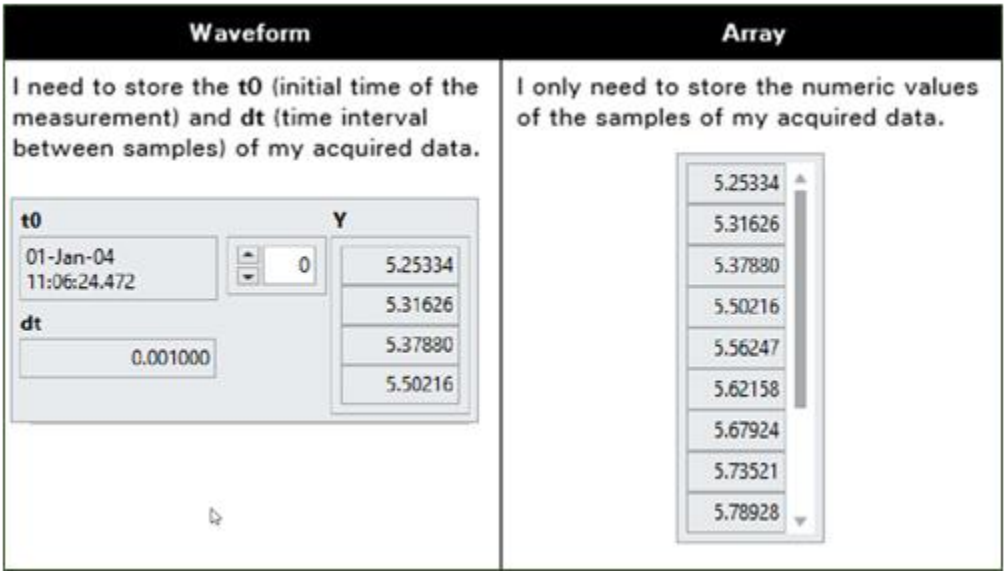
Exercise 8-4: Visualize N-Channel Data

Goal

- Become familiar with the different data types that represent *N*-channel data.
- View multiple channels of data in chart, graph, and array indicators.

Scenario

Select the column that best matches the needs of your applications.



Check the option that best matches the needs of your applications.

	N-Channels, 1-Sample
	N-Channels, *N*-Samples

Based on your answers to the previous questions, check which scenario(s) are most relevant to your applications.

	N-Channels, 1-Sample	Data type: 1D DBL Array
	N-Channels, *N*-Samples	Data type: 1D Waveform Array
	N-Channels, *N*-Samples	Data type: 2D DBL Array

Instructions

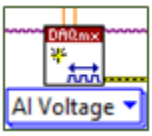
1. Open `C:\Exercises\LabVIEW Core 1\Visualize N-Channel Data\ Visualize N-Channel Data.lvproj`.
2. Follow the instructions for the scenarios you selected in the **Scenario** section.

***N*-Channel, 1-Sample (1D DBL Array)**

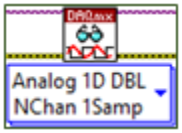
In this section, you create a VI that acquires and visualizes one data sample from each of the three different data sources at a rate of 1 Hz.

(BNC-2120) and **(Simulated Hardware)** Modify this VI to acquire 3 channels of voltage (Sine Wave Function, TTL Square Wave Function and Temperature Reference) from PCI-6221/ai0, PCI-6221/ai2:3.

