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Low-cost impedance spectroscopic system for investigation of solar cell characteristics.

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A low-cost impedance spectrometer capable of measuring impedance spectra of photovoltaic devices such as solar-cells in the frequency domain has been built. In order to consistently find the impedance of the device by applying low voltage signals that are frequently suppressed by noise, reliably finding the phase differences between measured sinusoidal signals are necessary. Thus, for persistently calculating the phase shift Φ_x between two measured sinusoidal signals a mathematical function, $\Phi_x = 2\left[Sin^{-1}\left(\frac{Maximum\,(V_{CH1n} - V_{CH2n})}{2}\right)\right]$ was derived and used in LabView, where V_{CH1n} and V_{CH2n} are the normalized sinusoidal signals recorded by the two channels in the LabView program and where the function $Maximum(f)$ was used to find the peak (maximum) value of the function f. The function was able to provide excellent results for the phase difference Φ_x under low voltage and currents, under high noise conditions. The system may be easily altered for different types of experimental necessities and applications due to the flexibility of the design. The measurements could be implemented in frequency range from 10 Hz to 10 kHz and the employed principles of the spectrometer are given in this paper. The spectrometer was tested on commercial solar cells to gain knowledge about them.

Keywords: *Low-cost Impedance Spectrometer, Complex Impedance Spectroscopy*

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