

Data Logging

Previously we discussed sensors and the value of measurement. Once you start using sensors such as an AFR (air fuel ratio) meter you realize saving that data will be helpful. Meters are fine but during competition there are too many things going. Analysing data later and creating pulling logs for different tracks or weather conditions can be very helpful.

Data loggers are popular with race teams but rarely seen in tractor pulling. Why? Because we are “old school” and perhaps don’t realize data acquisition is the next logical step to improving our results and measuring changes.

What kind should we use?

There are logging devices ranging from the \$59 DI-1100 from DataQ to the \$6500 Racepak Pro IIIA. The hardware setup is straight forward for them all, but software can be complex and user “unfriendly”. My goal was to find a logger that has a solid reputation for around \$500-600 with easy to use software. I needed it to be simple so we can teach customers how to use it.

My first logger was the cheap DI-1100 which required a laptop connection for power and honestly the software is geared towards scientific work. I realized motorsport logging devices were better suited for the environment of the pulling world. After studying over two dozen loggers, my choice was the AQ-1 made by AEM. Their instructions are geared towards seasoned users, but phone support is good and it has features not typically found in sub \$1000 units. Look around and decide which is best for you.

For this article I will reference the AQ-1 to avoid confusion.



When shopping for loggers pay attention to refresh rates, measured in Hz. If a logger claims to record at 5 Hz that means it records data five times per second. Some data should be recorded at a faster rate, so we need higher sampling. The AQ-1 can record up to 1,000 Hz on some channels. My AFR oxygen sensor is measured 50 times per second (50 Hz sample rate) and my Garmin GPS is 1 Hz sample rate, which is fine in a 6 mph class.

The next confusing thing involves how many channels are provided. Each channel is capable of measuring one thing. Analog channels record variable voltage like AFR meters or temperature sensors ... usually between 0-5 volts. Digital channels are used for switched devices such as fan motors, solenoids, or timers. Frequency based channels measure engine rpm or shaft rotation. You might think an 8 channel logging device is overkill until you start plugging in

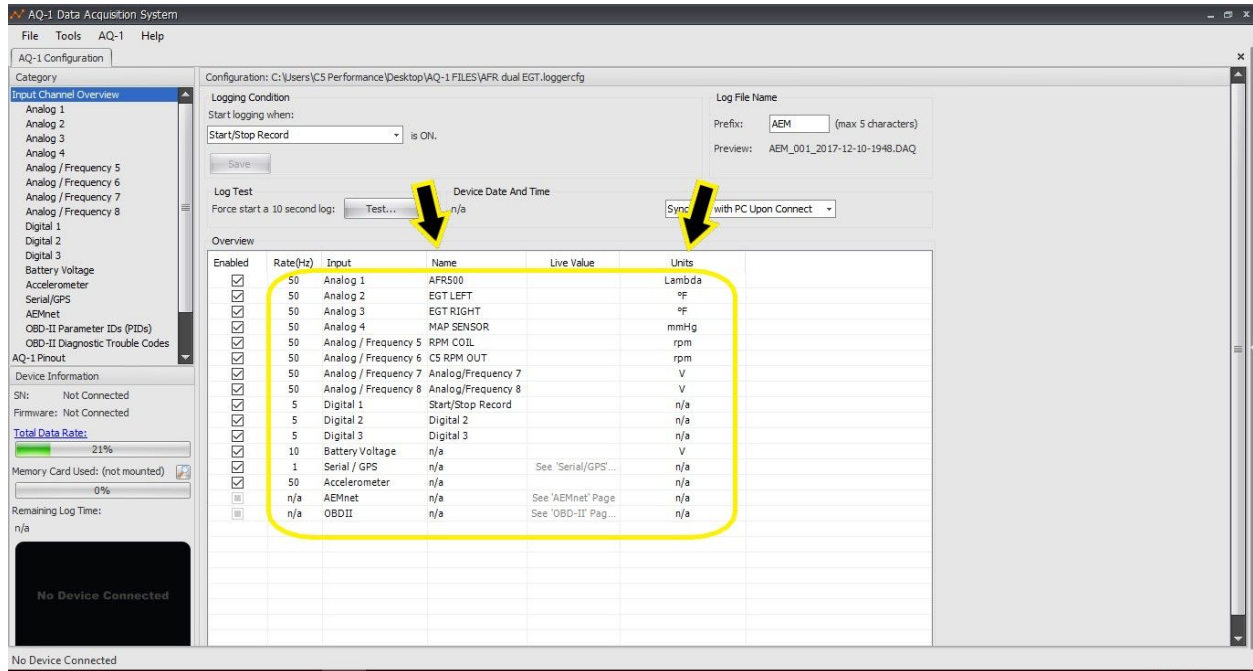
devices. Connect a few temperature sensors, AFR meter, and a throttle position sensor ... oops ... you just ran out of channels. Some data loggers use controllers or CAN bus technology to record several sensors using the same two wires. That opens up more channels for other things but the price starts to go up accordingly.

