

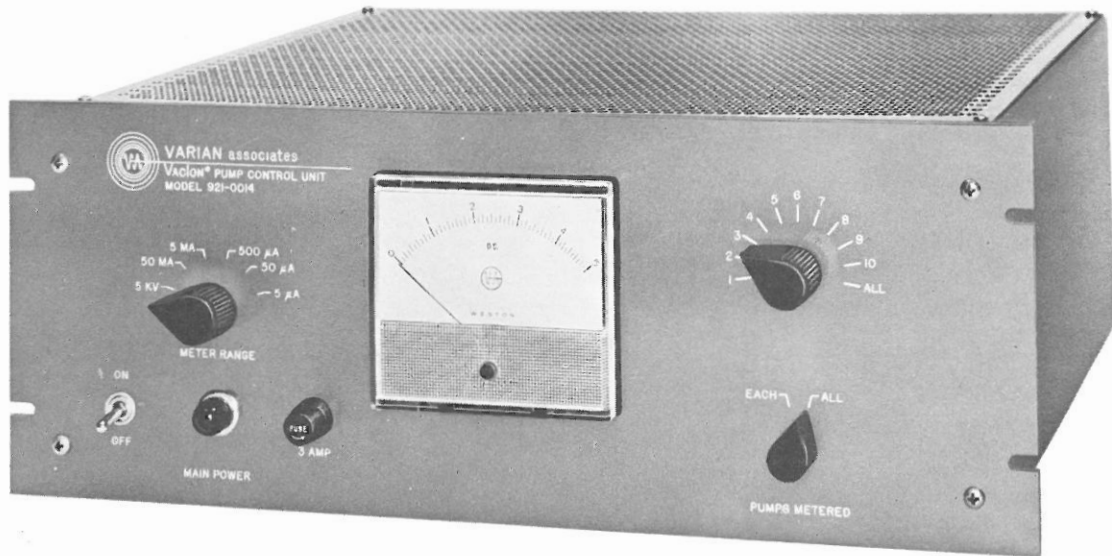
varian
vacuum
division

instructions

VacIon[®] pump control units

model nos. 921-0014

and 921-0015



VacIon PUMP CONTROL UNIT MODEL NO.921-0014
and



VacIon PUMP CONTROL UNIT MODEL NO. 921-0015
INSTRUCTION MANUAL

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The Varian Multiple-Pump Control Unit, Model No. 921-0014, starts and operates as many as ten VacIon Pumps having pumping speeds up through 8 liters per second. Control Unit Model No. 921-0015 operates a single VacIon Pump up through the 8 ℓ /s size. Larger VacIon Pumps requiring the same operating voltage can be operated also with this control unit; however, first the VacIon Pump must be started and pumped to a sufficiently low pressure with an appropriate control unit. The control unit output current or voltage for each pump, or for all the pumps connected, is read on the front panel meter by setting the selector switches. Pressure in the VacIon Pumps is determined by converting the current reading for each pump with the curve provided for Current vs Pressure on page 7. Recorder jacks on the rear of the chassis allow continuous monitoring of the pump current by a recorder.

The Single-Pump Control Unit is housed in a case but can be panel-mounted if required. The Multiple-Pump Control Unit can be mounted in a standard 19-inch rack, with the high-voltage outlets connected to as many as ten VacIon Pumps by high-voltage coaxial cable and connector assemblies. A separate high-voltage cable is required for each pump connected to the control unit. Various types of high voltage cable are used depending on the size of the VacIon Pump to be operated. High voltage cables must be ordered separately.

The control unit will operate from a single phase 115-volt or 230-volt, 50- or 60-Hz power source. It is connected for 115-volt operation when shipped from the factory. Changeover to 230-volt operation is described under Installation, Section IV.

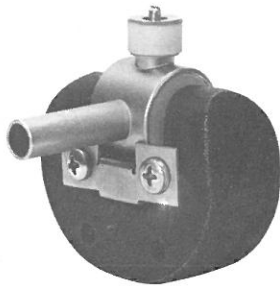
VacIon PUMPS NORMALLY OPERATED BY CONTROL UNITS

MODEL NOS. 921-0014 and 921-0015

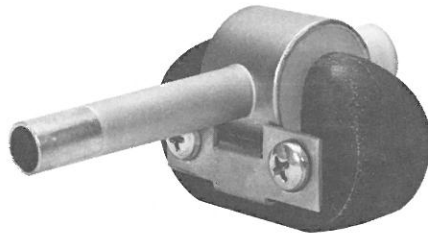
MINIATURE VacIon PUMPS

Model No.	Configuration	Tubulation	Magnet Required
913-0036	180°	7052 glass	For all pumps:
913-0037	180°	OFHC copper	
913-0038	180°	Type 304 stainless steel	Model No. 913-0021 (800 gauss)
913-0039	90°	7052 glass	or
913-0040	90°	OFHC copper	Model No. 913-0003 (1250 gauss)
913-0041	90°	Type 304 stainless steel	

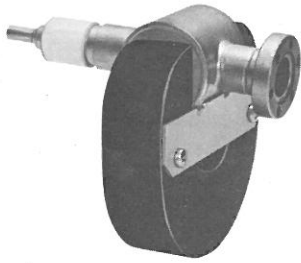
Pumping speed is determined by size of magnet. Slotted brackets adapt either magnet to either pump configuration.



90° Configuration with 1250-Gauss Magnet

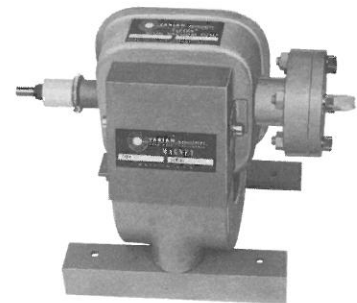


180° Configuration with 800-Gauss Magnet



2 l/s VacIon PUMPS

Model No.	Tubulation	Magnet Required
913-0032	Type 304 stainless steel	Model No. 913-0011
913-0035	OFHC copper	
913-0034	7052 glass	
913-5000	Mini-ConFlat Flange	



8 l/s VacIon PUMPS ON 2-3/4" o. d. ConFlat FLANGES

Model No.	Description	Magnet Required
911-5000	Standard VacIon Pump	Model No. 911-0001
911-5001	Tee-Style VacIon Pump	
911-5014	Super VacIon Pump (slotted cathodes)	

SECTION II

SPECIFICATIONS

Feature	Multiple-Pump Control Unit Model No. 921-0014	Single-Pump Control Unit Model No. 921-0015
Power	60 Hz: 115 V, 2A 230 V, 1 A 50 Hz: 115 V, 1.7 A 230 V, 0.85 A	60 Hz: 115 V, 0.9 A 230 V, 0.45 A 50 Hz: 115 V, 0.7 A 230 V, 0.35 A
Fuse	115 V input: 3 A Slo-Blo 230 V input: 1-1/2 A Slo-Blo	115 V input: 1 A Slo-Blo 230 V input: 1/2 A Slo-Blo
Output	60 Hz, 115 V or 230 V input: Open circuit 3500V dc \pm 10% Short circuit 43 mA dc \pm 10% 50 Hz, 115 V or 230 V input: Open circuit 3500V dc \pm 10% Short circuit 36 mA dc \pm 10%	
Metering	Current ranges: 5 μ A, 50 μ A, 500 μ A, 5 mA, and 50 mA, with accuracy of \pm 10% of full scale in each range Voltage range: 5 kV, with accuracy of \pm 10% of full scale	
Leakage Current	When high-voltage cables are removed from control unit: 0.20 μ A dc maximum for each high-voltage outlet	
Recorder Output	Negative 100 mV output (with respect to chassis ground) corresponds to full-scale meter deflection for all current ranges	
Duty Cycle	Continuous under any normal load condition	
Ambient Temperature	Operation: 32°F to 105°F (0°C to 41°C) Storage: 0°F to 150°F (-32°C to 66°C)	
Altitude Tolerance	Sea level to 15,000 feet (4570 meters)	
Size	Panel: 19" wide (48 cm) 7" high (18 cm) Chassis: 17" wide (43 cm) 6-1/2" high (16.5 cm) 14" deep (35.5 cm)	With cabinet: 11-1/2" wide (29.2 cm) 8" high (20.3 cm) 8-1/4" deep (21.0 cm) For panel mounting, see Installation
Weight	Actual: 37 lb (16.8 kg) Shipping: 50 lb (22.7 kg)	Actual: 14 lb (6.4 kg) Shipping: 18 lb (8.2 kg)

VacIon Pump Control Units will supply, regulate, and monitor the power that is applied to VacIon Pumps. The Multiple-Pump Control Unit, Model No. 921-0014, is designed to handle as many as ten pumps. Model No. 921-0015 is for a single pump. The output capability of a VacIon Pump Control Unit, for use with a specific pump, provides sufficient voltage and current to start the pump at its recommended starting pressure in a practical time and never exceeds the power dissipation limit of the pump. A high-voltage potential above 3000 volts is needed by a pump to provide pumping action over most of its functional range. The high-voltage requirement necessitates the use of a power transformer in the control unit. Voltage from the transformer secondary is rectified in a voltage-doubler circuit to provide dc voltage and current. (The Multiple-Pump Control Unit has two transformer secondaries and two rectifying doubler circuits.) Current limiting is necessary to prevent excessive power from being applied to the pump at high pressures (above 10^{-4} Torr) and during the starting condition. Current limiting is accomplished by capacitive reactance. Filtering is provided for low currents at high voltages.

A unique design feature of the VacIon Pump Control Unit is that it has a falling Voltage vs Current (soft supply) characteristic, as shown by the graph. With increasing load the dc output voltage falls from a maximum value at no load to zero volts at short circuit. At the same time the output current increases from zero amperes at no load to a maximum short-circuit current which is limited by the internal impedance of the control unit. The resulting power output of the control unit rises from zero power at no load to a maximum value established by the dissipation limit of the smallest VacIon Pump which the control unit is intended to operate, and then decreases to zero power at short circuit. This type of regulation in the high-voltage supply is necessary because the impedance of the electrical discharge in the VacIon Pump varies from several hundred ohms at the starting pressure to several thousand megohms at low pressures.

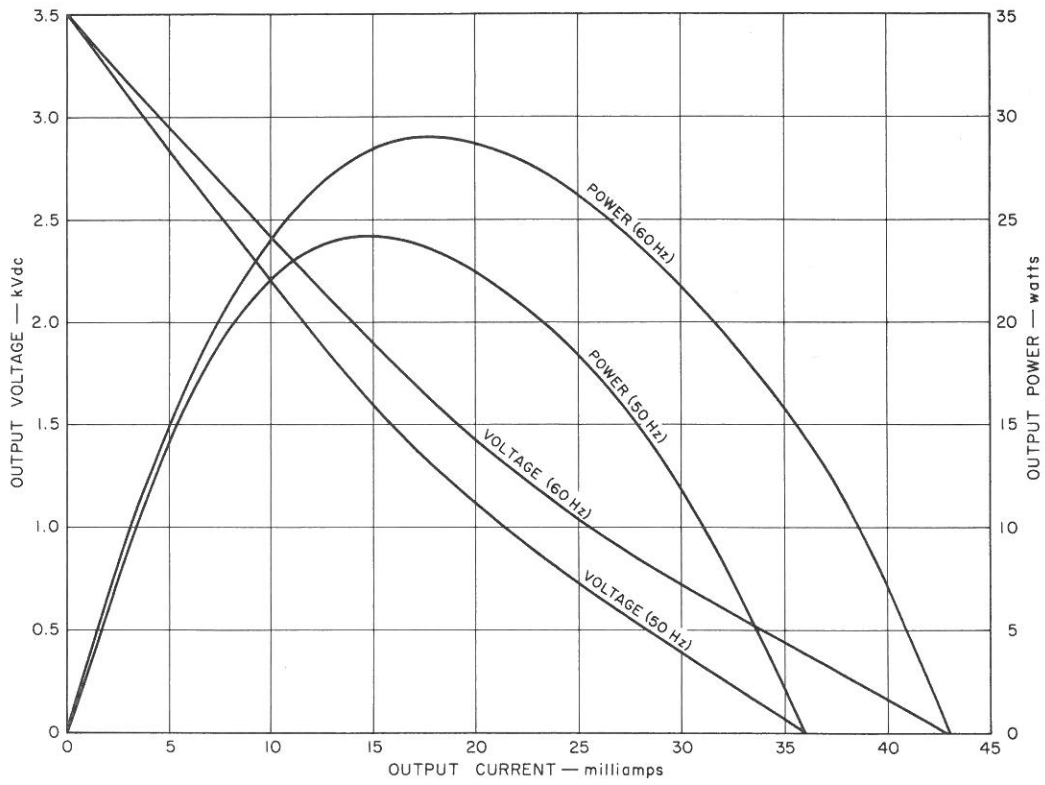
PRINCIPLE OF OPERATION

When a VacIon Pump is connected to the control unit, the output voltage will vary with the pump current. The doubler circuit supplies an increasing current demand up to the point where the output is shorted to ground. When a VacIon Pump is at a high pressure (1×10^{-2} Torr), such as in the starting condition, the unconfined glow discharge in the pump approaches a short circuit, or low impedance condition, and the potential across the pump is 300 to 400 volts. As the VacIon Pump reduces the pressure, the pump current will decrease and the voltage will rise accordingly.

