
HYDRA 15

3-GUN

SWITCHING

POWER SUPPLY

INSTRUCTION MANUAL

Version 2.02



NILES ELECTRONICS

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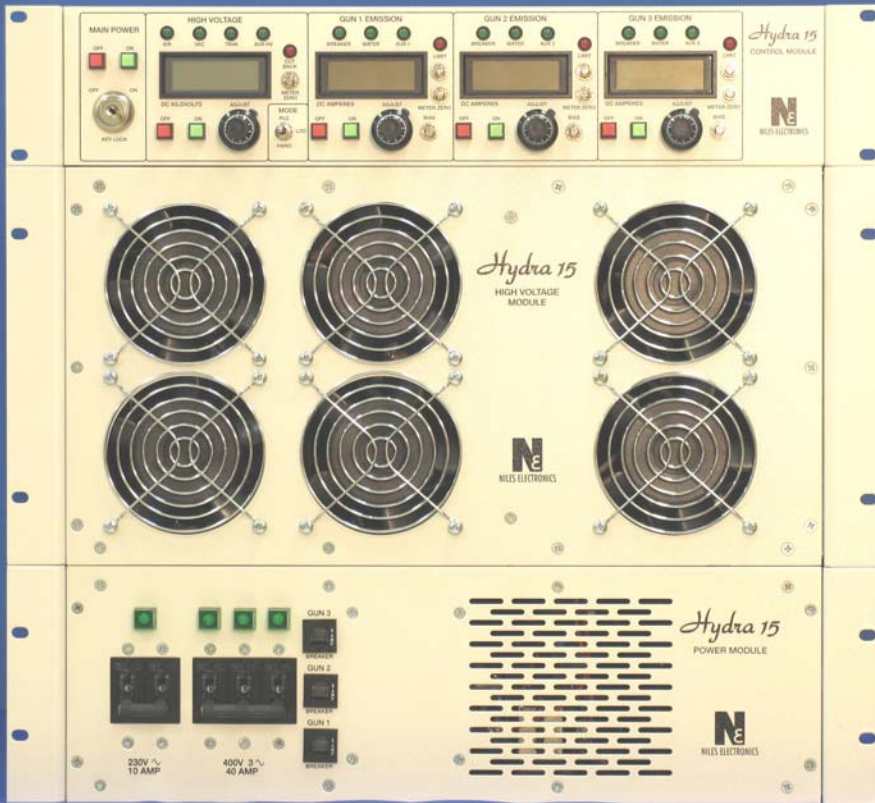


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OVERVIEW

SYSTEM COMPONENTS

The **Hydra 15 Power Supply** is a direct current, regulated constant high voltage power supply. It is manufactured as a three-gun version. Intended for use with E-Beam guns, it is compatible with E-Beam Guns that use electromagnetic deflection or combinations of electromagnetic deflection and permanent magnet focusing.

The **Hydra 15 Power Supply** consists of the following components:

- Power Module with two power cords attached and three outputs for Filament Transformers
- High Voltage Module with three 15-ft long HV Coaxial Cables attached
- Control Module
- Three Filament Transformers

LIST OF ACCESSORIES

The following accessories will be included with the shipment of the **Hydra 15 Power Supply**:

- One 15", 12-pin B+ connection cable (Power to HV)
- One 7", 7-pin cable (Power to HV)
- One 12", 5-pin cable (Power to HV)
- One 54", 7-pin cable (HV to Control)
- One 6", 25-conductor flat ribbon cable (HV to Power)**
- One 54", 37-conductor ribbon cable (Control to HV)**
- Three 15-ft Cables for Filament Primary Windings

- One Instruction Manual for the Hydra 15 Power Supply (the one you are reading now).

****Do not replace the ribbon cable with round computer cable nor with a longer cable. Doing so will cause interference amongst wires.**

NOTE: Niles Electronics Inc. accommodates Filament Transformer(s), since April 2005, with each power supply. The filament resistance, at room temperature, should not be less than 5 mOhms (5 thousandth Ohms). Too low filament resistance will trigger the breaker “Fast-Response Sensor” circuitry. If the mentioned sensor is triggered, the breaker indicator LED goes off while the breaker does not pop out. The user can reset the indicator LED by pushing the “emission off” button. However, the problem cannot be solved until the filament resistance is corrected. Should any customer have questions regarding this issue, please do not hesitate to contact Niles Electronics Inc.

