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varian

844/845
cvt model

DIGITAL IONIZATION GAUGE CONTROL

operating instructions

varian / lexington vacuum division / 121 hartwell avenue / lexington / massachusetts 02173 / (617) 861-7200

III

Note

1. This manual should be read in its entirety before operation of the Ionization Gauge Control is attempted. A thorough description is given of the control and its operation to assist the user in proper operation.

2. This manual applies only to 844/845 CVT units that have an "S" at the end of the serial number.

3. Operating manual part number 0881-6999-08-044 refers to 844/845 units with serial numbers which *do not end in an "S".*

CAUTION

HIGH VOLTAGE INSIDE CONTROL, AT GAUGE TUBE CONNECTIONS AND UHV FUSE. CAN CAUSE INJURY OR DEATH.

0881-6999-08-043
Edition No. 2
September 1981

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I. GENERAL INFORMATION

CAUTION

HIGH VOLTAGE INSIDE CONTROL, AT GAUGE TUBE CONNECTIONS AND UHV FUSE. CAN CAUSE INJURY OR DEATH.

This manual contains operating instructions and maintenance information for the Digital Ionization Gauge Control. Model 844 operates three types of hot filament ionization gauge tubes and provides digital readout of vacuum system pressure from 10^{-1} Torr down to 10^{-11} Torr. Model 845, in addition, provides meter pressure readout from 5 to 2000 millitorr using the Varian 531 Thermocouple Vacuum Gauge Tube.

Compatible ion gauge tubes are the Varian 564, for readings of 10^{-1} Torr (in Argon), the Varian 563, 571, for readings to 10^{-3} Torr and Varian UHV series tubes for readings from 10^{-3} Torr into the UHV region. The low pressure readout capability of the controller is below the x-ray limit of all these tubes.

The control is entirely auto-ranging, requires no operator adjustments and is available with process control options making it ideally suited for industrial or scientific vacuum applications where hot filament ionization gauges or both thermocouple and ionization gauges are used to monitor pressure.

DIGITAL IONIZATION 844/845 CVT GAUGE CONTROLS
60 Hz, Torr Display

844 Digital Ionization Gauge Control, no set points 0844-K8844-301

844 Digital Ionization Gauge Control with two ion gauge set points 0844-K8844-302

844 Digital Ionization Gauge Control non-set point model, with dual ionization gauge tube switch 0844-K8844-503

844 Digital Ionization Gauge Control, set point model, with dual ionization gauge tube switch 0844-K8844-504

845 Digital Ionization Gauge Control with two independent thermocouple gauge controls and one thermocouple gauge set point 0845-K8845-301

845 Digital Ionization Gauge Control with two independent thermocouple gauge controls, one thermocouple gauge set point and two ion gauge set points 0845-K8845-302

845 Digital Ionization Gauge Control non-set point model with dual ionization gauge tube switch 0845-K8845-503

845 Digital Ionization Gauge Control set point model with dual ionization gauge tube switch 0845-K8845-504

NOTE Models listed above are: 115/230V, ±15%; 60 Hz; 200 W
Factory set for 115V

DIGITAL IONIZATION 844/845 CVT GAUGE CONTROLS
50 Hz, Torr Display

844 Digital Ionization Gauge Control, no set points 0844-K8854-301

844 Digital Ionization Gauge Control with two ion gauge set points 0844-K8854-302

844 Digital Ionization Gauge Control non-set point model, with dual ionization gauge tube switch 0844-K8854-503

844 Digital Ionization Gauge Control, set point model, with dual ionization gauge tube switch 0844-K8854-504

845 Digital Ionization Gauge Control with two independent thermocouple gauge controls and one thermocouple gauge set point 0845-K8855-301

845 Digital Ionization Gauge Control with two independent thermocouple gauge controls, one thermocouple gauge set point and two ion gauge set points 0845-K8855-302

845 Digital Ionization Gauge Control non-set point model with dual ionization gauge tube switch 0845-K8855-503

845 Digital Ionization Gauge Control set point model with dual ionization gauge tube switch 0845-K8855-504

NOTE Models listed above are: 115/230V, ±15%; 50 Hz; 200 W
Factory set for 115V

INTERNATIONAL MODELS: 50 Hz, mbar Display

844 Digital Ionization Gauge Control 0844-K8844-305

844 Digital Ionization Gauge Control with two ion gauge set points 0844-K8844-306

845 Digital Ionization Gauge Control with two independent thermocouple gauge controls and one thermocouple gauge set point 0845-K8845-305

845 Digital Ionization Gauge Control with two independent thermocouple gauge controls, one thermocouple gauge set point and two ion gauge set points 0845-K8845-306

NOTE: European models are: 115/230V, ±15%; 50 Hz; 200W
Factory set for 230V

OPTIONS:

A Auto Filament Turn-on option (user installed) 0891-K3128-301

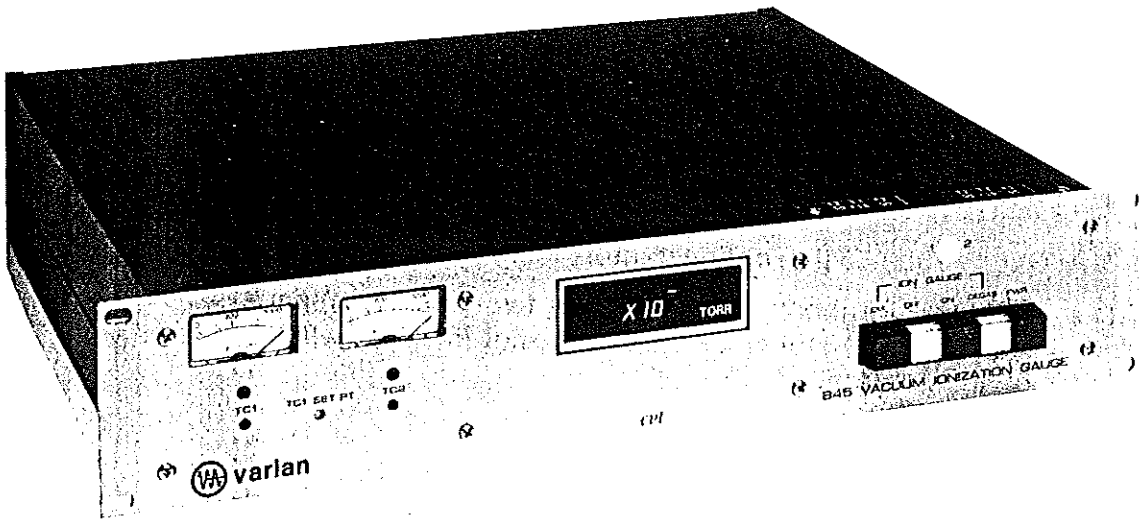
B Non-bakeable Ion Gauge Cable 0881-K3143-310

C Bakeable UHV Ion Cable for nude gauge (200 °C) 0891-K3938-310

D Dual Gauge Tube Switch option (factory installed only) .....

The dual tube switchbox option requires two ion cables (part number 0881-K3143-310) since cables are not included with these gauge controls.





SPECIFICATIONS

Power Required	200 W, 98-132/195-264 Vac, 60 Hz only
Power Required	200 W, 98-132/195-264 Vac, 50 Hz only
Thermocouple Gauge Range	1 x 10^{-3} to 2 Torr (indicates to atmosphere)
Ionization Gauge Range	Ten full decades, 10^{-11} through 10^{-2} Torr inclusive
Zero Drift	Negligible after 30 min. warm-up
Degas	50 W resistive (563 and 564 gauge tubes)
	25 W electron bombardment (UHV series gauge tubes)
Recorder Output	0 to + 10 V per decade range
Operating Temperature Range	0 °C to 50 °C
Grid Voltage	+ 180 V
Filament Bias Voltage	+ 40 V
Collector Voltage	Ground potential
Dimensions	3½ " (90 mm) H x 19" (483 mm) W x 15 " (381 mm) D
Process Control Contact Rating	5 A at 115 V ac or 29 V dc
	2.5 A at 230 V ac
Ion Gauge Cable	10 ft, 100 °C max.
Bakeable Ion Gauge Cable	10 ft, 200 °C max.
Thermocouple Gauge Cable	10 ft, 100 °C max.

II. GENERAL GAUGE PRINCIPLES

A. IONIZATION GAUGE

The hot filament ionization gauge tube consists of three basic elements:

- a heated filament
- a grid for extracting electrons from the filament
- an ion collector.

Electrons emitted by the filament are accelerated to the grid which is at a positive potential with respect to the filament. These electrons collide with gas molecules present and ultimately are collected by the grid. The collisions produce positive ions (electrons are removed from gas molecules to form ions) which are attracted by the collector and recorded as positive ion current. This ionization process is the basis for measurement of gas pressure within the tube.

Ion gauge pressure measurement is based on the following relationship:

$$P = \frac{i+}{i-}\left(\frac{1}{S}\right) \qquad \text{Equation (1)}$$

Where:
- P = Pressure in Torr
- $i+$ = Ion current in amps
- $i-$ = Ionizing current (emission) in amps
- S = Gauge sensitivity in $Torr^{-1}$

Gauge controls have conventionally interpreted and executed this relationship displaying pressure as a linear function of the ion current. This is accomplished by holding $i-$ constant (regulating emission). The emission regulator, therefore, must provide precise regulation in the face of variables such as voltage fluctuations, filament contamination, exposure to atmosphere and changes of filament temperature due to gas conductivity at high pressures (above 10^{-5} Torr) in order to maintain the relationship of the pressure equation precisely.

The 844/845 Digital Ionization Gauge Control eliminates the need for precise emission regulation. The analog to digital converter circuit which converts the ion collector current into the digital display representation does so using the emission current as a reference. The result is that should the emission vary, the displayed pressure will remain unaffected. The range of emission variance for which the circuit can compensate is on the order of $\pm 50\%$. Therefore, some regulation is needed, but regulation is not critical. In addition, the emission calibration adjustment is eliminated.

As can be seen by Equation (1), S, the gauge sensitivity factor, has a direct bearing on the pressure reading. The actual sensitivity depends mainly on the geometry of the particular gauge tube. In addition, it is affected by factors such as electrode voltages, the emission level, and the actual pressure within the gauge tube. Sensitivity varies with different gas species as well. For the relative gauge sensitivities of various gases refer to the gas sensitivity table on page 55.

B. THERMOCOUPLE VACUUM GAUGE

A thermocouple gauge operates on the principle that at sufficiently low pressures, the thermal conductivity of the gas decreases with a decrease in pressure.

A thermocouple is attached to a heater wire in which the temperature is raised to about 350 °C by passing a current through the wire. When constant power is maintained through the heater wire, the temperature measured by the thermocouple will change with pressure. This change is directly related to the heat conducted away by the gas in the environment. The electromotive force (e.m.f.) measured from the thermocouple is read on a scale which has been calibrated for pressure.

The thermocouple response is also affected by factors other than pressure. Normally, the tube is calibrated for nitrogen or air. If the gas composition in the vacuum system is different, the pressure reading may be affected. As an example, hydrogen and helium will conduct the heat away from the thermocouple more rapidly than air, leading to an erroneous reading which will be higher than the actual pressure. Contaminants such as oil, dust, and other chemicals can change the surface of the thermocouple and heater, which in turn will change the ability of the thermocouple to dissipate the heat and affect the pressure reading.

Because the thermocouple gauge tube is a thermal response device, the ability of the tube to respond to abrupt pressure changes is limited by the mass of the thermocouple and heater. If this combination is very small, the tube responds more rapidly than a tube with larger wire sizes.

In general, thermocouple gauge tubes are used to gain an indication of the vacuum in a system rather than an accurate measure. So many factors can affect the output of the tube that unless special care and precautions are taken, the pressure read on the control is usually accurate to within ±30 percent of indicated reading.

Thermocouple gauge tubes should be positioned on the vacuum system so that contaminants do not collect in the tube. Preferably the tube port should be looking down to prevent oil from mechanical pumps, etc. from building up in the tube base.

If further discussion on the theory and operation of ionization gauge and thermocouple gauge vacuum measurement is desired, the following references may be consulted.

References:

1. Dushman, S., J.M. Lafferty, *SCIENTIFIC FOUNDATIONS OF VACUUM TECHNIQUE,* John Wiley & Sons, Inc., Second Edition, New York, 1962.

2. Guthrie, A., *VACUUM TECHNOLOGY,* John Wiley & Sons, Inc., 1963.

3. Lewin, G., *VACUUM SCIENCE AND TECHNOLOGY,* McGraw-Hill, New York, 1965.

4. Redhead, P.A., et. al., *ULTRAHIGH VACUUM,* Chapman and Hall, London, 1968.

5. Van Atta, C.M., *THE DESIGN OF HIGH VACUUM SYSTEMS,* Kinney Mfg. Div., N.Y., Brake Co., 1955.

6. Van Atta, C.M., *VACUUM SCIENCE AND ENGINEERING,* McGraw-Hill, 1965.

III. PREPARATION FOR USE

A. UNPACKING

Each gauge control is inspected and carefully packed prior to shipment. If the unit arrives damaged, save the packing materials and immediately notify the carrier. Because the packing materials are designed specifically for this instrument, they should always be used when transporting the unit. The instrument is packed with the following contents:

Quantity	Item
1	Ionization Gauge Control
1	AC Line Cord
2	T.C. Gauge Cords (Model 845 only)
1	Operating Manual

NOTE: Gauge tubes and ion gauge cables must be ordered separately.

CAUTION

HIGH VOLTAGE INSIDE CONTROL, AT GAUGE TUBE CONNECTIONS AND UHV FUSE. CAN CAUSE INJURY OR DEATH.

The line voltage selector switch must be set to the proper voltage **before** applying power. This switch is **internal** and located on the Power Supply Board—(see Fig. 7 on page 16 for switch location).

CAUTION

FAILURE TO CHANGE THIS INTERNAL SELECTOR SWITCH TO THE PROPER POSITION TO CORRESPOND WITH INPUT VOLTAGE WILL RESULT IN SIGNIFICANT DAMAGE TO THE UNIT AND NULLIFY THE WARRANTY.

These 844/845 gauge controls are available in three basic configurations:

1. 60 Hz, Torr—factory preset for 115 Vac
2. 50 Hz, Torr—factory preset for 115 Vac
3. 50 Hz, mbar—factory preset for 230 Vac

These controls, therefore, are manufactured either for 60 Hz operation only, or for 50 Hz operation only. Be sure to check the identification tag, in silver, located above the edgeboard connector on the rear panel of the control to verify the complete part number, and frequency rating.

GAUGE TUBE SELECTOR PLUG:

The gauge tube selector plug should be positioned properly for the gauge tube type being used (see page 16). The selector plug is set for the 563 tube at the factory; the 563 tube has the same sensitivity as the 571 and 572 tubes: 10/Torr.

LINE CORDS

The AC line cord supplied with your gauge control conforms to a UL cord set with plug configuration for 115 Vac operation only.

For 230 Vac operation, a different plug configuration (and cord set) must be used to comply with National Electrical Code Regulations for US 230 Vac operation. Consult local electrical regulations in the concerned country for further guidance, approval in selection of cord set, and plug configuration.

Install ionization gauge cable with the AC line power OFF. For 563, 564 and 571 tubes, non-bakeable cable, Part No. 0891-K3143-310 is used. Pin connections are as shown:

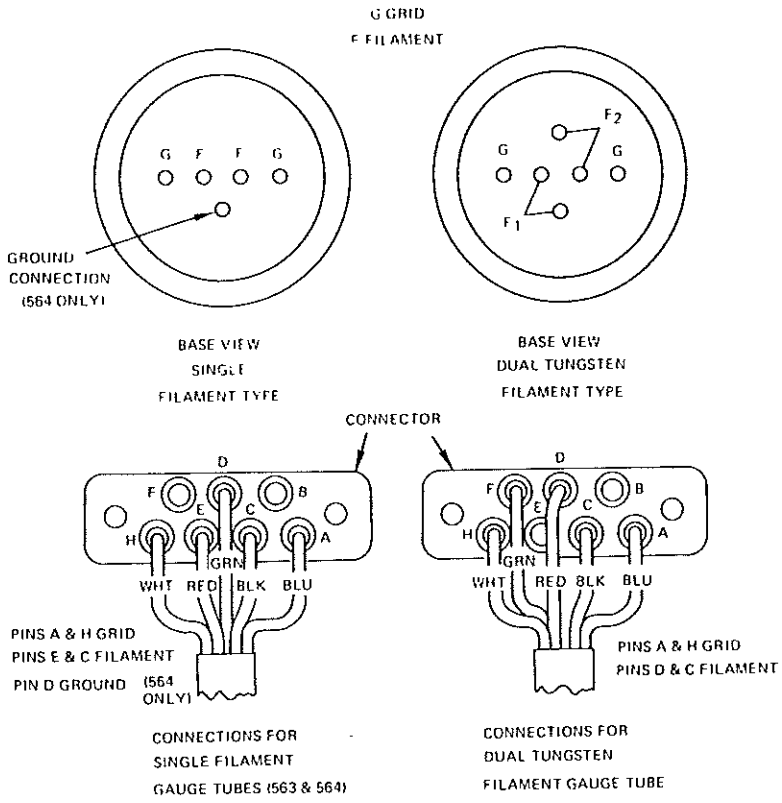


FIGURE 1. 563, 564 PIN CONNECTIONS

For the UHV series tubes, bakeable cable, Part No. 0891-K3938-310 is used. Pin connections are as shown:

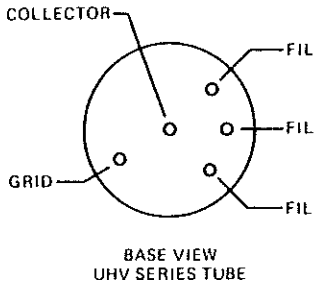


FIGURE 2. UHV TUBE PIN CONNECTIONS

Thermocouple gauge cables are furnished with a thermistor mounted inside the connector for temperature compensation. The gauge cable connections are:

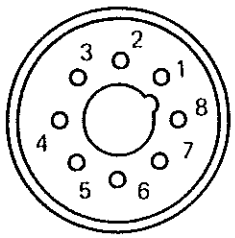
HEATER = PIN 1 (WHITE WIRE)

HEATER = PIN 3 (BLACK WIRE)

TIE POINT = PIN 2 (GREEN WIRE)

TC– = PIN 7 (RED WIRE)

TC+ = PIN 5 (THERMISTOR)



TC CONNECTOR

FIGURE 3. TC GAUGE TUBE CONNECTIONS

IV. OPERATION

A. DESCRIPTION OF CONTROLS (Front Panel)

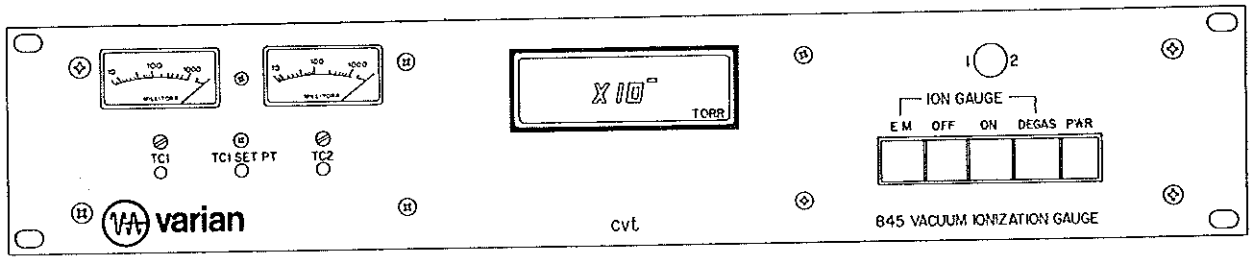


FIGURE 4. FRONT PANEL

- **PWR Switch:** Activates power for all circuits in the instrument. Push in to activate, push again to shut off power. The lamp indicates on condition.
- **ON Switch:** A momentary push button that turns on the gauge tube filament. The lamp indicates when the filament is on.
- **OFF Switch:** A momentary push button that turns off the gauge tube filament. The lamp indicates when the filament is off.
- **DEGAS Switch:** Activates degas function. Lamp indicates when degassing is taking place.
- **TC1, TC2 Adjustments:** Calibration adjustments for thermocouple gauges (refer to Thermocouple Control Section).
- **TC1 Set Point:** Adjusts the set-point pressure on TC1 (see Section VI).

B. DESCRIPTION OF CONTROLS (Rear Panel)

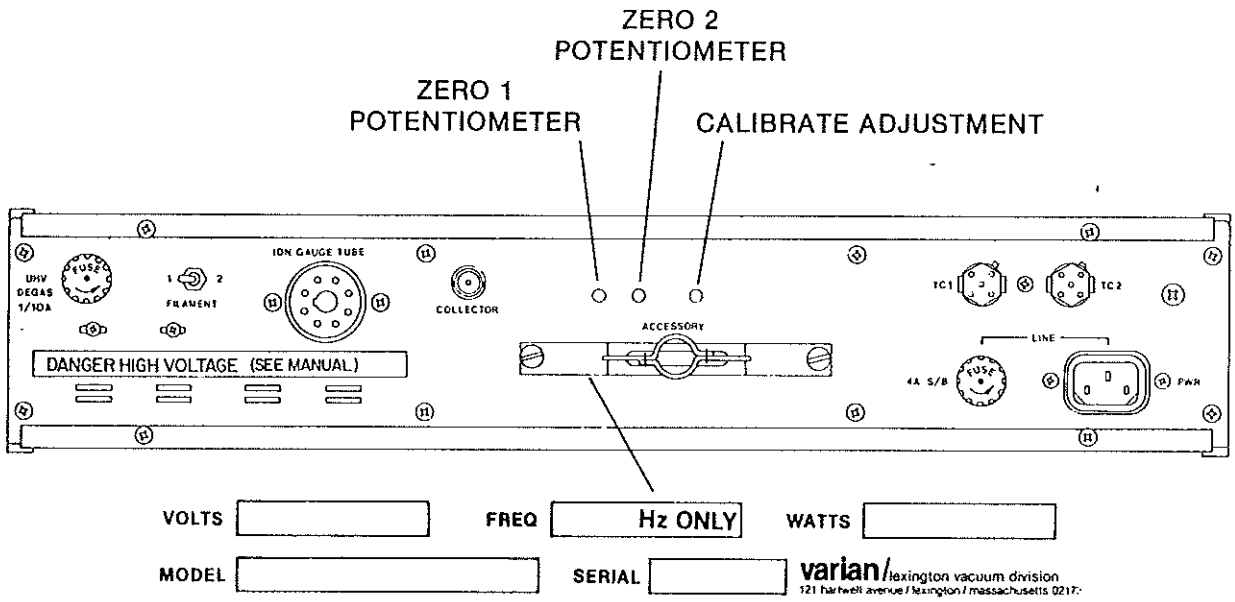


FIGURE 5. REAR PANEL

- **PWR:** Receptacle for AC power line.
- **4A/SB Fuse:** Main power fuse.
- **ION GAUGE TUBE:** Octal socket for either ion gauge cord. **(CAUTION HIGH VOLTAGE)**
- **COLLECTOR:** BNC connector for ion gauge tube collector cable.
- **TC1, TC2:** Miniature type connectors for connecting thermocouple gauge cords (845 only).
- **UHV DEGAS Fuse:** Fuses grid supply during electron bombardment degassing. **(CAUTION HIGH VOLTAGE)**
- **ACCESSORY:** Printed circuit edge connector for accessory functions (see Figure 6).
- **FIL 1, 2 Switch:** Toggle switch selects filament in dual filament UHV series tubes. For single filament tubes, switch must be left in the FIL 1 position.
- **FILAMENT STATUS:** This feature provides the user with a set of relay contacts indicating filament status. The relay is energized when the filament is on and de-energized when the filament is off. The switching contacts are available on the accessory output connector (see Figure 6).