Let's talk about data storage for a second. My first data logger used a laptop for power and memory storage. That is fine in a dyno room but useless at a tractor pull. Many loggers use onboard memory or removable SD cards. Mine came with a 2GB card and handles up to 32GB. That's plenty of storage for a season of pulling especially since I download all files after each day of testing.

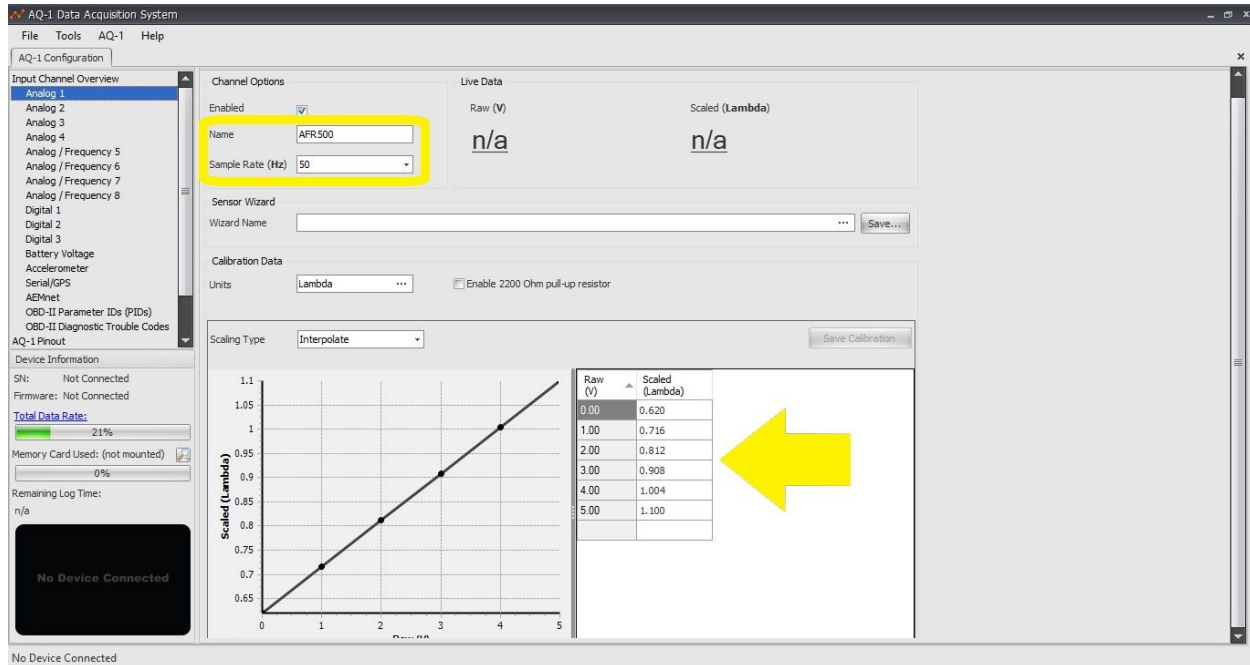
How do you connect devices? I thought you'd never ask!

Most air-fuel meters, tachometers, and sensors have data leads that output voltage. Simply find the wire coming from the data logger harness marked as "Analog 1" and connect it to your first sensor (such as the AFR meter). Do that for each sensor and write down which lead it's connected to. Type K thermocouples (exhaust temp or EGT probes) need an amplifier to convert low voltage readings to 0-5V linear analog output. We offer Type K thermocouple amplifiers designed to work with 1, 2, or 4 exhaust temp probes. The sensors connect to the amp, then the amp connects to the logging device. It's really not that difficult after the first time you do it.

The sensors are connected, now what? Download the software (you read the instructions, right?) and open it up. For the AQ-1 logger we start by building what is called a Configuration, which allows you to name the inputs that you are using and choose the units of measurement. Luckily all AQ-1 wires are numbered to help you get it right the first time. Grab that list you made earlier and start to label your sensors.



After you name your inputs the voltage must be calibrated so it accurately records the data. This MUST be done before you start recording. What exactly does that mean? Our AFR500 meter just spews out voltage readings with no real meaning for the logger. By creating a simple chart, the AEM data logging software knows that a certain voltage equates to a certain air-fuel ratio. The formula was provided in the AFR500 meter instructions.



