Lab 2 FYSS 585

Data sampling, buffer readout and triggering in LabView.

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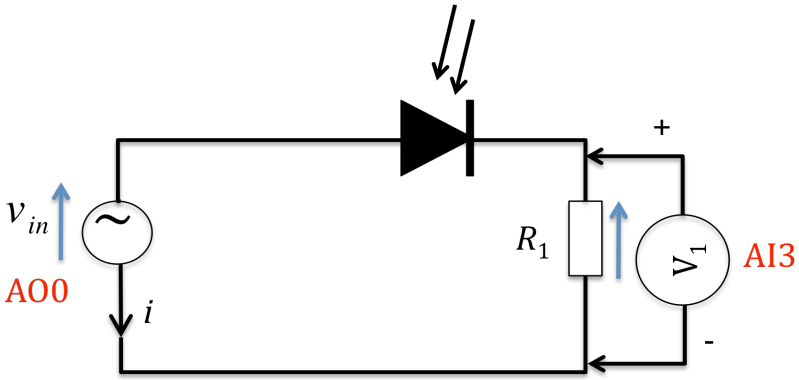
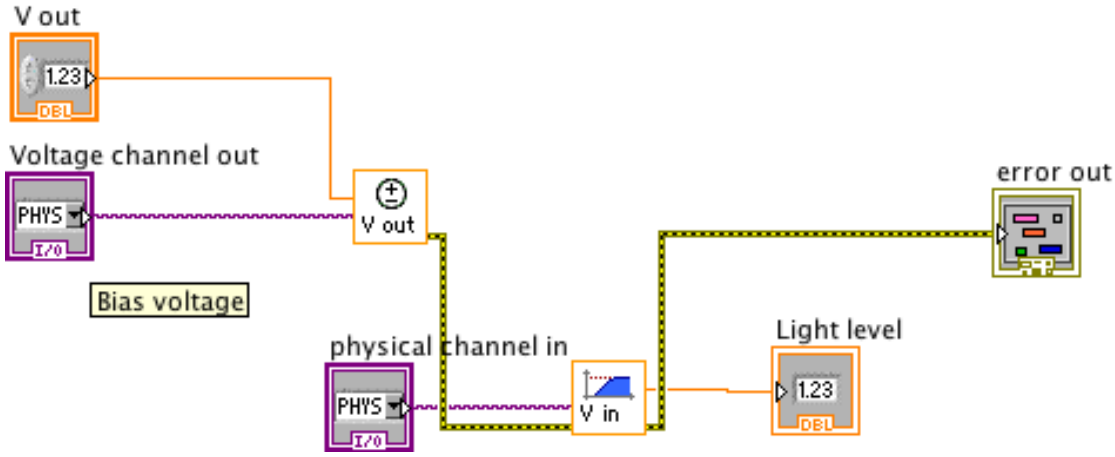
Objective

The goal of this lab is to investigate software timed register read-out, hardware buffered readout and hardware and software trigger strategies using LabView. We use the NI USB 6009 module. This allows hardware triggering (via a digital signal on PFI0). To generate the fast signal we use a phototransistor to measure the light intensity. The 50 Hz power to the fluorescent lights gives a repetitive high speed change in light intensity that will serve as our test signal. In addition fast changing signals can be made by briefly shielding the diode with a moving hand.

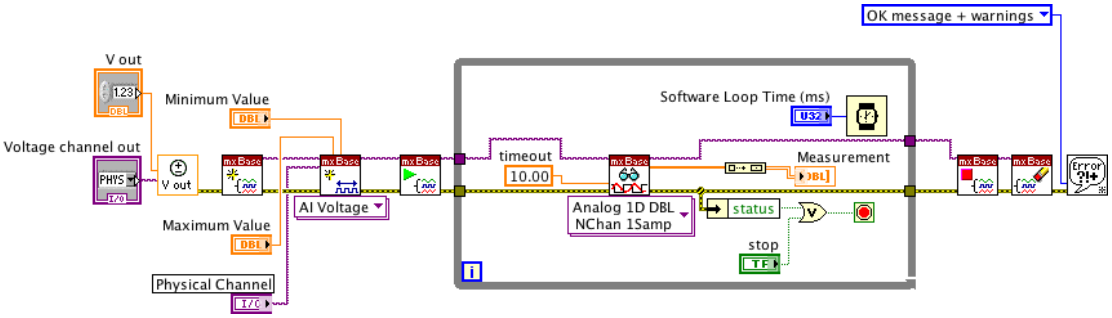
1. Connect up the circuit as shown below. The long wire on the phototransitor is the anode. R_1 is 5.6 kΩ.



