SingularXYZ

SAGRO100
Automated Steering System
User Manual

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Chapter 1 Introduction

1.1 Overview

The SingularXYZ SAgro100 Automated Steering System is an automatic steering system which uses high-torque motor control steering wheel. It integrates the advantages of convenient installation, large torque, high precision, low noise, low heat, and quick debugging. It is suitable for various applications of tractors, harvesting machines, plant protection machinery, rice transplants and other agricultural vehicles.

The system consists of a base station and a vehicle control part. The vehicle control part includeincludees a control tablet integrated with a high-precision GNSS board, a steering wheel motor with a built-in controller, and an angle sensor. It can be widely used for sowing, cultivating, trenching, ridging, spraying pesticide, transplanting, land consolidation, harvesting and other work scenarios.

1.2 System Composition

The whole system includes a T10 Control Tablet, a SEM1 Motor Wheel, two SA100 GNSS antennas, an angle Sensor, a gyroscope and other accessories and cables, see Table 1 for the packing list. The system needs external power source from vehicle or independent power supply.

Figure 1.1 Major parts in Sagro100 Automated Steering System

The two antennas are installed on the top the vehicle, the angle sensor is installed on wheel of the vehicle, the motor wheel is installed to replace the original steering wheel, and the tablet is installed beside the motor wheel for monitoring purpose.

Figure 1.2 Sagro100 Automated Steering System structure

Table 1: Packing List of SAgro100

No.	Name	Quantity	Figure	No.	Name	Quantity	Figure
1	T10 GNSS Tablet	1		15	Angle Sensor	1	
2	SA100 GNSS Antenna	2		16	Angle Sensor Cable	1	
3	Main Transmission Cable	1		17	Tablet Accessories	1	
4	Power Cable	1		18	Angle Sensor Accessories	1	
5	GNSS Antenna Cable – 4m	1		19	Power Switch	1	
6	GNSS Antenna Cable – 5m	1		20	4G Antenna	1	
7	RAM Bracket	1		21	External Radio	Option	
8	Antenna Crossbar	1 set		22	Radio Cable	Option	
9	SEM1 Electronic Motor	1		23	Radio Antenna	Option	

10	Motor Bracket (According to the tractor type)	1		24	Radio Configuration Cable	Option	
11	Steering Wheel	1		25	Auto-Steering Switch	Option	
12	Spline Sleeve (According to the tractor type)	1		26	Switch Cable	Option	
13	Gyroscope	1		27	Camera	Option	
14	Gyroscope Cable	1		28	Camera Cable	Option	

1.3 Main Devices in Package

1.3.1 T10 GNSS Tablet

T10 GNSS Tablet is a portable, robust android tablet which is equipped with a built-in high-precision GNSS board offering centimeter level accuracy positioning and heading.

T10 GNSS Tablet provides RS232, RS485, USB2.0, CAN etc. interfaces to connect with other equipment, and supports Wi-Fi, 3G/4G LTE wireless communication. The detailed specification refers to section 3.1 T10 GNSS Tablet. The outlook of T10 GNSS Tablet is shown as below.

Figure 1.3 T10 GNSS Tablet

1.3.2 SA100 GNSS Antenna

SA100 GNSS antenna is used to receive the RF signal from the satellites. There are two antennas in the package. The detailed specification of this antenna refers to section 3.2 SA100 GNSS Antenna.

Figure 1.4 SA100 GNSS Antenna

If an antenna from other companies is used, contact SingularXYZ to obtain permission, or the system may not work as expected

1.3.3 SEM1 Motor Wheel

The SEM1 Motor Wheel is an electric motor steering wheel. It is designed for easy-to-install operation. With high-torque, direct-drive electric motor, SEM1 can provide up to 2.5cm RTK accuracy. The detailed specification of this motor wheel refers to section 3.3 SEM1 Motor Wheel.

Figure 1.5 SEM1 Motor Wheel

1.3.4 Angle Sensor

Angle sensor is an auxiliary part which provides higher accuracy and stability. It is used to detect the angle change of the steering tire.

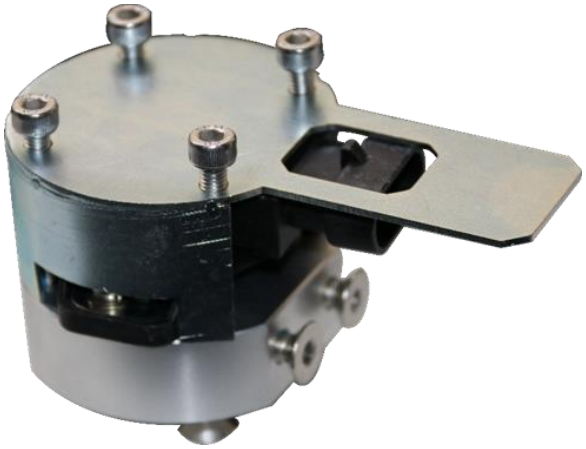


Figure 1.6 Angle sensor

Chapter 2 General Operations

This chapter introduces how to set up the system and make it start working properly.

2.1 Assembly and Installation

Sections 2.1.1-2.1.6 describes the assembly and installation of the MFWD (Mechanical Front Wheel Drive) tractor, if you are using a tractor with other drive systems, see section 2.1.7.

2.1.1 SEM1 installation

The SEM1 Motor Wheel is an electric motor steering wheel. The most important part is the spline sleeve, which is based on the selection of the vehicle model refer to the table in Appendix. Please indicate your vehicle model before placing order of this system. The other components include Loge cover, steering wheel, spline sleeve, bracket and screws which are shown as below.

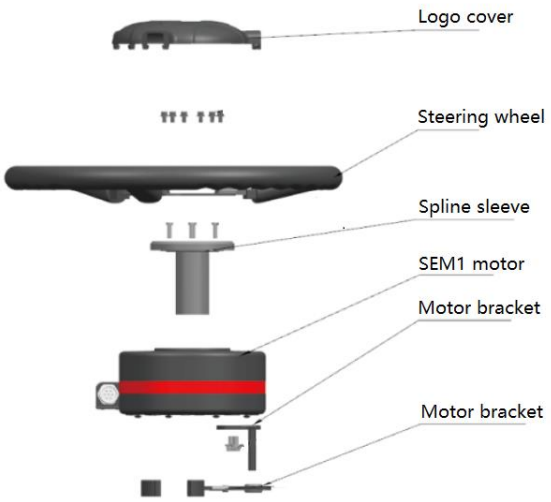


Figure 2.1.1 Assembly diagram of SEM1 motor wheel

The detailed steps of installing SEM1 Motor Wheel are shown as below.

1) Fix the spline on the motor.

Figure 2.1.2 Spline fixing

2) Remove the steering wheel cover and fix the steering wheel on the spline.

Figure 2.1.3 Steering wheel fixing

3) Fix the motor bracket on the motor bottom

Figure 2.1.4 Motor bracket fixing

4) Remove the original steering wheel from the tractor and fix the SEM1 motor exterior via the motor bracket.

Figure 2.1.5 Motor bracket fixing

Figure 2.1.6 Motor exterior fixing

5) Fix the SEM1 motor on the steering shaft.

Figure 2.1.7 Motor shaft fixing -1

Figure 2.1.8 Motor shaft fixing -2

6) Install the steering wheel cover.

Figure 2.1.9 Steering wheel cover fixing

7) Now the installation of SEM1 Motor Wheel is completed. It should be connected to the main cable after all parts are assembled properly. The cables connection refers to section 2.1.6 Cables Connection.

2.1.2 Angle Sensor installation

The detailed steps of installing Angle Sensor are shown as below.

1) Prepare the components needed for installing Angle Sensor.

① Angle Sensor; ② Round Fixing Plate; ③ Mounting Brackets; ④ Tie Rod; ⑤ Tie Rod Extension; ⑥ Other Accessories

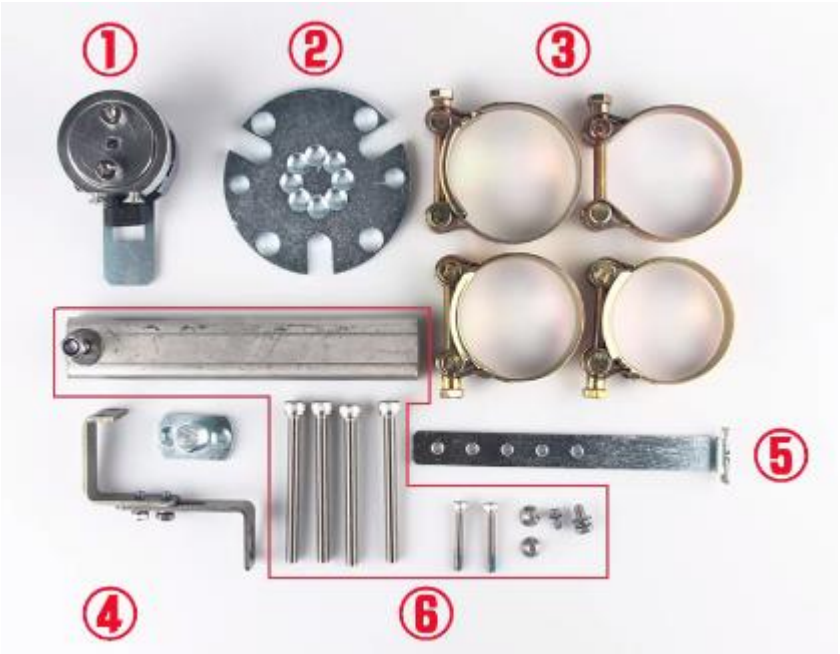


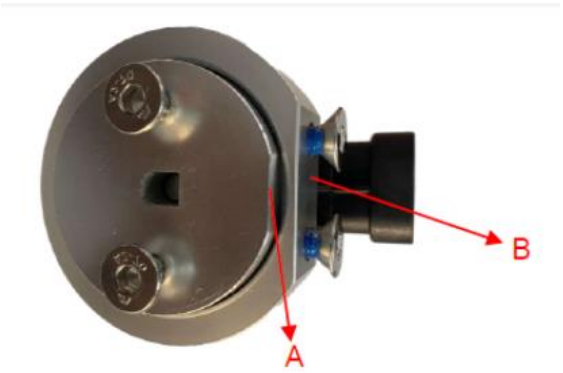
Figure 2.1.10 Components of angle sensor

2) Fix the angle sensor on the round fixing plate.

Note: There are 2 cut planes on the angle sensor, make sure that both cut planes face the angle sensor interface as shown in the figure.

Before installing the Angle sensor, check the model number, we have two models now.

Type 1:



Type 2:

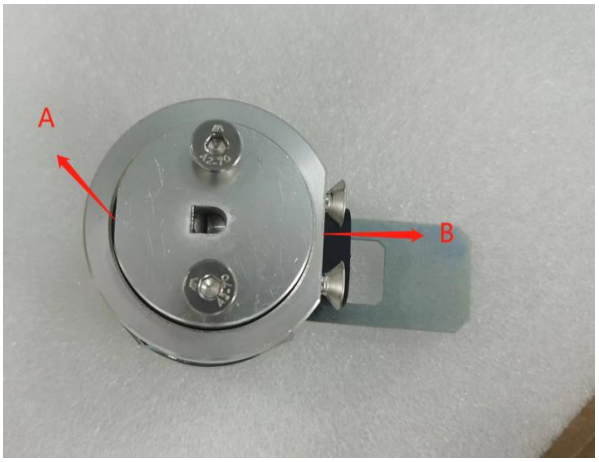


Figure 2.1.11 Mounting angle of the angle sensor

3) Fix the angle sensor on the **front** wheel with the 2 cutting planes facing the tractor body.

Note: Make sure the angle sensor can rotate properly. The installed angle sensor should rotate with the wheel.

Figure 2.1.12 Install the parts to fix angle sensor

4) Screw off the wheel axle screw and use tie rod to connect the angle sensor to the wheel axle. Then screw on the wheel axle screw to fix the tie rod.

Figure 2.1.13 Fix angle sensor

Note: If the axle is at a certain distance from the wheel, you can use the tie rod extension to connect. And if there is no screw on the wheel axle, you can use the extend board to fix as shown below.

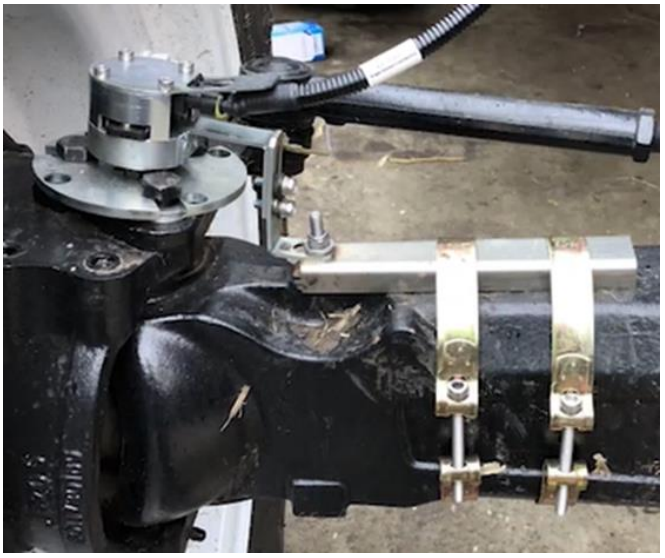


Figure 2.1.14 Installation example of angle sensor

5) Connect the angle sensor cable to the angle sensor interface. Use cable ties to secure the angle sensor cable to the tractor.

6) Now the installation of Angle Sensor is completed. It should be connected to the main cable after all parts are assembled properly. The cables connection refers to section 2.1.6 Cables Connection.

2.1.3 Dual-antenna installation

Two GNSS antennas should be fixed on the roof of the vehicle with the antenna crossbar. The following components will be used,

① GNSS Antenna Cable – 5m; ② GNSS Antenna Cable – 4m; ③ SA100 GNSS Antenna * 2; ④ Antenna Crossbar Assembly.

Normally the antenna on the left side of the tractor is the **primary** antenna, and the right one is the **secondary** antenna.

The detailed installation steps are shown below.

1) Assemble the antenna crossbar and install the GNSS antennas.

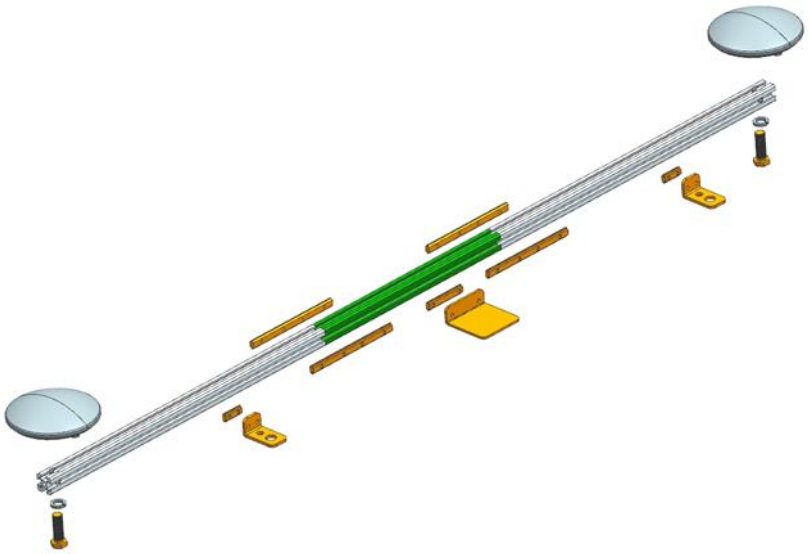


Figure 2.1.15 Assembly diagram of dual antennas

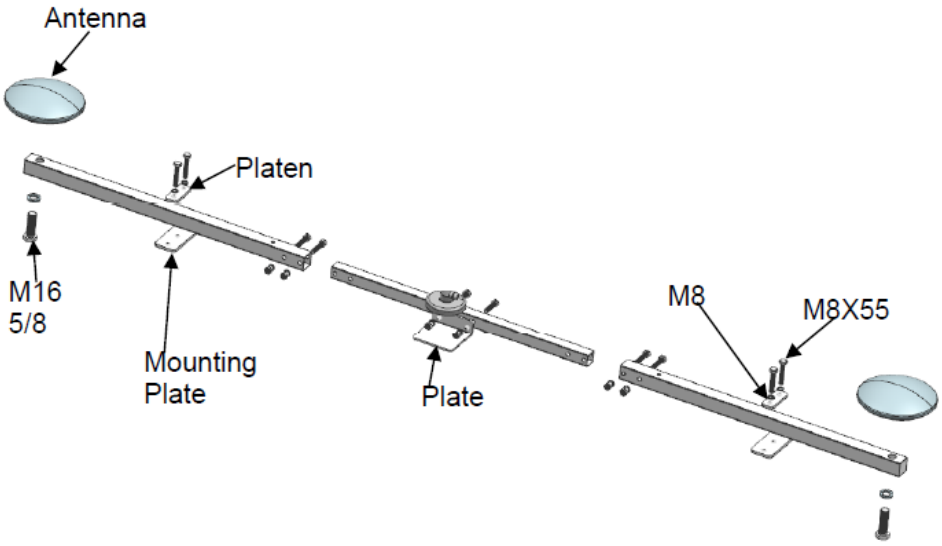


Figure 2.1.16 Descriptions of dual-antenna components

2) Fix the sliding mounting plates of the antenna crossbar on the roof of your tractor

Figure 2.1.17 Sliding mounting plates fixing

Note: The direction of the cross bar should be perpendicular to the forward direction of the tractor in the horizontal plane.

3) Measure and adjust the position of the crossbar, then tighten the screws of the sliding parts on both sides.

Note: The center of the antenna crossbar should be on the centerline of the tractor.

Figure 2.1.18 Crossbar fixing

4) If you prepare to install the T10 tablet in the right side of your tractor cab, then connect the 5m cable to antenna on the left side of the tractor and connect the 4m cable to antenna on the right side of the tractor. The left antenna connects to the ANT1 port, the right antenna connects to the ANT2 port.

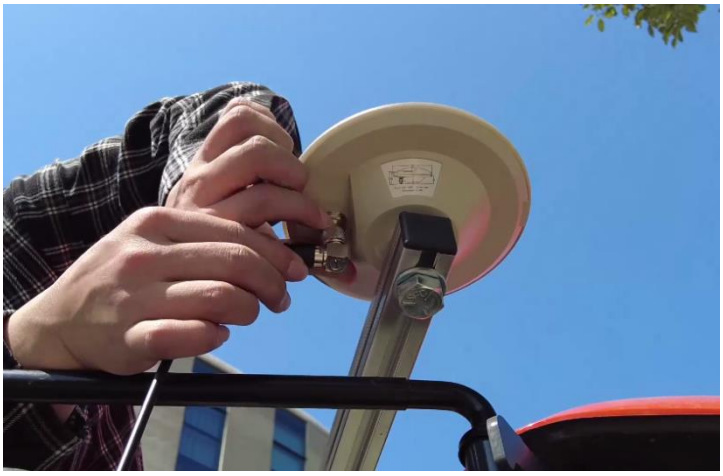


Figure 2.1.19 Antenna cables connection

5) Use cable ties to secure the antenna cable to the tractor.

