Lesson 4
Analog Output

TOPICS

A. Analog Output Architecture

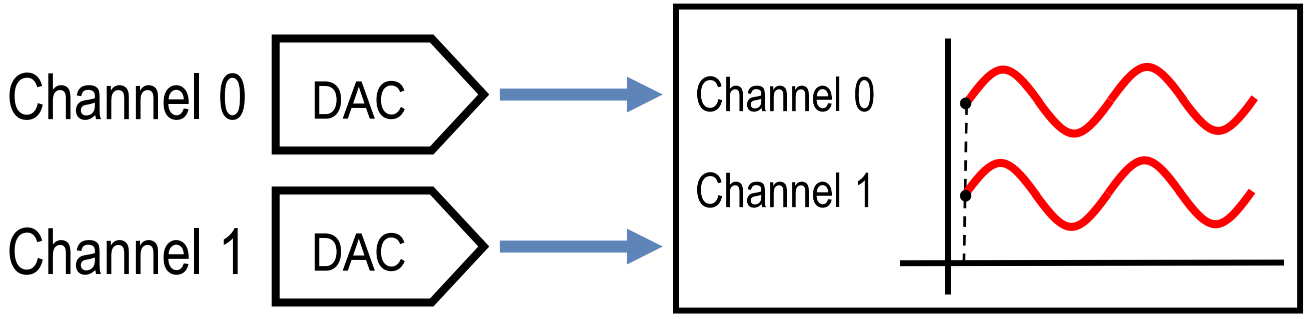
B. Single Sample Generation

C. Finite Buffered Generation

D. Continuous Buffered Generation

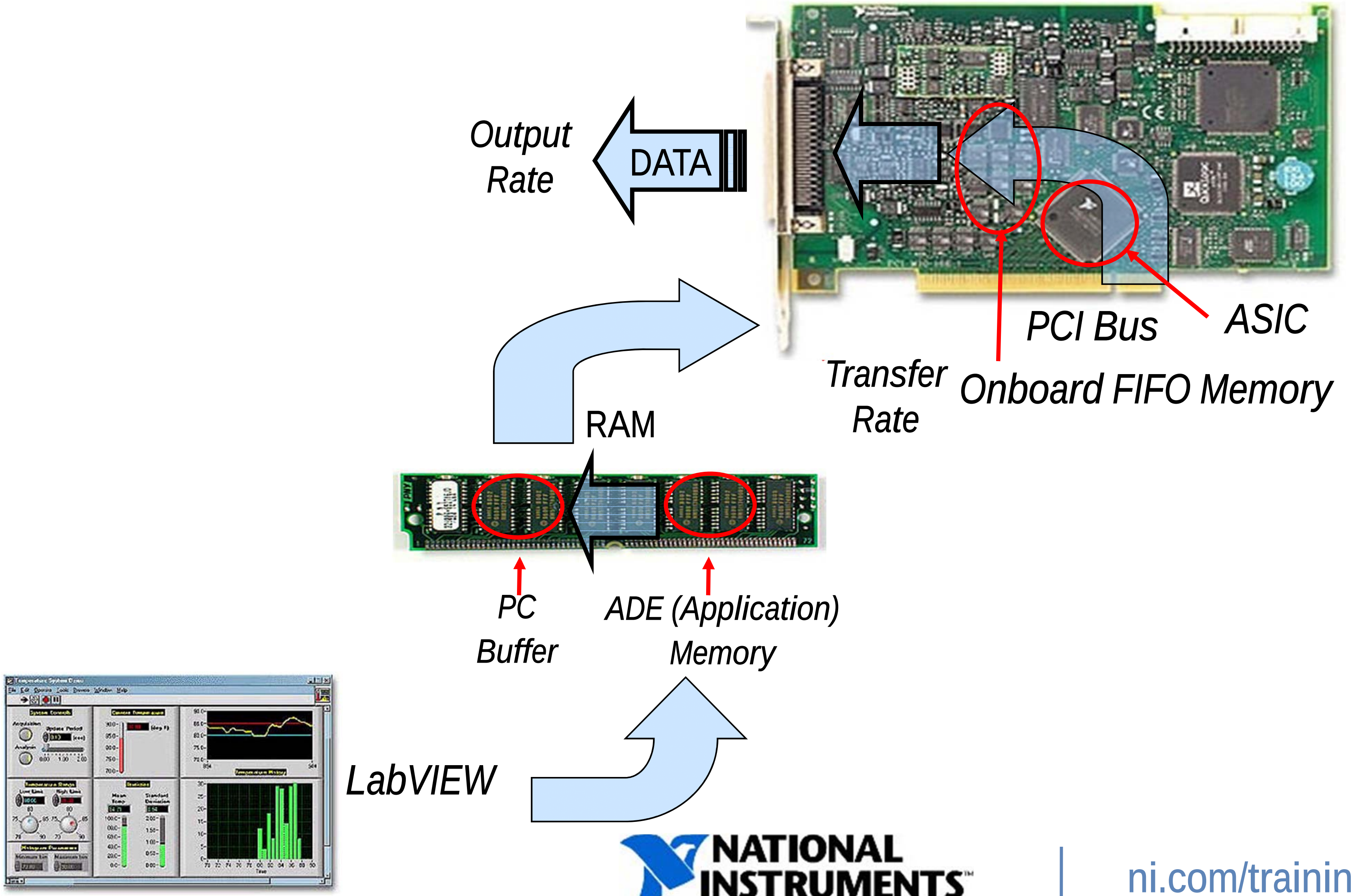
E. Triggered Generation

A. Analog Output Architecture



- Most multifunction DAQ devices have a Digital-to-Analog Converter (DAC) for each analog output channel
- DACs are updated at the same time
- Similar to simultaneous sampling for analog input

