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INSTRUCTION MANUAL

El Manual de la Instrucción

BK PRECISION

MODELS 1651A & 1652

MODELOS 1651A & 1652

Triple Output DC POWER SUPPLY

FUENTES DE PODER
De Triple Salida DC

BK PRECISION

TEST INSTRUMENT SAFETY

WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must sometimes be performed where exposed high voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Higher voltages are even more dangerous. Your normal work habits should include all accepted practices to prevent contact with exposed high voltage, and to steer current away from your heart in case of accidental contact with a high voltage. Observe the following safety precautions:

1. There is little danger of electrical shock from the dc output of this power supply. However, there are several other possible test conditions using this power supply that can create a high voltage shock hazard:
   a. If the equipment under test is the “hot chassis” type, a serious shock hazard exists unless the equipment is unplugged (just turning off the equipment does not remove the hazard), or an isolation transformer is used.
   b. If the equipment under test is “powered up” (and that equipment uses high voltage in any of its circuits), the power supply outputs may be floated to the potential at the point of connection. Remember that high voltage may appear at unexpected points in defective equipment. Do not float the power supply output to more than 100 volts peak with respect to chassis or earth ground.
   c. If the equipment under test is “off” (and that equipment uses high voltage in any of its circuits under normal operation), discharge high-voltage capacitors before making connections or tests. Some circuits retain high voltage long after the equipment is turned off.
2. Use only a polarized 3-wire ac outlet. This assures that the power supply chassis, case, and ground terminal are connected to a good earth ground and reduces danger from electrical shock.

3. Don’t expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after removing power.

(continued on inside back cover)

Instruction Manual

Triple Output
DC POWER SUPPLY

22820 Savi Ranch Parkway
Yorba Linda, CA 92887

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TABLE OF CONTENTS

INTRODUCTION

The **B & K-Precision** Models 1651A & 1652 Triple Output DC Power Supplies are high quality, general purpose dc power sources. They provide two supplies with a 0-24 volt dc output and one with a fixed 5 volt dc output. The 0-24V supplies are adjustable and are capable of current output of 0-0.5 amp. The fixed 5V supply has a current output of 0-4 amps, allowing it to handle extensive digital logic circuitry. Two panel mounted meters can simultaneously monitor the output current and output voltage of either of the 0-24V supplies.

The two 0-24 volt supplies can be operated independently or in one of two tracking modes. In the series tracking mode, the "B" supply tracks the voltage of the "A" supply. In the series tracking mode the "A" and "B" supplies are connected in series, allowing a single output of 0-48V at up to 0.5 amps. In the parallel tracking mode, the two supplies are connected in parallel, allowing a single 0-24V output at up to 1 amp.

Both 0-24 volt supplies may be used in constant voltage or constant current applications. The crossover from constant voltage to constant current modes is smooth and automatic. LED's indicate the Constant Current mode of operation. In constant voltage applications, a current limit may be preset. When load variations cause the current to reach the preset limit, the unit then regulates output current rather than output voltage. Current limits are adjustable from 6% to 100% of maximum. In constant current applications, the maximum voltage may be preset. When load variations cause current to drop below the regulated value, the unit reverts to regulated voltage operation at the preset value.

The fixed 5V supply is ideal for powering digital logic circuitry. The 0-4 amp capacity allows the supply to be used for large circuits. Built-in overload protection automatically limits the current output to a maximum of 4 amps. An LED indicator lights when the supply is overloaded.

These supplies exhibits excellent regulation and low ripple characteristics. The circuit design incorporates a pre-regulator, which greatly reduces internal power dissipation at low output voltages.

Reverse polarity protection prevents accidental damage to the power supply from improper connection to an external voltage, and current limiting protects the equipment being powered, as well as the power supply.

The output is isolated from chassis and earth ground, which permits full flexibility of connections. When needed, the (+) or (-) polarity may be strapped to ground, or either polarity may be floated to an external voltage. Additionally, the two "main" volt supplies can be used as a "split supply" with two positive voltages and a common negative, two negative voltages and a common positive, or one positive, one negative, and a common. All of these configurations can be used with either matching (tracking) or differing (independent) voltages.

INTRODUCTION

The features and versatility of these units, especially the triple output and tracking features, make them an ideal general purpose power supply for engineering lab applications. They can serve as a single or multi-voltage power source, including the bias supply, for breadboard and prototype circuits and equipment. They can provide single or simultaneously varying voltages for circuit evaluation. They can provide tracking (+) and (-) voltages for evaluating differential amplifiers. They may be used as a battery eliminator, or to power individual circuit boards or cards while removed from the system. Their output can be evaluated while powering a breadboard or prototype circuit to determine the circuit's power supply requirements. Their laboratory quality specifications will meet most engineering laboratory requirements.

The same features that make the Model 1651A and 1652 a good choice for an engineering lab also make them a good choice for most other solid state electronic applications. These applications include service shops; industrial production testing of components, assemblies, and complete equipment; for school laboratories, and home use by electronic hobbyists.

FEATURES

TRIPLE OUTPUT

Operates as three separate power supplies. Each has floating output and is completely isolated from the other two.

ONE FIXED 5V SUPPLY

0-to-4 amp fixed 5 volt supply is ideal for use with most digital logic circuitry. Adequate current capacity for extensive circuitry.

TWO 0-24 VOLT SUPPLIES

"A" and "B" supplies are continuously variable over 0-to-24 volt range. Each supply 0.5 amp current capacity.

UNIQUE TRACKING FEATURE

The two 0-to-24 V supplies can be operated so that the "B" supply tracks the "A" supply. Outputs can be strapped for two positive voltages with a common negative, two negative voltages with a common positive, or one positive and one negative with a neutral common.

SINGLE 0-48V SUPPLY

Series tracking feature allows use of "A" and "B" supplies as one 0-to-48 V, 0.5 amp supply.

SINGLE 0-24V 1 AMP SUPPLY

Parallel tracking feature allows use of "A" and "B" supplies as a 0-to-24 V supply with a 1 amp current capacity (through "A" output terminals).

CONSTANT VOLTAGE OR CONSTANT CURRENT

The "A" and "B" supplies provide regulated dc voltage output or regulated dc current output. Crossover is smooth and automatic.

