2018-08-22

# DAT093
# Introduction to Electronic System Design
## The AD/DA board

*Figure 1* gives the physical layout of the AD/DA card that is to be used in *Lab assignment 5* and *6*. There are two versions of the board that have some minor differences, but both follow the drawing quit closely.

In *Figure 2* you will find the block diagram of the AD/DA card.

You can see from the diagram that the card has two analog input channels connected to the two channels of the ADC. The signal chain starts with a variable gain stage that can give a gain of 1 to 6 times. This is followed by an anti-aliasing filter, a low-pass filter with a cutoff frequency of 15.8 kHz. This filter stage can be bypassed if you like. After this comes a DC correction stage that adds a positive voltage to a bipolar analog signal and thereby converts it to a unipolar signal that can be handled by the ADC. The added DC level can be adjusted but should preferably be set to half the supply voltage, that is 2.5 Volts. This stage can also be bypassed to handle unipolar signals.

The DAC has also got two channels and these are each followed by a DC blocking stage that converts the unipolar signal to a bipolar signal. The stage can be bypassed. This stage is followed by a low-pass filter with a cut off frequency of 15.8 kHz that smoothes the stair case signal from the DAC. This filter is implemented in the same way as the anti-aliasing filter placed before the ADC. There are two outputs, one filtered and one unfiltered.

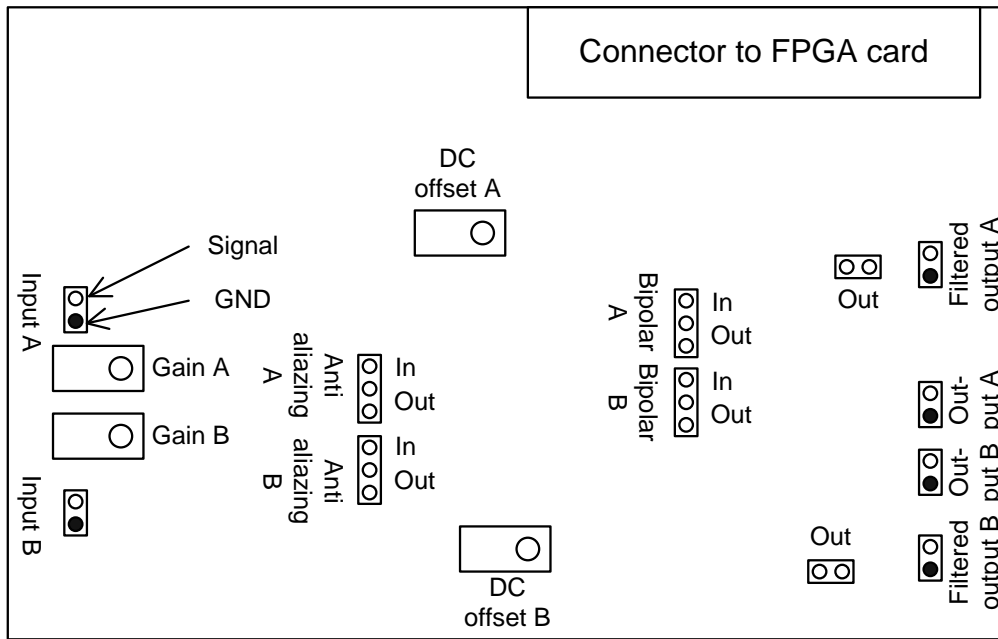In *Figure 3* you will find the schematic for the AD/DA card.
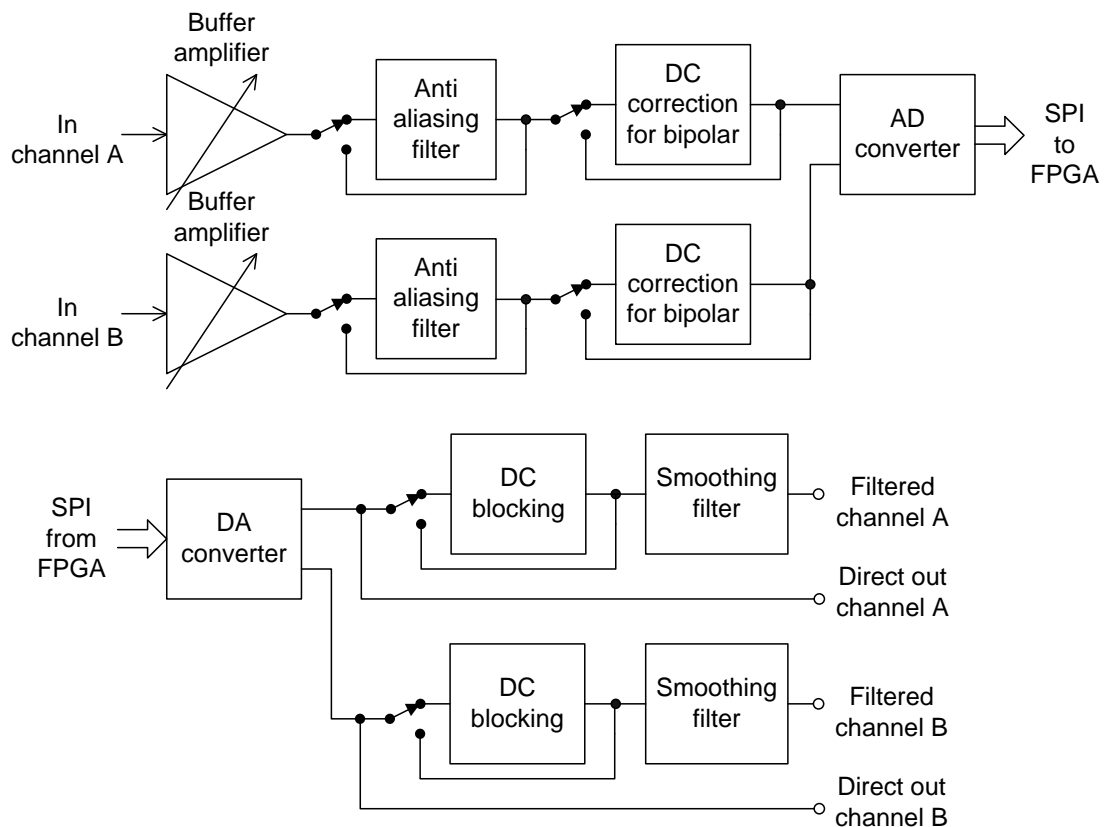
*Figure 1 Layout of AD/DA card*