Figure 2.1.20 Antenna cables fixing

2.1.4 T10 Tablet Installation

The T10 tablet should be installed in the driver cab of the tractor via the RAM bracket, the detailed steps are shown as below.

1) Fix one RAM ball on the back of T10 tablet.

Figure 2.1.21 Tablet installation-1

2) Fix the other RAM ball in the right side of the tractor cab, and connect the RAM &adjust the tablet to a suitable position.

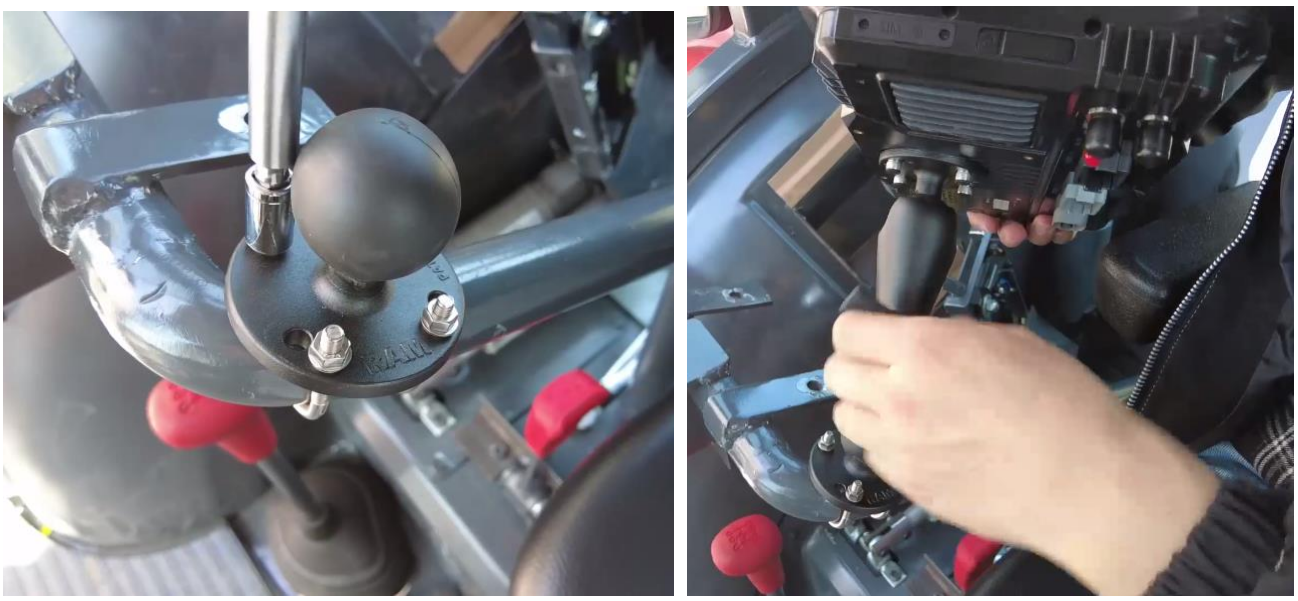


Figure 2.1.22 Tablet installation-1

Tip: If there is no appropriate handrail in the cab, self-tapping screws can be used to secure the RAM ball in a convenient location.

Figure 2.1.23 Tablet installation-2

2.1.5 Other Components Installation

2.1.5.1Gyroscope Installation

Fix the gyroscope horizontally in the tractor cab and connect with gyroscope cable. The orientation of the gyroscope should be perpendicular to the tractor forward direction.

Note: The gyroscope is best fixed near or under the seat, where there is less vibration.

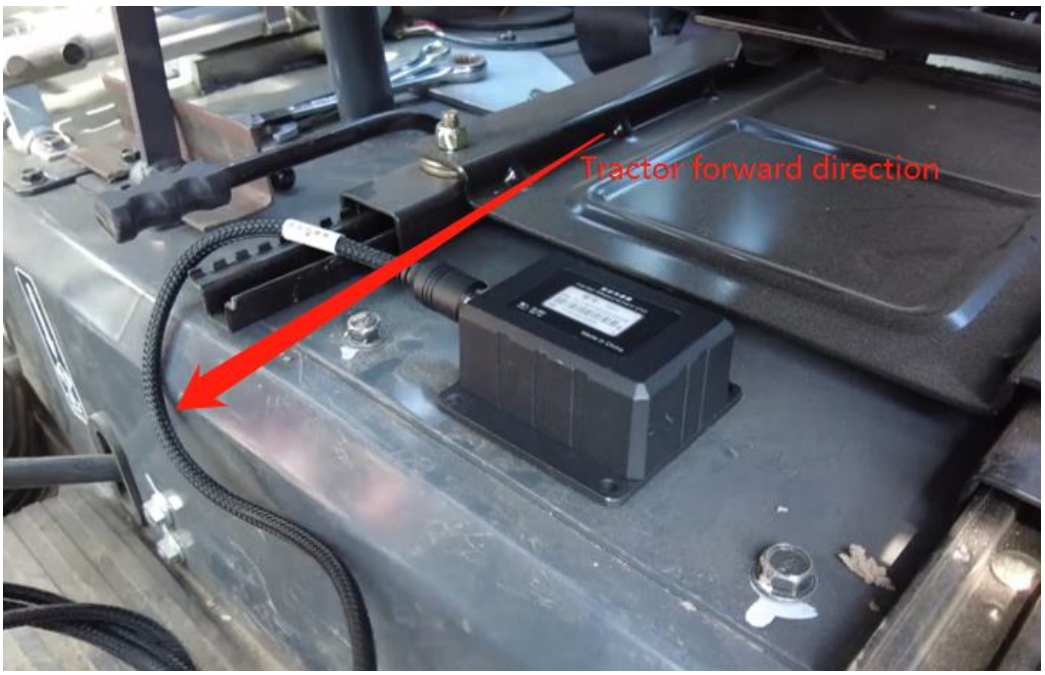


Figure 2.1.24 Gyroscope installation

2.1.5.2Camera Installation

Connect the camera with the camera cable and fix the camera to the rear of the tractor.

Figure 2.1.25 Camera installation

2.1.5.3Power Switch Installation

Fix the power switch with 3M glue to a convenient location in the tractor cab.

Figure 2.1.26 Power switch installation

2.1.6 Cables Connection

The cables connection should be paid much attention during assembly as there are various connectors on the main cable which is shown below.

Figure 2.1.27 Main Cable with multiple connectors

The cable connection of SAgro100 system is shown in figure 2.16. Connect the power cable to the tractor battery and current hardware supports 12V power supplies.

Note: For power cable, the red wire to positive and black wire to negative.

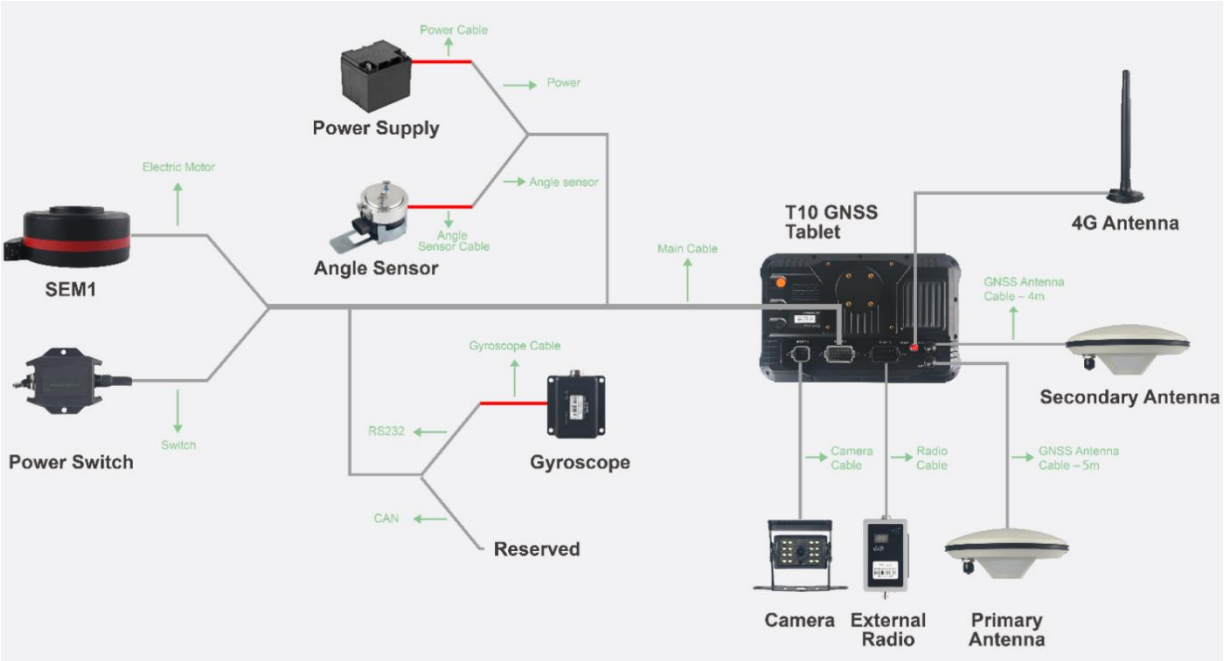


Figure 2.1.28 Cable Connection Diagram

2.1.7 Switch Connection

Figure 2.1.29 Switch

Figure 2.1.30 Switch Cable

This is the switch of the auto-steering function, click to turn on/off the auto-steering function. And the cable is connected the switch to the PORT 3 of the tablet.

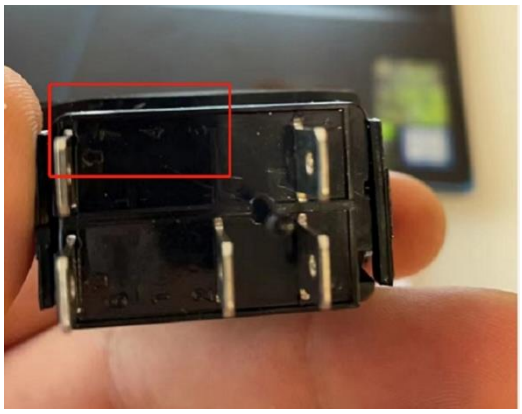


Figure 2.1.31 Number On The Switch

Figure 2.1.32 Number On The Switch Cable

Then connect cables and switch， they all have numbers on them.

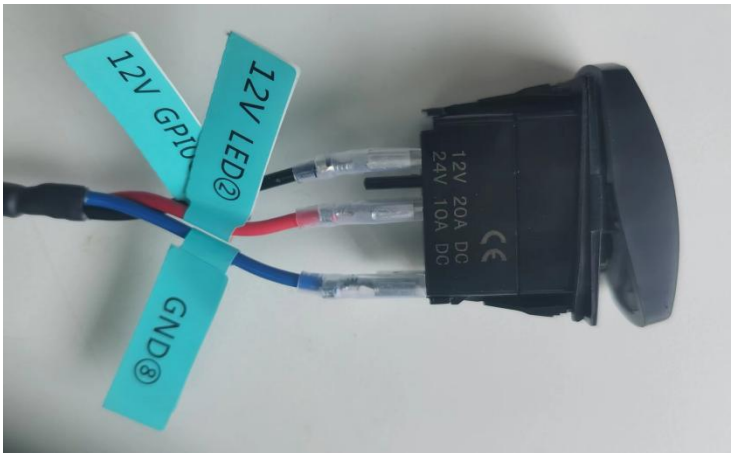


Figure 2.1.33 Connection

Finally, connect the connector of the cable to the PORT 3 on the plate. If you have a D1-L radio, you need to remove the connector on the other end, connect the switch cable to the connector of the radio, and then you can use it together.

Then open the Foot brake control switch in the software, it can be used, click to turn on/off the auto-steering function. And the cable is connected the switch to the PORT 3 of the tablet.

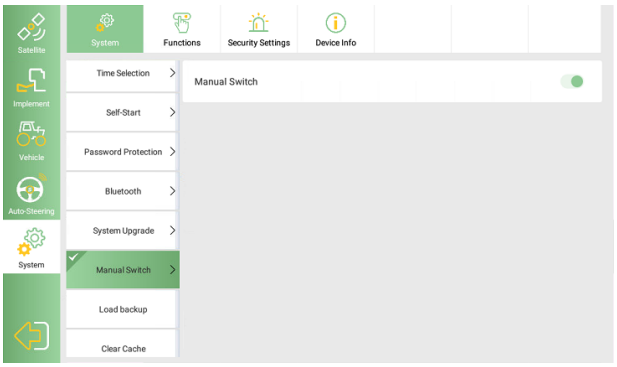


Figure 2.1.34 Open The Foot Brake Control

Figure 2.1.35 click to turn on the auto-steering

2.1.8 Other Tractors Types

Except the MFWD tractors, the SAgro100 system also supports rear wheel driving system tractors, articulated tractors, crawler tractors and etc.

2.1.7.1Rear Wheel Driving Tractor

The only installation difference between MFWD tractor and rear wheel driving tractor is the position of angle sensor. Other installation steps are the same.

For rear wheel driving tractors, users need to install the angle sensor on the **rear wheels** instead of front wheels.

2.1.7.2Articulated Tractor

For the particularity of this tractor, it is difficult to install the angle sensor on the wheels. Instead, the articulated tractor uses gyroscope to obtain tractor orientation data.

The gyroscope should be installed on a flat position on the front half of the tractor's articulated joint, as shown in fig 2.1.29.

Figure 2.1.36 Gyroscope on articulated tractor

2.2 Software Operation

2.2.1 Software Activation

The software PrecisionAg is activated before shipping out to customer. You can check the register information in System >> System Setting >> Device Info.

If users encounter any situation which needs activate this software or any other questions on the software or firmware, please contact SingularXYZ Technical Support by email support@singularxyz.com for guidance.

2.2.2 SAgro100 System Setup

If you are a new user of the SAgro100 system, after completing the hardware installation, follow the steps below to set up your auto-steering system and start your work.

2.2.2.1System Basic Setting

At first, you need to select the receiver and sensor type for your auto-steering system.

Go to System >> GNSS Overview >> Receiver Setting, use the default setting – GNSS Tablet for SAgro100 system, as shown in Fig 2.2.1.

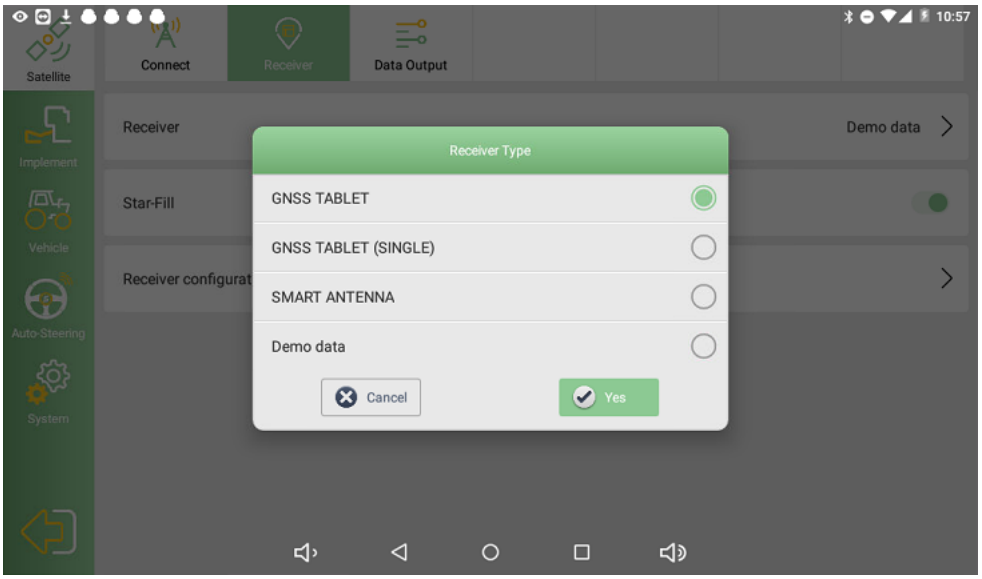


Fig 2.2.1 Receiver setting

Go to System >> Management >> Sensor Type, choose **Angle Sensor** for SAgro100 system, as shown below.

There four types you can choose

①If gyroscope only is used, select the Single Gyro Sensor mode

②Select the Angle Sensor mode when using both the angle sensor and gyroscope

③If both the angle sensor and gyroscope are damaged, select the Encoder mode(as an emergency plan). This mode is directly controlled by the motor. Each time before the tablet is turned on, the steering wheel needs to be centered, and then turned on tablet. Turn on auto-calibration in system Settings and do this every time you boot up.

Note: If you are using articulated tractor, then select **Single Gyro Sensor** instead.

Fig 2.2.2 Sensor type setting

Regarding the type of installation position of the angle sensor, please judge according to the following rules:

- Select **Left** if the angle sensor is mounted on the left wheel, select **Right** if it is mounted on the right wheel.
- Turn the steering wheel to the left, select **Positive** if the Median Value decreases and **Reverse** if it increases.

Note: If you are using a **rear wheel driving** tractor, please select **Reverse** if the Median Value decreases while turn the steering wheel to the left, and select **Positive** if the Median Value increases.

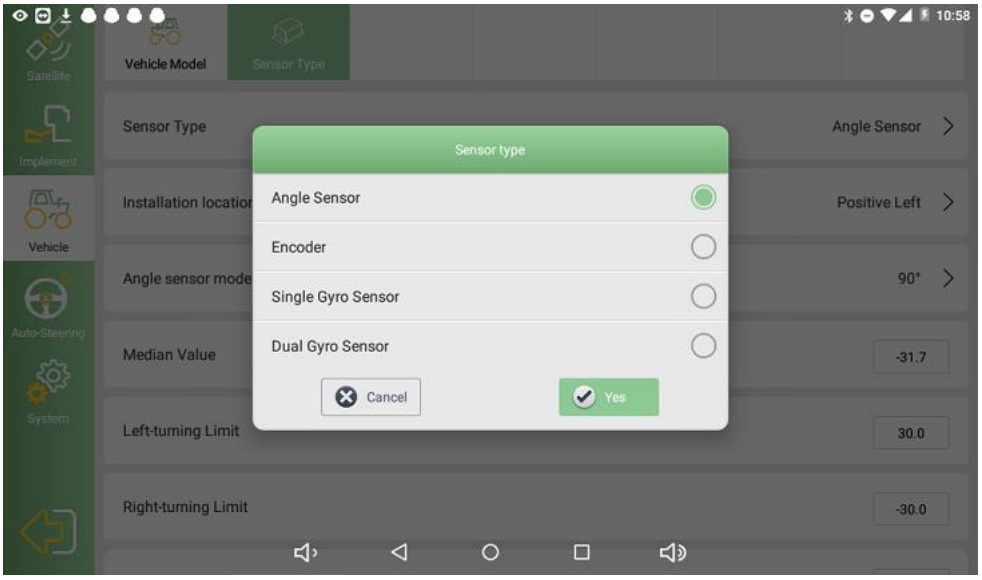


Fig 2.2.3 Sensor installation position setting

Turn on the Auto-steering function in System >> System Setting >> Functions interface.

