FOREWORD

Congratulations and thank you for purchasing this instrument from Trek, Inc. You will find this to be a superior instrument which will give you long lasting and reliable performance.

ABOUT THE MANUAL

This manual is provided to assist you with the installation and operation of the instrument.

To take full advantage of the features and benefits of the instrument and protect your investment, we recommend that you take the time to read this manual.

CUSTOMER SERVICE

We invite you to call or write to our Customer Service Department with your comments and suggestions, both positive and negative. This gives us an opportunity to resolve any immediate concern of yours, and we can make changes to our product and service which will benefit all of our future customers, including yourself.

We offer several convenient ways for you to contact us.

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      P.O. Box 231
      Medina, N.Y. 14103

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SECTION I

GENERAL INFORMATION

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DANGER

This instrument is not explosion proof. DO NOT use it in an explosive environment. A catastrophic explosion could result.

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INTRODUCTION

The 610C is a high voltage amplifier/supply/controller with an output voltage range of 0V to ±10kV and an output current range of 0 to 2mA rms. It can be operated in any of six modes:

- As a high voltage amplifier,
  It amplifies an externally applied signal. Its gain is fixed at 1000V/V or 100V/V (switch selectable);

- As a high voltage reference supply,
  It responds to a front panel dial commanding an output voltage;

- As a transconductance amplifier,
  It responds to an externally applied (voltage) signal to produce a proportional output current. The transconductance gain is fixed at 200 uA/V or 20 uA/V (switch selectable);
-As a current supply,

It responds to a front panel dial commanding an output current;

-As a high voltage controller,

It is maintained as in the high voltage amplifier mode, but the input amplifier's input and feedback elements are uncommitted and available for configuration by the user;

-As a transconductance controller,

It is maintained as in the transconductance amplifier mode, but the input amplifier's input and feedback elements are uncommitted and available for configuration by the user.

Current monitors provide a means for close regulation of either the total load current or a specific current path (when the load includes several current paths, only one of which is to be closely regulated).

The (current) compliance limit function can be based upon either the total current or a specific current path.

By using class B drivers, the output stage is truly four-quadrant and is capable of sinking or sourcing the full rated current into reactive or resistive loads anywhere within its output voltage range.

The use of ultrafast current limiting devices make the 610C insensitive to overloads and short circuits.
SPECIFICATIONS

The 610C operates in three modes: SUPPLY, AMPLIFIER and CONTROLLER. The operating parameters vary according to the mode selected.

Voltage Supply Mode:

Output Ranges: 0V to ±10kV at ±2.0mA rms.
                0V to ±1kV at ±2.0mA rms.

Regulation:
  Line: better than 0.01% for a line change from 105V to 125V.
  Load: better than 0.01% for a load change from 1uA to 1,000uA.

Stability:
  Temperature: better than 0.01%/°C
               better than 0.01%/day
  Time:

Noise and Ripple: <0.7V rms ±0.001%/mA of load current.

Settling Time: <1.0 us to 0.1% for a step change of 10kV.

Slew Rate: >20V/us

Current Supply Mode:

Ranges: 0 to ±2.0mA at ±10kV.
         0 to ±200 uA at ±10kV.

Regulation:
  Line: better than 0.01% for a line change from 105V to 125V.
  Load: better than 0.01% for a load change from 10V to 10kV.

Stability:
  Temperature: better than 0.01%/°C.
                better than 0.01%/day.
  Time:

Noise and Ripple:
  I₁ mode: <17 uA rms ±0.001% for each 10kV change.
  Iᵣ mode: <17 uA rms ±0.001% for each 10kV change.
Settling Time:

$I_t$ mode: \(<20\text{ms to 0.1\% for a 1mA step change.}\)
$I_r$ mode: \(<1.0\text{ms to 0.1\% for a 1mA step change.}\)

Amplifier and Controller Modes:

Input Offset:

Voltage: \(\pm 2.0\text{V at the output.}\)
Current: \(\pm 50\text{pA maximum.}\)

Input Bias Current: \(\pm 100\text{pA maximum.}\)
Input Voltage Range: \(\pm 14\text{V maximum.}\)
Voltage Gain: \(1000\text{V/V or 100V/V (switch selectable)}\)
Transconductance Gain: \(200\text{ uA/V or 20 uA/V (switch selectable)}\)
CMRR: \(60\text{dB at 60Hz}\)

Offset Voltage Temperature Coefficient:
\(6\text{mV/°C over 0°C to 50°C operating range.}\)

Offset Current Temperature Coefficient:
\(0.02\text{ mA/°C over 0°C to 50°C operating range.}\)

Output range:

Voltage: \(0\text{ to }\pm 10\text{kV}\)
Current: \(0\text{ to }\pm 2\text{mA}\)

Noise and Ripple: \(<0.7\text{V rms }+0.001\%\text{/mA of load current.}\)
Output Capacitance: \(100\text{pF}\)

Bandwidth:

$I_t$ mode: \(12\text{ MHz gain-bandwidth-product.}\)
$I_r$ mode: \(600\text{ kHz gain-bandwidth-product.}\)
Slew Rate: \(0\text{V to }\pm 10\text{kV=20V/µs}\)
**Miscellaneous Specifications:**

**Compliance Ranges:**
- 100V to 10kV adjustable to within 20V while in the current modes.
- 2μA to 2mA adjustable to within 5 μA while in the voltage mode.

