ARUN MICROELECTRONICS LTD.

PRESSURE GAUGE CONTROLLER MODELS PGC4S, PGC4D AND PGC4Q.

USER MANUAL ISSUE 3.1

For use with Program Version 2.06 onward
and instruments with serial numbers C139 001 or greater.

The information contained in this manual has been carefully checked and is believed to be correct. No responsibility is assumed for any errors. User comment and criticism is welcome: please write or fax. quoting the serial number of the instrument and the version number of the software as displayed by the instrument to:

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Please direct other enquiries to the distributor or agent from whom you purchased the instrument.

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♦♦♦ 1. INSTALLATION

♦♦ 1:1 CHECKS ON RECEIPT OF THE INSTRUMENT.

On receipt of the instrument remove all packing material and check that all items on the delivery note have been received. Report any damage or shortages to the Company or the Agent who supplied the instrument. The packing material has been specially designed to protect the instrument and should be retained for possible future use.

♦♦ 1:2 COLD-CATHODE GAUGEHEAD INSTALLATION.

Consult the information supplied with the gaugehead for advice on flanges, gaskets and adaptors for mechanical fixing.

Mount the gaugehead in a position where the free electrons and magnetic field generated in its vicinity will not affect other equipment. The performance of the cold-cathode gauge may be affected by other electron or ion generating processes within the vacuum chamber: should shielding of the gaugehead or interposition of an elbow be necessary, ensure that the conductance between the gaugehead and volume of interest is not significantly decreased by its presence.

The gauges and controller are each protected from all normal failure modes of the other. Users should be aware of potential hazards from other equipment, however, particularly those introducing high voltages into the vacuum chamber (X-ray sources for example). **Since a direct discharge from one of these at high pressure may cause extensive damage, shielding should always be introduced in such cases.**

♦♦ 1:3 INSTRUMENT INSTALLATION.

♦ 1:3.1 Mounting.

The instrument is suitable for mounting in a standard 19" rack and occupies 1U (1.75" , 44.5mm) of the rack. The mounting holes in the front panel are intended for retaining the instrument in the rack and will not support its weight. Additional support is required toward the rear and various arrangements are provided by rack manufacturers for this purpose. Support brackets may be mounted on the tapped M3 fixing holes on the sides near the rear. If these or other arrangements are attached to these holes, ensure that the screws used are steel and penetrate the case between 6 and 8 millimetres.

♦ 1:3.2 Ventilation.

The instrument is forced-air ventilated through grilles on the right side and a fan on the rear panel. Mount it in a location where there is an adequate supply of air as close as possible to cool room-ambient temperature. The instrument is tolerant of, and is compensated for, operation at elevated ambient temperatures up to 40° Celsius. Long-term accuracy and reliability will be enhanced by operation at the lowest possible temperature. If there are other instruments in the rack which generate significant amounts of waste heat, try to ensure that this is deflected away from this instrument.

♦ 1:3.3 Connection to the mains supply and earthing.

The mains is connected via an IEC CEE22 pattern connector.

THE INSTRUMENT SHOULD ALSO BE CONNECTED TO EARTH BY THE STUD PROVIDED. FAILURE TO PROVIDE THIS CONNECTION MAY RESULT IN A SHOCK HAZARD FOR THE OPERATOR IF EXTERNAL SOURCES OF HIGH VOLTAGES ARE INADVERTENTLY CONNECTED TO THE GAUGE OR SIGNAL LEADS WHEN THE MAINS LEAD IS DISCONNECTED.

The mains supply is filtered to help prevent conducted electromagnetic interference affecting the operation of this or other equipment nearby. To ensure that this filtering is effective, and because there is an earth leakage current generated within the instrument, it is desirable to return this directly to the vacuum system ground reference star point. Ensure that other instruments are directly and separately earthed so that return or fault currents cannot flow in any common ground impedance. This is particularly important in cases where there are high voltage power supplies in the system; there must be specific low impedance paths for return or flashover currents, reliance on frame continuity or sneak paths will cause noises and spikes to be coupled into instrumentation. Low resistance connections do not necessarily have low impedance, which is most successfully achieved with a wide, flat Litz conductor of large cross-section and number of insulated strands.

Information on wiring for process control will be found in section 3:7, below.

♦♦ 1:4 FUSING.

The rating of the mains fuse is printed on the rear panel adjacent to the fuseholder. It must be replaced with a 20mm x 5mm anti-surge fuse of the same type and rating. Such fuses are marked with a "T" adjacent to the current rating: ceramic fuses are generally unsuitable, even if so marked. There is provision to house a spare fuse in the fuse drawer, which is integral to the mains connector. It is necessary to disconnect the mains supply when replacing fuses.

♦♦ 1:5 COLD-CATHODE GAUGE CABLES.

The use of correctly constructed and installed cables will enable the instrument to meet its specification.

Triaxial cables are recommended for use with these instruments. AML Inverted Magnetron gaugeheads, type AMG10, have integral 3 metre triaxial cables, which are bakeable to 250°C while operating the gauge. Non-bakeable extension cables are available. If a longer bakeable or radiation-hard cable is required, these are available to special order.

Because of the high voltage on the cable and the requirement for extremely high insulation resistance, special cables, handling and testing techniques are required and AML do not recommend that users make or adapt cables.

The cold-cathode gauge cable should also be as short as is convenient. Although this cable is screened, the amount of interference which can be induced is proportional to its length and can become significant at UHV. Site the cable run away from other cables carrying high power or high frequency signals. The cable installation should be such that movement or flexing is discouraged. Mechanical movement of the cable can generate piezoelectric charges or changes in capacitance which may affect UHV measurements.

♦♦♦ 2. SETTING UP PRIOR TO OPERATION

Operation of the instrument is designed to be easy for users familiar with vacuum system operation and with the types of gauges used.

♦♦ 2:1 SWITCHING ON, BASIC OPERATION AND DISPLAY FUNCTIONS.

Connect the instrument to the mains supply. Do not connect any gauges or other equipment to the connectors on the rear panel at this stage. Rotate the "Gauge Select" switch to the P1 position and switch on. The green LED indicator adjacent to the mains switch will illuminate and the fan will start. The main LED display will show sequentially:

"PGC4"

then

"V X.YY"
(X.YY is the version number of the embedded software.)

then

"ID: Z"
(Z is the instrument address for remote communication purposes.
0 to 9 and A to F are the range of addresses.)

then

"P1 OFF"

with a pair of dots on the left end indicating the units of pressure measurement. Further dots at the right end of this display may be illuminated, showing that one or more of the relays is energised.

The "Local" LED should be illuminated and the "Remote" LED should not be.

The "Pirani/TC" LED display will be blank.

