

ITS-90 ISOTHERMAL TOWERS

User Maintenance Manual/Handbook

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The company is always willing to give technical advice and assistance where appropriate. Equally, because of the programme of continual development and improvement we reserve the right to amend or alter characteristics and design without prior notice. This publication is for information only

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CE EMC INFORMATION

This product meets the requirements of the European Directive on Electromagnetic Compatibility (EMC) 89/336/EEC as amended by EC Directive 92/31/EEC and the European Low Voltage Directive 73/25/EEC, amended by 93/68/EEC. To ensure emission compliance please ensure that any serial communications connecting leads are fully screened.

The product meets the susceptibility requirements of EN 50082-1, criterion B.

Symbol Identification	Publication	Description
	ISO3864	Caution (refer to manual)
	IEC 417	Caution, Hot Surface

ELECTRICAL SAFETY

This equipment must be correctly earthed.

This equipment is a Class I Appliance. A protective earth is used to ensure the conductive parts cannot become live in the event of a failure of the insulation.

The protective conductor of the flexible mains cable which is coloured green/yellow **MUST** be connected to a suitable earth.

The blue conductor should be connected to Neutral and the Brown conductor to Live (Line).

Warning: Internal mains voltage hazard. Do not remove the panels.

There are no user serviceable parts inside. Contact your nearest Isotech agent for repair.

Voltage transients on the supply must not exceed 2.5kV.

Conductive pollution, e.g. Carbon dust, must be excluded from the apparatus. EN61010 pollution degree 2.

Environmental Ratings

Operating Temperature	0-50°C
Relative Humidity	5-95%, non condensing

Fire Safety Information

Use only a Class D (Metal X) type fire extinguisher or Dry Soda Ash (Na_2CO_3) for extinguishing these fires. Protective equipment such as eye protection, jackets, gloves and respiratory equipment is recommended. Please refer to the MSDS for further information.



GUARANTEE

This instrument has been manufactured to exacting standards and is guaranteed for twelve months against electrical break-down or mechanical failure caused through defective material or workmanship, provided the failure is not the result of misuse. In the event of failure covered by this guarantee, the instrument must be returned, carriage paid, to the supplier for examination and will be replaced or repaired at our option.

FRAGILE CERAMIC AND/OR GLASS PARTS ARE NOT COVERED BY THIS GUARANTEE

INTERFERENCE WITH OR FAILURE TO PROPERLY MAINTAIN THIS INSTRUMENT MAY INVALIDATE THIS GUARANTEE

RECOMMENDATION

The life of your **ISOTECH** Instrument will be prolonged if regular maintenance and cleaning to remove general dust and debris is carried out.

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CAUTIONARY NOTE

ISOTECH PRODUCTS ARE INTENDED FOR USE BY TECHNICALLY TRAINED AND COMPETENT PERSONNEL FAMILIAR WITH GOOD MEASUREMENT PRACTICES.

IT IS EXPECTED THAT PERSONNEL USING THIS EQUIPMENT WILL BE COMPETENT WITH THE MANAGEMENT OF APPARATUS WHICH MAY BE POWERED OR UNDER EXTREMES OF TEMPERATURE, AND ARE ABLE TO APPRECIATE THE HAZARDS WHICH MAY BE ASSOCIATED WITH, AND THE PRECAUTIONS TO BE TAKEN WITH, SUCH EQUIPMENT.

HEALTH AND SAFETY INSTRUCTIONS

1. Read this entire manual before use.
2. Wear appropriate protective clothing.
3. Operators of this equipment should be adequately trained in the handling of hot and cold items and liquids.
4. Do not use the apparatus for jobs other than those for which it was designed, i.e. the calibration of thermometers.
5. Do not handle the apparatus when it is hot (or cold), unless wearing the appropriate protective clothing and having the necessary training.
6. Do not drill, modify or otherwise change the shape of the apparatus.
7. Do not dismantle the apparatus.
8. Do not use the apparatus outside its recommended temperature range.
9. If cased, do not return the apparatus to its carrying case until the unit has cooled.
10. There are no user serviceable parts inside. Contact your nearest Isotech agent for repair.
11. Ensure materials, especially flammable materials are kept away from hot parts of the apparatus, to prevent fire risk.



