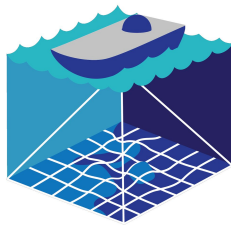# SimpleSCAN

Operations Manual

SimpleUnmanned, LLC

Thank you for purchasing the SimpleScan unmanned marine system! You've just purchased one most advanced and versatile marine platforms available. You will find the SimpleScan features industry leading stability, endurance and connectivity - all in a package that will fit in the trunk of even the smallest cars.

The SimpleSCAN is actually quite easy to use - don't let the size of this manual and appendix reference distract from the simplicity of actually using the product.

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Introduction

Items Included

The SimpleScan is a complete ready to go package. Included standard is everything you need to operate the platform:

SimpleScan Boat

All Aluminum, Laser Cut, Tig Welded Hull. The boat itself is equipped with a T100 thruster, powerful metal gear steering servo, marine grade hatch, and more

R/C Controller

The SimpleScan comes equipped with a TGY-i6s R/C Radio. This compact radio features a digital touch screen, three position switch, operates on 2.4ghz and uses spread spectrum technology. There is no need to worry about interference with other R/C or Unmanned Equipment.

USB Radio Link

This is essentially a 900mhz wireless radio modem. This device plugs into your computer or tablet's USB port and shows up as a COM port, allowing any software compatible with MAVLINK to connect to the SimpleScan. This link allows you to wirelessly upload missions, see useful real time information and operate the boat in guided mode.

(2) LiPo Batteries

This boat comes with two powerful 14.8v 16,000mah batteries. Each will provide 4-5 hours of runtime and charge in around 1 hour. This allows for easy continuous operation.

500w DC Battery Charger

This battery charger connects to the battery of your vehicle or any 9-30v power source and will rapidly charge your SimpleScan batteries - or nearly any other battery that exists.
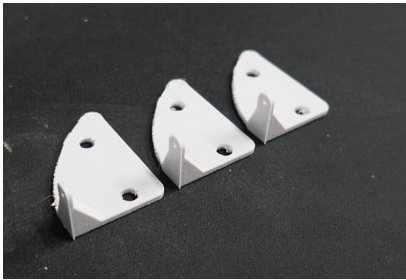
Spare Rudder Control Horns

We use 3D printed rudder horns for steering on the SimpleScan. These are reasonably rugged but may break upon impacts as a design feature. This prevents damage to the server and steering mechanism. The 3D printed horns are fast to swap, if you run out we are happy to help, plus the STL file to print new ones yourself is located on the USB Flash Drive.

10-24 Nuts & Bolts

These are used to attach the rudder during initial assembly.

USB Flash Drive

We include a USB Flash drive with each unit. This drive contains the Mission Planner software, drivers for the USB Radio Link, this instruction manual, instructional videos, hardware settings file and STL Files to components.

Assembly

The SimpleSCAN arrives mostly assembled and ready to go. However, in order to prevent damage during shipping the unit arrives with the rudder detached. To attach it, simply use a phillips head screwdriver and the included 10-24 bolts and lock nuts to attach it to the hinge on aft of the unit. Please see photos on the next page...

Once the rudder is securely attached, connect the servo control rod to the horn on the rudder. If you have trouble getting the clevis open, you may use a small flat head screwdriver to pry it, slip it onto the horn until the pin finds the hole and connects to the clasp on the other side.
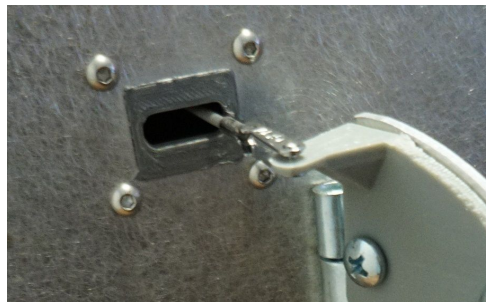
Basic Concepts

While the SimpleSCAN is a complex piece of hardware featuring an array of sensors such as gryos, accelerometers, magnometer, current and voltage sensor and more - it needn't be difficult to operate. It can be as simple as a toy R/C boat. Or, it can execute complex command point based missions autonomously.

This difference is controlled by *Operational Modes* which can be changed at anytime via the use of the 3 position switch on the R/C transmitter (SWB) or using Mission Planner. (See the The Data Link & Mission Planner for more information).

Operational Modes

The SimpleSCAN is operated through a number of operations modes, three of which are assigned to a switch on the handheld remote control. Modes can be changed at anytime using this R/C control or via Mission Planner's action pane. The key modes to understand are as follows:

Manual

This mode causes the SimpleSCAN to behave like any typical R/C Toy boat.

Steering

Steering mode can be thought of as computer assisted manual. It allows you to easily drive in a very straight line. Steering is managed by the computer and the course is automatically corrected to maintain target heading. The heading is changed via the use of the R/C joystick, so it's much like driving a toy R/C boat though much more accurate.

RTL

This stands for "Return to Launch." When activated the boat will automatically return to the initial GPS acquisition point. *Please note this does not automatically route around objects, islands, peninsulas etc. Use this mode with care.*

Guided

Guided mode allows for real time point-and-click on map control. Simply right click on the map to select a location to navigate, the mode will be automatically changed to Guided and the SimpleSCAN will navigate to selected location. You may select a new point at anytime.

Auto

This mode executes fully autonomous pre-programmed missions.

By default, the 3 position switch on the R/C Transmitter is configured as follows:

UP: Manual
This is the default setting when you first power on the boat. In this mode, the SimpleSCAN is a simple remote controlled boat. You may also switch to manual or steering at anytime. Manual is great for maneuvering the boat away from shore,

operating in small/tight areas, or making adjustments to the boat's course to avoid obstacles.

MID: Steering

We like to call this "heading lock." This mode is similar to manual, however steering is controlled by the navigational controller based on yaw gyro sensors and magnetic (compass) sensors. The goal is this mode is to keep the boat locked on whatever heading you specify. In this manner, it's very easy to drive straight - just push the throttle forward and the boat will go straight ahead, automatically compensating for anything that pushes it off course. If you move the joystick right/left, the boat will turn at variable rate specified by how far you push the stick.

DOWN: Auto

In auto mode, the boat will execute fully automatic missions. These missions are waypoint - or actually, command point based. During planning, you can specify functions to occur sequentially. Usually, these functions are navigational waypoints but may also be a command to collect a water sample, turn on/off a piece of equipment, stop for a period of time, jump to another command (to create repeating/looping missions), station keep, and many other things. Please see our Mission Planning section for more details.

Drivers & Software

While also on the included USB flash drive, you may download needed files from ww.simpleunmanned.com as well:

- Download Mission Planner.
- Download Radio Link Drivers

We typically recommend the use of Mission Planner with our products. Mission Planner is a free and open source MAVLINk control software. It may be freely downloaded and used - we do not charge for it nor should we or anyone else. Mission Planner is arguably the best software currently available for MAVLINK vehicles. It allows access to all features supported by the SimpleSCAN and has an active user base with wide support online. There are many tutorials for Mission Planner on Youtube.

That being said, you are free to use the Ground Control Software (GCS) of your choice. Other options include QGroundControl, APM Planner, Tower, Droidplanner, UGSC and many others. There are MAVLINK GCS for nearly any platform out there, including

Windows, Linux, Android, iOS* and more.

*iOS does not support USB OTG capability, so to use the SimpleSCAN with an iPad/iPhone or similar, you will need a bluetooth based telemetry link. We do not recommend this, but if it's a project requirement please contact us for details on how to set this up.

Batteries

Basic Information

We include MultiStar 4s 16,000mah batteries with the SimpleScan. These batteries were chosen because they are lightweight and have excellent performance. Their 10C discharge rate works perfectly with the maximum 25a power handling of the SimpleSCAN. They provide strong endurance and can be rapid charged in 1 hour using the included high powered battery charger.

However, we do not limited the platform to using this type of battery. The SimpleSCAN will accept anything between 10-16v, including LiPo, LiFeP04, Lead Acid, NIMH. While we typically recommend the use of the included batteries, if you are traveling, the large capacity lipos are challenging to transport due to Lipo/Airline regulations and you may find it easier to use a smaller <100wh lipo, a lead acid or NiMh Battery. If you find yourself in one of these special circumstances and need help selecting an alternate power source, please just contact us. We're happy to help!

Please note: the included batteries use the XT90 connector form factor, but the boat and charger use the XT60 connector. An adapter is included and typically should remain attached to the battery.

Installation & Removal

The SimpleSCAN Battery can be in Installed, Removed and Swapped in seconds. The battery is located under the black marine hatch. Simple pull up on the handle, twist to unlock and open the hatch. You will see the battery tray below, just drop the battery into the tray and secure it with the velcro straps. Once the battery is secured and you *are ready to power on the boat (please follow the startup sequence in the next section)* , simply connect the yellow connector to the corresponding plug inside the boat.

Charging

The SimpleSCAN system includes a high powered battery charger capable of fast charging the system in around 1 hour. It is powered by a 9-30V source, most typically a car battery - which is great for use in the field. If you need an A/C power adapter, we can provide one. This charger is also capable of charging most other types of batteries.

