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956 PORTABLE TURBO LEAK DETECTOR

Manual No. 6999-09-720

Revision C

OCTOBER 1989

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HAZARDS

Operators and service personnel must be aware of all hazards associated with this equipment. They must know how to recognize hazardous and potentially hazardous conditions, and know how to avoid them. The consequences of unskilled, improper, or careless operation of the equipment can be serious. This product must only be operated and maintained by trained personnel. Every operator or service person must read and thoroughly understand operation/maintenance manuals and any additional information provided by Varian Associates. All warnings and cautions should be read carefully and strictly observed. Consult local, state, and national agencies regarding specific requirements and regulations. Address any safety, operation, and/or maintenance questions to your nearest Varian office.

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WARNING
WARNINGS ARE USED WHEN FAILURE TO OBSERVE INSTRUCTIONS OR PRECAUTIONS COULD RESULT IN SERIOUS INJURY OR DEATH.

CAUTION
CAUTIONS ARE USED WHEN FAILURE TO OBSERVE INSTRUCTIONS COULD RESULT IN DAMAGE TO EQUIPMENT, WHETHER VARIAN-SUPPLIED OR OTHER ASSOCIATED EQUIPMENT.

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Notes contain information to aid the operator in obtaining the best performance from the equipment.

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WARNING

The mechanical components of leak detectors are typically cleaned with Freon TF, alcohol, methanol, or other solvents.

When heated, sprayed, or exposed to high-temperature equipment, these solvents become flammable and explosive, causing serious injury or death. DO NOT USE NEAR A HIGH-TEMPERATURE SOURCE. Ventilate the working area with a blower and use in a large, well-ventilated room. When heated or sprayed, Freon TF also becomes 4 to 5 times heavier than air and will flow down, settling in tanks, pits, and low areas, thus displacing air which can kill by asphyxiation. Use of a self-contained breathing apparatus may be necessary.

Freon TF, alcohol, methanol, and other solvents are irritants, narcotics, depressants, and/or carcinogenics. Their inhalation and/or ingestion may produce serious side effects. Prolonged or continued contact with the skin will result in absorption through the skin and moderate toxicity. Always ensure that cleaning operations are carried out in large, well-ventilated rooms, and wear eyeshields, gloves, and protective clothing.

WARNING

Liquid nitrogen (when used with the optional cold trap) can cause severe frostbite or blindness if splashed on body tissues or eyes. The extremely low temperature of liquified nitrogen can cause skin damage similar to high temperature burns. Contact with the cold gas evolving from the liquid may produce the same effect. To minimize the risk of hazardous contact with any part of the body, wear personal safety equipment recommended for use with cryogenic materials including a face shield, full-sleeved lab coat, and clean dry gloves which fit loosely so they can be thrown off quickly if frozen by contact with the gas or liquid.

CAUTION

Do not use Freon TF or other solvents on O-rings. To do so causes deterioration and reduces their ability to hold a vacuum. Wipe with a clean, lint-free cloth and use a small amount of Apiezon L grease, just enough to make the O-rings shiny.

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CAUTION
Do not clean any aluminum parts with Alconox. Alconox is not compatible with aluminum and will cause damage.

Note
During reassembly, always use Loctite PST (teflon-impregnated pipe thread compound) on pipe threads.

Note
Where applicable, inspect for any damage to retaining rings and O-rings. Remove them carefully with your fingers. Do not use any metal tools for this task. This prevents scratching of any sealing surfaces.

Note
To clean O-rings, wipe them with a clean, lint-free cloth or paper. If vacuum grease is required, apply Apiezon L lightly; remove excess grease until only a shiny, thin film remains.

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Figure 1-11 is a schematic representation of the 956 Leak detector used to test vacuum systems.

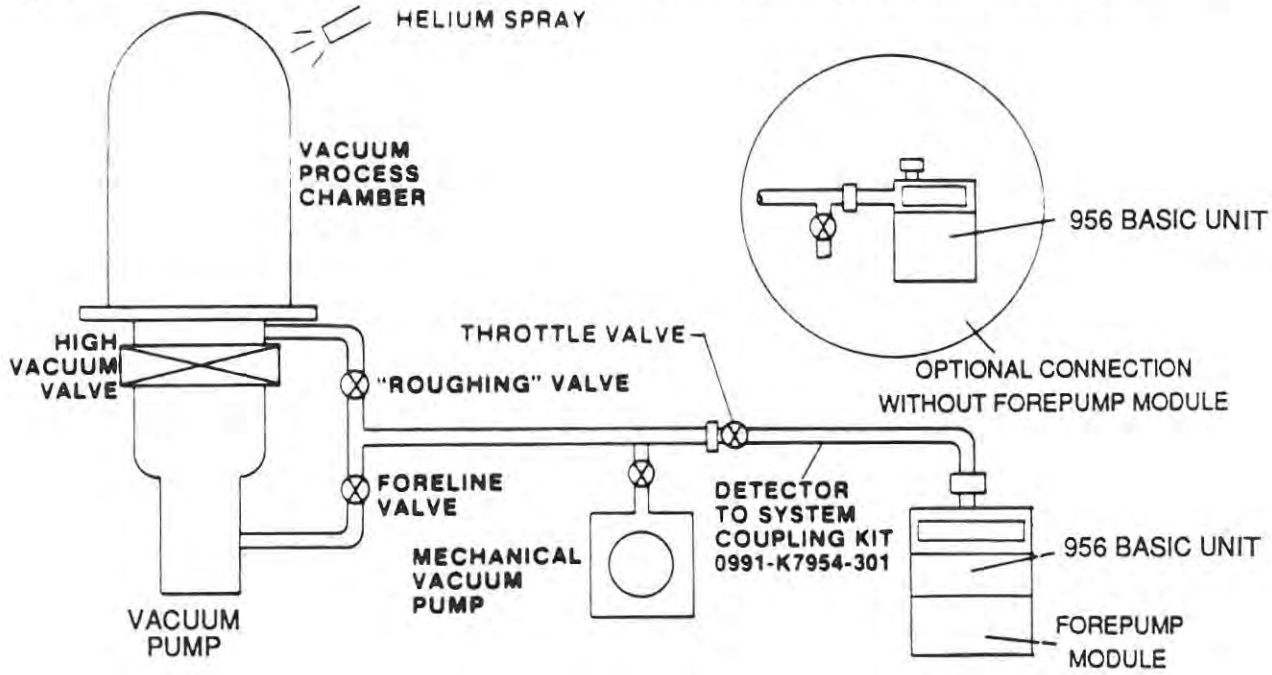


Figure 1-11. Using the 956 to Test Vacuum Systems.

Figure 1-12 is a schematic representation of a typical intermediate vacuum system of which the 956 Leak Detector is a vital part.

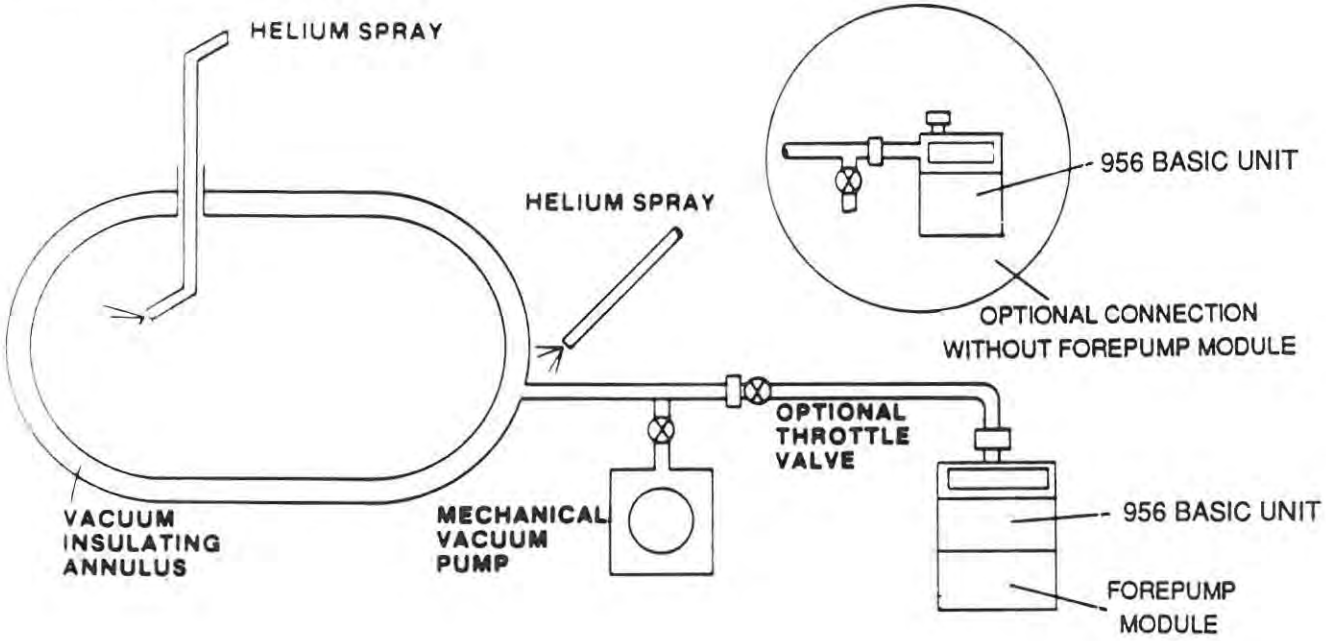


Figure 1-12. A Typical Intermediate Vacuum System.

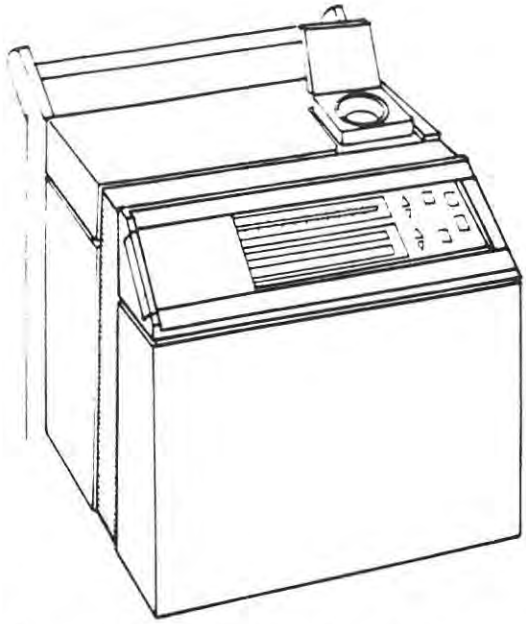


Figure 1-7. Varian's universal test fixture mounted on the leak detector with its cover open.

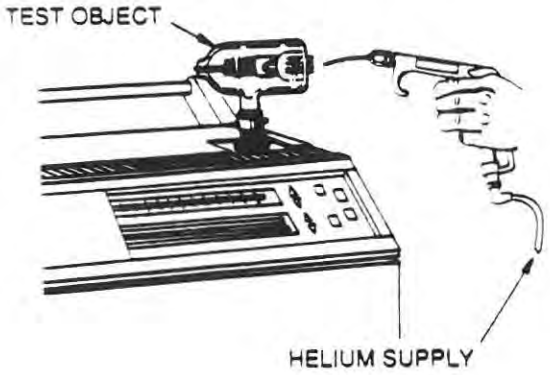


Figure 1-8. Outside-in leak testing an evacuated glass envelope.

Outside-in testing of an evacuated glass envelope is depicted in Figure 1-8.

Figure 1-9 is a compressor from an automotive air conditioner being leak-tested utilizing a "Power Probe". The part is pressurized with helium.

The "Bomb Parts" method of leak checking is demonstrated in Figure 1-10, a sealed Bourdon tube pressure gauge part under test.

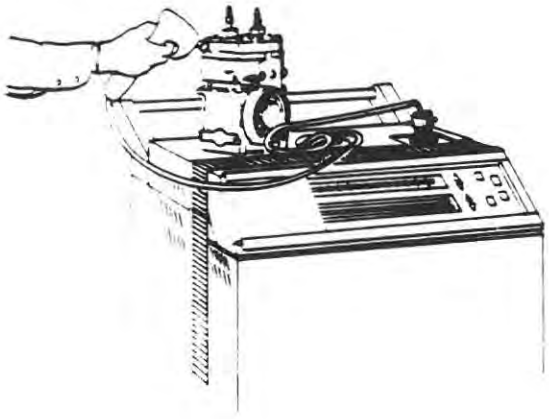


Figure 1-9 Utilization of a "Power Probe".



Figure 1-10. A Bourdon gauge, pre-bombed with helium, under test.

(3) TEST PIECE ALREADY SEALED (FIGURE 1-5)

Sometimes it is necessary to leak-check a completely sealed object. This may be done by placing helium inside the object before sealing (either 100% or mixed with other gas used for backfilling). The object is then placed in a vacuum chamber connected to the leak detector. Helium escaping from the object into the vacuum chamber is detected by the spectrometer tube. Sensitivity depends on the partial pressure of helium in the object.

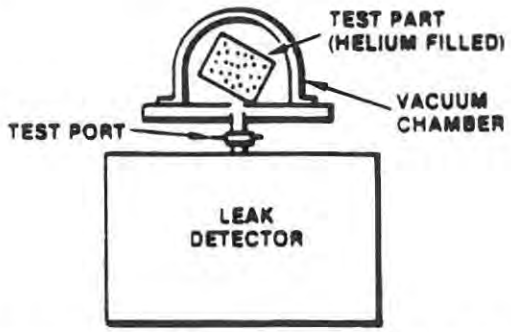


Figure 1-5. Test piece sealed with helium or tracer gas; bell jar used to determine total leak rate.

If the pressure of helium in the finished object is undesirable, units already sealed may first be placed in a container that is then pressurized with helium for a specific time at a known pressure. Helium will enter the object through any leaks and may be detected later, as in the previous paragraph. Gross leaks may sometimes not be detected, since all helium entering through a large leak may be lost prior to testing. Also, spurious signals may be given by helium not entering the object but entering surface fissures and remaining long enough to be detected.

Tables are available from Varian showing the relationship between actual leak rates and indicated leak rates for various internal volumes and pressurizing times. This method is commonly used to detect leaks in small electronic packages.

1-7 APPLICATIONS

The Varian 956 mass spectrometer leak detectors have a variety of applications and detection parameters. Typical uses are shown in Figures 1-6 through 1-10.

Figure 1-6, checking an evacuated CRT for leaks utilizing a hood to insure the integrity of the CRT. The surface of the CRT may be probed with a small jet of helium or, as shown here, the object under test may be surrounded (hooded) with helium and the CRT given an overall leak check.

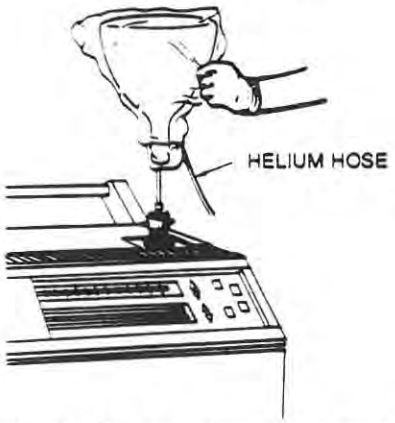


Figure 1-6. CRT evacuated and tested with a conventional automatic leak detector. The CRT is hooded to insure the integrity of the entire tube.

Leak-testing hermetically-sealed devices such as integrated circuits is almost totally automatic and very fast (see Figure 1-7) in which the quantity of test parts are placed in a universal fixture. The cup-shaped fixture has a spring-loaded lid, and is available in several sizes and shapes to suit the device being tested. Test cycle time in the automatic sequencer is adjustable. These features offer flexibility by allowing other fixture configurations to be easily mounted when necessary.

made" leak to remain constant. Manufacturing standard leaks for calibration purposes requires special techniques.

1-6 HELIUM MASS SPECTROMETER LEAK DETECTION METHODS

Leak detection by observing the presence of escaping gas is common and widespread, whether it is the visual observation of bubbles escaping from an object placed in water or by the detection of a tracer gas passing through a leak in an object under test. The mass spectrometer leak detector operates with helium as a tracer gas and is widely used because it combines high sensitivity with production testing capabilities. The following discussion is about the three basic methods commonly in use today.

(1) TEST PIECES EVACUATED (FIGURES 1-2 AND 1-3)

The object to be tested is evacuated by an auxiliary roughing pump, then connected through a valve to the spectrometer vacuum system. The surface of the test object is then probed with a small jet of helium to locate individual leaks, or surrounded by helium (hooded) for an overall leak check.

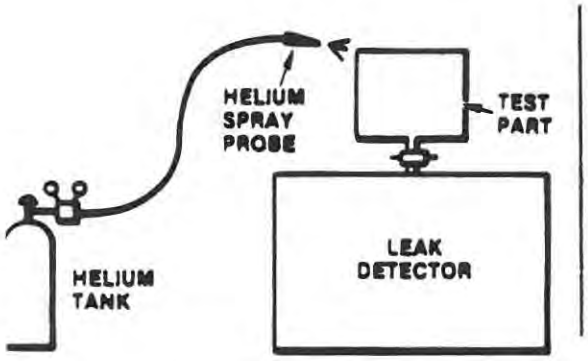


Figure 1-2. Test piece evacuated; tracer gas spray probe used to locate leak.

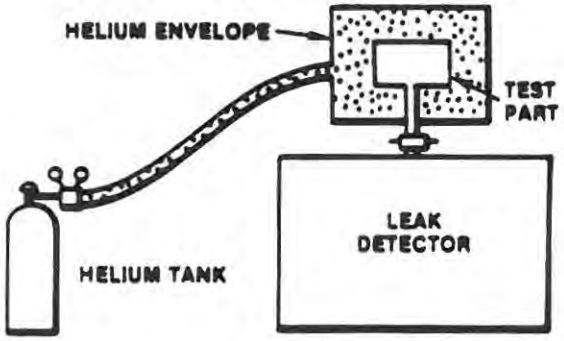


Figure 1-3. Test piece evacuated and hooded with helium atmosphere to determine overall leak rate.

(2) TEST PIECE PRESSURIZED (FIGURE 1-4)

A Varian power probe is connected to the leak detector. The object to be tested is filled with helium at the desired test pressure and the probe is moved over its surface. Some of the helium escaping from a leak is captured through the probe and enters the leak detector, thus locating the leak. Sensitivity of this type of testing is limited to about 10^{-6} std cc/sec, since most of the escaping helium diffuses into the surrounding atmosphere. The sensitivity is also limited by operator technique and variation in ambient helium concentration in the vicinity of the testing.

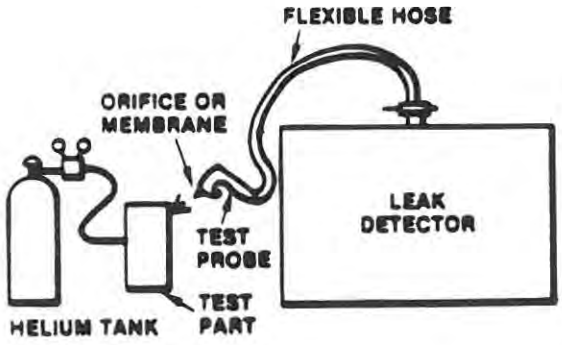


Figure 1-4. Test piece pressurized; detector probe used to locate leak.

connection to the spectrometer tube or, if it is a sealed object containing helium, to evacuate a chamber containing the test object.

(3) NATURE OF "FLOW" IN A VACUUM

It should be noted that the purpose of the vacuum system is to support operation of the analyzing spectrometer tube. Helium molecules entering through a leak individually reach the spectrometer tube in a few milliseconds. Helium molecules, as well as molecules of other gases, are continuously removed by the vacuum system. If helium is continuously applied to a leak, the concentration in the spectrometer tube will rise sharply at first, then it will reach equilibrium when it is being pumped out at the same rate as it is entering. When helium is completely removed from the leak, the input will drop to zero as the helium tracer gas is pumped out of the system. Thus, a leak is indicated by a rise in output signal of the spectrometer tube.

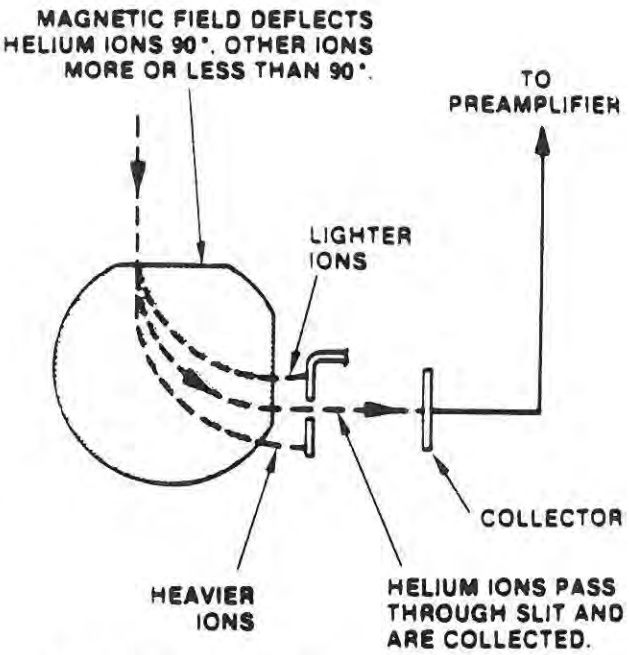


Figure 1-1. Magnetic separation principle

(4) FACTS ABOUT LEAK RATES

(a) *Visualizing leaks in everyday terms*

10^{-5} std cc/sec = approximately 1 std cc/day
10^{-7} std cc/sec = approximately 3 std cc/year

(b) *Audible or visual detection of leaks*

bubbles rising in water = 10^{-3} std cc/sec or larger
audible leaks = 10 std cc/sec or larger

(c) *Sizes of leaks in man-made joints*

Studies indicate that almost all leaks at joints are about 5×10^{-7} std cc/sec (about 1 cc/month) or larger. This is often true of ceramic-to-metal or plastic-to-metal seals, or welded, soldered, and brazed joints. Some long-path leaks may be slightly smaller. Diffusion of helium through glass may be as high as 10^{-8} std cc/sec per square centimeter of surface area.

(d) *Variation in leak sizes*

Leaks unintentionally "built-in" at joints during manufacture may vary from hour to hour and day to day. Breathing on a 10^{-6} std cc/sec leak provides enough moisture to close it temporarily, perhaps for several days. Atmospheric particles can close a leak of this size. Never depend on an "accidentally-

(4) HALOGEN (SENSITIVE TO HALOGEN ELEMENTS OR COMPOUNDS, ESPECIALLY REFRIGERANT GASES)

This method is good to approximately 10^{-5} std cc/sec in most current applications, but extendable to 10^{-9} std cc/sec under some limited situations. It is critically dependent on operator judgement if leaks are below 10^{-5} std cc/sec and requires a constant flow of fresh air in the test area because of the tendency of trace gas to "hang" in the area. The detector used in this method is sensitive to a variety of gases (other than the selected tracer gas) from external sources such as cigarette smoke and solvent fumes which may produce erroneous indications of leakage.

(5) RADIOISOTOPE

This method is useful only for testing hermetically - sealed cavities. It has approximately the same range as the helium method but it involves an expensive installation (from four to ten times the cost of a helium installation depending on degree of isolation of radiation required). It also requires a radiation safety officer.

(6) HELIUM METHOD

This method is accurate to 10^{-11} std cc/sec and is capable of finding leaks of any size larger. This method is useful for testing hermetic seals, vacuum enclosures, and vacuum systems, and is the most versatile of industrial and laboratory leak detection testing methods.

1-5 HELIUM MASS SPECTROMETER LEAK DETECTION

Helium is an excellent trace gas because it is the lightest of the inert gases and, as such, readily penetrates small leaks. In addition, its minute presence in the atmosphere (5 PPM or 4 milliTorr absolute), ease in being detected by a simple mass spectrometer (has a mass of 4 so that adjacent "peaks" of 3 and 6 are easily separated by this technique), and relatively low cost, make it particularly suited to this application.

(1) PRINCIPLES OF MASS SPECTROMETRY

A mass spectrometer sorts gases by their molecular weights (mass number) to determine the quantity of each gas present. With the helium mass spectrometer leak detector, the gas of interest is primarily helium (although such a device can be adjusted to indicate other gases such as hydrogen, argon, or neon). The mass spectrometer tube is relatively simple. The principle is to ionize the gases in a vacuum, electrostatically accelerate the various ions, and then separate the ions by passing them through a magnetic field which is set to bend the helium ion beam exactly 90°. See Figure 1-1. The light ions bend more than 90° and the heavy ions bend less than 90°. A slit, properly placed, allows only helium ions to pass through and be collected. The resulting current is amplified and a meter indicates the presence and amount of helium.

(2) APPLICATION AS A LEAK DETECTOR

A mass spectrometer leak detector consists of a spectrometer tube, the electronics to operate and interpret it, and a high-vacuum system to maintain proper vacuum. In addition, means are provided for connecting a test object to pump and valve systems necessary to evacuate the test object for

(3) CONVERSIONS

1 std cc/sec = 0.75 Torr-liter/sec (equal for all practical purposes); 1 Torr-liter/sec = 1.3 std cc/sec

1 std cc/sec = 9.7×10^4 micron cubic feet per hour or practically 10^5 micron CFH (μCFH)
1 μCFH = practically 10^{-5} std cc/sec

(4) NUMERICAL NOTATION, EXPONENTIAL SYSTEM

Most leak rates of commercial significance are very small fractions of std cc/sec. Therefore, negative powers of ten are used as a convenient system of numerical notation. Table 1-1 shows the relationship of exponents and multipliers (to the base 10) to the arithmetic form, and the equivalent decimal notation.

Table 1-1. Decimal Notation

Multiplier	Arithmetic Form	Decimal Notation
1×10^2	1 x 10 x 10	100
1×10^1	1 x 10	10
1×10^0	1	1
1×10^{-1}	1 x 1/10	0.1
1×10^{-2}	1 x 1/10 x 1/10	0.01
1×10^{-3}	1 x 1/10 x 1/10 x 1/10	0.001
5×10^{-3}	5 x 1/10 x 1/10 x 1/10	0.005

1-4 METHODS OF TESTING

There are many methods of testing for leaks in enclosures - either systems or containers. The more commonly used methods, along with their ranges of accuracy, are listed below.

(1) WATER IMMERSION (AIR BUBBLE OBSERVATION)

This method is accurate to approximately 10^{-3} std cc/sec and can be more sensitive if internal pressure is increased or vacuum is created above water. This method is limited because of difficulty in differentiating between leakage bubbles and surface desorption bubbles. It is used to test industrial items such as valves, hydraulic components, castings, automotive, and air-conditioning components.

(2) DYE PENETRANT

A special dye applied to one side of a surface suspected to contain a leak seeps through the leak and appears on the other side. This method can take an hour or more for a 10^{-4} std cc/sec leak to show up. This test is inexpensive but destructive in some applications, as well as slow and messy.

(3) ULTRASONIC

This method is accurate to approximately 10^{-3} std cc/sec. This method tests for ultrasonic sounds coming from a gas leak and is used for testing of high pressure lines.

SECTION I

INTRODUCTION

1-1 SCOPE

This manual provides information concerning the historical need for leak testing, a glossary of terms, testing methods and information, as well as alternative applications. Further, it provides equipment description, receiving and installation procedures, complete operating instructions, maintenance and calibration procedures, troubleshooting, and finally, its compatibility with interfacing equipments. The degree of information provided is sufficient for normal operation of the Varian 956 Leak Detector in all of its intended modes.

1-2 NEED FOR TESTING

The need for leak testing with a Varian mass spectrometer leak detector has been established by its success throughout the domestic and foreign manufacturing complex. All of these industries that either use or manufacture sealed or leakproof enclosures that carry a guarantee of such, have a need for leak testing. The Varian 956 mass spectrometer leak detectors are capable of detecting leaks from 2×10^{-10} std cc/sec to 10 std cc/sec. Typical user industries are:

- Vacuum or pressure chamber manufacturers
- Beverage canning industry
- Hermetically-sealed instrument manufacturers
- Research and development laboratories
- Refrigeration equipment manufacturers
- Health care industries such as cardiac pacemaker manufacturers and pharmaceuticals

The list goes on and on, as does the need for leak testing.

1-3 GLOSSARY OF TERMS

The following terms are applicable throughout this manual.

(1) FLOW

std cc/sec = one cubic centimeter of gas per second at a pressure differential of one standard atmosphere (760 Torr at 0° C).
atm cc/sec = one cubic centimeter of gas per second at ambient atmospheric pressure and temperature (used interchangeably with "std cc/sec" because the difference is usually insignificant for leak testing purposes.

(2) RATE OF RISE

In vacuum systems, this is defined as the rate of increase in absolute pressure per unit time with the vacuum pumps isolated from the system, and is the sum of actual leakage and internal outgassing. Rate of rise is usually expressed in Torr or milliTorr (microns) per hour. The flow rate is expressed in Torr-liters/second.

SECTION II

DESCRIPTION

2-1 SCOPE

Varian's 956 portable helium mass spectrometer leak detector is a microprocessor-controlled leak detector utilizing state-of-the-art technology for easy operator interface. A 48-character alpha-numeric display on the front panel is used to spell out information to alert the operator of the current status of the leak detector. The alpha-numeric displays also interact with the front panel keys enhancing the user-friendly environment. Control keys such as START, VENT, AUDIO, and AUTO/MAN keys appear on the right side of the front panel for easy access while programming or special function keys are on the left side under a cover.

Necessary valving takes place automatically as the leak detector moves through various ranges tracking the helium signal and the test port pressure. Additional features such as Auto Calibration, Gross Leak, large rough pumps, etc., make this portable leak detector a completely integrated package.

For unique applications and for the expert user, critical system parameters are programmable to make the 956 portable leak detector fit any leak detection application.

Figures 2-1 and 2-2 show the physical dimensions of the two models of the leak detector, both front and side views. Figure 2-3 shows the cabinet exposed, the vacuum system, and power controls.

2-2 SPECIFICATIONS

Table 2-1 lists the operating specifications of the Model 956 portable leak detector.

Table 2-1. Operating Specifications

Sensitivity	2×10^{-10} atm cc/sec - He
	8×10^{-11} atm cc/sec - air
Response time	<2 seconds-He
Amplifier drift	<2% of the most sensitive scale per AVS std 2.1
Noise level	<2% of the most sensitive scale per AVS std 2.1
Cycle time	mechanical pump dependent
Power	115 V, 50/60 Hz, single phase*
	Basic module requires 10-amp service
Startup time	3 minutes maximum
Operating Temperatures	5°C (41°F) low
	35°C (95°F) high

* The 956 is also available in 100V, 200V, 230V, and 240V models.

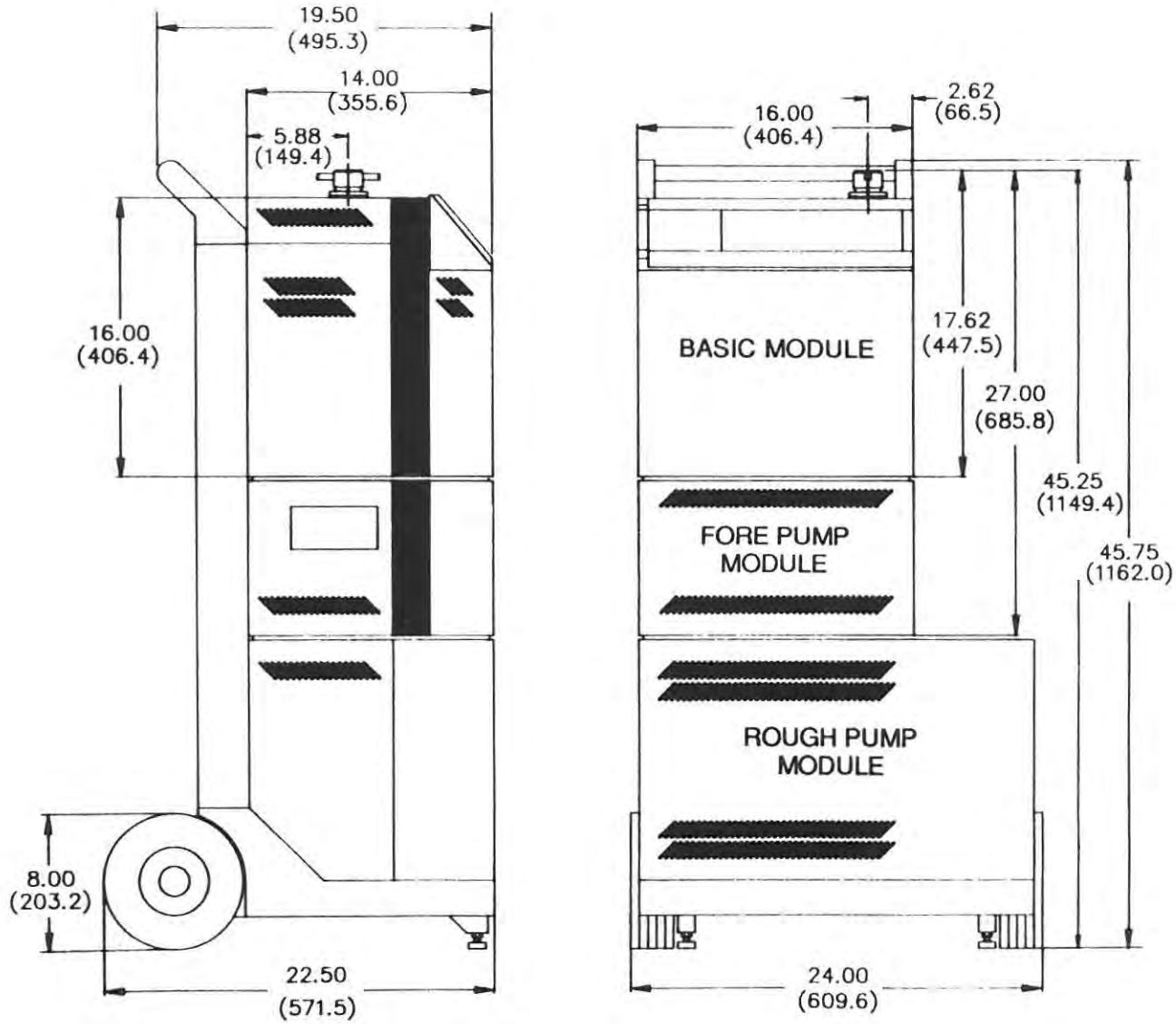


Figure 2-2. Varian 956 Leak Detector showing basic module, 1.2-cfm fore pump, 7-cfm roughing pump module, and large cart

3 The rough pump module is used as a rough pump only if a fore pump module is present, and as a fore pump if a fore pump module is not present. This pump can be turned on and off by a logic signal from the 956 leak detector and contains an electronic valve to isolate the vacuum system from the pump (also controlled by the basic module). This pump always requires the large cart for portability.

Note
Both the fore pump module and rough pump module are required for use when the gross leak option is purchased.

4 The carts come in two sizes: the small cart holds the basic module and the fore pump module and is ideal for a small, portable, complete package; the large cart can easily accomodate all five modules and has a convenient power strip to supply power to all the modules. This strip requires 30-ampere service.

2-4 VACUUM SYSTEM

The vacuum system provides the necessary vacuum, and the valving system, with the roughing pump, evacuates the object to be tested and properly sequences the testing operation. The vacuum system (see Figure 2-4) consists of a turbomolecular pump, one or two mechanical pumps, a spectrometer tube, valves, and interconnecting pipes. The system serves three functions: it maintains the required vacuum in the spectrometer tube, it connects the customers part or system to the spectrometer tube, and it removes helium after a test. Additionally, Contraflow ™, an innovation of Varian, is utilized.

2-4-1 Mechanical Pumps

The two mechanical pumps serve as the fore pump and the rough pump. The 1.2-cfm fore pump maintains the proper low pressure for the discharge of the turbo pump. The rough pump (7, 11, or 17 cfm) evacuates the test port and the test piece to the appropriate transfer pressure.

2-4-2 Spectrometer Tube

The spectrometer tube, Figure 2-5, is the heart of the leak detector. The spectrometer tube and the leak rate indicator provide a visual representation of the helium concentration in the vacuum system. The spectrometer tube consists of the following components.

Iridium Ion source
Analyzing magnets
Preamplifier Assembly
Enhancement magnets

Iridium Ion Source

The ion source consists of two filaments, two halves of an ion chamber, a pair of focus plates, and a grounded exit slit (the exit slit is a removable part of the spectrometer tube).

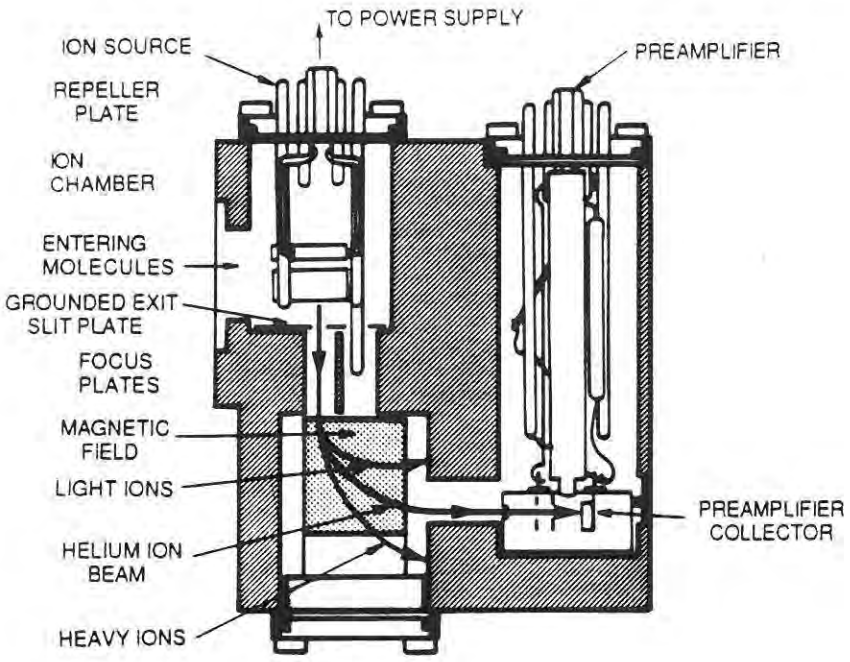


Figure 2-5. Cutaway View of 956 Spectrometer Tube

The top half of the ion chamber (the repeller plate) is held at a positive potential (repeller voltage) with respect to the bottom half of the ion chamber.

The bottom half of the ion chamber is held at a positive potential (ion voltage) with respect to the grounded exit slit. Two focus plates are also held positive (variable focus and fixed focus) with respect to the grounded exit slit.

When the filament is electrically heated, electron emission with help of the enhancement magnets divides the electrons into the ion chamber. Electrons colliding with molecules produce positive ions. These ions are forced through the bottom of the ion chamber, the grounded potential exit slit, and enter the analyzing magnetic field. This magnetic field separates and allows only the helium ions to reach the preamplifier.

The repeller, variable focus, and ion chamber require adjustment when ion sources are changed. This fine-tuning procedure will produce an efficient, helium-sensing spectrometer tube.

Preamplifier Assembly

The preamplifier assembly consists of an ion collector assembly and a sensitive electrometer amplifier.

The ion collector assembly includes:

much lower maximum compression ratio than other gases contained in air, diffuses backwards through the turbo pump to reach the spectrometer tube where it is detected in the normal manner. Although the mechanical forepump is also attached to the turbo pump foreline and removes all inlet gases, including some helium, there is no appreciable loss of sensitivity in the Contra-flow™ leak detector. In fact, at higher test pressures, it is more sensitive than the conventional method.

2-4-4 Turbo V-80 Controller

The Turbo V-80 Controller (see Figures 2-6 and 2-7) provides for the conversion of single-phase, 100-120-220-240 VAC, 50/60 Hz power into three-phase, 54V, variable-frequency power required by the turbo pump. It is specifically designed for the 956 leak detector and features:

- small size,
- light weight,
- two operating frequencies,
- a regenerative brake to speed up the high to low frequency change, and
- an opto-coupled Input/Output for easy interfacing with a computer.

The controller is equipped with the following protective features:

- a line fuse and a pump circuit fuse,
- thermal protection on the power transformer,
- thermal protection on the power board heat sink,
- thermal protection on the pump motor,
- short-circuit protection on the three-phase output,
- overload protection, and
- overvoltage protection.

Controller Specifications

Input	voltage	100-2-120-220-240 VAC, ± 10%, single phase
	frequency	47 to 63 Hz
	power	500 VA maximum
Output voltage		54 VAC, ± 15 %, three-phase
	high frequency	850 to 1000 Hz
	low frequency	500 to 600 Hz
A/B Inputs	minimum input ON voltage	4 VDC (1.1 mA)
	maximum input voltage	25 VDC (9 mA)
	maximum input reverse voltage	3 VDC
Normal/Overload Output	minimum saturation output current	1.6 mA (VCE max. 0.6 VDC)
	breakdown voltage BVCEO	70 VDC
Operating Temperature		0 to 40°C
Storage Temperature		-20 to +70 °C
Fuse F1	Main power	T8A (slow blow) for 100-120 VAC T5A (slow blow) for 220-240 VAC

Fuse F2	Pump	T8A (slow blow)
Weight		3.6 kg (8 pounds)

Circuit Description

The Controller contains two printed circuit boards, the control board and the power board. The Control Board controls 13 different functions.

1) DC Power Supply which provides unregulated 24 VDC, +12 VDC ±0.5%, and -12 VDC ±5%

2) An input decoder circuit consisting of two opticoupled (inputs A and B) circuits which provide the START, STOP, RESET, HIGH FREQUENCY, LOW FREQUENCY commands according to the following table.

A	B	Function
OFF	OFF	STOP/RESET
ON	OFF	HIGH FREQUENCY
ON	ON	LOW FREQUENCY

3) A DC current amplifier which amplifies the voltage across the power board amperometric resistor and supplies a control signal to the NORMAL, FREQUENCY CONTROL, BRAKE, and OVERLOAD circuits.

4) A Normal circuit which provides the optocoupled output NORMAL signal which goes on if the power board DC current is ranged between 0.3 ampere and 1.43 amperes; otherwise it goes off.

5) A Brake circuit which, when the frequency is required to decrease the BRAKE circuit, connects a load (R56, R57) across the power board DC voltage to absorb the energy fed back to the controller from the pump. The load is removed when the low frequency is reached.

6) A Starting Timer circuit which, when the controller is started, applies its output frequency at its maximum value. Immediately thereafter, the Starting Circuit decreases the initial frequency to reduce the slip and therefore to obtain a pump motor speed ramp as steep as possible.

7) An AC Power circuit which controld the AC power on the power board by means of the AC Power relay.

8) LATCH/OVERLOAD/THERMIC/PROTECTION/OVERVOLTAGE circuits which ensure the safety of the controller and the motor pump. If any maximum rating is exceeded, the controller goes into the Overload condition. That is, the AC POWER relay goes off, the power board output transistors are cut off, and the OVERLOAD optocoupled output goes on.

The overload can be caused by:

- motor pump PTC resistance exceeding 1 kohm (motor too hot)
- power transformer temperature exceeding 95°C

Pump Connector J1

Connector J1 has five pins; two for the motor pump thermal protection and three for the three-phase output.

2-5 OPTIONAL EQUIPMENT

2-5-1 Remote Controller Option (See Figure 2-8)

The hand-held remote controller option allows the operator to leak-test components/systems in areas where remote operation is desired. The operator has control of the leak detector, and can start, vent, and zero the leak detector up to 25 feet away from the hand-held, compact controller which is fitted with an audible signal to indicate the presence of a leak in the tested unit.

Note
The remote controller may display a "No Link" message on rare occasions. To remedy this, simply unplug and replug the connector back into the remote controller.

2-6 ELECTRONICS

The electronics of the 956 leak detector supplies the proper operating voltages to the spectrometer tube, provides those signals necessary for denoting quantitatively the presence of helium in the spectrometer tube, and controls all valve sequencing.

The new and automatic features of the 956 leak detector are accomplished by the microprocessor. This automatic distribution of internal signals not only enhances the leak detector's wide range of testing parameters but gives greater flexibility and reliability to the user.

The microprocessor also stores key tuning parameters in memory and retains them via an internal battery-operated circuit after a loss of power. This provides for fast recovery after a momentary loss of line voltage. Through the microprocessor, the leak detector will automatically search for all operating parameters stored in memory, start and warm up the leak detector, and bring it to the STANDBY stage ready for operation.

2-6-1 Accessory Output Connectors

The 956 leak detector has five accessory output connectors: J10, J11, J12, J13, and J14 through which various optional equipment can be connected and controlled.

J10 - Parallel I/O and Analog Output
J11 - Serial Interface, RS232C
J12 - Remote Box
J13 - External Pump Control
J14 - Audio Output

CONNECTOR J10 - Parallel I/O and Analog Output

Pin connections - J10, 37-pin DB Series (female)

Outputs	Pin no.	Inputs	Pin no.
Reject Set Point #1	3	Spare in #5	17, 18 (17 = +)
Reject Set Point #2	4	Start	19, 20 (19 = +)
Reject Set Point #3	5	Vent	21, 22 (21 = +)
Reject Set Point #4	6	Hold	23, 24 (23 = +)
Start (Roughing)	7	Spare in #1	25, 26 (25 = +)
Vent	8	Spare in #2	27, 28 (27 = +)
Test	9	Spare in #3	29, 30 (29 = +)
Busy	10	Spare in #4	31, 32 (31 = +)
Spare #1 (wakeup)	11		
Spare #2 (not ready)	12		
Spare #3	13	0 = Active	
Recorder out (0 to 10v)	33	1 = Not Active	
Analog ground	34		

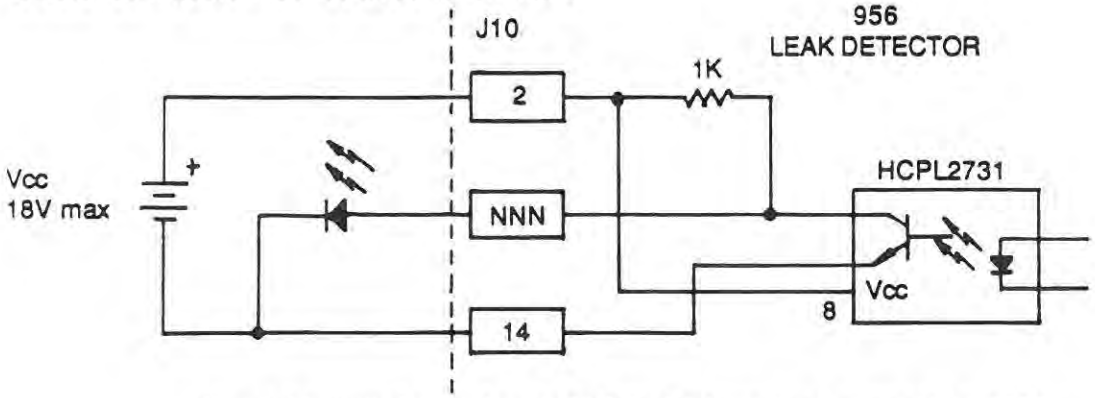
Pin 1	=	Vcc out	5v out (not isolated)
Pin 2	=	+Vcc in	voltage for optical isolators
Pin 14	=	-Vcc in;	ground in optic for isolation
Pin 15	=	ground out	+5v ground (not isolated)

Connector J10 contains several optically-isolated channels for inputs and outputs. J10 also contains an analog recorder output (0 to 10v, not optically isolated). Power to drive the optical isolation must be supplied by the customer if ground isolation is required. If ground isolation is not required, then connector J10 has 5 volts at 100 milliamperes available to supply power to optical isolators.

+5v at 100 ma	J10, pin 1
digital ground	J10, pin 15

Thus, pin 1 should be connected to pin 2 and pin 15 should be connected to pin 14.

All output channels of the optical isolators are pulled up to Vcc by a 1K resistor. All input diodes have a 1K resistor connected in series as current limiters.



Ground-isolated output as an LED indicator output; sense is inverted.

Optical isolators used are HCPL2731 with the following characteristics:

Vcc	2.5 v minimum to 18 v maximum
Input diode	0.5 ma minimum to 20 ma maximum input average current
Open collector current	60 ma maximum (Io)
At Vcc = 5v	I_f is approximately 3.5 ma and open collector will sink at least 30 ma.

Reject set points 1 through 4 will be in the HI state (open collector transistor off) when the leak rate is less than the reject set point. If the leak rate is greater than the set point, then the output will be in the LOW state (open collector transistor on). Each reject set point is independently set in Menu 7. Once the set point is tripped, it will untrip according to the hysteresis set in Menu 7, option 6. Refer to the description of Menu 7 in Section IV for more detailed information.

The START output will be in the LOW state (open collector transistor on) during rough-down and will be in the HI state (open collector transistor off) at all other times.

The VENT output will be in the LOW state (open collector transistor on) when the leak detector is in the VENT mode. The output will be HI (open collector transistor off) in all other modes.

The TEST output will be in the LOW state (open collector transistor on) when the leak detector is in the Gross or Fine Leak modes. The output will be HI (open collector transistor off) in all other modes.

The BUSY output will go LOW when the leak detector is in the Test mode and either ion gauge or extended rough cycle is activated. It will remain HI in all other modes.

SPARE #1 (Wake Up) output will go LOW when the system is started by using the automatic power-up (wake-up) feature described in Menu 16, System Wake Up. The output will go HI only if the SCRAM key is used to power down; otherwise, it remains LOW. This output can be used to enable an external process (such as starting the turbo pump, etc.) with the leak detector. This output works only with the System Wake up feature.

