Expanding the Arduino

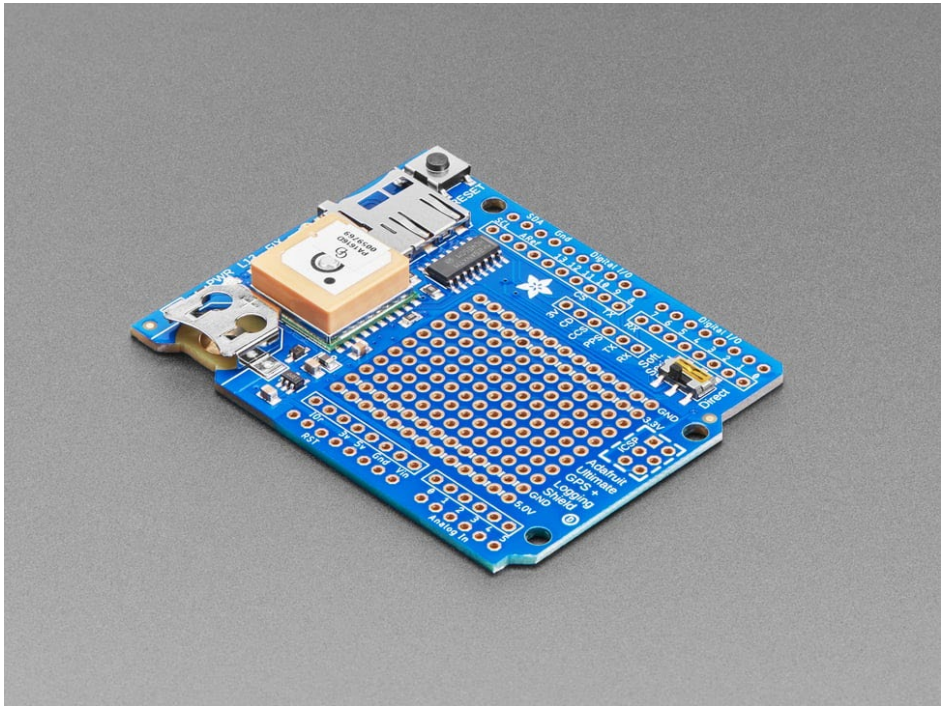
Adafruit GPS Logger Shield

Expanding the Arduino Mega

- You can enhance your project by adding additional boards to the microcontroller stack
  - The Arduino header layout has a standard pin footprint
  - These boards are called “Shields”
  - Commercial shields are available to perform specific tasks – Like combination SD card and GPS Shield we will use
  - They can be used for prototyping before adding a more permanent component to your PCB
  - Custom shields can be designed, like the MegaSat Shield we provide teams, to include a base set of sensors

