Calibration WORLD

BEAMEX CORPORATE MAGAZINE • 2020

TEMPERATURE CALIBRATION

Uncertainty components using a dry block

RESISTANCE MEASUREMENT

2, 3 and 4 wire connection

TEMPERATURE SENSORS

How to calibrate them

beamex

CEO'S LETTER

While writing my opening words we're going through a pandemic that is unlike anything we've experienced in modern times. While it's difficult to predict the consequences, we do know that there will be long-lasting effects. One of these effects that is very relevant to calibration is the digital transformation of the process industry. Digitalization has been a megatrend already for some time, but the COVID-19 pandemic has now lit the fuse for it to really boom.

In a struggling market this is excellent news for Beamex as we have been a forerunner in digitalization since mid-80s when we launched our first calibration software with support for documenting calibrators.

This year an immense amount of R&D effort comes to fruition with the launches of MC6-T, a unique and better way to calibrate temperature instruments, and LOGiCAL, the world's first subscription-based calibration software. As a result of these releases Beamex is today fully equipped to support you on your journey towards a digital transformation of your calibration process.

In this issue of Calibration World, you can read about our new revolutionary technologies as well as examples from some of our customers that have already streamlined their calibration and moved away from manual pen and paper processes. I hope that some of our articles will interest you and that you get inspired to start your own calibration improvement journey – and of course that you choose Beamex as your partner to do so.

Enjoy your reading, and remember that we very much appreciate (and need) your feedback!

Jan-Henrik Svensson
CEO, Beamex Group

CALIBRATION WORLD

Published by Beamex Oy Ab
Ristisuonraitti 10, FI-68600, Pietarsaari, Finland
Phone +358 10 550 5000, Fax +358 10 550 5404
info@beamex.com, www.beamex.com

Details and subscriptions calibrationworld@beamex.com
Layout Studio PAP

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Uncertainty components of a TEMPERATURE CALIBRATION *using a dry block*

In previous articles we have discussed temperature calibration and calibration uncertainty. This time we will be covering the different uncertainty components that you should take into account when you make a temperature calibration using a temperature dry block.

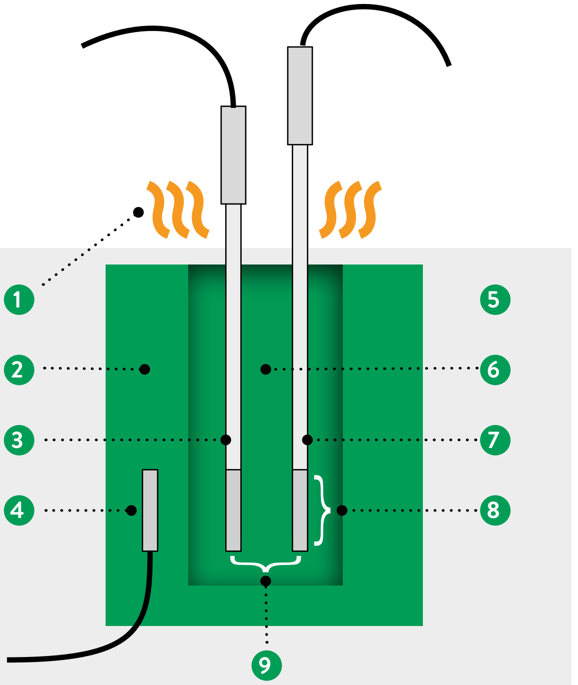
BEAMEX WHITE PAPER >>

Uncertainty components of a

TEMPERATURE CALIBRATION

using a dry block

Making a **temperature calibration** using a dry block seems like a pretty simple and straightforward thing to do, however there are many possible sources for uncertainty and error **that should be considered**.



1. Stem conductance / load effect
2. Temperature block
3. Sensor to be calibrated
4. Internal reference sensor
5. Stability over time
6. Insert
7. External reference sensor
8. Axial temperature homogeneity
9. Difference between borings

Simplified diagram of a dry block

Often the biggest uncertainties may come from the procedure on how the calibration is done, not necessarily from the specifications of the components.

WHAT IS A "DRY BLOCK"?

Let's start by discussing what I mean with a "temperature dry block" in the article.

A temperature dry block is sometimes also called a dry-well or a temperature calibrator.

It is a device that can be heated and/or cooled to different temperature values, and as the name hints, it is used dry, without any liquids.

A dry block typically has a removable insert (or sleeve) that has suitable holes/borings for inserting temperature sensors into.

The dry block typically has its own internal measurement for the temperature, or you may use an external reference temperature sensor that you will insert into one of the holes.

Typically a dry block has interchangeable inserts, so you may have several inserts, each drilled with different holes, to suit for calibration of different sized temperature sensors. It is very important in a dry block that the hole for the temperature sensor is sufficiently tight to enable low thermal resistance between the sensor and the insert. In too loose of a boring, the sensor stabilizes slowly or may not reach the temperature of the insert at all due to stem conduction.

Typically you would insert a temperature sensor in the dry block to be calibrated or calibrate a temperature loop where the temperature sensor is the first component in the loop.

The main benefits of a dry block are that it is easy to carry out in the field and there is no hot fluid that would spill when you carry it around.

Also, a dry block will not contaminate the temperate sensors being calibrated.

Dry blocks are almost always used dry. In some very rare cases you may use some heat transfer fluids or pastes. In most cases you may damage the dry block if you use liquids.

Using oil or pastes also cause a potential health and fire risk if later used in temperatures higher than, for example, the flash point of the foreign substance. A 660 °C dry block that has silicon oil absorbed into its insulation may look neat outside, but it will blow out noxious fumes when heated up. Calibration labs everywhere are probably more familiar with this than they would like to be...

As drawbacks for dry blocks, we could consider lower accuracy/stability than with a liquid bath and more difficult to calibrate very short and odd shaped sensors.

SO, IT'S NOT A "BATH"?

No, it is dry.

There are also temperature baths available, which have liquid inside. The liquid is heated/cooled and the temperature sensors to be calibrated are inserted into the liquid. The liquid is also stirred to achieve even temperature distribution.

There are also some combinations of dry block and liquid bath, these are devices that typically have separate dry inserts and separate liquid inserts.

The main benefits of a liquid bath are the better temperature homogeneity and stability and suitability for short and odd-shaped sensors.

While the drawbacks of a liquid bath are the bigger size, heavier weight, working with hot liquids, poorer portability and they're often slower than dry blocks.

Anyhow, in this article we focus on the temperature dry blocks, so let's get back to them.

EURAMET GUIDELINES

Let's take a quick look into Euramet guides before we proceed. And yes, it is very relevant for this topic.

Euramet is the Regional Metrology Organisation (RMO) of Europe. It coordinates the cooperation of National Metrology Institutes (NMI) in Europe. More on Euramet at https://www.euramet.org/

Euramet has also published many informative guidelines for various calibrations.

The one that I would like to mention here is the one dedicated for temperature dry block calibration: Euramet Calibration Guide No. 13, Version 4.0 (09/2017), titled "Guidelines on the Calibration of Temperature Block Calibrators".

The previous version, 3.0 was published in 2015 and the first version in 2007. The guideline was previously called EA-10/13, so you may run into that name too.

The guideline defines a normative way to calibrate temperature dry blocks. Many manufacturers use the guideline when calibrating dry blocks and when giving specifications for their dry blocks.

The table below shows the highlights of version 4.0 of the guide.

Making a temperature calibration using a dry block may seem like a pretty simple and straightforward thing to do.

HIGHLIGHTS – Euramet calibration guide no. 13, version 4.0
SCOPE
CALIBRATION CAPABILITY
CHARACTERIZATION • Axial homogeneity • Temperature difference between borings • Effects of loading • Stability over time • Heat conduction
CALIBRATION • Measurements • Uncertainties
REPORTING RESULTS
EXAMPLES

You can download the Euramet guide pdf for free here: ***Guidelines on the Calibration of Temperature Block Calibrators***

There are two principle ways to measure the true temperature of a dry block – using an internal or external reference sensor.

UNCERTAINTY COMPONENTS

Let's get into the actual uncertainty components. When you make a temperature calibration using a dry block, these are the things that cause uncertainty/error to the measurement results.

INTERNAL OR EXTERNAL REFERENCE SENSOR?

There are two principle ways to measure the true (correct) temperature of a dry block. One is to use the internal measurement using the internal reference sensor that is built in into the dry block, and the other is to use an external reference sensor that is inserted into the insert boring/hole.

There are some fundamental differences between these two ways and they have a very different effect on the uncertainty, so let's discuss these two options next:

1. Internal reference sensor

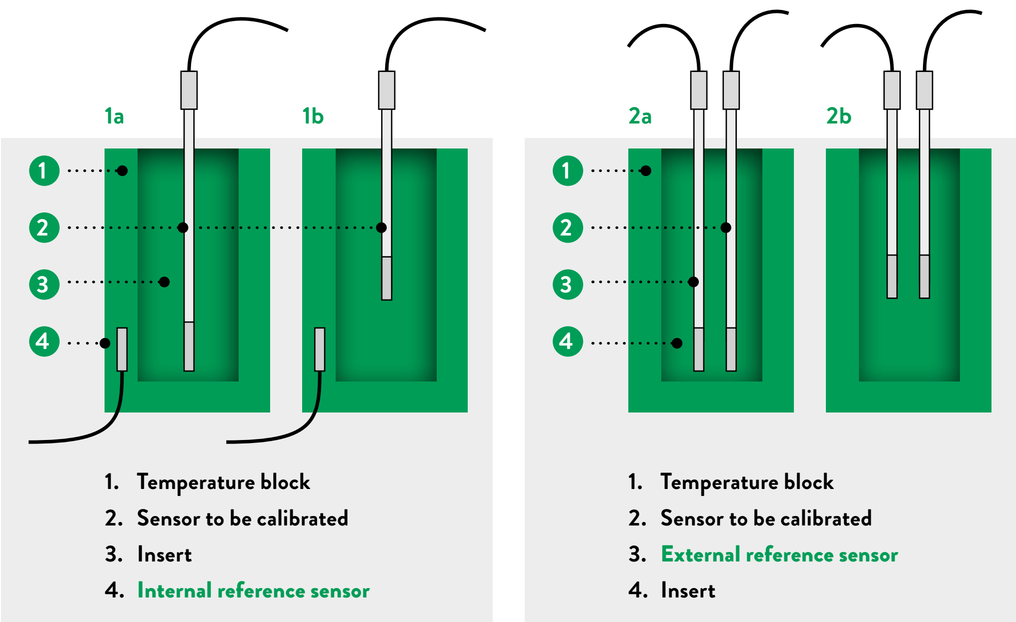
An internal reference sensor is permanently inserted into the metal block inside the dry block. It is typically close to the bottom part of the block and located in the metallic block surrounding the interchangeable insert. So, this internal sensor does not directly measure the temperature of the insert, where you insert the sensors to be calibrated, but it measures the temperature of the surrounding block. Since there is always some thermal resistance between the block and the insert, this kind of measurement is not the most accurate.