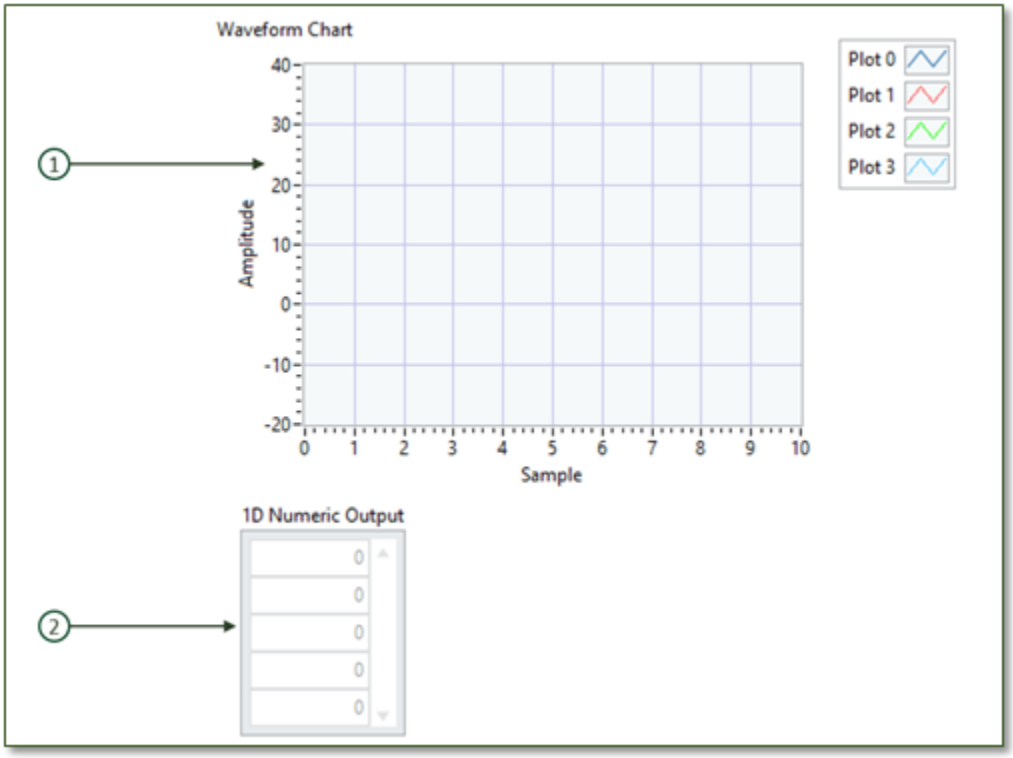
1. From the **Project Explorer** window, open the *N*-Channel 1-Sample (1D DBL) VI.
2. Examine the properties of the DAQmx Create Channel VI.



   - Click **polymorphic VI selector** of the DAQmx Create Channel VI and explore the selected instance.
   - Notice that this VI is configured for a Voltage measurement. You can modify this configuration if you want to acquire from a different type of measurement.
3. Examine the DAQmx Timing VI.
   - Notice that the sample rate is set to1 Hz. This sets the DAQ device to acquire 1 sample per channel per second.
4. Examine the DAQmx Read VI.
   - Click **polymorphic VI selector** of the DAQmx Read VI and explore the selected instance.
   - Notice that this VI is set to **Multiple Channels** and **Single Sample.** This VI will return a 1D DBL array that contains a single sample from multiple channels.



5. Create the front panel.



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1. **Waveform Chart** – Add a Waveform Chart to the front panel. Expand the plot legend to display three plots.
2. **Numeric Array Output** – Add a Numeric Array control to the front panel, right-click the **control** and press **Change to Indicator**. Resize the indicator to show 3 or more elements and rename it to `1D Numeric Output.`

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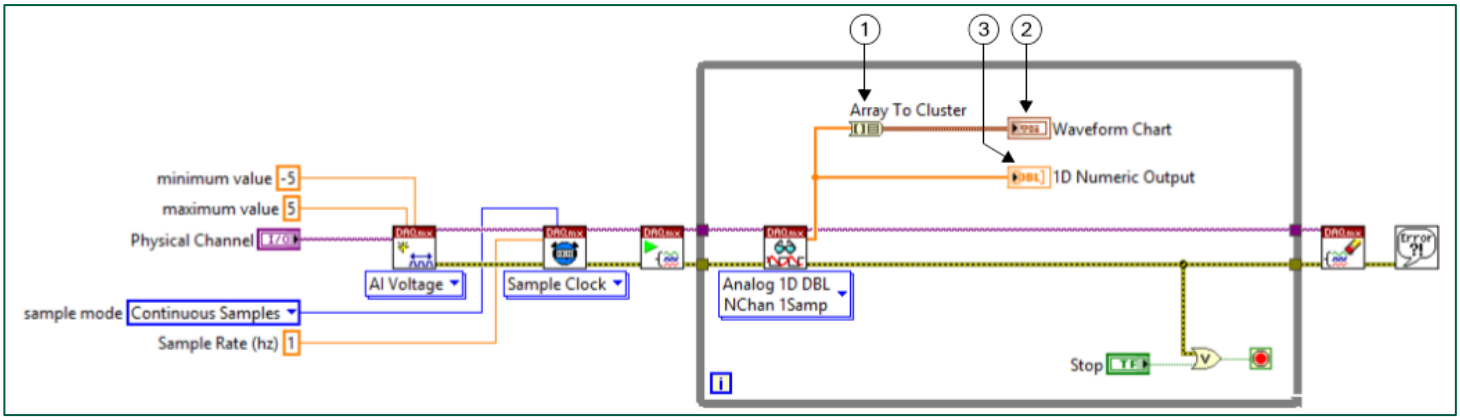
6. Modify the block diagram, as shown in the following figure, to visualize the multiple channels single samples data.



