OPERATOR'S MANUAL

MODEL 615-3

High-Voltage

AC/DC Generator

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Thank You

Thank you for buying a Trek instrument. This instrument has been designed and built to high standards to give you years of trouble-free service.

If you have any questions, please feel free to contact your Trek Representative at:

Write:	TREK, INC. 11601 Maple Ridge Road Medina, NY 14103-9710	
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We welcome any comments or suggestions you may have relative to the operation, performance, and/or quality of this product.

Trek products are covered by United States and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specifications are subject to change without notice.

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Safety

Review the following safety precautions to maintain safety and prevent damage to the instrument or equipment connected to it.

The safety features of this instrument may be ineffective if the equipment is not operated in the manner stated in this manual.

Refer all maintenance procedures to qualified personnel.

Safety Precautions

Use the Power Cord Provided

To avoid fire hazard, use only the power cord provided with this instrument.

Avoid Electric Overload

To avoid electric shock or fire hazard, do not apply a voltage to a terminal that is outside the range specified for that terminal.

Avoid Electric Shock

To avoid electric shock, do not touch the high-voltage output connector or the load circuit while the instrument is on.

Ground the Product

This product is electrically grounded through the ground conductor of the power cord. To avoid electric shock, the ground conductor must be connected to earth ground. Before making connections to the input and output terminals of the product, ensure that the product is properly grounded.

Safety Precautions (cont.)

Do Not Operate Without Covers

To avoid electric shock or fire hazard, do not operate this instrument with the covers removed.

Use Proper Fuses

To avoid fire hazard, use only the fuse type and rating specified for this instrument.

Indoor Use Only

This instrument is intended for indoor use only.

Do Not Operate in Wet or Damp Conditions

To avoid electric shock, do not operate this instrument in wet or damp conditions.

Do Not Operate in an Explosive Environment

To avoid injury or fire hazard, do not operate this instrument in an explosive environment.

Product Protection Precautions

Use the Proper Power Source

Do not operate this instrument from a power source that is different than the voltage specified on the serial number tag.

Provide Proper Ventilation

To prevent the instrument from overheating, provide proper ventilation.

Do Not Operate with Suspected Failures

If you suspect there is damage to this instrument, have it inspected by qualified personnel.

Safety Terms and Symbols

Terms in the Manual

These terms may appear in this manual:

Warning: Warning statements identify conditions or practices that could result in injury or loss of life.

Caution: Caution statements identify conditions or practices that could result in damage to this product or other equipment.

Symbols on the Product

These symbols may appear on the instrument:

Warning, risk of electric shock

Caution, refer to Operator's Manual

CAT I Installation category I (overvoltage category): Classification for the operation of a unit using voltage systems or circuits with required standardized limits for transient voltages. Category I pertains to voltages supplied at the peripheral level, with smaller tolerances for transient voltages as specified by the Low-Voltage Safety standard (EN 61010-1).

CAT II Installation category II (overvoltage category): Classification for the operation of a unit using voltage systems or circuits with required standardized limits for transient voltages. Category II pertains to using voltage supplied on the local level (example: local wall outlets) with smaller tolerances for transient voltages as specified by the Low-Voltage Safety standard (EN 61010-1).

CE This symbol refers to the compliance of the equipment to the European Council (E.C.) standards.

Preface

This manual provides user information for the Model 615-3 High-Voltage AC/DC Generator. It contains the following chapters and appendixes:

- ***Introduction*** contains a brief product description and an incoming confidence test that can be used to verify the instrument was not damaged during transit.
- ***Installation*** describes how to set up the instrument for operation. Information is included on mounting the instrument, the load connection, and the various input and output connections.
- ***Operation*** contains a description of the product's features and a detailed explanation of proper operating procedures.
- ***Specifications*** states the requirements, behavior, and the performance of the instrument in a concise format.
- ***Maintenance*** provides information on periodic maintenance procedures and fuse replacement.
- ***Appendix A: Accessories*** describes other products that are useful with the Model 615-3.
- ***Appendix B: Warranty Statement*** contains the terms and conditions of the Trek Warranty.
- ***Appendix C: Authorized Sales Organizations*** contains contact information for Trek sales organizations throughout the world.
- ***Appendix D: Authorized Service Organizations*** contains contact information for Trek service organizations throughout the world.

Section I Introduction

Danger: *This instrument is not rated for use in an explosive environment. DO NOT use it in an explosive environment or an explosion may result.*

This manual provides instructions to install and operate the Trek Model 615-3 High-Voltage AC/DC Generator.

We recommend you take the time to read this manual to take full advantage of the features and benefits of the instrument.

Introduction

The Model 615-3 is a high-voltage, AC/DC generator and amplifier specifically designed to provide the AC and DC operating bias and control voltages necessary to operate an electrophotographic charge roller for production and/or research applications.

The Model 615-3 has three major modes of operation: a Constant AC Voltage mode, a Constant AC Current mode, and a voltage Amplifier mode.

A DC voltage bias is adjustable from 0 to 10 kV and can be introduced as a constant DC offset voltage into any signal output in all three modes of operation. In addition, the model 615-3 has many extra features to adjust and control the output voltage and output current.

These features include:

Internal function generator to produce square, sine, or triangle AC output
Voltage limit setting
DC current limit control
Constant current mode range selection switch
Digital panel meter for indicating AC voltage and current levels
Digital panel meter for indicating DC voltage and current levels
I(s) terminal ground post for shield connection of high voltage wiring
Overload and compliance indication

Many of the Model 615-3 features can be controlled remotely through a 25 pin “D” socket connector on the back panel. Voltage and current values can be read by front panel displays or through rear panel buffered outputs providing low-voltage representations of the load current and the high-voltage output.

Introduction (cont.)

AC Generator Mode Operation (Constant AC Voltage or Constant AC Current)

For operation in the AC GENERATOR mode (either Constant AC Voltage or Constant AC Current) the Model 615-3 employs a precision technique for obtaining a feedback signal which is representative of the output quantity (either output voltage or output current) to be measured and controlled.

This technique employs full wave demodulation of either the divided down (1000 to 1 divider) output voltage signal or the output current signal derived from the HV power supply return line. These demodulated signals are then processed through a frequency tracking low-pass filter to obtain a DC signal which is then scaled to represent either the peak-to-peak value of sine, triangle, or square voltage waveforms, or scaled to represent the average of the current waveforms where:

$$\text{AC current average} = \frac{(2)\ I_{peak}}{3.14}$$

The demodulator's filtered and scaled feedback signals are compared against a set-point reference value to precisely obtain an output AC voltage or AC current, proportional to the set-point value. The set point values are calibrated in units of peak-to-peak voltage values or values of current. Please see the OPERATIONAL BLOCK DIAGRAM of Figure 1 on page 1-4.

For Square waveform AC generator operation, additional issues need to be considered. Please see "Special Consideration For Square Wave Operation for Constant AC voltage and Current Modes" on page III-17.

Constant AC Voltage Mode

In the CONSTANT AC VOLTAGE mode, the output AC voltage value is commanded/controlled over a range of 0 to 10 kV peak-to-peak by use of 0 to +10 V front panel precision potentiometer or a 0 to +10 V input control signal applied to the REMOTE INTERFACE CONNECTOR on the rear panel. Once commanded to a preset value , the voltage amplitude remains fixed over a wide range of output load current values. When operating in the CONSTANT AC VOLTAGE mode, an output DC bias voltage level in a range of 0 to 5 kV can be added to the output AC waveform.

The instantaneous combined total of AC voltage plus DC bias voltage cannot exceed 5 kV.

Introduction (cont.)

Constant AC Current Mode

In the CONSTANT AC CURRENT mode, the output AC current value is commanded/controlled over a range of 0 to 5 mA average by use of a front panel precision potentiometer or a 0 to +10 V input control signal applied to the REMOTE INTERFACE connector on the rear panel.

Once commanded to a preset value, the current amplitude remains fixed over a wide range of output voltage values. When operating in the CONSTANT AC CURRENT mode, an output DC bias voltage level in the range of 0 to 5 kV can be added to the output AC waveform.

The combined total of AC voltage plus DC bias voltage cannot exceed 5 kV.

Amplifier Mode

In the Amplifier mode, the Model 615-3 amplifies a signal applied to a front-panel AMPLIFIER signal input connector by a factor of 1000.

The Model 615-3 will amplify an applied input signal. The high-voltage ON/OFF control, the Master DC switch, the front panel DC voltage display, the front panel DC current display, and the DC Bias (polarities and settings) will function in the AMPLIFIER mode.

However, some of the front panel and remote control functions are not functional in the AMPLIFIER mode. These include the internal AC generator, the high-voltage AC output limit controls, the AC amplitude adjustment, the compliance indicator, the master AC switch, and the front panel digital AC display.

Model 615-3 Operational Block Diagram

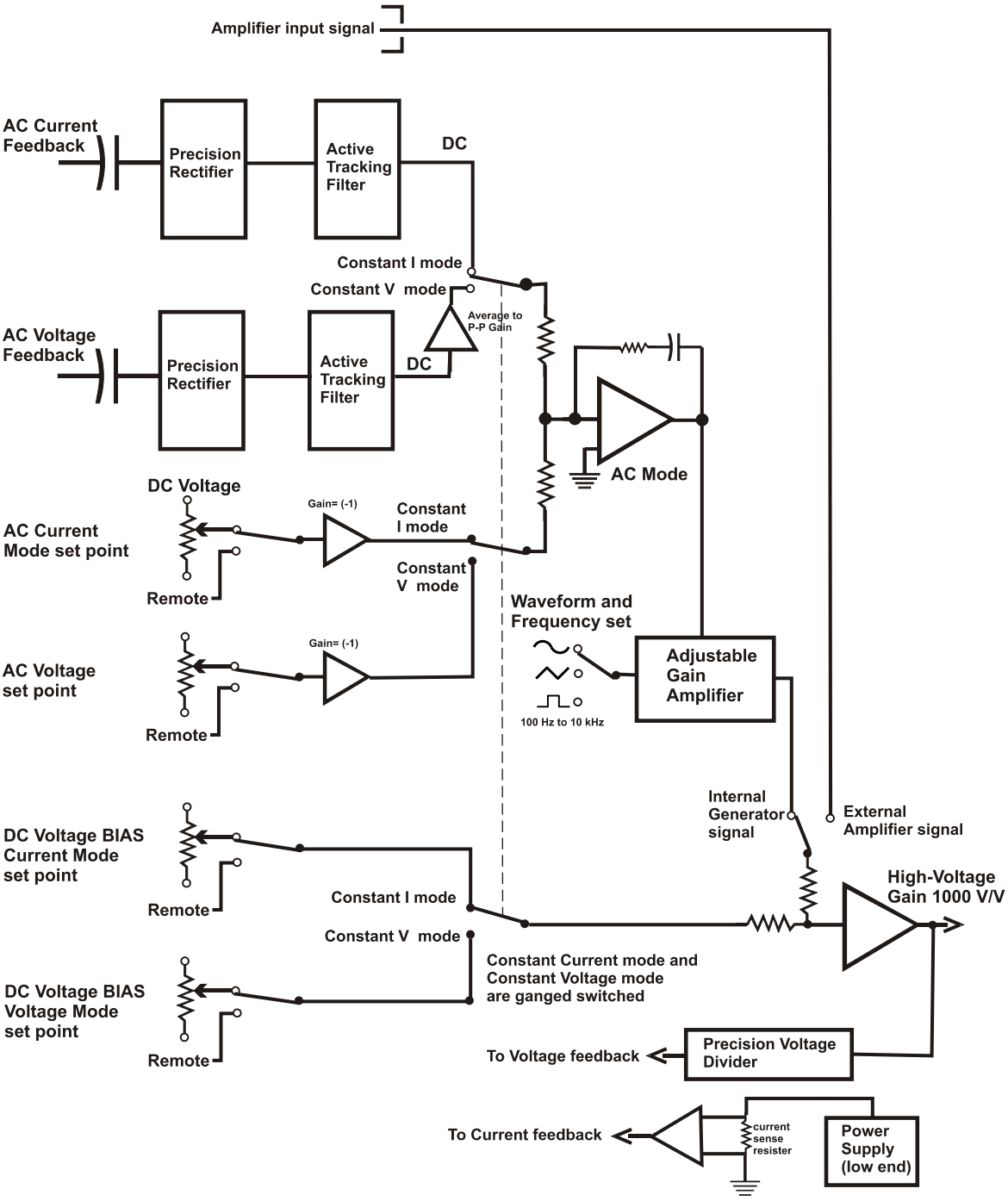


Figure 1-1 Operational Block Diagram

Incoming Inspection

Visually inspect the instrument for physical damage such as dents, nicks, scratches, broken fittings, etc. External damage may indicate more serious damage has occurred within the instrument. In the event of damage, notify the factory or your nearest authorized Trek Service Organization and request instructions. Do not attempt to use a damaged instrument.

