1.1 PURPOSE OF EQUIPMENT

The series 205A/210 is a family of regulated precision laboratory high voltage power supplies. They provide exceptional performance in critical applications such as nuclear and electro-optical instrumentation, precision CRT and electron beam applications.

1.2 DESCRIPTION

The units are fully enclosed and designed to mount in a standard 19" rack. A wide range of stable output voltages, up to 100 kV are available. The output voltage is controlled by the calibrated front panel controls or from a remote voltage or resistance programming is available (CBNY option) or the Spellman Model 200-C488 (IEEE-488 interface) can provide intelligent remote IEEE-488 programming and monitoring of any Series 205A/210 power supply.

The units are either fixed polarity, suffix P for positive or N for negative, or reversible polarity, suffix R. Reversible polarity units include either a polarity switch on the rear panel or an internal polarity reversing assembly (see section 2.4 REVERSIBLE POLARITY MODELS). Optional floating outputs, Suffix F, RF, PF, and NF are also available (see TABLE 1.1)

The Series 205A/210 units consist of a DC power supply which converts the AC line power to a low DC voltage and a DC to DC converter which generates the high DC voltage. Low voltage electronics solid state circuits are mounted on a single plug–in printed circuit board and the high voltage assembly is fully encapsulated in silicone rubber for reliable, arc- free, stable operation.

1.3 ELECTRICAL SPECIFICATIONS

Input Power: 115/230 Vac ± 10%, 50 - 60 HZ, 1.0A/0.5A for Series 205A

115/230 Vac ± 10%, 50 - 60Hz, 5.0A/2.5A for Series 210

Output Power: See TABLE 1.1 for output Voltage, Output Current and Ripple specifications for each model in the 205A/210 Series.

Table 1.1

MODEL	SUFFIX	OUTPUT VOLTAGE	OUTPUT CURRENT	RIPPLE pk-pk
205A-01	R, F	0 to 1kV	0 to 30mA	10Mv (R), 30mV (F)
205A-03	R, F	0 to 3kV	0 to 10 mA	30mV (R), 90mV (F)
205A-05	R, F	0 to 5kV	0 to 5 mA	50mV (R), 150mV (F)
205A-10	R, P, N, RF, PF, NF	0 to 10kV	0 to 2.5mA	100mV
205A-20	R, P, N, RF, PF, NF	0 to 20 kV	0 to 1 mA	300mV
205A-30	R, P, N, RF, PF, NF	0 to 30 kV	0 to 0.5mA	400mV
205A-50	R, F, N, RF, PF, NF	0 to 50 kV	0 to 0.3mA	2V
210-01	R, F	0 to 1kV	0 to 225mA	50mV (R), 150mV (F)
210-02	R, F	0 to 2kV	0 to 100mA	100mV(R), 250mV(F)
210-03	R, F	0 to 3kV	0 to 75mA	100mV(R), 300mV(F)
210-05	R, F	0 to 5kV	0 to 40mA	200mV(R), 600mV(F)
210-10	R, P, N, RF, PF, NF	0 to 10kV	0 to 15mA	500mV
210-20	R, P, N, RF, PF, NF	0 to 20 kV	0 to 7mA	1mV
210-30	R, P, N, RF, PF, NF	0 to 30 kV	0 to 4.5mA	1.5mV
210-50	R, P, N, RF, PF, NF	0 to 50 kV	0 to 2.5mA	5V
210-75	P, N, PF, NF	0 to 75kV	0 to 2mA	5V
210-100	P, N, PF, NF	0 to 100kV	0 to 1mA	10V

The complete model part number consists of the series designation followed by the model suffix including either a R, P, N, F, RF, PF, or NF to designate the output voltage polarity.

* See specifications on maximum current. Reduced output current may be required when operating unit into capacitive load or when operating unit at reduced voltage output.

The suffix definition is as defined by the following:

R Reversible polarity. Output is referenced to chassis ground.