‘DO’S AND DON’TS’

DON’T handle the accessories when they are very hot or very cold.

DON’T rely on the controller to tell you the temperature of the Isotower. Its job is only to provide an isothermal volume. It is the calibrated working standard that is used to measure actual temperature.

DON’T operate the equipment without the ceramic cap in place.

UNPACKING AND INITIAL INSPECTION

Our Packing Department uses custom designed packaging to send out your unit, but as accidents can still happen in transit, you are advised, after unpacking the unit, to inspect it for any sign of shipping damage, and confirm that your delivery is in accordance with the packing note. If you find any damage or that part of the delivery is missing you must notify us or our agent, and the carrier immediately. If the unit is damaged you should keep the packing for possible insurance assessment.

Electricity Supply

Before connecting to the electricity supply please familiarise yourself with the parts of the manual relevant to your model.

Your unit's supply voltage requirement is specified on a plate on the instrument along with the serial number. All instruments will work on an electricity supply frequency of 50Hz or 60Hz.

The apparatus is provided with an approved power cord. If the plug is not suitable for your location then the plug should be removed and replaced with an appropriate plug.



Take care to ensure the old plug is disposed safely.
The cable is colour coded as follows:

<u>COLOUR</u>	<u>FUNCTION</u>
Green/yellow	Earth (Ground)
Brown	Live (line)
Blue	Neutral

Please ensure that your unit is correctly connected to the electricity supply.

THE APPARATUS MUST BE CORRECTLY EARTHED (GROUNDED)

The units' on/off switch is located on the power inlet. Take care NOT to switch the unit off when it is hot - allow to cool first.

USING YOUR ISOTOWER

Congratulations, you have just purchased the most advanced fixed point calibration cell and apparatus ever invented!

Before you power up your Isotower it is worth spending a little time to get to understand its operation.

Isotowers work by using the amazing thermal properties of heat siphons. Once the fluid inside a heat siphon reaches its boiling temperature, it transfers heat by evaporation and condensation creating a thermal conductance up to 200 times better than copper. The ITS-90 cell inside the heat siphon therefore warms quickly and uniformly.

Due to thermal losses, a thermometer under test will conduct heat out of the cell causing a thermal gradient. To balance this loss a heated collar is included above the cell called an Immersion Compensator; this collar has its own controller and follows the main controllers' temperature.

The main controller and the top controller are factory set prior to despatch. The settings can be found on the melt and freeze that accompanies the Isotower.

Safe Operation of an Isotower

Always ensure that the ceramic cap is in place before connecting the power supply to the Isotower.



