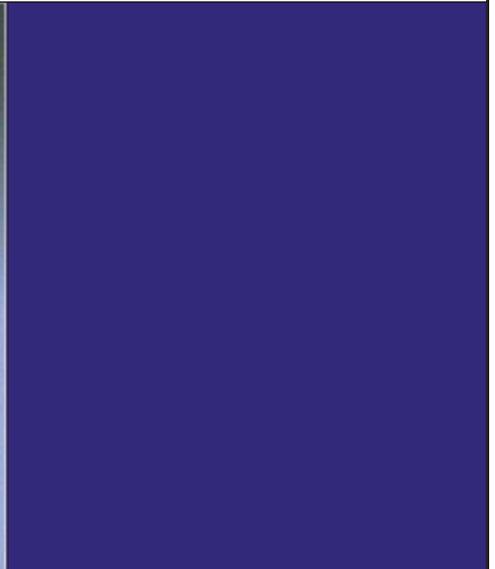
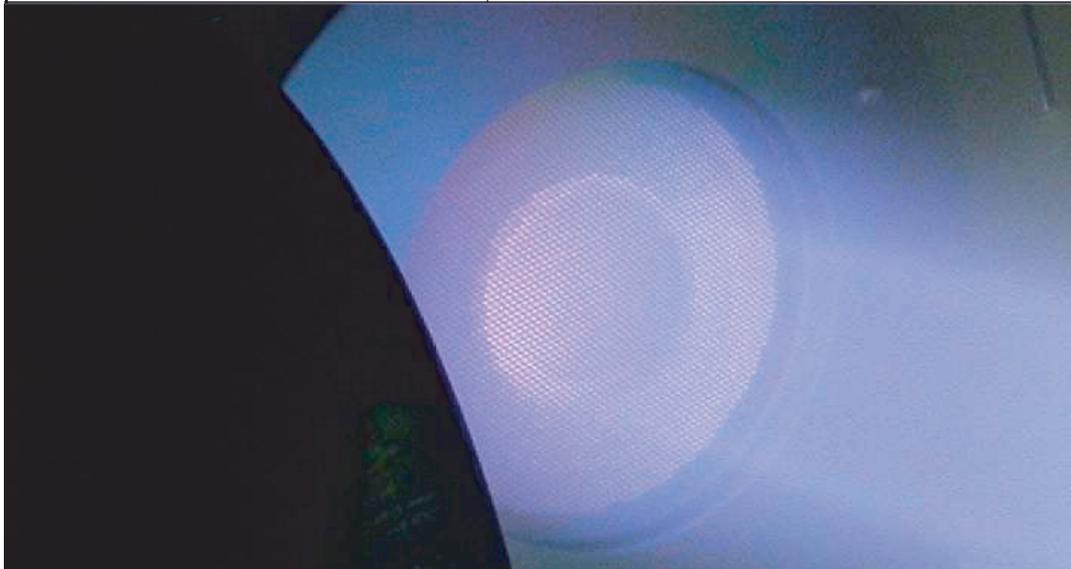




# **IBS 250 Power Supply**

**Technical Manual**



# **IBS-250**

Power Supply

Technical Manual



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**Veeco Instruments, Inc.**

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# Chapter 1: Safety



Understanding the correct installation, operation, and maintenance procedure is necessary for safe and successful operation. This safety alert symbol precedes safety messages in this manual, along with one of the three signal words explained below. Obey the messages that follow these words to avoid possible injury or death.



This symbol marks an imminent hazard which will kill or injure if ignored.



This symbol marks a potential hazard which may kill or injure if ignored.



This symbol marks a potential hazard which may cause minor injury if ignored.



This symbol marks a potential hazard which may cause damage if ignored.

Please read the following before continuing:



**To avoid electrical shock, keep clear of “live” circuits. Follow all local lock-out/tag-out procedures, before repairing or replacing any electrical devices.**

It is recommended that only trained, qualified persons using established safety procedures perform any work related to the installation, start-up, operation or maintenance of this system.



**To avoid electrical shock, check that all hardware interlocks are working. Keep all guards and panels in place during routine system operation.**

Complete ion beam systems from Veeco Instruments, Inc. are supplied with hardware interlocks and software safeguards at various points in the system. Whenever components or retrofits are added to existing systems, a local review of system safety is recommended.

  
 **WARNING**

Operation involves high voltages within the enclosure and at the output of the power supply. The equipment contains electrical interlocks to protect personnel from injury. An interlock system prevents the operation of the high-voltage power supplies while the top or back panels of the unit are removed. Do not defeat, override, or bypass the interlocks.

Disconnect the supply from the power main and ensure reconnection is impossible before opening the power supply enclosure.

Certain electrical components, such as electrolytic capacitors, may hold a lethal voltage after power is disconnected. Discharge all stored-energy sources by grounding the leads to the devices and verify the discharged status before working on the power supply.

The hinged front panel of the IBS-250 is not interlocked, and can be opened while the power supply is functioning. Voltages accessible inside the front panel are less than 30 volts. Care should still be exercised when the front panel is open.

  
 **WARNING**

Damage may result to the anode and magnet assembly of the ion source if the discharge current exceeds 2.5A at 40V and/or the cathode current exceeds 8.5A for the 3cm ion source.

# Chapter 2: Introduction

## Description

The IBS-250 Power Supply is a microprocessor-controlled switching power supply intended to drive gridded ion beam sources. It is compatible with Kaufman type permanent magnet ion sources, such as the 3cm and 8cm sources. It is designed for reliability and flexibility of operation. It is designed for production applications with the added capability of being suitable for a flexible research environment and provides up to 1500 eV ions in a 250 mA beam.

The unit is fully programmable, with the capability of storing 99 sets of operating parameter values or "recipes." Remote operation and programming are possible through an optional handheld terminal or a personal computer with an RS-232 interface.

The six individual power supplies within the unit provide current limiting circuits for overload protection. The cathode and neutralizer supplies feature programmable current limiters to prevent inadvertent damage to filaments in smaller ion sources.

## Mode of Operation

The IBS-250 can be operated in three modes:

- Manual unrestricted
- Automatic unrestricted
- Automatic restricted

The unrestricted modes allow operating parameters to be changed by the user. The restricted mode allows operation only by means of recipes (sets of stored parameters) and is provided for production applications in which the operator intends to modify the operating parameters. Transitions between restricted and unrestricted modes are effected by means of the handheld or remote PC terminals.

Manual mode provides direct, independent operation of the individual power supplies within the unit. This mode is useful for test and troubleshooting purposes.

Automatic mode uses feedback loops to dynamically maintain specified set points and relationships. For example, the cathode filament current is automatically varied to maintain the chosen beam current.

# Chapter 3: Installation

## Mounting

The IBS-250 may be rack or table mounted. It must be positioned to allow the free flow of air to the air vents at the rear of both side panels. The air intake is on the left side and the air exhaust is on the right side. The unit should be mounted at eye level or below for optimal viewing angle of the LCD displays.

## Electrical

The unit is factory wired for 208V  $\pm$ 5% operation. The electrical supply service must be capable of at least 10 amperes.

## Grounding

The power supply chassis must be connected to an earth connection, through the ground screw on the rear of the power supply. The supply has a common ground through which the ion source and supply are grounded. The shielded output cable provides an operating ground for the ion source and an earth ground to be connected to the vacuum system at a convenient ground point such as a flange bolt. The three wire power main provides the ground connection to the supply.

## Ion Source Connections

Connect the supplied cable to the ion source in accordance with [FIGURE F.1](#). Connect the cable to its corresponding connector on the rear of the power supply.

## Interlock Control

To prevent operation at high pressure, Veeco provides two pressure interlocks on complete systems, i.e., vacuum chamber, pumps, stage, controls, etc.

## Chapter 4: Electrical Description

This section provides a general description of the installation of an ion source and should be useful as background information.

A schematic diagram of a typical installation of a 3 cm ion source is shown in [FIGURE 4.1](#). The various currents and voltages indicated in [FIGURE 4.1](#) should be available to the operator. The cathode and neutralizer are typically heated with alternating-current supplies. The “ct” in these supplies is the center tap of the secondary winding that provides the heating power.

Power-supply units have ground connections to meet safety requirements. An additional ground connection, shown in [FIGURE 4.1](#), is necessary to avoid the possible adverse effects of ground-loop currents on ion source operation.

The operation of the 3 cm ion source can be described in summary form with reference to the schematic diagram of the ion source in [FIGURE 4.1](#). A pressure, at or above the minimum value required for operation, is established by a gas flow into the discharge chamber. An electrical discharge between the cathode and anode then generates positively charged ions. The effective origin potential for these ions is the anode potential. Ions are extracted from the discharge chamber, through the apertures in the screen grid, by the negative accelerator grid. Because the apertures in the two grids are aligned, the extracted ions do not strike the accelerator grid during typical operation, but continue on to form the ion beam. Electrons are added to the ion beam by the neutralizer. These electrons do not actually recombine with the ions to form neutral atoms or molecules, but serve to offset the disruptive mutual repulsion of the positive ions that would otherwise occur. This is called charge neutralization and is typically present. If the beam is directed toward an electrically isolated surface, such as the surface of an insulator, the neutralizing electrons can also serve to offset the positive current of the ion beam. This is called current neutralization and is the type of neutralization that is typically being considered when the word “neutralization” is used by itself. More complete descriptions of most of these processes can be found in literature.<sup>1,6</sup>

Limit the discharge voltage to a maximum of 40 V during typical operation. If either damage of the target surface or contamination of this surface with discharge-chamber materials is a problem, lower the discharge voltage to 35 V, or lower. The limitation on discharge voltage reduces or eliminates the production of doubly charged ions. A more complete description of the effects of doubly charged ions is available if this process is a concern<sup>6</sup>.

### **3 cm Ion Source:**

Avoid overheating of the 3cm ion source by limiting the discharge current to a maximum of 2.5A.

- Limit the beam voltage,  $V_b$ , to a maximum of 1500 V. The maximum practical accelerator voltage,  $V_a$ , is in the range of 300-400 V (negative of ground).
- Limit total voltage ( $V_a + V_b$ ) to 1700 V. Operation is typically possible at larger (more negative) accelerator voltages, but is seldom of interest as a result of the increased sputtering of the accelerator grid by charge-exchange ions.
- Limit the total voltage (the sum of the beam and accelerator voltages) to a maximum of 1700 V.

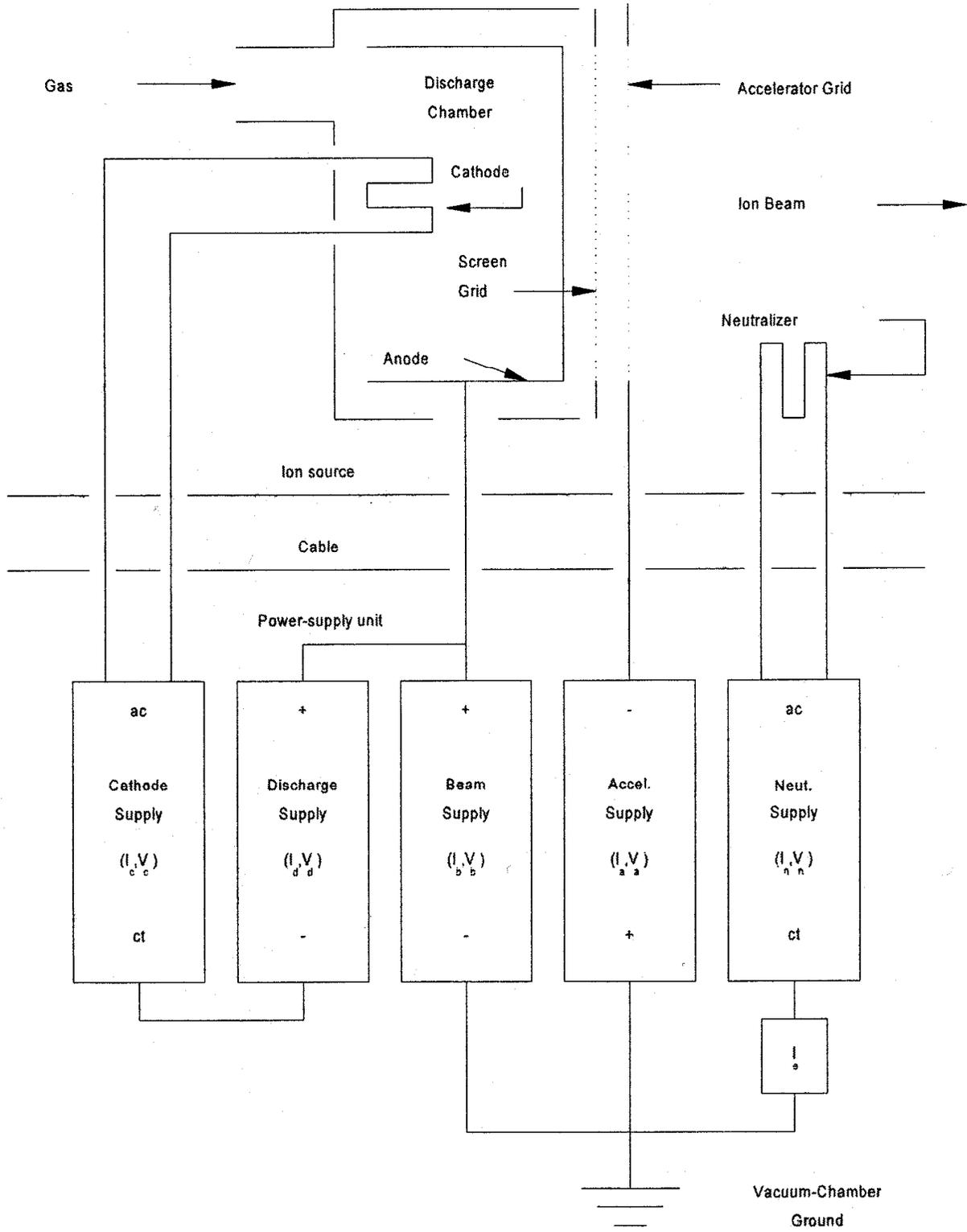
### **8cm Ion Source:**

Avoid overheating of the 8cm ion source by limiting the discharge current to a maximum of 4A.

