

## Hydra Model 798 Evaluation Report

The Isotech Hydra 798 Series has been developed to offer good immersion depth, 300mm at an affordable price.

There are four models, the temperature range of the 798H is 30 to 200°C the 798EHT has a range of 30 to 300°C. The M and L models include internal refrigeration and extend the minimum temperatures to -40°C and -80°C respectively, with a maximum operating temperature of 125°C.

Liquids are circulated by a propeller which mixes and forces the liquid up the rear of the calibration volume. The liquid flows down the front calibration volume and is recirculated.



This evaluation report describes the performance of the Hydra series, the intent is to provide a guide to the performance that can be expected in the calibration laboratory.

When comparing uncertainties and bath performance it is important to check that the specifications being compared are like for like, if in doubt please contact Isotech for advice. There is no agreed International standard for the expression of comparison bath performance and some other parties, without accredited labs of their own, have made claims which can lead to disappointment when a laboratory needs to measure the actual bath performance to establish calibration uncertainty. Isotech operates a UKAS Accredited Calibration Laboratory – equipped with baths of our own manufacture – check our schedule, ask for a copy or visit <http://www.isotech.co.uk>

The Hydras can be operated with different liquids over a temperature range from -80°C to 300°C. We recommend a range of liquids to suit different temperature ranges, other liquids can be used but the performance will vary depending on the viscosity and thermal properties of the liquid in use.

No one liquid can be used from -80°C to very high temperatures. If a silicone oil is used from below the dew point to above the boiling point of water there is a potential hazard. Moisture from the atmosphere will condense into the oil if the bath is operated below the dew point. If the bath is then operated above 100°C any moisture present can turn into steam and the expansion during this phase change can under certain circumstances lead to hot oil being expelled from the bath. This is due to properties of the liquid rather than the Hydra. Whilst there are laboratories who operate calibration baths over wide ranges that is not the practice of Isothermal Technology and our recommendation would be to use two liquids to span a wide range, or ideally two calibration baths.

## Stability

The stability of the Hydra varies with temperature range, liquid and method.

The recommended way of operating the Hydra is to use an equalizing block with the thermometer or thermometers under test compared to a standard or standards in the block. The equalizing block also provides a convenient support and ensures equal immersion of the sensors. The smallest uncertainties are obtained if the standard and thermometer under test are connected to the instrument simultaneously and the ratio of two recorded. With this method "Comparison Stability" is important, that is *the temperature variation over time of the difference between two thermometers in the calibration volume*. As the thermometers "see" the same temperature variation the errors are eliminated – or reduced to a value determined by the difference in time constants of the two probes.

Comparing the Glass Sheathed SPRT and the 100 Ohm industrial thermometer over 16 hours showed a comparison stability of better than  $\pm 0.005^{\circ}\text{C}$  – and this includes the uncertainty of the measuring instrument.

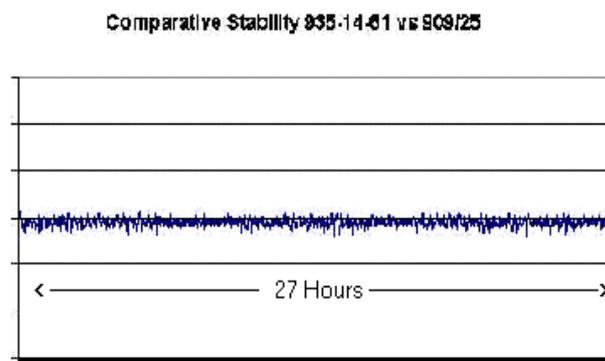


Fig 1. *Comparative Stability of an Industrial PRT vs a SPRT (Models 935-15-61 and 909/25) in an equalizing block over a 27 hour period*

### Performance Detail: Stability

On occasions, the bath's absolute stability is required and also the thermal profile needs to be evaluated, these for sensors whose length or mass is dissimilar to the reference standard.

