Spruce Science

Lab Mate

High Voltage Power Supply

Operating Manual

IMPORTANT SAFETY PRECAUTIONS

Your safety is paramount and rigorous safety practices must be enforced to ensure your safety when working with high voltage.

This power supply produces high voltages and stores energy that is hazardous. Physical contact with the high voltage output may result in life-threatening or fatal injury.

Before you turn on the high voltage power supply, always confirm first that the dial indicators are turned fully in the counter-clockwise direction and confirm the turn counting indicator reads 0.

Visually inspect the high voltage output connector and any high voltage connections for unintended touching or electrical shorts.

Always keep a safe distance from the test equipment and apparatus or system under test.

Do not touch connections unless the high voltage power supply is off and capacitors are completely discharged. Allow five minutes for the high voltage power supply internal capacitors to discharge. Also, make sure the load capacitance is discharged.

Be extra cautious of any high voltage connections that are exposed. Such live terminals should be shielded and barriers must be provided to prevent accidental contact.

Proper grounding is very important. High voltage power supplies must always be grounded. Ensure that a secure ground connection is made between the high voltage power supply and earth ground.

All ungrounded terminals of the test equipment or apparatus under test should be considered as energized.

The work area for the HV power supply should be kept clean. It is important to put away unnecessary parts and components and to keep them far away from the test area.

The general work area around the HV power supply and high voltage connections must be kept dry.

Do not ground yourself or work under wet or damp conditions.

Always consult with your organization's health and safety expert.

TABLE OF CONTENTS

SECTION 1: GENERAL INFORMATION

1.1 DESCRIPTION

It is essential to have the capability to generate high voltages and electrical field strengths in your lab for scientific development since high gradient electric fields can be used to develop new technology and discover more about the nature of the universe.

Lab Mate is the state-of-the-art precision high voltage power supply from Spruce Science and it is optimized for size, performance and reliability. This benchtop high voltage power supply is adjustable up to 30 kV at 1 mA. It is a switching power supply that converts low voltage DC (Direct Current) into regulated high voltage DC. It is incredibly simple to use with intuitive design features to help users get started quickly. All that is required to get going is for the user to plug-in and intuitively control everything from the front panel. The dual adjustment dials and 5-digits displays located on the front panel will give you precise control of the output voltage level. The feedback loop is fine-tuned to give you regulated high voltage output with 0.1% accuracy, ultra-low ripple, and high stability.

The benchtop high voltage power supply can be operated in either constant voltage mode or constant current mode. The maximum voltage output produced by the high voltage DC power supply is 30 kV and the output can be adjusted from 0 to 30 kV. The current output can be varied from 0 to the full rated current of 1 mA.

Remote control operation of the precision high voltage power supply is possible and remote features can be accessed through the remote connector located on the front panel. The connection is accessed through the micro HDMI Type-D receptacle and the remote enable pin will give you full remote control of the power supply.

Space is always limited because even the simplest of experiments require many instruments and with that in mind, Lab Mate was developed in the smallest size possible. This benchtop equipment is the most compact footprint on the market, leaving you plenty of room to conduct your experiments. Above all, the compact form factor will reduce clutter and integrate easily into your space-constrained systems.

High voltage cable and connector assembly is included as standard. The high voltage cable and connector assembly is rated up to the maximum rated voltage of 30 kV. The whole cable assembly is shielded with a robust stainless steel shell to provide additional safety layer and to help prevent physical damage to the high voltage wire insulation. Another benefit of the ground shield is that it helps to prevent capacitive charging and coupling that becomes problematic when operating at high voltages.

1.2 SPECIFICATIONS

Detailed specifications for Lab Mate high voltage power supply are given in Table 1 shown below.

Table 1: Detailed specifications.

