Lodz University of Technology
INTERNATIONAL FACULTY OF ENGINEERING
Department of Semiconductor and Optoelectronics Devices; **WWW.DSOD.PL**
http://www.ife.p.lodz.pl/downloads/Korczynsk
marian.korczynski@p.lodz.pl

LABORATORY OF MEASUREMENTS

LABORATORY EXPERIMENT No 4

Virtual Instruments for Engineering Practice

(development and deployment of the Virtual Instrument to analyse electrical signals)

Goal:

The main goal of the experiment is to familiarize students with Virtual Instruments which are now commonly applied foe engineering practice

SPECIFICATION:

The following instruments and software are used:

<u>Instruments</u>

1. Digital oscilloscope RIGOL DS1052E
2. Digital Signal generator DDS DF1410
3. Multifunction ADC and DAC module ADVANTECH USB4711

<u>Software:</u>

1. LabView a software platform for Integration of hardware and software for measuring and control purposes.

THEORY

INTRODUCTION

LabVIEW is a "G" language based platform enabling users to integrate hardware and software to build systems for measurement and control purposes.

LabVIEW is a shortcut from Laboratory Virtual Instrumentation Engineering Workbench. It is a system design platform and development environment for a visual programming language from National Instruments.

Why was LabVIEW introduced? National Instruments (NI) once realized that all measurement devices are basically composed of the same building blocks with different kinds of processing behind them: analog input, analog output, digital input and output, counters and timers. Almost all those measurement instruments can be defined by linking these blocks with processing. That is why NI made up a "Virtual Instrument" often referred to as "VI". VI is a set of software that links together basic hardware elements to form different instruments.

VI can be defined just as real instruments are. It has a Front Panel, which consists of:

Controls (they make things happen)

Indicators (represent status information)

Graphics (provide labels to interpreting controls and indicators).

VI also has Block Diagram. The Front Panel and Block Diagram are two basic programming modes of Virtual Instrument in LabVIEW.

LabVIEW is an example of Virtual Instrument.

LabVIEW was firstly released for Apple Macintosh in 1986 and is commonly used for data acquisition, instrument control and industrial automation.

LabVIEW is an object-oriented programming language (OOP). Programming is performed by linking objects or creating new objects with certain attributes.

Execution is controlled by the dataflow expressed in diagrams on which the programmer connects different function-nodes by drawing wires. These wires propagate variables and any node can execute as soon as all its input data become available

Application of LabVIEW:

Acquiring Data and Processing Signals

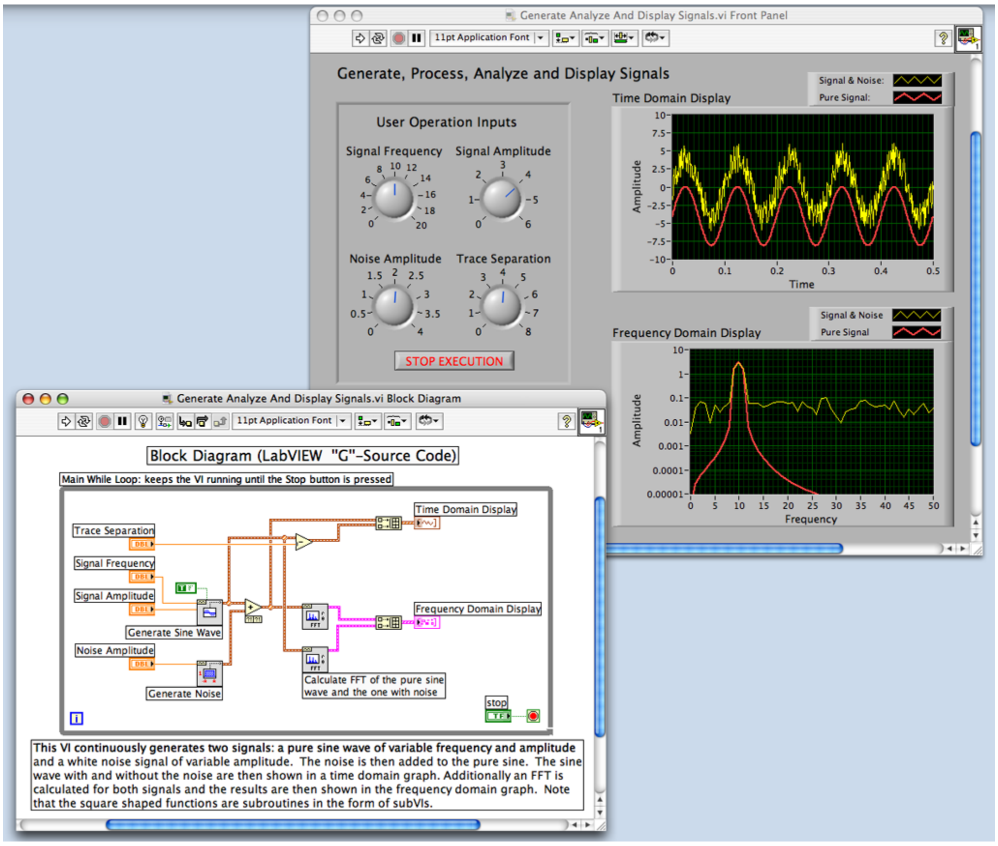
Controlling Instruments

Automating Test and Validation Systems

Measuring and Controlling Industrial Systems

Designing Embedded Systems

Teaching Engineering Concepts and Innovating on Research



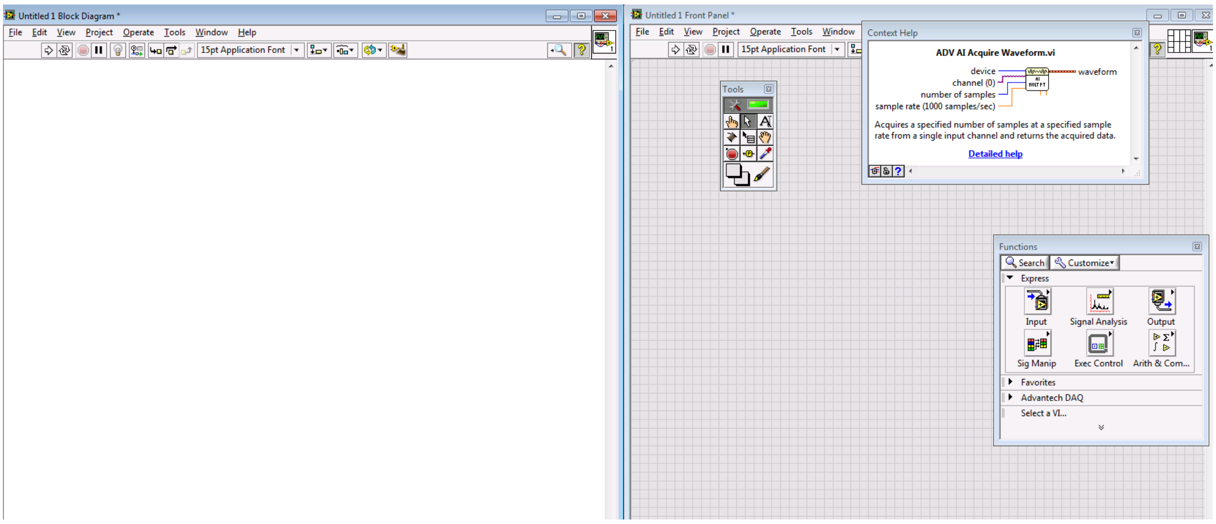
Screenshot of LabVIEW program

EXPERIMENT:

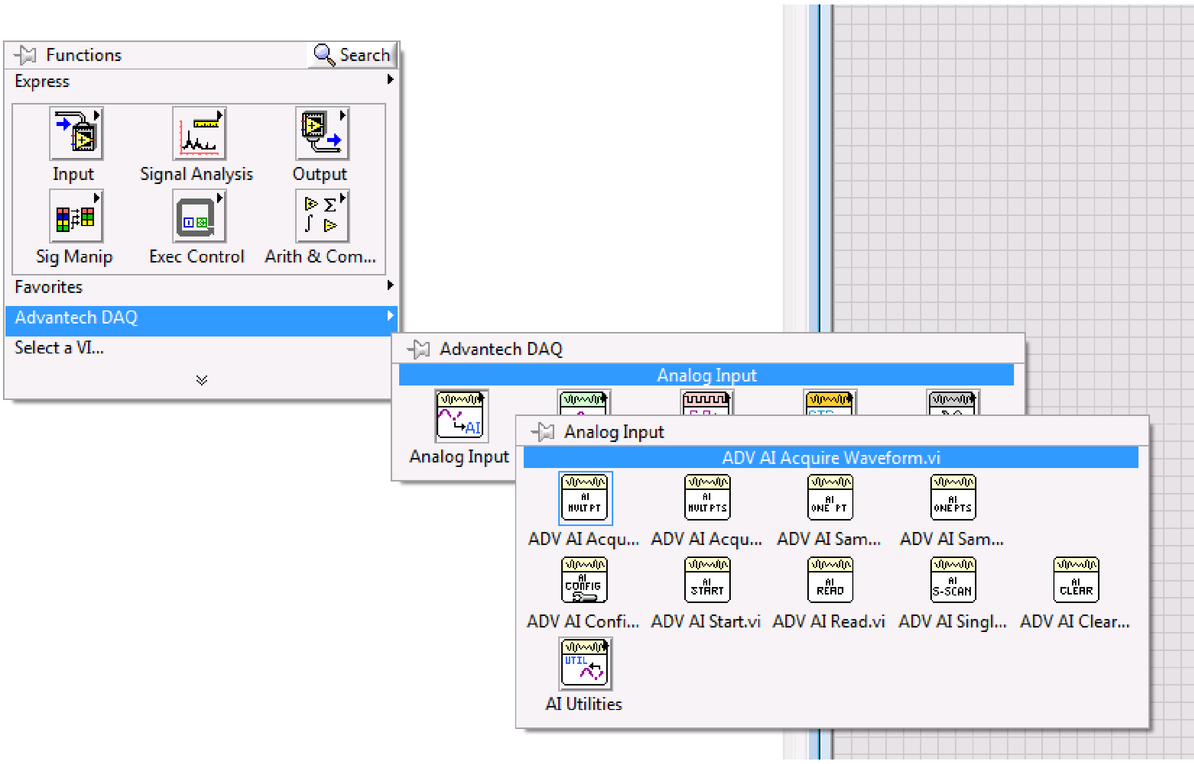
TASK 1:

Create an application to acquire data from signal generator.

1. Open LabView
   - **a.** Accommodate vertically "Block diagram" and "Front Panel"
     "Block diagram" is used for writing source of code
     "Front Panel" is used for communication with operator while application is running
   - **b.** Place front panel, which accommodate controls and indicators for communication between running application and operator) for controls and indicators
   - **c.** Activate tools palette and context help from toolbar

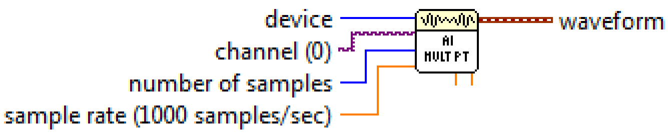


2. "Block diagram" place a mouse courser somewhere in block diagram – right click and labView functions will become available



3. Choose; left click and drag

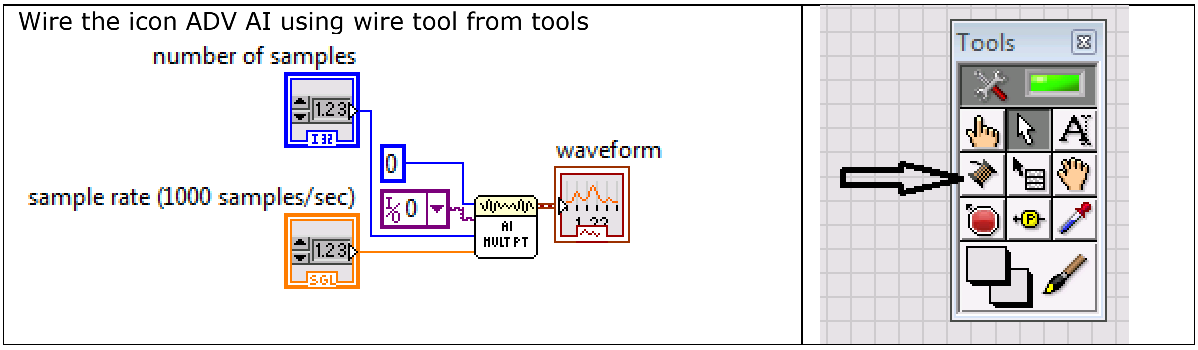
ADV AI Acquire Waveform.vi



Acquires a specified number of samples at a specified sample rate from a single input channel and returns the acquired data.

