Temperature Calibration
Tips and tricks from the real world

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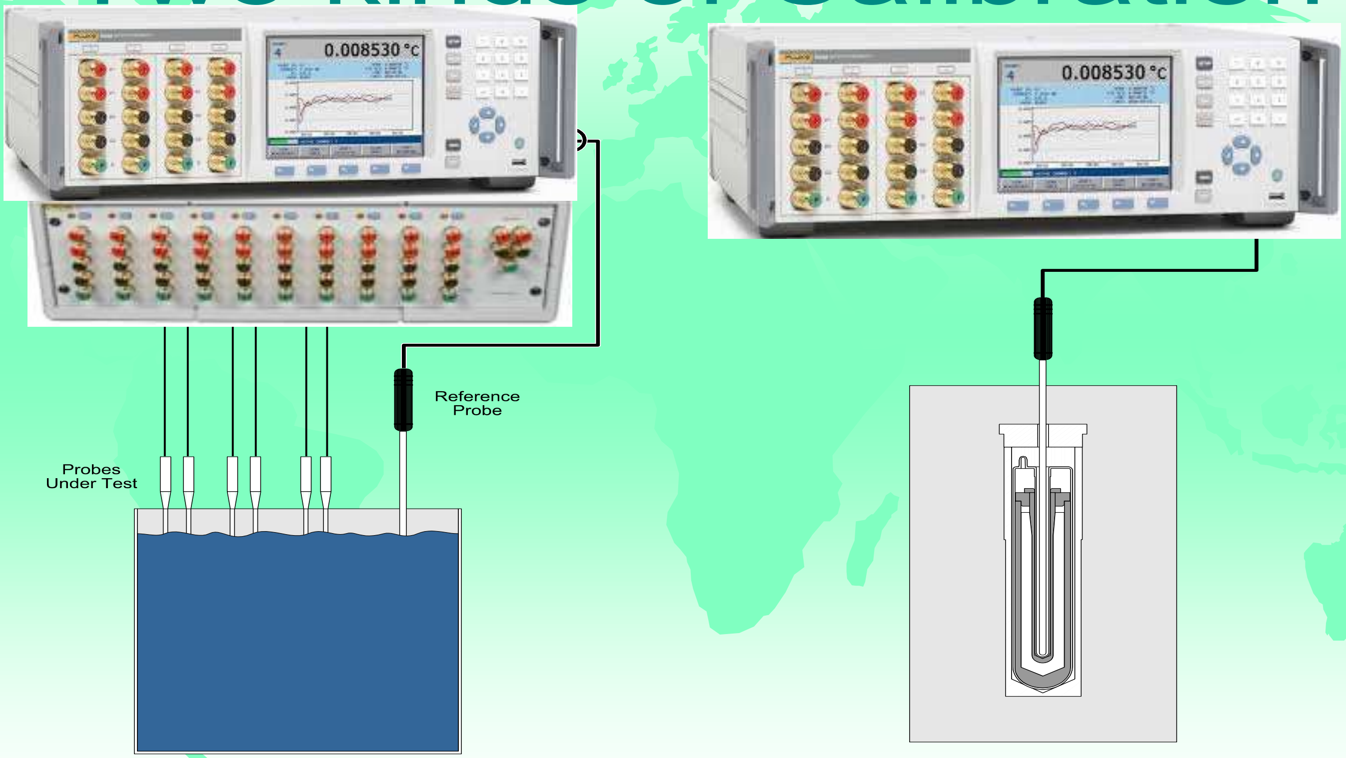
Agenda

Few tips and tricks you can use to keep things up and running:

- How to get the best calibration results
- System Calibration & sensor Calibration
- How to protect your calibration investments
- How to minimize the number of tools you take onsite
- How to do more in less time
- Automate Temperature Calibration without Software
- Questions & Answers

Fixed Point vs. Comparison Calibrations

Two kinds of Calibration



Comparison Calibration **Fixed Point Calibration**

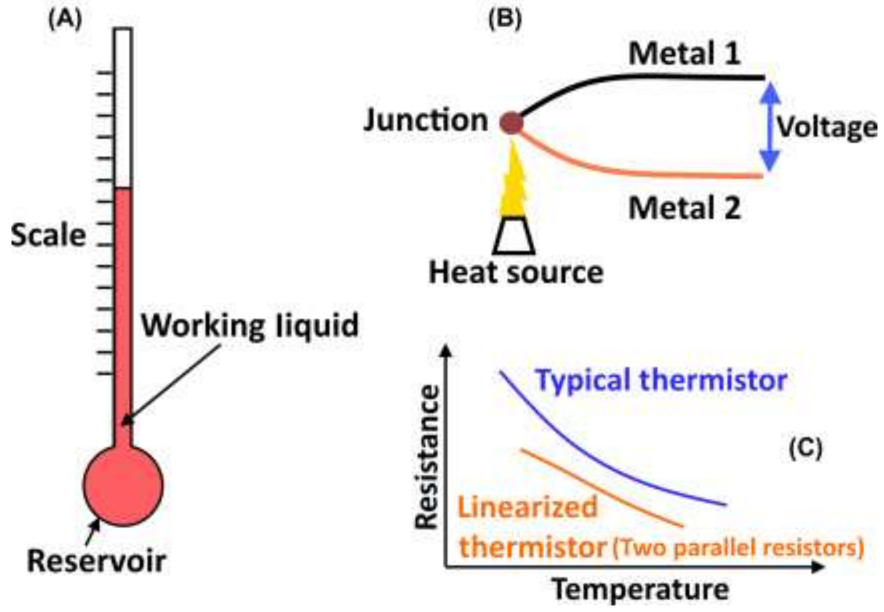
Temperature measurement devices

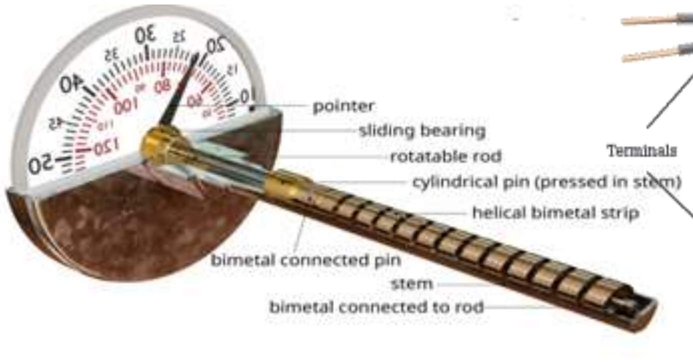
- Liquid-in-glass/Dial thermometer - Thermal expansion

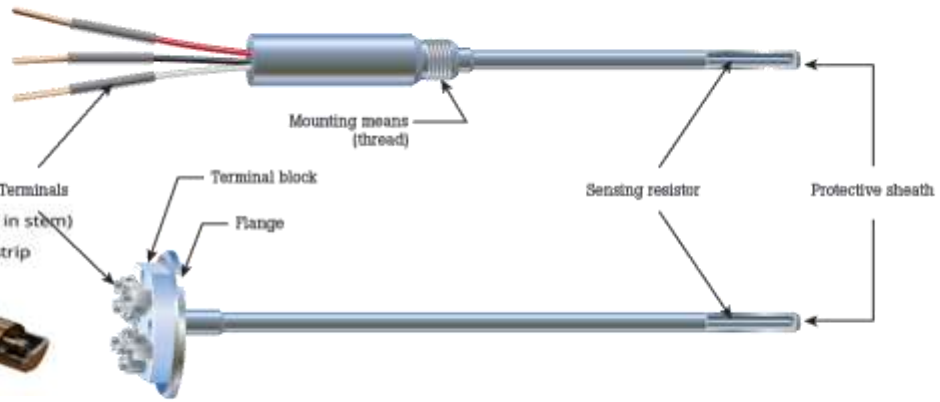
  the property measured is the length of the liquid column inside a glass tube or metal expansion

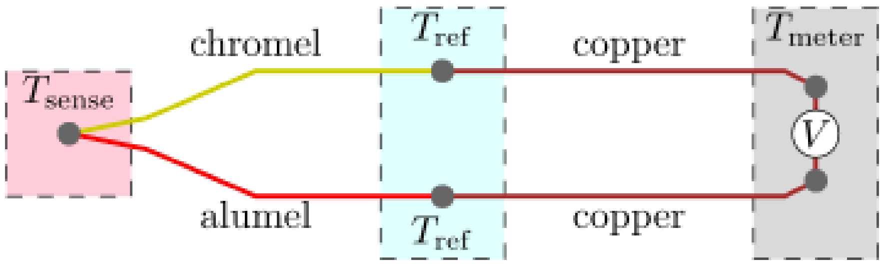
- Platinum resistance thermometer or a thermistor - the property measured is the electrical resistance of a piece of 'sensing' material

- Thermocouple - the property measured is the voltage generated along the wires making up the thermocouple

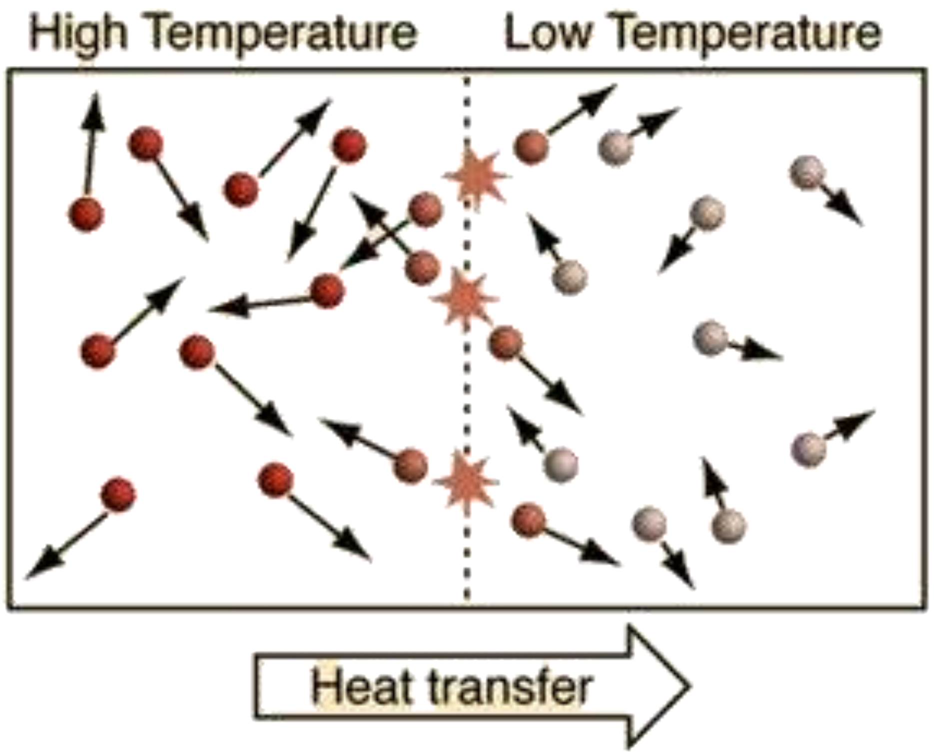








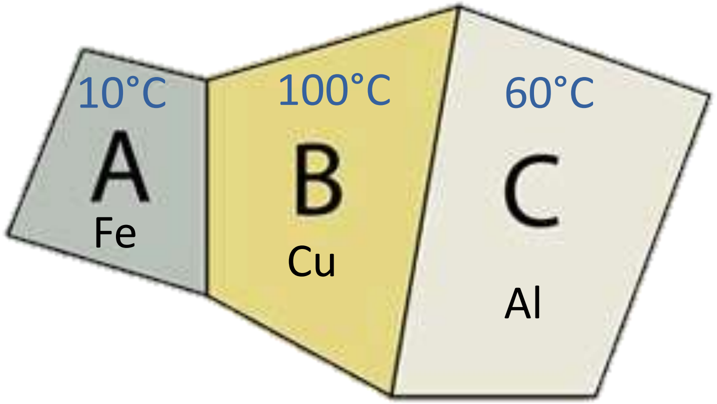
What is temperature ?

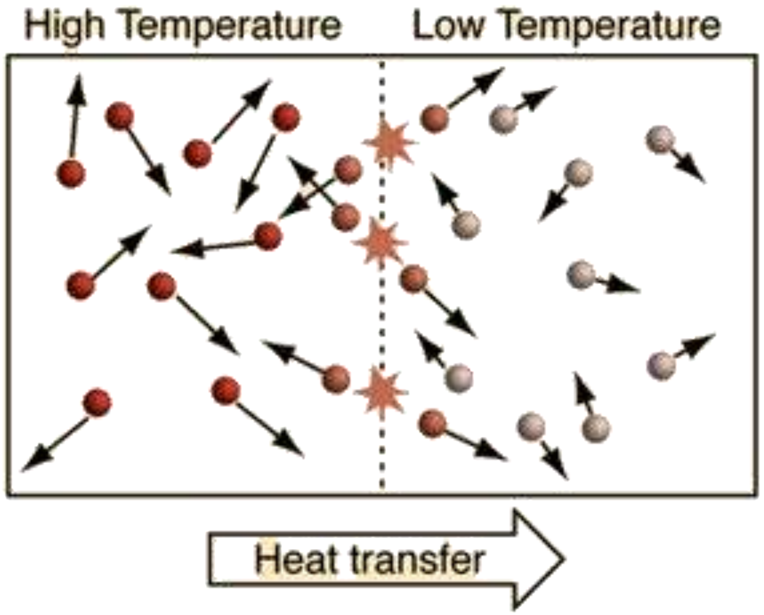


- The temperature of an object is a measure of the energy of the molecules in that object
- Industrial processes require a knowledge of temperature
- We measure temperature with sensors such as thermocouples and RTDs sometimes incorporated into transmitters
- What do we need to ensure these devices are reading correctly ?

Zeroth law of thermodynamics

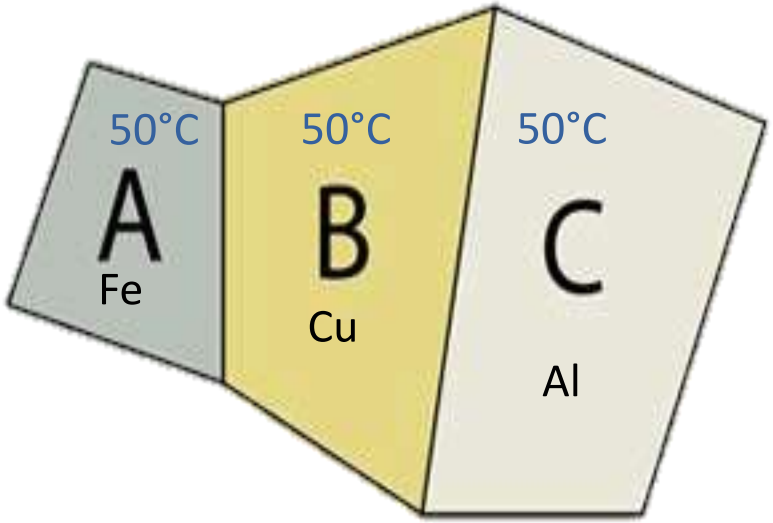
Thermodynamic equilibrium





Zeroth law of thermodynamics

Thermodynamic equilibrium



How do we measure temperature ?

