Quality assurance in measurements in wind energy applications

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1. Precision matters

Energy data strongly impact the growing investments in new wind power plants, so customers seek maximum certainty in the prediction of power output. Unfortunately, and different to a test bed measurement with well defined input parameters, on-site energy measurements have to meet highly dynamic weather characteristics, temperature changes and electro-magnetic fields.

DEWI ensures reliability and precision from scratch, starting with multiple cross-checks that verify the entire measurement chain from the very beginning to the end of the installation and measurement process. The institute employs a versatile test facility including a high-performance climate chamber covering the whole outdoor temperature range. This article shows a few illustrative examples of why this “special care” matters so much.

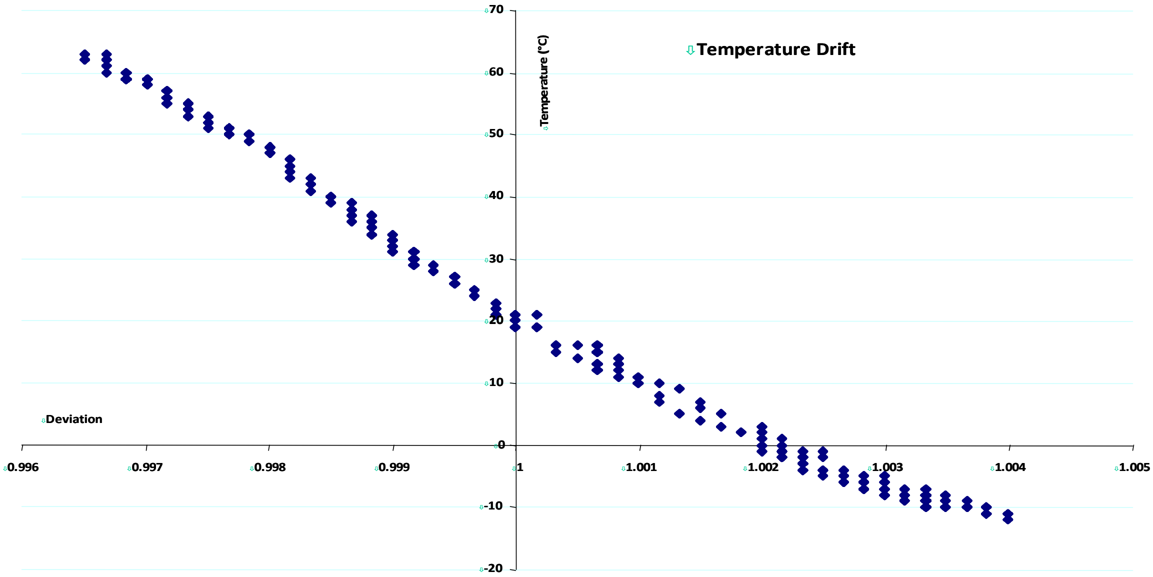
2. What can happen?

