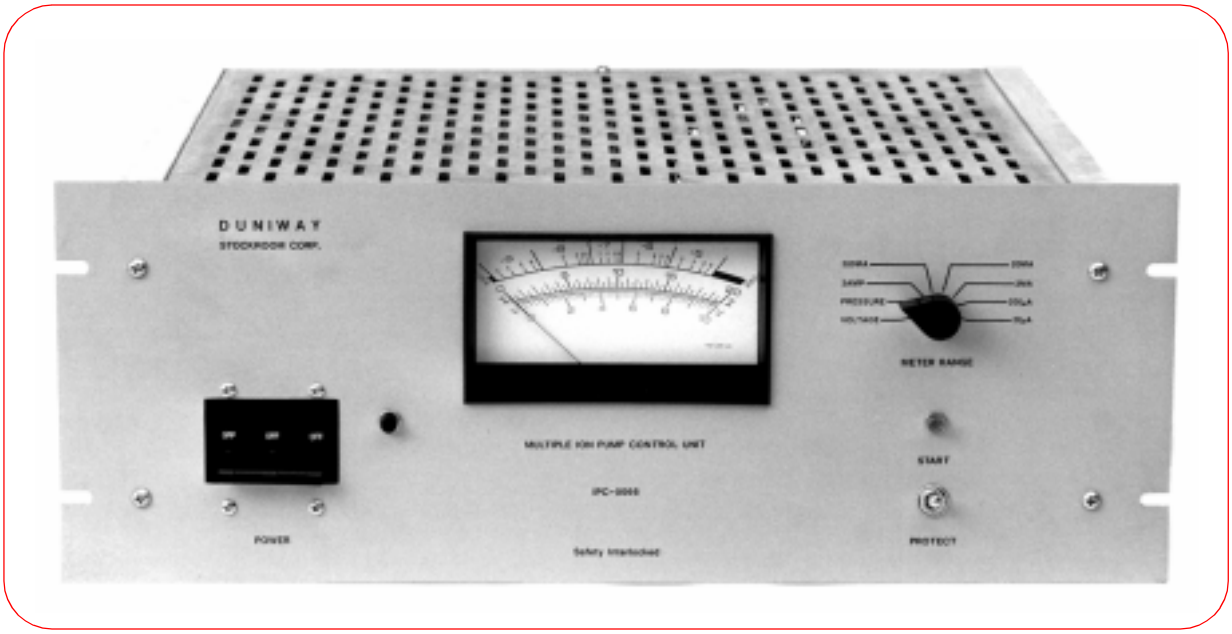
Instruction Manual

Ion Pump Control Unit
IPC-0066



DUNIWAY STOCKROOM CORP.

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List of Illustrations

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Important Notices

***NOTES*, CAUTIONS AND <u>WARNINGS!</u>** contained in the text provide important information. Please give them your attention to protect yourself, others and your equipment.

NOTE

A *NOTE* provides additional or special information to assist operation and/or maintenance personnel. Disregarding a note may cause inconvenience but will *generally* not result in personal injury or equipment damage.

CAUTION

A CAUTION is provided in a procedure whenever mechanical or electrical damage may occur. Failure to heed a caution will result in some form of damage to the equipment; however, personal injury is unlikely.

<u>WARNING!</u>

A <u>WARNING!</u> Is provided in a procedure where personal injury may occur if the <u>WARNING!</u> is not heeded. Mechanical or electrical damage *may also occur.*

Again, observe all *NOTES*, **CAUTIONS** AND **<u>WARNINGS!</u>** contained in the text.

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I Specifications

A. Electrical Specifications

1. INPUT PARAMETERS

Voltage	208/240 VAC, 50/60 Hz. (240 VAC operation requires internal tap change on transformer)
Current	20 Amps maximum in START mode

2. OUTPUT PARAMETERS

Open Circuit Voltage	+7500 Vdc (Diode) or -5200 Vdc (Triode); +/- 10% switched via internal PC card reversal
Short Circuit Current	At +7500 volts (Diode): 430 ma at 60 Hz 520 ma at 50 Hz At -5200 volts (Triode) 670 ma at 60 Hz 800 ma at 50 Hz

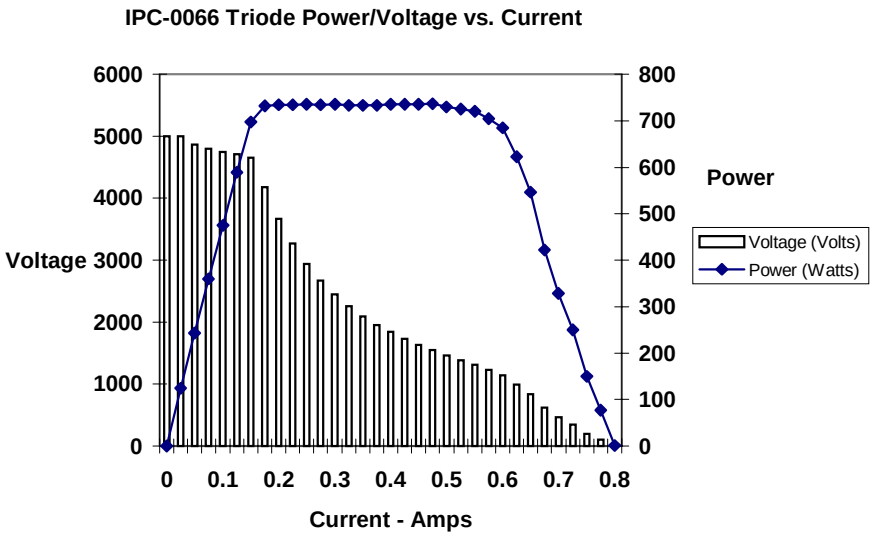

Figure 1: Power Curve for Triode (Noble) Pumps (-5200v)

