FIB POWER SUPPLY FOR FOCUSED ION BEAM

SPELLMAN HIGH VOLTAGE ELECTRONICS CORPORATION

- ***Integrated Accelerator and Ion Source Chassis***
- ***High Performance Ground Reference Lens Chassis***
- ***Very Low Ripple and Ultra Stable Outputs***
- ***Robust Arc and Short Circuit Protection***
- ***Design to Minimise Micro-discharge Events***
- ***Optically Isolated Digital Interface***
- ***CE Marked & Designed to Meet SEMI S2***

Spellman's FIB Series is an integrated multiple output high voltage power supply specifically designed for focused ion beam applications. It incorporates a high stability accelerator voltage with the floating outputs to drive traditional Ga Ion and Plasma Sources. An additional Lens Chassis is available, providing the high performance fixed or reversible polarity high voltage lenses required to focus the Ion Beam. Both the Main Chassis and Lens Chassis are 19" rack mountable. Focused Ion Beam is typically used in the semiconductor industry, materials science and increasingly in the biological field for imaging, etching and deposition of materials.

The Main Chassis provides an Acceleration voltage up to 35kV, with floating Filament, Extractor and Suppressor outputs, all designed to the exacting performance requirements for FIB applications. The Lens Chassis offers Lens voltages up to 30kV, with fixed or Reversible polarity. All outputs are offered with ultra-low output ripple, excellent regulation, stability, temperature coefficient, drift and accuracy specifications. Isolation and control of the respective floating sources is provided via Spellman's proprietary high voltage isolation techniques. Customer control of this integrated FIB power supply system is accomplished via a fiber optic interface. All high voltage safety interlocks are of a failsafe hardware based design. The FIB is CE marked and is designed to be compliant with applicable IEC, UL and SEMI standards. Consult factory for final configuration requirements.

TYPICAL APPLICATIONS

Focused Ion Beam (FIB)
Ion Gun Controller

SPECIFICATIONS

Input Voltage:
+24Vdc, ±5% @ 5.5 amps maximum.
Inrush is <6 amps for 1 second.

Safety Fuse:
A 5 x 20mm ceramic fuse changeable from the outside and marked with the fuse value.

Power Switch:
A shielded rocker switch allows the unit to be switched ON and OFF from the rear panel.

Environmental:

Operating Temperature:
+10°C to +45°C ambient for normal operation.
The unit will operate from 0°C but will require an extended warm up period.

Storage Temperature:
-20°C to +60°C

Humidity:
0 to 80% RH, non-condensing

Altitude:
2000 meters ASL at full power. For altitudes above 2000 meters the maximum ambient operating temperature is linearly derated by 1.1˚C per 300 meter interval.

Mechanical:
Main chassis (rack mountable): See dimension drawings
Lens chassis (rack mountable): See dimension drawings

Weight:
Main chassis: <66.12 lbs. (<30kg)
Lens chassis: <22.04 lbs. (<10kg)

Software:
All communications to the power supply is through a fiber optic link operating at 19.2 kbaud, or Ethernet. A basic self-test capability is provided. This self-test will verify internal consistency of the HVPS, including internal supply voltage levels, reference voltages, firmware integrity, etc. However, the HVPS will not change any output voltages during this test.

Regulatory Approvals:
IEC61010:2010 Safety requirements for electrical equipment for measurement, control and laboratory use. UL61010-1:2012 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements and CAN/CSA-C22.2 No.61010-1-12:2015. The unit is CE marked against EN61010:2010 and EN61326-2-1:2013 and is RoHS compliant.

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ACCELERATOR SUPPLY

Output Voltage:
0 V to +35 kV, referenced to ground.
100V absolute accuracy

Output Current:
30µA maximum

Current Limit:
30µA maximum

Load Regulation:
±0.01% of maximum for 0-100% rated current change

Line Regulation:
100mV over input power range

Ripple:
200mV p-p, from 0.1Hz to1MHz at 30kV and 30µA

Temperature Coefficient:
25ppm/˚C

Stability:
1.5V/10 hours after 2 hour warm-up

Programming:
16 bit resolution, 0V to +35kV

Monitoring:
14 bit resolution, 0V to +35kV, ±1% accuracy (±50V offset)
14 bit resolution, 0µA to 30µA, ±1% accuracy (±0.3µA offset)