METERING

Two, easy-to-read meters monitor output voltage and output current of the "A" and "B" supplies. Use of two meters allows simultaneous current and voltage metering when using "A" and "B" supplies in tracking or independent operation.

LABORATORY QUALITY

Excellent regulation, low ripple.

LED INDICATORS

Identify mode of operation.

PRE-REGULATOR

Limits internal dissipation for higher reliability and efficiency.

FEATURES

ISOLATED OUTPUT

Either polarity may be floated or grounded

OVERLOAD PROTECTION

Fully adjustable current limiting (from 6% to 100% of maximum output current) for “A” and “B” supplies protects circuit under test and the power supply

REVERSE POLARITY PROTECTION

Prevents damage to power supply from external voltage of reverse polarity.

HOOK-UP CABLES

Supplied with three sets of red and black hook-up leads.

SPECIFICATIONS

"A" AND "B" SUPPLIES

Output Voltage Range:
0V to 24VDC (0 ± 100mV)

Output Current Limit Range:
0 to 0.5A.

Constant Voltage Operation:

Voltage Regulation:	
Load:	≤0.01% + 3mV
Line (108 – 132V):	≤0.01% + 3mV
Ripple Noise:	≤2mVrms (5Hz to 1MHz)
Recovery Time:	≤100us typical.
Temp. Coefficient	
0°C to 40°C	≤300ppm/°C
Tracking Error:	
No Load:	≤0.2% + 20mV
Full Load:	≤0.2% + 100mV

Constant Current Operation:

Adjustable Current Limits:	≤30mA to ≥500mA
Current Regulation:	
Load:	≤0.2% + 6mA.
Line (108 – 132V):	≤0.2% + 3mA.
Ripple Current and Noise:	≤3mA rms.

Metering ("A" & "B" only):

Voltmeter:	
Range:	0 to 25V
Accuracy:	≤2.5% of Full Scale ±2% + 2 digits (1652)
Ampmeter:	
Range:	0 to 600mA
Accuracy:	≤2.5% of Full Scale ±2% + 2 digits (1652)

SPECIFICATIONS

FIXED 5V SUPPLY

Output Voltage:	5V ± 100mV.
Maximum Current:	≥4A.
Load Regulation:	≤10mV.
Line Regulation 108 – 132 V:	≤5mV
Ripple And Noise:	≤5mV rms (5 Hz to 1 MHz)
Overvoltage Protection Threshold:	5.7 to 6.5 V

GENERAL

Power Requirements:	100/120/220/240VAC ±10%, 50/60Hz.
Power Consumption:	165VA.
Protection:	Reverse polarity, overvoltage and current limiting.
Temperature Range & Humidity:	
Operation:	0°C to 40°C <80% R.H.
Storage:	-20°C to 60°C <70% R.H.
Dimensions (HxWxD):	4.5 x 11.75 x 10.375" (114 x 298 x 264 mm)
Weight:	4.8 kg (10.6 lbs)
Accessories Supplied:	Hook-Up Cables, 3 pair (Black & Red). Power Cord. Spare Fuse. Instruction Manual

NOTE: Specifications and information are subject to change without notice. Please visit www.bkprecision.com for the most current product information.

CONTROLS AND INDICATORS

1. **POWER Switch.** Turns power on and off.

2. **Power ON light**. Red LED lights to indicate a power on condition.

3. **GND Terminal (Green)**. Earth and Chassis Ground.

4. **A/B Metering Switch.** Selects simultaneous Voltage & Current metering for the **"A"** or **"B"** supplies. When in the A position, the V and mA meters are connected to the "A" supply. When in the B position, the V and mA meters are connected to the "B" supply.

5. **V Meter.** Indicates voltage on the "A" or "B" supply depending on the position of the A/B Metering switch.

6. **mA Meter.** Indicates current on the "A" or "B" supply depending on the position of the A/B Metering switch.

7. **Zero Adjusts.** Mechanical zero adjusts for the V & mA Meters thru the front panel with a slotted screwdriver.

8. **TRACKING/INDEPENDENT Mode Switch:** Three Position switch that selects INDEPENDENT mode, PARALLEL TRACKING mode, or SERIES TRACKING mode of the "A" and "B" supplies as follows:
   a. When the switch is in the right position, the unit is in the INDEPENDENT mode and the "A" and "B" power supplies are completely independent from one another.
   b. When the switch is in the middle position, the unit is in the PARALLEL TRACKING mode. In this mode the "A" and "B" supplies are wired together in parallel and both the maximum current and voltage are set using the "A" controls. The "A" and "B" outputs can be used as two individual (but tracking) power supplies or just the "A" output can be used as a 0-to-24 volt supply with a 1 A capability.
   c. When the switch is in the left position, the unit is in the SERIES TRACKING mode. In this mode, maximum voltage of both supplies is set using the "A" VOLTAGE controls (voltage at output terminals of the "B" supply tracks the voltage at the output terminals of the "A" supply). Also, in this mode of operation the positive terminal (red) of the "B" supply is internally connected to the negative terminal (black) of the "A" supply. This allows the two supplies to be used as one 0-to-48 volt supply.

"A" SUPPLY CONTROLS AND INDICATORS

9. **VOLTAGE Control.** Adjusts the output voltage of the "A" supply. Also functions as the adjustment control for the maximum output voltage of the "B" supply when either parallel or series tracking mode is selected. Voltage can be read from the V Meter when the A Metering mode is selected.

