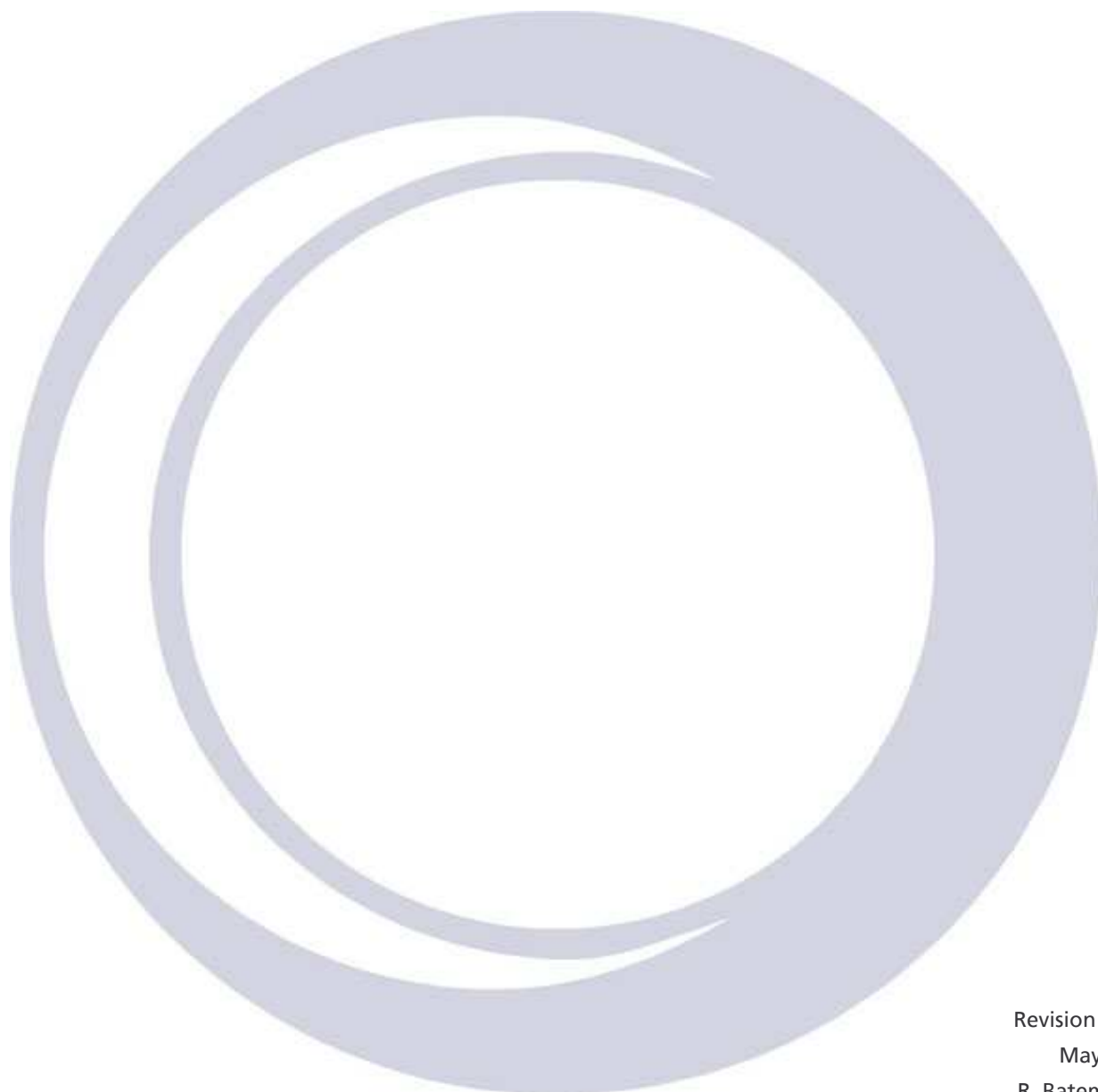


Operator's Handbook

INTEGRA™ AC

Control box V1.1



Revision 1.1
May 08
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Warnings

Before you operate this equipment for the first time, please make sure that you are aware of the precautions which you must take to ensure your own safety. In particular please read the Safety section of this manual.

Explosive Atmospheres

The INTEGRA™AC is intended quite specifically for use with liquid helium . It is not intended for use in an inflammable or explosive atmosphere. It must not be used under any circumstances for monitoring the level of combustible liquids or in the presence of combustible or explosive gases.

Important Note

This manual is part of the product that you have bought. Please keep it for the whole life of the product and make sure that you incorporate any amendments which might be sent to you. If you sell or give away the product to someone else please give him or her the manual too. Before you attempt to install or operate this equipment for the first time, please make sure that you are aware of the precautions that you must take to ensure your own safety.

