LabVIEW Lesson 2 – Modular Programming

Lesson Overview
   I.   What is a subVI?
   II. How to prepare a VI to be a subVI.
       a. Editing VI icon.
       b. Assembling connector pane.
   III. How to incorporate a subVI into another VI.

I. What is a subVI?

   a. A VI (LabVIEW program) that is used within another VI.

   b. The subVI maybe inserted into the block diagram of another VI.

   c. When inserted into another VI, the icon created for the subVI will appear with the corresponding inputs and outputs.

   d. The front panel and block diagram of a subVI may be accessed by double-clicking on the subVI icon.

II. Preparing a VI to be a subVI:

   • **EXAMPLE 2.1:** Create new C to F converter VI

   a. This VI will receive an input temperature in degrees Celsius and output the corresponding temperature in degrees Fahrenheit.

   b. Beginning with the **Front Panel**,

      i.   Insert one **Numerical Control** and one **Numerical Indicator** (reference Lesson 1, Ex. 1.1 for inserting procedure).

      ii. Rename the **Numerical Control** "Deg C" and the **Numerical Indicator** "Deg F".

   c. **Ctrl-E** to switch to the **Block Diagram**

      i.   Insert a **Multiplication Function** ▷ by …
          • **Left-Click** on **Arith/Compare** → **Numeric** → **Multiply** → **Front Panel**

      ii. Insert a **Addition Function** ▷ by …
          • **Left-Click** on **Add** → **Block Diagram** to place the **Add Function** (*this function is in the same palette as the multiplication function*).

      iii. Wire the **Input (Deg C)** to an **Input Terminal** on the **Multiplication Function** triangle by …

- Select the **Wire Icon** , from the **Tools Palette** → **Left-Click** on the **Deg C Terminal** → one of the **Multiplication Function Terminals** (*wire will turn orange when connected*).

iv. Wire the **Output** from the **Multiplication Function** to the **Top Input Terminal** of the **Add Function**.

v. Wire the **Output** from the **Add Function** to the output **Deg F Terminal.**

vi. Create **Numerical Constants** connected to the **Multiplication** and **Add Functions** by …

  1. With the wiring option selected, **Right-Click** on the **Multiplication Function** → **Left-Click** on **Create** → **Constant** (will create a textbox connected to the bottom terminal)

  2. Type in **1.8** and press **Enter**.

  3. Do the same for the **Add Function**, except enter **32**.

  4. Since **32** is an integer and this constant will always be an integer, **Right-Click** on **32** → **Left-Click** on **Representation** → **Left-Click** on **I32**, which stands for a 32-bit integer and should turn the box and wiring blue.

vii. NOTE: Delete wires by selecting them and pressing **Del** button on keyboard.

viii. Check if the VI is complete by …
  - Observing whether a **Broken Arrow** or a **Solid Arrow** is displayed at the top left on either the **Front Panel** or the **Block Diagram**.

  - A **Broken Arrow** indicates that an error is present or everything is not wired correctly.

  - A **Solid Arrow** indicates that the VI is completed and ready to run.

