

- The milliK Precision Thermometer can automate the calibration of both PRTs and Thermocouples
- I-Cal Easy Software can 'drive' the calibration and produce certificates from the data collected
- Calculation of CVD/ITS-90/Thermocouple Coefficients and Temperature Tables
- Equipment: Venus Temperature Calibrator (Site Model), milliK Precision Thermometer and millisKanner, Calibrated Reference Probe (Pt100), I-Cal Easy Automation Software, PC/Laptop, USB-Serial converter cable, Units Under Test

Application Note

Automation of Temperature Calibration

The automation of temperature calibrations has become more widespread in recent years as the demand from industry has grown and workloads have increased.

Significant time savings and the ability to produce tailored calibration certificates has enabled the metrology community to actively service this need.

Here, we show the equipment required and the configuration to automate the calibration-by-comparison of thermocouples and platinum resistance thermometers in the temperature range -20°C to +140°C.

We then use the data collected to produce a calibration certificate showing the calculation of CVD coefficients and the resulting uncertainties obtained.

Equipment and Configuration

The equipment listed opposite was connected and arranged as shown. I-Cal Easy software was installed on the PC/Laptop and connected to the precision thermometer and dry block via USB to serial connector.

The Units Under Test are Type T thermocouples and Pt100s.

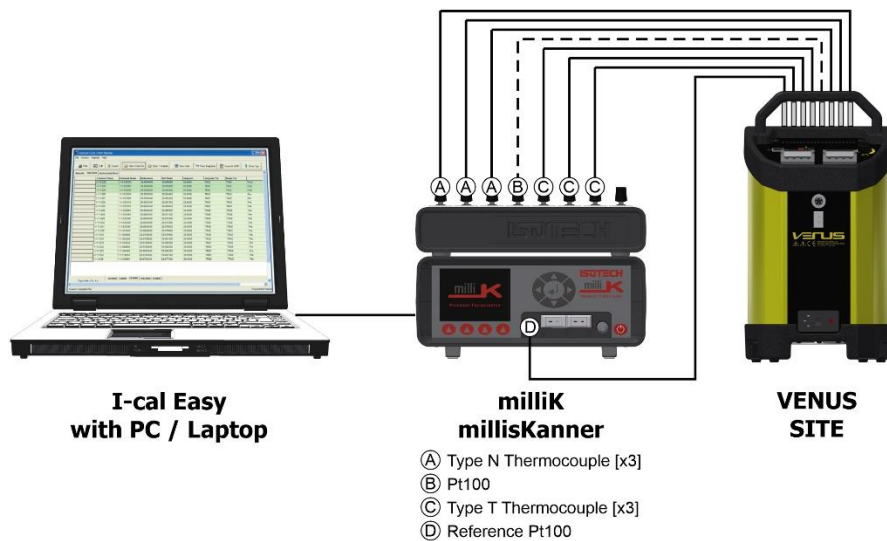


Figure 1 – Schematic of Equipment

I-Cal Easy – Interfacing with Equipment

1. Using the Interface Module of I-Cal Easy, simply *drag and drop* the relevant equipment (picture icons) onto the relevant com port and press start for each connection. The signals will then be seen continuously updating on the right-hand palette.

