Bluewhite Pathfinder

Operator's Guide

Autonomous technology that keeps you growing

Generation 3

bluewhite.ai

About This Operator's Guide

This operator's guide is designed for farm operators using the Bluewhite Pathfinder 3.3 system. It describes how to operate the Bluewhite Pathfinder system and does not cover traditional tractor procedures. The guide applies to a variety of tractors and farming tasks, providing comprehensive instructions to ensure efficient and safe autonomous operations.

This operator's guide contains the following chapters:

- **Chapter 1, Introducing the Bluewhite Pathfinder,** page 13, introduces the Bluewhite Pathfinder system, describes its components and how it works.
- **Chapter 2, Bluewhite Safety Features, Cautions and Warnings,** page 36, describes the Bluewhite Pathfinder safety features and provides cautions, warnings, and safety measures that operators must follow when operating and maintaining the Bluewhite System.
- **Chapter 3, Starting a Shift,** page 42, describes the procedures for starting an operator's shift.
- **Chapter 4, Performing Tasks,** page 70, describes the procedures for performing and monitoring autonomous tasks during a shift.
- **Chapter 5, Ending a Shift,** page 107, describes the procedures for ending an operator's shift.
- **Chapter 6, Pathfinder Application,** page 113, describes how to use all the features of the Pathfinder application on the Pathfinder tractor.
- **Chapter 7, Compass Control Application,** page 112, describes how to use all the features of the Compass Control application for monitoring and controlling Pathfinder tractors.
- **Chapter 8, Pathfinder Remote Control,** page 113, describes how to use the Pathfinder Remote Control to control a Pathfinder tractor.
- **Chapter 9, General Procedures,** page 164, describes various procedures to be performed on the Pathfinder tractor that are repeatedly referenced throughout this operator's guide.
- **Chapter 10, Maintenance,** page 168, describes how to stop the Pathfinder's autonomous self-driving to perform standard tractor maintenance and how to perform various Pathfinder-specific maintenance procedures.
- **Chapter 11, Troubleshooting,** page 172, provides troubleshooting procedures for Pathfinder operators.
- **Chapter 12, Operator Self-Service (Tier 0),** page 178, describes how an operator can repair issues that may arise with the Bluewhite Pathfinder system.
- **Appendix A, Warning Labels,** page 179, describes important warning labels to be placed on and around the Pathfinder equipment.
- **Appendix B, Acronyms and Terms,** page 180, describes the acronyms and terms of Bluewhite's solution.
- **Appendix C, Index,** page 182, provides an alphabetical list of topics, terms and their corresponding page references.

Table of Contents

1.4 How Does an Autonomous Pathfinder Tractor Work?

1.4.1 Basic Bluewhite Pathfinder Functions

- **Sense:** The Bluewhite Pathfinder tractor is equipped with multiple sensors that dynamically react to its surroundings in real time. The 3D LiDAR and cameras work together to provide a comprehensive view of the environment, while the GPS enables precise positioning. These sensors can detect trees, lanes, obstacles, canopy, ground, implements, people, and animals within 50 feet of the tractor. The system reacts to anything within 7 feet, allowing for intelligent navigation and obstacle avoidance. Additionally, remote operators can view camera images from th of the tractor to monitor its operation and surroundings.
- **Analyze:** The Pathfinder Computing Box on board the tractor provides real-t analyze field conditions. It determines the tractor's driving path, controls th according to sophisticated safety logistics. This advanced processing ensures performs its assigned tasks efficiently while maintaining the highest safety s the environment. The real-time field intelligence allows the tractor to adapt and execute its operations with precision.
- **Control:** The Pathfinder kit, retrofitted onto the tractor, integrates mechani systems to manage the tractor and its implements. This sophisticated integr tractor to execute commands assigned remotely by the operator using the application. The system includes controllers for hydraulic (HYD) operations, controls, and implement management, ensuring seamless operation and pr farming tasks.
- **Communication and Reporting:** The Pathfinder system facilitates continuou between the remote operator and the tractor. This connectivity allows the control, monitor, and view the tractor's surroundings. The Pathfinder kit tra of its activities throughout the day in real time and provides comprehensive This constant flow of information ensures that the operator is always aware and can make informed decisions to optimize performance and safety.

1.4.2 Autonomous or Manual Tractor Operation

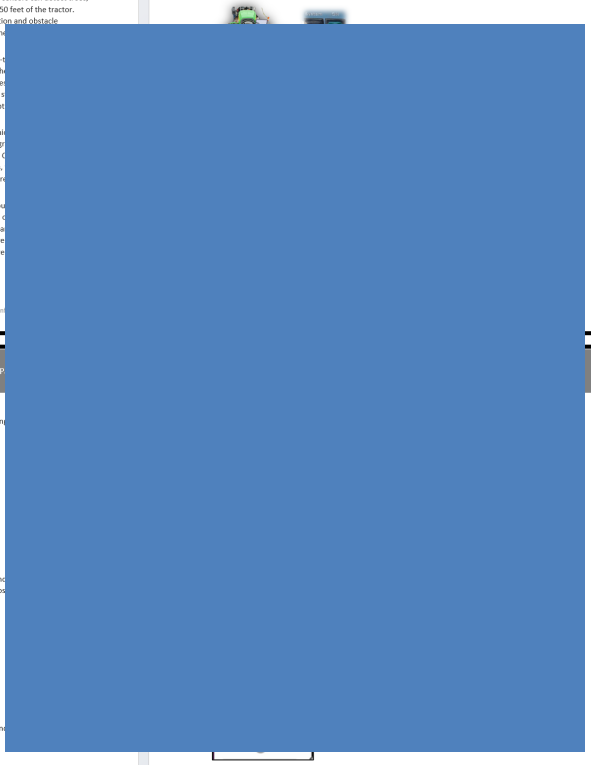
The Pathfinder Kit transforms regular tractors into autonomous machines while retaining their manual driving capabilities.

System Mode or Tractor Mode

The Bluewhite Pathfinder system offers two distinct operational modes that can be switched via the Pathfinder Computing Box installed on the tractor: System Mode and Tractor Mode. With a simple switch, operators can toggle between autonomous mode and manual mode, ensuring the tractor can still be used for tasks that require human intervention, such as pulling another tractor out of the mud.

- **System Mode:** This mode activates the Pathfinder system, enabling it to control the autonomous behavior of the tractor. When in System Mode, the tractor operates under the guidance of the Pathfinder's advanced navigation and task execution algorithms, performing predefined tasks such as spraying, mowing, spreading, or plowing autonomously.
- **Tractor Mode:** This mode allows the tractor operator to manually operate the tractor using traditional methods, as was done prior to the introduction of the Pathfinder system. Switching to Tractor Mode deactivates the Pathfinder's autonomous control, giving full manual control back to the operator. This mode is essential for tasks that require human intervention or when troubleshooting issues that require manual operation.

Note: In Tractor mode, the Pathfinder LLC is disabled and manual driving is possible.



20 Set the tractor's gear to neutral.

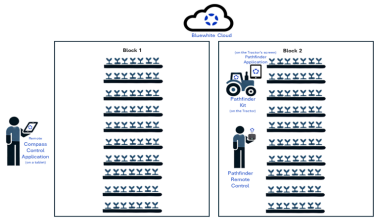
21 Engage the emergency handbrake/park lever.

22 Perform this same procedure for all Pathfinder tractors to be used during the current shift.

For each tractor, select the relevant tractor in the **RC Slot** field of the Pathfinder application by pressing the relevant **Tractor Selector** button on the Remote Control, as described earlier in this section.

1.5 The Bluewhite System Players

Here's a short description of the applications and devices that comprise the Bluewhite Pathfinder system.



1.5.1 Bluewhite Pathfinder Kit

The Bluewhite Pathfinder Kit is a sophisticated hardware and software solution designed to retrofit onto the most popular tractor models, transforming them into autonomous, self-driving vehicles. This kit enables tractors to perform a variety of farm tasks, such as plowing, mowing, spraying, and more, using attached implements. The Pathfinder Kit integrates various components, including GPS, LiDAR, and cameras, to navigate fields accurately, avoid obstacles, and optimize farming operations.

9 In the Pathfinder application window, disengage the Safety Lock by selecting

10 Engage the tractor in any gear.

11 Disengage the emergency handbrake/park lever.

12 Push the **Remote Control Mode** switch down to take control of the Pathfin sticks on the Remote Control are spring-loaded to return to their center pos shift is in neutral and the steering wheel is centered.

13 Push the left stick on the Remote Control upwards and then downwards an tractor's throttle (RPM) increase and then decrease accordingly.

14 Push the right stick upwards and then downwards to direct the tractor to drive slightly forward (approximately 2 feet) and then slightly backwards.

23 Power off the Remote Control for now until you arrive at the block and are ready to start a task. To do so, press and hold the power button in the center of the Remote Control for 3 seconds until it powers down.

24 If multiple Remote Controls are used in this shift, then perform this entire procedure for the other Remote Control on all Pathfinder tractors.

25 Switch the Pathfinder tractor's Computing Box to Tractor mode, enabling manual driving by an operator by setting the **System/Tractor** switch to **Tractor**.

26 Fill up the implement to be used, if needed.

27 Manually drive the tractor to the task starting point.

⚠ **WARNING:** If any of the checks above fail, do not use the Pathfinder tractor. These tests are crucial for ensuring safe and proper operation.

3.7 Securing the Block Perimeter

The operator is responsible for taking any and all measures to prevent unauthorized personnel from entering the area in which the Pathfinder is operating. For example, a yellow **No Passing Zone** signs should be placed at each of the entrance points around the perimeter of the block where the Bluewhite Pathfinder operates in accordance with the laws and regulations of the jurisdiction where the farm is located. These signs must clearly mark the boundaries, preventing unauthorized access and minimizing the risk of accidents, thus ensuring a safe environment for both equipment and personnel. For example, a sign may need to be placed in each of the four corners of the block.

Proceed to the *Chapter 4, Performing Tasks* to start operating the Pathfinder tractor.

3 Bluewhite Safety Features, Cautions and Warnings

This chapter describes the Bluewhite Pathfinder safety features and provides cautions, warnings, and safety measures that operators must follow when operating and maintaining the Bluewhite System..

⚠ WARNING: Adhering to these safety warnings and precautions is crucial not only for the safe and efficient operation of the Bluewhite Pathfinder system and the tractors on which it is installed but also to ensure the safety of people and the protection of property in the operational area.

3.1 General Safety

⚠ **WARNING:** Do not attempt to override or bypass any safety features of the Pathfinder system. Doing so may result in serious injury or equipment damage.

⚠ **WARNING:** Ensure the operational area is clear of obstacles, unauthorized personnel, and animals before starting the Pathfinder system.

△ CAUTION: Only Bluewhite-certified operators are allowed to operate any components of the Pathfinder system.

△ CAUTION: Ensure all operators have completed the required training sessions provided by Bluewhite before using the Pathfinder system.