♦♦ 2:2 PREPARING TO MEASURE PRESSURE. INTERNAL LINKS.

The sequence described in the previous section indicates that the power supplies, processor and display are functioning correctly. The following sections contain details of how to set some of the internal links relating to the type of gaugeheads to be used, units of pressure measurement, etc., as appropriate to the section heading. Some of the other links are described elsewhere. Users familiar with the instrument may prefer to refer to the tabular review of all the internal links and a diagram of their location shown in Appendix B and then proceed to section 2:3.

Disconnect the power connector and remove the smaller screws at the sides of the instrument. Note that the ventilation slots are at the right side, when viewed from the front. Remove the cover in an upward direction and locate USRLK1 near the front of the right hand circuit board, adjacent to the Gauge Select switch and USRLK2 near the centre of the same board. Spare links are stored on LKPARK1 and LKPARK2 which are near USRLK1 and USRLK2, respectively. Links stored on the LKPARKs do not

affect anything else. The links consist of two rows of gold-plated pins and each pair of pins has a legend on the circuit board adjacent, in order to identify the function controlled by a link fitted across that particular pair of pins. All links must be fitted across the two rows and not along a row.

♦ 2:2.1 Setting the gauge parameters.

PT0 and **PT1** of USRLK1 should have both links fitted for use with AML Pirani gauges. Consult appendix B or any supplementary information provided if the instrument was ordered to operate with Pirani gauges other than AML.

Fit or remove links at **GT0** and **GT1** of USRLK1, according to the following to specify the type of cold-cathode gauges used.

AML AMG10fit links to GT0 and GT1
Balzers IKR020fit link to GT1 only
ESRF Specialfit link to GT0 only (NB this also re-allocates relays)
To be definedfit no links

Fit or remove links at **CM0** and **CM1** of USRLK1, according to the following to specify the fullscale output of the Capacitance Manometer. Links CM0 and CM1 **MUST** be fitted on PGC4Q:

No CM used fit links CM0 and CM1
10 mBfit link CM0
100 mBfit link CM1 only
1 mBfit no links (1000mB for program versions before 2.06)

♦ 2:2.2 Specifying the units of pressure measurement.

Fit links at U0 and **U1** on USRLK1, according to the following;

Pascalfit no links
Millibarfit links to U0 only (or U0 and U1)
Torrfit link U1 only

♦ 2:2.3 Specifying the Pirani Interlock.

Fit a link in the NPLOCK position of USRLK1 to prevent **starting** the cold-cathode gauge when Pirani 1 pressure is above 5×10^{-3} millibar. Users should note that this interlock does not switch off the cold-cathode gauge if Pirani 1 pressure susequently exceeds the threshold.

♦ 2:2.4 Specifying Pulsed-Mode Operation of the Cold-Cathode Gauges.

Fit a link in the NP0 position of USRLK2 to cause the cold-cathode gauge to run in pulsed-mode when the pressure is above 2 x 10^{-6} millibar.

It is suggested that pulsed-mode is not selected until the user is familiar with the operation of the instrument.

♦ 2:2.5 Replacing the covers.

Before replacing the cover you may wish to adjust the links which specify other functions: a tabular review of all the links on USRLK1 and USRLK2 and a diagram of their location is shown in Appendix B.

Ensure that there are no loose links or foreign material inside the instrument. Replace the cover with the ventilation slots to the right, when viewed from the front, and screws in the correct locations. Do not use screws longer than those supplied (M3 x 6 mm).

You are now ready to connect gauges and measure pressure.

♦♦♦ 3. OPERATION

♦♦ 3:1 PRESSURE MEASUREMENT USING PIRANI GAUGES.

Switch off, disconnect the mains power lead and connect the Pirani gauges. AML and most other Pirani gauges may be run in air at atmospheric pressure with no hazard to the gauge or the operator. Ensure that the lead of the Pirani gauge which is interlocked to the cold-cathode gauges is connected to the Pirani 1 connector on the rear panel.

Reconnect the power lead, rotate the "Gauge Select" switch to the P1 position and switch on. After the initial sequence of messages is complete the display should show "P1 OFF". The separate left section of the LED display shows a low-resolution histogram of Pirani pressure at all times when the associated Pirani gauge is operating, and at this stage should be blank.

Press the "On/Off" switch to turn on P1. The main display will show Pirani pressure and the Pirani histogram will illuminate. This should be read against the scale at the top or bottom as indicated by the printed line to the illuminated pressure unit indicator LEDs at the left end of the main section of the LED display.

Pressing the "Change Display" switches will change the format of the main display between numeric indication of Pirani pressure and a leak detection indication. Leak detection is described below.

Numeric indication of Pirani pressure allows a higher resolution measurement of these pressures to be made, but is only available when the "Gauge Select" switch is in the P1 or P2 position. The histogram displays are useful for monitoring backing-line pressures, for example.

If "P1 OC" or "P2 OC" is displayed the Pirani Gauge sensing filament is open circuit or the gauge requires calibrating.

Pirani gauges are not very accurate or repeatable transducers at pressures close to atmospheric. For this reason, the instrument has poor discrimination of pressures between 1 bar and 5 mbar. This is of no practical consequence, since a typical rotary-pump roughed system will traverse this range in a few seconds and will adequately indicate that pumpdown is progressing by making the characteristic noises.

♦♦ 3:2 PRESSURE MEASUREMENT USING COLD-CATHODE GAUGES.

♦ 3:2.1 Setting the gauge overpressure trips.

Before starting the cold-cathode gauge you should have specified gauge type and Pirani interlock, as described in section 2:2, above.

Switch off, disconnect the mains power lead and connect the Cold-Cathode gauges.

COLD-CATHODE GAUGES MUST NOT BE RUN UNLESS THEY ARE INSTALLED IN A VACUUM CHAMBER. AN ATTEMPT TO DO SO MAY RESULT IN DAMAGE TO THE GAUGEHEAD AND MAY PRESENT A SHOCK HAZARD TO THE USER.

Operation of an IMG at high pressures can cause films to be deposited on the electrodes, which can adversely affect its operation at UHV. More information on this will be found in section 3:6 and in the gaugehead instructions. An overpressure trip is provided for each Cold-Cathode Gauge to automatically switch off the gaugehead when the trip level is exceeded. Some users will not require this protection, either because the total time that the gauge is exposed to high pressures is small or because they are using Pulsed-Mode Operation or because they do not require operation at extreme UHV. Depending on the gaugehead in use the maximum measurable pressure will be around 1 X 10^{-3} millibars and the overpressure trip will not operate if set above this level. The default setting for these trips is 1 x 10^{-3} millibar.

If you do not have enough information to decide on an appropriate trip pressure it is suggested that a trip level around 5 x 10^{-5} millibars is set until an informed decision can be made.