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1. **Array to Cluster** – This function converts the 1D array data type to a cluster data type. To plot a single sample from multiple channels on a waveform chart, you must pass the waveform chart a cluster data type containing the samples.
2. **Waveform Chart** – Chart that can be used to show historical data and append new data.
3. **1D Numeric Output** – This array indicator displays only the current array data in a specific iteration.

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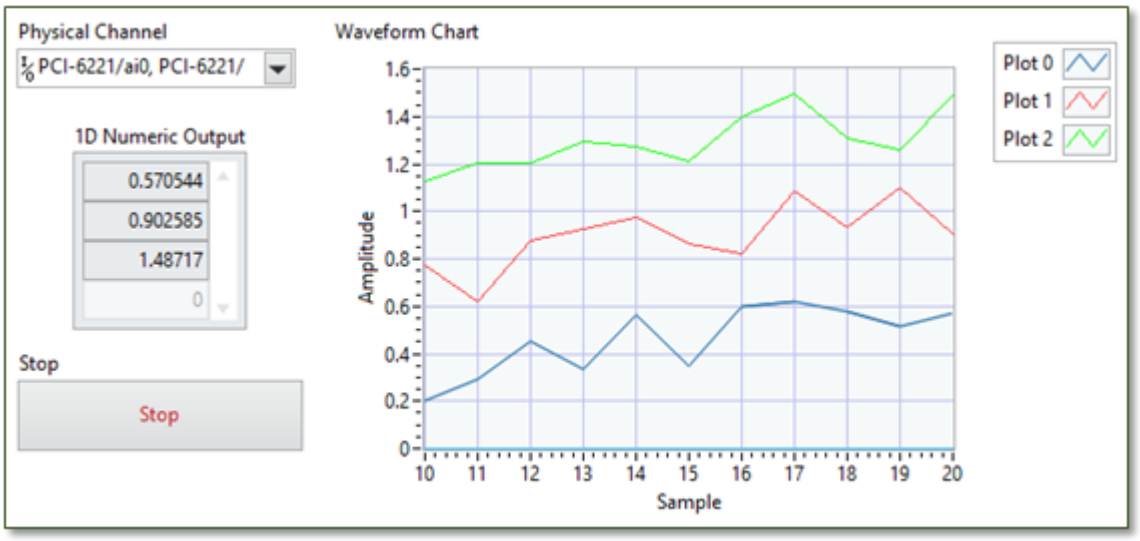
7. Configure the **Waveform Chart** properties.
   - Resize the plot legend to show 3 plots.
   - Double-click **Time** on the x-axis and rename it as `Sample`. The 1D array (DBL) data type does not contain any timing information, so the x-axis just represents the sample number.
   - Double-click the **minimum and maximum numbers** on the axis and change them to `0` and `10`. Now the waveform chart will show the most recent 10 samples per channel acquired.
   - Right-click the **waveform chart** and select **Chart History Length**. Notice that the history length is set to 1024 by default. This setting determines the maximum number of points per plot that the chart can show.