Especially when the temperature is changing, the block temperature normally changes faster than the insert temperature. If you make the calibration too quickly without allowing sufficient stabilization time, this will cause an error.

An internal reference sensor is anyhow pretty handy, as it is always ready inside the block, and you don't need to reserve a dedicated hole in the insert for it.

The recalibration of the internal measurement is a bit difficult, as you need to send the whole dry block to recalibration.

An internal measurement sensor's signal is naturally measured with an internal measurement circuit in the dry block and displayed in the block's display. The measurement typically has



PIC 1 & 2. The pictures illustrate the difference between an internal and external reference sensor.

an accuracy specification given. As discussed earlier, in practice this specification is only valid in stable conditions and does not include the uncertainties caused if the calibration is done too quickly or the sensors to be calibrated are not within the calibration zone at the bottom part of the insert, in a sufficiently tight boring.

PIC 1 shows how the internal reference sensor is typically located in the temperature block, while the sensor to be calibrated is inserted into the insert. If the sensor to be calibrated is long enough and reaches the bottom of the insert, the boring is tight enough, and we waited long enough for stabilization, we can get good calibration with little error.

In the second picture (***1b***) we can see what happens if the sensor to be calibrated is too short to reach to the bottom of the insert. In this case, the internal reference sensor and the sensor to be calibrated are located at different heights and are measuring different temperatures.

2. External reference sensor

The other way is to use an external reference sensor. The idea here is that you insert a reference sensor into a suitable hole in the insert, while you enter the sensors to be calibrated in the other holes in the same insert. As the external reference sensor is inserted into the same metal insert with the sensors to be calibrated, it can more precisely measure the same temperature as the sensors to be calibrated are measuring.

Ideally, the reference sensor would have similar thermal characteristics as the sensors to be calibrated (same size and thermal conductance). In that case, as the insert temperature changes, the external reference sensor and the sensor to be calibrated will more accurately follow the same temperature changes.

The external reference sensor naturally needs to be measured somehow. Often a dry block has internal measurement circuitry and a connection for the external reference sensor; you can also use an external measurement device. For uncertainty, you need to consider the uncertainty of the reference sensor and the uncertainty of the measurement circuitry.

Using an accurate external reference sensor results in a more accurate calibration with smaller uncertainty (compared to using an internal reference sensor). So, it is highly recommended if you want good accuracy (small uncertainty).

An external reference sensor also promotes reliability. If the internal and external sensor readings differ a lot, it's a warning signal to the user that something is probably wrong and the measurements may not be trustworthy.

For recalibration, in the case of an external reference sensor, you can send just the reference sensor for recalibration, not the whole dry block. This means that the dry block's functionalities – such as axial temperature and homogeneity – will not be checked and, if necessary, adjusted.

If you don't send the dry block for calibration, be sure to measure and record the axial gradient regularly yourself, as it's typically the biggest uncertainty component when the external reference sensor is used. Otherwise a strict auditor may profoundly question the traceability of your measurements.

Another matter is whether you use the dry block or an external thermometer/calibrator to measure the reference sensor. If you use the built-in reference sensor measurement, that needs to be calibrated too.

PIC 2 shows how the external reference sensor and the DUT sensor are both located in the insert. The first picture (*2a*) shows the case when both sensors reach the bottom of the insert. The second picture (*2b*) shows an example where the DUT sensor is short, and the reference sensor has been correctly positioned at the same depth as the DUT sensor.

If the sensor was located at a different height, that would cause additional error, but the error is still typically smaller than when using the internal reference sensor.

"Using an **accurate external reference sensor** results in a more accurate calibration with smaller uncertainty (compared to using an internal reference sensor). So, it is highly recommended if you want **good accuracy**.

3. Axial temperature homogeneity

Axial homogeneity (or axial uniformity) refers to the difference in temperature along the vertical length of the boring in the insert. For example, the temperature may be slightly different in the very bottom of the boring in the insert, compared to the temperature a little higher in the boring. Typically, the temperature will be different in the very top of the insert, as the temperature is leaking to the environment, if the block's temperature is very different than the environmental temperature.

Some temperature sensors have the actual measurement element being shorter and some longer. Also, some have the element closer to the tip than others. To ensure that different sensors are in the same temperature, the homogenic zone at the bottom of the block's insert should be long enough. Typically, the specified area is 40 to 60 mm.

A dry block should have sufficient area in the insert bottom within which the temperature homogeneity is specified. During a calibration of the block, this may be calibrated by using two high-accuracy reference sensors at different heights or using a sensor with a short sensing element that is gradually lifted higher from the bottom. This sort of short sensing element sensor needs to be stable but does not necessarily need to be calibrated because it's used just for measuring temperature difference at different heights. If needed, the axial temperature gradient can typically be adjusted.

If you have a short (sanitary) temperature sensor that does not reach all the way to the bottom of the boring in the insert, then things will get a bit more complicated. In that case, the internal reference measurement in the dry block cannot really be used as it is typically in the bottom of the block. An external reference sensor should be used and it should have the center of the measurement zone inserted as deep as the center of the measurement zone of the short sensor to be calibrated. Often, this means that a dedicated short reference sensor should be used inserted into the same depth as the short sensor to be calibrated. It gets even more difficult if the short sensor to be calibrated has a large flange as that will soak up heat from the sensor.

Summary - During the calibration you should ensure that your reference sensor is inserted to the same depth as the sensor(s) to be calibrated. If you know the lengths and the locations of the sensing elements, try to align the centers horizontally. If that is not possible, then you need to estimate the error caused by that. You should use an external temperature sensor if the accuracy requirements of the calibration are higher, or if the sensor to be calibrated is not long enough to reach the bottom of the insert hole.

PIC 3 illustrates what the "axial temperature homogeneity" means. Typically, a dry block has a specified area in the bottom that has a homogenic temperature, but as you start to lift the sensors higher, they will not be at the same temperature anymore.

4. Temperature difference between the borings

As the title hints, the temperature difference between the borings, sometimes referred to as "radial uniformity", is the temperature difference between each boring (hole) in the insert. Although the insert is made of metal compounds and has a good thermal conductivity, there can still be a small difference between the borings, especially the opposite ones.

In practice, when you have two sensors in the insert installed in the different borings, there can be a small temperature difference between them.

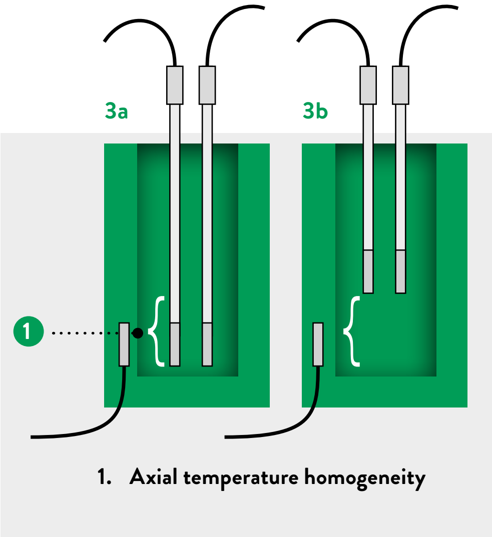
The difference can be caused by the insert touching the block more on one side or the insert being loaded unequally (more sensors on one side, or thicker sensors in one side than on the other side). Of course, the heaters and Peltier elements, located on different sides, have their tolerances too.

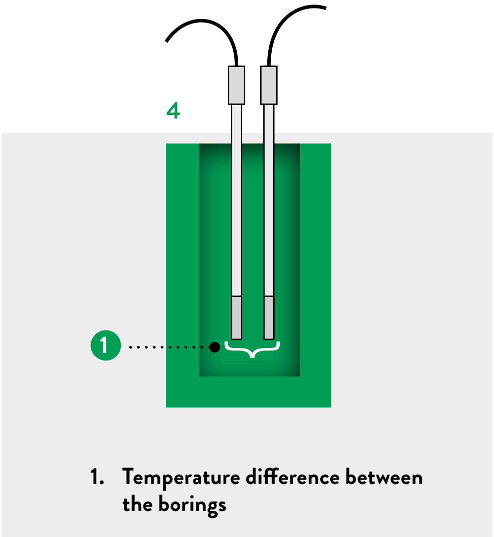
The temperature difference between the borings is normally relatively small in practice.

Summary – the specification of the temperature difference between borings should be taken into account.

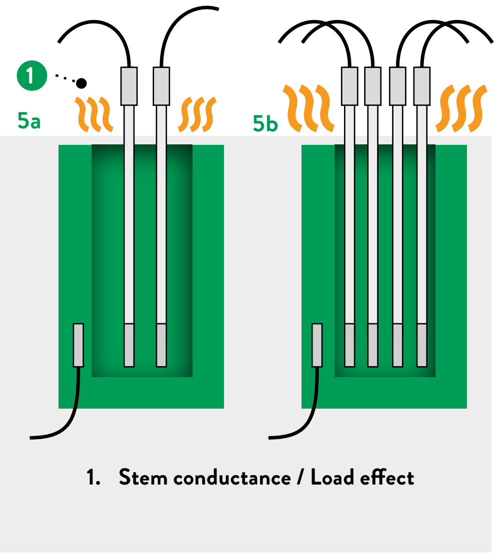
5. Influence of loading

There is always some heat conducted through the sensors to the environment (stem conductance) if the block's temperature differs from the environmental temperature.





PIC 3 & 4. The pictures illustrate what the "axial temperature homogeneity" means.



PIC 5. The pictures illustrate the stem conductance caused by the sensors leaking temperature to the environment.

If there are several sensors installed in the insert, there will be more temperature "leaking" to the environment. Also, the thicker the sensors, the more temperature leakage there will be.

The bigger the temperature difference between the insert and the environment temperature, the bigger the leakage will be.

For example, if you have the dry block at high temperature, temperature leakage will cause the insert to cool down because of the loading. The top of the insert will lose more temperature than the bottom of the insert and the top becomes cooler.

The deeper the insert is, the less loading effect there will be. Also, some dry blocks have two or more heating/cooling zones: one in the bottom, one in center and one in the top of the block. This will help to compensate the loading effect (e.g. the top heating can heat more to compensate the top of the insert to cool down).

If you use the internal reference measurement of the dry block, there will typically be a larger error since the internal reference is not in the insert but is in the bottom of the surrounding block. Therefore, the internal reference sensor does not see this effect of loading very well.

