SingularXYZ®

SAGRO150

Automated Steering System

User Manual

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Your feedback on this manual will help us improve it with future revisions.

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Chapter 1 Introduction

1.1 Overview

The SingularXYZ SAgro150 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 includes a control tablet integrated with a high-precision GNSS board, a steering wheel motor with a built-in controller, and 2 IMU, etc. 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 Electric Motor Wheel, a SA100 GNSS antenna, 2 gyroscopes and other accessories and cables, see below table for the packing list. The system needs external power source from vehicle or independent power supply.

The antenna is installed on the top the vehicle, the front wheel IMU is installed on steering tire of the vehicle, the tractor cab IMU is installed on the tractor cab. The motor wheel is installed to replace the original steering wheel, and the tablet is installed beside the motor wheel for monitoring purpose.

Major parts in Sagro150 Automated Steering System

Packing list:

No.	Name	Quantity	Figure	No.	Name	Quantity	Figure
1	T10 GNSS Tablet	1		13	Dual-Gyro Cable	1	
2	SA100 GNSS Antenna	1		17	Tablet Accessories	1	
3	Main Transmission Cable	1		19	Power Switch	1	
4	Power Cable	1		20	4G Antenna	1	
5	GNSS Antenna Cable	1		21	External Radio	Option	
6	RAM Bracket	1		22	Radio Cable	Option	
7	Antenna bracket	1		23	Radio Antenna	Option	
8	SEM2 Electronic Motor	1		24	Radio Configuration Cable	Option	
9	Motor Bracket (According to the tractor type)	1		25	Auto-Steering Switch	Option	
10	Steering Wheel	1		26	Switch Cable	Option	
11	Spline Sleeve (According to the tractor type)	1		27	Camera	Option	
12	Gyroscope	2		28	Camera Cable	Option	

Note:

1. The front wheel IMU of SAgro150 is type P, which is same with the SAgro100 dual-gyro. But the tractor cab IMU of SAgro150 is type AG, it is different with the SAgro100 dual-gyro.

2. The 2 IMU are both different with the IMU of old version, please do not mix the old version of IMU with the dual-gyro version of IMU.

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 Attachment I T10 GNSS Tablet. The outlook of T10 GNSS Tablet is shown as below.

T10 GNSS Tablet

1.3.2 SA100 GNSS Antenna

SA100 GNSS antenna is used to receive the RF signal from the satellites. There is one antenna in the package. The detailed specification of this antenna refers to section Attachment II SA100 GNSS Antenna.

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

SA100 GNSS Antenna

1.3.3 SEM2 Motor Wheel

The SEM2 Motor Wheel is an electric motor steering wheel. It is designed for easy-to-install operation. With high-torque, direct-drive electric motor, SEM2 can provide up to 2.5cm RTK accuracy. The detailed specification of this motor wheel refers to section Attachment III SEM2 Motor Wheel.

SEM2 Electric Motor

Chapter 2, Installation

2.1 Antenna Installation

The SA100 antenna should be mounted on the central axis of the tractor. The single antenna should connect to the ANT1 port in the back of tablet.

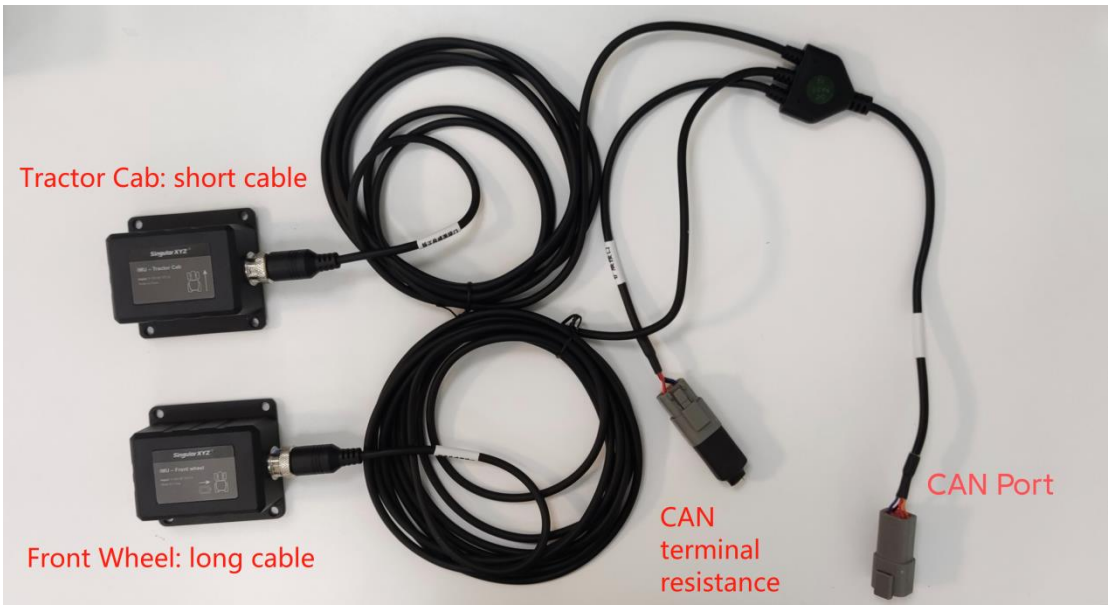
Single antenna installation

2.2 Installation of Dual-Gyroscope

The connection of the dual-gyro part is shown as follows, the two gyroscopes are different and they are connected to the specific ports. The front wheel IMU is connected to the longer IMU cable, and the tractor cab IMU is connected to the shorter IMU cable. The CAN terminal resistance is connected to the shortest cable. And the last

cable is connected to the ***CAN port*** on the main transmission cable. The cable port of the front wheel IMU should orient to the tractor body, and the port of the tractor cab IMU should orient to the ***right side*** of the tractor.

Note: The CAN terminal resistance should be connected otherwise the Dual-Gyro Sensor status will be wrong.



Dual-gyro Connection

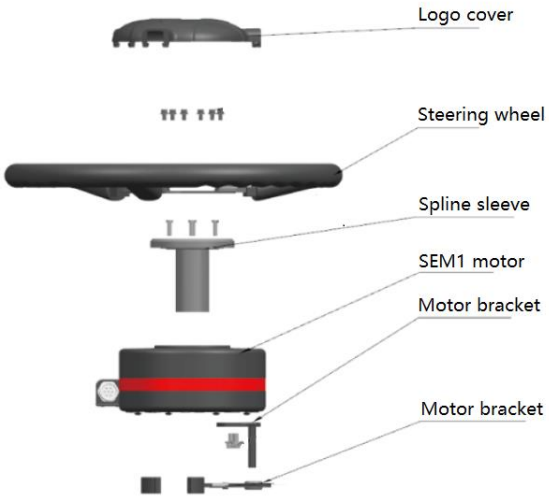
Front Wheel IMU Installation

Tractor Cab IMU installation

Note: Please use screws or double-sided tape to fix the IMU strictly, otherwise you may not able to initialize the IMU.

2.3 SEM2 Installation

The SEM2 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.



Assembly diagram of SEM1/SEM2 motor wheel

The detailed steps of installing SEM2 Motor Wheel are shown as below.

1) Fix the spline on the motor.

Spline fixing

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

Steering wheel fixing

3) Fix the motor bracket on the motor bottom

Motor bracket fixing

4) Remove the original steering wheel from the tractor and fix the SEM2 motor exterior via the motor bracket.

Motor bracket fixing

Motor exterior fixing

5) Fix the SEM2 motor on the steering shaft.

Motor shaft fixing -1

Motor shaft fixing -2

6) Install the steering wheel cover.

Steering wheel cover fixing

7) Now the installation of SEM2 Motor Wheel is completed. It should be connected to the main cable after all parts are assembled properly. The cables connection refers to section Cables Connection.