Indirectly - with a thermometer

A thermometer is a device which has a measurable property which changes with temperature

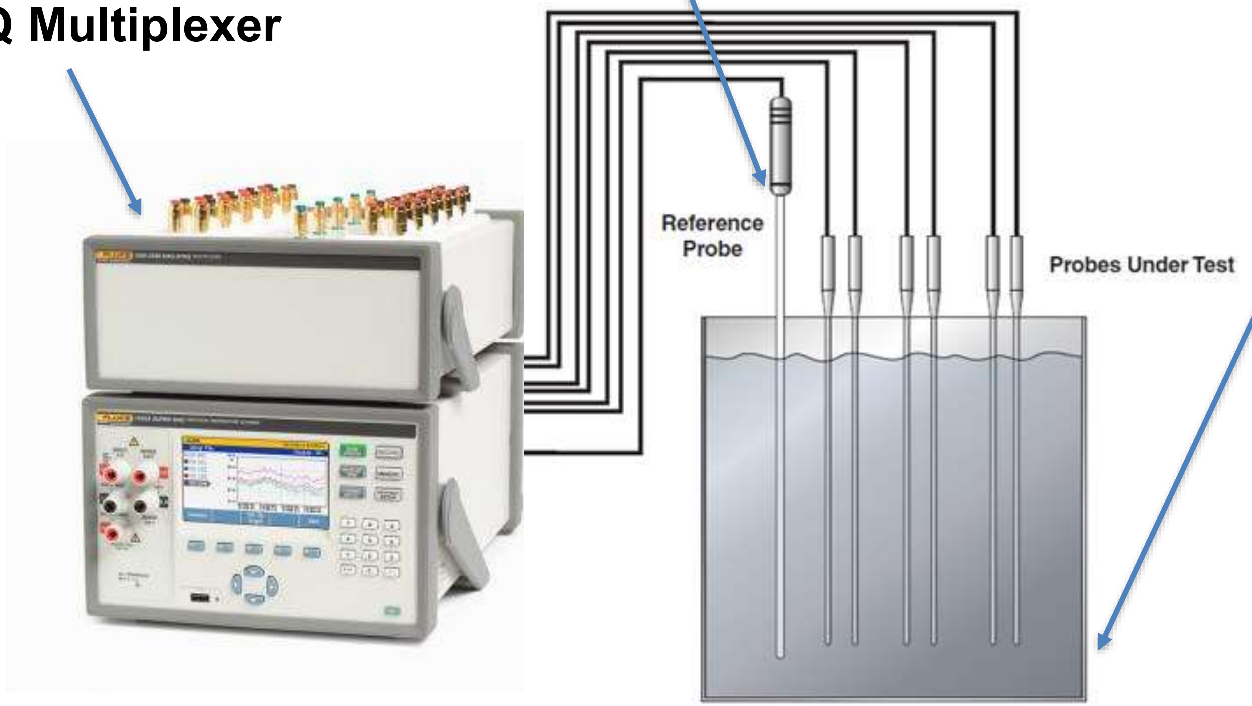
Tip #1 The truth about calibrating temperature sensors

- You cannot calibrate a temperature sensor if you wanted to, because a sensor cannot be physically adjusted
- yes you can. There are two ways to do it. You can calibrate the sensors as part of a system, or you can calibrate the sensors individually

Reference standard: PRT

Temperature source: Bath

Thermometer readout: Super-DAQ with DAQ-STAQ Multiplexer



Tip #1 The truth about calibrating temperature sensors

FLUKE ® Calibration

- **System Calibration definition**

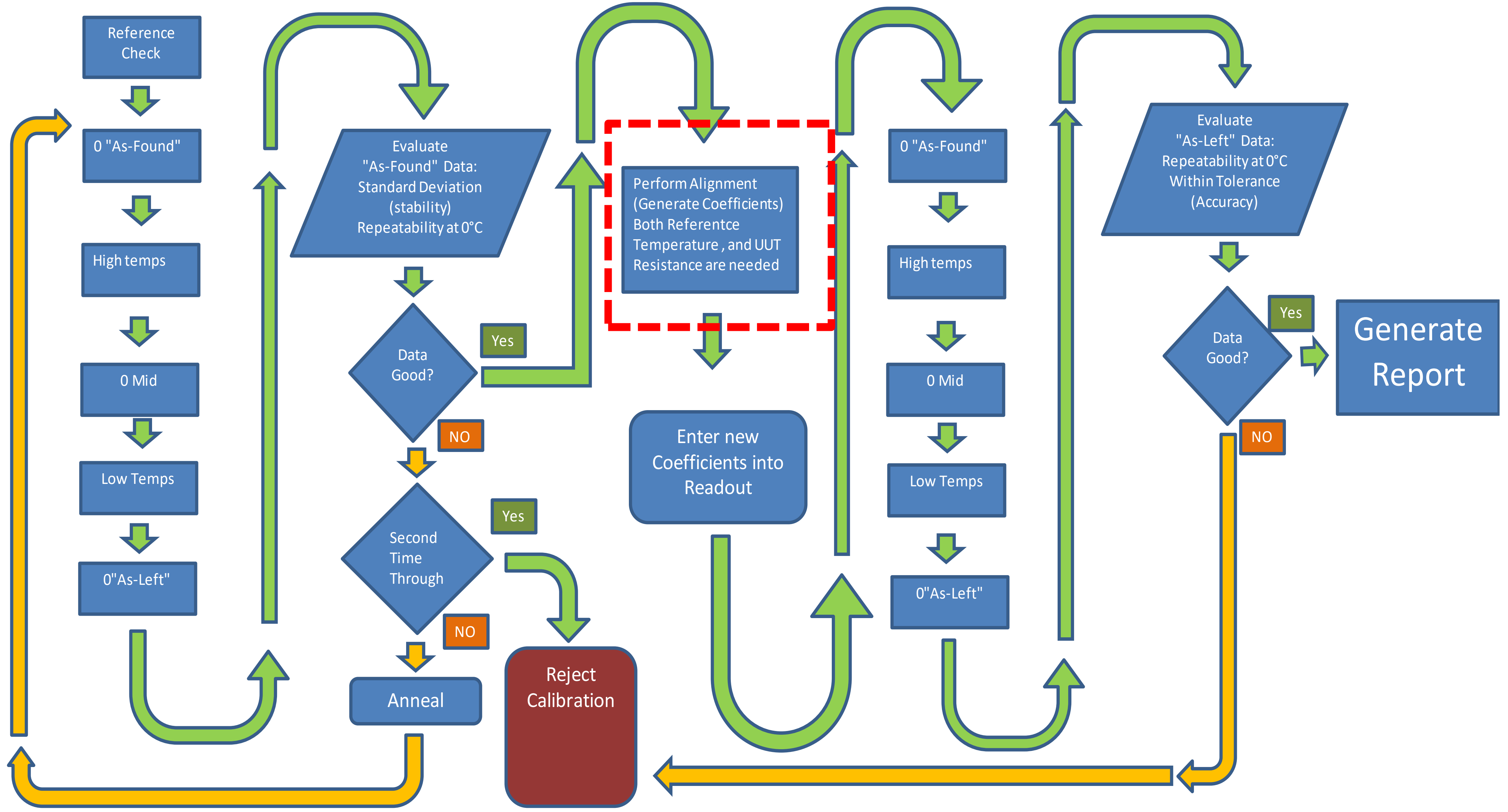
It is a calibration where:

- The readout and probe are connected as normally used
- A reference thermometer is used to verify nominal temperatures
- For an accredited calibration, the reference thermometer is also the “transfer” standard for traceability purposes
- A “Report of Calibration” summarizes the received condition (or “As-Found” state), any changes to the system, the Completed Condition (or “As-Left” state), and documentation of traceability
- The same nominal temperatures are used for both “As-Found” and “As-Left” data.

System Calibration process steps

1. Reference thermometer check
2. Record “As-Found” data
3. Evaluate “As-Found” data
4. Determine next step (anneal, align, or reject)
5. Anneal (if required)
6. Generate new coefficients (if data is good)
7. Program new coefficients into UUT readout
8. Record “As-Left” data
9. Evaluate results vs. limits
10. Build “Report of Calibration”

System calibration flow chart



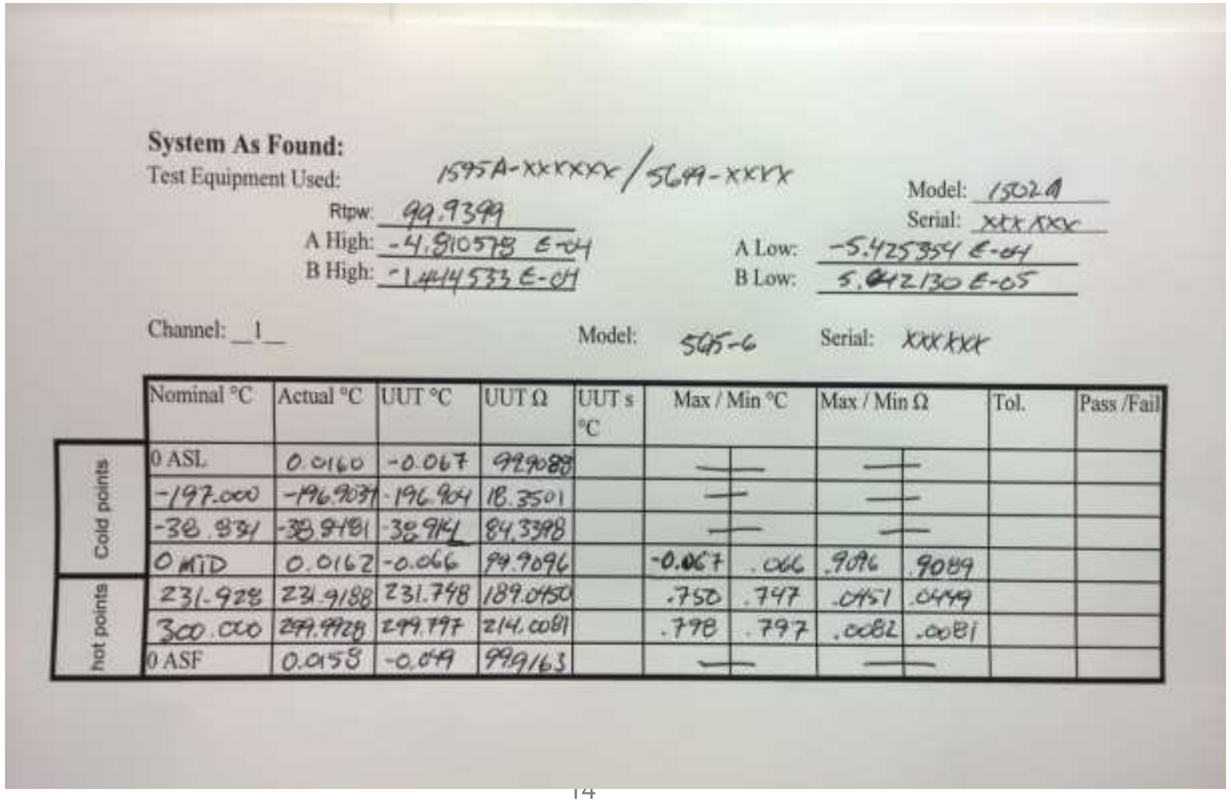
Reference thermometer check

Always check your reference, <u>before</u> you start your calibration

Data collection tips

- Start with an "As-Found" 0 ˚C point
- Measure the above 0 ˚C temperatures first
- Take a 0 ˚C "mid" point
- Then take the below 0 ˚C temperatures
- Finally, take the 0 ˚C "As-Left" point.

Taking multiple 0 ˚C points helps determine repeatability and stability of your probes



System As Found:

Test Equipment Used: 1595A-XXXXXX / 5699-XXXX

Model: 1502A
Serial: XXXXXX

Rtpw: 99.9399
A High: -4.910578 E-04
B High: -1.444533 E-04
A Low: -5.425354 E-04
B Low: 5.642130 E-05

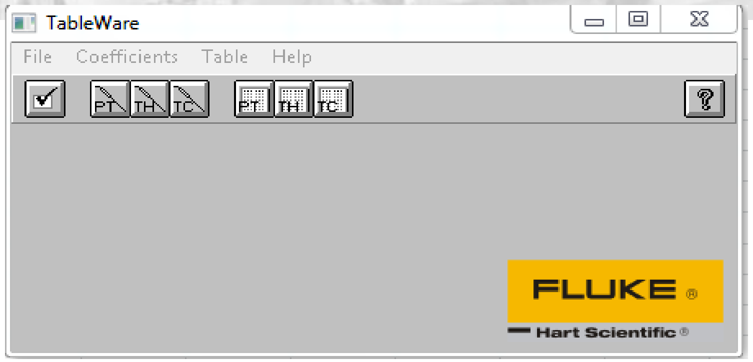
Channel: 1 Model: 5615-6 Serial: XXXXXX

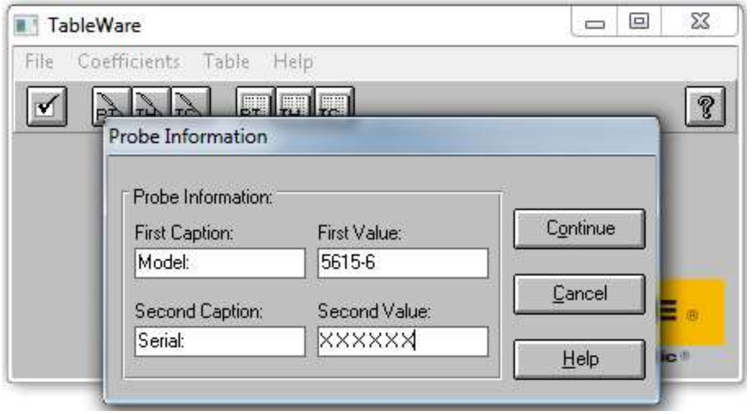
	Nominal °C	Actual °C	UUT °C	UUT Ω	UUT s °C	Max / Min °C		Max / Min Ω		Tol.	Pass /Fail
Cold points	0 ASL	0.0160	-0.067	99.9088		—	—	—	—		
	-197.000	-196.9031	-196.904	18.3501		—	—	—	—		
	-38.831	-38.8481	-38.914	84.3398		—	—	—	—		
	0 MID	0.0162	-0.066	99.9096		-0.067	.066	.9096	.9089		
hot points	231.928	231.9188	231.748	189.0450		.750	.747	.0451	.0449		
	300.000	299.9928	299.797	214.0081		.798	.797	.0082	.0081		
	0 ASF	0.0158	-0.049	99.9163		—	—	—	—		

Generate new coefficients using Tableware

So the data looks good…

- Time to perform the alignment!
    - I use Tableware, from Fluke when doing manual calculations.
    - Select the “P/T” button in Tableware.
    - Enter the Probe model & Serial information.