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SPECIFICATIONS

OVERALL SPECIFICATIONS

- Input Voltage for Control:
230 Volts, single phase, 50/60 Hz, 10 Amps
- Input Voltage for Power:
400 Volts, 3-phase, 50/60 Hz, 40 Amps
- Maximum output power: 15 KW
- High voltage range: from -3 kV to -10 kV (continuously adjustable)
- Maximum emission current: 1.5 Amps
- Maximum emission current each gun:
Up to 1.5 Amps, provided that total current of three guns does not exceed 1.5 Amps
- Ripple: less than 150 Volts p-p

OUTPUT FOR FILAMENT TRANSFORMER PRIMARY COIL

- Voltage: 0-230 Volts, single-phase, 50/60 Hz
- Primary Control: SCR pulse width control
- Maximum Current: 2.0 Amps RMS
- Insulation rating for Filament Transformer (Secondary to Primary and Core): 20 KV DC minimum

DIMENSIONS AND WEIGHT

Control	Power	High Voltage
19" wide (full rack)	19" wide (full rack)	19" wide (full rack)
3.5" high (2U)	5.25" high (3U)	8.75" high (5U)
17" deep including connectors and knobs	25" deep including strain relief	25" deep including strain relief
10 lbs	60 lbs	75 lbs

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INSTALLATION

SAFETY PRECAUTIONS

DANGER – HIGH VOLTAGE

High voltage, potentially lethal, is present within this equipment and at end of the high voltage cables. Great care must always be exercised when working with this equipment. Only qualified and properly trained personnel may test or work with this equipment.

All connections must be made with all the power turned off from their sources, not just on the equipment. Work should not be carried out in cramped and/or cluttered areas.

INTRODUCTION

The Hydra 15 Power Supply is designed to mount in a standard 19-inch rack cabinet. The complete installation comprises the following aspects:

- Cable Connections Between Modules
- Filament Transformer Connections
- High Voltage Cable Connections
- System Grounding
- Interlock Connections
- Remote Control Connections (Optional)

Both the Power and the High Voltage Modules are full-rack wide and are to be mounted in a 19-inch rack, with the HV Module placed above the Power Module. Since both Modules are deep and heavy, **usage of Heavy Duty Roller Slides is strongly recommended.** There should be ample clearance on both the front and rear

panels of these two modules to allow for proper airflow. If desired, it is allowable to place these two modules in the lower part of the 19" rack in order to preserve easier-to-reach space for other modules. The cables connecting the Control Module and the High Voltage Module are 54" long to allow for such usage. However, separating these two Modules by distances longer than 54" will impair the Power Supply's function.

CABLE CONNECTIONS BETWEEN MODULES



The connections are also labeled on the rear panels of the Modules.

FILAMENT TRANSFORMER CONNECTION

The core of the Filament Transformer must be connected to the Tank ground. It is advisable to remove the paint/varnish from a small area around the mounting holes of the Transformer and the frame. The mounting bolts themselves will establish a proper ground connection. As a result, the Transformer Core and the Ground Shield will have the same potential as the Ground during normal operation. The Filament Transformer Primary must be connected to the Output at the rear panel of the Power Module. Three 3.0 Amp Thermo Breakers, located at the front panel of Power Module, are used for over current protection. Use of AWG16 Wires is recommended for the Filament Transformer Primary Coil connections.

Outputs for Filament Transformers are clearly labeled 1-3 from the bottom up. Gun 1 uses only pins 2 & 3. Gun 2 uses only pins 1 & 3. Gun 3 uses only pins 1 & 2. This is a safety feature that ensures no damage will be done if the connector is plugged into the wrong output. **However, it is extremely important that the Filament Transformers themselves are connected to the correct output wires. Failure to do so may result in either not working or extensive damage.**

HIGH VOLTAGE CABLE CONNECTION

The High Voltage Cables are also labeled 1-3 from the bottom up. It is extremely important that the each HV Cable is connected to the correspondent Filament Transformer Secondary. **Incorrect connections will result in out-of-control emission current, which may cause extensive damage.**

WARNING:

The Hydra 15 is designed for use with exactly 3 E-Beam Guns inside the same vacuum chamber. If, for any reason, one or more HV Cables is/are not in use, extreme caution must still be exercised. These cables still contain potentially lethal high voltage. Unused HV Cable output terminals must be well insulated and isolated from the range of human contact.

The High Voltage connection is made with RG 213/U Cables. Shipment of the **Hydra 15 Power Supply** will include 3 High Voltage Coaxial Cables in our standard length of approximately 15 feet. The center conductors of these Coaxial Cables are the High Voltage Outputs and should be connected to the Secondary Windings of the Filament Transformers. The Copper Braided Shield is part of HV current flowing path and

should be connected to the Ground of the Vacuum Tank, as described in *Filament Transformer Connections* (see the section above).

