# Instruction Manual For
# Automatic Valve Controller
# **AVC-485**

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INTRODUCTION

## 1.1 Description

The AVC -485 (P/N 285862), control is designed to automate the valving sequence of any vacuum system which uses electrically operated valves. In the Automatic mode, the valves are operated in response to pressure within the vacuum system. The vacuum system is completely protected against improper sequencing of the valves. Provisions are made for handling diffusion pumped, turbo pumped, or cryo pumped systems. A Manual operating mode is provided to facilitate set -up or service work on the vacuum system.

The status of all valves is indicated by LED indicator lights on the front panel. (LED is on when valve is open.) Blinking lights identify trouble areas and warn of unsafe operating conditions.

## 1.2 Features

Optical isolation and RF filtering on all external connections provide excellent immunity to electrical "noise" and RF interference.

A tamper -resistant AUTO/MANUAL mode selector switch protects against operator error in the Automatic mode. Factory programmed microprocessor control ensures safe operation regardless of which buttons are pressed. All solid state, microprocessor controlled circuits have no electro-mechanical relays or contacts.

Easily set controls simplify calibration of trip points for foreline and chamber pressure circuits.

The AVC -485 is easy to service. All parts are readily accessible. All integrated circuits are mounted in sockets. The automatic section (microprocessor logic board, P/N 285860) can be removed for repair or exchange, and system operation can be maintained using the Manual mode.

Signals are available for controlling external loads after the high-vacuum valve opens, and for turning off the diffusion pump in the event of abnormally high forepressure.

The controller can be interlocked with external controls, such as a bell jar hoist switch, to prevent initiation of the START phase until conditions are safe.

Pressure sensors are rugged, interchangeable, contamination resistant thermistor tubes, with pressure read out on a front panel display. Pressure output signals suitable for recording and/or external control use is continuously available for each pressure sensor.

A built -in Automatic Vent Stop, adjustable up to 15 minutes, closes the vent valve after pre -set venting time.

Low -profile cabinet is suitable for bench top use or mounting in a 19 -inch rack.

## 1.3 Specifications

| | |
|---|---|
| Height | 3½ inch |
| Width | 19 inch |
| Depth | 8 inch (allow additional 3 inch for connections) |

Input Power 115 or 230 VAC, 50/60 Hz -- valves must operate from same voltage as AC input

| | |
|---|---|
| Fuse | 2 amp, type 3AG for 115 VAC<br>1 amp, type 3AG for 230 VAC |
| Output to energize valves | Same voltage as AC line |
| Valve solenoid current requirements | Typical inrush current .3 amp<br>Typical holding current .1 amp<br>Max. allowable current 2 amp |
| Time delay adjustment range | Valves -- 3-20 seconds<br>Vent Stop -- 1 - 15 minutes<br>Ext. control -- 5 - 20 seconds |
| Range of pressure sensitive circuits | 0 - 1000 millitorr |
| Trip Span (differential between turn-on and turn-off) | 0 - 25% of meter scale length |
| External control relay drive | 5 VDC, 10 milliamps |
| Pressure sensor tubes | Myers Vacuum type GT-034 |


Figure 1 -- Front and Rear Panels Of AVC-485


Figure 2 -- Top View of AVC-485 (Cover Removed)

## 2.0 CONTROLS AND INDICATORS

### 2.1 Front Panel Controls (See figure 1)

2.1.1 The POWER switch controls AC power to the AVC -485 and the valve circuits.

2.1.2 The AUTO / MANUAL mode switch allows selection of the desired mode. To prevent inadvertant selection of Manual mode, a tool is required to operate the switch.

In the Manual mode, the valves are operated using the four push -button switches labeled ROUGH, FORE, HI-VAC, and VENT. When the switch is depressed, the valve will open. In the Automatic mode, all valve operation is controlled by the microprocessor.

**CAUTION:THE MANUAL MODE BY-PASSES ALL AUTOMATIC CONTROLS AND SAFETY FEATURES.**

To select the Automatic mode, all valve switches must be in the closed (button out) position. If any switches are in the open position, the system will not enter the Automatic mode, the AUTO indicator will remain off, and the MANUAL indicator will blink.

2.1.3 The CHAM PRESS and FORE PRESS switches display pressure at their respective locations.

2.1.4 The START, STOP, and VENT switches control the vacuum system when in the Automatic mode.

The START switch starts the Automatic pumpdown cycle.

The STOP switch halts the Automatic cycle, leaving the system in standby mode.

The VENT switch opens the Vent valve and admits vent gas to the chamber. See section 4 for a detailed description of the vent sequence.

2.2 Internal Controls (See fig. 2 and section 6)

Factory-set internal adjustments are provided for:

Forepressure trip and span
Chamber pressure trip and span
Time delay adjustment for each valve
Time delay of external control circuit
Pressure, measuring circuit recalibration

2. 3 Indicators (See figure 1)

The LED's on the front panel indicate the status of each valve when the system is in the Automatic mode. When the LED is lighted, the valve is open. A schematic diagram of the vacuum system showing the valve locations is silk-screened on the front panel.

