

**Model 439**  
**Digital Current Integrator**  
**Operating Manual**

# **Advanced Measurement Technology, Inc.**

a/k/a/ ORTEC<sup>®</sup>, a subsidiary of AMETEK<sup>®</sup>, Inc.

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### **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, ORTEC must be informed, either in writing, by telephone [(865) 482-4411] or by facsimile transmission [(865) 483-2133], 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 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 designated 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 should follow the same procedure and ORTEC will provide a quotation.

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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 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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## SAFETY INSTRUCTIONS AND SYMBOLS

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

**DANGER** Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

**WARNING** Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

**CAUTION** Indicates a hazard that could result in property damage if the safety instruction is not observed.

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

In addition, the following symbol may appear on the product:



**ATTENTION – Refer to Manual**



**DANGER – High Voltage**

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

## SAFETY WARNINGS AND CLEANING INSTRUCTIONS

**DANGER** Opening the cover of this instrument is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

**WARNING** Using this instrument in a manner not specified by the manufacturer may impair the protection provided by the instrument.

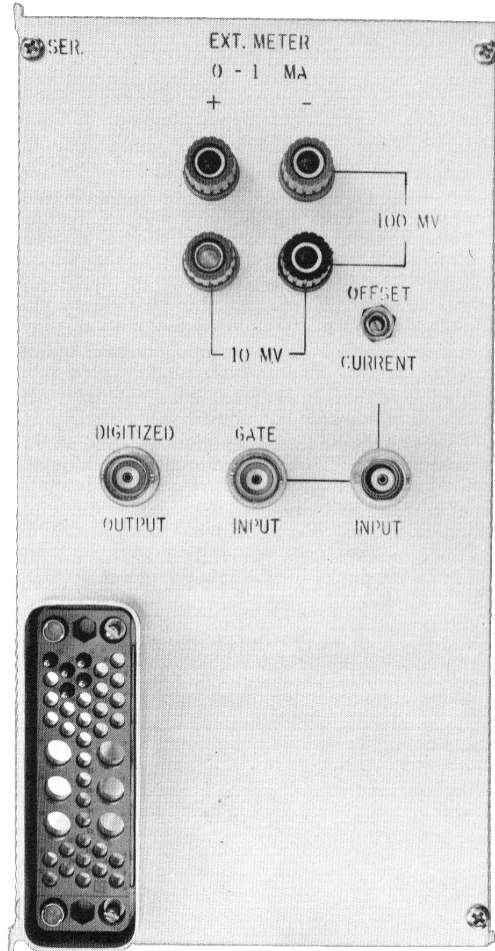
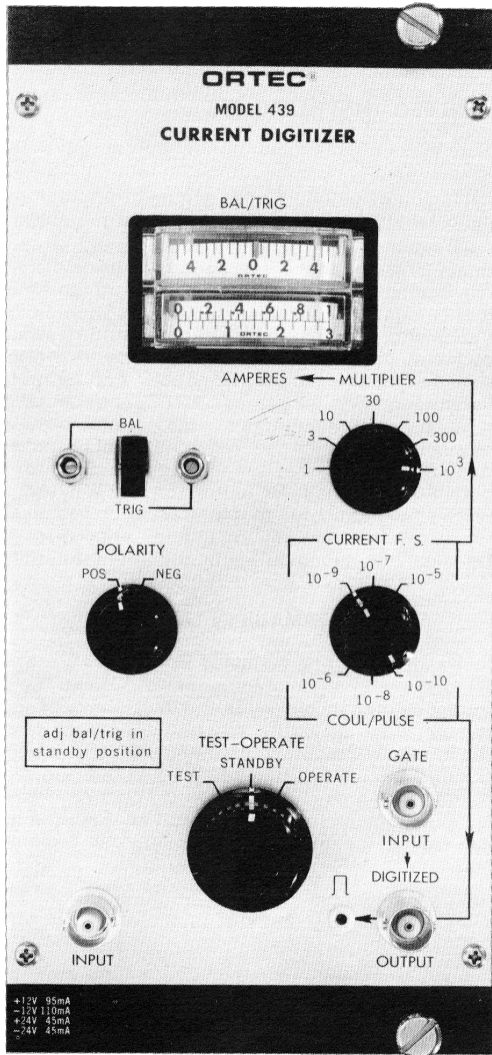
### Cleaning Instructions

To clean the instrument exterior:

- Unplug the instrument from the ac power supply.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

**CAUTION** To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

- Allow the instrument to dry completely before reconnecting it to the power source.



