

WORCESTER POLYTECHNIC INSTITUTE MECHANICAL ENGINEERING DEPARTMENT

Engineering Experimentation
ME-3901, D'2012

Laboratory #1
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General information

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General information

Please refer to handout:
"Laboratory 1: Digital Ohm Meter"



Objectives

The objectives of this laboratory are:

- To expose the user to LabVIEW Software;
- To understand the technicalities of analog to digital conversion (A/D conversion). Additionally, items created and/or displayed from this software will need to be placed in a variety of documents: WORD, PowerPoint, and/or Excel. Consequently, each user must be exposed to these software tools, utilities and directories;
- The user needs to configure a system so that external inputs (voltage, etc.) can be read by the DAQ system;
- The user will create a Virtual Instrument (VI) to measure analog inputs;
- Display in analog and digital forms and create a file of resistor values;
- The digital readings will be transferred to a spreadsheet for statistical analysis;
- You will also observe the temperature versus resistance characteristics of a batch of ten carbon resistors.



Background

The background information of this lab involves two very broad areas of study in instrumentation:

- graphical computer programming; and
- analog-to-digital conversion.

Both areas can be extensive, however, the following short introduction allows one to take simple measurements.



Graphical computer programming: example

Write LabVIEW program to perform the following operations:

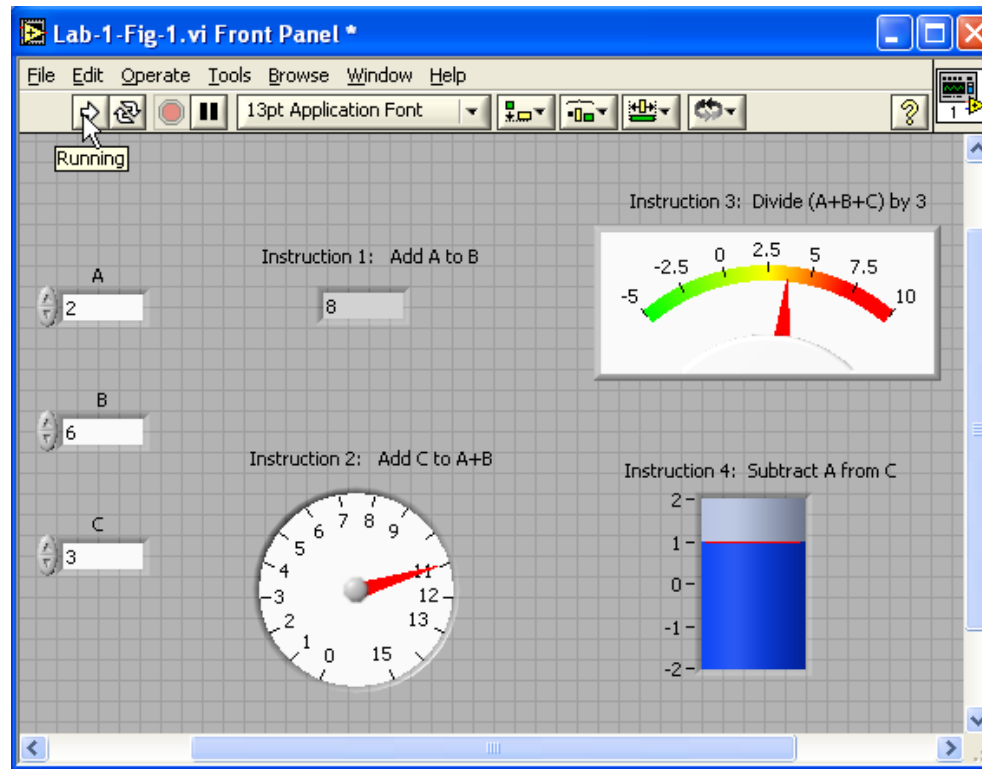
1. Add **A** to **B**
2. Add **C** to Sum of **A** and **B**
3. Divide Sum of **A**, **B**, and **C** by 3
4. Subtract **A** from **C**

Fig. 1-1a. Sequence of instructions to be programmed in a computer.



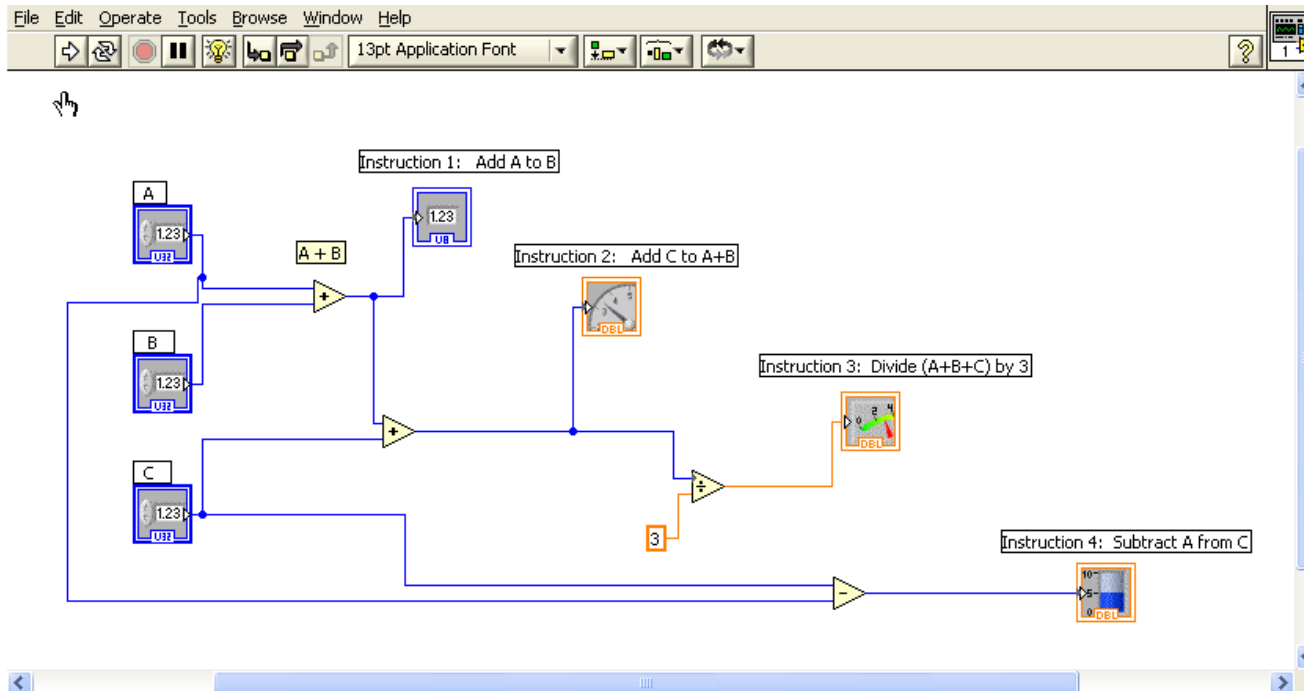
Graphical computer programming: example

Front panel



Graphical computer programming: example

Block diagram



Can you draw electronic diagram used for measurement of electrical resistance?

See an actual Ohm meter and measure electrical resistance



Ohms law

Ohm's law provides the relationship between Voltage, V [volts], current, I [amps], and resistance, R [Ohms].

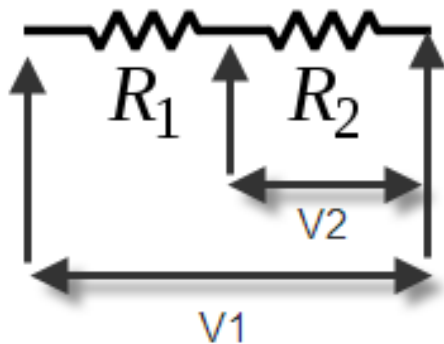
$$V = I \cdot R$$



Measuring Resistance

Our hardware is capable of generating (analog out) and measuring voltages (analog in). We will create a circuit as shown in the figure below with two resistors in series, R_1 and R_2 . R_1 will be known and R_2 will be unknown. By applying a voltage, V_1 , across the two resistors and measuring the voltage, V_2 , across the unknown resistor, R_2 , we can compute the unknown resistance.

Resistors in Series

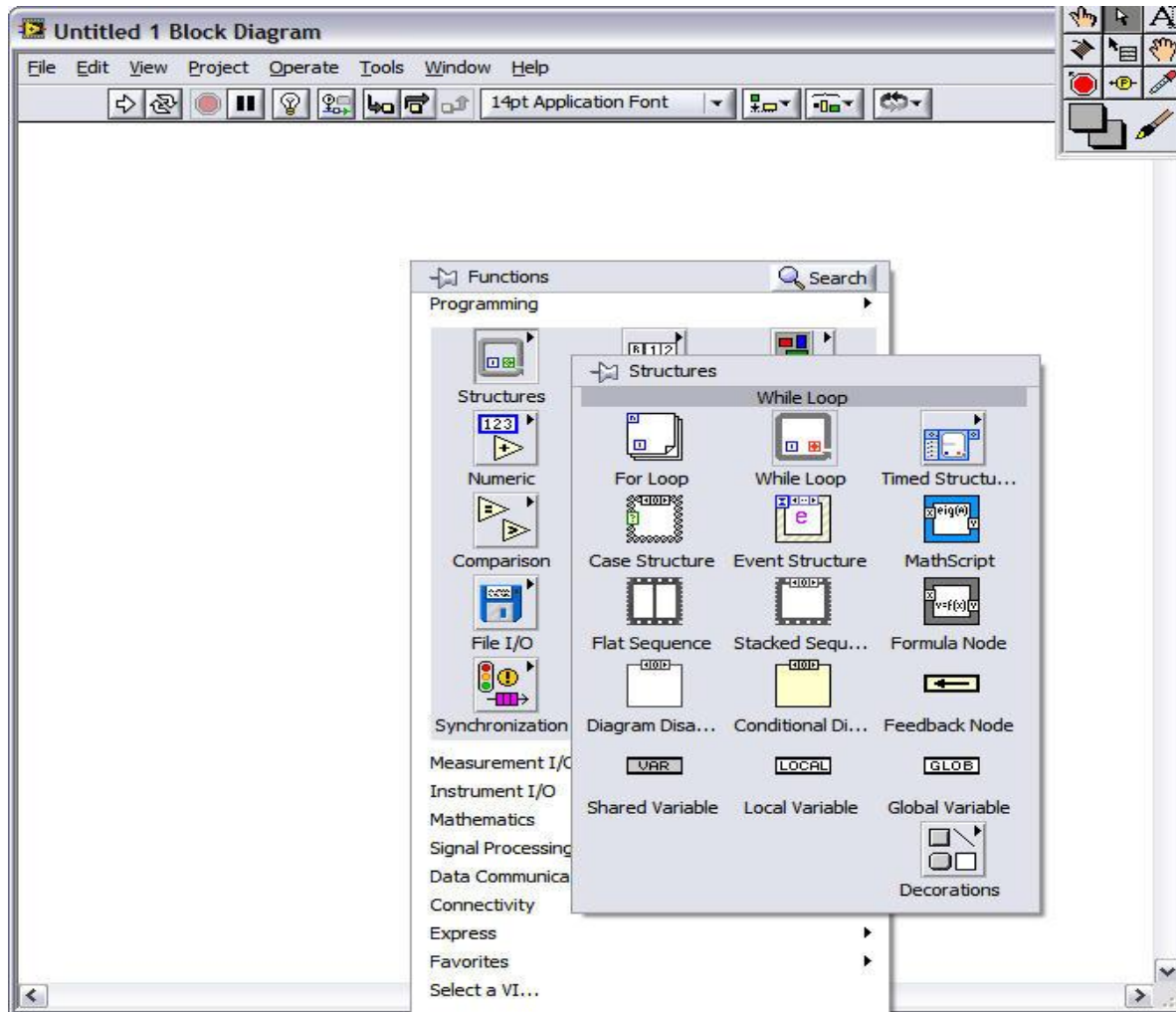


The resistors in series on the left form a voltage divider. The voltage V_1 is applied to an equivalent resistor of magnitude $(R_1 + R_2)$. The voltage V_2 is proportional to the ratio $R_2 / (R_1 + R_2)$. Hence you can compute R_2 from the measured values of R_1 , V_1 and V_2 .

