

Instruction Manual

*ION SPUTTERING GUN AND  
POWER SUPPLY, Model IPS3-D*

This product is intended to be  
professionally installed and operated



**Vacuum  
Microengineering**

Surface - Vacuum Analytical Instruments & Technology

Tel. (519) 457-0878, Fax (519) 457-0837

E-mail: [oci@gtn.net](mailto:oci@gtn.net)

340 Saskatoon St., London, Ontario, Canada N5W 4R3

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## I. INTRODUCTION

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The Ion Sputtering Gun, Model IG35/70, is an instrument for cleaning surfaces of the samples and for depth profiling for Auger Electron Spectroscopy. The gun produces high density ion beam of inert gases.

The basic instrument layout is a combination of an ion source and an electrostatic lens configuration for accelerating and focussing. The instrument is equipped with the mini flange port for the direct gas inlet to an ionization cell, which maximizes the pressure difference between the main chamber and ion source. The gun is also equipped with the port for the differential pumping.

The long life filament is directly mounted on the feedthrough flange for convenient replacement. The gun is mounted on a CF flange (1.33"/2.750", 35/70 mm O.D.).

The Ion Sputtering Gun is controlled by Power Supply Model IPS3 with the operating beam energy 0-3000 eV. The beam energy, filament current and emission current are monitored by digital panel meters.

## II. SPECIFICATION

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### Ion Sputtering Gun, model IG35/IG70

Mounting to Vacuum System	1.33" /2.75" (35/70 mm) O.D. conflate flange
Beam Energy	Variable, 0-3000 eV
Beam Current	15 $\mu$ A at 3 keV and with $5 \times 10^{-6}$ Torr of Ar and 15 mm beam size
Ion Source	Electron impact ionization in magnetic field
Bakeability	up to 220 °C
Overall Sizes	12.5 mm lens diameter and 75 - 220 mm length of drift tube for IG35 and 29 mm lens diameter and 20-100 mm long of drift tube
Conductance	0.52 l/sec (vacuum path from ion source to exit aperture) for IG35

### POWER SUPPLY (Model IPS3-D)

Input Power	100/110V A-C, 50/60 Hz 220V A-C, 50 Hz (optional)
Display	vacuum fluorescent display for filament current and beam energy, emission current and program functions
Setting and Monitoring:	
1. Filament Current:	0 - 3.5 A
2. Emission Current:	0 - 40 mA
3. Grid Voltage:	120 - 150 V
4. Beam Voltage:	0 - 3200 V
5. Focus Voltage:	factor 0.8 - 0.3 of beam voltage
6. Manual Control:	manual control of all voltages via rotary dials and selection buttons, manual programming available
7. On-board Automation	10 adjustable operating programs and also outgassing, stand-by, filament forming, constant emission current, diagnostics programs
8. PC Control:	full control of all functions, PC software is required
9. Protection:	over-voltage, over-current and short circuit protection
10. Mechanical:	19" rack mount box with 3U ( 5.25", 133 mm) in height and 17.5" (440 mm) in depth, weight: 12 kg

### III. INSTALLATION

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#### WARNING

HIGH VOLTAGES EXIST IN VARIOUS PARTS OF THIS INSTRUMENT. SPECIAL CARE SHOULD BE EXERCISED WHEN OPERATING WITH THE PROTECTIVE COVERS REMOVED.

#### CAUTION

The instrument is a fragile device and must only be handled by personnel trained for ultra high vacuum.

#### III.1. Initial checks

Please check for any signs of physical damage that may have occurred in shipment. If any damage is found, contact your shipping agent immediately; otherwise, you may unpack the equipment.

The Ion Sputtering Gun has been shipped protected by a clean plastic container. Remove the cover carefully and check the gun for obvious loose connections, electrical shorts or damage. Install the gun in the vacuum chamber as soon as possible after opening the container.