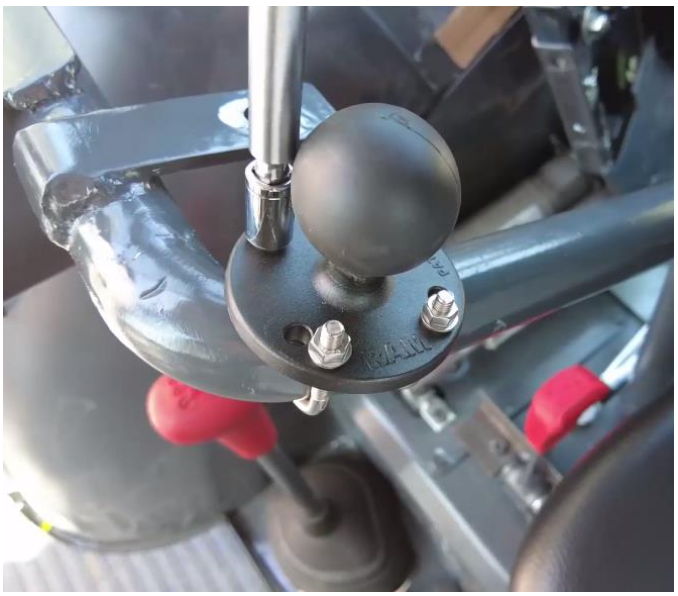
2.4 T10 Tablet Installation

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.

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.



Tablet installation-1

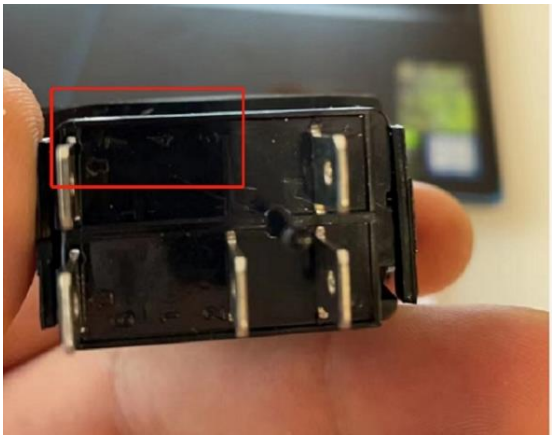
Tip: If there is no appropriate handrail in the cab, self-tapping screws can be used to secure the RAM ball in a convenient location.

2.5 Switch Connection

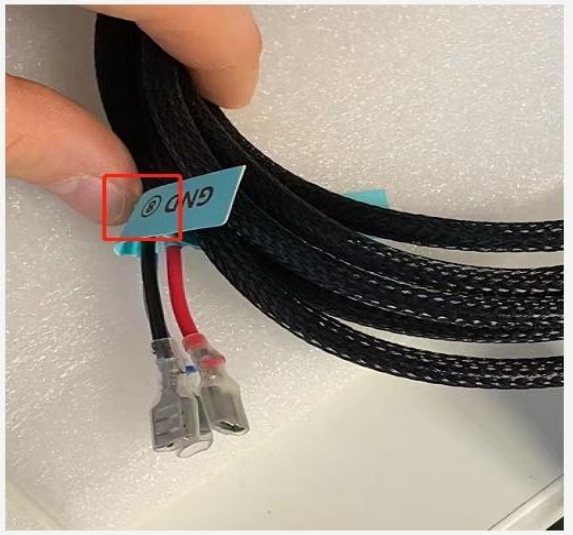
This is the switch of the auto-steering function, click to turn on/off the auto-steering function. And the cable is connected the switch to the PORT 3 of the tablet.

Switch

Switch Cable

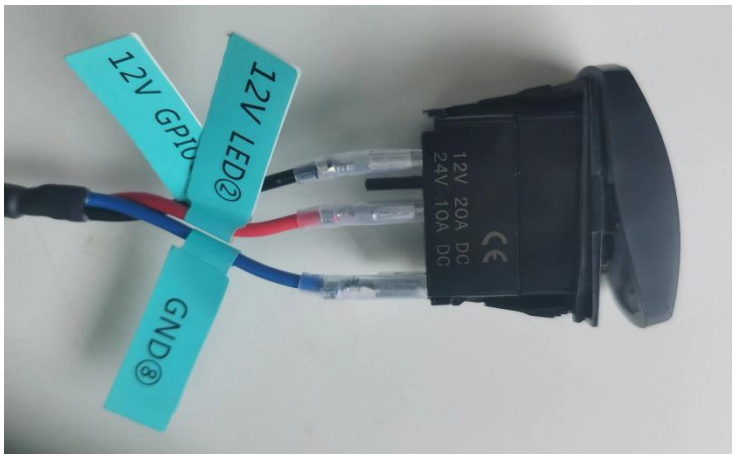


Number On The Switch



Number On The Switch Cable

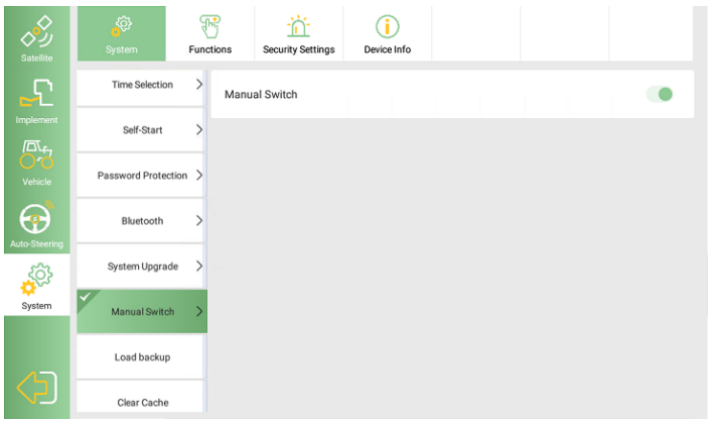
Then connect cables and switch, they all have numbers on them.



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.



Open The Foot Brake Control

click to turn on the auto-steering

2.6 Power Switch Installation

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

Power switch installation

2.7 Camera Installation

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

Camera installation

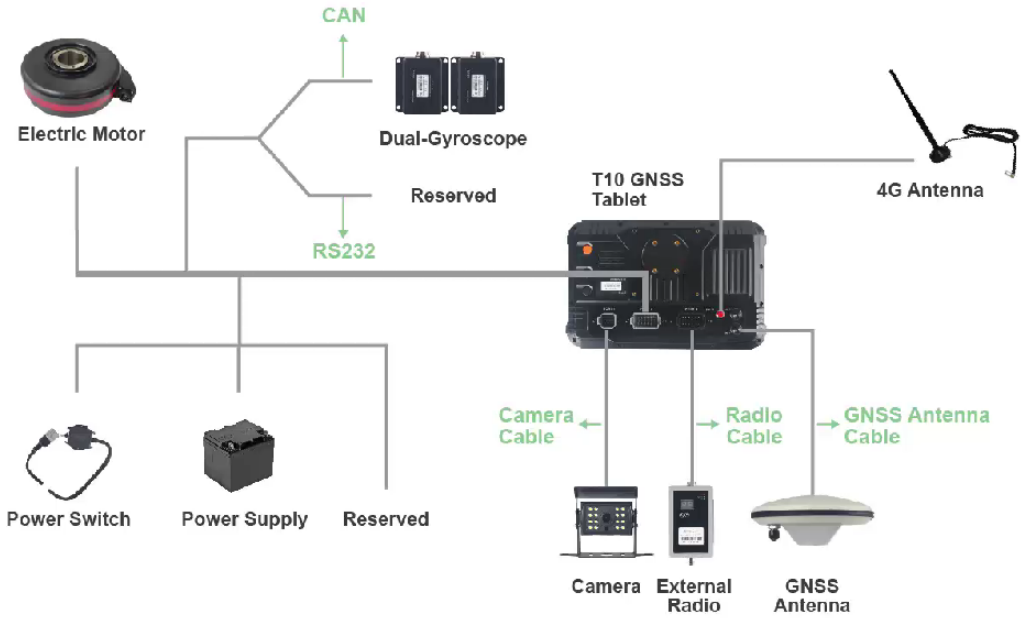
2.8 Cables Connection

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

Main Cable with multiple connectors

The cable connection of SAgro100 system is shown in figure below. 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.