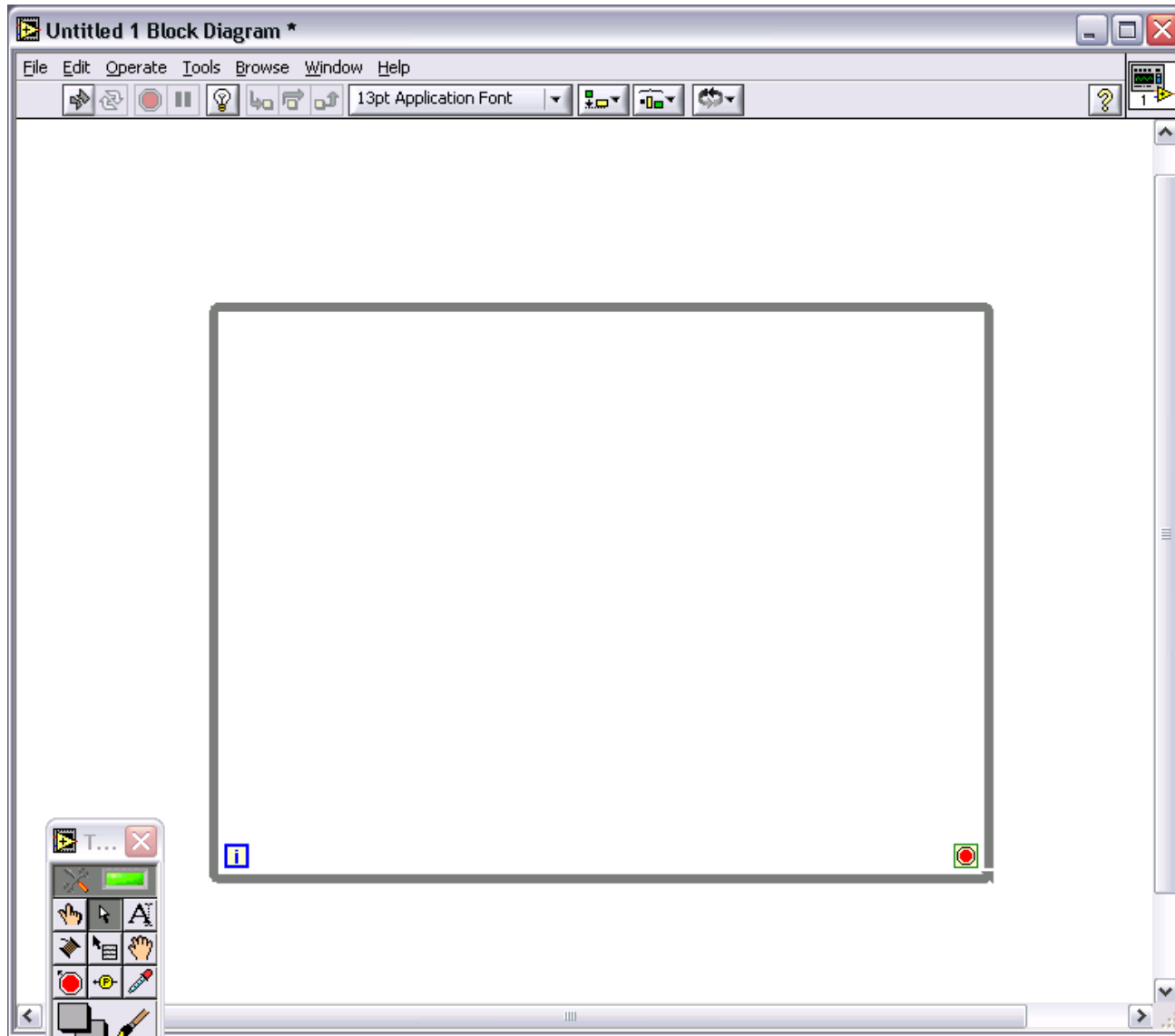


Building an Ohm meter: start from a "blank" VI

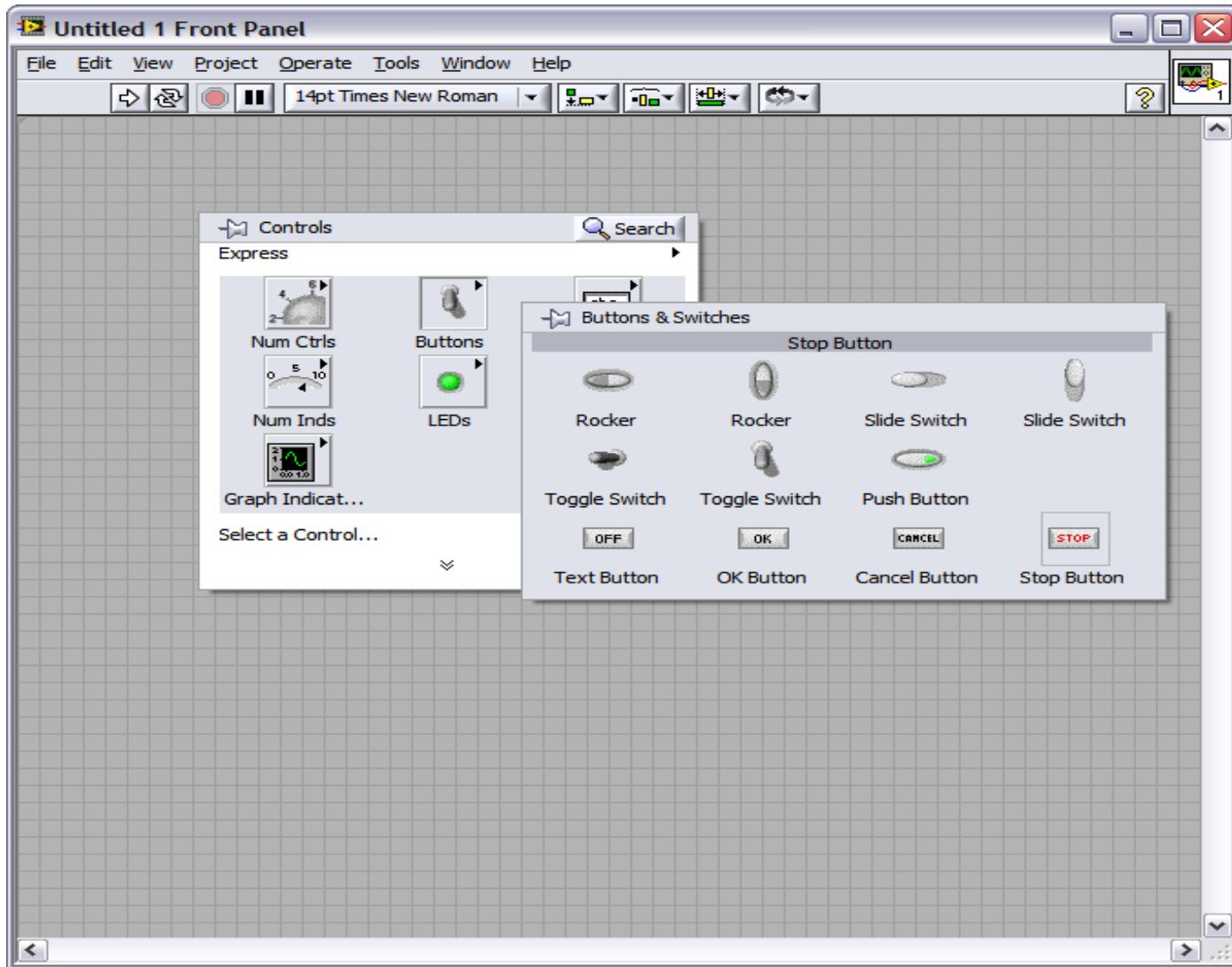
Right-click and add a "while" loop



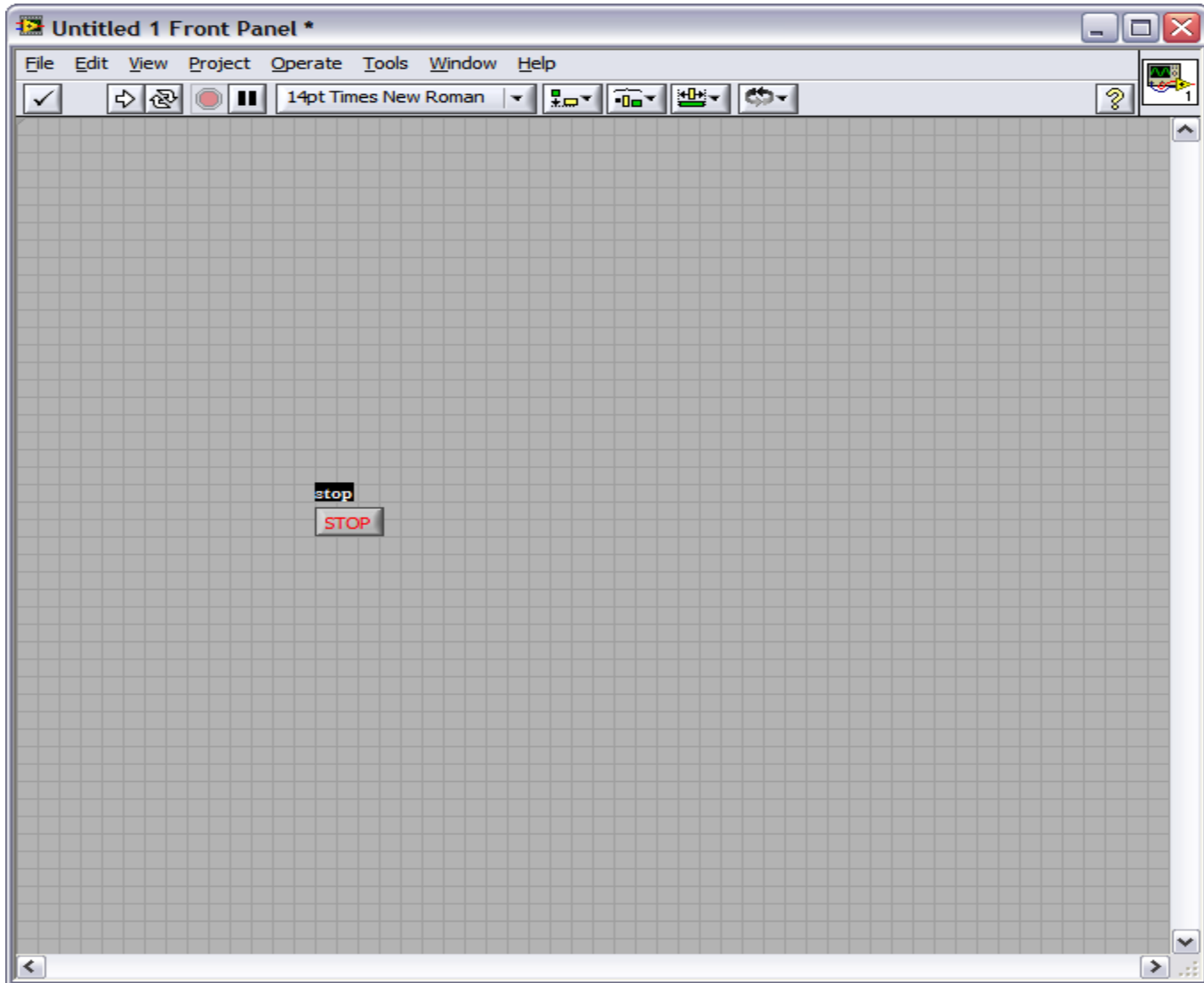
Build an Ohm meter: add a "while" loop