C. DESCRIPTION OF CONTROLS (Internal)

CAUTION

HIGH VOLTAGE INSIDE CONTROL, AT GAUGE TUBE CONNECTIONS AND UHV FUSE. CAN CAUSE INJURY OR DEATH.

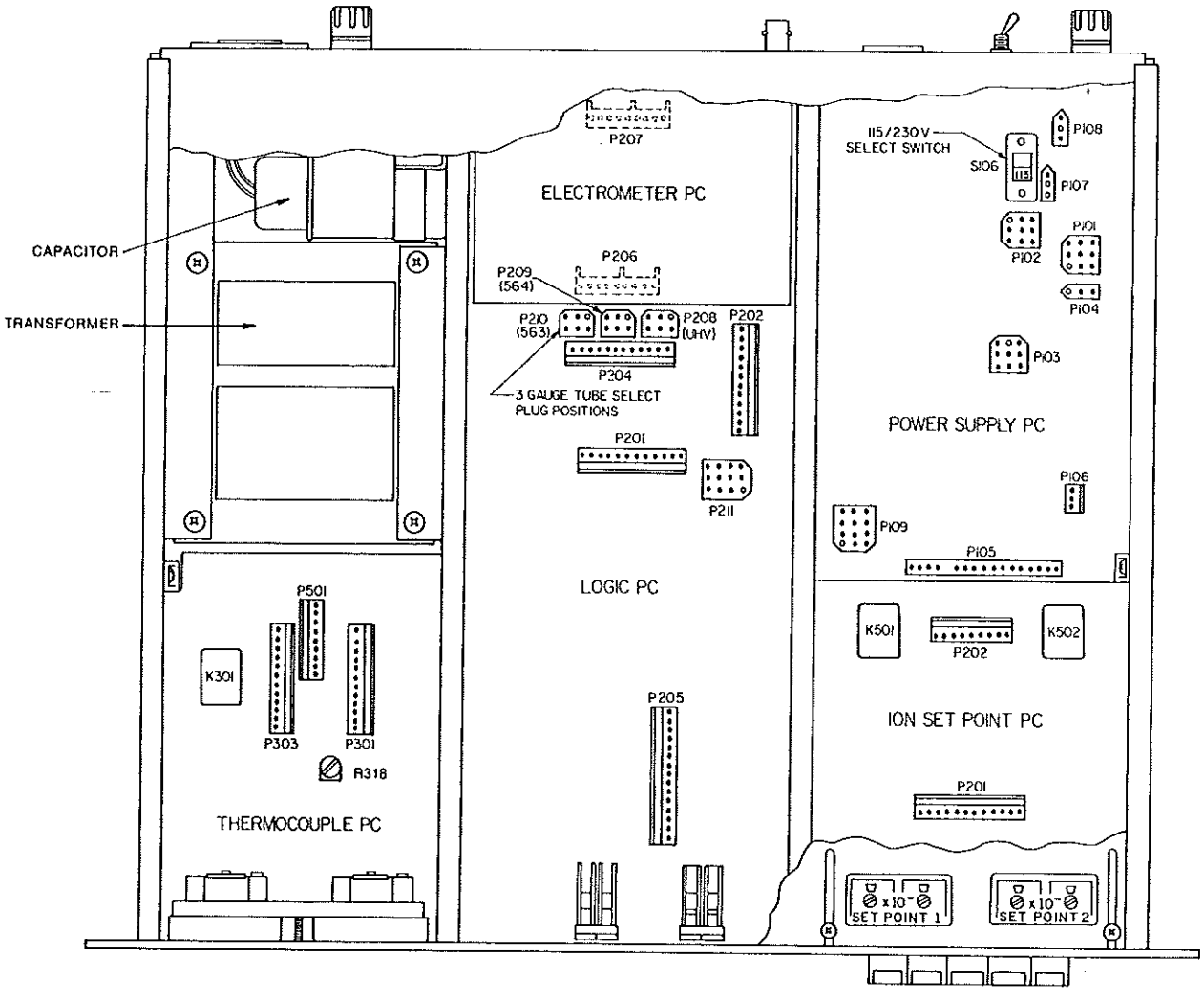


FIGURE 7. CHASSIS INTERIOR

- **115/230 Switch: on Power Supply board.** — Selects appropriate line voltage.
- **GAUGE TUBE SELECT PLUG:** — Plug position adapts control for desired gauge tube.

UHV: Bayard-Alpert tube with sensitivity of 25 $Torr^{-1}$, 25 W EB Degas.

563 and 571: Bayard-Alpert tube with sensitivity of 10 $Torr^{-1}$, 50 W resistance Degas.

564: Bayard-Alpert tube with sensitivity of 8 $Torr^{-1}$, 50 W resistance Degas.

*See page 62 for part numbers for transformer with capacitor.

NOTE The following controls should only be used by a qualified technician while performing detailed calibration of this unit.

- **ZERO 1 Potentiometer:** Adjusts zero of first stage ion current amplifier (see Section VII).
- **ZERO 2 Potentiometer:** Adjusts zero of second stage ion current amplifier (see Section VII).
- **Calibrate Potentiometer:** Pressure calibration adjustment (see Section VII).

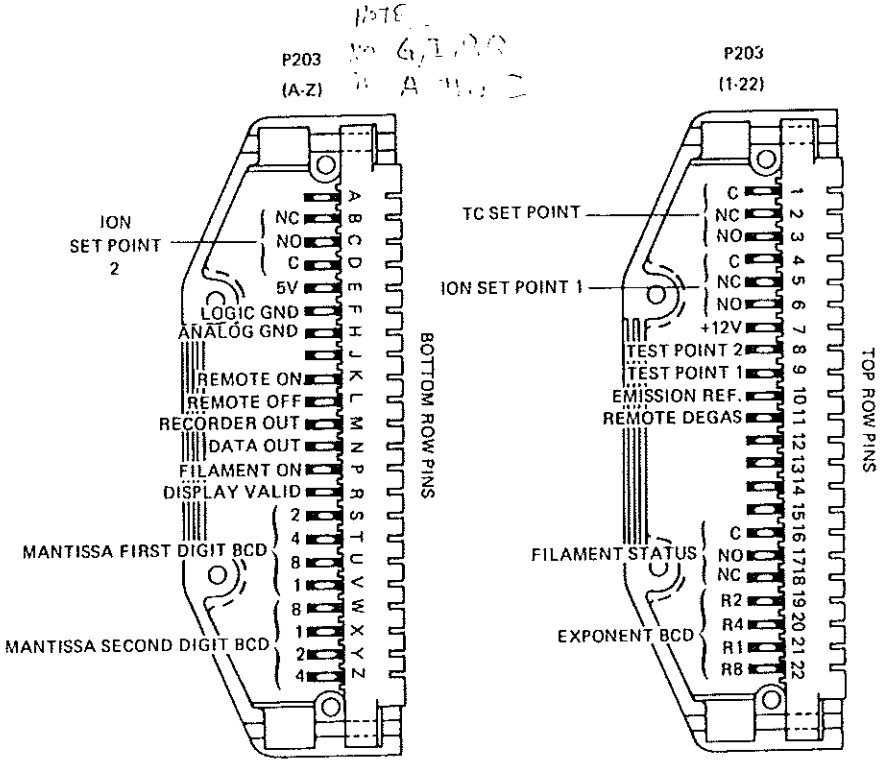


FIGURE 6. ACCESSORY OUTPUT CONNECTOR

V. DESCRIPTIONS OF FEATURES

A. GAUGE TUBE SELECTION

The control is entirely compatible with the Varian 563, Varian 564, 571 and Varian UHV series gauge tubes. Placing the gauge tube selector plug in the appropriate position will adapt the controller to the desired gauge tube. This includes compensating for the differing sensitivities, setting the proper overpressure trip point, and selecting the appropriate degas mode.

B. AUTO-RANGING

The control is able to cover the ten decades of its range by changing emission and electrometer gain by precise factors of ten. Ranging is accomplished through electrometer gain changes in the 10^{-11} through 10^{-6} range and by emission changes in the 10^{-5} through 10^{-2} ranges. Reduced emissions in the upper pressure decades have an added advantage since gauge tube response will be more linear.

Ranging up takes place when the mantissa reading rises above 9.9 and down ranging takes place when the reading drops below 0.8

C. FILAMENT PROTECTION

The gauge control turns off the gauge tube filament should the pressure reading exceed the overpressure trip point. The overpressure trip point is 10^{-3} Torr for the 563 and UHV selector position and 10^{-1} Torr for the 564 selector position. Should the gauge tube pressure be so high that emission current cannot be established (so many gas molecules present that electrons can't get through) an emission missing detecting circuit will sense this and the filament will be turned off.

When the filament is initially turned on, it requires a short amount of time to come up to operating temperature and establish proper emission. Due to this, the filament turn-on circuit initially holds the filament on for a second or so. If emission is not established in this time (indicating an overpressure condition or some other fault), then the filament will turn off.

These filament protection features operate automatically even if the filament "ON" button is held down.

D. DEGAS FUNCTION

The controller provides two methods of gauge tube degassing. When the gauge selection plug is in the 563 or 564 position, resistance degassing is employed. When the plug is in the UHV position, electron bombardment degassing is employed. Degassing is inhibited unless a valid pressure reading is being displayed. In the case of electron bombardment degassing, the full degas function is also inhibited unless the displayed pressure is in the 10^{-6} range or lower. Overpressure protection remains effective in either degas mode.

Electron bombardment degassing of 25 watts is achieved by raising the grid voltage to 525 volts and regulating the emission at 47 milliamps. Operating in this mode, the control can display pressure in the 10^{-6} range and below. To prevent glow discharge and enable continuous pressure display in the 10^{-5} and 10^{-4} ranges, the emission level is reduced and consequently full degas power is removed. Degassing in these upper pressure ranges would be of little benefit. Pressure readings obtained while operating in the degas modes are more intended to determine the condition of the gauge tube rather than to make accurate system pressure measurements. For further discussion on degassing, See Section VIII.

The degas indicator lamp will be lit when the degas function is activated by depressing the DEGAS button on the front panel or by closing a set of remote contacts. The remote contacts, if used, should be connected between pin 11 and logic ground, pin F, on the accessory output connector (see Figure 6). Therefore, in the case of electron bombardment degassing, the lamp will only be lit if the degas button is depressed (or remote contact activated). A contaminated gauge tube will sometimes exhibit a pressure rise into the 10^{-5} range when degassing is initiated. Since degas power is reduced in the 10^{-5} range, this will allow gauge pressure to immediately fall back into the 10^{-6} range whereupon full degas power will be reapplied. This cycle may repeat again and again for a period of time depending on the pumping speed at the gauge tube and how contaminated the tube actually is. This occurrence is in no way harmful to the gauge tube or controller, but merely indicates a relatively high level of contamination inside the gauge tube and that degassing may be necessary for an extended period of time.

E. BCD OUTPUT

This feature provides the user with binary coded decimal output for the mantissa of the display. The exponent is displayed in binary notation. In addition, a filament status logic signal, a data signal, and a "display valid" signal are also provided. These buffered outputs (maximum 5 V dc/60 mA) are compatible with TTL, DTL, RTL and CMOS logic types.

The unit's display is updated every 200 milliseconds; whereas the BCD output is continuously displayed. The "display valid" signal is a pulse 16.6 milliseconds wide, which occurs after each time the unit's display updates and during which the unit's display will be unchanging — indicating display and BCD output updating have been completed.

This can be used to facilitate the input of the data into a computer if it is only allowed to read on this pulse command. Possible error or misrepresentation arising from reading during a digit transition can thus be avoided.

The filament status signal is a logical "high" (+5 V referenced to digital ground) when the filament is on and a logical "low" (0 V referenced to digital ground) when the filament is off.

The data signal is the pulse train output of the voltage to frequency converter. The number of pulses occurring between each "DISPLAY VALID" pulse represents the displayed mantissa value. Fifty pulses, for example, would correspond to a mantissa of 5.0. These output signals are all available on the accessory output connector (see Figure 6).

F. RECORDER OUTPUT

This is an analog signal of zero to plus 10 volts when referenced to an analog ground, and corresponds to 0 to 9.9 of the mantissa of the display. The recorder connections should be made on the accessory connector from pin M to analog ground, pin H (see Figure 6). The recorder signal is derived from the electrometer at a stage prior to the voltage to frequency converter and, therefore, is not ratio compensated with emission as described in Section II. As a result, the full scale voltage (corresponding to 9.9) is nominally 10 volts. Linearity with pressure is accurate, and full scale deflection can be normalized at the recorder as required.

G. REMOTE ON/OFF

These connections are brought out on the accessory output connector (see Figure 6) and are intended to be used with any sort of remote switch or contactor. Momentary contact closure between the "Remote On" terminal (pin K) and the logic ground terminal (pin F) will turn the gauge filament on. Momentary contact closure between the "Remote Off" terminal (pin L) and the logic ground terminal will turn the filament off. The switching operation operates in exactly the same manner as the ON and OFF buttons on the front panel. (Continuous contacts may be used if desired. The "OFF" contact will always override the "ON" contact. The overpressure protection feature in the controller overrides the "ON" contact as well.)

H. ION SET POINTS (Set Point Model Only)

This option contains two independent process control set points that operate over the entire range of the digital display. A set of relay contacts for each set point are brought out on the accessory output connector (see Figure 6). The switching point is set digitally by dialing in the desired exponent and mantissa value on the set switches located on the ion set point printed circuit card. These switches can be accessed by loosening the screws in the top cover slide plate and sliding back the plate. The pressure setting can be read on the switches and adjusted with a screwdriver (see Figure 8).

The set point circuit incorporates a hysteresis band around the trip point in order to eliminate oscillations due to minor pressure variations. To illustrate, assume the mantissa switch setting is 4, for instance, in a particular decade. As the pressure reading decreases in that decade, the set point relay will not energize until the display makes the transition from 4.0 to 3.9. The relay will remain energized until the display reading rises high enough to make the transition from 4.9 to 5.0. Thus a hysteresis band of 10% of one exponent range is achieved.

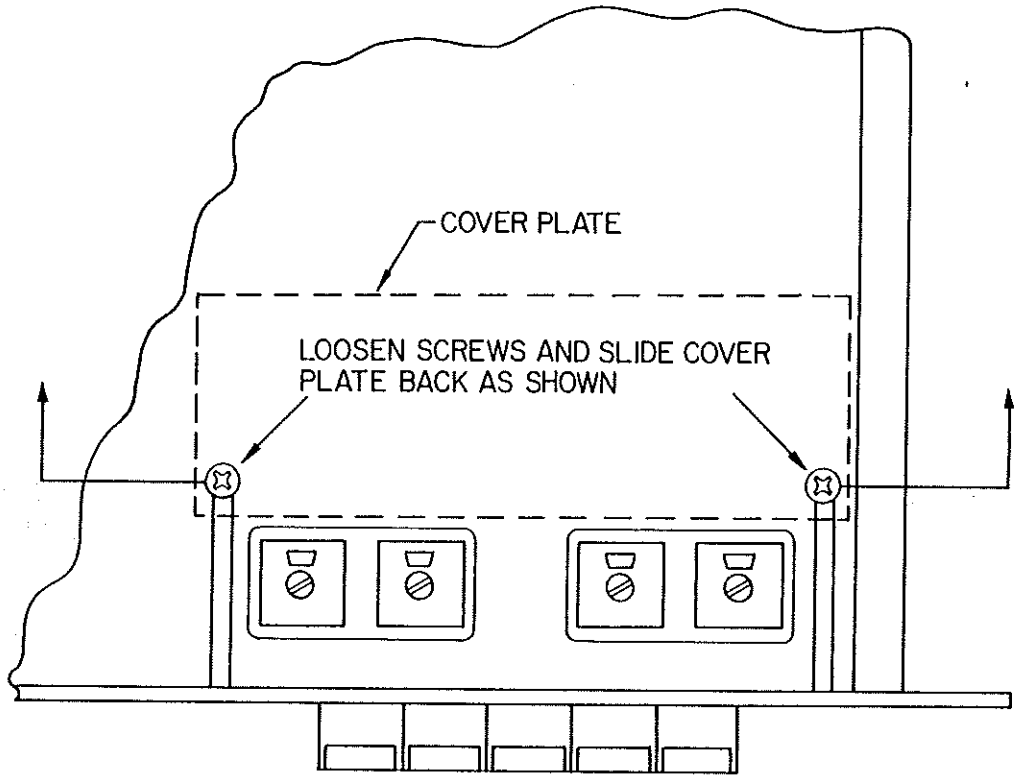


FIGURE 8. ION SET POINT SWITCHES

I. POWER SUPPLY PROTECTION

The controller removes all voltages from the gauge tube when the filament is off. This is to eliminate the shock hazard present where nude tubes with exposed elements are employed. In addition, the control is fully protected against shorts between any of the gauge tube elements and from any element to ground. The occurrence of any short during operation will cause the filament to be shut off.

VI. THERMOCOUPLE GAUGE CONTROL SECTION

Model 845 contains two independent thermocouple vacuum gauges, TC1 and TC2, along with a process control set point for TC1. The thermocouple gauge connectors are located on the rear panel and are labeled TC1 and TC2.

Calibration of the thermocouple gauges is simple and is set roughly at the factory. However, due to minor variations between gauge tubes it should be checked upon the installation of a new tube. With the gauge monitoring a system pressure of below one millitorr, adjust the recessed potentiometer (located directly below the respective label, TC1 or TC2) to zero each meter. The upper hole is the mechanical adjustment for the meter movement. With the control power off, the meter should rest full scale on the line to the right of the designation "ATM".

The thermocouple set point operates on the signal from TC1. A set of relay contacts are brought out on the accessory output connector (see Figure 6). The set point is adjusted with the recessed potentiometer on the front panel labeled TC1 SET PT. To set the set point, adjust the vacuum system pressure to the point where relay actuation is desired. After the system has stabilized, rotate the set point potentiometer until the relay actuates. This can be observed by connecting an ohmmeter between the common and normally open relay contacts. When the relay actuates, zero resistance is read on the ohmmeter. The set point hysteresis may be varied from approximately 5% to 20% of meter point deflection by use of R318 which is adjusted for minimum hysteresis in the fully clockwise direction (see Figure 7, page 16).

An alternative method of setting the set point is to make the TC meter read the desired pressure by deliberate misadjustment of the thermocouple calibration potentiometer for TC1. With TC1 monitoring high vacuum, misadjust the TC1 calibration control until the desired actuation pressure is indicated by the TC1 meter, i.e., if 100 millitorr is desired, adjust until the meter pointer reaches 100 millitorr on the meter scale. Next, adjust the TC1 set point potentiometer until the set point relay actuates. Then be sure to readjust the TC1 calibration control to return the meter to zero.

AUTOMATIC FILAMENT TURN-ON (845 Model Only)

This option is purchased separately. It is intended for use with standard and extended range Bayard-Alpert ionization gauge tubes such as Varian 563, 571 and extended range tubes such as the 564. This option is not recommended for UHV type gauge tubes. When used, it will override the normal filament starting procedure (Remote ON/OFF as well) and turn the ion gauge filament on and off at a pressure preset by the operator. This feature will also override the overpressure protection circuitry built into the gauge control.

The option is connected to TC1, therefore, it is mandatory to use the TC1 gauge tube to monitor the pressure for the ionization gauge filament turn-on. It will not interfere with the TC1 set point. A hysteresis of 3% of meter arc is built-in to prevent oscillation at the trip point.

To operate, plug card into P304 (plug located on TC card — see Figure 9). R501 (turn-on-point adjust potentiometer) is adjusted in exactly the same manner as the TC1 set point calibration. In general, the turn-on point should be set just below the pressure at which the cross-over from rough pumping to high vacuum pumping takes place. The intent is to start the ion gauge after the high vacuum valve has opened and the system pressure drops into ion gauge operating range.

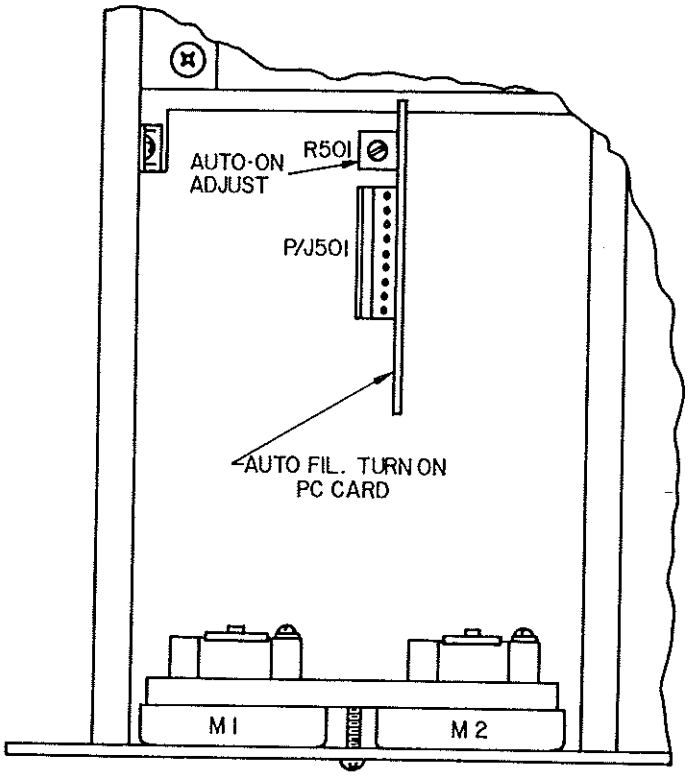


FIGURE 9. AUTOMATIC FILAMENT TURN-ON CARD

VII. IONIZATION GAUGE CALIBRATION PROCEDURE

CAUTION

HIGH VOLTAGE INSIDE CONTROL, AT GAUGE TUBE CONNECTIONS AND UHV FUSE. CAN CAUSE INJURY OR DEATH.

Each control is fully tested and calibrated at the factory. Calibration is stable and the full procedure is recommended only when performance of the instrument is questionable. The full procedure consists of first setting the electrometer zero and then calibrating the gain.

To set the electrometer zero, proceed as follows:

1. Allow control to warm up with gauge filament on and cover plates in place for at least one hour.
2. Turn off gauge tube filament, remove collector connection on rear panel.
3. Connect a digital voltmeter from ground to the output of the electrometer amplifier (pin H and pin 9 respectively on the accessory output connector—see Figure 6).
4. With the gauge tube selector (P210/J208 on the logic card in the 564 position, adjust the zero 1 (R305) potentiometer on the rear panel for a reading of precisely zero (see Figure 5).
5. Connect digital voltmeter now to pins H and 8 of the accessory output connector.
6. Adjust the ZERO 2 (R308) potentiometer for a reading of zero (see Figure 5). Within 2 mV is sufficient for this adjustment.
7. Replace collector connection. Replace gauge tube selector to proper position.

This completes the electrometer zeroing adjustment.

The amplifier gain can now be calibrated. This calibration can be accomplished in three ways. The first and simpler way is to calibrate to another gauge operating on the same system. This should be done with both tubes reasonably close together on the system and at least a decade above system blank off pressure in order to minimize errors due to outgassing and pumping speed effects. The pressure decade in which the calibration is carried out makes no difference. The calibration is for the mantissa reading. Decade switching in the controller is accomplished with precision multiplier resistors so that complete calibration will be achieved when the mantissa is calibrated in any one decade.

The second method of calibration can be carried out without the use of another gauge. It was stated earlier that ion gauge pressure measurement was based on the following equation:

$$P = \frac{i+}{i-}\left(\frac{1}{S}\right) \qquad \text{Equation (1)}$$

Where: P = Pressure in Torr

i+ = Ion collector current in amps

i− = Emission current in amps

S = Gauge tube sensitivity in $Torr^{-1}$

Using Equation (1) as a basis, any pressure reading can be simulated electronically by supplying a simulated ion collector current to the controller. Gauge tube sensitivity, S, is known; emission current, i−, can be measured; therefore, to obtain a simulated pressure, the required i+ can be calculated. With reference to Table 1, the following example is worked out for the 564 gauge tube.