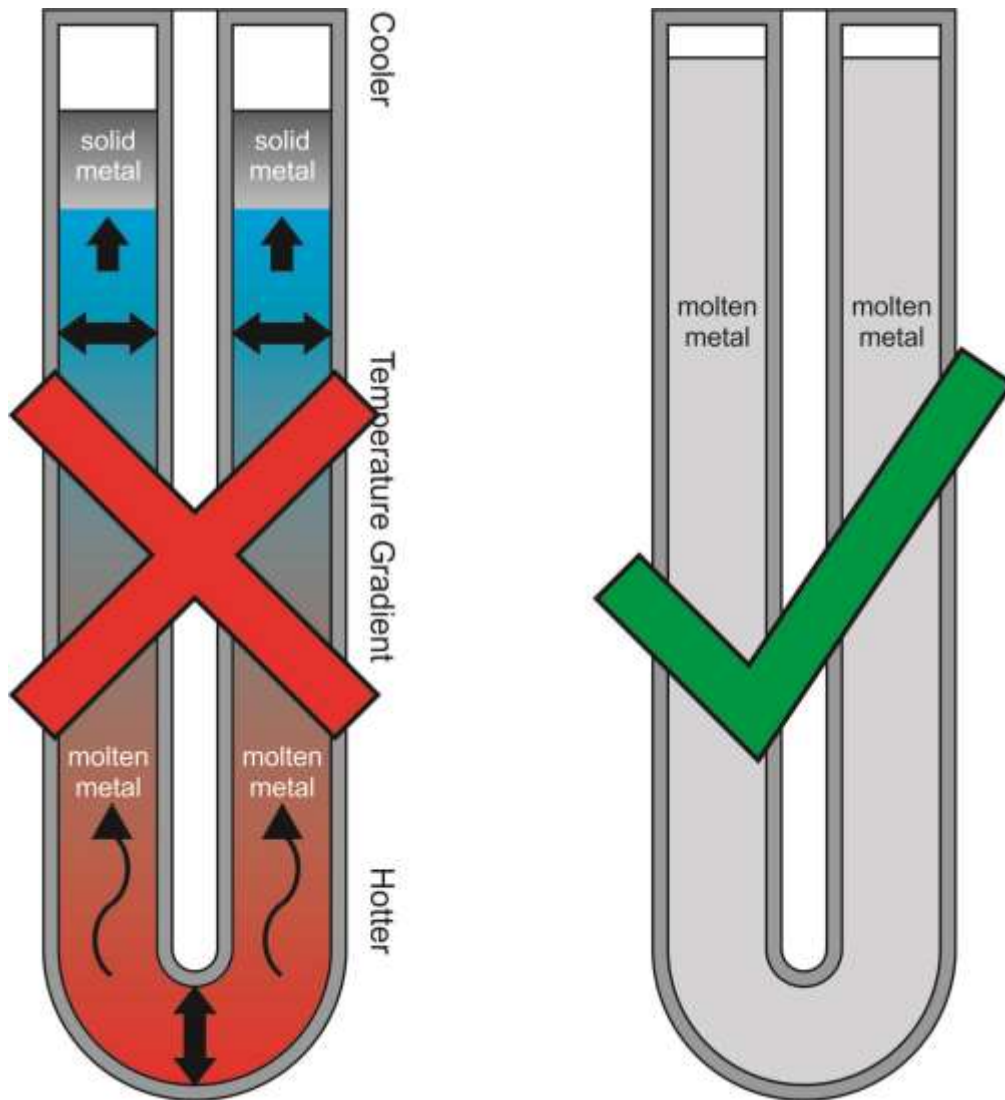
DON'T operate the equipment without the ceramic cap in place.

To Prevent Irreparable Damage the top of the thermometer pocket MUST not be allowed to become cooler than the bottom of the thermometer pocket

Inside the Isotower is a graphite crucible that contains metal, Indium, Tin, Zinc or Aluminium. These metals expand as they melt and contract as they freeze.

The crucible has sufficient volume to contain the metal when it is fully molten. As the metal freezes it contracts therefore occupying a smaller area of the crucible.

If the top of the cell is colder than the rest of the cell then on melting then as the metal expands from the bottom upwards there will not be space for the expansion and the graphite crucible will rupture. See illustration below.



Melting from the bottom upwards blocks room for expansion and can rupture cell

Keeping the top at or above the temperature at the bottom allow for expansion without pressure

It is vitally important that the top of the cell is at the same temperature or slightly hotter than the rest of the cell to stop any pressure building up within the cell

The most common cause for the top of the cell to be colder is due to thermometers being placed in the Isotower conducting heat out of the cell.

Test thermometers with larger thermal mass such as Metal Clad Thermometers or a continuous throughput of thermometers being calibrated will cool the top of the cell and freeze the metal.

To avoid this it is important to pre-warm the thermometers being inserted close to, or ideally above, the cell temperature before inserting it into the Isotower

To balance this loss a heated collar is included above the cell called an Immersion Compensator; this collar has its own controller (zone) and follows the main controllers' temperature.

The main controller and the top zone controller are factory set prior to despatch. The settings can be found on the melt and freeze graphs that accompany the equipment.

The top zone controller setting should be checked each time the Isotower is used and adjusted if necessary. See the next section on how to perform this.

Monitoring and Adjusting the Isotower Profile

Switch on and set a temperature 2°C below the cell's melt/freeze temperature.