Switch on and wait for the starting sequence of displays to run. Rotate the "Gauge Select" switch to the C1 position. The main display should be indicating "C1 OFF". If the display shows "C1 N/C" then C1 is not properly connected to the instrument.

Press the "Trips" switch. The main display should be showing "PW ???". This is the password display and can be ignored for the present purpose. Press the "Trips" switch again, observing the main display at the same time. Press the switch once or twice more until the display again shows "C1 OFF". The last display in sequence before the "C1 OFF" returned was the overpressure trip level for gauge C1 and was accompanied by a vertical flashing bar at the right margin of the display. It was preceded by a brief display of "OVP". The other displays in the sequence were the trip pressures of the relays associated with gauge C1 and were accompanied by a flashing indicator at the right of the display which is adjacent to the number of the relay. Displaying this sequence has no effect on the settings and new users may wish to cycle through it several times to become familiar with the presentation and meaning. The use of the relays is described in section 3:7, below: for the moment they can be ignored.

Press the "Trips" switch until the overpressure trip and flashing bar are displayed. The display shows "X-Y" , and indicates that the overpressure trip is set to X x 10^{-Y} units. While the display is in this condition the trip level may be adjusted by means of the "Inc" and "Dec" switches. The new trip level is confirmed by pressing the "Trip" switch. If a delay of more than about 15 seconds occurs during the review process in which no switches are pressed then the trip display "times out" and the normal pressure display is restored with the overpressure trip unchanged.

If there are other Cold Cathode Gauges (C2 on PGC4D or C2, C3 and C4 on PGC4Q) then the overpressure trips for those gauges can be reviewed and set in a similar way.

♦♦ 3:2.2 Starting the Cold-Cathode Gauge.

Check that the cold-cathode gauge is connected to both the SHV and 3.5mm jack sockets on the rear panel. Start pumping the system. When the system pressure is low enough, attempt to start operation of the cold-cathode gauge. If the gauges are new it is preferable to ensure that the pressure is well within the limits of the operating range, between 1×10^{-5} and 1×10^{-8} millibars, and less than the overpressure limit, by whatever gauging means are available. Rotate the "Gauge Select" switch to a position from C1 to C4, as appropriate, and press the "On/Off" switch. Operation of cold-cathode gauges is indicated by LEDs adjacent to the switch.

If the gauge has started a display of pressure in numerical format should be shown. The initial reading may be very low, but should rise over a few seconds to a pressure in the expected range. The settling speed depends on the low-pass filter setting. At pressures below 1×10^{-9} millibars cold-cathode gauges may take an appreciable time to establish a discharge and the start-up time increases progressively for lower pressures. Consult the gaugehead instructions for guidance on this point.

If any display other than a reasonable display of pressure is obtained **SWITCH OFF THE GAUGE IMMEDIATELY** and refer to section 3:3 for an explanation.

There may be a pressure burst immediately after the gauge is started if it has recently been exposed to the atmosphere. This will probably only be significant if the pressure is toward the bottom of the suggested range. Be prepared to switch the gauge off by pressing the "On/Off" switch if this is likely to cause problems in the gaugehead, pumps or system. Under typical conditions the outgassing will diminish fairly quickly but it may be necessary to switch the gauge on and off repeatedly to allow the pump to cope with the gas load.

Proceed to section 3:4 if no problems have been encountered.

♦♦ 3:3 PROBLEMS WITH STARTING OR RUNNING THE COLD-CATHODE GAUGE.

Most application problems with ionisation gauges are concerned with the gauge cables. The signal currents are very small and the required insulation resistance is very large. For this reason AML AMG10 gaugeheads have integral cables. The following diagnostic procedures will need to be modified by users of other gaugeheads and cables since they can be exchanged independently.

DISCONNECT THE MAINS POWER CONNECTOR BEFORE CHECKING, REMOVING OR EXCHANGING ANY CABLES. IT IS RECOMMENDED THAT SHV CONNECTORS ARE NEITHER MATED NOR DISCONNECTED WHILE THE GAUGES ARE SWITCHED ON.

♦ 3:3.1 Abnormally low pressure indication.

If sufficient time has been allowed for the gauge to start a low pressure indication or "LOW P" display may be a symptom of an open-circuit condition in the cable. Ensure that the correct gauge has been switched on and that the gaugehead is connected to the correct cable.

Switch off and move the cable to another cold-cathode gauge connector on the rear panel of the instrument (PGC4D and PGC4Q only). Switch on that gauge. If the gauge operates correctly then suspect a fault in the instrument. If a low reading is still obtained substitute another gaugehead.

♦ 3:3.2 Abnormally high pressure indication.

The gauge ion current must first be reduced to a low level. This may be done by withdrawing the magnet from the gaugehead while the gauge is operating. The instrument should indicate a rapidly reducing pressure and display "LOW P" after a few minutes. In this case the cause of the high pressure indication is within the vacuum system or gaugehead.

If a pressure reading is still obtained after some minutes, this may be due to a high leakage current across the gaugehead feedthrough insulator, in the cable or the connectors or in the instrument. Switch off the instrument and remove the gauge SHV connector, leaving the 3.5mm jack plug in place. Switch on again and start the gauge. Any reading other than "LOW P" after a few minutes of operation indicates that there is a significant leakage current within the instrument. However, if "LOW P" is obtained then the leakage is probably in the gaugehead, insulator or cable.

The source of leakage paths is often moisture on insulating surfaces. The performance of parts so affected may often be restored by placing them in a warm dry area for a day or two.

♦ 3:3.3 Other fault indications.

If "PLOCK" is displayed the Pirani interlock is preventing operation since Pirani 1 pressure indication is above 5×10^{-3} millibar. Pirani gauges are generally more repeatable at the lower end of their pressure range, although not necessarily more accurate. If you are confident that the system pressure is low enough and the Pirani interlock is preventing the cold-cathode gauge from being run, then remove the interlock link, as described in section 2:2.3, or adjust the Pirani calibration.

If **"EXT INH"** is displayed then cold-cathode gauge operation is being prevented by an external inhibit signal on the Auxiliary Connector.

If **"LOW P"** is displayed then there is either an open circuit in the cable to the gaugehead, the pressure

is below 5 x 10^{-11} millibar or the discharge has not yet become established.

♦♦ 3:4 MEASURING PRESSURE WITH THE COLD-CATHODE GAUGE.