You may see a manual for the charger in the appendix of this manual.

Please keep the following in mind when charging:
- Always **observe** the charging process, do not charge unattended
- Always use the **balance leads** when charging
- Select the correct **battery type** (LiPo for the included battery)
- Select the **correct voltage** (4s for the included battery)

Storage

The enemy of Lithium Polymer Batteries is high **State of Charge** and **Heat**. If you will not be using your SimpleSCAN for some time, we highly recommend discharging the battery to around 50% of total capacity and storing it in a cool area. If you live in a hot climate such as Texas, store it in a refrigerator. The charger has a convenient storage function for this purpose. To place battery into storage mode, you may elect to not charge it after its last use, or run the storage function per the battery charger's user manual.

<u>Powering On</u>

Start-Up Sequence

To power on the SimpleSCAN, complete the following tasks in order.

1. Power on the R/C Transmitter by pressing BOTH power buttons at the same time. Make sure all switches are in the "UP" position and the left stick is fully down or an error will be displayed.
2. (Optional) Plug in the USB Radio Link to your computer and open Mission Planner
3. Making sure your hands/fingers are clear of the impeller, connect the battery. The boat should power up and you should have steering/rudder control but not throttle. To activate throttle, see the arming section below.

Arming

Arming Prerequisites

Before the SimpleSCAN will arm (activate throttle), it will need to obtain a GPS Fix and have a solid link with the R/C transmitter. If you have a clear view of the sky, this usually takes 20 seconds to 2 minutes. Once a fix has been obtained, you will hear a solid continuous beep tone for around 1 second. You may then proceed with arming.

Note: This arming requirement can be disabled, please see "Data Link: Changing Settings: Arming & Safeys."
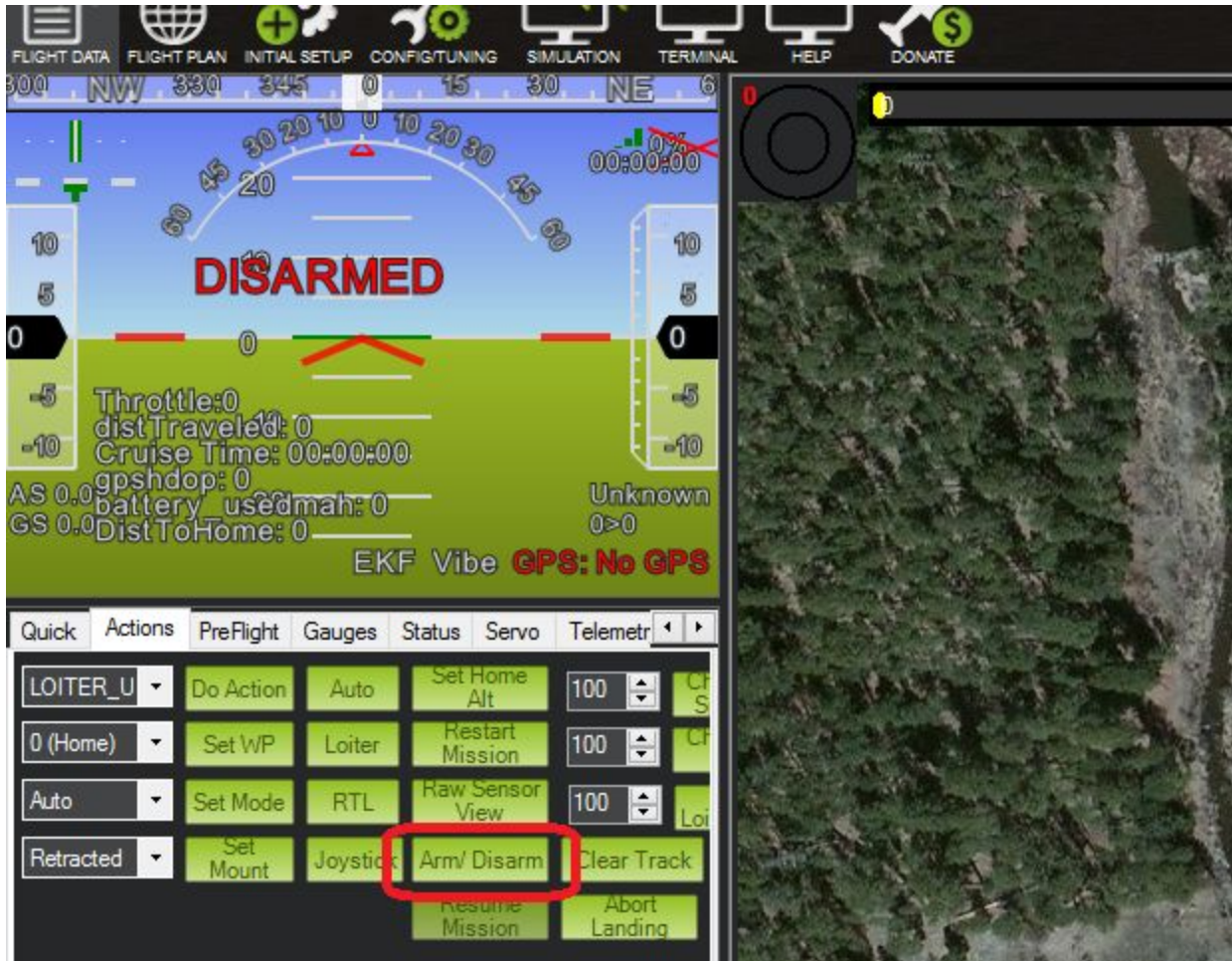
Arming the SimpleScan

Once the arming prerequisites are met and the "long beep" as been heard, you may arm the SimpleSCAN by using one of the two following methods:

- **Manual R/C**
  If you are operating without a laptop, it's useful to arm using just the R/C transmitter. Move the throttle (right) joystick to the mid-position (neutral) and then to the right fully. Hold it in this position for 5 seconds, you should hear a long tone and the throttle should now function.

- **Mission Planner**
  If you've connected via Mission Planner, select "ARM/DISARM" in the actions pane as shown below.

Operating the SimpleScan

Manual Remote Control

The SimpleSCAN system includes a manual R/C Control Unit, similar to that found in the hobby world. If you fly or drive R/C models, you will already been familiar with this aspect of operation. The platform is controlled via the right joystick, operation is simple:

Stick Direction	Boat Action
Forward	Increase Throttle
Backward	Reverse Throttle
Right	Turn Right
Left	Turn Left

After the boat is powered on and armed (please see preceding section), simply place it in the water and start driving in manual mode. Once you are comfortable with the basic concept and operation of the boat you are ready to move on to more advanced functionality including auto missions.

Autopilot Capabilities

The SimpleSCAN includes a powerful autopilot running open source DroneCode software. This enables the boat to execute simple (or complex) waypoint based missions. You can create paths by clicking points on a map, grid survey missions, looping missions, command the boat to navigate to locations and collect water samples, have it maintain it's current general location and more. The autopilot has an array of sensors including a full gyro and accelerometer suite as well as a compass, barometer, voltage and current sensor. This information is transmitted back to your laptop via the wireless data link included with each boat and is accessible via Mission Planner (or any other MAVLINK compatible software). Mission Planner places this information into a map view with head's up display. Detailed information about the HUD is provided provided in the next section.

Autopilot Operational Concepts

Operating the SimpleSCAN is quite easy once a few basics are understood. The three

main things to keep in mind (which may be a departure for those familiar with DJI and similar technology) are:

- Missions are planned anywhere: Your laptop at the job site, office computer, emailed to you from someone else, etc etc. They are then sent to and saved **ONBOARD** the SimpleSCAN. Unlike most consumer grade drones, your GCS/Laptop and R/C controller do not actually directly operate the SimpleSCAN- they are there to provide an interface for you to tell the SimpleSCAN what you want it to do, but actually doing it is upto the SimpleSCAN itself. Therefor, a real time radio connection is NOT required to operate the SimpleSCAN after it's been properly programmed. When in auto-mode, the default behavior will have it continue with its mission if it loses radio contact or you drive out of range. *(This functionality can be adjusted, please see the "Failsafes" section.)* This technology creates a much more powerful tool that is capable of operating in a much wider range of conditions and scenarios than the typical consumer grade drone.
- While most documentation, including this text, refer to drones as operating a "waypoint" based mission, it would be more correct to refer to this as "Command Point" based missions. This distinction is due to the fact that the waypoints or "Command Points" do not necessarily have to be a location. Command points can be many things, such as a navigational waypoint or a command to change modes, speed, activate a circuit, collect a water sample, or jump to a different command point.
- The SimpleSCAN follows command points sequentially as laid out during Mission Planning. Please see the following Mission Planning section for details.

