SOLO

Operation Manual

3DR

3DR Support

We're here to help! If you have any questions about your Solo or if you need technical support, don't hesitate to contact us.

online: **3dr.com/support**
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Support line hours:
Mon-Fri 8 am to 5 pm PST
Sat 9 am to 3 pm PST

Contents

Figures

1 System Description

Solo is a reliable, easy-to-use quadcopter optimized for capturing aerial video and still imagery. This section provides a technical description for the 3DR Solo system, including components, communication, control, telemetry, and operator interaction.

1.1 System Overview

The 3DR Solo system includes the Solo quadcopter, Solo controller, "3DR Solo" app, and the human operator. The operator interacts with the controller and app on the ground, and the controller communicates with the Solo quadcopter during flight.

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Solo Quadcopter
Solo is a small unmanned aerial vehicle powered by four brushless motors and four propellers. Solo's onboard computers control navigation, attitude, and communications in flight while sending real-time telemetry and video output and receiving control inputs over the 3DR Link secure WiFi network. Solo is optimized for aerial imagery using a GoPro® HERO camera.

Controller
The controller provides joystick, button, and dial controls and displays in-flight data on a full-color screen. Using twin long-range dipole antennae, the controller acts as the central hub for all communication on the 3DR Link network, receiving all communications from Solo and the app, forwarding telemetry outputs to the app, and controlling the transmission of all control inputs to Solo.

App
The "3DR Solo" app outputs a live video stream from Solo's onboard camera to an Android or iOS device. The operator can use the app to view the live video with overlaid telemetry and access a simplified graphic interface for controlling Solo's advanced functions. The app connects to the 3DR Link network to receive video and telemetry outputs and send control inputs.
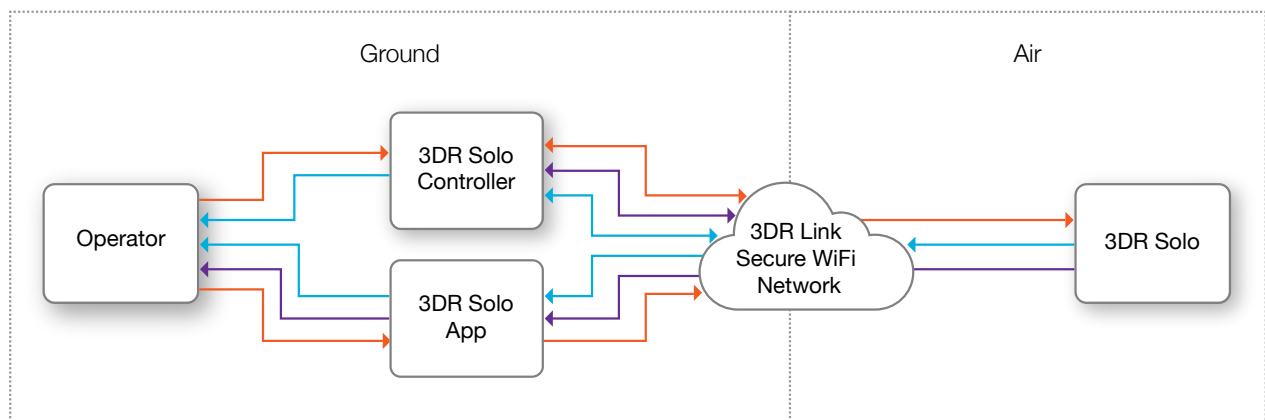
Figure 1.1.1: Solo System Context Diagram

1.2 Aircraft Overview

Smart Battery
The battery connects to Solo's battery bay. Solo's power button is located on the battery; Solo can only be powered when the battery is connected.

Motors and Propellers
Solo's arms are labelled one through four on the ends of the arms. Motors on arms #1 and #2 spin counterclockwise and use clockwise-tightening propellers with silver tops. Conversely, motors on arms #3 and #4 spin clockwise and use clockwise-tightening propellers with black tops.

Orientation LEDs
Each arm contains an LED for ground-to-air directional awareness; the two front arms (#1 and #3) display white, and the two rear arms (#2 and #4) annunciate red. This LED scheme mimics the headlight and taillight style of a car for easy association by any operator.

Fixed Camera Mount and HDMI Cable
Solo includes a GoPro® The Frame fixed mount to mount a GoPro® HERO camera. The HDMI cable connects to the GoPro® to output video and charge the camera during flight.

Silver-top propeller

Power button

Battery

Rear orientation LEDs

Black-top propeller

Motor

Arm numbering

Front orientation LEDs

Fixed camera mount

HDMI cable

Height: 10.2"
Motor-to-motor: 18.1"
Weight (no camera): 3.3 lbs.
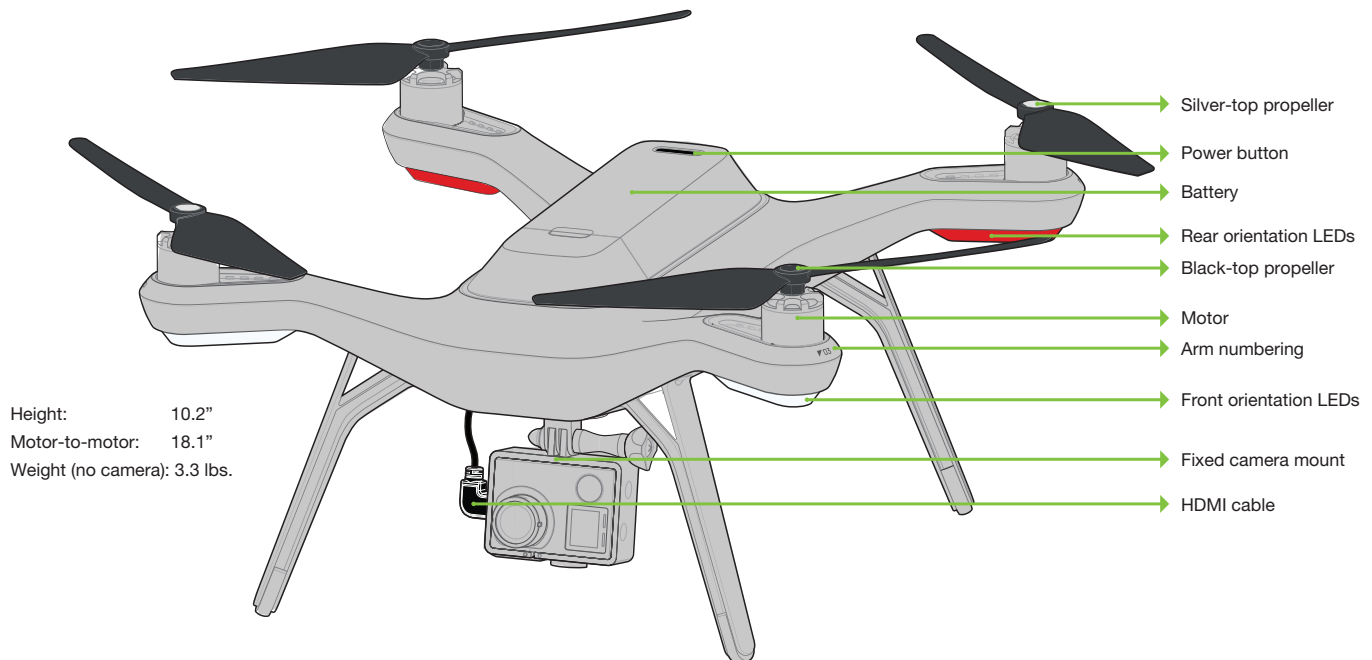
Figure 1.2.1: Solo Exterior Overview

Solo Mainboard
The Solo mainboard connects all components onboard Solo. It acts as a voltage regulator and power distribution system for the vehicle, sending power to all components and receiving voltage and current monitoring information from the Solo Smart Battery.

3DR Pixhawk 2
The Pixhawk autopilot handles all attitude estimation, inertial navigation, and failsafe monitoring for Solo. It receives data from internal sensors, the external GPS module, the external compass module, and 3DR Solo Link to calculate Solo's in-flight dynamics. Pixhawk outputs telemetry data to the 3DR Link network and send control commands to Solo's four electronic speed controllers. Pixhawk sends and receives all signal through the mainboard.

Compass Module

The compass module is placed in leg #4 to avoid interference from other electronic components. Data from the compass is sent to Pixhawk through the mainboard for use in attitude estimation.

GPS Module

The GPS module is located in front of the battery in a copper-shielded enclosure to reduce interference. GPS data is essential for Solo's automated flight capabilities. The GPS module sends data to Pixhawk through the mainboard.

Electronic Speed Controllers

Solo contains four electronic speed controllers (ESCs) to manage control of each of the four motors. ESCs receive commands from Pixhawk through the mainboard and regulate the rotation of the motors to achieve the correct flight speeds.

3DR Solo Link

The 3DR Solo Link module manages communication between Solo and the controller on the 3DR Link secure WiFi network. 3DR Solo Link receives all control inputs, outputs telemetry, and outputs video signals to communicate with the ground over the 3DR Link network. 3DR Solo Link also runs software processes regulating advanced automated functions and data conversion. This module sends and receives data from Pixhawk through the mainboard.

Antennas

Twin dipole antenna in the legs #1 and #2 send and receive signals from the 3DR Link WiFi network.
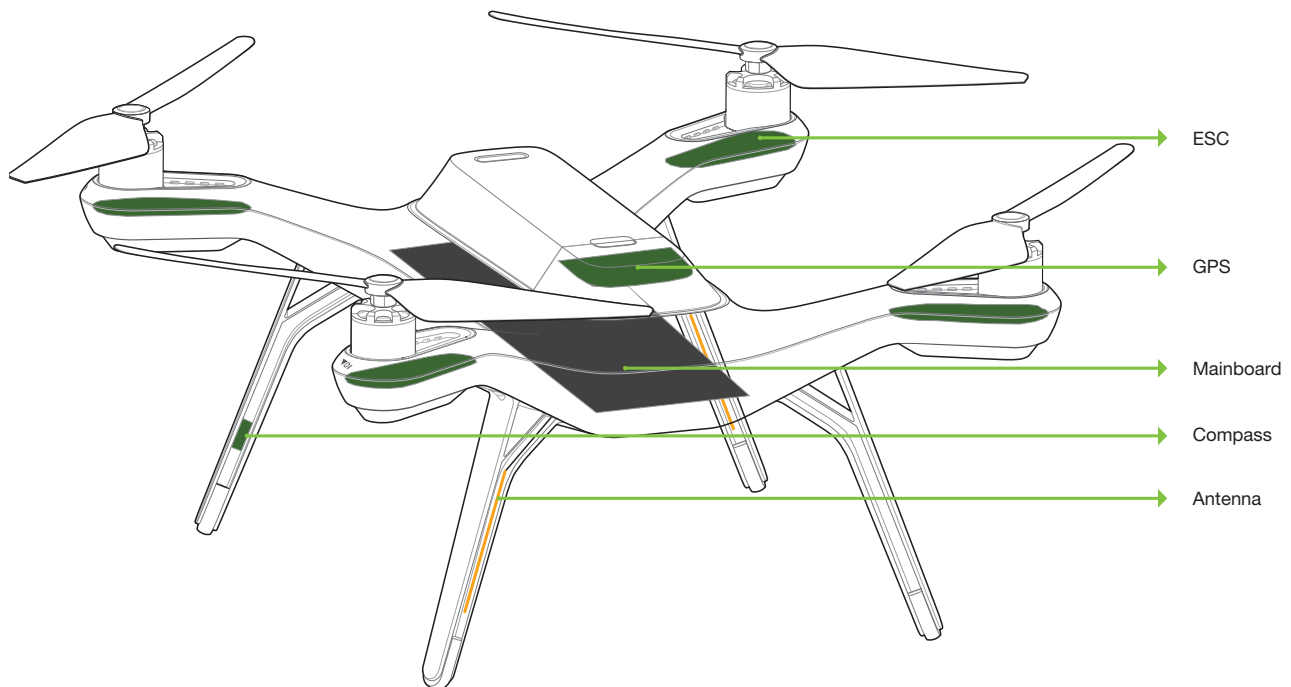
Figure 1.2.2: Solo Interior Overview

1.3 Controller Overview

Mobile-Device Holder
Mount an Android or iOS device to run the Solo app and effortlessly integrate the app into the controller's operation flow.

