

User Manual

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User Manual

For AG960 AutoSteer System

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1 General Description

This user manual provides description relating to the installation, commissioning, operation and maintenance of AG960 AutoSteer System (as “AG960” for the following) for agriculture machine. Appropriate operation and maintenance is vital to the safe and reliable operation of the system.

It is important to take some time to read this manual thoroughly. The information in this manual is current at the time of printing while the system may have slight changes. Information and related materials are subject to change without notice.

2 Introduction of AG960 AutoSteer System

AG960 AutoSteer System (“AG960”) is designed for precision agriculture and machinery. It takes advantage of the Global Navigation Satellite System (GNSS) differential technology, acquiring the position information of the agricultural machines within centimeter level, controlling the guide wheel of agricultural machines through electromagnetic hydraulic valve. As a result, agricultural machines can achieve automatic operation along the planned route. AG960 can be installed to small, medium and large farming vehicles with hydraulic power steering system, such as tractor, harvester, sprayer etc. It will enhance the operators’ work, improve the operation accuracy and efficiency and reduce the working intensity of operators.

AG960 need to be used together with the GNSS reference station or GNSS CORS network.

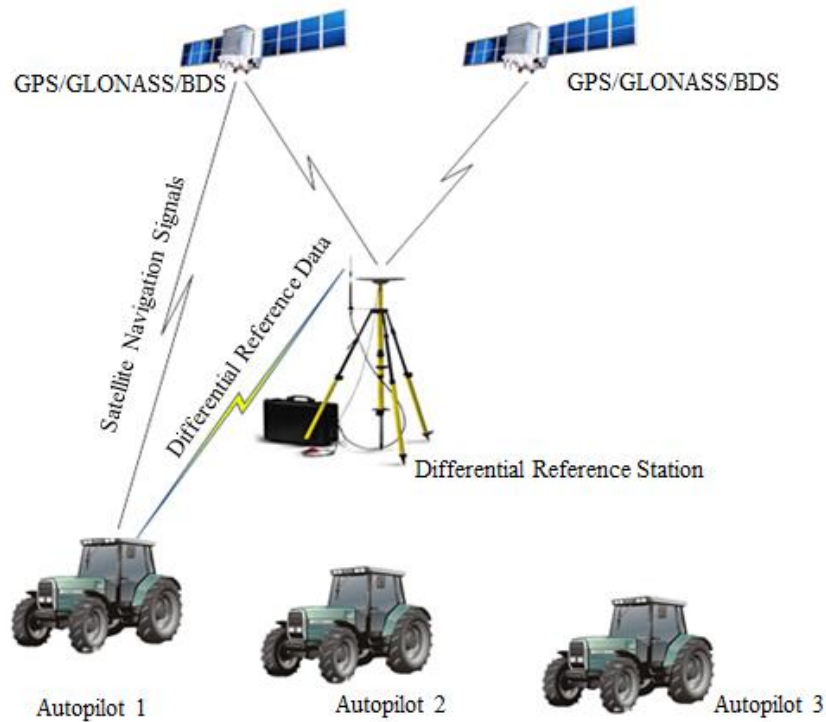


Figure 1 Autopilots Work with GNSS (GPS/GLONASS/BDS) and Differential Reference Station

During the operation, GNSS reference station broadcasts the satellite reference observation data via the data transceiver, and the autopilot precisely calculates the position and speed of itself with GNSS satellite signal and reference station signal received. Following the specified operation route, autopilot drives the electro-magnetic hydraulic valve to realize the guidance of wheel movement and operation route auto-tracking of the agricultural vehicles. For a single GNSS reference station, it can serve as many autopilots as required at the same time. However, the work area it may serve depends on the radio transmitting power of the reference station. In case of portable reference station, the work area usually is within 3km, while in case of stationary reference station, the work area can be up to around 20km (The work area will be reduced accordingly when there is windbreak and unfavorable topography between the reference station and agriculture machines in work).

This user manual introduces the components, installation, commissioning and operation of AG960 as well as the daily maintenance and troubleshooting for common issues of the system.

3 Components of AG960

3.1 Product List

AG960 AutoSteer System (“AG960”) package is as shown below.



Figure 2 Outlook of AG960 AutoSteer System (“AG960”) package

Parts and components included in the package are listed in the table below.

Table 1 AG960 AutoSteer System (“AG960”) unpacking list

Item	Description	Qty.	Remarks
1.	Satellite navigation antenna	2 pcs.	Including pedestal and double faced adhesive tape
2.	Radio receiving antenna mast	1 pcs.	
3.	Radio receiving antenna pedestal	1 pcs.	Including RF cable and double faced adhesive tape
4.	Autopilot (Controller)	1 unit	
5.	Panel computer	1 unit	
6.	Electro-magnet hydraulic valve	1 pcs.	Open center/ closed center
7.	CVB module	1 pcs.	Optional for closed center system
8.	Coaxial rotation direction sensor	1 pcs.	
9.	3m RF cable	2 pcs.	
10.	Drive harness (black end harness)	1 pcs.	Optional for 3.5m/4.5m
11.	Data harness (white end harness)	1 pcs.	

12.	Autopilot (Controller) adapter plate	1 pcs.	
13.	Panel computer bracket	1 pcs.	
14.	Coaxial rotation direction sensor bracket	1 set	Flanged base, stop frame, anchor ear, rubber strip
15.	Hydraulic valve adapter plate	1 pcs.	
16.	Hydraulic transit joint bag	1 bag	
17.	Screws & nuts bag	1 bag	
18.	3M double faced adhesive tape	1 set	
19.	Insulating tape	1 pcs.	
20.	Strapping tape	Several	
21.	Operation manual	1 pcs.	
22.	Product quality certificate	1 pcs.	

Outlook of actual parts and components are given below.



Figure 3 Outlook of GNSS antenna



Figure 4 Outlook of radio antenna



Figure 5 Outlook of navigation autopilot



Figure 6 Outlook of panel computer



Figure 7 Outlook of electromagnetic hydraulic valve



Figure 8 Outlook of CVB module (optional for closed center system)



Figure 9 Outlook of coaxial rotation direction sensor



Figure 10 Outlook of 3m RF cable



Figure 11 Outlook of data harness (white end harness)



Figure 12 Outlook of drive harness (black end harness)



Figure 13 Outlook of Autopilot (Controller) adapter plate



Figure 14 Outlook of panel computer bracket



Figure 15 Outlook of hydraulic valve adapter plate

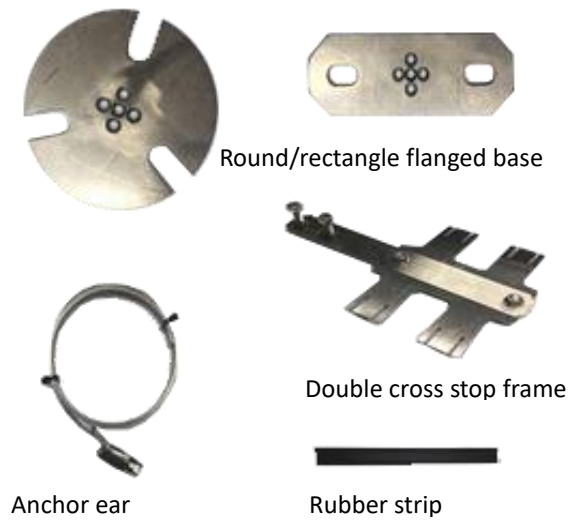


Figure 16 Outlook of coaxial rotation direction sensor bracket

3.2 Electrical Connection Relation

AG960 has an electric connection relation with the vehicle as shown in the figure below.

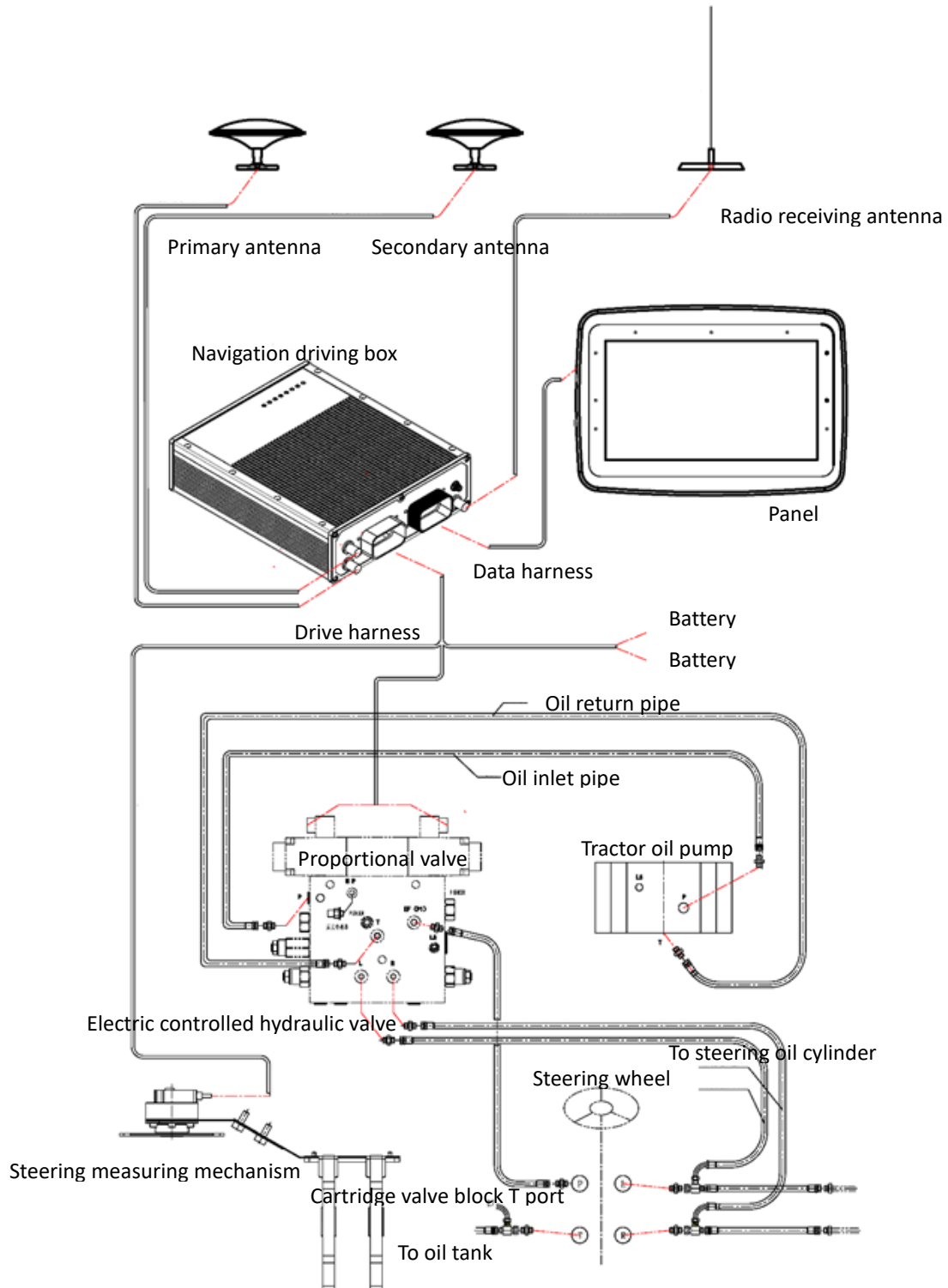


Figure 17 Electro-mechanical connection drawing of AG960 (open center system)

The electro-mechanical connection relation of AG960 is explained below.

- 1) The primary antenna of the satellite navigation antenna is connected to the “GNSS primary antenna” port of the front panel of navigation autopilot through a 3M RF cable.

- 2) The secondary antenna of the satellite navigation antenna is connected to the “GNSS secondary antenna” port of the front panel of navigation autopilot through a 3M RF cable.
- 3) The radio receiving antenna is connected to the “radio antenna” port of the front panel of navigation autopilot through a 3M RF cable.
- 4) Each end of the data harness (white end harness) is respectively connected to the Autopilot (Controller) and the panel computer.
- 5) One end of the drive harness (black end harness) is connected to the Autopilot (Controller) and the other end is divided into three lines each of which is respectively connected to vehicle battery, electromagnetic hydraulic valve and steering measuring mechanism.

4 Installation of AG960

In this chapter, it takes Dongfanghong (a tractor brand name) 904 tractor (open center type, medium-duty), John Deere 904 tractor (open center type, medium-duty) and Case 210 tractor (closed center type, heavy-duty) as examples to describe the process of installing the AG960 onto the agricultural vehicles.

The process of installing AG960 can be divided into 4 steps:

- 1) Install electronic components
- 2) Install the steering measuring mechanism
- 3) Install the hydraulic valve group
- 4) Lay the harness

Step 1, 2 and 3 has no specific order and can be completed by different installation personnel at the same time before laying the harness as step 4.

Tools required for the installation of AG960 are listed in the table below.

Table 2 Tools required for installing AG960

Item	Description	Spec.	Qty.	Remarks
1.	No-adjustable wrench		1 set	
2.	Adjustable wrench		2 pcs.	
3.	Inner hexagon spanner (Metric system)		1 set	
4.	Inner hexagon spanner (Imperial system)		1 set	

5.	Phillips screwdriver (large)	1 pcs.
6.	Phillips screwdriver (small)	1 pcs.
7.	Straight screwdriver (large)	1 pcs.
8.	Straight screwdriver (small)	1 pcs.
9.	Diagonal pliers	1 pcs.
10.	Pincer pliers	1 pcs.
11.	Sharp-nose pliers	1 pcs.
12.	Measuring tape	1 pcs.
13.	Pistol drill	1 set
14.	Cutting machine	1 set

4.1 Installation of Electronic Components

To install electronic components, the agricultural machines should be placed on a level plane, for example, flat cement surface or road surface. If it stops on an inclined ground, error may occur in terms of the installation position and orientation measurement of products on the vehicles and thus affect the autopilot performance.

The process of installing electronic components of AG960 can be divided into the following 4 steps.

- 1) Install satellite navigation antenna (including antenna pedestal, RF cable)
- 2) Install radio receiving antenna (including antenna pedestal, RF cable)
- 3) Install panel computer (including its bracket)
- 4) Install Autopilot (Controller) (including its adapter plate)

4.1.1 Installation of Satellite Navigation Antenna

AG960 contains two satellite navigation antennas installed to the left and right side at the top of the driving cab of the agriculture machine respectively, where the right antenna is the primary antenna responsible for acquiring vehicle position information and the left one is the secondary antenna responsible for acquiring vehicle orientation information.

The satellite navigation antenna is installed onto the vehicle according to the following procedures.

4.1.1.1 Position Requirement of Installing Satellite Navigation Antenna

Two satellite navigation antennas should be installed just above the rear axle of the vehicle as far as possible along the longitudinal direction of the vehicle, as shown in the figure below. If this is impossible due to the geometry of the top of driving cab or other structural constraints, the longitudinal distance from the satellite navigation antenna to the rear axle center of the vehicle should be accurately measured during the subsequent equipment commissioning process.



Figure 18 Electro-mechanical connection drawing of AG960 (open center system)

In the transverse direction, two satellite navigation antennas should be symmetrically installed to the edge of the driving cab top, as shown in the figure below. It is required that the distance between two antennas should be as large as possible, at least 1m. If 1m distance is not available at the driving cab top, antenna installation bracket should be fabricated.



Figure 19 Ideal position of satellite navigation antenna on the vehicle (rear view)

To install the satellite navigation antenna onto the driving cab top of the vehicle, it is required that the mushroom head of the antenna should be as level as possible to facilitate the receiving of satellite signal, as shown in the figure below. The RF connector of antenna should be orientated towards the inner side as far as possible to present a better appearance of the RF cable routing



Figure 20 The satellite navigation antenna should be horizontally installed onto the vehicle with the RF connector at the inner side

4.1.1.2 Fix the Antenna to the Top of Driving Cab

After installing the satellite navigation antenna at the driving cab top of the tractor is decided, remove the protective film of 3M double faced adhesive tape on the antenna pedestal. If the double faced adhesive tape is not adequately adhesive due to low temperature, heat it with a lighter. Then press the satellite navigation antenna onto the driving cab top of the vehicle according to the specified position and RF connector orientation. Press it with force until it is securely adhered. Before pressing, make sure the contact surface between the driving cab top and the antenna is level with little arc and is clean without any dust and water drop, or loose connection and falling off of the antenna may occur. To enhance the water-proof effect of the connection, apply waterproof sealant around the pedestal of the satellite navigation antenna after installation.

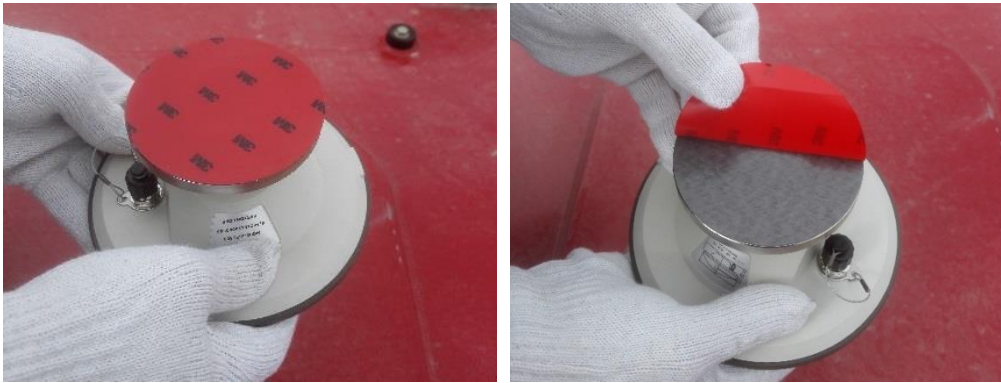


Figure 21 Remove the protective film of double faced adhesive tape on the antenna pedestal



Figure 22 Heat the double faced adhesive tape in case of low temperature



Figure 23 Press the antenna to specified position with force



Figure 24 Slightly pull the antenna to check if it is securely fixed



Figure 25 Apply waterproof sealant to the gap between antenna pedestal and vehicle top

4.1.1.3 Route Antenna RF Cable

After the satellite navigation antenna is installed, route the 3M RF cable. One end of the 3M RF cable is connected to the RF connector of the satellite navigation antenna with a threaded connection. Tighten it with hand instead of pliers or other tools to avoid damage to the RF connector of the antenna or the RF cable connector. After it is tightened, wrap and seal it with insulating tape. Route the cable along the driving cab top and fix it with cable tie holder with double-faced adhesive tape. Two 3M RF cables should be neatly routed in a symmetrical way along the driving cab top and

hang from the rear side of the vehicle after being bound with the strapping tape so as to enter into the driving cab through the rear side or rear window.



Figure 26 Tighten the 3M RF cable to the antenna (Do not use pliers or other tools to avoid damage to the connector)



Figure 27 Route and bind the 3m RF cable at the driving cab top

4.1.2 Installation of Radio Receiving Antenna

AG960 has only one radio receiving antenna to receive the differential information transmitted from the Beidou reference station. The radio receiving antenna is installed onto the tractor as described below.

4.1.2.1 Installation Position of Radio Receiving Antenna

To ensure a vast field of view, the radio receiving antenna must be mounted to the driving cab top instead of other positions such as rear side fender, engine hood of the vehicle. Otherwise the reference station signal may be shielded by the driving cab and thus cause intermittent or unstable signal affecting the automatic operation.

The distance between the radio receiving antenna and any satellite navigation antenna

must be at least 50cm to ensure that the whip rod of the radio receiving antenna does not disturb the signal receiving field of the satellite navigation antenna. Too close a distance may cause reduced location precision and affect the automatic operation.

4.1.2.2 Assembly and Fixation of the Radio Receiving Antenna

After the installation position of the radio receiving antenna at the driving cab top of the tractor is decided, first assemble the antenna mast and the antenna pedestal. During assembly, wrench can be used for tightening to prevent the antenna from getting loose during driving of the vehicle. Remove the protective film of 3M double faced adhesive tape on the antenna pedestal. If the double faced adhesive tape is not adequately adhesive due to low temperature, heat it with a lighter. Then press the radio receiving antenna onto the driving cab top of the vehicle. Press it with force until it is securely adhered. Before pressing, make sure the contact surface between the driving cab top and the antenna is level with little arc and is clean without any dust and water drop, or loose connection and falling off of the antenna may occur. To enhance the water-proof effect of the connection, apply waterproof sealant around the antenna pedestal.



Figure 28 Assemble antenna mast and antenna pedestal



Figure 29 Tighten the antenna mast the antenna pedestal with wrench



Figure 30 Remove the protective film of the double faced adhesive tape on the antenna pedestal



Figure 31 Press radio antenna to specified position with force



Figure 32 Slightly pull the antenna to check if it is securely adhered

4.1.2.3 Route RF Cable of Radio Receiving Antenna

After the radio receiving antenna is installed, route the RF cable. The pedestal of radio receiving antenna is provided with RF cable. Route the cable along the driving cab top and fix it with cable tie holder with double faced adhesive tape. It is recommended to bind the RF cable of radio receiving antenna together with two 3M RF cables of satellite navigation antenna and hang them from the rear side of the vehicle as a whole so as to enter into the driving cab through the rear side or rear window. In this way, the cable routing is neat and tidy.



Figure 33 Fix and bind the RF cables on the driving cab top and lead them into the driving cab from the rear side window

4.1.3 Installation of Panel Computer

The panel computer is the user operation interface of AG960 and it is installed onto the vehicle according to the following procedures.

4.1.3.1 Installation Position of Panel Computer

The panel computer must be installed inside the driving cab to avoid rain. Considering that usually the driver operates with right hand and gets on or off the vehicle from the left side of the driving cab, it is recommended to install the panel computer to the right side or right front position (consult the driver before installation). The screen of the panel computer should have a proper distance from and a proper installation angle for the driver to facilitate driver's operation.

4.1.3.2 Fixation of Round Plate Knob

Fix the round plate knob of the panel computer bracket to the specified installation position in the driving cab with electric tool and 3 outer hexagon self-tapping screws (ST4.2×32).



Figure 34 Fix and bind the RF cables on the driving cab top and lead them into the driving cab from the rear side window



Figure 35 Outer hexagon self-tapping screw



Figure 36 Fix the round plate knob of the panel computer bracket with electric tool and outer hexagon self-tapping screws

4.1.3.3 Fixation of Rectangle Plate Knob

Fix the rectangle plate knob of the panel computer bracket to the rear cover of the panel computer with 4 cross recessed pan head screws. To prevent the panel computer from getting loose during vibration and bumping, spring washers together with flat washers should be used during fixation.



Figure 37 Rectangle plate knob of panel computer bracket



Figure 38 Cross recessed pan head screws, spring washers and flat washers for fixing rectangle plate knob

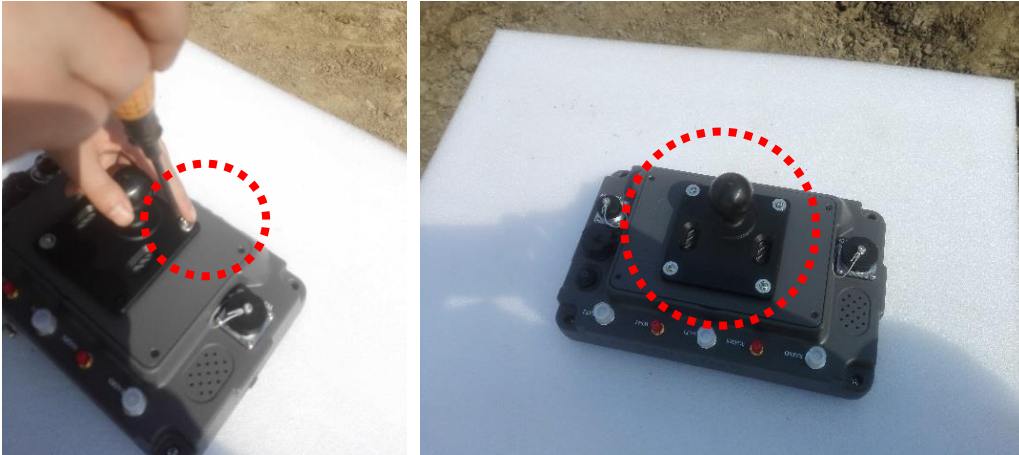


Figure 39 Fix the rectangle plate knob of panel computer bracket to the rear cover of the panel computer with cross recessed pan head screws

4.1.3.4 Installation of the 3G Antenna

For the autopilot which requires information remote control, 3G antenna is needed.

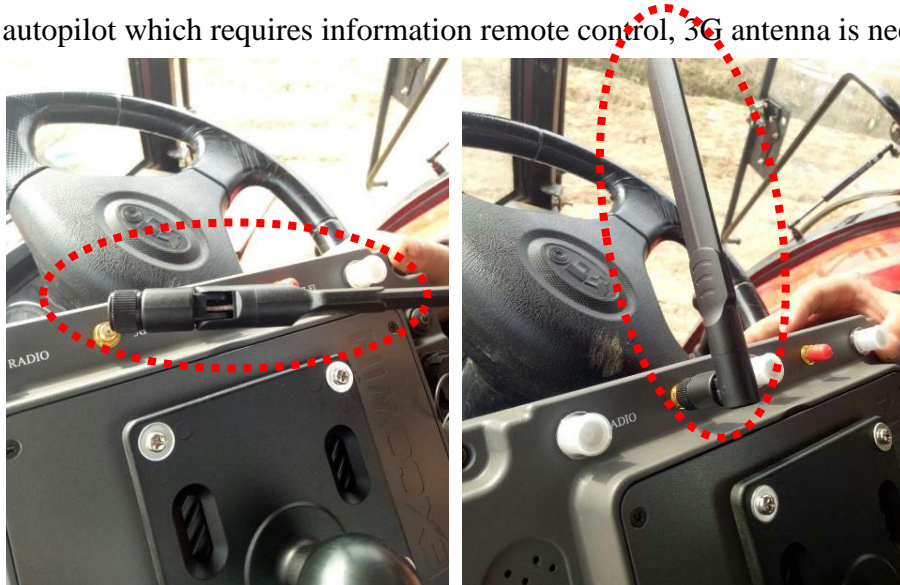


Figure 40 Installation of 3G antenna

4.1.3.5 Installation and Fix of the Panel Computer

Place the panel computer at a proper angle and connect the round plate knob and the rectangle plate knob with the link rod of the panel computer bracket. Fix with force by wrench if necessary to make sure that the panel computer will not drop or fall due to the bumping or vibration of vehicle.



Figure 41 Connect the round plate knob and the rectangle knob with the link rod



Figure 42 Panel computer properly installed

4.1.4 Installation of Autopilot (Controller)

As a core component of the autopilot, Autopilot (Controller) is used to realize the location, navigation, control and drive of the vehicle. The Autopilot (Controller) is installed inside the driving cab according to the following procedures.

4.1.4.1 Installation Position of Autopilot (Controller)

The Autopilot (Controller) is installed inside the driving cab in an orientation parallel to the coordinate system of the vehicle (Vehicle coordinate system takes the rear axle center as the origin O, the rear axle as X axis, the longitudinal axle as the Y axis and the vertical rise from the rear axle center to the driving cab top as the Z axis) (Any X, Y, Z edges perpendicular to each other starting from any angle of the Autopilot (Controller) should be respectively parallel with the X, Y, Z axis of the vehicle coordinate system).