Response:
<1.0 second

FILAMENT SUPPLY

Output Voltage:
0 to 5Vdc, referenced to Accelerator, current controlled

Output Current:
0 to 5 amp, 5mA absolute accuracy

Load Regulation:
±0.1% of maximum for 0 to maximum rated voltage change

Line Regulation:
5mA over input power range

Ripple:
10mA p-p, from 0.1Hz to 1MHz

Temperature Coefficient:
200 ppm/°C

Stability:
5 mA/10 minutes after 2 hour warm-up

Programming:
16 bit resolution, 0A to 5A

Monitoring:
16 bit resolution, 0V to 5V, ±4% accuracy (±0.1V offset)
16 bit resolution, 0A to 5A, ±4% accuracy (±50mA offset)

Response:
< 0.10 sec, >5A/s measured between 10% to 90% or
90% to 10%

SUPPRESSOR SUPPLY

Output Voltage
-2 kV to +2kV, referenced to Accelerator,
±20V absolute accuracy

Output Current:
30µA

Current Limit:
30µA

Load Regulation:
±0.01% of maximum for 0 to maximum rated voltage change

Line Regulation:
100mV over input power range

Ripple:
150mV p-p, from 0.1Hz to 1MHz

Temperature Coefficient:
25 ppm/°C

Stability:
0.5 V/10 hours after 2 hour warm-up

Programming:
16 bit resolution, -2kV to +2kV

Monitoring:
14 bit resolution, -2kV to +2kV, ± 1% accuracy (±8V offset)

Response:
<0.25 sec

EXTRACTOR SUPPLY

Output Voltage:
0 to -15kV, referenced to Accelerator,
100V absolute accuracy

Output Current:
400µA

Current Limit:
programmable, 8 bit resolution, 0 µA to 400µA, (default value on supply enable is 400µA)

Load Regulation:
±0.01% of maximum for 0 to maximum rated voltage change

Line Regulation:
100 mV over input power range

Ripple:
100mV p-p, from 0.1Hz to 1MHz at 30µA and below

Temperature Coefficient:
25 ppm/°C

Stability:
0.5 V/10 hours after 2 hour warm-up

Programming:
16 bit resolution, 0V to -15kV

Monitoring:
16 bit resolution, 0V to -15kV, ±1% accuracy (±15V offset)
16 bit resolution, 0µA to 400µA:
10µA to 400µA, ±3% accuracy (±5µA offset)
0µA to 10µA, > 5kV, ±0.05µA accuracy (±0.05µA offset)

Response:
<1 sec
>1.33kV/s measured between 10% to 90% and 90% to 10%

Trips:
Hard trip at 400µA in <0.25 sec programmable trip delay (for when current at I limit). 0 sec to 255 sec, 8 bit resolution (5 sec minimum, 20 second default)

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LENS 1 SUPPLY

Output Voltage:
0kV to +30 kV referenced to ground
100V absolute accuracy

Output Current:
30µA

Current Limit:
30µA

Load Regulation:
±0.01% of maximum for 0 to maximum rated current change

Line Regulation:
100mV over input power range

Ripple:
100mV p-p, from 0.1Hz to 1MHz

Temperature Coefficient:
25 ppm/°C

Stability:
1.0 V / 10 hours after 2 hour warm-up

Programming:
16 bit resolution, 0 to +30kV

Monitoring:
16 bit resolution, 0kV to +30kV, ± 1% accuracy (±30V offset)
16 bit resolution, 0µA to +30µA, ± 3% accuracy (±1µA offset)

Response:
<0.1 s

<4 sec to reach <2V away from steady state for 20kV to 18kV change.

<4 sec to reach <2V away from steady state for 18kV to 20kV change.

>6.0kV/s measured between 10% to 90% or 90% to 10%

Wobble Range:
2V to 2.5kV peak to peak, sinusoidal. If wobbling occurs near zero, the wobble waveform will be clipped so as to prevent crossing zero.

