

Improved measurement electronics for temperature measurement and control

D. Drung, J. Flügge, M. Voigt

Physikalisch-Technische Bundesanstalt, Germany

Jens.Fluegge@ptb.de

Abstract

For the calibration of gauge blocks and line scales at national metrology institutes the combination of Pt 25 Ohm reference thermometers and thermocouples are widely used to measure the temperature distribution at the measurement objects. Therefore the stability and influence factors on thermocouple metrology has been investigated in the EU funded project T3D. An update to the long time stability measurements will be presented.

The Avogadro project for a realization of a new kilogram requires the interferometric measurement of the volume of a silicon sphere and of the grating period of silicon in vacuum. Due to the CTE of silicon of about $2,5 \cdot 10^{-6} \text{ K}^{-1}$ the measurement of the temperature is a key part of these experiments. In vacuum the thermocouples have the advantage that no self heating is introduced by the measurement process. The reference temperature is measured by a Pt-25 at an ASL 900 AC bridge

A new chopper amplifier for small voltages with superior sensitivity has been developed. The amplifier stands out by fast transient times and a extremely low voltage noise of 0,73 nV/√Hz down to a few Millihertz. At the typical chopper frequency of 570 Hz a current noise of 40 fA/√Hz could be achieved with a $1/f$ cut off frequency of 3 mHz. Developed with a cryogenic current comparator as a main target, the amplifier is also superior for thermocouple measurements.

The amplifier has been compared to an comercial Nanovolt meter used before with an short and a thermocouple with both measurement points fixed on a copper block in an oil bath. The results of a measurement series with the amplifier changed in between is shown in figure one.

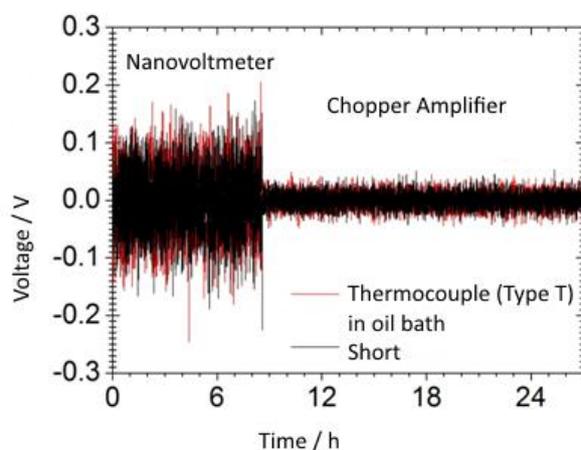


Figure 1: Measurement of a short and a thermocouple on a copper block in an oil bath to characterize the measurement noise of the chopper amplifier compared to a nanovolt meter

The project “Thermal design and dimensional drift- T3D” is a joint European project funded in the European Metrology Research Program EMRP.

“The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.”