P Positive polarity only. Output is referenced to chassis ground

N Negative polarity only. Output is referenced to chassis ground

RF Reversible polarity/Floating output. Output is referenced to the isolated common return binding post. The isolated return is floatable by – 100 volts maximum above chassis ground. Voltage and current monitoring (front panel and remote) and voltage programming is now referenced to the isolated return binding post.

PF Positive polarity only/Floating output. Output is refrenced to the isolated binding post common return. The isolated return is floatable by ± 100 volts maximum above chassis ground. Voltage and current monitoring (front panel and remote) and voltage programming is now referenced to the isolated return binding post.

NF Negative polarity only/Floating output. Output is refrenced to isolated return is floatable by ± 100 volts maxim above chassis ground. Voltage and current monitoring (front panel and remote) and voltage programming is now referenced to the isolated return binding post.

F Floating output. Differential High Voltage output via two isolated (+ and -) high voltage connectors. Either the + or the – output can be returned to the chassis ground or isolated from chassis ground by up to ± 100 volts maximum above chassis ground. Voltage and current monitoring (front panel and remote) and voltage programming is now referenced to the isolated return binding post.

WARNING – WHEN OPERATING ANY OF THE FLOATING OUTPUT UNITS. A RETURN TO GROUND MUST BE PROVIDED TO INSURE SAFE OPERATING CONDITIONS AND THAT THE MAXIMUM VOLTAGE ISOLATION CONSTRAINTS AS DEFINED ABOVE ARE NOT EXCEEDED.

Maximum Current: The maximum current rating for each model, as shown in Table 1.1, is applicable when the unit is operated at the maximum output voltage. When operating at reduced output voltage or when operating in a current limit mode for capacitor charging, the output current must be limited to reduce levels. This is required to protect against excessive dissipation of the power supply.

The maximum output current must be derated linearly from maximum rated value at maximum output voltage to 30% of maximum current at zero output voltage. Maximum output current available at any desired voltage can be calculated by applying the following formula.

I MAX = VSET (.7IRATED/VRATED) + .3IRATED

	When operating the power supply as a capacitor charger i.e. a capacitor is being continuously discharged the recharged from zero voltage by the power supply) use a charging resistor in series with the power supply) output. The resistance value should be equal to the power supply's maximum rated output voltage divided by the maximum rated output current. The derating factors are safe for all conditions and for all units. Consult the factory for special cases before exceeding these guidelines.
Control:	Multi-turn precision potentiometer and indicator dial (see section 2.3 VOLTAGE CONTROL)
Accuracy:	± (0.25% OF setting + 0.05% of max kV) for units ≤30kv
Resolution:	200mV for units ≤ 30kV; 20V for units ≥50kV
Meter:	Front panel analog meter, switch selectable for reading either output voltage or current, has an accuracy of ± 2% full scale.
Programming:	0 to -5V corresponds to maximum output voltage via rear panel PROGRAMMING/MONITOR connector (5kΩ input impedance). Programming may also be accomplished using a 5kΩ to 20kΩ low temperature coefficient wire wound or cermet type potentiometer. (Also available are digital computer programming options).
Monitoring:	Remote current and voltage monitoring signals (0 to +5V) are available at the rear panel PROGRAMMING/MONITOR connector. (See section on REMOTE MONITORING and Table 2.1 for pin designations).
Line Regulation:	± 0.001% for ± 10% input line change
Load Regulation:	± 0.005% for NL to FL and FL to NL
Stability:	0.01% /hr; 0.02% / 8hrs.
Temp. Coeff:	50ppm / C ° max, over the range 0 to +50° C
Protection:	Short circuit and arc protected, self-restoring. Automatic current limiting occurs at approximately 120% of maximum rated output current. (See section on Maximum Current which is allowable at reduced output voltages.)
HV Connector:	The high voltage panel connector and its respective mating connector for all models in the 205A/210 Series is listed in TABLE 2.3, all units are supplied with the appropriate mating high voltage connector.
LV Connector:	The remote analog connector is a Spellman part # JKB. The mating connector part # PKB is provided with each unit. PROGRAMMING/MONITOR connector pin designations can be found in TABLE 2.1.
Digital Conn:	The remote digital programming connector (applicable for all models ordered with CBNY option) is an Amphenol 57-40240. The mating connector required is Amphenol 57-30240 (provided with each unit containing CBNY option).

