



NITROGEN LEVEL METER; NLM2

INSTRUCTION MANUAL

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I M P O R T A N T

This operating manual is intended to help the user set up and operate an Oxford Instruments Nitrogen Level Meter.

Before attempting to operate the meter, PLEASE READ THE INSTRUCTIONS.

This product is guaranteed for 1 year against defective materials and workmanship under the general conditions of sale as detailed in the Company's order acceptance.

The guarantee does not apply to damage caused by failure of the operator to follow the recommended operating instructions. This point should particularly be remembered when dealing with the wiring.

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SPECIFICATIONS

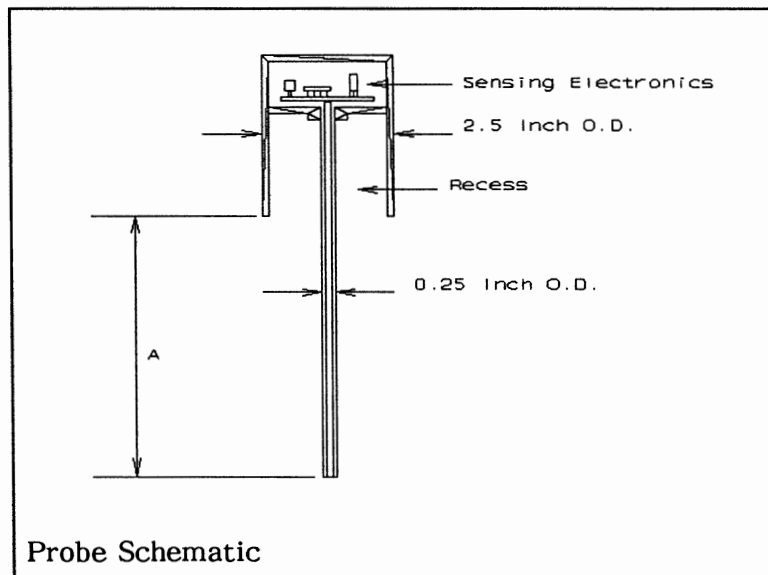
Sensing System	Co-axial tube capacitor
Probe length (dimension A)	0.5 to 3m - other lengths possible to special order.
Probe Diameter	6.35mm (0.25 inches)
Probe Head Diameter	63.5mm (2.5 inches)
Probe Head Length	130.2mm (5.125 inches)
	NB. The underside of the probe head is recessed to allow the head to fit neatly over a standard liquid nitrogen filler bush.
Indication	3 inch moving coil meter
Recorder Output	Approximately 500mV into 50K ohms
Control Output	Two pre-set levels operate changeover contacts.
	Rating: 250V, 3A, AC or DC.
	Maximum load: 80W DC, 200VA AC.
Accuracy	2% of FSD
Power Requirements	110/240V AC, 50-60 Hz, 8VA
Mains Lead Length	3m } Other lengths can be supplied to special
Probe Lead Length	3m } order.

MOUNTING OPTIONS

Free-standing case

Standard rack-mounting kit available. (Two instruments may be mounted side by side in standard 19 inch rack.

Standard probe mounting is as shown below. Other mountings can be supplied to special order. (Please specify dimension A when ordering).



CALIBRATION RECORD

Serial Number
Probe Length (Dim. A in fig. on page iv)
Supply Voltage
Mounting Option
Relay 1 Level
Relay 1 Hysteresis
Relay 2 Level
Relay 2 Hysteresis

Modifications:

1 OPERATING INSTRUCTIONS

1.1 General

The instrument monitors the liquid nitrogen level in a cryostat by means of a vertical capacitance sensor dipping into the liquid. The 'plates' of the capacitor consist of a pair of co-axial stainless steel tubes with the dielectric occupying the annular space between them. A series of holes in the outer tube admits liquid nitrogen to this space. The difference in dielectric constant between liquid and gas enables the length of the probe below the liquid surface to be determined.

To eliminate the effects of cable capacitance, the sensing circuit is built into the probe head. This may be mounted remotely from the indicator if required. A chart recorder output is provided to enable the nitrogen level to be recorded and two change-over relay contacts allow alarms or an automatic top-up system to be operated at preset levels.