Data Transfer for an Output Operation



Output Rate

DATA

PCI Bus

ASIC

Transfer Rate

Onboard FIFO Memory

RAM

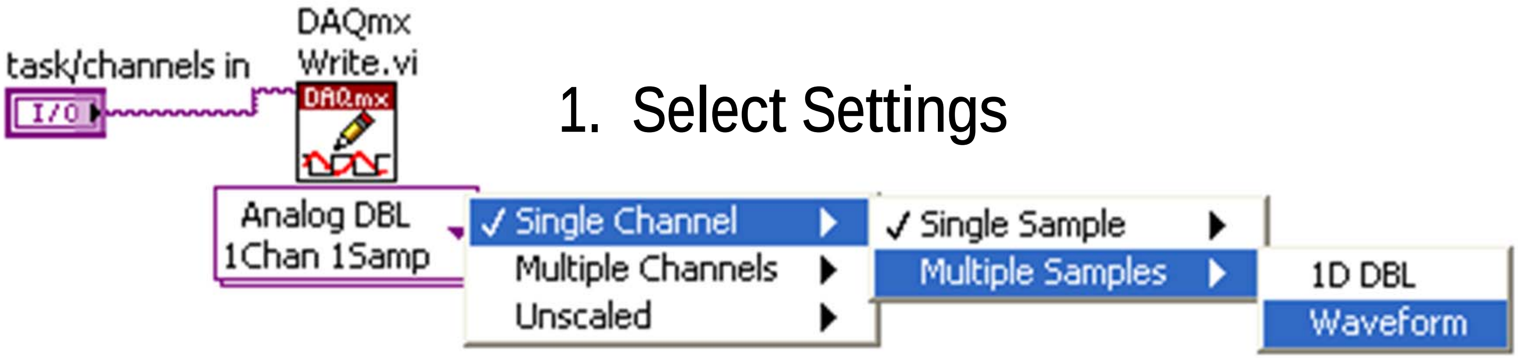
PC Buffer

ADE (Application) Memory

LabVIEW

DAQmx Write VI

1. Select Settings



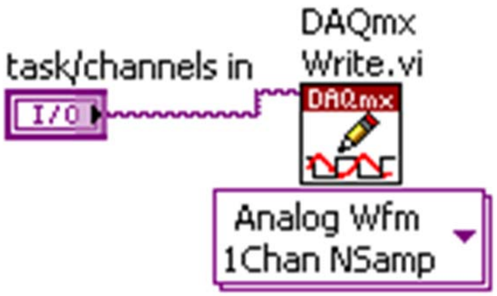
Signal type

Single or multiple channels?

Single or multiple samples?

Write data as waveform or double (array) type?

2. Verify Settings



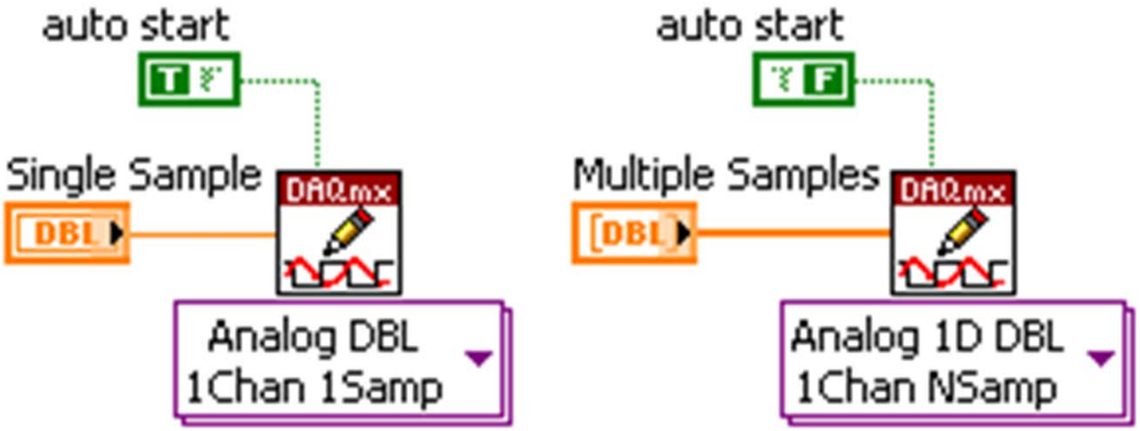
- ✓ Analog
- ✓ 1 Channel
- ✓ N Samples
- ✓ Waveform

Auto Start Parameter to Write VI

Controls whether the Write VI starts the generation

- For single samples, auto start is true by default
- For multiple samples, auto start is false by default

