CASE STUDY

Using Julabo *FP88-HP* for Temperature Calibration

Prepared by staff engineers at Julabo USA Inc.

The Objective:
Bath Temperature Uniformity that is tight enough for temperature sensor calibration to an absolute accuracy of ±0.1°C, without the use of an actual calibration bath.

Actual Calibration Baths

The Motivation:
Actual calibration baths are an expensive investment for the sole purpose of fine-tuning a temperature sensing system (say, a Pt100 RTD & digital reader). In the effort to cut cost, our customer would like to investigate Julabo's Heating and Refrigerated baths for calibration procedures that do not call for a ±0.001°C bath temperature accuracy.

The Solution:
Using Julabo Heating & Refrigerated Circulator *FP88-HP* (#9 300 688) for temperature control, and Julabo *EZTemp* *free* software for Data Acquisition, to control and monitor the temperature calibration test.

Julabo FP88-HP Heating & Refrigerated Circulator with EZTemp Software (downloadable from julabo.com)

Test Goal:
Our customer, requires a calibration bath with the following specifications:

1. Bath Temperature Stability (over 30 minutes) ≤ 0.05°C
2. Bath Temperature Uniformity (a limited area) ≤ ±0.05°C
3. Sensor Calibration to an Absolute Accuracy of ±0.1°C
4. Required Bath Temperature Range of –60°C to +60°C

Test Summary:
Tests conducted at Julabo USA, Inc. with an FP88-HP refrigerated circulator were able to meet the above stipulations but not exceed them. These initial tests were made at setpoints –60°C and +55°C respectively using a non-cryogenic, wide temperature-ranging bath liquid called Thermal HY (#8940104). The other requirements such as external control capability (via RS-232 interface), running on normal AC power outlets (230 VAC single phase, etc.), N_2 purge capability, and low acoustic noise levels could be accomplished as well. Furthermore, the recirculating head on the FP88-HP possesses an ATC (Absolute Temperature Calibration) function that allows for simple correction or "offset" of the internal sensor with respect to an external temperature standard.

Figure 1 illustrates the temperature probe positions for our initial tests.

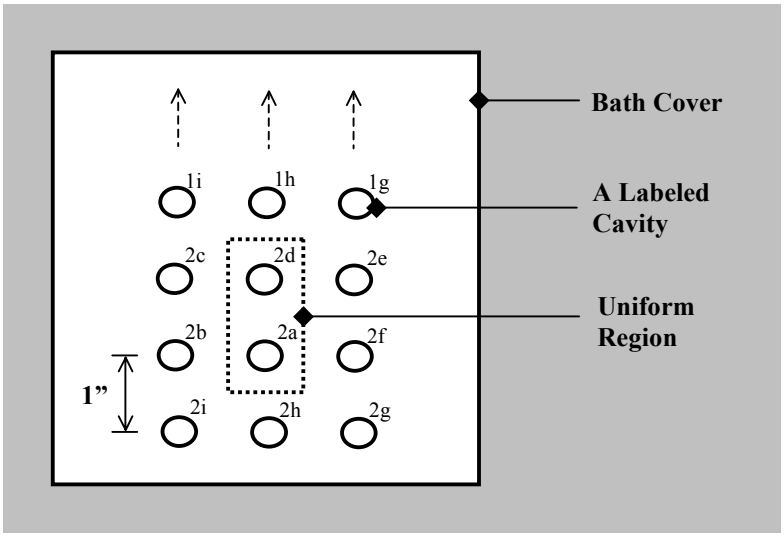

Figure 1: Temperature Probe Positions on the Bath Cover.

One RTD probe was used. A network of labeled cavities for the sensor was created on the bath cover. As seen in Figure 1, only the cavities of interest are labeled. A dotted box encloses the region of "acceptable uniformity", surrounding cavities "2a" and "2d".

Test Results:
In the first test, the bath temperature was raised from ambient (+20°C) to +55°C, whereas its counterpart went from ambient to –60°C. For the setpoint of +55°C, the best temperature stability obtained from a 30 minute interval in a 2 hour test period is shown in Figure 2 (a). For this case, stability was superior to ±0.05°C. On the other hand, an average temperature stability plot for a setpoint of –60°C, with similar testing conditions, can be seen in Figure 2(b). Bath temperature stability at deep temperatures, such as –60°C, is lower than say at +55°C. Note that the temperature data in Figure 2 was obtained from a separate internal sensor.