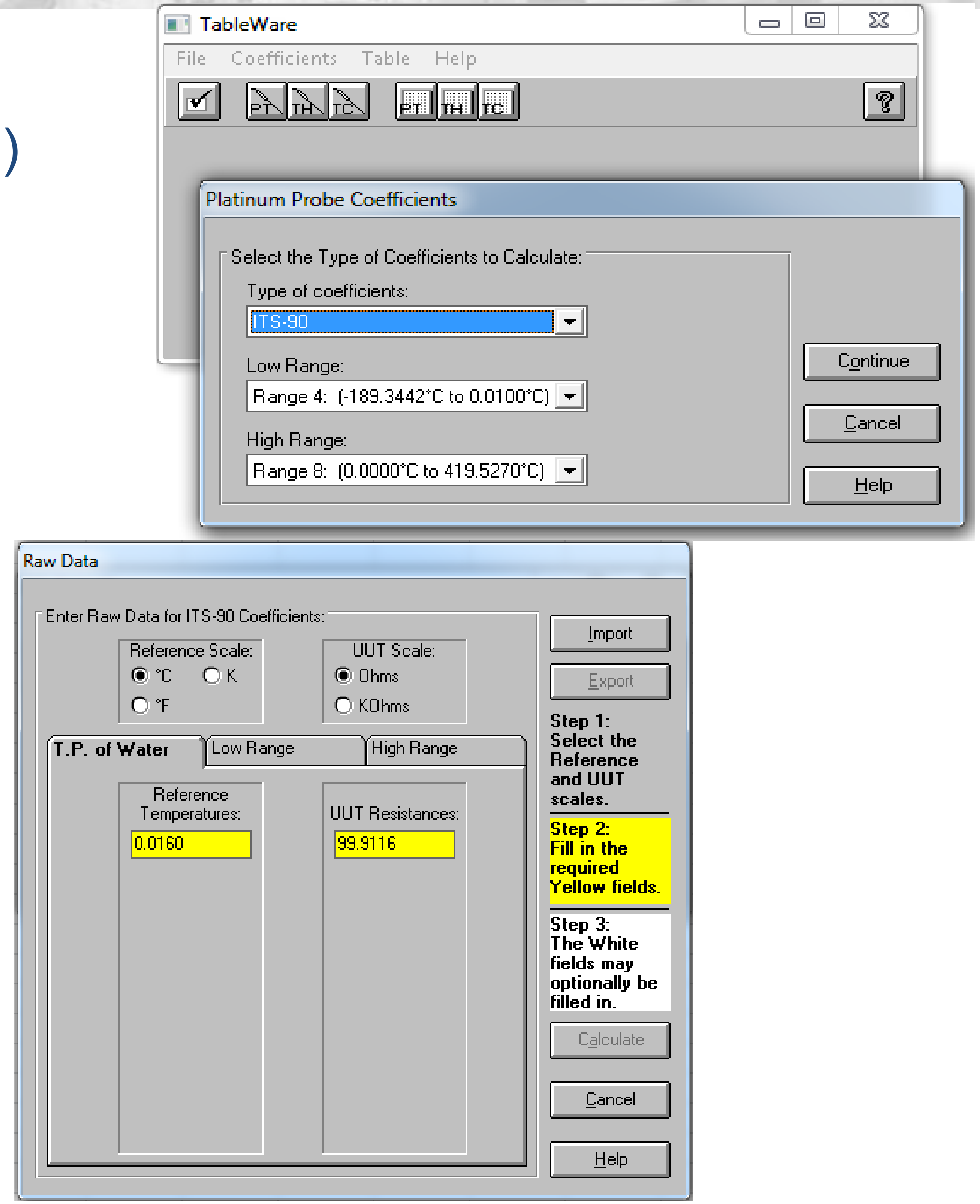


Generating new coefficients cont.

FLUKE® Calibration

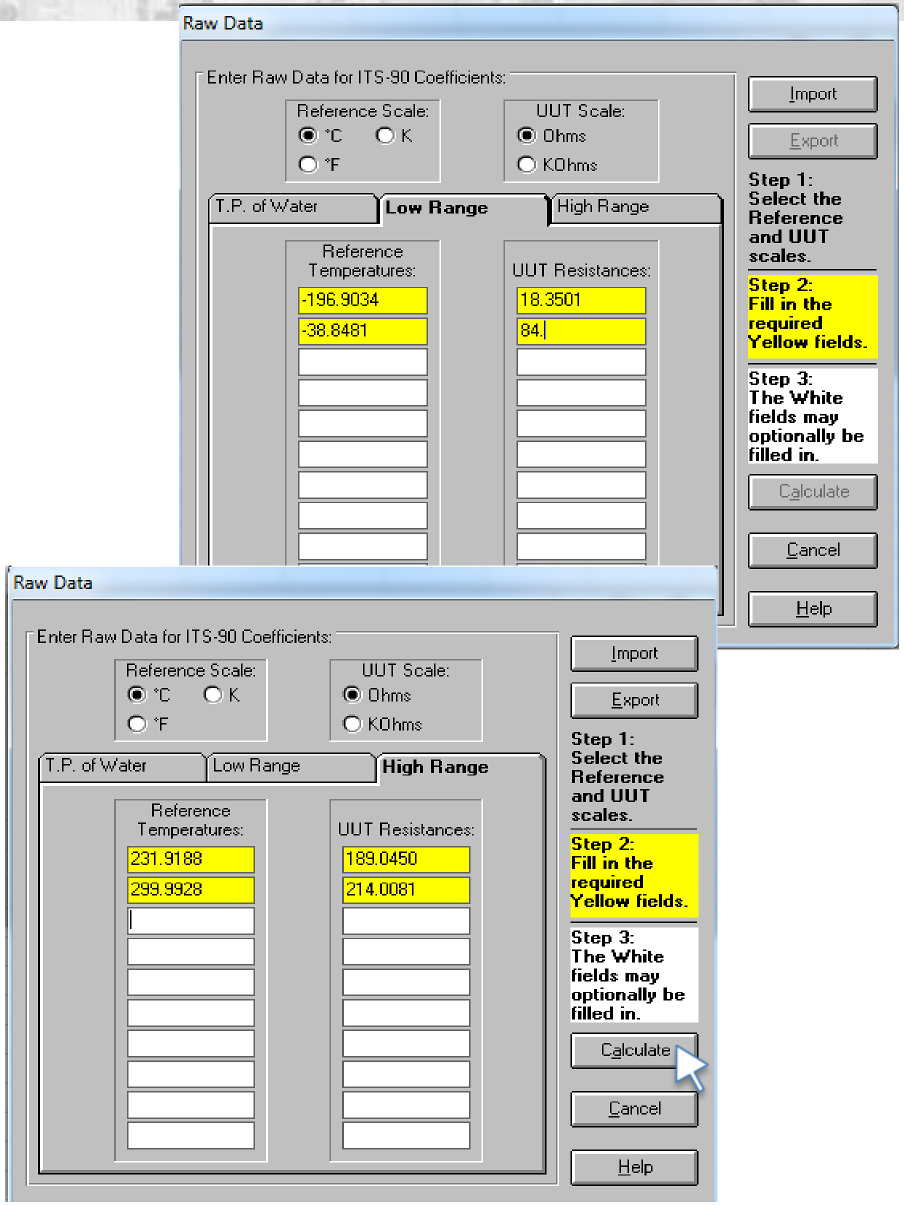
- Select the range of the calibration (by sub-range)

- And start entering the data
  - ❖ Always select "˚C" and "Ohms"
  - ❖ Use the average of your 0 ˚C points



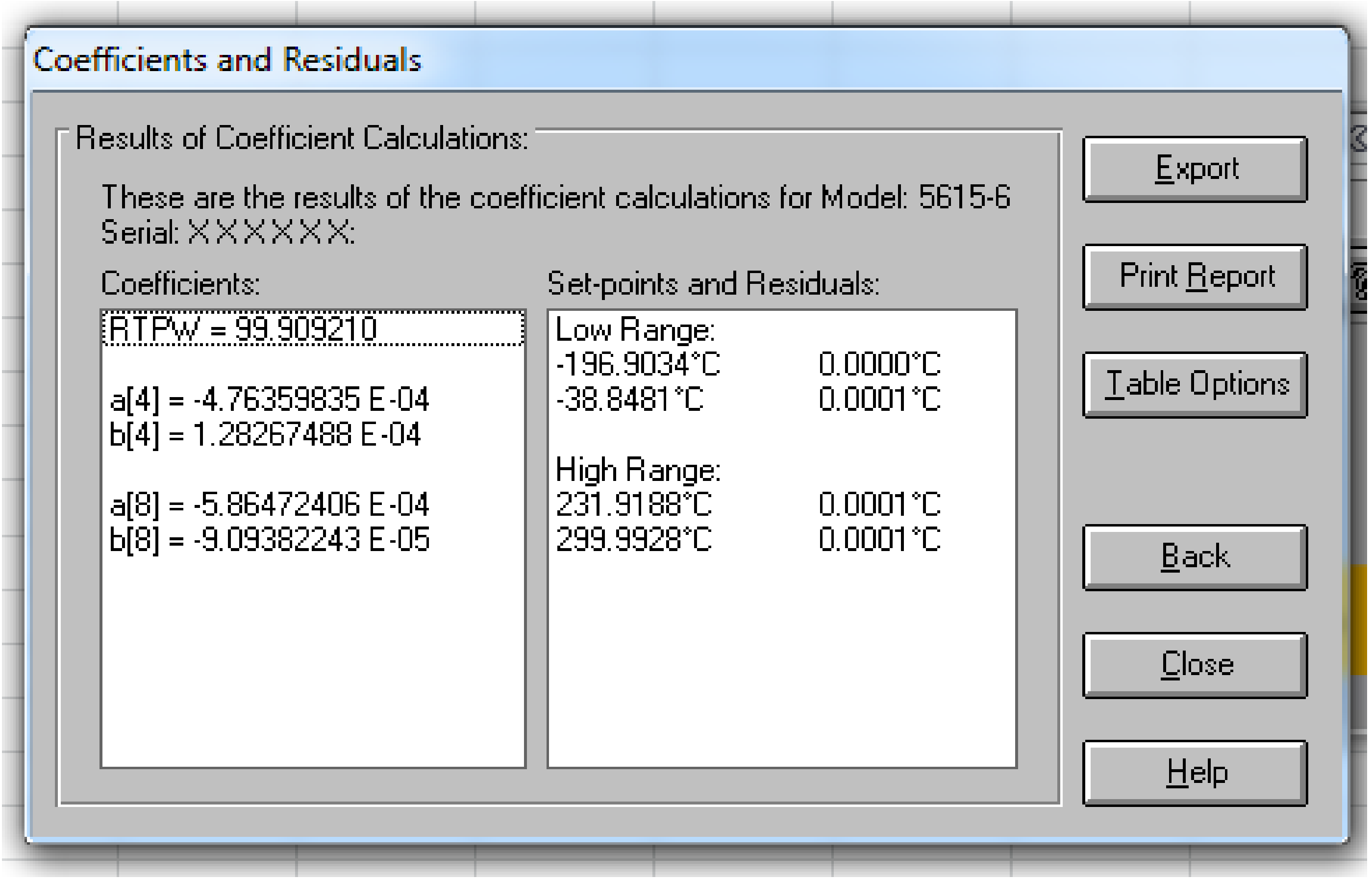
Generating new coefficients cont.

- Enter in the Below 0 ˚C data
- And the Above 0 ˚C data
- And click “Calculate”



Generating new coefficients cont.

- Here are the new probe coefficients!



Program the readout

- Press the “Menu” button on the 1502A.

- Press the “Probe” button when you see “SETP”. The readout will display the Coefficient Type (t90= ITS-90, rtd= CVD, t68= IPTS-68)

- Press the “Enter” key (same as “Menu” key).

Program the readout cont.

FLUKE ® Calibration

- “r0.01” should appear temporarily, then advance to the RTPW entry

- Use the green up/down arrows to change the value of each digit, and the left/right arrows to advance to the next position.

- After you set the “RTPW” value by pressing enter, it will advance you to the “a” (“A positive”), to allow you to input the “A“ Coefficient value.

Program the readout cont.

- After each coefficient is entered, the readout will display "E" to enter the exponent.

- To change exponents, use the "UP" key to increase, and the "DOWN" key to reduce the exponent. You will do this for each coefficient you have, "b", "c", "d", "a4", "b4" etc.

Tip #1 The truth about calibrating temperature sensors

FLUKE ® Calibration

- In the second method the temperature sensors are calibrated separate from the electronics and receive a calibration report with corrections that are later entered into the electronics connected temperature sensor for an accurate temperature reading

Report Number:
B1202017

Fluke Calibration, American Fork
Primary Temperature Lab
Report of Calibration

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The PRT was calibrated at the following temperatures with the associated uncertainties. The uncertainty evaluation accounts for all known uncertainties present at the time of calibration including long-term behavior of the calibration system, measurement noise, and any short-term effects of the PRT. The uncertainties are reported at the calibration temperatures only. The uncertainties at intermediate temperatures can be computed from these values and the ITS-90 propagation of error curves. The uncertainties are reported at a coverage factor of 2 (k=2).

CALIBRATION POINT (point °C)	(type)	(SN)	TEMPERATURE t90(°C)	MEASURED RESISTANCE	UNCERTAINTY (mK)
-197.000	Comp	N/A	-197.000	18.2097	±6.0
-100.000	Comp	N/A	-100.000	59.2614	±10.0
-38.834	Comp	N/A	-38.834	84.1391	±6.0
0.010	Comp	N/A	0.010	99.6745	±4.0
In	FP	44013	156.599	160.4537	±6.0
Sn	FP	S7005	231.928	188.6586	±6.0
Zn	FP	S9007	419.527	256.0466	±9.0
Al	FP	47007	660.323	336.4755	±14.0

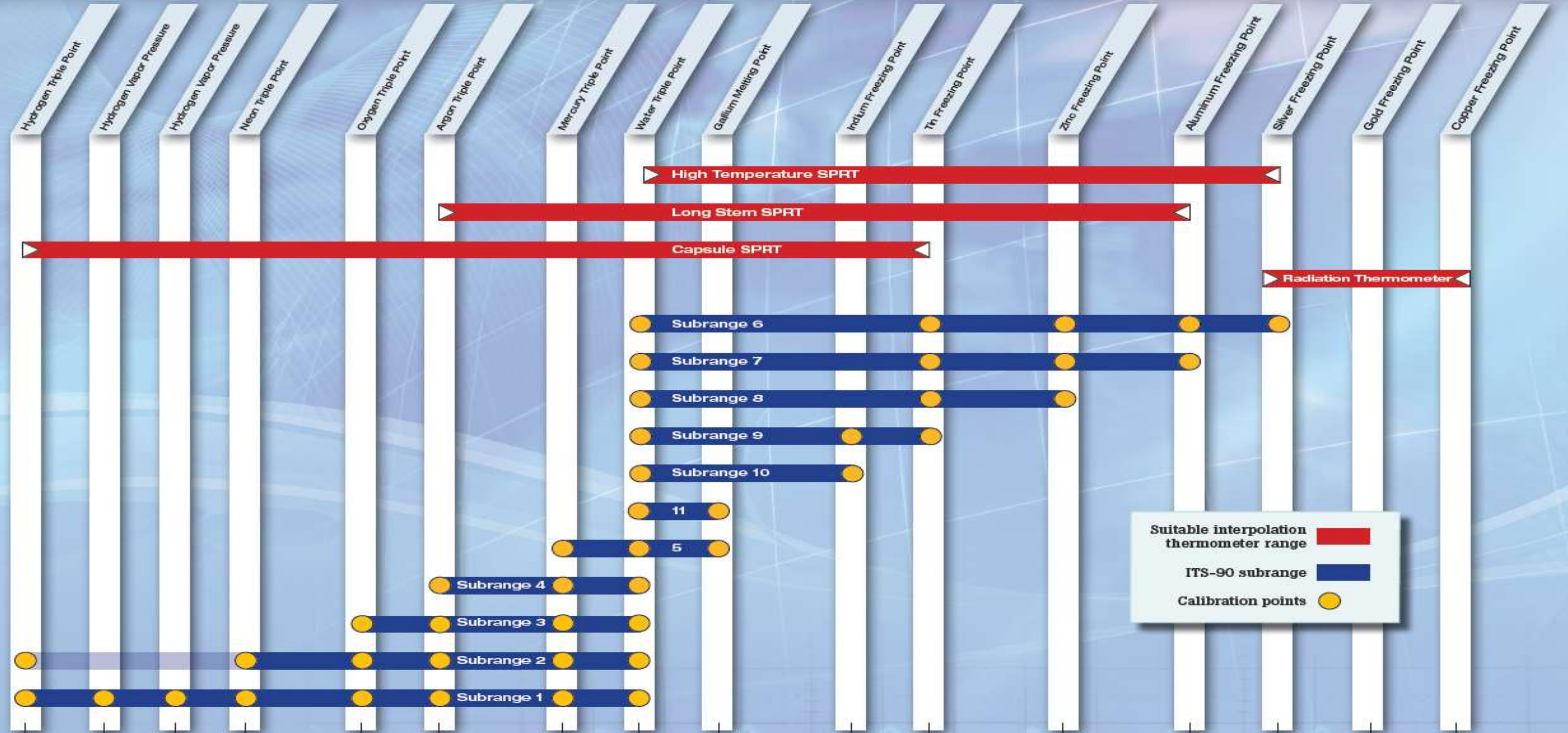
The following values were determined for the RTPW and the coefficients of the pertinent deviation functions of the ITS-90. For best results, the RTPW value shown should be used as a baseline value for determining the stability of the PRT. The user should maintain a record of RTPW values measured as a routine operation and use these values when computing temperature.