*Using ohmmeter check the ion gun:*

1. Filament continuity: resistance between pins B-D for IG35 and A-E or D-E for IG70 less than 0.5  $\Omega$
2. Pin-to pin shorts: no shorts between pins and to ground

#### III.2. Mounting on Vacuum System

- ▶ The vacuum flange on the Ion Sputtering Gun is a "Conflate" flange with a 1.33"/2.750" O.D. diameter and inside clearance of 0.625"/ 1.35". The seal can be made using either a copper gasket or an appropriate rubber or Viton gasket, depending on the nature of the vacuum system application. The instrument can operate in any position.
- ▶ Install a clean source of inert gas using variable leak valve.
- ▶ Blank off port for differential pumping if it is not used.

### III. INSTALLATION

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**NOTE:**

- The ion gun has two permanent magnets(IG35) and one (IG70) located outside of ion source and held by aluminum cap. This cap can be very easily removed by taking off 2 screws for IG35 and removing clamp for IG70.
- The cap should be removed before baking the ion gun to the temperature above 200°C.

#### III.3. Electrical connections

- ▶ Check the voltage labelling on the power input socket for correct setting for your supply level. Check that the correct fuse is installed. If necessary, replace the fuse.
- ▶ Ensure that the power switch is in the OFF position.
- ▶ Plug the electron gun cable into the rear panel to match labelling and plug the other end into the gun 4 or 6 pin and MHV feedthrough only for IG35
- ▶ Plug in the power cable.
- ▶ Now the instrument is ready to operate as a self-contained unit.  
(see operating instructions section V)

#### IV. PRINCIPLE OF OPERATION AND CONSTRUCTION

The ion gun consists of an ion source with external permanent magnets and electrostatic lenses. Electrons emitted by the filament are accelerated into the cylindrical tube by a positive potential. The magnetic force lines are formed axially at the centre of magnets position and magnetic mirror field with a divergent field is formed at the exit. This external magnetic field extends electron path and enhance ionization of inert gas atoms in the cell. The ions are accelerated toward the extractor, form the beam and are focussed on the target.

At room temperature the filament can be exposed to atmospheric pressure repeatedly without impairing its emission characteristic.

The power supply delivers all necessary voltages and current to operate the Ion Sputtering Gun. The power supply consists of the filament current regulator, fixed voltage for grid, one control circuit for beam voltage and focus voltage. The beam voltage, filament current and emission current are displayed by panel meters.

The schematic setup of the electrical connections is shown in Fig.1.

## V. OPERATING INSTRUCTIONS

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The IPS3-D is designed to control ion guns manufactured by OCI. The voltage outputs are set from the front panel via digital controls using an on-board microprocessor. The front panel board is the all-digital control electronics with vacuum fluorescent display. The main board contains analogue controls, power supplies and high voltage modules. The high voltage control and monitoring circuits are optically isolated from the digital electronics. All the voltages and currents displayed on the front panel are measured at the output points. The operating condition of the ion gun is continuously monitored using this controller.

1. The Ion Gun operates in the vacuum system at a pressure less than  $1 \times 10^{-5}$  Torr in main chamber to prevent destruction of the electron emission filament.
2. Set the front panel controls as follows:
  - ▶ turn the power switch on; the main power indicator lamp lights and the front panel display is activated.
  - ▶ slowly set the filament current to 2.7 - 3.2 A (3.3 A maximum) to have 30-40 mA emission current and monitor the pressure in vacuum system; reduce the filament current to zero Amps if the pressure rises above  $1 \times 10^{-5}$  Torr
  - ▶ for thoria coated iridium filaments use current: 5.1 - 5.8 A
  - ▶ set the beam energy to the desired value, for example 0.5- 1 kV
  - ▶ set the focus voltage for optimum operation, maximum beam current

The IG70 uses an external magnet. If you are changing from Filament No.1 to Filament No.2 the magnet positions require to be flipped-over 180 deg. with respect to the gun axis. Otherwise the beam current is very low.

The position of the magnet should be adjusted for maximum beam current.

