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CONTROL ELECTRONICS OF A PYRAMID WAVEFRONT SENSOR FOR THE "NEXTGEN" TELESCOPES

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INTRODUCTION

The next generation of ground-based astronomical instruments installed at the ELTs like planet finders and IFUs will need high contrast and high Strehl images on their focal plane to reach scientific goals. This is the case of MICADO, METIS and ANDES at the ELT or G-CLEF and GMTIFS at the Giant Magellan Telescope (GMT). All these instruments will be provided with a single conjugate adaptive optics (SCAO) system that will allow for diffraction limited observations up to near-infrared wavelengths, exploiting the full angular resolution of a 40m-class telescope. These SCAO systems will rely on pyramid wavefront sensors (WFS) to measure the atmospheric turbulence.

GOAL OF THE EXPERIMENT

One of the technical challenges in the development of the Pyramid wavefront sensor is the driving electronics of the tip-tilt modulator.

A. Generation of two sinusoidal signals with 0-10V output, 0-2kHz frequency range, THD <1%
B. synchronization up to 1% of the WFS (WaveFront Sensor) detector with respect to the PSF spatial modulation on the WFS focal plane made by the modulator itself.

The PLC (Programmable Logic Controller) is the platform that will be used for the automation of the "Nextgen" telescopes like ELT and GMT. While PLC are extremely suitable for motion control tasks, they have some limits in the analog electronics field.

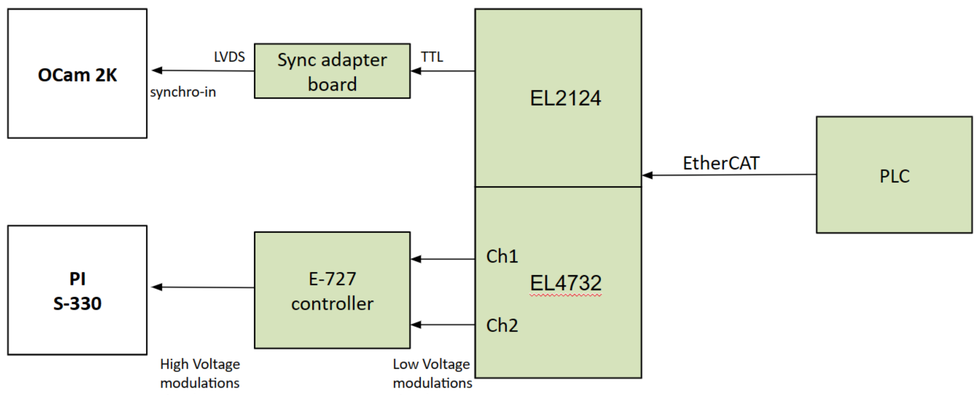

Fig.1 Typical electronics in a future pyramid wavefront sensor

The goal of the experiment is to evaluate the proposed design (shown in fig.1) that makes use of two important functions of the Beckhoff PLC and EtherCAT modules: the DC synchronization and the oversampling.

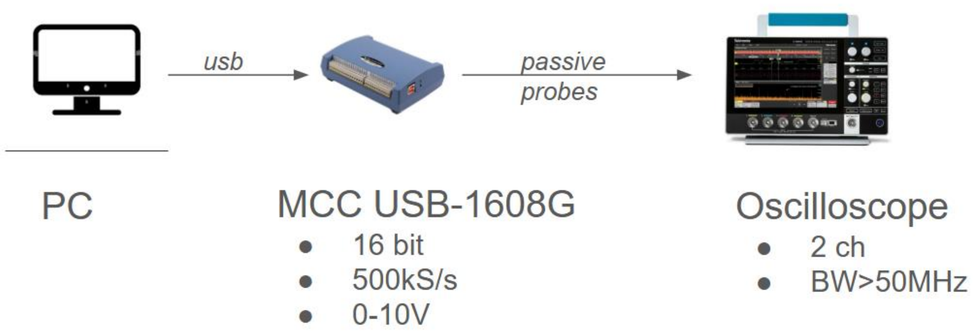

Fig.2 Reference test for the EL4732 Module

The first part of the research has been dedicated to the evaluation of the analog performances of the proposed solution by performing the tests shown in fig.2 and fig.3 (evaluation of requirement A).