The table shows that a collector current of between 7.52×10^{-7} and 7.52×10^{-8} amps will produce a pressure reading in the 10^{-3}, 10^{-4}, 10^{-5}, or 10^{-6} decade. The multiple decade values exist due to the different emissions in each of these decades. An easy and convenient way to obtain a current in the range is to utilize a dropping resistor from the +180 volt grid. A 500 MΩ (±1%) resistor is suitable.

$$I = \frac{E}{R}$$

$$1 = \frac{180 \text{ volts}}{500 \times 10^{6}\Omega} = 3.6 \times 10^{-7} \text{ amps} \qquad \text{Equation (2)}$$

To carry out this calibration, first perform the amplifier zeroing procedure. Then proceed as follows:

CAUTION

HIGH VOLTAGE INSIDE CONTROL, AT GAUGE TUBE CONNECTIONS AND UHV FUSE. CAN CAUSE INJURY OR DEATH.

1. Shut control power off and remove cover.

2. Connect 500 MΩ (±1%) resistor from grid to lead to collector pin connector.

   When using the non-bakeable ion gauge cable with 563 and 564 type tubes, this can be done most easily at the gauge tube end (see Figure 10).

When using the bakeable ion gauge cable with UHV series of ConFlat® flange type tubes, this connection can be made at the controller end of the cable. First pry up and slide back the connector cap to gain access to the octal pin connections. Remove the BNC connector. The resistor is then connected from pin 8 of the octal plug to the collector jack (see Figure 11).

3. Turn on power and turn on gauge tube filament. The current through the 500 MΩ resistor should place the control in the 10^{-3}, 10^{-4}, 10^{-5}, or 10^{-6} Torr range.

4. With voltmeter, measure the precise grid voltage. This value (nominally 180 V) can be used in Equation (3) to calculate simulated collector current precisely.

5. Again refer to Table 1 to determine emission. As pointed out before, emissions in the upper pressure decades are each reduced by factors of ten. The values shown in the table are nominal values. Actual emission may vary by ten percent or more. For this calibration the precise emission can be determined by measuring the voltage across R151 on the power supply printed circuit card (see Figure 13). This voltage divided by 100 will equal the emission value in amperes:

$$\frac{V_{R151}}{100} = i^- \qquad \text{Equation (3)}$$

For example, if the voltage measured was 0.95 volts, the actual emission is 9.5 mA.

6. Substitute the actual values of i−, i+ and S into Equation (1) and solve for the pressure. Then adjust the calibrate potentiometer (see Figure 5) so that the display agrees.

Alternate values for the dropping resistor can be used to simulate other pressures. Table 1 can be used to determine the collector currents corresponding to the different pressure decades. A calibrated electrometer current source, if available, would provide an alternate means of simulating ion collector currents.

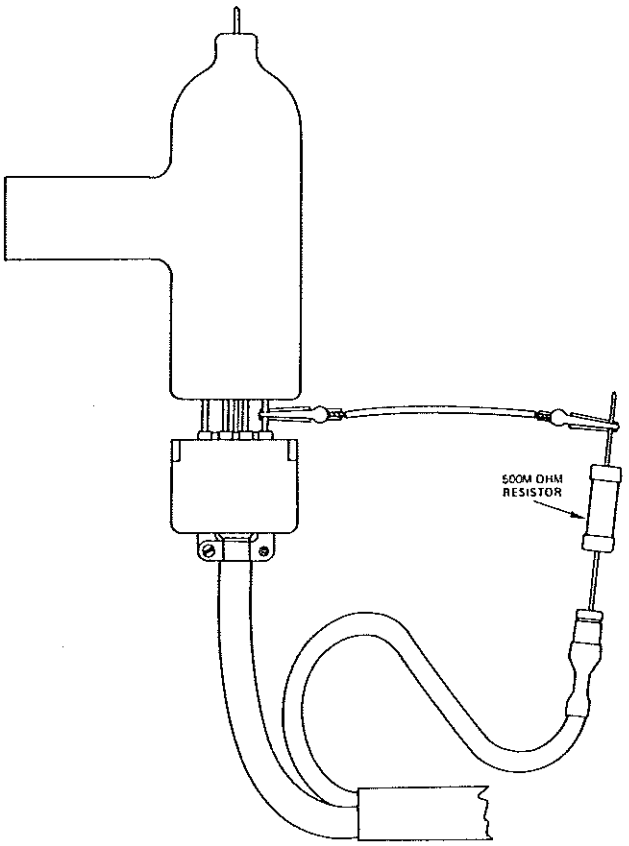


FIGURE 10. CALIBRATION CONNECTIONS

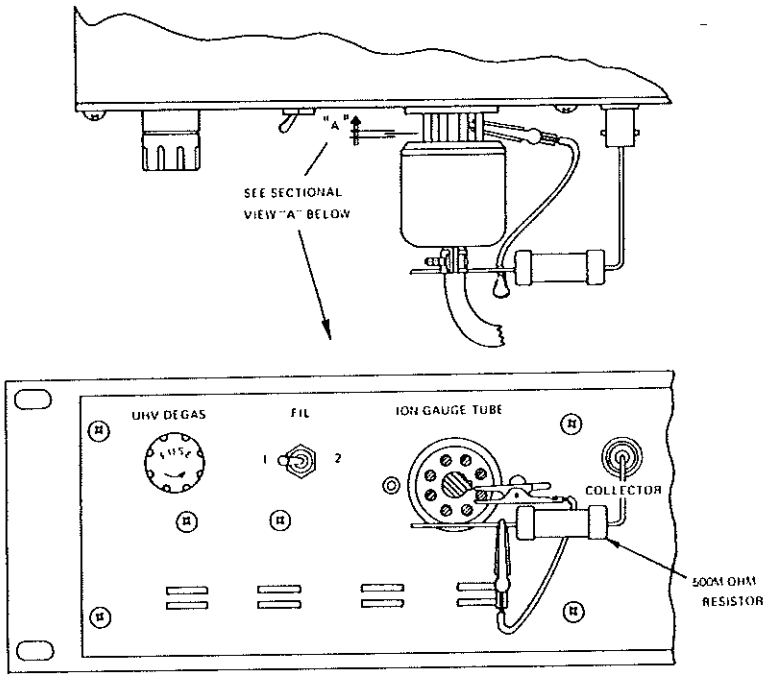


FIGURE 11. CALIBRATION CONNECTIONS

The third method of calibration uses the emission reference signal on pin 10 of the accessory connector. This method may be used on controls with serial numbers after Y030.

Because the emission regulator maintains this signal at a constant 4.7 volts, it may be used to produce a constant current through a resistor in series with the collector input to the control. Using a resistor value of 100MΩ (±1%), a current of 0.047×10^{-6} amps is seen by the collector input resulting in a display reading of 5×10^{-7} Torr.

To carry out this calibration, first perform the amplifier zeroing procedure. Then proceed as follows:

CAUTION

HIGH VOLTAGE INSIDE CONTROL, AT GUAGE TUBE CONNECTIONS AND UHV FUSE. CAN CAUSE INJURY OR DEATH.

1. Turn off gauge control power.
2. Disconnect collector plug from control (leave gauge tube plugged into control).
3. Connect one end of a 100 MΩ (±1%) resistor to the center pin of the collector jack on the control. Connect the other end to pin 10 of the accessory connector (see Figure 12).
4. Turn on gauge control power and gauge tube filament.
5. Adjust the calibrate potentiometer (see Figure 5) for a display reading of 5×10^{-7} Torr.

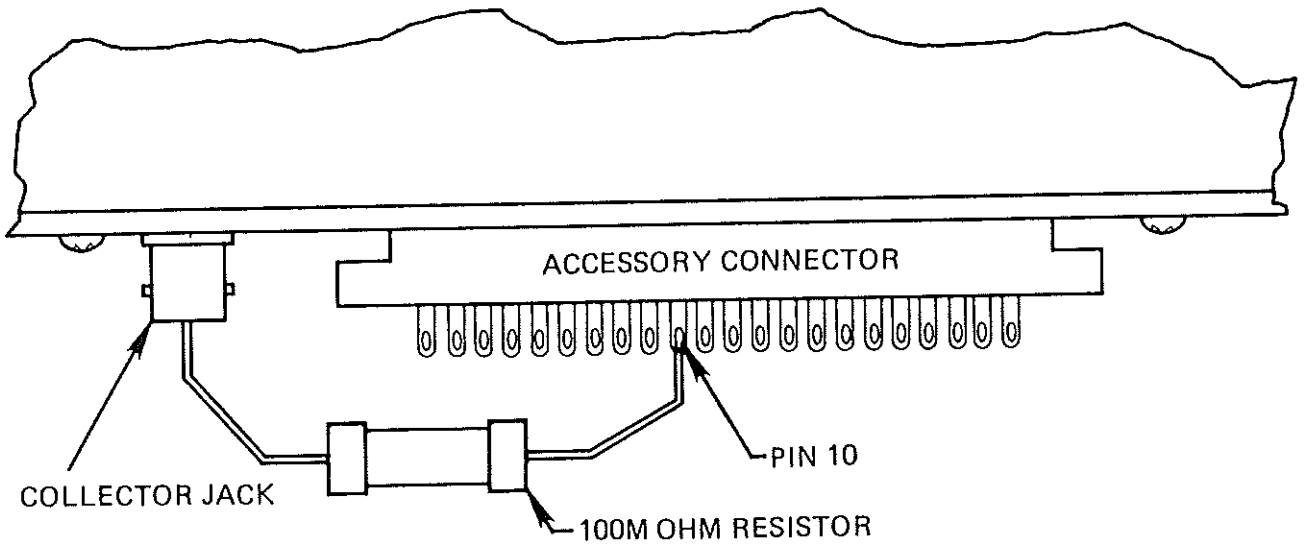


FIGURE 12. CALIBRATION CONNECTIONS

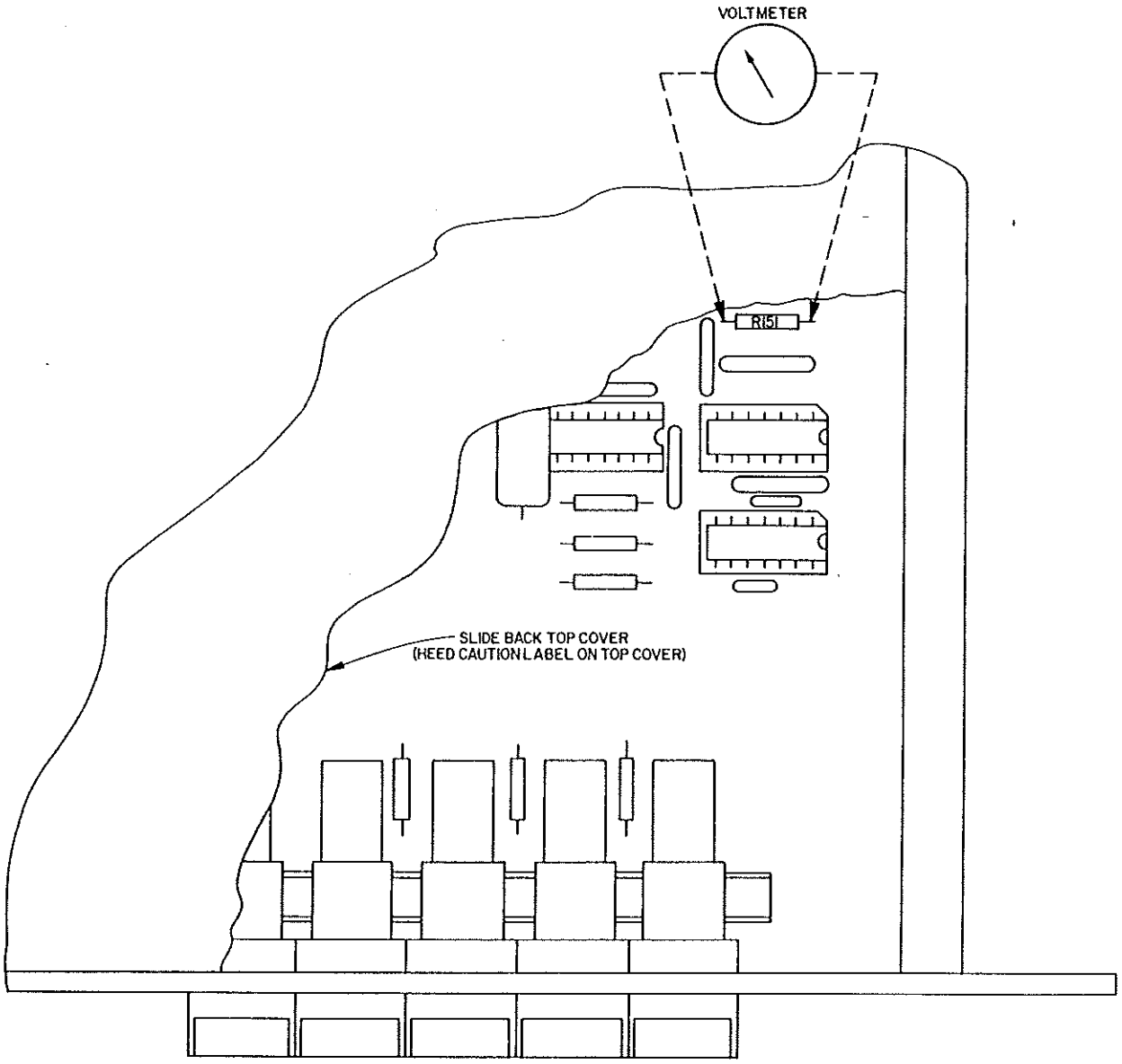


FIGURE 13. EMISSION MEASUREMENT

CAUTION

HIGH VOLTAGE INSIDE CONTROL, AT GAUGE TUBE CONNECTIONS AND UHV FUSE. CAN CAUSE INJURY OR DEATH.

TABLE 1

EMISSION AND COLLECTOR CURRENT DATA

	564 (S = 8)		563 (S = 10)		UHV (S = 25)	
Pressure Decade	Nominal Emission (mA)	Full Scale i + (A)	Nominal Emission (mA)	Full Scale i + (A)	Nominal Emission (mA)	Full Scale i + (A)
10^{-2}	0.0094	7.52×10^{-6}	—	—	—	—
10^{-3}	0.0094	7.52×10^{-7}	—	—	—	—
10^{-4}	0.094	7.52×10^{-7}	0.094	9.4×10^{-7}	0.047	1.175×10^{-6}
10^{-5}	0.94	7.52×10^{-7}	0.94	9.4×10^{-7}	0.47	1.175×10^{-6}
10^{-6}	4.7	7.52×10^{-7}	9.4	9.4×10^{-7}	4.7	1.175×10^{-6}
10^{-7}	4.7	7.52×10^{-8}	9.4	9.4×10^{-8}	4.7	1.175×10^{-7}
10^{-8}	4.7	7.52×10^{-9}	9.4	9.4×10^{-9}	4.7	1.175×10^{-8}
10^{-9}	4.7	7.52×10^{-10}	9.4	9.4×10^{-10}	4.7	1.175×10^{-9}
10^{-10}	4.7	7.52×10^{-11}	9.4	9.4×10^{-11}	4.7	1.175×10^{-10}
10^{-11}	—	—	—	—	—	—

VIII. MISCELLANEOUS INFORMATION

A. USING LONG CABLES

When it is necessary to use long cables to the ionization gauge, full range operation can be achieved if the filament lead resistance does not exceed one-half ohm. For longer lengths, wire size should be increased proportionately. In the case of resistance degassing, cable loss will decrease the power supplied to the grid. For longer cable lengths, wire size can be increased or longer degas times can be used.

The thermocouple control circuit is a constant current design which allows the use of cable lengths up to 100 feet using No. 20 Awg. wire.

B. DEGASSING

Operation of an ionization gauge during the pump down cycle of a vacuum system, particularly after a system has been exposed to atmospheric pressure, results in the outgassing of large quantities of absorbed gases from gauge tube surfaces. Unless these gases are driven off, readings observed by the gauge will remain high for a long period of time when compared with the actual system pressure. It is recommended that a new gauge tube be degassed for a period of 10 to 15 minutes if pressures below 10^{-6} Torr are expected and 30 to 60 minutes below 10^{-8} Torr. Nude gauges generally do not require as lengthy degassing. The readsorption of gases after degassing can cause temporarily low readings, especially with glass gauges. For critical work, a pressure versus time recording can be helpful to determine when the gauge has reached equilibrium.

C. SPUTTERING SHIELD

In applications where the pressure to be measured is in a sputtering system or other system where a glow discharge is present, a suitable screen should be placed across the gauge tube port to prevent stray ions from entering the tube. Erratic pressure readings may result if stray ions are allowed to enter the tube.

IX. SERVICE

TROUBLESHOOTING

CAUTION

HIGH VOLTAGE INSIDE CONTROL, AT GAUGE TUBE CONNECTIONS AND UHV FUSE. CAN CAUSE INJURY OR DEATH.

Fault Indication	Possible Causes/Checks/Remedies
With power switch on, all lights and functions inoperative.	1) Ensure that external power is operational. 2) Check power fuse.
Filament "ON" light will not remain on when button is depressed. Emission light does not come on.	1) Burned out gauge tube. 2) System pressure too high. 3) Defective gauge tube cable or connection. 4) Gauge tube contaminated below a useful level. Replace gauge tube.
Filament "ON" light will not remain on when button is depressed. Emission light does come on.	1) System pressure too high. 2) Inter-element short in gauge tube. 3) If automatic filament turn on is used, see instructions on page 21.
Filament won't stay on when EB degassing is used.	1) Check UHV degas fuse.

Fault Indication	Possible Causes/Checks/Remedies
Controller hunts back and forth between two adjacent decade ranges.	1) Electrometer zero adjustments not set properly. 2) If this occurs between 10^{-5} and 10^{-6} ranges, a contaminated gauge tube can be the cause. The higher emission level and higher filament temperature used in the 10^{-6} range may cause additional outgassing enough to raise gauge pressure back into the 10^{-5} range. This is the same phenomenon discussed in Section V under degassing. Operating the controller in the degas mode for a period of time will alleviate this situation.

PUSH-BUTTON LAMP REPLACEMENT

In the event that it becomes necessary to replace the indicator lamps in the push-button assembly the following steps should be followed:

1. Turn off power to the control.
2. The colored lens cap can be removed by simply depressing the top and bottom portion of the cap between the thumb and forefinger and pulling off.
3. With a long-nosed pliers the lamp may be carefully pulled from the base. The new lamp can similarly be installed.
4. Replace the colored lens cap by pushing back into place.

X. CIRCUIT DESCRIPTION

A. POWER SUPPLIES

The power supplies in the controller are all located on the large printer circuit card which contains the push button switches. Electronically regulated +15 and −15 volts for the operational amplifiers is provided by regulators A101 and A102. Regulated +5 volts for the logic circuitry is provided by regulator A103 in conjunction with transistor Q103.

The grid voltage supply provides regulated +180 volts for normal operation and +525 volts for electron bombardment degassing. Zener reference diode CR109, transistor Q101 and the associated circuitry regulate as well as provide current limiting for the +180 volt supply. Transistor Q102 removes the 180 volt reference from the base of Q101 when the filament is off, thus grid voltage is removed for shock hazard protection. Transistor Q104 senses the presence of grid voltage and provides this signal for the logic. In the event of a grid short, the loss of proper grid voltage will be signalled to the logic which in turn will shut off the filament.

Relay K101, which actuates for electron bombardment degassing, removes the grid from the +180 volt supply and essentially connects the filtered outputs of the diode bridges CR106 and CR107 in series to bring the grid up to the 525 volts required for electron bombardment degassing. Resistance degassing occurs when relay K102 closes, connecting the 7.5 volt transformer winding to the resistance grid.

Filament bias of +40 volts is obtained with zener diodes CR121, CR122, CR123 and CR129.

B. EMISSION REGULATOR

Emission current in the ion gauge tube is proportional to filament temperature. The emission regulator circuit senses the emission current and regulates it by controlling the electrical heating power applied to the filament.

Emission current is sensed by the string of precision resistors at the non-inverting input of amplifier A104. This sensing voltage, proportional to emission, is amplified by A104 and applied to the non-inverting input of amplifier A106. When the filament is on, the other input of A106 is held fixed at +4.7 volts by the voltage divider composed of R142 and R143. The output of A106 drives the phase control circuit comprised of Q110, Q111, CR112 and associated components, enabling it to control the power to the filament. By controlling the filament power it controls emission. A106 strives to regulate emission such that the voltage at its non-inverting input is driven toward the fixed +4.7 volts at its inverting input. Depending upon the gain of the preceding amplifier stage, A104, the voltage at the top of the emission sensing string is regulated at the value corresponding to the desired emission.

The gain of amplifier stage A104 is controlled by resistors R132, R133, and R134. When the gauge tube selector plug is in the UHV position, the top of R132 is connected to ground and the gain of this stage is 10. When the selector plug is in the 563 or 564 position, this ground connection is removed and the gain of this stage is 5. Since A106 maintains the output of A104 at +4.7 volts, the voltage at the top of the emission sensing string (R128, R129, R130, R131, R151) is this 4.7 volts divided by the gain of A104. For the UHV selector position, this voltage is 0.47 volts and for the 563 and 564 positions, this voltage is 0.94 volts.

Relays K103, K104 and K105, controlled by the ranging logic, are able to alter the resistance of the emission sensing string by precise factors of ten. This accomplishes the emission reductions that occur in the 10^{-5} through 10^{-3} Torr ranges. The actual emission current is the current through the emission sensing string that produces a voltage drop of the 0.47 or 0.94 volts that the regulator circuit maintains. In the 10^{-11} through the 10^{-6} ranges, all three relays are closed. As the pressure reading rises into the decades above the 10^{-6} Torr range, K103, K104, and K105 each in turn open to increase the resistance of the string thus decreasing emission. The same value of emission is used in both the 10^{-3} and 10^{-2} Torr range.

Electron bombardment degassing is employed when the selector plug is in the UHV position. During electron bombardment degassing, relay K101 closes. One set of contacts is responsible for raising the grid voltage to the 525 volts. The other set of contacts shorts out R134 which changes the gain of A104 from 10 to 1. This automatically increases the emission by a factor of ten. In the 10^{-11} through 10^{-6} Torr ranges, this is an emission change from the normal 4.7 milliamps to the degassing level of 47 milliamps.

Amplifier A105 is a comparator whose reference input is held fixed at 2.5 volts by the voltage divider composed of R140 and R141. A105 compares the output of A104 against reference. As previously explained, the output of A104 is proportional to emission and the regulator tries to maintain it at +4.7 volts. The comparator will switch into the positive state, signalling the logic that emission is established and turning on the emission light, as long as the output of A104 is higher than 2.5 volts (at least as much as 50% of its nominal value).

C. ELECTROMETER

A301 is a 100% negative feedback electrometer amplifier. Sensitivity is controlled by precision multiplier resistors, switched by relays K301 and K302, which are controlled by the logic. The output of stage A301 is applied directly to stage A302. The gain of this stage is controlled by precision multiplier resistors and logic controlled relays. The output of stage A302 is on the order of 0 to +10 volts per decade. The actual voltage range depends upon the sensitivity factor of the gauge tube being used. Amplifier stage A303 follows A302. Its gain is controlled by precision resistors which are switched by the gauge tube selector plug. This stage compensates for the different sensitivities of the different gauge tube types, normalizing the output of A302 to 0 to −4.7 volts per decade as it goes into the voltage to frequency converter.