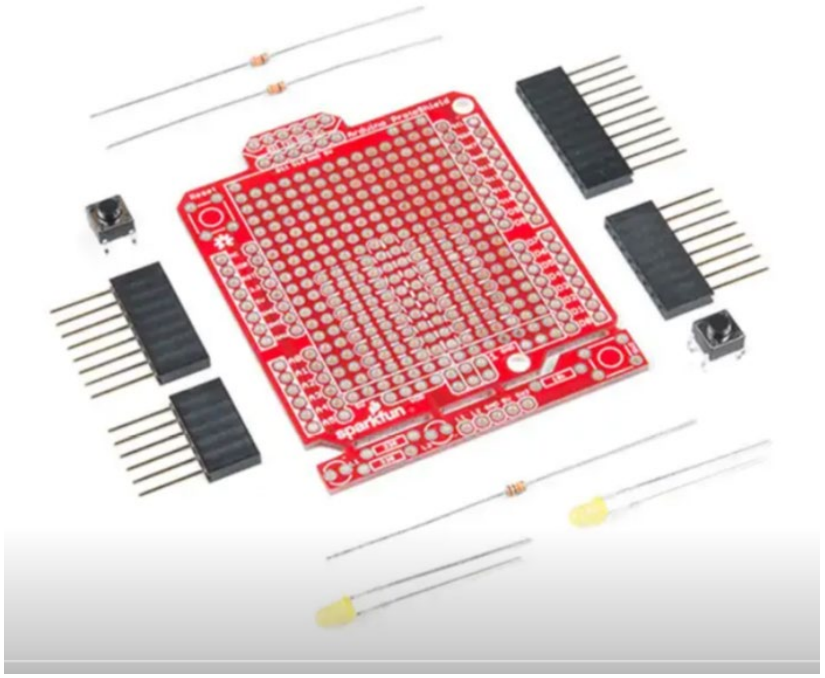
Adafruit Ultimate GPS Logger Shield

- This shield has a GPS receiver and an SD card for storing data
- Footprint designed for Arduino Uno, but can be used with other boards (like our Mega)
- Because it is half-length, usually will mount it to the top of the stack



Proto-Shields

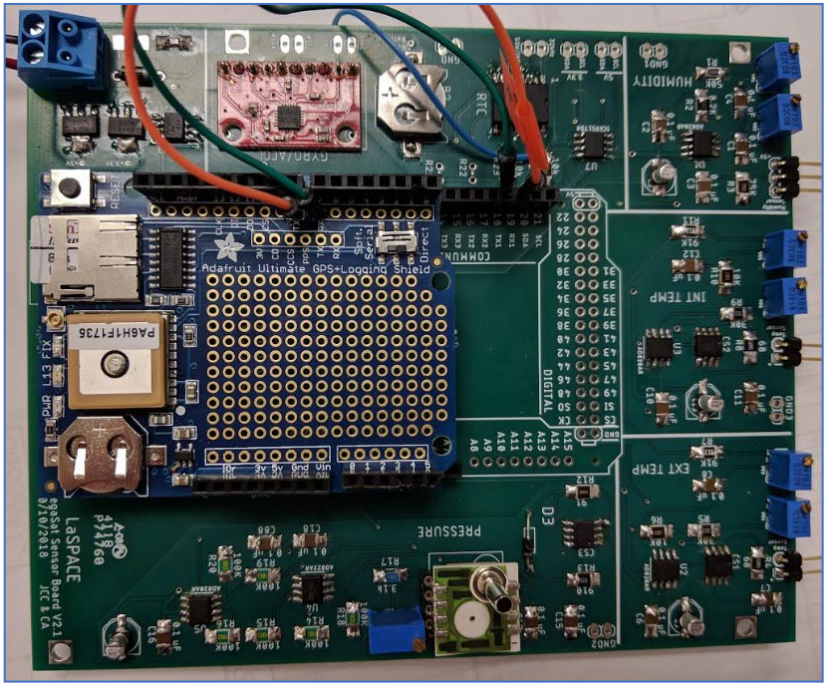
- Contain pads for soldering a semi-permanent version of a circuit you want to add to the microcontroller stack
  - Take care when selecting, often the pads will not have any internal connections requiring jumper wires for all connections
- Will have the standard header layout to connect to Arduino
- Allows a flight-ready soldered circuit without having to do a full PCB design



An Arduino Protoshield (not assembled)

LaACES MegaSat

- The MegaSat was designed by the LSU physics department as a custom shield for teams to have a baseline payload
- Contains a base set of environmental sensors common to many payloads
- Also provide breakout interfaces for adding additional detectors



