.uum Technology

Vacuum Process Engineering

Measuring and Analytical Technology

LEYBOLD

LEYBOLD INFICON INC.

PART NUMBER 074-117

H S D ENGINEERING INC.
10828 BANCROFT AVE.
OAKLAND, CA 94603

Vacuum Gauges **Manual**

APRIL 1993

Two Technology Place • East Syracuse, NY 13057-9714 • Telephone 315-434-1100 • Telefax 315-437-3803

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No warranty is made by Seller of any Seller product which has been installed, used or operated contrary to Seller's written instruction manual or which has been subjected to misuse, negligence or accident or has been repaired or altered by anyone other than Seller or which has been used in a manner or for a purpose for which the Seller product was not designed nor against any defects due to plans or instructions supplied to Seller by or for Buyer.

Note: These instructions do not provide for every contingency that may arise in connection with the installation, operation or maintenance of this equipment. Should you require further assistance, please contact Leybold Inficon Inc.

INFICON SERVICE DEPARTMENTS

SERVICE DEPARTMENT
Leybold Inficon Inc.
Two Technology Place
East Syracuse, New York 13057-9714
(315) 434-1128
TFX: 315-437-3803

SERVICE DEPARTMENT
Leybold Inficon Inc.
1860 Hartog Drive
San Jose, California 95131
(408) 436-2828
TFX 408-436-2849

Preface

The Vacuum Gauges Manual offers the user special attention via NOTES, CAUTIONS, and WARNINGS found throughout the text. For our purposes they are defined as follows:

NOTE: Pertinent information useful in achieving maximum instrument efficiency when followed.

CAUTION: *Failure to heed these messages could result in damage to your instrument.*

WARNING!!

THE MOST IMPORTANT MESSAGE. FAILURE TO HEED COULD RESULT IN PERSONAL INJURY AND/OR SERIOUS DAMAGE TO YOUR INSTRUMENT.

THIS SYMBOL IS INTENDED TO ALERT THE USER TO THE PRESENCE OF IMPORTANT OPERATING AND MAINTENANCE (SERVICING) INSTRUCTIONS IN THE LITERATURE ACCOMPANYING THE INSTRUMENT.

WARNING!!

POTENTIALLY LETHAL VOLTAGES ARE PRESENT WHEN THE POWER INPUT OR AUX I/O ARE CONNECTED.

REFER ALL MAINTENANCE TO QUALIFIED PERSONNEL.

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Introduction

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1.0 Introduction

This manual provides information pertaining to the installation, operation, and maintenance of the Inficon vacuum gauge product line. The hot cathode ionization (IG3), Pirani (PG3), cold cathode (CC3), capacitance diaphragm (CM3) control units, their options, and associated sensors are covered in this manual.

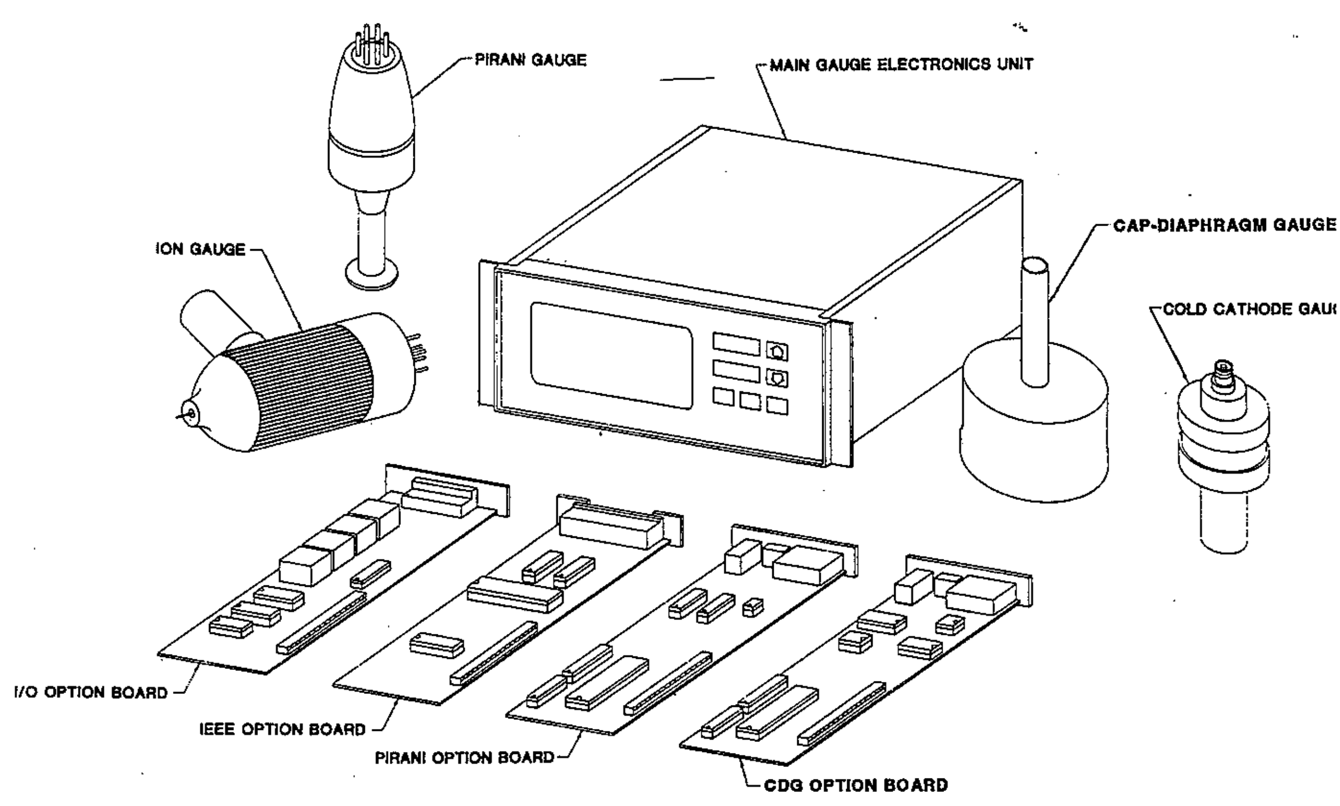


Figure 1.1 - Inficon Gauge System

1.1 General Description

Inficon programmable vacuum gauge controllers consist of four basic control units. These units use the latest in digital and analog technology and provide a versatile, easy means for measuring pressure. With the appropriate system, pressures ranging from 10^{-10} through 10^{+3} torr are accurately monitored. A large selection of sensors and mounting configurations as well as hardware control interfaces are available.

There is one basic controller chassis for each gauge type (hot cathode ionization, Pirani, cold cathode, capacitance diaphragm gauge [CDG]*). The controllers use many of the same assemblies, structures, and software, and differ only in the mother board, power supplies and front panel keyboards. Operation and features of all the gauges are nearly identical. The same user expansion options are available on all units. All controllers provide a choice of display data formats, display units, and parameter lock capability.

1.2 Standard Features

1.2.1 Measurement Expansion

Each basic controller chassis can support two additional measurement modules. These additional modules can be any mix of Pirani or capacitance diaphragm gauge (CDG).

1.2.2 Sensor Interfaces

Each type of gauge measurement has a specific sensor interface module. These modules contain the signal conditioning and measurement circuitry required to operate the sensor properly. They also provide you with a scalable analog output of pressure (either linear or logarithmic), and a set of configuration switches. These switches allow user selection of gas type, recorder format, and automatic turn-on of emission and degas operations where appropriate. (See Section 4.3)

1.2.3 Computer Interface

The computer interface provides a means for electronic communication with the gauge controller. An RS232 serial data link with selectable baud rates is provided. The data format may be selected by the user to conform to the SEMI SECS II protocol or to the INFICON protocol.

1.2.4 Non-Volatile Memory

The instrument contains non-volatile memory which will save all programmable parameters when the instrument power is off.

1.2.5 Display

The display system for all gauges is a multiplexed liquid crystal display (LCD) which can show a maximum of 3-digits of data along with an exponent. The display will also indicate selected measurement units, selected sensor number, gas type, and relay setpoint status. Emission, degas, program lock, and communication activity are also shown. A color bar graph trend indicator gives a visual representation of rate of change in pressure, either increasing or decreasing.

*formerly called capacitance manometers

1.2.6 Keyboard

The keyboard is a tactile feel membrane type unit that provides keys for programming and control. The number of keys has been kept at a minimum for simple operation. There are two operating mode keys (**PROGRAM** & **ZERO**), three system control keys (**SENSOR**, **EMIS** & **DEGAS**), and two data manipulation keys (Increase Arrow △ & Decrease Arrow ▽).

1.2.7 CPU Board Configuration Switches

The central processing unit (CPU) board of each gauge controller provides rear panel configuration switches that provide choices for the display format, measurement units, communications format and baud rates as well as the ability to lock out keyboard parameter changes.

1.3 Optional Features

1.3.1 Hardware I/O Interface

The I/O board allows remote hardware operation of emission and sensor selection functions. Three relays are provided to allow setpoint utilization. A status relay gives the user an indication of proper gauge operation. Input functions may be activated with either contact closure or TTL level signals.

1.3.2 IEEE488 Computer Interface

The IEEE board can be addressed as any of 32 devices and follows the IEEE/ANSI standard connection and protocol systems. It can operate simultaneously with the RS232 interface.

1.4 Operating Modes

1.4.1 Display Mode

Displays readings from the pressure sensor selected by the operator.

1.4.2 Zero Mode

Allows low end calibration of Pirani and capacitance diaphragm gauge (CDG) sensors. See Section 4.8 for details.

1.4.3 Program Mode

Allows the operator to view and modify parameters. See Section 5.0 for details.

1.5 Vacuum Gauge Sensors

Each controller supports a primary sensing technology and optionally Pirani and/or capacitance diaphragm gauges. Combinations of sensors can be used to cover a wide range of absolute pressures or to make measurements in several locations simultaneously. The four types of sensors: Pirani, capacitance diaphragm (CDG), cold cathode and hot cathode. They are described below:

A Pirani sensor measures absolute pressures by determining the heat loss from a fine wire filament. It is based on thermal conductivity and the constant resistance principle and measures pressures quickly and reliably from $1x10^{-4}$ to $1x10^{3}$ torr. They are electronically compensated for room temperature variation. The response of a Pirani is dependent on the type of gas present.

A capacitance diaphragm gauge (CDG) sensor measures absolute pressures by sensing very small deflections of a metal diaphragm. The reference side of the sensor, pumped to high vacuum and permanently sealed off, contains two capacitance electrodes. One electrode is fixed; the other, a thin metal diaphragm, deflects when pressures are applied to it. The change in capacitance that results from this movement is measured and converted to a pressure reading. These sensors provide highly accurate measurements that are independent of the type of gas. Two types of sensors are available, the CDG100 or the CDG120. The CDG100 provides electronic temperature compensation to offset some of the errors resulting from changes in ambient temperature. A heated jacket on the CDG120 makes the sensor less susceptible to ambient temperature changes, increasing its accuracy.

The Inficon cold cathode gauge is a high vacuum sensor; it measures pressures by ionizing the residual gases in a magnetron discharge. The body of the gauge serves as the anode, and is at ground potential. The cathode is a graphite spool that operates at a high voltage. A small permanent magnet traps electrons in the gauge to sustain the discharge at very low pressure. This type of gauge is sensitive to gas type and is often less precise in its reading than hot cathode gauges. It is relatively rugged and has no filament to burn out, so that it is often used in applications where hot cathode gauges are not reliable. The pressure range for these gauges is $1x10^{-7}$ torr to $1x10^{-2}$ torr.

WARNING!!

HAZARDOUS VOLTAGES MAY EXIST.

TURN POWER OFF BEFORE CONNECTING OR DISCONNECTING CABLES.

Hot cathode gauge sensors are ionization gauges that have the Bayard-Alpert geometry; they are sometimes called hot filament or ionization gauges. These gauges measure absolute pressures by ionizing residual gases. The ions are formed through collisions with electrons produced by a hot filament. The ions move toward a collector, and the gauge computes a pressure reading based on the ion current. The response of this type of gauge is dependent on the type of gas.

Both nude and glass-tubulated style sensors are available. Nude sensors are extremely accurate, especially at low pressures, and have replaceable filaments. Glass-tubulated sensors offer more durability.

Two types of filaments are available for both sensors to provide alternatives suited to different vacuum environments, thoria-coated iridium or tungsten. Thoria-coated iridium is resistant to burnout, but susceptible to decomposition when exposed to halogenated compounds such as chlorides or fluorides. Tungsten tends to run hotter, but is not halogen sensitive.

The pressure range for these sensors is $1x10^{-10}$ to $1x10^{-2}$ torr.

Section 2
Initial Checkout

Contents

2.1 Unpacking and Inspection Procedures

WARNING!!

IF GLASS ENCAPSULATED GAUGES WERE SHIPPED WITH YOUR INSTRUMENT, THERE IS A POSSIBILITY OF BREAKAGE DURING TRANSPORT.

VISUALLY CHECK FOR BROKEN GLASS BEFORE INSERTING YOUR HANDS INTO THE SHIPPING CONTAINER.

1. Remove the Vacuum Gauge Controller from its shipping container.
2. Carefully examine the unit for damage that may have occurred during shipping. This is especially important if you notice signs of obvious rough handling on the outside of the cartons. ***Please report any damage to the carrier and to Inficon, immediately.***
3. DO NOT discard any packing materials until you have taken inventory and completed the check procedures.
4. If the instrument must be returned to Leybold Inficon Inc., please contact the service department for a Return Material Authorization (RMA) number. Items will not be accepted without an assigned RMA. They must be packaged, insured and shipped transportation charges prepaid to one of the service departments. (See page ii for addresses.)

2.2 Inventory

Make sure you have received all of the necessary equipment by checking the contents of the shipping containers with the invoice.

2.3 Initial Check Procedures

For the initial check procedure you will need only the control unit and the power cord. *DO NOT* connect any sensors, cables or other devices to the unit for this check.

2.3.1 Correct Operating Voltage

A sticker that indicates the factory preset voltage is located over the power cord socket. Before connecting the power cord, remove the sticker and check the line voltage selector which is part of the power cord socket at the rear of the unit. For 96-126V applications the embossed "110" on the fuse holder should be directly above the power cord socket as shown in Figure 2.1. To change to 192-252V, use a small screwdriver to pry the fuse holder from its position and reinstall it with the embossed "220" in place above the power cord socket.

Make sure that the power switch is OFF and plug the power cord into the unit's socket and into an appropriate grounded outlet.

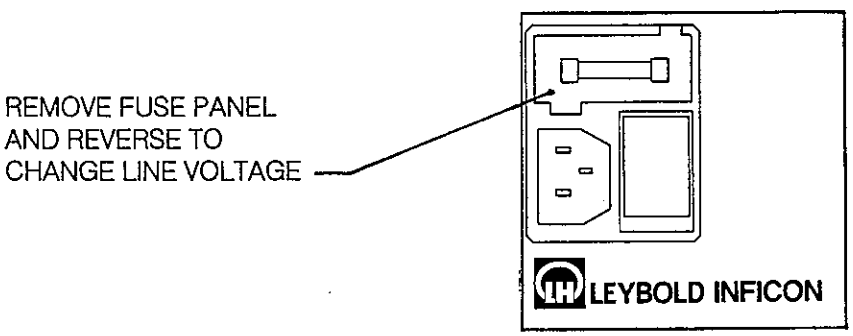


Figure 2.1 - Fuse Holder Details

WARNING!!

VOLTAGES MAY EXIST ON REAR PANEL CONNECTORS. DO NOT TOUCH THE EXPOSED CONNECTORS WHEN POWER IS CONNECTED TO THE INSTRUMENT.

WARNING!!

HAZARDOUS VOLTAGES MAY EXIST ON CC3 HIGH VOLTAGE CABLE. TURN POWER OFF BEFORE CONNECTING OR DISCONNECTING CABLES.

2.3.2 Initial Displays

Turn the power on by pressing the rear panel power switch to ON. To verify proper operation of all LCD segments, press and hold the △ arrow key while turning on the power switch. All segments will be displayed until the △ key is released. (See Figure 2.2) After all segments are displayed, a V followed by a number, indicating what version software is present, will be displayed. (See Figure 2.3)

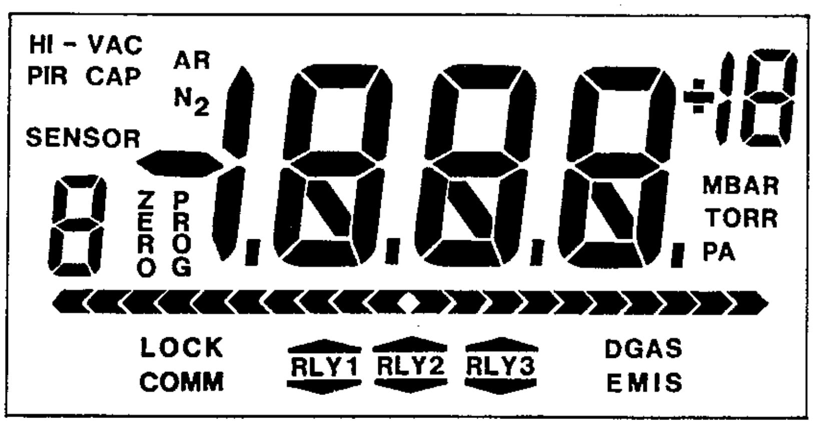


Figure 2.2 - LCD Verification Display

NOTE: This display will only appear if the △ arrow key is held down continuously when power to the unit is turned on. The display will appear as long as the key is held and then will continue on to normal operation.

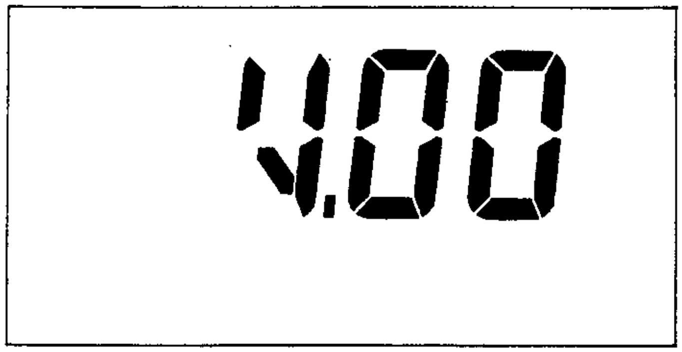
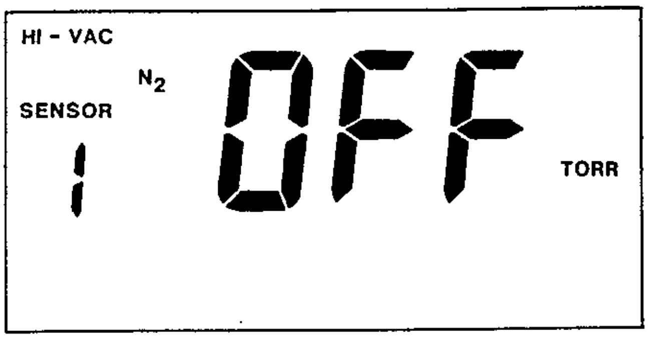
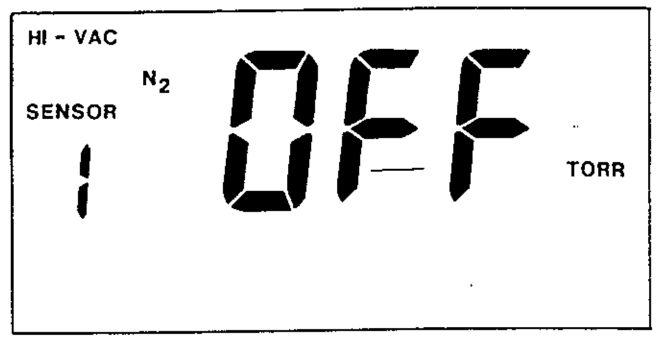


Figure 2.3 - Software Version Display

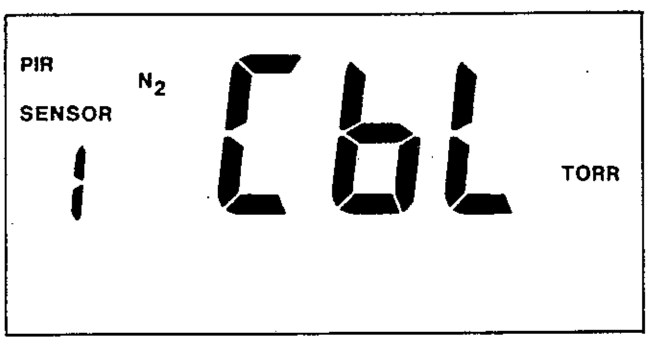
The initial display will then appear. For the Pirani or capacitance diaphragm gauge (CDG), the CBL message will blink. Figure 2.4 shows the correct initial displays for all our controller types. If a display does not appear, check the power outlet and the main fuse on the rear of the unit.



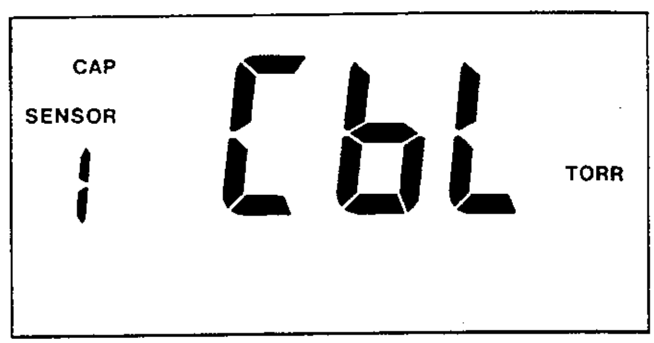
IG3 - HOT CATHODE IONIZATION



CC3 - COLD CATHODE IONIZATION



PG3 - PIRANI



CM3 - CAPACITANCE DIAPHRAGM

Figure 2.4 - Initial Displays

Assuming that the initial display check is successful, the instrument is ready for installation. Otherwise, contact your Inficon Service Department.

Section 3
Installation

Contents

3.1 Option Board Installation

If a controller is ordered with options, they will be factory installed before shipment. If a controller is ordered without options and later you wish to add options, install them as outlined below:

WARNING!!

THIS OPTION MUST ONLY BE INSTALLED BY TECHNICALLY QUALIFIED PERSONNEL.

ACCESS TO ELECTRONIC INSTRUMENTATION CAN EXPOSE POTENTIALLY LETHAL VOLTAGES—ALWAYS REMOVE THE POWER CORD BEFORE OPENING ANY COVERS.

IF THE UNIT IS HARD-WIRED INTO A SYSTEM BE CERTAIN THAT THE SYSTEM POWER IS SAFELY LOCKED OFF BEFORE OPENING THE INSTRUMENT.

1. Remove the two screws holding the upper rear panel support bar to the case side extrusions.
2. Firmly push the spring loaded top cover towards the front of the unit with one hand while lifting the upper rear support bar out with the other hand.
3. Slide the top cover toward the rear and out of the unit.
4. Remove the break-away plastic filler piece from the bottom support bar.
5. The CPU and base unit sensor interface boards reside in fixed locations on opposite sides of the motherboard. All other boards except the I/O board can be installed in any open slot.

NOTE: The I/O board can be placed in any slot other than the one closest to the CPU board due to potential EMI interference.

Viewing from the rear of the unit, the sensor boards are ordered from left to right. Sensor #1 will be closest to the line voltage connector (to the left) and the number will increase to #2 and #3 toward the CPU module (to the right). (See Figure 4.3.) Carefully insert the board into the desired slot. Note that there are PC board alignment openings in the motherboard sockets to insure the correct mating of the board and socket. The metal rear panel of the PC board sets into a groove in the bottom support bar.

6. Snap apart the required number of break-away plastic pieces and reinstall the filler piece in the opening in the rear of unit.

7. Re-install the cover, upper support bar and screws. Care must be taken to align all the small rear panels into the upper support bar.

3.2 Proper Line Voltage

The instruments are shipped from the factory with the line voltage set for 96-126 VAC operation. If 192-252 VAC operation is desired, refer to Section 2.3 for procedure.

3.3 Gauge Controller Installation

The instrument can be mounted in a standard 19" rack, a panel, or used as a free standing unit.

In all installations, allow proper instrument ventilation. Do not restrict top and bottom cover holes by placing anything in direct contact with the covers. Temperatures exceeding 50°C within the unit may result in improper operation. Do not mount the controller above other equipment that operates hot and will ventilate vertically through the controller chassis. Do not use the control unit as a support for other equipment or items.

WARNING!!

THE GAUGE CONTROLLER AND VACUUM SYSTEM SHOULD BE SEPARATELY GROUNDED TO A COMMON GROUND. IT IS NOT SAFE TO PLACE A GROUND WIRE BETWEEN THE VACUUM CHAMBER AND CONTROLLER CHASSIS, AS LARGE CONTINUOUS CURRENTS COULD FLOW THROUGH IT.

BEFORE OPERATING THE GAUGE AND VACUUM SYSTEM AND AFTER ANY MAINTENANCE OR SERVICE PROCEDURE, VERIFY THE INTEGRITY OF THE GROUND OF BOTH UNITS.

FAILURE TO DO SO COULD RESULT IN A FATAL INJURY.

3.3.1 Rack Adapter Kit

The Rack Adapter Kit (IPN 850-050-G1) is required to rack mount one or two controllers in a standard 19" rack. Refer to Figure 3.1 for component configuration.

For one controller, install the small interconnecting adapter to the unit and then the long filler panel to the interconnecting adapter. Use the 4 screws, nuts and washers provided.

For two controllers, install the small interconnecting adapter between the two units as shown in Figure 3.1.

> **NOTE:** Depending on the specific installation, it may be desirable to connect the power and signal cables and feed them through the back of the rack prior to installing the controller(s). See Section 3.4 for details on cable connections.

3.3.2 Panel Mounting Kit

A Panel Mounting Kit (IPN 850-055-G1) is available to assist in mounting the gauge controller into a panel. The kit is not required for panel mounting, but contains flanges for the top and bottom of the gauge controller that will eliminate gaps between it and the panel cut out. (See Figures 3.2 and 3.3)

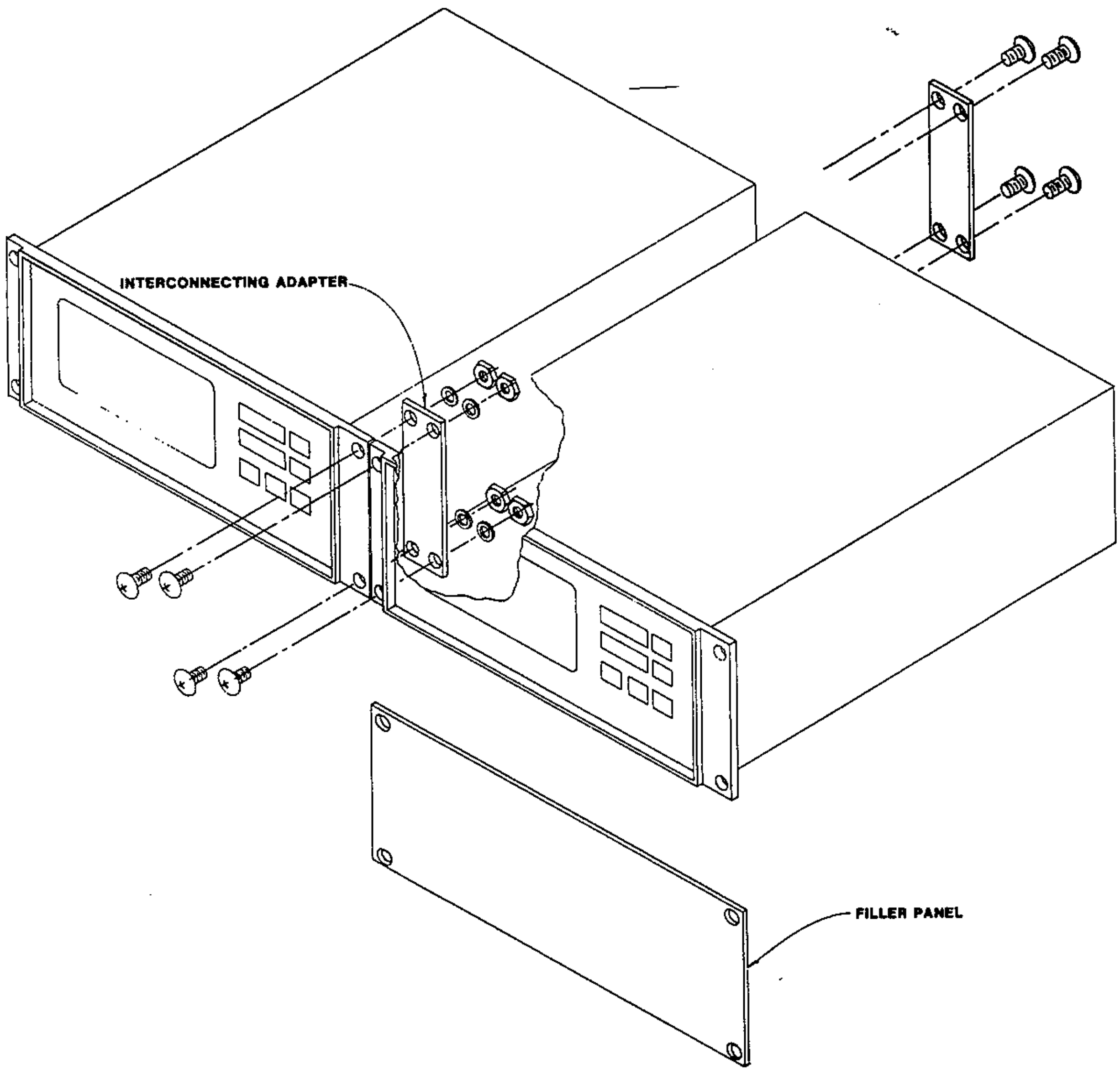


Figure 3.1 - Rack Adapter Details

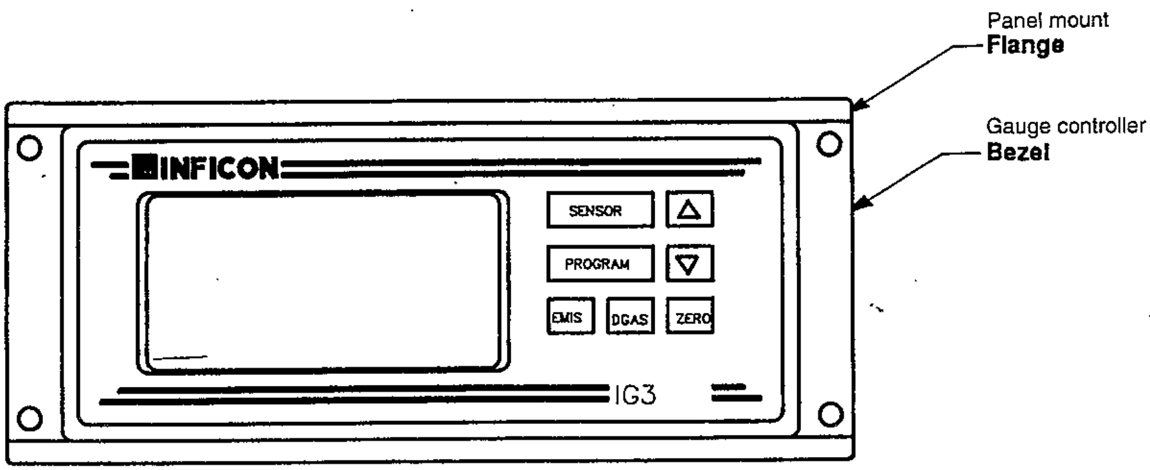


Figure 3.2 - Gauge Controller With Panel Mount Flange

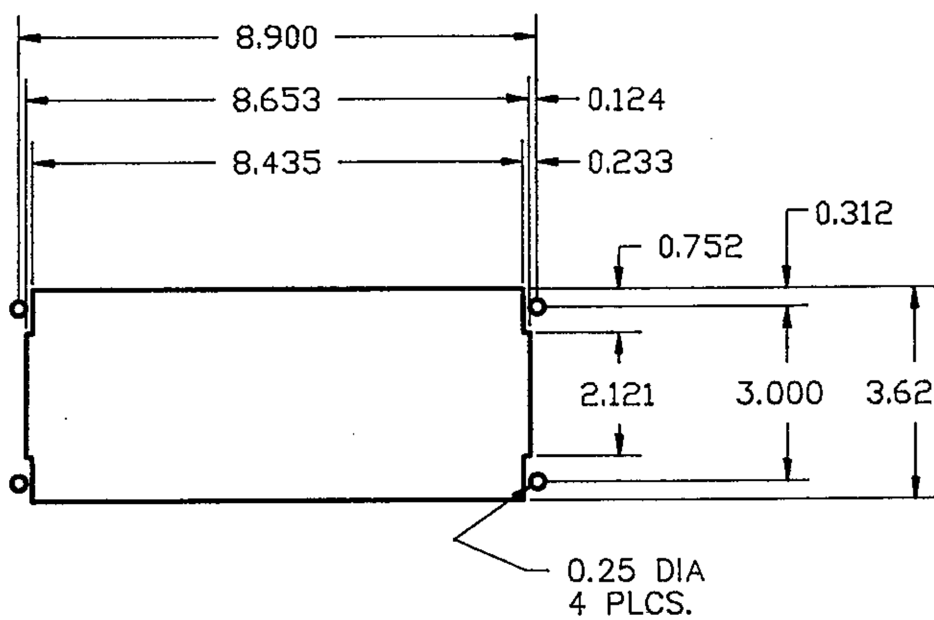


Figure 3.3 - Panel Mount Cut-Out Recommendations

3.4 Gauge Sensor Installation

3.4.1 Warnings

WARNING!!