An external reference sensor can better see the effect of loading, as it is in the insert and will also have the same change in the temperature. The error caused by the loading effect is much smaller when an external reference sensors is used (compared to using internal reference sensor), and the results are better.

Summary – check out the loading effect of your dry block in your application (how many sensors, which type of sensor) and use that as one uncertainty component.

PIC 5 illustrates the stem conductance caused by the sensors leaking the temperature to the environment. In the second picture there are several sensors at the same, so the stem conductance/leakage will be larger.

6. Stability over time

Stability over time describes how well the temperature remains stable over a longer period. The temperature needs to be stable for a certain time, as the different sensors may have different thermal characteristics, meaning the amount of time it takes for them to stabilize will be different. If the temperature is constantly creeping up and down, the different sensors may read different temperatures.

In case there is some fluctuation in the temperature, an external reference sensor will anyhow result in more accurate results, compared to the use of an internal reference sensor.

Often a dry block manufacturer will provide a stability specification, for example for a 30 minute period.

7. Don't be in a hurry!

It's good to remember the fact that a temperature sensor will always measure only its own tem-

Get to know your system and the sensors you calibrate and experiment to determine how much time is needed for stabilization.

perature. So, it does not measure the temperature where it is installed, but it will measure its own temperature.

Also, temperature changes pretty slowly and it takes some time before all parts of the system have stabilized to the same temperature, i.e. the system has reached equilibrium.

If you make a temperature calibration with a dry block too fast, that will be the biggest source of uncertainty!

So, get to know your system and the sensors you calibrate and experiment to see how long time is enough for sufficient stabilization.

Especially if you use the internal reference sensor, it will reach the set temperature much faster than the sensors to be calibrated, which are located in the insert. That is because the internal sensor is in the block that is heated/cooled, and the sensors to be calibrated are in the insert. Taking the results too soon can cause a big error.

In case of an external reference sensor, the need for stabilization depends on how different your reference sensor is compared to your sensors to be calibrated. If they have different diameter, they will most likely have different stabilization times. Regardless, an external reference sensor will be much more accurate than an internal one, in case you don't wait long enough for stabilization.

Often a dry block will have a stability indicator, but that may be measuring the stability of the internal reference sensors, so don't trust only on that one.

Summary – shortly, if you do the temperature calibration too fast, the results will be terrible.

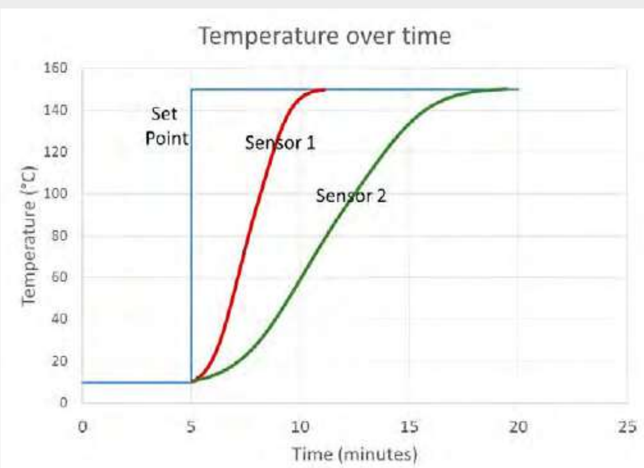
PIC 6 illustrates an (exaggerated) example where the temperature set point has been first 10 °C and at the five-minute mark it has been changed to 150 °C (blue line represents the set point).

There have been two sensors in the dry block – a reference sensor and a sensor to be calibrated.

We can see that the Sensor 1 (red line) changes much faster and reaches the final temperature at about 11 minutes point. The Sensor 2 (green line) changes much slower and it reaches the final temperature at around the 18 minutes mark.

Sensor 1 is our reference sensor and Sensor 2 is the sensor to be calibrated. We can see that if we read the temperatures too early, at the 10-minute mark, we will get a huge error (about 85 °C) in our results. Even if we take the readings at the 15-minute mark, we still have around 20 °C difference.

So, we should always make sure that we wait long enough to make sure that all sensors are stabilized to the new temperature, before we read the readings.



PIC 6. The picture illustrates an (exaggerated) example where the temperature set point has been first 10 °C and at the five-minute mark it has been changed to 150 °C.

SUMMARY

Making a temperature (sensor) calibration using a dry block seems pretty simple and straightforward. But there are anyhow many possible sources for uncertainty and error that should be taken into account. Often the biggest uncertainties may come from the procedure on how the calibration is done, not necessarily from the specifications of the components.

For example, you may have an accurate dry block that has combined total uncertainty being 0.05 °C and a high-quality reference sensor with uncertainty of 0.02 °C. Regardless of this, calibrating a temperature sensor with these devices can have an uncertainty of several degrees, if it is not made properly. That is one reason I don't like the discussion of TAR (Test Accuracy Ratio) as it does not take into account all the uncertainties caused by the calibration procedure.

I hope these considerations listed in the article help you to realize the possible sources of uncertainty and how to minimize them.

PRODUCTS & BLOGS

UNCERTAINTY COMPONENTS

BEAMEX OFFERING

Beamex offers various temperature calibration products, including two different series of temperature dry blocks. You can check our offering from the following link: [Beamex temperature calibration products]

RELATED BLOG POSTS

The main topics discussed in this article are temperature calibration and calibration uncertainty. Other related blog posts that could be of interest are:

- Measurement Uncertainty: Calibration uncertainty for dummies
- Metrological Traceability in Calibration – Are you traceable?
- Thermocouple Cold (Reference) Junction Compensation
- Temperature units and temperature unit conversion

You can find all our blog posts at: **blog.beamex.com**

Beamex celebrates 45th anniversary

BEAMEX 45

THIS YEAR we are celebrating Beamex's 45th anniversary.

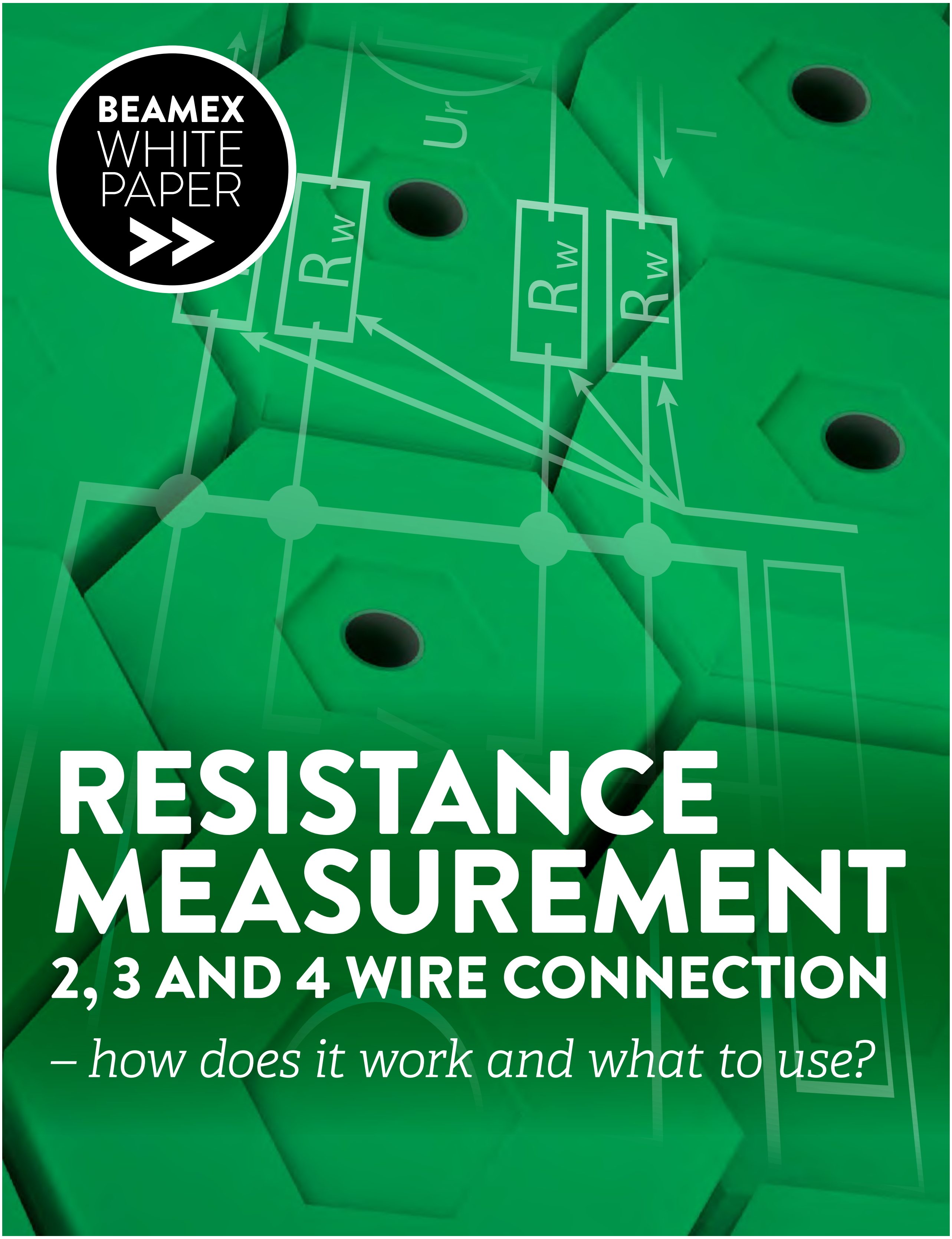
Beamex was founded back in 1975 by four instrument technicians that faced challenges in their calibration work and with their existing calibration equipment. They were convinced that there had to be a better way to perform calibrations, so they started to develop their own calibration equipment. They wanted to create a better way to perform calibrations. This is how Beamex and the idea of "a better way to calibrate" was born.

Our mission remains the same today: to seek better ways to calibrate together with our customers.

"We have recently launched two groundbreaking new products: Beamex MC6-T temperature calibrator and a subscription-based calibration software, Beamex LOGiCAL. Both these products continue our never-ending quest for better ways to calibrate for our customers and are built on feedback from and co-operation with our customers," says Jan-Henrik Svensson, the CEO of Beamex Group.

"The COVID-19 pandemic has forced us to be agile and change the way we conduct business with our customers, and I am really proud of our team and happy to see the successful results."

"Due to the current situation we have not been able to properly celebrate our anniversary but will certainly do that when it is possible. My sincere thanks also to our great customers – we couldn't have achieved our success without you!" continues Jan-Henrik.