Joysticks
The controller's left and right joysticks provide direct manual control of Solo and physical control mechanisms for using automated Smart Shots.

Screen
The controller's full-color screen provides prompts for correct operation of Solo, live in-flight data, and control over automated Smart Shots.

Power Button
The power button provides a quick check of the controller's power level when pressed once and powers on the controller when held. The controller provides vibration feedback to indicate that the power-up is successful.

Fly Button
The fly button lets you control Solo's main flight functions: starting motors, auto-takeoff, auto-land, and activating manual flight.

Return Home
The return-home button allows you to end your flight automatically at any point by returning Solo to its original launch point and landing.

Pause Button
The pause bottom is Solo's emergency air brake. Press pause to stop Solo and hover in place.

Option Buttons
The A and B buttons change functionality based on where you are in the operational flow. The screen will show the currently assigned functions of A and B at all times. You can program A and B to specific functions using the controller.

Antennae

Mobile-device holder

Gimbal controls

Joysticks

Screen

Pause

Return home

Fly

Power

Options
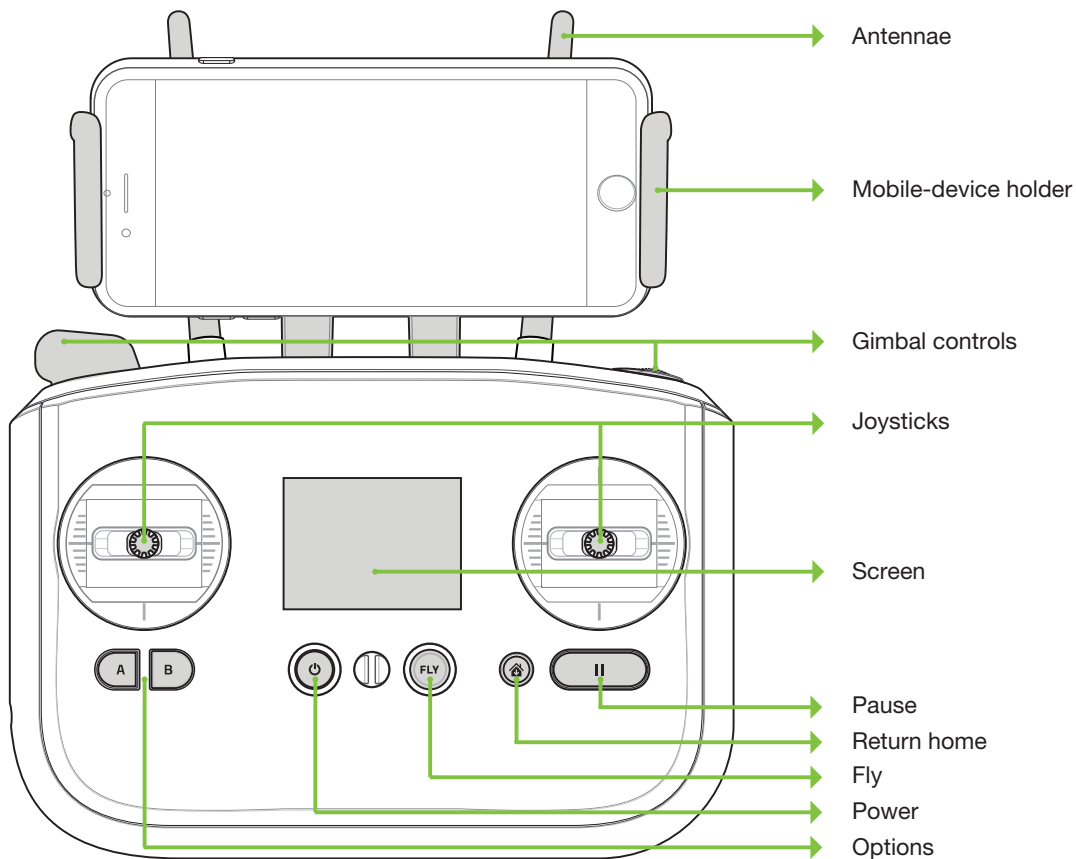
Figure 1.3.1: Controller Schematic Diagram

1.4 Operating Parameters

The operating parameters in Figure 1.4.1 apply to Solo. Always operate Solo within these parameters. Solo's performance and behaviors are not guaranteed when conditions violate the parameters listed below.

Figure 1.4.1: Solo Operating Parameters & Specifications Table

Communication frequency	2.4 GHz
Estimated flight time	25 minutes*
Maximum altitude	400 ft.
Range	2,000 ft. from launch point
Payload capacity	1.1 lbs.
Cruise speed	5 kts (2.5 m/s)
Maximum speed	55 mph (24.5 m/s)
Maximum climb rate	11 mph (4.9 m/s)
Maximum descent rate	6 mph (2.6 m/s)
Headwind limitation	17 mph (7.7 m/s)
Crosswind limitation	17 mph (7.7 m/s)
Operating temperature	32 F - 113 F
Operating relative humidity	0-85% RH
Max altitude above sea level	10,000 ft.

*Flight time varies with payload, wind conditions, elevation, temperature, humidity, flying style, and pilot skill. Listed flight time applies to elevations less than 2,000 ft above sea level.

1.5 Autopilot

Solo uses a Pixhawk 2 autopilot running APM:Copter 3.3-dev software. APM:Copter is open-source flight control based on the MAVlink communication protocol and part of the ArduPilot project. Pixhawk 2 runs an ARM Cortex-M4 STM32F427 processor with 2 MB of flash memory and 256 KB of RAM. Combined with an array of CAN, I2C, SPI, PWM, and UART interfaces, Pixhawk 2 uses a suite of onboard sensors to calculate Solo's orientation and motion in flight. This data is input into APM:Copter's inertial navigation and position estimation algorithms and combined with control inputs to send commands to Solo's propulsion system.

Figure 1.5.1: Solo Onboard Sensors Table

Location	Sensor	Manufacturer / Part Number*	Data Type
Pixhawk 2 FMU	Accelerometer	InvenSense / MPU6000	Orientation
Pixhawk 2 FMU	Gyroscope	InvenSense / MPU6000	Motion
Pixhawk 2 FMU	Magnetometer	Honeywell / HMC 5983	Cardinal direction
Pixhawk 2 FMU	Barometer	Measurement Specialties / MS5611	Altitude
Pixhawk 2 Stabilized IMU	Accelerometer	InvenSense / MPU6000	Orientation
Pixhawk 2 Stabilized IMU	Gyroscope	InvenSense / MPU6000	Motion
Pixhawk 2 Stabilized IMU	Barometer	Measurement Specialties / MS5611	Altitude
Pixhawk 2 Stabilized IMU	Accelerometer	STMicroelectronics / LSM303D	Orientation
Pixhawk 2 Stabilized IMU	Magnetometer	STMicroelectronics / LSM303D	Cardinal direction
Pixhawk 2 Stabilized IMU	Gyroscope	STMicroelectronics / L3GD20	Motion
3DR Solo GPS	GPS	u-blox / NEO-7N	Longitude & latitude
3DR Solo GPS	GPS patch antenna	Taoglas / GP.1575.25.4.A.02	Longitude & latitude
3DR Solo Compass	Magnetometer	Honeywell / HMC 5983	Cardinal direction

*Links to data sheets for sensors listed in this table are location in Appendix 6.4.

1.6 Propulsion

Solo uses four brushless, 880 K_v motors and four propellers for propulsion. For control and aerodynamic efficiency, two motors spin clockwise and two motors spin counterclockwise. Navigation in the air is achieved by mixing propulsion of the four motors to actuate flight control along the roll, pitch, and yaw axes.
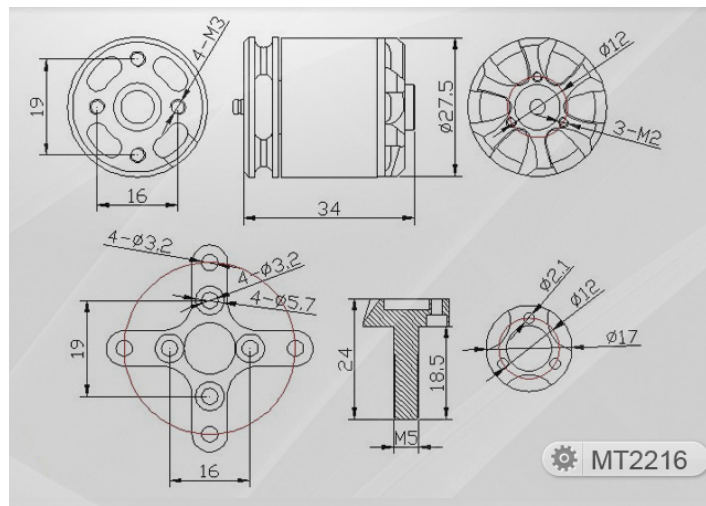
Figure 1.6.1: Motor Schematic Diagram

Each of the four motors is numbered by the marking on the arm. These numbers correspond to the autopilot calculations for these commands and are used for indicating motor replacement procedures. Each motor is controlled by an Electronic Speed Controller (ESC) that regulates the rotation of the motors to achieve the speed commanded by the autopilot.
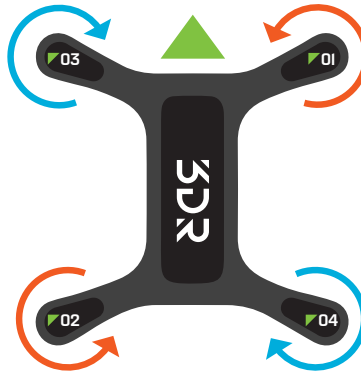
Figure 1.6.2: Solo Motor Order

1.7 Electrical System

Battery
Solo's onboard electrical system is powered by a rechargeable lithium polymer battery. The battery communicates over I2C with the Solo mainboard to report information about it's current voltage. This information is pushed over the telemetry output to the operator to provide data for in-flight power management and battery failsafe.

Mainboard
The Solo mainboard passes regulated voltage to the computing components onboard Solo: Pixhawk 2, 3DR Solo Link, 3DR Solo GPS, and 3DR Solo Compass. These components have a two-way serial signal link with the mainboard to transfer data between them via the mainboard as a central hub. The LEDs on each arm of Solo are components of the ESCs and receive power and I2C signals via the ESCs.

Figure 1.7.1: Solo Electrical System

Controller

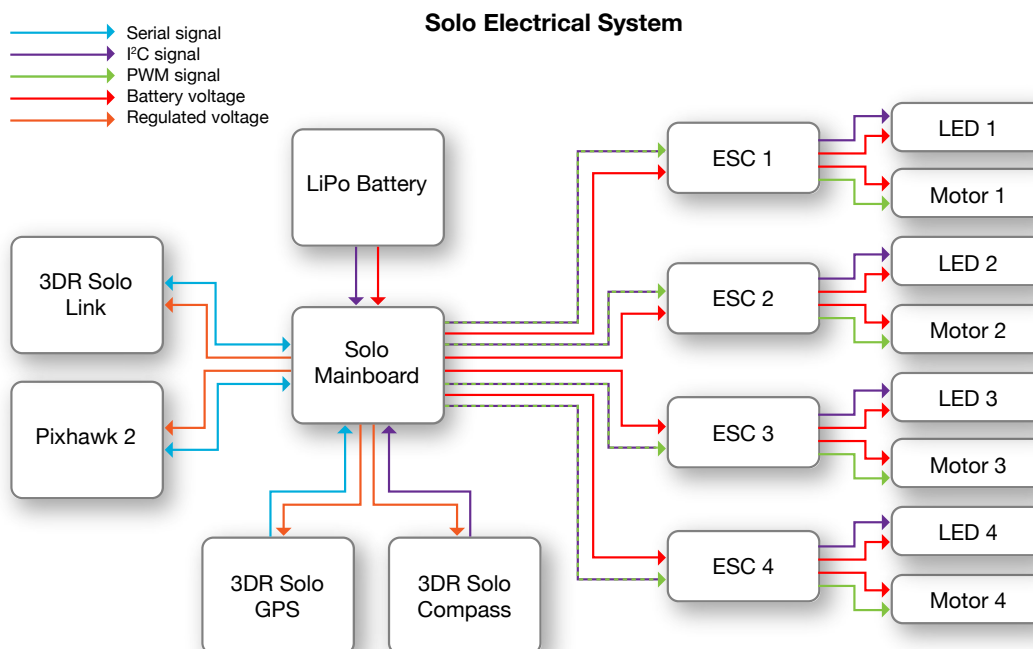The controller is powered by a rechargeable lithium ion battery. The controller mainboard monitors the battery's voltage and passes regulated voltage to the other components of the controller. 3DR Controller Link, the LED screen, and the controller's input devices (buttons, dials, and joysticks) receive regulated voltage from the battery via the mainboard. The data signals between the mainboard and the components are one-way with the exception of 3DR Controller Link, which communicates with the mainboard over a two-way serial link

1.8 Communication

To communicate with the operator, Solo runs three communication flows: joystick control input, video output, and control input/telemetry output.