# 439 DIGITAL CURRENT INTEGRATOR

## 1. DESCRIPTION

The ORTEC 439 Digital Current Integrator\* was designed to accurately measure the direct current or the average value of pulse currents such as accelerator beam currents. The ORTEC 439 digitizes the input current by producing an output pulse for specific values of input charge. A front-panel switch permits the selection of three different amounts of charge ( $10^{-10}$ ,  $10^{-8}$ , or  $10^{-6}$  Coulomb) required to produce an output pulse. This gives the user the option of more than one count rate for a given input current. The instrument has a digitizing rate from 0–10 kHz to provide wide dynamic range on each setting and high-resolution readout without meter interpolation. When combined with a preset scaler such as the 431, this instrument forms a digital charge integrator. When it is combined with a

digital ratemeter such as the 434, a digital electrometer is obtained.

A front-panel meter is provided to read the input current. Full-scale analog outputs of 1 mA, 100 mV and 10 mV are provided on rear-panel binding posts. There are 15 ranges from  $1 \times 10^{-9}$  to  $1 \times 10^{-2}$  A for obtaining full-scale readings for the front-panel meter and the analog outputs.

BNC connectors are provided on the front and rear panels for the application of a gate signal to inhibit the digitized output. This gate may be used to remotely control the 439 or it may be used to inhibit the digitized output with the multichannel analyzer dead-time pulse.

## 2. SPECIFICATIONS

### 2.1. PERFORMANCE

**LEAKAGE IMPEDANCE FROM INPUT TO GROUND**  $>1 \times 10^{10} \Omega$ .

**INPUT LEAKAGE CURRENT**  $<1 \times 10^{-12}$ A.

**TEMPERATURE STABILITY** 0.05%/°C, 0 to 50°C.

**DIGITIZED OUTPUT ACCURACY**  $\pm 0.2\%$  of reading from 100 nA to 10mA dc; typical accuracy  $\pm 0.3\%$  of reading at 50 nA. Count rate on  $10^{-10}$  Coulomb/pulse range limited to 1kHz.

**DIGITIZED REPRODUCIBILITY** 0.01%.

**ANALOG ACCURACY** Front-panel meter, 2%; rear-panel binding posts, 1.5%.

### 2.2. CONTROLS

**INPUT CHARGE PER OUTPUT PULSE** Selectable by front-panel switch,  $10^{-10}$ ,  $10^{-8}$ ,  $10^{-6}$  Coulomb/pulse.

**TEST CURRENT** Selectable by front-panel switch; produces a digital output of  $\sim 1$  kHz on each Coulomb/pulse setting.

### 2.3. INPUTS

**SIGNAL INPUT** Through SHV connectors on front and rear panels.

- **Impedance** Virtually ground with maximum excursion of  $\leq \pm 5$ mV.
- **Current Polarity** Positive or negative.
- **Current Range**  $1 \times 10^{-9}$  to  $1 \times 10^{-2}$  A.

**GATE INPUT** Signal normally enabled in absence of an input or when the dc value is nominally +6V; BNC connectors on front and rear panels.

- **To Enable Output** +3 V or greater.
- **To Inhibit Output** +1.5 V or less (e.g., can be shorted to ground by a relay).
- **Maximum Input** +25 V, -10 V.

**Duty Cycle Limitation** None, dc-coupled.

**Input Impedance**  $>1000\Omega$ ; driving source must be capable of sinking 1 mA of current from a positive source.

\*Based on a design by F.M. Glass, ORNL. See F.M. Glass *et al.*, "A New Approach to Direct Current Integration," *IEEE Trans. Nucl. Sci.* NS-14 (1), 143-146 (February 1967).