3. Slowly fill the ion gun with the inert gas to the pressure  $5 \times 10^{-6}$  Torr measured in the main chamber.
  - ▶ Set the beam voltage to value 1.0 kV.
  - ▶ Monitor the ion beam current on the sample.
  - ▶ Adjust focus voltage to maximum beam current.
  - ▶ Increase the beam voltage to operating conditions and adjust focus to maximum beam current.
  - ▶ adjust the magnet position to maximum beam current
  - ▶ model IG70 require flipping the external magnet by 180 deg. if the filament is changed from Filament 1 to Filament 2 in order to get maximum beam current

The beam current can be measured by connecting the micro-amperometer between floating target (sample) and the ground.



## Front Panel

1. Focus switch: sets focus voltage factor between 0.3 - 0.85 of Beam Voltage (0-3200V).

2. Mode buttons:

SELECTION – selects OPERATING or PRE-SETTING mode

SAVE – saves the parameters for two above modes.

3

Display buttons:

PROGRAM/TIMER – starts the timer while the instrument is in operating mode or selects programs while the instrument is in pre-setting mode

FILAMENT CURRENT – activates filament current adjusting

FILAMENT ON/OFF – turns filament on/off or activates setting of X-deflection voltage

CONSTANT EMISSION CURRENT – activates constant current mode for the value measured at the time of switching or activates adjustment of Y-deflection voltage

BEAM ENERGY – press once to activate adjustment of Beam Voltage, press again to active adjustment of XY-deflection voltage

4. The Settings: the knob on the front panel to adjust the filament current, beam energy voltage and XY-deflection voltages.

5. Protection indicators:

FIL. CURRENT – indicates filament protection error

BEAM VOLTAGE – indicates Beam Voltage protection error.

6. Power control buttons:

ON/OFF – activates AC Power and starts the instrument in the pre-setting mode.

SHUT DOWN – works only in operating mode for programs 1-10.

**CAUTION:** SHUT DOWN button must be pressed before ON/OFF button in order to turn the power supply off.

## REAR PANEL

**CAUTION:** Do not connect or disconnect the ion source gun cable when the instrument is working!  
Turn the power supply off before any operations with this cable.

## PROGRAM SELECTION MENU

**Mode: OPERATING**

PC CONTROL  
PROGRAM 1 ... 10  
STAND-BY  
OUTGASSING

**Mode: PRE-SETTING**

PC CONTROL  
PROGRAM 1 ... PROGRAM 2  
STAND-BY  
OUTGASSING SETUP  
TIMER  
FILAMENT FORMING  
SELF-TEST  
DEFAULT

### Quick Start-Up

1. Be sure that IPS3-D power supply is turned OFF.
2. Connect the cable from ION SOURCE GUN to IPS3-D power supply.
3. Turn the power supply ON. The display will show default parameters of Filament current and Beam Voltage of the last selected program.
4. Rotate the SETTINGS knob to change the parameters (i.e. filament current, beam energy voltage, xy-deflection voltage).
5. Press SELECTION button to load values of these parameters.
6. If filament is off press FILAMENT ON/OFF button: the filament current will go to pre-set value.
7. To change the values of filament current or Beam Voltage press appropriate button and rotate the SETTINGS knob.
8. To save the values press SAVE button.

### Changing Program

To change the program press SELECTION button and rotate SETTINGS knob to select another program. Press PROGRAM button and then press SELECTION button. The program will change filament current and Beam Voltage values to the new program settings.

### Saving Program

To save the program settings in operating or pre-setting mode press SAVE button.

### **Shut-down**

Press SELECTION button to change mode to operating. To shut down press the SHUT DOWN button. Beam Voltage and filament current will be reduced to zero. Next turn the power switch off after you see "YOU CAN TURN POWER SUPPLY OFF" message on the display.

## **SPECIAL FEATURES**

### **Setup**

This program sets hardware limit of beam energy and filament current. Select SETUP program in presetting mode. To change the values of filament current or beam voltage press appropriate button and rotate the SETTINGS knob. Press the SAVE button to save parameters.

### **Change filament**

Select SETUP program in presetting mode. Press FILAMENT CURRENT button twice and then rotate SETTINGS knob. Press the SAVE button to save.