**Digital Display:**
- 3½ digit DC voltmeter
- 0.1%, ±1 digit accuracy selectable to monitor output voltage or output current.

**Monitor Outputs:**
- **Voltage:** 1 volt out per 1kV; 10 ohm output impedance
- **Current:** 5 volts out per 1mA; 1k ohm output impedance

**Power Requirements:**
- 100/110/220 VAC, 50-60Hz

**Dimensions:**
- 5.9” (148mm) H x 17.0” (431mm) W x 15.4” (390mm) D

**Weight:**
- 25 lbs. (12kg)
INCOMING CONFIDENCE TEST

The 610C undergoes extensive checks and adjustments at the factory and should require no initial calibration. However, you may wish to perform an incoming confidence test as part of the incoming inspection on the instrument. An incoming confidence test of this nature is intended to confirm that the instrument was not damaged in transit only.

Operating the instrument as a voltage supply and measuring the voltage at the $V_0$ OUTPUT MONITOR connector would constitute a reasonable incoming confidence test.

We recommend that you familiarize yourself with the information in Section II and Section III before performing this test.

WARNING: Do not plug in the 610C or turn it on until instructed to do so. An electrical shock could result if this precaution is not observed.

CAUTION: Before connecting the 610C to a power source, check that it is set for the proper nominal line voltage as discussed in POWER REQUIREMENTS on page II-1. This instrument may be damaged if operated at an incorrect line voltage.

**STEP 1.** Insure that the POWER switch and the high voltage switch are off before beginning this test.

**STEP 2.** Insure that the cap for the DIGITAL ENABLE receptacle is installed.
STEP 3. Plug the AC line cord into the AC line cord receptacle on the rear panel.

STEP 4. Plug the 610C into a power source.

WARNING: Make no attempt to bypass the ground prong in the AC line cord. This is a safety feature and any attempt to negate it could result in an electrical shock.

STEP 5. Preset the front panel controls as follows:

1. FUNCTION:
2. MODE:
3. COMPLIANCE Dial:
4. Polarity Selector Switch:
5. COMMAND/OFFSET Dial:
6. uA/kV Range Switch:

SUPPLY
V (Voltage)
Fully Clockwise
+
Fully Counterclockwise
0-10kV
STEP 6. Connect a digital voltmeter to the $V_o$ MONITOR OUTPUT receptacle on the rear panel.

STEP 7. Turn on the POWER switch.

CAUTION: Always wait a minimum of thirty seconds after turning on the POWER switch before turning on the high voltage switch.

STEP 8. Turn on the high voltage switch.

WARNING: The HV OUT connector carries high voltage. DO NOT touch the HV OUT connector or the load circuit while the 610C is operating. An electrical shock could result. Always turn off the high voltage switch before making changes to the load connection.
STEP 9. Turn the COMMAND/OFFSET dial fully clockwise. The digital voltmeter must indicate 10 volts.

This completes the incoming confidence test. Turn off the high voltage switch and the POWER switch. Disconnect the digital voltmeter.
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SECTION II

INSTALLATION

MOUNTING

The 610C is designed for operation as a tabletop instrument.

Trek offers a rack mounting adaptor, model 600RA, to mount this instrument in a standard 19-inch wide enclosure. Installation instructions are included with each rack adaptor.

CAUTION: The 610C is air cooled. Therefore, care must be taken to insure that the airflow is not impaired. Allow adequate free air space around the rear panel fan and the vent holes in the covers.

POWER REQUIREMENTS

The 610C may be damaged if operated at an incorrect line voltage.

Before connecting it to a power source, check that it is set for the proper nominal line voltage. The AC line cord connector includes a line voltage selector card. Insure that this card indicates the correct nominal line voltage for your area: 100, 120, 220 or 240 volts. If this card does not indicate the proper nominal line voltage for your area, remove it and reinstall it with the proper nominal line voltage in view.
AC LINE CORD CONNECTION

STEP 1: Insure that the POWER switch is off before connecting the AC line cord to a power source.

STEP 2: Plug the AC line cord into the AC line cord receptacle on the rear panel.

STEP 3: Plug the free end of the AC line cord into the power source.

WARNING: Make no attempt to bypass the ground prong in the AC line cord. This is a safety feature and any attempt to negate it could result in an electrical shock.
LOAD CONNECTION

A high voltage cable is provided for connection to the HV OUT receptacle. Connect the terminated end of this cable to the HV OUT receptacle; connect the free, unterminated end of this cable to the load device.

Return the low side of the load device to ground. See also "I_t/I_r/I_s EXPLAINED" on page III-26.