- Limit the beam voltage,  $V_b$ , to a maximum of 1000 V. The maximum practical accelerator voltage,  $V_a$ , is in the range of 300-400 V (negative of ground).
- Limit total voltage ( $V_a + V_b$ ) is limited to 1200 V. Operation is typically possible at larger (more negative) accelerator voltages, but is seldom of interest as a result of the increased sputtering of the accelerator grid by charge-exchange ions.
- Limit the total voltage (the sum of the beam and accelerator voltages) to a maximum of 1200 V.

Successful use of an ion source in a difficult application often depends on the operator's understanding its operation. The description of the ion source operation presented in this section is brief.

**FIGURE 4.1 Permanent Magnet Ion Source Installation**



# Chapter 5: Initial Startup and Manual Mode Operation

## Start-up Notes

The following procedure is intended to demonstrate the application of power to each component of the ion source in a manually controlled sequence. It will serve to provide familiarity with the controls and to verify that the ion source operates properly.

### References:

- [FIGURE F.3](#), Front Panel Layout
- [FIGURE F.4](#), Flowchart of Manual and Automatic Operation
- [FIGURE F.6](#), Troubleshooting Flowchart

### CAUTION

Avoid damage to the ion source by making sure the filament current limits are set to the proper values for the source. Viewing and changing these limits requires the handheld terminal. Refer to [“Recipes/Operating Parameters” on page 32](#), [“Handheld Terminal” on page 18](#), and [FIGURE F.7](#) which tabulates current limits for various wire sizes.

## Manual Mode Operation

### CAUTION

Error alarms are disabled in Manual mode operation. This is to allow unhindered troubleshooting and adjustment activities.

1. Evacuate the system to a pressure of approximately  $5 \times 10^{-6}$  torr [ $7 \times 10^{-6}$  mbar].
2. Initiate process gas flow to chosen process pressure or to a flow sufficient to obtain a pressure of approximately  $2 \times 10^{-4}$  torr [ $3 \times 10^{-4}$  mbar].
3. Turn on the AC power switch. The red indicator within the switch should illuminate and the six meters should initialize with zeros (0000).

If “INTLK OPEN” flashes in the main display, the source cable interlock connections have not been closed. Disconnect the power and examine the source cabling for proper connection.

4. Initiate each of the five internal supplies as sequenced below. The start-up sequence is as follows:
  - a. Discharge voltage
  - b. Cathode filament current
  - c. Accelerator voltage
  - d. Beam voltage
  - e. Neutralizer filament current
  - f. Beam & Accelerator voltages
  - g. Cathode filament current >> beam current
  - h. Neutralizer filament current
  - i. Accelerator voltage
5. Press the MODE SELECT switch to select MANUAL mode. If the unit is in RESTRICTED mode, this will not be possible. In this case, refer to ["Handheld Terminal" on page 18](#), which outlines the operation of the handheld terminal.
6. Press the VIEW VOLTAGE switch under the DISCHARGE meter to obtain the VOLTS scale. Repeat operation of this switch will toggle between the VOLTS scale and the AMPS scale.
7. Press the SET VOLTAGE switch under the DISCHARGE meter. Press and hold the + switch (increase arrow) until a discharge voltage of approximately 40V is obtained. Use the - switch (decrease arrow) in case of overshoot.
8. Press the SET CURRENT switch under the CATHODE CURRENT meter. Press and hold the + switch to ramp up the cathode current to obtain a discharge:

**3cm Ion Source:**

You may require 4.5 to 7 amps cathode current to start the discharge.

**8cm Ion Source:**

You may require 10 to 16 amps cathode current to start the discharge.

You should now be able to observe a cathode discharge through a viewport in your vacuum system.

9. Neutralization is required if the target is a dielectric. To manually activate the neutralizer:
  - a. Press the NEUT switch to enable the neutralizer.
  - b. Repeatedly press the SELECT ITEM switch until NEUT FIL CURRENT appears on the main display screen (M1).
  - c. Press and hold the + switch until a neutralizer filament discharge is obtained. The actual neutralizer filament current may be viewed by pressing the VIEW CURRENT switch under the NEUTRALIZER meter.

You should now be able to observe a neutralizer filament glow through a viewport in the vacuum system.

10. Press the SET switch under the BEAM VOLTAGE meter:

3cm and 8cm Ion Sources:

Press and hold the + switch until approximately 250V is obtained.

11. Press the SET VOLTAGE switch under the ACCELERATOR meter. Toggle the VIEW VOLTAGE switch to obtain the VOLTS scale. Press and hold the + switch for the accelerator voltage while observing the ACCELERATOR voltage meter. Increase accelerator voltage set point until the accelerator voltage comes up to its minimum threshold value.
12. Increase the BEAM VOLTAGE and the ACCELERATOR voltage in a ratio of about 5:1 until the desired ion energy is obtained.
13. Press the SET CURRENT switch under the CATHODE CURRENT and use the +/- switches to adjust the filament current for the desired BEAM CURRENT.
14. SELECT ITEM to the NEUT FIL CURRENT and adjust so that neutralizer emission current matches the ion beam current. If necessary, toggle the VIEW CURRENT switch to view the neutralizer emission current in the mA scale.
15. Press the SET VOLTAGE switch under ACCELERATOR to adjust the accelerator for optimal grid wear and beam profile. To prevent electron back streaming and excessive grid wear, it is recommended that the accelerator voltage be at 15-20% of the beam voltage, i.e. 1000 Beam, 150V Accelerator.
16. To turn off the beam while saving the settings, press the MODE SELECT switch to drop out of Manual mode. All the individual power supplies will shut down.
17. Restart the beam at the same settings; reactivate Manual mode and press the SET switch and the + switch for each of the supplies in the order shown above. The SET switch selects the supply, and one press of the + switch re-enables the supply at the original setting.

## Recipe Use in Manual Mode Operation

Manual mode operation is often chosen in troubleshooting situations. But it can become tedious to repeatedly insert the same “starting point” parameters from one test to the next. A “manual recipe” is the solution; that is, a recipe that can be entered in automatic mode, then used in manual mode. Start with numbers that are about 2/3 of the final desired values. The following is an example for the 3cm ion source:

### Create Manual Recipes

1. Set Mode to Auto. Any use of a recipe must be done in Auto mode.
2. Press VIEW RECIPE and SELECT RECIPE.
3. Use the +/- buttons to select a recipe location for the “manual recipe”.
4. Press ENTER. This copies the contents of the recipe location into “working memory”.
5. Press SELECT ITEM to clear the VIEW RECIPE display, if it has not already done so.
6. Begin with discharge voltage. Press SET VOLTAGE under the DISCHARGE meter cause DISCHARGE V. to appear in the main display.
7. The recipes default to 40 volts. Use the +/- buttons to ramp this number up or down, if desired.

### NOTE

**Do not press ENTER again. This would cause present contents of the recipe location to again be copied into the working memory, thus overwriting what was just set.**

8. Press SELECT ITEM to advance the display scroll to BEAM VOLTAGE. Use +/- to select the chosen voltage. (Start with the voltage fairly low if an arcing situation is suspected.) A setting of 300 volts would be a good start.
9. Use SELECT ITEM and +/- to obtain the following parameters:  
DISCHARGE V40 V  
BEAM V300 V  
ACCEL VOLTS60 V  
NEUT FIL CUR5 A  
CATHODE CUR6 A  
The other parameters in the scroll may be ignored. Manual mode does not use them.
10. When all the desired numbers have been obtained, press STORE three times. This copies the contents of the “working memory” to the previously selected recipe location.

## Use Manual Recipes

If the recipe has just been made, it is already entered in the “working memory”. If not, select Auto Mode, press VIEW RECIPE and SELECT RECIPE, and use +/- to find the previously stored recipe. Press ENTER.

1. Make sure there is proper gas flow to the source. Select Manual mode
2. Press SET VOLTAGE under the DISCHARGE meter. Press +. To view the discharge voltage, press VIEW VOLTAGE. The meter should rise to 40 volts. Press VIEW VOLTAGE again to return the meter to reading discharge current.
3. Press SET CURRENT under the CATHODE meter. Press +. The cathode current should rise. Press and hold the + button to ramp up the cathode current to the point where discharge current appears. Press and hold the -button to bring the discharge current down to about 0.2 amps.
4. Under the ACCELERATOR meter, press SET VOLTAGE. Press + once. The accelerator voltage will rise to the set point. Press VIEW VOLTAGE to verify it. The accelerator current will rise to a relatively high value. It should not be left in this condition any longer than necessary.
5. Press SELECT ITEM to find NEUT. FIL. CUR. in the main display. Press the NEUT. enable button (lower left of the panel). Press + once to apply the preset neutralizer filament current. Press VIEW CURRENT to verify it. Press VIEW CURRENT again to return the meter to reading neutralizer emission current. Since there is no beam current yet, there will be no neutralizer emission current.
6. Under the BEAM VOLTAGE meter, press SET VOLTAGE. The beam voltage will rise to the set point, and beam current should now be present. The accelerator current should drop to a low value (< 10% of beam current).
7. Under the CATHODE meter, press SET CURRENT. Press + to increase the cathode emission to obtain the desired beam current.
8. Press SELECT ITEM repeatedly to find NEUT FIL CUR. Press +/- to obtain the chosen neutralizer emission.
9. To turn off the outputs, press MODE SELECT back to Auto.

# Chapter 6: Automatic Operation

## Description

Automatic mode operation makes use of predefined sets of operating parameters, called “recipes”. Recipes are stored in 99 memory locations, numbered 01 to 99. AUTOMATIC RESTRICTED mode allows the operator to preset parameters to be used but not modified in any way. AUTOMATIC UNRESTRICTED mode allows the preset parameters to be used but they may also be adjusted, appended, or deleted.

Unlike manual mode, automatic mode provides feedback control of power supply operations such that user-defined set points and inter-electrode relationships are maintained. Some of the parameters will always be independent set points, e.g., beam voltage and discharge voltage. However, some of the parameters will follow relationships, e.g., cathode filament current will vary automatically to produce a desired beam current.

The user may attempt to set up conflicting relationships in the power supply. For instance, the user could enter a certain cathode current, and then enter a beam current. When faced with this condition, the power supply will act upon the LAST setting entered, even though it will accept and display both numbers. In this example, the beam current setting would take priority since it was entered after the cathode current setting.

### CAUTION

**Use caution when directly specifying cathode and neutralizer filament currents, or accelerator voltage.**

In the procedures following, it is assumed that the user is acquainted with the basic setting and metering controls described in [“Manual Mode Operation” on page 8](#).

### CAUTION

**Avoid damage to the ion source by making sure that the filament current limits are set to the correct values for the source. In attempting to maintain a specified beam current or neutralizer emission, the power supply may run the filaments at currents which could damage them. Properly set the filament current limits to prevent this.**

Viewing and changing these limits requires use of the hand-held terminal. Please refer to [“Handheld Terminal” on page 18](#) which outlines the operation of the hand-held terminal, and to [FIGURE F.7](#) which tabulates current limits for various wire sizes.

## Automatic Operation Procedure

1. Evacuate the system to approximately  $5 \times 10^{-6}$  Torr.
2. Start gas flow and adjust for  $2 \times 10^{-4}$  Torr.
3. Turn on the AC power switch. The red indicator within the switch should illuminate and the meters should initialize with zeros. If the main display flashes "INTLK OPEN", it is an indication that the system interlock connections in the ion source cable have not been closed.
4. Using the MODE SELECT switch, select AUTOMATIC mode. If the unit is in RESTRICTED mode, use the handheld terminal to enter UNRESTRICTED mode.
5. Six generic sample recipes reside in memory files 01 through 06. Press the VIEW RECIPE switch. The parameter values stored in Recipe 01 will be displayed on the Main Display Screen and the power supply meters.
  - If the recipe uses ratios to determine accelerator voltage or neutralization, the value shown on the power supply meters may be zero.
  - If a value for these supplies has been entered, it will be ignored if a ratio parameter has been the last one entered.

The displays will revert to "real time" values after 30 seconds (or after 5 seconds if the power supply is running). Pressing the SELECT ITEM switch will cause the displays to revert immediately.

6. To view other recipes, press the SELECT RECIPE switch and use the +/- switches to scroll through the memory. Recipes 02, 03, 04, etc., may then be viewed after again pressing the VIEW RECIPE switch.
7. Choose the suitable selection by pressing the ENTER switch to "engage" the recipe into the working register. Press BEAM to start the beam sequence.