Stability or *absolute stability*, we define as the variation in temperature, with time, of the liquid in the calibration volume. This can be measured with a single sensor either direct in the liquid or with a sensor immersed in the equalizing block.

Stability Measured with Fast Response 935-14-61 RTD Probe in Equalizing Block

	Hydra L	M	H	EHT
-80°C	$\pm 0.009^{\circ}\text{C}$	N/A	N/A	N/A
-40°C	$\pm 0.009^{\circ}\text{C}$	$\pm 0.006^{\circ}\text{C}$	N/A	N/A
0°C	$\pm 0.010^{\circ}\text{C}$	$\pm 0.015^{\circ}\text{C}$	N/A	N/A
50°C	$\pm 0.005^{\circ}\text{C}$	$\pm 0.005^{\circ}\text{C}$	$\pm 0.005^{\circ}\text{C}$	$\pm 0.005^{\circ}\text{C}$
100°C	$\pm 0.005^{\circ}\text{C}$	$\pm 0.005^{\circ}\text{C}$	$\pm 0.005^{\circ}\text{C}$	$\pm 0.005^{\circ}\text{C}$
125°C	$\pm 0.005^{\circ}\text{C}$	$\pm 0.005^{\circ}\text{C}$		

200°C	N/A	N/A	+/-0.005°C	+/-0.005°C
250°C	N/A	N/A	N/A	+/-0.005°C

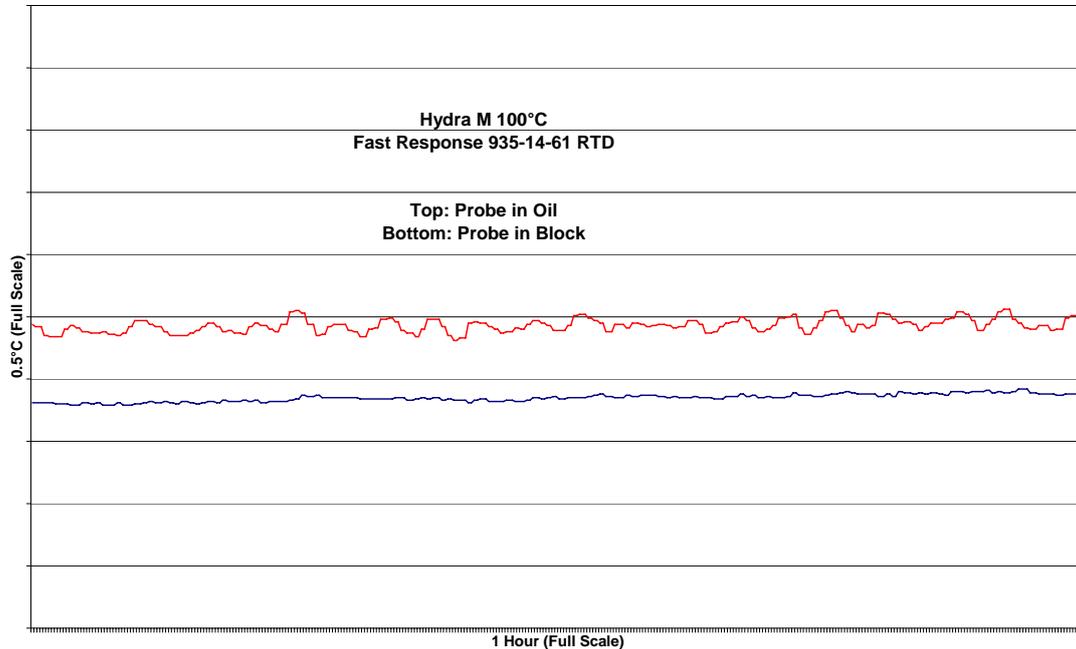
Stability Measured with Fast Response 935-14-61 RTD Probe Direct in Liquid