Wobble Period:
1 second to 4 seconds

LENS 2 SUPPLY

Output Voltage:
-30kV to +30kV referenced to ground
100V absolute accuracy

Polarity:
Bipolar

Output Current:
30µA

Current Limit:
30µA

Load Regulation:
±0.005% of maximum for 0 to maximum rated current change

Line Regulation:
100mV over input power range

Ripple
200mV pk-pk, from 0.1Hz to 1MHz

Temperature Coefficient:
25 ppm/°C

Stability:
1.0V / 10 hours after 2 hour warm-up

Programming:
16 bit resolution, -30kV to +30kV

Monitoring:
14 bit resolution, -30kV to +30kV, ±1% accuracy (±15V offset)
14 bit resolution, -30µA to +30µA, ±3% accuracy (±1µA offset)

Response:
<0.1 s

<4 sec to reach <2V away from steady state for 20kV to 18kV change.

<4 sec to reach <2V away from steady state for 18kV to 20kV change.

Wobble Range:
2V to 2.5kV peak to peak, sinusoidal. If wobbling occurs near zero, the wobble waveform will be clipped so as to prevent crossing zero.

Wobble Period:
1 second to 4 seconds

Additional Bipolar:
The above specifications do not apply in the range -500V to +500V. Operation at 0V output is not a requirement. The module must enable at 0V output. Programming and monitoring is offset binary

Indicators:

Power On:
A green LED illuminates when 24Vdc is applied to the unit

Interlock:
A yellow LED illuminates when the interlock(s) are made

Interlocks:
If the interlock is not present communication over the optical bus will remain operational.

Output voltages will be <1000V in <30 seconds when the interlock opens. The interlock will deactivate the power supply via relay contacts and will not reactivate until the supply is enabled through the computer control, even though the interlock may close.

Panel removal: all outputs disabled

Upper column: All outputs except lens 2 disabled

Lens 2: Disable only the lens 2 output

The individual modules of the HVPS can be enabled and disabled through computer control, provided the appropriate hardware interlocks are enabled.

Lens Supply Options:

LENS 1	LENS 2
+30kV	+25kV/-15kV
-30kV	+25kV/-15kV
+/-30kV	+/-30kV
+/-20kV	+/-30kV

INPUT POWER— AMP/TYCO 2-PIN MATE-N-LOCK

PIN	SIGNAL	I/O	PARAMETERS
1	+24Vdc	I	Power input
2	0V	I	Power ground

MAIN HV CONNECTOR

The main high voltage output is fitted with a custom 4 pole receptacle. See page 5 of 6 for detail.

INTERLOCK— 9 PIN FEMALE D CONNECTOR

PIN	SIGNAL	PARAMETERS
1	Not used	Not connected internally
2	Not used	Not connected internally
3	Not used	Not connected internally
4	Not used	Not connected internally
5	+ Upper Column Interlock	Current limited interlock supply
6	- Upper Column Interlock	Opto isolated interlock input
7	+ Lens 2 Interlock	Current limited interlock supply
8	- Lens 2 Interlock	Opto isolated interlock input
9	Shield/Ground	Ground

Switch closure turns ON or enables the supplies

RJ45 ETHERNET CONNECTOR —

PIN	SIGNAL	PARAMETERS
1	TD+	TD+
2	TCT (3V3)	TCT (3V3)
3	TD-	TD-
4	RD+	RD+
5	RCT (3V3)	RCT (3V3)
6	RD-	RD-
7	N/C	No Connection
8	0V (reference)	0V (reference)
9	0V (reference)	0V (reference)
10	0V (reference)	0V (reference)
11	N/C	No Connection
12	N/C	No Connection

The RJ45 socket is fitted for future use, it is configured for 10/100 Mb/s systems using the IEEE 802.3 serial management interface and can only be used for this purpose and is fitted with a blanking plug

LENS 1 CONNECTOR—Lemo ERA3Y430CTL

LENS 2 CONNECTOR—Lemo ERA3Y430CTL

FIBER CONNECTOR

The fiber optics communications connector is a dual channel Avago HFBR- 2524z/1524z connector.

INTERCONNECTIONS BETWEEN CHASSIS

COMMUNICATIONS

The main chassis is provided with a 9 pin D connector which connects via a “one to one” cable to the same connector on the lens chassis. This allows the main chassis to control and monitor the lens outputs. An additional connector is provided on the lens chassis to allow a second lens chassis to be connected to the base unit via the first lens chassis.