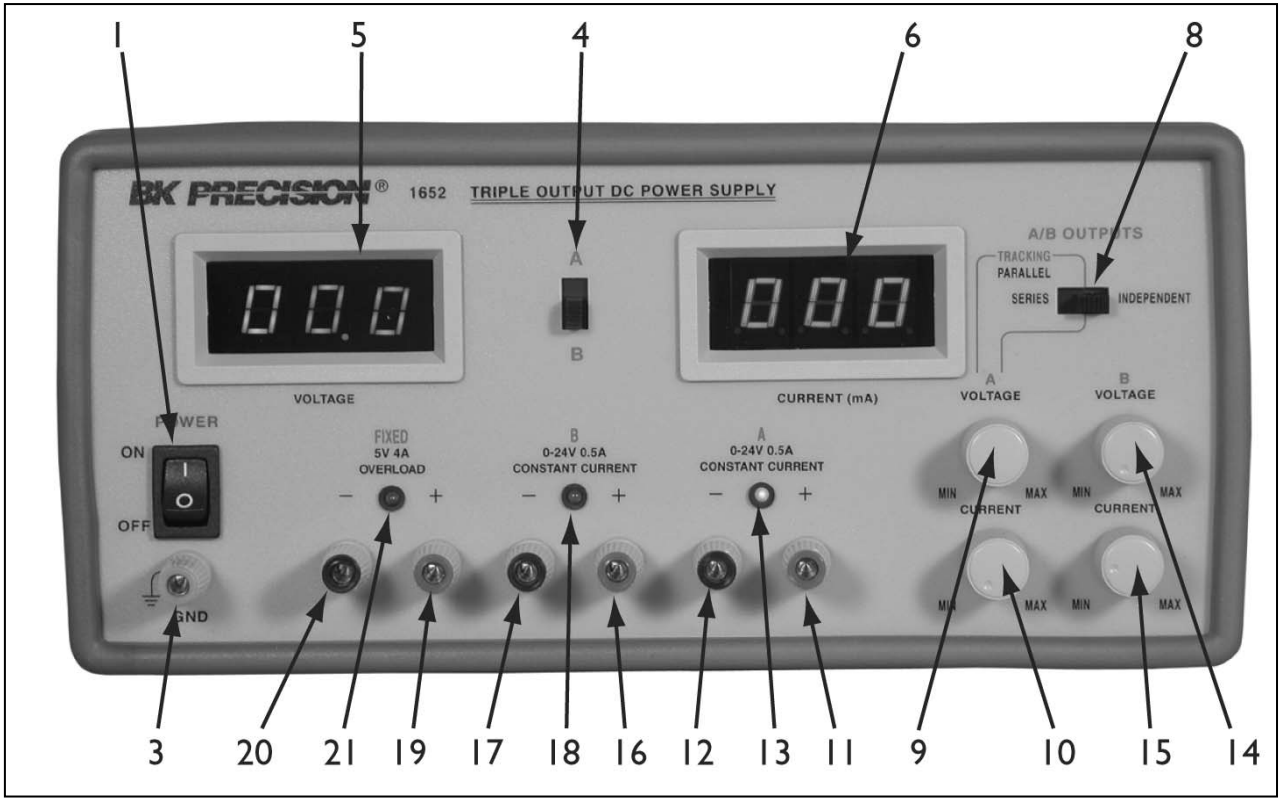

Figure 1. Front panel controls and indicators

10. **CURRENT Control.** Adjusts current limit of **"A"** supply in constant voltage mode. Adjusts constant current value of **"A"** supply in constant current mode. Adjusts the constant current value of the "B" supply when either SERIES or PARALLEL TRACKING is selected. Current can be read from the mA Meter when the A Metering mode is selected.
11. **"+" Terminal (Red).** Positive polarity output terminal for the **"A"** supply. Also serves as the positive polarity terminal for 0-to-48 V, 1A parallel tracking and 0-to-48 V, 0.5A series tracking operation.
12. **"-" Terminal (Black).** Negative polarity output terminal for the **"A"** supply. Also serves as the negative polarity terminal for 0-to-24 V, 1 A parallel tracking operation. In series tracking operation, this terminal is internally tied to the (+) positive terminal of the **"B"** supply.
13. **CONSTANT CURRENT Indicator.**
    a. Red LED lights when "A" supply is in the Constant Current mode. The Power Supply regulates the output current at the value set by the "A" CURRENT control. In the Parallel Tracking mode, when this indicator is lit, both the "A" and "B" supplies are in the Constant Current mode.
    b. When the LED is off, the "A" supply is in the Constant Voltage mode. The Power Supply regulates the output voltage at the value set by the "A" VOLTAGE controls. In either the Series or Parallel Tracking mode, when this indicator is off, both the A"A and "B" supplies are in the Constant Voltage mode.

"B" SUPPLY CONTROLS AND INDICATORS

14. **VOLTAGE Control.** Adjusts the output voltage of the "B" supply when the INDEPENDENT mode is selected. Voltage can be read on the V Meter when the B Metering mode is selected. Control is disabled when TRACKING mode is selected.
15. **CURRENT Control.** Adjusts current limit of "B" supply in constant voltage mode. Adjusts constant current value of "B" supply in constant current mode. Current can be read from the mA Meter when the current mA Metering mode is selected. Control is disabled when TRACKING mode is selected.
16. **"+" Terminal (Red).** Positive polarity output terminal for the "B" supply. In series tracking operation, this terminal is connected to the negative terminal of the "A" supply.
17. **"-" Terminal (Black).** Negative polarity output terminal for the "B" supply. Also serves as the negative polarity terminal for 0-to-48 V series tracking operation.
18. **CONSTANT CURRENT Indicator**
    a. Red LED lights when "B" supply is in the Constant Current mode. The Power Supply regulates the output current at the value set by the "B" CURRENT control when in the Independent mode.
    b. When LED is off, the "B" supply is in the Constant Voltage mode.

FIXED 5V SUPPLY TERMINALS AND INDICATOR

19. **"+" Terminal (Red).** Positive polarity output terminal for FIXED 5V supply.
20. **"-" Terminal (Black).** Negative polarity output terminal for FIXED 5V supply.
21. **OVERLOAD Indicator.** Lights when load on FIXED 5 Volt supply becomes too large.