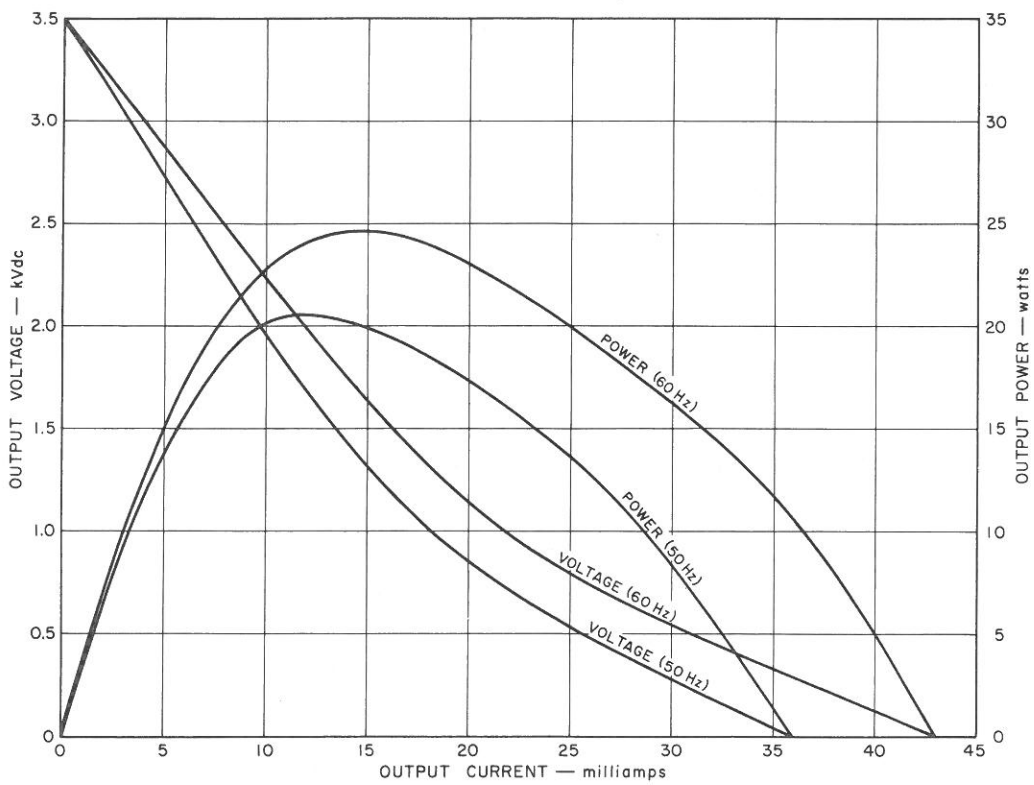
Current drawn by a VacIon Pump is proportionate to the pressure in the pump. Therefore, the pump acts as its own pressure gauge. The pressure can be determined by converting the current reading with the curves provided on the Current vs Pressure chart. The accuracy of such a determination is comparable to that of a good ionization gauge if leakage currents are negligible.

The control unit voltage and current are metered in low-voltage circuits for safety. The meter is placed in the negative or ground side of the control unit circuitry. The meter movement has a $5\text{-}\mu\text{A}$ full-scale deflection in each range, and is protected from surge currents by a special protection diode. The accuracy of a current or voltage reading is within $\pm 10\%$ of full scale in each range.

The output signal provided for recording is taken from the negative side of the current metering circuit. For an equivalent full-scale meter deflection in any current range, a negative (with respect to the chassis) 100-millivolt signal provides full-span deflection for a recorder. As VacIon Pump pressure decreases, the pump current decreases and the recorder output signal decreases in magnitude.



ELECTRICAL CHARACTERISTICS OF Vacion® PUMP CONTROL UNIT MODEL N° 921-0014



ELECTRICAL CHARACTERISTICS OF Vacion® PUMP CONTROL UNIT MODEL N° 921-0015

SECTION IV INSTALLATION

WARNING

THE VOLTAGES DEVELOPED IN THIS CONTROL UNIT ARE EXTREMELY DANGEROUS. USE CAUTION DURING INSTALLATION, OPERATION, AND MAINTENANCE. FOLLOW THE GROUNDING PROCEDURE GIVEN IN THESE INSTRUCTIONS CAREFULLY.

Power Requirements

The Model No. 921-0014 and 921-0015 VacIon Pump Control Units will operate from a single-phase 115-volt or 230-volt, 50 or 60 Hz power source. Control units are wired at the factory for 115-volt operation.

FOR PERSONNEL SAFETY IT IS ABSOLUTELY NECESSARY THAT THE GROUND PIN OF THE INPUT POWER PLUG BE CONNECTED TO EARTH GROUND THROUGH THE MATING FEMALE POWER-LINE RECEPTACLE.

Voltage Changeover

If an operating voltage change is desired, proceed as follows:

1. Disconnect the unit from the power source. Wait 30 seconds for the capacitors to discharge.
2. Model No. 921-0014: Remove the top cover.

Model No. 921-0015: Remove the four screws in the rubber feet on the bottom of the case and take the chassis assembly out of the case.
3. Discharge all capacitors completely by shorting their terminals.
4. Locate terminal board TB101, on the side opposite the transformer, with terminals numbered 1 through 4.

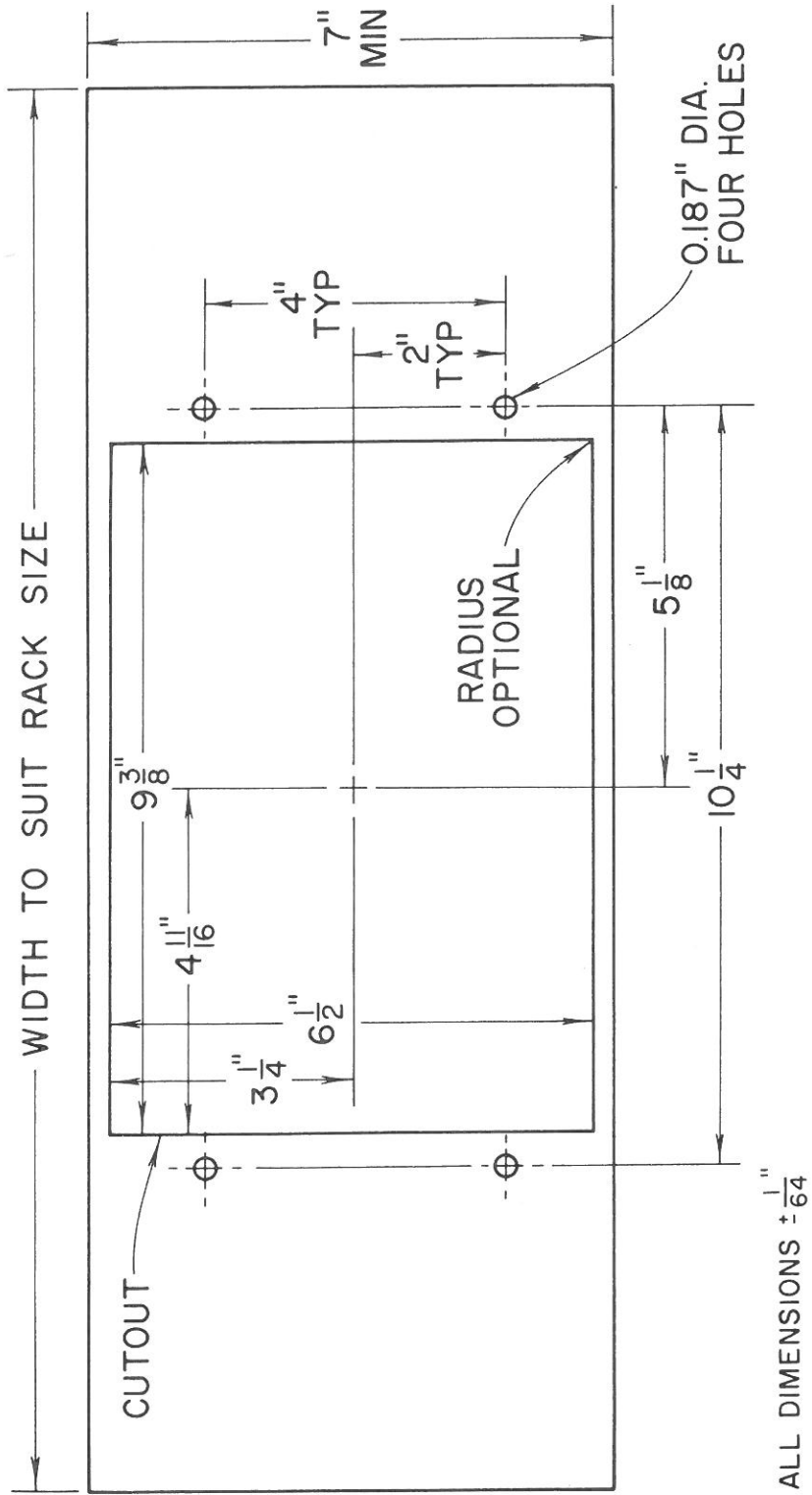
5. For 115-volt operation - On TB101, connect jumper strap E101 between terminals 1 and 2 and jumper strap E102 between terminals 3 and 4. Use P101 plug on power cord or use A101 Power Cord Set for 115 volts.
6. For 230-volt operation - On TB101, connect both jumper straps E101 and E102 between terminals 2 and 3. Use P102 Plug on power cord or use A102 Power Cord Set for 230 volts. Replace the terminal screws in terminals 1 and 4.
7. Model No. 921-0014: Replace the top cover.
Model No. 921-0015: Place the chassis assembly in the case and replace the four screws in the rubber feet on the bottom of the case.
8. Install the proper fuse for the voltage being used.

Location

Position the control unit so that the high-voltage cable will reach from it to the VacIon Pump(s) it is to operate. The usual length of the cable is 8 feet for miniature pumps and 10 or 12 feet for 2 and 8 ℓ /s pumps. However, if additional current leakage can be tolerated, cable lengths up to 50 feet are practical. Keep the control unit away from ventilation outlets that might introduce contamination such as dust or corrosive material. Avoid excessively humid locations.

Panel-Mounting the Single-Pump Control Unit

To cut a mounting panel, use the diagram of a cutout and bolt-hole pattern given below. Take the control unit chassis out of its case by removing the four screws in the rubber feet on the bottom of the case. Remove the four screws and nuts that hold the front panel to the chassis. Holding the front panel against the chassis, attach the mounting panel with these screws.



