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INSTRUCTION MANUAL

MODEL 605-0300 Monitorr 300

PERKIN ELMER

Part No. 1004913

TECHNICAL MANUAL

MODEL 605-0300 Monitorr 300

Part No. 1004913

PERKIN ELMER

Physical Electronics Division
6509 Flying Cloud Drive
Eden Prairie, MN 55344

WARRANTY

Subject to the conditions hereinafter stated, the Manufacturer (Perkin-Elmer Physical Electronics) warrants its equipment for a period of one year from the date of shipment. This warranty extends only to the original owner of the equipment and is limited to repair or replacement (at Manufacturer's option) of any part or parts which are returned to the Manufacturer.

This warranty shall not apply to any equipment which either (1) had been shipped from the plant more than one year before becoming defective or (2) had been so repaired or altered outside the Manufacturer's plant as, in the Manufacturer's judgment, to affect its stability.

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The decision of the Manufacturer shall be final and conclusive on any question in connection with the application or scope of this warranty.

OPERATOR SAFETY SUMMARY

All PHI products have been designed to assure operator safety. Like all other sophisticated instruments, however, continual operator safety depends on the proper use of system components. Such use is described in the manuals supplied with each unit.

LISTED BELOW ARE WARNINGS APPLICABLE TO THE EQUIPMENT DESCRIBED IN THIS MANUAL. ALL PERSONNEL INVOLVED IN THE OPERATION AND MAINTENANCE OF THIS EQUIPMENT MUST FULLY UNDERSTAND THE WARNINGS AND THE PROCEDURES BY WHICH THE HAZARD IS TO BE ELIMINATED.

WARNING

AN ENVIRONMENT OF HYDROGEN AND OXYGEN CAN EXIST WITHIN A SYSTEM, PARTICULARLY THOSE SYSTEMS INCORPORATING CRYOPUMPS. UNDER THESE CONDITIONS, IT IS POSSIBLE FOR AN EXPLOSION TO OCCUR IF THE FILAMENT TO THE ION TUBE OR THERMOCOUPLE GAUGE SETS OFF THESE GASES. ENSURE THAT THE ION GAUGE AND THERMOCOUPLE TUBES ARE NOT TURNED ON AT HIGH PRESSURES.

WE DO NOT RECOMMEND THAT THIS EQUIPMENT BE MODIFIED FOR ANY NON-STANDARD APPLICATION SINCE HAZARDOUS CONDITIONS MAY RESULT. BECAUSE THE PHYSICAL ELECTRONICS DIVISION OF PERKIN-ELMER HAS NO CONTROL OVER CUSTOMER MODIFICATIONS TO PHI PRODUCTS SHIPPED, IT DISCLAIMS ALL RESPONSIBILITY FOR ANY MALFUNCTIONS OR ACCIDENTS THAT MAY RESULT!

DANGER: ELECTRICAL SHOCK HAZARD

HIGH VOLTAGES ARE PRESENT IN THE SYSTEM WHEN THE SYSTEM POWER INPUT LINES ARE CONNECTED. DISCONNECT INPUT POWER AT THE WALL BEFORE MAKING ANY ADJUSTMENTS. REFER SERVICING TO PERSONNEL WHO HAVE BEEN TRAINED AND HAVE WORKING EXPERIENCE WITH VOLTAGES IN EXCESS OF 50 VOLTS.

ALL ELECTRICAL CABLES ASSOCIATED WITH VARIOUS UNITS INCLUDED IN A SYSTEM ARE WELL SHIELDED. TAKE CARE, HOWEVER, NEVER TO COME IN CONTACT WITH ANY ASSOCIATED TERMINALS WHEN THE POWER IS ON. SOME OF THESE LEADS CARRY POTENTIALLY LETHAL HIGH VOLTAGES. OTHER LEADS MAY CARRY SUFFICIENT RF POWER TO INFLICT SEVERE BURNS.

RF INTERFERENCE

THIS EQUIPMENT GENERATES, USES, AND CAN RADIATE RADIO-FREQUENCY ENERGY, AND IF NOT INSTALLED AND USED IN ACCORDANCE WITH THE INSTRUCTION MANUAL, MAY CAUSE INTERFERENCE TO RADIO COMMUNICATIONS. OPERATING THIS EQUIPMENT IN A RESIDENTIAL AREA IS LIKELY TO CAUSE INTERFERENCE, IN WHICH CASE USERS WILL BE REQUIRED TO TAKE THE NECESSARY MEASURES TO CORRECT THE INTERFERENCE AT THEIR OWN EXPENSE.

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TABLE OF OPTIONS AND ACCESSORIES

ITEM	DESCRIPTION	P-E PHI PART NO.
OPTIONS		
1	Thermocouple Option. Operates up to 4 thermocouple gauge tubes.	605-0301
2	Setpoint Option. 4 setpoints. Includes mating connector.	605-0302
3	Computer Interface Option (IEEE-488).	605-0303
4	Capacitance Manometer Option. Operates capacitance manometer and 3 thermocouple gauge tubes.	605-0304
ACCESSORIES		
4	Ion gauge tube without flange, 3/4" Kovar tube.	605-7000
5	Ion gauge tube on 2-3/4" (70 mm) O.D. CF flange.	605-7152
6	Wide range gauge tube on 1" (25 mm) O.D. tubulation.	605-7154
7	Wide range gauge tube on 2-3/4" (70 mm) O.D. CF flange.	605-7153
8	RH degasable nude tube on 2-3/4" (70 mm) O.D. CF flange.	605-7300
9	Thermocouple Gauge Tube.	804-8000
10	Non-Bakeable cable (for glass tubes) 15' (4.57 m).	605-0105
11	Nude tube cable for Monitorr 300 15' (4.57 m).	605-0115
12	Computer Interface Cable IEEE-488 0.5m (19.7").	830-4881
13	Computer Interface Cable IEEE-488 1m (39.4").	830-4882
14	Computer Interface Cable IEEE-488 2m (6.5').	830-4883
15	Computer Interface Cable IEEE-488 3m (9.8').	830-4884
16	Computer Interface Cable IEEE-488 4m (13.1').	830-4885
17	Computer Interface Cable IEEE-488 6m (19.7').	830-4886
18	Computer Interface Cable IEEE-488 8m (26.25').	830-4887

SECTION I
INTRODUCTION

1.0 GENERAL INFORMATION

This manual is intended to assist users in the installation, operation, and maintenance of the Perkin-Elmer PHI Monitorr 300 Ionization Gauge Controller. This manual is divided into five sections. Section I contains a brief description and the specifications of the unit. Section II explains installation, Section III describes operation, and Section IV outlines the theory of operation. Calibration and maintenance procedures are discussed in Section V.

1.1 GENERAL DESCRIPTION

The Monitorr 300 is a general-purpose ionization gauge controller designed to operate and read standard glass encapsulated Bayard-Alpert ionization gauge tubes. A Motorola 68008 microprocessor monitors and controls all activities in the Monitorr.

In addition to the microprocessor, the Monitorr has an emission controller and an electrometer. The emission controller provides a precisely regulated electron current to ionize the gas in the gauge tube. The electrometer measures the current generated by the ions, determining the pressure in the vacuum system.

The microprocessor computes the pressure from measurements of both the emission and ion currents. The microprocessor also performs the following tasks:

- monitors the power consumed by the filament
- selects the gain of the electrometer amplifier
- saves the current emission, sensitivity, display units, and setpoints in the non-volatile memory
- routes the current pressure reading to the pseudolog output
- interprets commands from the keypad
- starts and stops the degas.

The chassis contains a transformer, a wiring harness, a membrane keypad, and a liquid crystal display (LCD).

1.2 SPECIFICATIONS AND OPTIONAL EQUIPMENT

1.2.1 Gauge Tube Types

Compatible with standard Bayard-Alpert glass encapsulated tubes, wide range tubes, RH degasable nude tubes, thermocouple gauges (optional), and capacitance manometer (optional).

1.2.2 Number of Gauges

Standard

Ionization:	1
Thermocouple Gauges:	4

Capacitance Manometer Option

Capacitance Manometer	1
Thermocouple Gauges	3

1.2.3 Operating Pressure Range

Standard Glass Encapsulated Bayard-Alpert Ionization Gauge:
9.9×10^{-3} to 1×10^{-9} Torr
($1.3 \times 10^{+0}$ to 1.3×10^{-7} Pa)

1.2.4 Digital Display

5-1/2 digit liquid crystal alphanumeric display (LCD) for displaying pressure, and special annunciators for system status indication.

1.2.5 Display Units

User selectable between TORR, PASCAL, or MILLIBAR.

1.2.6 Electrical Inputs Supplied to Gauge Tube

Grid Voltage:	+180 V DC +/-5%
Emission Current:	User selectable from 0.04 mA to 11 mA. Factory preset to 1 mA. Stable to +/-2% of programmed value.
Filament Bias:	+27 V DC +/-10%
Collector Potential:	Ground

1.2.7 Electrometer

Current Range:	9.9×10^{-4} to 1×10^{-10} A
Accuracy:	+/-4% of reading

1.2.8 Filament Control

Front panel keypad

1.2.9 Ionization Gauge Sensitivity

Selectable from front panel by using COMMAND mode.

Range:	0.01 to 99.99 $Torr^{-1}$

1.2.10 Nonvolatile Memory

Electrically Erasable Programmable Read-Only Memory (EEPROM) stores current values of sensitivity constant, emission current, display units, and set points.

1.2.11 Leak Detection

Up/down display arrow on liquid crystal display (LCD) indicates rate of rise or fall of gauge reading.

1.2.12 Analog Output

Pseudolog output from D/A converter

Range:	0.10 to 9.99 V DC
Scaling:	0.10 V DC = 1.0×10^{-9} display units (Torr, Pa, Mbar.) 9.99 V DC = 9.9×10^{0} display units
Resolution:	0.02 V DC

1.2.13 Dimensions

Height:	3.5 in. (8.9 cm)
Width:	19.0 in. (48.3 cm)
Depth:	12.0 in. (30.5 cm)

1.2.14 Weight

Unit:	15 lbs. (6.8 kg)
Shipping:	25 lbs. (11.4 kg)

1.2.15 Input Power

Standard:	115 V AC (+/-10%), 2.0 A, 48-62 Hz.
Optional:	100 V AC at 2.0 A, 220 V AC at 1.0 A, 240 V AC at at 1.0 A. User changeable without tools. All units shipped set at 115 V AC, with 2 A fuse installed.

1.2.16 Power Dissipation

200 W (610 BTU/Hr) maximum, 125 W typical

1.2.17 Environmental Limits

Operating Temperature:	32 to 104° F (0 to 40° C)
Storage Temperature:	0 to 120° F (20 to 70° C)
Allowable Humidity:	0 to 80% relative humidity, non-condensing
Altitude:	10,000 ft. maximum (3048 m)

1.2.18 Options

THERMOCOUPLE BOARD
(Part No: 605-0301)

Number of Gauge Tubes:	4 (Hastings DV-6M or equivalent)
Indication:	Pressure is displayed on the liquid crystal display (LCD). Annunciator on the LCD shows which tube is being read.
Range:	1 to 1 x 10^{-3} Torr (130 to 1.3 Pa)

SETPOINT BOARD
(Part No: 605-0302)

Outputs:	4 independent relay contacts, 28 volts DC, 28 volts AC maximum (non-inductive load), at 1 A. Each relay contact may be assigned to one of five gauges. An automatic crossover between the ion gauge tube and a thermocouple is available and its parameters are set by a virtual setpoint (Setpoint #5). Note: the thermocouple option or the capacitance manometer option must be installed for the Automatic Crossover to work.
Range:	9.9 x 10^{-1} to 1.0 x 10^{-9} Torr 1.3 x 10^{2} to 1.3 x 10^{-7} Pa 1.3 x 10^{0} to 1.3 x 10^{-9} Mbar
Logic:	Relay energizes (trips) when pressure goes below the setpoint
Adjustment:	Front panel keypad or computer interface
Hysteresis:	User programmable. When the pressure is below the lower setpoint, the relay energizes, and when it is above the higher setpoint, the relay de-energizes.
Indication:	Trip point and hysteresis can be displayed on the front panel LCD or read through the computer interface. Annunciators on the LCD show which setpoints are tripped (energized.)

IEEE-488 INTERFACE
(Part No: 605-0303)
Compatible with IEEE standard 488-1978. Allows control of filament current, sensitivity constant, setpoint parameters, thermocouple gauge power, and keypad lockout. Allows reading of all five gauges and instrument status. Most of the functions which can be performed by the keypad can be performed through the IEEE-488 interface.

CAPACITANCE MANOMETER BOARD
(Part No: 605-0304)

Number of Capacitance Manometer Gauge Tubes:	1 (MKS 227A or equivalent)
Number of Thermocouple: Gauge Tubes:	3 (Hastings DV-6M or equivalent)
Indicators:	Pressure is displayed on the liquid crystal display (LCD). Annunciator on the LCD shows which tube is being read. G4 indicates the capacitance manometer. G1 through G3 indicate the thermocouple gauges.

Capacitance Manometer:	Four ranges depending on range of gauge selected:
	1 to 1 x 10^{-3} Torr (130 to 1.3 Pa)
	10 to 1 x 10^{-2} Torr (1300 to 13 Pa)
	100 to 1 x 10^{-1} Torr (1300 to 130 Pa)
	1000 to 1 (130000 to 1300 Pa)
Thermocouple:	1 to 1 x 10^{-3} Torr (130 to 1.3 Pa)

SECTION II
INITIAL CHECKOUT AND INSTALLATION

2.0 GENERAL INFORMATION

The Monitorr has been carefully packed in a special foam-lined shipping box. Save this box for shipping the instrument to another location in the future. While unpacking the box, be very careful not to scratch the front panel or otherwise damage the unit.

Check each item against the packing list to ensure that all parts have been received. If any items are missing, notify the carrier and Perkin-Elmer PHI immediately.

Carefully inspect each item for damage while unpacking. If any item looks damaged, notify the carrier immediately and send a copy of the claim to Perkin-Elmer. If the equipment has to be returned to Perkin-Elmer for repair, obtain a return authorization from the Customer Service Department of Perkin-Elmer PHI before shipping the equipment.

2.1 TOOLS REQUIRED

- Phillips screwdriver

2.2 INSTALLATION PROCEDURES

DANGER

GLASS ENCAPSULATED IONIZATION GAUGE TUBES WILL BREAK IF HIT WITH TOOLS OR ANY HARD OBJECT. IF THE TUBE BREAKS UNDER VACUUM, THE OPERATOR COULD BE INJURED BY FLYING GLASS. ALWAYS MOUNT GLASS ENCAPSULATED IONIZATION GAUGE TUBES IN PROTECTED LOCATIONS.

To install the Monitorr, set the line (mains) voltage and fuse to match the available voltage at the location, mount the Monitorr in a rack or on a bench, and connect the power and signal cables to the rear panel. Refer to Figure 2-1.

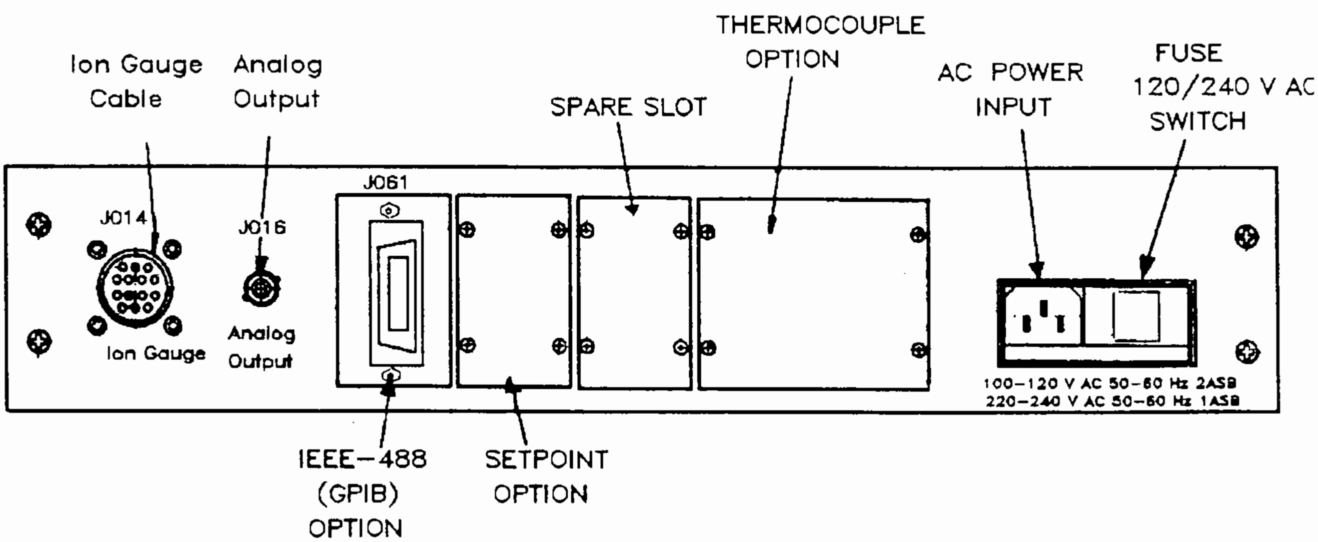


Figure 2-1. Monitorr Rear Panel and Connectors.