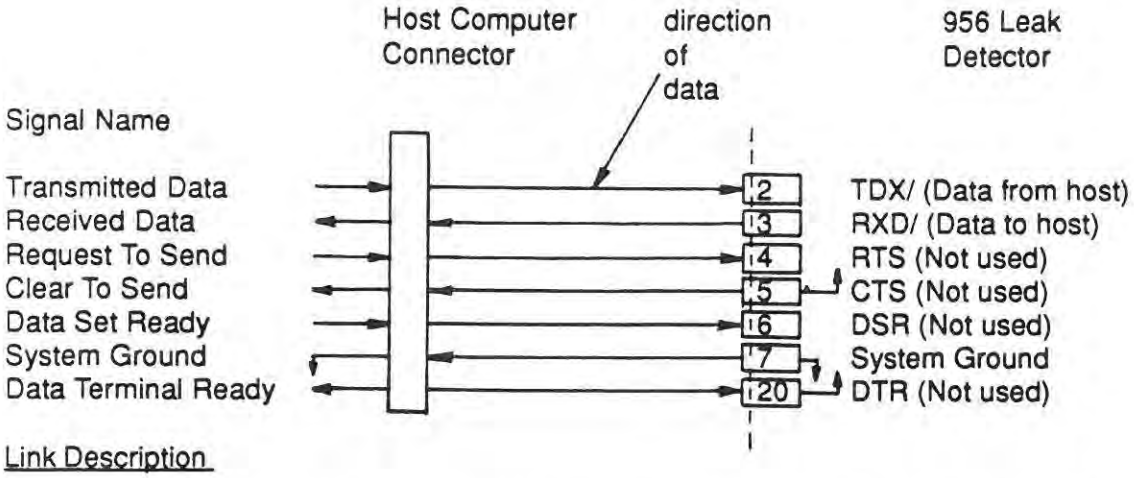
SPARE #2 (Not Ready) output remains LOW unless the leak detector is in the System Ready mode. Any error condition (filament burned out, etc.) will make this output go LOW. When the leak detector reaches System Ready or the error condition clears, the output will go HI.

A recorder output is available at pins 33 and 34 of J10. The output spans 0 to 10v for the particular sensor as selected by Menu 13, Recorder Output Control. The output impedance is approximately 2 kohms.

2-6-2 Connector J11, Serial Interface, RS232C

Voltage Interchange Information

The signal will be considered in the "marking" condition (refer to Table 2-2) when the voltage on the interchange circuit, measured at the interface point, is more negative than -3v with respect to signal ground. The signal will be considered in the "spacing" condition when the voltage is more positive than +3v with respect to signal ground. The region between +3v and -3v, defined as the transition region, will be considered invalid levels. The voltage that is more negative than -15v or more positive than +15v will be



Link Description

The 956 Leak Detector uses only three lines: TXD, RXD, and System Ground. Remaining lines such as DSR, DTR, RTS, and CTS are pulled up or down as required and do not need to be connected. XON and XOFF are used to control the flow of data.

Baud Rates

The 956 Leak Detector supports asynchronous baud rates of 19,200 bps, 9600 bps, 4800 bps, and 1200 bps. Slower baud rates are not possible because they would degrade system operation. In addition, these rates are consistent with most commonly-used computers. The baud rate is factory-selected to 4800 bps, but can be changed through Menu 14, Option 2.

Word Configuration

A word consists of 11 bits: one Start bit, one Stop bit, eight Data bits, and one Parity bit. The 956 Leak Detector transmits in even parity.

Technical Aspects of Encryption

In natural language, words are the primitive building blocks and sentences are the basic structures that convey commands, express ideas, and generate questions. Dialog is best interpreted in terms of sentences, not words; such sentences, or "messages", are the basic structures that convey instructions or information in the RS232 communications link. A message is defined as a sequence of bytes beginning with a "message type" byte and terminating with an "End Of Transmission" (EOT) byte. For a valid message, the body is composed of bytes that have meaning with respect to the 956 leak detector, producing intelligible transmissions and receptions between the host computer and the 956 leak detector.

The communication system operates in a master/slave configuration where the leak detector is subordinate to the host computer. The master (host computer) will initiate a communication transaction by making a request to the slave (956). Requests can be of two types: those that require a reply (queries) and those that do not (commands). The commands are further sub-divided into two categories: actions (those commands that change the state of the machine), and modifications (those that change certain parameters). This configuration facilitates maximum compatibility and flexibility by

32h	03h	19h	02h	02h	14h	02h	03h	key	EOT

type 33 a one-byte identifier to determine the information being requested.

type	request no.	EOT

Example: the host requests that leak rate information be sent back.

33h	00h	3dh

EOT one byte signifying the end of the message being transmitted. EOT = 3dh. The EOT byte must be received on or before the 16th byte to avoid a message length error.

Table 2-3
Command Mode Codes

COMMAND	BODY	HEX	ASCII
START	65	41	A
VENT	66	42	B
HOLD	67	43	C
SCRAM	68	44	D
ZERO	69	45	E
STD LEAK	70	46	F
CALIBRATE	71	47	G

Table 2-5. Byte Definitions

REQUEST NO.	DESCRIPTION	FORMAT
0	leak rate status info	E (see A)
1	test port pressure	F (see B)
2	system pressure	F (see C)
3	ion gauge pressure	E (see D)
4	date and time	BCD fixed (see E)

Key: E = exponential, F = floating point, BCD = binary coded data

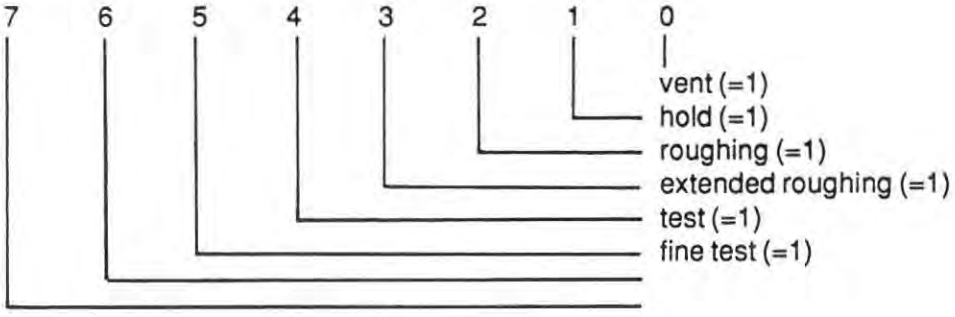
A Leak Rate, Status Information, and Reject and Error Status

Leak Rate

byte 0: most significant byte of mantissa in ASCII
byte 1: second most significant byte of mantissa in ASCII
byte 2: least significant byte of mantissa in ASCII
byte 3: exponent in ASCII

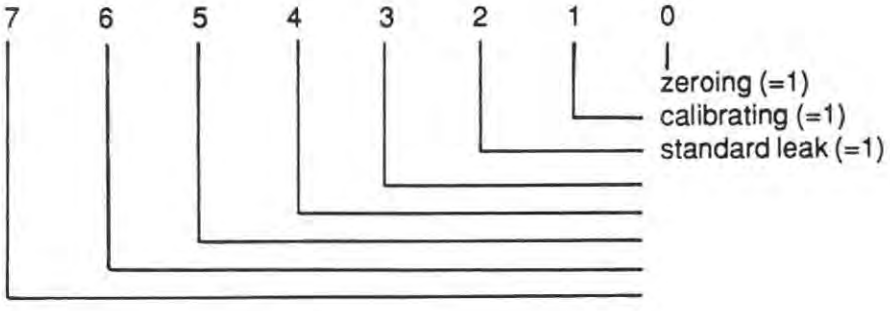
Status 1

byte 4



Status 2

byte 5



D Ion Gauge Pressure

byte 0: most significant byte of mantissa in ASCII
byte 1: second most significant byte of mantissa in ASCII
byte 2: least significant byte of mantissa in ASCII
byte 3: exponent in ASCII

E Date and Time

Date
byte 0: year; most significant byte of mantissa in BCD
byte 1: year; least significant byte of mantissa in BCD
byte 2: month; in BCD
byte 3: day; in BCD
Time
byte 4: hour; in BCD
byte 5: minute; in BCD
byte 6: second; in BCD

43.2 Fixed Numbers
byte 0: most significant byte of number in ASCII
byte 1: in ASCII
fbyte 2:least significant byte of number in ASCII

43.3 Floating Point Format
byte 0: most significant byte in ASCII
byte 1: second most significant byte in ASCII
byte 2: least significant byte in ASCII
byte 3: absolute value of exponent in ASCII

2-6-4 Connector J12, Remote Box

The Remote Box connector is a four-pin, modular connector which uses straight-through, pin-to-pin, wired cable. The cable can be up to 50 feet long. The baud rate is common to the host port and the Remote Box (which is set to 4800 baud). Although the baud rate in the remote box can be changed, it is not recommended.

Pin connections - J12, Remote box (modular connector)

Function	Pin no.
+9v at 1 ampere	1
TXD/ ——► (to remote)	2
RXD/ ——► (from remote)	3
System Ground	4

WARNING
Turn the volume of the Audio to its lowest level before connecting and wearing the headphones. A loud volume can cause hearing damage.

2-7 FRONT PANEL CONTROLS (See Figure 2-9)

The front panel is divided into two functional groups of keys, the right half and the left half. The right half keys can be considered as primary control keys which directly control the equipment and are always operational unless control is passed on to the host, remote, or parallel connectors through optional selections. The left half keys (under the hinged cover on the left side of the control panel) are those keys which are seldom used for normal operation. Operating the leak detector using the keys is further described in Section IV, Operation.

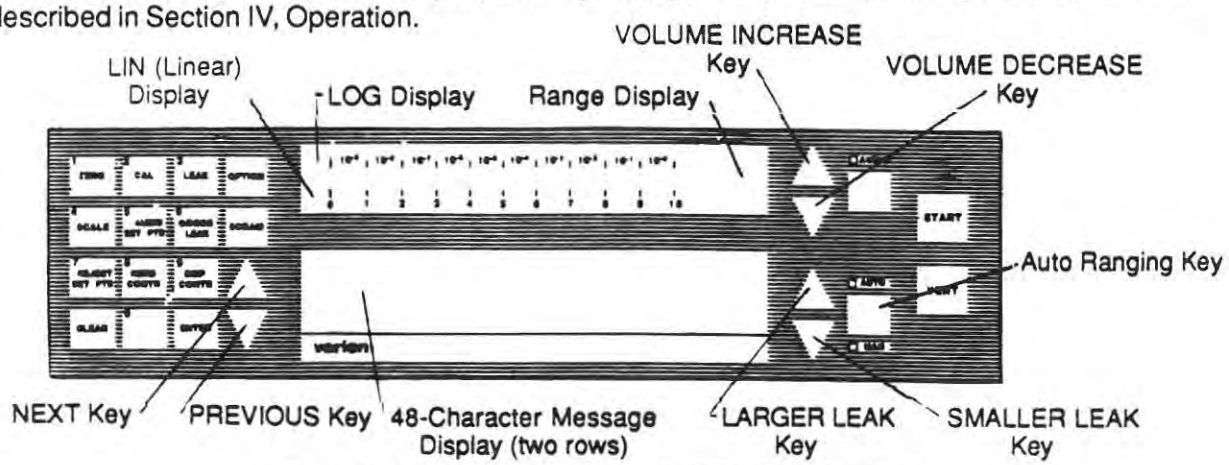


Figure 2-9. Front Panel Controls, 956 Leak Detector

2-8 MENU DESCRIPTIONS

Table 2-6 lists all of the menus used in the microprocessor for the 956 Leak Detector. Each menu, with its options and sub-options, is described in detail in Section IV, Operation.

Table 2-6. List of Menus

Menu No.	Title	Menu No.	Title
1	Zeroing	12	Options Control
2	Calibration	13	Recorder Output Control
3	StandardLeak	14	Serial Port Control
4	Log/Linear Select	15	Date and Time
5	Audio Controls	16	System Wake Up
6	Xfer to Fine Test	17	Sniffer Control
7	Reject Setpt Controls	18	Pump Options
8	Keyboard Controls	19	Service Information
9	Display Controls	20	Security Control
10	Display Units	21	Service Statistics
11	Sequencer	22	Manual Control
		23	Service Initialization

SECTION III

RECEIVING AND INSTALLATION

3-1 DESCRIPTION

The Varian 956 mass spectrometer leak detector is carefully packed onto a resiliently-mounted skid and enclosed by a heavy cardboard container banded to the skid. Upon receipt, inspect the container for evidence of damage in shipment. Do not discard any evidence of rough handling. Refer to the "Unpacking Instructions" located on the outside of the shipping container when opening the container. Factory packing provides for maximum protection during shipment. However, the leak detector and related items should be inspected immediately and any damage should be reported to the carrier without delay.

3-2 UNPACKING INSTRUCTIONS

To unpack the leak detector and remove it from the skid, proceed as follows.

1. Carefully remove the outer shipping container. SAVE IT AS EVIDENCE IF DAMAGED.
2. Carefully cut the strapping holding the leak detector on the skid.
3. Remove any loose boxes or packages and put them aside. DO NOT MISPLACE THEM.
4. Carefully remove the front 1-1/2- x 2-1/2-inch brace by removing the two 3/8-diameter lag bolts. See Figure 3-1.
5. Carefully remove the plastic bag covering the leak detector.
6. The leak detector can now be removed from the skid using the following method.

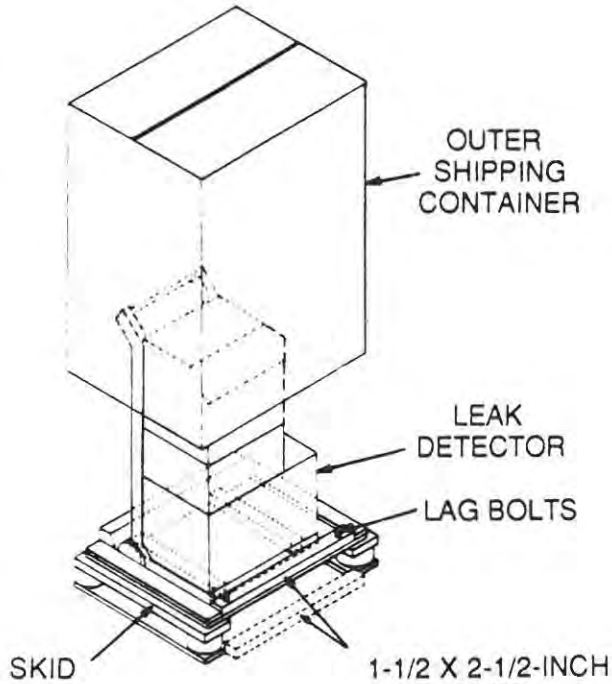


Figure 3-1. Unpacking the 956 Leak Detector

WARNING
Handle the leak detector carefully and properly in the following step. Personal injury or damage to the leak detector could result from improper handling.

1. Place the 1-1/2 x 2-1/2 inch brace on the floor in front of the leak detector.

2. Using the handle of the cart, tilt the leak detector back and roll it forward.

3. GENTLY lower it onto the brace then onto the floor.

3-3 SERVICES REQUIRED FOR OPERATION

(1) POWER
115 volts, 50/60 hertz, 30-ampere service, or 220 volt, 50/60 hertz, 15 ampere service if so ordered.

(2) HELIUM
Welding grade, standard cylinder with pressure regulating valve and hose.

3-4 PREPARATION FOR OPERATION

Remove and discard all loose packing from inside the leak detector. Access to the inside of the lower cabinets can be gained by removing the front portion of the cabinets.

(1) VACUUM PUMPS
The vacuum pumps are shipped with the proper initial charge of oil. However, the oil level should be checked after the leak detector is started and the pump(s) have been running for at least ten minutes. On the front of each of the roughing and fore pumps is an oil level sight glass. The oil level should be in the middle of the glass when the pump is not running.

(2) OPERATION
The leak detector is now ready for operation. Refer to Section IV of this manual for operating instructions.

3-5 INSTALLATION (See Figure 3-2)

Installation, operational checkout, and operating instructions for your Varian 956 leak detector are provided, as a service, by a qualified Varian representative.

When your leak detector is unpacked and the required services are available, contact your nearest Varian district office to arrange for field installation.

3-6 LEVELING THE LEAK DETECTOR

When the leak detector is moved to its operating location, it should be leveled by lowering the threaded legs.

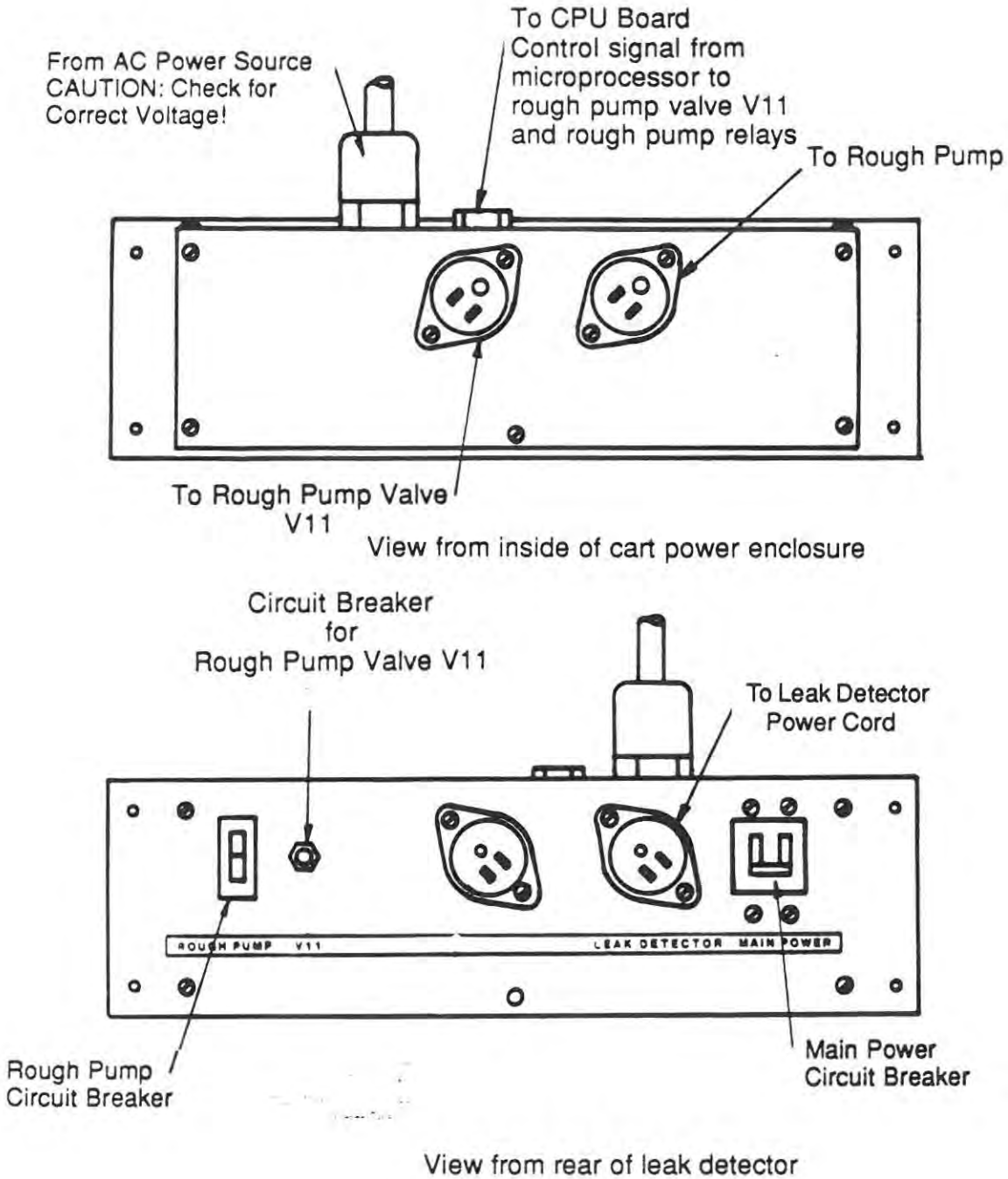


Figure 3-2. Leak Detector Installation Connections.

CAUTION
After moving the leak detector, do not drop the unit on its leveling leg; LOWER IT GENTLY. Failure to do so may dislodge the PEM nut permitting the leveling adjustment. ALWAYS raise the jam nut up against the bottom of the cart frame to lock the leveling adjustment.

3-7 STORAGE

If the leak detector will not be used immediately, it can be stored as received without special precautions. A dry, relatively dust-free area is preferred. The required environmental conditions for storage are:

0% to 95% relative humidity, non-condensing.
-30° to 150°F ambient temperature.

SECTION IV

OPERATION

4-1 GENERAL

Operation of the 956 leak detector is divided into three levels for ease of use.

Level 1, the operator level, has access and control of those keys which directly control the equipment - Level 1 requires no security. These keys and their functions are described in para. 4-3-1.

Level 2 operation, under security control, includes the use of level 1 and, in addition, access to some of the programmable settings which require changes to fit a specific application. Typical examples of this level of operation are 1) to change the Reject Set Point value, or 2) to set the time and day at which the leak detector will automatically warm up and be ready for use (for example, just before a shift starts). Level 2 operation is described in para. 4-3-2.

Level 3, the highest level of operation available to the customer, is intended for the in-house service technician who may require the use of manual controls to isolate problems such as large leaks in the vacuum system. Level 3 operation is described in para. 4-3-3.

All levels of operation have access to operating control keys. Only the higher security levels allow a greater degree of programmability.

4-2 STARTUP AND SHUTDOWN PROCEDURES

4-2-1 Startup

After unpacking the leak detector, it is good practice to let the instrument remain at room temperature overnight, especially if it has been stored below 40°F (4.4°C) for an extended period of time.

At this point, the leak detector is ready to be powered up as described in the following sequence.

1. Check that the electronics ON/OFF switch on the back of the Basic Module is off and the MAIN POWER switch on the cart power enclosure (if so equipped) is also off.
2. Check that all options (if any) are plugged in to their respective sockets (see Figure 3-2).
3. Plug the leak detector into an appropriate power source.
4. Set the MAIN POWER switch on the cart power enclosure (if equipped) to ON.
5. Set the ON/OFF switch on the back of the basic module to ON.

As soon as power is applied to the electronics, a beep will be heard and the front panel lights will light. The message "System shutdown - press Scram to restart" will appear on the alpha-numeric display.

The leak detector will then progress through its programmed sequence in the following order.

MESSAGE	APPROXIMATE TIME AND EXPLANATION
"Roughing out system Software Rev. ___" (level)	10 seconds - evacuates vacuum manifold
"Roughing out spec tube"	This message may not appear if spectrometer tube pressure is already low enough
"Rev up turbo"	Maximum of 1 minute (or less)
"Starting Ion Source"	Message remains for approximately 20 seconds - Turns on filament of the ion source
"System Ready"	System ready to be used

4-2-2 Shutdown

To shut the leak detector down from all modes except the Program mode, proceed as follows.

1 Press and hold the SCRAM key until the unit displays SLOWING DOWN TURBO. This message will remain for 20 seconds and allows the turbo pump to cool off. The mechanical pump will shut down and the unit will display SYSTEM SHUT DOWN - PUSH SCRAM TO RESTART.

2 To shut the unit down from any menu or option, proceed as follows.

3 Press the OPTION key to get out of the Menu mode. Press and hold the SCRAM key as described in a previous paragraph.

4 Do not shut off the MAIN POWER switch until SYSTEM SHUT DOWN is displayed.

4-2-3 Moving the Leak Detector

Varian recommends pressing and holding the SCRAM key for more than 1/2 second which initiates the shutdown mode. Wait 30 seconds until the message "System shut down" appears on the display before removing power to the leak detector. This assures that the speed of the turbo pump will be properly controlled.

4-2-4 Special Operating Instructions

Due to the short operating time between relubrication procedures on the turbo pump, Varian recommends that the turbo leak detector be shut off when not actually being used. As stated in Section II, para. 2-2, Specifications, the startup time for the 956 Turbo Leak Detector is only 3 minutes maximum, therefore it is unnecessary to keep the unit running when not in use.

4-3 LEVELS OF OPERATION

4-3-1 Operation Using Level 1 Keys

Level 1 operation is intended for the user who will directly use the leak detector in the most simplistic form - "two-button operation". Under Level 1, no system parameters can be modified except Menu 8, option 2, the key press beep, and Menu 11, option 1, the Sequenced Cycle enable/disable. The following is a list of direct equipment control keys of which the ZERO key (Menu 1, option 1) and the CAL key (Menu 2, option 1, sub option 1) can be disabled if necessary from Level 2.

The following are descriptions of the most often used keys on the panel of the leak detector.

VENT — Message displayed: "System vented"

Pressing the VENT key for more than 1/2 second will vent the test port. Pressing it for less than 1/2 second will place the 956 leak detector in the HOLD mode in which the valves isolate the test port and the test port is not air-released.

START — Messages displayed: "Roughing out test port", "Gross test", or "Fine test"

Pressing the START key will initiate a rough-down sequence of the test port and the leak detector proceeds to test. The crossover to the GROSS TEST mode is made at 700 milliTorr and to FINE TEST at 70 milliTorr unless changed by Menu 22 (described in a later paragraph).

AUDIO — Pressing the AUDIO key will turn on or off the audible tone. Audio ON is indicated by a steadily-lit red indicator next to the AUDIO key.

Volume Up/Volume Down — These two triangular keys to the left of the AUDIO key increase or decrease the volume level of the audible tone. The upper triangular key increases the volume; the lower key decreases the volume.

AUTO/MAN — Pressing the AUTO/MAN key causes the 956 leak detector to switch between auto ranging and manual ranging. Auto ranging is indicated by the AUTO light being lit and ranges to the most sensitive range possible in the TEST mode. Manual ranging is indicated when the MAN light is lit. In the MANUAL mode, the two triangular keys to the left of the AUTO/MAN key are enabled.

Larger/smaller leak — These are the two triangular keys to the left of the AUTO/MAN key and are operable in the MAN mode only. Pressing the upper triangular key will manually range the leak detector to measure larger leaks (smaller absolute exponent value); the lower triangular key will manually range the leak detector to measure smaller leaks (larger absolute exponent value).

The following is a description of the left-half group keys (keys under the cover flap).

ZERO — Message displayed: "Zeroing"

Pressing the ZERO key when the leak detector is in the TEST mode will zero a negative or positive signal in the range shown on the display. This key is otherwise ignored.

CAL — Pressing the CAL key when the leak detector is in the FINE TEST mode will initiate a self-calibration routine to tune and calibrate the leak detector to a known signal. With an internal leak option installed, calibration can be made easy by pressing this key. To calibrate the leak detector without this option, refer to Menu description of Menu 3, Option 1-3 (Calibrate with an external leak). In the GROSS LEAK TEST, or other modes, this key is not operational.

LEAK — Messages displayed: "Roughing std lk" or "Std lk on"

When the leak detector is in the FINE TEST mode, pressing this key will turn the internal calibrated leak on or off. If the leak option is not installed or when not in the FINE TEST mode, the key press is ignored.

SCALE — Pressing this key selects the leak rate bar graph scale (either log or linear). In the linear mode, the exponent is read with the bar graph mantissa value; in the log mode, the exponent is extinguished and the entire scale is presented on bar graphs in pseudo log fashion.

AUDIO SET PTS — Pressing this key arms or disarms the audio set point whose trip value can be seen in Menu 5 (described in a later paragraph). When armed, the AUDIO light will flash and will be off when disarmed. Exceptions to the audio light indications are described in Menu 5.

GROSS LEAK — Message displayed: "Gross leak only"

If the gross leak option is installed, pressing this key once will prevent the 956 leak detector from entering the FINE TEST mode thus enabling testing in the GROSS LEAK mode only. Pressing this key a second time will allow the 956 to proceed into the FINE TEST mode. This key is not operational if the Gross Leak option is not installed.

OPTION — Message displayed "Master Option Menu"
"1. Zeroing"

Pressing this key the first time forces the leak detector to enter the Program mode and exit the Program mode when pressed the second time. This key is further described in paragraph 4-5-2, step 7.

SCRAM — Messages displayed: "Slowing down turbo" then
"System shut down"
"Press SCRAM key to restart"

Pressing this key for greater than 1/2 second will execute a safe shutdown sequence. If pressed for less than 1/2 second, the key press will be ignored. If the leak detector is in the Program mode, pressing the SCRAM key will back up one menu level only. In this case, the system will not be shut down. This key is further described in paragraph 4-5-2, step 8.

All remaining keys are not operational unless the leak detector is in the Program mode.

4-3-2 Operation Using Level 2 Keys

Level 2 operation is intended for a supervisor who may set up the leak detector in a particular manner and who does not want the operator to change the parameters. Once the supervisor has entered the

appropriate password in Menu 20, the 956 leak detector will allow the supervisor to examine and change those system parameters that are designated under Level 2 security. A complete list of those menu options that can be changed under Level 2 operation is listed after Menu 20.

Programming Examples

1 To change the value of Reject Set Point #3 to 5.8×10^{-6}, press the keys in the order shown. It is assumed that the leak detector is not in the Program mode at the start.

Key Press	Explanation
Option	To enter the Program mode
#7	Menu number for Reject Set Pts
ENTER	Select the menu
#3	Menu option number for Set Point #3
ENTER	Selects the third choice
#5	
#8	Reject Set Point value. Decimal point is assumed.
ENTER	Accepts the mantissa and advances the cursor to the exponent field.
#6	Exponent value
ENTER	Accepts the value
OPTION	Exits the Program mode. If there are other changes, then there is no need to exit the program mode for each change.

2 To disable the CAL key so that calibration is not performed at the wrong time due to an accidental key press, proceed as follows.

Key Press	Explanation
OPTION	To enter the Program mode
#2	Menu number for the calibration option
ENTER	Select the menu
ENTER	Since the choice is already on Menu, ENTER is sufficient
ENTER	Disable the value for the option; selects the "Disable" choice
OPTION	To exit the Program mode

3 To display all messages in English, show the leak rate during test, and show the test port pressure during the HOLD mode, proceed as follows.

Key Press	Explanation
OPTION	Enter the Program mode
#9	Menu number for display controls
ENTER	Selects the menu
#3	Language menu/option number
ENTER	Selects the option
ENTER	Selects the English language (note that key #1 was not required to be pressed)
#1	Option number for alpha-numeric display control

ENTER	Selects a menu option
#2	Option number for leak rate
ENTER	Selects option choice
#2	Menu option #2 for HOLD mode display
ENTER	Selects the menu
#4	Option #4 for test port pressure
ENTER	Selects choice
OPTION	Exit the Program mode

After the parameters are changed to the satisfaction of the supervisor, security should be reset to Level 1 in Menu 20 to prevent accidental change. Proceed as follows.

Key Press	Explanation
Option	To enter Program mode
#20	Menu number for security control
ENTER	Select the menu
2	Sub level menu number
ENTER	Select menu
1000	Initial password for menu level 1 (see Menu description)
ENTER	Accept value (reduces security to Level 1)
Option	To exit Program mode

4-3-3 Operation Using Level 3 Keys

Level 3 is intended for the service technician who requires manual control of various valves, pumps, and voltages to isolate and correct problems. As in all control equipment, manual override is necessary to isolate problem areas. Therefore, care should be taken when under manual controls.

To enter Level 3 security, the password must be entered into Menu 20, Option 4. The operator must reset the security to Level 1 or 2 when finished.

Example - Manually roughing out the test port

To rough out the test port manually by using the fore pump, proceed as follows.

Key Press	Explanation
OPTION	To enter Program mode
#22	Menu number for manual control
ENTER	Select the menu
#2	Option number for manual control
ENTER	Select Option 2
#2	Sub-option number for fore pump
ENTER	Select Sub-option 2
#2	Option number for ON
ENTER	Select ON

If the fore pump was off, it will turn on as soon as the last ENTER key is pressed.

To select the proper valve state, proceed as follows.

Key Press	Explanation
OPTION	To enter the Program mode
#22	Menu number for manual control
ENTER	Select the menu
#3	Option 3 - valve control
ENTER	Select Option 3
#1	Sub level 1, set valve state
ENTER	Select sub level 1
#3	Sub level 3, rough-down state
ENTER	Select sub level 3
OPTION	To exit Program mode

As soon as the last ENTER key is pressed, the 956 leak detector will set up the valves in the rough-down state. By isolating various valve states or valves, problem areas can be quickly found. Varian recommends that valve states or individual valve controls be manipulated from the shut-down state using the SCRAM key.

All menu items that can be controlled under level 3 are listed under Security Control descriptions.

Calibration procedures for the 956 are described in Section V, paragraph 5-4.

4-4 SYSTEM VALVE OPERATION (See Figure 4-1 and Table 4-1)

4-4-1 Valve Designations and Functions

V1	Roughing valve	V6	Isolation valve
V2	Test valve	V7	Gross leak valve
V3	Vent valve	V11	External rough pump flow split valve (part of option)
V4	Turbo vent valve		
V5	Calibrated leak valve	V12	Gross leak metering valve (manual adjust) (part of option)
V6	Isolation valve		
V7	Gross leak valve		

4-4-2 Vacuum Modes

1	HOLD
2	VENT
3	ROUGHING OUT TEST PORT
4	GROSS LEAK TEST
5	FINE LEAK TEST

Figures 4-2 through 4-9 show the vacuum system in different modes of operation.

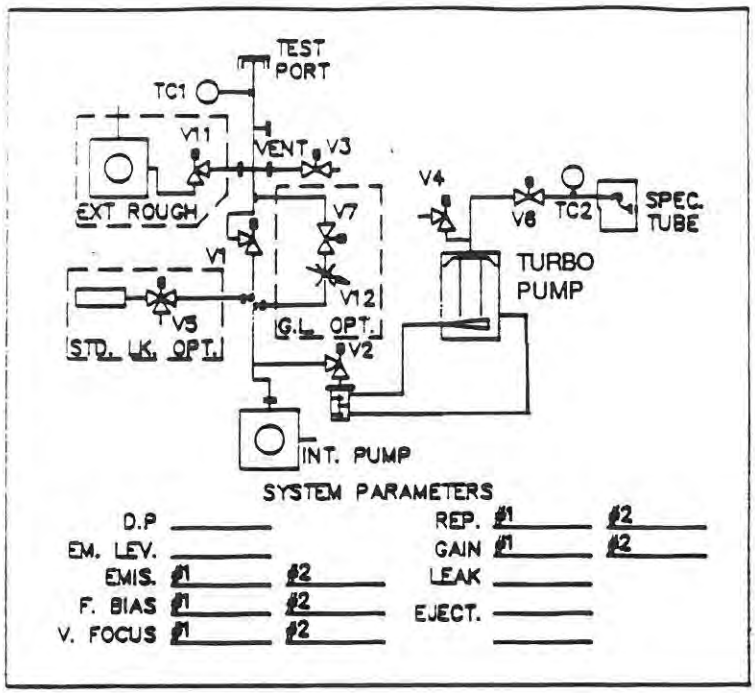


Figure 4-1. Schematic Diagram of 956 Vacuum System

Table 4-1. Valve Truth Table

VALVE	MODE					
	Hold	Rough down		Gross Leak	Fine Leak	Vent
		Small Pump	Large Pump			
V1 Roughing	C	O	C	C	O	C
V2 Test	O	C	O	O	O	O
V3 Vent	C	C	C	C	C	O
V4 Turbo VENT	C	C	C	C	C	C
V5 Standard Leak	C	C	C	C	C	C
V6 Isolation	O	O	O	O	O	O
V7 Gross Leak	C	NA	C	O	C	C
V11 Rough Pump	C	NA	O	O	C	C

C = Closed E = Either Open or Closed O = Open

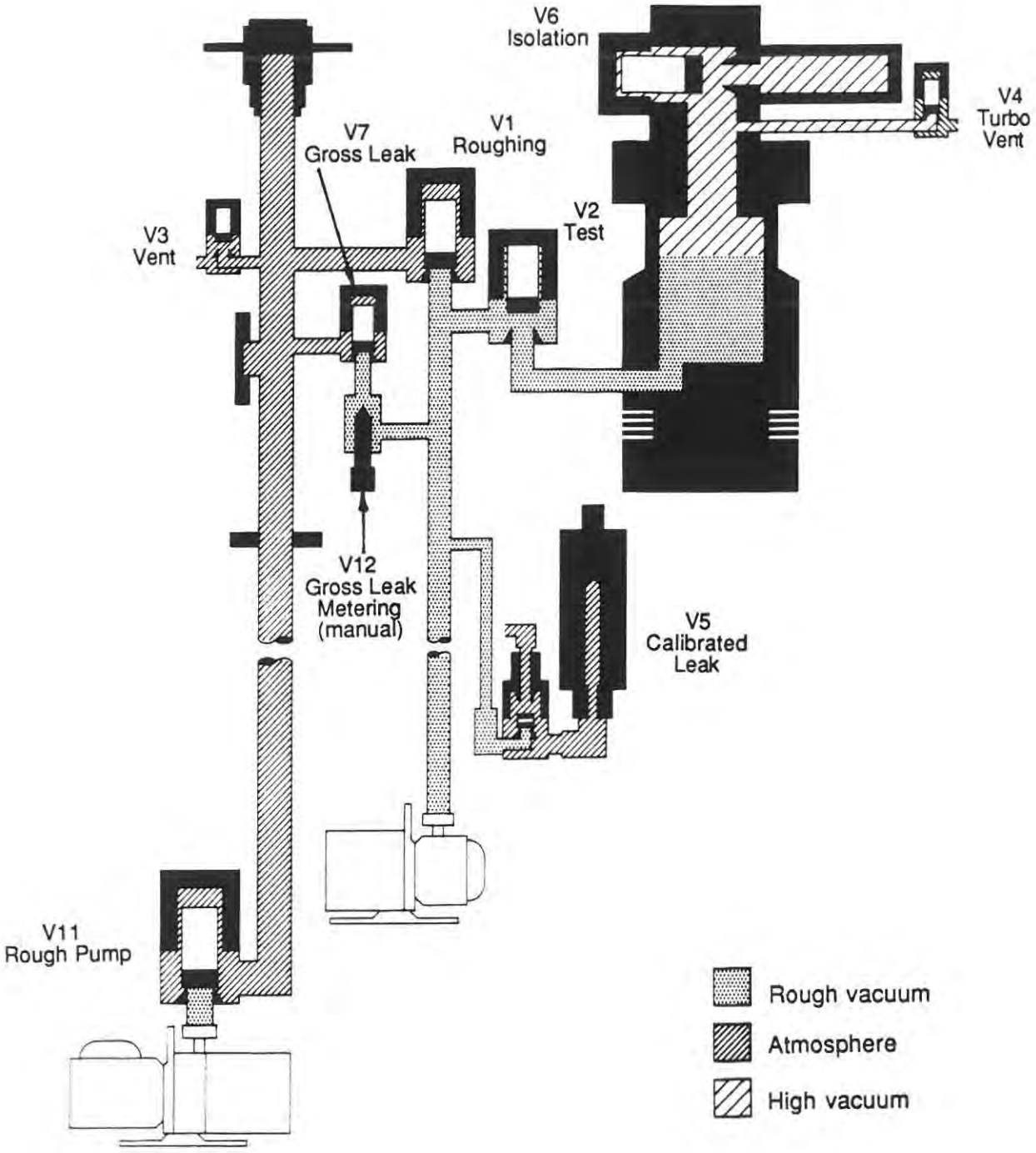


Figure 4-2. Vacuum system in the system Ready - Vent mode

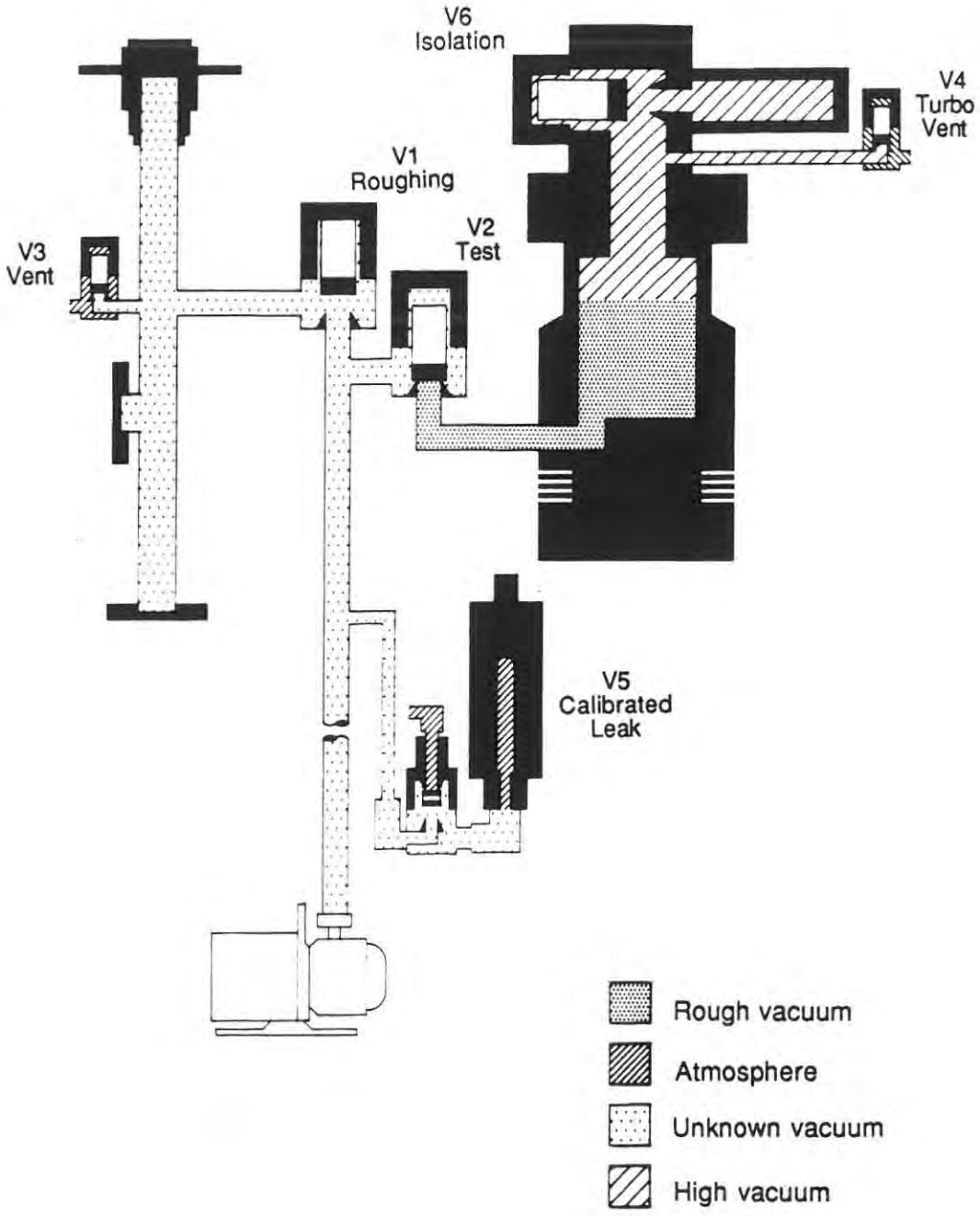


Figure 4-3. Roughing the test port using the internal pump only

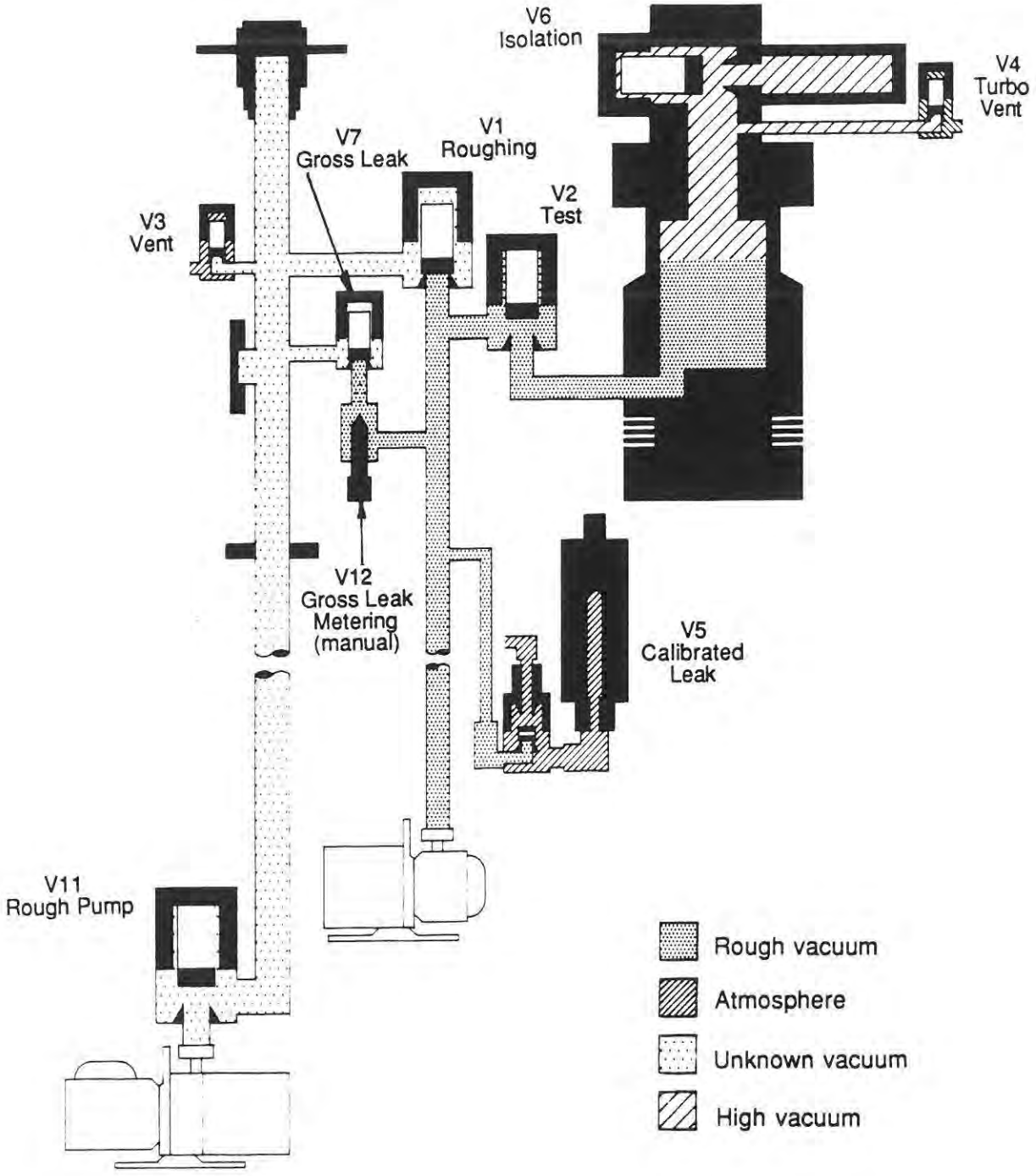


Figure 4-4. Roughing the test port with the external pump

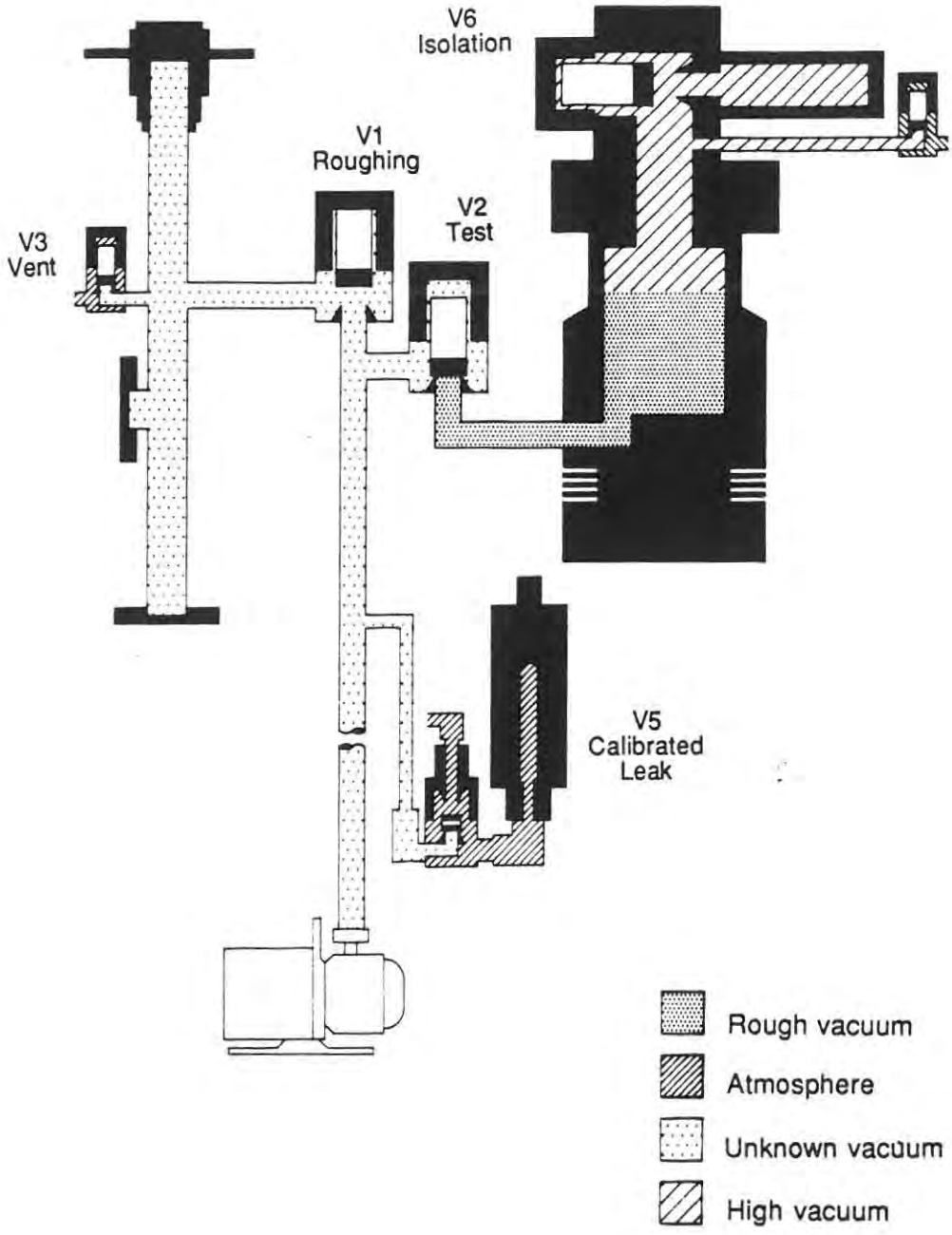


Figure 4-5. Roughing the Calibrated Leak (with internal leak option)

