ZEREF THERMOCOUPLE ICE-POINT REFERENCE UNIT MODEL 700

Isotech North America
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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. Failure as a result of misuse is not covered.
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 PROPERLY TO 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.

We recommend this instrument to be re-calibrated annually

Serial No:..

Date:..

ISOTECH

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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 (RS232 or RS422(485)) are fully screened.

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

Symbol Identification	Publication	Description
	ISO3864	Caution (Refer to Handbook)
	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 can not 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.

HEALTH AND SAFETY INSTRUCTIONS

1. Read all of this handbook 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, ie. 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.

12. Ensure adequate ventilation when using oils at high temperatures.

FOREWORD:

THERMOCOUPLE REFERENCING

It cannot be emphasised too strongly that thermocouple outputs are dependent upon emf's generated by temperature differentials along individual conductors and not upon the presence of junctions in the circuitry. However, access to an emf of this type, for measurement purposes, requires the connection of additional conductors, and these ineluctably introduce their own characteristic thermo-emf's into the circuit. The resultant nett emf will be the algebraic sum of the individual emf's corresponding to the respective temperatures of the end-points of each conductor, i.e., of the junctions present in the measuring circuit. Indeed, it is this principle that governs the practical application of thermocouples, although it should be noted that nett emf's are functions of actual temperatures and are not uniquely determined by temperature differences. In other words, the Seebeck coefficient (which is defined as the emf generated per unit temperature difference) for a given material is, itself, a function of temperature and, moreover, the uniqueness of its value at any given temperature is conditional upon physical and chemical homogeneity of that material.

For practicability as a measuring device, the principal implication for a thermocouple is that it must contain two junctions, one (the measuring junction) held at the temperature required to be determined and the other (the reference junction) maintained at a known (reference) temperature. Connections to the terminals of a measuring instrument potentially constitute thermocouple junctions and care must be taken in arranging circuitry to eliminate their contribution or to compensate for any influences thereby introduced. Qualitative acknowledgement, from a thermoelectric point of view, of the presence of every element in a composite circuit has led to a variety of arrangements to eliminate unwanted components of emf from thermocouple measurements. However, the practical necessity remains of providing some means of temperature referencing.

Some instruments involve the use of their terminals as reference junctions, for application with a specified type of thermocouple that possesses one other junction only (the measuring junction). Such instruments usually incorporate a facility for (electronic) "cold junction compensation," thus indicating an emf relative to 0˚C or, possibly, a direct reading of temperature. However, a fundamentally more satisfactory procedure is to form reference junctions using the conductors themselves and to employ an isothermal environment at a known temperature (typically 0˚C) into which these junctions can be immersed.

Several Isotech products are dedicated to the provision of such environments; it is interesting to note, also, the application of another thermoelectric phenomenon, peltier cooling, to establish the working conditions of those Isotech units designed to provide a reference temperature of 0˚C.

SYSTEM DESCRIPTION

The Zeref ice-point reference chamber consists of a thick-walled cylindrical copper vessel closed at its upper end with tube-plate (described later) and at its lower end with metal bellows. The chamber has been specially cleaned, then completely filled with pure water and sealed. Cooling is effected by two thermoelectric heat pumps (peltier modules) set in diametrically opposite positions on flats machined into the external face of the vessel and wired in parallel.

Formation of ice on the internal face will produce an increase in volume, which is accommodated by an extension of the bellows.

The end of the bellows has been arranged to operate a microswitch to disconnect the electrical supply to the modules when a predetermined amount of ice has formed. Subsequent melting of some of the ice in the chamber results in relaxation of the bellows and the consequent release of the switch, thus restoring the operating current to the modules and restarting the cooling part of the control cycle. At all times during this sequence of operations the chamber contains both water and ice, therefore maintaining an environment with a temperature of 0˚C.

The chamber, cooling modules and heat transfer blocks are set in a bed of rigid, thermally-insulating, foam contained in a plastic enclosure.

The tube-plate that forms the closure at the upper end of the chamber is penetrated by tubes (or a single tube of greater diameter) that extend into the water and that are closed at their immersed ends. These tubes constitute the re-entrant pockets for the insertion of thermocouple junctions.