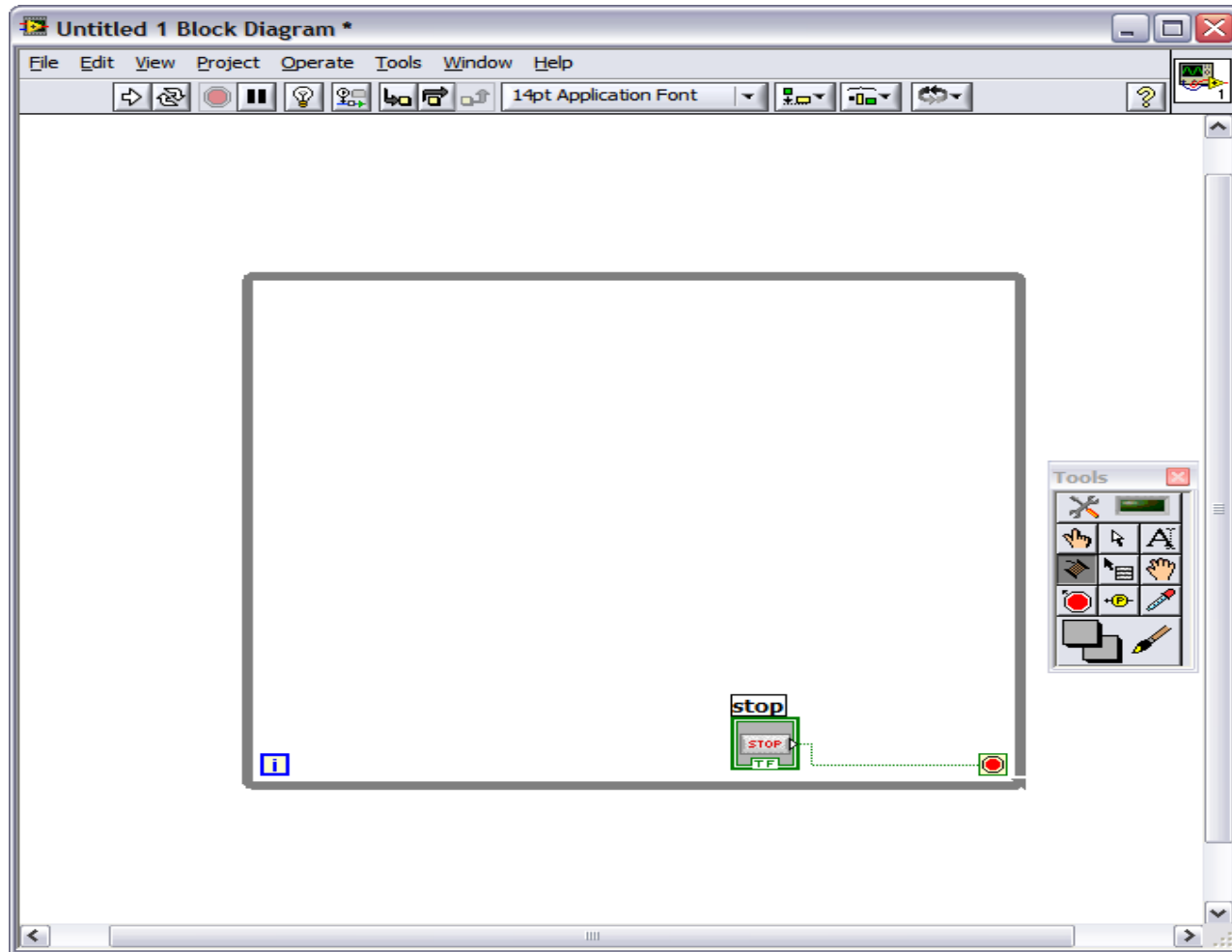
Add a "Stop Button" on the Front Panel



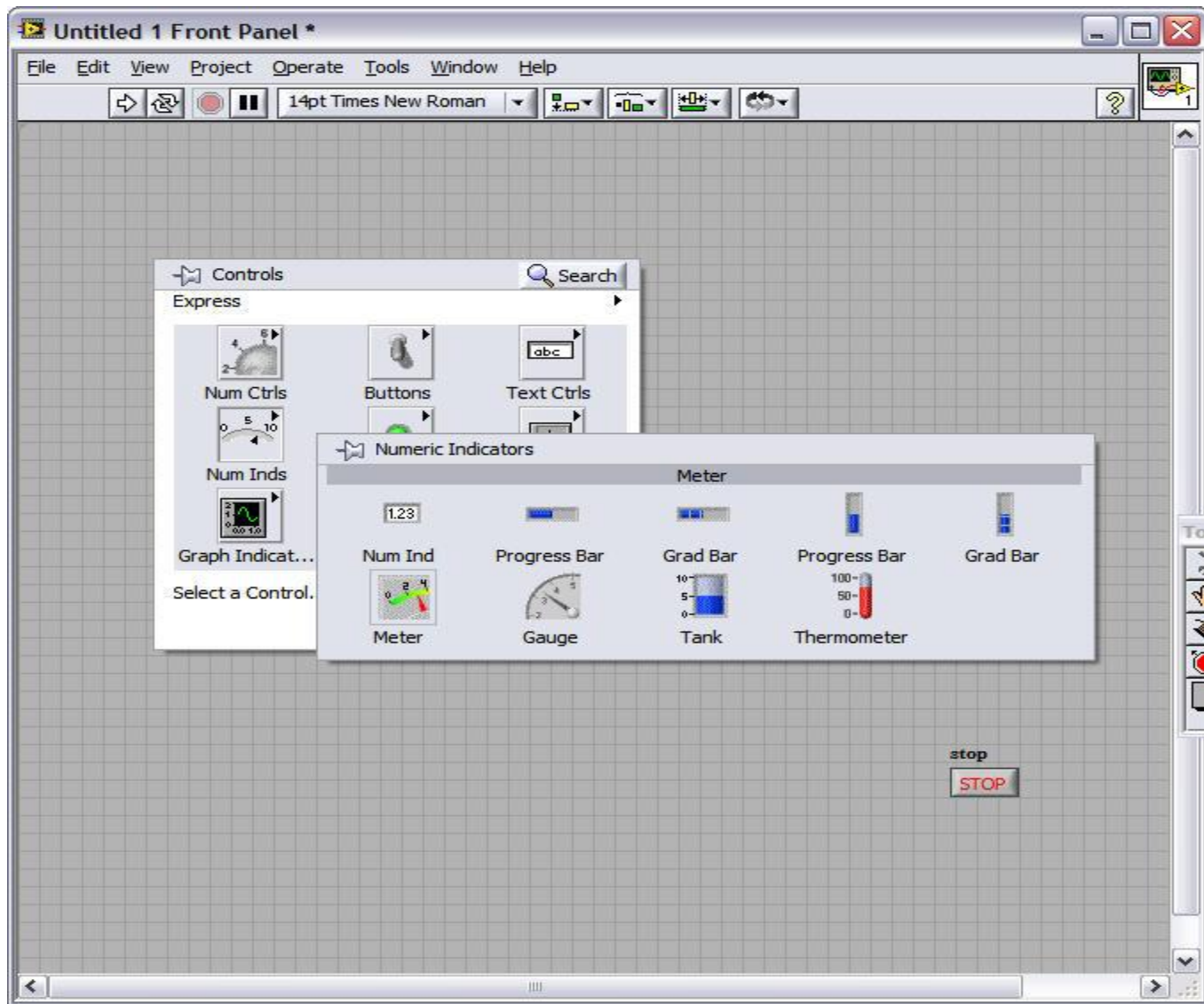
Front Panel showing "Stop Button"



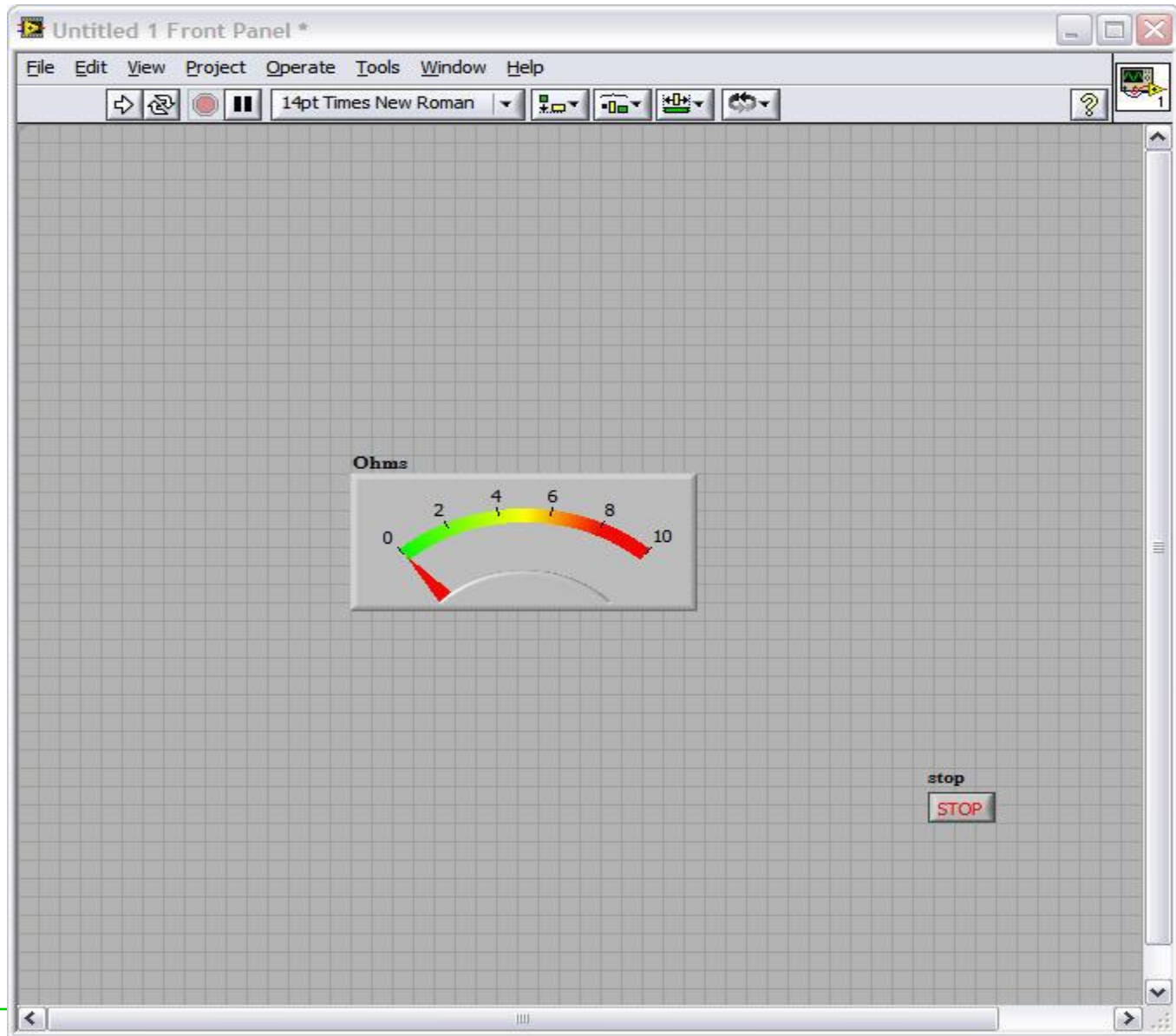
In the block panel, wire the "Stop Button"