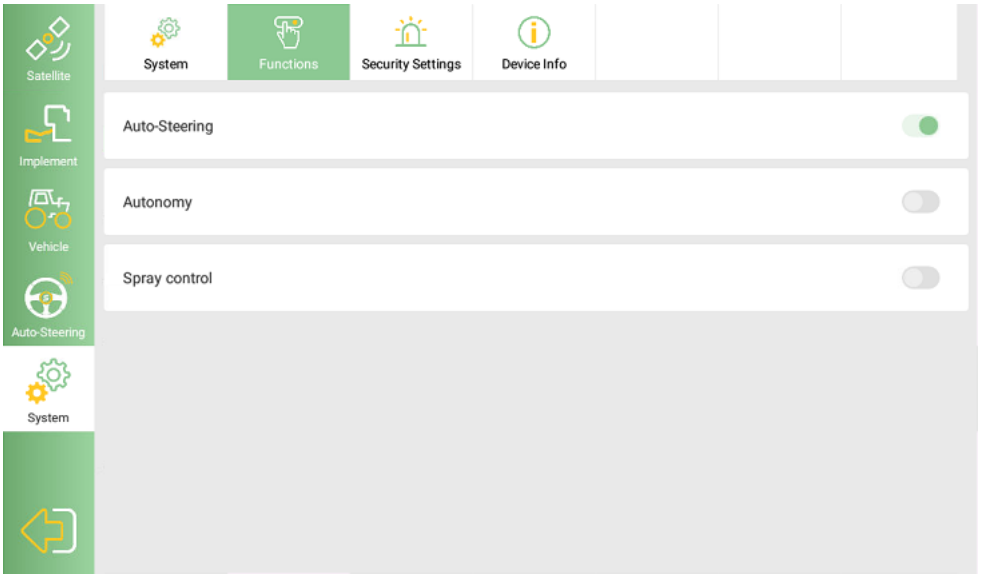


Fig 2.2.4 Auto-steering function

2.2.2.2Articulated Tractor Setting

For articulated tractors, please follow the steps below to continue setting up the system.

Step 1: Go to Auto-steering >> System Setting to turn on the Fixed Mode as shown below.

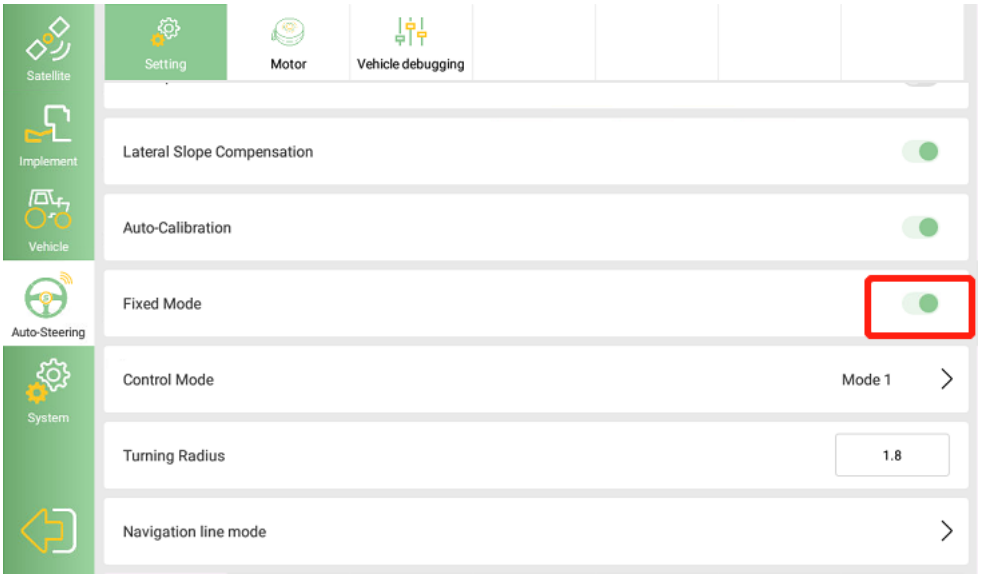


Fig 2.2.5 Fixed Mode

Then the first parameter in System setting interface will change from **Sensitivity** to **Foresight Distance**. Please adjust this parameter according to your tractor travel speed. It should increase with the increase of vehicle speed, and the value is about 3 when the speed is 10KM per hour.

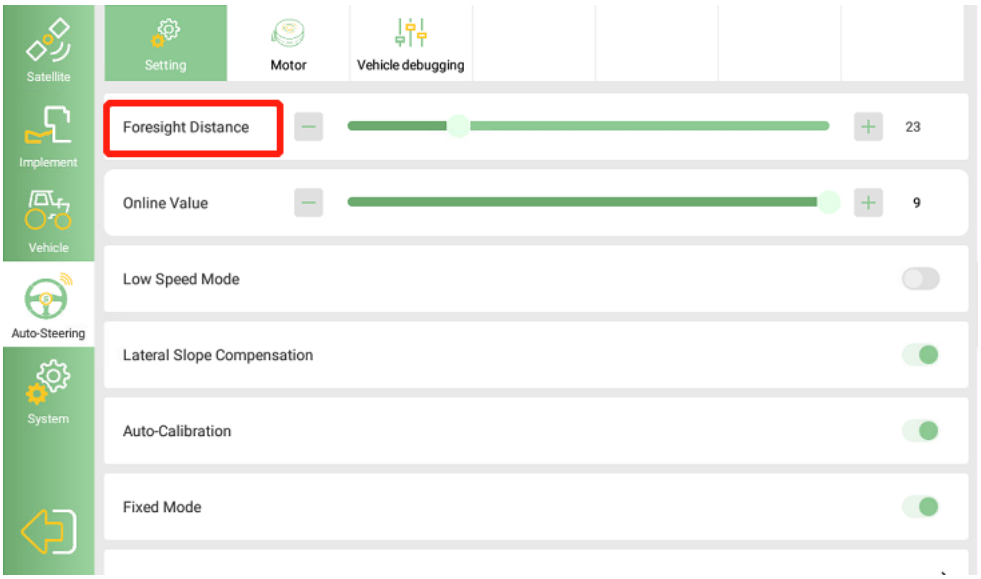


Fig 2.2.6 Foresight Distance

Step 2: Turn on the Lateral Slope Compensation and Auto-Calibration in Auto-steering >> System Setting interface, as shown in the figure below.

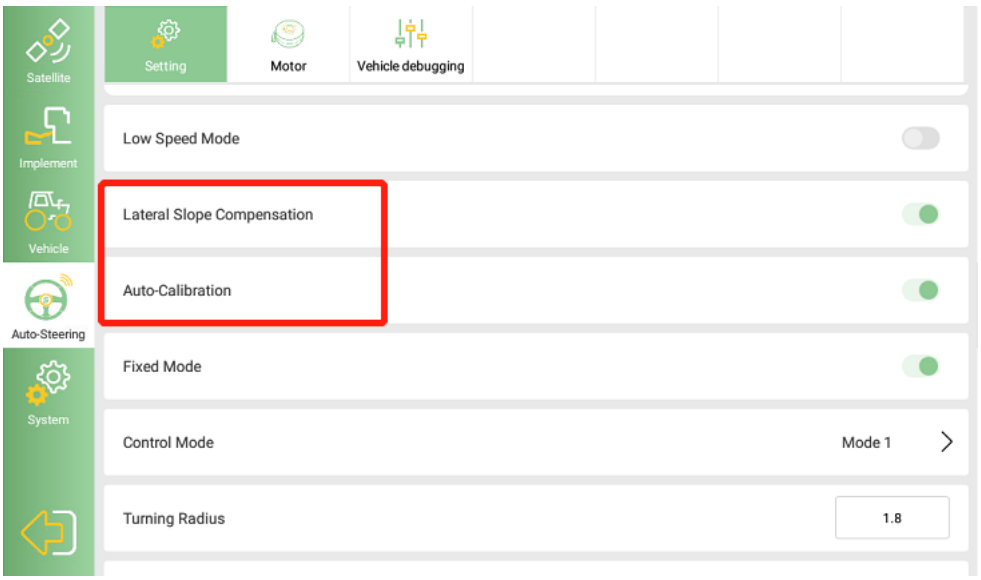


Fig 2.2.7 System Setting interface

Step 3: Go to Auto-steering >> Vehicle Calibration interface, complete the Steering Calibration according to the prompt in the software, for angle mode, you just need to do roll debugging and repeat line debugging. For single gyro mode, you should do the three calibration one by one, shown in Fig 2.2.8 - 2.2.10.

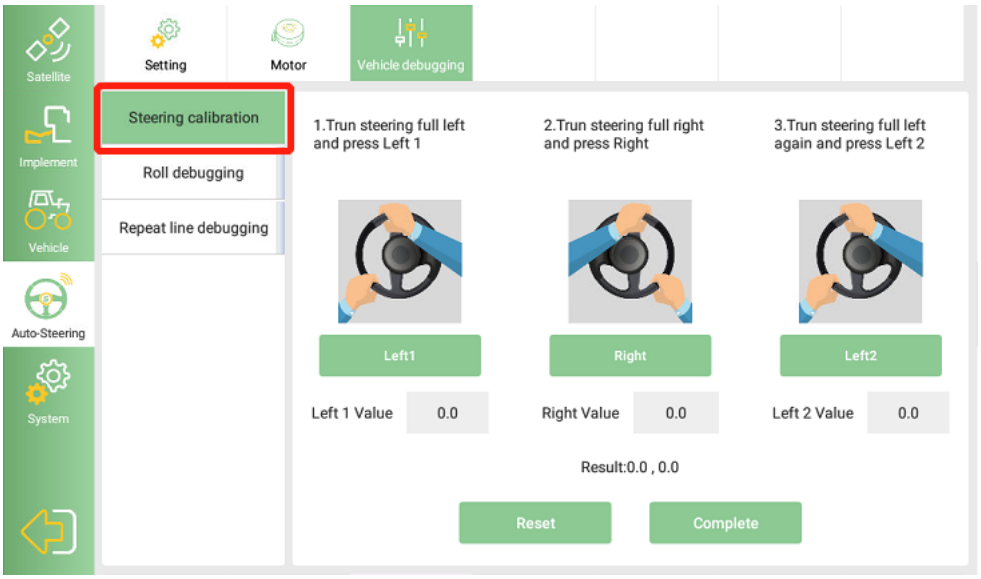
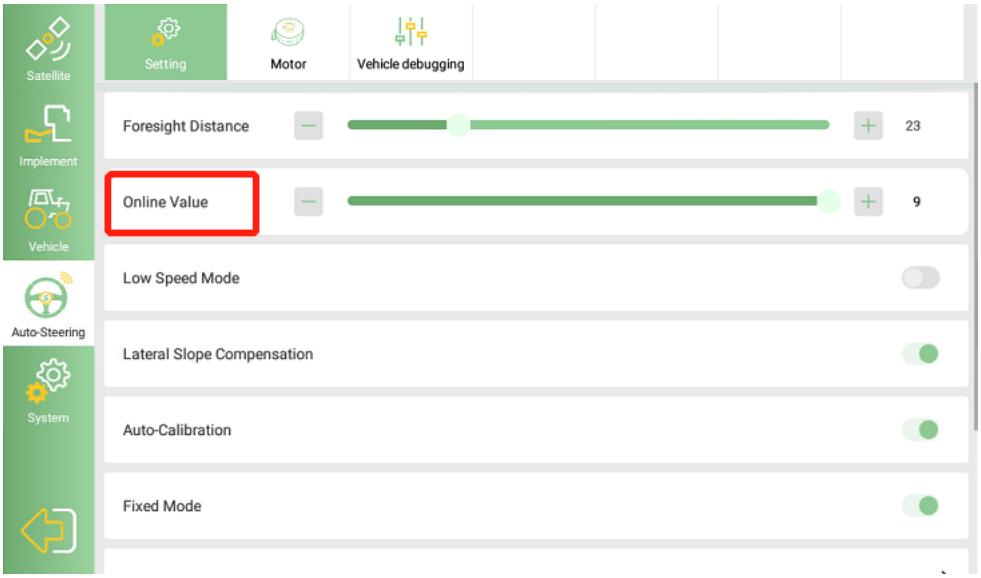


Fig 2.2.8 Vehicle calibration interface

Step 4: Go to Auto-steering >> System Setting interface, set the Online Value as 9.



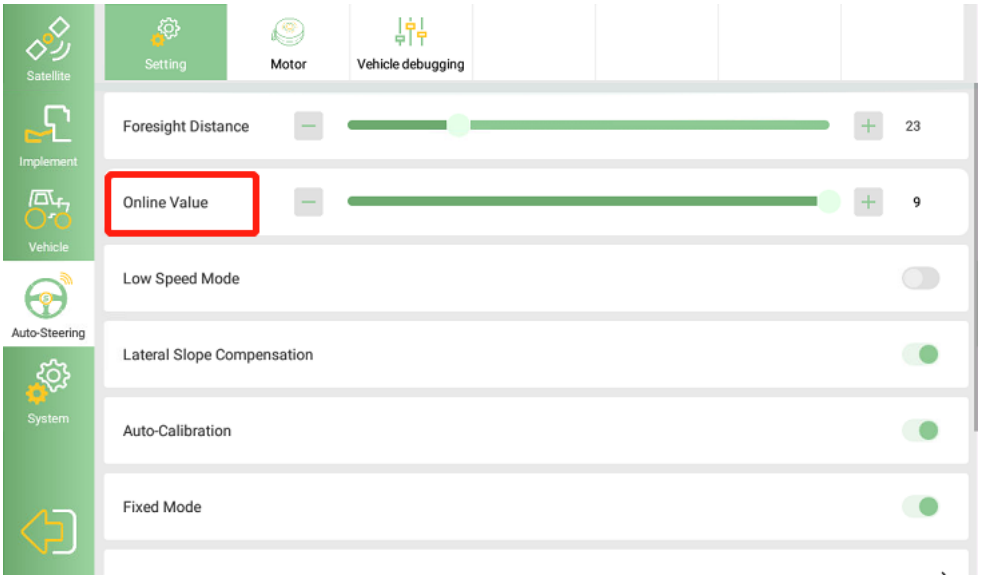
2.2.9 Online Value

Step 5: Parameter debugging

After previous steps, you can set up the AB line refer to chapter 2.2.3.5 and adjust system parameters according to the real-time performance of automatic driving.

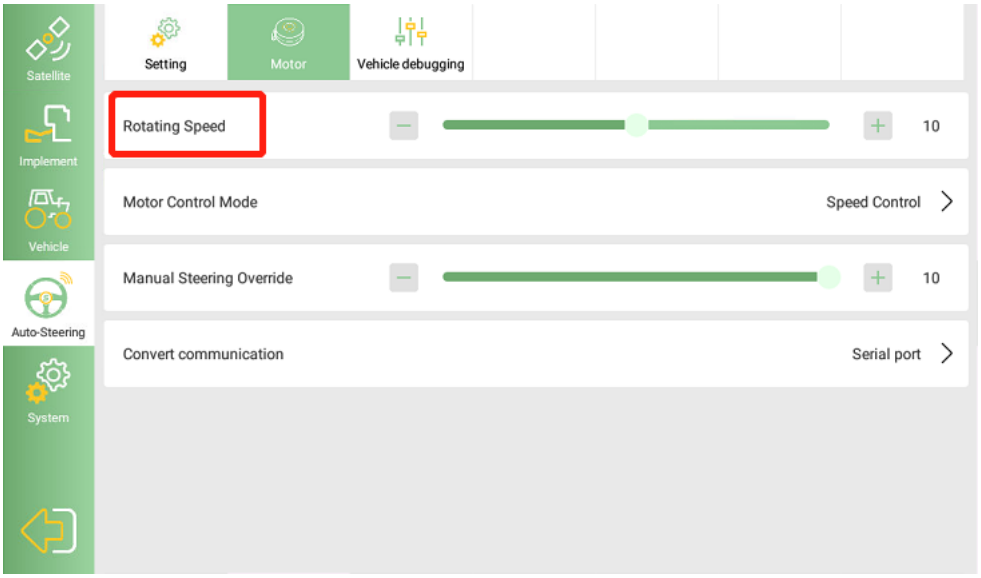
Note: Users can contact SingularXYZ support team to remotely help adjust the parameters.

1. If the tractor's route makes large S-curves when entering the AB line, reduce the **Online Value** by 1-2 and try again until the route becomes smooth.



2.2.10 Online Value

2. If the driving deviation during auto-steering jumps left and right. And the system corrects the deviation too quickly, the vehicle trajectory has some continuous small bends, and the steering wheel turns fast, you can reduce the value of **Rotating Speed** by 1 each time & then check the actual effect of the deviation.



2.2.11 Rotating Speed

2.2.3 Working Flow

After the hardware installation and system setup, users can follow the steps below to start their auto-steering workflow.

2.2.3.1Angle Sensor Inspection

After the device is installed, you need to debug it to check whether the device is correctly installed and works properly. This part is mainly to check whether the system settings and Angle sensor installation are correct. (Skip this step if you are using a system that does not include angles sensor.)

Turn on the tablet and open the software， Click System >> Management >> Sensor Type, there are there parameters you need to check.