2. Use the following Basic light sensor VI and verify that the measured light intensity behaves as you expect when the light intensity is changed by shielding the photodiode with your hand.



3. **Software-timed register readout**
   This represents the case where the conversion result from the ADC is read out from the register under software control. Set up the VI as shown below. Review the DAQmx Vis and their function. (Hint: use to contextual help function in LabView.)



In this circuit the data is collected one sample at a time. At a predetermined time after this the next sample is read. (n.b. The minimum and maximum value of the input data should be set to 0 and 5 V respectively. The display may need to be set to "Autoscale-y".)

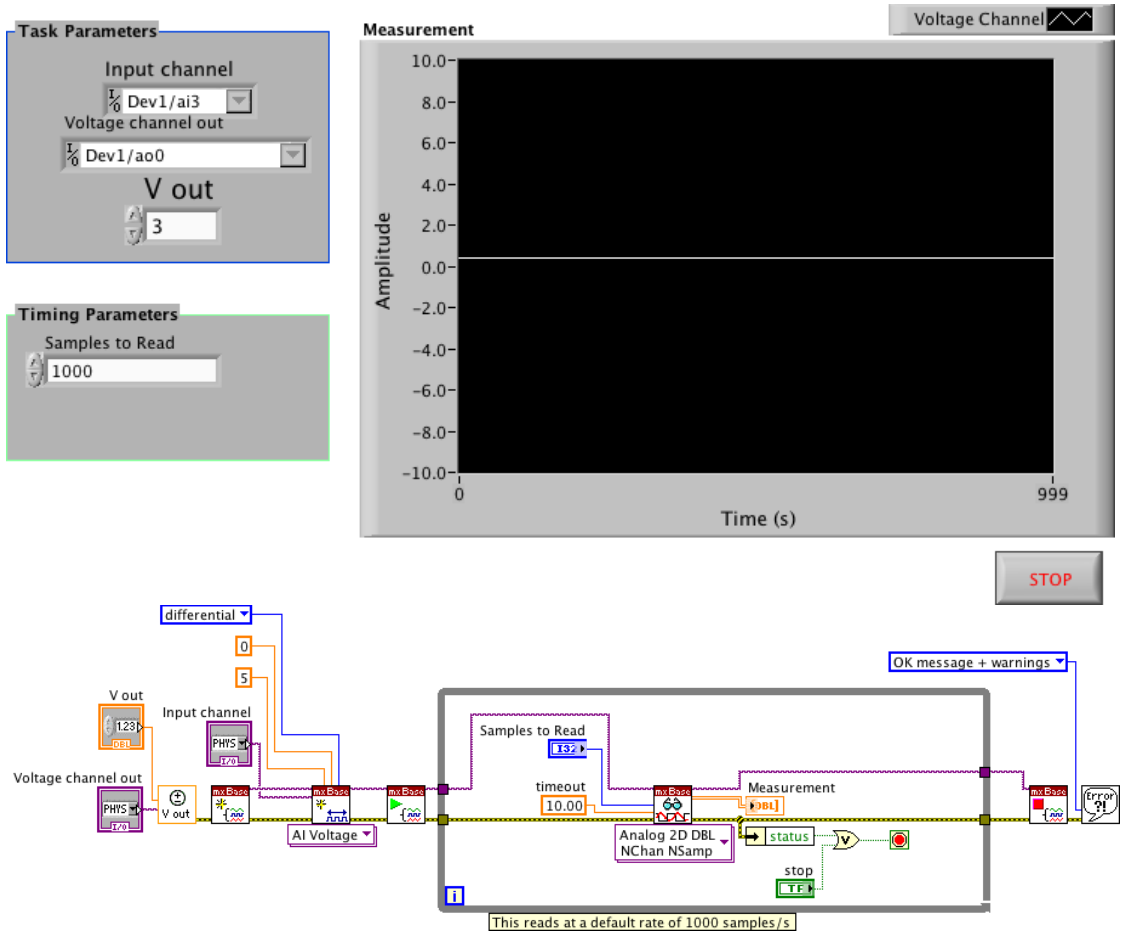
(i) Investigate the effect of different software loop times.