Incoming Confidence Test

The Model 615-3 undergoes extensive checks and adjustments at the factory, and no initial calibration should be required. 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.

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

Commanding an output voltage in the Constant Voltage mode and measuring the voltage at the external Voltage (V) Monitor connector would constitute a reasonable incoming confidence test.

Warning: *Do not plug in the Model 615-3 or turn it on until instructed to do so. To do so before the appropriate point in time could result in an electrical shock and/or damage to the instrument.*

Caution: *Ensure that the Model 615-3 has been configured for the proper nominal line voltage for your area. Damage to the system may result if it is operated at an incorrect line voltage. Refer to "Power Connection" on page II-1 for instructions to check the line voltage setting.*

1. Ensure that the Model 615-3 is off.
2. Ensure that the High Voltage switch is in the OFF position and that the Shorting Cap is installed on the REMOTE High Voltage On/Off receptacle.
3. Connect a digital voltmeter to the external Voltage (V) Monitor connector on the rear panel.
4. Place the AC MONITOR switch and the DC MONITOR switch in the "kV" position.
5. Plug the power cord into the power connector on the rear panel.

Incoming Inspection (cont.)

Incoming Confidence Test (cont.)

6. Plug the power cord into the power source.

Warning: *Make no attempt to bypass the ground feature in the AC line cord. This is a protective ground and any attempt to negate it could result in electrical shock.*

7. Place the front panel Amplifier/Generator mode switch to the GENERATOR position.

8. Turn on the Model 615-3.

9. Place the MODE switch in the CONSTANT VOLTAGE position.

10. Place the WAVEFORM SELECTION switch in the “sine” position.

11. Set the FREQUENCY potentiometer on the front panel to 1 kHz.

12. Set the CONSTANT VOLTAGE AMPLITUDE potentiometer on the front panel to 10 kV peak-to-peak.

13. Turn OFF the DC Master Switch, and turn ON the AC Master Switch.

14. Place the HIGH VOLTAGE switch in the ON position.

The Model 615-3 is now producing a 1 kHz, 10 kV peak-to-peak, sine wave.

Warning: *The HIGH VOLTAGE OUTPUT connector carries high voltage. DO NOT touch the HIGH VOLTAGE OUTPUT connector or the load circuit while the Model 615-3 is operating. An electrical shock could result. Always turn off the Model 615-3 before making changes to the load connections.*

The digital voltmeter connected to the external Voltage (V) Monitor connector will indicate 3.54 V AC. The AC MONITOR display will indicate 10.00 kV peak-to-peak.

15. Turn off the AC Master Switch.

16. Set the Constant Voltage DC BIAS potentiometer on the front panel to 5 kV.

17. Set the Constant Voltage Polarity switch to the “+” position.

Incoming Inspection (cont.)

Incoming Confidence Test (cont.)

18. Turn on the DC Master Switch.

The Model 615-3 is now producing a +5 kV DC bias.

The digital voltmeter connected to the external Voltage (V) Monitor connector will indicate a 5 V DC. The DC MONITOR display will indicate +5.00 kV DC.

Warning: *The HIGH VOLTAGE OUTPUT connector carries high voltage. DO NOT touch the HIGH VOLTAGE OUTPUT connector or the load circuit while the Model 615-3 is operating. An electrical shock could result. Always turn off the Model 615-3 before making changes to the load connections.*

This completes the incoming confidence test. Place the HIGH VOLTAGE switch in the OFF position and turn off the Model 615-3. Disconnect the digital voltmeter.

Section II Installation

Mounting

The Model 615-3 is designed for operation on a benchtop or, with optional hardware, in a standard 19-inch rack.

The Model 615-3 is air cooled. Allow approximately 50 mm (2 inches) of free air space around the fan on the rear panel. Allow approximately 25 mm (1 inch) of free air space around the vent holes in the top cover.

Caution: *Do not operate the instrument with the covers removed. The covers must be installed completely to ensure proper cooling.*

Power Connection

The Model 615-3 is factory set to be connected for either one of two ranges, 90 to 127 V AC or 180 to 250 V AC, both at 48 to 63 Hz.

Caution: *The Model 615-3 may be damaged if operated at an incorrect line voltage. Check the voltage rating on the serial number tag on the rear panel to ensure that the Model 615-3 is configured to operate at the line voltage in your area.*

For instructions on how to change the line voltage range, contact TREK, INC. or an authorized Trek Service Organization (see Appendix C).

1. Ensure that the Power switch is off before connecting the power cord to a power source.

2. Plug the power cord into the power connector on the front panel.

3. Plug the free end of the power cord into the power source.

   The power cord provided is equipped with a standard three-prong power plug to provide a grounded chassis when the cord is used in a grounded receptacle.

Warning: *Make no attempt to bypass the ground prong in the power cord. This is a protective ground and any attempt to negate it could result in an electrical shock.*

Load Connection

A high-voltage cable assembly is provided in the box of accessories for connection from the HIGH VOLTAGE OUTPUT connector on the rear panel to the load device.

1. In the case where the load circuit has its own ground connection (for example, to a machine ground), connect this ground connection to the rear panel 5-way ground (GND) post.

   It is recommended that, if possible, the connection to the shields of high-voltage shielded cables (if used) be returned to the I_s terminal. Figure 2-1 shows a typical load connection. (See page III-20 for more information on the I_s terminal.)

   NOTE: The shield must not be earth grounded at any other point.

2. Connect the free, unterminated end to the high (high-voltage) side of the load device.

3. Connect the terminated end of the cable assembly to the HIGH VOLTAGE OUTPUT connector.

Warning: *The HIGH VOLTAGE OUTPUT connector carries high voltage. DO NOT touch the HIGH VOLTAGE OUTPUT connector or the load circuit while the Model 615-3 is operating. An electrical shock could result. Always turn off the Model 615-3 before making changes to the load connections.*

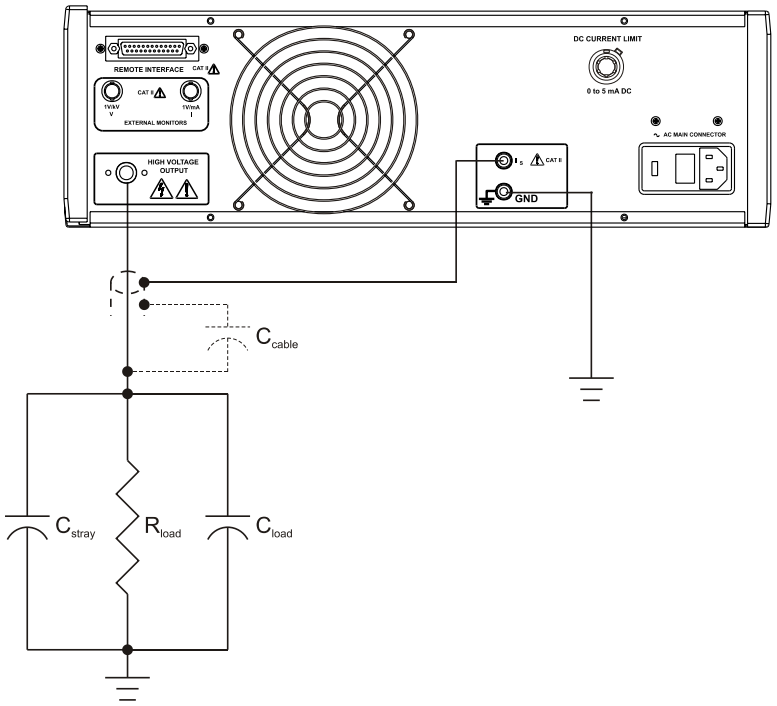


Figure 2-1:
Load connection using the GND terminal as the load return point

External Monitor Connections

Voltage Monitor

The VOLTAGE connector in the EXTERNAL MONITORS section on the rear panel is a BNC providing a buffered, low-voltage replica of the high-voltage output. The output at this connector represents 1/1000th of the voltage at the HIGH VOLTAGE OUTPUT connector.

Connect a monitoring device, such as an oscilloscope, to this connector to monitor the high-voltage output. The signal at this connector can also be used as a feedback signal in a closed-loop system.

Current Monitor

The CURRENT connector in the EXTERNAL MONITORS section on the rear panel is a BNC providing a buffered, low-voltage representation of the load current. 1 V at this connector represents 1 mA of load current.

Connect a monitoring device, such as an oscilloscope, to this connector to monitor the load current. The signal at this connector can also be used as a feedback signal in a closed-loop system.

Remote High Voltage On/Off Connection

The REMOTE High Voltage On/Off connector on the front panel can be connected to a remote device to turn on and off the high voltage output.

A TTL high will turn off the high voltage. A TTL low will turn on the high voltage.

Note: *A TTL high is a voltage that is greater than or equal to 3.3 V but less than or equal to 5.0 V. A TTL low is a voltage less than or equal to 0.8 V.*

Remote Interface Connection

The Remote Interface connector on the rear panel is a 25-pin “D” connector for connection of TTL signals and 0 to +10 V DC analog signals to remotely control the output of the Model 615-3 from a computer or process controller.

The function to be controlled through the Remote Interface is selected using a TTL digital signal while the magnitude of the function is controlled using a 0 to +10 V DC analog control signal.

Remote Interface Connection (cont.)

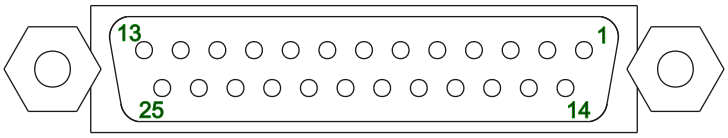


Figure 2-2: Remote Interface Connector

Selection of a function via the Remote Interface will supersede the front panel control of that function.

IMPORTANT: *The front panel AMPLIFIER mode switch must be set to GENERATOR for all remote functions to operate properly. (See page I-3 and page III-20 for more information about the AMPLIFIER mode.)*

Pins 1 through 13: Ground.

Pin 14: Frequency Adjustment: Connect a +0.1 to +10 V DC signal to this pin to adjust the frequency of the output voltage or load current from 0.1 kHz to 10 kHz.

Pin 15 and 16: Waveform Select: Connect TTL signals to these pins to select a sine wave, square wave, or triangle wave output. The logic is as follows:

Waveform	Pin 15	Pin 16
Sine	low	low
Square	low	high
Triangle	high	low

Table 2-1: Waveform Select Logic

Pin 17: Remote Frequency Control Select: Connect a TTL low to this pin to enable remote control of the frequency and the waveform of the AC output voltage or AC output current. These functions can then be remotely adjusted using the Frequency Adjustment (Pin 14 of the Remote Interface connector) and the Waveform Select (pins 15 and 16 of the Remote Interface connector). A TTL high, or no connection, retains the frequency adjustment by the FREQUENCY potentiometer on the front panel and the WAVEFORM selection on the waveform switch on the front panel.

Pin 18: Remote High Voltage On/Off: Connect a TTL signal to this pin to turn on and off the high-voltage output according to Table 2-2 (next page).

Remote Interface Connection (cont.)

High Voltage Switch (front panel)	Remote High Voltage On/Off (front panel)	Remote High Voltage On/Off (Pin 18)	High Voltage Status
on or off	low or high	low	off
on	low	high	on
on or off	high	low or high	off
off	low or high	low or high	off

Table 2-2: High Voltage On/Off Control

Pin 19: Mode Select: Connect a TTL high to this pin to select the Constant AC Current Mode. A TTL low selects the Constant AC Voltage mode.