Results for Nominal Current Calibration

RTPW = 99.6745 Ω
a4 = -1.320865 E-05
b4 = -2.063356 E-06
a7 = -8.464574 E-05
b7 = 7.092116 E-05
c7 = -3.463376 E-05

Defining Temperatures of the ITS-90

FLUKE Calibration



	$e\text{-}H_2$ TP	$e\text{-}H_2$ VP	$e\text{-}H_2$ VP	Ne TP	O_2 TP	Ar TP	Hg TP	H_2O TP	Ga MP	In FP	Sn FP	Zn FP	Al FP	Ag FP	Au FP	Cu FP
t_{90} °C	-259.3467	-256.15	-252.85	-248.5939	-218.7916	-189.3442	-38.8344	0.01	29.7646	156.5985	231.928	419.527	660.323	961.78	1064.18	1084.62
T_{90} K	13.8033	17	20.3	24.5561	54.3584	83.8058	234.3156	273.16	302.9146	429.7485	505.078	692.677	933.473	1234.93	1337.33	1357.77

Fixed Point Calibration - Equipment Needed

Reference Standard

Fixed Point Cells

- triple point of water, mercury, indium, tin, zinc, aluminum, silver, copper, gallium

5901 Triple Point of Water Cells

59XX ITS-90 Fixed Point Cells

59XX Mini Fixed Point Cells

Temperature Source

Maintenance Bath, Furnace

- a device to maintain the temperature of the cell

7312 TPW Maintenance Bath

9116A Metrology Furnace

9260 Mini Fixed Point Furnace

Thermometer Readout

Super Thermometer

- a device to read the SPRT under test

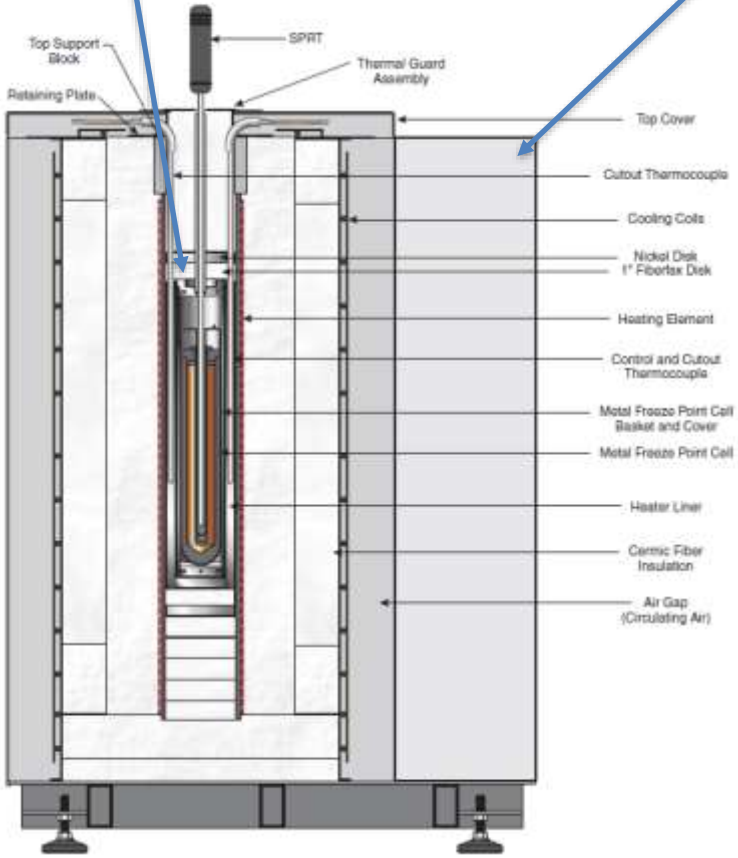
1595A Super Thermometer

Fixed Point Calibration Example

Thermometer readout:
1595A Super-Thermometer

Reference standard:
Fixed point cell

Temperature source:
9116A Furnace



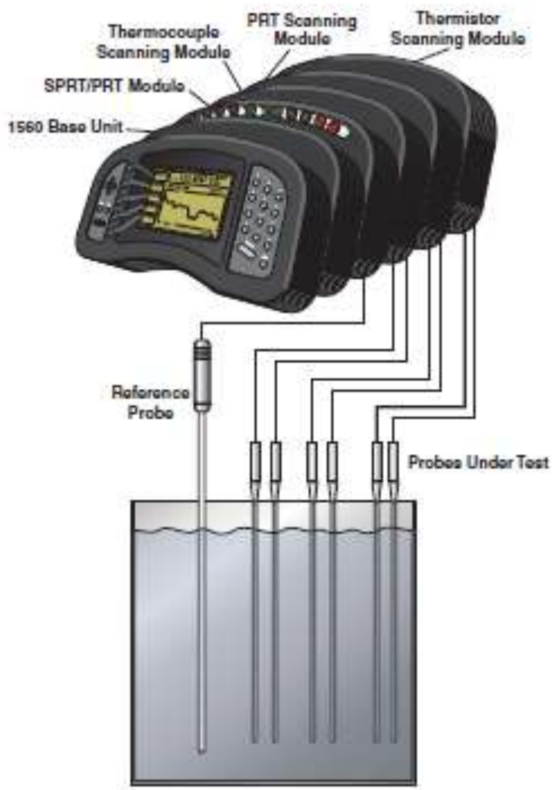
Tip #2 Calibration baths usually deliver the best results

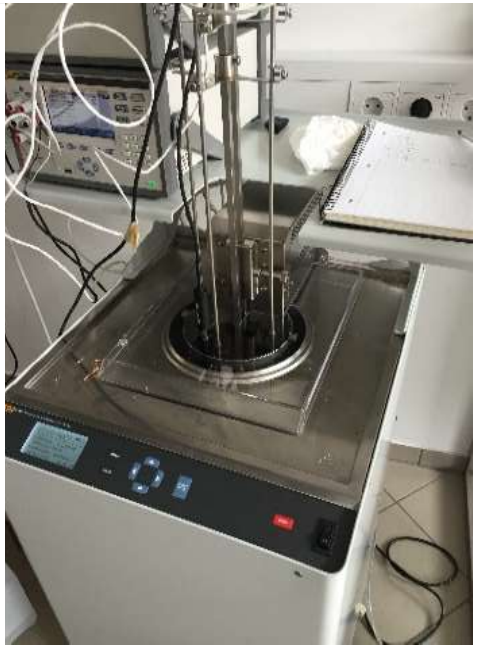
1- Calibration baths provide a very stable and uniform temperature environment. Stability refers to temperatures remaining constant over time and uniformity refers to the sameness of temperature vertically and horizontally all around the working region of the calibration bath

2- Owing to the exceptional stability and uniformity of a calibration bath, they provide the lowest uncertainties possible for comparison calibrations.

3. Calibration baths are compatible with the widest variety of temperature probes. They can accommodate many shapes and sizes and provide sufficient immersion to assure that both the temperature probes and the temperature standard are at the same temperature.

4. Calibration baths are an excellent choice for calibration of many temperature probes in one batch due to the large access openings.



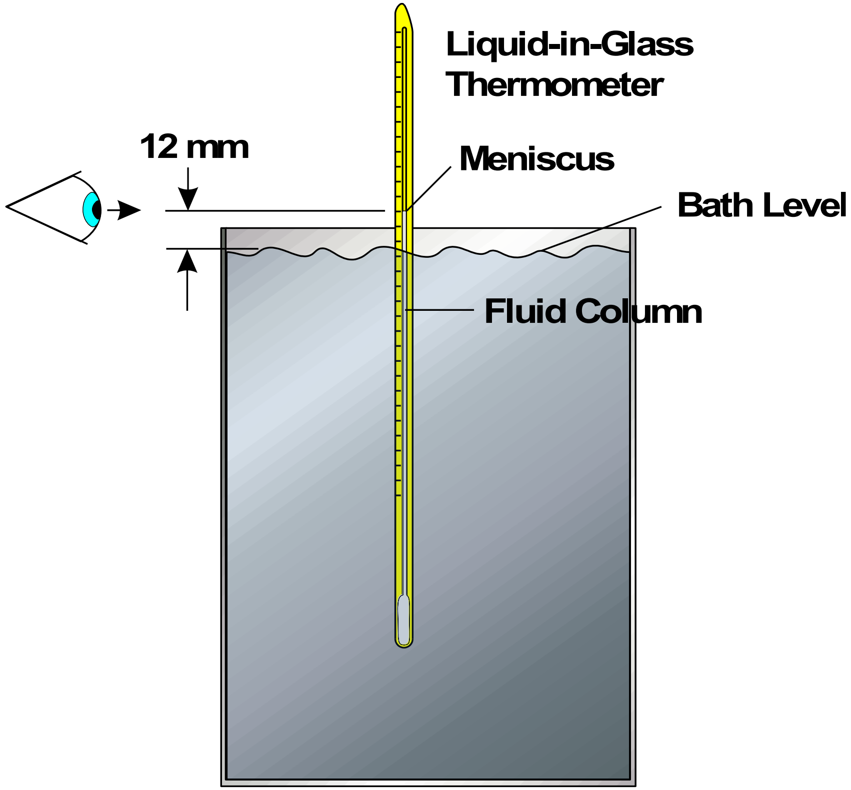


Tip #3 Calibrate more workload with a calibration bath

The great thing about a calibration bath is that the working area can be large enough to calibrate several probes at a time (our laboratory usually calibrates 10 at a time), and the probes can have a range of shapes and sizes. So if your customers or coworkers may bring you anything under the sun to calibrate then you definitely want a calibration bath. But, what if you still need to calibrate all of those different kinds of probes onsite? Use a Micro-Bath. They are easily carried in one hand, but still have many calibration bath advantages.

Liquid & Glass Requirements

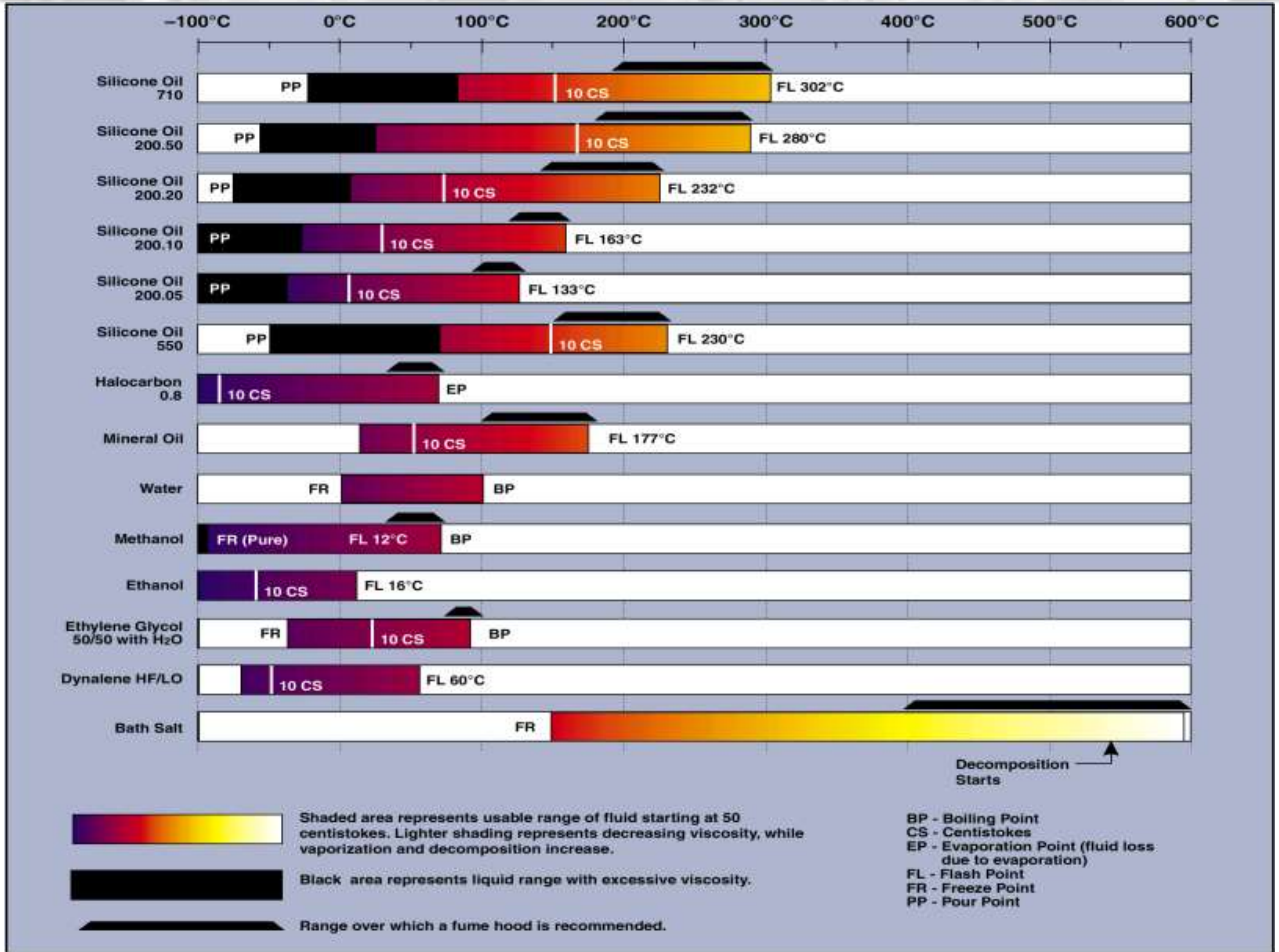
FLUKE ® Calibration



- **Designed for Stability (not necessarily speed)**
- **Secondary calibration lab typical application**
- **Temperature range limited to range of fluid used**
- **Large volumes and odd shaped or large diameter probes**
- **Different types of heat and cool/stirring**

The 2019-DCB Liquid-in-Glass Thermometer Calibration Kit includes a carousel which holds up to 10 thermometers and an adapter tube which raises the bath fluid level to within 5–15 mm of the thermometers’ readings. The 2069 Magnifier Scope mounts easily to the front of any Deep-Well Compact Bath to provide magnification of 8X or greater

Liquid Baths



Tip #3 Boost productivity with multiple calibration baths

- One reason a temperature calibration bath is so stable is the bath fluid prevents the temperature from changing rapidly.
- This has unwanted side effect of slowing the rate baths change to the next temperature test point. One way to boost productivity is to use more than one bath so that you always are ready for the next cardinal temperature

Tip #4 Protect your investment with a triple point of water cell

- If you have invested in an SPRT or a secondary reference thermometer for better accuracy, the last thing you want is to lose all of that accuracy because of an accident that you don’t even know about. Accidents can happen when you least expect them to and they can often happen in shipping before you ever take possession of your thermometer. The best way to be sure that your investment is protected is by checking it regularly in a triple point of water cell and comparing the result to your calibration report. The best practice is to keep a chart on the thermometer in a spreadsheet like Excel and watch for any sudden jumps in the reading at the triple point of water (0.010 °C).

