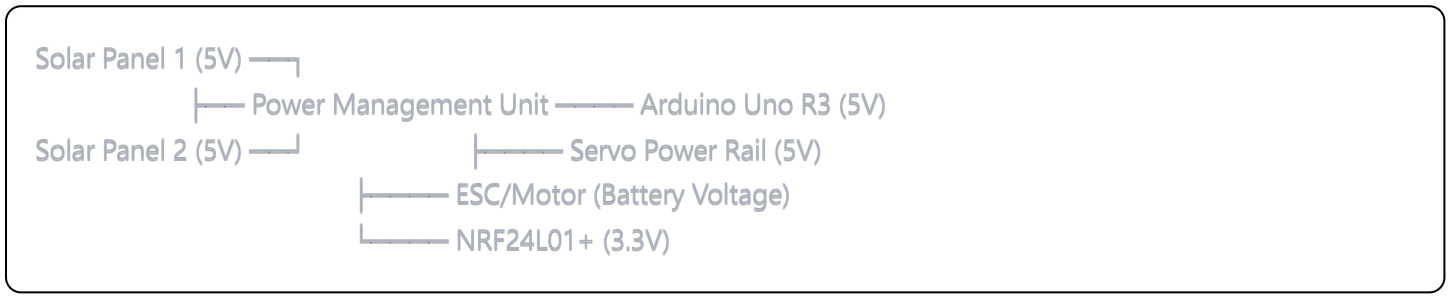
Fixed Wing Drone - Detailed Wiring Design

Overview

This document provides comprehensive wiring instructions for the fixed wing drone system based on the Arduino Uno R3 controller with dual solar panel power system, NRF24L01+ communication, and standard servo control surfaces.

Power System Architecture

Primary Power Distribution



Power Management Components Required:

- **Voltage Regulator**: LM7805 or similar (5V, 1A minimum)
- **Backup Battery**: 7.4V LiPo 2200mAh (recommended)
- **Diode Bridge**: 1N4007 x4 for solar panel combining
- **Filter Capacitors**: 1000µF electrolytic, 100nF ceramic
- **Current Sensor**: ACS712-30A Hall Effect sensor
- **Voltage Divider**: For battery monitoring (10kΩ + 20kΩ resistors)

Detailed Component Wiring

1. Arduino Uno R3 Main Controller

Digital Pins:

```
Pin D0  (RX)  ── Reserved for Serial Communication
Pin D1  (TX)  ── Reserved for Serial Communication
Pin D2        ── Emergency Stop Switch (INPUT_PULLUP)
Pin D3  (PWM) ── Servo 1 Signal (Left Aileron)
Pin D4        ── LED Status Indicator
Pin D5  (PWM) ── Servo 2 Signal (Right Aileron)
Pin D6        ── NRF24L01 CE Pin
Pin D7        ── Buzzer/Alarm Output
Pin D8        ── Mode Selection Switch (INPUT_PULLUP)
Pin D9  (PWM) ── NRF24L01 CSN Pin
Pin D10 (PWM) ── ESC Signal Wire (Motor Control)
Pin D11 (MOSI)── NRF24L01 MOSI (SPI)
Pin D12 (MISO)── NRF24L01 MISO (SPI)
Pin D13 (SCK) ── NRF24L01 SCK (SPI) + Built-in LED
```

Analog Pins:

```
Pin A0 ── Battery Voltage Monitor (via voltage divider)
Pin A1 ── Current Sensor Output (ACS712)
Pin A2 ── Solar Panel 1 Voltage Monitor
Pin A3 ── Solar Panel 2 Voltage Monitor
Pin A4 ── Reserved for I2C SDA (future IMU)
Pin A5 ── Reserved for I2C SCL (future IMU)
```

Power Pins:

```
VIN   ── 7-12V from Power Management Unit
5V    ── 5V Output to Servo Power Rail
3.3V  ── 3.3V Output to NRF24L01
GND   ── Common Ground (multiple connections)
```

2. NRF24L01+ 2.4GHz Transceiver

Pin Connections:

NRF24L01+	Arduino Uno R3	Wire Color (Suggested)
VCC	3.3V	Red
GND	GND	Black
CE	D6	Orange
CSN	D9	Yellow
SCK	D13	Green
MOSI	D11	Blue
MISO	D12	Purple
IRQ	Not Connected	—

Important Notes:

- **Power**: NRF24L01+ requires 3.3V, NOT 5V (will damage module)
- **Decoupling**: Add 10µF + 100nF capacitors close to VCC/GND
- **Antenna**: Ensure proper antenna orientation for range
- **Range**: Consider NRF24L01+PA+LNA version for extended range

3. Servo Connections

Servo 1 (Left Aileron):

Servo Wire	Connection	Notes
Signal (White/Orange)	Arduino D3	PWM Signal (1000-2000µs)
Power (Red)	5V Rail	From power management
Ground (Black/Brown)	GND	Common ground

Servo 2 (Right Aileron):

Servo Wire	Connection	Notes
Signal (White/Orange)	Arduino D5	PWM Signal (1000-2000µs)
Power (Red)	5V Rail	From power management
Ground (Black/Brown)	GND	Common ground

Servo Power Rail Design:

```
5V from Arduino ──┬── Servo 1 Power
                  ├── Servo 2 Power
                  └── 1000µF Filter Capacitor ── GND
```

4. ESC and Motor System

ESC Connections:

```
ESC Wire      Connection       Specifications
──────────────────────────────────────────────
Signal        Arduino D10      PWM (1000-2000µs)
Power (+)     Battery +        7.4V LiPo recommended
Power (-)     Battery - / GND  Common ground
Motor A       Brushless Motor  Phase A
Motor B       Brushless Motor  Phase B
Motor C       Brushless Motor  Phase C
```