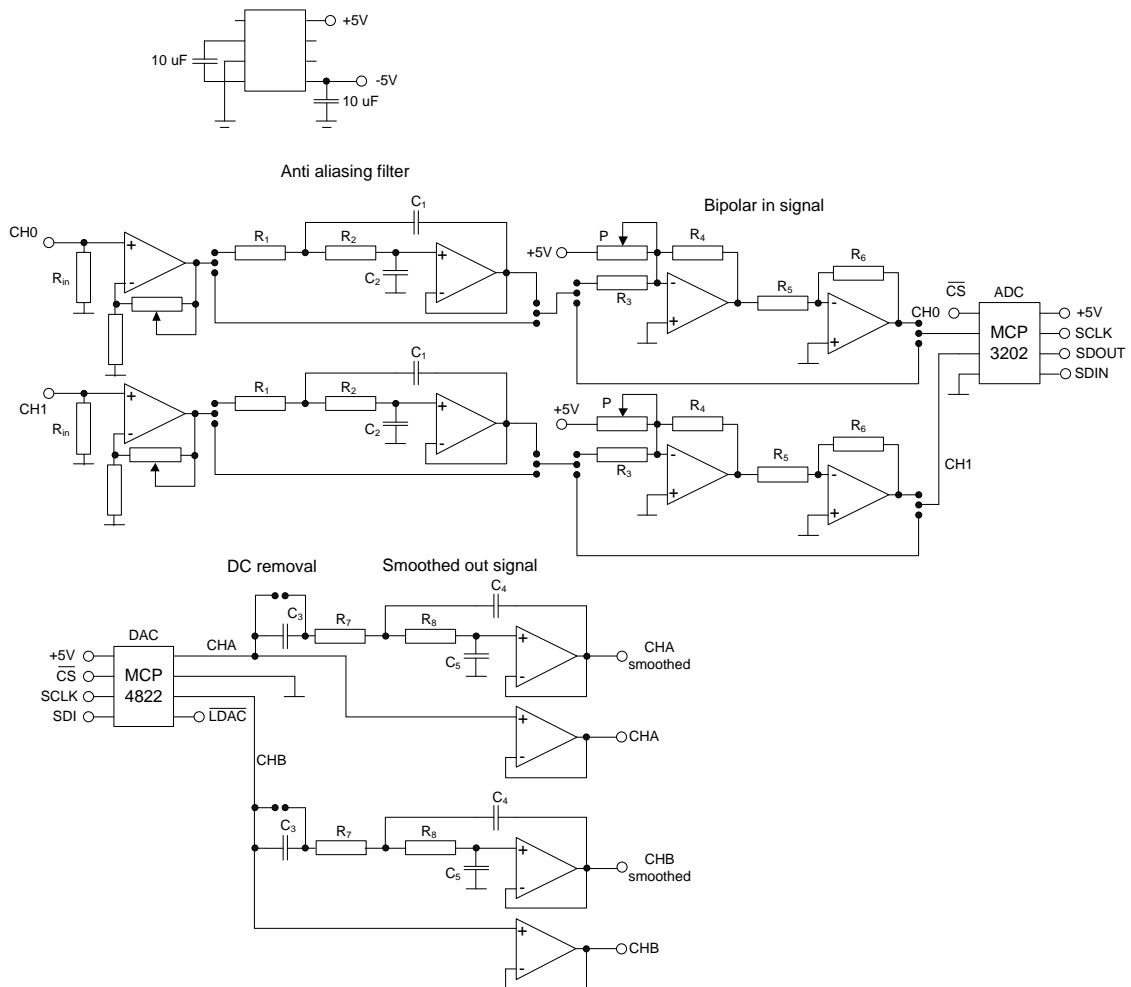*Figure 2 Block schematic of the AD/DA card*