REAR PANEL CONTROLS

22. **LINE VOLTAGE SELECT Switches.** Combination settings allow Universal Power Operation;
23. **Line Cord Receptacle. Fuse.**

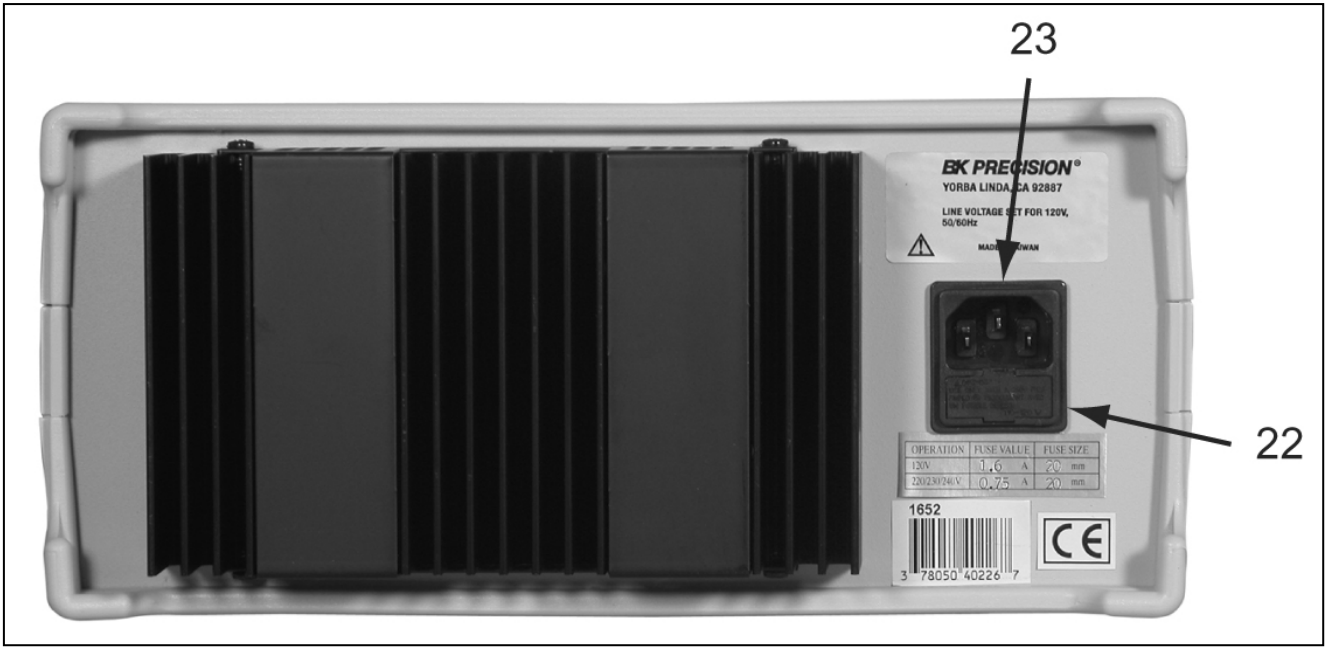

Figure 2. Rear panel controls.

SAFETY PRECAUTIONS

CAUTION

Avoid contacting the heat sink at the rear of the power supply. When the unit is providing large amounts of current at any or all of its outputs, the heat sink can become very hot. Contacting the heat sink when it is hot could result in skin burns or damage to the equipment in contact with them.

Use only a polarized 3-wire ac outlet. This assures that the power supply chassis, case, and ground terminal are connected to a good earth ground and reduces danger from electrical shock.

There may be great danger of electrical shock if the power supply output is connected to an external high voltage. Some equipment being powered may contain high voltage and present a shock hazard. Observe caution. If the power supply output is floated (referenced to a voltage rather than earth ground) turn off the power supply and the equipment under test when making connections. Never float the power supply to a potential greater than 100 volts peak with respect to earth ground.

EQUIPMENT PRECAUTIONS

Avoid using the power supply in ambient temperatures above +40° C. Always allow sufficient air space around the heat sink at the rear of the power supply for effective radiation to prevent internal heat build-up.

Although the power supply is protected against reverse polarity damage, the circuit being powered may not include such protection. Always carefully observe polarity; incorrect polarity may damage the equipment under test.

Do not exceed the voltage rating of the circuit being powered. Many transistors and integrated circuits will not withstand voltage of 30 volts.

There is no need to worry about voltage spikes or overshoot damaging the equipment under test. The voltage between the output terminals of the power supply never exceeds the preset value as the **POWER** switch is turned on or off.

INDEPENDENT USE OF "A" OR "B" SUPPLY

The **"A"** and **"B"** supplies each provide a 0-to-24 volt output at up to 0.5 amps. This procedure covers the use of the **"A"** and **"B"** supplies only when they are used independently from one another. When used in the **INDEP**endent operating mode, the operating controls of the two power supplies are completely independent and either supply can be used individually or both can be used simultaneously. Basic operation is covered here. Several variations are covered in the APPLICATIONS section of this manual.

Hook-up

3. Set the **INDEPENDENT/TRACKING** mode switch to the right position so that the power supply is in the **INDEP**endent operating mode.
4. Set the A/B Metering selection switch to the A (up) position to monitor the "A" supply.
5. Turn off the power supply and the equipment to be powered during hook-up.
6. Connect the positive polarity of the device being powered to the red (+) terminal of the power supply.
7. Connect the negative polarity of the device being powered to the black (-) terminal of the power supply.
8. Fig. 3 illustrates the grounding possibilities when used in the **INDEP**endent mode.
   a. If the negative polarity of the equipment or circuit being powered is also the chassis or common, it may be grounded to earth by strapping the black (-) terminal to the green (GND) terminal as shown in Fig. 3A.
   b. Similarly, the positive polarity can be grounded by strapping the red (+) terminal to the green (GND) terminal as shown in Fig. 3B.
   c. If an earth ground reference is not required, the configuration of Fig. 3C may be used. The scheme in Fig. 3C should also be used where it is not known whether the chassis is common with either the positive or negative polarity.
   d. If the chassis or common of the equipment being powered is separate from both the positive and negative polarity power inputs, use the connection shown in Fig. 3D.

1. Observe proper polarity. If the circuit being powered is not equipped with reverse polarity protection, damage to the circuit can result from reverse polarity. Use color coded hook-up leads, for convenience in identifying polarity, red for (+) and black for (-).
2. Make sure that the hook-up leads offer sufficient current capability and low resistance between the power supply and the circuits being powered. The hook-up leads supplied with the power supply are rated for 4 amp.