2.2.1 Setting Line (Mains) Voltage

DANGER: ELECTRICAL SHOCK HAZARD

VOLTAGES AS HIGH AS 375 VOLTS ARE USED IN THE MONITORR. ALWAYS TURN OFF THE FRONT PANEL POWER SWITCH BEFORE CONNECTING OR DISCONNECTING CABLES TO OR FROM THE MONITORR.

All Monitorr units are shipped from the factory with the input voltage set to 110 V AC operation. For 220 V AC operation, perform the following procedures:

1. Remove the power cord from the Monitorr back panel.

2. Remove the 2 A fuse.

3. Pull out the circuit board located beneath the fuse. Align the circuit board so that the correct voltage is on top at the left-hand side of the board. Reinsert the board. The correct voltage should be visible after it is in place.

4. Install a 1 A slow blow fuse.

To return to 110 V AC operation, reverse this procedure.

2.2.2 Mounting

The Monitorr can be mounted in a standard 19-inch rack or on a bench or can be used as a free standing unit.

In a rack installation, allow at least one-half inch air space around the sides and no less than one-quarter inch over the top of the chassis. The air temperature must be between 0^{o} C and 40^{o} C. Do not use the Monitorr as a support for other equipment, books, or papers.

The maximum heat load that the Monitorr will contribute to the room or rack cooling system is 200 W (610 BTU/Hr).

2.2.3 Power and Signal Cables

A 10 foot (3 m) long, three wire power cord is supplied with the Monitorr. Cables for the ionization gauge, thermocouple gauges, and IEEE-488 (GPIB) option may be ordered from Perkin-Elmer Vacuum Products.

The setpoint option is shipped with a mating connector so a cable can be made. Table 2-1 shows the pin connections for each relay.

TABLE 2-1. SETPOINT PIN CONNECTORS.

PIN	RELAY NO.	CONTACT
1	4	C
2	4	NC
3	4	NO
4	3	NC
5	3	C
6	3	NO
7	2	NC
8	2	C
9	2	NO
10	1	NC
11	1	C
12	1	NO

C - Common
NC - Normally Closed
NO - Normally Opened

2.2.4 Installing the Option Boards

If the Monitorr was ordered with option boards, then the boards were installed at the factory. If the options are ordered separately, they must be installed according to the procedures in 2.2.5 through 2.2.8. Each option card has its own identifier programmed into it. Refer to Figures 2-1 through 2-3.

2.2.5 Installing the Set Point Board (Model No. 605-0302)

CAUTION

MANY OF THE IC'S USED IN THE MONITORR ARE SENSITIVE TO ELECTROSTATIC DISCHARGE (ESD). THE POTENTIAL DIFFERENCE BETWEEN THE MONITORR AND THE PERSON SERVICING IT MAY BE LARGE ENOUGH TO DAMAGE THESE IC'S WHEN CONTACT IS MADE. TAKE THE FOLLOWING PRECAUTIONS TO REDUCE THIS RISK.

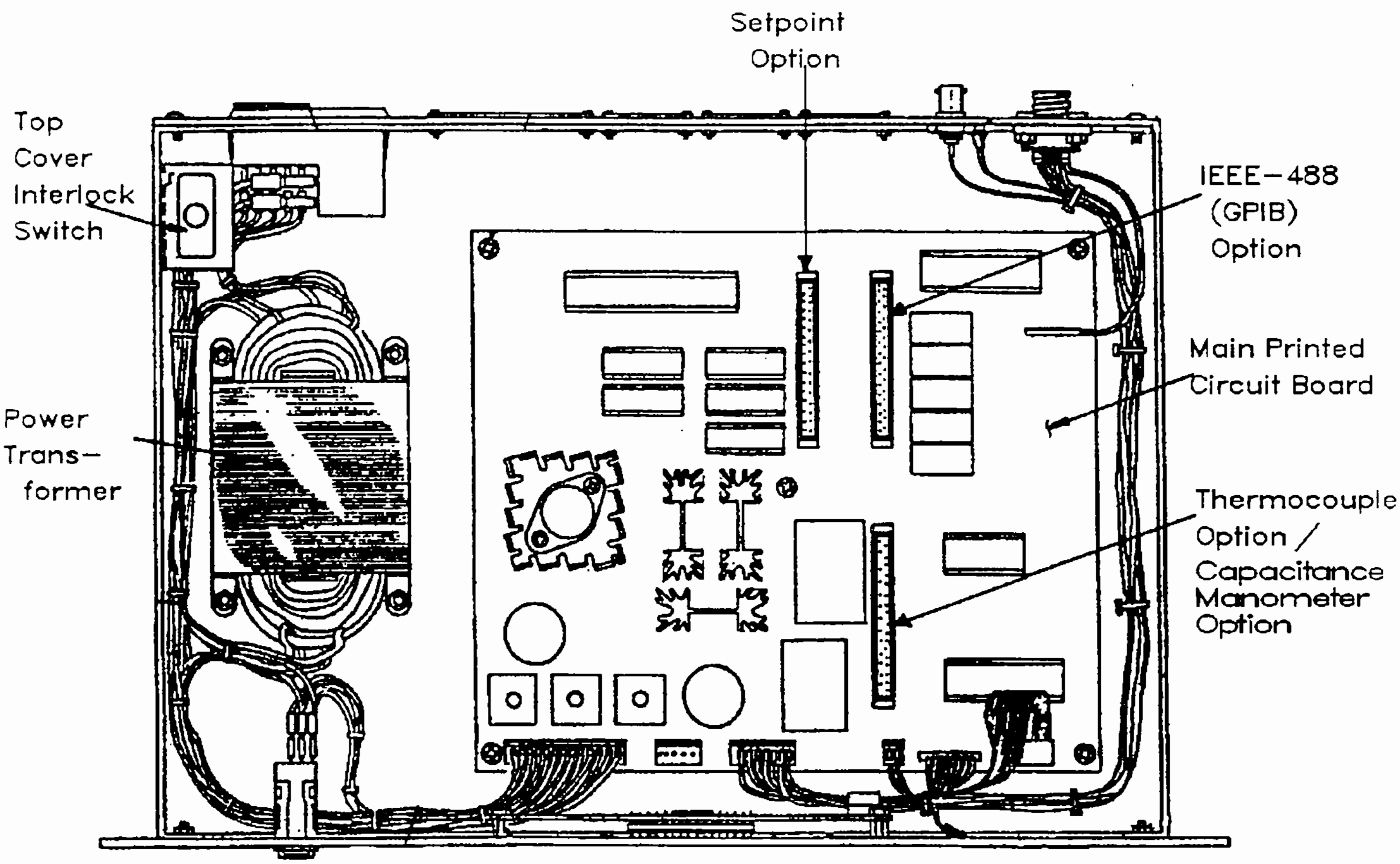


Figure 2-2. Monitorr Unit Assembly Mother Board and Options.

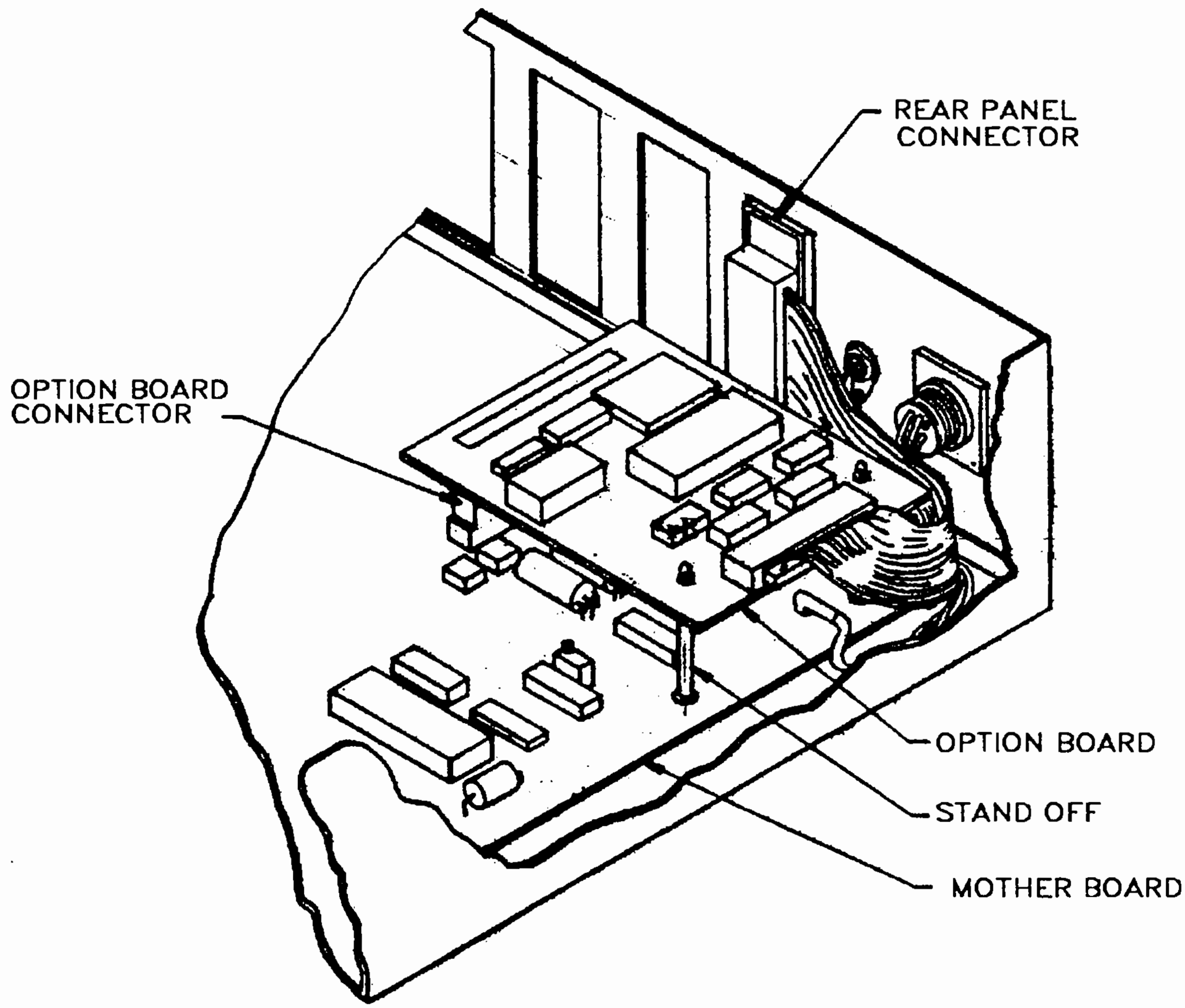


Figure 2-3. Cutaway View of Option Installation.

1. Disconnect the power cord from the Monitorr.
2. Disconnect the cables to all gauge tubes.
3. Place the Monitorr on a workbench or other solid surface.
4. Ground the Monitorr chassis and the operator.

DANGER: ELECTRICAL SHOCK HAZARD

VOLTAGES AS HIGH AS 375 VOLTS ARE USED IN THE MONITORR. A SAFETY INTERLOCK SWITCH HAS BEEN PROVIDED TO SHUT OFF ALL POWER IN THE UNIT WHEN THE TOP COVER IS REMOVED. DO NOT DEFEAT THIS INTERLOCK.

5. Remove the four screws from the top cover and lift the top cover off.
6. Install the two nylon standoffs on the mother board.
7. Insert the Setpoint option board connector into J108.
8. Remove the four screws from the rear panel blank located in the second space from the left as viewed from the rear.
9. Insert the setpoint connector panel into the rear panel from the outside.
10. Replace the four screws.
11. Connect the cable from the rear panel connector to the setpoint option board.
12. Replace the top cover and four screws.
13. Reinstall the Monitorr.
14. The setpoint pin connections for wiring the setpoints are shown in Table 2-1.

NOTE

The setpoint option is rated at 1 amp, 28 V DC or 28 V AC.

2.2.6 Installing the Thermocouple Board (Model No. 605-0301)

CAUTION

MANY OF THE IC'S USED IN THE MONITORR ARE SENSITIVE TO ELECTROSTATIC DISCHARGE (ESD). THE POTENTIAL DIFFERENCE BETWEEN THE MONITORR AND THE PERSON SERVICING IT MAY BE LARGE ENOUGH TO DAMAGE THESE IC'S WHEN CONTACT IS MADE. TAKE THE FOLLOWING PRECAUTIONS TO REDUCE THIS RISK:

1. Disconnect the power cord from the Monitorr.
2. Disconnect the cables to all gauge tubes.
3. Place the Monitorr on a workbench or other solid surface.
4. Ground the Monitorr chassis and the operator.

DANGER: ELECTRICAL SHOCK HAZARD

VOLTAGES AS HIGH AS 375 VOLTS ARE USED IN THE MONITORR. A SAFETY INTERLOCK SWITCH HAS BEEN PROVIDED TO SHUT OFF ALL POWER IN THE UNIT WHEN THE TOP COVER IS REMOVED. DO NOT DEFEAT THIS INTERLOCK.

5. Remove the four screws from the top cover and lift the top cover off.
6. Install the two standoffs on the mother board. Install the thermocouple option in the right front slot position.
7. Insert the thermocouple option board connector into J110 on the mother board.
8. Remove the four screws from the leftmost rear panel blank as viewed from the rear.
9. Insert the thermocouple connector panel into the rear panel from the outside.
10. Replace the four screws.
11. Connect the cable from the rear panel connectors to the thermocouple option board.

12. Replace the top cover and four screws.

13. Reinstall the Monitorr.

14. Connect the Monitorr to the thermocouple by plugging the four-pin connector end of the thermocouple cable to either J041 or J044 on the back panel of the Monitorr. Connect the other end to the thermocouple.

2.2.7 Installing the IEEE-488 Board (Model #605-0303)

CAUTION

MANY OF THE IC'S USED IN THE MONITORR ARE SENSITIVE TO ELECTROSTATIC DISCHARGE (ESD). THE POTENTIAL DIFFERENCE BETWEEN THE MONITORR AND THE PERSON SERVICING IT MAY BE LARGE ENOUGH TO DAMAGE THESE IC'S WHEN CONTACT IS MADE. TAKE THE FOLLOWING PRECAUTIONS TO REDUCE THIS RISK:

1. Disconnect the power cord from the Monitorr.

2. Disconnect the cables to all gauge tubes.

3. Place the Monitorr on a workbench or other solid surface.

4. Ground the Monitorr chassis and the operator.

DANGER: ELECTRICAL SHOCK HAZARD

VOLTAGES AS HIGH AS 375 VOLTS ARE USED IN THE MONITORR. A SAFETY INTERLOCK SWITCH HAS BEEN PROVIDED TO SHUT OFF ALL POWER IN THE UNIT WHEN THE TOP COVER IS REMOVED. DO NOT DEFEAT THIS INTERLOCK.

5. Remove the four screws from the top cover and lift the top cover off.

6. Install the two nylon standoffs on the mother board.

7. Insert the IEEE-488 option board into J109 on the mother board.

8. Remove the four screws fro\ the rear panel blank located third from the left.

9. Insert the IEEE-488 connector panel into the rear panel.

10. Replace the four screws.

11. Connect the cable from the rear panel connector to the IEEE-488 option board.

12. Set the address the unit will respond to by setting the five lower address switches to the binary representation of the address (address must be between 0 and 31).

13. Replace the top cover and four screws.

14. Reinstall the Monitorr.

15. Connect the Monitorr to other equipment using a standard IEEE-488 cable.

NOTE

Switch 1 corresponds to binary 1. Switch 2 corresponds to a binary 2 and so on through Switch 8, which corresponds to a binary 128. The upper three switches are not used and should be left shut off.

2.2.8 Installing the Capacitance Manometer Board (Part No. 605-0304)

CAUTION

MANY OF THE IC'S USED IN THE MONITORR ARE SENSITIVE TO ELECTROSTATIC DISCHARGE (ESD). THE POTENTIAL DIFFERENCE BETWEEN THE MONITORR AND THE PERSON SERVICING IT MAY BE LARGE ENOUGH TO DAMAGE THESE IC'S WHEN CONTACT IS MADE. TAKE THE FOLLOWING PRECAUTIONS TO REDUCE THIS RISK:

1. Disconnect the power cord from the Monitorr and cables to all gauge tubes.

2. Place the Monitorr on a workbench or other solid surface and ground both the Monitorr chassis and the operator.

DANGER: ELECTRICAL SHOCK HAZARD

VOLTAGES AS HIGH AS 375 VOLTS ARE USED IN THE MONITORR. A SAFETY INTERLOCK SWITCH HAS BEEN PROVIDED TO SHUT OFF ALL POWER IN THE UNIT WHEN THE TOP COVER IS REMOVED. DO NOT DEFEAT THIS INTERLOCK.