8. Your front panel should look similar to the following figure when the VI is running.



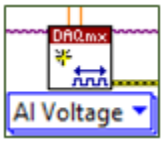
9. Test the VI.
   - On the front panel, set the **Physical Channel** control to **PCI-6221/ai0, PCI-6221/ai2:3**. This creates a DAQmx task that includes PCI-6221 channels 0, 2, and 3.
   - Run the VI and notice the following things.
     - The rate input (1 Hz) of the DAQmx Read VI controls the loop period.
     - Every iteration, one sample from 3 channels are updated on the waveform chart.
     - Every iteration, the 1D DBL Array indicator only shows the data for the current iteration.
     - The x-axis of the waveform chart is in units of Sample number (not seconds).
     - The waveform chart shows the most recent 10 samples per channel acquired.
   - Double-click the **minimum and maximum numbers** on the x-axis and change them to `0` and `5`. Now the waveform chart will show the most recent 5 samples per channel acquired.
   - Stop the VI when finished.
10. To clear the waveform chart between runs of the VI, right-click the **chart** and select **Data Operations»Clear Chart.**

N-Channel, *N*-Samples (1D Waveform Array)

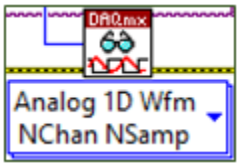
In this section, you create a VI that acquires and visualizes 3 channels of analog input voltage. Each loop iteration acquires/visualizes 1000 samples per channel. The samples are continuously acquired at a hardware timed rate of 1000 Hz. The waveform data type contains the sample values (Y), the start time for the samples (t0), and the time interval between each sample (dt).

(BNC-2120) and **(Simulated Hardware)** Modify this VI to acquire 3 channels of voltage (Sine Wave Function, TTL Square Wave Function and Temperature Reference) from PCI-6221/ai0, PCI-6221/ai2:3, at a sample rate of 2,560 Hz and number of samples of 256.

1. From the **Project Explorer** window, open the *N*-Channel, *N*-Samples (1D Waveform) VI.
2. Examine the DAQmx Create Channel VI.
   - Click **polymorphic VI selector** of the DAQmx Create Channel VI and explore the selected instance.

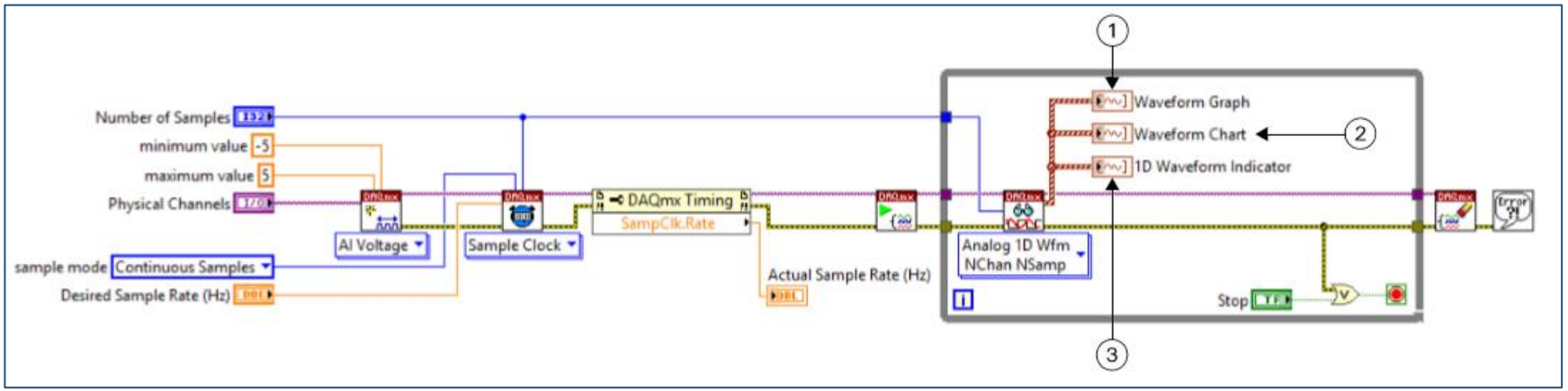


     Notice that this VI is configured for an Analog Input Voltage measurement. Modify the configuration if you want to acquire from a different type of measurement.
3. Examine the sample rate and number of samples controls.
   - The **Desired Sample Rate (Hz)** control sets sample rate of this DAQ task.
   - The **Number of Samples** control sets how many samples per channel the DAQmx Read VI will wait for and output in each loop iteration.
   - If the sample rate is 1000 Hz and number of samples is 1000, then during each While Loop iteration, the DAQmx Read VI acquires from multiple channels at a sample rate of 1000 Hz and outputs 1000 samples per channel.
4. Examine the DAQmx Read VI.
   - Click **polymorphic VI selector** of the DAQmx Read VI and explore the selected instance.