### **Timer**

Timer program will automatically change current program to pre-setting one. Press PROGRAM SELECTION button to change mode to presetting and select TIMER program. Press PROGRAM button and rotate SETTINGS knob to set time value. Press SETTINGS knob and rotate it to change active minutes or hours setting. Press the SAVE button to save. Change pre-setting program by rotating of SETTINGS knob and press the SAVE button to save.

### **Filament Forming**

Press PROGRAM SELECTION button to change mode to presetting and select FILAMENT FORMING program. The controller will perform filament forming to pre-set value selected in SETUP program. Forming rate is 0.02mA per minute.

### **Diagnostic**

Press PROGRAM SELECTION button to change mode to presetting and select SELF-TEST program. The controller will perform self- test. If the filament cable is not connected or is broken the error message will be displayed.

### **Erase Saved Parameters:**

Press PROGRAM SELECTION button to change mode to presetting and select DEFAULT program. Press simultaneously SAVE, FILAMENT ON/OFF and CONSTANT EMISSION CURRENT button. The saved values will be erased from the memory for all programs.

## V. OPERATING INSTRUCTIONS

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**NOTE #1:** Outgas the ion gun before starting sputtering by operating in ultra high vacuum.

**NOTE #2:** The high voltage section of the power supply has the overvoltage protection. In the situation when the high voltage starts to arc, the power of the high voltage module is automatically turned off. To start it again one has to turn "off" and "on" again the main power switch .

The situation when the frequent automatic shutting off exists, means that the pressure in the chamber is too low or the electric interference with other devices takes place.

## VIA. ROUTINE MAINTENANCE (filament replacement for IG35)

To confirm that the filament has blown measure the resistance between pin B-D for IG35. Resistance should be 0.5  $\Omega$  or less. If you measure a larger resistance or open circuit then change the filament.

- ▶ Remove the 4 pin feedthrough from the ion gun.
- ▶ Mount the new filament in the special parallel clamp. In order to do this, install the clamp horizontally in the vise and put horizontally filaments. Clamp slightly only the upper section of the filament socket. Avoid clamping filament wire. Adjust the distance between two filament socket to match the space on the feedthrough's pins. When the adjustment is done - tighten the clamp and remove whole assembly from the vise.
- ▶ Mount the feedthrough vertically in the vise.
- ▶ Disconnect the old filament socket from the feedthrough and replace the gasket on the flange.
- ▶ Slowly insert new filament socket onto the feedthrough's pins by holding the clamp. The distance between the end of the filament and flange face should be 56-57 mm.
- ▶ Remove the clamp and make sure that the filament is symmetrical over the axis of the feedthrough. If not, make adjustment by bending the pins. The position of the filament is not very critical, but significantly un-symmetrical position will lead to the shortage between grid and filament.
- ▶ Insert feedthrough to the ion gun. Avoid any displacement which might cause damage of the filament.

**Make sure that the grid pin is making contact to the inner cylinder of the ion source.**

If necessary, bend out the elastic ribbon. Keep the elastic ribbon facing out from the outside filament assembly. No contact to the inner cylinder is causing that the emission current is very low (about 4 mA) at the maximum filament current - 3.3A.

For better filament-grid pin alignment use plastic jig. Insert jig on filament assembly flange and check the alignment.

- ▶ Check the resistance of the new filament between its leads and no shortage to the other pins and ground.
- ▶ To achieve the maximum of ion beam current with the new filament the position of the permanent magnets located outside of ion source might require adjustments. This can be done during operating conditions by loosening the 2 long bolts holding the aluminium cap and 4 knurled thumb nuts holding the two magnets (one on each side).

## VI B. ROUTINE MAINTENANCE (filament replacement for IG70)

To confirm that the filament has blown measure the resistance between pin A-E or D-E for IG70. Resistance should be 0.5  $\Omega$  or less. If you measure larger resistance or open circuit then change the filament. It is a good habit to replace both filaments at the same time.

