

# **ITS-90 ISOTHERMAL TOWERS**

## User Maintenance Manual/Handbook

## GUARANTEE

© Isothermal Technology Limited

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

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.

**ISOTECH**

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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 1 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<sub>2</sub>CO<sub>3</sub>) 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.

**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 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.

## 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:

<b><u>COLOUR</u></b>	<b><u>FUNCTION</u></b>
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.

## ISOTOWER OVERVIEW

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

Isotowers work by using the thermal properties of heatpipes. Once the fluid inside a heatpipe 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 Fixed Point Cell inside the heatpipe therefore warms quickly and uniformly.

During use 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 which has its own controller labelled 'Zone controller', this follows the main controllers' temperature.

The main controller and the zone controller are factory set prior to despatch. The setpoints for these controllers are detailed on the melt and freeze curves within the certification which accompanies each Isotower.

### Internal Over-Temperature Protection

There is an internal over-temperature trip inside the Isotower which is pre-set to 4°C above the cells melt/freeze temperature, this is to protect the heatpipe.

To avoid tripping the over-temperature protection **DO NOT** set the temperature of the Isotower controller more than 3°C above the melt/freeze temperature.

Should you trip the unit you will need to contact Isotech for further instructions.



## ISOTOWER PRECAUTIONS

The details in the following sections should be adhered to in order to avoid failure of the cell through incorrect temperature profile.

### Ceramic Cap

**DO NOT** operate the equipment without the ceramic cap in place.

The zone controller has been factory set with the ceramic cap in place. Removal of this cap and subsequent use of the Isotower would inadvertently change the temperature profile across the length of the heatpipe resulting in the top of the cell being cold. See 'Cell Temperature Profile' section.



### Zone control drift

Over time the zone control sensor may drift so it is critical that the temperature profile of the Isotower is regularly checked and adjusted if required.

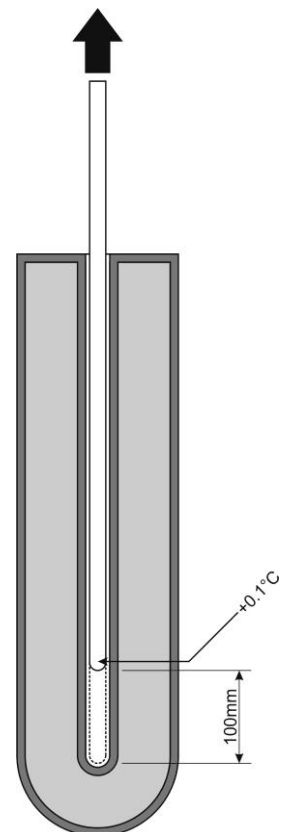
To do this power up the Isotower and set a temperature 2°C below the cell's melt/freeze temperature.

Place a thermometer (preferably calibrated) into the Isotower and monitor the temperature until stable.

Once stable record the temperature then raise the thermometer 100mm (4") and allow the temperature to stabilise once again before recording the temperature. Ideally the temperature 100mm up should be +0.1°C higher than the first measurement. This ensures the top of the cell is hotter than the rest of the cell. This procedure checks for any drift of the zone 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 controller's value will not increase the temperature measurement at the top of the cell by 0.1°C.



## Test Thermometers

One of the most common influences on temperature profile of the cell is the introduction of cold test thermometers. As each thermometer is introduced into the cell it removes heat from the top of the cell. It is therefore very important that test thermometers are always pre-warmed (to the temperature of the cell or hotter) before being placed into the Isotower, this will prevent the scenario where the top of the cell becomes cold.