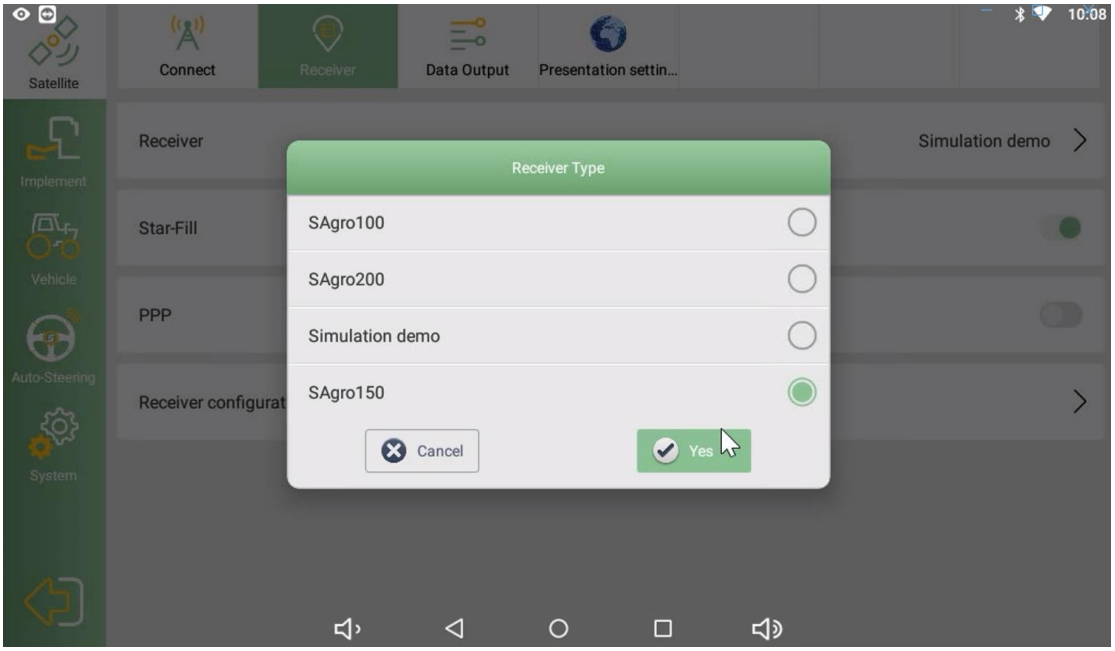
Cable Connection Diagram

Chapter 3 Configuration

3.1 Receiver Type

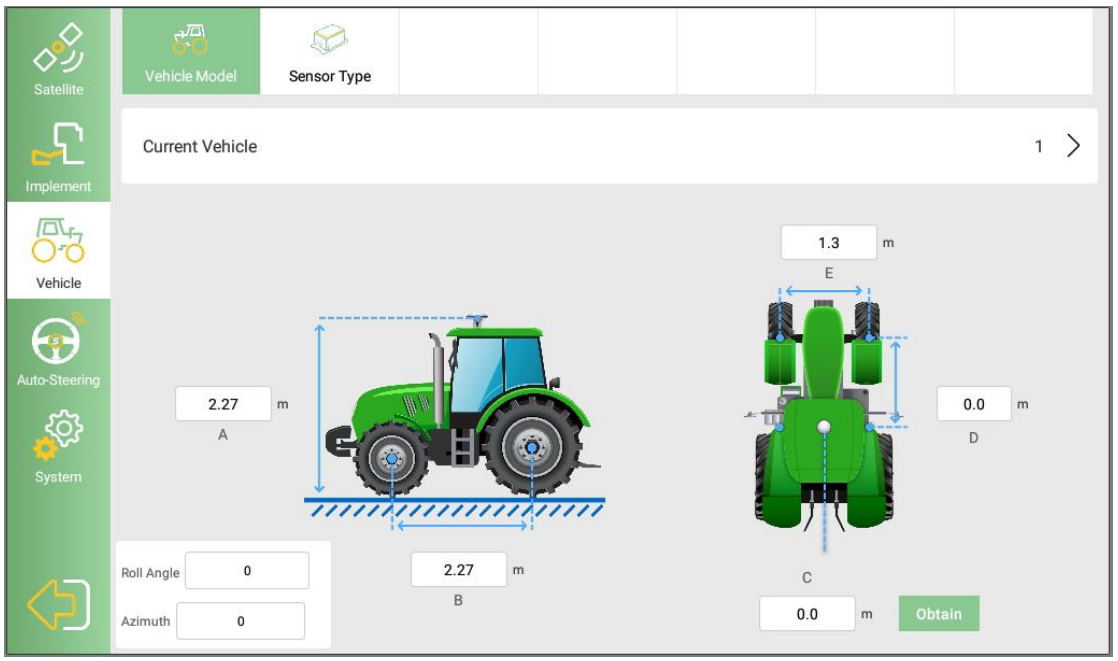
If your software version is older than 194.25, please choose the Receiver Type as ***T10 (single antenna)***

If your software version is newer than 194.25, please choose the Receiver Type as ***SAgro150***



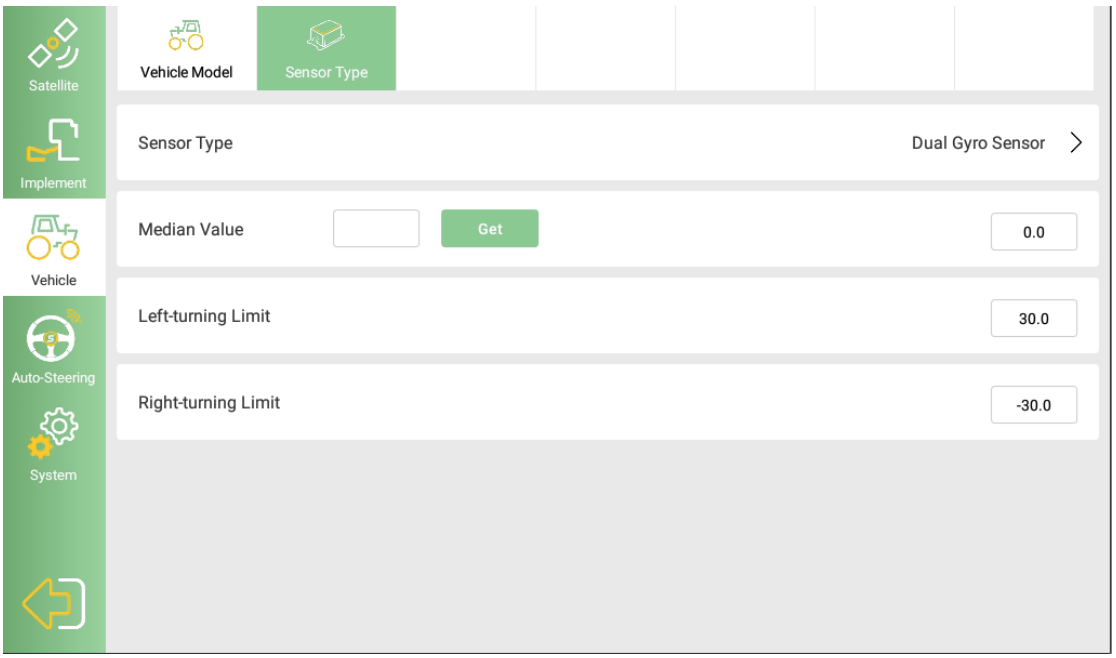
3.2 Implement and Vehicle parameter

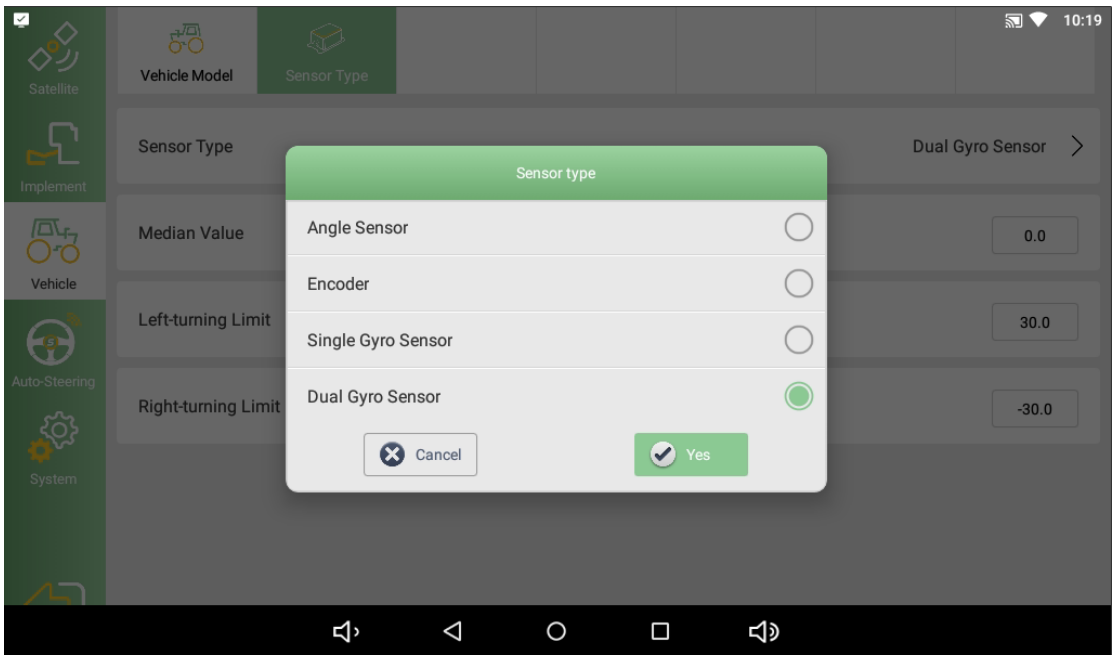
Please set the vehicle parameter.