Create a "Display" on the front panel



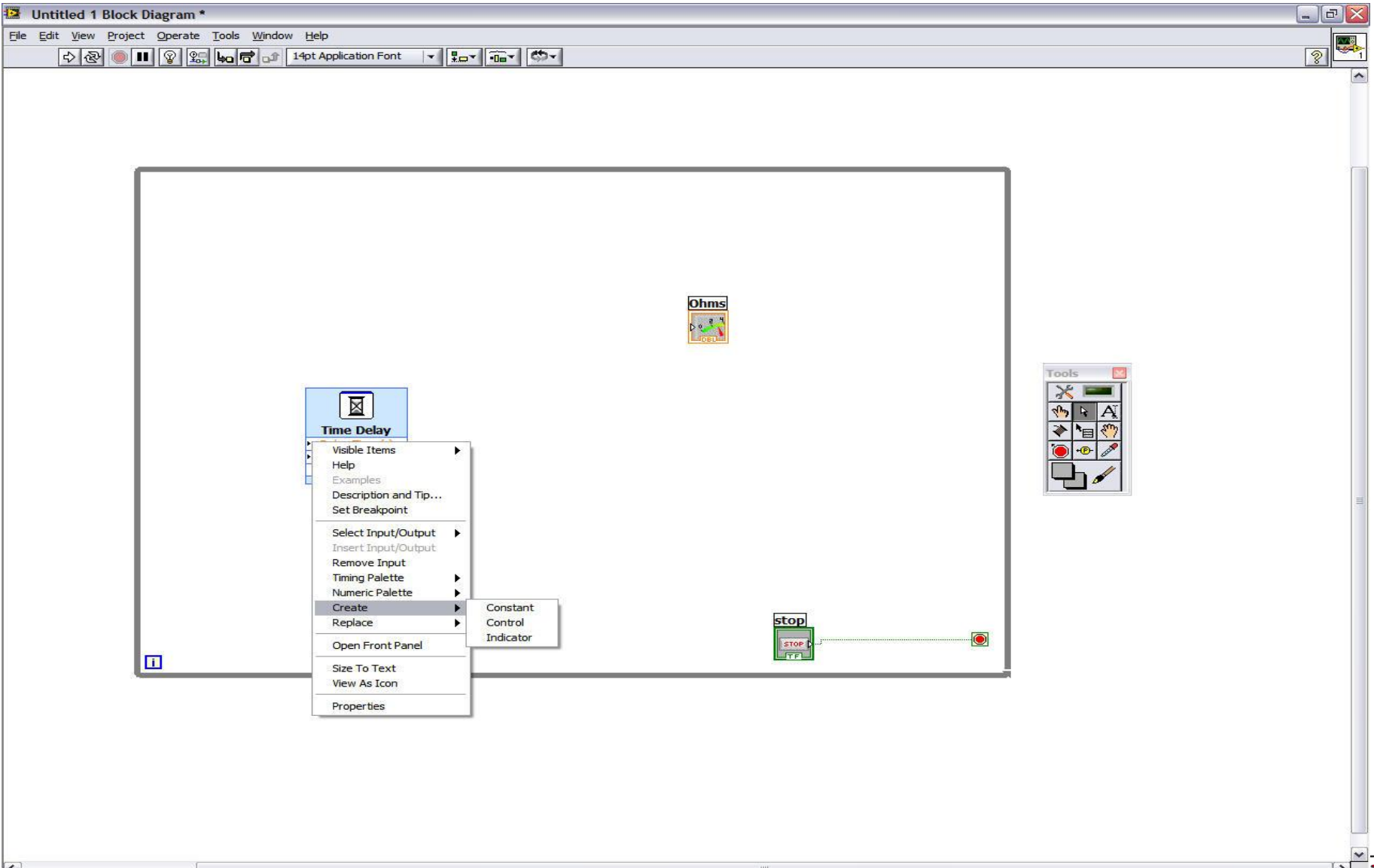
Front Panel. Change properties, as necessary



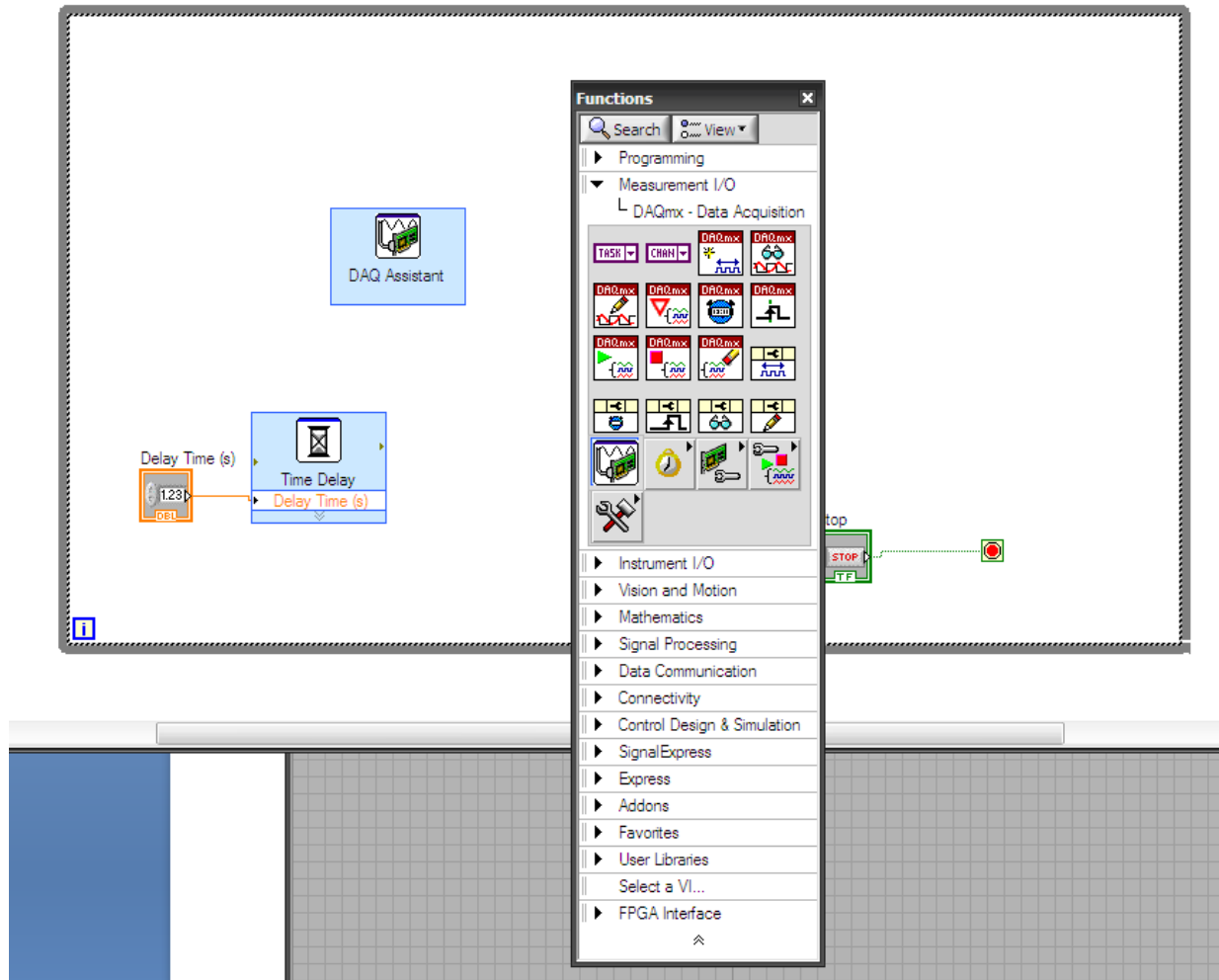
Add a "Timer"

The image shows a screenshot of a software interface titled "Untitled 1 Block Diagram *". The interface includes a menu bar (File, Edit, View, Project, Operate, Tools, Window, Help) and a toolbar with various icons. A large empty workspace is visible, containing a single "Ohms" block. A "Tools" palette is located on the right side of the workspace. A "Functions" palette is open in the lower-left area, displaying various function categories. The "Timing" category is expanded, showing several time-related blocks. The "Time Delay" block, represented by a clock icon, is highlighted with a red rectangular box. Other blocks in the "Timing" category include "Tick Count (ms)", "Wait (ms)", "Wait Until Ne...", "To Time Stamp", "Get Date/Tim...", "Date/Time To...", "Seconds To D...", and "Time Stamp C...".

Add "Timer" control: right-click (in select mode) -> Create -> Control



Add an "Analog Input" Channel by dragging the DAQ assistant icon to the block diagram



Configure Voltage input channel

Use the DAQ Assistant Tool

The image shows a screenshot of the DAQ Assistant software interface. On the left, a block diagram contains a 'Time Delay' block with a value of '123' and a unit of 'Ohms' (labeled 'Ohms' above the block). A 'DAQ Assistant' icon is visible in the top left. On the right, a dialog box titled 'Create New Express Task...' is open. The dialog box features the NI-DAQ™ logo and the National Instruments logo. The main text reads: 'Select the measurement type for the task. A task is a collection of one or more virtual channels with timing, triggering, and other properties. To have multiple measurement types within a single task, you must first create the task with one measurement type. After you create the task, click the Add Channels button to add a new measurement type to the task.' The right side of the dialog box has two checked options: 'Acquire Signals' and 'Generate Signals'. At the bottom of the dialog box are buttons for '< Back', 'Next >', 'Finish', and 'Cancel'.