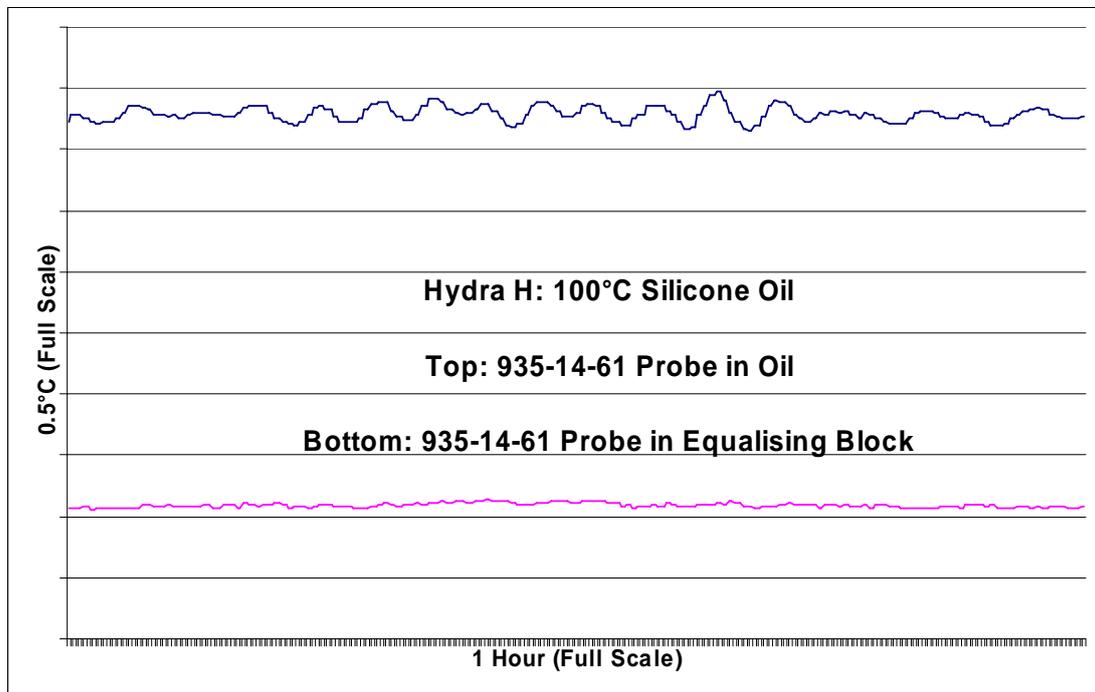
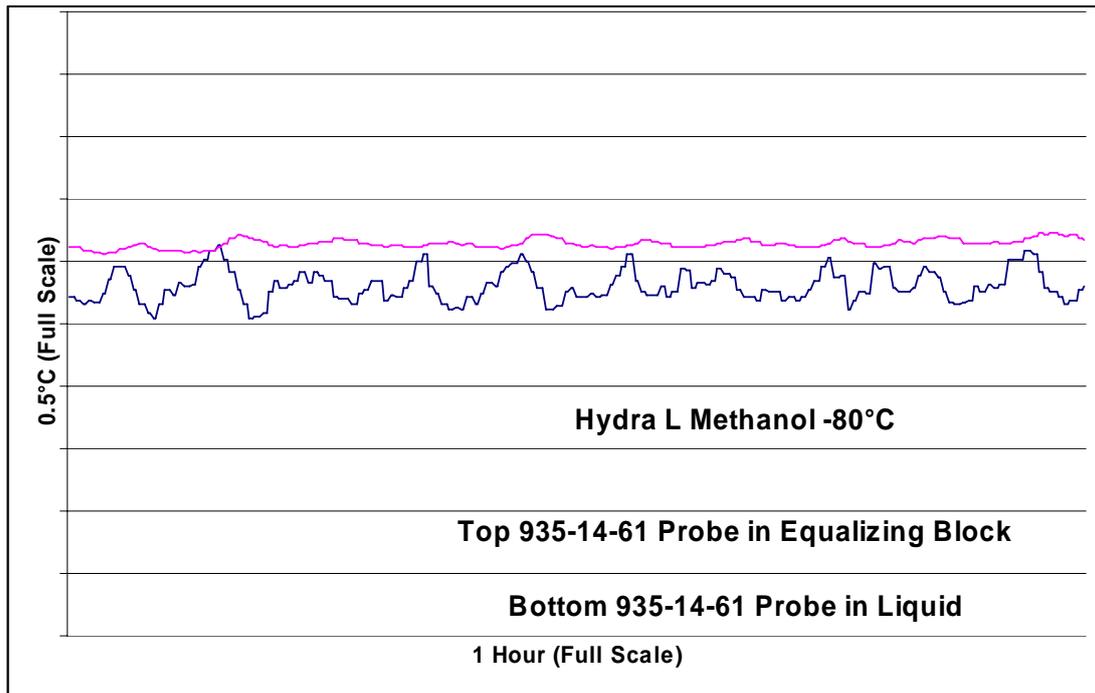
	Hydra L	M	H	EHT
-80°C	+/-0.030°C	N/A	N/A	N/A
-40°C	+/-0.025°C	+/-0.017°C	N/A	N/A
0°C	+/-0.075°C	+/-0.025°C	N/A	N/A
50°C	+/-0.010C	+/-0.010C	+/-0.015°C	+/-0.015°C
100°C	+/-0.010C	+/-0.010C	+/-0.015°C	+/-0.015°C
125°C	+/-0.010C	+/-0.010C		
200°C	N/A	N/A	+/-0.015°C	+/-0.015°C
250°C	N/A	N/A	N/A	+/-0.015°C