If the control function fails and excess ice is produced, the bellows will suffer greater extension. When this reaches a certain stage, a second microswitch will be brought into operation to disconnect the mains power supply to the transformer and to connect the supply to the ALARM indicator lamp.

A PRT is available as an optional extra to enable the chamber temperature to be checked.

INSPECTION ON RECEIPT

Zeref reference units are packed satisfactorily for shipment to any destination in the world. On receipt, immediate unpacking and visual inspection should be carried out.

If there is evidence of in-transit damage the following actions should be taken:

1. Immediately notify, in writing, both the carrier and the supplier, giving full details of the damage.

2. Retain the packaging and the unit in its as-received condition for possible inspection by an insurance assessor.

If visual inspection suggests that the unit is in good condition, check that the details on the attached label agree with the order specification. In particular, verify that the mains supply voltage applicable to the unit is correct; if a discrepancy is discovered, the supplier should be informed.

ASSEMBLING THE HEAT SINKS

The heat sinks for the peltier cooling modules of the Zeref are supplied as separate items. The reason for this is to avoid the possibility of damage to the modules caused by handling during transportation; the same procedure must be observed, by detaching the heat sinks, whenever the Zeref is to be transported.

ATTACHMENT PROCEDURE

1. Remove one of the side panels of the Zeref by extracting the four securing screws (an allen key is provided).

   The machined aluminium face, with four tapped holes, of the heat transfer block is now accessible, penetrating the centre of the white plastic containment of the ice-point reference chamber.

2. Apply a thin coating of heat sink compound (supplied with the Zeref) to the aluminium face and attach one of the heat sinks (observing the TOP designation) by its mating face, securing by means of four screws. Tighten the screws sufficiently to grip only.

   Excessive tightening can cause damage and must be avoided.

3. Replace the side cover.

4. Repeat steps 1 to 3 to fit the second heat sink to the opposite side of the unit.

   The Zeref is now ready to switch on.

   Do not, at any stage, rest or store the Zeref on its side.

INSTALLATION

MECHANICAL

The instrument has four plastic feet mounted on its underside to facilitate use as a free standing unit. These feet can be removed, if desired, to allow the instrument to be securely fixed in position.

However, care must be exercised to prevent obstruction of free convective airflow between the instrument casing and the cooling fins of the heat sinks (peltier modules and circuit). Also, the site of the instrument must be remote from direct sunlight or any other source of heat whose proximity might impair the cooling function.

ELECTRICITY SUPPLY

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

COLOUR	FUNCTION
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.

OPERATION

1. Plug mains cable into socket on front panel of Zeref casing and into appropriate AC mains supply.

2. Switch on supply.

3. Switch on instrument (POWER ON switch). The switch contains a red neon indicator which should light. Alongside the switch is an amber neon indicator which should remain lit whenever COOLING is in progress.

4. Partially fill the re-entrant tubes (access at the top of the instrument) with electrically non-conducting oil) or other heat transfer medium (British Standard 148/1972 or equivalent). DO NOT USE MERCURY. The optimum level with respect to accuracy of measurement lies in the range 75 to 80mm (about 3") below the top of the instrument, with the thermocouple junctions or probes in place (i.e. allowing for displacement of fluid caused by their introduction). This confines thermal contact to the ice-point chamber itself and, moreover, essentially covers its whole depth.

5. Insert thermocouple junctions until they are within about 3mm ($^1/_8$") of the closed ends of the tubes. They must be electrically insulated from each other and from the tube walls.

   NOTE: If convenient, steps 4 and 5 may be carried out as the initial stage of preparation.

6. Ensure that the control function has been established before making measurements. This is evidenced by alternate switching off and on of the amber neon COOLING indicator. The two segments of the control cycle might be 30 seconds off followed by any value between 1 and 15 minutes on.

   The period of cooling from ambient temperature necessary to form sufficient ice to initiate the control cycle will depend on ambient temperature on the number and thermal characteristics (diameters and materials) of the thermocouple wires involved, e.g. a Zeref fitted with 60 copper/constantan thermocouples of 0.2mm diameter might require up to 5 hours for ice formation when the ambient temperature is 34°C. The instrument will not function when the ambient temperature is at, or below, 0°C.