## 2.4. OUTPUT

**DIGITIZED** Signal +5 V, 500 ns wide; 0 to 10 kHz; BNC connectors on front and rear panels.

### ANALOG

- **Front-Panel Meter** 0–1 and 0–3 scales serving all multiplier ranges; there are 15 full-scale ranges.
- **Rear-Panel Binding Posts** 0 to 1 mA full scale, 0 to 100 mV full scale, 0 to 10 mV full scale; there are 15 full-scale ranges.

## 2.5. PHYSICAL DATA

**POWER REQUIRED** +24 V, 45 mA; +12 V, 95 mA; -24 V, 45 mA; -12 V, 110mA.

**DIMENSIONS** NIM-standard triple-width module (4.05 in. Wide by 8.714 in. High) per TID-20893 (Rev.).

## 3. INSTALLATION

### 3.1. GENERAL

The 439, used in conjunction with the 4001A/4002A Bin and Power Supply, is intended for rack mounting; therefore any vacuum tube equipment operated in the same rack must be sufficiently cooled by circulating air to prevent any localized heating of the all-transistorized circuitry used throughout the 439. The temperature of equipment mounted in racks can easily exceed the recommended maximum temperature of 120°F (50°C) unless precautions are taken.

### 3.2. CONNECTION TO POWER

The 439 contains no internal power supply but must obtain necessary operating power from a Nuclear Standard Bin and Power Supply, such as the ORTEC 4001A/4002A. It is recommended that the Bin and Power Supply be turned off when modules are inserted or removed. The 400 Series is designed so that it is not possible to overload the Bin and Power Supply with a full complement of modules in the Bin; however, this may not be true when the Bin contains modules of other than ORTEC design, and in such instances Power Supply voltages should be checked after the modules are inserted. ORTEC 4001A/4002A has test points on the Power Supply control panel to monitor the dc voltages.

### 3.3. INPUT CONNECTION FOR DC CURRENT

Input SHV connectors are provided on the front and rear panels. To ensure maximum accuracy, the impedance of the current source should be kept as high as possible ( $>10^{10}\Omega$ ), even though the 439

dynamic input impedance is very low. The input varies less than 3 mV from ground during operation. This small voltage variation should present no leakage problems except in those cases where water-cooled target current is measured. The current source impedance ( $R_s$  in Fig. 1) required to make a 0.1% accuracy measurement can be calculated by the formula

$$R_s \geq \frac{3}{1}$$

For example, to measure 1  $\mu\text{A}$  to an accuracy of 0.1%, a source impedance of at least 3 M $\Omega$  is required. If a 1% accuracy were acceptable, R could be reduced to 300 k $\Omega$ . The following table may be helpful to determine the source impedance required to measure the current in your system. Be careful to avoid ground loops when installing the 439. If a coaxial cable is used to connect the current source to the input of the 439, it may be necessary to leave the cable shield ungrounded at the current source. Of course, it would be advantageous to locate the 439 as near as possible to the current source to avoid long ground returns.

### 3.4. INPUT CONNECTION FOR PULSED CURRENT

The beam current from many accelerators arrives in the target area as a pulsed beam, whose rate varies from the megahertz range to a few pulses per second. Problems could be encountered when



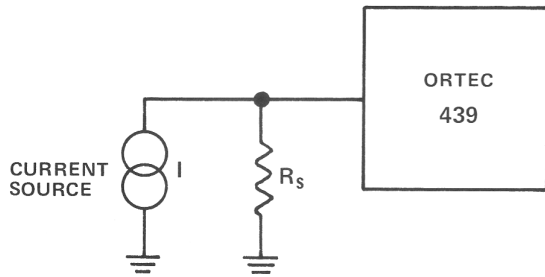


Fig. 1. Source Impedance Requirements.

high peak currents occur or when the charge in a beam current pulse exceeds one-tenth the amount selected by the Coulomb/pulse range selected on the 439. These problems can be overcome by adding a low leakage capacitor to the input of the 439. This capacitor will act as a storage element for the charge until the 439 can process it (see Section 5.1 for a functional description of the 439). If it becomes necessary to add a capacitor to the input when the  $10^{-6}$  Coulomb/pulse range is used, then 30 to 50 $\Omega$  should be added in series with the input of the 439 as shown in Fig. 2.