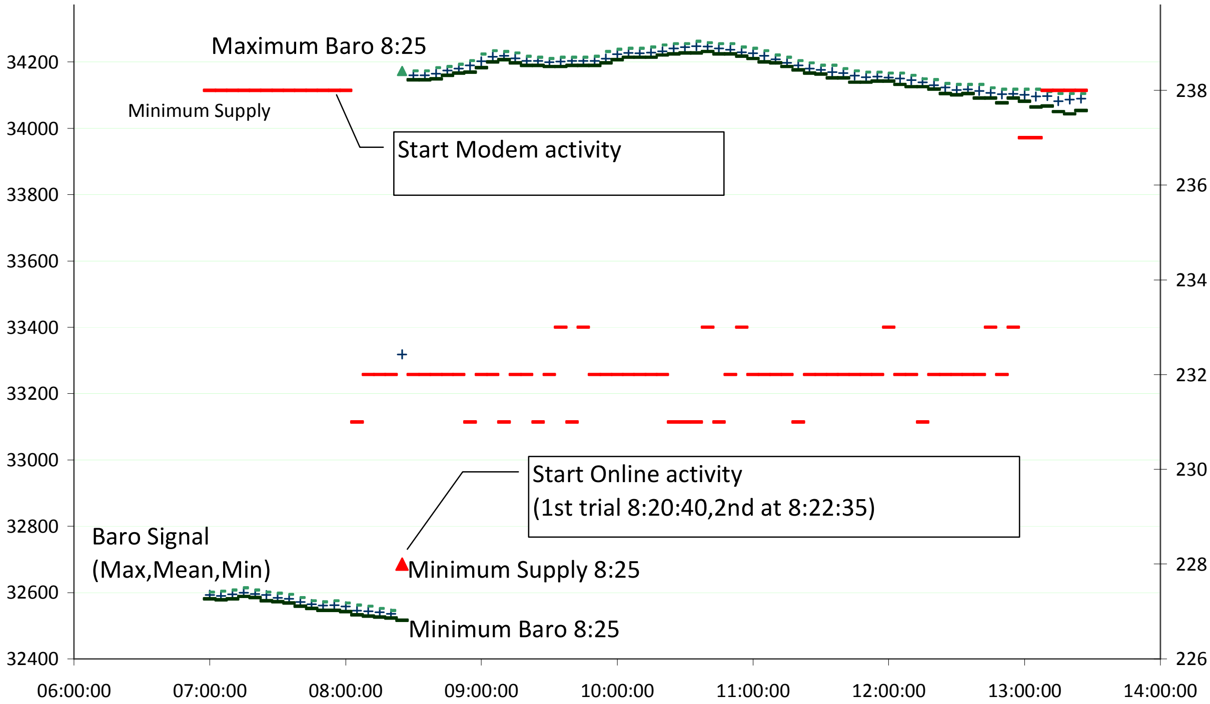
2.1 Calibration errors

Assuming a perfectly calibrated equipment leaving the premises, two main threats must be taken into account for the ongoing project: a thermal drift and a variation over time due to aging.

Both can be checked by respective provisions. Time stability gets countered by subsequent recalibration, and thermal drift patterns get unearthed beforehand and then again periodically in our climate chamber. The picture below shows the thermal drift of a data acquisition system (slope of a channel normalised to 1 at 20 °C). With the knowledge of this thermal behaviour the uncertainty of the measurements under ambient conditions can be determined.

It is also possible to increase the accuracy by adjusting the values according to the temperature.





One of the most annoying quality problems arise from sudden leaps of the output signal. The example shown above shows a sudden change of barometric pressure (raw data). Though the real source of error is still unknown, there is a significant correlation to a supply break.

In other cases sudden changes could be traced down to a self calibration of the analogue to digital converter.

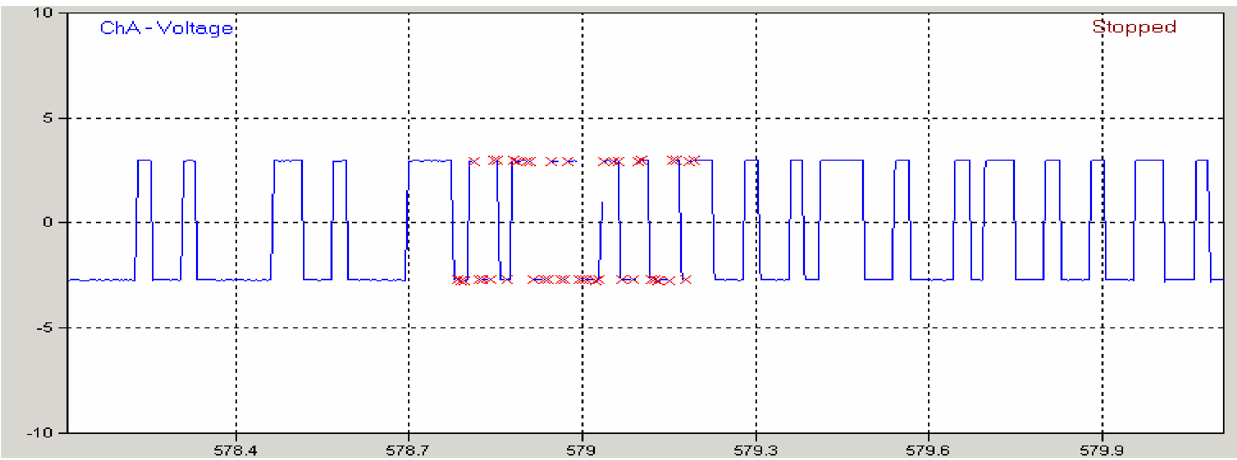
We asked the manufacturer to share with us details of the internal system calibration to ensure stability during the whole measurement campaign.

Above this, the manufacturer included some precautionary measures in recent firmware versions to keep the settings.

2.2. Sampling inaccuracies

Missing samples can really garble the signal if there are clusters. Timing inaccuracies have different effects to analogue and pulse inputs.