SYSTEM GROUNDING

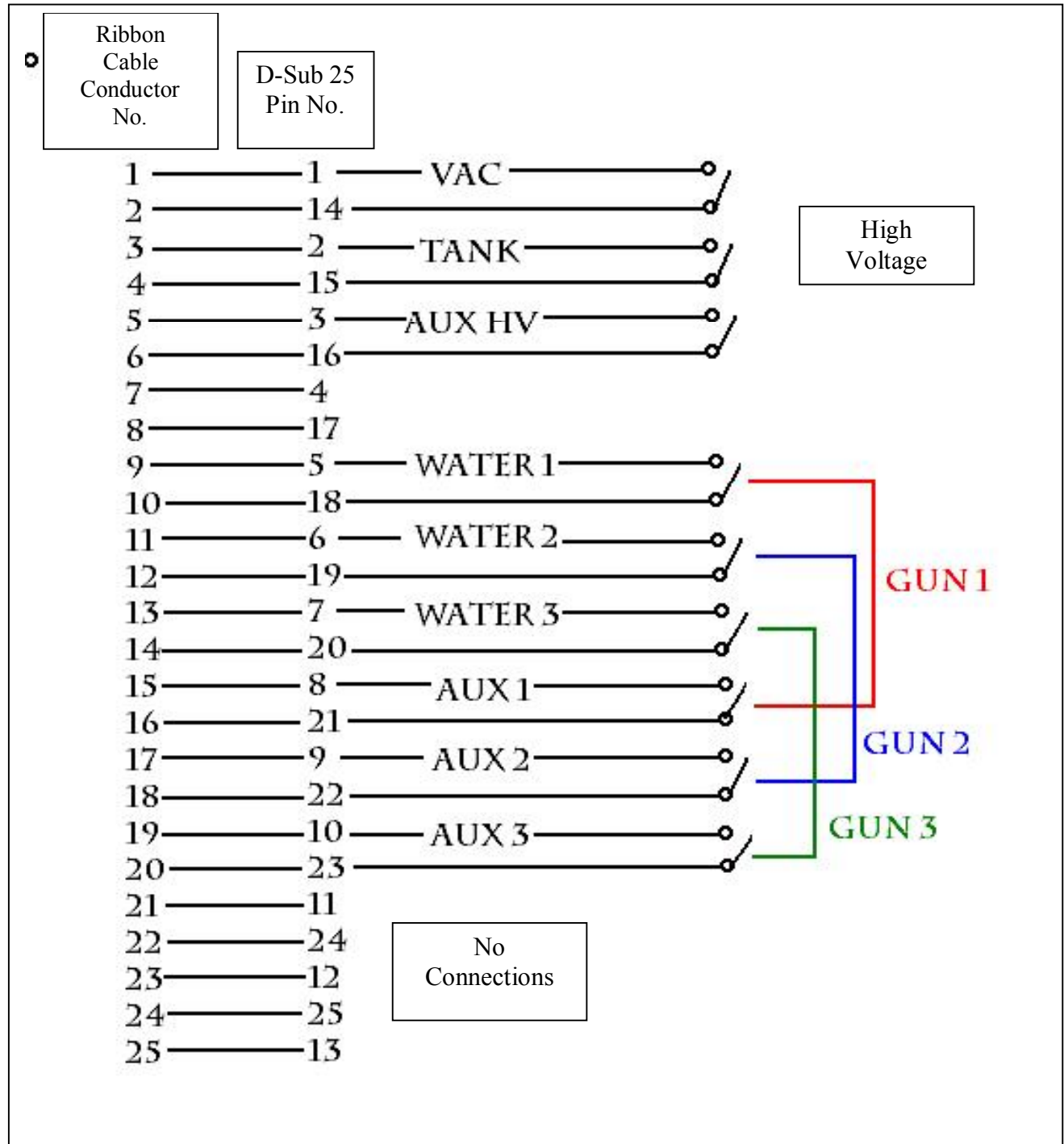
The following grounding connections are for the personnel safety purpose. It is not for functioning. As a matter of fact, the following connections are already done through the cables among the modules. However, duplicating the connections is recommended.

Each module has a Module Ground Stud. Connections should be made as follows:

1. Connect the Control Module Ground Stud to the High Voltage Module Ground stud.
2. Connect the High Voltage Module Ground Stud to the Power Module Ground Stud.
3. Connect the Power Module Ground Stud to the Ground of the 3-Phase AC Power Source.

INTERLOCK CONNECTIONS

A system of safety interlock functions protects both the operator and the equipment. The external interlocks are connected to the Power Supply and their installation is described below.