- ▶ Unscrew the 6 pin feedthrough.
- ▶ Remove it slowly and carefully from the ion gun body.  
Some models are equipped with an internal focus pin-socket connector which has to be disconnected with two pairs of needle nose pliers or tweezers.
- ▶ Mount the feedthrough vertically in a vise.
- ▶ Remove old filament connectors and discard them.
- ▶ Replace the gasket on the flange.
- ▶ Install new filaments. Replacement filaments are significantly shorter than the distance between the filament connectors. Insert the bent male connector into the upper socket. Repeat the same procedure for the other filament. Grasp the female filament connector with a pair of pliers. Stretching the filament wire to the desired length sleeve the socket onto the lower pin. Follow the same procedure for the other filament. At this time the filament common post will be repositioned toward the anode due to a spring action of the filaments. Do not attempt to straighten it. The post will come back to its normal position once the filaments are heated. Make sure the post doesn't touch the anode. Keep the elastic ribbon on the post facing out. If necessary bend it out. Filaments seen from the side view should be positioned symmetrically and parallel to the anode. If they are not, make adjustment by bending the lower pins or the common post. Avoid large displacement as it may cause damage to the filaments.
- ▶ Remove the feedthrough from the vise. Insert it carefully into the gun body. Make sure the filament common post is on the opposite side of the gas inlet. Do not touch the gun walls with filaments. The flange should be oriented this way that the flange slots are matched and the filament common pin is facing opposite side than the gas inlet. Fasten the feedthrough with bolts and nuts.
- ▶ Check the resistance of the new filaments between their leads and make sure there is no shortage to the other pins and ground.
- ▶ To achieve the maximum of ion beam current with the new filament the position of the permanent magnet, located outside of ion source, might require adjustments. This can be done during operating conditions by loosening the wing nut holding the aluminium half rings and moving the magnet assembly back and forth. If the ion beam current is too low open the magnet assembly and flip over the magnet. Flipping over the magnet will be required after switching to the filament No. 2.

## VII. TROUBLESHOOTING GUIDE

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**HIGH VOLTAGES (3KV) ARE PRESENT WITHIN THE POWER SUPPLY, CABLES AND ION GUN, CAPABLE OF CAUSING INJURY OR DEATH.  
USE EXTREME CARE WHILE TROUBLESHOOTING WHEN POWER IS APPLIED.**

1. Filament current is zero when the filament knob is turned clockwise (CW):
  - a) ion gun is not connected with cable
  - b) filament is blown, check the resistance between pin B-D for IG35 and B-F or E-F for IG70 on the feedthrough and replace filament ( switch cable to Filament#2 for model IG70)
2. Emission current is zero or is below 5 mA when the filament current is set to 2.5 - 3.3 A:
  - a) check the voltage on the pin G at the rear panel connector J10 and gun connector pin A for IG35, pin F for IG70 it should be 190 - 200 V,  
-if there is not voltage check the front panel board and replace front panel fuse,  
-if there is the voltage, the pin in ion gun is not making the contact to the Grid, take the filament feedthrough off the ion gun and replace the socket for the Grid contact.
3. Emission current is 55 - 65 mA at zero filament current:
  - a) the pin of the Grid is shorting to the Filament pin in the ion gun,  
-take off the Filament feedthrough and remove shortage
4. Beam Voltage is zero at the knob set clockwise:
  - a) turn switch External Voltage Control to "off" position
5. Beam Voltage monitor and power switch light is off:
  - a) reduce the beam voltage and turn power switch "off" and "on" again

