

# DAQ 3.0 MANUAL

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The DAQ 3.0 is designed to work with the Futek PFP350 0-3000psia pressure transducer, OMEGA LCM305-10000kN load-cell, and XCIB-4-5-10 thermocouples. The DAQ outputs data to a computer over USB. The system is plug and play, with one crucial rule that must be followed. Because of the way the amplifier is setup, **if the DAQ is powered on with either the load-cell or pressure transducer not connected, it will fry the micro-controller.** So make sure to have the sensors plugged in before connecting the battery, and still plugged in until after the battery is disconnected.

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# 1 Use

If the computer has been configured according to section 2, you can simply follow the steps in this section. Before using, check the battery voltage. The easiest thing to do is leave it charging while it is not in use. Note that if the battery voltage drops below 11.65V, readings can get distorted.

## 1.1 Connecting sensors to the DAQ

**The most important thing to remember about using the DAQ is to connect the pressure transducer and load cell before turning it on.** Thermocouples are optional. If the DAQ is powered on without the sensors connectors, you will have to replace the microcontroller. Section 3.3 explains how to do this. The load cell and pressure transducer have different connectors so they cannot be plugged in backwards. If you would like to take thermal data, you can connect the thermocouples. They are tagged with numbers 1-6 which corresponds to channels 1-6. Each channel is calibrated to that sensor according to the manufacturer, however they vary by fractions of a degree, so matching the thermocouple to the channel is not necessary, but slightly improves accuracy. Once the sensors are connected, you can connect the battery. **Do not connect the battery to a thermocouple port.** The power port is labeled on the side. The DAQ is now running, and you can connect your laptop to the DAQ over USB.

## 1.2 Logging Data

To begin logging data, open up putty and load the session saved for the DAQ. If there is not a saved session, follow the steps in section 2.1. Next, browse to name the data file. Remember to include the ".csv" file extension. Click open to begin recording. Check to make sure the stream looks good. If everything looks okay, you can walk away and let the recording go.

After the fire, close the window and the recording will be saved. I would recommend power cycling the DAQ between sessions.

## 1.3 Interpreting Data

The first column is time in microseconds. The second column is pressure in psi. You may have to offset the pressure curve so that the zero reading is atmospheric pressure. The third column is load in lbs. You may have to tweak the offset on this too. The remaining columns are thermocouple channels 1-6. Readings are reported in degrees Fahrenheit. Note that the cold junction reference in the chips that read the thermocouples are accurate to +/-3C. Post processing of the data is best done in a program other than excel. Matlab scripts are available that will calculate a and n values from csv files.

# 2 Setup

## 2.1 Configure your computer

To setup your laptop to log data from the DAQ, you will need to install the arduino IDE, putty, and the drivers for the teensy "teensyduino". These programs can be found here:

<https://www.arduino.cc/en/main/software>

<https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>

[https://www.pjrc.com/teensy/td\\_download.html](https://www.pjrc.com/teensy/td_download.html)

Once you have the proper programs and drivers installed, connect the sensors as described in section 1.1. Once you have connected your laptop, you will need to find what COM port your computer is talking to the DAQ on. To do so, open up the arduino IDE and check what COM port is being used under /tools/port. If you do not see the teensy, you might not have the teensyduino driver installed, the battery could be low, or the teensy was killed. If it is dead, follow the steps in section 3.3 to fix it. To test things, connect to the teensy and open the serial monitor. You should see a stream of data.

If you see data being transmitted successfully, you can then close the arduino IDE. You will no longer need it to run the DAQ. However the COM port might change if the teensy is ever replaced. Next you will want to open putty. This will be the program you use every time you want to use the DAQ. To configure your settings go to the session tab and input the COM port found earlier, the BAUD rate which should be 500000, the connection type as serial, and session name. Set close window on exit to "Only on clean exit". Your window should look like figure 1.

