User Manual

MR Series
High Voltage Multi-Range
DC Power Supplies



BK PRECISION

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Compliance Information

1.1 EMC

1.1.1 EC Declaration of Conformity - EMC

Compliance was demonstrated to the following specifications listed in the Official Journal of the European Communities: EMC Directive 2014/30/EU.

EN 55011: 2009+A2: 2010 Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement

EN 61000-3-11: 2000 Electromagnetic compatibility (EMC) - Part 3-11: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current $\leq$ 75 A and subject to conditional connection

EN 61000-3-12: 2011 Electromagnetic compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current $>$ 16 A and $\leq$ 75 A per phase

EN 61000-4-2 / -3 / -4 / -5 / -6 / -8 / -34 Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques:

- Electrostatic discharge immunity test
- Radiated, radio-frequency, electromagnetic field immunity test
- Electrical fast transient/burst immunity test
- Surge immunity test
- Immunity to conducted disturbances, induced by radio-frequency fields
- Power frequency magnetic field immunity test
- Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase

EN 61326-1: 2013 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

EN 61326-2-1: 2013 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-1: Particular requirements - Test configurations, operational conditions and performance criteria for sensitive test and measurement equipment for EMC unprotected applications

1.2 Safety

1.2.1 EC Declaration of Conformity - Low Voltage

Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive: 2014/35/EU.

EN 61010-1: 2010 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

1.2.2 cTUVus Certification

This instrument carries the cTUVus certification mark, tested and certified by a Nationally Recognized Testing Laboratory (NRTL) accredited by OSHA. It fulfills the following US and Canadian safety standards.

UL 61010-1: 2012 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

CAN/CSA-C22.2 No. 61010-1-12 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

Declaration of Conformity and test report available upon request.

1.3 IEC Measurement Category & Pollution Degree Definitions

Measurement Category (CAT) - classification of testing and measuring circuits according to the types of mains circuits to which they are intended to be connected.

Measurement Category other than II, III, or IV: circuits that are not directly connected to the mains supply.

Measurement Category II (CAT II): test and measuring circuits connected directly to utilization points (socket outlets and similar prints) of the low-voltage mains installation.

Measurement Category III (CAT III): test and measuring circuits connected to the distribution part of a building's low-voltage mains installation.

Measurement Category IV (CAT IV): test and measuring circuits connected at the source of the building's low-voltage mains installation.

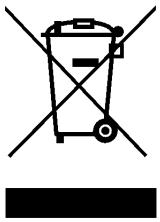
Mains Isolated: is for measurements performed on circuits not directly connected to a mains supply.

Pollution - addition of foreign matter, solid, liquid, or gaseous (ionized gases) that may produce a reduction of dielectric strength or surface resistivity.

Pollution Degree 2 (P2) - only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is expected.

1.4 Product End-of-Life Handling

The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product to an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



This product is subject to Directive 2012/19/EU of the European Parliament and the Council of the European Union on waste electrical and electronic equipment (WEEE), and in jurisdictions adopting that Directive, is marked as being put on the market after August 13, 2005, and should not be disposed of as unsorted municipal waste. Please utilize your local WEEE collection facilities in the disposition of this product.

1.5 Terms and Symbols

1.5.1 Terms

CAUTION

A caution statement calls attention to an operating procedure, practice, or condition, which, if not followed correctly, could result in damage to or destruction of parts or the entire product.

WARNING

A warning statement calls attention to an operating procedure, practice, or condition, which, if not followed correctly, could result in injury or death to personnel.

NOTICE

A note statement calls attention to an operating procedure, practice, or condition, which, should be noted before proceeding.

1.5.2 Symbols



WARNING - HIGH VOLTAGE - possibility of electric shock.



CAUTION – Statements or instructions that must be consulted in order to find out the nature of the potential hazard and any actions which must be taken.



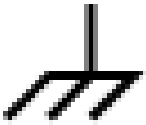
On (Supply). This is the AC mains connect/disconnect switch on the front of the instrument.



Off (Supply). This is the AC mains connect/disconnect switch on the front of the instrument.



Alternating current



Chassis (earth ground) symbol



Earth (ground) TERMINAL - Refer to the instructions accompanying this symbol in this manual.

Safety Notices

The following safety precautions apply to both operating and maintenance personnel and must be followed during all phases of operation, service, and repair of this instrument.

Before applying power to this instrument:

1. Read and understand the safety and operational information in this manual.
2. Apply all the listed safety precautions.
3. Verify that the local AC mains voltage matches the AC input rating of the instrument. Operating the instrument at an incorrect line voltage will void the warranty.
4. Make all connections to the instrument before applying power.
5. Do not operate the instrument in ways not specified by this manual or by B&K Precision.

Failure to comply with these precautions or with warnings elsewhere in this manual violates the safety standards of design, manufacture, and intended use of the instrument. B&K Precision assumes no liability for a customer's failure to comply with these requirements.

2.1 Electrical Power

This instrument is intended to be powered from a CATEGORY II mains power environment. The mains power should be 200 V to 240 V RMS, single phase. Use only the power cord supplied with the instrument and ensure it is appropriate for your country of use.

⚠WARNING **Do not use this instrument in an electrical environment with a higher category rating than what is specified in this manual for this instrument.**

⚠WARNING **You must ensure that each accessory you use with this instrument has a category rating equal to or higher than the instrument's category rating to maintain the instrument's category rating. Failure to do so will lower the category rating of the measuring system.**

2.2 Ground the Instrument

WARNING

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical safety ground. This instrument is grounded through the ground conductor of the supplied, three-conductor AC line power cable. The power cable must be plugged into an approved three-conductor electrical outlet. The power jack and mating plug of the power cable meet IEC safety standards.

WARNING

Do not alter or defeat the ground connection. Without the safety ground connection, all accessible conductive parts (including control knobs) may provide an electric shock. Failure to use a properly-grounded approved outlet and the recommended three-conductor AC line power cable may result in injury or death.

WARNING

Unless otherwise stated, a ground connection on the instrument's front or rear panel is for a reference of potential only and is not to be used as a safety ground. Do not operate in an explosive or flammable atmosphere.

2.3 Environmental Conditions

This instrument is intended to be used in an indoor pollution degree 2 environment. The operating temperature range is 0°C to 40°C and 20% to 80% relative humidity, with no condensation allowed.

Measurements made by this instrument may be outside specifications if the instrument is used in non-office-type environments. Such environments may include rapid temperature or humidity changes, sunlight, vibration and/or mechanical shocks, acoustic noise, electrical noise, strong electric fields, or strong magnetic fields.

⚠WARNING

Do not operate the instrument in the presence of flammable gases or vapors, fumes, or finely-divided particulates.

The instrument is designed to be used in office-type indoor environments. Do not operate the instrument:

- **In the presence of noxious, corrosive, or flammable fumes, gases, vapors, chemicals, or finely-divided particulates.**
- **In relative humidity conditions outside the instrument's specifications.**

⚠WARNING

- **In environments where there is a danger of any liquid being spilled on the instrument or where any liquid can condense on the instrument.**
- **In air temperatures exceeding the specified operating temperatures.**
- **In atmospheric pressures outside the specified altitude limits or where the surrounding gas is not air.**
- **In environments with restricted cooling air flow, even if the air temperatures are within specifications.**
- **In direct sunlight.**

2.4 Do not operate instrument if damaged

⚠WARNING

If the instrument is damaged, appears to be damaged, or if any liquid, chemical, or other material gets on or inside the instrument, remove the instrument's power cord, remove the instrument from service, label it as not to be operated, and return the instrument to B&K Precision for repair. Notify B&K Precision of the nature of any contamination of the instrument.

⚠WARNING

Hazardous voltages may be present in unexpected locations in circuitry being tested when a fault condition in the circuit exists.

2.5 Clean the instrument only as instructed

⚠WARNING

Do not clean the instrument, its switches, or its terminals with contact cleaners, abrasives, lubricants, solvents, acids/bases, or other such chemicals. Clean the instrument only with a clean dry lint-free cloth or as instructed in this manual. Not for critical applications.

2.6 Do not touch live circuits

⚠WARNING

Instrument covers must not be removed by operating personnel. Component replacement and internal adjustments must be made by qualified service-trained maintenance personnel who are aware of the hazards involved when the instrument's covers and shields are removed. Under certain conditions, even with the power cord removed, dangerous voltages may exist when the covers are removed.

To avoid injuries, always disconnect the power cord from the instrument, disconnect all other connections (for example, test leads, computer interface cables, etc.), discharge all circuits, and verify there are no hazardous voltages present on any conductors by measurements with a properly-operating voltage-sensing device before touching any internal parts. Verify the voltage-sensing device is working properly

before and after making the measurements by testing with known-operating voltage sources and test for both DC and AC voltages.

Do not attempt any service or adjustment unless another person capable of rendering first aid and resuscitation is present.

2.7 General Safety

⚠WARNING **Do not insert any object into an instrument's ventilation openings or other openings.**

⚠WARNING **This instrument is not authorized for use in contact with the human body or for use as a component in a life-support device or system.**

2.8 Servicing

WARNING

Do not substitute parts that are not approved by B&K Precision or modify this instrument. Return the instrument to B&K Precision for service and repair to ensure that safety and performance features are maintained.

WARNING

Fuse replacement must be done by qualified service-trained maintenance personnel who are aware of the instrument's fuse requirements and safe replacement procedures. Disconnect the instrument from the power line before replacing fuses. Replace fuses only with new fuses of the fuse types, voltage ratings, and current ratings specified in this manual or on the back of the instrument. Failure to do so may damage the instrument, lead to a safety hazard, or cause a fire. Failure to use the specified fuses will void the warranty.

2.9 For continued safe use of the instrument

- Do not place heavy objects on the instrument.
- Do not obstruct cooling air flow to the instrument.
- Do not place a hot soldering iron on the instrument.
- Do not pull the instrument with the power cord, connected probe, or connected test lead.
- Do not move the instrument when a probe is connected to a circuit being tested.

Introduction

3.1 Product Overview



Figure 3.1 MR25080: 250 V / 80 A / 5000 W

B&K Precision models MR3K160120, MR160120, MR25080, MR50040, and MR100020 are high voltage programmable DC power supplies with single outputs that offer a maximum power output of up to 5000 watts. By connecting up to *50 power supplies in parallel, the maximum output power can reach up to 250 kW. These power supplies are fully programmable and controllable through analog programming, USB, RS232, RS485, GPIB, and Ethernet interfaces. The front numerical keypad and rotary knob provide a convenient interface for adjusting voltage, current, operating functions, and enabling/disabling the output. The MR series power supplies also provide over voltage protection (OVP) and over current protection (OCP) features used to keep the output voltage and current within a specified safety level and prevent damage to the UUT (Unit Under Test).

Model	MR3K160120	MR160120	MR25080	MR50040	MR100020
Output Voltage	0 to 160 V		0 to 250 V	0 to 500 V	0 to 1000 V
Output Current	0 to 120 A		0 to 80 A	0 to 40 A	0 to 20 A
Output Power	3000 W	5000 W			

Table 3.1 Models

3.2 Contents

Please inspect the instrument mechanically and electrically upon receiving it. Unpack all items from the shipping carton, and check for any obvious signs of physical damage that may have occurred during transportation. Report any damage to the shipping agent immediately. Save the original packing carton for possible future reshipment. Every power supply is shipped with the following contents:

- 1 x MR3K160120, MR160120, MR25080, MR50040, or MR100020 Power Supply
- 1 x AC Power Cord

- 1 x Certificate of Calibration
- 1 x Test Report

NOTICE **Ensure the presence of all the items above. Contact the distributor or B&K Precision if anything is missing.**

3.3 Features

- High power output of up to 5000 watts (0-160V/120A) (0-250V/80A) (0-500V/40A) (0-1000V/20A)
- USBVCP (virtual COM)/USBTMC/RS232/RS485/Analog/GPIB and Ethernet interfaces
- Parallel connectivity for up to *50 units
- Adjustable voltage and current slope
- 9 user defined programs with up to 100 steps each
- OVP, OCP, OPP, CV to CC, and CC to CV protection
- Store/recall up to 100 sets of voltage/current settings

*Parallel connectivity and operations can be configured in several different modes, however speed and performance will decrease as each additional unit is paralleled. Refer to **chapter 6** Parallel Operation and section 4.1 RS485 for more details regarding the configuration, setup, and limitations. If you wish to connect more than 10 units in parallel, we advise you to contact us at **bkprecision.com** for further assistance.

3.4 Dimensions

The MR power supply's dimensions and weight are approximately:

- 16.5" x 3.5" x 21" (420 x 88 x 532 mm)
- 38.6 lbs (17.5 kg)

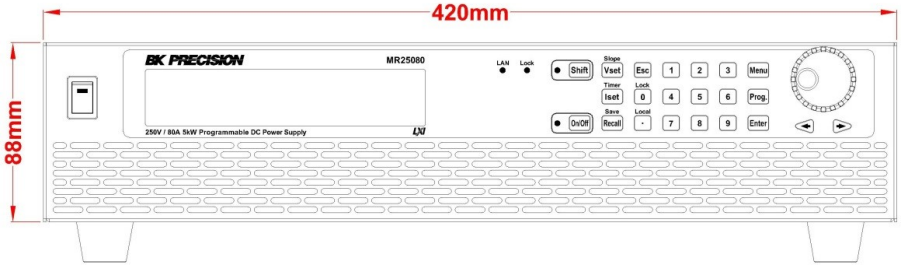


Figure 3.2 Dimensions

3.5 Front Panel

The front panel interface allows for control of the unit.

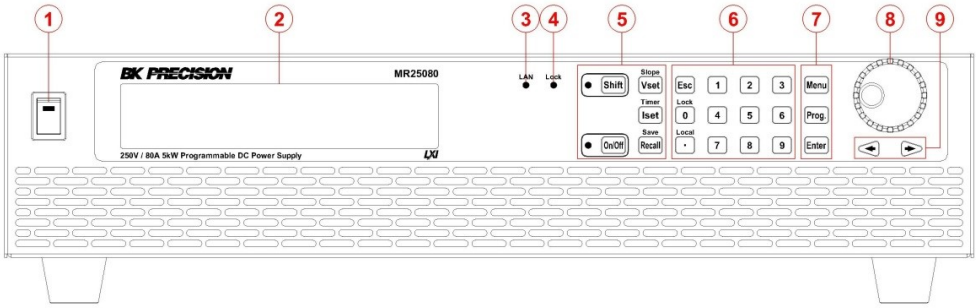


Figure 3.3 Front Panel

Item	Description
1	Power Switch
2	Vacuum Fluorescent Display
3	LAN Status indicator
4	Keypad lock indicator
5	Main function keys
6	Numeric keys
7	Function keys
8	Rotary Knob
9	Navigation Keys

Table 3.2 Front Panel Description

3.6 Display

3.7 Rear Panel

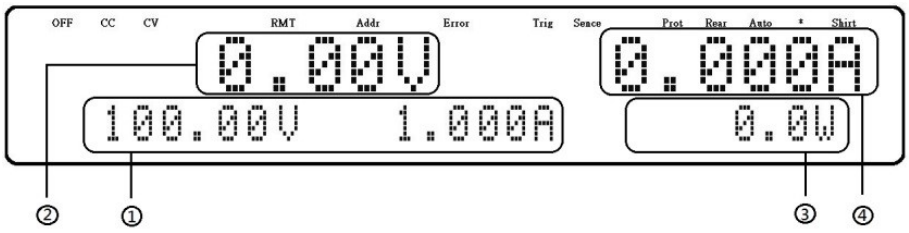


Figure 3.4 Display

Item	Description
1	Measured voltage
2	Settings voltage and current
3	Measured power output
4	Measured current
OFF	Indicates output is disabled
CC	Indicates constant current (CC) operation
CV	Indicates constant voltage (CV) operation
RMT	Indicates remote mode
Addr	Indicates remote communication activity
Error	Indicates an error has occurred
Shift	Indicates shift mode (access to secondary button functions)

Table 3.3 Display Description

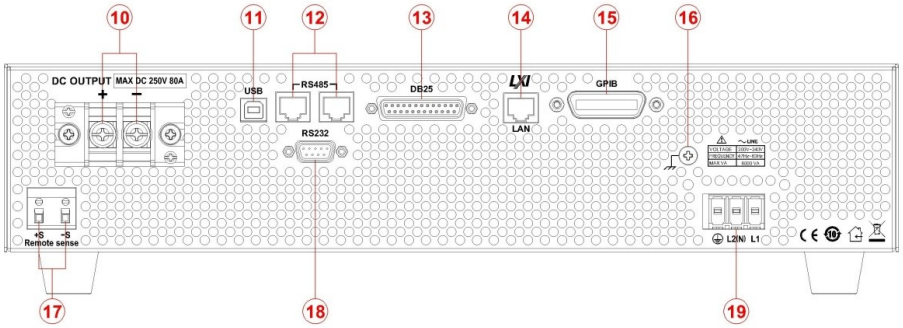


Figure 3.5 Rear Panel

Item	Description
10	Output
11	USB Interface
12	RS-485 Interface
13	Analog Programming Interface (DB25 Connector)
14	Ethernet (LAN) Interface
15	GPIB Interface
16	Earth ground connection
17	Remote sense terminals
18	RS-232 interface & fuse box
19	AC input receptacle & fuse box

Table 3.4 Rear Panel Description

Getting Started



Before connecting and powering up the instrument, please review and go through the instructions in this chapter.

4.1 Input Power Requirements

The supply accepts AC line voltage input within:

Model	MR3K16012	MR160120	MR25080	MR50040	MR100020
AC Line Input	200 to 240 VAC ±10%, 47 Hz to 63 Hz				
AC Line Phase	Single phase				
Maximum Rated Input Power	4000 VA	6000 VA			

Table 4.1 Input Power Requirements

Before connecting to an AC outlet or external power source, be sure that the power switch is in the OFF position and verify that the AC power cord, including the extension line, is compatible with the rated voltage/current and that there is sufficient circuit capacity for the power supply. Once verified, connect the cable firmly.



The included AC power cord is safety certified for this instrument operating in rated range. To change a cable or add an extension cable, be sure that it can meet the required power ratings for this instrument. Any misuse with wrong or unsafe cables will void the warranty.



SHOCK HAZARD: The power cord provides a chassis ground through a third conductor. Verify that your power outlet is of the three-conductor type with the correct pin connected to earth ground.

4.1.1 AC Power Connection

Follow the instructions below to connect the AC power cable to the AC input of the power supply on the rear panel.

Step 1. Connect the input receptacle (green terminal block) of the cable to the input terminals of the power supply.

Step 2. Align the mounting holes on the left and right sides of the power cord housing with the screw holes on the power supply.

Step 3. Use only the included screws to fasten and secure the cable housing assembly.

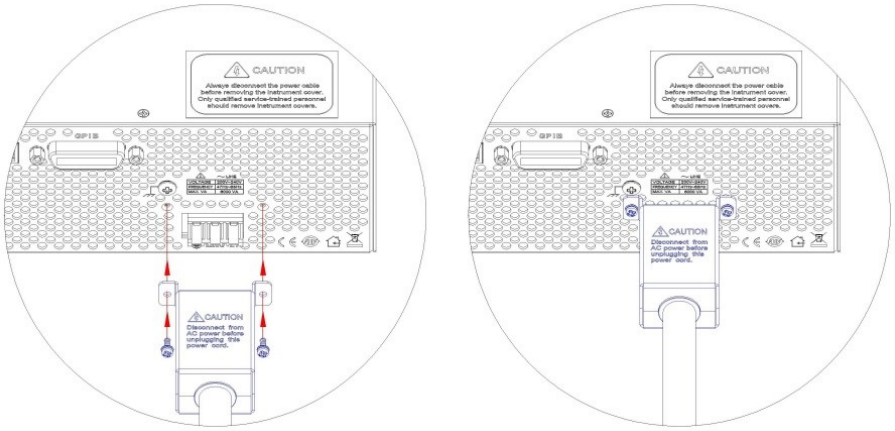


Figure 4.1 AC Power Connection Diagram

Refer to the descriptions below to connect the other end of the AC power cord to the AC distribution panel.