Pin 20: Remote Mode Control Select: Connect a TTL low to this pin to enable the mode to selected by the Mode Select (Pin 19 of the Remote Interface connector). A TTL high or no connection retains mode selection by the MODE switch on the front panel.

Pin 21: AC Control Select: Connect a TTL signal to this pin to select remote or front panel control of the peak-to-peak amplitude of the output voltage or load current. A TTL low allows the peak-to-peak amplitude to be controlled by the AC Adjustment (Pin 22 of the Remote Interface connector). A TTL high or no connection allows the peak-to-peak amplitude to be controlled by the AC potentiometers on the front panel.

Pin 22: AC Adjustment: Connect a 0 to +10 V DC signal to this pin to control the peak-to-peak amplitude of the output voltage from 0 to 10 kV peak-to-peak when operating in the Constant Voltage mode or control the peak-to-peak amplitude of the load current from 0 to 5 mA average, or 0 to 1 mA average (front panel selected), when operating in the Constant Current mode.

Pin 23: DC Adjustment: Connect a 0 to +10 V DC signal to this pin to control the level of the DC bias from 0 to 5 kV DC.

Pin 24: Remote DC Control Select: Connect a TTL low to this pin to enable the level and polarity of the DC bias to be controlled by the DC Adjustment (Pin 23 of the Remote Interface connector) and the Polarity input (Pin 25 of the Remote Interface connector). A TTL high or no connection retains control of the level and polarity of the DC bias by the DC BIAS potentiometer and Polarity switch on the front panel.

Pin 25: Polarity: Connect a TTL high to this pin to select a positive DC bias. A TTL low selects a negative DC bias.

Section III Operation

Front Panel Features

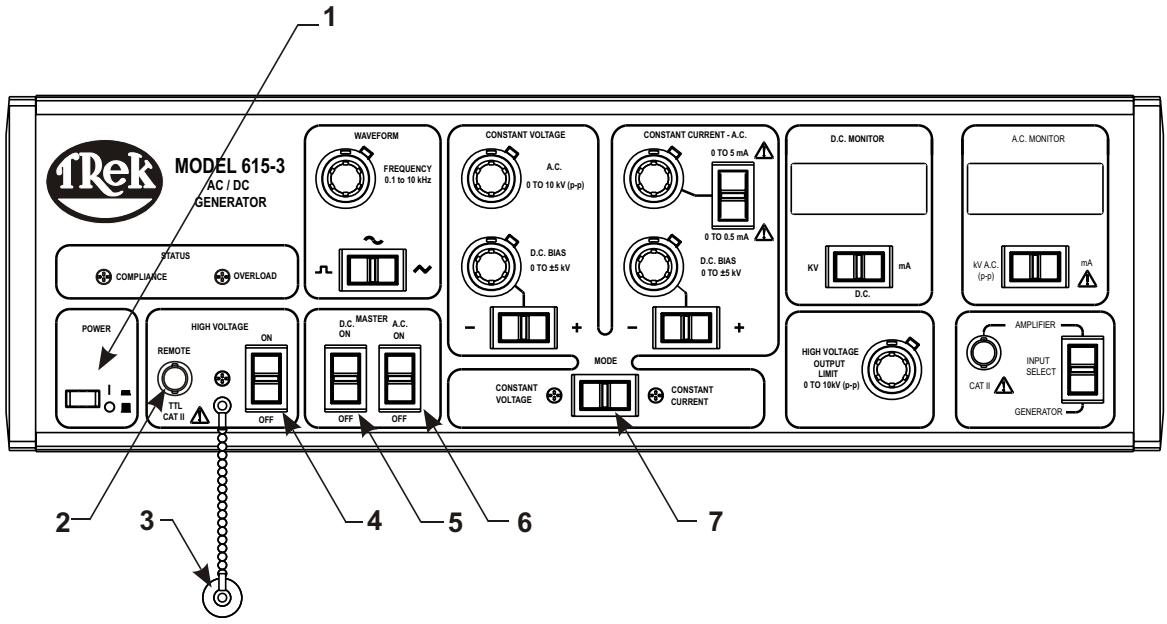


Figure 3-1: Model 615-3 front panel (features 1 through 7)

1. ***POWER Switch:*** This switch turns on and off the Model 615-3.

2. ***REMOTE High Voltage On/Off Connector:*** This BNC connector is for connection of an external digital signal to turn on and off the high-voltage output of the Model 615-3.

3. ***REMOTE High Voltage On/Off Cap:*** This cap must be installed on the remote high-voltage ON/OFF connector to allow operation of the Model 615-3 in the case where a digital signal is not used.

4. ***High Voltage Switch and Indicator:*** This switch turns on and off the high-voltage output of the Model 615-3. The red indicator to the left of this switch will illuminate when the high-voltage output is on.

5. ***DC Master Switch:*** This switch turns on and off the DC output generator.

6. ***AC Master Switch:*** This switch turns on and off the AC output generator.

7. ***MODE Switch:*** This switch selects the Constant AC Voltage mode or the Constant AC Current mode.

Front Panel Features (cont.)

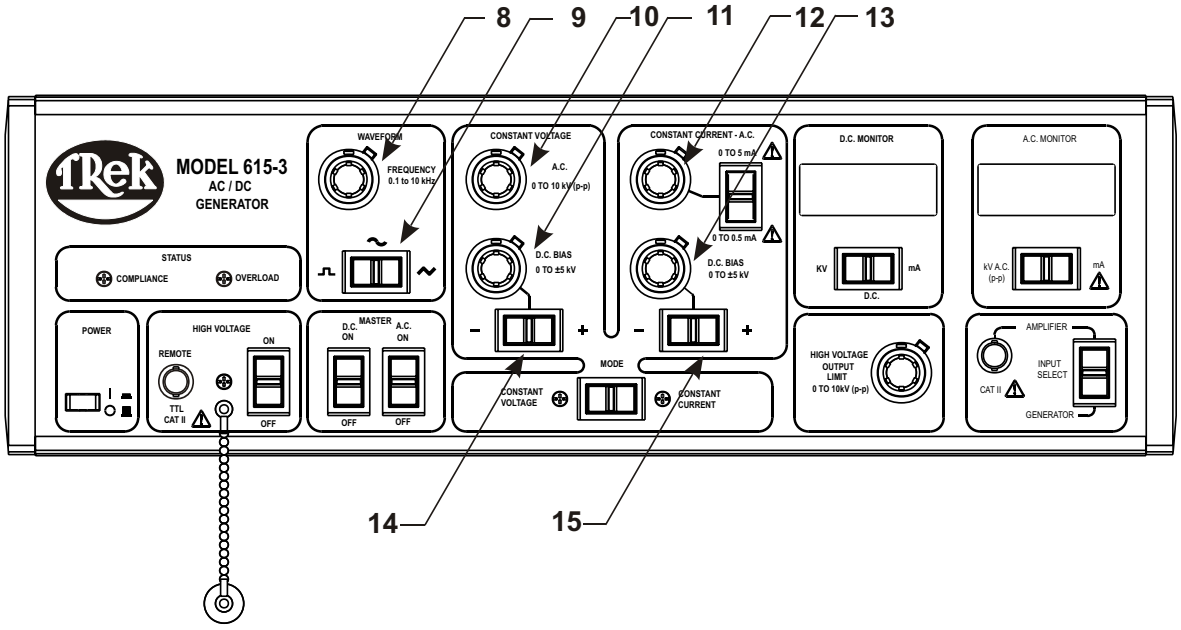


Figure 3-2: Model 615-3 front panel (features 8 through 15)

8. ***FREQUENCY Potentiometer:*** This potentiometer adjusts the frequency of the AC output voltage or AC output current from 0.1 to 10 kHz.

9. ***Waveform Selection Switch:*** This switch selects either a sine wave, square wave or triangle wave as the AC output voltage or AC output current waveform.

10. ***Constant AC Voltage Amplitude Adjustment:*** This potentiometer adjusts the peak-to-peak amplitude of the AC output voltage when the Model 615-3 is operated in the Constant AC Voltage mode.

11. ***DC BIAS Adjustment:*** This potentiometer adjusts the level of the DC bias while operating in the Constant AC Voltage mode.

12. ***Constant AC Current Amplitude Potentiometer:*** This potentiometer adjusts the average amplitude of the AC output current when the Model 615-3 is operated in the Constant AC Current mode.

13. ***DC BIAS Adjustment:*** This potentiometer adjusts the level of the DC bias while operating in the Constant AC Current mode.

14. ***Polarity Switch:*** This switch selects the polarity of the DC bias while operating in the Constant AC Voltage mode.

15. ***Polarity Switch:*** This switch selects the polarity of the DC bias while operating in the Constant AC Current mode.

Front Panel Features (cont.)

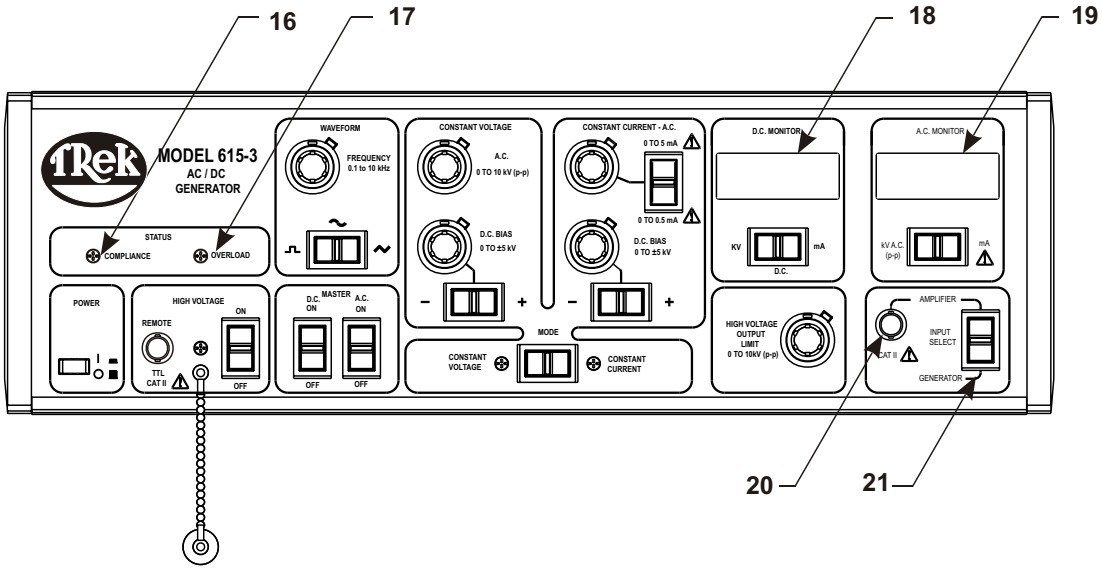


Figure 3-3: Model 615-3 front panel (features 16 through 21)

16. ***COMPLIANCE Indicator:*** This red indicator will illuminate when an overcurrent condition occurs while operating in the Constant Voltage mode or while operating in the Constant Current mode.

17. ***OVERLOAD Indicator:*** This red indicator will illuminate when the output current limit is exceeded.

18. ***DC MONITOR Display and Switch:*** This LED display indicates the DC bias level or the DC component of the load current. The switch below this display selects the quantity to be displayed.

19. ***AC MONITOR Display and Switch:*** This LED display indicates the output peak-to-peak AC voltage value voltage or the average AC component value of the load current. The switch below this display selects the quantity to be displayed.

20. ***AMPLIFIER:*** This BNC connector is for input of an external signal source. When using the AMPLIFIER mode, the generator function is disabled. Also, the following front panel controls and remote functions are by-passed when in the amplifier mode: The AC Master Switch, the Waveform Selection switch, the Frequency setting potentiometer, the Constant AC Voltage Amplitude setting, the Constant AC Current Amplitude setting, and the front panel AC Monitor (display and switch).

21. ***MODE Switch:*** This switch selects the mode of operation between generator mode and amplifier mode.

Front Panel Features (cont.)