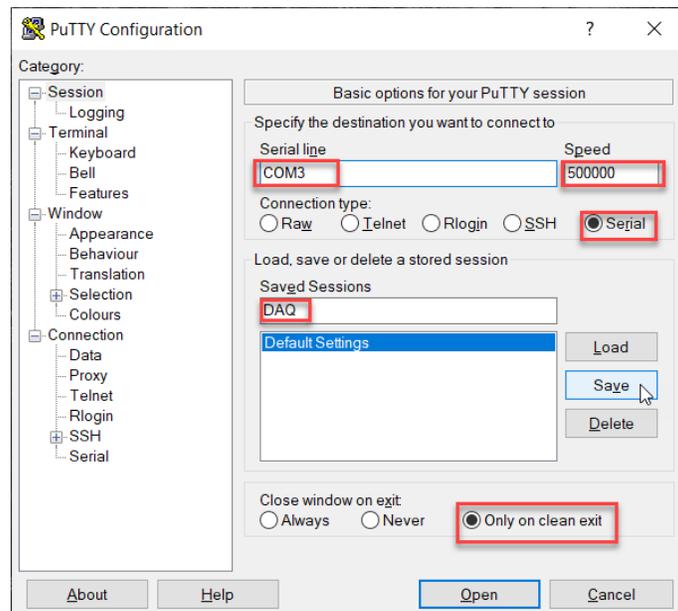


Figure 1: Putty session settings

Next go to the "Logging tab" and set session logging to "Printable output". Your settings should look like figure 2.

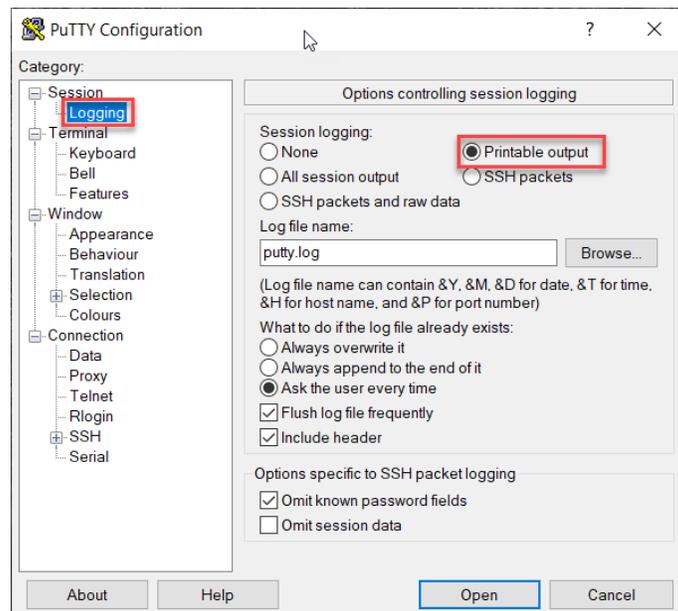


Figure 2: Putty logging settings

Now you can save these settings. click on the session you have created and load it every time you setup the DAQ, as shown in figure 3. This is the step you can skip to next time you use it.

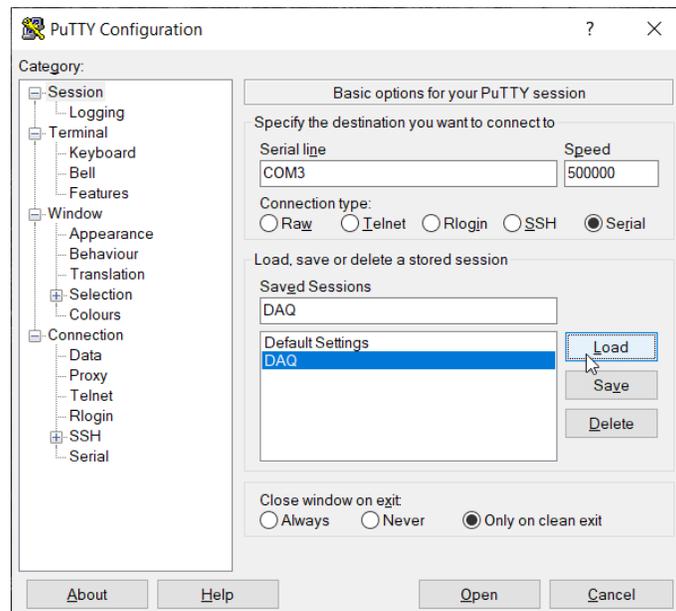


Figure 3: Loading session settings

Finally, you will want to name the file to save data to. With you settings loaded, under logging, browse to the file location you wish to save it to. **Make sure to enter ".csv"** at the end of you file name. This is shown in figure 4.