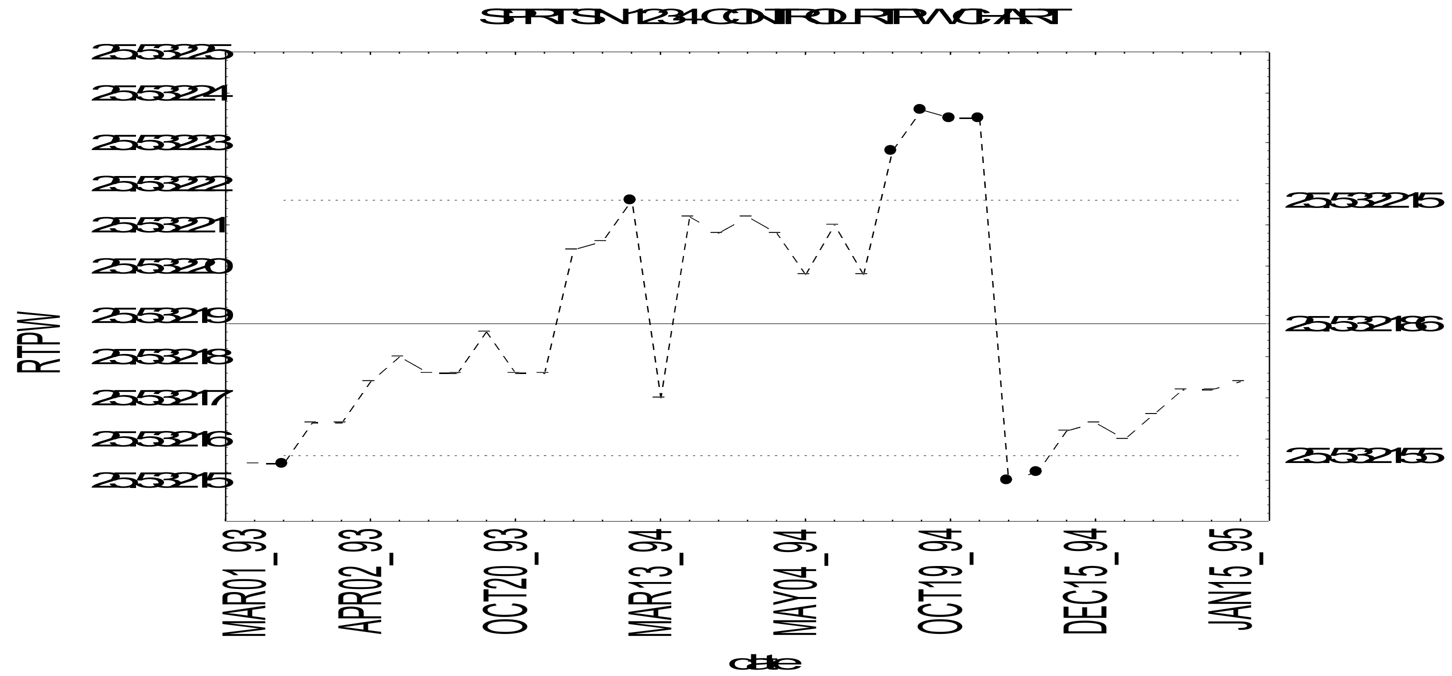
Control Chart of Reference Probes

Measure temperature using resistance ratio W(t)

W(t) = R(t) / Rtpw

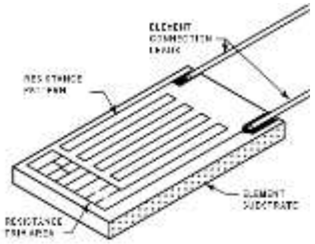
W(t) is much more stable over time than resistance only.

Regularly updating Rtpw greatly improves calibration uncertainty and lowers risk of erroneous measurements

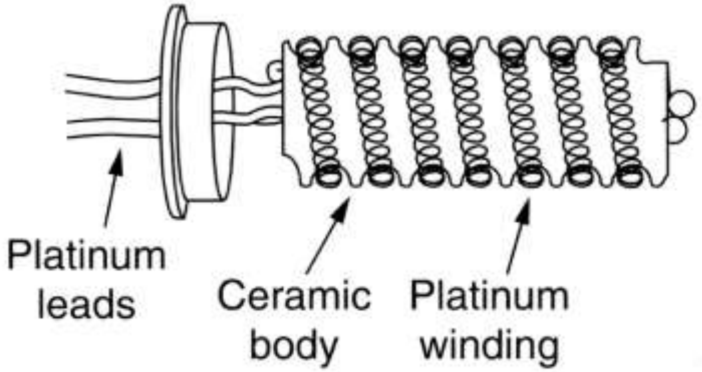


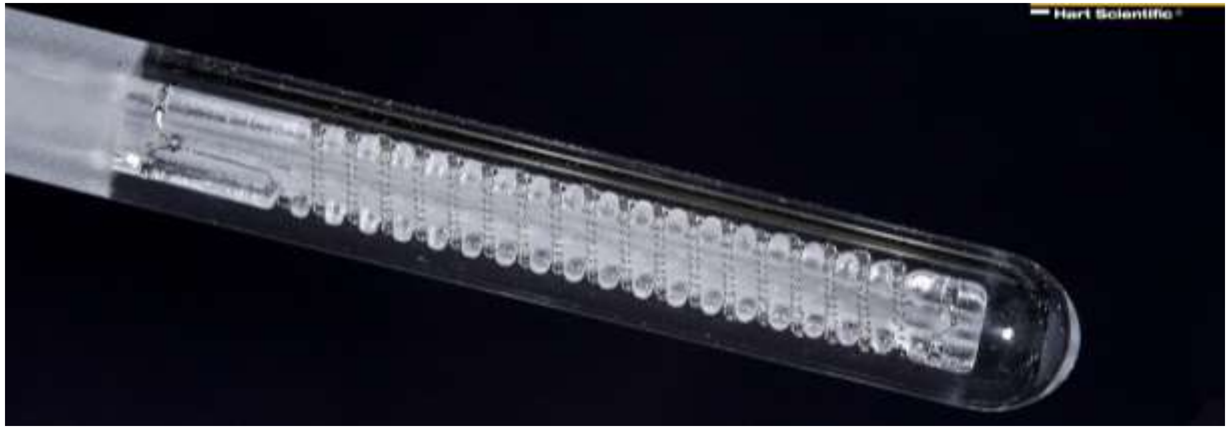
PRT Sensors

- Thin-film
  - Thin platinum foil mounted or deposited to a ceramic substrate and encapsulated inside a metal sheath
  - Very rugged, poor repeatability



- Wire-wound
  - Sensor wire is wound into a small-diameter coil which is mounted to a support . Support is filled with insulating alumina powder. Sensor is mounted inside a SST sheath
  - More accurate, good repeatability, can be delicate





PRT characteristics

1. Wide temperature range
2. Best accuracy over full range – linear
3. Nominal resistance typically 100 Ω or 25 Ω at 0 ºC
4. Wide applicability
5. Can be more expensive than other thermometers but generally most “bang for the buck” ROI
6. Susceptible to drift
7. Range from industrial sensors to highly accurate reference level devices (SPRT – Standard Platinum Resistance Thermometer)

Understanding PRT drift

- What is drift?
  - Drift is a change in the probes resistance that causes measurement error
  - All PRTs drift due, some a little, others a lot
- Two main causes of drift
  - Mechanical strain
  - Oxidation
- Other sources of drift
  - Moisture leaking into the probe
  - Loss of fill gas (inert gas mixture as noble gases like argon, helium, or nitrogen)
  - Aging of materials
  - Contamination of the platinum sensor

Understanding mechanical strain

- Mechanical strain is caused by vibration or mechanical shock
  - Dropping
  - Tapping
  - Mishandling in shipping
- Introduces deformations in the resistance element resulting in increased resistance
  - Changes can be as large as 0.1 ºC
  - Small effects are reversible through annealing
  - Catastrophic strain cannot be remedied

Examples of irreversible strain

- Magnified images of severely damaged platinum sensing elements

Another source of strain

FLUKE® Calibration

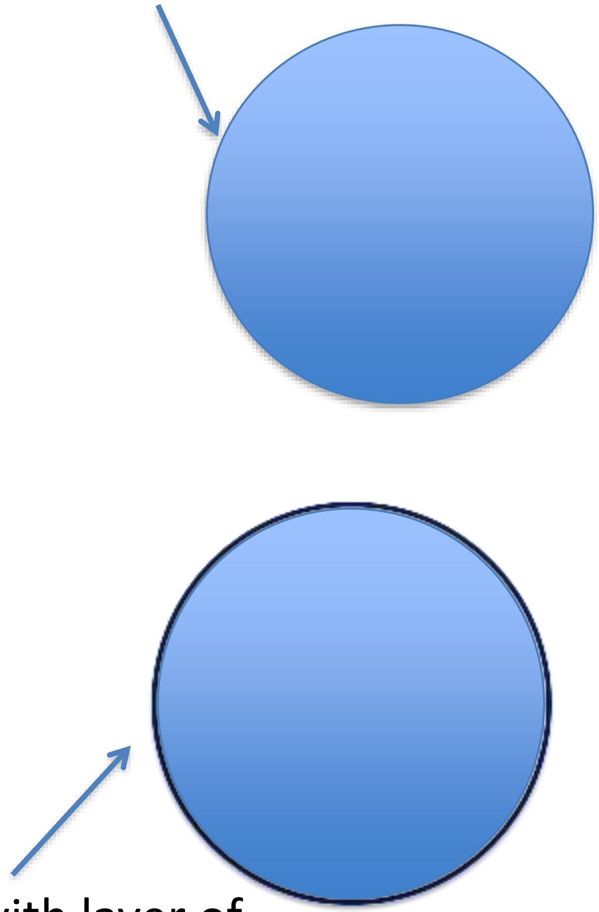
- Cold quenching / thermal shock
  - Caused by rapid cooling of a hot (> 500 ºC) thermometer
  - Introduces crystal lattice vacancies with resulting increases in resistance
  - Most effects are reversible by annealing
  - Some probes are designed to be rapidly cooled, others are very sensitive to it

5628 High Temp PRT

5681 High Temp SPRT

Understanding oxidation

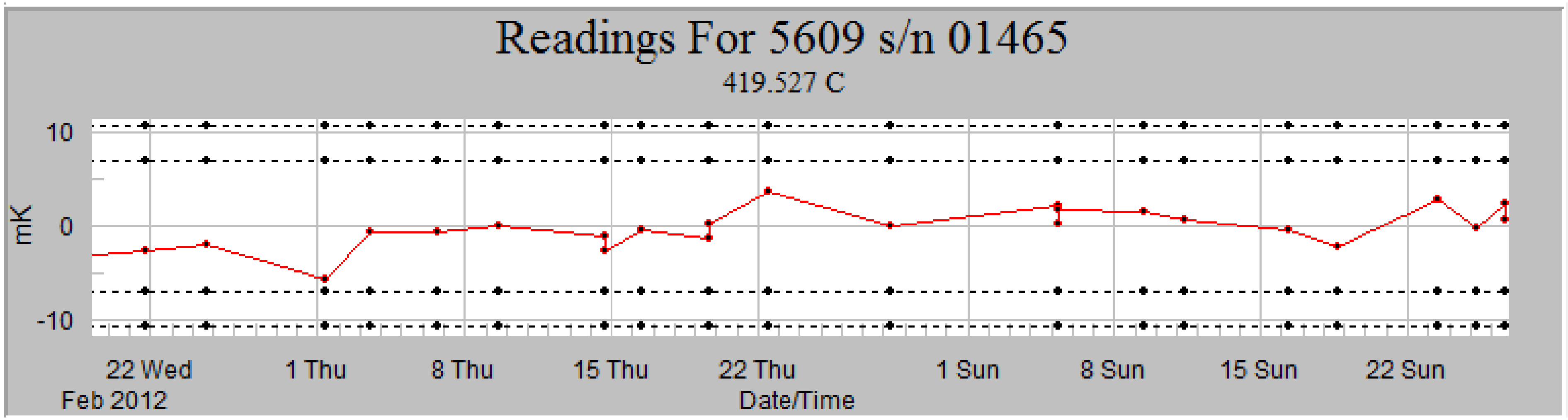
- Caused by a chemical reaction with oxygen
- Introduces deviations in the chemical composition of the sensor
- As the sensor wire oxidizes the wire diameter is reduced causing an increase in resistance
- Some oxidation is needed to protect the sensor
- Changes generally do not exceed 0.005 ºC
- Most effects are reversible by annealing
- Maximized at temperatures between 100 and 450 ºC



How to identify drift

FLUKE Calibration

- PRTs are specified for stability (short term repeatability and long term drift)
  - Drift is affected by time and use
  - Drift must be verified
- Monitor drift using interim checks
  - Periodically check at a known temperature
  - Use a repeatable temperature point such as triple-point of water or ice bath
  - Record results in a control chart
  - Assign drift limit



Anneal to reverse drift

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- Annealing is the action of heating the sensor to a point that softens the platinum wire to allow realignment of crystalline structure (above 450 ºC)
- High temperatures (above 450 ºC) can also drive oxidation from the sensor
- Sensor must be of strain-free design for most effective annealing
  - SPRTs and high quality PRTs are designed with strain-free or partially strain-free sensors
  - Industrial PRTs have supported sensors that will deform at annealing temperatures which causes hysteresis

Annealing recommendations

- Always consult manufacturer for annealing guidelines
- Don’t exceed maximum temperature of the probe
- Avoid using metal block furnaces when annealing quartz-sheathed SPRTs above 500 ºC
  - Metal ions can pass through quartz and adhere to the sensor
- Incorrect annealing can irreversibly damage a probe
- Exceeding annealing temperature of probe calibration can cause calibration invalidation

Guidelines for annealing PRTs

FLUKE ®
Calibration

- For high temperature PRTs (range up to 660 ºC), anneal temperature is typically 665 ºC.
- For other PRTs, some annealing can be achieved from about 300 ºC and up.
- Many types of high quality PRTs are partially supported
  - Can't be fully annealed due to support
  - "Heat Treating" is used to stabilize the probe before calibration
  - Expose the probe to max cal temperature +10 ºC for stabilization before calibration

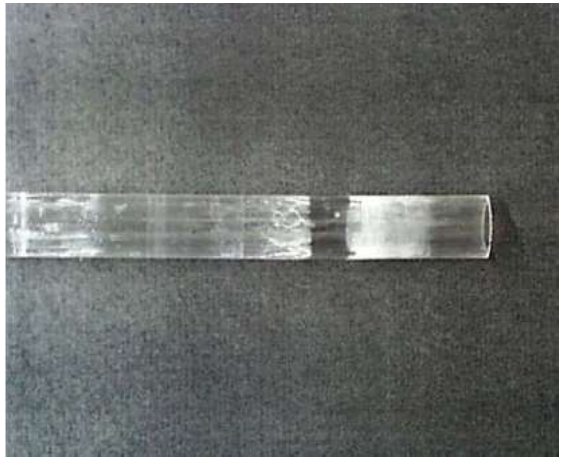
Steps for annealing PRTs

FLUKE ® Calibration

- For high temperature PRTs
  1. Measure resistance at triple-point of water
  2. Anneal at 665 ºC for 4 hours
  3. Ramp down to 480 ºC at ramp rate of 2 ºC per minute
  4. Remove probe to ambient
  5. Measure resistance at triple-point of water
  6. Calculate change in resistance
  7. Repeat if necessary
- For other PRTs
  1. Measure R_{TPW}
  2. Heat treat at highest calibration point +10 ºC
  3. Measure R_{TPW}
  4. Repeat if necessary

Guidelines for annealing SPRTs

- You must know the allowed annealing temperature of the SPRT!
  - Some SPRTs have materials that will break down above 500 ºC
- When annealing at high temperatures (665 ºC), ramp furnace down to 480 ºC before removing to ambient
- Don’t ramp down to ambient (will cause oxidation)
- Make sure sheaths are cleaned before annealing
  - Contamination will cause glass sheaths to break down (devitrify) at high temperatures



Steps for annealing SPRTs

FLUKE ® Calibration

- Regular SPRT annealing process:

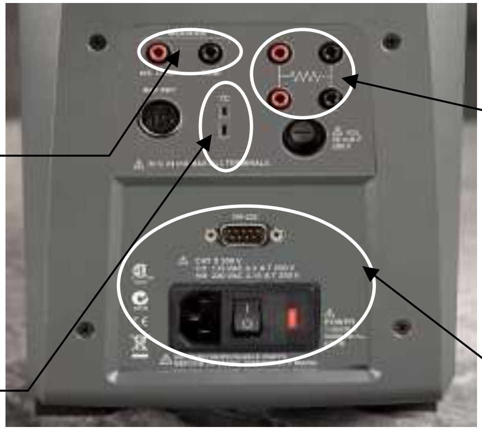
1. Measure R_{TPW}
2. Anneal at 480 ºC for 4 hours
3. Remove to ambient
4. Measure R_{TPW}
5. Repeat until resistance doesn’t change (changes less than 0.4 mK)

High temperature SPRT annealing

- High temperature SPRT annealing process (SPRTs used up to 660 ºC):
  1. Measure R_{TPW}
  2. Insert probe in furnace at 480 ºC
  3. Soak at 480 ºC for 4 hours
  4. Ramp furnace to 665 ºC at 2 ºC/minute
  5. Soak at 665 ºC for 2 hours
  6. Ramp down to 480 ºC at 2 ºC/minute
  7. Remove to ambient
  8. Measure R_{TPW}
  9. Repeat until resistance doesn't change (changes less than 0.4 mK)
- For ultra-high temperature SPRT annealing (SPRTs up to 965 ºC), consult with the manufacturer

Tip #5 Minimize the number of tools you take onsite

- If you perform onsite calibrations, time and space are a premium and the last thing you need is to spend most of your time hauling equipment around. Try to use the fewest instruments necessary for the job.
- For example, the process version of the Field Metrology Well is a dry-block calibrator that has all of the electronics you need built right in for measuring RTDs, thermocouples, and thermal switches. It is also a documenting 4-20 mA loop calibrator.
- You won't need a computer to automate and document the calibration either. It's built right in!



