycle; settings are 16, 32, 64, 128, and RAMP. In RAMP position, the number of steps is 1024.

**SWEEP TIME** Switch selects total time for a full-sweep cycle; settings are 1, 3, 10, 30, and 60 min.

**SINGLE CYCLE/AUTO RECYCLE** Switch selects the type of automatic program.

SINGLE CYCLE Program consists of starting at the selected start level, progressing toward zero across the adjusted span in the selected number of channel steps, and resetting to the start level, stopping at that point.

AUTO RECYCLE Program consists of the single cycle sequence above, repeated after each reset to the start level.

**FULL SWEEP/STEP ADVANCE** Switch selects either automatic or manual control.

FULL SWEEP Selects the automatic program cycle mode, using the selected sweep time for step advances; the cycle is initiated by pressing the start switch or by an advance input pulse.

STEP ADVANCE Selects manual or external control for step advances; the cycle is initiated by pressing the start push button, and each subsequent step is selected by

either pressing the start push button or furnishing an external advance signal through the rear panel.

**START** Push-button switch initiates the program cycle and also provides manual advance for the step advance mode of operation.

**STOP** Push-button switch interrupts the program cycle at any point; the start switch can be used to continue the program without reset.

**RESET** Push-button switch resets the output to the start level at any time.

## CONNECTORS

**ADVANCE, STOP, RESET, POS, NEG, and GATE** All are type BNC (UG-1094/U) on rear panel.

**RECORDER OUT** Three banana plugs on rear panel.

## INPUTS

**ADVANCE** Accepts an external signal to start a cycle for the full-sweep mode or to advance one channel after the cycle is initiated for the step advance mode; pulse is +3 V, rise time $\leqslant$ 1 $\mu$s, width 200 ns min, $Z_{in} > 1000\Omega$; protected to ±25 V.

**STOP** OR function with front-panel stop push button; pulse is +3 V, rise time $\leqslant$ 1 $\mu$s, width 200 ns min, $Z_{in} > 1000\Omega$; protected to ±25 V.

**RESET** OR function with front-panel reset push button; pulse is +3 V, rise time $\leqslant$ 1 $\mu$s, width 200 ns min, $Z_{in} > 1000\Omega$; protected to ±25 V.

## OUTPUTS

**POS** Positive bias level stepped sequentially from the selected start level (+1 to +10 V) through the adjusted span (1 to 10 V) toward zero; $Z_o < 1\Omega$.

**NEG** Negative bias level stepped sequentially from the selected start level (-1 to -10 V) through the adjusted span (1 to 10 V) toward zero; $Z_o < 1\Omega$.

**GATE** For either of two applications:

DRIVING ORTEC SCALER AND TIMER GATES

***Scanning*** Open circuit.

***Not Scanning*** Shorted to ground for loads connected to positive supply voltages.

DRIVING RECORDER PEN DROP

***Scanning*** Shorted to ground for loads connected to negative supply voltages; provides up to 50 mA.

***Not Scanning*** Open circuit.

**RECORDER OUT** Three binding posts; one is a common ground; one is for a 10-mV range output; and one is for a 100-mV range output; monitors the POS output level.

10 mV Range 0 to 10 mV, positive with sweep slope negative; $Z_o < 10\Omega$.

100 mV Range 0 to 100 mV, positive with sweep slope negative; $Z_o < 100\Omega$.

**METER** Front-panel meter indicates instantaneous sweep level; range 0 to 10 V.

**TEST POINT** Front-panel test point for convenience in monitoring the instantaneous sweep level with an external voltmeter or oscilloscope.

## ORDERING INFORMATION

**POWER REQUIRED** +24 V, 110 mA; +12 V, 150 mA; -24 V, 35 mA; -12 V, 25 mA.

**WEIGHT (SHIPPING)** 6 lb (2.72 kg).

**WEIGHT (NET)** 3 lb 2 oz (1.42 kg).

**DIMENSIONS** Standard double-width module (2.70 in. by 8.714 in.) per TID-20893 (Rev.).

# 3. INSTALLATION

## 3.1 GENERAL

The 487, used in conjunction with ORTEC's 401A/402A Bin and Power Supply, is intended for rack mounting; therefore vacuum tube equipment operating in the same rack must be sufficiently cooled by circulating air to prevent any localized heating of the all-transistor circuitry used throughout the 487. The temperature of equipment mounted in racks can easily exceed the recommended maximum of 120°F (50°C) unless precautions are taken.