(ii) Estimate the maximum number of samples per sec that can be handled in this circuit?

(iii) What are the advantages of this technique? (Yes - there are some advantages!)

4. Basic buffered readout

The following VI illustrates basic buffering.



The circuit uses the default timing of 1000/samples per sec. The size of the buffer is given by the "samples to read" control. Convert the previous VI to this new form and investigate the performance.

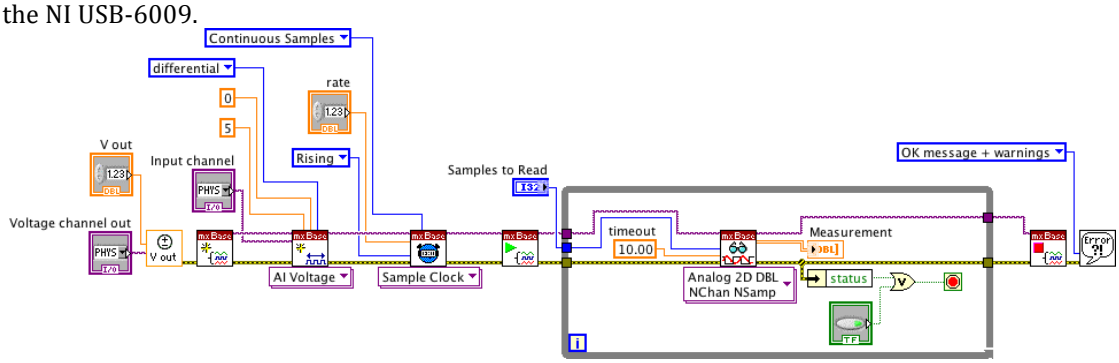
(i) What is the highest frequency signal that can be reliably read by the circuit?

(ii) The internal buffer in the NI-USB-6009 is 512 bytes. At a data rate of 1000 samples/s how many times per sec must this be emptied?

(iii) In (ii) what bit rate on the USB does this correspond to?

5. Timed sampling

A limitation of the basic buffer sampling is that the sample rate is limited to 1000 s^{-1}. DAQmx provides a VI that slows us to control the sample rate using the internal clock in the NI USB-6009.



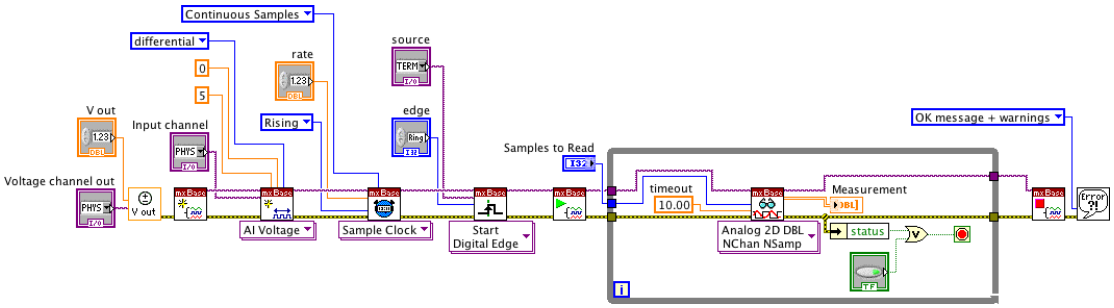
Modify the previous VI to include the sample clock VI as shown above.

