# SMALL HOTPLATE
# MODEL 983

User Maintenance Manual/Handbook

**Isothermal Technology Limited, Pine Grove, Southport, PR9 9AG, England**
**Tel: +44 (0)1704 543830 Fax: +44 (0)1704 544799 Internet: www.isotech.co.uk E-mail: info@isotech.co.uk**

# CONTENTS

# 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.

ISOTHERMAL TECHNOLOGY LTD.
PINE GROVE, SOUTHPORT
PR9 9AG, ENGLAND

TEL: +44 (0) 1704 543830/544611
FAX: +44 (0)1704) 544799

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.

# ⚠ 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.

# 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 degrees 2

## Environmental Ratings

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

# 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 has 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.

# FOREWORD; CONTACT SURFACE TEMPERATURE MEASUREMENT

A prime requisite for measurement of the temperature of a surface is, in all cases, good thermal contact between sensor and surface (thermal modelling of imperfect contact is not practicable), and, to accomplish this, it is common practice to use a thin layer of material of a suitable constitution to provide thermal coupling, e.g. grease.

If determination of the temperature of the surface is the ultimate aim, then good contact and the use of a sensor in which the sensing element itself is in close proximity to the surface will often provide an adequate basis for measurement.

There are many instances, however, in which the temperature of the surface is used to derive the temperature at a point not normally accessible, e.g. inside a pipe either by modelling techniques or by infrequent comparisons with a specially contrived measurement using a sensor in a superior location in order to establish consistency and relevance of the surface temperature measurement. Modelling may simply consist of the assumption of equality of temperature at the surface and at a desired, but inaccessible, point. In this case it is appropriate to introduce (as far as is possible) thermal isolation of the sensor from any heat sink or source other than the zone of interest. Normally, this involves some form of thermal insulation, fitted over the sensor after attachment of the latter to the surface.

Inevitably invoked is the need for sensor calibration, in order that measurements be rendered meaningful. This process is, in essence, the determination of the relationship between a measured parameter and temperature; the latter belongs specifically to the sensing element and it is a usual objective of calibration, to arrange conditions so that temperature gradients and heat transmission are absent from the measuring zone, i.e. that equality of temperature prevails for sensing elements and calibration environment. It is sometimes feasible, and advantageous, to adopt a compromise arrangement for the case in which intended subsequent use of the sensor necessarily involves a non-ideal condition with respect to temperature uniformity. The potential advantage to be gained is in realising, for calibration, an approximate simulation of the practical measurement set-up. To conform to this guiding principle in the use of a surface temperature sensor calibration system, of the type described in this manual, implies the necessity to take into account the specific conditions of each application. Consequently, no hard-and-fast rule can be formulated for the manner of assembly of the sensor to be calibrated, on the heated surface of the calibrator, except that of achieving good thermal contact. (Appendix 1)

# INTRODUCTION

Isotech Model 983 is a calibration facility for surface-mounted temperature sensors. It consists of an electrically-heated aluminium disc into the (exposed) face of which has been machined a shallow (2mm deep) cylindrical well. The latter is intended to contain a "smear" of heat-transfer fluid to enable good thermal contact to be made between the hot surface and the temperature sensor placed on it for calibration, provided that this is the way in which the surface sensor will normally be used.

# FEATURES OF THE INSTRUMENT

## 1. Disc assembly

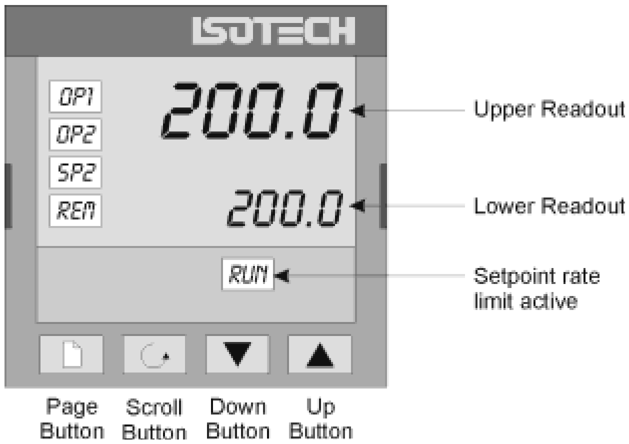
The underside of the "calibration" disc is recessed to accommodate a spirally-disposed mineral-insulated ohmic heater, which is enclosed by fitting a supplementary disc beneath it. The whole assembly is contained in a bed of insulating material (Kaowool).