## 3.2 CONNECTION TO POWER

The 487 contains no internal power supply and therefore must obtain power from a Nuclear Standard Bin and Power Supply such as ORTEC 401A/402A. It is recommended that the bin power supply be turned off when modules are inserted or removed. ORTEC instruments are designed so that the Bin Power Supply cannot be overloaded even when a full complement of modules is in the Bin. However, since this may not be true when the Bin contains modules of other than ORTEC design, power supply voltages should be checked after the modules are inserted. The 401A/402A has test points on the power supply control panel to monitor dc voltages. Before operating the 487, check to see that all 401A/402A supply voltages (±12, ±24) are within 0.5 V of their proper value.

When using the 487 outside the 401A/402A Bin and Power Supply, be sure that the jumper cable used properly accounts for the power supply grounding circuits provided as recommended by the AEC in TID-20893 (Rev.). Both high-quality and power-return ground connections are provided to ensure proper reference voltage feedback into the power supply, and they must be preserved in remote cable installations. Care must also be exercised to avoid ground loops when the module is operated outside the Bin.

## 3.3 CONNECTIONS TO ORTEC EQUIPMENT

The 487 is compatible with the external baseline input requirements of all ORTEC single-channel analyzers. It can supply sufficient current to drive up to ten of these inputs in parallel.

The rear-panel ADVANCE input is compatible with the BUSY output of the ORTEC 432 Printout Control. This connection would be made when a preset timer or scaler in the printer loop is used to determine the amount of time that the 487 dwells on each channel.

The rear-panel GATE output is compatible with the GATE input of all ORTEC scalers and timers. By making this connection, the 487 would gate ON a timer, for example, only while a scan was being run.

# 4. OPERATING INSTRUCTIONS AND APPLICATIONS

## 4.1 GENERAL

The 487 Spectrum Scanner provides a simple means of obtaining a strip-chart-recorder plot of counting rate versus energy information derived from an x-ray or nuclear spectroscopy system. Typically, the output pulses from a linear amplifier which lie in a 0- to 10-V range (the range for which the amplifier distribution of the amplifier output pulses accurately represents the energy spectrum of radiation incident upon the detector) are separated and analyzed with a single-channel analyzer by setting the analyzer window over one particular peak in the amplitude spectrum. The analyzer output then will be a logic signal, the count rate of which indicates the intensity of the energy represented by that setting of the analyzer lower-level discriminator (baseline). All energies in the spectrum may be analyzed in this way by merely changing the setting of the lower-level discriminator.

The 487 changes this setting automatically. As the 487 "steps" the analyzer window through the range of interest, the rate meter (see Fig. 4.1) will reflect the intensity of the energy being analyzed. A visual display may be obtained with a strip-chart recorder or an X-Y plotter by driving the ordinate with the rate-meter output voltage and the abscissa with the recorder's internal time base or with the output of the 487 for the plotter.

For explanation of the controls and connector data, see Section 2 "Specifications."

If the CHANNELS control is set to either the 16, 32, 64, or 128 position, then the "width" of each channel can be found by dividing the range to be swept (SPAN) by the number of steps (CHANNELS) in the span. The window width setting on the single-channel analyzer should then be adjusted to be equal to the 487 channel width. (Refer to Section 4.2 of this manual for calibration procedures.) The recorder plot will be a histogram of the energy spectrum analyzed.