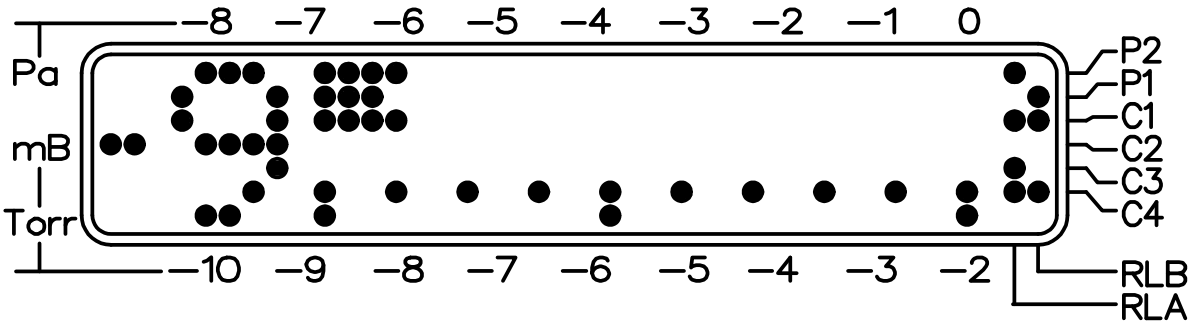
It is assumed that you have followed the procedures in section 2:2 and are running the cold-cathode gauge and displaying its pressure in numeric format.

Review the formats of pressure display available by rotating the "Gauge Select" to the position related to the gauge and pressing either of the "Change Display" switches a number of times. A sequence of displays relating to the selected gauge is available and the current display can be changed at any time. Note that the Pirani pressure is indicated in the separate dedicated section of the LED display. The status of the relays is shown at the right end of the main LED display. When illuminated these represent the energised condition. While cold-cathode gauge pressure is displayed in numeric format an arrow showing the current trend in measured pressure, if significant, is shown at the right of the display.

Two styles of histogram (bargraph) display are available, the long histogram shows the range of cold-cathode gauge pressures and the short histogram shows a single decade. The pressure trend is indicated by a pointer superimposed at the right end of the bar.

The long histogram is interpreted against a row of dots adjacent to scale marks on the panel which indicate the exponent. The mantissa is interpolated between adjacent scale mark dots. Although the resolution is only four points per decade this display is useful during pumpdown. At pressures below 1 x 10^{-10} the long histogram display is not available and is automatically replaced by the numeric display.

The diagram below represents a PGC4Q display of a short histogram of pressure at 2 x 10^{-9} millibar. Note that the scale marks at the bottom of the display represent a mantissa from 1 to 10, with the double marks on 1, 5 and 10. For Pascal the scale is at the top. Note the downward trend indication at the end of the bar and that several relays are energised. If the indicated trend continues, when the pressure histogram reaches the left end of the scale (approximately 1 x 10^{-9}) the instrument automatically changes the display to a full bar and an exponent of 10 (10 x 10^{-10}).
This autoranging function occurs at every change of exponent and includes a small hysteresis to avoid repeated changes of display when the pressure is fluctuating around the decade threshold.



There are two other displays available, which concern the leak detector and low-pass filter operation, these are described below.

♦♦ 3:5 OPERATION AT EXTREME UHV.

The ultimate low pressure which the instrument can measure is determined principally by the cold-cathode gaugehead used and the construction and disposition of the cables. AMG10 gauges with 100 metre cables should achieve 5×10^{-11} millibar readily.

Avoid starting cold-cathode gauges at very low pressures: some gauges take minutes or even hours to establish a stable pressure-representative ion current when switched on below 1×10^{-9} millibar.

This instrument contains an advanced electrometer circuit which is well compensated for ambient temperature changes. It is located in the path of cooling airflow, and it is isolated from internal sources of heat. Operation of the instrument in conditions of high humidity may affect extreme UHV measurements if condensation is allowed to form within the case. The most common cause of this is introducing a cold instrument into warm conditions. If this situation exists it will normally be self-correcting after a few hours of operation in non-condensing conditions.

Extreme UHV performance will be affected by contamination of the glass-reinforced-plastic insulators around the SHV connectors on the rear panel. Avoid touching these and, if necessary, clean them by flushing with 113 solvent or pure ethyl alcohol.

♦♦ 3:6 OPERATION OF THE COLD-CATHODE GAUGE AT HIGH PRESSURES.

Consult the manufacturer's recommendations for operation of cold-cathode gauges at relatively high pressures. Operation for extended periods at pressures over 1×10^{-6} millibars should be avoided in any case, since this can affect the low-pressure starting characteristics. At these pressures there is a relatively large amount of power in the discharge and this can polymerise any hydrocarbons present forming tenacious varnish-like films on the electrodes, leading to shifts in the characteristics.

Gauges which have been exposed to atmosphere and which are first operated around 10^{-4} millibars can produce an unstable discharge which is concentrated at the ends of the gauge's internal volume. This is due to a high local pressure caused by rapid desorption of large quantities of gas from the gauge surfaces. With a high main chamber pressure this is not pumped away quickly enough. Generally, the effect is not apparent to the user but should be avoided because of rapid and localised contamination of those parts of the anode. This type of discharge also generates a large amount of radio-frequency interference and in extreme cases this can disrupt the operation of the PGC4's processor, causing the program to reset the instrument and switch off the gauges. This undesirable discharge mode can be avoided by first operating a gauge at lower pressures: if this is not possible then it should be operated repeatedly for periods a few seconds.

Pulsed-mode operation is selected by the presence of a link on position NP0 of USRLK2. The location and changing of links is described fully in section 2:2.

During pulsed-mode operation the gauge is switched on for 0.5 seconds every 5 seconds. Since this mode of operation is used only when the pressure exceeds 2×10^{-6} millibars the discharge is established very quickly and can be measured to the limit of resolution of the instrument in less than 0.5 seconds. The pressure obtained is displayed for 5 seconds until the next measurement is available. The process control relays operate on the stored pressure readings and the low-pass filter is disabled. The indicator LED adjacent to the "Gauge Select" switch is illuminated when the gauge is operating so that it flashes during pulsed-mode operation. If several gauges on a PGC4D or PGC4Q are operating in this way they are switched on in a regular sequence at 1.25 or 2.5 second intervals.

When the condition for pulsed-mode is established, either by switching on at high pressure or by an increase in the system pressure above 2×10^{-6} millibars, continuous operation is maintained for the first

30 seconds. This allows stable conditions to be established after any pressure burst caused by gas desorption by the gauge discharge in the former case and to detect whether the pressure rise was due to a vacuum accident in the latter case.

Normal continuous-mode operation will start as soon as the measured pressure decreases below 1 x 10^{-6} millibar. The hysteresis and delay prevent rapid mode-switching if the pressure fluctuates around the threshold of the mode change.

♦♦ 3:7 PROCESS CONTROL AND TRIPS.

Six process control relays are provided within PGC4D, which can be used in a variety of ways. The relays and their contacts are described in the following paragraph, and their assignment and use in the remainder of this section.