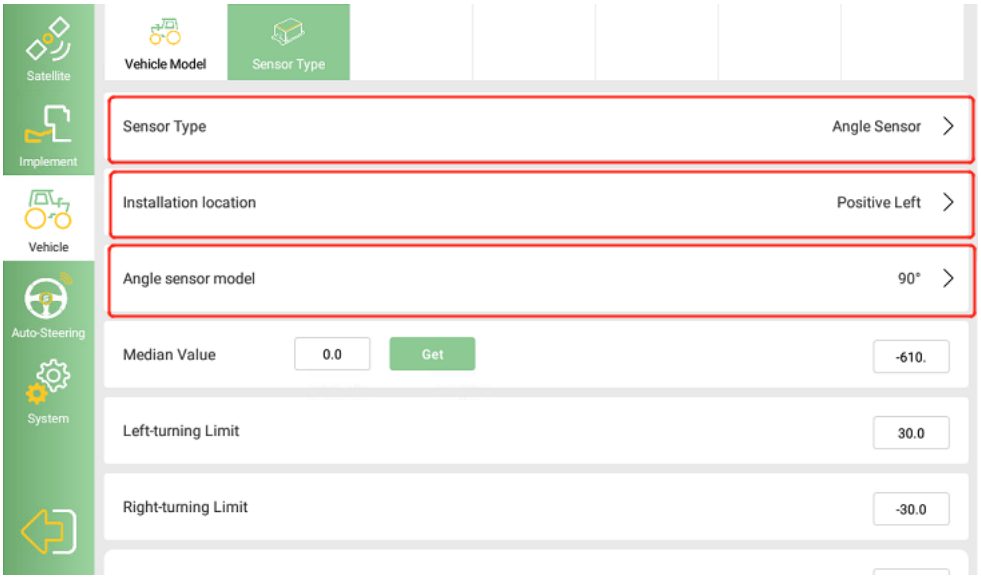


Fig 2.2.12 Angle Sensor Inspection

1) Sensor Type

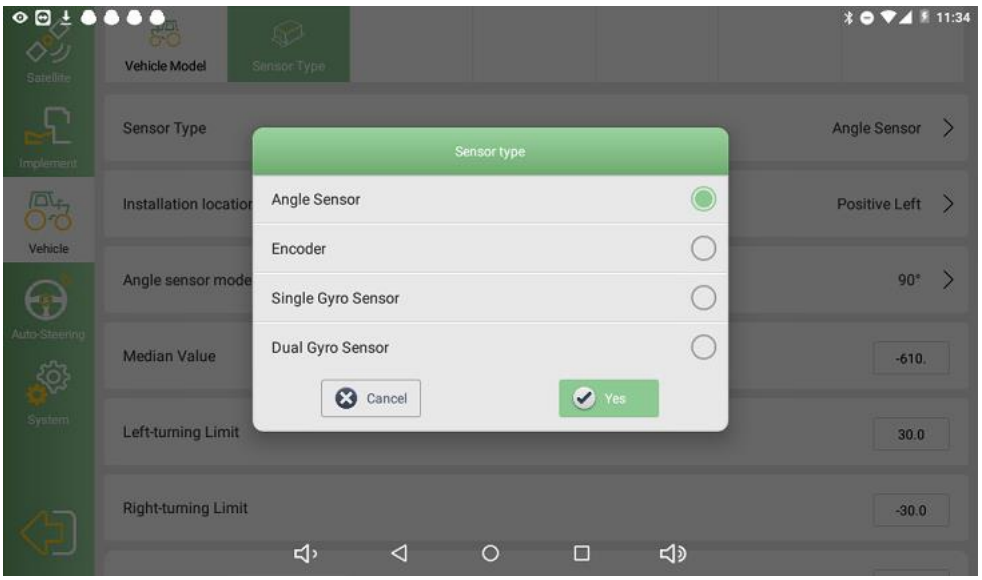


Fig 2.2.13 Sensor Type

2) Angel Sensor Reverse: Adjust according to working mode

3)Angle sensor model and Median Value: Get the value manually, this value depends on the type of angle sensor you have. Open the top cover of the angle sensor, you can see the label. Different values indicate different models

Fig 2.2.14 Sensor Label

①09，the value represents a 90 degree angle sensor. When the steering wheel is centered, the median value should be around 60.If it's around 30 or 90, then your angle sensor is not installed properly and the two cuts are not parallel.

②12，this value represents a 120 degree Angle sensor. When the steering wheel is centered, the median value should be around 80.

③36，this value represents a 360 degree Angle sensor. When the steering wheel is centered, the median value should be around 240.

④When the median value is correct, try to turn the steering wheel, if turn wheel left, median value is decreased, turn wheel right is increased, it is correctly installed. If turn to the left increases and turn to the right decreases, you need to adjust angel sensor reverse mode.

2.2.3.2Vehicle parameter input

The first step is to measure and input the parameters of your tractor, please follow the illustrated instructions in the software (shown in Fig 2.2.5) to measure the following parameters of your tractor,

- A: The height of the antenna to the ground.

- B: Distance from the center of the front wheel to the center of the rear wheel.
- C: The distance from the antenna to the central axis of the tractor, click obtain to get.
- D: Distance from the antenna to the center of the front wheel
- E: Distance between the centers of the two front wheels
- F: Distance between two antennas. This value is normally 1.4 m.

Note: If you are using a **rear wheel driving** tractor, the parameter of D and E should be changed as:

- D: Distance from the antenna to the center of the rear wheel
- E: Distance between the centers of the two rear wheels

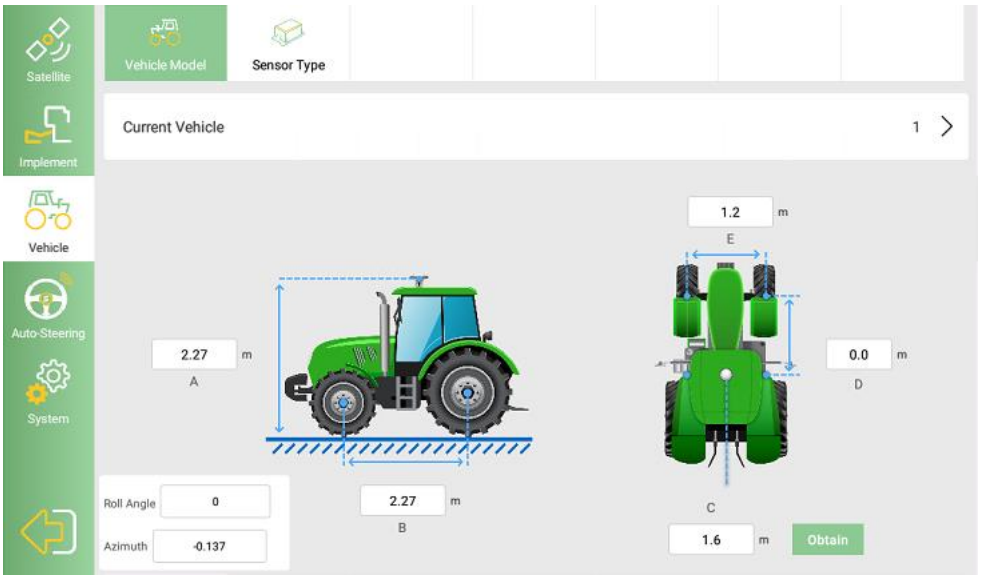


Fig 2.2.15 Vehicle parameter input

Tip: Please park your tractor on a flat surface when measuring the parameters.

The software records the parameters of some common tractor models. You can also check if your tractor model is included and import vehicle parameters directly from the software. For details, please refer to chapter 2.2.4.3 Vehicle Management.

2.2.3.3Base Station Connection

The next step is to connect your system to the base station and get a fixed RTK solution to facilitate the next steps. There are two modes.

1) External Data Mode

Go to System >> GNSS Overview >> Base Station >>External Data interface, apply the mode. The default transport protocol is TRIMTALK, click buttons to switch radio channel up and down.

Fig 2.2.16 External Radio

①Indicators: Three indicators, red - power indicator, blue - data upload indicator, green - data download indicator (when working normally, the indicator blinks red, green and blue in sequence)

②LED display: It shows the current working channel of the module.

③Buttons: Click buttons to switch radio channel up and down. The radio frequencies are as follows

Table 2: Radio Frequency List of External Radio

Radio Frequency List Protocol: TRIMTALK; Baud rate: 38400; Air baud rate: 9600					
Channel	Transmitting Frequency	Receiving Frequency	Channel	Transmitting Frequency	Receiving Frequency
0	445.05	445.05	16	441.05	441.05
1	460.0125	460.0125	17	442.05	442.05
2	461.0125	461.0125	18	443.05	443.05
3	462.0125	462.0125	19	444.05	444.05
4	463.0125	463.0125	20	445.05	445.05
5	464.0125	464.0125	21	446.05	446.05
6	465.0125	465.0125	22	447.05	447.05
7	466.0125	466.0125	23	448.05	448.05
8	467.0125	467.0125	24	449.05	449.05
9	434.05	434.05	25	450.05	450.05
10	435.05	435.05	26	451.05	451.05
11	436.05	436.05	27	452.05	452.05
12	437.05	437.05	28	453.05	453.05
13	438.05	438.05	29	454.05	454.05
14	439.05	439.05	30	455.05	455.05
15	440.05	440.05	31	456.05	456.05

④Trademark: Displays basic information of D1-D external radio

2)CORS Mode

Insert the SIM card on the left side of T10 tablet.

Fig 2.2.17 SIM card slot

Confirm whether the network status on the top status bar is normal.

Fig 2.2.18 Network status

Go to System >> GNSS Overview >> Base Station >> CORS interface,input your CORS account information to connect to the base station. If you are using other work modes, please refer to chapter 2.2.4.1 GNSS Overview.

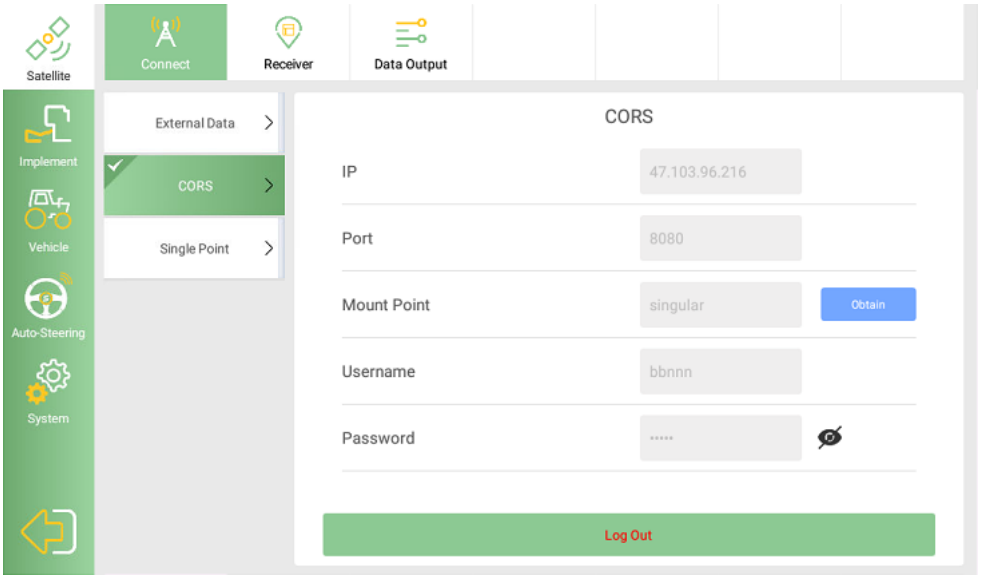


Fig 2.2.19 CORS connection

After connecting, check if the RTK status in the top status bar changes to FIX. If yes, you can proceed to the next step. If the status is not fixed, please contact SingularXYZ support team.

Fig 2.2.20 RTK status

2.2.3.4Roll Debugging

Before starting work, you need to do the **Roll Debugging** and **Repeat line debugging** to reduce errors and improve your navigation accuracy.

For articulated tractors, you should do some extra setup, please refer to section 2.2.2.8.

Go to System >> Auto-steering >> Vehicle Calibration >> Roll Debugging.

In order to eliminate the antenna errors, please follow the instructions in the software to complete the roll test on a flat surface, as shown in Fig 2.2.21 – 2.2.22.

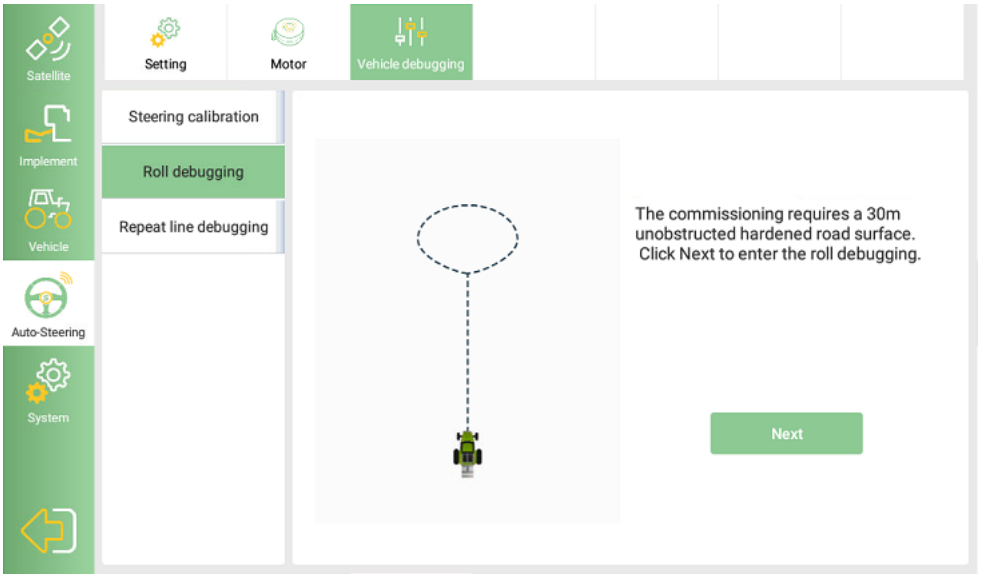


Fig 2.2.21 Roll Debugging - 1

Fig 2.2.22 Roll Debugging - 2

2.2.3.5AB Line Setting

In main interface, select your work mode and setup the AB line, you can manually setup the AB line or directly import it.

1. Manually determine the AB line

Click "**A**" at one end of the farmland, and manually drive the tractor to the other end of the farmland and

click "**B**" to generate the route of automatic driving. If you find that point B is incorrect, you can drive the tractor to the correct position and click "**B**" to setup again.

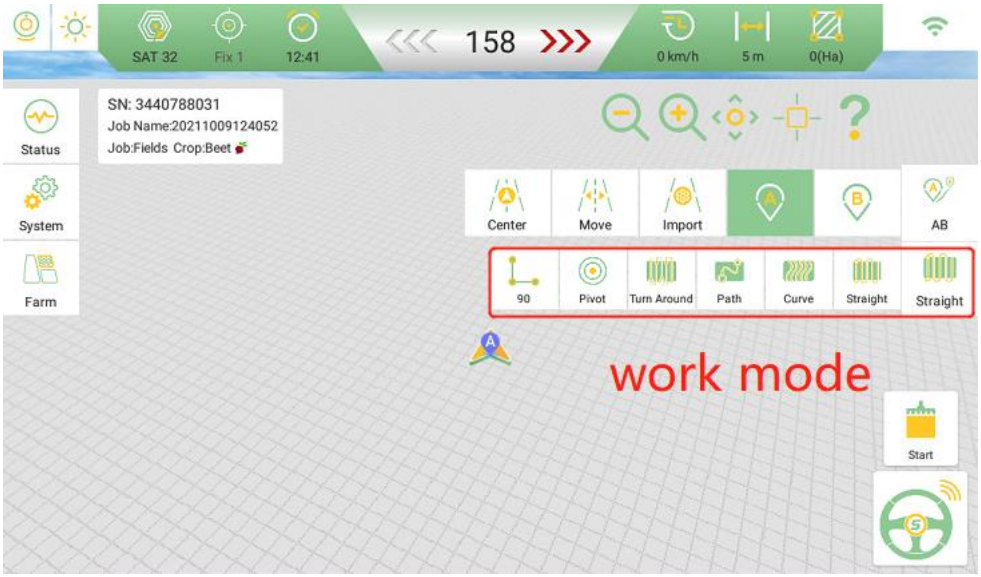


Fig 2.2.23 AB line

2. Import AB line

Click AB >> Manage >> USB to import an existing AB line via USB.

Note: The only type of AB line that can be imported through USB is **Straight**, and the data format is *.ini.

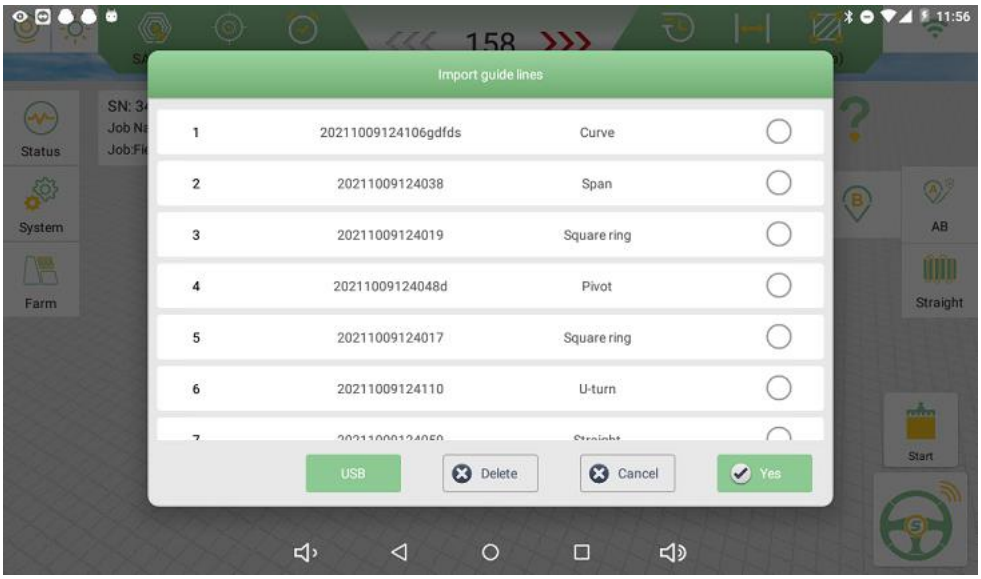


Fig 2.2.24 USB

2.2.3.6Repeat line debugging

Go to System >> Auto-steering >> Vehicle Calibration >> Repeat line debugging.