3. Remove the four screws from the top cover and lift the top cover off.

4. Install the two standoffs on the mother board. Install the capacitance manometer in the right front slot position.

5. Insert the capacitance manometer option board connector into J110 on the mother board.

6. Remove the four screws from the leftmost rear panel blank as viewed from the rear.

7. Insert the capacitance manometer connector panel into the rear panel from the outside.

8. Reinstall the four screws.

9. Connect the cable from the rear panel connectors to the capacitance manometer option board.

10. Install the +/-15 V power module on the left wall of the chassis using the four setscrews provided. The terminal block should be facing the rear of the chassis.

11. Plug the 5 conductor plug from the power module into J111 on the mother board.

12. Plug the 3 conductor plug from the power module into J407 on the capacitance manometer option board.

13. Reinstall the top cover and four screws and reinstall the Monitorr.

14. Connect the Monitorr to the capacitance manometer by plugging the 9-pin connector end of the capacitance manometer cable into the Cm jack of J041 on the back panel of the Monitorr. Connect the other end to the capacitance Manometer. Connect the Monitorr to the thermocouples as described in step 14 of Section 2.2.6.

    The capacitance manometer option is shipped with a 9-pin mating connector. An interface cable to the capacitance manometer head can be assembled using the 9-pin mating connector and the pinouts in Table 2-2.

TABLE 2-2. CAPACITANCE MANOMETER (CM) PIN CONNECTORS.

Pin Number	Description
1	ground
2	+15 V DC power
3	input from CM
4	-15 V DC power
5	CM analog output
6	CM analog ground

2.2.9 Connecting the Ion Gauge to the Monitorr 300

The Monitorr can be connected to the ion gauge using the ion gauge cable (Model No. 605-0105). Before making connection to the DGC, be sure that the controller is turned off. To connect to an ion tube, plug the cable end with the 14-pin connector into J014 at the rear of the Monitorr. Connect the other end of the cable to the ion tube. Power may now be applied to the Monitorr 300.

SECTION III
OPERATION

3.0 GENERAL INFORMATION

The PHI Monitorr 300 is controlled and monitored by a Motorola 68008 microprocessor. All users must read and understand the following information before operating the Monitorr 300.

3.1 CONTROLS AND INDICATORS

3.1.1 Key Description

POWER PUSH BUTTON. Turns power to the Monitorr ON and OFF. When the switch is OFF, all power to the electronics is removed. When the switch is on and power is being applied to the Monitorr, the red indicator light in the center of the push button is lit.

KEY. Controls all Monitorr functions. Maroon colored keys initiate major functions (fil on/off, select ION GAUGE or AUX GAUGE, or select DISP UNITS). White keys initiate support functions for the Monitorr (emission current, sensitivity, set point, command mode). Each key also has a number which can be used with the function keys.

FIL ON/OFF /7. Turns the ionization gauge tube filament ON or OFF. Inputs the number 7 when used as a number key.

ION GAUGE /4. Puts ionization gauge tube reading on the alphanumeric display. The IG annunciator on the display is also turned on. Inputs the number 4 when used as a number key.

AUX GAUGE /1. Displays one of the four thermocouple gauge readings if the thermocouple option board is installed. The first time it is pressed, the word AUX will appear on the LCD display. Pressing a numeric key (1, 2, 3, or 4) displays the reading of that thermocouple gauge tube. Inputs the number 1 when used as a number key.

DISP UNITS /0. Selects the pressure units for the LCD display from TORR, PASCAL, or MBAR. Inputs the number 0 when used as a number key.

DEGAS /. Turns power to resistive heating degas circuit ON or OFF. If pushed only once, the ion gauge tube will be degassed for 10 minutes. When pushed a second time, the degas will shut OFF. Inputs the decimal point when used as a number key.

SET POINT /9. Initiates a set point when the set point option board is installed. See Section 3.2.10 for complete instructions. Inputs the number 9 when used as a number key.

EMISS /6. Displays the emission current. Sets the emission current when used with numeric keys. Inputs the number 6 when used as a number key.

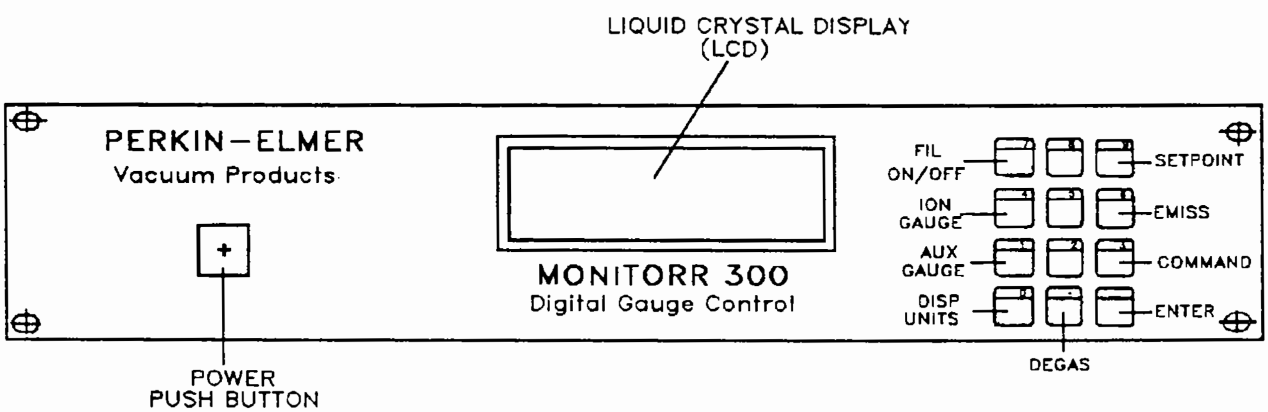


Figure 3-1. Monitorr Front Panel and Operating Controls.

COMMAND /3. Enables COMMAND mode. See Sections 3.2.8 and 3.2.9 for complete instructions. Inputs the number 3 when used as a number key.

ENTER. Enters numeric data when used with the function keys.

8. Inputs the number 8 when used with a function key.

5. Inputs the number 5 when used with a function key.

2. Inputs the number 2 when used with a function key.

3.1.2 Liquid Crystal Display

ALPHANUMERICS. 5-1/2 characters.

PRESSURE TREND ARROW. This 5 segment arrow indicates the pressure trend in the displayed reading. An up arrow is displayed when the pressure is rising and a down arrow when it is falling. The length of the arrow is proportional to the magnitude of the change.

3.1.3 Annunciators

DEGAS. This is displayed during the degassing of an ionization gauge tube.

FIL. This is displayed whenever power is being applied to an ionization gauge filament. When viewing the emission current, the FIL annunciator will flash.

SP 1 2 3 4. SP is displayed whenever a set point is energized. The numbers 1,2,3,4 indicate which setpoint relay is energized.

IG 1 2 3 4. The IG is displayed whenever an ionization gauge reading is being displayed on the LCD. The G and a 1, 2, 3, or 4 are displayed whenever an auxiliary gauge (such as a thermocouple) reading is being displayed on the LCD.

TORR. This is displayed whenever Torr is selected as the pressure unit for the display.

PASCAL. This is displayed whenever Pascal is selected as the pressure unit for the display.

MBAR. This is displayed whenever Millibar is selected as the pressure unit for the display.

CMD. This is displayed when in the command entry mode.

ERROR. This is displayed whenever a system error or improper entry is encountered. An improper entry condition can be cleared by pressing the ENTER key again.

3.1.4 How the Keys Operate

When power is first applied to the Monitorr, all the keys except 2, 5, and 8 perform the functions printed on them. The FIL ON/OFF and DEGAS function keys toggle ON and OFF each time the key is pressed.

The DISP UNITS key also toggles among three states: TORR, PASCAL and MBAR. Whenever the DISP UNITS key is pressed, the display advances to the next state in the order listed. Thus if the display is reading in Torr and the DISP UNITS key is pressed, the display advances to PASCAL. Similarly, if the display is reading in Millibar, and the DISP UNITS key is pressed, it advances to TORR.

The AUX GAUGE, SET POINT, EMISS, and COMMAND functions need numeric input. Once one of these function keys is pressed, all keys become number entry keys.

For the AUX GAUGE function, only the numbers 1, 2, 3, or 4 are valid. The other functions use all the numbers and the decimal point.

To engage these functions, press the corresponding key followed by the appropriate numbered key for the entry desired. The Monitorr then performs the function using the numeric value entered. If a function does not require the display, the display will return to its previous setting.

3.2 OPERATING PROCEDURES

3.2.1 Initial Procedures

The Monitorr allows the operator direct control over every operating parameter of the ionization and thermocouple gauges, although most users only need a pressure reading from a standard glass encapsulated Bayard-Alpert ion gauge tube. The Monitorr is shipped with parameters set at the default values listed in Table 3-1. To get a pressure reading, perform the following steps.

1. Ensure that all of the procedures in Section II have been performed.

2. Push the POWER button ON. The red pilot light in the power push button will light.

3. Press the FIL ON/OFF key. The filament will light. The FIL, TORR and IG annunciators should be displayed on the LCD. After a few seconds, the ion gauge reading should appear on the LCD as *N.N e-NN*.

4. Push the EMISS button. The reading on the LCD display should change to 10 MA. The IG and TORR annunciators should go OFF. The FIL annunciator should remain ON, indicating that the tube is still operating.

5. Push the ENTER button. The ion gauge reading will return.

3.2.2 Correction Procedures

To reinitialize the Monitorr to the factory preset values:

1. Press CMD. The CMD annunciator will light.

2. Press FIL ON/OFF/7. The LCD will now read 7.

3. Press 5. The LCD will now read *75*.

4. Press CMD/3. The LCD will now read *753*.

5. Press 2. The LCD will now read *7532*.

<u>NOTE</u>

When reinitializing the Monitorr to the factory set parameters, note that the setpoint trip points will also be reset.

6. Press ENTER. All the parameters in the Monitorr are reset to their default values listed in Table 3-1.

7. Repeat the initial operating procedures in Section 3.2.1 beginning with step two.

TABLE 3-1. FACTORY SET PARAMETER VALUES.

Sensitivity Constant:	10 $Torr^{-1}$
Emission Current:	10 mA

3.2.3 Reading Pressure With an Ionization Gauge

To read the pressure on the LCD, enable the filament by pressing the keys in the following order:

1. Press the FIL ON/OFF key to enable the filament. The filament will light up. The FIL, TORR and IG annunciators will be displayed on the LCD. After a few seconds, the ion gauge reading will appear on the LCD as *N.N e-NN*.

2. If the filament is not enabled, pressing the ION GAUGE key will give a display of ***0.0 e-00***. If the filament does not generate the proper emission current for some reason (i.e. filament burned out or not connected), the ERROR annunciator will flash on and off.

Whenever the FIL ON/OFF key turns the filament on, the LCD automatically displays the ion gauge reading. This means that if another gauge were being read before the filament was turned on, the LCD would switch over to the ion gauge as soon as FIL ON/OFF was pressed.

The pressure is read ten times per second. This goes on continually while the filament is ON, even when some other gauge or function is displayed on the LCD. Note that although the pressure is updated ten times per second, the display is updated only four times per second. Thus, any setpoints which have been vectored to the ion gauge will continue to operate.

The Monitorr can operate other hot filament ionization gauge tubes as long as they are electrically compatible. When using an ionization gauge other than the standard or wide-range Bayard-Alpert, the sensitivity constant which the Monitorr uses to calculate pressure from the electrometer current may need to be changed. Refer to Section 3.2.9 for complete instructions.

With a standard glass encapsulated Bayard-Alpert tube, valid pressure readings are from 1 x 10^{-9} Torr (1.3 x 10^{-7} Pa) to 9.9 x 10^{-3} Torr (1.3 x 10^{-1} Pa). A wide range gauge tube (which has a platinum coating on the glass envelope) gives valid readings from 1 x 10^{-9} Torr (1.3 x 10^{-7} Pa) to 1 x 10^{-2} Torr (1.3 Pa).

The default value of the sensitivity constant that the Monitorr uses is 10 $Torr^{-1}$. This is the sensitivity of a standard Bayard-Alpert tube for nitrogen. If the vacuum system contains a different gas such as hydrogen, oxygen, or argon, the sensitivity constant may be changed so that the Monitorr displays the actual pressure for the gas being used. If the default value for the sensitivity constant (10 $Torr^{-1}$) is used, then the pressure displayed on the Monitorr is the nitrogen equivalent pressure. Refer to Section 3.2.9. and to Appendices A, A.0, A.1, A.2, and A.3 for more information.

3.2.4 Changing Display Units

Whenever it is turned ON, the Monitorr will display pressure in units of Torr. To change to Pascal, simply press the DISP UNITS key once. To change to Millibar, press the DISP UNITS key twice. The DISP UNITS key wraps around. To return to Torr from Pascal, press the DISP UNITS key twice. The units options are in the following order: Torr, Pascal, Millibar.

3.2.5 Degassing the Ionization Gauge Tube

Under normal operation of the ion gauge below pressures of 10^{-8}, degassing is not required. However, bringing a chamber up to air introduces contaminants into the chamber which will contaminate the grid of the ion gauge. Thus once the system is brought back down to the HV range, degassing is required.

When operating the tube in higher pressures, 10^{-7} or above, periodically degas the tube. When the pressure reading bottoms out and will not go any lower, even though the actual pressure is lower, the tube needs degassing. For further information, refer to Total Pressure Measurements in Vacuum Technology by Armand Berman, Academic Press, Inc., 1985 (ISBN: 0-12-092440-4).

To degas the ion gauge tube, press the DEGAS key. The DEGAS annunciator will light and the grid of the ion gauge tube should begin to glow red after 30 to 60 seconds. One advantage of resistive heating degassing is that the gauge can continue to read pressure. If the ion gauge reading is being displayed, it should increase rapidly for one to two minutes, then the pressure should level off and slowly fall. The pressure trend arrow should point up during the time that the pressure is increasing, then down as the pressure decreases. If the DEGAS key is depressed only once, the tube will be degassed for 10 minutes. Pressing it any time before the default time has run out will turn the degassing power OFF.

The Monitorr will not allow the the tube to degas unless the tube filament is ON.

3.2.6 Reading the Emission Current

Since the Monitorr uses a programmable regulator to control the emission current, the emission can be set to any value between 0.04 and 11 mA. This flexibility creates situations in which the operator must determine what the emission current is. To do this, press the EMISS key.

DO NOT PRESS ANY OTHER KEY UNTIL THE LCD HAS BEEN READ. The emission current will appear in the form *NN.NN MA*.

After reading the emission, press ENTER. The Monitorr will return to the gauge reading that was displayed before the EMISS key was pressed.

CAUTION

PUSH ONLY THE EMISS AND ENTER KEYS WHEN READING THE EMISSION CURRENT, SINCE THIS IS THE MODE FOR SETTING THE EMISSION CURRENT. REFER TO SECTION 3.2.7 FOR FULL DETAILS.

3.2.7 Setting the Emission Current

With its programmable emission regulator, the Monitorr can supply any hot cathode ionization gauge with emission currents from 0.04 mA to 11 mA. The emission can be set by pressing the EMISS and the numeric keys in the following order:

1. Press the EMISS key to initiate the emission function. The present value of the emission current will be displayed on the LCD.

2. Enter the left-most digit of the desired emission current by pressing the key that corresponds to the number to be entered.

3. To enter the second digit, press the key corresponding to the number of the second digit. Press this key only if the desired emission is greater than 9.99 mA.

4. Press the DECIMAL POINT key to enter the decimal point. Decimal point will be displayed on the LCD. It is not necessary to press this key if the desired current is an integer.

5. Enter the first digit to the right of the decimal point by pressing the appropriate numbered key. It is not necessary to press this key if the desired current is an integer.

6. Enter the second digit to the right of the decimal point by pressing the appropriate numbered key. It is not necessary to press this key if this digit is zero.

7. Press ENTER to input the new value of emission current to the emission regulator. This will also return the Monitorr to the previous gauge reading that was displayed before the EMISS key was pressed.

EXAMPLE 1

If an emission current of 4 mA is desired, use the EMISS and the appropriate numbered keys in the following order:

- Press the EMISS key to display the present emission current on the LCD.
- Press the ION GAUGE/4 key to enter the number 4. The number 4 appears on the LCD as *4.00*.
- Press ENTER to input the new current setting of 4 mA to the programmable emission current regulator and to adjust the emission current to 4 mA.

EXAMPLE 2

If an emission of 8.50 mA is desired, use the EMISS, NUMERIC, DECIMAL POINT, and ENTER keys in the following order:

- Press the EMISS key to display the present emission current on the LCD in the form *NN.NN MA*. All keys except ENTER become numbered keys.
- Press the 8 key to enter the number 8. The number appears on the LCD as *8*.
- Press the DEGAS/. key to enter the decimal point. The LCD does not change. It still displays 8, but now the numbers will go to the digits to the right of the decimal point.
- Press the 5 key to enter the number 5. The number appears on the LCD as *8.5*.
- Enter the number 0 by pressing the DISP UNITS/0 key. The number appears on the LCD as *8.50*.
- Input the new emission current setting into the programmable regulator and adjust the emission current to 8.50 mA by pressing the ENTER key. The display returns to the pressure reading from the gauge that was displayed before the EMISS key was pressed.