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1 Warnings

- 1. Before you attempt to install or operate this equipment for the first time, please make sure that you are aware of the precautions that you must take to ensure your own safety.**
- 2. High Voltage Hazard. Isolate this equipment by switching off the external AC electrical supply, disconnecting and removing the external supply cable.**
- 3. The Disconnect Device for removal of the supply is considered to be the Appliance Coupler or the Mains Plug. These must be readily accessible or an alternative accessible disconnect device must be provided by the user of the equipment.**
- 4. Maintenance: Only qualified and authorised persons should carry out servicing and repair work on this equipment.**
- 5. High Voltage Hazard: High voltages are present inside this equipment. Isolate this equipment by switching off the external AC electrical supply, disconnecting and removing the external supply cable before any covers are removed.**
- 6. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.**
- 7. The equipment is not suitable for use with explosive or flammable gases. The equipment is not suitable for use in explosive, flammable or hazardous environments.**
- 8. The equipment does not provide protection against the ingress of water. The equipment should be positioned so that it will not be exposed to water ingress.**

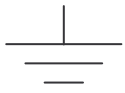
2 Cautions

ELECTROSTATIC HAZARD: This equipment contains Electrostatic Sensitive Devices (ESSD). ESSD protective procedures in accordance with BS CECC00015 Part 1 and American National Standard EIA-541-1988 must be applied when installing or maintaining this product. Refer to guidelines in the preliminary pages.

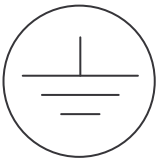
Explanation of symbols used in the Instrument



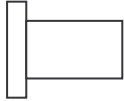
Attention; please refer to the manual



Functional earth



Protective earth



OFF



ON



This symbol indicates that loose fitting, insulating gloves should be worn, suitable for protection against splashes of liquid helium and nitrogen.



This symbol indicates that protective goggles or (for cryogenic use) a face mask should be worn.

3 Introduction

3.1 Use of this Manual

This manual provides operating and service information for the Oxford Instruments INTEGRA™AC Control Box. Sections 1-6 provide essential information and should be read before operating the instrument for the first time.

The remainder of the manual provides more detail on specific aspects and may be referred to as required. Section 7 attempts to identify some of the more common operating pitfalls and may be useful if problems are encountered.

3.2 Description of the INTEGRA™AC Control Box

3.2.1 Helium Level Probe

The probe consists of a length of superconductive wire extending from the bottom to the top of the helium reservoir. Normally the probe will be mounted vertically, though other geometries are possible to suit individual shapes of reservoir.

The probe relies on the wire below the liquid surface being more efficiently cooled than that in the gas above the liquid. Thus the Joule heating of the resistive section of the wire is sufficient to keep this above its critical temperature where it is in gas but not where it is in liquid. To maintain this situation requires the correct value of current in the wire. The graph accompanying the probe drawing at the end of this manual shows how this current varies as a function of the temperature of the liquid in the reservoir. With no current in the wire, the entire length will become superconducting. It is therefore necessary to include a small heater resistor in thermal contact with the top of the wire to drive the top end of the wire into its resistive state. Provided the current in the wire is sufficient this resistive region will then propagate down the wire to the liquid surface. When current has been flowing for sufficient time to ensure that the resistive region has reached the liquid, the voltage across the wire is measured and will be directly proportional to the length of wire in gas, from which the liquid level may be calculated. When the measurement has been made, the current through the wire is turned off and the measured reading displayed. The process is repeated at intervals varying from a few seconds to a few hours, depending upon the expected rate of change in the level.

The INTEGRA™AC outputs a 150mA, 1s duration (typical) pre-pulse before supplying the 100mA required to perform a Helium level measurement. The voltage measurement circuit has an input limit of 20V so this defines the maximum probe resistance of 200 ohms that the INTEGRA™AC controller can measure. Using the typical superconducting wire with a resistance of 178 ohms/metre and a standard Oxford Instruments design of probe this would set the maximum active probe length to 0.75 metres.

3.2.2 Pressure Control

The internal pressure of the INTEGRA™AC cryostat is monitored by the control box PLC. A resistive heater within the INTEGRA™AC cryostat is energised via a closed PID control loop driven from the pressure transducer to maintain the desired cryostat pressure relative to ambient atmospheric pressure. The gauge pressure is defined by the pressure set-point which is set relative to atmospheric pressure in units of mbar.

3.2.3 Disposal and recycling

Before disposing of this equipment, it is important to check with the appropriate local organisations to obtain advice on local rules and regulations about disposal and recycling.

You **must** contact Oxford Instruments NanoScience Customer Support (giving full product details) before any disposal begins.

4 Safety

The following general safety precautions must be observed during the operation, service and repair of this instrument.

4.1 Protective Ground

To minimise shock hazard the instrument must be connected to an electrical ground. The ground wire (green/yellow) in the instrument power cable must be connected to the installation electrical ground system. Do not use extension cords without a protective earth conductor. Do not disconnect the protective ground inside or outside the instrument. Do not have external circuits connected to the instrument when its protective ground is disconnected.

4.2 Working Environment

The INTEGRA™ AC indicator unit is not designed to be water or splash proof. Therefore it should not be exposed to rain or excessive moisture.

Neither the indicator unit nor the probes are designed to be used in areas where there are flammable or explosive gases or fumes.

4.3 Repair and Adjustment

There are no user serviceable parts within the controller. There are no user adjustments within the controller. Under no circumstances should the user open this unit while mains supply is connected.

5 Installation

5.1 Supply Connections



The Power supply within the box is a universal mains input device & no change of fuses or mains selection is required for operation within the input voltage limits.

