Motorcycle Display and Logger

I recently added a graphic LCD screen to my Goldwing. The new screen displays battery voltage, battery current (either charging or discharging), outside temperature, and altitude derived from a pressure sensor. It is also interfaced to an OEM GPS board and displays exact time and date, latitude, longitude, current speed, a resettable odometer, current direction, and altitude derived from the GPS.

Like most projects, it started out small and simple and grew from there. I wanted a simple display of battery voltage and temperature probably on an LED or text based LCD display. Then I talked to my son and he said I should add battery current as well to provide the best idea of the condition of the battery and the charging system and, while I was at it, why not add altitude since we spend a lot of time riding in mountains. OK that doesn't sound too bad. If you're interested in all of the technical details, skip ahead to here, otherwise follow along for the outcome.

My first attempt was a 5 digit LED display that I mounted in the blank panel where a CB would be mounted since I don't have one on this bike. The voltage worked great, the temperature worked great, the current sensor that I wanted to use was not available yet so I didn't have current sensing yet, and the altitude worked relatively well but could be off by +/- 200 feet or so since it was based on an absolute pressure sensor and could change with atmospheric pressure. As I said, it worked great on the bench, it worked great in the garage, but when I went out for a ride on a sunny day, which we occasionally have around here, I couldn't read the LED at all. If it clouded over or the sun was in front of me I could read it fine, but I knew that this wouldn't make it.

I started looking around for a different display and eventually ended up with a graphic LCD from Crystalfontz. It has a display area of about 1" X 2-1/8", LED

backlighting, and has dark characters on a light background so it is similar to the existing Goldwing display. Now I needed a way to mount the display and found the answer at Firecreek Accessories with a product called a Wing Panel. They sell it for mounting round gauges but it worked perfectly for my application. I also have a tank bag from them and have been very pleased with it. About the same time I found the display, I also found a great deal on a CMC Superstar OEM GPS board on Ebay, so I decided to interface the GPS board as well.

So here's the current display and the current screens. There are three screens and two control buttons, the button on the left selects one of the three screens. The button on the right is for resetting the odometer.

In the first two pictures above, the zero in the upper right hand corner is the number of satellites used for the current readings. The number in the picture is zero since I was in the garage at the time. I normally get 6 to 9 satellites when riding. In the second picture, there would be a direction arrow indicating the current direction once you were moving. Overall I have been quite pleased. The measurements seem to be very accurate and I can see the display in any light conditions, even bright sunlight.

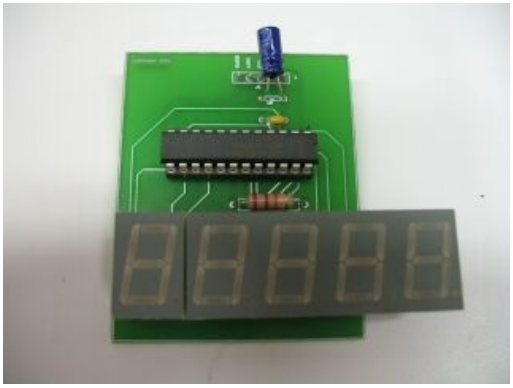
Technical Details

Version 1.0

For my first attempt, I decided I would use a controller with analog inputs and an LED display. I chose an Atmel AVR ATmega8 controller since I was familiar with them and had a programmer and the programming tools. I would use a simple resistor divider for voltage measurement, an Amploc AMP50 for current measurement, an LM34CZ for temperature measurement, and an MPX4115A for pressure sensing for altitude measurement. I also chose to use an OPA2340 op amp to buffer the voltage and current signals to keep any spikes out of the ADC. For the display I used 5 seven segment LEDs from Digikey and drove them with a MAX7219 LED display driver. I also used an RBO40-40T to protect my circuits from the nasty spikes often found in vehicle electrical systems.

The voltage, current, and temperature measurements were all linear and easy to convert to real world numbers. The relationship between pressure and altitude

is not linear so I used a 450 point lookup table in the program and interpolated in-between points. This method worked well and the results were never more than 10' different from the result derived from the appropriate formula. Unfortunately, since the pressure is affected by the constantly changing atmospheric pressure, the overall results could be off several hundred feet. Here are the two boards. The board on the left has the mega8 and all of the sensors and sensor conditioning and the board on the right has the LED driver chip along with the LEDs.