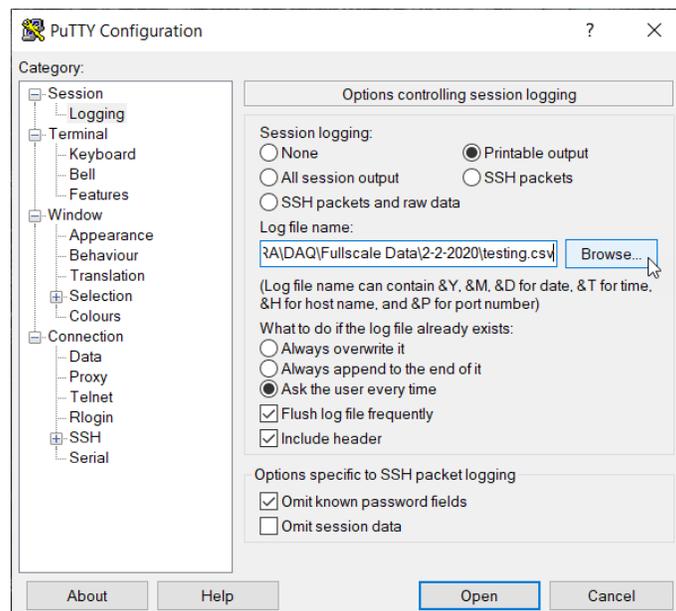


Figure 4: Name csv file for data

You may now hit open. You should see a window pop up with data streaming. Putty is now being recorded. To end the recording, simply close the window. The CSV file should be saved.

### 3 How it works

#### 3.1 Transducers

The pressure transducer and load cell output 2mV of signal per volt of excitation. A REF102 chip supplies a regulated 10.00V of excitation for each sensor. (If the battery voltage drops below 11.65V, the excitation voltage can drop

slightly.) Therefore the maximum signal voltage from each sensor is 20mV. PNP BJTs are used to increase the current available to each sensor. The signal is amplified using a INA122 amplifier for each, with a gain set to 165. The signal is then read using the teensy's 16bit ADC. The circuit is shown in figure 5.