3.0 INSTALLATION

3.1 Shipping List

The following items are included with the AVC -485:

1. The AVC -485 control unit.
2. AC line cord. (Part Number 6091307)
3. 2 Thermistor SensorTubes, Myers Vacuum Type GT -034. (Part Number 277289)
4. 2 Sensor tube cables.(PartNumber 286204, Sta. 1 and 286205, Sta. 2)
5. Spare fuses: one 3AG- 2A; one 3AG -lA. (Part Number 16656- 15, 2A, and 16656 -13, lA)
6. Four 3-prong male connectors for valve circuits. (Part Number 6091491 -2)
7. One 8-prong male connector for external control circuits. (Part Number 6091491 -1)
8. The instruction manual. (Part Number 9 -118)

3.2 Electrical Connections (See Schematic E -285771, Sheet 1)

All connections to the AVC -485 plug into terminals on the rear panel (see Figure 1). Use shieded wire if operating the AVC -485 near an RF generator or in a "noisy" electrical environment.

NOTE The labels on the back panel were designed for a typical diffusion-pumped system, and may be confusing when the controller is used with a cryo-pumped system. If the system is cryo pumped, the Forepressure is the regeneration line pressure. The Fore Valve is the Regen. Valve.

3. 3. 1 Input Power

The operating voltage for which the unit is configured can be determined by sliding the plastic cover over the line receptacle opening. This exposes the fuse and the line-voltage change card. The operating voltage will show on the top surface of the card. To change operating voltage, remove the fuse and pull the voltage change card out. Turn the card around and reinsert. Install the correct voltage fuse. Slide the plastic cover back to its normal position.

**NOTE:AVC-485 units installed in Myers Vacuum vacuum systems are shipped in the customer specified voltage configuration. Stand-alone units are shipped in the <u>120 Volt position.</u>**

3.3.2 Installing and Connecting Sensor Tubes

Mount the two thermistor tubes in suitable locations so that Sta. 1 senses chamber pressure and Sta 2 senses foreline pressure.

In a cryo pumped system, install the Sta. 2 tube in the regeneration line between the regeneration valve and the cryo pump.

Note: Station 1 and Station 2 electrical connections are different. They are not interchangable.

Although thermistor tubes are relatively immune to contamination, for accurate pressure response and freedom from zero drift they should be kept clean. Install the tubes so as to minimize the entrance of oil vapor or process contaminants. If possible, the Sta. 1 tube should also be located away from electrical discharges which may take place within the high-vacuum chamber.

The sensor tubes may be installed in any of the following ways:

a. Thread the tubulation into a mating 1/8 -inch pipe threaded opening in the vacuum system. Seal the threads with Teflon tape, Celvaseal® leak sealant, or other sealing material which has a low vapor pressure.

b. Use a type AC compression connector with 0 -Ring seal. Type AC connectors are designed for welding or soldering into the vacuum system. The sensor tube is then inserted into the connector and the knurled ring is hand tightened to compress the 0 -Ring against the tubulation sealing surface.

3. 3. 3 Valves

Valves are connected to plugs P3 through P6, pins 2 and 3. If shielded wire is used, connect the shield to pin 1. See schematic E -285771.

Connect the roughing valve, hi -vac valve, and vent valve to their respective terminals on the back panel of the controller. In a diffusion-pumped system, connect the foreline valve to the FORE VALVE connector. In a cryo-pumped system, connect the regeneration valve to this connector.

### 3.3.4 Remote Triggering of Valve Operating Cycle

The Start, Stop and Vent cycles can be triggered from a remote location by connecting momentary action, single pole, normally open switches to plug P2, pins 1 & 6, 2 & 6, and 3 & 6 respectively. See schematic E -285771, sheet 1.

### 3.3.5 Control of External Loads

Terminals 5 and 6 on plug P2 provide a 5 volt, 10 milliamp logic signal for controlling an external load such as a high vacuum gauge or process heater. The external load control circuit is activated 5 to 20 seconds (depending upon setting of R67 on logic board 285860) after the high-vacuum valve is opened, and remains active until the high -vacuum valve closes.

A solid -state relay, connected as shown on schematic E -285771, Sheet 1, is required to raise the logic level signal to power control level. Note that terminal 6 of plug P2 sinks to ground level upon activation.

### 3.3.6 Forepressure Warning Siqnal

If the forepressure rises above normal operating level and exceeds the circuit trip level, a 5 -volt logic signal will appear at terminal 1 of plug P2. This signal can be used (as suggested on Schematic E -285771, Sheet 1), to sound an alarm, or, with an additional relay, to turn off the diffusion pump.

### 3.3.7 External Interlock

External interlocks can be added to tie in other functions which must be satisfied before the vacuum cycle can start. Examples of such functions are belljar down or coolant water on. Each interlock should consist of a switch wired to connect pin 6 of connector P6 (+5 volts) to pin 2 of connector P6 (STOP input). As many additional interlocks as desired may be connected in parallel in this manner. The interlock switch should close in the unsafe condition. This produces a STOP signal which will close all valves. The interlock switches will control the valves in the Automatic mode only. Use shielded wire for all interlock wiring.

## 4.0 CHECK-OUT AND OPERATION

### 4.1 Controls

The ROUGH, FORE, HIVAC, and VENT switches provide manual operation of the indicated valves when the controller is in Manual mode. These switches do not operate when the controller is in Automatic mode.