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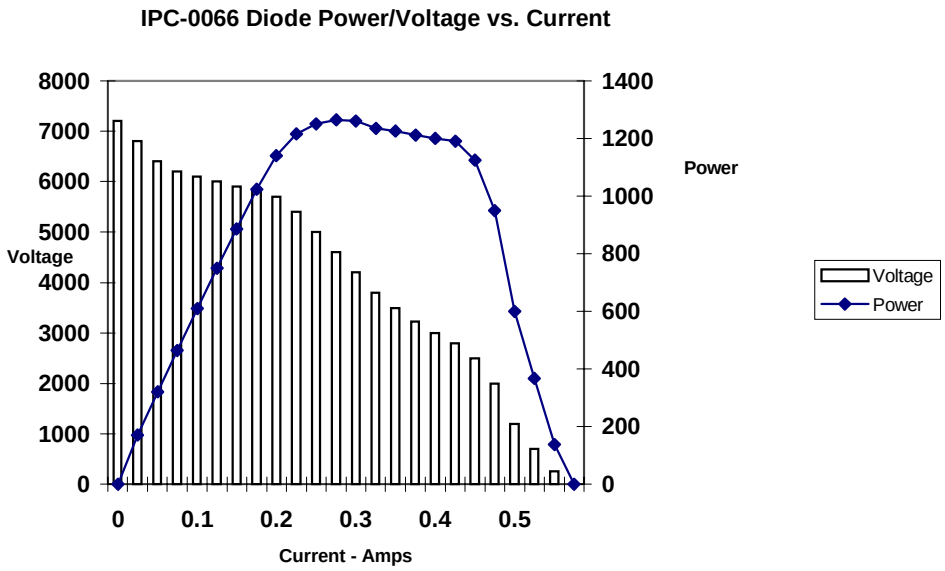

Figure 2: Power Curve for Diode Pumps (+7500v)

Overload Protection	With switch in PROTECT mode, main circuit breaker turns off at 250mA. Double Slo-Blo Fuses in Power Line
Interlock	High Voltage Interlock on cover
3. METERING	20 µA taut band meter
Current Scales	2A, 200mA, 20mA, 200µA, 20µa
Pressure Scale	Logarithmic, 10^{-9} to 10^{-5} Torr
Voltage Scale	10KV full scale
4. RECORDER OUTPUT	0-100mv, pressure scale See Figure 6

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B. Physical

1. DIMENSIONS

Panel	19 Rack Mount Panel 7 inches high (17.78cm)
Depth	16 inches (40.64cm) plus 4 inches (10.16 cm) cable clearance

2. WEIGHT

Installed Weight	103 lb (47 kg)
Shipping Weight	120 lb (54kg)

3. ENVIRONMENTAL CONDITIONS

Temperature	32° F to 105° F 0° C to 40° C
Humidity	Non-condensing
Altitude	0-10,000 ft (0-3,000 m)

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II Pre-Installation

A. General Considerations

The Duniway Stockroom Corporation's IPC-0066 is a general purpose ion pump control unit designed to operate a range of sputter-ion pumps. This range includes Varian-style pumps and pumps from other manufacturers; diode and triode pumps; and pumps in both Normal and Start modes.

Diode Pumps, requiring positive input voltage, are operated at +7500 volts DC:

11 liter/second, Hi-throughput diode pump
140 liter/second standard diode pump
270 liter/second standard diode pump
500 liter/second standard diode pump

Triode (Noble) Pumps, for enhanced noble gas pumping, requiring negative input voltage, are operated at -5200 volts DC:

110 liter/second noble triode pump
220 liter/second noble triode pump
400 liter/second noble triode pump

Pumps from other manufacturers can also be operated with the IPC-0066. Caution should be exercised in choosing the setup of the IPC-0066 to assure that:

1. The proper polarity of operating voltage is chosen, generally positive for standard diodes and noble diodes; and negative for triodes and StarCell types of pumps. Changing the polarity of the output voltage is easily accomplished using an internal reversible printed circuit card. (see Section III-B for the procedure to change the high voltage polarity)

2. The capacity rating of the pump to be operated should be equal to or more than the pump capacity setting on the Pump Selection Switch on the rear panel of the IPC-0066 - in no case should the pump capacity be less than that indicated on the Pump Selection Switch setting.

CAUTION
Operate approved sputter-ion pumps ONLY at the proper voltage polarity and pump selector switch setup of the IPC-0066 to avoid damage to the pump or control unit.

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A typical sputter-ion pump is generally very tolerant of a wide range of control unit operating characteristics in the *normal* mode of operation. This *normal* mode of operation occurs at lower pressures, where the current to the pump is proportional to the system pressure and where the current drawn by the pump is not near the capacity of the control unit. This *normal* mode exists at pressures less than the *critical transition pressure*, which depends on pump design parameters such as anode cell geometry and magnetic field strength. (For more information on this important topic, please contact a customer service representative at Duniway Stockroom Corporation.)

On the other hand, in the *start* mode of operation, sputter-ion pumps are generally **very intolerant** of improper matching of the pump requirements to the electrical characteristics of the control unit.

In general, if the control unit current capacity is inadequate for the sputter-ion pump being operated, it may be difficult to develop sufficient pumping speed to reduce the pressure below the *transition pressure*. In such a case, the pressure will not decrease significantly, but the pump will not overheat or be damaged. If a control unit has current capacity substantially in excess of the recommended current for the pump being operated, starting may be impossible due to overheating and excessive outgassing from the pump elements. In cases of protracted operation in the start mode with significant excess current capacity in the control unit, pump elements may be irreversibly damaged.

B. Compatibility

The Duniway Stockroom Corporation IPC-0066 Ion Pump Control Unit is designed to be highly compatible with the Varian Associates Model 921-0066 VacIon^{R} Ion Pump Control Unit.

Duniway Stockroom Corporation has incorporated several modifications to improve reliability and make servicing easier. These include:

1. Easy, 4-screw removal of front and rear panels avoids the necessity of removing electrical hardware for service of internal components.

2. Reinforced frame avoids sagging of the frame due to the weight of the power transformer when the sides are removed.

Many major electrical and electronic components are directly interchangeable between the IPC-0066 and the Varian model 921-0066. Consult this manual and the corresponding sections of the Varian manual.

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C. System Design Considerations

Many system design considerations are important to successful operation of sputter-ion pumps and control units. Such considerations include size of the chamber, materials used in construction, cleanliness, rough pumping capacity, pump down time requirements, process loads and bake-out procedures. These factors are particularly important in the *start* mode.