*Figure 3 Schematic of the AD/DA card*

We will use the A/D and D/A expansion board with the **Nexys4 Board** but it can also be used with the **Nexys3 trainer board**, the **Spartan3 StarterKitBoard** and with the **Virtex-II Pro Development System**.

In the Spartan3 system the board is connected to connector **A2** while it is connected to one of the two Digilent expansion connectors on the Virtex-II Pro board.

Since the conversion board was developed for the Spartan3 board it can´t be directly connected to the Nexys3 or Nexys4 board you will need a small adapter board between the FPGA board and the converter board. Since the converter board needs 5 Volts but the Nexys boards only have output connections for 3.3 Volts you will for the Nexys3 board need a cable to connect to 5 Volts from the FPGA boards USB connection. To do the same thing on the Nexys4 board you will need a small adapter. You can read about this is connected below.

*Table 1* gives the pin numbers in the 40-pin connector on the expansion board and the corresponding FPGA pin names on the Nexys3, Nexys4, Spartan3 and Virtex-II Pro FPGA circuits. The names of the A/D and D/A circuit pins used on the expansion board are also given.

Version 2 of the board has a 32-pin connector but since the top eight pins are not used on the version 1 card they work the same.

| Expansion board | | Device | Nexys3 or Nexys4 pin name | Spartan3 pin name | Virtex-II Pro pin name | |
|---|---|---|---|---|---|---|
| Pin name | Pin number | | | | Left connector | Right connector |
| GND | 1 | - | - | - | - | - |
| +5V | 2 | - | - | - | - | - |
| /CS | 11 | DAC | Jx(7) | D7 | R9 | U9 |
| SCLK | 13 | DAC | Jx(1) | D8 | M3 | V4 |
| SDI | 15 | DAC | Jx(8) | D10 | P1 | Y1 |
| /LDAC | 17 | DAC | Jx(2) | B4 | P7 | U8 |
| DIN | 19 | ADC | Jx(9) | B5 | N3 | V6 |
| DOUT | 21 | ADC | Jx(3) | B6 | P2 | AA2 |
| SCLK | 23 | ADC | Jx(10) | A7 | R7 | V8 |
| /CS | 25 | ADC | Jx(4) | A8 | P4 | W4 |

Table 1 Pin assignment for the AD/DA card

Depending on what port you use x in Jx(1)-Jx(8) could be A, B, C or D.