Implosion and Explosion **- IF HANDLED ROUGHLY, GLASS IONIZATION GAUGES MAY IMPLODE UNDER VACUUM CAUSING FLYING GLASS.**

BE SURE THAT CABLING TO THE GAUGE TUBE HAS PROPER STRAIN RELIEF SO THAT CABLE TENSION CANNOT BREAK THE GLASS.

IF PRESSURIZED ABOVE ATMOSPHERIC PRESSURE, GLASS TUBES MAY EXPLODE, CAUSING DANGEROUS FLYING GLASS. A SUBSTANTIAL SHIELD SHOULD BE PLACED AROUND VACUUM GLASSWARE TO PREVENT INJURY TO PERSONNEL.

WARNING!!

Temperature **- DURING DEGAS OPERATIONS, THE ION GAUGE TUBE BECOMES HOTTER THAN IN NORMAL OPERATION.**

BE SURE THAT HEAT SENSITIVE MATERIALS ARE NOT IN CONTACT WITH THE GAUGE TUBE, AND BE SURE THAT THE GAUGE TUBE IS NOT LOCATED WHERE PERSONNEL MIGHT COME IN CONTACT WITH IT.

WARNING!!

Overpressure **- DO NOT USE QUICK CONNECTS OR OTHER FRICTION TYPE CONNECTION WHERE POSITIVE PRESSURE WILL EXIST WITHIN SENSORS, SUCH AS IN BACKFILLING OPERATIONS.**

See next page for more warnings!

WARNING!!

Contamination **- CARE MUST BE EXERCISED DURING HANDLING AND INSTALLATION TO PREVENT ANY LOOSE DEBRIS OR CONTAMINATION OF ANY TYPE FROM ENTERING THE GAUGE SENSORS.**

AVOID HANDLING THE INSIDE SURFACES OF ANY VACUUM SENSOR.

CAUTION: *ConFlat Flanges - Care must be exercised when installing sensors with rotatable flange fittings as the rotatable fitting can slip and break or damage glass envelope sensors.*

NOTE: Sensor Location - The gauge sensors should be located as close as possible to the section of the system where pressure measurement is important. Valves or other constrictions between the sensor and the area where pressure measurement is required may cause erroneous readings.

WARNING!!

COLD CATHODE SENSORS WILL SOMETIMES OPERATE AROUND ATMOSPHERIC PRESSURE IF THE EMISSION IS TURNED ON, CAUSING THE GAUGE CONTROLLER TO HAVE A FALSE HIGH VACUUM INDICATION ON THE DISPLAY AND OUTPUTS.

THE NORMAL OPERATING RANGE IS 10^{-2} TO 10^{-7} TORR.

WHEN USING A CC3 FOR SYSTEM CONTROL, APPROPRIATE MEASURES SHOULD BE INCORPORATED TO ENSURE THE SYSTEM PROCESS CANNOT BE INITIATED AT ATMOSPHERIC PRESSURE.

3.4.2 Vacuum Connections

Six types of vacuum connection fittings are used in the Inficon gauge system: O-ring compression, ConFlat® flange, KF, NPT, Cajon® 8VCR and Cajon 8VCO fittings. A discussion of each is provided below.

1. O-ring compression fittings

   The tubulation of the glass encapsulated ion gauge sensors is inserted into the fitting, using care to avoid damage to the o-ring inside the fitting. The connection is then hand tightened to create a seal. Do not overtighten the connection.

   If necessary, a very small amount of vacuum grease may be used to obtain a good vacuum seal.

2. ConFlat Flange Fittings

   ConFlat, and similar compatible types made by other manufacturers, are widely used for attaching devices to ports on high vacuum systems. These flanges utilize knife edge surfaces and compression of copper or rubber gaskets to secure a vacuum seal. Be careful not to damage or contaminate the knife edges or gaskets during handling operations. *Do not touch copper gasket with hands.* Copper gaskets should be used for high temperature operation. Tighten all flange bolts evenly and fully in a crisscross pattern. Do not use copper gaskets more than once. If the flange is to be baked, pre-lubricate the bolt threads with an anti-seize compound (FelPro R C 100 or equivalent).

   CAUTION: *Be careful that the anti-seize compound does not get on the gaskets or the vacuum parts of the flange.*

3. KF Flange Connections

   These connections consist of a centering ring and clamp. The centering ring is self-centering and aids in alignment. The clamps should be finger-tightened until both flanges are firmly in contact with the o-ring seal.

   If necessary, a very small amount of vacuum grease may be used to obtain a good vacuum seal.

4. NPT Pipe Thread Connections

   These connections should be sealed using vacuum sealing compound such as Torr-Seal® or Teflon® tape.

   CAUTION: *Do not tighten the sensor by twisting the plastic cover. Damage to internal structures can result!*

®Cajon is a trademark of the Cajon Company
®ConFlat is a trademark of Varian
®TorrSeal is a trademark of Varian
®Teflon is a trademark of DuPont

5. Cajon 8VCR Fittings

   These fittings are used on capacitance diaphragm gauges (CDGs) only. Use a new gasket whenever the gauge is reconnected, unless gasket retainer assemblies are used.

6. Cajon 8VCO Fittings

   These fittings are used on CDGs only. If necessary, a small amount of vacuum grease may be used on the o-ring to obtain a good seal.

3.4.3 Ion GaugeSensor Installation

Mounting

Three types of mounting configurations are available for the glass tubulated gauge sensors: either 3/4" O.D. or 1" O.D. O-ring compression fittings, or a 2 3/4" ConFlat flange. The nude gauges use ConFlat fittings only.

> ***CAUTION:*** *If the ConFlat flanges are the rotatable type, check that the flange bolt ring does not drop on the glass tube during installation and cause breakage.*

The gauge sensor can be mounted in any position. It is important that the gauge have good communication with the vacuum space for accurate pressure readings, especially at lower pressures.

Cable Connections

Nude ion gauges have dual filaments. The active filament is selected through the connector installation method. Two cables are used. The small cable carries the sensor signal and the large cable carries the sensor power. Both cables terminate in a single protective cover at the sensor end. To install the connector on the sensor, slide the protective cover back to expose the individual wires. Install each wire on the appropriate pin of the sensor. One filament wire must be connected to the common filament pin and the other to the remaining pin for the filament to be used. Attach the cover to the flange of the sensor using the two screws provided. The cover is designed to support the cables so that the sensor pins will not be damaged. The other ends of the cables are attached to the respective sockets on the rear of the gauge controller chassis.

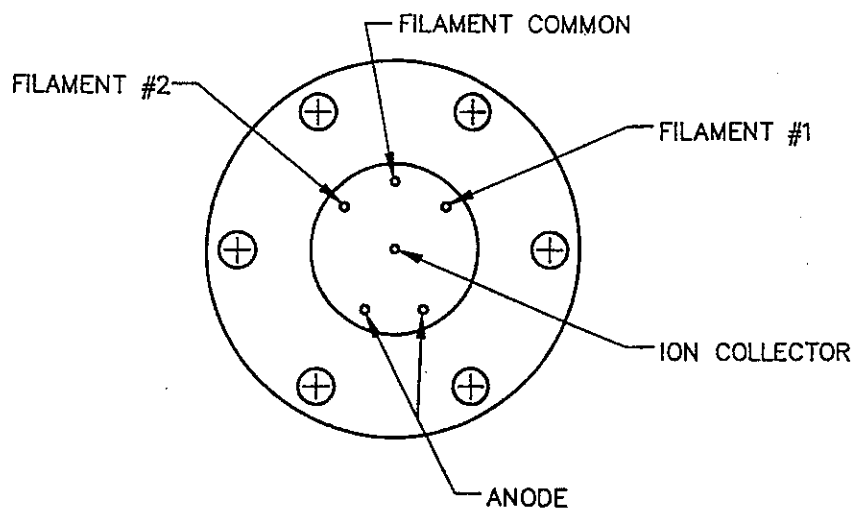


Figure 3.4 Sensor Pin Connections

Tubulated glass ion gauges are single or dual filament and the connector can be installed in either of two positions. Carefully avoid bending the gauge pins during installation. *BENT PINS MAY CAUSE VACUUM SEALS TO LEAK.* Install the signal connector to the signal lead opposite the tube base. Connect the 6 pin and shielded BNC connectors to the respective sockets on the back of the gauge controller.

3.4.4 Cold Cathode Gauge Sensor Installation

Mounting

The cold cathode gauge sensor is available in 1" nominal o-ring compression fittings, KF 25, and 2 3/4" ConFlat flange connections. The gauge sensor can be mounted in any position. The magnet should not be closer than 1 inch to any magnetic material. Additionally, it should be taken into account when mounting the sensor that the field of the gauge magnet may disturb beams of charged particles in the vacuum system.

Cable Connections

Install shielded high voltage BNC connector to gauge sensor and controller chassis sockets.

WARNING!!

HAZARDOUS VOLTAGES MAY EXIST.

TURN POWER OFF BEFORE CONNECTING OR DISCONNECTING CABLES.

3.4.5 Pirani Gauge Sensor Installation

Mounting

To prevent debris from entering the gauge sensor, and to provide the highest accuracy, we recommend that the gauge sensor be installed vertically with inlet pointing down. Do not mount the sensor in areas where gases are allowed to stream directly into the gauge tube since damage to the filament could result.

With regard to accuracy, Pirani sensors are recommended for vertical operation due to the effects of thermal convection (heat rises at higher pressures). Therefore, differences in pressure readings for units mounted horizontally will be seen at pressures above 20 torr. When mounted in a vertical position, the filament heats a column of gas evenly in all directions forming a cylindrical envelope around the filament. When the sensor is in a horizontal position, the convection losses change due to the lack of a cylindrical envelope and a different pressure reading is obtained.

Pirani sensors can be operated horizontally if the 0% and 100% adjustments are done horizontally. Readings above 20 torr will be less accurate than in the vertical position.

It is also necessary to install the sensor in an area where there is very little vibration to ensure the highest degree of accuracy and stability.

> ***CAUTION:*** *Do not tighten the sensor by twisting the plastic cover. Damage to internal structures can result!*

The Pirani gauge sensor model TR901 is available in a KF 10 flange fitting or 1/8" NPT. The TR905 bakeable model is available in a CF16 mini-ConFlat flange.

Zero and 100% adjustments should be checked upon installing the gauge.

> ***CAUTION:*** *Use TR901 and TR905 Pirani sensors only (IPN#89630, 89631 and 89632). The use of TR201, TR205 or TR206 sensors will cause damage to the instruments. TR201, TR205 and TR206 sensors can be identified by a blue case with a yellow band around it (IPN # 15851, 16202, 16231, 89672, 89673).*

Cable Connections

Install the cable to the sensor and controller chassis sockets. The connector is keyed to provide proper orientation at the sensor socket. Do not force the connector into the socket.

> ***CAUTION:*** *Do not remove and reconnect the Pirani cable while the instrument power is on. A strong impulse will enter the sensor and can change the character of the filament significantly. If this occurs, the sensor must be recalibrated. In some severe cases, the sensor will not be able to maintain its zero position and the sensing element will have to be replaced.*

3.4.6 Capacitance Diaphragm Gauge (CDG) Installation

Mounting

Mount the CDG sensors onto the vacuum system using either the standard port provided or any of several optional vacuum fittings. The sensor can be mounted in any position, but the preferred orientation is with the inlet tube pointing down. This positioning prevents debris from entering the sensor and causing errors in the pressure measurement. The CDG should be zeroed in the position in which it will be mounted. Care should be taken to isolate the sensor from all sources of vibration, especially for low range units.

Zero and 100% adjustments should be performed upon installing the gauge.

Cable Connections

The cables for both CDG100 and CDG120 sensors are fastened with a screw-on connector.

Sensor Range Selection

Three sensor head ranges are available: 10, 100, and 1000 torr full scale. The controllers will also operate 1 torr sensors. The CDG board must be configured to match the head range imprinted on the associated sensor. See Table 4.4 for details pertaining to configuration.

Capacitance Diaphragm Gauge Range (F.S.)	Lowest Pressure Reading	Minimum Pressure for Critical Meas. & Control
1 torr	$1x10^{-4}$ T	$1x10^{-3}$ T
10 torr	$1x10^{-3}$ T	$1x10^{-2}$ T
100 torr	$1x10^{-2}$ T	$1x10^{-1}$ T
1000 torr	$1x10^{-1}$ T	$1x10^{0}$ T

Table 3.1

3.5 Software Installation

3.5.1 Instructions for Changing an EPROM in the Gauge Controllers

NOTE: To determine which version of software is in your gauge controller, turn the power on and watch the display. The software version will be displayed in the format "VXX" (i.e., V11).

EPROMS are *static* sensitive. Please handle in a *static-free* environment.

1. With the power OFF, and the rear of the unit facing you, remove the top cover (see Figure 3.5).
   - After removing the bracket the cover will slide back
2. Find the CPU board located in the right corner of the gauge.
3. Locate the two ribbon cables which run from the CPU board to the display board.
   - Disconnect the cables from the connectors on the CPU board
   - This is to avoid damaging any contacts to the display board

4. Hold the CPU board at both ends; lift it vertically until it is released from the motherboard.

5. With the CPU board released, locate the EPROM to be replaced (labeled as Z6 on the CPU board).
   - Note the orientation of the EPROM; when inserting the new EPROM be sure to line up the notch in the holder with the notch in the EPROM (i.e. notch down)
   - Using a flathead screwdriver or chip remover tool, gently remove the chip from its holder

6. Insert the new EPROM (once again be sure of the orientation of the EPROM)
   - If the width between rows of leads on the EPROM is too wide for the holder you may narrow it by gently applying pressure on each row using a flat surface
   - Your software update is now complete

7. Put the CPU board back into the controller in its proper slot
   - Reconnect the two ribbon cables to the connectors on the CPU board

8. Slide on the top cover
   - While holding the top cover as far forward as possible; replace the bracket and insert screws.

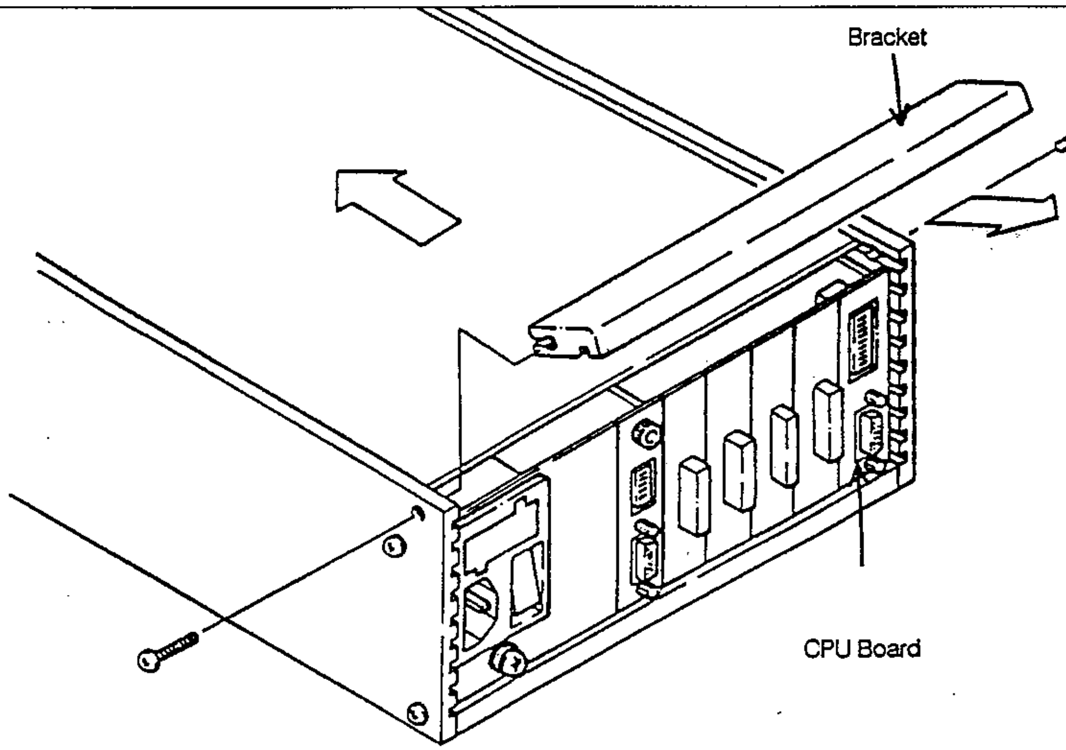


Figure 3.5 - Bracket Removal

Section 4
Controller Operation

Contents

4.0 Operation

To begin operating the gauge, turn on the power switch on the rear panel. If the gauge is installed in a rack or cabinet where the power switch is not accessible, power may be left on without damage to the instrument.

4.1 Display Description

Figure 4.1 shows the gauge controller LCD with all segments displayed. A definition of each is provided below.

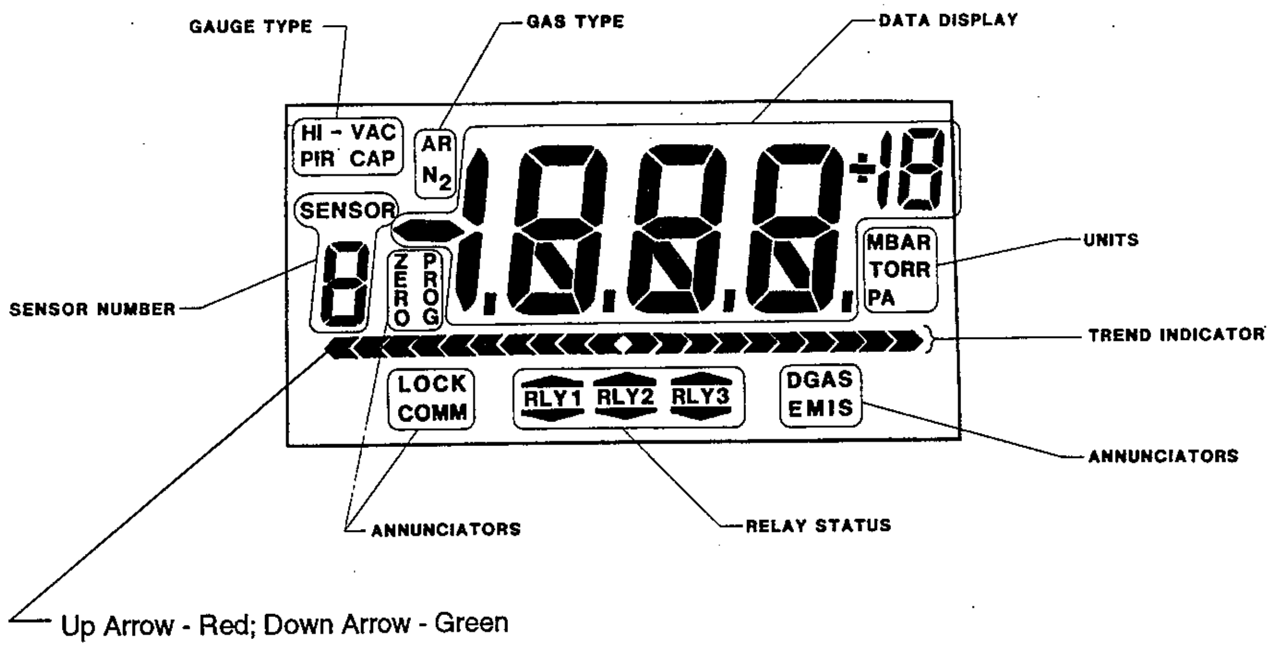


Figure 4.1 - Gauge Controller LCD

4.1.1 Display Definitions

Sensor Number

SENSOR # The number shown corresponds to the sensor that is being displayed or programmed (Sensor 1, 2, or 3). This position is also used for communications protocol programming with the character displayed corresponding to the parameter being programmed. (See Section 5.1.4)

Gauge Type

PIR,CAP,HI-VAC These abbreviations are associated with the sensor #, indicating the type of sensor being displayed or programmed.

PIR = PIRANI
CAP = CAPACITANCE DIAPHRAGM
HI-VAC = HOT CATHODE or COLD CATHODE IONIZATION.

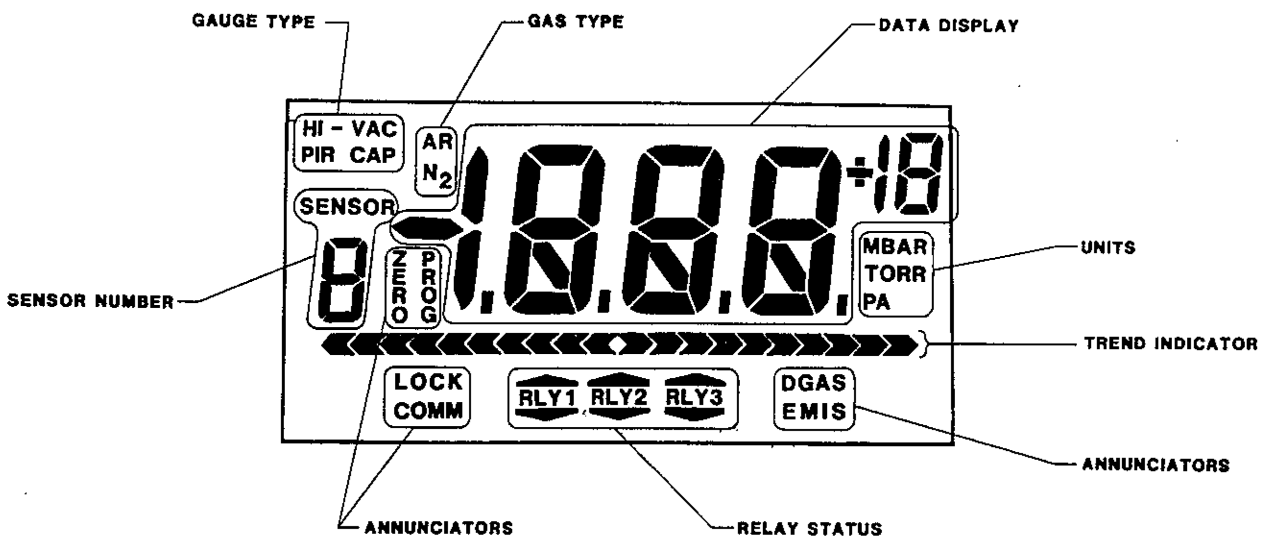


Figure 4.1b - Gauge Controller LCD

Gas Type

N_2, AR These abbreviations indicate the gas type that is being measured by the selected sensor. The gas type has been selected by the operator via the configuration switches on the rear of the sensor boards.

N_2 = NITROGEN
AR = ARGON

Units

TORR/MBAR/PA Indicates which measurement unit has been selected by the operator via the configuration switch on the rear of the CPU board.

Data Display

MANTISSA DATA	3- Digits of measurement or programming data.
EXPONENT DATA	1- Digits of measurement or programming data
SIGN EXP(+ or -)	Indicates sign of measurement or programming data exponent.

Annunciators

PROG	Indicates that the program mode is active and parameter data is being viewed. This message always flashes when ON.
LOCK	Indicates that program changes via the keyboard have been inhibited by the configuration switch on the rear of the CPU board and/or ZeroLock is enabled.
COMM	Indicates that the computer interface is receiving valid data.
EMIS	Indicates that the HI-VAC sensor power supply voltages are on.
DGAS	Indicates that the hot cathode ionization gauge is in a degas cycle.
ZERO	Indicates that AutoZero and/or ZeroLock is enabled.

Trend Indicator

BAR GRAPH	This is a trend representation of displayed data and indicates the rate of change of pressure. Full scale is approximately 4% per second. Arrows to the right indicate pressure increases, arrows to the left indicate pressure decreases. This is also used in Zero mode to indicate whether the zero factor needs to be incremented or decremented.

Relay Status (Relays are located on optional Hardware I/O Board)

▲ & ▼ RLY1	In Display mode, the ▲ above RLY 1 indicates that the system pressure has exceeded the upper setpoint value, and the relay is deactivated. The ▼ indicates the system pressure has gone below the lower setpoint value, and the relay is activated. In Program mode, the arrows indicate which setpoint is being viewed. In Program mode the arrow will flash.
▲ & ▼ RLY2	Operates in the same manner as RLY 1.
▲ & ▼ RLY 3	Operates in the same manner as RLY 1.

4.1.2 Error Indications

Using internal diagnostics, the gauge software system continuously monitors the unit to verify proper operating conditions during power-up and normal operations. Any "Error" conditions that are detected will be displayed on the LCD in the form of a message "ERR" in the data display and a number in the exponent location. The number indicates the particular error condition detected. Refer to Section 9 for a more detailed explanation.

4.2 Keyboard Description

Figure 4.2 shows a typical gauge unit keyboard. The **EMIS** key is used on the IG3 and CC3 gauges only; the **DGAS** key is used on the IG3 gauge only. The **ZERO** key is functional only on CDG and Pirani sensors.

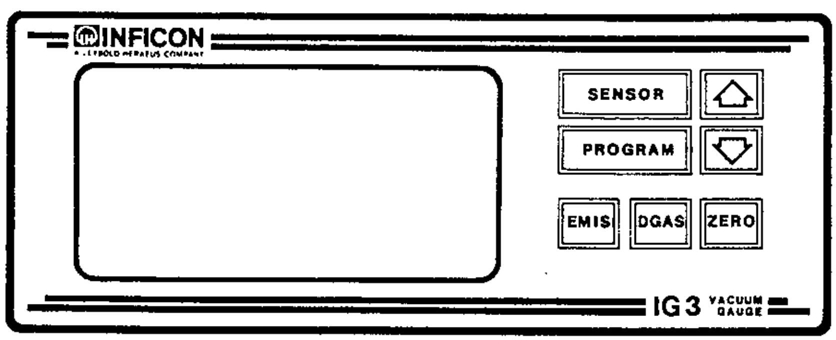


Figure 4.2 - IG3 Keyboard

A description of each key is provided below:

SENSOR - In Display mode this key selects which sensor module data to display. The sensor number is increased with each key press. The type of gauge measurement is also indicated (i.e. HI-VAC,PIR,CAP). Non-present sensors are skipped. For example: if only 2 sensors are present, the display will show 1, 2 and then 1 again.

In the Program mode this key allows the assignment of a relay to a particular sensor. The sensor number is increased with each key press and indicates which sensor the relay is assigned to. Non-present sensors are skipped. This key is active only when the upper relay setpoint is being programmed.

PROGRAM - When pressed, this key places the unit into Program mode and with each subsequent key press steps through the available parameters. See Section 5 for detailed information on programming. This key may be used to clear all programmed parameter values to factory set conditions by holding down the **PROGRAM** key while powering up the control unit. The keyboard lock configuration switch on the CPU must be in the unlocked position for this resetting operation to occur.

ZERO - This key is only functional if a Pirani or capacitance diaphragm gauge (CDG) sensor is being viewed. The unit is placed into a mode that allows adjustment of the display zero offset. (See Section 4.8) This key, if held down on power-up, will clear any zero offset adjustment values present in the controller memory.

Pressing this key while in Program mode will return the unit to the Display mode.

△(INCREASE) - In Program mode, this key increases the programmable parameter values. In Zero mode, this key increases the sensor reading of the Pirani or CDG sensors. This key is inactive in Display mode.

If held down on power-up, this key will activate all possible LCD display segments for test. The unit will resume normal operation when the key is released.

▽ (DECREASE) - In Program mode, this key decreases programmable parameter values. In Zero mode, this key decreases the sensor reading of the Pirani or CDG sensors. This key is inactive in Display mode.

If held down on power-up, this key will activate/deactivate the ZeroLockout feature (see Section 4.8).

EMIS (Emission) *(Hot Cathode Ionization* and *Cold Cathode Gauges Only)* - This key turns on the high voltage power supplies for the sensors. This key has an ON/OFF toggle operation. Turning emission off with degas active also terminates degas.

DGAS (Degas) *(Hot Cathode Ionization Gauge Only)* - This key turns on the self-timed degas supply. This key has an ON/OFF toggle operation.

4.3 Configuration Switch Settings

The CPU and all sensor interface boards have rear panel configuration switches that allow the operator to set the instrument parameters to meet the specific requirements of their application. Figure 4.3 is a view of the typical rear panels of the units and shows the locations of the configuration switches.

NOTE: These switches can be changed at any time but will only be acknowledged after a power-on.

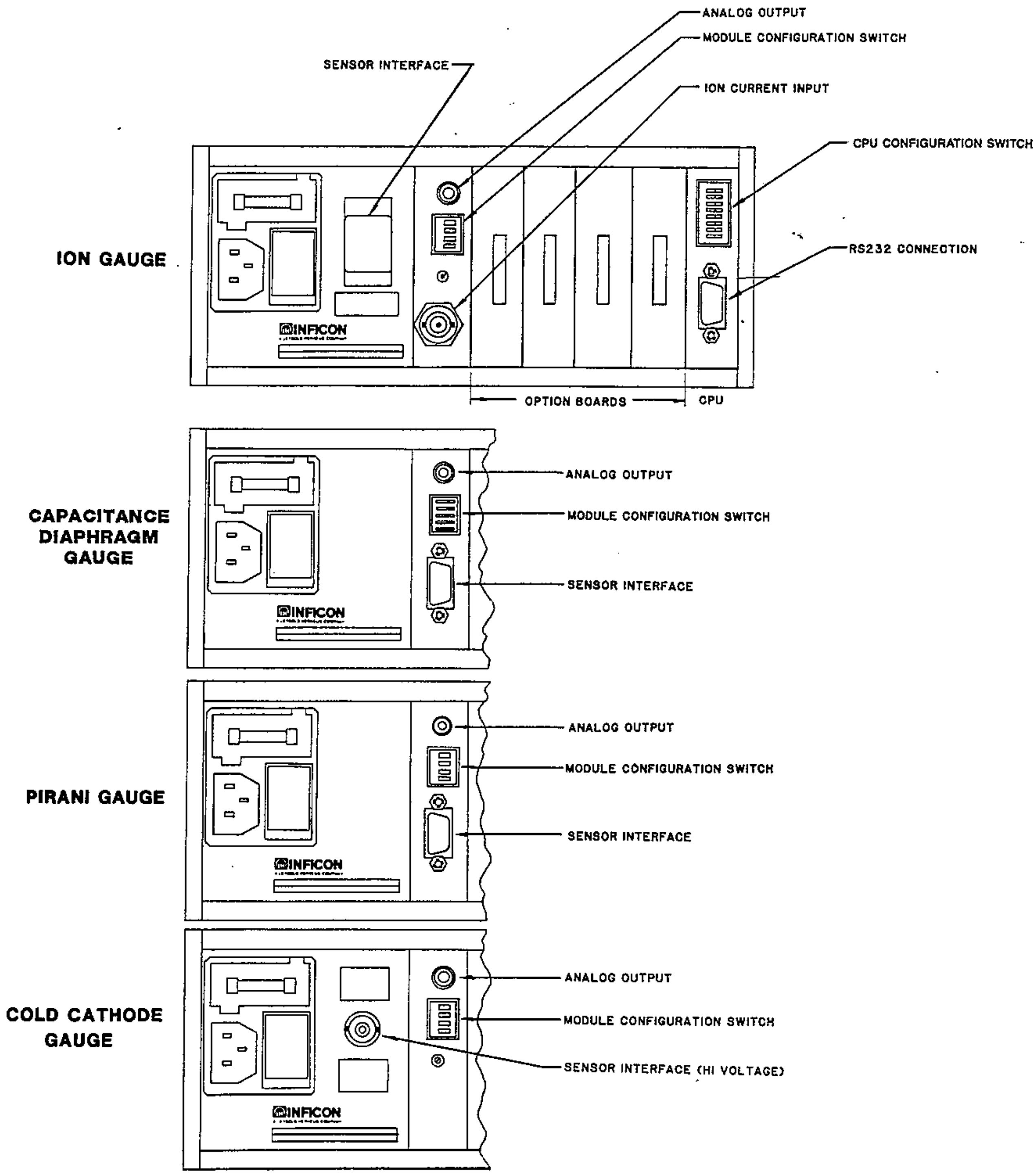


Figure 4.3 - Location of Option Switches

4.3.1 CPU Board Configuration

The following tables indicate the gauge module configuration switch numbers, definitions and available option choices.

Table 4.1 - CPU MODULE CONFIGURATION

Switch #	Definition	Desired Function	Switch Settings
8	Not Used	-	Off *
7	Display Format (see 4-12)	Scientific Engineering	Off * On
6	Keyboard Program Lock	Unlocked Locked	Off * On
5 4	Units	Torr	Off * Off *
5 4	Units	Pascal	Off On
5 4	Units	Millibar	On Off
3	RS232 Comm Format	Inficon Semi Secs II	Off * On
2 1	Baud Rate Baud Rate	9600	Off * Off *
2 1	Baud Rate	2400 Baud Rate	Off On
2 1	Baud Rate	300 Baud Rate	On On

* Indicates factory setting

Table 4.2 - ION MODULE CONFIGURATION

Switch #	Definition	Desired Function	Switch Setting
4	AutoDegas	No Yes	Off * On
3	Recorder	Log Linear	Off * On
2	Sensitivity Factor	Fixed Variable	Off * On
1	Gas Type	Nitrogen Argon	Off * On

*Indicates factory setting

Table 4.3 - PIRANI MODULE CONFIGURATION

Switch #	Definition	Desired Function	Switch Setting
4	AutoZero	No Yes	Off * On
3	Recorder	Log Linear	Off * On
2	AutoEmission (Hi Vac)	No Yes	Off * On
1	Gas Type	Nitrogen Argon	Off * On

*Indicates factory setting

Table 4.4 - CAPACITANCE DIAPHRAGM GAUGE MODULE CONFIGURATION
(formerly called capacitance manometer)

Switch #	Definition	Desired Function	Switch Setting
5	Head Range	1 torr	Off *
4	Head Range		Off *
5	Head Range	10 torr	Off
4	Head Range		On
5	Head Range	100 torr	On
4	Head Range		Off
5	Head Range	1000 torr	On
4	Head Range		On
3	Recorder	Log	Off *
		Linear	On
2	AutoEmission ** (Hi Vac)	No	Off *
		Yes	On
1	AutoSelect	No	Off *
		Yes	On

* Indicates factory setting ** 1 torr head only

Table 4.5 - COLD CATHODE MODULE CONFIGURATION

Switch #	Definition	Desired Function	Switch Setting
4	Unused		Off *
3	Recorder	Log	Off *
		Linear	On
2	Sensitivity Factor	Fixed	Off *
		Variable	On
1	Gas Type	Nitrogen	Off *
		Argon	On

* Indicates factory setting

Table 4.6 - IEEE488 MODULE ADDRESS SETUP

SWITCH	1 (A0)	2 (A1)	3 (A2)	4 (A3)	5 (A4)	DEVICE ADDRESS
	ON	ON	ON	ON	ON	0
	OFF	ON	ON	ON	ON	1
	ON	OFF	ON	ON	ON	2
	OFF	OFF	ON	ON	ON	3 * FACTORY
	ON	ON	OFF	ON	ON	4
	OFF	ON	OFF	ON	ON	5
	ON	OFF	OFF	ON	ON	6
	OFF	OFF	OFF	ON	ON	7
	ETC.					