1.2 Installation

The equipment comprises the following items:

- 1) Indicator Unit
- 2) Sensor Probe complete with Probe Head and Interconnecting Cable.
- 3) Power Supply Cable

These should be carefully unpacked and checked for mechanical damage. Before installing the probe in a cryostat, it is advisable to carry out a simple check for the presence of moisture in the probe. This may be done by means of a DC resistance check as described in section 5.1.

Note that where a cryostat has been in use for some time, it is not uncommon for water to collect in the bottom. If the probe is installed with the cryostat at room temperature, this water may get into the probe. One solution is to ensure that the cryostat is held below 0°C when the probe is in situ. Alternatively, the probe length may be chosen to stop short of the bottom of the cryostat.

The probe itself has a diameter of 0.25 inch and should be mounted through any suitable aperture in the top of the cryostat. The body of the head unit is recessed, allowing the probe to mount neatly over one of the nitrogen filler bushes on the standard Oxford Instruments cryostats.

After installing the probe, this may be connected to the indicator unit and the latter connected to the supply.

IMPORTANT Before connecting the instrument to the supply, ensure that the supply voltage corresponds to that shown on the rear of the instrument.

1.3 Operation

After connecting the instrument to the supply, the green lamp should light - indicating that the unit is in operation. If there is liquid nitrogen within the cryostat the liquid level will be indicated on the meter. The meter scale is expressed as a percentage of the total probe length immersed in liquid.

NB. This will only be directly proportional to the liquid volume for a parallel sided nitrogen vessel.

When supplied, probes are normally calibrated on the assumption that there will be a dead space of 3 inches between the top surface of the cryostat and the top of the nitrogen vessel. For the most accurate measurements, the probe should be recalibrated in situ as described in section 4.5.

Because the dielectric constant of warm gas differs slightly from that of cold gas, the probe will not read zero in an empty cryostat at room temperature. Typically, it will read 5 - 10% under these conditions. This reading will fall to zero as the gas is cooled prior to filling with liquid.

1.4 Recorder Output

An analogue output is provided at the rear of the instrument for use with a chart recorder in order that nitrogen consumption may be continuously monitored. An output voltage of zero corresponds to a full cryostat (Nitrogen Level = 100%), whilst a voltage of approximately 500 mV is obtained when all the nitrogen is exhausted (Nitrogen Level = 0%). If the recorder has an input impedance of less than 50K ohms, it will affect the calibration of the instrument by a small amount. The indicator unit calibration may be performed with the recorder connected to correct for this (see section 4.3).

1.5 Control Output

Two independent change-over relay contacts are provided at the rear of the instrument for the operation of alarms or an automatic filling system. The relays may be set to operate at any two chosen levels by means of an internal adjustment. In addition, it is possible to introduce hysteresis on either of the relays by adding a single resistor. In this way, a single relay may be used to control an automatic filling system. Thus a relay centered to operate at 50% but with 60% of hysteresis incorporated, will switch to the low state when the level in the cryostat falls to 20%, initiating the filling operation. It will remain in the low state and filling will continue until the level reaches 80%, when it will switch back to the high state and the fill process will be terminated. The second relay is then free for use as an alarm, set for example to 10% to indicate that the automatic filling process has failed for some reason.

As supplied, the relay contacts are normally set to operate at 10% and 20% respectively, with no hysteresis. Sections 4.6 and 4.7 describe the adjustment of the level setting and the addition of hysteresis.

2 MOUNTING

2.1 General

The instrument is built on a single printed circuit board, mounted in an integral frame and case assembly. The main frame consists of the front and back panels and four rails joining these together. The sideplates and the top and bottom covers bolt to the rails and may be removed to allow easy access for servicing. For most operations, it is only necessary to remove the top cover.

2.2 Freestanding Version

The normal version of the instrument is designed for free-standing operation and is fitted with four rubber feet attached to the bottom cover. The two sideplates incorporate carrying handles.