3.3 Sensor Type

Change the sensor type to Dual Gyro Sensor.





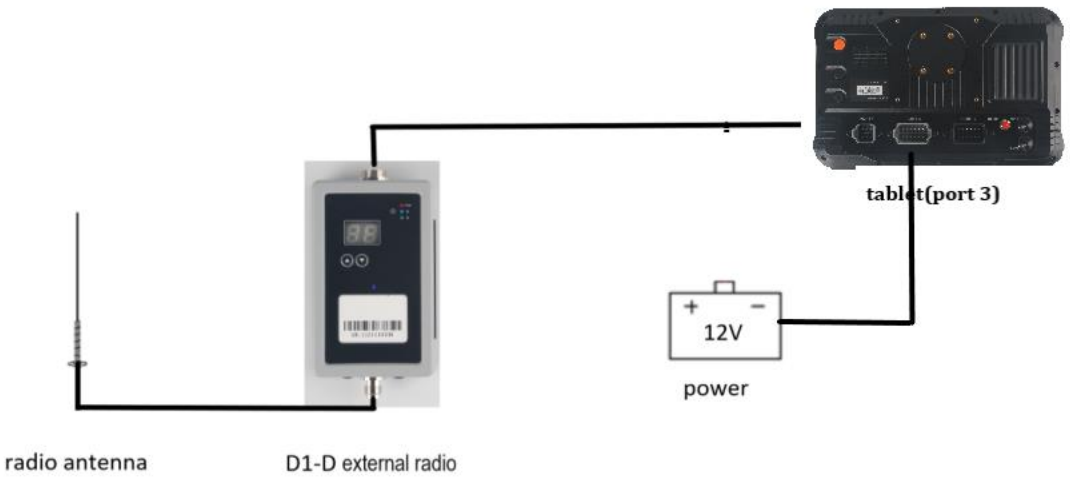
Return to the main interface and perform a self-check in the Status, the Dual Gyro Sensor should be normal.

3.4 Connect to Base Station

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 four modes.

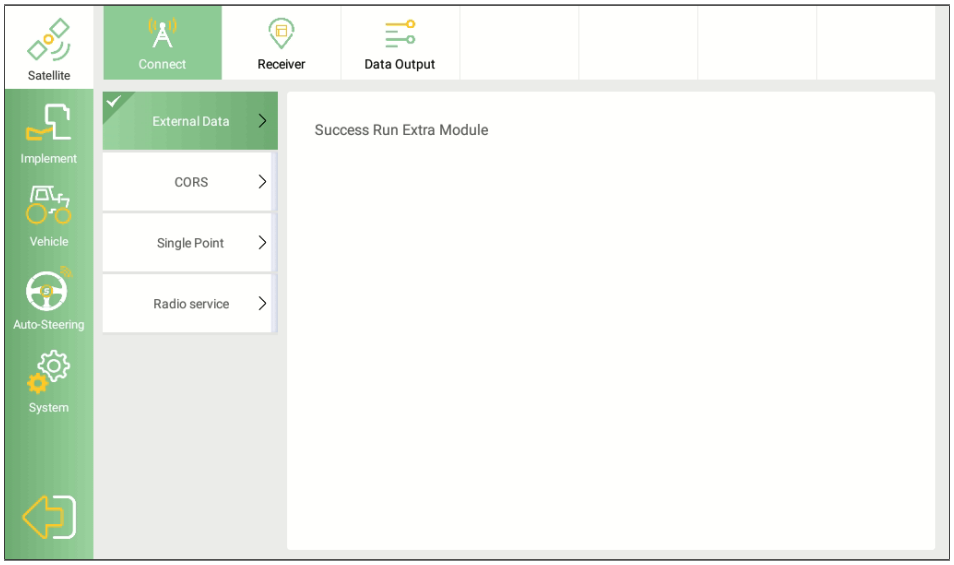
1) External Data Mode

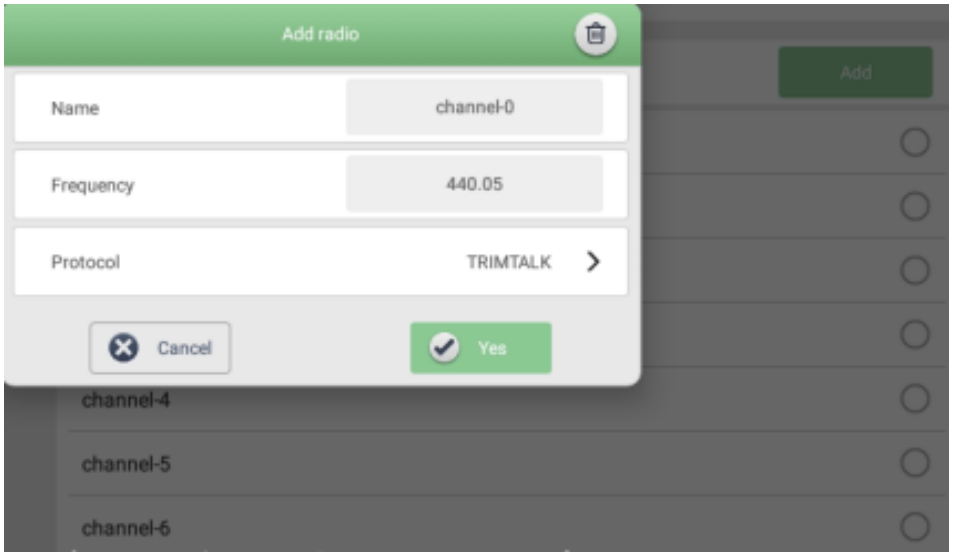
We have two types of external radio, D1-D and D1-L, which works with different radio base station. You need to connect external radio to port 3.



Then go to System >> Satellite >> Connect >>External Data interface, wait a few seconds it will run the extra module successfully, you should click the channel to configure the frequency and protocol, and click

the button in the right side to apply the setting. And then go to the DL model choose the channel.





External Data

The default transport protocol is TRIMTALK, click buttons to switch radio channel up and down.

External Radio

① Indicators: 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)

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

③ Buttons: Click buttons to switch radio channel up and down.

④ Trademark: one of the protocols of D1-D external radio, also it supports TRIMTALK, TRIMMK, TT450S, TRANSEOT.

2) CORS Mode

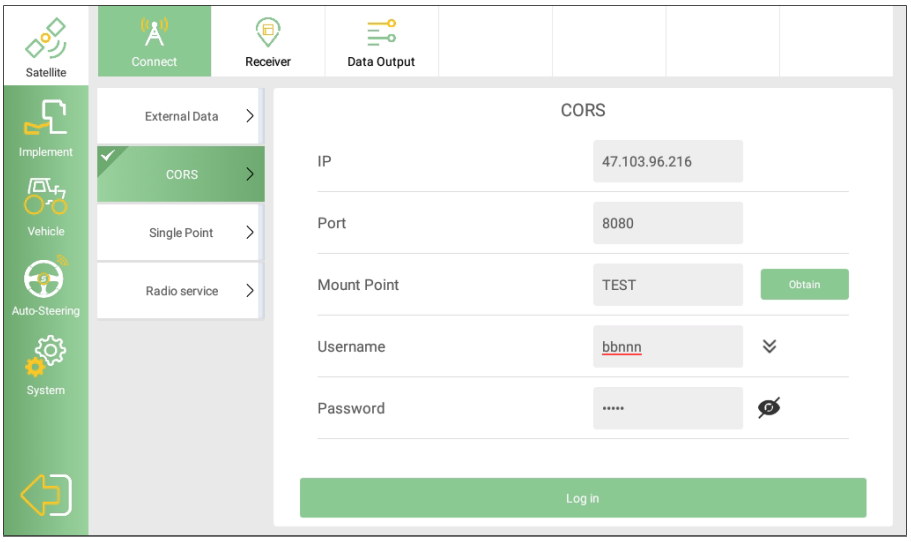
Insert the SIM card on the left side of T10 tablet.