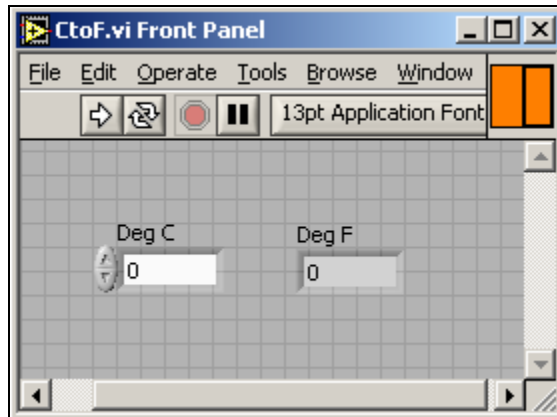ix. The VI should look similar to Figures 2.1 and 2.2 on top of the next page:
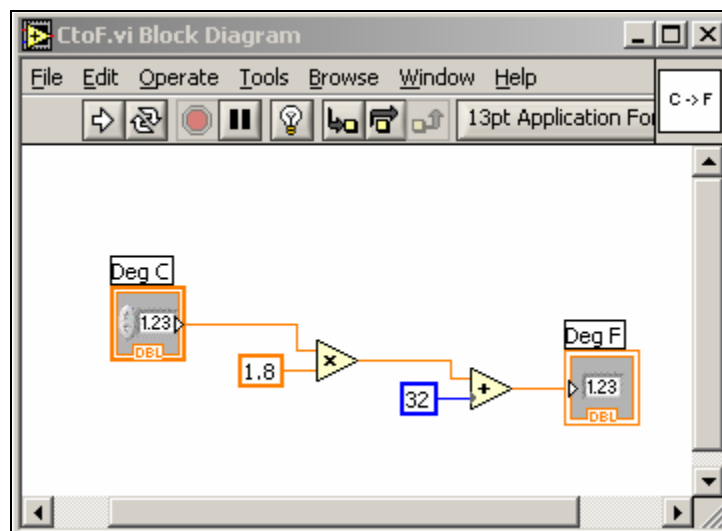
Figure 2.1: Front Panel for Celsius to Fahrenheit VI

Figure 2.2: Block Diagram for Celsius to Fahrenheit VI

d. Editing the VI icon *(First step to prepare a VI to be a subVI)*

  i. **Right-Click** on the icon in the upper right-hand corner of the **Front Panel** → **Edit Icon** (will bring up the icon editing window).
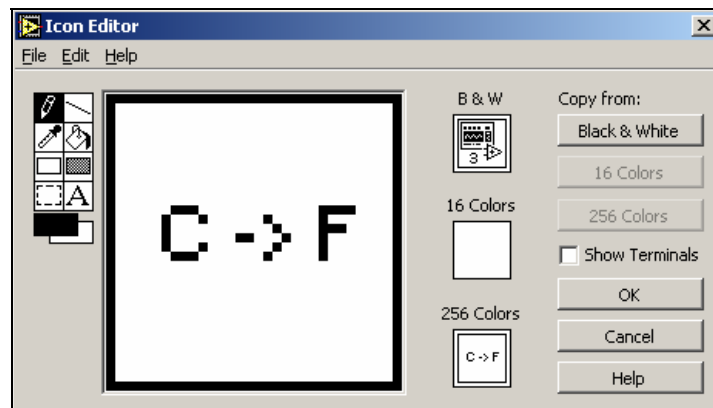

Figure 2.3: Icon Editor Window

    ii. Clear the default icon design by …

- **Click On** → **Draw** a box around everything **Except** the black border → **Del Button** to clear the contents in the box

    iii. Create new icon as shown above (use the **Text Control** to create a C and an F as well as the arrow, which is just a dash and the greater than sign) and click **OK**.

e. Connecting I/O's to the icon (*Enables VI to be used in another VI or as a subVI.*)

    i. **Right-Click** on the **Icon** → **Show Connector** (*will change the icon to a box divided into 2 rectangles*).

    ii. Left-side boxes correspond to inputs and the right-side boxes correspond to outputs (*number of boxes will depend on the number of inputs and outputs*).

    iii. **Connect** input to input and output to output by …

- **Left-Click** on an input box and then on an input in the **Front Panel** (*box should turn orange for numerical controls/indicators in double format, blue for integer format, and green for Boolean operators*) → **Repeat** for the output.

    iv. The connector pane should look as follows (*both boxes should be orange*):

f. **Save** VI as **CtoF.VI** and then, **Close** the VI. (*The VI can now be used as a subVI.*)

