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Autocal 230° C Piezoelectric Thermal Chamber (PTC)

User's Guide

12 March 2021

NOTE: The Autocal 230° C Task PTC uses a Doppler-detecting fiber bundle that terminates in an extended rigid "displacement detection probe". This document may refer to the "displacement detection probe", "detection probe", "displacement probe" or "probe" interchangeably.

The Autocal 230° C Piezoelectric Thermal Chamber (PTC) extends the capabilities of the HVDM II heated piezoelectric high-voltage displacement test chamber. It represents the fourth generation in a progression of test fixtures manufactured by Radiant Technologies, Inc. and compatible with the Precision tester High-Voltage Interface (HVI) and a High-Voltage Amplifier (HVA). The 10 kV Trek 609b HVA is the most common instrument and each of the test fixtures is capable of handling voltages up to ± 10 kV. Each of the test fixtures continues to be available from Radiant Technologies. In order of generation and complexity the test fixtures are:

- **High-Voltage Test Fixture (HVTF):** This test fixture provides a Teflon holder for bulk high-voltage samples of varying electrode areas (cm^2) and thicknesses (μm). It provides for high-voltage connection to the HVI H.V. DRIVE port, with the DRIVE voltage applied to one sample electrode. A test fixture electrical connection is made to the opposite sample electrode and returned to the HVI H.V. RETURN port. This provides the sample's charge (μC) response to the DRIVE voltage. The RETURN signal is normally held at 0.0 Volts by the HVI and Precision tester circuitry. Should the sample short the high-voltage DRIVE signal to the RETURN path, the High-Voltage Interface (HVI) serves to provide instant protection to the Precision test equipment and to human operators. This test fixture does not offer piezoelectric displacement detection.
- **High-Voltage Displacement Meter (HVDM):** This test fixture extends the capabilities of the HVTF by offering a stability arm attached to a micropositioner. The arm has a hole with sleeve inserts that can accommodate the probe of a Doppler displacement meter such as the MTI 2100 or Philtec meter. The probe detects changes in the position of the top electrode of the sample, thereby reporting sample displacement. The detected displacement (normally μm) is converted to a scaled voltage by the detection instrument and passed to the Precision tester SENSOR 1 port. Vision software then converts the detected voltage back to displacement for evaluation and archiving.
- **Heated High-Voltage Displacement Meter (HVDM II):** This test fixture extends the family further by adding the capability of heating the sample to a maximum of 230° C. Heating can be performed automatically, and adjusted in a Branch Loop, using the Vision Set Temperature Task, found in TASK LIBRARY->Hardware->External Instruments. Note that this instrument may be referred to as the HB-PTB.

Set Temperature

Set Temp. Task Name (60 Chars Max.)
Demo Temperature Control of HVDM II to 80

OK No Execute Cancel

Thermal Controller Type

- Linkam TMS94/TMS95
- Instec STC200
- Eurotherm
- Delta 9015
- Blue-M
- REX-F400/700/900
- ESPEC
- Place Holder
- User-Defined
- MMR K20
- Quantum 6000
- Lakeshore 340
- Oxford ITC503
- Omega CNi16
- Lakeshore 330
- Lakeshore 335 (Serial)
- Lakeshore 331
- Lakeshore 336
- Lindberg/Blue M UP150
- Lakeshore 335 (GPIB)
- HB-PTB (HVDM II)**
- Linkam T96
- Instec mK2000

Do Not Monitor Temperature Progress

Set Temperature

Temperature (°C)
80 [Set Adjust Temp](#)

Set Ramp Rate

Ramp Rate (°C/min)
10 [Set Adjust Ramp](#)

Adjust Temp. in a Loop

Adjust Ramp Rate in a Loop

Use Stability Delay

Stability Delay (s)
100

Tolerance °C
0.50 0.0 to 2.0 °C - ±0.1 °C Precision
0.0 °C is not recommended

Comments (511 Characters Max.)

Respond to Nesting Branch Reset

Beep On Execute
(Configure in Tools->Options)

[Click For Task Instructions](#)

Set Temp. Version: 5.29.0 - Radiant Technologies, Inc., 2002 - 1/18/21

Figure 1 - Set Temperature Task with HVDM II Selected.

- **Autocal 230° C Piezoelectric Thermal Chamber (PTC):** This is the latest extension to the high-voltage test fixture family. The HVDM II required manual calibration through a combination of probe insertion and micropositioner adjustment. With practice the calibration becomes simple, but tedious. Normally, the calibration must be repeated each time the temperature is changed. The PTC test fixture automates calibration by removing the micropositioner and adding a linear motor to the detector probe fixture. Calibration is



performed by first raising the detector probe to its maximum upper position and then lowering until a maximum voltage output is detected. When the maximum output is detected it is reset to 5.0 Volts and then the probe is further lowered until 2.5 Volts is detected. This places the probe in the center of the linear portion of the displacement curve. This is known as a "Near Side" calibration and provides higher precision for smaller displacements. A "Far Side" calibration is also available for larger displacement. This is done by raising the probe from 5.0 Volts to 2.5 Volts.