Detailed help

4. Wire the icon as below



Applying: device as constant

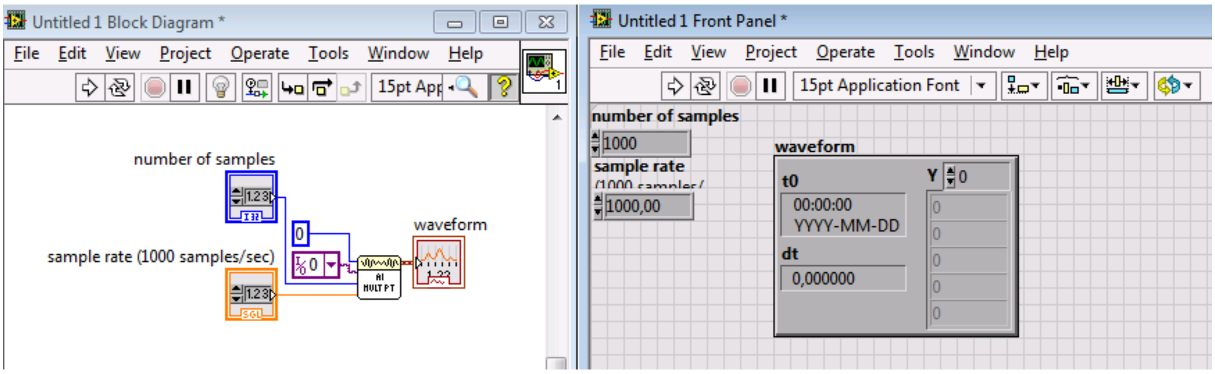
Channel: as constant

Number of samples as control

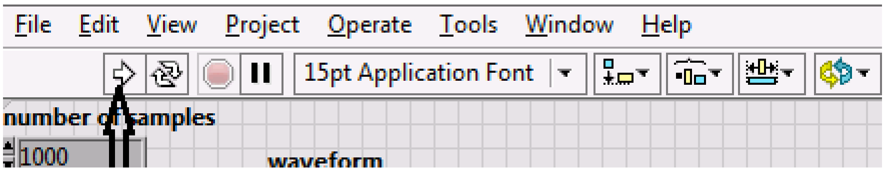
Sample rate as control

Output as indicator

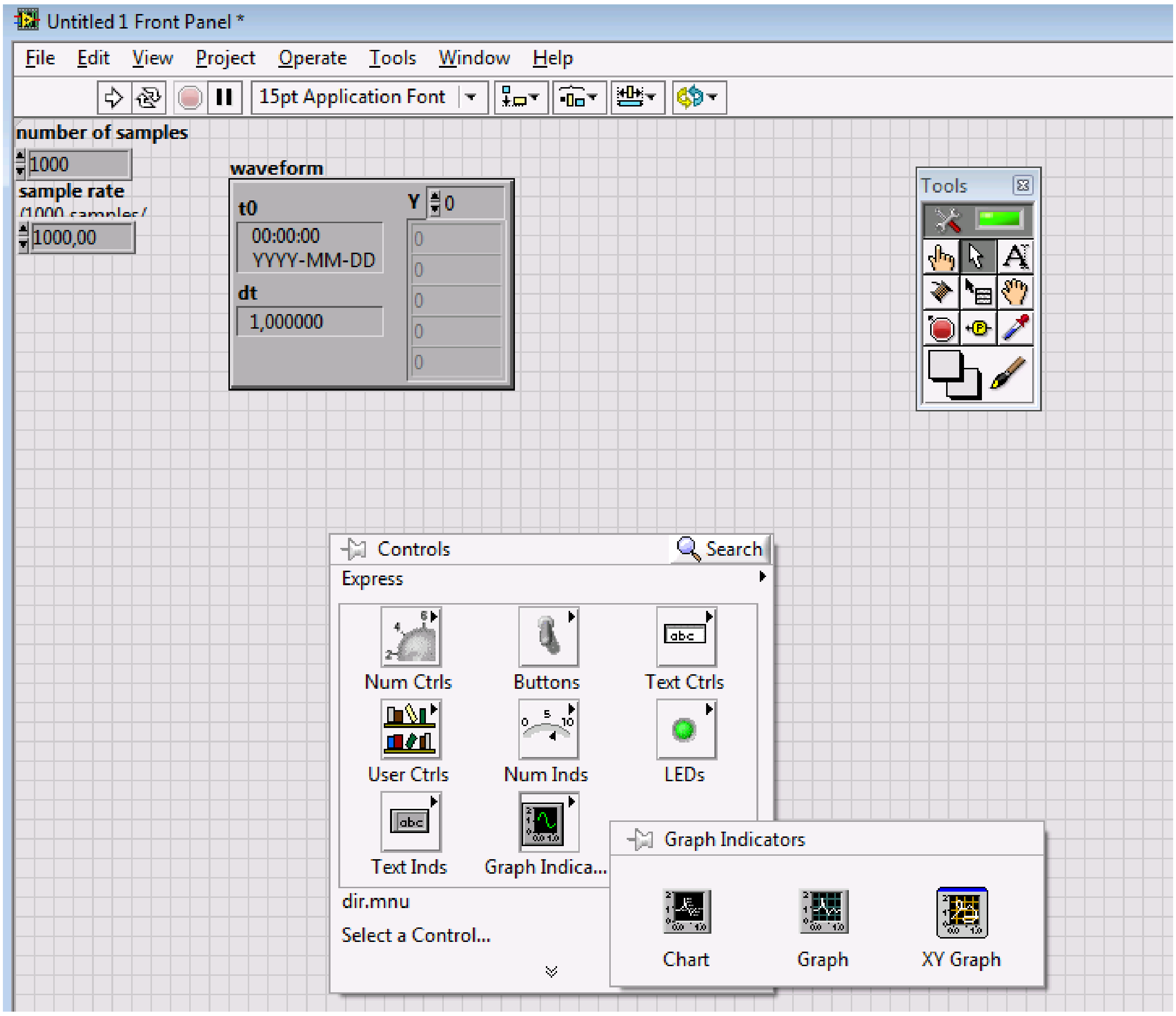
5. The controls and indicators will appear on Front panel