EXAMPLE 3

If an emission current of 10.00 mA is desired, use the EMISS, NUMERIC, DECIMAL POINT, and ENTER keys in the following order:

- Press the EMISS key to display the present emission current on the LCD in the form *NN.NN MA*. All keys except ENTER become NUMERIC keys.
- Press the AUX GAUGE/1 key to enter the number 1 into the leftmost digit. The number appears on the LCD as *1*.
- Press the DISP UNITS/0 key to enter the number 0 into the next digit to the right. The number appears on the LCD as *10*.
- Input the new emission current setting into the programmable regulator and adjust the emission cur-

rent to 10.00 mA by pressing the ENTER key. The display returns to the previous pressure gauge reading that was displayed before the EMISS key was pressed.

The emission regulator will not accept numbers less than 0.04 or greater than 11. If a number greater than 11 is entered, the regulator defaults to 11 mA. If a number less than 0.04 is entered, the regulator defaults to 0.04 mA.

If a wrong number is entered in this procedure, the only way that it can be corrected is to press ENTER and repeat the procedure.

3.2.8 Reading the Sensitivity Constant

CAUTION

BEFORE PERFORMING THE PROCEDURES IN THIS SECTION, READ APPENDIX A: "SENSITIVITY OF ION GAUGE TUBES."

CAUTION

CHANGING THE SENSITIVITY CONSTANT WILL CHANGE THE ACTUAL PRESSURE AT WHICH THE SETPOINTS VECTORED TO THE ION GAUGE OPERATE.

The Monitorr allows the user to program in any sensitivity between 0.01 and 99.99 $Torr^{-1}$. As in the case of the emission current function, situations may arise in which the operator must determine the current sensitivity constant value.

To prevent accidental or unauthorized changing of the sensitivity constant, this function is accessed through the COMMAND mode. To display the current sensitivity constant, use the COMMAND, numbered, and ENTER keys in the following order:

1. Press the COMMAND key to put the Monitorr in the Command Mode. All keys except ENTER become numeric. The LCD goes blank except for the annunciator CMD.
2. Press the 2 key to enter the first digit of the command number. The LCD displays *2*.
3. Press the 5 key to enter the second digit of the command number. The LCD displays *25*.
4. Press the 8 key to enter the third digit of the command number. The LCD displays *258*.
5. Press SET POINT/9 to enter the fourth digit of the command number. The LCD displays *2589*.
6. Press the ENTER key to enter the command number into the Monitorr command interpreter. The LCD displays the current sensitivity constant in the form *NN.NN*.
7. Press the ENTER key to terminate the command mode. The Monitorr returns to the gauge reading that was displayed before the COMMAND key was pressed.

3.2.9 Changing the Sensitivity Constant

CAUTION

BEFORE PERFORMING THE PROCEDURES IN THIS SECTION, READ APPENDIX A: "SENSITIVITY OF ION GAUGE TUBES."

CAUTION

CHANGING THE SENSITIVITY CONSTANT WILL CHANGE THE PRESSURE READING THAT THE MONITORR DISPLAYS. TO AVOID CONFUSION ABOUT THE ACTUAL PRESSURE IN THE VACUUM SYSTEM, RECORD THIS PARAMETER EVERY TIME IT IS CHANGED.

CAUTION

CHANGING THE SENSITIVITY CONSTANT WILL CHANGE THE ACTUAL PRESSURE AT WHICH THE SETPOINTS VECTORED TO THE ION GAUGE OPERATE.

The Monitorr allows the user to program in any sensitivity between 0.01 and 99.99 $Torr^{-1}$. This allows the Monitorr to read out pressure from any Bayard-Alpert ionization gauge tube.

The sensitivity that gives the correct pressure reading for the actual gas or gas mixture that is being used in the system can also be programmed in.

Table 3-2 lists typical sensitivities of the Perkin-Elmer standard glass encapsulated and wide-range Bayard-Alpert tubes. Manufacturing variations cause the sensitivity of commercial gauge tubes to vary by as much as 50% from tube to tube. Since the Monitorr regulates the emission current to 3% and reads the electrometer current to within 4%, each gauge tube must be calibrated individually in order to take full advantage of the precision and accuracy of the Monitorr. Refer to Appendix A for complete details.

TABLE 3-2. TYPICAL SENSITIVITIES OF PERKIN-ELMER IONIZATION GAUGE TUBES.

Part No.:	605-7000
Description:	Glass encapsulated
Sensitivity:	10 +/-2 $Torr^{-1}$
Part No.:	605-7152
Description:	Glass encapsulated
Sensitivity:	10 +/-2 $Torr^{-1}$
Part No.:	605-7154
Description:	Wide-range gauge
Sensitivity:	10 +/-2 $Torr^{-1}$
Part No.:	605-7153
Description:	Wide-range gauge
Sensitivity:	10 +/-2 $Torr^{-1}$
Part No.:	605-7300
Description:	RH degasable nude tube
Sensitivity:	10+/-2 $Torr^{-1}$

The Monitorr computes pressure from the ion current according to the following equation:

P = Du*(Ii/(S*Ie))

P = Pressure displayed on the LCD.

Du = Conversion factor to convert Torr into the display units selected.

Ii = Current measured by the electrometer.

S = Sensitivity constant of the gauge tube.

Ie = Current measured by the emission controller.

In working with sensitivity constants, it is essential to keep track of the units. The Monitorr assumes that the units are $Torr^{-1}$. If the tube manufacturer reports the sensitivity in $Pascal^{-1}$ or $Millibar^{-1}$, then you must convert to $Torr^{-1}$ by using the following conversion factors:

TABLE 3-3. CONVERSION FACTORS FOR SENSITIVITY.

From:	Multiply by:	Result:
Pa^{-1}	133	$Torr^{-1}/Pa^{-1}$
$Mbar^{-1}$	1.33	$Torr^{-1}/Mbar^{-1}$

EXAMPLE 1

Suppose that calibration shows that the gauge tube has a sensitivity of 8.51 $Torr^{-1}$. To set up the Monitorr to display the pressure according to this calibration, use the COMMAND, numbered, and ENTER keys in the following order:

- Press the COMMAND key to put the Monitorr in Command Mode. All keys except ENTER become numeric.
- Press the 2 to enter the first digit of the command number. The LCD displays *2*.
- Press the 5 to enter the second digit of the command number. The LCD displays *25*.
- Press the 8 to enter the third digit of the command number. The LCD displays *258*.
- Press the SET POINT/9 key to enter the fourth digit of the command number. The LCD displays *2589*.
- Press the ENTER key to enter the command number into the Monitorr command interpreter. The LCD displays the current sensitivity constant in the form

NN.NN. The leftmost digit will be flashing, indicating that it is ready to be changed from the keypad.

- Press the DISP UNITS/0 key to enter the number 0 in the tens digit. The next digit to the right (the units digit) will begin flashing.
- Press 8 to enter the number 8 in the units digit. The next digit to the right (the tenths digit) will begin flashing.
- Press 5 to enter the number 5 in the tenths digit. The next digit to the right (the hundredths digit) will begin flashing.
- Press the AUX GAUGE/1 key to enter the number 1 in the hundredths digit. The leftmost digit (the tens digit) will begin flashing.
- Press the ENTER key to terminate the command mode and enter the new value of the sensitivity constant. The Monitorr returns to the gauge reading that was displayed before the command mode was entered.

<u>EXAMPLE 2</u>

Suppose that the gauge tube manufacturer reports the sensitivity as 0.182 Pa^{-1}. Since the Monitorr expects the sensitivity to be in units of $Torr^{-1}$, multiply this number by the conversion factor found in Table 3-3. This gives a value of 24.20 $Torr^{-1}$. To set up the Monitorr to display the pressure according to this sensitivity, use the COMMAND, NUMERIC, and ENTER keys in the following order:

- Press the COMMAND key to put the Monitorr in Command Mode. All keys except ENTER become numeric.
- Press the 2 to enter the first digit of the command number. The LCD displays *2*.
- Press the 5 to enter the second digit of the command number. The LCD displays *25*.
- Press the 8 to enter the third digit of the command number. The LCD displays *258*.
- Press the SET POINT/9 key to enter the fourth digit of the command number. The LCD displays *2589*.
- Press the ENTER key to enter the command number into the Monitorr command interpreter. The LCD displays the current sensitivity constant in the form *NN.NN*. The leftmost digit will be flashing, indicating that it is ready to be changed from the keypad.
- Press 2 to enter the number 2 in the tens digit. The next digit to the right (the units digit) will be flashing, indicating that it is ready to be changed from the keypad.
- Press the ION GAUGE/4 key to enter the number 4 in the units digit. The next digit to the right (the tenths digit) will be flashing, indicating that it is ready to be changed from the keypad.
- Press 2 to enter the number 2 in the tenths digit. The next digit to the right (the hundredths digit) will be flashing, indicating that it is ready to be changed from the keypad.
- Press the ENTER key to terminate the command mode and enter the new value of the sensitivity constant. The Monitorr returns to the gauge reading that was displayed before the command mode was entered.

The command input display wraps around. If a wrong number is entered, continue entering digits until the incorrect digit appears, then enter the correct number.

3.2.10 Using the Pseudolog Output

An analog chart recorder output is designed into the Monitorr main board. This pseudolog output ranges from 0 to 10 V DC and can deliver up to 500 microamperes. 0.10 volts corresponds to a display reading of 1×10^{-9} units (Torr, Pa, Mbar). 9.99 volts corresponds to a display reading of 9.9×10^{0} units. The exponent is placed in the units digit and the mantissa is placed in the tenths and hundredths digit.

The pseudolog output transmits only what is on the display. Thus, if the display is changed from Ion Gauge to Aux Gauge 1, the voltage on the pseudolog output will change.

3.3 OPERATING PROCEDURES FOR THE OPTION BOARDS

3.3.1 Setpoint Board

The setpoint option has four SPDT relays which can be connected to any one of the pressure gauges. Thus, the relay associated with setpoint #1 (SP 1) can be connected to the ion gauge (IG) or any one of the auxiliary gauges G1, G2, G3, or G4. Once it is assigned to a gauge, the setpoint continues to operate independently of the gauge that is displayed on the LCD. If SP 2 is assigned to auxiliary gauge #4 (G4) and the ion gauge on the LCD display is then called up, the relay of SP 2 will operate according to the pressure sensed by G4.

When the setpoint relays are de-energized, the common contact (C) is connected to the normally closed (NC) contact. When these are energized, the C contact is connected to the normally open (NO) contact.

Each setpoint has two pressure values assigned to it. The upper limit sets the point at which the relay de-energizes. The lower limit sets the point at which the relay energizes. The Monitorr assigns the first value entered to the lower limit and the second value entered to the upper limit.

The relay will be energized only when the pressure falls through the lower limit and it will be de-energized only when the pressure rises above the upper limit. If the smaller pressure value is entered into the upper limit and the larger value into the lower limit, the setpoint relay will never energize. However, the relay will energize if both limits are set to the same value.

NOTE

If a positive exponent is required for a setpoint limit, pressing the decimal point key will toggle the exponent between "+" and "-". This can be entered at any point while programming the setpoints.

3.3.2 Adjusting the Operating Points

EXAMPLE

Suppose an electron gun is to turn on when the pressure gets to 5 x 10^{-7} Torr. First, wire the gun control line through the relay so that the gun is off when the relay is de-energized. (The relay will always be de-energized when the pressure is above the upper limit.)

Next, program the Monitorr. Choose which gauge to assign to SP 1. Since the pressure is below the range of the auxiliary gauges, use the ion gauge. Then set the higher and lower limits. If both the upper and lower limits are set to the same value when the gun first turns on, outgassing from the filament would cause the pressure to rise above 5 x 10^{-7}, de-energizing the relay and turning off the gun.

As the filament cools, the pressure will fall back below 5 x 10^{-7} Torr. The vacuum system and gauge controller will continue to oscillate until the gun is finally degassed. Setting the upper limit to a higher pressure, such as 8 x 10^{-7} will prevent this oscillation. Experiment to determine the exact value of the upper limit that prevents oscillation and still gives the equipment adequate protection.

Set SP 1 to energize when the pressure falls below 5 x 10^{-7} Torr. The process requires that SP 1 de-energize when the pressure rises above 8 x 10^{-7} Torr. Use the Monitorr keys in the following order:

1. Press the SETPOINT/9 key and the annunciator SP 1234 will begin blinking.
2. Press the AUX GAUGE/1 key. SP and 1 become solid. 2, 3, and 4 fade away. If SP 1 is already vectored to a gauge, that gauge annunciator will begin flashing.
3. Press the ION GAUGE/4 key to select the ion gauge to control SP 1. SP 1 is now vectored to the ion gauge. The IG annunciator turns on. The lower limit pressure is displayed with the leftmost digit blinking.
4. Press 5 and the display reads *5.x e-x*. The tenths digit begins blinking.
5. Press the DISP UNITS/0 key and the display reads *5.0 e-x*. The exponent begins blinking.
6. Press the FIL ON/OFF/7 key and the display reads *5.0 e-7*. The units begins blinking.

7. Press the ENTER key to input the lower limit. SP 1 will energize whenever the pressure in the system falls below 5.0 x 10^{-7} Torr. Pin 21 of J504 will be connected to pin 23 of J504. The setting of the upper limit now appears with its leftmost digit blinking.

8. Press 8 and the display reads *8.x e-x*. The tenths digit begins blinking.

9. Press the DISP UNITS/0 key and the display reads *8.x e-x*. The tenths digit begins blinking.

10. Press the FIL ON/OFF/7 key and the display reads *8.0 e-7*. The units digit begins blinking.

11. Press the ENTER key to input the upper limit. SP 1 will de-energize whenever the pressure in your system rises above 8.0 x 10^{-7} Torr. Pin 21 of J504 will be connected to pin 19 of J504. The Monitorr will return to the gauge reading which was displayed before pressing setpoint.

3.3.3 Setting the Autocross Pressure

In applications such as pumpdown operations, it is useful to have the ion gauge turn ON automatically after the chamber pressure falls below a preset value. This can be done by assigning one of the thermocouple gauges to a special setpoint called SP 5.

For example, in pumping down a load lock, a load transfer is desired after the pressure reaches 5 x 10^{-7} Torr (6.5 x 10^{-5} Pa). In addition, G2 has been chosen to monitor the load lock thermocouple gauge.

To get the Monitorr to turn the ion gauge ON automatically when the pressure gets below 10 microns (1.3 Pa.), enter the following keystrokes:

1. Press the SETPOINT/9 key and SP 1 2 3 4 will begin blinking. The keypad becomes numeric.

2. Press the 5 key and SP becomes solid. If SP 5 is already vectored to a thermocouple gauge, that annunciator will begin blinking.

3. Press the AUX GAUGE/0 key to select auxiliary gauges. Annunciators G1, G2, G3, and G4 begin blinking.

4. Press 2 to select auxiliary gauge 2. The G2 annunciator becomes solid.

5. Press the ENTER key to transmit the desired selection to the Monitorr. G2 is now vectored to the ion gauge. The lower limit pressure is now displayed in the form *x.x e-x* with the units digit blinking.

6. Press the AUX GAUGE/1 key and the display reads *1.x e-x*. The tenths digit begins blinking.

7. Press the DISP UNITS/0 key and the display reads *1.0 e-x*. The exponent begins blinking.

8. Press 2 and the display reads *1.0 e-2*. The units digit begins blinking.

9. Press the ENTER key to input the lower limit. SP 5 will turn on the ionization gauge whenever the pressure in the load lock falls below 2.0 x 10^{-2} Torr. The upper limit now appears with its units digit blinking.

10. Press the CMD/3 key and the display reads *3.x e-x*. The tenths digit begins blinking.

11. Press the DISP UNITS/0 key and the display reads *3.0 e-x*. The exponent begins blinking.

12. Press 2 and the display reads *3.0 e-2*. The units digit begins blinking.

13. Press the ENTER key to input the upper limit. SP 5 will turn OFF the ion gauge whenever the pressure in the load lock rises above 3.0 x 10^{-2} Torr.

14. To disable the auto cross feature, enter all zeros for the upper and lower trip points of setpoint #5.

For conver ience, Table 2-1, showing the pin locations for the setpoint relays, is reprinted below.

TABLE 2-1. SETPOINT PIN CONNECTORS.

PIN	RELAY NO.	CONTACT
1	4	C
2	4	NC
3	4	NO
4	3	NC
5	3	C
6	3	NO
7	2	NC
8	2	C
9	2	NO
10	1	NC
11	1	C
12	1	NO

C - Common
NC - Normally Closed
NO - Normally Opened

3.3.4 Thermocouple Board

The thermocouple board contains four drivers for Hastings DV-6M or equivalent thermocouple gauges.