PGC4Q contains drivers for twelve relays which are housed externally in PGC4R. Relays controlled by PGC4Q have fixed assignments, and are named to reflect those assignments, for example:

C1 RLA, C1 RLB, P1 RLA

Each relay is assigned to a gauge, and the relay is energised when the pressure is below the setpoint. The hysteresis is fixed and the relay will de-energise when the pressure exceeds twice the setpoint pressure. Adjustment of setpoints is described in section 3:7.5.

♦ 3:7.1 Use and wiring of the relays (PGC4S and PGC4D).

The chanegeover contacts of the relays are shown diagrammatically on the rear panel legend, in the de-energised condition, adjacent to the terminal blocks to which they are connected. Switching loads of more than 5 Amps is not recommended. Inductive loads, including contactor coils, should have "snubber" networks connected in parallel to avoid arc generation across the relay contacts, which could interfere with the operation of this and other equipment. In general, avoid introducing noise sources into the instrument via the relay contacts.

The external wiring is connected to the instrument through a two-part pluggable terminal block. This can be removed and wired independently of the instrument. Ensure that external wiring is of adequate cross section for the load current. Strip and twist the wires (do not tin them) and insert them into the receptacle in the terminal block. The stripped length should be such that the wire ends reach the back of the receptacle with the insulation just reaching its mouth. Close the leaf on the wire by tightening the screw immediately above.

TAKE APPROPRIATE ACTION TO STRAIN-RELIEVE THE WIRING NEARBY AND TO RESTRICT ACCESS TO THE TERMINALS IF HARMFUL VOLTAGES ARE TO BE PRESENT.

♦ 3:7.2 Assigning the relays to gauges (PGC4S only).

The four relays are designated RLC up to RLF. Four combinations of assignments of relays to gauges are available and may be selected by two internal links.

The relay associations may be changed by following the procedure below.

Disconnect the power connector and remove the smaller screws at the sides of the instrument. Note that the ventilation slots are at the right side, when viewed from the front. Remove the cover in an upward direction and locate USRLK1 near the front of the right hand circuit board, adjacent to the Gauge Select switch. Spare links are stored on LKPARK1 which is on the right edge of the same circuit board. Links stored there do not affect anything else. Fit or remove links at RL0 and RL1 positions on USRLK1 according to the following table:

LINKS		RELAY ASSIGNMENTS			
RL1	RL0	RLC	RLD	RLE	RLF
0	0	P1	C1	P1	P2
0	1	P1	C1	P2	P2/CM
1	0	P1	C1	C1	P2/CM
1	1	P1	C1	P1	C1/CM

N.B"0" above denotes the presence of a link at RL0 or RL1 on USRLK1.
Relay F is allocated to the Capacitance Manometer only if a CM is defined as being present by links CM0 and CM1 on USRLK1.
Before replacing the cover read section 3:7.4.

♦ 3:7.3 Assigning the relays to gauges (PGC4D only).

The six relays are designated RLA up to RLF. Four combinations of assignments of relays to gauges are available and may be selected by two internal links.

The relay associations may be changed by following the procedure below.

Disconnect the power connector and remove the smaller screws at the sides of the instrument. Note that the ventilation slots are at the right side, when viewed from the front. Remove the cover in an upward direction and locate USRLK1 near the front of the right hand circuit board, adjacent to the Gauge Select switch. Spare links are stored on LKPARK1 which is on the right edge of the same circuit board. Links stored there do not affect anything else. Fit or remove links at RL0 and RL1 positions on USRLK1 according to the following table:

LINKS		RELAY ASSIGNMENTS					
RL1	RL0	RLA	RLB	RLC	RLD	RLE	RLF
0	0	P1	P2	C1	C2	P1	C1/CM
0	1	P1	P2	C1	C2	P2	C1/CM
1	0	P1	P2	C1	C2	C1	C2/CM
1	1	P1	P2	C1	C2	C2	P1/CM

N.B "0" above denotes the presence of a link at RL0 or RL1 on USRLK1.
Relay F is allocated to the Capacitance Manometer only if a CM is defined as being present by links CM0 and CM1 on USRLK1. Relay assignments are different if the ESRF calibration table is used. Before replacing the cover read the next section.

♦ 3:7.4 Trip relay status when the gauge is not operating.

A link on the NIGREN position on USRLK1 causes the relays assigned to a gauge to be energised when the gauge is not operating. Absence of a link causes the relays to be de-energised when the gauge is not operating. Users should remember that the relays are always de-energised when the instrument is not switched on!

Disconnect the power connector and remove the smaller screws at the sides of the instrument. Note that the ventilation slots are at the right side, when viewed from the front. Remove the cover in an upward direction and locate USRLK1 near the front of the right hand circuit board, adjacent to the Gauge Select switch. Spare links are stored on LKPARK1 which is on the right edge of the same circuit board. Links stored there do not affect anything else. A link on the NIGREN position on USRLK1 causes the relays assigned to a gauge to be energised when the gauge is not operating. Absence of a link causes the relays to be de- energised when the gauge is not operating.

Ensure that there are no loose links or foreign material inside the instrument. Replace the cover with the ventilation slots to the right, when viewed from the front. Do not use screws longer than those supplied (M3 x 6mm).

♦ 3:7.5 Setting trip pressures.

When the instrument is running the assignment of the trips and the trip pressures can be reviewed at any time by rotating the "Gauge Select" switch to the desired gauge and pressing the "Trips" switch. The main display should be showing "PW ???". This is the password display and can be ignored for the present purpose. The relay LEDs at the right end of the main display which are associated with the selected gauge flash. Some of the gauges may have two relays associated and some may have none. The second relay is revealed by a further press on the "Trips" switch. For the cold-cathode gauges a further press on the "Trips" switch will reveal the overpressure trip setting and a final press will return the gauge pressure and status display.

Typically the display shows "X-Y" , and indicates that the relay indicated by the flashing LED is assigned to the gauge selected by the rotary switch and that the trip pressure is $X \times 10^{-Y}$ units.

While the display is in this condition the trip levels may be adjusted by means of the "Inc" and "Dec" switches. Note that the terminal values reached are "EN" and "DN", representing the permanently energised or de-energised condition of that relay, respectively. The new trip levels become active when all those associated with the gauge have been reviewed and changed if desired and the normal display is restored. If a delay of more than about 15 seconds occurs during the review process in which no switches are pressed then the trip display "times out" and the normal pressure display is restored with all the trips unchanged.

The trip levels are maintained in the instrument's memory, even when the power is switched off.

Users of trips on Pirani and thermocouple gauges should be aware that the resolution and repeatability of such gauges is relatively poor and that trips set outside the range 5×10^{-3} to 5 millibars may exhibit undesirable repetitive switching.