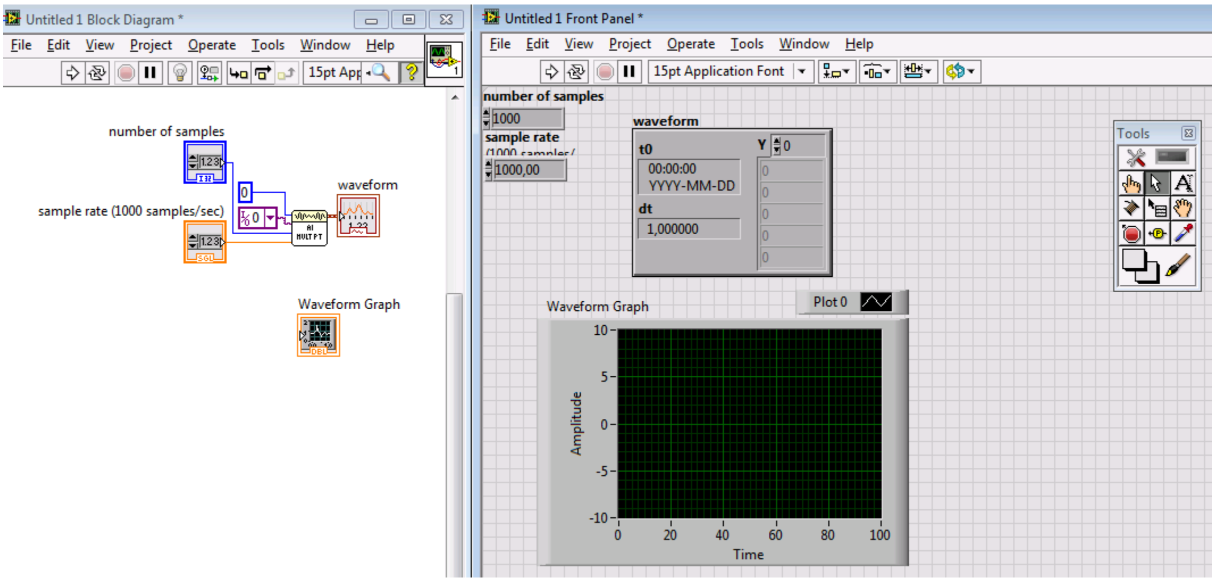
6. Press “white arrow” to run your firs aplication in LabView



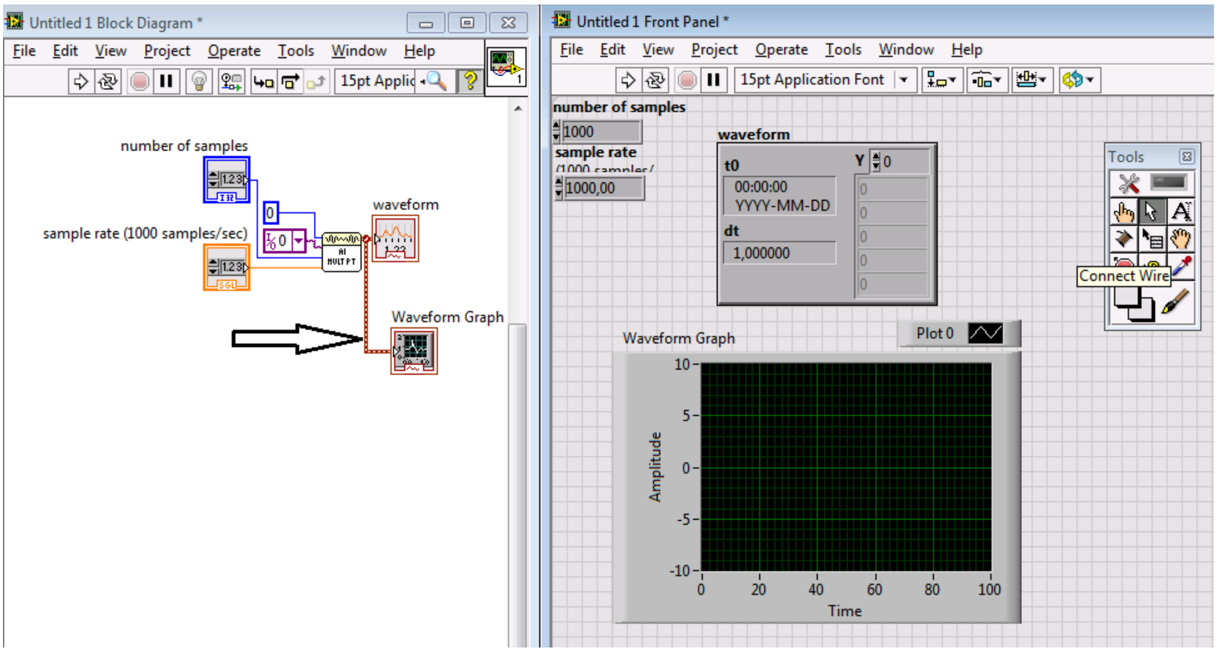
7. Place mouse indicator somewhere in Front Panel and write click, chose Graph, pressleft button and drag ”Graph” icon to Front Panel