2.3 Rack-Mounting Version

The free-standing version may be adapted for mounting in a half-width rack by the addition of two mounting ears which bolt through the front pair of holes in the sideplates. The top and bottom covers are left in position as dust covers though the feet must be removed.

The sideplates have symmetrical mounting holes so that, when the instrument is rack-mounted, these may either be left with the handles showing, as in the free-standing version, or reversed front to back so that the handles are hidden inside the rack. The choice will largely depend on the appearance of the other instruments in the rack.

For mounting in a full-width (19 inch) rack, two similar instruments may be mounted side by side. In this case, one side plate of each is discarded and the two units are bolted together by their rails. The front and back panels and the top and bottom covers butt together giving a neat unbroken appearance to the complete assembly. As in the half-rack mounting version, a pair of ears are used to support the assembly in the rack and the remaining two sideplates may be mounted with their handles hidden or visible as preferred.

When it is required to mount a single instrument in a full-width rack, a dummy unit is available to mount alongside it.

3 PRINCIPLES OF OPERATION

3.1 General

The instrument relies on the ability to detect the small change in probe capacitance when a gaseous nitrogen dielectric is replaced by liquid nitrogen. If a large, easily measured probe capacitance is required, it is necessary to make the clearances within the probe very small. This would tend to make the probe delicate. Alternatively, using a rugged probe with large clearances implies that cable capacitance between the probe and the sensing electronics is significant. The solution adopted in the OI level meter is to use a rugged probe and to mount the sensing electronics in the probe head, thus eliminating cable capacitance effects. Hence the circuitry is divided into two parts, the head circuit which converts the probe capacitance to a DC signal and the circuitry to operate the level sensing relays.

3.2 Probe Unit

The circuit of the probe unit is shown on page 6. The time circuit IC1 generates a series of short pulses which switch on Q1. The interval between pulses is directly proportional to the probe capacitance and hence to the liquid level.

At each pulse, Q1 discharges the capacitor C2, which is being continuously charged through R5. Thus, provided the voltage across C2 is kept small, its mean value is proportional to the liquid level. This voltage is smoothed by R6 and C3 and applied via R7 to the high impedance amplifier IC2.

A backing off voltage is generated by the 'Set 100%' control RV1 and is used to set the output voltage of IC2 to zero when the probe is totally immersed in liquid. As the liquid level falls, the time between pulses decreases, the voltage across C3 falls and the output of IC2 becomes more negative. With the probe totally in gas, the output voltage from IC2 is -5 volts, this calibration point being set by RV2.

