Instruction Manual
THERMO EC
EC2060/EC3000-90/ EC600-90/6000-90
Series 90 Power Supplies

⚠ WARNING ⚠

Please read these instructions carefully before using this power supply.

⚠ AVERTISSEMENT ⚠

Veuillez, avant tout emploi du générateur, lire attentivement ce manuel d´utilisation.

Thermo EC

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Thermo EC

A Thermo Electron business

159-3037-00 Rev. A ©02/01 Printed in USA

⚠ WARNING

This power supply is designed for use as a source of DC power for electrophoresis. It is capable of generating lethal currents. Use the same precautions as with any electrical device. Do not operate without the cover in place. Do not connect the output to earth ground. Do not operate in a damp, humid, environment where condensing moisture may short out internal electrical components. Do not operate with connecting cables which have exposed live wires. Follow all appropriate safety measures outlined by the chamber manufacturer.

⚠ AVERTISSEMENT

Ce générateur a été conçu pour être utilisé comme source de courant (DC) pour l´électrophorèse, et il est capable de générer un courant mortel. Prenez les mêmes précautions que pour tout autre appareil électrique. N´utilisez pas l´appareil sans que le couvercle de la chambre soit placé. Ne raccordez pas les sorties à la terre. N´utilisez pas l´appareil dans des environnements humides, où la condensation pourrait causer des dommages aux composants électriques internes. Ne mettez pas l´appareil en route avec des câbles ou partie de câble dénudé. Ne retirez pas les câbles des sorties de 4 mm pendant que l´appareil est en fonctionnement. Prendre toutes les précautions recommandé par le fabriquant de la chambre d´électrophorèse.

SAFETY NOTICES
NOTICES DE SÉCURITÉ

⚠ WARNING: This notice alerts you to a potentially dangerous situation.

⚠ AVERTISSEMENT: Cette notice attire votre attention sur des dangers potentiels.

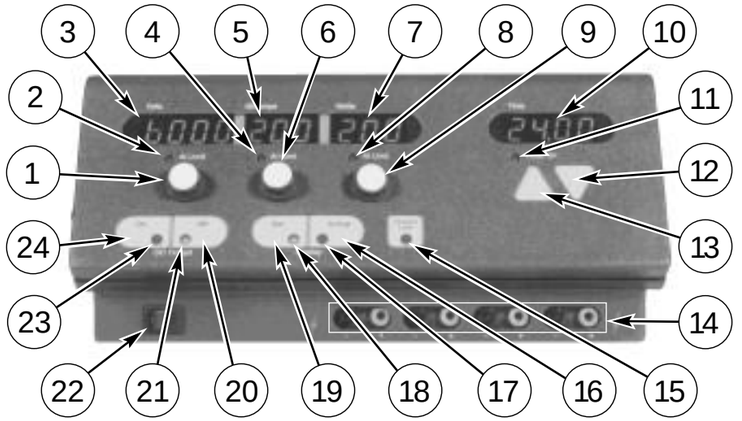
⚠ CAUTION: This notice means serious damage may occur to your power supply or chamber.

⚠ ATTENTION: Cette notice attire votre attention sur des dangers sérieux pour votre générateur ou votre chambre d´électrophorèse.

NOTE: This notice gives useful advice or suggestions to raise the performance or reliability of your power supply.

NOTE: Cette notice vous donne des conseils vous permettant d´augmenter la performance et la fiabilité de votre générateur.

THERMO EC HIGH VOLTAGE POWER SUPPLIES



1. Volts adjustment knob
2. Yellow At Limit light (Volts)
3. Volts display
4. Yellow At Limit light (Milliamps)
5. Milliamps display
6. Milliamps adjustment knob
7. Watts display
8. Yellow At Limit light (Watts)
9. Watts adjustment knob
10. Time display
11. Yellow Timer On light
12. Arrow Down key to adjust the timer
13. Arrow Up key to activate and to adjust the timer
14. 4 mm sockets
15. Red Ground Leak light
16. Actual Display key
17. Yellow Actual Display light
18. Yellow Set Display light
19. Set Display key
20. D.C. Output Off key.
21. Green D.C. Output Off light
22. Power On / Off switch
23. Red D.C. Output On light
24. D.C. Output On key

1. The voltage applied to both Cell "A" and Cell "B" is 100 volts. (Rule 1)
2. The sum of the currents flowing through Cell "A" and Cell "B" is equal to 60 milliamps. (Rule 3)

Switch off the power supply and momentarily disconnect Cell "B". Switch the power supply back on and note how the output current reading drops to 35 milliamps. From this, the following information can be derived.