A detailed discussion of these relationships is beyond the scope of this manual, but design assistance and consultation is available. For more information, contact a customer representative at Duniway Stockroom Corporation.

D. Physical Requirements

The IPC-0066 can be installed as a rack mounted unit or as a "stand-alone" unit, provided all safety requirements are met. (See Section IIIC, Safety Requirements for details.)

When controlling a sputter-ion pump operating in the normal mode, the power dissipated as heat by the IPC-0066 is negligible. However, during operation in the start mode, a modest heat load is presented by the control unit. This heat load is generally less than 100 watts.

For detailed dimensions and rack mounting information, see Section I, Specifications in this manual.

E. Electrical Requirements

The IPC-0066 Control Unit is designed to be operated from either 208 VAC, 50/60 Hz or 240 VAC, 50/60 Hz, selectable using internal taps on the power transformer. The procedure for changing the input voltage setting is described in Section IIA, Power Requirements. Detailed electrical requirements can be found in Section I, Specifications.

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III Installation and Setup

A. Power Requirements

The IPC-0066 is designed to operate from the power input as shown in Section IA, Specifications, Electrical. AC line power is supplied to the unit through a permanently attached line cord. Unless otherwise specified, the IPC-0066 is shipped configured for 208 VAC operation. However, as with all dual voltage electrical apparatus, it is prudent to confirm this selection prior to application of line power to the unit. See Figure 3 for the transformer line voltage tap positions.

WARNING!
Both line voltage and the pump operating voltages present in this unit are lethal!

PROCEDURE: **LINE VOLTAGE CHANGE**

Reference: Schematic Diagram Drawing IPCU-066 (Section V-B), and Figure 3.

1. Disconnect the power cord attached to the rear panel of the IPC-0066 from the electrical supply.

2. Disconnect the High Voltage cable (J1) from the rear of the IPC-0066. See Figure 5.

3. Connect a shorting wire from the shell to the center conductor of the High Voltage connector. (J1)

4. Remove the perforated metal cover of the IPC-0066 by removing the single screw at the top rear and sliding the cover to the rear from its slots in the side panels. This screw also operates the high voltage interlock circuit.

5. Change the tap on the main power transformer (T1) from 208 VAC, tap 3 to 240 VAC, tap 4 (or vice versa). See Figure 3 and the Schematic Diagram (Section V-B) for position details. Make sure that the terminal screws are tight.

6. Replace the perforated metal cover and the single fastening screw.

7. Remove the shorting wire from the High Voltage connector (J1).

8. Re-attach the High Voltage connector (J1).

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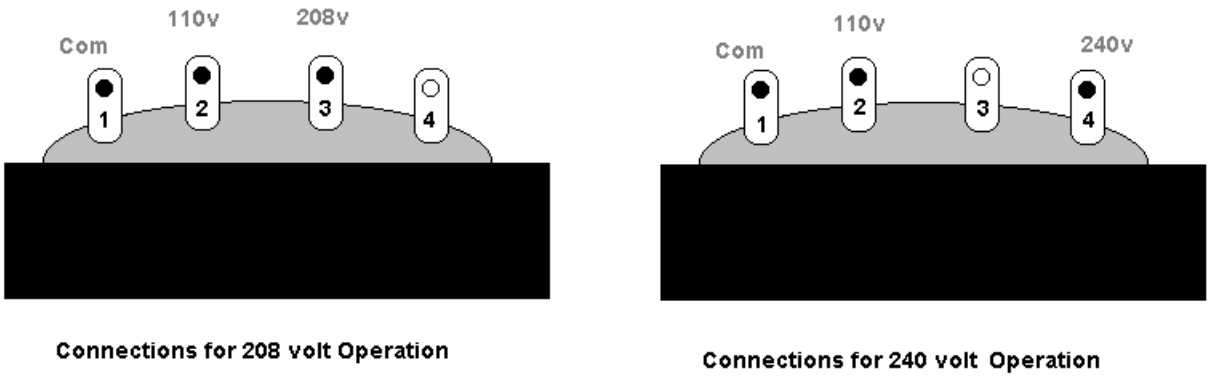

Figure 3: Transformer (T1) Line Voltage Tap Positions

B. Diode/Noble (Triode) High Voltage Polarity Changeover Procedure

Diode or Noble (Triode) pump operation is selected by a reversible printed circuit card inside the IPC-0066 chassis..

PROCEDURE: **DIODE/NOBLE (TRIODE) CHANGEOVER PROCEDURE**

1. Follow steps 1-4 of the LINE VOLTAGE CHANGE PROCEDURE, SECTION III-A.
2. Find the printed circuit card shown in Figure
3. Examine the printed circuit card. If "NOBLE" appears at the top of the card and "DIODE" operation is desired, remove the card, turn it over and reinsert the card in its connector, so that "DIODE" now appears at the top of the card.
4. Reverse step 3 if the change from "DIODE" to "NOBLE" operation is desired.
5. Repeat steps 6-8 of the LINE VOLTAGE CHANGE PROCEDURE, SECTION III-A