7. If use of the Zeref is to be discontinued for a considerable period, the power may be simply switched off and the tubes emptied either by gently inverting the instrument or by suction via an immersed small diameter pipe.

   However, because of the inherent feature of low power consumption, it might be judged not unreasonable to maintain continuity of the operational status of the Zeref for a long period, in order to provide instant access and a consequent greater flexibility of working.

GENERAL NOTES ON ZEREF OPERATION

1. Thermocouple junctions can be introduced or removed at any time but, even when the instrument is in controlling mode at the instant of insertion, time must be allowed for restoration of thermal equilibrium following the disturbance.

2. To avoid atmospheric moisture condensing in the calibration tubes, their open ends may be plugged with cotton wool.

3. Light loading (up to, say, 10 junctions of fine wire) produces best results, particularly if long periods (e.g. 3 to 5 hours) are allowed for stabilisation after the initial formation of ice.

4. Some advantage might be gained by initiating cooling with the Zeref in a relatively cool environment and transferring it to its normal working location after the formation of ice. The procedure, of course, refers to a free-standing instrument.

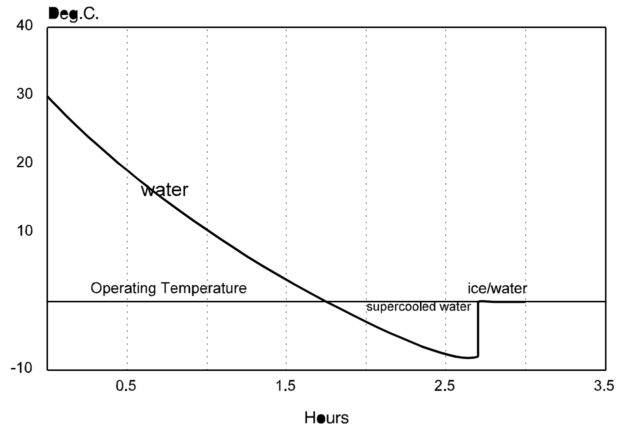
5. Although the expansion/contraction properties of the solid/liquid phase change in water are used as a mechanism for maintaining an environmental temperature of 0˚C, it is not always understood that very pure water can be cooled to a temperature between, perhaps, -4˚C and -8˚C before freezing initially occurs (the fewer the impurities, the lower the temperature).

Supercooling will proceed until, at some point, the first minute nucleus of ice is formed. At this stage the freezing condition will precipitate rapidly until sufficient latent heat has been released to increase the temperature to 0˚C. Thereafter, in the presence of both water and ice, this temperature will be maintained during the whole on/off control cycle. These features are illustrated in the graph presented below.

SPECIFICATION

Type 131 : Contains 1 probe hole of 18mm diameter and 170mm

TYPICAL COOLING CURVE OF A ZEREF



depth and is suited for referencing thermocouples or calibrating temperature sensors such as thermocouples and thermistors.

Type 136	:	Contains 6 holes of 5mm diameter and 170mm depth and is mainly used for referencing thermocouples.
Power	:	50 Watts typical 100-130 or 208-240 VAC 50/60Hz
Dimensions	:	Height 304mm Width 196mm Depth 284mm
Weight	:	11.5kg
Accuracy	:	The accuracy of the Zeref is 0±0.01˚C. Errors are introduced by loading the Zeref with Thermocouples wires or probes for calibration. The loading effect can typically vary from 0 to 0.1˚C.
Stability	:	0.01˚C at constant ambient temperature.
Ambient Temperature	:	The ambient temperature should not be allowed to exceed 30˚C until the yellow neon lamp occults. Thereafter, Zeref's may be operated continuously at ambient temperatures up to 35˚C. Zeref's will only operate at an ambient temperature above 0˚C. A free circulation of air to the heat sink fins is needed but fan assisted air circulation is unnecessary.
Stabilisation Time	:	Zeref's are ready for operation when the yellow neon lamp is seen to occult. This will happen in general 1 - 3 hours after switch on, when the correct amount of ice has formed. The time to form ice depends on the ambient temperature and load, so that a fully loaded Zeref in 30˚C ambient may require up to 5 hours to stabilise at 0˚C.
Alarm Facilities	:	A second and separate control circuit takes over an a green alarm light flashes.