WARNING: The HV OUT connector carries high voltage. DO NOT touch the HV OUT connector or the load circuit while the 610C is operating. An electrical shock could result. Always turn off the high voltage switch before making changes to the load connection.
The 610C may be configured as a differential amplifier, as a noninverting amplifier or as an inverting amplifier. These different configurations are accomplished by variations in the wiring of the AMP INPUT plug.

A mating plug for the AMP INPUT receptacle is provided in the bag of accessory parts. The pins for this plug are also found in the bag of accessory parts.

The wires from the signal source must be attached to these pins before the pins are inserted into the plug. The pin numbers are embossed on the front and rear of the plug. Refer to these numbers when inserting the wired pins.

CAUTION: Once a pin is inserted into the plug, a special tool is required to remove it. Make every effort to install the pins properly the first time.
EXT CONTROL CONNECTION

Connect a switch (single pole, normally open) between pin #3 and pin #6 of the EXT CONTROL connector to remotely control the high voltage. This switch controls a 5-volt logic circuit which controls the high voltage circuit.

A mating plug for the EXT CONTROL receptacle is provided in the bag of accessory parts. The pins for this plug are also found in the bag of accessory parts.

Insert the wired pins from the remote high voltage switch into the pin receptacles #3 and #6 on the EXT CONTROL plug.

CAUTION: Once a pin is inserted into the plug, a special tool is required to remove it. Make every effort to install the pins properly the first time.
DIGITAL ENABLE CONNECTION

The DIGITAL ENABLE connection is made at the rear panel BNC connector which is labeled "DIGITAL ENABLE".

To control the 610C from a remote device, connect this input to ground through a switch or relay contact or, connect it to the output of a controlling device such as an open collector transistor or TTL gate.

When a remote enable/disable function is not required, connect the cap over the DIGITAL ENABLE receptacle. This shorts the input and allows the 610C to operate.
SECTION III
OPERATION

FRONT PANEL CONTROLS AND INDICATORS

Refer to the illustration on page III-3 for assistance in locating the front panel controls and indicators.

POWER Switch: This switch turns the 610C on and off. A green lamp above the POWER switch glows when the 610C is on.

HV (High Voltage) Switch: The HV (High Voltage) switch turns the high voltage on and off. A red lamp above this switch glows when the POWER and HV switches are properly actuated; the 610C is operational.

When this switch is placed in the REMOTE position, the high voltage is placed under the control of a remotely located switch (not furnished) which may be connected to a rear panel remote control connector.

FUNCTION Switch: This switch selects the mode of operation for the 610C: SUPPLY, AMPLIFIER OR CONTROLLER.

SUPPLY The 610C functions as an adjustable voltage or current supply.

AMPLIFIER The 610C generates an output voltage or current which is proportional to a (voltage) signal applied at a rear panel input receptacle.

CONTROLLER The 610C is maintained as in the amplifier mode, but the input and feedback elements of the input stage are left uncommitted and available for configuration by the user.
COMMAND/OFFSET Section

These controls select and control an output function: voltage, total load current (I_t) or returned current (I_r).

V/I Switch:  This switch selects either voltage (V) or current (I) as the output function to be regulated.

I_t/I_r Switch: This switch selects either total load current, I_t, or returned current, I_r, as the output function to be regulated (when the V/I switch is in the “I” position).

COMMAND/OFFSET Dial:  This dial is a ten-turn dial permitting precise adjustment of an output function.

It sets an output voltage or current when the 610C is operated in the SUPPLY mode; it sets an output offset voltage or current when the 610C is operated in the AMPLIFIER or CONTROLLER mode.

This dial has a lever at its base. This is a locking feature for the dial; it secures the dial against accidental misadjustment. Push up on the lever to disengage the lock; push down to engage the lock.

Polarity Switch:  This switch selects the polarity of the output voltage or current in the SUPPLY mode; it selects an offset voltage or current in the AMPLIFIER and CONTROLLER modes;

No output/offset voltages or currents can be set when this switch is placed in the “OFF” position.

uA/kV Range Switch:  This switch selects the output (voltage or current) range in the SUPPLY mode; it is used to set the amplifier gain and offset range when the 610C is operated in the AMPLIFIER or CONTROLLER mode.

1. It selects a 1kV or 10kV output voltage range when the 610C is operated as a voltage supply;

2. It selects a 200uA or 2000uA output current range when the 610C is operated as a current supply.

3. When the 610C is operated as a voltage amplifier:

   “0-1kV” position: Each full turn of the COMMAND/OFFSET dial represents 100 volts offset;

   “0-10kV” position: Each full turn of the COMMAND/OFFSET dial represents 1000 volts offset;

4. When the 610C is operated as a transconductance amplifier:

   “0-200uA” position: Each full turn of the COMMAND/OFFSET dial represents 20uA of offset;

   “0-2000uA” position: Each full turn of the COMMAND/OFFSET dial represents 200uA of offset;
5. When the 610C is operated as a voltage controller:

   a. The gain and maximum offset are a function of the user's configuration of the input amplifier;

   b. This switch selects a 10:1 scale factor for the offset voltage. The offset voltage range is ten times greater when this switch is in the “0-10kV” position than when it is placed in the “0-1kV” position;

6. When the 610C is operated as a transconductance controller:

   a. The gain and maximum offset are a function of the user’s configuration of the input amplifier;

   b. This switch selects a 10:1 scale factor for the offset current. The offset current range is ten times greater when this switch is placed in the “0-2000uA” position than when it is placed in the “0-200uA” position.
COMPLIANCE Section

The COMPLIANCE section consists of one switch, one dial and an indicator which control the compliance function.