## 2. Heat input and control

The front panel holds the mains switch, which incorporates a neon indicator lamp, and the fascia of the Eurotherm 2116 temperature controller used to operate the heating system. The operating parameters of the controller include a pre-set upper limit to the operating temperature.

# OPERATING 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 plates are 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).

The plate 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,

SPrr

On the Upper Display, the lower display will show the current value from OFF (default) to 999.9. The desired rate is set here with the UP and DOWN keys, the units are °C/min.

When the SPrr is active the controller display will show "RUN", 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 plate (dry block) is connected to the same PC port.

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

Addr

The lower 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,

| | |
|---|---|
| OP1 | Heat Output |
| OP2 | Cool Output (Only for models which operate below 0°C) |
| REM | This beacon indicates activity on the PC interface |

## Units

Momentary pressing the Scroll key will show the controller units °C or °F.

# USING THE PC INTERFACE

The PLUS models include an RS422 PC interface and a special converter cable that allows use with 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 RS 422 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

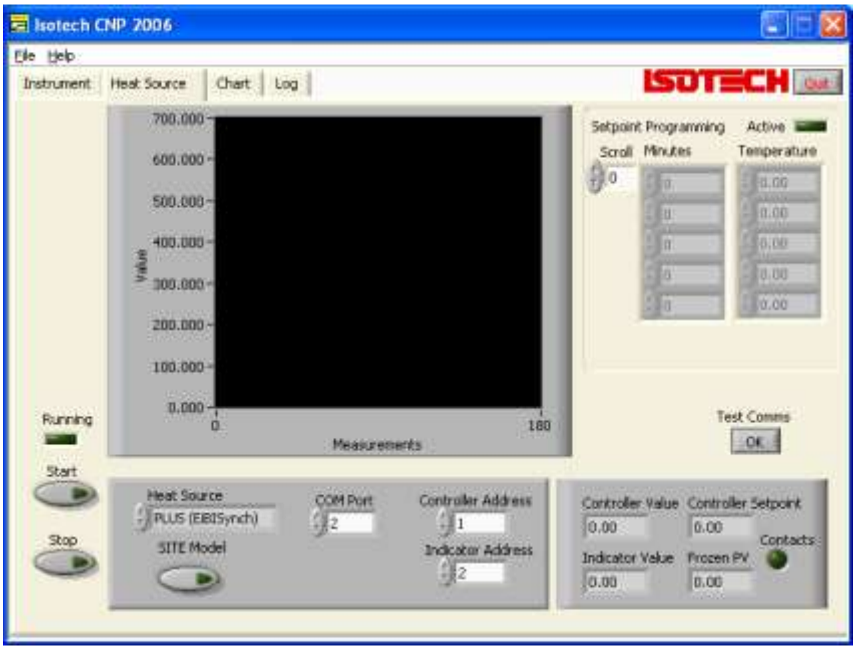
For RS232 use simply connect the Isotech cable.

RS422 Connections

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

# CAL NOTEPAD

Cal Notepad can be used 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

# TECHNICAL DETAIL

| | |
|---|---|
| Operating temperature range: | 50°C to 350°C |
| Power consumption: | 180W (220/240V or 110/120V, 50/60Hz)<br>(mains lead attached) |
| Temperature controller: | Eurotherm 2116, operated by N-type thermocouple set 3mm below centre of upper surface of disc. |
| Heated disc detail: | Mineral-insulated heater internally mounted in 2-disc assembly.<br>Diameter of disc: 75mm<br>Diameter of well for heat transfer medium: 71mm<br>Depth of well: 2mm |
| Approximate time (from ambient) to reach stability at maximum set-point temperature: | 30 minutes |
| Dimensions of outer casing: | Width : 230mm<br>Height : 115mm<br>Depth : 225mm |

# INSPECTION ON RECEIPT

Carefully examine the instrument for any signs of damage that may have occurred during transit.

In the event of damage, immediately inform the carrier and the supplier (Isotech or agent) and retain the instrument and packaging material as nearly as possible in its as-received condition, for possible inspection by an insurance assessor.

# OPERATION OF THE INSTRUMENT

When first switched on, the controller self-check procedure is initiated.

Thereafter, depressing either the up or down buttons will access the set-point value.  Adjustment (up to the pre-set operating limit) can then be effected by means of the up and down buttons once again.

There is no facility incorporated for cooling, the control range being 50°C to 350°C means naturally cooling is sufficient.

Stability of temperature at the selected set-point should be established within about 30 minutes of switching on at ambient temperature.