MOUNTING PANEL LAYOUT FOR MODEL NO. 921-0015 CONTROL UNIT

CONNECTION TO THE VacIon PUMP

A VacIon Pump is connected to the control unit high voltage outlet by one of several different types of coaxial high-voltage cable assemblies, depending on the pump size. The cable assemblies shown in the accompanying figures must be ordered separately. The insulated center conductor furnishes the positive high voltage to the VacIon Pump. The braided outer shield conductor is the negative electrical connection to the VacIon Pump and is also the ground lead from the pump case. For all the cable assemblies, connection to the HIGH VOLTAGE receptacle on the rear of the control unit is made with an MS (Military Specification MIL-C-5015) type connector. High-voltage receptacles not in use should be protected by the dust covers provided.



REAR VIEW OF MODEL 921-0014
CONTROL UNIT



REAR VIEW OF MODEL 921-0015
CONTROL UNIT

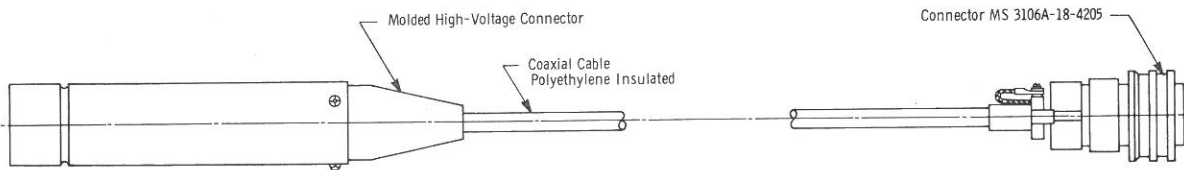
CONNECTION TO THE VacIon PUMP

Miniature VacIon Pumps

The cable assemblies for miniature VacIon Pumps have a miniature size (9/16-inch o.d.) high-voltage connector, Model No. 924-0020, which mates with the pump. Earlier style VacIon Pumps use a connector with different internal contacts, Model No. 924-0021. The plastic connector is molded onto the contacts and center conductor of the coaxial cable. Near the connector, the outer shield of the coaxial cable is brought out of the cable to a terminal lug.



MINIATURE SIZE HIGH-VOLTAGE CONNECTOR WITH 8' CABLE,
MODEL NO. 924-0020, FOR MINIATURE VacIon PUMPS



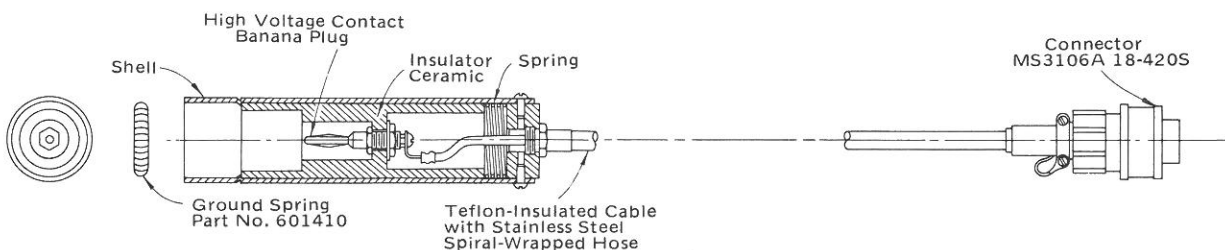
STANDARD SIZE HIGH-VOLTAGE CONNECTOR WITH 10' CABLE,
MODEL NO. 924-0750, FOR 2 AND 8 l/s VacIon PUMPS

To install a high-voltage connector on a miniature VacIon Pump:

1. Place the plastic connector on the pump high-voltage insulator and push it into place.
2. Attach the shield lead to the pump body under the head of a magnet mounting bolt. Be sure to make good mechanical and electrical contact.
3. Important: Attach the braided ground lead from the control unit to the pump body.

2 l/s and 8 l/s VacIon Pumps

The cable assemblies for 2 and 8 l/s VacIon Pumps have a standard size (1-inch o.d.) high-voltage connector that mates with the pumps. The center conductor of the coaxial cable is connected to a banana plug inside the connector housing. The outer shield of the coaxial cable is internally attached to the connector housing. This arrangement requires a ground spring for contact between the connector housing and the base of the pump high-voltage insulator.



250°C BAKEABLE HIGH-VOLTAGE CONNECTOR WITH 12' CABLE,
 MODEL NO. 924-0736, FOR 2 AND 8 l/s VacIon PUMPS

—WARNING—

ADEQUATE GROUNDING OF THE CONTROL UNIT CHASSIS IS EXTREMELY IMPORTANT. Be sure that both the ground spring and auxiliary ground lead are properly installed, as directed below.

The ground spring completes the ground return for the high-voltage circuit. The auxiliary ground lead is an uninsulated braided cable that comes through a rubber grommet on the back of the control unit chassis. Inside the unit, it is connected to the power line ground.

To install a standard size high-voltage connector on a VacIon Pump:

1. Place the ground spring in the recess on the pump high-voltage insulator.
2. Place the connector on the pump high-voltage insulator. With a quarter-turn rotary motion, push the connector as far as it will go. Make certain not to displace the ground spring.
3. Attach a braided ground lead from the control unit to the pump body.

Model Nos. 921-0014 and 921-0015 control units start and operate VacIon Pumps which have pumping speeds up to and including 8.0 l/s. However, at low vacuum these control units do not have sufficient power to maintain the rated pumping speeds of pumps larger than 2 l/s. VacIon Pumps larger than 8 l/s which require the same operating voltage can be operated at low pressures with this control unit. Larger pumps require special considerations which are discussed later in this section under "Control Unit Capability."

Controls

ON/OFF Toggle Switch - This is the main power switch. When turned ON the indicator light will glow. High voltage is then immediately available at the HIGH VOLTAGE outlet on the rear of the chassis. No warm-up period is required.

METER RANGE Selector Switch - This switch is used to select any of five current or voltage ranges for display on the meter. The current and voltage indicated are for the output of the control unit.

PUMPS METERED Switches (Model No. 921-0014 only) - These two switches are used in conjunction according to the following table. They make it possible either to monitor the current at any one of the ten high-voltage outlets, or to monitor the total current at all ten outlets.

Control Item	Switch Setting and Monitoring	
Top Switch (S 104)	1 through 10	ALL
Bottom Switch (S 102)	EACH	ALL
Meter Reads	Current at Numbered Outlet Only	Total Current at All Ten Outlets

Operating Instructions

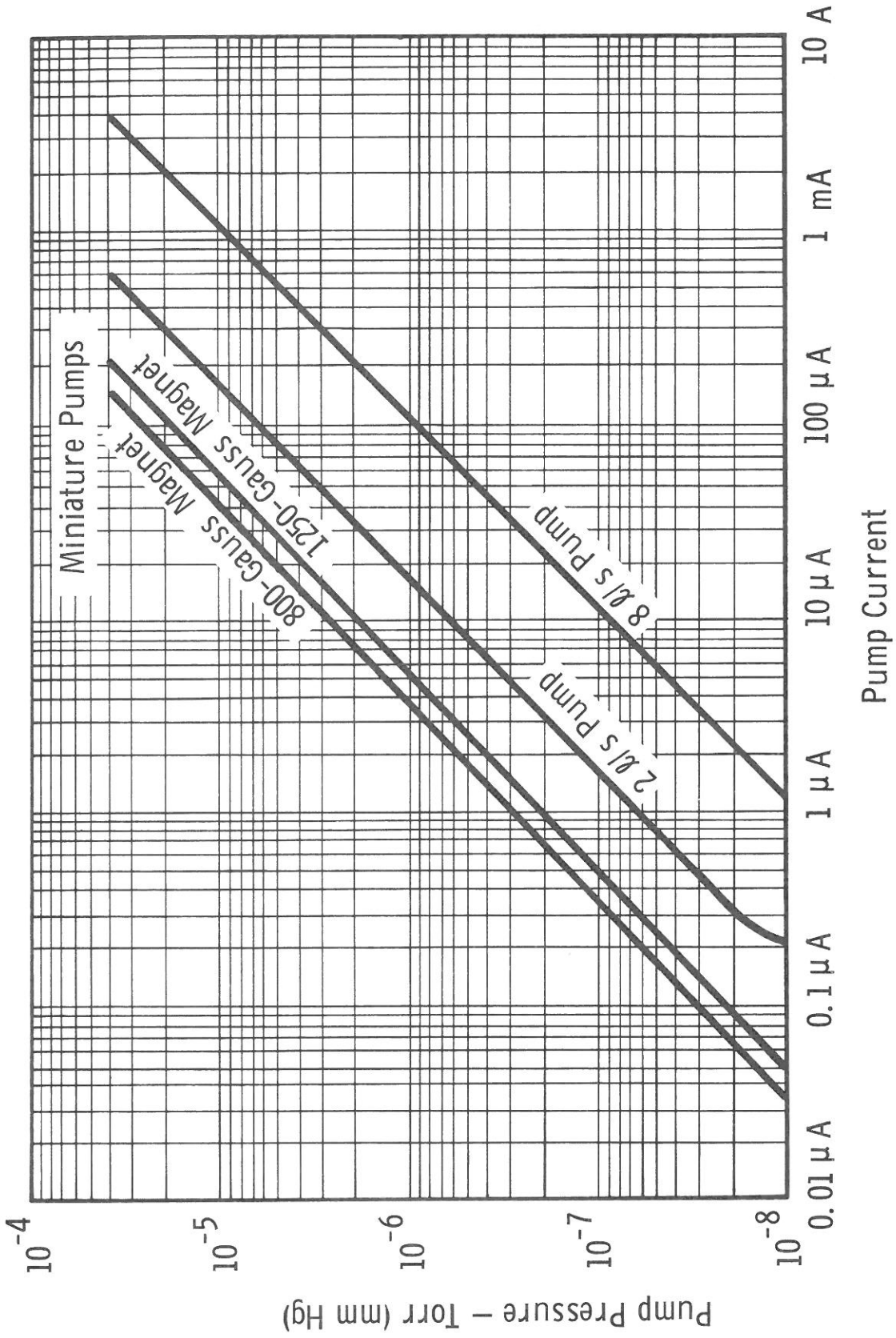
Before operating the control unit, complete all steps in Sections IV and V. Give particular attention to the grounding procedure.

1. Connect the power cord to the power source receptacle.
2. Place the main power toggle switch in the ON position. (For details of VacIon Pump starting and operating characteristics, consult the appropriate VacIon Pump instruction manual.)
3. To monitor the control unit output voltage, place the METER RANGE switch in the 5-kV position. On Model No. 921-0014, use the PUMPS METERED switches to select the particular pump to be monitored.
4. To monitor the VacIon Pump current, place the METER RANGE switch in an appropriate current range so that the meter indication can be read. Use PUMPS METERED switches as directed in 3.

Pressure Determination

Pressure at the inlet flange of a VacIon Pump is proportional to the current drawn by the pump. The Current vs Pressure curve for each pump normally operated by this control unit is shown on page 17. To determine the pressure at the inlet flange of the VacIon Pump, read the current displayed on the control unit meter and find the corresponding pressure value from the curve for the particular pump. The accuracy obtained is comparable to that of a good ionization gauge.

The pressure in a VacIon Pump is proportional to the ion current flowing in the pump. An additional current flow due to electrical leakage or field emission



Current vs Pressure

can occur and will result in pressure determinations which are too high. Electrical leakage currents often associated with high voltage circuits can be caused by the accumulation of dirt or moisture or by faulty insulation. Field emission currents result from the build-up of minute sharp points within a VacIon Pump. These additional currents are only of concern in connection with the accuracy of pressure determination. For evaluation of electrical leakage and field emission currents, see page 39.

Use of a Recorder

VacIon Pump current can be continuously recorded from two standard banana jacks on the back of the chassis. These output connections accommodate a dual banana plug (General Radio No. 274-MB). The black jack is grounded to the control unit chassis. The voltage on the red jack varies from 0 to -100 millivolts, with respect to the grounded black jack. The -100 mV corresponds to full-scale meter deflection for all current ranges. The maximum impedance looking into the recorder jacks is 20 kilohms. The input impedance of the recorder should be at least 100 kilohms. Varian recorders Series G-1000, G-2000, or G-4000 are compatible with this control unit.