Address Range - 0 to 30

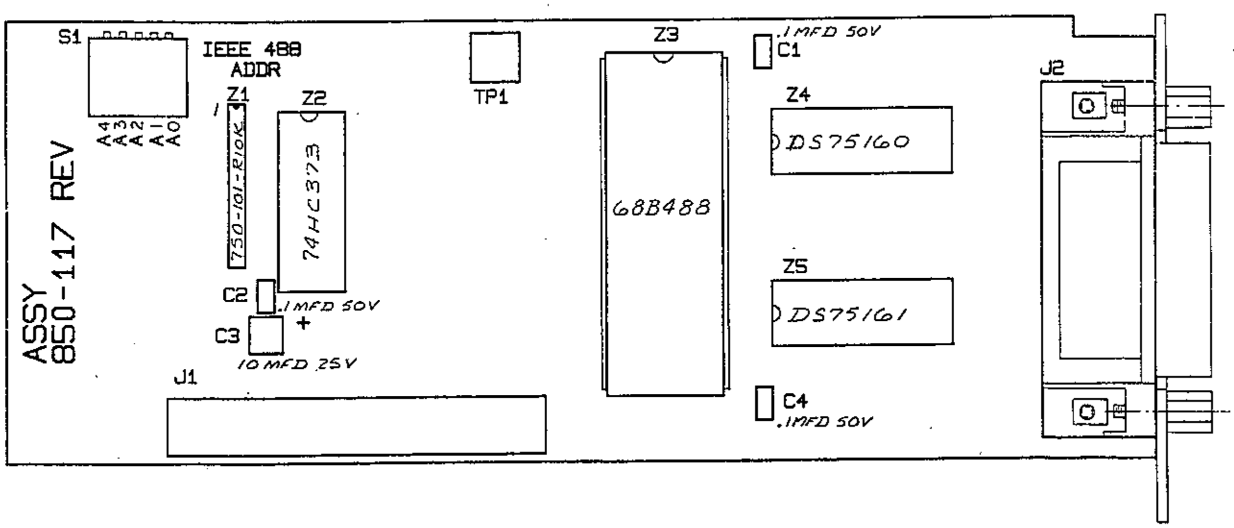


Figure 4.4 - IEEE488 Communications Board

4.4 Turning Ion and Cold Cathode Gauge Emission On

Emission can be turned on in the following ways:

1. Front Panel **EMIS** key
2. Hardware I/O remote input
3. Computer Interface commands
4. Automatic turn-on via Pirani or capacitance diaphragm gauge (CDG) modules

4.4.1 AutoEmission On Capability

To configure the gauge for AutoEmission ON, the emission switch on the Pirani or CDG (1 torr head only) measurement card must be in the ON position. The high vacuum gauge sensor emission will automatically turn on when the system pressure drops below a preselected pressure between $1x10^{-3}$ and $5x10^{-3}$ torr and the display will change to Sensor #1. This pre-selected pressure is termed the "crossover point" and is discussed further in Section 5.0.

If the system pressure rises above a pre-selected "crossback point," the emission of the high vacuum gauge will be turned off and the display will change back to the rough vacuum gauge (Pirani or CDG). This is also discussed in more detail in Section 5.0. The status relay does not de-activate under these conditions (will not indicate an error).

If you require the Status relay to indicate whenever the high vacuum gauge displays an over-pressure (OVP) condition, AutoEmission should not be selected.

4.5 Degassing Ion Gauges

To degas the ion gauge tube the emission must be on. Press the **DGAS** key. The **DGAS** annunciator will light and the grid of the ion gauge tube should begin to glow red after 30 to 60 seconds. The gauge will continue to read pressure during degas operations. If the ion gauge is being displayed, the reading may increase gradually and then should level off and slowly fall. The degas power is gradually increased for the initial 30 seconds then held at a constant level. The degas cycle will automatically terminate after 3 minutes. The degas function can also be implemented through a computer interface.

4.5.1 AutoDegas

An automatic degas operation can be implemented with each emission turn on by setting the AutoDegas configuration switch on the Ion module to the ON position. AutoDegas may not be desirable if the emission will be cycling on and off frequently, as frequent degassing will have an effect on the life of the sensor.

4.6 Analog Recorder Outputs

There is an analog recorder output for each sensor which corresponds to the pressure reading. This output can be either linear or logarithmic as selected by the operator via the configuration switch on each sensor module.

If the linear scaling is selected, a three decade range of pressure is available. The full-scale output scaling is determined by the recorder parameters (REC) which may be changed in the Program mode. Zero volts would be 3 full decades below the full scale reading. For example, if the recorder parameter is -3, the full-scale reading would be $1x10^{-3}$, and would correspond to 10 volts. $1x10^{-4}$ would be 1 volt and $1x10^{-5}$ would be 100 millivolts, and $1x10^{-6}$ would be 0 volts.

If the logarithmic output is selected, the entire range of pressure is displayed for each sensor. See Tables 4.7(a), (b) & (c) for the usable pressure ranges, number of decades and the volts per decade for each sensor type and measurement units.

The electrical connection is made to the measurement card on the rear of the controller using a standard "mini phone plug." The plug (IPN #051-601) is included with each measurement card.

Table 4.7 (a)
Logarithmic Analog Output - torr

Sensor Type	Pressure (torr) Minimum Measurable	Maximum Measurable	Decades	Volts/Decade (V_D)
Ion	$1x10^{-10}$	$1x10^{-2}$	8	1.11
Cold Cathode	$1x10^{-7}$	$1x10^{-2}$	5	1.67
Pirani	$1x10^{-4}$	$1x10^{+3}$	7	1.25
Capacitance Diaphragm Gauge (1000T)	$1x10^{-1}$	$1x10^{+3}$	4	2.00
(100T)	$1x10^{-2}$	$1x10^{+2}$	4	2.00
(10T)	$1x10^{-3}$	$1x10^{+1}$	4	2.00
(1T)	$1x10^{-4}$	$1x10^{0}$	4	2.00

Table 4.7 (b)
Logarithm Analog Output - mbar

Sensor Type	Pressure (mbar) Minimum Measurable	Maximum Measurable	Decades	Volts/Decade (V_D)
Ion	$1.33x10^{-10}$	$1.33x10^{-2}$	8	1.11
Cold Cathode	$1.33x10^{-7}$	$1.33x10^{-2}$	5	1.67
Pirani	$1.33x10^{-4}$	$1.33x10^{+3}$	7	1.25
Capacitance Diaphragm Gauge (1000T)	$1.33x10^{-1}$	$1.33x10^{+3}$	4	2.00
(100T)	$1.33x10^{-2}$	$1.33x10^{+2}$	4	2.00
(10T)	$1.33x10^{-3}$	$1x10^{+1}$	4	2.00
(1T)	$1.33x10^{-4}$	$1.33x10^{0}$	4	2.00

Table 4.7 (c)
Logarithmic Analoug Output - Pa

Sensor Type	Pressure (Pascal) Minimum Measurable	Maximum Measurable	Decades	Volts/Decade (V_D)
Ion	$1.33x10^{-8}$	$1.33x10^{-0}$	8	1.11
Cold Cathode	$1.33x10^{-5}$	$1.33x10^{0}$	5	1.67
Pirani	$1.33x10^{-2}$	$1.33x10^{+5}$	7	1.25
Capacitance Diaphragm Gauge (1000T)	$1.33x10^{+1}$	$1.33x10^{+5}$	4	2.00
(100T)	$1.33x10^{0}$	$1.33x10^{+4}$	4	2.00
(10T)	$1.33x10^{-1}$	$1x10^{+3}$	4	2.00
(1T)	$1.33x10^{-2}$	$1.33x10^{+2}$	4	2.00

To determine the recorder voltage for a given pressure, use the following mathematical formula:

$$V_R = V_D[\log(P/R)]$$

where V_R is the recorder voltage
V_D is the volts per decade for the sensor type used
P is the measure pressure
R is equal to $1x10^N$ where N is the exponent of the minimum measurable pressure for the sensor used (Note: this value depends on the units of measurement used.)

For example:

Using a Pirani sensor reading in torr:

Minimum measurable pressure = $1x10^{-4}$ torr
R = $1x10^{-4}$

Using a Pirani sensor reading in Pascal:

Minimum measurable pressure = $1.33x10^{-2}$ Pascal
R = $1x10^{-2}$

NOTES: For mbar and Pa units, V_R will not equal zero volts at the minimum measurable pressure. However, V_R may equal zero below the minimum measurable pressure in some cases.

Examples:

1) Find the recorder voltage for an Ion gauge pressure reading of $3.45x10^{-6}$ torr. P = $3.45x10^{-6}$ torr, R = $1x10^{-10}$ torr and V_D = 1.11 volts per decade.

$V_R = 1.11[\log(3.45x10^{-6}/1x10^{-10})]$

$V_R = 1.11[\log(3.45x10^{+4})]$

$V_R = 1.11[4.538]$

V_R = 5.04 volts

2) Find the recorder voltage for a cold cathode gauge pressure reading of $1.01x10^{-3}$ torr. P = $1.01x10^{-3}$ torr, R = $1x10^{-7}$ torr and V_D = 1.67 volts per decade.

$V_R = 1.67[\log(1.01x10^{-3}/1x10^{-7})]$

$V_R = 1.67[\log(1.01x10^{+4})]$

$V_R = 1.67[4.004]$

V_R = 6.69 volts

3) Find the recorder voltage for a Pirani gauge pressure reading of $1.4x10^{-1}$ Pascals. P = $1.4x10^{-1}$ Pascals, R = $1x10^{-2}$ Pascals and V_D = 1.25 volts per decade.

$V_R = 1.25[\log(1.4x10^{-1}/1x10^{-2})]$

$V_R = 1.25[\log(1.4x10^{+1})]$

$V_R = 1.25[1.15]$

V_R = 1.43 volts

4) Find the recorder voltage for a capacitance diaphragm gauge pressure reading of $2.61x10^{0}$ mbar using a 10 torr head. P = $2.61x10^{0}$ mbar, R = $1x10^{-3}$ mbar, and V_D = 2.00 volts per decade.

$V_R = 2.00[\log(2.61x10^{0}/1x10^{-3})]$

$V_R = 2.00[\log(2.61x10^{+3})]$

$V_R = 2.00[3.42]$

V_R = 6.84 volts

To find the pressure from the recorder voltage, use the following formula:

$$P = R[\text{INV} \log(V_R/V_D)]$$

where V_R is the recorder voltage
V_D is the volts per decade for the sensor type used
P is the measured pressure
R is equal to $1x10^{N}$ where N is the exponent of the minimum measurable pressure for the sensor used (Note: this value depends on the units of measurement used.)

For example:

Using a Pirani sensor reading in torr:

Minimum measurable pressure = $1x10^{-4}$ torr
R = $1x10^{-4}$

Using a Pirani sensor reading in Pascal:

Minimum measurable pressure = $1.33x10^{-2}$ Pascal
R = $1x10^{-2}$

NOTE: For mbar and Pa units, the calculated pressure could be below the minimum measurable pressure in some cases.

Examples:

5) Find the pressure in torr, for an Ion gauge with a recorder voltage of 5.04 volts. V_R = 5.04 volts, R = $1x10^0$ and V_D = 1.11 volts per decade.

P = $1x10^{-10}$[INV log(5.04/1.11)]

P = $1x10^{-10}$[INV log(4.54)]

P = $1x10^{-10}(3.5x10^4)$

P = $3.5x10^{-6}$ torr

6) Find the pressure in Pascals, for a Pirani gauge with a recorder voltage of 1.30 volts. V_R = 1.30 volts, R = $1x10^{-2}$ and V_D = 1.25 volts per decade.

P = $1x10^{-2}$[INV log(1.30/1.25)]

P = $1x10^{-2}$[INV log(1.04)]

P = $1x10^{-2}$[10.96]

P = $1.1x10^{-1}$ Pascals

7). Find the pressure, in mbar for a capacitance diaphragm gauge using a 10 torr head, with a recorder voltage of 6.58 volts. V_R = 6.58 volts, R = $1x10^{-3}$ and V_D = 2.00 volts per decade.

P = $1x10^{-3}$[INV log(6.58/2.00)]

P = $1x10^{-3}$[INV log(3.29)]

P = $1x10^{-3}$[$1.9x10^{3}$]

P = 1.9 mbar

4.7 AutoSelect for Capacitance Diaphragm Gauges (CDGs)

When there is more than one CDG sensor in the gauge, it is possible to automatically change the display from one sensor to another when the pressure of the system changes range. This is done by setting the "AutoSelect" configuration switch on the back of each CDG sensor module in the controller that will be involved in the autoselection process.

When a CDG sensor is being displayed, and the pressure goes out of the range of that CDG, each of the other CDGs will be checked. If one of them is within the current pressure range, the display will automatically change to that sensor. The crossover point between CDG sensors will differ depending on the direction of the pressure change.

NOTE: If there are three CDG sensors, and if autoselection is only desired between two of them, do not set the AutoSelect switch on the third. If only one CDG board has the switch set, no autoselection will be done.

4.8 Zeroing

Zeroing will allow low end calibration of Pirani or CDG sensors. It can be performed using a potentiometer on the sensor or electronically using the controller. To use the controller zero function, select the sensor to be adjusted via the **SENSOR** key and then enter the Zero mode by pressing the **ZERO** key. When the Zero mode is entered the data display will be replaced by the message "ZRO," and the bar display will give a relative indication of how far the sensor reading is from zero. A single arrow in each direction indicates that the sensor is zeroed. (For more detailed information on zero adjustment refer to Section 7.3.) When the system has been zeroed, exit the Zero mode by pressing the **ZERO** key again. If the system is in Zero mode and the **SENSOR** key or **PROGRAM** key is pressed, Zero mode will automatically be exited.

In Version 14 software and above (software version is displayed on power-up of the controller) the AutoZero function will appear in program mode. The gauge controller must be an IG3 or CC3 and must be equipped with a Pirani board. The "AutoZero" feature allows the user to program the controller for continuous automatic zero adjustment of Pirani Sensors. Zeroing is done by comparing the Pirani pressure reading to a "reference zero", (entered by the user in program mode). If the actual pressure is equal to or less than the "reference zero" the Pirani sensor will be zeroed. AutoZero is performed on first emission of the high vacuum sensor (assuming the high vacuum sensor is equal to or less than the "reference zero") and is done continuously every 10 minutes. For more detailed information see Section 5.1.6.

A feature called "Zero Adjustment Lockout" is also incorporated into the gauge controller. When this feature is activated, the **ZERO** key on the front panel is disabled and the operator of the controller is unable to make any adjustments to the zero offset of the controller.

To enable the Zero Adjustment Lockout feature, you should power up the gauge while pressing the ▽ (down arrow key). All adjustments that have been made to the zero offset of the controller prior to enabling the Zero Adjustment Lockout feature will remain active (i.e. locking out the zero adjustment does not reset the zero offset). Should you attempt to enter the Zero mode by pressing the **ZERO** button on the front panel while the Zero Adjustment Lockout feature is enabled, the **ZERO** and **LOCK** annunciators will flash.

To disable the Zero Adjustment Lockout feature, the controller must be powered down and then powered up again while pressing the ▽ (down arrow key). The Zero Adjustment Lockout feature can also be selected through the communication port (see Section 6).

4.9 Relay Setpoints

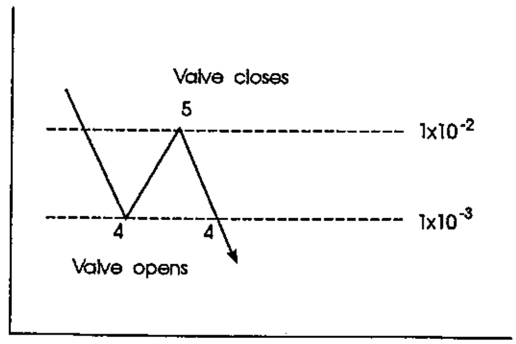
Relay setpoints are used to control the three relay outputs located on the optional Hardware I/O Board. Each relay has a pair of setpoints, an upper and a lower value. These setpoints correspond to the pressure value of a specified sensor. The relay will be energized when the pressure goes below the lower setpoint, and de-energized when the pressure goes above the upper setpoint. When the pressure is between the two setpoints, the relay will remain in the state it is already in. To adjust the setpoints, see Section 5.1.1.

A relay can be deactivated (i.e. the relay will always be de-energized) by giving its upper setpoint a value of zero.

The **RLY** messages on the display indicate which state the relay is in. If the **RLY** is energized, the ▼ (down arrow) will be on. If it is de-energized, the ▲ (up arrow) will be on. If the **RLY** is deactivated, no relay message will appear.

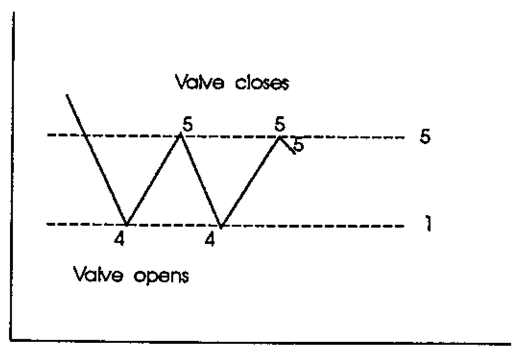
Example 1: Controlling a high vacuum valve

In this case **RLY 1** is set to operate on signals from Sensor 2. A different upper and lower setpoint are programmed. While the system is pumping down, the relay will not change its state until the pressure falls below the lower setpoint and will not revert back to its normal position until the pressure rises above the upper setpoint.



Example 2: Pressure Control

The relays are set up in a similar manner in example 2, in this case the relay controls a valve on a gas inlet line to roughly control the system pressure between 1 and 5 torr.



4.10 Status Output

The status output relay on the Hardware I/O Board will be activated when the gauge is on and operating normally. If the power is turned off, or certain errors occur on a sensor (see Section 9.1 for possible errors) the status relay is deactivated.

NOTE: Turning the emission off via the front panel, communication interface, or remote input will not deactivate the status relay. If, however, an error (such as overpressure) causes the emission to turn off, the relay will deactivate.

4.11 Emission Input

The I/O Emission Input will remotely turn on or off the sensor emission. It may be tied to ground through pins 14, 15, 16, or 17; or it may be connected through the setpoint relay to turn on/off the emission at a specific point.

4.12 Display Format

Scientific notation is the default setting for the display format. The other available option is "Engineering Units" which displays the pressure keeping the exponent value constant at "-3" through a given range. See Table 4.8 for examples.

Table 4.8
Display Formats

Pressure	Scientific*	Engineering
760 torr	$7.6\times10^{+2}$ torr	760 torr
7.6 torr	7.60×10^{0} torr	7.6 torr
.760 torr	7.60×10^{-1} torr	760×10^{-3} torr
.0760 torr	7.60×10^{-2} torr	76.0×10^{-3} torr
.00760 torr	7.60×10^{-3} torr	7.60×10^{-3} torr
.000760 torr	7.60×10^{-4} torr	$.760\times10^{-3}$ torr

*The number of significant digits will differ depending on the type of sensor.

Section 5
Programming

Contents

5.0 Programming

Stored parameter data may be viewed and modified by the user when in the Program mode. There are 18 possible programmable parameter values in the controller. These are divided into six groups.

Setpoint Group	This group determines the upper and lower values for relay operation.
Recorder Group	This group determines the scale factors for the linear recorder outputs.
Sensitivity Group	This group allows sensitivity adjustments on ion and cold cathode gauge measurements.
Communications Group	This group sets the values required for the SEMI SECS II communications link
AutoEmission Group	This group sets the crossover and crossback pressures for the AutoEmission function.
AutoZero Group	This group sets the pressure at which automatic zeroing of Pirani sensors is performed.

Parameter values are modified by using the △ and ▽ arrow keys. It is not possible to program an illegal parameter value. The longer the arrow keys are held down, the faster the values will increase or decrease.

Upper and lower setpoint values for each relay are programmed first, followed by recorder scaling for each sensor, sensitivity factors, communications parameters, AutoEmission crossover and crossback points and the AutoZero setpoint. Repeated pressing of the **PROGRAM** key will sequence the user through all the parameters and then out of the Program mode. The recorder, sensitivity, communications, AutoEmission, and AutoZero parameters will only appear if the appropriate configuration switches are set. (See section 4.3)

It is possible to "lockout" the programming mode through the Program Lock feature, thereby preventing unauthorized changes to the programmed parameters. To enable Program Lock, set DIP switch #6 on the CPU board to ON. The factory default setting is OFF. (See Table 4.1) When Program Lock is enabled, the user can view the parameter settings sequentially by repeatedly pressing the **PROGRAM** key. Changes to the settings are not possible when Program Lock is enabled.

5.1 Procedure

NOTE: To enter the Program mode, press the **PROGRAM** key. To exit the Program mode, either sequence through all the parameters or press the **ZERO** key.

5.1.1 Setpoint Parameters

After the Program mode has been entered, the display will indicate the sensor number associated with Relay 1, the **PROG** annunciator will be flashing, and **RLY 1** and the ▲ symbol above it will be on. The stored value for Relay 1 upper setpoint parameter will appear in the data display and exponent locations.

To change the sensor that Relay 1 is assigned to, press the **SENSOR** key.

To modify the upper setpoint value, use the △ and ▽ arrow keys until the desired value is reached. To step to the next parameter, press the **PROGRAM** key again. The value for Relay 1 upper setpoint will be stored in memory and the parameter data for Relay 1 lower setpoint will be displayed. The ▼ arrow below **RLY 1** will now be on.

Program the lower setpoint in the same manner as the upper limit.

Press the **PROGRAM** key again and the unit will sequence to the Relay 2 parameters and annunciators. The parameter values are changed in the same manner as Relay 1.

Repeat for Relay 3.

NOTE: Setting the upper setpoint of a relay to 0.00^{+0} will disable the relay (i.e., the relay will always be de-energized). If the upper setpoint is 0.00^{+0}, the lower setpoint will be skipped, and the program will go to the next parameter.

NOTE: Each relay can be assigned to any sensor. At initial start-up, relay 1 is automatically assigned to sensor 1, relay 2 to sensor 2, and relay 3 to sensor 3. Relay assignments default to sensor 1 if additional sensor modules are not installed. A relay may be assigned to a different sensor by pressing the **SENSOR** key while programming its upper limit. This will increment the sensor number assignment. If only one sensor module is present, the sensor number will not change. Upper and lower setpoints will always be assigned to the same sensor.

5.1.2 Recorder Scaling

After all the setpoint data has been entered, the unit will sequence to the linear recorder scaling parameters. These parameters will only appear for the sensors that have their recorder output configured for linear operation by the user configuration switch. If a sensor is configured for logarithmic, this parameter will be skipped.

The characters "REC" will appear in the data display, SENSOR will be the corresponding sensor and the exponent will indicate the full scale recorder decade value. This means that the recorder will output three decades of linear voltage for the three decades of pressure below the full scale value.

The full scale value may be modified using the arrow keys (△& ▽).

Follow the same procedure for all the sensors that have been configured for linear operation.

See Section 4.6 for details on the analog recorder output.

5.1.3 Sensitivity Parameter

The sensitivity parameter (F) will appear only if the unit is an ion or cold cathode gauge system and the user configuration switch on the measurement module has been set to Variable. This parameter allows the pressure reading to be corrected for various sensor sensitivities or gas types. The sensitivity values may be varied from 0.60 to 2.50 with the nominal value being 1.00. Increasing values will cause increasing pressure readings. (See Section 7 for details on selecting a sensitivity factor)

5.1.4 Communications Parameters

After the sensitivity values have been entered, the unit will sequence to the communication parameters, if the SEMI SECS II communication option has been selected. The SENSOR area will indicate the parameter being shown and a "C" will flash in the exponent position. There are five parameters associated with the SEMI SECS II protocol. (See table below.) They are entered and modified in the same manner as the previous parameters.

SEMI SECS PARAMETER 1

SECS II FUNCTION	(receive character timeout)
DISPLAY INDICATOR	(1 in sensor # position)
DATA UNITS	(seconds)
DATA RANGE	(0.1 through 10.0)

SECS II DEFINITION - The number of seconds the gauge will wait between received characters before aborting the command, once a command has been started.

SEMI SECS PARAMETER 2

SECS II FUNCTION	(protocol timeout)
DISPLAY INDICATOR	(2 in sensor # position)
DATA UNITS	(seconds)
DATA RANGE	(0.2 through 25.0)

SECS II DEFINITION - The number of seconds after the gauge controller sends an inquiry before a protocol header must be received.

SEMI SECS PARAMETER 3

SECS II FUNCTION	(retry count)
DISPLAY INDICATOR	(small R [r])
DATA UNITS	(counts)
DATA RANGE	(0 through 31)

SECS II DEFINITION - The number of times a command will be retried after it has been aborted.

SEMI SECS PARAMETER 4

SECS II FUNCTION	(upper device ID#)
DISPLAY INDICATOR	(large U [U])
DATA UNITS	(address)
DATA RANGE	(0 thru 127)

SECS II DEFINITION - The upper device ID NUMBER. Number must match the ID of the instrument to which the gauge is interfacing.

SEMI SECS PARAMETER 5

SECS II FUNCTION	(lower device ID#)
DISPLAY INDICATOR	(large L [L])
DATA UNITS	(address)
DATA RANGE	(0 thru 127)

SECS II DEFINITION - The lower device ID NUMBER. Number must match the ID of the instrument to which the gauge is interfacing.

5.1.5 AutoEmission Parameters

The AutoEmission parameters will appear only in ion or cold cathode controllers (IG3 or CC3) equipped with a Pirani or 1 torr capacitance diaphragm gauge (CDG) board configured for AutoEmission.

You will first select the Crossover parameter after entering the AutoEmission group. You may program a Crossover pressure of 1 to 5 millitorr, in increments of 1 millitorr. This parameter is displayed in the Program mode with the center down arrow flashing and with an "A" on the left side of the display.

After the Crossover parameter has been programmed, the Crossback parameter may be selected. This may be from 2 to 10 millitorr; however, it must always be at least one millitorr greater than the Crossover pressure. The software will automatically set the minimum value for the Crossback pressure equal to the Crossover pressure plus 1 millitorr. This parameter is displayed in the Program mode with the center up arrow flashing and with an "A" on the left side of the display.

After the crossback pressure has been entered the Program mode will be exited.

5.1.6 AutoZero Parameter

The AutoZero feature allows the user to program the controller for continuous automatic zero adjustment of Pirani sensors. Zeroing is done by comparing the Pirani pressure reading to a "reference zero", entered by the user in Program mode. If the actual pressure is equal to or less than the "reference zero", the Pirani sensor will be zeroed. AutoZero is performed on first emission of the high vacuum sensor (assuming the high vacuum sensor is equal to or less than the "reference zero") and is done continuously every 10 minutes.

In Version 14 software and above (software version is displayed on power-up of the controller) the AutoZero function will appear in Program mode. The gauge controller must be an IG3 or CC3 and must be equipped with a Pirani board. Furthermore, the user configuration switches on the Pirani board must be set correctly. Specifically, switch #4 must be "ON" (see Section 4, Table 4.3 Pirani Module configuration).

When AutoZero is enabled a "ZERO" will appear on the front program display. This feature allows automatic zero adjustment of Pirani sensors. In the default setting from the factory, AutoZero is disabled.

5.1.7 Operation of AutoZero

NOTE: Before powering up the controller make sure switch #4 is set to "OFF" on the Pirani board.

1. It is necessary to first manually adjust the sensor because it may be too far out of adjustment to be automatically zeroed. Refer to Section 7.3 and follow each step in performing a manual adjustment of the Pirani sensor. AutoZeroing is done continuously every 10 minutes; therefore, after repeated zeroing of the sensor, AutoZero may use up its window of adjustment.
2. With the controller OFF, set switch #4 on the Pirani board to the ON position. Power-up the controller. Turning the CC3 or IG3 off and then back on allows the controller to recognize a change has been made to the switch settings.
3. Depress the **PROGRAM** key until the letter "A", "ZERO", and a flashing "PROG" appear on the left side of the display. A number will appear in the range $1x10^{-4}$ to $1x10^{-5}$ torr.
4. Use the △ and ▽ arrow keys to select a value in the range $1x10^{-4}$ to $1x10^{-5}$ torr. This value should be at least $5x10^{-5}$ torr or less for optimum results. However, if your vacuum system does not reach this level a higher "reference zero" may be used. The specified value is the "reference zero" or what could be called absolute zero relative to a Pirani sensor. When the controller is reading the high vacuum sensor (cold cathode or hot cathode) it will compare the "reference zero" to the actual pressure reading. If the actual pressure is equal to or less than the "reference zero" the Pirani sensor will be automatically zeroed.
5. AutoZero is now programmed. Press the **PROGRAM** key to exit the program. The Pirani sensor will be zeroed when the actual pressure is the same or less than the "reference zero".
6. When AutoZero is enabled, a "ZERO" will appear on the left side of the front display.

NOTE: Temperature changes may significantly affect zero drift on the Pirani sensor. Therefore, if a process is run over the course of a day (heated up) and stopped at night (cools down) it may be necessary to clear any offsets due to AutoZero before restarting the process.

In the event AutoZero uses up its window of operation (i.e., Pirani sensor will not zero) turn it off via the configuration switches on the Pirani board; and repeat step #1 above under operation.

Assuming a manual adjustment of the Pirani sensor has been done, AutoZero will correct for drift up to $3x10^{-3}$ torr.

Section 6
Communications

Contents

6.0 Communications

6.1 General Information

The gauge controllers can support both a serial and parallel computer interface link. The serial link is a standard feature and utilizes standard RS232 level signals and baud rates. The user has a choice of two information protocols that may be utilized with the serial link. The choices are the Semi Standard SECS II format or the INFICON data format. This choice is made via the rear panel DIP switches on the CPU card, (See section 4.3 for details). The parallel link requires an option card be installed and conforms to the 1975 IEEE488 standard. The 488 device address may be set by the user. (Table 4.6). The serial and parallel interfaces may be operated simultaneously.

Any interface option will allow access to all front panel operations as well as system data and status.

> **NOTE: IMPORTANT NOTICE FOR IEEE488 USERS:** A change to the IEEE488 protocol was made for Version 12 and above software. The information contained in the following section concerning the IEEE488 interface reflects these software changes. To determine which software version your controller has, turn on the power and watch the display. The software version will be displayed in the format "Vxx" (i.e., V12).

6.2 RS232 Serial Interface

To communicate via the serial RS232 link the gauge communications baud rate and data format must be set to the same value as the computer it is interfacing with. This is done via the rear panel dip switches on the gauge CPU module. The four baud rate choices available are 300, 1200, 2400, and 9600. The data format may be either SEMI SECS II or INFICON. (See section 4.3 for details). The unit has been set at the factory for 9600 baud and INFICON format. Instrument power must be turned off and back on to recognize any configuration switch changes. Electrical connections between the gauge controller and the computer should be made according to the following table. The gauge controller serial port will accept a standard 9 pin male "D" type connector. This connector has been provided in the ship kit.

Table 6.1
RS232 Pin Designations

Gauge Pin #	Controller Function		Computer Function
2	XMIT DATA	>>>>FROM GAUGE>>>>	RECV DATA
3	RECV DATA	<<<<<TO GAUGE<<<<<	XMIT DATA
6	DTR	>>>>>>>>>>>>>>>>	DSR
5	SIG GND	>>>>>>>><<<<<<<<	SIG GND
9	SHIELD	>>>>>>>><<<<<<<<	SHIELD

NOTE: DTR (Data Terminal Ready pin 6) may be used to determine if the gauge has been turned on and is ready to communicate. This line will be active high (+ 12v) when ready and ground when not ready and is normally connected to the DSR (Data Set Ready) terminal on the computer serial port.