The temperature uniformity for the +55°C setpoint case is expected to surpass the specified ±0.05°C. Figure 3 (a) illustrates the temperature stability at position "2a" for the above setpoint. However, for the –60°C situation, this requirement is only met at positions "2a" and "2d".

Note that the temperature data in

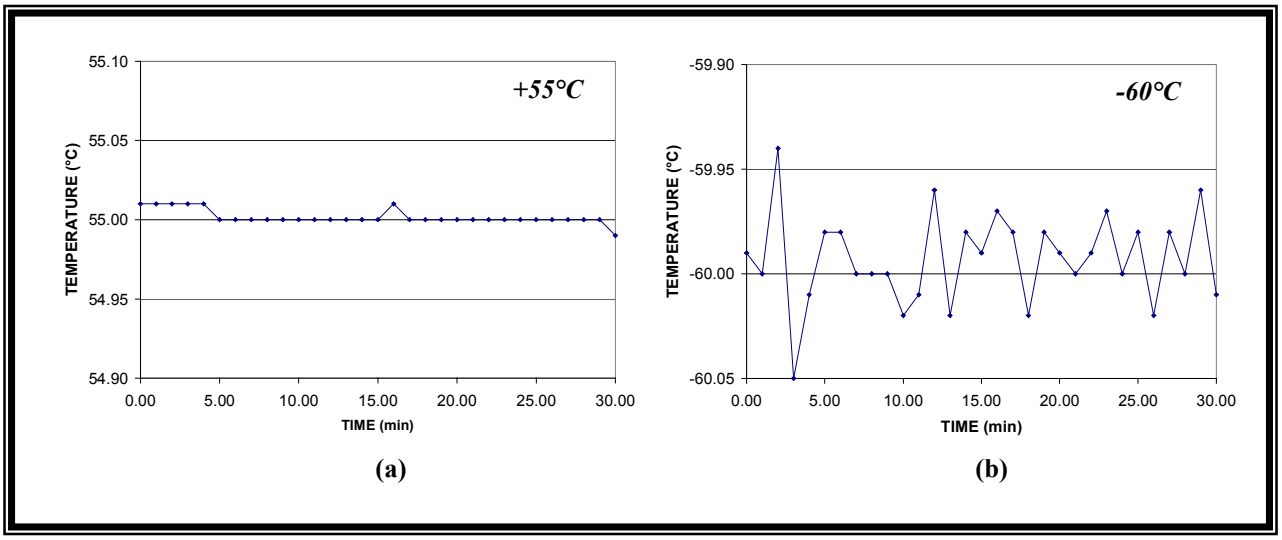

Figure 2: Temperature Stability Plots from the Internal Sensor for (a) +55°C, and (b)-60°C Setpoints.