△ CAUTION: Always wear appropriate Personal Protective Equipment (PPE) such as gloves, safety glasses, and steel-toed boots when operating or maintaining the tractor.

△ CAUTION: Maintain a safe distance from the tractor during autonomous operation to avoid accidental contact with moving parts.

3.2 Emergency Procedures

⚠ **WARNING:** Familiarize yourself with the location and operation of all emergency stop buttons. In case of an emergency, you can use the emergency stop button to halt the tractor immediately.

The two emergency stop buttons on the Pathfinder kit are shown below.

In an emergency, press one of the red emergency stop buttons firmly to stop the tractor immediately.

⚠ **WARNING:** The emergency stop buttons on the Pathfinder kit will only stop the tractor and shut off its motor when the Pathfinder is in System (Autonomous) mode, meaning that the Computing Box is set to System Mode. When the Computing Box is set to Tractor Mode, the tractor operates manually like any other standard tractor, and the standard emergency buttons have no effect.

To release an emergency stop button after it has been pressed, twist it clockwise and then pull it out until it pops out.

⚠ **WARNING:** Report any malfunctions or safety concerns to Bluewhite support immediately.

Note: Although it is uncommon if something (like a branch) inadvertently presses the emergency button, it will stop the tractor. If the tractor unexpectedly halts, check if the emergency button has been accidentally activated.

3.3 Pre-Operation Checks

A full description of the checks to perform before each shift is provided in the *Starting a Shift* section on page X.

⚠ **WARNING:** Verify that all safety devices and emergency stop mechanisms are functioning correctly.

△ CAUTION: Inspect the tractor and Pathfinder system for any signs of damage or wear before each use.

△ CAUTION: Ensure that the Pathfinder Kit is securely installed and all connections are intact.

△ CAUTION: Check antennas, LiDAR feeds, bumper sensors, pistons on the steering wheel, wires, and other critical components.

3.4 Operating the System

⚠ **WARNING:** Follow all operational procedures as described in this guide.

⚠ **WARNING:** Operate the Pathfinder tractor within the designated geofenced areas to prevent unintended operation outside safe zones.

⚠ **WARNING:** Avoid operating the Pathfinder tractor in extreme weather conditions.

△ CAUTION: Maintain a safe distance from the tractor during autonomous operation.

3.5 Maintenance and Troubleshooting

⚠ **WARNING:** Only qualified personnel should perform repairs or adjustments to the Pathfinder system. Unauthorized repairs may void the warranty and lead to unsafe conditions.

⚠ **WARNING:** Use only authorized materials, parts and accessories to maintain the integrity of the system.

△ CAUTION: Perform regular maintenance as specified in the maintenance schedule, as described on page x.

△ CAUTION: Disconnect the battery and secure the tractor before performing any maintenance to prevent accidental startup and injury.

△ CAUTION: Clean LiDAR and cameras regularly and check for any obstructions.

3.6 Environmental Considerations

⚠ **WARNING:** Avoid operating the system in extreme weather conditions unless the equipment is rated for such use. Extreme conditions may compromise safety and performance.

△ CAUTION: Dispose of any waste materials from maintenance activities in accordance with local regulations to prevent environmental contamination.

△ CAUTION: Periodically check the environment for obstacles and ensure safe conditions for operation.

5 Performing Tasks

This chapter describes the procedures for performing and monitoring autonomous tasks during a shift.

5.1 Workflow Overview: Performing a Task

The following is a short overview that summarizes how to start and monitor a new task and how to restart a task any time after the Pathfinder tractor stopped, such as after it has finished a task, after a task was dismissed, after filling a sprayer, or after the operator comes back from a break. This work overview assumes that the shift has already been started for the relevant Client and Ranch, as described in *Chapter 3, Starting a Shift* on page x.

▶ **Here's an overview of operations required for executing tasks using the Pathfinder tractor:**

1 **Prepare the Tractor Itself for a Task,** as described on page 74.

2 **Position the Tractor:** Ensure the Pathfinder tractor is correctly positioned at the designated sta as need for the task so that the tractor can operate according to the route you are planning for needed, manually drive the Pathfinder tractor to the starting point.

3 **In the Compass Control application, select a Pathfinder Tractor,** as described on page x.

4 **Define a Task for the Pathfinder Tractor,** as described on page 75. If the task's starting point is where you want to start, manually move the starting point in the Compass Control application, described on page x.

5 **Disengage the Safety Lock:** In the Compass Control application, turn off the Safety Lock (if it's already off) to allow the tractor to begin autonomous operation, as described on page x.

6 **Start the Task:** Click the **Play** button/slider in the Compass Control application to start the t and autonomous driving, as described on page x.

7 **Verify:** Watch the Pathfinder self-drive for at least a minute with eyes on the tractor as well as the Pathfinder tractor's icon in the Compass Control application to make sure that it is behaving expected. If not, stop the Pathfinder tractor using the Compass Control application, or the Rem Control, as described on page x.

8 **Repeat the steps above for all tractors to operate in that shift.**

Tip: You may refer to the *Staggering Tractor Starts* section on page x for tips about which Pathfinder tractor to start first.

9 **Monitor Task Performance and Handle Issues:** Monitor the operation of the Pathfinder tractor to ensure it is functioning as expected and at peak efficiency, as described on page x.

- Watch for Red Notifications on the Compass Control application and address any issues that may cause the tractor to stop or operate inefficiently.
- Monitor the Route
- Monitor the Pathfinder tractor's speed
- Monitor Tank Fullness: Periodically check if refilling sprayer tanks or making other adjustments is necessary during the task to maintain optimal performance.

10 **Taking a Break:** When taking a break of more than a few minutes, it is recommended to follow the instructions in the *Taking a Break* section on page x.

5.2 Preparing a Pathfinder Tractor for a Task

The following can be done for one Pathfinder tractor or for all of them in the block before proceeding with the assignment of tasks to the Pathfinder tractor.

▶ **To prepare a Pathfinder tractor to start/restart a task:**

1 **Shift to Neutral:** Place the Pathfinder tractor's shifter into neutral.

2 **Disengage the Emergency Handbrake/Park Lever.**

3 **Set the Desired Gears:** Engage the appropriate gears for the task to be performed by that tractor.

4 **Connect the Implement:** An Implement must be connected both mechanically and possibly electronically to the designated tractor. If the implement required by the shift's tasks is not already connected to the designated tractor, connect it, as described on page x. If using a sprayer, make sure that neither the right nor the left nozzle switch of the Implement's Box is on. Turn on the tractor's Implement Box.

Note: The implement that is mechanically attached to a Pathfinder tractor must also be defined as attached in the Compass control application. This is described as part of the defining a task procedure, described on page x.

5 **Switch on the Tractor:** Enter the cabin and switch on the tractor as you have always done before introducing the Pathfinder system.

6 **Turn on the Tractor's Lights:** If needed, for example, at night.

7 **Activate the Pathfinder's Computing Box:** Activate the Pathfinder's Computing Box by switching the green **ON/OFF** switch **ON** ().

8 **Activate System Mode:** Switch the Pathfinder tractor's Computing Box to **System** mode, which allows autonomous control, by setting the **System/Tractor** switch to **System** ().

The Pathfinder tractor is now ready to start self-driving upon receiving a Play command form the Compass Control application.

Important Information: Always make sure the shifter is in neutral when the Pathfinder is in System Mode.

5.3 Assigning a Task to the Pathfinder Tractor

5.3.1 Overview

By default, the Compass Control application, displays an image of the selected ranch, with the **Trac** tab selected listing all the tractors defined for this ranch during the onboarding stage. The followin shows two tractors in the center of the block:

A single task can be uploaded to the Pathfinder tractor at a time.

Tip: Tasks can range from covering just a few rows to an entire block and are generally designed to span an entire shift. However, the scheduling flexibility is yours, so, for example, multiple tasks can be undertaken within a single shift.

The Compass Control application does not permit ending a shift while tasks are still active. Tasks must either be completed or explicitly dismissed before the shift concludes.

After the Pathfinder completes a task, you can use the Compass Control application to upload another task or you can stop the Pathfinder tractor and then dismiss its task at any time.

A Pathfinder tractor appears as a icon before a task is uploaded to it and as a icon when selected.

2 Verify that this Pathfinder tractor is communicating with the Compass Control application so that it can receive a task from the Pathfinder system by looking at one of the following:

- The tractor's icon is not red . If it appears red when the Pathfinder kit is not connected to the Compass Control cloud. Refer to page x for troubleshooting.

– OR –

- The communication status icon in the Tractor's hexagon in the top left of the page is white to indicate that the Pathfinder tractor is connected to the Compass Control application. It should not be red .

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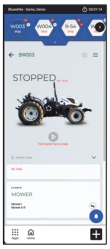
3 To select the Pathfinder tractor to which to assign a task, display its page in the left pane (shown below) by either:



- Clicking on the Pathfinder tractor's icon object the map:

– OR –

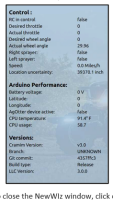
- Clicking on its hexagon icon at the top of the left pane:

– OR –

- **Navigation Method:** Specifies the current navigation method used by the Pathfinder tractor. For example, the following shows that the signal was lost and, therefore, the RTK navigation method is not functioning. This is one of the things to check of a Pathfinder tractor has stopped for an unknown reason.

- **Connectivity to the Compass Control Application:** indicates that the Pathfinder Kit is connected to the Compass Control application indicates loss of connection.
- **Autonomy Quality Indicator**

- **Pathfinder Autonomy Parameters:** A variety of system parameters are displayed in the blue area on the left, as shown below:



2 To close the NewWIz window, click on the **NewWiz** button again.

7.5 Viewing/Changing Pathfinder Settings

▶ **To view or change Pathfinder settings:**

In the Pathfinder application window, click the **Settings** button.

General Tab

The **General** tab displays by default, as shown below. It shows the name of the task and the **Starting Row** assigned by the Compass Control application.

For scenarios requiring manual operation of the tractor, such as navigating around obstacles like bee boxes, returning the tractor to its designated row after it exits its geofence, or starting a task from a different row than specified, this page allows you to designate the starting row in the **Starting Row** field. This feature ensures precise control when adjustments are needed for specific field conditions or task requirements.

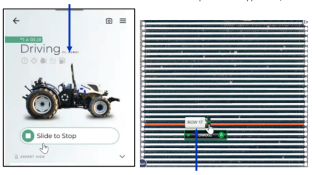
Important Information: It's important to update the value of the **Starting Row** field (as described above) each time you manually drive the Pathfinder tractor.

Tip: It is recommended to change the row in the Compass Control application, if possible. Otherwise, you can do it using the Pathfinder application.

Note: If the Pathfinder tractor detects that it is far away from the starting row that you specify, it will not allow the **Play** button to be clicked.