Notes:

Stability: Temperature variation over 30 minute period.

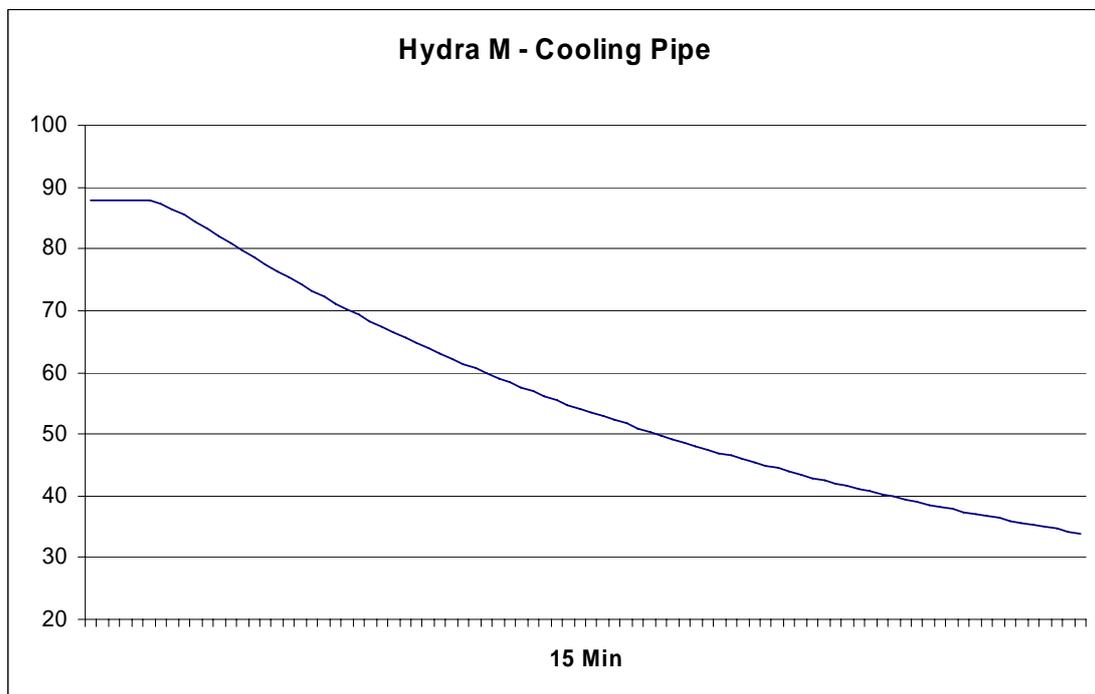
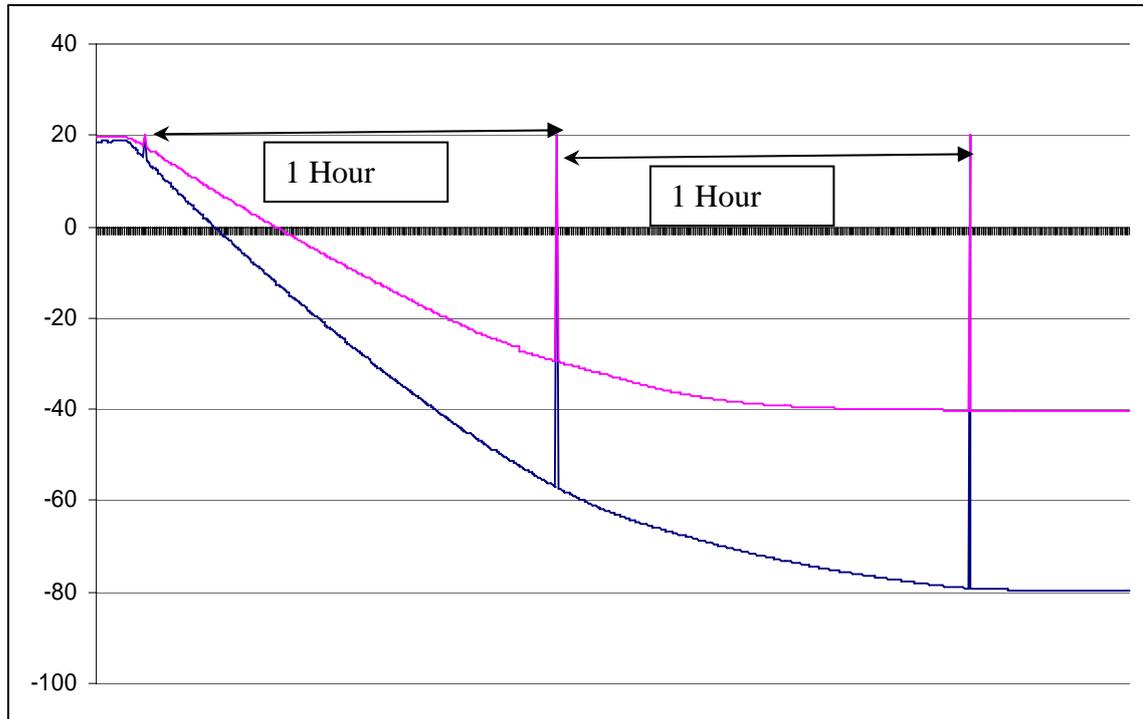
Liquids: L and M: T < 20°C Methanol T > 20°C Silicone Oil C10