In order to eliminate the driving errors, please follow the instructions in the software to complete the Repeat line debugging on a flat surface, as shown in Fig 2.2.25 – 2.2.26

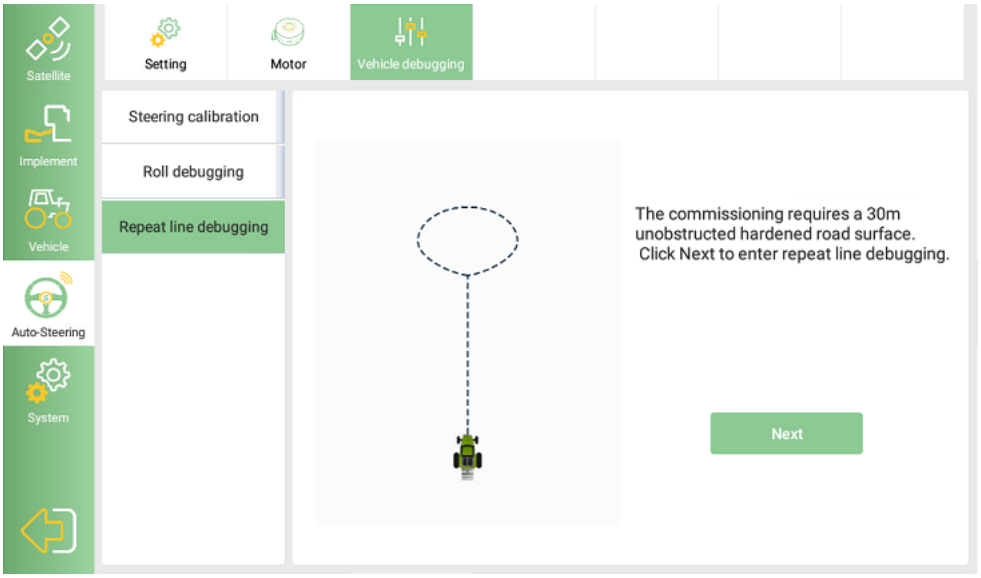


Fig 2.2.25 Repeat line debugging - 1

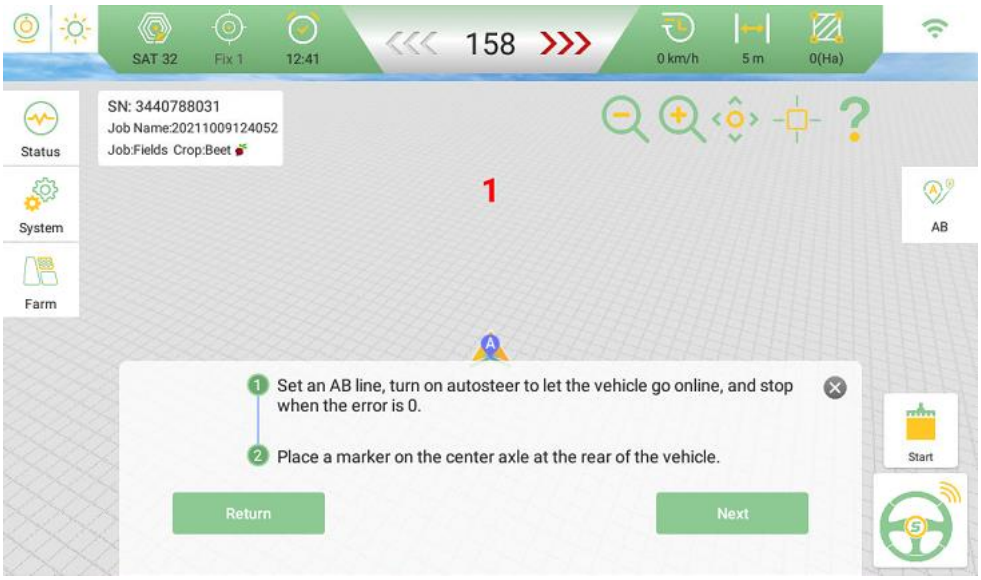


Fig 2.2.26 Repeat line debugging – 2

2.2.3.7Start Auto-steering

Click the auto-steering button in the main interface to start the auto-steering.

Fig 2.2.27 Auto-steering Button

2.2.3.8AB Line Adjustment

1. Center: Click the button to center the AB line to your vehicle's current location.

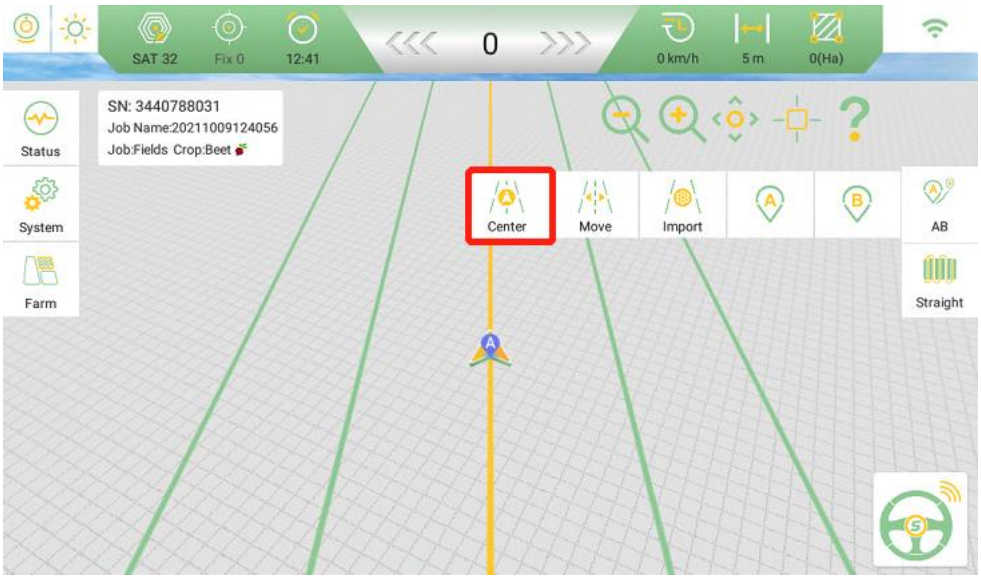


Fig 2.2.28 Center

2. Move: Click to shift your current AB line according to Fig 2.2.30your requirements, as shown below.

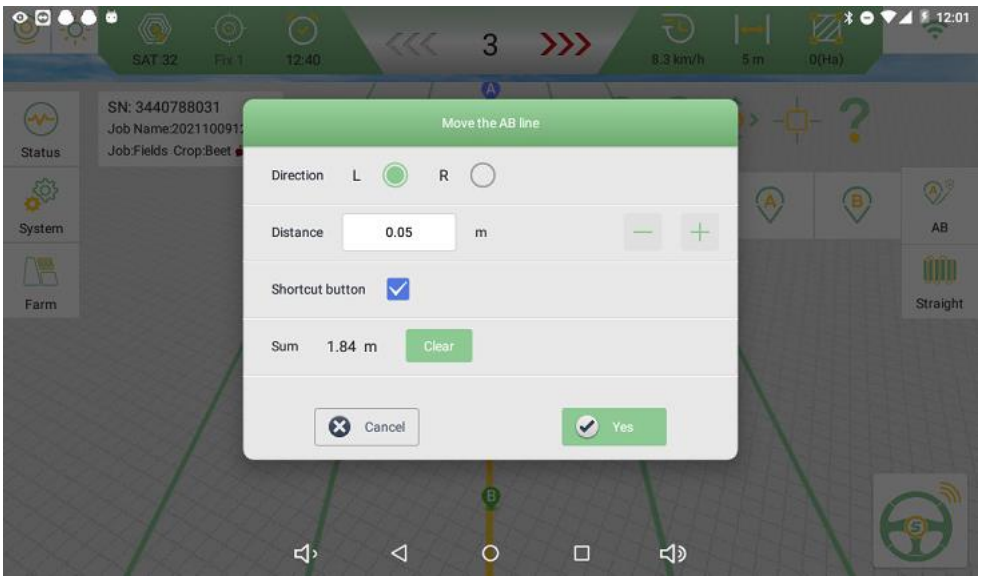


Fig 2.2.29 Offset

2.2.3.9Implement Width Setting

After the tractor is debugged, the next step is to install the implements for debugging. Go to System >> Implement >> Implement Setting, and setup the implement width based on the two parameters below.

- Width (A): Actual working width of your implement.
- Spacing (B): Your expected/required spacing between the adjacent pass.

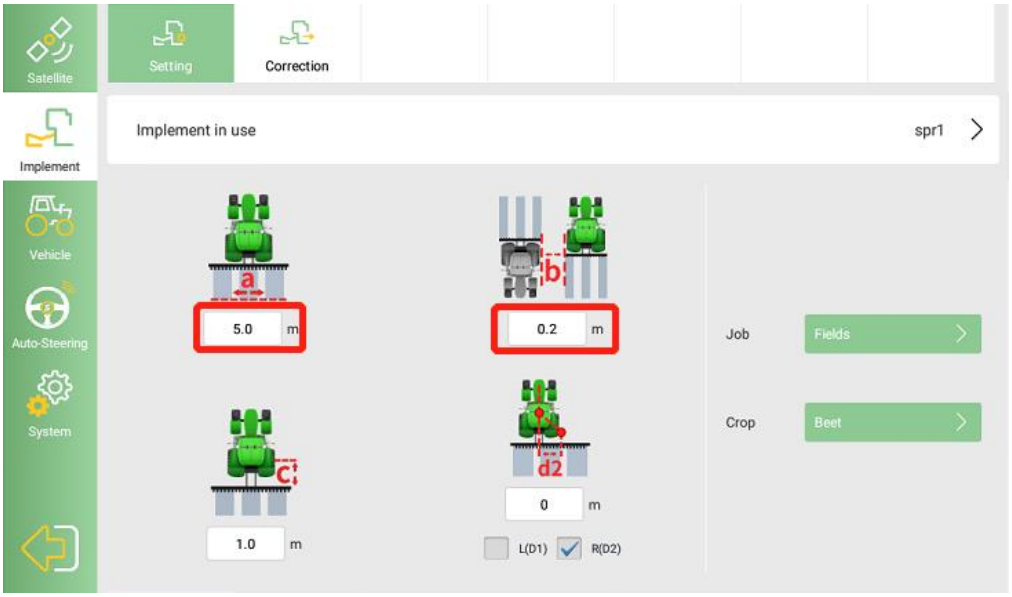


Fig 2.2.30 Implement Setup

You can also follow the software instruction to get the cumulative offset value with Manually. After this step, you can start your auto-steering work.

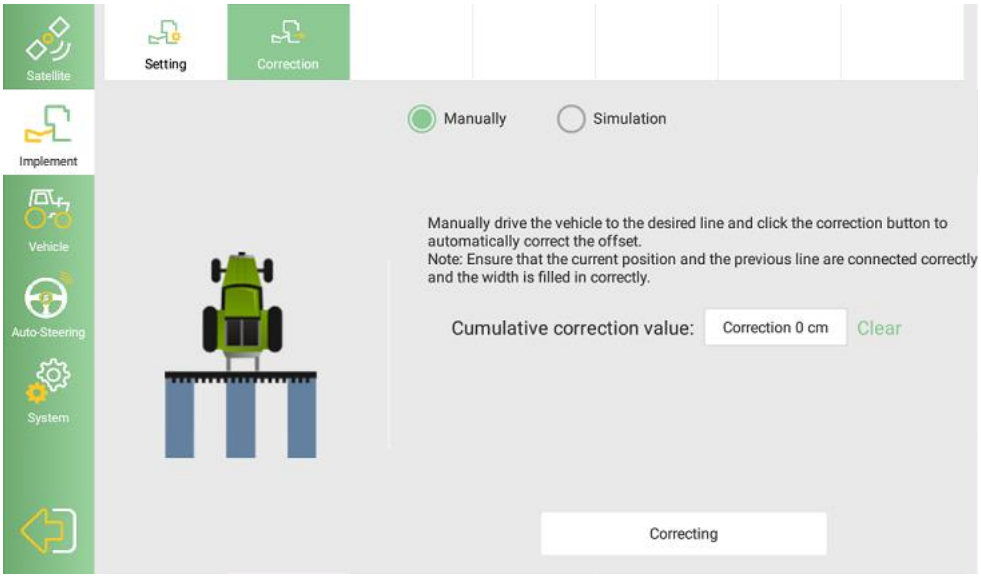


Fig 2.2.31 Implement Offset

2.2.4 Main Interface

The main interface of PrecisionAg is shown in the figure below.⑩⑪⑫⑬⑭⑮⑮⑯⑰

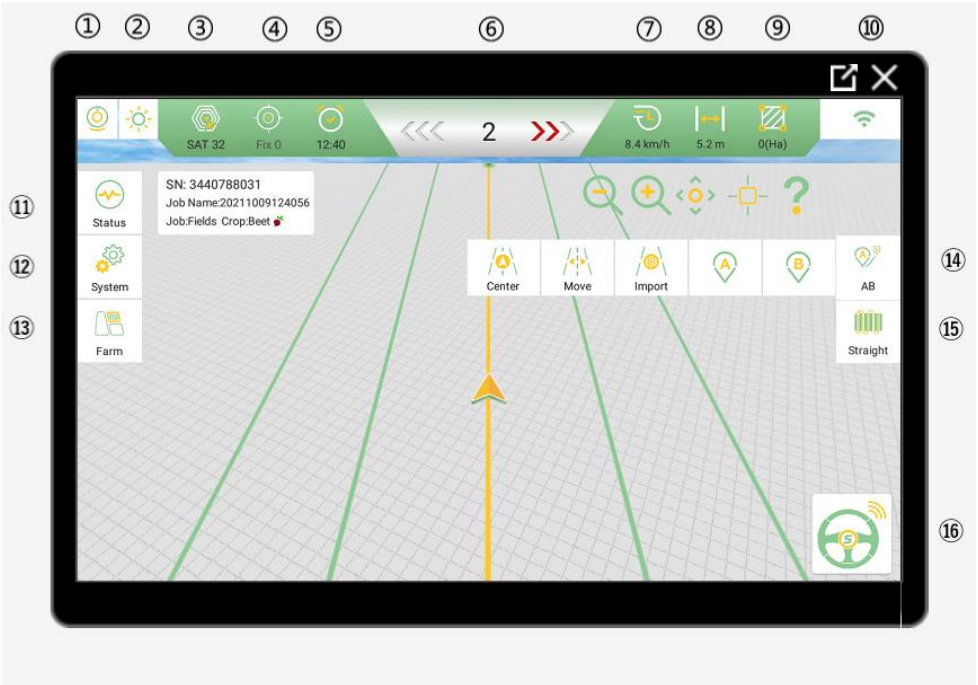


Fig 2.2.32 Main Interface

① Camera: Click to turn on/off the camera.

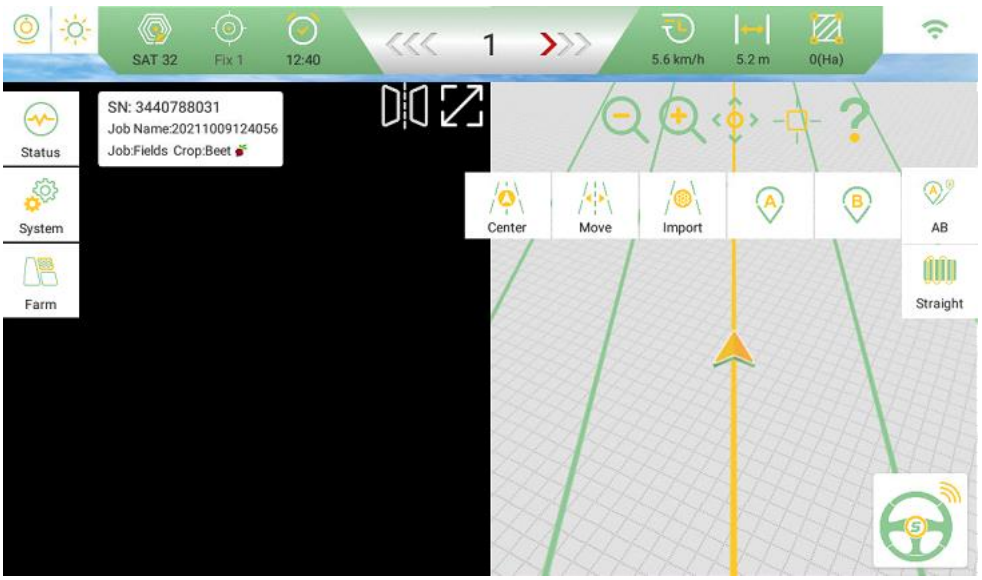


Fig 2.2.33 Camera

② Day/night mode: Click to switch the day mode and night mode.

Fig 2.2.34Day/night Mode

③ Number of tracking satellites: Click to show the satellite sky view and signal-noise ratio.

Fig 2.2.35 Satellites Information

④ RTK status and differential delay: Click to enter the configuration interface of RTK modes.

⑤ Time display: Click to enter the time zone setting interface.

⑥ Deviation from ab line: Real-time display of the deviation of the vehicle from the AB line when auto-steer is on. The arrow in the figure indicates the direction of the deviation and the number indicates the offset value (Unit: mm).

E.g. The figure below shows the tractor deviates 30mm from the route to the right.

Fig 2.2.36 Offset

⑦ Real time operation speed: Click to enter the speed limit threshold setting interface when the vehicle is running.

⑧ Implement width.

⑨ Completed area: Real-time display of the completed working area during operation. Long press to clear the working record, including tractor track, completed area and work line name.

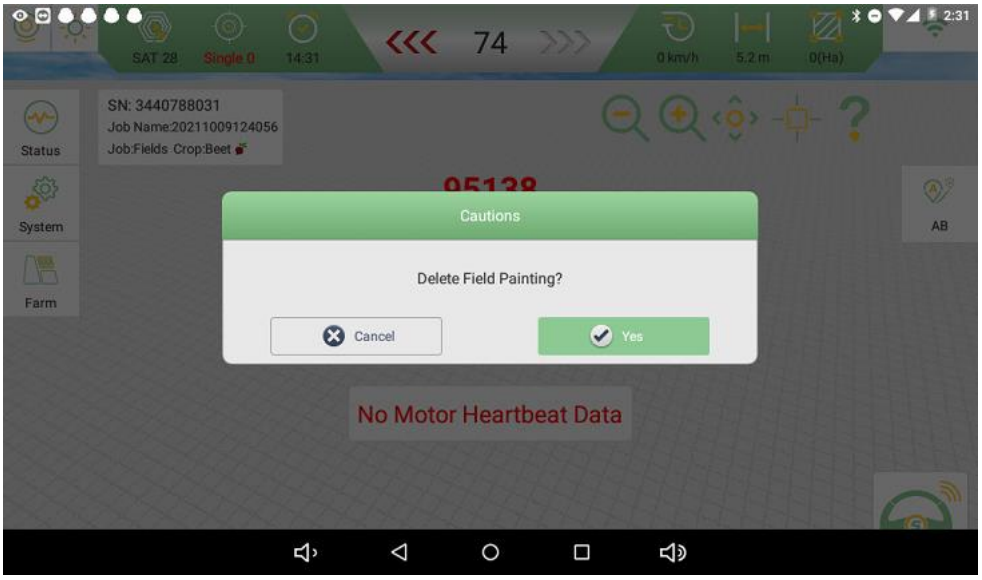


Fig 2.2.37 Cautions

⑩ Network: Display network operator and network signal strength.

⑪ Status: Real-time display of equipment status and equipment self-test function.

⑫ System: Click to enter the system setting interface, which will be introduced in subsequent chapters. Long press to open or close the automatic turning button. Click the left or right buttons on the screen to control the vehicle to turn around.

Fig 2.2.38 Long Press and choose turning button

⑬ Farm Management: Click to enter the farm interface, including farm list, job list and job data statistic.

