

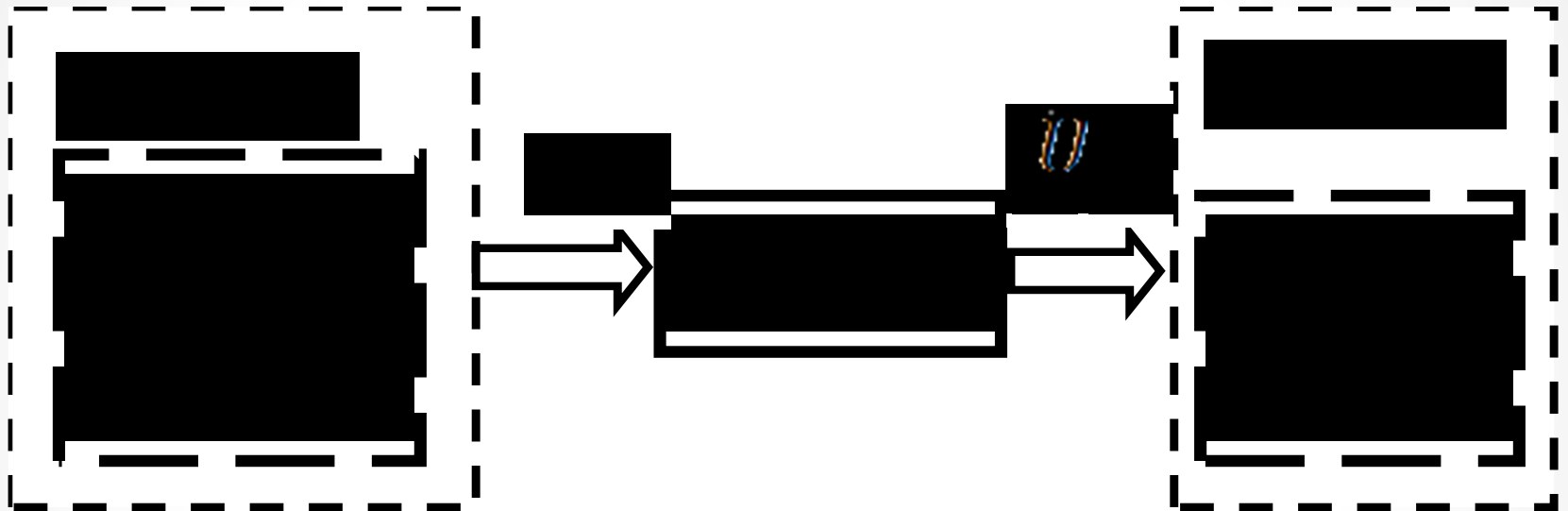
Virtual instrument for determining the content of heavy metals in the juice

Ihor Midyk

- The subject of the study is the development of a virtual device for determining the content of heavy metals in the juice.
- The purpose of the research is to develop a method for conducting rapid analysis of juice for mineral content by electrical parameters.
- To achieve this goal, the following tasks were solved:
- to generate a test signal for imitation measurements;
- to measure immittance by means of the NI USB 6009 block.

Software and hardware generation of a test signal for imitation measurements

- LabVIEW is a development environment and platform for executing programs created in the graphical programming language "G" by National Instruments (USA). They are used in data collection and processing systems, as well as for the control of technical objects and technological processes, ie they are ideally suited for exploitation in the newly created subsystems of cyber-physical systems related to measuring instruments. Thanks to interactivity and the ability to use optimized available multifunctional I / O devices - such as NI USB-6009, LabVIEW greatly simplifies the development and creation of unique virtual measuring instruments (if you have a PC with software installed), otherwise if you have a hardware and software platform LabVIEW.



- **Figure 1** Block-scheme for measuring the immitance of juice of vegetable products, Source: own.
- TS – test signal, \dot{U}_x – voltage at the measuring object.