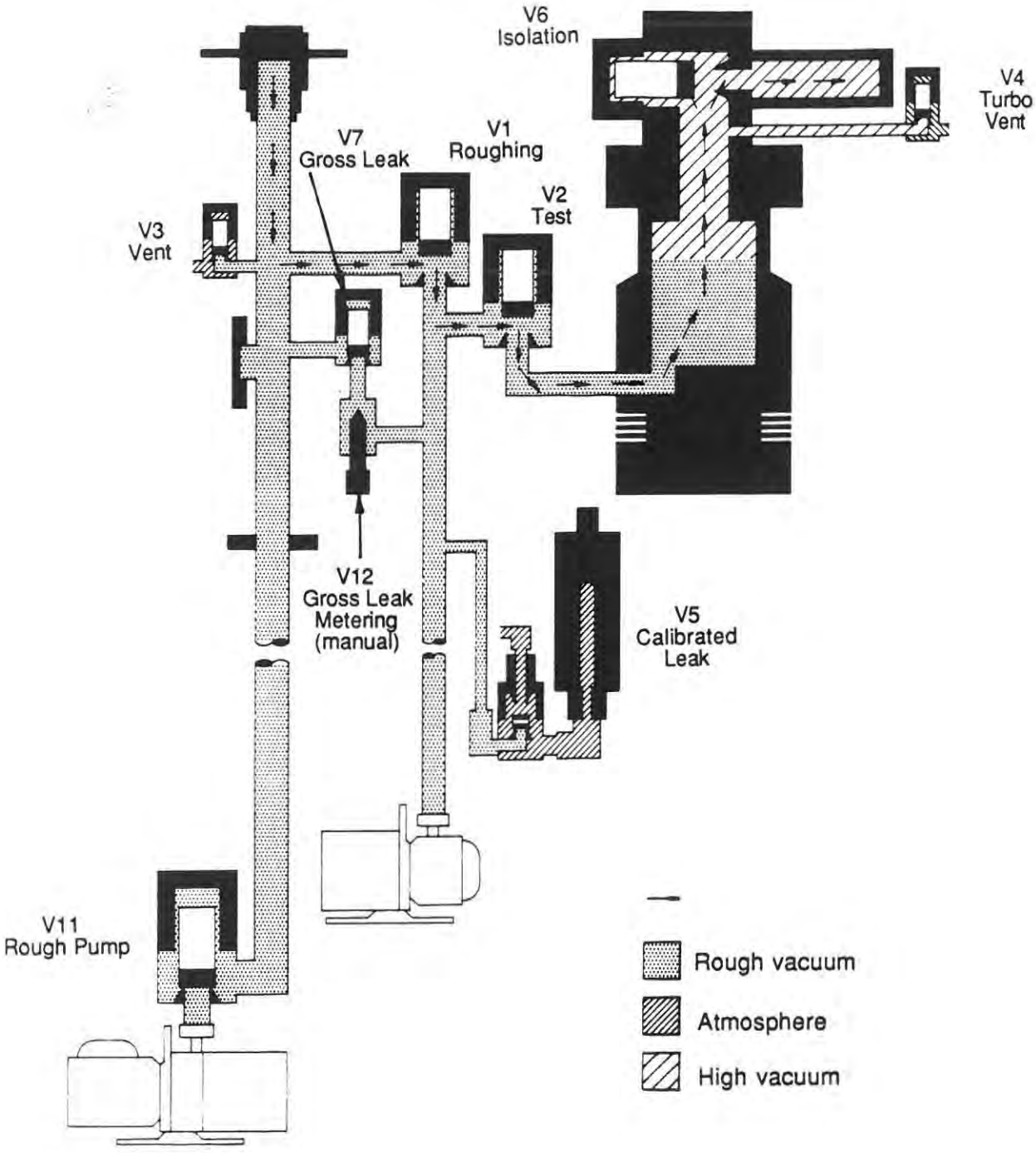


Figure 4-6. Calibrated leak open, vacuum system in the Test mode

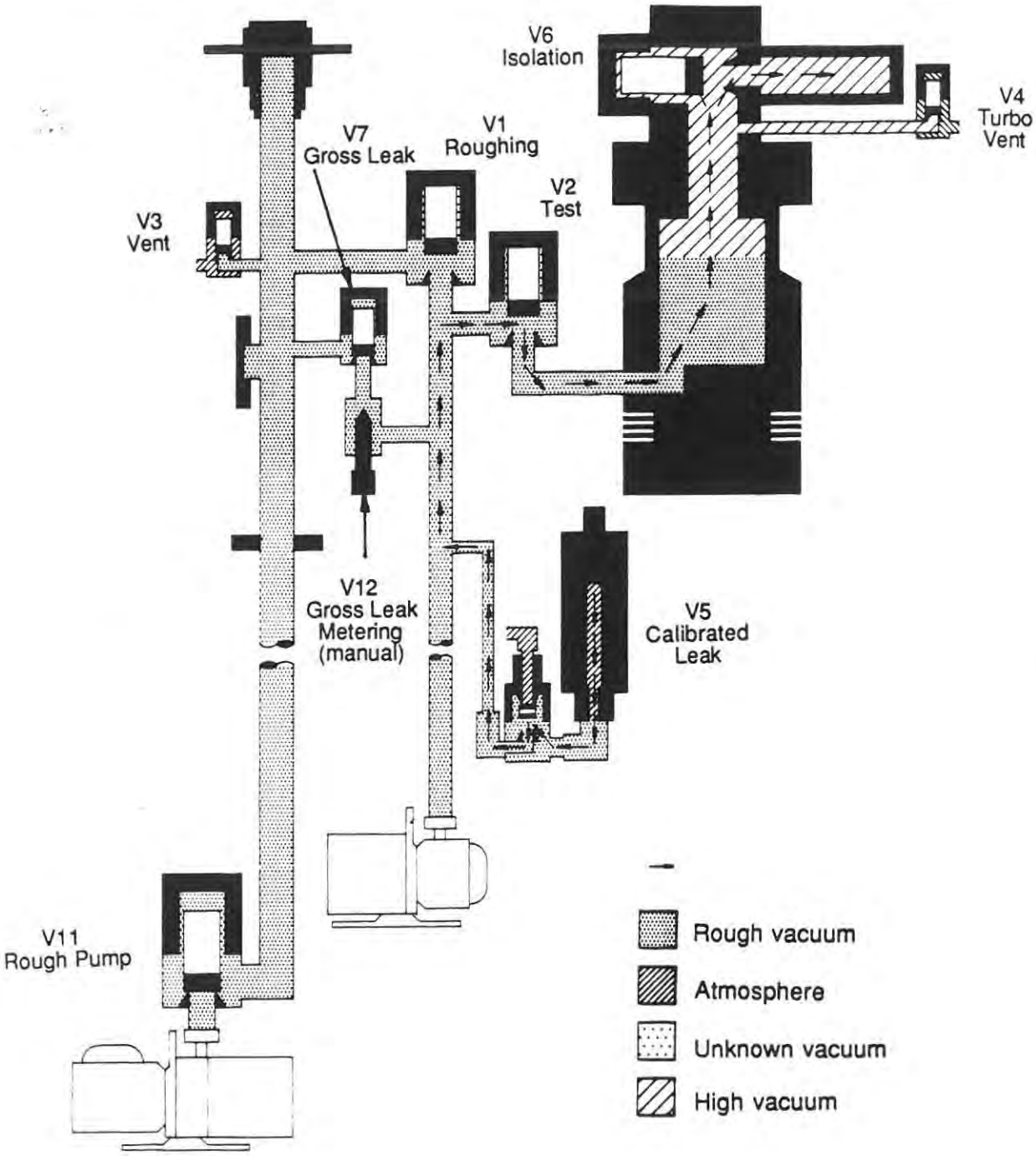


Figure 4-7. Vacuum system in the Gross Leak Test mode

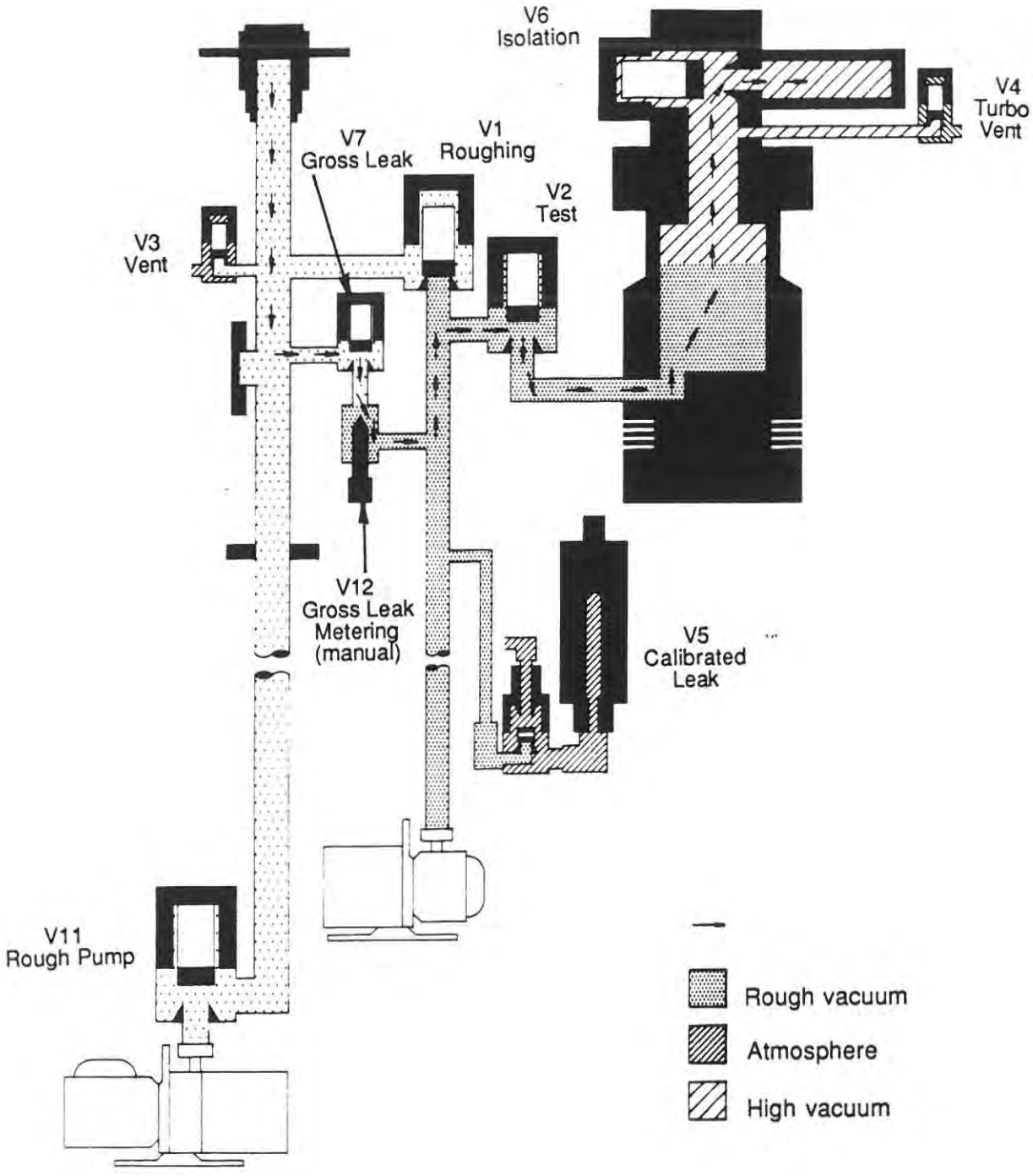


Figure 4-8. Vacuum system in the Fine Test mode

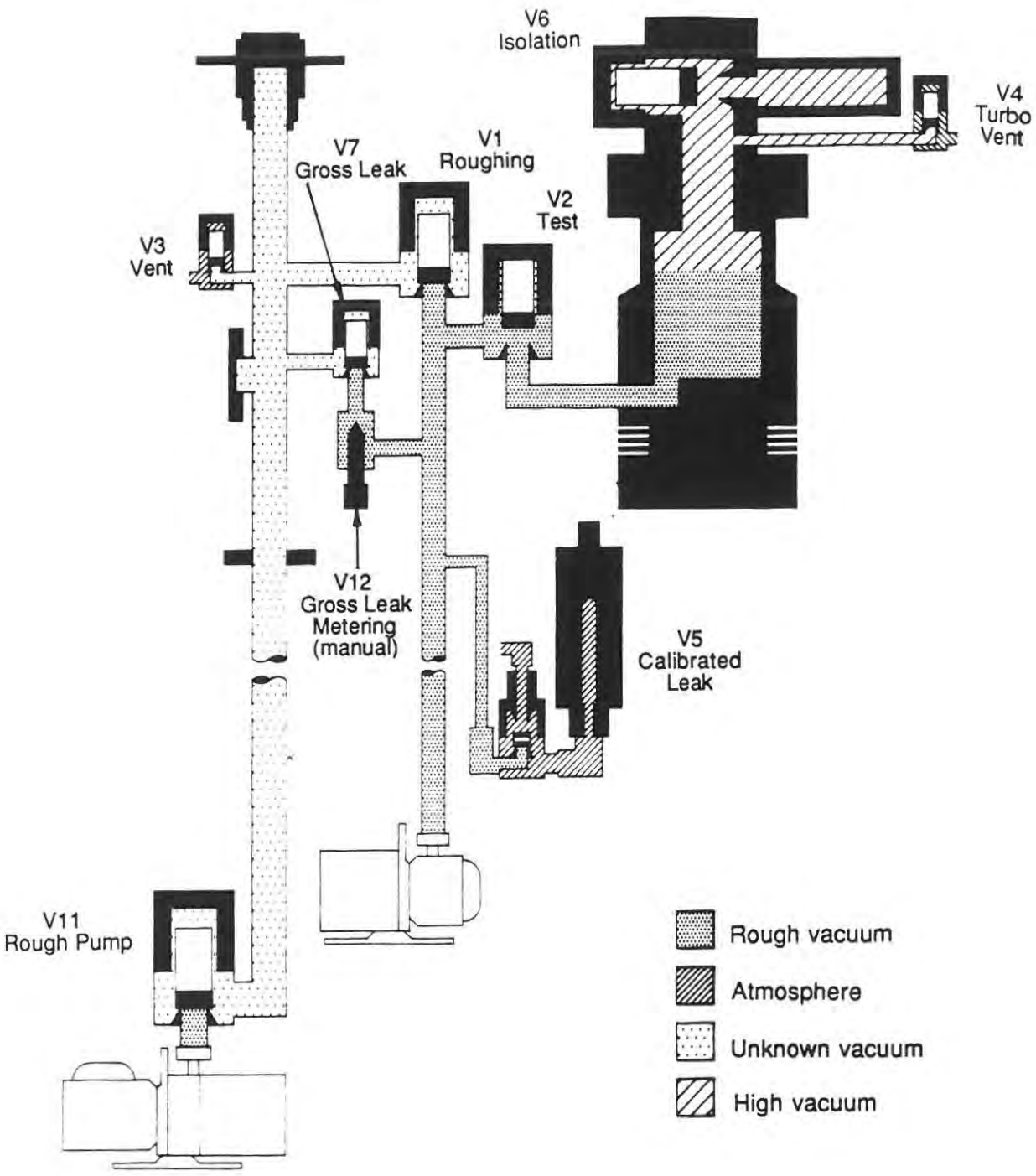


Figure 4-9. Vacuum system in the System Ready or Hold mode

In the following descriptions, the valves are considered to be in their final resting positions. It is assumed that valves turn on and off with sufficient delays such that misvalving is not possible.

1 The HOLD mode is a safe mode in which the system can remain indefinitely. Valves V2 and V6 remain open while valves V1, V3, V5, V7, and V11 close. Valve V4 remains in the position before the HOLD mode occurred. The display reads "System Ready." (The second line of the display is user-definable (Menu 9, option 2.)

2 The VENT mode is used to load and unload the test port and is also a safe mode and can be entered from any other mode. In the VENT mode, valves V2, V3, and V6 open while valves V1, V4, V5, V7, and V11 close. The display reads "System Ready - Vent".

3 The ROUGHING OUT TEST PORT mode can be entered only after system warmup. This mode is initiated by pressing the START key. Once the transfer pressure criteria is met, the system then proceeds to the GROSS LEAK TEST or FINE LEAK TEST mode. In the ROUGH DOWN mode, valves V1, V6, and V11 open while valves V2, V3, V4, V5, and V7 close.

4 The GROSS LEAK TEST mode can only be entered from the ROUGH OUT TEST PORT mode or the FINE LEAK mode. In this mode, valves V2, V6, and V7 open while valves V1, V3, and V5 close. Valve V4 opens or closes depending on the range of the leak detector. Valve V11 remains open or closed depending on the menu selection for flow split. V11 opens for flow split and remains closed if flow split is not selected.

5 The FINE LEAK TEST mode can be entered only from the ROUGH OUT TEST PORT mode if the gross leak option is not installed; the FINE LEAK mode can be entered from the gross leak mode only if the gross leak is present. In this mode, all valves remain as in the gross leak mode except roughing valve V1 which is opened or closed instead of gross leak valve V7.

4-5 FRONT PANEL CONTROLS (Detailed description) (See Figure 4-8)

As described in Section II, the front panel is divided into two functional groups of keys, the right half and the left half. The right half keys can be considered as primary control keys which directly control the equipment and are always operational unless control is passed on to the host, remote, or parallel connectors through optional selections. The left half keys (under the hinged cover on the left side of the control panel) are those keys which are seldom used for normal operation. The following paragraphs define the operating functions of the keys.

4-5-1 Right-side Control Key Functions

START
VENT
AUDIO (on/off)
AUDIO volume (VOLUME INCREASE or VOLUME DECREASE)
AUTO/MAN (ranging)
MAN (LARGER or SMALLER leak)

1 The START key initiates a rough down cycle and permits the 956 leak detector to proceed to the TEST mode if transfer pressure permits. The following restrictions apply.

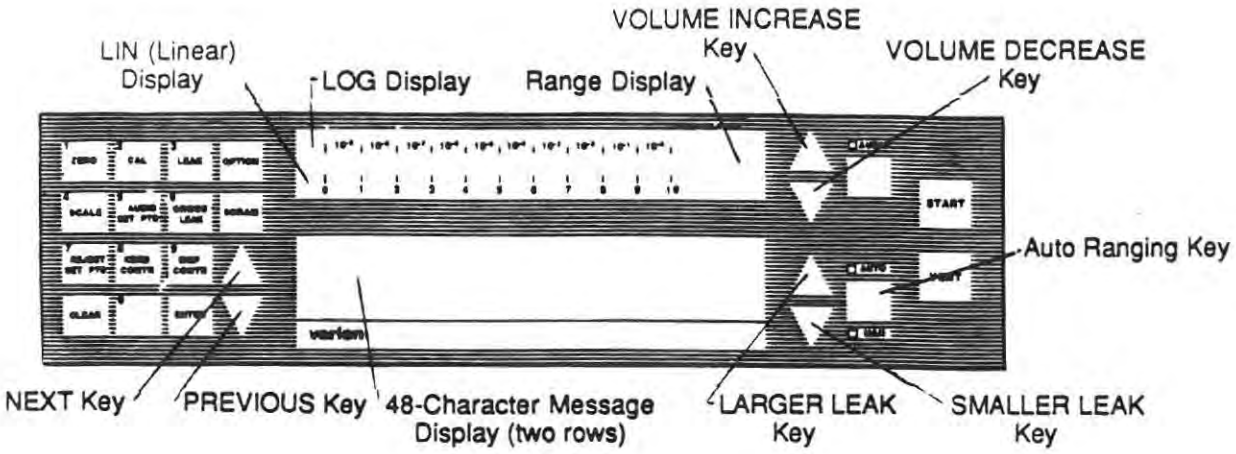


Figure 4-10. Front Panel Controls, 956 Leak Detector

The 956 Leak Detector proceeds to the most sensitive range if in the AUTO mode; it remains in the range selected if in the MANUAL mode.

The leak detector proceeds to FINE LEAK TEST mode unless held in GROSS LEAK mode by pressing the GROSS LEAK key (no. 6 in left half group).

The leak detector remains in the TEST mode unless:

a) The system is vented by pressing the VENT key.
b) A fault is present that can cause the system pressure to rise above the maximum tolerable foreline pressure in which case the system goes into the GROSS LEAK mode and proceeds to the ROUGHDOWN mode if it exceeds maximum foreline pressure in the GROSS LEAK mode.
c) Any failure occurs with the ion source, turbo pump, or mechanical pump which will send the system into the HOLD mode.
d) The AUTO SEQUENCER cycle is terminated in which case the system goes into the HOLD mode if the test sample fails and to the VENT mode if the test sample passes.

2 The VENT key vents the test port, terminating the cycle, from any vacuum state.

3 The AUDIO (on/off) key turns the audio on and off. The audio is a tone whose pitch (frequency) is proportional to the leak rate. The frequency increases for an increasing signal.

4 The triangular AUDIO volume (VOLUME INCREASE or DECREASE) keys, when pressed or held down, increase or decrease the volume of the tone if the audio is on. If the audio is off, these keys are not active.

5 The AUTO/MAN key puts the 956 leak detector in either the AUTO or MANUAL range changing mode of operation by alternately pressing the key. Once in the TEST and AUTO modes, the leak detector proceeds to a range in which the mantissa value of the leak rate is greater than

or equal to 0.8 and less than or equal to 9.9 thus proceeding to the most sensitive range possible. This key forces the leak detector to revert to the LIN scale. Once the leak detector is in the MANUAL and TEST modes, the leak detector remains in the range selected and can be changed using the LARGER and SMALLER (triangular) keys to the left of the AUTO/ MANUAL key to read larger or smaller leaks.

6 The MANUAL (LARGER and SMALLER) keys become active in the MANUAL mode and cause the leak detector to go to the next larger leak rate range when the LARGER (up) key is pressed, and to the next smaller leak rate range when the SMALLER (down) key is pressed.

4-5-2 Left-side Control Key Functions

The left half group consists of sixteen keys which can mean and do different things depending on previous key presses. Eight of these keys can be considered first function, secondary control keys. They are:

ZERO
CAL (Calibrate)
LEAK (Standard leak)
SCALE (Log/Lin)
AUDIO SET PTS
GROSS LEAK
OPTION
SCRAM

1 The ZERO key, depending on the menu setup, will zero the background or return it to the previous value when the key is pressed again.

2 The CAL key, if enabled through menu selection, will automatically calibrate the system. The leak detector must be in the TEST mode or the command will be ignored. The calibrate function first autozeroes the vacuum system, turns on the standard leak, scans the spectrometer tube voltages to find the helium peak, calculates the gain, turns off the standard leak, and then autozeroes the system. The gain must be greater than 0.8 and less than 7.

3 The LEAK key is a toggle switch which, if in the TEST mode, turns the standard leak on and off.

4 The SCALE key switches between the log and linear scales of the bar graphs upon alternate key presses.

5 The AUDIO SET PTS key either arms or disarms the audio set point upon alternate key presses.

6 The GROSS LEAK key is active if the GROSS LEAK option is installed and will hold the leak detector in the GROSS LEAK mode or allow it to transfer to the FINE LEAK TEST mode if conditions allow upon alternate key presses.

7 The OPTION key is the single most important key which allows the 16 keys to have a second function. When this key is first pressed, the leak detector is forced into a programmable mode

in which, through menu selections, the operator can examine or change the leak detector's parameters. The key also activates the second functions of this group of keys.

8 The SCRAM key causes the system to go into a SAFE SHUTDOWN mode (the key must be pressed and held for more than 1/2 second). In this mode (after the turbo pump has cooled down), all pumps and valves are turned off and only the digital electronics and the front panel are active. Power consumption in this mode is approximately 30 to 40 watts. If the system is already in the SAFE SHUTDOWN mode, pressing the SCRAM key again will turn the system on.

4-5-3 Second Function Key Definitions

1 The ENTER key is used to accept a choice or activate the current menu.

2 The CLR key clears an active choice. This action can be considered as "Backing Out". If the CLEAR key is pressed before the ENTER key, then the erroneous entry is cleared and the old value appears. If the CLEAR key is pressed again, then the current value is destroyed and the default (factory-set) value now becomes the current choice.

3 The NEXT and PREVIOUS keys are used to advance the menus or choices, backward or forward.

4 The SCRAM key is used to back up one level of the menus. For example, if pressed at the sub menu level 2, the display will then show the level 1 menu title.

5 Pressing the OPTION key causes the 956 leak detector to enter the PROGRAMMABLE mode. Pressing it again causes the leak detector to terminate the mode and return to operating the unit.

6 Digits 1 through 9

When the OPTION key is first pressed, the second function of the keys becomes active. The following definitions apply to the second functions of the 16 keys.

ENTER key	SCRAM key
CLR key	OPTION key
NEXT and PREVIOUS keys	Digits 0 through 9

Before describing these functions, it is necessary to understand the possible types of entries, their use, and how they are shown on the alpha-numeric displays. The alpha-numeric displays consist of two rows of 24 characters each. During normal use of the leak detector, the display spells out messages to describe the status of the leak detector. Once the OPTION key is pressed, the leak detector enters into the programmable mode and the alpha-numerics are divided into two rows. The top row shows the title of the present menu or option; the bottom row shows the submenu or the option value until the ENTER key is pressed. The ENTER key advances the bottom row to show any further sub-sublist or displays the current option value.

The letters "C" or "D" (or both) may appear next to the option value; "C" representing the current active value of the option, and "D" its default (or factory-set) value. Option values can be considered as a stack which is Last In, First Out. The default value is at the bottom of the stack and cannot be changed or erased. The current active value is the next item on the stack and can be modified. Once modified, the old value is lost; however, the modified value does not become active unless and until the ENTER key is pressed (except in some cases described later). The letter "P" alongside the option value indicates that the value is Protected (a Security Level); the # sign indicates the number of that security level of that option (see Menu 22).

Option values can be of the following types:

1 List Pick
2 Numerical Entry
3 Incremental or Decremental
4 Alpha-numeric

1 List Pick is a list of all possible choices. When the proper choice is reached, the ENTER key accepts and makes the choice current.

2 Numerical Entry allows entry from digit keys 0 through 9. The display will show the single digit change and advance to the next digit if required. Again, the ENTER key accepts and makes the choice current.

3 Incremental or Decremental (NEXT or PREVIOUS) keys can be used to scroll through the choices rapidly by holding the appropriate key down.

4 Alpha-numeric entry is possible where required for special features such as names, job number fields, etc. This is accomplished by pressing the NEXT and PREVIOUS keys to scroll through the set of available characters. When the proper character is displayed, press ENTER. Entry of up to 22 characters is possible for names. The last entry should be "." (period or decimal point) to indicate the end of the message field.

All menu titles are identified by numbers which correspond to available functions. On the next sub-level are the sub menus (or options) which can also be identified by numbers. This sub level could continue further; however, a four-level depth is sufficient for the 956 leak detector. For convenience, digit keys 1 through 9 also have abbreviated menu titles printed on them. To activate the menus, press the OPTION key then, if the menu number is known, press digits 0 through 9. Otherwise, the NEXT and PREVIOUS keys can be used to scroll through the menus. Once the proper menu is reached (by either method), press the ENTER key to enter into or activate the sub menu. Again, either the digit keys or the NEXT or PREVIOUS keys can be used to activate the next menu in line or option choice. If the choice is an option value then, again, the NEXT or PREVIOUS keys can be pressed to show the desired choice and the ENTER key will activate the choice. For example, to change the ion voltage (or filament bias) of the spectrometer tube, the following sequence of key presses are necessary. Ion voltage (filament bias) appears under Manual Calibration (Menu 2, Option 2).

1 Press the OPTION key (activates the menus).
2 Continue pressing the NEXT key to advance to the CALIBRATION menu title.
3 Press ENTER to activate the menu.

4 Continue pressing the NEXT key to advance to MANUAL CALIBRATE menu title.
5 Press ENTER to activate the menu.
6 Continue pressing the NEXT or PREVIOUS keys to get to the ion voltage (filament bias) sub menu.
7 Press ENTER to activate the menu.

At this point, the operator can enter the desired ion voltage using digit keys 0 through 9 followed by the ENTER key, or scrolling up or down to the desired voltage. Once satisfied with the ion voltage, the operator can exit the Program mode by pressing the OPTION key again or continue to change other parameters.

4-6 MENU DESCRIPTIONS

Table 4-2 lists all of the menus used in the microprocessor for the 956 Leak Detector. Each menu, with its options and sub-options, is described in detail in following paragraphs.

Table 4-2. List of Menus

Menu No.	Title	Menu No.	Title
1	Zeroing	12	Options Control
2	Calibration	13	Recorder Output Control
3	StandardLeak	14	Serial Port Control
4	Log/Linear Select	15	Date and Time
5	Audio Controls	16	System Wake Up
6	Xfer to Fine Test	17	Sniffer Control
7	Reject Setpt Controls	18	Pump Options
8	Keyboard Controls	19	Service Information
9	Display Controls	20	Security Control
10	Display Units	21	Service Statistics
11	Sequencer	22	Manual Controls
		23	Service Initialization

Menu 1 - Zeroing

Option 1 Auto Zero Leak Rate < 0
1 Disable
2 Enable D
Option 2 Last Zero Background
1 Disable D
2 Enable

This menu refers to the ground reference of the helium signal. The hardware and software have the combined ability to shift the zero reference of the preamplifier by approximately 3×10^{-7} atm cc/sec.

As the vacuum system is used, the background will increase or decrease with time. Selecting Option 1 (Auto Zero Leak Rate < 0), the operator can let the leak detector automatically compensate for decreasing background and adjust the leak rate to the proper zero reference.

Auto Zeroing accomplishes the following.

- Zeroes the leak detector when the leak rate falls below 0.0 by 2% of that scale.
- Zeroes the leak detector within 0.5% of any scale.
- Displays the ZEROING message during the process.
- Disables the function keys such as VENT, STD LK, and CAL during the zeroing process.

Option 2 - Last Zero Background

In some cases, it is necessary for the operator to know how much the system background has changed since the last calibration was performed. Option 2 contains the difference between the current zero reference and the zero reference at the last auto calibration. A positive number implies that the background has risen; a negative number implies that the background has improved. Values shown when this menu is accessed corresponds to the range the leak detector is in. This is due to the fact that the zero reference is different for different ranges.

Menu 2 - Calibration

Option 1	Auto Calibrate		
	1	Disable Calib. Key	D
	2	Enable for Int. Leak	
	3	Enable for Ext. Leak	
	4	Full Auto Tune Password (not presently available)	
Option 2	Manual Calibrate		
	1	Ion Voltage	(210V to 320V)
	2	Emission Current	(0.2 mA to 2 mA)
	3	Calibration Gain	(0.8 to 7)
	4	Response Time	(0.05 sec to 10 sec)

Option 1 - Auto Calibrate

This menu defines calibration techniques available to the operator. If Option 1-1 is selected, pressing the CAL key will produce an audible beep indicating an illegal or inoperable key press.

If Option 1-2 is selected, pressing the CAL key will initiate the following auto calibrate sequence with the internal leak provided the leak detector is in the TEST mode. During the auto calibration procedure, the VENT, ZERO, and STD LEAK are disabled.

- Turns on the standard leak
- Scans the ion voltage (+210 to +320 V DC ± 10%)
- Scans the ion voltage to find the maximum signal
- Sets the ion voltage to that peak or indicates an error message
- Calculates the gain by using the leak value set in Option 3-1. If the gain is greater than 7 or less than 0.8, an error message is displayed
- Turns off the leak
- Zeroes the display. Valves may be automatically sequencing during this process

If Option 1-3 is selected, an external leak can be used to calibrate the leak detector. The value of this leak should be placed in Option 2 so that it can be used in the gain calculations. This procedure follows the same sequence as in Option 1-2 except for the following user intervention.

- The external leak with valve open should be placed in the test port before the system is pumped down.
- When the leak detector is in the FINE TEST mode and in its most sensitive range, the CAL key can be pressed to initiate the CALIBRATE process.
- No further action is required by the user to complete the process.
- For best results, an external leak with a value of -6 range to -8 range should be used.

Option 2 - Manual Calibrate

Although Auto Calibrate is the better way of calibrating the leak detector, it may be necessary (for certain applications) to adjust the leak rate output to an operators' unique application. In this case, the operator has control of the Ion Voltage, Emission Current, Calibration Gain, and system response time.

Option 2-1 controls the Ion Voltage. Using the NEXT and PREVIOUS keys, the ion voltage can be increased or decreased from approximately 210V to 320V. This voltage adjustment should be used only when the other ion source parameters (repeller voltage, variable focus, and the enhancement magnet) have already been set up through the Service Calibration option menu (menu 22-1).

Option 2-2 controls the ion source emission current. Using the NEXT and PREVIOUS keys, the emission current can be increased or decreased from approximately 0.2 mA to 2 mA. This adjustment is also a peaking function of the helium signal. This current should be kept as low as possible so that the life of the ion source filament can be greatly increased. Typical emission currents are between 0.2 mA to 1 mA; the emission is factory-set at 0.2 mA.

Option 2-3, Calibration Gain, amplifies the output to the leak rate display. Its range is from 0.8 to 7.00.

Option 2-4 controls the response time of the leak detection system. Response time can be adjusted from 0.05 sec (direct) to 10 sec (slowest). Setting the response time applies to all ranges except the -9 range in which case the response is four times the set value (0.2 sec to 40 sec); the factory-set response time is 0.8 sec.

Menu 3 - Standard Leak

Option 1	Internal Standard Leak Value	
Option 2	External Standard Leak Value	
Option 3	Disable Leak	D

Option 1 contains the value of the Internal Standard Leak. This value is used to calculate gain by the Auto Calibration routine. **The value of this leak is automatically compensated for ambient temperature changes.**

Option 2 can be set to a value of a calibrated leak used at the test port. The value set in this option is used during Auto Calibration with an external leak. Even if external calibration is not used, the value of a leak used at the test port to verify system performance should be placed here.

Option 3 disables the Leak key and is used when the standard leak is not installed.

Menu 4 - Log/Linear Select

Option 1	Log	
Option 2	Lin (Linear)	D

This menu allows the operator to set the bar graph scale output (log or linear) to be selected to the desired choice when the leak detector is powered up.

Menu 5 - Audio Controls

Option 1	Audio Setpoint Value
Option 2	Audio Volume (1 to 100)

Option 1 of this menu allows the operator to set the value at which the audio will turn on if armed. The following criteria describes the audio set point.

- The audio is turned on for values greater than the set point and turned off for values less than the set point.
- The set point can be armed or disarmed by pressing key 5 only when in the non-programming mode (outside the menu options).
- When the audio set point is armed, the AUDIO ON light will flash to indicate that the set point alarm is armed.
- If the audio is on (enabled by the AUDIO key), the set point cannot be armed by pressing the AUDIO SET PTS key.
- If armed and the leak rate is greater than the set point, the AUDIO on light will goe from the flashing state to the solidly lit state.
- Turning off the audio does not disarm the set point; it turns off the AUDIO ON and the sound only.

Option 2 allows the operator to adjust the volume level that can be applied when the leak detector is powered up and the audio is first turned on.

Menu 6 - Transfer to Fine Test

Option 1	Hold in Gross Leak
Option 2	Xfer to Fine Leak

Option 1 allows the operator to set the leak detector to stay in the GROSS LEAK TEST mode only. This state is retained upon every power-up.

Option 2 allows the operator to set the leak detector to transfer (Xfer) to the FINE LEAK TEST mode if pressure and leak rate conditions are met. As in Option 1, this state is retained upon every power-up.

Menu 7 - Reject Set Point Controls

Option 1	Reject Setpoint #1
Option 2	Reject Setpoint #2
Option 3	Reject Setpoint #3

Option 4	Reject Setpoint #4
Option 5	Reject for Set Point # (#1 to #4)
Option 6	Setpoint Hysteresis (5% to 50%)

Options 1 through 4 allow the operator to set values for four independent reject set points. Each set point directly controls the action of the four optical isolators whose outputs are connected to parallel I/O connector J10.

Option 5 allows the operator to set the main reject set point indicator message to any of the four set points available (#1 through #4).

Option 6 allows the operator to set the hysteresis value to all the set points except the audio set point. For example, if the hysteresis was set to 10 % of full scale and the set point was set at 3.0×10^{-7}, then the reject set point will trip for leak rate values greater than or equal to 3.0×10^{-7} for an increasing signal and untrip when the leak rate falls below 2.0×10^{-7} (10 percent of full scale) for a decreasing signal.

Menu 8 - Keyboard Controls

Option 1	Active Keys Control			
	1	Front Panel		
		1	Disable	
		2	Enable D	
	2	Parallel Port		
		1	Disable	D
		2	Enable	
Option 2	Key Press Beep			
	1	Disable		
	2	Enable	D	

Options 1-1 and 1-2 select the location (s) of the source of the input commands.

Option 1-1-1 disables the START, VENT, AUTO/MAN, AUDIO ON/OFF, ZERO, CAL, LEAK, SCALE, AUDIO SET PT keys and the GROSS LEAK (Gross Leak Hold/Xfer Fine Test functions) key. The programming mode keys are still active.

Option 1-1-2 enables all the keys on the front panel.

Option 1-2-1 disables all the input lines of the parallel I/O connector J10. The output lines are always active.

Option 1-2-2 enables the parallel inputs on the parallel I/O connector J10.

Option 2-1 disables the key press beep. Pressing a key on the front panel will not produce any beep except as follows.

- Two beeps will be heard to indicate an illegal or not active key press.
- Three beeps will be heard to indicate an error that changes the state of the leak detector. These beeps are not associated with key presses.

Option 2-2 enables the key press beep. Pressing any key on the front panel will produce a single beep to acknowledge the key. Other beeps will be heard as indicated in Option 2-1.

Menu 9 - Display Controls

Option 1	Alpha-numeric Display		
	1	Nothing	D
	2	Leak Rate	
	3	Ion Gauge Pressure	
	4	Test Port Pressure	
Option 2	Hold Mode Display		
	1	Nothing	D
	2	Ion Gauge Pressure	
	3	System TC Pressure	
	4	Test Port Pressure	
Option 3	Languages		
	1	English	D
	2	Spanish	
	3	German	
	4	French	
	5	Italian	

Menu 9 allows the manipulation of the alpha-numeric displays. The first line of the alpha-numeric display describes the current state of the leak detector and the events taking place. This line is not controllable except for Options 2 and 3.

Options 1-1 through 1-4 apply to the information that can be displayed on the second line of the alpha-numeric display.

Option 1-1 allows the operator to keep the second line blank when the leak detector is in the TEST mode except for the leak rate units so that the display does not distract the operator with too much information.

Option 1-2 allows the operator to display the leak rate value to two decimal places thus giving more resolution.

Option 1-3 allows the operator to display the last reported system pressure from the ion gauge when the leak detector is in the TEST mode.

Option 1-4 allows the operator to monitor the test port pressure when the leak detector is in the TEST mode.

Options 2-1 through 2-4 allow the operator to display the various system pressures when the leak detector is in the Hold mode.

Options 3-1 through 3-5 allow the operator to display all the alpha-numeric messages in the language selected.

Menu 10 - Display Units

Option 1	Leak Rate Units		
	1	Atm cc/sec	D
	2	Oz Freon/yr	
	3	Pascal m^3/sec	
	4	Torr liters/sec	
	5	Air equivalent	
	6	User defined (0.001 to 99.999)	
Option 2	Pressure Units		
	1	Torr	D
	2	mbar	
	3	Pascal	
Option 3	Pump Speed Units		
	1	CFM	D
	2	m^3/hr	
	3	liters/min	

Menu 10 deals with the units of the numerical information reported on the displays. If the exponent value becomes positive or smaller than -9 due to units selected other than atm/cc sec, the exponent is blanked and the full value will appear on the alpha-numeric display. If the leak rate on the alpha-numeric display is disabled (Option 9-1-1), then the leak rate will be forced to be displayed.

Options 1-1 through 1-5 allow the operator to select the appropriate units for the leak rate output.

Option 1-6 allows the operator to enter a constant multiplier for units not commonly used. When this option is selected, the words "other units" will appear on the second line of the alpha-numeric display.

Options 2-1 through 2-3 allow the operator to display the pressure in the units selected.

Options 3-1 through 3-3 allow the operator to select the pumping speed units for various mechanical pumps.

Menu 11 - Sequencer

Option 1	Sequenced Cycle		
	1	Disable	D
	2	Enable	
Option 2	Rough Time	(2 sec to 200 sec)	
Option 3	Test Time	(3 sec to 200 sec)	

Menu 11 is to be used when repetitive testing is required which give pass or fail results only. This menu, in conjunction with Menu 14, Option 4, makes a very powerful tool for automatic testing and logging test results on a printer.

Option 1-1 disables the sequenced cycle operation; the leak detector therefore operates as a standard leak detector.

Option 1-2 enables the sequenced cycle operation with the following rules.

- Pressing the START key initiates the cycle.
- The test port is rough-pumped to get to the TEST mode.
- To allow zeroing, calibration, etc., press the ZERO, CAL, or LEAK keys during the rough pumping. The cycle is interrupted until the VENT key is pressed.
- If rough out time expires, the system reverts to the HOLD mode and rejects the sample. Pressing the VENT key terminates the cycle.
- Once in the TEST mode, the system waits for the test time to expire, at which point the leak rate is compared with the reject set point.
- If the leak rate is less than the reject set point, the massage "Passed" appears on the display and the test port is automatically vented to terminate the cycle.
- If the leak rate is greater than the reject set point, then the message "Failed" appears on the display and the system reverts to the HOLD mode. The cycle is terminated when the VENT key is pressed.

Option 2 allows the operator to set the maximum rough out time. If the rough out time expires, the system reverts to the HOLD mode and rejects the sample. Pressing the VENT key terminates the cycle.

Option 3 allows the operator to set the maximum time in test before making the set point comparison. This is to allow the signal to settle down.

Menu 12 - Options Control

Option 1	Gross Leak		
	1	Not Installed	D
	2	Installed	
Option 2	Internal Standard Leak		
	1	Not Installed	D
	2	Installed	
Option 3	Vacuum System Type		
	1	Diffusion Pump	D
	2	Turbo Molecular Pump	

Option 1 instructs the leak detector to function as a non gross leak machine. Fine Leak ranges from 10×10^{-4} to 0.2×10^{-9} are available to the user.

Option 1-2 enables the Gross Leak valve sequencing provided the option is installed. This allows additional ranges from 10×10^{-6} to 0.2×10^{-3} to be available to the operator.

Option 2 instructs the leak detector whether the internal calibrated leak is installed or not installed.

Option 3 instructs the leak detector regarding the type of pump (diffusion pump or turbo pump) in the vacuum system.

Menu 13 - Recorder Output Control

Option 1	Leak Rate Output Scale		
	1	Log	
	2	Linear	D
	3	Linear with Offset	
Option 2	Recorder Output Signal		
	1	Leak Rate	D
	2	System Pressure	
	3	Test Port Pressure	

Option 1 applies to the leak rate at the recorder output only.

Option 1-1 allows the operator to select the log scale for the recorder output; the output is scaled 1 volt per decade. 100 mv corresponds to 1×10^{-9}; 10 v corresponds to 10×10^{0}.

Option 1-2 allows the operator to select the linear scale for the recorder output; 0 to 10 v repeated for each decade.

Option 1-3 adds an offset to produce a mid 9 range signal. This makes AVS recordings possible so that positive and negative background shifts of the vacuum system can be recorded.

Option 2-1 allows the operator to output the leak rate signal to the recorder output.

Option 2-2 allows the operator to output the last reported ion gauge pressure measurement to the recorder output. This allows the operator to monitor long-term system pressure performance. Pressure range is from 760 Torr to 1×10^{-6} Torr. If the filament is off, then the pressure is measured from the system thermocouple; if the filament is on, then the pressure is measured from the ion source/gauge. Output approximately corresponds to 1 V per decade starting at 1000 Torr. 0V = 1000 Torr; 9V = 1×10^{-6} Torr.

Option 2-3 allows the operator to monitor the test port pressure on the recorder output. Again, the output corresponds to 1 V per decade from atmosphere to 1×10^{-3} Torr. 0V = 1000 Torr; 6V = 1×10^{-3} Torr.

Menu 14 - Serial Port Control (not presently available)

Option 1	Baud Rates		
	1	1200 Baud	
	2	2400 Baud	
	3	4800 Baud	
	4	9600 Baud	D
	5	19,200 Baud	

Menu 15 - Date and Time

Option 1	Set Date Mo/Day/Yr		(01/01/1988 to 12/31/2086)
Option 2	Set Time Hr:Mn:Sec		
Option 3	Date/Time Format		
	1	USA Format	D
	2	European Format	
Option 4	Time Format		
	1	12 Hour	D
	2	24 Hour	

Option 1 allows the operator to view and set the current month, day, and year. Two digits for the month, two digits for the date, and four digits for the year must be completely entered to be accepted by the leak detector. Proper setting of the date allows the software to display maintenance requirements if required.

Option 2 allows the operator to view and set the current time in hours, minutes, and seconds. Two digits each for hours, minutes, and seconds must be completely entered to be accepted by the leak detector. This allows the software to turn on the instrument at the required time, etc.

Option 3 allows the operator to select AM or PM if a 12-hour format is selected.

Option 4 allows the operator to select the 12-hour or the 24-hour timekeeping format.

Menu 16 - System Wake Up

Option 1	Wakeup Time (00:00 to 23:59)		
Option 2	Monday		
	1	Disable	D
	2	Enable	
Option 3	Tuesday		
	1	Disable	D
	2	Enable	
Option 4	Wednesday		
	1	Disable	D
	2	Enable	
Option 5	Thursday		
	1	Disable	D
	2	Enable	
Option 6	Friday		
	1	Disable	D
	2	Enable	
Option 7	Saturday		
	1	Disable	D
	2	Enable	
Option 8	Sunday		
	1	Disable	D
	2	Enable	

Option 1 allows the operator to set the time at which the leak detector should be ready for use. The leak detector will then turn at the set time to ensure stability at the time required for use.

Option 2 allows the operator to select AM or PM for turn-on time. In a 24-hour format, this selection is not required.

Options 2 through 8 allow the operator to select the specific day(s) on which the leak detector will be turned on automatically. The leak detector will be at the System Ready level on each Enable-selected day.

Menu 17 - Sniffer Control

Option 1	Sniffer Enable		
	1	Disable	D
	2	Enable	
Option 2	Sniffer Zero Rate (10 sec to 99.9 seconds/decade)		

Menu 17 is very useful where excessive use of helium causes large ambient helium background shifts. This option allows the operator to set the rate at which the leak rate display will be driven to zero. Any positive or negative trends are instantly transferred to the display with the response time chosen in Menu 2, Option 2-4. Once the value appears on the display, it is reduced to 0 at the rate chosen in this menu. If the leak detector is in the MANUAL mode, the zero will be adjusted to the decade selected. If the leak detector is in the AUTO mode, the zero will be in the most sensitive range possible.

Option 1 enables or disables the sniffer zero control.

Option 2 allows the rate at which the display is zeroed in seconds/decade.

Menu 18 - Pump Options

Option 1	Rough Pump Control		
	1	Disable	D
	2	Enable	
	3	Enable For Rough Only	
Option 2	Rough Pump Rate		
	1	7 CFM	D
	2	11 CFM	
Option 3	External Pump Control		
	1	Enable	
	2	Enable For Rough Only	D
Option 4	External Pump Rate (0.1 to 99.9)		

Menu 18 controls the large rough pump and the associated valving. The size of the pump and when it is connected to the foreline determines the degree of sensitivity or flow split.

Option 1-1 is used when only one pump is installed, regardless of its size

Option 1-2, Enable, permits control of the large pump in the TEST mode. When selected, valve V11 opens giving additional pumping capability to hold large chambers in the TEST mode. The operator

must then select Option 2 to enter the proper size of fore pump installed in the leak detector. There will be a loss of sensitivity in this mode.

Option 1-3, Enable For Rough Only, closes valve V11 in the TEST mode and selects only the 1.2 CFM fore pump. This allows maximum sensitivity.

Option 2 permits the operator to enter the size of rough pump that has been installed (7 or 11 CFM). This will produce a loss in sensitivity; however, electronic gain is automatically added based on the size of the pump selected.

Option 2-1 selects the 7 CFM pump size for the large rough pump. This will produce a loss in sensitivity of a factor of 5 (approximately); however, electrronic gain is automatically added .

Option 2-2 selects the 11 CFM pump instead of the 7 CFM pump as described in Option 2-1. The loss of sensitivity in this case is approximately a factor of 7. Again, the leak detector automatically adds electronic gain.

Option 3 allows one additional large pump to be controlled as described in Option 1. This pump is not intended to substitute for the gross leak option. This user-supplied pump could be connected to the blanked-off port inside the right cover. An electronic valve should be placed between the port and the pump such that the valve can be controlled by a logic signal available at pins 11 and 12 of connector J13.

Option 3-1 applies a logic O signal at pins 11 and 12 of connector J13 such that the valve can remain open in the Fine Test ranges. This is an open collector output capable of sinking 5 mA through 4.7K (see schematics). When ENABLE is selected, the software gain is automatically applied to compensate for the decrease in signal (see Option 4 of this menu).

Option 3-2 applies a logic 1 at pins 11 and 12 of connector J13 to close the external valve in the Fine Test ranges. Selecting "ENABLE - Rough only" allows a large pumping capacity to rough out test chambers and, once in the Fine Test mode, the valve closes to maintain the sensitivity.

Option 4 allows the operator to enter the external rough pump size in the units chosen in Menu 10, Option 3. This allows the software to apply the appropriate software gain where required.