The Data Link & Mission Planner

Connecting

After completing the startup process detailed in "Powering On" section, you may connect your SimpleSCAN to Mission Planner. To do this,

1. Make sure the USB Radio Link is plugged into your computer and the drivers are properly installed.* If the boat is also powered on at this time the green (or blue) light on the radio link module should be solid. If it is blinking, the radio link has not established a connection to the SimpleSCAN.
2. Open Mission Planner. Once open, you will see the connection parameters as shown in the screenshot below. Please choose the relevant COM port for your radio link and make sure the baud rate is set to 57600, as shown below. If you

have trouble determining which COM port is assigned to your radio link, unplug it and watch for which port disappears and then reappears when the unit is plugged back in.
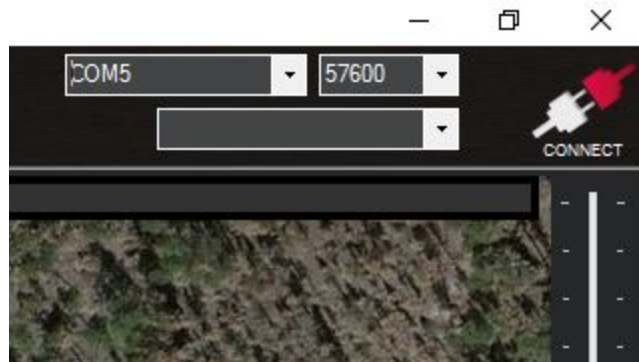
3. Once you have chosen the correct COM and BAUD Rate as described above, press "Connect." Mission Planner will establish a link to the SimpleSCAN and begin downloading the vehicle specific settings - this allows Mission Planner to understand the sensors and equipment on the SimpleSCAN (or other vehicles you may use)
4. Now that Mission Planner is connected, you will be able to see data coming in from various sensors. If you have a GPS lock and internet connection, it will also center the map on your current location, showing the boat onscreen. If you move the SimpleSCAN you will notice that the movements will be represented on screen in the HUD and/or on the map.

Uploading Missions

For Mission Planning information, please see "Mission Planning." This section describes the process required to send Missions to the boat and assumes you are already connected via the USB Radio Link.

- To send missions to the boat, you will need to be in the "Flight Plan" window as shown above
- On the right side, you will notice four buttons:
  - **Load WP File** - You may save missions using this button.
  - **Save WP File** - You may load saved missions using this button.
  - **Read WPs** - This will download a mission already saved on the SimpleSCAN
  - **Write WPs** - This will send a loaded/planned Mission to the SimpleSCAN and save it on board. This will overwrite any previously saved Mission.
- Simply select "Write WPs" and your mission will be sent to the SimpleSCAN. It will remain there until deleted or overwritten. This means that, if desired, you may plan your mission at home, save it on board, then at a later time take the SimpleSCAN out and execute the mission without reconnecting Mission Planner.*

We recommend using Mission Planner and it's real time functionality while operating the SimpleSCAN.

Logging
Both Mission Planner and SimpleSCAN will maintain logs continuously throughout all modes of operation. This allows advanced users to pull details from the logs, such as GPS track, pitch, roll, heading and similar information for any moment during the

mission. If there are any issues with your SimpleSCAN it also allows us to provide improved remote diagnosis and correct issues.

**There are two main types of logs for which to be familiar:**

- **Telemetry Logs:** Also known as T-Logs, these logs are saved by Mission Planner on your computer system. The information stored comes from the boat via the Radio Data Link. They can be opened and played back in Mission Planner. You can find them by selecting "Load Log" as shown in the screenshot below, or by navigating to the directory in which they are saved using My Computer.

- **Data Flash Logs**: Also known as DF logs, these are saved by the navigational controller on board the boat. These logs are less user friendly but contain more accurate information as they are not affected by radio link quality and contain all possible information. The DataFlash logs are physically located on an SD Card and can be accessed through the battery hatch door or by downloading them from the dataflash pane in Mission Planner. Logs are in .BIN format but can be converted to various formats using Mission Planner. You can essentially think of the DF log as a CSV File with all possible information logged continuously.

Data Link: NAV/Heads Up Display

Using the real time Data Link, Mission Planner is able to provide a wealth of information about the SimpleSCAN in real time. Below are a few screenshots and description of each section:

Navigational Display
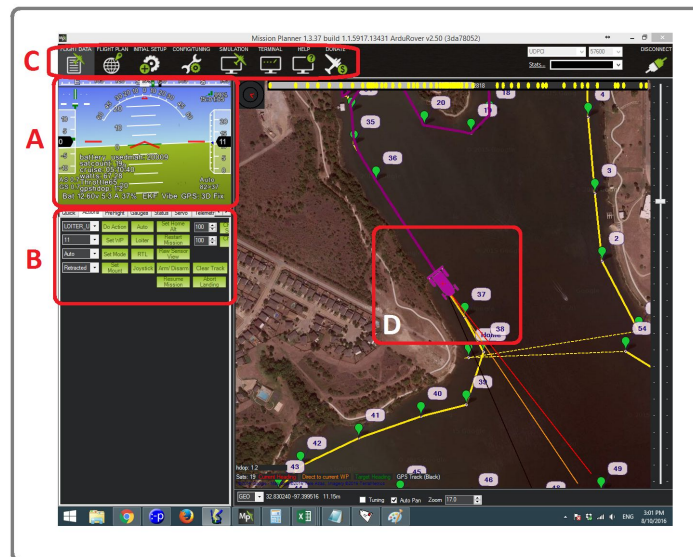
- A: This is the HUD area, which is detailed below.
- B: This is the "Actions" Pane. Modes, Waypoints, Arming/Disarming and more can be completed here. This section is detailed below.
- C: This is the options tab and is self explanatory.
- D. This is the current position of the SimpleSCAN.
  - Red Line: Compass heading
  - Black Line: GPS track heading
  - Purple Line: SimpleSCAN's path
  - Dark Yellow Line: Direction to the next navigational waypoint.
  - Navigational waypoints and the estimated track can be seen on this screen as green points with a yellow connecting lines.

The "HUD"

The HUD, or Heads Up Display, contains a wealth of useful information. Aside from the items highlighted below, you can add user items by right clicking in the HUD area and choosing which info points to add. There are a large number of user items available.
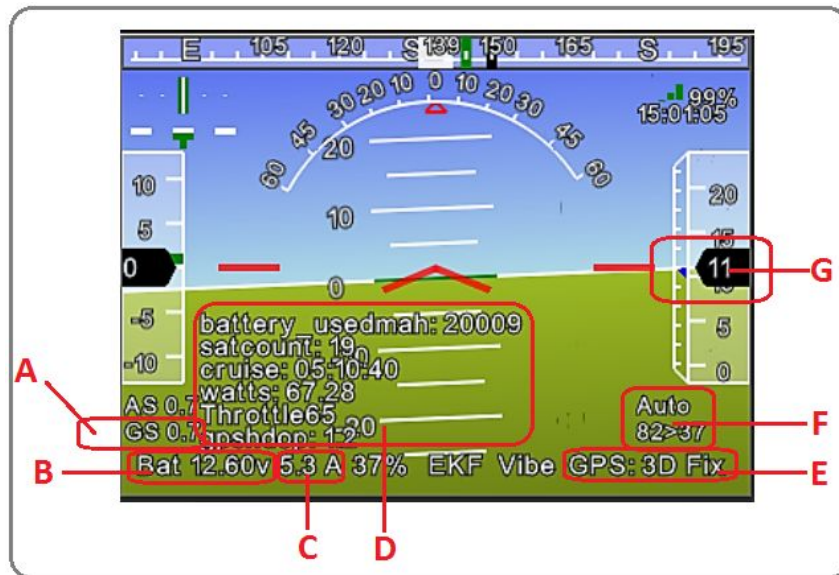
A. This shows the Ground Speed (GS) based on GPS track.
B. This is the current battery voltage
C. This is the current battery amperage
D. This is the User Items Section
E. This shows the current GPS Status
F. This shows operational mode, distance to next waypoint, and the next waypoint ID number. In this case it's 82m from waypoint 37.
G. Altitude above starting location. This is not really relevant in boats and can change based on differences in barometric pressure over time. However, if you see a very large number here (rare) it can indicate an incorrectly set home location necessitating a restart.

User Items

Below is a list of items which can be added to the "user items" section of the HUD. As you can see, there is an extensive number of readouts available. These are either based on readings from sensors or calculated via the use of various algorithms. For example, there is a mAh per KM item - which is a measure of efficiency similar to Miles per gallon. This is calculated based on the SimpleSCAN's current GPS track speed and amount of power being used.

Actions Pane

The actions pane can be thought of a list of commonly used buttons and shortcuts. Not all of these functions apply to the SimpleSCAN. A description is below:

- ● A. Action Drop Down. There are a number of actions which can be selected and performed. Simply select the desired action and click "Do Action."
- ● B. Waypoint Drop Down. This will allow you to select a new waypoint to whch to navigate. Simply select the waypoint ID and click "Set Waypoint." The SimpleSCAN will immediately head to the specific waypoint.
- ● C. Operational Mode Drop Down. You can choose a new operation mode here and select "Set Mode" to change the mode.
- ● D. This serves no function.
- ● Auto: This will immediately set AUTO mode
- ● Loiter: This has no function
- ● RTL: This will immediately set a course back to the starting position.
- ● Joystick: This will open a configuration window which allows you to operate the SimpleSCAN with a USB gamepad or joystick.
- ● Arm/Disarm: This will arm or disarm the SimpleSCAN's motor.
  Change Speed: This will set a new cruise speed in M/S. It's best to use the method described in the "Changing settings" section below for speed adjustments - but new speeds can be specified here as well.