Motor Specifications (from schematic):

- **Type**: 1200KV Brushless Motor
- **ESC Rating**: 20A-30A recommended
- **Propeller**: 8x4 or 9x5 recommended
- **Current Draw**: 2-3A typical cruise

5. Power Management Unit Wiring

Solar Panel Integration:

```
Solar Panel 1 (+) ──┐
                    ├─── 1N4007 Diode ──┐
Solar Panel 1 (-) ──┘                   │
                                        ├── Voltage Regulator Input
Solar Panel 2 (+) ──┐                   │   (LM7805)
                    ├─── 1N4007 Diode ──┘
Solar Panel 2 (-) ──┘
```

Backup Battery Integration:

```
LiPo Battery (+) ──── 1N4007 Diode ──── Power Management Input
LiPo Battery (-) ──── Common Ground
```

Power Distribution:

```
Regulated 5V Output ──┬── Arduino VIN
                      ├── Servo Power Rail
                      └── NRF24L01 (via 3.3V regulator)

Battery Voltage ──────── ESC Power Input
```

6. Monitoring and Safety Systems

Current Sensing (ACS712):

```
ACS712 Pin    Connection
──────────────────────────
VCC           5V
GND           GND
OUT           Arduino A1
IP+           Motor Positive Line
IP-           Motor Return Line
```

Voltage Monitoring:

```
Battery + ──── 20kΩ Resistor ──┬── Arduino A0
                               |
                           10kΩ Resistor
                               |
                              GND
```

This creates a 3:1 voltage divider for monitoring up to 15V

Status Indicators:

```
Component     Arduino Pin    Purpose
──────────────────────────────────────────
Status LED    D4             System status indication
Buzzer        D7             Audio alerts/alarms
Emergency SW  D2             Manual emergency stop
Mode Switch   D8             Flight mode selection
```

Physical Layout Recommendations

1. Component Placement:

```
Nose Section:
├── Motor and Propeller
├── ESC (with cooling airflow)
└── Current Sensor

Center Fuselage:
├── Arduino Uno R3 (main controller)
├── NRF24L01+ Module
├── Power Management Board
└── Battery Compartment

Wing Sections:
├── Solar Panel 1 (Left wing)
├── Solar Panel 2 (Right wing)
├── Servo 1 (Left aileron)
└── Servo 2 (Right aileron)

Tail Section:
├── Status LED
├── Buzzer
└── Antenna (if external)
```

2. Wire Routing:

- **Servo Wires**: Route through wing structure, protect from prop wash
- **Power Wires**: Use thicker gauge (16-18 AWG) for motor circuits
- **Signal Wires**: Keep separated from power wires to reduce interference
- **Antenna**: Mount away from motor and ESC for best reception

Wire Specifications

Recommended Wire Gauges:

Connection Type	Wire Gauge	Length (typical)
Motor/ESC Power	16 AWG	6-8 inches
Battery Power	18 AWG	4-6 inches
Servo Power	22 AWG	12-18 inches
Signal Wires	24-26 AWG	Various
Sensor Wires	26-28 AWG	6-12 inches

Color Coding (Recommended):

Function	Color
Power Positive	Red
Ground/Negative	Black
5V Regulated	Orange
3.3V Regulated	Yellow
PWM Signals	White
Digital Signals	Blue
Analog Signals	Green

Testing and Calibration Procedure

1. Power System Test:

1. Connect solar panels and battery
2. Verify 5V regulation under load
3. Test current sensing accuracy
4. Confirm voltage monitoring readings

2. Communication Test:

1. Power up NRF24L01+ module
2. Test radio communication range
3. Verify telemetry data transmission
4. Test failsafe activation

3. Control Surface Test:

1. Center all servos (1500µs pulse)
2. Test full range movement
3. Verify differential aileron operation
4. Calibrate servo endpoints

4. Motor System Test:

1. Arm ESC with minimum throttle
2. Test throttle response curve
3. Monitor current draw at various throttle settings
4. Verify emergency stop functionality

Safety Considerations

Critical Safety Points:

- **Battery Management**: Install fuse (5A) in battery circuit
- **Prop Safety**: Use prop saver or safety device
- **Emergency Stop**: Ensure emergency switch is easily accessible
- **Failsafe**: Test communication loss scenario thoroughly
- **Power Isolation**: Use separate power rails for critical systems
- **Wire Security**: Use strain relief on all connections
- **Redundancy**: Consider backup power for critical control systems

Pre-Flight Checklist:

1. ✓ Battery voltage sufficient (>7.0V)
2. ✓ Solar panels clean and functional
3. ✓ Radio communication established
4. ✓ Servo movement correct and smooth
5. ✓ Motor arming and disarming functional
6. ✓ Emergency stop tested
7. ✓ Control surface deflection checked
8. ✓ Current monitoring operational

Troubleshooting Common Issues

Power Issues:

- **No 5V Output**: Check voltage regulator, input voltage, heat sink
- **Servo Jitter**: Add larger filter capacitors, check power supply capacity
- **Motor Not Arming**: Verify ESC calibration, check throttle range

Communication Issues:

- **No Radio Link**: Check NRF24L01+ power (3.3V!), antenna, channel settings
- **Intermittent Connection**: Add decoupling capacitors, check wire connections
- **Range Problems**: Upgrade to NRF24L01+PA+LNA, improve antenna placement

Control Issues:

- **Servo Not Moving**: Check PWM signal, power supply, servo condition
- **Wrong Direction**: Reverse servo or change code logic
- **Limited Range**: Adjust servo endpoints in code, check mechanical binding

This wiring design provides a robust, reliable foundation for your fixed wing drone with proper power management, safety systems, and expandability for future enhancements.