Menu 19 - Service Information

Option 1	Salesman's Name
2	Salesman's Phone
3	Service Phone

Option 1 allows entry of the salespersons name up to 18 characters long. To enter the name, press and hold the scroll keys (up or down arrow) until the appropriate letter appears on the display then press ENTER to accept the character and advance the cursor to the next character. After entering the name, press and hold the scroll key until the (.) (decimal point) appears on the display. Press ENTER to terminate the entry field.

Option 2 allows entry of the salespersons telephone number. Press and hold the scroll key until the appropriate numbers appear in the display. Press ENTER to accept the number and advance the cursor to the next number. After entering the number, press and hold the scroll key until the (.) (decimal point) appears on the display. Press ENTER to terminate the entry field.

Option 3 allows entry of the Varian National Service Center telephone number (1-800-227-9722). The number can be entered as described in Option 2.

Menu 20 - Security Control

Option 1	Display Security Level	(0 to 5)
2	Level 1	(0000 to 9999)
3	Level 2	(0000 to 9999)
4	Level 3	(0000 to 9999)
5	Set Level 1 Password	(0000 to 9999)
6	Set Level 2 Password	(0000 to 9999)
7	Set Level 3 Password	(0000 to 9999)

Menu 20 is one of the most useful menus through which the degree of flexibility of the leak detector is controlled. Through this menu, unauthorized changing of critical system parameters can be prevented. This menu is divided into six levels of security; levels 1, 2, and 3 are intended for customer use, while levels 4, 5, and 6 are considered for Varian use only. Level 5 security is for factory setup while level 4 is for the Varian salesperson to enter service information into Menu 19. Levels 4, 5, and 6 will not be described any further.

When the leak detector is shipped, the password for Levels 1, 2, and 3 are set to 1000. After verification, the security passwords for Levels 2 and 3 should be changed to any two different, unique, four-digit numbers. A copy of these numbers should be kept in a safe place for later use, if required.

The following is a complete list of menus that can be changed under Levels 1, 2, 3, and 4.

Level 1

Menu 8, Option 2	Key Press Beep
Menu 11, Option 1	Sequenced Cycle

Level 2 - All of the following including those in Level 1

Menu 1	Zeroing (Complete)
Menu 2, Option 1-1	Disable Calibration Key
Menu 2, Option 1-2	Enable for Internal Leak
Menu 2, Option 1-3	Enable for External Leak
Menu 2, Option 1-4	Full Auto Tune Password
Menu 2, Option 2-1	Ion Voltage
Menu 2, Option 2-2	Emission Current
Menu 2, Option 2-3	Calibration Gain
Menu 2, Option 2-4	Response Time

Menu 4	Log/Linear Select
Menu 5	Audio Controls (Setpoints)
Menu 6	Transfer to Fine Test
Menu 7	Reject Set Point Controls
Menu 8, Option 1	Active Keys Control (Complete)
Menu 9	Display Controls (Complete)
Menu 10	Display Units (Complete)
Menu 11, Option 2	Rough Time
Menu 11, Option 3	Test Time
Menu 13, Option 1	Leak Rate Output Scale
Menu 13, Option 2	Recorder Output Scale
Menu 15, Option 1	Set Date Mo/Day/Yr
Menu 15, Option 2	Set Time Hr:Mn:Sec
Menu 15, Option 3	Date/Time Format
Menu 15, Option 4	Time Format
Menu 16	System Wakeup (Complete)
Menu 17, Option 1	Sniffer Enable
Menu 17, Option 2	Sniffer Zero Rate
Menu 20, Option 5	Set Level 1 Password
Menu 20, Option 6	Set Level 2 Password
Menu 20, Option 7	Set Level 3 Password
Menu 22, Option 1-1	Ion Voltage
Menu 22, Option 1-2	Repeller Voltage
Menu 22, Option 1-3	Variable Focus
Menu 22, Option 1-4	Emission Current
Menu 22, Option 1-5	Calibration Gain
Menu 22, Option 1-6	System TC Gain
Menu 22, Option 1-7	Test Port TC Gain
Menu 22, Option 1-8	Ion Gauge Gain
Menu 22, Option 1-9	Temperature Sensor Gain
Menu 22, Option 1-11	Gross Leak Transfer Set Point
Menu 22, Option 1-12	Fine Leak Transfer Set Point
Menu 22, Option 4-1	Filament Select

Level 3 - All of the following including those in Levels 1 and 2

Menu 3, Option 2	External Standard Leak Value
Menu 3, Option 3	External Leak Temperature
Menu 14, Option 1	Baud Rates
Menu 18	Pump Options
Menu 20, Option 7	Set Level 3 Password
Menu 22, Option 1-14	Zero Offset
Menu 22, Option 2	Pump Controls
Menu 22, Option 3	Valve Controls
Menu 22, Option 4-2	Emission Level
Menu 22, Option 4-3	Ion Gauge Relay
Menu 22, Option 4-4	D.P. High Power

Level 4 - All of the following including those in Levels 1, 2, and 3

Menu 3, Option 1	Internal Standard Leak Value
Menu 12, Option 2	Internal Standard Leak
Menu 19	Service Information
Menu 20, Option 8-4	Set Service Password
Menu 21	Service Statistics
Menu 22, Option 1-10	Ejector Stage Gain
Menu 22, Option 1-13	Diffusion Pump Voltage
Menu 23, Option 1-1	Reset Options
Menu 23, Option 1-2	Warmup Abort
Menu 23, Option 1-3	System Restart
Menu 23, Option 1-4	Memory Fill Value
Menu 23, Option 2	Initialized Statistics

Menu 20, Option 1 displays the current security level in which the leak detector is operating. This is only a displayable number 1 through 6.

Option 2 sets the leak detector into the most limited access form (Level 1). The password for this level should be left at 1000.

Option 3 sets the leak detector to Level 2 access mode. The system parameters listed in the previous table can be changed under Level 2 security.

Level 2 is intended for the supervisor who may want to set the machine to a unique set of system parameters. Initially, the password for this level is 1000, but should be changed to a different, unique, four-digit number such as the last four digits of the supervisor's Social Security number, for example.

Menu 20, Option 4 sets the leak detector to Level 3 security. This level is intended for in-house service personnel. The system parameters listed in the previous table can be changed under Level 3 security. Again, The as-shipped password is set to 1000; the number should be changed to a different, unique four-digit number.

Option 5 displays and/or sets the Level 1 security password. Level 2 or higher security access is required to see or change it.

Option 6 displays and/or sets the Level 2 security password. Level 2 or higher security access is required to see or change it.

Option 7 displays and/or sets the Level 3 security password. Level 3 or higher security access is required to see or change it.

Menu 21- Service Statistics

Option 1	Total Run Times		
	1	Turbo Pump	(0 to 10,000 hours)

On the 956 leak detector fitted with a turbo pump, the backward-running clock is factory-set at 1500 hours and begins operating when the leak detector is started. With 100 hours remaining on the clock,

the leak detector will continue to operate properly but the message "Re-lube turbo" will flash alternately with displayed parameters. At 0 hours, the leak detector will shut down and cannot be re-started until the turbo is re-lubricated and the clock reset by personnel with Level 4 security (Varian Service personnel).

Menu 22- Manual Controls

Option 1 System Calib. Controls

1	Ion Voltage	(210V to 320V)
2	Repeller Voltage	(Ion Voltage to Ion Voltage + 150)
3	Variable Focus	(Filament Bias to Fil. Bias + 150V)
4	Emission Current	(0.2 mA to 2 mA)
5	Calibration Gain	(0.8 to 7)
6	System TC Gain	(1.00 to 2.00)
7	Test Port TC Gain	(1.00 to 2.00)
8	Ion Gauge Gain	(0.80 to 2.00)
9	Temp. Sensor Gain	(0.80 to 2.00)
10	Ejector Stage Gain	(0.80 to 2.00)
11	Gross Leak Transfer Set Point	(0.1 Torr to 500 Torr)
12	Fine Leak Transfer Set Point	(20 mTorr to 200 mTorr)
13	Diff. Pump Voltage	(40.00 V to 68.00 V)
14	Zero Offset	(0 mV to 255 mV)

Option 2 Pumps Control

- 1 High Voltage
  - 1 Off
  - 2 On
- 2 Fore Pump
  - 1 Off
  - 2 On
- 3 Rough Pump
  - 1 Off
  - 2 On
- 4 External Pump
  - 1 Off
  - 2 On
- 5 Turbo Pump
  - 1 Off
  - 2 Low Speed
  - 3 High Speed

Option 3 Valves Control

- 1 Set Valves States
  - 1 All Valves Closed
  - 2 Vent State
  - 3 Roughdown State
  - 4 Gross Leak State
  - 5 Fine Leak State
  - 6 Hold State

2 Set Individual Valves
- 1 Roughing Valve V1
  - 1 Close Valve
  - 2 Open Valve
- 2 Test Valve V2
  - 1 Close Valve
  - 2 Open Valve
- 3 Vent Valve V3
  - 1 Close Valve
  - 2 Open Valve
- 4 Ejector Bypass Valve V4
  - 1 Close Valve
  - 2 Open Valve
- 5 Std. Lk. Valve V5
  - 1 Close Valve
  - 2 Open Valve
- 6 Isolation Valve V6
  - 1 Close Valve
  - 2 Open Valve
- 7 Gross Lk. Valve V7
  - 1 Close Valve
  - 2 Open Valve
- 8 Ext. Rough Valve V11
  - 1 Close Valve
  - 2 Open Valve

Option 4 Other Controls
- 1 Filament Select
  - 1 Filament #1
  - 2 Filament #2
- 2 Emission Level
  - 1 Off
  - 2 Low
  - 3 High
- 3 Ion Gauge
  - 1 Disable
  - 2 Enable
- 4 D.P. High Power
  - 1 Disable
  - 2 Enable

Menu 23 - Service Initialization

Option 1 System Initialization
- 1 Reset Options
- 2 Warmup Abort
  - 1 Continue Warmup
  - 2 Abort Warmup

3 System Restart
1 Do Not Reset
2 Reset System
4 Memory Fill Value
5 Software Watchdog
1 Disable
2 Enable
6 Reset Option Checksum
1 Do Not Reset D
2 Reset

Option 2 Initialize Statistics (not presently available)
1 Routine Maint. Clear
1 Rough Pump Oil Check
1 Do Not Initialize
2 Initialize
2 D. P. Oil Check
1 Do Not Initialize
2 Initialize
3 Turbo Maintenance
1 Do Not Initialize
2 Initialize
2 Total Run Times
1 System Power
1 Do Not Initialize
2 Initialize
2 Fore pump
1 Do Not Initialize
2 Initialize
3 Diff./Turbo Pump
1 Do Not Initialize
2 Initialize
4 Rough Pump
1 Do Not Initialize
2 Initialize
3 On/Off Cycles
1 System Power
1 Do Not Initialize
2 Initialize
2 Fore Pump
1 Do Not Initialize
2 Initialize
3 Diff./Turbo Pump
1 Do Not Initialize
2 Initialize
4 Rough Pump
1 Do Not Initialize
2 Initialize

5 Test Valve
- 1 Do Not Initialize
- 2 Initialize

6 Rough/Vent Valve
- 1 Do Not Initialize
- 2 Initialize

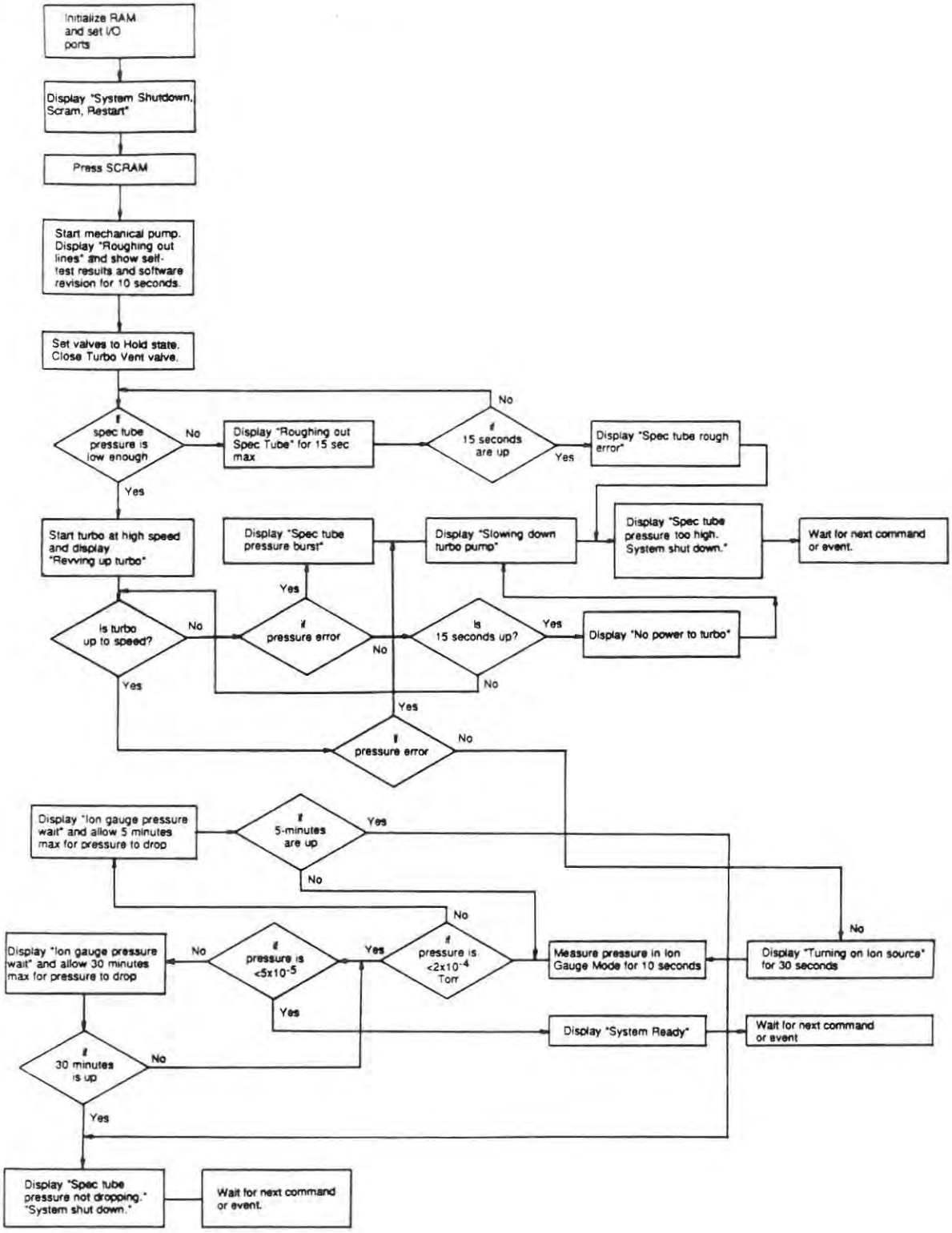
7 Ion Sources Used
- 1 Do Not Initialize
- 2 Initialize

4 Temperature Cycles

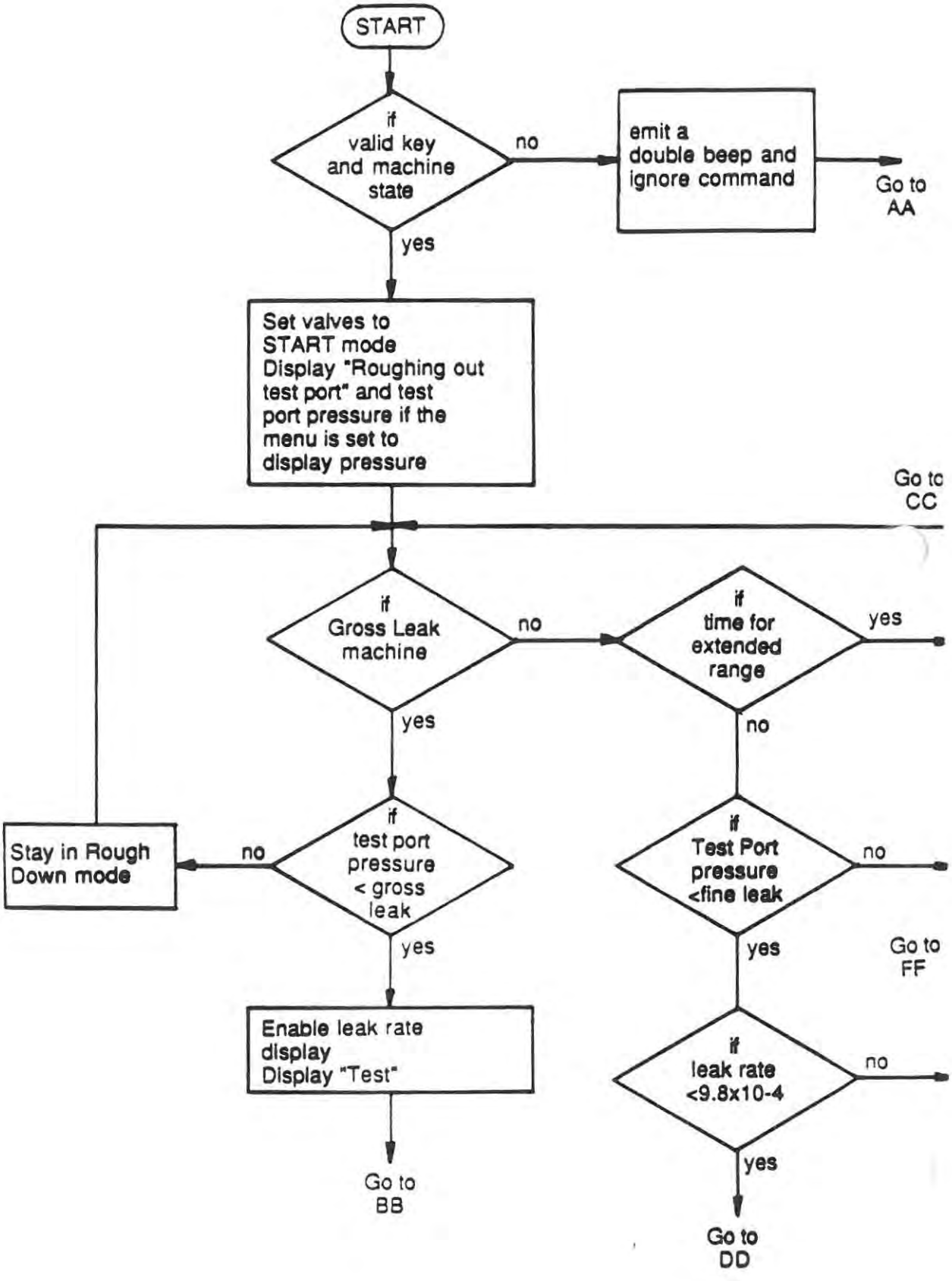
1 Diff./Turbo Overht Cnt
- 1 Do Not Initialize
- 2 Initialize

2 Maximum Temp. Reached
- 1 Do Not Initialize
- 2 Initialize

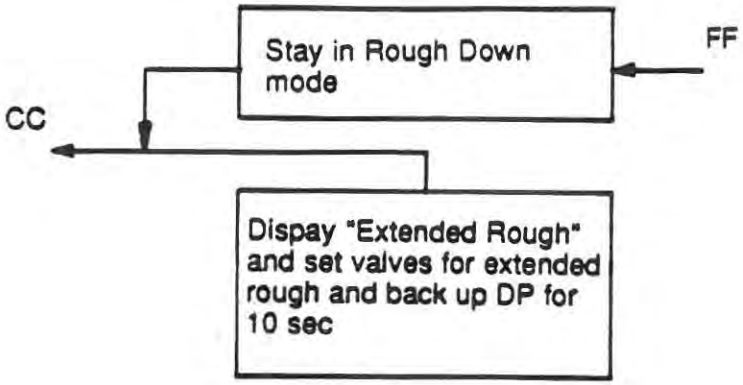
When in the POWER UP mode, the leak detector will:

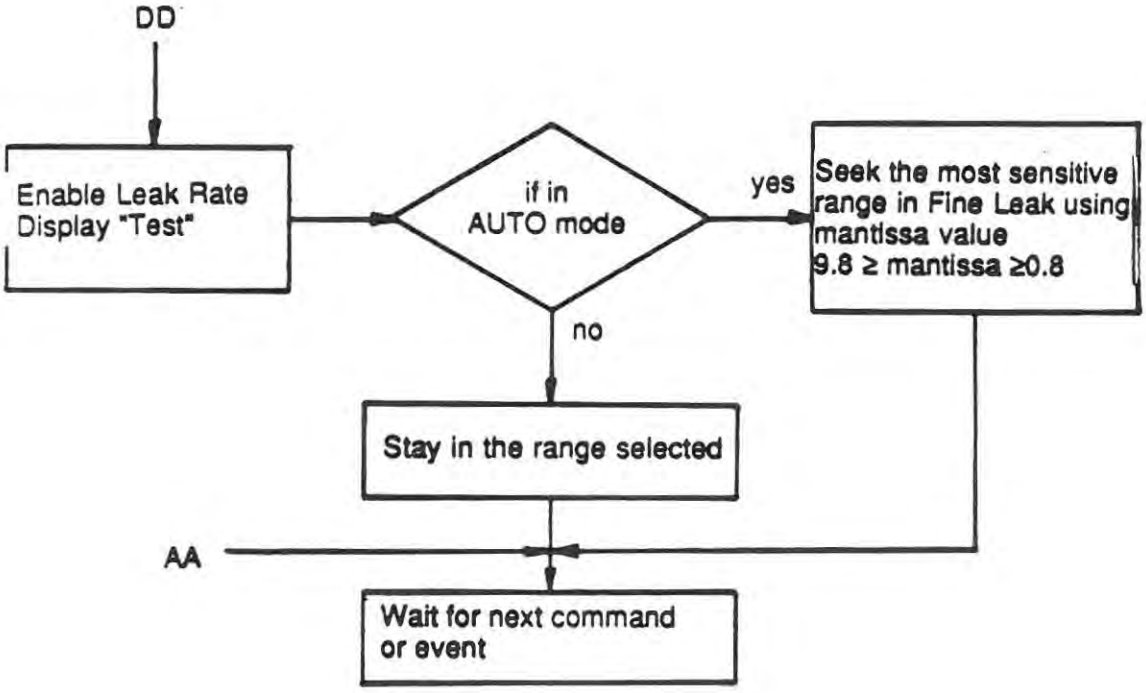


When the START key is pressed, the leak detector will:

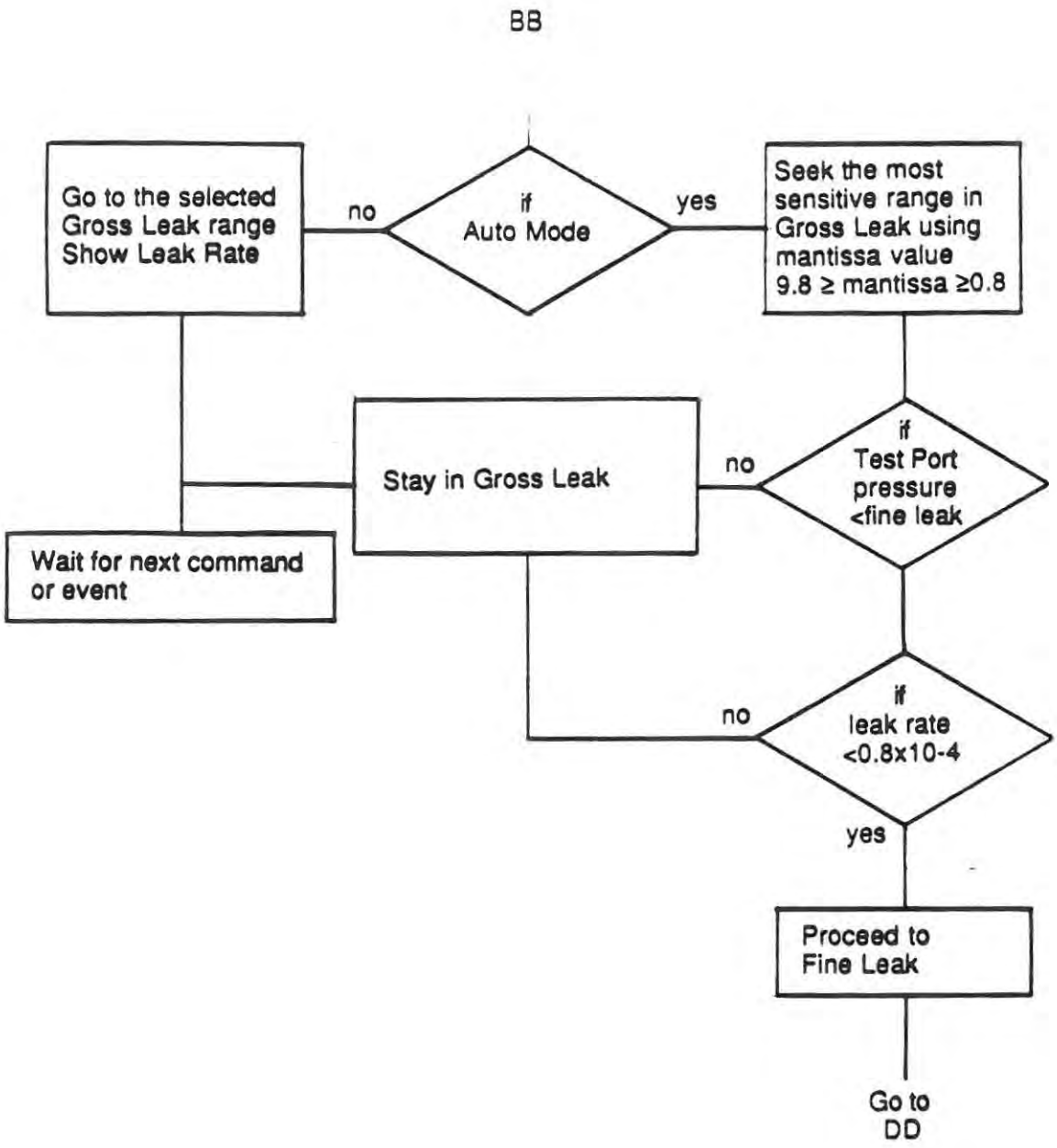


START (Cont.)

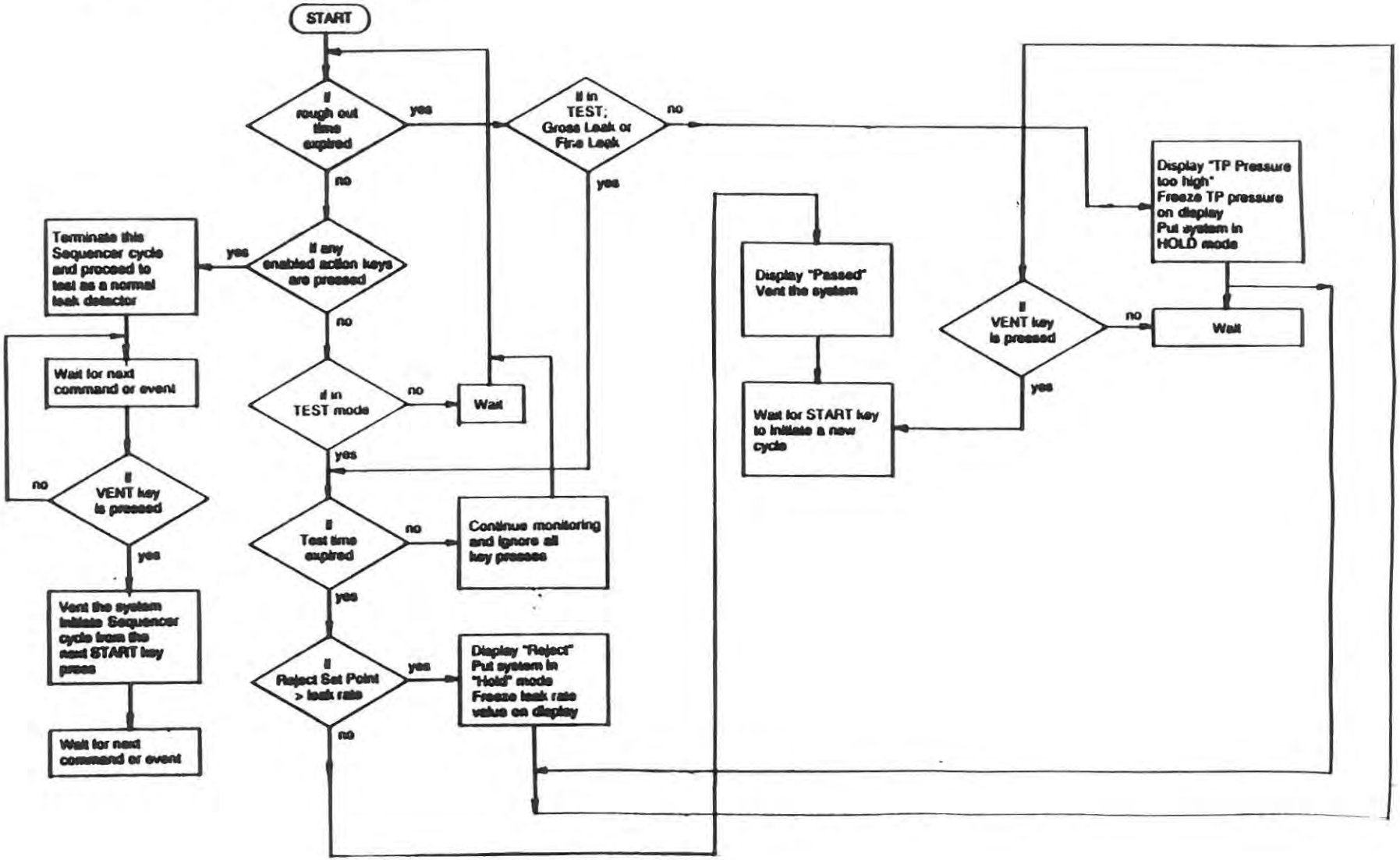

Stay in Rough Down mode
FF
CC
Dispay "Extended Rough" and set valves for extended rough and back up DP for 10 sec


DD
Enable Leak Rate Display "Test"
if in AUTO mode
yes
Seek the most sensitive range in Fine Leak using mantissa value 9.8 ≥ mantissa ≥0.8
no
Stay in the range selected
AA
Wait for next command or event

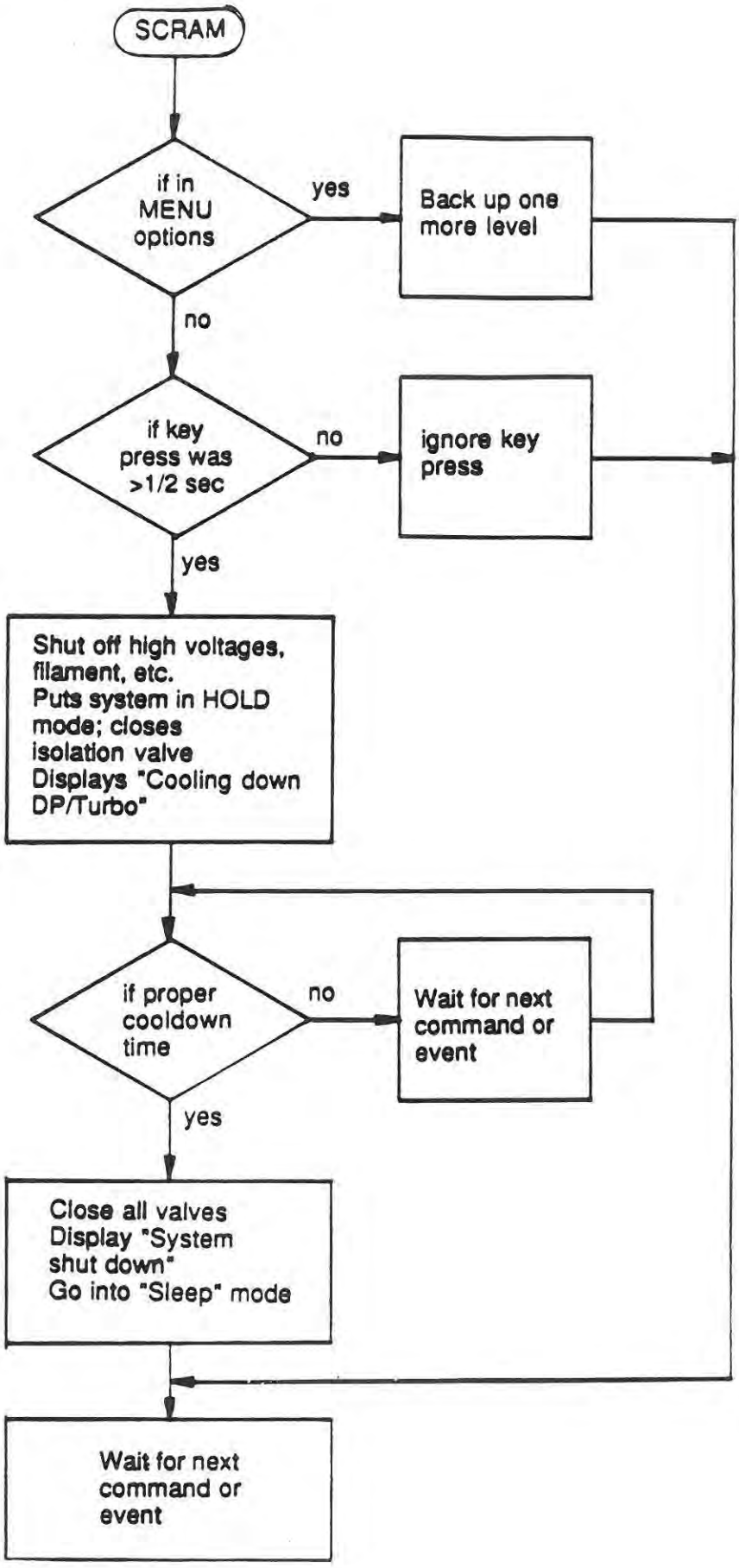
START (Cont.)


BB
Go to the selected Gross Leak range Show Leak Rate
no
if Auto Mode
yes
Seek the most sensitive range in Gross Leak using mantissa value 9.8 ≥ mantissa ≥0.8
Stay in Gross Leak
no
if Test Port pressure <fine leak
Wait for next command or event
no
if leak rate <0.8x10-4
yes
Proceed to Fine Leak
Go to DD

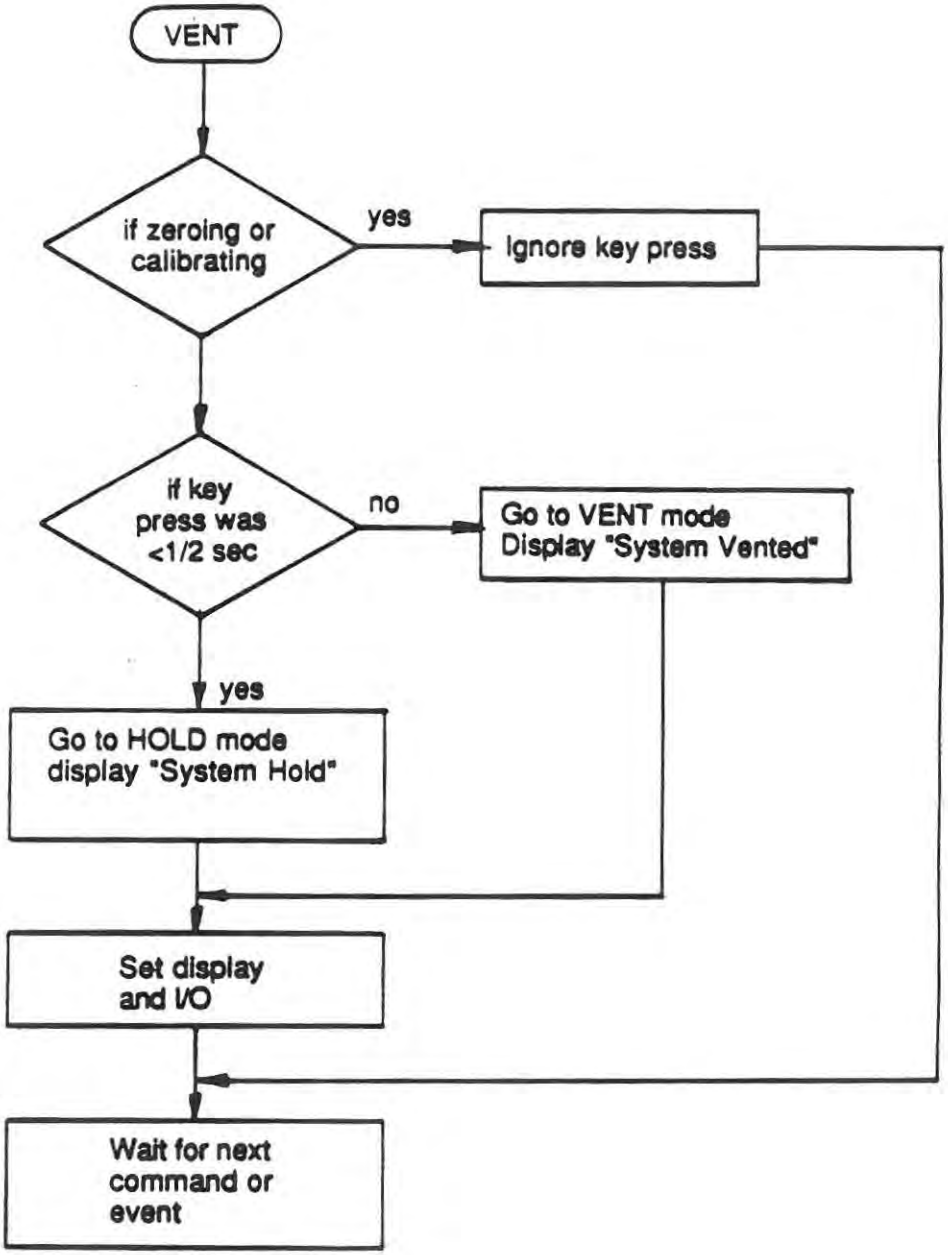
When the SEQUENCER key is pressed, the leak detector will:



When the SCRAM key is pressed, the leak detector will:



When the VENT key is pressed, the leak detector will:



SECTION V

MAINTENANCE, REPAIR, AND CALIBRATION

5-1 SCOPE

Quality test equipment, such as the Varian 956 Portable Mass Spectrometer Leak Detector, requires periodic maintenance, calibration, and checks to insure reliable operation. This section describes these procedures and the corrective steps to be taken should the proper findings be unobtainable through minor adjustments. Table 5-1 lists the area of maintenance, action to perform, frequency of action, the reference paragraph for step-by-step instructions, and the page number on which it is found.

Table 5-1. Maintenance actions to perform

AREA OF MAINTENANCE	ACTION TO PERFORM	FREQUENCY OF ACTION	PARA. REF.	PAGE
Calibration	Sensitivity check	Daily	5-2-1	5-2
Forepump and roughpump oil level	Check for proper level and condition	Weekly	5-2-3	5-3
Forepump	Flush and oil change	Semi-Annually *	5-2-4 a)	5-4
Roughpump	Flush and oil change	Semi-Annually *	5-2-4 b)	5-6
Turbo pump	Cleaning Lubrication	Annually Every 1500 hours*	5-3-16 5-3-17	5-27 5-28
Spectrometer tube	Removal, disassembly, cleaning, reassembly, installation	Annually	5-3-5	5-11
Mechanical pumps	Purging	As required	5-3-1	5-9
Thermocouple gauges	Cleaning/replacement	As required	5-3-2 5-3-3	5-9 5-10
System vacuum manifold	Replacement	As required	5-3-11	5-21
Ion Source	Replacement	As required	5-3-4	5-11

* or as required

5-2 SCHEDULED MAINTENANCE

Scheduled maintenance is maintenance performed on a regular basis and is usually considered preventive in nature. The leak detector will operate at its peak when these maintenance (preventive) procedures are performed at their scheduled intervals.

5-2-1 Daily

The calibration and sensitivity check should be performed at the beginning of each workday, shift, or as local conditions dictate. Successful completion of the following Calibration and Sensitivity Check assures the operator of the leak detector's integrity.

Note
During the first hour of warmup, system parameters such as pressure and temperature may not be fully stable under some conditions. Therefore, Varian recommends that the leak detector be calibrated after the system has stabilized even though the system is sensitive to helium and can be used for leak-checking immediately after warmup.

1 Turn on the leak detector.

2 With the test port plugged, press the START button and allow the leak detector to reach the TEST mode.

3 Turn on the calibrated leak by pressing the LEAK button. Check that the leak detector is sensitive to helium; if not, refer to Troubleshooting, Not Sensitive to Helium.

4 Press the CAL button; if the calibration gain (Menu 22, Option 1-5) is greater than 3 after calibration, sensitivity may be improved by using the following manual tuning procedure.

5-2-2 Manual Tuning

The manual tuning procedure is a method of increasing spectrometer tube sensitivity to helium. Over time, spectrometer tube parameters may change slightly; adjustment may provide a way to improve performance.

1 Allow the leak detector to warm up for at least one hour.

2 Place the leak detector in the TEST mode with the calibrated leak on.

3 In Menu 22, Calibration, adjust the ion voltage (filament bias, Option 1-1), focus (Menu 22, Option 1-3), and the repeller (Menu 22, Option 1-2) to maximize the display.

4 Press the CAL button. Check if the calibration gain decreases (Menu 22, Option 1-5).

CALIBRATION AND SENSITIVITY CHECKS AND MANUAL TUNING COMPLETE

5-2-3 Weekly

a) Forepump and roughpump oil level check

Both the forepump and the roughpump are equipped with a sight glass through which the oil level can be checked. The forepump oil level sight glass is accessible through the rear of the pump enclosure; the roughpump sight glass is accessible through the side of the pump enclosure. With the pump motors running, the proper oil level is indicated when the oil covers the lower half of the sight glass. If it is low, fill it to the proper level with mechanical pump oil, Varian part no. 0491-K7516-302.

b) Condition of oil

If the oil has a milky or frothy appearance in either the forepump or the roughpump, it is an indication of excess water in the oil. An oil change is therefore in order; proceed as discussed in the following paragraphs.

c) Forepump Oil Change

Varian recommends that the forepump flush and oil change be performed semi-annually or whenever the vacuum system must be cleaned and accessibility to the Forepump is easiest. The following steps describe the proper method of changing the oil in the Forepump.

Tools and supplies required:

Standard screwdriver
Adjustable wrench
Drain pan
Wiping rag
Varian Pump Oil, part no. 0491-K7516-302, 1 liter

1 Press the SCRAM button and allow the leak detector to cool for 20 minutes.

2 Remove the three screws holding the rear panel on the Forepump enclosure.

WARNING
Hot oil will burn the skin. Service in this area must be performed by authorized personnel only.

3 Remove the fill plug.

4 Use the forepump drain guide (provided near the forepump) to guide the oil away from the leak detector and into the drain pan (see Figure 5-1).

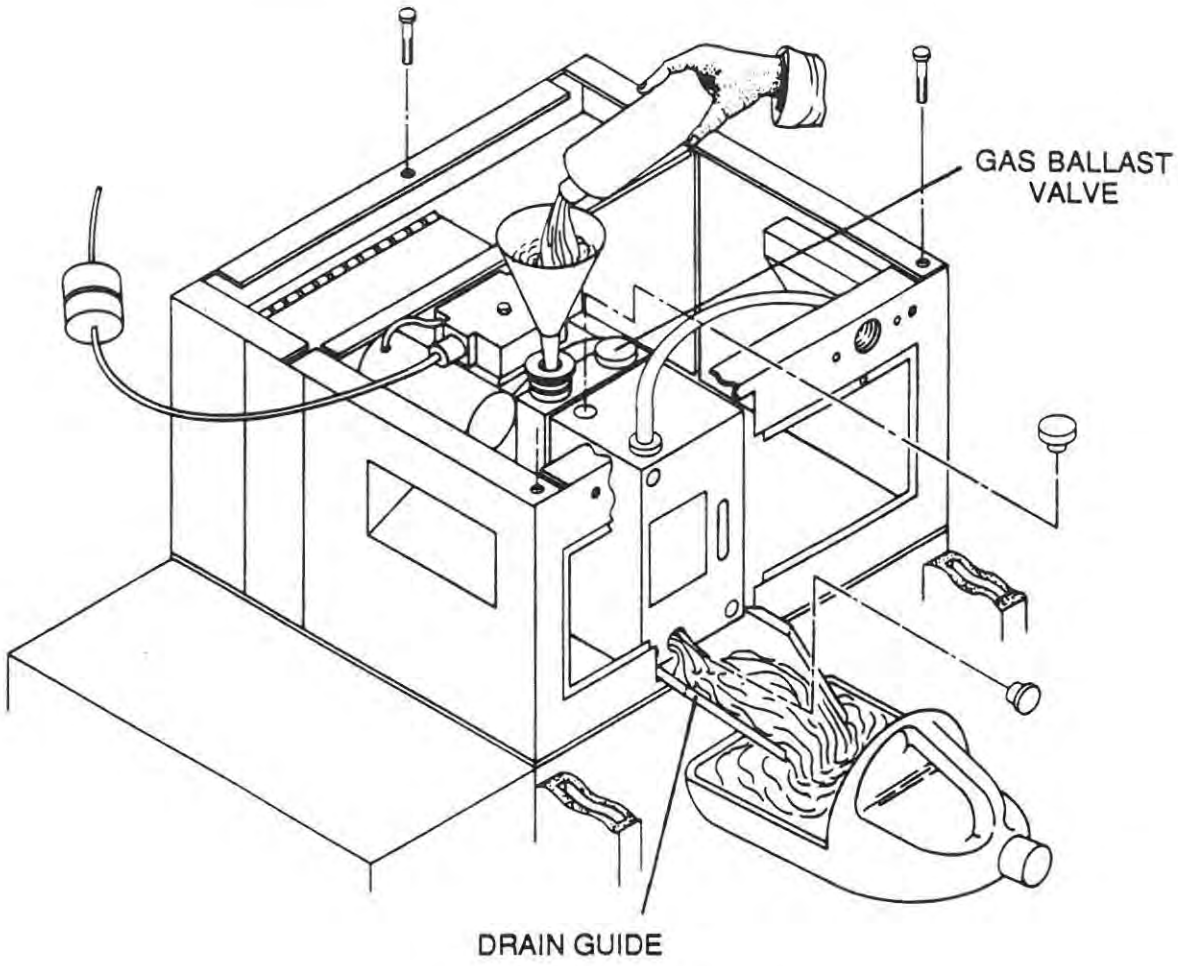


Figure 5-1. Fore Pump Flush and Oil Change

5 Place the drain pan under the drain guide then remove the drain plug. After the oil has stopped flowing, replace the drain plug.

6 Add fresh oil through the fill port. Check that the oil level is in the center of the sight glass.

7 Replace the fill plug and turn on the leak detector.

8 Check the oil level in the forepump sight glass; the oil must be visible in the middle of the glass when the pump is running.

5-2-4 Semi-annually

a) Fore pump flush and oil change (See Figure 5-1)

Perform the fore pump flush and oil change in accordance with the following steps.

Tools and supplies required:

Standard screwdriver, 4" to 6"
Adjustable wrench
Funnel
Drain pan
Wiping rag
Varian Pump Oil, part no. 0491-K7516-302, 1 liter

1 Separate the fore pump module from the basic module as follows.

2 Remove the front and rear covers to expose the fore pump.

3 Remove the leak detector top cover and the side cover near the flexible metal hoses connecting both pumps.

4 Detach both flexible metal hoses from the vacuum manifold.

5 Unplug the fore pump from inside the basic module.

6 Remove three screws to separate the basic module from the pump modules. See Figure 5-1.

7 Carefully separate the basic module from the fore pump module.

8 Remove the flexible metal hose from the fore pump by removing the K-F clamp.

WARNING
Hot oil will burn the skin. Service in this area must be performed by authorized personnel only. Stand back from fore pump before starting it.

CAUTION
Do not leave the fore pump on after the oil has stopped flowing. Damage to the fore pump can occur if it is allowed to operate with no oil.

9 Place a suitable drain pan under the fore pump drain guide and remove the drain plug. After the oil is drained, replace the drain plug.

10 With an offset funnel in place in the pump inlet (not the front fill hole), plug the fore pump into a separate supply, turn it on, and SLOWLY pour in approximately 1 cup of Varian pump oil, part no. 0491-K7516-302.

11 Turn the fore pump off. With the drain pan in place, remove the drain plug and then turn the fore pump back on. Allow the pump to drain, then turn the fore pump off.

12 Replace the drain plug then fill the pump through the fill hole on top of the pump.

13 Remove the fore pump power line from from the separate supply and plug it into the basic module. The leak detector remains off.

14 Replace the bellows and KF flange on the fore pump. Be sure there is a vacuum-tight connection.

15 Replace the basic module.

16 Start the leak detector and check the fore pump for proper oil level. The oil should be in the middle of the sight glass when the pump is running.

FOREPUMP FLUSH AND OIL CHANGE IS COMPLETE

b) Rough pump flush and oil change (See Figure 5-2)

The rough pump oil should be changed semi-annually or when rough pump pressure of 50 milliTorr cannot be obtained. Flushing of the rough pump should precede adding new oil. When the weekly oil level check is performed, look for a milky color in the oil. This is an indication of dirty oil and that it should be changed. With the tools and supplies listed below, perform the rough pump flush and oil change in accordance with the steps indicated in para. 5-2.

Tools and supplies required:

Slotted screwdriver, 4" to 6"
Nut driver, Spintite, 5/16
Allen wrench, 6-mm
Funnel
Drain pan
Wiping rag
Varian pump oil, part no. 0491-K7516-302, 1 liter

1 Press SCRAM button and allow the leak detector to cool for 20 minutes.

2 Remove the lower front cover and the lower right cover.

3 Loosen and remove the valve from the rough pump inlet by loosening the screw with a 6-mm Allen wrench. Remove the KF clamp.