Input voltage	90 V to 264 V, 47 to 63 Hz, single phase AC. Only use provided AC-DC power adapter.
Input current	1A max at 120VAC
Output voltage control*	Front panel: 10 turn precision potentiometer with dial indicator.
	Remote: externally adjustable from 0 to +10V. Accuracy: 0.1% of setting + 0.2% of rated voltage.
Output current control*	Front panel: 10 turn precision potentiometer with dial indicator.
	Remote: externally adjustable from 0 to +10V. Accuracy: 0.5% of setting + 0.2% of rated voltage.
Voltage monitor	Front panel: 5 digit LED display
	Remote: 0 to +10V equivalent to 0 to rated voltage. Accuracy: 0.1% of setting + 0.2% of rated voltage.
Current monitor	Front panel: 5 digit LED display
	Remote: 0 to +10V equivalent to 0 to rated current. Accuracy: 0.5% of setting + 0.2% of rated voltage.
Ripple	0.0001% VRMS of set voltage or less
Stability	0.01%/Hr after 3 minutes warmup
Temperature coefficient	25 ppm/°C
Temperature	Operating: 0C to +40 C. Humidity: 10-90%, Avoid Condensation. Storage: -20 C to +60 C. Sealed Electronics.
Input impedeance	1MOhm
Output monitor impedance	1 Ohm
HV enable	Enable = 4V to 10 V. Disable = 0 to 0.5V
+10V Reference	Max current = 20 mA. Accuracy: +/- 0.1%. 20ppm/°C
Accessories	Shielded high voltage cable with high voltage connector
Remote control	Enable = 5V to 10V. Disable = 0 to 0.5V
Size	Width = 50.8mm (2"), Height = 132mm (5.2"), Depth = 286mm (11.26")
Weight	2.3 kg (5.1 Lbs)

*Programmable from 0 to rated voltage/current. Locally adjustable from front panel or remote control with 0 to +10V signal.

1.3 ACCESSORIES

The accessories listed below are included with the high voltage power supply. Spares or custom high voltage cables and connectors may be ordered from Spruce Science.

1. AC-DC power adapter. 90 V to 264 V, 47 to 63 Hz, single phase AC to +24Vdc +/-2V. Max DC current of 2.5A consumed by high voltage power supply at full load output.
2. High voltage output connector is included. Mating connector with user side cable (RG 8/U) is also included with standard length of 3ft. Longer cables are optional.
3. Remote cable and breakout board.

1.4 SERVICING

This high voltage power supply does not contain any servicable parts.

SECTION 2: INSTALLATION

2.1 INITIAL INSPECTION

Before shipment, this instrument was inspected and found to be free of defects. As soon as the instrument is unpacked, inspect for any damage that may have occurred in transit. Save all packing materials until the inspection is completed. If damage is found, file a claim with the carrier as soon as possible. Spruce Science team should also be notified.

2.2 MECHANICAL CHECK

This check should confirm that there are no broken knobs or connectors, that the surfaces are free of dents and that the front panel is not cracked.

2.3 ELECTRICAL CHECK

The instrument should be checked to verify proper instrument operation. See the turn-on procedure outlined in section 3.

2.4 INSTALLATION

The instrument is shipped ready for bench operation. It is necessary only to connect the instrument to a source of power with proper grounding and it is ready for operation.

2.5 TEMPERATURE CONSIDERATION

This instrument is air-cooled and the temperature sensor inside the equipment will activate the cooling fan as necessary. Sufficient space should be allotted so that a free flow of cooling air can reach the sides and rear of the instrument when it is in operation. It should be used in an area where the ambient temperature does not exceed 40° C.

2.6 OUTLINE DIAGRAM

Figure 1 is a diagram showing the outline dimensions of this instrument.