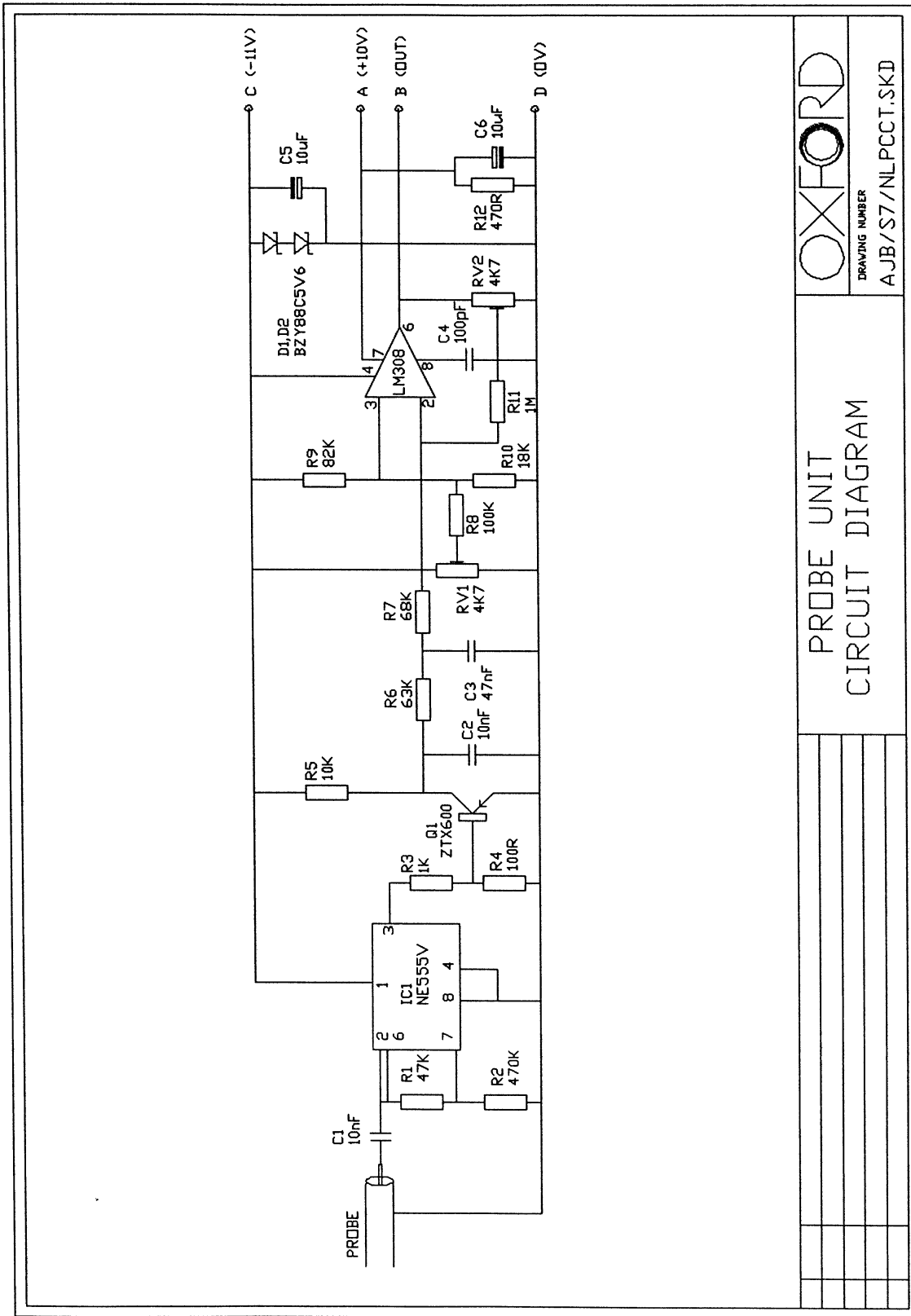
Supply rails for the head unit are derived from the indicator unit but, since the -11 volt rail affects the calibration of the instrument, this is stabilised within the head itself.

3.3 Indicator Unit

The circuit of the indicator unit is shown on page 7. The 0 to -5 volt signal from the head unit is applied via the meter scaling potentiometer RV3 to the meter M1. A low level signal (0 to -500mV) developed across R14 and the meter itself is made available on the rear panel as a chart recorder output.

The signal from the head unit is also applied to the two relay amplifiers IC3 and IC4 where it is compared with signals from the two set level potentiometers RV4 and RV5. When the probe signal is below the set level, the appropriate relay is energised. Positive feedback may be added around the relay amplifiers by means of R17 and R21 in order to introduce hysteresis into the relay operation. A very small amount of hysteresis is permanently incorporated by means of R16 and R20 to prevent dithering of the relays at the switch-over point.