6.2.1 RS232 Character Configuration

start bits	=	1
stop bits	=	1
data bits	=	8
parity	=	none

6.3 IEEE488 Parallel Interface

To communicate via the parallel IEEE interface the computer and gauge must be configured for the same "device address". The gauge is factory set to address (3) three. It may be changed to any address from 0 to 30 by DIP switches on the 488 interface option module. (See Table 4.6)

6.3.1 IEEE488 Capabilities

The IEEE488 computer interface option card coforms to the ANSI/IEEE488-1978 operating standard. The following list of implementation codes apply:

CODE	FUNCTION	IMPLEMENTED
SH1	SOURCE HANDSHAKE	YES
AH1	ACCEPTOR HANDSHAKE	YES
T8	TALKER	YES
TE0	EXTENDED TALKER	NO
L4	LISTENER	YES
LE0	EXTENDED LISTENER	NO
SR0	SERVICE REQUEST	NO
RL0	REMOTE LOCAL	NO
PP0	PARALLEL POLL	NO
DC0	DEVICE CLEAR	NO
DT0	DEVICE TRIGGER	NO
C0	CONTROLLER	NO

Interface Cable Compatability: HP 10833 or equivalent

ADDRESSING CAPABILITY

RANGE	-	0 Thru 30
LOCATION	-	On Card, Inside Unit
TYPE	-	5 Position DIP Switch
CONVENTION	-	Hex Code, 1=OFF, SWI is LSB
FACTORY SET	-	3

6.4 Software Handshaking Protocol (RS232 and IEEE488)

The message transferred between the gauge and computer is handled by a software handshaking protocol. This protocol allows the computer to transfer and receive messages with a high degree of confidence.

6.4.1 RS232 Message Format To Or From Gauge

All RS232 messages to or from a gauge follow the same format. A message consists of four parts:

```
  1       2         3        4
(STX)(LENGTH)(DATA)(CHECKSUM)
```

A message can contain a maximum of 24 characters.

6.4.2 IEEE488 Message Format To Or From Gauge

All IEEE488 messages to or from a gauge follow the same format. A message consists of two parts:

```
   1      2
(DATA)(EOS)
```

A message can contain a maximum of 24 characters.

6.5 Sending A Message To A Gauge

6.5.1 RS232 Format

Transmitting a message is accomplished in the following manner. A start of text character (STX) is sent to begin the exchange. After the STX character has been sent, additional character data must be sent with a maximum 3 second interval between characters. The gauge will automatically timeout if more than 3 seconds elapses between characters.

1. The STX character, (ASCII 02H) is the first character sent in the message.

2. The LENGTH character, (ASCII 01H) to (ASCII 15H), is the number of following DATA characters.

3. DATA characters - The DATA characters are organized into several group types, The first DATA character sent is called a COMMAND character. The type of command dictates the format and number of following characters. Commands are always an upper case ASCII letter. Several command types require a two digit ID number as a subset variable. If a command requires this variable it immediately follows the command character. Additional numerical data, if required, will then be sent most significant digit first.

4. CHECKSUM character - This binary character value is calculated as the numeric sum of all the unsigned binary DATA characters. The gauge controller or computer will use this character data to validate the received messages.

6.5.2 IEEE488 Format

Transmitting a message is accomplished in the following manner. The first character of the command is sent to begin the exchange. After this character has been sent, additional character data must be sent with a maximum 3 second interval between characters. The gauge will automatically timeout if more than 3 seconds elapses between characters.

1. DATA characters - The DATA characters are organized into several group types. The first DATA character sent is called a COMMAND character. The type of command dictates the format and number of following characters. Commands are always an upper case ASCII letter. Several command types require a two digit ID number as a subset variable. If a command requires this variable it immediately follows the command character. Additional numerical data if required will then be sent most significant digit first.

2. EOS character - The EOS character (ASCII 0AH) is sent to indicate the end of message.

6.6 Gauge Response To A Message

6.6.1 RS232 Format

When the gauge receives a complete message, it will process it and send a response to the computer. The gauge can receive and process only one message at a time. The computer must wait for a message response to be completed before transmitting another message. If no response is returned within 3 seconds, the message was not received properly and should be resent.

The response message sent by the gauge uses the same software handshaking protocol as the commanding message. The (STX) character is sent to initiate the gauge response message. Following characters will be sent within a 3 second internal. The computer should abort receiving the message if more than 3 seconds elapses between characters. A maximum of 24 characters will be sent to the computer in any message.

6.6.2 RS232 Gauge Response Message Format

A message from a gauge consists of four parts:

```
    1       2        3        4
(STX)(LENGTH)(DATA)(CHECKSUM)
```

A message can contain a maximum of 24 characters.

1. The STX character (ASCII 02H) is the first character sent in the message.
2. The LENGTH character. (ASCII 01H) to (ASCII 15H), is the number of following DATA characters.
3. DATA characters. The first DATA character sent in a response message will be either an ACK (ASCII 06H) or NAK (ASCII 15H) character. This character declares whether the message received and processed by the gauge was valid (ACK) or invalid (NAK). The NAK indicates a failed message response (see Section 6.7). If data is required in the gauge response then data is sent, most significant digit first.
4. CHECKSUM character. This binary character value is calculated as the numeric sum of all the unsigned binary data characters. The computer will use this character to validate the received messages.

6.6.3 IEEE488 Format

When the gauge receives a complete message, it will process it and send a response to the computer. The gauge can receive and process only one message at a time. The computer must wait for a message response to be completed before transmitting another message. If no response is returned within 3 seconds, the message was not received properly and should be resent.

The response message sent by the gauge uses the same software handshaking protocol as the commanding message. The first response character is sent to initiate the gauge response message. Following characters will be sent within a 3 second internal. The computer should abort receiving the message if more than 3 seconds elapses between characters. A maximum of 24 characters will be sent to the computer in any message.

6.6.4 IEEE488 Gauge Response Message Format

A message from a gauge consists of two parts:

```
   1     2
(DATA)(EOS)
```

A message can contain a maximum of 24 characters.

1. DATA characters - The first DATA character sent in a response message will be either an ACK (ASCII 06H) or NAK (ASCII 15H) character. This character declares whether the message received and processed by the gauge was valid (ACK) or invalid (NAK). The NAK indicates a failed message response (see Section 6.7). If data is required in the gauge response then data is sent, most significant digit first.

2. EOS character - The EOS characters (ASCII 0AH) is sent to indicate the end of message.

6.6.5 Computer Response From Gauge Messages For RS232 And IEEE488

The gauge does not expect any response from messages it sends to the computer. If the computer did not receive a message properly it should repeat the initial command.

6.7 Failed Command Response

If a gauge is unable to complete the command from the computer, it will respond with a specific error message including a code character to indicate the type of problem encountered.

6.7.1 Failed Command Response RS232 Format

The message from the gauge will consist of four parts:

```
  1     2         3      4
(STX)(LENGTH)(DATA)(CHECKSUM)
```

The message will contain a maximum of five (5) characters.

1. The STX character (ASCII 02H) is the first character sent in the message.
2. The LENGTH character. Always (ASCII 02H).
3. DATA will consist of the NAK (ASCII 15H) character declaring that the last command was unable to be processed. The next character will be an ERROR CODE character. This will be an ASCII upper case letter indicating the problem encountered. A list of the possible Error Codes and their definitions follows.
4. CHECKSUM character. This binary character value is calculated as the numeric sum of all the unsigned binary DATA characters. The computer will use this character to validate the received messages.

6.7.2 Failed Command Response IEEE488 Format

The message from the gauge will consist of two parts:

```
   1     2
(DATA)(EOS)
```

The message will contain a maximum of two (2) characters.

1. DATA will consist of the NAK (ASCII 15H) character declaring that the last command was unable to be processed. The next character will be an ERROR CODE character. This will be an ASCII upper case letter indicating the problem encountered. A list of the possible Error Codes and their definitions follows.
2. EOS character - The EOS character (ASCII 0AH) is sent to indicate the end of message.

6.7.3 Error Codes

ASCII Character	Definitions
(A)	ILLEGAL COMMAND CODE
(B)	ILLEGAL DATA VALUE
(C)	ILLEGAL COMMAND ID NUMBER
(D)	ILLEGAL MESSAGE FORMAT
(E)	DATA UNAVAILABLE DUE TO CONFIGURATION
(F)	COMMAND NOT EXECUTABLE
(G)	MESSAGE CHECKSUM ERROR

6.8 Gauge Commands

COMMAND characters are always upper case ASCII letters.

6.8.1 Overview List

ASCII	FUNCTION	ID# REQUIRED
(H)	HELLO	no
(K)	RS232 PORT TEST	no
(F)	READ PARAMETER VALUE	yes
(P)	SET PARAMETER VALUE	yes
(R)	REMOTE COMMAND	yes
(S)	STATUS REQUEST	yes

6.8.2 RS232 Inficon Format Or IEEE488 Commands

"H" - HELLO - Determine Presence and Type of Instrument

COMMAND FORMAT	- ("H")
ID#	- Not required
LENGTH	-1
RESPONSE FORMAT	- (ACK)(x)(x)(3)(sp)(n)(n)
LENGTH	-7
CHAR 1	- (ACK)
CHAR 2	- Either "I","P",or "C"
CHAR 3	- Either "C","G",or "M"
CHAR 4	- Always "3"
CHAR 5	- Always "space" character
CHAR 6	- MSD of version number
CHAR 7	- LSD of version number

"K" - COMMUNICATIONS DIAGNOSTICS (RS232 PORT)

COMMAND FORMAT	- ("K")(message characters, 20 max)
ID#	- Not required
LENGTH	- Variable
RESPONSE FORMAT	- (ACK)(message characters, 20 max)
LENGTH	- Same as transmission

"F" - READ PARAMETER VALUE (Requires a following ID#)

COMMAND FORMAT	- ("F")(IDM)(IDL)
ID#	- Two digit value required
LENGTH	- 3
CHAR 1	- "F"
CHAR 2	- MSD ID#
CHAR 3	- LSD ID#
RESPONSE FORMAT	- (ACK)(variable data)
LENGTH	- Variable with ID#

CMD	ID#	PARAMETER DEFINITION
"F"	64	- RELAY 1 SETPOINT, UPPER
"F"	65	- RELAY 1 SETPOINT, LOWER
"F"	66	- RELAY 2 SETPOINT, UPPER
"F"	67	- RELAY 2 SETPOINT, LOWER
"F"	68	- RELAY 3 SETPOINT, UPPER
"F"	69	- RELAY 3 SETPOINT, LOWER

RESPONSE FORMAT	- (ACK)(sensor#)(sp)(n)(dp)(n)(n)(E)(exp sign)(n)(n)
LENGTH	- 11
CHAR 1	- (ACK)
CHAR 2	- Sensor # "1","2",or "3"
CHAR 3	- Always "space" character
CHAR 4	- MSD of data field (DP may be in any loc.)
CHAR 5 THRU 7	- Rest of data field
CHAR 8	- Always "E" character
CHAR 9	- Exponent sign data "+" or "-" character
CHAR 10	- MSD of exponent data
CHAR 11	- LSD of exponent data

"F"	70	- LINEAR EXPONENT SENSOR 1
"F"	71	- LINEAR EXPONENT SENSOR 2
"F"	72	- LINEAR EXPONENT SENSOR 3

RESPONSE FORMAT	- (ACK)(exp sign)(n)
LENGTH	- 3
CHAR 1	- (ACK)
CHAR 2	- Exponent sign "+" or "-"
CHAR 3	- Number digit

CMD	ID#	- PARAMETER DEFINITION
"F"	73	**- GAIN FACTOR, (ION, COLD CATHODE)**
"F"	74	**- SECS TIMER 1, CHARACTER TIMEOUT (seconds)(01) for SECS**
"F"	75	**- SECS TIMER 2, PROTOCOL TIMEOUT (seconds)**

RESPONSE FORMAT	- (ACK)(n)(n)(dp)(n)
LENGTH	- 5
CHAR 1	- (ACK)
CHAR 2	- MSD data
CHAR 3	- Data
CHAR 4	- Always decimal point
CHAR 5	- LSD data

"F"	76	**- SECS RETRY COUNTER**

RESPONSE FORMAT	- (ACK)(n)(n)
LENGTH	- 3
CHAR 1	- (ACK)
CHAR 2	- MSD data
CHAR 3	- LSD data

"F"	77	**- SECS UPPER DEVICE ID**
"F"	78	**- SECS LOWER DEVICE ID**

RESPONSE FORMAT	- (ACK)(n)(n)(n)
LENGTH	- 4
CHAR 1	- (ACK)
CHAR 2	- MSD data
CHAR 3	- Data
CHAR 4	- LSD data

"F"	79	**- CROSSOVER PARAMETER**
"F"	80	**- CROSSBACK PARAMETER**

RESPONSE FORMAT	- (ACK)(n)(n)
LENGTH	- 3
CHAR 1	- (ACK)
CHAR 2 THRU 3	- Value code (see CMD "P79" and "P80")

CMD	**ID#**	**- PARAMETER DEFINITION**
"F"	**81**	**- AUTOZERO PARAMETER**

RESPONSE FORMAT	- (ACK)(n)(n)
LENGTH	- 3
CHAR 1	- (ACK)
CHAR 2 THRU 3	- Value code (see CMD "P81")

"P" - SET PARAMETER VALUE - (Requires following ID#)

COMMAND FORMAT	- ("P")(IDM)(IDL)(sp)(VARIABLE DATA)
ID#	- 2 Digit value required
LENGTH	- Variable with ID#
RESPONSE FORMAT	- (ACK)
LENGTH	- 1
CHAR 1	- (ACK)

"P"	**64**	**- RELAY 1 SETPOINT, UPPER**
"P"	**66**	**- RELAY 2 SETPOINT, UPPER**
"P"	**68**	**- RELAY 3 SETPOINT, UPPER**

CMD FORMAT	- ("P")(IDM)(IDL)(sp)(n)(sp)(n)(dp)(n)(n)(E)(sign)(n)(n)
LENGTH	- 14
CHAR 1	- ("P")
CHAR 2	- MSD ID#
CHAR 3	- LSD ID#
CHAR 4	- Always "space" character
CHAR 5	- Sensor # (1, 2, or 3)
CHAR 6	- Always "space" character
CHAR 7	- MSD data
CHAR 8	- Always "decimal point"
CHAR 9 THRU 10	- LSD's data
CHAR 11	- "E" character
CHAR 12	- Exponent sign "+" or "-"
CHAR 13 THRU 14	- Exponent data MSD first

"P"	**65**	**- RELAY 1 SETPOINT, LOWER**
"P"	**67**	**- RELAY 2 SETPOINT, LOWER**
"P"	**69**	**- RELAY 3 SETPOINT, LOWER**

CMD FORMAT	- ("P")(IDM)(IDL)(sp)(n)(dp)(n)(n)(E)(sign)(n)(n)
LENGTH	- 12
CHAR 1	- ("P")
CHAR 2	- MSD ID#
CHAR 3	- LSD ID#
CHAR 4	- Always "space" character

CHAR 5	- MSD data
CHAR 6	- Always "decimal point"
CHAR 7 THRU 8	- LSD's data
CHAR 9	- "E" character
CHAR 10	- Exponent sign "+" or "-"
CHAR 11 THRU 12	- Exponent data MSD first

CMD	**ID#**	**- PARAMETER DEFINITION**
"P"	**70**	**- LINEAR RECORDER EXPONENT SENSOR 1**
"P"	**71**	**- LINEAR RECORDER EXPONENT SENSOR 2**
"P"	**72**	**- LINEAR RECORDER EXPONENT SENSOR 3**

CMD FORMAT	- ("P")(IDM)(IDL)(sp)(sign)(n)(n)
LENGTH	- 7
CHAR 1	- ("P")
CHAR 2	- MSD ID#
CHAR 3	- LSD ID#
CHAR 4	- Always "space" character
CHAR 5	- Exponent sign "+" or "-"
CHAR 6	- MSD exponent data
CHAR 7	- LSD exponent data

"P"	**73**	**- GAIN FACTOR, (ION, COLD CATHODE)**
"P"	**74**	**- SECS TIMER 1, CHARACTER TIMEOUT (seconds) (01) for SECS**
"P"	**75**	**- SECS TIMER 2, PROTOCOL TIMEOUT (seconds)**

COMMAND FORMAT	- ("P")(IDM)(IDL)(sp)(n)(dp)(n)(n)
LENGTH	- 8
CHAR 1	- ("P")
CHAR 2	- MSD ID#
CHAR 3	- LSD ID#
CHAR 4	- Always "space" character
CHAR 5	- MSD data
CHAR 6	- Always "decimal point"
CHAR 7 THRU 8	- LSD data

"P"	**76**	**- SECS RETRY COUNTER**

COMMAND FORMAT	- ("P")(IDM)(IDL)(sp)(n)(n)
LENGTH	- 6
CHAR 1	- ("P")
CHAR 2	- MSD ID#
CHAR 3	- LSD ID#
CHAR 4	- Always "space" character
CHAR 5	- MSD data
CHAR 6	- LSD data

CMD	**ID#**	**- PARAMETER DEFINITION**
"P"	**79**	**- CROSSOVER PARAMETER**
"P"	**80**	**- CROSSOVER PARAMETER**

COMMAND FORMAT	- ("P")(IDM)(IDL)(sp)(n)(n)
LENGTH	- 6
CHAR 1	- ("P")
CHAR 2	- MSD ID#
CHAR 3	- LSD ID#
CHAR 4	- Always "space" character
CHAR 5 THRU 6	- Value code

CROSSOVER AND CROSSBACK VALUE CODES

CODE	TORR	MILLIBAR	PASCAL
01	1E-3	1.3E-3	1.3E-1
02	2E-3	2.6E-3	2.6E-1
03	3E-3	3.9E-3	3.9E-1
04	4E-3	5.3E-3	5.3E-1
05	5E-3	6.6E-3	6.6E-1
06	6E-3	7.9E-3	7.9E-1
07	7E-3	9.3E-3	9.3E-1
08	8E-3	1.06E-2	1.06E+0
09	9E-3	1.19E-2	1.19E+0
10	10E-3	1.33E-2	1.33E+0

"P"	**81**	**- AUTOZERO PARAMETER**

COMMAND FORMAT	- ("P")(IDM)(IDL)(sp)(n)(n)
LENGTH	- 6
CHAR 1	- ("P")
CHAR 2	- MSD ID#
CHAR 3	- LSD ID#
CHAR 4	- Always "space" character
CHAR 5 THRU 6	- Value code

AUTOZERO VALUE CODES

CODE	TORR	MILLIBAR	PASCAL
01	1E-5	1.33E-5	1.33E-3
02	2E-5	2.66E-5	2.66E-3
03	3E-5	3.99E-5	3.99E-3
04	4E-5	5.33E-5	5.33E-3
05	5E-5	6.66E-5	6.66E-3
06	6E-5	7.99E-5	7.99E-3
07	7E-5	9.33E-5	9.33E-3
08	8E-5	1.06E-4	1.06E-2
09	9E-5	1.19E-4	1.19E-2
10	1E-4	1.33E-4	1.33E-2

"R" - REMOTE COMMAND SEND (Requires following ID#)

FUNCTION	- Remotely operate gauge
ID#	- 2 Digit value required
LENGTH	- 3
DATA FORM	- ("R")(IDH)(IDL)
RESPONSE FORMAT	- (ACK)
LENGTH	- 1
CHAR 1	- (ACK)

CMD	ID#	- PARAMETER DEFINITION
"R"	00	- DISPLAY SENSOR 1
"R"	01	- DISPLAY SENSOR 2
"R"	02	- DISPLAY SENSOR 3
"R"	03	- LOCK OUT PARAMETERS
"R"	04	- UNLOCK PARAMETERS
"R"	05	- ZEROING ON
"R"	06	- ZEROING OFF
"R"	07	- INCREASE ZERO
"R"	08	- DECREASE ZERO
"R"	09	- TURN EMISSION ON
"R"	10	- TURN EMISSION OFF
"R"	11	- TURN DEGAS ON
"R"	12	- TURN DEGAS OFF
"R"	13	- LOCKOUT ZERO ADJ.
"R"	14	- UNLOCK ZERO ADJ.
"R"	15	- ENABLE SENSOR #2 AUTOZERO
"R"	16	- DISABLE SENSOR #2 AUTOZERO
"R"	17	- ENABLE SENSOR #3 AUTOZERO
"R"	18	- DISABLE SENSOR #3 AUTOZERO

"S" - READ EQUIPMENT STATUS (Requires following ID#)

COMMAND FORMAT	- ("S")(IDM)(IDL)
ID#	- 2 Digit value
LENGTH	- 3
RESPONSE FORMAT	- Variable with ID#
LENGTH	- Variable with ID#

CMD	ID#	- PARAMETER DEFINITION
"S"	00	**- READ PRESSURE SENSOR 1**
"S"	01	**- READ PRESSURE SENSOR 2**
"S"	02	**- READ PRESSURE SENSOR 3**

RESPONSE FORMAT	- (ACK)(dp)(n)(n)(n)(n)(E)(sign)(n)(n)
# CHAR	- 10
CHAR 1	- (ACK)
CHAR 2 THRU 6	- Value data MSD first, decimal point floats
CHAR 7	- "E" Character
CHAR 8	- Exponent sign "+" or "-"
CHAR 9 THRU 10	- Exponent value MSD first

"S"	03	**- READ SENSOR 1 TYPE**
"S"	04	**- READ SENSOR 2 TYPE**
"S"	05	**- READ SENSOR 3 TYPE**

RESPONSE FORMAT	- (ACK)(n)
LENGTH	- 2
CHAR 1	- (ACK)
CHAR 2	- Digit value 1 thru 6 0 = Capacitance diaphragm gauge, 1000 torr 1 = Capacitance diaphragm gauge, 100 torr 2 = Capacitance diaphragm gauge, 10 torr 3 = Capacitance diaphragm gauge, 1 torr 4 = Pirani 5 = Cold cathode 6 = Ion

"S"	06	**- READ BOARD CONFIGURATION SENSOR 1**
"S"	07	**- READ BOARD CONFIGURATION SENSOR 2**
"S"	08	**- READ BOARD CONFIGURATION SENSOR 3**

RESPONSE FORMAT	- (ACK)(n)(n)(n)(n)(n)(n)(n)(n)
LENGTH	- 9
CHAR 1	- (ACK)
CHAR 2	- AutoRange, 1 = off, 0 = on
CHAR 3	- AutoEmis , 1 = off, 0 = on
CHAR 4	- Lin/log recorder, 1 = log, 0 = linear
CHAR 5	- Nitrogen/Argon, 1 = Nitrogen, 0 = Argon
CHAR 6	- AutoDegas, 1 = off, 0 = on
CHAR 7	- Gain, 1 = Default, 0 = Programmable gain
CHAR 8	- AutoZero, 1 = off, 0 = on
CHAR 9	- Unused

CMD	ID#	- PARAMETER DEFINITION
"S"	**09**	**- READ ERRORS IN SENSOR 1**
"S"	**10**	**- READ ERRORS IN SENSOR 2**
"S"	**11**	**- READ ERRORS IN SENSOR 3**

RESPONSE FORMAT	- (ACK)(n)(n)
LENGTH	- 3
CHAR 1	- (ACK)
CHAR 2	- MSD error code
CHAR 3	- LSD error code
	- 00 = No errors
	- 10 = Emission error
	- 11 =180 volt error
	- 12 = Degas error
	- 13 = Cold cathode turn on error
	- 20 = Over pressure
	- 21 = Cable disconnected
	- 22 = Emission off

"S"	**12**	**- CPU CONFIGURATION**

COMMAND FORMAT	- ("S")(n)(n)
LENGTH	- 3
RESPONSE FORMAT	- (ACK)(n)(n)(n)(n)(n)(n)(n)(n)
LENGTH	- 9
CHAR 1	- (ACK)
CHAR 2	- SW 1, LSD baud, 00 = 300, 01 = 1200
CHAR 3	- SW 2, MSD baud, 10 = 2400, 11 = 9600
CHAR 4	- SW 3, 1 =RS232, 0=SECS
CHAR 5	- SW 4, LSD units, 01 = mbar, 10 = pascal
CHAR 6	- SW 5, MSD units, 11 =torr
CHAR 7	- SW 6, keyboard lock, 1 = off, 0 = on
CHAR 8	- SW 7, notation, 1 =scientific, 0=engineering
CHAR 9	- Unused

"S"	**13**	**- GET DISPLAYED SENSOR NUMBER**

COMMAND FORMAT	- ("S")(n)(n)
LENGTH	- 3 .
RESPONSE FORMAT	- (ACK)(n)
LENGTH	- 2
CHAR 1	- (ACK)
CHAR 2	- number 1, 2, or 3

CMD	ID#	- PARAMETER DEFINITION
"S"	**14**	**- GET EMISSION STATUS**
COMMAND FORMAT		- ("S")(n)(n)
LENGTH		- 3
RESPONSE FORMAT		- (ACK)(n)
LENGTH		- 2
CHAR 1		- (ACK)
CHAR 2		- code number, 0 = off, 1 = on
"S"	**15**	**- GET DEGAS STATUS**
COMMAND FORMAT		- ("S")(n)(n)
LENGTH		- 3
RESPONSE FORMAT		- (ACK)(n)
LENGTH		- 2
CHAR 1		- (ACK)
CHAR 2		- code number, 0 = off, 1 = on
"S"	**16**	**- READ I/O BOARD INPUTS**
COMMAND FORMAT		- ("S")(n)(n)
LENGTH		- 3
RESPONSE FORMAT		- (ACK)(n)(n)(n)(n)(n)(n)(n)(n)
LENGTH		- 9
CHAR 1		- (ACK)
CHAR 2		- 1 to 0 = select sensor 1
CHAR 3		- 1 to 0 = select sensor 2
CHAR 4		- 1 to 0 = select sensor 3
CHAR 5		- 1 to 0 = emission on, 0 to 1 =emission off
CHAR 6 THRU 9		- Unused
"S"	**17**	**- READ RELAY OUTPUT STATUS**
COMMAND FORMAT		- ("S")(n)(n)
LENGTH		- 3
RESPONSE FORMAT		- (ACK)(n)(n)(n)(n)(n)(n)(n)(n)
LENGTH		- 9
CHAR 1		- (ACK)
CHAR 2 THRU 5		- Unused
CHAR 6		- System relay, 0 = de-energized, 1 = energized
CHAR 7		- Relay 1, 0 = de-energized, 1 = energized
CHAR 8		- Relay 2, 0 = de-energized, 1 = energized
CHAR 9		- Relay 3, 0 = de-energized, 1 = energized

CMD	ID#	- PARAMETER DEFINITION
"S"	**18**	**- READ ZERO MODE ADJUSTMENT INDICATOR**

COMMAND FORMAT	- ("S")(n)(n)
LENGTH	- 3
RESPONSE FORMAT	- (ACK)(sign)(n)(n)
# CHAR	- 4
CHAR 1	- (ACK)
CHAR 2	- Sign of trend "+" or "-"
CHAR 3	- MSD data (0 or 1)
CHAR 4	- LSD data (0 thru 9)

"S"	**19**	**- GET COMMUNICATIONS ERRORS**

COMMAND FORMAT	- ("S")(01H)(09H)
LENGTH	- 3
RESPONSE FORMAT	- (ACK)(n)(n)(n)(n)(n)(n)(n)(n)
LENGTH	- 9
CHAR 1	- (ACK)
CHAR 2	- RS232 buffer full, 0=no error, 1 =error
CHAR 3	- IEEE488 buffer full, 0=no error, 1 =error
CHAR 4 THRU 7	- Unused
BYTE 8	- RS232 framing or overrun error 0=No error, 1=error
BYTE 9	- Unused

6.9 Basic Language RS232 Communications Driver Example

```
10 ' **** INITIALIZE CONSTANTS ****
20  STX$=CHR$(2) : NAK$=CHR$(21) : ACK$=CHR$(6)
50 '
60 ' **** OPEN RS232 COMMUNICATIONS ****
70  OPEN"COM1:9600,N,8,1,CS,CD" AS #1
80 '
90 ' **** MAIN PROCESSING LOOP ****
100 INPUT "ENTER COMMAND";COMMAND$            '— ENTER COMMAND FROM KEYBOARD —
110 GOSUB 150                                  '— TRANSMIT COMMAND —
120 PRINT RESPONSE$                            '— PRINT RESPONSE —
130 GOTO 90                                    '— LOOP BACK FOR NEXT COMMAND —
140 '
150 '***** TRANSMIT COMMAND & RECEIVE RESPONSE SUBROUTINE *******
160 '=== CALCULATE LENGTH OF COMMAND TO TRANSMIT ===
170 SIZE$=CHR$(LEN(COMMAND$))
190 '=== CALCULATE CHECKSUM OF COMMAND TO TRANSMIT ===
200 CHECKSUM=0                                 '— ZERO CHECKSUM —
210 FOR X= 1 TO ASC(SIZE$)                     '— ADD ASCII VALUE OF DATA —
220 CHECKSUM=CHECKSUM+ASC(MID$(COMMAND$,X,1))
230 NEXT
240 CHECKSUM$=CHR$(CHECKSUM AND 255)           '— STRIP OFF HIGH ORDER BYTE —
260 ' === TRANSMIT ENTIRE COMMAND ===
270 PRINT#1,STX$+SIZE$+COMMAND$+CHECKSUM$;
290 '== RECEIVE STX CHARACTER ===
300 GOSUB 540 : IF I$ < > STX$ THEN 270        '— READ CHARACTER —
330 '=== RECEIVE SIZE CHARACTER ===
340 GOSUB 540 : SIZE=ASC(I$)                   '— READ CHARACTER —
370 '=== RECEIVE DATA CHARACTERS ==
380 CHECKSUM=0                                 '— ZERO CHECKSUM —
390 RESPONSE$=" "                              '— CLEAR DATA RESPONSE STRING —
400 FOR I=1 TO SIZE
410 GOSUB 540                                  '— READ CHARACTER —
420 RESPONSE$=RESPONSE$+I$                     '— ADD CHARACTER TO RESPONSE$ —
430 CHECKSUM=CHECKSUM+ASC(I$)                  '— CALCULATE CHECKSUM OF DATA —
440 NEXT
460 '=== RECEIVE CHECKSUM CHARACTER ===
470 GOSUB 540 : N=ASC(I$)                      '— READ CHARACTER —
490 IF N< >(CHECKSUM AND 255) THEN PRINT "RESPONSE CHECKSUM ERROR"
510 '=== RETURN WITH DATA===
520 RETURN
530 '
540 '*** READ CHARACTER FROM INSTRUMENT TO I$ ***
550 ON TIMER(3) GOSUB 620                      '— INITIALIZE TIMEOUT VALUE —
560 TIMER ON                                   '— ACTIVATE TIMER —
570 IF LOC(1)<1 THEN 570 ELSE TIMER OFF        '— WAIT FOR CHARACTER —
580 I$=INPUT$(1,#1) : RETURN                   '— READ CHARACTER AND EXIT —
600 '
610 '=== RECEIVE TIMEOUT EXCEEDED ===
620 TIMER OFF                                  '— TURN TIMER OFF —
630 PRINT "RECEIVE TIMEOUT"                    '— PRINT ERROR MESSAGE —
640 RETURN                                     '— EXIT —
```

6.10 Basic Language IEEE488 Driver Example

```
' *****GAUGE IEEE488 TEST PROGRAM *****
'
' WRITTEN IN MICROSOFT "QUICK BASIC 4.5"
' USING "CAPITOL EQUIPMENT CORPORATION PC<=>488" IEEE488 CONTROLLER BOARD
'
 DEF SEG = &HC400
 INITIALIZE% = 0: SEND% = 36: ENTER% = 39: MY.ADDRESS% = 21
 DEVICE% = 3                                                  'DEFAULT GAUGE ADDRESS
 SYSTEM.CONTROLLER% = 0                                       'CONTROLLER ADDRESS
 CALL ABSOLUTE(MY.ADDRESS%, SYSTEM.CONTROLLER%, INITIALIZE%)

START:
 INPUT "ENTER COMMAND "; ST$
 CALL ABSOLUTE(DEVICE%, ST$, STATUS%, SEND%)                  'SEND COMMAND
 R$ = SPACE$(20)                                              'RESERVE SPACE FOR RESPONSE
 CALL ABSOLUTE(R$, LENGTH%, DEVICE%, STATUS%, ENTER%)         'RECEIVE RESPONSE
 PRINT R$                                                     'DISPLAY RESPONSE
GOTO START
```

6.11 SEMI SECS II Interfacing Standard

The gauge will support the SEMI EQUIPMENT COMMUNICATIONS STANDARD (SECS) II 1986 version with minor exceptions. A detailed explanation of this communications standard is beyond the scope of this manual. It is recommended that the user refer to the BOOK OF SEMI STANDARDS 1986 Volume 2, Equipment Division; for a complete operational specification. This document is available from the Semiconductor Equipment and Materials Institute Inc., 625 Ellis St., Suite 212, Mountain View, CA 94043 U.S.A.

6.11.1 Valid SECS II Communications Commands*

1- ARE YOU THERE? (STREAM 1,FUNCTION 1)
   Read Type of Instrument and Version Number.

2- EQUIPMENT STATUS REQUEST (STREAM 1,FUNCTION 3)
   Read Equipment Status.
   EXCEPTIONS: Request only one status variable ID# at a time. Zero length items do not report all status variable ID's.

3- EQUIPMENT CONSTANT REQUEST (STREAM 2,FUNCTION 13)
   Read Parameter Values.
   EXCEPTIONS: Request only one Equipment constant at a time. Zero length items do not report all equipment constant ID's.

4- EQUIPMENT CONSTANT REQUEST (STREAM 2,FUNCTION 15)
   Read Parameter Values.
   EXCEPTIONS: Program only one Equipment constant at a time.
   RECEIVER TIMER, ID#1, does not support 1 byte integer format data. It will support 3 byte ASCII data.

5- REMOTE COMMAND SEND (STREAM 2,FUNCTION 21)
   Send remote commands, key events, sensor display change.

6- LOOPBACK DIAGNOSTICS REQUEST (STREAM 2,Function 25)
   Echo transmission.
   Up to 21 characters after the 10 byte header are allowed.

6.11.2 Exceptions To The Standard

1. Hardware Interface: The gauge controllers provide a "9 pin D" connection instead of the specified "25 pin D" connection.