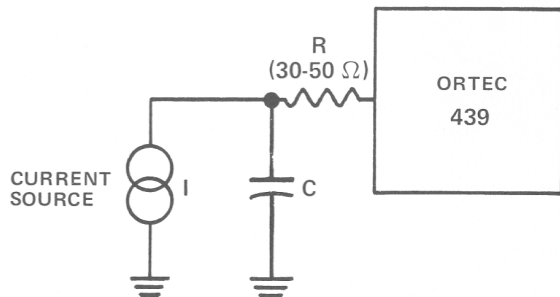


Fig. 2. Input Storage Network for  $10^{-6}$  Coulomb/Pulse Range.

Whenever practical, the value of C should be large enough so that the charge in each beam pulse does not create a voltage of more than 10 mV on C. For instance, if each beam pulse contained  $10^{-9}$  Coulomb of charge, the  $10^{-10}$  Coulomb/pulse range could be used on the 439 if a capacitor of the following size were added to the input:

$$C = \frac{Q}{V} = \frac{10^{-9}}{10^{-2}} = 0.1 \mu F$$

Of course, this assumes that the average current does not exceed the dynamic range of the  $10^{-10}$  Coulomb/pulse range.

### 3.5. CONNECTOR DATA

**INPUT SHV** connectors are provided on the front and rear panels for connection to the 439 input. SHV connectors are used because of their low-leakage characteristics. Care should be taken to keep the 439 input circuitry as clean as possible in order to prevent leakage paths to ground. The Test-Operate switch should be positioned to Standby before making connections to or from the input. Even though the input circuitry is protected against overvoltage, transients drive the input amplifier into saturation, producing a temporary imbalance in the input amplifier due to the long time required for the MOS-FET's to recover from overload.

**DIGITIZED OUTPUT** The output is dc-coupled and is provided on both the front and rear panels through BNC connectors. A standard logic pulse 5 V in amplitude and 500  $\mu s$  wide is produced each time the required amount of charge is received at the input. The width of this pulse can be altered as desired by changing the value of C15. The amplitude can be increased by increasing the value of R93.

**GATE INPUT** The gate input signal is connected to the 439 by front- and rear-panel BNC connectors. With no connection made to the gate input, the input voltage level is about +6 V and the gate will permit digital pulses to appear at the Digitized Output connector when an appropriate amount of charge is received at the input. When the gate input is pulled below +1.5 V, the digital output pulses are blocked and do not appear at the Digitized Output connector. To pull the gate input below +1.5 V, the driving circuit must be capable of absorbing 1 mA from the gate input circuit. The gate circuit will permit normal operation of the 439 when the gate input is at +3 V or greater.

## 4. OPERATING INSTRUCTIONS

### 4.1. TEST-OPERATE SWITCH

The Test-Operate is a three-position switch which controls the function of the instrument:

**STANDBY** This position grounds the input of the 439, preventing the application of transients to the input amplifier and should therefore be selected before applying power to the 439, making any connections to or from the Inputs connectors, or changing the Polarity or Current F.S. switches. This position must be selected when adjusting the input amplifier by use of the Bal and Trig potentiometers (see Section 4.3).

**OPERATE** This is the position in which the instrument will normally be used. In this position the input amplifier is connected to the input connectors (SHV's) on the front and rear panels.

**TEST** In this position an internal test current is provided to produce an output of approximately 1000 Hz on all Coulomb/pulse ranges. This current is not meant to be used as a calibration but merely as a reference test current once the unit has been calibrated.

### 4.2. POLARITY SWITCH

The polarity switch should be set to the polarity of the input current to be measured.

### 4.3. BAL/TRIG SWITCH

The Bal/Trig switch, in conjunction with the two front-panel screwdriver adjustment potentiometers, the Bal/Trig Meter and the Test-Operate switch, is used to balance and adjust the 439 input amplifier. Uninterrupted power should be applied to the 439 for approximately 20 min before the instrument is used. This is necessary because of the long-term drift characteristics exhibited by MOS-FET's. The following adjustments should be made on the 439 before it is used.