Since some of the Spartan3 StarterKitBoards have been extensively used a number of pins don´t work properly. These boards use the pin assignments in *Table 2* instead

| Expansion board | | Device | Nexys3 or Nexys4 pin name | Spartan3 pin name | Virtex-II Pro pin name | |
|---|---|---|---|---|---|---|
| Pin name | Pin number | | | | Left connector | Right connector |
| GND | 1 | - | - | - | - | - |
| +5V | 2 | - | - | - | - | - |
| /CS | 11 | DAC | Jx(7) | D7 | R9 | U9 |
| SCLK | 13 | DAC | Jx(1) | D8 | M3 | V4 |
| SDI | 15 | DAC | Jx(8) | D10 | P1 | Y1 |
| /LDAC | 27 | DAC | Jx(2) | B10 | T2 | AB1 |
| DIN | 19 | ADC | Jx(9) | B5 | N3 | V6 |
| DOUT | 9 | ADC | Jx(3) | E7 | N2 | W2 |
| SCLK | 23 | ADC | Jx(10) | A7 | R7 | V8 |
| /CS | 25 | ADC | Jx(4) | A8 | P4 | W4 |

Table 2 Alternate pin assignment for the AD/DA card

The AD/DA boards have an 8-pin connector close to the large 40- och 32 -pin connector where you can easily access the eight signals of interest.

# Connections between the Nexys4 board and the AD/DA board

The AD/DA board is designed for an older Spartan3 board, so you will need an adapter to connect the AD/DA board to the Nexys4 board.

To get the system with the Nexys4 board and the AD/DA board working you need to connect a supply voltage of +5V from the Nexys3 board to the corresponding pins on the AD/DA-board. When you are using a potentiometer to get a variable input signal to the AD/DA board this will also have to be connected to +3.3 or +5V.
Make sure that you don´t mix the voltage and Gnd connections.

## Nexys4 and AD/DA board

The Nexys4 board doesn´t have a dedicated +5V connection but by using a special jumper we can get +5V from the USB connection that we use for downloading programs.
Connect the special jumper at the position marked in *Figure 4*. Connect the wire running from the jumper to the +5V connection on the ADDA board marked in *Figure 5*. You will also need to connect a ground wire to the ADDA board but that can be taken from the Gnd connection on the board adapter.

The full connection is given in *Figure 6*.

