

BERTAN

The High Voltage People

***INSTALLATION
AND OPERATING
MANUAL
BERTAN SERIES 205B***

WARRANTY

The Del Power Conversion Group ("Del") warrants each of its products to be of sound design and free from defects in material and workmanship. Our obligation under this warranty is to repair or replace (at our option) FOB our factory:

Any STANDARD or CUSTOM product, or part thereof, at no charge, within 1 year after shipment date, which proves defective under normal use.

To exercise this warranty, contact the Customer Service Department at the factory (outside the U.S.A., contact your local Del sales representative) to obtain a Returned Material Authorization (RMA) number and shipping instructions. Send the product, shipping prepaid, to Del's factory. Repairs will be made and the product returned - we will cover return shipping charges. All repairs are shipped UPS Ground. Upon request, we can utilize faster shipping methods at customer's expense. Repaired products are warranted for the balance of the original warranty period or at least 90 days. Replaced products will have a new 1-year warranty beginning the day unit is shipped back to customer.

LIMITATION OF WARRANTY

Del does not warrant that the products can be used for any particular purpose other than those covered by the applicable specifications. This warranty does not apply to defects resulting from product modification without Del's express written consent or misuse of any product or part. Del assumes no liability, in any event, for consequential damages, for anticipated or lost profits, incidental damages or loss of time or other losses incurred by purchaser or any third party in connection with products covered by this warranty.

TABLE OF CONTENTS

Paragraph	Title	Page
SECTION 1 - GENERAL INFORMATION		4
1.1	PURPOSE OF THE EQUIPMENT	4
1.2	DESCRIPTION	4
1.3	SPECIFICATIONS	4
1.4	OPTIONS	4
1.5	SAFETY TERMS	4
1.6	WARRANTY INFORMATION	5
SECTION 2 - OPERATION		6
2.1	INSTALLATION	6
2.2	FRONT PANEL CONTROLS AND DISPLAYS	6
2.3	REAR PANEL CONTROLS, CONNECTORS, AND TERMINALS	6
2.4	POLARITY REVERSING:	7
2.5	PREPARATION FOR USE	8
2.6	LOCAL OPERATION	8
2.7	REMOTE OPERATION	9
2.8	COMPUTER PROGRAMMING (Optional)	10
2.9	INPUT POWER	12
2.10	CURRENT LIMITING	12
2.11	HIGH VOLTAGE OUTPUT	12
SECTION 3 - THEORY OF OPERATION		13
3.1	FUNCTIONAL DESCRIPTION	13
3.2	CIRCUIT DESCRIPTION	13
SECTION 4 - MAINTENANCE		14
4.1	GENERAL	14
4.2	CLEANING	14
4.3	CALIBRATION SERVICES	14
SECTION 5 - SPECIFICATIONS		15

SECTION 1 - GENERAL INFORMATION

1.1 PURPOSE OF THE EQUIPMENT

The Series 205B 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 Series 205B is a family of 19" rack-mountable power supplies with output voltages up to 50 kV. The units consist of a DC power supply that converts the AC line power to a low DC voltage and a DC to DC converter that generates the high DC output voltage. Low voltage electronic solid-state circuitry is mounted on the PCB100, and the high voltage assembly is fully encapsulated for reliable, arc-free, operation.

These stable, low noise high voltage power supplies feature front panel digital voltage and current metering, and calibrated direct-reading front panel controls. The rear panel features a HV output connector, a connector for remote analog programming and output voltage and output current monitoring, the output polarity switch, line power plug, fuse, and AC voltage selection switch. All units have arc and short circuit protection for safe, reliable, and arc-free operation. Although primarily designed for rack mounting, the unit may also be used in benchtop applications.

1.3 SPECIFICATIONS

For the Series 205B detailed specifications, refer to the Specifications section.

1.4 OPTIONS (OEM APPLICATIONS ONLY)

Isolated Floating Output

Units can be provided with the output capable of floating up to $\pm 2\text{kV}$ from ground. All controls, programming and monitoring functions operate normally, referenced to ground. The high voltage output polarity, with respect to the floating input terminal is reversible.

1.5 SAFETY TERMS

The **WARNING** used in this manual explains dangers that could result in personal injury or death. The **CAUTION** used in this manual explains hazards that could damage the instrument.

1.6 WARRANTY INFORMATION

The Warranty is given on the inside front cover of this Instruction Manual. If there is a need to exercise the Warranty, contact the factory to determine the proper action to be taken.

NOTE attempting to repair or tampering with the unit while still under warranty (less than 12 months since the date of shipment) will void the warranty. All in-warranty repairs should be sent to the factory.