3.3.5 Zeroing the Thermocouples

All Monitorr thermocouple circuits must be adjusted when the Monitorr is first installed or when any thermocouples are replaced. All thermocouples which will be used should be connected before the circuits are adjusted. This is done to compensate for manufacturing variations in the thermocouples. These circuits may also need to be adjusted at periodic intervals of three to six months to compensate for aging, contamination or corrosion of the thermocouples.

In many cases, however, it is possible to replace the thermocouples without the need for adjustment if slight gain and offset errors can be tolerated. The following adjustment procedure can be used for each of the thermocouples:

1. The adjustment potentiometers (POTS) are located on the top cover of the Monitorr. It may be necessary to remove the screws that hold the Monitor in position and slide it out so that these pots can be accessed. Ensure that the Monitorr is properly supported and that there is no tension on the connection wires when this is done.

TABLE 3-4. THERMOCOUPLE ADJUSTMENTS.

ADJUSTMENT	RESISTOR
Zero adjustment #1	R414
Zero adjustment #2	R415
Zero adjustment #3	R416
Zero adjustment #4	R417
ATM adjustment #1	R430
ATM adjustment #2	R431
ATM adjustment #3	R432
ATM adjustment #4	R433

2. Vent the thermocouple(s) to atmospheric pressure using room temperature dry nitrogen.

3. The thermocouples are always ON in the Monitorr. Allow a one minute warm-up time after the unit has been turned ON before adjusting the potentiometers.

4. For each thermocouple to be adjusted:

   Set the Monitorr in the appropriate display mode so that the thermocouple-couple's pressure is displayed.

   Turn the appropriate atmospheric ATM adjustment pot (see Table 3-4) counterclockwise until a numeric reading is obtained.

   Slowly turn the atmospheric adjust pot (see Table 3-4) clockwise until the display shows '+ + + +'. Then turn it clockwise an additional 1/4 turn.

   Pump the thermocouple to 5 x 10^{-4} Torr or less.

   Turn the appropriate zero adjust pot clockwise until the reading is $1.0e^{-3}$ or greater. Then turn it counterclockwise until the display shows $0.0E^{-0}$. Turn it an additional 1/4 turn counterclockwise.

5. Repeat step 4 if either pot was out of adjustment by more than one turn.

6. Repeat this procedure for each thermocouple installed on the Monitorr.

7. If the Monitorr was taken out of its rack to make these adjustments, reinstall the unit per Section 2.2.

3.3.6 Reading Pressure With a Thermocouple Gauge

The thermocouple gauges are accessed by using the AUX GAUGE key. Suppose that the chamber thermocouple gauge has been connected to G1.

To read the chamber pressure during rough pumping or any other operation in which the pressure is between 1 x 10^{-3} Torr (1.3 Pa) and 1 Torr (133 Pa.), use the following keys:

AUX GAUGE/1. All keys become numeric. The numeric part of the LCD displays the letters *AUX*.

AUX GAUGE/1. The G 1 annunciator becomes steady. The LCD displays the pressure reading from the chamber thermocouple gauge.

Other parts of the system such as the cryopump or foreline can be connected to any of the three other thermocouple drivers (G1, G2, G3). Suppose it is connected to G3. To read the pressure, use the following key sequence:

AUX GAUGE/1. All keys become numeric. The numeric part of the LCD will display the letters *AUX*.

CMD/3. The G 3 annunciator becomes steady. The LCD displays the pressure reading from the chamber thermocouple gauge.

3.3.7 IEEE-488 Board

The IEEE-488 Computer Interface Board is a General Purpose Interface Bus (GPIB) handler for the Monitorr. The interface board provides the capability to link the Monitorr to another computer. This allows the computer to control the Monitorr via an IEEE-488 communication link using IEEE-488 standards. There are three basic command types:

- **Function Commands** (F). Allow the host computer to turn gauge sensors on and off, change gauge tube sensitivity constants, display units, and emission current.

- **Read Variable Commands** (R). Allow the host computer to read the pressure indications of the various sensors and the various status words indicating system status.

- **Change Variable Commands** (C). Allow the host computer to change the parameters associated with gauge tube operation.

The interface board consists of a MC68488 General Purpose Interface Adapter (GPIA), on-board Read Only Memory (ROM) for the interface software, a switch bank for address selection and a parallel poll selection, and other associated circuitry. Communication with the host computer is performed using standard IEEE-488 interfacing commands and, although some interfacing commands are not applicable to the CI, handshaking is performed with them to accommodate the host computer. The switch bank is used to select the address the device will occupy on the IEEE-488 bus. The first five switch positions are used to select the address (0-31). The address is selected by determining the binary representation of the address and setting the switches to that address. The unit is factory preset at an address of 1.

The Monitorr interface option allows the host computer to communicate with the Monitorr with simple ASCII command strings. The commands are listed in Table 3-5. Each of the command strings must be terminated in accordance to one of the following formats:

1. Carriage Return (Hex 0D), Line Feed (Hex 0A).

2. Carriage Return, Line Feed and/or an EOI asserted with the Line Feed.

Complete information on the IEEE-488 standard can be found in the IEEE publication "IEEE Standard 488-1978 Digital Interface for Programmable Instrumentation."

TABLE 3-5. FUNCTION, READ, ANI CHANGE COMMANDS.

Function Command	Description
FO1	Filament ON
FO2	Filament OFF
FO3	Degas ON
FO4	Degas OFF
FO5	Keyboard OFF
FO6	Keyboard ON
FO7	FORCED RESET*
FO8	CLEAR ERROR
FO9	STORE PARAMETERS

* FORCED RESET - unit performs its power-up initialization routines.

Read Command	Description
RO1	Read Status IbDbEbSP1b2b3b4b. (See Table 3-7.)
RO2	Read Ion Gauge Tube n.n E +/-nn. Ex.(1.4E-09)
RO3	Read Aux Gauge 1 n.n E +/-nn Ex.(2.2E-02)
RO4	Read Aux Gauge 2 n.n E +/-nn Ex.(2.2E-02)
RO5	Read Aux Gauge 3 n.n E +/-nn Ex.(2.2E-02)
RO6	Read Aux Gauge 4 n.n E +/-nn Ex.(2.2E-02)
RO7	Read Emission Current n.n E +/-nn Ex.(1.0E-02)
RO8	Read Emission Setting nn.nn Ex.(10.00). See Note #1.
RO9	Read Sensitivity Setting nn.nn Ex.(10.00)

R10	Read Display Units Un. Ex.(U1). See Note #2.
R11	Read SP1 Gauge Attachment X. Ex.(1). See Note #3.
R12	Read SP1 Lower Setpoint Value X.X E +/-XX Ex.(1.2E-03)
R13	Read SP1 Upper Setpoint Value X.X E +/-XX Ex.(1.0E-02)
R14	Read SP2 Attachment X. See Note #3.
R15	Read SP2 Lower Setpoint Value X.X E +/-XX
R16	Read SP2 Upper Setpoint Value X.X E +/-XX
R17	Read SP3 Attachment X. See Note #3.
R18	Read SP3 Lower Setpoint Value X.X E +/-XX
R19	Read SP3 Upper Setpoint Value X.X E +/-XX
R20	Read SP4 Gauge Attachment X. See Note #3.
R21	Read SP4 Lower Setpoint Value X.X E +/-XX
R22	Read SP4 Upper Setpoint Value X.X E +/-XX
R23	Read SP5 Gauge Attachment X. See Note #3.
R24	Read SP5 Lower Setpoint Value X.X E +/-XX
R25	Read SP5 Upper Setpoint Value X.X E +/-XX
R26	Read Version of Software V_a. Ex.(V_A)
R27	Read Option 1 Type and Version V_na (Thermocouple Option) Ex.(V_1A). See Note #4.
R28	Read Option 2 Type and Version V_na (Setpoint Option) Ex.(V_2A). See Note #4.
R29	Read Option 3 Type and Version V_na (Computer Interface Option) Ex.(V_3A).
R30	Read Option 4 Type and Version V_na. See Note #4. (Future).
R31	Read Option 5 Type and Version V_na. See Note #4. (Future).

b - 1 or blank; ' - on, blank - off
a - alpha characters; A,B,C,.....
n - integer number value; 0,1,2,.....
_ - blank or space

Change Command	Description
C08_nn.nn in milliamps	Change Emission Setting. Ex.(C08 10.00)
C09_nn.nn	Change Sensitivity Setting. Ex.(C09 10.00)
C10_0n	Change Display Units. Ex.(C10 01)
C11_0n	Change SP1 Gauge Attachment. Ex.(C11 05)
C12_n.n E +/-n	Change SP1 Low Setpoint. Ex.(C12 1.2E-4)
C13_n.n E +/-n	Change SP1 High Setpoint. Ex.(C13 1.0E-3)
C14_0n	Change SP2 Gauge Attachment
C15_n.n E +/-n	Change SP2 Low Setpoint
C16_n.n E +/-n	Change SP2 High Setpoint
C17_0n	Change SP3 Gauge Attachment
C18_n.n E +/-n	Change SP3 Low Setpoint
C19_n.n E +/-n	Change SP3 High Setpoint
C20_0n	Change SP4 Gauge Attachment
C21_n.n E +/-n	Change SP4 Low Setpoint
C22_n.n E +/-n	Change SP4 High Setpoint
C23_On	Change SP5 Gauge Attachment
C24_n.n E +/-n	Change SP5 Low Setpoint
C25_n.n E +/-n	Change SP5 High Setpoint

Notes:
1) Emission setting, reading in milliamps.
2) 1 = TORR, 2 = PASCAL, 3 = MBAR
3) 1-4 = Auxiliary Gauge 1-4, 5 = Ion Gauge
4) If option is not installed, the returned value will be an "X".

3.3.8 Command Summary

The Monitorr responds to a set of 58 unique ASCII commands. Most of the functions which can be performed from the keyboard can be accessed through the board with its IEEE-488 interface. Some of the command functions, such as the reset to factory parameters function, are not implemented through the interface option. The complete list of commands is available in Table 3-5.

When sending commands to the Monitorr, the commands should be sent one at a time to the unit. When the unit is finished processing the command, it will assert a Service ReQuest (SRQ) to alert the controller the unit is ready for another command. Refer to Table 3-6 for a list of status bytes which will be returned from the unit when command processing has been completed.

TABLE 3-6. SERIAL POLL STATUS BYTES.

Description	Hex	Decimal
No SRQ asserted	0	0
Buffer Overflow	41	65
Invalid Command	42	66
Invalid Parameter	44	68
Command Complete	48	72
System Self Test OK	50	80
Data Ready for X-mit	60	96

TABLE 3-7. MONITORR 300 STATUS WORDS

Symbol	Status	Description
Ib	Ion Gauge Status	b = 1. Ion Gauge ON b = Blank = OFF
Db	Degas Status	b = 1. Degas ON b = Blank = OFF
Eb	Error Status	b = 1. Error has been generated b = Blank = No occurrence
SP	Setpoint Status	Sp present indicates setpoint option is present in system. If blank, then the option is not connected and the remainder of the word will be blanks.
1b	Setpoint One Status	b = 1. SP1 relay energized b = blank. SP1 relay deenergized
2b	Setpoint Two Status	b = 1. SP2 relay energized b = blank. SP2 relay deenergized
3b	Setpoint Three Status	b = 1. SP3 relay energized b = blank. SP3 relay deenergized
4b	Setpoint Four Status	b = 1. SP4 relay energized b = blank. SP4 relay deenergized

EXAMPLE:

A return of I1D1E_SP112_3_41 indicates that the ion gauge is on and degassing, no errors have been generated, the setpoint option is installed and setpoint relays 1 and 4 are energized while setpoint relays 2 and 3 are deenergized.

3.3.9 Capacitance Manometer Board

The capacitance manometer board contains one driver for an MKS 227A style capacitance manometer gauge or equivalent and three drivers for Hastings DV-6M or equivalent thermocouple gauges.

3.3.10 Zeroing the Capacitance Manometer

The Monitorr capacitance manometer and circuit must be adjusted when the Monitorr is first installed or when the capacitance manometer is replaced or anytime the capacitance manometer is brought up to air. This is done to compensate for manufacturing variations and stretching of the diaphragm.

TABLE 3-8. CAPACITANCE MANOMETER BOARD ADJUSTMENTS.

ADJUSTMENT	RESISTOR
Zero Adjustment #1	R414
Zero Adjustment #2	R415
Zero Adjustment #3	R416
ATM Adjustment #1	R430
ATM Adjustment #2	R431
ATM Adjustment #3	R432
CM Zero	R433

The following adjustment procedure can be used to zero the capacitance manometer circuitry of the Monitorr.

1. The adjustment potentiometers (pots) are located on the top cover of the Monitorr. It may be necessary to remove the screws that hold the Monitorr in position and slide it out so that these pots can be accessed. Ensure that the Monitorr is properly supported and that there is no tension on the connection wires when this is done.

2. Disconnect the capacitance manometer cable from connector CM of J041. Using a jumper wire, connect pin 1 of connector CM of J041 to pin 3 of the same connector. This grounds the input to the capacitance manometer circuitry.

3. Set the Monitorr to display auxiliary gauge #4 so that the pressure is displayed.

4. Slowly turn the CM ZERO adjustment pot counterclockwise until the display just shows 0.0E-0. Turn the pot an additional 1/4 turn counterclockwise.

5. Remove the jumper from J041, reconnect the capacitance manometer, and reinstall the Monitorr in its rack.

6. The remainder of the calibration lies with the capacitance manometer gauge head. Refer to the manufacturing data sheet of the capacitance manometer for calibration procedures.

7. Pump the capacitance manometer down to a pressure below 5×10^{-5} Torr.

8. Slowly turn the CM ZERO adjustment pot until it just reads 0.0E-0 on the Monitorr display. Turn the adjustment pot an additional 1/4 turn in the same direction.

9. The capacitance manometer is now ready for use.

10. To zero the thermocouple gauges on the capacitance manometer board, refer to Section 3.3.11. Note: Only thermocouples 1 through 3 are available on the capacitance manometer board.

3.3.11 Zeroing the Capacitance Manometer Board Thermocouple

All Monitorr thermocouple circuits must be adjusted when the Monitorr is first installed or when any thermocouples are replaced. All thermocouples which will be used should be connected before the circuits are adjusted. This is done to compensate for manufacturing variations in the thermocouples. These circuits may also need to be adjusted at periodic intervals of three to six months to compensate for aging, contamination or corrosion of the thermocouples.

In many cases, however, it is possible to replace the thermocouples without the need for adjustment if slight gain and offset errors can be tolerated. The following adjustment procedure can be used for each of the thermocouples:

1. The adjustment potentiometers (POTS) are located on the top cover of the Monitorr. It may be necessary to remove the screws that hold the Monitorr in position and slide it out so that these pots can be accessed. Ensure that the Monitorr is properly supported and that there is no tension on the connection wires when this is done.

2. Vent the thermocouple(s) to atmospheric pressure using room temperature dry nitrogen.

3. The thermocouples are always ON in the Monitorr. Allow a one minute warm-up time after the unit has been turned ON before adjusting the potentiometers.

4. For each thermocouple to be adjusted:

   Set the Monitorr in the appropriate display mode so that the thermocouple-couple's pressure is displayed.

   Turn the appropriate atmospheric ATM adjustment pot (see Table 3-8) counterclockwise until a numeric reading is obtained.

   Slowly turn the atmospheric adjust pot (see Table 3-8) clockwise until the display shows '+ + + +'. Then turn it clockwise an additional 1/4 turn.

   Pump the thermocouple to 5 x 10^{-4} Torr or less.

   Turn the appropriate zero adjust pot clockwise until the reading is $1.0e^{-3}$ or greater. Then turn it counterclockwise until the display shows $0.0E^{-0}$. Turn it an additional 1/4 turn counterclockwise.

5. Repeat step 4 if either pot was out of adjustment by more than one turn.

6. Repeat this procedure for each thermocouple installed on the Monitorr.

7. If the Monitorr was taken out of its rack to make these adjustments, reinstall the unit per Section 2.2.

3.3.12 Reading Pressure with the Capacitance Manometer

The Monitorr must be set up for the pressure range of the capacitance manometer to be used. Capacitance manometers are usually specified by their upper pressure range limit number; the Monitorr can be used with a 1, 10, 100 or 1000 mm Hg (or Torr) capacitance manometer.

To enter this into the Monitorr, the display must be set to show the ion gauge. Press the AUX GAUGE key and then press 8. A number will appear on the display (1, 10, 100, 1000). Each subsequent pressing of 8 will cross the number to the left, increasing it by a factor of 10. When the desired range number is reflected, press ENTER. The display will then automatically default to the capacitance manometer reading, Aux. Gauge 4.

To read the capacitance manometer without going through the pressure range setup, press the AUX GAUGE key and then press 4.

SECTION IV
THEORY OF OPERATION

4.0 GENERAL INFORMATION

NOTE

In order to fully understand the following discussion, refer to the schematic drawings and block diagram provided as a supplement to this manual.

The Monitorr 300 is a general-purpose ionization gauge controller designed to operate and read any glass encapsulated or wide-range Bayard-Alpert ionization gauge tube. All activities in the Monitorr are monitored and controlled by the Motorola 68008 microprocessor.