5.1.1 Supply Rating

Supply range: 100- 240V AC +10% -15% 60/50Hz 30VA

Immunity form micro power outages: 10ms

Maximum inrush current: 5A

5.1.2 Fuse Ratings

Supply fuse: T1.0 AH 250 V (Timed Blow)

24V Heater fuse F1.0AH 250V Type F (Quick Blow)

5.2 Classification

The INTEGRA™AC controller is Class 0 Equipment.

The equipment is not suitable for use in the presence of a flammable anaesthetic mixture with air or with oxygen or with nitrous oxide.

5.3 Environment

The following operating environment conditions must be observed;

The instrument is designed for indoor use only.

Altitude	2000 m
Atmospheric pressure	700 to 1060 mbar (10 to 15 psi)
Ambient temperature	-5 to 55 Celsius
Maximum Relative humidity	90% non-condensing
Maximum magnetic field	30 Gauss
Rated Pollution Degree	Degree 2

5.4 Handling and Storage Including Transport

The module may be stored for up to 15 weeks in a storage environment as follows;

Ambient temperature	-40 to 70 Celsius
Relative humidity	30% to 75% (non-condensing)
Atmospheric pressure	700 to 1060 mbar

5.5 Maintenance

Preventive maintenance

Warning

Access within the equipment and removal of connecting cables is restricted to suitably skilled and competent persons. See Warnings and Cautions.

Maintenance interval

Twelve months or as for cleaning if more frequent.

5.6 Cleaning

External cleaning

Interval between cleaning is as required by appearance.

Warning

Ensure that the AC supply to the equipment is isolated at the external disconnect device before cleaning. See Warnings and Cautions.

To remove surface dust and light markings, the equipment may be wiped down using lint free cloth, barely moistened with clean water. For removal of heavy marks, the use of a proprietary aerosol foaming cleaner is permissible. Test carefully on a small inconspicuous area to ensure that the product does not damage the surface finish.

5.7 Connections

Warning



High voltage hazard. Ensure that the AC supply to the equipment is isolated at the external disconnect switch before accessing any connection.

Check all cables and connections to the equipment for mechanical security and ensure all covers are securely fixed in place.

Mains cord selection

In the EU, the mains supply cord shall be rated for the maximum current for the equipment. The cable used shall meet the requirements of IEC227 or IEC245, mains cords certified or approved by any recognised national test house are regarded as meeting this requirement.

In the USA the mains cord selected must be a listed mains cord set approved to the standard UL817 for Cord Sets and Power Supply Cords, the mains plug must be a separable plug (without a locking device). If the mains plug is to be a disconnecting device for the equipment, the mains cord must be less than 3 m in length. In Canada the cord set must be certified by CSA. The cord set must be suitable for use and of current rating at least 125% that of the equipment rating.

Green/Yellow covered conductors shall be used only for connection to protective conductor terminals.

5.8 Probe Connections

Probes are connected by means of 9-way D-sockets on the rear panel.

Pin Connections are:

Pin	Name	Helium Probe	
1	VHIGH	V (Top)	(Unused)
2	VLOW	V (Bottom)	(Unused)
3	(Unused)		
4	(Unused)		
5	(Unused)		
6	I_{HIGH}	I (Top)	
7	I_{LOW}	I (Bottom)	0 V
8	(Unused)		
9	CHASSIS GND	SCREEN	SCREEN

5.9 Compatibility with Earlier Probes

The design of the Helium Probe for the INTEGRA™AC family is unchanged from that for earlier instruments, except for the type of connectors used. Old style probes may be used with the new meter, provided a suitable interconnecting lead is used.

Users familiar with Oxford Instruments earlier Helium Level meters models HLM2 and 4016 should note that the direction of current flow through the helium level probe is reversed with respect to these instruments. The top of the probe is now positive, where it was previously negative.

5.10 Heater and Temperature sensor Connections

Pin	Signal Name	Function
1	T Sensor	V-
2	T Sensor	V+
3	(Unused)	
4	T Sensor	I+
5	T Sensor	I-
6	Heater	Heater Drive
7	Heater Return	OV
8	(Unused)	
9	(Unused)	

6 Operation

6.1 Switching on the Controller

Upon switch on, the controller will go through a power-on sequence and then will display the status of the system (Fig 6-1). For most of the operational time, this will be the display. It is therefore referred to in this manual as the 'normal' mode.



Fig 6-1 Power-on display which is also the default operational display, termed "normal" mode

This display shows the pressure inside the cryostat in mbar relative to atmospheric pressure. Also shown is the pressure set point also in mbar relative to atmospheric pressure. Finally the heat exchanger heater power is displayed in mW. This is the power being applied to the pulse tube second stage (PT2) heat exchanger in order to control the pressure within the cryostat.

Other modes can be accessed by pressing buttons A and B together and then pressing button B to scroll through a list of options. An option can be selected by pressing the OK button. At any time the ESC button can be used to return to 'normal' mode.

6.1.1 Displaying Helium level

From 'normal' mode press buttons A and B together to get the display shown in Fig 6-2 (Helium level is the first item on the menu list so it is not necessary to scroll down using button B).