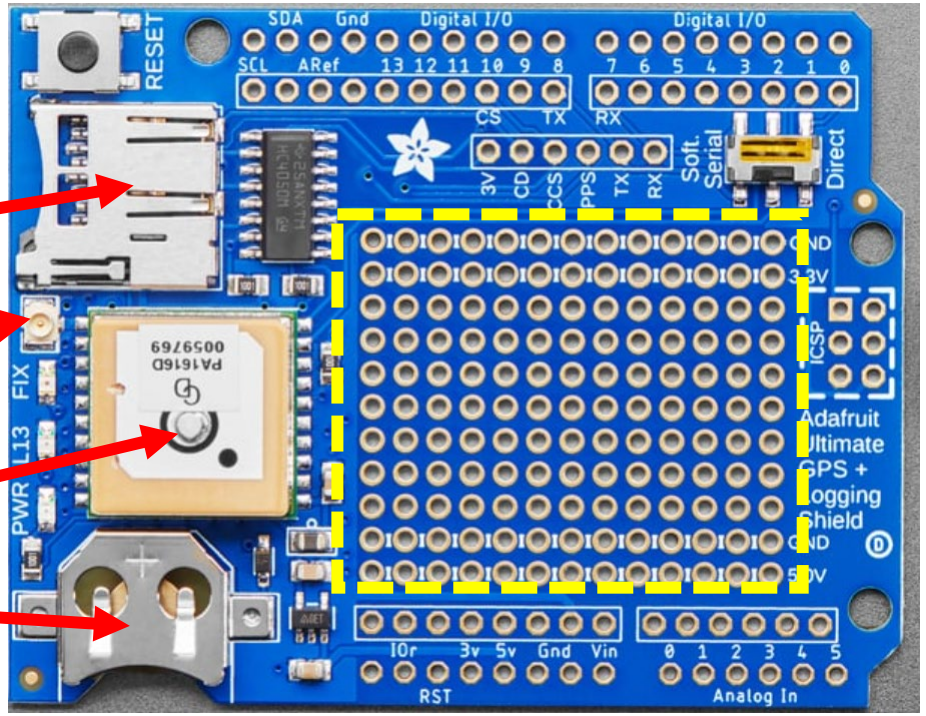
An assembled MegaSat prototype board assembled in the stack with the GPS shield and Arduino (on bottom), note this is an older version of the board,

Selecting Shields

- Shields that perform specific functions are available from retailers such as Adafruit, Sparkfun, and Amazon
  - Often, these manufacturers will have written Arduino libraries for these
- When using multiple shields, you must keep track of which pins are being used by which shields to avoid conflicts
- Make sure you select a shield that is compatible with your microcontroller
  - There are differences between the Arduino Mega and other Arduino microcontrollers, such as the UNO, so some shields are not automatically interchangeable

Adafruit Ultimate GPS Logger: Major Components

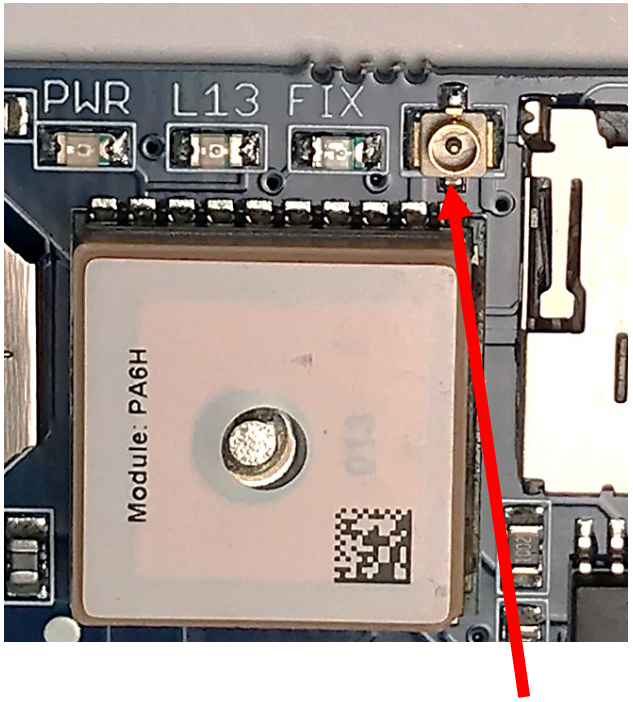
- This is the Arduino Ultimate GPS Logger Shield. It comes with
  - microSD socket
  - Connector for external antenna
  - Antenna and GPS unit
  - Coin cell holder
  - Prototyping area with solder pads (Yellow line)