The number of the row in which the Pathfinder tractor thinks it is driving is displayed in the center of the NewWiz page, shown below:

The current row can also be seen and modified in the Compass Control application, as shown below:



Example – Simple Navigation

Suggest Edits

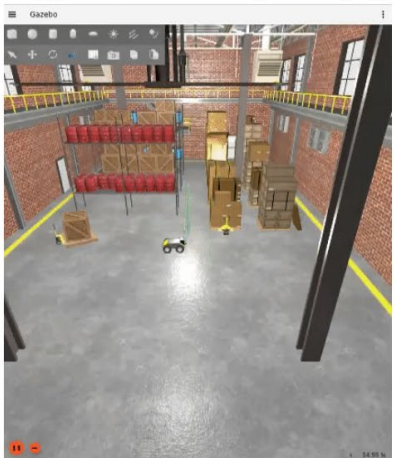
This topic describes how to select and customize an existing robot and/or to design your own robot by showing how to do it on a Husky and Tugbot robot.

Here's where we show how easy it is to control a Husky robot (as well as a Tugbot robot) navigating a square pattern of 2 m x 2 m. It comes with a readymade simulation in the **Depot** world of Gazebo Fortress.

The ROS **move_distance** node is used to send a velocity command in the X direction of the robot until the robot has moved a specific distance, which is verified using the wheel odometry feedback. The **rotate** function operates in a similar manner.

As the robot travels in squares, you will see that the feedback from the wheels' odometry causes accumulative errors so that the robot is **drifting** away from its initial starting point and is not repeating the same square pattern.

Note – Don't worry, MOV.AI Flow uses SLAM localization to fix this problem, as described in Learning About Robot Localization.



Introducing MOV.AI Flow™ for ROS Developers

Suggest Edits

What is MOV.AI Flow™ ?

MOV.AI Flow™ is an open Integrated Development Environment (IDE) designed especially for ROS and developed by MOV.AI.

It adds a visual layer to ROS as-well-as parameter structuring and built-in state machine. The ROS ecosystem is integrated into the IDE.

This visual IDE speeds up and streamlines ROS development by allowing quick project understanding, reducing configuration and integration work, speeding up debugging and making it easier to import assets, port projects across environments and share with the community.

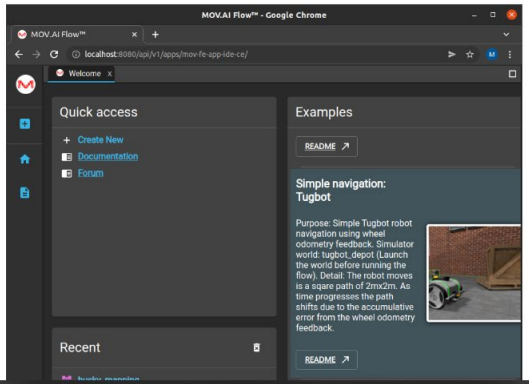
MOV.AI Flow™ is a source available tool. The source files are available on GitHub.

Watch the Control of a Tugbot Robot

Suggest Edits

Let's see the same demo on a Tugbot robot.

1. Launch MOV.AI Flow TM and open the **Simple Navigation: Tugbot** demo, as described in Launching MOV.AI Flow™. The following displays –

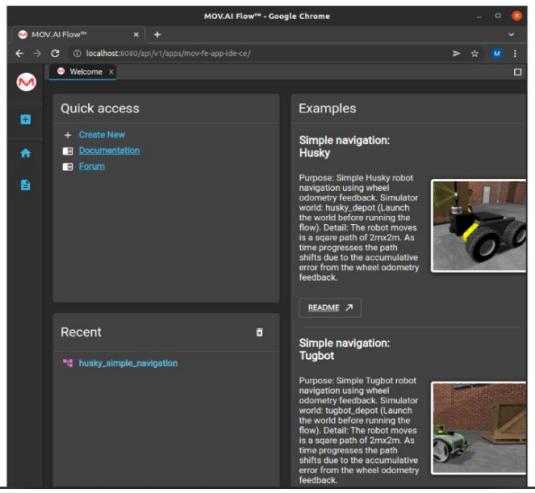


Watch the Control of a Husky Robot

Suggest Edits

To experience the ease of robot navigation with MOV.AI Flow –

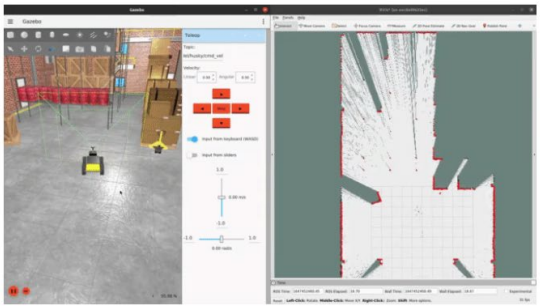
1. Launch MOV.AI Flow™ and open the **Simple Navigation: Husky** demo, as described in Launching MOV.AI Flow. The following displays –



Quick Tour – Mapping Application

Suggest Edits

Here's where we demonstrate a MOV.AI Flow™ mapping flow and how it can be used for any robot that requires global localization functionality. This lesson shows you how MOV.AI Flow enables any robot (such as Husky or a Tugbot) to map the environment in which it will be operating by traveling around the entire area in order to localize itself in its environment.



Here's a small taste. Click below to see the full video.

Watch the next steps!

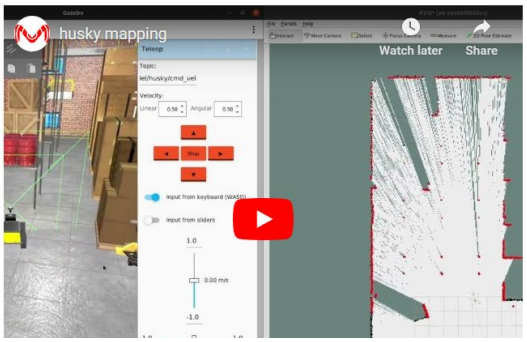


TABLE OF CONTENTS
Watch the next steps!

Setting Up Your Robot in MOV.AI Flow™

Suggest Edits

MOV.AI Flow™ enables you to design the behavior of any robot, whether it exists in the real world or is only a simulation.

Click one of the links below for a quick workflow for setting up any type of robot –

- A Husky, Panda or Tugbot robot. MOV.AI Flow provides the drivers for these robots as a subflow in MOV.AI Flow. MOV.AI Flow provides a simulation in Gazebo Fortress for the Husky and Tugbot robots.
- A robot simulation that you have in Gazebo Fortress
- A robot simulation that you will build
- A real physical robot that you have

Setting Up a Simulated Robot

Here's a quick overview of the steps for setting up a simulated robot –

1. Build your simulated robot, as described in Building a Simulated Robot.
2. Add this robot to a simulated world, as described in Building a Simulated World.
3. Create the robot's drivers so that the robot interacts with ROS and MOV.AI Flow, as described in Robot Drivers.
4. Design the Application Flow, meaning define the behavior of your robot in MOV.AI Flow.

Setting Up a Real Physical Robot

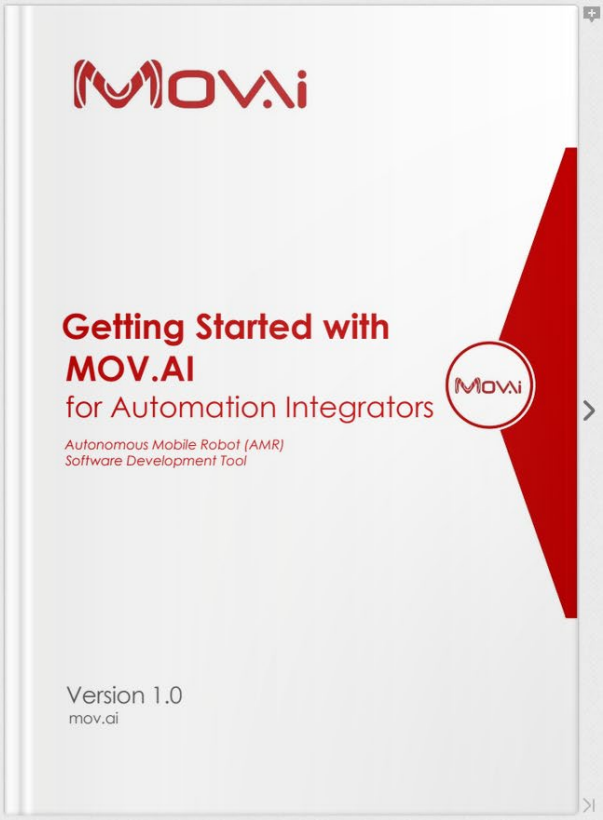
Here's a quick overview of the steps for setting up a real physical robot –

1. Design the drivers to control the real physical robot, as described in Real Robot ROS Drivers.
2. Design the Application Flow, meaning define the behavior of your robot in MOV.AI Flow.

Setting Up a Husky, Panda or Tugbot Robot

MOV.AI Flow™ provides the drivers for operating a real and a simulated Husky and Tugbot robot.

TABLE OF CONTENTS
Setting Up a Simulated Robot
Setting Up a Real Physical Robot
Setting Up a Husky, Panda or Tugbot Robot



Demonstrating MOV.AI in Three Lessons

In order to introduce and guide you through the features, benefits and usage of the MOV.AI solution for integrators, this getting started guide provides three ready-made MOV.AI flows that operate in a warehouse environment. These three flows are described in chapters 3, 4 and 5. Each flow builds upon the options presented in the previous one in order to demonstrate how a complete implementation can be performed.

This guide will walk you through the process of opening each flow and will show you how to view and modify its definitions. Each demonstration presented in this guide also describes how to play (run) it in the simulated environment provided by MOV.AI. This will enable you to watch the robot operate in the provided simulator according to the flow definitions created in MOV.AI.

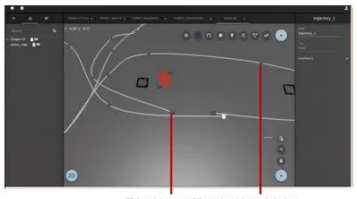
This Getting Started Guide contains the following chapters –

- Chapter 1, Introducing MOV.AI for Integrators, page 7, introduces MOV.AI and describes the features that make it easy for anyone – especially MOV.AI integrators.
- Chapter 2, Getting Started with MOV.AI, page 11, introduces the MOV.AI interface and describes how to launch it.
- Chapter 3, Moving the Robot, page 17, demonstrates how to start using the MOV.AI IDE to move your robot backwards and forwards.
- Chapter 4, Traveling along a Trajectory, page 34, demonstrates how to use the MOV.AI IDE to define that a robot travels along a specific trajectory.
- Chapter 5, Picking Up and Transporting a Cart, page 46, demonstrates how to use the MOV.AI IDE to define that a robot picks up and transports a cart from one place to another.
- Chapter 6, Quick Tour of the User Interface, page 59, provides a quick tour of the other options in the MOV.AI framework user interface, some of which may be particularly interesting for an ROS developer.