III.   Incorporating a subVI into a new VI

- **EXAMPLE 2.2:** Creating a Temperature Converter VI

a. This VI will accept an input temperature of user's choice with the input temperature scale being identified by the user, and the corresponding temperature in degrees Fahrenheit will be returned.

b. Beginning with the **Front Panel**,

    i. Insert one **Numerical Control** and one **Numerical Indicator** (reference Lesson 1, Ex. 1.1 for inserting procedure).

    ii. Insert a **Boolean Switch** by …
- Go to the **Controls Palette** → **Left-Click** on **Buttons** → **Vertical Toggle Switch** → **Front Panel**

iii. Rename the **Numerical Control** "**Input Temp**", **Boolean Switch** "**Input Temp Scale**", and **Numerical Indicator** "**Output Temp Deg F**"

iv. Additionally, add text next to the **Boolean Switch** as shown in Figure 2.4 below by **Left-Clicking** where you want the text and typing it in.
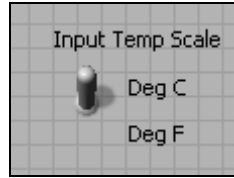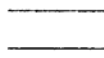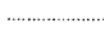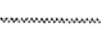

Figure 2.4: Labeling of Toggle Switch

v. If you would like more practice with aligning objects on the **Front Panel**, **Align Left Edges** of the new text to give the **Front Panel** a more polished appearance.

c. **Ctrl-E** to switch to the **Block Diagram**

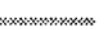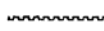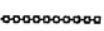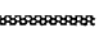i. Insert a **Comparison Function** by …
   - **Left-Click** on **Arith/Compare** in the **Functions Palette** → **Comparison** → **Select** ⤜ → **Block Diagram**

ii. Insert a **SubVI "CtoF.VI"** by …
   - **Left-Click All-Functions** in the **Functions Palette**→ **Select a VI** (bottom row first column) → **CtoF.VI** → **Front Panel** (*The icon we just created should show up with two terminals.*)

iii. Wire the **Toggle Switch** terminal to the **Select Function** at its green terminal (should be the middle terminal on its left side)

   1. **NOTE**: All wiring is color coded based on the following information:

Wire Type	Scalar	1D Array	2D Array	Color
Numeric	——— ———	~~~~~~ ———	═══ ═══	Orange (floating-point), Blue (integer)
Boolean	············	wwwwwww	xxxxxxxxx	Green
String	~~~~~~	ooooooooo	RRRRRRRRR	Pink

iv. Wire the **Input Temp** first to the **Input Terminal** of the **SubVI** and secondly, branch off from this wire to the **Bottom Terminal** of the **Select Function**.

v. Wire the **Output** from the **SubVI** to the **Top Terminal** of the **Select Function**.

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vi. Wire the **Output** from the **Select Function** to **Output Temp Deg F Terminal**.

vii. **NOTE**: You can clean up your wiring by **Right-Clicking** on the wires and select **Clean Up Wire**.