The START, STOP, and VENT switches initiate the automatic operating sequences when the controller is in Automatic mode.

4.2 Configuration For Cryo or Turbo Pump System

When purchased as a stand-alone unit, the AVC -485 is configured for a diffusion or turbo pump. To configure the controller for cryo pump operation, connect a jumper between terminals 64 and 65 on the Logic Circuit Board. This alters the controller program regarding forepump functions. Set the chamber pressure trip point to .15 to .2 torr. Set the regeneration (forepressure) trip point to the .1 torr mark. (See Figure 2)

4.3 Manual Mode Check-Out Procedure -- All Pump Types

**CAUTION:The high vacuum pump must be turned off for this test.**

4.3.1 Make sure the HIVAC VENT,ROUGH, and FORE valve switches are in the OFF (button -out) position.

4.3.2 Rotate the mode selector switch to MANUAL mode.

4.3.3 Press the POWER switch. POWER switch and MANUAL mode indicators will light.

4.3.4 Operate each valve switch to be sure the respective valve operates correctly. Return switches to the OFF (button -out) position.

4.3.5 Start the mechanical pump. Then press the FORE push button to open the fore valve. Observe the forepressure pump down on the meter by pressing the FORE PRESS button.

4.3.6 Press the ROUGH push button. Then observe the chamber pressure pump -down on the pressure meter by pressing the CHAM. PRESS button.

4.4 Automatic Mode Check-Out Procedure -- Diffusion & Turbo Pumps

**CAUTION:The high vacuum pump must be turned off for this test.**

4.4.1 Place all valve switches in the off position. Set the AUTO / MANUAL selector switch to AUTO. The AUTO and STOP indicators will come on. After 10 seconds, the foreline valve will be energized, and the FORE indicator light wil come on. The controller is now latched in the Automatic mode.

4.4.2 Press the VENT switch. The VENT indicator light should come on, and the foreline valve should remain open. After a 5-second delay, the vent valve will open.

4.4.3 To check for system protection against a gross leak in the high-vacuum valve, raise the forepressure by introducing a leak in the foreline or shutting off the mechanical pump.

When the forepressure exceeds the forepressure trip setting (approximately 0. 3 torr), the vent valve will close and the system should enter the Stop condition. The foreline valve remains open and the FORE PRESS light will blink, indicating abnormally high forepressure*

4.4.4 With the abnormally high forepressure existing, press the START button. There should be no change in valve status. The system will not enter the Start condition while forepressure is above the trip setpoint.

4.4.5 Correct the forepressure condition. When the forepressure has recovered to less than 0.2 torr, press the START button. The START indicator will light, and the foreline valve will close. After 10 seconds, the roughing valve will open allowing the mechanical pump to begin pumping the system.

If the forepressure rises above the set point during rough pumping, the roughing valve will close and after 10 seconds the foreline valve should open allowing the mechanical pump to restore the forepressure to a safe level. The FORE indicator will blink until the forepressure drops below the set point. The foreline valve will then close and, after 5 seconds, the roughing valve will open, resuming the roughing portion of the cycle.

4.4.6 Continue rough pumping the system. When the pressure in the vacuum chamber reaches the trip point, (approximately 50 millitorr), the roughing valve will close and 10 seconds later the foreline valve should open. Approximately 5 seconds after that, the high vacuum valve should open. After an additional 5 seconds, the external load control signal (Sect. 3. 3. 5) will be activated.

4.4.7 Press the VENT button on the left side of the panel. The high vacuum valve will close, the foreline valve should remain open, and after a 5 second delay the vent valve

will open. After a pre-set time, (l to 15 minutes, determined by the Auto Vent Stop time adjustment R71), the vent valve will close and the System will return to Stop condition.

4.4.8 Press the STOP button. The system can be placed in a Stop condition at any time during the cycle. All valves except the foreline valve will close. The system will remain in this safe stand-by condition until receiving further commands from the operator.

4. 5 Normal Operation -- Manual Mode

**CAUTION:Only qualified personnel should operate the system in Manual mode with the high vacuum pump running. Opening the wrong valve could damage the diffusion pump fluid and contaminate the system, requiring a major clean-up and significant downtime.**

With all valves closed, rotate the mode selector switch to MANUAL. The MANUAL indicator will light. Open or close valves using the valve switches as required.

4.6 Normal Operation -- Automatic Mode

4.6.1 Place all valve switches in the button-out position (valves closed ).

4.6.2 Set the mode selector switch to AUTO. The AUTO indicator will light. After 10 seconds, the foreline valve will open. The system is now ready.

4.6.3 To start the pump down, press the START button. Operation will be as described in Section 4.4.

4.7 Automatic Operation -- Cryo Pumped Systems

4.7.1 If the AVC-485 was purchased as a stand-alone unit, be sure it is configured for cryo pump operation according to the procedure in section 4.2

Note: Actual trip points may vary slightly from the trip point adjustment knob settings.

4.7.2 Place all valve switches in the OFF position (valves closed). Set the AUTO / MANUAL mode selecfor switch to AUTO. Push in the CHAM. PRESS switch. Turn on power. The controller should latch in the Automatic mode.