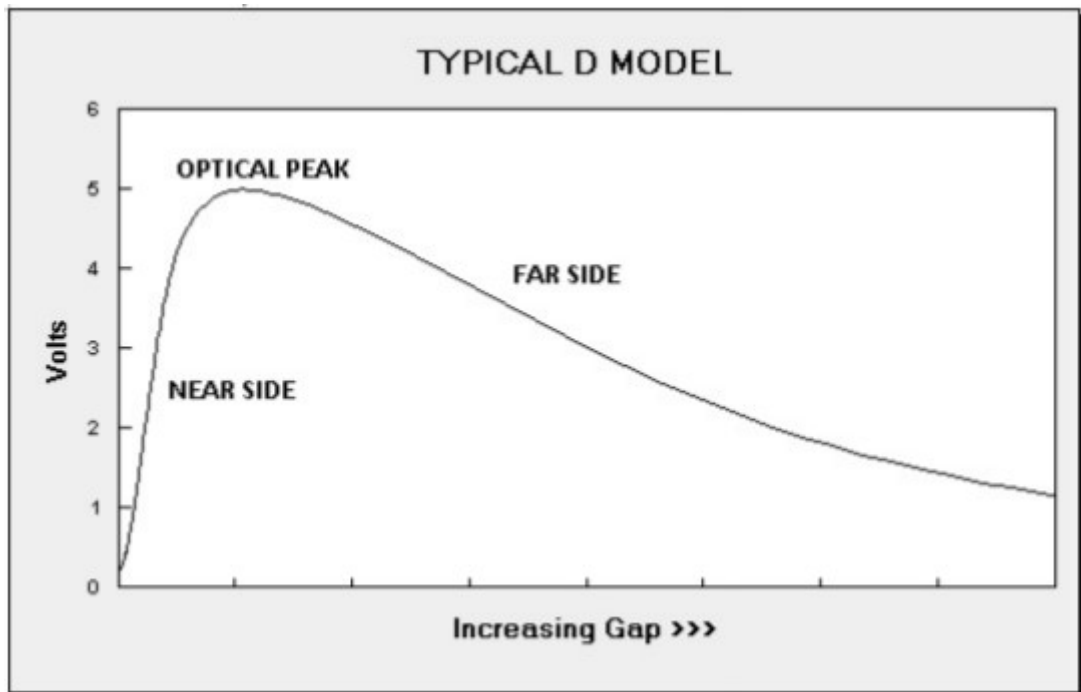


Figure 2 - Typical Philtec Response Curve.

The Autocal 230° C test chamber is operated entirely from the Vision Autocal 230° C Task. This Task can be used to:

- Step the displacement probe up by a programmed number of steps. Step size is 0.002 mm/step.
- Step the displacement probe down by a programmed number of steps.
- Retract the probe to the maximum elevated position.
- Extend the probe to the maximum lowered position.
- Find the position of maximum sample reflection.
- Fully calibrate the probe position making it ready for a displacement measurement. Either a "Near-Side" or "Far-Side" calibration may be performed.
- Set the temperature. With this option, the user may have the displacement probe retract before the temperature is set and/or calibrate the probe after the temperature is set. Both of these options are recommended. Temperature control is identical to the Set Temperature Task.
- Read the current temperature (°C). Temperature may be read repeatedly for a



specified number of counts, repeatedly on manual request by the user, repeatedly at a specified interval (ms) until the user stops the measurement, repeatedly at a specified interval (ms) for a specified sample duration (s) or repeatedly at a specified interval (ms) until the temperature is within \pm Tolerance ($^{\circ}\text{C}$) of a specified temperature ($^{\circ}\text{C}$).

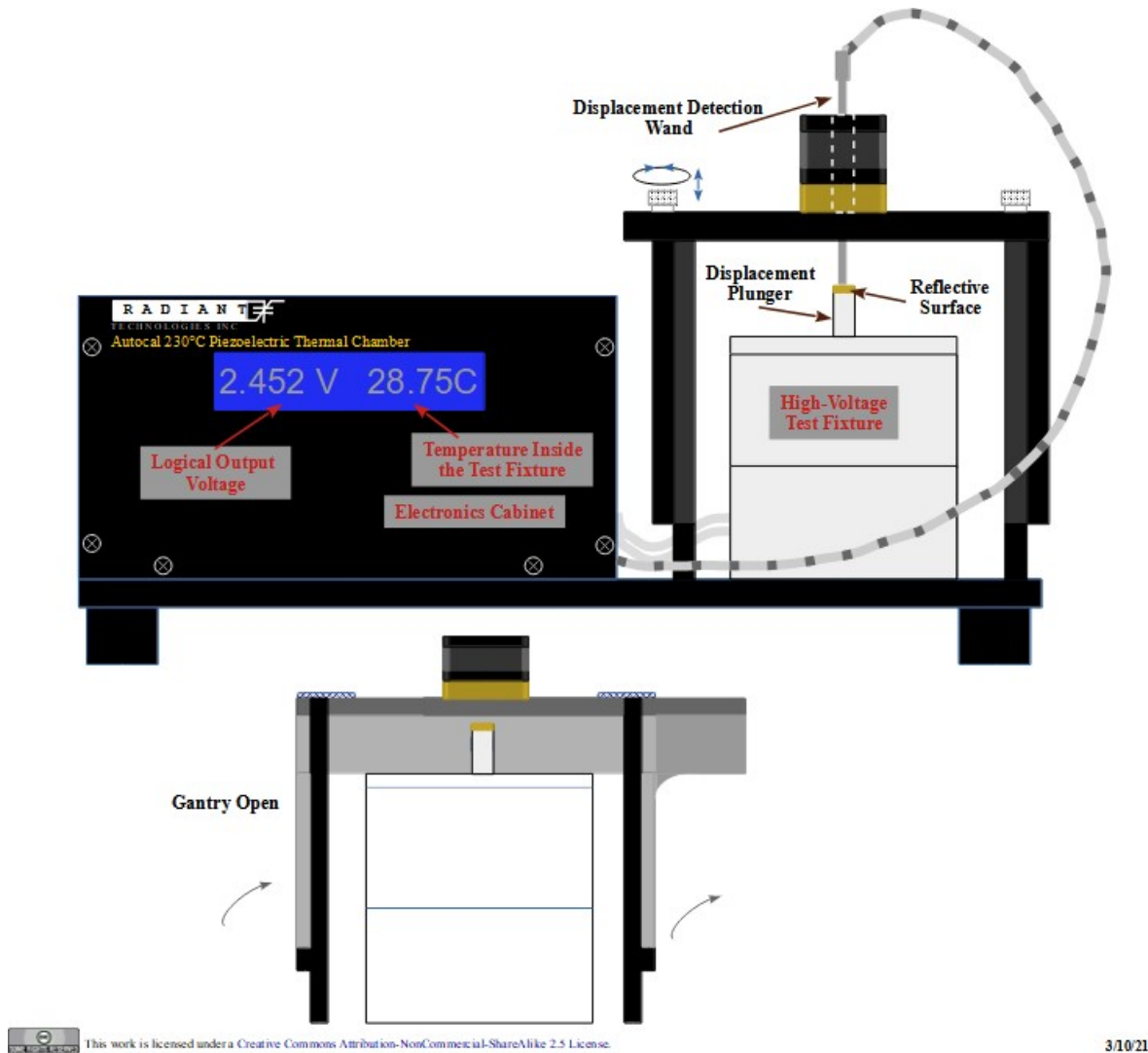
- Turn off the heater and stop temperature control.
- Initiate guided displacement probe insertion.
- Initiate automatic motor exercising when the motor is not operating smoothly.