WARNING
Hot oil will burn the skin. Service in this area must be performed by authorized personnel only. Stand back from the rough pump prior to plugging it in.

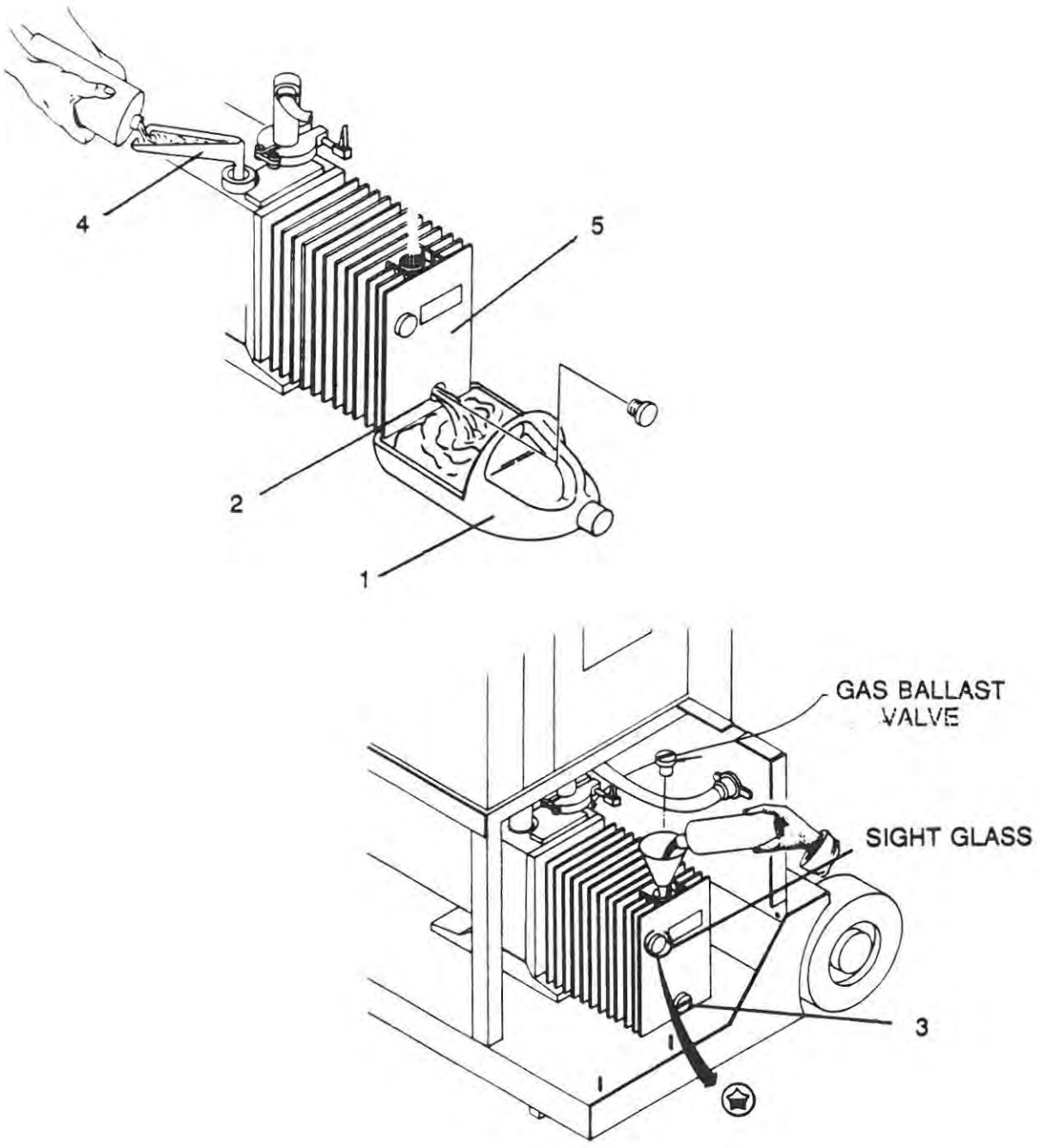


Figure 5-2. Rough Pump Flush and Oil Change.

CAUTION
Do not leave the rough pump on after the oil has stopped flowing. Damage to the rough pump can occur if allowed to operate with no oil.

4 Unplug the rough pump from the cart power enclosure and locate a separate electrical supply. DO NOT PLUG IN THE ROUGH PUMP AT THIS TIME.

5 Place a suitable drain pan (1, Figure 5-2) under the rough pump drain (2) and remove the drain plug (3). After the oil is drained, replace the plug.

6 With an offset funnel (4) in place in the pump inlet (not the front fill hole), plug in the rough pump (5) to turn it on and SLOWLY pour in approximately 1 cup of VARIAN pump oil, part no. 0491-K7516-302.

7 Unplug the rough pump to turn it off. With the drain pan (1) in place, remove the drain plug (3) and allow the pump to drain.

Reassembling and Filling the Rough pump.

8 Replace the drain plug (3) then fill the pump through the fill hole on top of the pump.

9 Install and tighten the valve to the pump inlet. Use a 6-mm Allen wrench to tighten the screw thus providing a vacuum-tight seal.

10 Check for:
- Proper level of oil in sight glass window (filled half way).
- Proper color of oil. Clean oil is light amber in color.
- Leaks at drain plug or anywhere on or about the rough pump.

THE ROUGH PUMP FLUSH AND OIL CHANGE IS COMPLETE

c) Turbo Pump Lubrication

When the turbo pump (and the leak detector) are operated continuously, lubricate the pump after every 1500 hours of operation.

When the turbo pump is operated intermittently, the pump should be lubricated every 3,000 hours of operation, or every six months, whichever comes first.

TURBO PUMP LUBRICATION IS COMPLETE

5-3 UNSCHEDULED MAINTENANCE

Unscheduled maintenance is that maintenance to be accomplished on an as-required basis. The design characteristics of the Model 956 Leak Detector are such that unscheduled maintenance should

be minimal. Strict adherence to scheduled (preventive) maintenance functions minimize unscheduled maintenance.

5-3-1 Purging (Gas Ballasting) the Fore Pump or Rough Pump

There may be occasions when, due to a high moisture content in the test pieces or the work environment, moisture may accumulate in the oil in either the fore pump or the rough pump or both. This moisture exhibits some very obvious symptoms. The first symptom is the failure of the leak detector to transfer into or to remain in the FINE TEST mode. Other symptoms are a reading of approximately 50 milliTorr on the Test Port Pressure gauge when the leak detector is in the FINE TEST mode, darkening of the pump oil, and/or froth (or foam) on top of the pump oil.

All these are indications of the need to purge the pump; refer to the following step-by-step procedures.

1 Remove the front cover to expose the pump.

2 Open the gas ballast valve on the pump by turning it counter-clockwise. See Figures 5-1 and 5-2 for the location of the valves on the each pump.

3 Run the leak detector for 30 minutes then close the gas ballast valve (1). This procedure should evaporate most of the moisture which is mixed with the oil. (This may produce undesirable oil vapors in a closed room; exhaust these vapors outdoors if possible). If it does not evaporate the moisture, change the oil.

4 Check for the presence of froth or foam on top of the pump oil, as viewed in its sightglass.

5 Check also for proper coloration. The pump oil should be light amber in color as viewed in its sightglass. If it is not, change the oil.

6 Check that the test port pressure is below 20 milliTorr when the leak detector is in the TEST mode (Menu 13, Option 2-2).

7 If symptoms persist, a pump flush and oil change is required. Refer to para. 5-2-3 for proper procedure.

PURGING (GAS BALLASTING) OF THE FORE AND ROUGH PUMPS IS COMPLETE

5-3-2 System Thermocouple Gauge (TC2) Cleaning/Replacement

Thermocouple gauge cleaning may be necessary if the gauge has been contaminated and/or it exhibits erratic pressure measurements due to outgassing. If the gauge continues its erratic behavior after cleaning, replace the gauge.

Tools and supplies required:

Wrench, open-end, 9/16 inch
Freon TF
Methanol
Sealant (Torr-Seal)

1 Press the SCRAM button and allow the leak detector to shut down then turn the leak detector off.

2 Remove the top cover of the leak detector to gain access to the turbo pump.

3 Remove the connector from the system thermocouple gauge.

4 Remove the thermocouple gauge by unscrewing it from its elbow.

5 Flush the gauge with Freon, empty it, then repeat with methanol.

6 Air-dry the thermocouple gauge thoroughly before replacing it in the turbo pump.

7 Lightly coat the threads of the thermocouple with Torr-Seal sealant then install the thermocouple gauge by screwing it into its elbow and tightening it firmly.

8 Install the connector on the thermocouple gauge.

9 Replace the top cover on the leak detector and turn it on. Wait ten minutes for it to warm up.

CLEANING/REPLACEMENT OF THE SYSTEM THERMOCOUPLE GAUGE IS COMPLETE

5-3-3 Test Port Thermocouple Gauge (TC1) Cleaning/Replacement

Tools and supplies required:

Freon TF
Methanol
O-ring, Parker part no. 2-110

1 Put the leak detector in the VENT mode.

2 Remove the top cover and side panels of the leak detector to gain access to the bottom of the test port.

3 Remove the connector from the test port thermocouple gauge.

4 Remove the thermocouple gauge by gently twisting it out of the test port; check that the O-ring and its spacer are removed with the thermocouple.

5 Remove and discard the O-ring; retain the spacer.

5 Flush the gauge with Freon, empty it, then repeat with methanol.

6 Air-dry the thermocouple gauge thoroughly before replacing it in the test port.

7 Install the spacer and a new O-ring then install the thermocouple gauge by gently pushing it into the test port.

8 Install the connector on the thermocouple gauge.

9 Replace the side panels and the top cover on the leak detector.

CLEANING/REPLACEMENT OF THE TEST PORT THERMOCOUPLE GAUGE IS COMPLETE

5-3-4 Ion Source Replacement

Tools and supplies required:

Phillips screwdriver
Allen wrench, 5/32-inch
Ion Source (Varian part no. 82850-302)
Clean, lint-free cloths

Replacement of the ion source should be accomplished when cleaning the spectrometer tube. Adjustment is required when replacement is complete.

1 Remove the ion source from the leak detector as described in steps 1 through 9, Disassembly of the Spectrometer Tube.

2 Check the ground slit plate; if contaminated, Varian recommends that the spectrometer tube also be disassembled and cleaned.

3 Place the locating pin of the new ion source approximately in the center of the guide hole as shown in Figure 5-3.

4 Ensure that pins 1 and 8 are parallel to the sidewall of the spectrometer tube.

5 Secure the flange cap evenly and firmly by tightening the four Phillips head screws.

6 Re-attach the spectrometer tube.

7 Turn on the leak detector; wait 30 minutes then use the manual tuning procedure to maximize sensitivity (See para. 5-2-2). When the leak detector is tuned to helium, press CAL.

5-3-5 Disassembly of the Spectrometer Tube

Tools and supplies required:

Phillips screwdriver
Allen wrench, 5/32-inch

To remove the spectrometer tube from the leak detector, proceed as follows.

1 Press the SCRAM button and let the leak detector cool down then turn the leak detector off.

2 Remove the top cover of the leak detector.

3 Remove the side cover of the leak detector on the spectrometer tube side.

4 Unplug the preamplifier and the ion source.

5 Remove the Allen screws (1, Figure 5-3) from the spectrometer tube flange.

6 Rock the spectrometer tube gently to break its vacuum. Look for and carefully remove the O-ring (2) under the flange. Note the position of the grounding strap.

7 Place the spectrometer tube and the O-ring on a clean cloth on a non-magnetic bench for further maintenance.

8 Remove the four Phillips head screws (3) that hold the flange cap (4) onto the ion source (5).

9 Firmly but gently separate the flange cap (4) from the ion source (5). Note the O-ring (6) on the ion source; remove and discard both the O-ring and the ion source (Varian part no. 82850-302).

Note
In the following step, carefully note the position of the ground slit plate inside the ion source cavity. It must be replaced in exactly the same relative position.

10 Carefully remove the ground slit plate (7) from the ion source cavity with a long screw-holding screwdriver. Varian recommends installing a new ground slit plate (see para. 5-3-6 for cleaning instructions if a new plate is not available).

11 Remove the four Phillips head screws (8) that hold the flange cap (9) onto the preamplifier (10).

12 Firmly but gently separate the flange cap (9) from the preamplifier (10). Note the O-ring (11); remove and replace it.

13 Place the preamplifier (10) on a clean, static-free paper napkin or cloth.

14 Remove four 9/64 Allen head cap screws (12) that hold the flange cap (13) onto the analyzing magnet assemblies (14). Remove and discard the O-ring (15). Be extremely careful with the magnets; do NOT drop them and do NOT place them on a magnetic surface; put them on a clean cloth to preserve their magnetic properties.

15 DO NOT remove the enhancement magnets (16 and 17) from the body of the spectrometer tube. If the enhancement magnets become chipped or broken during handling, refer to para 5-3-9 for replacement/adjustment instructions.

DISASSEMBLY OF THE SPECTOMETER TUBE IS COMPLETE

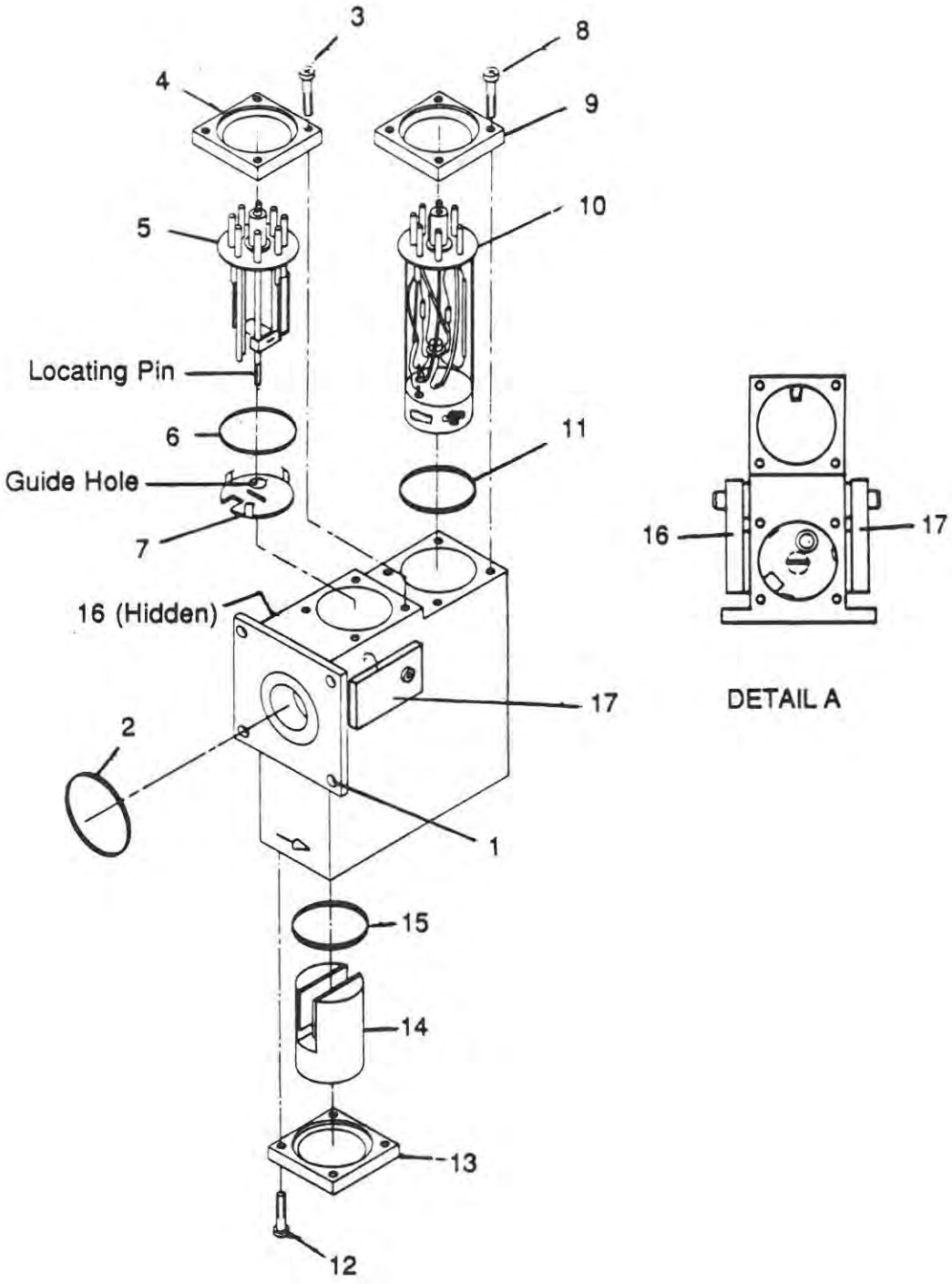


Figure 5-3. Spectrometer Tube Exploded View.

5-3-6 Cleaning the Spectrometer tube

Tools and supplies required:

Stiff-bristled brush
Freon TF
Methanol
Beartex or Scotch-Brite pads
Clean, lint-free cloths

CAUTION
Do not use Freon TF or other solvents on O-rings. To do so causes deterioration and reduces their ability to hold a vacuum. Do not clean any aluminum parts with Alconox. Alconox is not compatible with aluminum and will cause damage. Use new O-rings wiped with a clean, lint-free cloth.

1 Use Beartex or Scotch-brite flexible abrasive pads to remove heavy deposits from the spectrometer tube body and especially from the ground slit plate if it is not to be replaced. Varian recommends installing a new ground slit plate, however, for maximum reliability in the operation of the leak detector.

2 Wipe the internal surfaces of the spectrometer tube body with a cloth dampened with Freon TF. Repeat with methanol.

3 Inspect the preamplifier. Wipe oily surfaces with a clean lint-free cloth dampened with Freon TF. Repeat with methanol.

4 Carefully clean the analyzing magnet assembly. Use a small, stiff-bristled brush to clean deposits off the yoke and a soft, lint-free cloth dampened in Freon TF to clean the magnets. Repeat with methanol. Be careful not to damage the magnets, they are brittle and chip easily.

5 Allow all parts to air-dry thoroughly.

CLEANING OF THE SPECTROMETER TUBE IS COMPLETE

5-3-7 Assembly of the Spectrometer Tube (Refer to Figure 5-3)

Tools and supplies required:

Allen wrench, 5/32-inch
Phillips head screwdriver
Screw-holding screwdriver
Clean, lint-free cloth
Spare parts kit L8395-301

1 Install a new ground slit plate (7) carefully. Be sure that the snap prongs fit snugly and are facing up. Using a long, thin screwdriver, align the slit at 90° with the side wall of the spectrometer tube. Concentrically align the circular hole in the plate with the smaller guide hole in the bottom of the ion source cavity (see Detail A, Figure 5-3).

2 Wipe a new O-ring (6) and the mating surfaces with a clean, lint-free cloth and place the new ion source (5) in its cavity by:

a placing the locating pin approximately in the center of the guide hole (Detail A),

b ensuring that pins 1 and 8 are parallel to the side wall of the spectrometer tube, and

c tightening the flange cap (4) evenly and firmly with the four Phillips head screws (3).

3 Wipe a new O-ring (11) and mating surfaces. Place the preamplifier (10) in its cavity with the O-ring in place. Orient the preamplifier so it is properly keyed. Tighten the flange cap (9) evenly and firmly using the four 9/64 Allen head cap screws (8).

4 Carefully place the analyzing magnet assembly in its cavity with a new O-ring. **Be sure to place the magnets so that the arrow on the analyzing magnets is perpendicular to the side of the spectrometer tube body. Check that the arrow is in the same direction as the arrows on the spectrometer tube body and enhancement magnets (see Figure 5-3).** Again, wipe the O-ring and mating surfaces with a clean, lint-free cloth and tighten the flange cap (5) evenly and firmly.

5 Wipe a new mounting O-ring (2) and mating surfaces with a clean, lint-free cloth. Hold the spectrometer tube with one hand and install four Allen screws (1). Tighten the screws evenly to insure a proper metal-to-metal seal. Remember to attach the grounding wire.

6 Attach the plugs for the preamplifier and the ion source into their respective sockets. DO NOT INTERCHANGE THE PREAMPLIFIER AND ION SOURCE CONNECTORS.

7 Install the side cover of the leak detector.

8 Install the top cover of the leak detector.

9 Start the leak detector, wait 30 minutes. Use the manual tuning procedure to maximize sensitivity (para. 5-2-2) then calibrate the leak detector.

ASSEMBLY OF THE SPECTROMETER TUBE IS COMPLETE

5-3-8 Enhancement Magnet Replacement/Adjustment Procedure

The enhancement magnets should never need replacement or adjustment. However, should the magnets become chipped or broken during handling, proceed as follows.

1 While the spectrometer tube is disassembled from the pumping system frame, secure the rear magnet (closest to the pumping system frame). Check that the arrow on the magnet matches the direction of the arrow on the body of the spectrometer tube (see Figure 5-3).

2 Attach the front magnet in the center of its recess and secure it loosely with a 9/64-inch Allen wrench. Again, check that the arrow on the magnet matches the direction of the arrow on the body of the spectrometer tube.

3 Secure the spectrometer tube to the pumping system frame then connect all electrical connections to the spectrometer tube. DO NOT INTERCHANGE THE CONNECTORS TO THE PREAMPLIFIER AND THE ION SOURCE.

4 Turn on the leak detector and allow it to warm up for at least 30 minutes.

5 Press the START button to put the leak detector in the TEST mode.

6 Turn the calibrated leak on by pressing the LEAK button. While in the TEST mode, the leak detector must be sensitive to helium; if it is not, refer to Troubleshooting (Section 6), Leak Detector Not Sensitive To Helium.

7 Loosen the front magnet then adjust it by moving it very gradually. The leak rate will be very sensitive to magnet position. Maximize the signal then tighten the magnet carefully with a 9/64-inch Allen wrench without moving the magnet.

8 Record the filament bias (Ion Voltage, Menu 22, Option 1-1), the repeller voltage (Menu 22, Option 1-2), and the focus (Menu 22, Option 1-3). With the calibrated leak on, watch the leak rate meter and maximize the signal by adjusting these parameters. This step may be unnecessary if the magnet was replaced without removing the spectrometer tube or any of its parts.

9 Press the CAL button.

5-3-9 Vacuum System Removal

Tools and supplies required:

Screwdriver, Phillips head
Wrench, Open-end, 9/16-inch

1 Remove top cover and both side covers of the basic module.

2 Push down on the two locking clips at the rear of the control panel to unlock it then rotate the panel forward and lift it carefully to expose two connectors.

3 Carefully unplug the ribbon connector on the leak detector side.

4 Carefully unplug the connector at the control panel then remove the front panel.

5 Remove the KF clamps attaching the foreline plumbing assembly to the fore pump and to the roughing pump.

6 Remove the front cover by pulling it up then out.

7 Disconnect the connector to the electronics located near the front of the leak detector.

8 Disconnect the connector to the fans.

9 On the inside of the frame, remove the three no. 6-32 nuts holding the fan shroud, then remove the fan assembly and the shroud as an assembly by pulling it straight back.

10 Unplug the 5-pin connector at the turbo pump.

11 Disconnect the calibrated leak vent line.

12 Remove the control panel support by removing four screws.

13 Remove the front bracket.

14 Lift the vacuum system/circuit card assembly straight out.

15 Unplug all connectors from the vacuum system to the backplane.

16 Separate the vacuum system frame from the circuit card chassis by removing five screws. See Figure 5-4.

17 Carefully separate the vacuum system and circuit card assembly from main unit. Place on clean workbench for further disassembly.

18 Use at least one C-clamp to secure the vacuum system frame vertically to the end of the bench for easy maintenance and disassembly.

19 Varian recommends that the fore pump be flushed and charged with new oil at this time due to its easy access. See para. 5-2.

20 An exploded view of the main components of the vacuum system (the turbo pump, the spectrometer tube, the thermocouples, and the valves is shown in Figure 5-5.

VACUUM SYSTEM REMOVAL IS COMPLETE

5-3-10 Disassembly of Calibrated Leak (Refer to Figure 5-6)

Tools and supplies required:

Screwdriver
Adjustable wrench
Non-metallic O-ring lifter

1 Unplug the wires to the calibrated leak solenoid. Disconnect the helium line (1). Retain the gross leak rubber washer (2).

2 Separate the calibrated leak (3) and the valve from the bracket.

3 Remove the fitting (4) from the top of the coil with an adjustable wrench.

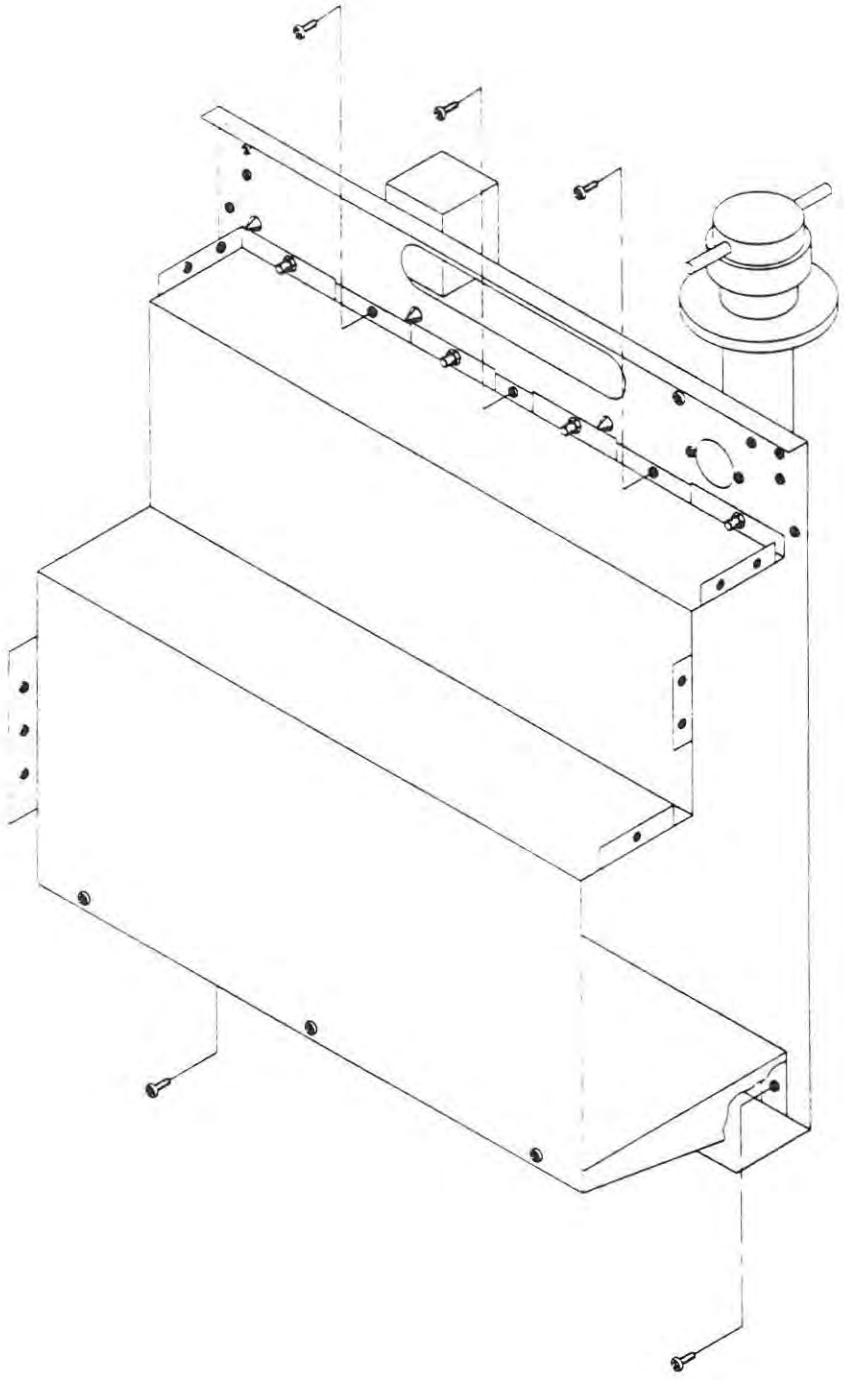


Figure 5-4. Mounting Screws for Vacuum System.

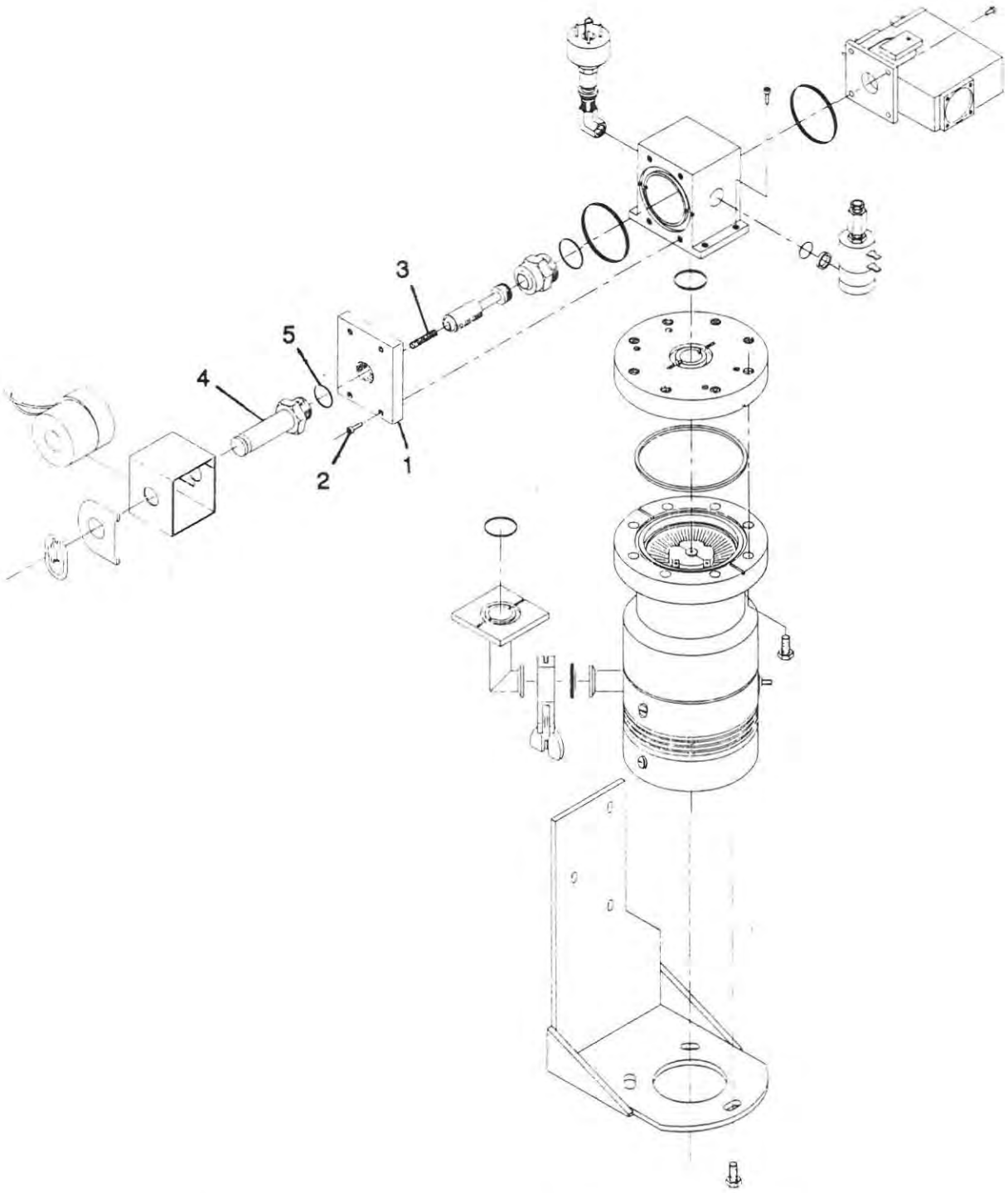


Figure 5-5. Exploded view of the main components of the vacuum system

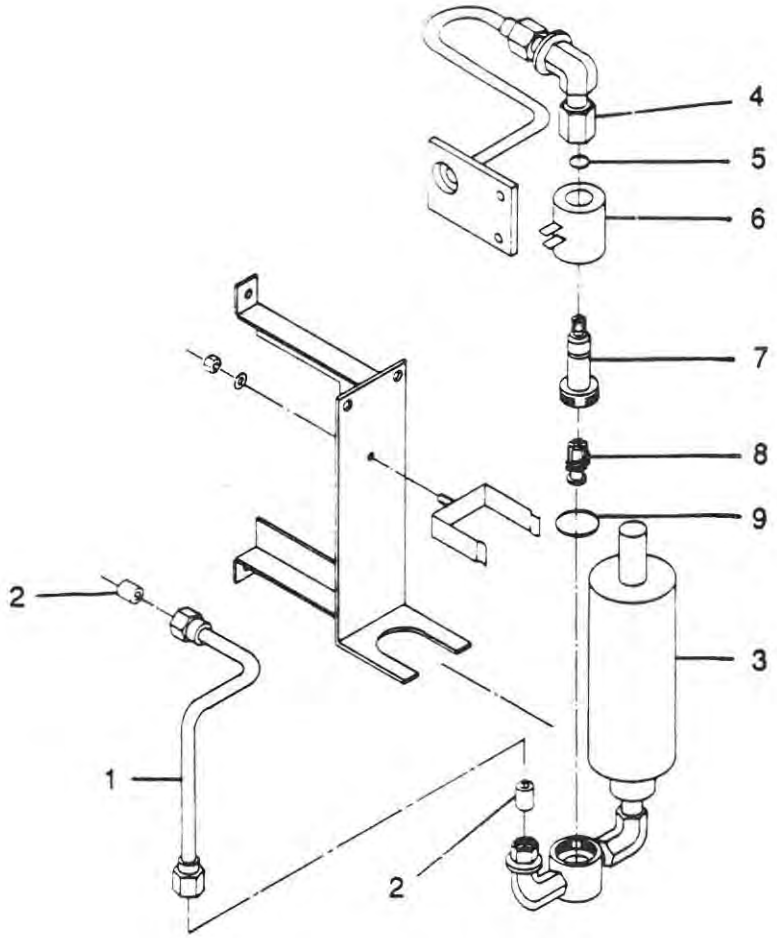


Figure 5-6. Calibrated Leak Exploded View

4 Discard the small O-ring (5).

5 Lift out the coil (6).

6 Unscrew the valve actuator (7) using a screwdriver.

7 Remove the valve plunger and spring (8).

8 Lift out and discard the valve body O-ring (9). DO NOT SCRATCH THE SEALING SURFACE.

To clean the calibrated leak, refer to CLEANING THE VACUUM MANIFOLD.

DISASSEMBLY OF THE CALIBRATED LEAK IS COMPLETE

5-3-11 Disassembly of Vacuum Manifold (Refer to Figure 5-7)

Tools and supplies required:

Screwdriver
Adjustable wrench
Spanner, Commercial
Non-metallic O-ring lifter

1 Leave the foreline manifold assembly (1) mounted to sheet metal frame until all other parts are disassembled.

2 Remove coil holding nut (2) and washer (3) on the top of valve.

3 Remove coil (4).

CAUTION
In the following step, use the commercial spanner; DO NOT USE ANY OTHER TOOL. The valve stem can easily be bent or twisted rendering the valve inoperable and unrepairable.

4 Unscrew valve actuator (5) using commercial spanner.

5 Separate the valve spring (6) and valve seat (7).

6 Remove valve body O-ring (8). DO NOT USE A SHARP METAL TOOL; it may damage the sealing surface.

7 Place all valve parts on individual clean lint-free cloths. Make sure that valve parts are not interchanged even though some parts are similar.

8 Repeat steps 2 through 8 for all four valves (rough, test, vent, gross leak, if fitted) and the vent valve on the turbo pump.

9 Remove the KF clamp at the test port. Disassemble it as shown in Figure 5-8. Discard all O-rings.

10 Remove the test port thermocouple gauge (9) by gently twisting it while pulling the gauge body. Discard the O-ring (10) and save the washer (11).

11 Remove the gross leak nut (12) with a 9/16-inch open-end wrench. Remove the gross leak assembly (13) by pulling it gently. Discard the O-ring (14) and the gross leak rubber washer (15).

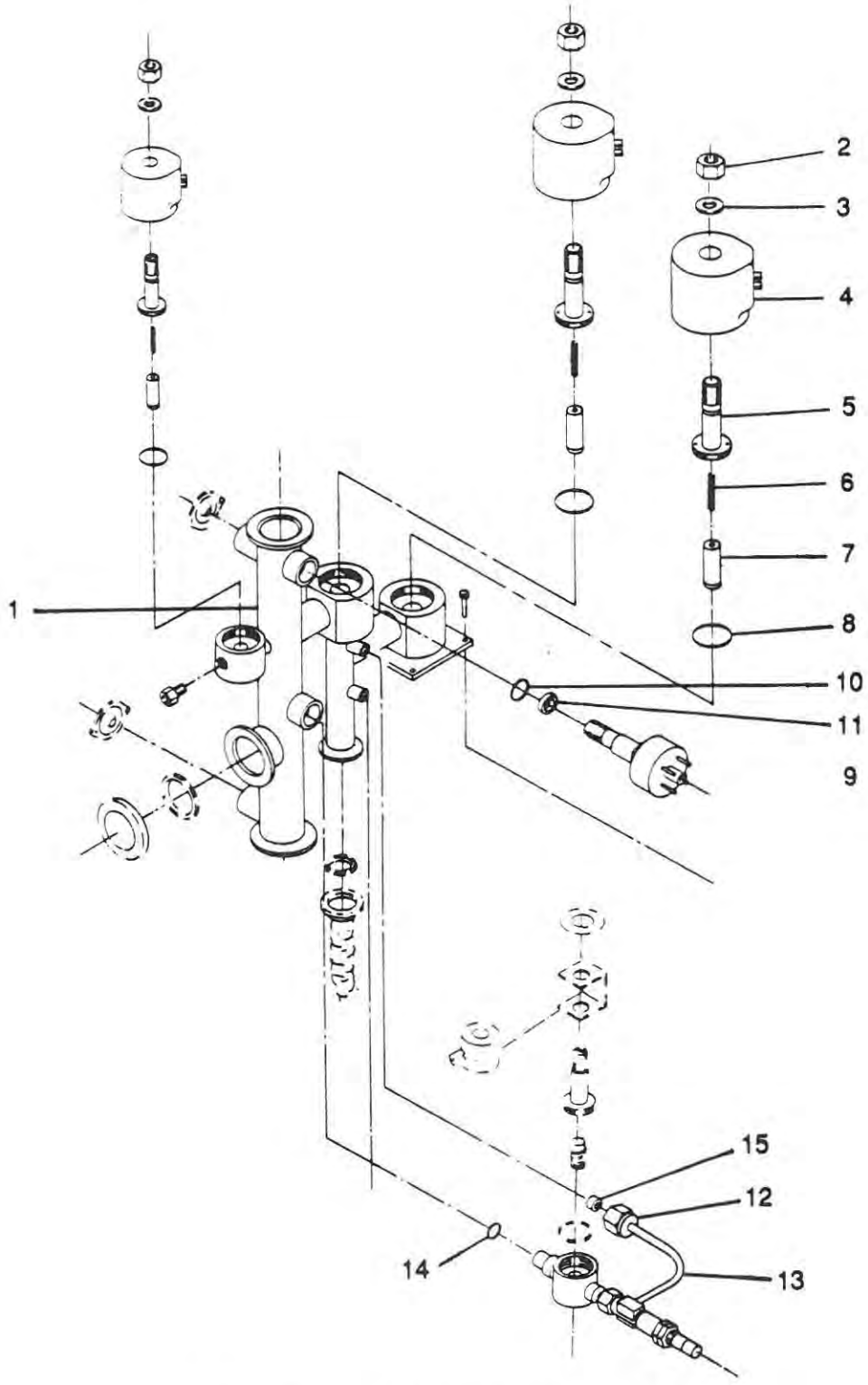


Figure 5-7. Exploded View of Vacuum Manifold

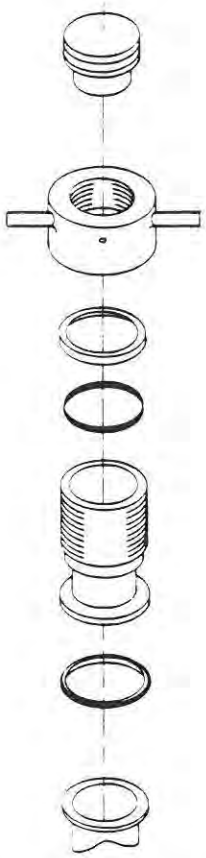


Figure 5-8. Exploded View of Test Port

12 Remove four foreline flange mounting bolts. Discard the foreline flange O-ring.

13 Remove two foreline mounting screws; the foreline manifold will separate from the pumping system flange.

DISASSEMBLY OF THE VACUUM MANIFOLD IS COMPLETE

5-3-12 Cleaning the Vacuum Manifold

Tools and supplies required:

Freon TF
Methanol
Clean, lint-free cloths or Kimwipes
Heat gun

1 Varian recommends that when the turbo pump becomes slightly contaminated and takes too long to pump down to the required vacuum, it should be cleaned (para. 5-3-16) to remove contaminants from its internal surfaces and re-lubricated (para. 5-3-17) whenever the foreline is cleaned.

2 Replace all O-rings and rubber gaskets.

3 The following parts should NOT be soaked in Freon or alcohol, but wiped with a cloth or napkin and a small amount of methanol.
- Calibrated leak and calibrated leak valve assembly
- Gross leak assembly
- Valve plunger

4 The following parts should NOT be cleaned with a solvent but wiped if necessary:
- Valve coil
- All rubber parts
- Coil holding nut
- All external hardware

5 The following parts should be soaked in Freon, rinsed with methanol, then thoroughly air-dried.
- Thermocouple gauge
- Valve spring
- Valve body
- Thermocouple gauge washer
- Gross leak nut
- Vacuum manifold assembly

6 The flexible metal hoses to both the roughing pump (optional) and the foreline pump should be cleaned by rinsing either Freon or methanol inside the tube, and then thorougly air-dried with a heat gun.

CLEANING OF VACUUM MANIFOLD IS COMPLETE

5-3-13 Assembly of Vacuum Manifold

Tools and supplies required:

Screwdriver
Spanner, Commercial
Spare parts kit 956-9901

CAUTION
Do not use Freon TF or other solvents on O-rings. To do so causes deterioration and reduces their ability to hold a vacuum. Wipe with a clean, lint-free cloth or use a small amount of diffusion pump oil.

1 Bolt the vacuum manifold to the pumping system flange by securing two mounting bolts. This will hold the manifold assembly on LOOSELY.

2 Insert a new O-ring then attach the foreline vacuum manifold to the turbo pump assembly using the KF clamp. This connection provides vacuum manifold rigidity needed for further maintenance.

3 Assemble a new rubber washer (15), and O-ring (14), then insert the gross leak assembly (13) into its appropriate hole as shown in Figure 5-6. The O-ring is gently pushed in similar to a thermocouple gauge and the other end is tightened with a 9/16 wrench.

4 Assemble a new O-ring (10) and washer (11), then install the thermocouple gauge (9) by gently pushing and twisting the gauge body into its appropriate hole.

5 Repeat the following procedures for each of the four valves (test, rough, vent, and gross leak).

a Place the valve spring (6) on the valve actuator (5).

b Place a new valve actuator O-ring (8) in the vacuum manifold (1).

c Screw the valve actuator (5) into the vacuum manifold (1) with the valve spring (6) and valve seat (7) in place as shown in Figure 5-6. Tighten the valve body with the spanner or with a screwdriver for the smaller valves.

d Place the coil (4) on the valve actuator (5), add the washer (3), then tighten the coil holding nut (2) snugly on the top of the valve.

ASSEMBLY OF THE VACUUM MANIFOLD IS COMPLETE

5-3-14 Assembly of Calibrated Leak (Figure 5-6)

Tools and supplies required:

Screwdriver
Adjustable wrench
O-ring kit

1 Install new valve body O-ring (9).

2 Install the spring and valve plunger in the valve body.

3 Screw in the valve actuator (7).

4 Install the coil (6).

5 Install a new, small O-ring.

6 Tighten the fitting on the end of the coil with an adjustable wrench.

7 Attach the calibrated leak assembly.

8 Re-attach the helium line.

9 Re-attach the wires to the calibrated leak coil.

ASSEMBLY OF THE CALIBRATED LEAK IS COMPLETE

5-3-15 Installation of the Vacuum System

Tools and supplies required:

Screwdriver

1 Check that the fore pump oil is in good condition (para. 5-2-2) or that it has been recently changed and flushed (due to its easy access at this time).

2 Attach the vacuum system frame to the circuit card chassis with five screws (Figure 5-4), then attach the connectors from the vacuum system to the backplane.

3 Install flexible metal hoses, KF clamps, and O-rings (with retainers) to the fore pump and rough pump.

4 Check carefully that hanging wires and flexible metal hoses are clear, then slide the vacuum system/circuit card assembly into position in the leak detector.

5 Install the control panel support with four screws.

6 Re-connect the 5-pin connector at the turbo pump.

7 Replace the fan assembly and the shroud as an assembly and secure it with three no. 6-32 nuts on the inside of the frame.

8 Plug in the fan connector.

9 Plug in the power supply to its appropriate socket near the front of the leak detector.

10 Attach the flexible metal hoses, with their KF clamps, O-rings and retainers, from the fore pump and rough pump to the vacuum manifold.

11 Re-install the vent line.

12 Install the side covers then the front cover by placing it above its mounting pins and pushing it down in place.

13 Plug the ribbon connector (red edge UP) into the leak detector then plug the pigtail from the leak detector into the back of the control panel assembly.

14 Install the control panel and secure it with its two holding clips.

15 Check all electrical connectors and nuts and bolts before starting the leak detector. Verify system performance before installing covers.

INSTALLATION OF THE VACUUM SYSTEM IS COMPLETE

5-3-16 Cleaning the Turbo Pump

WARNING
To avoid injury to personnel, wait until the turbo pump is completely stopped before disconnecting it from the vacuum system.

Tools and supplies required:

Allen wrench, 5/32-inch
Large, clean container
Approved hazardous waste container
Freon TF
Clean, lint-free cloths

1 Prepare a large, very clean container (large enough to put the turbo pump in as shown in Figure 5-9) and fill it with **CLEAN** Freon TF.

CAUTION
In the following steps, use only Freon TF; any other solvent could damage the pump.

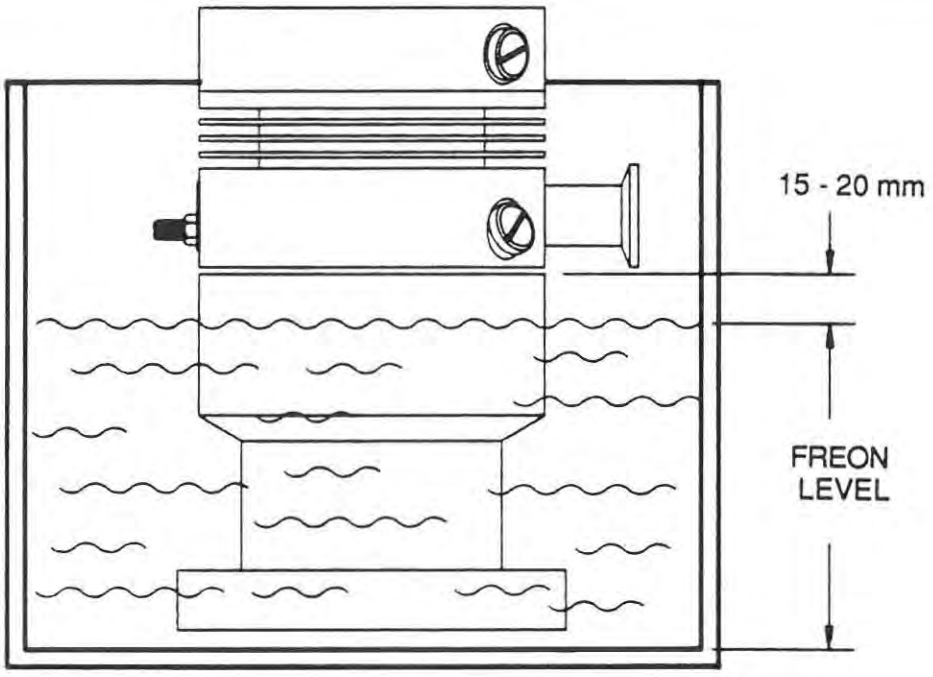


Figure 5-9. Turbo Pump Cleaning Procedure

2 Check that cables and cooling water pipes are disconnected from the turbo pump, then disconnect the high-vacuum flange and empty any water remaining in the cooling jacket.

3 Carefully place the pump in the clean container **UPSIDE DOWN** and fill the container with Freon TF until the Freon level is no higher than 1/2 to 3/4 inches (15 to 20 mm) from the end of the stainless steel envelope. DO NOT FILL THE CONTAINER ANY HIGHER; THE PUMP BEARINGS CAN BE DAMAGED.

4 While the pump is submersed in Freon, gently lift and lower it several times to remove the majority of contaminants from the blades and other surfaces of the pump.

5 Remove the pump, discard the used Freon into an approved hazardous waste container, then repeat steps 3 and 4 several times, using fresh Freon each time.

6 Remove the pump from the Freon and place it upside down on a clean surface to drain and dry.

7 After it is dry, re-install the pump on the vacuum system.

8 To disassemble the top cover (1, Figure 5-5) near the isolation valve without disassembling the entire valve:

a Remove cover (1) by removing four screws (2) with a 5/32-inch Allen wrench. Be careful not to drop or lose the valve core (4) or the valve core spring (3).

b Remove the valve core (4) and the valve core spring (3). Examine the valve core spring and verify its direction (the compressed end of the spring should be up).

c Carefully remove and discard the O-ring (5) under the cover (1). BE CAREFUL NOT TO SCRATCH THE SEALING SURFACE; use a non-metallic tool to remove the O-ring.

d Inspect the valve for contamination.