2. Commands 2, 3, and 4 are supported with minor restrictions as noted above.

**All ID's are ASCII items. All variable data are ASCII items.*

Section 7
Calibration

Contents

7.0 Calibration

The term calibration, in reference to vacuum gauges, is used in several ways. When a gauge is "calibrated" it may be adjusted for zero drift, calibrated to a specific gas, or compared to a standard. An adjustment for zero drift is done via the sensor, or the control unit for fine adjustment. Zero drift occurs in capacitance diaphragm (CDG) and Pirani type sensors. The cold cathode and hot cathode sensors can be calibrated to a standard or for a specific gas.

7.1 Ion Gauge

The Inficon IG3 ion gauge controller allows you to enter a sensitivity factor "F" in the program mode to correct "calibrate" the instrument for direct reading of pressure (see Section 5.1.3). The sensitivity factor has three primary uses: an adjustment for tube sensitivity; correction factor for the gas being measured; and a calibration factor against a standard. The default sensitivity factor (1.00) corresponds to a gauge sensitivity of 10 per torr; this is a typical value for commercial gauge tubes measuring nitrogen or air. For better accuracy a sensitivity factor, ranging from .60 to 2.50, can be entered.

Example: To correct the instrument for a gauge tube having sensitivity of 8.33 per torr (manufacturer's specification or calibration laboratory result)

Sensitivity Factor = $\frac{10}{8.33}$ = 1.20 (set the gauge factor to 1.20 in the program mode)

Inficon single filament ion gauge tubes have a typical sensitivity of 8/torr. For these sensors, accuracy can be increased without performing an entire calibration procedure by setting the gauge factor to 1.25 in the program mode. Dual filament gauge tubes typically have a sensitivity of 12/torr. These sensors can be roughly calibrated by entering a gauge factor of 0.83 in the program mode. Furthermore, hot cathode ionization gauges are gas dependent. Ionization efficiencies depend on gas types existing in the vacuum system. An adjustment for a specific gas can be made as follows:

Table 7.1

GAS	SENSITIVITY vs N_2	GAS	SENSITIVITY vs N_2
Nitrogen	1.0	Neon	0.23
Air	1.0	Argon	1.20
Water	1.0	Xenon	3.00
Oxygen	1.0	Carbon Dioxide	1.40
Hydrogen	0.45	Carbon Monoxide	1.05
Helium	0.14		

A multiplier for the existing gas type can be included in the sensitivity factor (within the available range .60 to 2.50).

Example:

Inficon single filament ion tube sensitivity is 8/torr.
From above: gauge factor is 1.25.

Gas is Carbon Dioxide, not Nitrogen.
Ionization sensors are calibrated for Nitrogen which has a default sensitivity factor of (1.00)
From Table 7.1, sensitivity vs N_2 is 1.40

(gauge reads too high)

Multiplier = 1.00/1.40 = .71

Multiply gauge tube sensitivity factor by .71 and enter the resulting number in the program mode.

(.71) (1.25) = .89

7.2 Cold Cathode Gauges

The cold cathode controller and sensor may be calibrated by comparing the system reading to a known standard and then changing the sensitivity factor in the controller, through the program mode, by the appropriate ratio to give a correct reading. The sensitivity factor has a range of 0.60 to 2.50 and is a multiplier applied to the sensor output. Because the output is not necessarily proportional to pressure, the pressure reading may not change by the expected amount, and some experimentation may be required to determine the best correction factor.

The most practical method for further calibration of a cold cathode unit is to attach the sensor to a vacuum system in which the pressure is known by other means and to adjust the sensitivity factor to increase or decrease the gauge reading, as required. Cold cathode gauges are operated in a non-linear manner to limit the power dissipation at high pressures and prolong gauge life. Therefore, there is no single sensitivity value like that given for the hot cathode ion gauge. The default sensitivity parameter for programming (1.00) corresponds to the typical output of a new sensor. The test is best done at similar pressure to that which will be encountered in use.

Cold cathode sensors are not as accurate or linear as hot cathode type sensors. However, cold cathode sensors are simple in design which allows easy cleaning and replacement of spare parts. (See Section 9.2) Furthermore, the sensor is rugged, insensitive to air exposure, and the electron current is pressure independent. As the pressure gets lower there is no need to increase emission current as in the hot cathode sensor.

Cold cathode sensors are also gas dependent. The sensor has varying sensitivities depending on the gas type or mixture being monitored. Caution should be observed to prevent possible over-pressure conditions caused by misleading pressure indications.

7.3 Pirani Gauge

Pirani type sensors are normally adjusted at the endpoints of their response for both a zero and full scale reading. There are adjustments for both of these settings on the sensor. In addition, a method for adjusting the zero reading is provided on the controller (see Section 4.8). The zero adjustment should be made at a system pressure of 5×10^{-5} torr or better. The full scale or (atm) adjustment can be made at atmospheric pressure. These adjustments have some interaction and may have to be repeated for best results. Although these sensors are fairly stable once adjusted, they may exhibit some long term zero drift with aging and contamination. If this occurs, cleaning and/or recalibration may be necessary.

WARNING!!

THESE SENSORS ARE TYPICALLY USED IN HIGHER PRESSURE VACUUM APPLICATIONS AND THEIR READINGS ARE HIGHLY SENSITIVE TO GAS TYPE.

FALSE PRESSURE READINGS MAY RESULT IN NON-INDICATED OVERPRESSURE SITUATIONS WHEN GASES OTHER THAN NITROGEN OR ARGON ARE BEING MONITORED.

The following procedure should be used for adjustment of a Pirani sensor:

NOTE: The use of Nitrogen gas with the gas configuration switch set to N_2, or the use of Argon with the gas configuration set to Argon is assumed in the following instructions. If an alternate gas is being used, please consult Figure 7.1.

NOTE: Controller should be off when starting this procedure. (See set up procedure Section 3.4.5.)

1. Connect Pirani sensor via cable to the vacuum gauge controller.
2. Make sure AutoZero is OFF before continuing (i.e., switch #4 on the Pirani board must be OFF).

   NOTE: This applies to gauge controllers (IG3 or CC3) with V14 software and above.

3. Turn the power switch to ON while simultaneously depressing the front panel ZERO button until the sensor display appears. This operation will reinitialize the zeroing circuit within the controller.
4. Allow the gauge to warm up for approximately 15 minutes.

5. With the Pirani sensor in its operating position, (horizontal or vertical), adjust the 100% potentiometer on the sensor until the gauge controller reads atmospheric pressure (i.e., 760 torr or 7.6^{+2}). After adjustment, the Pirani may drift in either direction. This drift is normal for Pirani sensors at higher pressures and will not affect readings below approximately 100 torr (an analog controller meter scale is about 0.2 inches wide between 1000 and 100 torr, making drift less apparent). For this reason, Pirani sensors are not recommended for control purposes over 100 torr.

6. Connect the Pirani sensor to a vacuum chamber and evacuate to a pressure of 5×10^{-5} torr or less.

7. If the controller displays a pressure reading other than 0.00, skip step #8 and continue with step #9.

8. If the controller displays a pressure reading of 0.00, turn the 0% potentiometer on the Pirani sensor clockwise until a pressure reading is displayed.

9. While observing the controller, slowly turn the 0% potentiometer counter-clockwise (watching the pressure decrease) until the pressure reads 0.00. DO NOT continue to adjust once a reading of 0.00 has been obtained.

   NOTE: The Pirani sensor zero potentiometer adjustment must be within the window of operation of the fine adjustment.

FINE ADJUSTMENT

10. Depress the **ZERO** button on the gauge controller. "**ZRO**" will be displayed. If the pressure trend display shows one green arrow and one red arrow, alignment is completed. More than one red arrow indicates the setting is too high, while multiple green arrows indicate it is too low.

11. If the pressure trend display shows red arrows, depress the ▽ key until one red arrow and one green arrow are displayed. If it shows green arrows, depress the △ key until one red and one green arrow are displayed.

12. These adjustments have some interaction and may have to be repeated for best results. After completing the procedure, vent the sensor to atmosphere and verify that the controller is reading correctly, taking into account normal drift. Otherwise, repeat steps 5-11.

The controller zero adjustment (fine adjustment) may be used after initial adjustment. This eliminates distance and placement difficulty involved with adjusting the sensor and then looking at the display. Instead, the adjustment is made through the gauge controller key pad, and there is no need to adjust the sensor.

Adjustments may be made until the window of operation of the zero function is exceeded. In this event, power down the controller and start with Step 3.

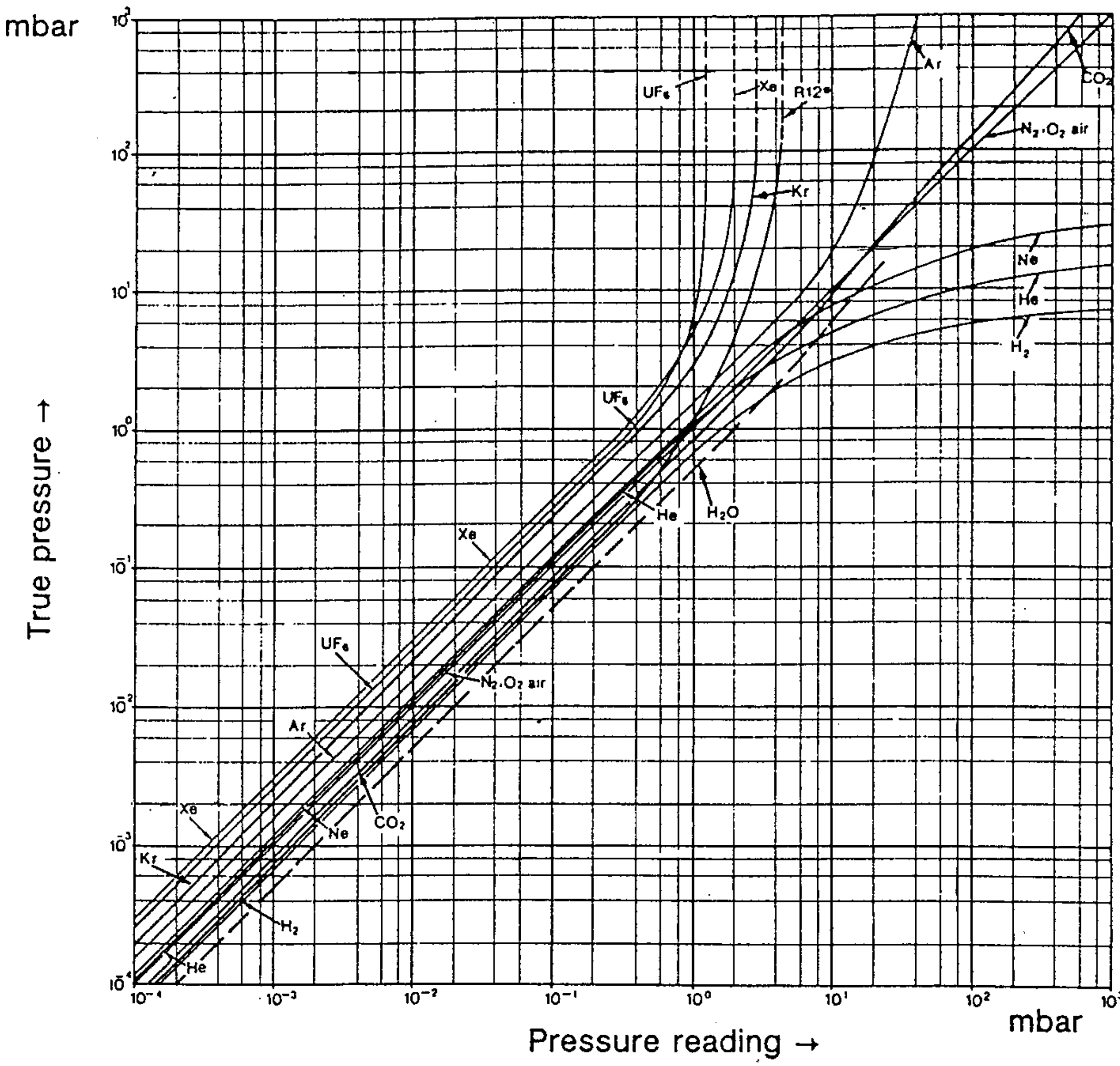


Figure 7.1 - Pirani Calibration Sensitivities

7.4 Capacitance Diaphragm Gauge (CDGs)

CDGs are fully adjusted and calibrated in-house to a standard. However, periodic adjustment of the sensor "zero point" will be necessary. Zero drift is a normal phenomena with CDG sensors. The required frequency of zero adjustment will be largely dependent on the application, conditions, and accuracy required of the reading. It is normal for zero drift to be more apparent after large pressure excursions, over-pressure conditions, or changing ambient temperatures. If frequent and fast venting is performed the sensor should be isolated with a valve upon rising pressure. Under normal conditions CDGs may have to be zeroed once a week. In addition, CDGs are not recommended for critical measurement in their lowest decade. This decade is where the effects of zero drift and resolution limits are most noticeable.

The following guidelines should be observed when making zero adjustments.

1. Verify the type of sensor you have. It will be either a model CDG120 or a CDG100. The model number is on the sensor. Before making any adjustments CDG120's should be allowed to warm up for four hours. CDG100's should be allowed to warm up for 15 minutes if both the sensor and the room are at approximately ambient temperature. Otherwise, let the sensor warm up longer; 1 to 2 hours.

2. Assuming the gauge controller is off, turn it on while holding in the ZERO button on the front keypad. Hold it in until the sensor display appears. This operation reinitializes the zeroing circuit in the controller.

3. To zero the sensor you will need to achieve a vacuum pressure of at least one decade below the lowest reading of the sensor (see table 7.2). For example, a 1000 torr sensor's lowest reading is $1x10^{-1}$ torr. Therefore, a vacuum pressure of at least $1x10^{-2}$ torr must be achieved. A reference sensor, or high vacuum sensor (i.e., Ion gauge) is needed to confirm that you have achieved the proper pressure for zero adjustment.

4. Find the potentiometer on the sensor for zero adjustment. It will be labeled "ZERO ADJ".

5. If the controller display *DOES NOT READ ZERO*, turn the potentiometer until a reading of 0.00 is obtained. After having obtained a reading of 0.00, turn the potentiometer back just until a reading appears; and then make it read 0.00 again. This is done to position the sensor so it is on the edge of reading the lower limit but still reading zero. In the case of a 1000 torr sensor the "edge" would be $1x10^{-1}$ torr.

6. If the controller display *READS ZERO*, adjust the potentiometer on the sensor so that it is on the "edge" of reading the lower limit of the sensor. As stated above, this means you must turn the potentiometer just until a reading appears; and then make it read zero again.

7. There is also a "ZERO" adjustment feature on the gauge controller that allows an electronic offset to be added or subtracted from the sensor reading (see Section 4.8 and 7.3, step 10 Fine Adjustment for Pirani sensors). Any offsets made by using this feature are cleared by following step number 3 above. For critical measurements, it is recommended to use only the zero potentiometer on the sensor to make adjustments. The adjustment on the CDG sensor is more sensitive than the controller adjustment. In version 11 software and above the **ZERO** key may be locked out to prevent unauthorized or accidental tampering with the zero offset (see section 4.8).

CDGs give a pressure response independent of the gas type being measured and as such may be used as a secondary calibration standard when properly adjusted.

Table 7.2
Capacitance Diaphragm Gauge Zero Adjustment Pressures

Capacitance Diaphragm Gauge Range (F.S.)	Lowest Pressure Reading	Maximum Pressure for Zero Adjustment
10 torr	1×10^{-3} T	1×10^{-4} T
100 torr	1×10^{-2} T	1×10^{-3} T
1000 torr	1×10^{-1} T	1×10^{-2} T

CAUTION: *Please* **do not** *make any adjustments on CDG sensors except for the zero point. There is an unlabelled potentiometer covered by a plug on the top of the sensor. Adjustment of this potentiometer could cause an unwanted calibration shift over the entire range of the sensor. It is only for use by qualified factory personnel who use it in conjunction with highly accurate standards.*

Section 8
Specifications

Contents

8.1 Specifications* - IG3, CC3, CM3, PG3 Controllers

8.1.1 Technical Data - Gauge Controllers

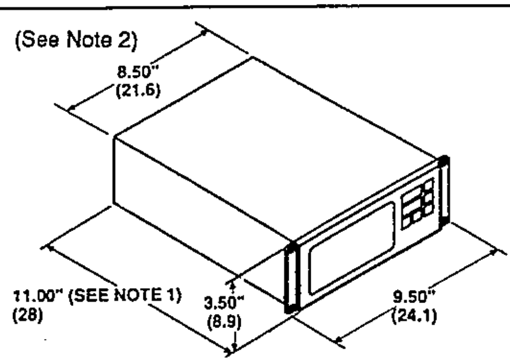
Standard Specifications	IG3 Ion Gauge	CC3 Cold Cathode Gauge	CM3 Capacitance Diaphragm Gauge	PG3 Pirani Gauge
Pressure Range .... torr for Primary Sensor	$1x10^{-2}$ to $1x10^{-10}$	$1x10^{-2}$ to $1x10^{-7}$	$1x10^{3}$ to $1x10^{-3}$	$1x10^{3}$ to $1x10^{-4}$
Measurement Rate .... for Primary Sensor	>15 Hz at >$1x10^{-9}$ torr decreasing to 0.25 Hz at $1x10^{-10}$	15Hz	15Hz	15Hz
Primary Sensors .... (Capability to use Pirani and Capacitance Diaphragm Gauges can be added to all controllers)	Standard Bayard-Alpert type sensors nude or glass tubulated	Inficon Cold Cathode Magnetron sensor	Inficon type 100 or type 120 Capacitance Diaphragm sensors or equivalent	Inficon Model TR 901 or TR 905 Pirani gauge sensor
Measurement Correction Factor	Digital Sensitivity Parameter		Zero Adjustment	Full scale and zero adjustment
Measurement Technique	Ion current to frequency and period	Cathode current to frequency and period	Voltage to frequency conversion (16 bit FS conversion)	Bridge current to frequency with digital linearization
Display Type	Multiplexed Liquid Crystal			
Display Update	4 per second			
Data Display	3½ digits plus exponent			
Keyboard	Membrane type with tactile feel			
Recorder Output	0-10 Vdc log or linear, 13 bit resolution, 5mA source capacity, 60 ms response time			
Computer Interface	RS232C (IEEE488 optional)			
Power Requirements	120/240 VAC, +5/-20%, 50/60 Hz, 100 VA max			
Ambient Temperature	Operating: 0 to 50°C, 80% RH NC; Storage: -40° to 65°C			
Dimensions (W x H x D)	8½" x 3½" x 11" (see Figure 8.1)			
Weight....................................	10 pounds			
Selectable Parameters				
Measurement Units	torr, mbar, Pascal			
Display Format	Scientific notation	Scientific notation	Scientific notation or Engineering Units	
Lock	Keyboard security lock out of program function Zero lock out			

**Due to Leybold Inficon's continuing program of product improvements, specifications may change without notice.*

Specifications	IG3 Ion Gauge	CC3 Cold Cathode Gauge	CM3 Capacitance Diaphragm Gauge	PG3 Pirani Gauge
Baud Rate	9600, 4800, 1200, 300			
RS232C Format	SEMI SECS II or Inficon Formats			
Recorder Output	Logarithmic or 3 decade linear			
Gas Type	N_2 or Argon	N_2 or Argon	-	N_2 or Argon
Automatic Emission Control	Controlled via Pirani or Capacitance Diaphragm plug-in boards		-	-
Auto Selection	-	-	Auto switching among 2 or 3 sensors	-
Auto Degas	With emission activation	-	-	-
Auto-Zero	Controlled via Pirani plug-in board-			-
Sensitivity	Programmable	Programmable	-	-
Relay Setpoints	Controlled via Relay I/O board			

8.1.2 Technical Data - Options for Gauge Controllers

Description	
Measurement Boards	Up to 2 chosen from Pirani or capacitance diaphragm
Relay I/O	4 Outputs: 3 relays with programmable upper and lower limits; 1 system status relay NO/NC contacts, 120 VAC, 100 VA, 1 amp max switching current. 4 Inputs: Remote emission activation and remote sensor selection.
Computer Interface	RS488 (IEEE) for operation with computer



NOTES:
1. An Additional 2.5" "(6.4) should be added to allow cable clearance.
2. Includes screwheads.

In (cm)

Figure 8.1 - Dimensional Data - Gauge Controllers

8.2 Inficon Gauge Sensors

8.2.1 Technical Data - Hot Cathode Ionization Gauge Sensors

Specifications	Nude	Kovar Glass Tubulated
Measuring Range	1 x 10^{-10} to 1 x 10^{-2} torr	
Nominal Sensitivity	12 per torr	8 per torr single filament 12 per torr dual filament
Vacuum Connection	2 ¾" ConFlat	1" or ¾" tubulation or mounted on 2¾" ConFlat
Filaments...............................	Replaceable, dual, thoria-coated iridium, or tungsten	Single thoria-coated iridium or dual tungsten
Filament Bias	30 Vdc	30 Vdc
Filament Power	30VA Max.	30VA Max.
Collector Bias	0 Vdc	0 Vdc
Anode Bias	180 Vdc	180 Vdc
Emission Current.....................	Auto variable 8.33 mA Max. 83.3 µA Min.	
Emission Regulation	.1%	.1%
Emission Protection	Auto shutdown 1. Over pressure 1 x 10^{-2} torr 2. Regulation failure	
Degas Type	Resistive Anode heating 0 to 5A RMS current regulated/30VA Max. 30 second ramp to full power 3 minute total duration with automatic timeout	
Max. Operating Temperature ..	50°C	50°C
Max. Bakeout Temperature	400°C	400°C
Volume (Internal)	-	220 cc

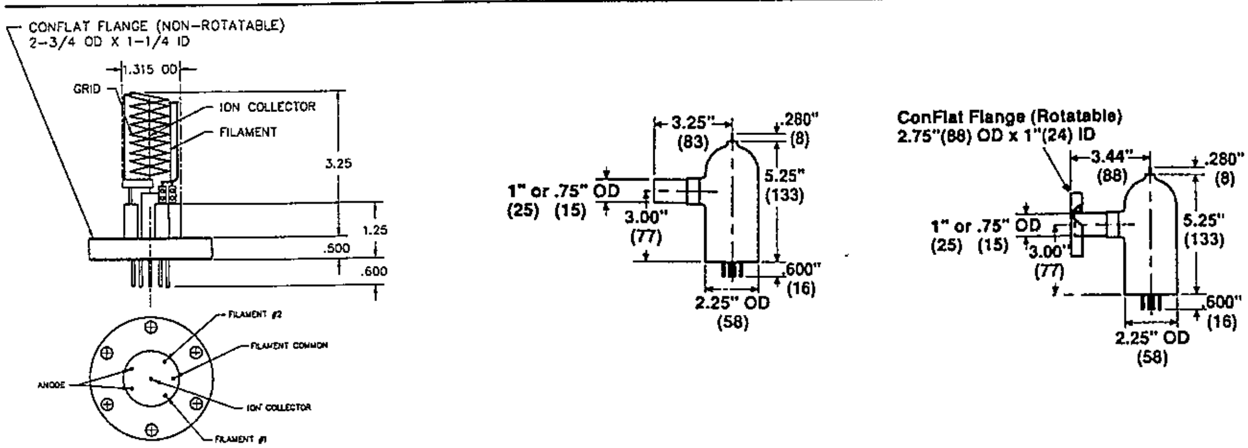


Figure 8.2 - Dimensional Data - Hot Cathode Sensors

8.2.2 Technical Data - Cold Cathode Gauge Sensors

Specifications	
Measuring Range	1 x 10^{-7} to 1 x 10^{-2} torr
Vacuum Connections	KF25, 1" tube connection or 2¾" ConFlat
Materials Exposed to Vacuum	Stainless steel, graphite, ceramic, pyrex
High Voltage Supply	3 kV @ 1mA Max. on Start-up 2 kV @ 1mA Max. after Start-up
High Voltage Protection	Current Limiting
Maximum Overpressure	2 psig 850-610-G1 15 psig 850-610-G2
Volume of Tube	25 cc
Max. Operating Temperature	50°C
Max. Bakeout Temperature	With magnet removed: 350°C

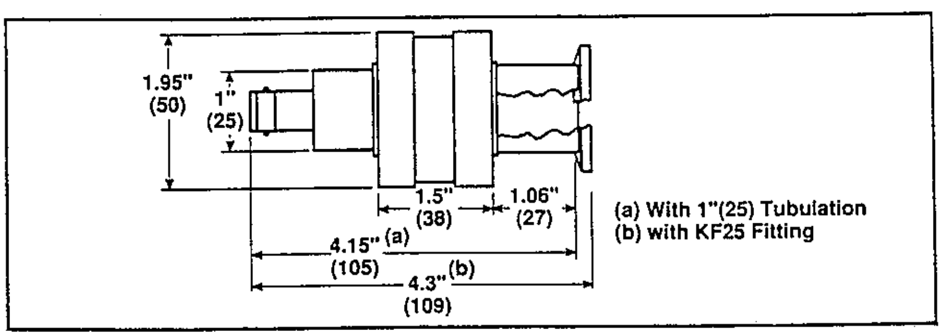


Figure 8.3 - Dimensional Data - Cold Cathode Sensors

8.2.3 Technical Data - Pirani Gauge Sensors

Specifications	Model TR 901	Model TR 905
Measurement Range	1 x 10^{-4} to 1000 torr	
Vacuum Connection	KF10 or ⅛" NPT	CF16
Materials Exposed to Vacuum	Nickel plated carbon steel, tungsten, nickel-chrome, Araldit epoxy, glass	Stainless steel 1.4301, nickel ceramics, nickel-chrome, tungsten
Max. Overpressure	2 Atm	-
Operating Temperature	0-40°C Temperature-compensated up to 70°C with some effect on accuracy	
Filament Temperature	125°C	
Sensor control	Closed Loop Balanced Bridge	
Bridge Bias	12 Vdc Max.	
Bridge Current	50 mA Max. - Current Limited	
Regulation	.1%	
Response Time	<20 ms	
Max. Bakeout Temperature	80°C with electronics removed	400°C
Volume of Sensor	10 cc	-
Filament Material	tungsten	

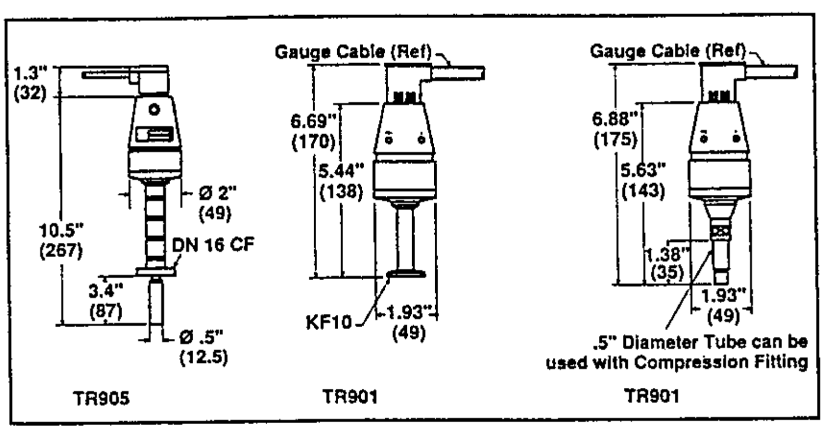
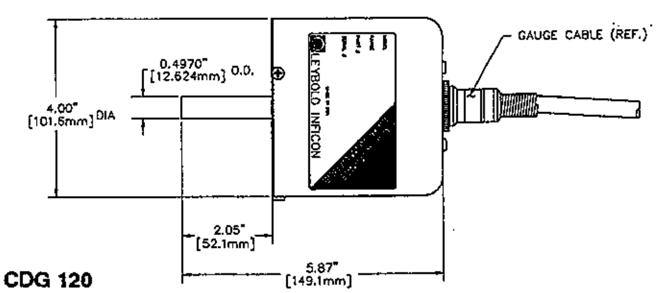


Figure 8.4 - Dimensional Data - Pirani Sensors

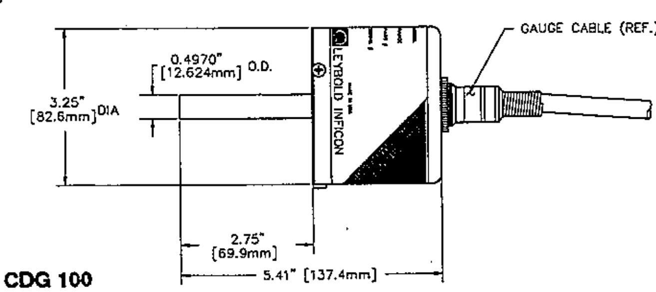
8.2.4 Technical Data - General Purpose Capacitance Diaphragm Gauge Sensors

Specifications	CDG 100	CDG 120 (Heated)
Measuring Range	10, 100, 1000 torr full scale	10, 100, 1000 torr full scale
Accuracy .... (Linearity, Hysteresis, Repeatability)	0.5% of reading ± zero span temperature coefficients	0.15% of reading ± zero and span temperature coefficients
Resolution	0.005% of FS	
Temperature Effects Zero Coefficient .... Span Coefficient	 0.01% of FS/°C 0.05% of reading/°C	 0.008% of FS/°C 0.04% of reading/°C
Operating Temperature .... Range	15° to 40°C	0° to 40°C
Time Constant	≤16ms	≤16ms
Input Signal	±15 Vdc ±5% @ 30 mA	±15 Vdc ±5% @ 300 mA
Output signal	0 - 10 Vdc into > 10 kOhm load	
Max. Overpressure	120% of FS or 20 PSIA, whichever is greater	
Volume	≈ 8 cc with ½" tube	
Materials Exposed .... to Vacuum	Inconel® and stainless steel	
Vacuum connections	VCR, VCO, KF16, 2¾ ConFlat	

NOTE: For optional fittings, add 1"–1½" (25.4mm–38.1mm) to length dimension.



CDG 120



CDG 100

Figure 8.5 - Dimensional Data - Capacitance Diaphragm Gauge Sensors

8.3 Spare Parts and Accessories

Hot Filament Ion Gauges

Description	Part Number
Hot Filament Ionization, Glass Envelope (Bayard-Alpert)	
¾" Kovar, Single Thoria-Coated Iridium Filament	850-675-G1
1" Kovar, Single Thoria-Coated Iridium Filament	850-675-G2
¾" Kovar, Dual Tungsten Filament	850-675-G3
1" Kovar, Dual Tungsten Filament	850-675-G4
1" Kovar, on 2¾" ConFlat®, Single Thoria-Coated Iridium Filament	850-675-G5
1" Kovar, on 2¾" ConFlat®, Dual Tungsten Filament	850-675-G6
Cables for Glass Envelope Tubes	
10 ft Cable	850-207-G10
30 ft Cable	850-207-G30
Nude Hot Filament Ionization on 2¾" ConFlat	
Nude Dual Tungsten Filament	850-676-G1
Nude Dual Thoria-Coated Iridium Filament	850-676-G2
Cables for Nude Tubes	
10 ft Cable	850-211-G10
30 ft Cable	850-211-G30
Replacement Filaments for Nude Gauge Tubes	
Tungsten Filament (set of 2)	850-660-P1
Thoria-Coated Iridium Filament (set of 2)	850-662-P1

Cold Cathode Gauges

Cold Cathode Gauge Tubes (Penning)	
Cold Cathode Gauge Tube with 1" Tube	850-610-G1
Cold Cathode Gauge Tube with KF®25 Flange	850-610-G2
Cold Cathode Gauge Tube with 2¾" ConFlat Flange	850-610-G3
Cables for Cold Cathode Tubes	
10 ft Cable	850-305-G10
30 ft Cable	850-305-G30
40 ft to 300 ft cable in 10 ft increments*	850-305-GXX
Replacement Electrodes for Cold Cathode Tubes	
Spare Parts Kit	850-614-G1

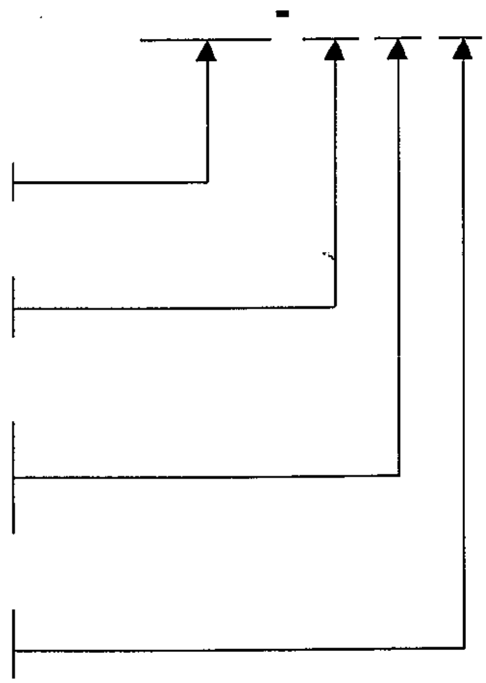
Pirani Thermal Conductivity Gauges

Pirani Gauge Tubes	
Model TR901 with KF10 Flange	89630
Model TR901 with ⅛" NPT Fitting	89631
Model TR905 with CF16 mini-ConFlat Flange	89632
Cables for Pirani Gauge Tubes	
10 ft Cable	850-405-G10
30 ft Cable	850-405-G30
40 ft to 150 ft cable in 10 ft increments*	850-405-GXX
Replacement Sensing Element	
Model TR901 with KF10 Flange	16209
Model TR901 with ⅛" NPT Fitting	89676
Model TR905 with CF16 mini-ConFlat Flange	15851

ConFlat is a registered trademark of Varian   KF is a registered trademark of Leybold Inc.   *Consult factory for longer length cables

Capacitance Diaphragm Gauge Sensors

Part Number Code (e.g., CDG100-230)



Description	**Ordering Code**
Sensor	
CDG100 Sensor	CM100
CDG120 Sensor	CM120
Sensor Range	
10 torr	2
100 torr	3
1000 torr	4
Fittings	
½" Tube Standard	0
Cajon 8VCR	1
Cajon 8VCO	2
KF16 Flange	3
2¾" ConFlat Flange	4
Cables	
None	0
10 ft.	4
30 ft.	5
(Special length cables can be ordered separately - see below)	

Cables can also be ordered separately:

10 ft for CDG100 & CDG120	850-505-G10
30 ft for CDG100 & CDG120	850-505-G30
40 ft to 100 ft cable in 10 ft increments	850-505-GXX

8.4 Hardware I/O Option Specifications

CAPABILITY	4 Inputs and 4 Outputs
CONNECTOR	25 Pin "D Type" Male
OUTPUTS	120V 100VA Contacts NO/NC/C Terminals 1 Amp Max Switching Current (Resistive) 3 Uncommitted Setpoint Relays 2 Programmable Setpoints per Relay 1 System Status Relay Leakage < 0.1 mA.
INPUTS	Closure or TTL Active Low Level Loading Equivalent to 1 TTL Gate 1 Emission On/Off 3 Sensor Selection Inputs for Display All Inputs are edge detected in software
CONNECTOR	Amp 747913-2 or equivalent INFICON IPN # 051-483 (Supplied with option board)

PIN FUNCTION LIST

	FUNCTION			**PIN**
INPUTS:	EMISSION		-	1
	SENSOR 1		-	4
	SENSOR 2		-	3
	SENSOR 3		-	2
	GROUND		-	14,15,16,17
OUTPUTS:	RELAY 1	COM	-	6
		NO	-	7
		NC	-	8
	RELAY 2	COM	-	11
		NO	-	10
		NC	-	9
	RELAY 3	COM	-	25
		NO	-	13
		NC	-	12
	STATUS	COM	-	21
		NO	-	22
		NC	-	23

Section 9
Troubleshooting

Contents

9.0 Troubleshooting

9.1 Error Messages

Gauge error messages are typically displayed in the format ERR ^{xx}; where xx is a number between 1 and 13 located in the exponent position.

