

Avionics Setup Guide – CS Capstone Team 12, CS 463

The following document details necessary hardware and software for setup and demonstration operation of the 2019 OSU USLI avionics and telemetry system.

As all the software being run for this part of the project is run on embedded systems and/or microcontrollers, there is no installation script. Necessary third-party libraries have been included in the Git repository and links to necessary software downloads are provided in this document.

Necessary Hardware

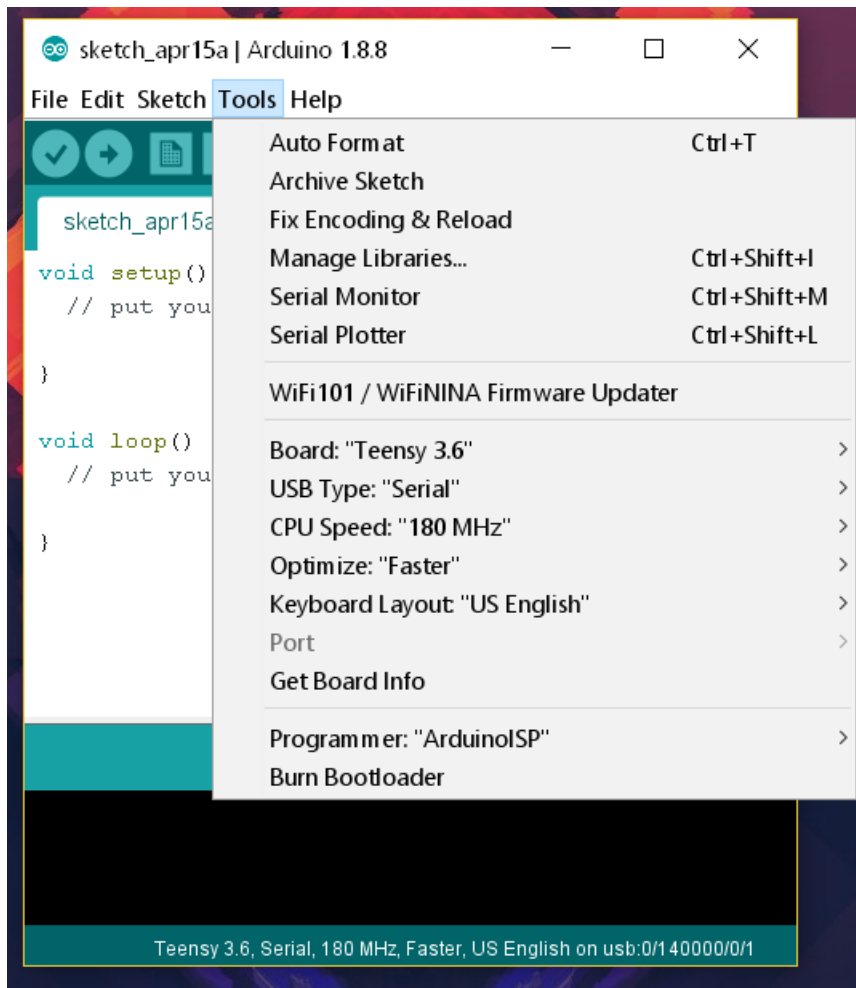
- PC running Windows 7 or Windows 10
- 2019 USLI Avionics Ground Station – all components listed below are included in physical unit and available for hardware demonstration upon request
 - Teensy 3.6 Microcontroller
 - XBee Pro S3 Transceiver configured for 900 MHz operation
 - Charged 7.4 V LiPo Battery
 - Connecting hardware (ex. voltage regulator for Teensy)
 - 900 MHz directional antenna (‘Yagi’)
- 2x 2019 USLI Avionics Telemetry Units (ATU)
 - Teensy 3.6 Microcontroller
 - XBee Pro S3 Transceiver configured for 900 MHz operation + antenna attachment
 - Charged 7.4 V LiPo Battery
 - 2019 USLI custom avionics PCB
- MicroUSB to USB-A cable
- 2x MicroSD card
- MicroSD card reader
- 2x Arduino Uno (for 433 MHz prototype demo)
- 2x SoLu 433 MHz CC 1101 breakout boards (for 433 MHz prototype demo)
- Sets of male to female jumper wires (for 433 MHz prototype demo)
- 2x USB-B cables (for 433 MHz prototype demo)

Necessary Software

- Latest revision of [Arduino IDE](#) (1.8.9 as of writing this document)
- Latest revision of [Teensyduino](#) (1.45 as of writing this document)

Avionics Setup and Operation

1. Clone <https://github.com/OSU-USLI-19/Avionics-2019> to a convenient location.
2. Open the Arduino IDE and under the *Tools* menu, configure with the following settings:



3. Navigate to `\Avionics-2019\ATU\FlightATU_TX` and open *FlightATU_TX.ino*.
4. Use the ‘verify’ button (checkmark in the top left) to build the program.
5. Slot MicroSD card into avionics telemetry unit (ATU), connect 7.4 V LiPo battery via Dean’s connectors, and plug connect to PC via MicroUSB to USB-A cable – an orange light on the ATU should turn on once the battery is connected.

Note: The 5 V rails on the Teensy 3.6 microcontrollers have been modified such that the Teensies cannot be flashed, programmed, or monitored without the batteries plugged into them. This is to prevent electrical back feed over the USB port.