Fig 6-2 The display after selecting the Helium level item from the options menu

To read the helium level press OK and a read sequence will be initiated, see section 3.2.1 for details on the probe energisation sequence. After about three seconds the current Helium level will be displayed (Fig 6-3).



Fig 6-3 Display showing Helium level (in this case the Helium level is 0%)

In this case a Helium level of 0% is being displayed. The rest of the display is the same as in the normal mode display. After 20 seconds the display reverts to normal mode automatically.

6.1.2 Applying full heater power

When opening the system for any reason a positive dewar pressure needs to be built up. To do this apply full heater power by pressing buttons 'A' and 'B' together followed by 'B' to bring up the screen below (Fig 6-4).



Fig 6-4 Requesting full heater power screen

Press 'OK' to apply full heater power. The display changes as shown (Fig 6-5) To cancel the operation press 'ESC' to switch full heater power mode off and return the system to the normal pressure control mode.



Fig 6-5 Screen display if the PT2 heater is fully energised

Note that the full heater power of 1285mW is being applied and the pressure has risen to 66 mbar above atmosphere. To cancel this operation and return to 'normal' mode press the ESC button. Full heater power will be switched off and the normal pressure control operation will resume.

6.1.3 Adjusting the control pressure

To adjust the controlling pressure (set-point) of the system, from the normal mode press buttons A and B together then press button B twice to get the display shown (Fig 6-6). Press 'OK' to enter set-point adjustment mode, the display does not change but the '+' and '-' keys are now activated to adjust the pressure set-point. To increase the control pressure set-point, press the '+' button. The set-point increases in 1mbar increments. Similarly, to decrease the pressure set-point, press the '-' button. The set-point decreases in 1mbar increments. To exit set-point adjustment mode press 'ESC'.



Fig 6-6 Display for pressure set-point adjustment mode.

6.1.4 Heat Exchanger thermometer

The second stage heat exchanger is equipped with an Allen Bradley thermometer. The calibration curve can be found in section 6.4.3 of this manual (Fig 6-15, Fig 6-16). If the dewar is not re-condensing at the expected rate it is possible that the PT2 heat exchanger has become contaminated, perhaps during an insert change (see section 6.2) or cryostat fill (see section 6.3) where proper procedures have not been observed. In this case the PT2 heat exchanger will be insulated from the 4.2K bath and its temperature will drop significantly below 4.2K. This mode allows you to diagnose this situation. Press buttons 'A' and 'B' together then press button 'B' three times to get the display shown (Fig 6-7).



Fig 6-7 Display with Allen-Bradley thermometer item selected

Then press 'OK' to select this mode and get the display below ().



**Fig 6-8 Display showing the measured resistance of the Allen-Bradley temperature sensor.
The rest of the display is the same as normal mode**

In this case the Allen Bradley has a resistance of 5452 ohms and the corresponding temperature can be determined from the graphs (Fig 6-15, Fig 6-16). When you have noted the reading press 'ESC' to return to normal operation.

6.2 Loading or unloading and Insert



The Integra AC recondensing dewar is design to accept and insert, say an Oxford dilution fridge, when the system is cold. Some precautions should be observed when loading and insert into the cold system: -

1. If possible and if the insert design permits the insert should be pre-cooled in liquid Nitrogen (LN₂).
2. Switch the Integra AC heater to full power (see section 6.1.2 for details) to generate a positive Helium pressure in the dewar.
3. Wait until the indicated dewar pressure is greater than 60mbar before opening the insert orifice.

4. If the insert has been pre-cooled in an LN₂ bucket move the insert to the Integra AC quickly to prevent frost forming. Lower the insert in halfway quickly but carefully.
5. Once the Helium boil-off increase's, slowly lower the insert the rest of the way.

6.3 Topping up the Helium



To top up the Helium level of the Integra AC recondensing dewar, follow a few standard precautions: -

1. Make sure you know the methods and dangers of transferring liquid Helium. If you are unsure you should read Safety Matters and Practical Cryogenics that were supplied with your system for advice.
2. Pre-cool the transfer siphon.
3. Switch the Integra AC heater to full power (see section 6.1.2 for details) to generate a positive Helium pressure in the dewar.
4. Wait until the indicated dewar pressure is greater than 60mbar before opening the siphon insert orifice.
Note: Wear gloves, there will be a jet of very cold gas when the siphon entry plug is removed.
5. Transfer the siphon entry nut and O-ring to the siphon leg.
6. Once there is a visible plume of cold Helium at the end of the siphon, insert the siphon leg and do up the siphon nut.
7. Gradually lower the siphon leg into the system.

6.4 Calibration

6.4.1 Zeroing the pressure reading

To take account of the variation of pressure sensor individual calibrations, this mode allows the pressure reading to be set to zero when the controller pressure line is disconnected from the cryostat. In this case the relative pressure is zero. Press buttons 'A' and 'B' together then press button 'B' four times to get the display below(Fig 6-9).