When using Start/Clear Task VI, always set auto start to **false**



B. Single Sample Generation

Use when signal level is more important than generation rate

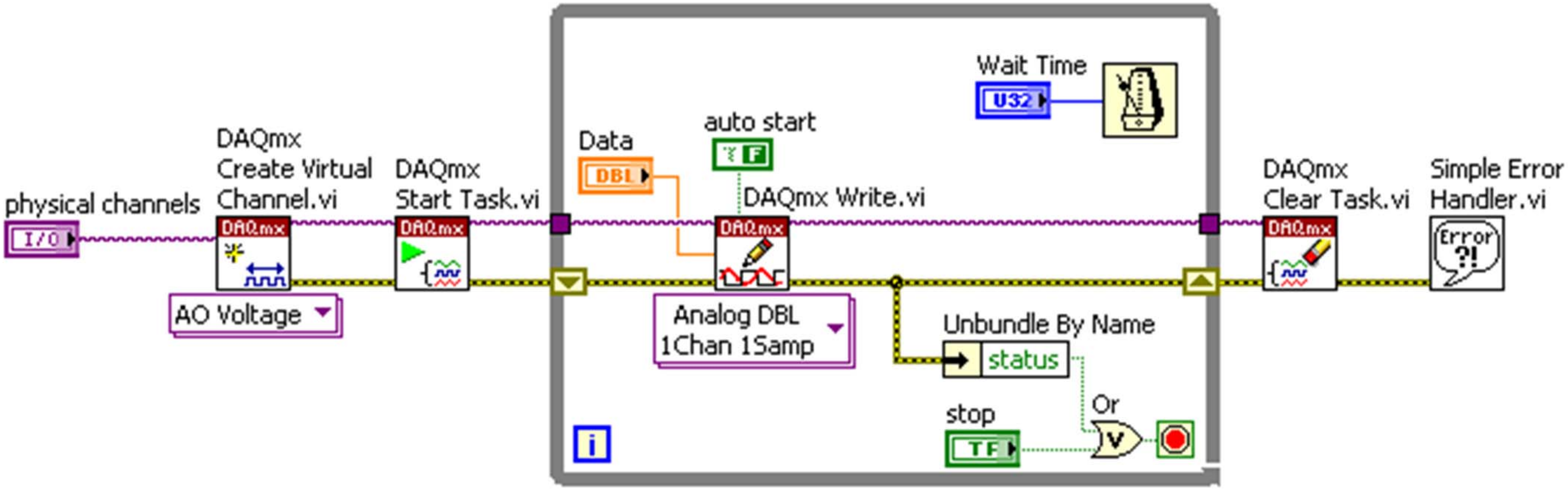
- Example: Outputting a constant DC voltage

Set timing with DAQmx Timing VI

- Software-timed
  - Rate is determined by the OS or the program (by adding a time delay in the generation loop)
  - Sample Timing Type property is set to On Demand
- Hardware-timed
  - Clock on your device controls the timing. Much faster and more accurate than a software loop.
  - Sample Timing Type property is set to Sample Clock

Software-Timed Analog Output Loop

Update the voltage on the analog output channel until user hits stop button



Exercise 4-1: Continuous Single-Point Generation

To create a VI that produces a variable voltage signal.