Configure Resistance Channel

Use the DAQ Assistant Tool

Ohms

DAQ Assistant

Create New Express Task...

NI-DAQ™
DAQ Assistant

NATIONAL INSTRUMENTS™

Select the measurement type for the task.

A **task** is a collection of one or more virtual channels with timing, triggering, and other properties.

To have **multiple measurement types** within a single task, you must first create the task with one measurement type. After you create the task, click the **Add Channels** button to add a new measurement type to the task.

Acquire Signals

Analog Input

- Voltage
- Temperature
- Strain
- Current
- Resistance
- Frequency
- Position
- Acceleration
- Custom Voltage with Excitation
- Sound Pressure

< Back Next > Finish Cancel

Delay Time (s)

1.23

DEL

Time Delay

Delay Time (s)

i



Configure Resistance Channel Number 0 in the USB-6229 signal conditioner. Other Channels can also be used

Create New Express Task...

NI-DAQ™
DAQ Assistant

NATIONAL INSTRUMENTS™

Select the physical channel(s) to add to the task.

If you have previously configured [global virtual channels](#) of the same measurement type as the task, click the **Virtual** tab to add or copy global virtual channels to the task. When you copy the global virtual channel to the task, it becomes a local virtual channel. When you add a global virtual channel to the task, the task uses the actual global virtual channel, and any changes to that global virtual channel are reflected in the task.

If you have TEDS configured, click the **TEDS** tab to add TEDS channels to the task.

For hardware that supports [multiple channels](#) in a task, you can select multiple channels to add to a task at the same time.

Physical **Virtual**

Supported Physical Channels

- Dev2 (USB-6229 (BNC))
- ai0
- ai1
- ai2
- ai3
- ai4
- ai5
- ai6
- ai7
- ai8
- ai9
- ai10
- ai11
- ai12
- ai13

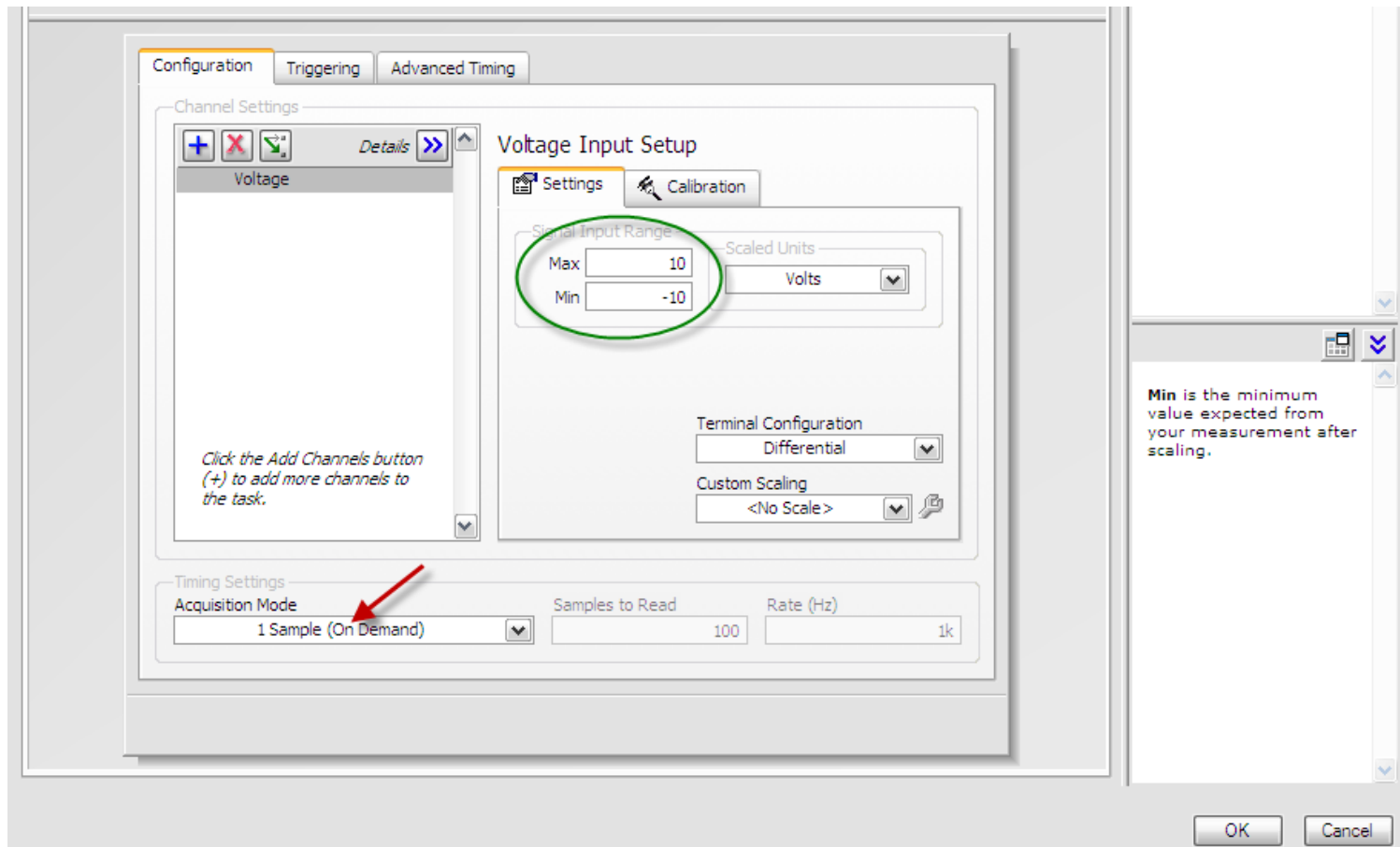
<Ctrl> or <Shift> click to select multiple channels.

< Back Next > Finish Cancel

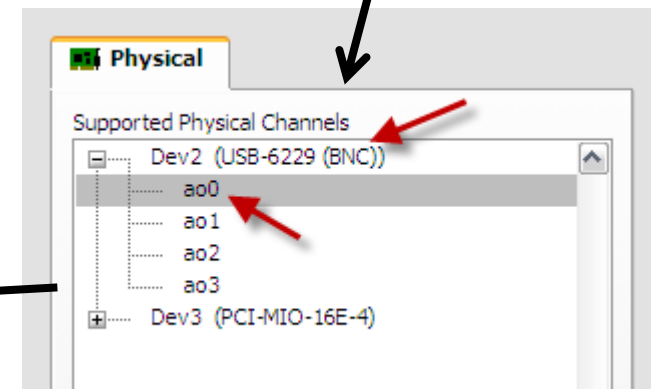
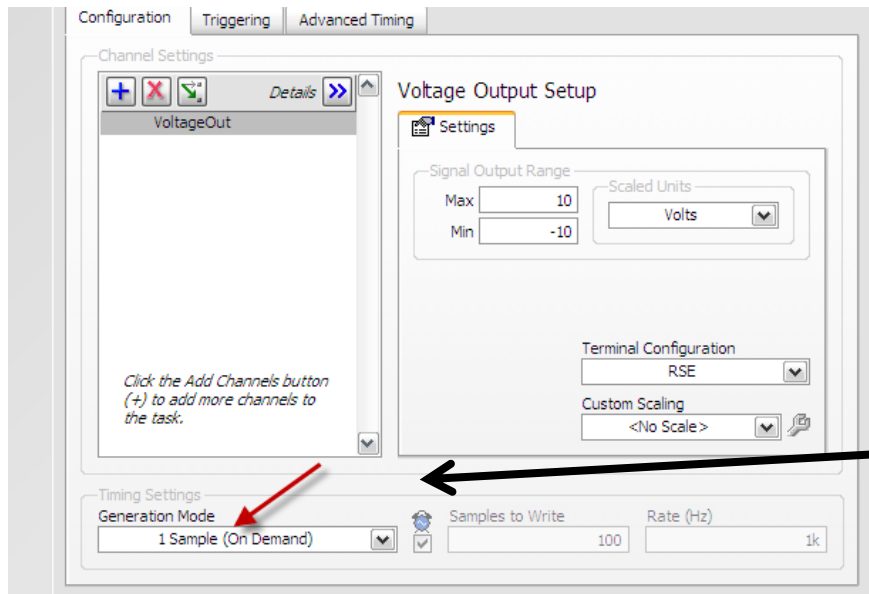
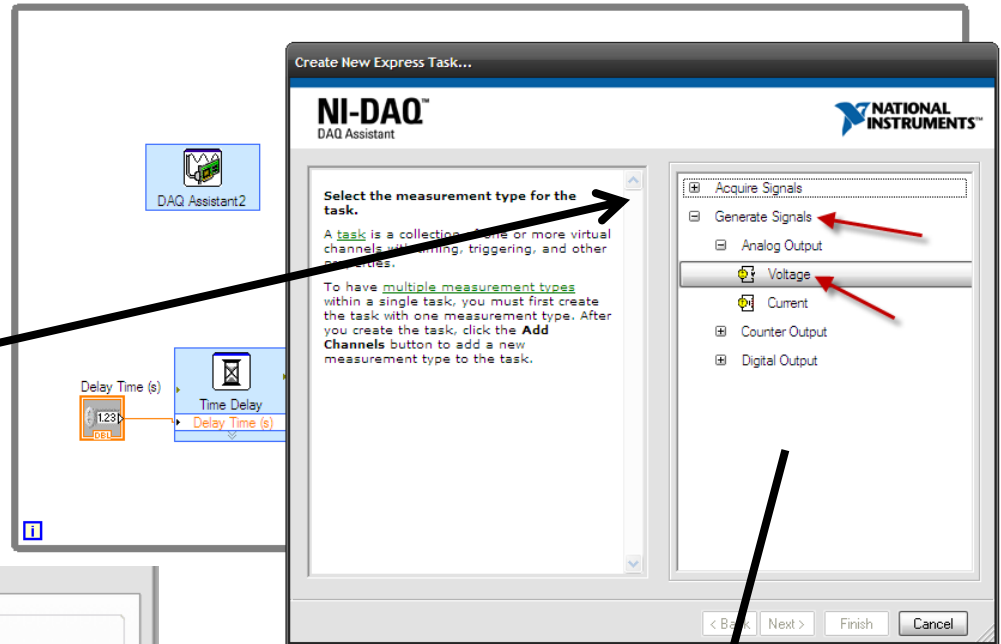
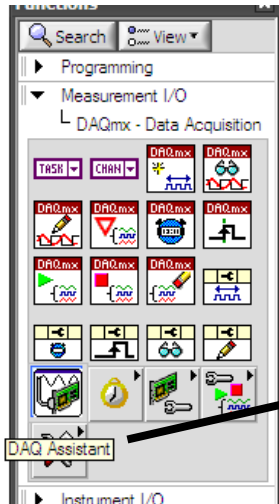