The Adafruit Ultimate GPS Logger Shield. From top to bottom, the red arrows show the microSD socket, the external antenna connector, the GPS unit, and the coin cell battery holder. The yellow dashed line shows the prototyping area

GPS Receiver and Antenna

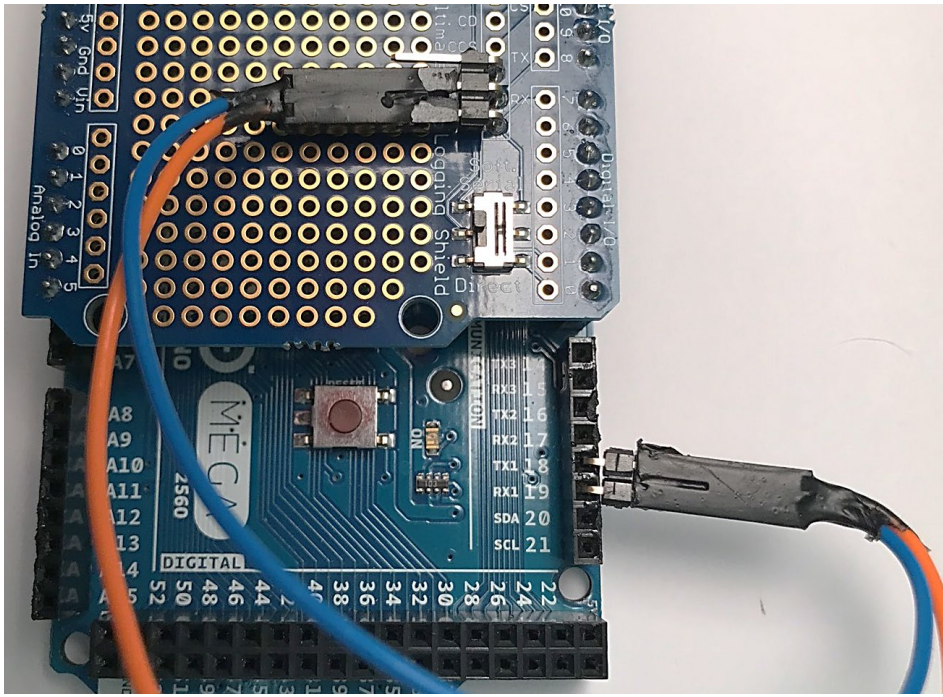
- The GPS shield has a built-in ceramic antenna. For the LaACES payloads, this antenna should be adequate
  - This will receive GPS signal through light obstruction like foam, but should be flown on top, facing up
- Payload shielding or sensitivity requirements may require an external antenna
  - This connector is called a uFL connector
- Actual GPS receiver chip is underneath the antenna and is GlobalTop PA6H



The red arrow is pointing to the Adafruit Ultimate GPS Logger Shield's external antenna connector. It is located between the microSD socket and the FIX LED.

Soft-Serial/Direct Switch

- You communicate with the GPS using the UART/Serial protocol with text strings
- Remember, UART is a one-to-one protocol, so you cannot have the Arduino, GPS, and a Laptop all connected to 1 Serial Port
  - If the Arduino is using the Serial Monitor, it will not be able to use the GPS default connection
- The switch changes which Arduino pins the GPS is connected to
  - In “Direct”, it connects to pins 0 and 1, aka Serial (the same as the USB)
  - In “Soft-Serial”, it connects to pins 7 and 8