1. Set Test-Operate switch to Standby.
2. Set Bal/Trig switch to Bal.
3. Adjust Bal potentiometer to zero the Bal/Trig Meter.
4. Set Bal/Trig switch to Trig.
5. Adjust Trig potentiometer to zero the Bal/Trig Meter.
6. Set Bal/Trig switch to Bal; recheck meter zero.

Note: The accuracy of the 439 is not affected as long as the Bal and Trig adjustments are within  $\pm 4$  divisions of zero.

The adjustment of the input amplifier should be rechecked by placing the Test-Operate Switch to Standby each time the power is applied to the instrument and at convenient intervals.

### 4.4. CURRENT F.S. AND COULOMB/PULSE SWITCH

The Current F.S. and Coulomb/pulse switch controls the amount of charge that must be injected at the input to obtain a digital output pulse ( $10^{-10}$ ,  $10^{-8}$ , or  $10^{-6}$  Coulomb). The Coulomb/pulse range is read from the bottom side of the double-indicating knob on the switch. The top index of this knob in conjunction with the multiplier switch indicates the amount of current required at the input to produce a full-scale deflection on the ampere meter. Currents up to 1  $\mu$ A can be measured on the  $10^{-10}$  Coulomb/pulse range with 0.01% repeatability; however, the accuracy of the measurement may be in error by as much as 1% for currents ranging from 100 nA to 1  $\mu$ A. The  $10^{-8}$  Coulomb/pulse range should be used for accurate measurements of currents in this range. Inaccuracies begin to appear on the  $10^{-10}$  Coulomb/pulse range when the digitized output rates exceeds 1000 Hz.

### 4.5. MULTIPLIER SWITCH

The position of the Multiplier Switch determines the multiplier to be applied to the Current F.S. reading in order to produce a full-scale deflection on the Ampere Meter. The rear-panel analog outputs (0-10 mV, 0-100 mV, 0-1 mA) have the same current input requirements for full-range signals as the Ampere Meter and are affected in a similar manner by the Multiplier switch.

### 4.6. INTERNAL TEST CHECK

After power has been applied to the 439 for a few minutes and the Bal and Trig trim potentiometers have been adjusted properly, the test position on the Test-Operate switch should produce a digitized output rate of approximately 1000 Hz and a full-scale reading on the Ampere Meter when  $10^2$  is selected on the Multiplier switch.

#### 4.7. OFFSET CURRENT ADJ

A potentiometer is provided on the rear panel to adjust the input offset current over a range of approximately  $\pm 10$  pA. See Section 5.1.2 of this manual for the procedure to measure and adjust the input leakage current of the 439. The 439 input leakage current is adjusted to less than 1 pA at the factory and should not require additional adjustment.

#### 4.8. USE OF DIGITIZED OUTPUT

In order to take full advantage of the accuracy and versatility of the 439, the digitized output pulse must be counted by a scaler. Depending on the application, it may be desirable for this scaler to

have a preset time or scale capability, as does the ORTEC 431. This would permit integration for a preset time or until a preset quantity of charge is obtained. If it is desirable to know at what rate an event or process is occurring, then a scaler with an internal time base such as the ORTEC 434 or 715 is needed.

Even though the 439 was designed primarily to measure accelerator beam current, it performs equally well for measuring current or charge from any source. All that is required is a transducer which will convert the variable to be measured to a current or charge.

## 5. MAINTENANCE

### 5.1. TESTING PERFORMANCE

The following information on front-panel controls and testing procedures is intended as an aid in the installation and checkout of the 439.

#### 5.1.1. Test Equipment

The following or equivalent test equipment is needed:

- NIM Bin and Power Supply, ORTEC 4001A/4002A.
- Extender cable, ORTEC 401-C3.
- A current source with a known accuracy of better than 0.1%.

Note: If a voltage and a resistor are used to form a current source, the voltage source should have a value greater than 5 V. The accuracy of the 439 is 1000 ppm, which is better than the temperature and/or voltage coefficients of most high-value resistors.

