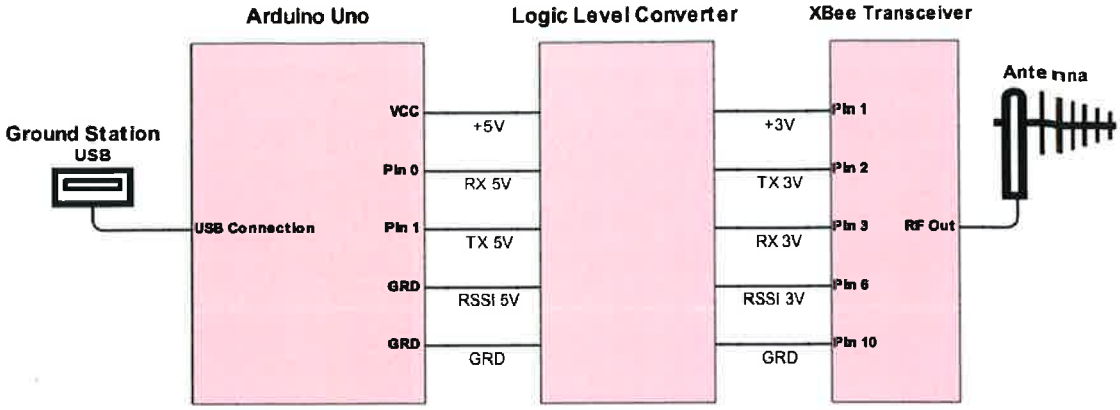
4. Bonus Challenge

4.1. Communications System Hardware Implementation

A set of XBee Pro 60 mW U.FL Connection - Series 1 (802.15.4) radio modules will be used for communications between the ground station and the rocket. The XBee units will be paired, and interference will be limited further by the addition of a "security code" that will proceed every transmission. The TFR and ground station computer will ignore all messages not preceded by the ASCII code "A2."

The rocket's XBee transceiver will be connected to the TFR computer. The UART protocol will be used to provide power to the XBee and will act as the interface between the TFR and XBee. A wire antenna will be used with the Xbee module to provide adequate air-to-ground signal strength. The antenna will be fed through a small hole in the side of the rocket and run the length of the rocket.

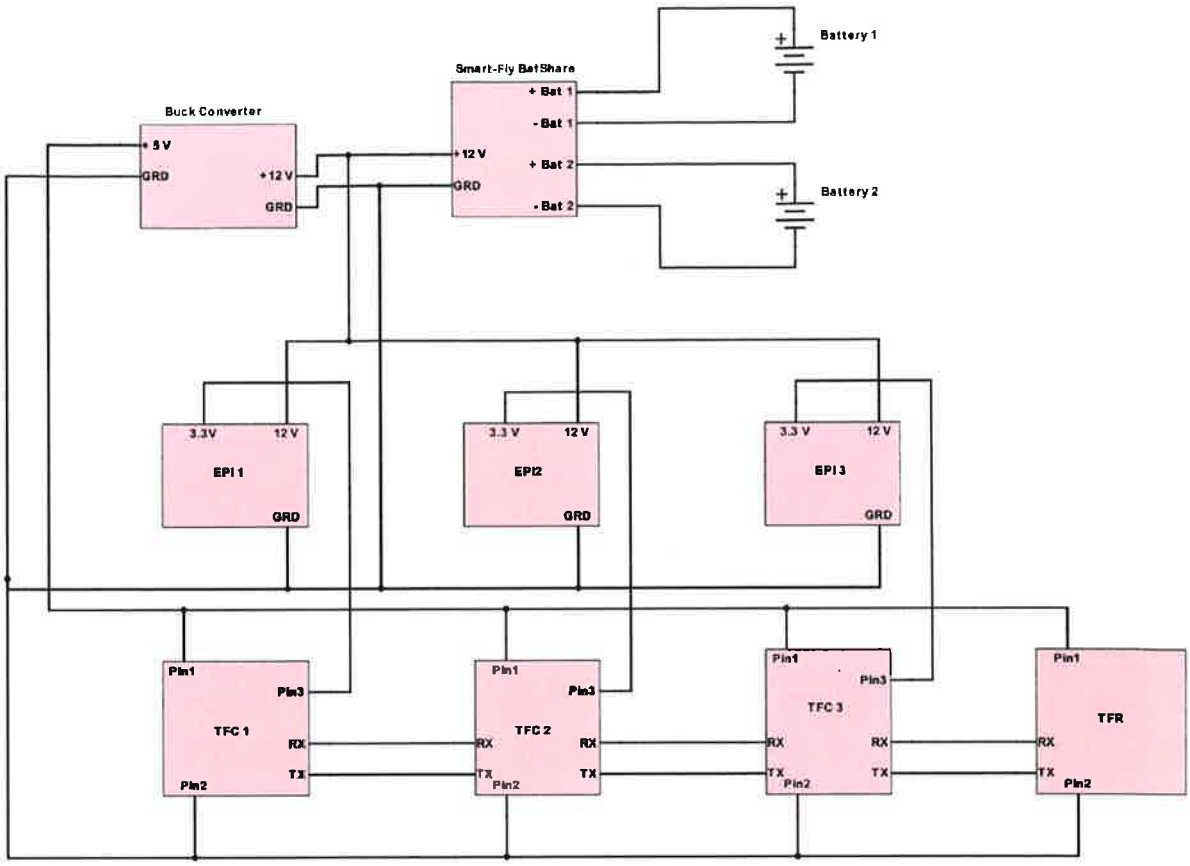
The groundside XBee will use a small monopole antenna to provide its transmitting and receiving capabilities. An Arduino Uno will serve as an intermediary between the XBee module and the ground station computer. Communication between the computer and the XBee will be done using the Uno's serial monitor. The Arduino will provide the necessary power to the XBee module, and the xbee-arduino library will be used to provide the necessary interfacing between the XBee module and Arduino Uno. Connection between the XBee and Uno will be achieved using the UART protocol. An additional wire will connect the Uno to the XBee's RSSI signal (pin 6), which will allow the ground station to monitor the rocket's broadcasting signal strength using a PWM signal. Because the Arduino Uno outputs digital signals using a 5 volt based digital logic system and the XBee module uses a 3.3 voltage based digital logic system, the connections between the Uno and Xbee will be routed through a logic level converter to ensure that all signals are using the proper voltage.



4.2. Bonus Challenge Specifications

The rocket will accept an alternative set of roll commands only while on the ground before launch. All commands received must be transmitted from the rocket back to the ground station. The ground station will then send a confirmation signal back to the rocket stating that all commands are correct. Only then will the rocket accept and change its pre-programmed flight orientation program. The TFR computer will also be capable of performing simple mathematical operations which are received as commands from the ground station during flight. Aquilla II's evaluated answers will be transmitted back to the ground as the last item in the comma-separated field of flight data from the rocket.

All available in-flight data will be transmitted from the rocket to the ground control station as a set of comma-separated fields at 10 Hz, including the time since engine ignition, TFC status, altitude, orientation, temperature, gyroscopic data, acceleration rate, estimated remaining tank psi, and answers to mathematical commands received from the ground station as specified in the rules for bonus challenge C.



5. Appendix

5.1. List of Figures

5.2. List of Acronyms

- TFC = Teensy Flight Controller
- TFR = Teensy Flight Recorder
- EPI = Electronics-Pneumatics Interface
- UAS = Upper Avionics Sled

- LAS = Lower Avionics Sled
- IMU = Inertial Measurement Unit
- PID = Proportional-Integral-Derivative
- PWM = Pulse Width Modulation
- RSO = Range Safety Officer