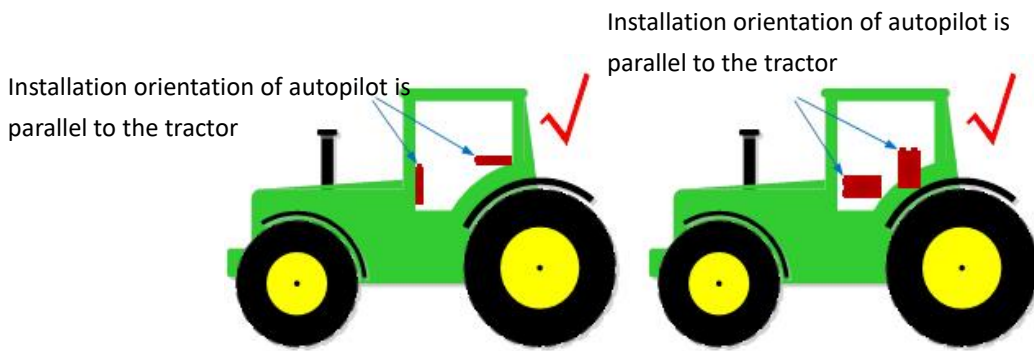


Figure 43 Installation orientation of autopilot should be parallel to the vehicle (CORRECT)

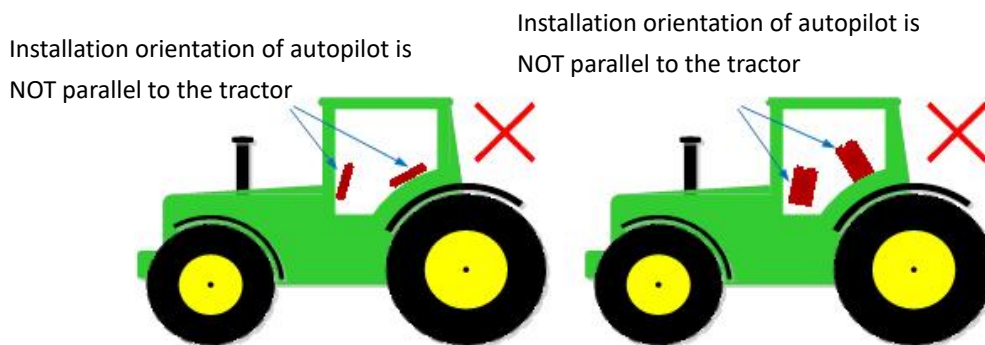


Figure 44 Installation orientation of autopilot should be parallel to the vehicle (WRONG)

Select a relatively flat plane in the driving cab as the installation surface of the Autopilot (Controller), for instance, the driving cab floor, the fender of left and right rear wheels of the driving cab, rear wall of the driving cab etc. It should be installed far away from the engine to the greatest extent and it is prohibited to install the driving box directly onto engine components. The installation position should ensure the driving box is not easy to be trodden on or hit by control stick. Sufficient space should be reserved for the outgoing cable of Autopilot (Controller) (at least 10cm in the outgoing cable direction of the Autopilot (Controller)). The installation position should provide relatively large bending radius for the harness and ensure relatively low stress at the end of the harness.

4.1.4.2 Fix Autopilot (Controller) at Specified Position

Connect the Autopilot (Controller) and its adapter plate with four cross countersunk screws (M6×12). Then fix the adapter plate of Autopilot (Controller) to the installation surface in vehicle driving cab with electric tool and 4 outer hexagon self-tapping screws (ST6.3×19)



Figure 45 Connect the autopilot and the adapter plate with cross countersunk screws



Figure 46 Proper installation position in the driving cab



Figure 47 Fix the adapter plate to the installation surface with self-tapping screws and electric tool

4.2 Installation of Steering System

4.2.1 Installation of Coaxial Steering System

AG960 is provided with coaxial steering system as standard, which can be easily installed to most farming machines (mainly various farming machines with four-wheel drive). The coaxial steering system consists of coaxial steering sensor (including sensor body, sensor stop plate) and its bracket (round flanged base, rectangle flanged base, double cross stop frame, anchor ear and rubber strip), which are shown in the following two figures.

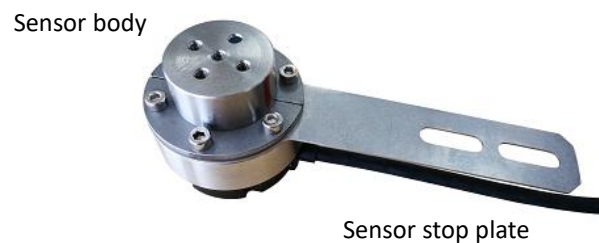


Figure 48 Coaxial steering sensor

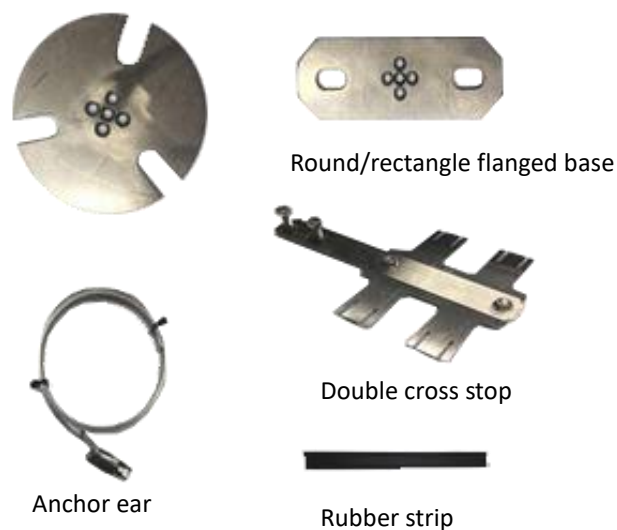


Figure 49 Coaxial steering sensor bracket

The coaxial steering system is installed to the left front axle of the tractor (from the view of the driver) according to the following procedures.

4.2.1.1 Select a Suitable Sensor Seat Based on the Knuckle Flange Type of the Tractor

Observe the shape and screw number of the flange of guide wheel knuckle. If the knuckle flange is round and has three screws as shown in the figure below, use the round flanged base of the sensor provided in the package. If the knuckle flange is rectangle and has 4 screws, use the rectangle flanged base of the sensor provided in the package. If it is neither type of the above mentioned (usually found in various agriculture machine with two-wheel drive), refer to section of “Install steering system of parallelogram type”.



Figure 50 Tractor knuckle and suitable sensor seat

4.2.1.2 Assembly of the Steering Sensor and Sensor Flanged Base

Select proper sensor flanged base and assemble the steering sensor and the sensor flanged base with 5 cross countersunk screws (M4×8).

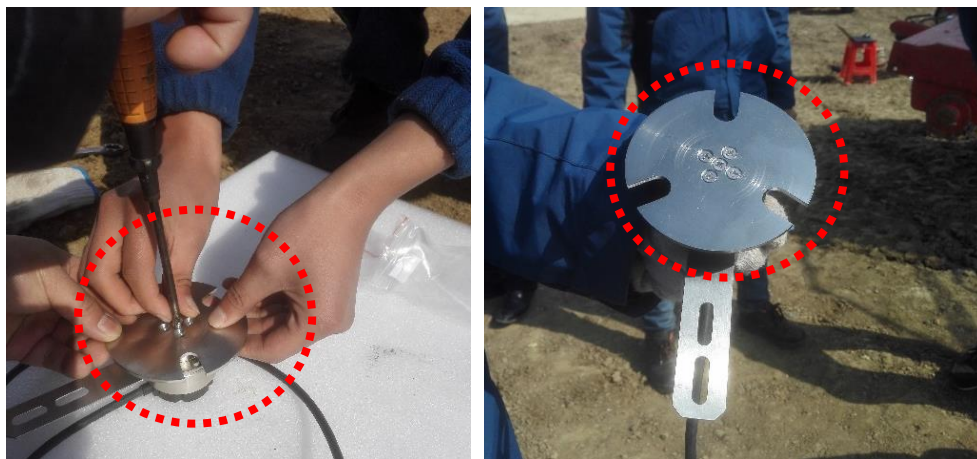


Figure 51 Assemble steering sensor and sensor flanged base

4.2.1.3 Assembly of the Steering Sensor and Sensor Flanged Base

Remove the screws on the knuckle flange of tractor guide wheel with socket spanner

and put the steering sensor with flanged base assembled onto the knuckle of tractor guide wheel. Align the rotation center of the steering sensor with that of tractor knuckle. The outgoing line of the steering sensor should point inward (toward the engine side) and be parallel with the front axle to facilitate the routing of cables. If there is grease filler protruding from the knuckle flange at the guide wheel affecting the installation of the steering sensor, it may be removed. Place the steering sensor properly and re-assemble and tighten the screws.



Figure 52 Remove the screws on the knuckle flange with a socket spanner



Figure 53 Place the assembled steering sensor onto the knuckle flange and secure it with original screws

4.2.1.4 Installation of Double Cross Stop Frame

Bend the stop plate of the sensor 45° downward with a sharp-nose plier. Place the double cross stop frame levelly on the tractor axle and bend it 45° upward so that it can overlap and connect the bent part of the sensor stop plate. Secure them with two screws. In case the overlapped part is not long enough due to too much vertical height

difference between the steering sensor and tractor axle, it may also be secured with one screw only.

Note: When bend the sensor stop plate downward, make sure the bending position has certain distance from three fastening screws of tractor knuckle to prevent interference during wheel steering and damages to the equipment.



Figure 54 Bend the sensor stop plate downward

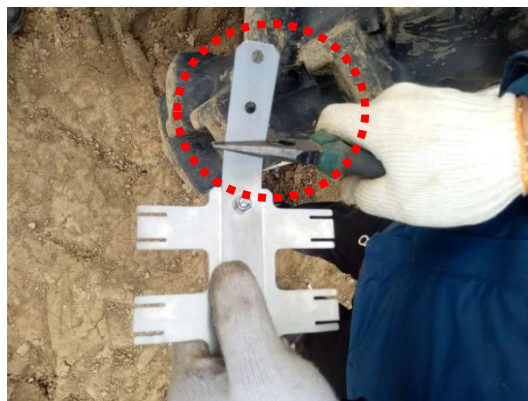


Figure 55 Adhere double faced adhesive tape to the lower part of the double cross stop frame (left) and bend the stop frame upward (right)

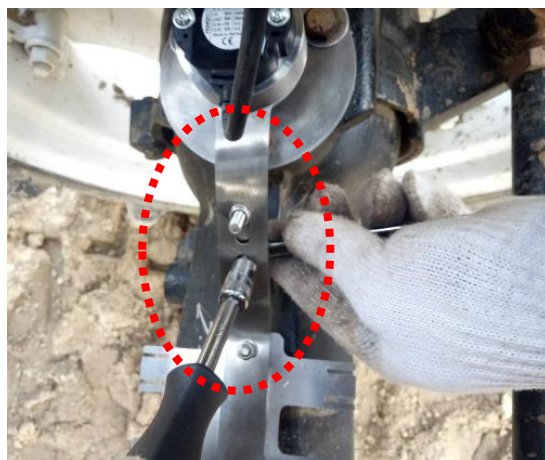


Figure 56 Connect the sensor stop plate and double cross stop frame and fix them with screws

4.2.1.5 Fix the Double Cross Stop Frame

Fix the double cross stop plate to vehicle front axle with anchor ear and rubber strip. First remove the protective film of the double faced adhesive tape on the lower part of the double cross stop frame and adhere it to the corresponding position on front axle to prevent stop frame from moving during locking the anchor ear. Then bind and lock it with the anchor ear. During binding, please note that the anchor ear should pass the spacing slot on the double cross stop plate. Lock the anchor ear adequately with a straight screwdriver to prevent the double cross stop plate from moving or loosening during the operation and bumping of the tractor.



Figure 57 Remove the protective film of the double faced adhesive tape and press the double cross stop frame against the front axle



Figure 58 Wrap the anchor ear with rubber strip



Figure 59 Bind and lock the double cross stop plate with anchor ear

4.2.1.6 Bind Steering Sensor Cable

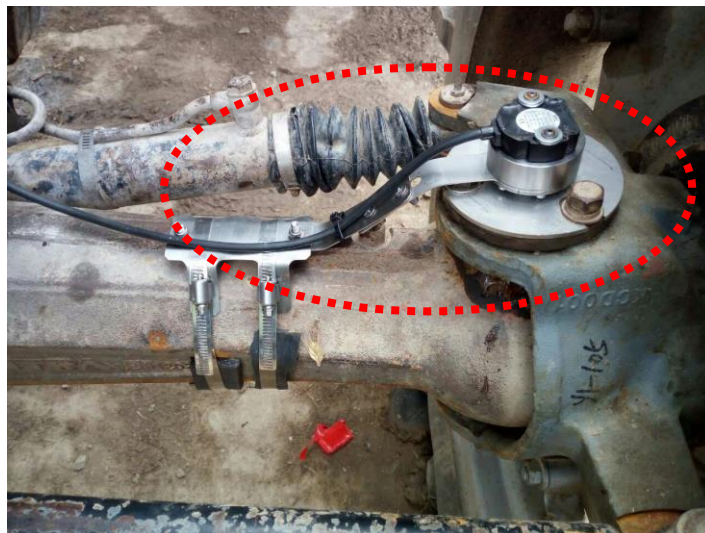


Figure 60 Coaxial steering system installed

4.2.1.7 Check the Motion of the Steering System

After the device is installed, start the engine, repeatedly turn the guide wheel to the left and right side to the maximum extent with vehicle staying at the same location and observe the coaxial steering system. Make sure that during the wheel rotation, the steering system does not interference with or impact on the oil tubing mechanism (in particular, the sensor stop plate should have no contact with the bottom plate flange and screws), the sensor seat can turn freely along with the knuckle and the sensor

itself is locked to the front axle by protruding sensor stop plate and does not turn at all.

4.2.2 Installation of Parallelogram Type Steering System

If the coaxial steering system cannot be installed to some types of tractors, for example, when there is only one master screw at the knuckle flange of the guide wheel, or there is high protrusion that cannot be removed at the knuckle flange, contact the support team of Tersus to replace steering system of parallelogram type.

Technical Support: support@tersus-gnss.com

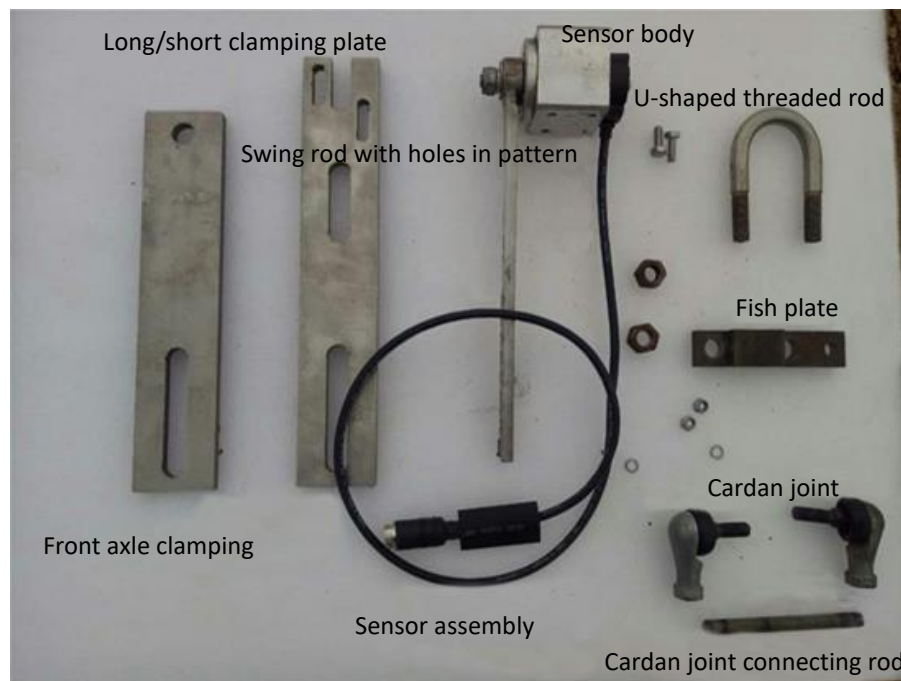


Figure 61 Components of parallelogram steering system

The parallelogram steering system consists of sensor assembly (including sensor body, swing rod with holes in pattern), axle clamping plate (including long clamping plate, short clamping plate and M12 connecting threaded rod), toe-in U-groove (including U-shaped threaded rod, fish plate) and cardan joint connecting rod (including cardan joint and M10 connecting threaded rod).

One end of the cardan joint connecting rod connects the toe-in and the other end connects the swing rod with holes in pattern. When the guide wheel moves, the toe-in drives the sensor to rotate via the connecting rod and the swing rod so as to measure the guide wheel angle, as shown in the figure below (viewing from the cross section

of tractor front axle)

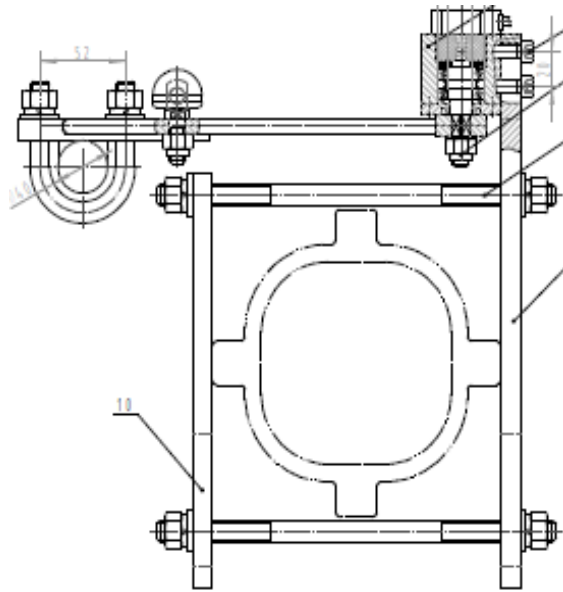


Figure 62 Installation sketch of parallelogram steering system (viewing from cross section of tractor front axle)

The parallelogram steering system is installed to the left front axle of the tractor (viewing from the driver) according to the following procedures.

4.2.2.1 Install Toe-in U-Groove

Fix the U-shaped threaded rod and fish plate onto the toe-in link rod at a position near the hinged point. Tighten the nuts at both sides simultaneously.

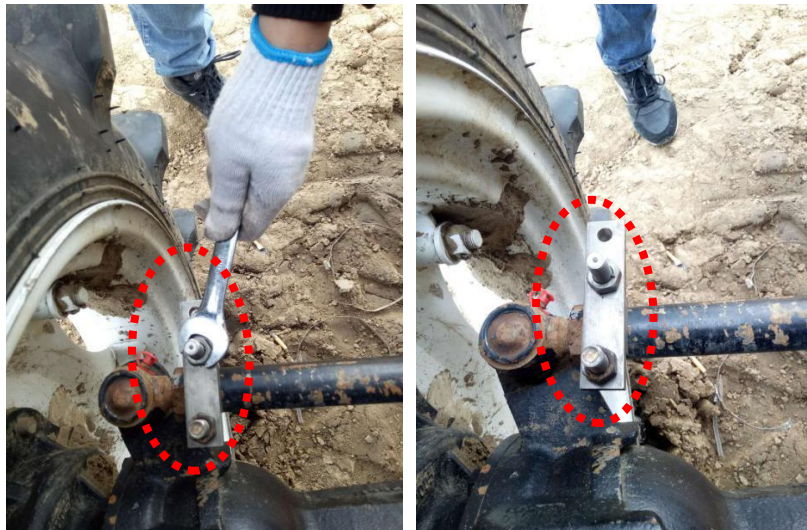


Figure 63 Fix U-shaped threaded rod and fish plate to the toe-in

4.2.2.2 Install Axle Clamping Plate

Fix the short and long clamping plates to tractor front axle with a M12 threaded rod. It is required that two clamping plates must have certain deformation to maintain necessary clamping force exerted on tractor front axle (the long clamping plate can be placed in the front or rear of axle as per the actual conditions).

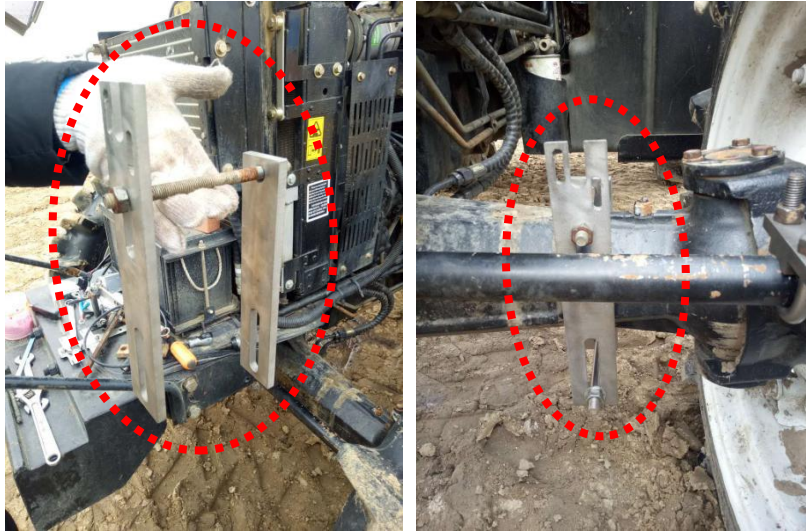


Figure 64 Fix the clamping plates to the front axle with a M12 threaded rod

4.2.2.3 Install Sensor Assembly

Install the sensor assembly at the long clamping plate side.

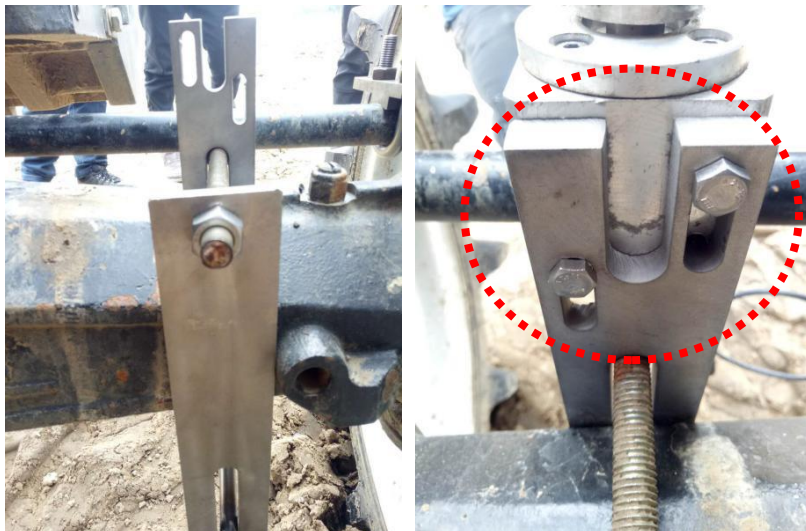


Figure 65 Fix sensor assembly at the long clamping plate side

4.2.2.4 Install Cardan Joint Connecting Rod

Install cardan joint connecting rod, with one end fixing toe-in U-groove and the other

end fixing swing rod with holes in pattern. The cardan joint connecting rod should be fixed with two M10 nuts to prevent the connecting rod from moving or loosening during the operation and bumping of the tractor.

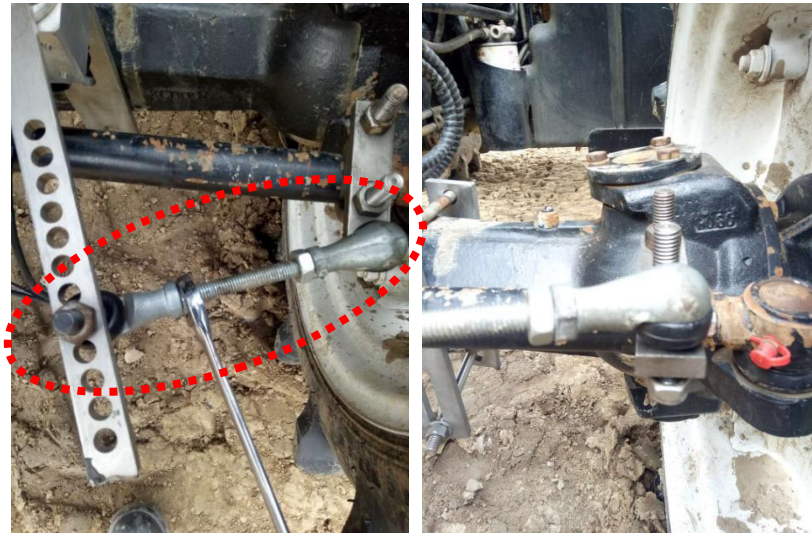


Figure 66 Install cardan joint connecting rod

4.2.2.5 Adjust the Parallelogram

Adjust the length of the cardan joint connecting rod and the connecting holes of the swing rod with holes in pattern to pay attention to below.

- The swing rod with holes in pattern (Line AB) is parallel with the line between the toe-in hinged point and the rotation center of guide wheel (CD line)
- Cardan joint connecting rod (BC line) is parallel with the line between the rotation center and the sensor center (AD line)

OR

- The length of AB equals that of CD; 2) the length of BC equals that of AD. If taking equal length as standard, the difference of lengths of both lines should be no more than 1cm.

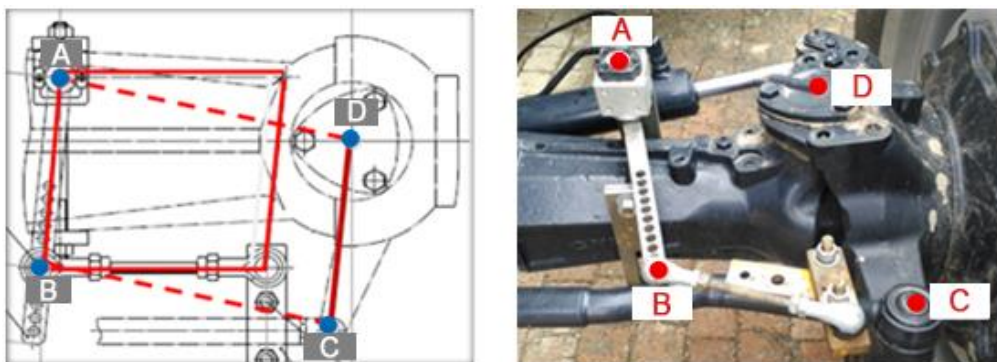


Figure 67 Install cardan joint connecting rod

4.2.2.6 Check the Motion of Pallelogram Mechanism

When the parallelogram is adjusted properly, tighten the fastening screws at both ends of cardan joint connecting rod. Start the engine, continuously turn the guide wheel to the left and right side to the maximum extent and observe the parallelogram mechanism. Make sure that the parallelogram mechanism do not interfere with or impact on the oil tubing mechanism of the vehicle during the rotation, and $\angle ABC$ will not be straightened or get close to 180° , nor will the parallelogram be overturned.

4.3 Check the Motion of Pallelogram Mechanism

The steering system for precision agriculture machines mainly includes two types, named as open center system and closed center system. Taking John Deere 904 tractor, Dongfanghong 904 tractor and Case 210 tractor as example, this manual describes the installation process of hydraulic valve group of open center and closed center systems.

4.3.1 Install Hydraulic Valve Group of Open Center System

The hydraulic valve group of open center system has such mechanical connections to the agriculture machine as shown in the figure below.

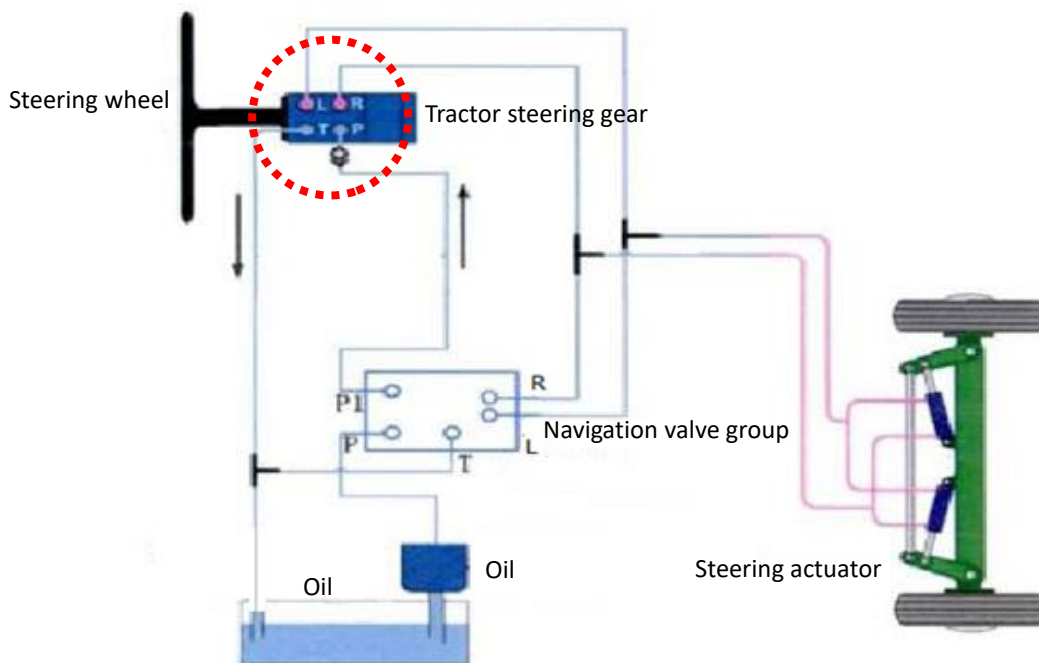


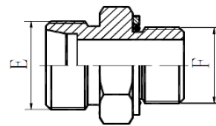
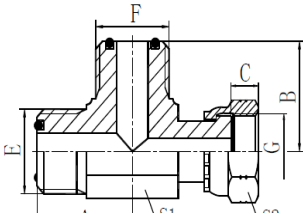
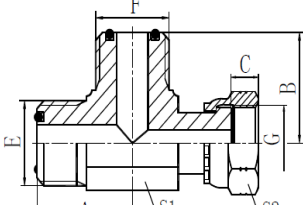
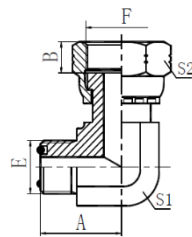
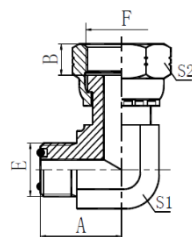
Figure 68 Connection diagram of open center hydraulic system

The open center hydraulic system has the following connections.