4.7.3 Be sure the mechanical pump and the cryo pump are operating. Press the START button. After 10 seconds the roughing valve will open. Observe the chamber pressure pump down on the pressure meter.

4.7.4 When the chamber pressure is below approximately 0.1 torr, the roughing valve will close. After a ten second delay, the high vacuum valve will open. An additional 5 seconds later, the external load control signal (see 3.3.5) will be activated. The vacuum system is now ready for use.

4.7.5 System venting is as described in paragraph 4.4.9 except that the regeneration valve (Fore Valve) remains closed throughout the cryo pump operating cycle.

## 4. 8 Cryo Pump Regeneration Procedure

After prolonged use, the cryo pump will become saturated with captured gases. To regenerate the pump, use the following procedure.

WARNING: The mechanical pump must be turned on and be at a low pressure before opening the regeneration valve. Failure to meet this requirement will expose the cryo pump to too high a pressure and could cause it to become contaminated with oil vapor from the mechanical pump.

4.8.1 With the AVC -485 in the Automatic mode, press the START and STOP buttons simultaneously. Release the STOP button first, then the START button. This latches the controller in the regeneration cycle.

4.8.2 Turn off the cryo -pump compressor, and allow the pump to warm up.

4.8.3 When pressure in the pump exceeds the forepressure trip setting, the regeneration valve will open allowing the mechanical pump to remove the gases until the pressure decreases below the trip point. The regeneration valve will then close. This cycle will continue until you end the regeneration sequence by pressing the STOP button.

A more refined regeneration procedure is available by adding a cryo pump control panel (Myers Vacuum part number E290900) to the system.

4.8.4 When regeneration is complete, press the STOP button. This returns the controller to the normal cryo pump operating cycle. Turn on the cryo pump compressor and allow the pump to cool before starting another process cycle.

# 5.0 PRESSURE MEASURING SYSTEM

## 5.1 Pressure Meter

To select the location (foreline Sta. 2 or vacuum chamber Sta.1) of the pressure indicated on the panel meter, press the CHAM. PRESS or FORE PRESS switch.

## 5.2 Calibration For Various Gases

The two sensor stations are calibrated for dry air. To determine the pressure of gases other than air, refer to Figure 3.

## 5.3 Remote Pressure Read-Out

For recording pressure or indicating pressure at a location remote from the AVC -485 unit, the pressure can be read as a function of the voltage at the thermistor bridge output terminals . Bridge output for Sta.1 is available at pins 11 (neg. ) and 12 (pos .); Sta. 2 output is available at pins 11 and 9.

NOTE: Any recorder or remote display device connected to the bridge output circuit must be a high-impedance type to avoid loading the bridge and affecting calibration.

## 5.4 Leak Detection

The AVC-485 is useful for locating leaks of moderate size. The response of the pressure meter is related to the thermal conductivity of the gas in the sensing tube as well as to its pressure. When the pressure has stabilized, probe the suspected area with a gas whose thermal conductivity is substantially different from that of air. Probe gas entering the leak will cause a meter response which is either upscale or downscale, depending upon the probe gas used. Argon can be used with complete safety. It provides a down -scale meter response.