Typical Constant Voltage Operation

1. Before connecting the device to be powered to the power supply, determine the maximum safe load current for the device to be powered and set the current limit value (see "Setting Current Limit" procedure in this section).
2. Set the A/B Meter selection switch to the A (up) position to monitor the "A" supply.
3. Set **VOLTAGE** control to minimum (fully counterclockwise).
4. Turn off power supply and connect it to the device to be powered (see "Hook-Up" procedure in this section).
5. Turn on **POWER** switch. The **CONSTANT CURRENT** indicator should not light.
6. Increase the **VOLTAGE** setting until the Volt meter reads the desired value.
7. The load current is read directly on the mA meter.

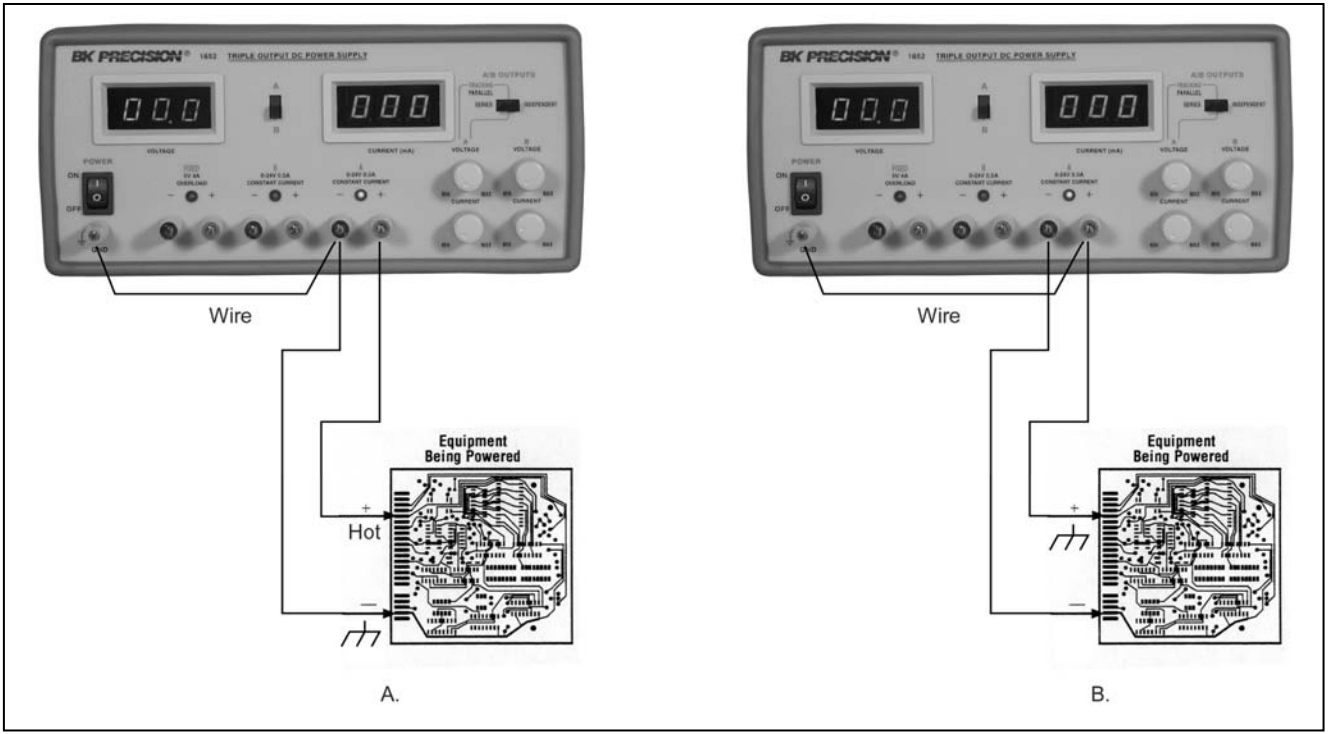

Figure 3. Independent operation grounding possibilities (sheet 1 of 2)