INTERCONNECTION POWER— AMP/TYCO 3-PIN MATE-N-LOCK

PIN	SIGNAL	I/O	PARAMETERS
1	OV	I	DC24V Common
2	N/C	I	No Connection
3	+ 24V	I	DC24V Input

Power is transferred between the two chassis via 3 pin “Mate-n-Lok” style connectors. This is interlocked via the main chassis.

An additional power connector is also provided on the lens chassis to allow 24V to be provided to a second lens chassis.

Input and Output cables are not provided with unit.
Interconnect cables are provided with the unit.
Consult factory for available options.

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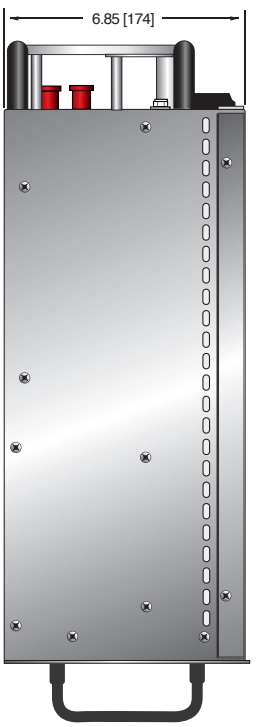
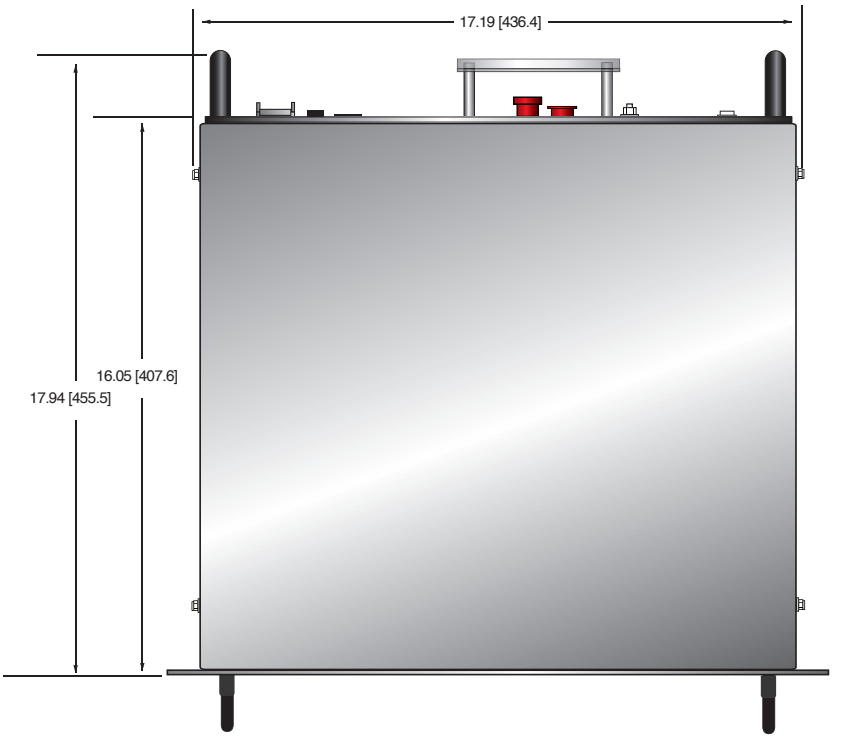
Main Chassis

DIMENSIONS: in.[mm]