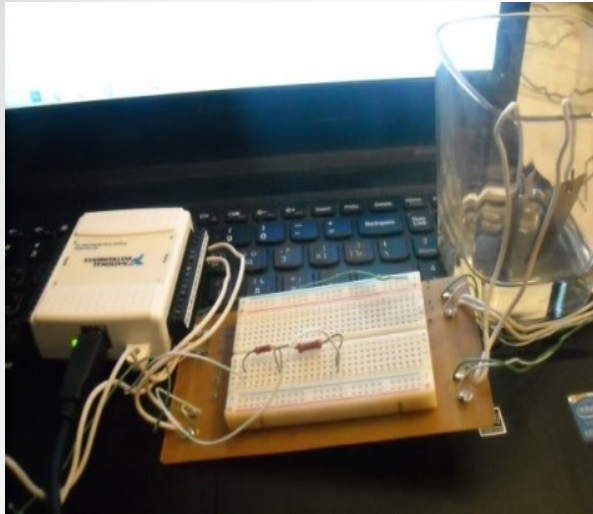


Figure 2 Virtual means of generating sinusoidal voltage and measuring the immittance of non-electric objects (juices), Source: own.

Immittance measurement using a block NI USB 6009

- For a single-phase circuit that operates at a constant sinusoidal wave velocity, the voltage and current have the following expressions:
- $u(t) = U\sqrt{2} \sin \omega t$ (1)
- $i(t) = I\sqrt{2} \sin(\omega t - \varphi)$ (2)
- For AC systems, it is necessary to receive signals with amplitude from the range used at the system input. By Bobalo YU relation (3) defines the active component as the active power divided by the square of the current:
- $R = \frac{\frac{1}{T} \int_t^{t+T} u(t) \cdot i(t) dt}{I^2}$ (3)
- For AC systems, it is necessary to receive signals with amplitude from the range used at the system input. Relation (3) defines the active component as the active power divided by the square of the current [10]:
- $|Z| = U_{\text{д}} / I_{\text{д}}$ (4)

- Taking into account these connections, two input sections are defined: one for voltage and the other for current.
- To calculate the RMS values of voltage and current used to measure the amplitude and level, which are in the subpalette of functions "VI Express" Signal analysis, by dividing the RMS values of voltage and current, the modulus of impedance Z is obtained (Fig. 3).
- By multiplying the instantaneous values of voltage and current, and then mediation and passing through a low-pass filter (Express Filter VI), we obtain the active power, and then the active component R (Fig. 4).
- The reactive component is determined by the ratio:
- $$X = \sqrt{Z^2 - R^2} \quad (5)$$