Controls

The operator can initiate control inputs from the controller or the app. On the controller, the mainboard receives inputs from the joysticks, buttons, and dials and converts them to MAVlink commands. The mainboard sends the MAVlink commands to 3DR Controller Link for transmission to Solo over the 3DR Link WiFi network. When initiated from the app, control inputs are sent from the app over the 3DR Link network and received by 3DR Controller Link which re-transmits the inputs to Solo over the 3DR Link network. The redirection of controls from the app is due to the improved range of the controller's antennas. Solo receives the controls through 3DR Solo Link and transfers to the data to Pixhawk via the Solo mainboard.

Smart Shots

Solo's Smart Shots are autonomous flight patterns that make it easy to create aerial video. Smart Shots allow the operator to choose points of interest in 3D space and fly specific patterns in relation to those points. The operator can control Smart Shots from either the controller or the app. When using the controller with Smart Shots, the joysticks are re-mapped to restrict Solo's movement within the limitations of the Smart Shot. On the app, touch-screen controls provide the same functionality as the joysticks. To Smart Shot control inputs and telemetry outputs, the Shot Manager software module runs on 3DR Solo Link and regulates all control inputs to ensure compatibility with any active Smart Shots.

Telemetry Output

Telemetry data from Solo is pushed from Pixhawk to 3DR Solo Link via the mainboard and transmitted to the controller over the 3DR Link network. On the controller, 3DR Controller Link receives the outputs, translates the MAVlink commands, and displays the live values on the controller's screen. To transmit data to the app, 3DR Controller Link forwards the data to the app through the 3DR Link network.

2 Setup

This sections covers everything you need to set up Solo out of the box.

2.1 In the Box

Solo includes the quadcopter vehicle, controller, propellers (four plus two spares), Solo charger, and controller charger.
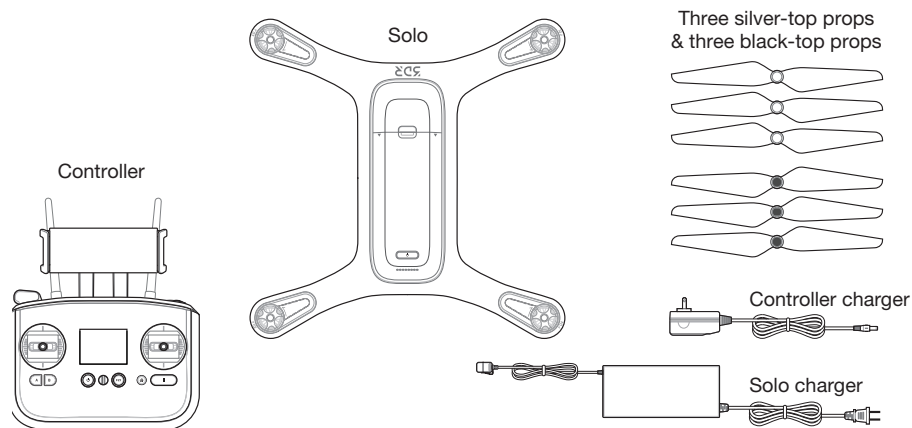

Figure 2.1.1: Solo Parts

2.2 Battery

Solo is powered by the rechargeable Solo Smart Battery that provides approximately 25 minutes of flight time per full charge. (Keep in mind that flight time depends on payload, wind conditions, elevation, temperature, humidity, flying style and pilot skill, so the actual flight time may vary.) As a lithium polymer battery, the Solo Smart Battery requires specific handling practices to ensure safe operation and prevent accidents. For more information about battery safety, see section 20.

Charging
The level of the battery is indicated by the lights below the power button. Press the power button once to display the current power level. The Solo battery ships with approximately 50% charge, so charge fully before your first flight for maximum flight time.

Remove the battery from Solo before charging. Only charge the battery using the designated Solo charger; using a different charger can damage the battery or cause a fire. Charge the battery in conditions between 32° F and 113° F only.

To charge the battery, connect the Solo charger to the battery and a wall outlet. While charging, the indicator lights pulse at the current level, and when fully charged, the lights turn off. There is an additional indicator on the battery charger that turns from red to green when the battery is fully charged. The battery takes approximately 1.5 hours to charge fully.
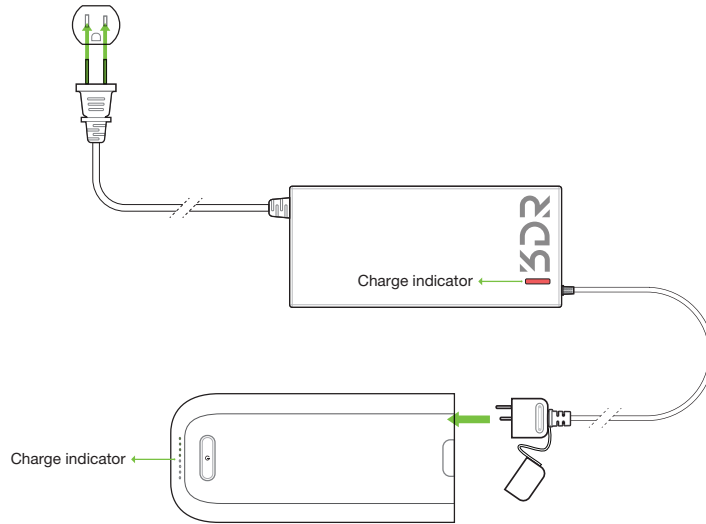
Figure 2.2.1: Charge Solo Battery

Powering

To power Solo, insert the battery into Solo's battery bay and slide the battery forward until it clicks into place. Press and hold the battery power button to turn on Solo. When Solo power on, the battery will display an LED animation and you will hear the startup tone. Only power Solo using the designated 3DR Solo Smart Battery; using a different battery can permanently damage Solo.

> ⚠ Make sure Solo is level before powering on and keep Solo still during power up and while the sensors initialize. Moving Solo during this process causes the sensors to calibrate incorrectly and can create a preflight error or affect in-flight performance.

Figure 2.2.2: Insert Solo Battery

2.3 Controller

The rechargeable lithium ion (Li-ion) controller battery is housed inside the controller, accessible by the battery door at the back of the controller. The controller battery is pre-attached to the controller, and shouldn't be disconnected unless:

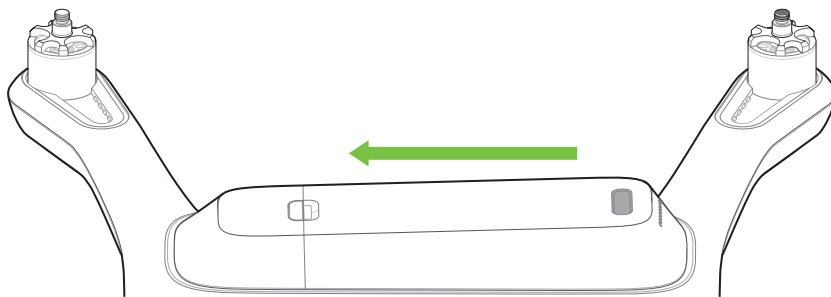 • You plan to store the controller for over three months without using it. In this case, disconnect the battery from the controller and leave the battery inside the controller to store it.
 • You need to switch the controller battery for a new or upgraded controller battery. Upgraded controller batteries with double the capacity are available from store.3dr.com. In the case where you need to store the extra controller battery, store it in location where it will not come into contact with metal objects or other batteries. If the battery's connector comes into contact with a metal object, it can short circuit the battery and cause a fire.

Charging
Only charge the controller using the designated controller charger; using a different charger can damage the controller or cause a fire. Charge the controller in conditions between 32° F and 113° F only.

To charge the controller, connect the controller charger to the barrel jack on the side of the controller and to a wall outlet. To check the battery level of the controller, press the power button. A fully charged controller lasts for approximately 6 hours. Always check the controller's battery level before you fly, and recharge when prompted by the controller. The controller takes approximately 3 hours to charge fully.
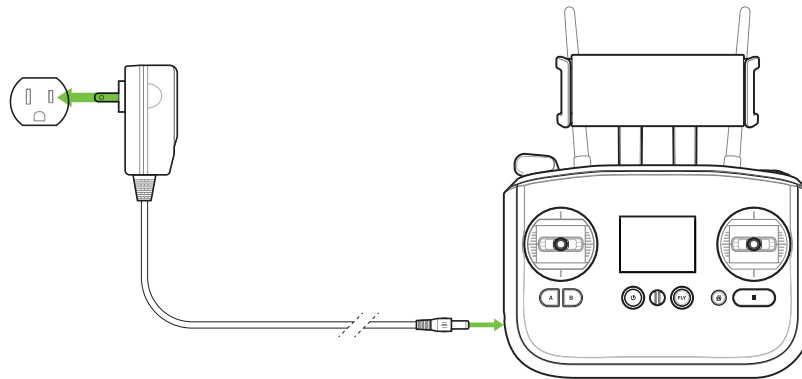
Figure 2.3.1: Charge Controller

Powering
To power on the controller, press and hold the controller power button until you receive the vibration feedback and see the startup screen.
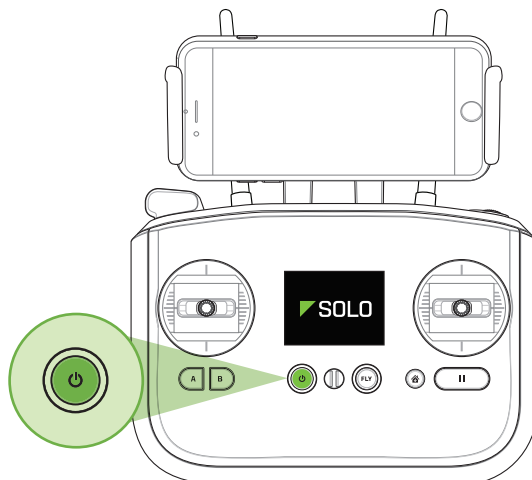
Figure 2.3.2: Power On Controller

2.4 Propellers

Solo uses two types of self-tightening propellers, indicated by the color of the circle at the center of the propeller.

Attaching
Attach the propellers with silver tops to the motors with a silver dot on the top of the motor shaft, and attach the black-top propellers to the motors with the black dots. Make sure to remove the paper labels from the motors before attaching the propellers.

Silver-top propellers tighten clockwise; black-top propellers tighten counterclockwise. Check the lock and unlock icons on each propeller to see the correct directions for tightening and removing.