D. VOLTAGE TO FREQUENCY CONVERTER

A304, A305, A306 and associated components form a voltage to frequency converter. A304 is an integrator. It produces a linear voltage ramp whose slope is directly proportional to the voltage at its input from A303. This voltage ramp is delivered to A305 which performs the function of a comparator and one shot multivibrator. The voltage to the reference input of A305 is set by the sensitivity potentiometer, R322. When the voltage output of A304 ramps higher than this reference voltage, A305 will switch positive, turning on transistor Q303. Q303 produces the logic signal NDATA which at this time goes to logical low. The logic immediately gates back a signal to A306, an analog switch, which in turn shorts out C306, returning the output of A304 to zero. C307 at this time discharges through CR304 and R320. The voltage drop across R320 produced by this discharge current holds the comparator in the positive state for about a tenth of a millisecond. The comparator then reverts back to the negative state at which time Q303 goes back into cutoff and the signal NDATA returns to logical high. The logic then opens the analog switch, A306, and this cycle repeats again. The result is a sawtooth waveform at the output of A304 whose frequency is proportional to its input voltage. The output of A305 is a train of positive going pulses which applied to the base of Q303 produce the output logic signal NDATA.

The reference voltage at the top of the sensitivity potentiometer, R322, is derived in the emission regulator. This voltage is taken from the output of amplifier A104 and is directly proportional to gauge tube emission. If this voltage should change, the amplitude of the sawtooth wave produced at the output of A304 will change in the same manner. The period of the sawtooth wave will vary in direct proportion to its amplitude for a constant input voltage from A303. Since period is the inverse of frequency, the output of the voltage to frequency converter will vary inversely with changes in emission. The result is that the output of the voltage to frequency converter, over prescribed limits, is proportional to the ratio of ion current to emission current and not their absolute values.

E. LOGIC

The logic circuitry performs all the decision-making operations in the controller. This section is located on the large printed circuit card that contains the LED display. Functionally, the logic circuitry can be broken down into five main areas.

Clock

The clock generates the 200 millisecond time base required to implement the analog to digital conversion for the readout display. This time base also synchronizes the operation of the ranging logic. The clock utilizes the power line as a frequency standard, insuring the high accuracy and stability of the time base.

Display

The display section, composed of decade counters, latches and steering logic, produces the numeric pressure readout and the BCD output. The decade counters count the pulse train output of the voltage to frequency converter to produce the mantissa portion of the display. The clocking is arranged so that the counters total up the number of pulses which occur during the 200 millisecond sampling period. Ninety-nine pulses would correspond to a mantissa reading of 9.9. This number is transferred to the display in BCD form and the counters are then reset to zero as the next sampling period begins.

The exponent portion of the display receives it information from the range logic section.

Range Logic

The heart of the range logic is the decade up/down counter which keeps track of the pressure decade. The associated gating decodes the output of this counter to derive the control signals for the relays which in turn control the electrometer gain and emission level.

Up range and down range commands are derived from the counters in the display section which count the pulses from the voltage to frequency converter. A D-type filp-flop, tied to the high order bit on the counter for the most significant figure of the mantissa, detects overflow of the mantissa. The occurrence of overflow in any sampling period will result in a countdown command being gated to the range counter. To detect underflow of the mantissa, a set/reset latch is employed. This latch is set at the end of each sampling period. The high order bit on the counter for the least significant figure of the mantissa is gated to the reset input of the latch. The latch is reset when this bit makes the transition from low to high. If this bit does not go high during the sampling period, it means the accumulated mantissa value is less than 0.8 and the latch will not be reset. If the latch is not reset during the sampling period, then a count up pulse will be gated to the range counter at the end of the sampling period.

The count up and count down pulses are also gated to a pair of flip-flops. These generate a "data valid" signal when a total of two sampling periods go by with no ranging commands. This signal controls actuation of the display, the degas control, and ion set point logic circuits.

Filament Control

The filament control logic receives commands from the front panel filament control buttons, the remote control lines on the accessory connector, the automatic filament turn-on option and the range logic. It is responsible for controlling the filament in response to these inputs and for providing fault protection.

A set/reset latch is employed as a filament status memory. When the latch is set, the filament is on. To facilitate filament turn on, a timer is employed. When the front panel filament ON button or remote ON terminal are momentarily activated, it begins a one-second timing cycle. The output of the timer is gated to the set input of the filament latch. Signals from the emission and grid voltage detectors and the range logic, all which signal fault conditions, are gated to the reset input of the latch. When the filament turn on command is given, the timer overrides the fault signals and holds the latch set. If all fault conditions are cleared within the timing period, the latch remains set and normal ranging and pressure readout begins. In the event that any one of the fault conditions does not clear or arises later during operation, the latch will reset and turn the filament off.

Degas Section

Depressing the degas button on the front panel sends a signal to the degas control logic. This signal is gated in such a manner as to insure that the gauge tube filament is on and a valid pressure reading is being displayed before degassing can commence. When the gauge tube selector plug is in the 563 or 564 position, the degas command then goes to K102, the resistance degas relay. When the gauge tube selector plug is in the UHV position, another condition must be met, then the degas command will go to K101, the electron bombardment degas relay. A set/reset latch and appropriate gating is utilized to insure that the displayed pressure has gone as low as the 10^{-6} Torr range before full power degassing is allowed to commence. In the case of electron bombardment degassing, the range logic also receives the degas signal so that control of electrometer gain can be altered to compensate for the higher degas emission.

F. ION SET POINTS

Each ion set point employs a pair of BCD set switches and BCD comparators. One comparator compares the value from the exponent set switch with the displayed exponent. The other comparator compares the value from the mantissa set switch with the most significant figure of the displayed mantissa. The logic transfers the output from the comparators to the set-point relays provided the gauge tube filament is on and the "data valid" signal is present. When these conditions are met, the set-point relays will engage whenever the exponent comparator senses that the displayed exponent is lower in pressure than the exponent switch setting. If the exponents are equal, the mantissa comparator then controls whether or not the relay engages.

A set/reset latch, tied to the "greater than" and "less than" outputs of the mantissa comparator provides one digit of hysteresis in the set-point actuation.

G. THERMOCOUPLE SECTION

Two independent control and metering circuits are provided for TC1 and TC2. Voltage regulator A301 and transistor Q301 form an adjustable constant current source which supplies power to the heater of the thermocouple gauge tube. A301 regulates the voltage across Q301 and its biasing network at 5 volts. The calibration potentiometer, R302, varies the base bias of Q301 producing a variable load on the regulator. The heater, placed in series with the supply to the input of the regulator, receives a constant current which is then independent of changes in heater circuit resistance and power line voltage. The meter is connected across the thermocouple junction for pressure readout.

The set-point circuit also senses this thermocouple voltage. A303 is a comparator which compares the thermocouple output voltage against a reference voltage from the set-point potentiometer, R313. This comparator in turn drives transistor, Q303, to control K301, the set-point relay. R316 is the offset null adjustment for A303. This is set at the factory and need only be reset if A303 is replaced. The set point hysteresis is controlled by R318 and R319 which comprise an alternate feed-back loop for the switching voltage of A303; therefore, allowing a different de-activating high threshold voltage on A303 than the activating low threshold voltage.

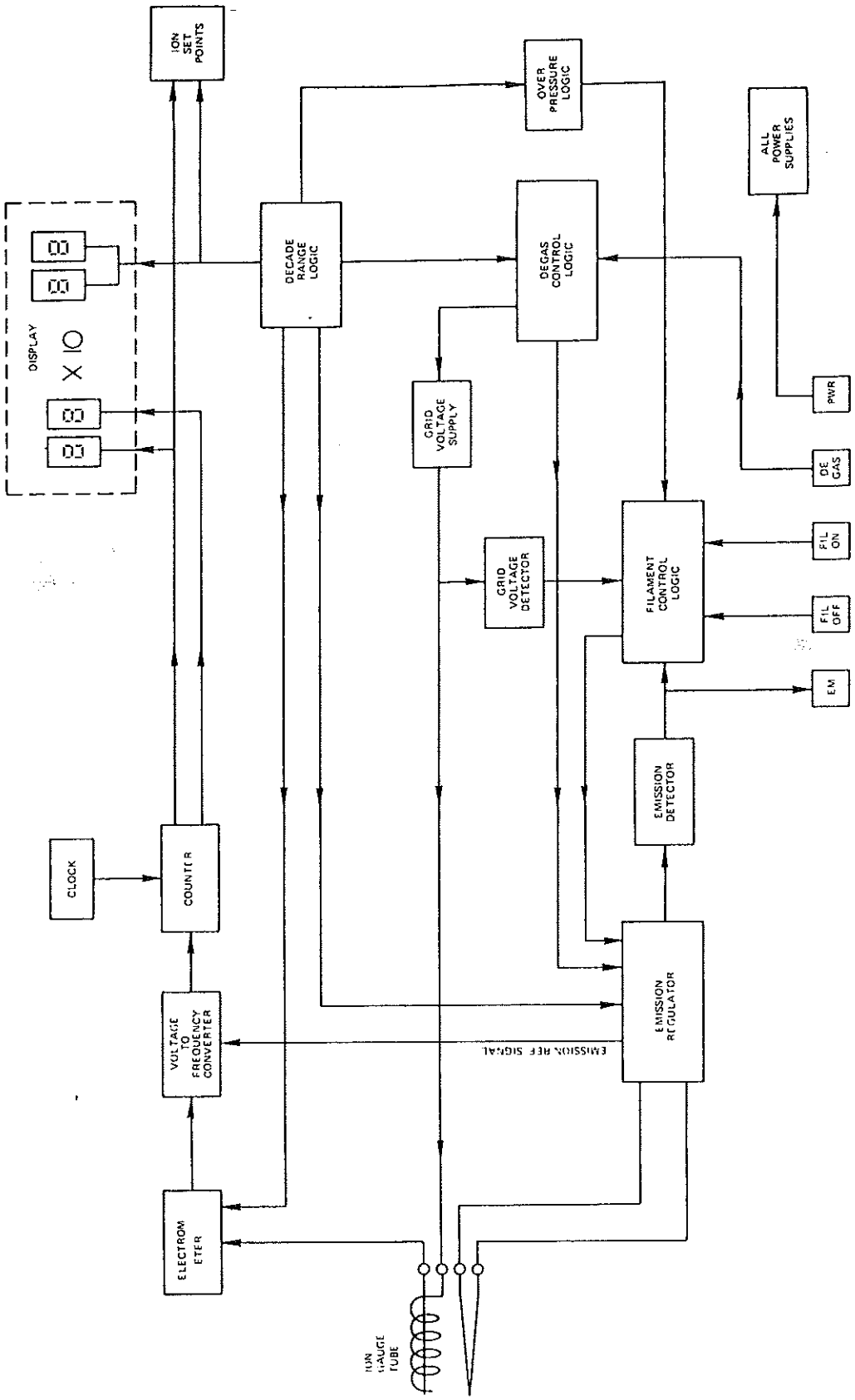
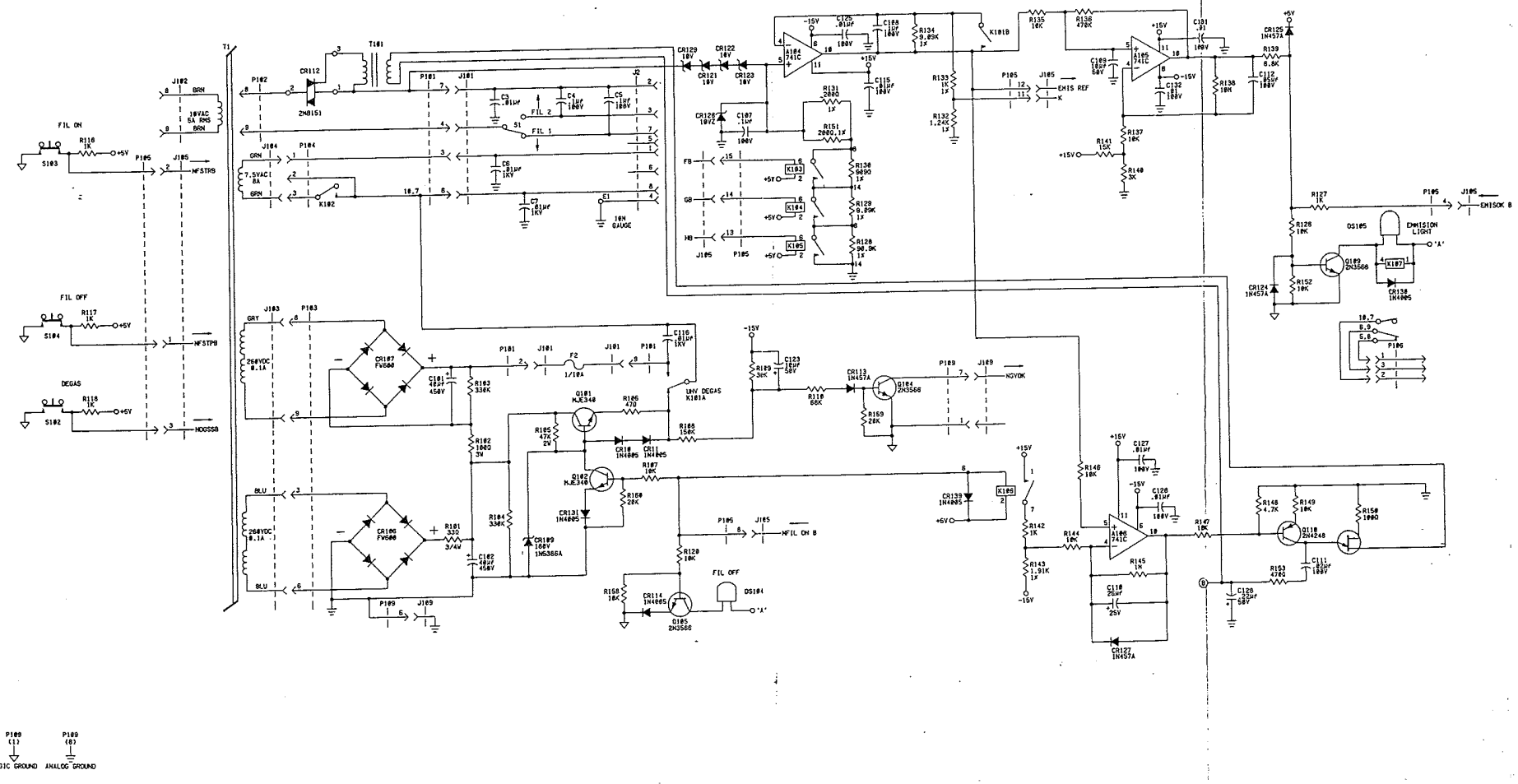
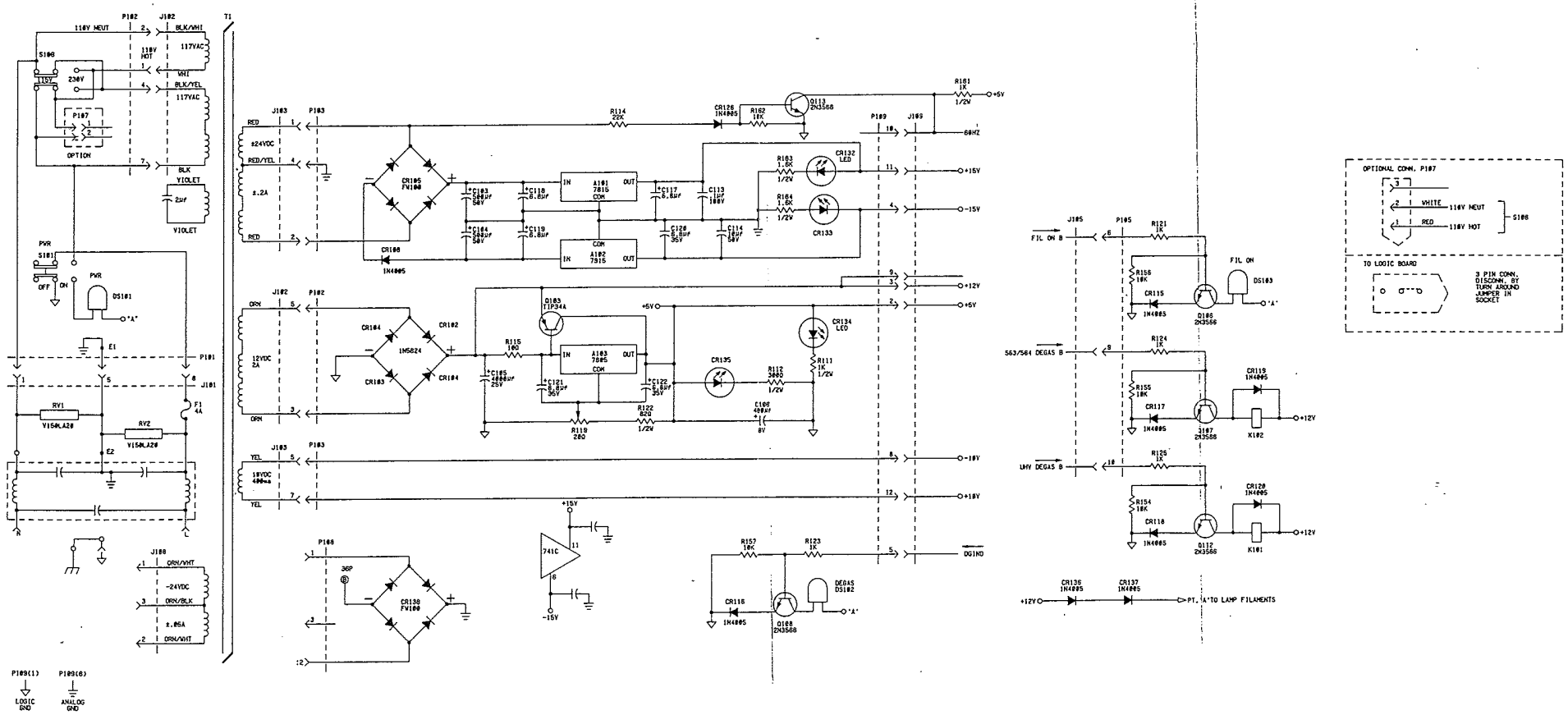