COMPLIANCE Dial: The COMPLIANCE dial sets a compliance limit value; it sets a current limit value in the voltage mode or a voltage limit value in the current mode. This limit is effective for output voltages and currents of either polarity.

When setting a compliance current limit value (in the voltage mode), the compliance current may be set to any value within the range of 20uA to 2000uA. Each full turn of the COMPLIANCE dial represents a change of 200uA to the compliance current limit up to 2000uA for ten full turns.

When setting a compliance voltage limit value (in the current mode), the compliance voltage may be set to any value within the range of 100V to 10kV. Each full turn of the COMPLIANCE dial represents a change of 1kV to the compliance limit up to 10kV for ten full turns.

I_t/I_r LIMIT Switch: This switch selects either I_t or I_r to be limited using the COMPLIANCE dial. This switch is active only when the 610C is in the voltage mode.

COMPLIANCE LIMIT Lamp: An amber lamp glows when the 610C enters the compliance limit mode.

METER Section

The METER section includes a digital panel meter and three switches. The switches select functions and ranges for display; they in no way effect the operational model or range of operation of the 610C.

Digital Panel Meter: The digital panel meter displays the output voltage (V) or the output current (I_t or I_r).

V/I Switch: This switch selects either voltage (V) or current (I) as the parameter to be displayed on the digital panel meter.

I_t/I_r Switch: This switch selects either I_t or I_r for display when the V/I switch is in the “I” position.

uA/kV Range Switch: The uA/kV range switch selects the full scale range for the digital panel meter:

a. It selects a 1kV or 10kV full scale range when the V/I switch is in the “V” position;

b. It selects a 200uA or 2000uA full scale range when the V/I switch is in the “I” position.
REAR PANEL CONTROLS AND CONNECTORS

Refer to the illustration below for assistance in locating the rear panel controls and connectors.

**HV OUT:** This receptacle is for connection of the load device using the high voltage cable provided.

**AMP INPUT:** This receptacle is for connection of an external, low voltage signal source.

**$V_o$ MONITOR OUTPUT:** This output provides a low voltage analog of the signal at the HV OUT receptacle. The voltage at this connector is $1/1000$th of the voltage at the HV OUT receptacle.

**$I_o$ MONITOR OUTPUT:** This output provides a low voltage analog of the load current. The ratio of this output signal is 5 volts out for each 1mA of load current. The voltage at this connector is a representation of either $I_t/I_r$ according to the position of a rear panel $I_t/I_r$ Switch.

**$I_t/I_r$ Switch:** This switch selects either $I_t/I_r$ at the $I_o$ MONITOR OUTPUT.

![Rear Panel View](image)
Ir: This binding post is a return point for (ungrounded) loads to be closely regulated or monitored.

Is: This binding post is a return point for loads which are not to be included as components of either the returned current, Ir, or the total load current, It.

Ground Connector: This binding post is a ground reference point for other equipment and is a ground return point for loads to be monitored as part of the total current, It, and which need not be closely regulated as a component of the returned current, Ir.

EXT. CONTROL: This receptacle is for connection of an optional, remotely located high voltage control switch.

DIGITAL ENABLE: This receptacle is for connection of a control signal which enables and disables the high voltage.
OPERATING PROCEDURES

WARNING: The HV OUT connector carries high voltage. DO NOT touch the HV OUT connector or the load circuit while the 610C is operating. An electrical shock could result. Always turn off the high voltage before making changes to the load connection.

The 610C may be used in any one of six modes:

As a high voltage supply;
As a high voltage amplifier;
As a current supply;
As a transconductance amplifier;
As a high voltage controller;
As a transconductance controller.
HIGH VOLTAGE SUPPLY

When the 610C is operated as a high voltage supply, the operator sets an output voltage using the COMMAND/OFFSET dial.

To operate the 610C as a high voltage supply:

STEP 1. Preset the front panel controls as follows:

1. V/I (Mode) Switch:     V (Voltage)
2. COMPLIANCE Dial:      Fully Clockwise
3. FUNCTION:              SUPPLY

STEP 2.  Set the polarity switch to the desired position, “+” or “-”.

NOTE: The 610C will not produce an output voltage when the polarity switch is placed in the “OFF” position.

STEP 3.  Place the uA/kV (range) switch (which is in the COMMAND/OFFSET section) to the desired position: “0-1kV” for 1kV full scale or “0-10kV” for a 10kV full scale output.

STEP 4.  Set the COMMAND/OFFSET dial for the desired output voltage.
STEP 5. Turn on the POWER switch.

CAUTION: Always wait a minimum of thirty seconds after turning on the POWER switch before turning on the high voltage switch.