.... remove motor labels   .... remove motor labels
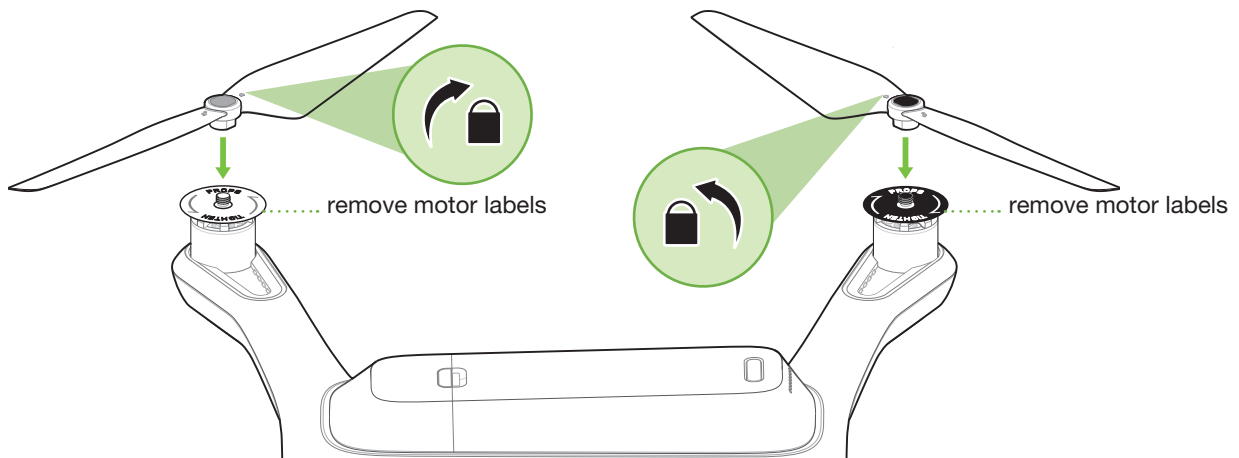
Figure 2.4.1: Attach Propellers

2.5 Camera

Solo includes a fixed GoPro® The Frame™ mount for your GoPro® HERO 3, 3+ or 4.

Attaching
To attach the camera to the GoPro® The Frame™ fixed mount, insert your GoPro® upside down and connect the Solo HDMI cable to the camera.

Your GoPro®
HERO 3, 3+ or 4

GoPro® The Frame™

Mount your GoPro®
upside down.

Connect the HDMI
cable.
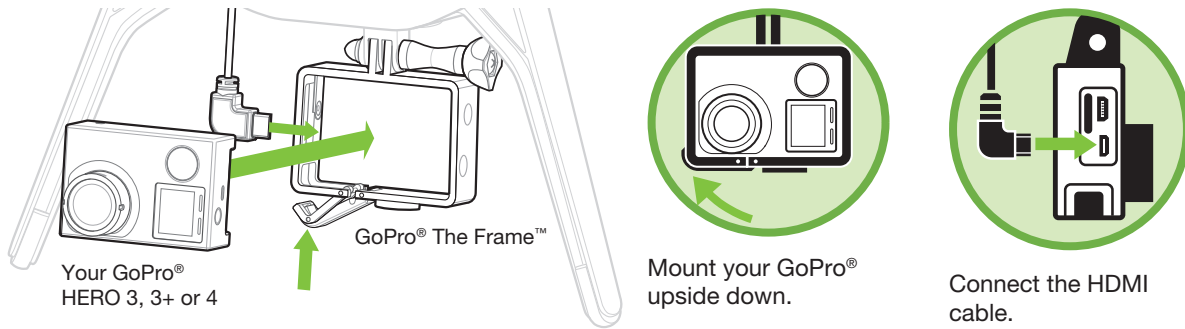
Figure 2.5.1: Attach Camera

Settings
For best results, adjust the camera settings for inverted orientation and medium field of view. (Setting the field of view to medium ensures that you won't see the propellers in the frame.)

Set the GoPro® to
inverted orientation:

GoPro®
Settings

Camera
Orientation

Set the GoPro® to
medium field of view:

GoPro®
Settings

FOV

Figure 2.5.2: Camera Configuration Process

⚠️ Make sure that the Wi-Fi on your GoPro® is turned OFF. It can interfere with Solo's communication signals and cause unexpected behavior.

2.6 App

"3DR Solo" provides a streaming video link to a mobile device and provides a simple graphic interface for interacting with Smart Shots and other advanced Solo features.

Install
Visit 3dr.com/soloapp or download "3DR Solo" from the App Store or Google Play Store. 3DR Solo works with iOS 8.0 or later and Android 4.1.2 (Jelly Bean) or later.

Connect to Solo
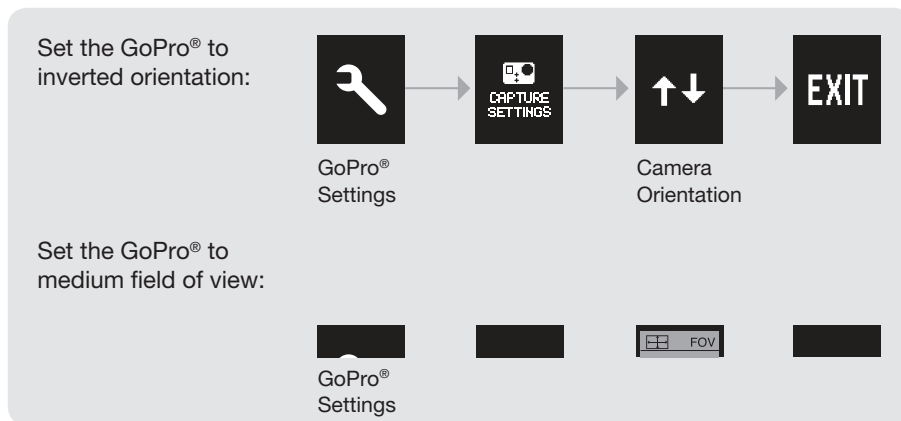To connect the app to the 3DR Link WiFi network, access the WiFi settings on the mobile device and select Solo_ Link-####. Enter the temporary password "sololink". Once connected, return to the app to continue.
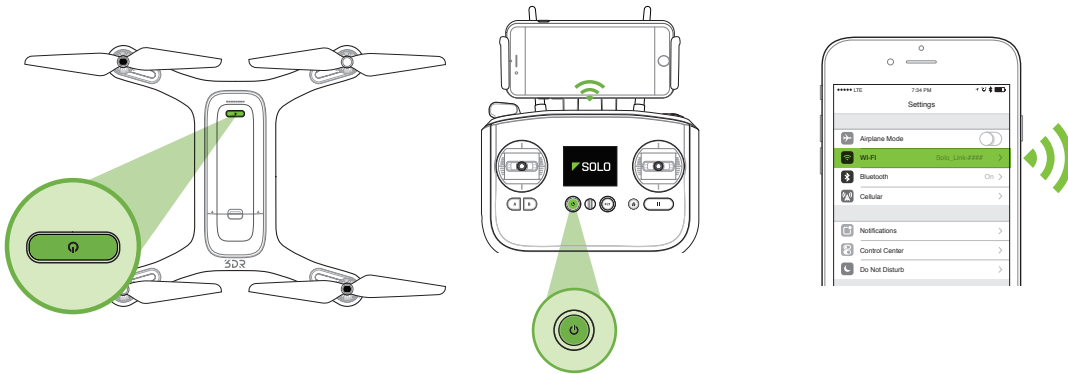
Figure 2.6.1: Connect to Solo Link

Update
Before your first flight, perform the required first-flight update for Solo and the controller using the app. The controller will prompt you for the update with the screen shown in Figure 2.6.2.
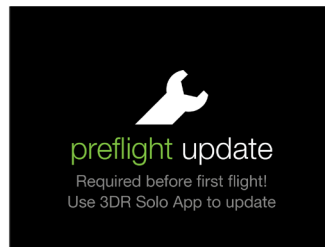
Figure 2.6.2: Controller Preflight Update Prompt

To complete the update, open the app and select the settings menu in the top-left corner. Select Software Update to begin the update process. Use a fully charged Solo battery, ensure that both the controller and Solo are powered, and the app will automatically update the system wirelessly.
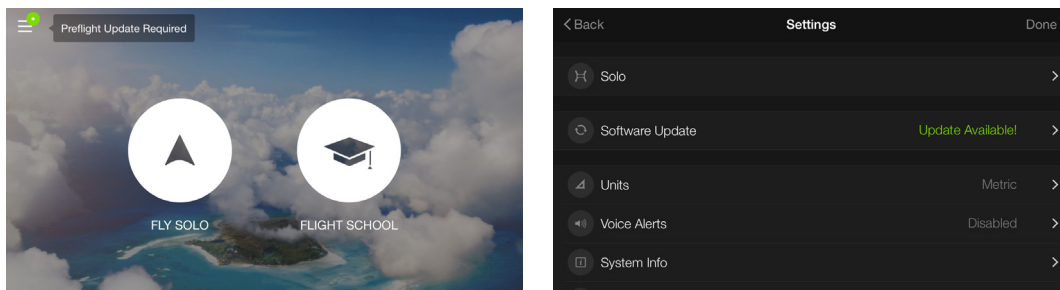
Figure 2.6.3: Solo App Update Process

Ensure that the controller is connected to the charger during the update process. While the update is in progress, the controller will show the screen shown in Figure 2.6.4. The controller may complete a restart as part of the update process.
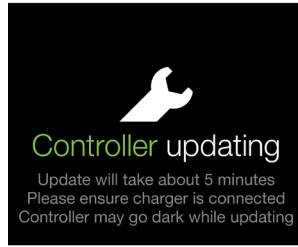
Figure 2.6.4: Controller Updating Display

When the controller update is complete, the controller will display the screen shown in Figure 2.6.5. Press A to continue the update.
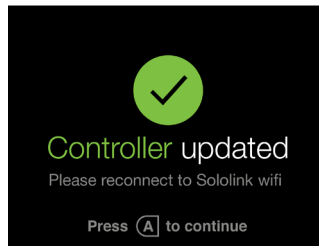

Figure 2.6.5: Controller Update Display

After pressing A, Solo will update. The controller will display waiting for Solo and Solo updating (Figure 2.6.6) while the update is in progress. When the update is complete, Solo's LEDs will display green and the controller will return to the standard startup screen.
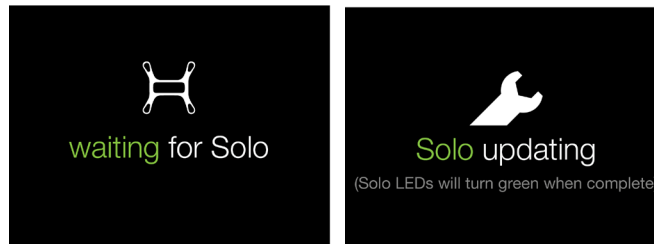
Figure 2.6.6: Solo Update Displays

View Video
After the update is complete, select Fly Solo to view video. Solo, the controller, and the GoPro® must be powered to view video. Verify that you can view video before your first flight.
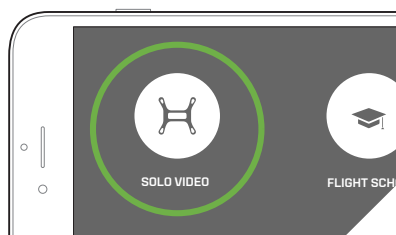
Figure 2.6.7: Viewing Video on the App

3 Safety

The following best practices will help to ensure safe, successful flights and reduce the risk of accident and serious injury.

> ⚠️ Read and understand these important safety instructions before your first flight to help reduce the risk of accident and serious injury.

3.1 Location

Don't fly Solo indoors. Always fly in clear, open areas at a safe distance from yourself, other people, power lines, animals, vehicles, trees, and buildings. When flying in areas with potential hazards, maintain 100 feet from any people, vehicles, or structures. As the operator, you are responsible for navigating Solo to avoid obstacles, including during automated flight.

Don't fly within 5 miles of an airport or anywhere pilots operate manned aircraft, or within any airspace restricted by your local, state or national airspace authority. As the operator, you are responsible for knowing and understanding the regulations that govern small unmanned aircraft like Solo in your jurisdiction.

3.2 Environmental Awareness

Before flying, determine the boundaries of the safe flying area at your flying location. Be aware of any risks at your location, including bodies of water, structures, trees, etc. Designate a few areas as safety zones where you can safely land the copter in case of an unsafe situation. Throughout your flight, be prepared to recover Solo manually if it goes outside the safe flying area.

Don't fly Solo in extreme weather conditions such as rain, high winds, snow or fog. Environmental factors and GPS irregularities can cause instability in flight, and this can affect Solo's performance or cause an in-flight failure.

3.3 Propellers

> ⚠️ Spinning propellers can cause serious injury. Never touch moving propellers or place any objects in the way of the propeller arcs.