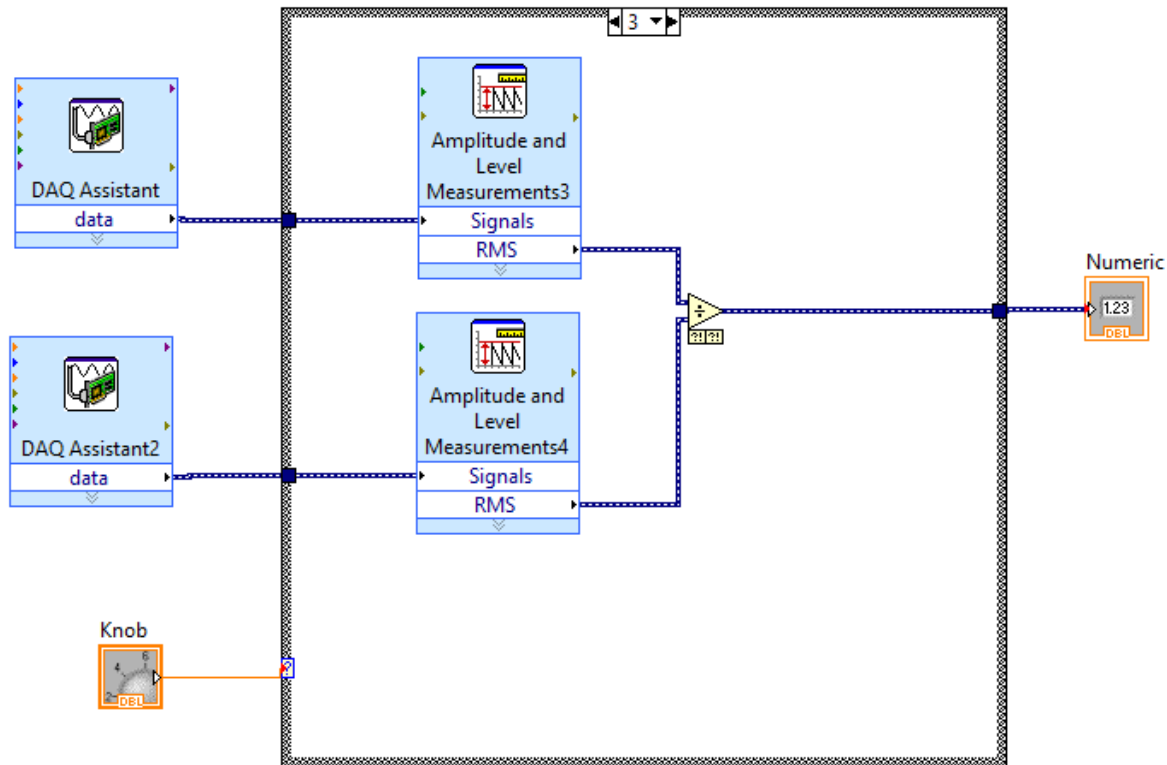


Figure 3 Block diagram for calculating the impedance modulus, Source: own.