- Ports L, R, T of the hydraulic valve is respectively connected to ports L, R, and T of the steering gear via a tee union.
- Disconnect existing connection between the pressure output port P of vehicle power steering pump and port P of steering gear, and then connect the port P of hydraulic valve to port P of power steering pump and port P1 of hydraulic valve to port P of steering gear.

The pipe fittings list of different agriculture machine models can be obtained from the Tersus. For example, the pipe fittings list for John Deere 904 tractor is given below.

Table 3 Pipe fittings list for John Deere 904 tractor

Item	Description	Specification	Qty.	Legend	Remarks
1.	Transition union	G3/8-M18x1.5	5		
2.	Tee union	CF08	2		
3.	Tee union	CF06	2		
4.	Quarter bend	2F908	1		
5.	Quarter bend	2F906	2		
6.	High pressure	M18x1.5H-90/13/16A	3		

	oil pipe	-L1.2	
7.	High pressure	M18x1.5H-90/11/16A	2
	oil pipe	-L1.2	

The installation process of hydraulic valve group is described below.

4.3.1.1 Check the Operating Conditions of Existing Hydraulic Power Steering System of Tractor

Before installing hydraulic valve group, check the operating conditions of the hydraulic power steering system of tractor.

- Switch on the engine, and set the engine speed to idling position.
- Continuously turn the steering wheel left and right for preliminary inspection. If the steering wheel is too difficult to turn, it indicates insufficient pressure of the power steering pump. If it is too easy to turn, it indicates ineffective return spring of steering gear. If the steering wheel has idle travel, it indicates leakage in the steering gear, or mechanical gap between front or rear angle axles of steering oil cylinder, or mechanical gap between two end shafts of toe-in. In a word, idle travel is related to mechanical gap.
- Check if the power steering pump is normal. Turn the steering wheel with hand when the tractor stays at the same position. If the guide wheel can turn left or right to the maximum extent, it means the hydraulic steering system of the agriculture machine is normal. If it requires force to turn the steering wheel with hand, it indicates that the pressure of the hydraulic power steering pump is critical and it is difficult to turn when the hydraulic valve is installed. If it is hard to turn the steering wheel with hand, and the guide wheel can manage to turn with the accelerator pressed to the maximum extent but still is unable to reach the limiting position at both left and right sides, it means the hydraulic power steering system of this tractor is nearly ineffective, and it is impossible to install the hydraulic valve. In this case, repair the power steering pump of the tractor before the autopilot is installed. Usually the power steering pump will be replaced.
- Check if the steering gear is normal. Turn the steering wheel with hand when the tractor stays at the same position. When the steering wheel turns to the maximum extent at both left and right sides, release the steering wheel and observe if it can return freely. If the steering wheel does not return, it means the steering gear is malfunctioned and it is impossible to install the hydraulic valve. Repair the

steering gear before the installation process.

- Check the mechanical gap of steering oil cylinder. Turn the steering wheel with hand when the tractor stays at the same position and observe if there is oversized gap at the connections of both ends of the steering oil cylinder and the tractor axles causing dead running of oil cylinder. If any, eliminate the gap before the installation process.
- Check the mechanical gap at toe-in of tractor. Turn the steering wheel with hand when the tractor stays at the same position and observe if there is oversized gap between the toe-in and the connection shaft of left & right guide wheels causing dead running of toe-in. If any, eliminate the gap before the installation process.

4.3.1.2 Install Transition Unions onto Hydraulic Valve

The positions of oil ports are shown in the figure below. Mount transition unions to ports P, P1, L, R, and T of the hydraulic valve.

Note: bonded washer should be used for the installation.

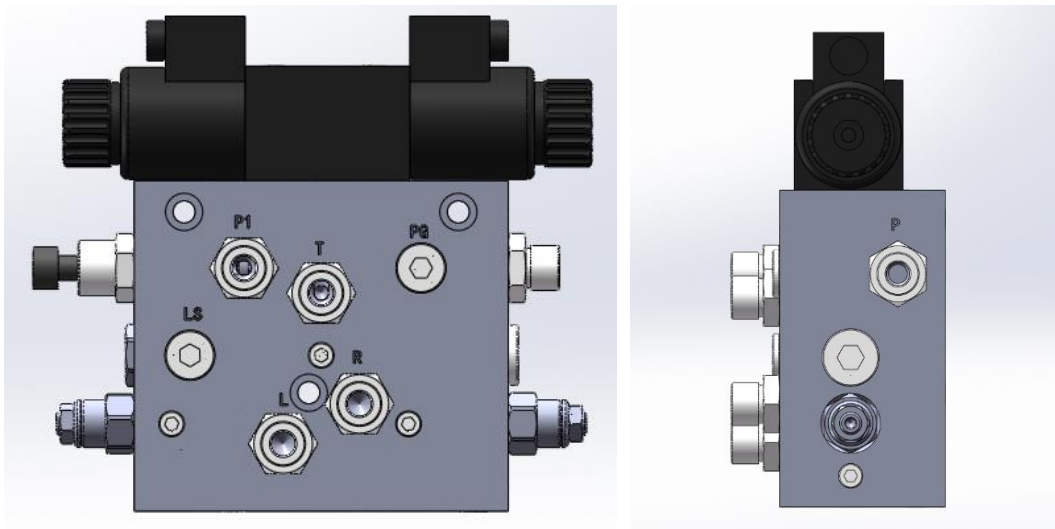


Figure 69 Installation positions of transition unions on the hydraulic valve

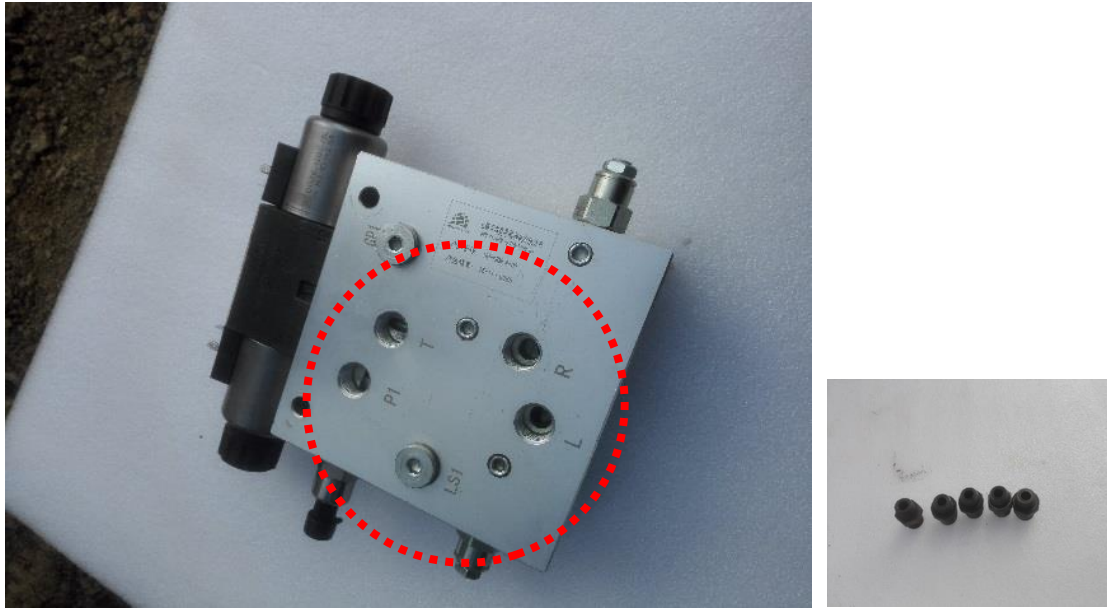


Figure 70 Hydraulic valve (left) and transition unions (right)

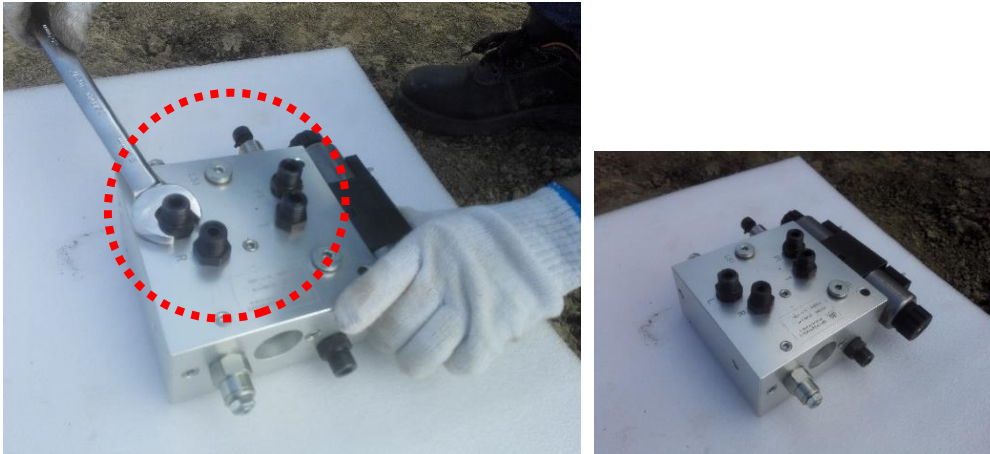


Figure 71 Install the transition unions to corresponding ports on the hydraulic valve

4.3.1.3 Install the Hydraulic Valve to Tractor

Hang and mount the hydraulic valve to the specified position on the tractor with an L-shaped adapter plate, such as the left front and right front of driving cab, inside the engine compartment, inside the driving cab etc. Either threaded or welded connection is OK. There is no special requirement for the orientation of valve body, but it is required to make sure that the valve body does not swing after being mounted and sufficient space is available to install pipelines.

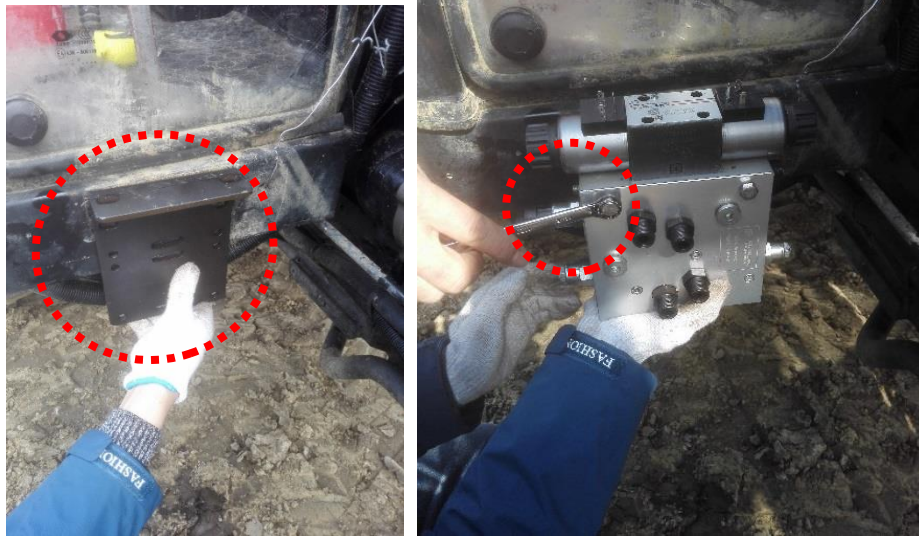


Figure 72 Determine the connection position of L-shaped adapter plate on tractor (left), hang and tighten hydraulic valve (right)

4.3.1.4 Connect Port P of Power Steering Pump and Port P of Hydraulic Valve

Disconnect the existing connection at port P of power steering pump (pressure output port) and connect it to port P of hydraulic valve with transition union and oil pipe. The existing connection can be disconnected directly from port P of power steering pump or the other end of oil tube of port P of power steering pump, whichever is convenient for the installation process.

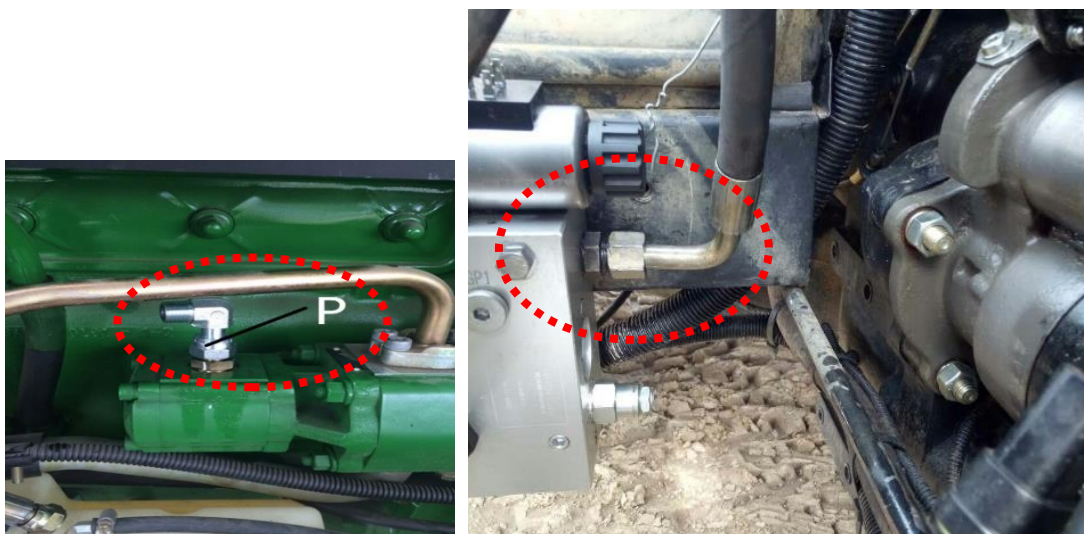


Figure 73 Disconnect existing connection at port P of power steering pump, mount transition union, and connect it to port P of hydraulic valve with oil pipe

4.3.1.5 Connect Hydraulic Valve and Ports L, R, T of Steering Gear Respectively with Tee Unions

Disconnect existing connections of ports L (also A), R (also B), T of the steering gear, and replace them with tee union for re-connection. The connection can be disconnected from the steering gear or the other end of the oil pipe to the steering gear, whichever is convenient for the installation process.

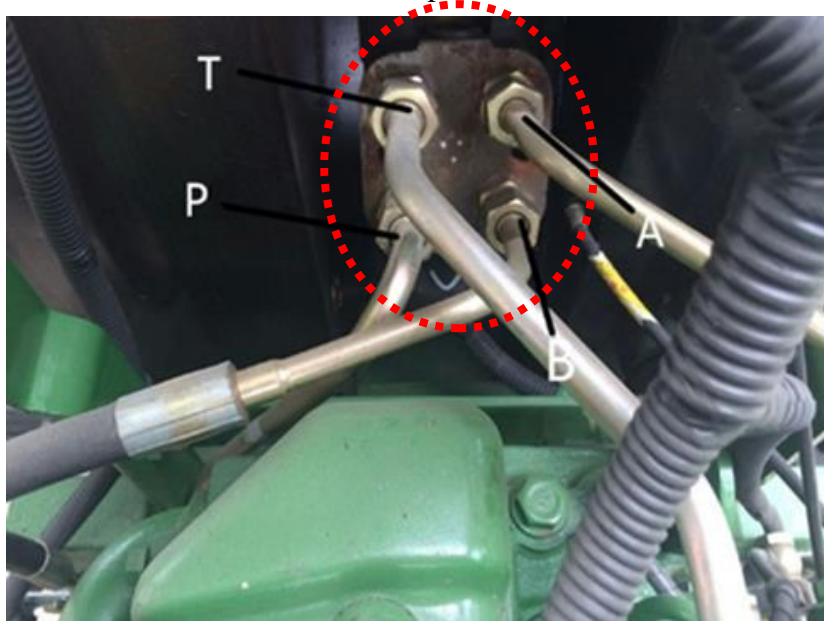


Figure 74 Ports P, T, L (A), R (B) of steering gear



Figure 75 Disconnect existing connection at ports L/R/T of steering gear, connect a tee union, and then connect it to ports L/R/T of hydraulic valve

4.3.1.6 Connect Port P1 of Hydraulic Valve to Port P of Steering Gear

Connect port P1 of hydraulic valve and port P of steering gear.

4.3.1.7 Sort out Oil Pipes

Sort out oil pipes and arrange the exposed oil pipes in a proper way so as to present a beautiful and tidy appearance. Make sure to prevent the contact of oil pipe with high temperature components such as engine exhaust pipe.



Figure 76 Sort out oil pipe

4.3.1.8 Check the Actuation Function of Hydraulic Valve

Start the engine and maintain a speed of 1000rpm~1500rpm in order to confirm the actuation function of hydraulic valve.

- Check for oil leakage. Check if there is oil spray or leakage around the hydraulic valve and the connection between oil pipe and tractor body. If any, stop the engine immediately to check if the connector is secure, if the washer is in place, correctly used or has any damage or if the connector has any damage. If any, repair in time.
- Check if hand turning of steering wheel is normal. Turn the steering wheel by

hand with tractor staying at the same position and observe if the turning process is difficult. If yes, it indicates the pressure of existing hydraulic power steering system is critical and the autopilot of agriculture machine will not work well. It can be improved by repairing or replacing the power steering pump. Check if the steering wheel rotates in the same direction with the guide wheel. If it rotates in a reverse direction, exchange L and R oil pipes.

- Check if the hydraulic valve functions normally. Press the hand pressing point at both ends of the hydraulic valves with a tool. First press the left one to check if the guide wheel of tractor can rapidly turn to the maximum extent at the left side. Then press the right one check if the guide wheel of tractor can rapidly turn to the maximum extent at the right side. Test repeatedly for several times. When the pressing point is pressed, if the guide wheel turns at a very slow speed or is difficult to pass the middle point, it means the hydraulic system is abnormal. It may be because the pressure of power steering pump of tractor is too critical or the hydraulic valve or oil line has problem. In this case, press the accelerator pedal to the utmost and check if there is obvious improvement of the response speed. It is also recommended to adjust the main knobs of the hydraulic valve, including system pressure etc. to check if the response is improved.



Figure 77 Start the engine and press the pressing points at both ends of the proportional valve to observe the actuation capability of the guide wheel

4.3.2 Installation of Closed Center Hydraulic Valve System

The mechanical connections of closed center hydraulic valve system on the tractor are as shown in the figure below.

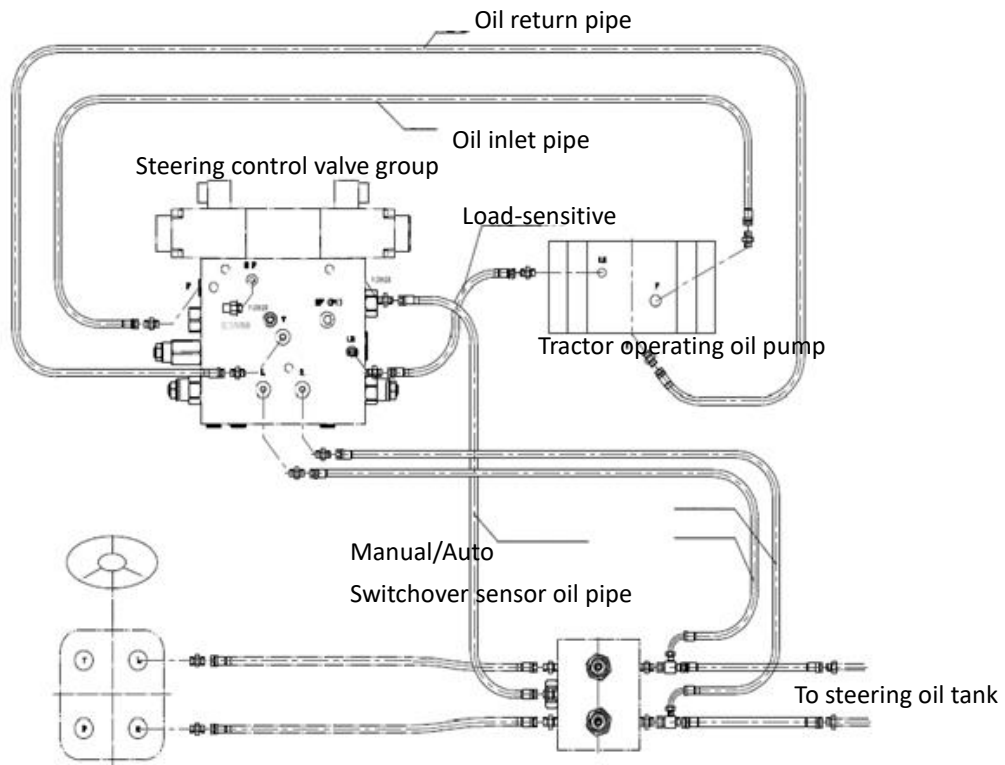


Figure 78 Connection diagram of closed center hydraulic system

Taking Case 210 tractor for example, the hydraulic valve group of closed center system should be installed according to the following procedures.

4.3.2.1 Check Relevant Oil Ports

The operating oil pump is located at the rear side of the tractor. Replace the end caps at ports P, T, LS with transition unions, as shown in the figure below.



Figure 79 Locate ports P, T and LS at the rear axle

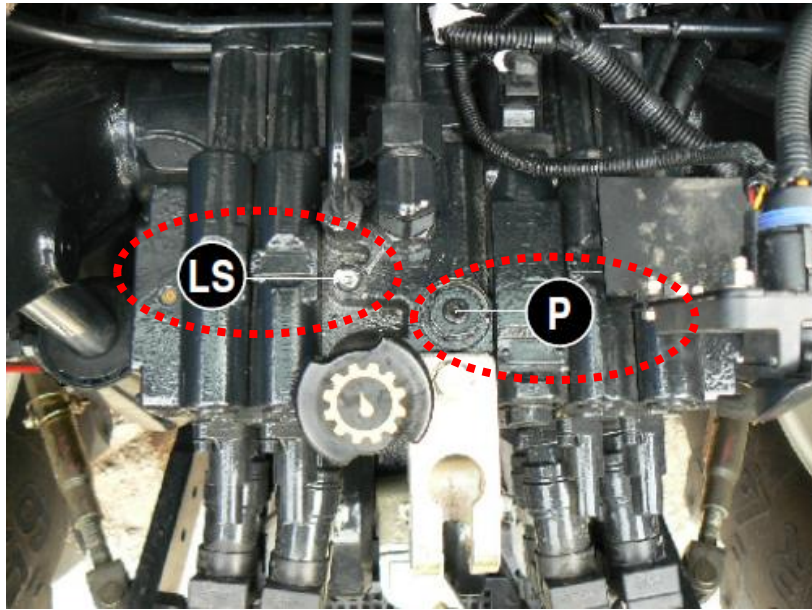


Figure 80 Locate ports P and LS

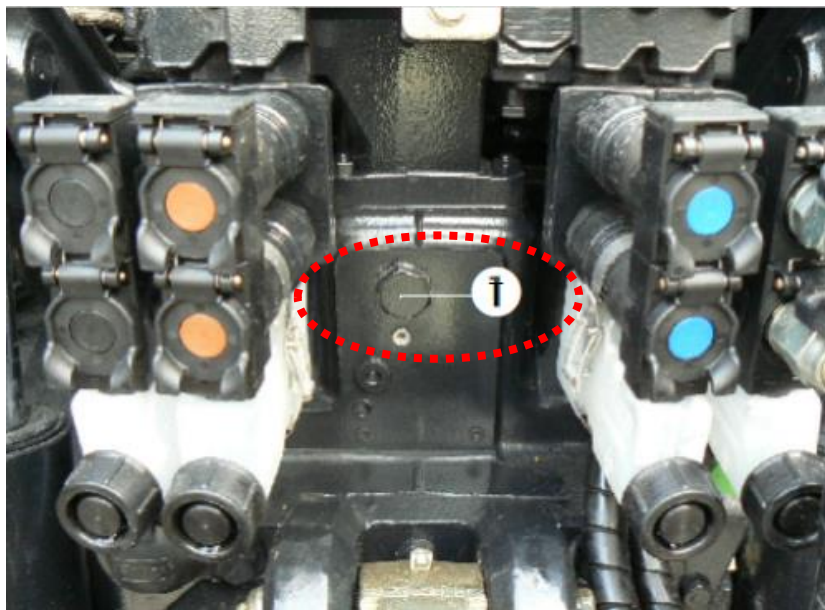


Figure 81 Locate port T



Figure 82 Replace the end caps of ports P and LS with transition union

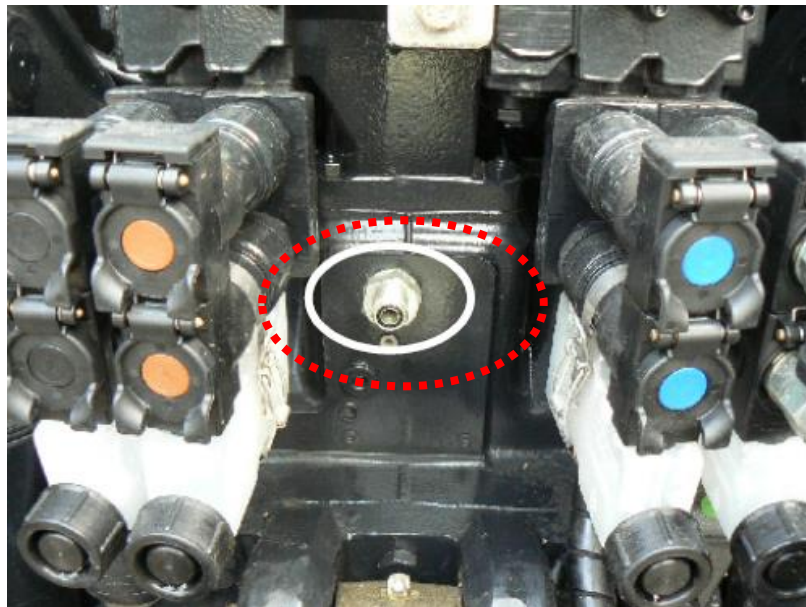


Figure 83 Replace end cap at port T with transition union

4.3.2.2 Install Hydraulic Valve System

Fix the hydraulic valve group to the vehicle with an L-shaped adapter plate.

