QuadraticFormula Build

This guide walks the reader through building a Virtual Instrument, VI, using LabVIEW. This VI uses the quadratic formula to find the solutions of a quadratic equation.

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Thank you for reviewing this document and providing any feedback.

Warm regards,

Eric Mann

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Building QuadraticFormula VI

This guide walks the reader through building a Virtual Instrument, VI, using LabVIEW. The VI uses the quadratic formula,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a},$$

to find the solutions of a quadratic equation, $ax^2 + bx + c = 0$. It also displays the value of the discriminant. Let's start by adding controls for the coefficients, *a*, *b*, and *c* of the quadratic equation, $ax^2 + bx + c = 0$.

1) Create a new VI by selecting **File»New VI** or pressing **<Ctrl-N>**

The <Ctrl> key in keyboard shortcuts corresponds to the **(Mac OS)** <Command> key or **(Linux)** <Alt> key.

2) Add a numeric control to the front panel
   a. Right-click on the front panel to open the **Controls** palette
   b. Tack the **Controls** palette down by clicking the thumb tack in the upper right hand corner of the palette
   c. Select **Numeric Control** from **Express»Numeric Controls**
   d. Click on the front panel to place the control

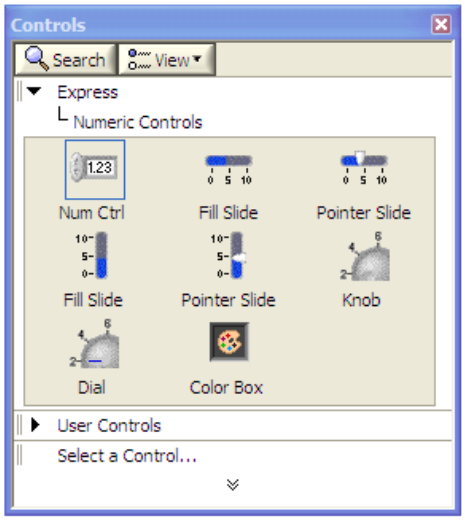

Figure 1. The Controls palette

3) Make two copies of the numeric control
    a. Hover the mouse over the control until the cursor becomes an arrow (This is the position/size/select tool.)
    b. Click on the control to select it
    c. Select **Edit»Copy** or press **<Ctrl-C>**
    d. Click on the front panel and select **Edit»Paste** or press **<Ctrl-V>**
    e. Repeat the previous step two more times
4) Name the controls
    a. Triple-click the label of each control to highlight the text
    b. Name the controls “a”, “b”, and “c”
5) Save your VI
    a. Select **File»Save** or press **<Ctrl-S>**
    b. Call the VI **myQuadraticFormula**

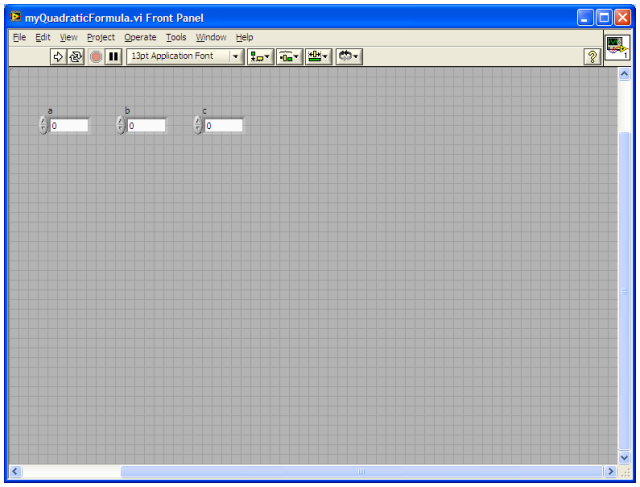

Figure 2. The beginnings of the front panel

You will add code to the VI to use the coefficients to calculate the solutions. The block diagram of a VI displays the code that executes when the VI is run. So far, the block diagram has only three items on it – orange icons for the Numeric Controls.