SIM card slot

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

Network status

Go to System >> Satellite >> Connect >> 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.



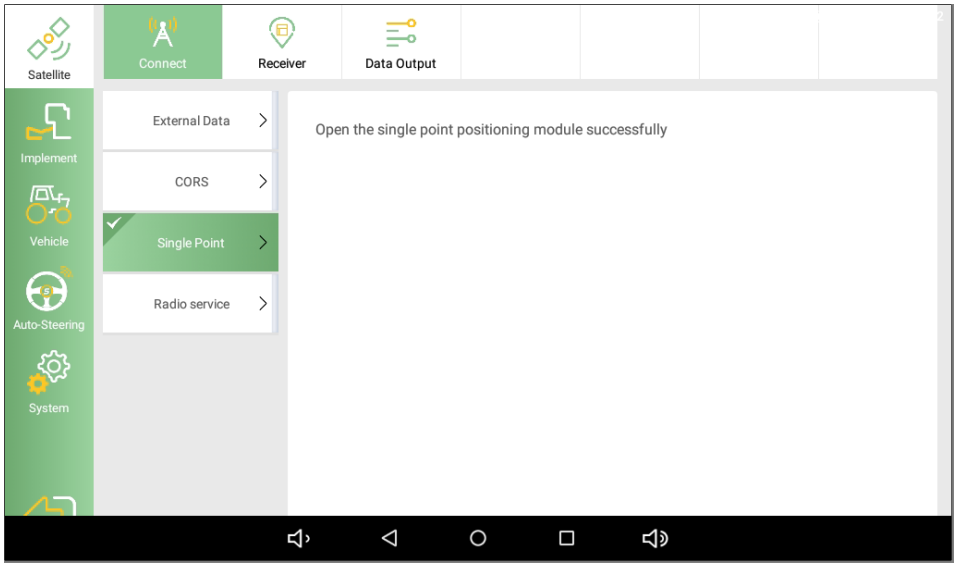
CORS connection

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.

RTK status

3)Single point

This mode no need to connect to base station, so it cannot reach a centimeter-level accuracy, the biggest accuracy is about 20 centimeters.



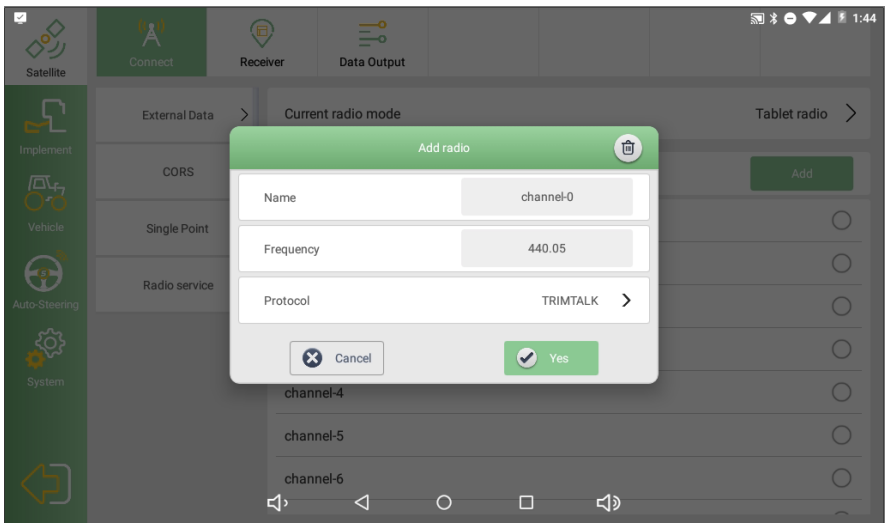
Single point

4)Radio Service Mode

The tablet is equipped with internal radio, you can use it to connect with Base.

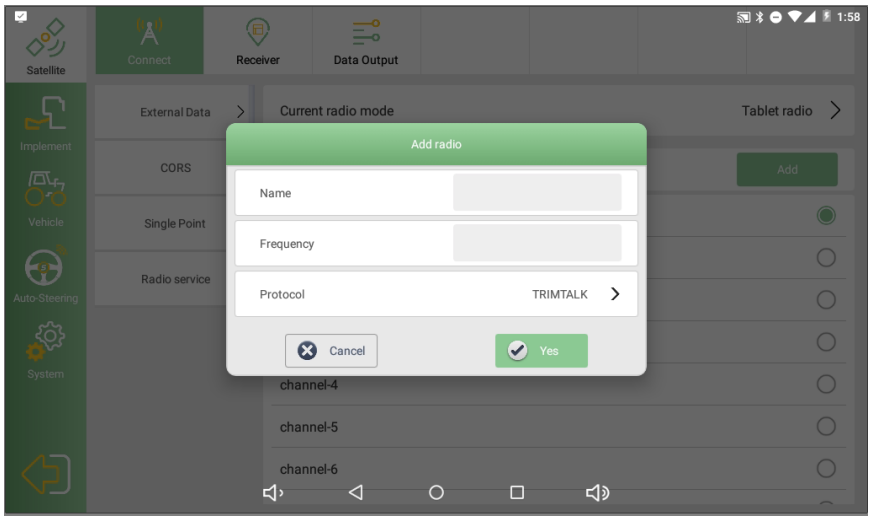
Go to System >> Satellite >> Connect >> Radio Service Interface. Choose Tablet radio option in Current radio mode.

There are already some channels for you to use. The default transport protocol is TRIMTALK. You need to set the frequency and protocol same as your radio base station. Then click the circle on the right to log in.



Radio Service

You can also add a channel by yourself. Click Add button and then input name, frequency and protocol of the channel.



Add channel

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.

RTK status

3.4, Auto-steering parameter

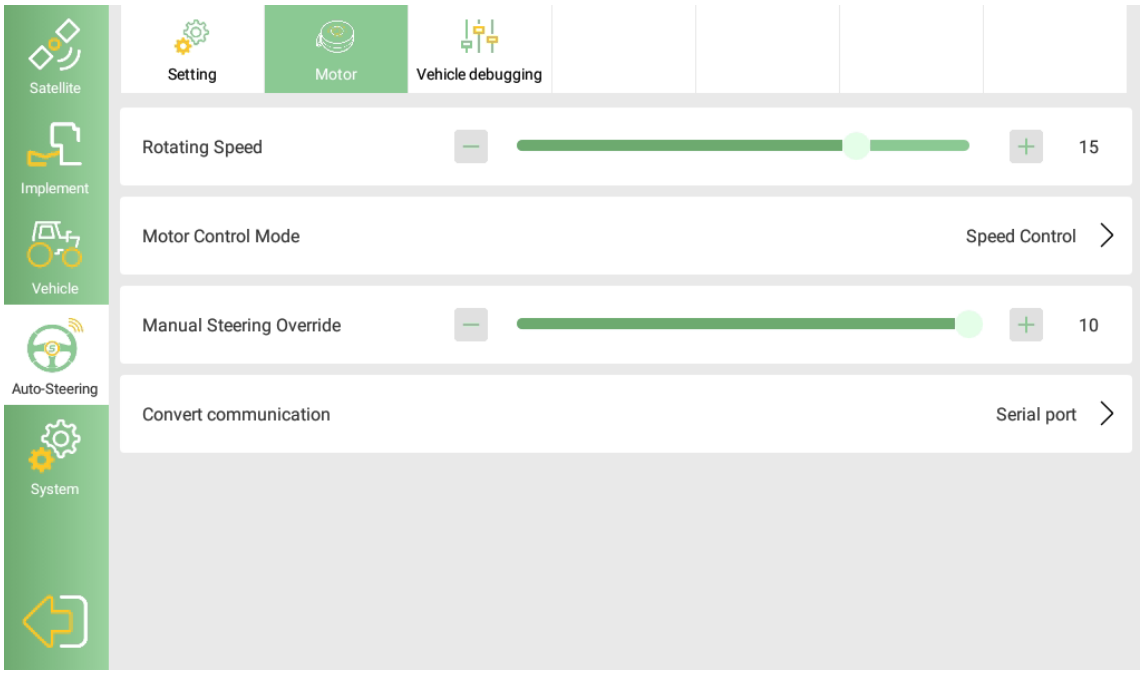
The auto-steering parameter settings method is same with the angle sensor mode.