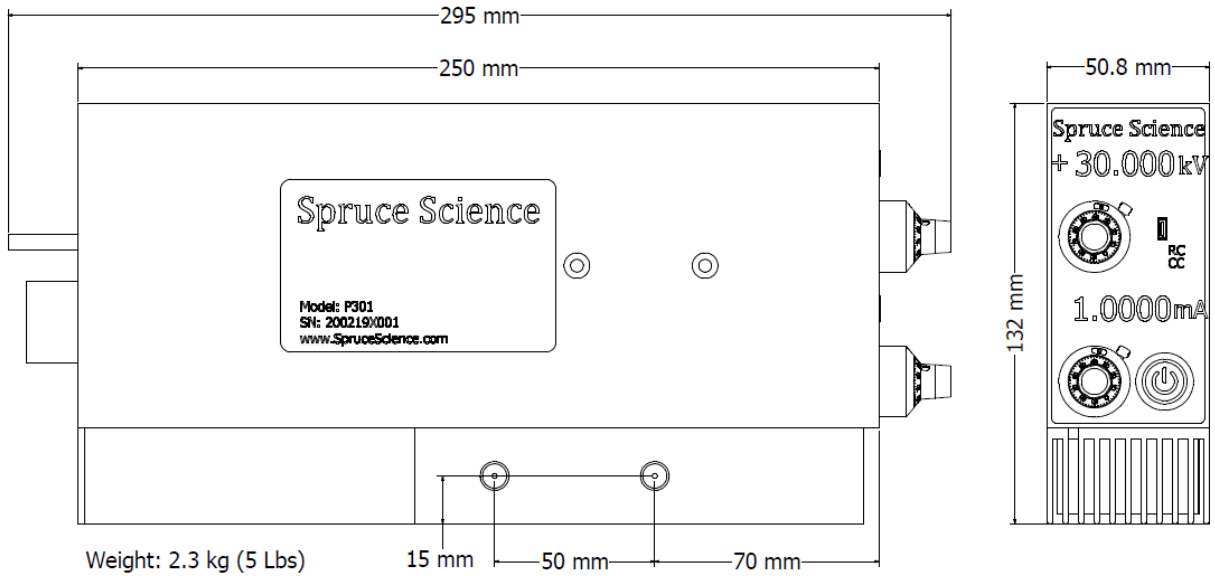

Figure 1: High voltage power supply dimensions

2.7 INPUT POWER REQUIREMENTS

This power supply may be operated from either a nominal 90 V to 264 V, 47 to 63 Hz, single-phase AC. It is recommended to only use the provided AC-DC power adapter.

AC-DC power adapter:

AC Input: 90 V to 264 V, 47 to 63 Hz, single-phase AC

DC Output: +24Vdc +/-2V. Max DC current of 2.5A consumed by high voltage power supply at full load output.

2.8 REPACKAGING FOR SHIPMENT

To ensure safe shipment of the instrument, it is recommended that the package designed for the instrument be used. The original packaging material is reusable. If it is not available, contact Spruce Science for suggestions. Be sure to attach a tag to the instrument which specifies the owner, model number, full serial number, and service required, or a brief description of the trouble.