Set the properties for the channel - 1 Sample on Demand

Notice the voltage range

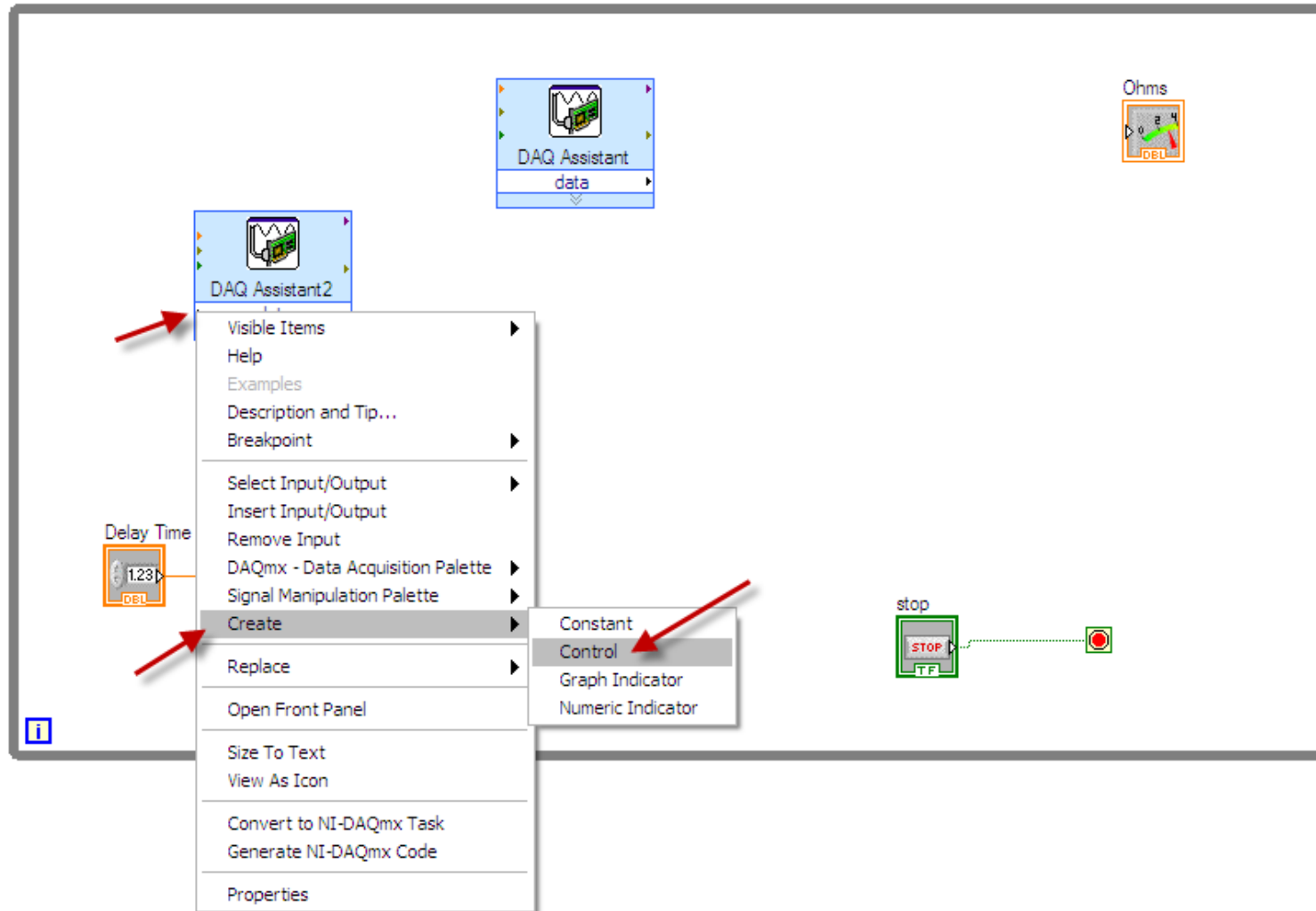


Create one more DAQ assistant block - this time make it analog output with 1 sample on demand option

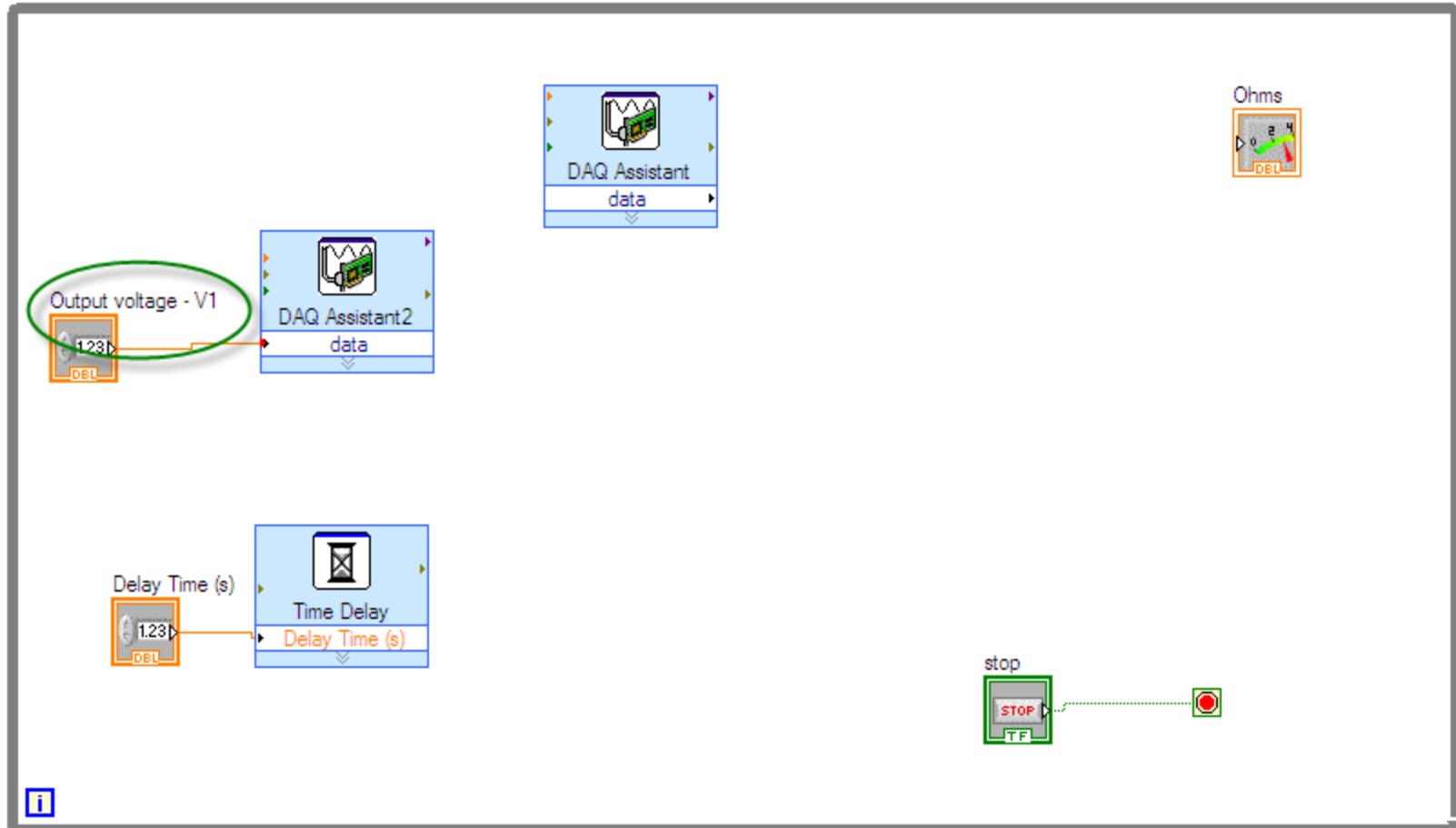


Create a control for the second DAQ Assistant block

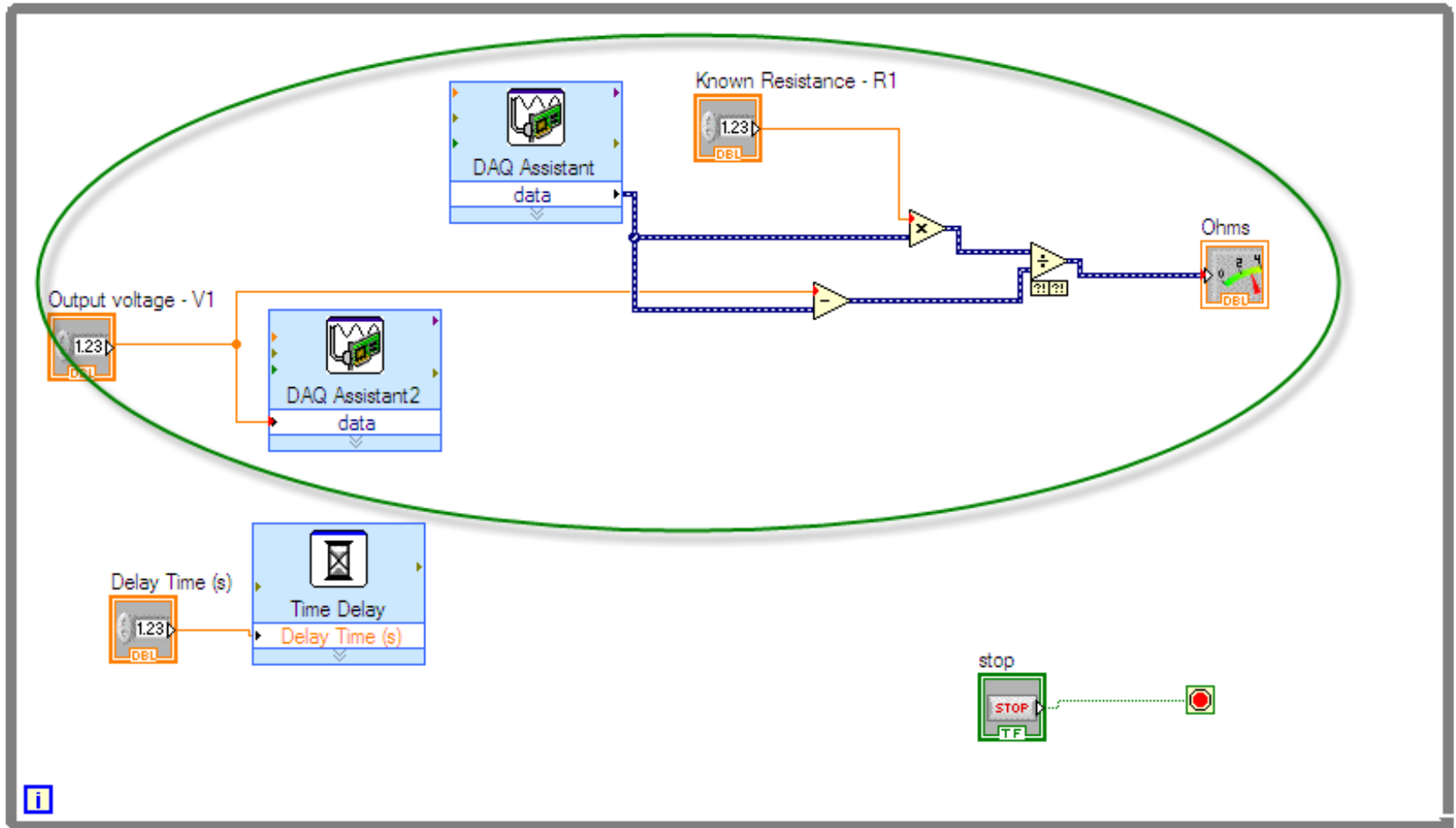
This allows you to control the input voltage - V1