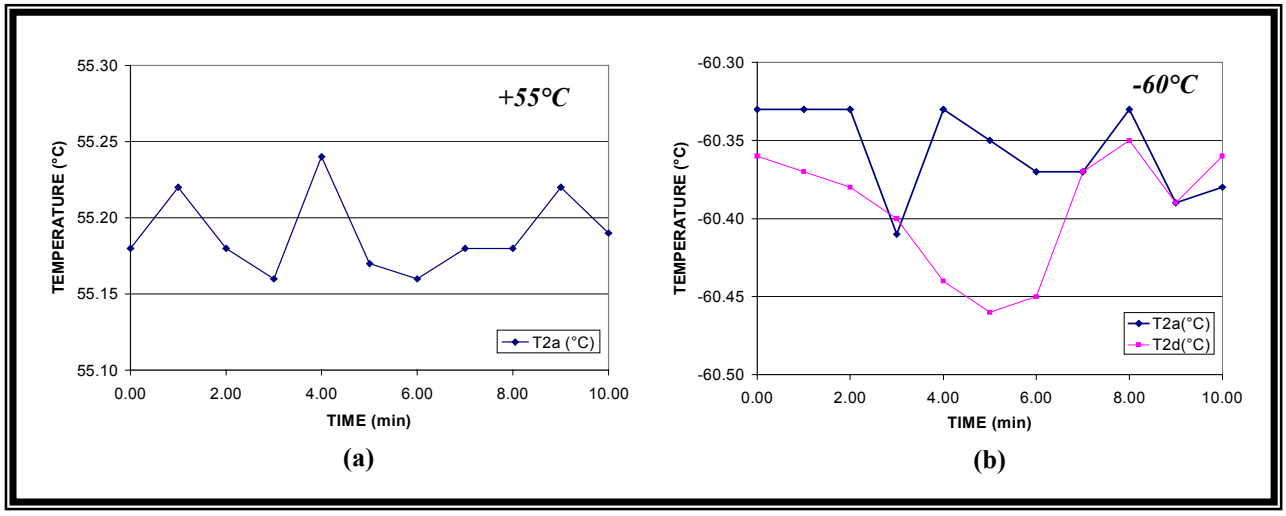

Figure 3: Temperature Stability Plots from a Single Temperature Probe for (a) +55°C Setpoint at Position "2a", and (b) -60°C Setpoint at Positions "2a" and "2d", through the Bath Cover.

Figure 3 were obtained from one probe submersed approximately 92mm from the bath tank opening. Also the testing conditions were as follows: Average Ambient Temperature=+20°C, Average Relative Humidity=50%, Average Noise Level=78dB).

Test Conclusions:
The Julabo FP88-HP Heating & Refrigerated Circulator is an inexpensive alternative to an actual calibration bath. The FP88-HP is more suited for sensor calibrations down to a tolerance of ±0.5°C when performed within the "uniform region" defined in the above test results. Seeing as the temperature stability and uniformity of our off-the-shelf FP88-HP unit tread the boundaries of the calibration needs of the US Department of Commerce, we suggest some simple modifications, pictured in Figure 4, which will ensure the attainment of your goal. This alteration involves the introduction of a solid block, like an aluminum billet with pre-drilled cavities, to hold your sensors in the bath while providing an increased temperature stability and uniformity.

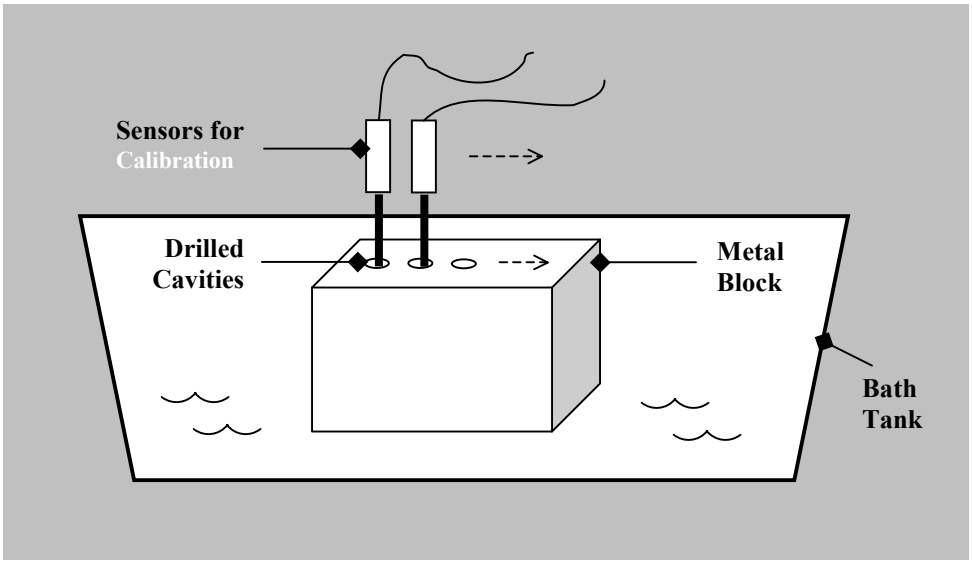

Figure 4: The Suggested Uniform Temperature Distribution Modification within the Bath Tank of Julabo's FP88-HP Circulator.