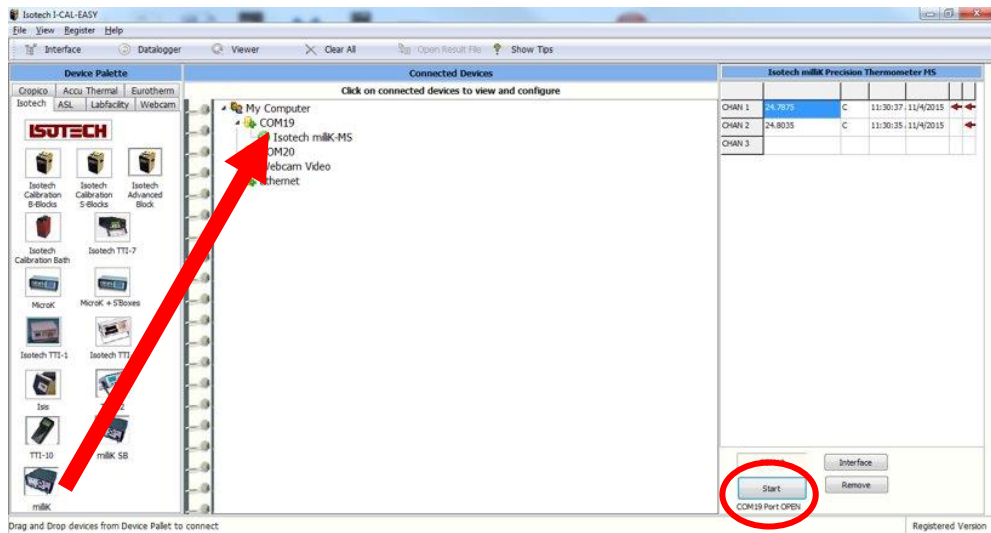


Figure 2 - I-Cal Easy Interface (Equipment)

2. Next, Configure the test - including units and decimal places required, making sure to label the reference channel and the setpoint control.

	Value	Units	Time	Date	Ref	SP	Decimals
1milk CHAN 1 COM19	24.802600	C	11:53:01 AM	11/4/2015	✓		0.000000 [Set]
2milk CHAN 2 COM19	24.832400	C	11:53:04 AM	11/4/2015			0.000000 [Set]
3milk CHAN 3 COM19	8.005810	mA	11:53:06 AM	11/4/2015	←		0.000000 [Set]
4 ABlock Setpoint	25.000000		11:53:07 AM	11/4/2015		✓	0.000000 [Set]
5 ABlock Proc Var	25.000000		11:53:07 AM	11/4/2015			0.000000 [Set]
6 ABlock Chan 1	24.250000		11:53:05 AM	11/4/2015			0.000000 [Set]
7 ABlock Chan 2	26.470000		11:53:06 AM	11/4/2015			0.000000 [Set]
8 ABlock Chan 3	24.510000		11:53:07 AM	11/4/2015			0.000000 [Set]

Figure 3 - I-Cal Easy Interface (Test Set-up Channels)

3. Then enter the parameters of the test: number of data points, repeat measurements and tolerances. Remember to “park” the equipment at a safe temperature after completing the program.

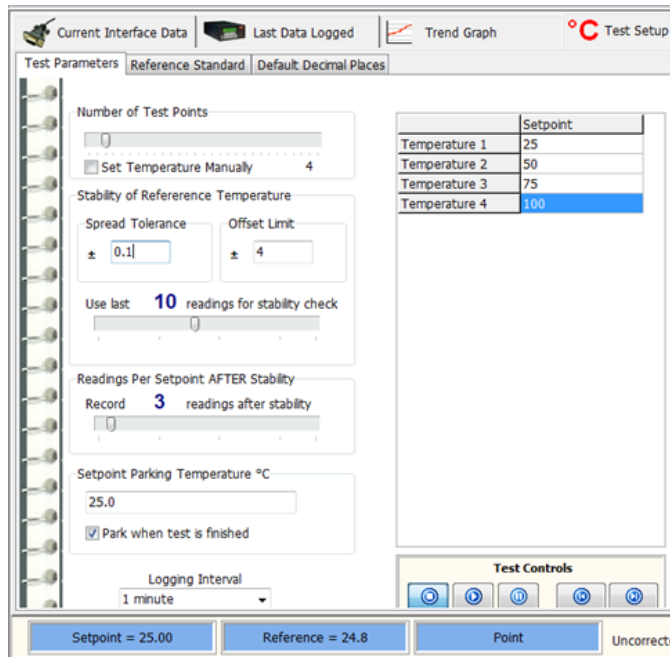


Figure 4 - I-Cal Easy Interface (Test Set-up Temperature Range & Tolerance)

Note: There is also a page to enter any optional information e.g. Operator ID, model, serial numbers of probes, etc. Use this page if you'd like this information to be transferred to the subsequent calibration certificate.

Reference Standard

Details of the Reference Standard can also be entered such as calibration coefficients if available. In this example, we can use this to generate our own CVD equation from the data and apply to the units under test.

