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Implementation of a Precision Logarithmic Ammeter

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***Abstract*:** A precision ammeter is in development for the acquisition of sensor signals such as photodiodes, gold mesh (by photoelectron effect) and ionization chambers. One of the problems of conventional ammeters is the automatic scale selection, which hinders many measurements performed in ample energy range. The ammeter in development is based on a different methodology than present on most commercial systems, using a logarithmic amplifier. This choice can provide a logarithmic response output in the range of pico to milli-amperes. The electronic board is in development by LNLS, and is being installed and tested at the Toroidal Grating Monochromator (TGM) Beamline.

Introduction

A logarithmic amplifier (LogAmp) is a device which can express the output in a logarithmic function of the input, either electrical current or voltage.

$$V_{OUT} = V_Y \log\left(\frac{I_{LOG}}{I_Z}\right)$$

The setup below utilizing a Femtoampsourcemeter was proposed to find experimental parameters and to obtain the curve I-to-V characteristic of the LogAmp. The communication between the Terminal Computer and the Voltmeter is made by IOC's from the EPICS system.

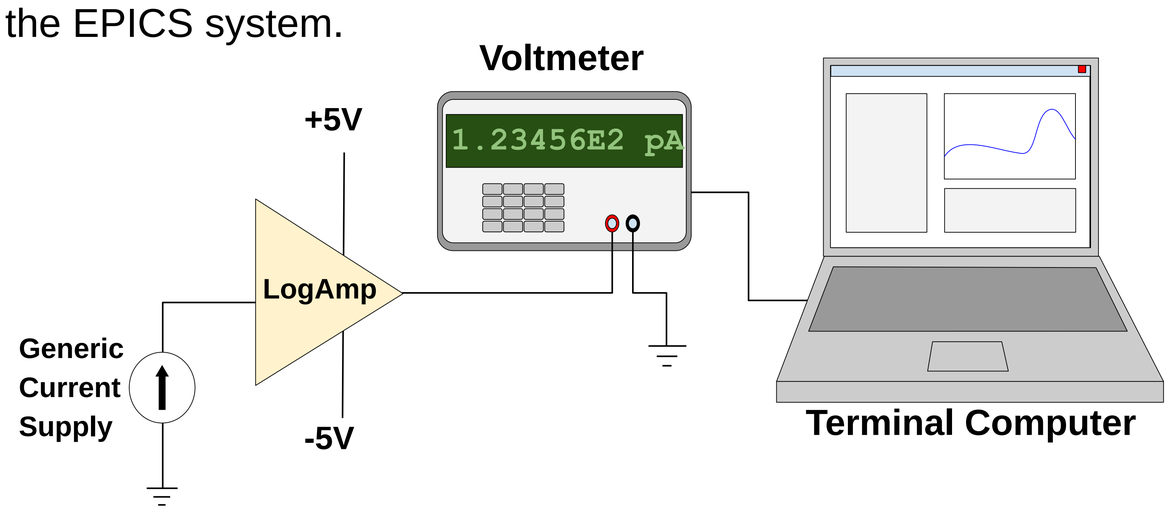

Fig. 1 - Experimental setup schematic for the LogAmp's characterization.

Results and Discussion

The system was designed to produce an output voltage from -1V to 1V for an input from 1 pA to 10 mA. By the results in figure 2 (a) is possible to determine experimental parameters $V_Y = 0.2015\ \mathrm{V/decade}$ and $I_Z = 115\ \mathrm{nA}$.

The figure 2 (b) shows the capacity of the LogAmp to vary 7 decades without change the scale of measurement. In a normal alignment, the beamline operator needs to find the best position for a scale and then, change the scale until find the most intensive position (about -0,03 a.u, this case).