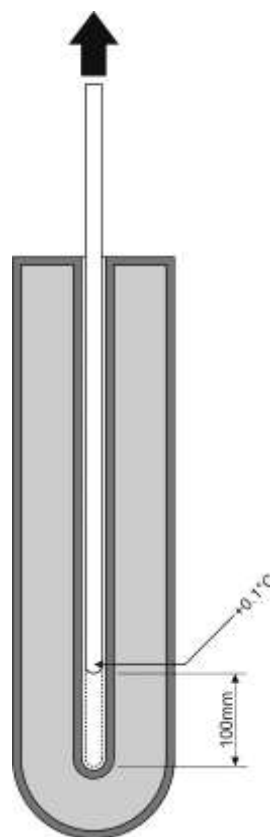
Monitor the cell with a stable thermometer. Allow enough time for your Isotower to stabilise.

When the Isotower temperature stabilises, record the temperature then raise the monitor 100mm (4") and allow the monitor to stabilise and record the temperature again, ideally the raised temperature should be +0.1°C higher than the bottom measurement. This takes only 10 minutes and checks for any drift on the Immersion Compensation Controller.

If the measurements indicate that the top is colder the temperature of the zone controller can be raised by increasing the setpoint value.

Please note that the relationship between the zone controller temperature and the temperature at the top of the cell is not linear and an increase of 0.1°C in the zone controllers value will not increase the temperature measurement at the top of the cell by 0.1°C.

DO NOT set the top temperature more than 2°C above the melt. There is an over-temperature trip inside the ISOTower preset to 4°C above the melt to protect the heat siphon. Should you trip the unit you will need to contact Isotech for further instructions.





COMMISSIONING YOUR ISOTOWER

Switch on and set a temperature 5°C below the cell's melt/freeze temperature.

Allow one or two hours for your Isotower to stabilise. Monitor the cell with a stable thermometer such as Isotech's 670SQ/25 SPRT and microK bridge.

Once the system is stable, raise the monitor 100mm (4"), after a few minutes it will restabilise, the new temperature reading should be the same, or slightly above the fully inserted temperature. If not, increase the top controller offset in small steps until it is. It is worth spending some time getting this right.

If the monitor thermometer is already calibrated it can be used to calibrate the main controller.

Once this is done set the controller 1°C above the melt temperature and monitor the complete melt. When the melt is complete increase the temperature a further 1°C so that the cell is 2°C above its melt temperature and allow one hour for the liquid metal to fully melt and mix.

Next set the controller 1°C below the freeze point and use the monitor to follow the cells temperature as it drops and then enters the super cool zone.

Carefully remove the monitor and insert a cold rod into the re-entrant tube for 2 minutes. Repeat with a second cold rod before reinserting the cool monitor SPRT. Record the freeze of your Isotower.

You are now ready to calibrate thermometers either on the cells melt or its freeze.

THE IMMERSION COMPENSATOR

The offset value is provided as part of the calibration certificate, you could regularly check its value and adjust it as described above.

Ensure the ceramic cap is in place before use – see Figure 1 for details

Figure 1

Always ensure that the ceramic is in place before powering up the Isotower



Changing the Length of the Melt Plateau

By setting the controller 0.1°C above the melt temperature you will obtain a melt up to 30 hours 0.2°C will give you a typical 15 hour melt etc.

Getting a Freeze

Isotowers can be used as a melt or a freeze point apparatus. The melt is arrived at more quickly and using a 24 hour timer and allows a melt to be available all day every day.

The freeze curve is slightly flatter in temperature than the melt and some of you may wish to use the Isotower during its freeze.

Firstly melt the cell and set the controller 2°C above the melt.

DO NOT set the controller more than 2°C above the melt. There is an over-temperature trip inside the Isotower preset to 4°C above the melt to protect the heat siphon. Should you trip the unit you will need to contact Isotech for further instructions.

NEVER change the trip temperature!

Leave the Isotower for an hour before resetting the controller temperature 0.1 to 0.2°C below the freeze. Monitor the temperature in the cell and when it dips below the freeze temperature remove the monitor and in succession introduce two cold rods, each for two minutes. Replace the monitor which should quickly achieve the freeze temperature. Calibration of the Units Under Test (UUT) can commence, each UUT will freeze some metal and so shorten the freeze time and so if a number of thermometers are to be calibrated they should be pre-warmed.