## VIII. WARRANTY

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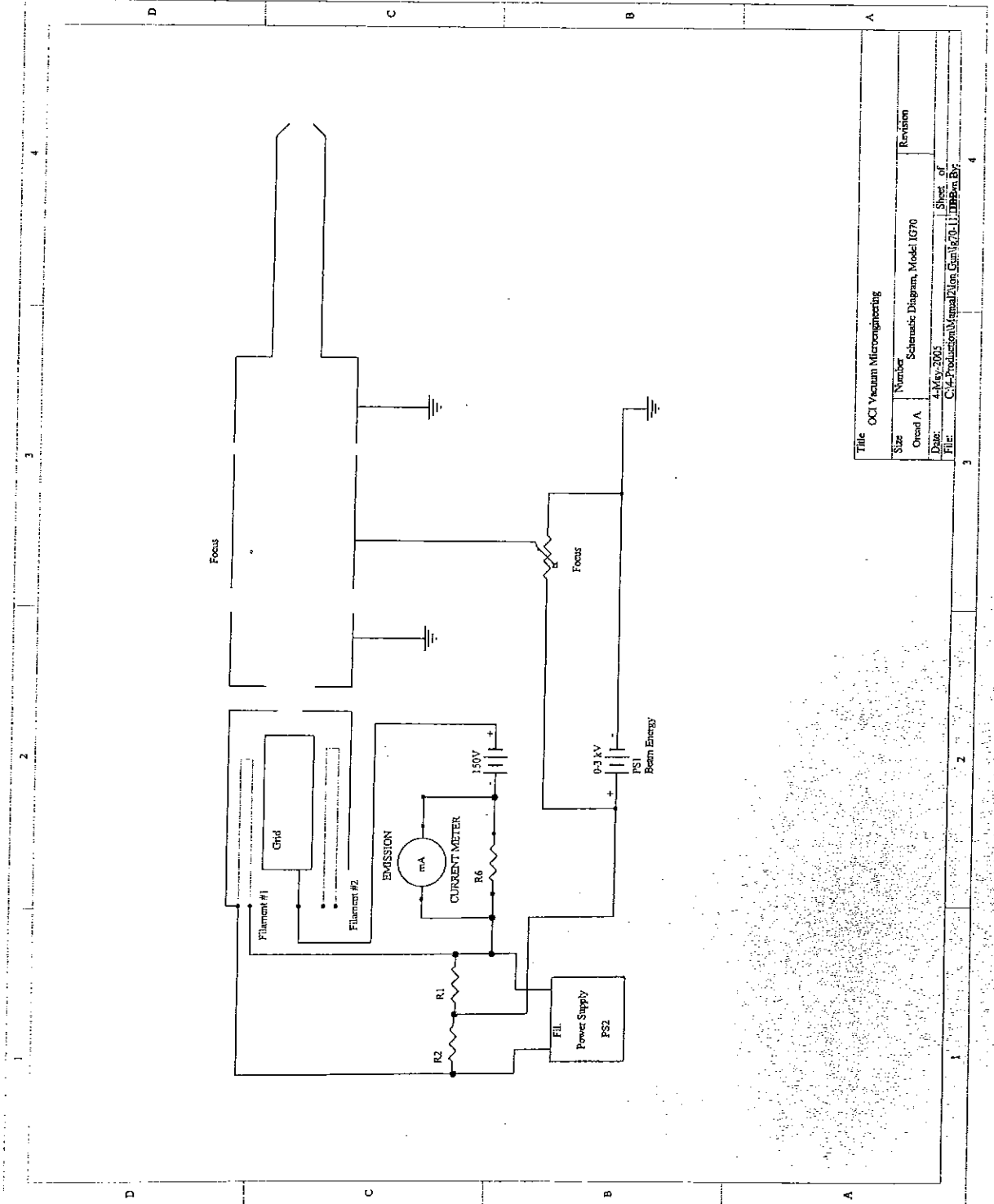
Products manufactured by OCI Vacuum Microengineering are warranted to be free from all defects in materials and workmanship for one year from the date of shipment to the original purchaser. The liability of OCI Vacuum Microengineering under this guarantee is limited to servicing, adjusting or replacing defective parts subject to the following conditions:

- the product is returned to the factory transportation charges prepaid and undamaged by the failure to provide sufficient packaging.
- the product appears, to OCI Vacuum Microengineering's satisfaction that the defect is no fault of the user
- the equipment has been operated in accordance with the instructions and advice detailed in the appropriate operating instruction manuals or any other advice which may be provided by OCI Vacuum Microengineering.