RESISTANCE MEASUREMENT

2, 3 AND 4 WIRE CONNECTION

– how does it work and what to use?

Maybe you know that in resistance and RTD measurement you can use **2, 3 or 4 wires**. But maybe you don't really remember how these methods differ and how the connections really work.

In this article we explain shortly & simplified how a resistance or RTD meter works, what's the difference of the 2, 3 and 4 wire connections. We hope this info helps you in your job.

LET'S START DIGGING – HOW DOES A RESISTANCE/ RTD METER WORK?

Let's start building this from the foundation up. Before talking about the number of wires, let's first look at how a resistance meter works.

To start with, a resistance meter does not actually measure directly resistance. What?

The way resistance meter work is that the device sends a small accurate current through the resistance to be measured and then it measures the voltage drop formed over the resistance. Then, after it knows the current and voltage, the rest is solved with our good old friend, Ohm's law. Ohm's law says that resistance is voltage divided by current, or R = U/I.

So, the resistance meter measures the resistance via the current and voltage measurement.

Typically, the measurement current is around 1 mA, so if you are measuring a resistance of 100 ohms, there will be a 0.1 V voltage-drop over the resistance. The higher resistance ranges will use smaller measurement currents. Often temperature transmitters use current of about 0.2 mA. I've seen transmitters from 0.1 mA up to several mA.

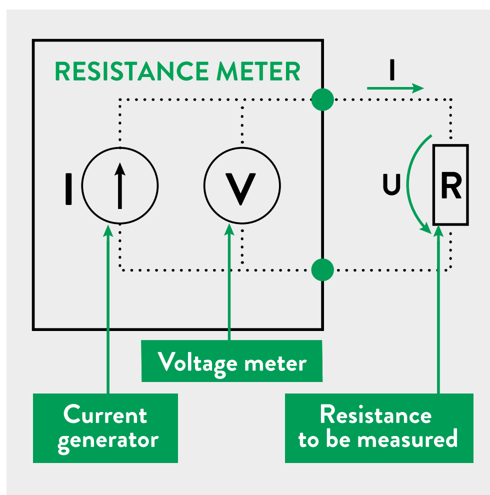
A resistance meter does not actually measure directly resistance. What?

The measurement current will cause self-heating in an RTD probe, due to power dissipation, especially in small RTD elements that have poor thermal connection with its surroundings. Therefore, the measurement current should be kept low.

The main point is that the resistance measurement device itself must know exactly what current it is using, to make the calculation correctly.

Maybe it is time for a picture to explain this:

The picture below (***SEE PIC.1***) is using a 2-wire connection, as there is only two wires (test leads) being used to connect the resistance. In the picture the wires are ideal with no resistance in them. But in practice all wires and test leads have



PIC 1. A 2-wire connection.

some resistance and also the contacts will always have more or less resistance.

So, if we illustrate the practical two wires connection, considering the resistance of the wires and connections, we get the following kind of practical schematics (***SEE PIC.2***).

The big problem here in practice is that the resistance meter will now measure the resistance which is the combination of the "resistance to be measured" and all the resistance in the wires and connections.

What the meter sees is the sum of Uw+Ur+Uw, although it would like to see only the Ur.

Therefore, there is error in the result.

Depending on wires and connections, this can cause huge error to the measurement. In case of long wires and poor connections, the error can be several ohms (or even infinite). But even in case of high quality test leads and clips, there will always be some error.

If you want to make reliable and accurate resistance (or RTD) measurements, never use a 2-wire connection. How to get rid of the errors seen in 2-wire measurement? The best answer is to use 4-wire connection.

4-WIRE RESISTANCE MEASUREMENT

With the 4-wire connection the idea is to have separate wires to deliver the measurement current and to measure the voltage drop over the resistance.

For this kind of connection, 4 wires are needed, therefore the name. Pretty logical...

Let's look at a picture to illustrate a 4-wire connection (***SEE PIC.3***).

You may wonder what difference does this make compared to 2-wire connection? Well, it does not make any difference with ideal wires and connections, but it's pretty difficult to get ideal wires...

So in practice, with all the unknown varying resistances in the wires and connections, this will make all the difference.

Why is that? Well, that's what I'm here for:

There are now separate wires that will deliver the accurate current through the resistance. If there is some resistance in these wires and connections, it does not matter, because the fixed current generator will still generate the same current and the current does not change as it passes through these connection resistances.

Also, there are separate wires for the voltage measurement. And these wires are connected straight to the legs of the resistance to be measured. Any resistance in these voltage measurement wires does not have any effect to the voltage measurement, because the voltage measurement is a very high impedance measurement, so there is practically no current in these wires. Even if there was resistance it would not cause any voltage drop, so there is no error.

A practical schematics of the same earlier 4-wire measurement schematics would look something like the below picture (***SEE PIC.4***), with wire and connection resistances (Rw) added.

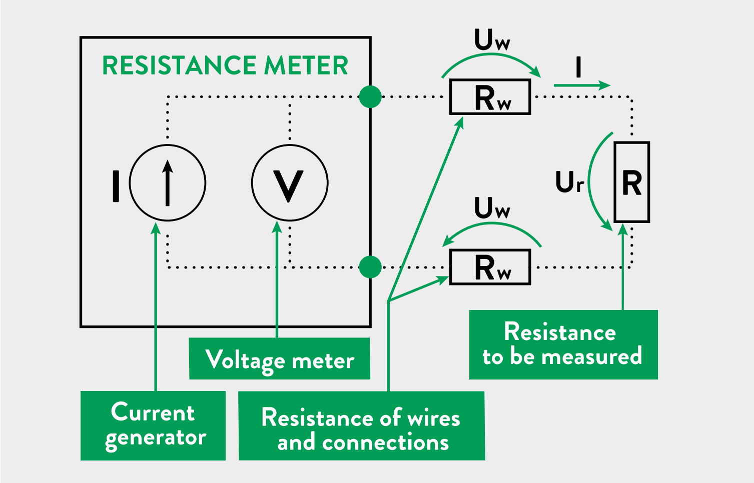
The 4-wire connection is the best and most accurate way to measure resistance or RTD sensor.

3-WIRE RESISTANCE MEASUREMENT

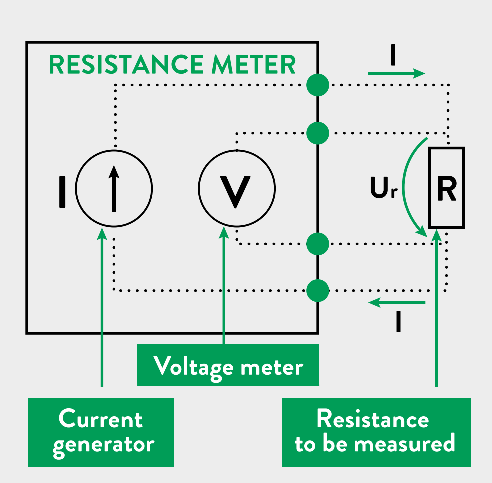
In practice, in industry, having to use/install 4 wires can be a bit expansive. There is a simplified modification of the 4-wire connection, which is a 3-wire connection. Yep, it uses 3 wires.

Although the 3-wire connection is not quite as accurate as the 4-wire one, it is very close if all 3 wires are similar. In practice the 3-wire connection is very close to 4-wire connection in accuracy and if far better than the poor 2-wire connection. Therefore the 3-wire connection has

PIC 2. Practical 2-wire connection schematics.



PIC 3. 4-wire connection.



become a standard in many industrial applications.

In 3-wire connection, the idea is that we remove one of the voltage measurement wires and assume that all the wires are similar in resistance.

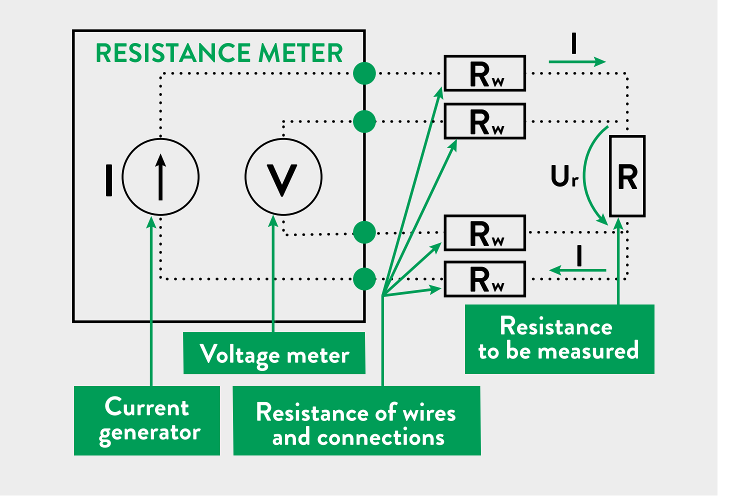
In the schematics to the right (***SEE PIC. 5***), the lower voltage measurement wire has been removed, and it is connected to the same wire with the measurement current. So, the lower side connection reminds the 2-wire connection, while the higher side is like the 4-wire connection. In the higher part, the meter can compensate for wire resistance, but in the lower part it has no means to compensate for the wire (Rw3) resistance.

So, how does the connection work?

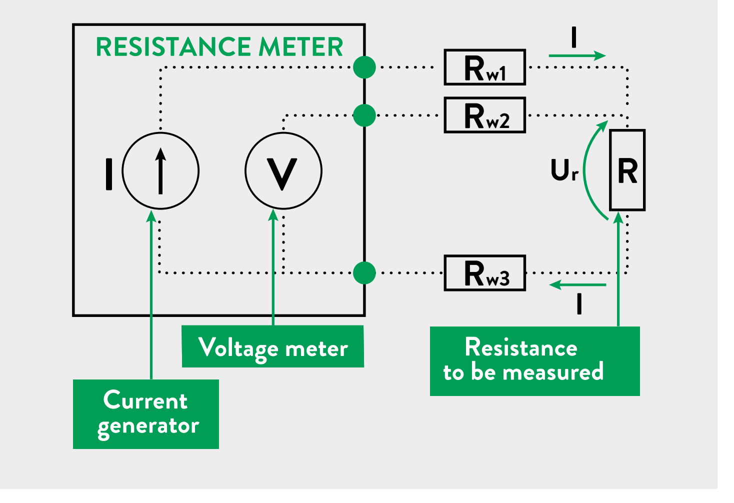
The resistance meter has internal switching so it can first measure only the resistance of the upper loop (summary of Rw1+Rw2), then divides that result by 2 and gets the average resistance of these two wires. The meter then assumes that the third wire (Rw3) has the same resistance as the average of Rw1 and Rw2. Then it switches to normal connection (as in the picture) to measure the connected impedance R, and it uses the results of the earlier measured wires resistance in the measurement result.