The LED on the SOURCE switch will begin flashing as the unit brings up the discharge voltage and the cathode current to establish a plasma discharge. If a discharge is established the SOURCE light will stop flashing and go continuous. The BEAM light will also be flashing as the supply then activates the neutralizer, accelerator, and beam supplies. When a satisfactory ion beam has been established, the BEAM light will also go continuous.

- If any of these sequences proves unsuccessful, an audible alarm will sound and an error message will appear on the Main Display. The alarm may be silenced by pressing the SILENCE switch. Its LED will remain "on" as long as the alarm condition exists.

- If the recipe contains a timer value, the beam will remain on for the duration of the timer. It will then sequence down from the “beam” function and maintain a low, idling discharge. It will remain in this state until the SOURCE button is pressed or until another recipe is entered and started using the BEAM button. If no timer value had been selected, the beam will remain active indefinitely and will increment the run time indicator to record the length of time the beam was on.
8. To adjust the recipe parameters of the individual supplies, use the appropriate SET switches and the +/- switches. The other parameters, as well the power supply parameters, may be accessed by repeatedly pressing the SELECT ITEM switch. As each recipe item appears it may be adjusted using the +/- switches. The adjustments may be made during beam operation, idle discharge, or at the standby state.
  9. If the new settings are to be saved, use the SELECT RECIPE and VIEW RECIPE functions to locate the desired recipe position. Press the STORE switch to write them to recipe memory. Note that pressing the STORE switch can also overwrite an existing recipe position with the new values.

## NOTE

The IBS power supply utilizes a number of different feedback and control mechanisms which may be selected by the user. These mechanisms provide user flexibility.

### Cathode/Beam Relationships

Beam current is ultimately controlled by the cathode current. The user may specify either a BEAM CURRENT or a CATHODE CURRENT while operating in automatic mode.

- If BEAM CURRENT is selected last it becomes the controlling parameter. The control system will vary the cathode current as required to achieve the specified beam current.
- If CATHODE CURRENT is the last of the two settings adjusted, the cathode current will ramp to that setting, regardless of the beam current.

## NOTE

Both the cathode and beam current numbers may be present in the recipe but only the last one adjusted (up or down with the +/- arrow switches) will take priority.

## Accelerator Relationships

In automatic mode, the user may select an accelerator voltage, an accelerator-to-beam (A/B) ratio, or an R-factor. The last setting adjusted will take priority.

A/B ratio is the ratio of accelerator voltage to beam voltage. For example, if the A/B ratio is set to 0.200, the accelerator voltage will track itself to 20% of the beam voltage, even if the beam voltage is changed during a run.

R-factor operates in a similar manner except that the relationship is beam voltage divided by the sum of the beam voltage plus the accelerator voltage. (R-factor= $B/(B+A)$ )

## Neutralizer Relationships

1. The user may select one of the following controlling currents:
  - a neutralizer emission
  - an emission with an offset
  - a neutralizer filament current
2. Neutralizer emission may be entered directly from the front panel controls using the SET button under the neutralizer meter window.
3. The total beam neutralization (TBN) is the option in which the neutralizer emission tracks the beam current. Select this function by using the SELECT ITEM switch to scroll to the TCN/SCN option where TBN is selected and then scrolling to the NEUTRALIZER IMBALANCE setting. Set the imbalance to zero, in which the neutralizer emission will equal the beam current, or set to an offset current where the neutralizer emission will equal the beam current plus the offset.

### NOTE

**Adjust the IMBALANCE setting up or down, in order for the function to have priority. If zero imbalance is chosen, use the + arrow button to increase the setting one unit, then use the - arrow button to return it to zero.**

4. Stage current neutralization varies the neutralizer emission to achieve a net zero current flowing from an electrically isolated stage in the vacuum chamber. The lead from the stage connected to pin 5 of the accessory connector on rear of the IBS-250 and the chamber ground is connected to pin 6.
  - The 1 ohm shunt resistor is internal to the power supply and should not be included in the stage.

Select SCN by scrolling to the TBN/SCN option and using the +/- arrows to select SCN. Then scroll to NEUTRALIZER IMBALANCE to select a setting for zero or over neutralization.

- Adjust the setting, even if just up and down, to signal SCN priority.

The stage current will appear in the main LCD display in the upper right corner. If VIEW PROBE CURRENT has been selected during use of the beam profiling probe, the probe current reading will overlay the stage current reading. It will return when VIEW PROBE CURRENT pressed again.

5. When a neutralizer filament current is desired without any feedback operations, it may be set by scrolling the main LCD to NEUT FIL CURRENT and adjusting the number with the +/- arrows.

## **NOTE**

**The NEUT switch must be enabled if neutralizer filament operation is desired in manual mode.**

# Chapter 7: Handheld Terminal

## Description

The handheld terminal is an RS-232 remote terminal which performs control and setup functions not normally accessed during production applications. To use it, plug it into the REMOTE TERMINAL jack on the front panel. The LCD on the remote cover terminal will display a few diagnostic messages, then it will display: SELECT FROM MENU (1-4)

The Main Display Screen will display:

- Control
- Reports
- Recipe Setup
- Shutdown

Subsequent operation of the unit is driven by menus displayed on both the remote and the Main Display Screen.

Terminal display menu selections may be made by pressing the appropriate number keys on the handheld unit and then pressing the ENTER key. After the chosen functions have been performed, unplug the handheld unit and operate the IBS-250 as usual.

### NOTE

**The handheld terminal allows direct entry of parameter values, as well as using the front panel's +/- switches.**

When entering numbers directly, do not use the decimal point. If the desired number is 43.00 volts, enter 4300. Just entering 43 will be interpreted as 00.43.

## Functions

Each of the functions of the hand held unit will now be discussed in turn. Refer to the flow chart in [FIGURE F.5](#) as the following discussion is read.

## Control

Selection of the CONTROL menu provides:

- SOURCE STATE: mimics front panel SOURCE switch
- BEAM STATE: mimics front panel BEAM switch
- CHAIN TO RECIPE: accesses recipe chaining options
- MODES: selects manual, auto restricted, and auto unrestricted modes
- LIMITS: views and edits filament current limits

## Recipe Setup

Selection of the RECIPE SETUP menu followed by a recipe number (1 to 99) provides:

- EDIT RECIPE: access to recipes for editing. Once selected, use the SELECT ITEM switch to access each parameter to be edited
- DELETE RECIPE: ability to delete a recipe
- STORE RECIPE: mimic of the front panel STORE switch
- CHAINING TO RECIPE: ability to construct or edit a recipe chain

## Shutdown

Selection of SHUTDOWN, followed by a confirmation command, turns off all IBS-250 outputs.

# Chapter 8: Recipe Chaining

## Description

Recipe chaining allows the automatic operation of a group of recipes in a continuous series. As each recipe in the chain successively times out, the next set of parameters is automatically entered and run, without any operator action.

## Chaining Operation

Chaining is accessed from the AUTOmatic mode in the following way:

1. Use the SELECT ITEM switch to scroll through to CHAIN.
2. Press ENTER. The word CHAIN will remain on the display, even if other recipe items were scrolled up.
3. Use the +/- switches to access the chosen recipe in memory.
4. Press ENTER. The recipe number will appear to the right of the word CHAIN.

To choose the second recipe, press select recipe and +/- to access the chosen recipe. Press ENTER. The second sequential recipe will appear to the right of the first recipe number.

5. Continue finding and entering recipe numbers until the chosen string of numbers is listed
  - If the unit's outputs were already on, the chaining process will begin immediately.
  - If the outputs were not on, it will begin the next time the beam is brought up.
  - If the chain is interrupted by forcing a beam shutdown, the process will pick up where it left off when restarted. The number of the currently-used recipe flashes.

Each recipe in the chain is defined as finished when its beam count-down timer runs down to zero. The BEAM functions will sequence down and the discharge will drop to idle. The next recipe will be automatically entered and the BEAM sequence will restart.

6. Clear a chain by using the SELECT ITEM switch to scroll through the items until the word CHAIN flashes.
7. Press + to make the word CHAIN and the recipe numbers clear.

# Chapter 9: Troubleshooting and Diagnostics

Refer to [FIGURE F.6](#) for the Troubleshooting Chart for the IBS-250 power supply.

Refer to the Technical Note, “Diagnostics and Maintenance of Gridded Ion Sources”. It contains valuable information for the care, repair, and operation of your ion source.

If further assistance is necessary please contact Veeco Service Support. Before you call or fax, please have ready all voltages, currents, gas pressures and flows, and any other information that would be pertinent, such as type of mount, gas type, other ion or electron sources in the chamber, etc.

## IBS Power Supply Error Alarms and Possible Causes

The IBS power supplies feature a number of monitoring and shut-down functions designed to protect the power supply, the ion source, and the work from improper adjustments or equipment failures. The onset of each new alarm will be accompanied by an audible beeper signal. The audible signal may be silenced by pressing the ALARM SILENCE button. If the alarm condition is still present, the red light in the ALARM SILENCE switch will remain illuminated. It will extinguish if the alarm condition has passed. The audible signal will re-start each time a new alarm occurs. To avoid nuisance tripping due to system transients, the alarms include a 15 second delay, except for the beam current alarm which has a 20 second delay.

### NOTE

The alarms only function in automatic mode. They do not function in manual mode since manual mode operation is primarily intended for troubleshooting. Alarm shut-downs would hinder troubleshooting procedures. Use caution when using manual mode.

The following is a list of the IBS alarms, the immediate symptoms causing the alarms, and some possible reasons for the indicated symptoms:

### **Cathode Alarm**

The microprocessor has specified a cathode current and the power supply has not supplied it.

This will sometimes happen when a cathode filament fails, although the cathode fail alarm will usually indicate this condition first.

The cathode supply may have failed. Check to see if the HV light on the cathode board is illuminated. If not, the cathode fuse has blown and the cathode output transistors must be checked before the fuse can be replaced.

### **Cathode Filament Fail Alarm**

The microprocessor has measured cathode supply output voltage but has detected no cathode current. Normally, this means that the cathode filament has failed.

### **Discharge Alarm**

The microprocessor has specified a discharge voltage and the power supply has not supplied it. (This alarm can also occur when the discharge meter is indicating a voltage when the microprocessor is specifying zero voltage.)

A short or overload in the ion source has drawn excessive discharge current. The discharge supply then “current limits” (it allows the output voltage to drop down in an effort to limit the output current to a safe level).

The discharge supply may have failed. Check to see if the HV light on the discharge board is illuminated. If not, the discharge fuse has blown and the discharge output transistors must be checked before the fuse can be replaced.

## **Beam Alarm**

The microprocessor has specified a beam voltage or beam current which has not been provided. (This alarm can also occur when the beam meter is indicating a voltage when the microprocessor is specifying zero voltage.)

The typical cause of beam alarms is the inability of the system (power supply + ion source + gas) to produce the chosen beam current. This can be a result of a number of causes:

- The cathode current limit has been set too low.
- There is insufficient gas flow to the ion source.
- The requested beam current may not be possible with certain ion sources and/or grids.
- General maintenance problems with ion source.

There is arcing in the system (grid arcs, arcs to chamber, etc.), which is causing the beam supply to “current limit”.

The beam supply may have failed. Check to see if the HV light on the beam board is illuminated. If not, the beam fuse has blown and the beam output transistors must be checked before the fuse can be replaced.

## **Accelerator Alarm**

The microprocessor has specified an accelerator voltage, which has not been provided. This alarm can also occur when the accelerator meter is indicating a voltage when the microprocessor is specifying zero voltage.

- The usual cause of accelerator alarms is grid arcing which forces the accelerator supply to “current limit”.
- The accelerator supply may have failed. Check to see if the HV light on the accelerator board is illuminated. If not, the accelerator fuse has blown and the accelerator output transistors must be checked before the fuse can be replaced.

## **Neutralizer Filament Alarm (N FIL)**

The microprocessor has specified a neutralizer filament current which has not been provided. This alarm may also be accompanied by the N BAL (neutralizer balance) alarm.

- The usual cause of N FIL alarms is the failure of the neutralizer filament.
- The neutralizer supply may have failed. Check to see if the HV light on the neutralizer board is illuminated. If not, the neutralizer supply fuse has blown and the neutralizer output transistors must be checked before the fuse can be replaced.

## **Neutralizer Balance Alarm (N BAL)**

The microprocessor has specified a neutralizer emission current which has not been provided.

- The neutralizer filament current limit may be set too low, which prevents adequate neutralizer emission.
- The neutralizer filament may be too long. This would present the neutralizer supply with too high a load resistance. The resulting low filament current would cause low emission.
- If there is no neutralizer emission, the neutralizer emission fuse may be blown. This is a small fuse located under a gray cap near the AC power cord on the rear of the unit. Failure of this fuse usually indicates that insulator maintenance is required in the ion source.
- The neutralizer filament may be improperly placed so that it cannot couple electrons to the ion beam.
- There may be insufficient gas flow for proper ion production, thus causing low neutralizer emission.
- The neutralizer supply may have failed. Check to see if the HV light on the neutralizer board is illuminated. If not, the neutralizer supply fuse has blown and the neutralizer output transistors must be checked before the fuse can be replaced.