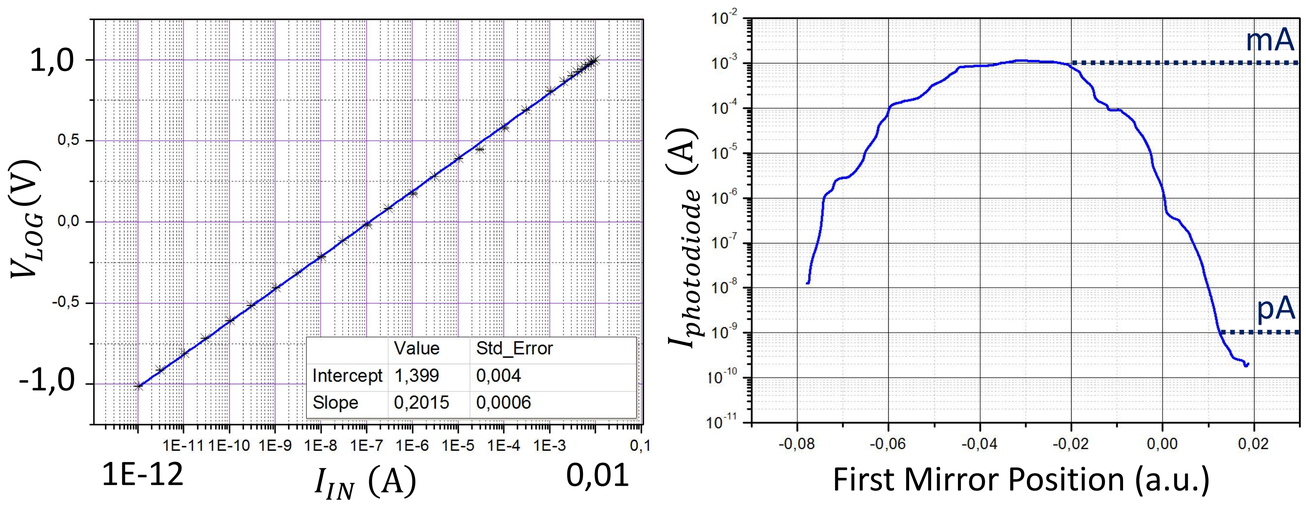

Fig. 2 - (a) Input current vs. measured output voltage. (b) Current in the photodiode in function of zenithal position of the Beamline first mirror.

The TGM beamline operates in the Vacuum-Ultraviolet (VUV), in energies from 3 eV to 300 eV.