     Notice that this VI is set to **Analog»Multiple Channels»Multiple Samples»1D Waveform (Samples).**

5. Create the front panel.
   - Add a waveform graph to the front panel. Resize the plot legend to show 3 plots.
   - Add a waveform chart to the front panel. Resize the plot legend to show 3 plots.
   - Create a 1D waveform array indicator.
     - Add an array shell on the front panel. Rename it `1D Waveform Indicator`.
     - Add a waveform control inside the unconfigured array.
     - Resize the array to show 4 elements.
     - Right-click the **array** and select **Change to Indicator**.
6. Modify the block diagram, as shown in the following figure.



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1. **Waveform Graph** – Graphs display the current array data in a specific iteration.
2. **Waveform Chart** – Chart that can be used to show historical data and append new data.
3. **1D Waveform Indicator** – This indicator displays only the current data in a specific iteration. Each array element is the waveform data received from an individual channel.

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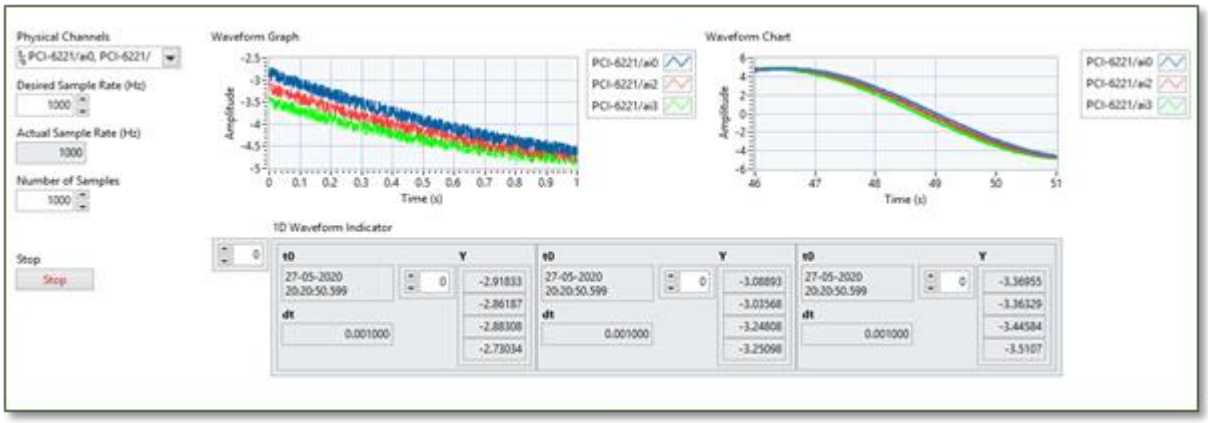
7. Configure the Waveform Graph properties.
   - Switch to the front panel and double-click **Time** on the x-axis and rename it as `Time (s)`. The waveform data type contains timing information in units of seconds.
8. Configure the waveform chart properties.
   - Right-click the **Waveform Chart** indicator and select **Properties**, then in the **Display Format** tab make sure that the **Default editing mode** is selected and set Type to **Floating point**. Click OK to save changes.
   - Double-click **Time** on the x-axis and rename it `Time(s)`. The Waveform data type contains timing information in units of seconds.
   - Double-click the **minimum and maximum numbers** on the x-axis and change them to `0` and `5`. Now the waveform chart will show the most recent 5 seconds of data acquired.
   - Right-click the **waveform chart** then select **Chart History Length** and change the history length from 1,024 to 5,000. This setting determines the maximum number of points per plot that the chart can show.

Note: Because this VI acquires 1000 samples per channel per second, changing the history length to 5,000 configures the chart to show 5,000 samples per channel, which is equivalent to the most recent 5 seconds of data.

9. Your front panel should look similar to the following figure when the VI is running.



10. Test the VI.
    - On the front panel, set the **Physical Channels** control to **PCI-6221/ai0, PCI-6221/ai2:3**. This creates a DAQmx task that includes PCI-6221 analog input channels 0, 2, and 3.
    - Run the VI.
    - Notice that the following things happen every iteration.
      - Multiple samples from 3 channels are appended to the waveform chart.
      - The waveform graph shows the data only for the current iteration (that is, the 1,000 samples read in that specific iteration).