Table of Contents

To modify the actual path of the trajectory –

1. Click the **Grab Object** tool.
2. Click anywhere on the white line of the trajectory shown in the Scene Map.
3. Click on any of the grab points (dots) along the trajectory (the white line) and drag it to a new position.



Click and drag any of the grab points on a trajectory to modify the trajectory

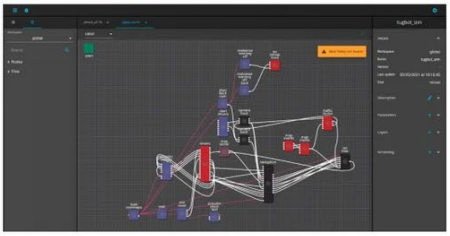
To add additional points to the trajectory that can be grabbed in order to modify the trajectory, select the trajectory and then click on one of the following buttons > < (located in the bottom right of the page). Each of these buttons adds an additional point on the trajectory – either before or after the currently selected point.

TUGBOT Simulator

The TUGBOT simulator icon represents the proprietary functionality and drivers that are provided ready-made by MOV.AI for the supported robot. There is nothing to configure or do here in order to use MOV.AI to its full potential. The interface enables you to display and drill down into all its nodes for the sake of openness and for information purposes only.

Therefore, you do not have to read this section and you can skip directly to page 46.

But if you are interested, you can double-click on this icon to display the underlying flow that comprises it, as shown below –



This flow shows the drivers that are provided by MOV.AI for the supported robot as a black boxes. They are literally encapsulated black boxes that enable the robot's specific functionality that makes it easy for you to program the robot using MOV.AI.

The following describes some of these nodes for information purposes only. Double-clicking on one of these boxes may display an additional subflow.

Note – These subflows do not need to be handled or configured by you, it comes ready-made and set up for you by MOV.AI.

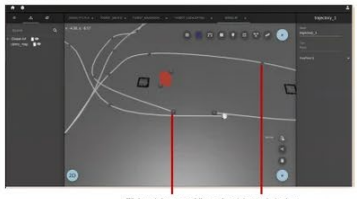
- **Localization –** Provides the robot with awareness of the environment in which it is operating and indicates its location within that environment.
- **Navigation –** Enables the robot to follow a trajectory through the environment that is defined in MOV.AI. This functionality includes the control of the robot's motors and movement mechanisms, such as wheels and steering mechanisms, which will enable it to move to the destination on the Scene Map that you define in the flow.
- **mux –** Handles the multiplexing of the various methods published by the nodes of this flow in order to determine which one will be executed by the robot at any given moment.
- **init sim –** Resets the robot in its initial position.

Getting Started with MOV.AI for Automation Integrat... | pages: 44 - 45 / 80

MOV.AI User Guide

To modify the actual path of the trajectory –

1. Click the **Grab Object** tool.
2. Click anywhere on the white line of the trajectory shown in the Scene Map.
3. Click on any of the grab points (dots) along the trajectory (the white line) and drag it to a new position.



Click and drag any of the grab points on a trajectory to modify the trajectory

To add additional points to the trajectory that can be grabbed in order to modify the trajectory, select the trajectory and then click on one of the following buttons > < (located in the bottom right of the page). Each of these buttons adds an additional point on the trajectory – either before or after the currently selected point.

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Therefore, you do not have to read this section and you can skip directly to page 46.

MOV.AI 44
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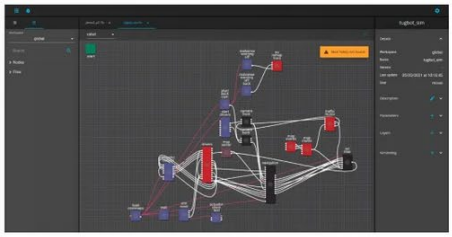
MOV.AI User Guide

But if you are interested, you can double-click on this icon to display the underlying flow that comprises it, as shown below –



This flow shows the drivers that are provided by MOV.AI for the supported robot as a black boxes. They are literally encapsulated black boxes that enable the robot's specific functionality that makes it easy for you to program the robot using MOV.AI.

The following describes some of these nodes for information purposes only. Double-clicking on one of these boxes may display an additional subflow.

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- **mux –** Handles the multiplexing of the various methods published by the nodes of this flow in order to determine which one will be executed by the robot at any given moment.
- **init sim –** Resets the robot in its initial position.

MOV.AI 45
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WONDER ROBOTICS LTD

WONDERLAND

INTEGRATION AND OPERATION MANUAL

Welcome to the Drone Revolution

Version 0.1
www.wonderrobotics.com

ABOUT THIS MANUAL

This integration and operation manual is intended for system integrators and operators of the Wonder Robotics WonderLand vertical awareness system for commercial drones.

CAUTION – The WonderLand system must only be integrated and operated according to the instructions in this manual.

CAUTION – Using the WonderLand system does not eliminate all risks of drone operation. Fly, land and deliver responsibly and in accordance with the rules and regulations defined by authorities in the area where you are operating.

This manual contains the following chapters –

- **Chapter 1, Introduction,** page 8, introduces the WonderLand system and describes its components and regulatory compliance.
- **Chapter 2, Vertical Awareness,** page 18, describes how WonderLand provides intelligent vertical awareness and drone autonomy for flight, descent, landing and package drop.
- **Chapter 3, Integration,** page 18, describes how to integrate the WonderLand system into a drone, using either the WonderLand Pod Integration Kit or the WonderLand Component Integration Kit.
- **Chapter 4, Profile Configuration,** page 32, describes how to configure a profile that defines the behavior and decision-making autonomy of the WonderLand system.
- **Chapter 5, Monitoring,** page 34, describes how to monitor a WonderLand system (which is optional) during and after a mission.
- **Chapter 6, Maintenance,** page 35, describes how to perform routine maintenance of the WonderLand system.
- **Chapter 7, Troubleshooting,** page 36, describes issues that may arise while working with the WonderLand system and how to resolve them.
- **Chapter 9, Labels,** page 37, describes the labels to be placed on the WonderLand system.
- **Chapter 9, Safety,** page 37, provides cautions, warnings and safety measures that are mandatory for the integration, operation and maintenance of the WonderLand system.

EDITION NO. REVISION HISTORY

0.1	November 2022	First Partial Draft

CONVENTIONS USED IN THIS MANUAL

This manual indicates safety instructions, warnings and important information using the following symbols. These symbols are distributed throughout this manual. Detailed safety instructions are provided in the Safety chapter on page x.

CAUTION – Describes potential actions or situations that may adversely affect the integrity and quality of the WonderLand system.

WARNING – Describes potential actions or situations that may result in damage to the WonderLand system or its malfunctioning, as well as injury or bodily harm.

LASER WARNING – Describes laser-related warnings. The WonderLand system is a laser class 2. The laser radiation is harmless to the eye for short exposure times (up to 0.25 s). Therefore, no separate protective equipment is required. Nevertheless, avoid looking directly into the laser beam. IS THIS RELEVANT? GDO

ELECTRICAL WARNING – Describes electrical current issues that may cause health impairments, injuries, lasting bodily damage or death.

Note – Provides additional information.

1 INTRODUCTION

This chapter introduces the WonderLand system, describes its components and regulatory compliance.

1.1 What is WonderLand?

WonderLand is Wonder Robotics' platform agnostic, vertical awareness system that enables safe and precise descent and landing of vertical take-off and landing (VTOL) commercial drones and manned aircrafts. WonderLand provides a wide of options for configuring the system's behavior and determining whether it serves as an Advanced Pilot Assistance System (APAS) or whether it provides the drone with total autonomy regarding landing site selection, ground clearance, descent, package lowering and safe landing, as well as vertical navigation and obstacle detection-and-avoidance issues.

Figure 1 – WonderLand's Vertical Awareness

Wonder Robotics utilizes highly advanced proprietary vision-based capabilities that look down in order to inform and warn about static and dynamic obstacles, as well as to communicate commands to a drone's flight controller or flight management system.

Wonder Robotics enables drones to land safely and completely autonomously and/or with operator assistance on any marked site and on an unprepared site.

Wonder Robotics brings each drone to a safe and autonomous precision landing, ensuring that no risk is posed to surrounding objects (such as humans) and no damages are caused to drone, its payload or to the underlying property.

2 VERTICAL AWARENESS

This chapter describes how WonderLand provides vertical awareness and intelligent drone autonomy for flight, descent, landing and package drop.

2.1 WonderLand Flow Overview

WonderLand enables drones to make autonomous flight, descent and landing decisions independently without any communication from the ground.

Depending on the Wonderland profile that has been uploaded to the onboard processing unit (NVDIA computer) that is connected to the drone's flight controller or the drones management system, Wonderland provides information, warnings and commands regarding flight, descent, landing and package drop.

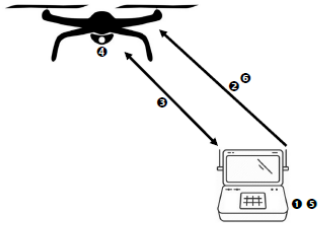

Figure 9 – WonderLand Flow Overview

The following flow of the Wonderland system starts after it has been integrated into the drone, as described on page X.

❶ **Defining Profiles –** Define one or more profiles on a standard computer for each Wonderland/drone behavior scenario – precision landing, contingency/emergency landing and ground clearance, as described on page X.

4 PROFILE CONFIGURATION

This chapter describes how to configure a profile that defines the behavior and decision-making autonomy of the WonderLand system.

The WonderLand system provides a wide variety of behavior and autonomy configuration options that are encapsulated in a profile to be uploaded to the processing unit in which the Wonderland firmware is running. The WonderLand system operates according to the parameters of this profile. You have the option to upload a different profile at any time. The following are the main types of profiles that can be defined.

4.1 Precision Landing Profile

WonderLand unique intelligent precision landing system enables safe and precise landing by implementing multiple redundant, vision-based technologies in parallel. These configurable 2D/3D tracking mechanisms complement and back each other up so that the system never loses track of th at commercial drones requi y.

Won

- I red signals in all d
- C codes and markers.
- C s and RGB data (mean a correlation is an e atures nor high c
- 3 ientation of one or n wn location.

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Home Tools Document 1 / 15 Barbara

Bookmarks

- SafeAir M200 Installation Guide
  - Table of Contents
  - List of Figures
  - List of Tables
- Chapter 1 - Safety Instructions
- Chapter 2 - Package Contents
- Chapter 3 - Installation
- Chapter 4 - Operating Guidelines

SafeAir M200

INSTALLATION GUIDE

8.27 x 11.69 in

Table of Contents

Important Notice

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Home Tools Document 13 / 15 Barbara

Bookmarks

- SafeAir M200 Installation Guide
  - Table of Contents
  - List of Figures
  - List of Tables
- Chapter 1 - Safety Instructions
- Chapter 2 - Package Contents
- Chapter 3 - Installation
- Chapter 4 - Operating Guidelines

4 Operating Guidelines

4.1 Preflight

Initial Conditions: The safety cover is on and the safety pin is in.