- Counter with an internal time base.
- Oscilloscope.
- Schematic and block diagram of 439.

#### 5.1.2. Preliminary Procedures

1. Visually check the module for damage due to shipment.
2. Connect ac power to the Nuclear Standard Bin and Power Supply, ORTEC 4001A/4002A..

3. Plug module into Bin and check for proper mechanical alignment.
4. Switch on ac power and check the dc Power Supply voltage at the test points on the 401A control panel.
5. Set the 439 Test-Operate switch to Standby.

NOTE: The Test-Operate switch should be set to Standby at any time Bal and Trig adjustments are made or the polarity or current range is changed.

6. After uninterrupted power has been applied to the 439 for approximately 20 min, set Bal/Trig switch to Bal.
7. Adjust the Bal potentiometer to zero the Bal/Trig Meter.
8. Set the Bal/Trig switch to Trig.
9. Adjust the Trig potentiometer to zero the Bal/Trig Meter.
10. Set the Bal/Trig switch to Bal and recheck meter zero.

Note: The accuracy of the 439 is not affected as long as the Bal and Trig adjustments are within  $\pm 4$  divisions of zero; however, an attempt should be made to keep them adjusted to zero. During operation the Bal/Trig Meter will not necessarily indicate zero. No attempt should be made to adjust

the Bal or Trig until the Test-Operate switch is placed to the Standby position. The adjustment of the input amplifier should be rechecked at convenient intervals and each time power is applied to the instrument.

11. Set Coulomb/pulse switch to  $10^{-10}$ .
12. Set multiplier switch to  $10^2$ .
13. Set Test-Operate switch to Test.
14. Monitor the Digitized Output with a scaler. The digital rate should be approximately 1000 Hz, and the front-panel meter should read full scale with the Multiplier switch on  $10^2$ .
15. Using the precaution mentioned in the Note in Step 5, check the  $10^{-8}$  and  $10^{-6}$  Coulomb/pulse range on the Test position. A digital rate of approximately 1000 Hz should be obtained.
16. The input leakage current of the 439 can be checked by removing all connections from the input connectors, selecting the  $10^{-10}$  Coulomb/pulse range and setting the Test-Operate switch to the Operate position. If the Bal/Trig Meter moves to the right, Neg polarity should be selected. The output count rate should be less than 1 pulse per 100 s. If the leakage current is greater than 1 pulse per 100 s, it should be adjusted to zero with the Offset Current Adj potentiometer on the rear panel.
17. Check the calibration of the 439 by applying a known current to the input connector and measuring the digitized output rate.

Note: The 439 is calibrated at the factory on the  $10^{-10}$ ,  $10^{-8}$ , and  $10^{-6}$  Coulomb/pulse range for a positive current and the  $10^{-10}$  Coulomb/pulse range for negative current. If a negative current is measured on the  $10^{-8}$  or  $10^{-6}$  Coulomb/pulse range as calibrated at the factory, an error as large as 1% may be observed. These ranges can be calibrated for negative current by adjusting R2 and R5. Check Section 5.2 of this manual for calibration procedures.

## 5.2. CALIBRATION PROCEDURE

### 5.2.1. Digital

The  $10^{-10}$  Coulomb/pulse range is calibrated by adjusting the width of the pulse created by the pulse-shaping circuit. This pulse width is normally

about 44  $\mu$ s and is adjusted by R68 for positive and negative calibration. Calibration of the  $10^{-8}$  and  $10^{-6}$  Coulomb/pulse is accomplished by adjusting R2 and R5. Since a change in the width of the pulse from the pulse-shaping circuit affects the calibration of all ranges, the  $10^{-10}$  Coulomb/pulse range must be calibrated first. The polarity of the current to be measured in the experiment should be selected before calibrating the  $10^{-8}$  and  $10^{-6}$  Coulomb/pulse ranges. When calibrating the 439 it is desirable to apply a current to the input which will produce approximately the following count rates:

<u>Range (Coulomb/pulse)</u>	<u>Count Rate (Hz)</u>
$10^{-10}$	1000
$10^{-8}$	10000
$10^{-6}$	10000

Note: If a current source made from a high-value resistor and a voltage source is used, a minimum of 5V should be used across the resistor. Most high-value resistors have extreme voltage and/or temperature coefficients; so this should be taken into consideration.