Data Link: Changing Settings

Using the Data Link and Mission Planner, you may update any of the SimpleSCANs settings. The SimpleSCAN arrives tuned and tested, so under normal circumstances it's not recommended to update settings. However, there are some circumstances in which you may wish to alter the performance or behavior of the boat such as: Adding Equipment, Changing Cruise Speed, fix issues with weaving, change failsafe actions, adjust current and voltage calibration etc. In the event you have any issues or want to change the desired behavior, this section will provide details on how to do so.

First, you will need to connect the SimpleSCAN to Mission Planner using the USB Radio Link as described in "The Data Link & Mission Planner" section. Once this is connected, navigate to the Config/Tuning tab as seen below.

There are two main sections that will be used for settings changes. They are "Basic Tuning" and "Full Parameter List." Most settings which correspond to physical behavior of the boat, such as throttle or steering, can be found under "Basic Tuning." Settings which control software or behavior are typically located under "Full Parameter List" as is everything else.

In either case, once the desired setting has been changed you will need to select "Write Parameters" or the change will not take effect.
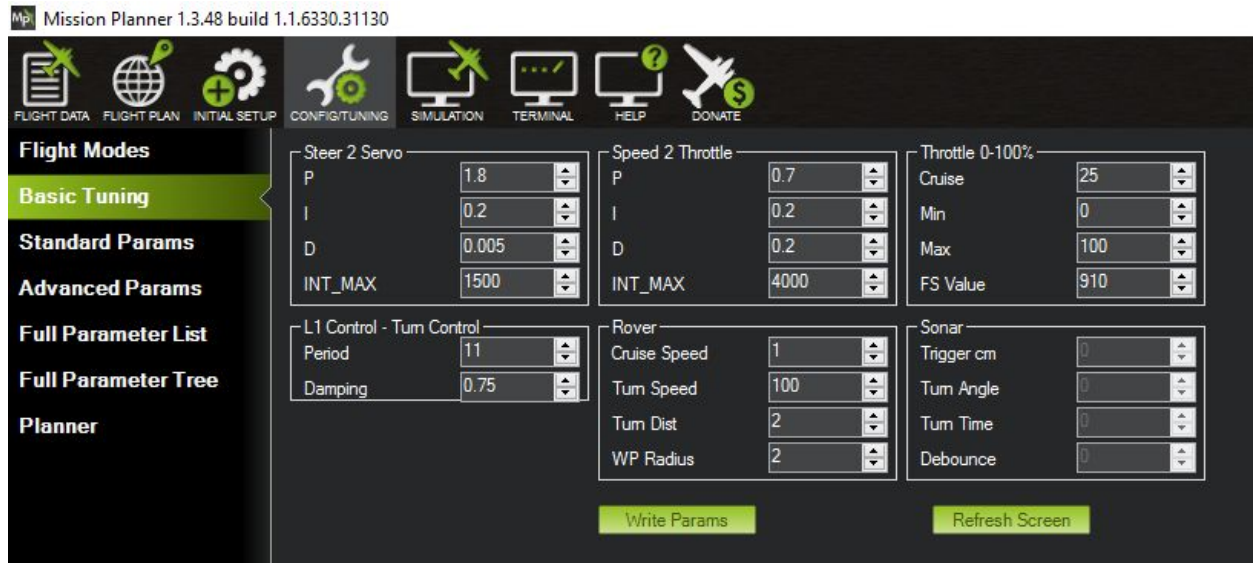
Cruise Speed

The cruise speed is a target speed specified by the parameter "Cruise Speed" shown above. Adjusting this will adjust the target cruise speed, however, it will take some time for the autopilot to determine and update the throttle settings required to achieve your target cruise speed. Therefore, when adjusting cruise speed, for an immediate response, we recommend you change both the "Cruise Speed" and "Cruise" throttle percentage, as shown under the "Throttle 0-100%" box above, on the right. Please use the table below as a guide:

Target Cruise Speed (M/S)	Throttle Percent
0.75	24%
1	35%
1.25	40%
1.5	100%

Note: Mission Planner will often round the number you enter into this box. The actual number will still be recoded to the boat, so if you enter 0.75 and it appears as "1" after a moment - disregard this difference. Mission Planner is used with a wide variety of vehicles, most typically aircraft which do not have the speed accuracy to differentiate between 0.25 m/s.

Navigational Controller

While the SimpleSCAN arrives tuned and tested, equipment and weight changes can sometimes throw off the tune. This section will describe how to resolve issues with weaving or navigational inaccuracy.

There are three main parameters to consider for navigation. These are:

Steer_2_Servo: P: This parameter is most simply described as the SimpleSCAN's understanding of its turn radius. Using this understood radius, the SimpleSCAN computes the amount of rudder input required to achieve the desired turn rate. If this number is too high, the SimpleSCAN may apply too much rudder leading to a continuous over correcting behavior. If this number is too low, the SimpleSCAN may not apply enough rudder and won't turn sharply enough.

L1 Control - Turn Control - Period: This can be thought of as the amount of time the used per sample in the SimpleSCAN's navigational computer. A smaller number will

result in computing a course based on a small snapshot of time, whereas a larger number will average it out more. In the case of a boat such as SimpleSCAN, a large number between 10 and 20 is usually required. If the boat is weaving along a straight line, increasing the *Period* will usually correct this, but at a cost of less accurate/tight turns. You can increase the tightness of the turns with the *Dampening* parameter.

Getting these settings correct and to an ideal number is somewhat of a balancing act. If you plan on changing these, please take note of the original settings or be prepared to restore your original configuration from the tune file located on the USB flash drive.
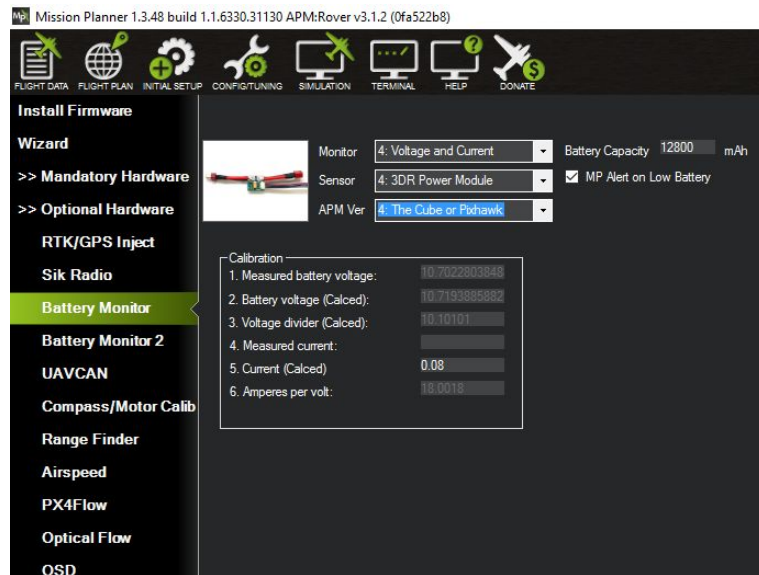
Current & Voltage Calibration
You can see the accuracy of the SimpleSCAN's current meter by adding the user item "battery_usedmah" to your HUD. (Please see the HUD section for details). After operating the SimpleSCAN for at least 30 minutes at a speed you will typically be using, please take note of the number of mahs consumed. Then, when charging, take note of the number required to charge the battery. This number should be reasonably close - though will never be 100% match.

To test the voltage sensor, simply use a multimeter to measure the battery's voltage from the black and red leads on the balance connector and compare that to what's displayed on your HUD.

The SimpleSCAN uses a shunt style current/voltage sensor. These work well, but calibrations can drift - especially in lower amperage conditions.

Adjusting Calibrations

To adjust the current calibration, access the "Battery Monitor" section from the "Initial Setup" tab as shown above.

Adjust the Amperage Calibration

There are a number of ways to do this, if you have a wattmeter or ampmeter you can use the measure the actual amperage, that is the easiest and most accurate. However, you can do it without any equipment:

Take note of the numbers used in the Current & Voltage Calibration section above, from the battery_usedmah and actual number recorded on the charger and reduce the values to a multiplier by dividing them. For example: If you actually used 5000mah (5ah) as recorded by the charger but the sensor said you used 3500mah, divide 5000 & 3500, your multiplier would be 1.42.

Now, hold the throttle at a set point and observe the amperage in the "Current (Calced)" box. Multiply this number by 1.42, that will be your actual current usage. Input this number into the "Measured Current" box, the software will update the calibration.

Adjusting the Voltage Calibration

This is simple - use a multimeter to check the voltage via the black/red wires on the balance leads. Input this voltage "Measured Battery Voltage" box, the software will update the calibration.

Arming & Safteys

If you wish to change the arming behavior of the SimpleSCAN, there are a number of alternate configurations available. To access these settings, please go to the "Full Parameter List" under the Tuning/Config section in Mission Planner. There are two functions to keep in mind:

Arming Required

You can first choose if you want arming to be required at all or not. If no, then the SimpleSCAN will arm immediately upon power on. If yes, then it will check which conditions need to be met in order to arm and once those conditions are met, it will wait for your confirmation to arm. This is controlled with the following parameter:

ARMING_REQUIRE

Options:
  ● 0: There are no conditions, arm immediately.
  ● 1: There are conditions, check them and allow arming when ready. *

1 is the default behavior.