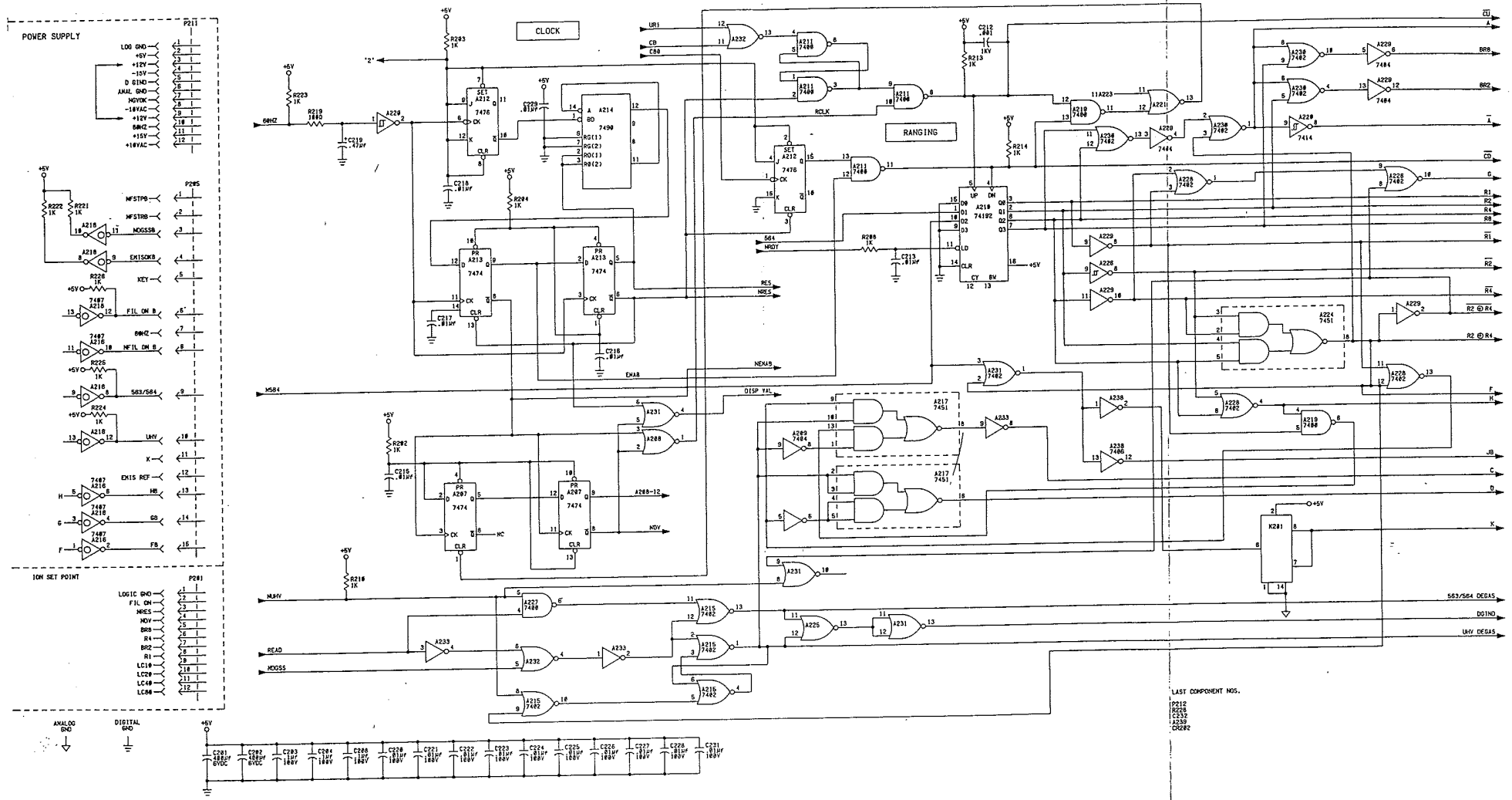
FIGURE 14. BLOCK DIAGRAM

XI. SCHEMATICS

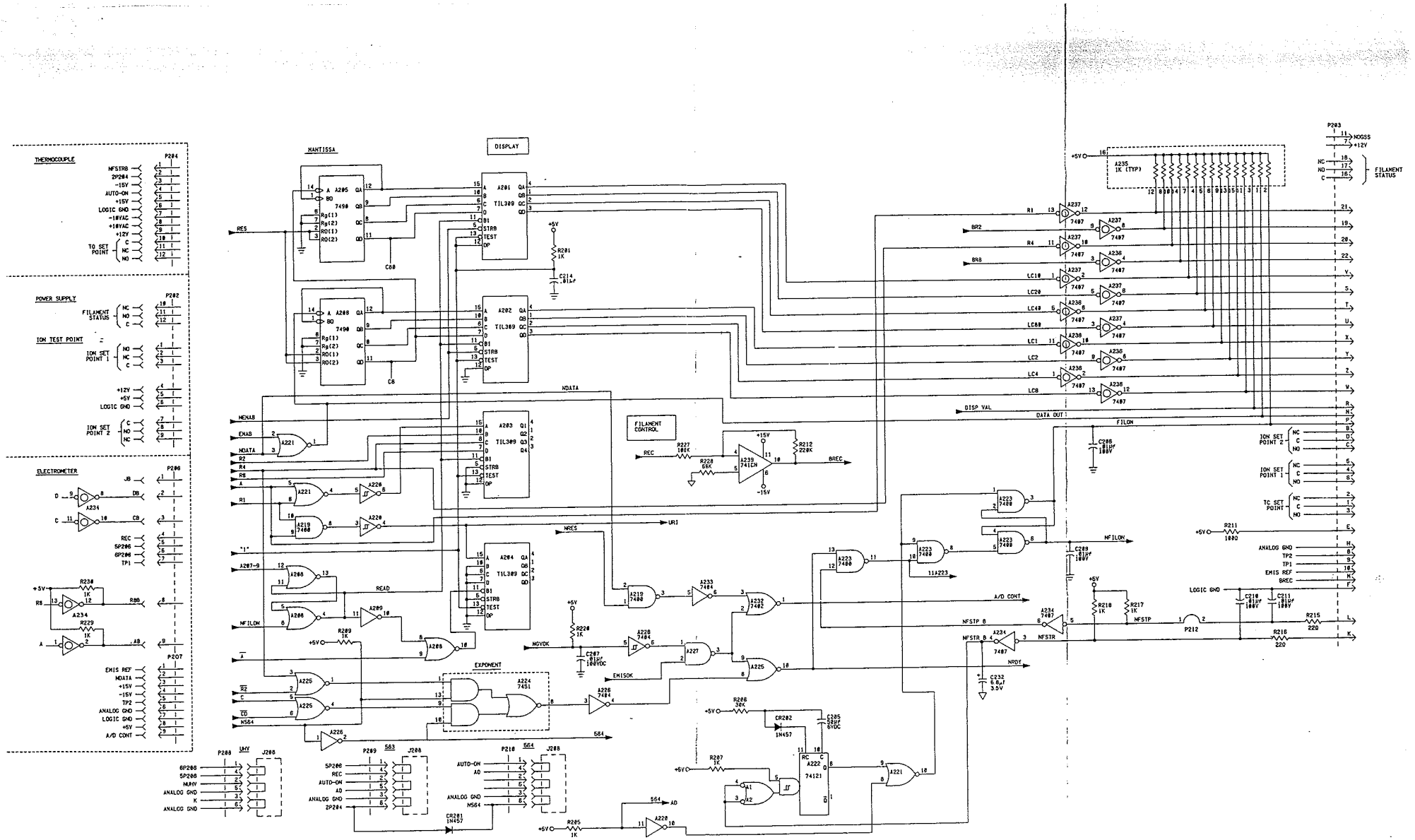

FIL ON
FIL OFF
DEGAS
LOGIC GROUND
ANALOG GROUND
EMISSION LIGHT
FIL OFF

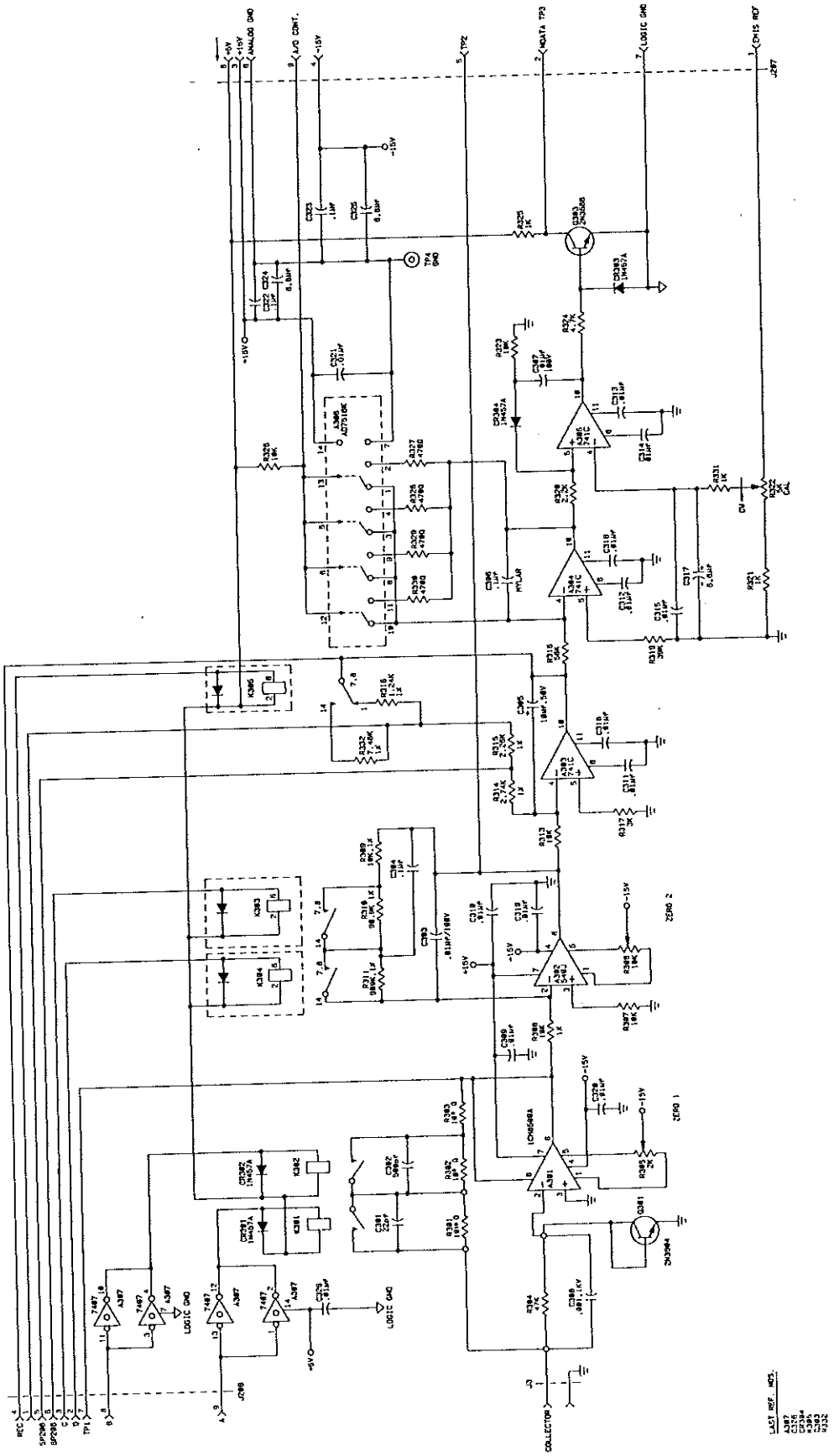


POWER SUPPLY (2 of 2)

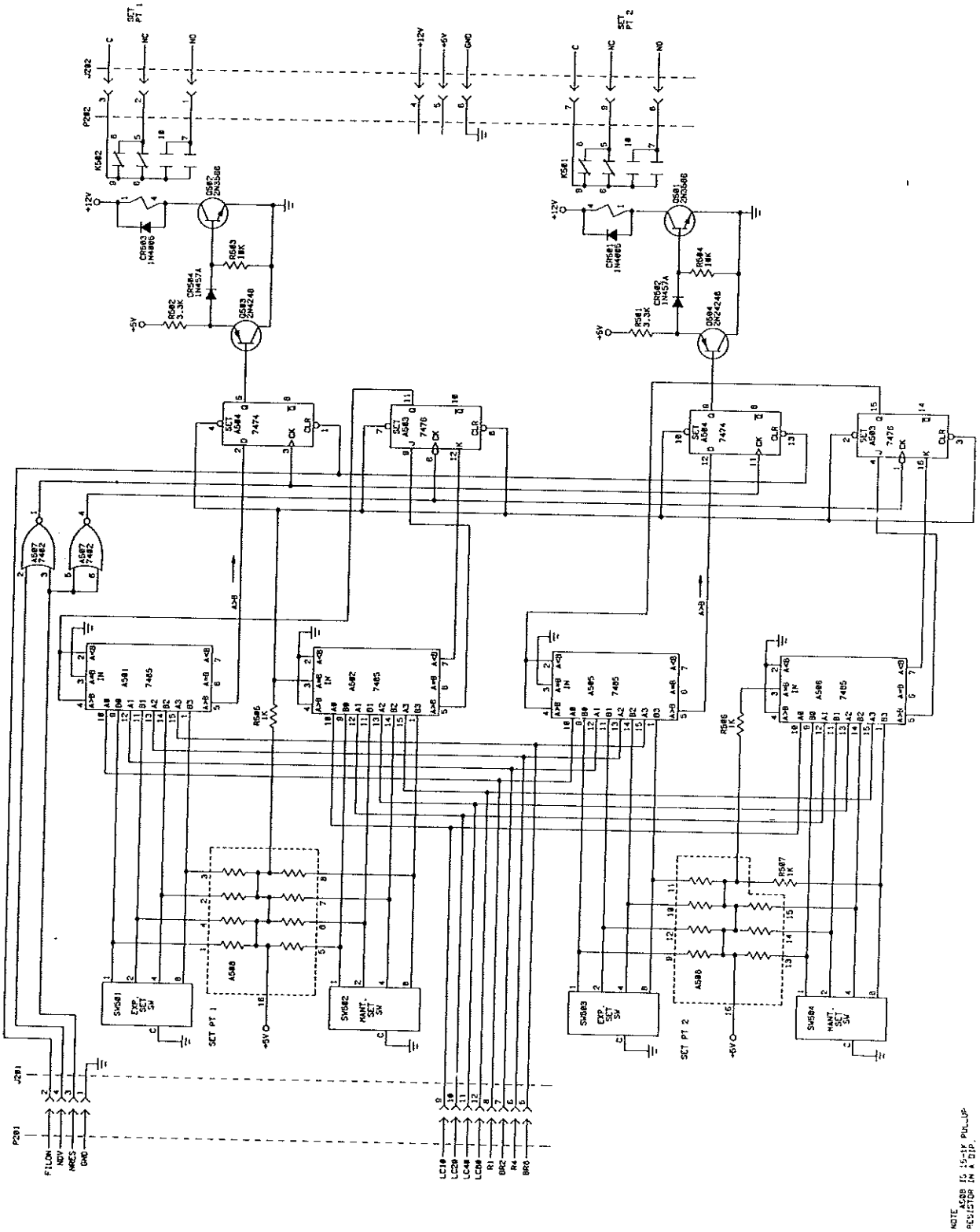

POWER SUPPLY
P211
LOG GND
+5V
+12V
-15V
D GND
ANAL GND
MGVOK
-16VAC
+12V
66KHZ
+15V
+16VAC
P285
MFSTPB
MFSTRB
MOSSB
EXISCKB
KEY
FIL ON B
66KHZ
NFIL ON B
583/584
UHV
K
EXIS REF
HB
GB
FB
ION SET POINT
P281
LOGIC GND
FIL ON
NRES
MOV
BR8
R4
BR2
R1
LC10
LC20
LC40
LC80
ANALOG GND
DIGITAL GND
CLOCK
RANGING
RCLK
HRDY
RES
NRES
EMAB
NEXAS
DISP VAL
A288-12
MOV
NUHV
READ
NOGSS
583/584 DEGAS
DGIND
UHV DEGAS
LAST COMPONENT NOS.
P212
R226
C232
A239
CR282

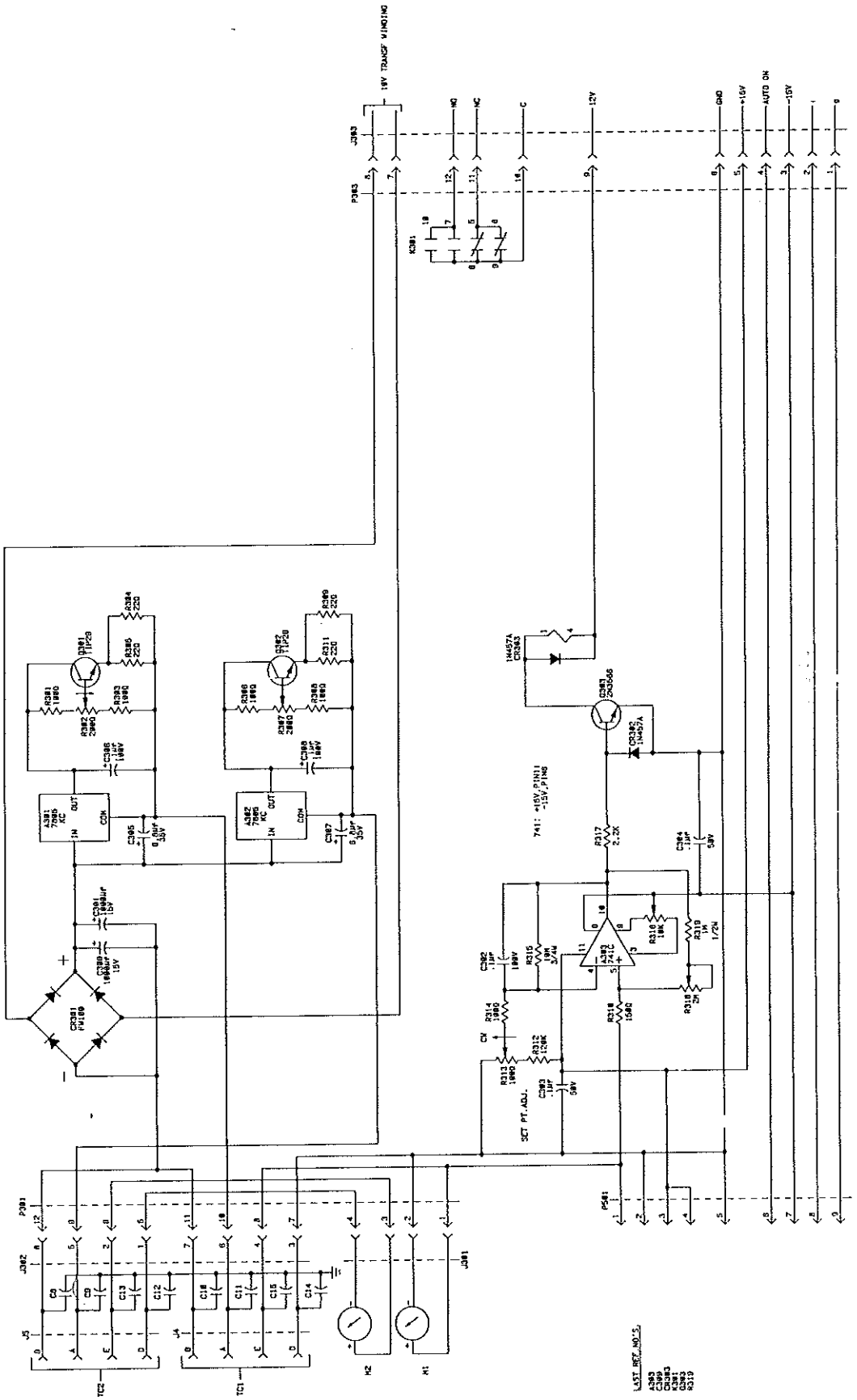
LOGIC (1 of 2)


THERMOCOUPLE
POWER SUPPLY
ION TEST POINT
ELECTROMETER
MANTISSA
DISPLAY
EXPONENT
FILAMENT CONTROL
NDATA
DISP VAL
DATA OUT
FILON
NFILON
NFSTR
NFSTP
NRDY
READ
EMISOK
MGVOK
AD
A/D CONT
LOGIC (2 of 2)



ELECTROMETER


ION SET POINTS
SET PT 1
SET PT 2
+12V
+5V
GND
NOTE
A588 IS 15-1K PULLUP
RESISTOR IN A DIP.



THERMOCOUPLE BOARD

APPENDIX A

A. PRESSURE MEASUREMENT NEAR THE X-RAY LIMIT OF BAYARD-ALPERT IONIZATION GAUGES

Pressure measurements near the x-ray limit of Bayard-Alpert Ion Gauges can be most accurately made by finding the x-ray limit of a particular gauge installation and subtracting this residual indication from the indicated pressure. Since Bayard-Alpert type gauges are widely used, this report offers a convenient, graphically illustrated reference for performing extremely low pressure measurements with them.

B. LINEARITY OF BAYARD-ALPERT IONIZATION GAUGES (See Figure 15)

The pressure indication of a Bayard-Alpert gauge is based on the ionization of gas molecules by a constant flow of electrons through the interior of a highly transparent cylindrical grid. The electrons are injected from a filament outside the grid. The positive ions are collected by a collector wire along the axis of the grid cage, resulting in current flow in the external measuring circuit. The rate of ionization for constant electron current is directly proportional to the density of molecules in the space, and therefore the ion current is proportional to pressure at constant temperature.

SCHEMATIC (END VIEW) OF BAYARD-ALPERT ION GAUGE SHOWING ELECTRONS, IONS, X-RAYS AND PHOTO-ELECTRONS.

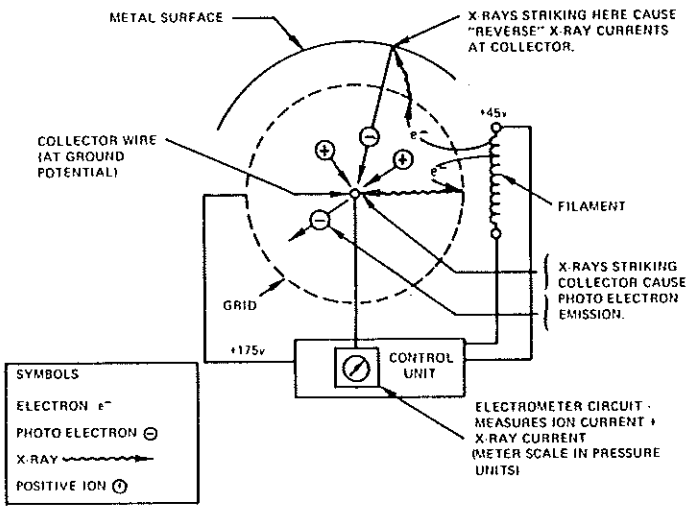


FIGURE 15

Vacuum gauge calibration data have verified the linearity of Bayard-Alpert gauges down to 10^{-9} Torr, and there is no known reason for non-linearities at lower pressures with the exception of the x-ray limit.

C. EXPLANATION OF X-RAY LIMIT (See Figure 15)

When the electrons from the filament ultimately reach the grid, they have appreciable kinetic energy. X-rays are produced when energetic electrons strike metal surfaces, such as the grid wires in an ionization gauge. Some of these x-rays strike the collector wire and cause photo-electrons to be ejected from the collector. The resulting electron current flows in the measuring circuit and adds to the ion current. Since the x-ray current is constant and not affected by pressure, there is a base or lower limit to the pressure indication. This lower limit is the x-ray limit of the gauge.

D. REVERSE X-RAY CURRENTS LOWER THE X-RAY LIMIT (See Figure 15)

Some of the x-rays from the grid are intercepted by nearby metal surfaces (see Figure 14), and photo-electrons are emitted. Some of these photo-electrons reach the collector and cause electron current in the measuring circuit which subtracts from the ion current and normal x-ray current. These reverse x-ray currents flowing in the opposite direction to the normal x-ray current lower the x-ray limit of a gauge by varying amounts depending on the installation.

E. DETERMINATION OF X-RAY CURRENT REQUIRED FOR EACH INSTALLATION

The x-ray current differs for each ion gauge installation because of variations of reverse x-ray currents with different surrounding surface configurations. Therefore, an assumed value cannot be used for the x-ray limit of every gauge.

F. METHOD FOR DETERMINING X-RAY LIMIT

X-ray current versus grid voltage method (electron energy), using a standard Bayard-Alpert Gauge, is demonstrated in Figure 16.

SCHEMATIC OF STANDARD BA GAUGE AND
CIRCUIT FOR X-RAY LIMIT DETERMINATION

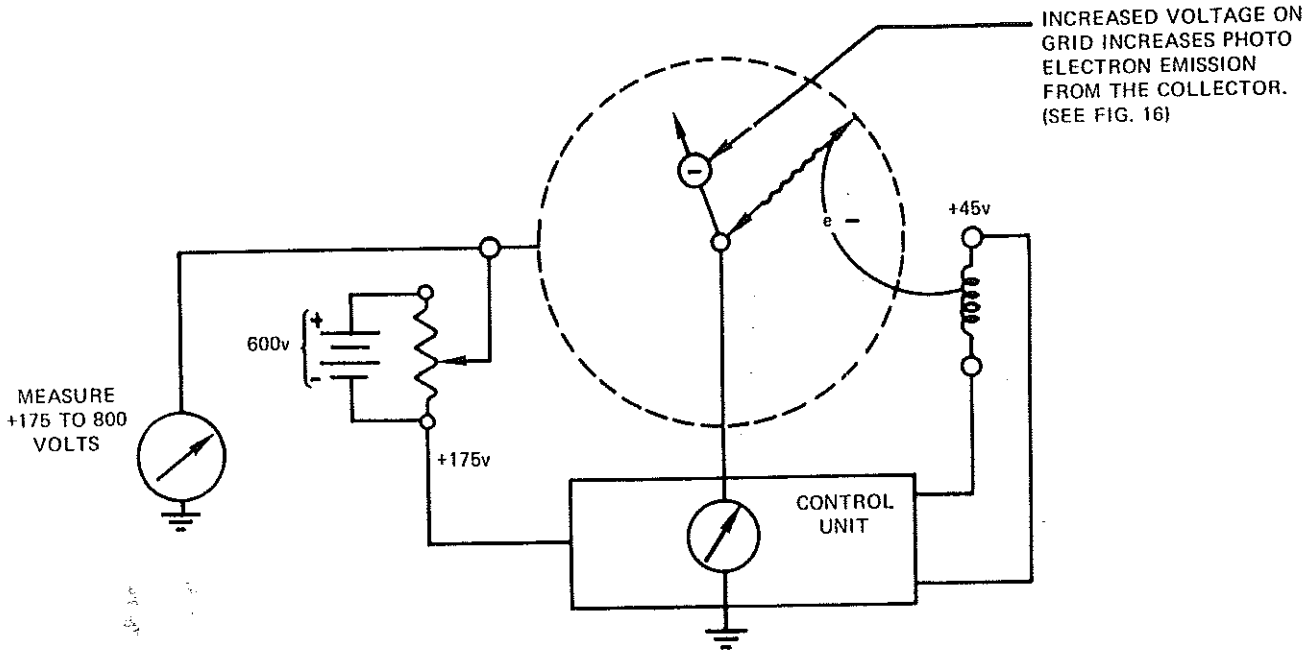


FIGURE 16

Procedure

1. With a constant pressure in the region of the x-ray limit, increase grid voltage.
2. Plot indicated pressure as a function of electron energy (grid voltage less filament voltage). Use a log-log plot.
3. Extrapolate linear portion of data back down to normal electron energy (typically 175 – 45 = 130 electron volts). (Refer to Figure 17.)
4. Determine true pressure by subtracting x-ray limit (P_X) from indicated pressure.

TYPICAL X-RAY DETERMINATION DATA--INDICATED PRESSURE VS. ELECTRON ENERGY

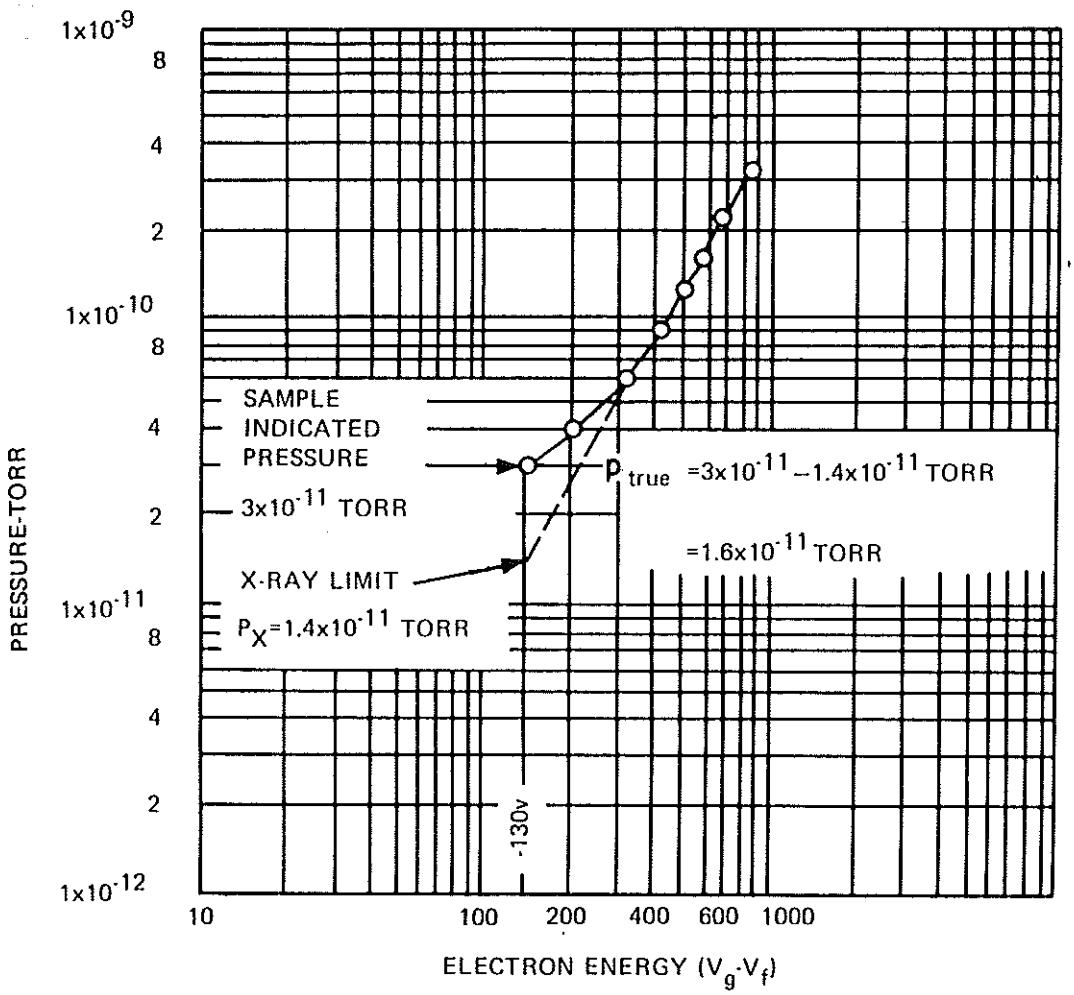


FIGURE 17

GAS SENSITIVITY TABLES

The following table lists relative gauge sensitivities for various gases. The values are derived by empirical methods substantiated by measurements reported in literature. The multiple values found in the table represent several different references. This table has been compiled and published by Robert L. Summers of Lewis Research Center, NASA Technical Note TN D-5285, National Aeronautics and Space Administration, Washington, D.C., June 1969.