STEP 6. Turn on the High Voltage switch. The 610C is now operating as a high voltage supply and will deliver a voltage to the HV OUT as is commanded by the COMMAND/OFFSET dial.

WARNING: THE HV OUT connector carries high voltage. DO NOT touch the HV OUT connector or the load circuit while the 610C is operating. An electrical shock could result. Always turn off the high voltage switch before making changes to the load connection.
HIGH VOLTAGE AMPLIFIER

When the 610C is operated as a high voltage amplifier, a low voltage signal is applied to the AMP INPUT receptacle will generate a proportional output voltage.

To operate the 610C as a high voltage amplifier:

STEP 1. Connect the signal source to the rear panel AMP INPUT connector. See also “INSTALLATION INSTRUCTIONS: “Input Connection” on page II-4.

Input Voltage Range Considerations. The input voltage range is 0V to ±10V. Input voltages of higher magnitudes will place the output voltage out of its rated range of operation.

STEP 2. Preset the front panel controls as follows:

1. V/I (Mode) Switch: V (Voltage)
2. COMPLIANCE Dial: Fully Clockwise
3. FUNCTION Switch: AMPLIFIER
STEP 3. Set the polarity switch to the "OFF" position unless an offset voltage is to be introduced.

To produce an offset voltage:

a. Set the polarity switch for the polarity of the desired offset voltage, "+" or "-".

b. Set the uA/kV (range) switch in the COMMAND/OFFSET section to the desired position:

Set it to the "0-1kV" position to introduce an offset voltage at the rate of 100 volts per turn of the COMMAND/OFFSET dial (up to 1kV volts for ten full turns of the COMMAND/OFFSET dial).

Set it to the "0-10kV" position to introduce an offset voltage at the rate of 1000 volts per turn of the COMMAND/OFFSET dial (up to 10kV for ten full turns of the COMMAND/OFFSET dial).

c. Use the COMMAND/OFFSET dial to set a specific offset voltage.

STEP 4. Turn on the POWER switch.

CAUTION: Always wait a minimum of thirty seconds after turning on the POWER switch before turning on the high voltage switch.
STEP 5. Turn on the High Voltage switch. The 610C is now operating as a high voltage amplifier and a voltage applied to the AMP INPUT is amplified by 100 or 1000 according to the position of the uA/kV switch in the COMMAND/OFFSET section of the front panel.

WARNING: The HV OUT connector carries high voltage. DO NOT touch the HV OUT connector or the load circuit while the 610C is operating. An electrical shock could result. Always turn off the high voltage switch before making changes to the load connection.
CURRENT SUPPLY

When the 610C is operated as a current supply, the operator sets an output current using the COMMAND/OFFSET dial.

To operate the 610C as a current supply:

STEP 1. Preset the front panel controls as follows:

1. V/I (Mode) Switch: I (Current)
2. COMPLIANCE Dial: Fully Clockwise
3. FUNCTION Switch: SUPPLY

STEP 2. Set the polarity switch to the desired position, "+" or "-".

NOTE: The 610C will not produce an output voltage when the polarity switch is placed in the "OFF" position.

STEP 3. Place the \( I_{t} \)/\( I_{f} \) switch (which is in the COMMAND/OFFSET section) in the desired position. "\( I_{t} \)" to closely regulate total load current or "\( I_{f} \)" to closely regulate the load path which is returned to the \( I_{f} \) terminal on the rear panel.

STEP 4. Place the \( uA/kV \) (range) switch (in the COMMAND/OFFSET section) to the desired position.

STEP 5. Set the COMMAND/OFFSET dial for the desired output current.
STEP 6. Turn on the POWER switch.

CAUTION: Always wait a minimum of thirty seconds after turning on the POWER switch before turning on the high voltage switch.

STEP 7. Turn on the High Voltage switch. The 610C is now operating as a current supply and will deliver a current to the high voltage output as in commanded using the COMMAND/OFFSET dial.

WARNING: The HV OUT connector carries high voltage. DO NOT touch the HV OUT connector or the load circuit while the 610C is operating. An electrical shock could result. Always turn off the high voltage switch before making changes to the load connection.
TRANSCONDUCTANCE AMPLIFIER

When the 610C is operated as a transconductance amplifier, a low voltage signal applied to the rear panel AMP INPUT receptacle will generate a proportional output current.

To operate the 610C as a transconductance amplifier:

**STEP 1.** Connect the signal source to the AMP INPUT connector.

*Input Voltage Range Considerations.* The input voltage range is 0V to ±10V. Input voltages of higher magnitudes will place the output current out of its range of operation.

**STEP 2.** Preset the front panel controls as follows:

1. V/I (Mode) Switch: I (Current)
2. COMPLIANCE Dial: Fully Clockwise
3. FUNCTION: AMPLIFIER
STEP 3. Place the $I_l/I_T$ switch (in the COMMAND/OFFSET section) in the desired position: $I_l$ to closely regulate total load current or $I_T$ to closely regulate to load path which is returned to the $I_T$ terminal on the rear panel.

STEP 4. Set the polarity switch to the “OFF” position unless an offset current is to be introduced.