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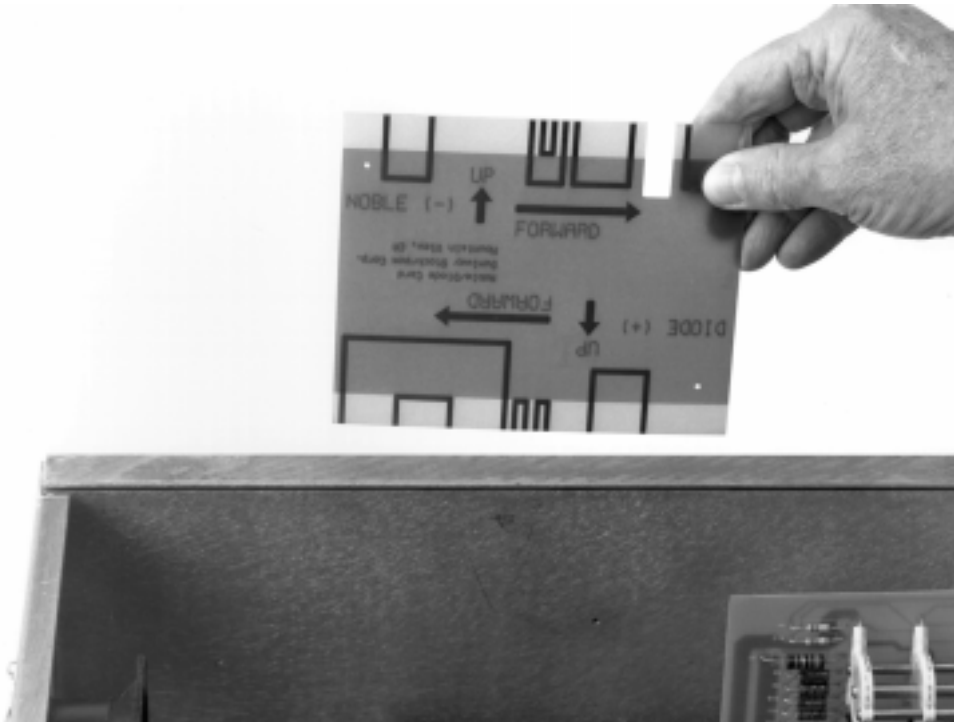

Figure 4: Diode/Noble Reversible Printed Circuit Card

C. Safety Requirements

The primary safety hazard, when operating high voltage power supplies such as the IPC-0066, is electrical shock. Electrical shock can result from contact with line voltage, internal control unit voltages or the output voltage of the control unit itself. Electrical shock from the output voltage of the control unit can either be a result of accidental contact with the output or as a result of loss of proper grounding.

In addition, a large filter capacitor is employed in the circuit. (2x0.3 mf, 5KV, reference C1). Although a 10 megohm, 5W "bleeder" resistor (reference R2) is employed to dissipate the charge on these capacitors when the IPC-0066 is turned off, failure of this resistor could allow a substantial and dangerous charge to remain in the capacitors.

WARNING!
Always wait at least 15 seconds after turning OFF the High Voltage before working on either the IPC-0066 or the Sputter Ion Pump.

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NOTE

In a properly operating IPC-0066, the absence of hazardous potentials on the high voltage output may be verified by reading the meter on the front panel with the switch in the "Voltage" position.

A Safety Interlock circuit has been incorporated into the IPC-0066 control unit to reduce the risk of electrical shock if proper grounding is lost. Grounding is provided through the shield in the high voltage cable, but it is preferable to provide grounding through a separate, visible, positive grounding connection.

CAUTION

The ground safety strap connector, (binding post on the rear panel marked 'Pump Ground') is for *ground fault sensing* only, and may NOT be used for the ground connection itself.

PROCEDURE: **GROUND FAULT SAFETY STRAP**

1. Ensure that continuity exists between the high voltage output connector shell (J4) and the sputter-ion pump body. While the outer shielding braid of the high voltage cable is commonly used for this function by making connection through a grounding spring on the high voltage feedthrough of the sputter-ion pump, this connection is marginal.

   It is recommended that a separate grounding braid (Belden 8669 or equivalent) be positively fastened to a mounting screw of the high voltage connector and any convenient fastener on the sputter-ion pump body.

2. Make a connection between the ground safety strap connector ("Pump Ground" see Figure 3) on the back of the Control Unit and any convenient fastener on the sputter-ion pump body.

3. If there is a fault in the grounding system, this circuit will remove power from the main power transformer of the IPC-0066. To restore power, correct the grounding problem and reset the circuit breaker (CB1) on the front panel. (see Figure 7).

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Figure 5: Rear Control Panel

WARNING!

Under no circumstances should the ground safety strap be connected directly to the case of the IPC-0066. This would defeat the protection provided by this safety feature and may result in serious electrical shock hazard to personnel.

NOTE

The same circuit will also remove power from the main power transformer and cause the FAULT lamp to be illuminated if an overload condition occurs during normal operation.

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D. Connection to Pump

The IPC-0066 is connected to a sputter-ion pump by means of a coaxial cable assembly, such as Duniway Stockroom part number A-110-MS (Standard 10 foot cable, equivalent to Varian 924-0750) or B-112-MS (Bakeable 13 foot cable, equivalent to Varian 924-0736). If required, special longer or shorter cables may be used with no detectable loss of sputter-ion pump performance. Call Duniway Stockroom Corporation and ask a customer representative for information on special cable lengths.

PROCEDURE: **CONNECTING THE IPC-0066 TO THE SPUTTER-ION PUMP**

1. Turn OFF the MAIN POWER SWITCH on the front panel of the IPC-0066.
2. Remove the LINE POWER CORD, on the rear panel of the control unit, from the external power source.
3. Make or confirm the required ground connections as described in Section IIIC.
4. Position the GROUNDING SPRING (Duniway Stockroom part number GSP-1000) on the pump high voltage feedthrough in the recess between the ceramic body of the insulator and the metal weld sleeve.
5. Push the pump cable connector over the pump high voltage insulator, twisting the connector as needed, until the connector body slides OVER the grounding spring and will go no further.
6. Align the hole in the cable connector with the pump bracket and install the safety screw.
7. Connect the MS control unit connector to the high voltage output connector (J1) on the rear panel of the control unit.
8. Reconnect the line power cord to the external power source.

WARNING!
NEVER apply power to the IPC-0066 until proper grounding has been checked and verified.
NEVER operate the IPC-0066 without the safety screw installed.

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E. Use with a Pressure Relay

A multi-pin connector (J2) is provided on the rear panel (see Figure 5) for operating the IPC-0066 with a pressure relay, Varian Associates Model 924-0048. For use of this accessory, consult the instruction manual supplied with the pressure relay. The IPC-0066 is fully compatible with the Varian model 924-0048.

F. Use with a Recorder

A recorder output connector and ground (J3 and J4) are available on the rear panel (see Figure 5) of the IPC-0066. The output from this connection corresponds to the front panel reading, with full scale being 100mV, provided the input impedance of the recorder is 500Kohm or greater. Other instruments or measuring devices may be used as long as they meet this input impedance requirement.