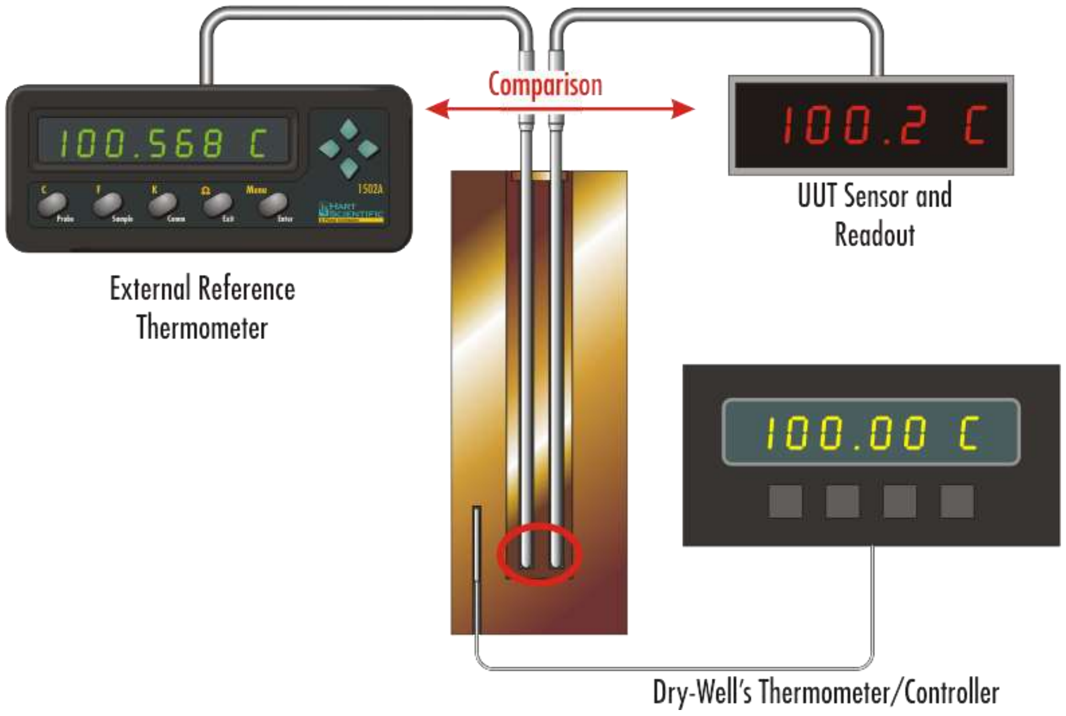
Tip #6 Infrared temperature calibration needs infrared temperature standards

- Infrared temperature readings are influenced greatly by the type material and surface finish of the objects they are pointed at, because infrared temperature readings depend on surface emissivity. Infrared calibrators are sometimes called blackbody calibrators even though a flat painted surface is not really a blackbody. Real blackbodies are cavities with a well-known emissivity value (i.e. 1.000 ± 0.001)

- The emissivity of a painted surface is only known if it is measured. Therefore, to calibrate an infrared thermometer you will need to use an infrared temperature standard like a radiometer or you will need a radiometrically calibrated calibrator. Most infrared calibrators are temperature sources like the 9132 and 9133 that require an infrared temperature standard to compare to the infrared thermometers being tested. However the 4180 Series Precision Infrared Calibrators have been radiometrically calibrated in our infrared thermometry laboratory with some of the lowest uncertainties possible so that expensive extra equipment is not required.

Tip #7 Boost calibrator accuracy with a platinum resistance thermometer (PRT)

- The convenience of a handheld dry-well is very appealing but sometimes you need a little more accuracy. A great way to improve the accuracy of any dry-well is to use a platinum resistance temperature standard for your known temperature instead of the calibrator display. The best dry-block calibrators can directly read PRT standards to improve their display accuracy. A good example is the Field Metrology Well process version.



- Typical system uncertainty can be as good as ± 0.05 ° C

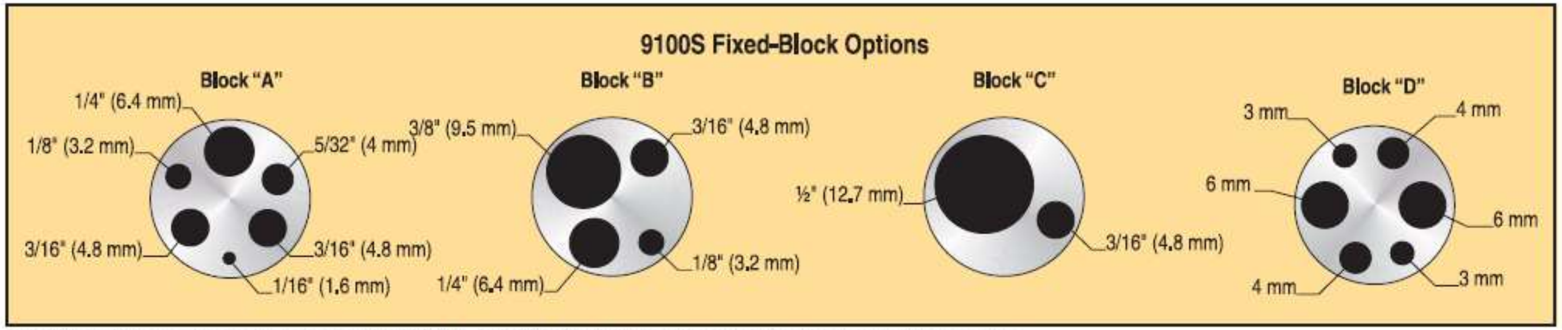
- Better than display uncertainty by nearly a factor of five

Tip #8 Use a dry-well or metrology well to eliminate messy fluids

- One great thing about dry-wells is they are dry. That means you don’t have to deal with a lot of messy fluids. This can be very helpful if cleanliness is one of your chief requirements. Of course there are ways to keep bath fluids from becoming a mess, but why bother if you don’t have to?
- Fluke Calibration 9170 Series Metrology Wells are so accurate they can be used as an alternative to a calibration bath in many applications. We use Metrology Wells in our lab for certain calibrations, and you can do that too or take them onsite.

Tip #9 Conveniently check devices onsite with a handheld dry-well

- If you’re just getting started with temperature calibration you probably want to look at the 9100S dry-wells. Anyone can learn to use one in less than 15 minutes, they are inexpensive, and they literally fit in the palm of your hand. You can use them to easily check RTDs, thermocouples and small dial thermometers because the display accuracy is ±0.25 °C.



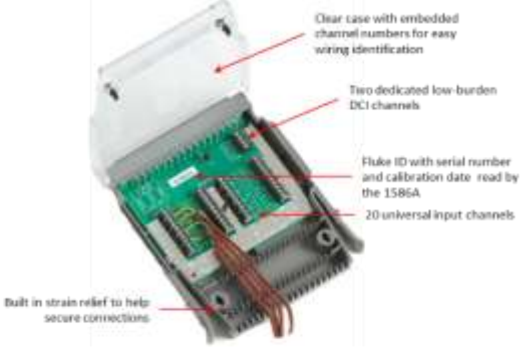
9100S fixed-block options. Order number 9100S-A, 9100S-B, 9100S-C, or 9100S-D for the desired block option.

Tip #10 Capitalize on your intuition with a graphing digital thermometer

- The best way to understand your data is to see it. The best digital thermometers help you visualize your data. A good example is the Fluke Calibration 1524 Handheld Reference Thermometers or 1586A which let you graph your data in real time. It's easy to know when to take a measurement if you can see for yourself the temperature is stable

Tip #11 Read multiple thermometers simultaneously

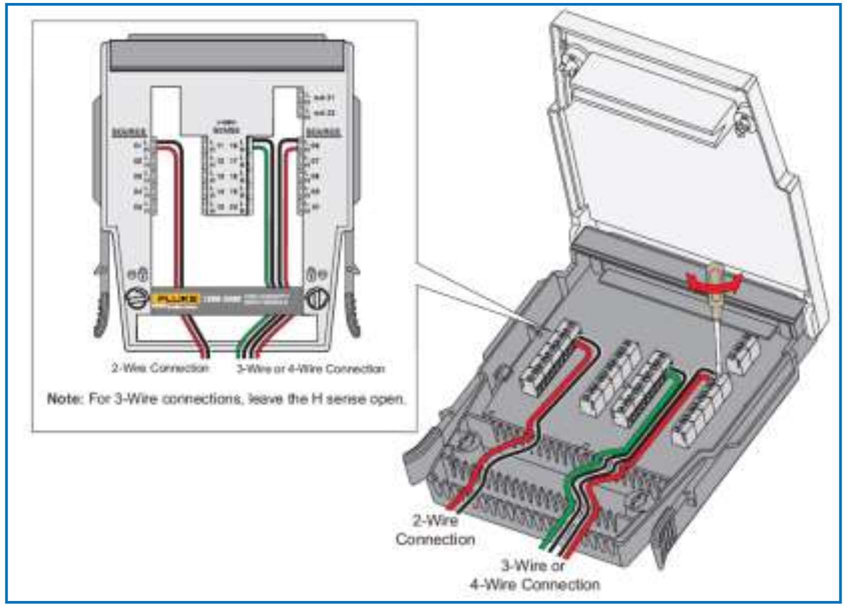
There's more than one reason why measuring multiple thermometers at the same time could be a good idea. One is that you can be more productive if you can calibrate multiple devices in parallel rather than sequentially. Another reason for simultaneous measurement can be accuracy. If your temperature source is not very stable try measuring the reference and the device under test at the same time. Measuring both at the same time can reduce the uncertainty in your measurement by eliminating time dependent temperature differences. With four independent measurement circuits the Fluke Calibration 1529 reads up to 4 RTDs, thermistors, or thermocouples Simultaneously 1586A reads up to 40 channels, as 20 RTDs, thermistors, or 40 thermocouples

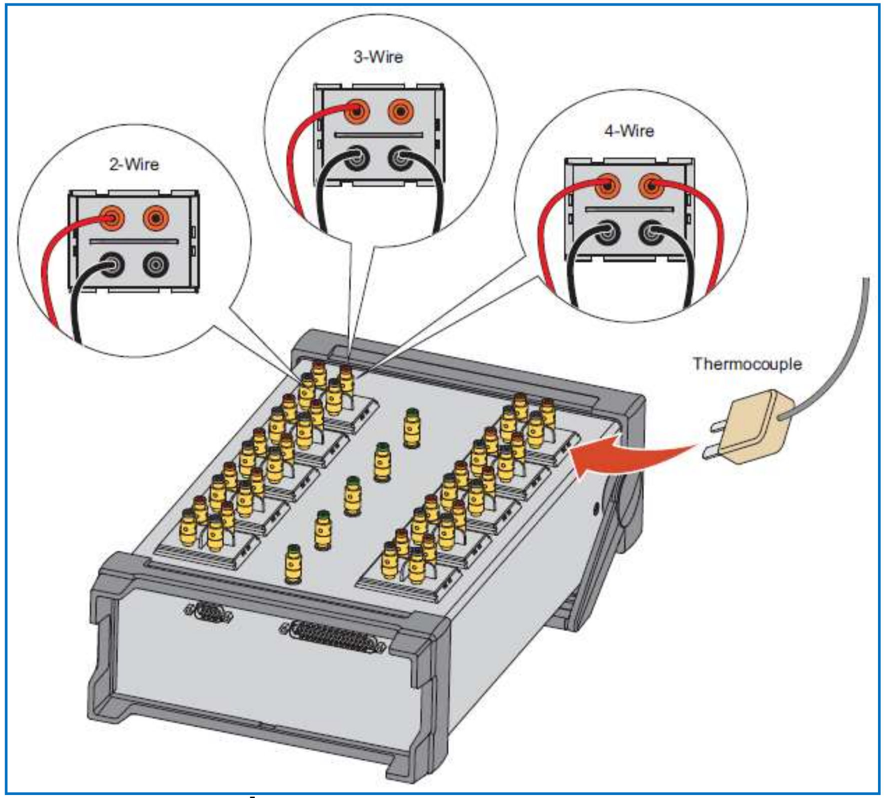


1586A Super DAQ

40 input channels…

(not including DCI and DMM channels)





…and up to 10 channels per second

Tip #12 Compensate for ambient temperature variation

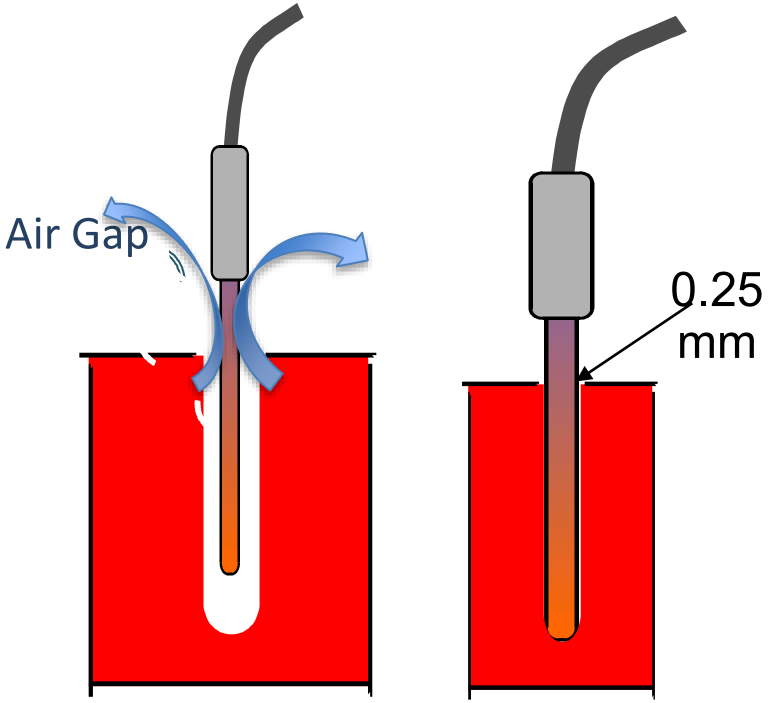
One difference between working onsite and working in the lab is that temperature control is rarely very good on the shop floor. Environmental conditions are typically unstable, having wide temperature variations.