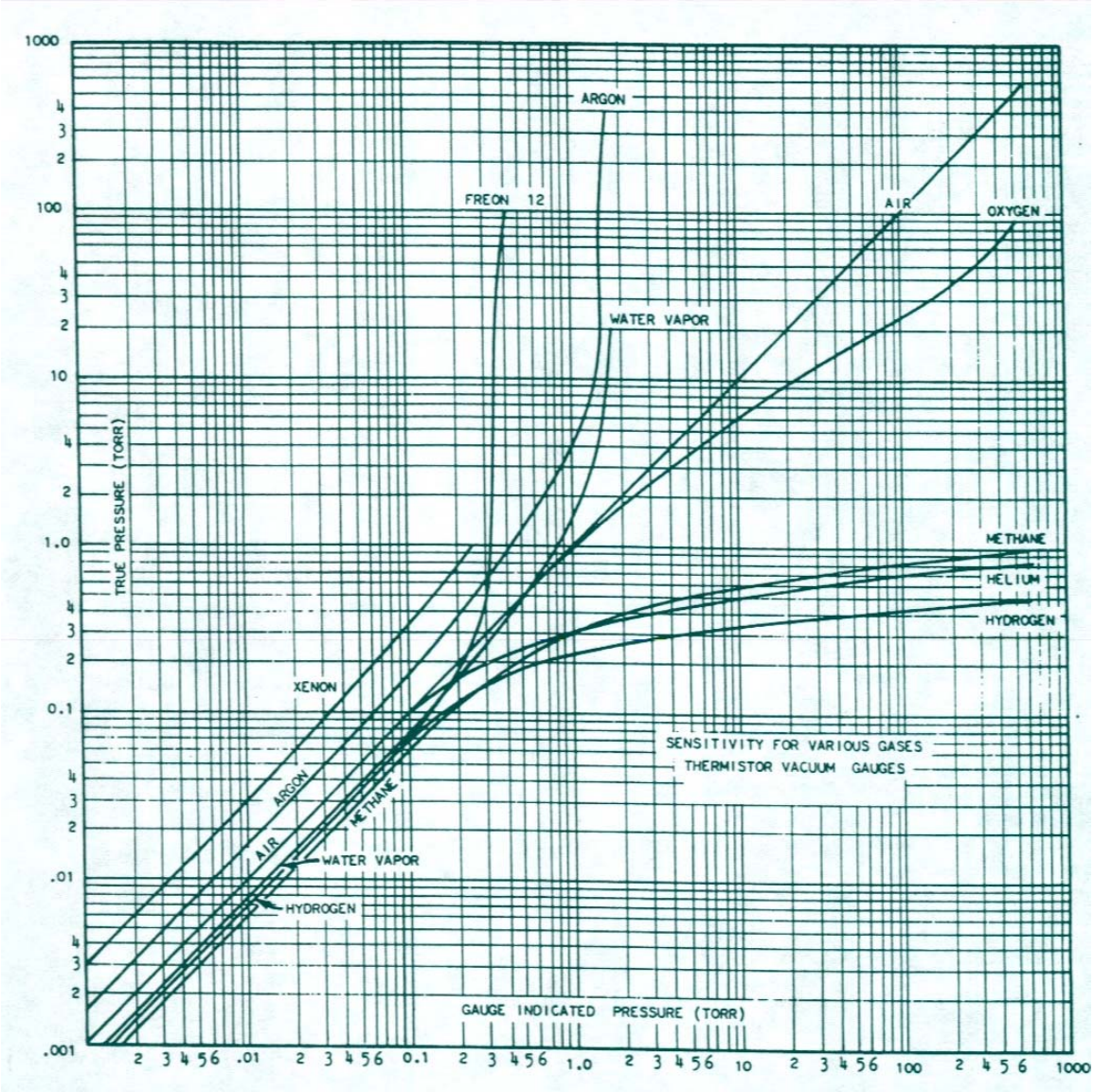


Figure 3 -- Thermistor Sensitivity For Various Gases

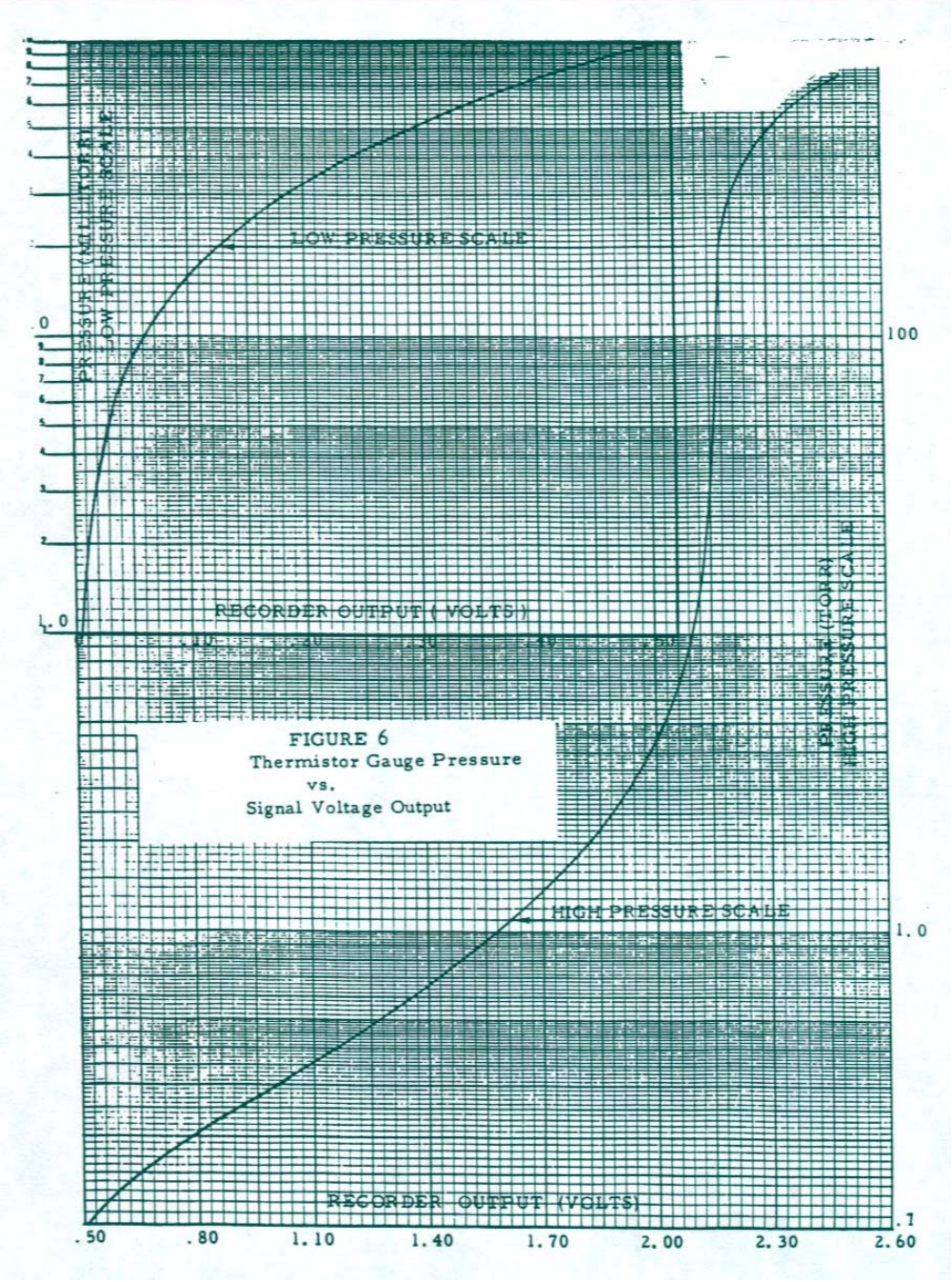


FIGURE 6
Thermistor Gauge Pressure
vs.
Signal Voltage Output

Figure 4 -- Thermistor Gauge
Pressure vs. Signal Voltage Output

## 6.0 NORMAL CIRCUIT ADJUSTMENTS

All adjustment potentiometers are located on the printed circuit boards, and are accessible if the cabinet top cover is removed. They are identified in Figure 2. The adjustments described in this section have been set for normal operation at the factory.

### 6.1 Forepressure and Chamber Pressure Trip Settings

These adjustments are set to the desired trip pressures. Note that the knob sets the pressure at which the circuit will trip as pressure in the system decreases.

### 6.2 Span Adjustments

Span is defined as the pressure difference between trip "on" with decreasing pressure, and trip "off" with increasing pressure. A reasonable span is necessary to prevent cycling of the valves as the system is pumped down. Recommended span settings are:

| | |
|---|---|
| Chamber Pressure: | Trip on at 0.05 -0.06 torr<br>Trip off at 0.1 -0.12 torr |
| Forepressure: | Trip on at 0.22 -0.25 torr<br>Trip off at 0. 30 -0. 32 torr |

If it is difficult to cycle the pressure in the vacuum system up and down in order to check and set the trip and span adjustments.

The trip-off pressure setting for Sta. 2 (foreline pressure control) should consider the tolerable forepressure of the diffusion pump and the magnitude of the gas pressure surge which occurs when the high vacuum valve is opened. Set the circuit to trip off before the tolerable forepressure is exceeded.

On large systems it may be desireable to adjust the high vacuum valve to open slowly, so as to minimize the gas load in the foreline. Time delays on all valves must take this factor into account.

The type of gas being pumped is also a factor. The trip off pressure, as indicated by the gauge, should be decreased approximately 50% when pumping argon rather than nitrogen or air.

## 6.3 Pressure Calibration

The pressure measuring circuits are carefully calibrated at the factory before shipment. Any new GT -034 Sensor Tube can be plugged into the circuit and used without need for further adjustment.

Drift in the calibration or zero setting of the pressure measuring circuits is usually due to contamination of the sensor tube by oil vapor or process contaminants. Cleaning, as specified in Section 7.1, will frequently restore the original accuracy. Should this fail, install a new GT -034 tube.

