

# Fixed Wing Drone - Detailed Hardware Wiring Guide

## Power System Wiring

### Solar Panel Configuration

**Components:** 2x 5V Solar Panels

**Series Connection (Recommended):**

Solar Panel 1 (+) → Solar Panel 2 (-)  
Solar Panel 1 (-) → Power Management Ground  
Solar Panel 2 (+) → Power Management Input (10V)

**Parallel Connection (Alternative):**

Solar Panel 1 (+) → Solar Panel 2 (+) → Power Management Input (5V)  
Solar Panel 1 (-) → Solar Panel 2 (-) → Power Management Ground

## Power Management Circuit

**Required Components:**

- Voltage Regulator (7805 or LM2596 Buck Converter)
- Filter Capacitors (1000µF, 100µF)
- Schottky Diodes (1N5819) for reverse protection
- Fuse (2A for protection)

**Wiring:**

Solar Input (10V) → Diode → Capacitor → Voltage Regulator Input  
Voltage Regulator Output → 5V Rail (Arduino VIN)  
Ground → Common Ground Rail

## Arduino Uno Connections

### Power Connections

VIN Pin → 5V from Power Management (7-12V input range)  
5V Pin → 5V Rail Distribution (for servos and sensors)  
GND Pins → Common Ground Rail (connect all GND pins)

## Digital Pin Assignments

Pin D2 → Reserved (External Interrupt)  
Pin D3 → Servo 1 Signal Wire (PWM - Left Aileron)  
Pin D4 → Reserved  
Pin D5 → Servo 2 Signal Wire (PWM - Right Aileron)  
Pin D6 → ESC Signal Wire (PWM - Motor Control)  
Pin D7 → Reserved  
Pin D8 → NRF24L01 CE Pin  
Pin D9 → NRF24L01 CSN Pin  
Pin D10 → Reserved (Hardware SS)  
Pin D11 → NRF24L01 MOSI (SPI)  
Pin D12 → NRF24L01 MISO (SPI)  
Pin D13 → NRF24L01 SCK (SPI)

## Analog Pin Assignments

Pin A0 → Battery Voltage Monitor (Voltage Divider)  
Pin A1 → Solar Panel Voltage Monitor  
Pin A2 → Current Sensor (Optional)  
Pin A3 → Reserved  
Pin A4 → I2C SDA (for future sensors like IMU)  
Pin A5 → I2C SCL (for future sensors like IMU)

## NRF24L01 Radio Module Wiring

### Pin Configuration

NRF24L01 Pin	Arduino Pin	Wire Color
VCC (3.3V)	→ 3.3V	→ Red
GND	→ GND	→ Black
CE	→ D8	→ Orange
CSN	→ D9	→ Yellow
SCK	→ D13	→ Green
MOSI	→ D11	→ Blue
MISO	→ D12	→ Purple
IRQ	→ Not Used	→ (Leave disconnected)

### Important Notes:

- **NEVER connect NRF24L01 VCC to 5V** - it will damage the module
- Use 3.3V output from Arduino
- Add 10µF capacitor between VCC and GND near the module
- Keep wires short (< 10cm) to reduce interference

- Consider using a breakout board with voltage regulator

## Servo Wiring (Control Surfaces)

### Servo 1 (Left Aileron)

Servo Pin	Connection
Red Wire	→ 5V Rail
Brown/Black	→ Ground Rail
Orange/White	→ Arduino Pin D3 (PWM)

### Servo 2 (Right Aileron)

Servo Pin	Connection
Red Wire	→ 5V Rail
Brown/Black	→ Ground Rail
Orange/White	→ Arduino Pin D5 (PWM)

### Servo Power Considerations:

- Standard 9g servos draw 100-200mA each
- Use separate 5V rail with adequate current capacity (1A minimum)
- Consider using a BEC (Battery Eliminator Circuit) for servo power
- Add 470µF capacitor near servo power connections to reduce voltage spikes

## Motor and ESC Wiring

### ESC (Electronic Speed Controller)

#### ESC Input (from Arduino):

ESC Signal Wire (Usually White)	→ Arduino Pin D6 (PWM)
ESC Red Wire (+5V BEC)	→ Not Connected (or 5V rail if no separate BEC)
ESC Black Wire (Ground)	→ Ground Rail