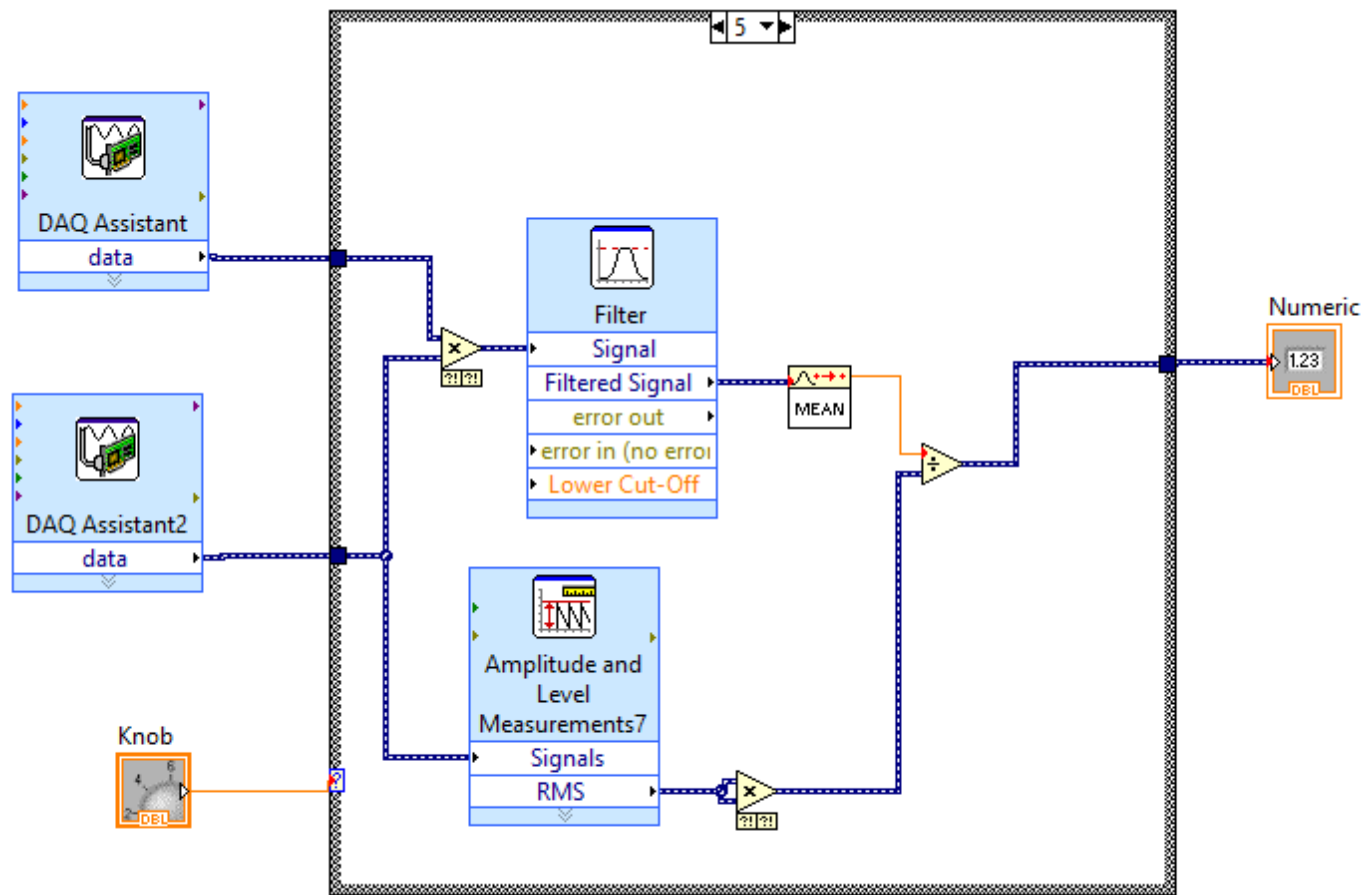


Figure 4 Block diagram for calculating the active component of the impedance, Source: own.