5-3-17 Re-lubricating the Turbo Pump

Tools and supplies required:

Varian re-greasing kit for turbo pump (Varian part no. 969-9903, supplied with turbo pump)

To re-grease the turbo pump, proceed as follows.

1 Turn off the leak detector.

2 Remove the top grease port (see Figure 5-10).

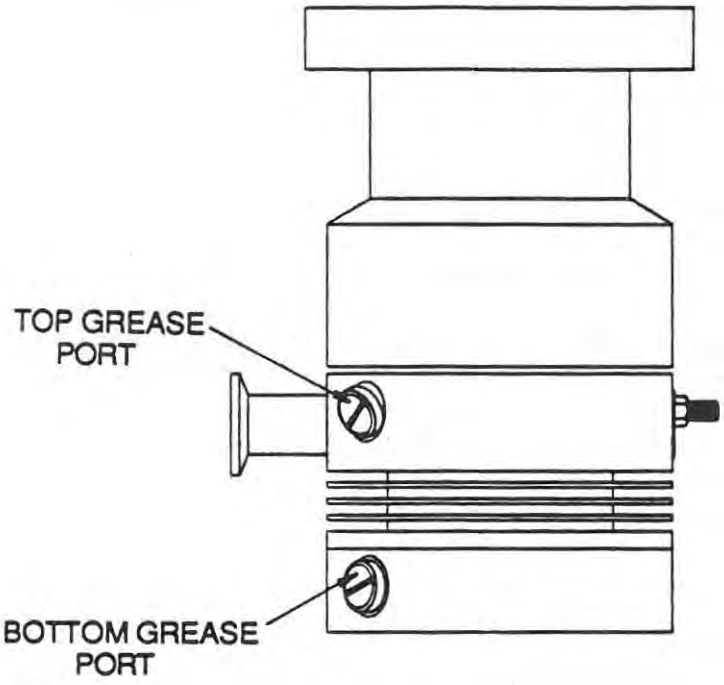


Figure 5-10. Turbo Pump Grease Ports

Note
In the following steps, use only the oil provided in the Varian Turbo Re-greasing Kit.

3 Insert the nipple (provided in the kit) and the syringe and very slowly inject 0.5 cm^3 of oil into the top grease port (a full syringe contains 1 cm^3 of oil).

4 Remove the nipple, reinstall and tighten the top grease port.

5 Repeat steps 3 and 4 in the bottom grease port.

6 Reset the turbo timer to 1500 hours (refer to description of Menu 21 in Section IV).

7 Start up the leak detector.

8 Run the leak detector at slow speed (10^{-9} range in TEST mode) for 24 hours before shutting system off. NOTE: Pump may require several starts after it has been re-lubricated.

5-3-18 Disassembly of the Isolation Valve (Figure 5-11)

Disassemble the isolation valve as shown in the following steps.

a Carefully remove the retaining clip (1) with a screwdriver.

b Remove the coil (2) by lifting it off the valve.

c Unbolt the solenoid actuator assembly (3) using a 3/4-inch wrench. Discard the O-ring (4) after removing it carefully with a non-metallic tool. DO NOT SCRATCH THE SEALING SURFACE.

d Lift out the valve plunger (5) and the valve core spring (6) and verify its orientation. The compressed end of the spring should be facing up.

DISASSEMBLY OF THE ISOLATION VALVE IS COMPLETE

5-3-19 Assembly of the Isolation Valve

1 Place a new O-ring (4) in the cover (7).

2 Place the valve plunger (5) with its spring (6) in the solenoid actuator assembly. Make sure the compressed end of the spring is facing up.

3 Carefully center the valve plunger (5) then screw the solenoid base assembly into the cover (7).

4 Install the coil (2) and secure it with the retaining clip (1).

ASSEMBLY OF THE ISOLATION VALVE IS COMPLETE

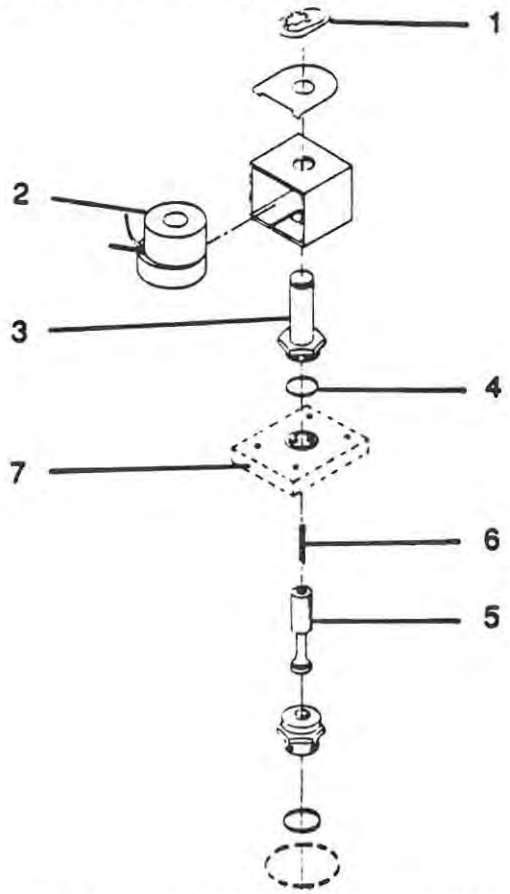


Figure 5-11. Exploded View of Isolation Valve.

5-4 CALIBRATION

The following finite calibration procedures apply when the leak detector has been disassembled, cleaned, and reassembled (annual maintenance) and a specific problem exists to prevent the leak detector from operating as it was designed.

5-4-1 System Thermocouple TC2 Calibration

The system thermocouple requires calibration only if error 5 or 6 (refer to Section VI, Troubleshooting) is displayed or if the user wishes to check the accuracy of the thermocouple. If the error (s) are displayed, refer to Menu 21, Option 1-6, to increase or decrease the gain so that the system pressure from the thermocouple is 1 mTorr after the turbo pump is fully warmed up. Excessive gain is not recommended. The gain should be increased up to the 1 mTorr mark. If the turbo pump is not on, the thermocouple can also be calibrated during the first two to three minutes of leak detector warmup since the mechanical pump has the ability to pump the spectrometer tube down to between 1 to 10 mTorr. Again using Menu 21, Option 1-6, adjust the gain of the system thermocouple to produce a 5-mTorr reading.

5-4-2 Test Port Thermocouple TC1 Calibration

Calibration of the test port thermocouple is also not critical; however, if the leak detector experiences difficulty in transferring to the TEST mode, calibrating this thermocouple can help. With the test port plugged and the leak detector in the TEST mode, refer to Menu 22, Option 1-7, to adjust the test port thermocouple gain to show a 1- to 5-mTorr pressure reading. Further accuracy can be achieved with a calibrated thermocouple in the test port such as the Varian 810 gauge controller. Again, adjust the gain of the test port thermocouple to agree with the 810 controller.

5-4-3 Zeroing Ranges

For good performance of the leak detector, all ranges must be zeroed periodically when the leak detector is in the MANUAL mode. This requirement becomes obvious when the leak detector autoranges and stops in ranges several decades above the expected leak testing range due to high background. With the leak detector in the TEST mode and the test port plugged, the leak detector should be manually set and zeroed by pressing the ZERO key in ranges -1, -4, -6, and -9. These ranges are also automatically zeroed after auto calibration.

5-4-4 Ion Source Tuning

Refer to paragraph 5-2-2.

5-4-5 Checking Tolerable Forepressure

The following steps must be followed to display the test port pressure (Menu 9, Option 1, sub option 4, Test Port Pressure) and to set the Fine Leak Crossover Pressure (Menu 22, Option 1, sub option 12, Fine Leak Set Point).

1 Set the display to show the test port pressure (Menu 9, Option 1, sub option 4, Test Port Pressure).

2 On Menu 22 (Manual Controls), Option 1, sub option 12 (Fine Leak Set Point) set the fine leak set point to 150 mTorr.

3 Vent the leak detector to activate the new crossover pressure.

4 Connect a Varian 802 Thermocouple Gauge Controller with a tuning leak and start the system.

5 Verify that the pressure reading on the display panel is less than 10 mTorr and that the reading on the Gauge Controller is also below 10 mTorr.

6 Slowly open the tuning leak and watch the pressure rise on the display. The leak rate signal must still be increasing when the pressure of the test port is 120 mTorr. Record the pressure at which the leak rate begins to decrease.

7 If the leak rate is decreasing when the pressure is 120 mTorr, increase the turbo pump low speed by turning the trimmer potentiometer P2 on the controller one turn toward INCREASE. See para. 5-4-9.

8 Repeat step 7 as required.

9 When the tolerable forepressure is met at 120 mTorr, reset the fine leak set point to 70 mTorr and reset the display back to show leak rate. If the turbo pump speed has been changed, the calibration gain must be reset to agree with the value of the calibrated leak.

5-4-6 Turbo Speed vs Sensitivity

1 Manually zero the leak detector in all ranges.

2 Place a capillary leak in the test port or a helium permeation leak that is in the high -7 range. If using a capillary leak, apply enough helium to achieve a leak in the range of 7 to 9 x 10^{-7}.

3 In Menu 22, Option 2, sub-option 5, select and enter Turbo High Speed. The leak value should decrease one decade ± one bar. If it does not, proceed as follows.

   1 If the leak value decreases less than 1 decade, turn potentiometer P1 on the controller toward INCREASE until the desired value is reached.

   2 If the leak value decreases more than 1 decade, turn potentiometer P1 on the controller toward DECREASE until the desired value is reached.

4 Re-check the turbo speed vs sensitivity by following the procedure in steps 1 to 3.

5-4-7 Gross Leak Calibration

This adjustment is possible to ensure that the leak rate reading in the -5 range (when the leak detector is in the Fine Test mode) is the same as in the -4 range when the leak detector is in the Gross Leak mode.

1 Place a tuning leak in the test port and attach a helium hose to the intake of the tuning leak. Open the tuning leak until the leak rate reading is high (8 to 9) in the 10 (-5) range when the leak detector is in the Fine Test mode.

2 Switch to the -4 range. The leak detector is now in the Gross Leak mode.

3 Loosen the larger screw on the Gross Leak which holds the cover in. Move the cover back. Loosen the smaller screw so that the needle valve can be adjusted.

4 Adjust the gross leak needle valve until the reading is the same as was seen in the Fine Leak mode, plus or minus one bar (i.e., $9 \times 10^{-5} = 1 \times 10^{-4}$).

5 Return to the Fine Leak mode in the -5 range and check the reading. Repeat this procedure until the readings in the Gross Leak mode and Fine Leak mode agree within one bar.

5-4-8 Controller Waveform Check

CAUTION
To check the power board waveform with the pump disconnected, connector J7 must be disconnected, otherwise resistors R54 through R57 and transistor Q13 might be damaged. The thermal protection on the pump connector must then be short-circuited.

5-4-9 Controller High and Low Frequency Adjustments

Two trimmers, P1 and P2, enable the user to calibrate the high and low frequencies independently from the rear panel. The high frequency can be adjusted within 850 Hz and 1000 Hz; the low frequency can be adjusted within 500 HZ and 600 Hz. A 12V digital signal having a frequency six times the output frequency is available at Test Point 5.

A third trimmer, P3, is internal and acts simultaneously on both the high and low frequencies; however, it is factory-trimmed and requires no re-calibration.

5-4-10 Control Board Calibration

Check the DC Power Supply:

- check that the voltage selector is on the proper position
- apply power to the Control Board
- at the Test Point "+24V", check that the DC voltage is +24 V ± 10%
- adjust P4 until the voltage at Test Point "+12V" is 12V ± 0.5 %
- at Test Point "-12V", check that the DC voltage is 12V ± 5%

Check the Input Decoder as shown in the following table:

Input	A	B	TP2	TP3
	OFF	OFF	High	Low
	OFF	ON	Low	High
	ON	OFF	Low	High
	ON	ON	Low	High

Check the DC Current Amplifier:

- check that the DC output voltage at TP12 is less than 60 mV if the input is shorted
- check that the DC output voltage at TP12 is +3V ± 0.1V if the DC input ivoltage is +200 mV

Check the Normal circuit:

- check that the NORMAL switch is in the ON position if the DC input voltage is between 30 mV (0.3 amperes) and 143 mV (1.43 amperes); otherwise it must be in the OFF position

Check the Brake circuit:

- set the input voltage at 100 mV
- set A and B in the ON position
- verify that Q13 goes on for approx. 0.3 second
- verify that Q13 is on if the DC input voltage is less than 30 mV

Check the Starting Timer/AC Power/Latch circuits:

- set the input voltage at 0V
- apply power to the board
- verify that TP2 goes Low after approximately 2 seconds
- set A on the ON position
- check that pin 4 of U10 goes Low, relay RL1 is energized, TP6 goes Low, the Starting Timer output remains Low for approx. 1 second, and TP15 remains at 0.6 V for approx. 1 second.

Check the Overload/Thermal Protection/Overvoltage/Reset/Autoreset circuits:

- verify that the output OVERLOAD light lights when:
  - the thermal protection resistance exceeds 1 kohm,
  - the negative voltage at pin 10 of J3 exceeds 83 V ± 3V, or
  - the DC input voltage exceeds +200 mV for more than 35 seconds.
- check that the Overoad condition is removed when:
  - both A and B go off, or
  - the power is removed for a few seconds.

Check the Frequency Control circuit:

- set A and B to the ON position
- check that the voltage at TP15 is -3V ± 5%
- verify that TP7 goes High and the voltage at TP3 goes to its upper value when the input voltage is lower than -200 mV, but it goes to its lower value when the input voltage is greater than -200 mV
- check the voltages at either ends of P1 and P2. They must be 3.54V; 4.4V and 5.8V; and 7.5V respectively.

Check the V/F Converter circuit:

- set A and B to the On position
- set P1 to its lowest frequency
- trim P3 so that the output frequency of V/F (TP5) is 2958 Hz
- set P1 to its highest frequency
- verify that the output frequency exceeds 3600 Hz
- set A to the ON position and B to the OFF position
- set P2 to its lowest frequency
- verify that the output frequency is greater than 5100 Hz
- set P2 to its highest frequency
- verify that the output frequency is less than 6000 Hz

Check the Power Drive circuit:

- disconnect J3
- connect a jumper between the plus (+) terminal of the power board bridge and the common terminal (TP COM)
- connect a 1-kohm resistor between the minus (-) terminal of the power board bridge and the collector of Q5
- verify that the voltage across the resistor is a pulse of approximately 12V and a duty cycle of 1/3
- repeat the above procedure for Q6 through Q11

Check the Power Board:

- to check power transistors:
  - use a digital multimeter set on the 2 kohm setting, full scale
  - check the IRF 540 resistances as shown in the following table. Positive on the first pin; negative on the second pin.

GS	0.7 Kohm
SG	0.7 Kohm
GD	1.2 Kohm
DG	OL
DS	OL
SD	0.5 Kohm

Note

Record these values as approximations; the measured values may differ because they depend on the current of the multimeter.

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SECTION VI

TROUBLESHOOTING

6-1 GENERAL

The accuracy, reliability, and stability of any mass spectrometer leak detector depends upon the leak-free integrity of its own vacuum system. Inherent helium background and its effect on sensitivity demands the elimination of all detectable leaks. If performance degrades during operation or after some part of the vacuum system is opened for service, a methodical check will eliminate the possibility of a leak as the cause.

The following suggestions apply whether leak-checking components, systems, or the leak detector itself.

Note
Varian recommends the use of its helium Spray Probe Assembly (part number 0991-K0167-301), or equivalent, designed specifically for accurate and economical leak checking.

1. When spraying suspected leak locations, always apply helium SPARINGLY, starting at the highest points first, since helium rises. Use only enough helium to reach the leaks; do not flood the area.
2. If drafts (such as from a fan) exist in the area, apply helium downstream from the source first, or deflect the draft until leak checks are completed.
3. If vent grooves exist at flanges or other assembled seals, apply helium to these points (rather that a general spray) to obtain the most positive response, minimize the use of helium, and save time in leak-checking.
4. Locate and repair large leaks before attempting to locate extremely small leaks.

6-2 TROUBLESHOOTING SYMPTOMS

Table 6-1 lists the particular symptoms encountered when troubleshooting the leak detector. With each symptom is a listing of possible causes, possible solutions, and additional checks that may be necessary.

Table 6-1. Troubleshooting Symptoms

SYMPTOM	EXPLANATION
Electrical Components	
No Power/No lights on panel	Verify that the leak detector is plugged into a power receptacle.

	Make sure that all circuit breakers are properly set or reset as appropriate.
	Check that the MAIN POWER switch on the back of the cart power enclosure is on and that the ON/OFF switch on the basic module is on.
	Check that all circuit boards are properly plugged in.
Turbo Pump	
Not running	Press the circuit breaker to reset.
	Make sure the turbo pump controller is plugged in.
	Check that power is applied to the plug for the turbo pump power supply.
	Fuse F1 or F2 blown.
	Relay RL1 defective.
	Power board defective.
	U1 or U5 defective.
Controller does not change to low frequency	U2, U3, or U5 defective.
Controller does not signal NORMAL	U1 defective.
Controller does not signal OVERLOAD	U4 defective.
Vacuum Pumps	
Pumps not running	Verify that the pumps are properly plugged into the leak detector and that the leak detector is plugged into a power receptacle.
	If the leak detector is in the SYSTEM READY mode, the rough pump will be running.
Pumps make excessive gurgling sounds. (The 1.2 cfm fore pump will naturally gurgle; the operator should differentiate this sound from an actual leak.	Pump oil may be low.
	Tighten the KF clamps.

	Check the vacuum system manifold as well as the rest of the vacuum lines for possible vacuum leaks. Verify that the pump drain plugs are securely in place.
Leaks (Refer to para. 6-4-1 to 6-4-3 for more datails)	Tighten the KF clamps. Check the vacuum system manifold as well as the rest of the vacuum lines for possible vacuum leaks. Check all valves, vacuum lines, connectors, and vacuum seals for proper operation. Any leak or break in the vacuum integrity will be a cause for abnormal operation.

Leak Detector

Reaches System Ready state but fails to transfer to the TEST mode. Press START button; display reads 760 Torr.	Remove test piece, plug test port, try again. Check for a leak at an inlet line in the vacuum manifold. Look for the severe darkening of the forepump oil, the presence of foam or froth on top of the oil, or a pungent odor. The above conditions accompanied by a reading of approximately 100 milliTorr on the Test Port Pressure gauge indicate that either the rough pump or the fore pump is in need of an oil change and flush. Perform test port thermocouple gauge check (para. 6-4-7). Check that pumps are plugged into power source and are operating. If pumps do not operate, enter Menu 22, Option 2 to operate manually. If pumps still do not operate, check power to pumps or for pump failure.

Check that rough pump valve V11 or roughing valve V1 are open (listen for an audible click).

If valve V11 does not operate, refer to Menu 22, Option 3 to operate manually. If valve does not open, check power to valve or for pump failure.

Check that the test port thermocouple gauge connector is plugged in and making a good electrical connection.

Check that there are no large leaks.

Check that the test port thermocouple is working properly (see para. 6-4-7).

6-3 ERROR MESSAGES

The following is a list of error messages that may appear on the front panel display. A description of each is followed by corrective action procedures.

6-3-1 "Spec tube rough error"

This error message can occur only during initial startup when the forepump fails to pump the spectrometer tube down within 15 seconds after the isolation valve V6 opens. Power will not be applied to the turbo pump until this condition clears.

Corrective Action - Proceed as follows.

1. Press the SCRAM button twice to reset the leak detector and to allow further roughing of the spectrometer tube. Repeat the step again.
2. Check the system thermocouple connector to verify a good electrical connection.
3. Check that the system thermocouple gauge is operating properly (see para. 6-3-5).
4. Check for leaks in the vacuum system between the test valve and the spectrometer tube. See para. 6-4-1.

6-3-2 "Spec tube pressure burst"

Burst-type errors occur only when pressure criteria for that sensor met the conditions once and now has failed. In this case, it indicates that the thermocouple pressure has risen above 10 mTorr after the spectrometer tube was pumped down and the turbo pump has started.

Corrective Action - Refer to para. 6-3-1, steps 1 through 4.

6-3-3 "Pressure burst"

This message indicates a sudden pressure rise in the spectrometer tube. It can occur only when the filament is on, when the vacuum system is in the HOLD, ROUGH DOWN, or VENT state, or when the leak detector is in the TEST mode. If pressure recovers, then the filament is turned on in the ion gauge mode pressure is checked, the vacuum system reverts to the HOLD state, and the leak detector displays a "System ready" message.

Corrective Action - None; when this message appears, others will follow.

6-3-4 "System over pressure"

This error message is produced by the system pressure thermocouple TC2 and can occur any time after turbo pump startup. This message indicates a large pressure burst error. Typically, the high-vacuum side of the turbo pump is air-released to a level that the thermocouple is able to measure it. Again, as in the "pressure burst" error, the filament is shut off first and, as the pressure recovers, conditions are automatically checked and the microprocessor proceeds to the "system ready" level.

If the pressure reported by the thermocouple does not drop within 5 minutes, the turbo pump is shut off and cooled down to prevent possible damage.

Corrective Action - Check for leaks in the vacuum system between the test valve and the spectrometer tube (see para. 6-4-1).

6-3-5 "System pressure wait"

This message occurs when the system pressure thermocouple report pressure higher than the set point after the turbo pump has started.

Corrective Action - Refer to para. 6-4-1, steps 1 through 4.

6-3-6 "System pressure timeout"

This error message occurs when the pressure in the high-vacuum side of the turbo pump, as reported by the system pressure thermocouple, does not go low enough in the allotted time.

Corrective Action - Refer to para. 6-3-1, steps 1 through 4.

6-3-7 "Ion gauge pressure wait"

This message can occur when, after warmup, the ion gauge reports pressure in the spectrometer tube to be greater than 5×10^{-5} Torr. Up to 30 minutes are allowed for this condition to improve.

Corrective Action - Wait for pressure to improve. Check for leaks and proper operation of pumps. Spectrometer tube may be contaminated and require cleaning.

6-3-8 "Ion gauge time out"

This message occurs when, after 30 minutes, the spectrometer tube pressure does not fall below 5 x

10^{-5} Torr. The turbo pump is automatically shut off to prevent damage to the vacuum system.

Corrective Action - Check for leaks and proper operation of vacuum pumps. Spectrometer tube may be contaminated and require cleaning.

6-3-9 "Filament #1 burned out"

This error message indicates that filament #1 of the ion source is burned out.

Corrective Action - None. Leak detector will automatically switch to Filament #2.

6-3-10 "Filament #2 burned out"

This error message indicates that filament #2 of the ion source is burned out.

Corrective Action - If both filaments are burned out, the leak detector will display the message "both filaments burned out".

Before disassembling the spectrometer tube to change the ion source, Varian recommends the following.

1 Press SCRAM then SCRAM again. If the message does not disappear and the leak detector does not start up automatically, check the continuity of the ion source.

2 Remove the connector from the top of the ion source and check for continuity between pins 1 and 8 (filament #1) and between pins 5 and 6 (filament #2) of the ion source. If there is no continuity between either of the pins, change the ion source as described in Section V.

6-3-11 "Test port over pressure"

This error message occurs when the leak detector is in the TEST mode and indicates that the test port thermocouple TC1 reports pressure greater than the transfer pressure.

Corrective Action

1 Remove the test piece, plug the test port, try again.

2 In Menu 22, Option 1-2, adjust the Fine Leak Set Point if desired.

3 Check that the test port thermocouple gauge is properly connected electrically.

4 In Menu 22, Option 1-7 (Test Port TC Gain), check the value of the gain. Increase it by 20 percent. Press the SCRAM button twice and check if the message is still displayed. Increase the test port thermocouple gain twice if necessary. If no improvement is noted, reset the gain to its original value.

5 Refer to para. 6-4-7 for detailed test port thermocouple gauge check.

6-3-12 "Xfer pressure wait"

This condition can occur when the leak detector is forced to transfer manually from the GROSS LEAK TEST mode to the FINE LEAK TEST mode and the test port pressure is higher than the fine leak transfer set point. This message will also appear when the leak detector is in the AUTO mode if the leak rate is less than 0.8×10^{-4} and the test port pressure is greater than the fine leak set point.

Corrective Action - Remove the test piece; the pressure is too high to test in the FINE TEST mode.

6-3-13 "Gain too high" (Low sensitivity to helium)

This error message is displayed when the calibration gain required after auto-calibration is greater than 7.

Corrective Action

1 Attempt the manual tuning procedure if the leak detector responds to helium but the sensitivity is low (Section 5-2-2).

2 Switch ion source filaments to determine if sensitivity improves. Refer to Menu 22, Option 4-1.

3 Check that the valves are operating properly, especially the ejector bypass valve V4 and the isolation valve V6. Refer to para. 6-4-4 for valve checks.

4 Clean the vacuum system, especially the spectrometer tube (Section V).

6-3-14 "Gain too small" (sensitivity too high)

This error message is displayed when the calibration gain required after auto-calibration is less than 0.8.

Corrective Action - In Menu 22, Option 1-2, lower repeller voltage to reduce sensitivity. Repeat until calibration (Menu 22, Option 1-5) is between 1.2 and 2.0.

6-3-15 "No helium peak" (leak detector not sensitive to helium)

This error message is displayed when, during autocalibration, the leak detector scans the ion voltage and finds no peak.

Corrective Action

1 Zero the leak detector in the TEST mode with the test port plugged.

2 Check that the valves are operating properly especially the standard leak valve, V5, the ejector bypass valve V4, the test valve V2, and the isolation valve V6. Refer to para. 6-4-4.

3 Check that the ion source is operating properly by performing the ion source check (para. 6-4-5).

8 Perform preamplifier check (para. 6-4-6). If preamplifier reads approximately 20-300 mv between pins 7 and 8 (Figure 6-3) and goes to 1 - 10 mv when all leaks are off, the vacuum system/spectrometer tube is operating properly; the problem exists in the electronics or the display (see para. 6-5, Electronics Troubleshooting) for further details.

6-3-16 "Too many peaks"

This error message is displayed when, during autocalibration, the leak detector scans the ion voltage and finds more than one peak.

Corrective Action - Clean the spectrometer tube.

6-4 DETAILED TROUBLESHOOTING

6-4-1 Leak Symptoms

1 Pumps make gurgling sound (more than normal)

2 Error messages which are repeated

a Spectrometer tube rough error
b System over pressure
c Spectrometer tube pressure burst
d Pressure burst

3 Difficulty in transferring into the TEST mode or failure to transfer into the FINE LEAK mode when the test port is plugged

4 Inconsistent reading of leak rate meter especially during leak checking

6-4-2 Leak-Checking the Leak Detector (small leaks)

Sometimes a small leak will cause inconsistent operation of the leak rate meter but will still allow the leak detector to transfer into the TEST mode. In this case, the operator can use helium to identify leaks in the vacuum system by spraying suspected areas and watching the response on the display.

6-4-3 Leak-Checking the Leak Detector (large leaks, will not reach System Ready)

Most leaks in the vacuum system will occur after the leak detector has been disassembled or cleaned. The most likely areas for leaks are O-rings and poor sealing surfaces. This can be caused by using damaged or rolled O-rings or by not tightening KF clamps properly. Poor sealing surfaces can be identified by scratches or possibly foreign substances across O-ring grooves. Check for loose bolts preventing metal-to-metal contact on sealing surfaces.

The key to finding leaks in the 956 leak detector is to anticipate which O-rings or seals are faulty. This can be accomplished by using a thermocouple gauge controller or digital voltmeter and using the test port thermocouple gauge TC1 and the system thermocouple gauge TC2 to measure pressure. Use the valves to manually isolate sections of the vacuum system (Menu 22, Option 3); use Menu 22, Option 2 to manually control the pumps. Use the flow diagrams in Section II to isolate and pump down sections of the vacuum system, then valve off the pumps.

Watch the thermocouple gauge controller or the digital voltmeter for a gradual pressure or voltage change. A gradual pressure rise will indicate a leak. A digital voltmeter can be used by placing it on the 20 mv scale and connecting the test leads across the red and green wires of a plugged-in thermocouple connector (see para. 6-4-7). A reading of 0 to 3 mv indicates atmosphere; 7 to 11 mv indicates vacuum.

6-4-4 Valve Check

1 Check that the test port is pumped down to a rough vacuum if possible.

2 In Menu 22, Option 3-1-6, put the leak detector in the HOLD state.

3 Verify proper valve operation by listening for an audible click when the valves are actuated. Start with the valves that are likely to cause a problem and always finish with the VENT valve.

4 If any valve fails to operate properly, measure the D-C voltage from each coil lead to ground while the leads remain connected to the coil. Voltages should be as shown in the following list (within 10 percent).

VENT valve (V3)	24 VDC
TEST valve (V2)	12 VDC
ROUGH valve (V1)	12 VDC
STD LEAK valve (V5)	24 VDC
GROSS LEAK valve (V7)	24 VDC
Turbo pump VENT valve (V4)	24 VDC
ISOLATION valve (V6)	12 VDC
ROUGH PUMP valve (V11)	A-C line voltage

Refer to Figure 2-4 for location of valves in the vacuum system.

The presence of equal voltage on both leads indicates a) that the power supply is operating properly, b) the coil is good, and c) that the valve is de-activated.

An 80 percent voltage drop across the coil indicates a) that the coil is good and b) that the valve is activated.

5 In the case of the ROUGH PUMP valve, check the coil for continuity then plug the valve into an alternate A-C power source and listen for actuation.

6 If a voltage drop is present but any valve still does not operate, check whether the valve is mechanically stuck.

6-4-5 Ion Source Check

1 Separate the ion source from its connector. At Menu 22, Option 1-1, record the ion voltage (filament bias).

2 Reset the ion voltage to 250.

3 Measure the following D-C voltages (± 20 percent) at each pin to ground on the ion source connector as shown in Figure 6-1.

Pin 1	70V
Pin 2	350V
Pin 3	220V
Pin 4	70V
Pin 5	70V
Pin 6	250V
Pin 7	210V
Pin 8	70V

4 If no voltages can be read, go to Menu 22, Option 2-1, and turn on the high voltage. If voltage problems still exist, refer to para. 6-5, Electronics Troubleshooting.

5 With the ion source connector disconnected from the ion source, check for continuity between pins 4 and 5 of filament 2, and pins 1 and 8 of filament 1. Continuity verifies that the filaments are not open.

6 Check pins 2, 3, 6, and 7 in the ion source corresponding to the pins shown on the connector (Figure 6-1). Check that the pins are electrically isolated from ground as well as from each other.

7 Visually inspect the ion source and replace it if electrical shorts exist.

Note
Improper installation of the ion source could ground the repeller (pin 2). Check that the ion source is properly installed (refer to para. 5-3-5).

6-4-6 Preamplifier Check

1 Carefully unscrew the cap from the preamplifier connector while it is still connected to the preamplifier.

WARNING
HIGH VOLTAGES CAN KILL. DO NOT TOUCH OR SHORT OUT THE 160-VDC WIRE ON PIN 1.

2 Verify the voltages shown in Figure 6-2. If voltages do not exist, refer to para. 6-5.

3 Attach a voltmeter to pins 7 and 8 of the preamplifier (use the 200 mv scale).

4 Turn the leak on/off and note meter output changes. With a -7 range leak on, the meter should read 20 to 200 mv. With the leak off, the meter should read 1 to 10 mv. With the emission off, the meter should read 1 to 5 mv.

5 Turn the emission on (Menu 22, Option 4-2); the meter output should increase 1 to l0 mv. When the meter has stabilized, then the spectrometer tube is probably operating properly.

6-4-7 Test Port Thermocouple Gauge (TC1) Check

1 Verify continuity of all leads on the thermocouple gauge. If an open circuit exists, replace the gauge.

2 Check that the test port is pumped down properly (10 to 40 mTorr). Check by feeling the "force" of the vacuum at the test port and listening to the mechanical pump (the pump should not gurgle more than normal).

3 Loosen the screws securing the thermocouple cap to the wire. Unscrew the cap from the thermocouple gauge connector and measure the voltage across the white and black wires while the connector is plugged into the thermocouple. The voltage should read approximately 0.3 volt. If not, refer to para. 6-5, Electronic Troubleshooting. No voltage to thermocouple gauge.

4 Measure the voltage across the red and green wires while the connector is plugged into the thermocouple. The voltage should read 7 to 11 mv. With the meter still connected, vent the test port; the meter should decrease to 0 to 3 mv. If the meter output does not change, replace the test port thermocouple gauge.

6-4-8 System Thermocouple Gauge (TC2) Check

The system thermocouple gauge should be checked for proper operation if error messages such as "Spec tube rough error", "System pressure wait", "System pressure time out", and/or "Spec tube pressure burst" appear often and/or unpredictably.

1 Remove the thermocouple connector from the thermocouple gauge and check continuity of all four pins on the thermocouple gauge. An open circuit indicates that the gauge is defective; replace it.

2 Check that the thermocouple gauge connector makes good electrical contact with the thermocouple gauge.

3 Press the SCRAM button and allow the leak detector to shut down.

4 Vent the spectrometer tube by opening the following valves in Menu 21, Option 3-2: VENT (V3), ROUGH (V1), TEST (V2), and ISOLATION (V6).

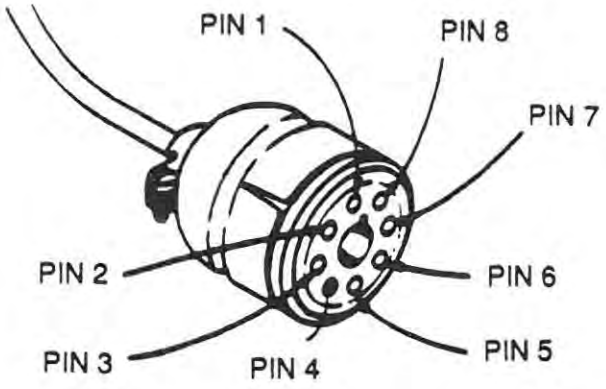


Figure 6-1. Ion Source Connector

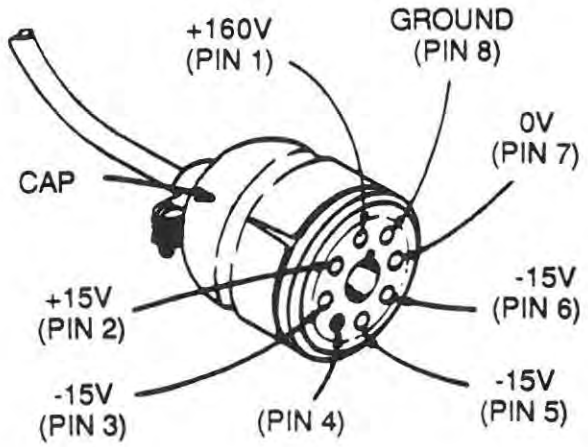


Figure 6-2. Voltages at Preamplifier Connector

5 Loosen the screws securing the thermocouple cap to the wire. Unscrew the cap from the thermocouple gauge connector and measure the voltage across the white and black wires while the connector is plugged into the thermocouple. The voltage should read approximately 0.28 volt with the leak detector on. If not, refer to para. 6-5, Electronic Troubleshooting. No voltage to thermocouple gauge.

6 Measure the voltage across the red and green wires while the connector is plugged into the thermocouple. The voltage should read 0 to 4 mv. With the meter still connected, start the leak detector so that the fore pump pumps down the spectrometer tube. The meter output should read 7 to 11 mv. If the meter output does not change, replace the thermocouple gauge.

6-5 ELECTRONICS TROUBLESHOOTING

When an electronic problem exists, Varian recommends that the service technician replace the circuit board rather than the individual components on the board. This section will aid the service technician in isolating the particular board.

SYMPTOM	EXPLANATION
No voltage to thermocouple gauge (should measure approximately 0.3V between the white and black wires while the connector is connected to the gauge) (See para. 6-4-7.)	Check for a short or broken thermocouple gauge connector and cable.
	Check that the thermocouple gauge cable is properly plugged into the Backplane.
	Check that the leak detector is on.
	Check that the circuit boards are properly plugged in.
	Replace the power supply board or CPU board.
No voltage to the ion source	Refer to Menu 22, Option 2-1 to turn on voltage to ion source.
	Check that all connectors are properly plugged into the Backplane board.
	Check for damaged ion source cable or connector.
	Replace the power supply board or CPU board.

No voltage to valve coil	Refer to Menu 22, Option 2-1 to turn on voltage to valves. Check for broken wires to valve coil. Check that circuit boards are properly plugged in. Check for loose or damaged connector on Backplane board. Replace power supply board or CPU board.
No voltage to preamplifier	Check for damaged preamplifier cable or connector. Check that all connectors are properly plugged into the Backplane board. Check that circuit boards are properly plugged in. Replace power supply board or CPU board.
Display not lit	Check that both connectors to the display are properly connected and undamaged. Check that circuit boards are properly plugged in.
No power to turbo pump	Check that circuit breakers are reset. Check that turbo pump is plugged in. Replace power supply board.

6-6 POWER-UP SEQUENCE

The GO/NO GO diagram (see Section IV) shows the steps automatically taken by the microprocessor when the START button on the control panel is pressed. (GO/NO GO diagrams for the leak detector in each of several modes, START, SEQUENCER, SCRAM, and VENT are shown following the POWER-UP diagram).

All valves in the 956 are closed when power is off. As soon as power is applied, the system goes through hardware reset. After this reset, the software goes through its initialization and configures all the output lines. At this time, the 1.2 cfm pump is turned on and a message ROUGHING OUT VACUUM SYSTEM

No voltage to valve coil	Refer to Menu 22, Option 2-1 to turn on voltage to valves.
	Check for broken wires to valve coil.
	Check that circuit boards are properly plugged in.
	Check for loose or damaged connector on Backplane board.
	Replace power supply board or CPU board.
No voltage to preamplifier	Check for damaged preamplifier cable or connector.
	Check that all connectors are properly plugged into the Backplane board.
	Check that circuit boards are properly plugged in.
	Replace power supply board or CPU board.
Display not lit	Check that both connectors to the display are properly connected and undamaged.
	Check that circuit boards are properly plugged in.
No power to turbo pump	Check that circuit breakers are reset.
	Check that turbo pump is plugged in.
	Replace power supply board.

NOTE

If the main Printed Circuit Board (L8017301) is changed for any reason, the S-Ram must be changed on to the new Printed Circuit Board to carry over the Turbo run time.

6-6 POWER-UP SEQUENCE

The GO/NO GO diagram (see Section IV) shows the steps automatically taken by the microprocessor when the START button on the control panel is pressed. (GO/NO GO diagrams for the leak detector in each of several modes, START, SEQUENCER, SCRAM, and VENT are shown following the POWER-UP diagram).

All valves in the 956 are closed when power is off. As soon as power is applied, the system goes through hardware reset. After this reset, the software goes through its initialization and configures all the output lines. At this time, the 1.2 cfm pump is turned on and a message ROUGHING OUT VACUUM SYSTEM appears on the alpha-numeric display for approximately 5 seconds. This action evacuates the vacuum lines so that when the valves are opened, the spectrometer tube pressure may not rise.

Once the vacuum lines are roughed out, valves V2 and V6 open. If the spectrometer tube was already under vacuum, then the software will start the turbo pump.

If the spectrometer tube was not under vacuum when valves V2 and V6 were opened, then a message ROUGHING OUT SPEC TUBE appears. If the pressure does not go low enough in 30 seconds, then the system produces SPEC TUBE ROUGH OUT ERROR and does not start the turbo pump. This usually means that there can be one of the four following problems.

1 The test valve or the isolation valve did not open,
2 there is a leak between the spectrometer tube and the turbo pump,
3 the thermocouple is burned out, or
4 a signal measurement problem exists from the thermocouple.

After the problem is found and fixed, and if power to the unit is not turned off, pressing the SCRAM key twice will restart the system by roughing out the vacuum lines. If the power was turned off, then the system will start from the beginning when the power is applied.

Once the turbo pump is up to speed, the system is ready to turn on the ion source; TURNING ON THE ION SOURCE will be displayed on the control panel for approximately 10 seconds. Power to the filament is increased at a very slow rate to extend the life of the filament. Once the proper emission is achieved, system pressure is automatically checked from the ion source in the ion gauge mode. If the pressure is less than 5×10^{-5} then the display SYSTEM READY will be shown and the leak detector is ready to be calibrated or operated.

If the system pressure is greater than 5×10^{-5}, the leak detector can be used although its sensitivity will be poor. Thus, a message SPEC TUBE PRESSURE WAIT appears on the display. If conditions don't improve within 30 minutes, the software executes the SCRAM function to prevent damage to the system. This can usually happen when the turbo pump is contaminated or a small leak exists on the high vacuum side of the turbo pump.

SECTION VII

PARTS LIST

7-1 GENERAL

This Parts List illustrates all of the procurable assemblies and parts for the Portable Leak Detector, Model Number 956, Varian Part Number 0956-L8003-301, designed and manufactured by Varian Associates, Vacuum Products Division, 121 Hartwell Avenue, Lexington, Massachusetts, 02173.

7-2 CONTENTS

The Parts List provides an illustration and description of procurable assemblies and parts, indexed for easy cross-reference. It is not to be taken as the authority for the procedure of assembly or disassembly; it is intended only for use in identifying parts, illustrating disassembly relationship, and ordering the correct replacement parts. Overhaul or repair should be done by authorized personnel using applicable Varian Instruction Manuals.

7-3 FIGURE AND INDEX NUMBER COLUMN

The Figure and Index No. column shows the applicable figure number on which an assembly/part appears and the particular item number in the list for parts identification.

7-4 PART NUMBER COLUMN

Numbers listed in this column reflect the Varian part number for the assembly or part for ordering purposes. The three-digit class code (956) are an integral part of the part number for parts normally furnished with the Leak Detector. The class code 0991 applies only to optional parts available for the 956 Leak Detector. If the part is available commercially, the word "Coml" will appear in this column.

7-5 DESCRIPTION COLUMN

The description or name of the part is listed by its principal noun followed by modifiers, followed by size or specifications, and is indented under the numbers 1 through 6 to show the relationship of one part or assembly to another part or assembly. For example, an item listed under indent 3 is a component part of the next higher assembly listed under indent 2 above it.

7-6 ABBREVIATIONS

The following abbreviations are used in the parts listing.

Alum	Aluminum
Cad pl stl	Cadmium plated steel
Fil hd	Fillister head
MPT	Male pipe thread
NC	Normally-closed
NPT	National pipe thread
Rd hd	Round head
s/s	stainless steel

7-7 UNITS PER ASSEMBLY COLUMN

The number appearing in the Units Per Assembly column is the total quantity of the listed part required in its immediate assembly.

7-8 ILLUSTRATIONS

Titles

The illustration in the Parts List carries the same caption as its corresponding listing and is identical to the title of the Varian drawing to which it applies.

Method of Presentation

Wherever practical, one model is selected as the most representative of the equipment and its components are shown in the main portion of each illustration. Visually different parts for similar models are shown on the same illustration in ellipses. Circles are used to show detail sections of the equipment. A bracket indicates a breakdown of an assembly. Dashline drawings represent items that are illustrated for reference such as to show location or relationship to other parts or assemblies.

7-9 HOW TO USE THIS PARTS LIST

To find the part number if the major assembly in which the part is used is known:

a. Turn to the Table of Contents and find the page number of the illustration showing that major assembly. Turn to the page determined.

b. Locate the part and index number of the major assembly in the illustration.

c. Find the index number in the parts list to determine the part number and description.

7-10 HOW TO ORDER PARTS

a. Determine the complete part numbers, descriptions, and quantities of parts required from the appropriate parts lists. Include the class code number (for example, 0981) before each part number.

b. Call the National Order Entry toll-free telephone number listed inside the title page of this instruction manual (1-800-8-VARIAN).

c. Place the order with the operator, describing the name, model number, and serial number of the equipment on which the part is used. Give the complete part number of the part ordered (the figure and index number is not required), the description as shown on the parts list, and the quantity required.

d. A minimum order of $50 will be required to complete the order.

7-11 FACTORY-INSTALLED OPTIONS

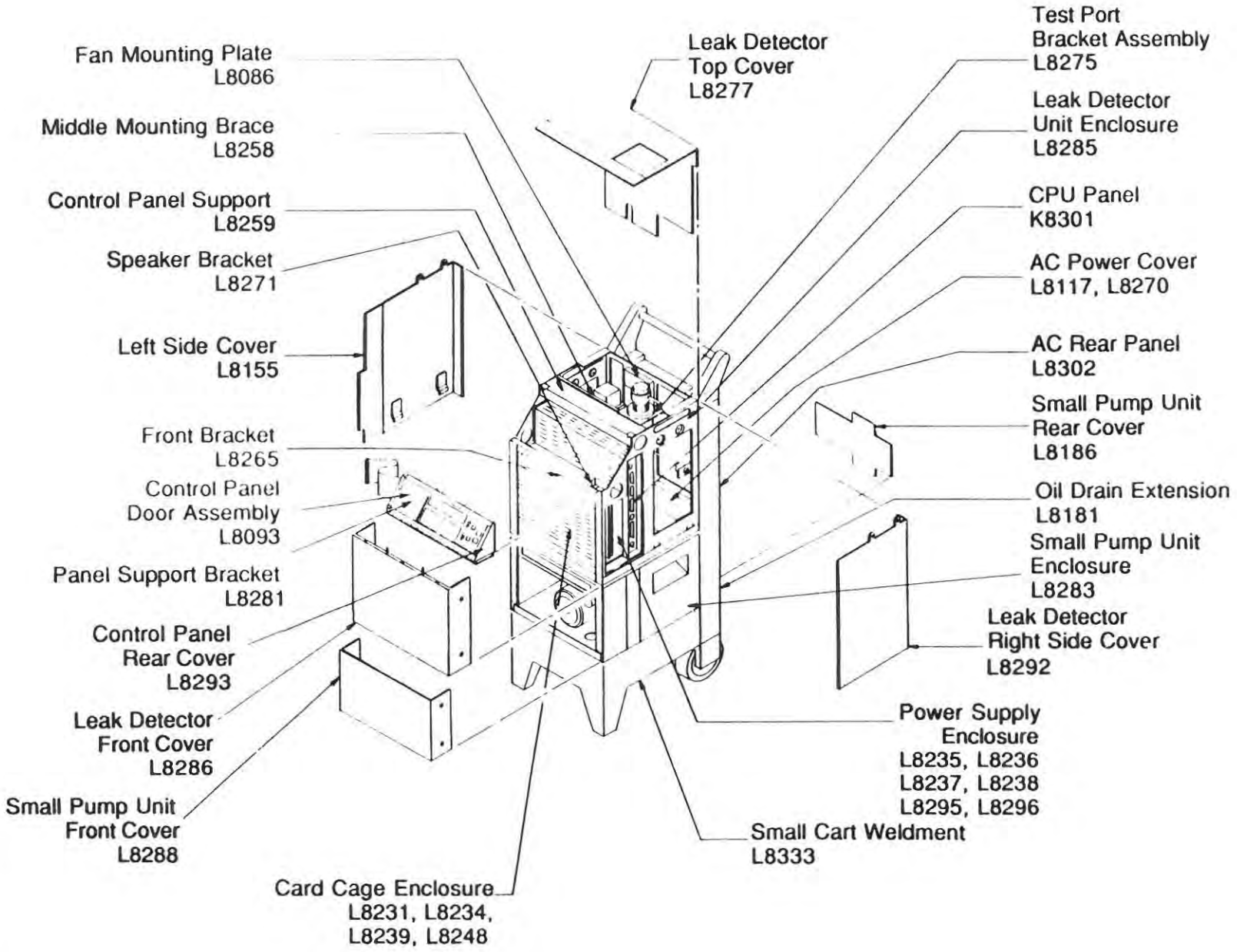
The following factory-installed option is available for purchase with the 956 Auto-Test Leak Detector.