To produce an offset current:

a. Set the polarity switch for the desired polarity of the offset current, “+” or “−”.

b. Set the uA/kV (Range) switch in the COMMAND/OFFSET section to the desired position:

Set it to the “0-200uA” position to introduce an offset current at the rate of 20uA per turn of the COMMAND/OFFSET dial (up to 200uA for ten full turns of the COMMAND/OFFSET dial).

Set it to the “0-2000uA” position to introduce an offset current at the rate of 200uA per turn of the COMMAND/OFFSET dial (up to 2000uA for ten full turns of the COMMAND/OFFSET dial).

c. Use the COMMAND/OFFSET dial to set a specific offset current.

![Diagram of switch positions]

STEP 5. Turn on the POWER switch.

CAUTION: Always wait a minimum of thirty seconds after turning on the POWER switch before turning on the high voltage switch.
STEP 6. Turn on the High Voltage switch. The 610C is now operating as a transconductance amplifier and an output current is generated which is proportional to the input voltage (20μA/V or 200μA/V, depending upon the position of the μA/kV range switch in the COMMAND/OFFSET section of the front panel.

WARNING: The HV OUT connector carries high voltage. DO NOT touch the HV OUT connector or the load circuit while the 610C is operating. An electrical shock could result. Always turn off the high voltage switch before making changes to the load connection.
HIGH VOLTAGE CONTROLLER

This mode is similar to the high voltage amplifier mode, the input amplifier's input and feedback elements are configured to produce a different, user specified output function, such as operation with a different voltage gain, or operation as a differentiator, integrator or phase shifter.

To operate the 610C as a high voltage controller:

**STEP 1.** Connect the signal source to the rear panel AMP INPUT connector.

*Input Voltage Range Considerations.* The input voltage range is dependent upon the user's application. However, the maximum allowable input voltage is ±10V.

**STEP 2.** Preset the front panel controls as follows:

1. V/I (Mode) Switch: V (Voltage)
2. COMPLIANCE Dial: Fully Clockwise
3. FUNCTION Switch: CONTROLLER
STEP 3. Set the polarity switch to the "OFF" position unless an offset voltage is to be introduced.

To produce an offset voltage:

a. Set the polarity switch for the polarity of the desired offset voltage, "+" or "-".

b. Set the uA/kV (range) switch in the COMMAND/OFFSET section to the desired position:

   Set it to the "0-1kV" position to introduce an offset voltage at the rate of 100 volts per turn of the COMMAND/OFFSET dial (up to 1kV for ten full turns of the COMMAND/OFFSET dial).

   Set it to the "0-10kV" position to introduce an offset voltage at the rate of 1000 volts per turn of the COMMAND/OFFSET dial (up to 10kV for ten full turns of the COMMAND/OFFSET dial).

c. Use the COMMAND/OFFSET dial to set a specific offset voltage.

![Diagram of control panel]

STEP 4. Turn on the POWER switch.

CAUTION: Always wait a minimum of thirty seconds after turning on the POWER switch before turning on the high voltage switch.
STEP 5. Turn on the High Voltage switch. The 610C is now operating as a high voltage controller.

WARNING: The HV OUT connector carries high voltage. DO NOT touch the HV OUT connector or the load circuit while the 610C is operating. An electrical shock could result. Always turn off the high voltage switch before making changes to the load connection.
TRANSCONDUCTANCE CONTROLLER:

This mode is similar to the transconductance amplifier mode, however, the input amplifier’s input and feedback elements are configured to produce a different, user-specified output function, such as a different transconductance gain.

To operate the 610C as a transconductance controller:

STEP 1. Connect the signal source to the AMP INPUT connector.

Input Voltage Range Considerations. The input voltage range is dependent upon the user’s application. However, the maximum allowable input voltage is ±10V.

STEP 2. Preset the front panel controls as follows:

1. V/I (Mode) Switch
2. COMPLIANCE Dial:
3. FUNCTION:
   I (Current)
   Fully Clockwise
   CONTROLLER
STEP 3. Place the $I_t/I_r$ in the COMMAND/OFFSET section) in the desired position. "$I_t$" to closely regulate total load current or “$I_r$” to closely regulate the load path which is returned to the $I_r$ terminal on the rear panel.

STEP 4. Set the polarity switch to the “OFF” position unless an offset current is to be introduced.

To produce an offset current:

a. Set the polarity switch to the polarity of the desired offset current, “+” or “-”.

b. Set the uA/kV (range) switch in the COMMAND/OFFSET section to the desired position:

   Set it to the “0-200uA” position to introduce an offset current at the rate of 20uA per turn of the COMMAND/OFFSET dial (up to 200uA for ten full turns of the COMMAND/OFFSET dial).

c. Use the COMMAND/OFFSET dial to set a specific offset current.

STEP 5. Turn on the POWER switch.

CAUTION: Always wait a minimum of thirty seconds after turning on the POWER switch before turning on the high voltage switch.
STEP 6. Turn on the High Voltage switch. The 610C is now operating as a transconductance controller.