CAUTION
DO NOT use a chart recorder or other measuring device on the IPC-0066 which has an impedance less than 500Kohm.

For use with the logarithmic pressure scale on the front panel meter ("Pressure" setting on the scale switch, see Figure 7), a calibration chart is given in Figure 6. Note that this chart is approximate.

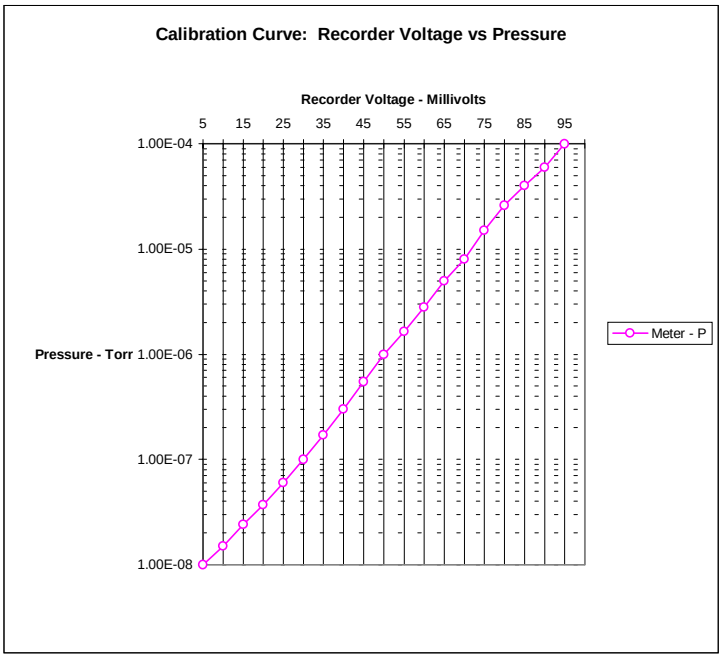

Figure 6: Recorder Output versus Pressure

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IV Operation

Operation of the IPC-0066 is described below for two general modes: the START mode and the NORMAL operating mode.

A. Pre-Start Checks

Prior to any operation, perform the following checks, referring to Figure 3, Figure 4 and Figure 5:

1. Verify that all grounding is in place and secure. Refer to Section IIIC for procedures, if required.

2. Verify (or set) the pump selector switch on the rear panel to the correct size of sputter-ion pump. Refer to Section IIA for procedures, if required.

3. Verify (or set) the "Diode/Noble(Triode)" card is in the correct position. Refer to Section IIIB for procedures, if required.

4. Verify (or set) the START-PROTECT switch on the front panel is set to "START".

5. Set the METER RANGE switch on the front panel to the VOLTAGE position.

Now, rough pump the system to a pressure of 10mTorr or below. The use of cryosorption roughing is highly recommended for its cleanliness and simplicity. However, two stage oil sealed rotary pumps can be used, if careful attention to technique and trapping of pump oils is observed.

CAUTION
At pressures below about 150 mTorr for most systems and pumps, the backstreaming of mechanical pump oil is a significant problem. High quality oil traps MUST be used.

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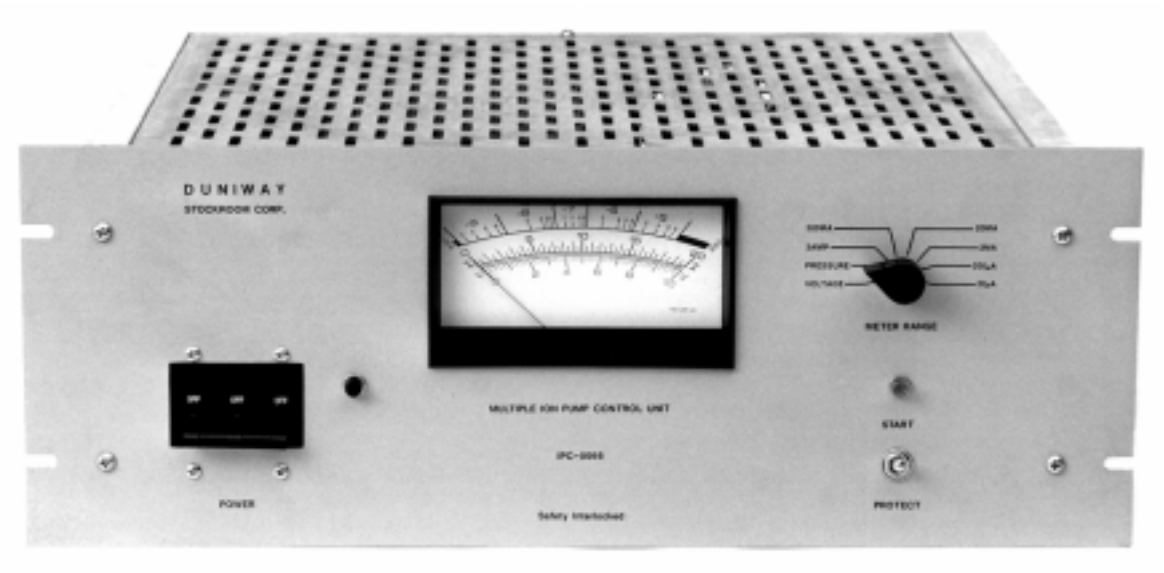

Figure 7: Front Panel

B. Start-Mode Operation

1. When the roughing pressure falls below 10mTorr, turn the POWER switch on the control unit front panel to the ON position. The red "High Voltage On" lamp and the amber "START" lamp on the front panel will light. No warm-up period is required.

2. IMMEDIATELY check the voltage indication on the control unit front panel meter for the following indications of expected START conditions:

Diode Pump:	300 V (approximately)
Triode Pump:	1,100 V (approximately)

   If the voltage indication is zero, IMMEDIATELY turn the POWER switch to the OFF position. The zero voltage reading indicates a short circuit or arc discharge condition in the pump or cable, which must be found and corrected before proceeding.

3. Turn the METER RANGE switch to the 2 Amp full scale position and verify that the current is near the appropriate (near short circuit current) value for the pump selected. (See Section I-A Electrical Specifications).