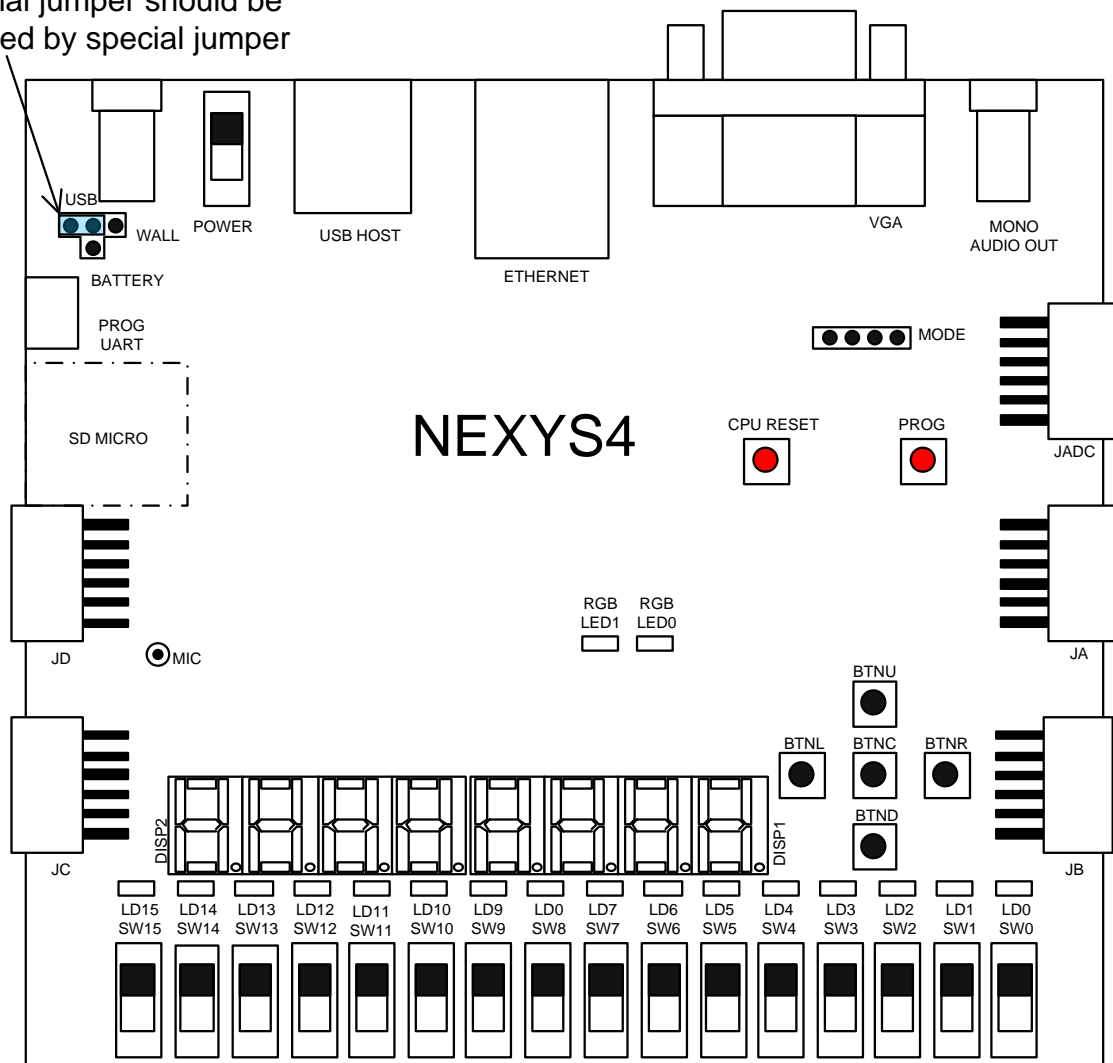Once again make sure that you don´t mix the voltage and Gnd connections.

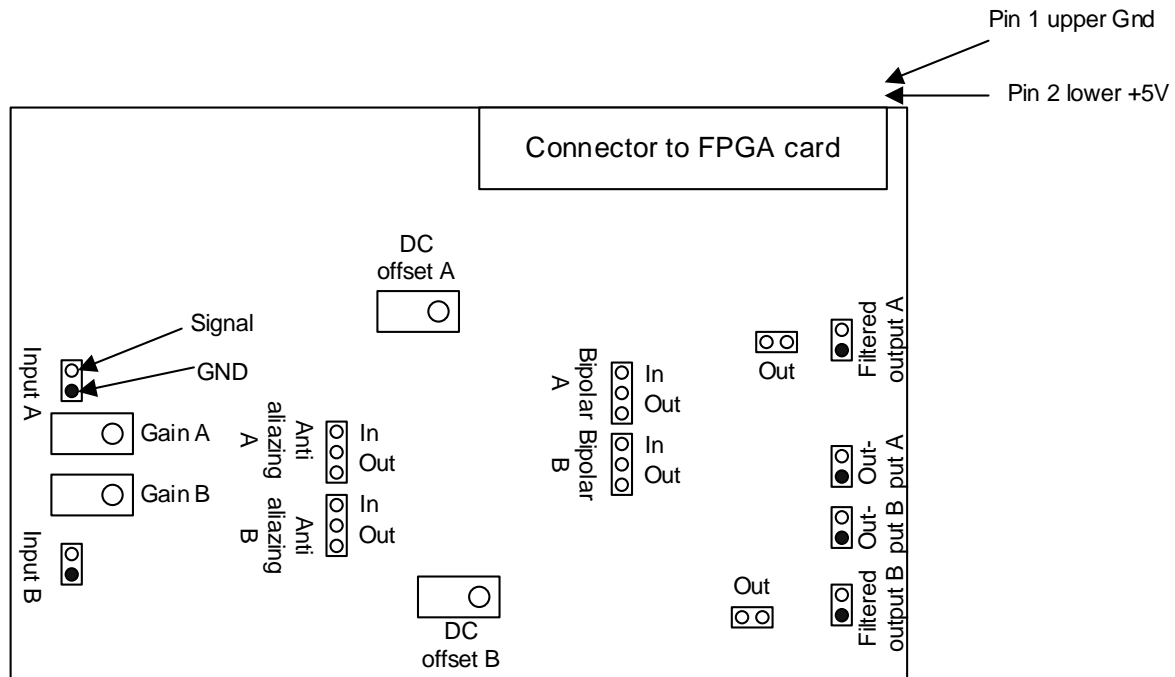*Figure 4 Nexys3 board with marked +5V and Gnd connections*