Control Unit Capability

From the Electrical Characteristics curves it can be seen that the power output of the control unit, Model No. 921-0015, reaches a maximum value when the current demand is 15 mA. On Model No. 921-0014, the power output of either of the power supplies of the control unit is maximum when the current demand is 18 mA.

The throughput of the VacIon Pump (Q , in Torr-liters/second*) will also be at a maximum when the power output of the control unit is highest. At this point, an increase in pressure in the pump will cause the current to increase, but the power will decrease. Therefore, the throughput of the pump will decrease when the pump pressure rises above the maximum power point of the control unit.

The practical requirement for operating pumps larger than 1.0 ℓ/s up to and including 8.0 ℓ/s with Model No. 921-0015 is that the current demand on the control unit should not exceed 15 mA when a gas-evolving process is at its maximum. That is, a pump can handle a gas load which results in a pressure corresponding to a current demand of 15 mA on the Current vs Pressure curve. For example, an 8.0 ℓ/s VacIon Pump draws 15 mA at a pressure of 1.2×10^{-4} Torr. If gas evolution forces the pressure higher, the gas-evolving process must be slowed down or stopped until the pump brings the pressure down again. A similar example for Model No. 921-0014 would be nine 1.0 ℓ/s VacIon Pumps at a pressure of 1.6×10^{-4} Torr (2 mA each) for a total current demand of 18 mA.

VacIon Pumps larger than 8.0 ℓ/s which require approximately 3000 volts can be operated satisfactorily at low pressures with these control units. However, it is usually desirable to start the pump with its appropriate control unit. These larger pumps should only be expected to pump gas loads that result in pump pressures corresponding to a current demand to the left of the 15 mA line (Model No. 921-0015) or the 18 mA line (Model No. 921-0014) on its Current vs Pressure curve. For example, to operate a 50 ℓ/s VacIon Pump with Model No. 921-0015, the pressure should remain less than about 2.5×10^{-5} Torr.

 * Q is defined as throughput in pressure-volume units, per unit time. Example:
 At 2×10^{-6} Torr and with a pumping speed of 8 liters/second, $Q = 2 \times 10^{-6}$ Torr
 x 8 liters/second = 1.6×10^{-5} Torr-liters/second.

Adapting the Pressure-Sensitive Relay to VacIon Pump Control Units

Although the Pressure-Sensitive Relay, Model No. 924-0040, was designed specifically for large-cell VacIon Pumps (140 to 1000 liters per second), it can also be used with Model No. 921-0014 or 921-0015 Control Units. Adapter cable, Model No. 924-0746, provides the means of transmitting the 1-100 mV signal from the control unit to the pressure-sensitive relay.

Using a 1.5-volt battery, a 1-kilohm resistor, a 100-ohm potentiometer, and a voltmeter, establish a millivolt output corresponding to the required pressure point. The control unit's output current is proportional to its recorder output. A millivolt set-point can be selected from the current-pressure characteristic.

A 1 liter-per-second pump has a current of $100 \mu\text{A}$ at a pressure of 1×10^{-5} Torr. This current corresponds to a recorder output of approximately $60 \text{ mV} \pm 5\%$. This millivolt signal, when used to trigger a pressure-sensitive relay, can be very useful in controlling processes.

Multiple-Pump Control Unit, Model No. 921-0014

Power Supply Circuit

The power supply circuit of Control Unit Model No. 921-0014 consists of a transformer which has two secondaries and two identical half-wave voltage doubler circuits. (See the schematic diagram.) The voltage doubler circuit designated as "ALL" on the schematic provides dc power for the simultaneous operation of as many as ten VacIon Pumps. The voltage-doubler circuit designated as "EACH" on the schematic provides dc power for only one pump at a time. This doubler circuit can be sequentially connected to any one of the ten high-voltage outlets by switch S104.

Line power is supplied to the dual-voltage primary of transformer T101 by a three-conductor power cord from Plug P101. The black and the white insulated conductors in the cord are for power; the green conductor is for grounding. The power to the transformer primary is controlled by the ON/OFF toggle switch S101. Fuse F101 is a 3A Slo-Blo fuse that protects against overload. For 115-volt operation, the primary coils of the transformer are connected in parallel; for 230-volt operation, the primaries are connected in series. For voltage changeover procedure see page 8.

The "ALL" half-wave voltage-doubler circuit consists of capacitors C101, C103, and diodes CR101 through CR116. The "EACH" half-wave voltage-doubler circuit consists of capacitors C102, C104, and diodes CR117 through CR132. The two transformer secondaries provide 1500 volts at no load. Both voltage-doubler circuits provide a positive 3500 volts dc $\pm 10\%$ with respect to chassis ground at the high-voltage outlets J101 through J110 when no load is applied. Both voltage-doubler circuits will supply a short circuit current of 43 mA $\pm 10\%$. When operated from a 50-Hz power source, the open-circuit voltage and short-circuit current values will be slightly lower than those given above for 60-Hz operation. However, VacIon

CIRCUIT DESCRIPTION

Pumps will operate equally well from this control unit when it is powered from a 50-Hz source. Specific values for 50-Hz operation are given on page 4.

The secondary voltages of the transformer are established by the open circuit dc voltage requirement. The short circuit current values are mainly determined by the reactance of capacitors C101 and C102. A low-ripple dc output voltage at low current is obtained for each circuit by the filtering action of C103 and C104. Resistors R106 and R107 are used to limit the peak surge currents that C103 and C104 can supply when a heavy load is suddenly placed on the control unit. The peak current values are then low enough to be conducted safely by the meter diodes CR133 or CR134. Resistors R108 through R113, and R114 through R119 form power supply bleeders to discharge C101 and C103, or C102 and C104 within 30 seconds after the main power switch S101 is opened.

Meter Circuit

The control unit meter M101 has a 5- μ A full-scale movement. Currents from 0.05 μ A to 50 mA can be read. The METER RANGE selector switch S103 is used to select the proper shunt resistor R101 through R104 so that the current can be displayed in decade increments on the meter. For safety, all current and voltage measurements are made in circuits with voltages less than one volt from chassis ground.

The current to the VacIon Pumps in either circuit is metered between the negative terminal of the power supply and its connection to ground. Filter capacitors C105 or C106 and meter-protect diodes CR133 or CR134, respectively, are connected in parallel with M101 for all current ranges. C105 and C106 minimize the ac ripple and current surges that are applied to M101. The exponential voltage-versus-current characteristics of CR133 and CR134 are used to prevent excessive currents in M101. These diodes have less than 0.1 μ A forward current at 250 mV and less than one volt across them at 3/4 A forward current. During normal

operation, either diode has 235 mV across it for full-scale meter deflection. Its forward current is negligible in any current range. Any surge current up to 3/4 A will produce less than one volt across the parallel combination of capacitor, diode, and M101 in series with R105, because the diode goes into heavy conduction. With one volt across the series combination of M101 and R105, the total current is limited to 4.25 times full-scale deflection current. During normal operation, the current through M101 will not exceed three times full-scale current even if it is on the 5- μ A range and there is a short circuit current of 43 mA.

When the PUMPS METERED switch S102, for selection of EACH/ALL, is in the EACH position the meter indicates the current of one pump only. The current indicated is for the pump selected with the PUMPS METERED switch S104, for selection of 1-10/ALL. When S102 is in the EACH position the negative terminal of the "EACH" doubler circuit is connected through S102A1(1) to the current metering circuit, and the negative terminal of the "ALL" doubler circuit is connected through S102A2(1) to ground.

When S102 is in the ALL position, the meter indicates the total current of all the pumps connected to the control unit, except the one pump which corresponds to the number selected with S104. When both S102 and S104 are in their ALL positions, the current displayed is the total current of all the pumps connected to the control unit. When S102 is in the ALL position the negative terminal of the "ALL" doubler circuit is connected through S102A1(2) to the current metering circuit, and the negative terminal of the "EACH" doubler circuit is connected through S102A2(2) to ground.

The voltage applied to a VacIon Pump by either voltage doubler circuit is indicated on M101 when the METER RANGE switch S103 is in the 5-kV position. M101 is then connected in parallel with either R113 or R119 by S102. The voltage developed across R113 or R119 is applied through S102A3 to meter M101 to indicate the output voltage for the respective circuit. When the PUMPS METERED switch S102,

CIRCUIT DESCRIPTION

for EACH/ALL selection, is in the EACH position the meter indicates the voltage of one pump only as developed by the "EACH" doubler circuit. The voltage indicated is for the pump which corresponds to the number selected with the PUMPS METERED switch S104, for selection of 1-10/ALL.

When S102 is in the ALL position, the voltage displayed is that of the "ALL" doubler circuit, to which all pumps on the control unit are connected except the one corresponding to the position of S104. The voltage value displayed will correspond to the total current demand of all the pumps on the "ALL" doubler circuit. When S102 and S104 are both in their ALL positions, the voltage displayed is for the "ALL" doubler circuit. The voltage value displayed will correspond to the total current demand of all pumps connected to the control unit. For a 3500-volt output, the voltage across M101 and R113 or R119 will be 94.5 mV.

Recorder Circuit

A permanent record of VacIon Pump current can be made by connecting a recorder across jacks J111 and J112. J111 is red and varies linearly from 0 to -100 mV with respect to ground for a zero to full-scale meter deflection in any current range. J112 is black and is grounded to the chassis. When a full-scale current of five μ A flows through M101 and R105 which are in series, -100 mV is developed across R105 in each current range. C107 is connected across R105 to reduce the ac ripple and noise at the recorder jacks. The maximum impedance looking into the recorder jacks is 20 kilohms. The input impedance of the recorder should be at least 100 kilohms to minimize errors due to its shunting effect on R105.

When the PUMPS METERED switch S102 for EACH/ALL selection is in the EACH position, current is recorded for one pump only. The current recorded is for the pump connected in the position indicated by the number selected with the PUMPS METERED switch S104. When S102 is in the ALL position, the current recorded is the total current of all the pumps connected to the control unit, except

the one pump selected with S104. When both S102 and S104 are in their ALL positions, the current recorded is the total current of all the pumps connected to the control unit.

KEY TO WIRE-MARKING CODE USED BY VARIAN

Prefix = AWG Size		Number = Base Color		Number = Stripe Color	
A	24	0	Black	0	Black
B	22	1	Brown	1	Brown
C	20	2	Red	2	Red
D	18	3	Orange	3	Orange
E	16	4	Yellow	4	Yellow
H	14	5	Green	5	Green
J	12	6	Blue	6	Blue
K	10	7	Violet	7	Violet
EE	16 HV	8	Gray	8	Gray
		9	White	9	White

Single-Pump Control Unit, Model No. 921-0015

Power Supply Circuit

The power supply circuit of Control Unit Model No. 921-0015 consists of a transformer and a half-wave voltage doubler circuit to provide dc power for the VacIon Pump. (See the schematic diagram.) Line power is supplied to the dual voltage primary of transformer T101 by a three-conductor power cord from Plug P101. The black and the white insulated conductors in the cord are for power; the green conductor is for grounding. The power to the transformer primary is controlled by the ON/OFF toggle switch S101. Fuse F101 is a 1-A Slo-Blo fuse that protects against overload. For 115-volt operation the primary coils of the transformer are connected in parallel; for 230-volt operation the primaries are connected in series. For voltage changeover procedure see page 8.

The half-wave voltage doubler circuit consists of capacitors C102, C103, C104, and diodes CR101 through CR114. The transformer secondary voltage is 1250 volts at no load. The voltage doubler circuit provides a positive 3500 volts dc $\pm 10\%$ with respect to chassis ground at high-voltage outlet J101 when no load is applied. The voltage doubler circuit will supply a short circuit current of 43 mA $\pm 10\%$. When operated from a 50-Hz power source, the open circuit voltage and short circuit current values will be slightly lower than those given above for 60-Hz operation. However, a VacIon Pump will operate equally well from this control unit when it is powered from a 50-Hz source. Specific values for 50-Hz operation are given on page 4.