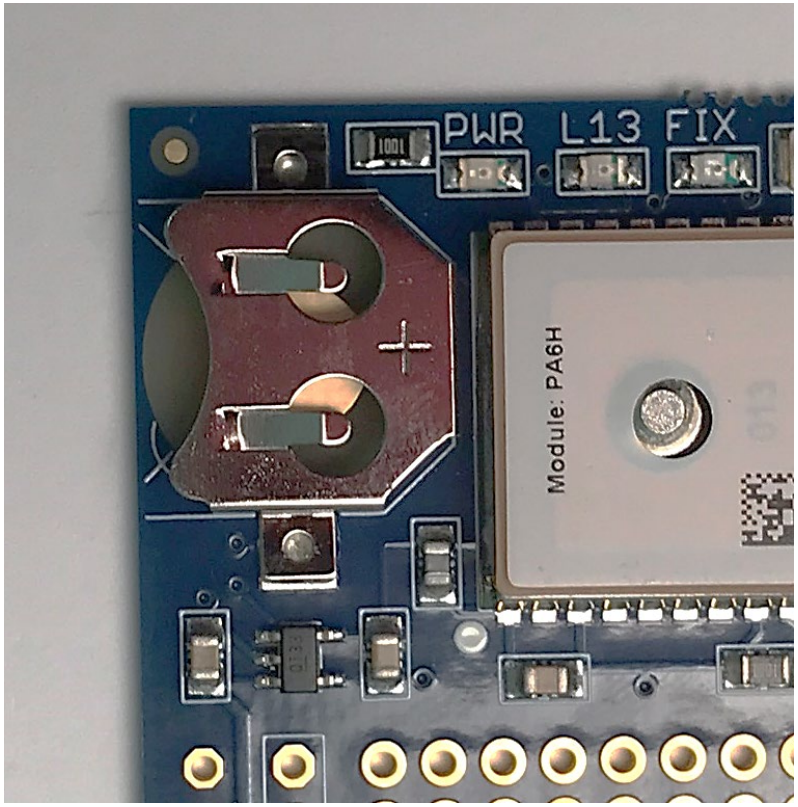
The communication switch on the Adafruit Ultimate GPS Logger Shield. The jumpers connect the RX and TX breakout pins to Arduino pins 18 and 19 allowing use of Serial1 to talk to the GPS

Direct Connect/Software Serial Switch

- Direct Connect connects the Shield to the Arduino's Serial 0 channel(TX0, RX0)
  - In general, we want to use TX0, RX0 for computer to Arduino communications
  - Direct connect does allow us to communicate directly with the GPS on the Serial Monitor, bypassing the Arduino
- Software Serial connects the GPS to pins 7 and 8 of the Arduino and TX and RX on the breakout
  - We will install jumpers that allow us to connect this output to Serial1, Serial2, or Serial3
  - This arrangement is based on the Arduino UNO, which only has one Hardware serial port on pins 0 and 1

Coin Cell Battery Holder

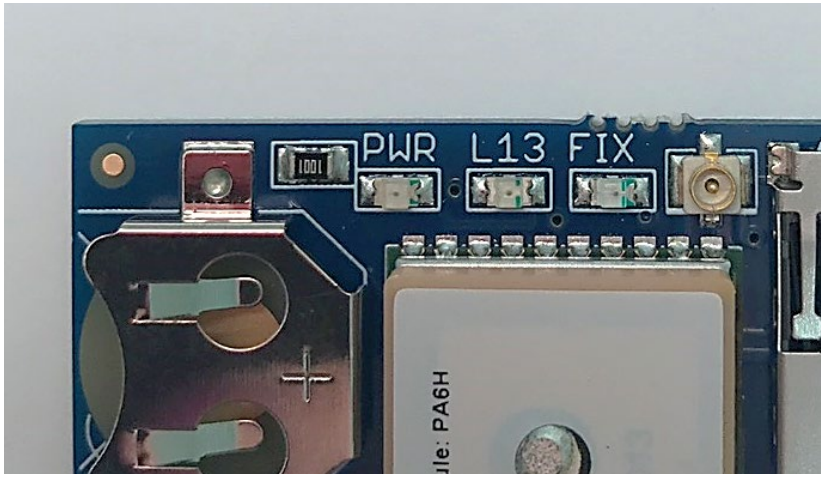
- The GPS has a number of settings that can be changed by sending it commands
- If the GPS loses power, it will return to the default settings
- By installing a battery in the coin-cell slot, the GPS will keep its settings on restart
- This will also allow the GPS's internal clock to be accurate even with no satellite fix, assuming it had a fix in the past
  - It will automatically set its time when it gets a satellite fix



The Adafruit Ultimate GPS Logger Shield's coin cell battery holder. Notice the + sign on the top indicating the battery should be installed positive side up.