Finalize all the preflight procedures to your drone and payload. The following tasks are in addition to the regular preflight tasks –

- Plug in the battery after verifying that it is fully charged and firmly close the battery bay door.
- Ensure that the thumb screws are firmly closed.
- Verify that the lever of the TerminateAir is in its down position.
- Remove the safety cover.
- Turn on the power to the drone.
- Carefully remove the safety pin.
- Move back to a safety distance of at least three meters.

4.2 Takeoff

- When climbing, you must climb to approximately eight meters before the system is armed. Climb until you hear a single long beep, and the LED is **DARK BLUE**.
- The system is now armed and ready for activation in case of an emergency.

4.3 Before Landing

When approaching landing, at approximately three to five meters from the takeoff altitude, the parachute system automatically disarms. At that point, a long double-beep is heard and the LED is **PURPLE**.

If the landing point is at a different altitude than the takeoff altitude, or the system did not discharge for some reason in the air, which may occur when there is a sudden change in atmospheric pressure, land the drone slowly while keeping it level. After three seconds, the system disarms itself.

4.4 After Landing

- After the Disarm signal has been heard, insert the safety pin all the way in before touching the drone.
- Place the safety cover back on the system.

The system is now safe and secured.

4.5 Troubleshooting

LED Shows an Alternating Red-Yellow Sequence

This is normal system behavior indicating that the sensors did not complete their initialization process. This indication may appear for several seconds at the end of the system initialization process.

LED Shows a Single Flashing-Yellow Sequence

This indicates a problem with the RC channels. This indication is only relevant for customers using an RC for system operations. Check that both RC channels are connected and in an inactive state.

LED Shows Two Flashing-Yellow Sequences

The system is not level. Try to move it slightly until this indication is resolved.

LED Shows Three Flashing-Yellow Sequences

This indicates a problem with the SD card. Use the desktop application to resolve this issue.

LED Flashes Teal

This indicates that the system's GPS has no converge. This does not affect operational performance.

LED Flashes Orange

This indicates that the system's cellular connectivity is inactive. This does not affect operational performance.

Fly Safely!

Should you have questions, contact our support team at –

contact@parazero.com

Phone – +972-548881012

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Home Tools Document 10 / 15 Barbara

Bookmarks

- SafeAir M200 Installation Guide
  - Table of Contents
  - List of Figures
  - List of Tables
- Chapter 1 - Safety Instructions
- Chapter 2 - Package Contents
- Chapter 3 - Installation
- Chapter 4 - Operating Guidelines

6 Pass the power cable through the legs. Then, place the two mounting cable straps to secure the electrical wires in place. To do so, place one strap on the base of the arm and wrap the second strap around the mounting leg on the side of the cable.

3.3 Connecting the Electrical Wires

Caution During all installation stages, be sure –

- Not to connect the batteries to the system.
- That the safety pin remains in its proper place.
- That the safety cover remains in its place, covering the system.

Be sure that the battery is not connected to the M200. If it is, disconnect the battery.

1 Take the main parachute system (see #1 in Table 1) and turn it over until its bottom side is facing you.

2 Connect the pyrotechnic device connector to the two-pin connector, located on the bottom of the parachute system.

3 Connect the TerminateAir cable to the three-pin connector located on the bottom of the parachute system.

3.4 Connecting the Parachute System to the Legs

There are two options for connecting the parachute system to the legs – using the parachute system's forward or rear position.

After connecting the electrical connectors, position the parachute system according to your needs using either the forward or rear location, and then attach the four thumb screws, four washers and four spring washers. Tightly secure the screws.

The SafeAir M200 system is now installed, and you are ready for operation!

3.5 Activating the System

1 Charge the M200 battery for two hours using the supplied charger, as shown below.

2 Check the charge level of the battery by connecting it to the middle connector, as shown below. Verify that a green light appears.

3 Verify that the safety pin is inserted all the way into position.

4 Release and pull up the safety cover, in order to access the battery bay.

Vorpal's VigilAir Operator's Guide

Vorpal's innovative drone monitoring and mitigation suite – returning safety and security to the skies

Version 7.0

Introducing VigilAir

1 Introducing VigilAir

This chapter introduces the Vorpal VigilAir system and describes its features, benefits and system components.

1.1 What is VigilAir?

Vorpal's VigilAir is a sensitive and accurate drone detection, geolocation and tracking solution that provides long-range, wide-coverage drone aerial situation awareness. VigilAir is a passive RF-based solution that is accurate in both urban and rural environments, without false alarms and with a minimal system footprint.

VigilAir quickly geolocates and tracks the path of targeted drones, as well as geolocating the drone operators. With only a few ground-based sensors, its functionalities include unparalleled signal processing capabilities, telemetry data extraction and drone Identification Friend or Foe (IFF).

VigilAir is intended for a wide range of airspace safety and security scenarios.

1.1.1 Features

VigilAir provides the following main features –

- **Drone Detection –** VigilAir enables the detection of drone RF communication and data links at significant distances, with high sensitivity, even in high-noise environments. This is done by employing its advanced signal processing algorithms, dedicated hardware and graphical user-friendly interface. This RF-based detection technology does not require any RF transmission and is fully passive.
- **Drone Geolocation –** After the initial detection (described above), once the drone is closer, VigilAir provides highly accurate geolocation of a large number of drones with less than a second of temporal resolution by employing Vorpal's proprietary enhancements that radically power-up Time Difference of Arrival (TDOA) technology. This provides reliable, timely, and clear information on drone location and activity.
- **Drone Tracking –** VigilAir uses multiple consecutive geolocations of the same drone to generate a drone track that follows the drone along its flight path. VigilAir carefully filters and fuses raw detection and geolocation information to generate a high-fidelity moving target indication of multiple drone tracks.

Table of Contents

2.6.5 Connecting the Sensor Unit to the RF

Use the 4.5-meter RF cable with an N-type connector on both ends of the cable is provided that connects between the Sensor Unit and the RF box. This cable has a white label that differentiates it from the GPS cable, which has the same N-type connector. This cable is part of the VigilAir system.

▶ **To connect the Sensor Unit to the RF –**

1 Connect the 4.5-meter RF cable with an N-type connector on both ends to the **RF** socket on the sensor unit, as shown below. Both the socket on the sensor unit and the cable have a white label. This cable is provided in the package containing the RF box. After connecting it, twist the silver ring at its end all the way to the right.

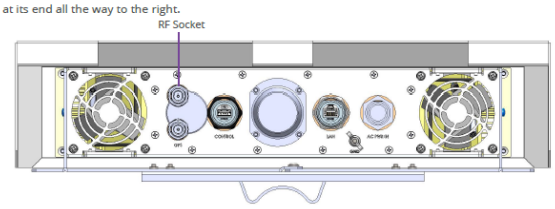


Figure 29 – Sensor Unit RF Socket

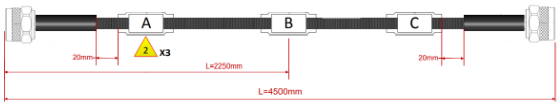


Figure 30 – 4.5m RF Cable with N-type Connectors on Both Ends

2 Connect the other end of this cable to the RF socket on the RF box, which also has a white label.

2.6.6 Connecting the Sensor Unit to the GPS

Use the 4.5-meter GPS cable with an N-type connector on both ends of the cable that connects between the sensor unit and the RF box. This cable has a yellow/gold label that differentiates it from the RF cable, which has the same N-type connector. This cable is part of the VigilAir system.

▶ **To connect the sensor unit to the GPS –**

1 Connect the 4.5-meter RF cable with an N-type connector on both ends to the **GPS** socket on the sensor unit, as shown below. Both the socket on the sensor unit and the cable have a yellow/gold label. This cable is provided in the package containing the RF box. After connecting it, twist the silver ring at its end all the way to the right.

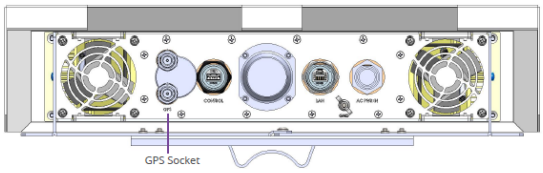


Figure 31 – Sensor Unit RF Socket

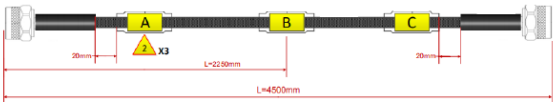


Figure 32 – 4.5m GPS Cable with N-type Connectors on Both Ends

2 Connect the other end of this cable to the GPS socket on the RF box, which also has a yellow/gold label.

3 If possible, we recommend using plastic or metal ties to stabilize the RF cable. For example, to the tripod or pole.

SIMPLEX3D

3D Data Collection System
Operation Guide
(Dual Camera – Hatch Data Collection System)

Version 2.0
simplex-mapping.com

Where all perspectives meet

About This Operation Guide

This guide describes how to operate the Simplex Mapping 3D Data Collection system and specifies the procedures before, during and after a 3D data collection mission.

This guide assumes that the Simplex Mapping 3D Data Collection system has been installed and connected as described in the *Simplex Mapping Installation Manual*.

This operation guide is intended for individuals certified by Simplex Mapping Solutions who are able to follow simple, straightforward instructions in English.

This operation guide contains the following chapters –

- **Chapter 1, Safety,** page 8, describes the safety cautions and warnings regarding the Simplex Mapping 3D Data Collection system.
- **Chapter 2, Introduction,** page 9, introduces the 3D Simplex Mapping system, its features, benefits and how it works.
- **Chapter 3, Pre-Mission – Ground Preparation,** page 19, describes the procedures for preparing for a mission while the aircraft is still on the ground.
- **Chapter 4, During a Mission – Aerial Operations,** page 58, describes the procedures to perform during a mission while the aircraft is in the air and how to complete the mission.
- **Chapter 5, Removing the Simplex System,** page 81, describes the procedures to perform after all Simplex procedures have been completed for a specific aircraft.
- **Chapter 6, Safety Report,** page 82, provides a consolidated list of all the warnings and cautions pertaining to the operation of the 3D Data Collection System.

Note – The photos presented throughout this installation manual serve as illustrative examples and may not precisely represent the actual installation.

Note – This guide provides comprehensive guidance for operating the Data Collection system. In addition, product-specific manuals for off-the-shelf components, such as the Pilot and Operator monitors, are also provided.

3
Pre-Mission – Ground Prepara

This chapter describes the procedures for preparing for a mission still on the ground.

CAUTION – The procedures in this chapter must be performe order to verify the proper functioning of the system.

3.1 Step 1, Cleaning the Camera

▶ **To clean the camera lenses –**

1 Carefully remove the lens covers from both cameras.

1 Use the lens wipes provided in the Simplex toolkit to clean each motion from the center of the lens outward.

2 Inspect the lenses after cleaning to ensure it is clear. Repeat ste lenses are completely clean.

3 Leave the lens covers off.

3.2 Step 2, Powering On the Simplex System

3.2.1 Before Powering On the Electrical Box

The following steps should be performed while the aircraft's engine is still off.