Electrically, the Monitorr is made up of the following major blocks: the emission controller, the electrometer, the microprocessor, and the chassis. The emission controller provides a precisely regulated electron current to ionize the gas in the gauge tube. The electrometer measures the current generated by the ions.

The microprocessor computes the pressure from the emission and ion currents according to the following equation:

P = Du*(Ii/(S*Ie))

where **P** is the pressure in the gauge tube (in Torr, Pa, or Mbar); **Du** is the conversion factor that the microprocessor uses to convert the pressure from Torr to the units desired; **Ii** is the ion current (in amps); **S** is the sensitivity of the gauge tube (in $Torr^{-1}$); and **Ie** is the emission current (in amps).

The microprocessor also performs the following tasks:

- monitors the power consumed by the filament
- selects the gain of the electrometer amplifier
- saves the current emission, sensitivity, display units, and setpoints in the non-volatile memory
- routes the current pressure reading to the pseudolog output
- interprets commands from the keypad
- starts and stops the degas.

The chassis contains a transformer, the AC power wiring, a membrane keypad, and a liquid crystal display (LCD).

4.1 EMISSION CONTROLLER

Refer to block diagram 1004974 and schematic 1004815.

The emission controller circuit produces a precisely regulated current of electrons by controlling the temperature of the filament of the gauge tube. The microprocessor sets the desired emission current by generating an analog reference voltage through the digital-to-analog converter U123. U123 sends this analog reference signal to pulse width modulator U122.

At intervals determined by the timing components C115 and R111, U122 compares this to the voltage generated across the emission shunt resistors R118, or R119, and R120. If the emission shunt voltage is lower than the reference voltage, U122 turns ON Q101.

Current flows through the filament, increasing its temperature, which in turn increases the emission current. As the emission current increases, the emission shunt voltage increases until it exceeds the reference voltage. U122 then shuts Q101 OFF and the filament begins to cool slowly.

Whenever Q101 is turned ON, one section of the programmable timer U160 is counting. If the count exceeds a preset number (corresponding to the filament operating at a pressure greater than 2 x 10^{-2} Torr (2.6 Pa), U160 signals U101 that the pressure is too high. U101 then shuts down the instrument and displays an error message on the LCD.

Power for the filament is supplied from the 22 volt winding of T001. It is rectified by the full-wave bridge BR103. Short circuit protection is provided by resistor R114. When a short occurs, the voltage across R114 increases until the opto-isolator U120 turns ON. This causes the flip-flop U120 to change state. U122 immediately shuts OFF Q101, removing power from the filament.

At the same time, an interrupt is sent to U140. U140 passes the signal on to U101. At this time U101 shuts down the instrument and displays an er or message on the LCD. The flip-flop U121 keeps U122 cut off until U121 receives a reset signal from U140.

To prevent electrons from reaching the surfaces surrounding the ion gauge, the filament is biased to +30V by the Zener diodes CR105 and CR106. This bias will vary from +30 V to +36 V depending on the emission current flowing through the emission shunt resistors R120 and R118 or R119.

Power for the emission current is supplied by the DC-to-DC converter U135. The current flows through the emission shunt resistors R120 and R118 or R119.

The voltage across this resistor is amplified by U130 and fed to the multiplexer U142. At a command from the PIA U140, the multiplexer U142 feeds the emission shunt voltage into the analog to digital converter U141. The digitized emission shunt voltage is then fed to the microprocessor U101 for conversion into emission current units.

4.2 ELECTROMETER

The electrometer measures the ion current produced in the gauge tube by the emission current. It can measure currents from 10 picoamperes to 100 microamperes.

The high impedance amplifier U145 is the first stage to process the ion current signal. Its gain is controlled by resistors R132, R133, and R134 which are switched by relays K104 - K106. These relays are selected by the microprocessor through U140 and U143.

The next stage to process the ion current signal is the amplifier U146. Its gain is controlled by resistors R137 and R138 which are selected by the microprocessor through U140 and U144. U146 feeds the ion current signal to the multiplexer, U142. On command from U144, U142 feeds the signal into the analog to digital converter U141. U141 feeds the digitized value of the ion current to the microprocessor, U101.

4.3 MICROPROCESSOR

The microprocessor circuit is the brain of the Monitorr. The circuit consists of the Motorola 68008 microprocessor, two Read-Only Memory (ROM) IC's, a Random Access Memory (RAM) IC, and a programmable timer.

Timing for the system is generated by the clock chip U103. It supplies 8 MHz to the clock pin of U101 and the divider chain U104 and U105. U105 supplies 125 kHz to the programmable timer U160, 62.5 kHz to the LCD clock, and 1 MHz to the option boards.

Memory for the programs is provided in ROMs U111 and U112. Random access memory is provided in U113. These chips are selectively enabled by three high order bits of the address bus decoded by U110. Memory chips located on the option boards are also selected by U110.

Peripherals (such as the keyboard, option boards, etc.) are enabled by the four high order bits of the address bus decoded through U109. U109 is synchronized with the microprocessor by the flip-flops in U108. The analog to digital converter (U141) is accessed through the custom IC, U107. U107 also generates the external sequencing signals needed by U101.

The system is timed by U160. One of the timers generates a periodic interrupt to U101 through pins 13 and 16 of U107. Another timer on U160 is used as a "watchdog" for U101 in case an error prevents the microprocessor from completing its tasks. If this timer is not reset by U101 before its period expires, pin 3 of U160 is set low. This triggers the one shot, U115 through a gate on U102. U115 then pulls the HALT and RESET lines on U101 low, which returns the microprocessor to its initial power-on state.

4.4 CHASSIS

All of the electronics to operate the ionization gauge are contained on a single printed circuit board. The Liquid Crystal Display is mounted on a separate board which is attached to the front panel.

The AC power is brought in through a line filter (which also contains the voltage selection switch), then passed through the top cover interlock S001. It then goes on the POWER pushbutton switch (S002) located on the front panel. When this switch is open, no power is applied to the electronics.

From S002 the power goes to the primary of transformer T1. The secondary of T1 supplies all the AC voltages needed by the electronics. The +/-12 V supplies are derived from the 30 V winding by bridge BR 102. Regulator VR102 supplies the +12 V while regulator VR103 supplies the -12 V. These voltages power the operational amplifiers and other analog circuits. In addition, the +12 V is used to supply the +180 V for emission current through the DC-to-DC converter U135.

The +5 V is derived from the 10 V winding by bridge BR101 and regulator VR101. This supply powers all the digital electronics and the LCD. Degas power is supplied by the 7.5 V winding through relay K101. Since this power is applied to the grid, this winding floats at +180 V during degas. Filament power is supplied by the 22 V winding through bridge BR103.

4.5 SETPOINT BOARD

The setpoint board is made up of three basic blocks, a ROM, a PIA, and a set of relays. The ROM U501 stores the information that the microprocessor needs to identify to operate the option. The ROM is connected directly to the Monitorr bus.

U503, the PIA, translates the data sent from the microprocessor into control signals for the relays.

Four control signals are sent from U503 to the relay driver U502. Each of the four drivers in U502 operates one relay. When the relays are de-energized, the common contact (C) is connected to the normally closed (NC) contact.

When a relay is energized, the common contact is connected to the normally open (NO) contact.

Each setpoint is assigned permanently to one relay. SP 1 is assigned to K501; SP 2, to K502; SP 3, to K503; and SP 4, to K504. SP 5, however, is a "virtual" setpoint assigned to the filament power supply through U123. It does not have a relay on the setpoint board. Its job is to turn the ion gauge filament on and off depending on the pressure sensed by the assigned thermocouple gauge.

4.6 THERMOCOUPLE BOARD

The thermocouple board has the following blocks: a Read-Only Memory (ROM), a Programmable Interface Adapter (PIA), a heater power supply, and a thermocouple amplifier.

The ROM stores the information that the microprocessor needs to identify and operate the board. The PIA U401 converts the data sent to it by the microprocessor into multiplexer channel selection signals.

The heaters are powered by 3906 Hz alternating current. This is derived from the 1 MHz clock signal by U406. It is amplified by U404, U405, Q401, and Q402. The diode bridge assembly CR401 - CR405 controls the feedback to amplifier U405 so that the AC voltage at TP 401 remains constant no matter how many thermocouple heaters are running. Pots R414 - R417 adjust the maximum temperature attained by the heater when the pressure is low enough so that the gas does not cool it. This is the low end adjustment. The thermocouple signal from each gauge tube is amplified by the corresponding amplifier U409, U410, U412, or U414. Potentiometers R430 - R433 adjust the high end reading of the gauges by offsetting the thermocouple voltage produced when the gauge tube is at atmospheric pressure with power applied to the heater. Multiplexer U403 selects which gauge signal will go to the amplifier U411. U411 conditions the signal for the analog to digital converter U415. U415 places the digitized thermocouple signal onto the Monitorr bus for the microprocessor to use.

4.7 IEEE-488 INTERFACE BOARD

The IEEE-488 option board has the following blocks: ROM, 488 bus adapter, device address switches, and bus transceivers. Information that the microprocessor needs to identify and operate the interface is stored in the ROM U607. The 68488 bus adapter U601 converts data and commands sent to it on the Monitorr bus into IEEE-488 commands and character strings.

This data is then sent to the bus transceivers U603 - U606 which convert the signals from the 68488 into voltage levels compatible with IEEE-488 standards. S601 and RA602 allow the user to select a unique address for each Monitorr on the IEEE-488 bus. The settings of S601 are transmitted to the 68488 by transceiver U602.

4.8 CAPACITANCE MANOMETER BOARD

The capacitance manometer board is essentially identical to the thermocouple board except that it utilizes a 12-bit analog-to-digital converter (ADC) for the greater accuracy required by the capacitance manometer. There are three thermocouple drivers on the board and three input amplifier stages. The input amplifier stage boots the signal to a 10 volt full scale limit required by the ADC. The capacitance manometer has its own amplifier gain stage with unity gain throughput because the output from the capacitance manometer gauge is already 0-10 volts. An external chassis mounted power module provides +/-15 V DC power to the capacitance manometer gauge. This power module obtains its power from the 7.5 V AC degas power on the mother board (J111).

SECTION V
CALIBRATION AND MAINTENANCE

5.0 GENERAL INFORMATION

The Monitorr 300 and its options require no periodic maintenance. The Monitorr is, however, a complex electronic device and should always be operated within its environmental limits. Contamination, dust, high humidity or heat, as well as shock and vibration must be avoided. If repair is ever needed, it is recommended that the unit be returned to the factory.

The factory maintains a complete line of specially designed test equipment to repair and calibrate the Monitorr 300. Highly trained technicians will test the Monitorr as a system, calibrate it, and return it promptly. Because the technicians are well trained, experienced, and have the right test equipment, the repair can be done more quickly by the factory than by any other method.

DANGER: ELECTRICAL SHOCK HAZARD

VOLTAGES AS HIGH AS 375 VOLTS ARE USED IN THE MONITORR. A SAFETY INTERLOCK SWITCH HAS BEEN PROVIDED TO SHUT OFF ALL POWER TO THE UNIT. DO NOT DEFEAT THIS INTERLOCK.

5.1 TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSES
Display does not come on. Unit is completely dead.	Power not connected to the unit. Incorrect line voltage setting. Fuse blown. Cover removed--check interlock. Main printed circuit board. Power transformer T1.
Display will not respond to the keyboard.	Key pad ribbon cable not connected. Main printed circuit board. Front panel.
Ion gauge tube filament does not come on when FIL ON/OFF key is pushed.	Pressure too high. Shorted filament. Shorted cable. Cable not connected. Power transformer T1.
Filament lights but turns off immediately.	Pressure too high. Shorted filament. Shorted cable. Cable too long or other high resistance in filament circuit.

SYMPTOM	POSSIBLE CAUSES
Filament lights but pressure is not consistent with other indicators.	Wrong display reading units. See Section 3.2. Wrong sensitivity constant. See Section 3.2. Collector lead not connected (glass tubes o Defective or contaminated gauge tube. Defective ion gauge cable.
Filament lights but pressure reading fluctuates continually.	Gaseous tube or vacuum system. Ion gauge cable. Bad filament. Main printed circuit board. Collector lead not connected (glass tubes only). Defective ion gauge cable.
Ion gauge tube will not degas.	Pressure too high. See Section 3.2.4. Bad filament. Too much resistance in gauge tube cable. Main P.C. board.
Thermocouple gauge reads + + + +.	Cable not connected to gauge. Broken key on gauge tube. Thermocouple option board. Main P.C. board.
Thermocouple will not read 0 when system pressure is known to be 1×10^{-3} Torr (1.3×10^{-1} Pa).	Low end potentiometer not adjusted. Defective thermocouple gauge tube. Defective cable.
Setpoint relays do not transfer.	Setpoint not programmed. Setpoint vectored to the wrong gauge. Pressure too high. Setpoint board.
LCD indicates that SP relay has transferred, but external circuit does not operate.	Wiring to external circuit incorrect or defective. External circuit not functioning. Setpoint board. Wiring to rear panel connector.

5.2 ELECTROMETER CALIBRATION

The electrometer is calibrated at the factory against a calibrated picoamp source. It should not require adjustment.

5.3 EMISSION CURRENT CALIBRATION

The emission current shunt resistors are selected at the factory to give the proper current value to the microprocessor. This circuit should not require adjustment.

5.4 PRESSURE CALIBRATION

The Monitorr 300 provides the correct operating voltages and currents for Bayard-Alpert type ionization gauge tubes. For the reasons discussed in Appendix A, each gauge tube must be calibrated for particular applications. The user must determine the exact sensitivity constant if an application requires an accuracy of better than 20%. Otherwise, use the manufacturer's sensitivity constant by following the instructions in Section 3.2.8.

APPENDIX A
SENSITIVITY OF ION GAUGE TUBES

A.0 SENSITIVITY

At the low pressures used in vacuum work, the pressure (**P**), volume (**V**) occupied by the gas, the number (**n**) of molecules in that volume, and the absolute temperature (**T**) (in degrees Kelvin) are related by the Ideal Gas Equation:

P = n*R*T / V

(**R** is a constant called the universal gas constant.) An ionization gauge gives a current proportional to the number of molecules present in its electron cloud. This current will be proportional to pressure only if the following parameters stay constant:

- the volume of the electron cloud
- the number of electrons trapped in the cloud
- the number of ions produced by each electron
- the temperature of the gas being measured.

For the moment, assume that these four things are under control. In order to convert the ion current measured by the electrometer into pressure, two things are needed:

- the number of electrons being put into the cloud
- the number of electrons needed to produce an ion.

The number of electrons being put into the cloud can be determined by measuring the emission current. Each milliampere of emission current represents 6×10^{15} electrons going into the cloud each second. Calculating how many electrons it takes to make one ion is much more difficult.

First, the probability that an electron-molecule collision will produce an ion must be known. Accurate measurements of this probability have been made for all gases. However, it is different for each gas. To get an accurate conversion factor, the percentage of each type of gas that is present in the vacuum system must be determined. (For example: air is 20% oxygen, 76% nitrogen, 2% carbon dioxide, 1% argon and 1% other gases.)

Secondly, determine how far the electrons travel before they are collected on the grid. Mapping the electron paths in practical gauge tubes is a prohibitively large task, especially since this conversion factor can be found by simply putting the gauge into a vacuum of known pressure, temperature, and gas composition.

In the vacuum literature this conversion factor is called the sensitivity (**S**). Because it is virtually impossible to calculate the sensitivity, ion gauges are not considered absolute pressure gauges. In order to make accurate pressure measurements, the sensitivity (**S**) must be measured.

When a gauge tube is calibrated, the pressure is set to a known value and the ion current (**Ii**) and the emission current (**Ie**) are measured. Since the ion current changes with emission current, it is the ratio of ion current to emission current that is proportional to pressure. Thus an ion gauge controller will compute the pressure (**P**) according to the equation:

P = Ii /(Ie*S)

The sensitivity is computed by rearranging this equation as follows:

S = Ii / (Ie*P)

If access to an absolute pressure gauge (such as a spinning rotor gauge) is available, the sensitivity can easily be determined using the Monitorr, since the Monitorr can display the emission current.

A.1 MEASURING ION GAUGE TUBE SENSITIVITY

In order to determine the sensitivity constant, put the tube into a system whose pressure, temperature and gas composition are accurately known.

There are two ways to accomplish this:

- install a transfer standard such as a spinning rotor gauge or calibrated ion gauge tube into the system

- send the tube (carefully packed in its original shipping container) to a vacuum standards laboratory.

To measure the sensitivity of the ion gauge tube, perform the following procedure.

1. Install the transfer standard and a supply of pure gas onto the system.

2. Set the sensitivity constant to 10.00 (**Sc = 10**) (Section 3.2.9). This simplifies calculations at the end of the measurement.

3. Adjust the system pressure to the first calibration point using the calibration standard.

4. Record the pressure reading on the Monitorr (**Pmonitorr**).

5. Record the emission current (**Ie**).

6. Calculate the ion current from the pressure INDICATED BY THE MONITORR according to the following equation:

   Ii = Pmonitorr * Sc * Ie

   Ii is the ion current.