LEDs on GPS Shield

- There are 3 different LEDs on the GPS shield
  - Green (PWR)
    - Power LED. If it's not on, the shield doesn't have power
  - Yellow (L13, same as built-in Arduino LED)
  - Red (GPS Fix Status)
    - Blinking every second, GPS does not have a fix
    - Blinking once every 15 seconds, GPS has a fix



3 indicator LEDS are located

Prototyping and Breakout Areas

- There is a small prototyping area on the GPS shield
- Next to the Prototyping area are six breakouts
  - 3V: 3.3 volts but comes from a 5V to 3.3V regulator on the GPS shield not the Arduino 3.3V
  - CD: Detects if an SD card is physically installed
  - CCS: Card chip select line. It is connected to digital 10
  - PPS: This is a pulse per second output when the GPS has a fix
  - TX: GPS "Soft-Serial" transmit line
  - RX: GPS "Soft Serial" receive line

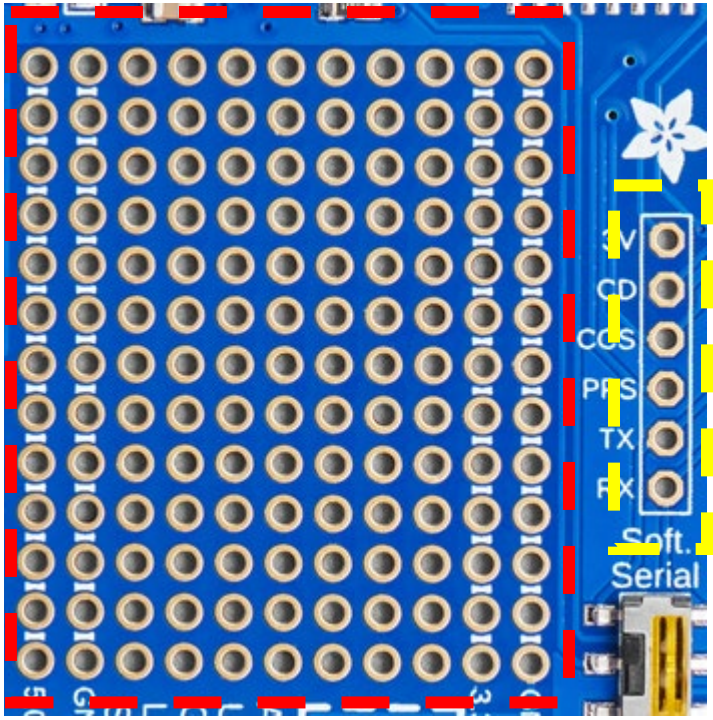
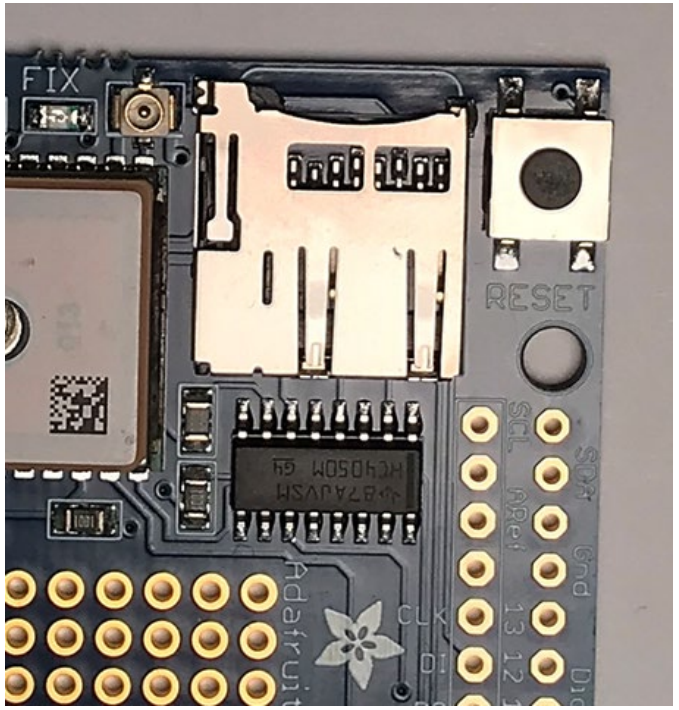