## **Source Alarm**

The source alarm occurs when there is a loss of discharge current while running the source, or a failure to achieve discharge current when starting the source. The typical cause of source alarms is inadequate gas flow. Possible reasons:

- gas valve is shut
- flow rate is set too low
- gas leak in the ion source
- cracked or leaky gas line to ion source

Cathode current limit is set too low so that the source cannot ignite a plasma discharge. Improper length or wire thickness of cathode causes low cathode emission.

- The anode may be coated with contaminants, which insulates it.
- The ion source may have other maintenance-related problems such as:
  - degaussed magnets
  - coated insulators
  - coated feedthroughs

# Chapter 10: Conversion to Different Line Voltages



**WARNING**

Qualified personnel must perform this procedure following typical safety precautions. Disconnect the unit from the source of AC power. All conductors must be shorted to ground.

## Procedure

1. Measure the voltage of the AC line. Do not assume it is 208 V or 240 V simply because a transformer may say so.
2. Remove the top cover from the power supply.
3. Locate the small control transformer, T1, situated in the right front corner, on the side wall.
4. Move the quick-disconnect terminal to the appropriate transformer tab (refer to [FIGURE F.7](#)). If in doubt, place the terminal on the tab corresponding to the next lower voltage. For instance, if the measured line voltage is 230 volts, use the 220 volt tab rather than the 240 volt tab.
5. Ensure that no terminals or wires are shorting.
6. Replace the cover and resume installation.

# Chapter 11: Service Support

For service, contact:

Veeco Instruments, Inc.  
2330 East Prospect  
Fort Collins, CO 80525  
Phone: 1.888.221.1892  
Fax: 970.493.1439  
petechsupport@veeco.com

When contacting Veeco Instruments, Inc. for parts or service:

Provide the ion source model number, serial number, and grid serial number. The ion source model and serial number are engraved on the downstream surface of the grid mount plate. The grid serial number is engraved on the upstream surface of the grid.

Provide the ion source power supply model and serial number; a list of all operating parameters and/or error messages displayed by the power supply; gas flow rate; and vacuum chamber pressure.

## Chapter 12: Warranty Statement

Seller warrants to the original Buyer that new equipment will be free of defects in material and workmanship for a period of one year commencing (x) on final acceptance or (y) 90 days from shipping, whichever occurs first. This warranty covers the cost of parts and labor (including, where applicable, field service labor and travel required to restore the equipment to normal operation).

Seller warrants to the original Buyer that replacement parts will be new or of equal functional quality and warranted for the remaining portion of the original warranty or 90 days, whichever is longer.

Seller warrants to the original Buyer that software will perform in substantial compliance with the written materials accompanying the software. Seller does not warrant uninterrupted or error-free operation.

Seller's obligation under these warranties is limited to repairing or replacing at Seller's option defective non-expendable parts or software. These services will be performed, at Seller's option, at either Seller's facility or Buyer's business location. For repairs performed at Seller's facility, Buyer must contact Seller in advance for authorization to return equipment and must follow Seller's shipping instructions. Freight charges and shipments to Seller are Buyer's responsibility. Seller will return the equipment to Buyer at Seller's expense. All parts used in making warranty repairs will be new or of equal functional quality.

The warranty obligation of Seller shall not extend to defects that do not impair service or to provide warranty service beyond normal business hours, Monday through Friday (excluding Seller holidays). No claim will be allowed for any defect unless Seller shall have received notice of the defect within thirty days following its discovery by Buyer. Also, no claim will be allowed for equipment damaged in shipment sold under standard terms of F.O.B. factory. Within thirty days of Buyer's receipt of equipment, Seller must receive notice of any defect which Buyer could have discovered by prompt inspection. Products shall be considered accepted 30 days following (a) installation, if Seller performs installation, or (b) shipment; unless written notice of rejection is provided to Seller within such 30-day period.

Expendable items, including, but not limited to, lamps, pilot lights, filaments, fuses, mechanical pump belts, V-belts, wafer transport belts, pump fluids, O-rings and seals ARE SPECIFICALLY EXCLUDED FROM THE FOREGOING WARRANTIES AND ARE NOT WARRANTED. All used equipment is sold 'AS IS, WHERE IS,' WITHOUT ANY WARRANTY, EXPRESS OR IMPLIED.

Specifically excluded from this warranty is all stand-alone computer and data storage equipment not manufactured by Seller (such as computers, monitors, printers and printer buffers). Such equipment will carry only the original manufacturer's warranty.

Seller assumes no liability under the above warranties for equipment or system failures resulting from (1) abuse, misuse, modification or mishandling; (2) damage due to forces external to the machine including, but not limited to, acts of God, flooding, power surges, power failures, defective electrical work, transportation, foreign equipment/attachments or Buyer-supplied replacement parts or utilities or services such as gas; (3) improper operation or maintenance or (4) failure to perform preventive maintenance in accordance with Seller's recommendations (including keeping an accurate log of preventive maintenance). In addition, this warranty does not apply if any equipment or part has been modified without the written permission of Seller or if any Seller serial number has been removed or defaced.

No one is authorized to extend or alter these warranties on Seller's behalf without the written authorization of Seller.

THE ABOVE WARRANTIES ARE EXPRESSLY IN LIEU OF ANY OTHER EXPRESS OR IMPLIED WARRANTIES (INCLUDING THE WARRANTY OF MERCHANTABILITY), AND OF ANY OTHER OBLIGATION ON THE PART OF SELLER. SELLER DOES NOT WARRANT THAT ANY EQUIPMENT OR SYSTEM CAN BE USED FOR ANY PARTICULAR PURPOSE OR WITH ANY PARTICULAR PROCESS OTHER THAN THAT COVERED BY THE APPLICABLE PUBLISHED SPECIFICATIONS. SELLER ASSUMES NO LIABILITY FOR CONSEQUENTIAL DAMAGES, FOR ANTICIPATED OR LOST PROFITS, INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES, LOSS OF TIME, LOSS OF USE, OR OTHER LOSSES, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES AND EVEN IF CAUSED BY THE NEGLIGENCE OF SELLER, INCURRED BY BUYER OR ANY THIRD PARTY IN CONNECTION WITH EQUIPMENT, SYSTEMS OR SERVICES COVERED BY THESE WARRANTIES OR OTHERWISE.

**Rev 1.01**

# Appendix A: Specifications

## General

Dimensions: 7" (H) x 19" (W) x 19.25" (D) [18 x 48 x 49 cm]

Weight: 44 lbs [16.4 kg]

Power: 208, 220, or 240 VAC, 50/60 Hz. (factory set for 208 VAC), 8 Amperes @ 208V

Cooling: forced air

Mounting: EIA-type rack

## Beam Supply

Output: 50 to 1500 VDC

Accuracy:  $\pm 0.2\%$

Current range: 0 to 250 Ma

Ripple and noise: less than 1

Voltage regulation

A 3cm ion source is software limited to 100mA maximum current

## Accelerator Supply

Output: 25 to 500 VDC

Current range: 0 to 150 Ma

Current meter recalibrates to 0 - 50 Ma resolution during operation and to 0 - 10 Ma Full-Scale with 3 cm Ion Source.

Ripple and noise: less than 1%

Voltage regulated

## Discharge Supply

Output: 20 to 65 VDC

Current range: 0 to 5 A

Ripple and noise: less than 1%

Voltage regulated

## Cathode Filament Supply

Output: 3 to 10 Amperes AC rms for 3 cm Ion Sources, 4 to 20 Amperes AC rms for 8cm ion sources

Current regulated, with software safety limit

Voltage compliance: up to 25 V AC rms

Output frequency: 50 kHz, sinusoidal

Softstart characteristic

## Neutralizer Filament Supply

Output: 3 to 10 Amperes AC rms for 3 cm Ion Sources, 4 to 20 Amperes AC rms for 8cm ion sources

Current regulated, with software safety limit

Voltage compliance: up to 20 V AC rms

Output frequency: 50 kHz, sinusoidal

Softstart characteristic

## Probe Supply

Output: fixed 35 VDC

Voltage regulated

Current range: 0 to 20 mA

Noise and ripple: less than 1%

Short circuit protected

## Operating Parameters

The list below contains recommended average operating parameters for the different type of optics that are available with the 3 cm ion source.

### WARNING

Damage may result to the anode and the magnet assembly of the ion source if the discharge current exceeds 2.5A at 40V and/or the cathode current exceeds 8.5A.

Use a base operating pressure between  $1.0 \times 10^{-4}$  torr and  $4.0 \times 10^{-4}$  torr.

Select the chart that matches the optics in the source and start at the lowest setting.

**Table 1.1: 3CM Graphite Optics**

Beam (V)	Beam (I)	Accelerator	Discharge	Neutralizer
500 V	30 mA	15%	40 V	TBN
750 V	40 mA	15%	40 V	TBN
1000 V	50 mA	15%	40 V	TBN
1250 V	60 mA	15%	40 V	TBN
1500 V	70 mA	15%	40 V	TBN

**Table 1.2: 3CM Moly Optics**

Beam (V)	Beam (I)	Accelerator	Discharge	Neutralizer
500 V	20 mA	15%	40 V	TBN
750 V	30 mA	15%	40 V	TBN
1000 V	40 mA	15%	40 V	TBN
1250 V	50 mA	15%	40 V	TBN
1500 V	60 mA	15%	40 V	TBN

**Table 1.3: 3CM Single Grid Low Voltage**

Beam (V)	Beam (I)	Accelerator	Discharge	Neutralizer
50 V	30 Ma	Not Used	40 V	TBN
75 V	40 Ma	Not Used	40 V	TBN
100 V	50 Ma	Not Used	40 V	TBN

# Appendix B: Recipes/Operating Parameters

## Factory Recipes

The IBS-250 is pre-programmed with recipes in memory register locations 1 through 6, and 94 through 99. DO NOT MODIFY THESE RECIPES. These recipes are provided for use as reference recipes to facilitate installation and troubleshooting, and as model recipes, which can be copied to other recipe locations and makes recipe building easier.

The pre-programmed recipes are as follows:

**Table 2.1: 3cm Ion Source Recipes**

Recipe	Beam (V)	Beam (I)	Accelerator	Discharge (V)	Discharge (I)	Cathode (I)	Neutralizer
1 & 94	0	0	15%	40 V	2.5 A	8.5 A	TBN*
2 & 95	500 V	20 mA	15%	40 V	2.5 A	8.5 A	TBN
3 & 96	750 V	30 mA	15%	40 V	2.5 A	8.5 A	TBN
4 & 97	1000 V	40 mA	15%	40 V	2.5 A	8.5 A	TBN
5 & 98	1250 V	50 mA	15%	40 V	2.5 A	8.5A	TBN
6 & 99	1500 V	60 mA	15%	40 V	2.5 A	8.5 A	TBN

**Table 2.2: 8cm Ion Source Recipes**

Recipe	Beam (V)	Beam (I)	Accelerator	Discharge (V)	Discharge (I)	Cathode (I)	Neutralizer
1 & 95	0	0	15%	40 V	4.0	15	TBN
2 & 96	250 V	75 mA	15%	40 V	4.0	15	TBN
3 & 97	500 V	100 mA	15%	40 V	4.0	15	TBN
4 & 98	750 V	150 mA	15%	40 V	4.0	15	TBN
5 & 99	1000 V	200 mA	15%	40 V	4.0	15	TBN

\*TBN: Total Beam Neutralization

### To copy a recipe:

1. Use the VIEW RECIPE, SELECT RECIPE, and +/- arrow buttons to select the chosen recipe.
2. Press ENTER. The recipe is now entered into the recipe "work space".
3. Use the SELECT RECIPE and arrow buttons again to select the location where you want to create a new recipe.
4. Press STORE three times to copy the recipe from the "workspace" to the new recipe location.

### Operating Parameters

Listed below are recommended average operating parameters for the available optics for 3cm and 8cm ion sources. As listed in the recipes, discharge and cathode currents should not exceed those listed or equipment damage may result.

3 cm Sources: The discharge current should not exceed 2.5 amps at 40 volts and/or the cathode current should not exceed 8.5 amps. The base operating pressure should be between  $1.0 \times 10^{-4}$  Torr and  $4.0 \times 10^{-4}$  Torr ( $1.3 \times 10^{-4}$  mbar and  $5.3 \times 10^{-4}$  mbar).

8 cm Sources: The discharge current should not exceed 4.0 amps at 40 volts and/or the cathode current should not exceed 15 amps. The base operating pressure should be between  $8.0 \times 10^{-5}$  Torr and  $3.0 \times 10^{-4}$  Torr ( $1.0 \times 10^{-4}$  mbar and  $4.0 \times 10^{-4}$  mbar).

Select the chosen beam voltage from the charts below according to the optics in use on the ion source. Start at one half the recommended beam current and increase the current to the chosen output level.