Got to System>>Auto-Steering, enable the Fixed mode. The other 2 options, lateral slope compensation and auto

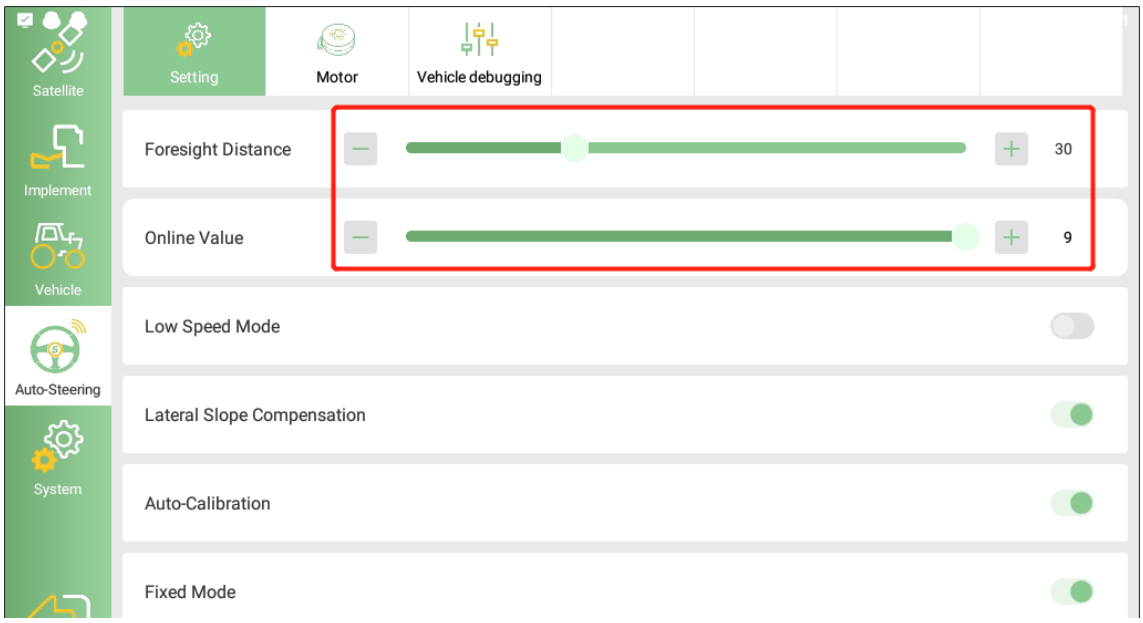
calibration, they don’t necessarily have to be opened, we should choose based on the actual scenarios. Choose the Control mode as Mode 2.

You should keep the motor setting as default, the Motor Control Mode is Speed Control, The Convert Communication is ***Serial port***.

Note: Please do not change the Motor Convert communication to CAN!



You should set the Foresight Distance based on different speeds and adjust it according to actual performance.



If you will use the speed as 5km/h, you need to set foresight distance around 20

If you will use the speed as 10km/h, you need to set foresight distance around 30

If you will use the speed as 15km/h or higher, you need to set foresight distance around 40 or higher

After it is set, you should do auto-steering for the first time to check the performance, if it appears small and continuous S curve, you should increase the foresight distance 5-10 at a time and drive again to check. If it is too slow to fix the deviation, you should reduce the foresight distance appropriately.

For online value, usually we use the default value.

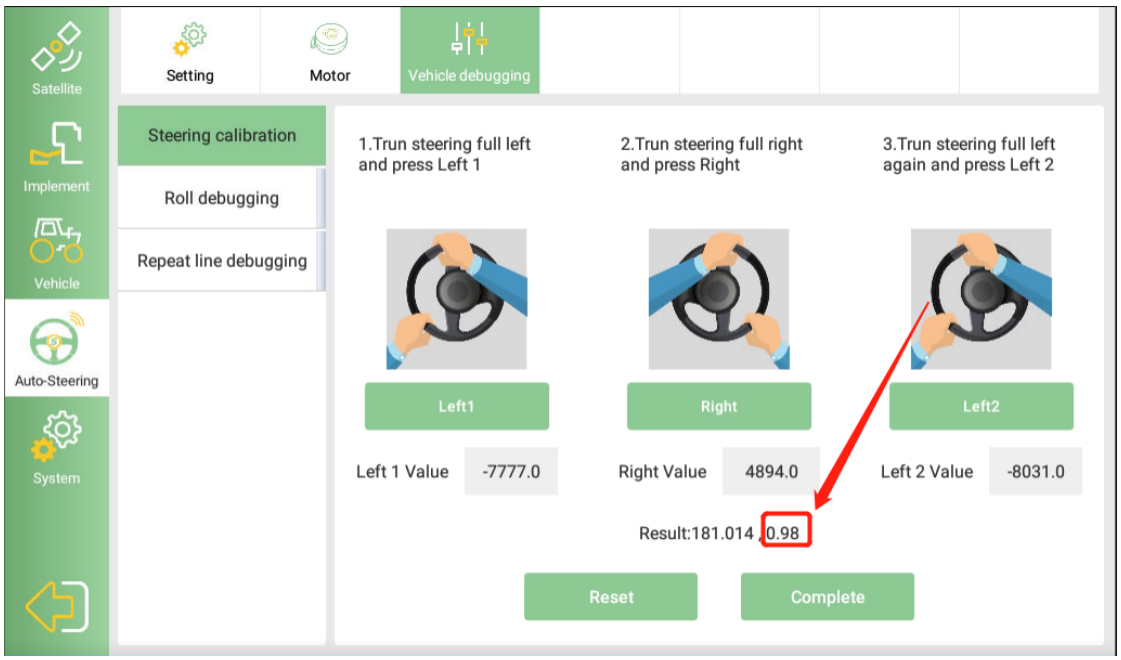
Chapter 4 Calibration

It will prompt to ask you to calibrate the IMU when you enter into the main interface, the method is to ***drive forward a few meters*** at a low speed, it is very simple. After calibration, the prompt will disappear, you can start the auto-steering.

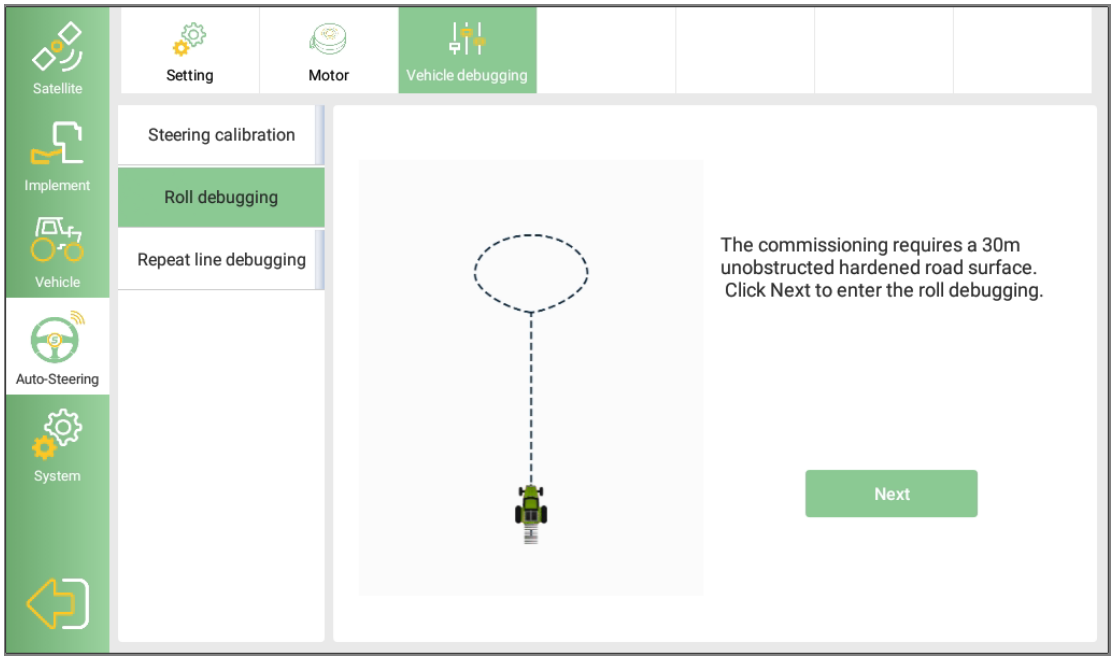
4.1 Vehicle debugging of single gyro mode

You need to do 3 calibrations for single gyro mode: Steering calibration, Roll debugging, Repeat line debugging.