The following steps should now be taken:

1. Set the Test-Operate switch to Standby.
2. Set the Multiplier switch to  $10^3$ .
3. Set the Bal/Trig switch to Bal.
4. Adjust Bal trim potentiometer to zero the Bal/Trig Meter.
5. Set the Bal/Trig switch to Trig.
6. Adjust the Trig trim potentiometer to zero the Bal/Trig Meter.
7. Connect the digitized output of the 439 to a scaler that has an internal time base.
8. Set the Coulomb/pulse switch to  $10^{-10}$ .
9. Set the Polarity switch to the polarity of the test current.
10. Connect a current source to the 439 input. (The desired value of this current source is 100 nA; this should produce a digitized output rate of 1000 Hz.)
11. Set Test-Operate switch to Operate.

12. Adjust trim potentiometer R68 to give the desired digitized output rate. Access to all calibration adjustments is available through the top cover of the 439.
13. Set the Test-Operate switch to Standby.
14. Connect a test current source of opposite polarity to the 439 input and check the calibration of the 439 for the opposite polarity.

The  $10^{-10}$  Coulomb/pulse range is now calibrated. The  $10^{-8}$  and the  $10^{-6}$  Coulomb/pulse range should be calibrated for the same polarity as the current to be measured in the experiment.

15. Set the Test-Operate switch to Standby.
16. Set the Coulomb/pulse switch to  $10^{-8}$ .
17. Set the Polarity switch to polarity of input test current.
18. Connect a test current (approximately 100  $\mu$ A) to the 439 input.
19. Set the Test-Operate switch to Operate.
20. Adjust the  $10^{-8}$  calibrate trim potentiometer to obtain the desired digitized output.
21. Set the Test-Operate switch to Standby.
22. Set the Coulomb/pulse switch to  $10^{-6}$ .
23. Connect a 10-mA test current to the 439 input.
24. Set the Test-Operate switch to Operate.
25. Adjust the  $10^{-6}$  calibrate trim potentiometer to obtain the desired digitized output.
26. Set the Test-Operate switch to Standby.

The digitized output of the 439 is now calibrated.

### 5.2.2. Analog

1. Set the Test-Operate switch to Standby.
2. Adjust the Bal and Trig trim potentiometers in steps 1 through 6 above.
3. Connect a digital voltmeter across the 100 mV terminals on the rear panel.

4. Connect the digitized output to a scaler with an internal time base.
5. If count rate is not zero, adjust the meter zero trim potentiometer until the digital voltmeter reads zero.
6. Connect a variable current source to the input. (A variable voltage source of zero to 25V and a 2.5 k $\Omega$  resistor in series with the 439 input may be used.)
7. Set the Polarity switch to the same polarity as the variable current source.
8. Set the Coulomb/pulse range switch to the proper range.
9. Set the Test-Operate switch to Operate.
10. Set the Multiplier switch to  $10^3$ .
11. Adjust the variable current source to obtain 10000 Hz digitized output rate.
12. Adjust the Multiplier calibrate potentiometer until the voltmeter reads 100 mV.
13. Adjust the variable current source until a digitized output rate of 3000 Hz is obtained.
14. Set the Multiplier switch to 300.

Digital voltmeter should read 100 mV with 1.5% tolerance.

15. Adjust the variable current source until the digitized output rate reads 1000 Hz.
16. Set the Multiplier switch to  $10^2$ .

Digital voltmeter should read 100 mV with 1.5% tolerance.

17. Adjust the variable current source until the digitized output rate is 300Hz.
18. Set the Multiplier switch to 30.

Digital voltmeter should read 100 mV with 1.5% tolerance.

19. Adjust the variable current source until the digitized output rate is 100 Hz.
20. Set the Multiplier switch to 10.

Digital voltmeter should read 100 mV with 1.5% tolerance.