9.1.1 CPU Errors

ERR #	*Definition*
1	CPU ROM FAILURE
2	CPU INTERNAL RAM FAILURE
3	CPU EXTERNAL RAM FAILURE
9	ILLEGAL INTERRUPT TO CPU BOARD

The system will not run if a CPU is present. Typically they cannot be corrected by the user. The CPU board should be returned to the factory for repair.

9.1.2 Installation Errors

ERR #	*Definition*
4	NO BASE UNIT SENSOR BOARD INSTALLED
5	EXTRA I/O BOARD INSTALLED
6	EXTRA IEEE488 BOARD INSTALLED
7	MORE THAN 3 SENSOR BOARDS INSTALLED
8	ILLEGAL BOARD INSTALLED

Installation errors indicate a board is either missing or misplaced, or that an extra board has been installed. Removing, rearranging, or adding the correct boards should correct the error.

9.1.3 Sensor Errors

ERR #	*Definition*
10	EMISSION ERROR *(Ion Gauge only)* - Indicates a failure to achieve the required filament emission level. Filament burned out; Cable connections bad; Cathode heater fuse blown inside control unit. Replacement fuse IPN 062-004, (10A, 32V).
11	180 VOLT ERROR *(Ion Gauge only)* - Indicates a power supply regulation problem. Check for shorted sensor or cable.

12 DEGAS ERROR *(Ion Gauge only)* - Indicates a failure to achieve desired degas current levels. Check for poor cable connections, open or high resistance sensor anode.

13 COLD CATHODE TURN ON ERROR - Indicates a failure of the cold cathode sensor to start. check cable connections. Raise system pressure and retry. Clean sensor.

9.1.4 Additional Error Messages

The following errors do not follow the typical error format. Instead, the following codes are used, with these meanings:

OVP OVER PRESSURE (Ion or CC) - Sensor emission turned off because system pressure is too high for proper operation.

CBL CABLE DISCONNECTED (Pirani or CDG) - Cable connections poor or missing. This error only occurs for CDGs when the cable is disconnected from the controller.

OFF EMISSION OFF (Ion or CC) - Sensor emission is off.

9.2 Cleaning Sensors and Replacement of Sensing Elements

9.2.1 Ion Gauge

Cleaning is not recommended for glass tubes; replace the sensor tube if performance is unsatisfactory.

Nude type Ion gauge sensors have replaceable filament assemblies (tungsten 850-660-P1, ThO_2/ Iridium 850-662-P1). Care must be taken during replacement to ensure proper alignment and spacing of the new filament assembly. The two support wires must be cut after installation to prevent shorting: see Figure 9.1. Good vacuum practices (gloves, finger cots, etc.) should be observed when handling all components.

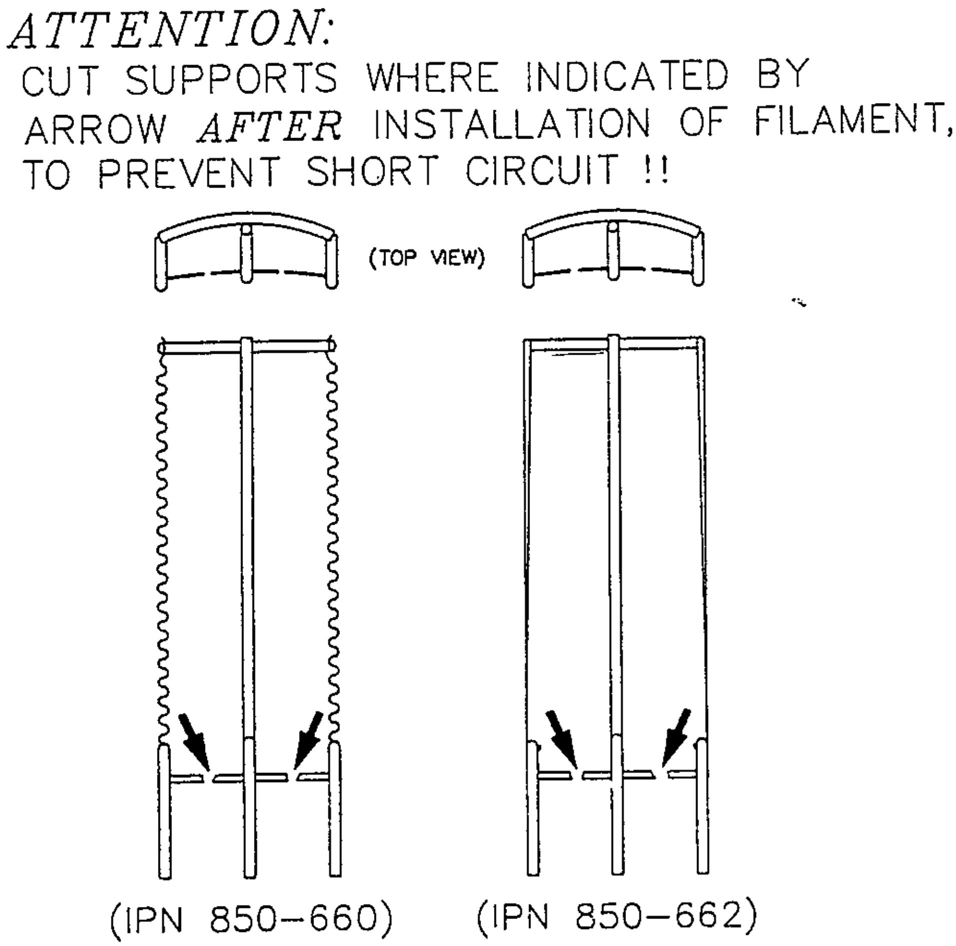
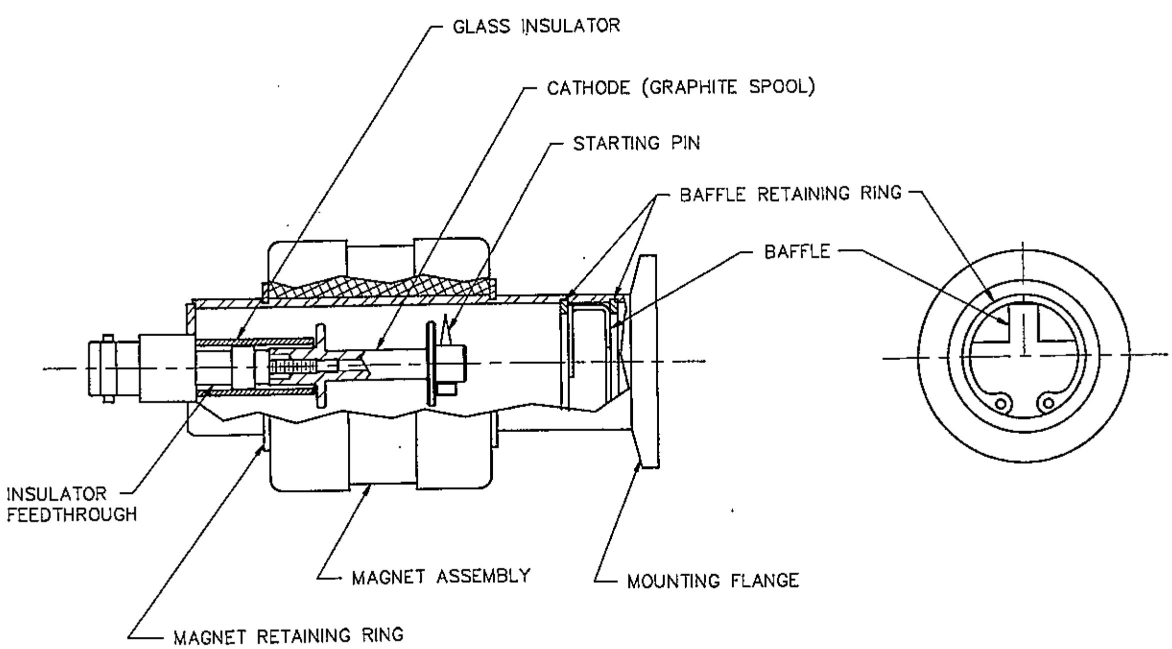


Figure 9.1 Filament Replacement

9.2.2 Cold Cathode Gauge

Cleaning is recommended if the gauge reading becomes erratic or if the sensor becomes excessively hard to start. Remove the baffle retaining ring with a snap-ring tool and remove the baffle. Very gently unscrew the cathode, taking special care not to strip the delicate threads. A non-magnetic tool is highly desirable for this job unless the magnet assembly is completely removed from the sensor body. (A special tool is included with the replacement cathode kit 850-614-G1.) Remove the cathode and glass insulator. The glass insulator can be cleaned in acetone followed by alcohol. **The cathode should not be cleaned.** If the cathode is excessively worn away due to sputtering, or has been contaminated, it should be replaced using replacement kit (part number 850-614-G1). The sputtered deposits on the anode (inside wall of the tube) cause erratic behavior and must be removed periodically. A bead blaster, wire brush or abrasive cloth will remove this deposit. Be careful not to damage the insulator feedthrough or its threads. Prior to reassembly, clean the internal surface with acetone followed by alcohol. Reassemble the unit, being careful not to overtighten the cathode or damage the sharp starting pin.



NOTE: COLD CATHODE GAUGE SHOWN WITH KF25 MOUNTING FLANGE OPTION.

Figure 9.2 Cut-away View of Cold Cathode Sensor

9.2.3 Pirani

The sensing tube can be cleaned using suitable organic solvents (benzine, ether, etc.). Please note that the CCl_4 is unsuitable since the adhesive used on the sensing element is not resistant to it. The sensing tube should be carefully filled, using a syringe, with the solvent and then left for at least 10 minutes. The solvent should be gently drained out of the tube. Do not shake the tube or attempt to clean it using mechanical means such as a brush because damage to the filament would result. Repeat this procedure one or two times and then let the tube dry.

After cleaning and drying, the sensing tube should be evacuated to a pressure below 10^{-4} torr. The reading will probably be too high (in the 10^{-2} range) for a few minutes after cleaning. After that, the pressure should read $0.00x10^{0}$. If not, perform a zero adjustment as instructed in Section 7.3. If the sensor cannot be properly adjusted then the sensing element should be replaced.

To replace the TR901 sensing element, remove the screws from the base of the plastic gauge head and unplug the sensing tube from its base in the gauge head. Plug in the new sensing tube and replace the screws.

After installing the replaceable sensing element, the zero and 100% adjustments must be made for proper operation. See section 7.3.

9.2.4 Capacitance Diaphragm Gauge

Cleaning of these sensors is seldom necessary and generally not recommended. However, if cleaning is desired, the sensor can be carefully filled with a solvent such as pure acetone, ethanol, or freon. The solvent may be allowed to remain in the sensor for up to 30 minutes, and then should be poured out and discarded. Allow the gauge to dry thoroughly before installing on a vacuum system.

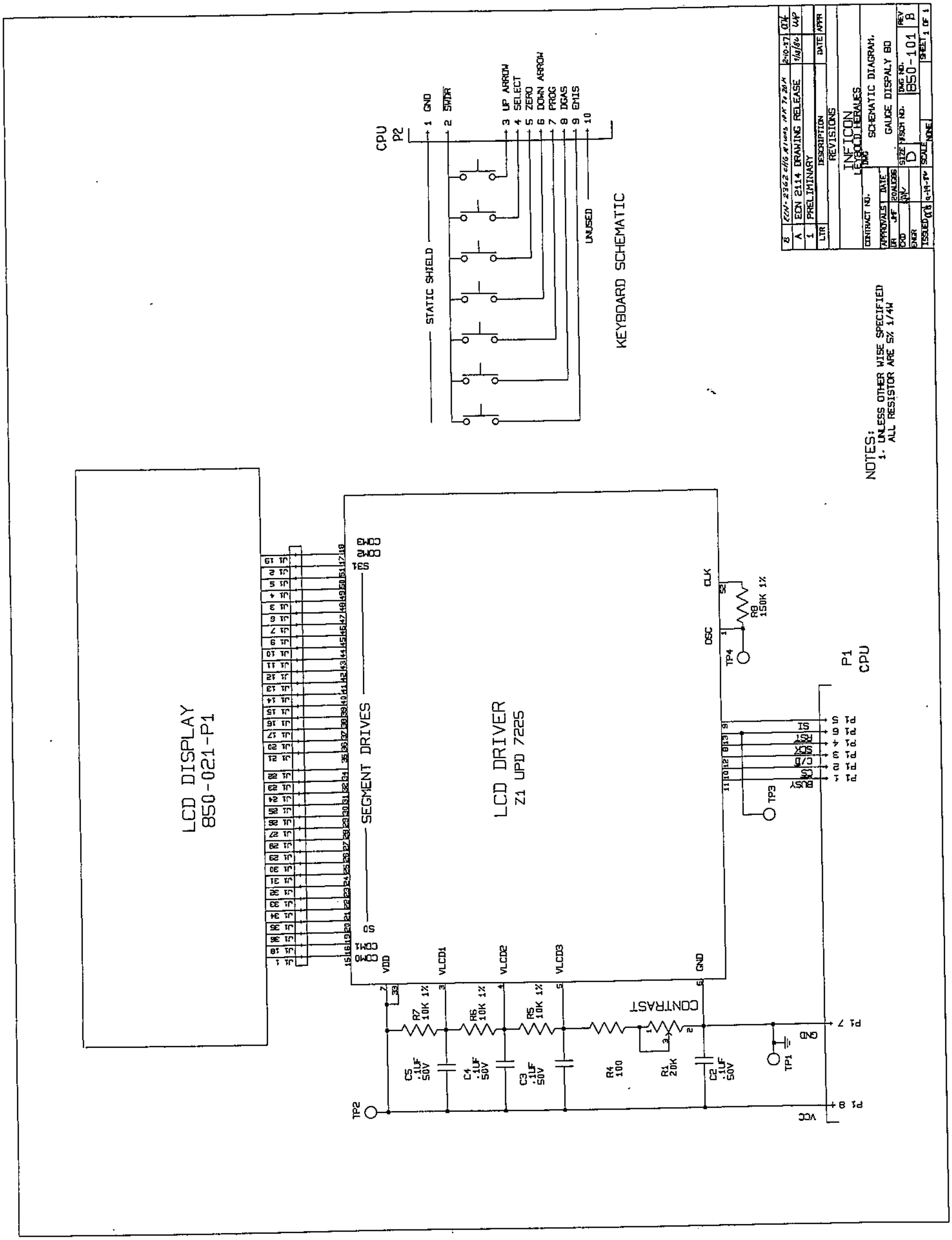
APPENDIX

Schematic information has been included for reference only. There are no user-related maintenance items within the controller units.

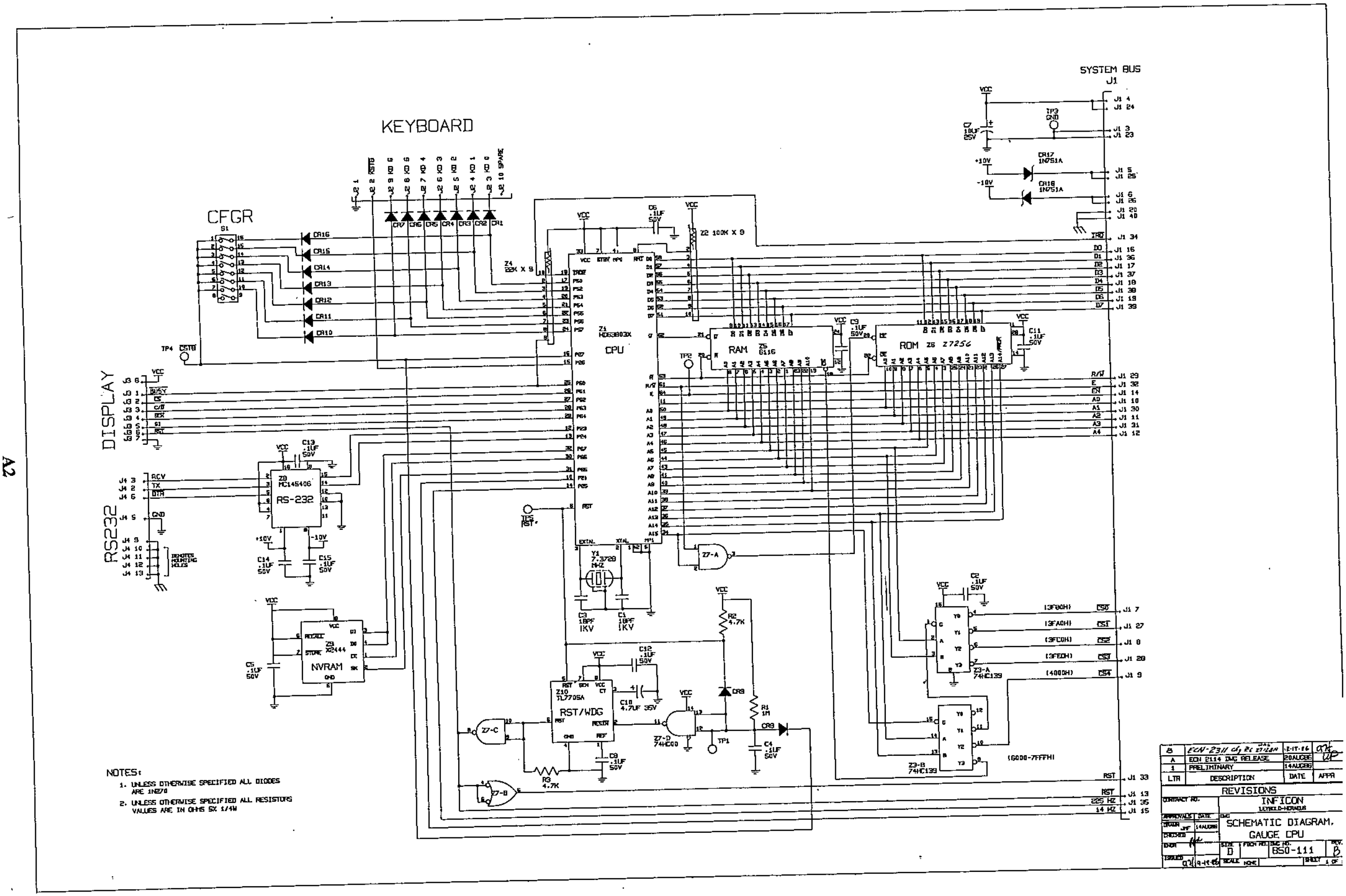
WARNING!!

THERE ARE POTENTIALLY LETHAL VOLTAGES PRESENT WITHIN THE CONTROLLERS. SERVICE OR TROUBLESHOOTING SHOULD ONLY BE ATTEMPTED BY QUALIFIED PERSONNEL.

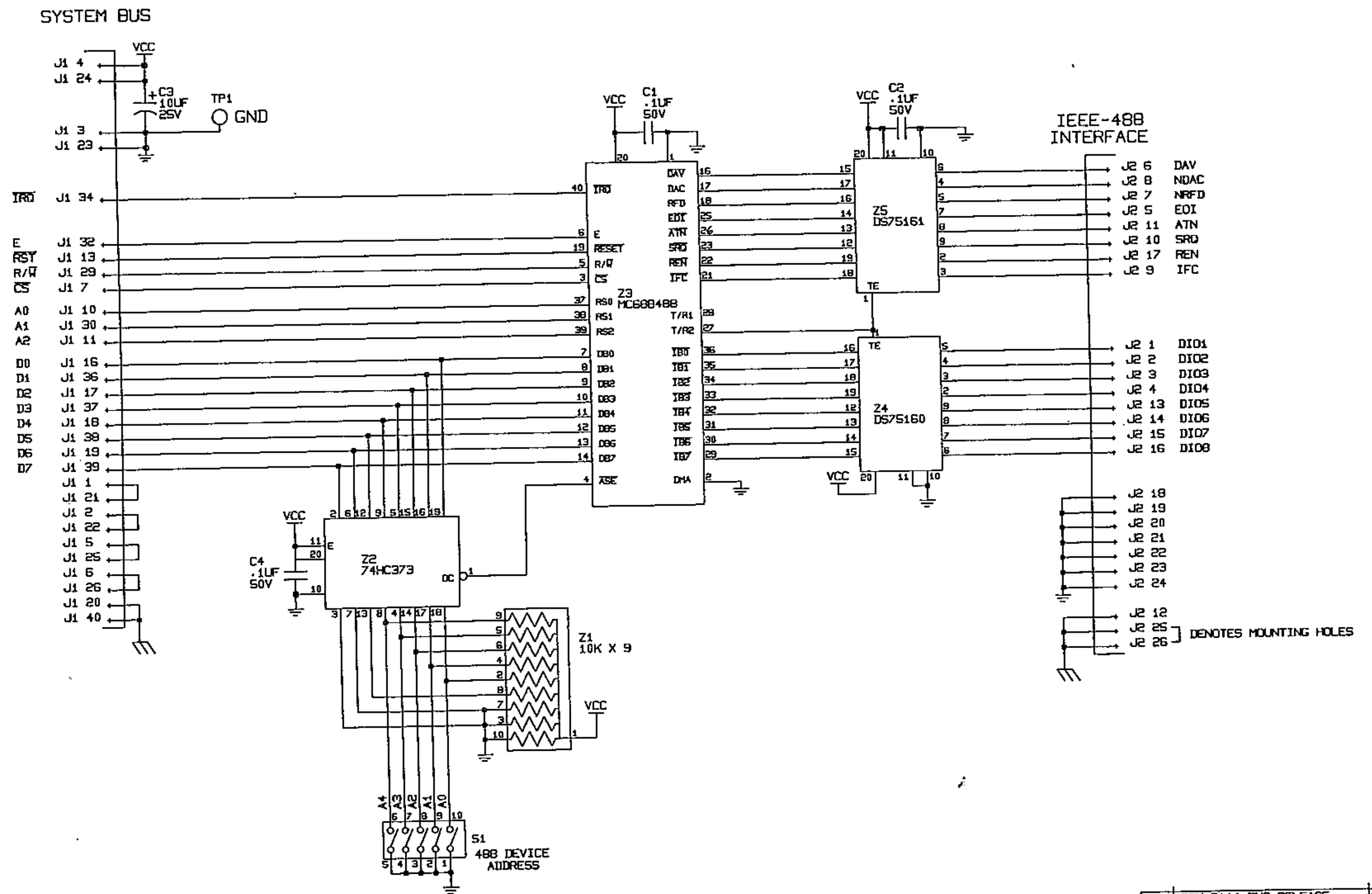
SCHEMATIC INDEX



Gauge Display Board


SYSTEM BUS
J1
KEYBOARD
CFGR
DISPLAY
RS232
CPU
HD63B03X
RAM
6116
ROM
Z7256
RS-232
MC14540G
NVRAM
X2444
RST/WDG
TL7705A
74HC139
74HC00
NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL DIODES ARE 1N270
2. UNLESS OTHERWISE SPECIFIED ALL RESISTORS VALUES ARE IN OHMS 5% 1/4W
REVISIONS
ECN 2114 DWG RELEASE
PRELIMINARY
INFICON
SCHEMATIC DIAGRAM, GAUGE CPU
850-111

Gauge CPU



NOTES

1. UNLESS OTHERWISE SPECIFIED ALL RESISTOR VALUES ARE IN OHMS 1/4W 5%.

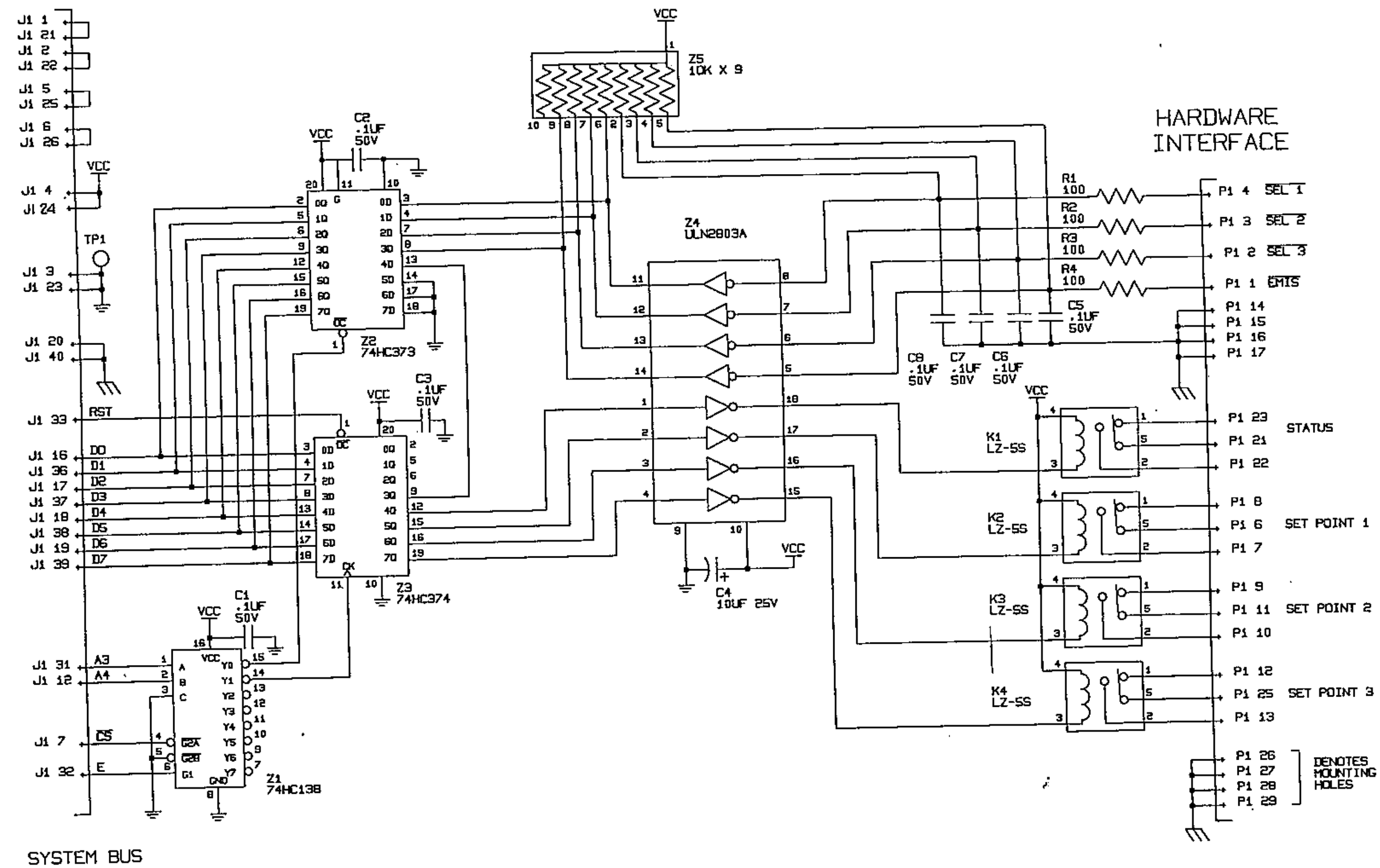
LTR	DESCRIPTION	DATE	APPR
A	ECN 2114 DWG RELEASE	20AUG86	WP
1	PRELIMINARY	14AUG86	

REVISIONS

INFICON
LEYBOLD HERAEUS

CONTRACT NO.	DWG: SCHEMATIC DIAGRAM, GAUGE IEEE 488		
APPROVALS / DATE: DR JMF 14AUG86	SIZE D	FSCM NO.	DWG NO. 850-116 / REV A
CKD / ENGR	SCALE NONE		SHEET 1 OF 1
ISSUED 9-19-86			

Gauge IEEE 488

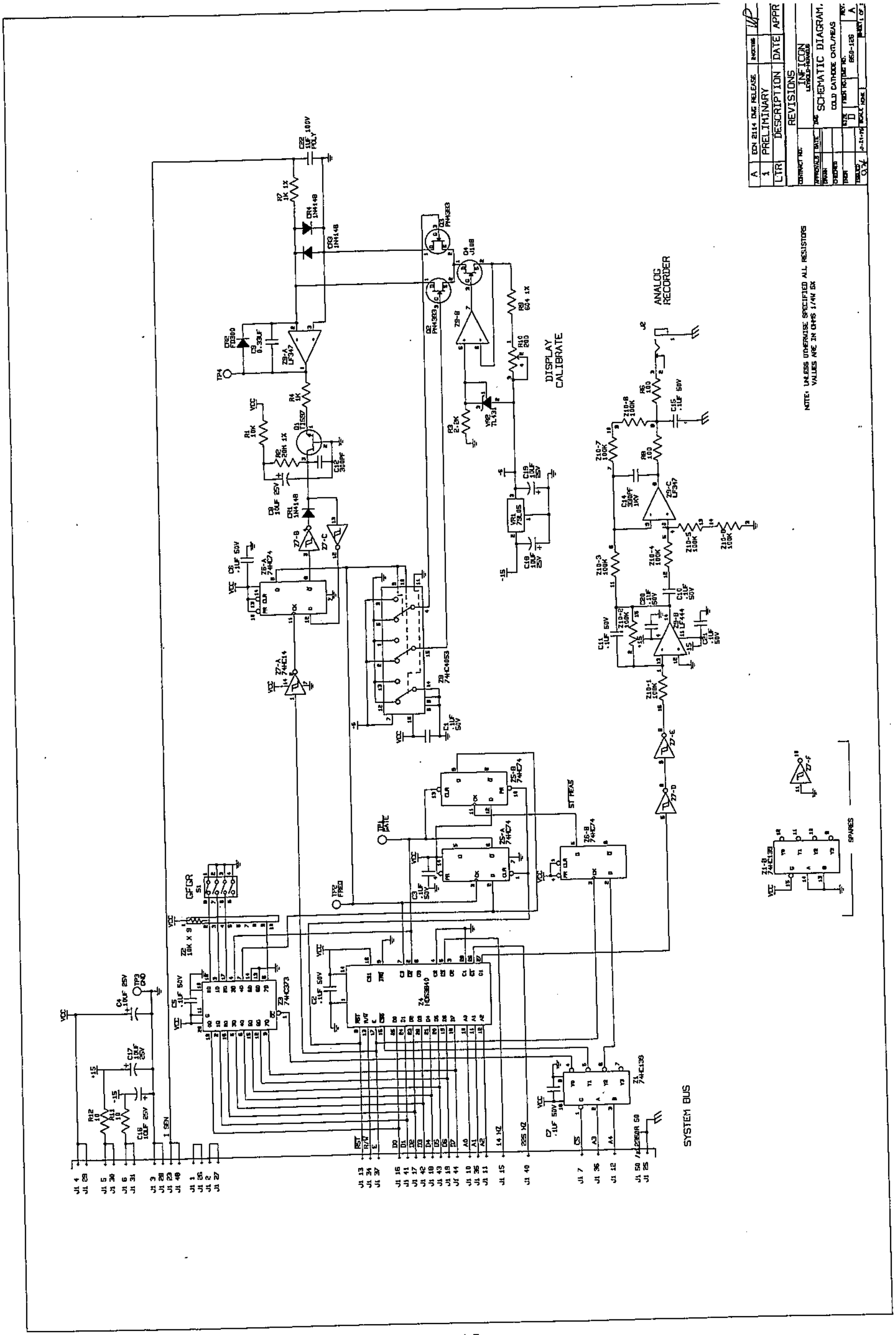


NOTES:

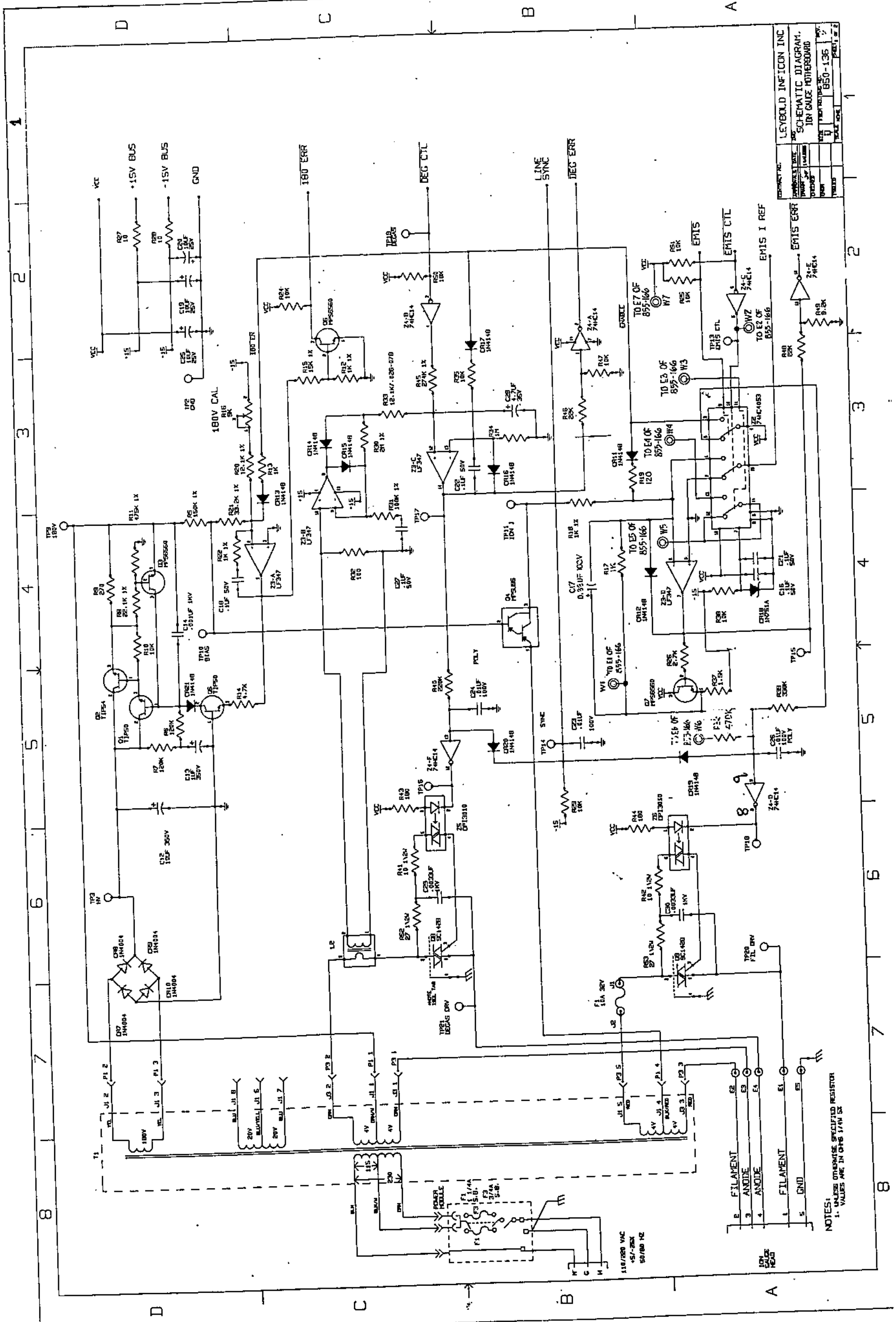
1. UNLESS OTHERWISE SPECIFIED ALL RESISTOR VALUES ARE IN OHMS 1/4W 5%.