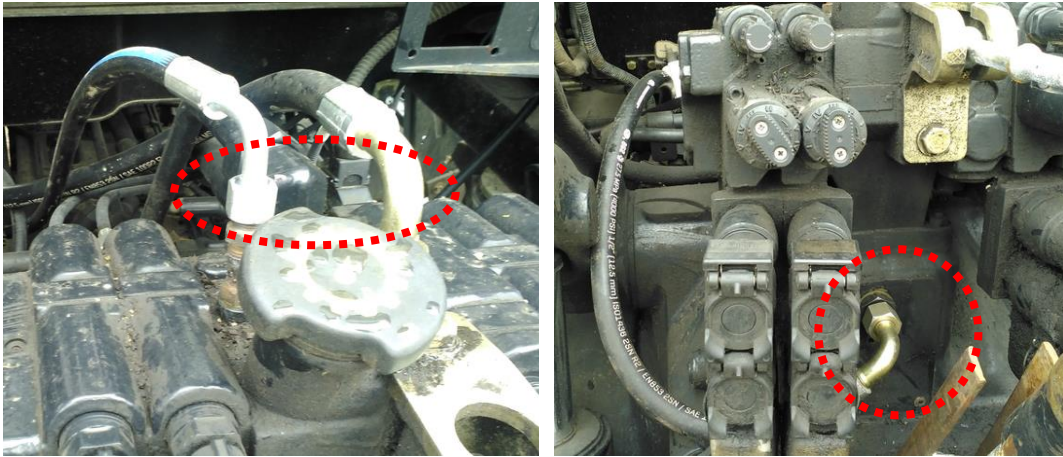


Figure 84 Connect ports P, T, LS at the rear axle of agriculture machine to hydraulic valve with oil pipe

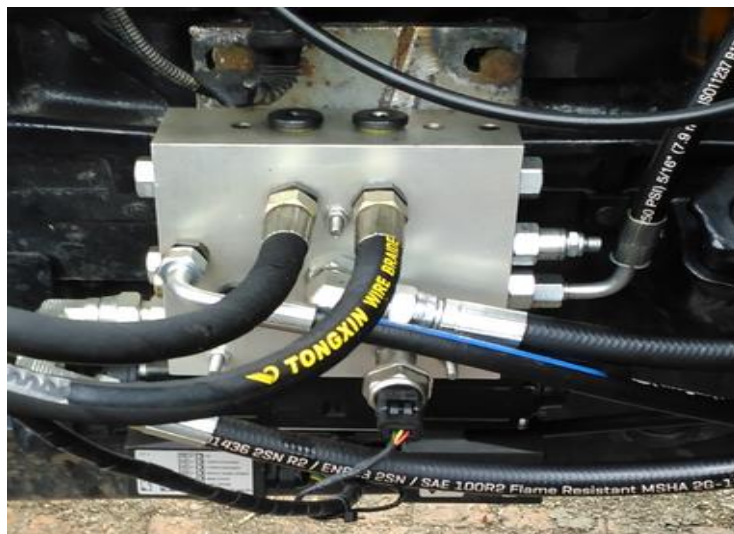


Figure 85 Connect hydraulic valve and CVB module with oil pipe

Similar to the open center type agriculture machine, check the operating conditions of steering system of the agriculture machine before installing hydraulic valve group. After the hydraulic valve group is installed, check the operating condition of hydraulic valve group.

4.4 Routing of Cables

After the installation of electronic assemblies, steering system and hydraulic valve group, cables should be routed to complete the electrical connection between the components and assemblies of autopilot.

The cables are routed around the Autopilot (Controller). The front panel of Autopilot (Controller) is shown in the figure below.



Figure 86 Outlook of front panel of navigation driving box

The connections of various ports at the front panel of Autopilot (Controller) are as follows.

- GNSS primary antenna port. It is connected to the right satellite navigation antenna at driving cab top of the vehicle via a 3M RF cable.
- GNSS secondary antenna port. It is connected to the left satellite navigation antenna at driving cab top of the vehicle via a 3M RF cable.
- Power & drive port. It is connected to the 23-pin vehicle standard connector terminal of drive harness (black end harness). The other end of drive harness (black end harness) is divided into three parts, namely “battery terminal”, “hydraulic valve drive terminal” and “steering system terminal”, respectively connecting to vehicle battery, electromagnetic hydraulic valve and steering system.
- Panel computer port. It is connected to the 23-pin vehicle standard connector terminal of data harness (white end harness). The other end of data harness (white end harness) is connected to the panel computer via a round aviation connector.
- Bluetooth antenna port. It is not used in this product and is blocked with an end cap.
- Radio antenna port. It is connected to the RF connector of the radio antenna that hangs into the driving cab.

The cables are routed in the following order.

- RF cables
- Data harness (white end harness)
- Drive harness (black end harness)

4.4.1 Routing of RF Cables

4.4.1.1 Connect Radio Antenna

For the radio receiving antenna at the driving cab top, the corresponding RF cable is connected to the RF plug marked with “Radio antenna” on the front panel of Autopilot (Controller). Tighten it with hand. Never use any tool for tightening to prevent damages to the connector.



Figure 87 Connect radio antenna

4.4.1.2 Connect Satellite Navigation Antenna

The satellite navigation antenna at the right side of driving cab top is the primary antenna, and its RF cable is connected to the RF plug marked with “GNSS primary antenna” on the front panel of Autopilot (Controller). Tighten it with hand. Never use any tool for tightening to prevent damages to the connector. The satellite navigation antenna at the left side of driving cab top is the secondary antenna, and its RF cable is connected to the RF plug marked with “GNSS secondary antenna” on the front panel of Autopilot (Controller). Tighten it with hand. Never use any tool for tightening to prevent damages to the connector.

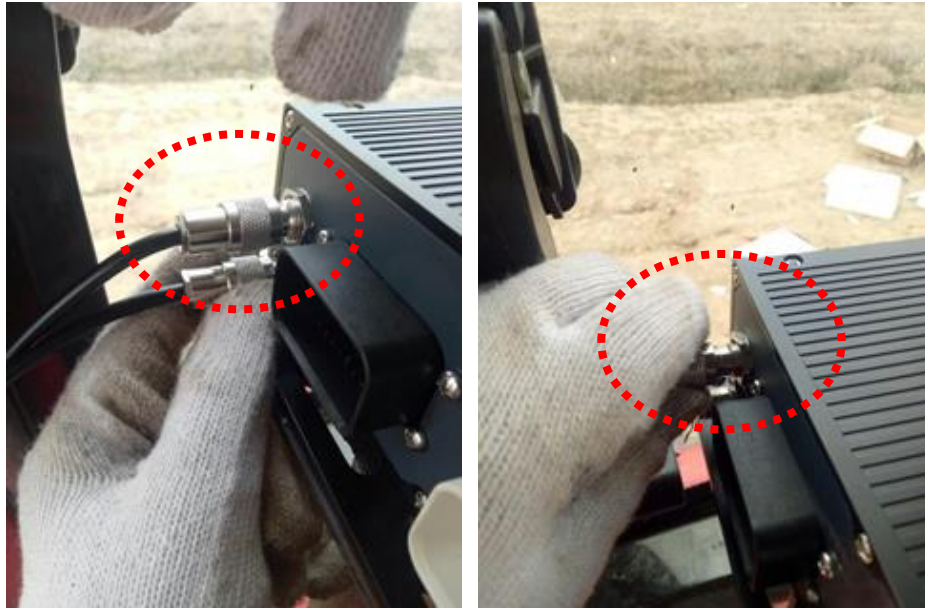


Figure 88 Connect satellite navigation antenna

4.4.1.3 Sort out and Bind RF Cables

After connecting, sort out and bind the RF cables. Note that the bending radius of cables should not be too small to prevent damaging the cables.

4.4.2 Routing of Data Harness (White End Harness)

One end of the data harness (white end harness) is white 23-pin vehicle standard connector (female) and the other end is connected to the terminal of the panel computer. In addition, two lines are divided from the root of the white 23-pin vehicle standard connector, where the 4-pin round connector is the interface for external radio and the 11-pin round connector is a general extended port. If external radio or other external communication device is required to receive data from **Beidou** reference station, it should be connected with the 4-pin round connector (when external communication device is used, GNSS-RTK data source should be provided at the user interface). The general extended port contains 12V power supply for external extension equipment, RS232 serial port, CAN bus interface, digital IO interface and other common vehicle bus interface, and it can be used to communicate with agriculture machine ECU with electric control system, collect status information of agriculture machine, issue commands of agriculture machine movement, and connect other intelligent farm tools for variable operation etc.



Figure 89 White 23-pin vehicle standard connector terminal of data harness



Figure 90 Panel computer connector terminal of data harness



Figure 91 External radio interface terminal (left) and general extended terminal (right) of data harness

The data harness is routed according to the following procedures.

4.4.2.1 Connect Autopilot (Controller)

Insert the white 23-pin vehicle standard connector (female) at the end into the white 23-pin connector (male) on the Autopilot (Controller) (The connector is marked with text “Panel computer” on the panel). When the plug is in place, the locking device will be locked with a clear click, which means the connection is completed. Make sure the locking device is locked, or it may cause damage when the equipment is

powered on due to bad contact.

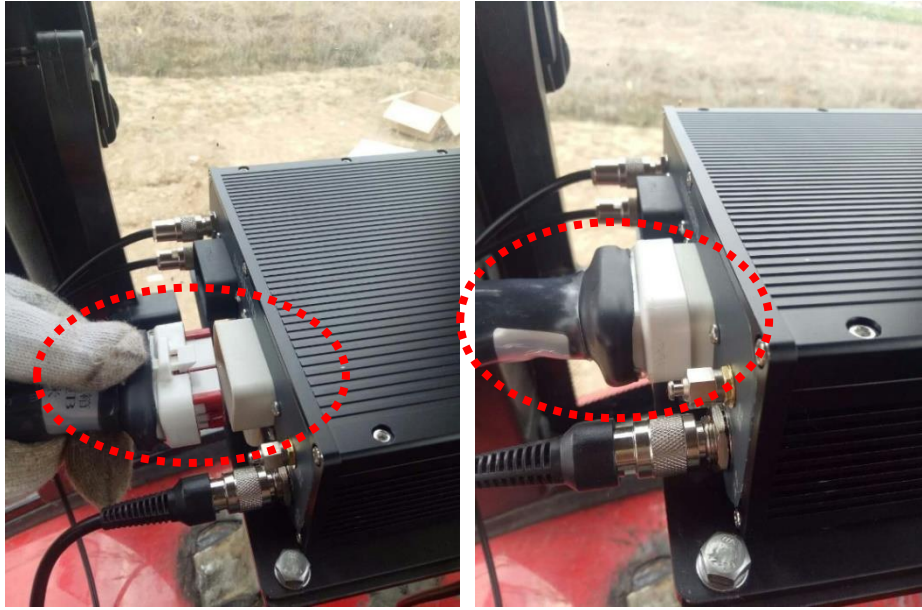


Figure 92 Insert white 23-pin connector (female) of data harness into white 23-pin connector (male) of Autopilot (Controller)

4.4.2.2 Connect Panel Computer

Select appropriate routing to connect the connector for panel computer to corresponding interface on the panel computer. The cable route should be along the edge of driving cab as far as possible to prevent the driver from kicking or tripping during operation, and should be far away from various operating levers and easy to be bound.

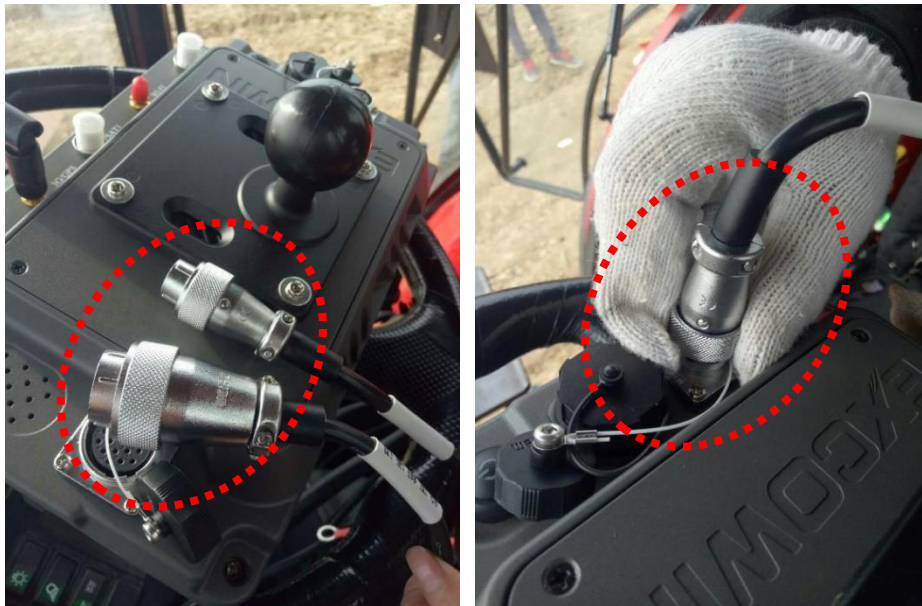


Figure 93 Connect data harness and panel computer



Figure 94 Connect data harness and panel computer

4.4.2.3 Sort Out and Bind Harness

Bind the harness routed. Fold and bind the excessive part.

4.4.3 Routing of Drive Harness (Black End Harness)

One end of the drive harness is a black 23-pin vehicle standard connector (female) and the other end is divided into three lines respectively connecting the agriculture machine battery, electromagnetic hydraulic valve and the steering system. The terminal connected to vehicle battery extends another line at the root of the harness to connect a gourd-shaped switch with LED light for switching the entire machine on and off.



Figure 95 Black 23-pin connector end of drive harness



Figure 96 Battery connector (left) and power supply switch (right) of drive harness



Figure 97 Hydraulic valve connector (left) and steering system connector (right) of drive harness

The drive harness is routed according to the following procedures.

4.4.3.1 Connect Autopilot (Controller)

Insert the black 23-pin connector (female) at the end into the black 23-pin connector (male) on the Autopilot (Controller) (The connector is marked with text “Power & drive” on the panel). When the plug is in place, the locking device will be locked with a clear click, which means the connection is completed. Make sure the locking device is locked, or it may cause damage when the equipment is powered on due to bad contact.

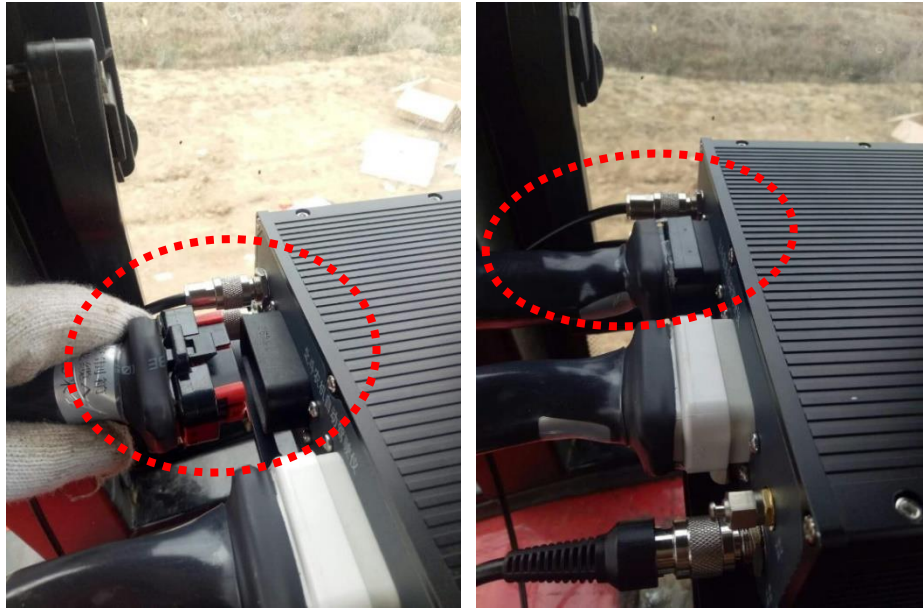


Figure 98 Insert black 23-pin connector (female) of drive harness into black 23-pin connector (male) of Autopilot (Controller)

4.4.3.2 Connect Electromagnetic Hydraulic Valve

Select proper routing to connect the hydraulic valve drive terminal and hydraulic sensor terminal of drive harness to two electromagnetic valve plugs of the hydraulic valve and the pressure sensor seat respectively. During connection, two drive terminals of the harness can be arbitrarily connected to two drive seats of the hydraulic valve (if it is wrong, it can be identified during the commissioning later. In such case, exchange them.)

Note: The fastening screws on drive terminals should be firmly tightened, or bad contact may occur, thus damaging the drive circuit of hydraulic valve in the Autopilot (Controller).

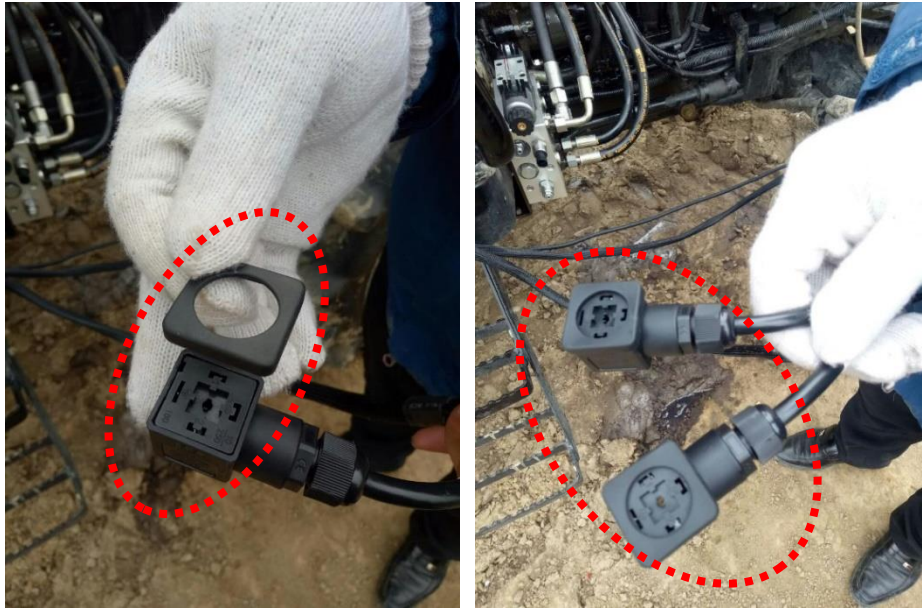


Figure 99 Mount water-proof rubber ring to the hydraulic valve drive terminal of drive harness

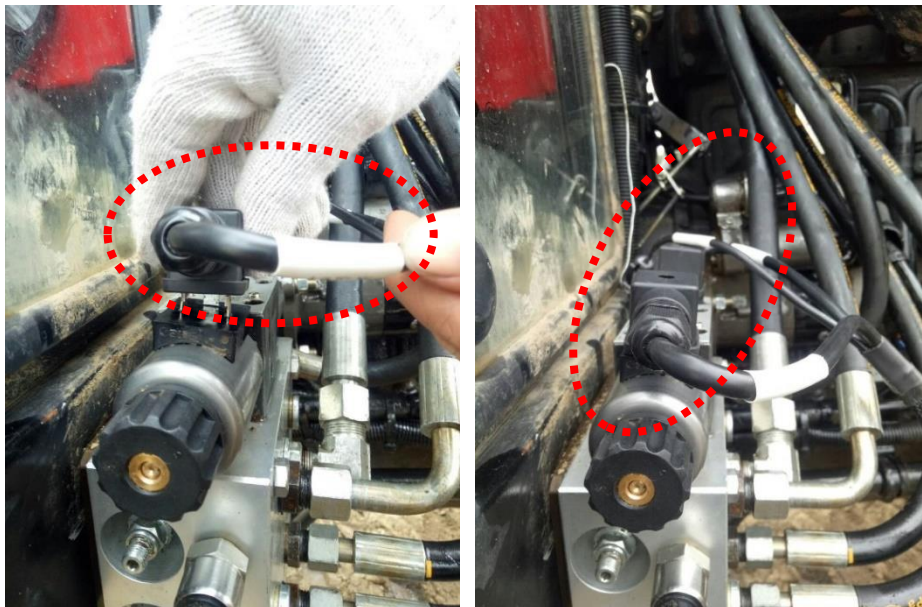


Figure 100 Mount drive terminal to the electromagnetic socket of hydraulic valve

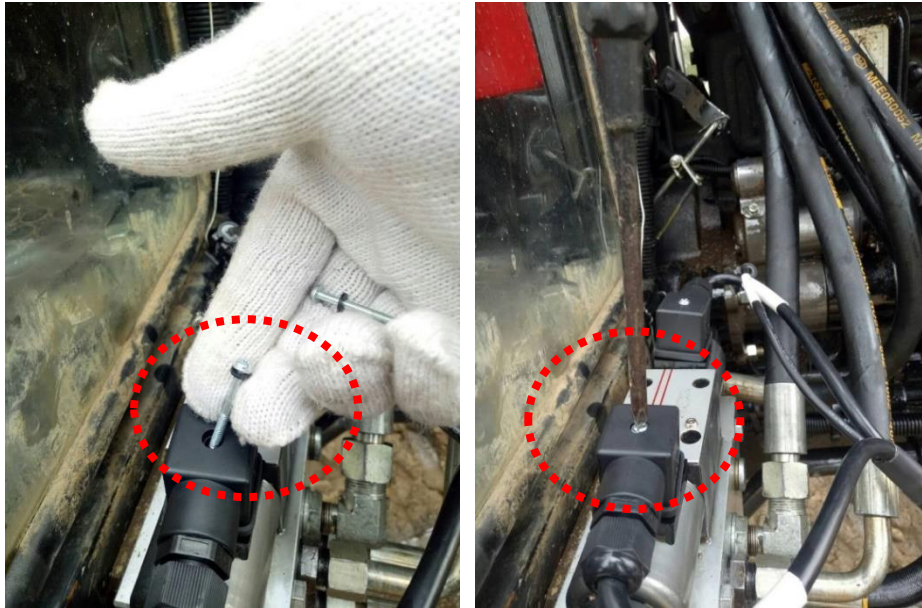


Figure 101 Fix hydraulic drive terminal with screws

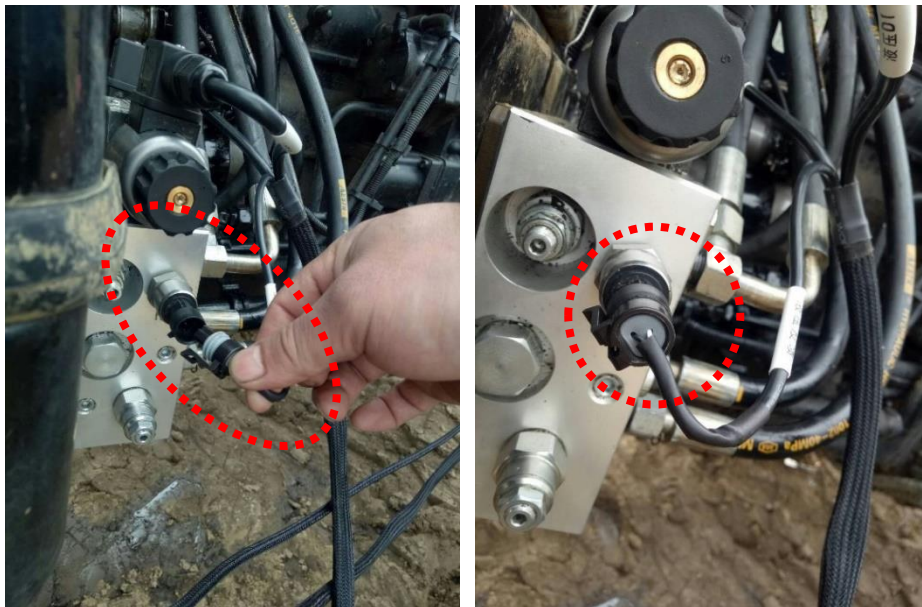


Figure 102 Connect pressure sensor terminal

4.4.3.3 Connect Steering Measuring Mechanism

Select suitable routing to connect the drive harness connector for steering measuring mechanism (8-pin round connector) to the steering measuring mechanism. It should be noted that there is a free space with certain angle between the front axle and vehicle body as the steering measuring mechanism is fixed to the front axle of guide wheel of the agriculture machine.

Therefore, during routing and binding process, sufficient free space should be provided for this section of harness to prevent the cable being pulled apart. In addition,

as the 8-pin round connector is heavy, it should be located as close to the engine structure as possible to be bound beside the engine. In this way, it can prevent the connector from swinging during operation and thus causing damages due to mechanical fatigue. When it is connected, seal the connector with insulating tape.



Figure 103 Connect pressure sensor terminal

4.4.3.4 Connect Battery

Do not connect the battery until the cables for all other components are connected.

Select suitable path to route the connecting terminal for battery to near the battery. Pay attention to the polarity of the battery. Connect the black terminal marked with “Battery -” of the drive harness to the negative pole of the battery (“-” is engraved near the negative pole of battery) and connect the red terminal marked with “Battery +” of the drive harness to the positive pole of the battery (“+” is engraved near the positive pole of battery). Remove the nuts at the positive and negative poles of battery, connect corresponding terminals of drive harness and secure the connection. If the terminals of drive harness are incompatible with the screws and nuts at the positive and negative poles of battery, gaskets may be added.

When selecting the routing, as a priority, lead the cable out from gaps at the driving cab bottom and try to avoid the driving cab door. When the cable is out from the driving cab bottom, lead the cable to the battery along the engine. Note: avoid the high temperature zone such as exhaust pipe of engine, to prevent burn of cable. The cable part inside the driving cab should be routed along the edge of the driving cab to prevent driver from kicking or tripping and be far away from various operating levers.

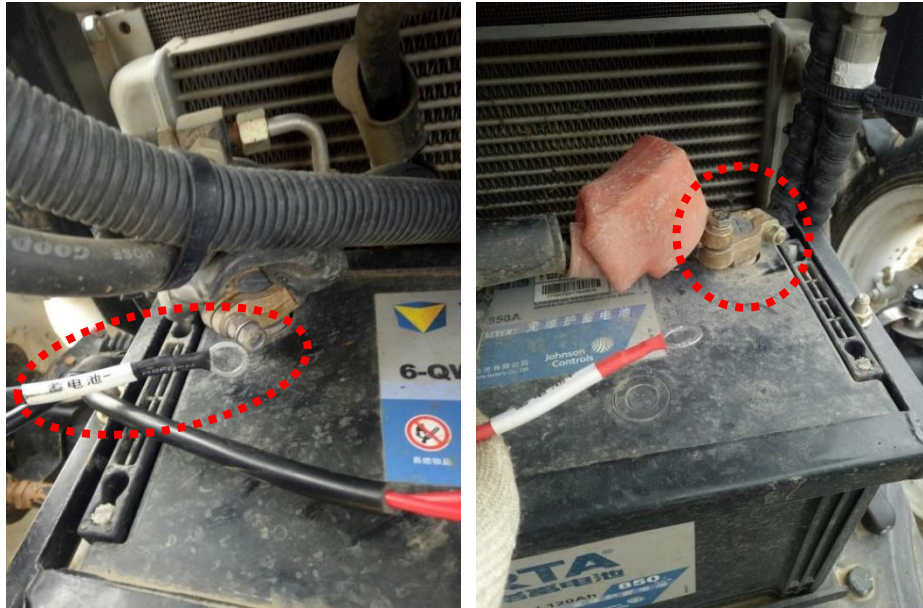


Figure 104 Connect battery connecting terminal of drive harness to corresponding position on battery and secure the connection

If the agriculture machine uses two 12V batteries in serial to supply a 24V power, the 24V power supply cannot be directly used for the device, or abnormal operation of or damage to the equipment may occur. In this case, the power supply should be connected as shown in the figure below.

