Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

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Implementing and Developing a Phasemeter on LabVIEW.

ABSTRACT - Masterthesis

With our measurement system we are able to investigate the coefficient of thermal expansion (CTE) of dimensionally ultra stable materials. Low CTE materials are important for stable structures in space applications and enable precise measurements. The expansion of material samples was determined with our heterodyne interferometer. The expansion causes a phase change between two signals, in our case with the heterodyne frequency of 10 kHz. For this purpose, we implemented a phasemeter on a FPGA with LabVIEW which allowed us to measure ~ µcycles of the 10kHz signal. The signals are detected by quadrant photo diodes where the quadrants were used to measure the tip and tilt of the measurement mirror and reference mirror using differential wavefront sensing method (DWS).

Therefore I implemented a phasemeter for a constant frequency, based on DFT (discrete Fourier transform), realized with IQ-phase demodulation method. This system was adopted to our measurement system and its performance has to be tested.

In the first step, I studied the working of a PXI system and set it up in working mode with LabVIEW installed on it. I also downloaded all the necessary support software so that the LabVIEW code could be downloaded onto the FPGA.

In the second step, I understood what exactly a phasemeter does and then I implemented a phasemeter using a Phase Locked Loop (PLL), the advantage of this second phasemeter is that the frequency need not be a constant. I designed a LabVIEW code which enabled me to take variable frequency measurements.

In the third step, I compared the performances of both phasemeters by taking a series of measurements and then tested it with the interferometer and thus concluded on the set up which provides maximum performance.

The proposed thesis was an effort to measure the phase changes by measuring the length changes of thermally highly stable materials under observation such as CFRP (Carbon Fiber Reinforced Plastic) or Zerodur whose coefficient of thermal Expansion (CTE) was measured later on using the formula: CTE= 1/L x ΔL/ ΔT

Where ΔL is the change in length of a sample with its length L when a change in temperature ΔT is applied.

Thus using the phasemeter, the material characteristics of specific materials (mainly CFRP) at cryogenic temperatures were estimated and the target was achieved.