To convert readings from the ionization gauge control (normally calibrated for nitrogen) divide the indicated pressure by the number listed in the third column for the particular gas (S/S_{n_2}).

Substance	Formula	Relative Ionization Gauge Sensitivity, S/S_{N_2}
Acetaldehyde	C_2H_4O	2.6
Acetone	$(CH_3)_2CO$	3.6
		4.0
		3.6
Acetylene	C_2H_2	1.9
		2.0
Air		1.0
		0.98
Ammonia	NH_3	1.3
		1.2
		1.3
Amylene:		
Iso-	iso-C_5H_{10}	5.9
cyclo-	cy-C_5H_{10}	5.8
Argon	Ar	1.3
		1.1
		1.2
		0.9
Benzene	C_6H_6	5.9
		5.8
		5.7
		5.9
		6.0
Benzoic acid	C_6H_5COOH	5.5
Bromine	Br	3.8
Bromomethane	CH_3Br	3.7
Butane:		
n-	n-C_4H_{10}	4.9
		4.7
Iso-	iso-C_4H_{10}	4.6
		4.9
Cadmium	Cd	2.3
		3.4
Carbon dioxide	CO_2	1.4
		1.4
		1.5
		1.5
		1.4

Substance	Formula	Relative Ionization Gauge Sensitivity, S/S_{N_2}
Carbon disulfide	CS_2	5.0
		4.7
		4.8
Carbon monoxide	CO	1.05
		1.05
		1.1
Carbon tetrachloride	CCl_4	6.0
		6.3
Cesium	Cs	4.3
		2.0
		4.8
Chlorine	Cl_2	0.68
		2.6
		1.6
Chlorobenzene	C_6H_5Cl	7.0
Chloroethane	C_2H_5Cl	4.0
Chloroform	$CHCl_3$	4.7
		4.8
		4.8
Chloromethane	CH_3Cl	2.6
		3.2
		3.1
Cyanogen	$(CN)_2$	2.8
		3.6
		2.7
Cyclohexylene	C_6H_{12}	7.9
		6.4
Deuterium	D_2	0.35
		0.38
Dichlorodifloromethane	CCl_2F_2	2.7
		4.1
Dichloromethane	CH_2Cl_2	3.7
Dinitrobenzene:	$C_6H_4(NO_2)_2$	
o-		7.8
m-		7.8
p-		7.6
Ethane	C_2H_6	2.6
		2.8
		2.5
Ethanol	C_2H_5OH	3.6
		2.9

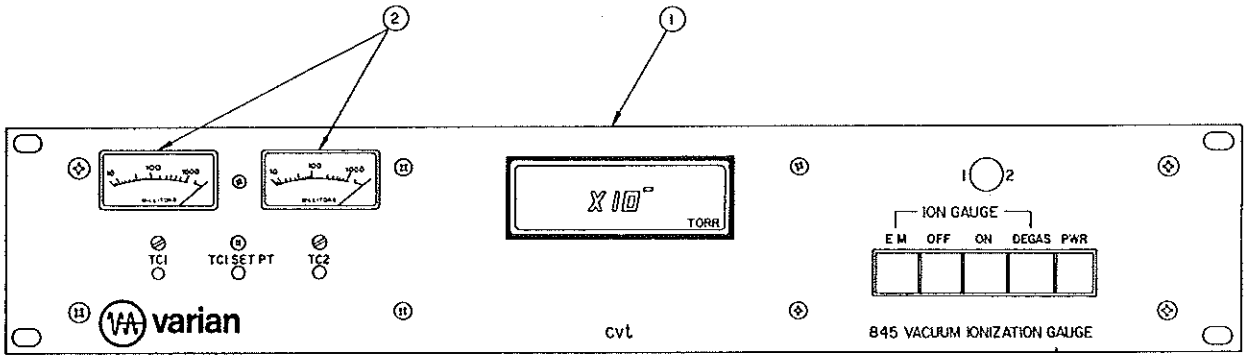
Substance	Formula	Relative Ionization Gauge Sensitivity, S/S_{N_2}
Ethyl acetate	$CH_3COOC_2H_5$	5.0
Ethyl ether	$(C_2H_5)_2O$	5.1
		5.1
Ethylene	C_2H_4	2.3
		2.4
		2.2
		2.2 to 2.5
Ethylene oxide	$(CH_2)_2O$	2.5
Helium	He	0.18
		0.15
		0.13
		0.12
Heptane	C_7H_{16}	8.6
Hexadiene:		
1,5-	1,5-C_6H_{10}	6.4
cyclo-	cy-C_6H_{10}	6.0
Hexane	C_6H_{14}	6.6
Hexene:		
1-	1-C_6H_{12}	5.9
cyclo-	cy-C_6H_{10}	6.4
Hydrogen	H_2	0.46
		0.38
		0.41
		0.45
		0.44
Hydrogen bromide	HBr	2.0
Hydrogen chloride	HCl	1.5
		1.6
		2.0
		1.5
Hydrogen cyanide	HCN	1.5
		1.6
Hydrogen floride	HF	1.4
Hydrogen iodide	HI	3.1
Hydrogen sulfide	H_2S	2.2
		2.2
		2.3
		2.1
Iodine	I_2	5.4
Iodomethane	CH_3I	4.2
Isoamyl alcohol	$C_5H_{11}OH$	2.9
Isobutylene	C_4H_8	3.6
Krypton	Kr	1.9
		1.7
		1.7
Lithium	LI	1.9
Mercury	Hg	3.6
Methane	CH_4	1.4
		1.5
		1.6
		1.4 to 1.8
		1.5
		1.5
Methanol	CH_3OH	1.8
		1.9
Methyl acetate	CH_3COOCH_3	4.0

Substance	Formula	Relative Ionization Gauge Sensitivity, S/S_{N_2}
Methyl ether	$(CH_3)_2O$	3.0
		3.0
Naphthalene	$C_{10}H_8$	9.7
Neon	Ne	0.30
		0.31
Nitrobenzene	$C_6H_5NO_2$	7.2
Nitrogen	N_2	1.0
Nitrotoluene (o-, m-, p-)	$C_6H_4CH_3NO_2$	8.5
Nitric oxide	NO	1.3
		1.2
		1.0
Nitrous oxide	N_2O	1.5
		1.7
		1.7
		1.3 to 2.1
Oxygen	O_2	1.0
		1.1
		0.9
		0.9
Pentane:		
n-	n-C_5H_{17}	6.2
		6.0
		5.7
iso-	iso-C_5H_{17}	6.0
neo-	$(CH_3)_4C$	5.7
Phenol	C_6H_5OH	6.2
Phosphine	PH_3	2.6
Potassium	K	3.6
Propane	C_3H_8	4.2
		3.7
		3.7 to 3.9
		3.6
Propene oxide	C_3H_6O	3.9
Propene:		
n-	n-C_3H_6	3.3
		3.2 to 3.7
cyclo-	cy-C_3H_6	3.6
Rubidium	Rb	4.3
Silver perchlorate	$AgClO_4$	3.6
Sodium	Na	3.0
Stannic iodide	SnI_4	6.7
Sulfur dioxide	SO_2	2.1
		2.3
Sulfur hexafloride	SF_6	2.3
		2.8
Toluene	$C_6H_5CH_3$	6.8
Trinitrobenzene	$C_6H_3(NO_2)_3$	9.0
Water	H_2O	1.1
		1.0
		0.8
Xenon	Xe	2.9
		2.2
	-	2.4
Xylene:		
o-	o-$C_6H_4(CH_3)_2$	7.8
p-	p-$C_6H_4(CH_3)_2$	7.9

PARTS LISTS

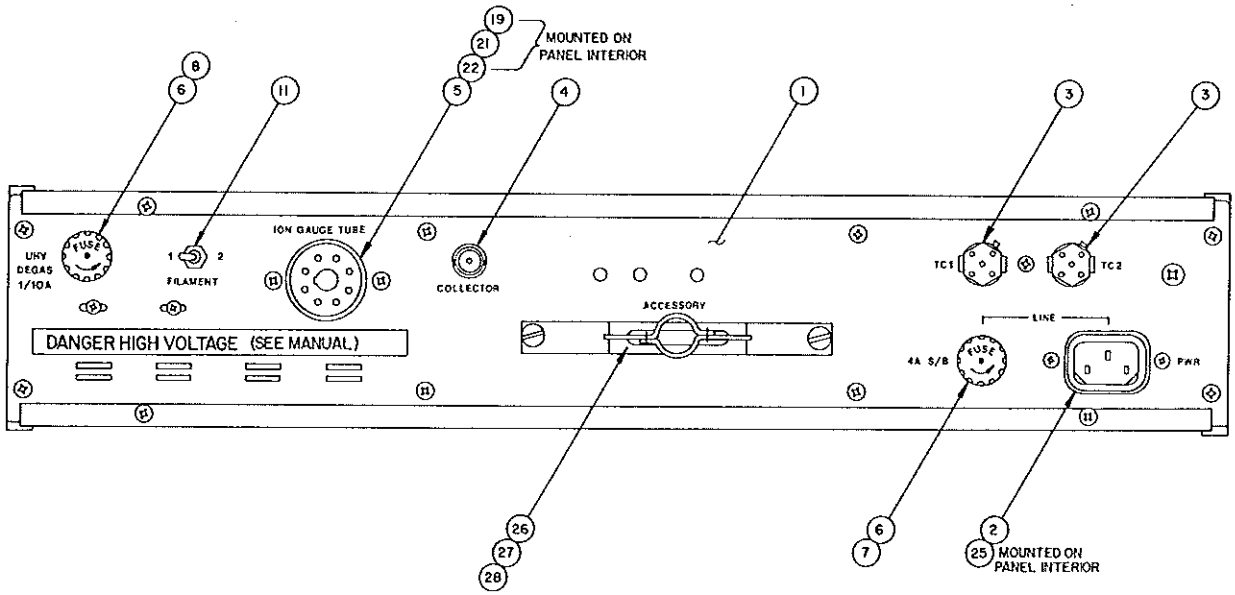
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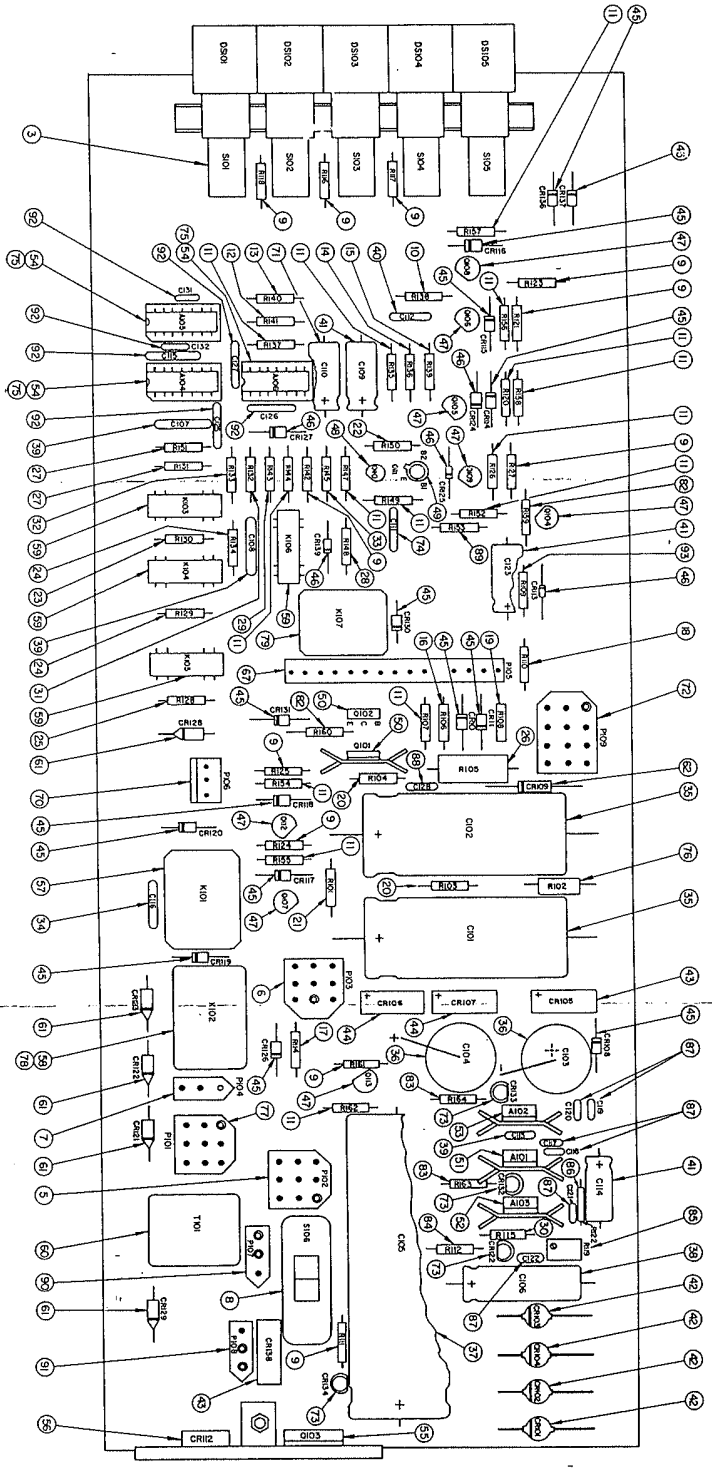
FRONT PANEL ASSEMBLY
PARTS LIST

Item	Description	Part No.
1	Front Panel D-K8248	0881-K8248-001
2	Meter: B-F0210	0881-6522-08-125



REAR PANEL ASSEMBLY
PARTS LIST

Item	Description	Part No.
1	Rear Panel: D-K8241	0881-K8241-001
2	Line Filter: Potter 610H3 (3 Amps)	0881-6429-71-003
3	Conn: Amphenol 126-218-1000	0881-6480-70-062
4	Conn: Kings KC-79-106	0881-6480-70-579
5	Socket: Amphenol 77-MIP-8	0881-6480-73-073
6	Fuseholder: Littelfuse 342014	0881-6456-00-005
7	Fuse: 4 Amp S/B Littelfuse 313002	0881-6453-00-007
8	Fuse: 1/10 Amp S/B Littelfuse 323.100	0881-6453-00-295
11	Switch: C&K 7101SYPWQ	0881-6421-02-032
19	Capacitor: 0.01 μF/1 kV Sprague 10TS-S10	0881-6441-02-008
21	Capacitor: 0.1 μF/100 V Sprague TG-P10	0881-6449-10-020
22	Capacitor: 0.01 μF/100 V Sprague TG-S10	0881-6449-10-032
25	Varistor: GE V150LA20	0881-6543-19-020
26	Conn: S.A.E. SAC 22D/1-2	0881-6480-72-418
27	Hood Assy: S.A.E. Type 8031 w/Cable Clamps	0881-6480-72-308
28	Polarizing Key: S.A.E. 007900	0881-6700-72-179



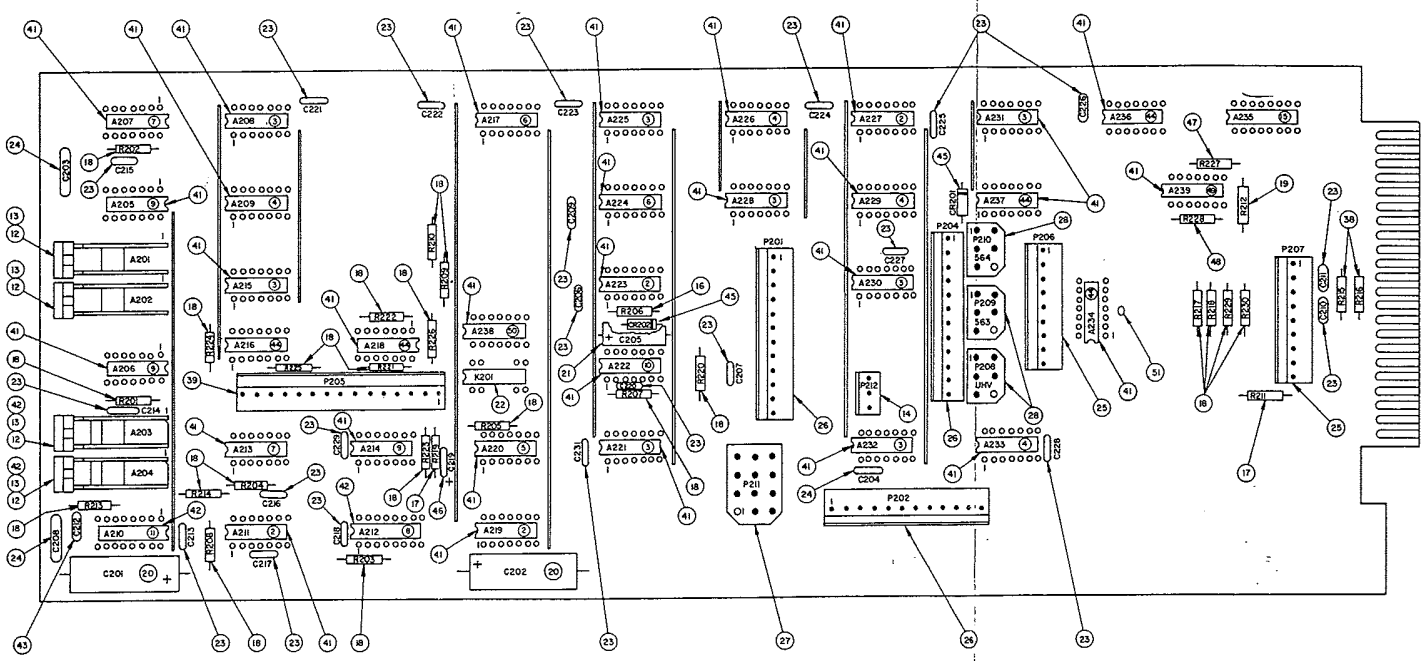
POWER SUPPLY P.C. ASSEMBLY
PARTS LIST

Item	Description	Part No.
3	P.B. Switch Assy.: A-K3115	0881-K3115-001
5	Conn: Molex 09-18-5094	0881-6480-70-049
6	Conn: Molex 09-18-5092	0881-6480-72-122
7	Conn: Molex 09-18-5031	0881-6480-70-047
8	Switch:	0881-6421-10-010
9	Resistor: 1K ½W ±5% Dep. Carb.	0881-6541-09-175
10	Resistor: 10 Meg ½W ±5% Dep. Carb.	0881-6541-09-120
11	Resistor: 10K ½W ±5% Dep. Carb.	0881-6541-09-102
12	Resistor: 15K ½W ±5% Dep. Carb.	0881-6541-09-144
13	Resistor: 3K ½W ±5% Dep. Carb.	0881-6541-09-162
14	Resistor: 470K ½W ±5% Dep. Carb.	0881-6541-09-133
15	Resistor: 6.8K ½W ±5% Dep. Carb.	0881-6541-09-168
16	Resistor: 47Ω ½W ±5% Dep. Carb.	0881-6541-09-100
17	Resistor: 22K ½W ±5% Dep. Carb.	0881-6541-09-170
18	Resistor: 68K ½W ±5% Dep. Carb.	0881-6541-09-190
19	Resistor: 150K ½W ±5% Dep. Carb.	0881-6541-09-161
20	Resistor: 330K ½W ±5% Dep. Carb.	0881-6541-09-131
21	Resistor: 33Ω ¾W ±5% Dep. Carb.	0881-6541-11-213
22	Resistor: 100Ω ½W ±5% Dep. Carb.	0881-6541-09-108
23	Resistor: 909Ω ¼W ±1% Type RN60D	0881-6542-77-299
24	Resistor: 9.09K ¼W ±1% Type RN60D	0881-6542-77-324
25	Resistor: 90.0K ¼W ±1% Type RN60D	0881-6542-77-372
26	Resistor: 47K 2W ±10% Carbon	0881-6541-18-047
27	Resistor: 200Ω ±1% Type RN60D	0881-6542-78-270
28	Resistor: 4.7K ½W ±5% Dep. Carb.	0881-6541-09-165
29	Resistor: 1.91K ¼W ±1% Type RN60D	0881-6542-77-308
30	Resistor: 10Ω ½W ±5% Dep. Carb.	0881-6541-09-015
31	Resistor: 1.24K 4W ±1% Type RN60D	0881-6542-77-311
32	Resistor: 1K ¼W ±1% Type RN60D	0881-6542-77-310
33	Resistor: 1 Meg ½W ±5% Dep. Carb.	0881-6541-09-123
34	Capacitor: Sprague 5GA-S10 0.01 μF 1 kV	0881-6449-10-030
35	Capacitor: Sprague TVA-1712 40 μF 450 V	0881-6449-02-075
36	Capacitor: Sprague 5GA-S10 500 μF/50 V	0881-6449-10-018
37	Capacitor: Sprague 39D 4000 μF 1 kV	0881-6449-02-038
38	Capacitor: Sprague TE-1107 400 μF 1 kV	0881-6449-09-117
39	Capacitor: Sprague TGP-10 0.1 μF 6 V dc	0881-6449-10-020
40	Capacitor: Sprague TG-S50 0.05 μF 100 V	0881-6449-10-033
41	Capacitor: Sprague TE-1304 10 μF 50 V dc	0881-6449-09-090
42	Diode: Sarkes Tarzian 3AF1	0881-6491-02-029
43	Diode: Mallory FW-100	0881-6491-02-080
44	Diode: Mallory FW-600	0881-6491-02-088
45	Diode: Sarkes Tarzian E6	0881-6491-02-025
46	Diode: ITT IN457A	0881-6491-07-057
47	Transistor: Fairchild 2N3566	0881-6543-18-020
48	Transistor: Fairchild 2N4248	0881-6543-18-025