It's good to remember, that the 3-wire connection is accurate only if all the 3 wires and connections have the same resistance. If there are differences in the wire and connection resistances, then the 3-wire connection will result in erroneous measurement result.

In industrial applications, the 3-wire connection is often a good compromise; it is accurate enough and you need to use one less wire than in the perfect 4-wire measurement.



PIC 4. Practical 4-wire connection schematics.



PIC 5. 3-wire connection schematics.

CONCLUSION

RESISTANCE MEASUREMENT

A FEW THINGS TO REMEMBER:

- When calibrating resistance of RTD, always use 4-wire connection, if possible.
- Of course, when you calibrate an RTD temperature transmitter that is configured for 3-wire measurement, you need to use 3 wires. Make sure you use 3 similar wires and that you make good contacts.
- When using a 3-wire RTD probe in process, connected to RTD transmitter make sure you make good contacts to the transmitter screws for all 3 wires.
- When using an RTD reference probe in calibration, make sure you always use 4-wire connection.
- Newer use 2-wire resistance measurement in any application where accuracy is critical. Sure, it can be used for troubleshooting and for rough measurements.

Data is today's gold

Data is a **valuable raw material** offering unprecedented opportunities

Decisions based on data should be the core of every modern business, and the calibration business is no exception. However, in order for data to be valuable, it needs to be accurate as well as unmanipulated. A policy for data integrity and regular data analyses are becoming key factors for success.

Being able to retrieve calibration data in a smooth and quick way will help decision makers to gain an important overview of all calibrations in the company. The data provided by Beamex's calibration software can help companies analyze, predict, improve and enhance their processes.

In order to make the calibration data even more transparent and easily accessible, Beamex transfer them into the **Power BI** analytics tool upon the customer's request. Reports in Power BI are easy to filter and should be adapted according to the customer's specific needs. A custom-made report will harness the full potential of the calibration data and make the records more visual for decision making. The same reports can be used for decision making by senior management, auditors, technicians, and engineers.

It is just as important to know when to calibrate as it is to know when not to. By using data analytics, companies learn how their instruments drift. Thanks to this data, they are able to optimize their calibration intervals. Sometimes calibrating in a better, smarter and more efficient way, can be, to calibrate less. Taking a further step towards digitalization, calibration data can be part of a bigger infrastructure. This, when combined with a company's other data.

WHY USE BEAMEX BI DASHBOARDS FOR CALIBRATION DATA?

- Quick access to your needed data and KPIs
- Data can easily be filtered according to your needs
- Easy way of getting insights
- All crucial calibration data in one place
- Detect potential risks/problems
- Access calibration history and predict trends
- Optimize your calibration interval
- Predict how an instrument will drift
- Schedule your work and improve resource planning

For more information contact us on
solutions@beamex.com

CALIBRATION WEBINARS
ONLINE EVENTS 2020

BEAMEX WEBINARS

BEAMEX VIRTUAL EVENTS & WEBINARS 2020

2020, the year of adaption and change; when online meetings, webinars and virtual events have become the new norm for many and have possibly changed the way we work for the foreseeable future.

Like many, we had a number of plans and events that have inevitably had to be postponed and rescheduled. The safety of our colleagues and customers is our priority, but so is staying connected; here at Beamex we implemented a number of safety precautions to ensure that we are working safely and responsibly whilst continuing to provide our services to our customers.

This year we have changed the way we connect and have offered a number of training sessions, webinars and events, all online and supporting multiple different native languages including English, French, Spanish and German. The webinars that we have hosted this year have received some great feedback and we're happy that we've been able to adapt and support you during this time.

FIND OUR WEBINAR RECORDINGS AT:

www.beamex.com/resources/webinars/

Our annual American-hosted **Annual Calibration Exchange** (ACE) was this year held as a virtual event. You can (re)watch any of the informative presentations, detailed content, and hands-on demonstrations from the event at:
beamex.com/resources/webinars

Additionally, after the success of last year's Calibration Awareness and Learning (CAL) day hosted in central England, this will also be available online. Keep an eye out on our website for all of our planned, upcoming virtual events!

How to calibrate

TEMPERATURE SENSORS

Temperature measurement is one of the most common measurements in the process industry.

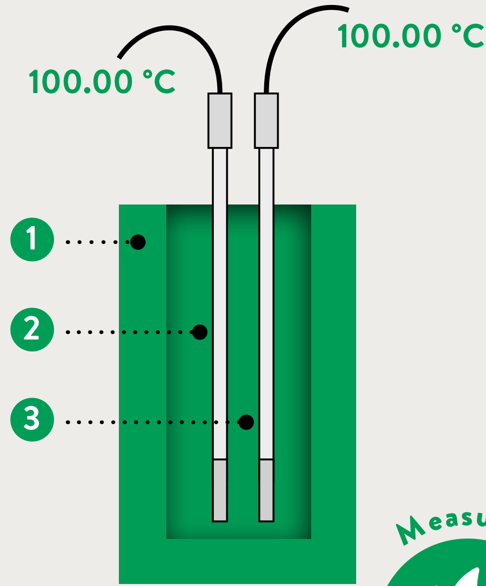

BEAMEX
WHITE
PAPER

How to calibrate

TEMPERATURE SENSORS

Every temperature measurement loop has a temperature sensor as the first component in the loop. So, it all starts with a temperature sensor.

DRY-BLOCK TEMPERATURE SOURCE



1. Temperature source
2. Sensor to be calibrated
3. Reference sensor

The temperature sensor plays a vital role in the accuracy of the whole temperature measurement loop. Just like any other measurement instrument you want to be accurate, the temperature sensor needs to be calibrated regularly. Why would you measure temperature, if you don't care about the accuracy?

In this article, we will take a look at how to calibrate temperature sensors and what are the most common things you should consider when calibrating temperature sensors.

WHAT IS A TEMPERATURE SENSOR?

Let's start from the basics... discussing what a temperature sensor is:

As the name indicates, a temperature sensor is an instrument that can be used to measure temperature. It has an output signal proportional to the applied temperature. When the temperature of the sensor changes, the output will also change accordingly.

There are various kinds of temperature sensors that have different output signals. Some have a resistance output, some have a voltage signal, some have a digital signal and many more.

In practice, in industrial applications, the signal from temperature sensor is typically connected to a temperature transmitter, that will convert the signal into a format that is easier to transfer for longer distances, to the control system (DCS, SCADA). The standard 4 to 20 mA signal has been used for decades, as a current signal can be transferred longer distances and the current does not change even if there is some resistance along the wires. Nowadays transmitters with digital signals or even wireless signals are being adopted.

Anyhow, to measure temperature, the measuring element that is used is the temperature sensor.

MEASURING THE TEMPERATURE SENSOR OUTPUT

As most temperature sensors have an electrical output, that output obviously needs to be measured somehow. That being said, you need to have a measurement device to measure the output, resistance or voltage, for example.

The measurement device often displays an electrical quantity (resistance, voltage), not temperature. So it is necessary to know how to

convert that electrical signal into a temperature value.

Most standard temperature sensors have international standards that specify how to calculate the electrical/temperature conversion, using a table or a formula. If you have a non-standard sensor, you may need to get that information from the sensor manufacturer.

There are also measuring devices that can display the temperature sensor signal directly as temperature. These devices also measure the electrical signal (resistance, voltage) and have the sensor tables (or polynomials/ formulas) programmed inside, so they convert it into temperature. For example, temperature calibrators typically support the most common RTD (resistance temperature detector) and thermocouple (T/C) sensors used in the process industry.

SO HOW TO CALIBRATE A TEMPERATURE SENSOR?

Before we go into the various things to consider when calibrating a temperature sensor, lets take a look at the general principle.

First, since the temperature sensor measures temperature, you will need to have a known temperature to immerse the sensor in to calibrate it. It is not possible to "simulate" temperature, but you must create a real temperature using a temperature source.

You can either generate an accurate temperature, or you can use a calibrated reference temperature sensor to measure the generated temperature. For example, you may insert the reference sensor and the sensor to be calibrated into a liquid bath (preferably a stirred one) and you can perform calibration at that temperature point. Alternatively, a so called dry-block temperature source can be used.

As an example, using a stirred ice-bath provides pretty good accuracy for the 0 °C (32 °F) point calibration.

For industrial and professional calibration, typically temperature baths or dry-blocks are used. These can be programmed to heat or cool the temperature into a certain set point.

In some industrial applications, it is a common practice to replace temperature sensors on regular intervals and not to calibrate the sensors regularly.

Temperature dry blocks are common in industrial applications because they are compact, portable, and provide sufficient accuracy.

Temperature changes pretty slowly and you should always wait long enough so that all parts have stabilized to the target temperature.

HOW TO CALIBRATE TEMPERATURE SENSORS – THINGS TO CONSIDER

Lets start digging into the actual calibration of temperature sensors and the different things to consider....

1. Handling temperature sensor

Different sensors have different mechanical structures and different mechanical robustness.

The most accurate SPRT (standard platinum resistance thermometer) sensors, used as reference sensors in temperature laboratories, are very fragile. Our temperature calibration laboratory people say that if a SPRT touches something so that you can hear any sound, the sensor must be checked before any further use.

Luckily most of the industrial temperature sensors are robust and will survive normal handling. There are some industrial sensors that are made very robust and then can withstand pretty rough handling.

But if you are not sure of the structure of the sensor you should calibrate it, because it is better to be safe than sorry.

It's never wrong to handle any sensor as if it was a SPRT.

In addition to mechanical shock, a very fast change in temperature can be a chock to the sensor and damage it or affect the accuracy.

Thermocouples are typically not as sensitive as RTD probes.

2. Preparations

There are normally not that many preparations, but there are some things to take into account. First, a visual inspection is performed in order to see that the sensor looks ok and make sure it has not been bent or damaged, and that the wires look ok.

External contamination can be an issue, so it is good to know where the sensor has been used and what kind of media it has been measuring. You may need to clean the sensor before calibration, especially if you plan to use a liquid bath for calibration.

The insulation resistance of an RTD sensor can be measured in prior to calibration. This is to make sure that the sensor is not damaged and the insulation between the sensor and the chassis is high enough. A drop in insulation resistance can cause error in measurements and is a sign of a sensor damage.

3. Temperature source

As mentioned, you need to have a temperature source to calibrate a temperature sensor. It is just not possible to simulate temperature.

For industrial purposes, a temperature dry-block is most commonly used. It is handy and portable and typically accurate enough.

For higher accuracy needs, a liquid bath can be used. That is anyhow not typically easily portable but can be used in laboratory conditions.