1.4 MECHANICAL SPECIFICATIONS

Physical dimensions and weight of all models are specified as listed in TABLE 1.2 (NOTE: The depth given in the chart below is depth of the chassis behind the front panel and does not include allowance for the rear panel high voltage or remote connectors).

TABLE 1.2

MODEL	SIZE ALL UNITS ARE 19" WIDE HIGH " X DEEP (mm)	WEIGHT Lbs (kgms)
205A-01	3.5 X 9.625 (83 X 245)	12 (5.5)
205A-03	3.5 X 9.625 (83 X 245)	12 (5.5)
205A-05	3.5 X 9.625 (83 X 245)	12 (5.5)
205A-10	3.5 X 9.625 (83 X 245)	12 (5.5)
205A-20	3.5 X 9.625 (83 X 245)	15 (6.8)
205A-30	5.225 X 11 (133 X 279)	19 (8.6)
205A-50	5.225 X 11 (133 X 279)	24 (10.9)
210-01	5.225 X 11 (133 X 279)	34 (15.3)
210-02	5.225 X 11 (133 X 279)	34 (15.3)
210-03	5.225 X 11 (133 X 279)	34 (15.3)
210-05	5.225 X 11 (133 X 279)	34 (15.3)
210-10	5.225 X 16 (133 X 406)	34 (15.3)
210-20	5.225 X 16 (133 X 406)	37 (16.8)
210-30	5.225 X 16 (133 X 406)	39 (17.7)
210-50	5.225 X 16 (133 X 406)	46 (20.9)
210-75	5.225 X 16 (133 X 406)	46 (20.9)
210-100	5.225 X 16 (133 X 406)	46 (20.9)

SECTION II OPERATION

CAUTION – THIS UNIT CAN STORE HAZARDOUS VOLTAGE. COMPLETELY DISCHARGE HIGH VOLTAGE AT REAR PANEL GROUND TERMINAL BEFORE ATTEMPTING REMOVAL OF THE HIGH VOLTAGE CABLE.

2.1 INSTALLATION

The series 205A/210 high voltage power supplies mount in a standard 19" wide rack.

2.2 INPUT POWER

Input AC line voltage required is 115/230 Vac $\pm$ 10%, 50 – 60 Hz single phase. The recessed LINE VOLTAGE selector switch on the rear panel selects either 115 Vac or 230 Vac operation.

The toggle switch on the front panel is used to turn the unit on. A led indicator light is illuminated when the unit is under power.

2.3 VOLTAGE CONTROL

The standard Series 201A/210 power supply has three modes of controlling the high voltage output, available to the user. Set the LOCAL /REMOTE switch on the rear panel to LOCAL if front panel control is desired. If remote operation is required, set the switch to REMOTE. The high voltage output can be remotely programmed from either an external voltage source or with an external potentiometer. When in the REMOTE position the front panel controls have no effect on the output voltage and therefore need not to be turned to zero. When in the LOCAL position, the front panel controls determine the high voltage

output independent of any programming input. Optional computer programming is available, (see SECTION V COMPUTER PROGRAMMING).

2.3.1 LOCAL CONTROL

The output voltage can be set by the controls on the front panel. A continuous 10 turn digital dial directly reads from 0 to 1000v with a resolution of 0.2 V on all models, except those with an output greater than 500kV.

A 1kV selector switch, with up to 10 positions as appropriate is used on all 3kV to 30kV models.

A 5kV selector switch, with up to 6 positions as appropriate is used on all 20kV and 30kV models.

The output voltage is the sum of the dial settings as described above.

The 500kV and greater output models employ a continuous multi- turn digital dial to control the high voltage output, resolution and resetability of this potentiometer is 20.0V.