Arming Conditions

If you choose to require arming, there is a large list of options available in the form of a bitmask. These are controlled with the following parameter:

ARMING_CHECK

You will see a list of option in MissionPlanner, each represented by a number. Add the numbers of the options together and enter this number into the ARMING_CHECK box to set the bitmask. For example, 72 would require an R/C Signal and GPS lock prior to arming and is the default behavior.

Please note that the SimpleSCAN sets its home location upon arming. In some cases if the platform has armed before a GPS lock has been obtained, it will set home at "0" altitude (Sea-Level) and once the GPS obtains a fix it will incorrectly report altitude at it's current elevation above sea-level. Unless you're actually at sea-level, this may make the platform "think" it's high in the air and will result in navigational errors as it's can't technically get "close" the target waypoint. If this issue has occurred, it's clearly visible in the HUD by observing the boat's current altitude. If the altitude displays a high

number (>30), it's safe to assume this home elevation has been set incorrectly. This can be rectified by resetting the boat. You may do this by disconnecting and reconnecting power. If the boat is already deployed, you can do a remote reset by pressing "Control + F" and accessing the hidden menu in Mission Planner and selecting "Reset Pixhawk." Ideally, the boat should be stationary during bootup for a gyro calibration but the above process will work in a pinch - you may see a gyro error until reset in a stationary environment.

Failsafes

The SimpleSCAN is equipped with a number of failsafes. By default, these are disabled so that if the SimpleSCAN is in an automatic operation mode, it will continue on with its mission regardless of radio signal.

You may set new failsafes based on the following:

- R/C Radio Signal Loss (see page xxxx)
- USB Data Link Signal Loss (see page xxxx)

Failsafe Timeout
A failsafe event needs to occur for a period of time before it will trigger the actual failsafe event and thus the behavior. This is set to 5 seconds by default. If you would like to change this, please enter the desired number of seconds the event needs to persist in the following parameter box:

FS_TIMEOUT

Failsafe Behavior
Each of these events above can be setup to trigger a failsafe event and the corresponding behavior. Once a failsafe event has been detected and persists for the timeout duration, the behavior can be one of the following:

- Do Nothing
- Switch to HOLD mode (Stop moving)
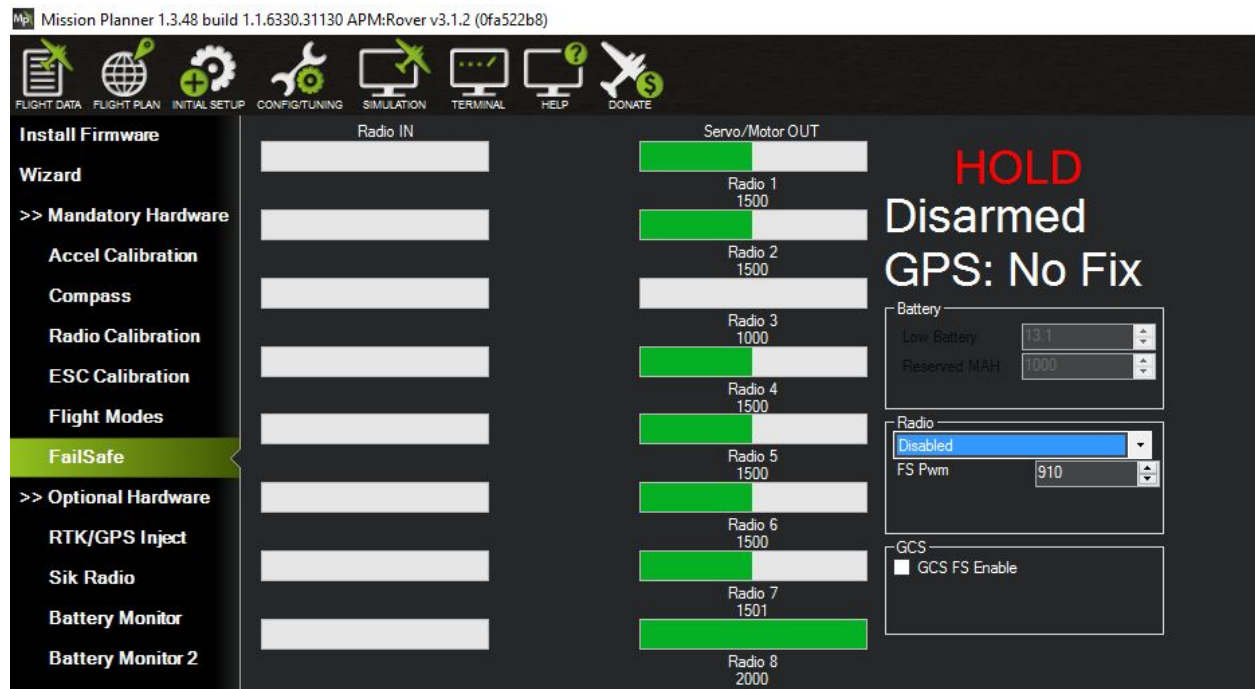- Switch to RTL mode (Return Home)*

To Adjust this, use the following parameter:

FS_ACTION

- 0: Do nothing
- 1: HOLD
- 2: RTL

Please note that Return Home Mode will plot a straight path back to the initial GPS acquisition position. It will not account for objects or land which may be between the SimpleSCAN and the home location.

R/C Radio Signal Loss

To set R/C Signal Loss Failsafe, navigate to Initial Setup tab => Mandatory Hardware => FailSafe as shown above.

- Select "Enabled" from the "Radio" dropdown as shown above. This will enable the radio failsafe, so if you drive out of R/C radio range a failsafe event will be triggered.

USB Data Link Signal Loss
A failsafe trigger event can also be set if the USB Data Radio loses its signal. You can enable this even by going to the "Full Parameter List" and changing the following parameters:

FS_GCS_ENABE

- 0: Disabled
- 1: Enabled

Mission Planning

Basic Concepts

As you already know, the SimpleSCAN is capable of executing complex autonomous missions. These Missions, to put it simply, are a list of commands (waypoints) which the SimpleSCAN will execute sequentially. Each command may include one of a large number of functions. Most commonly, this is a location to which to navigate. However, they may also include other functions such as: changing operational modes, turning equipment on/off, changing speeds, performing a various function for a period of time, jumping to another command, etc.
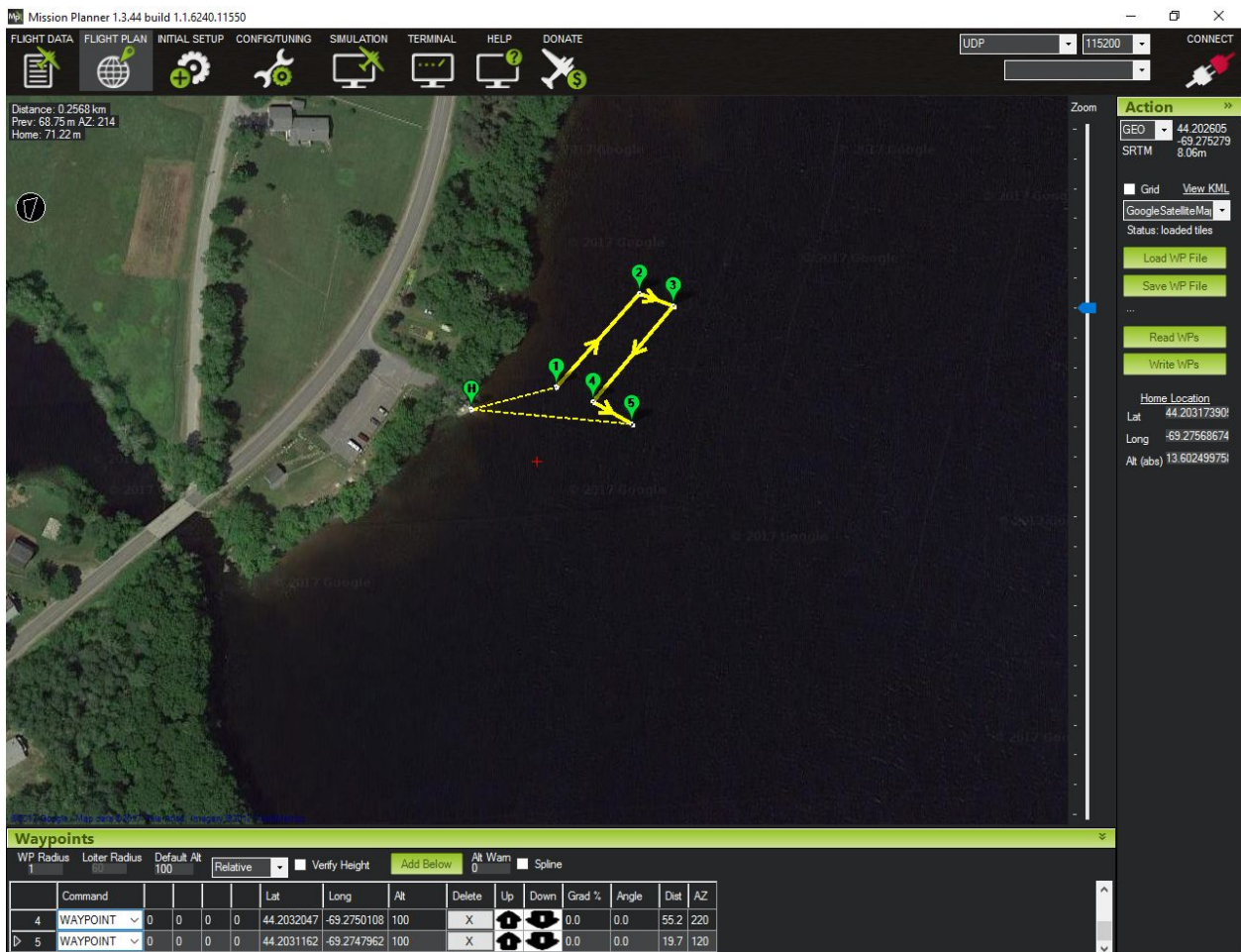
The most common way to setup mission is to use Mission Planner's Flight Planning interface, shown above. To create commands, especially navigation waypoints - it's as

simple as clicking a point on a map. You may also select "Add Below" to create a new blank command to which you may assign a function.