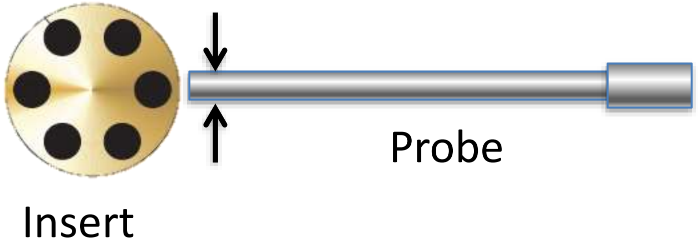
That's why each 914X Field Metrology Well has a built-in gradient-temperature compensation that adjusts control characteristics to ensure stable performance in unstable environments.

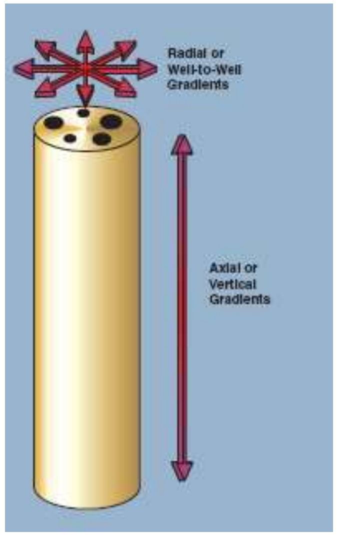
In fact, all specifications are guaranteed over the environmental temperature range of 13 °C to 33 °C.

Tip #13 Cover more workload with removable inserts

- If you are using a dry-well calibrator and you have to calibrate a probe that does not fit snuggly into one of the wells, you still have some options, but putting the probe into a well that’s too large with an air gap around the sheath is not one of them. What you need is another insert with a correctly sized hole. Interchangeable removable inserts make it possible to calibrate a wider variety of probes without giving up on good results. You have the option of ordering interchangeable inserts with any Fluke Calibration dry-well except the 9100S





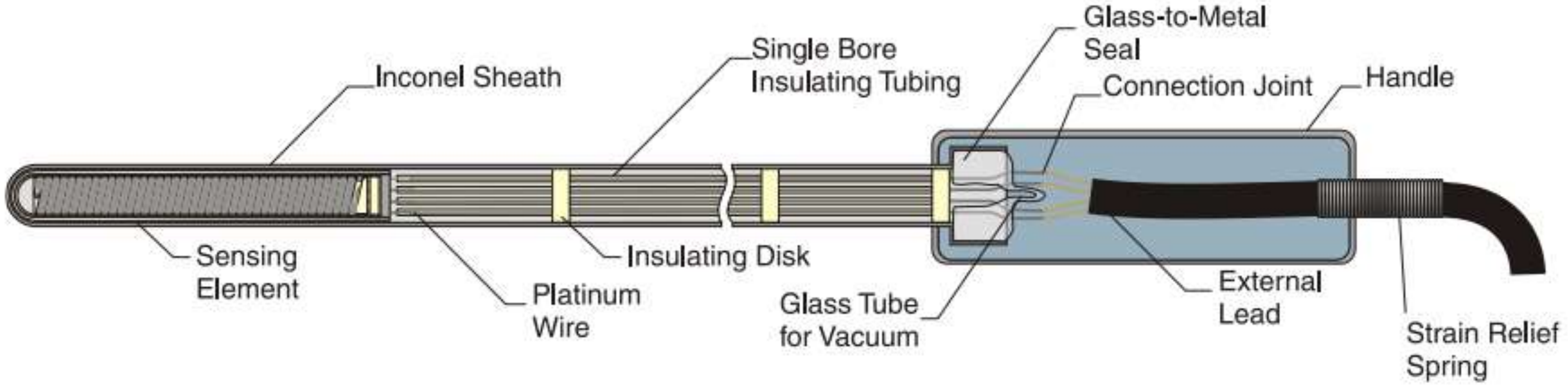


Immersion Depth of Thermometers in Baths

- Rule of Thumb
- Immersion Depth = 20 X the diameter + sensor length

- Example:
- for a thermometer diameter of .25 inches and sensor length of 1.25 inches

- Immersion depth = 20 X .25 + 1.25 = 6.25 • inches



Tip #14 Automate Temperature Calibration without Software

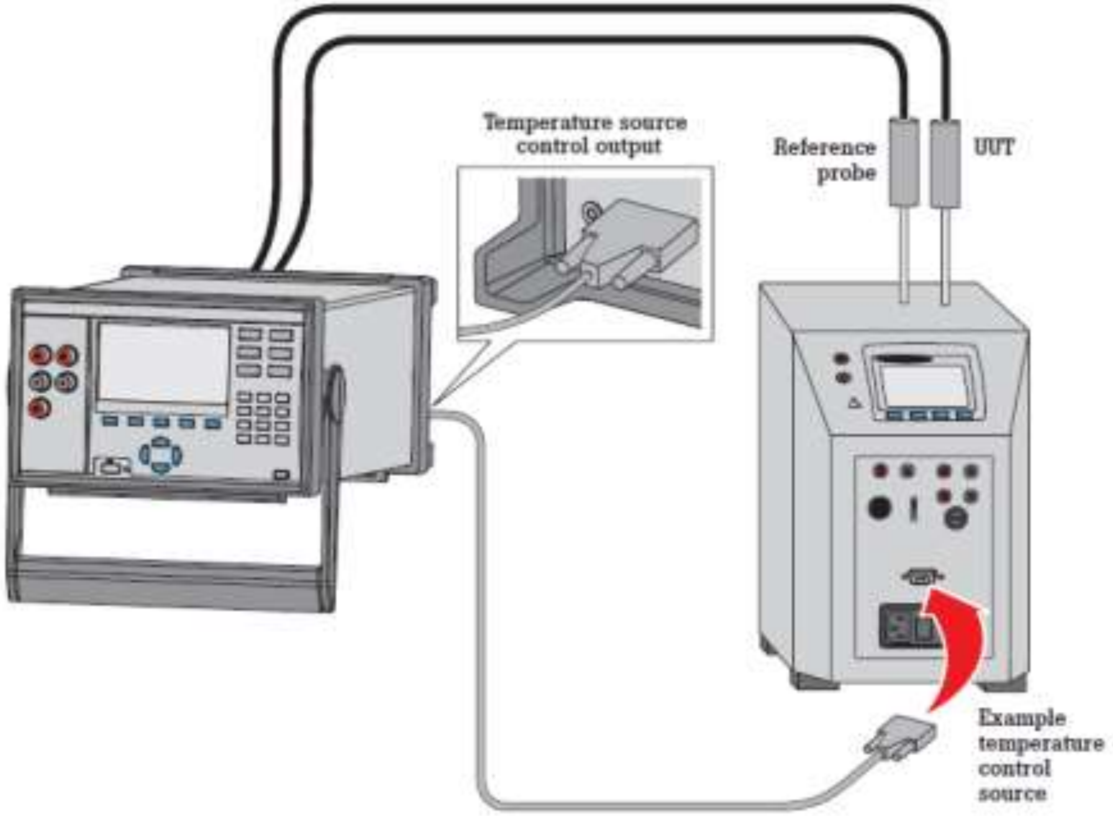
- **Use the 1586A Super-DAQ to automate temperature sensor calibration**

The 1586A Super-DAQ Precision Temperature Scanner provides a unique feature for automating sensor calibration that can greatly increase your lab productivity—without a PC and software.

When the Super-DAQ is connected to a Fluke Calibration dry-well or fluid bath, it can control the temperature source to run the calibration automatically. You simply program the number of set-point temperatures and their values, select a scan sequence, assign a reference channel, and set the required stability band

One temperature source can be connected to the Super-DAQ at a time. The Super-DAQ can control almost all models from Fluke Calibration

1586A Example:
Calibrate Temperature Probes

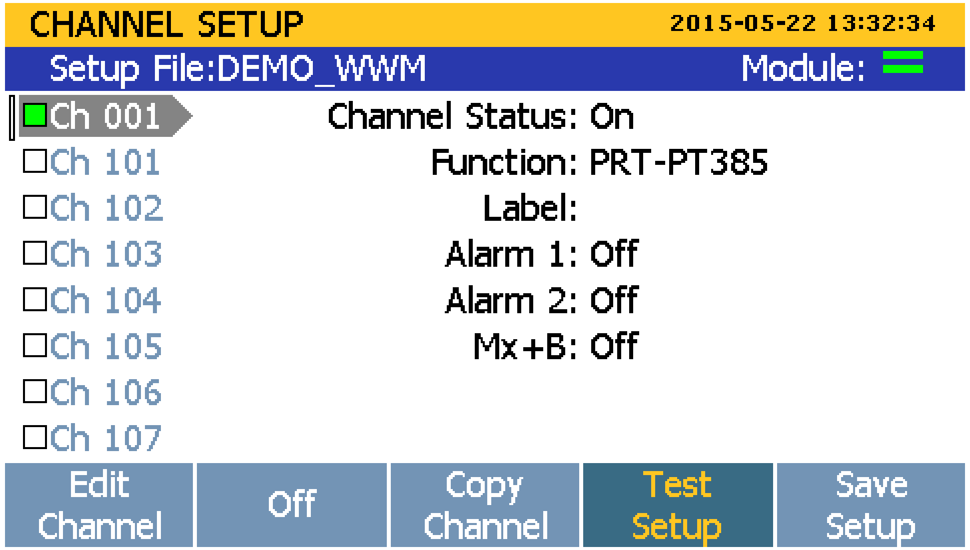


1. Connect Dry-Well to 1586A's control port (on back) with serial cable
   - Cable supplied with all Fluke Dry-Wells
2. Insert Reference and probe to be calibrated
3. Connect all probes to 1586A
4. Configure test on 1586A
5. Start the test
6. Results stored on 1586A internal memory or external USB memory

Read the "Automated Temperature Sensor Calibration with the 1586A Super-DAQ" Application Note (6002875A) for more information

1586A Setup

- All setup is done from the 1586A
  - Configurations can be named and stored in memory for quick recall and consistency
- Setup measurements
- Setup test type
  - Set points
- Start test
  - Several options to monitor progress



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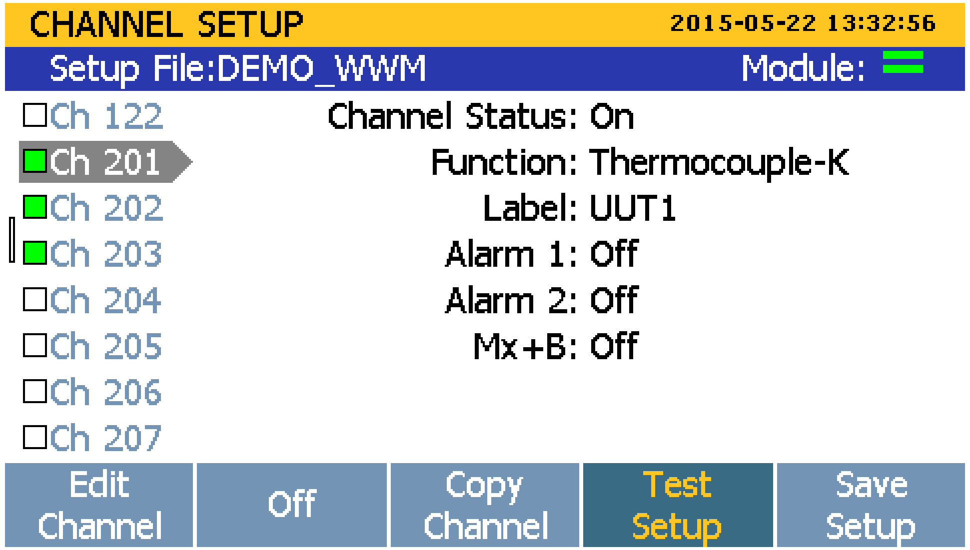

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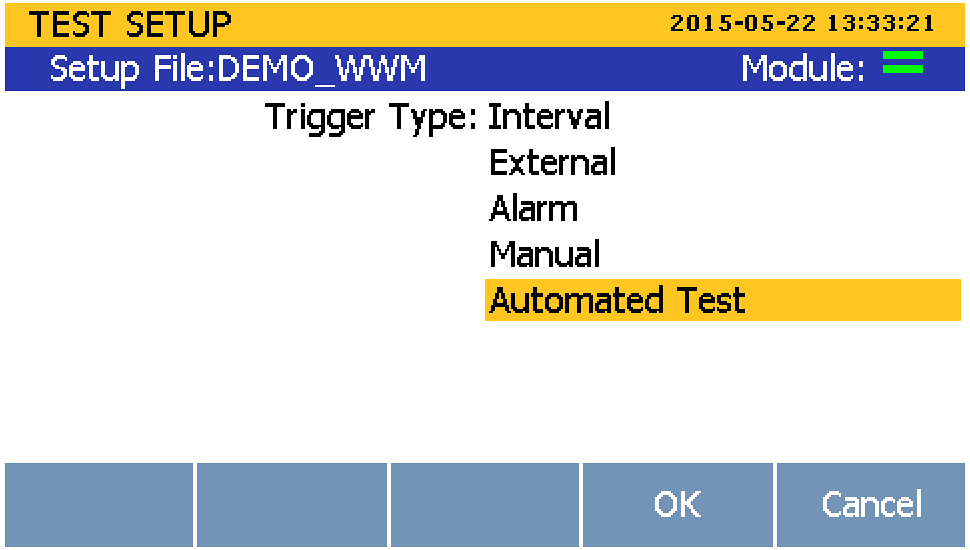

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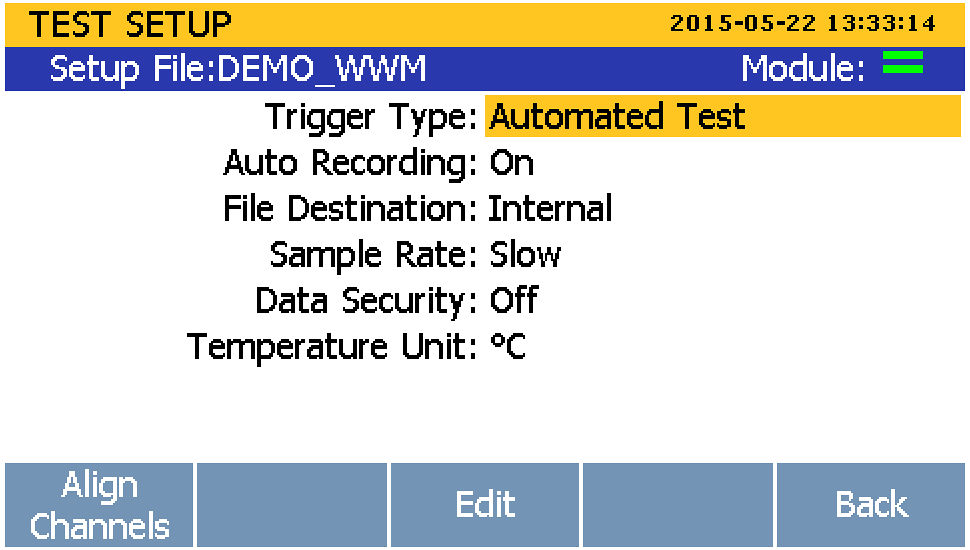