8. Graph appears on Front panel and its icon for wiring on block diagram

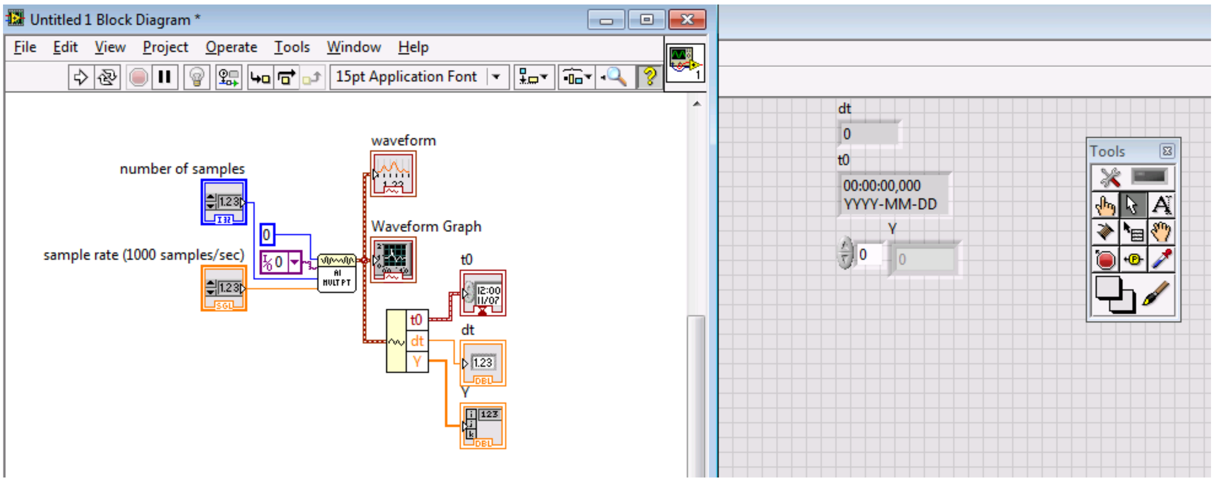


9. Wire using "connect wire" tool wire: the out from "AI" icon to "Graph"

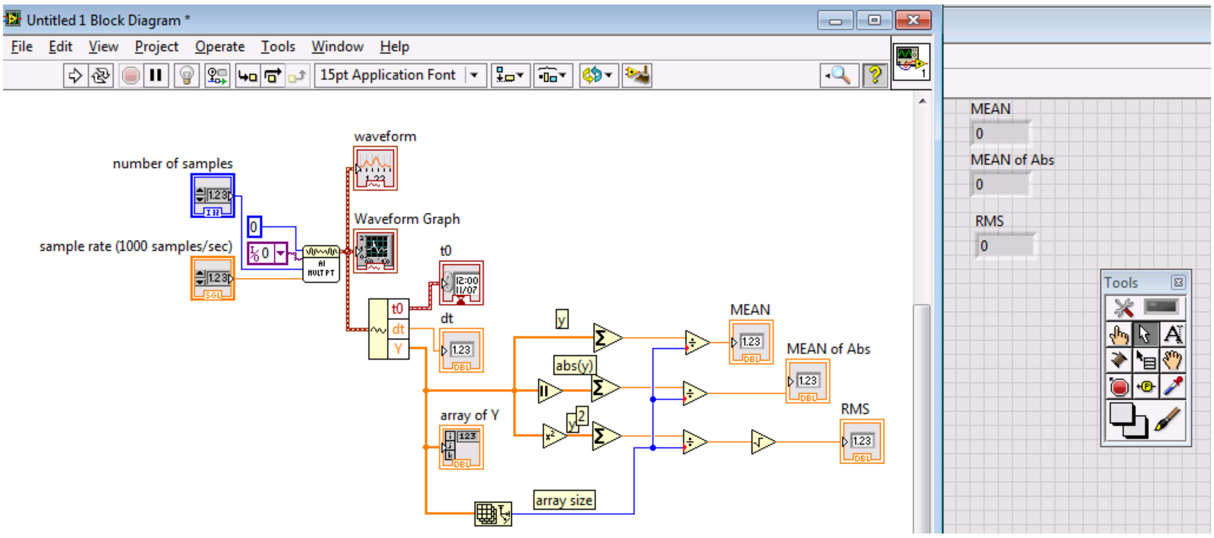


10: Run application with a number of sample 32 and sample rate 800/1600 while from signal generator is a sin wave of 50 Hz and amplitude Vpp=2 V