For zero Centigrade point, a stirred ice-bath is often used. It is pretty simple and affordable yet provides a good accuracy for the zero point.

For the most accurate temperatures, fixed-point cells are being used. Those are very accurate, but also very expensive. Those are mostly used in accurate (and accredited) temperature calibration laboratories.

4. Reference temperature sensor

The temperature is generated with some of the heat sources mentioned in the previous chapter. You obviously need to know with a very high degree of accuracy the temperature of the heat source. Dry-blocks and liquid baths offer an internal reference sensor that measures the temperature. But for more accurate results, you should be using a separate accurate reference temperature

Our temperature calibration laboratory people say that if a SPRT touches something so that you can hear **any sound**, the sensor must be checked before any further use.

sensor that is inserted in the same temperature as the sensor(s) to be calibrated. That kind of reference sensor will more accurately measure the temperature that the sensor to be calibrated is measuring.

Naturally the reference sensor should have a valid traceable calibration. It is easier to send a reference sensor out for calibration than sending the whole temperature source (it is good also to keep in mind the temperature gradient of the temperature block if you always only have the reference sensor calibrated not the block).

As for thermodynamic characteristics, the reference sensor should be as similar as possible compared to the sensor to be calibrated, to ensure they behave the same way during temperature changes.

The reference sensor and sensor to be calibrated should be immersed at the same depth in the temperature source. Typically, all sensors are immersed to the bottom of a dry-block. With very short sensors, it gets more difficult as they will only immerse a limited depth into the temperature source, and you should make sure that your reference sensor is immersed equally deep. In some cases, this requires a dedicated short reference sensor to be used.

Using fixed-point cells, you don't need any reference sensor, because the temperature is based on physical phenomena and is very accurate by its nature.

5. Measuring the temperature sensor output signal

Most temperature sensors have an electrical output (resistance or voltage) that needs to be measured and converted to temperature. So, you need to have some device to be used for the measurement. Some temperature sources offer also measurement channels for the sensors, both device under test (DUT) and reference.

If you measure the electrical output, you will need to convert that into temperature, using international standards. In most industrial cases, you will use a measurement device that can do the conversion for you, so you can see the signal conveniently in the temperature unit (Centigrade or Fahrenheit).

What ever means you use for the measurement, make sure you know the accuracy and uncertainty of the device and ensure it has valid traceable calibration.

6. Immersion depth

Immersion depth (how deep you insert the sensor into the temperature source) is one important consideration when calibrating temperature sensors.

Our temperature calibration lab people follow this rule of thumb when using a stirred liquid bath:

- 1% accuracy - immerse 5 diameters + length of the sensing element
- 0.01% accuracy - immerse 10 diameters + length of the sensing element
- 0.0001% accuracy - immerse 15 diameters + length of the sensing element

Heat conduction in a stirred liquid bath is better than in a dry-block and the required immersion depth is smaller.

For dry-blocks, there is an Euramet recommendation that you should immerse 15 times the diameter of the sensor added with the length of the sensor element. So, if you have a 6 mm diameter sensor, which has a 40 mm element inside, you immerse it (6 × 15 mm + 40 mm) 130 mm.

Sometimes it is difficult to know how long the actual element is inside the sensor, but it should be mentioned at the sensor specifications.

Also, you should be aware of where the sensor element is located (it is not always in the very tip of the sensor).

The sensor to be calibrated and the reference sensor should be immersed into the same depth so that the middle points of the actual sensor elements are in the same depth.

Naturally with very short sensors, it is not possible to immerse them very deep. That is one reason for the high uncertainty when calibrating short sensors.

7 – Stabilization

Remember that a temperature sensor always measures its own temperature!

Temperature changes pretty slowly and you should always wait long enough to have all parts stabilized to the target temperature. When you insert the sensor into a temperature source, it will always take some time before the temperature of the sensor has reached that temperature and stabilized.

Your reference sensor and the sensor to be calibrated (DUT) may have very different thermodynamic characteristics, especially if they are mechanically different.

Often one of the biggest uncertainties related to temperature calibration can be that the calibration is done too quickly.

Often one of the biggest uncertainties related to temperature calibration can be that the calibration is **done too quickly**.

With temperature sensors, it is pretty common that you don't calibrate the whole temperature range of the sensor.

If you typically calibrate similar kinds of sensors, it is wise to make some type tests to learn the behavior of those sensors.

8 – Temperature sensor handle

The sensor handle part, or the transition junction, typically has a limit of how hot it can be. If it is heated too hot, the sensor may be damaged. Make sure you know the specifications of the sensors you calibrate.

If you calibrate in high temperatures, it is recommended to use a temperature shield to protect the sensor handle.

9 – Calibrated temperature range

With temperature sensors, it is pretty common that you don't calibrate the whole temperature range of the sensor.

The very top of the range is something you should be careful in calibrating. For example, a RTD sensor can drift permanently if you calibrate it in too high temperature.

Also, the coldest points of the sensor's temperature range can be difficult/expensive to calibrate.

So, it is recommended to calibrate the temperature range that the sensor is going to be used in.

10 – Calibration points

In industrial calibration, you need to pick enough calibration points to see that the sensor is linear. Often it is enough to calibrate 3 to 5 points throughout the range.

Depending on the sensor type, you may need to take more points, if you know that the sensor may not be linear.

If you calibrate platinum sensors and you plan to calculate coefficients based of the calibration results, you will need to calibrate at suitable temperature points to be able to calculate the coefficients. The most common coefficients for the platinum sensors are the ITS-90 and Callendar van Dusen coefficients. For thermistors, Steinhart-Hart coefficients can be used.

When sensors are calibrated in an accredited laboratory, the points may also be selected based on the lab's smallest uncertainty.

11 – Adjusting / trimming a temperature sensor

Unfortunately, most temperature sensors can not be adjusted or trimmed. So, if you find an error in calibration, you cannot adjust to compensate it. Instead you will need to use coefficients to correct the sensor's reading.

In some cases, you can compensate the sensor error in other parts of the temperature measurement loop (in transmitter or in DCS).

OTHER THINGS TO CONSIDER

Documentation

As with any calibration, the temperature sensor calibration needs to be documented in a calibration certificate.

Traceability

In calibration, the reference standard used, must have a valid traceability to National Standards, or equivalent. The traceability should be an unbroken chain of calibrations each having stated uncertainties.

More info on metrological traceability, please see the blog post Metrological Traceability in Calibration – Are you traceable?

Uncertainty

As always in calibration, also in temperature sensor calibration, you should be aware of the total uncertainty of the calibration process. In temperature calibration the calibration process (the way you do the calibration) can easily be by far the biggest uncertainty component in the total uncertainty.

More information on calibration uncertainty, please see the blog post Calibration uncertainty for dummies.

Automating the calibration

Temperature calibration is always a pretty slow operation since temperature changes slowly and you need to wait for the stabilization. You can benefit a lot, if you can automate your temperature calibrations. The calibration will still take a long time, but if it is automated, you don't need to be there to wait for it.

This will naturally save time and money for you.

Also, when automated, you can be sure that the calibration gets always done the same way.

PRODUCTS & BLOGS

UNCERTAINTY COMPONENTS

BEAMEX OFFERING

Beamex offers various temperature calibration products, including two different series of temperature dry blocks. You can find our full offering at: Beamex temperature calibration products

RELATED BLOG POSTS

If you found this article interesting,

you may also like some of the listed below blog posts.

- Uncertainty components of a temperature calibration using a dry block
- Pt100 temperature sensor – useful things to know
- Thermocouple Cold (Reference) Junction Compensation
- How to calibrate temperature instruments [Webinar]

Thanks to our accredited temperature calibration laboratory experts for their help in creating this article. Special thanks to Mr. Toni Alatalo, the head of our accredited temperature laboratory!

You can find all our blog posts at: blog.beamex.com

Future Calibration Trends

If you don't have time to read the whole article on the Beamex blog, here is a **quick-read executive summary**.

EXECUTIVE QUICK-READ SUMMARY

We regularly organize user-group meetings for our pharmaceutical customers. During a recent meeting, we interviewed some of these pharmaceutical calibration experts on future calibration trends and then compiled their answers into an article.

What are your biggest calibration challenges?

For pharmaceutical companies, compliance with regulations is naturally a vital consideration.

Data integrity is a challenge that seems to come up time and time again, i.e. to produce calibration data without any media breaks. There is a drive to remove paper-based systems for recording and approval in calibration solutions and to digitalize the whole calibration process.

Another repeating comment is the mobility, the security and data integrity with mobile devices.

Also, the implementation of a standardized global calibration solution across multiple sites is another challenge.

How do you see your calibration changing in the next 5 years?

The most common issue is the drive to replace paper-based systems with a digital calibration process. Integrating calibration systems with other systems such as maintenance management systems also seems to be a common topic. In addition, there is the use of calibration data in other systems and the drive to improve mobility.

Do you see any future technology changes that could affect the need to calibrate, or how to perform your calibrations?

When discussing future technology the topics included: cloud technology, automatic calibration, digitalization enabling paperless calibration, more productivity with more efficient calibration, using calibration data for analysis, integration of systems, increased mobility and naturally the effects of the Industry 4.0.

Do you see digitalization changing your calibration?

Most delegates commented that they will definitely be going digital and are excited to do so.

Other comments include improved data analytics, increased mobility, better connectivity of systems, expecting digitalization to improve data integrity and the development of the DCC (digital calibration certificate) standard.

LATEST NEWS

Beamex introduces a better way to perform temperature calibrations with a new revolutionary, versatile temperature calibration solution called the **Beamex MC6-T**.

The MC6-T is the latest member of the hugely successful and respected Beamex MC6 family including the MC6 documenting calibrator and communicator, the MC6 Workstation bench calibrator and communicator and the ATEX, IECEx and North American certified MC6-Ex intrinsically safe field process calibrator and communicator.

A BETTER WAY TO CALIBRATE TEMPERATURE

"For over 40 years Beamex has developed competence in temperature metrology and we have

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As standard, the **MC6-T** provides a class-leading **customer experience** with outstanding **ease-of-use** coupled with dependable **safety features** protecting people and the workplace."

recently gained a more comprehensive understanding of thermodynamics and temperature control systems. This has allowed us to combine our experience of calibrator design, temperature calibration and expertise in temperature metrology culminating in a cutting-edge temperature dry block, that remarkably simplifies temperature calibration," *Beamex Product Manager* **Antti Mäkynen explains**.