The secondary voltage of the transformer is established by the open circuit dc voltage requirement. The short circuit current value is mainly determined by the reactance of C102. A low-ripple dc output voltage at low current is obtained by the filtering action of C103 and C104. Resistor R106 is used to limit the peak surge currents that C103 and C104 can supply when a heavy load is suddenly placed on the

control unit. The peak current values are then low enough to be conducted safely by the meter diode CR115. Resistors R105, R107, R108, R109 and R110 form the power supply bleeder to discharge C102, C103 and C104 within 30 seconds after the main power switch S101 is opened. These resistors are also used to divide the dc output voltage equally across C103 and C104 to assure that their rated working voltage is not exceeded.

Meter Circuit

The control unit meter M101 has a 5- μ A full-scale movement. Currents from 0.05 μ A to 50 mA can be read. The METER RANGE selector switch S102 is used to select the proper shunt resistors R101 through R104 so that the current can be displayed in decade increments on the meter. For safety, all current and voltage measurements are made in circuits with voltages less than one volt from chassis ground.

The current to the VacIon Pump is metered between the negative terminal of the power supply and its connection to ground. Filter capacitor C101 and meter-protect diode CR115 are connected in parallel with M101 for all current ranges. C101 minimizes the ac ripple and current surges that are applied to M101. The exponential voltage versus current characteristic of CR115 is used to prevent excessive currents in M101. CR115 has less than 0.1 μ A forward current at 250 mV and less than 1 volt across it at 0.75 A forward current. During normal operation, CR115 has 235 mV across it for full-scale meter deflection. Its forward current is negligible in any current range. Any surge current up to 0.75 A will produce less than one volt across the parallel combination of CR115, C101, and M101 in series with R111, because CR115 goes into heavy conduction. With one volt across the series combination of M101 and R111, the total current is limited to 4.25 times full-scale deflection current. During normal operation the current through M101 will not exceed three times full-scale even if it is on the 5- μ A range and there is a short circuit current of 43 mA.

CIRCUIT DESCRIPTION

The voltage applied to the VacIon Pump is indicated on M101 when the METER RANGE switch S102 is in the 5-kV position. M101 is then connected in parallel with R105 by S102. For a 3500-volt output, the voltage across M101 and R105 will be 94.5 mV.

Recorder Circuit

A permanent record of VacIon Pump current can be made by connecting a recorder to jacks J102 and J103. J102 is red and varies linearly from 0 to negative 100 mV with respect to ground for a zero to full-scale meter deflection in any current range. J103 is black and is grounded to the chassis. When a full-scale current of five μA flows through M101 and R111, which are in series, -100 mV is developed across R111 in each current range. C105 is connected across R111 to reduce the ac ripple and noise at the recorder jacks. The maximum impedance looking into the recorder jacks is 20 kilohms. The input impedance of the recorder should be at least 100 kilohms to minimize errors due to its shunting effect on R111.

KEY TO WIRE-MARKING CODE USED BY VARIAN

Prefix = AWG Size	Number = Base Color	Number = Stripe Color
A 24	0 Black	0 Black
B 22	1 Brown	1 Brown
C 20	2 Red	2 Red
D 18	3 Orange	3 Orange
E 16	4 Yellow	4 Yellow
H 14	5 Green	5 Green
J 12	6 Blue	6 Blue
K 10	7 Violet	7 Violet
EE 16 HV	8 Gray	8 Gray
	9 White	9 White

This section describes routine maintenance such as cleaning, troubleshooting, meter tests and electrical leakage determination. If service is necessary, contact the nearest Varian Vacuum Division District Office.

Cleaning

The high-voltage components of the control unit tend to attract dust particles electrostatically. When these particles absorb water vapor from the air, electrical leakage or even arc-over may occur. Therefore, it is important to wipe or vacuum-clean the high-voltage components regularly.

Model No. 921-0014 has a dust cap for each high-voltage outlet. Whenever a cable assembly is not connected to the control unit, be sure to keep its dust cap in place to ensure both cleanliness and safety.

—WARNING—

THE VOLTAGES DEVELOPED IN THIS CONTROL UNIT ARE EXTREMELY DANGEROUS. BEFORE REMOVING THE CHASSIS FROM THE CASE, UNPLUG THE CONTROL UNIT AND WAIT 30 SECONDS. BEFORE CHECKING CIRCUITS, SHORT ALL CAPACITORS. USE AN OHMMETER FOR ALL TESTS UNLESS DIRECTED OTHERWISE.

Troubleshooting

SYMPTOM	POSSIBLE CAUSE Model No. 921-0015	POSSIBLE CAUSE Model No. 921-0014	REMEDY
1. DS101 will not light when S101 is ON and P101 is plugged into power source.	F101 is blown.	Same	Replace.
	No source power	Same	Check power fuse or circuit breaker.
	DS101 defective	Same	Replace.
	S101 defective	Same	Replace.
	Open in power cord	Same	Repair or replace.
	Open in wiring between S101 and T101	Same	Repair.
	E102 loose on TB101	Same	Tighten screws.
2. F101 blows repeatedly.	T101 primary or secondary windings shorted, or shorted to each other and/or to chassis	Same	Confirm with ohmmeter and replace.
	T101 primaries phased incorrectly	Same	Check connections and phasing against schematic. Wire correctly.
	Wiring between F101 and T101 shorted or grounded	Same	Repair or replace.
	C102 shorted or grounded to chassis	C101 or C102 shorted or grounded to chassis	Replace.
	High-voltage wire from T101 to C102 grounded	High voltage wire from T101 to C101 or C102 grounded	Replace.
3. Power source circuit breaker opens or fuse blows, but F101 does not blow.	Short or ground in P101, power cord, S101, or wire to F101	Same	Confirm with ohmmeter and repair or replace.
	Replacement line-power plug wired incorrectly	Same	Confirm with ohmmeter and correct.
	Wire between terminal 4 of T101 and P101 grounded, and "hot" side of power source connected to "low" terminal of source receptacle or power extension cord	Same	Check T101 terminal 4 for ground. Rewire receptacle or power extension cord.

SYMPTOM	POSSIBLE CAUSE Model No. 921-0015	POSSIBLE CAUSE Model No. 921-0014	REMEDY
4. T101 overheats on 115 or 230V ac while furnishing short circuit current, but F101 does not blow.	One primary winding open	Same	Confirm with ohmmeter and replace.
	E101 or E102 loose on TB101	Same	Tighten screws.
	Open wiring between TB101 and T101	Same	Repair or replace.
	T101 windings partially shorted	Same	Replace.
5. When high-voltage cable is connected to J101 but not to VacIon Pump, DS101 lights but M101 indicates zero voltage and current.	C102 open	C101 or C102 open	Replace.
		C103 or C104 shorted	Replace.
	T101 primary or secondary windings open	Same	Confirm with ohmmeter and replace.
	CR101 through CR107 open	CR101 through CR108 open	Replace.
	CR108 through CR114 shorted	CR109 through CR116 shorted	Replace.
	M101 open or shorted	Same	Repair or replace. Refer to Meter Tests.
	High voltage cable shorted and CR115 or C101 shorted	High voltage cable shorted and CR133 or CR134, and C105 or C106 shorted	Repair or replace. (Disconnect M101 before testing.)
	R106 open	R106 or R107 open	Replace.
	R107 through R110 open	R108 through R112, or R114 through R118 open	Replace.
R105 shorted	R113 or R119 shorted	Replace.	
6. DS101 lights and M101 indicates 3.5 kV but no current on any range.	VacIon Pump is at a very low pressure corresponding to less than 0.1 μ A. This is a satisfactory condition indicating high vacuum in pump.	All VacIon Pumps are at a very low pressure corresponding to less than 0.1 μ A. This is a satisfactory condition indicating high vacuum in the pumps.	To confirm, turn S101 OFF and allow pressure to rise. After several minutes turn S101 ON and note current decrease.

MAINTENANCE

SYMPTOM	POSSIBLE CAUSE Model No. 921-0015	POSSIBLE CAUSE Model No. 921-0014	REMEDY
<p>6. DS101 lights and M101 indicates 3.5 kV but no current on any range.</p>	<p>VacIon Pump at low vacuum or atmospheric pressure.</p>	<p>All VacIon Pumps are at low vacuum or atmospheric pressure.</p>	<p>Check pump pressure and rough pump system to 10 microns or lower.</p>
	<p>CR115 shorted</p>	<p>CR133 or CR134 shorted</p>	<p>Replace (Disconnect M101 before testing)</p>
	<p>C101 shorted</p>	<p>C105 or C106 shorted</p>	<p>Replace (Disconnect M101 before testing.)</p>
	<p>R111 open</p>	<p>R105 open</p>	<p>Replace.</p>
	<p>Open contacts on S102A</p>	<p>Open contacts on S103A</p>	<p>Replace.</p>
	<p>Open circuit in high voltage cable</p>	<p>Open circuit in one or more high voltage cables</p>	<p>Repair or replace.</p>
<p>7. For any single pump monitored, M101 gives a voltage and current indication, but one or both are suspected of being wrong.</p>	<p>Confirm by comparing M101 voltage and current readings to Voltage vs Current curve. The difference between two corresponding values of current or voltage should not exceed the average value of the two readings by more than 20 per cent.</p>	<p>Same</p>	<p>Test M101 per Meter Tests. Repair or replace.</p>
	<p>Excessive leakage current in high voltage circuit, connector, cable or VacIon Pump</p>	<p>Same</p>	<p>Test for electrical leakage. Clean or replace.</p>

SYMPTOM	POSSIBLE CAUSE Model No. 921-0015	POSSIBLE CAUSE Model No. 921-0014	REMEDY
8. M101 reads short circuit current but zero volts (M101 should read several hundred volts during normal starting conditions.)	Short in VacIon Pump	Same	Remove connector from pump. M101 should read open circuit voltage and zero current. Test pump with ohmmeter.
	Short in high voltage cable	Same	Remove cable assembly from control unit. M101 should read open circuit voltage and zero current. Test cable through to pump with ohmmeter.
	J101 or connecting lead grounded	High voltage receptacle (J101 through J110) or its connecting lead grounded	Replace.
	C103 grounded to chassis	C103 or C104 grounded to chassis	Replace.
9. M101 indicates zero voltage but reads correctly on all current ranges	C104 shorted	C103 or C104 shorted	Replace.
	R107 through R110 open	R108 through R112, or R114 through R118 open	Replace.
	R105 shorted	R113 or R119 shorted	Replace.
	S102A(1) open	S103A(1) open	Replace.
10. M101 indicates low voltage but reads correctly on all current ranges.	R107 through R110 <u>increased</u> in resistance	R108 through R112, or R114 through R118 <u>increased</u> in resistance	Replace as required.
	R105 <u>decreased</u> in resistance	R113 or R119 <u>decreased</u> in resistance	Replace.
	C103 leaky	C103 or C104 leaky	Replace.
	Source voltage low	Source voltage low	Check. Not probable if short circuit current is correct.