viii. The **Arrow** at the top of the window should now be **Solid** ⇨ and your VI should look something like Figures 2.5 and 2.6 on the next page (*except without one of the outputs on the block diagram, which will be introduced shortly*):
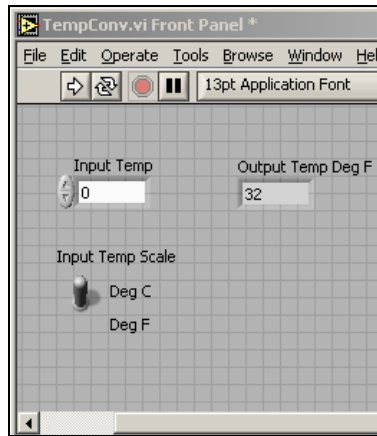
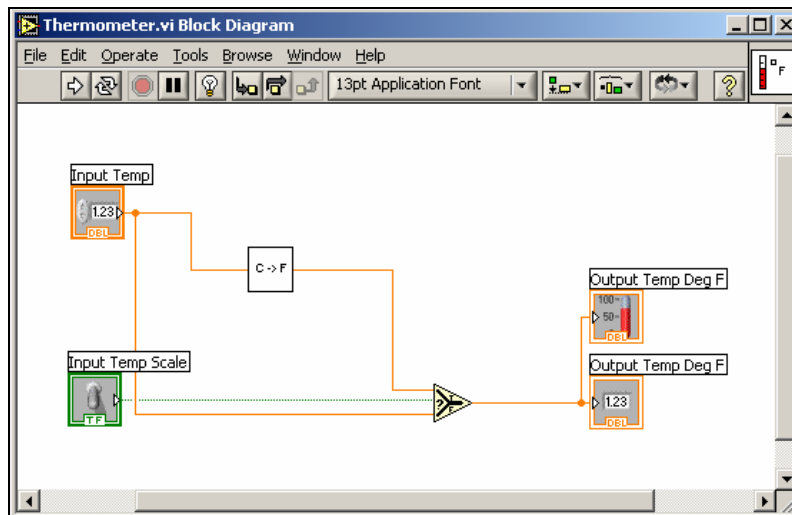

Figure 2.5: Front Panel for the Temperature Converter VI

Figure 2.6: Block Diagram for the Temperature Converter VI

ix. To test the VI, type in **100** with the switch in the **Deg C** location and run the VI. The output should read **212 F**. If you change the switch to **Deg F** and run, the output should read **100 F**.

d. Adding an input and using the **Replace** operation.

i. Hold down **Ctrl-E** → **Left-Click** on the **Numerical Indicator** → **Drag** to the right and place on the front panel.

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ii. **Right-Click** on the **Numerical Indicator** just created → **Replace** →
Num Inds → **Thermometer**

iii. Now there is a digital indicator and a thermometer to represent the
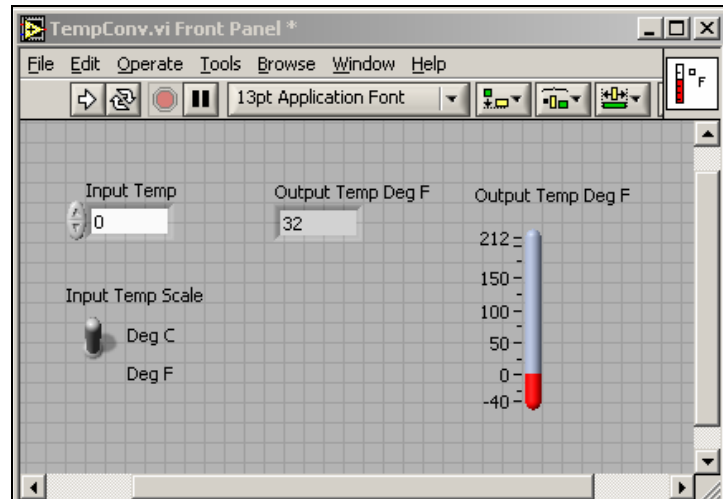output temperature (as shown in Figure 2.7).

Figure 2.7: Front Panel of Temperature Converter VI with Thermometer

iv. Rename the **Thermometer** to **"Output Temp Deg F"**.

v. Edit thermometer scale by …
- **Right-Click** on **Thermometer** → **Format & Precision** → **Scale
Tab** → **Enter "212"** for **Max** and **"-40"** for **Min** → **OK**
- Another way to change the scale, is to use the **Finger Tool** ,
and **Left-Click** on the top number (should be 100) and type in **212**
and then do the same for the bottom, except type in **-40**.

vi. Switch to the block diagram and **Wire** the **Thermometer** branching off
the other output wire.