POWER SUPPLY P.C. ASSEMBLY
PARTS LIST

Item	Description	Part No.
49	Transistor: T.I. 2N4948	0881-6543-18-088
50	Transistor: Motorola MJE-340	0881-6543-18-042
51	Regulator: Motorola MC7815CP	0881-6429-71-178
52	Regulator: Fairchild 7805CP	0881-6429-72-041
53	Regulator: Motorola 7915UC	0881-6429-71-179
54	IC: T.I. SN72741N	0881-6490-71-035
55	Transistor: Texas Instrument TIP-34 w/Mounting Kit	0881-6543-18-028
56	Thyristor: Motorola 2N6151 w/Mounting Kit	0881-6543-18-045
57	Relay: ITT 2B-BR	0881-6572-00-102
58	Relay: Magnecraft W65RPCX-202	0881-6572-00-019
59	Relay: P&B R10-E1-X2-V185	0881-6571-00-009
60	Transformer: Sprague 11Z2003	0881-6583-68-003
61	Diode: Schauer SZ-10.0	0881-6491-10-050
62	Diode: Motorola 1N5386A	0881-6491-02-018
63	Heat Sink: Thermalloy 6025D	0881-6492-00-012
64	Screw: Pan Hd Phil 4-40 × ¼ NI/PLT	0881-6144-12-132
65	Nut: KPS 4-40 CAD/PLT	0881-6178-11-024
66	Screw: Pan Hd Phil 4-40 × ½ NI/PLT	0881-6144-20-140
67	Conn: Molex 22-11-2281	0881-6480-72-221
68	Washer: Flat No. 4 CAD/PLT	0881-6181-20-014
70	Conn: Molex 09-61-1031	0881-6480-70-035
71	Capacitor: Sprague TE-1207 25 μF 25 V dc	0881-6449-09-170
72	Conn: Molex 09-18-5121	0881-6480-70-044
73	Resistor: 15Ω ½W ± 5% Dep. Carb.	0881-6541-09-215
74	Capacitor: Sprague TG-S20 0.02 μF 100 V	0881-6449-10-028
75	Socket: CIP14 Aries No. 14-511-11	0881-6480-74-090
76	Resistor: 100Ω, 3W, Ohmite Brown Devil	0881-6541-02-067
77	9-Pin Connector: Molex 09-18-5091	0881-6480-72-121
78	Socket w/Clip: Allied 30055-3	0881-6480-73-070
79	Relay: P&B R10-E2-X2-V185	0881-6571-00-075
82	Resistor: 20K ½W ±5% Dep. Carb.	0881-6541-09-143
83	Resistor: 1.6K ½W ±5% Dep. Carb.	0881-6541-09-150
84	Resistor: 300Ω ½W ±5% Dep. Carb.	0881-6541-09-115
85	Pot: 20Ω Bourns 3299W-1-200	0881-6545-32-062
86	Resistor: 82Ω ½W ±5% Dep. Carb.	0881-6541-09-104
87	Capacitor: Sprague 196D685X0035KA 6.8 μF/35 V	0881-6449-13-135
88	Capacitor: Sprague 196D224X0050HA 0.22 μF/50 V	0881-6441-02-012
89	Resistor: 470Ω ½W ± 5% Dep. Carb.	0881-6541-09-155
90	Conn: Molex 09-18-5035	0881-6480-70-050
91	Conn: Molex 09-18-5033	0881-6480-70-048
92	Capacitor: Sprague TG-S10 0.01 μF/100 V	0881-6449-01-032
93	Resistor: 30K ½W ± 5% Dep. Carb.	0881-6541-09-135
94*	Transformer with Capacitor (60 Hz)	0881-6581-00-259
95*	Transformer with Capacitor (50 Hz)	0881-6581-00-260
NOTE:	Assembled and Tested Power Supply Board	0881-K7885-301

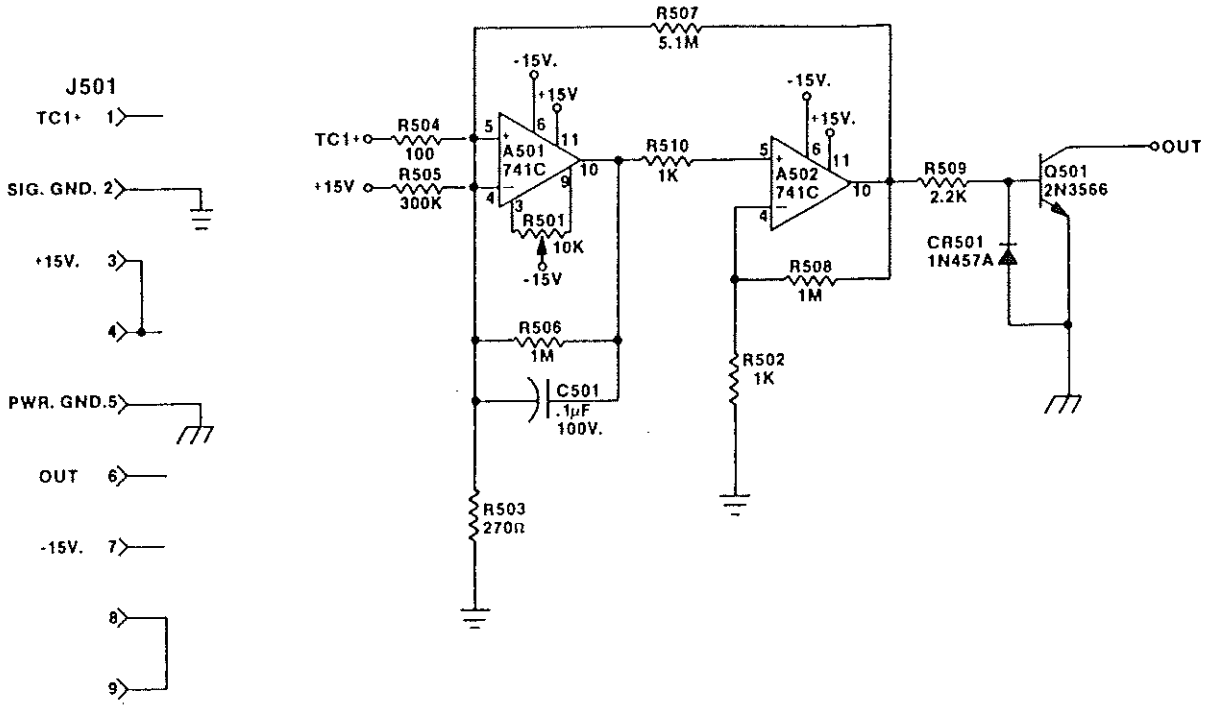
*See page 16 for location of this item (Figure 7).



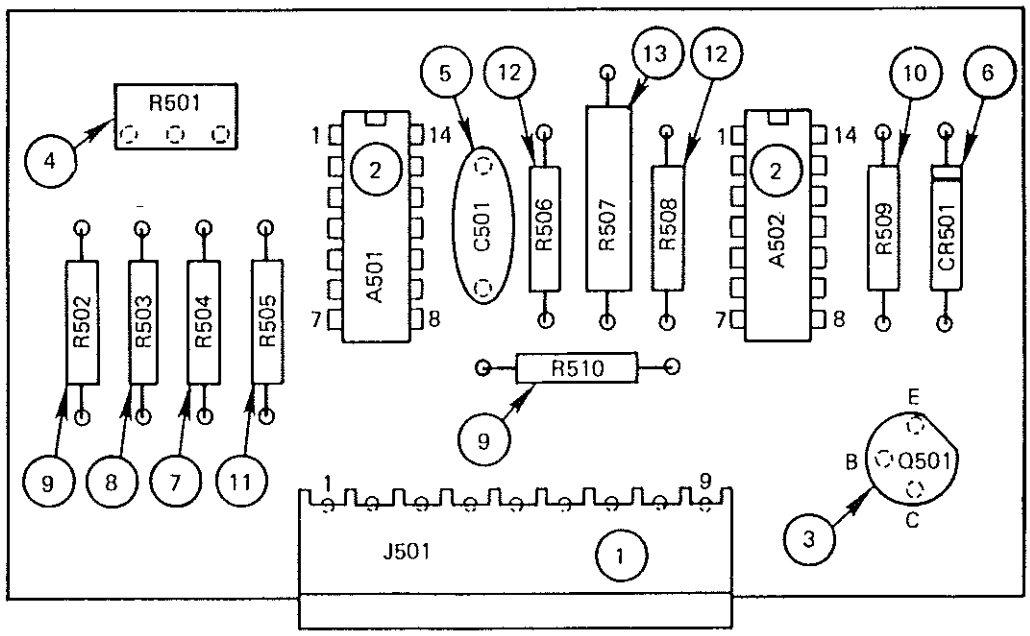
LOGIC P.C. ASSEMBLY

PARTS LIST

Item	Description	Part No.
2	IC: T.I. SN7400N 2-Input Nand	0881-6491-15-000
3	IC: T.I. SN7402N 2-Input Nor	0881-6491-15-002
4	IC: T.I. SN7404N Hex Inv	0881-6491-15-004
5	IC: T.I. SN7414N Trig Inv	0881-6491-15-014
6	IC: T.I. SN7451N And/Or/Inv	0881-6491-15-051
7	IC: T.I. SN7474N Flip/Flop	0881-6491-15-074
8	IC: T.I. SN7476 Flip/Flop	0881-6491-15-076
9	IC: T.I. SN7490 Dec. Cnt.	0881-6491-15-090
10	IC: T.I. SN7412N Mul. Vib.	0881-6491-15-121
11	IC: T.I. SN74192N UP/Dn Cnt.	0881-6491-15-192
12	LED Display: T.I. TIL-309 Numeric Display	0881-6510-08-309
13	Socket: Augat 516-AG21D Right Angle 16-Pin	0881-6480-74-083
14	Conn: Molex 09-61-1031	0881-6480-70-035
15	Resistor: Beckman 898-1-RIK 15 Res. Dip	0881-6542-71-270
16	Resistor: 30K ½W ± 5% Dep. Carb.	0881-6541-09-135
17	Resistor: 100Ω ½W ± 5% Dep. Carb.	0881-6541-09-108
18	Resistor: 1K ½W ± 5% Dep. Carb.	0881-6541-09-175
19	Resistor: 220K ½W ± 5% Dep. Carb.	0081-6541-09-228
20	Capacitor: Sprague TE-1107 400 μF 6 V dc	0881-6449-09-117
21	Capacitor: Sprague TE-1100 50 μF 6 V dc	0881-6449-09-110
22	Relay: EI&S DLIA05	0881-6570-08-270
23	Capacitor: Sprague TG-S10 0.01 μF 100V	0881-6449-10-032
24	Capacitor: Sprague TGP-10 0.1 μF 100V	0881-6449-10-020
25	Conn: Molex 09-72-1091	0881-6480-70-039
26	Conn: Molex 09-72-1121	0881-6480-70-041
27	Conn: Molex 09-18-5121	0881-6480-70-044
28	Conn: Molex 09-18-5061	0881-6480-70-046
38	Resistor: 22Ω ½W ± 5% Dep. Carb.	0881-6541-09-018
39	Conn: Molex 09-72-1151	0881-6480-70-075
41	Socket: (DIP14) Aries No. 14-511-11	0881-6480-74-090
42	Socket: (DIP16) Aries No. 16-511-11	0881-6480-94-089
43	Capacitor: Sprague No. 10TS-010 0.001 μF 1 kV	0881-6449-09-055
44	IC: T.I. SN7407 Hex Buffer Dr.	0881-6491-15-007
45	Diode: Fairchild IN457A	0881-6449-07-057
46	Capacitor: Sprague 150D474X9015A2	0881-6441-02-024
47	Resistor: 100K, ½W ± 5% Dep. Carb.	0881-6541-09-160
48	Resistor: 68K, ½W ± 5% Dep. Carb.	0881-6541-09-190
49	IC: T.I. SN72741N	0881-6491-71-035
50	IC: T.I. SN7406N	0881-6491-15-006
51	Capacitor: 6.8 F, 35V, Sprague 196D685X0035KA	0881-6441-02-015
NOTE: Assembled and Tested Logic Board		0881-K7889-301



AUTO ON SCHEMATIC

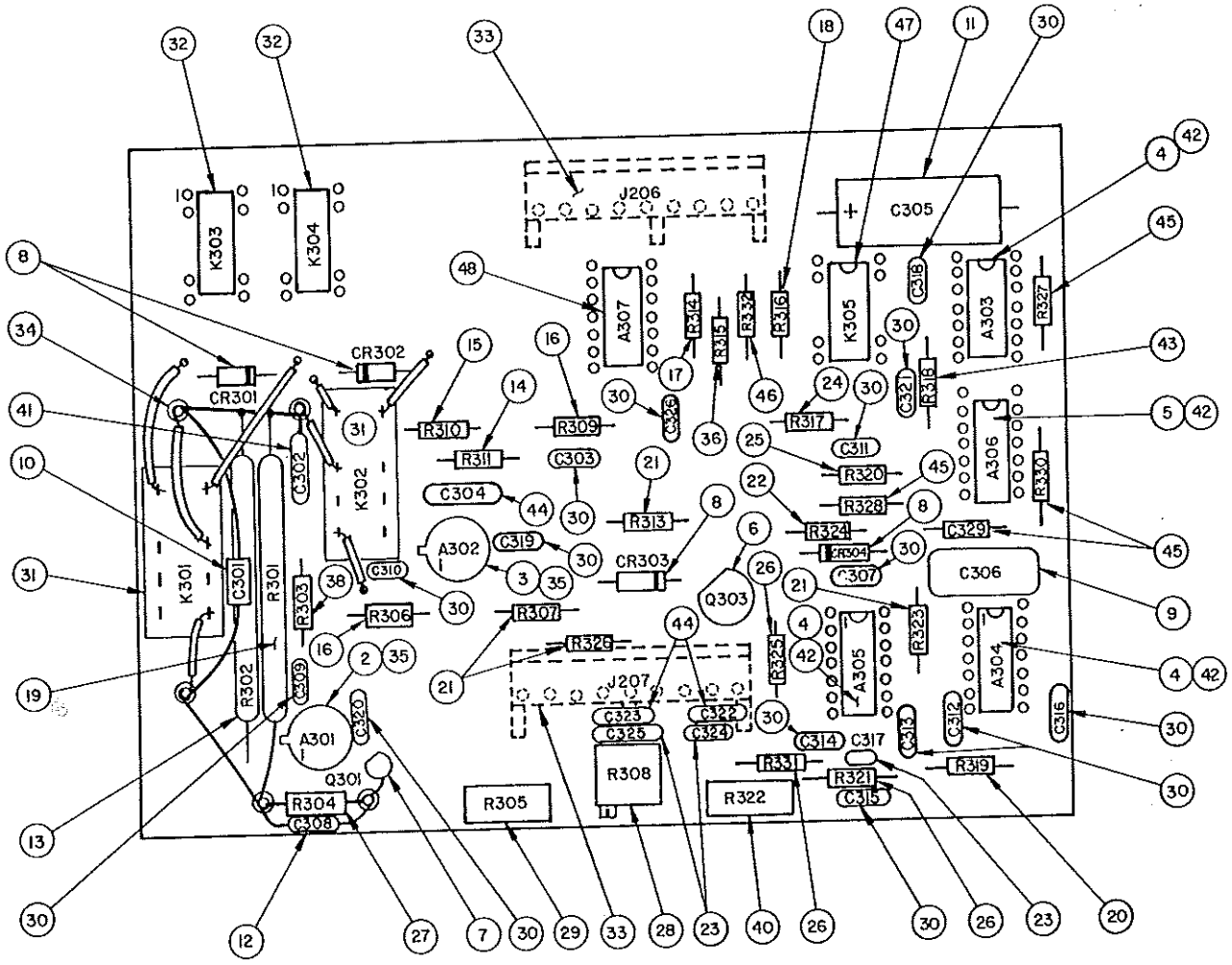


AUTO TURN ON CARD

AUTO TURN ON CARD

PARTS LIST

Item	Description	Part No.
1	Connector: P.C. Edge 9-Pin Molex No. 09-62-3091	0881-6480-70-072
2	Op.-Amp.: Lin. Type 741C T.I. No. SN72741N	0881-6490-71-035
3	Transistor: 2N3566	0881-6543-18-020
4	Pot.: 10 kΩ ½W ± 10% Cermet, Beckman No. 72XW-10k	0881-6545-12-208
5	Cap.: 1 μF/100 V dc Sprague No. TG-P10	0881-6449-10-020
6	Diode: 1N457A ITT	0881-6491-07-057
7	Res.: 100Ω ½W ± 5% Dep. Carb. Dale Type SBC	0881-6541-09-108
8	Res.: 270Ω ½W ± 5% Dep. Carb. Dale Type SBC	0881-6541-09-113
9	Res.: 1 kΩ ½W ± 5% Dep. Carb. Dale Type SBC	0881-6541-09-175
10	Res.: 2.2 kΩ ½W ± 5% Dep. Carb. Dale Type SBC	0881-6541-09-153
11	Res.: 300 kΩ ½W ± 5% Dep. Carb. Dale Type SBC	0881-6541-09-130
12	Res.: 1 MΩ ½W ± 5% Dep. Carb. Dale Type SBC	0881-6541-09-123
13	Res.: 5.1 MΩ ¾W ±5% Dep. Carb. Dale Type SBE	0881-6541-11-329
NOTE: Auto Turn On Card (user installed)		0891-K3128-301

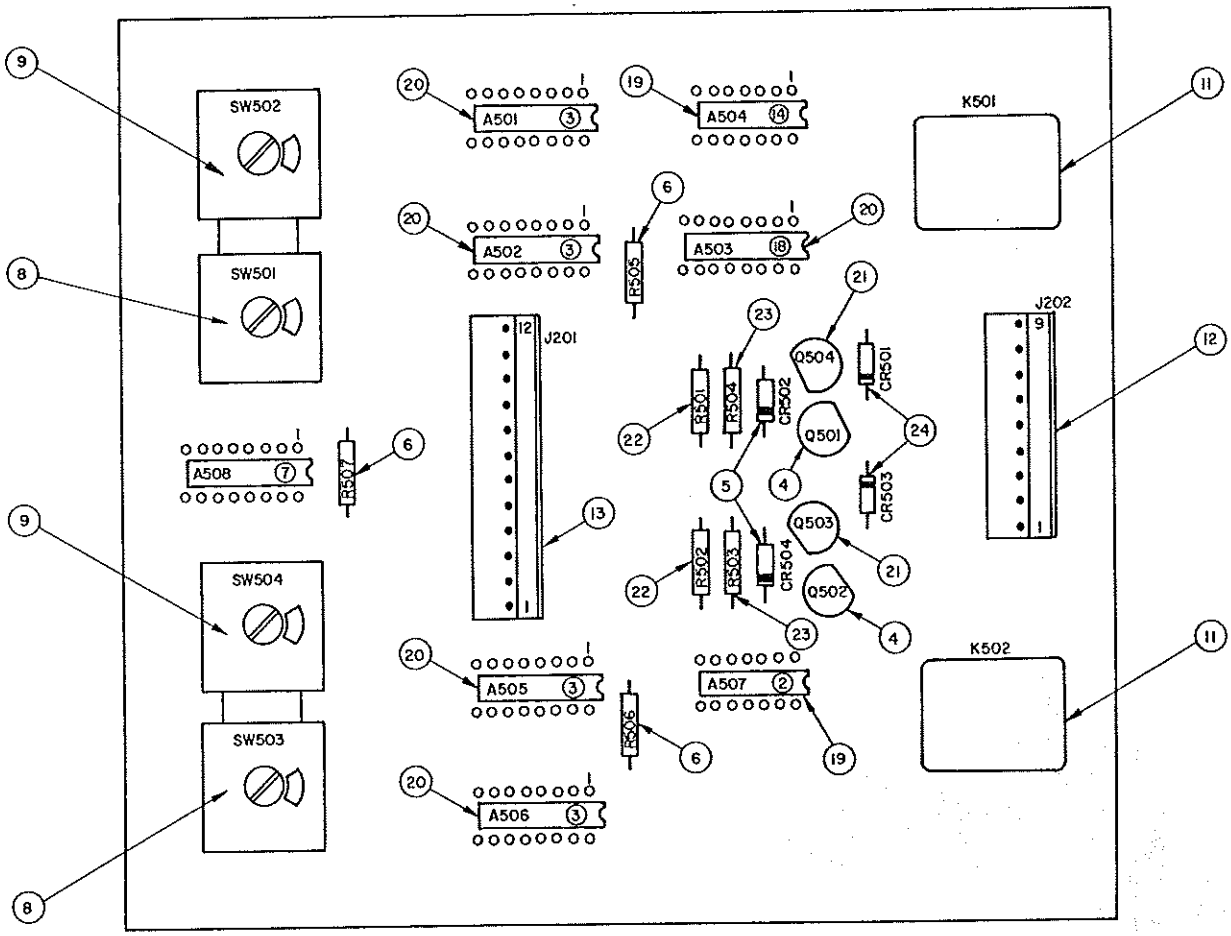


ELECTROMETER P.C. ASSEMBLY

PARTS LIST

Item	Description	Part No.
2	IC. Intersil ICH8500A	0881-6491-19-500
3	IC: Analog Devices 540J	0881-6491-16-140
4'	IC: T.I. SN72741N	0881-6490-71-035
5	Analog Switch: A/D, AD7516KN	0881-6421-08-216
6	Transistor: Fairchild 2N3566	0881-6543-18-020
7	Transistor: Motorola 2N3904	0881-6543-18-016
8	Diode: ITT IN457A	0881-6591-07-057
9	Capacitor: Sprague 225P10491WD3; 0.1 μF 100 V	0881-6442-01-025
10	Capacitor: Corning 22 pF	0881-6449-02-065
11	Capacitor: 10 μF/50 V, Disc TE1304	0881-6449-09-090
12	Capacitor: Sprague 10TS-D10, 0.001 μF 1 kV	0881-6449-09-055
13	Resistor: Victoreen 100 M ± 1% RX-1	0881-6543-17-612
14	Resistor: 909K ¼W ± 1% Type RN60D	0881-6542-77-609
15	Resistor: 90.0 ¼W ± 1% Type RN60D	0881-6542-77-372

Item	Description	Part No.
16	Resistor: 10K ¼W ±1% Type RN60D	0881-6542-77-325
17	Resistor: 2.74K ¼W ±1% Type RN60D	0881-6542-77-314
18	Resistor: 1.24K ¼W ±1% Type RN60D	0881-6542-77-311
19	Resistor: Victoreen 10,000M ±2% RX-1	0881-6543-17-611
20	Resistor: 39K ½W ±5% Dep. Carb.	0881-6541-09-188
21	Resistor: 10K ½W ±5% Dep. Carb.	0881-6541-09-102
22	Resistor: 4.7K ½W ±5% Dep. Carb.	0881-6541-09-165
23	Capacitor: 6.8 μF/35 V, Sprague 196D685X0035KA	0881-6441-02-015
24	Resistor: 3K ½W ±5% Dep. Carb.	0881-6541-09-162
25	Resistor: 2.2K ½W ±5% Dep. Carb.	0881-6541-09-153
26	Resistor: 1K ½W ±5% Dep. Carb.	0881-6541-09-175
27	Resistor: 47K ½W ±5% Dep. Carb.	0881-6541-09-138
28	Pot.: Beckman 68PR10K ±10%	0881-6545-12-038
29	Pot.: Beckman 72XW-R2K ½W 2K ±10%	0881-6545-12-202
30	Capacitor: Sprague TG-S10 0.01 μF 100 V	0881-6449-10-032
31	Relay: Per Spec. Dwg. B-K8360	0881-K8360-001
32	Relay: Magnecraft W171DIP-7	0881-6570-08-270
33	Conn: Per Dwg. A-K6267	0881-K6267-001
34	Terminal: Sealectro ST1500L2	0881-6480-93-060
35	Socket: EMC 6005-211-0	0881-6480-73-077
36	Resistor: 2.26K ¼W ±1% Type RN60D	0881-6542-77-317
38	Resistor: 1.00M ¼W ±1% Type RN60D	0881-6542-78-101
40	Pot.: 5K ±10% 72XWR5K Beckman	0881-6545-12-205
41	Capacitor: Sprague 5GA-T10 500 pF 1 kV	0881-6449-00-033
42	Socket: DIP14, Aries No. 14-511-11	0881-6480-74-090
43	Resistor: 56K, ½W, ±5%, Dep. Carb.	
44	Capacitor: 0.1 μF/100 V, Sprague No. TGP-10	0881-6449-10-020
45	Resistor: 470Ω ½W ±5% Dep. Carb.	0881-6541-09-155
46	Resistor: 7.48K ½W ±1% Dep. Carb.	0881-6542-78-326
47	Relay: E.I.&S #DLIC05D	0881-6570-08-271
48	Hex Buffer/Driver: TI SN7407	0881-6491-15-007
NOTE: Assembled and Tested Electrometer Board		0881-K8374-301