SECTION 2 - OPERATION

2.1 INSTALLATION

WARNING! *This unit produces hazardous voltage. Do not apply line voltage input unless adequate ground is connected to the unit and the high voltage output has been properly connected.*

2.2 FRONT PANEL CONTROLS AND DISPLAYS

Power Switch:

A rocker switch turns the line power on or off to the entire instrument. The display panel will be lit when line power is applied to the unit.

Output Meter:

The digital output meter can display the output current or the output voltage. A switch below the meter allows the operator to select which output parameter to monitor. The accuracy of the meter is given in the Specification section.

Polarity Indicator:

An LED on the front panel display indicates the polarity of the output. The appropriate LED is lit as soon as line power is applied regardless of whether high voltage output is enabled or disabled. To change the polarity setting, see paragraph 2.4.

Voltage Controls:

The output voltage is the sum of the course and fine dial settings as described below.

Fine Adjust: A continuous, 10-turn, locking digital dial directly reads from 0 V to 1kV with a resolution of 0.2V on all models.

Coarse Adjust: The voltage switch sets the output voltage in increments of 1kV. In addition, a 1 kV selector switch, with up to 10 positions, is provided on all 3kV to 30kV models. A 5 kV selector switch, with up to 6 positions, is provided on all 20kV.

On 30kV & 50kV model a continuous multi-turn digital dial is used to adjust the high voltage output. The resolution and repeatability of this control is 20.0V.

2.3 REAR PANEL CONTROLS, CONNECTORS, AND TERMINALS

Gnd:

Ground is connected to the case of the Series 205B.

Output Connector:

The HV output connector mates with a shielded mating connector supplied with each unit. Refer to the specifications on page 12 to identify the mating connector. Assembly procedures for mating connectors are given at the end of this manual. Only the proper mating connector should be used with the indicated power supply and the power supply should NEVER be energized without a mating connector and suitable load connected.

Fuse:

The fuse is the ac line power fuse. It is rated for 1A, 250Vac for 105Vac-125Vac operation and 0.5A, and 250Vac for 210Vac-250Vac operation. Should a fuse ever need replacement, only these values should be used unless otherwise advised by a qualified Del service technician.

Line Voltage Selector:

The line voltage selector selects the appropriate line voltage 105Vac-125Vac or 210Vac-250Vac at 50-60 Hz. By default, power supplies are shipped from the factory in the 105-125V position. Before energizing your power supply, verify that the line voltage selector switch is in the proper position for your mains input.

AC Line Plug:

The IEC 320 line plug receptacle accepts a three-wire female line plug for ac line power.

WARNING! This unit is equipped with a three-wire grounded line cord. This must be used with a three-wire receptacle where the "third wire" is connected to earth ground; otherwise personal injury or death may occur.

2.4 POLARITY REVERSING:

WARNING! Before attempting to reverse the power supply's polarity, the power supply must be turned off and the output fully discharged. Failure to follow these procedures may result in damage to the power supply, associated test equipment and/or personnel.

For 1kV to 5kV output models, a screwdriver-adjustable POLARITY SELECTOR SWITCH is accessible at the rear panel of the unit, next to the HV output connector. For 10kV to 50kV output models, the polarity of the HV output is reversible by means of an internal switching mechanism that is easily accessible upon removal of the top cover. The polarity reversal module is a clear plastic assembly identified by the exiting silicone high voltage cables. It is a two-part assembly. To change the polarity, turn off power supply, remove all cover screws holding the top cover on and:

- a. Remove the two diagonally opposed screws fastening the top portion of the module assembly to the bottom portion. NOTE: DO NOT DESOLDER WIRES OR PINS.
- b. Carefully separate the module by pulling the top portion from the bottom portion. The module portions are fitted very snugly and removal may be eased by slightly rocking the assembly.
- c. Rotate the top portion of the module assembly 180°, taking care not to unduly stress the high voltage cables.
- d. Rejoin the 2 portions of the module assembly. Make sure that the top portion is entirely seated to the bottom portion. NOTE: An interlock automatically insures that the high voltage cannot be applied until the portions of the module are properly mated.
- e. Re-secure the top portion to the bottom portion of the Polarity Reversal Module Assembly.
- f. Re-cover the power supply.

2.5 PREPARATION FOR USE

WARNING! Before energizing your power supply, thoroughly review and follow these procedures. Failure to do so may result in damage to equipment and injury or death to personnel.

To prepare the Series 205B for use, use the following procedure:

Set the Series 205B for the appropriate line voltage as specified in Section 2.3.

Connect a ground strap from case ground (on the rear panel) to a system common.

Select the appropriate HV output polarity for the application.

Set the front panel controls to:

- a. Power Switch - OFF
- b. Output Voltage Switch(s) – 0 (205B only).
- c. Multi Turn Digital Dial - 000 (fully counterclockwise)

Set the LOCAL/REMOTE (ANALOG/DIGITAL) rear panel switches (205B only) to:

- a. LOCAL for local front panel operation.
- b. REMOTE/ANALOG for remote analog operation. Note: Selecting the REMOTE control will override all local front panel controls of the output.
- c. REMOTE/DIGITAL for Computer Programming if equipped with a CBNY option. Reference Section 2.7.