2.3.2 REMOTE CONTROL

The high voltage output can be remotely programmed from either an external voltage source or with an external potentiometer from the internal reference voltage source. A 0 to –5V programming voltage applied to Pin B of J2 (PROGRAMMING/MONITOR) connector jack on the rear panel will remotely program the high voltage output from zero to maximum OUTPUT. Programming can also be accomplished using a potentiometer connected between Pin a (-5V), Pin C (GND) and with the wiper connected to Pin B (PRGM INPUT). The potentiometer should be a low temperature coefficient wire wound or cermet type, 5kΩ to 20kΩ resistance value. The output is proportional to the programming input. TABLE 2.1 below lists the PROGRAMMING/MONITOR connector pin designations.

TABLE 2.1

PIN #	FUNCTION
A	-5 volt reference output
B	Remote program input
C	Ground
D	Remote current monitor output
E	Remote voltage monitor output
F	Polarity ident (gnd+/-open -)
H	No connection

2.4 REVERSIBLE POLARITY MODELS

The front panel polarity lights indicate which polarity the unit is set for. The appropriate light becomes lit as soon as the line power is applied even if there is no high voltage output.

CAUTION – LINE INPUT POWER MUST BE TURNED OFF AND THE HIGH VOLTAGE SHOULD BE DISCHARGED FULLY BEFORE PROCEEDING TO REVERSE THE POLARITY.

2.4.1 REVERSIBLE POLARITY MODELS 1kV TO 5kV OUTPUT

The screwdriver operated POLARITY SELECTION switch is accessible at the rear panel of the instrument.

2.4.2 REVERSIBLE POLARITY MODELS 10kV to 50kV OUTPUT

The polarity is reversible by means of an internal switching mechanism which is easily accessible upon removal of the top cover.

The polarity is reversed by removing the bracket containing the high voltage connectors, rotating the bracket 180 º and then re-inserting it. An interlock automatically assures that the high voltage cannot be turned on until this bracket is installed in either position.

A remote polarity indication is provided at J2 (PROGRAMMING/MONITOR) connector jack located on the rear of the unit. Pins F and H of J2 are shorted when the polarity is set for positive output and are open when the terminals are set for negative output. These terminals are both isolated, (see TABLE 2.1).

2.5 REMOTE MONITORING

Remote current and voltage monitoring signals are available at Pins D and E respectively of the PROGRAMMING/MONITOR connector. A 0 to 5V voltmeter or a 0 to 100ꝼA current meter may be used to monitor both current (Pin D) and voltage (Pin E) for the full output range. Both outputs are positive polarity regardless of the actual polarity of the output voltage.

Remote output voltage monitor; 0 to +5 volts (49.9K series impedance) for 0 to max rated output voltage.

Remote output current monitor; 0 to +5 volts (49.9K series impedance) for 0 to max rated output current except as shown for the models listed below in TABLE 2.2 below.

TABLE 2.2

MODEL	mA MONITOR (FULL SCALE)
210-01	0 to +5 volts via 49.9K for 0 to 250mA.
210-10	0 to +5 volts via 49.9K for 0 to 20mA.
210-20	0 to +5 volts via 49.9K for 0 to 7.5mA.
210-30	0 to +5 volts via 49.9K for 0 to 5mA.
210-50	0 to +5 volts via 49.9K for 0 to 3mA.

2.6 CURRENT LIMITING

The series 205A/210 includes a current limiting circuit that drops the output voltage to a safe level when the rated output current is exceeded by approximately 20%. (See specification on Maximum Current when operating the unit at reduced output voltages or when operating in a current limit mode for capacitor charging).

2.7 HIGH VOLTAGE OUTPUT

The high voltage output connector is located on the rear panel. An appropriate shielded mating connector is supplied with each unit.

TABLE 2.3

MODEL	HIGH VOLTAGE CONNECTOR OUTPUT	MATING
205A-01	JDK	PDB
205A-03	JDK	PDB
205A-05	JDK*	PDB*
205A-10	JJA	405787
205A-20	JJA	405787
205A-30	JJA	405787
205A-50	JJB	405786
210-01	JAC	PAE
210-02	JAC	PAE
210-03	JAC	PAE
210-05	JAC	PAE
210-10	JJA	405787
210-20	JJA	405787
210-30	JJA	405787
210-50	JJB	405786
210-75	206907	206906
210-100	206907	206906

* The 205A-05F has JBA high voltage connectors (mate is PBA)

The Model 210-75 and 210-100 include a mating connector assembled to 3 meters of high voltage cable.