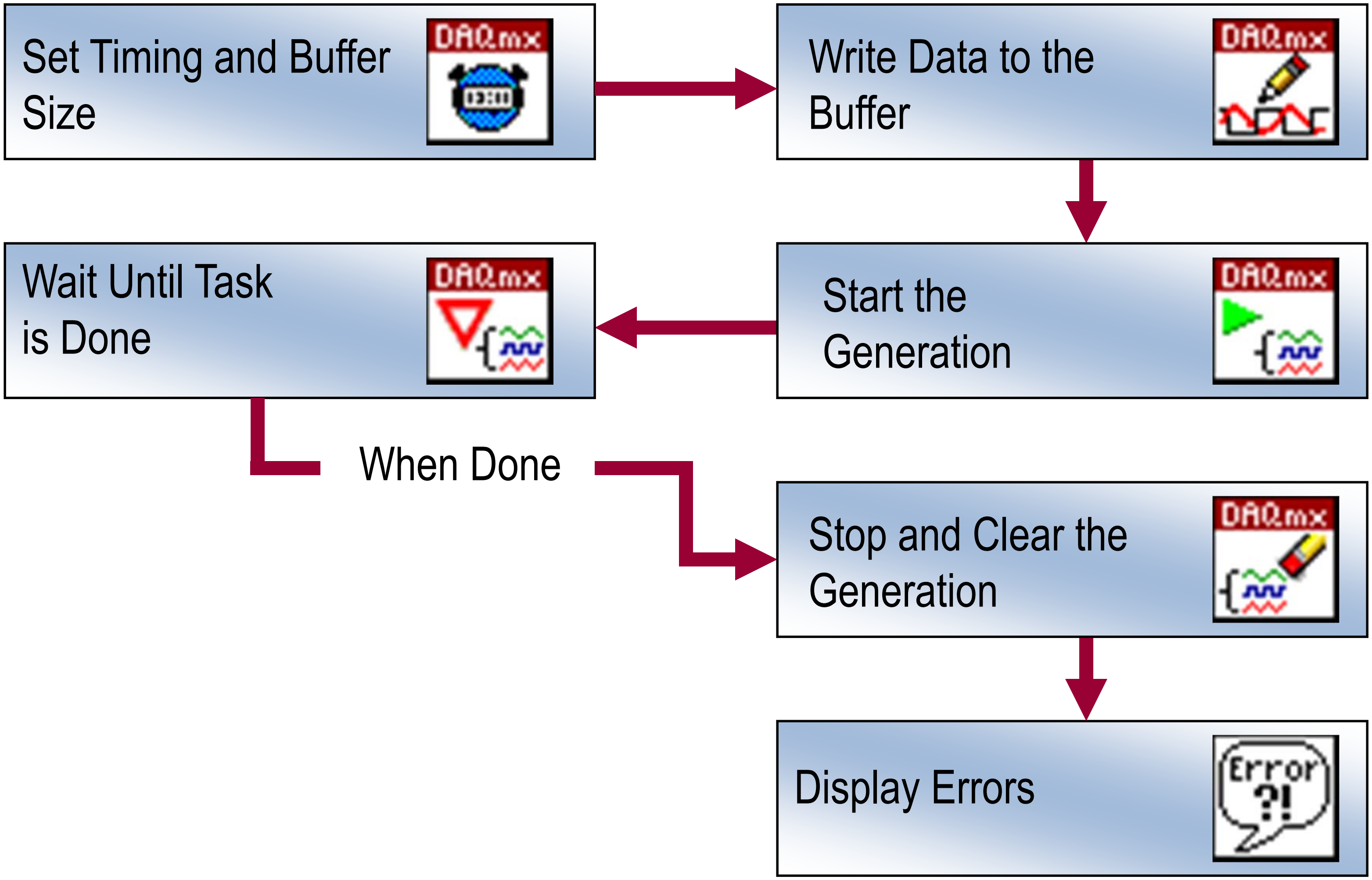
GOAL

Exercise 4-1: Continuous Single-Point Generation

- Should you use this application to output a 10 Hz sine wave? Why or why not?

DISCUSSION

C. Finite Buffered Generation Flowchart



Set Timing and Buffer Size

Write Data to the Buffer

Start the Generation

Wait Until Task is Done

When Done

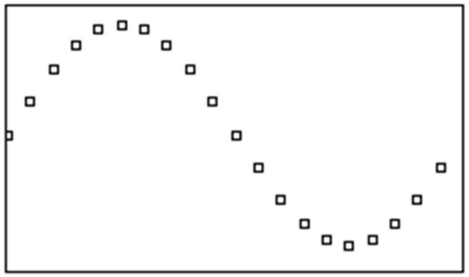
Stop and Clear the Generation

Display Errors

Output Waveform Frequency

Output waveform frequency depends on three factors:

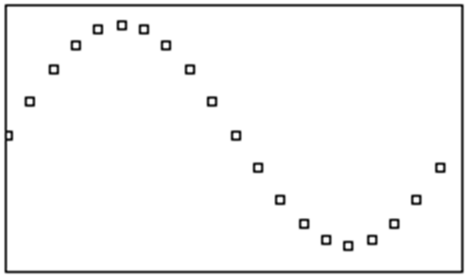
- Update rate
- Points in the buffer
- Number of cycles in the buffer



$$\text{Signal Frequency} = \text{\# of cycles in buffer} \times \frac{\text{update rate}}{\text{points in the buffer}}$$

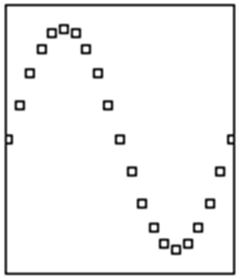
Output Waveform Frequency

- Buffer size = 1000 pts
- # of cycles in buffer = 1
- Update rate = 1000 Hz



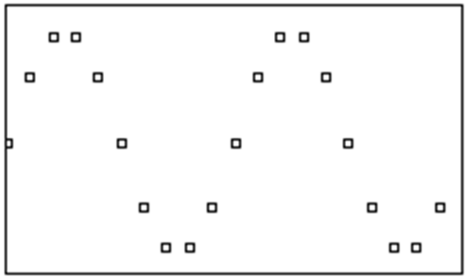
Signal frequency = 1 Hz

- Buffer size = 1000 pts
- # of cycles in buffer = 1
- Update rate = 2000 Hz



Signal frequency = 2 Hz

- Buffer size = 1000 pts
- # of cycles in buffer = 2
- Update rate = 1000 Hz



Signal frequency = 2 Hz

$$\text{Signal Frequency} = \text{\# of cycles in buffer} \;\; \text{X} \;\; \frac{\text{update rate}}{\text{points in the buffer}}$$

Wait Until Done vs. Is Task Done

Wait Until Done VI

- Used for finite generations
- User can set timeout
- Blocks task until finished executing

Is Task Done VI

- Used for error checking in continuous generations
- Polls to determine state of the generation