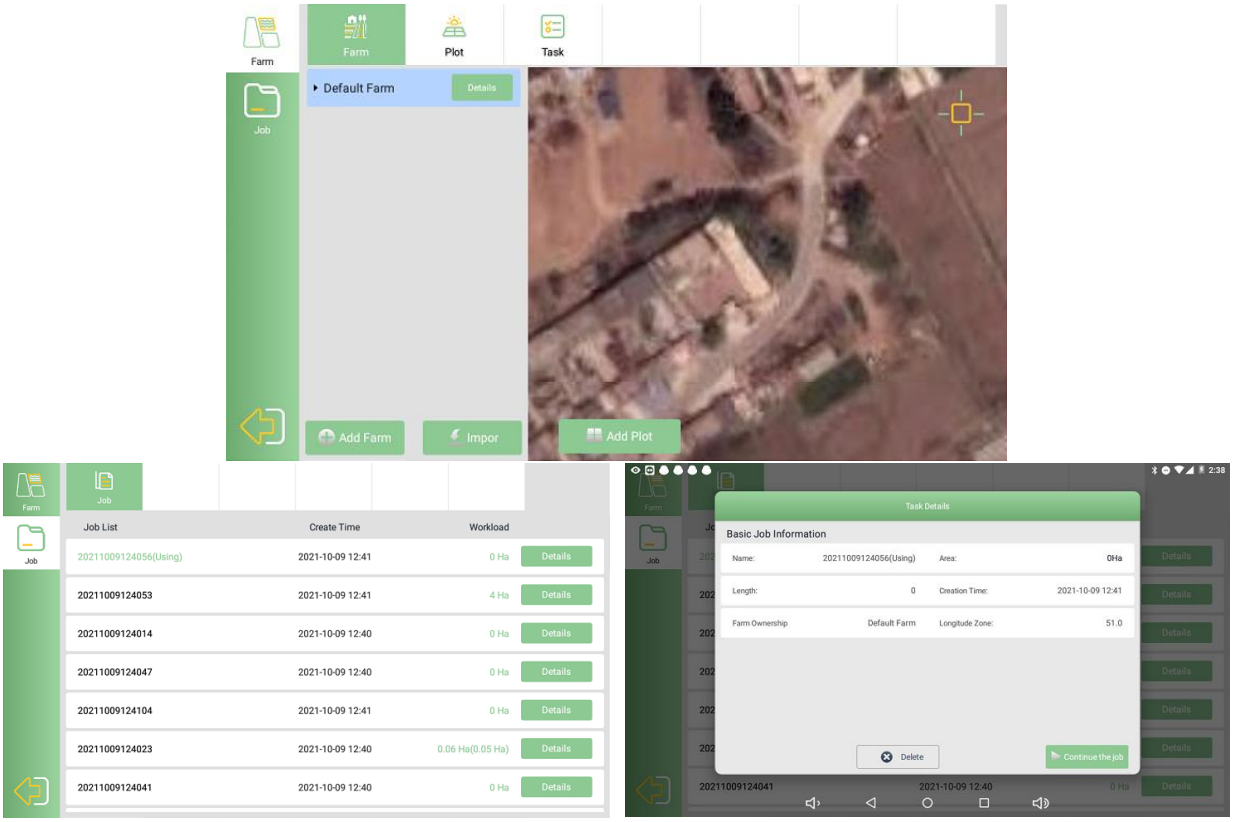


Fig 2.2.39 Farm Management

⑭ AB line: Used for AB line setting and adjustment of straight line, curve and other work mode.

Fig 2.2.40AB Line

The buttons contains three operation types: line AB setting, line AB editing, and navigation line type.

(1)AB line setting

In the new plot operation, we need to set line AB first, set point A at the start of the plot, and set point B at the end of the plot, as shown below:

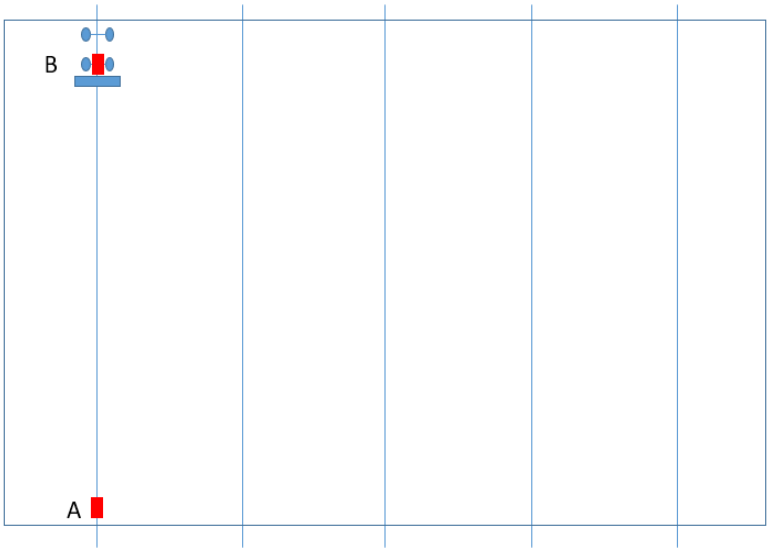


Fig 2.2.41 AB Line Setting-1

The software operation is shown in the figure below：

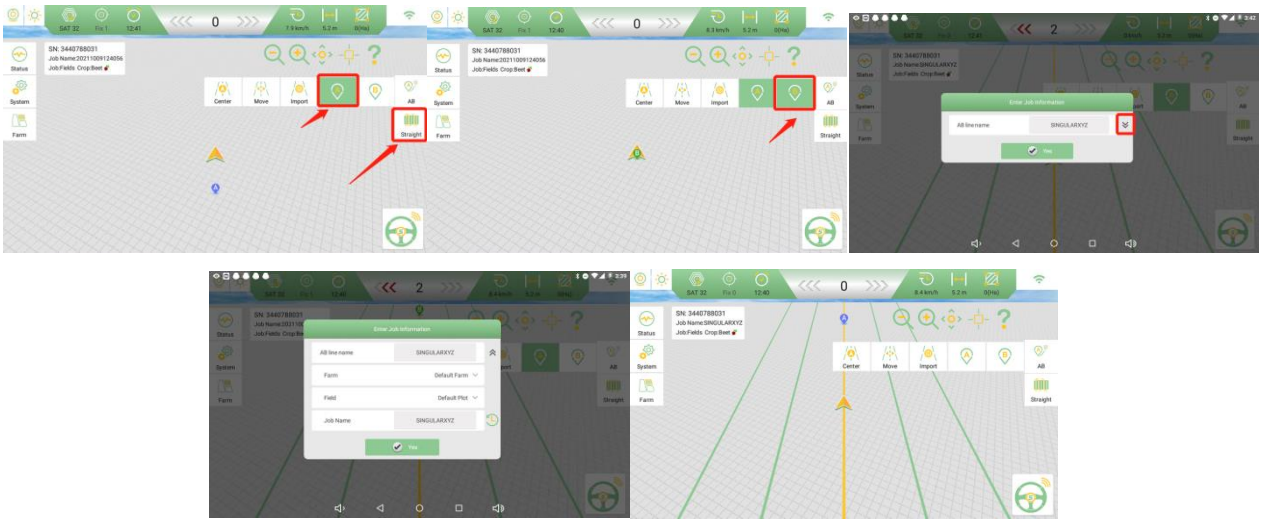


Fig 2.2.42 AB Line Setting-2

A. Click the line AB

B. When you reach the start of the field, click point A.

C. When you reach the end of the field, click point B.

D. The name window will pop up. The drop-down window can improve the information inside.

E. You can set the name of line AB, if not set, the system will be in time to set the name, you can then select set ahead of farms and plot, if there is no set up farms and block information in advance, the system will select the default plot and farms, the last is to fill in the name of this task, if not fill in, its name will be consistent with AB line name.

After filling in the information, click the OK button to complete the setting of AB line, you can navigate the operation.

(2) Line AB editing

Line AB editing includes Center, Offset and Manage three functions.

1)Center

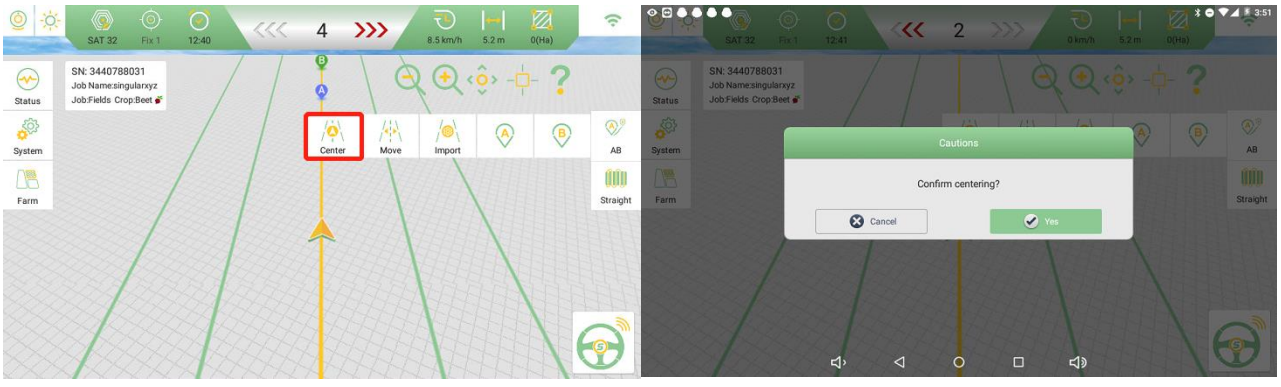


Fig 2.2.43 Center

First, the navigation interface exist line AB, and it is in the non-navigation state, you can use this function (Linear operation process).

When you finish the previous AB line and reach a new location, click Center. It will automatically generate a new AB line at your current location. Generally used for the current navigation line cannot work (front is a discharge water pile, pole, etc.), you can stop the tractor to the appropriate position, and then click reset AB line can continue to work.

A. Click the Center button

B. Click Yes to generate a new line AB from the current position

2) Move

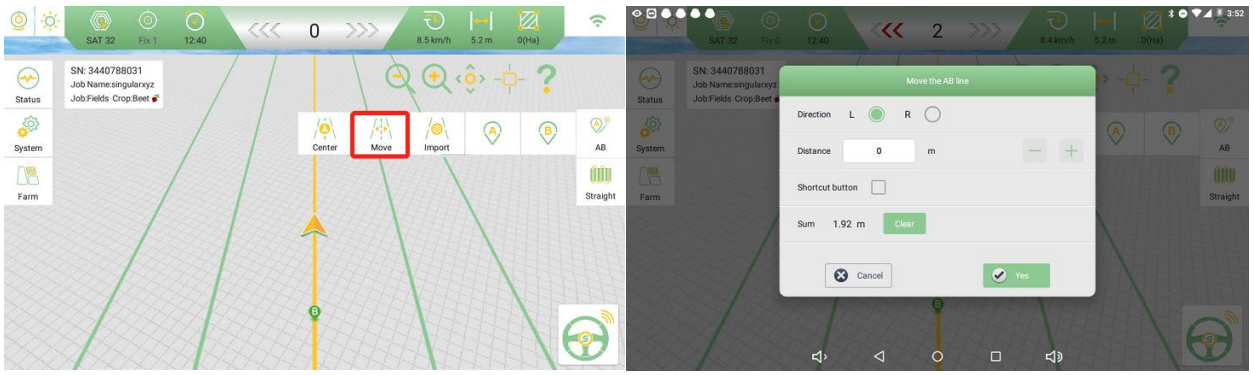


Fig 2.2.44 Offset

Offset function is similar to Center, except that Offset is precise shift line AB, can choose the direction and distance. For example, at the end of the last trip, sometimes it is necessary to move to the sown direction to avoid the ridge. When planting in the middle area, it is necessary to change the track several times to avoid damaging the seedlings.

A. Click the Offset button

B. Select the offset direction and set the offset distance

C. Select the shortcut button. After setting, you can operate directly from the main interface

D. Click Yes to save the Settings

(3) Import

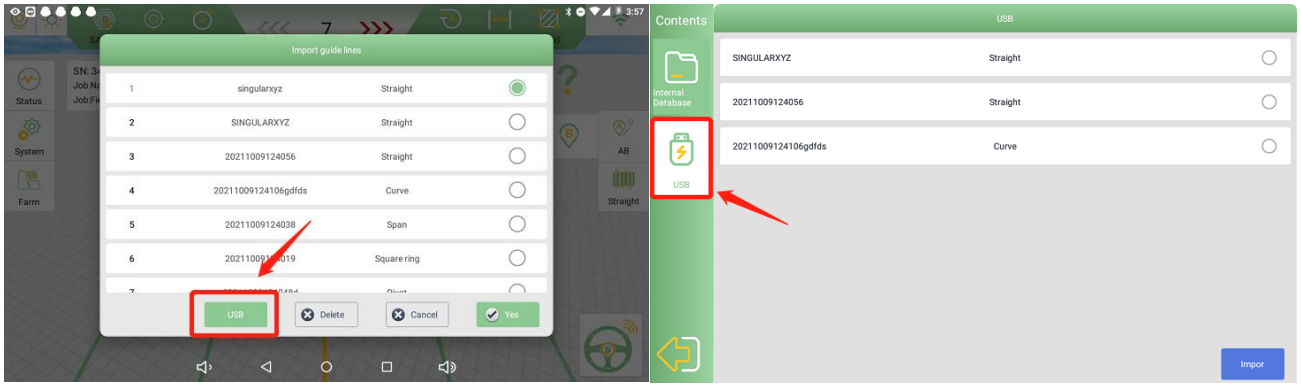


Fig 2.2.45 Manage

AB line import is to manage, import, and delete existing lines. The AB line can be imported from the local, only lines can be imported in *. ini format. And the AB line can be shared with other vehicles through the U disk.

⑮ Work mode: Click to select work modes including Straight line, Curve. The new version adds some new features that can be turned on in Settings.

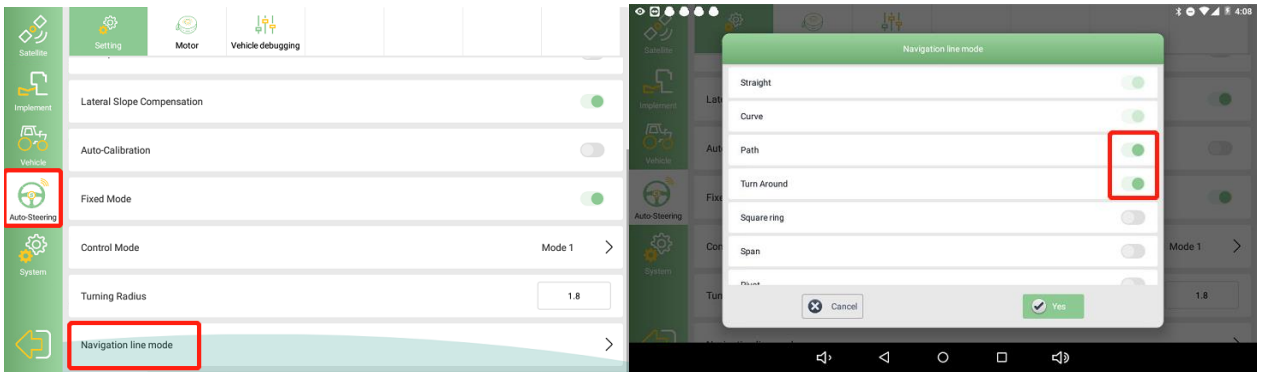


Fig 2.2.46 Work Modes

We have added many functions, but some of them are still under optimization, so they cannot be used at present. We suggest adding: straight, curve, path, Pivot, 90°.

(1) Straight: driving in straight line

(2) Curve: according to the track of the customer's first trip, the left and right navigation lines are generated through the width. (Try to be as smooth as possible on the first ride.)

Note: Optimization is in progress

(3) Path: Only one navigation line can be set to record the track from point A to point B, and vehicles can only run on this navigation line.

(5)90°: Once you have AB line, you can use 90 degrees to generate a line perpendicular to it

⑯ Auto-steer switch button: Click to turn on/off auto-steer.

2.2.5 System Interface

2.2.5.1GNSS Overview

Users can make GNSS related configuration in this interface.

1. Base Station: SAgro100 supports 3 positioning modes.

- External Data: This mode is made for users using external radio for RTK correction data receiving.
- CORS: In CORS mode, users can load their CORS account to get RTK correction data.
- Single Point: Designed for users who using single-point smooth positioning method.

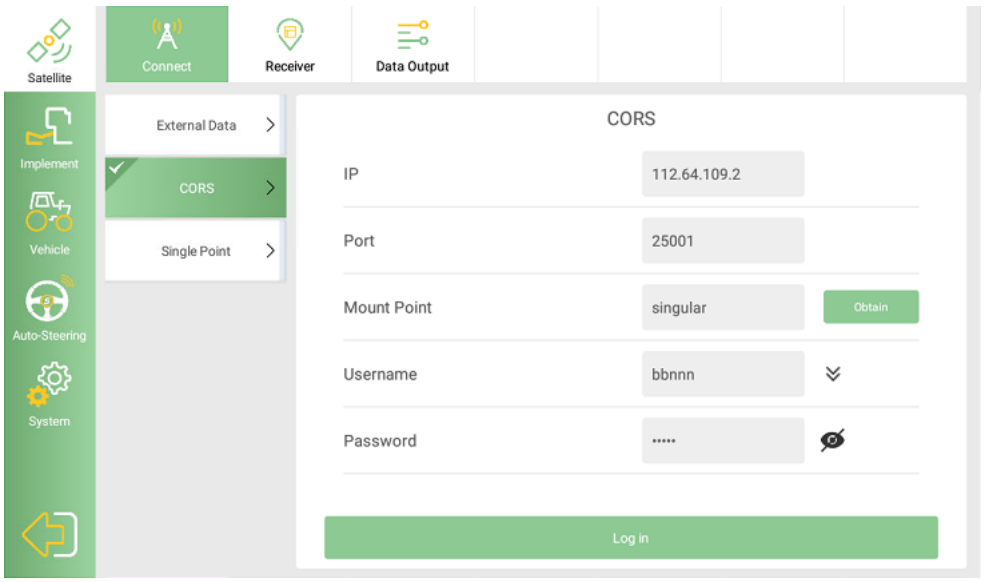


Fig 2.2.47 Work Mode

2. Receiver Setting

Use the default setting – GNSS Tablet for SAgro100 system.

Star-fill: To maintain positioning accuracy when correction data is briefly lost.

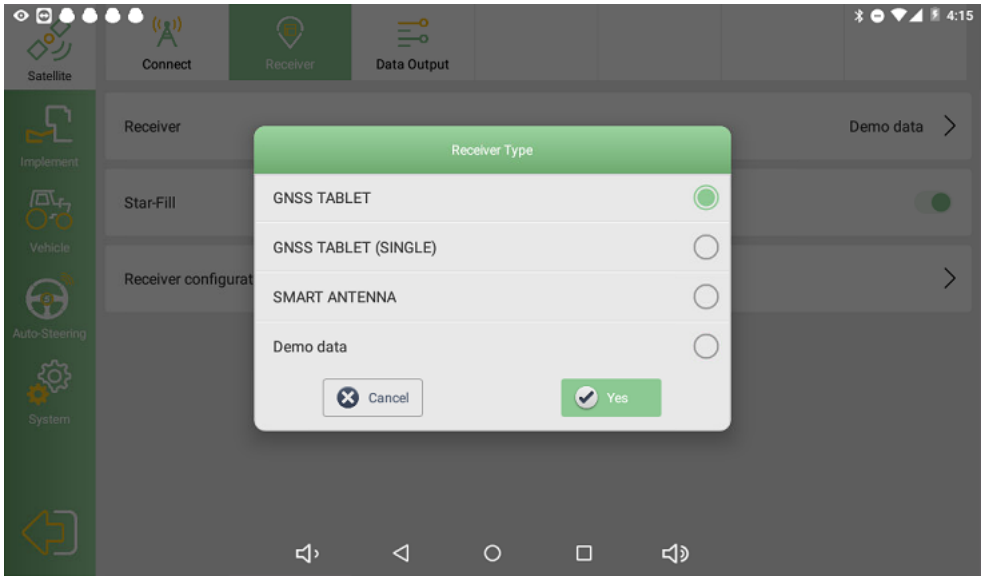


Fig 2.2.48 Receiver Setting

2.2.5.2Implement

Users can set the implement width, spacing and offset in this interface.