The important thing to understand is that: **The SimpleSCAN will execute the commands in order and immediately upon completion of the previous command.** The last point is important because if you select a point on the map creating a new waypoint and then change it from a waypoint to a command to perform an action - this action will not occur at the selected point on the map but rather immediately after the previous command/waypoint is considered complete.

That said - don't worry about it too much. The nice thing about a boat compared to an airplane or multicopter is that a mission planning mistake does not send the boat plummeting to the ground in a grande finale of expensive destruction. There is no "sink" command, so start by planning missions close where you can observe and if the SimpleSCAN does something unexpected, just use the R/C controller to switch to manual and drive it back.

Waypoint Creation
As mentioned and shown above, simply selecting waypoints on the map shown in the Flight Planning tab will create navigational waypoints. Once selected, you will see the waypoint appear on the map as well as in the list at the bottom of the screen. You can see an example of this in the image below. Each command will have a designation, four boxes the function of which will vary based on the type of command and lat, long altitude. Please note altitude is not a relevant function for the SimpleSCAN but exists in the software nonetheless. The other boxes are functions of Mission Planner and used for managing your waypoints.

- Delete, Up, Down are self-explanatory command management functions.
- Gradient & Angle are not relevant for the SimpleSCAN
- Dist: Shows the distance between two waypoints.
- AZ: This is the heading between two waypoints.

Waypoints															
WP Radius	Loiter Radius	Default Alt	Relative			Verify Height		Add Below	Alt Warn	Spline					
1	60	100							0						
	Command					Lat	Long	Alt	Delete	Up	Down	Grad %	Angle	Dist	AZ
▷ 1	WAYPOINT ∨	0	0	0	0	44.2032624	-69.2752147	100	X	⬆	⬇	255.6	68.6	38.9	75
2	WAYPOINT ∨	0	0	0	0	44.2036354	-69.2747533	100	X	⬆	⬇	0.0	0.0	55.4	42
3	WAYPOINT ∨	0	0	0	0	44.2035854	-69.2745656	100	X	⬆	⬇	0.0	0.0	16.0	110
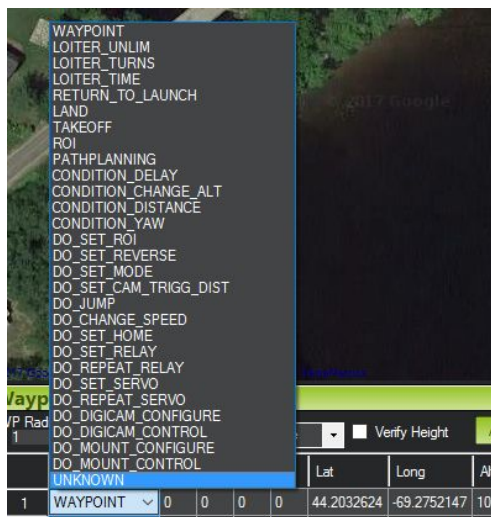
Each command has a drop down which allows you to specify the type of command. You can see an example of the functions available in that drop down menu to the left. Depending on the type of command selected, the four following boxes on that row may change to allow additional functionality.

For example, please see below where a "DO_CHANGE_SPEED" command has been selected. The boxes will allow you to choose airspeed or ground speed, the target speed and the estimated throttle percentage required to obtain that speed. Depending on the command chosen, different options will appear here.
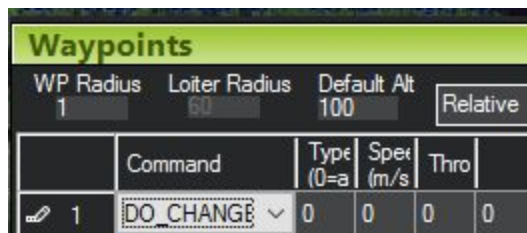

Automatic Survey Grid Tool

Mission Planner includes a number of handy tools, including several grid planning tools. If you are going to be using the SimpleSCAN for bathymetry, you will find the Grid Tools exceedly helpful as they allow you to specify distance between lines and will auto-generate navigational waypoints for you.

First, you will need to create a polygon detailing the area you for which you wish to perform a grid survey. There are two ways to do this:

1. Select the Polygon tool via the button shown below in the left image, circled in red then select the first polygon point.

2. Right click on the map where you'd like the first point to be created. Then select "Draw Polygon => Add Polygon Point"
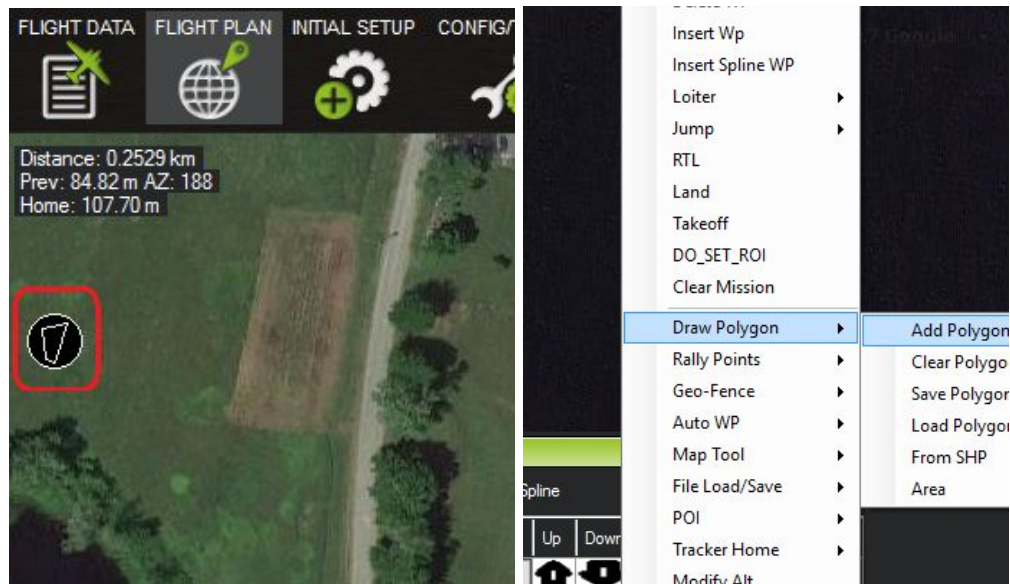
Once you are in Polygon mode, you can continue selecting polygon points as needed. You can create reasonably complex polygons, but please keep in mind the grid tool does not understand how to avoid islands and shoreline and will sometimes attempt to "bridge" polygons with navigational waypoints where areas are otherwise removed from survey consideration.