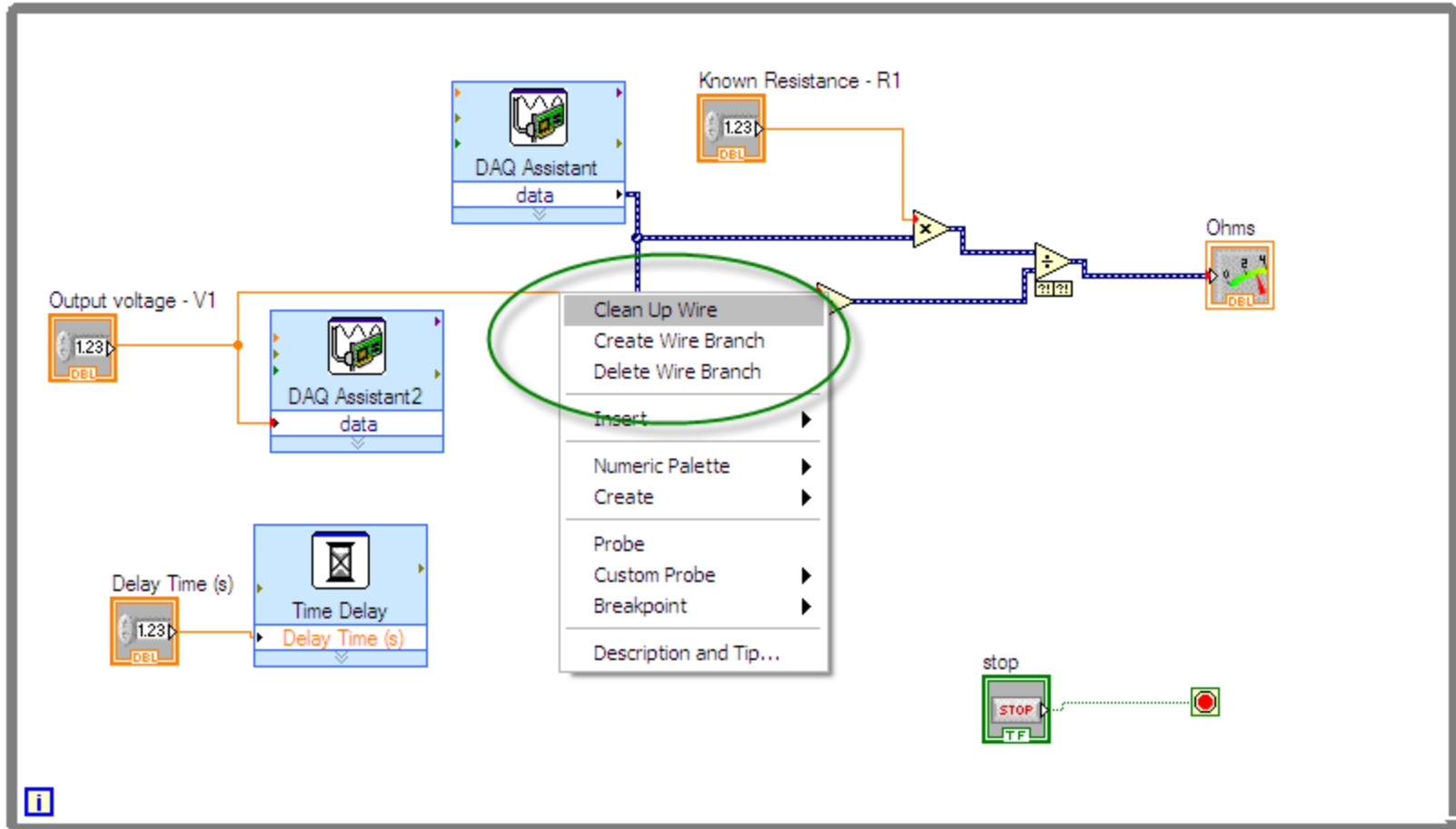
Label the newly created control properly



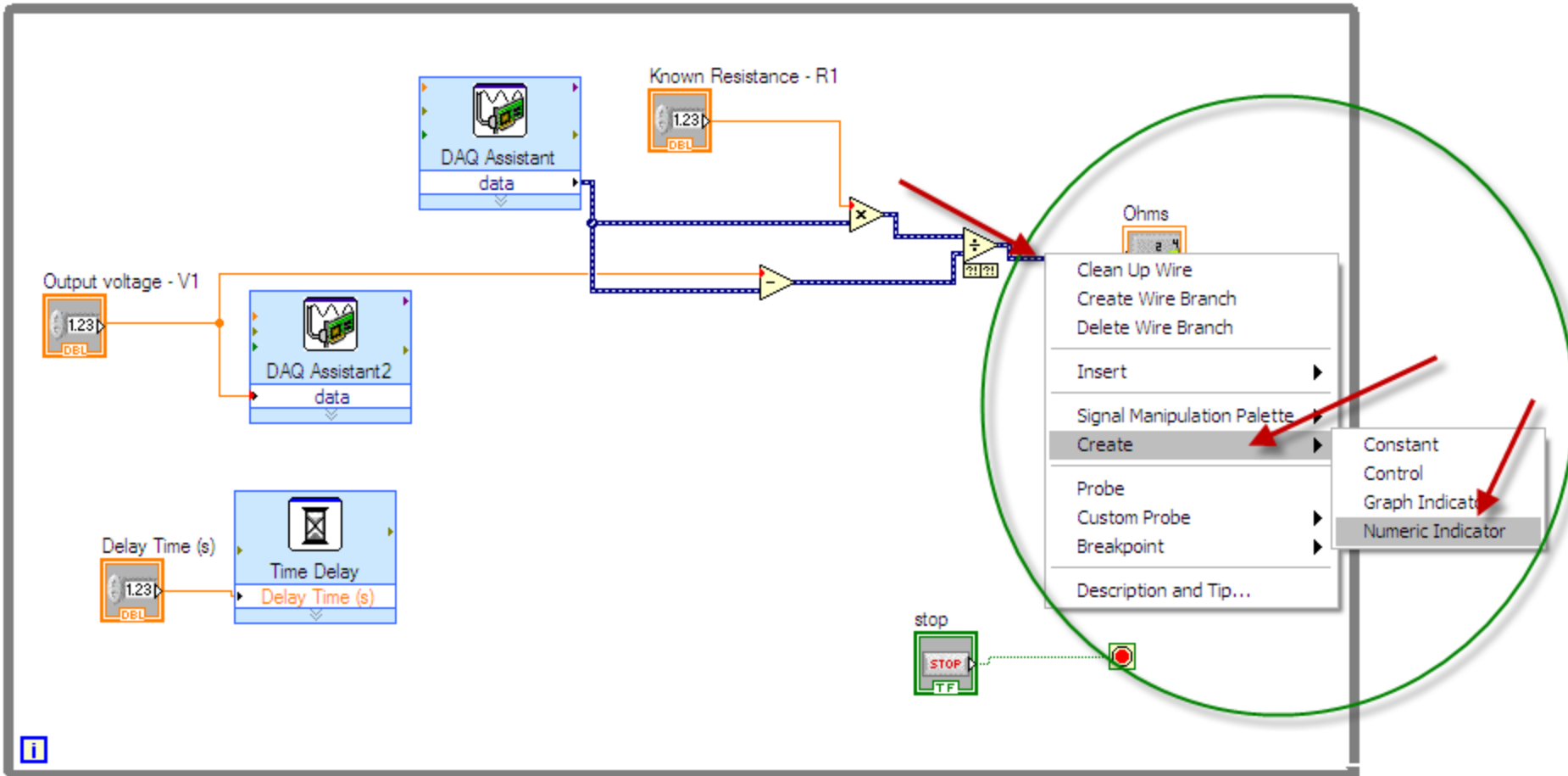
Create a block diagram to calculate the resistance R2 knowing V1, V2 and R1 and using the voltage divider properties. Again, label properly.



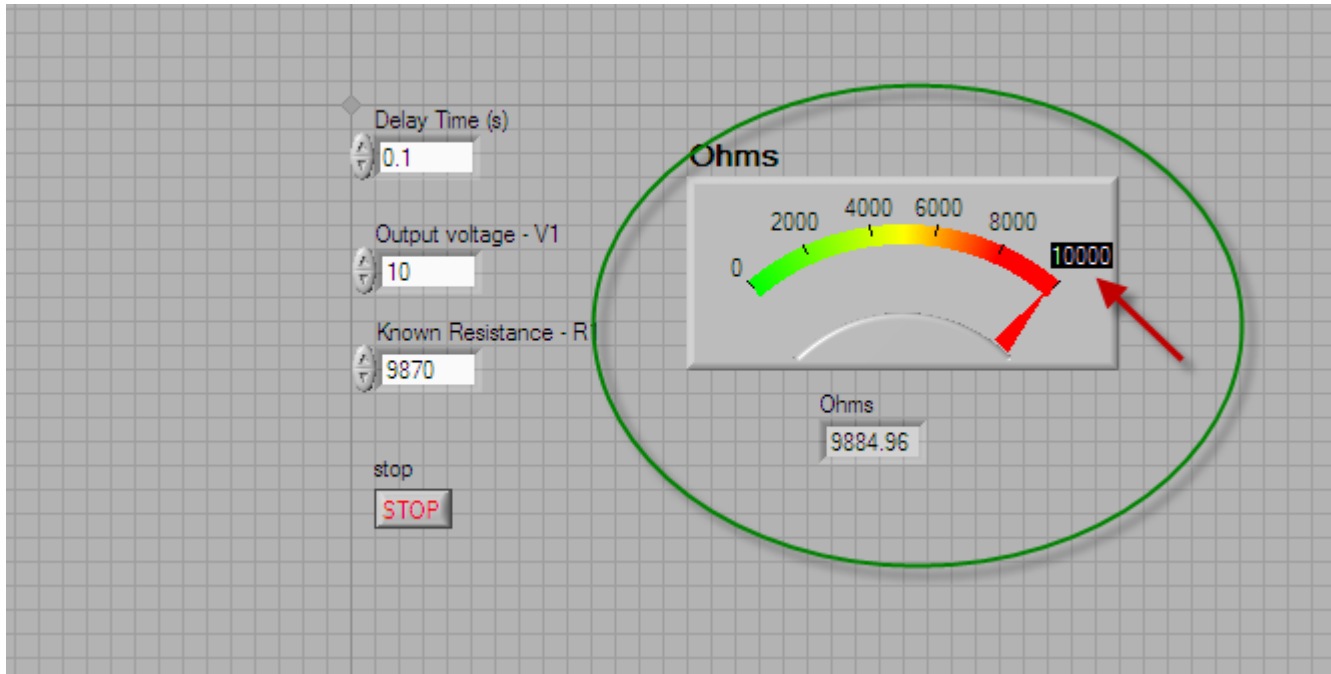
When wiring, a useful feature is the 'Clean Up Wire' - just right-click on the messy wire.