1. The current flow through Cell "B" is equal to 60 milliamps, minus 35 milliamps, i.e., a net value of 25 milliamps. (Rule 3)
2. The reason Cell "A" and Cell "B" have different current readings is due to the difference in resistance between Cells "A" and "B". (Rule 2)

GUARANTEE

This laboratory equipment was produced by Thermo EC with the highest practical standards of materials, workmanship, and design. The design and manufacture of parts have been conceived with one purpose — to produce a unit which will give satisfactory service.

Thermo EC guarantees this unit to be free from defects in materials or workmanship under normal use or service for four years from date of shipment. If, during this time, this unit proves defective in materials or workmanship, the Company will repair or replace it free of charge if returned to us prepaid. This guarantee does not cover damage in transit, damage caused by carelessness, misuse or neglect, or unsatisfactory performance as a result of conditions beyond our control or consequential losses as a result of failure of our product.

TABLE OF CONTENTS

INTENDED USES

This power supply is intended to be used with electrophoretic devices which operate below the rated output levels listed below. The maximum output levels are shown for each model using this instruction manual. Four sets of output connectors operate in parallel to provide an output of constant voltage, constant current (milliamps) or constant power (watts).

- Model EC600-90 4000 V, 300 mA, 300 W
- Model EC2060 2000 V, 600 mA, 300 W
- Model EC3000-90 3000 V, 300 mA, 300 W
- Model EC6000-90 6000 V, 200 mA, 200 W

SET-UP

Unpacking of the Unit: Unpack and inspect the power supply carefully for any damage. Do not use the unit if it is damaged. If damage is found, save the packing material and report the problem to Thermo EC or your local distributor.

Location: Make sure that the unit is set up in a location where it is protected from physical damage, moisture, corrosive agents and extreme temperatures, and make sure that the "fins" at the rear are not obstructed. The unit should be readily accessible for safe operation.

Connection with the AC Mains: Connect the unit to the AC mains carrying the appropriate specified voltage (V) in accordance with the rating label located at the rear of the unit. Make sure that the mains receptacle and the power supply plug both have the proper 3–wire (grounded or earthed) connections.

BASIC OPERATING INSTRUCTIONS

(See fold out locator guide on last page)

Notes on General Operation: The output of this power supply is controlled by three separate operating limits. An operating limit, with a value above zero, must be set for voltage, milliamps and watts in order to generate an output. Once activated, the output of the power supply will then increase until an operating limit is reached. When this occurs, one of the three yellow At Limit lights will be illuminated. This light will indicate which operating limit has been reached and which mode of control (constant volts, current or power) has been established. The detailed instructions contained in this manual refer to adjustment for operation in constant voltage. In principal, the method is the same for any mode of operation; only the value of operating limits change.

For added convenience, this power supply will restart itself in the event of a power failure. This will not reset the operation of the count–down timer.

APPENDIX A. Relationships Between Volts, Milliamps, Watts and Chamber Resistance

There are three fundamental concepts which form the basis for understanding the relationship between volts, milliamps and chamber resistance. When combined with the power formula they also define watts.

1. A movement of free electrons from atom to atom forms an electric current which is measured in milliamps (mA) or amps (A).
2. Electrostatic lines of force between two different charges produce a pressure that can move electrons (measured in volts).
3. All substances oppose the movement of electrons to some extent and are said to have resistance (measured in ohms).