# MAINTENANCE

Each unit is fully tested before despatch from the facility and does not require the specification of a regular servicing/maintenance routine.

In the unlikely event of failure or of the incidence of a fault condition, the unit should be returned, carriage-paid, to Isotech (or its agent) for inspection and repair.

# APPENDIX 1: WHAT OTHERS SAY ABOUT SURFACE TEMPERATURE MEASUREMENT

## Surface Temperatures

A surface, because it is the interface between 2 systems, does not have a temperature as such. A user who wants to know temperature should define his measurement problem more exactly. For example:

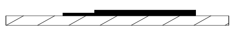
Is he interested in the amount of heat dissipated by the surface?
How hot the surface feels to the touch - will it burn fingers?
The amount of radiation emitted by the surface?
The temperature of one of the systems near the surface?

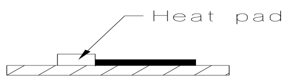
Each of these measurement problems has a different answer and each would give a different "surface" temperature for the same surface. In general there are 2 classes of techniques used to measure surface temperature.

## Non-Contact Methods

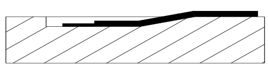
Infrared and optical pyrometers measure the temperature by determining the amount of energy radiated from the surface. Generally the emissivity of the surface needs to be known, though the advent of "two colour" pyrometers allows the temperature to be found without knowledge of the emissivity. (Pyrometers are discussed in more detail in Chapter 13).

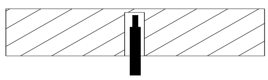
Coloured paints or crayons which change colour at specified temperatures can be applied to the surface as temperature indicators. For many the colour change is irreversible, and they are, therefore, "once only" techniques. They may also change the temperature profile of the surface due to the insulation effects and different emissivity's.


(a) Mounted directly on surface



(b) Use of heat collecting pad


(c) Mounted in groove


(d) Mounted from rear of surface

Several measurement techniques have been developed that establish a heat balance between the thermometer and the surface. The thermometer is slowly heated to the same temperature as that of the surface, with the only contact between the 2 being through the intervening warm air. These thermometers have found application where large moving surfaces are involved.

## Contact Methods

The problem of obtaining sufficient immersion depth, when surface temperatures are measured, is by itself difficult. When combined with the large temperature gradients usually found on one or both sides of the surface, accurate measurements of surface temperature by contact methods become almost impossible.

Most surface thermometers are based on thermocouples, PRT's or thermistors.

Some of the common mounting techniques are shown in Fig. 8.14. To obtain a good immersion depth, the thermometer should be "thermally tied" to the surface for several centimetres. Another approach is to bed the thermometer under the surface, i.e. approach the surface from the side with the smallest temperature gradients.

## Bibliography

1. An older text, still in print, offers a comprehensive look at many industrial temperature measurement problems. It is "Temperature measurement in engineering", by H.D. Baker, E.A. Ryder, and N.H. Baker, Wiley, Vol. 1. 1953, Vol. II 1961.

2. Some more modern development in industrial temperature measurements can be found in "Advances in instrumentation", Proceedings of the ISA Conference held annually.

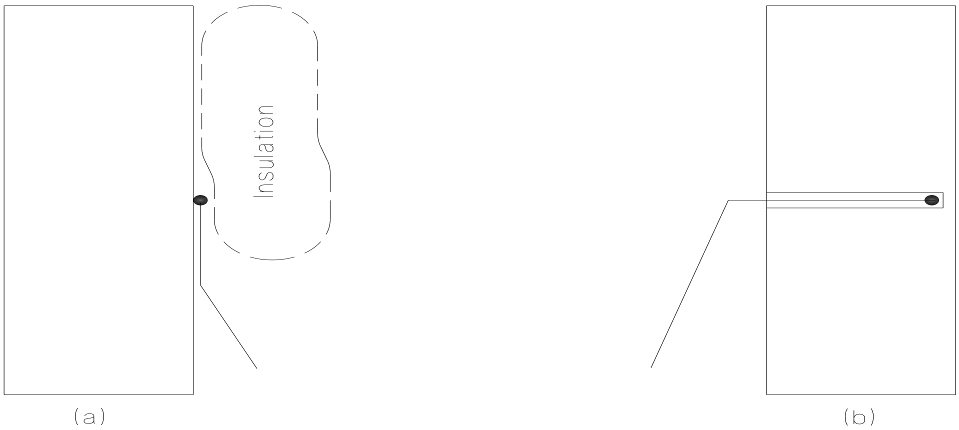
3. Thermometer applications are covered by articles in TMCSI.