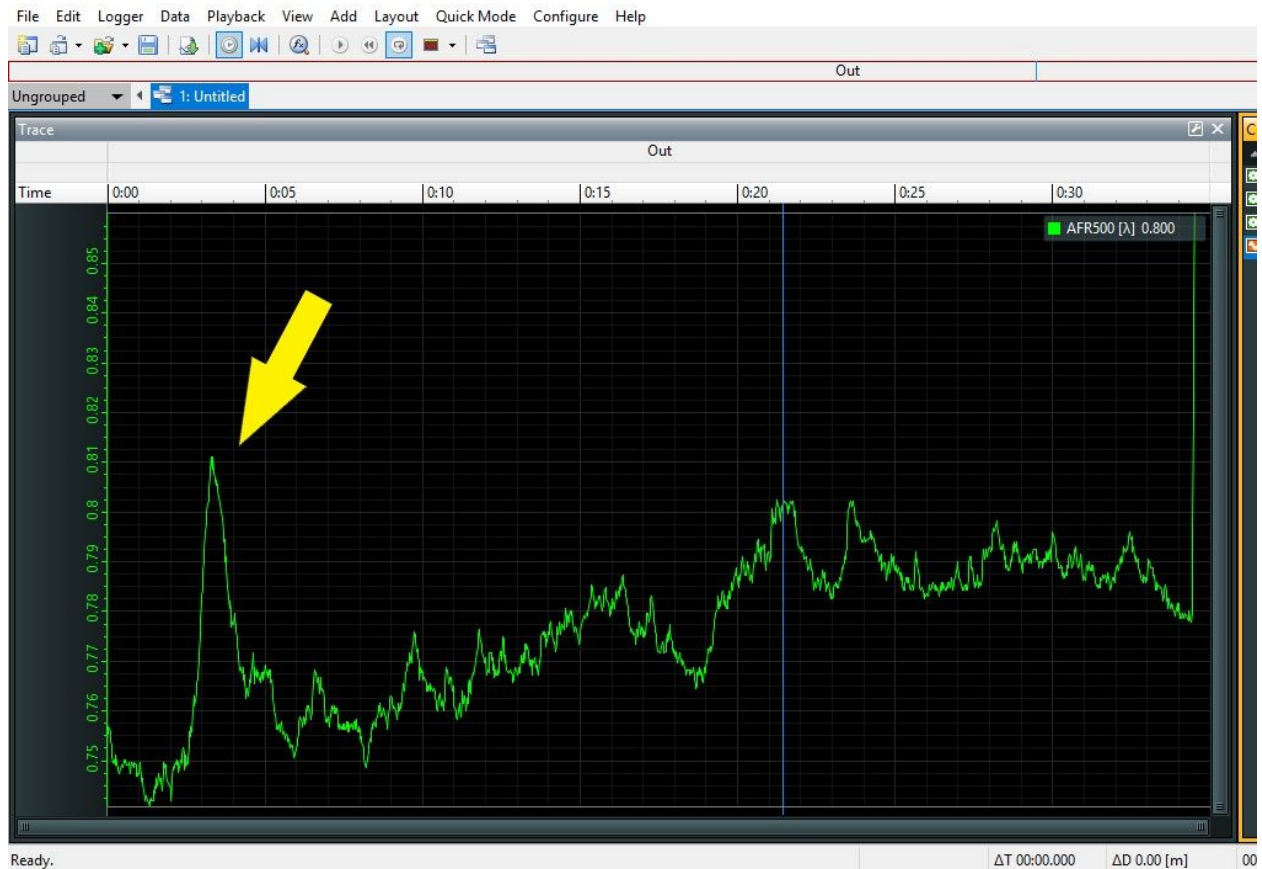
Once you have all sensors calibrated you can start having fun. If you purchase your data logger from C5 Performance we'll do this for you. Some sensors can use the AEM Wizard function to auto calibrate which is a bit easier.

How do I record my pull? We use a waterproof camera case to protect the recorder, mount a removable power cord to it, and install an LED on-off toggle switch to the case. When we connect the leads to the tractor, it powers up the GPS and data logger. It can easily be moved from one vehicle to another. Think about this for a moment. Why not share the cost of a logger with a friend or two by making it small and portable?

Although there are several methods to “trigger” a logging event to start, we are using one of the inputs as a signal, grounded to the lighted LED switch. You can also start recording events based on sensor input such as rpm, axle rotation, throttle position, or vehicle speed.

I recorded all my pulls, now what? The AQ-1 is designed to automatically download your “logs” when you plug the USB cord into a computer. You can also remove the SD card if you prefer. Open up the software, pick the event you want to view, and start learning. I prefer to keep the screen simple, and AEM allows me to select which sensor I want to view. So choosing only my AFR data (see the photo below and notice my tractor is lean just off idle) is as easy as dragging the AFR500 name onto the viewing screen. Later you can add rpm, exhaust temp, or

anything else you previously recorded. By clicking on the “run” button it will show a progress bar that scrolls across the screen similar to a video editor.



Can I edit the run or change settings? Absolutely! You can save sections, combine runs, and heck you can even calculate tire slippage as a percentage. You knew that, right? Don't be scared ... in a few weeks you'll be data logging your garden tractor and everything else in your garage. It's addicting!

What I find exciting is we get to help elevate the antique pulling sport. We offer the C5 optical beam ignition, PRO distributors, digital AFR meters, and now data acquisition. Our goal is to help our friends and customers measure performance just like race teams have been doing for decades. We even have a web page dedicated to air fuel meters and tuning. Once you start paying attention to the details you will become more consistent and hopefully have more fun.