6. Select the correct port in the Arduino IDE and press the ‘upload’ button (arrow in the top left) to push the code to the ATU Teensy.
7. Unplug the flight ATU from the computer, then repeat the same process exactly (from step 2) with the second ATU.
8. Open the avionics ground station and connect the Yagi antenna to the XBee transceiver
9. Plug the 7.4 V LiPo battery into the breadboard via the Dean’s connectors, an orange light on the Teensy should come on to indicate the device is powered.
10. Navigate to `|Avionics-2019|ATU|GroundATU_RX` and open *GroundATU_RX.ino*, ensuring that the Arduino IDE settings remain the same.
11. Use the ‘verify’ button (checkmark in the top left) to build the program.
12. Connect the ground station to the computer via the MicroUSB to USB-A cable.
13. Select the correct port in the Arduino IDE and press the ‘upload’ button (arrow in the top left) to push the code to the ATU Teensy.
14. Open the Arduino serial monitor using the magnifying glass button in the top right corner; if transmission lock has been obtained and timestamps are enabled, the serial monitor will look similar to this image but with significantly more commas:

```
10:00:38.651 -> $GNRMC,170036.00,A,3453.74421,N,08636.94753,W,7.49i,summer@
10:00:38.744 -> $GNRMC,170036.00,A,3453.81055,N,08636.88623,W,17.2i,rick@
10:00:39.682 -> $GNRMC,170037.00,A,3453.74625,N,08636.94769,W,7.32i,summer@
10:00:39.729 -> $GNRMC,170037.00,A,3453.81323,N,08636.88038,W,17.0i,rick@
10:00:47.884 -> $GNRMC,170039.00,A,3453.81880,N,08636.87613,W,8.92i,rick@
10:00:47.978 -> $GNRMC,170040.00,A,3453.81998,N,08636.87417,W,6.81i,rick@
10:00:48.025 -> $GNRMC,170041.00,A,3453.82011,N,08636.87298,W,3.61i,rick@
10:00:48.119 -> $GNRMC,170042.00,A,3453.82116,N,08636.87185,W,3.30i,rick@
10:00:48.166 -> $GNRMC,170043.00,A,3453.82097,N,08636.87112,W,2.70i,rick@
10:00:48.259 -> $GNRMC,170044.00,A,3453.82004,N,08636.87085,W,4.91i,rick@
10:00:48.306 -> $GNRMC,170045.00,A,3453.81927,N,08636.86933,W,7.13i,rick@
10:00:48.681 -> $GNRMC,170046.00,A,3453.81787,N,08636.86453,W,14.0i,rick@
10:00:49.665 -> $GNRMC,170047.00,A,3453.81691,N,08636.85820,W,18.4i,rick@
10:00:50.697 -> $GNRMC,170048.00,A,3453.81666,N,08636.84987,W,20.8i,rick@
```

15. Wait for up to half an hour for the GPS lock to resolve; once GPS lock is obtained for both ATUs the serial feed will look like the above rather than mostly filled with commas. A partial lock has been attained when timestamps become accurate.

16. To test GPS data logging, unplug LiPo batteries from the ATUs and pull the MicroSD cards from the microcontrollers. **Note: the ground station can remain connected to the computer for the next section of setup and operation.**
17. Use the MicroSD card reader to check the ‘DATALOG’ file on both MicroSD cards. Data should appear similar to the serial monitor above but without the call-signs and with more types of packets and more information in the \$GNRMC packets.

Payload Ejection Controller (PLEC) Setup and Operation

1. Navigate to `|Avionics-2019|PLEC|PLEC_TX` and open `PLEC_TX.ino`.
2. Use the ‘verify’ button (checkmark in the top left) to build the program.
3. Connect the ground station to the computer via the MicroUSB to USB-A cable.
4. Select the correct port in the Arduino IDE and press the ‘upload’ button (arrow in the top left) to push the code to the ATU Teensy.
5. Open the Arduino serial monitor using the magnifying glass button in the top right corner.
6. When ready, flick the red cover up, flick the switch under the red cover, then press the green button. A series of hex values will print out over the serial monitor with ‘covfefe’ and a series of other bytes as the result. Enjoy the meme. This is the activation signal for detonating the ejection charges on the receiving end of the PLEC. Transmission will cease when the green button is released.

433 MHz Prototype Setup and Operation

1. Navigate to `|Avionics-2019|ATU|433MHzPrototype|ElecHouseCC1101Libraries|` and locate the `ELECHOUSE_CC1101.cpp` and `ELECHOUSE_CC1101.h` files.
2. Move the above files to `C:|Program Files (x86)|Arduino|libraries` or wherever else your local install of Arduino is. **Note: these files should NOT go in the ‘My Documents’ version of the Arduino files.**
3. Ensure that Arduino Unos are wired to SoLu 433 MHz CC 1101 modules as follows:

<u>Pin Name (on SoLu)</u>	<u>Pin Number (on Uno)</u>
VCC	3.3 V
SI	11
SO	12
CSN	10
GND	GND
SCK	13
GO2	9
GO0	2

4. Plug both Arduino Unos into separate USB ports via the USB-B to USB-A cables
5. Go to `Avionics-2019\ATU\433MHzPrototype\` and choose which revision of the 433 MHz prototype code you will be running, then open one Arduino IDE window for TX and one window for RX. Configure the Arduino IDE for “Arduino/Genuino Uno”.
6. Flash the code to each Arduino Uno, then open the serial monitor on the Arduino that was flashed with the RX code to view the data stream.