⚠WARNING

Do NOT plug the AC power cord into the wall socket before connecting ALL three AC power wires to the rear panel and securely mounting the safety metal housing over the input receptacle. Doing so may create a shock hazard. Connection of this power supply to an AC power source should be made by a qualified electrician or other qualified personnel. Incorrect wiring may damage the power supply or cause a fire hazard.

⚠CAUTION

Connect the three terminals on the other end of the power cord to your AC distribution panel: black to line 1 (L1), white to line 2 (L2) or neutral (N), and green to ground (G).

⚠CAUTION

Safety agency requirements dictate that there must be a way to physically disconnect the AC mains cable from the unit. A disconnect device, either a switch or a circuit breaker, must meet the input rating requirement of 30 A at 200 VAC. The disconnect device provided in the final installation must be close to the instrument, must be easily accessible, and must be marked as the disconnect device for this instrument.



Figure 4.2 AC Power Cord

4.2 Fuse Replacement

This power supply does not have a user-replaceable fuse. The internal fuse, if blown, may indicate a malfunction in the unit. In this event, contact B&K Precision.

WARNING **Any disassembly of the case or changing of the fuse not performed by an authorized service technician will void the warranty of the instrument.**

4.3 Rackmount Installation

The MR series power supplies are designed to fit in a space of two rack units (2U) and can be mounted in a standard 19-inch rack panel or cabinet. Rack mount brackets must be assembled before mounting the unit in a rack. Refer to **figure 4.3** to assemble the rack mount brackets.

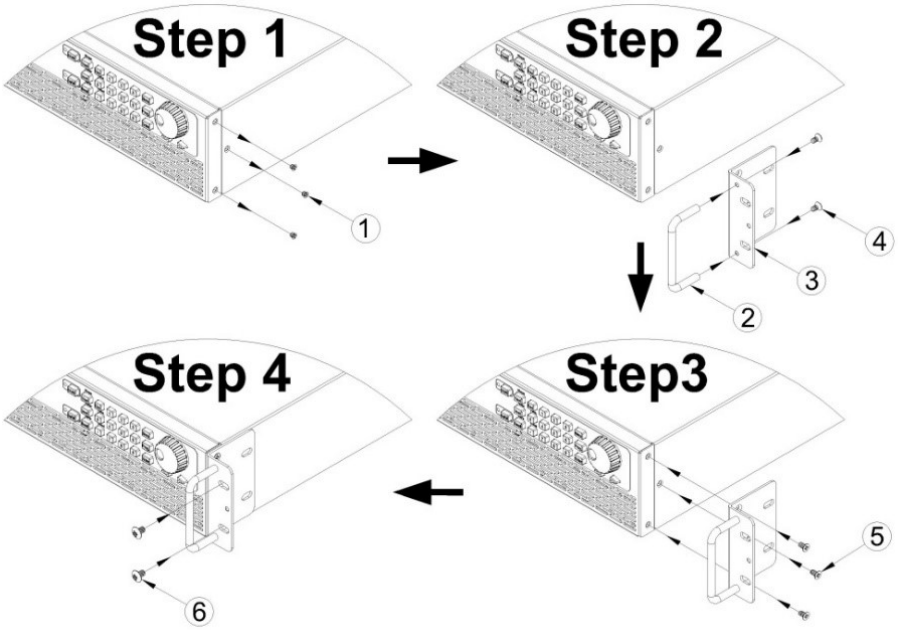


Figure 4.3 Rack Mount Bracket Assembly

4.4 Output Connections

The main DC output terminal is a screw type terminal block located on the rear panel. Each output terminal accepts a ring or fork terminal (lug) up to 18.5 mm wide. Due to the high current rating of the power supply, proper wire sizes are necessary for safe connections and to prevent the wires from overheating. Refer to **section 4.4.1** for the proper wire sizes.

⚠WARNING

Before connecting wires to the output terminals, turn OFF the power supply to avoid damage to the instrument and the device under test (DUT). For safety, load wires must have a wire gauge size large enough to prevent overheating when the power supply operates at maximum short circuit output current. This also prevents large voltage drops from resistance in the wires.



Hazardous voltages may exist at the outputs and the load connections when using a power supply with a rated output greater than 40 V. To protect personnel against accidental contact with hazardous voltages, ensure that the load and its connections have no accessible live parts. Ensure that the insulation rating of the load wiring is greater than the maximum output voltage of the power supply.

4.4.1 Wire Sizing

⚠WARNING

FIRE HAZARD: Select a wire size large enough to carry the short-circuit current without overheating (refer to table 4.2). To satisfy safety requirements, load wires must be heavy enough not to overheat while carrying the short-circuit output current of the unit.

Along with conductor temperature, you must also consider voltage drop when selecting wire sizes. **Table 4.2** lists, for each model, the wire sizes that can carry the full rated output current and the maximum length of each lead that limits the voltage drop to 1.0 V per lead. The minimum wire size required to prevent overheating may not be large enough to prevent over-voltage tripping or to maintain good regulation. Under most conditions, the load wires should also be heavy enough to limit the voltage drop to no more than 1.0 V per lead.

To help prevent tripping of the over-voltage circuit, select a wire size sufficient to handle the FULL output current of the unit regardless of the intended load current or current limit setting.

Load lead resistance is also an important factor relating to the CV stability of the instrument when remote sensing capacitive loads. If high capacitance loads are expected, keep the load leads as short as possible.

Model	Rated Current	Required Gauge	Max. Length
MR3K160120 MR160120	120 A	1 AWG	50 ft (15 m)
		1/0 AWG	65 ft (19.5 m)
		2/0 AWG	85 ft (25.5 m)
MR25080	80 A	4 AWG	40 ft (12 m)
		3 AWG	50 ft (15 m)
		2 AWG	60 ft (18 m)
		1 AWG	80 ft (24 m)
		1/0 AWG	100 ft (30.5 m)
MR50040	40 A	8 AWG	30 ft (9 m)
		6 AWG	50 ft (15 m)
		4 AWG	80 ft (24 m)
		3 AWG	100 ft (30.5 m)
MR100020	20 A	12 AWG	25 ft (7.5 m)
		10 AWG	40 ft (12 m)
		8 AWG	65 ft (19.5 m)
		6 AWG	100 ft (30.5 m)

Table 4.2 Minimum Wire Gauge

NOTICE

The minimum gauge for each model is based on the ampacity of copper wire with 75 °C rated insulation (NEC Table 310.16). The maximum lengths are based on the resistance of stranded copper wire at 75 °C at the full rated output current, and are per lead (one way) and rounded down. Use a heavier gauge for long runs or high ambient temperatures.

⚠CAUTION

The + and - output terminals accept ring or fork terminals (lugs) with a maximum width of 18.5 mm. Use crimp lugs rated for the wire gauge. Wire heavier than 2/0 AWG generally requires lugs wider than 18.5 mm. For lead lengths longer than listed in table 4.2, connect two load wires in parallel to each output terminal.

4.5 Preliminary Check

Complete the following steps to verify that the power supply is ready for use.

4.5.1 Verify AC Input Voltage

Verify that proper AC voltages are available to power the instrument. The AC voltage range must meet the acceptable specification as explained in **section 4.1**.

4.5.2 Connect Power

Connect the AC power cord to the AC receptacle on the rear panel and press the power switch to the ON position to turn ON the instrument. On power up, the unit displays its model, as shown in **figure 4.4**, and then checks for the optional modules.

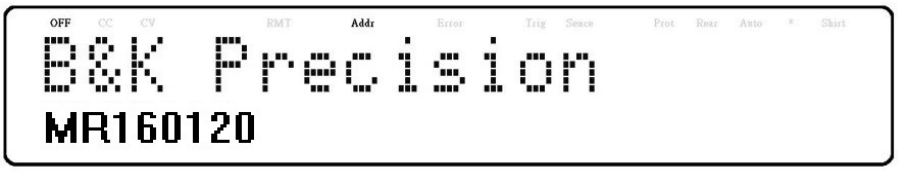


Figure 4.4 Power On Display

4.5.3 Warm-Up Time

The MR series is fully operable upon switching the power ON. However, to reach the specified equipment accuracy, allow the supply to warm up for at least 15 minutes.

4.5.4 Output Check

4.5.4.1 Voltage Check

Follow the steps below to check the voltage output with no load connected.

Step 1. Turn ON the power supply. The display shows the OFF annunciator above the voltage display.

Step 2. Enable the output by pressing On/Off. The LED next to the button lights, and the OFF annunciator changes to CV.

Step 3. Enter a voltage value using the numeric keypad or the voltage adjust knob. The voltage display shows the value you entered. If entering with the numeric keypad, press Slope Vset first, then enter the value and press Enter.

Step 4. (Optional) Verify the output voltage by connecting the (+) and (-) terminals on the rear panel to an external voltmeter. The measured value should match or be within the entered voltage value.

4.5.4.2 Current Check

Follow the steps below to check the current output of the power supply.

Step 1. Turn ON the power supply. The display shows the OFF annunciator above the voltage display. Be sure that the output is disabled (the LED next to the On/Off button is not lit when the output is off). If the LED is ON, press On/Off to disable the output. Short the (+) and (-) output terminals with test leads, a shorting bar, or a clip. Refer to **section 4.4.1** to select appropriate test leads.

Step 2. Enter a small current value (e.g. 1.000 A) using the numeric keypad or the current adjust knob. If entering with the numeric keypad, press Timer Iset first, then enter the value and press Enter. The current display shows the value you entered.

Step 3. Enable the output by pressing On/Off. The LED next to the button lights, and the OFF annunciator changes to CC.

Step 4. (Optional) Verify the output current by connecting the (+) and (-) terminals on the rear panel to an external current meter capable of measuring the current that you set. The measured value should match or be within the entered current value.

Step 5. Press the power switch to the OFF position to turn off the power supply, then remove the short from the output terminals.

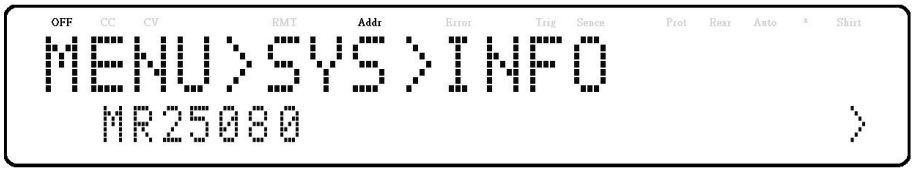
4.5.4.3 Check Model and Firmware Version

The model and firmware version can be verified by using the `*IDN?` remote query. They can also be found in the menu system by following these steps:

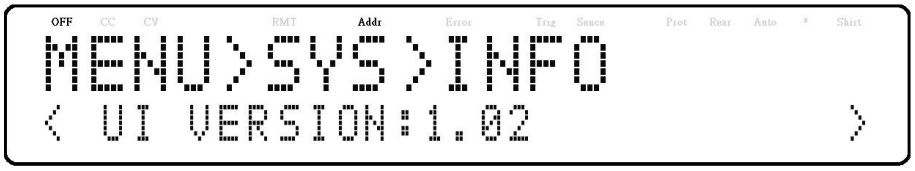
Step 1. Press Menu to enter the menu system.

Step 2. Press the ⇨ button five times until **SYSTEM** is selected. Press Enter.

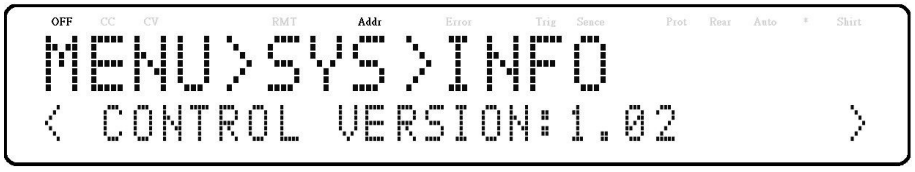
Step 3. Press the ⇨ button once to select **INFORMATION**. Press Enter. The display shows the model, shown below as MR160120.



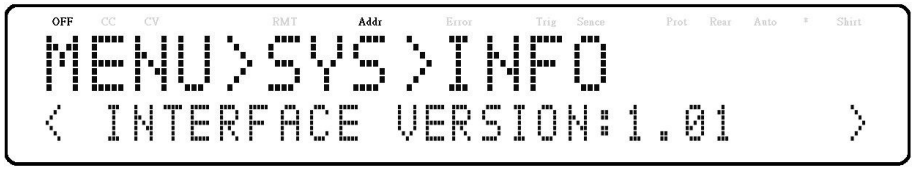
Step 4. Press ⇨ twice to display the UI firmware version, shown below as 1.02.



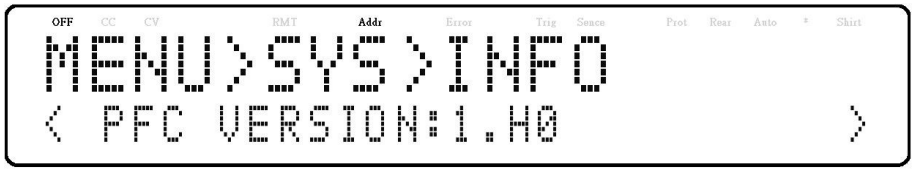
Step 5. Press ⇨ once to display the control firmware version, shown below as 1.02.



Step 6. Press ⇨ once to display the interface firmware version, shown below as 1.01.



Step 7. Press ⇨ once to display the PFC firmware version, shown below as 1.52.



Step 8. Press Esc three times to exit the menu and return to the normal display.

Menu Options

All settings and parameters can be configured from the built-in menu system of the power supply. To access the menu, press Menu.

The menu system is divided into 6 sections, which are organized as follows:

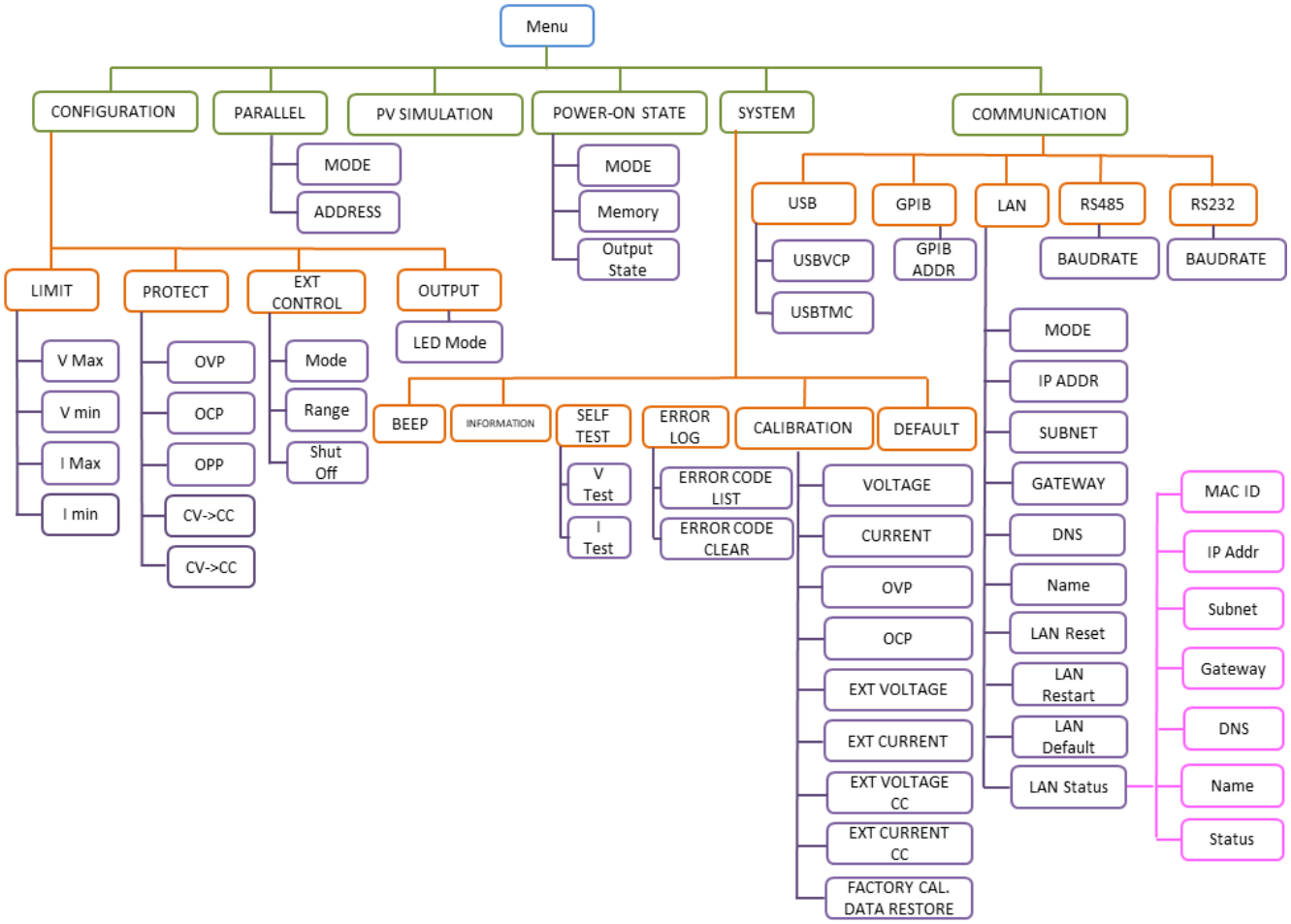


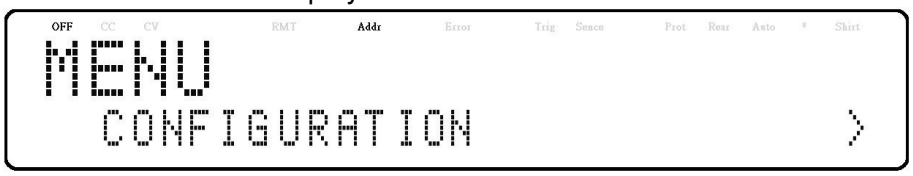
Figure 5.1 Menu Tree

Before using the instrument, it is important to be familiarized with its menu structure and learn how to view or change settings and parameters. Follow the steps below to guide you in selecting menu options.

Step 1. From the normal display, press the Menu button to enter the menu.

Step 2. The selected item will be shown. Use the ◁▷ keys to move through the menu selections.

Step 3. When the desired menu section is shown, press Enter to access its menu settings. Below is the display when **CONFIGURATION** is selected.



Step 4. The selected item will be shown. Use the ◁▷ keys to move through the menu items. When there is a ⋱ on the right side of the display, there are more menu items available to select from. Similarly, a ⋰ will appear on the left side of the display when there are menu items to the left. Use the ◁▷ keys accordingly to select the desired menu item.

Step 5. Press Enter to access the selected menu item.

Step 6. There may be parameters or options to select within each menu item. Follow the same instructions as described in the previous steps to select them. To save changes to a setting, press Enter.

Step 7. To exit the menu at any time, press Esc until the normal display is shown.

5.1 Configuration

All setup procedures and settings explained in this section can be accessed from the **CONFIGURATION** menu. To access this menu, press Menu, select **CONFIGURATION**, then press Enter.

5.1.1 Output Limit Settings

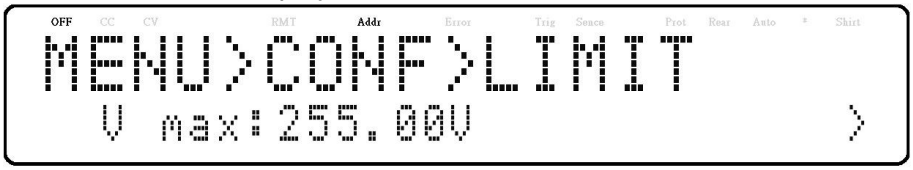
The voltage or current output limits can be configured to provide limit protection to prevent accidental changes to the output settings. There are four limit values that can be set: voltage maximum (**VMAX**), voltage minimum (**VMIN**), current maximum (**IMAX**), and current minimum (**IMIN**).