SECTION 3: OPERATING INSTRUCTIONS

3.1 INSTRUMENT OVERVIEW

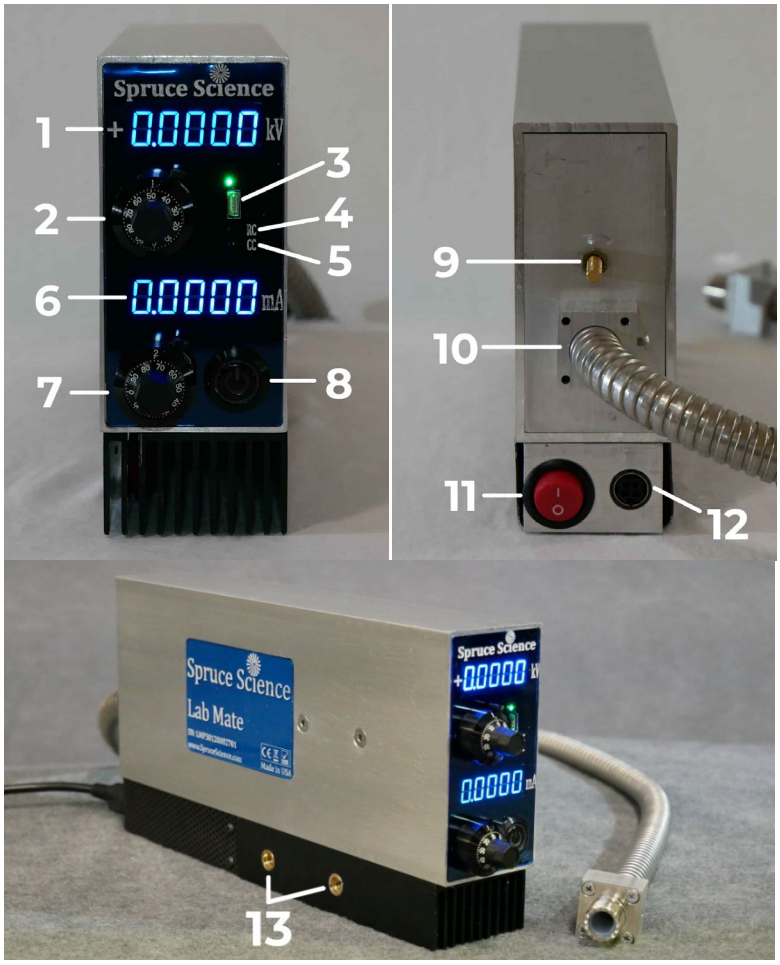

Figure 2: Controls, indicators and features.

1. Output voltage meter displayed in 5 digits.
2. Voltage adjustment dial with turns-counting indicator.
3. Remote control receptacle.
4. Remote control indicator light turns on when the unit is in remote mode.
5. Constant current mode indicator light will turn on when the HV power supply maintains a constant current output.
6. Output current meter displayed in 5 digits.
7. Current adjustment dial with turns-counting indicator.
8. High voltage On/Off switch.
9. Ground terminal. M5 threaded stud.
10. High voltage output connector.
11. Main power On/Off switch.
12. DC input connector.
13. 1/4-20 threaded holes for anchoring. There are two on each side of the instrument.

3.2 TURN-ON POCEDURE

The following procedure describes the use of the front panel controls and indicators and ensures that the high voltage power supply is operational.

A. Set voltage adjustment dial (2) to 0 by turning CCW.
B. Set current adjustment dial (7) to 0 by turning CCW.
C. Proper grounding is very important. Ensure that a secure ground connection is made between the high voltage power supply (9) and earth ground.
D. Check that the high voltage output is unconnected and keep the plastic cap on. Then place the high voltage output connector in a secure location.
E. Plugin the AC-DC power adapter to DC input connector (12) on the back panel.
F. Set Main Power Switch (11) to ON.
G. Observe that the front panel display light goes on.
H. Set the current adjustment dial (7) to 0.5, which will limit the current output to 0.05 mA.
    a. For reference, setting the current dial to 10 turns is equivalent to 100% of full-scale output, which set the current at max current of 1 mA.
    b. Setting the dial to 1 is equivalent to 10% of full scale, which is 0.1 mA.
I. Set the Voltage adjustment dial (2) to 0.33, which will regulate the output voltage to 1 kV.
    a. For reference, setting the voltage dial to 10 turns is equivalent to 100% of full-scale output, which is 30 kV.
    b. Setting the dial to 1 is equivalent to 10% of full scale, which is 3 kV.
J. Set the High voltage switch (8) to ON.
K. Observe that the high voltage switch (8) light goes on.
L. Observe that the output voltage meter display (1) show a value of around 1.0000kV.
M. With the open load output condition, observe that the output current meter display (6) is 0.0000 mA.
N. Adjust the voltage dial (2) until desired output voltage is indicated on voltage meter (1).
O. Set the high voltage switch (8) to OFF.

WARNING!

After the high voltage is turned OFF, do not touch anything that has been connected to the output of the power supply. Wait five minutes for the high voltage power supply internal capacitors to discharge and also make sure the load capacitance is discharged. And, then discharge any remaining stored energy by connecting the high voltage output to the ground. Failure to follow these safety warnings can result in injury or death.

3.3 OPERATING MODES

This benchtop high voltage power supply can be operated in either constant voltage mode or constant current mode. These two modes are the two regulating conditions that control the output of the power supply. When it is operating in the constant voltage mode, the HV power supply maintains a constant output voltage that is defined by the operator while the current drawn is varied as required from 0 to the full rated current, which in this case is 1 mA. For this type of high voltage power supply, constant voltage mode is the most common mode of operation.