WARNING

All statements pertaining to operator and equipment safety apply only if the external interlocks are installed as specified below and only if the operator does not disable the safety features, inherent in the interlocks, by bypassing the switches. Although these interlocks are designed to protect both operator and equipment, extra care and good judgment should always be exercised when operating High Voltage equipment. It is conceivable that, under certain circumstances, an interlock could fail and hence, the interlocks should never be solely relied upon to provide 100% safety at all times.

HIGH VOLTAGE INTERLOCKS

The **Hydra 15 Power Supply** has two groups of interlock connections: one for the High Voltage and another for the Emission Current (Source Current). The High Voltage has the following interlocks:

- Air
- Vacuum
- Tank High Voltage Access
- Auxiliary HV

AIR INTERLOCK

When the equipment is overheating, both the Air Interlock light and the High Voltage will shut off. This happens when there is not sufficient fresh air flowing through the system. **In the event that this occurs, consider it as a warning sign, check the airflow of every module especially the High Voltage Module.** It is recommended, however, that the equipment not be turned off because the system fan will drop the temperature of the equipment more rapidly. Pushing the HV “OFF” button will reset the Air Interlock circuitry if the temperature has dropped sufficiently. **The light of the Air Interlock will come back on only if the reset has been successful.**

However, the High Voltage may be shut off again if the airflow is not improved. Every time when this “Air Interlock” is triggered, the power supply has already been pushed to the verge of burning its parts inside. If this “Air Interlock” is triggered too often, it may cause serious permanent damage.

VACUUM INTERLOCK

A vacuum switch should be installed on the Tank so that it closes only if there is enough vacuum inside the Tank.

TANK HIGH VOLTAGE ACCESS INTERLOCK

When these interlocks are installed, the switches on the doors and high voltage panels will normally remain open. They will be closed only when the doors of the chamber and all panels are in place. These interlocks should be closed only when there is no possible chance of coming into contact with high voltage.

AUXILIARY HV

This interlock is provided to enable the user to insert additional interlocks, such as emergency off pushbuttons, crucible rotation interlocks, etc. If more than one interlock is required, simply connect the interlock switches in series.

EMISSION INTERLOCKS

Each Gun has a set of three interlocks devoted to it. The interlocks for the Emission Current are:

- Breaker
- Water
- Auxiliary X (where X stands for 1, 2, or 3)

BREAKER

These Thermo Breakers are located at the front panel of the Power Module, and work in series with the Filament Transformer Primary Winding. If the Filament Transformer is overloaded (which could result from the Secondary Winding being in short circuitry or too low Filament Resistance), the Breaker may or may not pop out (there is a surge current detecting circuitry that can turn off the Breaker Led without popping out the Breaker) and its LED indicator will turn off. To reset, simply push the Breaker back into place, then push the Source “OFF” button to turn the LED indicator back on.

NOTE: The LED will light only if the Breaker is pushed in. After resetting, the

emission can be turned back on by pushing the Source “ON” button. However, if the Breaker LED indicator is turned off again, there is a problem that needs attention. At such point, an inspection of the circuitry of the Filament Transformer and/or the Filament circuitry is required before operations can be resumed.

WATER

A water flow switch for each gun should be installed in the return line of the cooling system for the HYDRA 15. This switch should close automatically once there is sufficient water flow to cool the Gun and associated shields.

AUXILIARY 1, 2, & 3

These interlocks are provided to enable the user to insert additional interlocks. If more than one interlock switch/switches is/are required, simply connect the switches in series.

REMOTE CONTROL CONNECTIONS

D-SUB 37 REMOTE CONTROL SIGNAL LIST

(CAN BE DIVIDED INTO TWO 25 CONDUCTOR RIBBON CABLES AND CONNECTED TO TWO D-SUB 25 CONNECTORS)