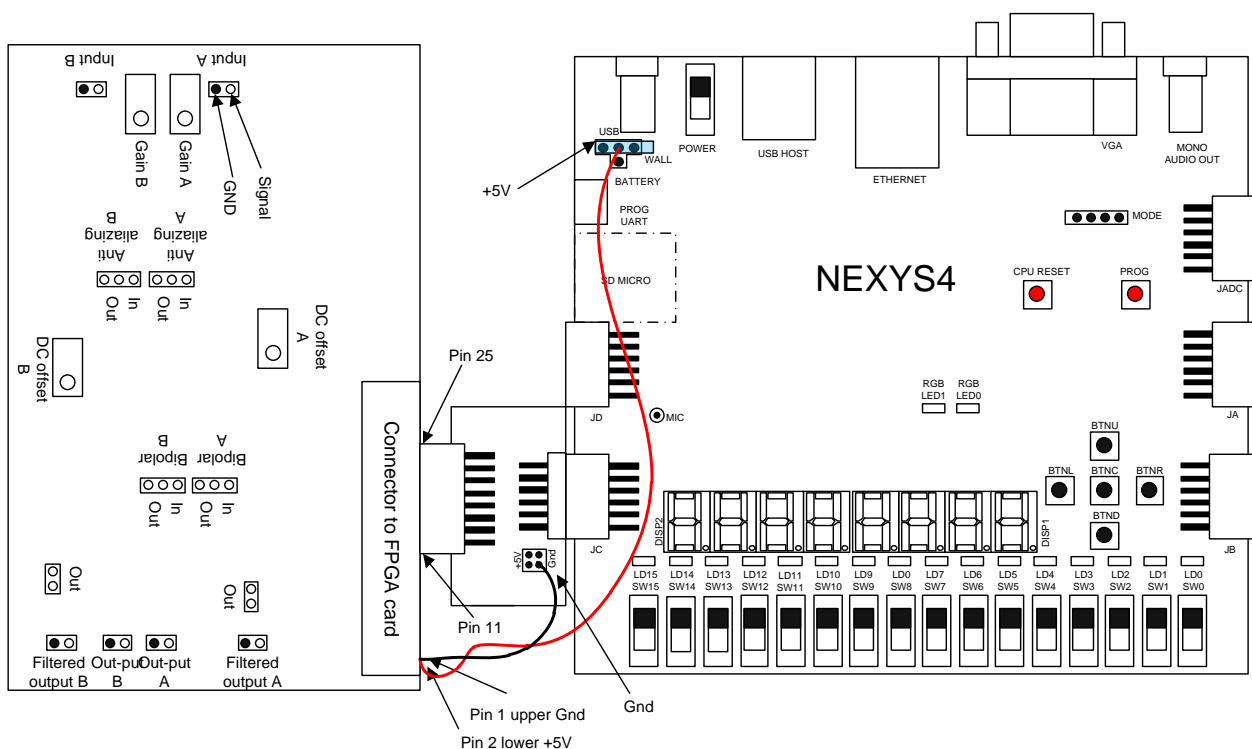*Figure 5 AD/DA board with marked +5V and Gnd connections*