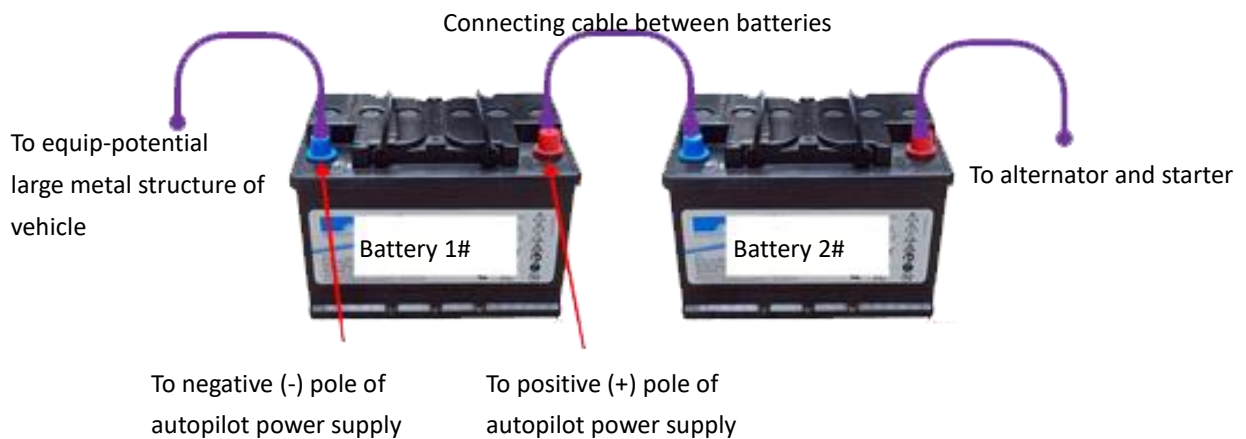


Figure 105 Power connections for the device on agriculture machine using 24V power supply

Note: The aluminum casing of the Autopilot (Controller) of the autopilot is directly connected to the negative wire of battery connecting terminal on the drive harness. During use, try to directly contact the casing of Autopilot (Controller) with big metal piece of the tractor so as to achieve better grounding. Moreover, the autopilot has been designed with inverse connection protection. But the installation personnel

should do their best to ensure correct connection of battery to prevent damage to the equipment.

4.4.3.5 Sort Out and Bind the Harness

Bind the harness routed. Fold and bind the excessive part. Cables routed along the inside and outside of the driving cab and the engine as well should be bound to the vehicle structure or existing harness at proper position to present a neat and tidy appearance. When the harness is bound, arrange the gourd-shaped switch at a place easily accessible for the driver.

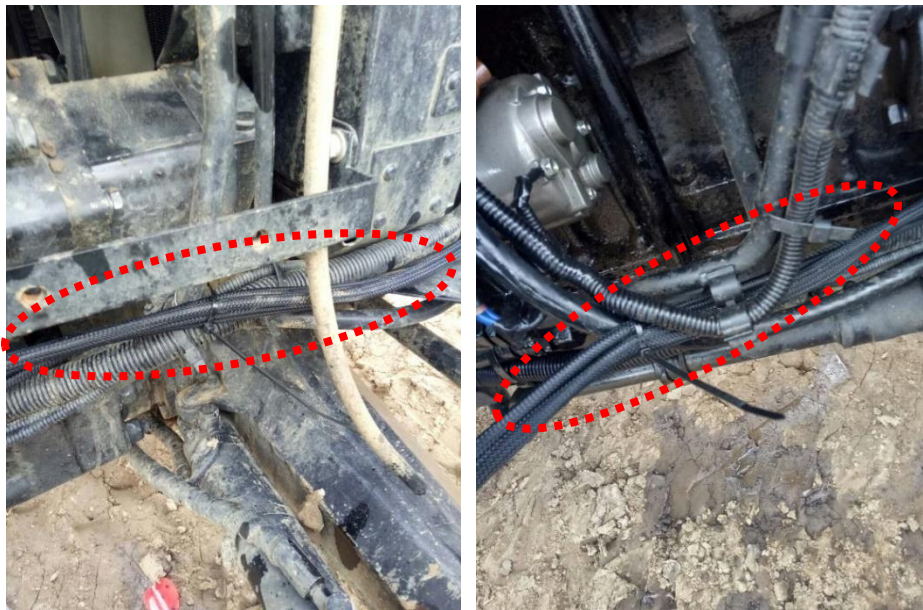


Figure 106 Bind the harness (1)



Figure 107 Bind the harness (2)

5 Commissioning the AutoSteer Systems

When the AG960 Auto Steering System is installed, commissioning is required to make sure that the performance of the autopilot can satisfy the operation requirement before the product is delivered to the user. The commissioning is divided into the following 5 steps.

- Power on the equipment
- Check the version of the program
- View the self-checking information of equipment
- Perform equipment setting-up
- Calibrate the equipment.

More details can be found in the following sections.

5.1 Power on Equipment

Prior to the power-on of the equipment, measure the battery voltage with a multimeter. If it is less than 12V, the tractor is under voltage. Start the engine to charge battery for certain time before the commissioning. This is to prevent the battery in under voltage status from continuously supplying power to the equipment and thus causing lack of power to start the engine or damage to the battery.

Press the gourd-shaped switch with hand to power on the equipment. When the gourd-shaped switch is pressed, the LED indicator on the switch turns on (blue). Observe that 8 LED indicators on the cover of the Autopilot (Controller) are all on (red or green) and the screen of panel computer is lightened too. Press the gourd switch again and the equipment is powered off. The LED indicators on the gourd-shaped switch and the Autopilot (Controller) turns off and the screen of panel computer turns off (The screen of panel computer is dependent on the model of the provided computer. If panel computer with lithium battery is provided, the panel computer should be turned on or off separately).

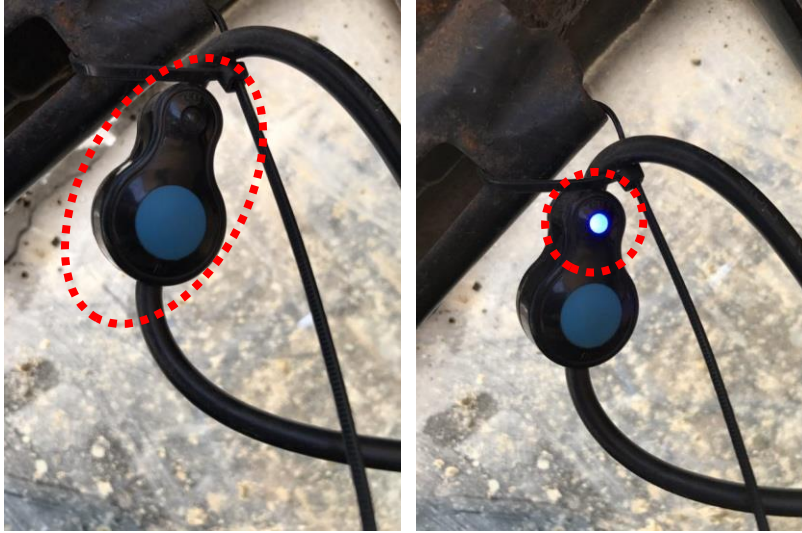


Figure 108 The LED indicator on gourd-shaped switch is off before power-on (left) and is on after power-on (right)

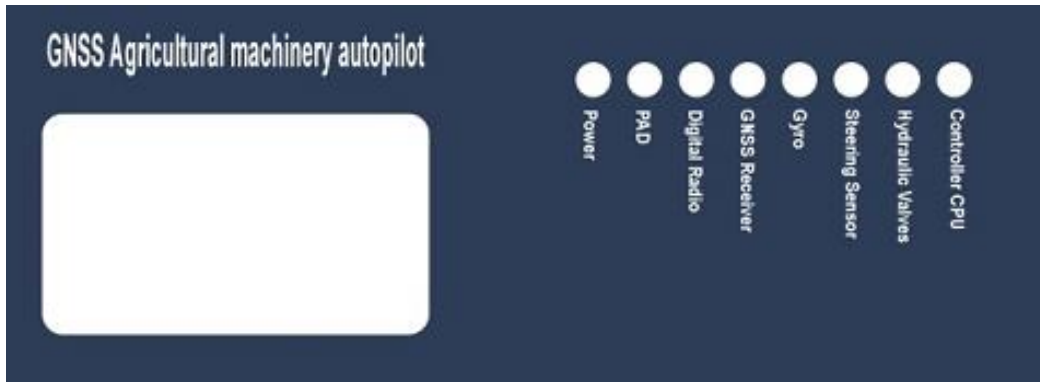


Figure 109 The LED indicators on Autopilot (Controller) are off before power-on (left) and is on after power-on (right)



Figure 110 The panel computer screen is off before power-on (left) and is on after power-on (right)

When the panel computer is switched on, the screen will display boot animation.



Figure 111 Initializing icon of AG960 on Display

When the initializing animation is over, the login screen is displayed.

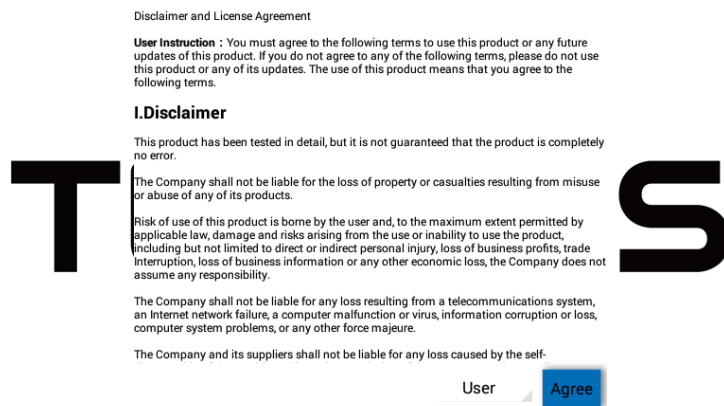


Figure 112 Login screen of panel computer

There is a pull-down menu at the right bottom corner of the login screen, which will display “User” as default. Directly touch the “Agree” button beside “User” to enter the user interface directly. Touch the pull-down menu to select “Technical Support” or “Developer”. Different login will require different operating authorization for the equipment.

- User interface. No password is required. Directly touch “Agree” to log in. All normal operation can be completed in the user interface.



Figure 113 Pull-down menu

- Technical support interface. Technical support password is required, which can be obtained from the distributor of autopilot. The commissioning and calibration, diagnosis and troubleshooting of the system can be performed in the technical support interface.

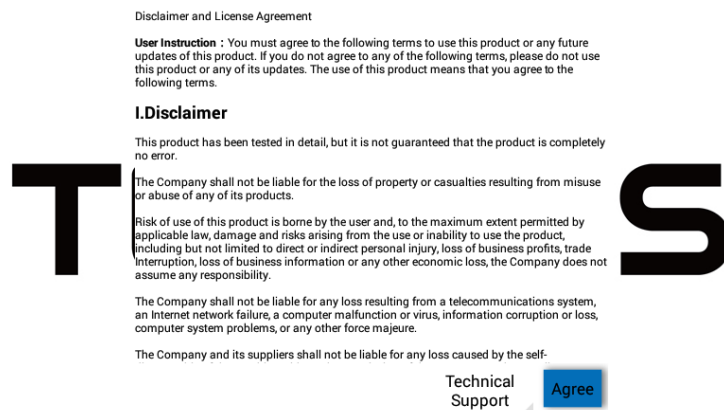


Figure 114 Select technical support

- Developer interface. Developer password is required, which is for the development and test of the product and is not available to the technical support personnel and users.

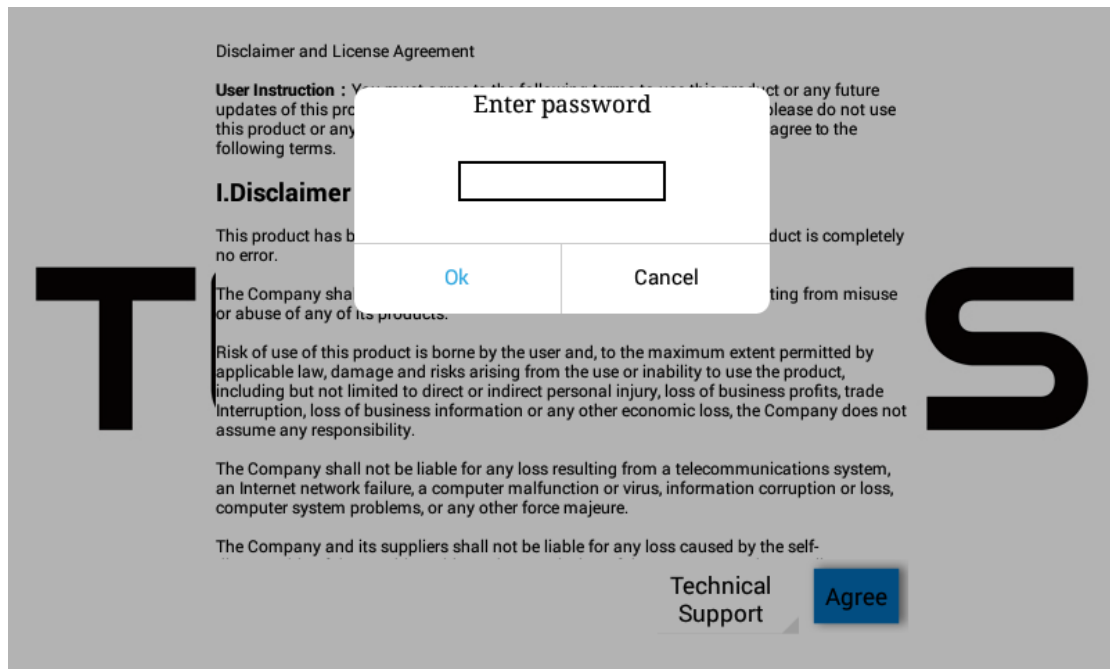


Figure 115 Password input box

To perform commissioning of the system, the technical support password is required to enter the technical support main interface as shown in the figure below. The main interface is divided into 6 display zones as below.

- Left side: main menu zone
- Lower part: instrument panel zone
- Right side: shortcut keys operation zone
- Upper part: display adjustment zone
- Middle: operation zone
- MANUAL/AUTO: switchover button.

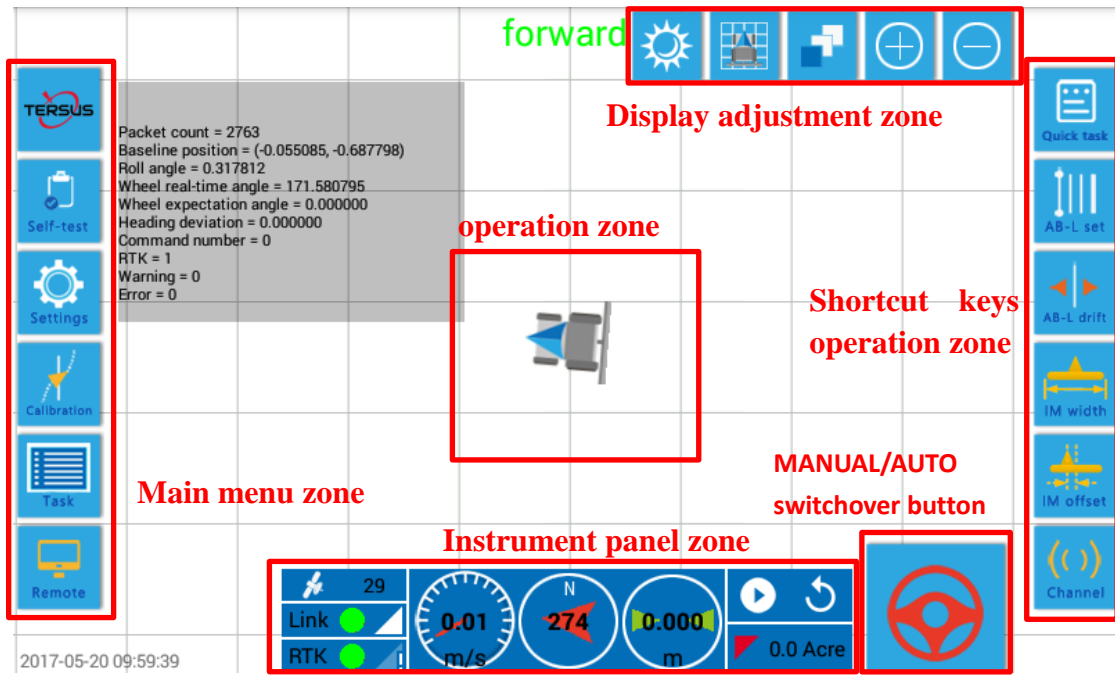













Figure 116 Main interface of technical support


Detailed explanations about the 6 zones are given below.


Table 4 Main interface of AG960 autopilot display



Item	Zone	Icon	Description	Function/Meaning
1.	Main menu zone		Manufacturer information	Touch this icon and a small window will pop up to display the manufacturer information, product information and program version of the equipment.
2.			Self-test	Touch this icon and a small window will pop up to display the self-diagnosis information to indicate if every component and assembly works well.
3.			Settings	Touch this icon to enter “Settings” screen to perform system setting, main machine setting, agriculture machine setting, farm tool setting and program updating. (Only agriculture machine configuration and farm tool configuration can be viewed in User interface.)



4.		Calibration	Touch this icon to enter the “Calibration” screen. When the system calibration is completed, the equipment can be delivered to the user for use. (This icon is ineffective in User interface).	
5.		Task	Touch this icon to enter the “Task” screen, where it is possible to set information relating to agriculture machine, driver and plot, establish operation task, load operation task and perform routine management of operation tasks.	
6.		Remote interaction	Touch this icon to enter “Remote interaction” screen. (This icon is ineffective in User interface).	
7.	Instrument panel zone		Satellite number	To indicate the number of navigation satellites from which the signals can be received currently.
8.			Radio status	To indicate whether the radio can receive signals from Beidou reference station. Red light means no reference station signals are received while green light means signals received. The strength of reference station signals received is indicated at the right side where full block is the most strong.
9.			Differential state	To indicate if now it is in centimeter level high precision RTK positioning status. Red light means it is not in RTK status and green light means it is in RTK status. The signal strength symbol at the right side indicates the connection status of 3G network.
10.			Vehicle speed	To indicate current speed in m/s. (The vehicle speed is shown in AP/h in User interface).

11.  Vehicle direction To indicate current direction the vehicle is heading, with 0° and 360° representing north, 90° east, 180° south and 270° west. (In user interface, the direction is indicated with text “east, south, west, north, southeast, southwest, northeast and northwest”.)

12.  Lateral deviation The most important information displayed. To indicate the error of current autopilot process, i.e. the lateral distance between vehicle rear axle center and current Line AB in meters (in centimeters in the User interface). As shown in the figure, when the left triangle occurs, it means deviation to the left side and when the right triangle occurs, deviation to the right.

13.  Acre counter To indicate current operation area that has already been finished in acre. The acre counter is set in such a way that it starts counting from the first autopilot operation ever since the Line AB is set and the area calculation is not affected by the power-off or other work during the operation until another Line AB task is started when the mu counter will be automatically reset.

Touch  button, the acre counter starts automatically and touch the button again to pause; touch  button, the acre counter is reset and restarts counting immediately.

14. 
 Manual/Auto switchover The most important operation button. The steering wheel icon in the middle of the button will switch among three colors, namely white, red and green. White: It means the vehicle is now in



manual operation and is allowed to switch to auto operation;

Red: It means the vehicle is now in manual operation and is not allowed to switch to auto operation (in any of the following cases: no task is established, no Line AB is set, or the vehicle is too far from the Line AB (2m), or the vehicle has an oversized angle with Line AB (30 °));

Green: The vehicle is now in auto operation.

Rules of switching:

When the icon is white, touch the button and the autopilot takes over the steering control of the agriculture machine immediately. Now the driver can release the steering wheel and the agriculture machine will run along the specified route automatically. When the icon is red, it is ineffective to touch the icon. When the icon is green, touch the symbol and the autopilot gives up the steering control of the agriculture machine and the vehicle now is in manual operation.

15. Shortcut operation area



Establish a shortcut task






Touch the icon and the system will automatically establish a new task, which is named after current Beijing time automatically by the system. The user can find the task in "Operation" screen in the main menu zone later and load the task to continue the work. For example, "20161023153207" means a task established at Beijing time 15:32'07" p.m. dated October 23th, 2016.







16.



Set Line AB

Touch this icon to establish a Line AB. The icon is effective only when a task is established or loaded, that is, there is an

17.		Line AB drift	<p>existing current task.</p> <p>Touch this icon to shift current Line AB for specified distance to the left or right. Note: When the Line AB is shifted, it will be saved in the database of the system and any Line AB task later will be planned based on the shifted AB. Touch the icon to show three options: shift to left, shift to right, shift to current position. The user can make choice as desired.</p>	
18.		Implement width	<p>Touch the icon to quickly set the operation width of the farm tool.</p>	
19.		Implement offset	<p>Touch the icon to quickly set the shift of the farm tool. The purpose of farm tool shift is to adjust the border row.</p>	
20.		Channel number	<p>Touch the icon to quickly switch current channel number of the radio.</p> <p>In case of stationary reference station, when the agriculture machine moves from near one reference station to near another reference station during the operation, it can switch the channel to the nearest reference station so as to achieve better quality of reference station signals.</p> <p>In case of portable reference station, when the quality of received signals decreases due to interference, the channels of reference station and autopilot can be switched simultaneously so as to improve the signal quality.</p>	
21.	<p>Display adjustment</p>		Day/night	<p>Touch the icon to switch between display modes of day or night. In day mode, the screen uses a white background to display clearly in the sunlight; in night mode, the screen uses a black background to prevent the light from the screen affecting the view</p>

22.		Grid display	of the driver. Touch the icon to show or hide the grid on the screen background.
23.		Operation highlighting	Touch the icon to show or hide the operation highlighting information on the screen. When the operation highlighting function is ON, the operated area will be in green color, while that not operated will be in the background color. For tasks where it is difficult to discern operated or unoperated area, such as insecticide spraying, fertilizing etc., this function can provide instruction and thus is greatly helpful.
24.		Zoom	 Touch icon to zoom in the display element in the middle of the screen; touch  icon to zoom out the display element in the middle of the screen.
25.	Operation area		Agriculture machine This abstract icon is to indicate current position and direction of agriculture machine.
26.	Task Name: 170520141119	Task name	To indicate the name of current task.
27.	2017-1-12 17:8:21	Current time	To indicate current Beijing time.

If fault occurs during the power-on process of the equipment, eliminate the fault by the following means.

- During power-on, the LED lights of gourd-shaped switch and Autopilot (Controller) and screen of panel computer are all OFF
 - Check if the battery terminals of drive harness are correctly connected to the “+”, “-“ terminals of battery, and if they are inversely connected
 - Check if the battery terminals of drive harness is securely connected to the

- battery
 - Check if the battery still has voltage ($\geq 12V$)
 - Replace the drive harness
 - Contact the distributor or FAE department of manufacturer.
- During power-on, the LED light of gourd-shaped switch is ON while the LED light of Autopilot (Controller) and the screen of panel computer both are OFF
 - Check if the battery still has voltage ($\geq 12V$)
 - Check if the drive harness (black end harness) and data harness (white end harness) are inversely connected
 - Disconnect and reconnect the connection between the drive harness and the Autopilot (Controller)
 - Replace drive harness
 - Replace Autopilot (Controller)
 - Contact the distributor or FAE department of manufacturer.
- During power-on, both the LED light of gourd-shaped switch and the LED light of Autopilot (Controller) are ON, while the screen of panel computer is OFF
 - Press the gourd-shaped switch to power on the equipment again
 - Disconnect and reconnect the connection between the data harness and the Autopilot (Controller)
 - Disconnect and reconnect the connection between the data harness and the panel computer
 - Replace data harness
 - Replace the panel computer
 - Replace Autopilot (Controller)
 - Contact the distributor or FAE department of manufacturer.

5.2 Check Program Version

Enter the main interface, first touch the topmost icon “Manufacturer information”




in the menu zone at the left side and a block pops out from the left upper corner of the screen, as shown in the figure below.



Figure 117 Check the firmware version number at “About us”

In this screen above, the user may view the program version of AG960.

5.3 View Self-test Information

Touch “Self-test” icon  in the main interface to view the self-test information of the equipment.

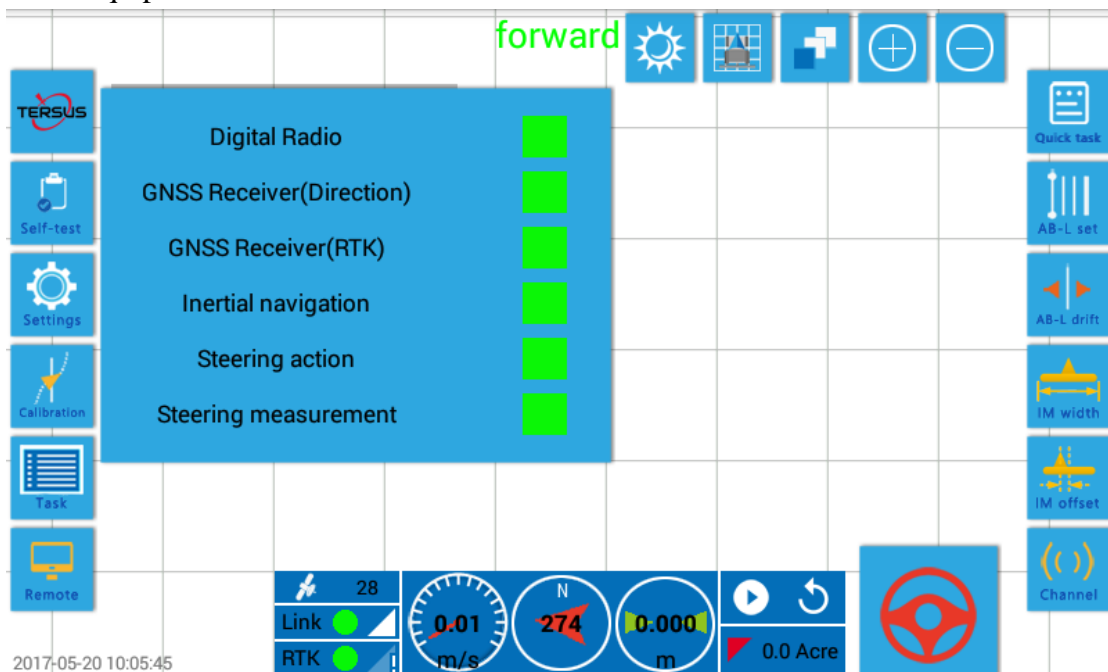


Figure 118 View self-test information of equipment

The self-test information shows the status of main components and assemblies of the autopilot. Green icon at the right side means the component or assembly is normal and the self-test is acceptable. Red icon means abnormal status and troubleshooting is required.

If all icons shown in the self-test information are green, it means the self-test is acceptable. If there is any red icon, please see to indication below.

➤ Red self-test icon for data transfer radio

It means the data transfer radio cannot receive signals from the reference station. Eliminate the fault according to the following procedures.

- Make sure the vehicle is in an open area outdoor, and there is no obvious obstacle around or above the agriculture machine
- Check if a reference station is established near the location of vehicle
- Check if the reference station works normally and the signals are available
- Check if the vehicle is too far away from the reference station (stationary station: $\leq 20\text{km}$, portable station: $\leq 3\text{km}$)
- Check if the radio of the autopilot is correctly set (see section 4.4.1)
- Check if the radio receiving antenna is correctly installed to the driving cab top
- Check if the RF connector of radio receiving antenna hanging from the driving cab top is correctly connected to the “radio antenna” socket on the front panel of the Autopilot (Controller)
- Check if the RF connector is securely connected
- Replace the radio receiving antenna
- Replace the Autopilot (Controller)
- Contact the distributor or FAE department of manufacturer.

➤ Red self-test icon for GNSS receiver (direction-finding)

It means the GNSS receiver does not accomplish the function of direction finding. Eliminate the fault according to the following procedures

- Make sure the vehicle is in an open area outdoor, and there is no obvious obstacle around or above the agriculture machine
- Check if the receiver of the autopilot is correctly set
- Check if both satellite navigation antennas are correctly installed to the driving cab top
- Check if the RF connection of both satellite navigation antennas are secure;
- Check if the RF cable connectors of both satellite navigation antennas hanging from the driving cab top are correctly connected to “GNSS primary

antenna” and “GNSS secondary antenna” sockets on the front panel of the Autopilot (Controller)

- Check if the RF connectors are securely connected
- Replace both satellite navigation antennas and corresponding RF cables
- Replace the Autopilot (Controller)
- Contact the distributor or FAE department of manufacturer

➤ Red self-test icon for GNSS receiver (RTK)

It means the autopilot cannot achieve the centimeter-level high precision positioning against the reference station. Eliminate the fault according to the following procedures

- Make sure data transfer radio icon is green
- Make sure GNSS receiver (direction finding) icon is green
- If both 1) and 2) are green, and GNSS (RTK) is still red after waiting for 5min, power off and restart the autopilot and wait another 5min
- Replace the Autopilot (Controller)
- Contact the distributor or FAE department of manufacturer

➤ Red self-test icon for inertial navigation unit

- Power off and restart the autopilot and wait another 5min
- Replace the Autopilot (Controller)
- Contact the distributor or FAE department of manufacturer.