The RAMP position of the CHANNELS control is actually a simulated ramp consisting of 1024 equal steps. In this position the analyzer window may be set to any width greater than 100 mV. If an analog rate meter (ORTEC 441) is used in the experiment, then the plot will

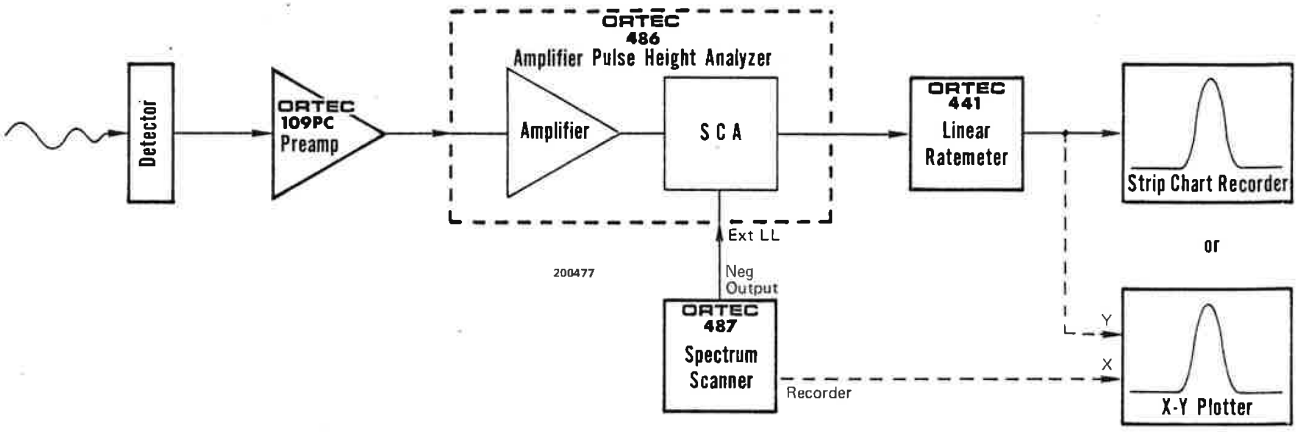



**Fig. 4.1. Open Loop System.**

be a smooth plot of the energy spectrum analyzed. If a digital rate meter (ORTEC 434) is used, then the recorder plot will be a histogram of the energy spectrum analyzed.

## 4.2 CALIBRATION ADJUSTMENTS

### START LEVEL

A trim potentiometer (R88) is accessible through the top of the module for calibrating the full-range starting voltage (10.00 V dc). (This trim potentiometer is that one nearest the rear of the module.) The output voltage may be monitored with a digital voltmeter at the 487 front-panel test point while this adjustment is being made. For this adjustment RESET should be depressed and then the START LEVEL control should be turned full clockwise.

### SWEEP TIME

Another trim potentiometer (R130) is accessible through the top of the module for adjusting the frequency of the internal oscillator (SWEEP TIME). (This potentiometer is the one nearest the front of the module.) This adjustment is made easily by observing the output waveform on an oscilloscope and adjusting the time spacing between adjacent channels. The input coupling into the oscilloscope must be ac. For example, with the SWEEP TIME control set at 1 min, the time spacing between channels (dwell time at each channel) would be 60 sec/1024 or 58.6 $\mu$s.

### SPAN

The span can be adjusted more accurately than by merely relying on the front-panel markings. The procedure is as follows. Depress the RESET push button. Set the START LEVEL at full scale (full clockwise). Set the FULL SWEEP/STEP ADVANCE switch to STEP ADVANCE. Set the CHANNELS control to 16. Manually depress the START push button 17 times. This places the output in channel zero. The SPAN control can now be adjusted so that the voltage at the monitor test point is 0.00. The 487 is now calibrated for a full range sweep of 10.00 V. This procedure may be used for any settings on the START LEVEL and SPAN controls when it is desired to sweep between two precisely known voltage levels.

## 4.3 APPLICATIONS

### OPEN LOOP SYSTEM

Figure 4.1 shows a system for obtaining a recorder plot of count rate vs energy, using the 487 for sweeping the window of the single-channel analyzer through the spectrum derived from the detector. This system is "open loop" in the sense that, for an energy scan, operation of the 487 is not controlled by the results of the data being collected. That is, there is no feedback to alter the operation of the 487 as the scan progresses.