   Pmonitorr is the pressure indicated by the Monitorr.

   Sc is the sensitivity constant that was programmed in; namely 10.00.

   Ie is the emission current.

7. Now use the pressure indicated by the transfer standard to compute the sensitivity according to the following equation:

   Sgas = Ii / (Pcal * Ie)

   Sgas is the sensitivity constant for the calibration gas at the calibration pressure.

   Pcal is the pressure indicated by the transfer standard.

A.2 GAUGE FACTORS FOR VARIOUS GASES

As mentioned earlier, the ionization probability is different for each gas present in the chamber. The number of electrons needed to produce an ion is also different.

This means that the sensitivity of the gauge tube will be different for each gas. To simplify this situation, the American Vacuum Society has agreed to use nitrogen as a standard and express sensitivities for other gases as the ratio between nitrogen and the gas in question. Table A-1 lists these relative sensitivities or gauge factors for some common gases. These factors are intended to give approximate corrections in situations where calibration against a standard is not warranted. For maximum accuracy, the gauge tube must be calibrated.

TABLE A-1. COMMON GAS SENSITIVITIES.

GAS	GAUGE FACTOR
Nitrogen	1.0
Oxygen	0.9
Hydrogen	0.5
Helium	0.1
Neon	0.2
Argon	1.2
Xenon	2.7
Carbon Dioxide	1.4
Carbon Monoxide	1.1
Water	0.9

To compute the sensitivity constant for the Monitorr 300 for a gas other than nitrogen, multiply the sensitivity for nitrogen by the gauge factor.

EXAMPLE
Suppose the system is backfilling with argon for sputtering. The Monitorr is to read directly in Torr of argon. If using a Perkin-Elmer gauge tube, the sensitivity for nitrogen is approximately 10 $Torr^{-1}$. The sensitivity constant desired to program into the Monitorr is:

Sc = 10*1.2 = 12 $Torr^{-1}$

A.3 HIGH ACCURACY PRESSURE MEASUREMENTS

If the application requires an accuracy of greater than 20%, more care must be taken in selecting the gauge location, handling the gauge during calibration and installation, and finding out the exact gas composition in the system.

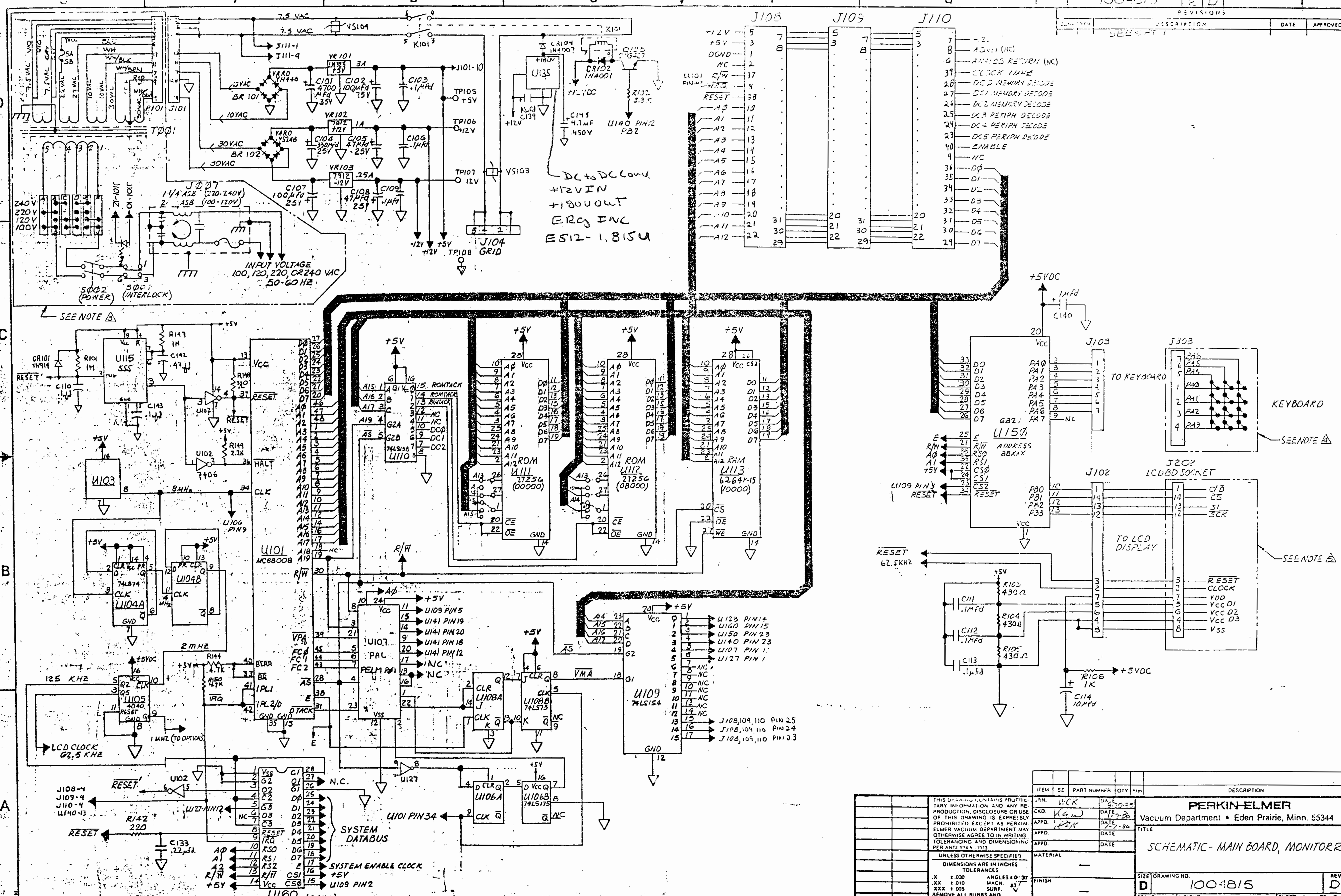
The Monitorr is easily able to achieve an accuracy of 4% in the emission and ion current measurements. However, the gauge tube is sensitive to many influences other than gas pressure. For further information regarding vacuum technology, consult the references listed in Section A.4.

A.4 REFERENCES

Armand Berman. Total Pressure Measurements in Vacuum Technology, Academic Press, Inc., 1985 (ISBN: 0-12-092440-4).

John F. O'Hanlon. A User's Guide to Vacuum Technology, Wiley-Interscience, 1980 (ISBN: 0-471-01624-1).

Alexander Roth. Vacuum Technology, North Holland Publishing Co., 1976 (ISBN: 0-07204-0213-8).



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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES

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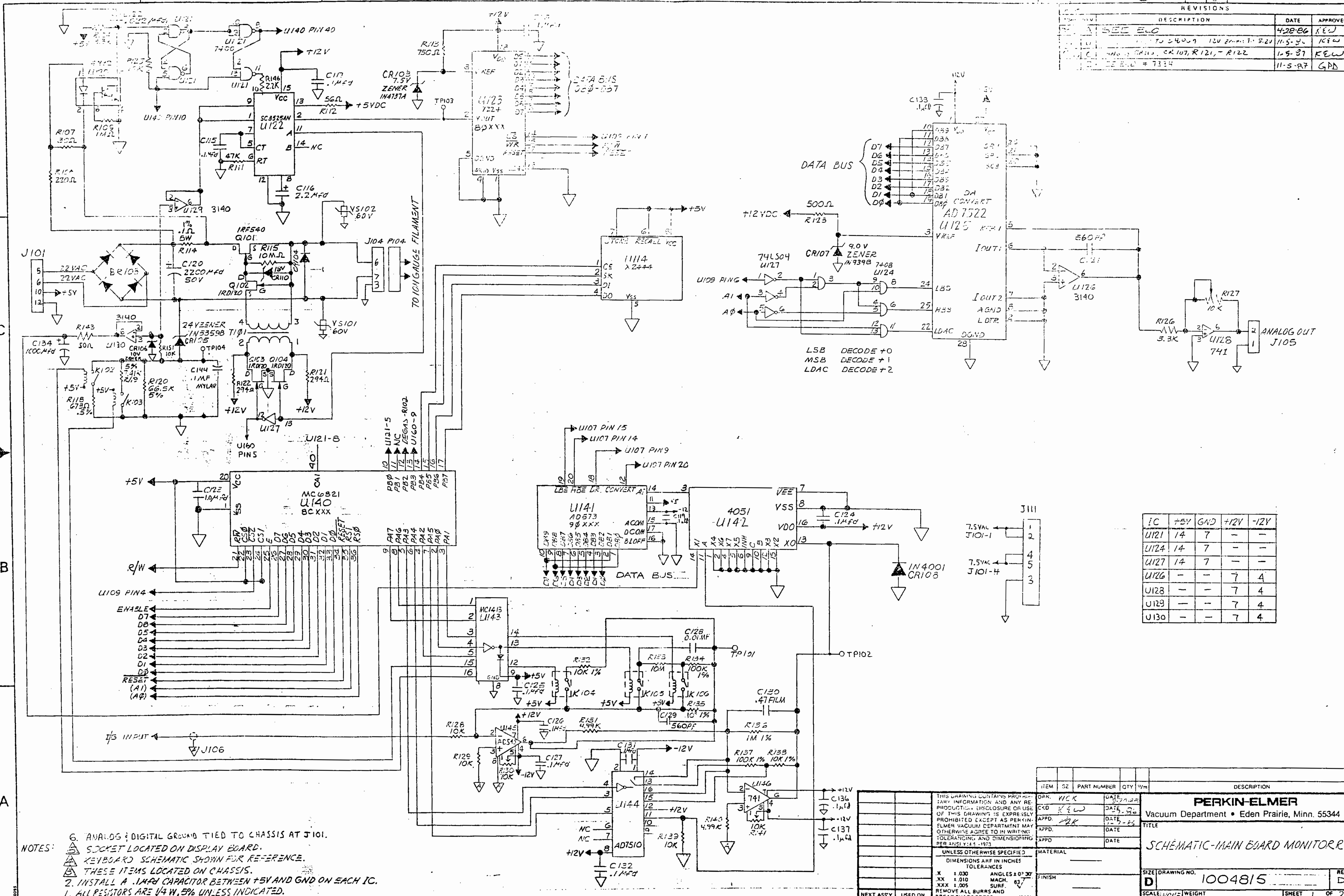
TITLE: SCHEMATIC - MAIN BOARD, MONITOR

SIZE D | DRAWING NO. 1004815 | REV. D

SHEET 2 OF 2



IC	+5V	GND	+12V	-12V
U121	14	7	—	—
U124	14	7	—	—
U127	14	7	—	—
U126	—	—	7	4
U128	—	—	7	4
U129	—	—	7	4
U130	—	—	7	4

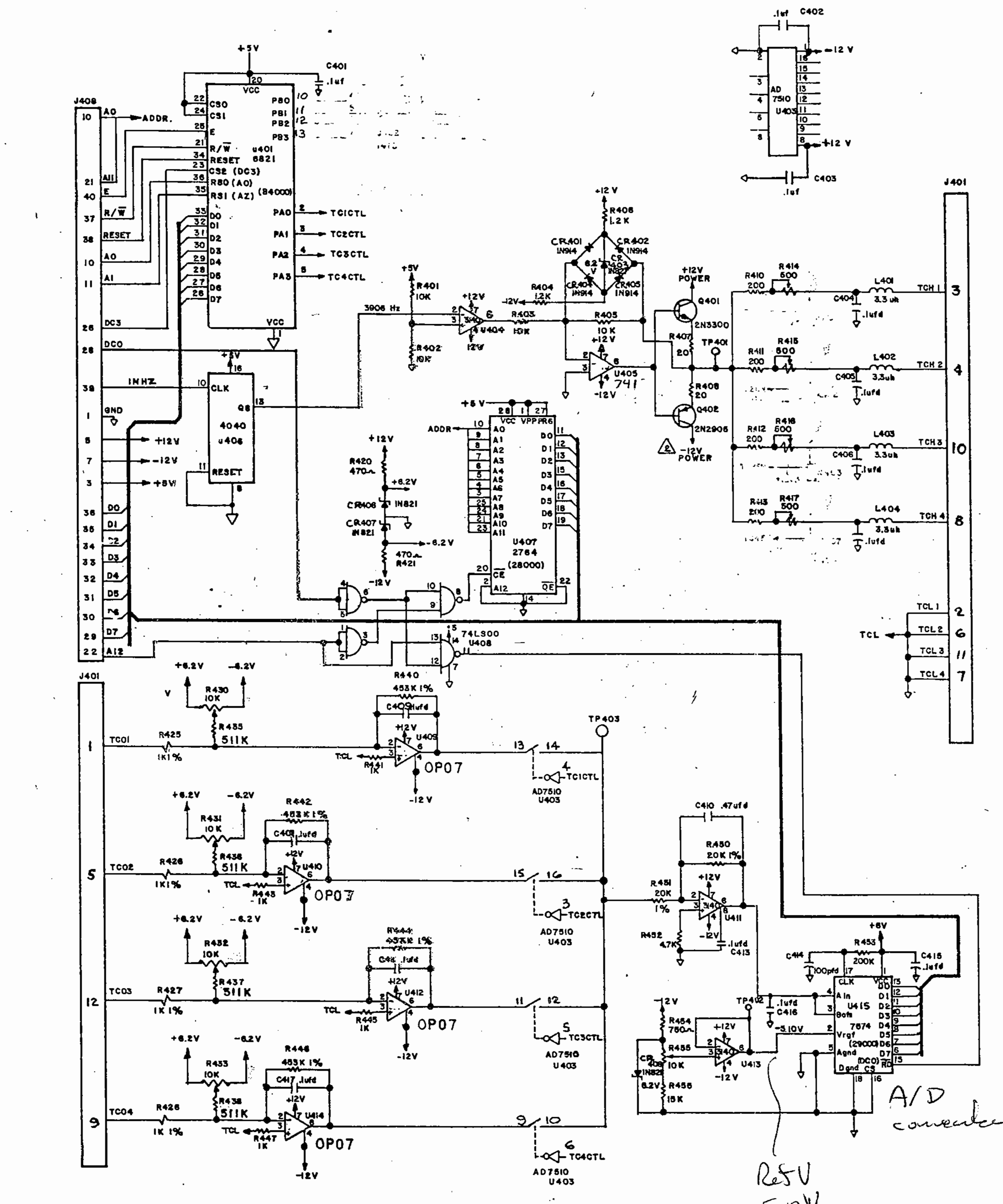
NOTES:
6. ANALOG & DIGITAL GROUND TIED TO CHASSIS AT J101.
5. SOCKET LOCATED ON DISPLAY BOARD.
4. KEYBOARD SCHEMATIC SHOWN FOR REFERENCE.
3. THESE ITEMS LOCATED ON CHASSIS.
2. INSTALL A .1MFd CAPACITOR BETWEEN +5V AND GND ON EACH IC.
1. ALL RESISTORS ARE 1/4 W, 5% UNLESS INDICATED.