MAINTENANCE

SYMPTOM	POSSIBLE CAUSE Model No. 921-0015	POSSIBLE CAUSE Model No. 921-0014	REMEDY
11. M101 indicates off-scale, or higher than rated voltage, but reads correctly on all current ranges.	R107 through R110 <u>decreased</u> in resistance	R108 through R112, or R114 through R118 <u>decreased</u> in resistance	Replace as required.
	R105 <u>increased</u> in resistance	R113 or R114 <u>increased</u> in resistance	Replace.
	C103 leaky	C103 or C104 shorted or leaky	Replace.
	Source voltage high	Source voltage high	Check. Not probable if short circuit current is correct
12. M101 indicates voltage correctly but all current ranges are <u>high</u> . Recorder output low or zero	R111 decreased in resistance	R105 decreased in resistance	Replace.
	C105 shorted or leaky	C107 shorted or leaky	Replace.
13. M101 indicates voltage correctly but all current ranges are <u>low</u> . Recorder output low	C101 leaky	C105 or C106 shorted or leaky	Replace.
	CR115 changed characteristics.	CR133 or CR134 changed characteristics	Replace.
14. M101 indicates voltage correctly but all current ranges except 5 μ A range are incorrect.	R101 through R104 <u>incorrect</u> resistance	Same	Replace as required.
	S102B has high resistance contacts	S103B has high resistance contacts.	Replace.
15. M101 indicates incorrectly on all current and voltage ranges.	M101 defective. Accumulative problems	Same	Repair or replace.

Meter Tests

DO NOT test meter M101, or circuit to which M101 is connected, with an ordinary ohmmeter. Test current from a typical ohmmeter greatly exceeds five microamperes and M101 would be seriously damaged. Simpson Model 270 is recommended. A voltmeter with a dc sensitivity of 20,000 ohms per volt is also suitable.

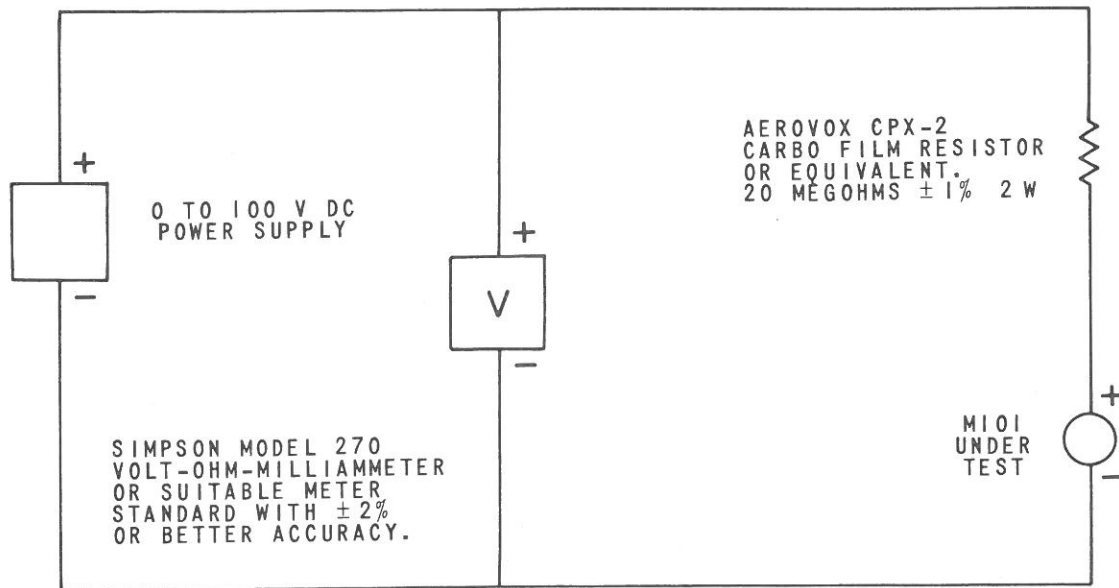
Before making test connections, turn control unit OFF, unplug from power source, and remove the lead used for grounding. Remove the high-voltage cable and wait 30 seconds. Ground high-voltage receptacle J101. Tolerances on control unit voltage and current values are $\pm 10\%$ of full scale.

CONTROL UNIT			METER-STANDARD	
Meter Range	Test Condition	M101 Should Read	Range	Reading
	Connect meter-standard positive lead to the high-voltage contact of J101 and negative lead to a braided ground lead. Supply input voltage from a variable transformer.			
5 kV	J101 open: 115/230-V, 60/50-Hz input	3.5 kV	5 kV dc	3.5 kV $\pm 10\%$
50 mA	J101 shorted: 115/230-V, 60-Hz input 50-Hz input	43 mA 36 mA	100 mA dc 100 mA dc	43 mA $\pm 10\%$ 36 mA $\pm 10\%$
5 mA	Increase input voltage from zero until meter-standard reads 5 mA.	5 mA	10 mA dc	5 mA

CONTROL UNIT			METER-STANDARD	
Meter Range	Test Condition	Meter 101 Should Read	Range	Reading
500 μ A	Connect meter-standard positive lead through a 1-megohm 2-W (for the voltage rating) composition resistor to the high-voltage contact of J101, and the negative lead to the braided ground lead. Increase input voltage until meter-standard reads 500 μ A	500 μ A	1 mA dc	0.5 mA
50 μ A	Same procedure as above except use a 10-megohm 2-W composition resistor Increase input voltage until meter-standard reads 50 μ A	50 μ A	50 μ A	50 μ A
5 μ A	Same procedure as for 500- μ A range except use five 20-megohm 1-W composition resistors in series Increase input voltage until meter-standard reads 5 μ A	5 μ A	50 μ A	5 μ A

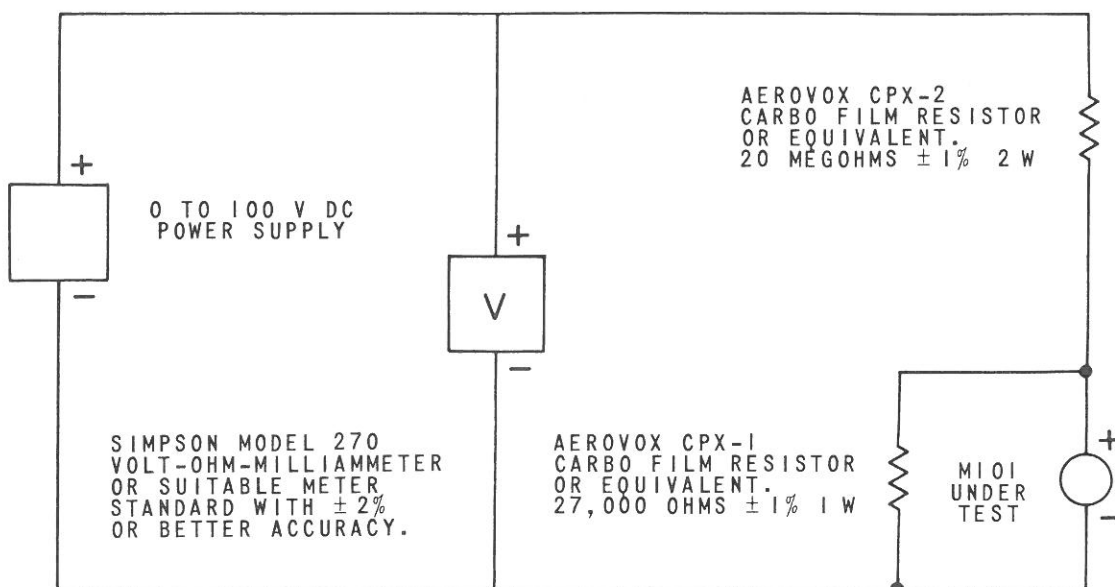
Meter Movement Tests - The meter has a full-scale deflection current of $5 \mu A \pm 2\%$ and a terminal resistance of 27,000 ohms $\pm 1\%$. These tolerances can be determined only if tests on M101 are made with laboratory equipment at $25^{\circ}C \pm 10^{\circ}C$. A satisfactory practical test without the aid of laboratory equipment can be made as follows.

To check full-scale deflection current, connect M101 as shown below. Make all connections with the dc power supply OFF. Starting at zero, adjust the dc power supply for 100 volts on the meter-standard. At 77°F, M101 should read $5 \mu A \pm 5\%$.



METER FULL SCALE DEFLECTING CURRENT TEST

To check the terminal resistance, connect M101 as shown. Make all connections with the dc power supply OFF. Starting at zero, adjust the dc power supply for 100 volts on the meter-standard. At 77°F, the needle on M101 should point between 2.3 and 2.7, with a nominal half-scale reading of 2.5 when the terminal resistance is 27,000 ohms. If M101 reads above half-scale, the terminal resistance is below 27,000 ohms and vice versa. Do not remove the meter-standard during these tests.



METER TERMINAL RESISTANCE TEST

Diode Tests

Special test diodes CR133 and CR134 (Model No. 921-0014) or CR115 (Model No. 921-0015) must have a forward current of less than $0.1 \mu\text{A}$ at 250 mV across the junction in order to function properly. The forward voltage drop should be less than one volt at 750 milliamperes and 77°F . If a diode is suspected of excessive conduction and adequate test equipment is not available, it can easily be checked by performing the meter test for $5\text{-}\mu\text{A}$ current indication. If a diode is conducting excessively, M101 will read appreciably lower than the meter-standard; this effect is less pronounced in the higher current ranges. Each diode should have a forward resistance of about 7 ohms when tested with a Simpson Model 270 Volt-Ohm-Milliammeter. Other ohmmeters can give a different resistance because of different test currents.

Rectifier Diode Test - When measured with a Simpson Model 270 Volt-Ohm-Milliammeter, the diodes CR101 through CR132 (Model No. 921-0014) or CR101 through CR114 (Model No. 921-0015) should have a forward resistance of about

7 ohms and a backward resistance of infinity (60 megohms). The forward resistance may differ when measured with other ohmmeters because of different test currents. At 77°F, a good diode should have a reverse current of less than 10 microamps at 600 V dc. The forward voltage drop should be less than 1.2 volts at 0.75 A.

Electrical Leakage and Field Emission

When electrical leakage and field emission currents are suspected, this evaluation can be made. The VacIon Pump pressure should be below approximately 1×10^{-6} Torr. Turn the control unit OFF and remove the magnet from the pump. With the magnetic field removed, no pumping action will occur. Turn the control unit ON. With the Multiple-Pump Control Unit, evaluate each VacIon Pump and its high-voltage cable by setting the PUMPS METERED switch at EACH. The current indicated will be the accumulated leakage and field emission currents of the control unit, high voltage cable and VacIon Pump. Normally, the current for this combination should not exceed $0.3 \mu\text{A}$.

If the electrical leakage and field emission current is considered significant, its value can be subtracted from the indicated pump current (with the magnet in place on the pump) to obtain the pump ion current for pressure determination. However, this approach will yield only a close approximation of the actual ion current in the pump, because the field emission current value can change when the magnetic field is removed from the pump.

If the undesirable current is excessive and it is considered necessary to reduce it, these steps will locate the source of the current. Turn the control unit OFF and disconnect all the high-voltage cables from the control unit. Turn the control unit ON and observe the current. Normally, the indicated current should be no greater than 0.2 microampere for the control unit alone. If the leakage current for the control unit is normal, any undesirable current flow is in the high voltage

cable and/or the VacIon Pump. If this is the case, turn the control unit OFF, connect the high voltage cable to the control unit and disconnect the high voltage connector from the VacIon Pump. Turn the control unit ON and observe the current. If the current indication is higher than the previous reading, the difference is the current in the high voltage cable. If the current indication is the same as in the previous test or less than in the original test, the excessive current is in the VacIon Pump.

If excessive leakage current is found in the control unit, the leakage to ground from C101, C102, C103, C104, T101, or J101 through J110 (Model No. 921-0014) or from C102, C103, C104, J101 or T101 (Model No. 921-0015) and from the associated wiring and terminal boards can be eliminated by cleaning or replacement. Turn the control unit OFF and disconnect the power cord.

Multiple-Pump Control Unit (Model No. 921-0014): Remove the top cover. Discharge all capacitors. Unsolder all leads to the capacitors and printed circuit board. Be careful not to loosen the printed circuitry from the circuit board. Remove the printed circuit board and capacitors from the chassis. Disconnect the leads from the high voltage connectors, J101 through J110, and remove the connectors.