### CLOSED LOOP SYSTEM

Figure 4.2 shows a system for obtaining a histogram plot of count rate vs energy, using the 487 for stepping the window of the single-channel analyzer through the spectrum derived from the detector. In this digital data acquisition system, data are collected for a preset time (selected by the ORTEC 434 Digital Rate Meter) at one energy. At the end of the preset time interval a BUSY signal is generated from the printout control unit, the rate meter is automatically reset for a new data-taking interval, and the 487 output is moved to the next level. The data taken at each energy setting may be printed out on computer-compatible punched paper tape with the Teletype 33-ASR.

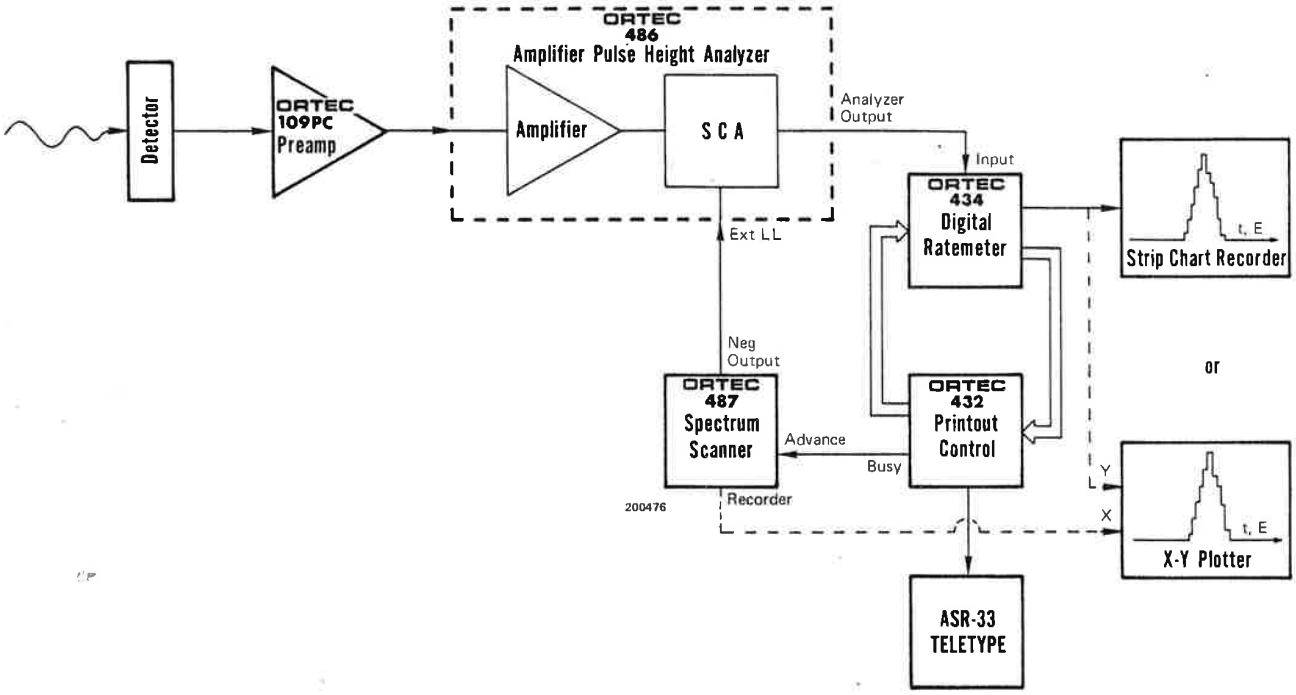



**Fig. 4.2. Closed Loop System Digital Data Acquisition.**

## 5. CIRCUIT DESCRIPTION

The 487 is basically a programmable voltage staircase generator. The staircase output is obtained by sequencing a digital-to-analog converter from a selected starting voltage (START LEVEL) through a number of steps selected by the CHANNELS control.

IC1 through IC11 comprises an eleven-bit binary counter. The outputs of the successive binary stages of this counter are fed into eleven gates comprised of Q1 through Q33. Q1, Q2, and Q3 make up the basic gate which is duplicated for the successive stages. The output of the gate (junction of emitters of Q2 and Q3) is either at ground potential or at a positive 12–V level, depending upon the state of the driving flip-flop in the binary counter.