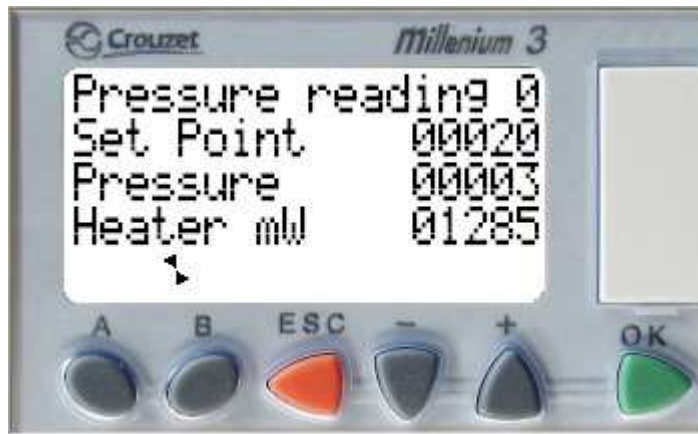


Fig 6-9 Display for the "set pressure to zero mode".
The rest of the display is the same as normal mode

Press OK to select this mode. The display does not change but you can now use the '+' and '-' buttons to adjust the measured pressure to zero. In this example the '-' button needs to be pressed three times to get the indicated pressure back to zero. Press 'ESC' to return to normal operation.

6.4.2 Set the Helium level

On initial setup the Helium level probe will have to be calibrated. To achieve this two calibration points need to be entered, one near the full level and one near empty. Below describes the procedures for setting these points.

6.4.2.1 Setting He level 1

To set the first point, "He level 1", access the appropriate mode by pressing buttons 'A' and 'B' together then pressing button 'B' five times to get the selection display below (Fig 6-10).



Fig 6-10 Display to select "Set He level 1" mode.
The rest of the display is the same as normal mode

The select the "Set He level 1" mode by pressing OK to get the display (Fig 6-11)



Fig 6-11 Display for the "Set He level 1" mode.
The rest of the display is the same as normal mode

The '-' and '+' buttons can now be used to enter the current Helium level in %, in this case 23%. The level probe can be moved in and out of the cryostat to simulate varying levels. Refer to the cryostat operator's manual for the Helium can dimensions and the active length of the level probe. Press 'ESC' when you have finished to return to normal operation.

6.4.2.2 Setting He level 2

The procedure is identical to that for setting He Level 1 above, except that it is accessed by pressing buttons 'A' and 'B' together then pressing button 'B' six times to get the display (Fig 6-12),



Fig 6-12 Display to select "Set He level 2" mode.
The rest of the display is the same as normal mode

then pressing the OK button to display (Fig 6-13).



Fig 6-13 Display for the "Set He level 2" mode.
The rest of the display is the same as normal mode

Note that the two levels should be separated by several tens of percent to ensure accurate calibration. In this case Level 2 is set at 81%. To exit setup, press buttons 'A' and 'B' together then press button 'B' seven times to display the "Exit setup" option ().

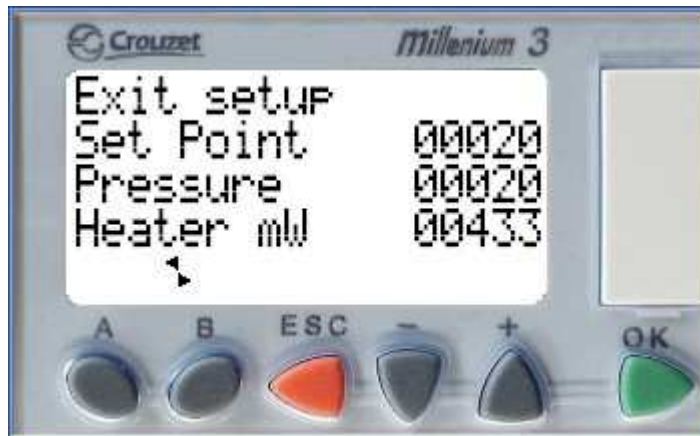


Fig 6-14 Display to Exit He level probe setup mode

Press the OK button to exit the set-up mode and return to normal operation.

6.4.3 Heat Exchanger temperature sensor

When checking the resistance of the heat exchanger temperature sensor, the following two plots (Fig 6-15, Fig 6-16) should be used to convert the resistance into temperature.