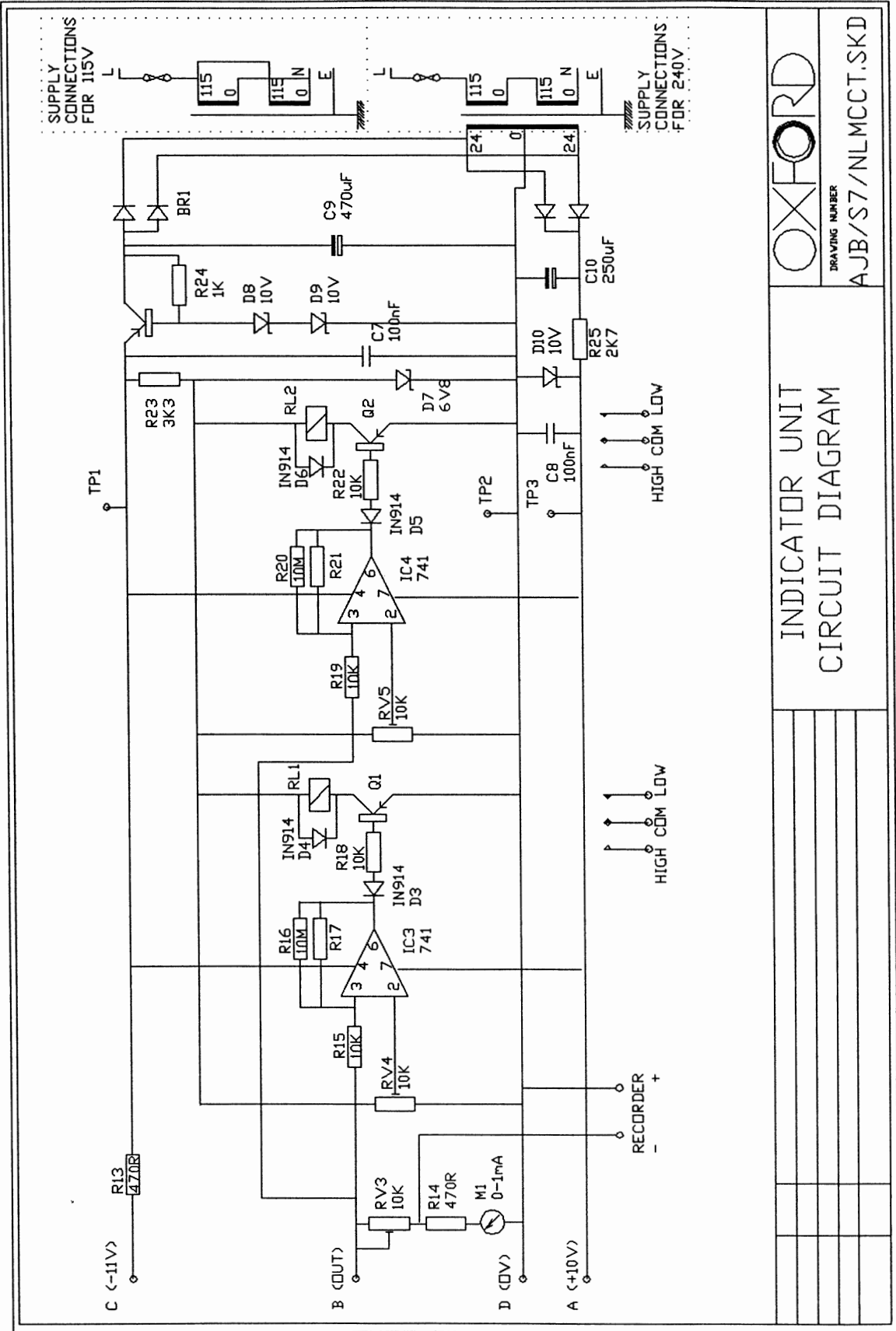
The power supply circuit is conventional and supplies both the indicator unit and the head electronics. A simple Zener stabilises the +10 volt rail, whilst a series regulator Q3 supplies the more heavily loaded -20 volt rail. R13 provides current limiting for the -11 volt rail stabilised within the head.



OXFORD

DRAWING NUMBER
AJB/S7/NLPCCT.SKD

PROBE UNIT
CIRCUIT DIAGRAM



4 CALIBRATION

4.1 General

The head unit and the indicator unit are separately calibrated so that it is possible to use a number of heads and indicators interchangeably. As supplied, the head unit is normally calibrated on the assumption that there will be a 3 inch dead-space between the top face of the cryostat and the top of the nitrogen working volume. Since this will vary between cryostats, it will be necessary to perform a final calibration with the probe in situ if the most accurate results are to be obtained.

If a probe is to be used with more than one indicator unit, the calibration of the latter should be checked before probe recalibration is carried out.

4.2 Access to Indicator Unit

Removal of the top cover by means of its four securing screws allows access to all the calibration adjustments in the indicator unit. The potentiometers are clearly labelled on the circuit board.