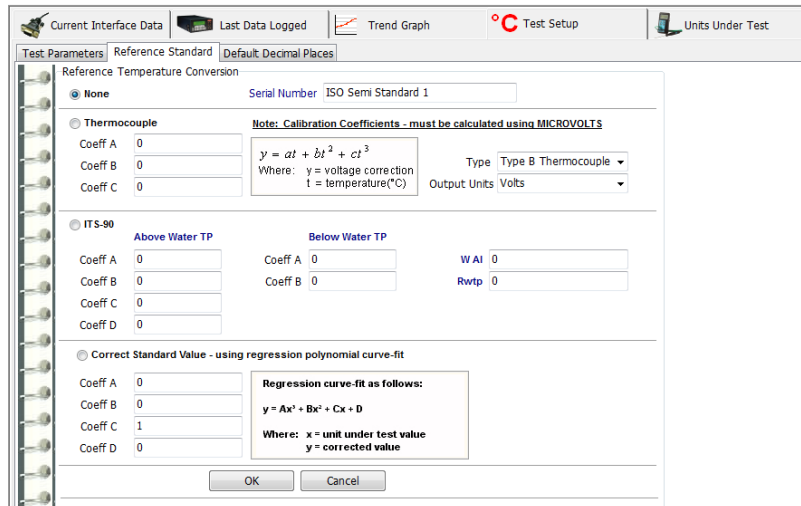
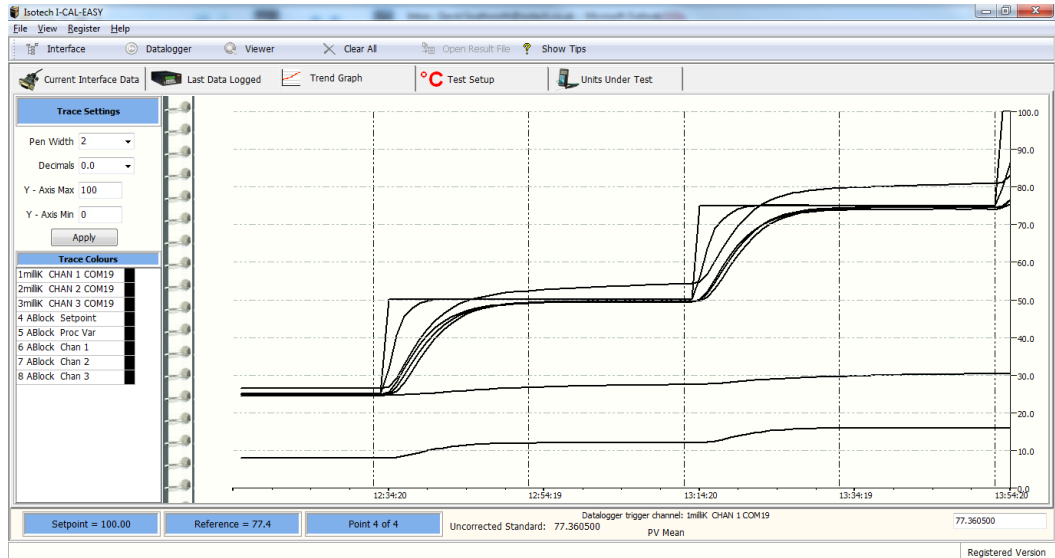


Figure 5 - I-Cal Easy Interface (Reference Standard)

4. After saving this interface for future use, start the test (assigning a file location for the data), and monitor the progress using the run-data windows and/or the graphical view.