**Table 2.3: 3CM Graphite Optics**

Beam (V)	Beam (I)	Accelerator	Discharge	Neutralizer
500 V	30 mA	15%	40 V	TBN
750 V	40 mA	15%	40 V	TBN
1000 V	50 mA	15%	40 V	TBN
1250 V	60 mA	15%	40 V	TBN
1500 V	70 mA	15%	40 V	TBN

**Table 2.4: 3CM Moly Optics**

Beam (V)	Beam (I)	Accelerator	Discharge	Neutralizer
500 V	20 mA	15%	40 V	TBN
750 V	30 mA	15%	40 V	TBN
1000 V	40 mA	15%	40 V	TBN
1250 V	50 mA	15%	40 V	TBN
1500 V	60 mA	15%	40 V	TBN

**Table 2.5: 3CM Single Grid Low Voltage**

Beam (V)	Beam (I)	Accelerator	Discharge	Neutralizer
50 V	30 Ma	Not Used	40 V	TBN
75 V	40 Ma	Not Used	40 V	TBN
100 V	50 Ma	Not Used	40 V	TBN

**Table 2.6: 8CM Graphite and Moly Optics**

Beam (V)	Beam (I)	Accelerator	Discharge	Neutralizer
250 V	100 mA	25%	40 V	TBN
500 V	150 mA	15%	40 V	TBN
750 V	200 mA	15%	40 V	TBN
1000 V	250 mA	15%	40 V	TBN

## Appendix C: Controls and Indicators

Please refer to [FIGURE 4.1](#) or the power supply front panel.

Power:	Applies line power to IBS-250.
Source:	<p>Initiates the source sequence. The discharge and cathode supplies are enabled to establish a plasma discharge.</p> <p>The LED (light-emitting diode) flashes until a stable discharge has been obtained.</p> <p>Pressing the SOURCE switch a second time will shut down the beam if it had been running, and then shut down the source.</p> <p>SOURCE only functions in AUTOMATIC mode, after a recipe has been entered.</p>
Beam:	<p>May be used to initiate the SOURCE sequence if not previously selected.</p> <p>Initiates the beam sequence if the SOURCE sequence has been activated. The neutralizer, accelerator, and beam supplies are automatically ramped up. The LED flashes until a stable beam condition has been established.</p> <p>Pressing the BEAM switch when illuminated will shut off the neutralizer, accelerator, and beam supplies, but will not shut off the SOURCE supplies.</p> <p>BEAM only functions in AUTOMATIC mode, after a recipe has been entered.</p>
Probe:	Applies -32 volts to a calibration probe. An LED illuminates when this function is enabled.
View Probe Current:	Causes probe current value to be displayed in upper right corner of the Main Display Screen.
Neutralizer:	Enables the neutralizer filament current when in the manual mode. The switch is non-functional in automatic mode. The LED illuminates when NEUT is enabled.

Silence:	Turns off the audible alarm during an error condition. The switch must be pressed each time a new alarm occurs.  The LED flashes while the alarm is sounding and goes continuous when an alarm has been silenced but is still present.
Main Display Screen:	A four-line dot matrix LCD (liquid crystal display) which indicates recipe number, alarm conditions, elapsed and remaining times, probe current, and individual recipe parameters.
Mode Select:	Used to toggle between MANUAL and AUTO modes if UNRESTRICTED access has been selected via the handheld terminal. LEDs indicate MANUAL or AUTOMATIC modes, and RESTRICTED or UNRESTRICTED access. MODE SELECT can not be selected out of AUTO while a discharge is active.
Store:	Used to save parameter values to a selected recipe location in memory. A recipe is stored by pressing the STORE switch three times.
Enter:	Loads recipe values into working memory.

All parameters should be set to the desired values before STOREage of the file to a recipe memory file. STORE places the file into a recipe memory file.

Notes about the ENTER and STORE switches:

- In order to run, modify, or store a recipe, it must first be loaded into the working memory register using the ENTER switch.
- Pressing ENTER will overwrite the working register with the contents of the current recipe being viewed.
- Save the recipe in the desired memory register by pressing STORE. Note that the choice of a memory register with a recipe residing in it will overwrite the existing recipe data. If you have changed recipe parameters in the working registers and want to use them again, DO NOT press ENTER.
- All parameters should be set to the desired values before STOREage of the file to a recipe memory file. STORE places the file into a recipe memory file.
- Before pressing STORE make sure you are storing to the intended recipe memory register (01 to 99). To help prevent accidental overwrites, the STORE switch must be pressed three times in succession to perform a STORE. If the STORE switch is accidentally pressed, wait 10 seconds and the function will reset.

- To save time in building a recipe which is similar to an existing recipe, use SELECT RECIPE to locate the similar recipe. ENTER it. Use SELECT RECIPE and the +/- switches to move to the new storage location. Modify the recipe items as desired; STORE the new recipe in the new memory register.

+ / -  
(Increase/  
Decrease)      Used to change the value of a quantity (such as a recipe number, voltage, etc.) shown on the Main Display Screen.

If the manual mode is in effect, the change takes place in real time. If the automatic mode is in effect, the change is entered into working memory. And, if the source and/or beam are active, the changes will also occur in the outputs.

Select Recipe:      Used to change the recipe viewed in the Main Display Screen. After SELECT RECIPE is pressed, the INCREASE and DECREASE switches will change the recipe number.

View Recipe:      Causes all values in the current recipe to be displayed on the LCD meters and the Main Display Screen. If the outputs are active, the selected recipe will be displayed for 5 seconds. If the outputs are not active, the recipe displays will remain in place for 30 seconds after the last INCREASE/DECREASE change. The presence of the VIEW RECIPE parameters on the meters will not affect the operating parameters. The display may be returned to normal manually by pressing SELECT ITEM.

Select Item:      Used to scroll through the operating parameters shown in the Main Display Screen.

Aux:      Auxiliary switch not being used at the present time.

Remote Terminal:      Connector for interfacing the handheld terminal to the IBS power supply.

Cathode Current Meter:      Displays cathode filament current (also displays cathode filament voltage if selected by the VIEW VOLTAGE switch).

Discharge Meter:      Displays discharge current (or cathode-to-anode voltage if selected by the VIEW VOLTAGE switch).

Beam Current Meter:      Displays the amount of ion current extracted from the discharge.

Beam Voltage Meter:      Displays the anode-to-ground voltage.

Accelerator Meter:	Displays the accelerator grid current (or the ground-to-accelerator grid voltage if selected by the VIEW VOLTAGE switch).
Neutralizer Meter:	Displays amount of electron current emitted from the neutralizer filament (or the amount of AC current applied to heat the neutralizer filament if selected by the VIEW CURRENT switch).
Set Current/ Set Voltage/ Set Emission	Pressing one of these switches selects its corresponding parameter for use in the Main Display Screen and for modification by the + / - (INCREASE/ DECREASE) switches.
View Volt- age/View Current	Pressing one of these switches changes the parameter displayed on the meter above the switch. The new parameter will be displayed on the meter for 30 seconds or until the VIEW switch is pressed again.

# Appendix D: IBS Serial Communications - Version 2

IBS Serial Communications      May 4, 1994

IBS Power Supply: "Version Two" Communications Protocol

## Communications Parameters

Baud Rate:            1200  
Parity:                0 (none)  
Data Bits:            8  
Stop bit:              1

Communications will be character-based terminated with a termination character, followed by a checksum. All alpha characters are in uppercase.

	Decimal	
<ACK>	Acknowledge Character	06
<NAK>	Negative Acknowledge	21
<TER>	Termination Character	13
<CHECKSUM>	Checksum (1 byte)	

To calculate the checksum:

```
For (i=0 ; i < strlen ( message ) ; ++i) checksum += message [ i ];  
checksum = checksum %256
```

Protocol:

I - Status information

Parameter 1: 01-(All return parameters will be integers. The PC code should calculate the real values by using the designated divisor.)

Input Information

Parameter 1: Discharge Voltage / 100  
Parameter 2: Discharge Current / 1000  
Parameter 3: Beam Voltage / 1  
Parameter 4: Beam Current / 10 (except IBS-1200: /1)  
Parameter 5: Accelerator Voltage / 10

- Parameter 6: Accelerator Current / 10
- Parameter 7: Cathode Voltage / 100
- Parameter 8: Cathode Current / 100
- Parameter 9: Neutralizer Voltage / 100
- Parameter 10: Neutralizer Current / 100
- Parameter 11: Neutralizer Emission Current / 10
- Parameter 12: Current Recipe. /1
- Parameter 13: Current Time. / 10
- Parameter 14: Current State of Supply.

Return values of state:

- 0 All Off
- 1 to 63 Ramping Source
- 64 Source OK
- 65 to 127 Ramping Beam
- 128 Beam OK

Parameter 15: Error Flag (1 - ON / 0 - OFF)

The third parameter is the number of seconds to repeat the status information indefinitely. A value of zero will send the status only once and will stop the current repetition.

Example:

PC to IBS: I 01 00<TER><CHECKSUM>

IBS to PC: 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000  
0000 0000 0000 0000 0 0<TER><CHECKSUM>

Parameter 2: 02 - Modes (1 is On / 0 is Off)

Input Information

- Parameter 1: Automatic (On) / Manual Mode (Off).
- Parameter 2: Restricted (On) /Unrestricted Mode (Off).
- Parameter 3: Probe (On / Off).
- Parameter 4: Neutralizer (On / Off)
- Parameter 5: Second Filament
- Parameter 6: Auto Restart

Example:

PC to IBS: I 02 <TER> <CHECKSUM>

IBS to PC: 0 0 0 0 0 0 <TER> <CHECKSUM>

Parameter 2: 03 - Limits

Input Information

Parameter 1: Get Cathode Maximum

Parameter 2: Get Neutralizer Maximum

Example:

PC to IBS: I 03 <TER> <CHECKSUM>

IBS to PC: 0000 0000 <TER> <CHECKSUM>

Parameter 2: 04 - Error Flags (On (1) / Off (0))

Input Information

Parameter 1: Discharge

Parameter 2: Beam

Parameter 3: Source

Parameter 4: Accelerator

Parameter 5: Cathode

Parameter 6: Neutralizer

Parameter 7: Neutralizer Emission

Parameter 8: Interlock Open

Example:

PC to IBS: I 04 <TER> <CHECKSUM>

IBS to PC: 0 0 0 0 0 0 0 0 <TER> <CHECKSUM>

Parameter 2: 05 - Recipe

Input Information

Parameter 1: ## - Recipe Number/ 1

Parameter 2: Beam Voltage/ 1

Parameter 3: Accelerator

Type Parameter

0 Accelerator Voltage/ 10

1 Accel / Beam Ratio/ 1000

2 R-Factor/ 1000

Parameter 4: Neutralizer

Type Parameter

- 0 Neutralizer Emission/ 10
- 1 Total Beam Neutralization/ 100
- 2 Neutralizer Filament/ 100

Parameter 5: Cathode Current

Type Parameter

- 0 Beam Current/ 10
- 1 Cathode Current/ 100

Parameter 6: Timer/ 10

Parameter 7: Magnet 1 On/Off

Parameter 8: Magnet 2 On/Off

Parameter 9: Accelerator Type/ 1

Parameter 10: Neutralizer Type/ 1

Parameter 11: Cathode/Beam Type / 1

Example:

PC to IBS: 1 05 01 <TER> <CHECKSUM>

IBS to PC: 0000 0000 0000 0000 0000 0000 0 0 0 0 0  
<TER> <CHECKSUM>

Parameter 2: 06 - Recipe Equipment Constants

Input Information

Parameter 1: Accelerator

Accelerator Voltage0

Accelerator / Beam Ratio1

R-Factor2

Parameter 2: Neutralizer

Neutralizer Emission0

Total Beam Neut.1

Stage Current Neut.2

Neutralizer Filament3

Parameter 3: Cathode

Beam Current0

Cathode Current1

Parameter 4: Discharge Voltage/100

Example:

PC to IBS: I 06<TER><CHECKSUM>

IBS to PC: 0 1 0 400<TER><CHECKSUM>

## Action

Parameter 2: 01 - Beam Action

1 - ON

0 - OFF.

Parameter 2: 02 - Source Action

1 - ON

0 - OFF.

Parameter 2: 03 - Reset errors

Example:

PC to IBS: A 1 1<TER><CHECKSUM>

IBS to PC:<ACK><TER><CHECKSUM>

S - Set information

Parameter 2: 01 - Set Current Recipe.

Parameter 3: ## - Recipe Number \* 1

Example:

PC to IBS: S 01 16<TER><CHECKSUM>

IBS to PC:<ACK><TER><CHECKSUM>

Parameter 2: 02 - Download a Recipe to IBS.

Parameter 3: ## - Recipe Number \* 1

Parameter 4: Beam Voltage \* 1

Parameter 5: Accelerator Method

Equipment Constant Parameter

0 Accelerator Voltage\* 10

1 Accelerator/Beam Ratio\* 1000

2 R-factor\* 1000

Parameter 6: Neutralization

Equipment Constant Parameter

- 0 Neutralizer Emission Current\* 10
- 1 Total Beam Neutralization\* 1
- 2 Stage Current Neutralization\* 1
- 3 Neutralizer Filament Current\* 100

Parameter 7: Cathode

Equipment Constant Parameter

- 0 Beam Current\* 10
- 1 Cathode Current\* 100

Parameter 8: Timer \* 10

Parameter 9: Magnet 1(On) /0 (Off)

Parameter 10: Magnet 2(On) /0 (Off)

Parameter 2: 03 - Set Discharge Volts Default (0 - 75.0) \* 100

Example:

PC to IBS: S 03 400<TER> <CHECKSUM>

IBS to PC:<ACK> <TER><CHECKSUM>

Parameter 2: 04 - Set Cathode Maximum (0 - 30.00) \* 100

Parameter 2: 05 - Set Neutralizer Maximum (0 - 20.00) \* 100

Parameter 2: 06 - Automatic (1) / Manual Mode (0)

Parameter 2: 07 - Restricted (1) / Unrestricted Mode (0).