4.3 Calibration of the Indicator Unit

With the instrument disconnected from the supply, the mechanical meter zero should be checked. Unenergised, the meter should read 100%. This may be corrected if necessary by means of the small screw in the centre of the meter.

To calibrate the meter span, an accurate 5 volt calibration source is required. This is connected between pins 3 and 4 (Pin 3 is +ve) of the Bulgin connector socket on the rear of the meter (see figure on page 12). The probe itself should be disconnected whilst this operation is carried out. With a 5 volt input, the indicator should read exactly 0%. This may be corrected if necessary by adjustment of RV3.

NB. If the indicator unit is to be mounted in a strong magnetic field, this may affect the sensitivity of the meter itself. If the field is permanently present, this may be compensated for by adjustment of RV3. However, if the field varies, it will be necessary to re-site the indicator unit or to interpose some magnetic shielding between this and the magnet.

4.4 Access to the Probe Unit

The probe casing may be removed to allow access for calibration and servicing by means of the three screws in its top surface. With these removed, the cover may be lifted off the electronics. Note that the bottom edge of the cover is normally in contact with the top flange of the cryostat and serves to provide the probe height reference. With the cover removed, it is necessary to check that the probe is still at the correct height before carrying out any calibration.

4.5 Calibration of the Probe Head

Two calibration adjustments are provided in the probe head corresponding to the 0% and 100% points respectively. To avoid interaction between the adjustments, it is essential that the 100% point is set up first.

With the probe installed in the cryostat, the latter should be completely filled with liquid nitrogen. RV1 should then be adjusted so that the meter reads 100%. The probe should now be withdrawn from the cryostat until the meter reading ceases to fall (ie until the end of the probe is just clear of the liquid surface). At this point, RV2 should be adjusted so that the meter reads 0%.

NB. This adjustment should be made quickly before the probe has time to warm up.

WARNING The calibration of the instrument should not normally drift after it has been initially set up. If an apparent change in calibration occurs, it is probable that water has entered the probe. Before attempting recalibration, refer to section 5.1

4.6 Relay Levels

The operating point of the control relays may be set anywhere in the range 0 to 100% by means of the preset potentiometers RV4 and RV5 in the indicator unit. RV4 sets the operating level for relay 1 and RV5 that for relay 2.

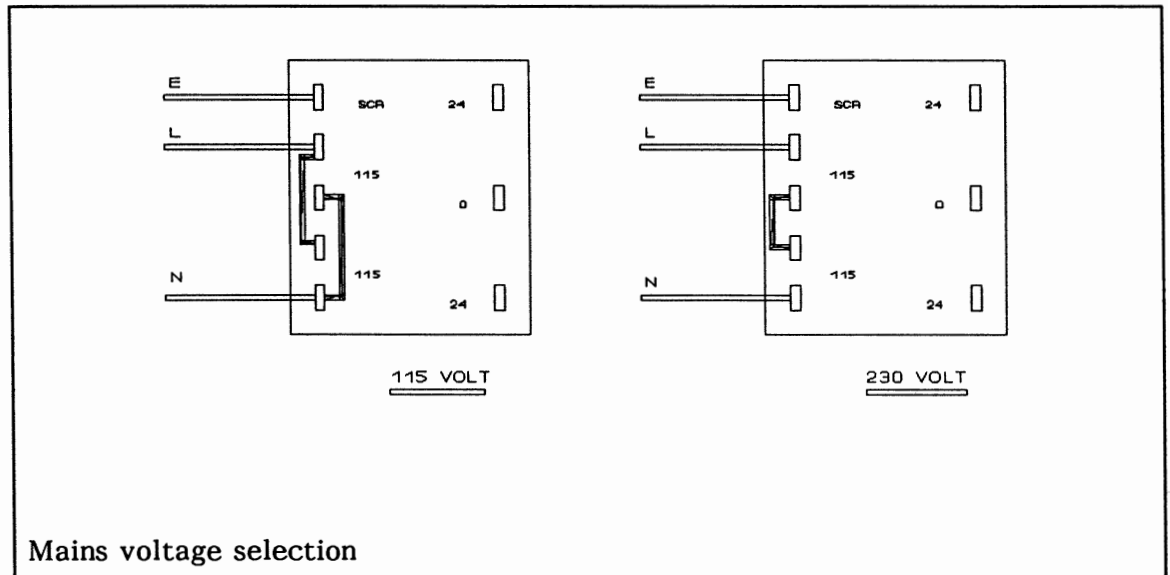
To set these, the probe should be withdrawn until the meter reads the desired level. (Alternatively, an external input in the range 0 to -5 volts may be applied to the indicator unit as described in section 4.3). The appropriate potentiometer RV4 or RV5 is then set to the point at which its relay operates.