*Figure 6 Nexys4 and AD/DA board connected*

When you test the AD/DA board you will need a test source. It is easiest to start with a DC source and we use a potentiometer for this. The potentiometer is placed on a bread board. You can find the layout of a typical breadboard in *Figure 7*. Not all of our breadboards look like

this one, but the structure is the same. The holes marked with red lines are connected internally. The connections for the potentiometer are given in *Figure 8*.
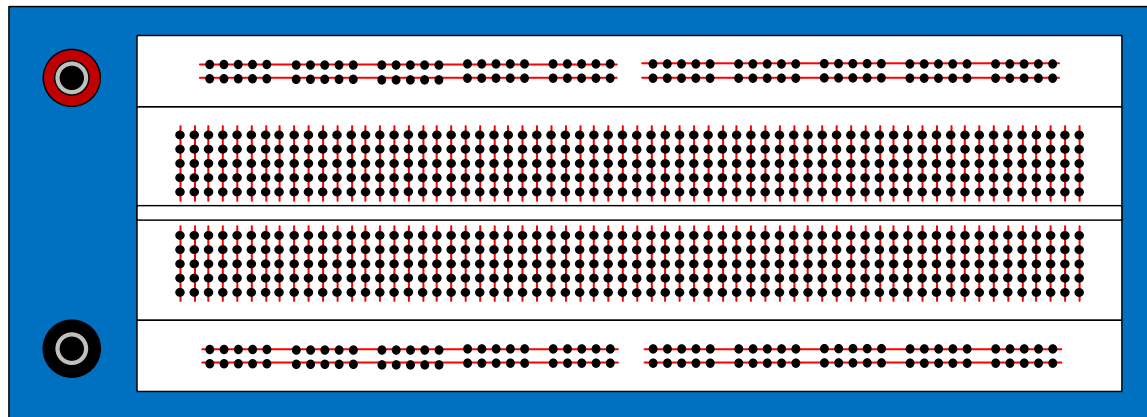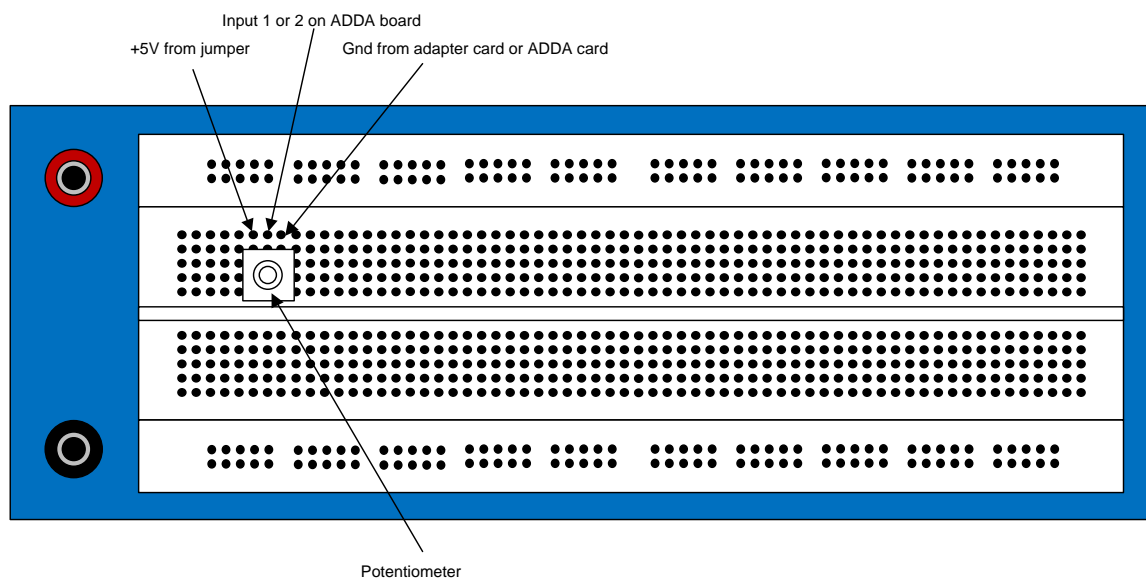


*Figure 7 Connections on the bread board*



*Figure 8 Potentiometer on the bread board*