The Autocal 230° C Task is unique in that the positing functions - the first five functions listed above - can be done from within the QuikLook configuration dialog without closing the dialog. In a single instance of the Task's QuikLook configuration, any combination of those actions may be repeatedly executed. Please see the Autocal 230° C Task Instructions for complete Task details.

The Autocal 230° C Piezoelectric Test Chamber (PTC) Instrument

Figures 3 and **4** show the Autocal 230° C PTC front and rear panels. Rear-panel connections are specified.



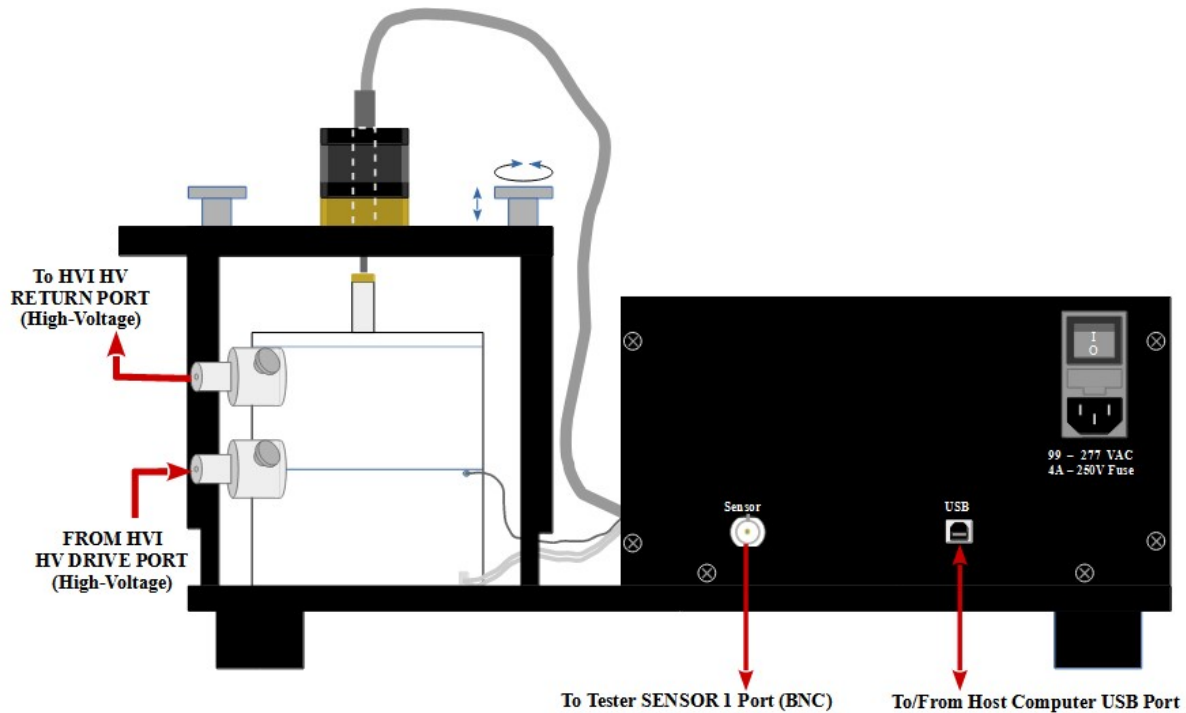


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3/10/21

Figure 3 - Autocal 230° C PTC Front Panel.





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Figure 4 - Autocal 230° C PTC Rear Panel with Connections.

The LCD display of **Figure 3** normally shows the voltage to the left and the temperature ($^{\circ}\text{C}$) in the test fixture to the right. This LCD may also be temporarily used to display the action in progress or error conditions. The voltage displayed at the LCD will be approximately 2.5 V after calibration. When the calibration is finished a user-programmed offset is applied to set the zero-displacement reference voltage that is output by the Sensor port at the rear panel as in **Figure 3**. Normally, the offset is set so that the Sensor port outputs 0.0 Volts, but the user may set any voltage in the ± 5.0 -Volt range at the *Output Voltage Offset* control, making that voltage the zero-displacement reference. This offset would be set to a value other than 0.0 Volts if the displacement is expected to be asymmetric with respect to the zero-displacement position. Regardless of the *Output Voltage Offset* value, the LCD will display a value near 2.5 V at zero displacement. **Figure 5** shows the voltage detection locations. **Figure 6** shows an example condition that calls for a non-zero (negative) *Output Voltage Offset*.