4. Return the METER RANGE switch to the VOLTAGE position to monitor the operation of the pump.

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NOTE
The voltage (when it begins to rise) is a more reliable indication that the ion pump is about to "start" than the current.

5. When it appears that the roughing system has reached its base pressure, close the roughing valve and observe the results on the VOLTAGE scale of the control unit.

   If the voltage falls, indicating a rising pressure and pump current, reopen the roughing valve.

   If the voltage increases or remains the same, indicating a decreasing or constant pressure, leave the roughing valve closed.

NOTE
With a diode sputter ion pump, a modest rise in pressure is normal during the initial START. This is caused by heating of the pump components by the dissipated power and normally precedes operation in the NORMAL mode.

6. When the voltage has increased to approximately 2 kV, indicating that the pump has successfully "started" and the pressure (and pump current) have decreased into the NORMAL region, place the START/PROTECT switch on the front panel of the control unit to the PROTECT position. The amber START lamp will go off.

The system and pump are now protected against a rise in pressure above approximately 0.5 mTorr while unattended. Should such a pressure rise occur due to a leak or other failure, the control unit will automatically turn off after a delay of a few seconds. This protects both the pump and control unit against excessive current and heat conditions which might occur as a result of a leak or other failure.

C. Normal-Mode Operation

Operation in the NORMAL mode is simple and automatic. The operating voltage approaches the open-circuit value (see Electrical Specifications, Section IA) and the pump current is approximately proportional to the pressure over a wide range of pressures.

Pressure at the pump inlet flange may be read directly on the PRESSURE scale of the front panel meter by selecting PRESSURE on the METER RANGE switch on the front panel. The PRESSURE scale is a logarithmic scale from below $1x10^{-9}$ Torr to above $10x10^{-5}$ Torr. The calibration of this meter has been set at the factory for best accuracy and should generally not be adjusted by the operator.

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As an alternative method of determining the pressure, if the pump current versus pressure relationship is known for the specific sputter-ion pump in use, the pump current can be read directly on the appropriate METER RANGE setting and converted to a pressure reading. Pump current versus pressure graphs for some Varian diode pumps are shown in Figure 8 and for some Varian triode (Noble) pumps in Figure 9.