Control	Ribbon Cable Conductor No.	D-SUB 37 Pin No.	Signal Direction	FUNCTION DESCRIPTION
				All output signals have a 1 Kohm Resistor in series
HAND USE ONLY	1	1	OUT	Hand set in control = H = 12 V *
	2	20	IN	HV on = ↑ & H OFF = L **
	3	2	IN	HV value command (5.2 V max.) *** ^
	4	21	IN	Hand set connected (hand set side connects to GND)****
	5	3		GND
	6	22		GND
	7	4	IN	GUN 1 ON = H **
	8	23	IN	GUN 1 Value (7.5 V max.) ***
	9	5	IN	GUN 2 ON = H **
	10	24	IN	GUN 2 Value (7.5 V max.) ***
	11	6	IN	GUN 3 ON = H **
	12	25	IN	GUN 3 Value (7.5 V max.) ***
OVERLAP PINS (COMMON)	13	7	OUT	HV Ready = H
	14	26	OUT	GUN 1 Ready = H
	15	8	OUT	GUN 2 Ready = H
	16	27	OUT	GUN 3 Ready = H
	17	9	OUT	HV ON = H (H = 5.2 V)
	18	28	OUT	GUN 1 ON = H (H = 7.5 V)
	19	10	OUT	GUN 2 ON = H (H = 7.5 V)
	20	29	OUT	GUN 3 ON = H (H = 7.5 V)
	21	11	OUT	HV Value: 5 V for 10 KV
	22	30	OUT	GUN 1 Value: 7.5 V for 1.5 Amps
	23	12	OUT	GUN 2 Value: 7.5 V for 1.5 Amps
	24	31	OUT	GUN 3 Value: 7.5 V for 1.5 Amps
	25	13	OUT	12 V with 499 Ohm in series
	26	32	OUT	PLC in control = H = 12 V *
	PLC USE ONLY	27	14	IN
28		33	IN	HV value command (5.2V max.) *** ^
29		15		GND
30		34		GND
31		16	IN	GUN 1 ON = H **
32		35	IN	GUN 1 Value (7.5 V max.) ***
33		17	IN	GUN 2 ON = H **
34		36	IN	GUN 2 Value (7.5 V max.) ***
35		18	IN	GUN 3 ON = H **
36		37	IN	GUN 3 Value (7.5 V max.) ***
37		19	IN	PLC Connected (PLC side connects this pin to GND) ****

* This Voltage is mainly for remote control circuitry use. It can only supply enough current for the remote control. Do not use this voltage for other purposes.

** The High Voltage is turned on by the Low to High edge of the ON/OFF Control Signal. 5V is enough for the High State, but do not input more than 12V. During the time that the



ON/OFF Control Signal stays high, the front panel ON/OFF push buttons also gain control of the ON/OFF operation for safety reasons. The High Voltage is turned off by the Low State of its ON/OFF Control Signal. During the time that this Signal stays low, the front panel “ON” button cannot turn on the High Voltage. These statements are also true for the Emission Current.

*** Both the High Voltage and Emission Current take positive inputs. Using 5 K Ω Variable Resistors is recommended for the input voltage adjustment on the handheld unit. The Input Resistance for HV Control Signal is 20 K Ω . There are pull-up resistors, with resistance more than 20 K Ω , for the emission current control inputs.

Do not apply higher than the specified maximum voltage to the inputs. Input voltage higher than the specified maximum voltage allowed may burn the circuitry in the control module.

**** This pin needs to be connected to the Ground at the Remote Control Unit. The Remote Control Unit cannot gain control if this fails to be done, even if it is connected to, and selected on the Control Module. This is an important safety feature to ensure that the Power Supply has a control source at all times.

^^ Most customers prefer a high voltage that is adjustable only from the front panel of the Control Module. That is how the Remote Control is configured when the Hydra 15 is shipped. However, customers can still have the choice of a remotely adjustable high voltage by performing the following steps:

1. Take off the top lid of the Control Module.
2. On the PCB that is labeled “P1520X”, where “X” can be any alphabet that stands for version, look for the only one jumper that is labeled “JS” and “HV CONTROL SOURCE”.
3. When the jumper is set at the side labeled “FRONT PANEL”, the HV Adjust Variable Resistor on the front panel has sole control over the high voltage, even if the Remote Control is selected. This is the way the jumper is set at the time of shipment from Niles Electronics Inc. Moving the jumper to the other side that is labeled “REMOTE” will give the user the option of adjusting the high voltage from the Remote Control Unit when the Remote is selected.