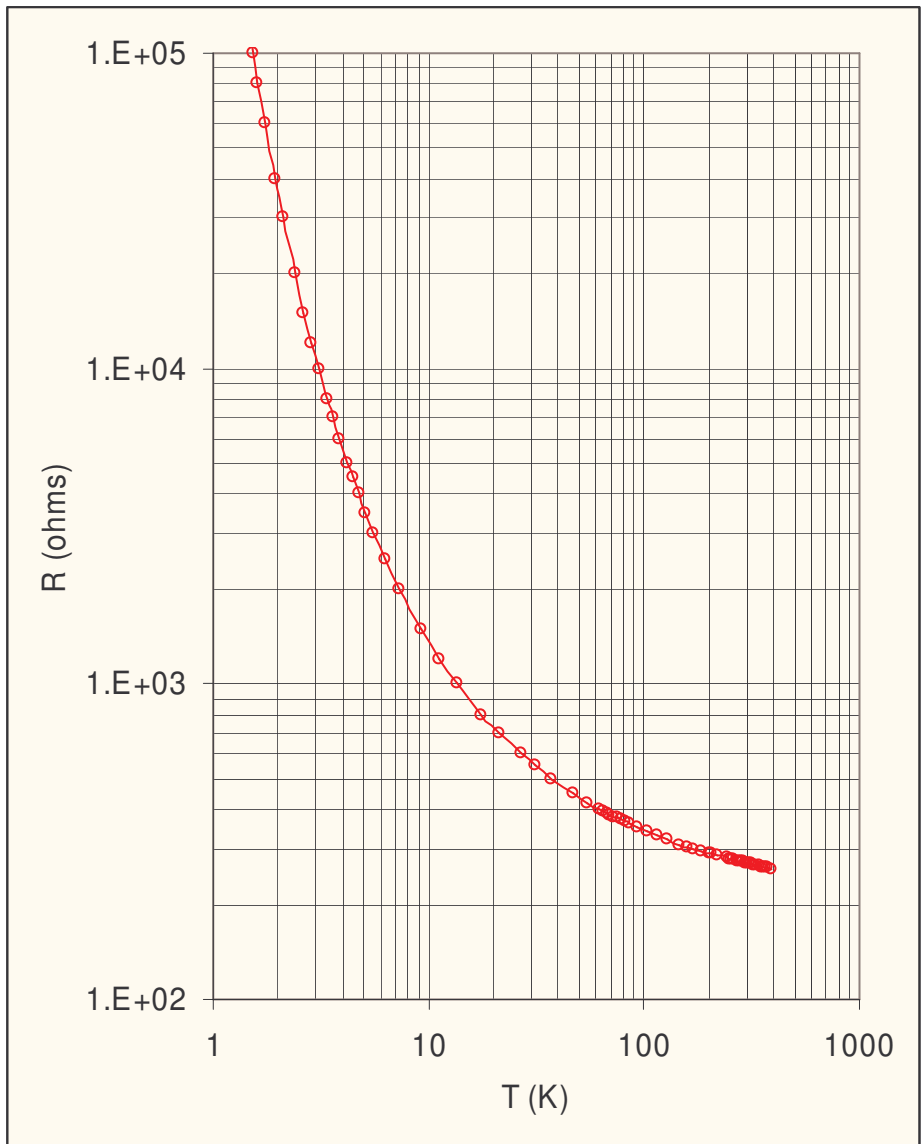


Fig 6-15 Generic 270Ω Allen-Bradley resistance to temperature curve

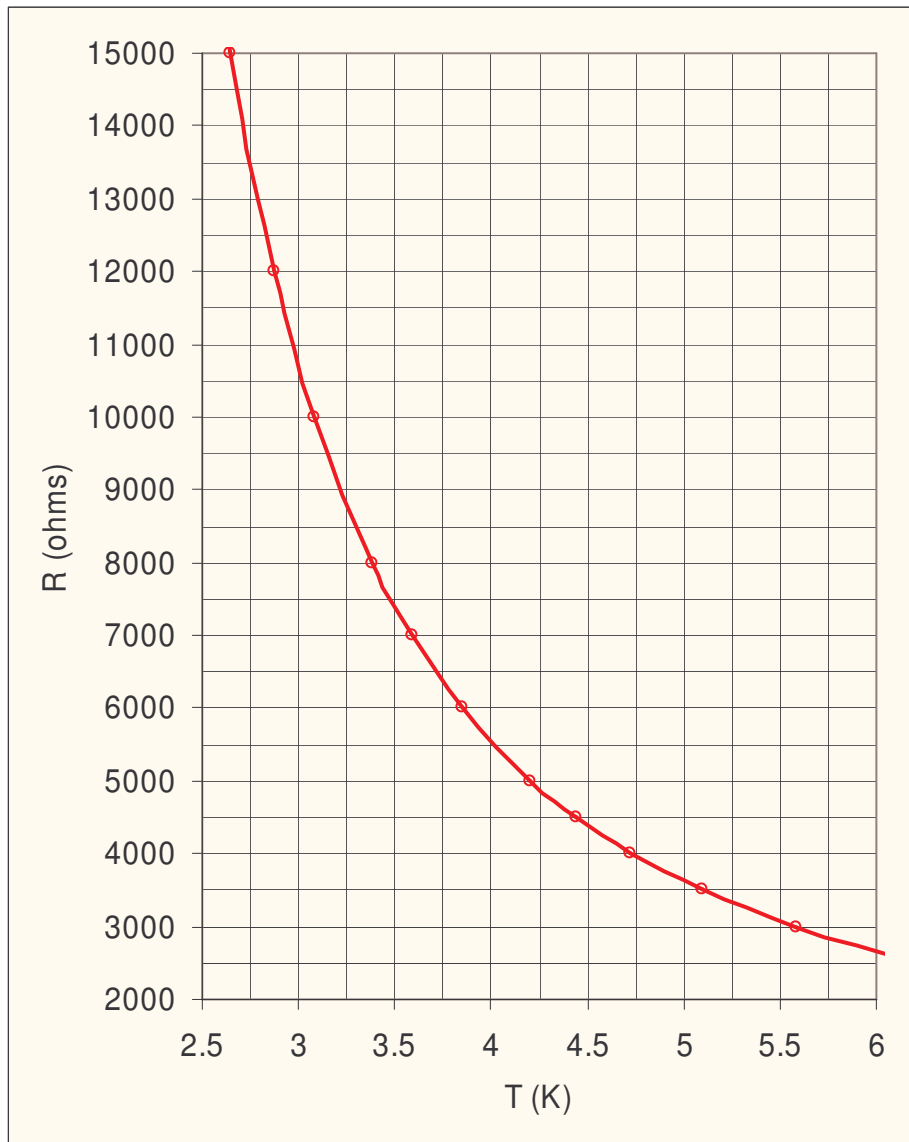


Fig 6-16 Detail of generic 270Ω Allen-Bradley resistance to temperature curve over the typical operating range of the Integra AC

7 Troubleshooting

This section indicates some of the more common pitfalls and operator errors.