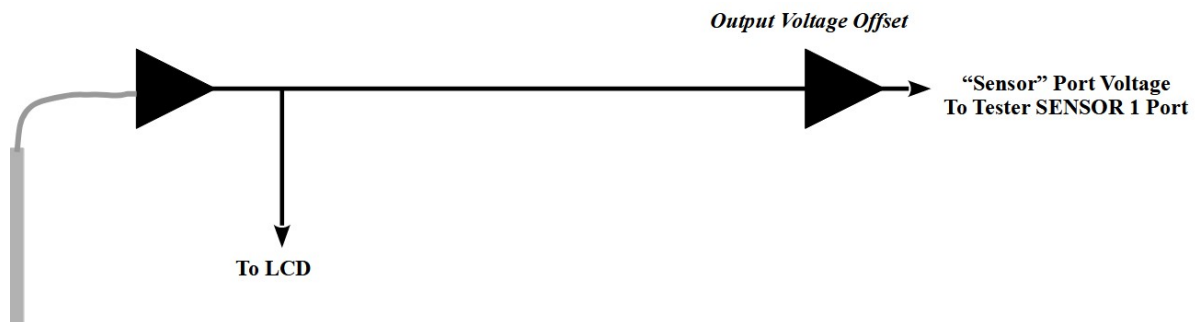


Figure 5 - Voltage Tap-Off Points.

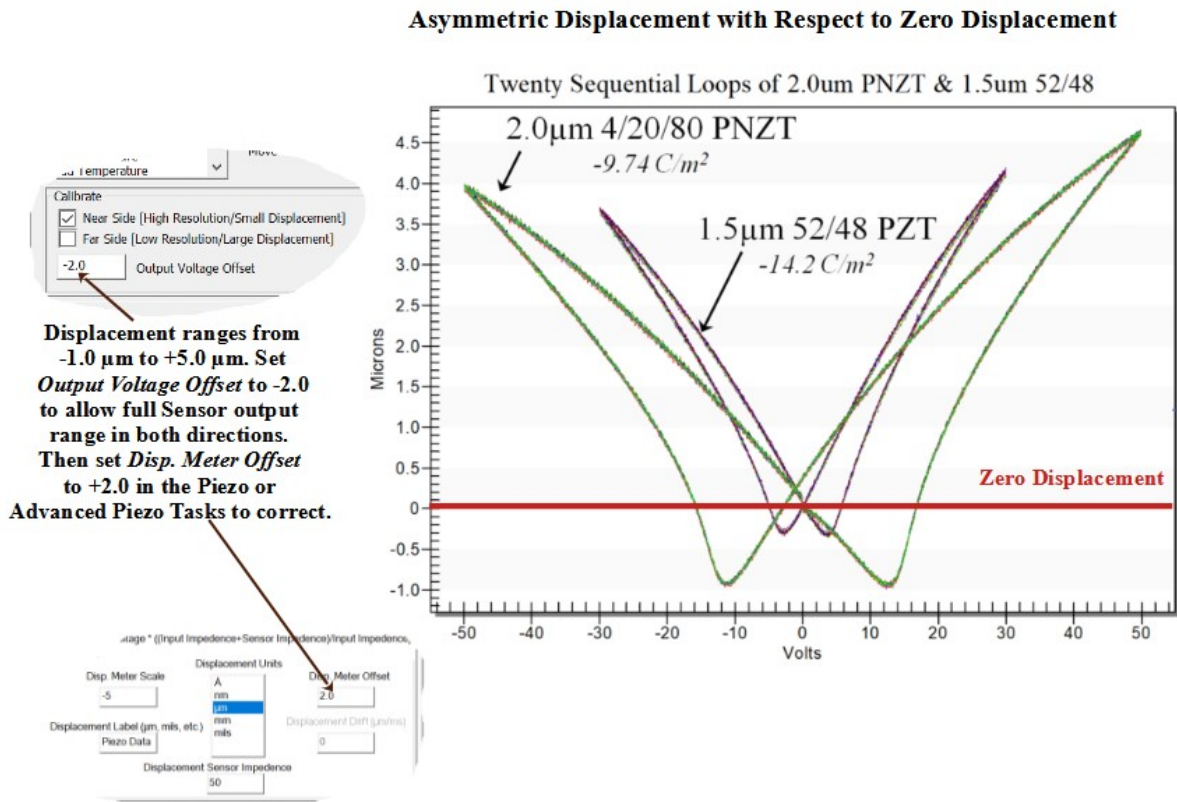


Figure 6 - Asymmetric Displacement with Respect to Zero Displacement.

While the Autocal 230° C Task is used to control the displacement probe position, along with the sample temperature (° C), displacement is actually detected by the Vision Piezo or Advanced Piezo Task. Displacement is not taken logically from the Autocal 230° C PTC, but is captured by the Piezo/Advanced Piezo Task at the Precision tester rear-panel SENSOR 1 port. In the example of **Figure 6**, the PTC Sensor port voltage is set to -2.0 V at zero displacement. The Piezo/Advanced Piezo Task has a Disp. Meter Offset value of 2.0 set to convert the detected voltage back to displacement (μ m).

Figure 7 shows the external connections to the heated test fixture and a cutaway view of the internal test fixture.