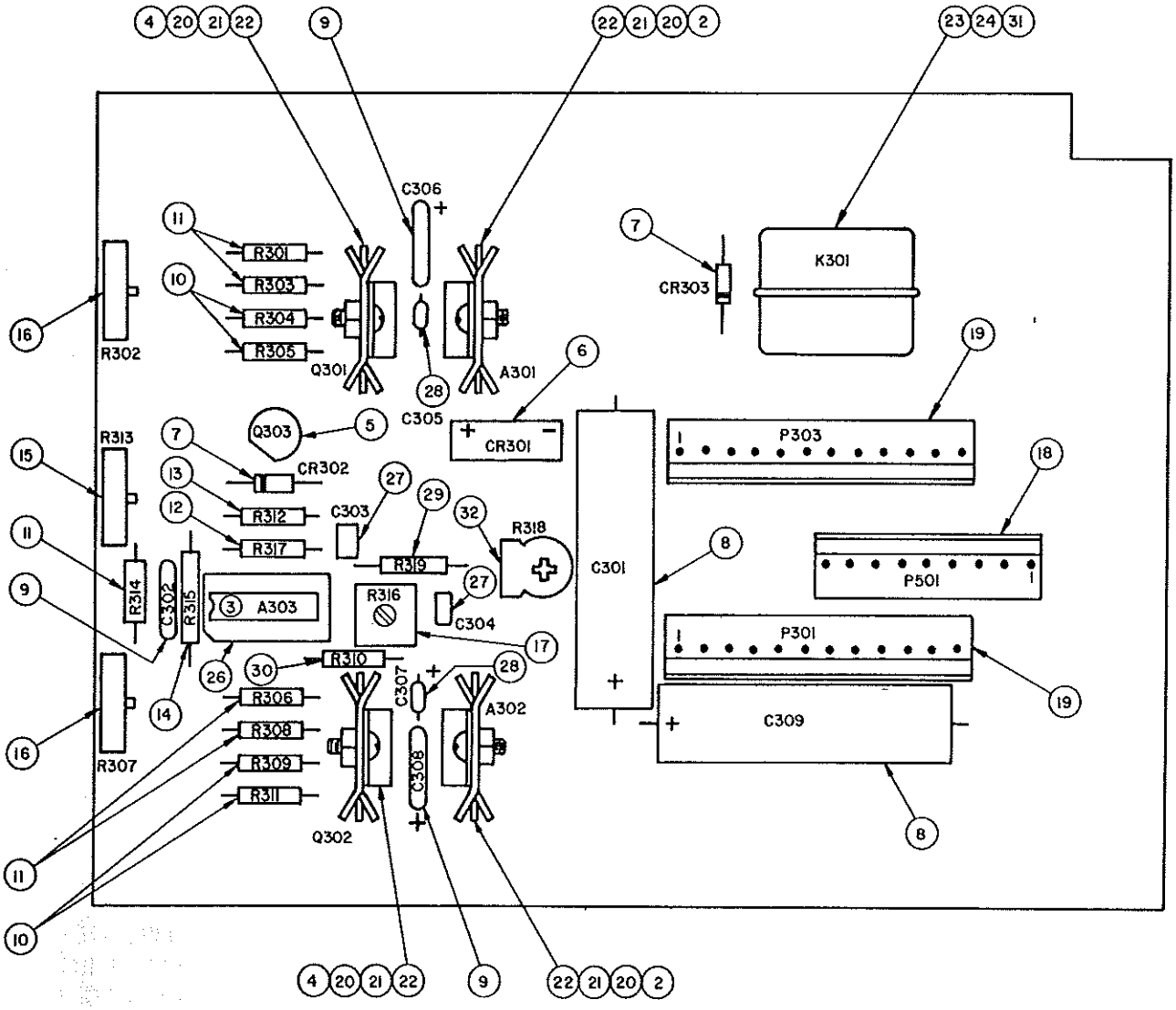


ION SET POINT P.C. ASSEMBLY

PARTS LIST

Item	Description	Part No.
2	IC: T.I. SN7402N 2-Input Nor	0881-6491-15-002
3	IC: T.I. SN7485N 4-Bit Comparator	0881-6491-15-085
4	Transistor: Fairchild 2N3566	0881-6543-18-020
5	Diode: ITT IN457A	0881-6491-07-057
6	Resistor: 1K ½W ±5% Dep. Carb.	0881-6541-09-175
7	Resistor: Beckman 898-1-R1K, 15 Res Dip	0881-6542-71-270
8	Switch: EECO 1A219031G	0881-6421-08-049
9	Switch: EECO 1A210012G	0881-6421-08-044
11	Relay: P&B, R10-E2-X2-V185 (12 V dc)	0881-6571-00-075
12	Conn: Molex 9-Pin 0972-72-1091	0881-6480-70-039
13	Conn: Molex 12-Pin 09-72-1121	0881-6480-70-041
14	D-Type Flip-Flop T.I. SN7474N	0881-6491-15-074
18	I.C.: SN7476N J-K Flip-Flop	0881-6491-15-076
19	Socket: DIP 14, Aries No. 14-511-11	0881-6480-74-090
20	Socket: DIP 16, Aries No. 16-511-11	0881-6480-74-089
21	Transistor: Fairchild 2N4248	0881-6543-18-025
22	Resistor: 3.3K ½W ±5% Dep. Carb.	0881-6541-09-163
23	Resistor: 10K ½W ±5% Dep. Carb.	0881-6541-09-102
24	Diode: IN4005	0881-6491-02-006

NOTE: Assembled and Tested Ion Set Point Board 0881-K3930-301



THERMOCOUPLE P.C. ASSEMBLY (MODEL 845 ONLY)

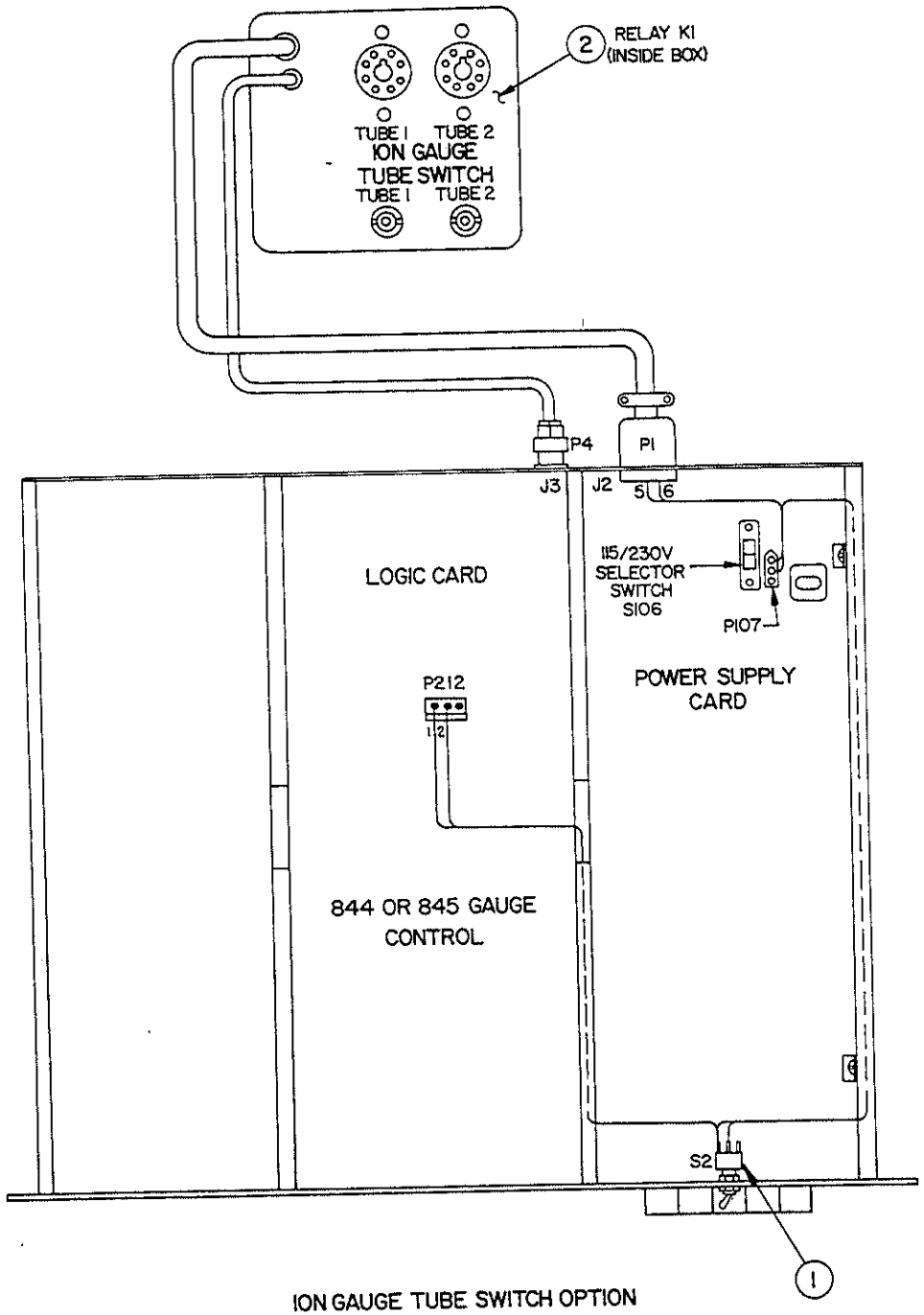
THERMOCOUPLE P.C. ASSEMBLY (MODEL 845 ONLY)

PARTS LIST

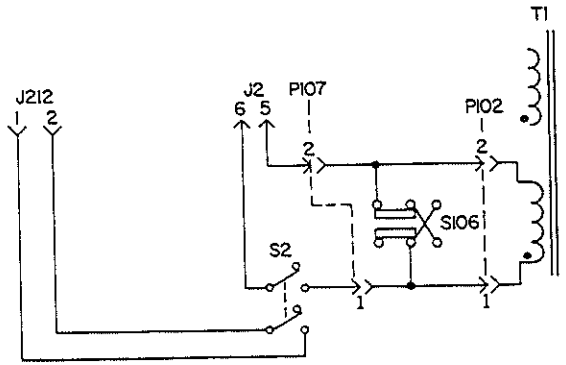
Item	Description	Part No.
2	Regulator: Fairchild 78M05UC	0881-6429-72-041
3	IC: T.I. SN72741N	0881-6490-71-035
4	Transistor: Texas Instrument TIP-29	0881-6543-18-029
5	Transistor: Fairchild 2N3566	0881-6543-18-020
6	Diode: Mallory FW-100	0881-6491-02-080
7	Diode: ITT 1N457A	0881-6491-07-057
8	Capacitor: Sprague TVA-1163 1000 μF 16 V dc	0881-6449-10-017
9	Capacitor: Sprague TGP-10, 0.1 μF 100 V	0881-6449-10-020
10	Resistor: 22Ω ½W ±5% Dep. Carb.	0881-6541-09-018
11	Resistor: 100Ω ½W ±5% Dep. Carb.	0881-6541-09-108
12	Resistor: 2.2K ½W ±5% Dep. Carb.	0881-6541-09-153
13	Resistor: 120K ½W ±5% Dep. Carb.	0881-6541-09-159
14	Resistor: 10 Meg ¾W ±5% Dep. Carb.	0881-6541-09-120
15	Pot.: CTS X201 100Ω 30%	0881-6545-26-020
16	Pot.: CTS X201 200Ω 30%	0881-6545-28-201
17	Pot.: Beckman 72P 10K	0881-6545-12-070
18	Conn: Molex 2391 Ser. 9-Pin w/Lock Wafer 09-72-1091-G	0881-6480-70-039
19	Conn: Molex 2391 Ser. 12-Pin w/Lock Wafer 09-72-1121	0881-6480-70-041
20	Heat Sink: Thermalloy 6025D	0881-6492-00-012
21	Screw Pan Hd Phil 4-40 X ¼ Ni Plt Cad Plt	0881-6144-12-132
22	Nut Kps 4-40 Cad Plt	0881-6178-11-024
23	Relay: P&B R10-E1-X2-V185 (12 V dc)	0881-6571-00-009
24	Relay Socket: P&B 27E162	0881-6480-75-162
26	DIP Socket: Aries 14-511-11	0881-6480-74-090
27	Capacitor: 10 μF, 50 V Sprague/CZ5U104X0050C4	0881-6442-01-005
28	Capacitor: 6.8 μF, 35 V Sprague 196D685X0035KA	0881-6449-03-135
29	Resistor: 1 Meg ½W ±5% Dep. Carb.	0881-6541-09-123
30	Resistor: 150, ½W ±5% Dep. Carb.	0881-6541-09-109
31	Retaining Spring: P&B 20C249	0881-6480-75-149
32	Pot.: 2 Meg. Bourns 3352T-CP9-205	0881-6545-32-105
NOTE:	Assembled and Tested Thermocouple Set Point Board	0881-K3927-301

DUAL ION GAUGE TUBE SWITCH OPTION
PARTS LIST

Item	Description	Part No.
1	Switch: C&K 7201	0881-6421-02-036
2	Relay: P&B KAP11AG-120 V	0881-6571-00-018



ION GAUGE TUBE SWITCH OPTION



SCHEMATIC
(INTERNAL WIRING)

DUAL ION GAUGE TUBE SWITCH OPTION

XIV. MISCELLANEOUS ACCESSORIES

VARIAN 563 IONIZATION GAUGE TUBE



SPECIFICATIONS

Sensitivity ..... 10.0 $Torr^{-1}$

Operational Ratings:

Collector	0 V dc
Shield	Internally connected to filament
Grid	+150 V dc to ground
Filament Bias	+30 V dc to ground
Filament Voltage	4 V ac nominal (6 V ac max)
Filament Current	3.5 A nominal (6 A max)
Emission	100 mA maximum

X-ray Limit ..... 2×10^{-10} Torr

Pumping Speed ..... 0.06 liter/second, ionic $-N_2$ (1 mA emission)

Material

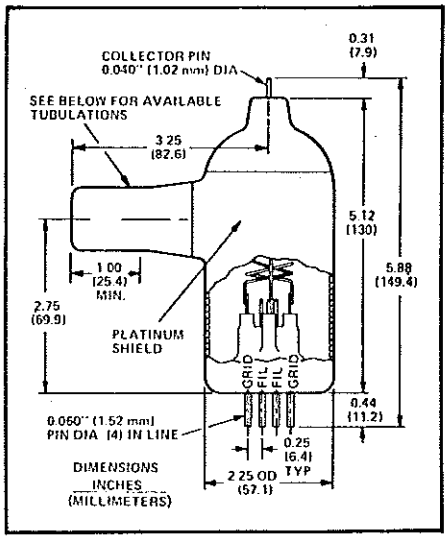
Grid	Tungsten (0.025 dia)
Collector	Tungsten (0.010 dia)
Envelope	Nonex
Filament	Hairpin thoria-coated iridium

Maximum Recommended Operating Pressure (air): 1×10^{-3} Torr

Platinum Coating ..... 30 V dc (The platinum coating located on the inside surface of the gauge reduces glass charging effects.)

Degas (Resistance Heating)

Grid Voltage	6.3 V ac
Grid Current	8.7 A

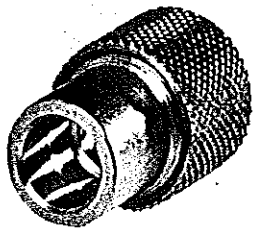


Tubulation Sizes

Model Number	Tubulation Description
0563-K2466-301	1″ Nonex
0563-K2466-302	1″ Kovar
0563-K2466-303	2-¾″ Conflat Flange
0563-K2466-304	¾″ Nonex
0563-K2466-305	¾″ Kovar

Recommended Vacuum Seals

Model Number	Tubulation Size
1340-F0205-382	Stainless Steel, O-ring for 1″ Tubing
1340-F0205-374	Stainless Steel, O-ring for ¾″ Tubing



VARIAN 571 IONIZATION GAUGE TUBE



SPECIFICATIONS

Sensitivity ..... 10.0 $Torr^{-1}$

Operational Ratings:

Collector	0 V dc
Grid	+150 V dc to ground
Filament Bias.....	+30 V dc to ground
Filament Voltage.....	4 V ac nominal (6 V ac max)
Filament Current.....	3.5 A nominal (6 A max)
Emission	100 mA maximum

X-ray Limit..... 2×10^{-10} Torr

Pumping Speed..... 0.06 liter/second, Ionic – N_2 (1 mA emission)

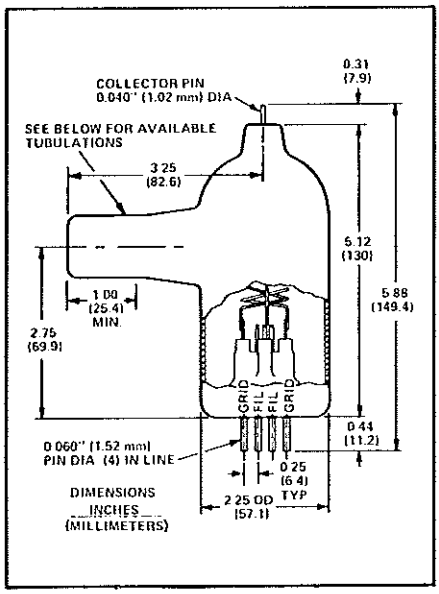
Material

Grid	Tungsten (0.025 dia)
Collector	Tungsten (0.010 dia)
Envelope	Nonex
Filament	Hairpin thoria-coated iridium

Maximum Recommended Operating Pressure (air): 1×10^{-3} Torr

Degas (Resistance Heating)

Grid Voltage.....	6.3 V ac
Grid Current.....	8.7 A

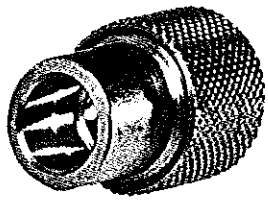


Tubulation Sizes

Model Number	Tubulation Description
0571-K2471-301	1″ Nonex
0571-K2471-302	1″ Kovar
0571-K2471-303	2-¾″ Conflat Flange
0571-K2471-304	¾″ Nonex
0571-K2471-305	¾″ Kovar

Recommended Seals

Model Number	Tubulation Size
1340-F0205-382	Stainless Steel, O-ring for 1″ Tubing
1340-F0205-374	Stainless Steel, O-ring for ¾″ Tubing



VARIAN 564 IONIZATION GAUGE TUBE



SPECIFICATIONS

Sensitivity ..... 8 $Torr^{-1}$

Operational Ratings:

Collector	0 V dc to ground
Shield	0 V dc to ground
Grid	+160 V dc to ground
Filament Bias.....	+30 V dc to ground
Filament Voltage.....	4 V ac nominal (6 V ac max)
Filament Current.....	3.5 A nominal (6 A max)
Emission	100 mA maximum

X-ray Limit..... 4×10^{-10} Torr

Pumping Speed..... 0.06 liter/second, Ionic $-N_2$ (1 mA emission)

Material

Grid	Tungsten (0.025 dia)
Collector	Tungsten (0.010 dia)
Envelope	Nonex
Filament	Hairpin thoria-coated iridium

Maximum Recommended Operating Pressure

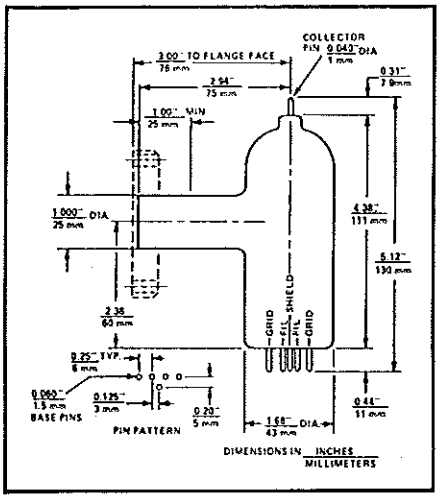
(air) 3×10^{-2} Torr

(argon) 1×10^{-1} Torr

Platinum Coating..... 0 V dc (The platinum coating located on the inside surface of the gauge reduces glass charging effects.)

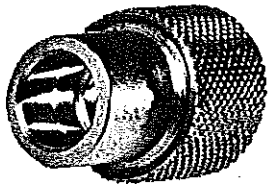
Degas (Resistance Heating)

Grid Voltage.....	6.3 V ac
Grid Current.....	8.7 A



Tubulation Sizes

Model Number	Tubulation Description
0564-K2500-301	1″ Nonex
0564-K2500-302	1″ Kovar
0564-K2500-303	2-¾″ Conflat Flange



Recommended Vacuum Seals

Model Number	Tubulation Size
1340-F0205-382	Stainless Steel, O-ring for 1″ Tubing

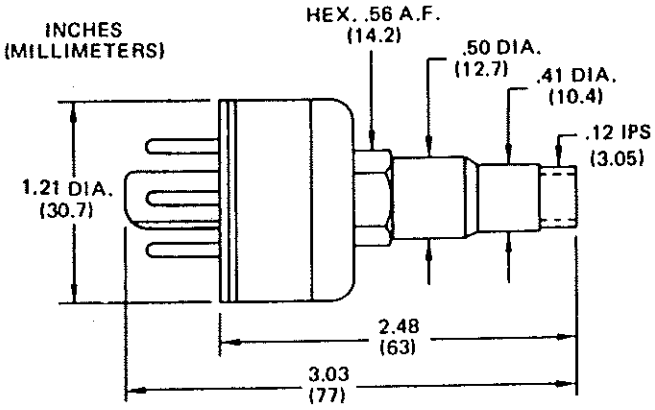
VARIAN 531 THERMOCOUPLE VACUUM GAUGE TUBE

OPERATING SPECIFICATIONS

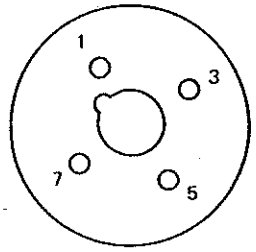
Filament Current	140 to 180 mA, Max 300 mA
Response Time	3 sec (10^{-3} to 1.0 Torr)
Range	2.5 to 10^{-3} Torr
Output	0.14 mV (with 163 mA heater current)
Heater Resistance	1.4 ohms (approx.)
Dimensions	1-½" O.D. x 3" long
Connections	May be used with ½" "O" ring compression seal or threaded on ⅛" IPS threaded port.
Cable Connection	Octal base (std.)
Casing	nickel-plated mild steel
Volume	12 cc
Weight	2 oz.



VARIAN 531 THERMOCOUPLE VACUUM GAUGE TUBE



THERMOCOUPLE GAUGE TUBE



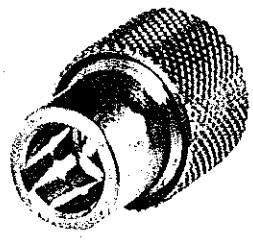
1 & 3 = Heater
5 & 7 = Thermocouple

PLUG

VARIAN 531 THERMOCOUPLE VACUUM GAUGE TUBE OUTLINE DRAWING

Recommended Vacuum Seal

Model Number	Tubulation Size
1340-F0502-366	Stainless Steel, ½ Tubulation



VACUUM SEAL

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