Remote Module, Part No. 956-0910

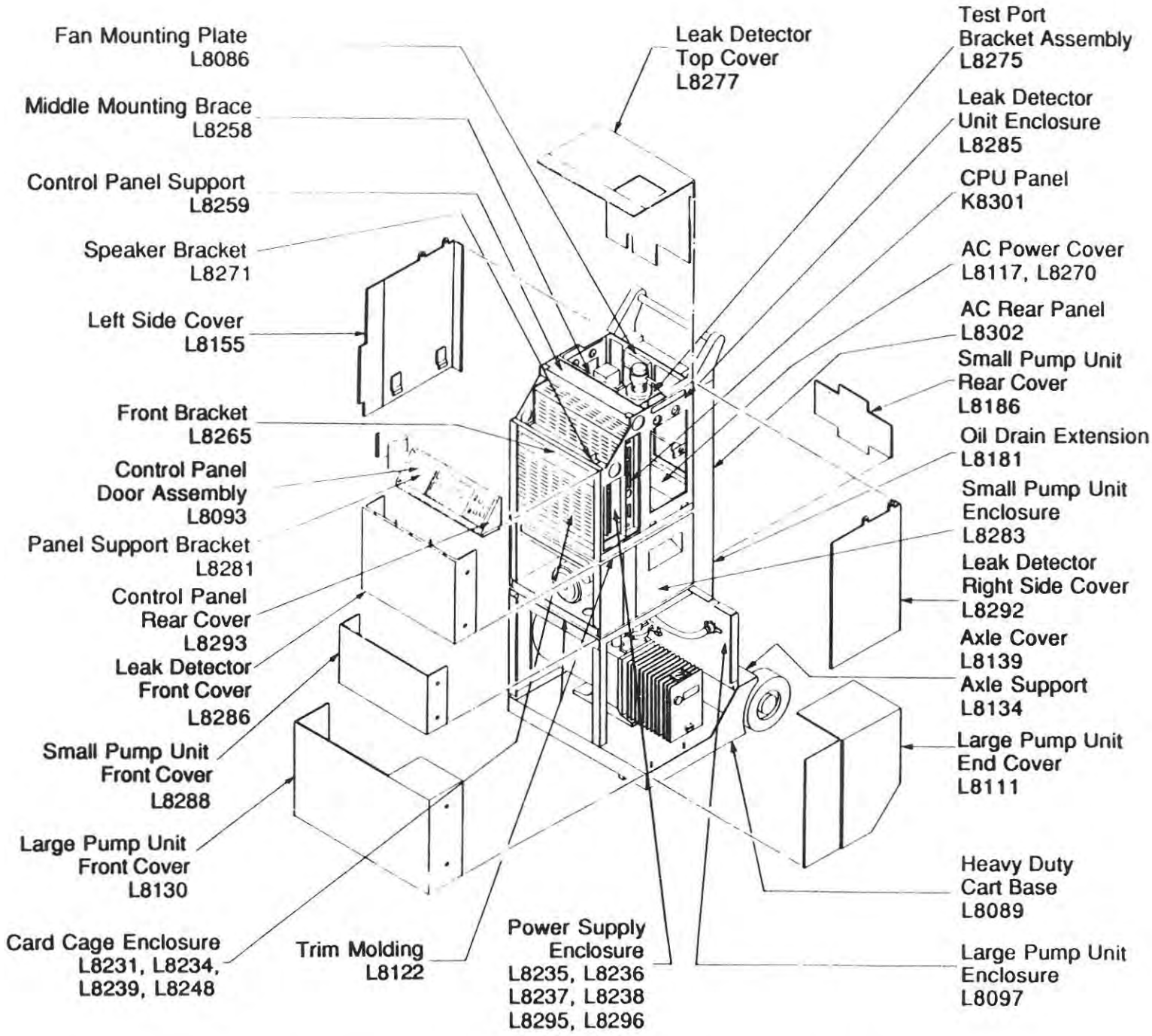
The calculator-type remote module displays leak rate readings with a visual bar graph and exponent and an audible alarm with adjustable volume. The module outputs leak rate readings in auto- or manual-ranging. Manual switching and auto-zero functions are included on the module and self-

diagnostic codes are displayed. The Accessory Output option listed above is required with this module.

Gross Leak Valve Option, Part No. 956-0920



Model 956 Leak Detector with Sm Cart, without Large Pump Unit



Model 956 Leak Detector with Large Pump Unit and Heavy-Duty Cart

RECOMMENDED SPARE PARTS KIT (9569901)
For Turbo Pump Models

PARKER P/N	VARIAN P/N	QTY FOR ONE LEAK DETECTOR	DESCRIPTION/LOCATION
FOR THE SPECTROMETER TUBE			
2-025	660892025	3	O-Ring (Ion Source, Analyzing Magnets, Preamplifier)
2-212	660892212	1	O-Ring (Spectrometer Tube Mounting)
FOR THE TEST PORT/FORELINE			
2-110	660892110	3	O-Ring (Foreline TC Gauge / Gross Leak)
2-220	660892220	1	O-Ring (Foreline Flange)
2-216	660892216	1	O-Ring (Test Port)
	Q1000301	1	NW 16 & Center Ring
	Q1000302	3	NW 25 & Center Ring
	624361040	1	Imperial 1/4" Viton sleeve (Gross Leak Option)
2-016	660892016	3	O-Ring (Gross Leak, Calibrated Leak, and Vent)
2-010	660892010	1	O-Ring (Calibrated Leak)
2-019	660892019	2	O-Ring (Rough and Test)
FOR THE TURBO PUMP			
2-116	660892116	2	O-Ring (Valve)
2-212	660892212	1	O-Ring (Isolation Valve to Turbo Cover)
2-225	660892225	1	O-Ring (Isolation Valve Cover)
	9535015	1	Gasket, Copper (Turbo Cover to Turbo Flange)

All O-rings are "Viton" (Parker compound V747-75 or equal) unless otherwise specified

SECTION VIII

GLOSSARY OF TERMS

ABSOLUTE PRESSURE

A term used in engineering literature to indicate pressure above the absolute zero corresponding to empty space as distinguished from "gauge " pressure. In vacuum technology, pressure is always absolute pressure, and therefore the term "absolute pressure" is redundant.

ABSORPTION

The binding of gas in the interior of a solid (or liquid).

ADSORPTION

The condensing of gas on the surface of a solid.

ATMOSPHERIC PRESSURE

The pressure of the atmosphere at a specified place and time. The standard atmosphere, or normal atmosphere, is defined (independently of barometric height) as a pressure of 1,013,250 dyne/cm^2.

AUDIBLE LEAK INDICATOR

An auxiliary component of a leak detector which converts the output signal to an audible note whose frequency is a function of the leak size.

BACKGROUND

An output signal of the leak detector due to entrapment of the tracer gas or other substance to which the detecting element responds in the vacuum system which cannot be quickly removed by pumping. A virtual leak of the tracer gas.

BACKGROUND SIGNAL

The steady or fluctuating output signal of the leak detector caused by the presence of residual tracer gas or other substance to which the detecting element responds.

BAKE-OUT

The degassing of a vacuum system by heating during the pumping process.

BOMB TEST

A form of leak test in which enclosures are pressurized with tracer gas for the purpose of driving it through possible leak passages and thus into the internal cavities. Subsequent leak testing is done by evacuation or immersion (see Helium Bombing).

BUBBLE TEST

A form of leak testing gas-containing enclosures in which a leak is indicated by the formation of a bubble at the site of a leak.

COLD TRAP

A vessel designed to hold a refrigerant and which, when inserted into a vacuum system, will trap on its surface condensable vapors present in the vacuum system. Most traps operate with liquid nitrogen at a temperature of -196°C (-320°F).

CONTRA-FLOW™

A technique that utilizes the differences in the maximum compression ratios of the tracer gases (such as helium) and other gases found in the air. When the tracer gas exceeds its maximum compression ratio, it diffuses backwards through the diffusion pump and is detected by the spectrometer tube.

DIFFUSION PUMP

A vapor pump having boiler pressures less than a few Torr and capable of pumping gas at intake pressures not exceeding about 2 milliTorr and discharge pressures (forepressures) not exceeding about 500 milliTorr.

FINE LEAK

A leakage rate of less than 10^{-4} std cc/sec.

FORELINE VALVE

A vacuum valve placed in the foreline to permit isolation of the diffusion pump from its fore pump.

FOREPUMP

The pump which produces the necessary fore vacuum for a pump which is incapable of discharging gases at atmospheric pressure. Sometimes called the backing pump.

GROSS LEAK

A leakage rate more than 10^{-4} std cc/sec.

HELIUM BOMBING

A method of testing for leaks in which hermetically-sealed units containing an internal volume are subjected to a helium pressure. If leaks are present in the sealed unit, the helium pressure will drive some helium into the internal volume and this may be subsequently detected during bell jar testing or immersion in a hot fluid to detect bubbles. (See BOMB TEST.)

ION SOURCE

That part of a leak detector tube in which the trace gas is ionized prior to being detected.

LEAK RATE

The rate of flow through a leak with a specified gas (at a specified pressure on the inlet and exit sides). Preferred units: Standard cc/sec of a specified gas. Standard gas conditions: 760 mm pressure (absolute), 25°C (77°F) temperature.

MASS SPECTROMETER LEAK DETECTOR

A mass spectrometer adjusted to respond only to the tracer gas. Helium is commonly used as the tracer gas, and thus the instrument is normally referred to as a helium leak detector.

MILLISECOND

One one thousandth of a second.

MILLITORR

A unit of pressure equal to 10^{-3} Torr (1/1000 Torr).

MINIMUM DETECTABLE LEAK RATE

The magnitude of the smallest leak rate that can be unambiguously detected by a given leak detector (in the presence of noise and background).

OUTGASSING

The evolution of gas from a material in a vacuum.

PARAMETERS, TESTING

The controlled circumstances under which a test is conducted.

PRESSURE TESTING

A leak testing procedure in which tracer gas is introduced under pressure into or around the enclosure under examination, and detected as it is emitted from a leak.

PROBE

A tube having a fine opening at one end, used for directing or collecting a stream of tracer gas.

PROBE TEST

A leak test in which the tracer gas is applied by means of a probe so that the area covered by the tracer gas is localized. This enables individual leaks to be located.

ROUGH PUMP

A vacuum pump used for the initial evacuation of a vacuum system.

ROUGHING

The initial evacuation of a vacuum system.

ROUGHING VALVE

A vacuum valve placed in a roughing line to isolate the test port and vacuum system from the roughing pump.

SENSITIVITY

In the case of a leak detector, the response of the detector to tracer gas leakage (that is, scale division per unit leak rate).

SPECTROMETER TUBE

The sensing element of a helium leak detector.

STANDARD LEAK

(1) A capillary or porous wall leak, usually in a glass or metal tube, whose dimensions have been adjusted to give a specified leak rate of a gas at a standard temperature with specified inlet and exit pressures. (2) A device that permits a tracer gas to be introduced into a leak detector or leak testing system at a known rate to facilitate tuning and calibration of the leak detector. Also known as a calibrated leak.

TORR

Pressure unit used to replace the term millimeter of mercury (mm of Hg). The Torr is defined as 1/760 of a standard atmosphere or 1,013,250 dynes/cm^2.

TURBOMOLECULAR (TURBO) PUMP

A high-speed (up to 75,000 rpm), fast startup time (60 seconds) mechanical pump featuring fast evacuation, hydrocarbon-free vacuum, and low ultimate pressures.

VIRTUAL LEAK

The semblance of a leak in a vacuum system caused by slow release of trapped gas.

SECTION IX

SCHEMATIC DIAGRAMS

This section contains the following schematic diagrams and includes a description of the operation of the Power Supply circuit (following drawing D-L8022).

Title	Drawing No.
System Interconnect - 956 Portable Leak Detector	D-L8001
Printed Circuit Board Main Assembly (with parts list)	D-L8020
Main Printed Circuit Board Schematic Diagram	D-L8022
Power Supply Schematic Diagram	D-L8025
Auxiliary Power Supply Assembly Printed Circuit Board (with parts list)	D-L8026
Auxiliary Power Supply Printed Circuit Diagram	D-L8028
Backplane Printed Circuit Board Power Supply Schematic Diagram	D-L8031
Control Panel Assembly (with parts list)	D-L8032
Control Panel Printed Circuit Board Schematic Diagram	D-L8034
Control Panel Keyboard Schematic Diagram	C-L8345
Main Power Panel Schematic Diagram	C-L8409
Cart AC Power Assembly Schematic Diagram	—

FIND	PART NUMBER	DESCRIPTION	QTY.

L.D. POWER ENCLOSURE
CB1
CB2
SW1
P/J 20
EM1
EM2
RY3
TB1
P/J 21
P/J 22
P/J 39
L8433301
L8415001
P/J 31
P/J 28
SERVICE
TURBO PUMP
DIFF. PUMP
L8118301
CARD CAGE
L8118302
SM. PUMP ENCL. (TURBO)
L8433302
FANS

TURBO P/S
L8385301
P/J 40
L8386301
P/J 41
D.P. PUMP
P/J 42
TURBO PUMP
FORE PUMP
1.2 CFM
L8368301

BACKPLANE
L8029301
P/J 5
P/J 16
P/J 4
P/J 29
P/J 8
P/J 6
P/J 9
P/J 15
P/J 17
P/J 18
P/J 19

SPEAKER
L8312301
P/J 2
FRONT PANEL BOARD
L8032301
(P/J 1)
L8311301
P/J 3
FRONT PANEL DISPLAY
L8079301
(P/J 4)

CPU BOARD
L8020301
1. CPU
2. ROM, RAM, CLOCK
3. DISCRETE LOGIC
4. FREQ. GENERATORS
5. ADDR. ICS DECODERS
6. HELIUM SIG. INTEGRATE
7. D/A CONVERTERS
8. A/D CONVERTERS
9. V/F CONVERTERS
10. PARALLEL I/O
11. SERIAL I/O
12. RESET LOGIC
13. VALVE DRIVERS
14. TC DIFF. AMPS
15. REFERENCES (VOL)
16. ANALOG MUX.
17. AUDIO DRIVER

PARALLEL I/O
P/J 10
(PINS 34 & 35 TO RECORDER– NOT SUPPLIED)
HOST COMPUTER
P/J 11
P/J 12
J13
PHONO JACK
J 14
REMOTE CONTROL BOARD
L8035301
P/J 47
J/P 46
REMOTE CONTROL DISPLAY
L8342301

LVPS BOARD
L8023301
1. D.P. REGULATOR
2. ION SOURCE REG.
3. +5 @ 8A
4. +24 @ 3.5A
5. +12 @ 3A
6. ±15 @ 0.5A
7. +9 @ 1.0A
8. +24 @ 2A
P/J 7
J 30
P 30

HV BOARD
L8026301
1. FILAMENT BIAS
2. SUPPRESSOR
3. ION CHAMBER
4. FIXED FOCUS
5. VARIABLE FOCUS
6. REPELLER

L8377301

CART POWER ENCLOSURE
CB3
TB3
CB4
CB5
J32
RY4
RY5
SERVICE
P2
P/J 33
P/J 36
P/J 34
P/J 35

L8071301
V1 ROUGH
V2 TEST
V3 VENT
V4 BYPASS
V5 CAL LEAK OPTION
V6 ISOLATION
V7 GROSS LEAK OPTION

L8074301
P/J 24 PREAMP
L8362301
TEMP. SENSOR
P/J 25 TEST PORT PRESS. TC1
L8072301
P/J 26 SYSTEM PRESS. TC2
L8073301
P/J 23 ION SOURCE

ROUGH PUMP VALVE V11
ROUGH PUMP
7, 11, 17 CFM

REF. DESIGNATIONS	
LAST	UNUSED
P/J 47	

DO NOT SCALE DRAWING

PART	DESCRIPTION
CAD GENERATED DOCUMENT MANUAL CHANGES NOT PERMITTED	varian VACUUM PRODUCTS DIVISION

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS EXCEPT AS AUTHORIZED IN WRITING BY VARIAN ASSOCIATES

FABRICATE IN ACCORDANCE WITH VARIAN FABRICATION PROCEDURES QA 8000 AND/OR M-70000

FOR OTHER REVISIONS SEE ECO HISTORY FILE.

	DRAWN	DATE	CHECKED	DATE	APPROVED	DATE	APPROVED	DATE
	C COMEAU	10/88						

SYSTEM INTERCONNECT
PORTATEST II

		CMS	C COMEAU	ECO
				DFT
				CHK
			10/88	DATE
		B	A	REV

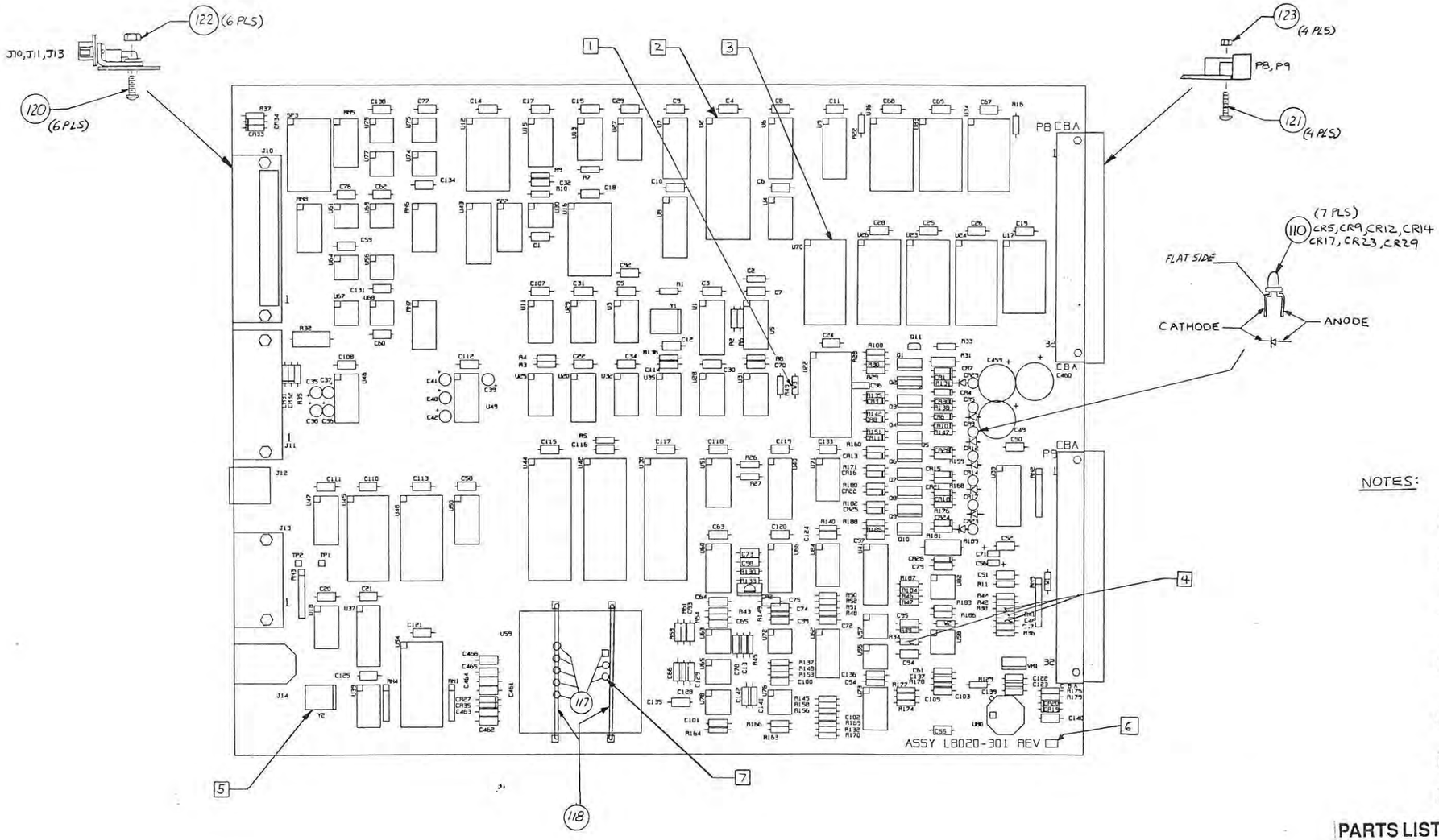
NOT OTHERWISE SPECIFIED
FRAC± 1/32 ANG± 1/2
DEC.XX±.020 XXX±.005
CONC .005TIR
FIN. 63RMS

SIZE	DRAWING NO.	REV.
D	L8001	B
SCALE 1=1	PROD. 09	SHEET 1 OF 1

CASH NO	TYPE OR MODEL	NEXT ASSEMBLY
	PT2	L8017

D L8020

ITM	PART NUMBER	DESCRIPTION OR MASTER NO	QTY



NOTES:

1. DO NOT ASSEMBLE W3.
2. U2 IS ASSEMBLED WITH A SOCKET (ITEM 116).
3. U70, U26, U23, AND U24 ARE ASSEMBLED WITH SOCKETS (ITEM 115).
4. DO NOT ASSEMBLE R34, R38, R41, AND C48.
5. USE ITEM #119 TO MOUNT Y1 & Y2 ON THE P.C. BOARD.
6. CLEARLY MARK REV IN INDELIBLE BLACK INK IN AREA SHOWN.
7. STRIP & TIN ITEM 127 0.12" ON BOTH ENDS & SOLDER BETWEEN U59-3 & PC9-16 ON SOLDER SIDE.

PARTS LIST IS ON A DETACHED DOCUMENT

UNLESS OTHERWISE SPECIFIED: FABRICATE IN ACCORDANCE WITH VARIAN FABRICATION PROCEDURES 8000 AND OF WW5000

DO NOT SCALE THIS PRINT UNLESS OTHERWISE SPECIFIED. BREAK ALL SHARP EDGES. DIMENSIONS ARE IN INCHES

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DRAWN	DATE	APPROVED	DATE	CODE
C. Gustavson	10-15-87	J. QUILTY	10/15/87	
CHECKED	DATE	APPROVED	DATE	CLASS
MRB	10/15/87	W. C FITZGERALD	10/15/87	09

PCB ASSY MAIN

PT2

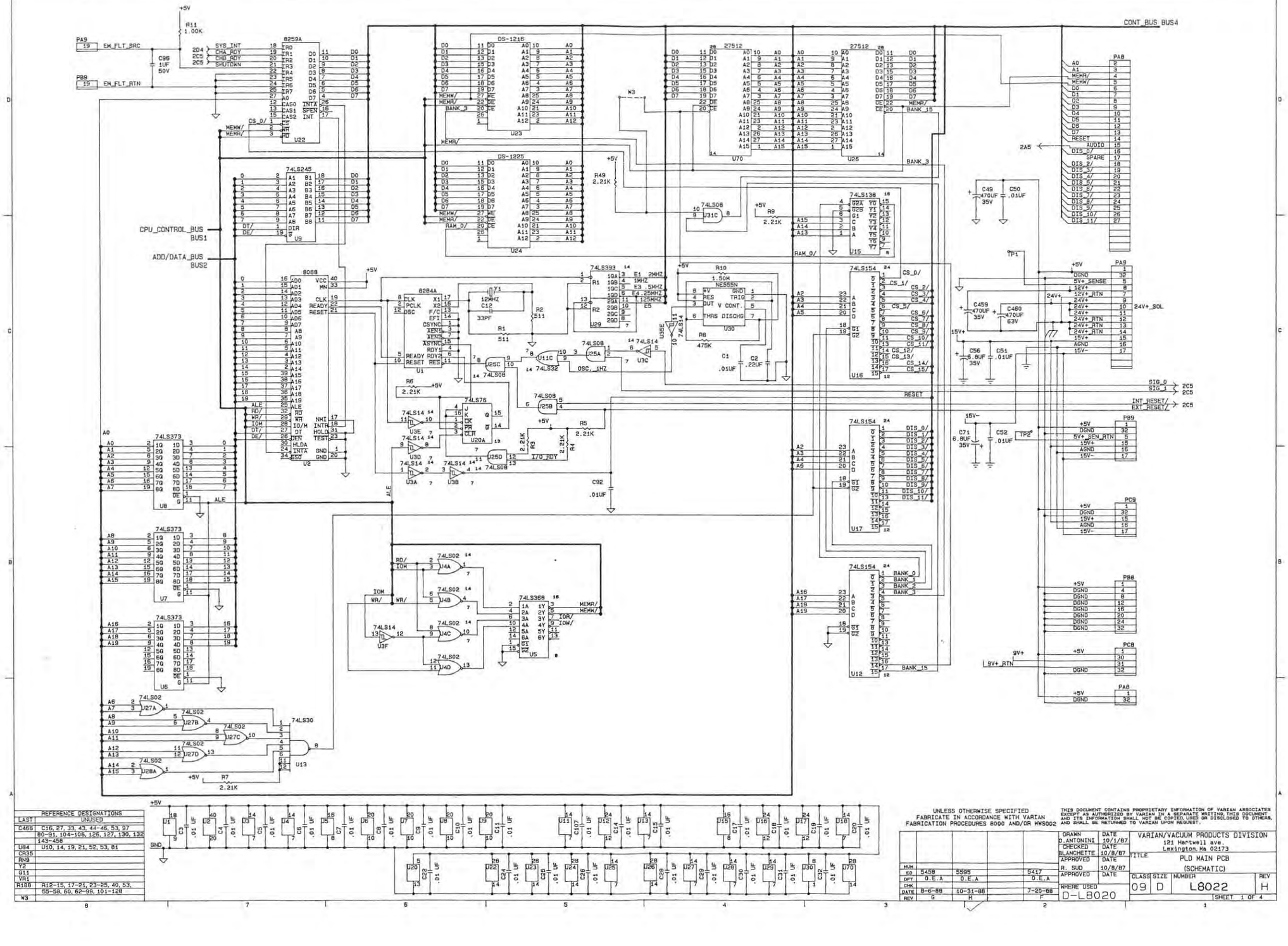
DESCRIPTION OF CHANGE		INITIAL RELEASE	SEE ECO	REVISION ADJUSTMENT			
NUM			5144	5513	5800	5860	6071
ECL			CEA	MRB		OEA	OEA
DFT	JJC		MRB	WCF			
CHK			WCF	9-8-88	1-30-89	5-3-89	6-22-89
DATE			11-1-87	A	B	J	K
REV		A					

NOT OTHERWISE SPEC: FRAC = ± ANG = ± | SCALE 1:1

FIN √ DEC X = ± XX = ± XXX = ±

varian | VAC. PROD. | D | L8020 | K

DIVISION | SIZE | DRAWING NO | REV



REFERENCE DESIGNATIONS	
LAST	UNUSED
C486	C16, 27, 33, 43, 44-46, 53, 97
	80-91, 104-106, 126, 127, 130, 132
	143-456
U84	U10, 14, 19, 21, 52, 53, 81
CR35	
RN9	
Y2	
U11	
VR1	
R188	R12-15, 17-21, 23-25, 40, 53,
	55-58, 60, 62-99, 101-128
W3	

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MUM				
SO	5458	5595		5417
DFT	O.E.A	O.E.A		O.E.A
CHK				
DATE	8-6-88	10-31-88		7-20-88
REV	G	H		F

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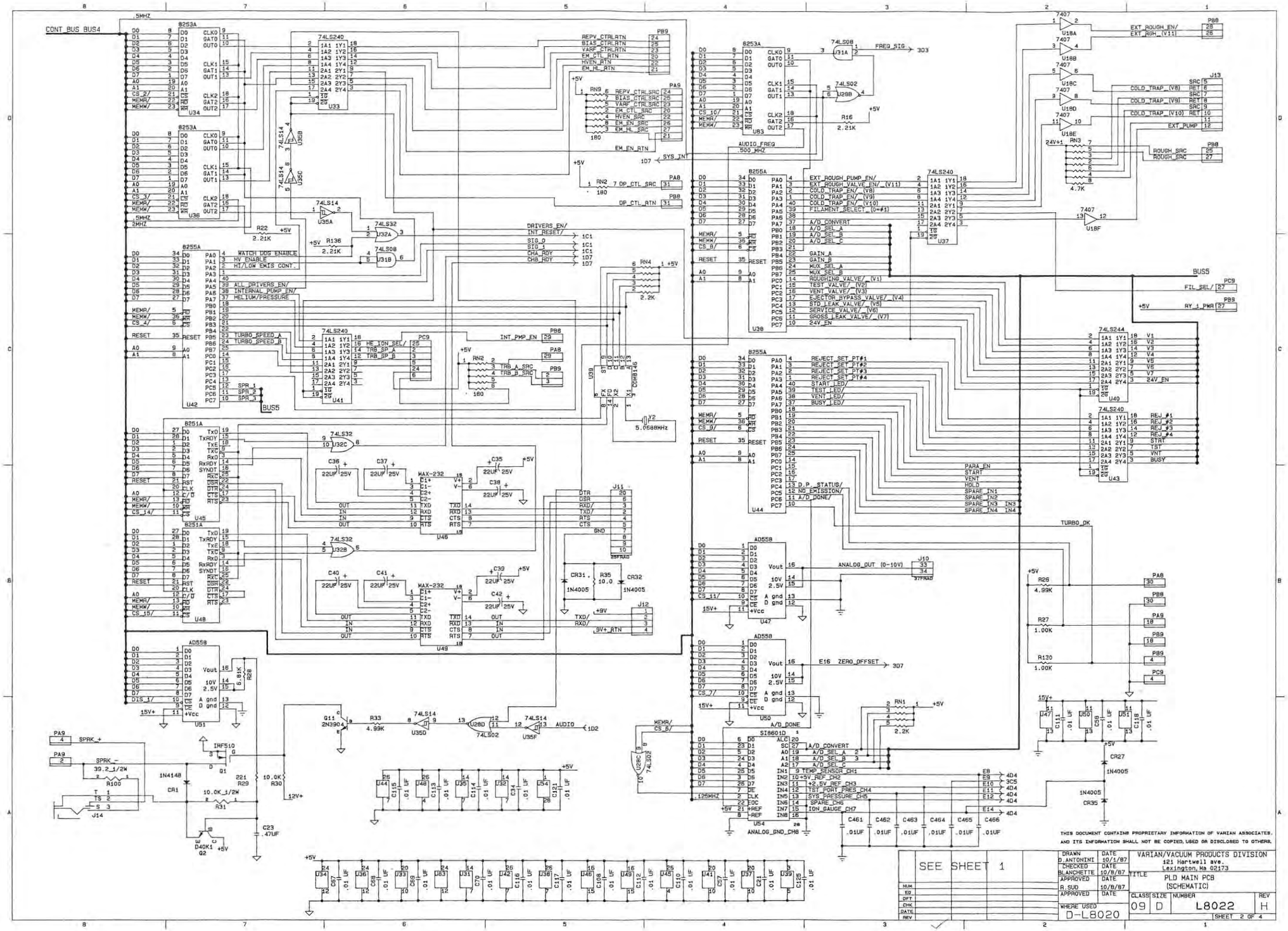
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APPROVED	R. SUD	DATE 10/8/87
APPROVED		DATE
WHERE USED	D-L8020	

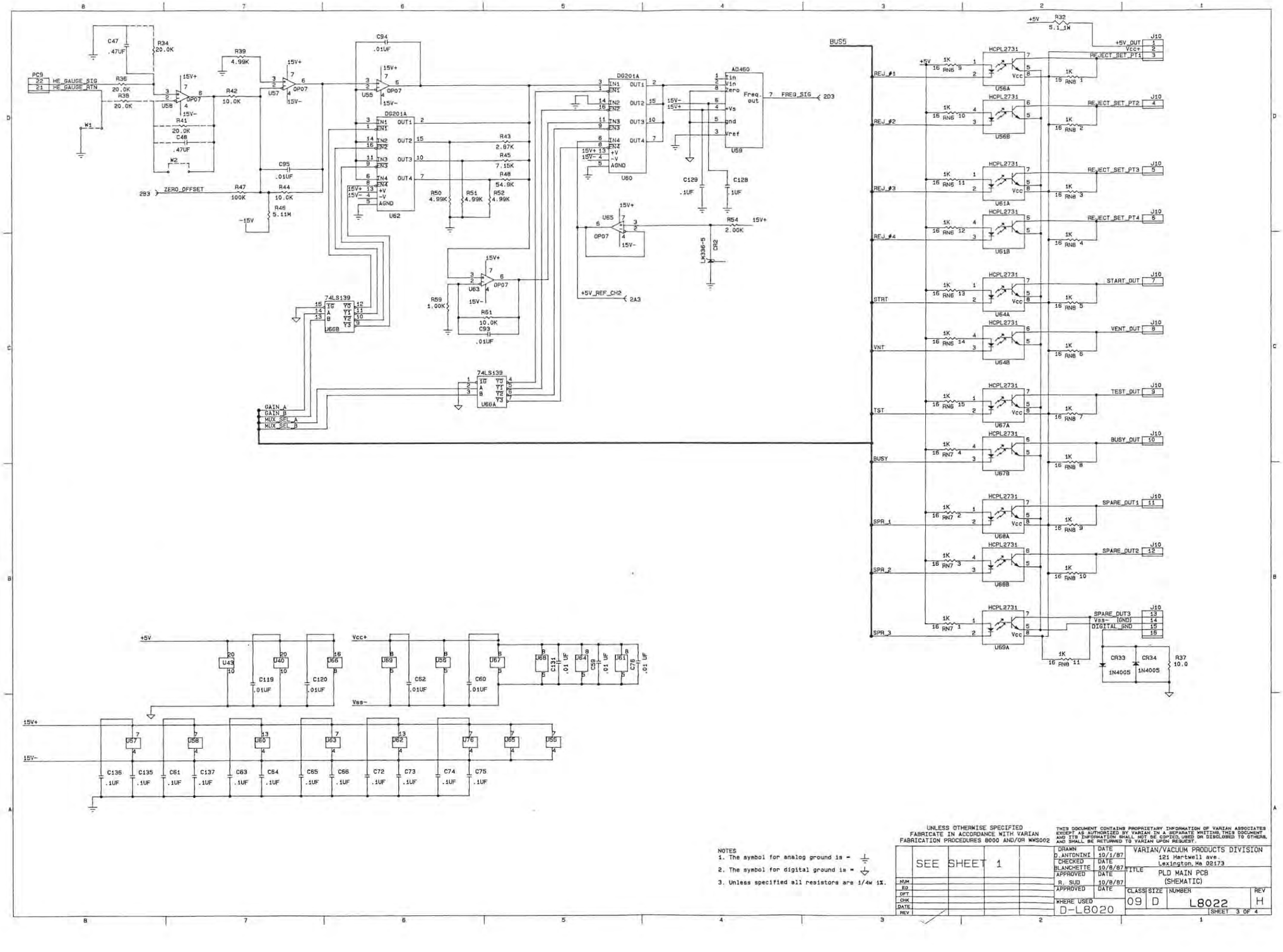
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TITLE: PLD MAIN PCB
(SCHEMATIC)

CLASS	SIZE	NUMBER	REV
09	D	L8022	H

SHEET 1 OF 4


CONT_BUS BUS4
.5MHZ
2MHZ
8253A
U34
U36
74LS240
U33
74LS14
U35A
U35B
U35C
74LS32
U32A
74LS08
U31B
74LS08
U31A
74LS02
U28B
74LS02
U28C
74LS02
U28D
74LS14
U35F
74LS14
U35D
74LS14
U35E
74LS32
U32C
74LS32
U32B
74LS32
U32D
8255A
U42
U41
U44
U43
U40
U38
8251A
U45
U46
U48
U49
MAX-232
AD558
U51
U47
U50
U37
SI8601D
U54
74LS244
74LS240
7407
U18A
U18B
U18C
U18D
U18E
U18F
RN3
4.7K
RN4
2.2K
RN2
180
RN1
2.2K
R16
2.21K
R22
2.21K
R136
2.21K
R26
4.99K
R27
1.00K
R130
1.00K
R33
4.99K
R35
10.0
R100
39.2_1/2W
R29
221
R30
10.0K
R31
10.0K_1/2W
R28
5.81K
Y2
5.0688MHz
Q1
IRF510
Q2
2N3904
CR1
1N4148
CR31
CR32
CR27
CR35
1N4005
J14
J10
J11
J12
J13
C23
.47UF
C36
C37
C38
C39
C40
C41
C42
C35
22UF 25V
C44
C45
C46
C47
C48
C49
C50
C51
C52
C53
C54
C55
C56
C57
C58
C59
C60
C61
C62
C63
C64
C65
C66
.01 UF
C111
C118
.01UF
REPV_CTRLRTN
BIAS_CTRLRTN
VARF_CTRLRTN
EM_CTL_RTN
HVEN_RTN
EM_HL_RTN
EM_EN_RTN
REPV_CTRLSRC
BIAS_CTRLSRC
VARF_CTRLSRC
EM_CTL_SRC
HVEN_SRC
EM_EN_SRC
EM_HL_SRC
DP_CTL_SRC
DP_CTL_RTN
AUDIO_FREQ
500_MHZ
SYS_INT
FREQ_SIG
EXT_ROUGH_EN/
EXT_RGH_(V11)
COLD_TRAP_(V8)
COLD_TRAP_(V9)
COLD_TRAP_(V10)
EXT_PUMP
ROUGH_SRC
ROUGH_SRC
EXT_ROUGH_PUMP_EN/
EXT_ROUGH_VALVE_EN/_(V11)
COLD_TRAP_EN/_(V8)
COLD_TRAP_EN/_(V9)
COLD_TRAP_EN/_(V10)
FILAMENT_SELECT_(0=#1)
A/D_CONVERT
A/D_SEL_A
A/D_SEL_B
A/D_SEL_C
GAIN_A
GAIN_B
MUX_SEL_A
MUX_SEL_B
ROUGHING_VALVE/_(V1)
TEST_VALVE/_(V2)
VENT_VALVE/_(V3)
EJECTOR_BYPASS_VALVE/_(V4)
STD_LEAK_VALVE/_(V5)
SERVICE_VALVE/_(V6)
GROSS_LEAK_VALVE/_(V7)
24V_EN
BUS5
FIL_SEL/
RY_1_PWR
REJECT_SET_PT#1
REJECT_SET_PT#2
REJECT_SET_PT#3
REJECT_SET_PT#4
START_LED/
TEST_LED/
VENT_LED/
BUSY_LED/
PARA_EN
START
VENT
HOLD
SPARE_IN1
SPARE_IN2
SPARE_IN3
SPARE_IN4
REJ_#1
REJ_#2
REJ_#3
REJ_#4
STRT
TST
VNT
BUSY
TURBO_OK
ANALOG_OUT (0-10V)
ZERO_OFFSET
A/D_DONE
ANALOG_GND_CH8
WATCH_DOG_ENABLE
HV_ENABLE
HI/LOW_EMIS_CONT.
ALL_DRIVERS_EN/
INTERNAL_PUMP_EN/
HELIUM/PRESSURE
TURBO_SPEED_A
TURBO_SPEED_B
SPR_1
SPR_2
SPR_3
HE_ION_SEL/
TRB_SP_A
TRB_SP_B
INT_PMP_EN
TRB_A_SRC
TRB_B_SRC
DRIVERS_EN/
INT_RESET/
SIG_0
SIG_1
CHA_RDY
CHB_RDY
SPRK_+
SPRK_-
AUDIO
TEMP_SENSOR_CH1
+5V_REF_CH2
+2.5V_REF_CH3
TST_PORT_PRES_CH4
SYS_PRESSURE_CH5
SPARE_CH6
ION_GAUGE_CH7
+5V_REF_CH8
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APPROVED DATE
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TITLE PLD MAIN PCB (SCHEMATIC)
CLASS 09 SIZE D NUMBER L8022 REV H
SHEET 2 OF 4



NOTES
1. The symbol for analog ground is =
2. The symbol for digital ground is =
3. Unless specified all resistors are 1/4w 1%.

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NUM
EQ
DFT
CHK
DATE
REV

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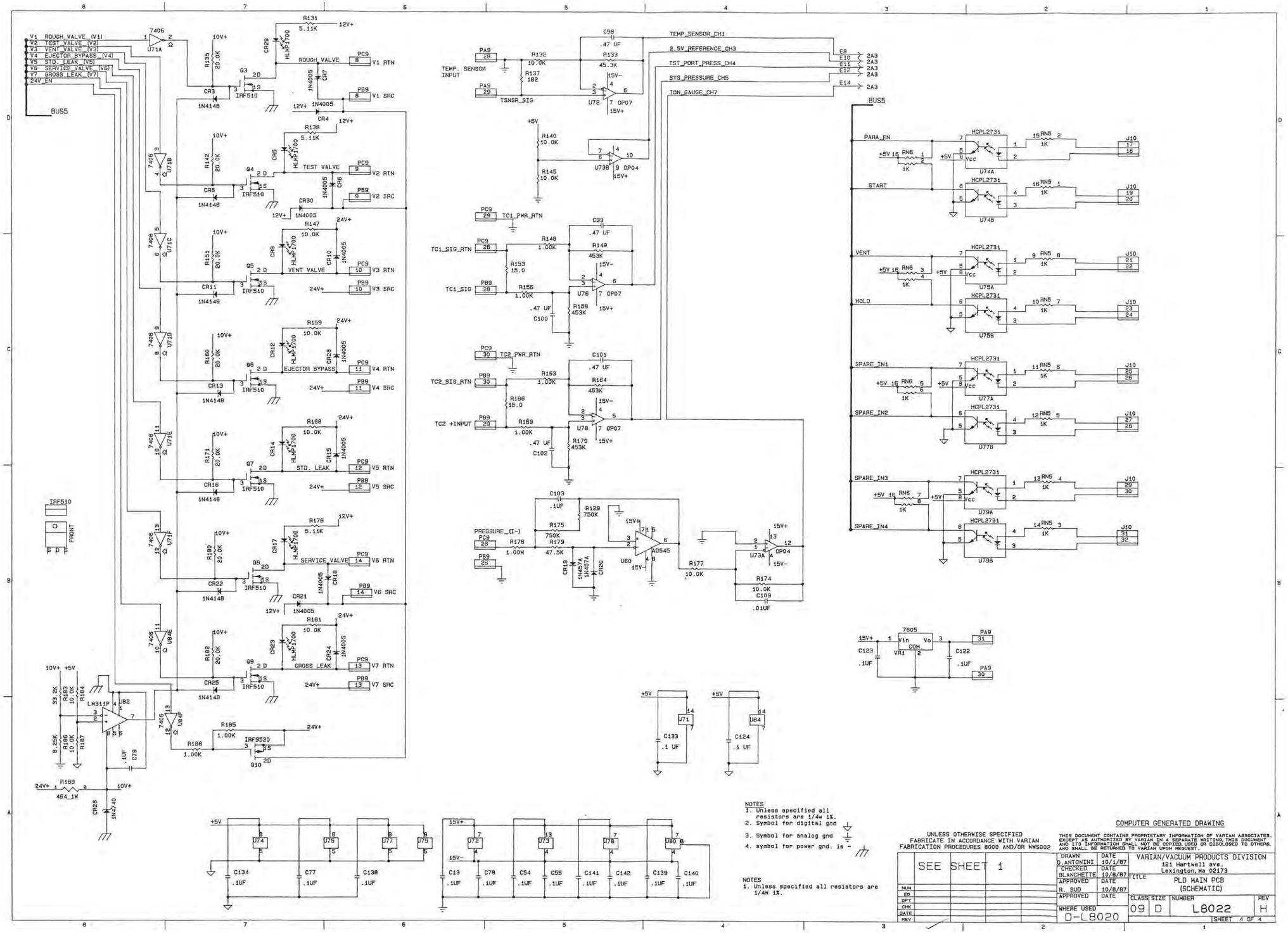
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TITLE: PLD MAIN PCB (SHEMATIC)

CLASS	SIZE	NUMBER	REV
09	D	L8022	H

SHEET 3 OF 4


V1 ROUGH_VALVE (V1)
V2 TEST_VALVE (V2)
V3 VENT_VALVE (V3)
V4 EJECTOR_BYPASS (V4)
V5 STD. LEAK (V5)
V6 SERVICE_VALVE (V6)
V7 GROSS_LEAK (V7)
24V_EN
BUS5
ROUGH VALVE
TEST VALVE
VENT VALVE
EJECTOR BYPASS
STD. LEAK
SERVICE VALVE
GROSS LEAK
V1 RTN
V1 SRC
V2 RTN
V2 SRC
V3 RTN
V3 SRC
V4 RTN
V4 SRC
V5 RTN
V5 SRC
V6 RTN
V6 SRC
V7 RTN
V7 SRC
IRF510
FRONT
TEMP. SENSOR INPUT
TSNSR_SIG
TEMP_SENSOR_CH1
2.5V_REFERENCE_CH3
TST_PORT_PRESS_CH4
SYS_PRESSURE_CH5
ION_GAUGE_CH7
TC1_PWR_RTN
TC1_SIG_RTN
TC1_SIG
TC2_PWR_RTN
TC2_SIG_RTN
TC2 +INPUT
PRESSURE_(I-)
PARA_EN
START
VENT
HOLD
SPARE_IN1
SPARE_IN2
SPARE_IN3
SPARE_IN4
NOTES
1. Unless specified all resistors are 1/4W 1%.
2. Symbol for digital gnd
3. Symbol for analog gnd
4. symbol for power gnd. is -
NOTES
1. Unless specified all resistors are 1/4W 1%.
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TITLE
PLD MAIN PCB
(SCHEMATIC)
CLASS 09 SIZE D NUMBER L8022 REV H
SHEET 4 OF 4

POWER SUPPLY BOARD

Introduction

The power supply board is housed with the CPU board in the card cage and contains the circuitry to supply voltages to the various electrical components in the system. It also contains a regulator circuit for controlling emission current and a second regulator circuit for controlling power to the diffusion pump heater coil. The power supply block diagram is shown in Figure 9-1. The AC line voltage can be either 110 or 220 volts (a jumper on the power supply board will allow operation from either line voltage). There is a filter and rectifier section which converts the AC line voltage into DC for use by the main converter section which is a switching power supply that controls the 24-volt output (labeled 24VINT). The flyback transformer in the converter has six secondary windings which supply the voltages listed in the block diagram. The diffusion pump power regulator is connected directly to the AC line voltage. This regulator can deliver as much as 500 watts to the diffusion pump. For this reason, it has been kept separate from the main converter section and is powered directly from the main AC line.

In the paragraphs that follow, each major component of the power supply board is described.

Main Converter

The main converter is a two-switch converter running off of DC power provided by the AC rectifier. The schematic for this circuit is shown on drawing L8025, sheet 2. Transformer TX1 has a primary winding N1 which is controlled by the two MOSFET's, Q10 and Q11. These transistors switch at roughly 100 kHz rate and provide power to the six secondary windings on transformer TX1.

Winding N5 on transformer TX1 provides a supply voltage to regulator VR1 which controls the 9V output.

A +15-volt supply is provided by winding N6. This voltage is also controlled by a three-terminal regulator VR2. A -15 volt supply is provided by winding N7. A three-terminal regulator VR3 controls this output. Ground for all three of these power supplies are connected to analog ground AGND.

Winding N4 provides a 12-volt semi-regulated output.

The regulated 24-volt output 24VINT is controlled by the primary feedback loop in the power supply. The control regulator is chip U26 which is a pulse width modulator. U27 provides the clock frequency to this chip. The control loop has a primary current sensing loop which controls the peak current in the primary of transformer TX1. There is an outer loop for this controller provided by measuring the size of the voltage on 24VINT. This feedback is provided through optocoupler U30 to provide isolation between the primary and secondary side of the power supply. The output voltage is controlled by varying the pulse widths delivered to MOSFET's Q10 and Q11 as the primary switches. Pulse width modulation varies the output voltage to close the loop.

A few additional features are provided in the basic converter control loop. Amplifier U31 detects an undervoltage condition and shuts down the pulse width modulator chip if the AC line voltage is too low. In addition, there are three secondary current sensors in the control loop. The output currents for the 12-volt supply, the unregulated 24-volt supply I24, and the regulated 24-volt supply 24VINT are measured. If these currents become too high, these conditions are OR'ed together to provide a fault condition shutting down the pulse width

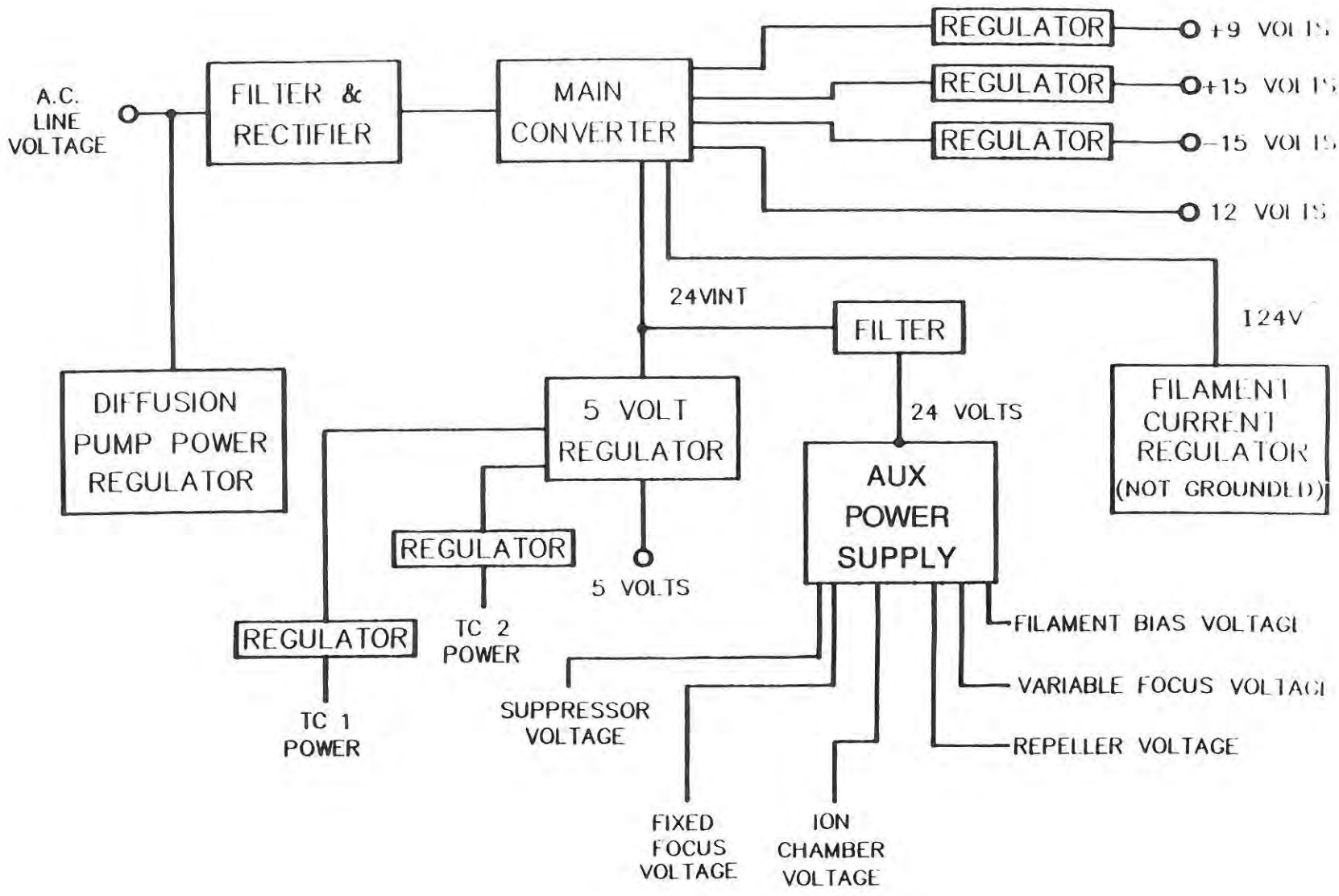


Figure 1. Power Supply Block Diagram

modulator. The undervoltage lockout amplifier and the three secondary current fault condition amplifiers are contained in chip U31.