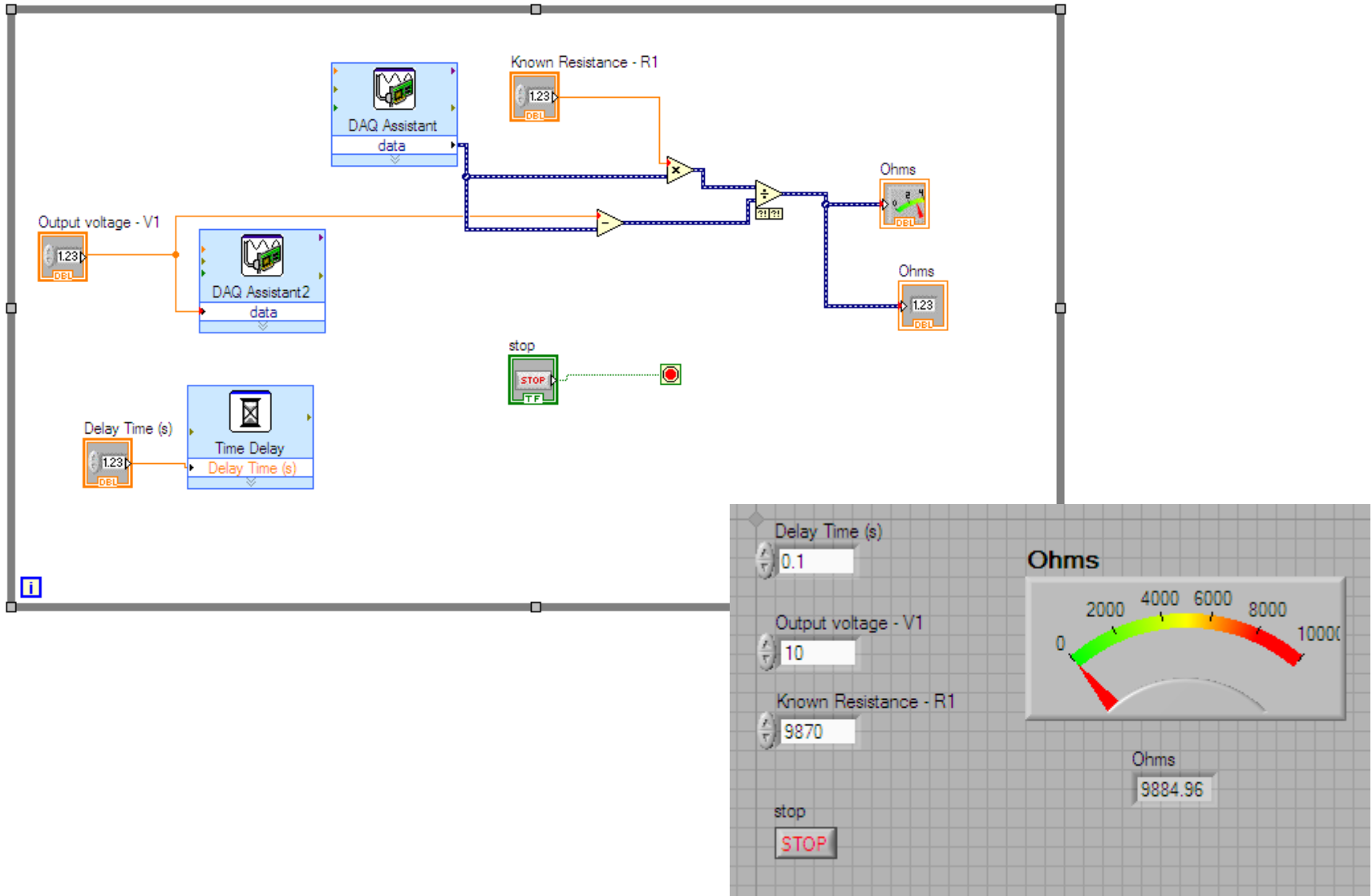
Create a numeric indicator at the output of the VI for more convenient reading



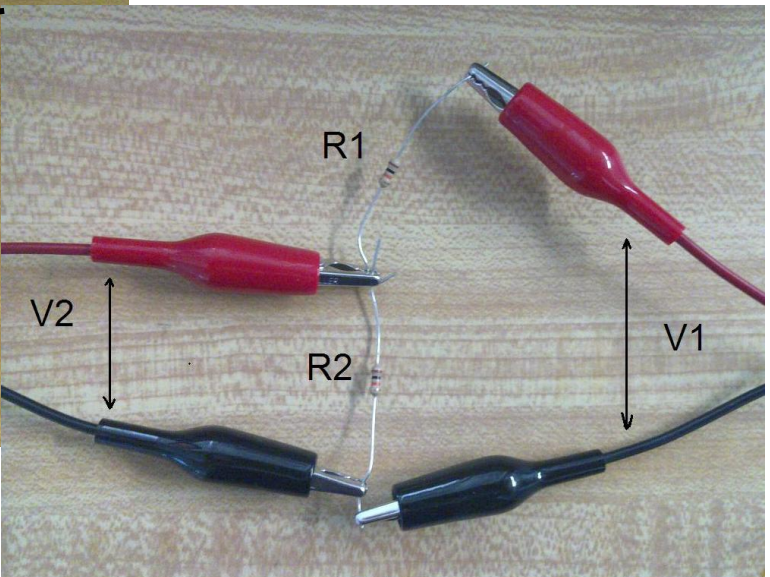
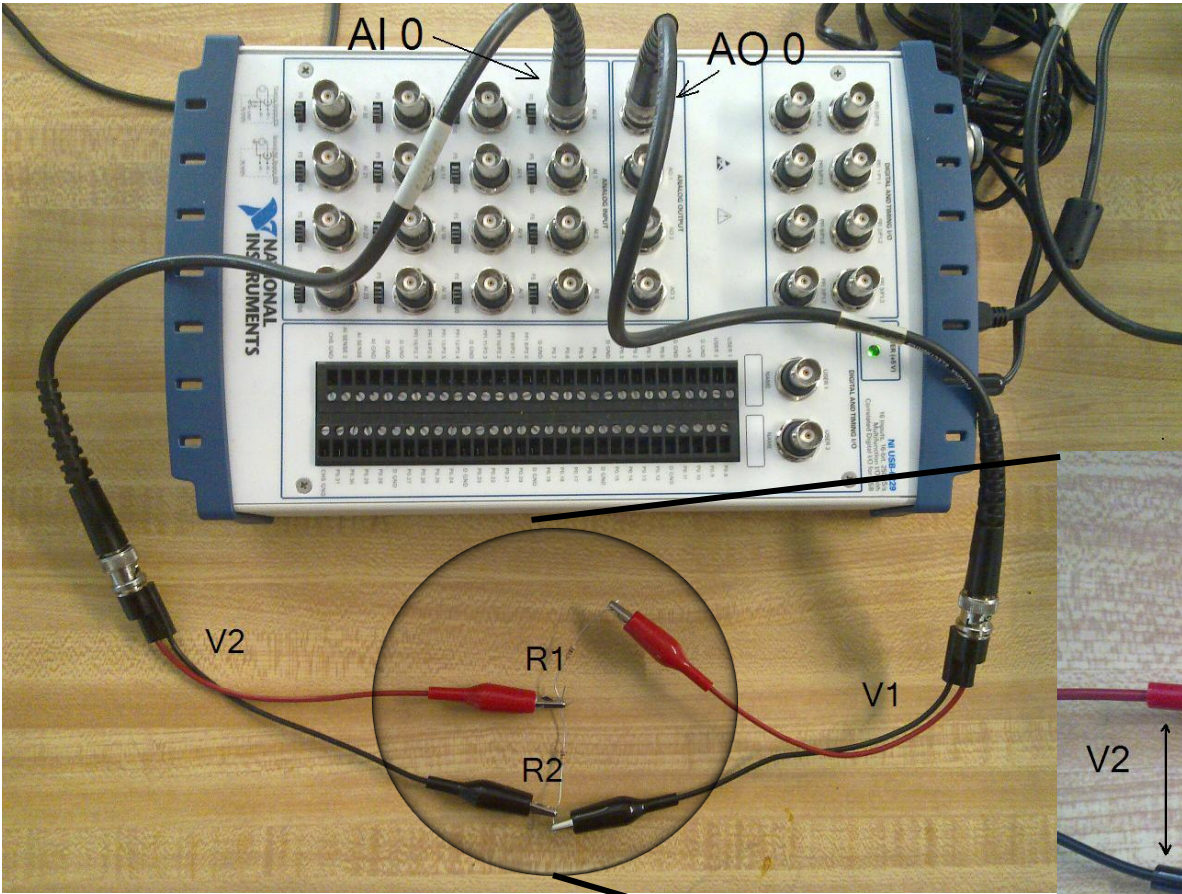
Make sure you change the scale of the meter indicator to accommodate your readings



Final view of the front panel and the block diagram



Experimental setup

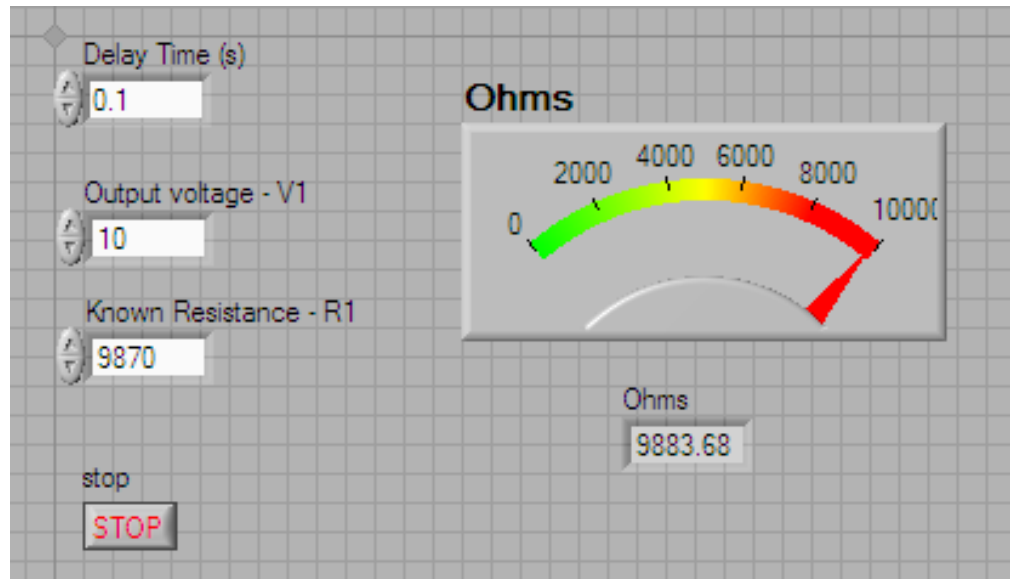


Make sure to know how to decipher / read “bands” on electrical circuits of interest... see Handout



Measurements on a $10\text{ k}\Omega \pm 5\%$ resistor: $9887.53\ \Omega$, is this correct? Discuss.

(Recall: digital resolution; uncertainties in both, equipment used and resistors)



Next lab: update VI program to write data to a "File"



We will be doing error and statistical analysis.

We will also use Chauvenet's criterion for "data rejection"