INFICON LEYBOLD HERAEUS	
CONTRACT NO.	DWG SCHEMATIC DIAGRAM, GAUGE I/O BD
APPROVALS / DATE	
DR JMF 14AUG86	
CKD	SIZE D / FSCM NO. / DWG NO. 850-121 / REV A
ENGR	
ISSUED 9-19-86	SCALE NONE / SHEET 1 OF 1

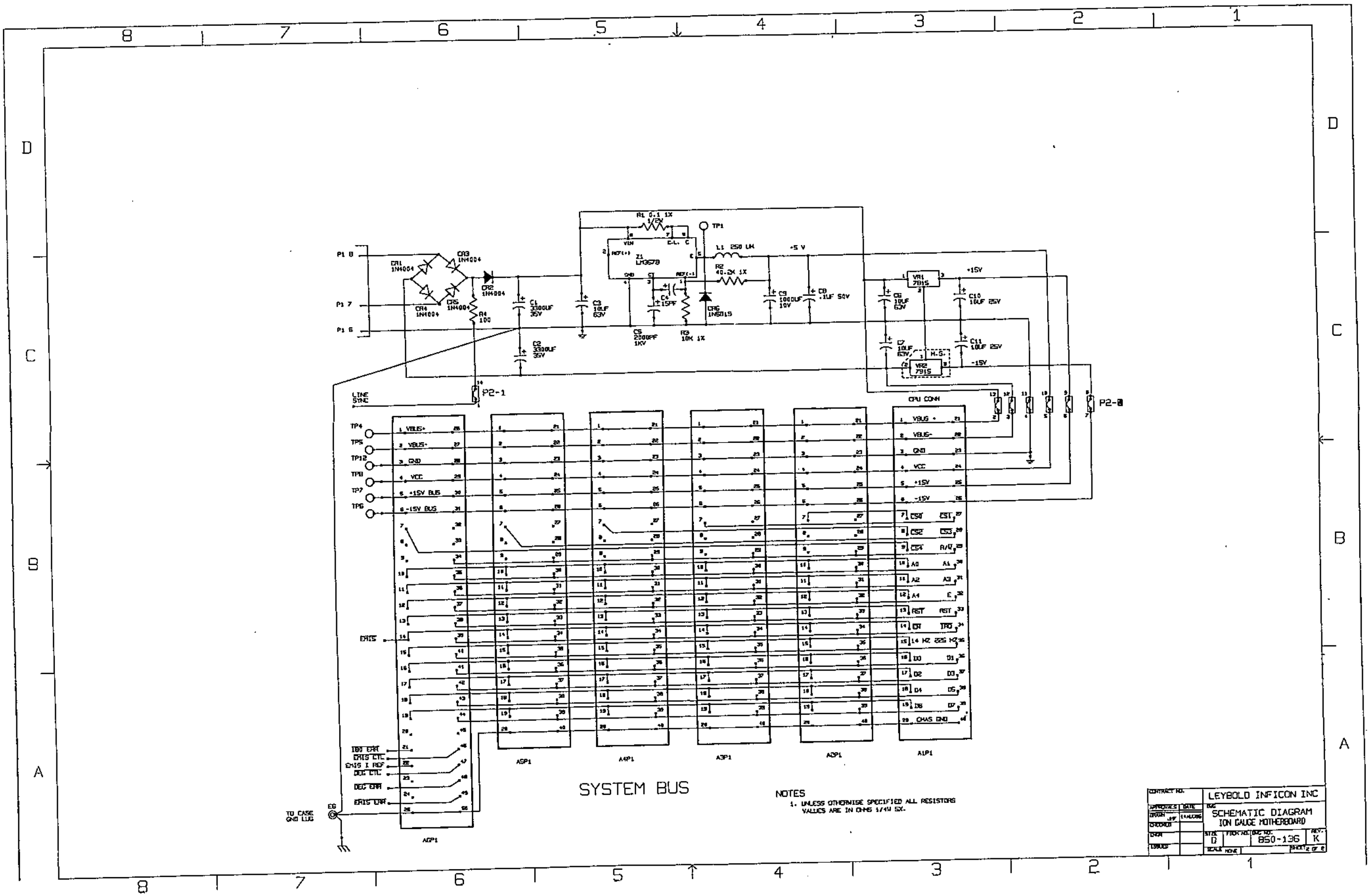
Input/Output Option Module 850-121A



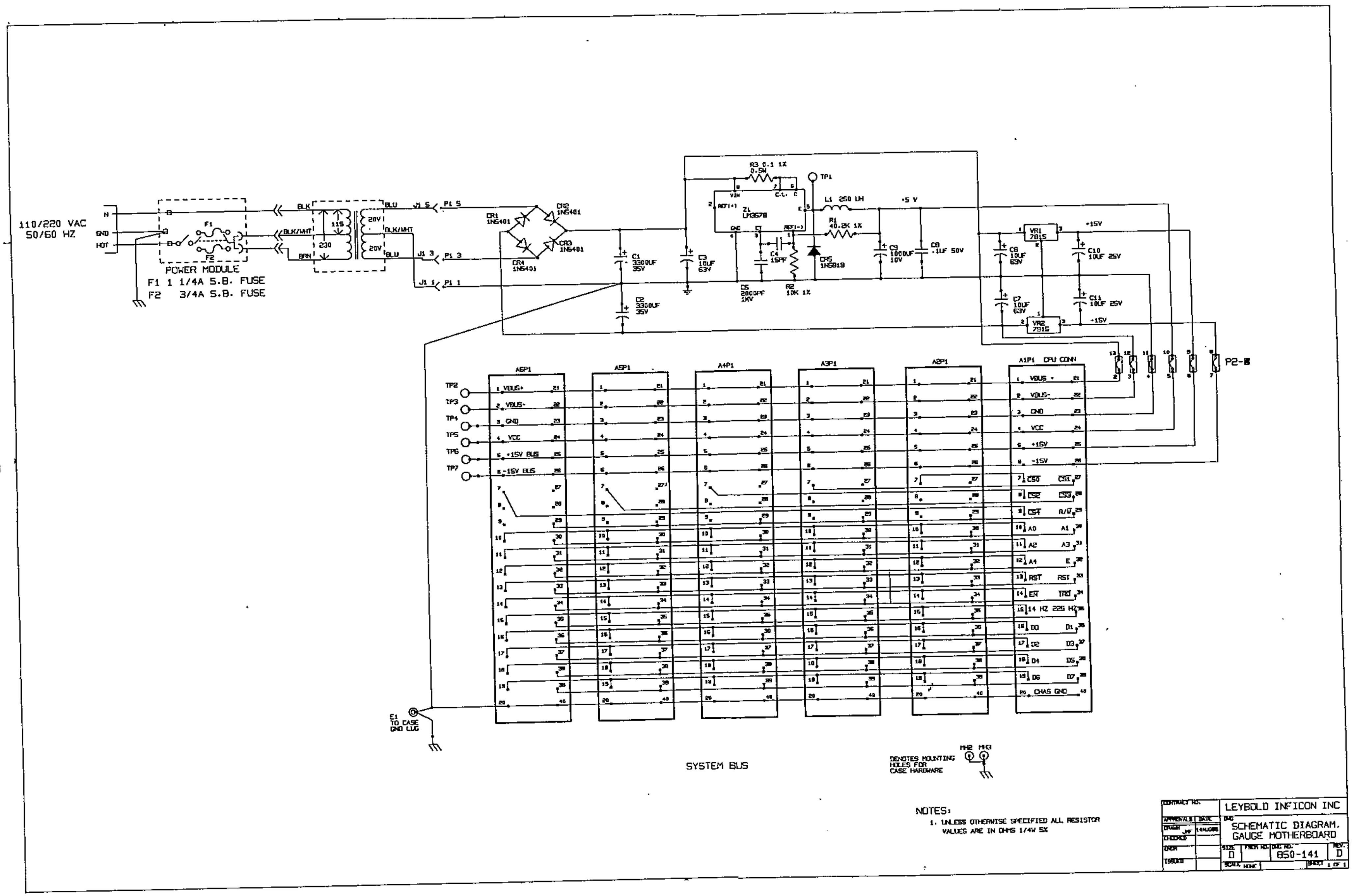
Cold Cathode Cntl/Meas



ION Gauge Emis Cntl

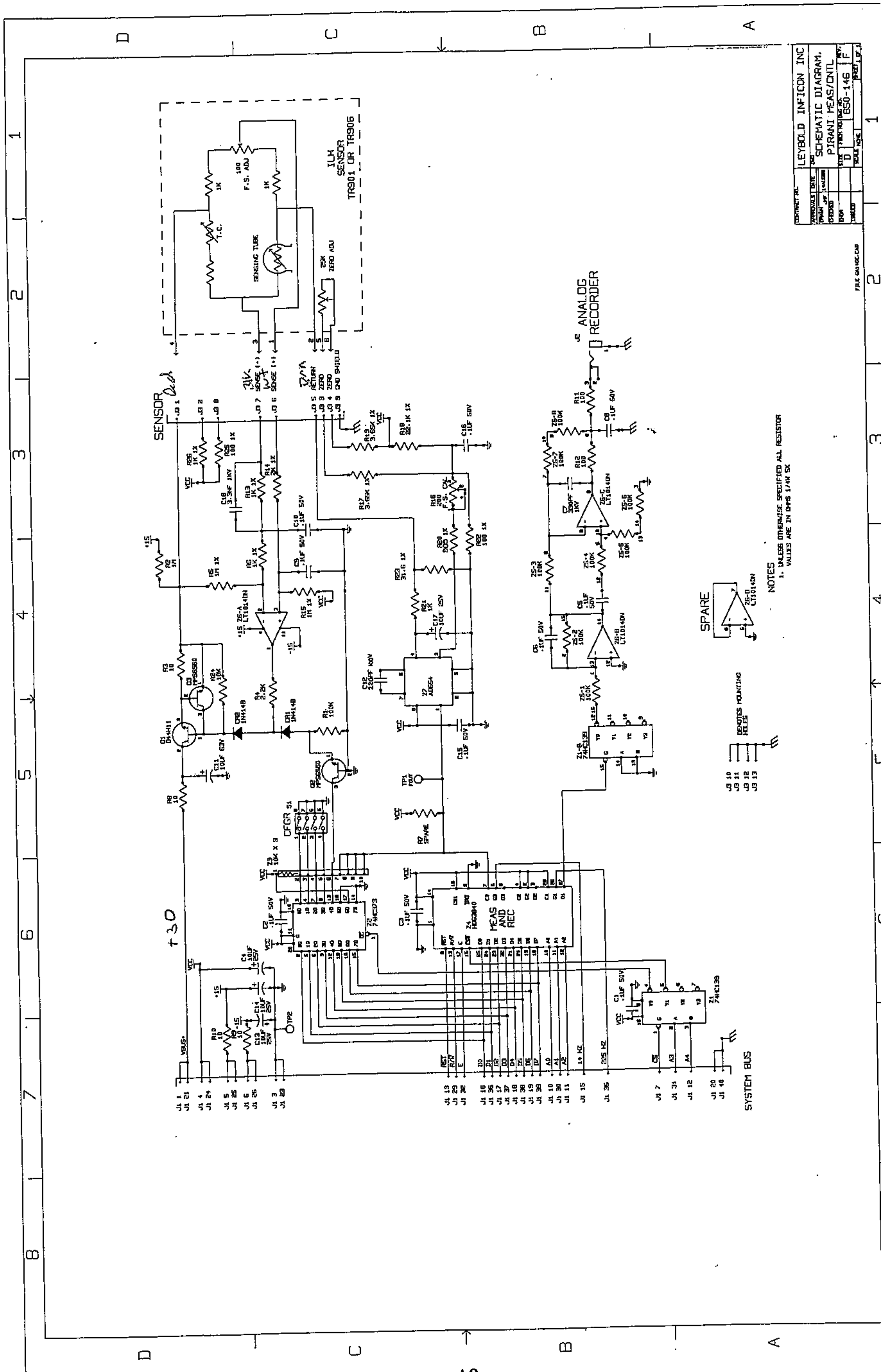


ION Gauge Mother Board

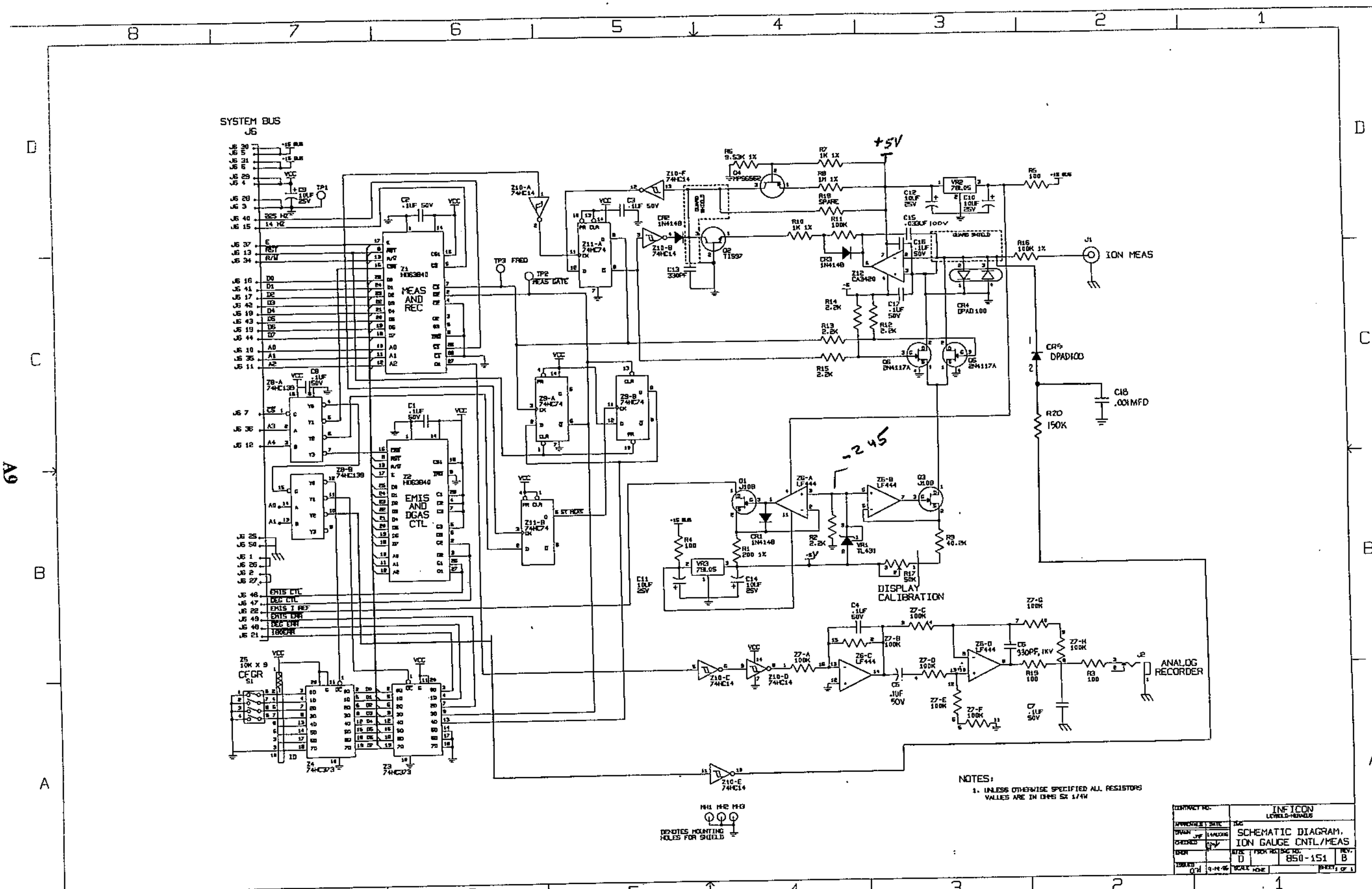


Gauge Mother Board

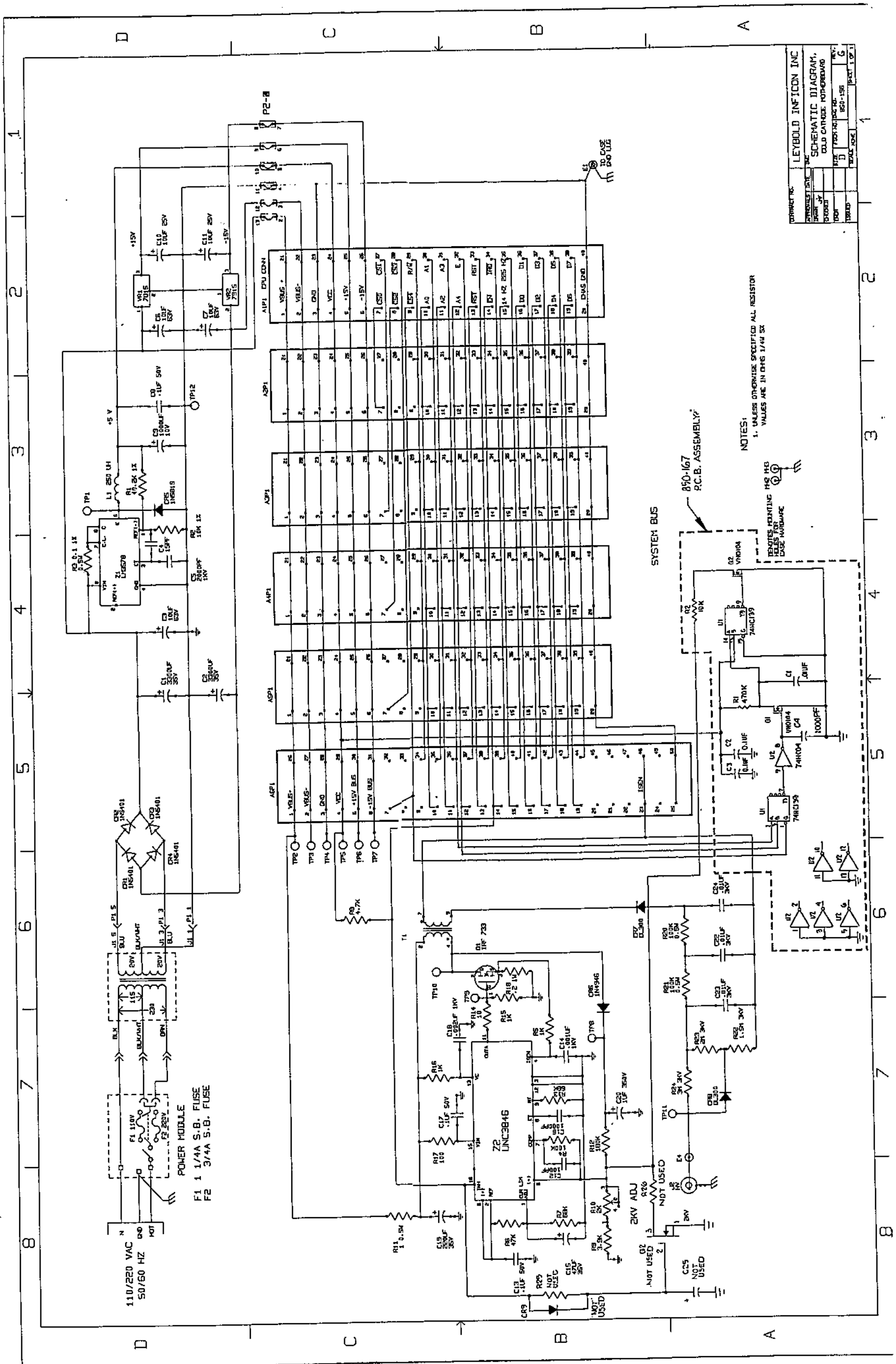
Larry
650-965-0264



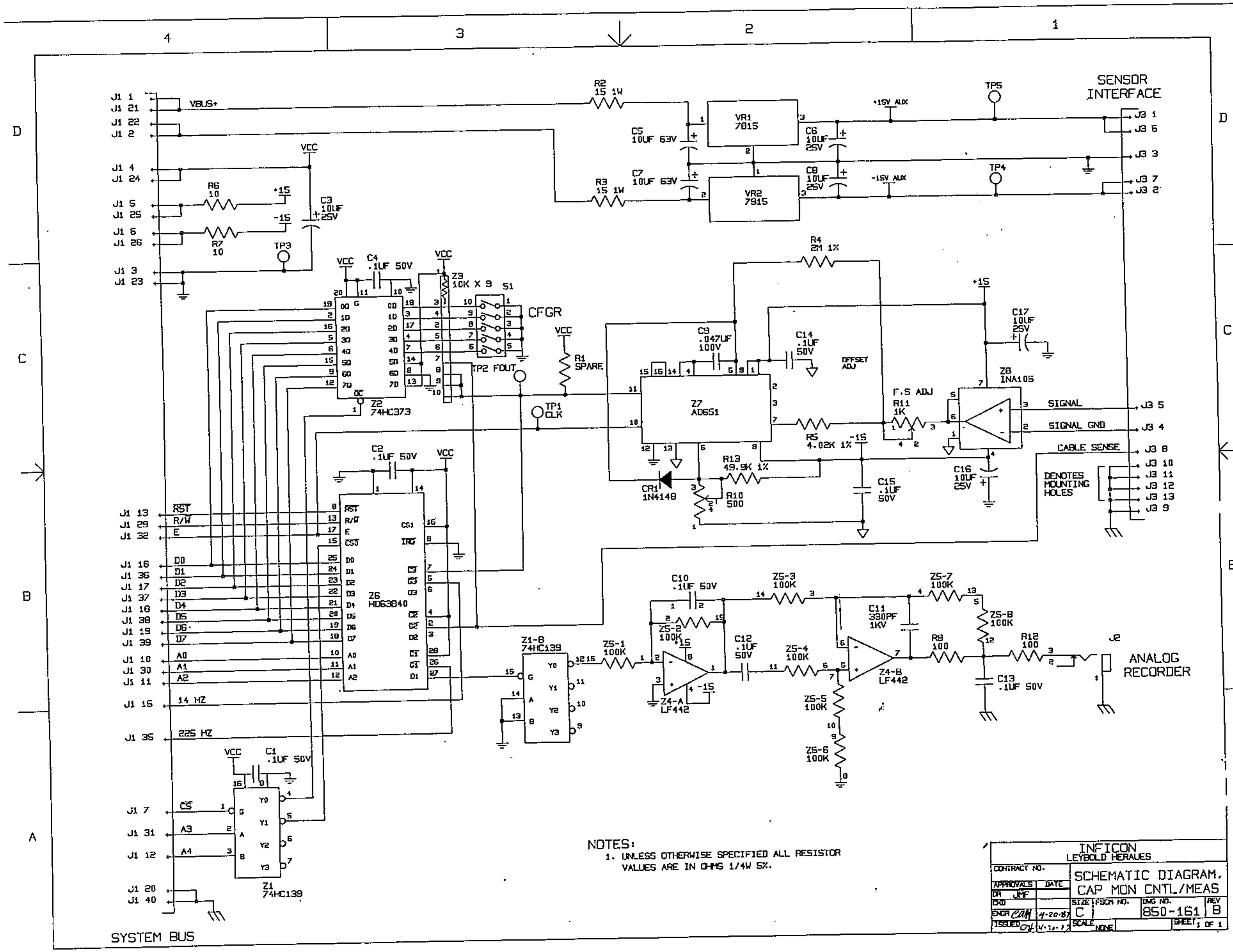
Pirani Meas/Cntl



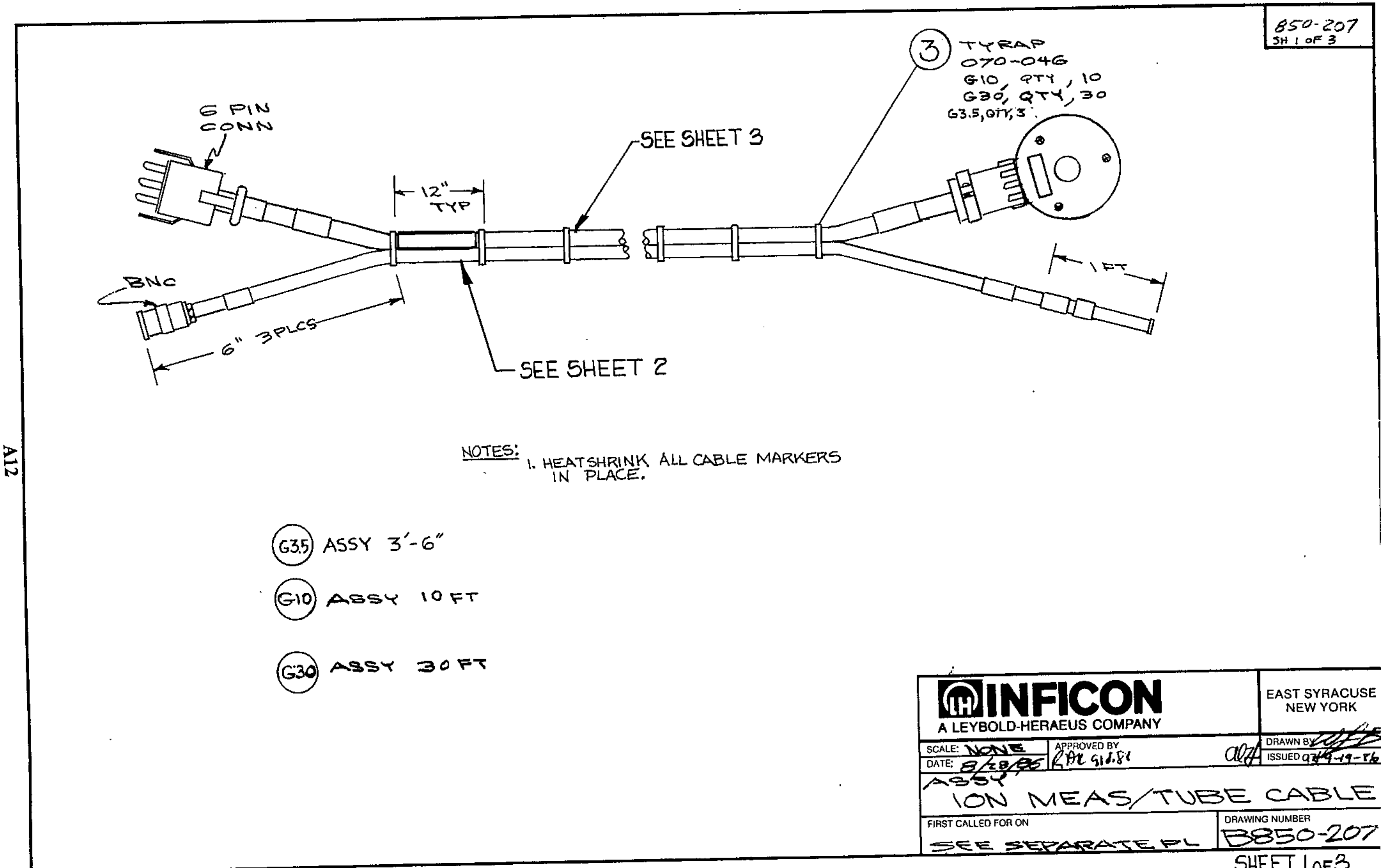
ION Gauge Cntl/Meas



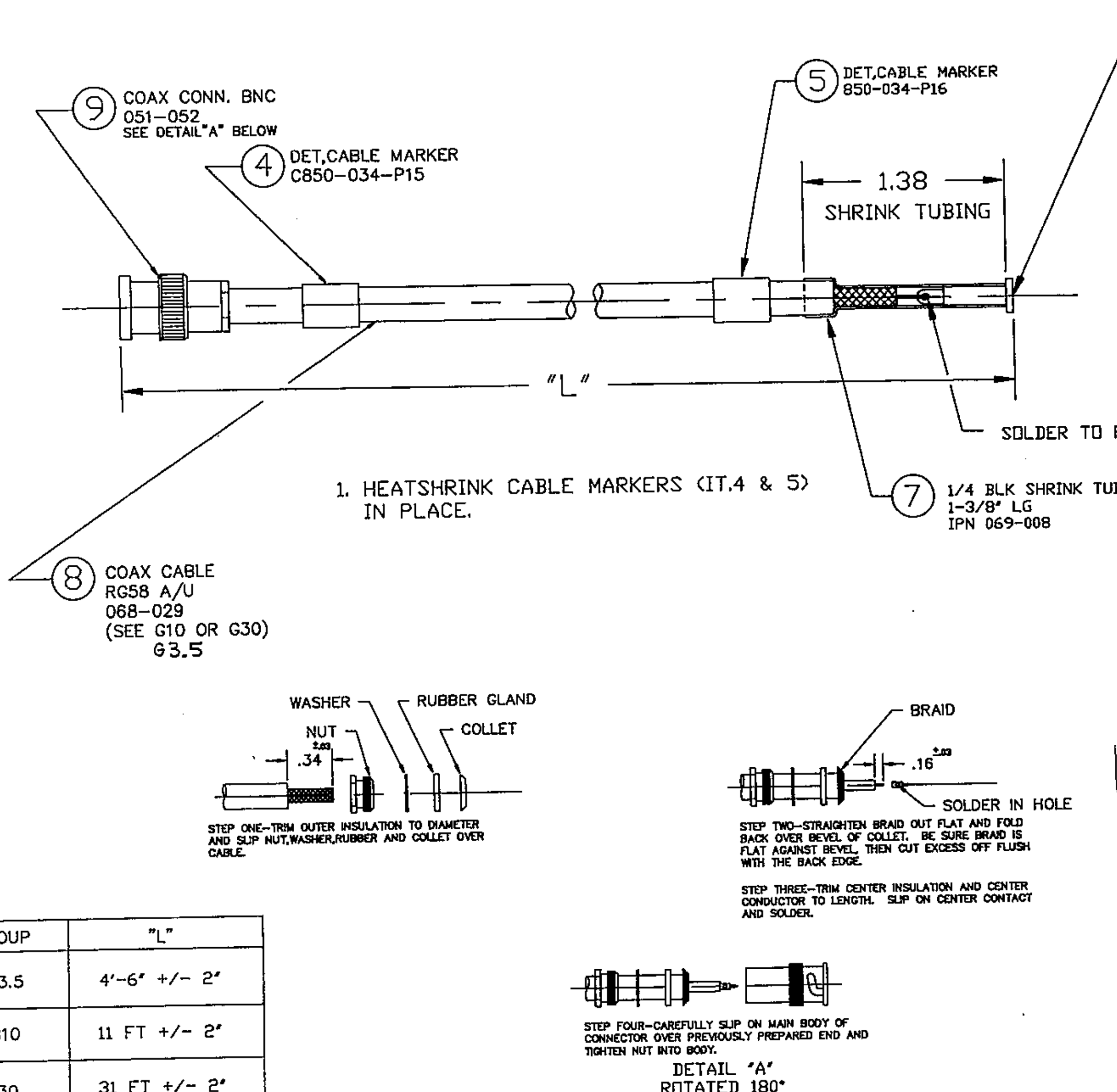
Cold Cathode Mother Board



Cap Mon Cntl/Meas



Ion Measurement/Tube Cable 850-207D Sheet 1 of 3



GROUP	"L"
G3.5	4'-6" +/- 2"
G10	11 FT +/- 2"
G30	31 FT +/- 2"