- The 1D waveform indicator shows the data only for the current iteration.

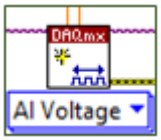
- Notice that the x-axis of the waveform chart is in units of time (s). This is because the waveform data type includes timing information.
- Stop the VI when finished.

N-Channel, *N*-Samples (2D DBL Array)

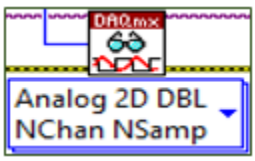
In this section, you create a VI that acquires and visualizes 3 channels of analog input voltage. Each loop iteration acquires/visualizes 256 samples per channel. The samples are continuously acquired at a HW-timed rate of 2,560 Hz. The 2D DBL array data type contains the sample values.

(BNC-2120) and **(Simulated Hardware)** Modify this VI to acquire 3 channels of voltage (Sine Wave Function, TTL Square Wave Function and Temperature Reference) from PCI-6221/ai0, PCI-6221/ai2:3 at a sample rate of 2,560 Hz and number of samples of 256.

1. From the **Project Explorer** window, open *N*-Channel *N*-Samples (2D DBL) VI.
2. Examine the DAQmx Create Channel VI.
   - Switch to the block diagram, click the **polymorphic VI selector** of the DAQmx Create Channel VI and explore the selected instance.



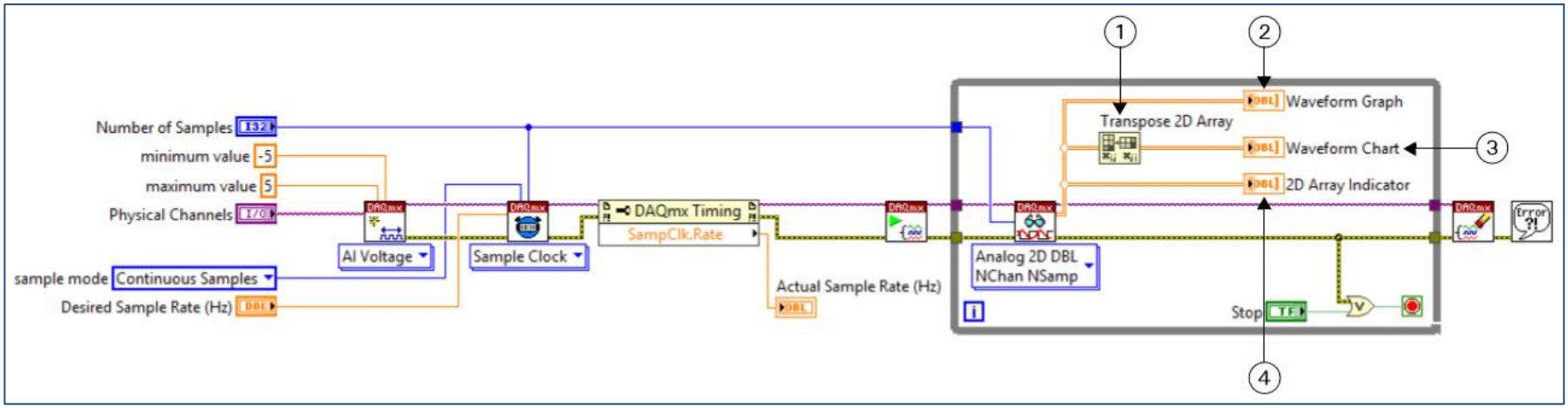
     Notice that this VI is configured for an Analog Input Voltage measurement. Modify the configuration if you want to acquire from a different type of measurement.
3. Examine the sample rate and number of samples controls.
   - The **Desired Sample Rate (Hz)** control sets the sample rate for this DAQ task.
   - The **Number of Samples** control sets how many samples per channel the DAQmx Read VI will wait for and output in each loop iteration.
   - If the sample rate is 2,560 Hz and number of samples is 256, then during each While Loop iteration, the DAQmx Read VI will acquire from multiple channels at a sample rate of 2,560 Hz and output 256 samples per channel.
4. Examine the DAQmx Read VI.
   - Click the **polymorphic VI selector** of the DAQmx Read VI and explore the selected instance.