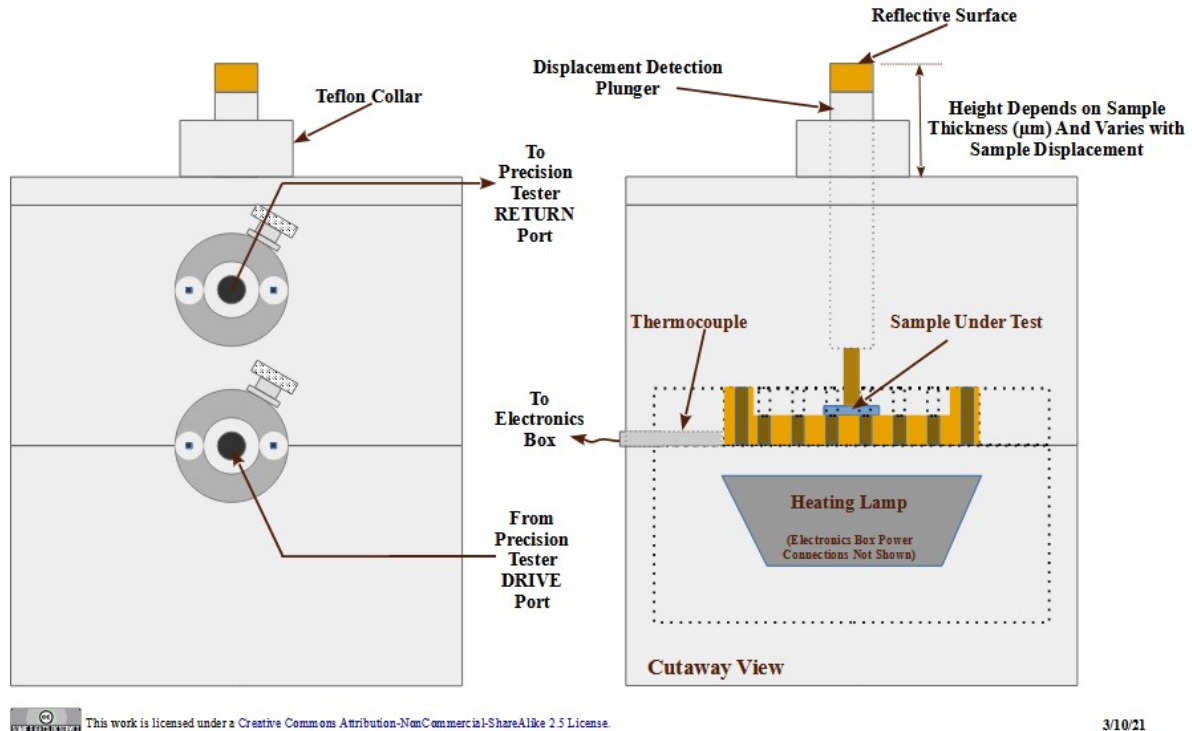


Figure 7 - Heated Test Fixture.

Instrument Installation

Unlike many Radiant Technologies, Inc. Precision Tester accessories, the Autocal 230° C is a stand-alone instrument that is independent of the Precision tester. The instrument does not connect to the Precision tester through an I²C cable. Instead it connects directly to the Vision host computer through a separate USB port from the tester.

With the Autocal 230° C instrument connected to a Windows 8, 8.1 or 10 host and powered, the instrument will self-install with no additional action by the user. For Windows 7 installation, the user must manually install the instrument to Windows by selecting the instrument in the Device Manager, right-clicking and selecting "Update driver". (The instrument will probably be listed as "Unknown Device".) Select manual installation and browse to C:\RT_USB. Click Next and allow the installation to proceed.