PERKIN-ELMER
Vacuum Department • Eden Prairie, Minn. 55344

TITLE: SCHEMATIC-MAIN BOARD MONITOR

SIZE D | DRAWING NO. 1004815 | REV. D | SHEET 1 OF 2

REVISIONS				
ECO NO.	REV.	DESCRIPTION	DATE	APPROVED
861089	A	REMOVED U402, K401-404	8/12/86	KGW
7269	B	SEE ECO	9-17-87	GPD
	C	SEE ECO #7918	5-3-88	GPD
9381	D	INACTIVE - FOR SERVICE USE ONLY - SUPERSEDED BY NONE PER ECO 9381	12/11/89	KGT



2. INSTALL A .1 ufd CAPACITOR BETWEEN +5V AND GND ON EACH IC.

1. ALL RESISTORS ARE 1/4 W, 5% UNLESS INDICATED

ITEM	SZ	PART NUMBER	QTY	U/M	DESCRIPTION

TOLERANCING AND DIMENSIONING PER ANSI Y14.5 - 1982

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES .X ± ANGLES ± 0° 30' .XX ± MACH. 63 .XXX ± SURF.
REMOVE ALL BURRS AND BREAK SHARP EDGES .02 MAX

DRN. CDVB	DATE 12-27-85	
CKD. KGW	DATE 1-2-86	
APPD. R2K	DATE 1-27-86	
APPD.	DATE	
APPD.	DATE	
MATERIAL		
FINISH		

PERKIN-ELMER
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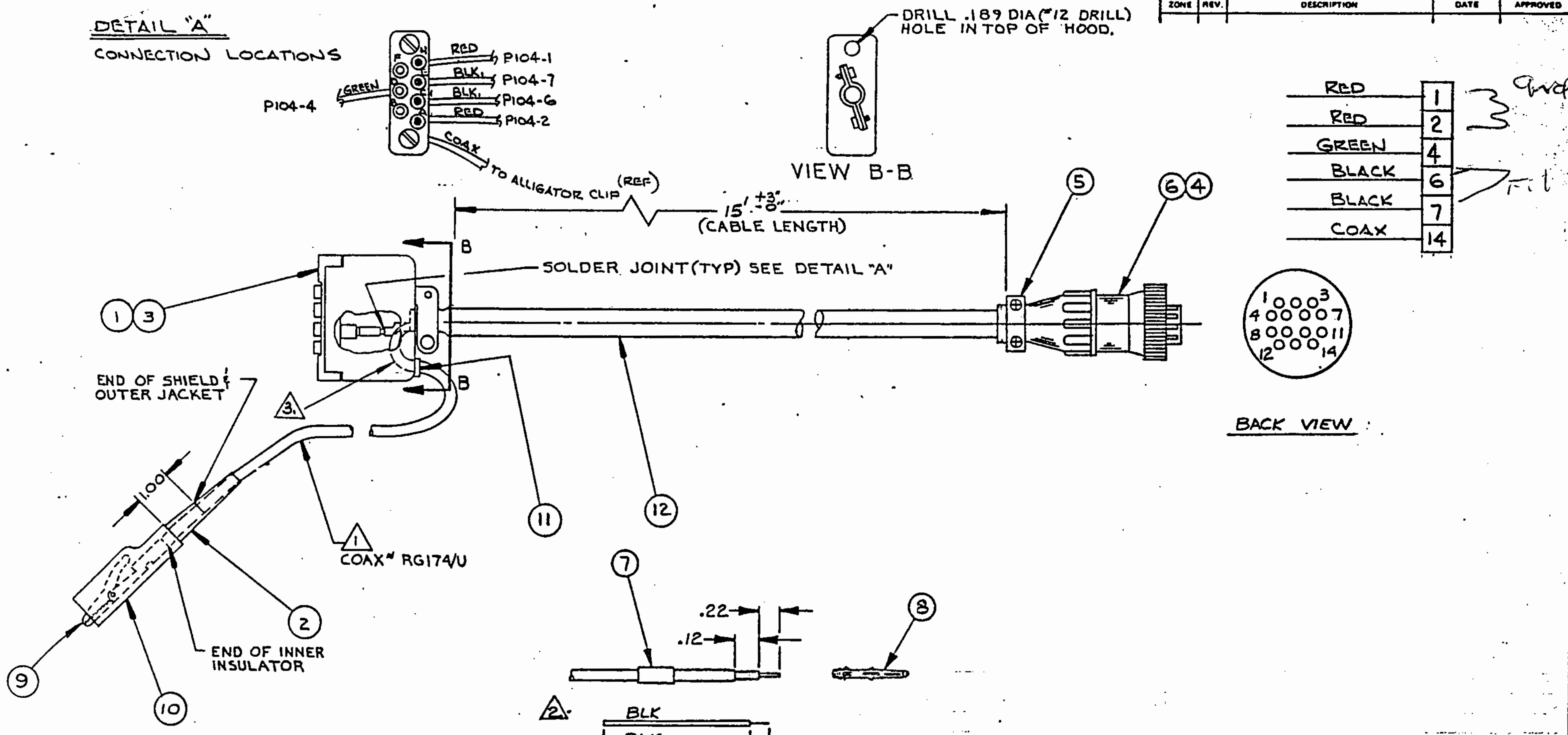
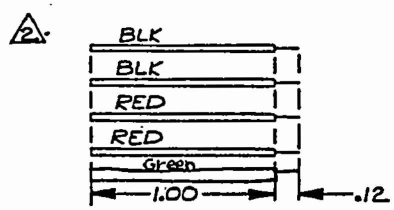
TITLE SCHEMATIC THERMOCOUPLE (MONITORR)

SIZE C | DRAWING NO. 1004812 | REV. D
SCALE | WEIGHT | SHEET 1 OF 1

DWG. NO. 1004812 SH. 1 REV. D

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED





NOTES:

1. COAX CABLE 10" LONG FROM HOOD GROMMET
2. SLIDE FERRULE ON CABLE, THEN STRIP CABLE. FLARE BRAID, THEN INSERT CONDUCTOR INTO CONTACT AS FAR AS IT WILL GO. BRAID PASSES OVER AND AROUND THE SUPPORT SLEEVE ON CONTACT. SLIDE FERRULE OVER BRAID UNTIL FERRULE BOTTOMS AGAINST SHOULDER OF CONTACT. USE AMP CRIMPING TOOL 69656-5 MOD. D OR EQUIVALENT
3. COAX CABLE IS THREADED THROUGH WINCHESTER CONNECTION (3) BUT IS NOT ELECTRICALLY CONNECTED.

ITEM	REQ	U/M	PART NUMBER	DESCRIPTION
12	16	FT.	1004856	CABLE 5 #16 AWG 1-RG 174/U COAX
11	1	EA	1001557	GROMMET 5/16 O.D. 1/8 I.D.
10	1	EA	A-1002358	BOOT, ALLIGATOR CLIP
9	1	EA	A-1002357	ALLIGATOR CLIP
8	1	EA	1004660	CONN. - CONTACT PIN COAX
7	1	EA	1004634	CONN. - CRIMP FERRULE, COAX
6	5	EA	1003804	CONN. CONTACT - PIN
5	1	EA	1003803	CONN. - CABLE CLAMP
4	1	EA	1004141	CONN. PLUG AMP MULTIMATE 17-14
3	1	EA	A-1002361	CONNECTOR - PLUG 7 PIN WINCHESTER A-7S
2	1.0	IN.	A-1002265	TUBING - HEAT SHRINK
1	1	EA	A-1002362	HOOD - RECEPTACLE WINCHESTER A7H-28

NEXT ASS'Y.	USED ON

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TOLERANCING AND DIMENSIONING PER ANSI Y14.5 - 1973.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES .X ±.030 .XX ±.010 .XXX ±.005 ANGLES ± 0° 30' MACH. SURF. REMOVE ALL BURRS AND BREAK SHARP EDGES ___ MAX.

DRN. GRB	DATE 1-13-86	
CKD. KEW	DATE 1-16-86	
APPD. RZK	DATE 1-15-86	
APPD.	DATE	
APPD.	DATE	
MATERIAL		
FINISH		

PERKIN-ELMER
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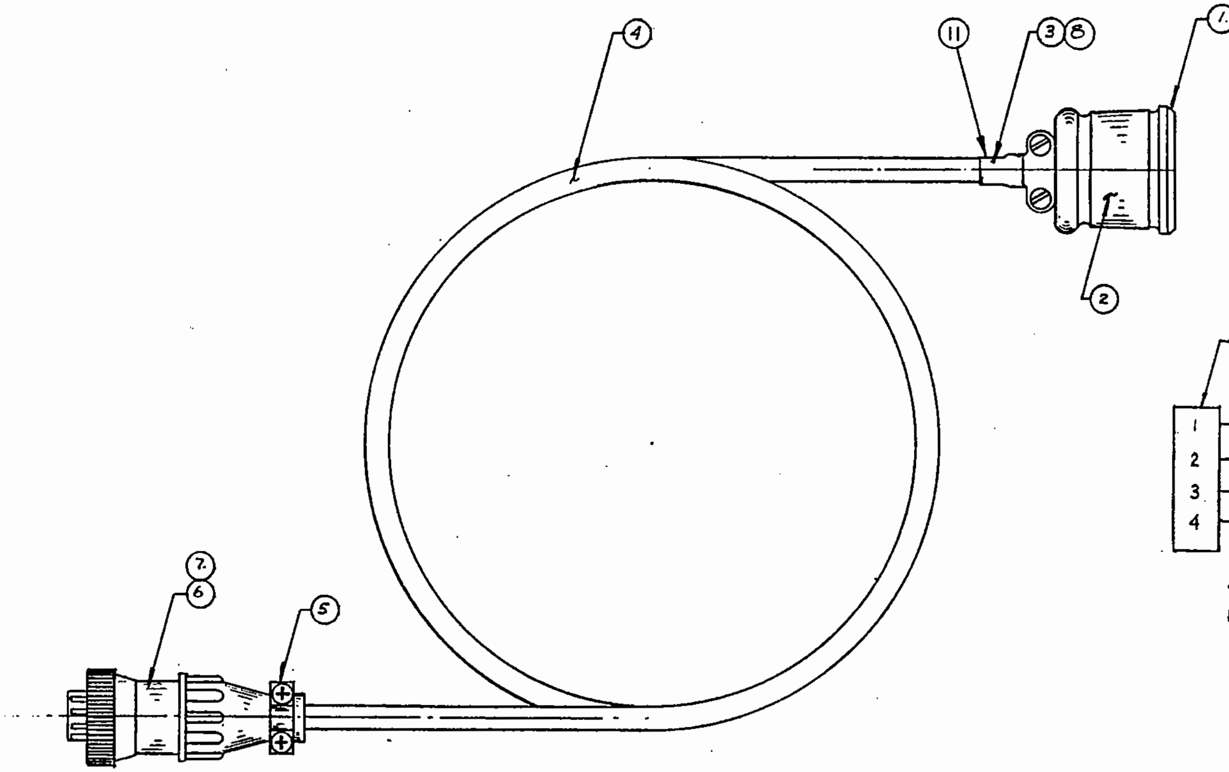
TITLE: CABLE ASSY. NON-BAKEABLE WIDE RANGE GAUGE

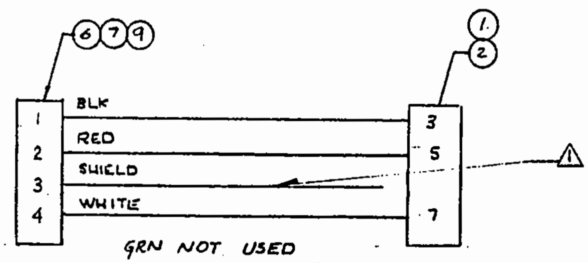
SIZE	DRAWING NO.	REV.
C	6050105	

SCALE	WEIGHT	SHEET
NONE		1 OF 1

DWG. NO. 6050105 SH. 1 REV.

ECO	REV.	DESCRIPTION	DATE	APPROVED
2933	A	ADD NOTE ⚠	7/17/84	KEW
850592	B	ADD HEAT SHRINK	12-11-84	KEW
8530	C	SEE ECO	11-19-86	CMP
9278	D	SEE ECO	9-26-89	





GRN NOT USED
CONNECT SHIELD TO ⑦⑥ ONLY
PLACE HEAT SHRINK OVER SHIELD

MODEL #	OVERALL LENGTH	QTY. ④
804 - 8050	15'-0" ± 3"	15'-0"
804 - 8055	25'-0" ± 3"	25'-0"

⚠ SHIELD SHOULD RUN ENTIRE LENGTH OF CABLE

SEE DETACHED P.L.

ITEM	SZ	PART NUMBER	QTY	U/M	DESCRIPTION
9	A	506704	.1	FT	TUBING - SHRINK 1/8 IN
8	A	1001410	.1	FT	TUBE HEAT SHRINK .250 IA
7	A	1003804	4	EA	PIN-CONN
6	A	1003881	1	EA	PLUG - 11-4 PIN AMP
5	A	1003888	1	EA	CABLE CLAMP
4	A	1001451	SEE TAB	FT	CABLE-SHIELDED
3	A	506708	1.5	IN	HEATSHRINK
2	A	1001452	1	EA	CAPPLUG
1	A	172015	1	EA	SOCKET - OCTAL, 8 PIN

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TOLERANCING AND DIMENSIONING PER ANSI Y14.5 - 1973.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X ± ANGLES ± 0° 30'
.XX ± MACH.
.XXX ± SURF. 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .02 MAX

NEXT ASS'Y | USED ON

DRN	SAMPSON	DATE 12-1-83
CKD.	Ken ...	DATE 12-1-83
APPD.	CMP	DATE 12-2-83
APPD.		DATE
APPD.		DATE
MATERIAL		
FINISH		

PERKIN-ELMER
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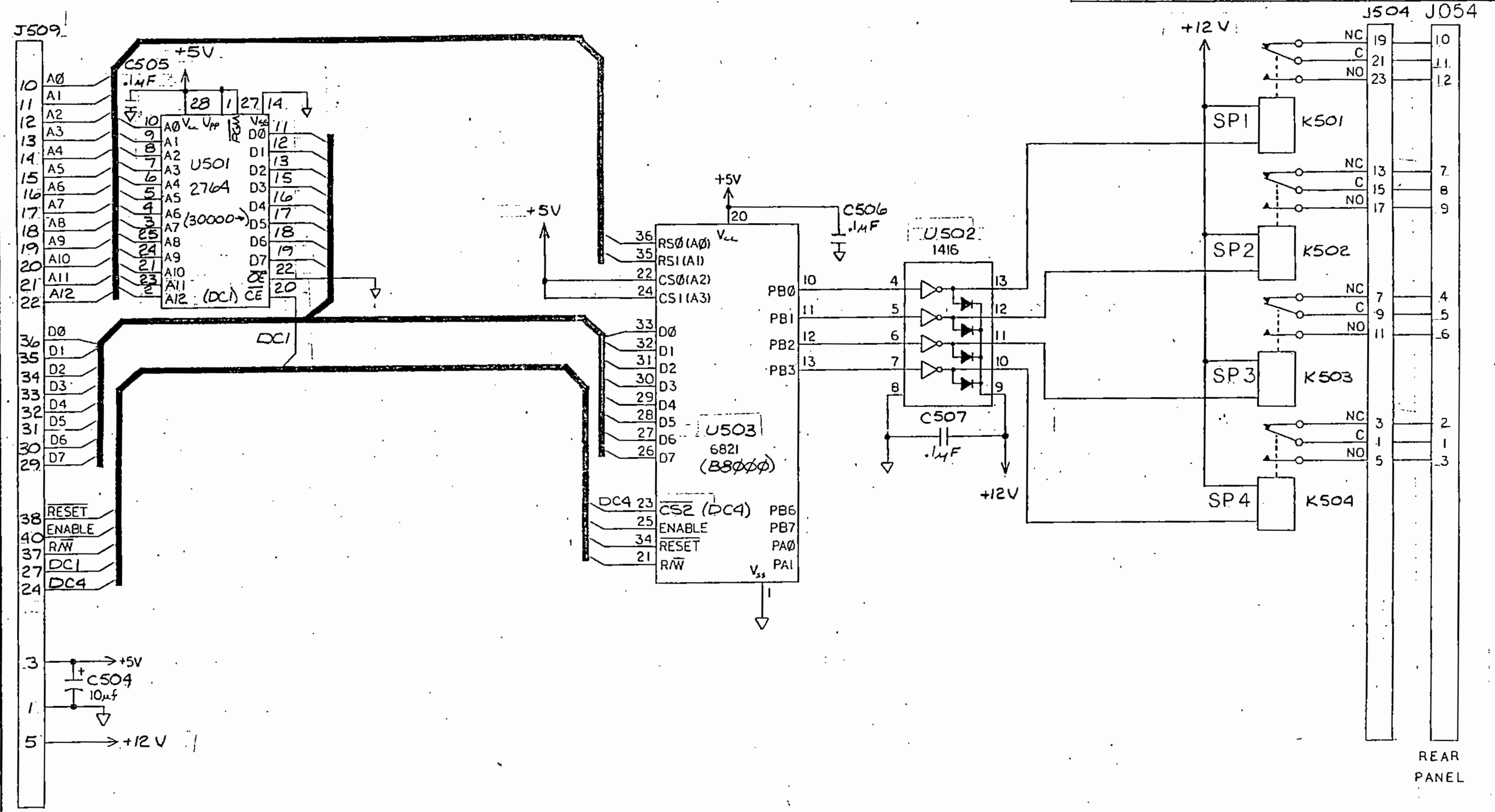
TITLE CABLE ASS'Y - THERMOCPL

SIZE C | DRAWING NO. 804-8050 + 8055 | REV. D
SCALE 1:1 | WEIGHT | SHEET 1 OF 1

DWG. NO. 804-8050+55 | SH. 1 | REV. D

ECO	REV	DESCRIPTION	DATE	APPROVED
070209	A	Added J054	9-16-86	KEW
9381	B	INACTIVE - FOR SERVICE USE ONLY - SUPERSEDED BY NONE PER ECO 9381	12/11/89	KJT



NOTES:
1. ALL RESISTORS ARE 1/4W 5% UNLESS OTHERWISE SPECIFIED.
2. PLACE A .1µf CAP BETWEEN +5V AND GROUND ON EACH IC.

ITEM	SZ	PART NUMBER	QTY	U/M	DESCRIPTION

DRN DJL DATE 12/27/85
CKD DJL DATE 12/30/85
APPD DATE 1/2/86

PERKIN-ELMER
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TITLE SCHEMATIC - SETPOINT, MONITORR

SIZE C DRAWING NO 1004813 REV B
SCALE NONE WEIGHT SHEET 1 OF 1

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TOLERANCING AND DIMENSIONING PER ANSI Y14.5 - 1973

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES
ANGLES ± 0° 30'
MACH SURF 125
REMOVE ALL BURRS AND BREAK SHARP EDGES .02 MAX

MATERIAL
FINISH
NEXT ASS'Y | USED ON