Figure 6: Shown is the prototyping and breakout areas on the Adafruit Ultimate GPS Logger Shield. The red dashed box is surrounding the prototyping area. The yellow dashed box surrounds the breakout area. The RX and TX breakout pins are used for Software Serial communication

SD Card

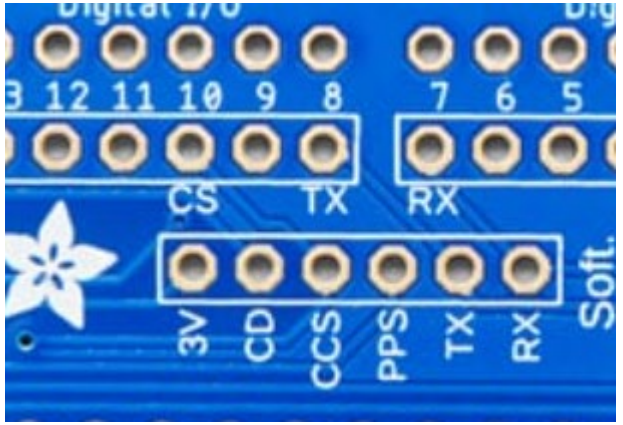
- The GPS shield has a microSD card slot
- Allows the storage of flight data payloads
- Communication between the Mega and the SD card uses the SPI protocol
- SD card slides in and locks, press it in again to release
- Data is saved in regular files on the SD card, allowing reading of flight data by

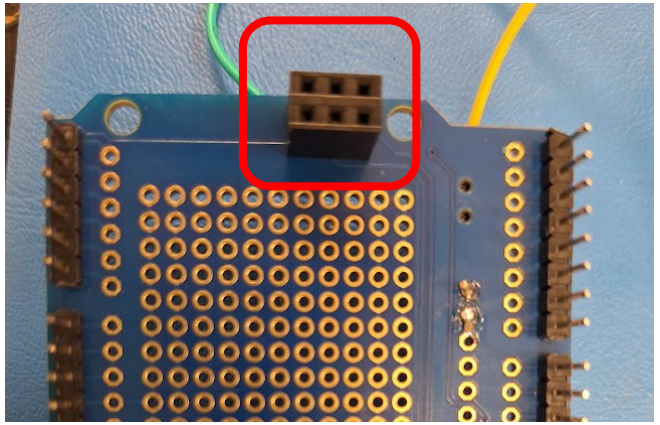


The Adafruit Ultimate GPS Logger Shield's microSD socket. The SD card will latch once fully inserted with a click. To eject, simply push the card in again

SD Card Communications

- SPI communication requires 4 lines: MISO, MOSI, Clock, and Chip Select
- On the Mega2560, MISO, MOSI, and SCK are digital pins 50, 51, and 52
  - This connection is made via the 6-pin header in the middle of the Arduino
  - The header should be soldered with the sockets down to mate with the pins on the Arduino
- CS is freely selectable in software, but the SD card is connected to pin 10, so that should be chosen in software