	3millK CHAN 3 COM1	Chan Mean	Reference	Ref Mean	Setpoint	Spread Tol	Offset Tol	Status
Reading 1	15.948600	15.948600	74.536600	74.536433	75.000000	TRUE	TRUE	post-stability
Reading 2	15.948600	15.947700	74.536500	74.531670	75.000000	TRUE	TRUE	post-stability
Reading 3	15.948600	15.947330	74.536200	74.529450	75.000000	TRUE	TRUE	pre-stability
Reading 4	15.948200	15.946770	74.535900	74.526140	75.000000	TRUE	TRUE	pre-stability
Reading 5	15.948200	15.946020	74.534400	74.521490	75.000000	TRUE	TRUE	pre-stability
Reading 6	15.947700	15.944950	74.533900	74.515100	75.000000	TRUE	TRUE	pre-stability
Reading 7	15.947700	15.943460	74.532500	74.506250	75.000000	TRUE	TRUE	pre-stability
Reading 8	15.947700	15.941360	74.531100	74.494060	75.000000	TRUE	TRUE	pre-stability
Reading 9	15.947200	15.938470	74.528900	74.477340	75.000000	TRUE	TRUE	pre-stability
Reading 10	15.946800	15.934510	74.525600	74.454540	75.000000	TRUE	TRUE	pre-stability
Reading 11	15.946300	15.929100	74.521700	74.423640	75.000000	TRUE	TRUE	pre-stability
Reading 12	15.944900	15.922060	74.514300	74.381730	75.000000	FALSE	TRUE	unstable
Reading 13	15.943000	15.912590	74.503100	74.325460	75.000000	FALSE	TRUE	unstable
Reading 14	15.940700	15.899860	74.489400	74.249960	75.000000	FALSE	TRUE	unstable
Reading 15	15.937500	15.882740	74.470500	74.148230	75.000000	FALSE	TRUE	unstable
Reading 16	15.932800	15.859690	74.445400	74.010750	75.000000	FALSE	TRUE	unstable
Reading 17	15.926700	15.828900	74.410600	73.826610	75.000000	FALSE	TRUE	unstable
Reading 18	15.918800	15.787520	74.363900	73.580230	75.000000	FALSE	TRUE	unstable
Reading 19	15.907600	15.732560	74.300900	73.249780	75.000000	FALSE	TRUE	unstable
Reading 20	15.892700	15.659830	74.216600	72.826860	75.000000	FALSE	TRUE	unstable

Figure 6 - I-Cal Easy Interface (Run Data)

Summary of Interface

In our “setup” we have used a Pt100 as the reference on ch1 of the milliK, our units under test are attached to the milliKanner, these are 6x Type T thermocouples and 2x Pt100 PRTs, we can also choose collection of data in mV and Ohms respectively.

Certificate Builder

In addition to interfacing calibration equipment and data collection, I-Cal Easy also has a Certificate Builder whereby users can generate and print their own Calibration Certificates using the run data to show temperature points of references, Units Under Test and comparison errors for PASS or FAIL decision making.

Generation of CVD Coefficients for a Reference Probe

To obtain a curve fit for the reference probe and produce coefficients, open the data file for the reference channel, and choose Callendar Van Deusen from the Calculation Types (*ITS-90, comparisons and Thermocouple options also available*).

Simply *Drag & Drop* the appropriate results into the relevant fields and calculate...