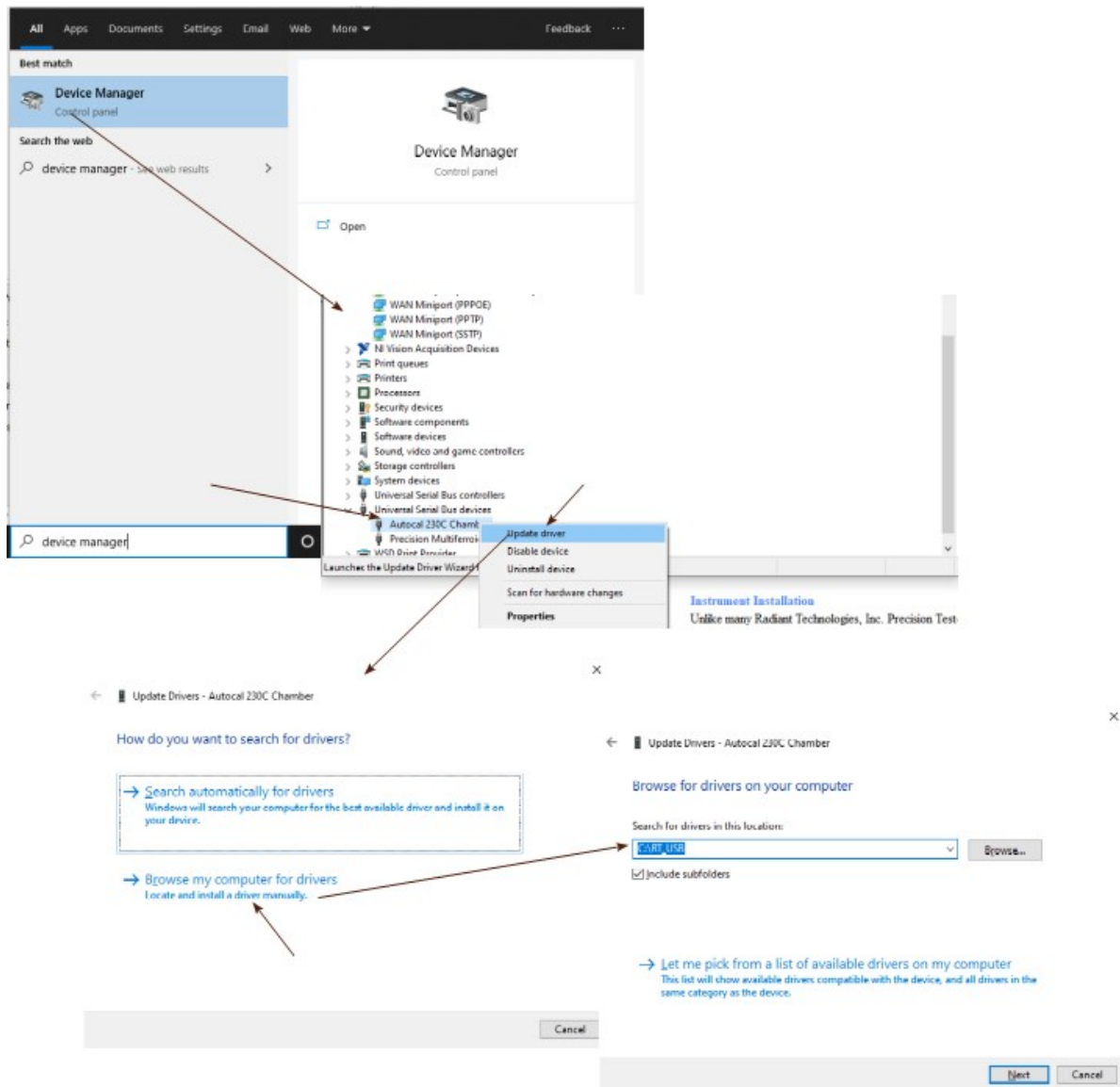


Figure 8 - Manually Install the Autocal 230° C Instrument to Windows 7.

Instrument Preparation

Operation of the PTC is made fully automatic by the Autocal 230° C Task. However, before working with the instrument some physical preparation should be performed.

Insert the Displacement Probe

1. Open the PTC Gantry.
2. Remove the Test Figure Lid: The upper half of the Teflon test fixture can be removed from the lower half by lifting straight up.
3. Retract the Probe Motor: From the QuikLook->External Instruments menu select the



Autocal 230° C Task. In the dialog that opens select "Retract Probe" in the *Choose Action* list, then click *Do Selected Action*. Click *Close Window No Operation* to exit the Task.

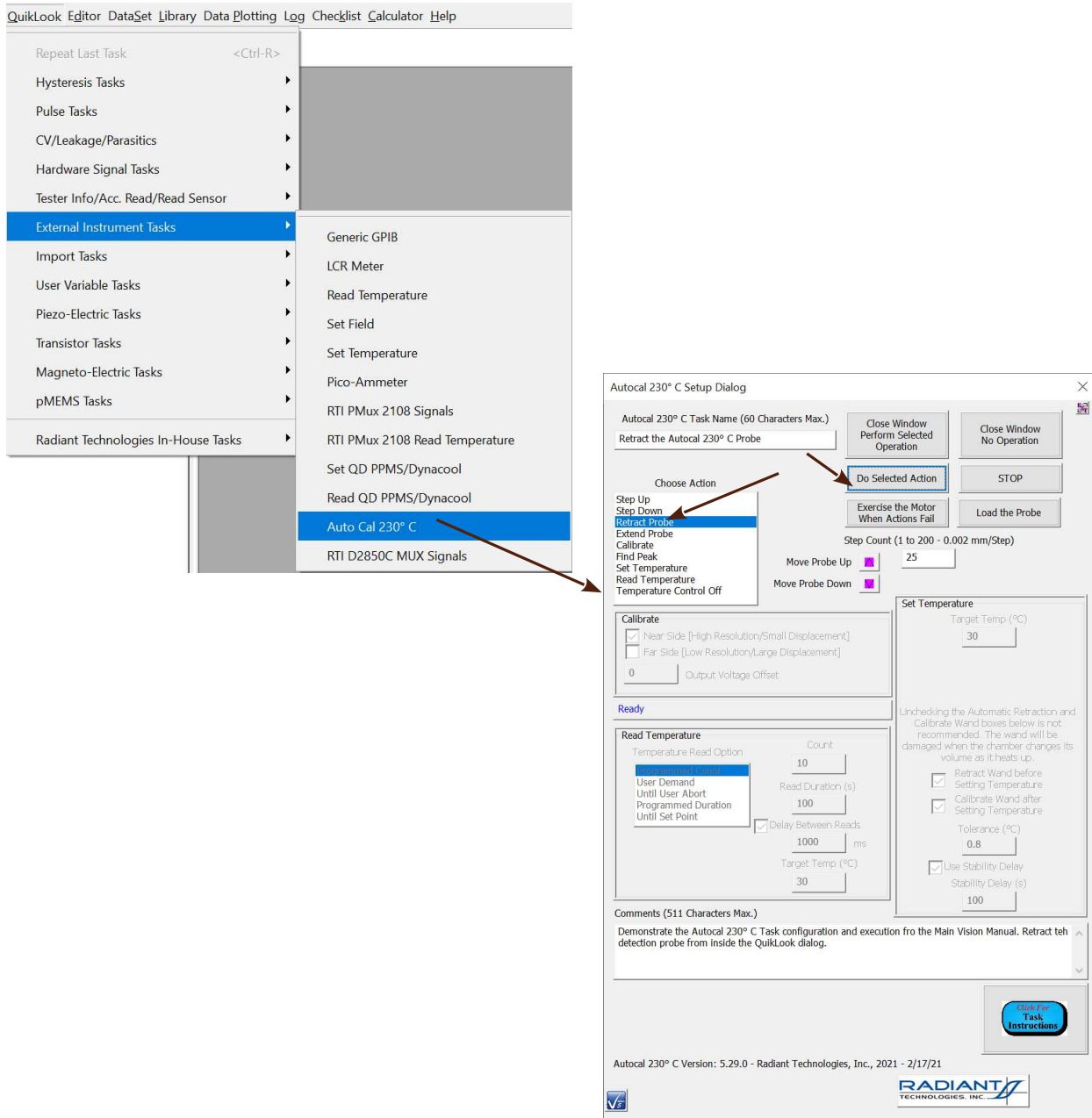


Figure 9 - Retract the Probe in QuikLook.