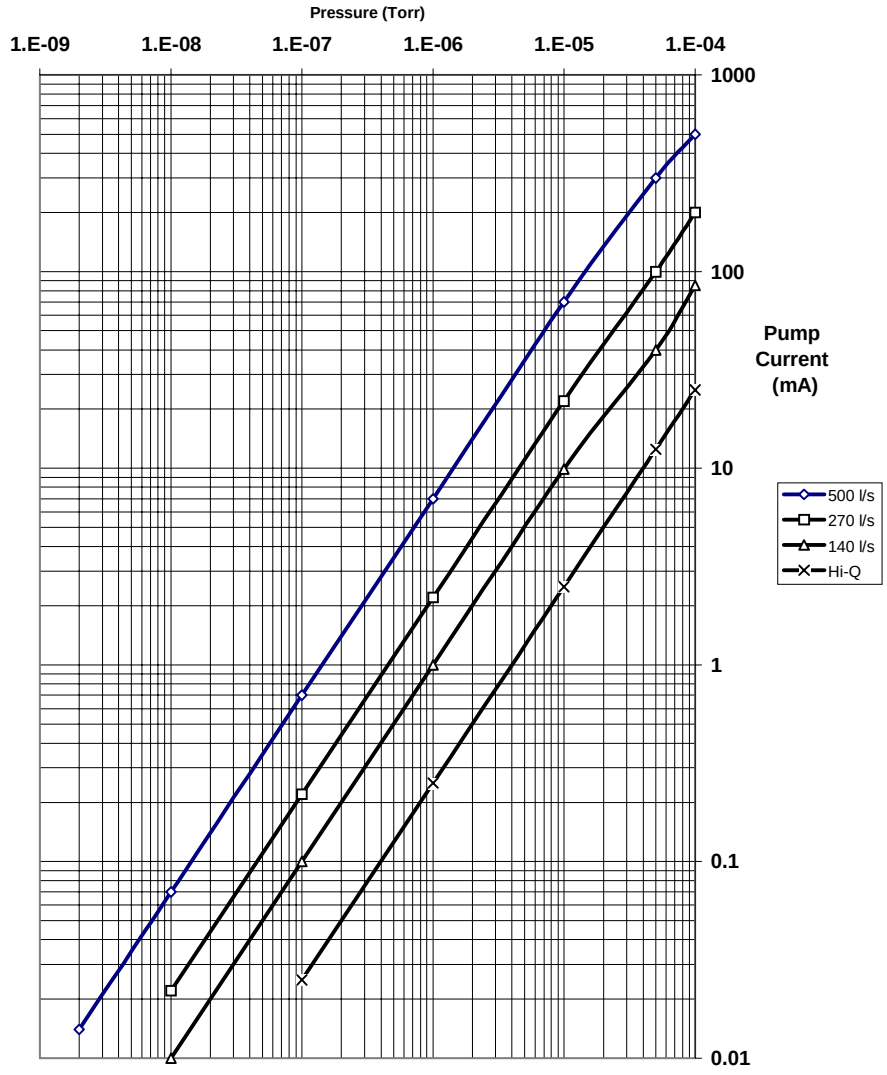

Figure 8: Pump Current versus Pressure Selected Varian Diode Pumps

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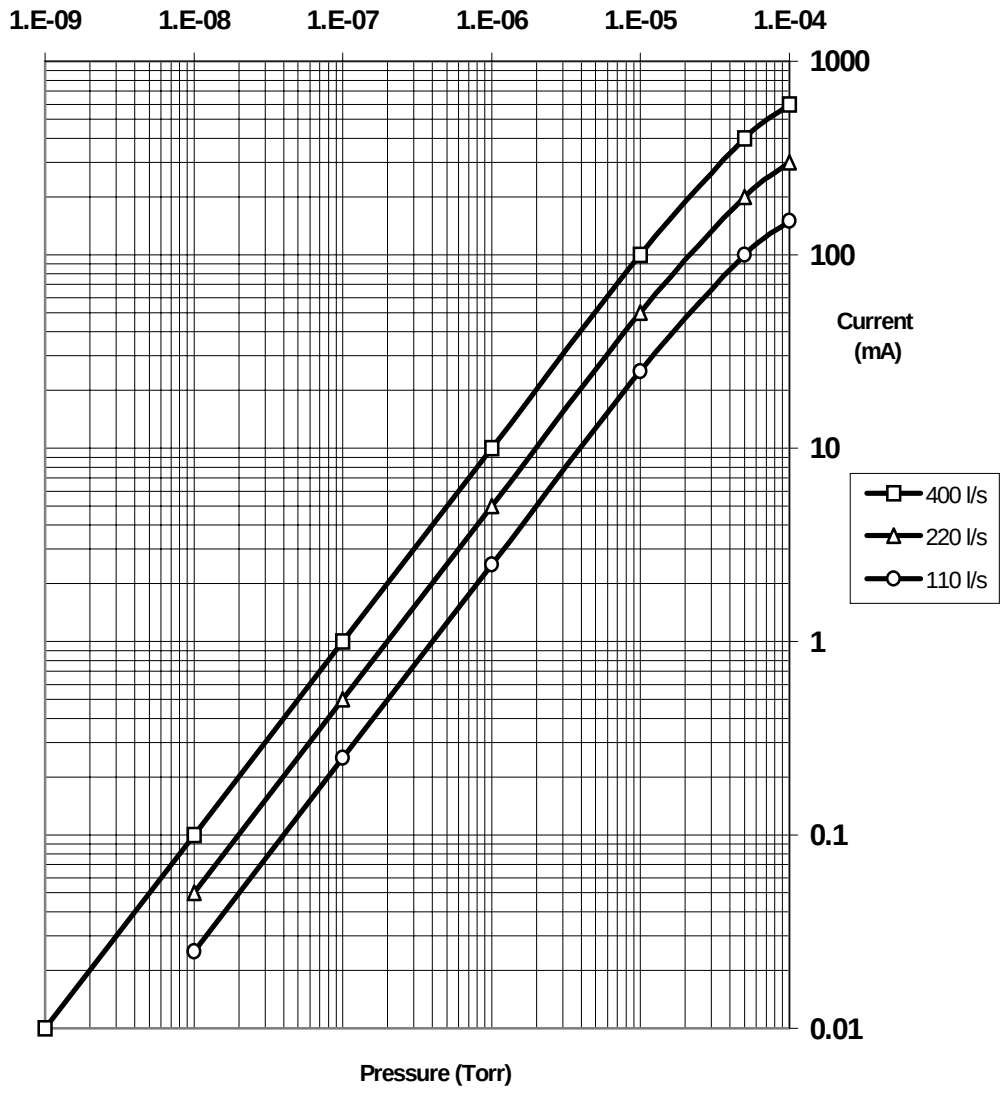

Figure 9: Pump Current versus Pressure
Selected Varian Triode (Noble) Pumps

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DISCUSSION OF USING PUMP CURRENT TO MEASURE PRESSURE

While it is true and useful that the sputter-ion pump current is nearly proportional to pressure over a wide range, there are some limitations to using pump current as an indicator of pressure.

1. The proportionality is only approximate.

2. At high pressures, above 10^{-4} Torr for Noble (triode) pumps and at low pressures, below 10^{-8} Torr for the diode pumps, the pump current versus pressure curve can be multiple valued. That is, it displays significant hysteresis, the exact ratio depending on whether the pressure is rising or falling immediately preceding the measurement.

3. Sharp points and edges, particularly in triode pumps, can give rise to field emission leakage currents which are independent of the pressure. These field emission leakage currents can be removed by the technique of "hi-potting", the application of AC of DC voltages significantly above the operating voltage. For more information on this technique, call a Customer Service Representative at Duniway Stockroom Corporation.

For these reasons, the accuracy of pressure reading should be treated as only semi-quantitative, is no better than +/- 20%, and only in the mid range of 10^{-7} Torr to 10^{-5} Torr.

For accurate pressure measurements, especially in the lower pressure ranges, it is strongly recommended that a Bayard-Alpert type ionization gauge be used.

Also note that, while this discussion applies to pressure measurement, these effects do not significantly influence the pumping efficiency of the sputter-ion pumps.