Version 1.1

This next version is the one that I had installed in the bike for 3 years and about 30,000 miles and worked great the whole time. Since the sensor board worked great - with the exception of the errors in elevation caused by the changing atmospheric pressure - and since I didn't want to start all over again, I decided to retain the sensor board and design a new board. This new board would interface with the existing sensor board, the new LCD display that I had chosen, and the GPS board that I would be using.

The new board mounts directly to the display and contains an ATmega 8535 to control the display as well as communicate with both the sensor board and the GPS board. It also contains power supply and conditioning as well as headers to connect to the sensor board, the GPS board, and the two pushbuttons for controlling the display. Here are pictures of the display board. The left side is the component side of the board and the right side is the display side.

Version 2.0

Well my Ebay OEM GPS board failed this winter while we were in Yuma and I needed to do something different. I looked around a little to see if I could find another GPS board like the one I have been using. I couldn't find one and decided that I needed to go with a GPS unit that was more readily available either for myself or anyone else that wanted to copy what I was doing. After some research, I decided on a Garmin GPS 18 LVC which is an OEM GPS unit that is basically a small, sealed puck that is powered by 5 volts and communicates using a 5 volt, RS232 serial protocol to transmit either standard ASCII NMEA messages or proprietary Garmin messages.

At the same time, I decided I should use this opportunity to address a few other issues. When we are on a trip, I have been using a Forerunner GPS to record our route each day. While this worked, it was a lot of extra effort to download multiple files each evening, combine them, and convert them to the appropriate form. It also required extra cables, download adapters, and special programs. I also had no way to track temperatures during the day other than to watch the display and remember highs and lows. Since I now had a GPS that provided route information, as well as a temperature measurement - all I needed to do was add logging capability to something like a standard SD card. So that's what I did. I retained the sensor board, redesigned the display board so that it talked to the standard GPS, as well as provided a serial output port for logging, and designed a simple logger that accepted commands from the display board and logged information to an SD card. This way, I could log GPS trackpoints and temperatures all day long and then remove the SD card at the end of the day and upload the information to my laptop.

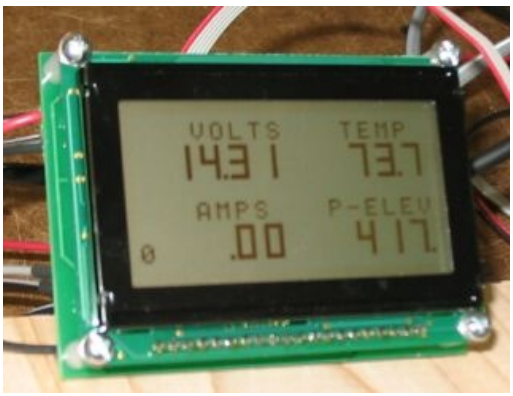
So what changes did I make to the display board:

- **The mega8535 was just about filled up so I needed to add a new processor. Even though a mega16 would have been more than sufficient from a memory standpoint, I chose a mega324p since it had 2 UARTs. I could use one to communicate with the GPS and the other to communicate with the data logger. I could have gotten by with a mega164p but the 324p was only about a buck more and gave me twice the memory to implement future features.**
- **Although the serial output from the GPS was 5 volts which would be compatible with the mega324p UART, it was designed to interface with a PC so it was inverted relative to the UART on the mega324p. This meant the addition of an inverter and I chose an SN74LVC2GU04DBVR. This is a 2 channel inverter (one channel for send and one for receive) in an SOT23 package.**
- **I decided that I would use standard RS232 to communicate with the data logger so that both the display board and the logger would be more or less standard and provide more options for future expansion or changes. This required adding an RS232 transceiver and I chose a Dallas/Maxim DS275. These are great little 8 pin chips and very easy to use - I have used them**

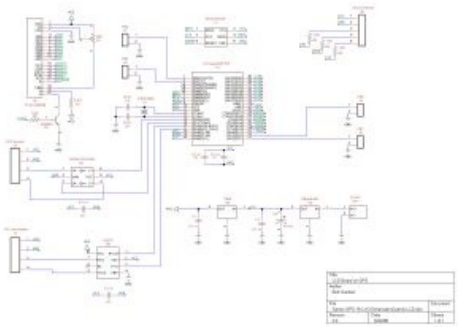
frequently in past projects.