Note that this action cannot be performed unless the PTC is properly connected to the Vision host computer. If the connection is made and/or the instrument powered after Vision is started, you must perform a hardware refresh by going to **Tools->Hardware Refresh** or pressing <Alt-W>. This allows Vision to detect all hardware accessible to the program.



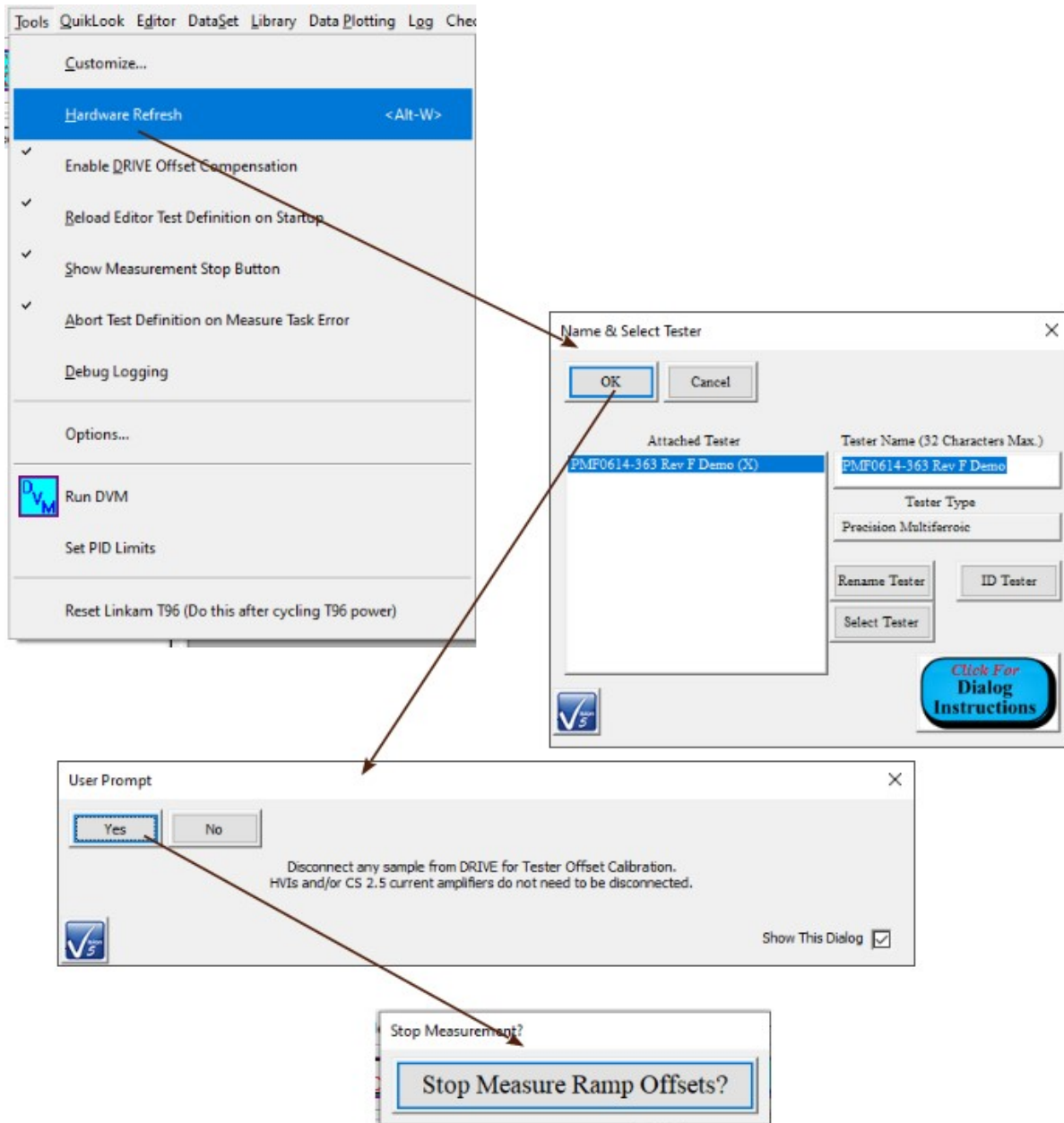


Figure 10 - Refresh the Attached Hardware in Vision.

4. Loosen the upper set screw.
5. Extend the probe motor.
6. Loosen the lower set screw.
7. Insert the probe all the way.
8. Tighten the lower set screw.
9. Retract the probe.
10. Tighten the upper set screw.
11. Replace the test fixture top.



12. Close the gantry.

A guided course through this sequence can be accessed by clicking Load the Probe. This opens a subdialog that will guide the process as show in detail under Execution, Archive Regraphing and Exporting.

Insert the Sample

Normally this action would be combined with the probe insertion, above.