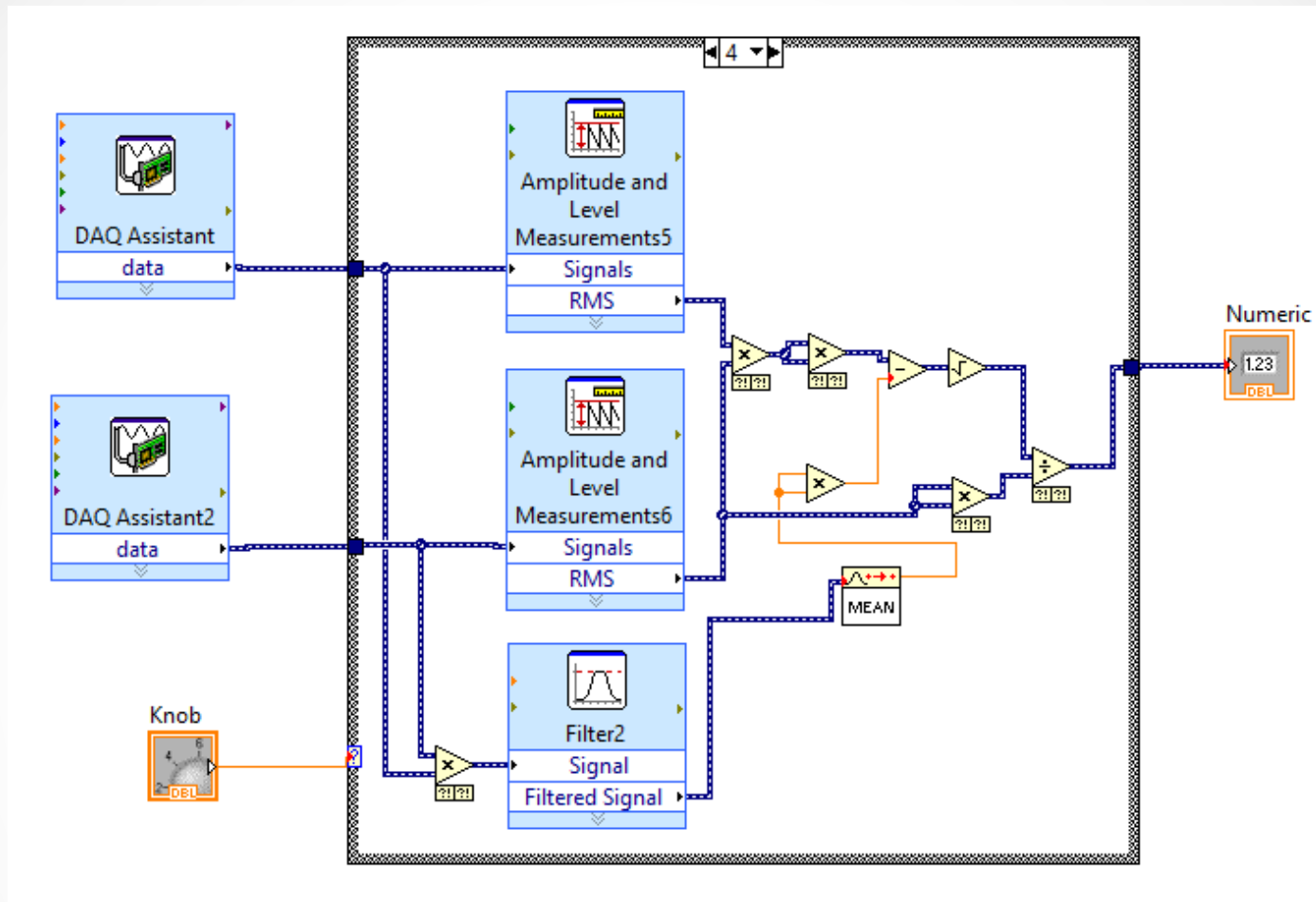


Figure 5 Block diagram for calculating the reactive component of the impedance, Source: own.

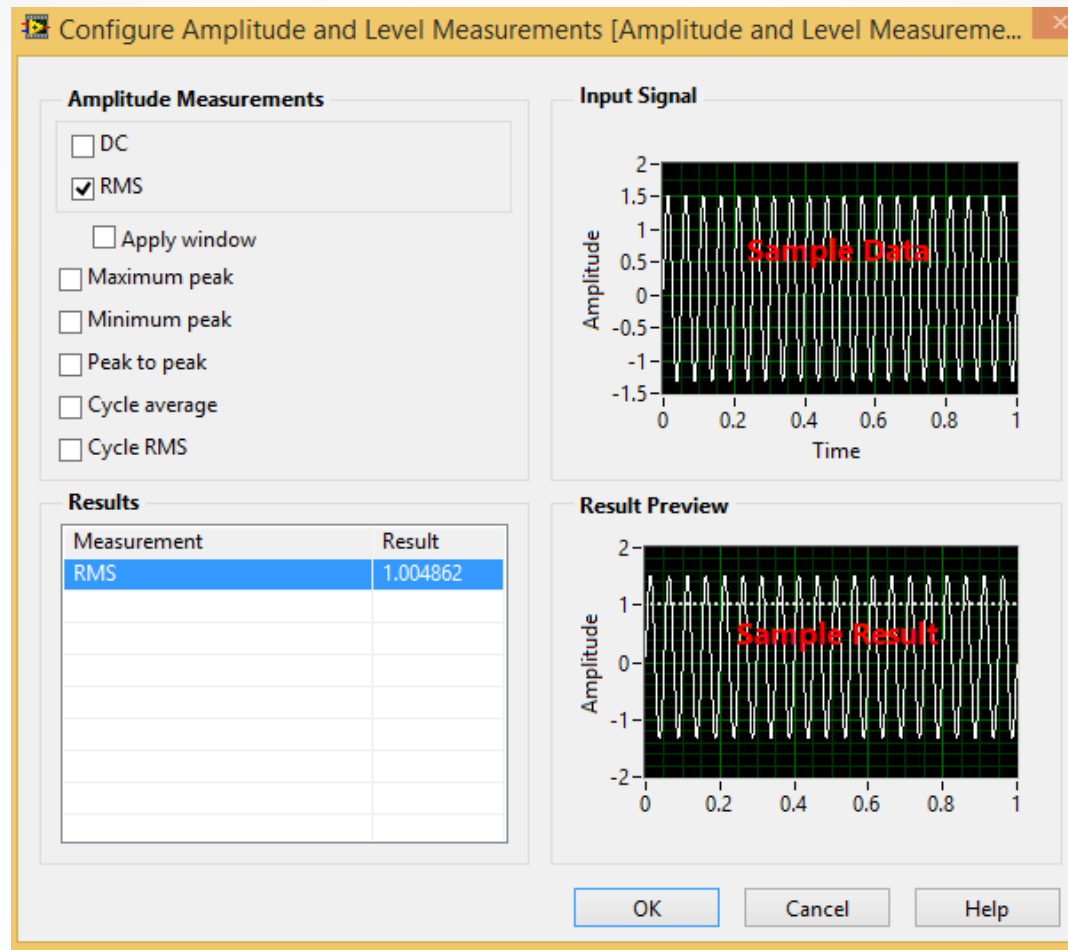


Figure 6 Amplitude measurement setting window, Source:
own.