4

POWER MODULE



FRONT PANEL

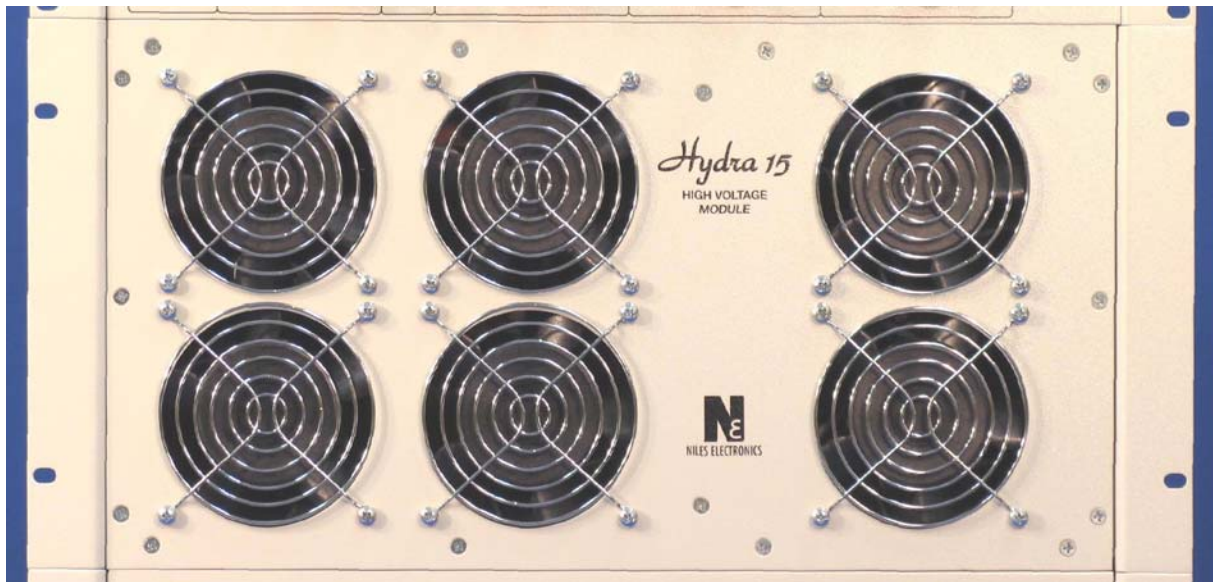
There are two main switches on the Power Module Front Panel. Both are Magnetic Hydraulic Circuit Breakers. Flipping them upwards turns them on while flipping them downwards turns them off. The left switch is the 230V, single phase, 50/60 Hz, 10 Amp Control Switch. The switch to the right is the 400V, 3-phase, 50/60 Hz, 40 Amp Power Switch.

Located above the switches are the pilot lights that indicate the electricity condition. If any of the lights is off while the switch is turned on, this is an indication that the corresponding wire is not connected, or that its fuse is broken. If the switch turns off by itself right after the switch is turned on, it means the load side is short-circuited. Troubleshooting needs to be done.

To the right of the switches and the lights are three Filament Transformer Breakers, labeled 1-3 from the bottom up. For detailed information on these Filament Transformer Breakers, please refer to the subject “breaker, interlock” in former chapter.

5

HIGH VOLTAGE MODULE

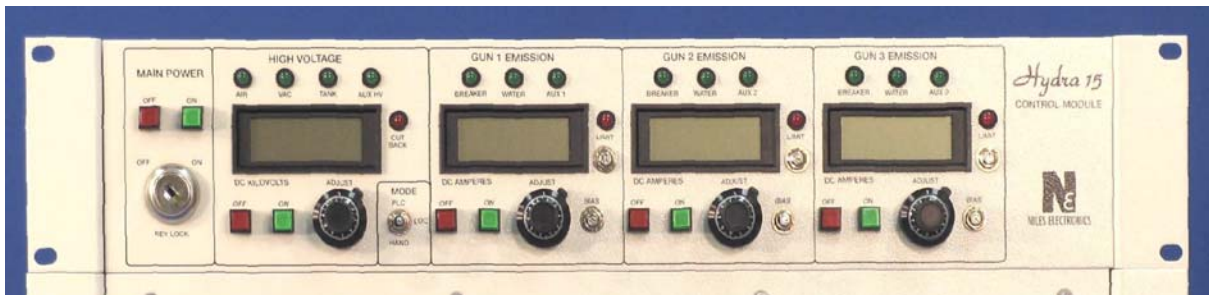


Front Panel

The HV output connections are to be made on the back panel. There are no controls that can be touched on the front panel of the High Voltage Module. Nonetheless, the cooling air needs to flow into the module through the front panel. **It is important to maintain sufficient fresh airflow.** Insufficient fresh airflow will cause the temperature to rise inside the Modules, consequently, turn off the Air Interlock Indicator LED, the High Voltage Outputs and all of the Emission Current. Or, even worse, burn the parts inside the power supply and cause permanent damage that requires repair.