The guarantee does not apply to:

- consumable items
- components which are outside the component manufacturer's usual guarantee period
- filaments



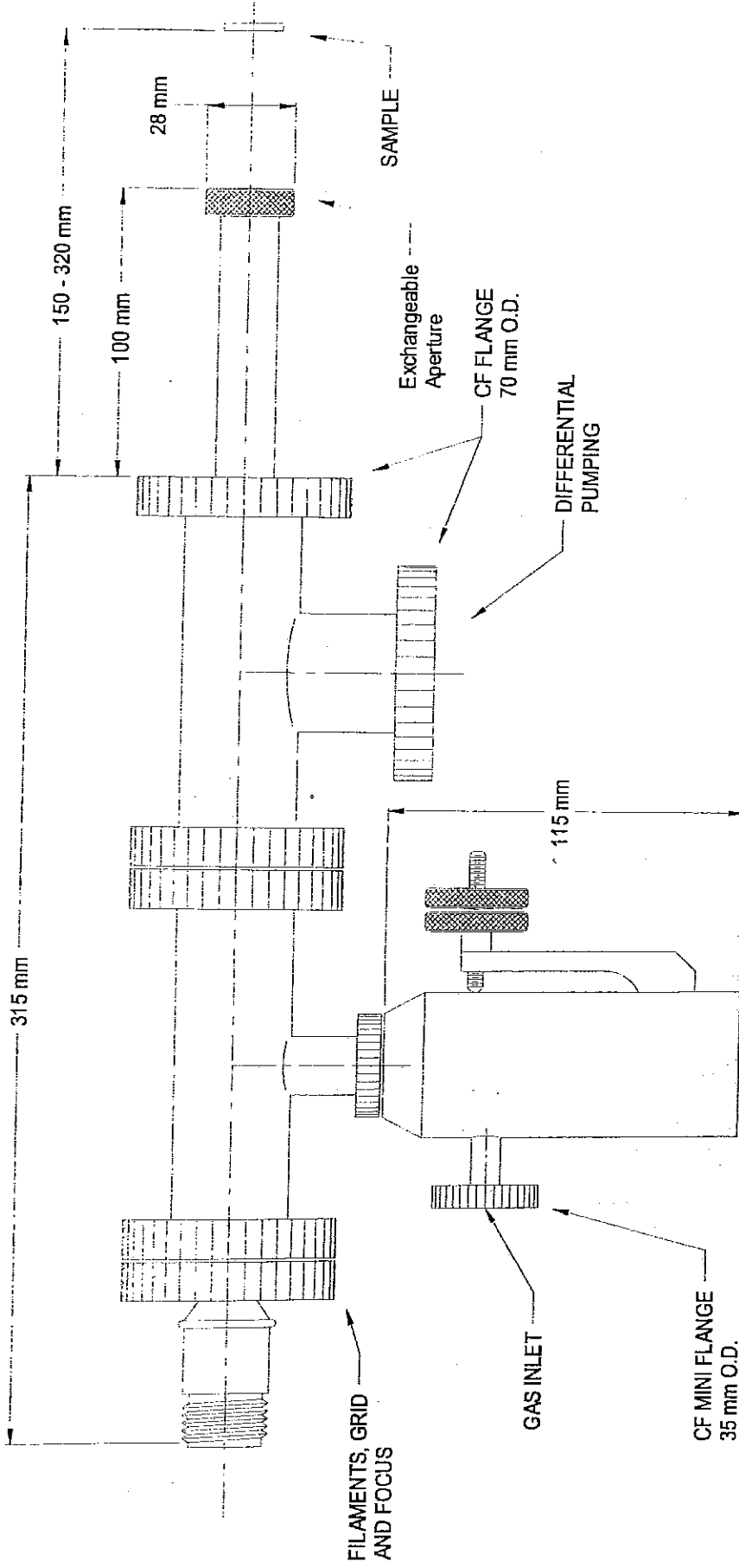