Certification

The unique feature of the Isotower is that it is complete. A certificate such as a UKAS certificate includes the uncertainties of not just the cell but also the apparatus and immersion characteristics of the UUT. This reduces the overall uncertainties of your laboratory and simplifies the task of calculating uncertainties, which in turn improves confidence in your measurements.



A BASIC CONCERN

Heat siphons contain fluids. There is a basic concern that in the very unlikely event of a leak that there is a health and safety issue.

Dealing with each fixed point in turn. Both Indium and Tin use a heat siphon containing water as the fluid at either temperature the water is pressurised i.e. it is above 1 bar. If a leak occurred some moisture may leak out into the insulation.

A user would notice that the cell was not melting properly.

The Zinc Isotower heat siphon contains potassium under a partial vacuum. A leak would allow a certain amount of air to enter the heat siphon.

A user would notice that the cell was not melting properly.

An Aluminium Isotower heat siphon contains sodium under a partial vacuum. A leak would allow a small amount of air to enter the heat siphon.

A user would notice that the cell was not melting properly.

In the unlikely event of a leak the user should contact Isotech.

The other remote possibility is that the heat siphon leaks into the cell while the cells metal is molten.

To Indium and Tin no reaction takes place with the water vapour. With Zinc and Potassium neither is affected by the other (Ref. Hansen)

With Aluminium and Sodium neither is affected by the other (Ref. Hansen).

Again, the cell would melt badly. In this unlikely event please contact Isotech.

The Isotower wants to please you but to get the best from it you need to understand the controller temperature settings and the top heater offsets.

LEARNING MORE ABOUT YOUR ISOTOWER

1. Try adjusting the controller temperature between melts by 0.1 or 0.2°C. See the melts get longer and shorter.

Select the setting that gives you the length of plateau that suits you (I like about 15 hours so that I can have a new plateau each day).
2. Check your furnace profile each time you use your Isotower. After the Isotower settles down 2°C below its melt, raise the monitor 100mm (4") and check the temperature is the same or increases slightly. This takes only 10 minutes and checks for any drift on the Immersion Compensation Controller.
3. When calibrating, leave the Unit Under Test (UUT) in the Isotower long enough for the system to fully restabilise – see notes below.

We recommend pre-warming the UUT in all cases.

Note: How the thermal profile along the cell can affect or even destroy it

The easiest cell to describe is the Water Triple Point because the container, being made of glass, is transparent, so the effects can be seen.

As cold rods are inserted into the cell to create an ice mantle an ice bridge forms at the surface of the water in the cell. If this is not immediately re-melted then further cooling and ice formation expands the volume beneath the ice bridge and the cell will implode.

This is because ice is 8% less dense than water, for example in a Isotech BI I/50 cell the water level increases 12mm as the ice increases from 0 to 50%.

Although we cannot see inside other fixed point cells, during melting, a similar process is occurring.

For example the metal inside a Slim Aluminium Cell will expand 7.2% and the level of aluminium will increase by 12.6mm as the cell melts.

The cells are heated in furnaces which will be either 3 Zone or Heatpipe furnaces.

It should be obvious from the above that the cell should either have zero temperature gradient along its length or the top of the cell should be hotter than the rest of the cell.

If the cell melts from the bottom upwards the expanding liquid metal will rupture the graphite crucible.

Note: Putting numbers to the theory

Traditionally the fixed points of ITS-90 have been used on their freezes. This is because during freezing the metals shrink; In by 2.3%, Sn by 2.5%, Zn by 4.6%, Al by 7.2% and Silver by 4.5%.

During melting, pressure can build up inside the cell as it melts and expands. This is why the freeze is chosen.

In practice it is very convenient to use the melt plateau for calibrating thermometers, and we, along with other producers recommend it in all but the most exacting requirements.

However it is important to pre-warm the UUT before inserting it into the melting cell to avoid refreezing it.