Pressure calibration adjustments are described in Section 7.2.

# 7.0 MAINTENANCE

## 7.1 Cleaning Sensor Tubes

1. Disconnect and remove the sensor from the vacuum system. Wash the interior with a hot water and detergent solution (Joy and Alconox are good). Agitate gently.

2. Rinse thoroughly with hot water. Fill and empty the tube carefully to avoid breaking the fine wire elements.

3. Rinse with clean acetone or isopropyl alcohol.

4. Dry the tube byheating at 50° - 6O° C for several hours. Do not use compressed air.

## 7.2 Calibrating The Pressure Measuring Circuit

Frequent recalibration should not be necessary unless voltage regulator VR2 or other circuit components have been changed.

### 7.2.1 Sensor Tube Recalibration

In cases where, after cleaning the sensor tube, a minor error in pressure or zero reading remains, the calibration can be adjusted as follows:

1. Install the sensor tube in the vacuum system and pump to a pressure less than 1 millitorr.

2. Disconnect the tube cable from the tube and provide temporary connections from contact 1 and 3 of the tube cable socket to respective pins on the sensor tube. Make this connection so the end of the locating key at the center of the tube -pin circle is exposed while the tube is operating.

3. Insert a small screwdriver into the hole in the locating key and engage the potentiometer which is located in the sensor base. Adjust for zero meter reading.

### 7.2.2 Pressure -Measuring Circuit Calibration

All circuits are factory adjusted to produce a specified output under standard operating conditions. When new precalibrated sensor tubes are connected to a correctly adjusted circuit, the pressure should read properly over the entire scale. Should the meter fail to read properly when used with a new sensor tube, the following adjustments should be made.

1. Adjust the bridge voltage to exactly 10.00 volts using an accurate voltmeter. Potentiometer R lOl on the printed wiring board is used for this adjustment, and the voltage can be measured from taper pin terminal #8 (neg .) to R 102.

2. With the sensor tube exposed to atmospheric pressure and at normal room temperature, adjust R123 (for Station 1) or R119 (for Station 2) to bring the meter to exactly full scale.

3. Pump the sensor tube down to less than 1 millitorr. The meter should read zero. If necessary, adjust the bridge voltage to obtain a zero reading.

Note: Changing the bridge voltage affects the calibration of both sensor tube stations.