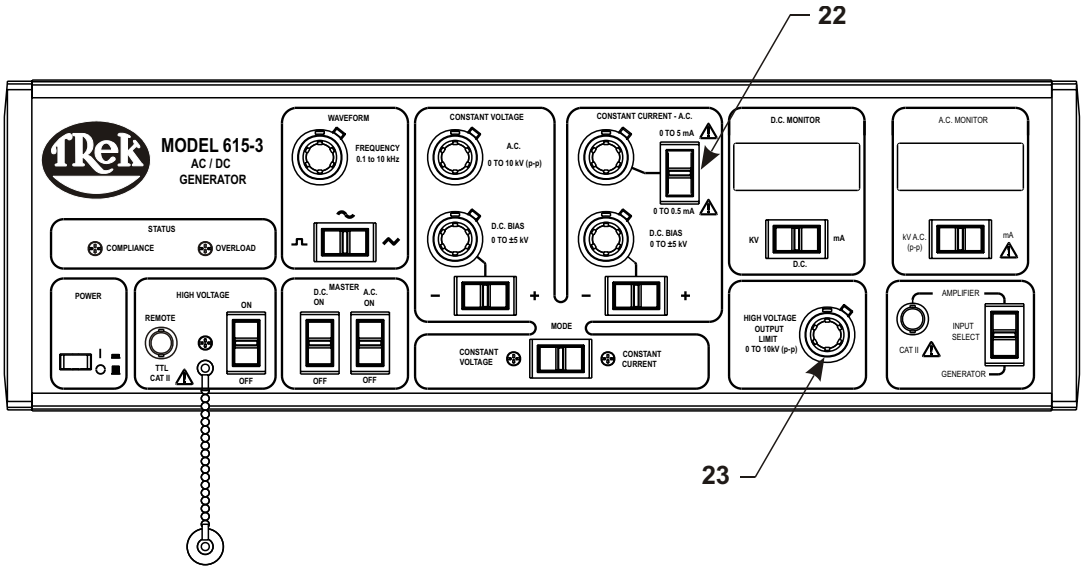


Figure 3-4: Model 615-3 front panel (features 22 and 23)

22. ***CONSTANT CURRENT AC scale switch:*** Selectable for 0 to 5 mA or 0 to 0.5 mA, full scale.

23. ***HIGH-VOLTAGE OUTPUT LIMIT:*** When operating in the CONSTANT AC CURRENT mode or the CONSTANT AC VOLTAGE mode, the HIGH-VOLTAGE OUTPUT LIMIT potentiometer sets a output voltage limit of 0 to 10 kV peak-to-peak.

Rear Panel Features

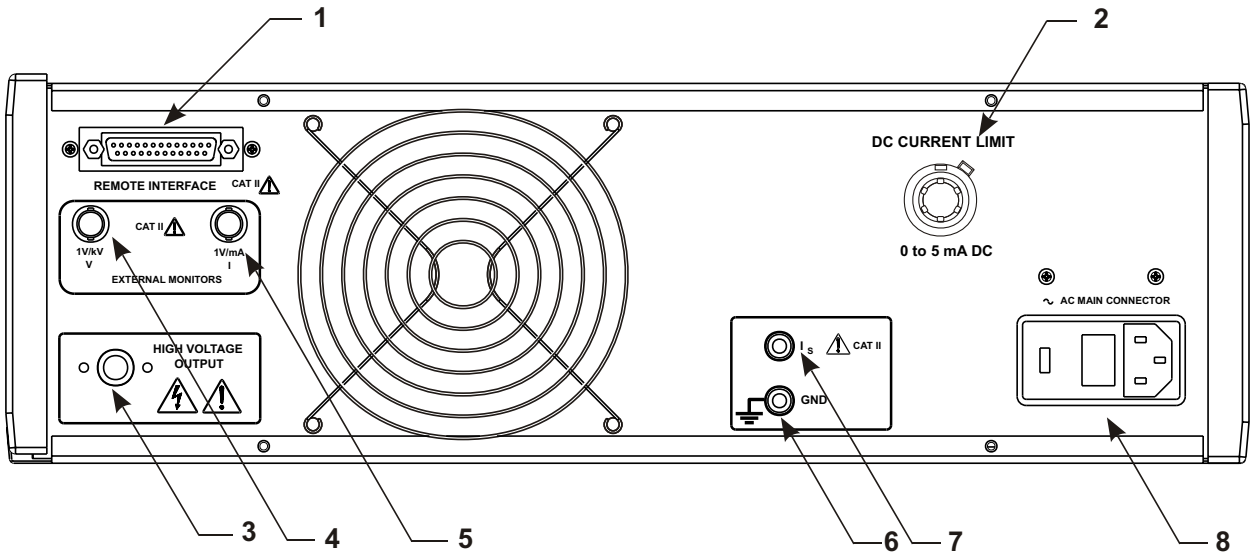


Figure 3-5: Model 615-3 rear panel (features 1 through 8)

1. ***Remote Interface Connector:*** This 25-pin "D" connector is for connection of TTL signals and 0 to +10 V DC analog signals to remotely control the operation of the Model 615-3.

2. ***DC Current Limit Control:*** This control sets an output current limit value of 0 to 5 mA DC.

3. ***HIGH VOLTAGE OUTPUT Connector:*** This connector is for connection of the load device using the high-voltage cable assembly provided.

4. ***External VOLTAGE MONITOR Connector:*** This BNC provides a buffered, low-voltage replica of the output voltage.

5. ***External CURRENT MONITOR Connector:*** This BNC provides a buffered, low-voltage representation of the load current.

6. ***GND Ground terminal Post:*** The ground terminal post is used as a general grounding point for load devices or other devices.

7. ***I_s Terminal Post:*** The I_s (shield current) terminal post is used as a return connection for the high-voltage output cabling and/or other non grounded shielding associated with the load. All currents returned to the I_s terminal are not monitored. (See page III-20 for more information.)

8. ***POWER CONNECTOR:*** This receptacle is a standard three-prong power connector with an integral fuse holder.

Operation as a Generator

The following instructions assume that the instrument has been installed according to the instructions given in Section II, INSTALLATION.

Warning: *The HIGH VOLTAGE OUTPUT connector carries high voltage. Do not touch the HIGH VOLTAGE OUTPUT connector or the load circuit while the Model 615-3 is operating. An electrical shock could result. Always turn off the Model 615-3 before making changes to the load circuit.*

Important: *The front panel Amplifier/Generator mode switch must be set to GENERATOR in order to perform the following operations.*

In the Constant AC Voltage mode the Model 615-3 regulates output voltage as set by front panel controls and/or input signals connected to the Remote Interface connector.

Note: *The following pages separately describe how to produce outputs using the front panel controls and/or inputs to the Remote Interface connector. The front panel controls and inputs to the Remote Interface can be used together to produce the desired output, as the user may wish to control some features using front panel controls and others using the Remote Interface.*

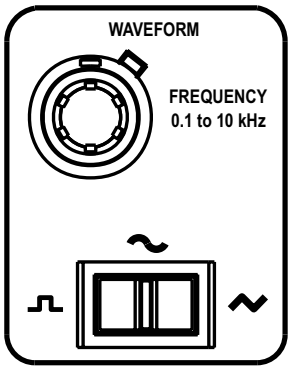
Producing an Output in the Constant AC Voltage Mode Using the Front Panel Controls

1. Ensure the shorting cap is installed on the REMOTE High Voltage On/Off BNC Connector, or apply a TTL low to this BNC Connector.

2. Place the front panel MODE switch in the CONSTANT VOLTAGE position.

3. Place the Waveform Selection switch in the desired position: square, sine, or triangle.

4. Set the FREQUENCY potentiometer on the front panel to the desired frequency of the output voltage between 100 Hz and 10 kHz. Each complete turn of the FREQUENCY potentiometer represents a change of 1 kHz to the frequency of the output voltage.



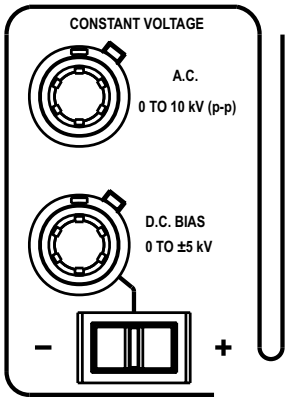
5. Set the AC Constant Voltage Amplitude potentiometer on the front to the desired amplitude of the AC output voltage between 0 and 10 kV peak-to-peak. Each complete turn of the Constant Voltage Amplitude potentiometer represents a change of 1 kV peak-to-peak to the amplitude of the output voltage.

Operation as a Generator (cont.)

Producing an Output in the Constant AC Voltage Mode Using the Front Panel Controls (cont.)

6. Set the DC BIAS potentiometer in the Constant AC Voltage section of the front to the desired level of the DC bias between 0 and 5 kV DC. Each complete turn of the DC BIAS potentiometer represents a change of 1000 V DC to the level of the DC bias.

Note: *The sum of the DC bias level and the peak value (peak-to-peak value/2) of the output voltage must not exceed 5 kV. For example, if the amplitude of the output voltage is set for 4 kV peak-to-peak (2 kV peak), the level of the DC bias must not exceed 3 kV (2 kV + 3 kV = 5 kV).*



7. Place the Polarity switch in the Constant Voltage section of the front panel in the desired position.

8. Turn on the Model 615-3 main power.

9. Turn on the DC MASTER Switch.

10. Turn on the AC MASTER Switch.

11. Place the HIGH VOLTAGE switch in the ON position.

The Model 615-3 will begin producing an output voltage as set by the front panel controls.

Warning: *The HIGH VOLTAGE OUTPUT connector carries high voltage. Do not touch the HIGH VOLTAGE OUTPUT connector or the load circuit while the Model 615-3 is operating. An electrical shock could result. Always turn off the Model 615-3 before making changes to the load circuit.*

Producing an Output in the Constant AC Voltage Mode Using Inputs to the Remote Interface Connector

1. Apply a TTL low to the remote Mode Control Select input (pin 20 of the REMOTE INTERFACE connector) to allow the mode to be selected by the Mode Select input (pin 19 of the REMOTE INTERFACE connector).

Note: *A TTL high allows the mode selection to be retained by the MODE switch on the front panel.*

Operation as a Generator (cont.)

Producing an Output in the Constant AC Voltage Mode Using Inputs to the Remote Interface Connector (cont.)

2. Apply a TTL low to the Mode Select input (pin 19 of the Remote Interface connector) to select the Constant AC Voltage Mode.

3. Apply a TTL low to the Waveform and Frequency Control Select input (pin 17 of the REMOTE INTERFACE connector) to allow the waveform of the output voltage to be selected by the Waveform Select inputs (pins 15 and 16 of the REMOTE INTERFACE connector) and allow the frequency of the output voltage to be adjusted by the Frequency Adjustment input (pin 14 of the REMOTE INTERFACE connector).

   Note: *A TTL high allows the waveform selection to be retained by the Waveform Selection switch on the front panel and allows the frequency of the output voltage to be adjusted using the FREQUENCY potentiometer on the front panel.*

4. Apply TTL compatible signals to the Waveform Select inputs (pins 15 and 16 of the REMOTE INTERFACE connector) to select the desired waveform of the output voltage. The logic is as follows:

Waveform	Pin 15	Pin 16
Sine	low	low
Square	low	high
Triangle	high	low

Table 3:1 Waveform Select Logic

5. Apply a +0.1 to +10 V DC signal to the Frequency Adjustment input (pin 14 of the REMOTE INTERFACE connector) to adjust the frequency of the output voltage from 100 Hz to 10 kHz. A 1 V change in the signal applied to the Frequency Adjustment represents a 1 kHz change in the frequency of the output voltage.

6. Apply a TTL low to the AC Control Select input (pin 21 of the REMOTE INTERFACE Connector) to allow the peak-to-peak amplitude of the output voltage to be adjusted by the AC Adjustment input (pin 22 of the REMOTE INTERFACE connector).

   Note: *A TTL high allows the peak-to-peak amplitude adjustment of the output voltage to be retained by the Constant Voltage Amplitude potentiometer on the front panel.*

Operation as a Generator (cont.)