Plug the line cord into the power line with a three-wire IEC receptacle to maintain proper case ground.

WARNING! This unit is equipped with a three-wire grounded line cord. This must be used with a three-wire receptacle where the "third wire" is connected to earth ground; otherwise personal injury or death may occur.

Connect the output of the Series 205B to the circuit. Use a properly rated shielded cable with the supplied HV output connector to insure good circuit connections and safe operation. Refer to Section 2.10.

WARNING! Prior to connecting or removing any equipment from the High Voltage power supply, always return the Output Voltage Control(s) to 0V prior to applying or removing power. External circuits may retain voltage after controls are set to zero. Discharge any residual voltage before connecting or removing any equipment.

2.6 LOCAL OPERATION

Turn POWER - ON to the instrument. Slowly increase the output voltage using the appropriate Voltage Control(s) until the desired output level is reached. Apply power to the load by switching the High Voltage - ON. The output will quickly reach the value set by the controls. Full stability will be achieved after approximately 30 minutes.

2.7 REMOTE OPERATION

PROGRAM CONTROL SWITCH:

Before the Series 205B can be remotely programmed, the instrument must be configured by setting the rear panel PROGRAM CONTROL SWITCH (S102) to the REMOTE ANALOG position. All monitoring and enable functions are active, independent of the S102 switch, as are the front panel meters. When in remote mode the front panel controls are inactive.

REMOTE PROGRAMMING:

The high voltage output can be remotely programmed from either an external voltage source or with an external potentiometer using the internal reference voltage source (Pin 4). A 0 to +5Vdc programming voltage applied to Pin 6 of J107 (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 4 (+5Vdc), Pin 7 (GND) and with the wiper connected to Pin 6 (PRGM INPUT). The potentiometer should be a low temperature coefficient wirewound or cermet type, 5k Ω to 20k Ω resistance values. The power supply output will be proportional to the programming input. The programming input impedance is greater than 1M Ω . TABLE 2.1 below lists the PROGRAMMING / MONITOR connector pin designations. The accuracy of the remote programming is detailed in the Specifications section.

TABLE 2.1 - J107 PIN DESIGNATIONS

<i>PIN #</i>	<i>FUNCTION</i>
1	Output voltage monitor, buffered, 0 to +5Vdc (output impedance 10k Ω)
2	No connection
3	Enable/Disable. Input logic zero <u>disables</u> high voltage generation. Open circuit or input logic one <u>enables</u> high voltage generation.
4	Precision +5Vdc reference output referenced to analog ground.
5	Output current monitor, buffered, 0 to +5Vdc (output impedance 10k Ω)
6	Remote analog voltage programming input, 0 to +5Vdc
7	Analog Ground
8	Digital Ground
9	Polarity Indicator

REMOTE ANALOG MONITORING:

Buffered, analog output monitors, 0 to + 5Vdc, linearly proportional to the power supply's voltage and current output are provided. To monitor the output voltage, connect a high impedance meter to pin 1 and pin 7 (ground). To monitor the output current, connect a high impedance meter to pin 5 and pin 7 (ground). The accuracy of the voltage and current monitors is given in the Specifications section. The monitor output impedance is approximately 10k Ω .

ENABLE/DISABLE:

A TTL level logic TRIP input signal can be used to enable or disable the power supply output remotely. Input logic zero or grounding pin 3 disables high voltage generation. Open circuit or input logic one on pin 3 enables high voltage generation.

+5Vdc REFERENCE OUTPUT:

A precision +5Vdc reference output is provided on pin 4 for the user's convenience. This fixed output can be used for remote resistance programming (see REMOTE PROGRAMMING, above) or various control functions. This output is referenced to analog ground (pin 7).

POLARITY INDICATOR:

A TTL polarity indicator output signal is available at pin 9. An NPN open collector connection with respect to digital ground indicates the high voltage output polarity. NPN saturation denotes positive polarity.

2.9 INPUT POWER

Input AC line voltage required is 115Vac/230Vac \pm 10%, 50-60Hz, single phase. The recessed LINE VOLTAGE selector switch on the rear panel selects either 115 Vac or 230 Vac operation. By default, power supplies are shipped from the factory in the 115Vac position. Before energizing your power supply, verify that this switch is in the proper position for your mains input.

2.10 CURRENT LIMITING

The Series 205B includes a current limiting circuit that drops the output voltage to a safe level when the rated output current is exceeded by approximately 5%. (See specification on Current Capability when operating the unit at reduced output voltages or when operating in a current limit mode for capacitor charging).