4. Re-check the atmospheric full-scale reading (step 2) and the zero reading (step 3) as there is a slight interaction between these adjustments.

Repair and recalibration service is available at the factory. For information, contact your local Myers Vacuum sales office or call the Myers Vacuum Order Service Dept. at 1-888-780-8331.

## 7.3 Zeroing The Pressure Meter

With the POWER switch off ,adjust the mechanical zero screw in the front panel (just below the meter scale) to bring the pointer to zero.

Note: The following adjustment should be made only if the sensor tubes are new, or if it is certain that the tubes are not contaminated.

With the vacuum chamber pumped to less than 1 millitorr, and the CHAM. PRESS switch pressed, adjust R128 to produce zero meter reading.

## 7.4 Calibrating The Pressure Trip Adjustment Scales

Full-scale trimmers (R130 and R133) and zero-end trimmers (R132 and R135) have been provided for calibrating the chamber pressure trip adjustment scale and the forepressure trip adjustment scale. These potentiometers should not normally require adjustment. If the trip dial settings do not agree with pressure meter readings, recalibrate as follows.

1. Press the CHAM. PRESS meter switch. Pump the chamber to less than 1 millitorr. Set both trip adjustment knobs to zero. Rotate span adjustment pots R140 and R142 fully clockwise (minimum span).

2. With an accurate high-impedance voltmeter, measure voltage from pin 8 (neg. ) to pin 12 (pos. ).

3. Transfer positive voltmeter lead to U21 pin 3 and adjust pot R135 for the voltage observed in step 2. Move voltmeter lead to U23 pin 3 and adjust R132 for the voltage as observed in step 2.

4. Raise system pressure to approximately 1 torr. Set both trip knobs to 1 torr.

5. Repeat steps 2 and 3 using terminals 8 and 12 for chamber pressure (Sta. 1) and terminals 8 and 9 for forepressure.

6. Repeat step 4, adjusting full-scale potentiometers R133 and R130 respectively.

There is some interaction between zero and full -scale adjustments so it may be necessary to repeat steps 2 thru 6.

# 8.0 SERVICE AND TROUBLE SHOOTING

## 8.1 Circuit Description

### 8.1.1 Power Supply

The power supply is a conventional full-wave, bridge-rectified and capacitor-filtered supply. The DC output is regulated to 10.00 volts by VRl and VR2 for powering the pressure measuring circuit. It is then reduced to 5 volts by VR3 for use in the digital control circuitry.

### 8.1.2 Pressure Measuring Circuit

A thermistor type sensor tube senses pressure as a function of the heat conducted away by the surrounding gas. The resulting temperature change in the thermistor element alters its electrical resistance. The pressure measuring circuit contains a double bridge with resistors R103 and R106/107 common to both bridges. The thermistor sensor tubes (with their compensating networks) form one arm of each bridge.

The 10 volt power applied to each bridge causes precisely the current flow required to heat the thermistor so that its resistance balances the bridge under high-vacuum conditions. Any increase in pressure tends to cool the thermistor, unbalancing the bridge. The bridge unbalance output is applied to voltage follower amplifier U20 through a calibrating network and selector switch S4 (Sta. 1) or S5 (Sta. 2). Amplifier U20 output drives the pressure meter.

Bridge outputs are also applied to comparator amplifiers U21 and U23. These amplifiers compare the bridge output with a reference signal and supply the chamber pressure and forepressure trip signals to the microprocessor.

### 8.1.3 Microprocessor Control Circuit

This circuit includes the central processor ( U5) with internal clock, two 4 -bit program counters (U7 and U8), an 8 -bit x 512 -address memory (U6), two input selectors (Ul and U2), and two addressable output latches (U3 and U4).

The program counters step the memory output from one address to the next, in sequence, until the program has been completed, where upon the counters reset to zero and start over again.

The program stored in memory appears at the eight output terminals. The four least significant bits are used to address the desired output latch or input selector. The other four memory output bits instruct the central processor to accept a signal from the selected input, or to deliver an output signal to the addressed output latch. These memory bits also include instructions on what to do with the input signal, or whether a high or low output signal is to be sent to the output latches.

Input sources and output addresses are identified on the I/0 code, section 8.2.2.

Output signals calling for valve or external control actuation are passed through buffers and time delay circuits, and, finally, to optical isolator output modules OAC5A, where the 5 volt level is raised to 120 volt or 240 volt power level.

### 8.1.4 Time Delay Circuits

There are six time delay circuits and two flasher circuits. Operation of the Hi Vac time delay circuit as described here is typical:

A high signal on latch output U3 -l is inverted to a low at UlO -1g and U18 -6 switch control pin. This releases the short circuit on C13, allowing it to charge slowly through R87 and R88. When C13 charge reaches 2/3 Vcc, (approx. 3. 33V), timer output pin U15 -5 goes low. The low output is used to accomplish three things:

1. To sink current from the b5 -volt supply through opto-coupled output module OAC5A #1, thereby closing OAClA #1 switch contacts 1 and 2 and applying line AC power to the high -vacuum valve.

2. To sink current from the +5 -volt supply through HIVAC indicator LED -D5, through the non -inverting buffer Ull, to ground, thereby lighting the HIVAC LED.