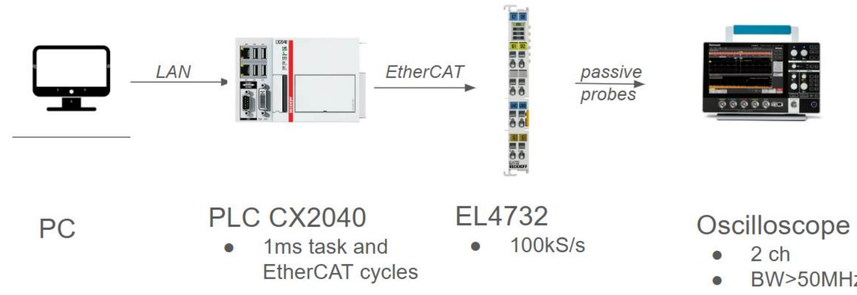

Fig.3 Test for the EL4732 Module

PRELIMINARY RESULTS

A Twincat solution has been developed to use the EL4732 module: the oversampling has been achieved by writing more than one waveform sample in a single PDO (Process Data Object).

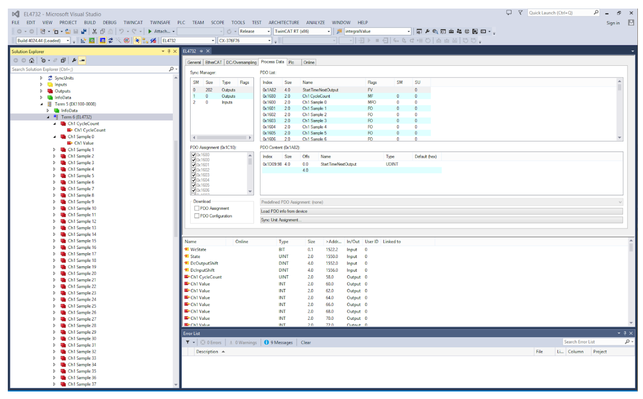

Fig.4 EL4732 Module programming

Fig. 5 and Fig.6 show the ideal and actual response of the EL4732 EtherCAT module.

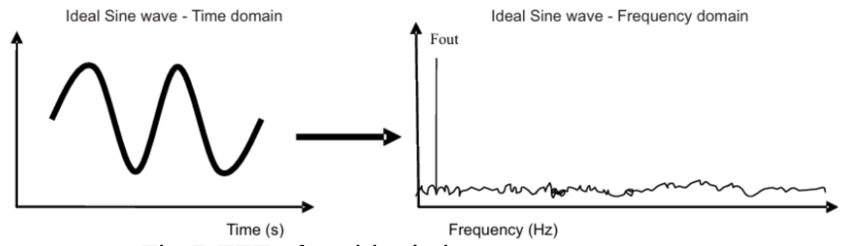

Fig.5 FFT of an ideal sinewave

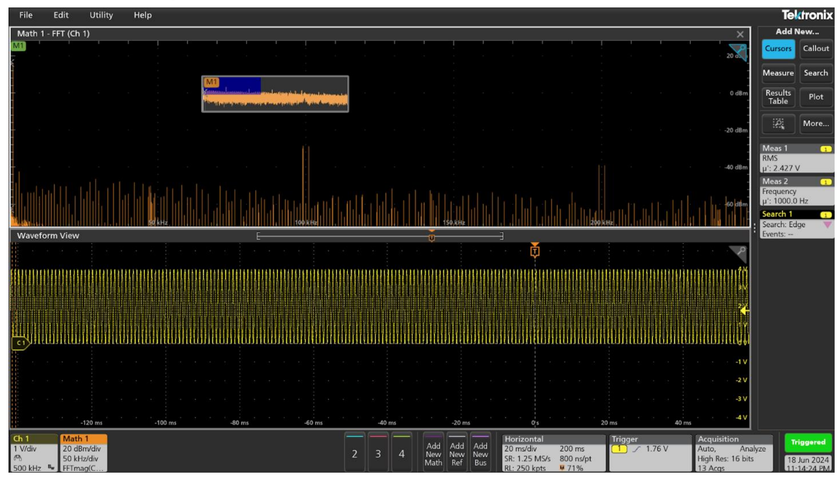

Fig.6 FFT of the EL4732 output with 1kHz PLC cycle and 10us oversampling

NEXT STEPS

- Design of the low-pass reconstruction filter at the output of the EL4732.
- Quantitative analysis of the THD (Total Harmonic Distortion).
- EL2124 programming.
- Impact of EL2124 signal conversion from TTL (Transistor Transistor Logic) to LVDS (low Voltage Differential Signaling) on the WFS detector synchronization.

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