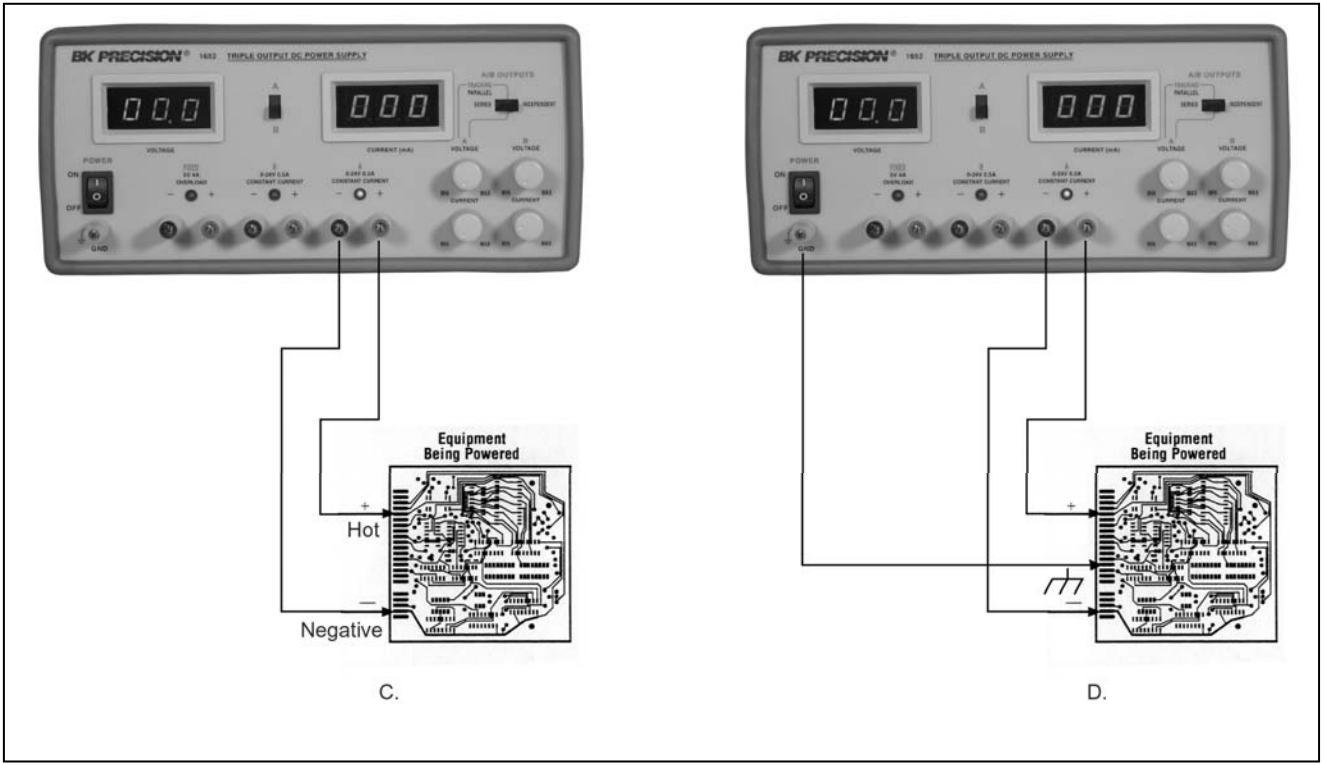

Figure 3. Independent operation grounding possibilities (sheet 2 of 2)

8. If the load current exceeds the preset current limit, the CONSTANT CURRENT indicator will light. In this case, the power supply automatically switches to the constant current mode and further rotation of the VOLTAGE control will not increase the output voltage.

Setting Current Limit

1. Determine the maximum safe current for the device to be powered.
2. Temporarily short the (+) and (-) terminals of the power supply together with a test lead.
3. Rotate the **VOLTAGE** control away from zero sufficiently for the **Constant Current** indicator to light.
4. Adjust the **CURRENT** control for the desired current limit. Read the current value on the mA meter.
5. The current limit (overload protection) has now been preset. Do not change the **CURRENT** control setting after this step.
6. Remove the short between the (+) and (-) terminals and hook up for constant voltage operation.

Typical Constant Current Operation

1. Before connecting the device to be powered to the power supply, determine the maximum safe voltage to be applied, set the A/B Meter s election switch to the A (up) position, and set the VOLTAGE control to obtain that voltage reading on the Volt meter.
2. Determine the desired constant current value.
3. Set the CURRENT control to minimum (fully counterclockwise).

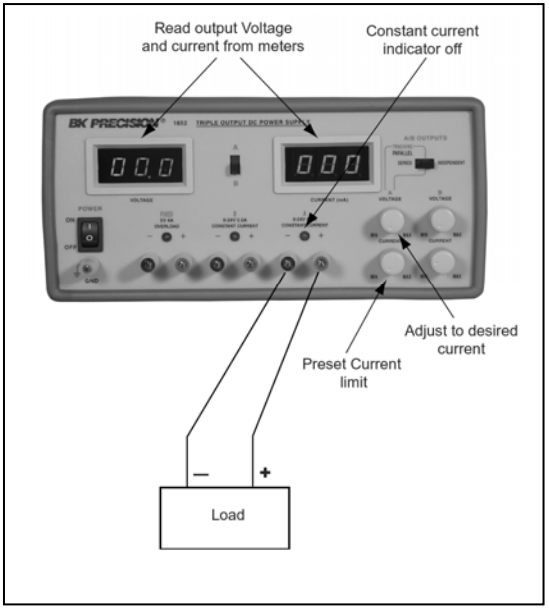

Figure 4. Typical constant voltage operation

4. Turn off the power supply and connect it to the device to be powered.
5. Turn on the power supply. The CONSTANT CURRENT indicator should light.
6. The current can be read directly on the mA meter.

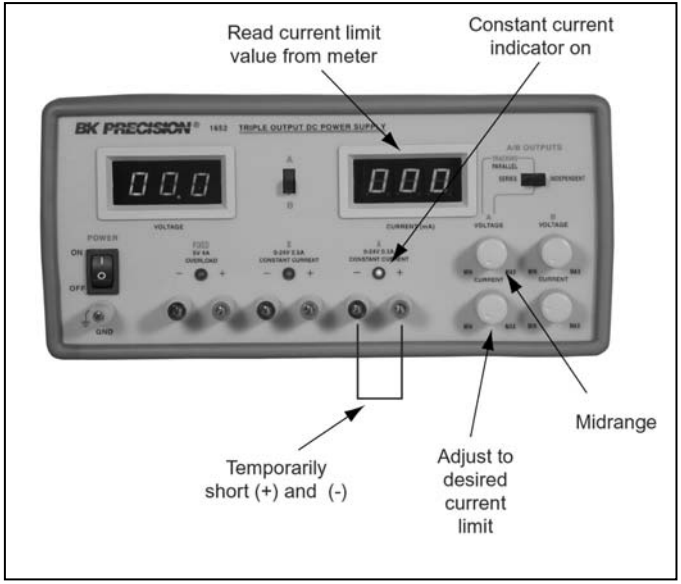

Figure 5. Setting Current limit.

7. Increase the CURRENT control setting until the desired constant current value is read on the display, or set the current limit in advance (before connecting the load) as prescribed earlier in the "Setting Current Limit" procedure.

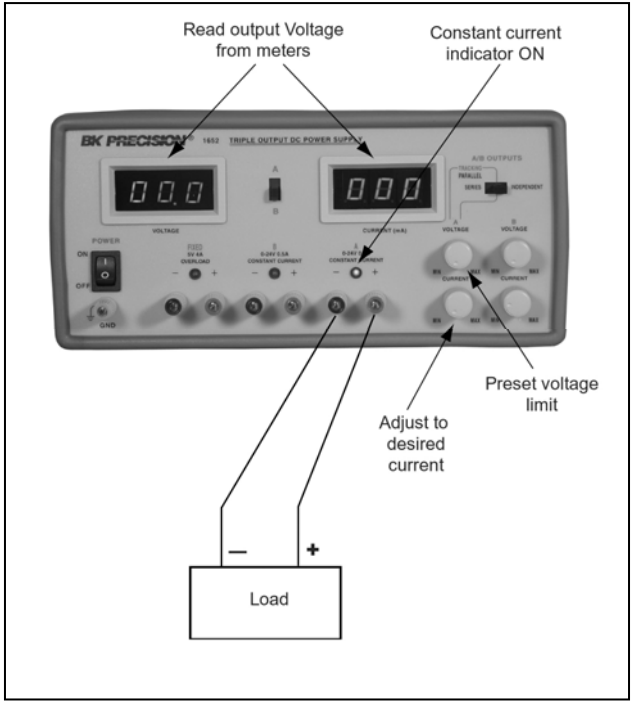

Figure 6. Typical constant current operation.