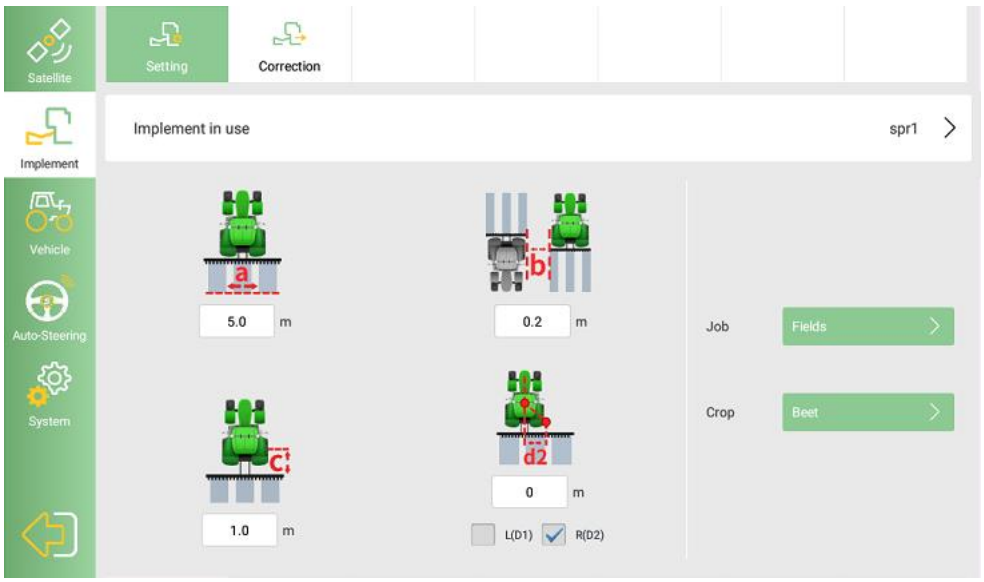


Fig 2.2.50 Implement

2.2.5.3Vehicle Management

Users can set vehicle model parameters by inputting or importing in this interface.

Click Current Vehicle >> Import to select the tractor type or import your tractor parameters. These parameters need to be accurately measured and input.

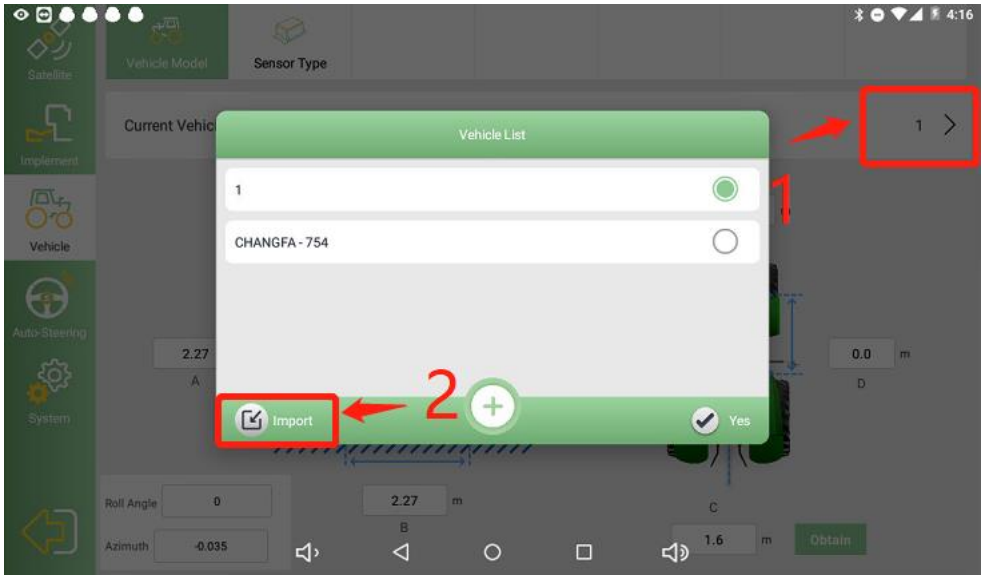


Fig 2.2.51 Vehicle Management

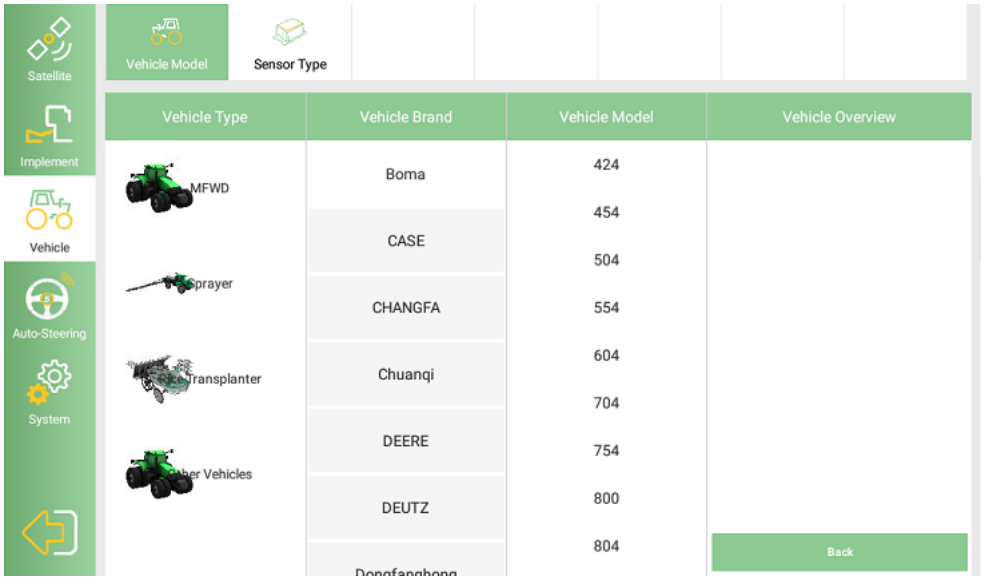


Fig 2.2.52 Vehicle Type

For sensor type selection: select the corresponding sensor type according to the installed sensor.

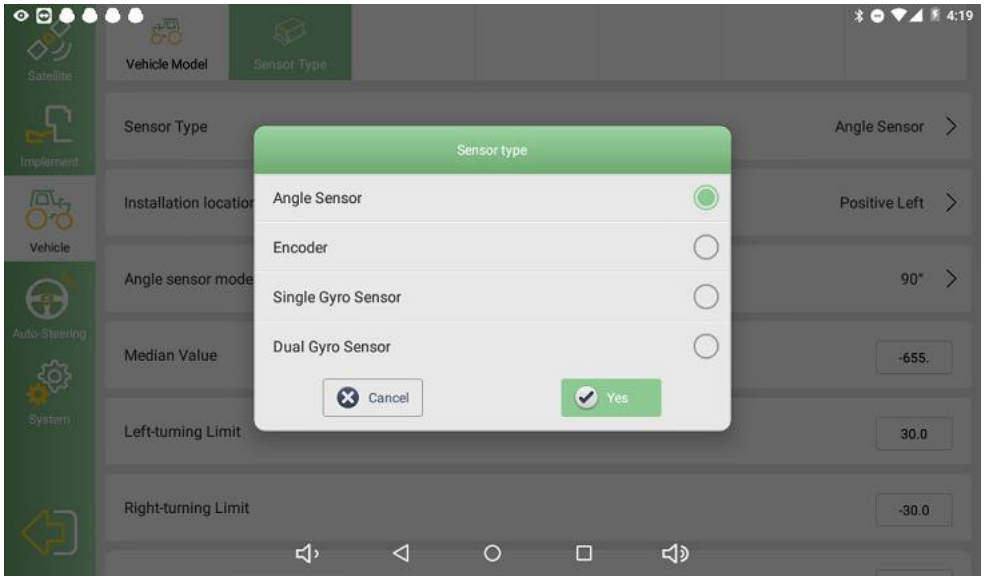


Fig 2.2.53 Sensor Type

2.2.5.4Auto-steering Settings

Auto-steering related parameters can be adjusted in this interface. Please keep the default settings or change the parameters under the guidance of the SingularXYZ support team.

(1) System Setting

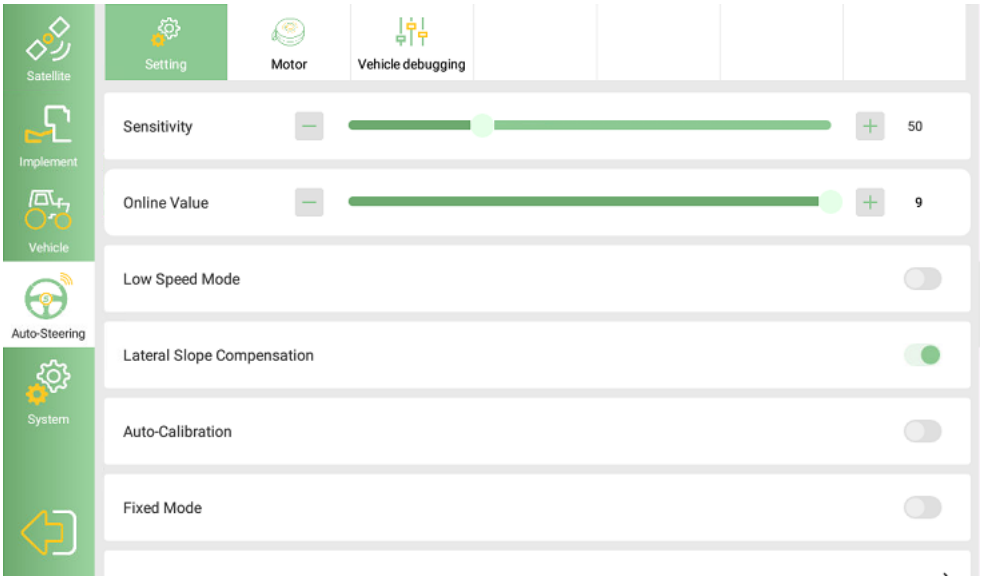


Fig 2.2.54 System Setting-1

1) Sensitivity: It can control the online speed from 0 to 180, normally 3 to 4 km/h, using the default value. When the speed increases, it can be appropriately increased.

2) Transmission Coefficient: It can control the motor adjustment speed, the range of 0-320, normal use of the default value. When the reel rotation is too slow, it can be increased, when the reel rotation is too fast, it can be reduced.

3) Online Value: The default value is used and generally does not need to be changed

4) Low Speed Mode: Start when the speed is less than 0.5 km/h, off by default

5) Lateral Slope Mode: The default open

6) Auto-Calibration: The default open

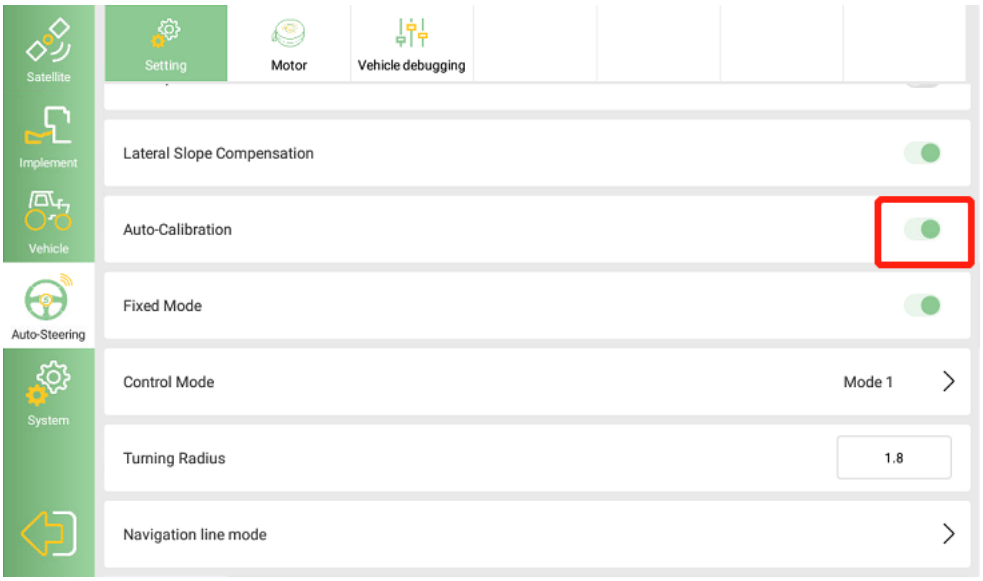


Fig 2.2.55 System Setting-2

7) Fixed Mode: Off by default, there are three conditions that need to be opened:

①When the force of agricultural tools is large;

②The speed is greater than 10 km/h; Sensitivity option changed to foresight distance, the default value is 35. As the velocity increases, the value increases.

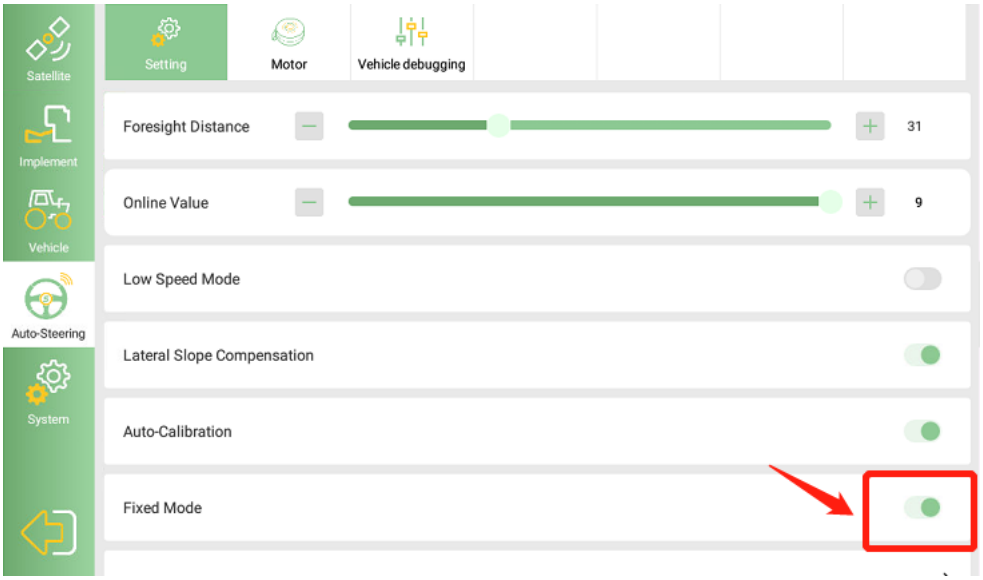


Fig 2.2.56 System Setting-3

③When the sensitivity is invalid

8) Control Mode: The default open

9) Turning Radius: Without change

(2) Motor Setting

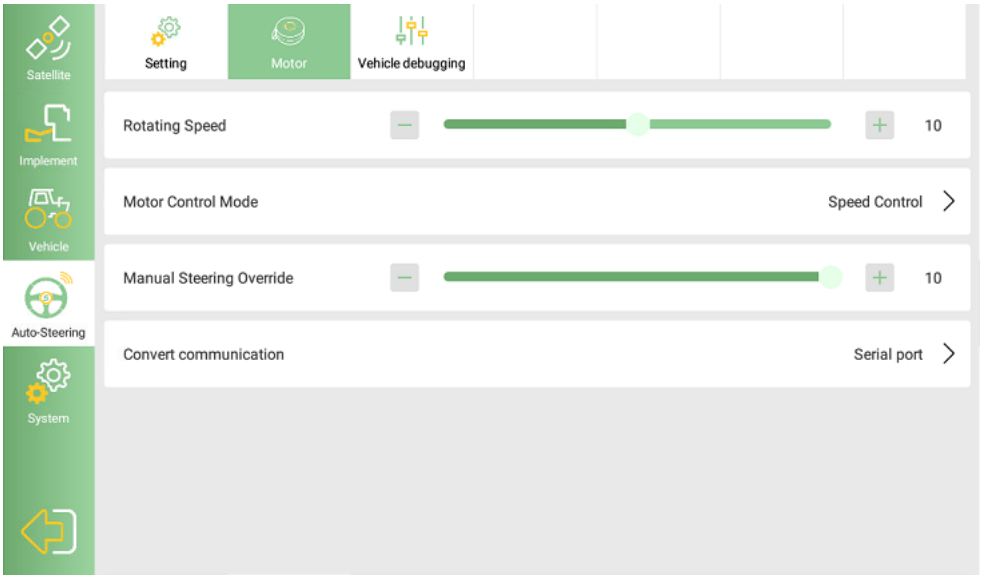


Fig 2.2.57 Motor Setting-1

1) Rotating Speed: Control motor rotation speed

2) Motor Control Mode: The default mode is speed control and does not need to be changed

3) Manual Steering Override: When it is on, and the parameter is set to 0, when the auxiliary driving mode is on, the hand holding the steering wheel will end the auxiliary driving mode

2.2.5.5System Settings

System settings include language, unit, time zone, password protection, cache, etc., which can be set up in this interface.

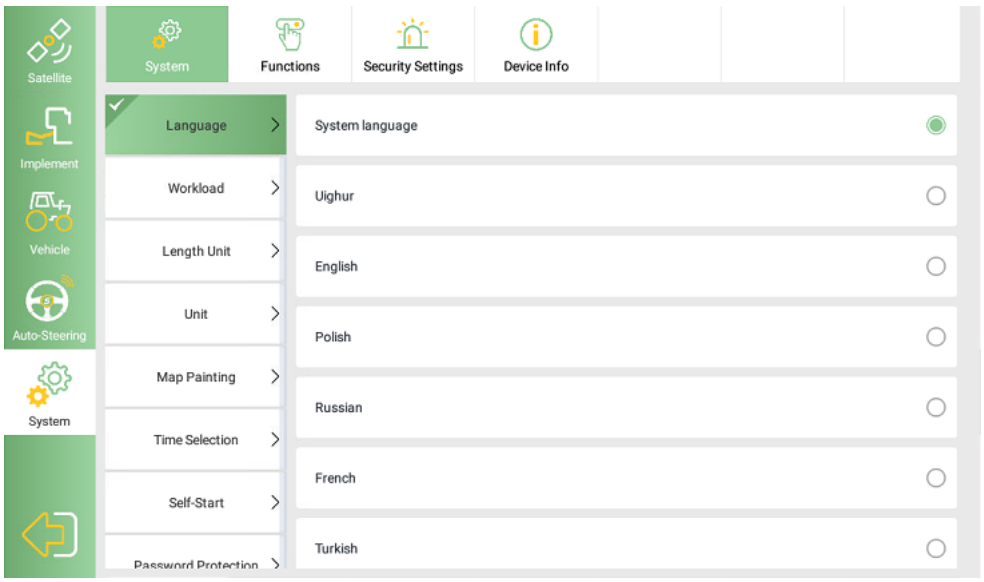


Fig 2.2.58 System Settings

In Functions interface, users can enable and disable the auto-steering or flow control functions according to their needs.