When prompted to start motors before takeoff, always ensure that the propellers are clear of any obstructions and away from any people, animals, or property before activating. Do not touch moving propellers or approach Solo while the propeller are spinning. Always hold the fly button to stop the motors before approaching Solo.

After an auto-landing or return home, Solo will automatically detect the landing and stop the motors. Do not approach Solo until the propellers stop spinning. After a manual landing, hold the throttle (left joystick) to the bottom-left corner to stop the motors.

3.4 Home Position

Abstractly, Solo's home position is the latitude and longitude coordinates of the launch point used by the autopilot as the end point of a return home command. In practice, the autopilot saves the home position at the location where the motors are started *only after achieving GPS lock*. If Solo does not acquire GPS lock before starting the motors, no home position will be saved and the return-to-home feature will be unavailable.

3.5 Altitude & Safety Fence

Fly at appropriate altitudes for your flying location and local regulations. Solo cannot avoid obstacles on its own, so always select altitudes that avoid any obstacles, such as trees, buildings, and other tall structures.

Solo includes a 400-foot safety fence enabled by default. This altitude reflects current FAA regulations to avoid potential conflicts with manned aircraft and represents a safe line-of-sight altitude. If Solo reached the maximum altitude, it will stop ascending and limit throttle input to stay below 400 feet. In this case, the display shown in Figure 3.5.1 will be displayed to the user to inform them to fly at a lower altitude.
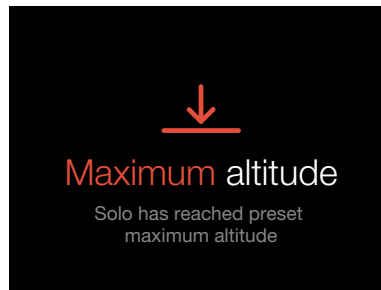

Figure 3.5.1: Controller Maximum Altitude Warning

3.6 Emergency Procedures

If Solo exhibits instability in flight or flies outside your designated safe flying area, perform one of Solo's emergency recovery procedures to land safely.

Pause
The controller's pause button allows you to stop Solo mid-air. Solo will hover at the paused location until given another command. Use the pause button to stop Solo before hitting an obstacle or to re-orient Solo for navigation.

Regain Manual Control
During Smart Shots and other autonomous behaviors, keep the controller easily accessible, and be prepared to regain manual control at any time. To regain manual control during Smart Shots, press the fly button.

Return Home
If Solo acquired GPS lock prior to takeoff, press the controller's home button to return Solo to the launch point and land. Use return home after receiving a low battery notification or to end your flight easily.

Land
To land Solo at its current position, press and hold the fly button. Solo will land immediately at the current position. If Solo does not have GPS lock, there will be no automatic position as Solo descends and drifting may occur depending on environmental conditions.

3.7 Power Management

The controller monitors the level of the controller battery and the Solo battery in flight. If either battery reaches low levels during flight, the controller announces the low battery state and provides an instruction to end your flight and recharge the battery. If the controller battery reaches a critical level during flight, Solo automatically returns to home. If the Solo flight battery reaches a critical level, Solo automatically lands to prevent a crash.
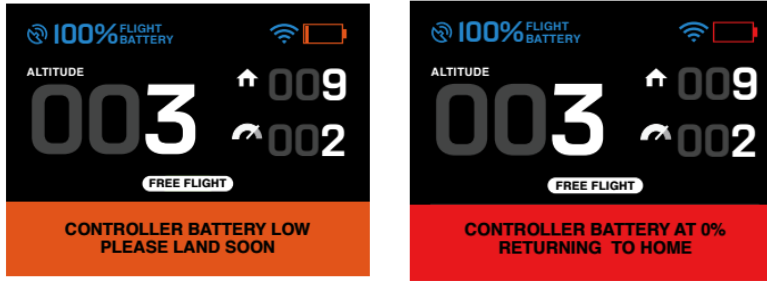
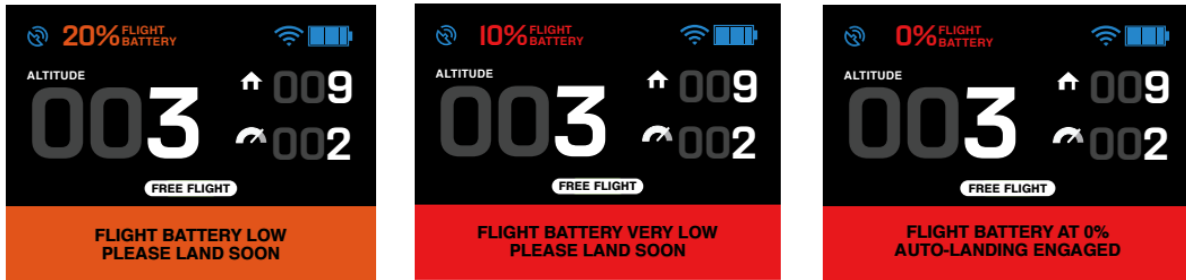Figure 3.7.1: Low controller battery warning and return-home notifications

Figure 3.7.2: Low flight battery warning and auto-land notifications

3.8 Flight Battery

Use caution when handling the Solo Smart Battery; there is a risk of fire if the battery is handled roughly enough to damage it. Never alter, puncture, throw, bend or impact the battery. Keep the battery away from liquids, fire, microwaves, and other hazardous or combustible materials. Don't expose the battery to extreme temperatures. The battery functions optimally when used in -4° F to 140° F; operating Solo at the extremes of this range can affect its performance. If the battery is hot to the touch, wait for it to cool before using or charging.

Inspect the battery before and after each flight. It is possible for the battery to be damaged in shipping, use or charging. If you notice any abnormal features such as damage to the exterior shell, swelling, deformation of the battery, abnormal smell, leakage, or other unexpected behavior, do not use the battery! These can be signs of serious damage that can cause the battery to catch fire or explode. In this case, do not use the battery again. Disconnect the battery, place the battery in a safe area outside of any buildings or vehicles and away from fire and flammable materials to prevent a hazard in case of fire or explosion. Do not dispose of the battery in the trash; dispose of the battery at local battery recycling center. In the US and Canada, visit call2recycle.org to find a location.

For long term storage, the battery will last longer if you store it in 64° F to 82° F, between 45-85% relative humidity and with 50% charge (instead of at empty). Always make sure to store the battery in a place where it won't be exposed to extreme temperatures or direct sunlight.

3.9 Controller

Keep the controller away from liquids, fire, microwaves, and other hazardous or combustible materials. Don't expose the controller to extreme temperatures. The controller functions optimally when used in -4° F to 140° F. If the controller is hot to the touch, wait for it to cool before using or charging.

Perform periodic visual inspections of the controller battery to check for any damage. It is possible for the battery to be damaged in shipping, use or charging. If you notice any abnormal features such as damage to the exterior shell, swelling, deformation of the battery, abnormal smell, leakage, or other unexpected behavior, do not use the battery! These can be signs of serious damage that can cause the battery to catch fire or explode. In this case, do not use the battery again. Disconnect the battery, place the battery in a safe area outside of any buildings or vehicles and away from fire and flammable materials to prevent a hazard in case of fire or explosion. Do not dispose of the battery in the trash; dispose of the battery at local battery recycling center. In the US and Canada, visit call2recycle. org to find a location.

For long term storage, the controller battery will last longer if you store it in 64° F to 82° F, between 45-85% relative humidity and with 50% charge (instead of at empty). Always make sure to store the controller in a place where it won't be exposed to extreme temperatures or direct sunlight.

3.10 GPS Management

Solo requires an active GPS signal for advanced automated functions and Smart Shots. After powering on, Solo will wait to acquire a strong GPS lock. The following requirements define a GPS lock:

• Reported horizontal position accuracy	< 16 ft. (5 m)
• Reported speed accuracy	< 2 mph (1 m/s)
• Number of satellites	≥ 6
• Difference between GPS and inertial navigation vertical velocity	< 2 mph (1 m/s)

After acquiring GPS lock, Solo will enter into standard flight, known as fly mode, and all advanced features and Smart Shots will be available, including return home. If GPS lock is not acquired before takeoff, return to home will be unavailable for the duration of the flight and the user will have the option of taking off in non-GPS-assisted fly: manual mode by pressing A (Figure 3.10.1).
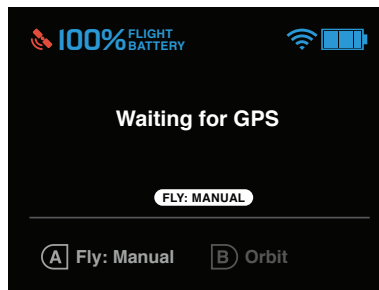

Figure 3.10.1: Controller Waiting-for-GPS Prompt

If GPS is lost during flight, the controller will display the screen shown in Figure 3.10.2 and switch from GPS-assisted fly mode to fly: manual. If GPS is recovered during flight, the user will be informed that standard fly is now available.
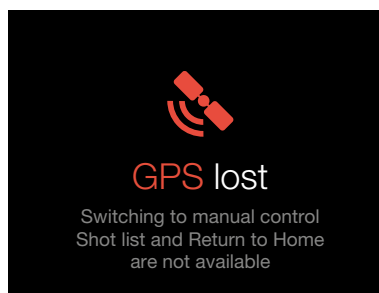

Figure 3.10.2: Controller GPS Lost Notification

3.11 Signal Management

Flying behind solid objects, like buildings and trees, blocks communication signals between Solo and the controller. Always maintain visual contact with Solo to ensure that the signal is unobstructed. Cell phone towers and nearby WiFi signals can cause interference with the communication system and decrease its range. Avoid flying in populated areas to avoid sources of interference.

If the communication signal with the controller is lost during flight, Solo will automatically return home if it has GPS lock. If the signal is recovered, the user will be prompted to re-take control and cancel the return-home command.
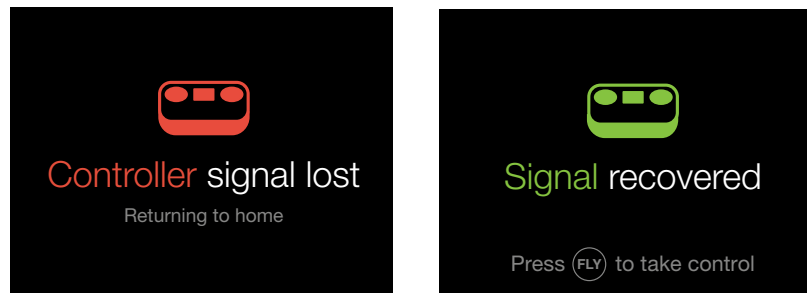

Figure 3.11.1: Controller Signal Lost Warnings With GPS

If there is no GPS lock and the controller signal is lost, Solo will initiate an emergency landing and display the screen shown in Figure 3.11.2.
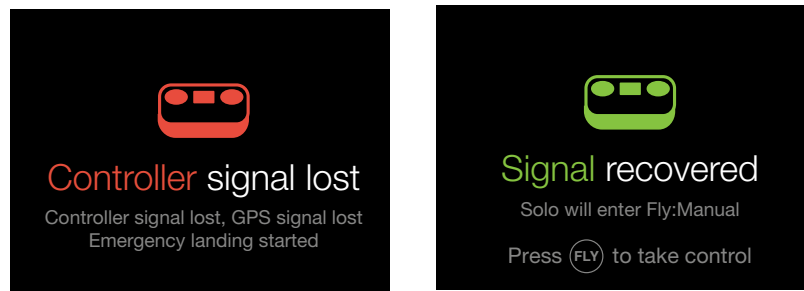

Figure 3.11.2: Controller Signal Lost Warnings Without GPS

4 Operating Procedures

This section covers the complete procedures for flying Solo, including preflight checks, manual control, automatic recall, and Smart Shots.

4.1 Preflight Checklist

Before flying, check the following operating conditions.

Location
-Current location and environmental conditions are suitable for flight. (See page 18 for safe flight guidelines.)
-Solo is placed at a clear launch point, facing away from you. (See page 18 for home position instructions.)

Components
-The propellers are correctly attached. (See page 14 for propeller installation instructions.)
-The propellers can spin smoothly and without obstruction when turned.
-No components on Solo appear loose or damaged.