7.1 Controller fails to power up.

Check indicator LED, if this is not illuminated, check the fuses in the IEC inlet socket. If the fuses are OK then contact Oxford Instruments NanoScience customer support (see contacts page).

7.2 Other fault conditions

As a simple test, power cycle the supply to reset the controller. Switch off the power, wait at least 5 seconds and then switch on the supply. The PLC controller has no programmed fault indicators. If the unit fails to operate correctly contact Oxford Instruments NanoScience customer support (see contacts page) with a description on the unit and of the fault symptoms.

8 Specification

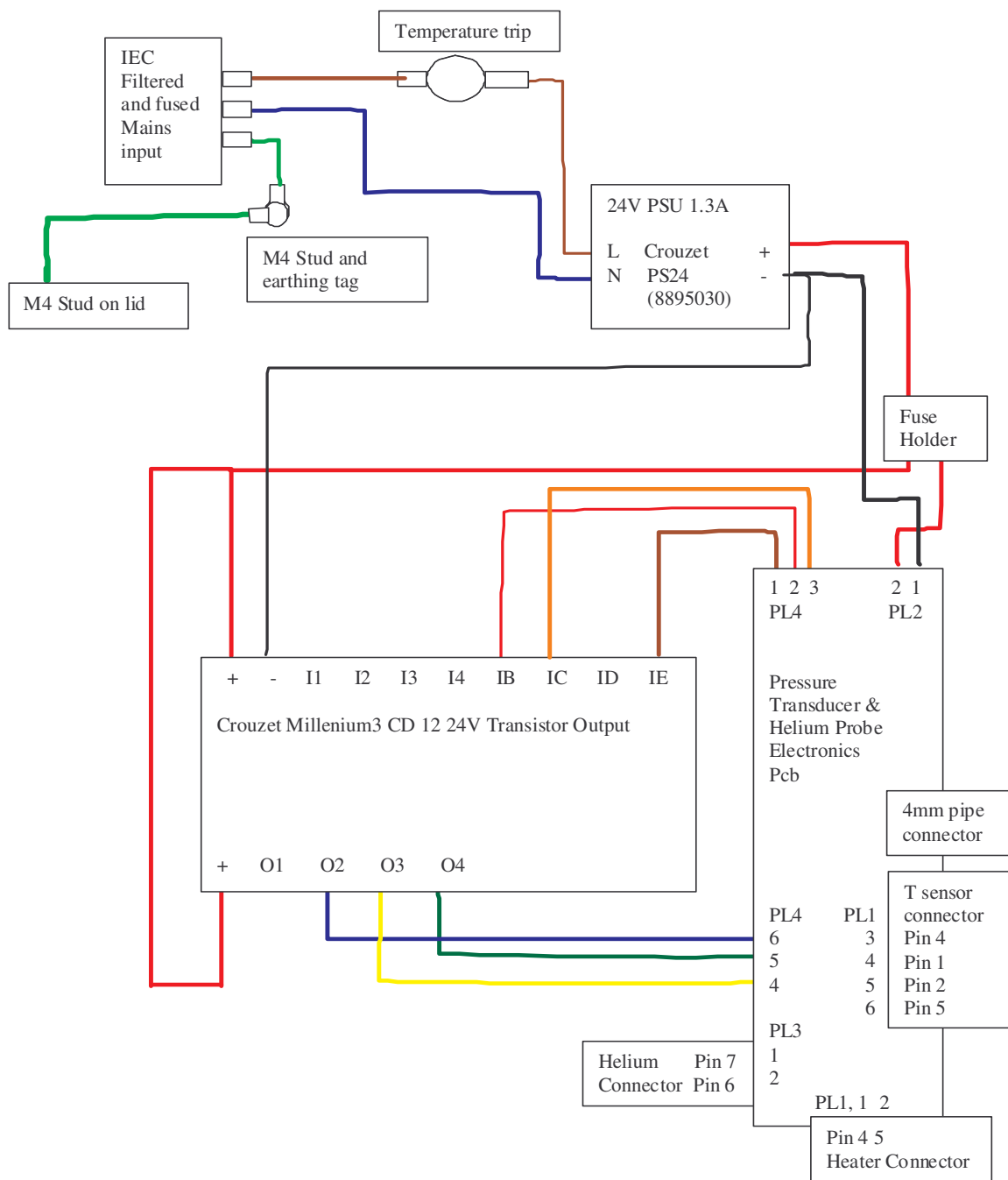
SENSING METHOD	
Helium level	Superconductive Wire
PROBE LENGTH	
Helium	0.8 metres (standard wire)
PROBE CURRENT (Helium)	100 mA Typ, 160 mA Max Pulsed
PULSE WIDTH (Helium)	Adjustable 1 second to continuous
VOLTAGE COMPLIANCE (Helium)	20 volts
DISPLAY TYPE	LCD, 4 lines of 12 characters
REAL TIME CLOCK	Drift < 1 min/month at 25°C
PROGRAM MEMORY	Flash EEPROM
DATA MEMORY	256 bits / 64 words
DATA RETENTION	10 years (lithium battery)
CONNECTORS	
Power Inlet	IEC 3 pin, filtered
Probe input	1 off 9 way D socket
Heater output	1 off 9 way D socket
CASE STYLE	Die cast Al
DIMENSIONS	
Free-standing	W = 175, D = 65, H = 275 mm
WEIGHT	1.7 kg