6) Select **Window»Show Block Diagram** or press **<Ctrl-E>** to view the block diagram
7) Arrange the icons as shown below

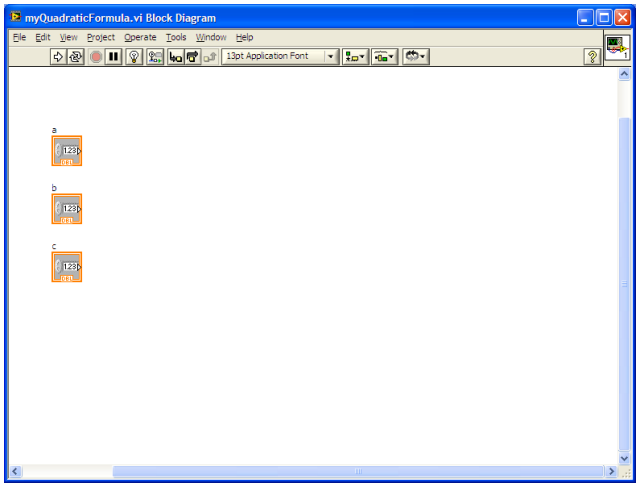

Figure 3. The beginnings of the block diagram

To calculate the solutions of the quadratic equation, $ax^2 + bx + c = 0$, you can use the quadratic formula,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

First, let's evaluate the expression inside the square root, $b^2 - 4ac$. The value of this expression is called the discriminant. The discriminant is useful in that you can tell how many and what sort of solutions the equation has. For example, think about what kind of solutions you would get if the discriminant was a negative number.

8) Add the **Square** VI to the block diagram
    a. Right-click on the block diagram to open the **Functions** palette
    b. Tack the **Functions** palette down by clicking the thumb tack in the upper left corner of the palette
    c. Click on the double arrows at the bottom of the **Functions** palette to expand the menu
    d. Select **Programming»Numeric»Square**
    e. Click on the block diagram to place the VI

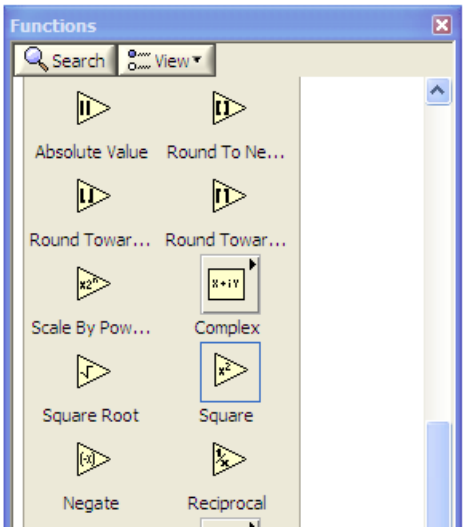

Figure 4. The Functions palette

9) Connect **b** to the **Square** VI
    a. Move the cursor over the right edge of the **b** icon where there is a small triangle

The cursor becomes a wire spool, the Wiring tool, when it is over an input or output terminal of a VI. Use the Wiring tool to connect objects together on the block diagram.

    b. Click and drag the cursor to the **x** input terminal of the **Square** VI

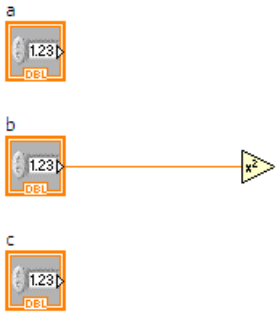

Figure 5. Calculating b^2

The output terminal of the **Square** VI has the value of b^2. You want to subtract $4ac$ from b^2. Before subtracting, you will calculate the product, $4ac$. LabVIEW has a **Multiply** VI that calculates the product of two numbers. You want the product of three numbers. For that, you could use the **Multiply** VI twice, or you can use the **Compound Arithmetic** VI. Let's use the **Compound Arithmetic** VI.