Power
-The controller is powered on with at least 50% charge. (See page 13 for controller setup instructions.)
-Solo is powered on with the fully charged battery. (See page 11 for battery setup instructions.)
-The camera is attached, powered on and recording. (See page 15 for camera setup instructions.)
-Your phone or tablet is attached to the controller with the Solo app on and streaming video.
(See page 15 for app setup instructions.)

4.2 Takeoff

There are two options for taking off: manual and automatic. We recommend using automatic takeoff to begin the flight.

Start Motors
When you're ready to fly, the controller will prompts you to hold the fly button to start Solo's motors. Hold fly until the propellers spin. Solo is now active, ready for takeoff, and needs to be treated with appropriate caution to avoid safety hazards.
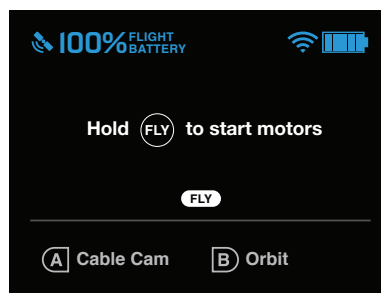

Figure 4.2.1: Controller Start Motors Prompt

Spinning propellers can cause serious injury! Always make sure Solo is clear of any obstructions and all people and animals are away from Solo before spinning the props.

Automatic Takeoff
Hold fly again to initiate automatic takeoff. Solo will rise to 10 ft and hover until receiving further control inputs.
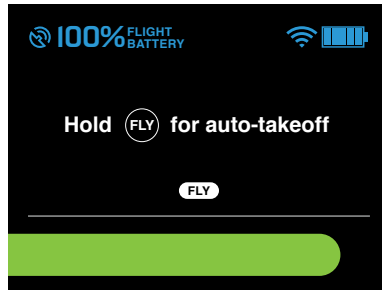

Figure 4.2.2: Controller Auto-Takeoff Prompt

Manual Takeoff
Once the propellers are spinning, raise the throttle stick above the center position to increase Solo's altitude and take off.
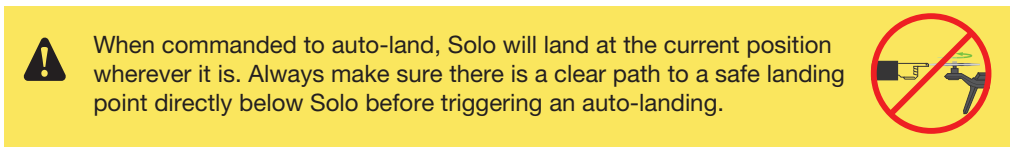
4.3 Land

There are three options for landing Solo: manual, automatic, and return to launch. We recommend automatic landing and return to launch.

Automatic Land
For auto-landing (recommended), press the Fly button in flight, and Solo will land at the current position. Optionally, you can auto-land Solo at the home position using the controller's return to home button. (See page 11 for more information about return to home.) After an auto-landing or return-to-home, the propellers will stop spinning automatically; wait until the propellers stop spinning before approaching Solo.

> ⚠ When commanded to auto-land, Solo will land at the current position wherever it is. Always make sure there is a clear path to a safe landing point directly below Solo before triggering an auto-landing.

Return Home
The return-to-home button ends your flight automatically by first returning Solo to the home position (launch point) then auto-landing. The propellers stop spinning automatically after activating return-to-home.

When commanded to return to home, Solo:
1 Achieves minimum altitude of 50 feet or maintains current altitude if above 50 ft.
2 Moves to launch point and loiters for 5 seconds.
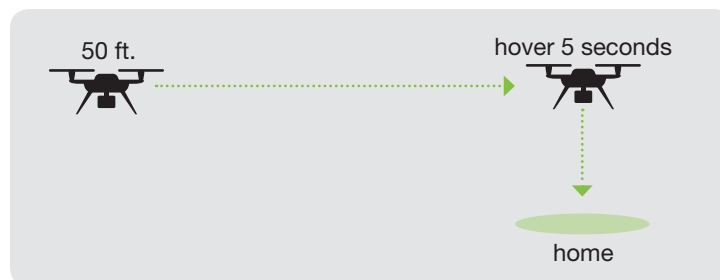3 Lands at the home point, and the propellers automatically stop after a few seconds.

Figure 4.3.1: Return Home Behavior

> ⚠ Never approach Solo while the propellers are spinning. After an auto-landing or return-to-home, always wait until the propellers stop before approaching or touching Solo. For a manual landing, hold the Fly button until the propellers stop before handling Solo.

Manual Land

For manual landing, move the left stick slightly below center, and slowly decrease Solo's altitude. When it is a few inches above the ground, hold the left stick fully back. Continue to hold the left stick fully back and hold the controller's Fly button until the props stop spinning.

4.4 In-Flight Data

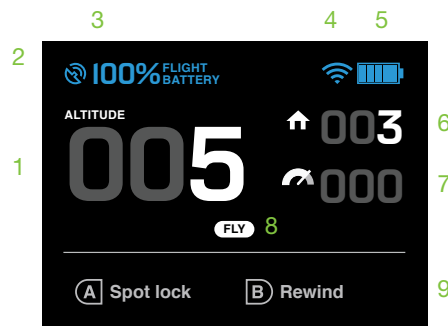Use the controller's main data display to monitor Solo's status in flight.

Figure 4.4.1: Controller In-Flight Data Display

1 Current altitude in feet
Keep Solo below 400 feet at all times. Solo returns to home if flown higher than 400 feet from home.

2 GPS signal status
Icon illuminates to indicate active GPS lock. GPS flight, pause, return to home, selfie and cable cam modes require GPS lock. Solo automatically switches to manual flight when no GPS lock is available.

3 Percentage of Solo battery remaining
The controller provides notifications at 20% and 10% to end your flight. At 0%, Solo automatically lands at the current position.

4 Signal strength between Solo and controller
Solo returns to home if the signal between Solo and the controller is lost during flight.

5 Controller battery level
The controller provides a notification to end your flight when the controller battery is low. When the controller battery reaches 0%, Solo automatically returns to home.

6 Current distance from the home point in feet
Keep Solo within 2,000 feet from home at all times. Solo return to home if flown farther than 2,000 feet from home.

7 Current speed in miles per hour

8 Current mode

9 Currently assigned functions of controller A and B buttons

4.5 Joystick Control

The controller's two joysticks allow you to navigate Solo in flight. The left stick controls Solo's altitude and rotation.
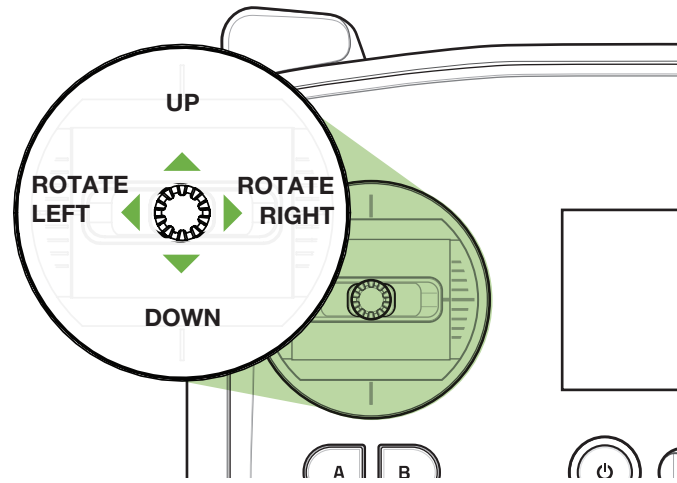
Figure 4.5.1: Controller Left Joystick

Move the left stick vertically to control Solo's altitude and acceleration.

To take off and to gain altitude, move the left stick slightly past the center position.

Set the left stick to center to maintain the current altitude.

Move the left stick back from center to decrease altitude.

Set the left stick fully back to land once Solo is a few inches above the ground.

Figure 4.5.2: Throttle Joystick Behaviors

Move the left stick horizontally to rotate Solo and control orientation.

Move the stick to the left to rotate counterclockwise.

Move the stick to the right to rotate clockwise.

Release the stick to stop rotating the maintain the current orientation

Figure 4.5.3: Yaw Joystick Behavior

Use the right stick to fly Solo forward, back, left and right in space. These movements are relative to Solo's current orientation, so always maintain awareness of Solo's forward-facing direction before using right stick controls.

FORWARD

LEFT   RIGHT

BACK
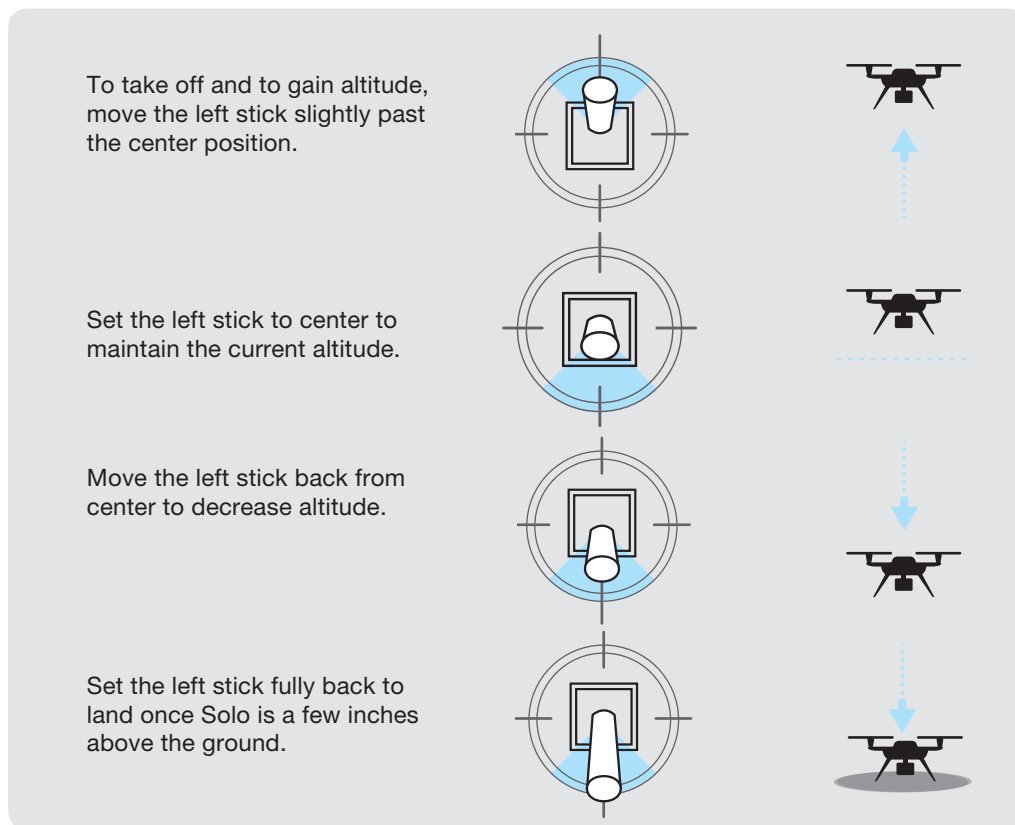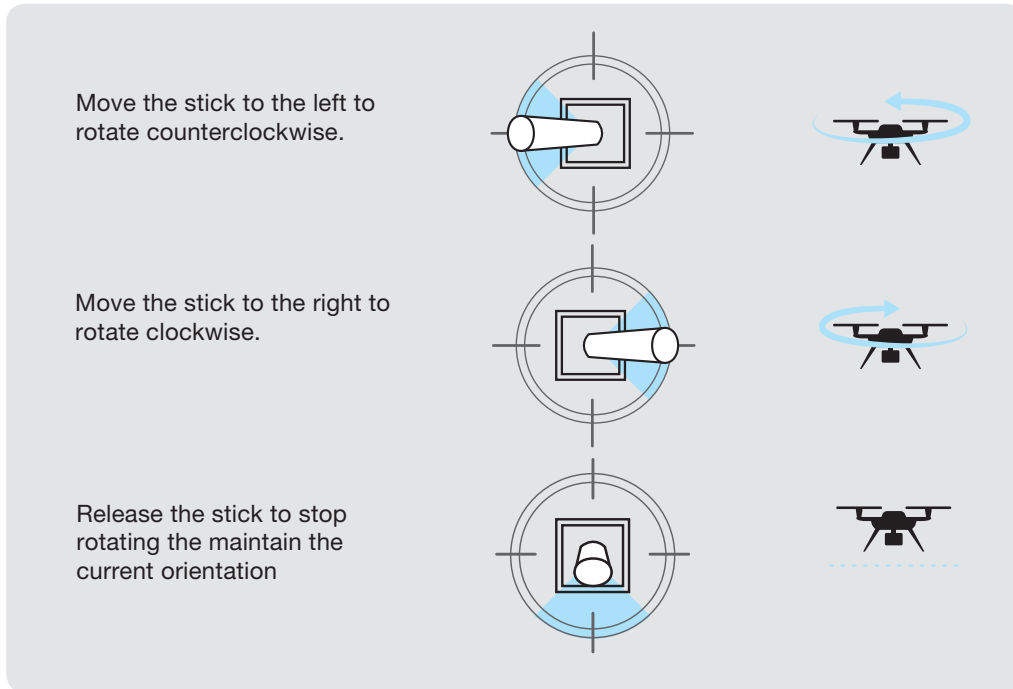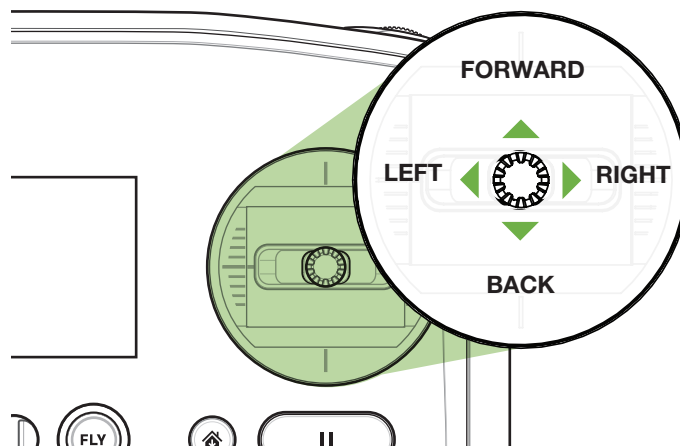
Figure 4.5.4: Controller Right Joystick Controls