<u>FAULT DIAGNOSIS</u>

<u>NOTES ON ACCESS FOR INVESTIGATION AND REPAIR</u>

1. Before any investigation is undertaken, it is necessary to disconnect the Zeref from the electricity supply.

2. Diagnosis of certain fault indications requires removal of the underside panel of the Zeref.

   Four screws attach the panel to the casing and a further four screws are used for attachment of the white plastic containment for the chamber, peltier modules and heat transfer blocks. To gain access for removal of these screws, the unit should be gently inverted after removing any heat transfer fluid from the re-entrant tubes. Removal of the panel exposes a small square plastic plate (held by four screws) covering the end of a Perspex tube inside which the microswitch assembly block is housed. Removal of this plate releases the spiral spring which supports the assembly, thus allowing the latter to be removed (still attached to its connecting wires).

3. Access to electrical terminals at the flange of the plastic containment is also possible although it might be more convenient to remove the side panels also, for this purpose.

4. In the absence of ice, the lower end of the bellows (the switch contacting surface) should be at a distance of 62±2mm from the lower end of the Perspex tube. Deviations beyond the quoted limits suggests the presence of a fault condition. Investigations of this nature should be conducted only after a few hours have elapsed subsequent to the latest use of the instrument. This is in the order to allow all ice, initially present, to thaw.

5. When a microswitch block is fitted/refitted, it is necessary to make sure that there is freedom of axial movement along the perspex tube so that the switch-operating rods are situated in their intended operating locations after assembly.

6. Circuitry and connections can be inspected after removal of panels.

7. Chamber temperatures can be measured by use of a platinum resistance thermometer placed in any one of the re-entrant tubes.

DIAGNOSTIC TABLE

The following is an outline of possible (although extremely unlikely) fault conditions and a guide to their diagnosis and correction:

OBSERVATION	DIAGNOSIS	SUGGESTED REMEDIAL ACTION
Mains-supply neon indicator lamp fails to operate	No power supply	Check that mains cable is plugged into supply and instrument sockets. Check that switches are selected ON. Check integrity of cable (continuity).
	Fuse blown	Test fuse for integrity and rating. Fuse (and spare) are in tray beneath instrument mains socket. Replace if necessary. Rating is 1.6A
	Lamp faulty	Prise switch/neon from panel, detach leads and test lamp using appropriate supply voltage. Replace lamp, if necessary.
	Circuit faulty	Check terminal connections and integrity of wiring.
Cooling neon indicator lamp fails to operate	Lamp faulty	Prise neon from panel, detach and test. Replace, if necessary
	Microswitch faulty	Extract, test and refit/replace, as appropriate. Check block is in correct position on spring-support (and not stuck in tube). Remove block and check mechanical operation of switch push-rods. Test electrical contacts with continuity meter.
	Bellows ruptured	Examine perspex tube for presence of water. Alarm should have operated and caused instrument power to be switched off (fail-safe). Replace complete chamber containment assembly (heat-sinks can be re-used).

OBSERVATION	DIAGNOSIS	SUGGESTED REMEDIAL ACTION
	Ambient temperature too low	Operate unit in suitable environment

	Circuit faulty	(As before)
Cooling neon indicator lamp fails to switch off	Power unit failure	Replace
	Microswitch faulty	(As before)
	Peltier module/rectifier faulty	Check combined current to modules (the two units are connected in parallel) - a clip-on ammeter is convenient for this purpose. The correct operating current is approximately 14A. A rectifier failure could result in a 50% loss of current. An unsatisfactory peltier module is indicated by a combined current of less than 12A and can be corrected only by replacement of the complete chamber containment assembly.
	Ambient temperature too high	Work only with instrument in ambient temperatures below 35˚C. The required cooling is unlikely to be achieved in ambient temperatures greater than 38˚C.
	Circuit faulty	(As before)
	Chamber not yet temperature-stabilised	Wait and recheck. Several hours may be required to achieve thermal equilibrium, depending on ambient temperature and loading.
Alarm indication	Microswitch (for cooling system) faulty	(As before)
	Bellows ruptured	(As before)