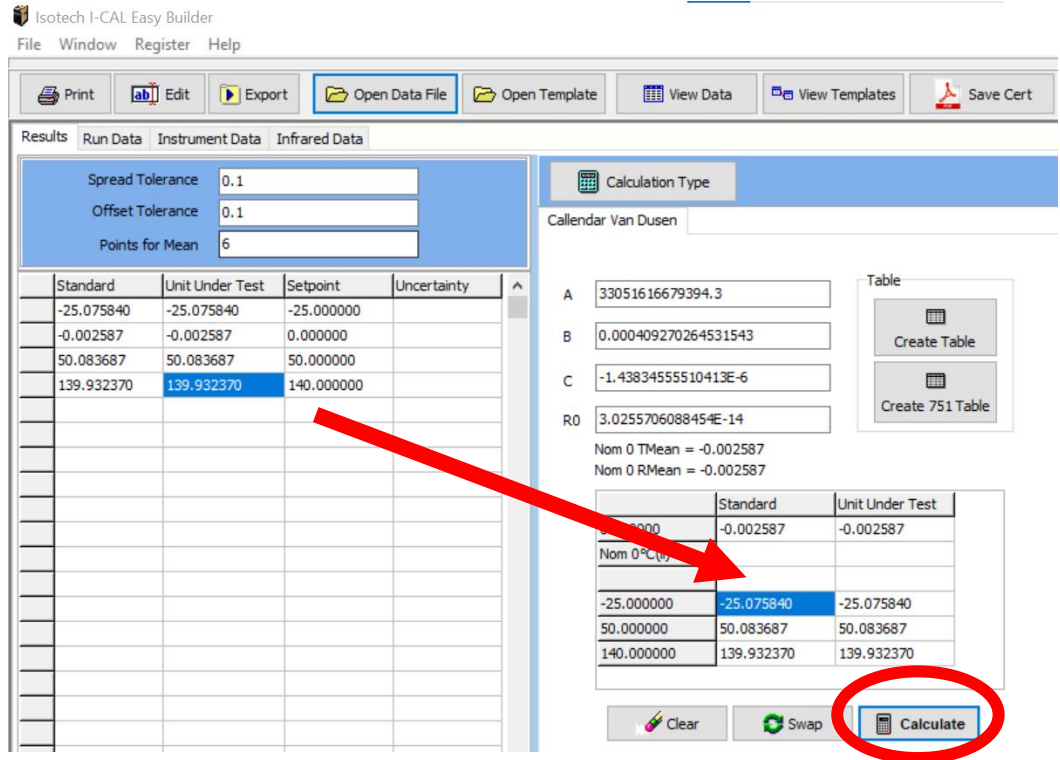


Figure 7 - I-Cal Easy Builder: Generating Calibration Coefficients

Standard Comparison Table

One of the simplest forms of temperature calibration is to compare Units Under Test with a known standard reference at the same temperature. Here we can generate a table showing the "error" values.

Note: In I-Cal Easy, you can also use a multipoint comparison from all channels recorded.

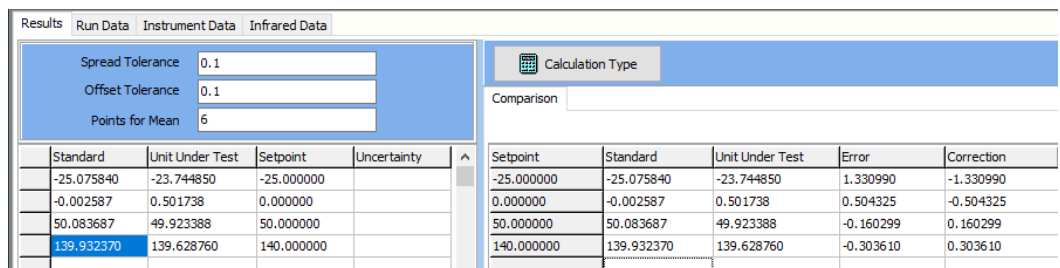


Figure 8 - I-Cal Easy Builder: Standard Comparison Table – PRT Standard, Type N Thermocouple under test

Certificate Editor

Having chosen our calculations and treated data, we are now in a position to present this using a certificate template. In addition to the collected Run Data., The template can be populated with text fields from the interface section, e.g. serial numbers, job number, engineer, notes, etc. Pictures of company logo can also be added. Using Drag & Drop, this is an effortless exercise and produces a truly professional conclusion to your calibrations with certificates that can be used for customers both internally and externally.

The screenshot shows the 'Certificate Designer' interface. The main area displays a 'Calibration Certificate' for 'I-cal Easy Laboratory'. The certificate includes the date of calibration (28/04/2021), a description of the test (thermometer comparison), and a table of results. A red arrow points to the 'Error' column in the table. The 'Database Field Properties' panel on the right shows the 'Comparison_Data' field selected.

Setpoint	Standard	Unit Under Test	Error	Correction
-25.000000	-25.075840	-23.744850	1.330990	-1.330990
0.000000	-0.002587	0.501738	0.504325	-0.504325
50.000000	50.083687	49.923388	-0.160299	0.160299
140.000000	139.932370	139.628760	-0.303610	0.303610

The Standard temperature values and the corresponding resistance values from the unit under test were used to calculate CVD coefficients as below.

R0	3.0255706088454E-14
Coefficient A	33051616679394.3
Coefficient B	0.000409270264531543
Coefficient C	-1.43834555510413E-6

The serial number of the unit under test was 1295
The serial number of the standard thermometer was: Type T

Figure 9 - I-Cal Easy Builder: Certificate Editor - Comparison of Thermocouple with Standard Pt100 Reference.

Conclusion

I-Cal Easy Automation software is a powerful addition to any temperature metrology laboratory. The Modern Calibration Engineer needs both speed and confidence in results. The method approached here is systematic and logical from the acceptance of units for test through to production of a calibration certificate. If you feel this would be the next step for your laboratory then contact us for discussion of how we can help you automate your calibrations.

Help and Advice

If you need low uncertainty measuring systems we can help, contact us for free advice and consultation. We have proven solutions at all levels in temperature metrology, from high accuracy cost effective industrial measurements systems to the lowest uncertainty systems for primary metrology used by the world's leading National Metrology Institutes.

If you have any questions, if you need any advice, if you would like a free consultation then please get in touch