NOTICE

At any time during operation, when you are unable to set a desired voltage or current, check these limit settings to make sure the set value is within the limit's range.

The shaded area illustrated above is the settable range of the output voltage and current. Follow the steps below to configure the output limits:

Step 1. From the **CONFIGURATION** menu, select **LIMIT**, then press Enter. The following screen will display:



Step 2. Use the ◁ ▷ keys to select the limit setting value of V max, V min, I max, and I min. Press Enter to confirm the selection.

Step 3. Use the numerical keys to set the limit value and press Enter to confirm the setting.

Step 4. Press Esc several times to exit the menu setting.

5.2 Protect

5.2.1 Over Voltage Protection (OVP)

The MR over voltage protection utilizes a hardware comparator that quickly protects the instrument when the voltage presented at the output terminal exceeds the OVP setting voltage.

Follow the steps below to set the OVP limit:

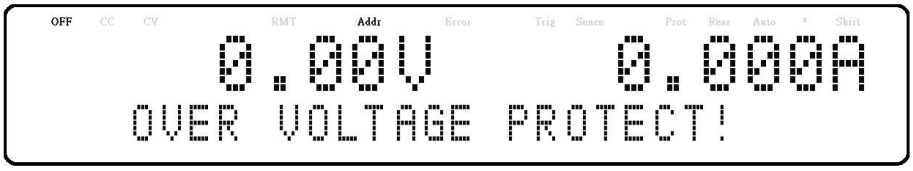
Step 1. Press the Menu button, select **CONFIGURATION**, then press Enter.

Step 2. Press the ⇨ button one time until **PROTECT** is selected and press Enter. The display will then show **OVP**; press Enter.

Step 3. Use the numerical keys directly or use the ◁▷ keys with the rotary knob to adjust the value. Press Enter to confirm the OVP value.

Step 4. Press Esc several times to exit the menu setting.

When OVP protection is tripped during operation, the output will turn off and the following OVP status message will display:



To clear the trip status, press Esc once.

5.2.2 Over Current Protection (OCP)

The MR over current protection utilizes a hardware comparator that quickly protects the instrument when the current presented at the output terminal exceeds the OCP setting current.

Follow the steps below to set the OCP limit:

Step 1. Press the Menu button, select **CONFIGURATION**, then press Enter.

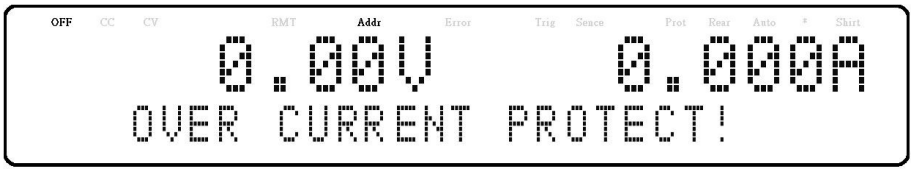
Step 2. Press the ⇨ button one time until **PROTECT** is selected and press Enter. The display will then show **OVP**.

Step 3. Press the ⇨ button one time until **OCP** is displayed, and press Enter.

Step 4. Use the numerical keys directly or use the ◁▷ keys with the rotary knob to adjust the OCP value. Press the Enter button to confirm the OCP value.

Step 5. Press Esc several times to exit the menu setting.

When OCP protection is tripped during operation, the output will turn off and the following OCP status message will display:



To clear the trip status, press Esc once.

5.2.3 Over Power Protection (OPP)

The MR over power protection continuously monitors the output power. If it is greater than the OPP setting, it turns off the power supply output to protect the device under test.

Follow the steps below to set the OPP limit:

Step 1. Press the Menu button, select **CONFIGURATION**, then press Enter.

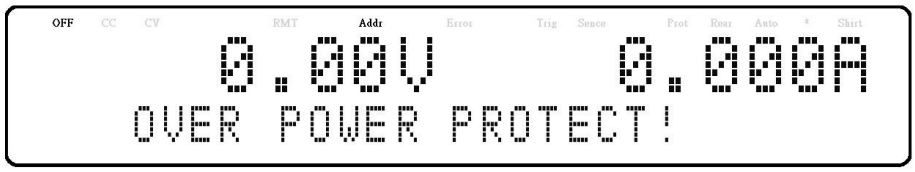
Step 2. Press the ⇨ button one time until **PROTECT** is selected and press Enter. The display will then show **OVP**.

Step 3. Press the ⇨ button one time until **OPP** is displayed, and press Enter.

Step 4. Use the numerical keys directly or use the ◁▷ keys and the rotary knob to adjust the OPP value. Press the Enter button to confirm the OPP value.

Step 5. Press Esc several times to exit the menu setting.

When OPP protection is tripped during operation, the output will turn off and the following OPP status message will display:



To clear the trip status, press Esc once.

5.2.4 CV to CC Protection

The MR CV to CC protection monitors the transition between constant voltage to constant current mode. If this event occurs, the output of the power supply will turn off. Follow the steps below to set the CV to CC limit:

Step 1. Press the Menu button, select **CONFIGURATION**, then press Enter.

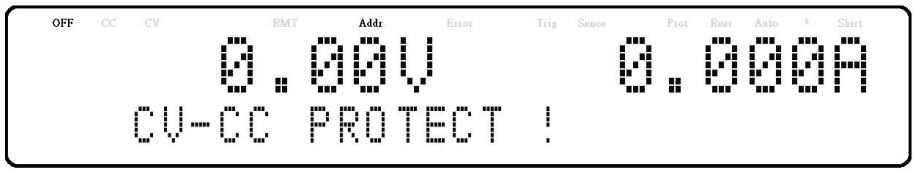
Step 2. Press the ⇨ button one time until **PROTECT** is selected and press Enter. The display will then show **OVP**.

Step 3. Press the ⇨ button three times until **CV to CC** is displayed.

Step 4. Use the rotary knob to set CV to CC **ON** or **OFF**, followed by Enter.

Step 5. Press Esc several times to exit the menu setting.

When CV to CC protection is tripped during operation, the output will turn off and the following CV to CC status message will display:



To clear the trip status, press Esc once.

5.2.5 CC to CV Protection

The MR CC to CV protection monitors the transition between constant voltage to constant current mode. If this event occurs, the output of the power supply will turn off. Follow the steps below to set the CC to CV limit:

Step 1. Press the Menu button, select **CONFIGURATION**, then press Enter.

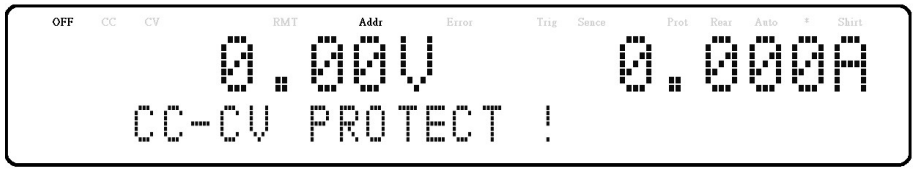
Step 2. Press the ⇨ button one time until **PROTECT** is selected and press Enter. The display will then show **OVP**.

Step 3. Press the ⇨ button three times until **CC to CV** is displayed.

Step 4. Use the rotary knob to set CC to CV **ON** or **OFF**, followed by Enter.

Step 5. Press Esc several times to exit the menu setting.

When CC to CV protection is tripped during operation, the output will turn off and the following CC to CV status message will display:



To clear the trip status, press Esc once.

5.3 Configure Voltage/Current Output

Voltage and current can be set from the front panel. Remote sense is also available on the rear panel for voltage compensation at the output.

5.3.1 Setting Voltage

Follow the steps below to set the output voltage:

Step 1. From the normal front panel display, users can use either the voltage adjust knob or the numeric keypad to enter the setting voltage.

Step 2. If entering using the numeric keypad, press Slope Vset first so that the cursor selects the voltage display. Then, enter the value and press Enter to set the voltage.

Step 3. To change the cursor position, use the ◁▷ keys. The voltage can be adjusted with the rotary knob.

When the output is ON, the user can use the rotary knob to adjust the voltage value when the output is in constant voltage (CV) mode. The output value will change simultaneously with the adjusted value. This is the so-called on-the-fly function, which allows the user to easily change the output value if the test requires it.

5.3.2 Setting Current

Step 1. From the normal front panel display, users can use either the current adjust knob or the numeric keypad to enter the setting current.

Step 2. If entering using the numeric keypad, press Timer Iset to select the current parameter. Then, enter the value and press Enter to set the current.

Step 3. To change the cursor position, use the ◁▷ keys. The current can be adjusted with the rotary knob.

When the output is ON, the user can use the rotary knob to adjust the current value when the output is in constant current (CC) mode. The output value will change simultaneously with the adjusted value. This is the so-called on-the-fly function, which allows the user to easily change the output value if the test requires it.

5.3.3 Local Sense

By default, the power supply is set up for local sense. See **Figure 5.2** for the Remote and Local Sense setup.

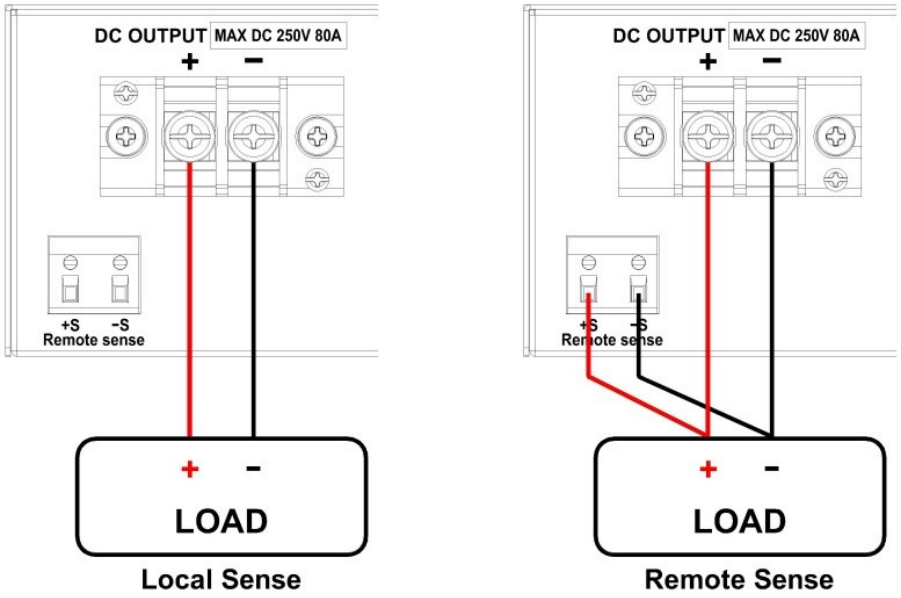


Figure 5.2 Local Sense

When local sense is selected, the positive lead (+) of the DC output is connected to the positive end (+) of the load and the negative lead (-) of the DC output is connected to the negative end (-) of the load.

When this sensing mode is selected, the wires connecting the DC outputs to the load must be as short as possible. The local sense is the default configuration.

WARNING

DO NOT disconnect the wires if remote sense is not used. Doing so will cause erratic behavior and may damage the power supply under certain conditions.

Never connect any power source into any of the four terminals at any time during operation.
When output is enabled, DO NOT use your hands to touch the terminals or the screws that are designed to tighten wires to the terminals. Doing so may create a shock hazard under high voltage output conditions.

5.3.4 Remote Sense

When remote sense is selected, the positive sense (+S) and positive lead (+) of the DC output are connected to the positive end (+) of the load, whereas the negative sense (-S) and negative lead (-) of

the DC output are connected to the negative end (-) of the load. To enable remote sense, follow the steps below:

Step 1. Power OFF the supply and disconnect all loads and cables connected to it.

Step 2. Use a small flat blade screwdriver to connect the S+ to the DUT's positive (+) terminal, and connect the S- to the DUT's negative (-) terminal.

Step 3. Do not connect any wires to the Vo+ and Vo- terminals.

Step 4. Power ON the power supply, and then configure and enable the output. The setup should look like the **figure** above.

⚠CAUTION **DO NOT at any time disconnect the wires from the Vs+ and Vs- terminals to the DUT while the output is enabled (ON). Doing so may damage the power supply and cause unstable output.**

5.4 Voltage/Current Measurement

The display will show the set voltage and current values and the measured values of the output.

5.4.1 System Messages

The MR has built-in sensors to detect system conditions. If a fault status occurs, the error message will show on the display and the power supply output is automatically protected. The following display occurs when the fan has failed or stopped turning:



System Message	Description
MEMORY CHECK ERROR !	Cannot read or write the internal non-volatile memory
OVER TEMPERATURE PROTECT !	Internal temperature is too high and the protection mechanism is activated
FAN ERROR !	FAN not functioning
HW Fail OVP	Module hardware over voltage
HW Fail OCP	Module hardware over current
CALIBRATION ERROR !	Calibration cannot be done
AC FREQUENCY ABNORMAL !	AC input frequency is out of range
AC VOLTAGE ABNORMAL !	AC input voltage is out of range
PFC ERROR !	PFC not functioning correctly
POWER OFF !	Power supply is powering off
OUTPUT SHORT CIRCUIT	Output voltage drop too fast
HW Fail BVbus	Module hardware fail

Table 5.1 System Messages

5.4.2 External Analog Control

To control or monitor the output of the power supply using external signals, refer to the following figure of the DB25 connector located on the rear panel. The logical signal L is a TTL compatible signal. The analog signal cannot exceed the range of 0 to 12 VDC.

WARNING

DO NOT exceed 12 VDC on any of the analog signal pins or TTL voltage on any of the logical signal L pins of the DB25 connector. Doing so will cause erratic behavior and may damage the power supply under certain conditions.

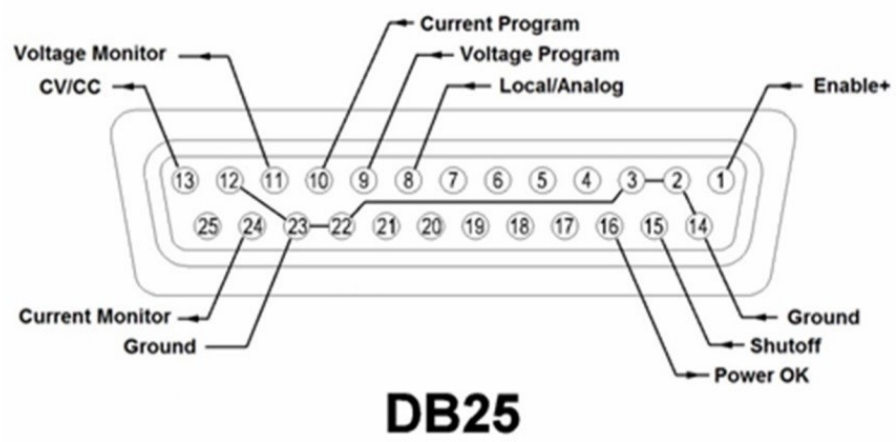


Figure 5.3 DB25 Pinout

Pin	Signal	I/O	Description
1	Enable	I	Open: Output is OFF Short to ground: Output is ON
2	Ground		
3	Ground		
8	Local/Analog	I	Open: Front panel control Short to ground: Rear analog control
9	Voltage Program	I	Input 0-5 V / 0-5 kΩ or 0-10 V / 0-10 kΩ for voltage output setting, full scale input equals maximum output voltage
10	Current Program	I	Input 0-5 V / 0-5 kΩ or 0-10 V / 0-10 kΩ for current output setting, full scale input equals maximum output current
11	Voltage Monitor	O	Output 0-5 V / 0-10 V represents power supply output voltage, full scale output equals maximum output voltage
12	Ground		
13	CV/CC	O	High: Constant voltage Low: Constant current
14	Ground		
15	Shutoff	I	Open: No action Short to ground OFF: Ignore Shutoff LIVE: Output is OFF LATCH: Output is OFF
16	Power OK	O	High: Output is ON Low: Output is OFF
22	Ground		
23	Ground		
24	Current Monitor	O	Output 0-5 V / 0-10 V represents power supply output current, full scale input equals maximum output current

Table 5.2 DB25 Pins

5.4.3 External Control Settings

If you want to use the external mode to control the power supply, you must configure external analog control in the menu before entering the external mode.

Follow the steps below:

Step 1. Press the Menu button, select **CONFIGURATION**, then press Enter.

Step 2. Press the button twice until **EXT CONTROL** is selected and press Enter.

Step 3. Press the Enter button to set the Mode.

External Mode	Description
EXT-V	Program the voltage output by connecting an external DC voltage to Pin 9.
EXT-R	Program the voltage output by connecting an external resistor to Pin 9.

Table 5.3 External Mode

Step 4. Press the button to set the range.

External Range	Description
10V/10K	The external voltage range or resistance range used to control the output voltage full scale is 0-10 V / 0-10 kΩ.
5V/5K	The external voltage range or resistance range used to control the output voltage full scale is 0-5 V / 0-5 kΩ.

Table 5.4 External Range

Step 5. Press the button to set Shut Off (Remote Inhibit).

External Shut Off	Description
OFF	The Inhibit input is ignored.
LIVE	The output follows the state of the Inhibit input.
LATCH	The output remains disabled. The latched INH status bit is cleared by sending the OUTPut:PROTection:CLEar command or by pressing the Esc button on the front panel.

Table 5.5 External Shut Off

5.5 Local/Analog Control

Pin 8 can be used to select the control mode (local or analog) of the power supply's output. When the input command for this pin is at high level (or open), the control mode will be local. When the input command for this pin is at low level (or shorted to GND), the control mode will be analog. If you enter external mode, the front panel will be disabled.

5.5.1 Local/Analog Control

When Enable (Pin 1) is open, the output is OFF.

When Enable (Pin 1) is shorted to ground, the output is ON.

5.5.2 Power OK Signal

Pin 16 is used to indicate whether a fault condition is present in the power supply. Normally this pin will output a logic high (5 V). When a fault occurs, this pin will output a logic low (0 V).

Fault conditions are defined as follows:

1. Overvoltage protection
2. Overcurrent protection
3. Overpower protection
4. CV to CC protection
5. CC to CV protection
6. Over temperature protection
7. AC line failure
8. Enable signal
9. Shutoff signal
10. Remote failure
11. Output off
12. Hardware protection

5.6 Voltage Program

5.6.1 Voltage Mode

Under voltage mode, the user may control the full scale output voltage value through Pin 9, by inputting a voltage level of 0-5 V (0-5 V / 0-5 kΩ mode) or 0-10 V (0-10 V / 0-10 kΩ mode) as shown below.

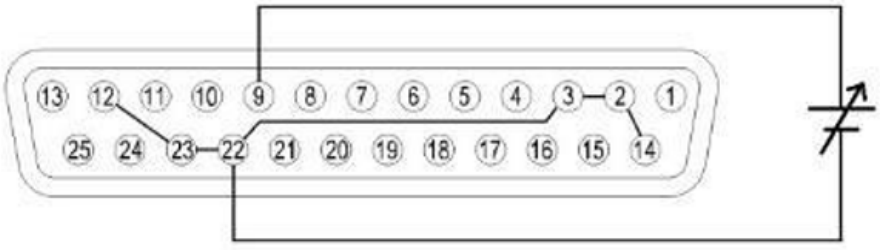


Figure 5.4 Voltage Mode: 0-5 V or 0-10 V

5.6.1.1 Current Program

Under voltage mode, the user may control the full scale current output value through Pin 10, by inputting a voltage level of 0-5 V (0-5 V / 0-5 kΩ mode) or 0-10 V (0-10 V / 0-10 kΩ mode) as shown below.