➤ Red self-test icon for steering actuator

- Check if the hydraulic valve drive terminal of drive harness is correctly connected to the hydraulic valve
- Check if the hydraulic valve drive terminal of drive harness is securely connected to the hydraulic valve
- Check if the pressure sensor terminal of drive harness is securely connected to the hydraulic valve
- Replace the hydraulic valve
- Replace the Autopilot (Controller)
- Replace the drive harness
- Contact the distributor or FAE department of manufacturer

➤ Red self-test icon for steering measuring mechanism

- Check if the steering measuring mechanism terminal of drive harness is correctly and securely connected to the steering measuring mechanism
- Replace the steering sensor

- Replace the drive harness
- Replace the Autopilot (Controller)
- Contact the distributor or FAE department of manufacturer.

5.4 Set up the Equipment



AG960 is set up by 5 steps as following.

- System setting. To set the model of main components and assemblies of the autopilot
- Host setting. To set the installation position and orientation of the Autopilot (Controller) on the agriculture machine
- Antenna setting. To set the installation position and orientation of the satellite navigation antenna
- Vehicle setting. To set the dimensional parameters of the vehicle
- Implement setting. To set the dimensional parameters, connecting positions, operation width parameters of implements.

In addition, the autopilot program needs to be updated in some special cases; details of program updating process will also be given in this section.

5.4.1 System Setting



Touch “Setting” icon  in the main menu zone at the left side of the screen to enter the setting screen, as shown in the figure below. The setting screen further has 6 sub-screen from left to right, namely “System setting” (Default sub-screen after entering the setting screen), “Host setting”, “Antenna setting”, “Vehicle setting”, “Implement setting” and “Program updating”. Touch corresponding icon at the top of the screen to enter each sub-screen. There is a “Back” button  at the left upper corner of the screen. Touch this icon to exit from the setting screen and enter the main interface of the panel computer.

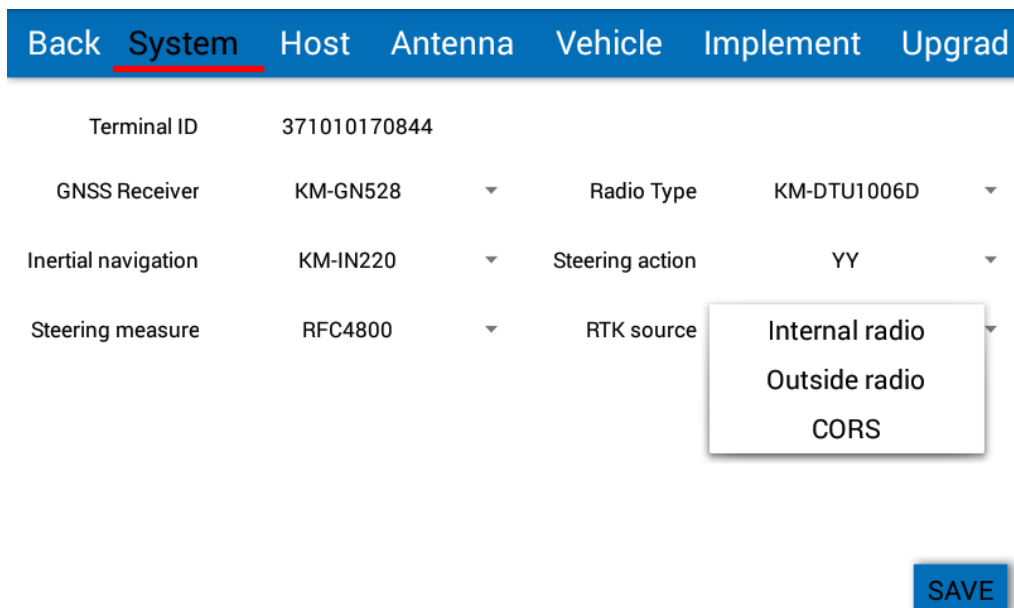


Figure 119 Setting screen

The sub-screen “System” shows the unique ID number of the AG960 and the name of every main components and assemblies, followed by corresponding pull-down menu for model selection. With modular design, AG960 can easily select GNSS high precision board card, data transfer radio module, inertial sensor, steering actuator and steering measuring mechanism etc. from different manufacturers so as to provide personalized and customized products for the distributors and users.

Each autopilot is provided with a unique ID number when delivered and neither the technical support nor the user has authorization to reset the ID number.

Except in some special cases, each autopilot has completed the setting of models of components and assemblies when delivered. Neither the technical support nor the user needs to reset models except for “RTK data source”.

The setting of RTK data source is used to select the source of differential reference information required for centimeter-level high precision positioning of autopilot and the options available are internal radio, external radio and CORS network.

5.4.1.1 RTK Data Source

If internal radio of Autopilot (Controller) is used (as in most applications), select “433MHz radio (internal)” as “RTK data source” and now the lower part of the sub-screen “System” will display setting options of internal radio. Set “Channel” at the pull-down menu to current transmitting channel number used by the reference

station currently available. For example, when the transmitting channel of reference station is “Channel 2”, set “Channel” of such internal radio to “Channel 2”.

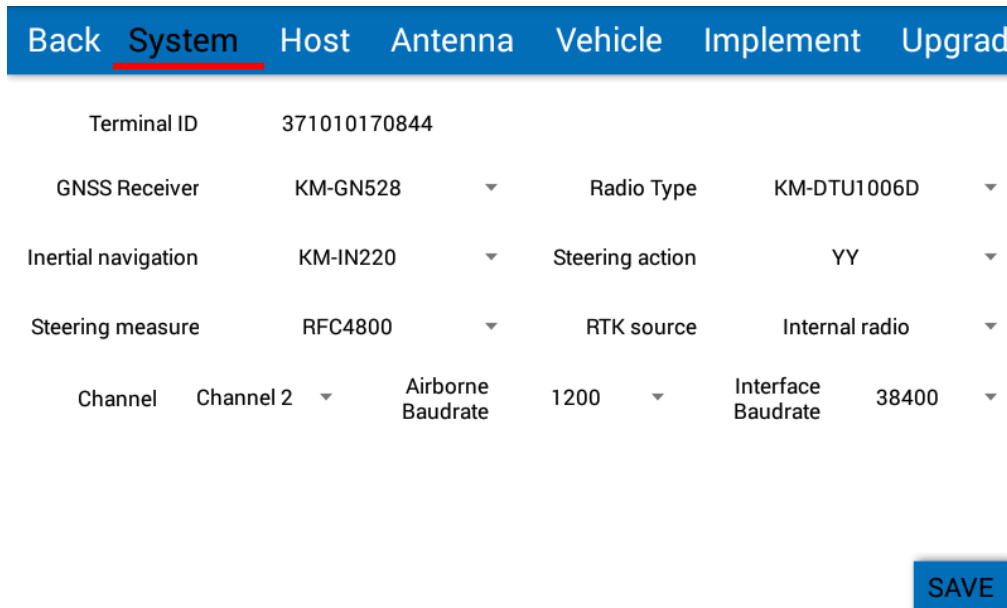


Figure 120 System setting screen to select “433MHz radio (internal)” as “RTK data source”

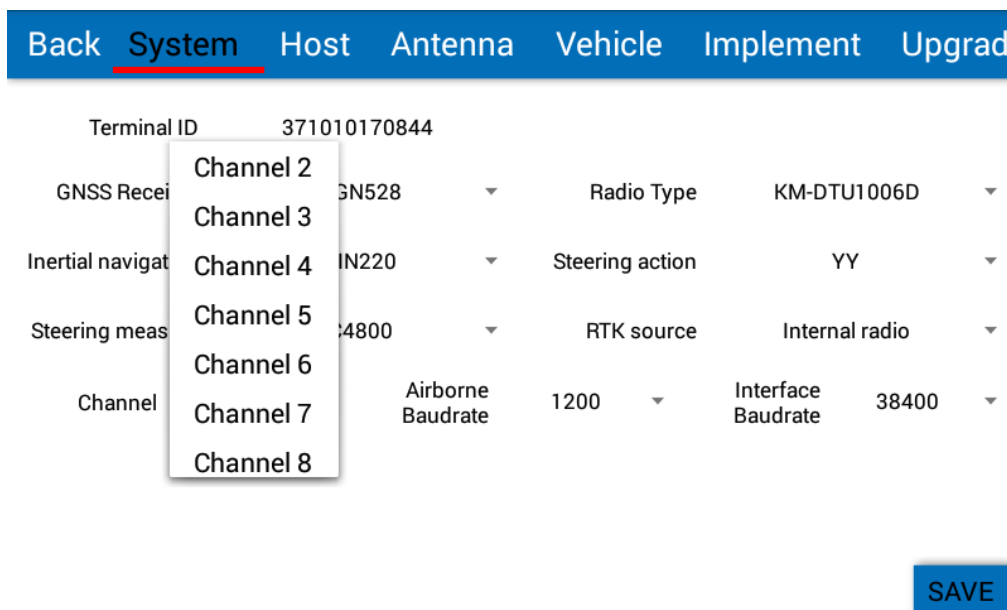


Figure 121 Select channel number of internal radio

5.4.1.2 External Radio

If external radio is used, select “433MHz radio (external)” as “RTK data source”, and now there is no radio setting options available at the lower part of the sub-screen “System”.

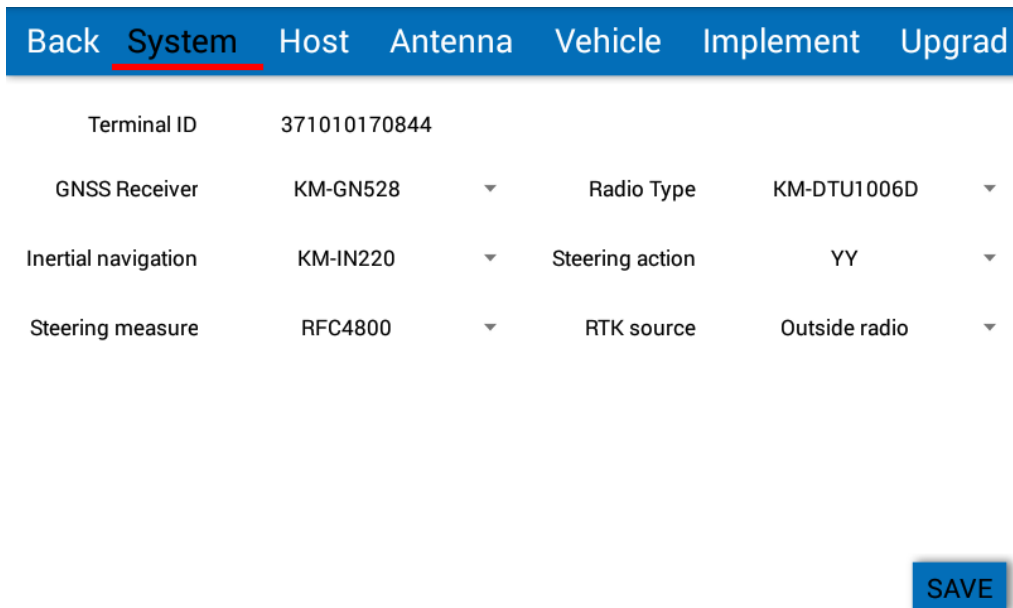


Figure 122 System screen to select “433MHz radio (external)” as “RTK data source”

5.4.1.3 CORS Network

If CORS network is used, select “CORS network” as “RTK data source” and now the lower part of the sub-screen “System” will provide setting options of CORS network, such as account, password, server ID, port number etc. The user can perform the setting via the purchased account and password of local CORS network.

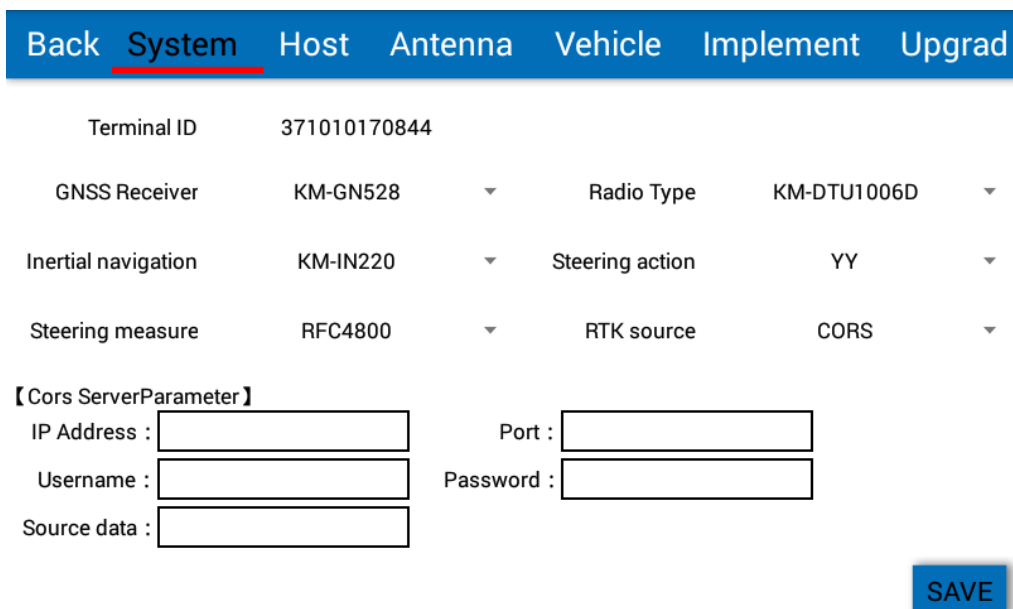









Figure 123 Screen to select “CORS network” as “RTK data source”



It must be noted that because the autopilot in “CORS network” mode should have access to the Internet, 3G SIM card should be purchased from a local mobile communication operators. Insert the card into the SIM card slot of the panel computer

and pay the traffic cost on time. In this way can the “CORS network” be used.


When the setting of RTK data source is completed, touch “Back” button to exit from the setting screen. Observe three icons at the left-most position in the instrument panel zone at the lower part of the main interface, and the followings can be found.

- “Satellite number” icon . For example, , which means now the autopilot receives signals from 26 navigation satellites
- “Radio status”  icon. If the red light turns green, for example, , it means the autopilot receives signals from GNSS reference station
- “Differential state” icon . When the red light turns green, for example, , it means the autopilot has achieved centimeter level high precision positioning

If CORS network is used as RTK data source, the user can also observe that the icon  is followed by “CORS”.

When the RTK data source is correctly set, if “Radio status” icon  and “Differential status” icon  are still red, it means the equipment has fault.

5.4.2 Host Setting - Autopilot (Controller)

When the “System setting” is completed, touch “Host setting” button  at the upper part of the setting screen to enter the sub-screen “Host setting” as shown in the figure below.

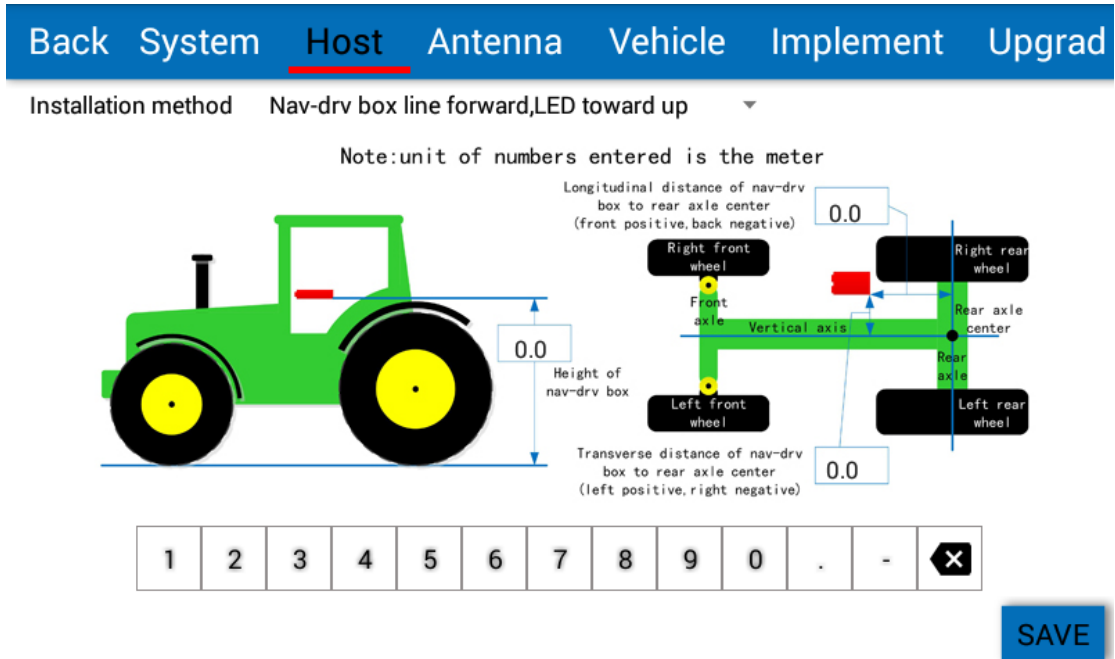


Figure 124 Sub-screen of “Host setting”

The “Host” in the screen is indicating as “Autopilot (Controller)”.

The sub-screen “Host setting” is used to set the installation position and orientation of the Autopilot (Controller) on the tractor.

To install the Autopilot (Controller) on the tractor, it is required three sides perpendicular to each other starting from the same angle of the Autopilot (Controller) should be parallel with the coordinate system of the tractor (With rear axle center of vehicle as the origin, vehicle rear axle as X axis, vehicle longitudinal axle as Y axis and the half-line starting from vehicle rear axle center pointing to sky as Z axis).

5.4.2.1 Set Installation Orientation of Autopilot (Controller)

Select the installation orientation of main machine based on the actual orientation of the Autopilot (Controller). Touch the pull-down menu of installation orientation of main machine and make the choice as per the actual conditions. The pull-down menu provides 8 options for the installation orientation as below.

- Main machine line outlet forward, LED light face upward
- Main machine line outlet forward, LED light face downward
- Main machine line outlet forward, LED light face left
- Main machine line outlet forward, LED light face right
- Main machine line outlet upward, LED light face forward

- Main machine line outlet upward, LED light face backward
- Main machine line outlet upward, LED light face left
- Main machine line outlet upward, LED light face right.

Where, the six directions, namely upward, downward, forward, backward, left and right are determined as the driver views from the seat in the driving cab.



Figure 125 Main machine line outlet forward, LED light face upward (left); main machine line outlet forward, LED light face right (right)





Figure 126 Main machine line outlet upward, LED light face forward (left); main machine line outlet upward, LED light face right (right)

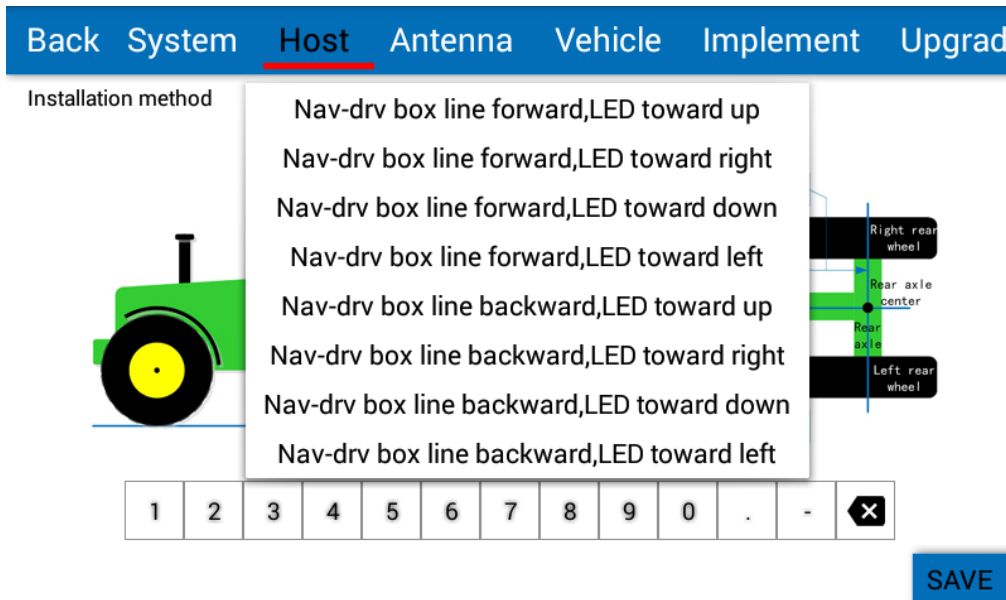


Figure 127 Open the pull-down menu for installation orientation of main machine for selection

5.4.2.2 Set the Installation Position of Autopilot (Controller)

Place the vehicle on a level plane. Measure the coordinate of the reference point on the Autopilot (Controller) in the coordinate system of the tractor with spirit level, plumb line and measuring reel, that is, measure the distances between the reference point of Autopilot (Controller) to the projection point of vehicle rear axle center on the ground in lateral, longitudinal and height directions. Enter three distances into corresponding number boxes according to the instruction on the sub-screen “Main machine setting”. Touch “Save” button to save the installation parameters of the main

machine.



Figure 128 Reference point on Autopilot (Controller)

5.4.3 Antenna Setting

When the “Host setting” is completed, touch the “Antenna setting” button [Antenna](#) at the upper part of the setting screen to enter the sub-screen “Antenna setting” as shown in the figure below.

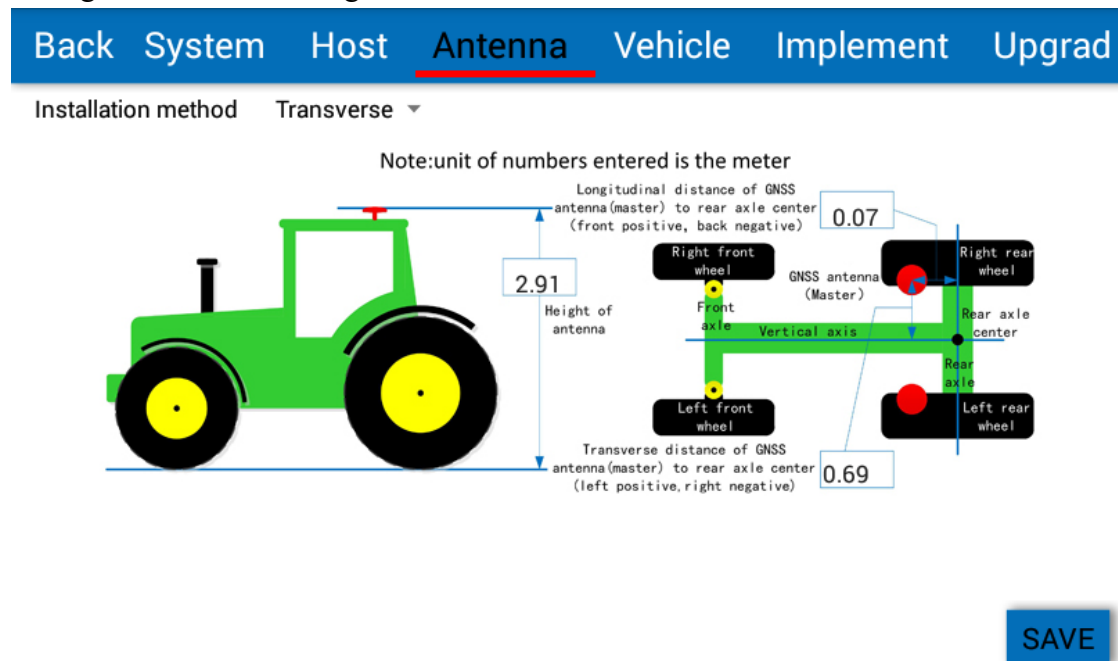


Figure 129 Sub-screen “Antenna setting”

The sub-screen “Antenna setting” is used to set the installation position and orientation of satellite navigation antenna on the tractor.

5.4.3.1 Set Installation Orientation of Antenna

Select the installation orientation of antenna based on the actual orientation of two satellite navigation antennas. Touch the pull-down menu “Antenna installation

method” to make the choice according to the actual conditions. The pull-down menu provides 2 options for the installation orientation as below.

- Lateral. Primary antenna at right and secondary antenna at left
- Longitudinal. Primary antenna in the back and secondary antenna in the front.



Figure 130 Example of lateral installation of antenna on the agriculture machine

5.4.3.2 Set Installation Position of Antenna

Select the installation orientation of antenna based on the actual orientation of two satellite navigation antennas. Touch the pull-down menu “Antenna installation method” to make the choice according to the actual conditions. The pull-down menu provides 2 options for the installation orientation as below.

Place the tractor on a level plane. Measure the coordinate of the geometrical center of the mushroom head of primary antenna in the coordinate system of the tractor with spirit level, plumb line and measuring reel, that is, measure the distances between the geometrical center of the mushroom head of primary antenna to the projection point of tractor rear axle center on the ground in lateral, longitudinal and height directions. Enter three distances into corresponding number boxes according to the instruction on the sub-screen “Antenna setting”. Touch “Save” button to save the installation parameters of the antenna.

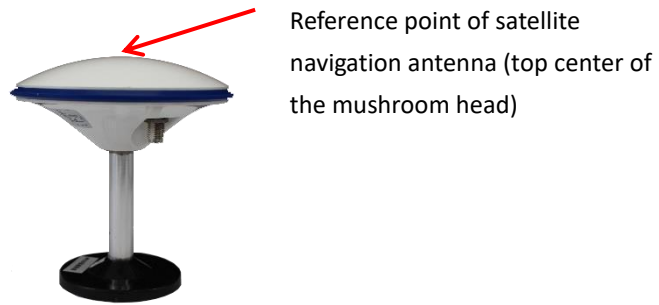


Figure 131 Reference point for measuring position of satellite navigation antenna

5.4.4 Vehicle Setting

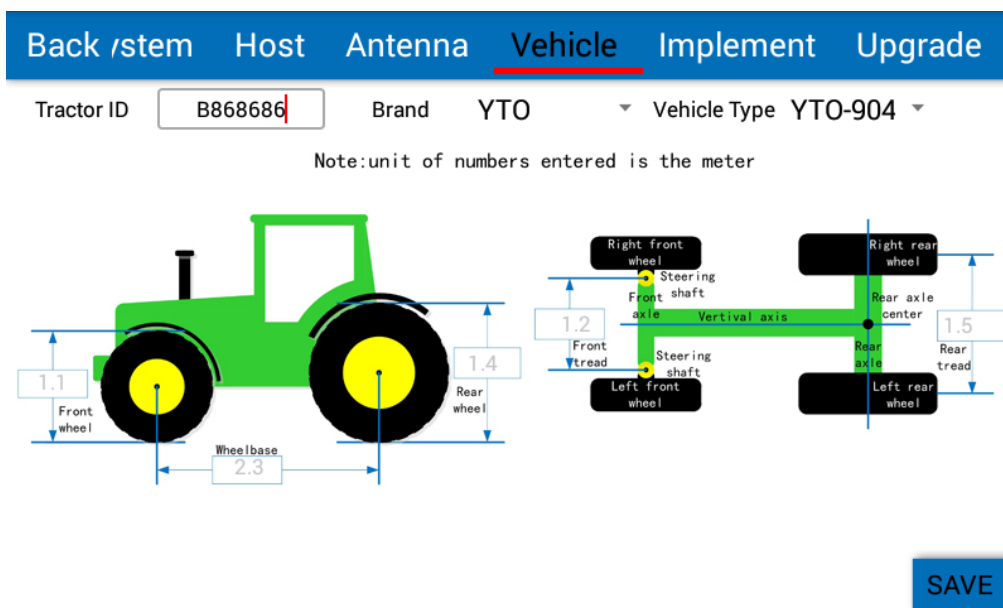


Figure 132 Sub-screen “Vehicle setting”, front wheels

The sub-screen “Vehicle setting” is used to set the geometrical parameters of the machine, including the following 5 parameters.