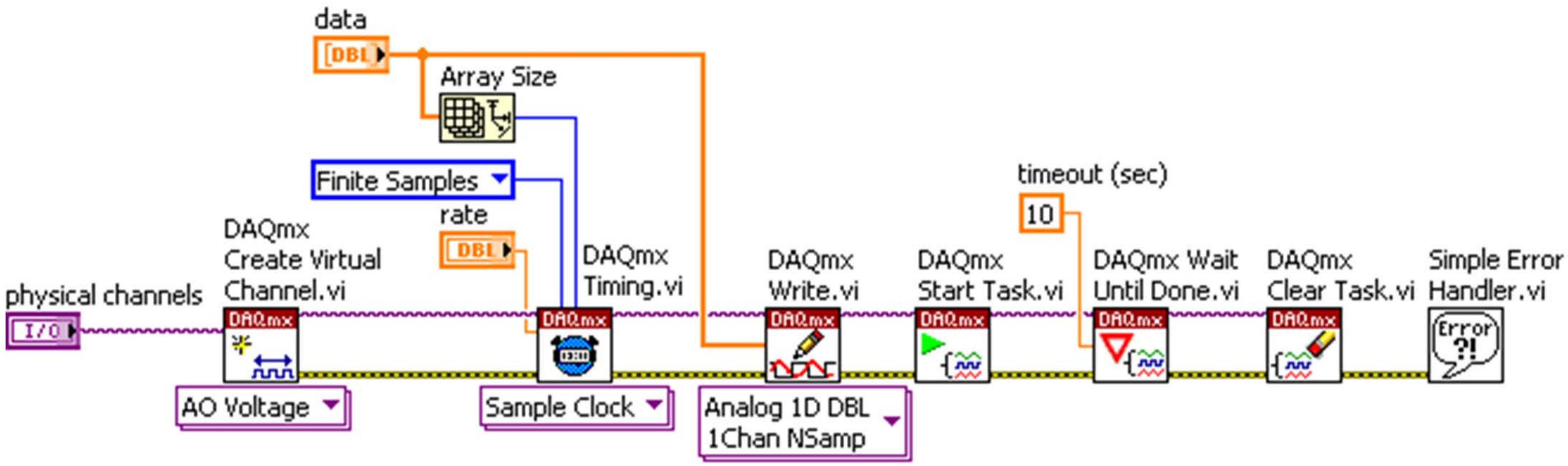
Timing for Finite Generation

Set timing with DAQmx Timing VI

- Software-timed
  - Rate is determined by the OS or the program (by adding a time delay in the generation loop)
  - Sample Timing Type property is set to On Demand
- Hardware-timed
  - Clock on your device controls the timing. Much faster and more accurate than a software loop
  - Sample Timing Type property is set to Sample Clock

Finite Buffered Generation Example

- Set the sample mode to Finite Samples
- Write data to buffer with DAQmx Write VI
- Use DAQmx Wait Until Done VI



Exercise 4-2: Finite Buffered Generation

To create a VI that generates a finite waveform of sound data.

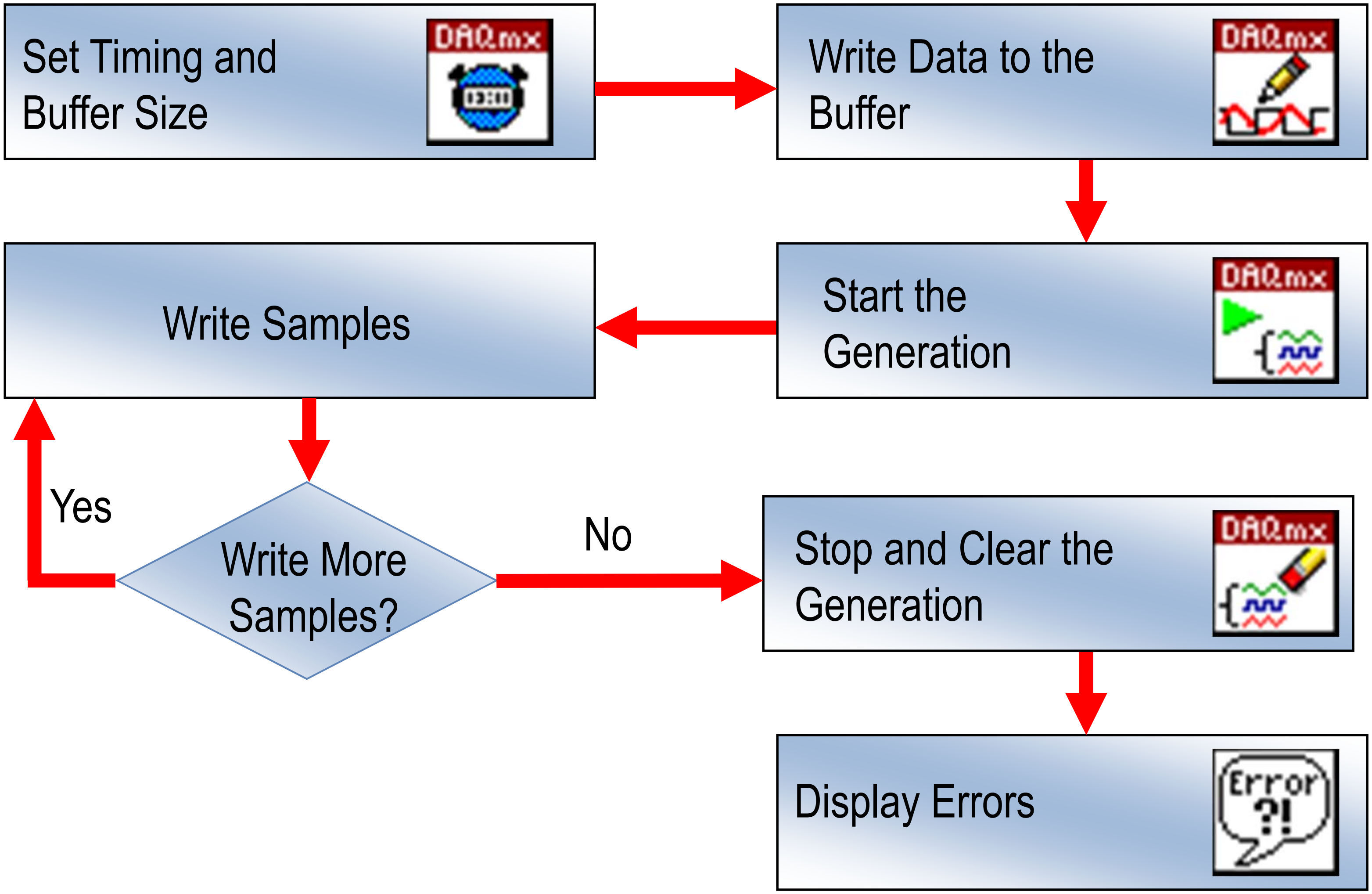
GOAL

Exercise 4-2: Finite Buffered Generation

- What would happen if you removed the DAQmx Wait Until Done VI from the block diagram?