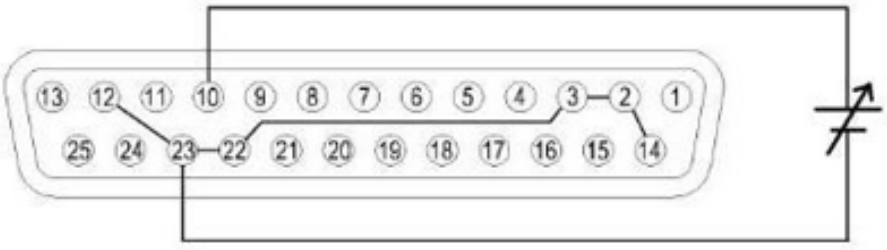


Figure 5.5 Voltage Mode Current Program: 0-5 V or 0-10 V

5.6.2 Resistor Mode

Under resistor mode, the user may control the full scale voltage output value by connecting a resistance value of 0-5 kΩ (0-5 V / 0-5 kΩ mode) or 0-10 kΩ (0-10 V / 0-10 kΩ mode) between Pin 9 and Pin 22 as shown below.

5.6.2.1 Current Program

Under resistor mode, the user may control the full scale current output value by connecting a resistance value of 0-5 kΩ (0-5 V / 0-5 kΩ mode) or 0-10 kΩ (0-10 V / 0-10 kΩ mode) between Pin 10 and Pin 23 as shown below.

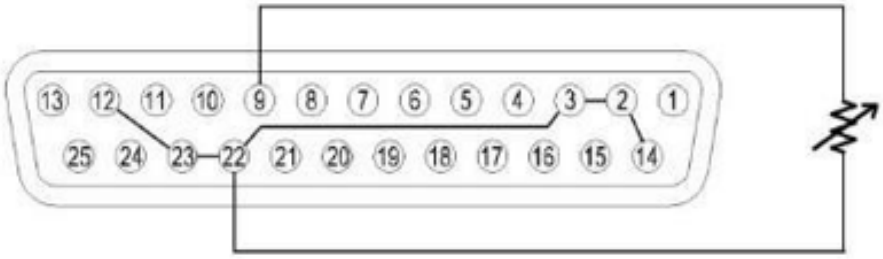


Figure 5.6 Voltage Mode: 0-5 V or 0-10 V

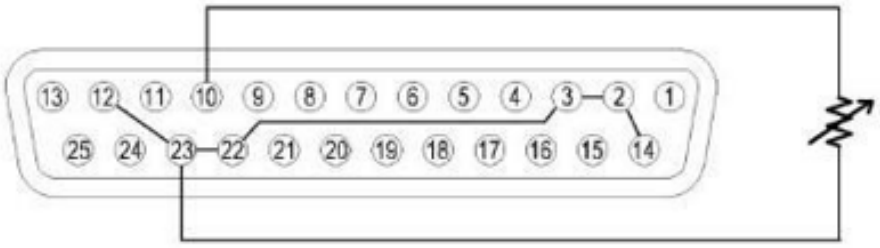


Figure 5.7 Resistance Mode Current Program: 0-5 V or 0-10 V

5.6.3 Voltage Monitor

This function is able to monitor the voltage output using Pin 11 and one of the ground pins (i.e. Pin 22), which can be connected to a digital voltage meter (DVM) or other voltage monitoring device, as shown below. The output control must be in analog mode to use this function. The monitoring of the output voltage range (which reflects 0 to full scale of the power supply's output voltage) can be selected between 0-5 V and 0-10 V.

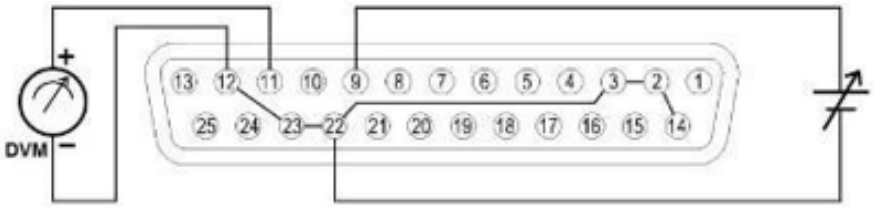


Figure 5.8 Voltage Monitor

5.6.4 Current Monitor

This function is able to monitor the voltage output using Pin 24 and one of the ground pins (i.e. Pin 23), which can be connected to a digital voltage meter (DVM) or other voltage monitoring device, as shown below. The output control must be in analog mode to use this function. The monitoring of the output voltage range (which reflects 0 to full scale of the power supply's output voltage) can be selected between 0-5 V and 0-10 V.

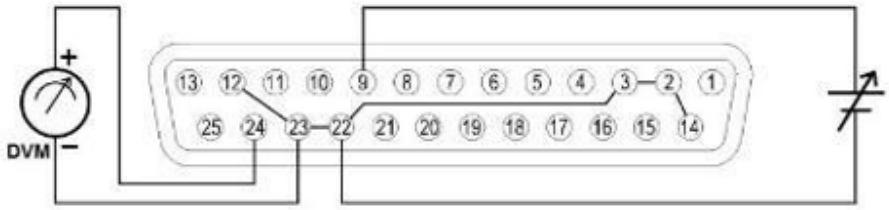


Figure 5.9 Current Monitor

5.6.5 Shut Off Control

Shut off control allows Pin 15 of the DB25 interface to be used to shut off the power supply's output, which is controlled by an input trigger signal.

When shut off occurs, the output will be turned off immediately and **REMOTE INHIBIT !** will appear on the display as shown below. To enable the output again, first set Pin 15 open.

Then, press Esc or send the OUTPut:PROTection:CLEar command before pressing the On/Off button again to enable the output.

MENU:CONF:EXTCTRL

NOTICE **Shut off can only occur when the power supply receives a trigger. Maintaining that pin constantly open will not trigger a shut off.**

5.7 Output (LED Mode)

The MR Series provides the LED mode, which enables it to function specifically for LED test applications. When this mode is ON (enabled), the power supply can operate in such a way as to minimize or almost eliminate the inrush current drawn by the LED load, which normally exists when the output switches from an OFF state to an ON state.

To enable LED mode, follow these steps:

Step 1. From the normal display, press the Menu button to enter the menu.

Step 2. Use the ◁▷ keys to navigate to the **OUTPUT** submenu.

Step 3. Press the Enter key to enter the **OUTPUT** submenu.

Step 4. Use the rotary knob to enable **LED** mode.

5.7.1 Example

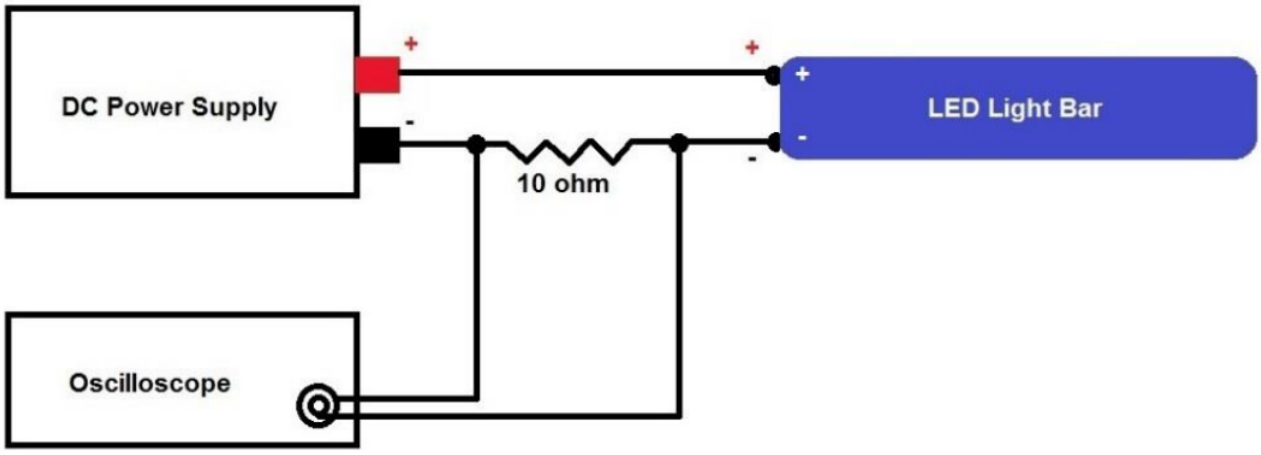


Figure 5.10 LED Testing Example

The MR output is initially OFF (disabled). The LED light bar is rated for 170 V. A 10 Ω resistor is placed in series with the LED light bar. The power supply current setting (ISET) is 20 mA. Using an oscilloscope to probe across the resistor to measure current, the power supply's output is then turned ON. The measured results are shown in **Figure 5.11**, which compares the measured results with and without LED mode ON (enabled).

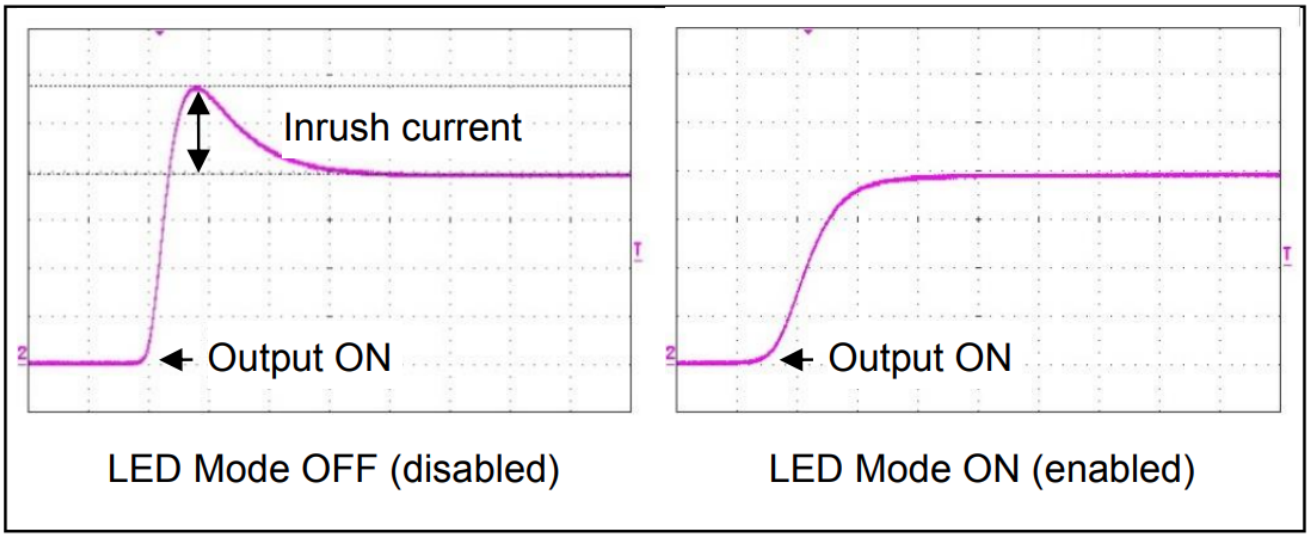


Figure 5.11 Inrush Current With and Without LED Mode Enabled

With LED mode ON (enabled), the power supply can minimize or eliminate any inrush current from turning the output ON, which in turn will minimize damage or life of the LEDs under test.

NOTICE

For LED mode to function correctly, the output must be turned OFF when connecting between the power supply and the LEDs under test. Turn ON the output after LED mode is enabled and all other settings are configured.

Parallel Operation

The MR power supplies can be connected in parallel to increase the power output capability as well as the output current. Up to *50 units of the same model can be connected for an output of up to 250 kW (max).

6.1 Connection and Setup

To connect multiple units in parallel, follow the diagram shown below:

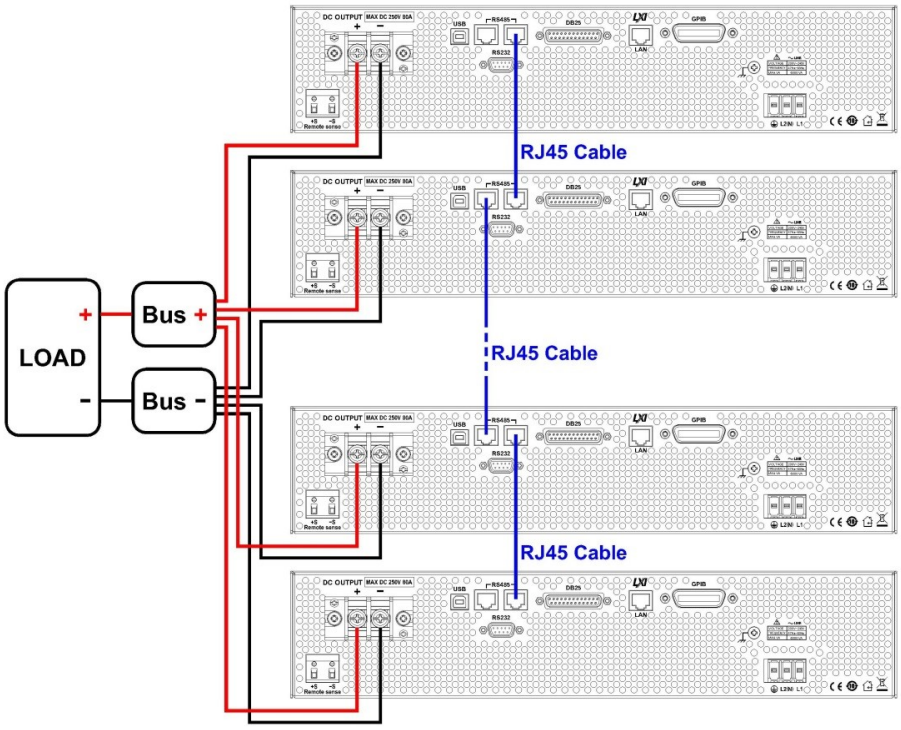


Figure 6.1 Connection and Setup

The power supplies must all be of the same model for parallel operation to function properly. If you want to connect more than 10 units in parallel, we recommend contacting us at **bkprecision.com** for further assistance.

After wiring is complete, configure one of the supplies as the Master and the others as Slaves (i.e. SLAVE 1 – SLAVE 49). After one of the supplies is configured to be the Master, it will start searching for all Slaves that are connected to the Master. To operate correctly, the user must set up the Slaves before the Master.

Follow the steps below to set a supply to master or slave mode.

NOTICE **Multi-unit connection (chain) mode will be cancelled.**

Step 1. Press the Menu button and press the ⇨ button one time until **PARALLEL** is selected.

Step 2. Press Enter to select the **Parallel Mode**.

Step 3. Use the rotary knob to select the setting of OFF or ON and press Enter.

Step 4. Press the ⇨ button one time until **Address** is selected and press Enter.

Step 5. Use the rotary knob to set the master or slave and press Enter. Use the same procedure to set up MASTER, SLAVE 1, SLAVE 2, …, SLAVE 49 for the other power supplies.

Step 6. Press Esc several times to exit the menu setting.

6.2 Slave Unit

When a power supply is set up to be a slave unit, it will wait for the master connection, as shown below.

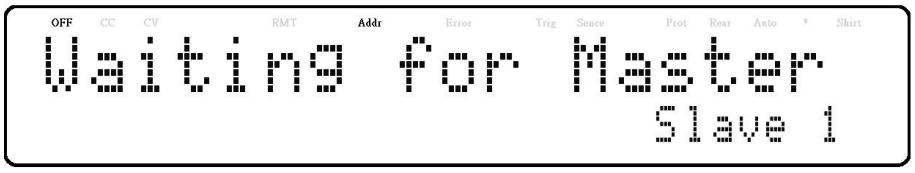


Figure 6.2 Slave Waiting for Master

If the master unit has found the slave unit, the slave unit will be controlled by the master unit and the following will be displayed:

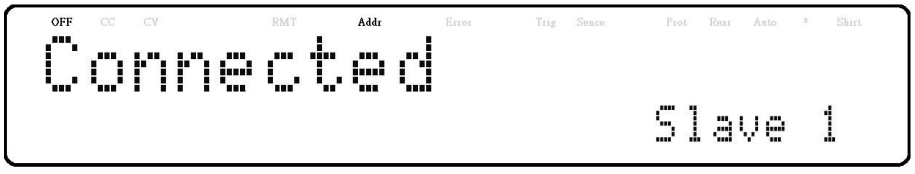


Figure 6.3 Slave Controlled by Master

In parallel mode, the slave unit is remote controlled by the master unit. The keypad will be locked. To exit the parallel mode, press the Local key to access the parallel mode ON/OFF setting in the menu. Turn it off to disable parallel mode control.

6.3 Master Unit

After all of the slave units have been set, the master unit can be set by the same procedure with the role set to **MASTER**. As shown below, the master unit will start to search for the slave units.

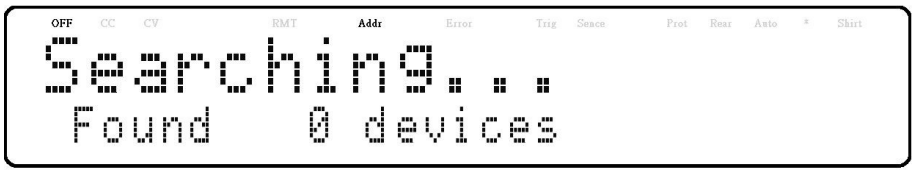


Figure 6.4 Master Searching for Slaves

After the search, the master will show how many slave units have been found, as shown in the following display:

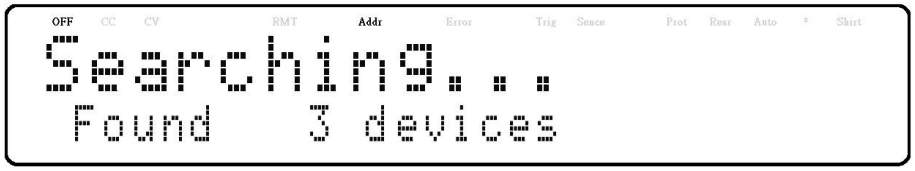


Figure 6.5 Slave Units Found

Once the search is completed, the unit will go into parallel mode operation. The following screen should be displayed.

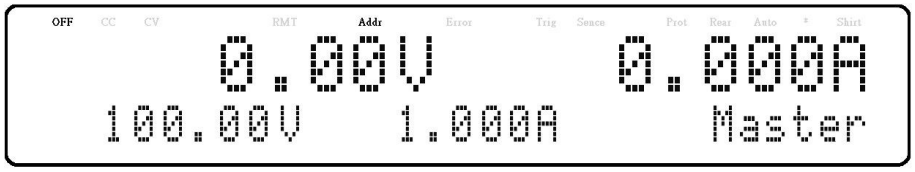


Figure 6.6 Parallel Mode Connected

CAUTION **While in parallel connection mode, the output voltage of each power supply should be set to an equal value. If the voltage value of each unit is not the same, the higher output voltage will feed back to the lower voltage unit and damage its internal components.**

WARNING **DO NOT connect multiple power supplies in series as it will cause damage or malfunction.**

CAUTION

When connecting in parallel mode, only the MASTER unit can be controlled by a computer for remote communication. There is also a decrease in speed and performance with each additional SLAVE unit connected in parallel and linked together. The voltage and current scan speed, which affects synchronization between the supplies (between the slave units and the master unit), will increase based on the following formula:

$$200 + 50 \times (N - 1)$$ **(in milliseconds)**

where N is the number of units in parallel. Please note as more units are paralleled and linked together, speed will become slower. Thus, we do not recommend paralleling too many units with this setup to ensure fast performance and operation. If the application requires connecting more than 10 units in parallel operation, we advise you to contact us at bkprecision.com for further assistance.