4.7 Relay Hysteresis

It is possible to apply hysteresis to either of the relays as described in section 1.5 To do this, a resistor must be inserted in the printed circuit board in the position labelled R17 or R21. The former affects relay 1 and the latter relay 2. The value required is best determined empirically since it will vary slightly between instruments. Typically a 200 kilohm resistor will give around 30% of hysteresis. Smaller values of resistor will give larger amounts of hysteresis. After applying the required amount of hysteresis, the appropriate relay level preset may be adjusted to centre the hysteresis band in the desired part of the operating range.

4.8 Mains Supply

The instrument is normally supplied set for 230 volt operation. To convert it to 115 volt operation, it is only necessary to change the links on the mains transformer primary. For 230 volt operation, the two halves of the primary are connected in series whilst for 115 volt operation they are connected in parallel. The appropriate positions for the links are shown in figure below.



5 SERVICING

5.1 Removal of Moisture from the Probe

The most likely cause of malfunctioning of the instrument is the presence of water in the probe. This can arise where a cold plate has been allowed to warm up in a damp atmosphere. Condensation on the outside of the probe can run into the annular space via the vent holes. It is best to allow the probe to warm up in situ in the cryostat if possible.

The presence of water may easily be detected by means of a resistance test between the inner and outer tubes of the probe. The inner tube is readily accessible at the bottom of the probe. The resistance between this and the outer tube should be greater than 5 Megohms for a dry probe when measured on a low voltage test meter. (e.g. Avo Model 8).

ON NO ACCOUNT MUST A HIGH VOLTAGE TEST METER OR MEGGER BE USED.

If the probe resistance is significantly lower than this value, water has entered the annular space.

If water is present, it can most rapidly be removed with the aid of a small vacuum pump. The probe should first be allowed to warm up to room temperature or slightly above. A vacuum pump should then be connected via a piece of rubber tubing to the lower end of the probe. If the vent holes in the outer tube are blocked by covering them with small pieces of sellotape, the annular space between the two tubes may be evacuated, effectively removing any water which may be present. (This space is sealed at the upper end where it enters the probe head, as is the inner tube).

After 2 or 3 minutes, the pump may be disconnected and the insulation resistance re-checked. If the water has been successfully removed, the probe resistance should have risen to 5 Megohms or more.

NB. It is necessary to cover ALL the vent holes when evacuating the probe. The top hole will normally be under the recessed portion of the head cover and may be easily overlooked.

5.2 Electronics

If the probe is free of moisture but the instrument is still not functioning correctly an electronic fault may have developed.

If the instrument is totally dead with not even the green 'Power' lamp lit, the mains fuse should be suspected.

Where the 'Power' lamp is lit but the meter is reading incorrectly, the fault may lie in either the head or the indicator unit. The latter may be checked independently by applying a calibration voltage as described in section 4.3.

Before suspecting the head itself, the supply voltages generated within the indicator unit should be checked. These may be monitored at TP1 (-20v) and TP3 (+10v) relative to TP2 (0v).

Within the head unit, operation of the oscillator may be checked by monitoring with an oscilloscope at pin 3 of IC1. Monitoring the collector of Q1 enables the correct operation of this switching transistor to be checked, whilst the mean level of the voltage across C2 may be measured across C3 with the aid of a simple voltmeter. This voltage should vary as the height of the probe above the liquid is varied. Assuming the offset circuit RV1, R8, 9 and 10, and the span circuit RV2, R11, are functioning correctly, IC2 should convert this voltage to the 0 to -5 volt signal required by the indicator unit.