10) Add the **Compound Arithmetic** VI to the block diagram
    a. Select **Programming»Numeric»Compound Arithmetic** from the Functions palette

b. Click on the block diagram to place the VI

11) Resize **Compound Arithmetic** to allow for three inputs
    a. Double-click on the VI to select it
    b. Hover the cursor over the bottom of the VI until double-arrows appear
    c. Click and drag to increase the size of the VI and allow for three inputs

12) Use **Context Help** to see how **Compound Arithmetic** VI is used
    a. Hover the cursor over the **Compound Arithmetic** VI
    b. Press **<Ctrl-H>** to open the **Context Help**

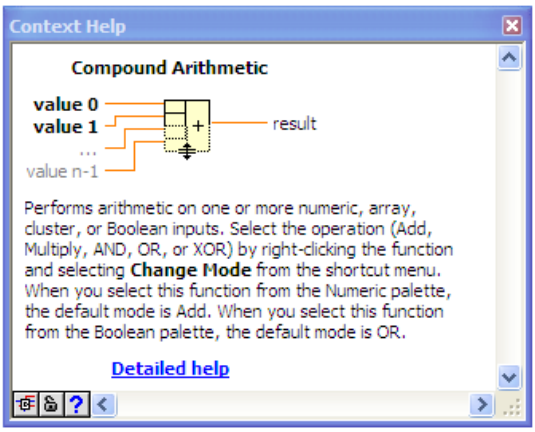

Figure 6. Context Help

13) Follow the instructions in the **Context Help** to change the mode of the VI to multiplication
    a. Right-click on the **Compound Arithmetic** VI
    b. Select **Change Mode»Multiply** from the context menu

Now, the **Compound Arithmetic** VI is set to multiply three inputs. Next, connect 4, *a*, and *c* to the **Compound Arithmetic** VI.

14) Create a constant for the first input
    a. Right-click on the first input terminal of the **Compound Arithmetic** VI
    b. Select **Create»Constant** from the context menu
    c. Set the value of the constant to 4
15) Use the Wiring tool to connect *a* and *c* to second and third inputs

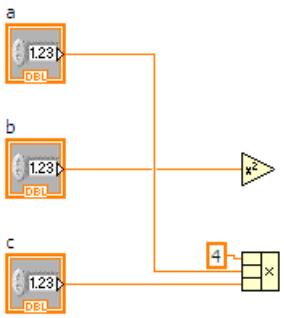

Figure 7. b^2 and $4ac$ calculated

16) Add a **Subtract** VI to the block diagram
    a. Select **Programming»Numeric»Subtract**
    b. Click on the block diagram to place the VI
17) Connect b^2 and $4ac$ to the **Subtract** VI
    a. Connect the output terminal of the **Square** VI to the first input of the **Subtract** VI
    b. Connect the output terminal of the **Compound Arithmetic** VI to the second input of the **Subtract** VI

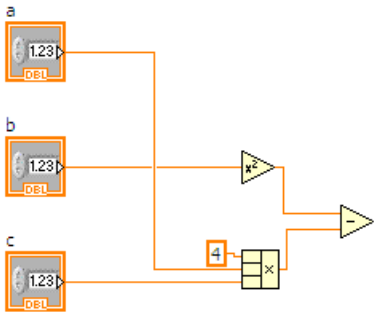

Figure 8. $b^2 - 4ac$

18) Save your VI **<Ctrl-S>**

The next step in using the quadratic formula, $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$, is to take the square root of $b^2 - 4ac$. On the Numeric subpalette, there is a VI that will take the square root of the input.

19) Add the **Square Root** VI to the block diagram
    a. Select **Programming»Numeric»Square Root**
    b. Click on the block diagram to place the VI
20) Use the Wiring tool to connect the output of the **Subtract** VI to the input of the **Square Root** VI

Next, you will set up the VI to handle the "$-b\pm$" part of the quadratic formula. Even though, "$\pm$" is read as "plus or minus", the two solutions come from calculating with both addition and

subtraction.