These three factors are always present in any operating electric circuit. It is possible to incorporate them into one inclusive statement:

Ohm's Law

The value of the current that will flow in any circuit will be directly proportional to the value of the voltage applied and inversely proportional to the value of the resistance.

or

amps = volts / resistance

combined with

The power formula:

volts x amps = watts

(where 1 amp = 1000mA)

Together, these two formulas define all aspects of the relationship between volts, milliamps, watts and chamber resistance.

APPENDIX B. Running Multiple Chambers

This power supply is equipped with four sets of 4 mm output connectors which are connected in parallel. The significance of this is explained by following statements:

1. The voltage is applied equally to all branch paths in a parallel circuit.
2. The current flow in the branch paths of a parallel circuit is determined by the resistance of the individual paths.
3. The sum of the currents entering the branch paths of a parallel circuit is equal to the sum of the currents leaving the branch paths of a parallel circuit.

A practical example of this is described as follows:

The power supply is connected to two identical horizontal submarine electrophoresis chambers (cells A and B). The power supply output is adjusted to 100 volts, at constant voltage, and the current display indicates 60 milliamps. By applying the three rules for parallel circuits we can determine the following information.

SPECIFICATIONS

High Voltage Power Supplies (refer to page 2 for models)

Type Output:	Constant Voltage, Constant Watts or Constant Milliamps with automatic crossover
Maximum Voltage:	2000 – 6000 Volts, (depending on model)
Maximum Current:	200 – 600 Milliamps (depending on model)
Maximum Power:	200 – 300 Watts (depending on model)
Regulation:	≤ 1%
Accuracy:	± 1.5% full scale for each display
Number of Output Terminals:	Four recessed sets of 4 mm sockets
Safety Interlock:	Load sensing shut-down-on-disconnect. D.C. Output On key actuation necessary to begin voltage generation. In the event of shutdown due to power interruption, automatic restart is provided.
Timer:	00 to 99 hrs. 59 min.
Ground Leakage:	Leakage of 400 microamps or more will interrupt the generation of high voltage.
Input Power:	115 VAC / 60 Hz. / 400 W 230 VAC / 50 Hz. / 400 W
Ambient Operating Temperature Range:	0 ° – 30 °C (non-condensing atmosphere)
Dimensions:	11.25″ (D) x 12.6″ (W) x 5″ (H) 28.6 cm x 32 cm x 12.7 cm
Weight: net:	15.4 lbs. 7 kgs.
shipping:	17 lbs. 7.7 kgs.

BASIC OPERATING INSTRUCTIONS

(See fold out locator on last page)

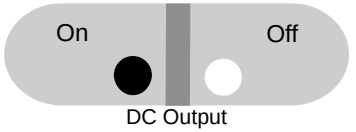
Operation in Constant Voltage:

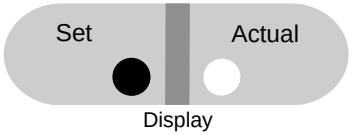
Locator Number

1. The electrophoresis chamber should first be set up, then filled with buffer and sample, before plugging the chamber's leads into the appropriate positive and negative 4 mm sockets (14) on the power supply. — 14

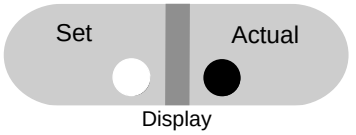
NOTE: *An alterntive procedure favored by some users is as follows: Sample is withheld from the chamber until the power supply has been properly adjusted and successfully started. Once the user has confirmed that the chamber and power supply are both functional, the power supply is turned off and sample is loaded. The power supply will remember its settings, so it can be turned on and started without further adjustment.*

2. Switch on the power supply using the Power On / Off switch (22). The main power switch is marked with a 1 to indicate on and a 0 to indicate off. Once on, the Green D.C. Output Off light (21) and Yellow Actual Display light (17) will be illuminated. The Volts display (3), Milliamps display (5) and Watts display (7) will all indicate zero. The Time display (10) will indicate zero as well. — 22, 21, 17, 3, 5, 7, 10





3. Gently press the Set Display key (19). The actual switch itself is located in the grey area located immediately below the word "Set" in the Set Display key. When pressed, there will be a tactile sensation, the power supply will beep and the Yellow Set Display (18) light will be illuminated. Each key on — 19, 18



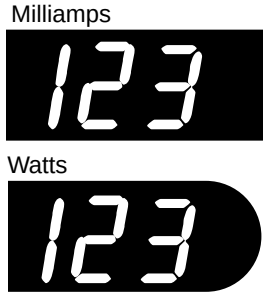
this power supply has a similar switch location and sensory cue upon activation.