Move the right stick vertically to control pitch.
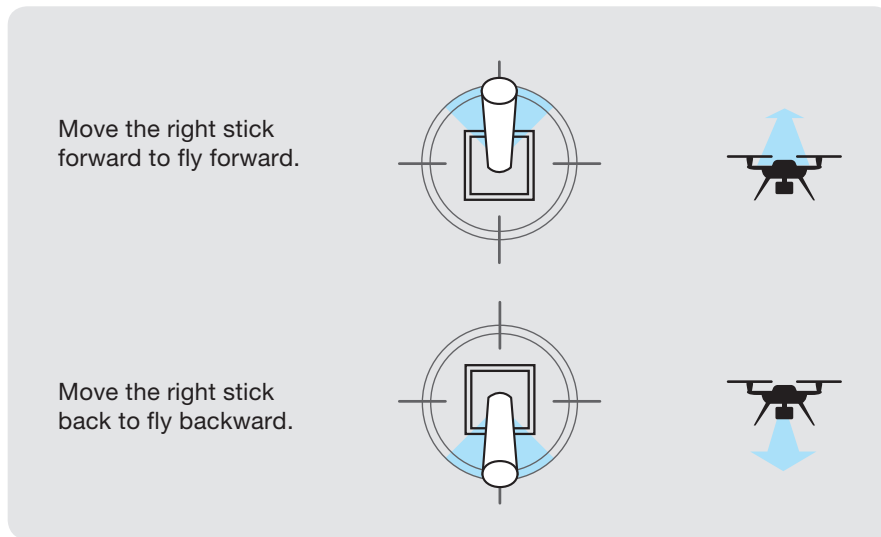

Figure 4.5.5: Pitch Joystick Controls

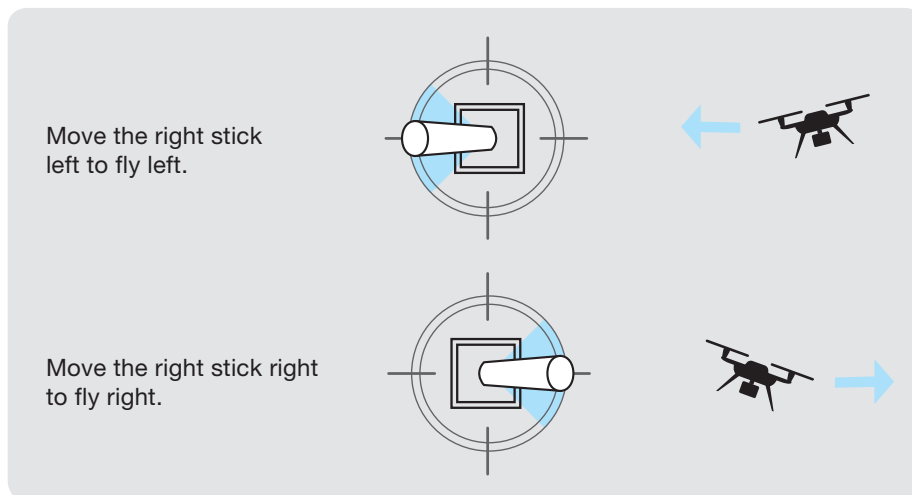Move the right stick horizontally to control roll.

Figure 4.5.6: Roll Joystick Controls

If you're new to drones, take some time to learn the basics before your first flight. Visit 3dr.com/solo/info or check out Flight School in the Solo app to learn about flight controls and best practices.

4.6 Smart Shots

Solo's Smart Shots automate video capturing to make it easy to replicate traditional filming techniques. Smart Shots can be useful for designing artistic video or for automating the flight procedure to restrict Solo to within a designated area.

Selfie
Solo performs an automated maneuver to capture a subject in a cinematic establishing shot.

To take a selfie:
1. Navigate Solo manually so the subject appears in the video frame with Solo approximately 10 feet from the subject.
2. Ensure that there is 100 feet of unobstructed space behind and above Solo.
3. Press A to start the selfie.
4. Solo flies backward 100 ft and upward 100 ft in a smooth arc.
5. Press pause to stop the automatic maneuver and use the right stick to move manually along the selfie path.

Use the Solo app to configure the distance and speed of the selfie shot or to activate selfie mode before takeoff.

Cable Cam
Create a smooth shot by flying Solo along an invisible cable between two preset points.

To fly a cable cam:
1. Press B to enter cable cam mode.
2. Navigate Solo manually to the first point so the video displays the desired subject, and press A to save the first point.
3. Navigate manually to the second point, and press A again to save the second point. Add a difference of altitude or orientation between the two points for an impressive cinematic effect.
4. Use the right stick to fly along the cable in either direction.

Use the Solo app to configure and interact with automatic cable cam shots.

5 Maintenance

Solo's components are designed to absorb impact from hard landings and protect the core electronics. If damage is sustained to Solo's legs or motors, replace them with official 3DR parts from store.3dr.com or an authorized retailer.

5.1 Legs

To replace one of Solo's legs, purchase a Leg Replacement Set form store.3dr.com or an authorized retailer.

1 Remove the plastic sheet from the leg.
2 Detach the antenna.
3 Use a #2 Phillips screwdriver to remove the two screws and detach the old leg.
(For legs without an antenna module, remove the two screws and replace the leg only.)

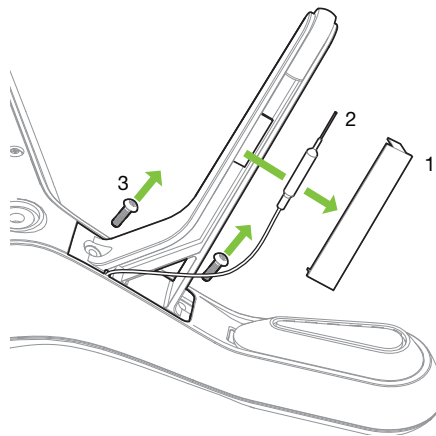Figure 5.1.1: Leg Replacement Process 1

1 Thread the antenna cable through the notch in the new leg. Be careful not to crush the cable.
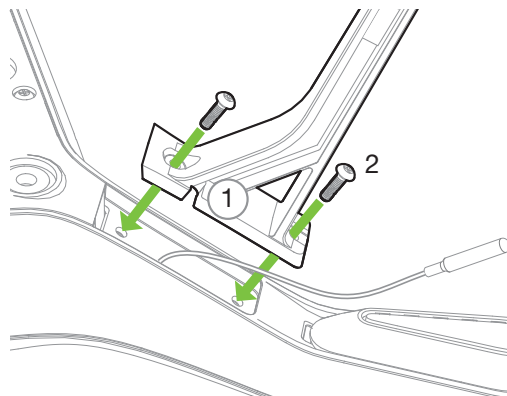2 Secure the leg using the two screws.

Figure 5.1.2: Leg Replacement Process 2

1 Affix the antenna to the inside of the leg.
2 Fold the ends of the new plastic sheet at right angles.
3 Remove the adhesive backing and stick the plastic sheet to the leg so it secures the antenna in place.
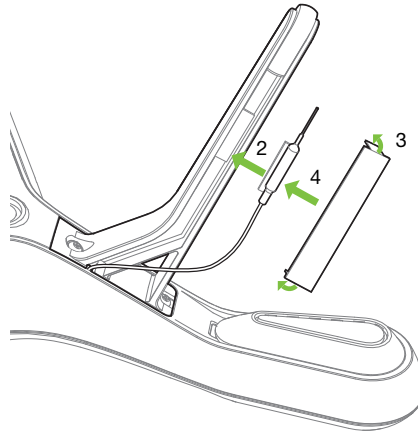
Figure 5.1.3: Leg Replacement Process 3

Replacing the Right-Rear Leg
Solo's right-rear leg (arm #04) contains the compass module. To replace the right-rear leg, purchase a Solo Replacement Leg with Compass from store.3dr.com or an authorized retailer.

5.2 Motors

Replacement motors are available as clockwise and counterclockwise motor pods. Use a counterclockwise motor pod to replace motors on arms #01 and #02, and use a clockwise motor pod to replace motors on arms #03 and #04.