Please see completed polygon below. Once you are done selecting your polygon, you may use it to view information or create a survey grid for the selected area.
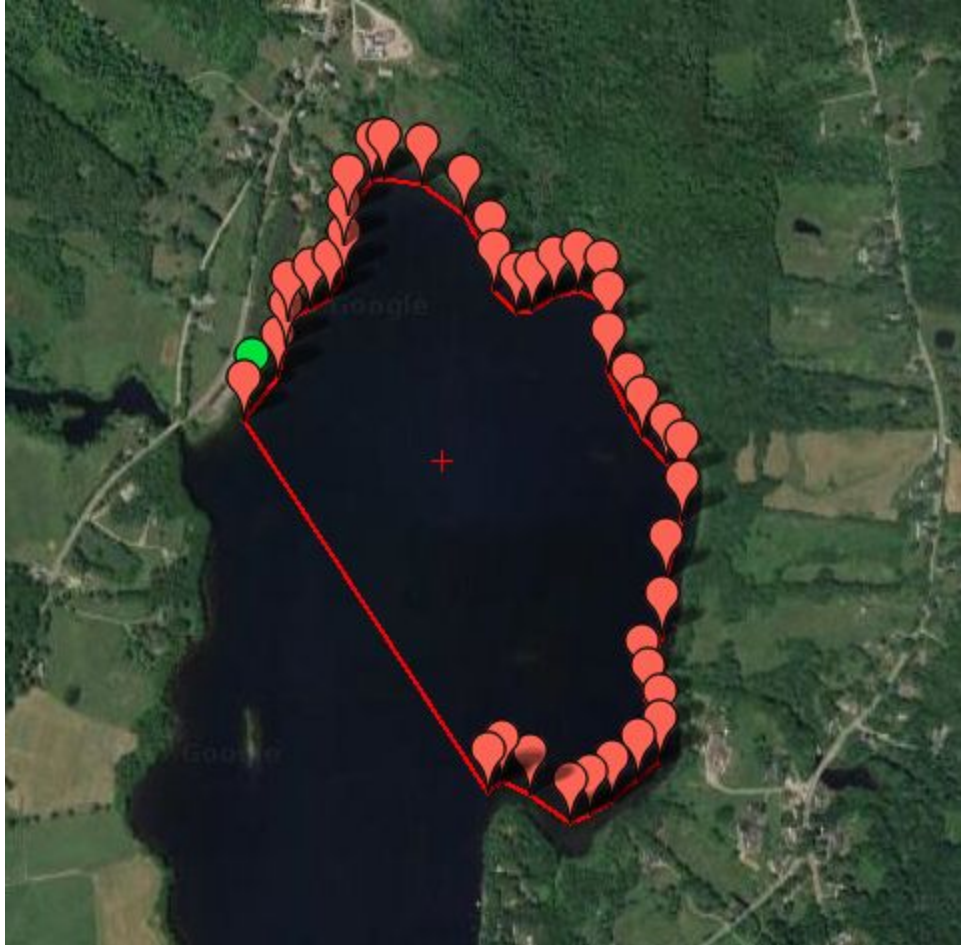
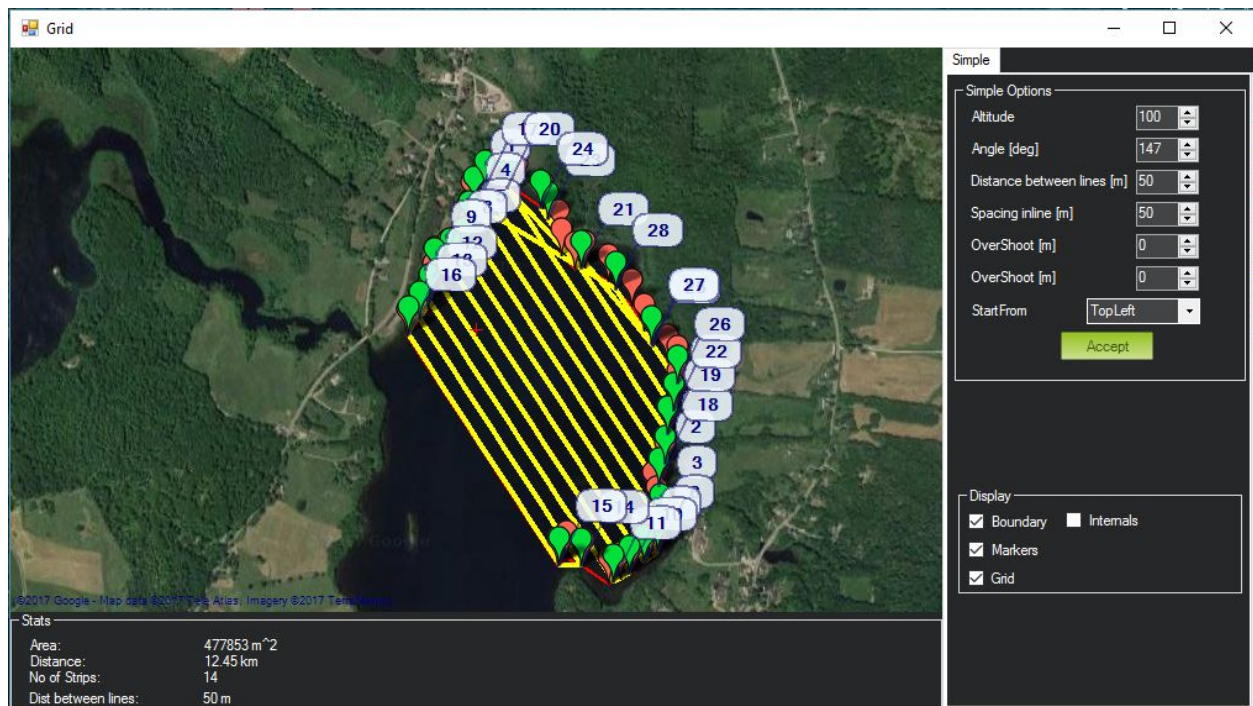To perform various functions with the polygon, right click inside of it and select "Auto WP". The two most commonly used tools are "Area" and SimpleGrid.

Area simply tells you some useful information about the polygon area, please see below area screenshot for the polygon above.
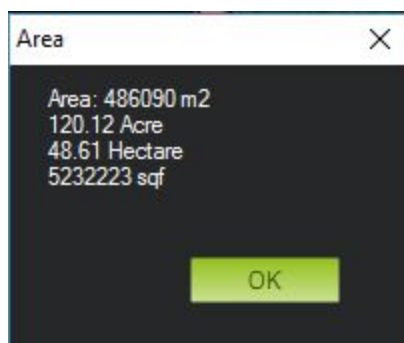
SimpleGrid creates waypoints for you in order to perform a Grid Survey. Below is a sample:


Please uncheck the "internals" box. You may also adjust the other parameters available to suit your needs. The most common and useful parameters are the "Angle" and "Distance between lines" which are self explanatory.

The "Stats" box at the bottom of the window also contains useful information, including total distance traveled. You will need to make sure this is within range of your SimpleSCAN, or expect to perform battery swaps. Range is not stated in this manual as it can vary depending on speed and environmental facts, currents, winds etc.

Once you are happy with your auto mission, click "accept." The waypoints will be added to your flight planning screen.

Below is an example of the when the software may create navigational waypoints which are outside of the polygon area and may cause issues. If the boat followed this path, it would run aground here. It's important to review auto-generated missions and remove these types of errors by manually editing the waypoints. You can click and drag them, add new ones, or delete them as needed.
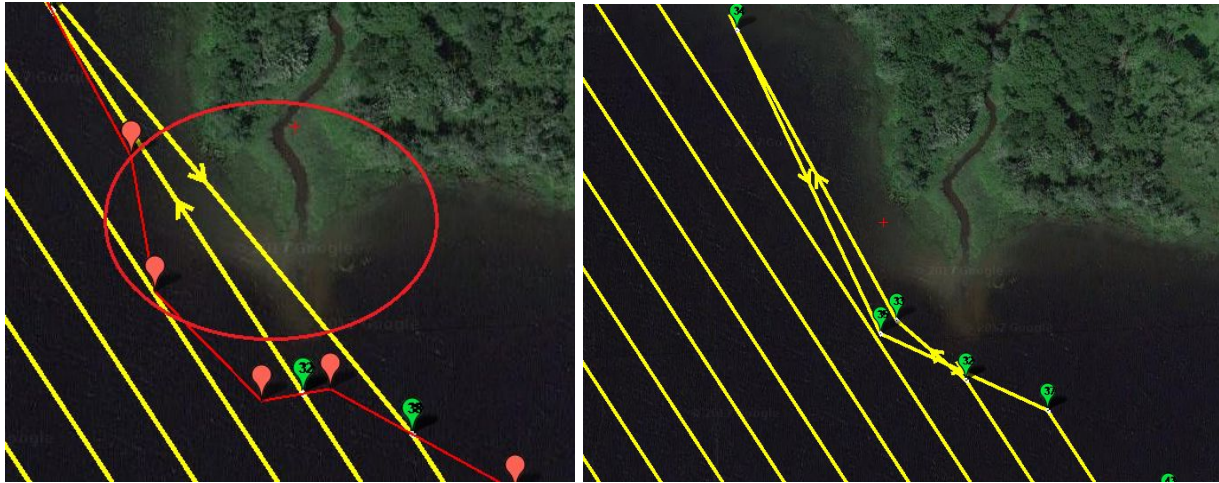
In this case, simply moving a few waypoints around solved the problem. The correction took less than 20 seconds.

Here are a few additional tips:
- Always manually add a few waypoint after the auto-grid to bring the boat back to your location. When it reaches the last waypoint it will simply stop.
- Make sure to take into account the turning distance when planning missions. Do not plan them too close to shore. Instead, plan a mission which follows the shoreline and then do another which covers the main body of water with a grid. This will prevent the boat from having to do a 180 turn close to shore and will allow a more complete dataset.

Station Keeping

The boat is cable of basic station keeping or "*loitering.*" To set this up, select a point on the map and change it to one of the "Loiter" commands as shown below.
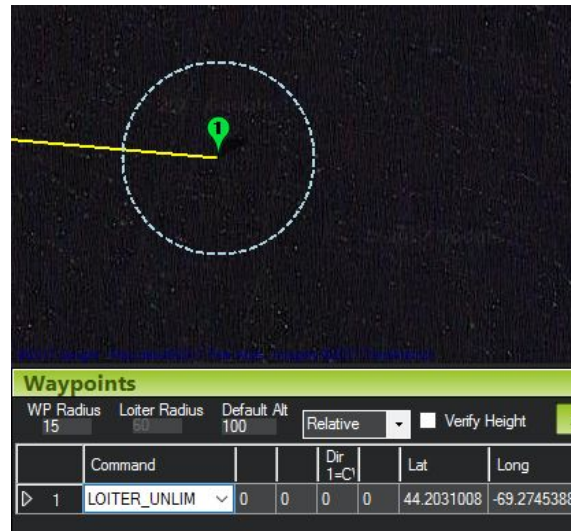
- LOITER_UNLIM: This will cause the boat to loiter in this area until a new command is received or until the user takes manual R/C control.
- LOITER_TIME: This will cause the boat to loiter for a period of time before moving on.