1. Retract the Probe Motor.
2. Open the PTC Gantry.
3. Remove the Test Figure Lid: The upper half of the Teflon test fixture can be removed from the lower half by lifting straight up.
4. Center the Sample: The sample must be centered in the lower cup portion of the text fixture. This places the bottom sample electrode in contact with the bottom (high-voltage DRIVE) electrode of the test fixture. It allows the top (RETURN) electrode of the test fixture to contact the top electrode of the sample when the test fixture top is replaced.
5. Replace the Test Fixture Top: Set the Teflon top of the test fixture down onto the bottom half of the chamber. Be sure that the top settles fully down with the arched portion over the RETURN signal connector. Be careful not to allow the sample to move off the bottom electrode as the top is replaced.
6. Close the PTC Gantry:

Make Electrical Connections

1. Connect the Autocal 230° C voltage output to the Precision tester SENSOR 1 port on the tester rear panel.
2. Connect the Autocal230° C to a Vision host USB port.
3. Connect the HVI H.V. DRIVE port to the bottom HV connector of the high-voltage test fixture.

Note that it is important that this connection be made to the bottom and not the top test fixture connector. This connection provides voltage of up to ± 10 kV. If connected to the top connector, voltage may arc between the test fixture top electrode and the displacement detection probe, permanently damaging the probe.

4. Connect the HVI H.V. RETURN port to the top HV connector of the high-voltage test fixture.

Instrument Operation

Setting the Autocal 230° C PTC temperature and reading the current temperature value can be done by selecting the "RTI Autocal 230° C PTC" instrument in the standard Vision Set Temperature or Read Temperature Tasks.



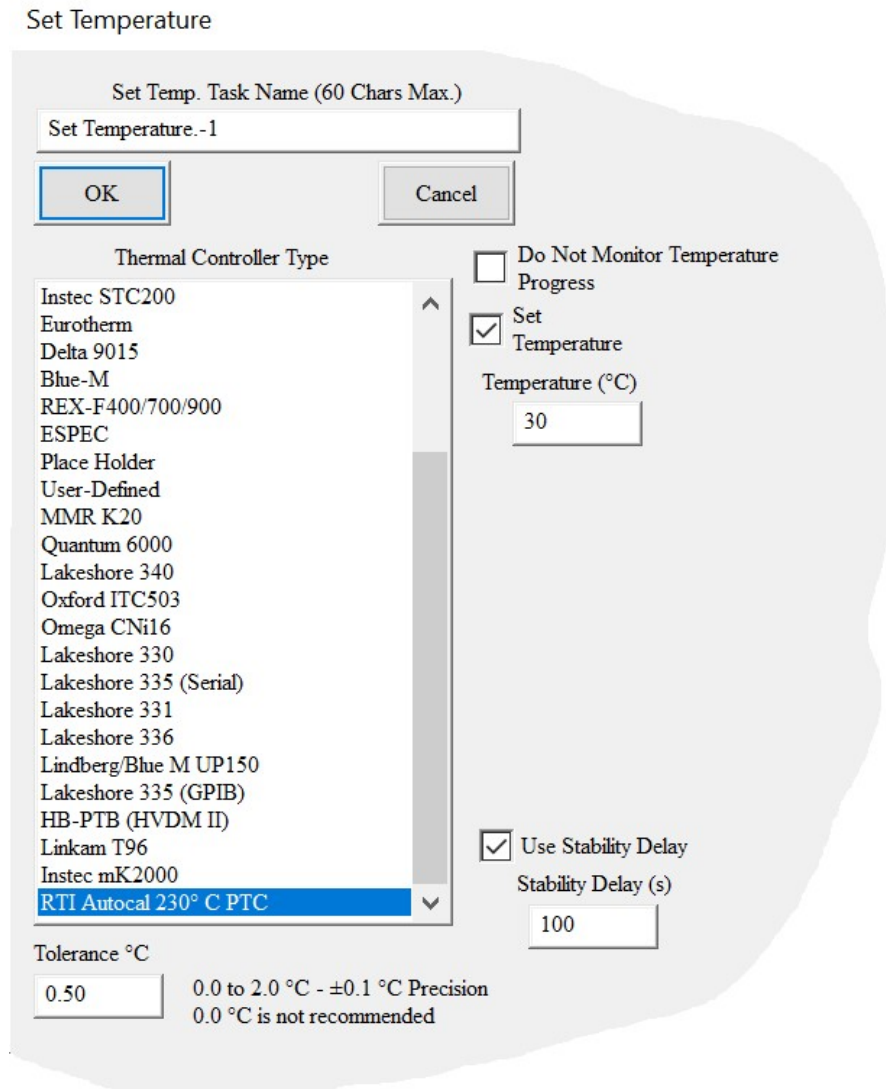


Figure 11 - Select the RTI Autocal 230° C PTC Instrument in the Set Temperature Task.

All functions of the instrument can be operated using the Autocal 230° C Task. The choice between the Read Temperature Task and the RTI Autocal 230° C Task is equivalent for reading the current temperature. Although the temperature may be set using Set Temperature, it is highly recommended that the Autocal 230° C Task be used for temperature control. The reason is that thermal expansion will necessitate recalibration after the temperature is reached. The Autocal 230° C Task can be configured to automatically retract the probe before the temperature is set and then calibrate the probe when temperature stability is reached. This allows the Task to be incorporated into a Test Definition, possibly within a Branch Loop, without requiring any human intervention in the experiment.

When operating in QuikLook, positioning actions, including:



1. Step Up x Steps
2. Step Down x Steps
3. Retract the Probe
4. Extend the Probe
5. Find Peak Reflection
6. Calibrate the Probe

can be performed repeatedly and in any combination from within the configuration dialog without the need to close the dialog for each operation.

When operating in QuikLook or when configuring to include the Task in an EDITOR Test Definition, *Load the Probe* and *Exercise the Motor* actions are available at configuration time.

For complete details on Task theory, configuration and operation please see the Autocal 230° C Task Instructions.