Go to system >> auto steering >> vehicle debugging, start to do steering calibration. Follow the steps. When you complete, you need to make sure the result value is around 1. Value 0.9 to 1.0 is fine.

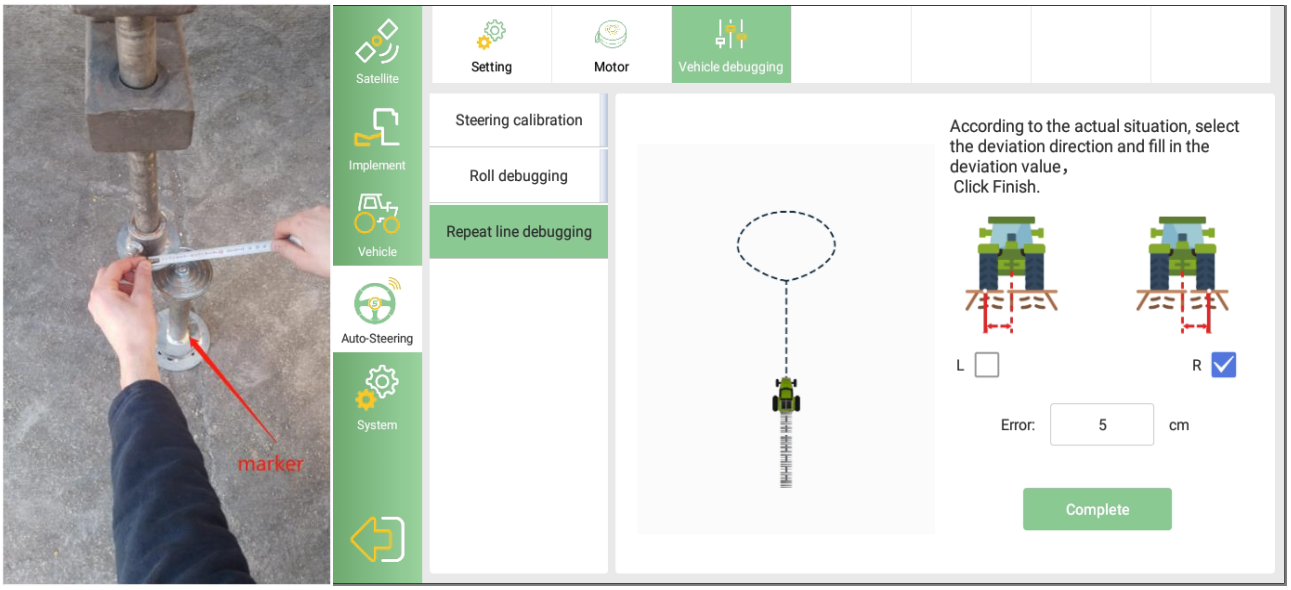


Then do the roll debugging.

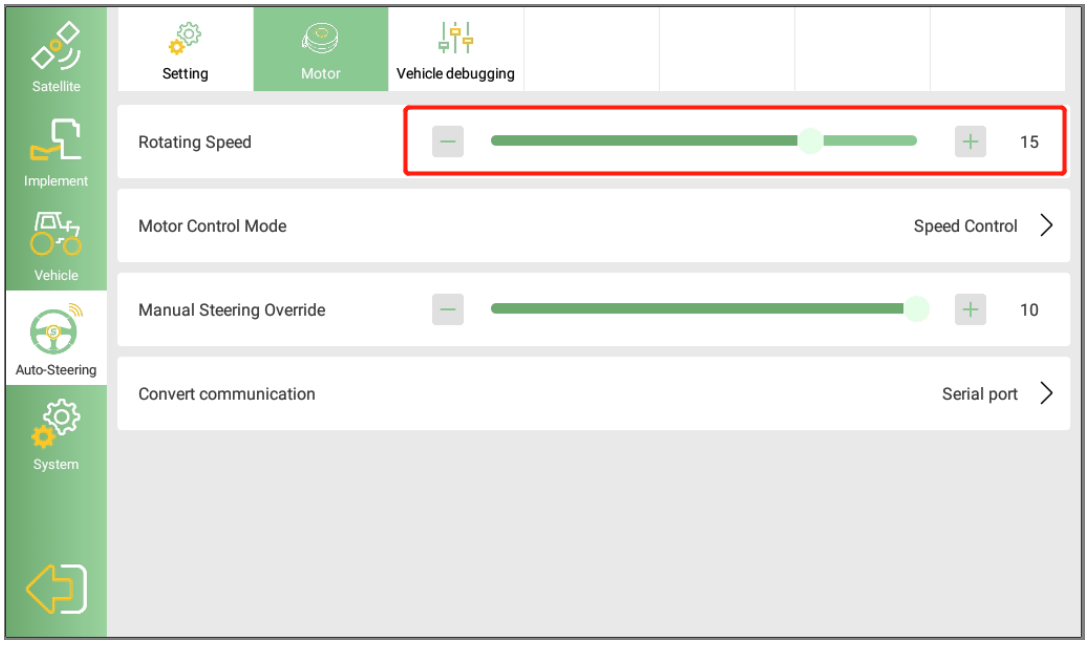


Note: when you step 2 and step 3 for roll debugging, please stop in the red frame and wait collection finish, then drive.

Finally, do repeat line debugging, when you finish it, measure the distance between the marker and your vehicle. Enter the result and click complete.



Finally, test the performance of it. If you find when your speed get higher, the offset change to bigger sometimes. You can system>> auto steering>>motor and adjust rotating speed. When you choose a higher speed, it should be reduced appropriately.

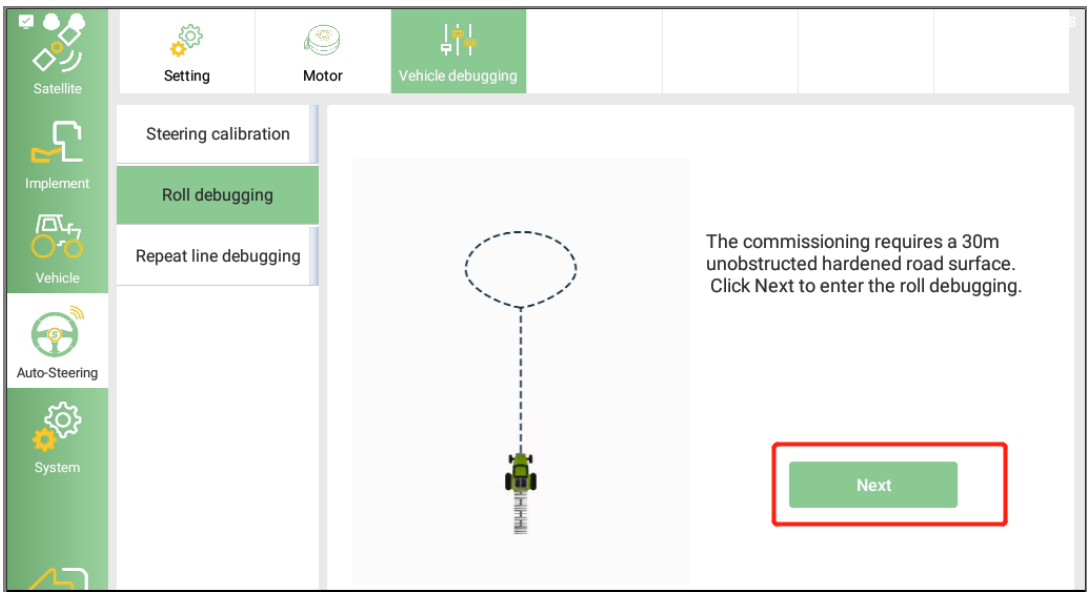


4.2 Vehicle debugging for Dual gyro mode

You only need to do 2 calibrations for dual gyro mode: Roll debugging and Repeat line debugging.