PV Simulation

Typically, a solar array is connected to an inverter, which converts the panel's output from DC to AC. Due to varying environmental conditions and the nonlinear output of solar cells, many inverters use a maximum power point tracking mechanism to maximize the power generated from the solar panel. Using an actual solar array to test inverters is not cost-effective and environmental conditions are difficult to control in this scenario.

The MR power supply can simulate the output of a solar array with its solar array simulator (SAS) function. Combined with the SAS application software, users can simulate the I-V curve of different arrays under various irradiance conditions while measuring and validating the effectiveness of the inverter's MPPT algorithm.

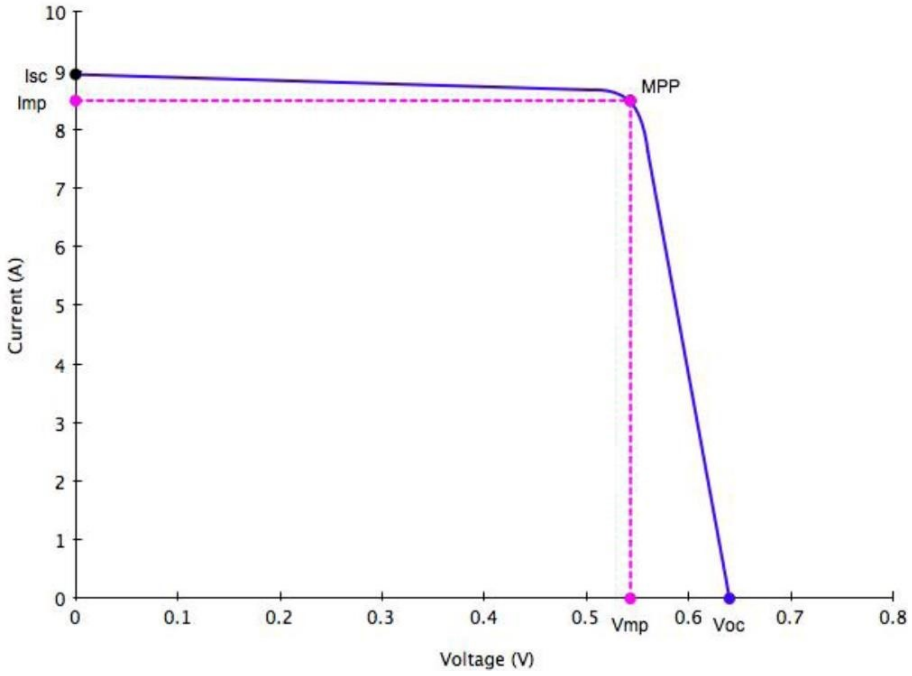


Figure 7.1 PV Simulation Curve

Solar arrays consist of multiple solar cells characterized by a complex voltage and current profile that is represented in an I-V curve. The I-V curve of a solar array can be generated automatically or manually using one of the following two methods:

a. Automatically generate the I-V curves by specifying the type of regulation for testing, and the material types such as cSi and TF. The software supports testing against EN50530, SANDIA, and NB/T32004 regulation standards. Up to 101 sets of curve parameters can be created and downloaded to the MR supply's non-volatile memory or entered directly from the front panel. Based on these input parameters, the power supply will then automatically calculate the I-V profile.

b. Manually generate the I-V curve by creating a user-defined table of points in the SAS software. Up to 4096 I-V points can be downloaded to the MR supply's non-volatile memory.

Once one of these I-V curves has been selected and set from the front panel, the power supply will operate in PV mode and output a voltage and current value according to the active I-V profile and load conditions. Different points on the I-V curve will be output in 1 ms intervals to test the inverter's MPPT efficiency. To create a user-defined table of I-V points and simulate a change in irradiance conditions (e.g. cloudy or rainy day), the PV supply must be controlled by the SAS software. The SAS software also monitors and logs real-time voltage, current, and power as well as real-time and average MPPT efficiency to validate the inverter's MPPT algorithm.

To configure and set the MR power supply to PV mode from the front panel, follow the steps below:

Step 1. Press the Menu button and press the ⇨ button three times until **PV SIMULATION** is selected, then press Enter. The following display will be shown:

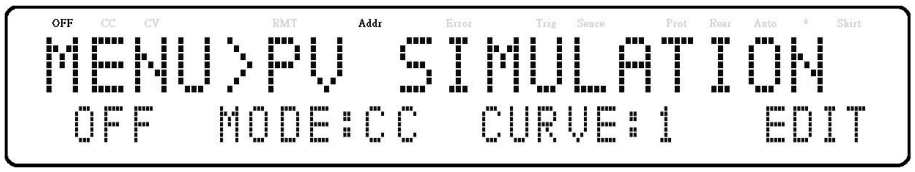


Figure 7.2 PV Simulation Menu

Step 2. Use the ◁▷ keys to move the cursor to the ON/OFF field and use the rotary knob to select ON or OFF.
– **ON**: MR supply is set to PV mode.

Step 3. Use the ◁▷ keys to move the cursor to the **CURVE** field and use the rotary knob to select the desired curve number. The curve number can be **1-101** or **TABLE** (table of up to 4096 I-V points).

Step 4. Once again, use the ◁▷ keys to move the cursor to the **EDIT** field and press Enter. The following display will be shown:

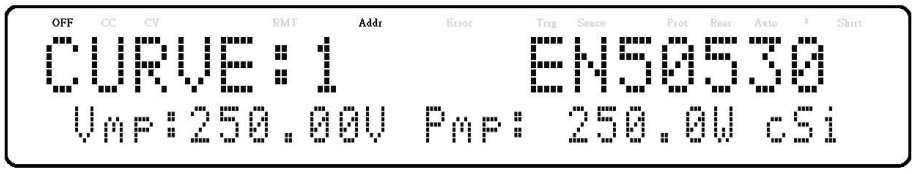


Figure 7.3 PV Curve Parameter Setup

Step 5. Use the ◁▷ keys to move the cursor through the four parameter settings. Use the numerical keys to enter parameter values and press Enter to confirm each of the four parameter settings.

Step 6. Press Esc several times to exit the menu setting.

Power-On State

The initial Power-On state of the power supply (voltage, current, output state) can be configured by following the steps below:

Step 1. From the menu, press the  button 3 times to select **POWER-ON STATE** and press Enter.

Step 2. The mode is shown on the display. Press the Enter button. There are four options which can be selected using the rotary knob:

- **DISABLE**: Last voltage and current values before power off and output state is OFF.
- ***RST**: Reset output settings, voltage, current, output state, slew rate.
- **LAST**: Last voltage, current, and output state values before power OFF.
- **USER**: User defined voltage, current, and output state.

Step 3. Select one of the settings wanted during power up, and press Enter to save changes. If **USER** has been selected, set user defined memory and output state.

Step 4. Press Esc several times to exit the menu setting.

Communication Configuration

Select and set up the remote interface.

There are several interfaces available for remote communication: USB, RS232, GPIB, Ethernet, and RS485.

Users can program the power supply by using the SCPI (Standard Commands for Programmable Instruments) commands over any one of the remote interfaces. This section will describe how to set up all of the supported interfaces.

NOTICE

The RMT indicator will appear on the display when the power supply is successfully connected to a PC remotely through any remote interface. Keys on the front panel will be locked until the instrument is in LOCAL mode. To return to LOCAL mode from the front panel, press Local. The RMT indicator will disappear when the instrument is in LOCAL mode.

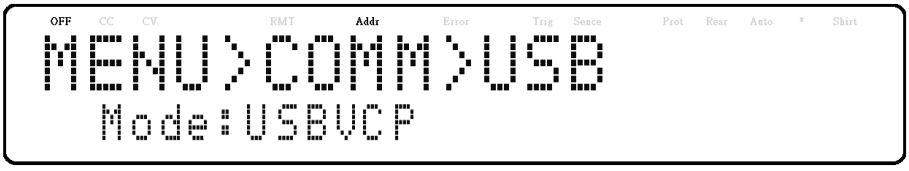
9.1 USB

The MR series supports USBVCP and USBTMC.

To select either USBVCP or USBTMC:

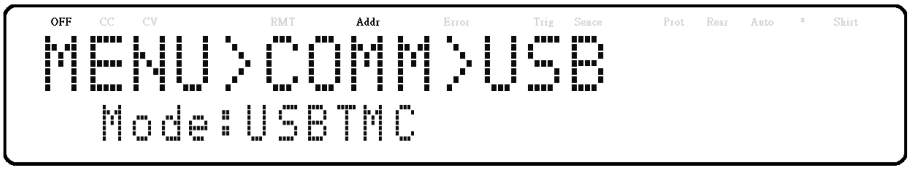
Step 1. From the menu, select **Communication** and press Enter.

Step 2. When USB is selected, press Enter to select **USB**. The following display will be shown:



Step 3. Use the ◁▷ keys to navigate between USBVCP and USBTMC. Press Enter to select an interface.

If USBTMC is chosen, the following display will be shown:



9.1.1 USBVCP

The USBVCP is a virtual COM port that can be used for remote communication. There are no settings in the menu for USB configuration. To configure the USBVCP settings, refer to the RS232 settings below, as they are the same.

9.1.2 USBTMC

The USBTMC driver must be installed to use the USBTMC interface. The driver is included in the VISA software download and can also be found on our website, **bkprecision.com** (we recommend using NI-VISA, which can be downloaded at **www.ni.com**).

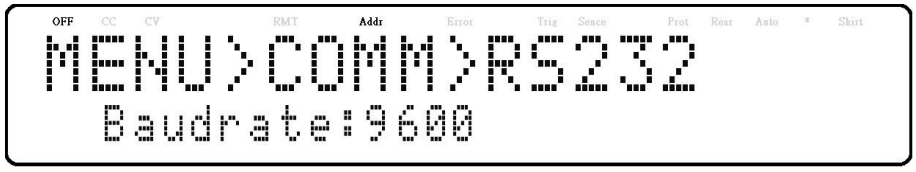
9.2 RS232

To configure the power supply for RS232 operation:

Step 1. From the menu, select **Communication** and press Enter.

Step 2. Press the ▷ button four times until RS232 is selected.

Step 3. Press Enter to configure the settings for RS232. The following display will be shown:



Step 4. Use the ◁▷ keys to select between each setting.

Step 5. Press Enter to configure the corresponding settings.

- To change the baud rate or any of the parameter settings, use the rotary knob.
- Press Enter to save each setting.
- Once the settings have been saved, the display will return to the RS232 menu.

The parameters available for each setting are listed below.

Baud rates: 9600, 19200, 38400, 57600

NOTICE

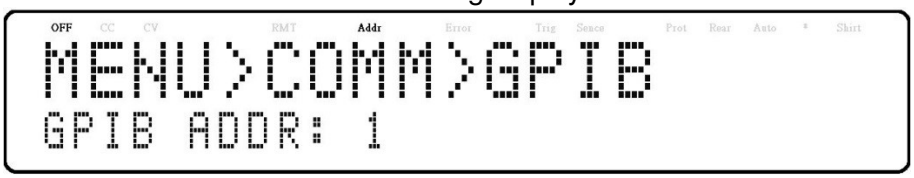
The default settings are 9600, None/8 bits, 1.
*** The RS232 interface does not have a flow control mechanism. The programmer should be aware of this limitation and notice the command process time of the power supply. If the remote commands are sent too fast to the power supply, the internal buffer may overrun and cause a communication error. Therefore, a delay between commands to let the power supply have enough time to process them is mandatory. All serial settings must match the settings configured on the PC in order for communication to link successfully.**

9.3 GPIB

Each model can be configured with a GPIB address from 1-30. Follow the instructions below to select and configure the GPIB interface for remote operation.

Step 1. From the menu, select **Communication** and press Enter.

Step 2. When **GPIB** is selected, press Enter to configure the settings for GPIB remote communication. The following display will be shown:



Step 3. Press Enter to configure the **GPIB Address** to which the power supply will be assigned. Use the rotary dial or numeric keypad to enter a value from 1-30.

Step 4. Press Enter to save each setting and the display will return to the GPIB menu.

Step 5. Make sure the address assigned in the power supply unit matches the address the data commands are being sent to.

9.4 RS485

The MR series supports multiple power supplies (of the same model, up to *50) that can be connected together via RS485. The power supplies can be controlled with a computer via the USB (virtual COM) interface (Chain mode). When connecting more than 10 units, add a 120 Ω resistor terminator to the last unit as shown in the **figure** below. Follow the instructions below to select and configure the RS485 interface for remote operation.

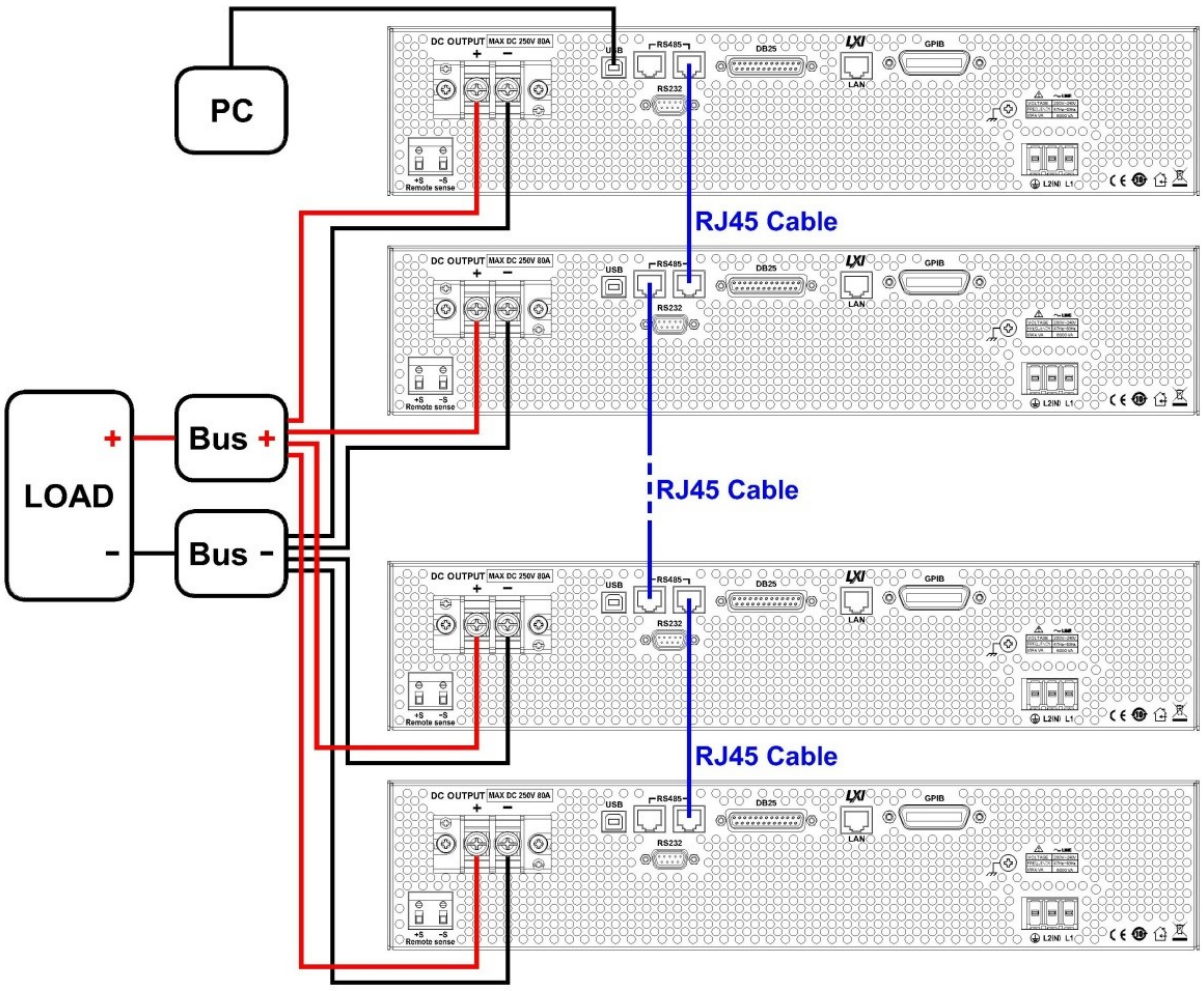
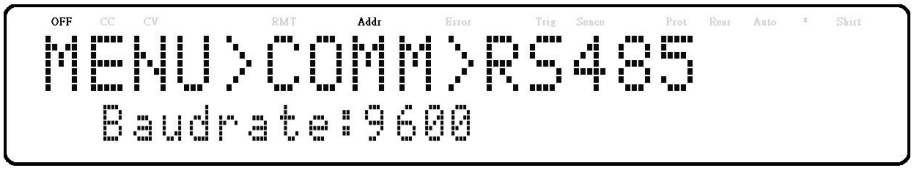


Figure 9.1 RS485 Connection Diagram

Step 1. From the menu, browse and select **Communication** and press Enter.

Step 2. Press the ▷ button two times until RS485 is selected and press Enter to configure the settings for RS485 remote communication. The following display will be shown:



Step 3. Use the ◁▷ keys to select between each setting and press Enter to configure the corresponding setting.

Step 4. To change the parameter settings, use the rotary knob or the ◁▷ keys.

Step 5. Press Enter to save each setting and the display will return to the RS485 menu.

Below are the options that can be changed for each setting:

Baud rate: 9600, 19200, 38400, 57600

NOTICE **The default is 9600, None/8 bits, 1, Address = 1, Off.**

For each power supply that you want to control, provide a different address. For example, if you have three power supplies to control, set the first supply to address 1, second supply to address 2, and third supply to address 3. If two or more supplies have the same address, the RS485 protocols will create communication errors.

Repeat the above steps for each power supply that you want to connect together and control, making sure that each of them has a different address assigned.

To enable chain mode, return to the RS485 menu on any of the connected slave power supplies and set Chain to ON. The following display will be shown:



The slave number will change as more slaves are added.

After enabling chain mode on all connected slaves, repeat the process to enable chain mode on the master (address = 1) power supply. The master will search and automatically connect to slave power supplies. Slave power supplies will display “Connected” if setup is successful.

Connect the USB of the first supply (address 1) to the computer, then use the Multi-Unit Programming commands to communicate with each power supply. Refer to “Multi-Unit Control Commands (Chain mode)” in the programming manual.



⚠CAUTION

When connecting multiple power supplies (of the same model) in parallel while in chain mode, there will be a decrease in speed and performance with each additional unit connected in parallel. The voltage and current scan speed, which affects the synchronization between the power supplies, between the slave units and the master unit will increase based on the following formula: 250 * N (in milliseconds) where N is the number of power supplies (of the same model) in parallel. Please note as more power supplies are paralleled and linked together, speed will become slower. Thus, we do not recommend paralleling more than 4 power supplies while in chain mode to ensure fast performance. Parallel mode is recommended when the application requires paralleling 5 to 10 power supplies. Refer to the Parallel Operation chapter for more details.

9.4.1 True RS485

The RS485 port is in true RS485 mode by default, allowing it to be used as an I/O interface for remote control and programming when parallel and chain mode are disabled.

Table 9.1 shows under what conditions true RS485 mode can be enabled:

Condition	True RS485 mode	Parallel mode	Chain mode
Factory default	ON	OFF	OFF
Parallel mode on	OFF	ON	ON
Chain mode on	OFF	OFF	ON
Parallel mode and Chain mode off	ON	OFF	OFF

Table 9.1 True RS485 Mode

9.5 LAN (Ethernet)

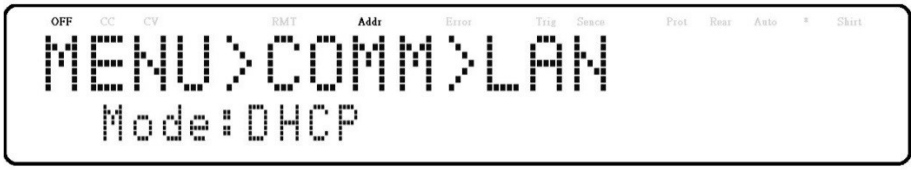
The LAN interface supports Static IP address and DHCP connection. The device has a built-in web server GUI.