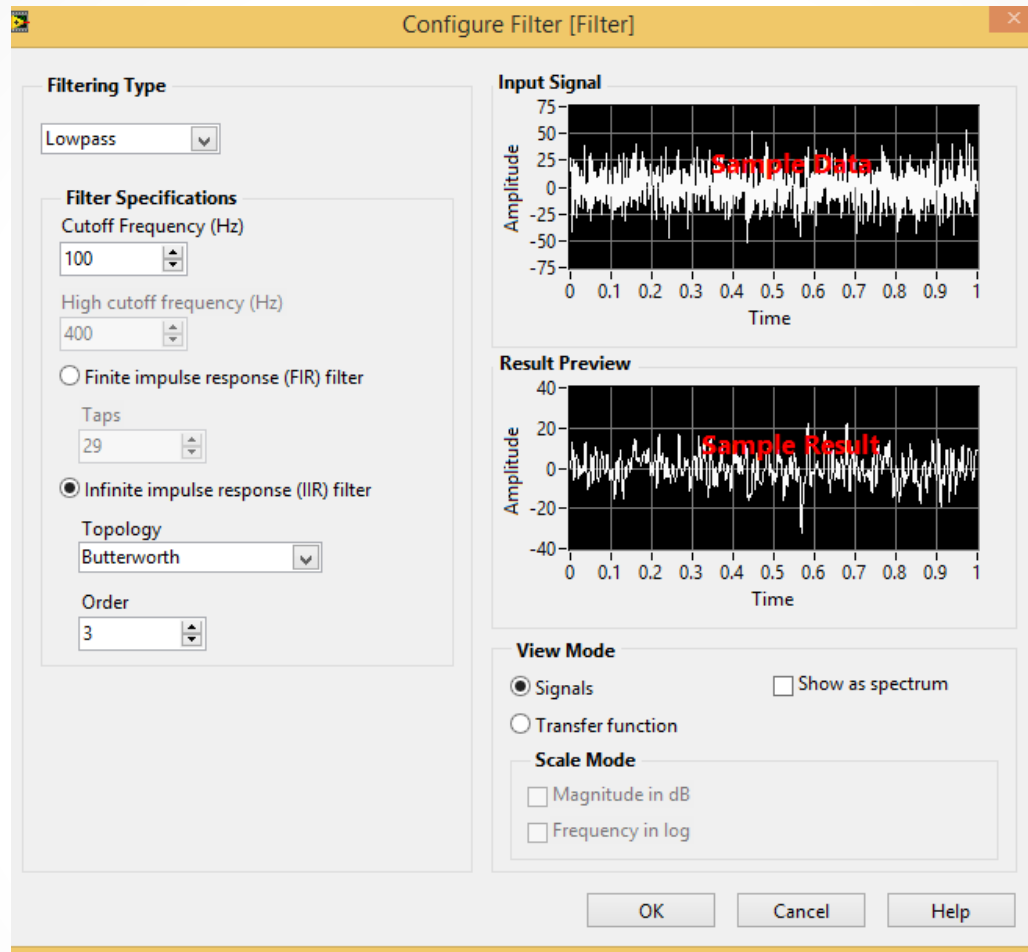


Figure 7 Electric filter settings window, Source: own.