The powerful and versatile nature of the MC6-T shows through when you consider that this one device can provide high accuracy reference measurements and simulations for: temperature, pressure and electrical signals such as resistance, mA, mV, V, pulses and frequency together with HART, Profibus PA and FOUNDATION Fieldbus communicator. "With all this functionality, the MC6-T can replace many individual devices such as a temperature block, temperature calibrator, pressure calibrator, field communicator, datalogger and many more. There is nothing on the market that has this combination of functionality," Mr. Mäkynen explains. "As standard, the MC6-T provides a class-leading customer experience with outstanding ease-of-use coupled with dependable safety features protecting people and the workplace," he continues.

The combination of superior temperature, metrological performance, shortened calibration cycle time and special design consideration for immunity to environmental conditions are a few of the unique features. It also offers the capability to calibrate short and flanged sanitary sensors. Typically, this is not possible with traditional temperature dry-blocks. The MC6-T is available in two different models: MC6-T150 for low temperature applications and the MC6-T660 for higher temperature calibrations.

By combining the MC6-T with Beamex software, the temperature calibration process will be fully automated and hence also paperless. With this kind of integrated calibration solution, the time spent on calibration can typically be reduced by up to 50%, saving money while at the same time improving the quality of records.

The MC6-T is the latest member of the hugely successful and respected Beamex MC6 family.

MC6-T can replace many individual devices such as a temperature block, temperature calibrator, pressure calibrator, communicator and datalogger.

About Beamex

BEAMEX is a leading worldwide provider of calibration solutions with the sole purpose to create better ways to calibrate for the global process industry. Beamex offers a comprehensive range of products and services — from portable calibrators to workstations, calibration accessories, calibration software, industry-specific solutions and professional services. Through Beamex's subsidiaries, branch offices and an extensive network of independent distributors, their products and services are available in more than 80 countries. Beamex has more than 12,000 customers worldwide.

LATEST NEWS

BEAMEX SIRT
SHORT TEMPERATURE PROBE

THE BEAMEX SIRT-155 IS A SHORT AND ACCURATE PT100 TEMPERATURE PROBE

■ The Beamex SIRT-155 is a very short temperature probe provided with a thin flexible cable. The SIRT-155 is a perfect solution when calibrating short sanitary sensors with the Beamex MC6-T temperature calibrator. It may also be used as a general-purpose short and accurate temperature probe. SIRT-155 offers a temperature range of -30 … 155 °C (-22 … 311 °F).

Short sanitary temperature sensors, especially ones with a flange, are a challenge to calibrate. You need a suitable temperature source and also a reference probe that is short enough to be immersed in the same depth as the sanitary sensor to be calibrated. The Beamex SIRT-155 is a temperature probe designed for that purpose.

The SIRT-155 is a standard IEC60751 Class A Pt100 sensor and can be used accurately without coefficients. For improved accuracy, it can be used with the ITS-90 coefficients provided as standard.

The SIRT-155 probe is provided with a connector for the Beamex MC6-T and several other Beamex calibrators.
More info: **www.beamex.com/calibrators/beamex-sirt-short-temperature-probe/**

SIRT-155 is provided with a handy Lemo connector, so it can be easily connected into several Beamex calibrators.

SIRT-155 is a great solution to be used as a short reference sensor when calibrating short sanitary sensors with the Beamex MC6.

MAIN FEATURES:

- Short sensor with thin flexible cable
- Optimal for calibration of short sanitary sensors
- Temperature range –30 °C to 155 °C (–22 to 311 °F)
- Provided with a 6 pin Lemo connector compatible with many Beamex calibrators
- Comes with an accredited calibration certificate with data and ITS-90 coefficients

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THE BEAMEX WEBSHOP IS NOW OPEN FOR BUSINESS

BEAMEX IS PROUD TO OPEN A DEDICATED GLOBAL DIGITAL PLATFORM FOR THE SALE OF BEAMEX PRODUCTS

■ The new webshop will initially focus on the sale of spare parts and accessories for Beamex calibrators providing an opportunity for customers to purchase directly from the Beamex warehouse, through a website optimised for use on a smartphone, tablet or desktop interface.

"The new webshop is truly a Better Way to buy Beamex spare parts and accessories. Significant effort has been made to ensure products are clearly listed and categorized in a way to make it simpler and faster to buy. The ease of selecting the correct essential spares and accessories is enhanced using a related products feature and artificial intelligence," says **Jonas Heinola**, *Sales Manager* for eCommerce at Beamex.

In addition to providing a new channel for the sales of Beamex products, the new webshop also acts as a useful resource to better understand the range of spare parts and accessories available and to confirm component compatibility: Instruction manuals, a pressure fittings guide and comprehensive search functions exists.

> The new webshop is truly **a Better Way** to buy Beamex spare parts and accessories.

The webshop is available in many different languages and can be browsed without needing to create an account.

The webshop is available in many different languages and can be browsed without the need to create an account. Once an account is created and your purchase is concluded your goods are fast-tracked for shipment and arrive to you quickly. While initially the webshop only allowed for the purchase of products for shipment to Germany, Finland, France, and the UK, by the end of 2020 coverage will be expanded to the whole of Europe and the US. The intention is to expand even further within the near future.

"Our new webshop is a significant step forward to providing our global customers with a 24/7 access to the right spare parts and accessories quickly and efficiently. This new initiative supports our corporate strategy of a 'One Beamex' approach to doing business," says **Jan-Henrik Svensson**, *CEO* of Beamex Group. He adds: "Beamex spare parts and accessories will continue to be sold through existing Beamex sales channels around the world providing customers with local support and expertise when needed."

LATEST NEWS

SAUDI ARABIA

Beamex would like to welcome our recently appointed sales distributor for Saudi Arabia, Aujan Industrial Supplies Co.

■ Aujan offers a variety of technology-based products, services and solutions to a wide customer base across Saudi Arabia and the GCC (Gulf Cooperation Council) states. Our new partner Aujan will work closely with Mark Slater, Sales Director at Beamex for India Middle East Asia, and his team.

Welcome Aujan Industrial Supplies Co. to the Beamex family!

HONG KONG / MACAO

We are happy to announce that we have signed a partnership agreement with Chung Wah Metal.

■ Chung Wah Metal in Hong Kong was established in the 1950s. They specialize in comprehensive range of pipe, fittings and accessories. The company is also committed to providing first-rate calibrators and related services throughout Hong Kong and Macao.

Welcome Chung Wah Metal. It's good to have you on board!

CROATIA

We are happy to welcome Mjerenje i automatizacija d.o.o. (MAPing) from Croatia to our global team of partners!

■ MAPing provides equipment and solutions for measuring pressure, temperature and calibration technology for the market in Croatia. The attached picture was taken when Denis (on the right) from MAPing came to Beamex headquarters for a visit and training. Denis is pictured alongside Mikko Mourujärvi, Beamex Area Sales Manager for Europe.

Welcome to the Beamex family MAPing!

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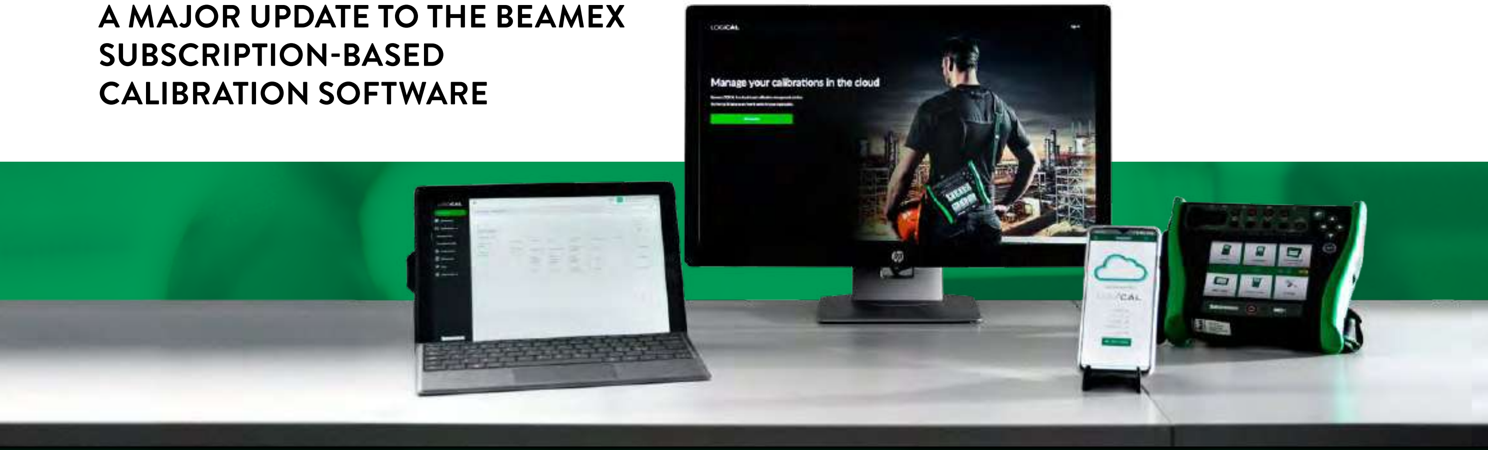
BEAMEX INTRODUCES LOGiCAL 2.0

A MAJOR UPDATE TO THE BEAMEX SUBSCRIPTION-BASED CALIBRATION SOFTWARE



■ Beamex introduces a significant milestone in the development of LOGiCAL, a cloud-based Software as a Service (SaaS) calibration execution platform. The latest release of LOGiCAL features new functionality for the management of LOGiCAL accounts and users, the creation of plant structure and instruments for calibration, the management of calibration references and the storage of calibration results.

"LOGiCAL continues to support mobile calibration execution using the Beamex range of documenting calibrators, such as: the Beamex MC2, MC4, MC6, MC6-Ex, MC6-WS, and the recently launched MC6-T temperature calibrator. For those customers who wish to use LOGiCAL with their existing references; LOGiCAL also supports the bMobile tablet or smartphone application. Beamex has been producing and developing calibration equipment for more than 40 years and calibration software for over 20; Beamex LOGiCAL is the latest generation of calibration software", *Product Manager* **Antti Mäkynen** describes.

"To start using LOGiCAL, all you need to do is to visit the Beamex LOGiCAL website and navigate from there to register. After the registration, you can select your SaaS subscription plan and purchase a truly pay-per-use environment. LOGiCAL purchase plans have been designed to allow a scalable cost of executing calibrations, starting with a very low-cost monthly fee allowing the smallest of companies to benefit from a digitalized paperless calibration environment," *LOGiCAL Commercialization Manager* **Jonas Heinola** adds.

Beamex LOGiCAL is the latest generation of calibration software.