WARNING: The HV OUT connector carries high voltage. DO NOT touch the HV OUT connector or the load circuit while the 610C is operating. An electrical shock could result. Always turn off the high voltage switch before making changes to the load connection.
THE COMPLIANCE FUNCTION

The compliance function sets a current limit point when controlling voltage, and it sets a voltage limit point when controlling current.

This feature is used to limit the output of the 610C to within a safe operating range for the load device. For example, when in the current (I) mode, voltage can be limited so as not to exceed the voltage rating of the load device. When in the voltage (V) mode, current can be limited so as not to exceed the power dissipation capabilities of the load device.

Setting a Current Limit in the Voltage (V) Mode:

The compliance limit point is set to any value in the range of 20uA to 2000uA using the COMPLIANCE dial. This limit point is effective for output currents of either polarity. Each full turn of the COMPLIANCE dial represents a change of 200uA to the compliance limit point.

The $I_{l1}/I_{r}$ switch in the COMPLIANCE section selects either $I_{l1}/I_{r}$ as the current to be limited by the COMPLIANCE function.

For example, if the 610C is set up for an output voltage of 500V and the COMPLIANCE dial is set for a 700uA current limit, and it is driving a 1M ohm load, then 500uA of current flows through the load. This does not exceed the current limit value set on the COMPLIANCE dial and the output voltage is not restricted.

\[
\begin{align*}
500\text{uA} \\
500\text{V} & \quad 1\Omega \\
I &= \frac{E}{R} = \frac{500\text{V}}{1\Omega} = 500\text{uA}
\end{align*}
\]

However, if we apply the same 500V to a 600k ohm load, the load current would be 833uA. This output current exceeds the current limit value (700uA) set on the COMPLIANCE dial;

\[
\begin{align*}
833\text{uA} \\
500\text{V} & \quad 600\text{k}\Omega \\
I &= \frac{E}{R} = \frac{500\text{V}}{600\text{k}\Omega} = 833\text{uA}
\end{align*}
\]

The 610C automatically restricts the output voltage to 420V to hold the output current at the compliance limit (700uA).

\[
\begin{align*}
700\text{uA} \\
420\text{V} & \quad 600\text{k}\Omega \\
E &= IR = (700\text{uA})(600\text{k}\Omega) = 420\text{V}
\end{align*}
\]

III-24 610C Cor-a-trol
Setting a Voltage Limit in the Current (I) Mode:

The compliance limit point is set to any value in the range of 0V to 10kV using the COMPLIANCE dial. This limit point is effective for output voltages of either polarity. Each full turn of the COMPLIANCE dial represents a change of 1kV to the compliance limit point.

For example, if the 610C is set up for an output current of 500uA and the COMPLIANCE dial is set for a 2000V voltage limit, and it is driving a 3M ohm load, then 1500V is required to drive 500uA of current through the load. This does not exceed the voltage limit set on the COMPLIANCE dial and the output voltage is not restricted.

\[ E = IR = (500\mu A)(3M\Omega) = 1500V \]

However, 2500V is required to drive the same 500uA into a 5M ohm load. This exceeds the voltage limit value (2000V) set on the COMPLIANCE dial;

\[ E = IR = (500\mu A)(5M\Omega) = 2500V \]

The 610C automatically restricts the output voltage to the 2000V compliance limit value.

\[ I = \frac{E}{R} = \frac{2000V}{5M\Omega} = 400\mu A \]
**I_t/I_r/I_s EXPLAINED**

Current flowing from the high voltage output to the load may be returned to the 610C by one of three paths which are offered in this instrument to enhance its usefulness.

These three return paths for the load current are:

1. The rear panel I_s terminal;
2. The rear panel I_r terminal;
3. The instrument grounds (including the power line ground, the chassis and the rear panel ground terminal).

I_r (returned current) refers to the load current which is returned to the 610C through the rear panel I_r terminal. This current is monitored separately from other return current paths and provides a means for close regulation or monitoring of a specific (ungrounded) load path using the I_t/I_r switches. I_r current is a component of total load current, I_t.

I_t (total load current) refers to all of the load current which is returned to the 610C except those load currents which are returned to the I_s terminal. Total load current, I_t, is monitored by the 610C and provides a means for close regulation and monitoring of the total load current using the I_t/I_r switches.

The I_s (shield current) terminal was originally included as a termination point for corotron shield currents. The I_s terminal is used to terminate load current paths which are not to be monitored or controlled as a component of the total load current. I_s currents bypass all features for current monitoring and are not detected by the circuits which monitor the “total” load current, I_t.

A common misunderstanding in the use of the I_s terminal occurs when the sum of the I_t current and the I_s current exceeds the current sourcing capability of the high voltage output. As the 610C's output current is regulated on the basis of the monitored current, I_t or I_r, it is possible for the additional I_s current to take the instrument out of (current) regulation. Under these conditions the output current capability of the 610C is exceeded, although this condition is not apparent by monitoring the meter or the current monitor output.
SECTION IV

MAINTENANCE

SAFETY

Observe the following safety precautions when performing maintenance procedures on the 610C:

1. Hazardous voltages exist within the instrument enclosure. Always turn off the 610C and disconnect it from its power source before cleaning or inspecting it. Failure to observe this precaution could result in an electrical shock.