This note explores the worst case situation of a UUT being inserted into a melting cell from room temperature.

For an Isotech model 670 thermometer the end 18cm weighs 10.5g.

The 670 will freeze 5.4cc's of In, 4.4cc's of Sn, 5.4cc's of Zn, 7cc's of Al and 11.2cc's of Ag.

There are approximately 67cc's of metal in an Isotech Slim Cell and 200cc's in an Optimal Cell.

A 670 will refreeze the following percentages of metal in a Slim Cell.

7.8% of In, 6.6% of Sn, 7.8% of Zn, 12% of Al and 17% of Ag.

By setting the Slim Cell's apparatus a melt of eight hours can be achieved. This means 12% of the metal is melted per hour. So now we can calculate the time for the melting cell to recover after a cold thermometer is inserted.

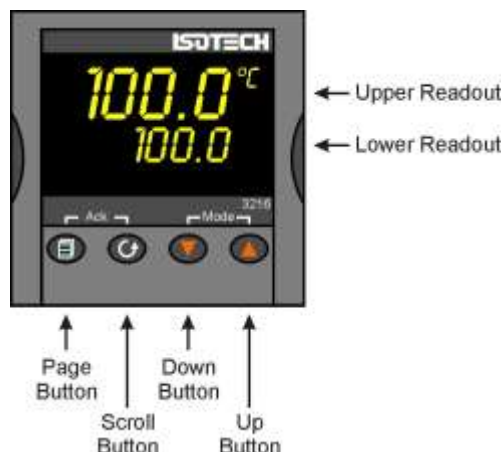
This is one hour for an Aluminium Slim Cell, less for In, Sn and Zn and longer for Ag.

Heavier UUT's such as Metal Clad Thermometers will freeze more metal and so will require longer for the cell to recover.

Preheating the UUT will reduce this time considerably because less metal is refrozen, and is recommended in all cases.

USING THE CONTROLLER

Front Panel Layout



The Temperature Controller

The controller has a dual display, the upper display indicates the nominal block temperature, and the lower display indicates the desired temperature or setpoint.

Altering the Setpoint

To change the setpoint of the controller simply use the UP and DOWN keys to raise and lower the setpoint to the required value. The lower display changes to indicate the new setpoint.

Advanced Controller Features

Setpoint Ramp Rate

By default the bath is configured to heat (and cool) as quickly as possible. There may be some calibration applications where it is advantageous to limit the heating (or cooling rate).

An example might be when testing bimetallic thermostats, by forcing the bath to heat at a controlled rate it is easier to determine the temperature at which the thermostat changes state.

The bath can have its heating rate limited with the Setpoint Ramp Rate feature. This feature is accessed from the Scroll key. Depress the key until the display shows,

OFF
SP.RAT

The upper display will show the current value and is adjustable from OFF to 999.9. The units are °C/min and are adjustable via the UP/DOWN keys.

When the SP.RAT is active the lower setpoint display will now automatically update with the current value, known as the working setpoint. The setpoint can be seen by pressing either the UP and DOWN key.



The Setpoint ramp rate operates when the bath is heating and cooling.

Instrument Address

The controller has a configurable "address" which is used for PC communications. Each instrument has an address; this allows several instruments to be connected in parallel on the same communications bus. The default value is 1. This address would only need to be changed if more than one Dry Block is connected to the same PC port.

To check the Address value press the scroll key until the lower display indicates,

ADDR

The upper display will show the current value that can be modified with the UP and DOWN keys.

Monitoring the Controller Status

A row of beacons indicate the controllers status as follows,

Output 1 (op1) Heater – shows when the heater is active, seen to pulse to display heater output

REM This beacon indicates activity on the PC interface

Units

The units can be changed from °C. Press the scroll key until the lower displays shows

UNITS

Use the UP and DOWN keys to select the desired display unit.

Using the zone controller

The zone controller is set to read the temperature difference between the heat siphon temperature and the immersion compensator. Typically if there was no difference in the temperature then the controller would read "0".

If the immersion compensator was cold by 1°C then the zone controller would be set to +1°C etc.

To adjust the controller temperature simply use the up/down buttons.