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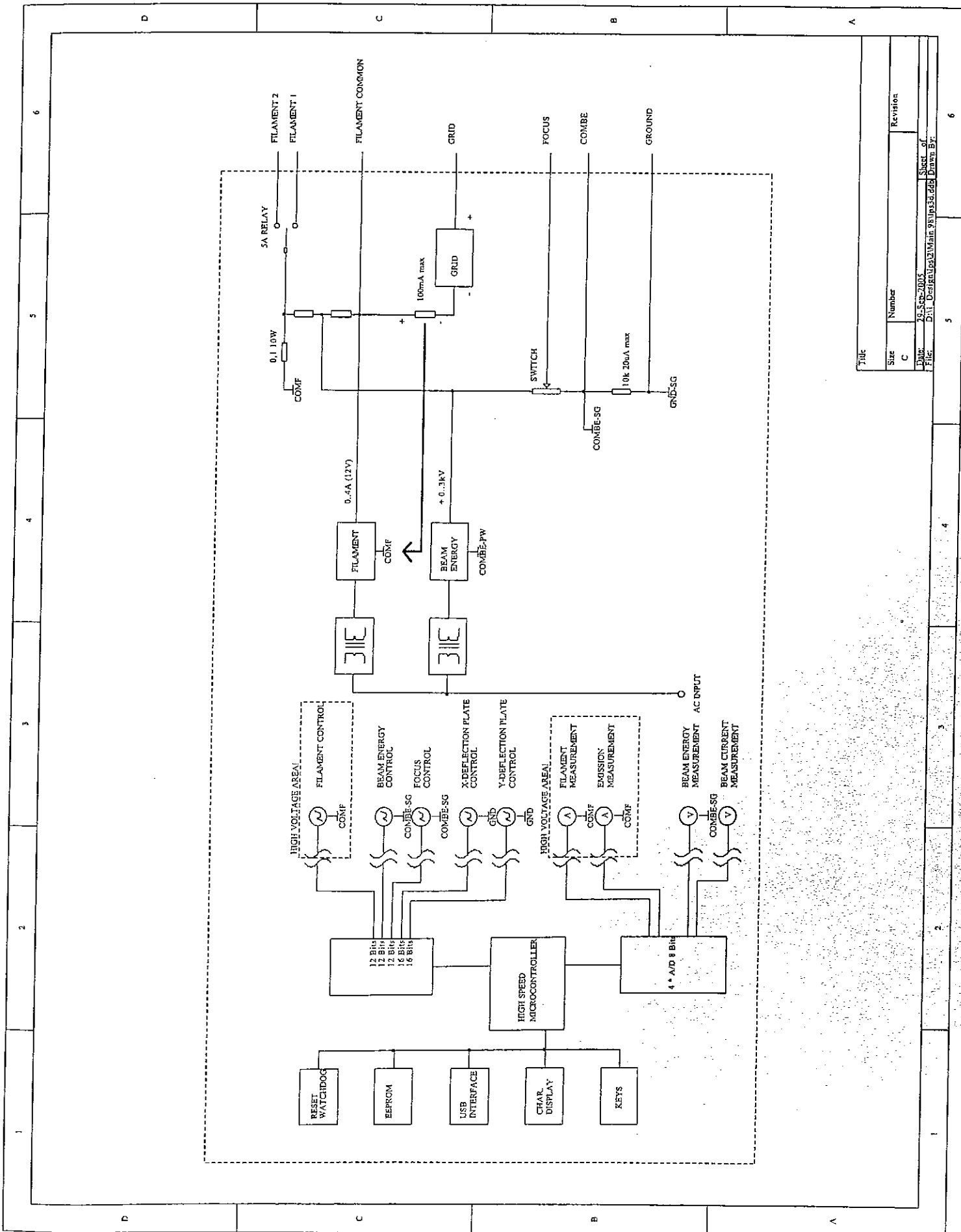
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# ION SPUTTERING GUN, MODEL IG70DP, OUTLINE DRAWING



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