4. Using the Volts adjustment knob (1), select the operating voltage limit by turning the knob until the desired value appears on the Volts display (3). Rotating the knob slowly in the clockwise direction will increase the displayed value in one–volt increments. Rotating the knob slowly in the counterclockwise (anticlockwise) direction will reduce the displayed value in the same manner. Rotating the same knob (1) rapidly in either direction will cause the displayed value to change in ten–volt increments.

1, 3

5. Using the Milliamps Adjustment knob (6) and Watts Adjustment knob (9), select the desired operating limits for milliamps and watts, respectively. The method used to select these values is the same as that used to select the operating voltage limit.

6,9



NOTE: *Each adjustment knob has a RAPID ADJUSTMENT MODE which is activated whenever the knob is rotated rapidly.*

CHOOSING SAFE OPERATING

WARNING: *This power supply is capable of producing output levels well in excess of the maximum safe operating limits for most electrophoretic chambers. For this reason, it is important to determine the safe operating limits for milliamps and watts. The section entitled "Choosing Safe Operating limits" has been included to guide the user in selecting proper operating limits. This section details both the method and rationale used in selecting these operating limits.*

Erratic Operation: Unstable, erratic displays, inoperable timer and / or adjustment knobs are all possible symptoms of corrupted memory. To clear this condition turn off the power supply, depress and hold any key and turn the power supply back on before releasing the key.

Ground Leakage: Ground leakage is the interconnection of earth ground and either high voltage output. This interconnection will defeat the primary operator safety feature of this power supply. Do not operate the power supply when this condition exists. For further assistance, call the telephone number listed in the service section or contact your local distributor.

NOTE: If this power supply experiences an electrostatic discharge of ≥ 8000 volts an overcurrent message will be displayed and DC output will shut down.

WARNING
This power supply is not equipped with any user serviceable parts.

SERVICE

Contact Thermo EC for technical assistance if problems occur. The telephone numbers are 631-244-2929, 1-800-EC-RANGE (toll free U.S.).

C. Ground Leakage Detected: A continuous tone accompanied by the illumination of the ground leakage light. The voltage and wattage displays will hold their last value. The milliamps display will go blank. (See below "Ground Leakage")

D. Power On Restart: Nine short bursts in groups of three each with each output display showing decimal points. This alarm activates to alert the operator to the fact that auto-restart will occur at the end of a mains power failure. The alarm will clear itself.

E. Overheating Detected: A continuous tone accompanied by flashing displays. This alarm indicates the heatsink, located at the rear of the unit, has exceeded safe operating temperatures. Momentarily turning off the power supply will clear the alarm. (See Service)

F. Mains Overload: A continuous tone accompanied by flashing displays. This alarm is indistinguishable from the "Overheating detected" alarm. It indicates an internal fault or a temporary surge in the mains supply. Momentarily turning off the power supply will clear the alarm. (See Service)

Unit Will Not Start: This power supply is equipped with a load sensing interlock which is designed to inhibit the generation of high voltage whenever an open connection is detected at the output.

Open Connection: An open connection is defined as a break in the path in which electricity normally flows. This could be caused by any of the following conditions:

1. A broken electrode within the electrophoretic chamber.
2. A broken wire within the connecting cord (either positive or negative).
3. Insufficient buffer levels within the electrophoretic chamber.
4. Loose connectors in any electrical connection going to or coming from the power supply or chamber.
5. Electrochemical energy stored within the chamber. (See below, "Unit Will Not Restart")

Unit Will Not Restart: Certain types of electrophoretic techniques will, over a period of time, store energy within the electrophoretic chamber. This charge may inhibit the normal function of the load sensing interlock when attempting to restart an experiment which has been temporarily interrupted. To overcome this effect depress and hold the D.C. Output On key until the power supply reaches its proper operating voltage. Upon releasing the D.C. On key the power supply should remain engaged. If it will not remain engaged refer to the section entitled "Unit Will Not Start".