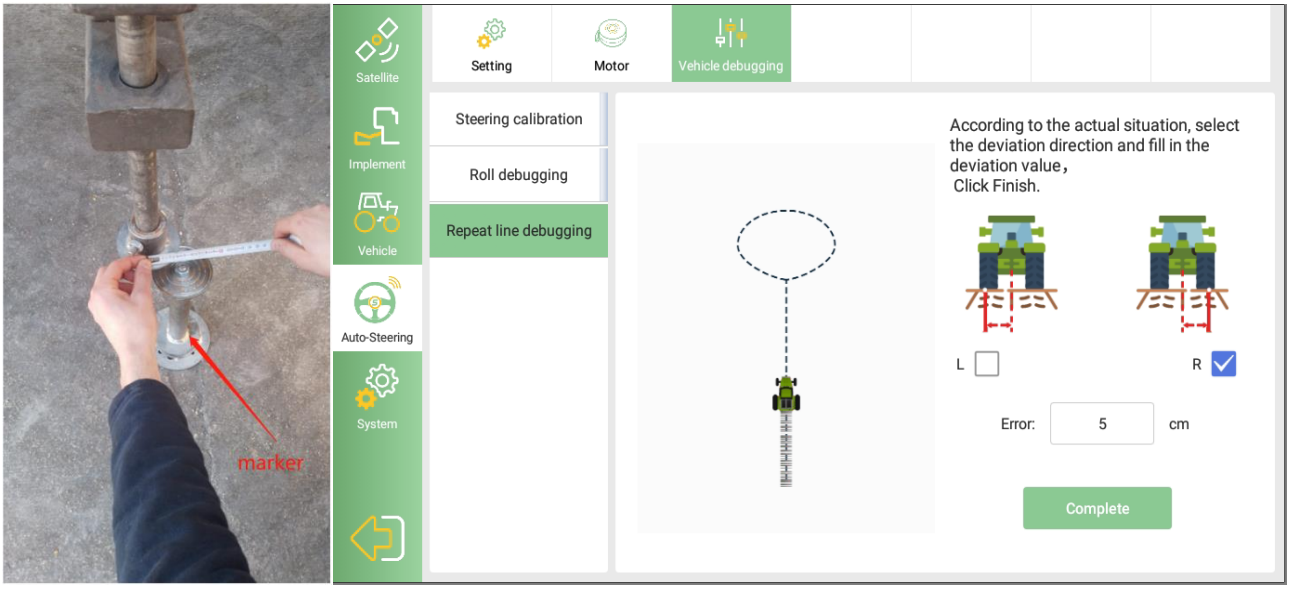
Go to system >> auto steering >> vehicle debugging, start to do steering calibration. You don't need do steering calibration, just roll debugging and repeat line debugging.

First do the roll debugging.



Note: when you step 2 and step 3 for roll debugging, please stop in the red frame and wait collection finish, then drive.

Then do repeat line debugging, when you finish it, measure the distance between the marker and your vehicle. Enter the result and click complete.



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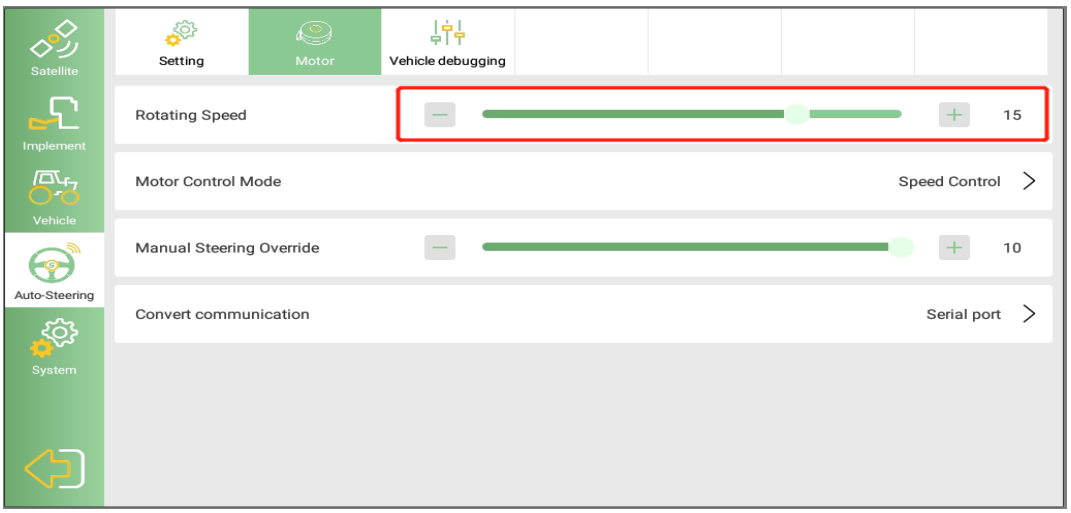


Chapter 5 Start Auto-steering

Now you have finished the setting and ready for auto-steering, please create a new AB line and click the auto-steering button in the main interface to start the auto-steering.

Attachment I: T10 GNSS Tablet

T10 GNSS Tablet Specifications

GNSS Performance		
Signal Tracking	GPS L1C/A, L2P (Y), L2C, L5 GLONASS G1, G2 BDS B1I, B2I, B3I GALILEO E1, E5a, E5b QZSS L1, L2, L5 SBAS L1	
GNSS Channels	1408	
Position Accuracy	DGPS Positioning	0.4m (Horizontal)
		0.8 (Vertical)
	RTK Positioning	8 mm+1ppm (Horizontal)
		15 mm+1ppm (Vertical)
Heading Accuracy	0.1° RMS @ 1m baseline	
Time Accuracy	20ns RMS	
Velocity Accuracy	0.03m/s RMS	
Reacquisition	< 1s	
Correction	RTCM 3.X	
Date Output	NMEA-0183	
Heading and RTK update rate	Maximum 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 *2 (J1939, CANOpen, ISO15765)
Ethernet	RJ45 (100M Ethernet) x1
Electrical	

Power Input	9V~36V DC
Power Consumption	⩽4.5W
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

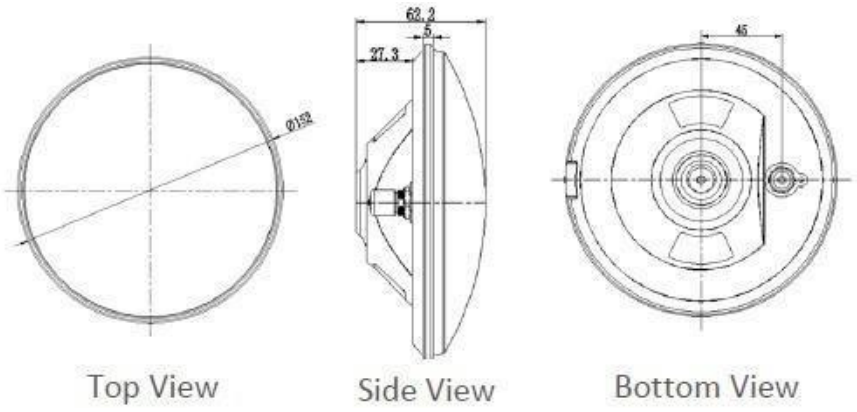
Attachment II: SA100 GNSS Antenna

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	



Attachment III: SEM2 Motor Wheel

SEM2 Motor Wheel Specifications

Motor Performance	
Rated speed	100 rpm
Rated torque	9 N*M

Control mode	Speed Mode, Position Mode
Electrical	
Rated voltage	12 VDC
Voltage range	9 ~ 36VDC
Rated current	10 A
Stall current	25A
Communication	
Interface	RS232, Analog to Digital conversion
Protocol	ModBUS
Physical	
Dimension	Φ181.5mm*60.4mm
Weight	2.8 kg
Material	Aluminum alloy
Environmental	
Operating temperature	-20°C - +70°C (motor)
Storage temperature	-40°C - +85°C (motor)
Environmentally	IP67 dustproof and waterproof

Attachment IV: Typical Applications

The typical applications using SAgro150 automated steering system:

- Spraying Pesticide

- Harvesting

- Sowing

- Plowing
- Transplanting

Attachment V: Spline Sleeve

The available spline sleeves are listed in below table. 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.

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) 3.DEUTZ 370	36	18.3-18.7	
T	1. KUBOTA models M704K, 954 2. YANMAR rice transplanters	36	15.45	