Producing an Output in the Constant AC Voltage Mode Using Inputs to the Remote Interface Connector (cont.)

7. Apply a 0 to +10 V DC signal to the AC Adjustment input (pin 22 of the REMOTE INTERFACE connector) to adjust the amplitude of the output voltage from 0 to 10 kV peak-to-peak. A 1 V change in the signal applied to the AC Adjustment represents a 2 kV peak-to-peak change in the amplitude of the output voltage.

8. Apply a TTL low to the DC Control Select input (pin 24 of the REMOTE INTERFACE Connector) to allow the level of the DC bias to be adjusted by the DC Adjustment input (pin 23 of the REMOTE INTERFACE connector) and the polarity of the DC bias controlled by the Polarity input (pin 25 of the REMOTE INTERFACE connector).

Note: *A TTL high allows the level and polarity selection of the DC bias to be retained by the DC BIAS potentiometer and Polarity switch in the Constant Voltage section of the front panel.*

9. Apply a 0 to +10 V DC signal to the DC Adjustment input (pin 23 of the REMOTE INTERFACE connector) to adjust the level of the DC bias from 0 to 5 kV DC. A 1 V change in the signal applied to the AC Adjustment input represents a 1 kV DC change in the level of the DC bias.

Note: *The sum of the DC bias level and the peak value (peak-to-peak value/2) of the output voltage must not exceed 5 kV. For example, if the amplitude of the output voltage is set for 4 kV peak-to-peak (2 kV peak), the level of the DC bias must not exceed 3 kV (2 kV + 3 kV = 5 kV).*

10. Apply a TTL compatible signal to the Polarity input (pin 25 of the REMOTE INTERFACE connector). A TTL high selects a positive polarity for the DC bias. A TTL low selects a negative polarity for the DC bias.

11. Apply a TTL high to the Remote High Voltage On/Off input (pin 18 of the REMOTE INTERFACE Connector).

12. Ensure the shorting cap is installed on the REMOTE High Voltage On/Off BNC Connector, or apply a TTL low to this BNC Connector.

13. Turn on the Model 615-3 main power.

14. Turn on the DC MASTER Switch.

15. Turn on the AC MASTER Switch.

Operation as a Generator (cont.)

Producing an Output in the Constant AC Voltage Mode Using Inputs to the Remote Interface Connector (cont.)

16. Place the HIGH VOLTAGE switch in the ON position.

The Model 615-3 will begin producing an output voltage as set by the input signals to the REMOTE INTERFACE connector.

Warning: *The HIGH VOLTAGE OUTPUT connector carries high voltage. Do not touch the HIGH VOLTAGE OUTPUT connector or the load circuit while the Model 615-3 is operating. An electrical shock could result. Always turn off the Model 615-3 before making changes to the load circuit.*

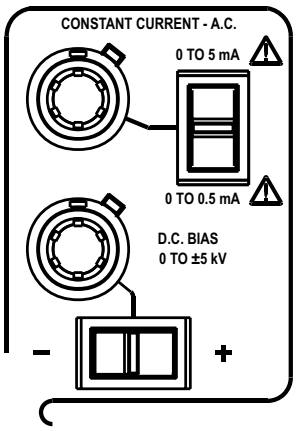
Producing an Output in the Constant Current Mode Using the Front Panel Controls

1. Ensure the shorting cap is installed on the REMOTE High Voltage On/Off BNC Connector, or apply a TTL low to this BNC Connector.

2. Place the front panel MODE switch in the CONSTANT AC CURRENT position.

3. Place the WAVEFORM SELECTION switch in the desired position: square, sine, or triangle.

4. Set the FREQUENCY potentiometer on the front panel to the desired frequency of the load current between 100 Hz and 10 kHz. Each complete turn of the FREQUENCY potentiometer represents a change of 1 kHz to the frequency of the load current.



5. Set the Constant AC Current Amplitude potentiometer on the front to the desired amplitude of the load current between 0 and 5 mA (average) or 0 to 500 A (average). Each complete turn of the Constant AC Current Amplitude potentiometer represents a change of 1 mA (average) or 100 A (average) to the amplitude of the load current.

Operation as a Generator (cont.)

Producing an Output in the Constant AC Current Mode Using the Front Panel Controls (cont.)

6. Set the DC BIAS potentiometer in the Constant AC Current section of the front to the desired level of the DC bias between 0 and 5 kV DC. Each complete turn of the DC BIAS potentiometer represents a change of 1000 V DC to the level of the DC bias.

   Note: *The sum of the DC bias level and the peak value (peak-to-peak value/2) of the output voltage must not exceed 5 kV. For example, if the amplitude of the output voltage is set for 4 kV peak-to-peak (2 kV peak), the level of the DC bias must not exceed 3 kV (2 kV + 3 kV = 5 kV).*

7. Place the Polarity switch in the Constant AC Current section of the front panel in the desired position.

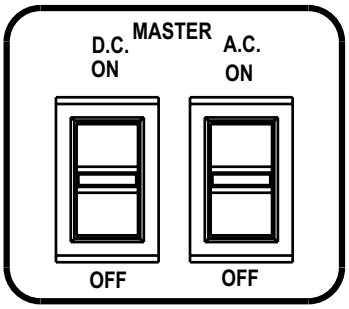
8. Turn on the Model 615-3 main power.

9. Turn on the DC MASTER Switch.

10. Turn on the AC MASTER Switch.

11. Place the HIGH VOLTAGE switch in the ON position.

    The Model 615-3 will begin producing a load current as set by the front panel controls.



Warning: *The HIGH VOLTAGE OUTPUT connector carries high voltage. Do not touch the HIGH VOLTAGE OUTPUT connector or the load circuit while the Model 615-3 is operating. An electrical shock could result. Always turn off the Model 615-3 before making changes to the load circuit.*

Producing an Output in the Constant AC Current Mode Using Inputs to the Remote Interface Connector

1. Apply a TTL low to the Mode Control Select input (pin 20 of the REMOTE INTERFACE connector) to allow the mode to be selected by the Mode Select input (pin 19 of the REMOTE INTERFACE connector).

   Note: *A TTL high allows the mode selection to be retained by the MODE switch on the front panel.*

2. Apply a TTL high to the Mode Select input (pin 19 of the Remote Interface connector) to select the Constant AC Current mode.

Operation as a Generator (cont.)

Producing an Output in the Constant AC Current Mode Using Inputs to the Remote Interface Connector (cont.)

3. Apply a TTL low to the Waveform and Frequency Control Select input (pin 17 of the REMOTE INTERFACE connector) to allow the waveform of the load current to be selected by the Waveform Select inputs (pins 15 and 16 of the REMOTE INTERFACE connector) and allow the frequency of the load current to be adjusted by the Frequency Adjustment input (pin 14 of the REMOTE INTERFACE connector).

   Note: *A TTL high allows the waveform selection to be retained by the Waveform Selection switch on the front panel and allows the frequency of the load current to be adjusted using the FREQUENCY potentiometer on the front panel.*

4. Apply TTL compatible signals to the Waveform Select inputs (pins 15 and 16 of the REMOTE INTERFACE connector) to select the desired waveform of the load current. The logic is as follows:

Waveform	Pin 15	Pin 16
Sine	low	low
Square	low	high
Triangle	high	low

Table 3:1 Waveform Select Logic

5. Apply a +0.1 to +10 V DC signal to the Frequency Adjustment input (pin 14 of the REMOTE INTERFACE connector) to adjust the frequency of the load current from 100 Hz to 10 kHz. A 1 V change in the signal applied to the Frequency Adjustment represents a 1 kHz change in the frequency of the load current.

6. Apply a TTL low to the AC Control Select input (pin 21 of the REMOTE INTERFACE Connector) to allow the peak-to-peak amplitude of the load current to be adjusted by the AC Adjustment input (pin 22 of the REMOTE INTERFACE connector).

   Note: *A TTL high allows the peak-to-peak amplitude adjustment of the load current to be retained by the Constant Voltage Amplitude potentiometer on the front panel.*

Operation as a Generator (cont.)

Producing an Output in the Constant AC Current Mode Using Inputs to the Remote Interface Connector (cont.)

7. Apply a 0 to +10 V DC signal to the AC Adjustment input (pin 22 of the REMOTE INTERFACE connector) to adjust the amplitude of the AC load current from 0 to 5 mA, average. A 1 V change in the signal applied to the AC Adjustment represents a 1 mA average change in the amplitude of the load current.

8. Apply a TTL low to the DC Control Select input (pin 24 of the REMOTE INTERFACE Connector) to allow the level of the DC bias to be adjusted by the DC Adjustment input (pin 23 of the REMOTE INTERFACE connector) and the polarity of the DC bias controlled by the Polarity input (pin 25 of the REMOTE INTERFACE connector).

Note: *A TTL high allows the level and polarity of the DC bias adjustments to be retained by the DC BIAS potentiometer and Polarity switch in the Constant AC Current section of the front panel.*

9. Apply a 0 to +10 V DC signal to the DC Adjustment input (pin 23 of the REMOTE INTERFACE connector) to adjust the level of the DC bias from 0 to 5 kV DC. A 1 V change in the signal applied to the AC Adjustment input represents a 500 V DC change in the level of the DC bias.

Note: *The sum of the DC bias level and the peak value (peak-to-peak value/2) of the output voltage must not exceed 5 kV. For example, if the amplitude of the output voltage is set for 4 kV peak-to-peak (2 kV peak), the level of the DC bias must not exceed 3 kV (2 kV + 3 kV = 5 kV).*

10. Apply a TTL compatible signal to the Polarity input (pin 25 of the REMOTE INTERFACE connector). A TTL high selects a positive polarity for the DC bias. A TTL low selects a negative polarity for the DC bias.

11. Turn on the DC MASTER Switch.

12. Turn on the AC MASTER Switch.

13. Ensure the shorting cap is installed on the REMOTE High Voltage On/Off receptacle or apply a TTL low to this receptacle.

14. Place the HIGH VOLTAGE switch in the ON position.

Operation as a Generator (cont.)

Producing an Output in the Constant AC Current Mode Using Inputs to the Remote Interface Connector (cont.)

15. Apply a TTL high to the Remote High Voltage On/Off input (pin 18 of the REMOTE INTERFACE Connector).

The Model 615-3 will begin producing a load current as set by the input signals to the REMOTE INTERFACE connector if the front panel High Voltage switch is on and the front panel Remote High Voltage On/Off input is low (0 V to 0.8 V). See page II-4.

Warning: *The HIGH VOLTAGE OUTPUT connector carries high voltage. Do not touch the HIGH VOLTAGE OUTPUT connector or the load circuit while the Model 615-3 is operating. An electrical shock could result. Always turn off the Model 615-3 before making changes to the load circuit.*

Monitoring the Output Voltage

The output voltage can be monitored using the DC MONITOR display, the AC MONITOR display and the external Voltage Monitor.

DC MONITOR Display

The DC MONITOR display indicates the level of the DC bias in kilovolts when the switch below this display is in the “kV” position.

AC MONITOR Display

The AC MONITOR display indicates the peak-to-peak value in kilovolts of the AC component of the output voltage when the switch below this display is in the “kV” position.

External Voltage Monitor

A buffered, low-voltage replica of the high-voltage output is provided at the VOLTAGE connector in the EXTERNAL MONITORS section on the front panel. 1 V at this connector represents 1000 V at the HIGH VOLTAGE OUTPUT connector.

Operation as a Generator (cont.)

Monitoring the Load Current

The load current can be monitored using the DC MONITOR display, the AC MONITOR display and the External Current Monitor.

DC MONITOR Display

The DC MONITOR display indicates the value of the DC component of the load current in milliamperes when the switch below this display is in the “mA” position.

AC MONITOR Display

The AC MONITOR display indicates the average value in milliamperes of the AC average of the total current which is represented by:

$$\text{AC current average} = \frac{(2)\ I_{peak}}{3.14}$$

External Current Monitor

A buffered, low-voltage representation of the total current is provided at the CURRENT connector in the EXTERNAL MONITORS section on the front panel.

1 V at this connector represents 1 mA of current.

Operation as a Generator (cont.)