No Displays Light: This power supply is equipped with 2 circuit breakers located at the rear of the instrument. If either circuit breaker is activated the power supply will not turn on. When activated, the circuit breakers expose a white stem.

6. Gently press the D.C. Output On key (24). The Red D.C. Output On light (23) should illuminate and the D.C. output as indicated by the three displays (3, 5, 7) should rapidly increase until the operating voltage limit is reached. At this point the Yellow At Limit light (volts) (2) should be the only "at limit" light illuminated.	24, 23, 3, 5, 7, 2	 DC Output

NOTE: *The power supply output may be adjusted while operating. If you turn any of the three adjustment knobs while the D.C. Output On light is illuminated, the power supply will automatically switch to the Set Display Mode. Each display will show the set operating limit while in this mode and new limits may be set. One second after releasing the adjustment knob the power supply will revert to the Display Actual Mode.*

Operation in Constant Current: The method used to set the power supply in constant current is the same as the method used for constant voltage. The only difference involves the selection of an operating limit for current which, as the output increases, is attained before the operating limits for voltage or watts.

Operation in Constant Watts: The method used to set the power supply in constant watts is the same as the method used for constant voltage. The only difference involves the selection of an operating limit for watts which, as the output increases, is attained before the operating limits for voltage or current.

LIMITS

Electrophoretic chambers are generally designed for a relatively specific purpose. For example, horizontal chambers use agarose gels to separate DNA or RNA fragments while a DNA Sequencing chamber is almost always used to separate DNA in a denaturing polyacrylamide gel. In each case, the voltage, milliamp and wattage requirements are well–defined within a reasonable range of values. In cases such as these, the user can safely assume that the manufacturer has designed the chamber to withstand the voltage and heat energy necessary to perform the electrophoretic separation when standard protocols are followed.

Some types of electrophoretic chambers are specifically designed to be multipurpose devices. For example, a vertical slab gel chamber could be used for anything from DNA Sequencing to Isoelectric Focusing depending on the gel type and buffer system used. Choosing safe operating limits for a chamber of this type requires a

higher degree of caution. Chamber manufacturers normally rate their product for maximum voltage and/or maximum wattage. Whenever possible, contact the manufacturer and request this information. It is the safest method of determining if a chamber is suitable for a particular procedure.

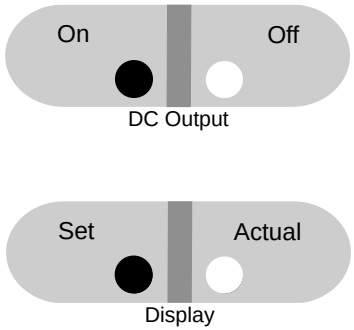
Whether you use special purpose or multipurpose chambers, the maximum operating temperature the chambers will withstand is a critical aspect of safe operation. Most electrophoretic chambers (with a few notable exceptions) are made of acrylic plastic and must operate well below a temperature of 55 °C. If there is a lack of information about the capabilities of the chamber being used, regular monitoring of the operating temperature is recommended. This should be done without coming into physical contact with the chamber when voltage is applied. Use the procedure listed below to select operating parameters.

PROCEDURE:

(See fold out on last page)

1. The electrophoresis chamber should first be set up, then filled with buffer and sample, before plugging the chamber's leads into the appropriate positive and negative 4 mm sockets (14) on the power supply.	14

NOTE: *An alternative procedure favored by some users is as follows: Sample is withheld from the chamber until the power supply has been properly adjusted and successfully started. Once the user has confirmed that the chamber and power supply are both functional the power supply is turned off and sample is loaded. The power supply will remember its settings, so it can be turned on and started without further adjustment.*

2. Switch on the power supply using the Power On/Off switch (22). Once on, the Green D.C. Output Off light (21) and Yellow Actual Display light (17) will be illuminated. The Volts display (3), Milliamps display (5) and Watts display (7) will all indicate zero. The Time display (10) will indicate zero as well.	22, 21, 17, 3, 5, 7, 10	

TROUBLESHOOTING GUIDE

Unit Alarms: This power supply is equipped with both audible and visual alarms. Items A through F listed immediately below are graphical representations of each alarm mode. To understand which alarm has been activated and why, match the letter (A-F) to the corresponding text below.

