Skill Booster 3: "Protocol Pro" Drone Design Report

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1 Introduction

This report details the design of a custom quadcopter drone, focusing on the selection of a flight controller, sensors, and remote control components. The design emphasizes compatibility and appropriate communication protocols. The chosen firmware is PX4, suitable for research and modular development. The drone is intended for autonomous missions and mapping applications.

2 Selected Components

2.1 Flight Controller

The Holybro Pixhawk 6C is selected as the flight controller. It features an STM32H743 microcontroller, integrated IMU (ICM-45686 gyroscope/accelerometer and BMI055), and barometer (BMP388). It supports PX4 firmware natively and offers flexible I/O ports for sensors and peripherals. Key specs:

- Processor: STM32H743 (480 MHz)
- Integrated sensors: ICM-45686 (16-bit gyro/accel), BMI055 (16-bit gyro/accel), BMP388 barometer
- Interfaces: UART, I2C, SPI, CAN, PWM
- Size: 44 x 84 x 12 mm
- Weight: 63.6 g

2.2 Sensors

The flight controller includes integrated IMU and barometer sensors, ensuring low-latency and reliable data fusion for attitude and altitude estimation. For positioning, an external GPS module is added.

2.2.1 IMU

Integrated: ICM-45686 (InvenSense) and BMI055 (Bosch). Key specs:

- Range: ± 2000 dps (gyro), ± 16g (accel)
- Resolution: 16-bit
- Interface: SPI (internal)
- Low noise for precise orientation control

2.2.2 Barometer

Integrated: BMP388 (Bosch). Key specs:

- Resolution: 0.016 Pa
- Range: 300–1250 hPa
- Interface: I2C/SPI (internal)
- Temperature compensated for accurate altitude hold

2.2.3 GPS Module

u-blox NEO-M8N GPS module for global positioning. Key specs:

- Concurrent GNSS: GPS, GLONASS, BeiDou, Galileo
- Accuracy: 2.5 m CEP
- Update rate: Up to 10 Hz
- Interface: UART (default 38400 baud)
- Size: 52 x 77 mm
- Weight: 52 g

2.3 RC Transmitter and Receiver

2.3.1 Transmitter

FlySky FS-i6X 10CH 2.4GHz RC Transmitter. Key specs:

- Channels: 10
- Frequency: 2.4 GHz AFHDS 2A protocol
- Range: Up to 500 m
- Features: Telemetry support, trainer port

2.3.2 Receiver

FlySky FS-iA6B 10CH Receiver. Key specs:

- Channels: 10
- Protocols: PPM, iBUS, SBUS output
- Size: 47 x 26.2 x 15 mm
- Weight: 16.6 g (without crystal)

3 Wiring Setup

The wiring diagram illustrates the connections between components. The receiver connects to the flight controller via SBUS for serial bus communication of RC commands. The GPS module connects via UART for MAVLink telemetry and position data. Integrated sensors use internal buses (SPI/I2C). Power distribution (5V BEC) is assumed from the flight controller.

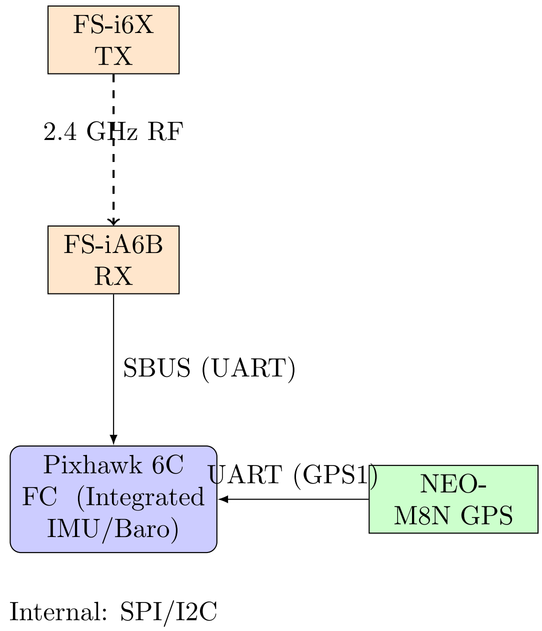

Figure 1: Wiring Diagram Overview

4 Communication Protocols and Compatibility

Compatibility is ensured through standard interfaces supported by PX4 firmware:

- **SBUS**: Serial protocol from RX to FC for low-latency RC input (up to 10 channels at 100 kbps). PX4 maps SBUS to RC channels seamlessly.
- **UART/MAVLink**: GPS communicates position data over UART using MAVLink protocol (UDP/TCP capable). Baud rate: 38400 (configurable).
- **Internal Buses**: IMU and barometer use SPI (high-speed, 10 MHz) and I2C (400 kHz) for sensor fusion in the FMU.
- **RF Protocol**: AFHDS 2A (proprietary FlySky) for reliable 2.4 GHz link with frequency hopping to avoid interference.

All components are verified compatible: Pixhawk 6C supports SBUS on RC IN and UART on GPS port; FlySky receiver outputs SBUS; u-blox GPS uses standard NMEA/UBX over UART. PX4 firmware handles protocol parsing and calibration via QGroundControl.

5 Firmware Selection

PX4 is chosen for its modular architecture, ROS2 integration, and support for the Pixhawk hardware. It supports typical use cases such as GPS and a heavier codebase.

6 Conclusion

This design provides a robust, compatible drone setup for PX4-based applications. Future enhancements could include a companion computer for advanced processing via DDS or additional sensors like LiDAR over Ethernet.