The LOGiCAL cloud communicates with calibrators and tablets allowing for seamless movement between online and offline environments, enabling a digital calibration process, even when there is no access to the internet. LOGiCAL uses web service technologies enabling calibrations to be configured and performed using any device with a web browser connected to the internet. LOGiCAL is compatible with most browsers such as: Chrome, Internet Explorer or Safari. Beamex LOGiCAL version 2.0.1 was released in September 2020. This update included language options for the user interface, simplified subscription management, and much more.

"We are excited to bring a truly revolutionary technology to the market that delivers a very high value to customers that today use pen and paper or manual processes for calibration. LOGiCAL makes it easy and inexpensive for everyone to take their first steps towards a streamlined and digitalized calibration process," says **Jan-Henrik Svensson**, *CEO* of Beamex Group.

Beamex continues to develop its market leading CMX calibration software; an excellent choice for even the most demanding and regulated companies.

Visit the LOGiCAL product page: **https://www.beamex.com/software/logical-calibration-software/**

LATEST NEWS

BEAMEX bMOBILE CALIBRATION APPLICATION VERSION 2.3.0

WHAT IS bMOBILE:

- An intuitive paperless mobile solution for executing and documenting process instrument calibrations, maintenance-related inspections and weighing instrument calibrations.

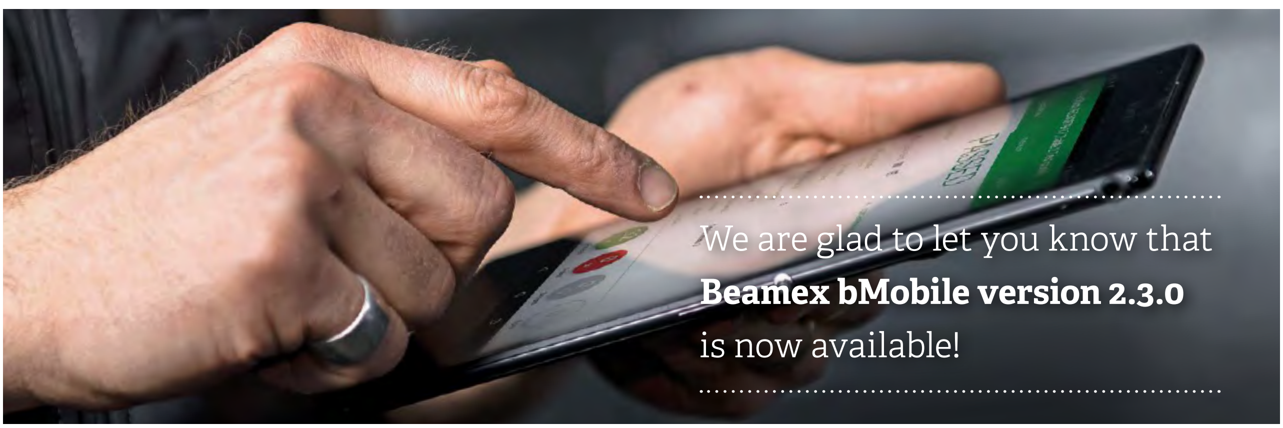
WHAT'S NEW:

- You have now a possibility to set the calibration date for a result. This is useful for example when transcribing calibration certificates from paper to electronic format. This feature requires the upcoming CMX 2.12 version and supports its backdating feature.
- Result summary page now shows additional information for passed results: (PASSED, Adjust / Do not Adjust)
- A confirmation dialog has been added for individual result deletion
- Bug fixes related to weighing scale calibrations

HOW TO INSTALL AND UPDATE:

- For Android, the application will be updated automatically if your device settings allow automatic updates. The update can also be found in the Google Play store: (**https://play.google.com/store/apps/details?id=com.bmobile**)
- For Windows, please go to the Beamex bMobile update page (**https://resources.beamex.com/bmobile-download-page**) for update instructions and to download the update file.

Beamex bMobile version 2.3.0 is now available.



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www.beamex.com

BEAMEX INTRODUCES CMX CALIBRATION MANAGEMENT SOFTWARE VERSION 2.12.1

MAIN FEATURES

MULTIPLE TOLERANCES

We are excited to release one of the most requested features ever in CMX – "Multiple Tolerances". Shortly said, this enables you to split the instrument's range into multiple subranges and specify different error limits for each subrange.

This new feature is a solution for the following types of requests:

- I want to give different error tolerance for each calibration point.
- I need to have tighter tolerance in the middle of the instrument range, which is most critical in my process
- I need to specify my thermocouple accuracies according to AMS2750 standard, where it is a fixed error in the lower part and a "% of reading" in the upper part of the range.
- And many other practical needs can be solved with this new feature.

Please note that the Multiple Tolerances feature is also supported in Beamex MC6 family calibrators and the Beamex bMobile application.

TEMPERATURE ENHANCEMENTS

We have added several useful features to enhance the user experience in temperature calibration. These features include for example support for ITS-90 coefficients, enhanced support for reference temperature sensors, and many more.

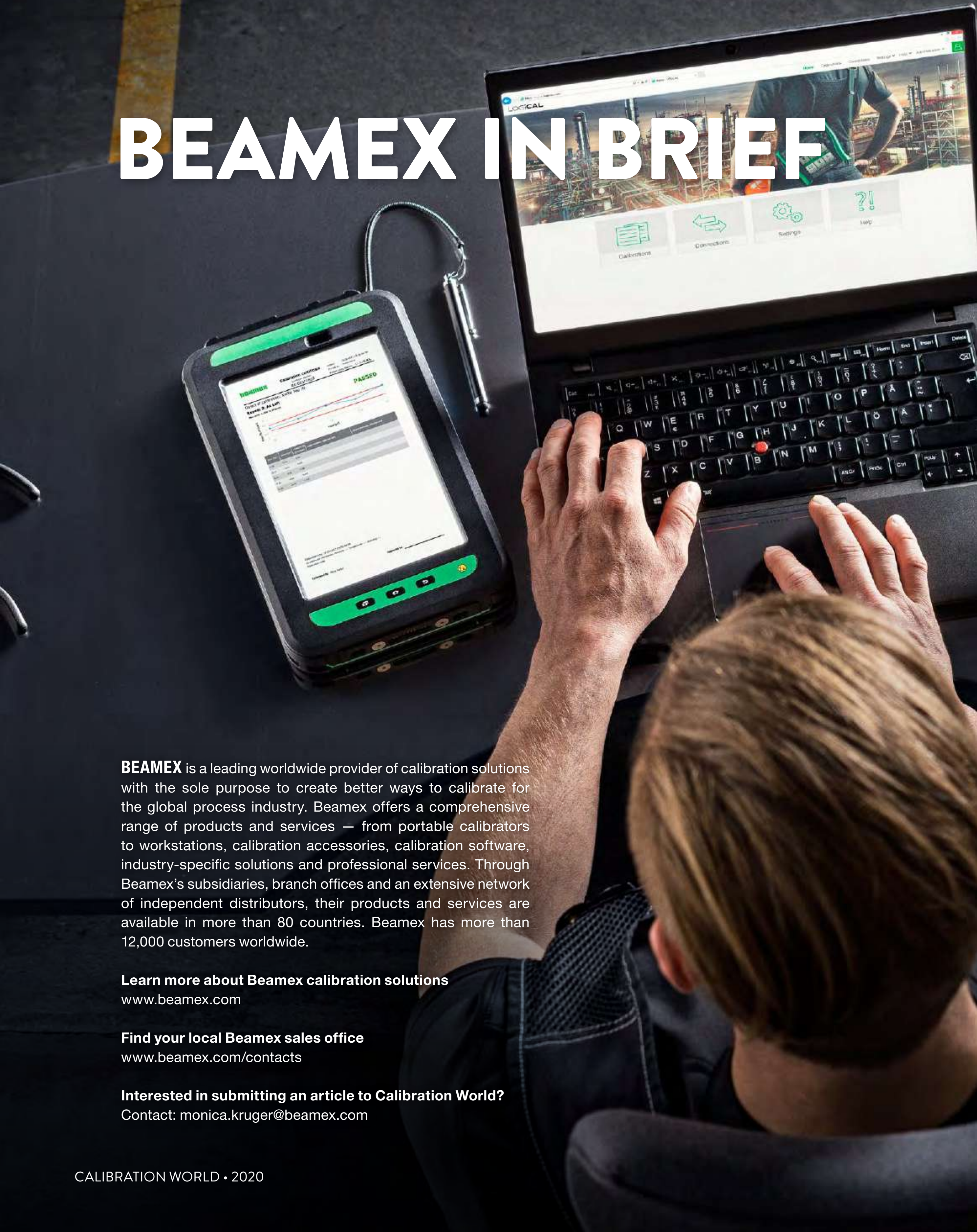
MOBILE DEVICE COMMUNICATION

The communication is now a standard feature with the Beamex bMobile application and the Beamex MC2 and Beamex MC6-T660 devices.

ADDITIONAL FEATURES

There are also many additional features included, such as Audit Trail filtering possibilities and Electronic Signature enhancements.

BEAMEX IN BRIEF



BEAMEX is a leading worldwide provider of calibration solutions with the sole purpose to create better ways to calibrate for the global process industry. Beamex offers a comprehensive range of products and services — from portable calibrators to workstations, calibration accessories, calibration software, industry-specific solutions and professional services. Through Beamex's subsidiaries, branch offices and an extensive network of independent distributors, their products and services are available in more than 80 countries. Beamex has more than 12,000 customers worldwide.

Learn more about Beamex calibration solutions
www.beamex.com

Find your local Beamex sales office
www.beamex.com/contacts

Interested in submitting an article to Calibration World?
Contact: monica.kruger@beamex.com

PRODUCTS AND SERVICES

PORTABLE CALIBRATORS

Beamex's range of portable MC calibrators for field calibration is known for its accuracy, versatility and meeting both high and uncompromised quality standards.

- MC6 advanced field calibrator and communicator
- MC6-Ex intrinsically safe multifunction calibrator
- Beamex MC6-T multifunction temperature calibrator and communicator
- MC2 documenting process calibrator
- MC4 documenting process calibrator
- POC8 automatic pressure controller

CALIBRATION SOFTWARE

Plan, manage and document all your calibrations efficiently and safely using Beamex's calibration software.

- CMX Calibration Management Software
- LOGiCAL Calibration Software
- bMobile Calibration Application

SERVICES

An essential part of a complete calibration solution is professional services – service and re-calibration, installation and training, software support and validation and integration services.

WORKSTATIONS

A workstation is ideal when most of the maintenance and calibration tasks are performed in the workshop.

- CENTRiCAL Calibration Bench
- MC6 Workstation

ACCESSORIES

Beamex's calibration accessories complete your investment in calibration equipment. Order your accessories and spare parts from **shop.beamex.com**

- External pressure modules
- Calibration hand pumps
- Temperature probes
- Spare parts