- Wheel base: the horizontal distance from the front axle to the rear axle of vehicle
- Front wheel diameters: the diameter of vehicle front wheels
- Rear wheel diameters: the diameter of vehicle rear wheels
- Front wheel spread: the horizontal distance between left and right knuckles of the front wheels
- Rear wheel spread: the horizontal distance between the centers of left and right tyres of the rear wheels.

Place the tractor on a level plane and measure the above-mentioned 5 parameters with a measuring reel. Create an vehicle model and fill the data into corresponding number

boxes. Touch the button “Save” to finish the setting of machine. Meanwhile the license plate number can be entered to facilitate the management. In addition, if the machine installed can be found in the pull-down menu of “Vehicle models”, it is unnecessary to measure the parameters. In such cases, the machine setting can be completed by directly selecting the specific model of the machine.

5.4.5 Implement Setting

When the “Vehicle setting” is completed, touch the button “Implement setting” **Implement** at the upper part of the Setting screen to enter the sub-screen “Implement setting” as shown in the figure below.

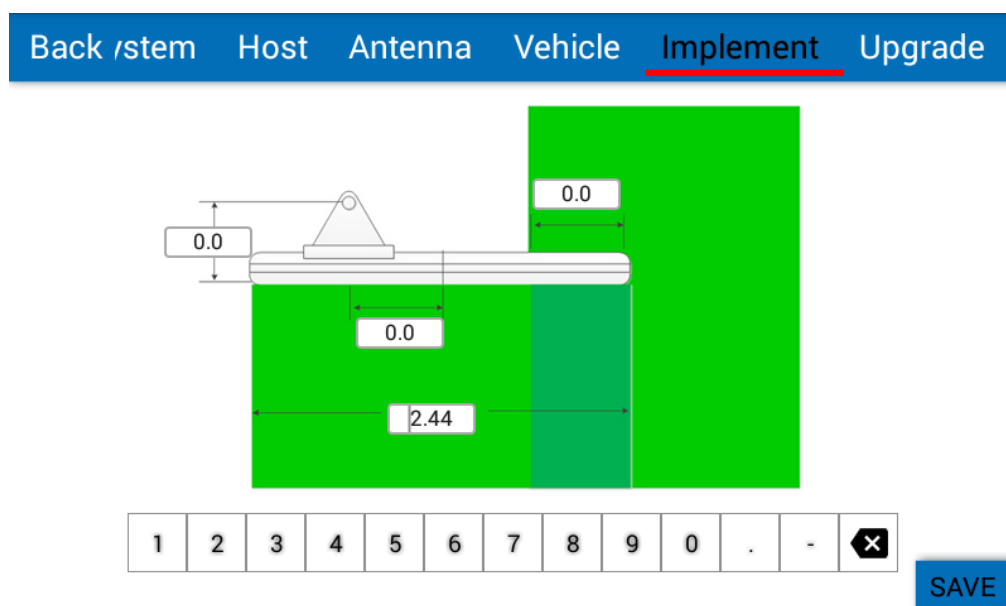


Figure 133 Sub-screen “Implement setting”

In the sub-screen “Implement setting”, fill each measured parameter of the farm tool in the number box to finish the implement setting as below.

- The longitudinal distance from the implement to the hanging point
- The lateral shift of implement
- The operation width of implement
- The operation width overlap of implement

The number filled into every number box is in meters. When all numbers are entered, touch “Save” button to save the implement parameters.

5.4.6 Program Update

For commissioning of the system in normal conditions, it is usually unnecessary to update the system by entering the sub-screen “Program update”. Under some special conditions, if program update is required, enter the sub-screen “Program update” of setting screen.

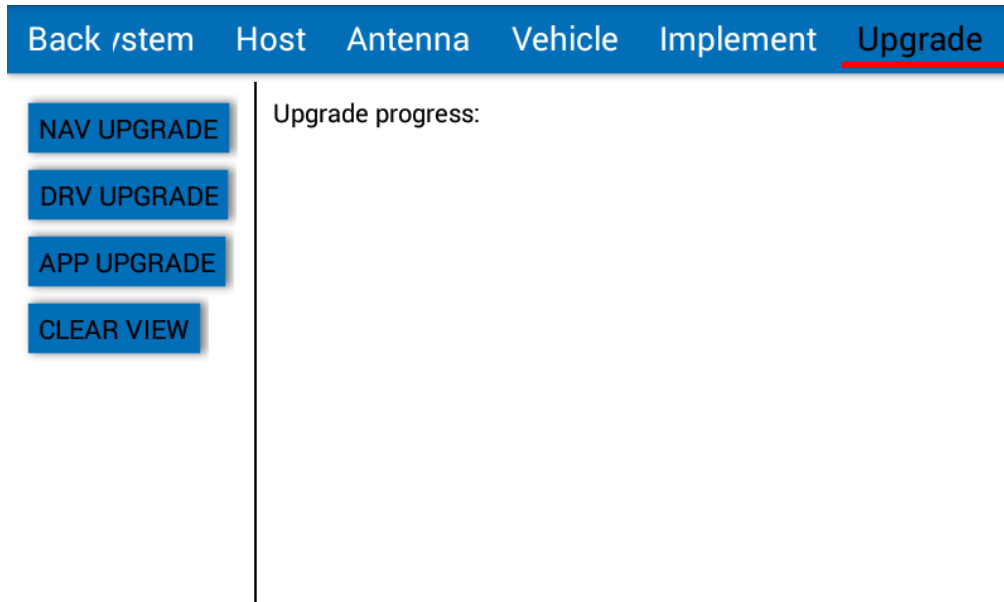


Figure 134 Sub-screen “Program update”

To update the program of AG960, insert the special updating flash disk into the USB port of the panel computer, which can be obtained from the distributor or the manufacturer. If SIM card is inserted into the panel computer, the program can also be updated through the Internet.

When the special updating flash disk is inserted to the USB port of the panel computer, touch buttons “Navigation update”, “Drive update”, “APK update” successively in the sub-screen “Program update” to update the system.

5.5 Calibration of the Equipment

When the setting of equipment is completed, calibration of the equipment is required before delivery to the user. During the calibration process, all the self-checking information of equipment must be normal. The calibration activity requires a flat road or farmland without inclination being at least 5m wide and 100m long.



Figure 135 Flat farmland acceptable for equipment calibration




Figure 136 Flat road acceptable for equipment calibration

AG960 is calibrated in the following steps.

- Calibration zeroing: Perform zeroing for calibration
- Guide wheel calibration: Calibrate the steering range of the guide wheel
- Attitude calibration: Calibrate the attitude of roll and pitch
- Steering sensitivity calibration
- Driver sensitivity calibration
- System deviation calibration
- Farming vehicle deviation calibration
- Farmland autopilot test

5.5.1 Calibration Reset

In the main interface of the technical support, touch the button “Calibration”  at



the left side of the screen to enter the calibration screen, where 8 small icons will pop out, as shown in the figure below.

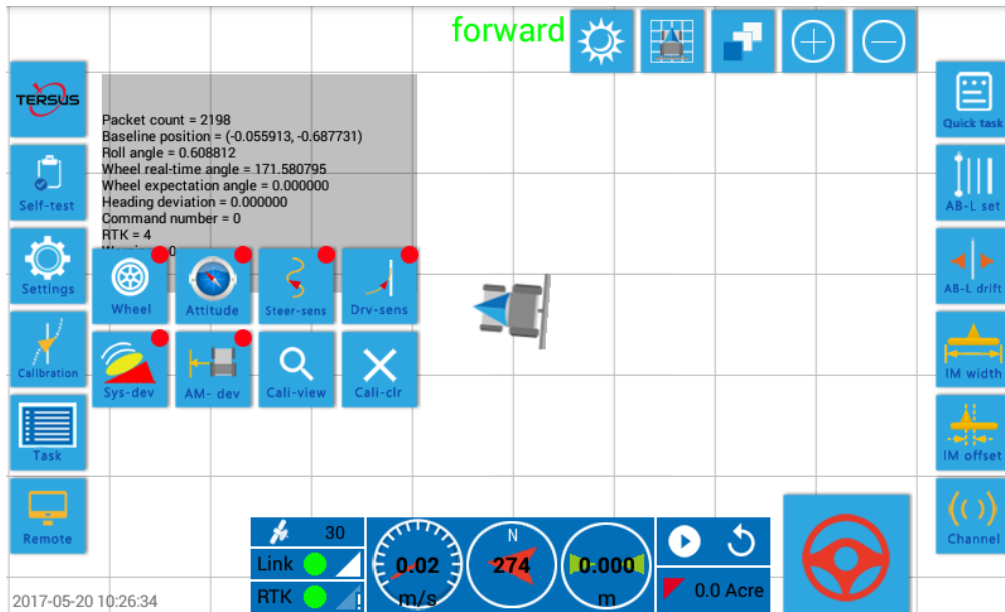












Figure 137 Calibration screen

Table 5 Definition of icon in the calibration screen

Item	Icon	Description	Function/Meaning
1		Guide wheel	Calibrate the steering range of the guide wheel
2		Attitude	Calibrate the attitude of roll and pitch
3		Steering sensitivity	Calibrate steering sensitivity
4		Driver sensitivity	Calibrate Driver sensitivity
5		System deviation	Calibrate system deviation

6		Agricultural machine deviation	Calibrate farming vehicle deviation
7		View calibrated value	View the results of calibration
8		Calibrated value clear	Clear calibration details

The red point at the right upper corner of the button means “This step of calibration is not finished yet” and the green point means “This step of calibration is finished”.


If it is the initial calibration of the product after the equipment is installed, first touch the zeroing button  to eliminate the calibration data left by the pre-delivery test of the product, where the calibrated value of guide wheel, attitude, system deviation and farming vehicle deviation are all zeroed and both the steering sensitivity and the Driver sensitivity are reset to the default value at delivery. When the zeroing button  is pressed, all the green points on other buttons representing calibration steps will turn red, indicating that this calibration step is not performed.

It must be noted that when all calibration are finished, if some steps have to be separately calibrated under some special conditions, the calibration of a preceding step may turn succeeding steps ineffective (the green point on the calibration icon turns red) and re-calibration of such succeeding steps is required. But the calibration of a succeeding step will not turn preceding steps ineffective.

- Touch “Calibration Zeroing” button: Calibration of all steps turns ineffective and re-calibration is required
- Separate calibration of “Guide wheel”: The calibration value of “System deviation” becomes ineffective and re-calibration is required
- Separate calibration of “Attitude”: The calibration value of “Farming vehicle deviation” becomes ineffective and re-calibration is required
- Separate calibration of “Steering sensitivity”: The calibration value of “Driver sensitivity” becomes ineffective and re-calibration is required.

5.5.2 Guide Wheel Calibration

When the calibration zeroing is done, first perform guide wheel calibration. The purpose of calibration is to obtain the maximum angle value of the left and right steering of guide wheel and the middle point of the guide wheel during the straight line driving of farming vehicle.

Touch the guide wheel steering range calibration button  in the calibration screen, and the sub-screen as shown in the figure below pops out in the screen.

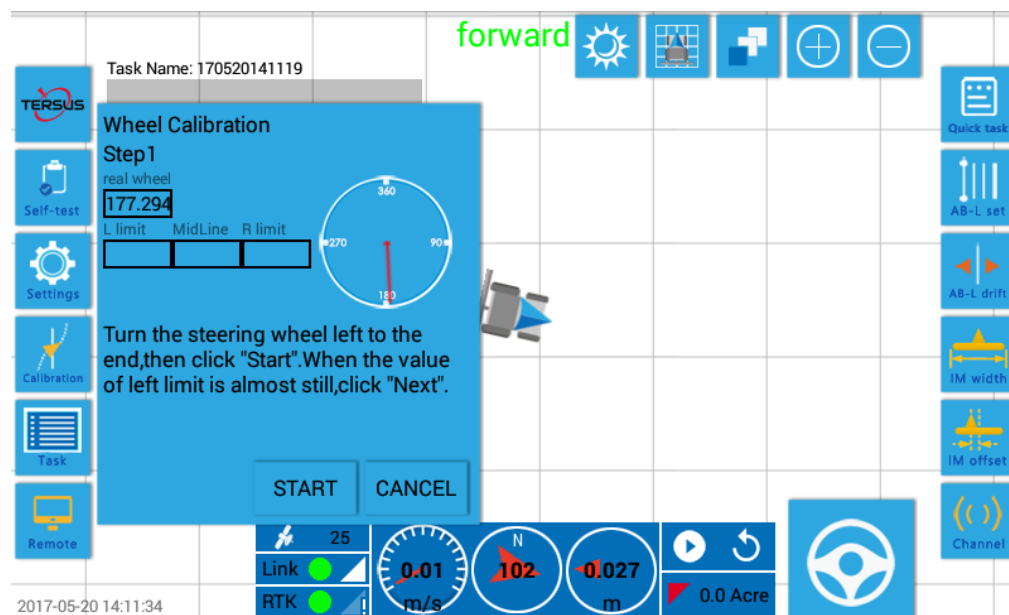
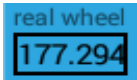




Figure 138 Sub-screen popping out for guide wheel calibration

In this sub-screen,  box contains numerical values to indicate the real-time


angle of guide wheel,  uses a pointer to display the real-time angle of guide

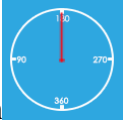
wheel, and  shows the left & right limit and middle point information of guide wheel obtained during the operation according to relevant instructions. AG960 measures the guide wheel angle with 360° non-contact sensor, therefore, the value of guide wheel angle ranges from 0° to 360°.

Calibration of the steering range of guide wheel can be completed by following the instructions in the sub-screen of guide wheel steering range calibration.

5.5.2.1 Prior to Calibration, Observe if the Guide Wheel Angle is Normal

Start the engine, and continuously turn the steering wheel left and right to the limit.

During the process, observe if the numerical information in  and the pointer

in  change in a continuous and gradual way, and if they are consistent with the actual change of guide wheel steering witnessed. If the number or pointer change in an abrupt way or does not correspond to the steering witnessed, eliminate the fault according to the following procedures.

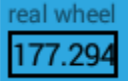
- Check if the drive harness and the steering sensor are securely connected.
- Check if the steering measuring mechanism is correctly installed.
- Observe if the steering measuring mechanism has any interference with or impact on the front axle and knuckle of the farming vehicle.
- Unscrew the screws on the guide wheel knuckle, remove the flange seat of the steering sensor, and check if 5 cross recessed countersunk head screws at the back of the seat are secure without swaying.
- Turn the stop plate of the steering sensor and check if the numerical information

in  and the pointer in  have any change.

- Unscrew 2 inner hexagon screws at the top of the steering sensor, dismantle the sensor from the structure and check if the cylindrical magnet is secure without swaying.
- Replace the steering sensor.
- Replace the drive harness.
- Replace the Autopilot (Controller).
- Contact the distributor or FAE department of the manufacturer.

5.5.2.2 Prior to Calibration, Check if the Guide Wheel Angle Surpasses the Zero Point

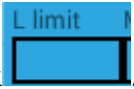
During the process, observe the real-time information of guide wheel angle in

. If the real-time angle of guide wheel surpasses 0° and 360°, unscrew the

screws on the knuckle on the guide wheel, remove the flange seat of the steering sensor, rotate the flange seat of the steering sensor by 120 °(for round flange seat) or 180 °(for rectangle flange seat) and reinstall the flange seat to the knuckle of the guide wheel.

5.5.2.3 Calibration Step 1

Turn and hold the steering wheel to the left limit and touch “Start” button. When the numerical value in the number box of left limit is almost constant, touch “Next step” button to obtain the left limit angle of the guide wheel. Such numerical value will be

shown in “Left limit” box .

Note: If the steering gear of the tractor has leakage, it will cause a returning tendency of the guide wheel at the left limit position. In this case, it is required to keep turning the steering wheel left in order to maintain the guide wheel angle at the left limit position.)

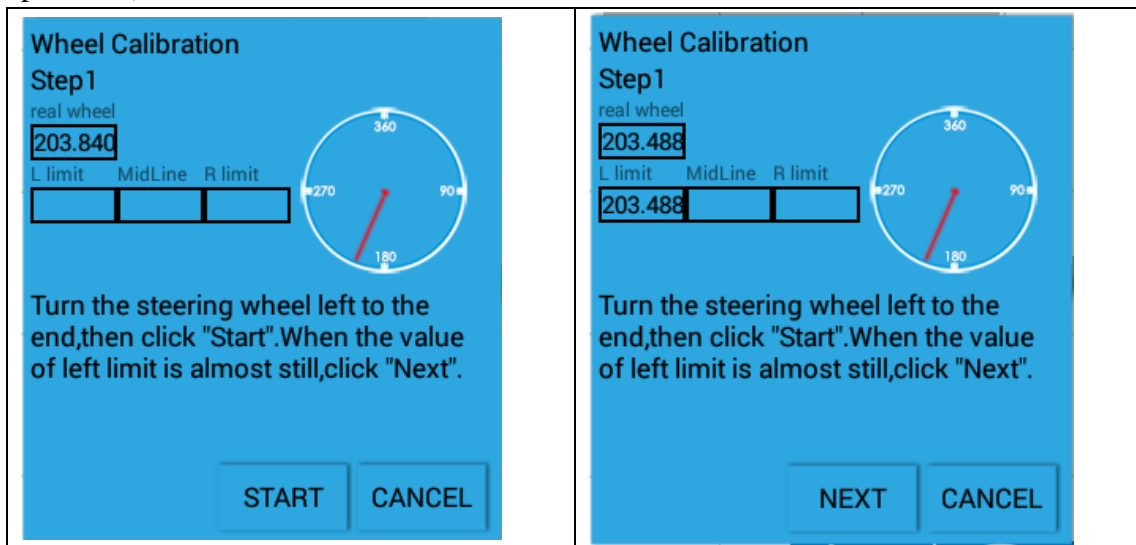
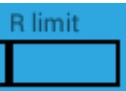


Figure 139 Step 1: obtain the left limit angle of guide wheel

5.5.2.4 Calibration Step 2

Turn and hold the steering wheel to the right limit and touch “Start” button. When the numerical value in the number box of right limit is almost constant, touch “Next step” button to obtain the right limit angle of the guide wheel. Such numerical value will be

shown in “Right limit” box .

Note: If the steering gear of the tractor has leakage, it will cause a returning tendency of the guide wheel at the right limit position. In this case, it is required to keep turning the steering wheel right in order to maintain the guide wheel angle at the right limit position.

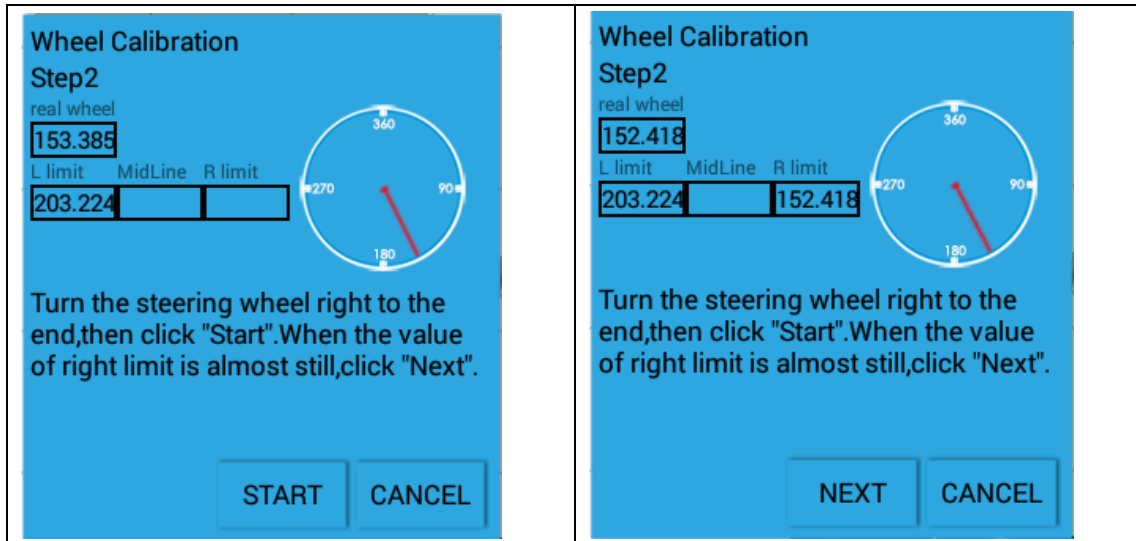



Figure 140 Step 2: obtain the right limit angle of guide wheel

5.5.2.5 Calibration Step 3

Drive the tractor to the middle of the road. Turn the steering wheel to the middle position and touch “Start” button. Drive the tractor forward along a straight line for at least 70m. During the process, try not to turn the steering wheel, and if possible, keep hands off the steering wheel. Therefore, the steering wheel is free to return. When the distance reaches 70m, the system acquire the middle point of the guide wheel automatically and the value will be shown in “Middle line” box . When the middle point of guide wheel is acquired, the text “Guide wheel calibration completed” will pop out in the screen as below.

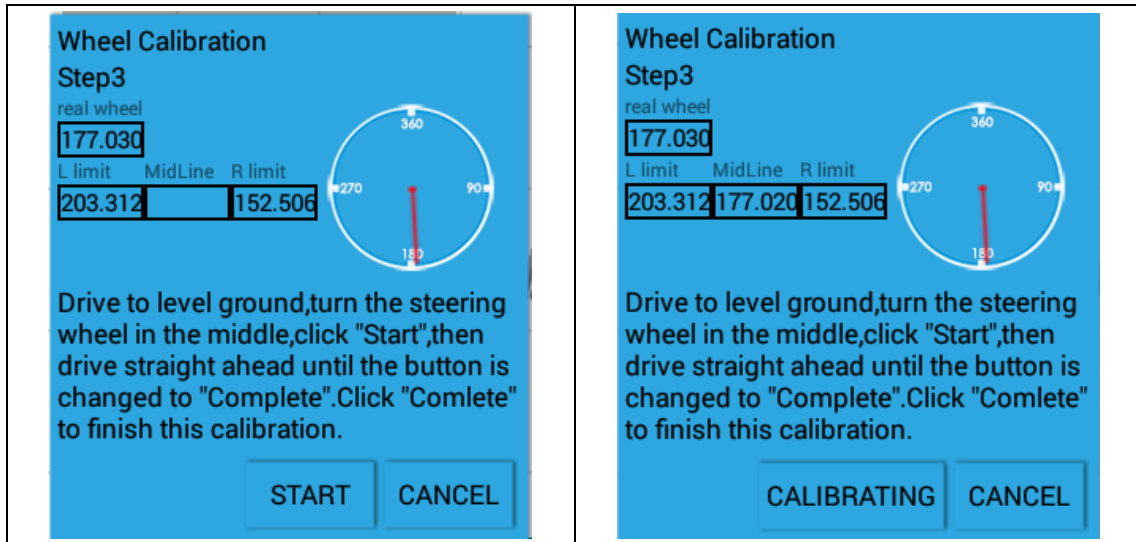


Figure 141 Step 3: acquire the middle point angle of guide wheel

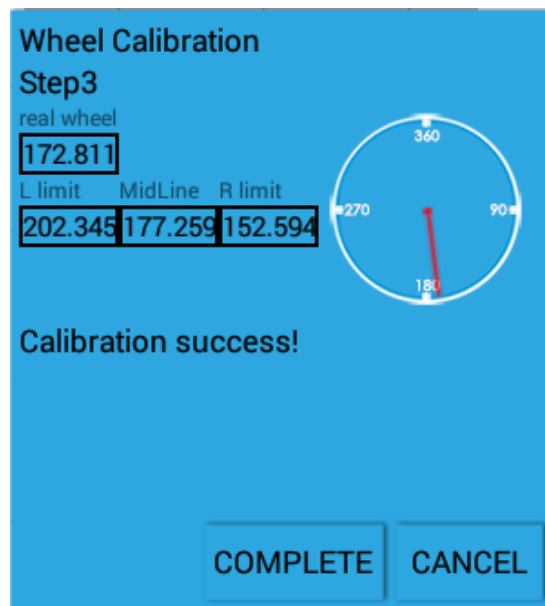


Figure 142 Step 3: guide wheel calibration completed

5.5.2.6 After the Calibration, Check if the Calibration Result is Correct

Observe the calibration information of the guide wheel the left & right limits and middle point. The calibrated values can be regarded correct only if they can satisfy both conditions given below at the same time.

- The numerical value of left limit, middle point and right limit increases or decreases gradually, i.e., the values should be arranged in the order of left limit > middle point > right limit or the reverse

- The difference between the left limit and the middle point is over 20 °and that between the middle point and the right limit is also over 20 °.

If the left & right limits and middle point information of guide wheel acquired by calibration cannot satisfy both conditions, the calibration fails. In this case, perform the following steps.

- Recheck if the guide wheel angle is wrong and if the guide wheel surpasses the zero point
- Recalibrate the guide wheel
- Check if the self-checking status of equipment now is all green
- Observe if the actual steering angle range of the guide wheel is too small. If yes, make necessary mechanical adjustment, or the line tracking process will be too slow
- Contact the distributor or the FAE department of the manufacturer

When the guide wheel is calibrated, touch “Calibration” button again, and the calibration icon of guide wheel now turns green.

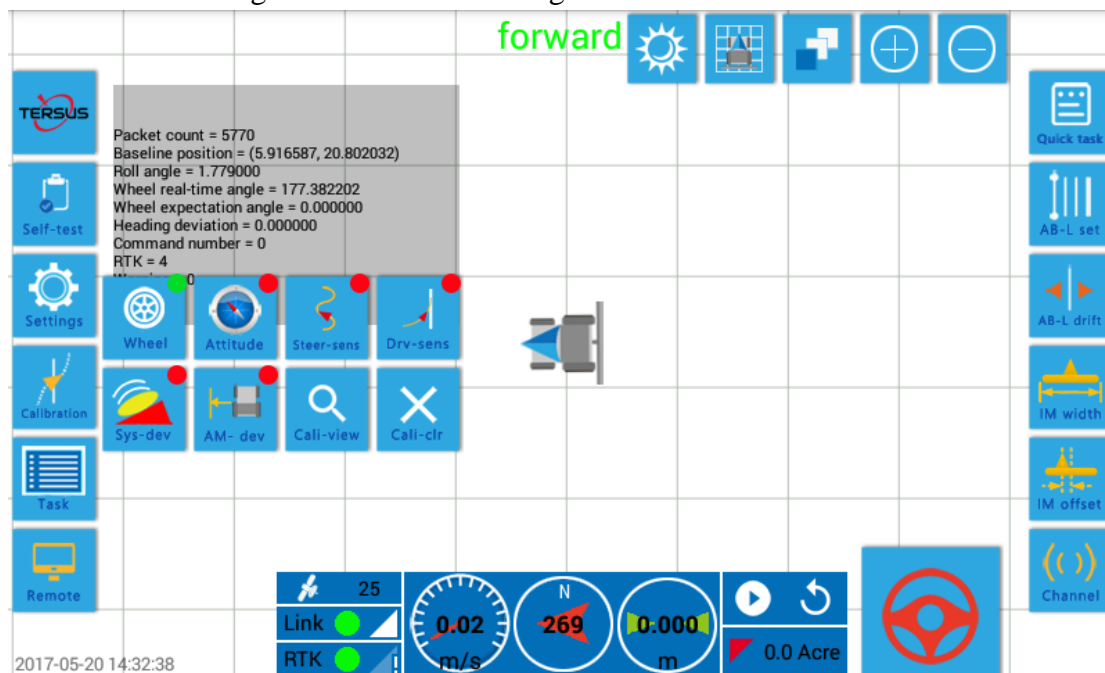
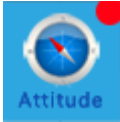


Figure 143 When the guide wheel is calibrated, the corresponding icon turns green

5.5.3 Attitude Calibration

After the steering range of guide wheel is calibrated as the first step, start the second step, attitude calibration. First touch the “Calibration” button to display the calibration

screen. Touch the “attitude calibration” button  in the calibration screen and the sub-screen as shown in the figure below pops out in the screen.