#### ESC Output (to Motor):

ESC Motor Wire A	→ Motor Wire A (Any color)
ESC Motor Wire B	→ Motor Wire B (Any color)
ESC Motor Wire C	→ Motor Wire C (Any color)

#### ESC Power Input:

ESC Red Power Wire → Battery/Solar Positive (7.4V-11.1V recommended)  
ESC Black Power Wire → Battery/Solar Negative

## Motor Connections

### 1200KV Brushless Motor:

- Connect the three motor wires to ESC output wires
- Order doesn't matter initially - if motor spins backward, swap any two wires
- Secure all connections with heat shrink tubing
- Mount motor with proper cooling airflow

## Ground System (Critical!)

### Ground Rail Distribution

All grounds must be connected together:

Arduino GND → Ground Rail  
NRF24L01 GND → Ground Rail  
Servo Grounds → Ground Rail  
ESC Ground → Ground Rail  
Power Management Ground → Ground Rail  
Solar Panel Negative → Ground Rail

### Ground Loop Prevention:

- Use a single ground point (star grounding)
- Keep ground wires short and thick (16-18 AWG minimum)
- Avoid ground loops by not creating multiple ground paths

## Voltage Monitoring Circuit

### Battery/Solar Voltage Divider

Solar/Battery + → 10kΩ Resistor → Arduino A0 → 10kΩ Resistor → Ground

### Calculation for voltage reading:

Actual Voltage = (Analog Reading / 1023) × 5V × 2

## Wire Gauge and Color Coding

## Recommended Wire Gauges:

Power Rails (5V, Battery): 16-18 AWG

Motor/ESC Power: 14-16 AWG

Signal Wires: 22-24 AWG

Ground Connections: 16-18 AWG

## Color Coding Standard:

Red: Positive Power (+5V, +Battery)

Black: Ground/Negative

Orange: PWM Signals

Yellow: Digital Control

Green: SPI Clock

Blue: SPI Data

White: Serial Communication

## Connection Checklist

### Pre-Flight Checks:

#### 1. Power System:

- ☐ Solar panels connected with correct polarity
- ☐ Voltage regulator outputting stable 5V
- ☐ All power connections secure

#### 2. Arduino Connections:

- ☐ All pins connected per pin assignment table
- ☐ No loose connections on breadboard/PCB
- ☐ Power LED on Arduino illuminated

#### 3. Radio System:

- ☐ NRF24L01 powered from 3.3V (NOT 5V)
- ☐ SPI connections correct
- ☐ Antenna properly connected

#### 4. Servos:

- ☐ Correct PWM signal connections
- ☐ Adequate power supply for servo operation
- ☐ Servo horns and linkages secure

#### 5. Motor System:

- ☐ ESC properly calibrated
- ☐ Motor rotation direction correct
- ☐ Propeller securely mounted

- ☐ ESC thermal protection adequate

## Troubleshooting Common Issues

### Power Problems:

- **Symptom:** Arduino resets randomly
- **Solution:** Check voltage regulation, add larger filter capacitors

### Communication Issues:

- **Symptom:** NRF24L01 not responding
- **Solution:** Verify 3.3V power, check SPI connections, add power filtering

### Servo Problems:

- **Symptom:** Servos jittering or not responding
- **Solution:** Check PWM signal quality, ensure adequate power supply

### Motor Issues:

- **Symptom:** Motor not starting or running rough
- **Solution:** Verify ESC calibration, check motor wire connections

## Safety Considerations

### Electrical Safety:

- Always disconnect power when making connections
- Use fuses on main power lines
- Insulate all connections properly
- Check for shorts with multimeter before powering up

### Mechanical Safety:

- Secure all wiring away from moving parts (propeller)
- Use strain relief on all cable connections
- Mount components securely to prevent vibration damage

### Flight Safety:

- Test all systems on the ground before flight
- Have manual override capability
- Monitor battery/solar voltage during flight
- Implement failsafe procedures in software

## Tools Required

### For Assembly:

- Soldering iron (40W minimum)
- Solder (60/40 rosin core)
- Wire strippers
- Heat shrink tubing and heat gun
- Multimeter for testing
- Small screwdrivers
- Crimping tool for connectors

### For Testing:

- Digital multimeter
- Oscilloscope (for signal verification)
- Servo tester
- ESC programming card

This wiring guide provides the foundation for a reliable fixed-wing drone electrical system. Always double-check connections before applying power, and test each subsystem individually before integrating everything together.