## Response Times

### Cooling

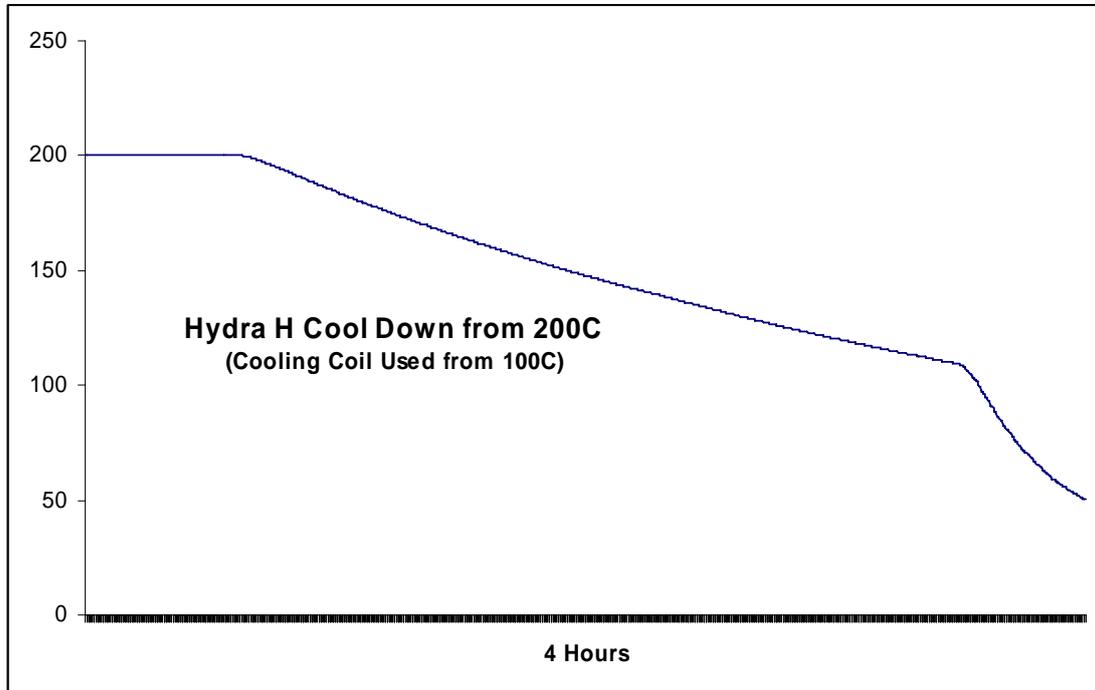


The mechanical refrigeration system runs from a nominal 40°C. The cool down time from high temperatures to the point the chiller operates is several hours. To reduce this the Hydra L and M can be used with a simple cooling pipe. Tap water can be passed through the pipe to substantially reduce the cooling time. The graph is for a Hydra M and shows the cool down time from a

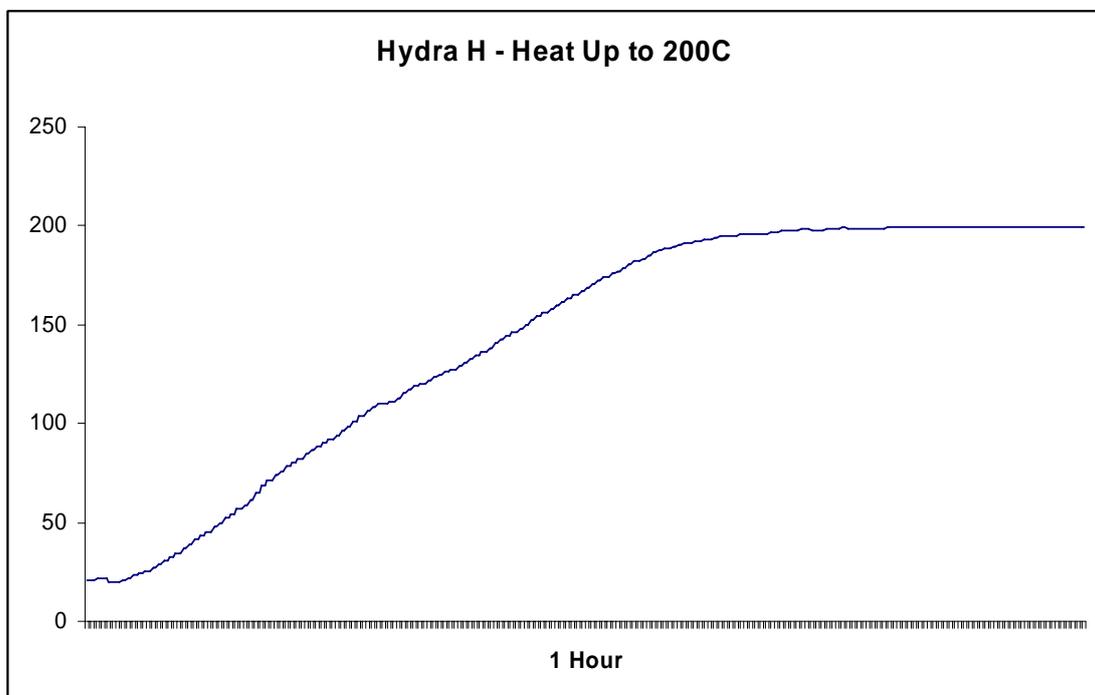
nominal 90°C to 35°C in less than 15 minutes. The cooling accessory is included as standard with Hydra's built from March 2005.