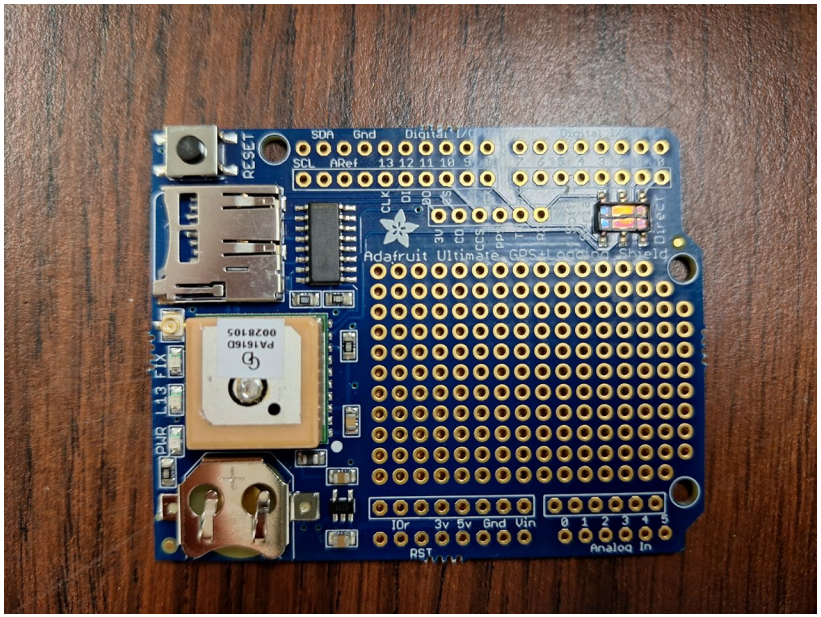


Identifying Old Revision (No longer used)

Old Revision

Lacks 6-Pin Header below GPS

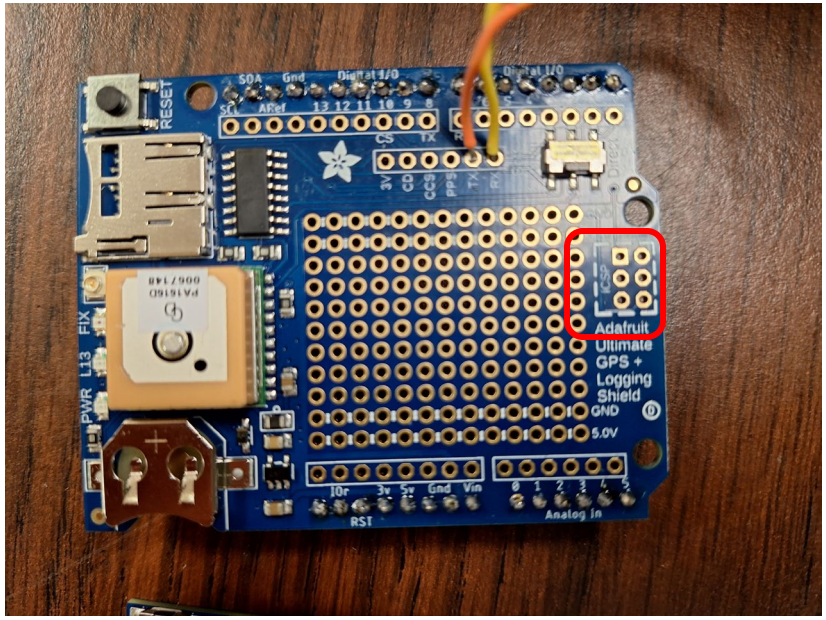
Do not use



New Revision

Modified Prototyping Area with 6 Pin ICSP header

This is the current version



SPI Jumpers

- New board revision also has jumpers on the back side to connect SPI to pins 11, 12, and 13
  - This is how the old board worked
- The chevron-shaped pads circled in red to the right
- To connect, you would simply bridge across the pads
  - This would be done to use with an UNO or if you had a shield that blocked the 6-pin header
  - Should not be needed for standard LaACES config