DISCUSSION

D. Continuous Buffered Generation Flowchart



Set Timing and Buffer Size

Write Data to the Buffer

Start the Generation

Write Samples

Write More Samples?

Yes

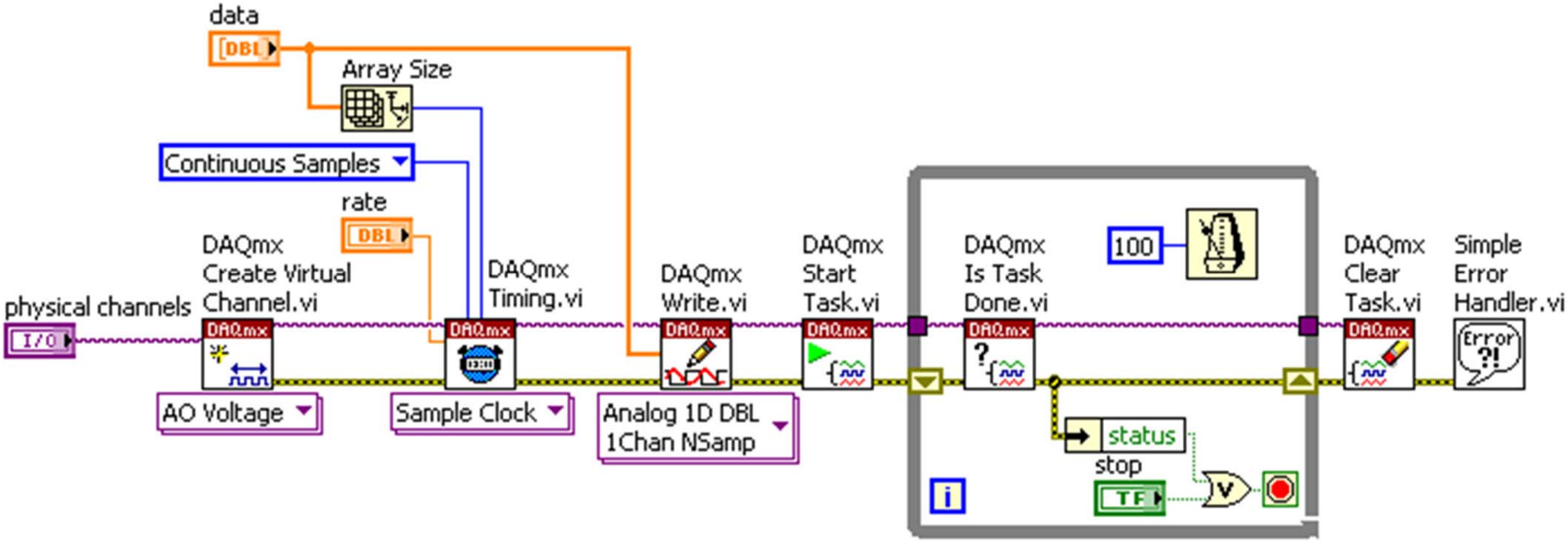
No

Stop and Clear the Generation

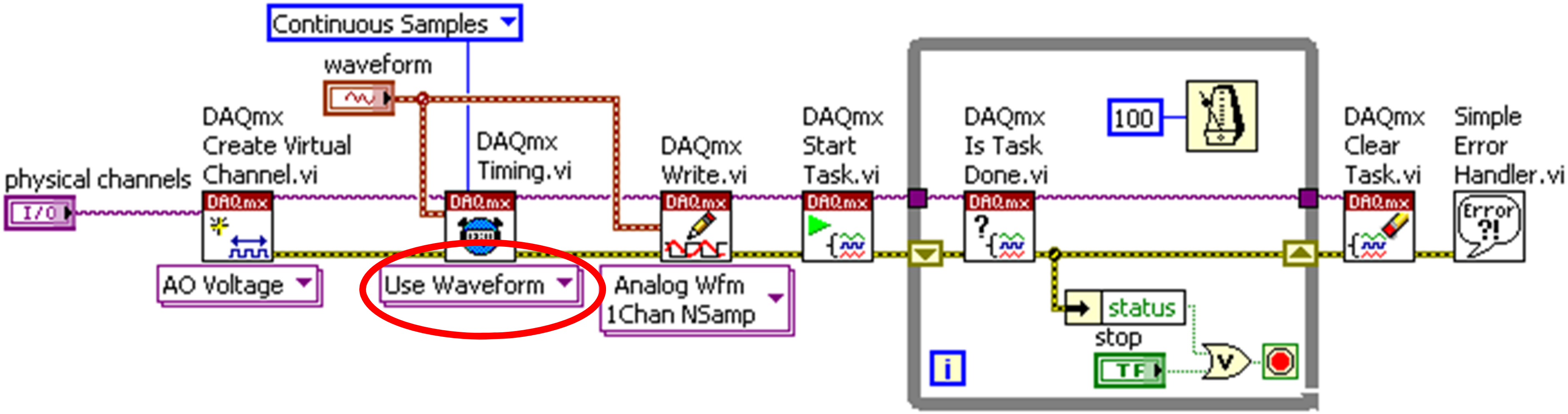
Display Errors

Continuous Waveform Generation Using the Sample Clock

- Set the sample mode to Continuous Samples
- Write data to buffer with DAQmx Write VI
- Use DAQmx Is Task Done VI