   Hazardous voltages are present at the vacuum tube assemblies even after power has been removed. To prevent electrical shocks, take care not to touch the vacuum tube assemblies.

2. Allow a cool-down period to reduce the danger of burns from heated parts such as transistors and heat sinks.

3. Refer all maintenance procedures to qualified personnel.
FACTORY ASSISTANCE

Customer Service Assistance

In the event that you require assistance on a maintenance item, direct your request for assistance to the customer assistance department at Trek, Inc.

Telephone assistance is usually effective for obtaining additional maintenance information which is beyond the scope of this manual. Troubleshooting advice which is given over the telephone may be useful for solving the simpler malfunctions or confirming that the instrument should be returned to the factory or to an authorized service organization for repair.

Factory Repairs

The terms and conditions of the warranty are given in the warranty which is found at the beginning of this manual.

CAUTION: The warranty is voided if the instrument is serviced within the warranty period by anyone other than Trek, Inc. or one of their authorized service organizations.

In the event of a malfunction, and the instrument must be returned to the factory for repair:

a. Notify the customer service department at Trek, Inc., giving full details about the difficulty, including the model number and serial number of the instrument; obtain a return authorization number, which will be issued by the customer service department.

b. If a return authorization number is issued, forward the instrument (prepaid), with the return authorization number prominently displayed on the shipping container and the packing list, to Trek, Inc. for repair.

If we determine that the malfunction is not covered by the terms and conditions of the warranty, an estimate will be submitted for customer approval before the commencement of repairs.

PREVENTATIVE MAINTENANCE

Preventative maintenance consists of inspecting and cleaning the instrument. Preventative maintenance performed on a regular basis may prevent instrument failure and improve reliability.

ACCESS. Remove the top cover to expose all assemblies for inspection and cleaning.

INSPECTION. Visually inspect the instrument for loose or damaged components or other undesirable conditions such as heat-damaged parts.

CLEANING. Clean the 610C as operating conditions require. Dust and dirt on components act as an insulating blanket and prevent efficient heat dissipation. This can cause overheating and component failure.

Dust and dirt also provide an electrical conduction path which can result in instrument failure, especially under conditions of high humidity which can cause arcing in the high voltage sections.

Use dry, low pressure compressed air to blow the accumulated dust and dirt from the interior of the instrument. Use a brush to dislodge dirt and dust which is not readily dislodged by the compressed air.

Clean the exterior of the instrument with an equal part solution of denatured alcohol and water. The use of stronger solvents may damage the finish or plastic components. A small brush is effective in removing dirt from the front and rear panel controls and connectors.
SERVICING THE MAIN FUSE

Refer servicing of the fuse to qualified personnel. The fuse is contained in a fuseholder which is integral to the AC line cord receptacle on the rear panel. This is the only fuse.

Always replace the fuse with a new fuse of the same rating. The fuse required for the 610C is a type 3 AG. TABLE 1 gives the fuse requirements for the various nominal line voltages.

<table>
<thead>
<tr>
<th>LINE VOLTAGE</th>
<th>FUSE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 VAC</td>
<td>1A SLO-BLO</td>
</tr>
<tr>
<td>115 VAC</td>
<td>1A SLO-BLO</td>
</tr>
<tr>
<td>230 VAC</td>
<td>1/2A SLO-BLO</td>
</tr>
</tbody>
</table>

STEP 1. Unplug the AC line cord from the power source before attempting to change the fuse.

WARNING: NEVER attempt to service the fuse when the instrument is plugged into the power source. An electrical shock could result.

STEP 2. Unplug the AC line cord from the AC line cord receptacle on the rear panel.

STEP 3. Slide the plastic cover over the fuse holder to the left to expose the fuse.

STEP 4. The fuse is removed by pulling the FUSE PULL lever to the left.

If the instrument continually blows fuses, a more serious problem probably exists within the instrument. In this instance, contact the customer service department at Trek, Inc. and request instructions.
SERVICING THE INTERNAL FUSE

If the power LED and the high voltage LED are illuminated but there is no output, the internal power supply protection fuse may be blown. This fuse is located on the 610B-3001 PCB. (See illustrations to the right.)

Refer servicing this fuse to qualified personnel.

STEP 1. Unplug the AC line cord from the power source before attempting to service the fuse.

WARNING: NEVER attempt to service the fuse when the instrument is plugged into the power source. An electrical shock could result.

STEP 2. Remove the top cover of the 610C.

STEP 3. Locate the fuse on the 610B-3001 PCB and remove. The fuse pulls directly out of its socket.

STEP 4. Replace the blown fuse with a new fuse of the same value. The fuse required on the 610B-3001 PCB is a 1.5 A, 125 V fast-acting microfuse such as the Littlefuse Series 273.

STEP 5. Replace the top cover of the 610C.

If the instrument continually blows fuses, a more serious problem probably exists on the 610B-3001 PCB. In this instance, contact the customer service department at Trek, Inc. and request instructions.