Alarm Tones and Displays:

A. Tone Pattern:

Display Pattern: noLoAD

B. Tone Pattern:

Display Pattern: o o o

C. Tone Pattern:

Display Pattern: LAST VALUE | GOES BLANK | LAST VALUE

Ground Leakage: Ground Leak

D. Tone Pattern:

Display Pattern: . . . . . .

E. Tone Pattern:

Display Pattern: FLASHING | FLASHING | FLASHING

F. Tone Pattern:

Display Pattern: FLASHING | FLASHING | FLASHING

A. Open Connection: A continuous tone which is generated as soon as the D.C. Output On key is depressed. The displays will spell noLoAD. Depressing D.C. Output Off key will cancel the alarm mode. (For cause see, "Unit will not start".)

B. Timer At Zero: Nine short bursts in groups of three followed by the D.C. Off light illuminating. The three output displays will indicate zero. This indicates that the set time interval has expired.

SETTING AND RESETTING THE TIMER (See fold out locator on last page)

⚠ **Notes on Timer Operation:** This power supply is equipped with a multi-function timer. In the passive mode the timer accrues elapsed time whenever the D.C. On light is illuminated. The elapsed time resets to zero whenever the D.C. Off light is illuminated or the mains power is switched off. To function as a count–down timer, a time interval must be set using the up / down arrow keys. Each arrow key adjusts the timer in a single direction. For convenience, the time increments switch from minutes to hours after continuously depressing either key for several seconds. Once set, the timer will count down whenever the D.C. On light is illuminated. The Timer On light will illuminate whenever the count–down mode is activated. Upon reaching zero time remaining, the power supply will sound an alarm and switch off the output. After timer goes to zero it will reset itself to the original time. To disable the count–down mode of operation the time interval must be reset to zero.

Setting:

1. Switch on the power supply using the Power On / Off switch (22). Once on, the Green D.C. Output Off light (21) and the Yellow Actual Display light (17) will be illuminated. The Volts display (3), Milliamps display (5), and Watts display (7) will all indicate zero.
2. Gently depress the center of the Arrow Up key (13). When pressed there will be a tactile sensation and the time shown on the Time display (10) will begin to increase. Continue depressing the Arrow Up key until the Time display indicates the desired time interval.

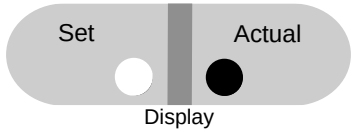
Note: *For convenience, the incremental changes in time switch to hours after continuously depressing either Arrow key for several seconds.*

3. Confirm that all operating limits are correct, the power supply is properly connected to the electrophoretic chamber and gently depress the D.C. Output On key (24). Once on, the Red D.C. Output On light (23) and the Yellow Timer On light (11) will be illuminated and the timer will begin counting down.

Resetting:

1. Switch on the power supply using the Power On / Off switch (22). Once on, the Green D.C. Output Off light (21) and the Yellow Actual Display light (17) will be illuminated. The Volts display (3), Milliamps display (5), and Watts display (7) will all indicate zero.
2. Gently depress the center of the Arrow Down key (12). When pressed there will be a tactile sensation and the time shown on the Time display (10) will begin to decrease. Continue depressing the Arrow Down key until the Time display indicates zero time remaining.
3. Confirm that all operating limits are correct, the power supply is properly connected to the electrophoretic chamber and gently depress the D.C. Output On key (24). Once on, the Red D.C. Output On light (23) will be illuminated and the timer will begin accruing elapsed time.