SECTION III THEORY

3.1 FUNCTIONAL DESCRIPTION

The functional schematic and block of a Series 205A and Series 210 units are shown in pages 14 through 19 for reversible polarity units and for fixed polarity units. The circuit uses a DC to DC converter which converts low voltage DC power to a high voltage Dc output. This output voltage is highly regulated and filtered and can be varied either by the front panel controls or through the REMOTE PROGRAM input on the rear panel. The input to the DC to DC converter is obtained from internal low voltage power supplies powered by the AC line input.

An oscillation determines the frequency (approximately 20kHz) at which all amplification, high voltage transformation, rectification and filtering occurs. The amplification is a function of a control voltage which performs the function of control and regulation. A sample of the output voltage is compared against a reference voltage in the sensing circuit. The sensing circuit generates the control voltage to set and maintain a fixed voltage output.

3.2 CIRCUIT DESCRIPTION

The input AC line is converted to the B+ (36Vdc) supply and regulated $\pm$12Vdc low voltage power supplies. The B+ supply is a filtered full wave rectifier circuit located on the chassis. The regulated low voltage power supply circuit ($\pm$ 12Vdc) consists of a rectifier circuit located on the T1 and output regulators located of the PCB 100.

The output of the oscillator circuit is amplified in the AGC amplifier. The gain of the ACG amplifier is a function of the control voltage developed at the output of the error amplifier.

The encapsulated high voltage assembly includes a high voltage power transformer, rectifier or multiplier circuits, ripple filter and sensing circuits. These are all critical custom designed and encapsulated components.

A sample of the high voltage Dc output is fed to the output voltage sensing circuits and is compared to a command voltage. Output voltage control is obtained by varying the command voltage fed to the error amplifier. The error amplifier compares the command voltage and the correction in the gain control of the ACG amplifier. The command voltage is controlled by the front panel controls when the rear panel program switch is in the LOCAL position.

The reference and reference control and buffer provide a stable −5Vdc to the front panel output voltage controls.

The current sensing circuit monitors the output current. The buffered output of this circuit is employed for both internal and remote current monitoring.

SECTION IV MAINTANCE

4.1 GENERAL

The high voltage power supply should not require any maintenance or calibration. It is designed for reliable, trouble free operation. If any question should arise, contact the Spellman Customer Service Department for assistance or return authorization. Although adequate information is provided in the schematics provided with this manual, it is suggested that the unit be returned to the factory if service should become necessary.

CALIBRATION SERVICES

Your Spellman high voltage power supply is designed to provide years of reliable service. For a nominal charge it can be returned to the factory for annual calibration to its original specification. For traceability, a certificate will be issued, identifying the serial number of the unit calibrated and all test equipment used to perform the calibration. All measurements are traceable to the National Institute of Standards and Technology (N.I.S.T.). Contact the factory at (914) 686-3600 for additional details.

5.1 GENERAL

All units in the 205A/210 Series can be provided with a factory installed option for remote digital programming of the high voltage output. The programming inputs are TTL compatible and the data is positive logic (all data bits low yield 0 high voltage output). The addition of this option allows the unit to be easily interfaced to any computer or microprocessor utilizing one of it's three user selectable modes of operation.

16 Bit Transparent:	The 16 bit data is passed from the inputs directly to the DAC. This is the default mode (is 100% compatible with all the CBNY digital programming boards).
16 Bit Register:	The 16 bit data is latched into an internal 16 bit register in one write cycle.
8 Bit Register:	Two bit bytes (Most Significant Byte and Least Significant Byte) are latched into two 8 bit registers. The MSB and LSB registers are individually addressed and written. This allows an 8 bit data bus system provide 16 bit programming in two write cycles.