- Verify that the Simplex Electrical Box is charged with at least 20 minutes lifespan.
- Verify that the aircraft is ready to be powered on within less than 20 minutes.

ng On the Electrical Box

wer on the Simplex Electrical Box if the aircraft is not ready to be powered on

Box provides power to all the components of the Data Collection raft is powered on, the Electrical Box receives power from the **TPUT** connector shown below –

cal Box Power Connection

t powered on, the Simplex Electrical Box uses its battery, which can

rical Box –

ower switch of the Simplex Electrical Box, as shown below –

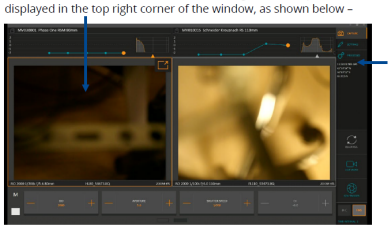
Figure 11 – Powering On the Electrical Box

3.7 Step 7, Verifying Image GPS Coordinates

▶ **To confirm that both cameras are synchronized with the GPS coordinates and timestamp –**

1 Click on the image of one of the cameras, which is then highlighted with an orange rectangle.

2 Check whether the GPS coordinates and image timestamp of the selected camera are displayed in the top right corner of the window, as shown below –



3 Take note of the GPS and timestamp values of the selected camera and then quickly click on the image of the other camera and verify that it shows similar values.

3.8 Step 8, Calibrating

A black reference process calibrates the came
consistent color and contrast in the varying lig

▶ **To calibrate the black reference –**

1 If the **Black Reference** button is activ

Note – For certain camera model series, black referen
Reference button will be inactive and will not require

3.9 Step 9, Preparing the NovAtel Application

The primary purpose of the NovAtel application is to record and back up the GPS tracking data that was acquired in order to enable the verification of the exact location where each image was taken.

The NovAtel application must be running in the background throughout the entire image data collection process. Later, if any timestamp inconsistencies are detected by the Simplex Mapping data processing center in the images stored by the IX Capture application, then the NovAtel application's recorded GPS coordinates and timestamps can be used to provide accurate location data for each captured image.

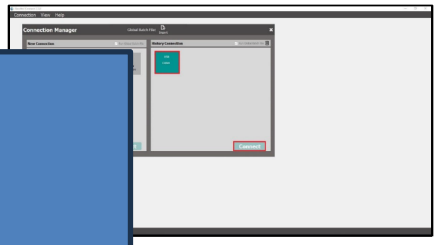
CAUTION – The following procedures must be performed before takeoff in order to verify the proper functioning of the GPS system.

3.9.1 Launching NovAtel

▶ **To verify proper GPS tagging and recording of the captured imagery –**

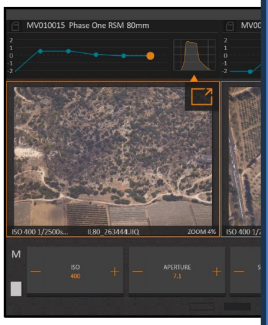
1 Double-click the NovAtel desktop (shown below) icon to launch NovAtel –

The following is displayed –



4.1.3 Verifying Image Quality

During the flight, and just before you arrive at t
image quality at the current altitude, the values
APERTURE and **SHUTTER SPEED fields** in IX Ca



Verify image quality and reconfigure these para
previous page.

4.1.4 Monitoring the Mission

The operator is responsible for verifying that the system is functioning properly and capturing high-quality images with balanced exposure. The following sections describe how to monitor the Simplex system throughout the mission.

- **Monitoring TopoFlight**, as described on page 62.
- **Monitoring IX Capture,** as described on page 66.
- **Monitoring NovAtel**, as described on page 69.

ing TopoFlight

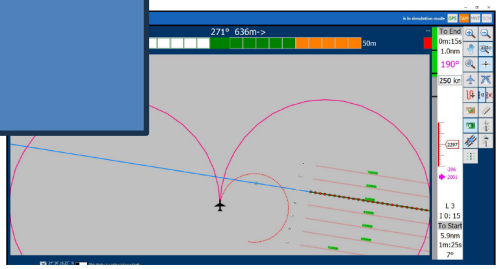
Flight throughout the mission, as described below.

g the GPS and Camera Indicators

dler GPS and Camera Indicators are always green.

Navigation along Flight Lines

e proposed flight path, serving merely as a suggestion for the nce to it is not obligatory.



SIMPLEX3D

3D Data Collection System
Installation Manual
(Dual Camera – Hatch Data Collection System)

Version 2.0
simplex-mapping.com

Where all perspectives meet

About This Installation Manual

This manual describes how to install the Data Collection system into any general aircraft with a hatch of at least 410 mm diameter.

Note – If needed, within days, a customized adapter plate can be created for any such hatch.

This installation manual is intended for anyone with experience installing mechanical or electrical systems and the ability to follow straightforward instructions in English.

For operation instructions of the 3D Data Collection System, refer to the *Data Collection System Operation Guide*.

This installation manual contains the following chapters –

- **Chapter 1, Safety,** page 8, describes the safety cautions and warnings regarding installing the 3D Data Collection System.
- **Chapter 2, Introduction,** page 9, introduces the 3D Data Collection System, its features, benefits and how it works.
- **Chapter 3, Mechanical Installation,** page 19, describes the procedures for installing and preparing the mechanical aspects of the Data Collection System.
- **Chapter 4, Electronic Installation,** page 43, describes the procedures for installing and preparing the mechanical aspects of the Data Collection System.
- **Chapter 5, Lifecycle Management,** page 52, describes the recommended procedures for disassembling, transporting, storing, and decommissioning the Simplex Mapping 3D Data Collection System.
- **Chapter 6, Safety Report,** page 55, provides a consolidated list of all the warnings and cautions pertaining to the installation of the 3D Data Collection System.

Note – The photos presented throughout this installation manual are illustrative examples and may not precisely represent the installation.

2.2 System Con

- **The system is comprised of the**
  - **Camera Mount,** on page 12
  - **Control Box,** on page 14
  - **Electrical Box,** page 15
  - **Monitors,** page 16 – A pilot m
  - **GNSS Antenna,** page 17
  - **Cables**

This efficient setup ensures easy image data collection process.

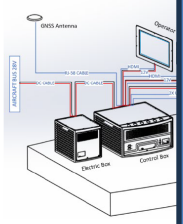
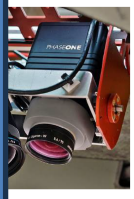


Figure 2 – Schematic System Diagram

Mount

udes a CNC-crafted aluminum platform fitted with a DC motor that chronized PhaseOne™ cameras. This Camera Mount is positioned and is designed to capture images while performing sweeping ure 4 on the following page. The system's cameras sweeping apture both Nadir and Oblique images in a single pass. The y a hardware trigger signal that originates from the system's ered via a 22-pin wire harness cable.



Mount – 1

t includes the following features –
s of each object in a single flight pass
a large city scale from one flight direction
any standard shooting hatch that has a minimum diameter of

is achieved for both nadir and oblique imagery
han any other 3D collection systems
eld of view (>110 degrees)

key specifications of the Camera Mount –
– 12V

x 407.5 x 220.2mm
45° (which is adjustable to a smaller angle)

3.6 Step 5, Attaching the Adapter Plate Base Frame to the Aircraft's Hatch

The Simplex Mapping airborne components can be installed on a wide variety of aircraft types. The installation process described in this manual assumes that the aircraft has already been prepared with attachment points to suit the Data Collection System components. This preparation process (if needed) is out of the scope of this user manual.

Simplex will provide a designated Adapter Plate t
attachment points of the hatch of the predetermi
Adapter Plate has been specifically tailored for th
around the contour of the hatch's opening and to
points on the aircraft's cabin floor, as described b

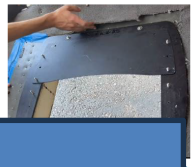
▶ **To attach the Adapter Plate Base Frame –**

1 Align the provided Adapter Plate's Base Frame
on the aircraft hatch by matching the bolts on
corresponding holes. The correct fastening or
proper alignment and be self-evident.

Figure 26 – Adapter Plate Base Frame

Note – Proper screws and bolts will be provided acco
customized for this aircraft.

2 Make sure the carpet is neatly trimmed away from the Adapter Plate's Base Frame, as shown below –



uch

dapter Plate's Base Frame is not resting on any
h materials are present, trim them before fastening
ow.

rame onto the aircraft hatch's designated attachment

ne bolts that protrude through the bolt hole in the

bolts.

tric drill until the required torque is achieved.

ate off its bolts to confirm that it is securely attached.

4.5 Step 5, Connecting a Control Box

Data Collection System's GPS antenna enables the
GPS coordinates.

There are two options for connecting a GPS antenn

- **Preferable –** If the aircraft is equipped with a G
extends from the ceiling into the cabin, then co
the Simplex Control Box, as shown below –

Figure 56 – Connecting the GPS Antenna

– OR –

- **Simplex GPS Antenna –** If the aircraft does not have a GPS antenna or the cable leading from it into the cabin does not have a connector that fits into the Control Box, then attach the following provided antenna, as described in the procedure below.

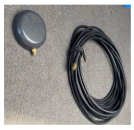


Figure 57 – Simplex GPS Antenna

s cable, as shown below –

na to Its Cable

into the Control Box's antenna connector, as shown above in Figure 56.

3 Position the antenna on the dashboard of the aircraft.

Figure 59 – Placing the GPS Antenna on the Dashboard

CAUTION – Ensure that the GNSS antenna is placed away from anything that can cause interference, such as radio antennas.

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Home Tools Document 1 / 44 57.2% Sign In

NANODIMENSION
Electrifying Additive Manufacturing™

DragonFly™ Pro
USER GUIDE

Date: Feb. 2019

www.nano-di.com

TABLE OF CONTENTS

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File Edit View Window Help

Home Tools Document 3 / 44 57.2% Sign In

About This User Guide

The DragonFly PC software enables you to operate the Nano Dimension DragonFly Pro printer in order to print jobs that were created using the Switch application (as described in the *Nano Dimension Switch User Guide*).

This user guide contains the following chapters –

- **CHAPTER 1 – INTRODUCTION,** page 6, introduces the Nano Dimension solution for printing Printed Circuit Boards (PCBs) on the Nano Dimension DragonFly Pro printer using the DragonFly PC software.
- **CHAPTER 2 – PRINTING WORKFLOW,** page 7, describes the workflow for printing PCB jobs on the Nano Dimension DragonFly Pro printer.
- **CHAPTER 3 – DRAGONFLY PC SOFTWARE FEATURES,** page 33, describes the two main windows of the DragonFly PC software.
- **APPENDIX A – ERROR MESSAGES,** page 42, describes the alerts (errors) that may be displayed and suggests how to handle each one.

Important Notice

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Home Tools Document 5 / 44 57.2% Sign In

System Safety

WARNING!