Notice that this VI is set to **Analog»Multiple Channels»Multiple Samples»2D DBL.**

5. Create the front panel.
   - Switch to the front panel, add the following indicators.
   - Waveform Graph indicator
   - Waveform Chart indicator
   - 2D Array indicator

6. Modify the block diagram, as shown in the following figure, to visualize the multiple channels multiple samples (2D DBL) data.

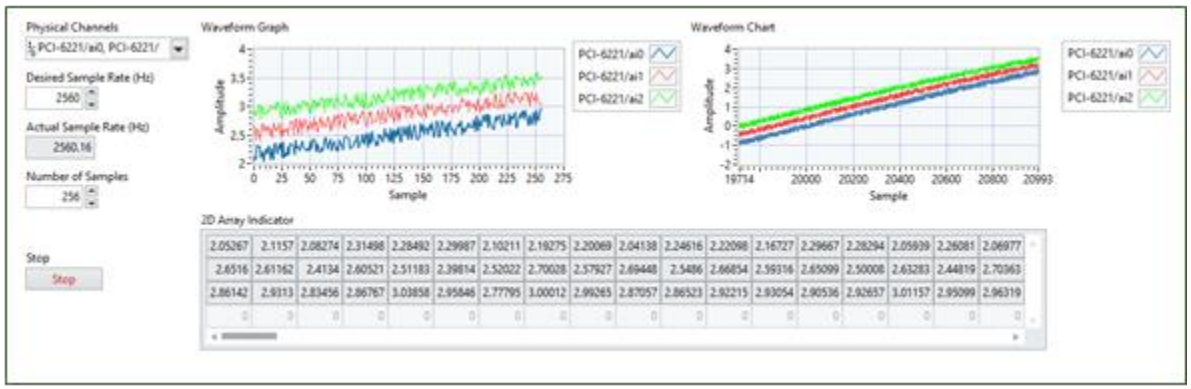


1. **Transpose 2D Array** – You must transpose the 2D array before passing it to the chart for the chart to correctly interpret the 2D array as 4 channels of data with 256 samples per channel.
2. **Waveform Graph Indicator** – Graph that displays the current array data in a specific iteration
3. **Waveform Chart-** Chart that can be used to show historical data and append new data.
4. **2D Numeric Array Indicator** – This indicator displays only the current data in a specific iteration. Each row contains the data points for a channel. When you run this VI, you will notice that for a "3 channel, 256 samples per channel" acquisition, the 2D array has 3 rows and 256 columns.

7. Configure the waveform graph properties.
   - Switch to the front panel.
   - Resize the plot legend to show 3 plots.
   - Double-click **Time on the x-axis** and rename it as `Sample`. The 2D DBL data type does not contain any timing information, so the x-axis just represents the sample number.
8. Configure the waveform chart properties.
   - Resize the plot legend to show 3 plots.
   - Double-click **Time** on the x-axis and rename it as Sample. The 2D DBL data type does not contain any timing information, so the x-axis just represents the sample number. Double-click the minimum and maximum numbers on the x-axis and change them to `0` and `1280`. Now the chart will show the most recent 1,280 samples per channel acquired.
   - Right-click the **waveform chart** then select **Chart History Length** and change the history length from 1,024 to 1,280. This setting determines the maximum number of points per plot that the chart can show.

Note: Because this VI acquires 256 samples per channel per second, changing the history length to 1,280 configures the chart to show 1,280 samples per channel, which is equivalent to most recent 5 seconds of data.

9. Your front panel should look similar to the following figure when the VI is running.



10. Test the VI.
    - On the front panel, set the **Physical Channels** control to **PCI-6221/ai0, PCI-6221/ai2:3**. This creates a DAQmx task that includes PCI-6221 analog input channels 0, 2, and 3.

Note: Set the Physical Channels control to channels that are appropriate for your DAQ device.

- Run the VI.

- Notice that the following things happen every iteration.
  - Multiple samples from 3 channels are appended to the waveform chart.
  - The waveform graph shows the data only for the current iteration (that is, the 1,000 samples read in that specific iteration).

    - 2D numeric array indicator shows the data only for the current iteration.
- Notice that the x-axis of the waveform chart indicates the sample number of a data point (not seconds). This is because the 2D DBL data type does not includes timing information.
- Stop the VI when finished.

End of Exercise 8-4