However, the high voltage power supply can also operate in the constant current mode where the output current is regulated as defined by the operator. When it runs in the constant current mode, the power supply maintains a constant current output into a load while the voltage output is varied as required by the connected load.

The feedback circuit for constant voltage mode and current mode are always active and constantly working together to provide a continuous output that is always regulated to user's input levels. However, it is important to note that although both circuits are always active, only one mode is in control at a time to regulate the output. The response time of these circuits are very fast and crossover automatically as needed between the two modes. Also, the HVPS will enter the constant current mode when faults such as overload, arcing, and short circuit occur, thus providing protection.

3.4 CONSTANT VOLTAGE MODE

To select a constant voltage output, proceed as follows:

A. Adjust Voltage controls for desired output voltage.
B. Adjust Current controls for maximum output current allowable, current limit, as determined by load conditions. If a load change causes the current limit to be exceeded, the high voltage power supply will automatically crossover to constant current output at the preset current limit and the output voltage will drop proportionately. In setting the current limit, allowance must be made for high peak current which can cause unwanted cross-over.

3.5 CONSTANT CURRENT MODE

To select a constant current output, proceed as follows:

A. Adjust Current controls for desired output current.
B. Adjust Voltage controls for maximum output voltage allowable, voltage limit, as determined by load conditions. If a load change causes the voltage limit to be exceeded, the power supply will automatically crossover to constant voltage output at the preset voltage limit and the output current will drop proportionately. In setting the voltage limit, allowance must be made for high peak voltages which can cause unwanted crossover.

3.6 REMOTE PROGRAMMING

Remote control operation of the precision high voltage power supply is possible through the remote connector located on the front panel. The connection is accessed through the micro HDMI Type-D receptacle. Pin assignments and the signal functions are provided in Table 2.

3.7 REMOTE PROGRAMMING IN CONSTANT VOLTAGE MODE

To place the equipment in remote programming mode, proceed as follows:

A. Apply 5V to the Remote Control signal, which is pin 11 on micro HDMI Type-D receptacle. Refer to Table 2.
B. Adjust Voltage Program Input, pin 5 on micro HDMI Type-D receptacle, for desired output voltage.
    a. For reference, 0 to +10V equals 0 to 100% of rated voltage. The output voltage will vary linearly with changes in the programming voltage.
    b. Example 1: If the rated voltage is 30 kV then applying +10V to the Voltage Program Input pin will output 30 kV.
    c. Example 2: Applying +1V to the Voltage Program Input pin will output 3 kV.
C. Adjust the Current Program Input, pin 3 on micro HDMI Type-D receptacle, for maximum output current allowable, current limit, as determined by load conditions.
D. Turn ON high voltage by applying +5V to Enable High Voltage, pin 9 on micro HDMI Type-D receptacle.

3.8 REMOTE PROGRAMMING IN CONSTANT CURRENT MODE

To place the equipment in remote programming mode, proceed as follows:

A. Apply 5V to the Remote Control signal, which is pin 11 on micro HDMI Type-D receptacle. Refer to Table 2.
B. Adjust Current Program Input, pin 3 on micro HDMI Type-D receptacle, for desired output voltage.
    a. For reference, 0 to +10V equals 0 to 100% of rated current. The output voltage will vary linearly with changes in the programming voltage.
    b. Example 1: If the rated current is 1 mA then applying +10V to the Current Program Input pin will output 1 mA.
    c. Example 2: Applying +1V to the Current Program Input pin will output 0.1 mA.
C. Adjust the Voltage Program Input, pin 5 on micro HDMI Type-D receptacle, for maximum output voltage allowable, voltage limit, as determined by load conditions.
D. Turn ON high voltage by applying +5V to Enable High Voltage, pin 9 on micro HDMI Type-D receptacle.

3.9 REMOTE SENSING

High voltage output and current output signals are available for remote monitoring or recording. The signals are always available rather the instrument is operating in local or remote programming mode.