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V Maintenance

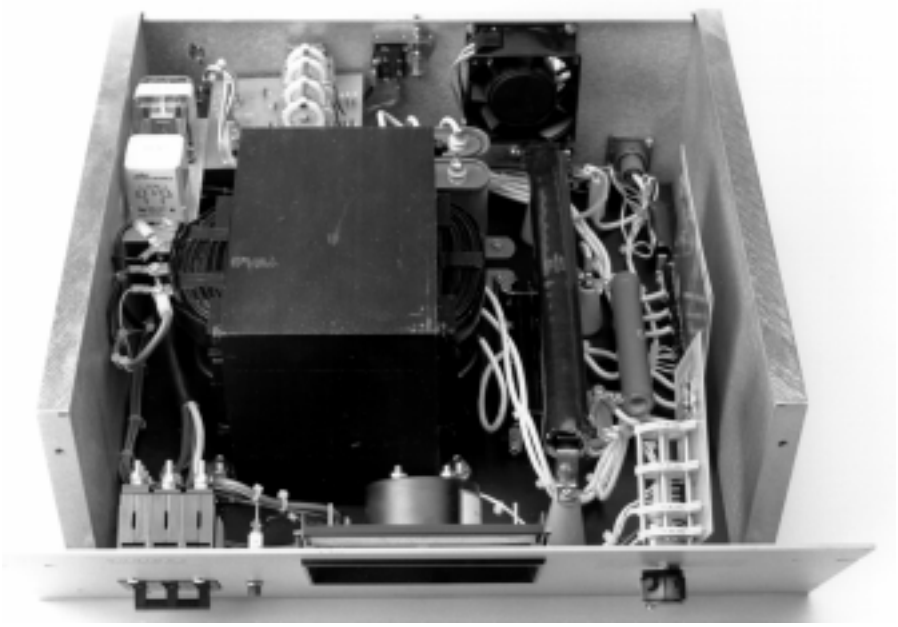

Figure 10: Front Panel Removal for Electrical Service

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A. Parts List

Circuit Reference Designator	Number Required	Part Number	Description
C1, C4	2	62-C1	Capacitor, 5KV, 3mf
C2, C3	2	62-C2	Capacitor, --V, 47mf
D1	2	62-D2	Rectifier, HV
D2	2	62-D2	Diode
D4	2	62-D4	Diode, Reverse
DS2	1	62-DS2	Lamp, Red Neon, 125V
DS6	1	62-DS4	Lamp, Neon Glow, NE-2
J2	1	62-J2	Connector, Relay
J3Y	2	62-J3Y	Jack, Yellow
J4	1	62-J4	Connector, HV Output
R7	1	62-R7	Resistor, 4990 Ohm
VR1	2	62-VR1	Varistor, Metal Oxide
A1	1	66-A1	Printed Circuit Board - Noble/Diode
B1	1	66-B1	Fan
CB1	1	66-CB1	Circuit Breaker
66-DS2	1	66-DS2	Lamp, Amber Neon
F1	2	66-F1	Fuse, Slo-Blo, 3AG, 1A
J5	1	66-J5	Copnnector, Card-Edge
K1	1	66-K1	Relay, 10 Amp, 6 Volt DC
K2	1	66-K2	Relay, Delay
K3	1	66-K3	Relay, 10 Amp, 12 Volt DC
M1	1	66-M1	Meter
R1	1	66-R1	Resistor, 10 MegOhm, 10 Watt
R2	1	66-R2	Resistor, 250 Ohm
R3	1	66-R3	Resistor, 100 MegOhm
R40	1	66-R40	Resistor, 100 Kohm, 100 Watt
R5	1	66-R5	Resistor, 2490 ohm, 1 Watt
R6	1	66-R6	Resistor, 25 Ohm, 25 Watt
S1 ASSY	1	66-S1	Switch Assembly, Meter
S2 ASSY	1	66-S2	Switch Assembly, Selector
S3	1	66-S3	Switch, DPDT Toggle
S4	1	66-S4	Switch, Safety
T1	1	66-T1	Transformer, Main
T2	1	66-T2	Transformer, Stancor

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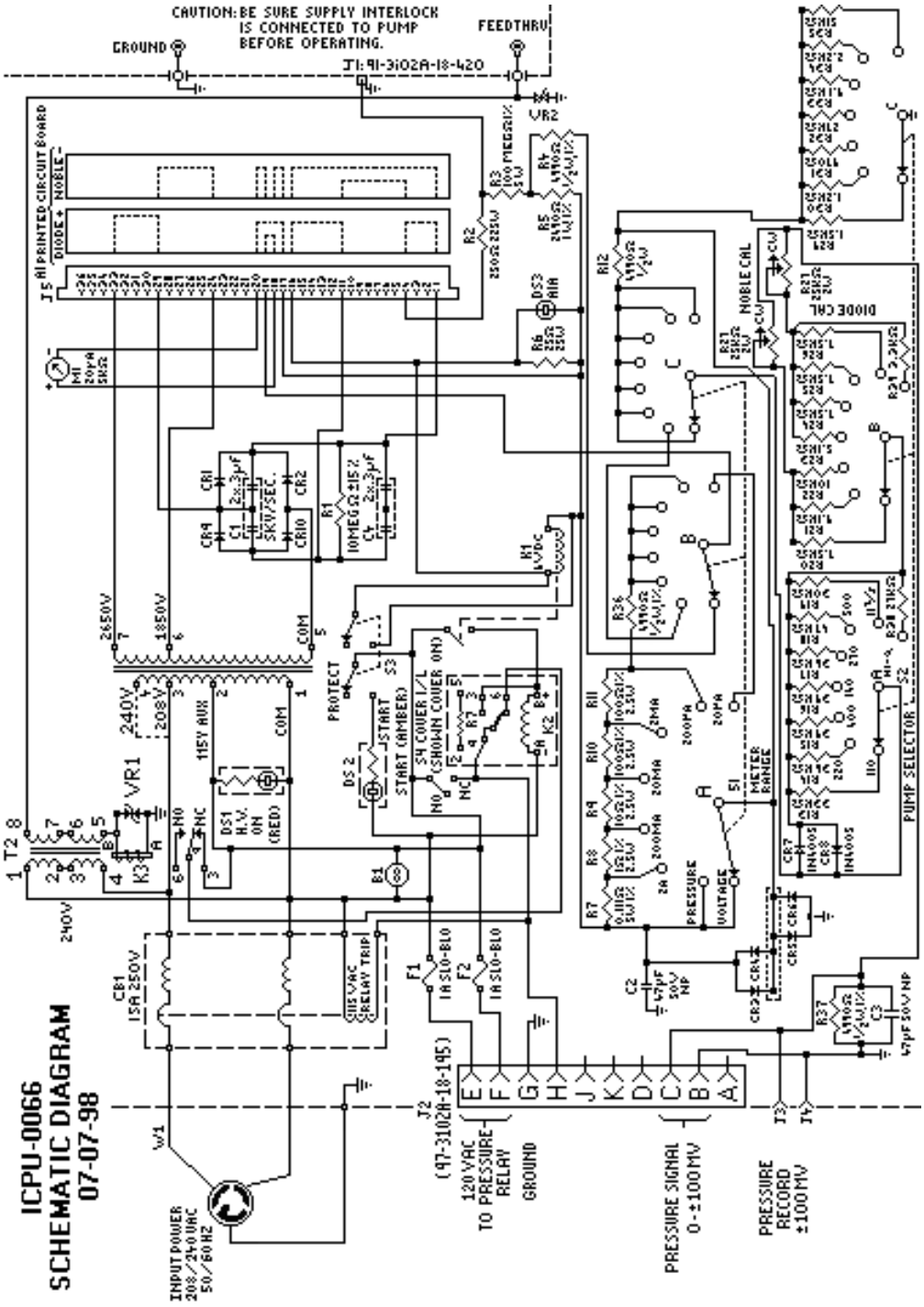
B. Schematic



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