The outputs of the gates go to a resistive ladder network which sums the weight of the successive stages of the counter in binary fashion. This sum is fed into the input of the operational amplifier IC12. The output of IC12 is a voltage which reflects the state of the counter with a resolution of 1 out of 1024 steps. The eleven-bit counter is automatically reset to zero state after the 1024th step by the network comprised of Q39 and Q40.

R86 is a single-turn potentiometer (SPAN) in the feedback loop of IC12 and thus determines the closed loop gain of that stage. IC13A takes the output voltage of IC12 and amplifies it to a 10-V level for a START LEVEL setting (R89) of 10 V or full scale. This output (NEG OUTPUT) is present at the emitter of Q42. Q42 is an emitter follower that provides the current-handling capability of driving the external baseline inputs of up to 10 ORTEC single-channel analyzers. IC13B and Q43 invert the negative output voltage to provide a positive output voltage at CN-4.

The binary counter may be driven in several different ways. In the FULL SWEEP mode of operation it is driven by the unijunction oscillator Q35. Q34 acts as a constant current source for charging the capacitor C13. The oscillation frequency is determined by C13, the magnitude of its charging current, and the trigger voltage at the emitter of Q35. Q44 serves as a current sump to stop the oscillator whenever a STOP has been made.

IC18A and IC18B form a flip-flop which eliminates switch bounce from the START push button switch. IC16A and IC16B form an R-S flip-flop for the start-reset function. Suppose that in the FULL SWEEP mode, a start input is obtained, either from the front-panel START push button or the rear-panel ADVANCE input. A negative transition at pin 7 of IC19A will occur which will be inverted by IC19B. This positive signal at pin 6 of IC19B will set the start-reset flip-flop IC16A and IC16B. The resulting negative transition at pin 6 of IC16B will allow the oscillator pulser to pass through the gate, IC15B, which was closed up to now. Thus a train of pulses will appear

at point F, which is the input of the least significant bit of the binary counter. The purpose of grounding points G, H, J, and K successively with the CHANNELS switch is to inhibit the contribution of the corresponding least significant bits to the output staircase waveform.

In the STEP ADVANCE mode, suppose that the START push button is depressed. This action will set pin 7 of the start-stop flip-flop consisting of IC14A and IC14B low. Simultaneously, pin 6 of IC16B will be set low. Thus input pulses present at the ADVANCE input will pass through the gate, IC15A, and appear on one of the points A, B, C, D, or E, according to the setting of the CHANNELS switch. Suppose, for example, that the CHANNELS control is set at 64. Then the clock pulses will be present at point C and thus be fed into the fifth binary stage of the binary counter. The first four stages or the four least significant bits will not contribute to the output staircase voltage; therefore the output will step through its range in $\frac{1024}{2^4}$ or 64 equal steps and then automatically reset. Once the start-reset flip-flop has been set with a START, then all subsequent depressions of the START push button will cause the output staircase voltage to move one step via the gate IC17A.

IC17B and Q41 comprise a one-shot multivibrator for reshaping the RESET input pulse into a pulse sufficiently long to assure the resetting of all the associated logic circuitry. The front-panel RESET push button is essentially connected in parallel with this input.

The GATE output circuitry (Q37, Q38, and Q45) is driven from the output of the start-reset flip-flop consisting of IC16A and IC16B. When a start has been made and pin 6 of IC16B goes low, Q38 becomes saturated and Q45 is turned off. When the start-reset flip-flop has been given a reset input, then Q38 turns off and Q45 becomes saturated due to pin 6 of IC16B going high. This means that while the 487 is scanning, should the GATE output be connected to the GATE input of an ORTEC scaler or timer, then that scaler or timer will be allowed to count (due to its GATE input going high). Resetting the 487 pulls this gate low and inhibits further counting in the scaler or timer. Should the GATE output of the 487 be connected to the chart advance input of a strip-chart recorder whose input circuitry consists of a load to some negative supply voltage, then the GATE output would supply up to 50 mA of current to enable the chart to advance while the 487 is sweeping.