### Hydra H Cooling from 200°C

Probe in Equalizing Block



### Heating



Probe Direct In Oil

## Uniformity

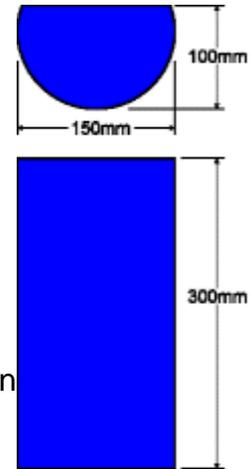
### Performance Detail: Vertical Temperature Gradient for 50°C to 250°C

#### Test Method

Two metal sheathed 100 Ohm thermometers are immersed 245mm, and then one is withdrawn in 10mm steps to provide a thermal survey over a depth of 150mm.

The probes are Isotech Model Type 935-14-61 and were immersed directly into the oil at temperatures of 50, 125 and 200°C.

This includes the measurement error, the immersion or stem conduction error will increase as the thermometer is withdrawn



Temperature Maximum Variation over 150mm

50°C	0.002°C
125°C	0.002°C
200°C	0.005°C

### Performance Detail: Horizontal Temperature Gradient for 50°C to 250°C

#### Test Method

The two 935-14-61 thermometers are supported by the standard probe support, and interchanged between the clamping positions of the probe support. The variation in temperature being recorded. The probes are immersed directly into the oil.

Temperature Maximum Variation (Probes Separated 60mm)

50°C	0.001°C
125°C	0.001°C
200°C	0.002°C

## Conditions of Test

The graphs are from tests carried out under the following conditions, **Model:** Isotech Hydra 798, (March 2005)

### Measuring Equipment:

Isotech TTI 2 Thermometer, resolution 0.01mK (Statistics Mode)

Isotech TTI 7 Thermometer, resolution 1mK

Data recorded with CalNotePad Software, sampling rate 10 seconds

Thermometers Used: Isotech Model 909/25 Ohm Standard Platinum Resistance Thermometers, SPRT.

Isotech Model 935-14-61 Pt100 Metal Sheathed Thermometer.

### Environmental:

Ambient Temperature 23°C variation better than +/-2°C  
Supply Voltage 230VAC 50Hz (Stable)

Results shown are typical for the above conditions and do not constitute a formal specification.

### TTI 2

In statistics mode, the TTI-2 resolves and averages up to 50 readings of 2 channels simultaneously and present the mean values (Temperature, Resistance or Ratio) to  $\pm 0.00001^\circ\text{C}$  resolution as well as giving the standard deviation of the mean value.



### TTI 7

The TTI-7 is a very high accuracy multi purpose digital thermometer for both platinum resistance thermometers and thermocouples. Laboratory users will welcome the features to eliminate Thermal EMF Errors and Self Heating Errors along with provision to store the calibration data of up to 20 PRT probes. Accuracy to  $0.01^\circ\text{C}$ , Resolution  $0.001^\circ\text{C}$



### 935-14-61

Model Number	935-14-61
Diameter (A)	4mm
Length (B)	300mm
Sensing Length	6mm
Handle (C)	Yes
Cable (D)	2m PTFE 4 wire
Temperature Range ( $^\circ\text{C}$ )	-50 $^\circ\text{C}$ to +250 $^\circ\text{C}$
Application	Fast Response
Features	Small Stem Conduction