Parameter 2: 08 - Probe (1-On / 0-Off).

Parameter 2: 09 - Neutralizer (1-On / 0-Off)

Parameter 2: 10 - Auto Restart (1-On / 0-Off)

Parameter 2: 11 - Beam Current - (0 - 999.9) \* 10 - Auto mode only.

Example:

PC to IBS: S 11 1200<TER> <CHECKSUM>

IBS to PC:<ACK> <TER><CHECKSUM>

Parameter 2: 12 - Beam Voltage - (0 - 9999) - Auto/Manual

Parameter 2: 13 - Discharge Voltage - (0 - 99.9) \* 100 - Auto/Manual

Parameter 2: 14 - Cathode Current - (0 - 99.99) \* 100 - Auto/  
Manual

Parameter 2: 15 - Accelerator Voltage - (0 - 999.9) \* 10 - Auto/Man-  
ual

Parameter 2: 16 - Neutralizer Filament Current  $-(0 - 99.99) * 100$  - Manual mode only.

Parameter 2: 17 - Neutralizer Emission Current  $-(0 - 99.9) * 10$  - Auto mode only.

Parameter 2: 18 - Neutralizer Imbalance Current  $-(0 - 999.9) * 10$  - Auto mode only.

Parameter 2: 19 - Neutralizer Recipe Default -

Neutralizer Emission	0
Total Beam Neut.	1
Stage Current Neut.	2
Neutralizer Filament	3

Parameter 2: 20 - Accelerator Recipe Default -

Accelerator Voltage	0
Accelerator / Beam Ratio1	
R-Factor	2

Parameter 2: 21 - Cathode Recipe Default -

Beam Current	0
Cathode Current	1

## Basic Program Sample

The following is a sample basic program run under GWBASIC to act as a control terminal.

```
100 OPEN "com1:1200,n,8,1,rs,ds0" AS #1
200 CLS
300 LOCATE 9,1:PRINT "RECEIVED DATA:"
1000 IF X=0 THEN LOCATE 1,1:PRINT "enter command string:"X=1
1010 X$=INKEY$
1020 IF LEN(X$)=0 THEN 2000
1025 IF X=1 THEN LOCATE 2,1:PRINT " ":A$=X$:GOTO 1050
1030 IF RIGHT$(X$,1)=CHR$(13) THEN 1110
1040 A$=A$+X$
1050 LOCATE 2,X:PRINT X$;:X=X+LEN(X$)
1060 GOTO 2000
1110 CHKSUM=0
1120 FOR I=1 TO LEN(A$)
```

```

1130 CHKSUM=CHKSUM+ASC(MID$(A$,I,1))
1140 NEXT I
1150 C$=CHR$((CHKSUM+13) MOD 256)
1160 PRINT #1,A$;CHR$(13);C$;
1170 X=0:CHKSUM=0
1190 LOCATE 2,1
1200 PRINT "SENT";
1210 FOR I=5 TO 80:PRINT "";:NEXT I
1220 GOTO 2000
2000 Y=LOC(1)
2010 IF Y=0 THEN 1000
2020 IF Z<100 THEN LOCATE 10,Z+1 ELSE LOCATE 11,Z-100
2025 IF Z=0 THEN FOR J=1 TO 80:PRINT "";:NEXT J:LOCATE 11,1
2027 IF Z=0 THEN FOR J=1 TO 80:PRINT "";:NEXT J:LOCATE 10,1
2030 A2$=INPUT$(1,#1)
2035 CHKSM=CHKSM+ASC(A2$)
2040 IF CKSFLG=0 THEN PRINT A2$;:Z=Z+1 ELSE Z=0:CKS-
FLG=0:
GOTO 1000
2050 IF Z=78 THEN Z=101
2060 IF A2$<>CHR$(13) THEN 2000
2062 C2$=INPUT$(1,#1)
2064 LOCATE 12,1: PRINT ASC(C2$),CHKSM MOD 256:CHKSM=0
2066 CHKSFLG=1
2070 GOTO 2000

```

# Appendix E: IBS Accessory Port Specifications

Specification for the IBS Accessory Port, J3.

The IBS Accessory Port, J3, is a 9-pin D-subminiature connector with female pins located on the rear of the power supply. The pin-out is as follows:

Pin	Description
1 & 2	Pins 1 and 2 are the floating contacts of a reed relay which signal a "Source Good" condition, that is, a stable plasma has been established within the ion source. Do not exceed 24 volts and/or 100mA, non-inductive. If the contacts will be controlling a relay coil, the coil must use a suppression diode or transorb.
3 & 4	Pins 3 and 4 are the floating contacts of a reed relay which signal a "Beam Good" condition, that is, a stable ion beam has been established. Do not exceed 24 volts and/or 100mA, non-inductive. If the contacts will be controlling a relay coil, the coil must use a suppression diode or transorb.
5	Pin 5 is the positive side of the Stage Current sensing circuit. If stage current neutralization is to be used, connect the electrically-floating stage directly to pin 5. A 1 ohm shunt resistor is internal to the sensing circuit. Shielded wire must be used.
6	Pin 6 is the negative (or ground) side of the Stage Current sensing circuit. This pin should be connected directly to the stage ground at the chamber.
7	Pin 7 is the SOURCE START remote control input to activate the same functions as the "SOURCE" switch on the front panel. The following conditions are mandatory: Pin 8, and only pin 8, is to be the source of voltage for this input. Connect a normally open floating, dry contact between pins 7 & 8. Do not connect these pins to anything else. Keep the connections to these contacts less than 10 feet long.
8	Pin 8 is a filtered, current-limited 5 volt output to be used only for driving pins 7 & 9.
9	Pin 9 is a remote control input to activate the same functions as the "BEAM" switch on the front panel. The following conditions are mandatory: Pin 8, and only pin 8, is to be the source of voltage for this input. Connect a normally open floating, dry contact between pins 9 & 8. Do not connect these pins to anything else. Keep the connections to these contacts less than 10 feet long.

Do not connect these pins to anything else. Keep the connections to these contacts less than 10 feet long.

## CAUTION

Improper connections to pins 7, 8, and 9 can cause significant damage to the CPU board, especially if they are connected to external voltage sources. Do not connect pin 8 to ground or to a cable shield. Check external wiring before power is applied.

## SOURCE and BEAM Input Operation

Both inputs require a maintained contact closure to operate. Activation of the SOURCE input initiates the sequence to produce a plasma in the ion source. The discharge voltage will climb to maximum, and the cathode will ramp up until a discharge current is obtained. The discharge voltage will then drop to the set point value. The cathode will ramp down until an appropriate idling current is obtained. At this point, the SOURCE GOOD contacts (outputs) will close. With the SOURCE input being maintained, the BEAM input may now be closed. The remaining power outputs will ramp up in sequence to produce an ion beam at the specified set points. When a successful ion beam has been established, the BEAM GOOD contacts will close to indicate this.

- If the SOURCE input is turned off, all the power outputs will sequence down to shut off.
- If only the BEAM input is turned off, the beam, accelerator, and neutralizer supplies will turn off, and the cathode supply will ramp down to maintain an idle discharge.

Both inputs may be closed or opened simultaneously if chosen. The IBS will sequence the outputs in the proper order.

## NOTE

The SOURCE and BEAM inputs are enabled only if a recipe has been ENTERed and the IBS is in automatic mode.

If the front panel SOURCE switch is pressed while the unit is under command of the SOURCE and BEAM inputs, the unit will shut down the power outputs. In other words, the front panel SOURCE switch will always have priority to stop automatic source operation.

The following parameters are displayed, in order, in the SELECT ITEM scroll:

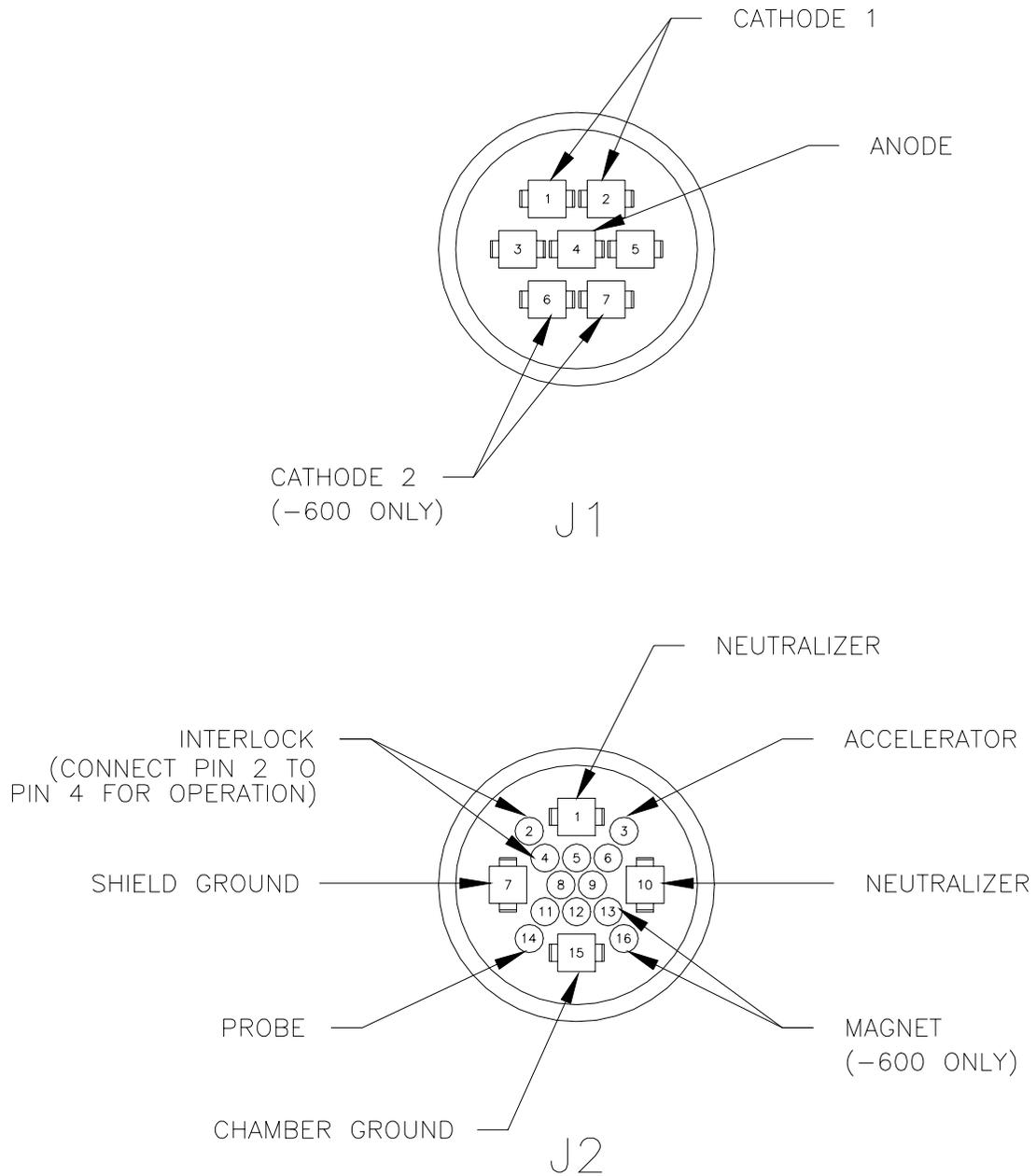
Discharge V:	The power supply set point for discharge voltage. The voltage of the anode with respect to the cathode.
Beam Voltage:	The power supply set point for beam voltage. The voltage of the anode with respect to ground.
Accel Volts:	The power supply set point for accelerator voltage. The voltage of the accelerator grid with respect to ground,. Usually reads zero, unless a specific fixed voltage is desired.
Neut Fil Cur:	The power supply set point for neutralizer filament current. Usually indicates zero. Set only when a specific neutralizer filament current is desired, and no emission feedback is desired.
Cathode Cur:	The power supply set point for cathode current. Cathode filament current. Usually reads zero unless a specific filament current has been set and no feedback control is desired.
Neut Emi Cus:	The power supply set point for neutralizer emission current. May read zero if TBN with an imbalance of zero has been set. In normal TBN operation, the neutralizer emission will automatically track the beam current.
Accel Ratio:	The set point for the ratio of accelerator voltage/ beam voltage. This is a decimal number, less than 1. It is customary to operate with an A/B ratio of 0.15 to 0.20, that is, the accelerator voltage is 15% to 20% of the beam voltage.
Current Recipe:	Indication of the recipe number currently loaded in working memory. When first powered-up, the current recipe will be "00", since no recipe has been ENTERed yet.
Timer Set:	The set point for beam time in minutes. If a non-zero time has been entered, the beam will run for this time, then shut down. If a set point of zero is present, the beam will run indefinitely until stopped by the operator.