## 6. MAINTENANCE INSTRUCTIONS

The only maintenance that the 487 should require is routine calibration of the 401A Power Supply voltages. All power supply voltages, ±12 and ±24, should be kept within 0.05 V of their proper value.

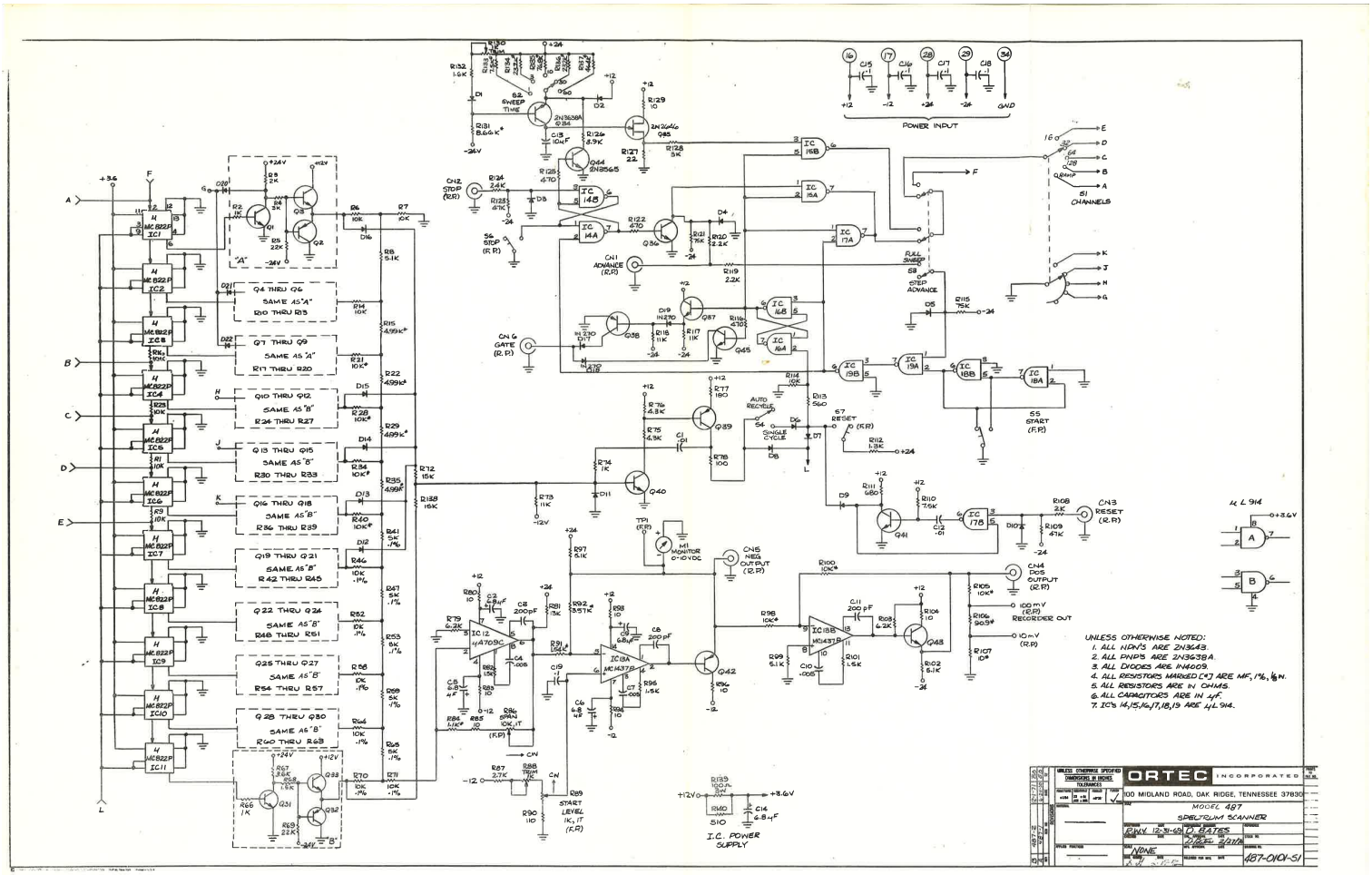
For calibration adjustments internal to the 487, refer to Section 4.2 of this manual, "Calibration Adjustments."