INFICON
A LEYBOLD-HERAEUS COMPANY

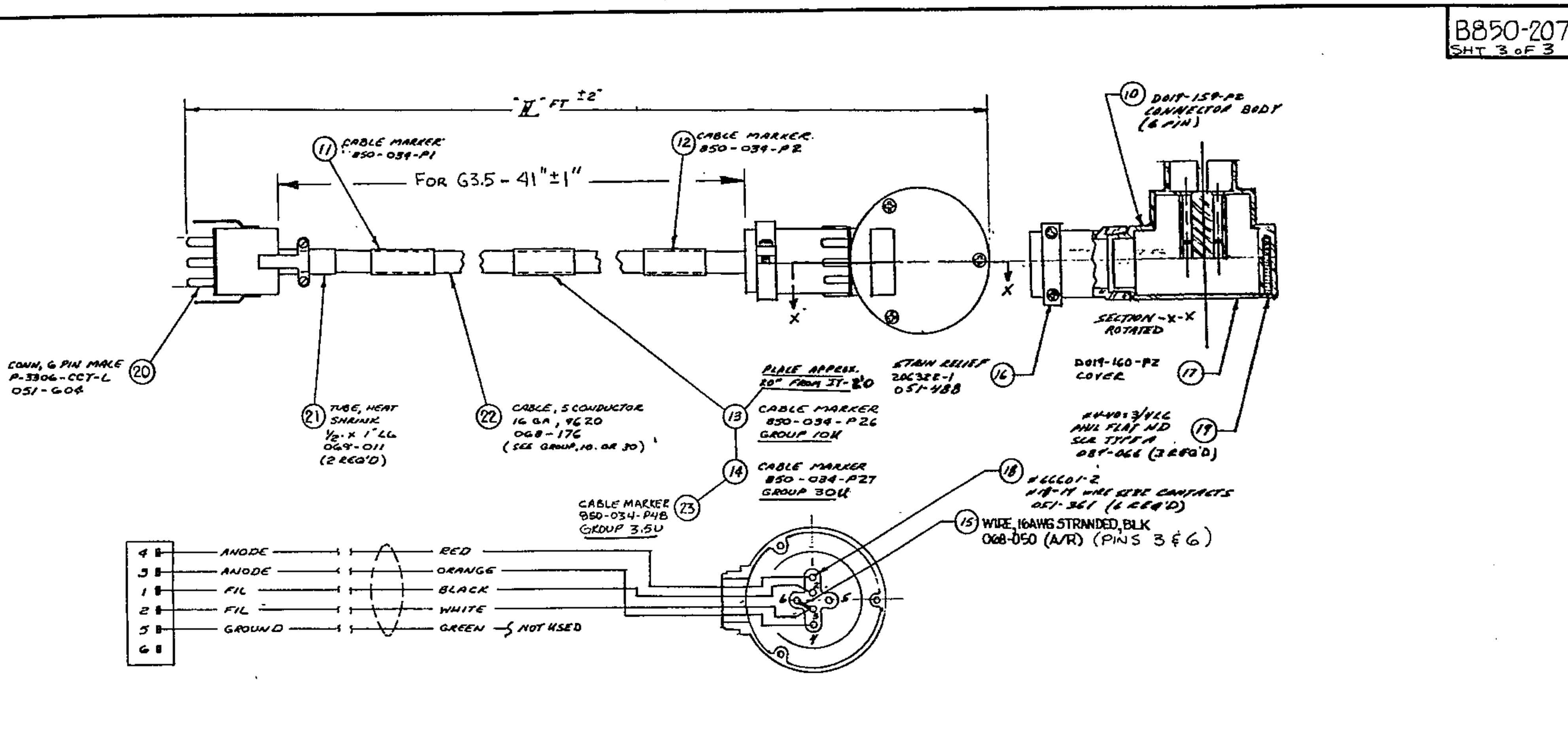
EAST SYRACUSE
NEW YORK

SCALE: NONE
DATE: 8-27-86
APPROVED BY: AH
DRAWN BY: WLB(KMT)
ISSUED: AH 9-19-86

ASSY, CABLE, ION MEASUREMENT,TUBE

FIRST CALLED FOR: SEE SEPARTATE PL
DRAWING NUMBER: B850-207
SHEET 2 OF 3

Ion Measurement/Tube Cable 850-207D Sheet 2 of 3



NOTES:
1. HEATSHRINK CABLE MARKERS IN PLACE.

GROUP	"L" CABLE LENGTH (ITEM 22)
G10	10 FT
G30	30 FT
G3.5	3'-6"

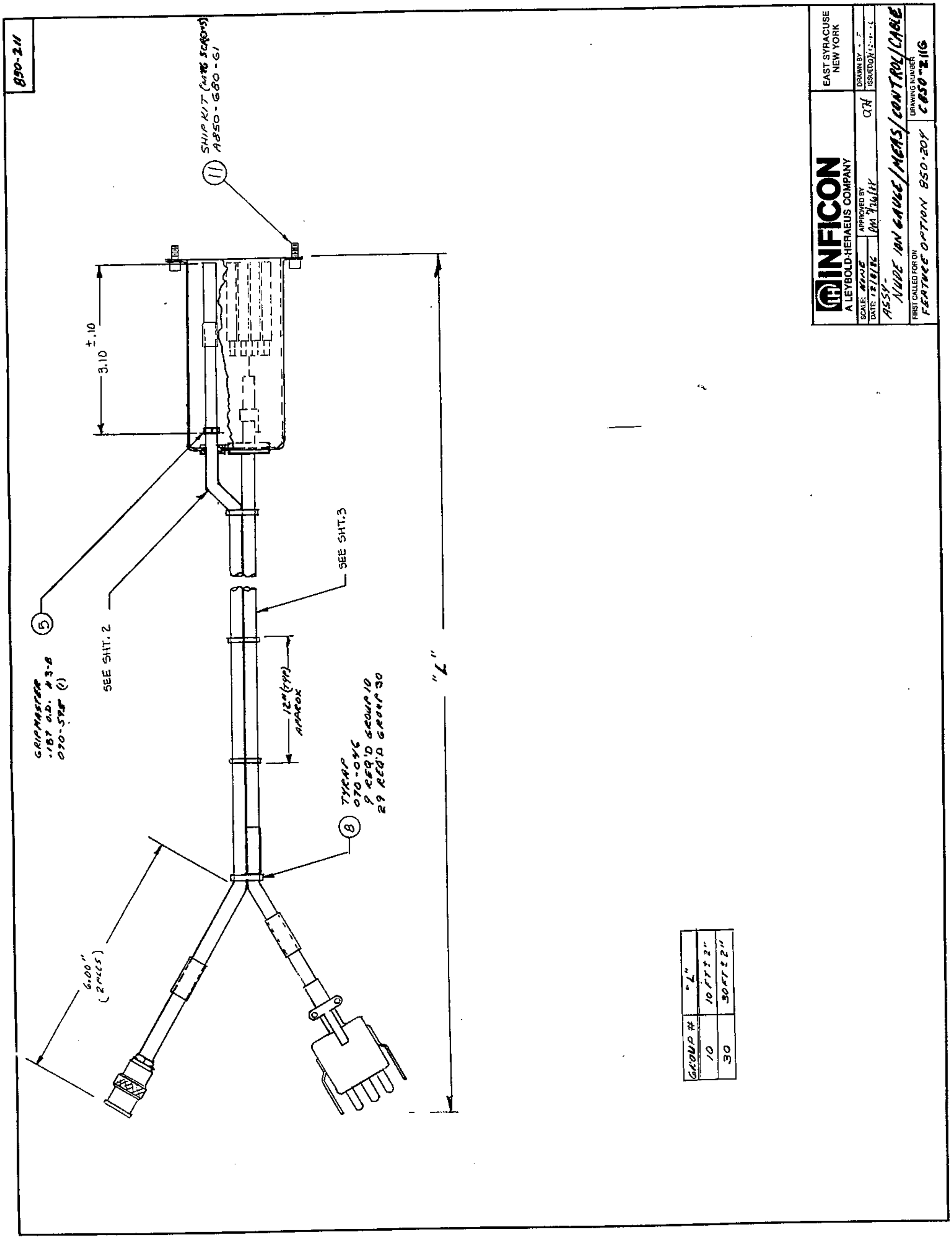
INFICON
A LEYBOLD-HERAEUS COMPANY
EAST SYRACUSE NEW YORK

SCALE: ~
DATE: 8-28-86
APPROVED BY
DRAWN BY F. LEONE
ISSUED 3-30-87

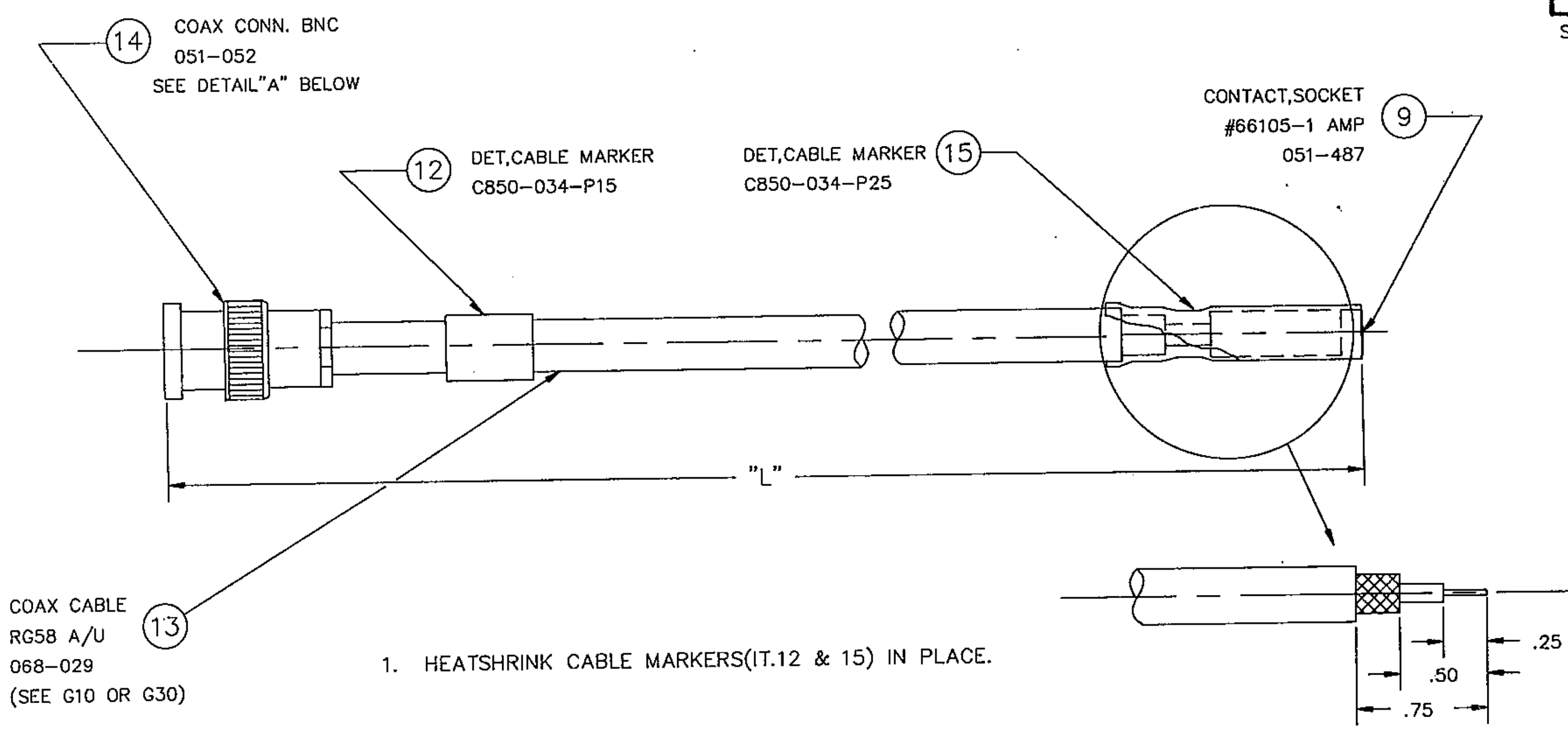
ASSY,
ION MEASUREMENT/ TUBE CABLE

FIRST CALLED FOR ON
DRAW NO NUMBER B850-207
SHEET 3 OF 3

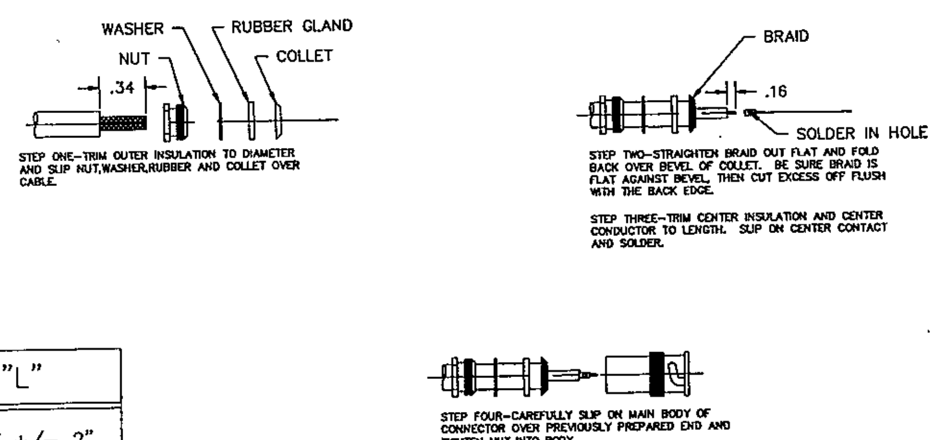
Ion Measurement/Tube Cable 850-207D Sheet 3 of 3



Nude Ion Gauge Measurement/Control/Cable



1. HEATSHRINK CABLE MARKERS(IT.12 & 15) IN PLACE.



DETAIL A
ROTATED 180°

GROUP	"L"
G10	10 FT +/- 2"
G30	30 FT +/- 2"

INFICON

EAST SYRACUSE NEW YORK

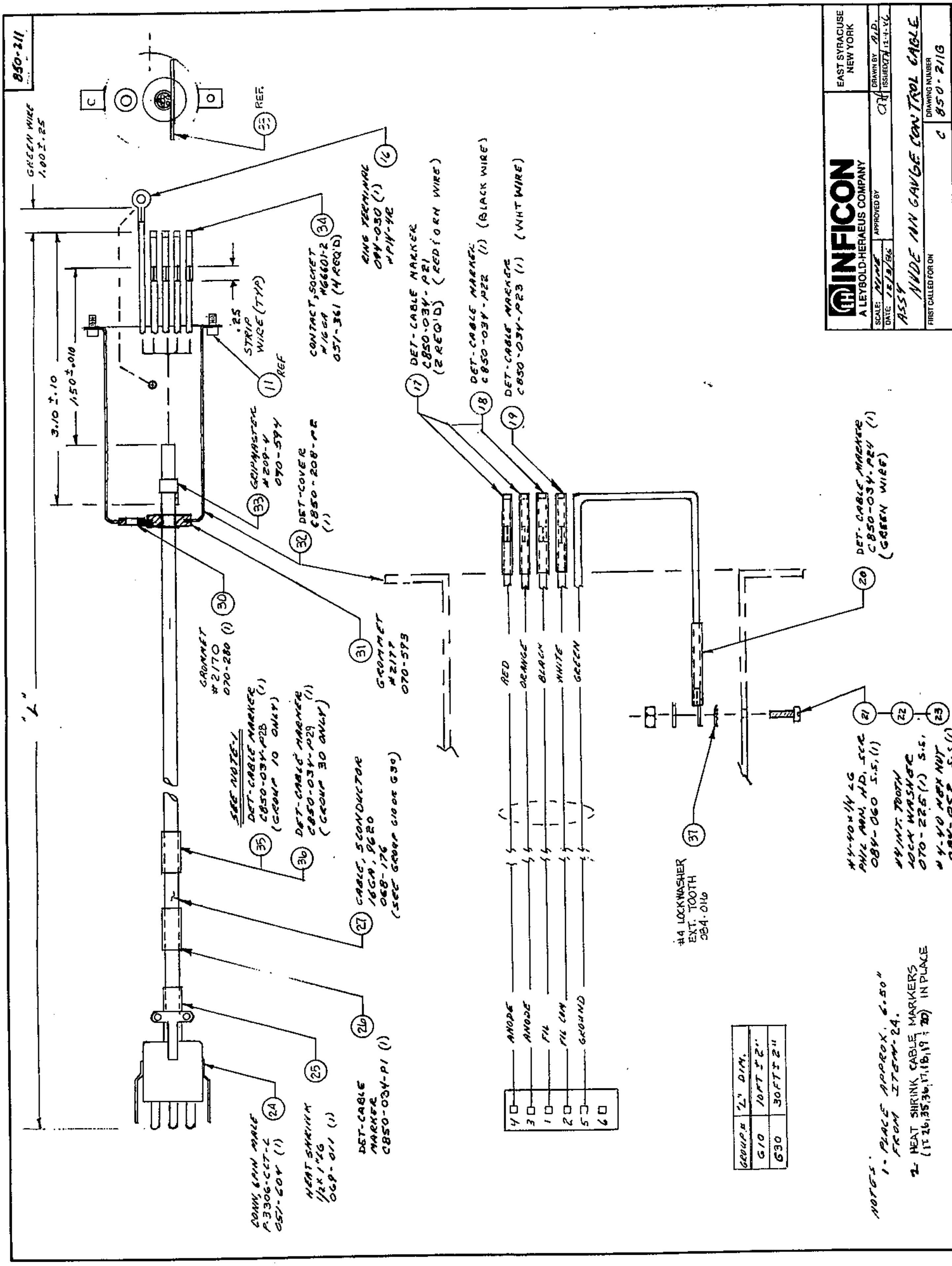
SCALE: NONE DATE: 12-3-86	APPROVED BY: AH	DRAWN BY: KMT ISSUED: AH 8/27/88

ASSY,CABLE,NUDE ION GAUGE

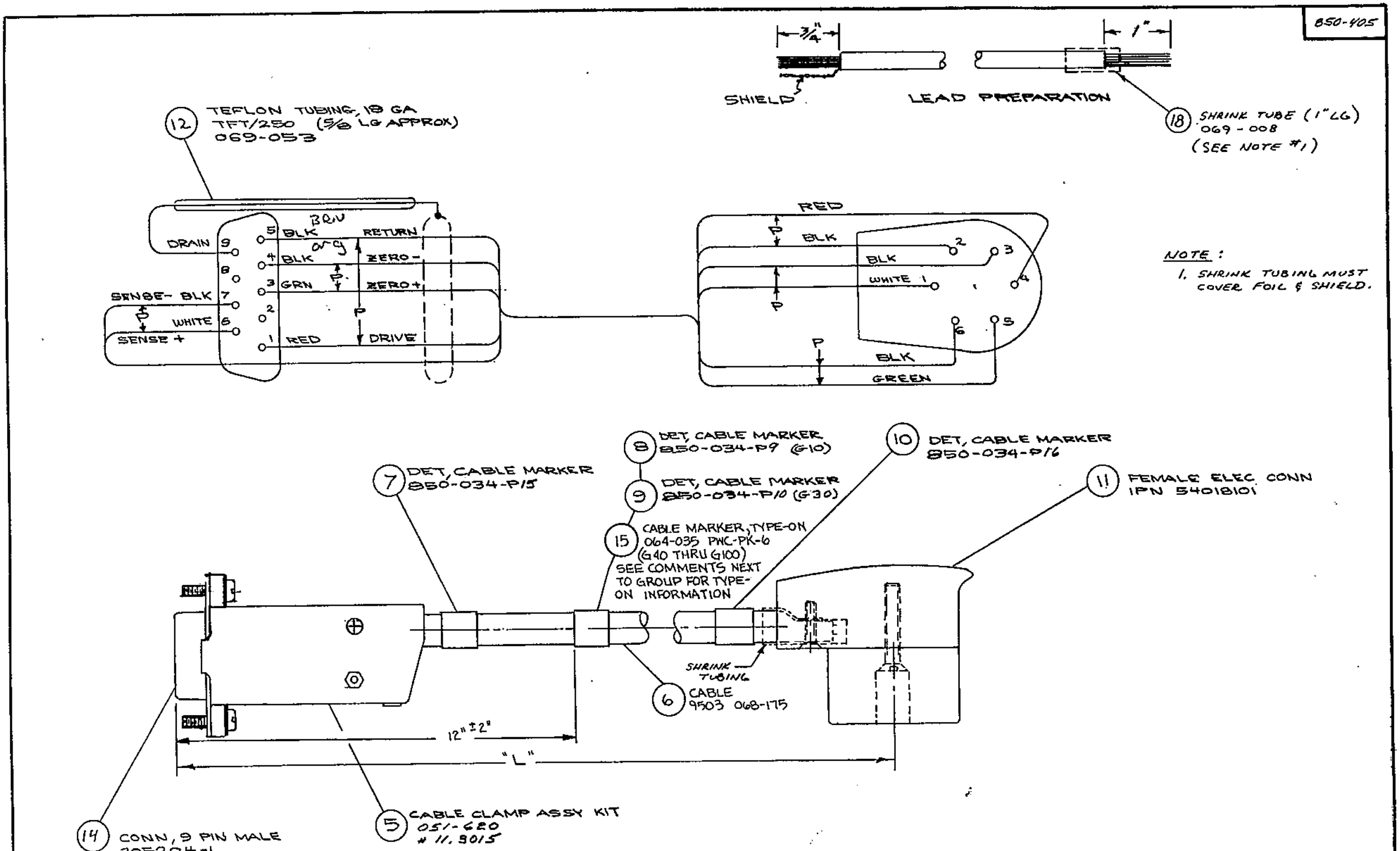
FIRST CALLED FOR:

DRAWING NUMBER: C850-211

SHT 2 OF 3



Nude Ion Gauge Measurement/Control/Cable



GROUP	"L" ±2"	COMMENTS
G110	110 FT	850-405-G110 PG110'
G120	120 FT	850-405-G120 PG120'
G130	130 FT	850-405-G130 PG 130'
G140	140 FT	850-405-G140 PG140'
G150	150 FT	850-405-G150 PG150'

GROUP	"L"	COMMENTS
G10	10 FT ±2"	———
G30	30 FT ±2"	———
G40	40 FT ±2"	850-405-G40 PG 40'
G50	50 FT ±2"	850-405-G50 PG 50'
G60	60 FT ±2"	850-405 G60 PG 60'
G70	70 FT ±2"	850-405 G70 PG 70'
G80	80 FT ±2"	850-405-G80 PG 80'
G90	90 FT ±2"	850-405-G90 PG 90'
G100	100 FT ±2"	850-405-G100 PG 100'

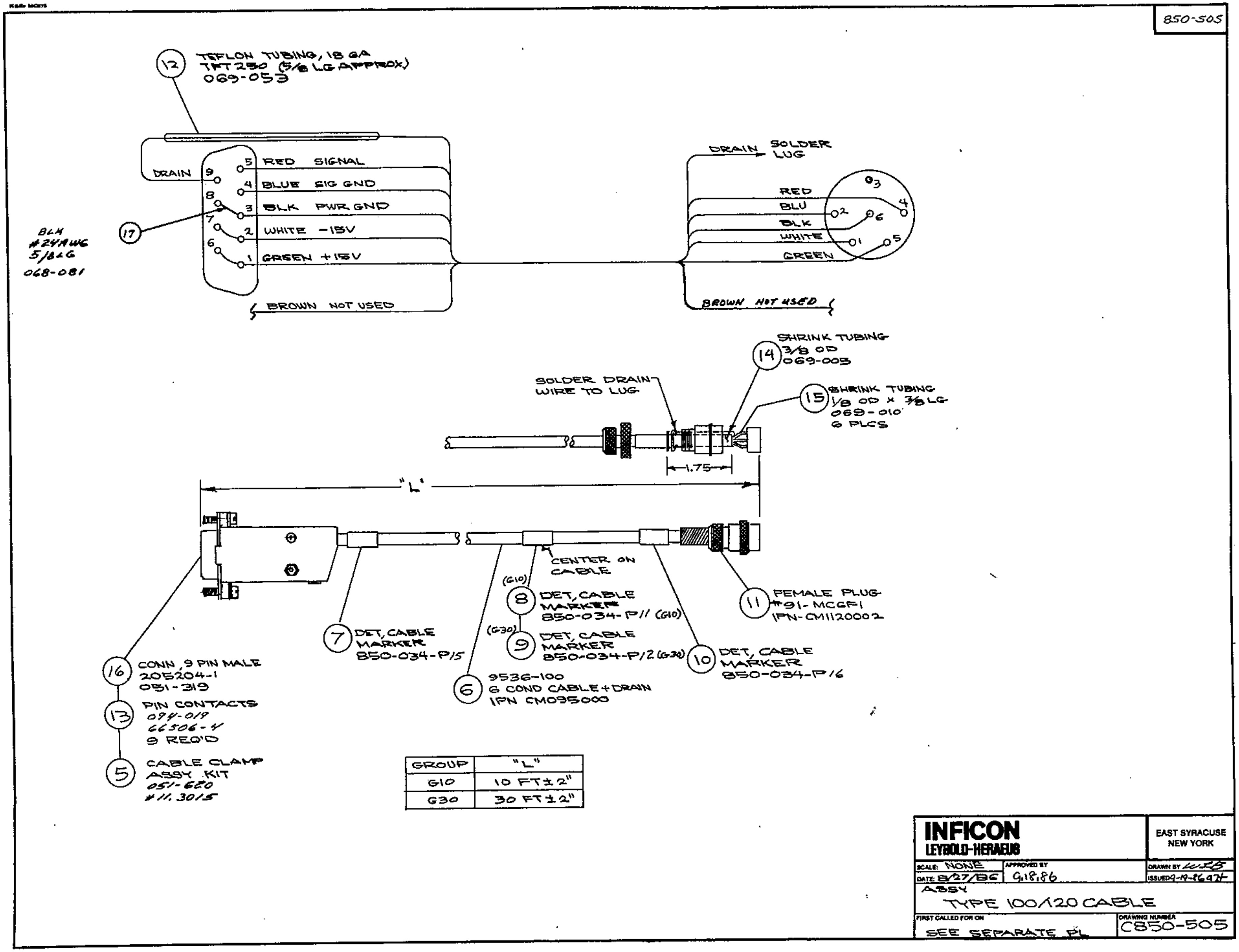
INFICON
LEYBOLD-HERAEUS
EAST SYRACUSE NEW YORK

SCALE: NONE
DATE: 8/26/86
APPROVED BY GPK 9/8/86
DRAWN BY WZB
ISSUED 9-19-86

ASSY, PIRANI GAUGE CABLE

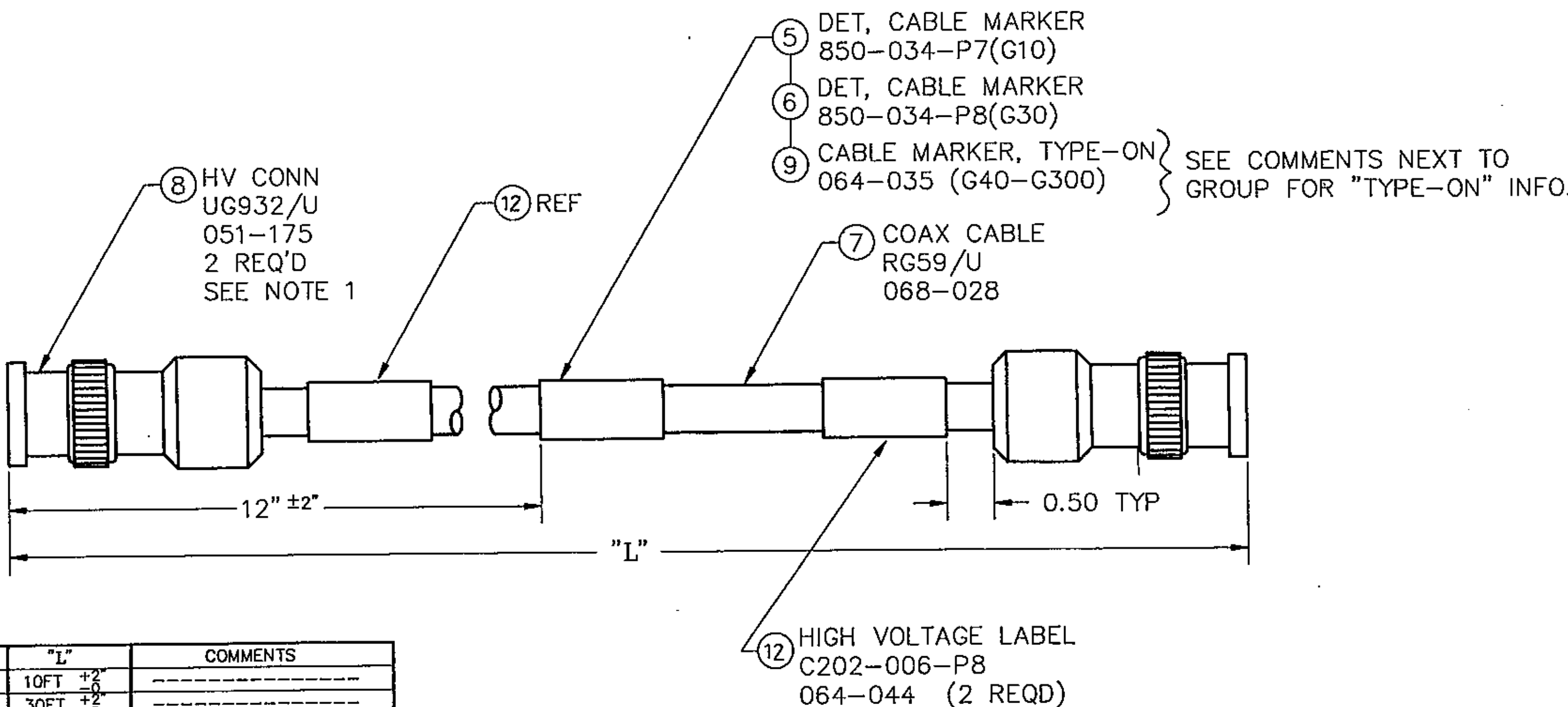
FIRST CALLED FOR ON: SEE SEPARATE PL
DRAWING NUMBER: C850-405

Pirani Gauge Cable 850-405C



Type 100/120 Cable 850-505D

C850-



GROUP	"L"	COMMENTS
G10	10FT +2' -0	--------------------
G30	30FT +2' -0	--------------------
G40	40FT +2' -0	850-305-G40 CC 40'
G50	50FT +2' -0	850-305-G50 CC 50'
G60	60FT +2' -0	850-305-G60 CC 60'
G70	70FT +2' -0	850-305-G70 CC 70'
G80	80FT +2' -0	850-305-G80 CC 80'
G90	90FT +2' -0	850-305-G90 CC 90'
G100	100FT +2' -0	850-305-G100 CC 100'
G110	110FT +2' -0	850-305-G110 CC 110'
G120	120FT +2' -0	850-305-G120 CC 120'
G130	130FT +2' -0	850-305-G130 CC 130'
G140	140FT +2' -0	850-305-G140 CC 140'
G150	150FT +2' -0	850-305-G150 CC 150'
G160	160FT +2' -0	850-305-G160 CC 160'
G170	170FT +2' -0	850-305-G170 CC 170'
G180	180FT +2' -0	850-305-G180 CC 180'
G190	190FT +2' -0	850-305-G190 CC 190'
G200	200FT +2' -0	850-305-G200 CC 200'
G210	210FT +2' -0	850-305-G210 CC 210'
G220	220FT +2' -0	850-305-G220 CC 220'
G230	230FT +2' -0	850-305-G230 CC 230'
G240	240FT +2' -0	850-305-G240 CC 240'
G250	250FT +2' -0	850-305-G250 CC 250'
G260	260FT +2' -0	850-305-G260 CC 260'
G270	270FT +2' -0	850-305-G270 CC 270'
G280	280FT +2' -0	850-305-G280 CC 280'
G290	290FT +2' -0	850-305-G290 CC 290'
G300	300FT +2' -0	850-305-G300 CC 300'

NOTES:
1- REFER TO HV BNC PROCEDURE A204-037.

PROPRIETARY
NOT FOR REPRODUCTION
NOR DISTRIBUTION

INFICON — EAST SYRACUSE NEW YORK

SCALE: NONE (PLT 1=1) DATE: 5-11-89 | APPROVED BY: PM 7/26/88 RAK 9/18/86 | DRAWN BY: Ziemba ISSUED: AH 9-19-86

ASSY, COLD CATHODE CABLE

FIRST CALLED FOR: SEE SEPARATE PL | DRAWING NUMBER: C850-305

Cold Cathode Cable