2.11 HIGH VOLTAGE OUTPUT

The high voltage output connector is located on the rear panel. An appropriate shielded mating connector is supplied with each unit. These connectors are as listed in Table 2.3. Refer to pages 13-16 for the mating connector assembly instructions. Only the proper mating connector should be used with the indicated power supply and the power supply should never be energized without a mating connector and suitable load connected.

TABLE 2.3: SERIES 205B HIGH VOLTAGE CONNECTORS

MODEL	OUTPUT	MATING
-01R	JDK	PDB
-03R	JDK	PDB
-05R	JDK	PDB
-10R	JJA	405787
-20R	JJA	405787
-30R	JJA	405787
-50R	JJB	405786

SECTION 3 - THEORY OF OPERATION

3.1 FUNCTIONAL DESCRIPTION

The circuit uses a DC to DC converter that 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 oscillator 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 that 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 high voltage output.

3.2 CIRCUIT DESCRIPTION

The input AC line is converted to the B+ (36Vdc) supply and regulated +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 (+12Vdc) consists of a rectifier circuit located on T1 and output regulators located on the PCB 100.

The output of the oscillator circuit is amplified in the AGC amplifier. The gain of the AGC 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 circuit 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 signal from the output voltage sense circuit. Any difference causes a correction in the gain control of the AGC 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 4 - MAINTENANCE

4.1 GENERAL

The Series 205B instrument should not require any maintenance. It is designed for reliable, trouble free operation. If any question should arise, contact the Bertan Customer Service Department for assistance or return authorization. It is suggested that the unit be returned to the factory if service should become necessary.

4.2 CLEANING

Cleaning of the power supply should *only* be performed with the supply disconnected from the ac power source. A soft cloth moistened with conventional ammonia-based cleaning agents will suffice for all exposed surfaces. The metal shell of the HV connector should be cleaned with isopropyl alcohol.

If the supply is operated in a dusty environment, an accumulation of dust/debris may build-up inside the unit which may cause noisy operation (i.e., “ticking” or minor crackling) in the area of the HV cabling on the –10R through –50R. The safest way to remove such debris is with compressed air. Ensure that no dust/debris is left behind in the insulative medium of the HV output connector after this cleaning operation. Such dust may be removed with a cotton swab moistened with isopropyl alcohol.

4.3 CALIBRATION SERVICES

Your BERTAN high voltage power supply is designed to provide many years of reliable service. For a nominal charge it can be returned to the factory for calibration and certification 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 (NIST). Calibration is guaranteed from 1 year of issuance. Contact the factory at 1-800-966-2776 or your local sales representative for additional details. For a list of local representatives and other information go to our website at www.bertan.com. You may also email us at support@bertan.com.

SECTION 5 - SPECIFICATIONS

Output Voltage/Current Capability:

<u>MODEL:</u>	<u>OUTPUT:</u>
205B-01R	1kV@30mA
205B-03R	3kV@10mA
205B-05R	5kV@5mA
205B-10R	10kV@2.5mA
205B-20R	20kV@1mA
205B-30R	30kV@500 μ
205B-50R	50kV@300 μ A

Line Regulation:

$\pm 0.001\%$ maximum for a $\pm 10\%$ line change.

Load Regulation:

$\pm 0.005\%$ for a NL-FL or FL-NL change.

Ripple (maximum @ max Vout, max Iout):

<u>MODEL:</u>	<u>RIPPLE (pk-pk):</u>
205B-01R	10mV
205B-03R	30mV
205B-05R	50mV
205B-10R	100mV
205B-20R	300mV
205B-30R	400mV
205B-50R	2V

Temperature Coefficient:

50ppm per $^{\circ}$ C

Stability (after 30min. warm-up):

0.01% per hour, 0.02% maximum per 8 hours (of maximum rated voltage).

Ambient Temperature Requirements:

Storage: -40° C to $+85^{\circ}$ C.

Operating: 0° to $+50^{\circ}$ C.

Humidity:

<90%, non-condensate

Current Capability:

The maximum current rating for each model, as shown in the table to the left, is applicable when the unit is operated at maximum output voltage. When operated at reduced output voltage levels, or when operating in a current limit mode for charging capacitors, the output current must be

limited to reduced levels. This is required to protect against excessive power dissipation of the driver transistors.

The maximum output current must be linearly derated from 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:

$$I_{max} = V_{set}(.7I_{rated}/V_{rated})+.3I_{rated}$$

When operating the power supply as a capacitor charger (i.e., a capacitor is being continuously discharged then recharged from zero voltage by the power supply) use a charging resistor in series with the power supply output. The resistance should be equal to the power supply's maximum rated output voltage divided by the maximum rated output current.

The above derating factors are safe for all conditions and all models. Consult BERTAN for special cases before exceeding these factors.