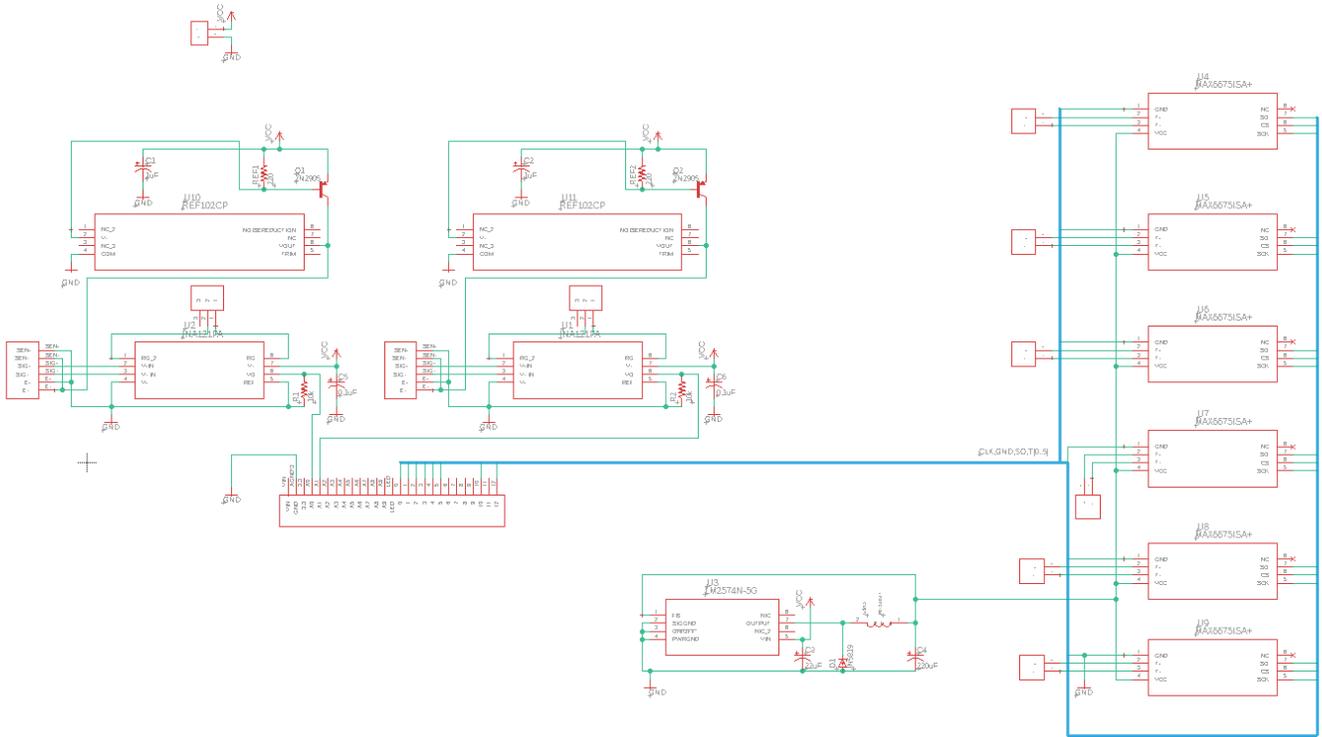


Figure 5: DAQ circuit diagram

The reason that it is important that sensors are plugged in before giving it power, is because if the signal pins are floating, the amplifiers output  $V_{cc}$ , far exceeding the maximum input voltage to the teensy's ADC. If this does happen, you will have to install a new teensy as explained in section 3.3.

### 3.2 Thermocouples

The thermocouples are read using MAX6675 chips as shown in figure 5. The chips require a supply voltage of 5V, supplied by the LM2574 switching mode voltage regulator. The MAX6675 chips send their readings over SPI. Note that the chips cannot simultaneously update their readings from the thermocouple and send data. Asking to send data interrupts the reading process. Therefore the sample rate must be set low to allow time to update. The teensy samples each chip at 10Hz at different times.

### 3.3 Replacing the microcontroller

In the event that the microcontroller needs to be replaced, simply program another teensy 3.2, and install it into the socket shown in figure 6. Be careful when pulling the old one out. I have found that prying with a flathead screwdriver alternating prys on each side works well.

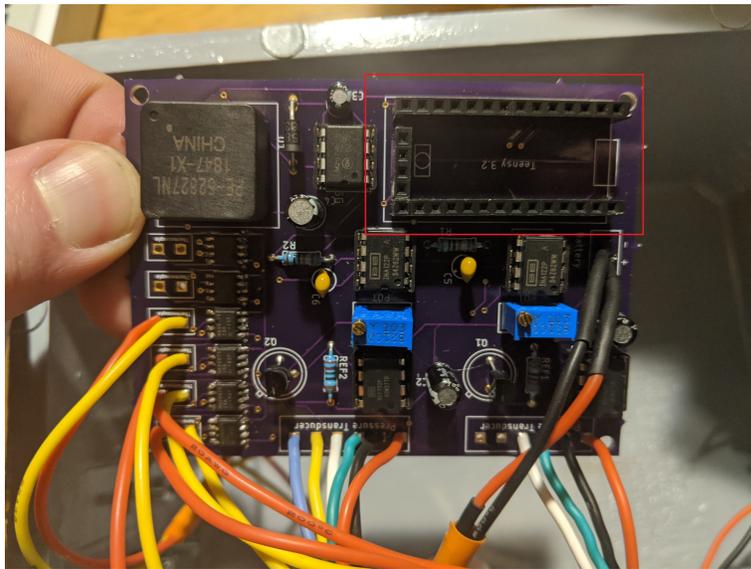


Figure 6: DAQ socket