e. Editing the VI icon

i. **Right-Click** on the icon in the upper right-hand corner of the **Front
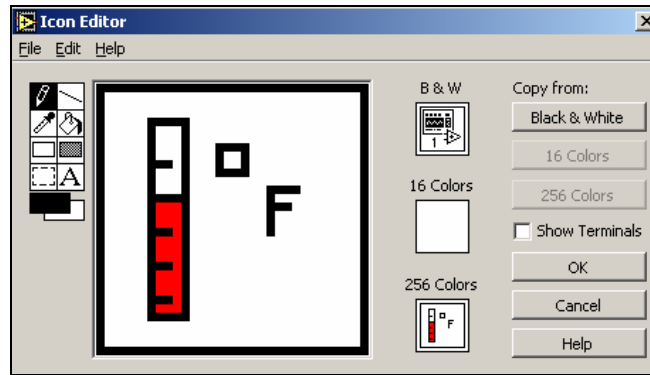Panel** → **Edit Icon** (*will bring up the icon editing window*).

Figure 2.8: Icon Editor Window with Thermometer Icon

    ii. Clear the default icon design by …

- **Click On** [ ] → **Draw** a box around everything EXCEPT the black border → **Del Button** to clear the contents in the box

    iii. Create new icon as shown above and click **OK**.

f. Connecting I/O's to the icon

    i. **Right-Click** on the **Icon** → **Show Connector** (*will change the icon to a box divided into 4 squares*).

    ii. Left-side boxes correspond to inputs and the right-side boxes correspond to outputs (*number of boxes will depend on the number of inputs and outputs*).

    iii. **Connect** input to input and output to output by …

        a. **Left-Click** on an input box and then on an input in the **Front Panel** (*box should turn orange for the numerical control and green for the Boolean switch*) → **Repeat** for all inputs and outputs.

    iv. Lastly, depending on the application, you may not want all the inputs or outputs to be available when used as a subVI. The number of inputs and outputs can be altered by changing the pattern of the **Connector Pane**. To do this, **Right-Click** on **Connector Pane** → **Patterns** → choose the pattern desired. You can also **Right-Click** on a specific terminal and choose **Add Terminal** or **Remove Terminal**. The menu will be similar to what is shown in Figure 2.9:
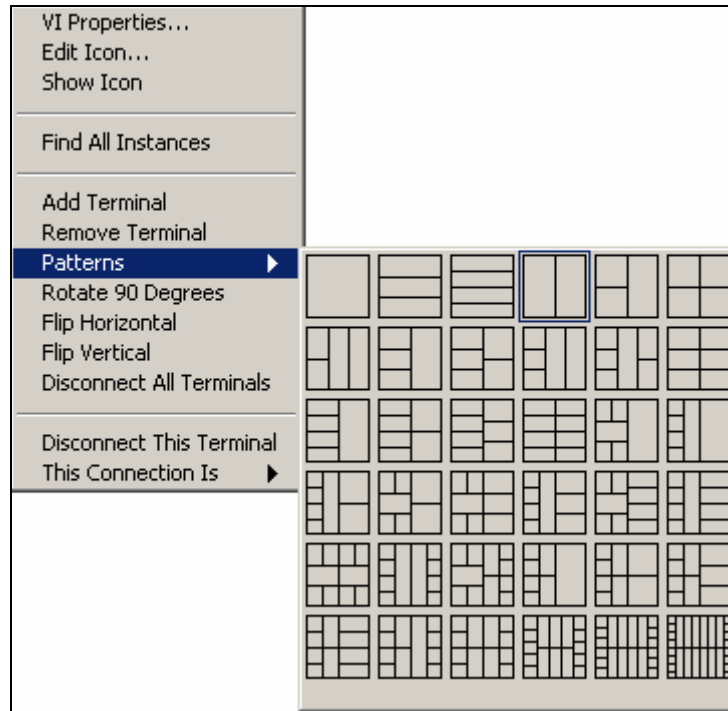
Figure 2.9: SubVI Terminal Patterns

g. **Save** VI as **TempConv.VI**.