Single-Pump Control Unit (Model No. 921-0015): Remove the chassis from the case by means of the four screws in the rubber feet. Discharge all capacitors. Unsolder all leads to the printed circuit board. Be careful not to loosen the printed circuitry from the circuit board. Disconnect the leads from the high-voltage connector J101 and remove the connector. Remove the six screws holding C102, C103, and C104 to the back of the chassis and lift out the printed circuit board and C102, C103, and C104.

Wash the printed circuit board and capacitor insulators with acetone. Take care to keep the solvent off the paint on the capacitors. Thoroughly dry the circuit board in air or bake in an oven at 150°F for two hours.

Disassemble and wash the connectors with methyl alcohol. Bake the phenolic parts at 250°F for two hours. Do not blow on these parts with an air hose, because most air lines contain oil vapor, water vapor and other contaminants. Do not contaminate the clean high voltage components by touching them with bare fingers. Install and connect the cleaned components; test for leakage current.

If the undesirable current is determined to be in the high voltage cable or VacIon Pump, consult the appropriate instruction manuals for corrective procedure.

SECTION IX

PARTS LIST

Model No. 921-0014 VacIon Pump Control Unit

Schematic Diagram C606365E

REFERENCE DESIGNATION	DESCRIPTION	MFR. AND CATALOG NO.	VARIAN PART/DWG. NO.
A108-A117	Braided Ground Cable Assembly 10 ft.	Varian Associates	A607238
C101,C102	Capacitor, oil-filled. 0.20 μ F \pm 10%, 3000 WVdc	Varian Associates	C617654-06
C103,C104	Capacitor, oil-filled. 0.10 μ F \pm 10%, 5000 WVdc	Industrial Cond. Corp., No. 2700	41-499-895
C105-C107	Capacitor, Electrolytic. 25 μ F, 50 WVdc	Sangamo Electric Co., MT-0525	41-507-798
CR101-CR132	Crystal Diode, silicon. 600 PIV, 750 mA	Diodes Inc., DI-56	66-396-950
CR133,CR134	Crystal Diode, silicon. 600 PIV, 750 mA, Special Test	Varian Associates	A606463
F101	Fuse, 3 A, 125 V, Slo-Blo. 1/4" dia. x 1-1/4" long	Littelfuse 313003	67-136-430
H101,H102	Knob, Meter Range and Pumps Metered selector switch	Raytheon DS 90-5-2	23-508 071
H103	Knob, EACH/ALL Switch	Raytheon DS 70-5-2	23-508 070
H104-H113	Cap, dust, with chain. Fits size 18 shell. For J101 through J110	Amphenol, 9760-18	51-909-921
J101-J110	Connector, high voltage chassis receptacle	Amphenol, MS3102A- 18 420 P	52-999-950
J111	Connector, banana jack, red	E. F. Johnson, 108-902	51-451-982

REFERENCE DESIGNATION	DESCRIPTION	MFR. AND CATALOG NO.	VARIAN PART/DWG. NO.
J112	Connector, banana jack, black	E. F. Johnson, 108-903	51-451-983
M101	Meter, 0 to 5 microamperes dc $\pm 2\%$. Special scale.	Varian Associates	C606269
P101	Plug, male, 3-contact. U. S. Standard 15A, 125 V with "U" ground.	Hubbel, No. 5266	51-133-990
P102	Plug, male, 3-contact. U. S. Standard, 15 A, 250 V with "U" ground.	Hubbel, No. 5664	51-133-983
R101	Resistor, fixed composition. 4.7 ohms, 1/2 W, 5%	Allen-Bradley, EB47G5	32-201-147
R102	Resistor, fixed composition. 43 ohms, 1/2 W, 5%	Allen-Bradley, EB4305	32-201-243
R103	Resistor, fixed composition. 430 ohms, 1/2 W, 5%	Allen-Bradley, EB4315	32-201-343
R104	Resistor, fixed composition. 4700 ohms, 1/2 W, 5%	Allen-Bradley, EB4725	32-201-447
R105	Resistor, fixed composition. 20,000 ohms, 1/2 W, 5%	Allen-Bradley, EB2035	32-201-520
R106, R107	Resistor, fixed wirewound. 1000 ohms, 20 W, 5%	Ohmite Mfg. Co., 1821	35-489-410
R108-R112 R114-R118	Resistor, fixed composition. 2.2 megohms, 2W, 5%	Allen-Bradley, HB2255	34-401-722
R113, R119	Resistor, fixed composition. 270 ohms, 1 W, 5%	Allen-Bradley, Type GB	33-301-327
S101	Switch, toggle, DPST, 6 A at 125 V, 3A at 250 V	Arrow-Hart and Hegeman, 81024-GB	71-139-990
S102	Switch, rotary, 1-section, 3-pole, 2-3 position, shorting	Centralab 1406	71-710-952
S103	Switch, rotary, 2-section, 2-pole, 6 position, shorting.	Centralab 1412	71-729-950
S104	Switch, special	Varian Associates	C606480

PARTS LIST

REFERENCE DESIGNATION	DESCRIPTION	MFR. AND CATALOG NO.	VARIAN PART/DWG NO.
T101	Transformer, 115/230 V primary, 50/60 Hz, 10 ohms per winding. Secondaries: 1500 V at no load, 1150 V at 90 mA	Varian Associates	C606456
DS101	Lampholder, red lens, with 120 K ohm, 1/3 W resistor	Dialco 135-9408H-1431	55-299-962
XF101	Fuseholder 15 A, 250 V	Bussman Mfg. Div., HKP	55-198-999

Model No. 921-0015 VacIon Pump Control Unit

Schematic Diagram C606281D

REFERENCE DESIGNATION	DESCRIPTION	MFR. AND CATALOG NO.	VARIAN PART/DWG NO.
C105	Capacitor, electrolytic. 25 μ F, 50 WVdc	Sangamo Electric Co., MT-0525	41-507-798
C102-C104	Capacitor, oil-filled. 0.20 μ F \pm 10%, 3000 WVdc	Varian Associates	C617654-06
CR101- CR114	Crystal Diode, silicon. 600 PIV, 750 mA	Diodes Inc., DI-56	66-396-950
CR115	Crystal Diode, silicon. 600 PIV, 750 mA, special test	Varian Associates	A606463
E101, E102	Jumper strap for T 101	Kulka 601J	56-999-981
F101	Fuse, 1A, 125 V, Slo-Blo, for 115 operation	Littelfuse 313001	67-136 410
	Fuse, 1A, 250 V, Slow Blow, for 230 V operation	Bussmann Type MDC	67-135 410
H101	Knob, Meter Range switch	Raytheon DS 90-5-2	23-508 071
J101	Connector, high voltage chassis receptacle	Amphenol, MS3102A 18-420P	52-999-950
J102	Connector, banana jack, red	E. F. Johnson, 108-902	51-451-982
J103	Connector, banana jack, black	E. F. Johnson, 108-903	51-451-983
M101	Meter, 0-5 microamp dc \pm 2%. Special scale	Varian Associates	C606269
P101	Plug, male, 3-contact. U.S. Standard 15A, 125 V with "U" ground	Hubbel, No. 5266	51-133-990
P102	Plug, male, 3-contact. U.S. Standard 15A, 250V with "U" ground	Hubbel, No. 5664	51-133-983
R101	Resistor, fixed composition. 4.7 ohms, 1/2 W, 5%	Allen-Bradley, EB47G5	32-201-147

PARTS LIST

REFERENCE DESIGNATION	DESCRIPTION	MFR. AND CATALOG NO.	VARIAN PART/DWG. NO.
R102	Resistor, fixed composition. 43 ohms, 1/2 W, 5%	Allen-Bradley, EB4305	32-201-243
R103	Resistor, fixed composition. 430 ohms, 1/2 W, 5%	Allen-Bradley, EB4315	32-201-343
R104	Resistor, fixed composition. 4700 ohms, 1/2 W, 5%	Allen-Bradley, EB4725	32-201-447
R105	Resistor, fixed composition. 220 ohms, 1 W, 5%	Allen-Bradley, GB2215	33-301-322
R106	Resistor, fixed wirewound. 1000 ohms, 20 W, 5%	Ohmite Mfg. Co. 1821	35-489-410
R107-R110	Resistor, fixed composition. 2.2 megohms, 2 W, 5%	Allen-Bradley, HB2255	34-401-722
R111	Resistor, fixed composition. 20,000 ohms, 1/2 W, 5%	Allen-Bradley, EB2035	32-201-520
S101	Switch, toggle, DPST, 6A at 125V, 3A at 250V.	Arrow-Hart and Hegeman 81024-GB	71-139-990
S102	Switch, rotary, 2 Section, 2 pole, 6 position, shorting	Centralab, 1412	71-729-950
T101	Transformer, 115/230 V primary, 50/60 Hz, 10 ohms per winding. Secondary: 1250 V at no load, 1150 V at 60 mA.	Varian Associates	C617832
DS101	Lampholder, red lens, with 120 K ohm, 1/3 W resistor	Dialco 135-9408H-1431	55-229-962
XF101	Fuseholder, 15A, 250 V	Bussman Mfg. Div. HKP	55-198-999

ACCESSORIES

<u>Description</u>	<u>Model No.</u>
High-voltage cable and connector assemblies:	
for miniature pumps (8 feet long)	924-0020
for earlier style 0.2 l/s pump (8 feet long)	924-0021
for 2 and 8 l/s pump (12 feet long, bakeable)	924-0736
for 2 and 8 l/s pump (10 feet long, standard)	924-0750
Repair parts for Model No. 924-0736 cable:	
Banana plug and ceramic insulator in connector	924-0737
Metal cable hose with ends welded on for connecting to control unit chassis and to pump (no wire)	924-0739
Teflon-insulated wire and braided ground-return cable	924-0741
Ground-contact spring for 2 or 8 l/s pump	601410
Ion Gauge Leak Detector	975-0010
Pressure-Sensitive Relay	924-0040
Recorder, single-channel, 5" span	G-1010
Recorder, single-channel, 10" span	G-2010

WARRANTY

Varian VacIon Pump Control Units are warranted to be free of defects in materials and workmanship for one year after delivery. The liability of Varian Associates is limited to servicing and adjusting the product, or replacing defective parts. There will be a charge for repairs necessitated by misuse of the product or by abnormal operating conditions. Before work begins, an estimate of repair charges will be sent to the customer for authorization.

FIELD SERVICE

Installation, adjustments, maintenance, or repair can be provided on request. Fees for this type of work will be estimated by the nearest Vacuum Division Field Office. A service center is staffed and equipped to provide thorough service and prompt delivery of parts.