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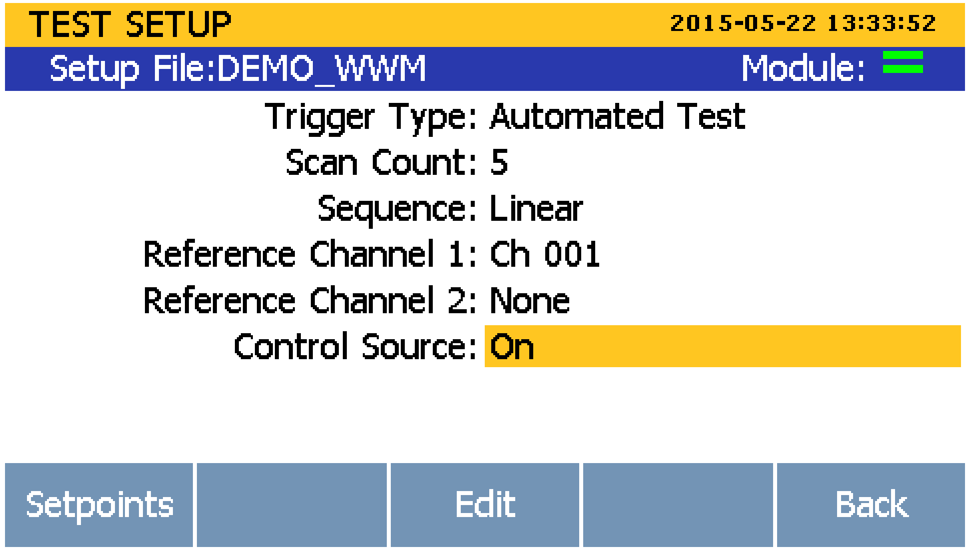

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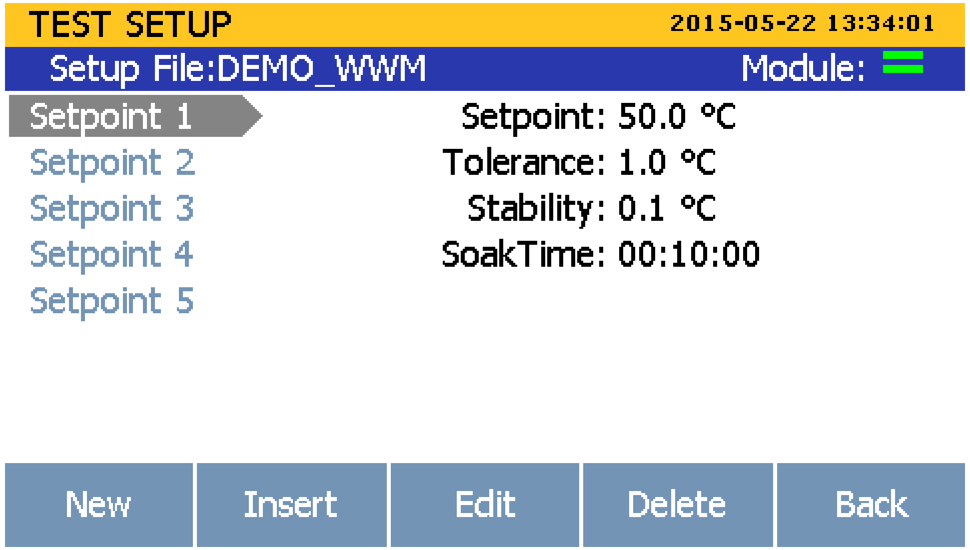

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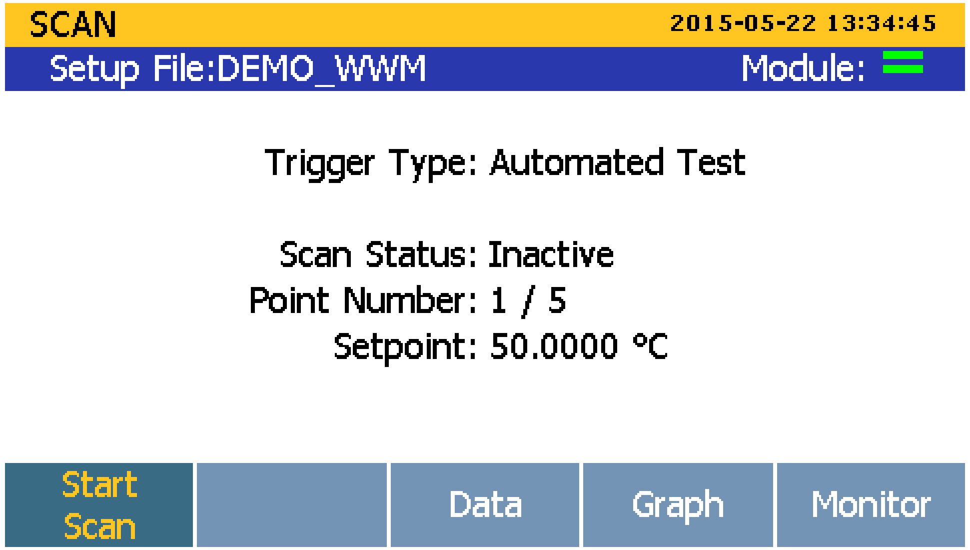

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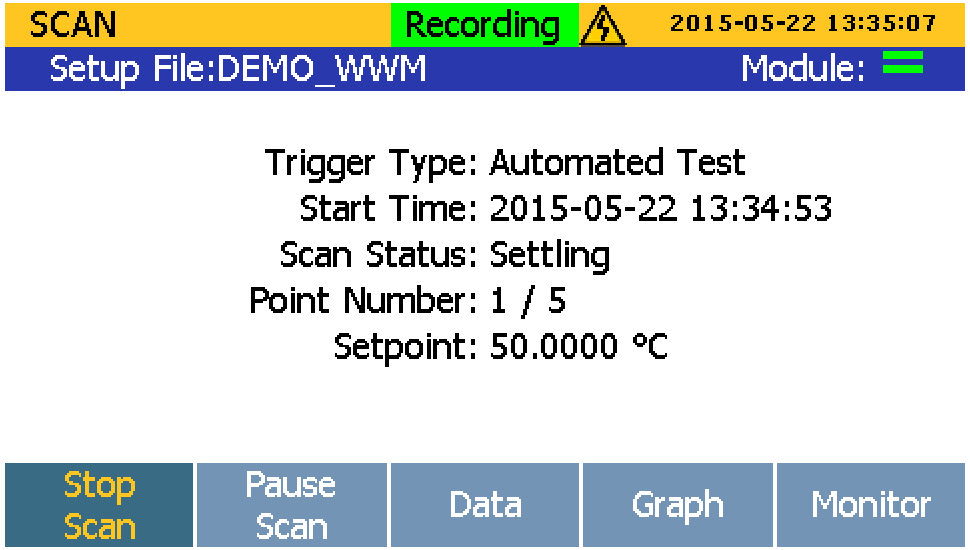

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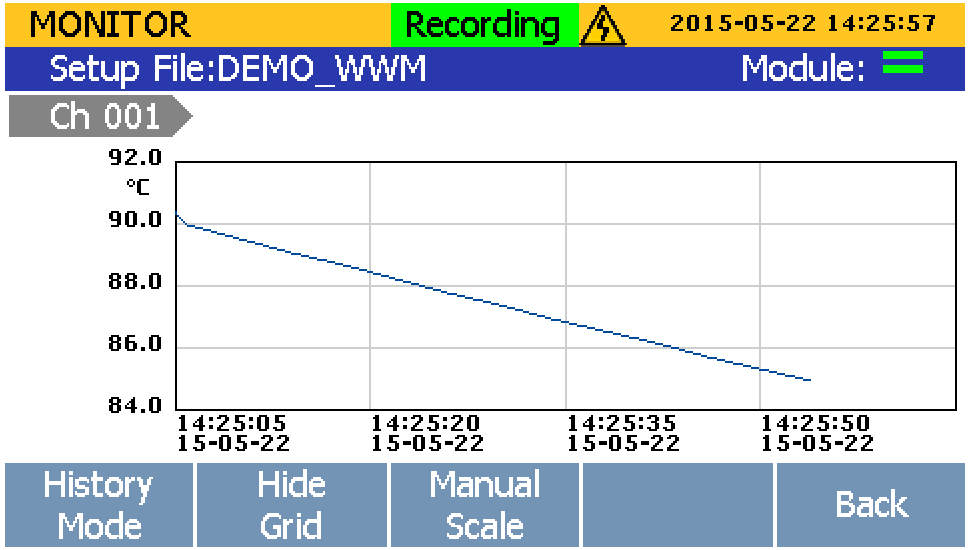

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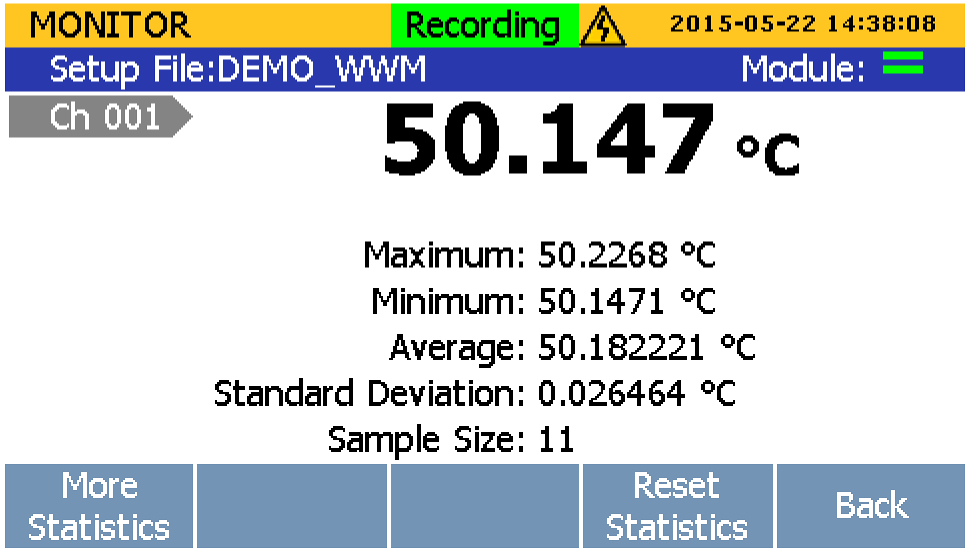
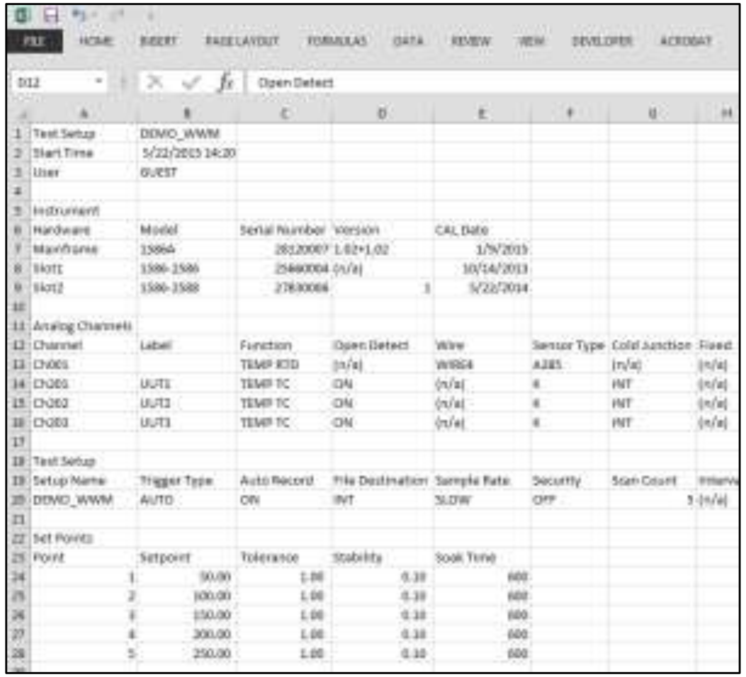
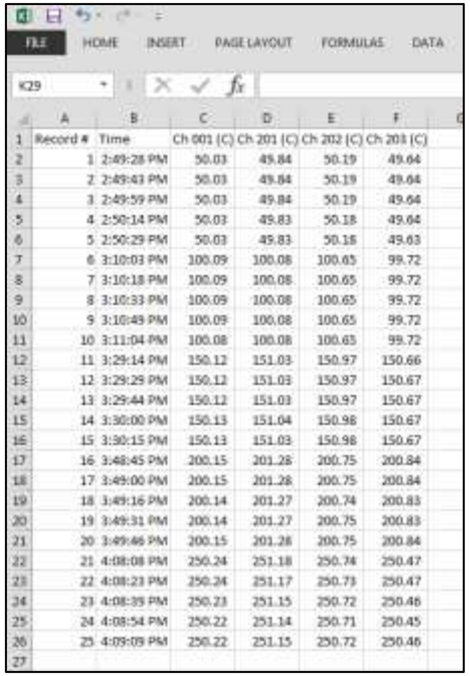


1586A Results

- Files stored in CSV format, easily read by Excel or other analysis or reporting tools
- Two files stored with each test
  - Setup.csv – records all configuration details
  - Data.csv – all measurement data with time tag



Test Setup	DEMO_WWM						
Start Time	5/22/2015 14:20						
User	GUEST						
Instrument							
Hardware	Model	Serial Number	Version	CAL Date			
Mainframe	1586A	28120007	1.02+1.02	1/9/2015			
Slot1	1586-2586	25460004	(n/a)	10/14/2013			
Slot2	1586-2588	27630006	1	5/22/2014			
Analog Channels							
Channel	Label	Function	Open Detect	Wire	Sensor Type	Cold Junction	Fixed
Ch001		TEMP RTD	(n/a)	WIRE4	A385	(n/a)	(n/a)
Ch201	UUT1	TEMP TC	ON	(n/a)	K	INT	(n/a)
Ch202	UUT2	TEMP TC	ON	(n/a)	K	INT	(n/a)
Ch203	UUT3	TEMP TC	ON	(n/a)	K	INT	(n/a)
Test Setup							
Setup Name	Trigger Type	Auto Record	File Destination	Sample Rate	Security	Scan Count	Interva
DEMO_WWM	AUTO	ON	INT	SLOW	OFF	5	(n/a)
Set Points							
Point	Setpoint	Tolerance	Stability	Soak Time			
1	50.00	1.00	0.10	600			
2	100.00	1.00	0.10	600			
3	150.00	1.00	0.10	600			
4	200.00	1.00	0.10	600			
5	250.00	1.00	0.10	600			



Record #	Time	Ch 001 (C)	Ch 201 (C)	Ch 202 (C)	Ch 203 (C)
1	2:49:28 PM	50.03	49.84	50.19	49.64
2	2:49:43 PM	50.03	49.84	50.19	49.64
3	2:49:59 PM	50.03	49.84	50.19	49.64
4	2:50:14 PM	50.03	49.83	50.18	49.64
5	2:50:29 PM	50.03	49.83	50.18	49.63
6	3:10:03 PM	100.09	100.08	100.65	99.72
7	3:10:18 PM	100.09	100.08	100.65	99.72
8	3:10:33 PM	100.09	100.08	100.65	99.72
9	3:10:49 PM	100.09	100.08	100.65	99.72
10	3:11:04 PM	100.08	100.08	100.65	99.72
11	3:29:14 PM	150.12	151.03	150.97	150.66
12	3:29:29 PM	150.12	151.03	150.97	150.67
13	3:29:44 PM	150.12	151.03	150.97	150.67
14	3:30:00 PM	150.13	151.04	150.98	150.67
15	3:30:15 PM	150.13	151.03	150.98	150.67
16	3:48:45 PM	200.15	201.28	200.75	200.84
17	3:49:00 PM	200.15	201.28	200.75	200.84
18	3:49:16 PM	200.14	201.27	200.74	200.83
19	3:49:31 PM	200.14	201.27	200.75	200.83
20	3:49:46 PM	200.15	201.28	200.75	200.84
21	4:08:08 PM	250.24	251.18	250.74	250.47
22	4:08:23 PM	250.24	251.17	250.73	250.47
23	4:08:39 PM	250.23	251.15	250.72	250.46
24	4:08:54 PM	250.22	251.14	250.71	250.45
25	4:09:09 PM	250.22	251.15	250.72	250.46

Questions?