♦ **3:7.6 Password protection of trip pressures.**

Unauthorised changes to trip pressures may be prevented by entering a 3 digit password number.

WARNING! IF YOU ENTER A PASSWORD NUMBER IT IS ESSENTIAL THAT YOU RECORD IT.

The position of the "Gauge Select" switch does not matter, since one password protects all the trips. Press the "Trips" switch. The main display will show "PW ???". Press the "Inc" or "Dec" switches until the desired password number is displayed, then press the "Trips" switch to confirm it. There is no "timeout" on setting the password number, to allow more time to consider and record the setting. If you decide not to proceed during the setting process return the display to "PW ???" (between "PW 999" and "PW 001") and press "Trips".

After a password number has been set the relay trip pressures may be displayed without entering the password number. If the relay trips are to be modified then the password must be entered every time the "PW ???" prompt is displayed.

♦♦ 3:8 LEAK DETECTION.

The leak detector works by indicating rapid changes of pressure on a bargraph and a frequency-modulated tone. Such changes are produced with a probe gas or volatile blocking agent. It is difficult to exercise this function unless you have a leak valve (or a leak!) on the system, although you may be able to produce a pressure burst by switching on other equipment or firing a titanium sublimation pump. During leak detection the process control relays function normally.

Select which gauge is to be used by means of the "Gauge Select" switch, switch it on if it is not operating and press either "Change Display" switch repeatedly until the word "LEAK" appears in the display. Which gauge is best to use will depend on the pressure at which the leak is limiting pumpdown. The display "LEAK" is replaced by a histogram of rate of pressure deviation with baseline restoration. If you have means to simulate a leak, you should do so and observe the effect on the display and tone.

A volume control for the sounder is adjacent to the "Gauge Control" switch and is accessible with an instrument screwdriver with a flat 3mm blade.

After a pressure change has been observed, turn off the probe gas supply or stop applying the blocking agent and wait until the baseline restorer has caused the histogram and tone to return close to the centre of their range. This shows that the leak detector has adjusted to the new system pressure and does not necessarily indicate that the pressure is the same as before probe gas was introduced via the leak. A blocking agent may give rise to a deviation first to the right and then to the left before settling. A probe gas may give a single deviation in either direction, depending on the relative sensitivity of the cold-cathode gauge to the residual gas in the chamber and the probe gas, and to the relative pumping rates for those gases. Further localisation of a leak may be attempted after the deviation has been restored.

♦♦ 3.9 CAPACITANCE MANOMETER (PGC4S AND PGC4D ONLY).

The capacitance manometer (CM) is connected via the Auxiliary Connector. For details on this connector refer to Appendix A. The instrument caters for a single unheated capacitance manometer with a full-scale output voltage of 10v, representing 1, 10 or 100 millibar. (The 1mB range replaced a 1000mB range at program version 2.06.) If your CM has a fullscale in Torr consult AML for advice on matching this to the instrument. ±15v power is available to drive the CM at up to 35mA, if your CM requires more power than this an external power supply will be required: this will also allow heated CMs to be used. These have better resolution and stability.

The CM can be interrogated by rotating the "Gauge Select" switch until the CM pressure reading appears. This is only available in numeric format. If the pressure measured by the CM is greater than its full scale pressure then the reading displayed on the LEDs is "M > FS".

Ensure that the fullscale selected by the internal links matches that of the CM. Capacitance Manometers used with these instruments must have a full-scale defined in millibars or Pascal, although the display of pressure may be in in millibars, Torr or Pascal. CMs with scaling in Torr can usually be adjusted or adapted; consult the manufacturer or AML for advice on this.

If pressure readings are not consistent with the measured pressure the range and units of display may be changed by the following procedure:

Disconnect the power connector and remove the smaller screws at the sides of the instrument. Note that the ventilation slots are at the right side, when viewed from the front. Remove the cover in an upward direction and locate USRLK1 near the front of the right hand circuit board, adjacent to the Gauge Select switch. Spare links are stored on LKPARK1 which is on the right edge of the same circuit board. Links stored there do not affect anything else.

Fit or remove links on USRLK1 according to the following fullscale output of the CM:

No CM used fit links CM0 and CM1
10 mBfit link CM0
100 mBfit link CM1 only
1 mBfit no links (1000mB before program version 2.06)

Pascalfit no link to U0 or U1
Millibarfit link U0 only (or U0 and U1)
Torrfit link U1 only

Before replacing the cover you may wish to adjust the links which specify other functions: a tabular review of all links on USRLK1 and a diagram of their location is shown in Appendix B.

Ensure that there are no loose links or foreign material inside the instrument. Replace the cover with the ventilation slots to the right, when viewed from the front. Do not use screws longer than those supplied (M3 x 6mm).

♦♦ 3:10 EXTERNAL INHIBIT OF THE COLD-CATHODE GAUGE.

Operation of the cold-cathode gauges may be inhibited by an external contact closure or TTL "low" signal, which prevents starting or running of the cold-cathode gauge by any means. The contacts should be connected to the appropriate pins of the Auxiliary connector and must not be connected to any external source of voltage outside the range ±15v with respect to the earth stud. Gold-plated contacts are recommended as the internal voltage and current source are small. Consult Appendix A for connector information.

♦♦ 3:11 REMOTE OPERATION.

Logging and control of the instrument by a host computer through the Remote connector is possible. A demonstration program which will run on any IBM XT, AT or compatible computer is available on diskette. The host computer must have at least one RS232 or RS422/RS485 serial port, to match the line drivers and receivers present in the PGC4. Information on the interface protocols and hardware is given in the PGC4 Interface Manual.

This manual describes the operation of the instrument in local mode, when the "Local" LED is illuminated at all times. When the instrument is switched to the remote mode by the host computer the "Local" LED is extinguished, the "Remote" LED is illuminated, and only the display functions of the instrument can be performed with the front panel controls.

♦♦ 3:12 RECORDER OUTPUT.

The outputs of the electrometers are connected to the Auxiliary connector. The output resistances are 10 kilohms and the output voltages are analogues of the logarithm of gauge currents. The scaling is +1 volt per decade and 0 volts output represents 100fA (10^{-13}A). Consult the IMG gaugehead calibration information for interpreting pressure from this voltage.

♦♦ 3:13 LOW-PASS FILTER.

If there is some fluctuation of the IMG gauge pressure readings at very low pressures, these may be reduced by increasing the time-constant of the filter. To do this, press a "Change Display" switch until "LP XX" is displayed. XX indicates the current low pass filter status and time-constant in seconds i.e. OFF, 1, 2, 4 or 8 seconds. To change the time-constant press the "Trips" switch, which causes all the relay indicator LEDS to flash. Use the "Inc" and "Dec" switches to change the displayed time and confirm it by pressing "Trips" again. Select a time which just exceeds any observed periodicity in the fluctuations, or the minimum time which reduces them to an acceptable level. The trips and trend indicator operate on unfiltered pressure readings, so their response times are not affected by the filter.