3.10 DIFFERENCES IN PIN ASSIGNMENTS FOR DIFFERENT SIZE HDMI CONNECTOR

When using a cable assembly such as the one shown in Figure 3 that converts from micro HDMI-D male type to HDMI-A type, which is the regular size that is more common, attention should be paid to the pin assignments. In such a cable, pin 1 on micro HDMI-D does not become pin 1 of HDMI-A. Instead, pin 1 on micro HDMI-D becomes pin 19 of HDMI-A.

When using the breakout board for HDMI-A, refer to Table 3 of the wire chart for micro-HDMI-D to HDMI-A cable assembly translation.

Table 2: Remote connection pin assignments for Micro HDMI Type-D receptacle located on the front panel.

Pin	Signal Function	Signal Parameters
1	Signal Ground	Ground
2	Signal Ground	Ground
3	Current Program Input	0 to +10V equals 0 to 100% of rated high voltage. Input impedance is 1MOhm.
4	Signal Ground	Ground
5	Voltage Program Input	0 to +10V equals 0 to 100% of rated current. Input impedance is 1MOhm.
6	Current Monitor	0 to +10V equals 0 to 100% of rated current. Output impedance is 1 Ohm.
7	Signal Ground	Ground
8	Voltage Monitor	0 to +10V equals 0 to 100% of rated high voltage. Output impedance is 1 Ohm.
9	Enable High Voltage	Enable = 4V to 10 V. Disable = 0 to 0.5V
10	Signal Ground	Ground
11	Remote Control	Enable = 5V to 10V. Disable = 0 to 0.5V.
12	+10V Reference	Max current = 20 mA. Accuracy: +/- 0.1%. 20ppm/°C.
13	Signal Ground	Ground
14	Signal Ground	Ground
15	Signal Ground	Ground
16	Signal Ground	Ground
17	Signal Ground	Ground
18	Signal Ground	Ground
19	Not Connected	

Table 3: Wire chart for micro-HDMI-D to HDMI-A cable

micro-HDMI-D	HDMI-A	Signal Function
Pin 1	Pin 19	Signal Ground
Pin 2	Pin 14	Signal Ground
Pin 3	Pin 1	Current Program Input
Pin 4	Pin 2	Signal Ground
Pin 5	Pin 3	Voltage Program Input
Pin 6	Pin 4	Current Monitor
Pin 7	Pin 5	Signal Ground
Pin 8	Pin 6	Voltage Monitor
Pin 9	Pin 7	Enable High Voltage
Pin 10	Pin 8	Signal Ground
Pin 11	Pin 9	Remote Control
Pin 12	Pin 10	+10V Reference
Pin 13	Pin 11	Signal Ground
Pin 14	Pin 12	Signal Ground
Pin 15	Pin 13	Signal Ground
Pin 16	Pin 17	Signal Ground
Pin 17	Pin 15	Signal Ground
Pin 18	Pin 16	Signal Ground
Pin 19	Pin 18	Not Connected

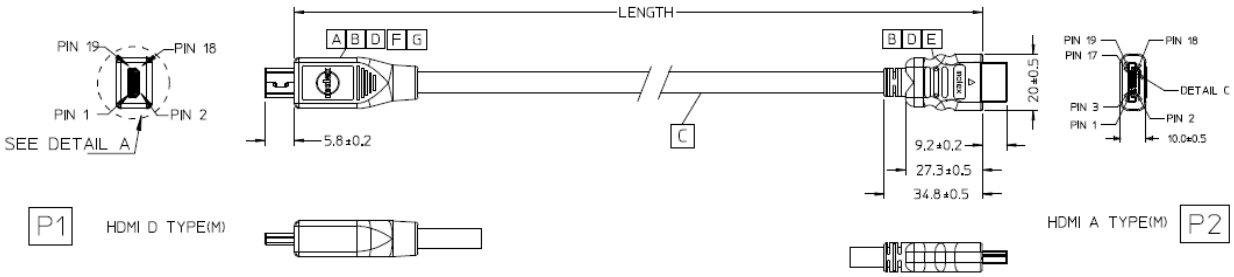

Figure 3: HDMI-A Male to Micro HDMI-D Male Cable Assembly. WARNING: pin 1 of micro HDMI-D type is pin 19 of HDMI-A type. See Table 3.