5-Volt Regulator

The 5-volt regulator (see Figure 9-1) receives its power from the regulated 24-volt supply in the main converter. The 5-volt regulator schematic is shown on drawing L8025, sheet 3. The 5-volt regulator is implemented by using MOSFET transistor Q12 to switch voltage across inductor L5. When Q12 is on, energy is delivered to L5. When Q12 is off, energy is delivered from L5 to the 5-volt output.

The basic operation of the regulator is controlled by U28. This device has an inner and an outer loop for operation. The inner loop controls the peak current flowing through Q12. Measurement of this peak current is implemented using transformer TX6. The output of the transformer is rectified by CR46. This signal is fed back to U28 to sense the current flowing to inductor L5. The outer loop of the 5-volt supply is a voltage regulator. The output of the 5-volt supply is detected using the 5-volt sense lines. If these remote sense lines are not connected, resistors R160 and R161 provide internal connections to the 5-volt output. Remote sense amplifier U34 feeds back the output voltage for comparison with an internally-generated reference voltage in U28. Fine adjustment of the 5-volt power supply output can be implemented by adjusting potentiometer RV1. The pulse width modulation controller regulates the output by controlling the pulse on time delivered to the drive circuitry for Q12. The drive circuitry is implemented using transformer TX7 and its associated resistors and capacitors.

The regulator loop has an undervoltage lockout amplifier U34. If, for some reason, the 24-volt supply drops to a low value, the pulse width modulator is turned off by the output of U34.

The 5-volt supply also supplies the input to the two three-terminal regulators, VR4 and VR5, which in turn power thermocouples TC1 and TC2 which provide 150-ma currents to the test port thermocouple and system thermocouple respectively.

Auxiliary Power Supply

The auxiliary power supply provides the high voltages to operate the ion source and the mass spectrometer. Raw power is delivered to this controller by using the filtered 24-volt supply labeled 24V+. Again, pulse width modulation is used to control a current switch, Q8. This supply schematic is shown on drawing L8028. The pulse width modulation control is implemented by chip U22. The primary current in transformer TX10 is sensed by resistor R118. This peak current is controlled by the pulse width modulator. An outer loop senses the suppressor voltage provided by the secondary of TX10. The pulse width modulator controls the output voltage by varying the pulse width of the drive circuitry to Q8.

There are three fixed voltages generated in the auxiliary voltage supply, the suppressor voltage, the fixed focus voltage, and the ion chamber voltage. In addition, there are three variable voltages which are controlled by a variable frequency signal from the CPU. The three variable voltages are the filament bias voltage, the variable focus voltage, and the repeller voltage.

The commands for these voltages are generated using U16, U19, and U24, a frequency-to-voltage coverter (F/V converter). These chips convert variable frequency commands from the CPU to analog command voltages which are delivered to shunt regulators. The currents required from these three variable voltage supplies are low. Therefore, shunt regulators can be used to control their outputs. Chips U17, U20, and U25 are feedback amplifiers which compare the command voltage from the F/V converter with a sample of the output voltage. The

error signal generated is delivered to the base of Q7, Q9, and Q17. These transistors draw varying amounts of current through a voltage dropping resistor. This scheme controls the output voltage from the regulator. A sample of this output voltage is fed back to the operational amplifier thereby closing the loop. Capacitors C50, C58, and C72 provide frequency compensation to stabilize the feedback loop.

These three voltages (filament bias, variable focus, and repeller) controlled by the CPU can be adjusted by the operator to tune the system to detect helium.

Emission Current Regulator

The emission current regulator is used to control the emission current from the ion source. A schematic of this control loop is shown on drawing L8025, sheet 1. The power provided to the filament floats on top of the filament bias voltage supply. Therefore, the voltage which supplies this power must be floating rather than grounded. This floating supply is provided by I24V from the main converter section. Frequency-to-voltage converter U10 receives a command signal from the CPU to determine the current command signal. The output voltage provided to the filament element is controlled by the primary voltage switch Q4. This switch controls the primary current delivered to transformer TX9. The current through this switch is sensed through resistors R81 and R82. The primary current signal is fed back to pulse width modulator chip U14. Chip U13 is a clock chip which provides the timing signal for the pulse width modulator. The output voltage applied to the filament element is fed back to voltage sensing amplifier U12.

This basic design is similar to the pulse width modulation schemes used in other parts of the power supply. That is, the primary current in transformer TX9 is controlled by an inner loop and the voltage across the filament element is controlled by the outer voltage loop. This voltage regulator, in turn, is controlled by the current command from the frequency-to-voltage converter. Emission current from the filament element is measured across resistors R48 and R49. Switch Q3 is turned on if high emission current is required. When Q3 is turned off, the voltage is measured across both R48 and R49 to give low emission current. The range switching for emission current is provided through optocoupler U11.

The variable frequency signal from the CPU which commands the magnitude of the emission current is delivered through optocoupler U9. The emission enable circuitry is implemented using transistor Q6. A control line from the CPU allows the filament emission current to be turned on or off under operator control. The emission enable circuit signal is also provided through optocoupler U9.

There are two fault sensing circuits in the emission current regulator. Amplifiers U12 are used to sense a low current or open filament element condition. Pin 7 of U8 controls the emission low output of optocoupler U36. This signal ordinarily is low and will go high if a fault condition exists. This output is sensed by the CPU and generates an error message on the display indicating a burned out filament.

The output of U8, pin 1, controls the emission burst current error condition. If a large rate of change in the filament current is detected, the emission fault line output of optocoupler U36 goes high. This output is sensed by the CPU and generates a message on the display indicating a pressure burst in the mass spectrometer tube.

Diffusion Pump Power Regulator

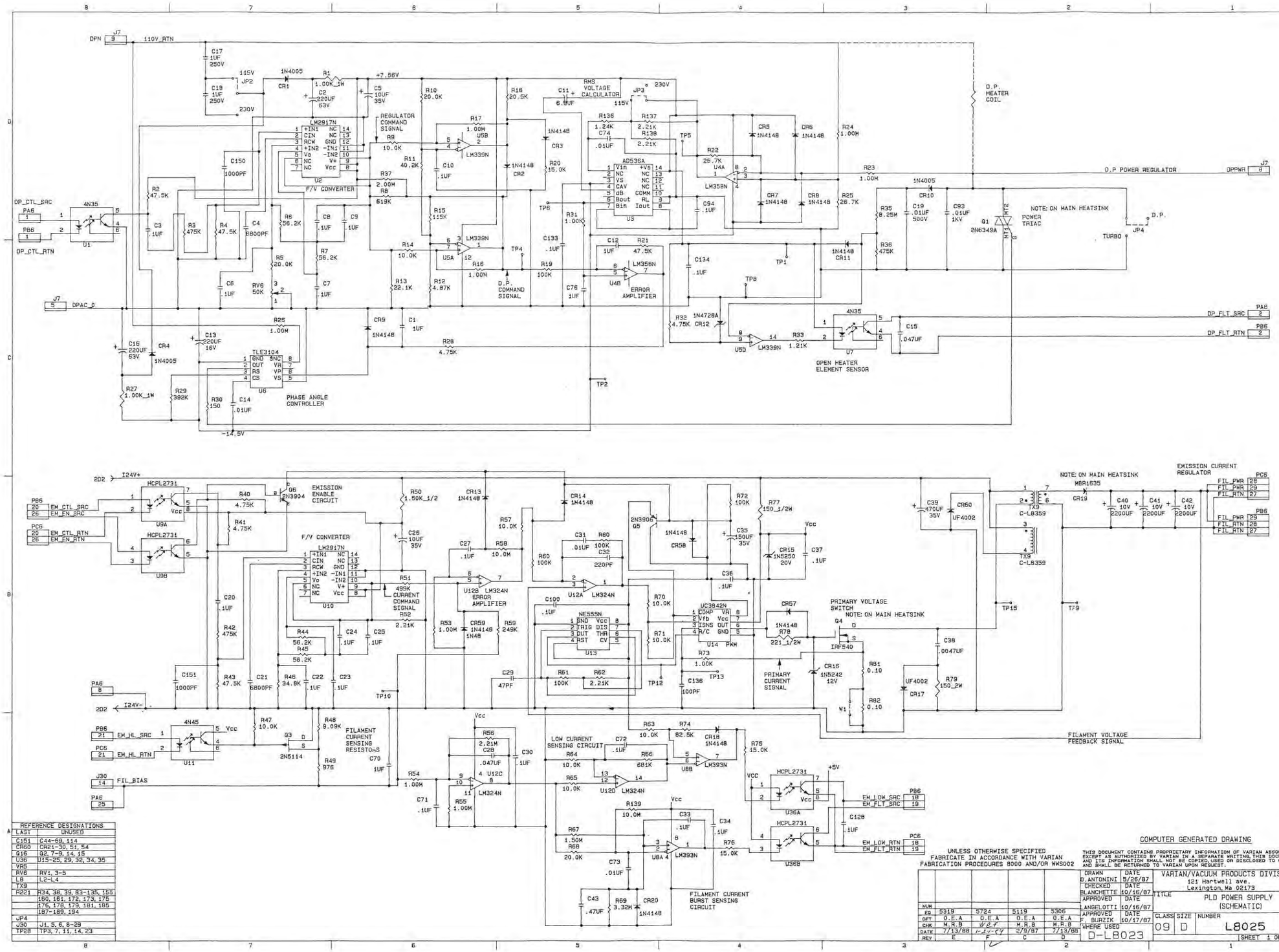
The schematic for the diffusion pump power regulator is shown on drawing L8025, sheet 1. The diffusion pump power regulator receives input power directly from the line voltage. A

switch in the circuit allows operation from either 110 or 220 volts. A +7.56-volt supply is generated by rectifying the AC line voltage using CR1. A -14.5 voltage is generated from the AC power using CR4.

This regulator is a feedback loop used to control the RMS voltage delivered to the diffusion pump heater coil. The power triac Q1 is connected in series with the heater coil to control the power delivered to the heater element by varying the firing angle of the triac. The firing angle is controlled by a phase angle controller chip U6. Chip U3 calculates the RMS voltage across the power triac. This output is compared with a command signal in error amplifier U4 (pins 5, 6, and 7). The error signal is used to control the phase angle controller (pin 6 of U6).

The power delivered to the diffusion pump heater coil is commanded by a frequency modulated signal applied to the control loop through optocoupler U1. This signal is converted to an analog command voltage by the frequency-to-voltage converter U2.

An open heater element condition is determined by a low voltage condition across the power triac. When the diffusion pump heater coil is connected, the voltage across the traic is never less than 25 volts RMS. This voltage is rectified and compared with a reference voltage Zener diode CR12. If the voltage does drop below 25 volts due to an open heater coil, the optocoupler U7 is not turned on. The open heater element condition is indicated by the diffusion pump fault line being high. This condition is sensed by the CPU and a message is displayed indicating an open diffusion pump heater coil.



REFERENCE DESIGNATIONS	
LAST	UNUSED
C151	C44-69, 114
CR60	CR21-30, 51, 54
Q16	Q2, 7-9, 14, 15
U36	U15-25, 29, 32, 34, 35
VR5	
RV6	RV1, 3-5
L8	L2-L4
TX9	
R221	R34, 38, 39, 83-135, 155 160, 161, 172, 173, 175 176, 178, 179, 181, 185 187-189, 194
JP4	
J30	J1, 5, 6, 8-29
TP28	TP3, 7, 11, 14, 23

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EQ				
DFT	D.E.A	D.E.A	D.E.A	D.E.A
CHK	M.R.B	WDF	M.R.B	M.R.B
DATE	7/13/88	12-14-87	2/9/87	7/13/88
REV	E	F	C	D

WHERE USED: D-L8023

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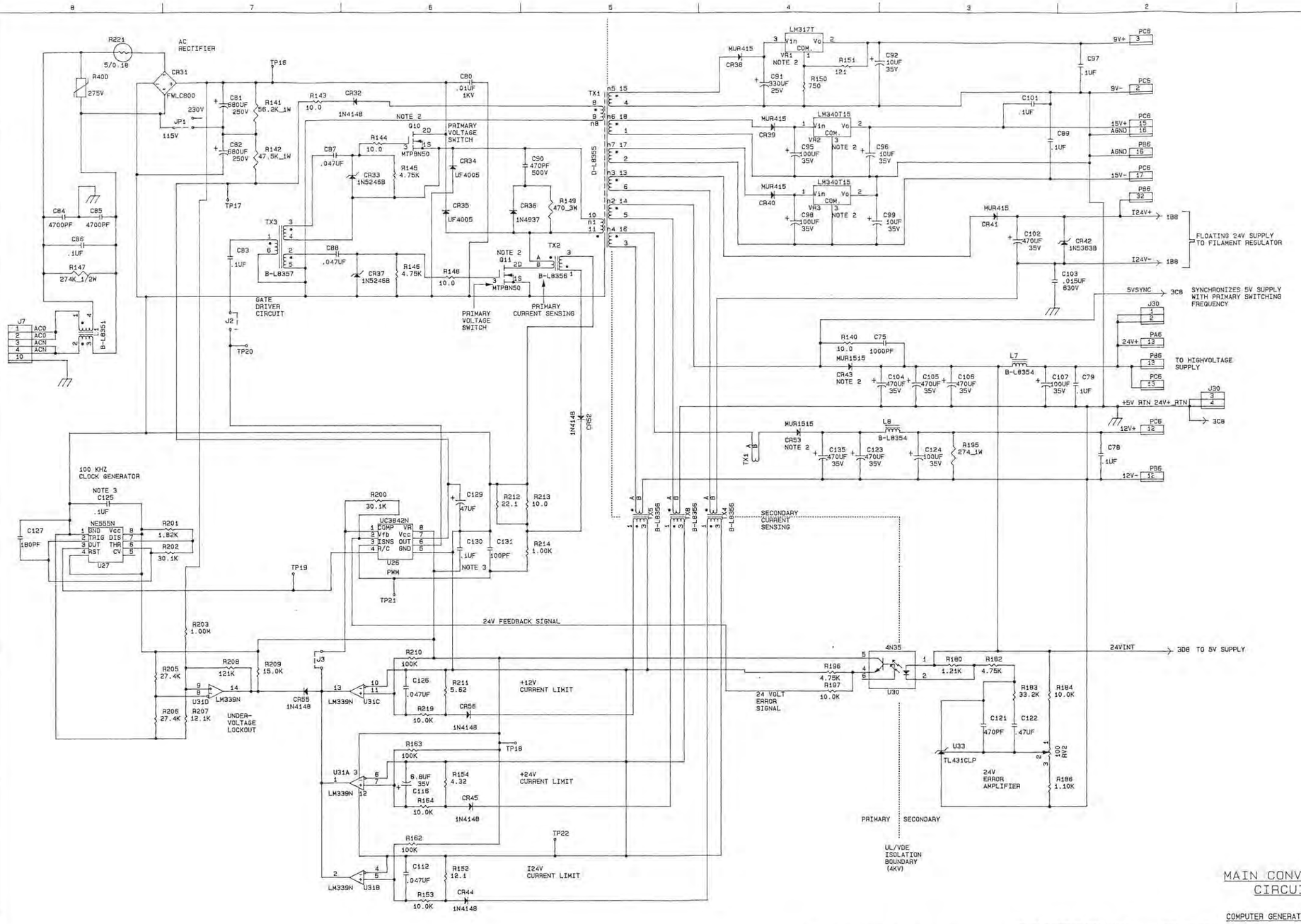
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APPROVED	F. BURITK	DATE 10/17/87

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TITLE: PLD POWER SUPPLY (SCHEMATIC)

CLASS	SIZE	NUMBER	REV
09	D	L8025	F

SHEET 1 OF 3



NOTES: 2 COMP TO BE MOUNT ON MAIN HEATSINK.
3 .1UF CAPS TO BE MOUNT AS NEAR AS POSSIBLE TO EACH DEVICE, U26 AND U27.
4 C92, C96 AND C99 TO BE NEAR TO VR1, VR2 AND VR3 AS APPLICABLE.

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DFT				
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DATE				
REV				

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APPROVED	F. BURZIK	DATE 12/18/87
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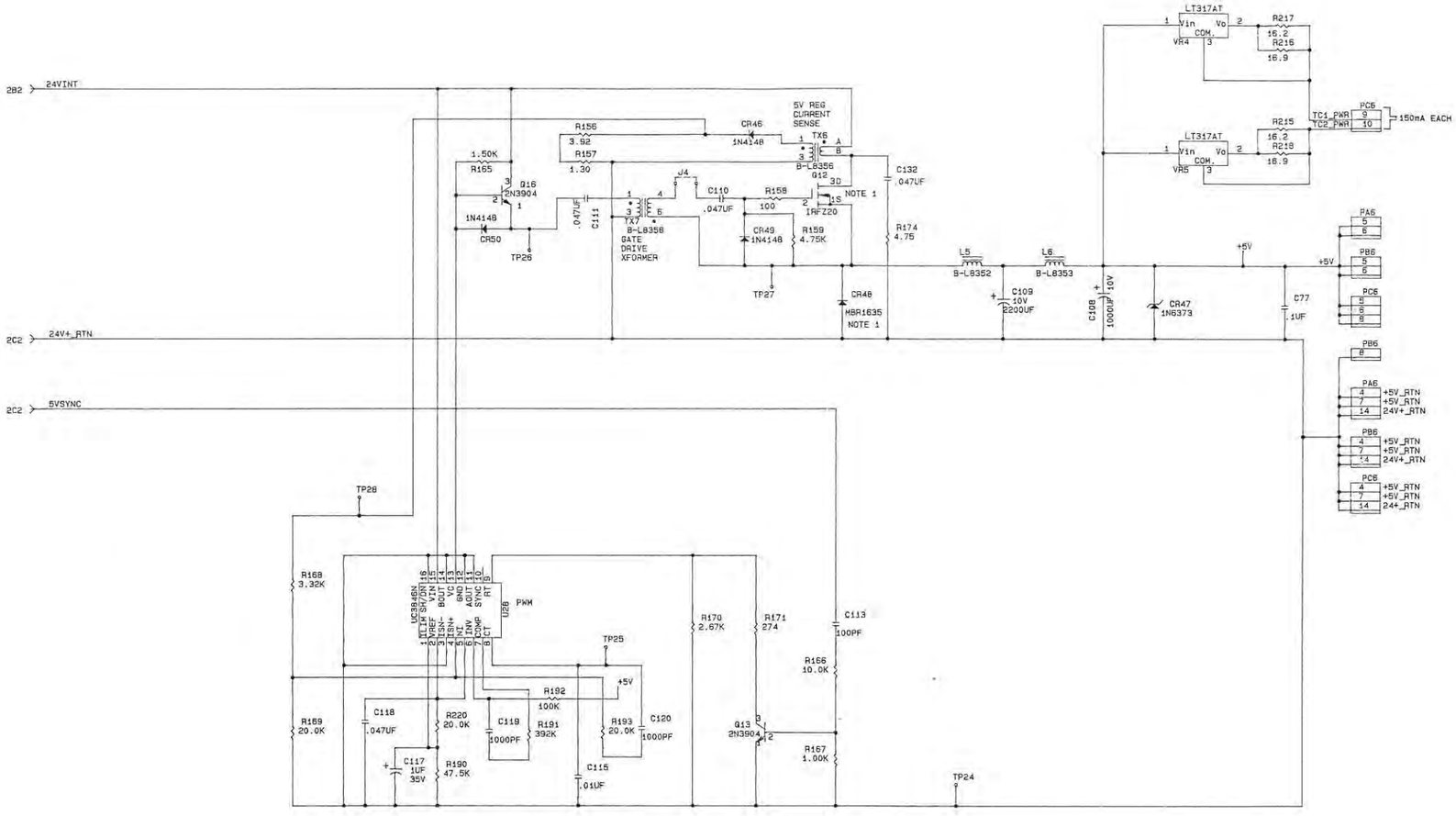
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CLASS	SIZE	NUMBER	REV
09	D	L8025	F

SHEET 2 OF 3

MAIN CONVERTER CIRCUIT

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P30		PA6
13	SUPRSR_V	25
15	APLR_V	28
17	FFOCUS_V	30
20	VFOCUS_V	32
6	HVEN_SRC	PB6 22
8	VARF_CTRLSRC	23
10	REPV_CTRLSRC	24
12	BIASCTRL_SRC	25
5	HVEN_RTN	
7	VARF_CTRLRTN	PC6
9	REPV_CTRLRTN	22
11	BIASCTRL_RTN	23
19	ION_CHAMBER	24
		25
		32

5 VOLT REGULATED SUPPLY

NOTE: 1 COMP. TO MOUNT ON HEATSINK (THERMALLOY #6021 OR EQUIV.)

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SEE SHEET 1

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		DATE
DRAWN	D.ANTONINI	5/26/87
CHECKED	BLANCHETTE	10/16/87
APPROVED	LANGELOTTI	10/16/87
APPROVED	F. BURZIK	12/18/87
WHERE USED	D-L8023	

VARIAN/VACUUM PRODUCTS DIVISION
121 Hartwell ave.
Lexington, Ma 02173

TITLE: PLD POWER SUPPLY (SCHEMATIC)

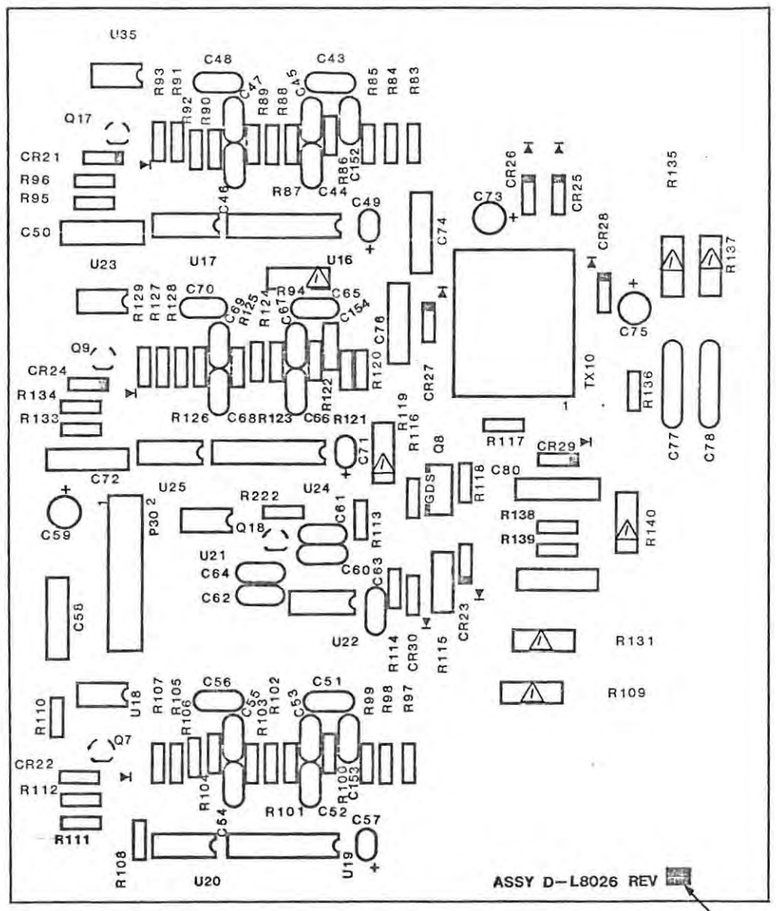
CLASS	SIZE	NUMBER	REV
09	D	L8025	F

SHEET 3 OF 3

ASY NO	TYPE OR MODEL	NEXT ASSEMBLY
	PT2	D-L8016

L8026

ITEM	PART NUMBER	DESCRIPTION OR MATERIAL	QTY



CLEARLY MARK ASSY REV IN INDELIBLE BLACK INK IN AREA SHOWN

NOTES: ⚠ COMP. TO BE MOUNT OFF PC CARD.

PARTS LIST: P/L

PARTS LIST IS ON A DETACHED DOCUMENT

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DESCRIPTION OF CHANGE	INITIAL RELEASE	REVISION ADJUSTMENT	BM UPDATE, CHG CAP DESIG			
NUM	—					
EO	—	5800	5850			
DFT	RJC		WSW			
CHK	[illegible]					
DATE	1-30-89	3-3-89				
REV	A	B	C			

DRAWN	DATE	APPROVED	DATE	CODE
A Antonini	10-13-87			
CHECKED	DATE	APPROVED	DATE	CLASS
MRB	10/14/87	WC#	10/27/87	09

POWER SUPPLY AUX. ASSY.

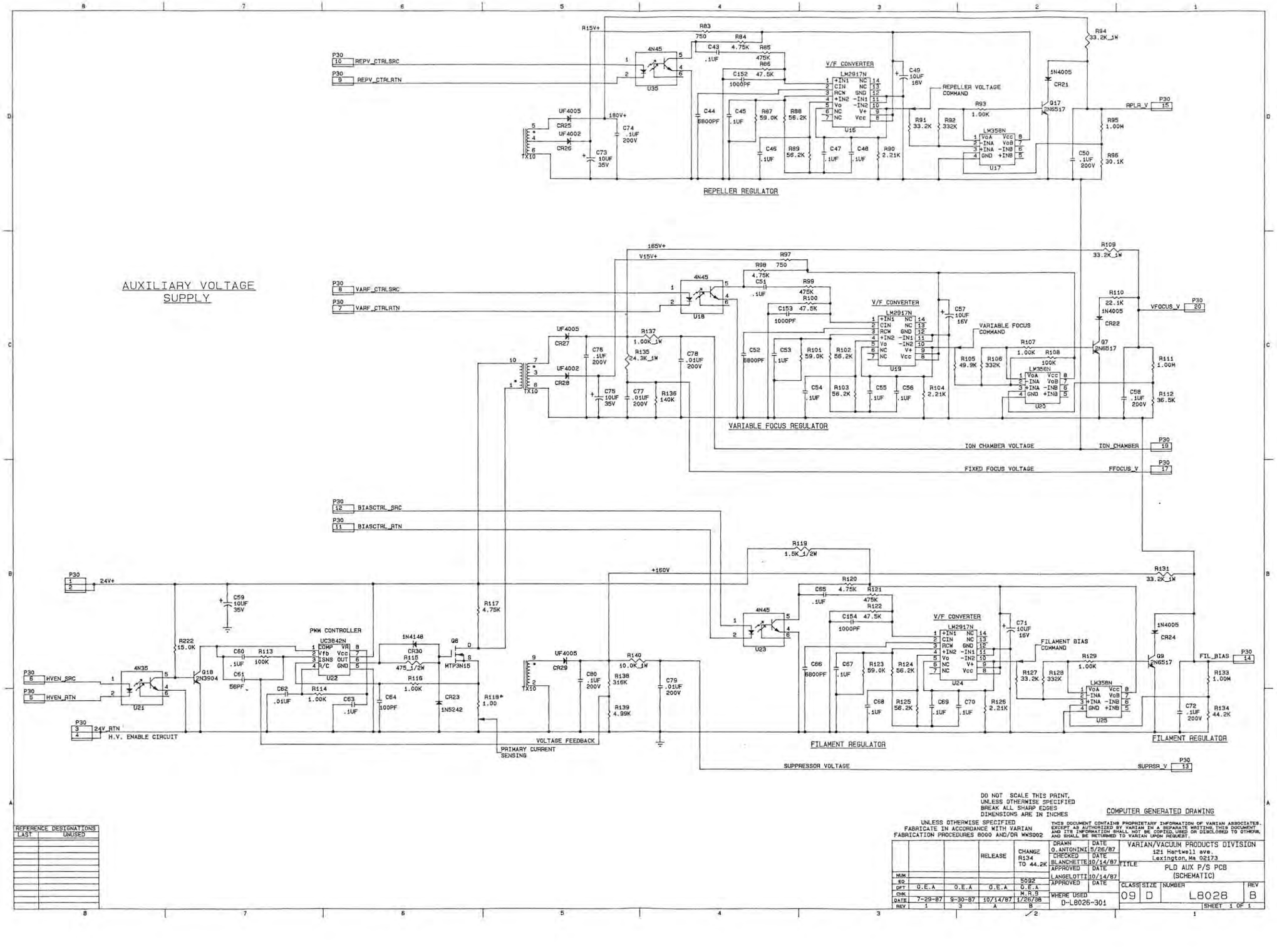
varian — VAC. PROD. | D | L8026301 | C

DIVISION | SIZE | DRAWING NO | REV

NOT OTHERWISE SPEC: FRAC = ± ANG = ± SCALE 2:1

FIN √ DEC X = ± XX = ± XXX = ±

AUXILIARY VOLTAGE SUPPLY



REFERENCE DESIGNATIONS	
LAST	UNUSED

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			RELEASE	CHANGE R134 TO 44.2K	
MJH					
EQ				5092	
DFT	O.E.A	O.E.A	O.E.A	O.E.A	
CHK				M.R.B	
DATE	7-29-87	9-30-87	10/14/87	1/26/88	
REV	1	3	A	B	

DRAWN	O.ANTONINI	DATE 5/26/87
CHECKED	BLANCHETTE	DATE 10/14/87
APPROVED	LANGELOTTI	DATE 10/14/87
APPROVED		DATE

WHERE USED: D-L8026-301

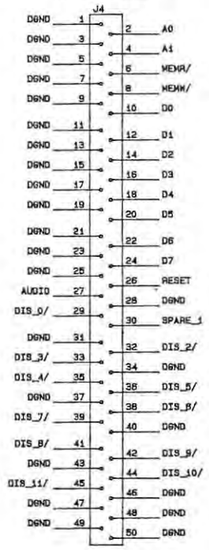
VARIAN/VACUUM PRODUCTS DIVISION
121 Hartwell ave.
Lexington, Ma 02173

TITLE: PLD AUX P/S PCB (SCHEMATIC)

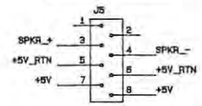
CLASS	SIZE	NUMBER	REV
09	D	L8028	B

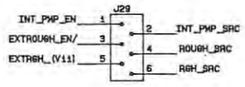
SHEET 1 OF 1

TO FRONT PANEL

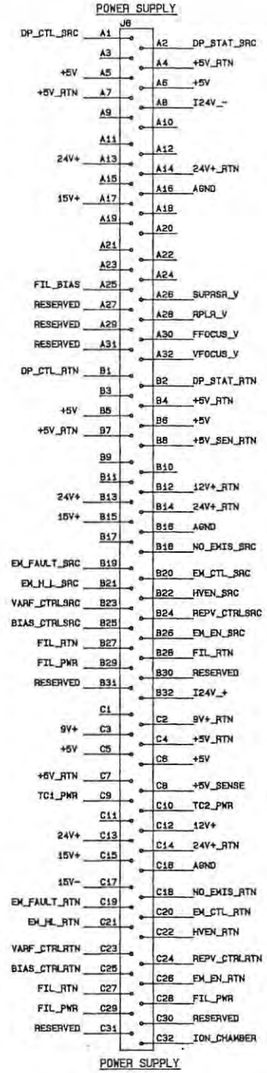


TO FRONT PANEL (PWR)



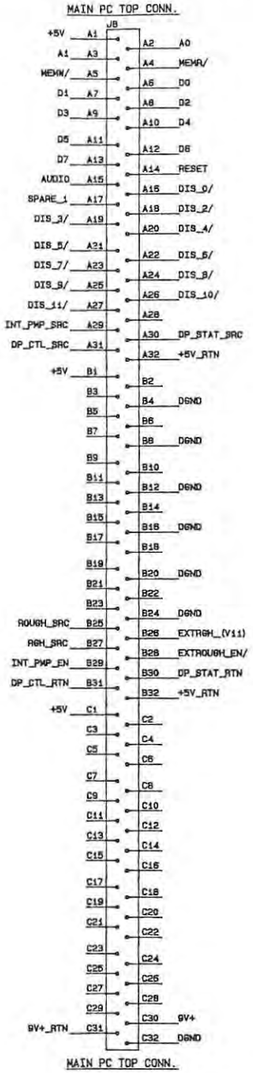


POWER SUPPLY



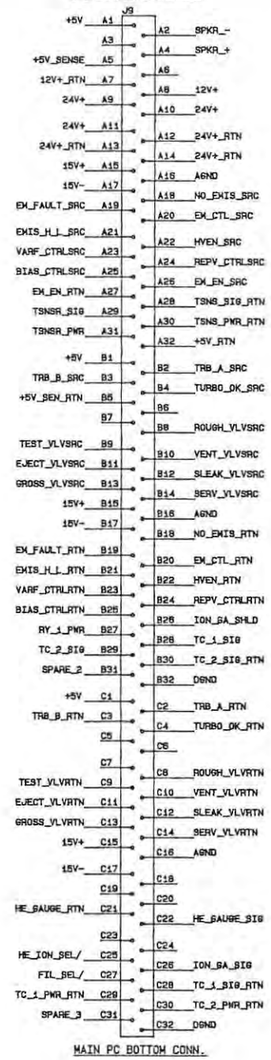
POWER SUPPLY

MAIN PC TOP CONN.



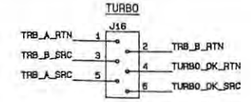
MAIN PC TOP CONN.

MAIN PC BOTTOM CONN.

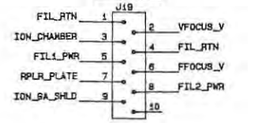


MAIN PC BOTTOM CONN.

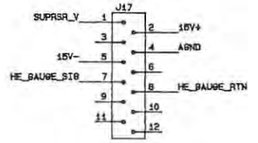
TURBO



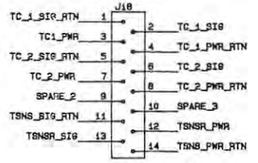
ION SOURCE



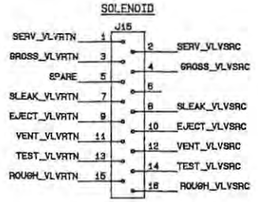
PREAMP

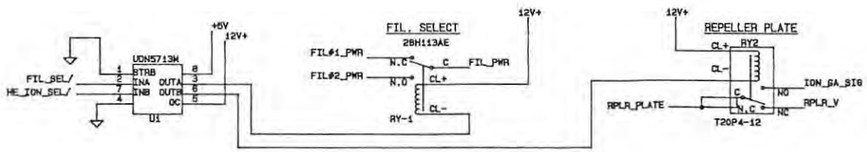


TC SENSOR



SOLENOID





REFERENCE DESIGNATIONS	
LAST	UNUSED

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FABRICATE IN ACCORDANCE WITH VARIAN
FABRICATION PROCEDURES 8000 AND/OR WWS002

	DEL. R1	DEL. RY1		RELEASE
NUM				
EQ	5028	5176		
DFT	O.E.A	O.E.A		M.J.C.
CHK		M.C.F		
DATE	11/12/87	3/15/88		10/15/87
REV	B	C		A

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DRAWN	D.ANTONINI	DATE 10/15/87
CHECKED	BLANCHETTE	DATE 10/15/87
APPROVED	R. SUD	DATE 10/15/87
APPROVED		DATE
WHERE USED	D-L8029	

VARIAN/VACUUM PRODUCTS DIVISION
121 Hartwell ave,
Lexington, Ma 02173

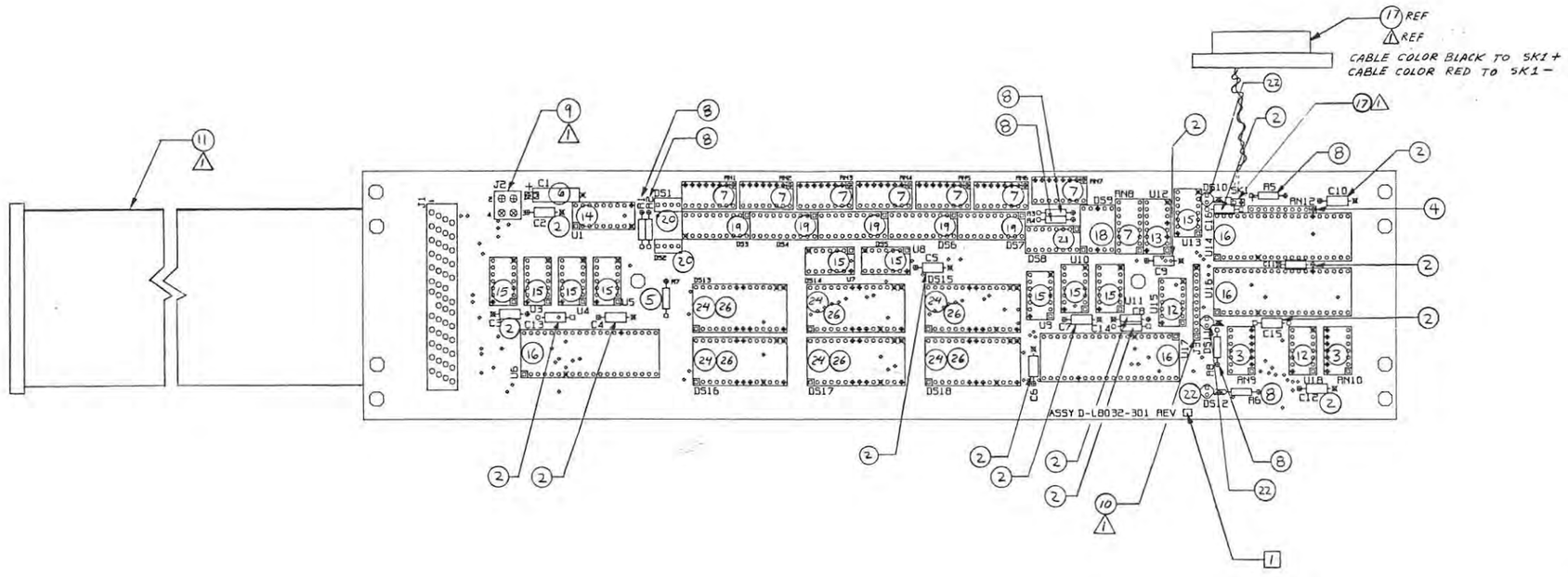
TITLE
PLD BACKPLANE
(SCHEMATIC)

CODE	SIZE	NUMBER	REV
09	D	L8031	C

SHEET 1 OF 1

DASH NO	TYPE OR MODEL	NEXT ASSEMBLY
		D-L8015

REQ	PART NUMBER	DESCRIPTION OR MATERIAL	ITEM



NOTE: 1 COMP. TO BE MOUNTED ON SOLDER SIDE.

PARTS LIST: P/L-L8032301

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DESCRIPTION OF CHANGE	INITIAL RELEASE	REVISION ADJUSTMENT		
NUM	—	5190		
EO	—		5800	
DFT	99C	DEA		
CHK	—	WCF		
DATE	—	3-15-88	1-30-89	
REV	A	B	C	

DRAWN	DATE	APPROVED	DATE	CODE
D Antonini	10-8-87		10/14/87	
CHECKED	DATE	APPROVED	DATE	CLASS
M Blanchette		WCF	10/14/87	09

CONTROL PANEL ASSY PT II

varian

NOT OTHERWISE SPEC. FRAC = ± ANG = ± SCALE 1:1

FIN √ DEC X = ± XX = ±.010 XXX = ±.005

VAC. PROD. | D | L8032301 | C

DIVISION | SIZE | DRAWING NO. | REV

591BS1

BIRLINING

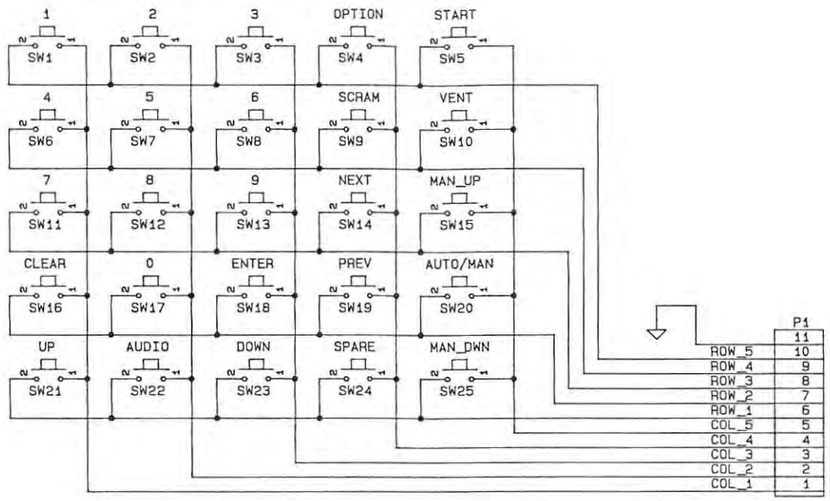
461-6-6 NOV84

REFERENCE DESIGNATIONS	
LAST	UNUSED
R8	
RN12	RN11
DS12	
U18	
C17	
SK1	

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ADD C17 CHANGE C6 6.8UF	ADD C13-C16	RELEASE	DRAWN D.ANTONINI	DATE 10/1/87	VARIAN/VACUUM PRODUCTS DIVISION 121 Hartwell ave. Lexington, Ma 02173
			CHECKED BLANCHETTE	DATE 10/7/87	
			APPROVED J. QUILTY	DATE 10/9/87	TITLE CONTROL PANEL PCB (SCHEMATIC) PT II
NUM 5455			APPROVED F. BURZIK	DATE 10/9/87	
EO			WHERE USED		CLASS 09 SIZE D NUMBER L8034 REV B
DFT D.E.A		D.E.A	D-L8032		
CHK W.C.F.		M.R.B.			SHEET 1 OF 1
DATE 8-3-88		9-18-87	10-7-87		
REV B		4	A		



REFERENCE DESIGNATIONS	
LAST	UNUSED

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	INITIAL RELEASE				
NUM					
ED	R0023				
DFT	MRB				
CHK					
DATE	11/16/87				
REV	A				

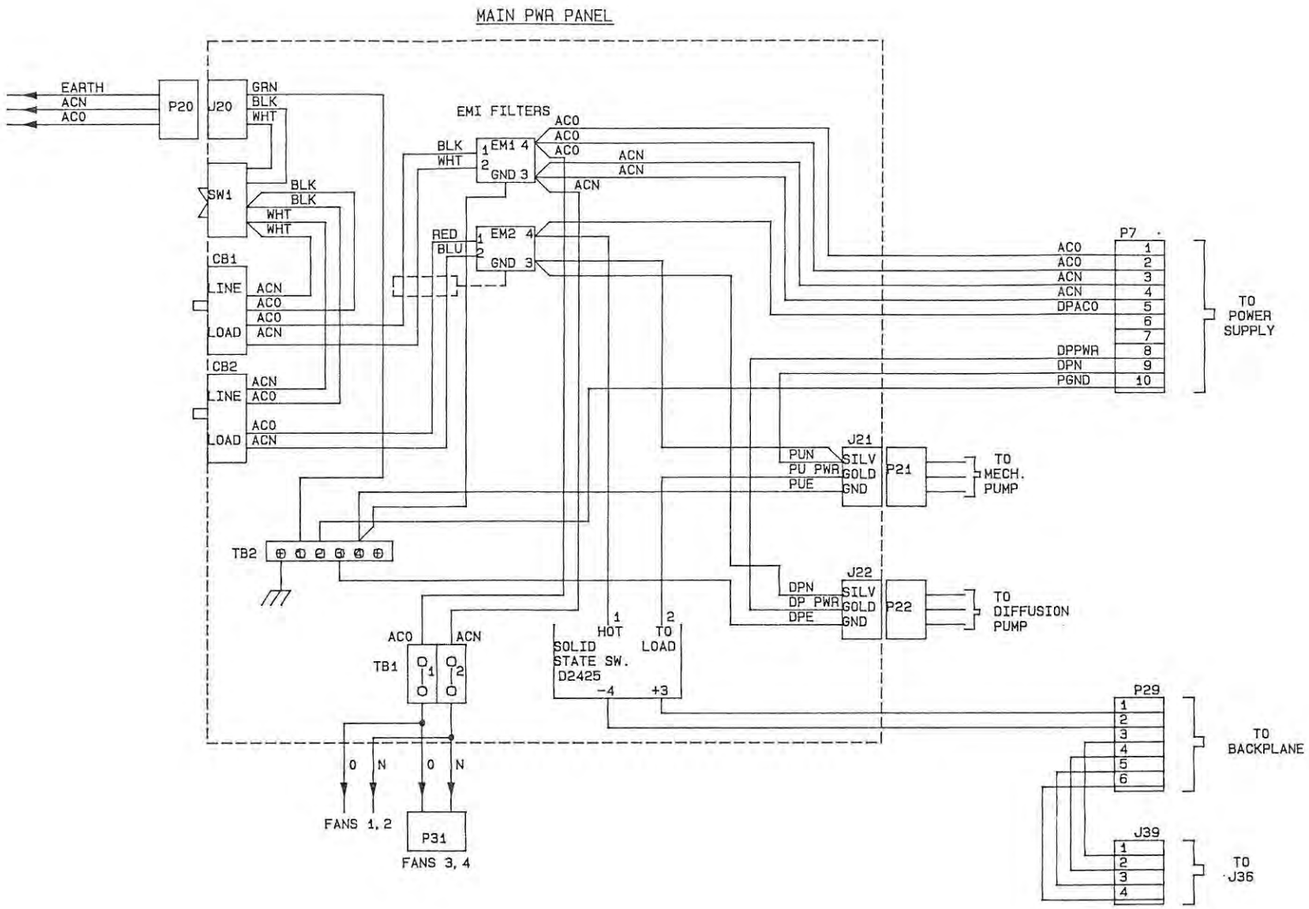
DRAWN O.ANTONINI	DATE 10/1/87
CHECKED BLANCHETTE	DATE 11/12/87
APPROVED R. SUD	DATE 11/12/87
APPROVED W.L.F	DATE 11/16/87
WHERE USED D-L8079	

VARIAN/VACUUM PRODUCTS DIVISION
121 Hartwell ave.
Lexington, Ma 02173

TITLE
CONTROL PANEL KEYBOARD
(SCHEMATIC) PT II

CLASS	SIZE	NUMBER	REV
09	C	L8345	A

SHEET 1 OF 1



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FABRICATION PROCEDURES 8000 AND/OR WWS002

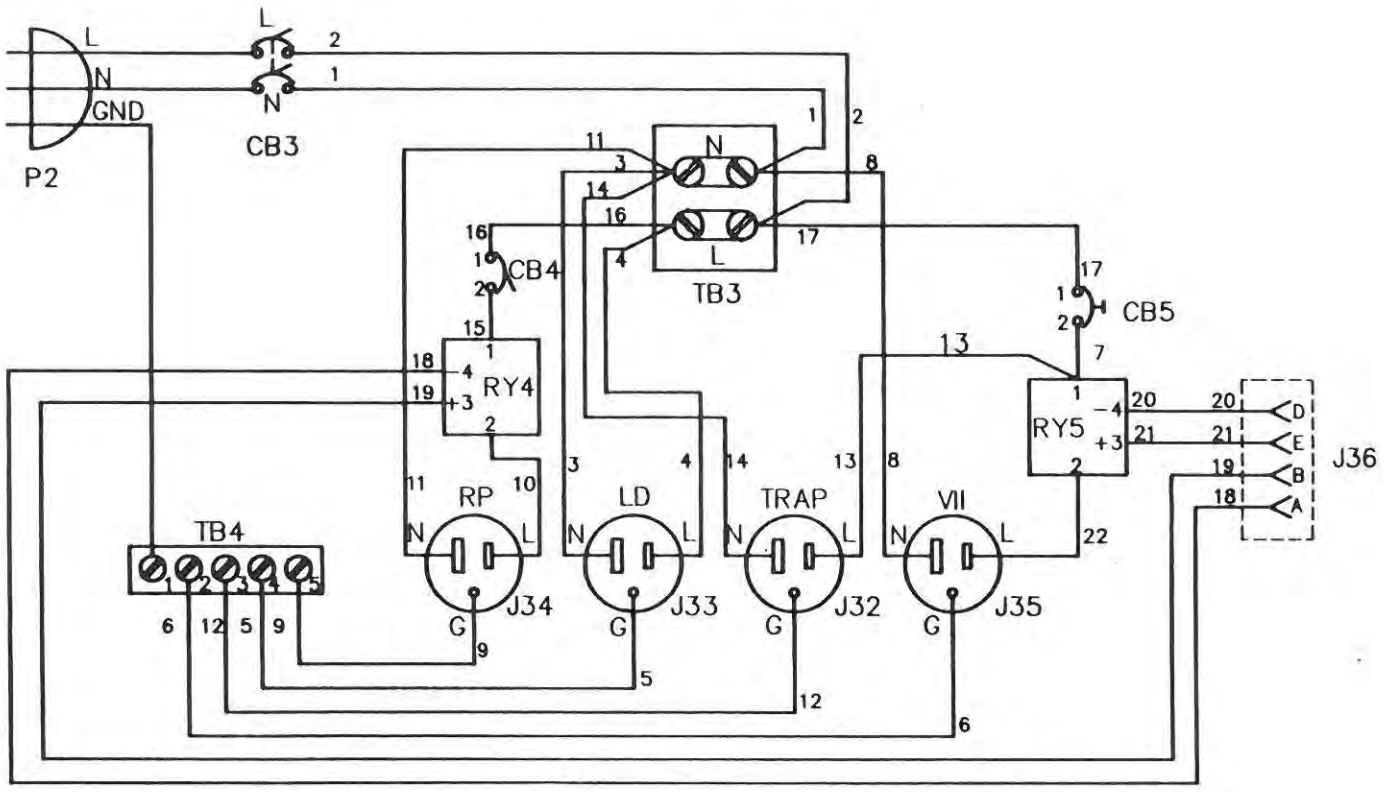
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					DRAWN O.ANTONINI	DATE 3/21/88
					CHECKED M.R.B.	DATE 8/25/88
					APPROVED	DATE
NUM					APPROVED	DATE
ECO						
DFT				O.E.A		
CHK				M.R.B.	WHERE USED	

VARIAN/VACUUM PRODUCTS DIVISON
121 Hartwell ave.
Lexington. MA 02173

TITLE PLD MAIN PWR
(DIAGRAM)

CLASS	SIZE	NUMBER	REV
09	C	L8409	A



Cart AC Power Assembly Schematic Diagram