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CONTROL MODULE



FUNCTIONS

The front panel of the Control Module's consists of six distinct functions that are clearly labeled at the top of each section. They are, from left to right:

- Main Power
- High Voltage
- Control Source
- Gun 1 Emission
- Gun 2 Emission
- Gun 3 Emission

MAIN POWER

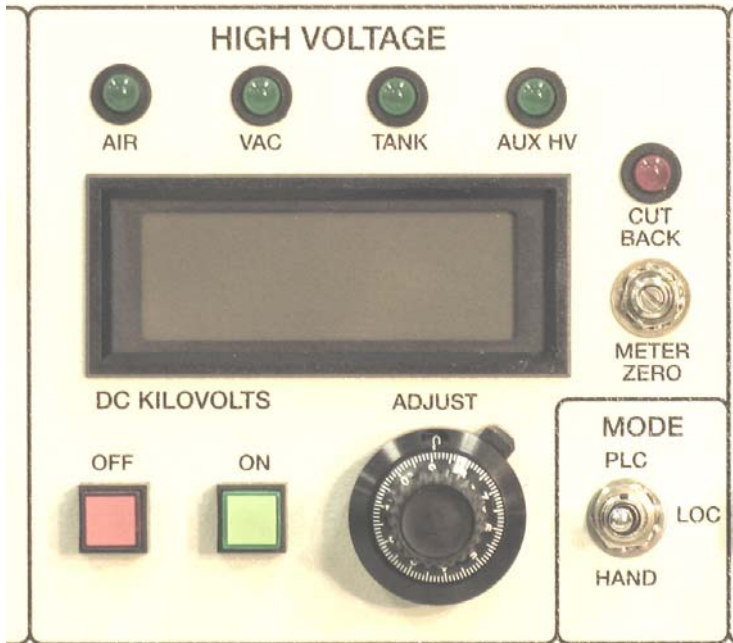


The Main Power has a Key Lock Switch that prevents unauthorized access to the Power Supply. The OFF button lights red after the Key Lock Switch is turned on. The ON push button lights green when the main power is on. If the Key Lock is turned off, no lights will be lit. Before you turn on the main power, make sure that you have turned on the Magnetic Hydraulic Circuit Breakers located on the Front Panel of the Power Module.

WARNING

Even if there are no lights lit, it does not mean there is no voltage inside the Modules. There are no user serviceable parts inside the cases.

HIGH VOLTAGE



The High Voltage Interlock Indicator Lights, from left to right, are:

AIR: Temperature inside HV Module

VAC: Vacuum

TANK: Tank High Voltage Access

AUX HV: Auxiliary External Interlocks for High Voltage

The Interlock LED Indicators (Air, VAC, Tank, Aux HV) light when the conditions these LEDs reflect are correct for operation of the system. (For greater detail of these Interlocks, please see Chapter 3 – Interlock Connections.)

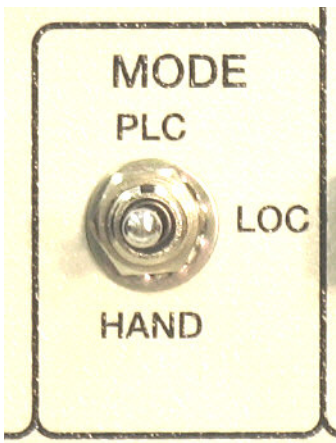
The digital meter at the center of the High Voltage control group displays measured High Voltage.

The Meter Zero semi-variable resistor is located at right lower corner of the digital meter and is used to adjust the HV meter reading to zero when there is no high voltage. This feature not only avoids the annoyance but also increase the reading accuracy. Since the meter is very sensitive and the DC drift of the circuitry is inevitable, users may see small reading on the meter from time to time even if the reading should be zero. This is considered normal.

The Voltage Adjust Variable Resistor (labeled ADJUST on the panel) is located at the lower right of the High Voltage control group and is used to set the output voltage.

Each flash of the Cut Back LED indicates the occurrence of arcing inside the Vacuum Chamber under normal operation. Since the Power Supply is designed to handle arcing quite well, the user may not notice its occurrence without the Cut Back LED. During an arc, the Power Supply is designed to cut the high voltage to 0V for about 20 milliseconds before recovering to full voltage. Consequently, the Voltage Meter will dip, giving apparently random readings. If arcing continues, the Voltage Meter will not give a steady reading and the Cut Back LED will continue flashing.

CONTROL SOURCE



The Control Source Switch, located below the power meter, has three settings to select the source from which the High Voltage and Emission Current will be controlled.

- PLC: Controlled by PLC or equivalent devices.
- LOC: Controlled by the Front Panel.
- HAND: Manual control via the Hand-Held Remote Control Unit.

EMISSION CURRENT



The Emission Current Interlock Indicator Lights, from left to right, are:

- BREAKER: Breaker Overload
- WATER: Water
- AUX #: Auxiliary Interlock #. Where # can be 1, 2 or 3.

(The function of these Interlock Switches has been described in detail in Chapter 3 – Interlock Connections.)