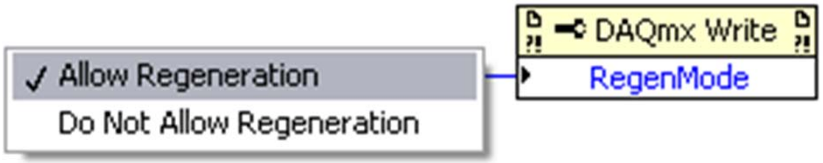


Waveform Generation Using dt for Timing



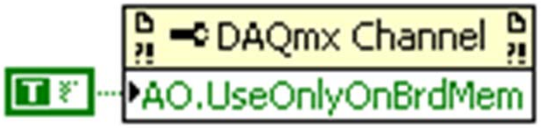
- Use Waveform instance of DAQmx Timing VI to use dt for timing

Regeneration



Use Regeneration Mode property

- **Allow Regeneration** generates the same data multiple times

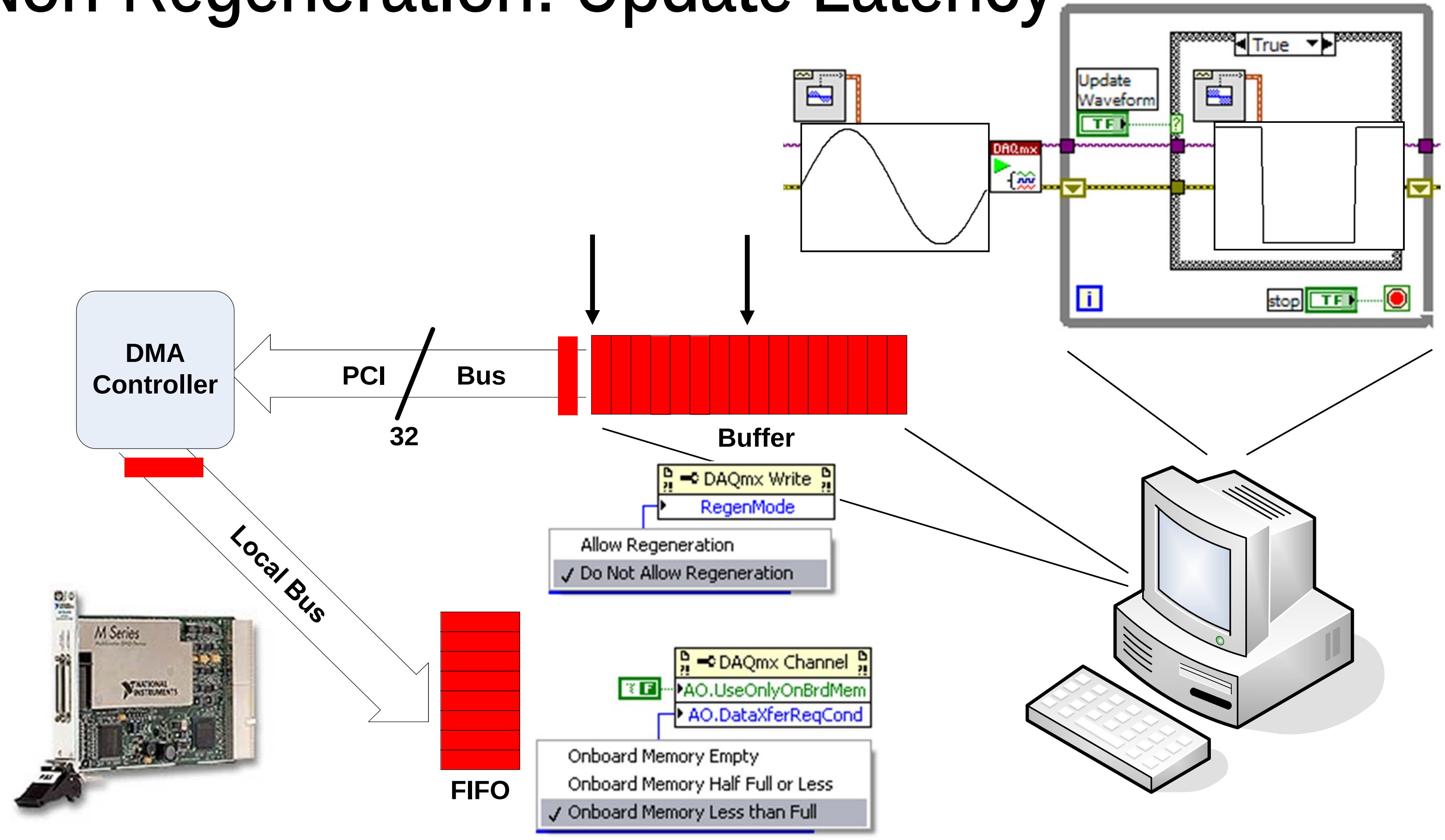


Use On Board Memory property

- If true, regenerate data from onboard memory of device
- If false (default), regenerate data from PC buffer

If regeneration is enabled and you write new data to the buffer, **glitching** can occur during the transition