♦♦♦ 4 FAULT MESSAGES

All faults or potential faults detected by the instrument are announced on the LED display. Some are accompanied by a warning sound.

♦♦ 4:1 "C1 N/C, EXT INH and PLOCK."

These faults are normally reported when attempting to start the cold-cathode gauge. Refer to section 3:3.3.

♦♦ 4:2 "TRIPS LOST".

This fault message indicates that the trip pressures have been lost and have been replaced by the default pressures for some reason. It is present after switch-on and is cancelled by operation of one of the front panel switches.

After cancelling this fault message switch off and on again after a few seconds. If the instrument is operating correctly the fault should not be reported again. If this message is shown occasionally the probable cause is electrical interference: refer to the discussion at the end of section 4:4 for more information.

After many years of operation the battery which maintains the trips will need replacing. Trip pressures will be lost every time the instrument is switched off once the battery is discharged.

♦♦ 4:3 "P1 OC" or "P2 OC" or flashing Pirani histogram.

All of these indicate that the Pirani gauge has an open-circuit sensing element.

♦♦ 4:4 OTHER ERRATIC BEHAVIOUR.

Environments where there is a large amount of electrical noise may cause occasional erratic behaviour. In extreme cases this may cause the instrument to revert to a condition corresponding to that which pertains just after switch on, with all gauges switched off. This symptom shows that the instrument's program has been disturbed in some way. Normally, the stored operating and setup parameters will not have been altered: if they were then a warning message will be displayed. Operation may be restored in the normal way.

If this occurs more than extremely infrequently you should attempt to cure the problem at the source of the noise. The most common cause is noise coupling via inadequate earthing arrangements. Refer to section 1:3.3 for general advice on this point.

♦♦♦ APPENDIX A
CONNECTORS

IN THE SECTIONS BELOW THE MATING CONNECTORS ON THE CABLES ARE DESCRIBED.

♦♦ A.1 Mains connector.

This is a female IEC CEE22 type and is normally supplied with the instrument in the accessory pack in the form of a moulded lead with integral 13 Amp. British domestic-style plug. Continental (Schuco) or North-American pattern connectors may be supplied as alternatives in appropriate cases.

If you need to change from the British to an alternative style of connector take care to make the connections correctly to ensure operator safety. The wires are colour-coded as follows:-

Brown Line
Blue Neutral
Green and yellow Earth

♦♦ A.2 Cold-Cathode Gauge connectors.

There are two connectors for each cold-cathode gauge. The centre conductor and inner screen of the triaxial cable are connected to a SHV type free plug. These are available from Huber und Suhner AG or Kings Electronics Co. Inc.. The outer screen is connected to the outer screen terminal of a 3.5mm Audio jack plug. The other two terminals of this jack are shorted together in order to satisfy the safety interlock feature. If extension cables are used these two terminals must be wired between free jack connectors at the ends of the extension cable to preserve the interlock.

Because of the extremely high insulation resistance requirement and the high voltage involved AML do not recommend that users make or adapt cables for cold-cathode gauges.

♦♦ A.3 Pirani connectors.

Two of these are supplied with the instrument in the accessory pack. They are 180°,5 way DIN audio free plugs with screen. Types with or without latches may be used.

Pin connections for gauges are:

1Bridge supply 0v
2 Signal voltage
3Bridge supply 2.06v
4Bridge sense low.
5Bridge sense high.

Using AML PVU or PVB gaugeheads with 5 pin connectors allows compensation for voltage drops in the cables without calibration. The maximum length of cable which can be accommodated depends on the siting and construction of the cables. The maximum resistance of wires in the cable for which the circuits will automatically compensate is 10 ohms. Cables of over a few metres length should be screened and the screen should be connected to the connector clamp only at the controller end.

The pin numbering is consistent with that of the 3-way connector types formerly used on AML and on

current VG Pirani gauges and these gauges are suitable for use with this instrument although the will not be effective. Consult AML for information on how to adapt older AML gaugeheads for automatic lead-length compensation.

♦♦ A.4 Remote connector.

This is a 9 way "D" type male connector. Used pin connections and signal names for **RS232** are:

3 Received Data
2 Transmitted data
5 Signal ground

The pin numbering has been chosen so that a 9-way 'straight-through' male-to-female cable will be satisfactory for use with a PC and AML demonstration program. If users write their own applications using BIOS toutines it will be necessary to link pins 4 and 6 at one end of the cable.

If **Option F** is present (as indicated by the suffix F in the model number on the rear panel) then the pin connections and signal names are compatible with **RS422 or RS485** as follow:

6Received data +
7Received data -
8Transmitted data +
9Transmitted data -
5Signal ground
1Protective ground

Consult the PGC4 Interface Manual for more information.

♦♦ A.5 Auxiliary connector.

External connections should be made to a free 15 pin male high-density "D" connector with screen, as supplied in the accessory kit.

Connections for **external reset** are:

11Not external reset
10Logic ground

A short circuit between these pins or a TTL low signal on pin 11 will reset the PGC4 program. Pin 11 is protected against inadvertent connection to ±15 volts.

Connections to the **capacitance manometer** are:

12 +15 volt supply
13-15 volt supply
14Signal voltage (i.e. manometer output)
15Signal return and supply 0 volts

The capacitance manometer function is not present on PGC4Q.

Connections to the **external inhibit** lines are:

6Not Inhibit C1
7Not Inhibit C2
8Not Inhibit C3
9Not Inhibit C4
10Signal return (logic ground)

A short circuit between an inhibit signal and pin 10, or a TTL low level on an inhibit signal input will prevent a cold-cathode gauge from operating. The inhibit signal inputs are protected against inadvertent connection to ±15 volts. C2 to C4 are not present on PGC4S, C3 and C4 are not present on PGC4D.

Connections for the **recorder** outputs are:

1 Signal voltage C1
2 Signal voltage C2
3 Signal voltage C3
4 Signal voltage C4
5 Signal return (earth)

Recorder outputs C2 to C4 are not present on PGC4S, those for C3 and C4 are not present on PGC4D.

♦♦ A.6 Relay drive connector (PGC4Q)

The relay drive connector is a 16 way female IDC connector. A suitable cable is supplied with each PGC4R instrument. Users wishing to construct longer cables or their own relay units should consult AML for guidance.

APPENDIX B
FUNCTIONS AND LOCATIONS OF THE INTERNAL LINKS.

Refer to the diagrams on the last page of this manual to locate USRLK1, USRLK2, LKPRK1, LKPRK2, LK5 and LK6.