The ON/OFF function is provided by the two pushbuttons at the lower left of the Emission Current section. . The OFF button lights red when the Source Filament is OFF. The ON button lights green when the Source Filament is ON.

The Limit Semi-Variable Resistor is used to limit the highest emission current. The Limit LED indicates whether or not emission is being limited by the limit Semi-Variable Resistor. If the light is on, emission is being limited.

The BIAS Semi-Variable Resistor is used to calibrate the Adjust Variable Resistor so that a setting of zero on the Adjust Variable Resistor is the point just before the emission current comes on.

The Emission Current Variable Resistor (labeled ADJUST on the front panel) is used to set the desired value of emission current.

The digital meter at the center of the EMISSION CURRENT displays measured emission current.

OPERATION OF THE CONTROL MODULE

PRELIMINARY PRECAUTIONS

Prior to turning the system on for the first time, it is essential that the following conditions be ascertained:

- The system has been installed correctly (see Chapter 3 Installation).
- The Vacuum Tank is operational.
- The Filament Transformers are installed according to specifications and is not shorted to ground.
- The E-Beam gun has material in its crucible.
- Unused HV Cables are properly insulated and isolated (Please refer to the “Warning” on page 3-3)

INITIAL TURN ON

1. Turn on the KEYLOCK.
2. Observe the Interlock lights. All the Interlock lights should be on. If any of these lights are not illuminated, this means that at least one of the Interlocks is open. These Interlock must be identified and properly remedied.
3. Wait at least five seconds.
4. Turn on the High Voltage by pressing the “ON” pushbutton.
5. Turn the “ADJUST” Variable Resistor Knob to the desired voltage. High Voltage will now be applied to the E-Beam gun.
6. Turn on the E-Beam source by depressing the “ON” pushbutton of the EMISSION CURRENT.

7. Slowly adjust the BIAS Variable Resistor of the EMISSION CURRENT until a small amount of emission current is evident. Check the E-Beam gun crucible for a beam.

TURN OFF

1. Reduce the ADJUST Variable Resistor of the EMISSION CURRENT to zero. If the indicated emission does not go to zero, the BIAS setting is too high and should be reduced to the point that the emission current reaches zero.
2. Turn off the source filament power by depressing the OFF pushbutton of the EMISSION CURRENT.
3. Turn off the High Voltage by depressing the OFF pushbutton on the HIGH VOLTAGE. The indicated voltage reading will go to zero.
4. Press the red "OFF" in the MAIN POWER section.
5. Turn off the KEYLOCK.
6. Flip the Magnetic Hydraulic Circuit Breakers located on the Power Module downwards to the "OFF" position.

WARRANTY

The E-Beam Gun Switching Power Supply is guaranteed against faulty materials, functioning, and workmanship for a period of 12 months after delivery by Niles Electronics Inc.

This warranty only covers failures due to defects in material or workmanship that occur during normal use, as described in this product manual. This warranty shall not apply if any repair has been performed or any alteration has been made by anyone other than an authorized Niles Electronics representative. This warranty shall not apply if failures occur which result from abuse, misuse, negligence, accident, mishandling, faulty installation, misapplication, improper operation or maintenance, alteration, modification, improper voltage supply, lightning damage, or damage that is attributable to acts of God.

The warrantor shall not be liable for incidental or consequential damages resulting from the use of this product, or arising out of any breach of this warranty. All express and implied warranties are limited to the applicable warranty period set forth above.

Repairs made under warranty at Niles Electronics' facilities will be made free of charge. Freight cost, both ways, will be at customer's expense. Niles Electronics reserves the right for any final warranty adjustment.

This warranty is limited only to repairs. No returns for refunds.

SAFETY WARNING

IN CASE OF EQUIPMENT FAILURE:

If the equipment malfunctions, **DO NOT ATTEMPT TO TROUBLESHOOT.** The equipment was not designed for user troubleshooting, which may be dangerous to do. Contact Niles Electronics in the event of Power Supply failure. Shipment of the equipment back to Niles Electronics for repair may be necessary. If the customer's company cannot afford the downtime, it is recommended that spare units be purchased.

USER RESPONSIBILITY

The user is responsible for proper installation and operation, in accordance with the procedures described in this manual. If the user has any doubt about understanding these procedures, please contact Niles Electronics.

The warranty shall be null and void if the equipment has not been installed properly.

Alteration of the design of any function of the equipment, without the written consent of Niles Electronics, Inc. voids the warranty and is entirely the responsibility of the user.

CONTACT

Please contact Niles Electronics for any inquiries, installation, or repair issues.

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