Load Compensating Dynamic Adjustments

The Model 615-3 has been factory calibrated at no load. The Model 615-3 is designed to operate under a wide range of loads without requiring any load compensating dynamic adjustments. However, as load capacitance exceeds 500 pF, the Load Compensating dynamic adjustment potentiometers, P8 and P10, may need to be adjusted to eliminate a slight overshoot when producing a square wave output.

1. Ensure the Model 615-3 is off.

2. Remove the two screws that secure the top cover. Slide the top cover towards the back of the instrument approximately 20 mm.

3. Locate the P8 and P10. P8 and P10 are located towards the front of the instrument. See Figure 3-10.

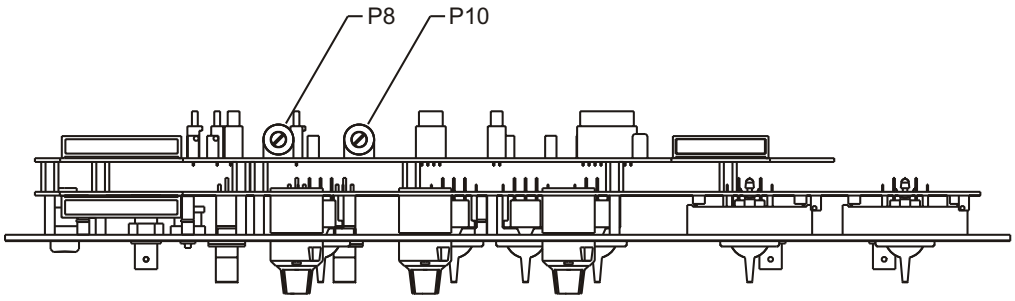


Figure 3-10: Location of P8 and P10 (top view)

4. Adjust both P8 and P10 to ensure no overshoot when using square wave AC constant current or square wave AC constant voltage modes.

5. Replace the top cover.

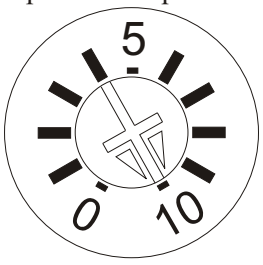


Figure 3-11: Adjust to 10 (fully clockwise)

Operation as a Generator (cont.)

Special Considerations for Square Wave Operation for Constant AC Voltage and Current Modes.

To provide control and regulation of the output voltage and current levels when operating in the CONSTANT AC VOLTAGE and CONSTANT AC CURRENT modes, feedback signals are derived from the output quantity to be controlled and regulated (output voltage or output current). These feedback signals are derived using a demodulation process to produce averaged DC signal representations of the peak-to-peak value of the output AC waveforms average of the AC current waveforms which is represented by

$$\text{AC current average} = \frac{(2)\ I_{peak}}{3.14}$$

This demodulation process will produce an averaged DC value equal to:

$\frac{\text{peak-to-peak}}{3.14}$ for a SINE wave.

$\frac{\text{peak-to-peak}}{4}$ for a TRIANGLE wave.

$\frac{\text{peak-to-peak}}{2}$ for a SQUARE wave.

Where-as the SINE and TRIANGLE waveforms can be produced without distortion over a wide amplitude and frequency range thus producing good conformity to the above peak-to-peak to average conversion ratios, the square waveform is always distorted due to the limitation in the ability to produce instantaneous rise and fall times of the square wave sides. This limitation is based upon finite bandwidth and slew rate capability, particularly with high capacitive loads. At lower frequencies and lighter capacitive loads, the "square" waveform will appear to be fairly square and thus the: $\frac{\text{peak-to-peak}}{2}$ conversion ratio will be fairly accurate.

However, at high frequencies and higher capacitive loading, the slew rate capability of the square wave sides will be reduced to a (worst case) limit where the waveform degenerates to a triangular waveform having a conversion ratio of:

$\frac{\text{peak-to-peak}}{4}$ (See figures 3-12, 3-13, and 3-14.)

When the waveform of figure 3-14 is used as the CONSTANT AC mode feedback signal (either constant V or I), the actual peak-to-peak controlled waveform produced will accurately follow the peak-to-peak command potentiometer or control signal setting.

Operation as a Generator (cont.)

Special Considerations for Square Wave Operation for Constant AC Voltage and Current Modes (cont.).

As a worst case, if the waveform of figure 3-16 is used, the peak-to-peak controlled waveform produced will be twice the value as commanded by the command potentiometer or control signal setting. As this error is a scaling error only, when operating at a fixed frequency and fixed capacitive load, excellent regulation will be produced, however, the input command signal would be reduced by a factor to compensate for the different conversion ratio.

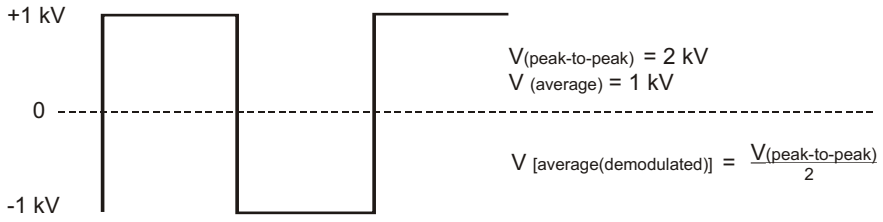


Figure 3-12: Close to "Perfect" Square Wave

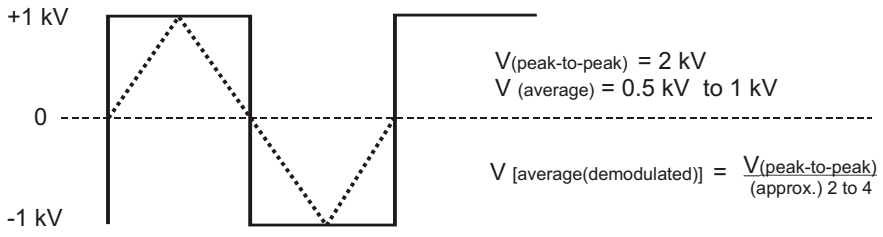


Figure 3-13: Square Wave with Current Limiting

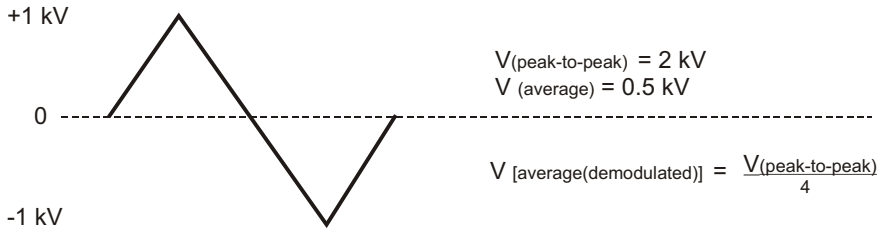


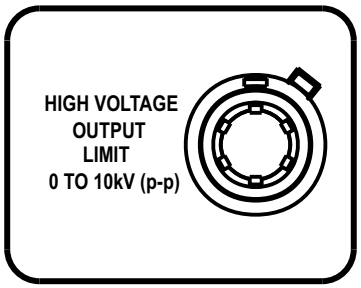
Figure 3-14: Square Wave degenerated to a Triangle Wave due to Current Limiting

Operation as a Generator (cont.)

Setting a Maximum Voltage Limit Value

When operating in the Constant AC Current Mode or the Constant AC Voltage Mode, a calibrated ten-turn potentiometer is used to set a desired maximum output voltage. Each full turn represents a 1000 V peak-to-peak and limit to produce a 10 kV peak-to-peak limit at full scale setting.

This function is especially useful when operating in the Constant Current mode. In this mode, the generator output voltage will go to whatever value necessary to produce the required set point current value. In the case where a particular load has a maximum voltage capability rating, the use of the HIGH-VOLTAGE OUTPUT LIMIT will provide a maximum applied voltage, even in the case of a misadjusted set-point current value.



Setting a DC Current Limit Value

This feature is operational in both the GENERATOR and AMPLIFIER modes.

The DC CURRENT LIMIT control provides an adjustable current limit value over a range of 0 to 5 mA DC load current using a calibrated 5-turn potentiometer. Each full turn represents a 1 mA limit to produce a 5 mA full scale limit.

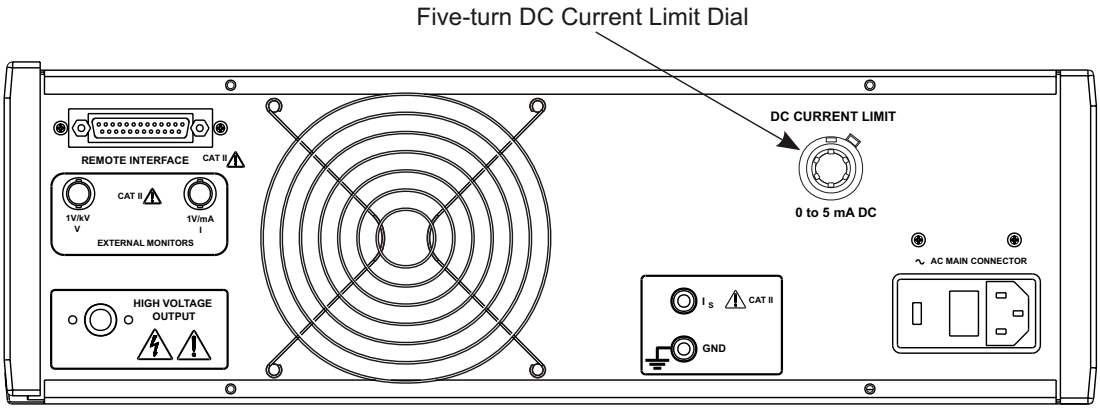


Figure 3-16: DC Limit Control Dial on Model 615-3 back panel.

Operation as an Amplifier

Using the AMPLIFIER Mode

For operation as a amplifier, the AMPLIFIER/GENERATOR mode switch is set to AMPLIFIER mode *and* the signal to be amplified is connected into the BNC AMPLIFIER IN connector on the front panel of the unit.

The Model 615-3 will amplify an input signal using the main components of the amplifier circuitry. The high-voltage ON/OFF control, the Master DC switch, the front panel DC voltage display, the front panel DC current display, and the DC Bias (polarities and settings) will operate in the AMPLIFIER mode.

When using the AMPLIFIER mode, the Constant Current and Constant Voltage capabilities do not function. The AMPLIFIER mode by-passes the following front panel controls and remote functions from operating:

> The AC Master Switch, the Waveform Selection Switch, the Frequency setting, the Constant AC Voltage Amplitude setting, the Constant AC Current Amplitude setting, and the front panel AC Monitor (display and switch).

I(t) and I(s) EXPLAINED

Current flowing from the high voltage output connector may be returned to the 615-3 by one of two paths.

These two return paths for the load current return are:

1. The rear panel I(s) terminal.

2. The rear panel I(t) terminal, which includes the power line ground, the chassis, and the rear panel ground terminal.

I(t) (total load current) refers to the total load current which is supplied through the HV output connector. Total load current, I(t), is monitored by the 615-3 and provides a means for close regulation and monitoring of the total load current using the [I(t) control mode].

The I(s) [shield current] terminal provides a virtual ground connection to return current to the 615-3. Any current supplied by the HV output connector which is returned to the I(s) terminal will not be measured (or monitored) as a component of I(t). Furthermore, because the I(s) component of I(t) is neither measured (or monitored) as a component of I(t), when the I(t) current control mode is used, the I(s) current will not be controlled. To illustrate this feature, please refer to Figure 1.

I(t) and I(s) EXPLAINED (cont.)

In figure 1, the Model 615-3 is configured to supply a constant output voltage of 10 kV. A 10 M load resistor connected between the HV output terminal and the virtual ground I(s) terminal will provide a +1.0 mA current load path.

Due to the connection of the 10 M load into the I(s) terminal, rather than ground, the I(t) monitors [either the panel DPM or external current monitor output (BNC) , will report zero I(t)current]. If the 10 M load is reconnected to ground, the I(t) will then report a +1.0 mA load current.