Current Timer:	<p>Indication of the elapsed beam time in minutes. This is an indication of how long the ion beam has been running. If a time has been set, the current timer will count down from the set time to zero, then the beam will shut down. If timed operation is interrupted by an error alarm, the current time indication will hold. When the beam is continued, it will continue timing down. If no beam time has been specified (Timer Set = 000.0), the current timer will count up to indicate accumulated beam time. To manually reset this timer to zero, re-ENTER the recipe.</p>
Beam Current:	<p>The set point for beam current. The feedback systems will vary the cathode current in order to obtain the desired beam current. If the cathode current filament limit is set too low, the cathode supply may not be allowed to drive the cathode hard enough to produce the desired beam current.</p>
Neut Imbal:	<p>The set point for neutralizer imbalance current in mA. Usually indicates zero. In normal TBN operation, the neutralizer will adjust itself to produce a neutralizer emission current equal to the beam current (beam matching). If "beam matching" does not provide sufficient neutralization, set the neutralizer imbalance current to the number of milliamps of excess neutralization desired.</p>
Neut Method:	<p>The set point for neutralizer method. Normally set to TBN. The two selections are TBN and SCN.</p> <p>TBN= Total Beam Neutralization or "beam matching".</p> <p>SCN= Stage current neutralization where an external stage current sense line causes the neutralizer emission to vary to bring the net stage current to zero.</p>
A/B or R-Fac:	<p>The set point for accelerator voltage feedback selection. A/B= a decimal number less than 1 which represents the Accelerator voltage divided by the Beam voltage. This is the default selection.</p> <p>R-FAC= "R" factor. <math>R\text{-factor} = A/(A+B)</math></p>
Magnet:	<p>The selection of which preset current (MAGNET 1 or MAGNET 2) is to be applied to the ion source electromagnet. (This applies to 4", 6", 8" sources only. The "cm"-size sources use permanent magnets.)</p> <p>The default setting is "OFF".</p>

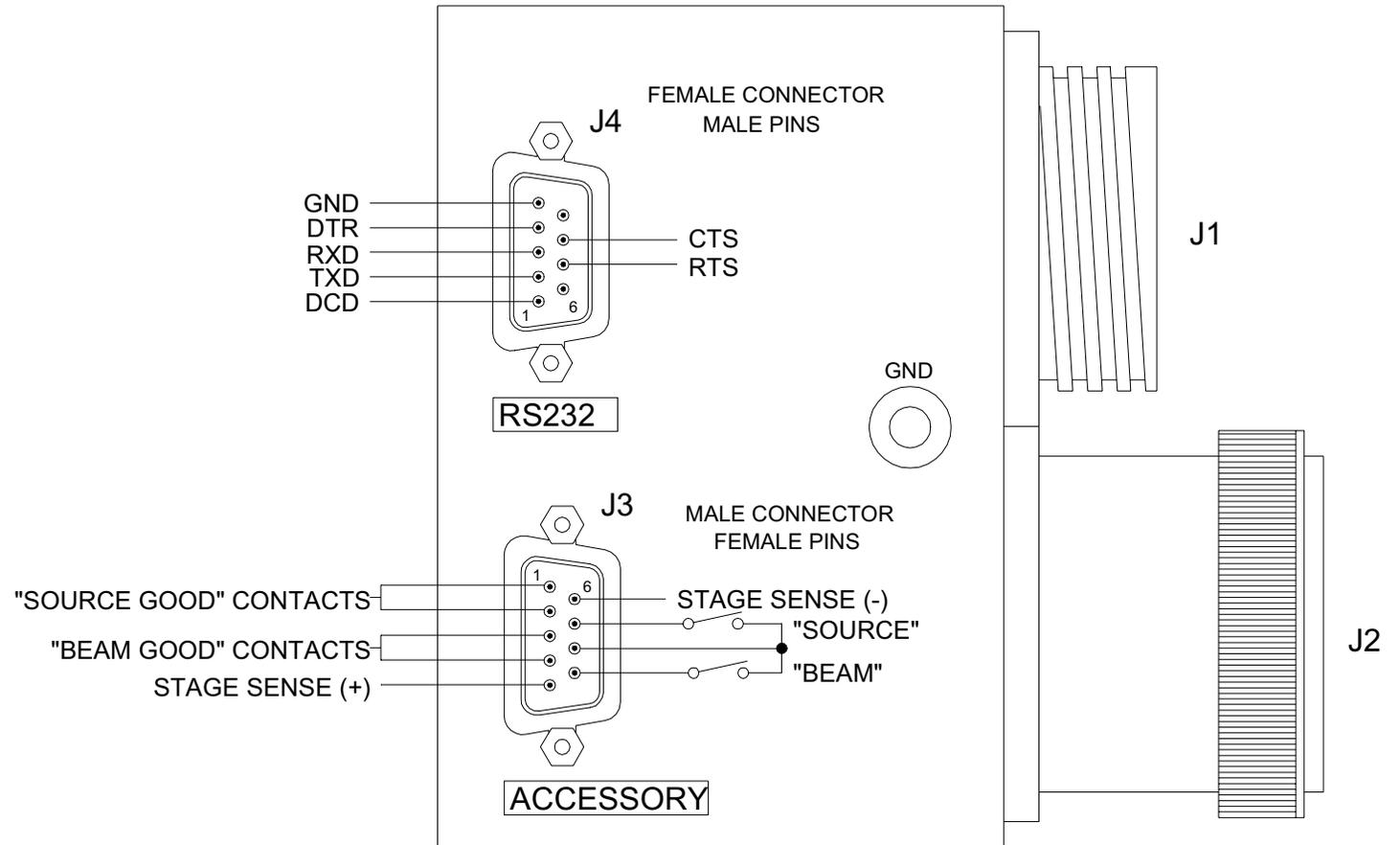
- Notes: There are two modes for magnet supply operation. When operation is via the front panel adjustments, and not via recipes, the manual selection of MAGNET 1 or MAGNET 2 will remain as set. If a recipe is selected, the recipe's magnet setting will override the manual selection.
- In order to “start” the ion discharge more easily, the magnet supply will turn off temporarily during a SOURCE start. When the BEAM button is pressed and the beam sequence has begun, the magnet supply will turn back on.
- C Fail Restart: The selection of automatic beam restart after a cathode failure (AUTO), or no auto restart (“OFF”). This selection cannot be stored in a recipe.
- Chain: The selection to activate the recipe chaining option. Refer to [“Chaining Operation” on page 20](#) . This selection cannot be stored in a recipe. The list of recipe numbers which forms the chain also cannot be stored to a recipe.

# Appendix F: Figures

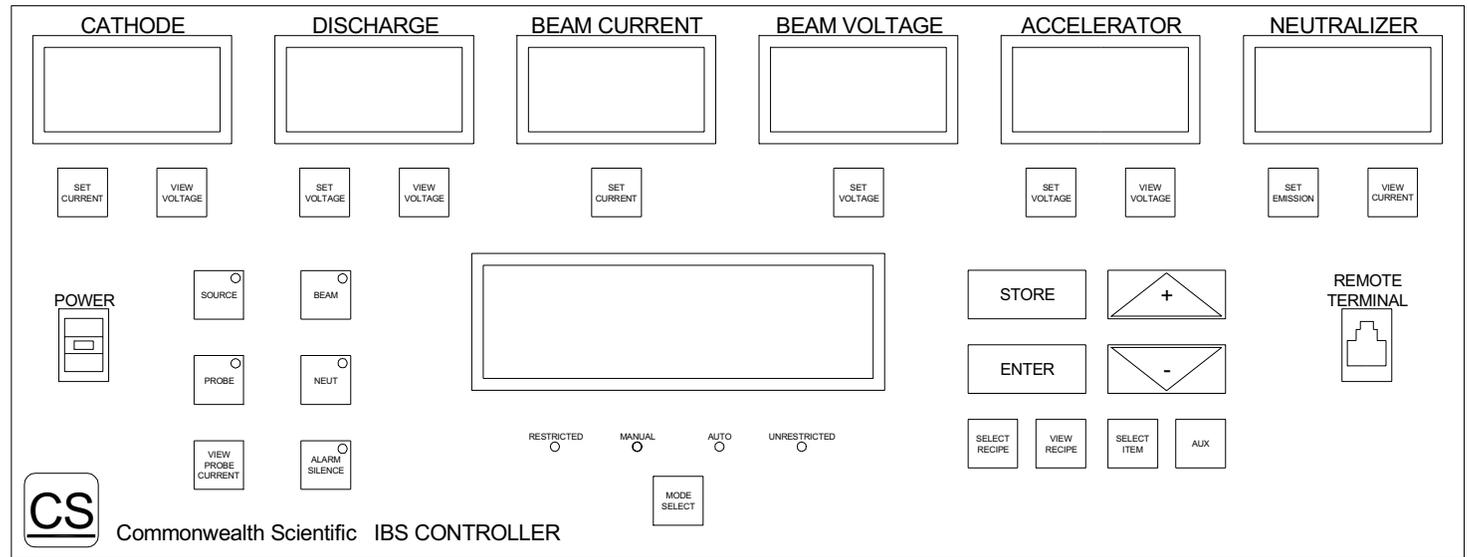
**FIGURE F.1** Connections to Ion Source



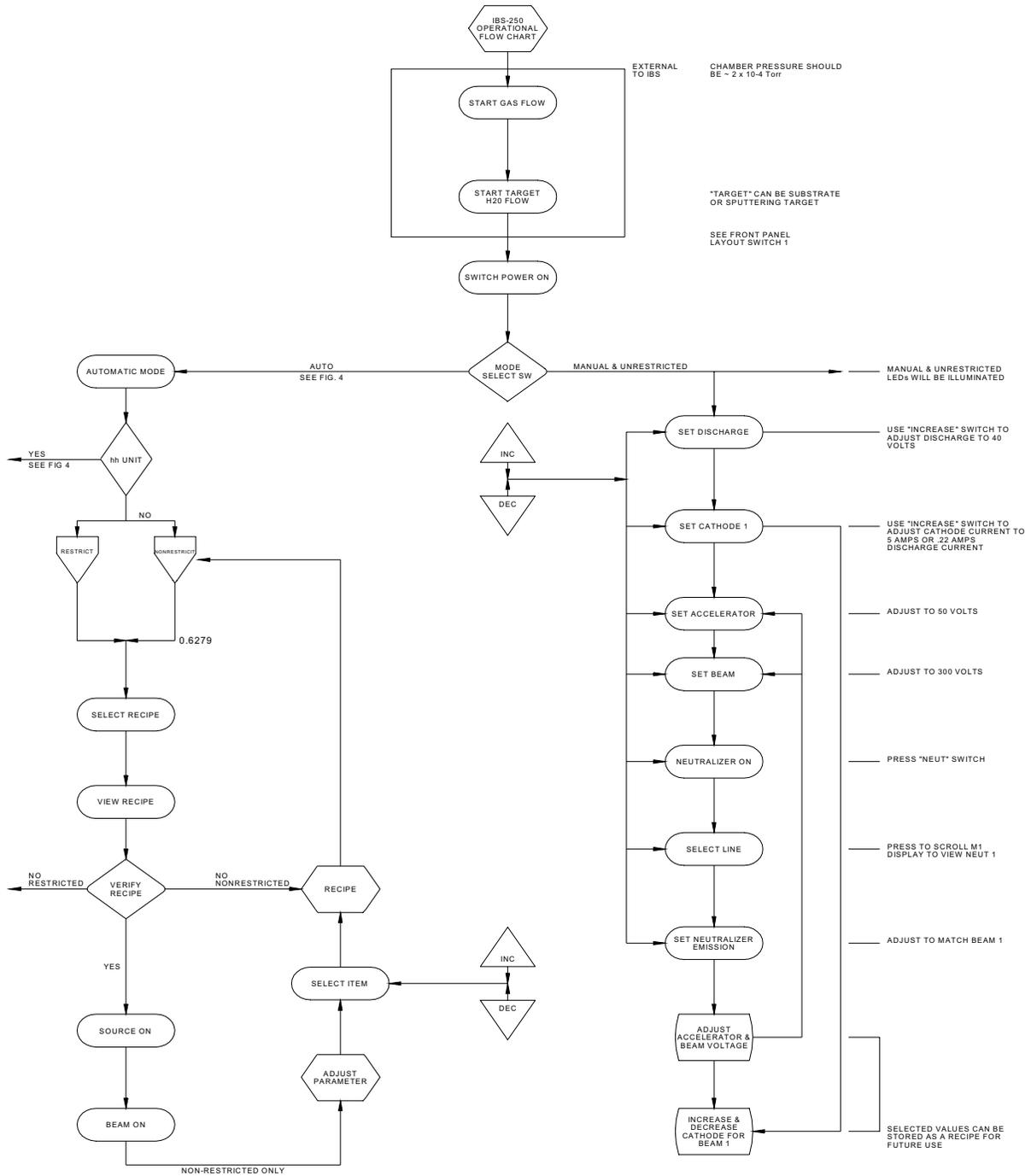
**FIGURE F.2** Rear Panel  
Accessory Connector