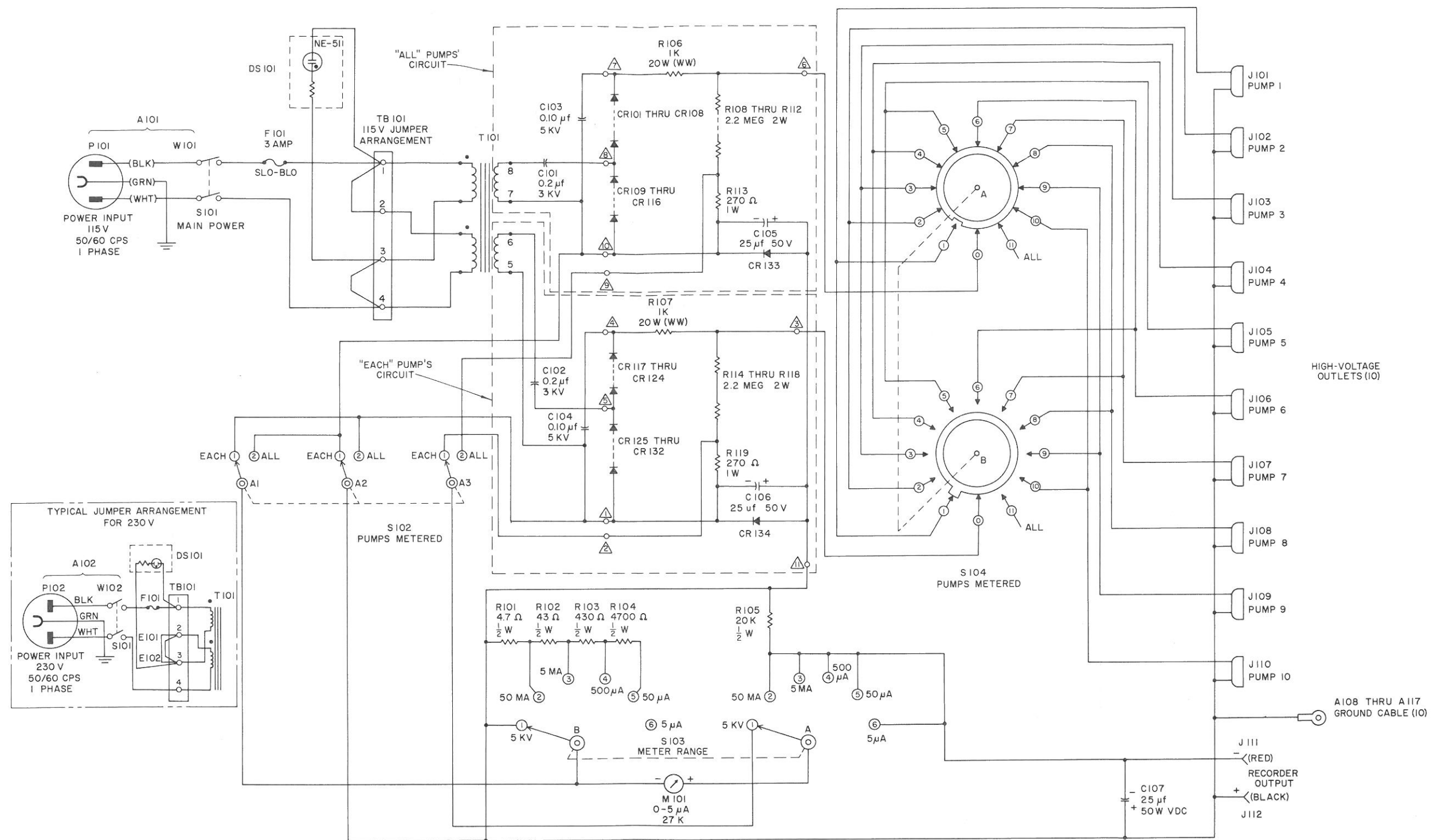
Varian Vacuum Division Service Center
611 Hansen Way
Palo Alto, California 94303
Phone: (415) 326-4000

EXCHANGE SERVICE

Interruptions in operation can be minimized by Varian's unique exchange service. VacIon Pumps and Control Units can be quickly exchanged for factory-rebuilt units carrying the same one-year warranties as new products.

HOW TO ORDER

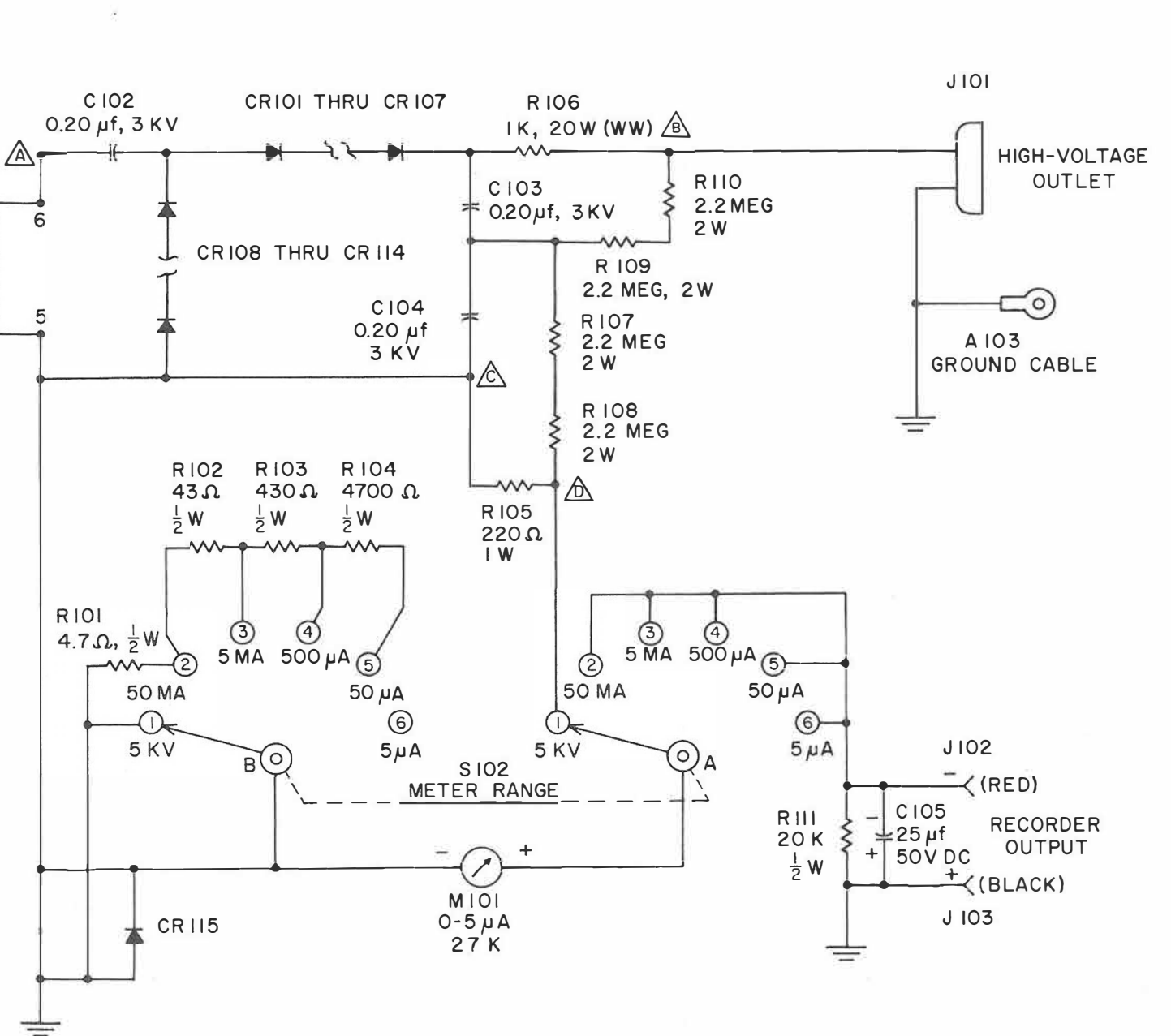
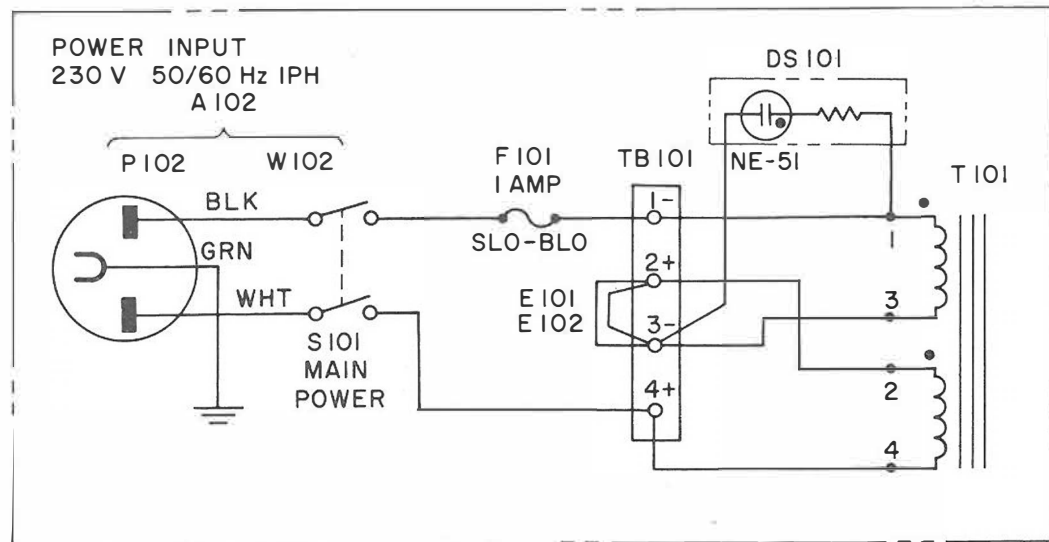
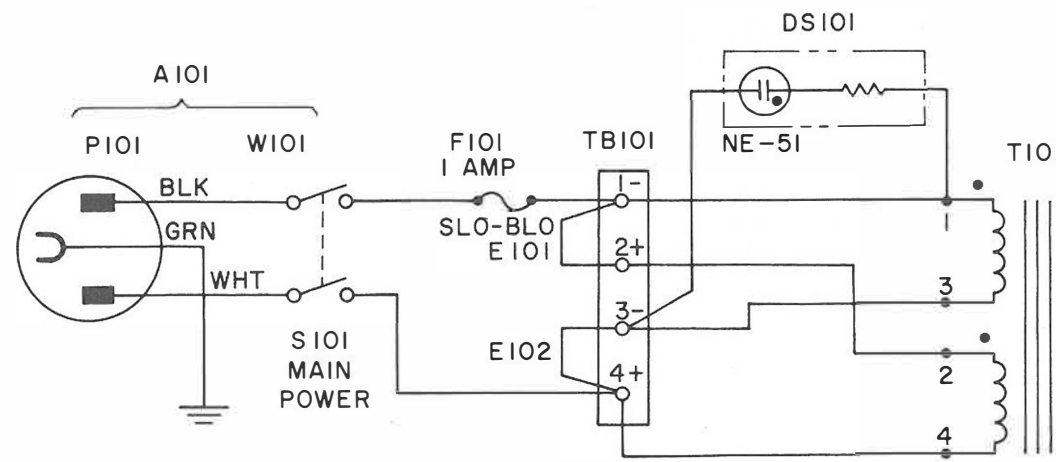
Address orders or requests for additional information to the nearest Varian District Office or to Varian Vacuum Division, 611 Hansen Way, Palo Alto, California 94303. European orders should be addressed to Varian A. G., Baarerstrasse 77, Zug, Switzerland.



- NOTES: 1. ALL RESISTANCE VALUES ARE IN OHMS WITH A TOLERANCE OF $\pm 5\%$ UNLESS OTHERWISE SPECIFIED.
2. DIODE ORIENTATION $\xrightarrow{\text{BLACK}} \xrightarrow{\text{BLUE}}$ (CATHODE)
3. ALL ROTARY SWITCHES ARE SHOWN IN CCW POSITION WHEN VIEWED FROM PANEL FRONT. THE "A" WAFER IS NEAREST THE FRONT PANEL.
4. SYMBOL \odot CORRESPONDS TO CONTACT NUMBERS ON SWITCHES.
5. SYMBOL \triangle CORRESPONDS TO LETTERS ON PRINTED CIRCUIT BOARD.

SCHMATIC DIAGRAM C606365E
 VACION® PUMP CONTROL UNIT
 MODEL No. 921-0014

POWER INPUT
115 V 50/60 Hz 1PH



- NOTES: 1. ALL RESISTANCE VALUES ARE IN OHMS WITH A TOLERANCE OF $\pm 5\%$ UNLESS OTHERWISE SPECIFIED.
2. DIODE ORIENTATION $\xrightarrow{\text{BLACK}} \text{BLUE}$ (CATHODE)
3. SWITCH S102 IS SHOWN IN CCW POSITION WHEN VIEWED FROM PANEL FRONT. THE "A" WAFER IS NEAREST THE FRONT PANEL.
4. SYMBOL \otimes CORRESPONDS TO CONTACT NUMBERS ON SWITCHES.
5. SYMBOL \triangle CORRESPONDS TO LETTERS ON PRINTED CIRCUIT BOARD.

SCHMATIC DIAGRAM C606281 D
VACION[®] PUMP CONTROL UNIT
MODEL N^o 921-0015