3. To supply a low signal to the External Control Time Delay circuit initiating its timing sequence.

## 8.2 SERVICE

WARNING:
LINE VOLTAGE IS PRESENT ON THE AUTO / MANUAL SWITCH CONTACTS AND AT MANY PLACES ON THE POWER (RIGHT SIDE) PRINTED WIRING BOARD. SERVICE SHOULD BE PERFORMED ONLY BY A QUALIFIED TECHNICIAN.

Components are conservatively rated, and under normal operating conditions little or no service should be required. Should trouble develop, it can usually be corrected by replacement of one or more of the socket -mounted integrated circuits.

### 8.2.1 Single-Step Program Operation

Troubles in the microprocessor section can be tracked down by disabling the internal clock and stepping through the program manually using a single step switch circuit.

1. Op -Code data (instructions from memory) arelatched into U5 internal register on falling edge of clock pulse.

2. Flags are active for one full cycle following falling edge of clock pulse.

3. Program counter U7 and U8 count up on the rising edge of clock pulse.

4. The +5 -volt write signal occurs on falling edge of clock and remains for one cycle.

The information in chart 1 should be helpful.

CHART - 1
Microprocessor Logic Functions

| IC Chip | Pin No. | Function | Comments |
|---|---|---|---|
| U5 | 14 | Clock output | Program counters U7 and U8 advance on rising edge of clock pulse. Write pulse (U5-2) generated on falling edge of clock pulse |
| U6 | 9, 10, 11 | Provide 3 bit binary address to input/output address lines | Address lines connect to U1, U2, U3, U4 |
| U1 | 15 | Chip enable(active Low) | U1 enabled when:U6-13 High, and U5-2 Low, and U5-14 Low |
| U2 | 15 | Chip enable(active Low) | U2 enabled when:U6-13 High, and U5-2 Low, and U5-14 Low |

| | | | |
|---|---|---|---|
| U3 | 4 | Write disable | U3 enabled when:U6-13 High, and U5-2 Low, and U5-14 Low |
| U4 | 4 | Write disable | U4 enabled when:U6-13 High, and U5-2 Low, and U5-14 Low |
| U1U2 | 14 14 | Input data on selected address line | Instruction from memory U6 determine whether input data is to be received at U5-3 or output fromU5-3 is transmitted to selected output latch |
| U3U4 | 3 3 | Output data to selected output latch | |
| U3, U4 | 1, 11 thru 17 | Addressable latch outputs | Active High output on addressable latches |
| U9, U10 | | Inverting buffer amplifier | |
| U18&U19 | 5, 612, 13 | Active High control for bi-lateral switch | High on control pin established low impedance on transmission path, holding timing capacitor at ground potential |
| U14, U15U16, U17 | 7 & 8 | Trigger control for 7556 dual timer | Trigger held low produces high on output pins 5 & 9 respectively. |

| 8.2.2 Microprocessor I/0 Code Input Number | Description | Output Number | Description |
|---|---|---|---|
| X0 | Result Register | Q0 | Not used |
| X1 | Start Sw. (Sw. open = 1) | Q1 | Not used |
| X2 | Stop Sw. (Sw. open = 1) | Q2 | Not used |
| X3 | Vent Sw. (Sw. open =1) | Q3 | Not used |
| X4 | Sw. Chain S6, 7,8,9(Sw. open =1) | Q4 | Man. light flashing |
| X5 | AUTO / MAN Switch (Auto =1) | Q5 | Not used |
| X6 | Forepressure(Low pressure =1) | Q6 | Forepressure light flashing |
| X7 | Chamber pressure(Low pressure =1) | Q7 | Not used |
| X8 | Vent time delay | Q8 | Vent time delay |
| X9 | Auto Vent Stop(Not timed out =1) | Q9 | Man. light steady |
| X10 | Forepressure time delay | Q10 | Forepressure time delay |
| X11 | Auto Latch | Q11 | AUTO Latch |
| X12 | Start Latch | Q12 | Start Latch |
| X 13 | Rough Time Delay | Q13 | Rough Time Delay |
| X14 | Stop Latch | Q14 | Stop Latch |
| X15 | Hi Vac Time Delay | Q15 | Hi Vac Time Delay |

8.2.3 Microprocessor Program
Refer to drawing C -286002

8.2.4 Removal of the Microprocessor Logic Board (Part Number 285860)

The microprocessor logic board is on the left side of the AVC-485 unit. The logic board can be removed for return to the factory if field service is impractical, and the vacuum system can be operated using the manual control section. To remove the microprocessor logic board:

1. Disconnect the power cable.

2. Carefully disconnect all taper-pin connections along the rear edge of both boards.

3. Remove the four screws holding the front panel to the chassis. Then remove the front panel with circuit boards attached by sliding straight out.

4. Remove the two screws holding the logic board push button switch assembly to the front panel. Loosen the two screws holding the manual board push button assembly.

5. Slip the logic board switch buttons out of the front panel. Then separate the two boards at the 15 -pin connector.

6. Re -install the manual board by reversing the above steps. Be sure taper pins are securely inserted into the proper connectors.

Note: For convenience, the wire color code corresponds to the second digit in the code number adjacent to each taper pin connector.