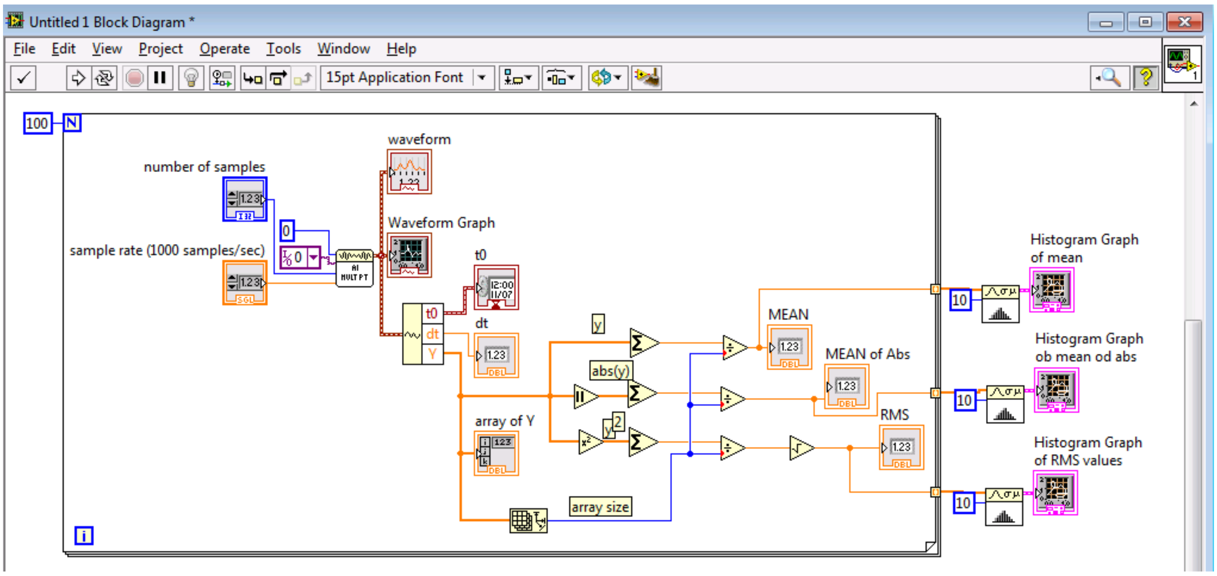
11. Next gradually build up application so you obtain the following steps:



12 next



And finally:



In your report please present results of data handling as screen snapshots and conclude how LabView can support your data acquisition, data handling and data presentation

TASK 2

Create application which records collected data to a file

Add an appropriate icon which allows to store collected data in desired location.

TASK 3

Analysis source of errors in Virtual Instruments

Disuses sources of uncertainties in Virtual Instruments crated during the experiment.

USEFULL FORMULAS

Several useful formulas to calculate parameters o signals presented in discrete form:

Average value over an internal

$$\bar{x} = \frac{1}{n_2 - n_1 + 1} \sum_{n=n_1}^{n_2} x(n)$$

Average value over the whole signal

$$\bar{x} = \lim \frac{1}{2N+1} \sum_{n=-N}^{N} x(n)$$

Average value over a period of signal

$$\overline{x_N} = \frac{1}{N} \sum_{n=n_0}^{n_0+(N-1)} x(n), \quad N - period$$

Power of the whole signal expressed in a discrete form

$$E_x = \sum_{n=-\infty}^{+\infty} x^2(n)$$

Average power of the signal over an interval

$$P_x = \overline{x^2} = \frac{1}{n_2 - n_1 + 1} \sum_{n=n_1}^{n_2} x^2(n)$$

Average power of the whole signal over an interval

$$P_x = \overline{x} = \lim \frac{1}{2N+1} \sum_{n=-N}^{N} x^2(n)$$

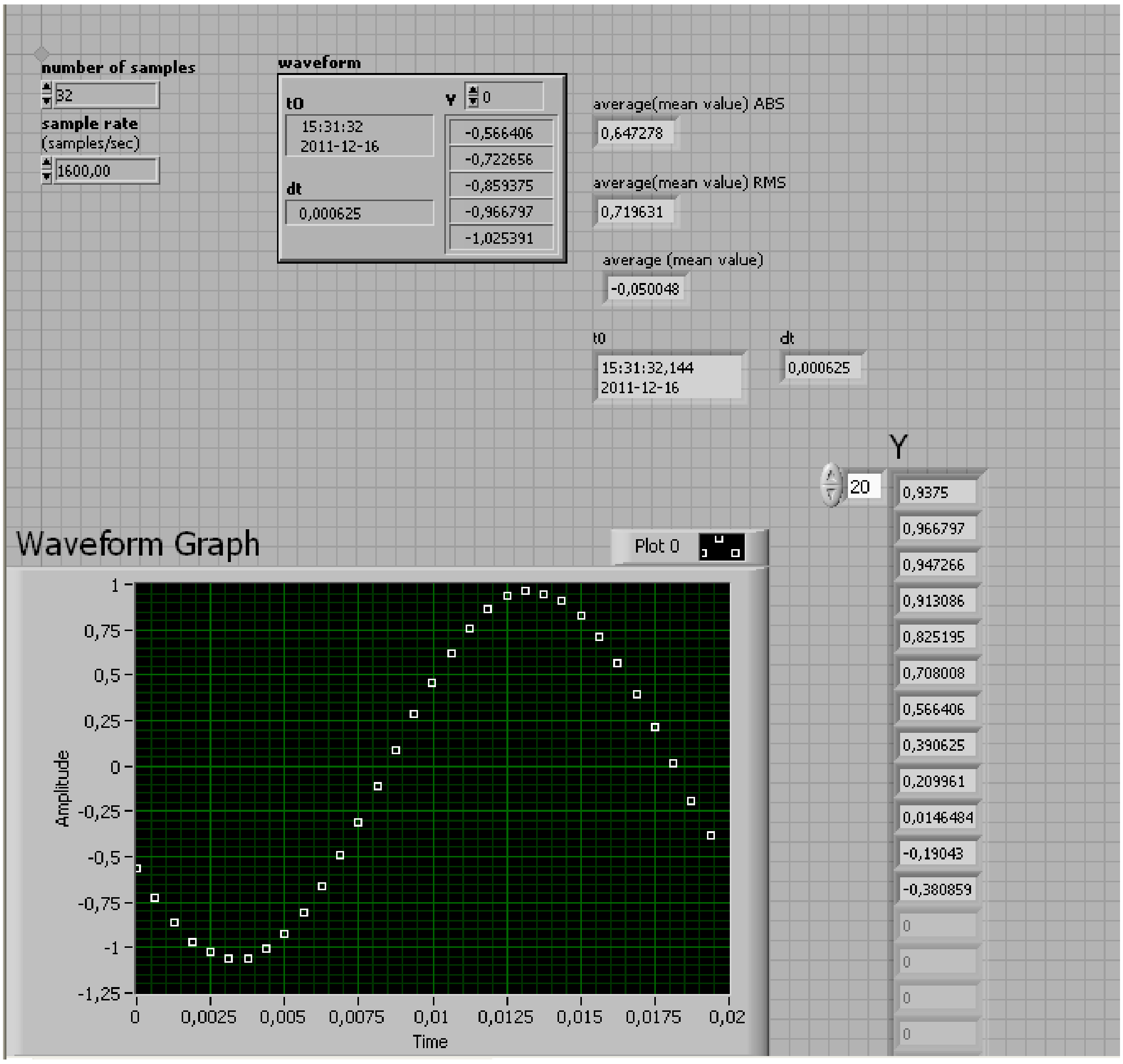
Average power of the periodical signal (over a period)

$$P_x = \overline{x^2}_N = \frac{1}{N} \sum_{n=n_0}^{n_0+(N-1)} x^2(n), \quad N - period$$

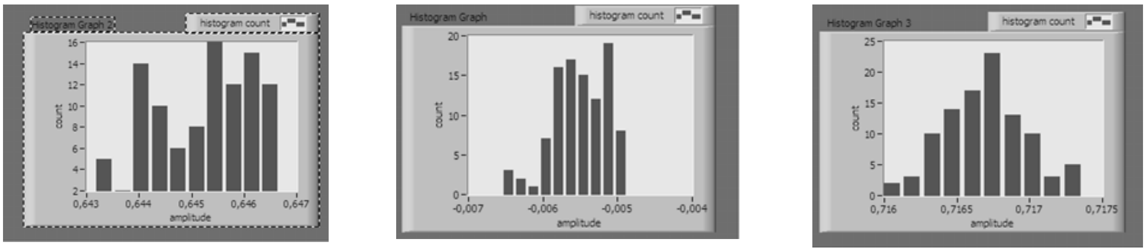
RMS value signal in a discrete form

$$x_{RMS} = \sqrt{P_x}$$

DATA PREZENTION EXAMPLEAS



Screenshot of front panel



Histograms

LITERATURE AND OTHER RECOMMENDED MATERIAL

1. P. Lesiak, D. Świsulski, Komputerowa technika pomiarowa – w przykładach, Agenda Wydawnicza PAK, Warszawa 2002.
2. W. Nawrocki, Komputerowe systemy pomiarowe, Wydawnictwa Komunikacji i Łączności, Warszawa 2002.
3. R. Rak, Przyrządy wirtualny – realne narzędzie współczesnej metrologi, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2003.
4. R. Rak, Systemy informacyjno-pomiarowe, podręcznik multimedialny, Ośrodek Kształcenia na Odległość Politechniki Warszawskiej – OKNO, Warszawa 2005.
5. W. Tłaczała, Środowisko LabVIEW w eksperymencie wspomaganym komputerowo, Wydawnictwa Naukowo-Techniczne, Warszawa 2002.
6. W. Winiecki, Organizacja mikrokomputerowych systemów pomiarowych, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 1997.

Additional information:

1. http://www.ni.com/

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LABORATORY OF MEASUREMENTS

EXPERIMENT NO:	**4**
EXPERIMENT TITLE:	**Virtual Instruments for Engineering Practice**

LABORATORY GROUP		***Program/Term***	
No.	***STUDENT'S NAME***		***ID***
1			
2			
3			
4			

Lecturer:	
Data date of experiment:	
Data of submitted report :	
Mark:	
Comments	