4. British Standards Institute publishes a Code of Practice which is in several parts, not all available, and some are currently in need of revision, but contains much useful information. BS1041 "Code for Temperature Measurement".

The most difficult immersion problems occur when making measurements of air and surface temperatures. For air-temperature measurements the effective diameters of probes may be as large as ten times the actual diameter of the probe; a probe requiring 10 diameters immersion in the calibration bath may require more than 100 diameters immersion in air.

The fundamental problem with surface temperature measurements is that, since a surface is an infinitely thin boundary, there is no `system' into which you can immerse the thermometer. With surface-temperature measurements, the answer to the measurement problem often lies in analysing the reason for making the temperature measurement in the first place. For example, if we need to know how much energy the surface is radiating we should use a radiation thermometer; if we want to know the likelihood of the surface posing a human burn risk then we should use a standard finger as specified by a safety standard; and if we require a non-intrusive measurement of the temperature of the object behind the surface, then a measurement using one of the techniques in Figure 4.6 may be the answer. Assessment of the uncertainties in surface measurements is also difficult because of the number of sources of error present.

In all cases where immersion errors are suspected it is a very simple matter to vary the immersion length by one or two diameters to see if the reading changes. As a crude approximation about 60% of the total error is eliminated each time the immersion is increased by one effective diameter. In some cases it may be practical to estimate the true temperature from a sequence of measurements at different immersions.




Two solutions to the problem of surface temperature measurement: (a) attaching a length of the probe to the surface can approximate immersion. In some cases insulation may be helpful in reducing the losses by radiation or convection, although it can cause the surface to become hotter; (b) approaching the surface from the side which has the least temperature gradient will give the least error.

# RADIATION ERRORS AND SHIELDING

Heat can be transferred by any of three mechanisms:

- Conduction - for example, heat is conducted along a metal bar;
- Convection - for example, heat is transferred by the movement of air or other fluids;
- Radiation - for example, heat is radiated by lamps, radiant heaters, and the sun.

Radiation is one of the most insidious sources of error in thermometry. We often fail to recognise the physical connection between the radiant source and the thermometer and overlook it as a source of error. Radiation errors are a particular problem in air and surface thermometry where there is nothing to obscure or shield the source, and where the thermal contact with the object of interest is already weak. Examples of troublesome radiant sources include lamps, boilers, furnaces, flames, electrical heaters and the Sun.

A particularly common problem to watch for is the use of incandescent lamps when reading thermometers. If you must use a lamp, then use a low-power fluorescent lamp which will radiate very little in the infra-red portion of the spectrum.

With more difficult measurements, such as air and surface temperatures, anything at a different temperature which has a line-of-sight to the thermometer is a source of error. This includes cold objects such as freezers which act as radiation sinks and absorb radiation emitted by the thermometer. To put things in perspective, remember that at room temperature anything radiates (and absorbs from its neighbours) about 500 watts per square metre of surface area, so the radiative contact between objects is far greater than we would expect intuitively. In a room near a large boiler a mercury-in-glass thermometer may exhibit an error of several degrees.

There are two basic strategies when you are faced with a measurement that may be affected by radiation. Firstly, remove the source; and secondly, shield the source. Removing the source is obviously the most effective strategy if this is possible. However, the thermometry is very often required in association with the source, particularly in temperature-control applications. In these cases it may be possible to change the source in a way which will give an indication of the magnitude of the error.

If you are unable to remove the radiation source then shielding is the only resort. A typical radiation shield is a highly reflective, usually polished, metal tube which is placed over the thermometer. The shield reflects most of the radiation away from the thermometer and itself. An example is shown in Figure 4.10. The shield will usually reduce the error by a factor of about 3 to 5. The change in the thermometer reading when the shield is deployed will give a good indication of the magnitude of the error and whether more effort is required. Successive shields will help but will not be as effective as the first. Suitable trial shields are clean, shiny metal cans and aluminium foil.

The disadvantage of using a radiation shield in air-temperature measurements is that the movement of air around the thermometer is greatly restricted, further weakening the thermal contact between the air and the thermometer. The problem is compounded if the shield is warmed by the radiation and conducts the heat to the stagnant air inside the shield. Therefore, to be effective the shield must allow free movement of air as much as possible. In some cases a fan may be needed to improve thermal contact by drawing air over the sensor, and to keep the shields cool. Note that the fan should not be used to push the air as the air will be heated by the fan motor and friction from the blades.