21) Negate the value of *b*
    a. Select **Programming»Numeric»Negate**
    b. Click on the block diagram to place the VI
    c. Hover the cursor over the wire between **b** and the **Square** VI until the Wiring tool appears
    d. Click and drag to connect the wire to the input terminal of the **Negate** VI
22) Place the **Add** VI on the block diagram
    a. Select **Programming»Numeric»Add**
    b. Click on the block diagram to place the VI
23) Place the **Subtract** VI on the block diagram
    a. Select **Programming»Numeric»Subtract**
    b. Click on the block diagram to place the VI
24) Connect $-b$ to the first inputs of the **Add** and **Subtract** VIs
    a. Use the Wiring tool to connect the output of the **Negate** VI to the first input of the **Add** VI
    b. Hover the cursor over the wire between **Negate** and the **Add** VI until the Wiring tool appears
    c. Click and drag to connect the wire to the first input terminal of the **Subtract** VI
25) Connect $\sqrt{b^2-4ac}$ to the second inputs of the **Add** and **Subtract** VIs
    a. Use the Wiring tool to connect the output of the **Square Root** VI to the second input of the **Subtract** VI
    b. Hover the cursor over the wire between **Square Root** and the **Subtract** VI until the Wiring tool appears
    c. Click and drag to connect the wire to the second input terminal of the **Add** VI
26) Save your VI **<Ctrl-S>**

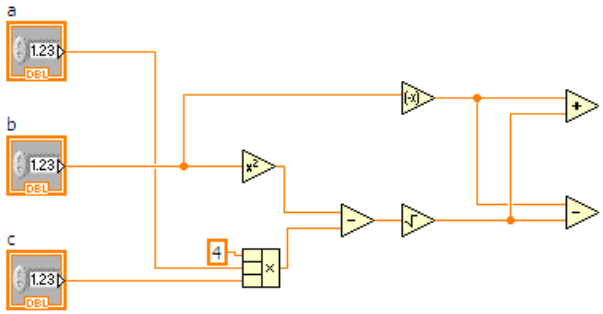

Figure 9. $-b \pm \sqrt{b^2-4ac}$

The outputs of the **Add** and **Subtract** VIs are $-b \pm \sqrt{b^2-4ac}$ respectively. All that is left is to divide these two outputs by $2a$.

27) Add a **Multiply** VI to the block diagram
    a. Select **Programming»Numeric»Multiply**
    b. Click on the block diagram to place the VI

c. Right-click on the first input terminal and select **Create»Constant**
d. Set the value of the constant to 2

28) Connect **a** to the **Multiply** VI
   a. Hover the cursor over the wire coming from the **a** icon until the Wiring tool appears
   b. Click and drag to connect the wire to the second input terminal of the **Multiply** VI

29) Add the **Divide** VI to the block diagram
   a. Select **Programming»Numeric»Divide**
   b. Click on the block diagram to place the VI
   c. Add a second **Divide** VI to the block diagram

30) Connect the outputs of the **Add** and **Subtract** VI to the first input of the **Divide** VIs

31) Connect the output of the **Multiply** VI to the second input of the **Divide** VIs

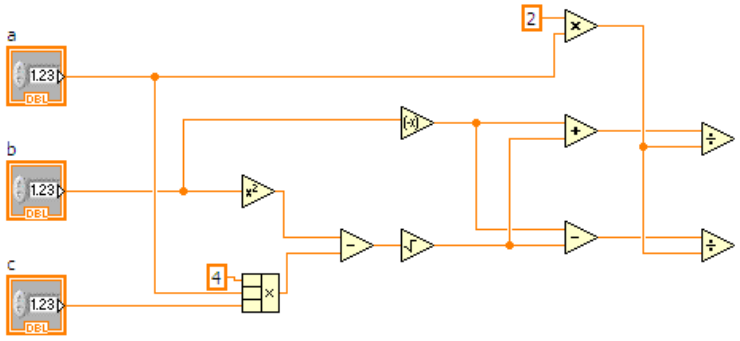

Figure 10. The outputs of the Divide VIs are the solutions!

32) Create indicators for the solutions
   a. Right-click on the output terminal of each of the **Divide** VIs
   b. Select **Create»Indicator** from the context menu
   c. Change the labels on the indicators to "Solution 1" and " Solution 2"

Next, check where the indicators are on the front panel and see how the VI runs.