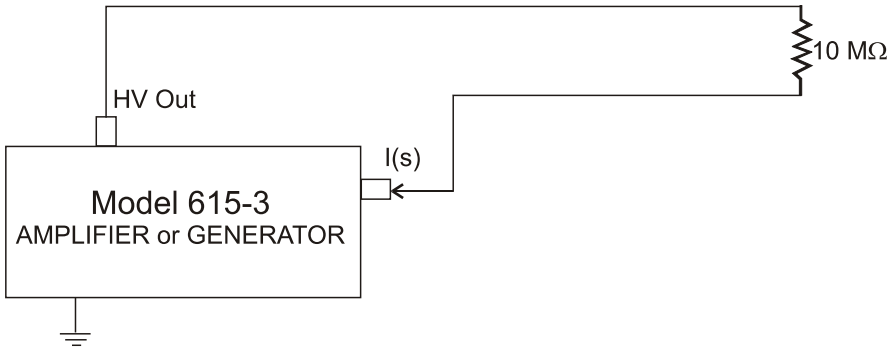


Figure 1: Model 615-3 regulated voltage without monitored current

This unique feature of the Model 615-3 can be used to advantage when using the 615-3 to energize typical xerographic Corotron as Scoratron air ionization devices. In these applications, it is desirable to cause the air ion current between the ion generating wire and the ground referenced xerographic surface (the OPC) to be constant.

Shown in Figure 2 is a 615-3 connected to a Corotron device. As shown, the ionization wire is connected to the HV output terminal, the Corotron shield is connected to the I(s)terminal, and the OPC substrate is connected to ground. Also shown are ammeters (A) used to measure I(t) the total current, I(s) the Corotron shield current, and I(opc) the OPC current to ground.

Upon turn-on of the 615-3, configured as an I(t) regulator, the value of I(t) will be tightly controlled by the 615-3 I(t) control mode. As I(s) the shield current, will not be measured as a component of I(t), it will not be controlled. However, I(opc) the component of I(t), which flows to ground will be measured and tightly controlled by the 615-3 I(t) control mode, thus achieving the desired result.

I(t) and I(s) EXPLAINED (cont.)

Due to the connection of the 10 M load into the I(s) terminal, rather than ground, the I(t) monitors [either the panel DPM or external current monitor output (BNC) , will report zero I(t)current]. If the 10 M load is reconnected to ground, the I(t) will then report a +1.0 mA load current.

This unique feature of the Model 615-3 can be used to advantage when using the 615-3 to energize typical xerographic Corotron as Scoratron air ionization devices. In these applications, it is desirable to cause the air ion current between the ion generating wire and the ground referenced xerographic surface (the OPC) to be constant.

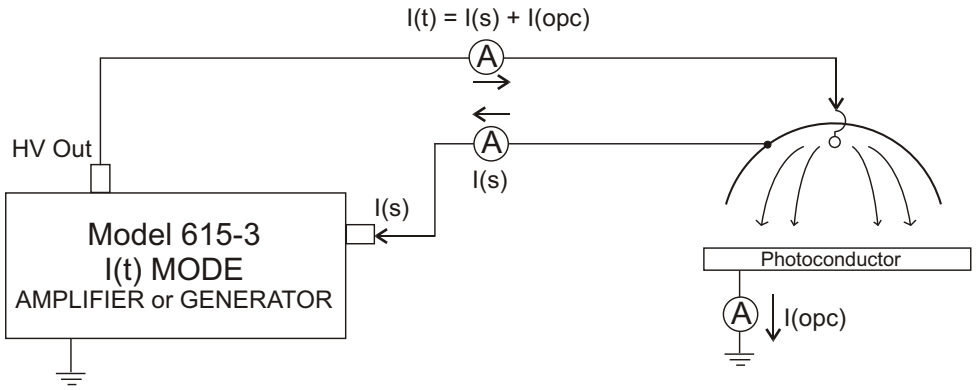


Figure 2: Typical "Corotron" control system

Shown in Figure 2 is a 615-3 connected to a Corotron device. As shown, the ionization wire is connected to the HV output terminal, the Corotron shield is connected to the I(s)terminal, and the OPC substrate is connected to ground. Also shown are ammeters (A) used to measure I(t) the total current, I(s) the Corotron shield current, and I(opc) the OPC current to ground.

Upon turn-on of the 615-3, configured as an I(t) regulator, the value of I(t) will be tightly controlled by the 615-3 I(t) control mode. As I(s) the shield current, will not be measured as a component of I(t), it will not be controlled. However, I(opc) the component of I(t), which flows to ground will be measured and tightly controlled by the 615-3 I(t) control mode, thus achieving the desired result.

I(s), although not measured by I(t) monitors, is still being supplied by the HV output therefore the sum of I(s) and I(opc) must be within the output current limitation of the 615-3.

I(t) and I(s) EXPLAINED (cont.)

As conventionally known, as the distance between the Corotron and the OPC surface changes (or as a change in air pressure or air temperature occurs) the value of I(opc) would normally change, however, the operation of this special 615-3 control technique will hold the I(opc) current constant over a wide ranges of spacing, temperature, and pressure.

Figure 3 shows a typical control system for a “Scoratron” device where the grid of the “Scoratron” is normally biased at some voltage value V(s) above (or below) ground by use of a zener diode (ZD) device. In AC applications, dual ZD devices are used to produce symmetrical voltage bias values. This Scoratron control system operates identically as the control system of Figure 2.

In this configuration, voltage V(s) is produced at the shield and grid due to the current returned through the zener device(s).

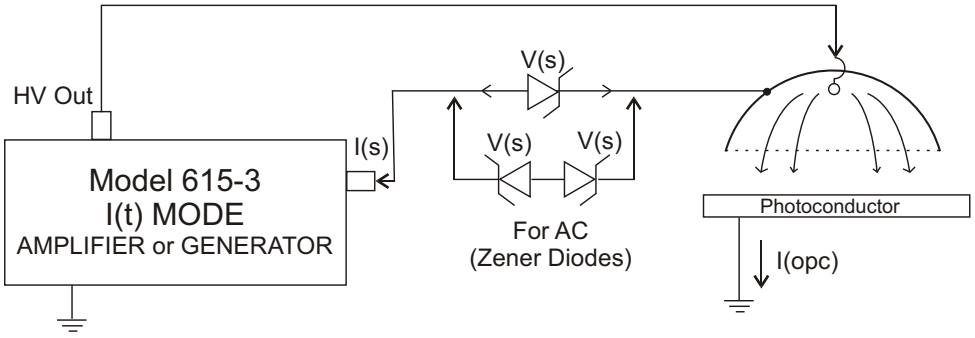


Figure 3: Typical control system for a “Scoratron” device

Section IV Specifications

Model 615-3 High-Voltage AC/DC Generator Specifications

OUTPUT (any mode)

AC Voltage (DC Bias is zero)	0 to 10 kV peak-to-peak.
DC Bias (AC voltage is zero)	0 to ±5 kV DC.
AC Voltage + DC Bias	0 to ±5 kV (combined AC and DC instantaneous voltage value).
AC Current (DC Current is zero)	0 to ±5 mA average*.
DC Current (AC current is zero)	0 to ±8 mA DC.
AC Current + DC Current	0 to ±8 mA peak.

$$*\text{AC current average} = \frac{(2)\ I_{peak}}{3.14}$$

Frequency	100 Hz to 10 kHz.

FEATURES

Amplifier Input Mode	A front panel BNC connector to input an external signal.
Current Range Switch	Selects current mode for 0 to 500 A or 0 to 5 mA.
High-Voltage AC Output Limit	Adjustable from 0 to 10 kV peak-to-peak for both Constant Current mode and Constant Voltage mode.

Specifications (cont.)

Features (cont.)

Internal AC Generator	An internal AC function generator is used to produce the AC output voltage (Constant AC Voltage mode) or the AC output current (Constant AC Current mode).
Waveform Options	Square, sine, or triangle.
Frequency Range	100 Hz to 10 kHz.
Local Operation	
Waveform Select	Front panel switch.
Frequency Adjustment	10-turn potentiometer with dial.
Remote Operation (20 Hz Resolution)	
Waveform Select	2-bit TTL compatible input.
Frequency Adjustment	A +0.1 to +10 V DC signal to produce 100 Hz to 10 kHz operation.
DC Current Output Limit	Adjustable from 0 to ±5 mA DC.
Accuracy	±5% of full scale.
Response Time	50 ms, typical at less than or equal to a 1 mA setting.
Dial Resolution	20 A.

Specifications (cont.)

Features (cont.)

Amplitude Ranges

Constant AC Voltage Mode	0 to 10 kV peak-to-peak.
Local Operation	10-turn potentiometer with dial for the Constant AC Voltage mode.
Dial Resolution	20 V peak-to-peak dial resolution.
Remote Operation	1 kV peak-to-peak per each applied DC volt ± 0.5% of full scale.

Constant Current Mode

Local Operation	5-turn potentiometer with dial for the Constant AC Current mode: 0 to 500 A average range, 2 µA dial resolution or 0 to 5 mA average range, 20 µA dial resolution.
Remote Operation	0 to 500 A average range, 50 A average per each applied DC volt ±5% of full scale. or 0 to 5 mA average range, 500 A average per each applied DC volt ±2 % of full scale.
Compliance Indicator	A LED will illuminate during an overvoltage condition when operating in the Constant AC Current mode or during an overcurrent condition when operating in the Constant AC Voltage mode.

Specifications (cont.)

Features (cont.)

High-Voltage On/Off

Local	A front panel switch.
Remote	A TTL compatible input.
Master DC Switch	Turns ON and OFF the DC generator.
Master AC Switch	Turns ON and OFF the AC generator.

Constant AC Voltage or Constant AC Current Mode Selection

Local Operation	A front panel switch.
Remote Operation	A TTL compatible signal applied to the Mode Select input of the Remote Interface connector.
DC Bias	Adjustable from 0 to ±5 kV DC.

Local

Level Adjustment	Two 0 to ±5 kV range 5-turn potentiometers with dials, one for the Constant Voltage mode and one for the Constant Current mode.
Polarity Selection	Two front panel switches, one for the Constant AC Voltage mode DC Bias and one for the Constant AC Current mode DC Bias.

Remote

Level Adjustment	A 0 to +10 V DC signal to produce 0 to 5 kV DC Bias.
Polarity Selection	A TTL compatible input.
Overload Indicator	A LED will illuminate when the output current limit is exceeded.

Specifications (cont.)

VOLTAGE AND CURRENT DISPLAYS AND MONITORS

AC Display — A 3½ digit LED display indicates the peak-to-peak value of the AC voltage output or the average AC current waveform (switch selectable).

Range

AC Voltage — 0 to 10.00 kV peak-to-peak.

AC Current — 0 to 5 mA average AC current.*

Resolution

AC Voltage — 10 V peak-to-peak.

AC Current — 10 µA average.

Accuracy — Better than 0.5% of full scale ±1 digit.

$$\text{*AC current average} = \frac{(2)\ I_{peak}}{}$$

DC Display — A 3½ digit LED display indicates either the level of the DC bias or the level of the DC load current (switch selectable).

Range

DC Voltage — 0 to ±5.00 kV DC.

DC Current — 0 to ±5.00 mA DC.

Resolution

DC Voltage — 10 V DC.

DC Current — 10 µA DC.

Accuracy — Better than 0.2% of full scale ±1 digit.

Specifications (cont.)

VOLTAGE AND CURRENT DISPLAYS AND MONITORS (cont.)

Voltage Monitor	A buffered output providing a low-voltage replica of the high-voltage output.
Scale	1/1000th of the high-voltage output.
DC Accuracy	Better than ±0.1% of full scale.
AC Accuracy	Calibrated using a Ross Model VD 30-4.1-BD-KC-ALU high-voltage divider
. **Offset Voltage**	Less than 2 mV.
Output Noise	Less than 10 mV rms (measured using the true rms feature of the Hewlett Packard Model 34401A digital multimeter).
Output Impedance	50 .

Current Monitor	A buffered output providing a low-voltage representation of the load current.
Scale	1 V/mA.
DC Accuracy	Better than ±0.2% of full scale.
Offset Voltage	Less than 2 mV.
Output Noise	Less than 20 mV rms (measured using the true rms feature of the Hewlett Packard Model 34401A digital multimeter).
Output Impedance	50 .