8. If the load current drops below the constant current value, the CONSTANT CURRENT indicator will go off. In this case, the power supply automatically switches to the constant voltage mode, and further rotation of the CURRENT control will not increase the output current.

Constant Voltage/Constant Current Characteristic

The working characteristic of this power supply is called a constant voltage/constant current automatic crossover type. This permits continuous transition from constant current to constant voltage modes in response to the load change. The intersection of constant voltage and constant current modes is called the crossover point. Fig. 7 shows the relationship between this crossover point and the load.

For example, if the load is such that the power supply is operating in the constant voltage mode, a regulated output voltage is provided. The output voltage remains constant as the load increases, up until the point where the preset current limit is reached. At that point, the output current becomes constant and the output voltage drops in proportion to further increases in load. The crossover point is indicated by the front panel LED indicators. The crossover point is reached when the **CONSTANT CURRENT** indicator comes on.

Similarly, crossover from the constant current to the constant voltage mode automatically occurs from a decrease in load. A good example of this would be seen when charging a 12-volt battery. Initially, the open circuit voltage of the power supply may be preset for 13.8 volts. A low battery will place a heavy load on the supply and it will operate in the constant current mode, which may be adjusted for a 0.5 amp charging rate. As the battery becomes charged, and its voltage approaches 13.8 volts, its load decreases to the point where it no longer demands the full 0.5 amp charging rate. This is the crossover point where the power supply goes into the constant voltage mode.

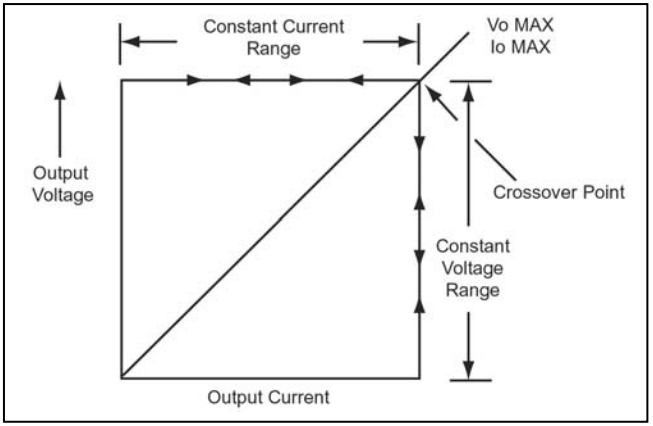

Figure 7. Constant voltage/constant current characteristic.

SERIES TRACKING OPERATION

When the series tracking mode of operation is selected, the positive (red) terminal of the **"B"** supply output is internally connected to the negative (black) terminal of the **"A"** supply. This allows the power supply to be used as a single 0-to-48 volt power supply simply by using the negative (black) terminal of the **"B"** supply and the positive (red) terminal of the **"A"** supply.

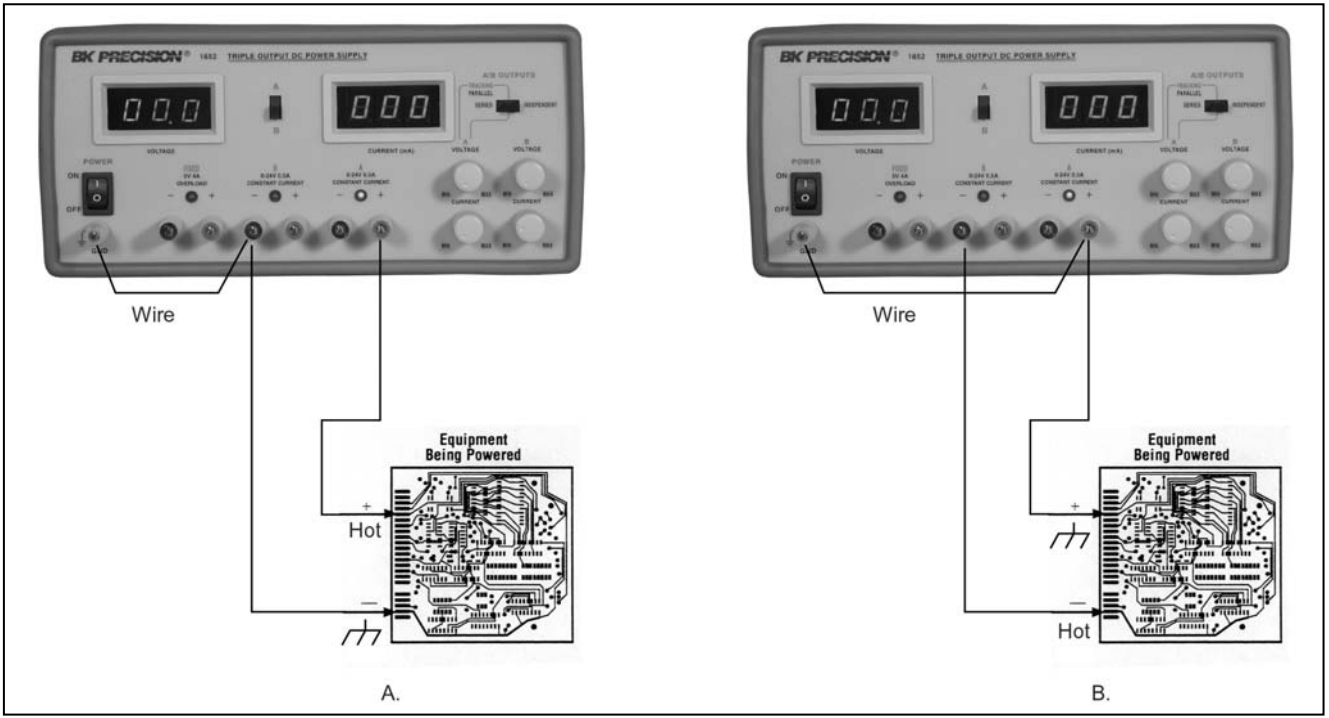

Figure 8. Series tracking (0-48 V) operation grounding possibilities (sheet 1 of 3).