33) Return to the front panel by selecting **Window»Show Front Panel** or pressing **<Ctrl-E>**

34) Move the indicators below the numeric controls

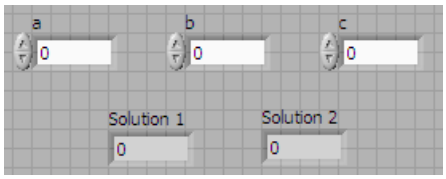

Figure 11. Solutions displayed on front panel

35) Save the VI, **<Ctrl-S>**

36) Use the controls to enter the coefficients for $x^2 - 2x = 0$

a. Set **a** to 1
b. Set **b** to -2
c. Set **c** to 0

37) Run the VI by pressing the **Run** button or by pressing **<Ctrl-R>**
   a. The solutions should equal 2 and 0

You can run the VI using the **Run Continuously** button as well. Running continuously will have the code in the block diagram executed over and over again. To stop the execution, use the **Abort Execution** button.

38) Next, solve $x^2 - 2x + 1 = 0$
   a. The solutions will be the same and equal to 1
39) What about $x^2 - 2x + 2 = 0$?

Recall that the discriminant, $b^2 - 4ac$, will give you information about the solutions. Let's add an indicator for the discriminant.

40) Return to the block diagram by selecting **Window»Show Block Diagram** or pressing **<Ctrl-E>**
41) Add an indicator to display the discriminant
   a. Hover the cursor over the wire between the **Subtract** VI and the **Square Root** VI until the Wiring tool appears

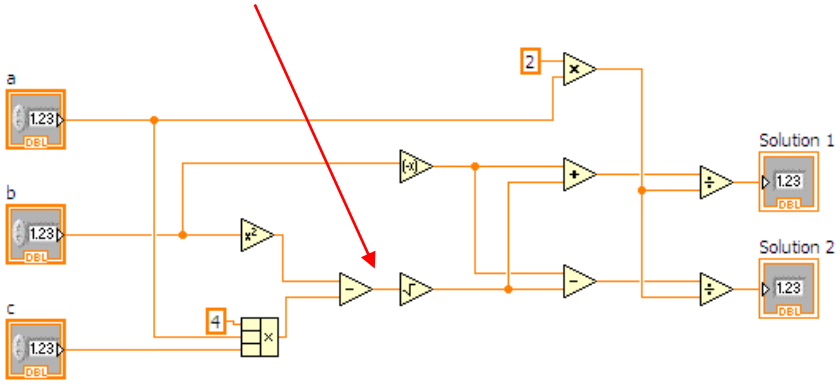

Figure 12. Adding an indicator for the discriminant

   b. Right-click to open the context menu
   c. Select **Create»Indicator**
   d. Change the label on the indicator to "Discriminant"
42) Return to the front panel by selecting **Window»Show Front Panel** or pressing **<Ctrl-E>**
43) Move the **Discriminant** indicator below the solution indicators
44) Save, **<Ctrl-S>**, and run, **<Ctrl-R>**, the VI

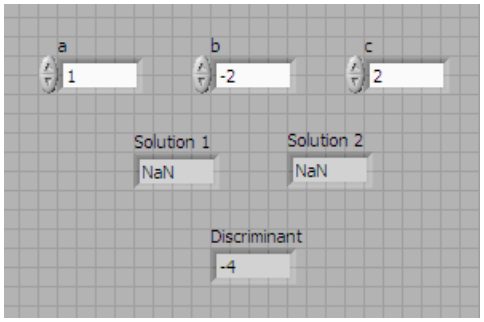

Figure 13. Discriminant displayed with solutions

45) Solve the quadratic equations from above and notice the value of the discriminant

The QuadraticFormula VI is complete. Of course, more customization is possible. You could resize the graph or the front panel itself. Also, right-click on any of the controls or indicators to see what else could be made visible or what properties could be changed. Many display options are configurable.