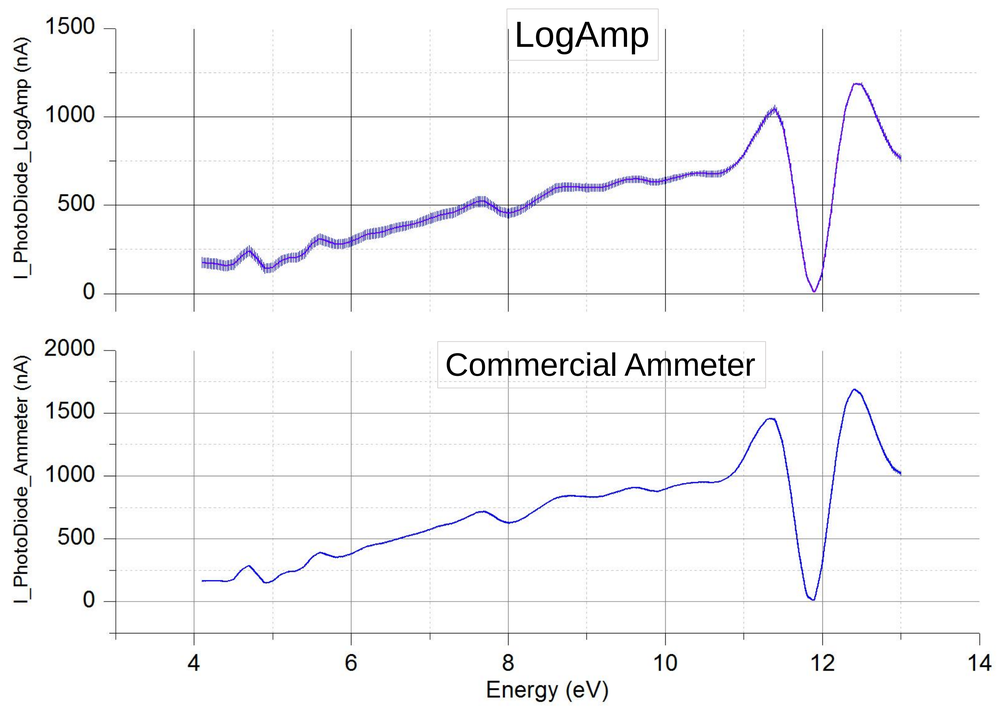

Fig. 3 - Energy scan for the grating 1 (3 eV to 13 eV).
Each graph refers to the average curve of an instrument with standard error.

An important application to use the LogAmp system was measuring a standard sample at TGM Beamline. The Total Electron Yield (TEY) is a system that allows to measure the Auger electrons expelled from a sample when hit by the incident VUV and X-ray beam.

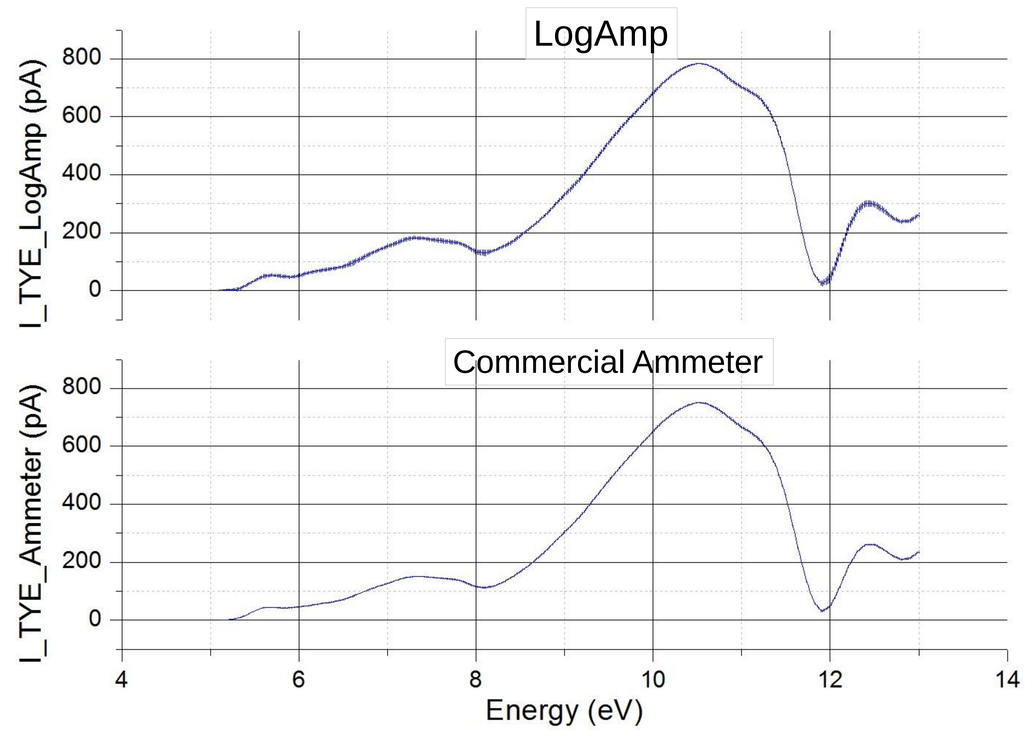

Fig. 4 - TEY scans for the grating 1 (3 eV to 13 eV).
Each graph refers to the average curve of an instrument with standard error.

Conclusion

The proposed LogAmp circuit can provide a logarithmic response output in the range of pico to milli-amperes, and it is able to eliminate almost any temperature dependence.

Also, a data acquisition and signal processing system was developed using ultra-low noise and high resolution ADC with FPGA for data communication interface.

[1] LNLS TGM Beamline, http://lnls.cnpem.br/beamlines/uvsoftx/toroidal-grating-monochromator-tgm/tgm/
[2] Maxim Engineering Journal, "Integrated DC Logarithmic Amplifiers". Vol. 56, **2005**.