Specifications (cont.)

PERFORMANCE

Stability

Drift with Temperature	Less than 200 ppm/°C.
Line Regulation Effects	Less than 0.1% of full scale, nominal line ± 10%.
Load Regulation Effects	Less than 0.1% of full scale.
DC Bias Offset (Master DC switch off)	Less than 1 V DC.
Output Noise (Constant Voltage Mode)	Less than 2 V rms (measured using the true rms feature of the Hewlett Packard Model 34401A digital multimeter)

AMPLIFIER MODE SPECIFICATIONS

Input Voltage Range	0 to 5 V DC or peak AC.
Input Impedance	50 k .
Gain for Noninverting Voltage	1000 V/V.
DC Voltage Gain Accuracy	0.5% of full scale
Offset Voltage	Less than 1 V DC.
Output noise	Less than 2 V rms (measured using the true rms feature of the Hewlett Packard Model 34401A digital multimeter).
Slew Rate (10 to 90 %) typical	Greater than 80 V/µs.

Specifications (cont.)

AMPLIFIER MODE SPECIFICATIONS (cont.)

Large Signal Bandwidth, typical	DC to greater than 3 kHz with less than 1% distortion.
Small Signal Bandwidth (-3 db)	DC to greater than 10 kHz.

GENERAL SPECIFICATIONS

Dimensions	134 mm H x 432 mm W x 432 mm D (5.25" H x 17" W x 17" D)
Weight	15 kg (33 lb).
High-Voltage Output Connector	Alden high-voltage connector.
Voltage Monitor Connector	BNC coaxial connector.
Current Monitor Connector	BNC coaxial connector.
Front Panel Remote High Voltage On/Off Connector	BNC coaxial connector.
Amplifier Input	BNC coaxial connector.
Remote Interface Connector	25-pin “D” socket connector.
AC Line Receptacle	Standard three-prong AC line connector with an integral fuse holder.
Power Requirements	
Line Supply	90 to 127 V AC at 48 to 63 Hz (180 to 250 V AC at 48 to 63 Hz optionally available).
Power Consumption	100 VA.

Specifications (cont.)

GENERAL SPECIFICATIONS (cont.)

Operating Conditions

Temperature	15 °C to 35 °C.
Relative Humidity	To 85%, noncondensing.
Altitude	To 10,000 meters.

Certification

TREK, INC. certifies that each Model 615-3 is tested and calibrated to specifications using measurement equipment traceable to the National Institute of Standards and Technology or traceable to consensus standards.

Section V Maintenance

Safety

Observe the following safety precautions when performing maintenance procedures on the Model 615-3:

1. Refer all maintenance procedures to qualified personnel.

2. Always turn off the Model 615-3 and disconnect it from its power source before cleaning or inspecting it. Failure to observe this precaution could result in an electrical shock.

Maintenance Assistance

Customer Service Assistance

In the event that you require assistance on a maintenance item, direct your request for assistance to the Customer Service Group at TREK, INC. or an authorized Trek Service Organization (see Appendix D).

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 system should be returned to the factory or to an authorized Trek Service Organization.

Maintenance Assistance (cont.)

Repairs

The terms and conditions of the warranty are stated at the beginning of this manual.

Note: *The warranty is voided if the instrument is serviced within the warranty period by anyone other than TREK, INC. or one of its authorized Trek Service Organizations.*

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

1. Notify the Customer Service Group at TREK, INC., giving full details about the difficulty, including the model number and serial number of the instrument. The Customer Service Group will issue a return authorization number.

2. Forward the instrument (prepaid), with the return authorization number prominently displayed on the shipping container and the packing list, to TREK, INC.

   The instrument may also be returned to an authorized Trek Service Organization. Contact the service organization nearest you for details (see Appendix D).

Preventative Maintenance

Cleaning the Instrument

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

INSPECTION: Visually inspect the instrument for loose or damaged controls and connectors or other undesirable conditions.

CLEANING: Disconnect the unit from all external connections prior to cleaning. Clean the Model 615-3 as operating conditions require. Clean the exterior of the instrument with a soft cloth dampened with water. Use only water to dampen the cloth. The use of 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 Fuses

Refer servicing the fuses to qualified personnel.

Always replace the fuses with fuses of the same type and rating.

Always unplug the power cord from the power source before attempting to change the fuses.

Warning: *Never attempt to service the fuses when the instrument is plugged into the power source. An electrical shock could result.*

The line fuses are contained in a fuse holder which is an integral part of the power connector. These are the only fuses.

1. Remove the fuses from the fuse holder.

2. Replace any blown fuses with a 5 mm x 20 mm, time-lag (T), 2 A, 250 V fuse if operating the instrument with a 90 to 127 V AC power source or a 180 to 250 V AC power source.

If the instrument continually blows fuses, a more serious problem exists within the instrument. In this instance contact the Customer Service Group at TREK, INC. or an authorized Trek Service Organization.

Appendix A Accessories

Included Accessories

Item	Part Number
Operator's Manual	23186
High-Voltage Output Cable Assembly	43406
Line Cord (90 to 127 V AC operation)	N5002
Unterminated Line Cord (180 to 250 V AC operation)	*

Optional Accessories

Item	Part Number
High-Voltage Output Cable Assembly (5 meter)	43421
High-Voltage Output Cable Assembly (10 meter)	43422
High-Voltage Output Cable Assembly (20 meter)	43423
Rack Mount Hardware	Contact Factory

* Line cord type is determined by the geographical destination for the unit.

Appendix B Warranty Statement

Instruments sold by TREK, INC. (hereinafter called the "Company") are warranted only as stated below:

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or in the Company's sole discretion, by replacement, any defect of material or workmanship which develops within one year from the date of original purchase by the customer (user), provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use. Repair or replacement are the exclusive remedies under this warranty (batteries are not included under this warranty).

The exceptions and conditions mentioned are as follows:

(a) The Company makes no warranty concerning components or accessories not manufactured by itself.

(b) The Company is released from all obligations under this warranty in the event that repairs or modifications are made by persons other than its own or authorized personnel, unless such repairs by others are made with the prior written consent of the Company. In the event of a failure, and the customer neglects to take prompt and reasonable actions to prevent further damage, the Company cannot be responsible for consequent damage.

(c) THERE ARE NO OTHER WARRANTIES WHICH EXTEND BEYOND THOSE EXPRESSLY PROVIDED FOR HEREIN AND THE AFORESAID WARRANTY AND THE COMPANY'S OBLIGATIONS AND LIABILITIES THEREUNDER ARE IN LIEU OF, AND CUSTOMER WAIVES ALL OTHER WARRANTIES AND GUARANTEES AND ALL OTHER LIABILITIES THEREFORE, EXPRESS OR IMPLIED, ARISING BY LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND ALL OBLIGATIONS AND LIABILITIES WITH RESPECT TO LOSS OF USE, REVENUE OR PROFIT, OR INDIRECT, CONSEQUENTIAL OR INCIDENTAL DAMAGES OF ANY KIND AND FROM ANY CAUSE WHATSOEVER ARISING OUT OF OR IN ANY WAY CONNECTED WITH THE MANUFACTURE, SALE, HANDLING, REPAIR, MAINTENANCE OR REPLACEMENT OF SAID PRODUCTS.

(d) Representation and warranties made by any person, including dealers and representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including, but not limited to, the limitations of the liability of the Company as set forth above), shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(e) This warranty shall be governed by the laws of the State of New York.

Appendix C Authorized Sales Organizations

Please go to our web site: www.trekinc.com for the latest listing of our sales and service representatives.

Inside the United States

Keyser Technology
Territory: CO, NM, AZ, UT, NV
7200 Montgomery NE
Suite 335
Albuquerque, NM 87109
Tel: (505) 867-3975

High Voltage Connection, Inc.
Territory: MA, ME, NH, VT, RI, CT
8 Morning Glory Circle
Westford, MA 01886
Tel: (978) 692-1385
Fax: (978) 692-1378

RDX Corporation
Territory: CA
17096 Sequoia Street, Suite 101
Hesperia, CA 92345
Tel: (760) 947-5282
Fax: (760) 947-5482

Outside the United States

BFI Optilas BV
Territory: Netherlands, Belgium, Luxembourg
P.O. Box 222
2400 AE Alphen aan den Rijn
The Netherlands
Tel: 31 172 44 60 60
Fax: 31 172 44 34 14

BFI Optilas GmbH
Territory: Germany, Austria, Switzerland
Boschstrasse 12
82178 Puchheim-Bhf, Germany
Tel: 49 89 8901350
Fax: 49 89 8002561

BFI Optilas LTD
Territory: United Kingdom
Mill Square, Featherstone Road
Wolverton Mill South
Milton Keynes MK12 5ZY England
Tel: 44 1908 326326
Fax: 44 1908 221110

BFI Optilas Nordic Operations
Territory: Denmark, Finland, Norway, Sweden
Hedelykke, Hovedgaden 451K
DK-2640 Hedehusene, Denmark
Tel: 45 4655 9999
Fax: 45 4655 9998

BFI Optilas S.A.
Territory: France
4 allée du Cantal
ZI La Petite Montagne Sud
C.E. 1834-91018 Evry Cedex, France
Tel: 33 1 60 79 59 00
Fax: 33 1 60 79 89 02

BFI Optilas S.A.
Territory: Spain and Portugal
Anabel Segura, 7 Planta Acceso
28108 Alcobendas, Madrid, Spain
Tel: 34 91 453 11 60
Fax: 34 91 662 68 37

BFI Optilas S.p.A.
Territory: Italy
Via Brembo 27
20139 Milano, Italy
Tel: 39 02 53583209
Fax: 39 02 53583229

Outside the United States (cont.)

En-Centrum, LTD
Territory: Czech Republic, Slovakia, Hungary
Radlicka 2 / schranka 69
CZ - 150 23 Prague 5
Czech Republic
Tel: 420 2 5732 2538
Fax: 420 2 5156 0202

Pro-Pack Materials PTE LTD
Territory: Singapore, Malaysia, Thailand
BLK 970 Toa Payoh North
#04-18 Toa Payoh Industrial Estate
Singapore 318992
Tel: 65 6 354 1511
Fax: 65 6 354 1711

Quatek Co LTD
Territory: Taiwan, Guang Dong China
4th Fl., 308 Sec. 1 Nei-Hu Road
Nei Hu, Taipei, Taiwan 114, ROC
Tel: 886 2 27973357
Fax: 886 2 27973957

Scientific Devices Australia PTY LTD
Territory: Australia
118 Atkinson Street
Oakleigh Vic 3166
Australia
Tel: 61 395691366
Fax: 61 395634728

Supervy Sistemas, SA de CV
Territory: Mexico
Circuito Bahamas No. 9-16
Col. Lomas Estrella- Iztapalapa
Mexico, D.F.
APDO Postal 150-076
Tel: 52 55 5656 3864
Fax: 52 55 5656 6156

Suplitec LTD
Territory: Brazil
Rua Sena Madureira 495
31340-000 Belo Hte - MG Brazil
Tel: 55 31 3498 1177
Fax: 55 31 3441 0841

Trek Japan KK
Territory: Japan
Sumitomo Gotanda Building
7-1-1, Nishi Gotanda, Shinagawa-ku
Tokyo 141-0031 Japan
Tel: 81 3 5496 0220
Fax: 81 3 5496 0670

Appendix D Authorized Service Organizations

Please go to our web site: www.trekinc.com for the latest listing of our sales and service representatives.

BFI Optilas BV

P.O. Box 222
2408 AE Alphen aan den Rijn
The Netherlands

Tel: 31 172 44 60 69
Fax: 31 172 44 34 14

Quatek Co LTD

Territory: Taiwan, Guang Dong China
4th Fl., 308 Sec. 1 Nei-Hu Road
Nei Hu, Taipei, Taiwan 114, ROC

Tel: 886 2 27973357
Fax: 886 2 27973957

Trek Japan KK

Sumitomo Gotanda Building
7-1-1, Nishi Gotanda, Shinagawa-ku
Tokyo 141-0031 Japan

Tel: 81 3 5496 0220
Fax: 81 3 5496 0670