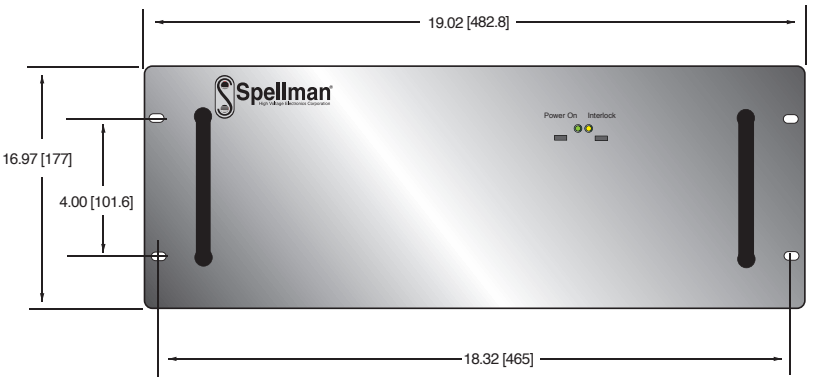
SIDE VIEW



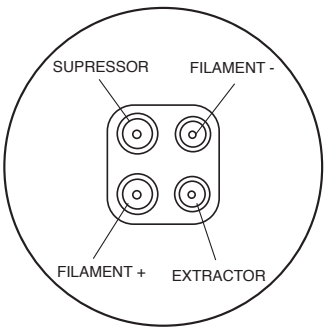
TOP VIEW



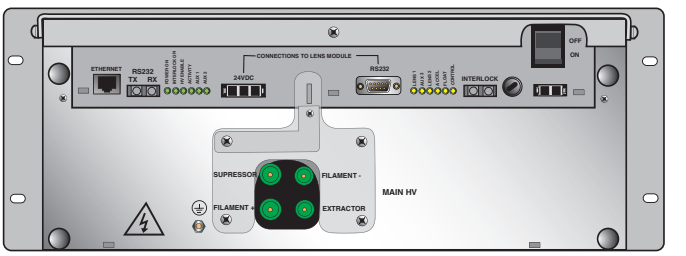
FRONT VIEW



MAIN HV OUTPUT



REAR VIEW



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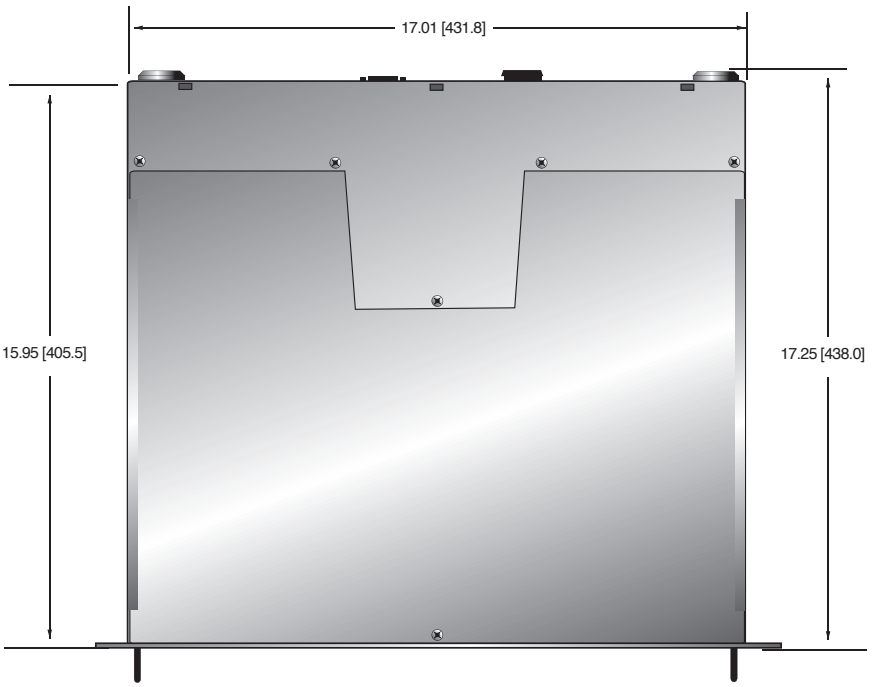
Lens Chassis

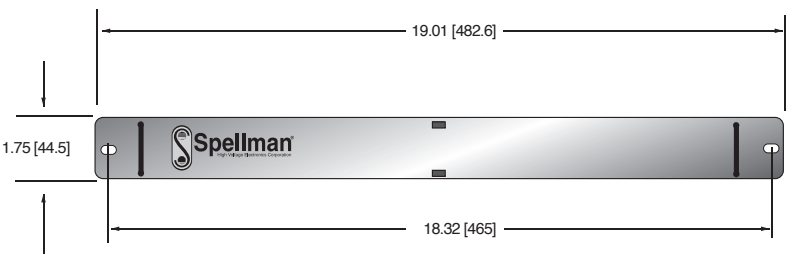
DIMENSIONS: in.[mm]

SIDE VIEW

TOP VIEW



FRONT VIEW



REAR VIEW

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