- **UV Light** – The UV curing lamps emit high-power UV light. The printer must be operated with all safety shielding installed in order to protect the operator from eye and skin damage. When operated according to the manufacturer's instructions, other protective clothing is not necessary.
- **Hot Surfaces** – The covers and windows/lenses of the near-IR and UV lamps reach high temperatures before and during printing. The printing Chuck heats up to 140°C. Take extreme care when placing hands in the vicinity of the lamps and Chuck.
- **Mechanical Hazards** – Keep fingers away from the carriage and axis path. Use a forklift truck to lift the printer. Do not exceed the maximum weight load of the input or output tables, as printed on the label.
- **Inks** – Read and practice safety guidelines as outlined in the Material Safety Data Sheet (MSDS) for the ink and post the document in the work area as required by prevailing law. Avoid any contact with skin and eyes. Collect waste ink in the provided container. Dispose of ink according to the MSDS and local regulations. Keep the waste-ink spigot closed during printing.
- **Electrical** – When the power switch is in the OFF position, power may still be supplied to the printer components. To completely cut power from the printer, you must unplug the power cord from the power outlet.
- **Curing Lamps** – The high-power near-IR light emitted by the curing lamps reacts with oxygen and produces ozone. This formation tends to be greatest during lamp start-up. The lamps include ozone filters to reduce ozone production. The printer should be operated in a well-ventilated area to avoid minor effects, such as headaches, fatigue and dryness of the upper respiratory tract. Normal air movement mixes the ozone with fresh air, causing it to revert back to oxygen.

1 Introduction

The DragonFly Pro enables precision, in-house 3D printing of multilayer Printed Circuit Board (PCB) prototypes, sensors, antennas, experimental electronic circuits and more.

With the DragonFly Pro, many of the complexities and bottlenecks inherent to PCB prototyping are removed, which enables companies involved in developing electronics to take control of their development cycles and realize the benefits of fast, secure and cost-effective Agile electronics development.

1.1 DragonFly Pro Printing Flow

1.1.1 Stage 1 – PCB Designer

The PCB fabrication process starts with a PCB designer preparing schematics and then a layout, which are saved as files (such as Gerber and Excellon files). Each Gerber file represents a layer of the PCB design, and the Excellon files represent drill locations and measurements.

1.1.2 Stage 2 – Switch Software

The Switch application (Job Editor) enables you to prepare a print job – a single file (.apcb) that is ready to be printed on the Nano Dimension DragonFly Pro printer. The Switch application takes the provided PCB layout files (Gerber and Excellon files) and guides you through the process of adding the required metadata. For more information, you may refer to the *Nano Dimension Switch User Guide*.

1.1.3 Stage 3 – DragonFly Pro PC Software

The Switch application enables you to send each PCB job from the Switch application to the printer's queue. The printer's queue is handled by the printer operator using the DragonFly PC software and can handle jobs from multiple workstations.

A PCB job is comprised of a .pcbp and an .apcb file (only the .apcb file is printed). These file extensions represent Nano Dimension's proprietary file format.

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2 Printing Workflow

This chapter describes the workflow for printing PCB jobs on the Nano Dimension DragonFly Pro printer.

2.1 Workflow – Printing

The printing process for the DragonFly Pro printer workflow has the following stages –

2.2 Launching the DragonFly PC Software

After installation, the DragonFly Pro printer is left powered on and the DragonFly PC software is launched. Therefore, there is typically no need to launch the software. Should you need to launch the software, follow the procedures below.

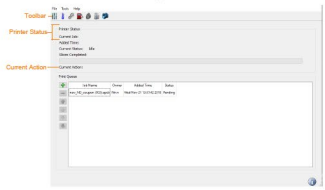
1 Double-click the DragonFly PC software desktop icon or select **Start → Programs → DragonFlyPC**.

2 After the software launches, two windows automatically display –

- The Job Queue Window
- The Job Controller Window

2.2.1 Job Queue Window

The Job Queue window displays the printer's status and enables you to view and control the jobs that have been added to the Job Queue to be printed. You may refer to Section 3.1 for a detailed description of this window.



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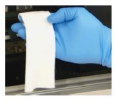
Home Tools Document 16 / 44 57.2% Sign In

2.3.1.2 Wiping the DI Print Head

1 Use a new wipe.

2 Fold the wipe, as shown below.



3 Wet the wipe with Print Head wash fluid.

4 When standing in front of the front service door and facing the printer, the DI Print Head is on the left of the CI Print Head. Gently and carefully wipe the DI orifice plate with the wipe in one direction. Do not apply pressure while wiping.

5 Turn the wipe over to use the other end of the wipe (the dry end). Do not wet it.

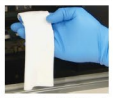
6 Gently and carefully wipe the DI orifice plate with the dry wipe in one direction (the same direction as used above). Do not apply pressure while wiping.

7 Dispose of the used wipe.

2.3.1.3 Wiping the Group

1 Use a new wipe.

2 Fold the wipe, as shown below.



3 Wet the wipe with Print Head wash fluid.

4 Gently and carefully wipe the bottom and the sides of the Group frame. Do not apply pressure while wiping.

5 Turn the wipe over to use the other end of the wipe (the dry end). Do not wet it.

6 Gently and carefully wipe the bottom and the sides of the Group frame. Do not apply pressure while wiping.

7 Dispose of the used wipe.

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Home Tools Document 38 / 44 57.2% Sign In

3.1.5.1 Parameter Viewer

The Parameter Viewer window enables you to view and configure various parameters relating to the printer itself.

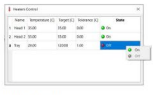
CAUTION

- Only the parameters shown and explained in this user guide are allowed to be changed.
- DO NOT CHANGE any other parameters or settings; severe damage may occur to the hardware and/or software.

3.1.5.2 Heater Control

Before and during printing, the printer's two Print Heads (1 – Conductor and 2 – Insulator) and Chuck temperature must be within a specific range. If not, then the printer does not start printing or pauses during printing until the Print Heads and Chuck are within the defined set point temperature.

You can click the **Heater Control** button to display the Heater Control window.



Temperature (C)

Shows the current temperature of print **Head 1** (Conductor), print **Head 2** (Insulator) and the **Chuck**.

Target (C)

This field shows the desired set point to which the Print Heads and Chuck must heat up for printing.

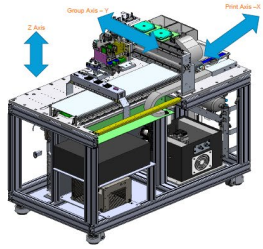
State

This field indicates whether the Chuck heater is on or off.

3.1.5.3 Motors Control

The Motors Control window controls and activates the movement of the three axes' control motors – Print Axis (X), Group Axis (Y) and Z Axis.

The following shows the axis directions –



3.1.5.4 IDS (Ink Delivery System) Control

This window enables the control of the printer's pneumatic system and its IDSs (Ink Delivery Systems). Only use this option if you have been instructed to do so by a certified Nano Dimension support engineer.

CONNEX HD VIDEO YOU CAN FLY WITH

CONNEX™ User Guide

Simply Plug-and-Fly!

CONNEX
Version 1.0
www.amimon.com

About This Guide

This user guide describes how to setup and use the CONNEX™ wireless video link in order to transmit video from an aircraft. This user guide consists of the following chapters:

- **Chapter 1, Introducing CONNEX**, page 9, introduces the CONNEX system, its components, its connectors, buttons and cables.
- **Chapter 2, Setting Up CONNEX**, page 19, describes how to setup and connect the CONNEX Air Unit and Ground Unit.
- **Chapter 3, Using CONNEX**, page 29, describes how to get started using the Air Unit and the Ground Unit. This chapter also describes the Ground Unit's On Screen Display (OSD), how to set up multicasting and how to set up control of the aircraft's camera gimbal from a gimbal remote control.
- **Chapter 4, CONNEX Management Application**, page 37, describes how to configure and upgrade the CONNEX Air Unit and Ground Unit.

For a quick summary of the essential steps for setting up quickly, you may refer to the *CONNEX Quick Start Guide*.

Support and Contacting Information

Support: www.AMIMON.com/support

When contacting a support representative, make sure to have the Air Unit's and Ground Unit's serial number available. This number appears on the label on the bottom of each device.

Important Notice

CE 1588 This equipment is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

Revision History

Version	Date	Description
1.0	March 2015	Initial Release

Safety Instructions and Maintenance

All the instructions in this user guide must be adhered to when operating this equipment. Keep these instructions in a safe and accessible place for future use.

Safety Symbols

High Voltage Sign: Warns the user of the presence of uninsulated *dangerous voltage* within the product enclosure, which may be of sufficient magnitude to constitute a risk.

General Warning Sign: Warns the user of the presence of important operating and maintenance (servicing) instructions in the product manual.

Safety Instructions

- Do not open the Air Unit or Ground Unit enclosures. There are no user-serviceable parts inside. Refer servicing to qualified service personnel only. The use of controls, adjustments or procedures other than those specified in this user guide may result in exposure to shock and/or electrical or mechanical hazards.
- Do not immerse the units in water.
- Do not block the air ventilation openings.
- Always disconnect a unit's power by pulling the mains plug.
- Only clean with a dry cloth.
- Keep powered on units at least 20 cm from your body.
- Do not expose the units to moisture or excessive heat. Unit operating temperature is 32–104ºF or 0–40ºC.
- Unplug the units during lightning storms or when not using them for long periods of time.
- Only use the originally approved power supply adapter and only use it indoors.
- Only use the supplied accessories or those recommended on the Amimon website. Accessories (including cables) must not be replaced, as they may affect performance or functionality or damage the unit. We highly recommend that you use the provided Amimon cables. If an alternate cable is used, make sure that it is of the highest quality.
- Do not use the product if there is any physical damage to the enclosure.
- It is normal for the product to become slightly hot during use. However, if the enclosure's temperature becomes unbearable to touch, turn the product off and contact support. The internal fan of the Air Unit (transmitter) should work at all times when the power is on.
- Do not let the product come into contact with corrosive materials.
- Do not let the product come into contact with explosives, corrosive gas or nuclear weapons.
- Do not let the product come into contact with fire.