**FIGURE F.3 Front Panel Layout**

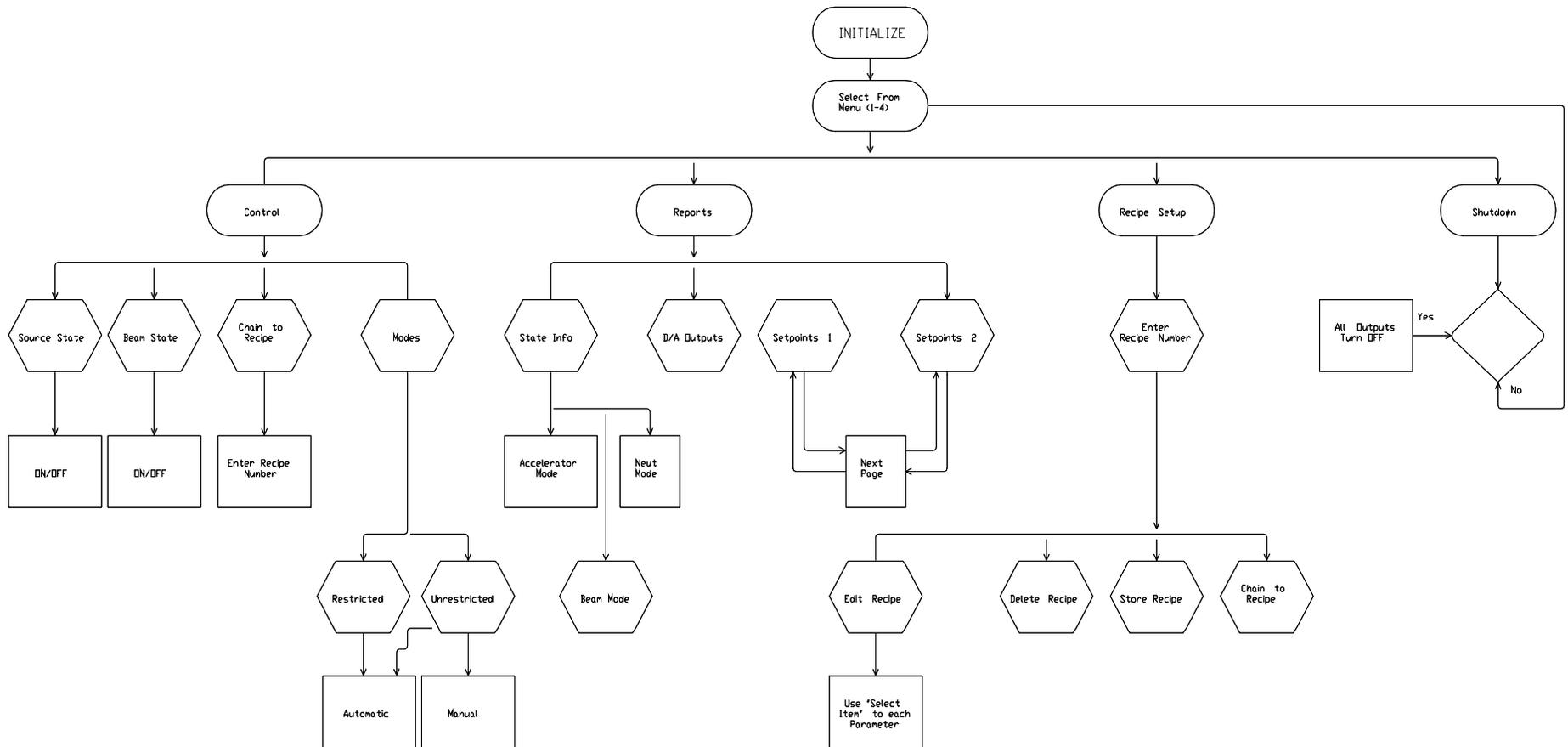


**FIGURE F.4 Manual and Automatic Operation**



**FIGURE F.5 Handheld Terminal Operation**

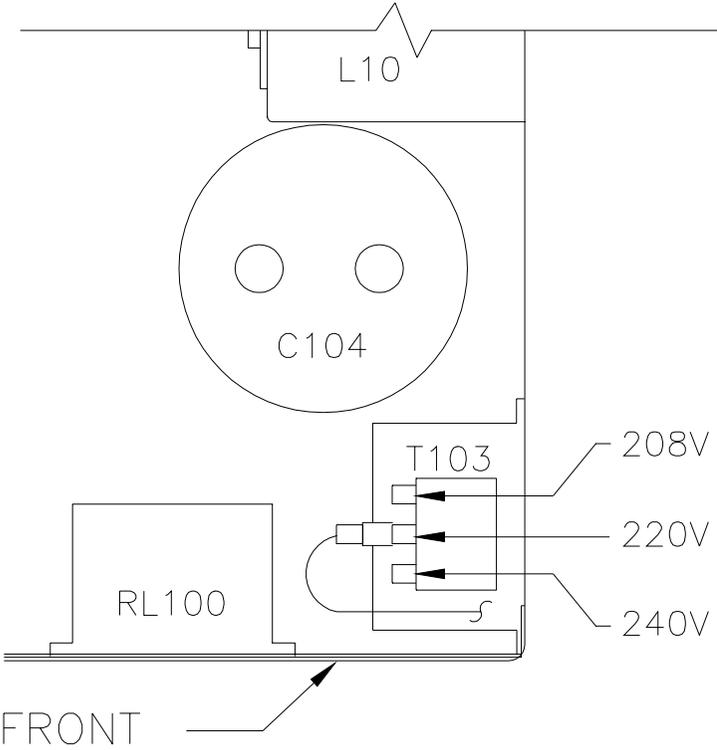
## OPERATION OF HAND-HELD TERMINAL



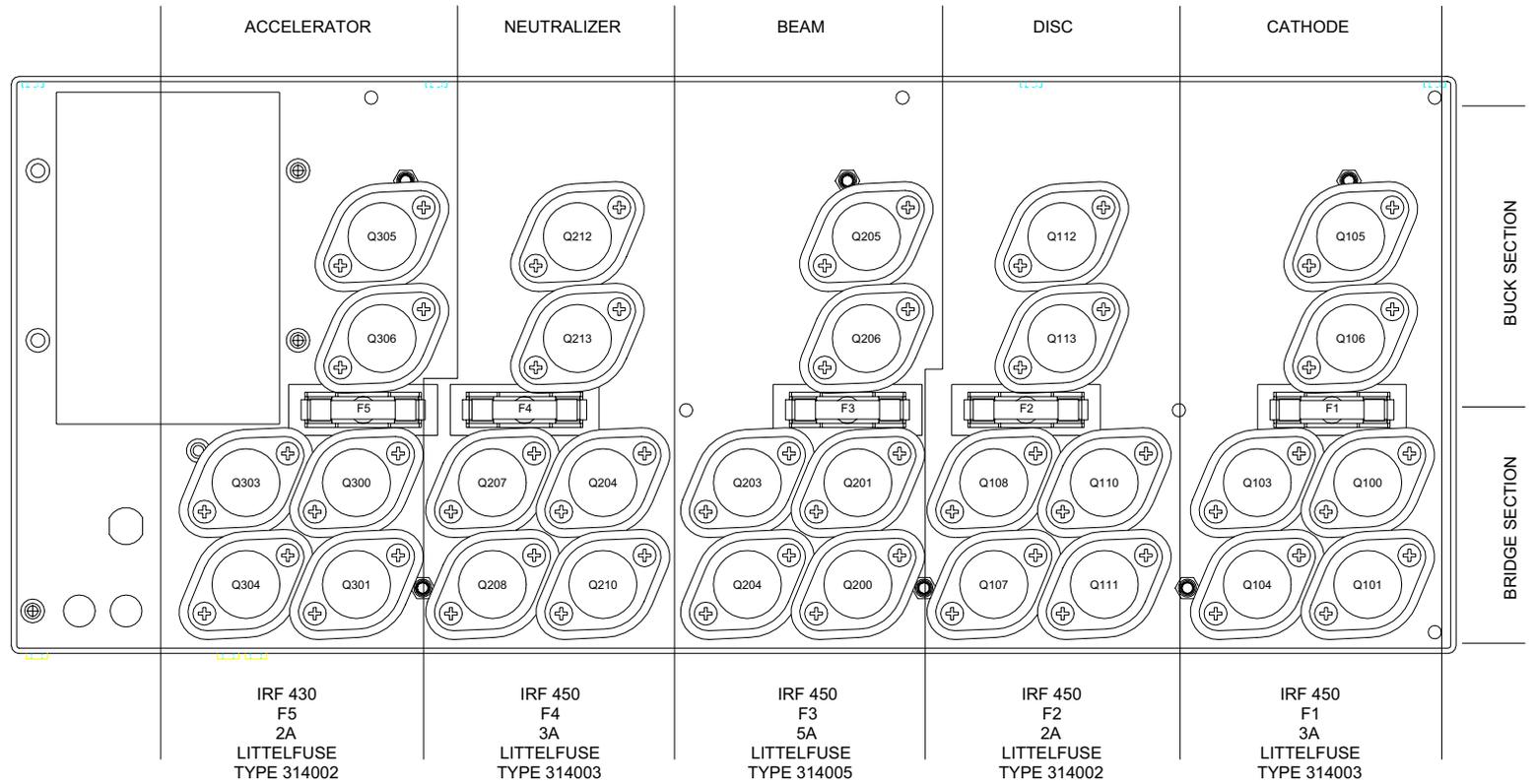




**FIGURE E.7 Control Transformer Connections**



**FIGURE F.8 Output Transistor Locations**



IBS 250

△ 1 BUSSMAN ABC-SERIES MAY ALSO BE USED.

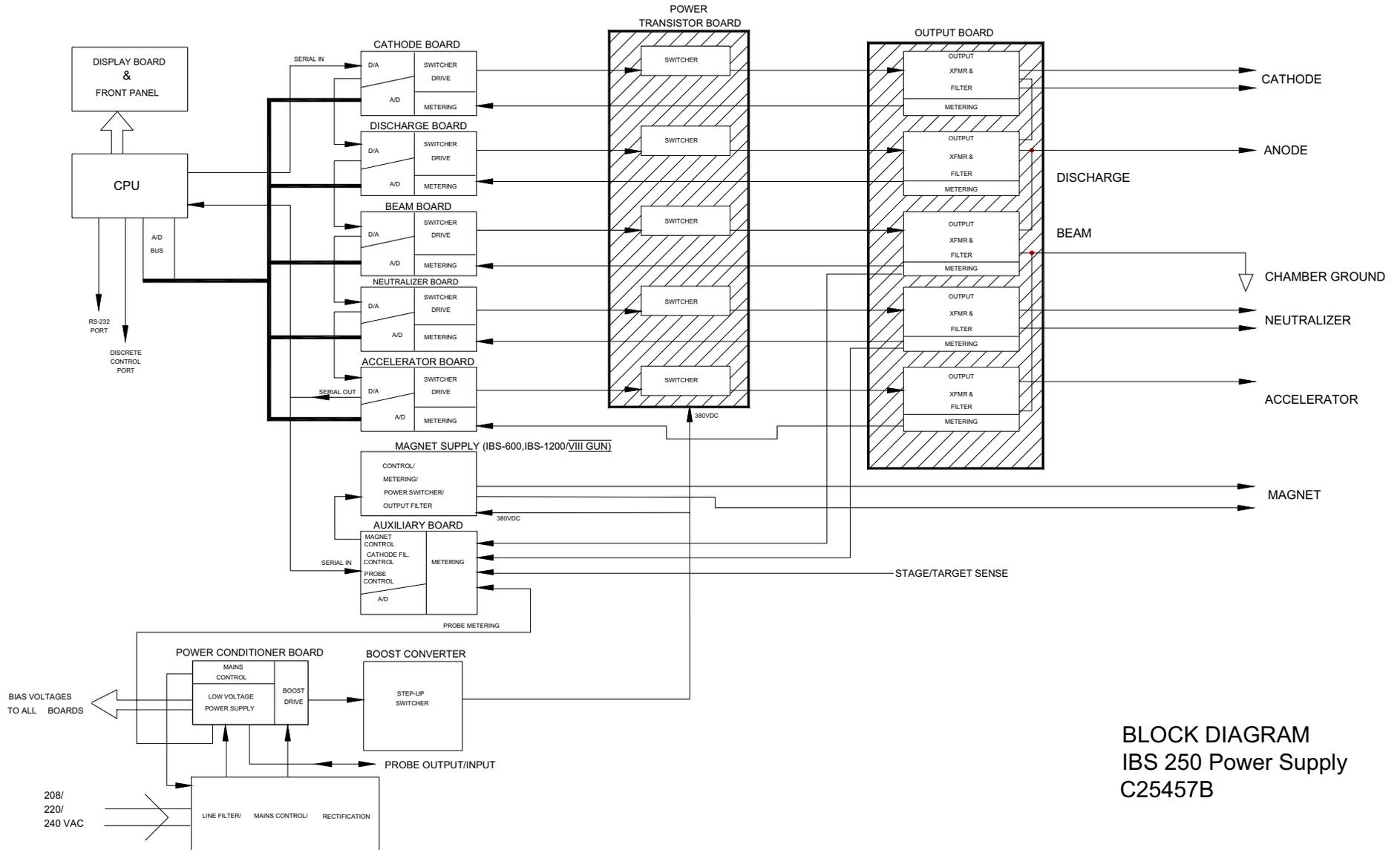
**Table 1: Filament Current Limits**

**Table 1: Filament Current Limits**

Wire Size (in dia)	Maximum Current	Source
.010 W	9.0 A	3cm
.016 W	15.0 A	8cm

# Appendix G: Drawings

## Block Diagram IBS-250



**BLOCK DIAGRAM  
IBS 250 Power Supply  
C25457B**

# Electrical Schematic Interconnect IBS-250 (Pg 1-2)