Follow the instructions below to select the Ethernet interface for remote operation.

Step 1. From the menu, select **Communication** and press Enter.

Step 2. Press the  button two times until LAN is selected.

Step 3. Press Enter to configure the settings for LAN remote communication. The following display will be shown:



Step 4. Use the ◁▷ keys to select between each setting.

Step 5. Press Enter to configure the corresponding setting.

Step 6. To change any of the parameter settings, use the rotary knob.

Step 7. Press Enter to save each setting and the display will return to the LAN menu.

9.5.1 IP Mode

Select **Dynamic Host Configuration Protocol** (**DHCP**) or **Manual** to set how the LAN settings will be configured.

The easiest way to configure the LAN settings is to set the IP Mode to **DHCP**. **DHCP** will automatically assign an IP address to the instrument.

The settings can be configured manually by selecting **Manual**.

9.5.2 IP Address

The **IP Address** is a unique string of numbers separated by periods. To enter an IP address:

Use the numeric keypad to enter an IP address. The ▷ keys are used to separate each number in the string. After inputting each number, press Enter to set the address.

9.5.3 Subnet Mask

The **Subnet Mask** divides the IP address into network address and host address. To set the **Subnet Mask**:

Use the numeric keypad to enter the subnet mask. The ▷ keys are used to separate each number in the string. After inputting each number, press Enter to set the address.

9.5.4 Gateway IP

The gateway address is by default the IP address of the network device that connects the instrument. If **IP Mode** is set to DHCP, the **Gateway IP** does not have to be set.

To set the **Gateway IP**:

Use the numeric keypad to enter an IP address. The  keys are used to separate each number in the string. After inputting each number, press Enter to set the address.

9.5.5 Primary DNS

Domain Name Service (DNS) is the system that automatically translates Internet addresses to numeric machine addresses. The DNS address is the IP address of the system that performs this service.

If **IP Mode** is set to DHCP, the DNS will automatically be set. To set the **Primary DNS**:

Use the numeric keypad to enter an IP address. The  keys are used to separate each number in the string. After inputting each number, press Enter to set the address.

9.5.6 Web Server

There is an embedded web server GUI that can access the power supply via the LAN interface using a web browser. The GUI provides a simple way of setting voltage and current, as well as monitoring the output, using a web browser from a computer connected to the same local area network as the power supply.

To access the web server:

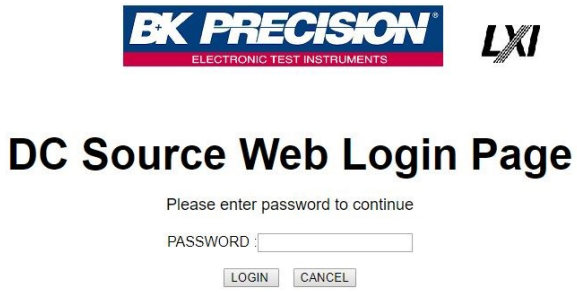
Step 1. Connect the power supply to the same network as the PC.

Step 2. Open a web browser on the computer to control the power supply.

Step 3. Check the IP address of the power supply through INFO in the MENU.

Step 4. Type the IP address of the power supply in the URL bar of your browser with the http:// prefix (i.e. http://192.168.1.55 for IP Address 192.168.1.55).

Step 5. If correctly configured, the Home page will be shown. When entering the Lan Config page, Config page, or Control page, the Web Server Login page will be shown:



Step 6. A password is required to log in and access the menu items on the page. The default admin password is **123456**.

9.5.6.1 Home Page

The HOME page provides general information of the power supply: LXI Device Model, Manufacturer, Serial Number, Description, LXI Version, mDNS Hostname, MAC address, TCP/IP address, Firmware Version, LXI Extended Function, LXI Device Address String, TCP/IP SOCKET Device Address String, USBTMC Device Address String, GPIB Device Address String, USB Port Function, RS232C setting, RS485 setting, Identification indicator function.

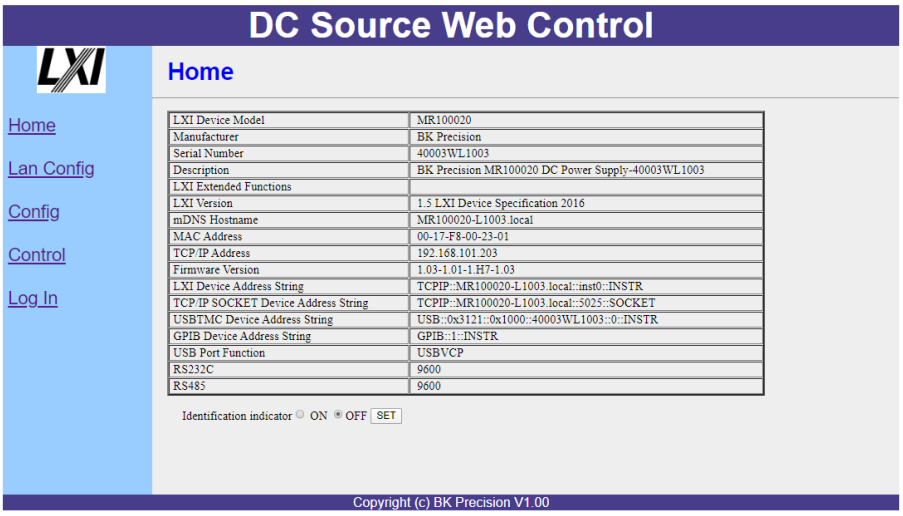


Figure 9.2 Web Server Home Page

9.5.6.2 LAN Configuration

The LAN CONFIG page provides the Hostname, Description, IP Address, Netmask, Gateway, DNS, password, LAN configuration, initialize, and Restore Factory Settings.

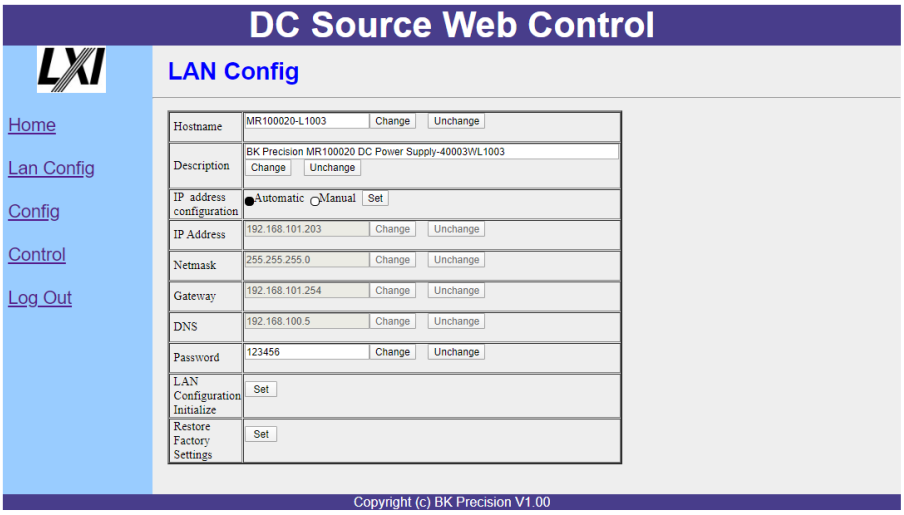


Figure 9.3 LAN Configuration

9.5.6.3 Parameter Configuration

The CONFIG page provides the protection settings (OVP, OCP, OPP, CV to CC, and CC to CV) and output related parameters such as voltage/current slope and limit settings.

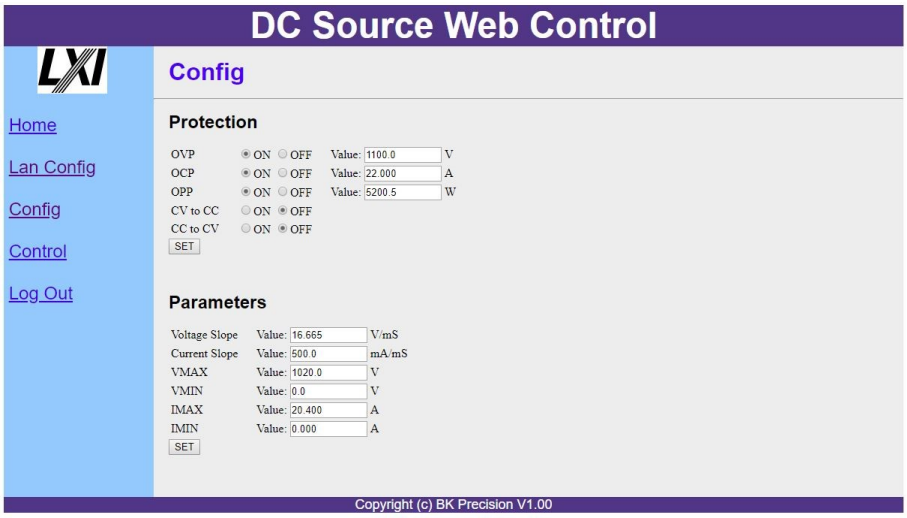


Figure 9.4 Parameters Configuration

9.5.6.4 Control Page

The CONTROL page provides the general control of the power supply such as the output On/Off setting as well as the voltage and current setting. The command line for SCPI commands can also be accessed here.

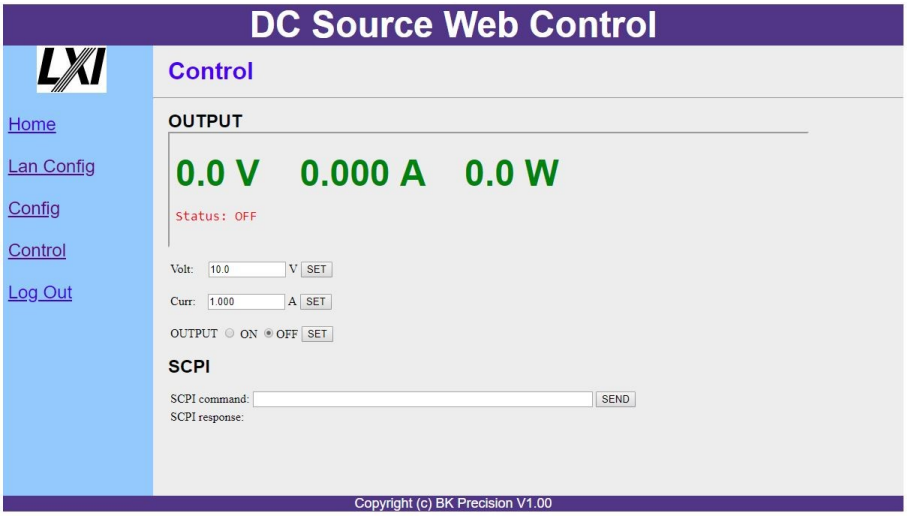


Figure 9.5 Control Page

9.5.7 Socket Connection

Socket connection is available for communication via the LAN (Ethernet) interface. The instrument uses the TCP/IP protocol for communication. Users can use socket port **5025** to open a raw socket connection for sending remote commands.

9.6 Error/Event List

The SCPI interface offers an error/event list that contains up to 20 errors/events. Users can read the errors/events through the `SYStem:ERRor?` query command in a first-in first-out manner. Once an error/event is read, the read process will clear it from the memory. To clear all errors/events from the memory, the `*CLS` command can be used.

Error	Description
-000	No error
-102	Syntax error
-103	Invalid separator
-104	Data type error
-105	GET not allowed
-108	Parameter not allowed
-109	Missing Parameter
-110	Command header error
-111	Header separator error
-113	Undefined header
-131	Invalid suffix
-138	Suffix not allowed
-200	Execution error
-203	Command protected
-221	Settings conflict
-222	Data out of range
-223	Too much data
-240	Hardware error
-350	Error queue overflow

Table 9.2 Error/Event List

System Menu

All setup procedures and settings explained in this section can be accessed from the **SYSTEM** menu.

To access this menu, press Menu and press the ⇨ button five times until **SYSTEM** is displayed.

Press the Enter button to enter the menu.

10.1 Enable/Disable Key Sound

By default the key sound is enabled. To disable or re-enable the key sound:

Step 1. From the **SYSTEM** menu, select **BEEP** and press Enter.

Step 2. Select between the two options using the rotary knob:
- **On:** Enable key sound
- **Off:** Disable key sound

Step 3. Select the desired option and press Enter to save the change.

Step 4. Press Esc several times to exit the menu setting.

10.2 Error Log

Errors are listed in the order in which they were encountered, with 1 being the most recent. The error log displays up to 50 error codes. After reaching 50 error codes, no more codes will be reported in the error log. To continue filing error codes, the error log list must be cleared.

To view the error codes:

Step 1. From the **System** menu, select **Error Code List**.

To clear the error codes:

Step 1. From the **System** menu, select **Error Code Clear**.



Step 2. Enter the default password: “13579” and press Enter.



Error	Definition	Error	Definition
B001	Buck BUS Error	P001	PFC Over current
D001	Control board EEPROM Error	P002	PFC board no response
F001	AC Input Freq. Error	P003	PFC BUS low
H001	H/W OVP fail	P004	PFC BUS High
H002	H/W OCP fail	P005	PFC Relay OFF
M001	Module 1 voltage Error	R001	Remote sense reverse
M002	Module 2 voltage Error	R002	Remote sense open
M003	Module 3 voltage Error	R003	Remote sense fail
M004	Module 4 voltage Error	T001	Transformer of DC to DC over temperature
M101	Module 1 current Error	T002	MOSFET of buck over temperature
M102	Module 2 current Error	T003	MOSFET of Dummy Load over temperature
M103	Module 3 current Error	T004	PFC over temperature
M104	Module 4 current Error	V001	H/W high voltage
N001	FAN Error	V101	AC Input voltage too low
		V102	AC Input voltage too high

Table 10.1 Error Code List

10.3 Restore Factory Default Settings

To set all settings to factory default:

Step 1. From the **SYSTEM** menu, press the button 3 times to display **DEFAULT**.

Step 2. Press Enter to select **DEFAULT**.

Step 3. The instrument will return to the normal display and all settings will now be restored to factory default (see **Table 10.2**).

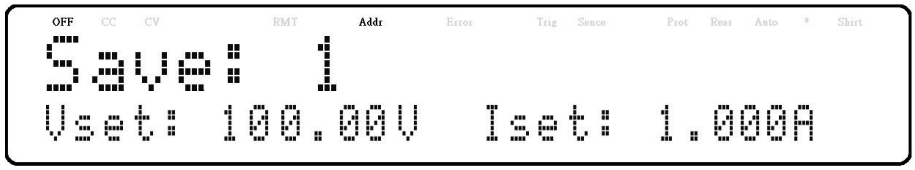
10.4 Save/Recall Instrument Settings

The instrument can save up to 10 voltage/current values for quick recall.

10.4.1 Save Settings

Step 1. Set up the output voltage and current settings that you want to save.

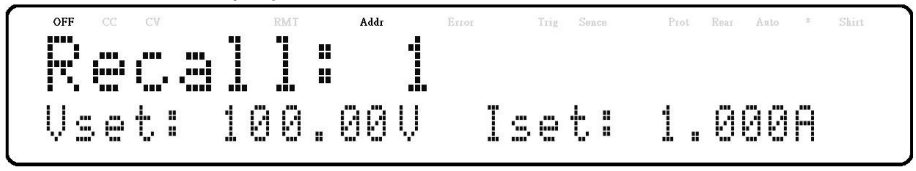
Step 2. Then, press Shift followed by Save Recall. The display will show the following:



Step 3. Use the current adjust knob or the numeric keypad to enter the memory location in which to store the current instrument settings. Select between 1 – 10. Press Enter to save to the selected location.

10.4.2 Recall Settings

Step 1. Press Save Recall to enter **Recall** mode. The current group number will be shown on the display.



Instrument settings can only be recalled when the instrument enters this mode.

Step 2. Use the keypad to enter the memory location you want to recall. Enter a value between 1 and 10. The voltage and current settings of that memory location will be shown on the bottom of the display.

Step 3. Once entered, the saved settings at the location will be immediately recalled.

Item	Parameter	MR160120	MR3K160120	MR25080	MR50040	MR100020
Output	Voltage	10	10	10	10	10
	Current	1	1	1	1	1
	State	OFF	OFF	OFF	OFF	OFF
Protection	OVP Voltage	176	176	275	550	1100
	OCP Current	144	144	96	48	24
	OPP Power	5200.5	3120	5200.5	5200.5	5200.5
	CV to CC	OFF	OFF	OFF	OFF	OFF
	CC to CV	OFF	OFF	OFF	OFF	OFF
Limit	Vmax	163.2	163.2	255	510	1020
	Vmin	0	0	0	0	0
	Imax	122.4	122.4	81.6	40.8	20.4
	Imin	0	0	0	0	0
Slope	Voltage Slope	5.33	5.33	8.33	16.67	33.33
	Current Slope	1000	1000	1000	1000	1000
Beep	Mode	ON	ON	ON	ON	ON
Timer	Mode	OFF	OFF	OFF	OFF	OFF
	HHH:MM:SS	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
Program	Mode	OFF	OFF	OFF	OFF	OFF
	Program Number	0	0	0	0	0
Parallel	Mode	OFF	OFF	OFF	OFF	OFF
	Address	Master	Master	Master	Master	Master
PV Simulation	Mode	OFF	OFF	OFF	OFF	OFF
	Curve	1	1	1	1	1
	Control Mode	CC	CC	CC	CC	CC
External Control	Mode	EXT_V	EXT_V	EXT_V	EXT_V	EXT_V
	Range	10V/10K	10V/10K	10V/10K	10V/10K	10V/10K
	Shut Off	Live	Live	Live	Live	Live
Power-on State	Mode	Disable	Disable	Disable	Disable	Disable
	MEM	1	1	1	1	1
	Output State	Off	Off	Off	Off	Off
GPIB	Address	1	1	1	1	1
RS-232C	Baud	9600	9600	9600	9600	9600
RS-485	Baud	9600	9600	9600	9600	9600
	Mode	DHCP	DHCP	DHCP	DHCP	DHCP
	IP address	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0

NOTICE

When in Recall mode, users can recall settings from different locations without having to press additional keys each time. For example, you can press 1 to recall settings in location one, and then press 5 to immediately recall settings in location 5.

10.5 Program Function

The MR has a Program feature that allows storing of programs into internal non-volatile memory and recalling and running them per configured parameters. A total of 100 steps can be configured for each program, and a total of 10 programs are available for storage. Additionally, multiple programs or all 10 programs can be saved into a program configuration, where each program configuration allows running one program after another or repeating a finite number of times. This allows for a total of 900 steps in a single configuration. **Figure 10.1** illustrates how programs are structured, stored, and recalled. **Figure 10.2** shows an example of a program.