First, use a small, flat prying tool to remove the LED cover form the underside of the arm.
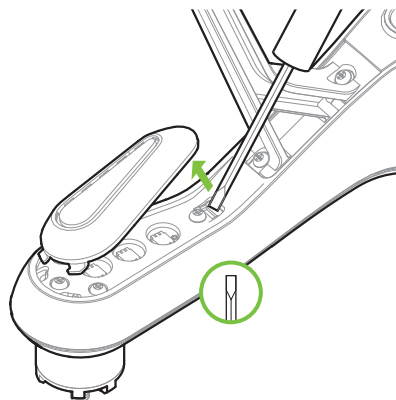
Figure 5.2.1: Motor Pod Replacement Process 1

Use a #2 Phillips screwdriver to remove the four screws securing the pod to the arm. (Figure 5.2.2 not to scale.)
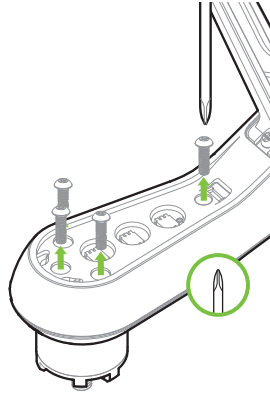
Figure 5.2.2: Motor Pod Replacement Process 2

Disconnect the wide beige connector, the red wire and the black wire to remove the old motor pod. To remove the wide beige connector, carefully lift the edges of the connector away from the pod until they pop out then remove the connector. Don't pull on the wires! The connector can break easily if force is used to remove it.
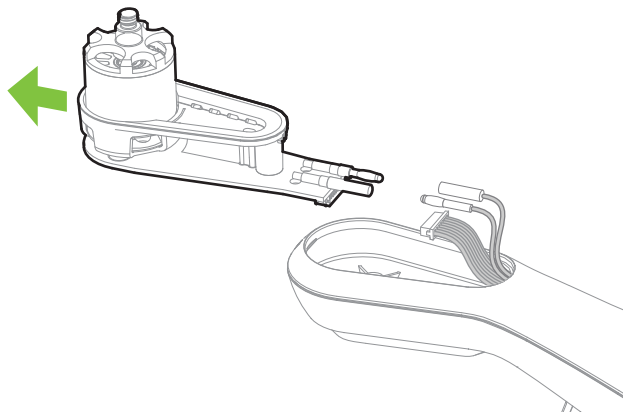
Figure 5.2.3: Motor Pod Replacement Process 3

Connect the 3 cables from the arm to the new motor pod. Tuck cables inside the arm, and set the pod into place.
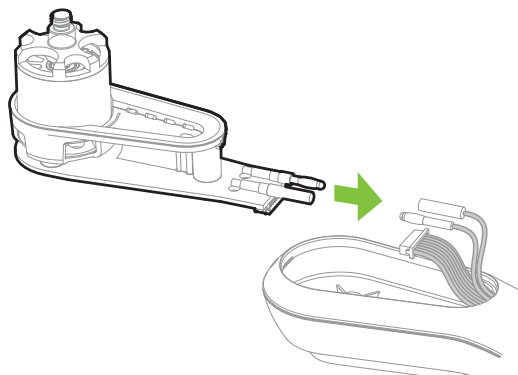
Figure 5.2.4: Motor Pod Replacement Process 4

Turn over Solo and replace the 4 screws to secure the new motor pod into place. Snap the LED cover back into place by positioning the front (1) and snapping the back tab into place (2).
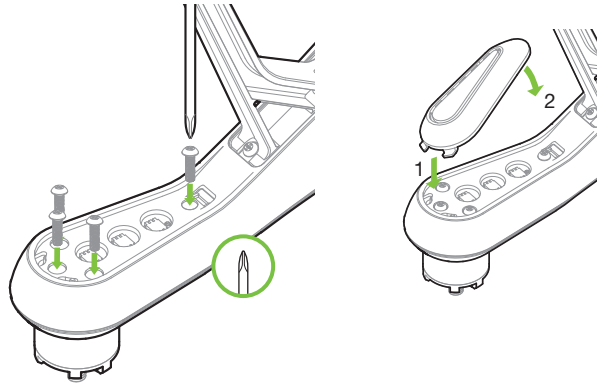
Figure 5.2.5: Motor Pod Replacement Process 5

5.3 Pairing

To pair a new controller with Solo, first power both the controller and Solo. Power off any other Solos or controllers in the vicinity. Once powered, press the pair button on the underside of Solo to activate pairing mode. To cancel pairing, press B.
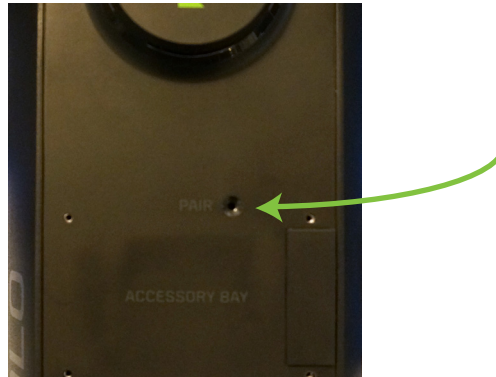
Figure 5.3.1: Solo Pair Button

The controller will automatically detect Solo and prompt you to pair. Hold the A and B buttons on the controller to start pairing.

Figure 5.3.2: Controller Pairing Process

6 Appendix

6.1 Specifications and Operating Parameters

Solo is a quad-rotor aerial vehicle powered by the 3DR Pixhawk 2 autopilot system and APM:Copter 3.3 flight control software. Solo communicates with the controller and Solo app over the 3DR Link secure wireless connection.

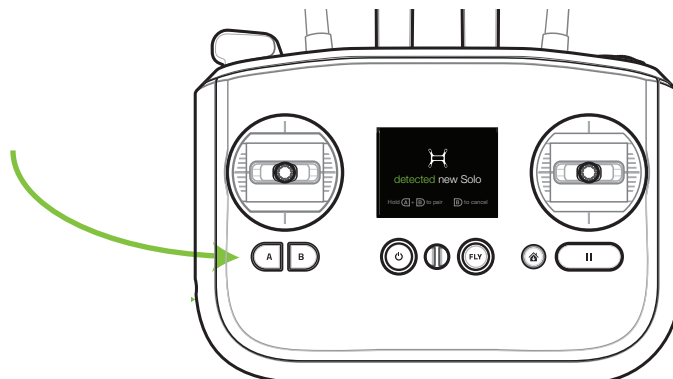|	
Autopilot:	3DR Pixhawk 2
Flight code:	APM:Copter 3.3
Control:	3DR Solo Controller
Wireless communication:	3DR Link 1.0
Frequency:	2.4 GHz
Height:	10.2 in.
Motor-to-motor dimension:	18.1 in.
Propulsion:	880 K_V motors, two clockwise rotating motors and two counterclockwise rotating motors
Propeller:	10 in. x 4.5 in.
Weight with battery:	3.3 lbs.
Controller battery life:	6 hours
Controller battery:	Li-ion 2600 mAh 7.2 Vdc (5200 mAh for extended battery)
Power:	Electric (rechargeable lithium polymer battery)
Battery:	Lithium polymer, 5200 mAh, 14.8 Vdc
Battery weight:	1 lb.
Estimated flight time:	25 minutes*
Maximum altitude:	400 ft.
Range:	2,500 ft. from launch point**
Payload capacity:	1.1 lbs.
Cruise speed:	5.7 mph (2.5 m/s)
Maximum speed:	55 mph (25.5 m/s)
Maximum climb rate:	11 mph (5.0 m/s)
Maximum descent rate:	5.5 mph (2.5 m/s)
Headwind limitation:	17 mph (7.7 m/s)
Crosswind limitation:	17 mph (7.7 m/s)
Camera:	Streaming video compatible with GoPro® HERO 3, 3+ or 4 Full compatibility with GoPro® HERO 3+ or 4
Solo app compatibility:	iOS 8.0 or later / Android 4.1.2 or later
Operating temperature:	32° F - 113° F (0° C - 45° C)
Operating relative humidity:	0-85% RH

*Flight time varies with payload, wind conditions, elevation, temperature, humidity, flying style, and pilot skill. Listed flight time applies to elevations less than 2,000 ft above sea level.

**Range varies with location, antenna orientation, background noise and multi-path.

6.2 Warranty

3D Robotics warrants to the original retail purchaser of Solo (the "Product") that at the time of purchase that this product is free from material defect in materials and workmanship. Should this Product fail during normal consumer usage and conditions due to defective material or workmanship within one year from the date of purchase, or such longer period as is required by applicable law ("Warranty Period"), such defect(s) will be
repaired or replaced at 3D Robotics' option, without charge for parts or labor directly related to the defect(s). The complete terms of the limited warranty applicable to Solo can be found at 3dr.com/terms.

This Warranty extends only to consumers who purchase the product from a 3D Robotics authorized reseller and is not transferable or assignable. This Warranty does not apply to: (1) Product subjected to abnormal use or conditions, accident (including without limitation, collision, crash or fire), alteration, or improper repair; (2) damage from exposure to moisture or extreme environmental conditions; (3) damage from use with any accessory, software or other product not expressly authorized by 3D Robotics; (4) damage from external causes such as dirt, sand, battery leakage, blown fuse, or improper usage of any electrical source; (5) commercial use; or (6) use in violation of law or ordinances in effect in the jurisdiction in which the Product is used.

3D Robotics assumes no liability for any accident, injury, death, loss, or other claim related to or resulting from the use of this product. 3D Robotics makes no other warranties for Solo, and makes no warranties whatsoever for service, software, maintenance or support for non-3D Robotics branded products. Such products, service, software, maintenance or support is provided by 3D Robotics "As Is" and any third-party warranties, products, software, services, maintenance or support are provided by the original manufacturer or supplier, not by 3D Robotics.

Software is subject to the separate software license agreement accompanying or made available to you in connection with the software. A portion of the software contains or consists of open-source software, which you may use under the terms and conditions of the specific license under which the open-source software is distributed. You agree that you will be bound by any and all such license agreements, and that your usage of this product indicates your acceptance of those agreements. Title to software remains with the applicable licensor(s). In no event will 3D Robotics be liable to you for damages, including any general, special, incidental or consequential damages arising out of the use or inability to use the software.

THE EXTENT OF 3D ROBOTICS' LIABILITY UNDER THIS WARRANTY IS LIMITED TO THE REPAIR OR REPLACEMENT PROVIDED ABOVE AND, IN NO EVENT, SHALL ITS LIABILITY EXCEED THE PURCHASE PRICE PAID BY PURCHASER FOR THE PRODUCT.

6.3 Regulatory Compliance

U.S. - FCC (Federal Communication Commission)

3DR Solo FCC: 2ADYD-S111A
3DR Solo Controller FCC: 2ADYD-AT11A

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by 3D Robotics could void the user's authority to operate the equipment.

Radiation Exposure Statement:
The Solo system has been tested to ensure compliance with FCC-mandated limits for general population radio frequency (RF) exposure for an uncontrolled environment. These limits ensure that no harmful effects will result from operating Solo according to the standard operating procedures described in this manual.

The body's Specific Absorption Rate (SAR) for the Solo controller is 1.33 watts per kilogram (W/kg) in compliance with the FCC limit of 1.6 W/kg. To reduce exposure to RF energy, hold Solo at least 20 cm away from your body at all times during operation. Do not operate the Solo controller co-located or in conjunction with any other antenna or transmitter.

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

Canada - Industry Canada

3DR Solo IC: 12768A-S114A
Model number: S110A

3DR Solo Controller IC: 12768A-AT14A
Model number: AT10A

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

IC Radiation Exposure Statement:
The Solo system has been tested to ensure compliance with IC-mandated limits for general population radio frequency (RF) exposure for an uncontrolled environment. These limits ensure that no harmful effects will result from operating Solo according to the standard operating procedures described in this manual. To reduce exposure to RF energy, hold Solo at least 20 cm away from your body at all times during operation. Do not operate the Solo controller co-located or in conjunction with any other antenna or transmitter. Changes or modifications not expressly approved by 3D Robotics could void the user's authority to operate the equipment.

6.4 Sensor Data Sheets

Pixhawk Flight Management Unit:

- InvenSense MPU6000 integrated accelerometer/gyroscope
http://www.invensense.com/mems/gyro/mpu6050.html

- Honeywell HMC 5983 temperature compensated magnetometer
http://www51.honeywell.com/aero/common/documents/myaerospacecatalog-documents/Defense_Brochures-documents/HMC5983_3_Axis_Compass_IC.pdf

- Measurement Specialties MS5611 Barometer
http://www.meas-spec.com/product/pressure/MS5611-01BA03.aspx

Pixhawk Stabilized Internal Measurement Unit:

- InvenSense MPU6000 integrated accelerometer/gyroscope
http://www.invensense.com/mems/gyro/mpu6050.html

- Measurement Specialties MS5611 Barometer
http://www.meas-spec.com/product/pressure/MS5611-01BA03.aspx

- STMicroelectronics LSM303D integrated accelerometer/magnetometer
http://www.st.com/web/catalog/sense_power/FM89/SC1449/PF253884

- STMicroelectronics L3GD20 gyroscope
http://www.st.com/web/catalog/sense_power/FM89/SC1288/PF252443?sc=internet/analog/product/252443.jsp

3DR GPS Module:

- u-blox NEO-7N
http://www.u-blox.com/en/gps-modules/pvt-modules/neo-7.html

-Taoglas GPS Patch Antenna, 1575MHz
http://www.taoglas.com/images/product_images/original_images/GP.1575.25.4.A.02%20GPS%20Patch%20Antenna%201575MHz%20280110.pdf

3DR Compass Module:

- Honeywell HMC 5983 temperature compensated magnetometer
http://www51.honeywell.com/aero/common/documents/myaerospacecatalog-documents/Defense_Brochures-documents/HMC5983_3_Axis_Compass_IC.pdf

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