Non-Regeneration: Update Latency



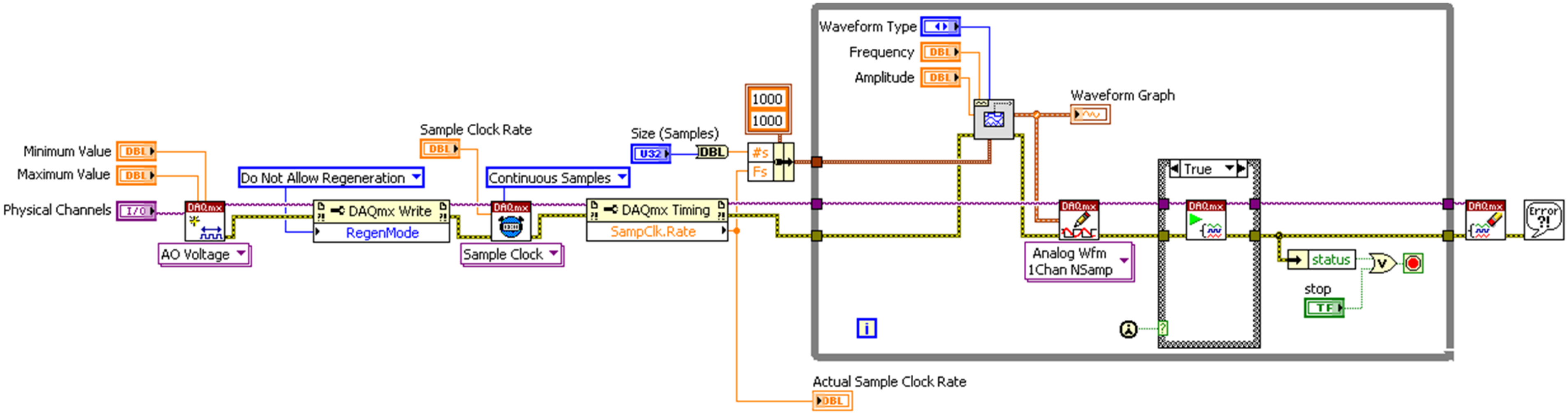
DAQmx Write
RegenMode

Allow Regeneration
✓ Do Not Allow Regeneration

DAQmx Channel
AO.UseOnlyOnBrdMem
AO.DataXferReqCond

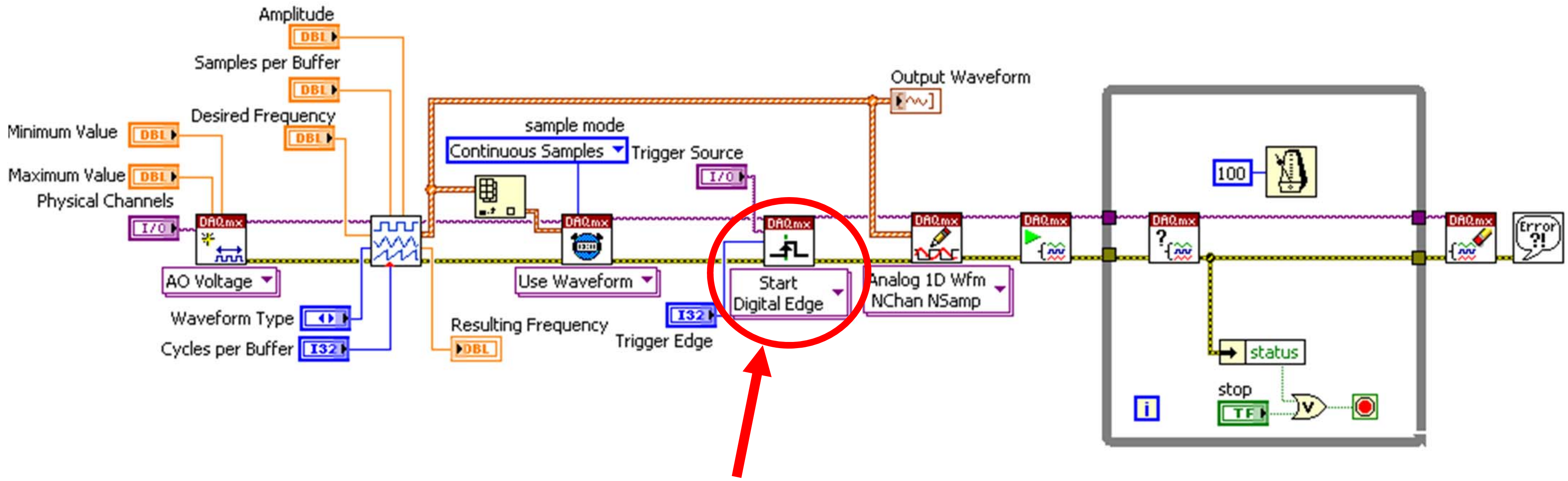
Onboard Memory Empty
Onboard Memory Half Full or Less
✓ Onboard Memory Less than Full

Non-Regenerated Generation



E. Triggered Generation

Use DAQmx Trigger VI



DAQmx Trigger VI

Exercise 4-3: Triggered Continuous Buffered Generation

To build a VI to trigger a continuous buffered generation on an analog input channel.

GOAL

Exercise 4-3: Triggered Continuous Buffered Generation

- How would you modify the block diagram to output your own custom analog signal?

DISCUSSION

Summary—Quiz

1. In a typical DAQ device how many channels are there per DAC?

   a) 1

   b) 8

   c) 16

   d) 32

Summary—Quiz Answer

1. In a typical DAQ device how many channels are there per DAC?

   a) 1

   b) 8

   c) 16

   d) 32

Summary—Quiz

2. If you generate a sinusoidal waveform with 200 samples and 10 cycles at an output rate of 1 kHz, what is the apparent rate of the sine wave?

   a) 1000 Hz

   b) 500 Hz

   c) 50 Hz

   d) 20 Hz

Summary—Quiz Answer

2. If you generate a sinusoidal waveform with 200 samples and 10 cycles at an output rate of 1 kHz, what is the apparent rate of the sine wave?

   a) 1000 Hz

   b) 500 Hz

   c) 50 Hz

   d) 20 Hz