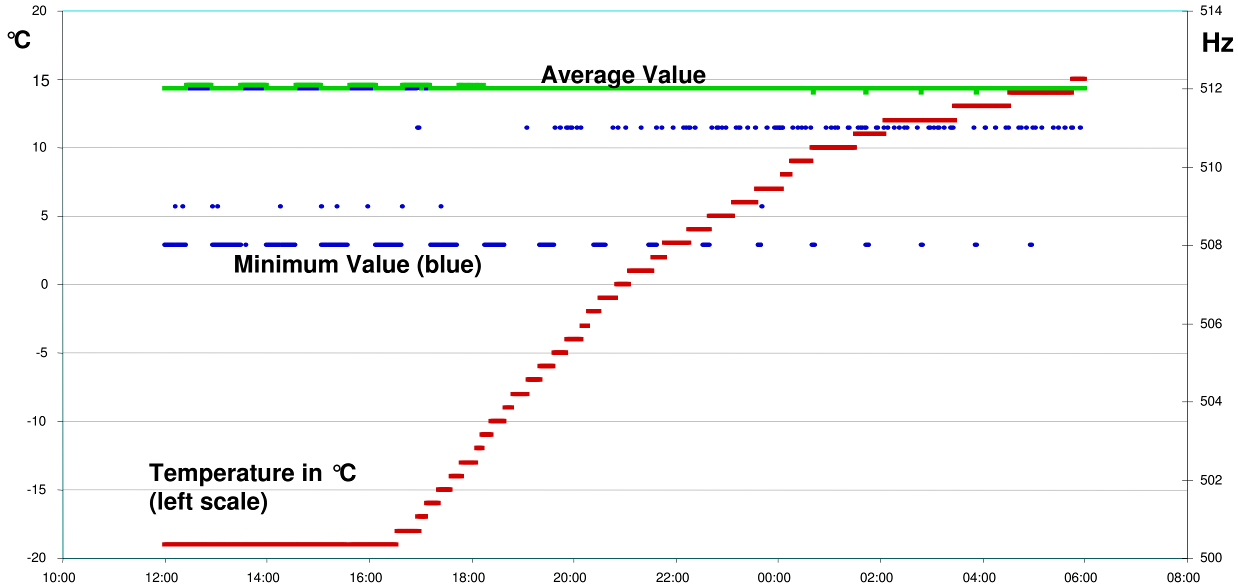
While “slow” signals as temperatures are insensitive to some timing inaccuracies a precise clock is mandatory for power quality measurements.



The above figure shows an example of missing samples (marked red).

Pulse signals are directly affected by timing errors as the number of pulses depend directly on the count interval. The best way to avoid such trouble is not to exhaust the data acquisition systems to its limits. To avoid this, we check the real performance of data acquisition systems in extended test runs in our laboratory prior to any use in the field.

In general, data loggers are less prone to inaccurate timing than PC based instruments.



Another example for timing inaccuracies we had to uncover and judge about is the following odd phenomenon.

A test signal of 512 Hz was recorded starting at an ambient temperature of approximately -20°C.

During the test the temperature (left scale) rises up to +15°C. The measured average frequency keeps over the whole range within 1/Hz and is thus pretty reliable.

Anyhow there is a clear pattern at the minimum values (blue graph). This is induced by an internal time adjustment procedure.

The quartz frequency of a real time clock obviously varies with temperature. The increasing deviation at lower temperatures is cancelled out by internal time leaps.

The blue graph indicates the more frequent adjustments at low temperatures as the dots form a longer line there.

At room temperature there are only sporadic adjustments resulting in single dots there (scattered dots above 508 Hz were irrelevant noise).

In this special case, we could let it go by as it turned out to stay buried within the overall noise level of real signals, but we value the additional insight as it gave us a more comprehensive understanding of the internal software as such.

Especially more elaborate systems are suspect to some oddity in frequency counting. Especially for anemometer measurements tricky data polishing could seriously affect the results. Therefore it is good to check the performance of data acquisition systems prior to on site installation.

2.3 Data Transfer Error
In spite of comprehensive data verification some false patterns might show up only in later stages of a project. T

6350	6421	6753	7435	6232	6737	6845
6011	5741	6129	5805	256	6175	5661

In this application sporadically an invalid pattern was wrongly assigned to the value 256. This might be a synchronisation failure as only the first data channel was affected. This failure would have been undiscovered by checking the mean value only as it is still in a valid range.

There are different ways to address such sporadic transfer errors. The easiest way is to use such channels only for insensitive data like status information.

It is a good practice to check the whole database for some odd numbers.

The still remaining temperature drift is now predictable and can be cancelled out if the temperature is recorded.

An additional procedure was included to ensure fixed calibration values.

Nevertheless we decided not to rely on those input channels for very sensitive measurements.

5. Conclusion
Time and again it turned out to be good not to rely on the data sheet specification but on our own intensive tests.

Yet, it is also important to keep these efforts within economic limits and not to fight for precision as an end in itself.

Our tests help us to make optimum use of the equipment and definitely increase the quality of our application process as well as of the resulting data.