The 487 may at any time be returned to ORTEC for repair service at nominal cost. Our standard procedure requires that each repaired instrument receive the same extensive quality control tests that a new instrument receives. Before returning the instrument, contact Customer Service at ORTEC (615) 482-4411 for information concerning shipment of the instrument.

## BIN/MODULE CONNECTOR PIN ASSIGNMENTS FOR AEC STANDARD NUCLEAR INSTRUMENT MODULES PER TID-20893

| Pin | Function | Pin | Function |
|---|---|---|---|
| 1 | +3 volts | 23 | Reserved |
| 2 | −3 volts | 24 | Reserved |
| 3 | Spare Bus | 25 | Reserved |
| 4 | Reserved Bus | 26 | Spare |
| 5 | Coaxial | 27 | Spare |
| 6 | Coaxial | *28 | +24 volts |
| 7 | Coaxial | *29 | −24 volts |
| 8 | 200 volts dc | 30 | Spare Bus |
| 9 | Spare | 31 | Spare |
| *10 | +6 volts | 32 | Spare |
| *11 | −6 volts | *33 | 115 volts ac (Hot) |
| 12 | Reserved Bus | *34 | Power Return Ground |
| 13 | Spare | **35 | Reset (Scaler) |
| 14 | Spare | **36 | Gate |
| 15 | Reserved | **37 | Reset (Auxiliary) |
| *16 | +12 volts | 38 | Coaxial |
| *17 | −12 volts | 39 | Coaxial |
| 18 | Spare Bus | 40 | Coaxial |
| 19 | Reserved Bus | *41 | 115 volts ac (Neut.) |
| 20 | Spare | *42 | High Quality Ground |
| 21 | Spare | G | Ground Guide Pin |
| 22 | Reserved | | |

Pins marked (*) are installed and wired in ORTEC 401A and 401B Modular System Bins.
Pins marked (*) and (**) are installed and wired in EG&G/ORTEC–HEP M250/N and M350/N NIMBINS.


POWER INPUT
61 CHANNELS
IC MA
IC 15B
IC 16A
IC 16B
IC 17A
IC 17B
IC 18A
IC 18B
IC 19A
IC 19B
Q1 THRU Q3 SAME AS "A" R1 THRU R5
Q4 THRU Q6 SAME AS "A" R10 THRU R13
Q7 THRU Q9 SAME AS "A" R17 THRU R20
Q10 THRU Q12 SAME AS "B" R24 THRU R27
Q13 THRU Q15 SAME AS "B" R30 THRU R33
Q16 THRU Q18 SAME AS "B" R36 THRU R39
Q19 THRU Q21 SAME AS "B" R42 THRU R45
Q22 THRU Q24 SAME AS "B" R48 THRU R51
Q25 THRU Q27 SAME AS "B" R54 THRU R57
Q28 THRU Q30 SAME AS "B" R60 THRU R63
SWEEP TIME
STOP (R,R)
ADVANCE (R,R)
GATE (R,P)
AUTO RECYCLE
SINGLE CYCLE
RESET (R,R)
STEP ADVANCE
START (F,P)
RESET (R,P)
MONITOR 0-10 VDC
NEG OUTPUT (R,P)
POS OUTPUT (R,P)
100 mV (R,P) RECORDER OUT
10 mV (R,P)
START LEVEL 1K, 1T (R,R)
I.C. POWER SUPPLY
UNLESS OTHERWISE NOTED:
1. ALL NPN'S ARE 2N3643.
2. ALL PNP'S ARE 2N3638A.
3. ALL DIODES ARE IN4009.
4. ALL RESISTORS MARKED [*] ARE MF, 1%, 1/8 W.
5. ALL RESISTORS ARE IN OHMS.
6. ALL CAPACITORS ARE IN μF.
7. IC'S 14,15,16,17,18,19 ARE μL 914.
ORTEC INCORPORATED
100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 37830
MODEL 487
SPECTRUM SCANNER
RMV 12-21-69 TO BATES
NONE
487-0101-S1

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