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12 / 54 82%

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Air Unit (Transmitter)

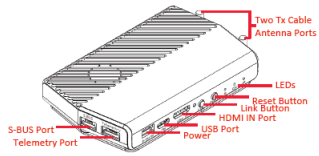

Figure 2: Air Unit (Transmitter)

Table 1: Air Unit Components

S.BUS: Control port for the gimbal, which can be connected to a flight controller compatible with the S.BUS protocol or directly to an Air Unit receiver for the purpose of controlling the camera gimbal. S.BUS properties can be configured using the CONNEX Management application, which runs on the computer connected to the Ground Unit, as described in *3BChapter 4, CONNEXTM Management Application* on page 37. ⚠ Do not try to use the S.BUS signal for controlling the aircraft's flight. This port should only be connected to the gimbal's S.BUS of D.BUS port.
Telemetry: Enables the display of flight control data from an aircraft that has a MAVLink-supported flight controller overlaid on an On Screen Display (OSD). Telemetry information includes flight mode, number of connected GPS satellites, speed, height and more. To receive telemetry data on Ground Unit, the Air Unit should be connected to the aircraft's telemetry port. You may refer to *Appendix B* on page 48 for more information.
Power Connector: 8-26-VDC voltage (3~6 cells).
Micro USB Port: This port enables configuration and upgrade of the Air Unit software using the CONNEX Management application, as described in *3BChapter 4, CONNEXTM Management Application* section on page 37.
Mini HDMI IN: For receiving video from the camera.
HDMI Connector Screw: For stabilizing the HDMI cable to the Air Unit.
Link Button: The Air Unit is provided pre-paired (preregistered) with the Ground Unit that comes in the box. The **Link** button can be used to pair up to three additional Ground Units with the same Air Unit. You may refer to the *21BMulticasting to Multiple Ground Units* section on page 34 for a description of how to pair additional Ground Units with an Air Unit.
Reset Button: Resets the Air Unit.
Tx Cable Antenna Ports: Two lightweight 2dbi cable antenna ports.

For a description of the Air Unit LEDs, you may refer to:

- *Table 3:* ⏻ *Air Unit* – Power LED
- *Table 4:* *Air Unit* – Video LED
- *Table 5:* *Air Unit – Network* LED

Air Unit Accessories

The box number in which each cable is provided is indicated below.

Tx Cable Antennas

Two flat lightweight 2dbi cable antennas. Box 2.

Figure 3: Flat Tx Cable Antennas

Cable Antenna Mounting Accessories

Plastic accessories for mounting the antennas on the aircraft. Box 2.

Figure 4: Cable Antenna Mounting Accessories

Micro to Mini HDMI Cable

Micro to Mini (Right Angled) – 50cm length. Box 1A.

Figure 5: Micro to Mini HDMI Cable

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22 / 54 82%

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4 Connect the two Air Unit flat cable antennas to the two Air Unit cable antenna ports, as shown below:

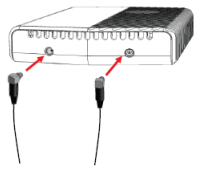


Figure 20: Connecting the Antennas to the Air Unit

5 Connect the provided **Micro to Mini HDMI cable** (Figure 5) from the **HDMI IN** port on the Air Unit to the camera.

The right side of this cable (as shown in Figure 18) goes into the Air Unit **HDMI IN** port (Figure 2).

The left side of this cable (as shown in Figure 18) goes into the aircraft's camera.

Figure 21: Connecting the Air Unit HDMI Cable – Box 1A Micro to Mini HDMI

Close the **HDMI Connector Screw** (which is to the right of the HDMI IN port) to stabilize the connected HDMI cable to the Air Unit.

6 Connect the provided Air Unit **Power cable** (Figure 8) to the power port on the Air Unit.

The right side of this cable (as shown in Figure 22) goes into the Air Unit power port labeled **8-26-VDC** (Figure 2).

The left side of this cable (as shown in Figure 22) goes to the battery.

Figure 22: Connecting the Air Unit Power Cable – Box 1B

7 Connect the other end of the provided Air Unit power cable to the power source (battery). Use an 8-26-VDC voltage battery.

Note that the Air Unit Power LED ⏻ lights up. The following describes the various states of the Air Unit Power LED:

Table 3: ⏻ **Air Unit – Power LED**

On (White)	The Air Unit is powered on.
Off	No power is being supplied to the Air Unit.
Blinks Quickly	Indicates a system error.

8 The Air Unit automatically connects with the powered on Ground Units that are paired with this Air Unit.

A connection is established between the Air and Ground Units regardless of whether video is transmitted on the wireless link, as follows:

- If video is transmitting, then the Ground Units display the video.
- If video is not transmitting, then the Ground Units display the message: *Video signal not detected* upon linking to the Air Unit.

The Air Unit's video and transmission status is indicated by its LEDs, as described below:

Table 4: **Air Unit – Video LED**

On (White)	The video signal from the camera is locked, meaning that it is being correctly received by the Air Unit from the camera.
Off	The video from the camera is not locked, meaning that the Air Unit is not receiving the video from the camera.
Blinks Quickly	The Air Unit is powered down or the camera is transmitting a video resolution that is not supported by the Air Unit.

Table 5: **Air Unit – Network LED**

On (White)	A link has been established to the Ground Unit, meaning that video is being transmitted to it.
Off	The Air Unit is not broadcasting because it has not recognized any Ground Units with which it was paired previously.
Blinks Quickly	The Air Unit is pairing with a Ground Unit or the Air Unit has gone out of range of the Ground Unit and is searching for it.
Blinks Slowly	The Air Unit is establishing a link with a Ground Unit.
Blinks Very Slowly	The Air Unit is searching for an available frequency on which to transmit. **Note:** This may take up to 70 seconds when working outdoors in Japan.

9 [Optional] To display information received from the aircraft's flight controller overlaid on the video on the Ground Unit monitor, you may refer to the *42BConnecting the Telemetry Port* section on the following page.

CONNEX HD VIDEO YOU CAN FLY WITH

CONNEX™ Quick Link Setup

Amimon's CONNEX™ provides a high-end, high-performance wireless HD connection that can operate in challenging unmanned air or ground platforms under harsh conditions, such as UAV/UGV.

The small and lightweight CONNEX system transmits commercial, industrial, inspection and monitoring video in real time to its Ground unit 1,000 m below.

The Air unit can be connected to an aircraft in order to capture video and to transmit it to the Ground unit, thus creating a wireless video link.

The Ground unit connects to your computer monitor via the HDMI port, which enables you to monitor the video transmitted from the Air unit.

CONNEX

Version 1.0

www.amimon.com

Use this card to quickly install and connect your wireless link in order to start streaming.
You may refer to the *CONNEX User Guide* for a full description of all the CONNEX configuration and management options,

Air Unit (Transmitter)

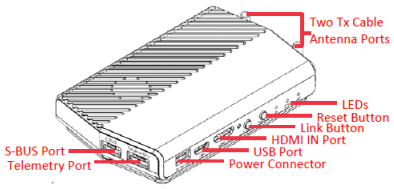


Figure 1: Air Unit (Transmitter)

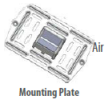
Table 1: Air Unit Components

S-BUS: Enables control of the aircraft's gimbal using a dedicated SBUS remote control over the wireless return channel. This port must be connected to the SiBUS port on the camera's gimbal. Use the CONNEX Management application running on the Ground unit computer.
Telemetry: Enables the display of flight control data (OSD) from an aircraft that has a MAVLink-supported flight controller. OSD information includes flight mode, number of connected GPS satellites, speed, height, orientation and more. The aircraft must be connected to the Air unit's Telemetry port.
Power Connector: 8-26-VDC voltage.
USB Port: This port enables a software upgrade using the CONNEX Management application. This application can be downloaded to the computer connected to the Ground unit.
HDMI IN: For receiving video streaming from the camera.
HDMI Connector Screw: For stabilizing the HDMI cable to the Air unit.
Link Button: The Air unit is provided out-of-the-box to automatically search for and connect to (register) to the Ground unit that is provided in the same box. Each Air unit can transmit perfect video downlink to up to four Ground units. This button is used to register additional Ground units to an Air unit.
Reset Button: Resets the Air unit.
Tx Cable Antenna Ports: Two lightweight 2dbi cable antenna ports.

Please say that again CARD 1st Draft Sent to Client 26JAN15.pdf - Adobe Acrobat Pro
File Edit View Plug-Ins Window Help
Create
Tools Comment Share
Bookmarks
CONNEXTM Quick Link Setup
Air Unit (Transmitter)
Ground Unit (Receiver)
OSD View

To set up the CONNEX Air unit:

1 Connect the Air unit to the provided mounting plate and then connect the mounting plate to the aircraft. Make sure that the Air unit's ventilation openings are not obstructed. Only use the two center screw holes on the unit and mounting plate.

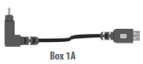


Mounting Plate

2 Connect the two provided **cable antennas** to the two Air unit **cable antenna ports** (Figure 1). The right side of each of the two cable antennas goes into the Air unit connector. Leave the other ends of the cable antennas loose and hanging.

Box 1B

3 Connect the provided **HDMI cable** from the **HDMI IN** port on the Air unit to the camera. The right side of this cable goes into the Air unit **HDMI IN** port (Figure 1). The left side of this cable goes into the aircraft's camera. Close the **HDMI Connector Screw** (which is to the right of the HDMI IN port) to stabilize the connected HDMI cable to the Air unit.



Box 1A

4 Optionally, connect the Air unit **S-BUS** port to the SDBUS port on the camera's gimbal using the provided **S-BUS cable** to enable remote control of the camera. The right side of this cable goes into the Air unit **S-BUS** port (Figure 1). The left side of this cable goes into the flight control module on the aircraft.

Box 6

5 Optionally, connect the Air unit **Telemetry** port to the aircraft using the provided Air unit **Telemetry** to enable viewing additional information from the aircraft on the Ground unit. The right side of this cable goes into the Air unit **Telemetry** port (Figure 1). The left side of this cable goes into the flight control module on the aircraft.

Box 6

6 Connect the provided Air unit **Power cable** to the power port on the Air unit. The right side of this cable goes into the Air unit power port labeled **8-26-VDC** (Figure 1). The left side of this cable goes into the flight control module on the aircraft.

Box 1B

7 Connect the other end of the provided Air unit power cable to the power source (battery). Use an 8-26-VDC voltage battery. Make sure that the Air Unit Power LED lights up lights up white.

8 If the camera is transmitting video, the Air unit searches for the Ground unit that was provided with it in the same box and then starts transmitting immediately. If additional Ground units are registered with this Air unit, then the Air unit automatically connects to them also. The Air unit's LEDs should be:

- **Air Unit – Video LED:** On (Blue). The video signal from the camera is locked, meaning that it is being received by the Air unit from the camera.
- **Air Unit – Network LED:** On (Blue). A link has been established to the Ground unit, meaning that video is being transmitted to it.

Ground Unit (Receiver)

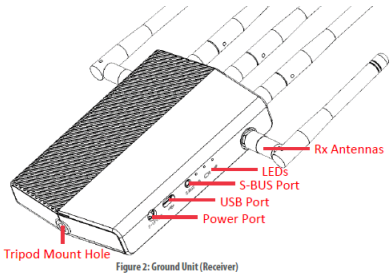


Figure 2: Ground Unit (Receiver)

Table 2: Ground Unit Components

Tripod Mount Hole: Optional – Enables you to connect the Ground unit to a tripod.
Power Port: 7-17VDC voltage.
USB Port: For software upgrade and direct connection to the CONNEX Management application. This application can be downloaded to your own computer monitor connected to the Ground unit, as described in the *CONNEX User Guide*.