(i) Investigate the high sample rate performance and interplay between refresh rate, number of samples and sample rate.

(ii) What happens if the number of samples is reduced?

6. Digital hardware triggered buffered sample data acquisition.

The system is now working as a free running oscilloscope without a trigger function. Often we require that the data acquisition is synchronised with a a external signal e.g. an extermal digital trigger. In the NI USB-6009 one can set-up a digital trigger using the PFI 0 input. To do this one uses the trigger VI in DAQmx. Specify PFI 0 as digital source and select rising or falling edge.



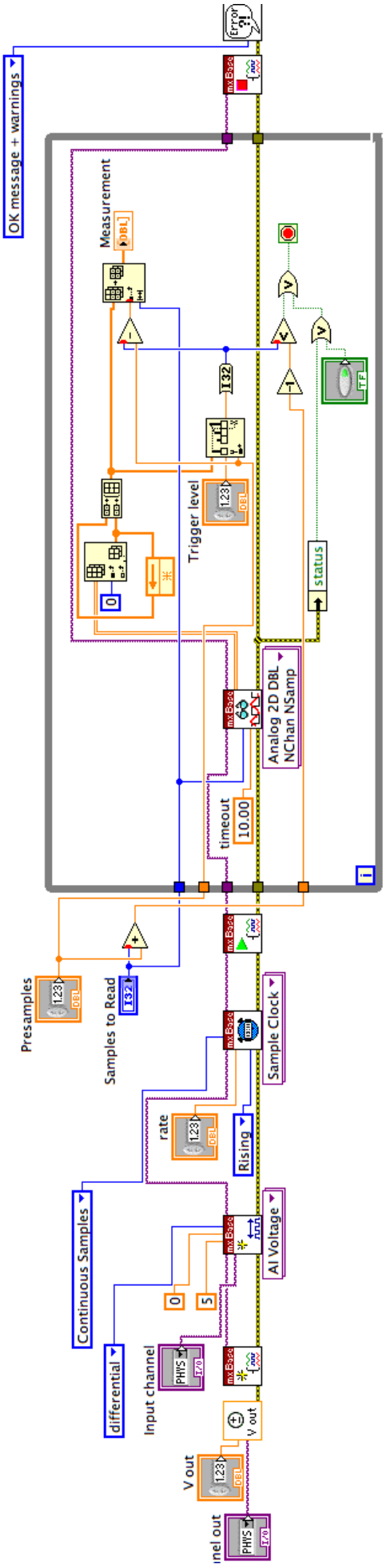
In the above circuit the source is Dev1/PFI0 and generated by shorting this digital input to ground. This starts the data acquisition. You should set up the circuit and verify this behaviour.

7. Analogue software triggered buffered sample acquisition

Often we need to trigger on when the analogue level exceeds or falls below a given level. In fully-fledged input-output devices this is done implemented in hardware on the device itself. The NI USB-6009 does not have this functionality implemented. However, the function can be implemented in software. The figure on the next page shows how this can be done. Note that a pretrigger function is implemented that displays the data for a number of samples before the trigger occurred. Here a simple positive threshold trigger was implemented. Try to cover the phototransistor with your hand and observed that the transient is recorded when it is removed. (light intensity transient.) Till the circuit is triggered the data up to the number of pre-trigger samples is displayed. Once the circuit has been triggered the entire transient is diplayed – both pre- and post-trigger.

(i) What are the advantages and disadvantages of software analogue triggering compared to hardware analogue triggering?

(ii) How could a negative edge software trigger be implemented?


OK message + warnings
Measurement
Trigger level
status
Analog 2D DBL NChan NSamp
timeout
10.00
Presamples
Samples to Read
Sample Clock
rate
Rising
Continuous Samples
AI Voltage
differential
Input channel
V out
inel out