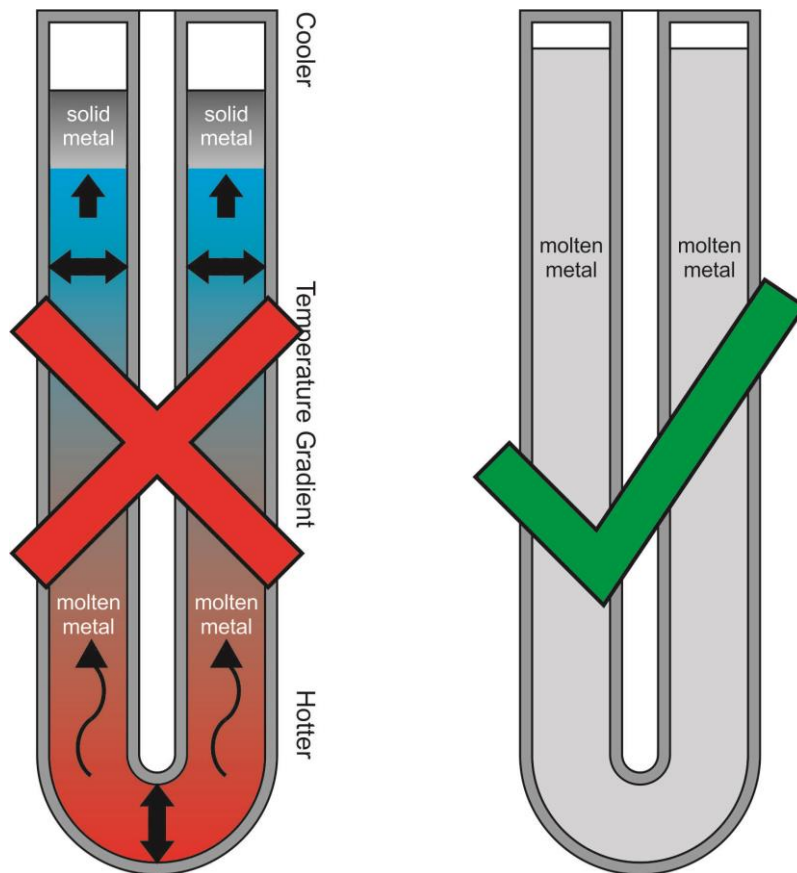
## Mode of failure

**If the Isotower is operated for a prolonged period of time with the top of the cell colder than the bottom of the cell then this may cause irreparable damage to the Isotower, this is explained below.**

Inside the Isotower is a graphite crucible that contains 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 volume of the crucible.

If the top of the cell is colder than the bottom of the cell, then on melting, the metal inside the cell will melt at the bottom first. The metal at the top of the cell will remain frozen solid. As the melting metal expands upwards the expansion will become impaired by the frozen section of metal, resulting in a pressure increase inside the cell and subsequent failure of the graphite crucible of the cell. See illustration below.



Melting from the bottom upwards solid metal at the top of the cell impairs expansion causing internal pressure and cell failure

Keeping the temperature of the top of the cell at or hotter than that of the bottom of the cell allows for expansion of the metal

## USING YOUR ISOTOWER

### Controller set-point error

Prior to performing a melt or freeze plateau on a cell it is best practise to measure the temperature of the cell with a calibrated thermometer at a set-point above or below the cells melt/freeze temperature (with the metal fully molten or fully frozen).

This enables the calculation of the controller error which should then be taken into account when changing the controller set-point prior to realising a melt or freeze plateau.

This measurement of the controller error should take place prior to each realisation in order to reproduce consistent plateaus.

### Fixed Point Cell Super-cool

Super-cool occurs during the realisation of the freeze plateau, when the metal inside the cell cools beyond its freeze temperature, during this time it is still in a molten state.

All fixed points cells can be seen to super-cool during a freeze realisation, this is normal, however, Tin fixed point cells generally super-cool further than all other fixed point cells.

### Realisation Procedure

Note: For simplicity the Fixed Point temperature, melt temperature or freeze temperature are all the same.

Realisation of a freeze plateau:

1. Place a calibrated thermometer into the Isotower.
2. Change the Isotower set-point to 2 °C above the melt temperature (For example, 234 °C for Tin) and leave overnight.
3. Record the temperature of the Isotower during this time.
4. From this measurement calculate the controller set-point error.
5. Change the controller set-point to 5 °C below the freeze temperature taking into account the controller set-point error and monitor the temperature.
6. The temperature will be seen to decrease below that of the freeze temperature and into super-cool.
7. After time the temperature will suddenly start to increase\*.
8. At this stage adjust the controller set-point taking into account the controller set-point error to 0.5 °C below the freeze temperature\*\*.
9. Then remove the thermometer and insert one cold rod for 2 mins.
10. Return the thermometer to the cell and begin to record the freeze plateau.
11. The thermometer temperature will quickly increase to the fixed point temperature and remain there until all of the metal inside the cell has frozen.