This is useful if you want to boat to remain in a location but cannot pick it up for some reason. The loiter time is excellent for having the boat wait to be picked up but if it's not picked up by the specified time, it will continue on to another location.

The method of loitering/station keeping used on the SimpleSCAN will head towards the the waypoint which includes the loiter command. Once it enters the waypoint's radius (User settable via the "WP Radius" box) it will shut off the motor and float. Once it has drifted outside of this radius, it will power up and repeat. Therefore, it's important to set a decent sized WP Radius when using this function. If the radius is too small, the SimpleSCAN may drift to the other side and power up immediately.

Properly planned on a typical day, this will reduce the duty cycle to around 20%.

Looping Missions

Looping/Repeating Missions can be setup via the use of the DO_JUMP command. This is useful for security routes or as a less efficient means of station keeping at the end of a Mission. Looping Missions are also excellent for tuning and testing hardware and configurations.

Waypoints

WP Radius 3	Loiter Radius 60	Default Alt 100	Relative ▾	☐ Verify Height	Add Below	Alt Warn 0	☐ Spline							

	Command	WP #	Rep⊢						Delete	Up	Down	Grad %	Angle	Dist	AZ
2	WAYPOINT ▾	0	0	0	0	44.2031470	-69.2747238	100	X	⬆	⬇	0.0	0.0	28.5	37
3	WAYPOINT ▾	0	0	0	0	44.2030393	-69.2744261	100	X	⬆	⬇	0.0	0.0	26.6	117
4	WAYPOINT ▾	0	0	0	0	44.2028374	-69.2746112	100	X	⬆	⬇	0.0	0.0	26.9	213
▷ 5	DO_JUMP ▾	1	-1	0	0	44.2028778	-69.2748016	100	X	⬆	⬇	0.0	0.0	15.8	286

Please see looping Mission Example above. In this case, waypoint 5 was changed to a "DO_JUMP" command. In the following box, the waypoint to which to jump is specified. The next box allows the user to specify the number of times to repeat. This can be any number, or -1 means forever. In the mission above, the boat will follow the square box path indefinitely or until interrupted by a new command or manual R/C control.

It's easy to plan a mission where it will repeat the box a number of times and then continue on with the rest of the mission by specifying the number of times to repeat in

the 3rd box after "DO_JUMP" and planning additional commands after the DO_JUMP.

It's worth noting that the DO_JUMP command will be executed immediately upon the boat reaching waypoint 4. If a location is assigned to DO_JUMP, it will be ignored. Therefor, the boat will go immediately from Waypoint 4 to Waypoint 1.

Your First Mission (An Example)

As you already know, this boat is capable of fully autonomous waypoint based missions. This section is not exhaustive, but it should help you correctly setup a mission which will navigate to several waypoints automatically. First, go to the Mission Planner's "Flight Planning" tab. Here you will be greeted with a map, if Mission Planner is already connected to the SimpleSCAN, it should be visible on the map. In this exercise, the goal will be to complete a small box shaped mission.

It's worth noting that it's good practice to think of this vehicle as "Command" based and not "Waypoint" based. That is to say that it will perform Missions by execution of sequential commands – which may be navigational waypoints, but also may be many other things, such as change mode, change speed, move a servo, turn something on/off, repeat, etc.

First

- Note that Mission Planner is set to metric units by default.
- Choose the little up arrows on the right bottom of the screen to display the waypoints screen.
- Make sure WP Radius is set to a reasonable number. I choose 2.
- Note that altitude is ignored on unmanned ground vehicles.

Then:

- Create a few waypoints by clicking on the map as shown below.
- Once you are happy with your Mission select "Write WPs" as shown below highlighted in red. The Mission will be sent to the SimpleSCAN over the wireless radio link.
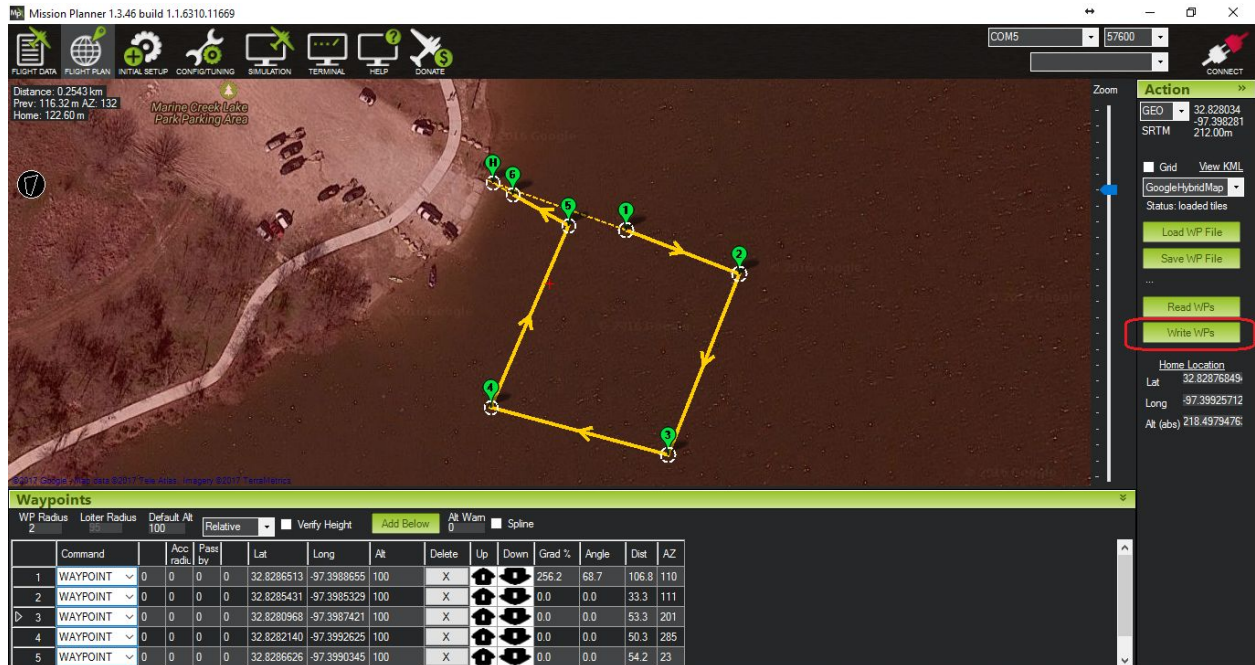
That's it. Put the SimpleSCAN in the water, switch to auto and watch it follow the Mission Path!

<u>Contact & Support</u>

Our Commitment to Service

We know you have a choice when it comes to purchasing unmanned systems and sincerely appreciate your business!

We want to make sure you're successful with your SimpleSCAN platform and that it becomes a part of your operation by serving you well. As such, we are available via email anytime to answer questions and help solve problems you may have. Furthermore, for the first 30 days after receipt, we are happy to help instruct you in Mission Planning and operation via phone and teamviewer as well as prepare up to 10 sample missions for you based on your location.

Warranty

We guarantee this product to be free from defects for a period of 90 days. During the warranty period, SimpleUnmanned, LLC may at its discretion ship replacement components, repair or replace the affected products. In the event a return for repair is required, shipping to SimpleUnmanned, LLC will be covered by the customer. After the repairs are completed, SimpleUnmanned, LLC will cover shipping to the customer.

After Warranty Service

SimpleUnmanned, LLC products are built to last and very serviceable. We try to keep our products as universal as possible so, unlike most Unmanned Systems Providers, you are not stuck buying overpriced components from us! If you have issues with your SimpleSCAN, most of the time affordable components are available locally at Hobby Shops or Hardware Stores. Just drop us an email and we'll be happy to help source them and provide recommendations. In the event components are not available, we can provide needed components at a fair market price. In the event of more significant issues and/or damage, your SimpleSCAN may be returned to us for repair at the current shop rate. A full estimate will be provided prior to repair work.

Email/Phone Info

Please feel free to reach out for any questions, comments, or concerns.

- Our Phone Number is: 817-350-6694
- Our Email is: support@simpleunmanned.com

Mission Planning Assistance & Teamviewer Support

First 30 Days

We understand that unmanned systems can have a learning curve and we are here to help you through it! As such, for the first 30 days after receiving your SimpleSCAN - we are happy to be available to discuss concerns, questions and go through its operation with you via SMS, Phone & TeamViewer.

After 30 Days

We will always be available to help via email - most emails are handled within 24 hours. If you require teamviewer support after this time, we charge a rate of $50 USD per hour.

Appendix

Full Parameter List

Field Reference

Advanced Use