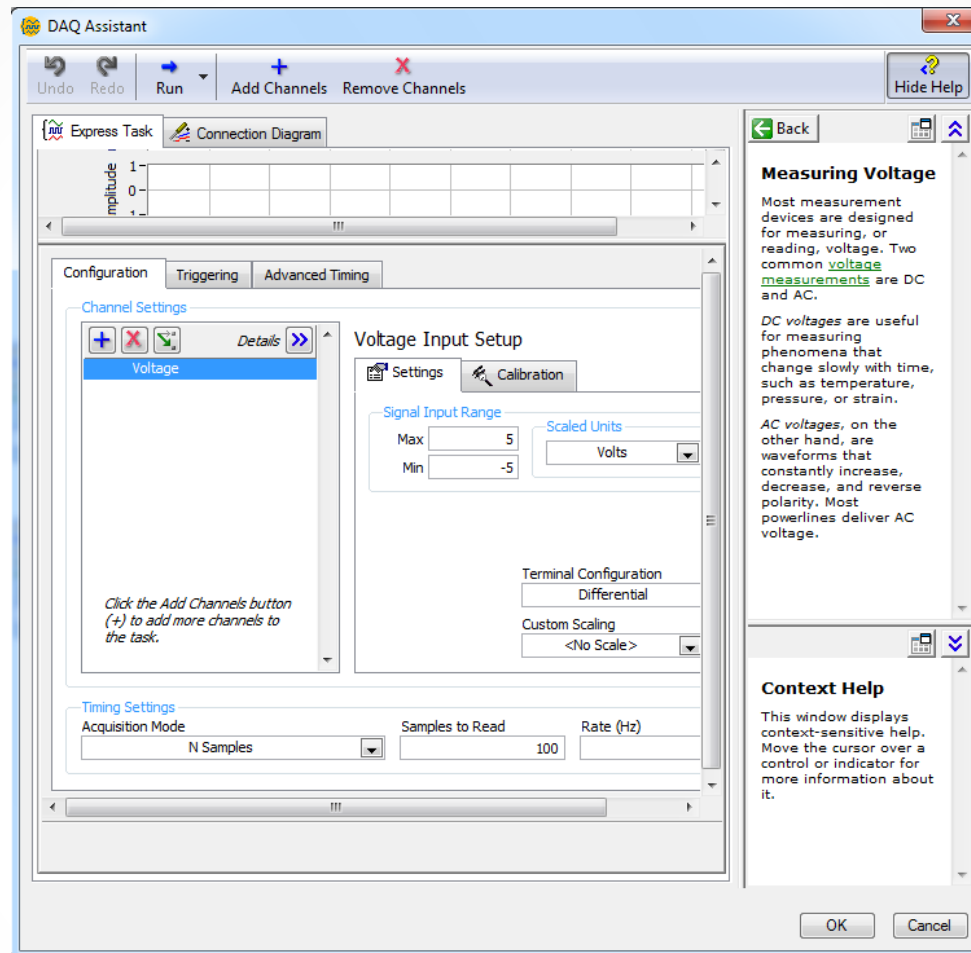


Figure 8 NI-DAQ Assistant settings, Source: own.

Conclusion

- 1. For imitative control of vegetable juice quality indicators, a virtual measuring instrument based on the LabVIEW hardware and software platform and a compatible NI USB 6009 unit has been proposed, developed and implemented.
- 2. A sinusoidal test signal in the form of an alternating voltage with an amplitude of 10-20 mV was generated to measure and calculate the imittance of the object. Because the NI USB 6009 is not able to generate AC voltage, the program uses some elements of the NI-DAQ task with the While Loop with Stop Button cycle. To do this, create a generation channel Create Channel (start generation Start, write voltage generation, clear task Task), as well as Wait, which regulates the sine wave period.
- 3. Reading and processing of complex components of immittance was performed by module and active component of immittance (to obtain the value of the module of immittance used Amplitude & Level measurement → RMS (root mean square), and to obtain the active component of immittance - Filter i mean). In this case, the reactive component of immittance is calculated algebraically.
- 4. A virtual device consisting of a PC with LabVIEW software, a NI USB 6009 unit and a juice conductivity cell is used to determine the content of heavy metals in this juice. This made it possible to perform a rapid analysis of the juice for mineral content by electrical parameters. Thus, in production conditions at low cost, you can quickly control the quality of vegetables from which the juice is obtained.