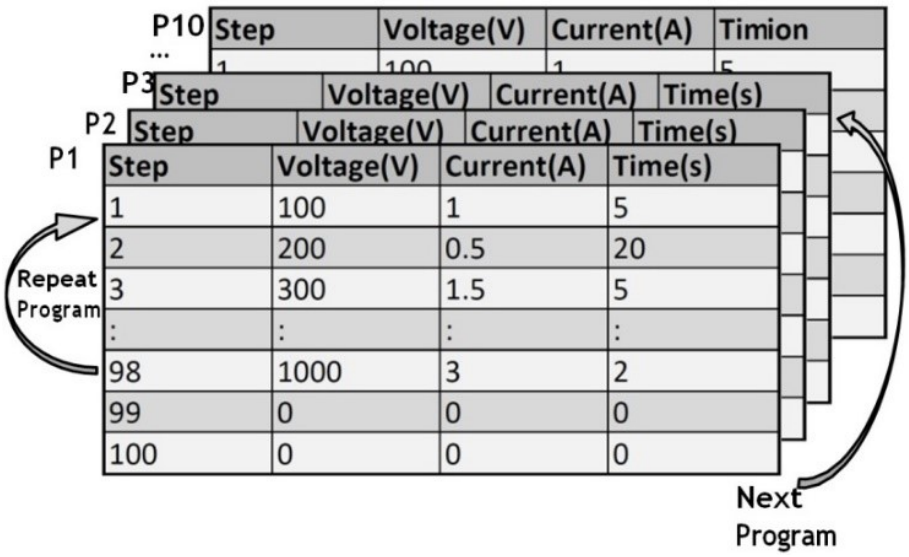


Figure 10.1 Program Structure Illustration

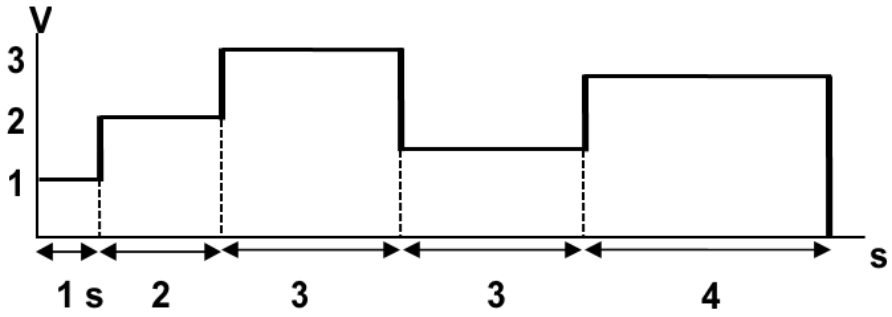


Figure 10.2 Program Example

10.5.1 Repeat and Next

Users also have the ability to utilize the **REPEAT** and **NEXT** options.

10.5.1.1 REPEAT

REPEAT allows the user to execute the same program as many times, continuously, as needed.

10.5.1.2 NEXT

NEXT allows the user to select the next program to be executed once the current program ends.

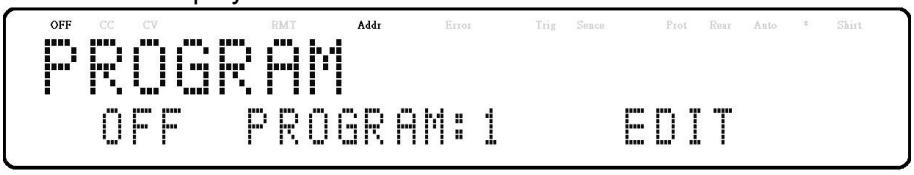
NOTICE

REPEAT and NEXT options are part of a program, so if one program's NEXT option is pointed to a previous program, the power supply will cycle these programs infinitely.

10.5.2 Setup a Program

To setup a program:

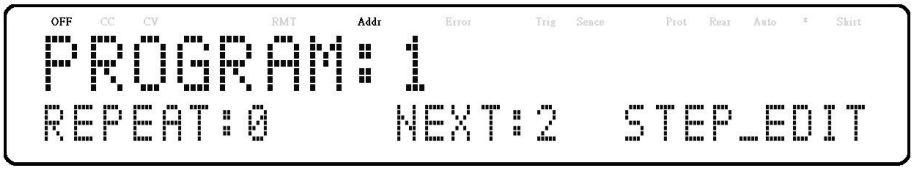
Step 1. Press the Prog. button to enter the program function settings. The following will be displayed:



Step 2. Use the rotary knob to select the setting of **OFF** or **ON**.

Step 3. Use the ◁▷ keys to move the cursor to the **PROGRAM** selection and use the rotary knob to select a program between 1-10.

Step 4. Use the ◁▷ keys to move the cursor to the **EDIT** selection and press Enter. The following screen will be displayed:

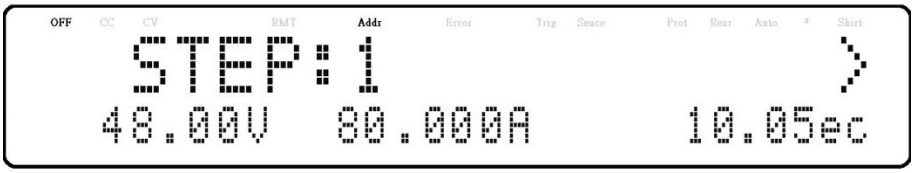


Step 5. Press Enter. At this point, the user may select how many times they wish the current program to repeat in the **REPEAT** field, by using the keypad or the rotary knob.

Step 6. Press ⇨ to select the **NEXT** parameter and use the rotary knob to select a value of 0-10.

– As described previously, the user has the ability to queue another program once the current program is finished. By default, 0 is placed as the parameter value, and represents the end of the program.

Step 7. Press ⇨ to select the **STEP_EDIT** parameter. After pressing Enter, the following will be displayed:



Each step has the following parameters to be edited: voltage, current, and time.

a. Press Enter to edit the step, use the ⇦⇨ keys to move the cursor to the desired parameter and use the rotary knob or keypad (numeric values only) to change the parameter values.

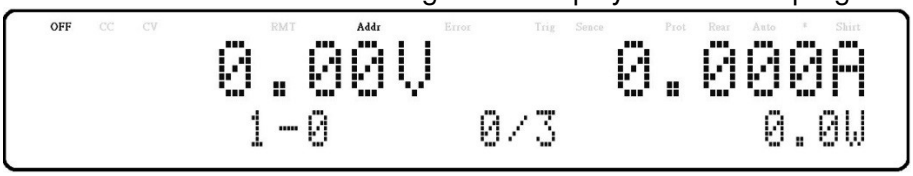
b. Press Enter to complete this step edit.

c. Press ⇨ to edit the next step, change the step value and continue this procedure for each step for as many steps as needed.

d. Once all desired steps have been set, press Esc several times to complete the program configuration.

Step 8. Make sure the program is turned ON and press Esc to exit the program settings.

Step 9. Once the output state is enabled, by pressing On/Off, the program will automatically execute. The following will be displayed when the program is executing:

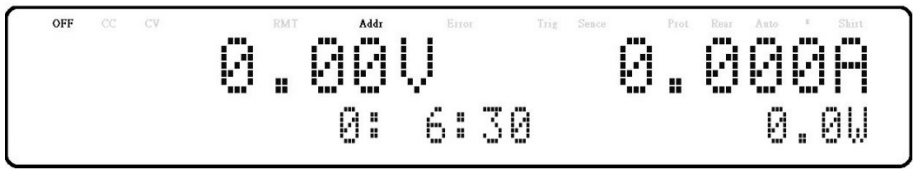


Where p is the program number, step (1-0 : 0) is the step number, repeat number (0/3 : 0) is the present repeated number and repeat number (0/3 : 3) is the total repeat number.

For example, if the repeat number is 1/3, this means that there are three repeats of this program and it is now running the first repeat.

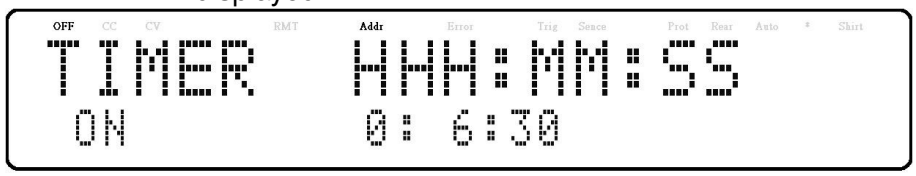
10.6 Timer

The timer function is a countdown clock, which allows the user to set up how long the output will be enabled when it is initially turned ON. When it is running, a clock on the display counts down until it reaches zero and the output will turn OFF. When the timer is running, the following screen will be displayed:



To activate the **Timer** function:

Step 1. Press the Shift and Timer Iset buttons to enter the timer setup screen. The following will be displayed:



Step 2. Use the ◁▷ keys to move the cursor to the desired parameter (hour, minute, and second) and use the keypad to change the parameter values.

Step 3. Use the ◁▷ keys to move the cursor to the ON/OFF parameter and use the rotary knob to change **ON** or **OFF**.

Step 4. Press Enter to complete the timer setting.

Step 5. Pressing the On/Off key will enable the output and start the timer.

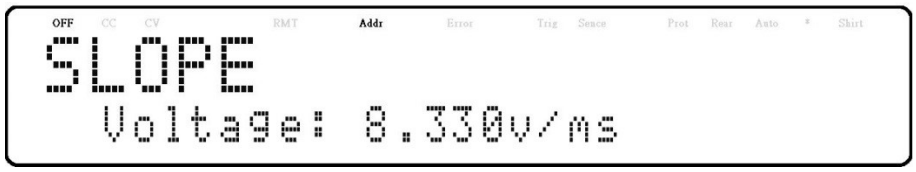
10.7 Slew Rate

The power supply has the capability of controlling the output voltage and current slew rate. The timing can be configured for the rising/falling edge between voltage and current output transitions.

To configure the voltage or current slew rate:

Step 1. Press Shift and Slope Vset buttons to enter the slope menu.

Step 2. Use the ◁▷ keys to select **VOLTAGE** or **CURRENT** and press Enter to confirm. The following will be displayed:



Step 3. Use the keypad or rotary knob to enter the slope value and press Enter to confirm.

Step 4. Press Esc to exit the slope menu.

Calibration

B&K Precision recommends a calibration interval of one year to ensure that the power supply meets specifications. This instrument features closed-case calibration. To perform the calibration, the following equipment is required:

- 6 ½ digit digital multimeter (DMM); B&K Precision 5493C or equivalent

WARNING **The following calibration instructions may be used by authorized technicians or calibration personnel only. If you are not authorized, do not attempt to calibrate the instrument yourself, as it may damage the instrument and void the warranty.**

To enter the calibration procedure:

Step 1. Press the Menu button.

Step 2. Press the button until **SYSTEM** is selected.

Step 3. Press Enter to enter the **System Menu**.

Step 4. Press the button until **CALIBRATION** is selected and press Enter.

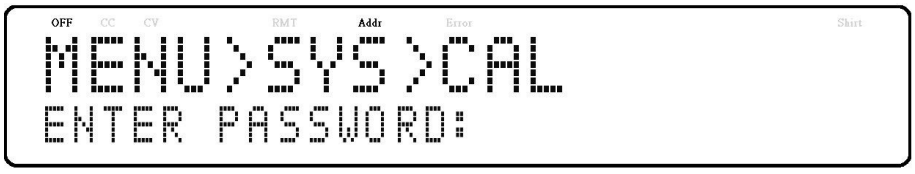


Figure 11.1 Calibration Password

Step 5. Enter the password **13579** using the numeric keypad, and press the Enter key to confirm. The following display will be shown:

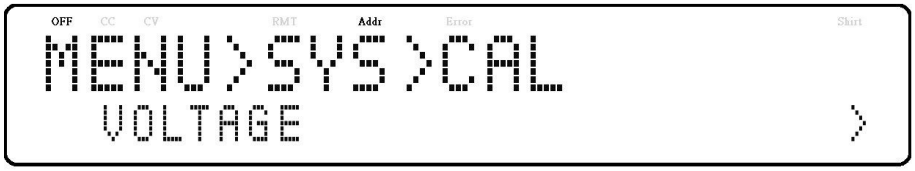


Figure 11.2 Calibration Menu

11.1 Calibration Options

- Output voltage
- Output current
- Overvoltage protection
- Overcurrent protection
- External voltage programming
- External current programming
- Constant current of external voltage programming
- Constant current of external current programming

These options are only accessible in the calibration menu. The following calibration procedures assume the operator is in the CAL menu.

11.2 Voltage Calibration

To perform a voltage calibration:

Step 1. Connect the DMM to the output of the power supply as shown in the figure below:

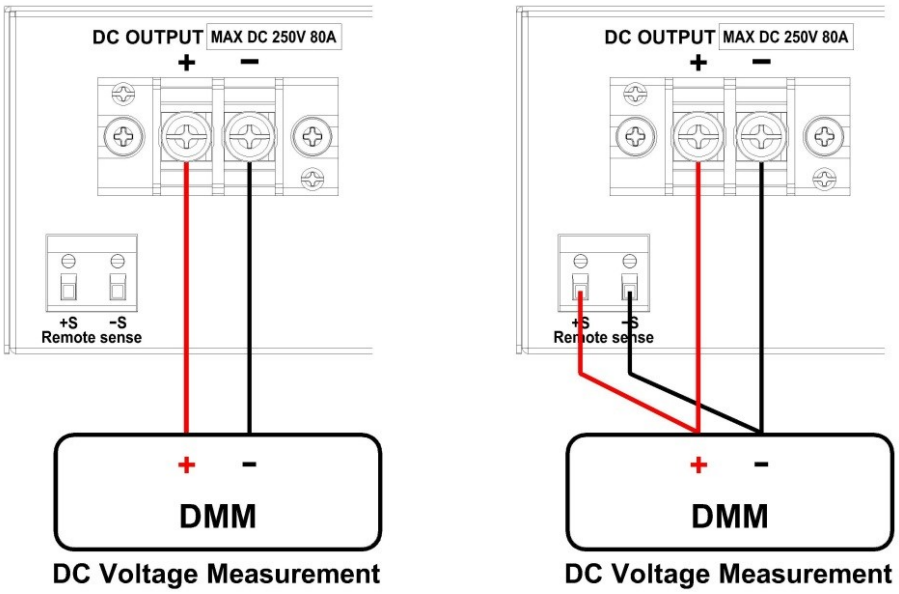


Figure 11.3 Voltage Calibration Diagram

When calibrating local sense only, connect the DMM to the output. When calibrating remote sense, connect the DMM to the output and remote sense.

Step 2. Set the DMM to a DC voltage measurement. Select the VOLTAGE parameter in the **Calibration** menu and press Enter. The following will be displayed:

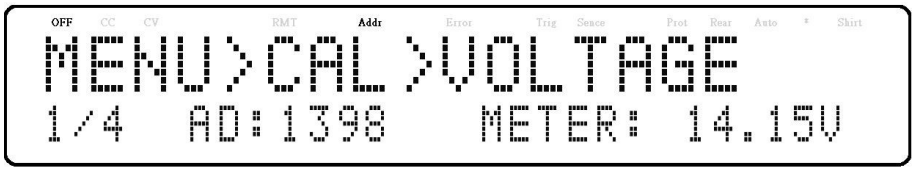


Figure 11.4 Voltage Calibration

The 1/4 signifies there are 4 points to be calibrated and the current calibration point is 1. Press On/Off to start calibration.

Step 3. When the **METER** parameter is blinking, input the voltage reading from the DMM in the **METER** parameter by using the numeric keypad and press Enter.

Step 4. Repeat this procedure by entering the meter readings for points 2 – 4.

11.3 Current Calibration

To perform a current calibration:

Step 1. Connect the shunt resistor, DMM, and electronic load to the output of the power supply as shown in the figure below:

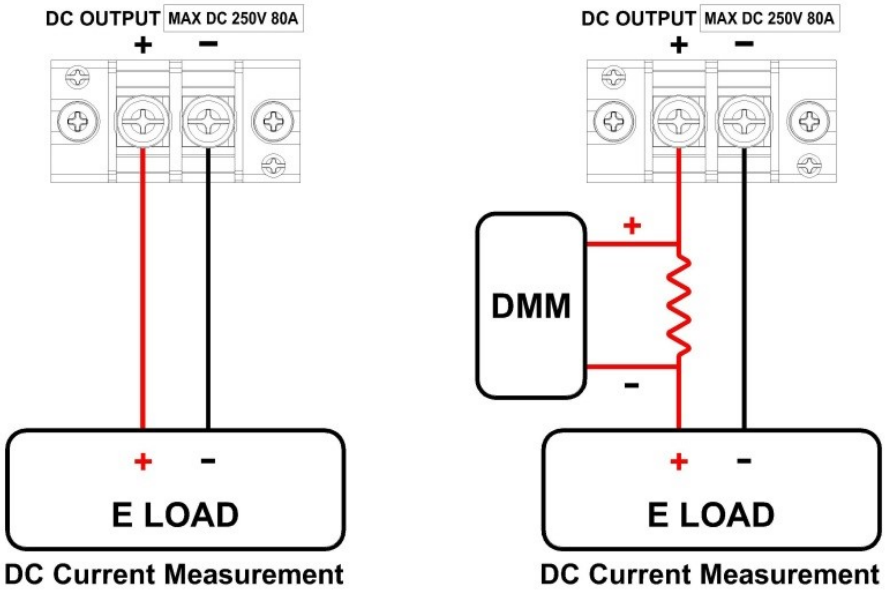


Figure 11.5 Current Calibration Diagram

Step 2. Set the DMM to a DC voltage measurement. Set the electronic load to CV mode with the voltage set to 5 V. Select the **CURRENT** parameter in the **CALIBRATION** menu and press Enter. The following will be displayed:

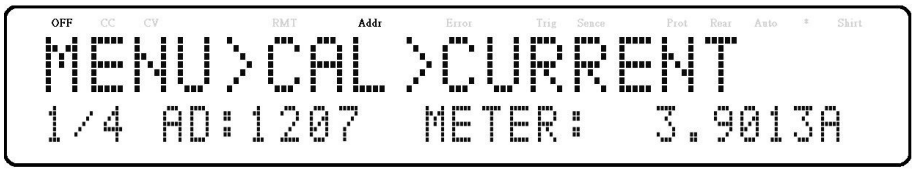


Figure 11.6 Current Calibration

The 1/4 signifies there are 4 points to be calibrated and the current calibration point is 1. Press On/Off to start calibration.

Step 3. When the **METER** parameter is blinking, input the current (the voltage reading from the DMM divided by the shunt resistance) in the **METER** parameter by using the numeric keypad and press Enter.

Step 4. Repeat this procedure by entering the meter readings for points 2 – 4.

11.4 OVP Calibration

The overvoltage protection (OVP) calibration can be executed right after the voltage calibration, or the user can select OVP in the Calibration menu.

To perform the overvoltage protection calibration:

Step 1. Disconnect any load from the output terminal of the power supply.

Step 2. Select the **OVP** parameter in the **CAL** menu and press Enter. The following will be displayed:

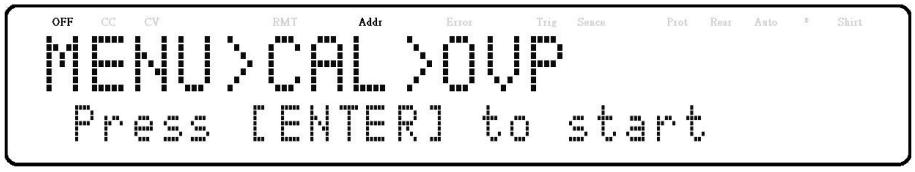


Figure 11.7 OVP Calibration Start

Step 3. Press Enter to run the **OVP** calibration or press Esc to abort. The **OVP** calibration is an automatic process that will take about 10 to 20 seconds.

Step 4. After the calibration is finished, the following message will be displayed:

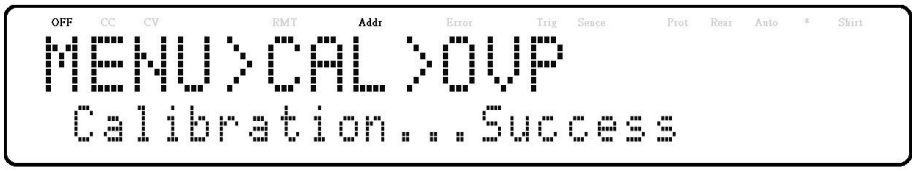


Figure 11.8 OVP Calibration Finished

11.5 OCP Calibration

The overcurrent protection (OCP) calibration can be executed right after the current calibration, or the user can select **OCP** in the **Calibration** menu.