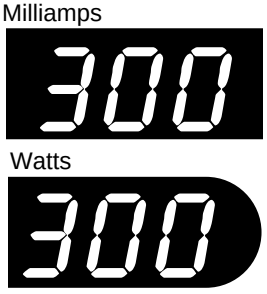
3. Gently press the Set Display key (19). The actual switch itself is located in the gray area located immediately below the word "Set" in the Set Display key. When pressed there will be a tactile sensation, the power supply will beep and the Yellow Set Display (18) light will be illuminated. Each key on this power supply has a similar switch location and sensory cue upon activation. — 19, 18



4. Using the Volts adjustment knob (1), select the operating voltage limit by turning the knob until the desired value appears on the Volts display (3). Rotating the knob slowly in the clockwise direction will increase the displayed value in one–volt increments. Rotating the knob slowly in the counterclockwise (anticlockwise) direction will reduce the displayed value in the same manner. Rotating the same knob (1) rapidly in either direction will cause the displayed value to change in ten–volt increments. — 1, 3

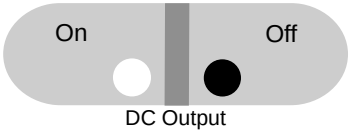
NOTE: *Each adjustment knob has a RAPID ADJUSTMENT MODE which is activated whenever the knob is rotated rapidly.*

5. Using the Milliamps and Watts adjustment knobs (6, 9), select the maximum operating limits of 300 milliamps and 300 watts respectively. — 6, 9



6. Gently press the D.C. Output On key (24). The Red D.C. Output On light (23) should illuminate and the D.C. output as indicated by the three displays (3, 5, 7) should rapidly increase until the operating voltage limit is reached. At this point the Yellow At Limit light (volts) (2) should be the only "at limit" light illuminated.

24, 23, 3, 5, 7, 2



7. Once the power supply has reached the operating voltage limit, note the actual values displayed for milliamps and watts.

8. Add 10 watts and 15 milliamps to the actual values noted above.

9. Rotate the Milliamps Adjustment Knob (6). The power supply will automatically switch to the Display Set Mode and the Yellow Set Display light (18) will be illuminated. Adjust the Milliamps Adjustment Knob downward until the new limit value has been achieved. Repeat this process with the Watts Adjustment Knob (9) . Once set to the new operating limits, the power supply will automatically return to the Actual Display Mode and the Yellow Actual Display light (17) will be illuminated.

6, 18, 9, 17

NOTE: *It may be necessary to readjust the watt or milliamp operating limit during the course of the separation process to ensure that the entire procedure is performed at a constant voltage. This readjustment, if necessary, is required to compensate for large changes in resistance which occur during certain types of electrophoresis.*

NOTE: Utilizing Automatic Crossover

Certain electrophoretic techniques require the careful adjustment of operating limits to utilize a function of this power supply known as automatic crossover. Automatic crossover is a method used when the experiment requires two or more modes of operation during the course of the experiment.

The most common example of a technique which requires this function is semi-dry electrophoretic transfers of proteins or nucleic acids. Semi-dry transfer chambers consist of two closely spaced parallel plates which serve as electrodes. Positioned between these plates is a sandwich consisting of buffer–saturated filter paper sheets on the outside and the gel and charged membrane on the inside. Typically, the transfer process is most efficiently accomplished by applying a constant current flow between the two plates. As the transfer progresses, the buffer in the filter paper begins to break down. This leads to an increase in overall resistance between the two plates.Since the power supply is trying to maintain constant current, it increases the voltage output to compensate for the increased resistance. Left unchecked, the increasing voltage would eventually reach a potential great enough to arc over between the plates, resulting in damage to the chamber and experiment failure.

Automatic crossover can be used to prevent this unfortunate incident from occurring. Set an operating limit for voltage at a value below the arc–over threshold (for example, a limit that is 10% above the starting voltage). As the voltage increases during the experment, it will eventually reach the operating limit for voltage and "automatically crossover" to constant voltage operation. At this point, the current will start to drop as the buffer breaks down, but the experment and chamber will be unharmed.