9 Circuit Diagrams

The following circuit diagrams are included, covering INTEGRA™ AC itself, together with its accessories:

Drawing Number	No. of sheets	Description
	(1 sheet)	Box Wiring
	(1 sheet)	PCB Circuit
	(1 sheet)	Helium Probe

9.1 Box Wiring



9.2 Integra AC CVH0100 PCB description

The Pcb is an interface between the Crouzet Millennium 3 PLC and the Interga AC cryostat.

9.2.1 Pressure Transducer Circuit

+24V is provided on connector PL2 pin 2 (0V on Pin 1).

IC2 is a 5 volt Regulator providing the power to the pressure transducer IC1.

The pressure transducer is a gauge instrument with a range of ambient pressure +/- 50millibar.

(0V -50millibar, 5V +50 millibar)

The output of the transducer 0 to 5V is present on connector PL4 pin 1 & is connected to the millennium 3 input 'IE'.

9.2.2 Heater output.

The Crouzet millennium 3 output O4 is a pulse width modulated output that is connected to the interga AC heater resistor on PL1 pins 1 & 2. This heater is a resistor & is used to provide a maximum of 1 watt (600ohm resistor)

9.2.3 Helium Probe Circuit.

When the Crouzet millennium 3 output O3 is turned on, IC3 in combination with R4 & R5 produce a current output of 100 milliamps between PL3 pins 1 & 2. This is used to energise the helium probe. To start the helium probe operation by increasing the probe current to 150milliamps the Crouzet millennium 3 outputs O2 & O3 must be energised together. The input impedance of the crouzet millennium 3 is 12K ohms so the voltage across on the helium probe is halved by R2 & input IB keeping the input to the PLC in the 0 to 10V range

The sequence of operation for measuring the helium level should be :-

1, turn on O3 & O2.

2, turn off O2 after ~1 second.

3, after ~3 seconds measure the voltage on IB. (Depending on the probe length ~10v =no helium, ~ 0v= 100% Helium.)

4, turn off O3

9.2.4 Temperature indicating resistor measurement.

An Allen Bradley carbon resistor is provided on the Integra AC cryostat for diagnostic purposes. It is possible to measure the resistors' value in the following way.

Turn on the Crouzet millennium 3 output O2. This provides a current source of 10 micro amps via RL1, R6, R7 & R11. (Filtering is provided by R6 & C5). The voltage produced by this current source is applied to amplifier IC4 (set to a gain of 100 by R10). The output of the amplifier is measured on the Crouzet millennium 3 input IC, (maximum resistance of 10K ohms gives a 10v signal). The current source resistors R6, R7 & R11 (500k ohms total) provide 10 uamps from the 5V supply. Putting R11 in the '0v' end ensures that the measurement input to IC4 is within its common mode operating level.

10 Restriction of certain Hazardous Substances Statement

European Union

Under the provisions of the Restriction of certain Hazardous Substances (RoHS Under 2002/95/EC) Directive, as applied to products manufactured and sold in the UK and Europe by Oxford Instruments NanoScience (OINS). OINS has been advised that the product(s) to which this manual relates is exempt under category 6 of the RoHS Directive because it is, or will form part of, a large-scale stationary industrial tool.

China

The Chinese regulations on RoHS require that the product manual has a table stating whether the product and its sub-assemblies contain any of the restricted materials. The table below is included to meet this requirement.

TABLE LISTING RESTRICTED SUBSTANCES / 受限物质列表

Product INTEGRA ™AC 200	Toxic Hazardous Substances and Elements 有害物质及元素						
Part Name 部件名	Description 描述	Pb 铅	Hg 汞	Cd 镉	Cr(VI) 六价铬	PBB 多溴联苯	PBDE 多溴联苯醚
59-CNC2220	MAIN PCB 主电路板	X	O	X	O	O	X
59-CNC1211	DISPLAY PCB 显示电路板	X	O	X	O	O	X
59-CND3211	FRONT PANEL 前面板	O	O	O	O	O	O
59-CND4221	REAR PANEL 后面板	O	O	O	O	O	O
59-ELS0094	TRANSFORMER 转接器	X	O	O	X	O	O
59-CNC1110	TRANS. CABLE 转接电缆	X	O	X	O	O	O

Key: X = substance present (含此物质)
O = substance NOT present (不含此物质)

Rest of World

There are currently no other countries or communities mandating compliance with any RoHS legislation.