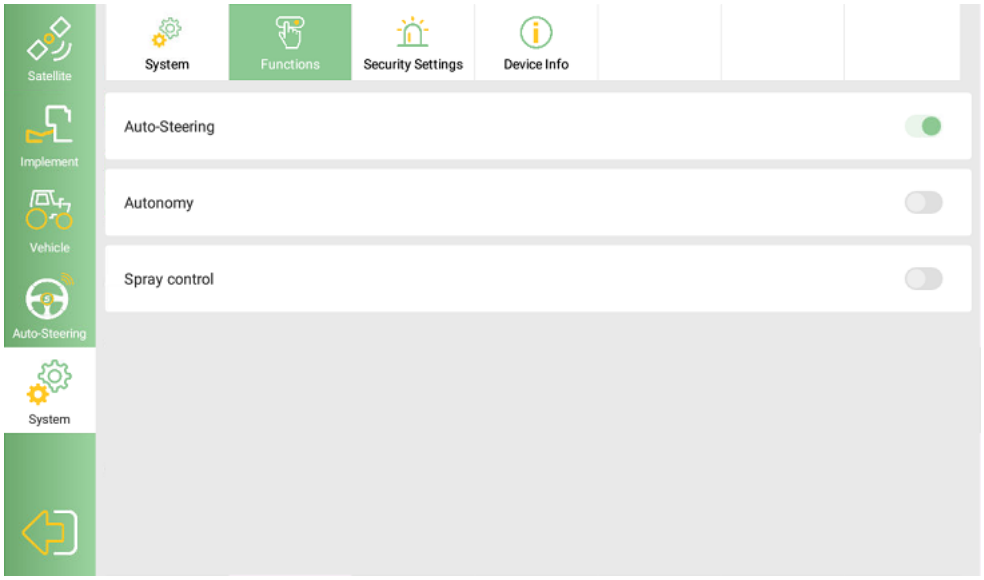


Fig 2.2.59 Functions

2.2.6 System Error Debugging

2.2.6.1Fixed Driving Deviation Error

If the driving deviation during auto-steering is always towards a fixed direction (left or right) as shown below, please go to System >> Management >> Sensor Type to adjust the Median Value.

Increase the Median Value if driving deviation is to the left, and decrease the Median Value if driving deviation is to the right.

Generally, adjust the value by 0.2 each time and then check the actual effect of the deviation until the deviation value on the top status bar is less than 2.

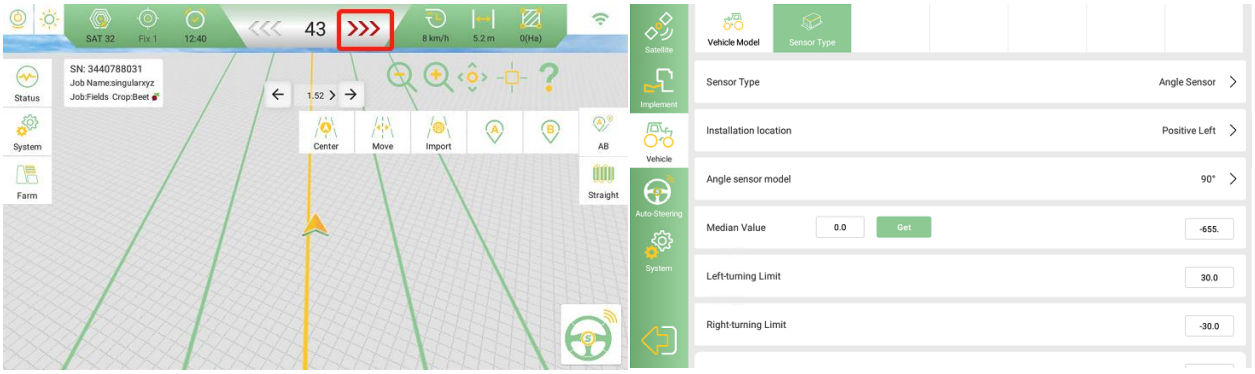


Fig 2.2.60 Fixed Driving Error

1. When turn on the auto-steering system, the deviation from ab line changes frequently, the value is large, often offset about 5cm, it is necessary to turn down the sensitivity in the system setting. If the adjustment sensitivity is not used, it is necessary to open the fixed mode.

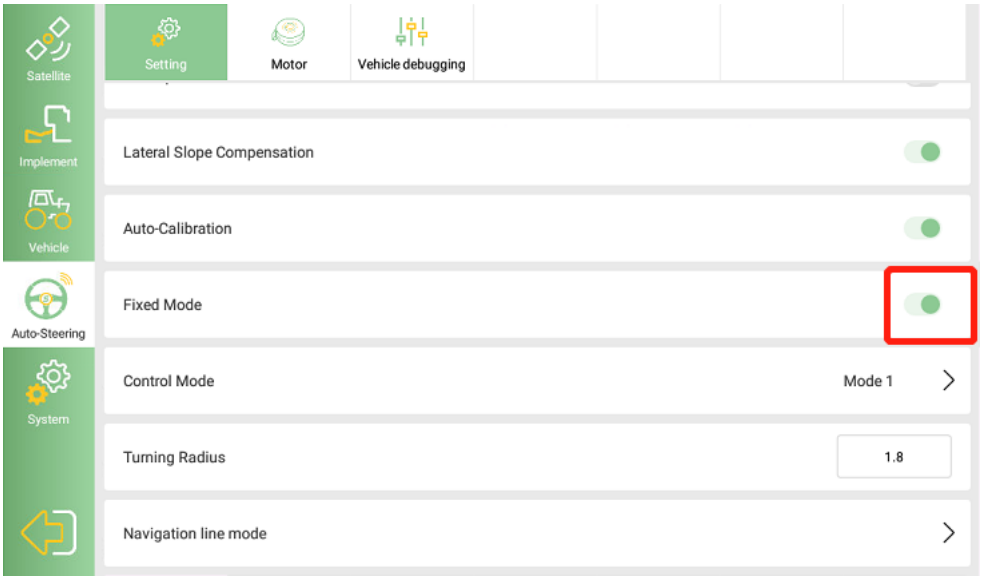


Fig 2.2.61 Fixed Mode

2.2.6.2Variable Driving Deviation Error

If the driving deviation during auto-steering jumps left and right, go to System >> Auto-steering >> Motor Setting to adjust the **Rotating Speed** parameter.

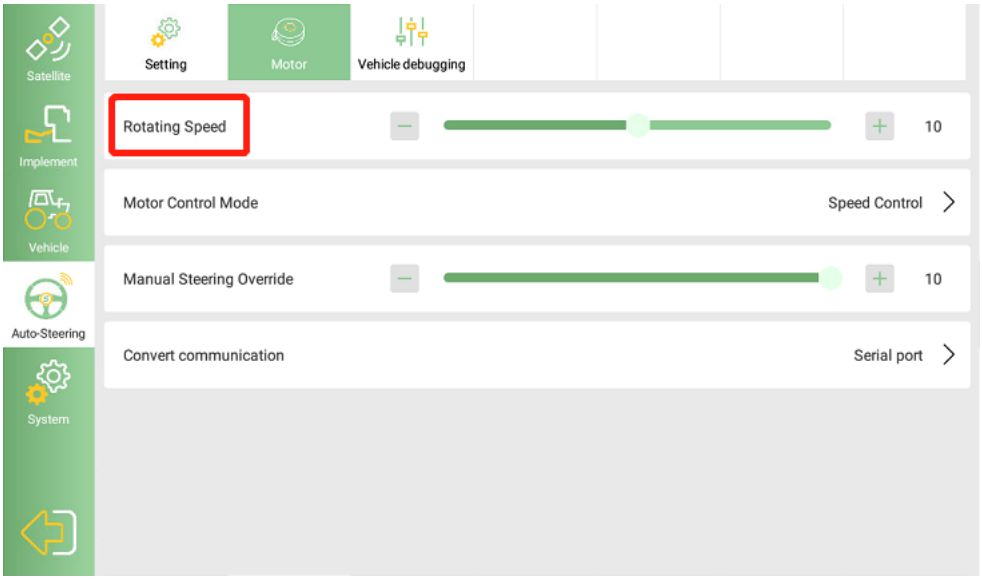


Fig 2.2.62 System Setting

There are two common situations as below

1. If the auto-steering system corrects the deviation too slowly, and the vehicle trajectory has some large bends, you can try the following way to adjust.

Please note that the way should be done independently.

- Increase the value of **Rotating Speed** by 1 each time & then check the actual effect of the deviation.

2. If the auto-steering system corrects the deviation too quickly, the vehicle trajectory has some continuous small bends, and the steering wheel turns fast, you can try the following way to adjust.

Please note that the way should be done independently.

- Decrease the value of **Rotating Speed** by 1 each time & then check the actual effect of the deviation.

3.If the motor does not work properly, steering wheel cannot be controlled, check whether motor control mode is speed control.

Tip: The actual adjusted value should be considered based on the actual situation, and you can also contact the SingularXYZ team for technical support.

Chapter 3 Specifications

This chapter includes the specifications of T10 GNSS Tablet, SA100 GNSS Antenna and SEM1 Motor Wheel.

3.1 T10 GNSS Tablet

Table 3.1 T10 GNSS Tablet Specifications

GNSS Performance		
Signal Tracking	GPS L1, L2 GLONASS L1, L2 BeiDou B1, B2 GALILEO E1, E5b QZSS L1, L2 SBAS L1	
GNSS Channels	432	
Position Accuracy	Single Point Positioning	1.5m RMS (Horizontal)
		2.5m RMC (Vertical)
	DGPS Positioning	0.4m (Horizontal)
		0.8 (Vertical)
	RTK Positioning	10mm+1ppm (Horizontal)
		15mm+1ppm (Vertical)
Heading Accuracy	0.1° RMS @ 1m baseline	
Time Accuracy	20ns RMS	
Velocity Accuracy	0.03m/s RMS	
Reacquisition	< 1s	
Correction	RTCM 2.3/3.0/3.2	
Date Output	NMEA-0183	
Heading and RTK update rate	20Hz	
Network Protocol	NTRIP, TCP/IP	

System Performance	
Operating System	Android 6.0
CPU	Quad-Core 1.5GHz
Memory	2GB RAM + 16GB ROM
LCD	10.1“Capacitive Touch Screen
Resolution	1024x600 pixels
Communications	
Wi-Fi	2.4GHz IEEE 802.11 b/g/n
Cellular	FDD-LTE 800 / 1800 / 2100 / 2600MHz TD-LTE 1900 / 2300 / 2500 / 2600MHz WCDMA 850 / 900 / 1900 / 2100MHz GSM 850 / 900 / 1800 / 1900MHz
Bluetooth	V4.0
USB	USB 2.0 (host & debug) x1
Audio	3.5mm Audio Jack for Audio
Serial Port	RS232 x2, RS485 x1
CAN Port	CAN x2 (J1939, CANOpen, ISO15765)
Ethernet	RJ45 (100M Ethernet) x1
Electrical	
Power Input	9V~36V DC
Power failure detection	supported
Power output	12V DC x2
Physical	
Dimension	281mmx181mmx42mm
Weight	1.5kg

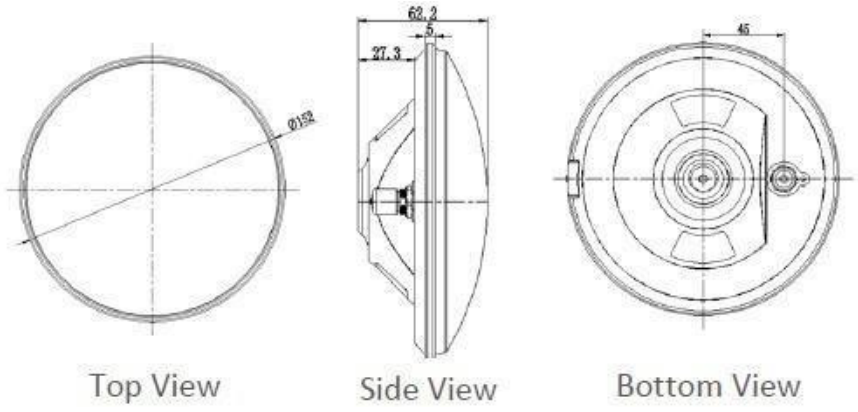
Environmental	
Operating Temperature	-20°C to +70°C
Storage Temperature	-40°C to +85°C
Water & Dust proof	IP65
Vibration	MIL-STD-810G
Road Vehicle Standards	ISO16750
Humidity	0%~90%RH @ -20°C ~+70°C 30%~95%RH @ -40°C ~+85°C

3.2 SA100 GNSS Antenna

Table 3.2 SA100 GNSS Antenna Specifications

Antenna Specification	
Tracking signals	GPS L1/L2/L5 BDS B1/B2/B3 GLONASS L1/L2 Galileo E1/E5a/E5b/AltBoc
Impedance	50 Ohm
Polarization	RHCP
Axial Ratio	≤ 3dB
Azimuth Coverage	360°
Output VSWR	≤ 2.0
Peak Gain	5.5dBi
Phase Center Error	± 2mm
LNA Specification	
LNA Gain	40±2dB
Noise Figure	≤ 2.0dB
VSWR	≤ 2.0
Input Voltage	3.3~12V DC
Operating Current	≤ 45mA
Ripple	± 2dB

Physical	
Dimension	Φ152*62.2mm
Weight	374g
Signal Connector	TNC Female
Installation connector	5/8'' x 11 UNC Female
Environmental	
Operating temperature	-45°C - +85°C
Storage temperature	-45°C - +85°C
Damp	45% - 95%
Mechanical Drawing	



3.3 SEM1 Motor Wheel

Table 3.3 SEM1 Motor Wheel Specifications

Motor Performance	
Rated speed	100 rpm
Rated torque	4.5N*M, maximum: 9N*M
Control mode	Speed Mode, Position Mode
Electrical	
Rated voltage	12 VDC
Voltage range	6 ~ 35VDC
Rated current	12.5A

Input power continuous current	25A, maximum
peak current	40A
Stall current	25A
Rated voltage	12 VDC
Software overload current	25A (Overload time could be set)
Hardware peak protection current	60A
Output Rated Power	100W
Communication	
Interface	RS232, CANBUS, Analog to Digital conversion
Protocol	ModBUS, CAN
Encoder resolution	53248 line, 4000 pulses per circle
Encoder interface	Parallel communication, no protocol
Feedback element	Incremental encoder 53248PPR
Encoder output frequency	200Khz maximum
Max backlash error (degrees)	No reducer, no backlash error
Physical	
Hight	85mm
Diameter	182mm
Weight	4.5 kg
Material	Aluminum alloy
Environmental	
Operating temperature	-40°C - +105°C (motor)
Storage temperature	-45°C - +150°C (motor)
Environmentally	IP67 dustproof and waterproof

Chapter 4 Typical Applications

4.1 Typical Applications

The typical applications using SAgro100 automated steering system:

- Spraying Pesticide

- Harvesting

- Sowing

- Plowing
- Transplanting

Chapter 5 Appendix

5.1 Terms and Abbreviations

Sensitivity: equivalent to the line stability coefficient of the previous automatic driving software. It mainly adjusts the motor sensitivity. The higher the value setting, the more sensitive the motor rotation is, and the lower the value, the less sensitive it is.

Confidence degree: different values can be selected for the confidence degree, which mainly adjusts the sensitivity of the gyroscope. The smaller the set value, the higher the sensitivity. Generally, the default value is 0.01.

Automatic calibration: mainly calibrate azimuth offset. Slope correction: real time correction of roll.

Speed limit threshold: the maximum speed allowed under automatic driving mode. If it exceeds, automatic driving will be released. The adjustment range is 0-50km / h, and the default is 20km / h.

Flow control: GNSS intelligent spray control system.

5.2 Spline Sleeve

The available spline sleeves are listed in Table 6.1. If your vehicle is not included in the table below, please

contact SingularXYZ support team (email support@singularxyz.com) to customize a new spline shaft.

Table 5.1 List of Available Spine Shafts

Spline	Verified Tractor Model	Steering Column Tooth	Steering Column Diameter	Note
A	1. John Deere models (350, 720, 754, 804, 850, 854, 904, 954, 7830, 2204, 8295, 1204, 1404, 1354, 6605, JD 5-754, 5-850, 5-854, 5-900, 5-904, N754, 6B954), 5050D, 8430 (Lengthen) 2. French Renault1404 3. ZOOMLION PL2604 4. Fendt (716) 5. New Holland (1404, 2104, 6070, 110-90, 165, TD85D, 1654, 1304) 6. CASE 110 7. Kirovets K744	36	21.3-21.7	
B	1. WORLD 1304 2. LOVOL 1004, 900, 1654 3. Foton 904, 700, 750, LX800, 754, 90, LF904, 1204	36	17.75-17.9	
N1	1. CASE (PUMA145,185CVX) 2. CLAAS 2204 3. MASSEY FERGUSON 204, S1304-C 4. Fendt (936) 5. MASSEY FERGUSUN (1004, 1104, 1204, 1304) 6. McCormick ZTX280	36	15.3-15.7	15-16 diameter\ N1\N2 same steering column tooth
NH40	1. CASE MXM	40	17.3-17.5	Steering column40 tooth
D1	1. CASE CVX 1170 2. Fendt (vario 772, 714 Vario, 2204) 3. LAMBORGINI	36	20.3-20.4	The same dimension D and D1
F	1. Valtra (2104, 191, 1904, 1504, 8158, T183)	Keyway form	24.2	
JD 60	1. JD 60	Keyway form	26.7	

JG	1. PZ60(rice transplant) 2. T954(tractor)	36	14.75	
K	1. Belarus MTZ 824, 1204	36	17.6-17.75	
W	1. LOVOL (1304, 900, 904, 654, 1204, 1504, 800) 2. DEUTZ (904, 454, 604, 704, 804, 1204, 1604, 1654)	36	18.3-18.7	
T	1. KUBOTA models M704K, 954 2. YANMAR rice transplanters	36	15.45	