To perform the overcurrent protection calibration:

Step 1. Short the output + and - terminals of the power supply as shown below:

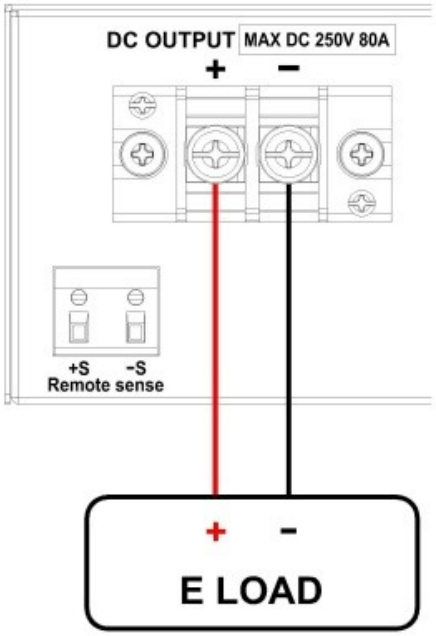


Figure 11.9 OCP Calibration Diagram

Step 2. Set the electronic load to CV mode with the voltage set to 5 V. Select the **OCP** parameter in the **CAL** menu and press Enter. The following will be displayed:

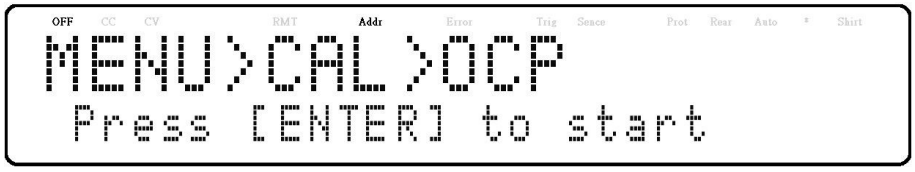


Figure 11.10 OCP Calibration Start

Step 3. Press Enter to run the **OCP** calibration or press Esc to abort. The **OCP** calibration is an automatic process that will take about 20 to 30 seconds.

Step 4. After the calibration is finished, the following message will be displayed:

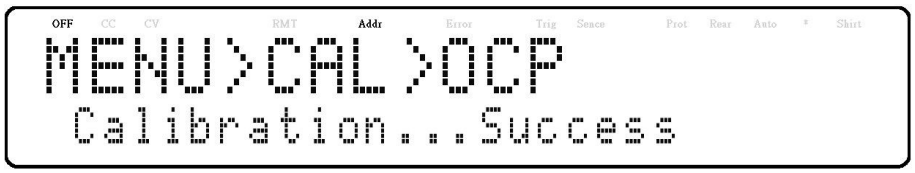


Figure 11.11 OCP Calibration Finished

11.6 External Voltage Programming Calibration

To perform the external voltage programming calibration:

Step 1. Connect the DMM to the external analog control terminals of the DB25 connector (+ on the DMM to Pins 9 and 11, - on the DMM to Pin 22 (GND)) on the rear of the power supply, as shown in the figure below:

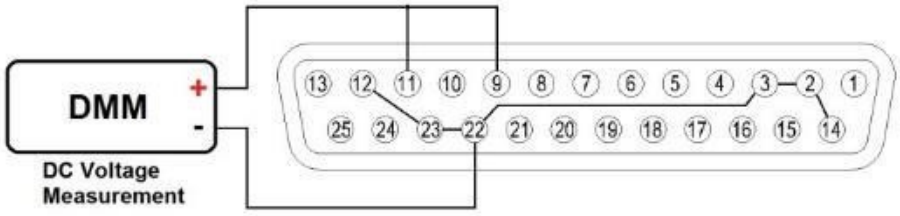


Figure 11.12 External Voltage Programming Calibration Diagram

Step 2. Set the DMM to a DC voltage measurement. Select the **EXT_VOLT** parameter in the **Calibration** menu and press Enter. The following will be displayed:

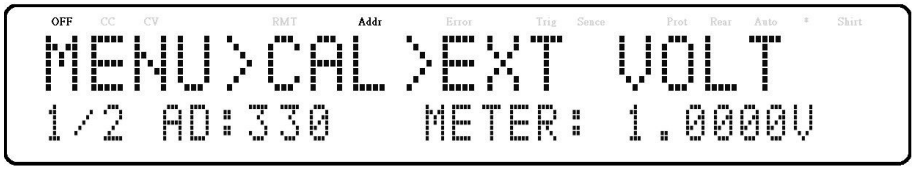


Figure 11.13 External Voltage Programming Calibration

The P: 1/2 signifies there are 2 points to be calibrated and the current calibration point is 1.

Step 3. Input the voltage reading from the DMM in the **METER** parameter by using the numeric keypad and press Enter.

Step 4. Repeat this procedure by entering the meter reading for point 2.

11.7 External Current Programming Calibration

To perform the external current programming calibration:

Step 1. Connect the DMM to the external analog control terminals of the DB25 connector (+ on the DMM to Pins 10 and 24, - on the DMM to Pin 22 (GND)) on the rear of the power supply, as shown in the figure below:

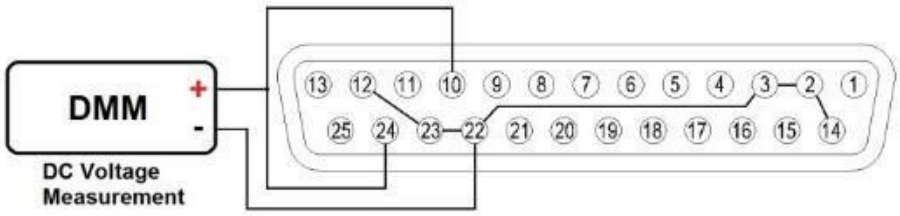


Figure 11.14 External Current Programming Calibration Diagram

Step 2. Set the DMM to a DC voltage measurement. Select the **EXT_CURR** parameter in the **CAL** menu and press Enter. The following will be displayed:

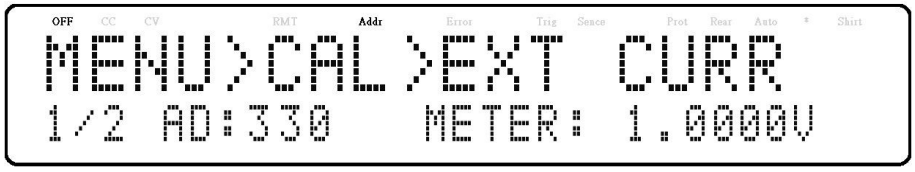


Figure 11.15 External Current Programming Calibration

The P: 1/2 signifies there are 2 points to be calibrated and the current calibration point is 1.

Step 3. Input the voltage reading from the DMM in the **METER** parameter by using the numeric keypad and press Enter.

Step 4. Repeat this procedure by entering the meter reading for point 2.

11.8 CC Calibration of External Voltage

To perform the calibration procedure for the constant current source of the external voltage programming by resistor mode:

Step 1. Connect the external analog control terminals of the DB25 connector (Pins 9, 22 (GND)) on the rear of the power supply, as shown in the figure below:

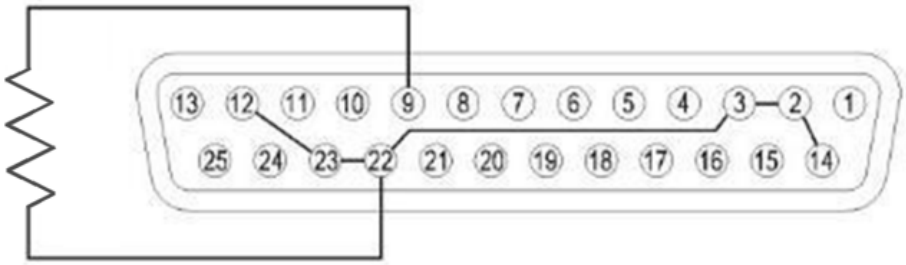


Figure 11.16 CC Calibration of External Voltage Diagram

Step 2. Select the **EXT_V_CC** parameter in the **Calibration** menu and press Enter. The following will be displayed:

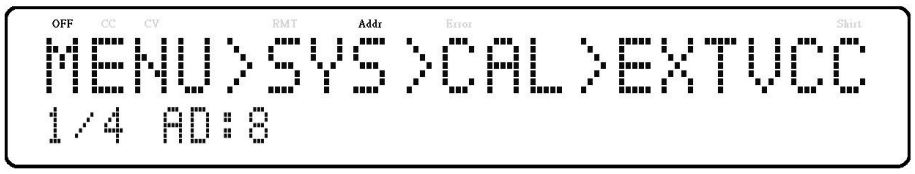


Figure 11.17 CC Calibration of External Voltage

The P: 1/4 signifies there are 4 points to be calibrated and the current calibration point is 1. The four points use 0 Ω, 2.5 kΩ, 7.5 kΩ, and 10 kΩ.

Step 3. Press On/Off and the calibration will start. If the resistor is not inserted or not correct, the following will be displayed:

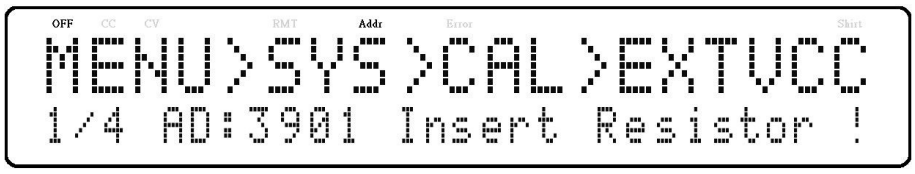


Figure 11.18 Incorrect Resistor

Step 4. If the resistor is correct, the following will be displayed. Press Enter.

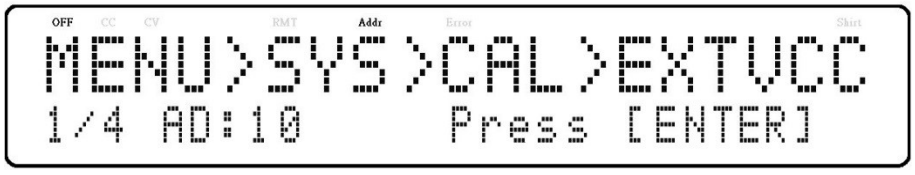


Figure 11.19 Correct Resistor

Step 5. Repeat this procedure by entering the meter readings for points 2 – 4.

11.9 CC Calibration of External Current

To perform the calibration procedure for the constant current source of the external current programming by resistor mode:

Step 1. Connect the external analog control terminals of the DB25 connector (Pin 10, Pin 22 (GND)) on the rear of the power supply, as shown in the figure below:

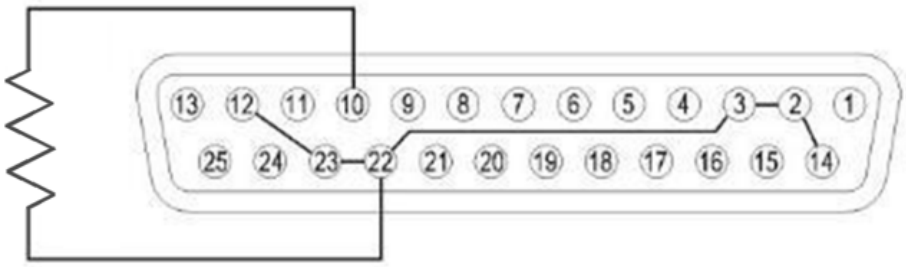


Figure 11.20 CC Calibration of External Current Diagram

Step 2. Select the **EXT_I_CC** parameter in the **Calibration** menu and press Enter. The following will be displayed:

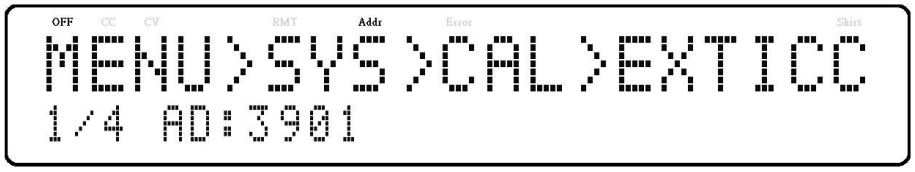


Figure 11.21 CC Calibration of External Current

The P: 1/4 signifies there are 4 points to be calibrated and the current calibration point is 1. The four points use 0 Ω, 2.5 kΩ, 7.5 kΩ, and 10 kΩ.

Step 3. Press On/Off and the calibration will start. If the resistor is not inserted or not correct, the following will be displayed:

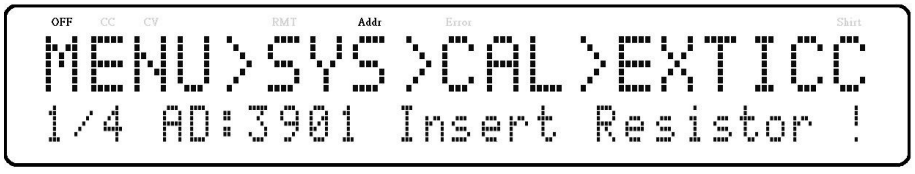


Figure 11.22 Incorrect Resistor

Step 4. If the resistor is correct, the following will be displayed. Press Enter.

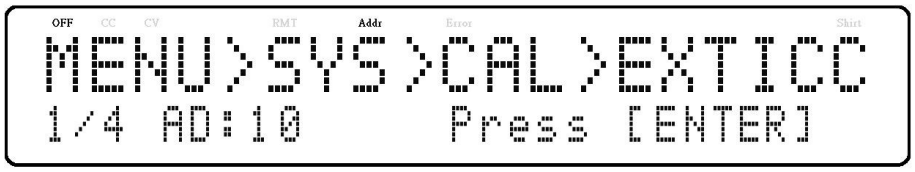


Figure 11.23 Correct Resistor

Step 5. Repeat this procedure by entering the meter readings for points 2 – 4.

Specifications

Note: All specifications apply to the unit after a temperature stabilization time of 15 minutes over an ambient temperature range of 23 °C ± 5 °C. Specifications are valid for single unit operation only.

Model	MR3K160120	MR160120	MR25080	MR50040	MR100020
Output Rating					
Output Voltage	0 to 160 V		0 to 250 V	0 to 500 V	0 to 1000 V
Output Current	0 to 120 A		0 to 80 A	0 to 40 A	0 to 20 A
Output Power	3000 W	5000 W			
Line Regulation					
Voltage	32 mV		15 mV	55 mV	80 mV
Current	60 mA		20 mA	12 mA	10 mA
Load Regulation					
Voltage	80 mV		120 mV	200 mV	250 mV
Current	180 mA		50 mA	40 mA	25 mA
Ripple and Noise (20 Hz to 20 MHz)					
Voltage p-p	120 mV	160 mV	500 mV	600 mV	700 mV
Voltage rms	48 mV		85 mV	75 mV	120 mV
Current rms[1]	120 mA	160 mA	20 mA	10 mA	5 mA
Resolution					
Programming	10 mV / 7.5 mA		10 mV / 5 mA	20 mV / 2 mA	100 mV / 1 mA
Readback	10 mV / 7.5 mA		10 mV / 5 mA	20 mV / 2 mA	100 mV / 1 mA
Programming Accuracy					
Voltage	160 mV		100 mV	300 mV	500 mV
Current	360 mA		60 mA	50 mA	25 mA
Readback Accuracy					

Table 12.1a Specifications

Model		MR3K160120	MR160120	MR25080	MR50040	MR100020
Voltage		160 mV		250 mV	300 mV	500 mV
Current		240 mA		60 mA	50 mA	25 mA
Output Response Time[2]						
Rising Time	Full Load	≤ 30 ms		≤ 30 ms		
	No Load	≤ 30 ms		≤ 30 ms		
Falling Time	Full Load	≤ 80 ms	≤ 50 ms	≤ 55 ms	≤ 40 ms	≤ 50 ms
	No Load	≤ 10 s		≤ 8 s	≤ 10 s	≤ 10 s
Protection						
OVP	Range	0 to 176 V		0 to 275 V	0 to 550 V	0 to 1100 V
	Accuracy	1.6 V		2.5 V	5 V	10 V
OCP	Range	0 to 132 A		0 to 96 A	0 to 48 A	0 to 24 A
	Accuracy	1.2 A		0.8 A	0.4 A	0.2 A
General						
Remote Sense Compensation		3.2 V		5 V	10 V	20 V
Transient Response Time[3]		≤ 1.5 ms				
Command Response Time[4]		20 ms		10 ms		
Efficiency[5]		≥ 80%	≥ 85%			
Power Factor		0.99				
I/O Interfaces		Analog (galvanically isolated DB25), USB (USBTMC-compliant and virtual COM), RS232, GPIB, LAN (1.5 LXI device specification 2016)				

Table 12.1b Specifications

Model		MR3K160120	MR160120	MR25080	MR50040	MR100020
AC Line Input		200 to 240 VAC ±10%, 47 Hz to 63 Hz				
AC Line Phase		Single phase				
Maximum Rated Input Power		4000 VA	6000 VA			
Temperature Ratings	Operation	32 °F to 104 °F (0 °C to 40 °C)				
	Storage	14 °F to 158 °F (-10 °C to 70 °C)				
Temperature Coefficient	Voltage	32 mV/°C		50 mV/°C	100 mV/°C	200 mV/°C
	Current	48 mA/°C		32 mA/°C	16 mA/°C	8 mA/°C
Dimensions (W x H x D)		16.5 x 3.5 x 21 in (420 x 88 x 532 mm)				
Weight		38.6 lbs (17.5 kg)				
Warranty		3 years				
Standard Accessories		Power cord, test report, and certificate of calibration				
Optional Accessories		Rack mount kit (RKPVS)				
Regulatory Compliance						
Safety		Low Voltage Directive (LVD) 2014/35/EU, EN 61010-1:2010, cTUVus certification mark[6] fulfills US (UL 61010-1:2012) and Canadian (CAN/CSA-C22.2 No. 61010-1-12) safety standards				
Electromagnetic Compatibility		EMC Directive 2014/30/EU, EN 61326-1:2013				

Table 12.1c Specifications

[1] Current ripple applies when the output power is > 1.0% of full power.

[2] From 10% to 90% or from 90% to 10% of total voltage excursion.

[3] Time for the output voltage to recover within 1% of its rated output voltage for a load change of 50% to 100% of rated output current.

[4] Typical time required for the output to begin to change following receipt of command data.

[5] At nominal line and maximum load.

[6] Tested and certified by a Nationally Recognized Testing Laboratory (NRTL), accredited by OSHA.

Service Information

Warranty Service: Please go to the support and service section on our website at bkprecision.com to obtain an RMA #. Return the product in the original packaging with proof of purchase to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device.

Non-Warranty Service: Please go to the support and service section on our website at bkprecision.com to obtain an RMA #. Return the product in the original packaging to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device. Customers not on an open account must include payment in the form of a money order or credit card. For the most current repair charges please refer to the service and support section on our website.
Return all merchandise to B&K Precision Corp. with prepaid shipping. The flat-rate repair charge for Non-Warranty Service does not include return shipping. Return shipping to locations in North America is included for Warranty Service. For overnight shipments and non-North American shipping fees please contact B&K Precision Corp.

Include with the returned instrument your complete return shipping address, contact name, phone number and description of problem.

B&K Precision Corp.
22820 Savi Ranch Parkway
Yorba Linda, CA 92887
bkprecision.com
714-921-9095

LIMITED THREE-YEAR WARRANTY

B&K Precision Corp. warrants to the original purchaser that its products and the component parts thereof, will be free from defects in workmanship and materials for a period of **three years** from date of purchase.

B&K Precision Corp. will, without charge, repair or replace, at its option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form of a sales receipt.

To help us better serve you, please complete the warranty registration for your new instrument via our website www.bkprecision.com

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. The warranty is void if the serial number is altered, defaced or removed.
B&K Precision Corp. shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitations of incidental or consequential damages. So the above limitation or exclusion may not apply to you.
This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

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714-921-9095

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