21. Adjust the variable current source until the digitized output rate is 30 Hz.

22. Set the Multiplier switch to 3.

Digital voltmeter should read 100 mV  $\pm 1$  mV.

23. Adjust the variable current source until the digitized output rate is 10 Hz.

24. Set the Multiplier switch to 1.

Digital voltmeter should read 100 mV with 1.5% tolerance.

The analog portion of the 439 is now calibrated.

### 5.3. SUGGESTIONS FOR TROUBLESHOOTING

Set the Test-Operate switch to the Standby position and recheck the Bal and Trig adjustment following the procedure given in Section 4.3 of this Manual. If these adjustments cannot be made as described, the malfunctioning is in the input amplifier, A1, and the instrument should be returned to the factory for repair. If an attempt is made to repair the instrument locally, Sections 5 and 6.4 and the block diagram and schematic should be referred to.

After the Bal and Trig adjustments have been made, the Polarity and Current Range switches should be checked for proper settings. If pulsed current is being measured, refer to Section 3.4 for assistance. If further information is needed, contact the factory.

The testing instructions in Section 5.1 of this manual along with the voltage table in Section 5.5 should provide assistance in locating the region of trouble and repairing the malfunction. The guide plate and shield cover can be completely removed from the module to enable oscilloscope and voltmeter observations with a minimal chance of accidentally short-circuiting portions of the etched board.

### 5.4. FACTORY REPAIR

This instrument can be returned to the ORTEC factory for service and repair at a nominal cost. Our standard procedure for repair ensures the same quality control and checkout that are used for a new

instrument. Always contact the ORTEC Global Service Center, (865) 482-4411, before sending in an instrument for repair to obtain shipping instructions and so that the required Return Authorization Number can be assigned to the unit. Write this number on the address label and on the package to ensure prompt attention when it reaches the ORTEC factory.

### 5.5. TABULATED TEST POINT VOLTAGES ON ETCHED BOARD

The following voltages are intended to indicate the typical dc voltages measured on the etched circuit board. The voltages given here should not be considered as absolute values, but should merely be used as an aid in troubleshooting.

Notes:

1. All voltages were measured from ground with a voltmeter having an input impedance of 10 M $\Omega$  or greater.
2. Voltages are dc values with no current applied to the input.
3. Set the Test-Operate switch to Standby. Adjust the Bal and Trig trim potentiometers as stated in Section 4.3.
4. Set the Polarity switch to Positive.
5. Set the Coulomb/pulse range to 10<sup>-10</sup>.

Q1b	- 0.100	Q23e	- 0.500
Q2b	+ 0.100	Q26e	0
Q3e	-14.0	Q26c	+16.5
Q12b	- 8.9	Q27C	0
Q13b	- 8.9	Q28c	0
Q14e	0	Q29e	- 0.500
Q15e	0	Q31e	+ 0.600
Q16b	0	Q33e	- 12.08
Q17b	- 0.500	Q35e	0
Q19c	+22	Q37b	+ 2.7
Q20c	+ 0.1	Q37e	+ 3.3
Q22e	+ 2.0	Q39e	+ 2
Q21c	+ 1.2	Q40e	- 2
		Q43e	+ 12

**Bin/Module Connector Pin Assignments  
For Standard Nuclear Instrument Modules  
per DOE/ER-0457T.**

Pin	Function	Pin	Function
1	+3 V	23	Reserved
2	-3 V	24	Reserved
3	Spare bus	25	Reserved
4	Reserved bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 V
7	Coaxial	*29	-24 V
8	200 V dc	30	Spare bus
9	Spare	31	Spare
*10	+6 V	32	Spare
*11	-6 V	*33	117 V 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 V	38	Coaxial
*17	-12 V	39	Coaxial
18	Spare bus	40	Coaxial
19	Reserved bus	*41	117 V ac (neutral)
20	Spare	*42	High-quality ground
21	Spare	G	Ground guide pin
22	Reserved		

Pins marked (\*) are installed and wired in ORTEC's 4001A and 4001C Modular System Bins.