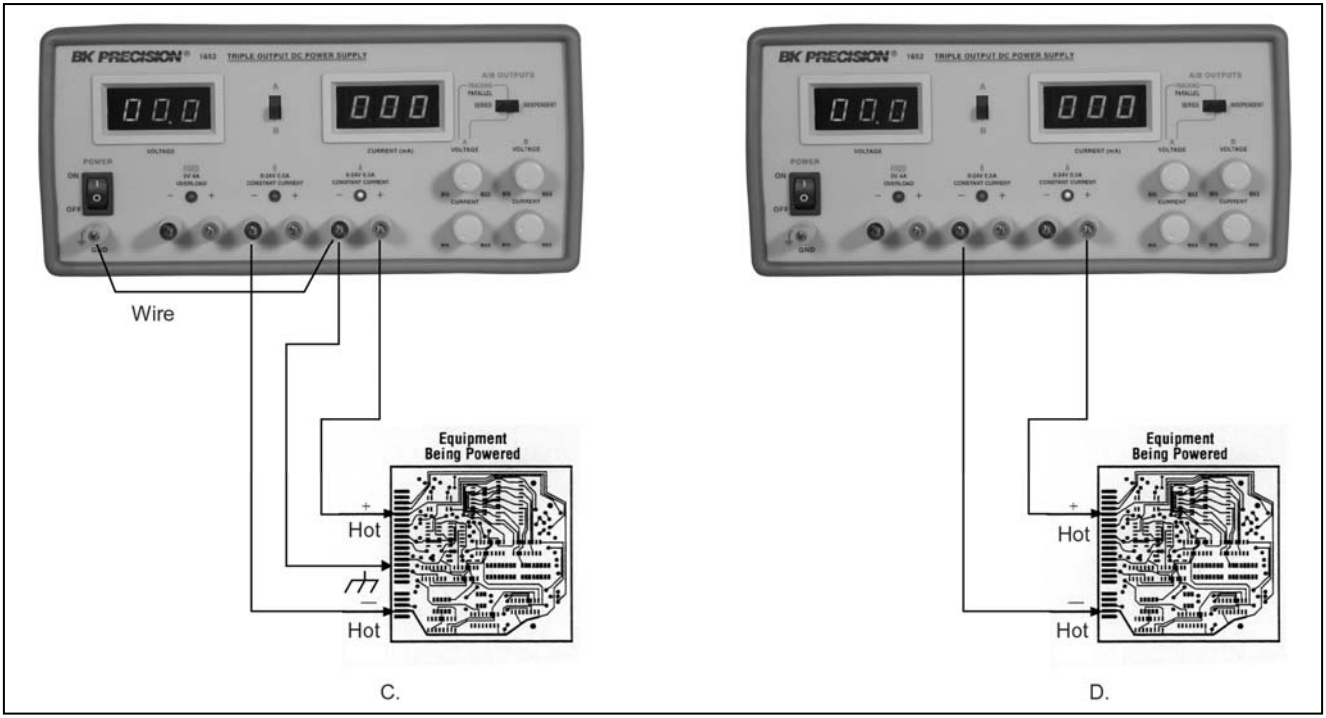

Figure 8. Series tracking (0-48 V) operation grounding possibilities (sheet 2 of 3)

In the series tracking mode, the maximum output voltage of both the **"A"** and **"B"** supplies can be simultaneously varied with one control. The maximum **"B"** supply voltage can be set to the same value of the **"A"** supply by using the "A" VOLTAGE control.

The output voltage (across the two supplies) is actually double the Volt meter reading. The actual output current would be the value read from the mA meter (since the two supplies are wired in series, current flowing through each supply must be equal).

1. Set the power supplies to the TRACKING SERIES mode by setting the TRACKING/INDEPENDENT switch to the SERIES (left) position.
2. Set the A/B Metering switch to the A (up) position.
3. The "B" VOLTAGE AND CURRENT controls are disabled; turn both to their minimum positions. The maximum current is set using the "A" CURRENT control. Follow the instructions for "Setting Current Limit" (INDEPENDENT USE OF "A" OR "B" SUPPLY section of this manual) using the "A" CURRENT control.
4. Adjust the output voltage to the desired level using the "A" VOLTAGE control (remember that the actual output voltage is double the reading on the Volt meter).
5. Turn off the power supply and the equipment to be powered during hook-up.
6. Connect the positive polarity of the device being powered to the red (+) terminal of the "A" power supply.
7. Connect the negative polarity of the device being powered to the black (-) terminal of the "B" power supply.

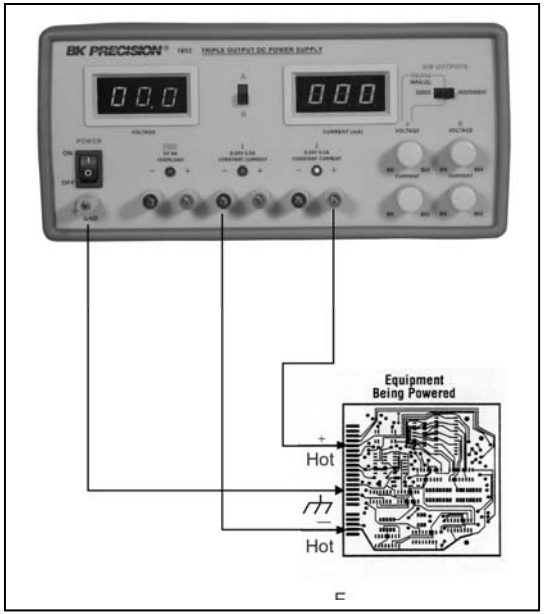

Figure 8. Series tracking (0-to-48 V) operation grounding possibilities (sheet 3 of 3).

8. Fig. 8 illustrates the grounding possibilities when the unit is used as a 0-to-48 \volt supply.
   a. If the negative polarity of the equipment or circuit being powered is also the chassis or common, it may be grounded to earth by connecting the black (-) terminal of the "B" supply to the green (GND) terminal as shown in Fig. 8A.