LKPRKs are used for storing spare links. Links stored there do not affect anything else.

A link on the **NIGREN** position causes the relays to be energised when the gauges to which they are assigned are not operating.

Fit a link in the **NPLOCK** position to prevent starting the cold-cathode gauges when Pirani 1 pressure is above 5 x 10^{-3} millibar.

Fit or remove links at **U0** or **U1** according to the following in order to specify the units of pressure measurement:

Pascalfit no link to U0 or U1
Millibarfit link U0 only (or U0 and U1)
Torrfit link U1 only

Fit or remove links at **GT0** and **GT1** according to the following to specify the type of cold-cathode gauges used:

AML AMG10fit links to GT0 and GT1
Balzers IKR020fit link to GT1 only
ESRF Specialfit link to GT0 only (NB this also re-allocates relays)
To be definedfit no links

Fit or remove links at **CM0** and **CM1** according to the following to specify the fullscale output of the CM:

No CM used fit links CM0 and CM1
10 mBfit link CM0
100 mBfit link CM1 only
1 mBfit no links (1000mB before program version 2.06)

Links CM0 and CM1 **MUST** be fitted on PGC4Q:

Fit or remove links at **PT0** and **PT1** according to the following to specify the type of Pirani gauges used:

AML, PVU or PVBfit links to PT0 and PT1
Balzers etc.*fit link to PT1 only
To be definedfit link to PT0 only
To be definedfit no links

* These gauges can only be used if the instrument has been specifically ordered to operate them. A special suffix, e.g. B for Balzers, will be present in the model number on the rear panel of the instrument.

Fit or remove links at **RL0** and **RL1** positions on USRLK1 according to the following table for PGC4S only:

LINKS		RELAY ASSIGNMENTS			
RL1	RL0	RLC	RLD	RLE	RLF
0	0	P1	C1	P1	P2
0	1	P1	C1	P2	P2/CM
1	0	P1	C1	C1	P2/CM
1	1	P1	C1	P1	C1/CM

Fit or remove links at **RL0** and **RL1** positions on USRLK1 according to the following table for PGC4D only:

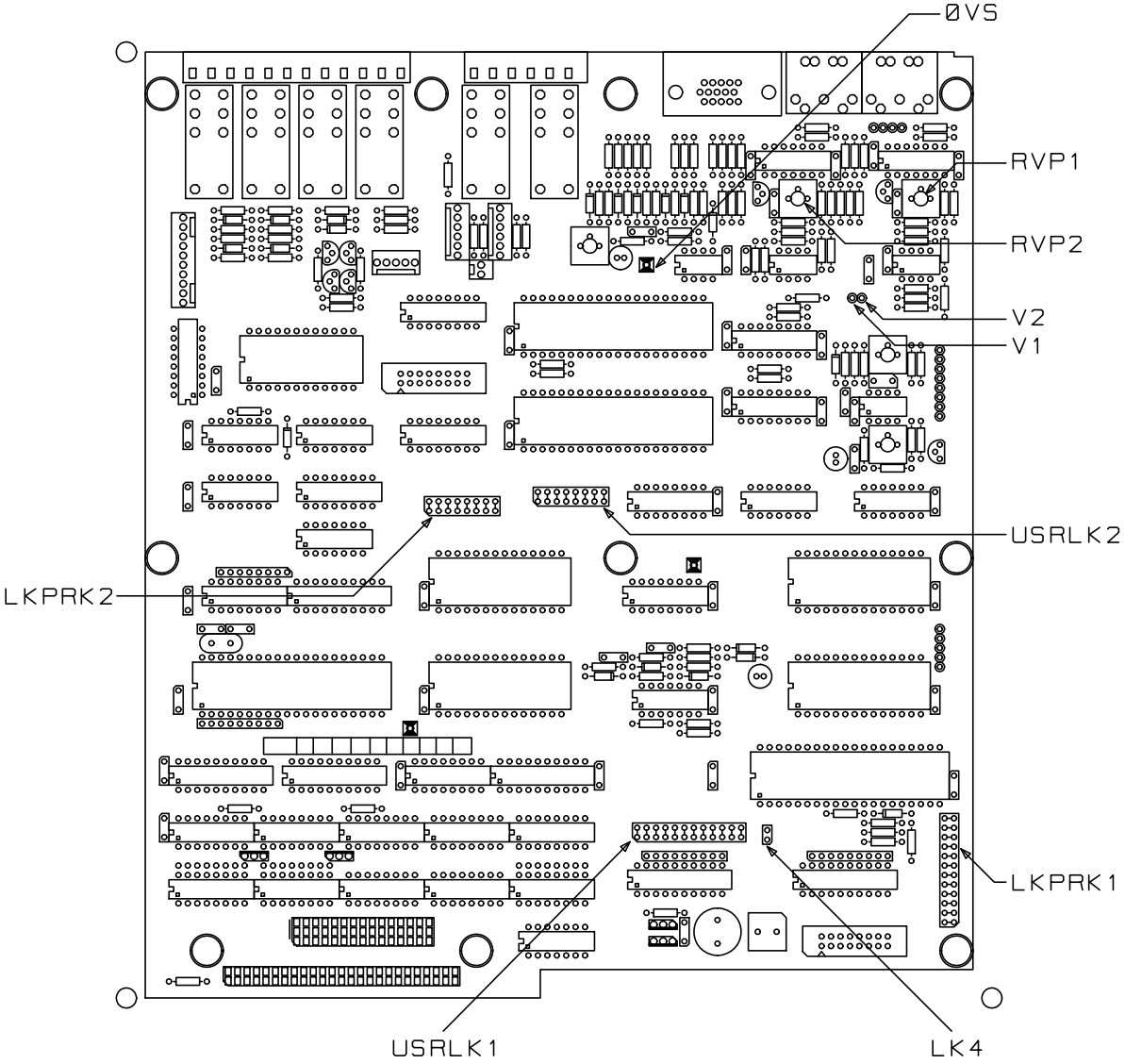
LINKS		RELAY ASSIGNMENTS					
RL1	RL0	RLA	RLB	RLC	RLD	RLE	RLF
0	0	P1	P2	C1	C2	P1	C1/CM
0	1	P1	P2	C1	C2	P2	C1/CM
1	0	P1	P2	C1	C2	C1	C2/CM
1	1	P1	P2	C1	C2	C2	P1/CM

N.B "0" above denotes the presence of a link at RL0 or RL1 on USRLK1.

Relay F is allocated to the Capacitance Manometer only if a CM is defined as being present by links CM0 and CM1 on USRLK1.

If the ESRF calibration table has been selected for the Capacitance Manometer then the relay assignments are different.

Location of user-definable links.



Arrangement of individual links