USING THE PC INTERFACE

The bath includes an RS422 PC interface and a special converter cable that allows use with the a standard RS232 port. When using the bath with an RS232 port it is essential that this converter cable is used. Replacement cables are available from Isotech, part number ISO-232-432. A further lead is available as an option, Part Number ISO-422-422 lead which permits up to 5 instruments to be daisy chained together.

The benefit of this approach is that a number of calibration baths may be connected together in a "daisy chain" configuration - and then linked to a single RS232, see diagram.



Note: The RS422 standard specifies a maximum lead length of 1200M (4000ft). A true RS422 port will be required to realise such lead lengths. The Isotech conversion leads are suitable for maximum combined lead lengths of 10M that is adequate for most applications.

Connections

For RS232 use simply connect the Isotech cable, a 9 to 25 pin converter is included to suit PCs with a 25 pin serial converter.

RS422 Connections

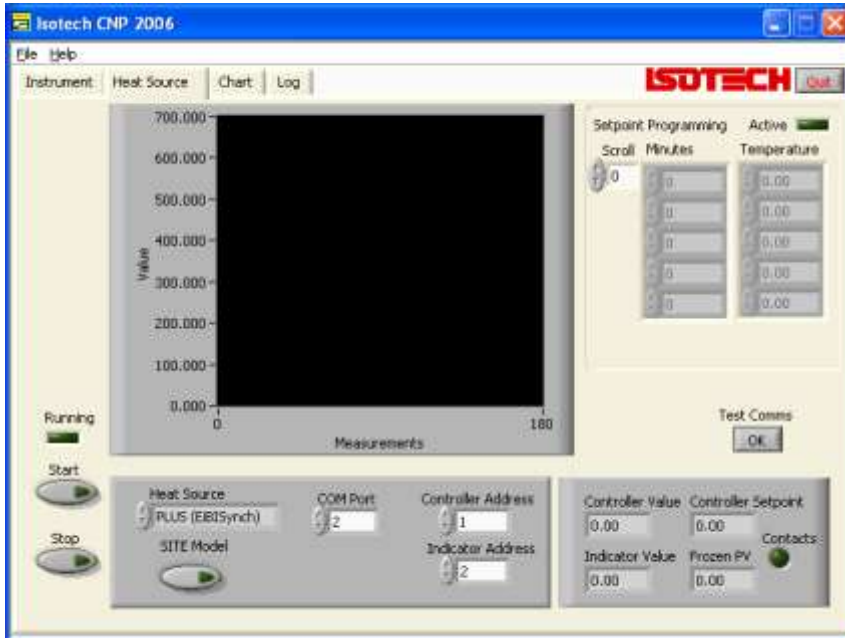
Pin	Connection
4	Tx+ A
5	Tx- B
8	Rx+ A
9	Rx- B
1	Common

Using the Interface

The models are supplied with Cal NotePad as standard. This easy to use package is compatible with MS Windows 9x. A manual for Cal NotePad can be found on the first installation disk in Adobe PDF format. If required a free Adobe PDF reader can be downloaded from, www.adobe.com.

CAL NOTEPAD

Cal Notepad can be used to log and display values from the Dry Blocks and an optional temperature indicator such as the milliK or TTI-10. The software requires Windows 9X, XP, a minimum of 5Mb of free hard drive space and free serial ports for the instruments to be connected.



DEVELOPMENT

Cal NotePad was developed by Isothermal Technology using LabVIEW from National Instruments. The license details are shown on the download page and in the Cal Notepad manual.

HOW TO INSTALL CAL NOTEPAD

1. Download the ZIP from <http://www.isotech.co.uk/downloads> (7.6Mb)
2. Extract the files to a temporary folder
3. Run setup.exe



4. Follow the prompts which will install the application, a user manual with setup information and the necessary LabVIEW run time support files.
5. Should you ever need to uninstall the software then use the Add/Remove Programs option from the Control Panel.

PROTOCOL

The instruments use the "Modbus Protocol"

If required, e.g. for writing custom software the technical details are available from our Document Library at <http://www.isotech.co.uk>