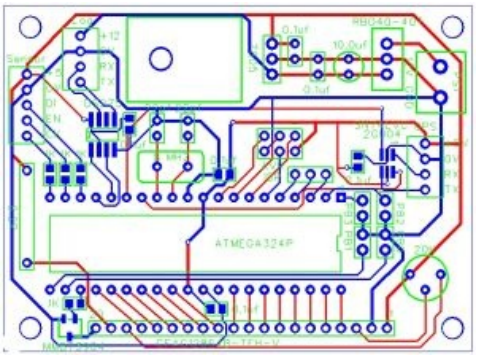
- **I wasn't entirely happy with the headers in my last board so I added new headers with locking ramps to make sure they stayed in place.**
- **I wanted to be able to turn off the display backlight to conserve power so I added a transistor to control the backlight. I could also use this in the future to vary the backlight brightness if I choose to do this.**
- **Finally I used more SMD components. They take up significantly less board space and are pretty easy to use as long as you don't go ridiculously small. I'm finding I like using these more and more.**

Here are pictures of the new display board:



And here are the schematic and PCB for the display board:





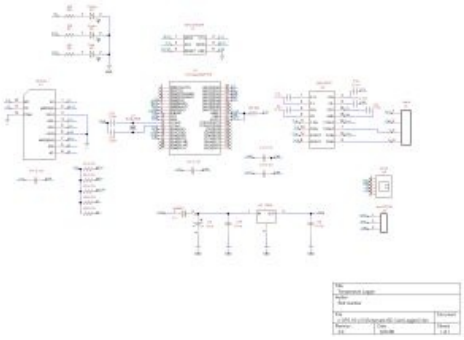
The logger ended up being fairly simple. It included another mega324p, power supply, SD card socket, an RS232 transceiver, and LEDs for status. I used the mega324P since I was already using the same processor on the display board and I would again use both UARTs. The first UART would interface with the display board and the second would output diagnostic messages for debugging and troubleshooting. I used an SD card since Bascom, that I would be using to program the logger, has a built in library - AVR-DOS - to simplify interfacing with all types of storage devices. Since SD cards operate on 3.3 volts, I added a 3.3 volt power supply and associated passives. I used a Sipex 3232E transceiver since it would operate at 3.3 volts and provided an interface for both UARTs. Finally I added 3 LEDs for status - one indicates that a card is inserted, it is not

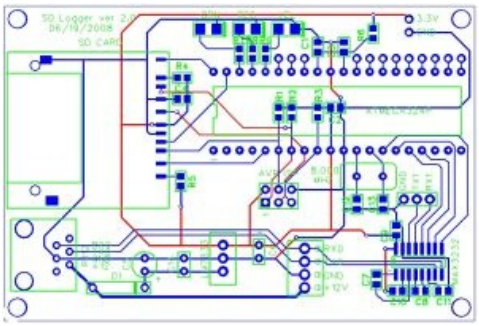
write-protected, and it has initialized correctly, one indicates that the card is ready, and the third indicates a write in progress.

I found a nice case at Spark Fun Electronics. It's clear so that it would be easy to see the LEDs, and has a clever mounting feature for the PCB built into the case. I cut 2 openings in the case - a slot for the SD card and an opening for the RJ11 jack that I use to connect the logger to the display board. This makes it very easy to disconnect the logger or remove the SD card.

Here are pictures of the logger board and all 3 boards:

And here are the schematic and PCB for the logger board:





The GPS is configured to output standard NMEA messages. I am currently only using the GGA and RMC messages since these provide everything I need. These messages are logged to the SD card every 4 seconds along with the temperature. This file can be read directly by RoboGeo. I use RoboGeo to create Google maps and geocode pictures and place markers on the map. Here's a sample of a log file and here's a page with a Google map and pictures. I also have a simple VB program that can extract each of the messages in the file to its own file. This way I can import these files into Excel and graph any of the information being logged. I can't wait to use it on my next trip.

Thanks for visiting and feel free to email me with questions or suggestions. I can also provide TinyCAD schematic, FreePCB pcb, and Bascom files if anyone is interested. After several requests, I have posted the Bascom source files for all three processors, you can download them from the link below.

DOWNLOAD FILES