\*If the temperature of the monitor thermometer stabilises at the set-point temperature then reduce the set-point further, the reason we do this is to force the cell through the super-cool.

Realisation of a melt plateau:

1. Continuation following a freeze plateau - allow sufficient time for the cell temperature to stabilise at the previously set controller set-point. (metal in cell now fully frozen)
2. Record the temperature of the Isotower.
3. From this measurement calculate the controller set-point error.
4. Change the controller set-point to 0.5 °C above the melt temperature taking into account the controller set-point error\*\*.
5. The thermometer temperature will be seen to increase to the fixed point temperature and remain there until all of the metal inside the cell has melted.

**Tips:**

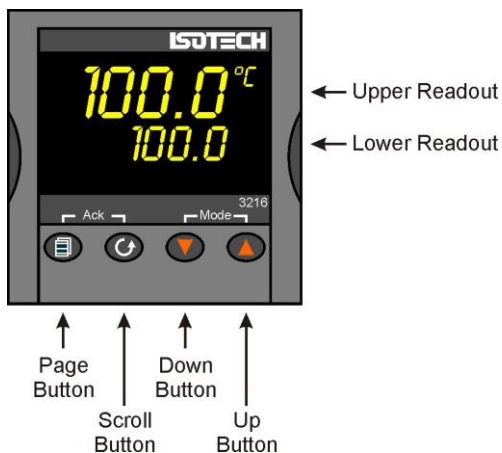
In order to achieve consistent plateaus, it is vital this procedure is repeated precisely each time, including points 1-3 prior to each realisation.

The freeze plateau will give the smallest temperature variation with time (flattest plateau).

\*\*To increase the plateau length, instead of setting the controller set-point 0.5 °C above or below the fixed point temperature adjust the controller set-point to 0.2 °C.

## 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 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

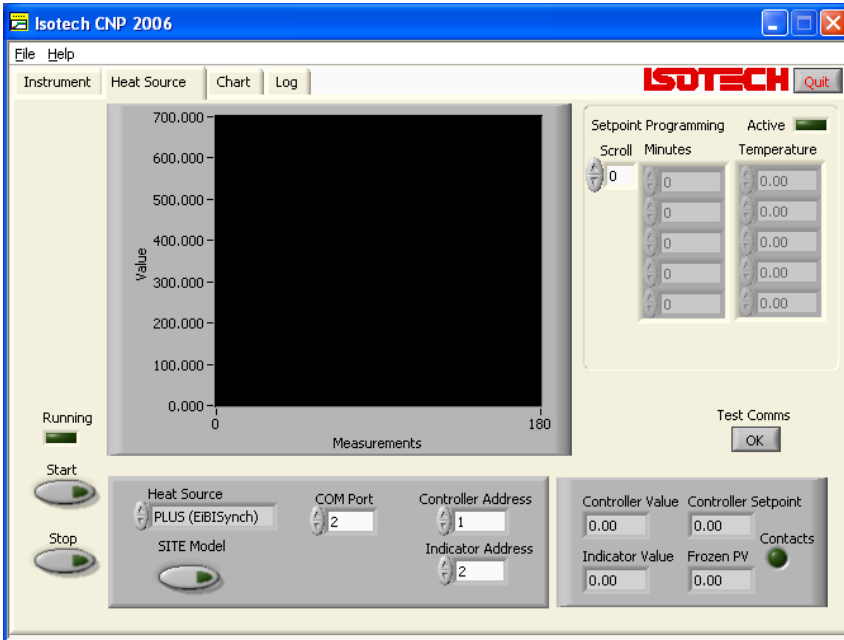
Pin	Connection
4	Tx+ A
5	Tx- B
8	Rx+ A
9	Rx- B
1	Common

## 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](http://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>