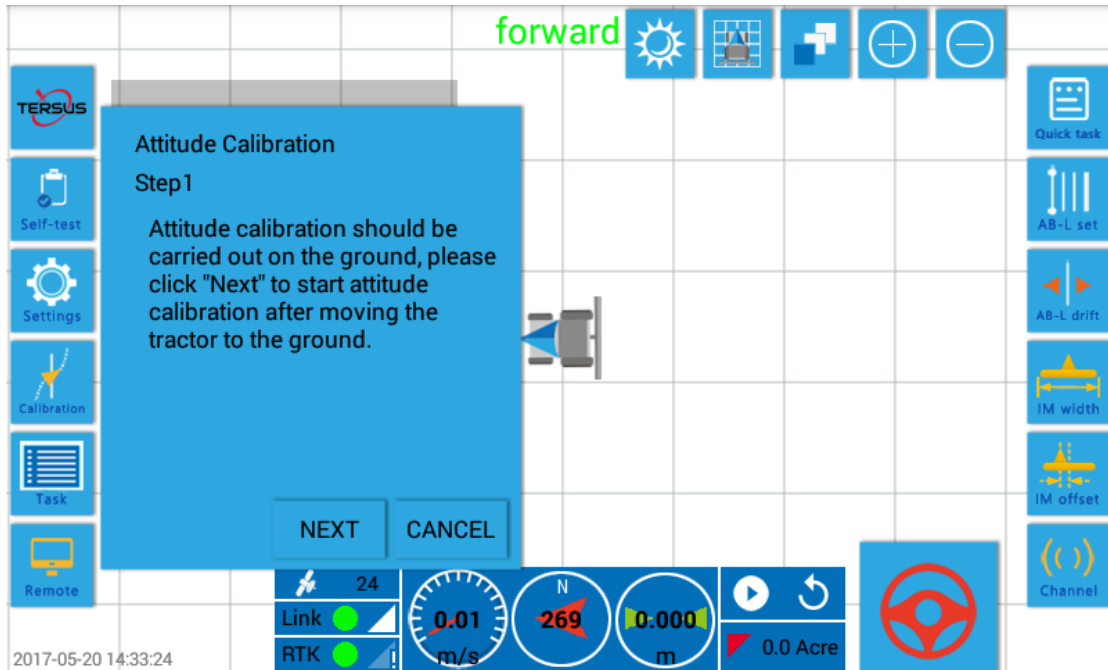


Figure 144 Sub-screen “Attitude calibration” pops out

The attitude calibration process can be completed by following the instructions in sub-screen “Attitude calibration”.

5.5.3.1 Attitude Calibration – Step 1

Drive the tractor to a flat ground and keep idling of engine. Now put a stone or branch as a mark at the outer edge of the rear wheel of the tractor or make a mark with a chalk on the ground at the outer edge of the rear wheel.

Touch “Next step” button to proceed with step 2.

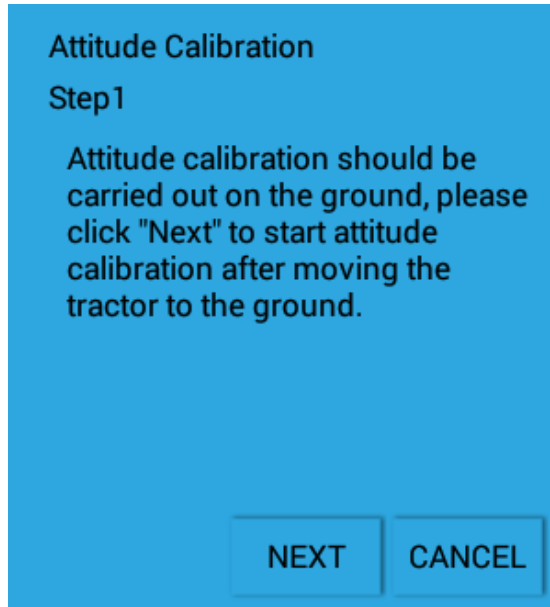


Figure 145 Step 1 start calibration

5.5.3.2 Attitude Calibration – Step 2

Keep the tractor standstill and touch “Start” to start the time counter. Count for 1 minute. When 1 minute is elapsed, proceed with step 3.

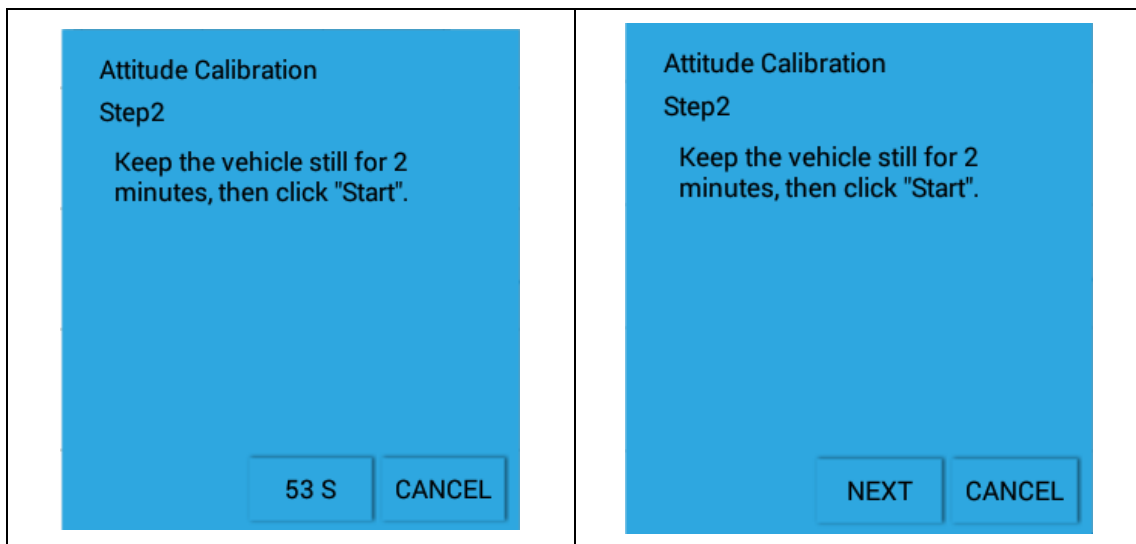


Figure 146 Step 2 time counting

5.5.3.3 Attitude Calibration – Step 3

Drive the tractor to turn around. With reference to the traces left at step 2, rest the rear

wheels at the same position in step 2, as shown in the figure below. Then touch “Next step” again to proceed with step 4.

Figure 147 Sketch of repositioning the farming vehicle after turning around

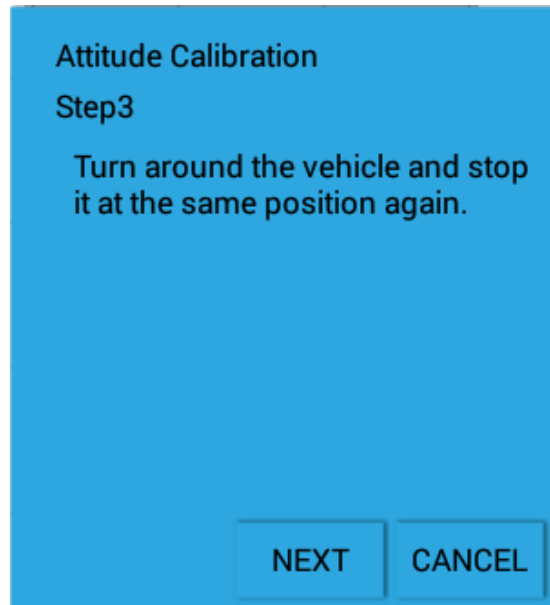


Figure 148 Step 3 turning around

5.5.3.4 Attitude Calibration – Step 4

Repeat step 2 to count for 1 minute.

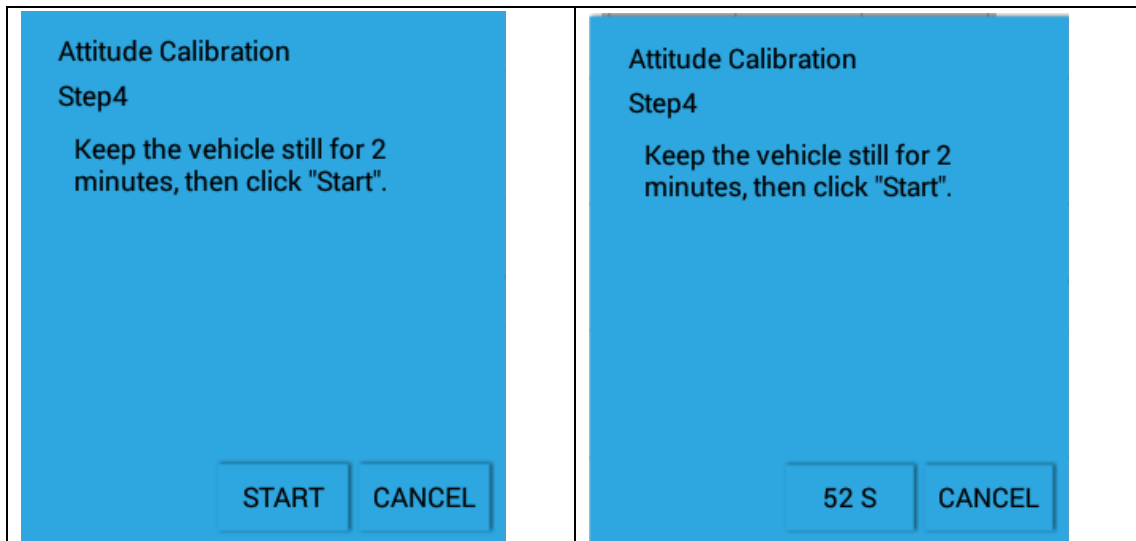


Figure 149 Step 4 timing count

5.5.3.5 Attitude Calibration – Step 5

Now the calibration is completed.

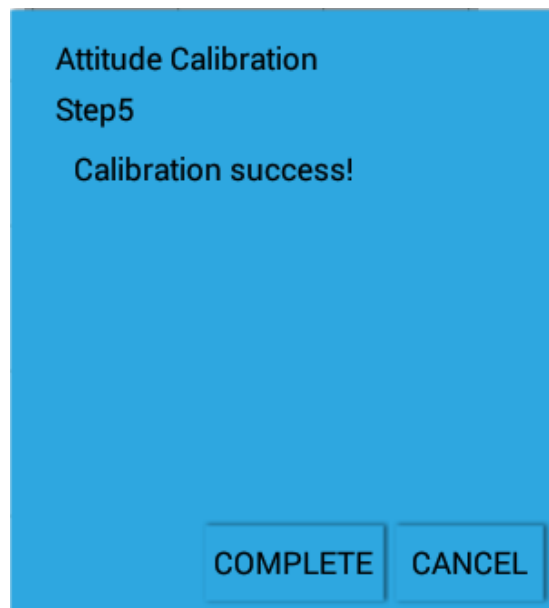


Figure 150 Step 5 complete attitude calibration

5.5.3.6 After Calibration, Observe if the Calibrated Value is Correct

The calibration result is correct only if the value range of calibrated data is within $\pm 5^\circ$. If the calibration result is incorrect, eliminate the fault according to the following procedures.

- Perform attitude calibration again
- Check if the self-checking status of equipment now is all green
- Check if the vehicle now is on a flat ground and if the ground have excessive inclination
- Contact the distributor or the FAE department of the manufacturer.

When the attitude calibration is completed, enter “Calibration” menu again and the attitude calibration icon now turns green.

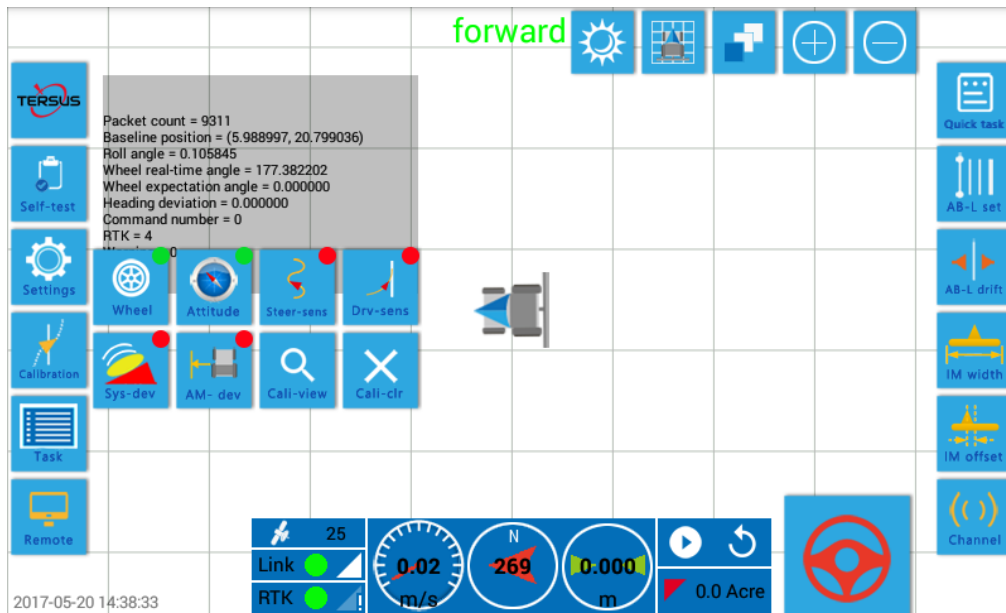



Figure 151 When the attitude calibration is completed, the corresponding icon turns green

5.5.4 Steering Sensitivity Calibration

When the attitude calibration is completed, start the steering sensitivity calibration. The purpose of this step is to obtain fast, stable and correct performance of the steering operation of guide wheel when the farming vehicle is in auto driving mode by setting steering start voltage and the steering sensitivity.



Touch “Steering sensitivity” button  in the calibration screen to enter the sub-screen of steering sensitivity calibration.

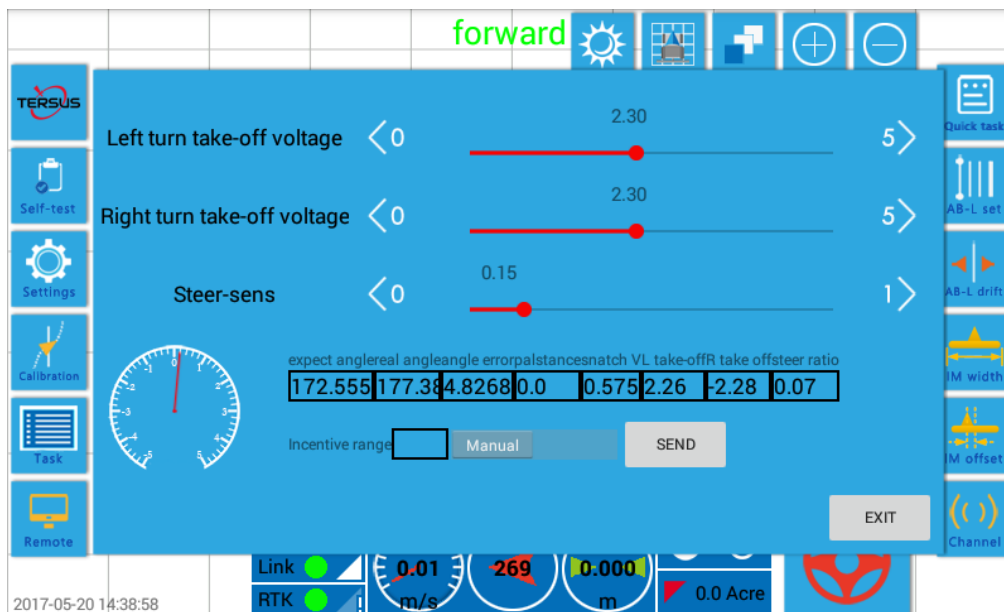


Figure 152 Sub-screen “Steering sensitivity calibration”

The sub-screen “Steering sensitivity calibration” is used to finish the commissioning of three parameters, namely “Left take-off voltage”, “Right take-off voltage” and “Steering sensitivity”.

5.5.4.1 Calibrate Left & Right take-off Voltage

The value of left/right take-off voltage means that when the voltage applied to the left/right drive port of the hydraulic valve is less than this value, the guide wheel of the tractor keeps standstill and does not turn; when the voltage applied to the left/right drive port of the hydraulic valve is more than this value, the guide wheel of the tractor start to turn left/right slowly.

The hydraulic steering systems of different tractors are different in terms of machine conditions, pressure of power steering pump, steering gear wear, oil cylinder leakage, mechanical gap etc. Therefore the value of left/right take-off voltage has to be calibrated based on the characteristics of each vehicle. Based on our experience, the typical value for left take-off voltage and right take-off voltage is usually 2.3V (i.e. the default left/right take-off voltage displayed when the sub-screen “Steering sensitivity calibration” is opened) and the usual commissioning range is 2.0V~2.8V. The difference between left and right take-off voltage usually is no more than 0.3V after the commissioning.

The calibration is done as follows. Keep the tractor stationary at flat cement road surface, pitch road surface or farmland etc.; start the engine and maintain a speed of

1200~1500 (or the speed in normal operation), and turn the guide wheel to the middle position.

- Drag the vernier corresponding to the left take-off voltage to 3.0V and left turn of the guide wheel should be observed (If right turn of guide wheel is observed when the left take-off voltage is dragged, it means the left and right drive terminals of hydraulic valve are inversely connected and has to be exchanged and re-connected)
- Drag the vernier corresponding to the right take-off voltage to 3.0V and right turn of the guide wheel should be observed
- Drag the vernier corresponding to the left take-off voltage to 2.9V and left turn of the guide wheel at a reduced speed should be observed
- Drag the vernier corresponding to the right take-off voltage to 2.9V and right turn of the guide wheel at a reduced speed should be observed
- Drag the vernier corresponding to the left take-off voltage to 2.8V and left turn of the guide wheel at a further reduced speed should be observed
- Drag the vernier corresponding to the right take-off voltage to 2.8V and right turn of the guide wheel at a further reduced speed should be observed
-
- Repeat the above steps to continuously reduce the value of left & right take-off voltages and it can be observed that the speed of left or right turn reduces gradually. When the average speed of the entire process of turning is reduced to around 1 %s and slow change of angle data can be observed at the same time, the voltage value can be regarded as the value of corresponding left/right take-off voltage.

5.5.4.2 Calibration of Steering Sensitivity

The steering sensitivity refers that when the angle of guide wheel changes from a to b as instructed, the higher the steering sensitivity is, the higher and greater the speed that the guide wheel turns, but at the same time the guide wheel may failure to stop at b and even pass b; while the lower the steering sensitivity is, the lower and gentler the speed that the guide wheel turns, but at the same time the guide wheel may stop when b is not reached. Therefore, the steering sensitivity must be calibrated so as to make sure the guide wheel of tractor turns in a rapid, stable and correct way. Based on the experiences in installation and commissioning, the typical value for the steering sensitivity is usually 0.15 (i.e. the default value of steering sensitivity that is seen when open the sub-screen “Steering sensitivity calibration”) and the normal range for commissioning is usually 0.1~0.4.

The steering sensitivity is calibrated according to the following steps: first enter an angle value in the “Incentive Range”, 5 for instance. Then slide the block behind it from “Manual” to “Auto” and touch “Send” button. The operation is meant to first make the guide wheel of tractor turn left by 5° and hold for some time to make it turn right by -5° after the tyres stabilized. Turn the tyre in this way repeatedly.

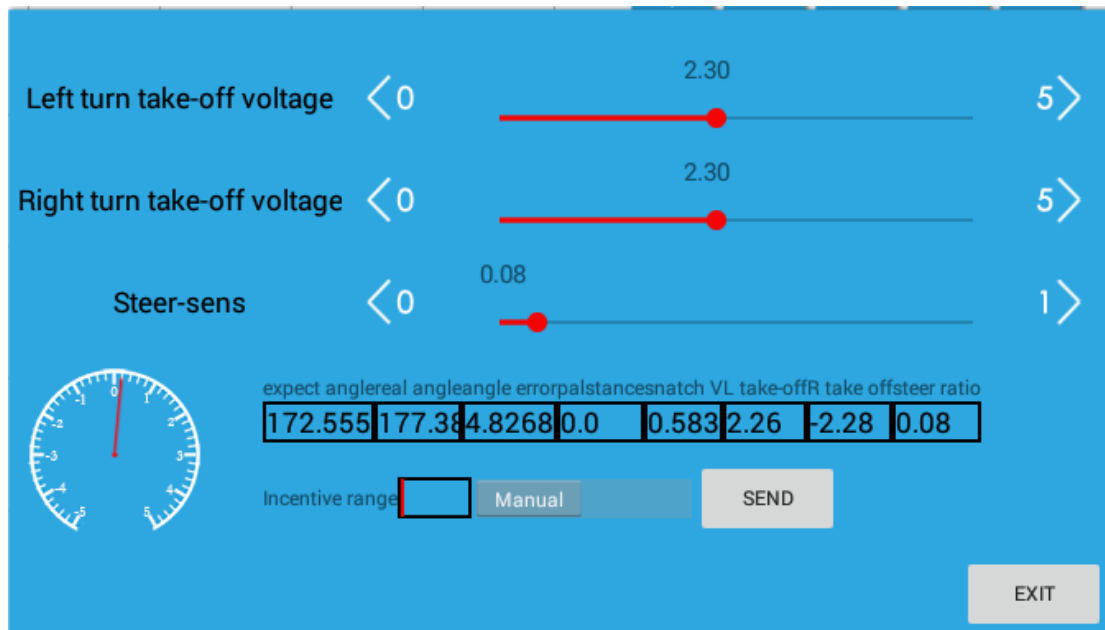


Figure 153 Render angle excitation and observe the execution of steering movement

During the process, observe if the red pointer on the instrument panel can quickly point to 5°-5° and rapidly stop at 5°-5° after once or twice vibrations of small amplitude (the amplitude of each vibration is no more than 0.2°, and no more than 0.1° is better) when the guide wheel turns.

- If the red pointer turns too slowly or cannot point to 5°-5°, the tyre reaches and stops at the specified position without any vibration, consider to accelerate the turning speed by increasing the steering sensitivity (adjust the cursor by 0.05 each time).
- If the red pointer continues moving without stop at 5°-5° or the vibration amplitude is no less than 0.3°, or the tyre keeps vibrating and can hardly stop, consider to reduce the turning speed by reducing the steering sensitivity (adjust the cursor by 0.05 each time).
- If the red pointer does not move in a symmetrical way during the process of turning left by 5° and turning right by -5°, for example, it can point to 4.7° in the left but exceeds 5.3° in the right. In this case, slightly increase the left jump-off voltage (increase by 0.05V each time) and reduce the right jump-off voltage

(reduce by 0.05V each time), till the processes of left turn and right turn are almost symmetrical. The final degree of asymmetry should be no more than 0.1 °.

When the commissioning is completed, switch the slide block from “Auto” to “Manual” and touch “Send” button to exit from the steering sensitivity commissioning.

5.5.4.3 Common Problems and Troubleshooting During the Calibration of Left/Right Jump-off Voltage

When the engine is started, the guide wheel does not move or move only by small amplitude no matter how the cursor of left/right jump-off voltage is adjusted or even when it is adjusted to 5V at the maximum.

- Throttle up the engine and observe if the guide wheel has any movement. If yes, set the left/right jump-off voltage to an arbitrary value of 2.5V~2.8V. If not, go to step b).
- Throttle up the engine, drive the tractor to move at a low speed (It is recommended to be no more than 0.5/s to prevent any possible danger) and observe if the guide wheel has any movement. If yes, set the left/right jump-off voltage to an arbitrary value of 2.5V~2.8V. If not, go to step c).
- Throttle up the engine press the action button of the hydraulic valve manually and observe if the guide wheel has any movement. If not, refer back to section 3.3 to check if the hydraulic valve is correctly installed.

5.5.4.4 Common Problems and Troubleshooting During the Calibration of Steering Sensitivity

No matter how high the steering sensitivity is, the guide wheel does not move.

- Throttle up the engine and observe if the guide wheel has any movement. If yes, perform the steering sensitivity commissioning as normal. And consider to increase the steering sensitivity to 0.4~0.6 during the process. If not, go to step b).
- Throttle up the engine, drive the tractor to move at a low speed (It is recommended to be no more than 0.5/s to prevent any possible danger), and observe if the guide wheel has any movement. If yes, perform the steering sensitivity commissioning when the tractor is moving forward at low speed. And consider to increase the steering sensitivity to 0.4~0.6 during the process. If not, go to step c).

- Throttle up the engine, press the action button of hydraulic valve manually and observe if the guide wheel has any movement. If not, refer back to section 3.3 to check if the hydraulic valve is correctly installed.

No matter how high the steering sensitivity is, the left/right turn is done at a low speed and even cannot turn to the set target: Set the steering sensitivity to an arbitrary value of 0.4~0.6.

No matter how low the steering sensitivity is, the tyre keeps shaking when it reaches the specified position: reduce the left/right jump-off voltage at the same time by 0.1V each time till 2.0V. If the tyre still shakes, there is no need to further reduce the left/right jump-off voltage. Directly set the left/right jump-off voltage to 2.0V and set the steering sensitivity to 0.1.

5.5.4.5 How to Complete the Calibration of the Left/Right Jump-off Voltage and the Steering Sensitivity Rapidly by Non-professional Personnel

- Directly use the default parameters. Directly use the default left/right jump-off voltage of 2.3V and default steering sensitivity of 0.15.
- Directly observe the excitation test. Enter 5 % as excitation for test. If the tyre can turn left and right, directly go to the succeeding steps of commissioning. If the tyre directly turns to the left or right limit, exchange the connection of left and right drive terminals of the hydraulic valve.

When the calibration of steering sensitivity is done, enter “Calibration” screen again, and it will be expected to see that the steering sensitivity calibration icon turns green.

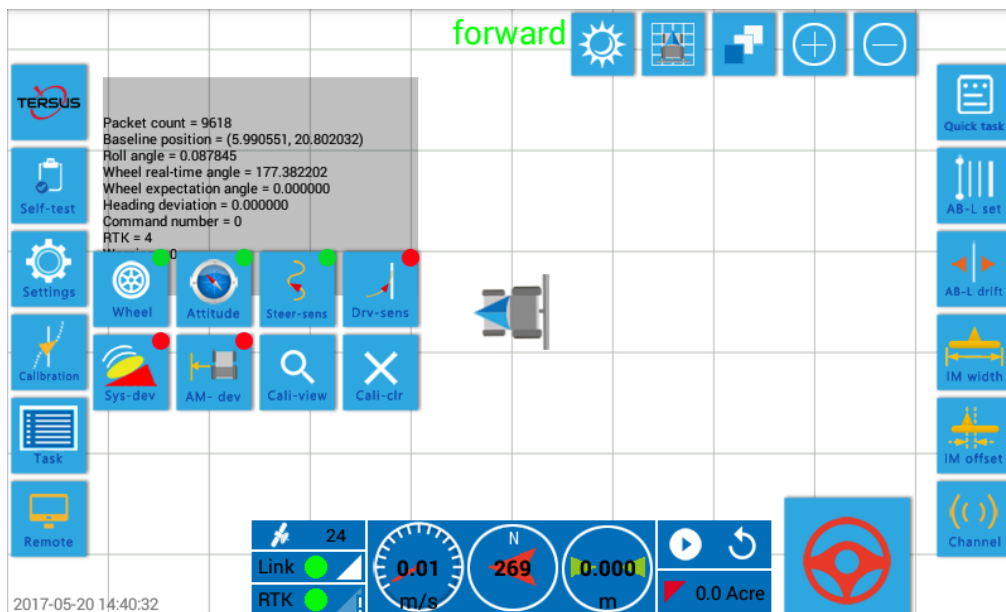


Figure 154 When the calibration of steering sensitivity is done, the corresponding icon turns green

5.5.5 Calibration of Driver Sensitivity

When the steering sensitivity is calibrated, start to calibrate driver sensitivity. The purpose of this step is to set a proper value for driver sensitivity so as to make sure that the driving path can track the specified Line AB in a rapid, stable and correct way and the tractor maintains required operation precision when the tractor is in auto driving mode.



Touch “Driver sensitivity” button in the calibration screen to enter the sub-screen “Driver sensitivity calibration”.

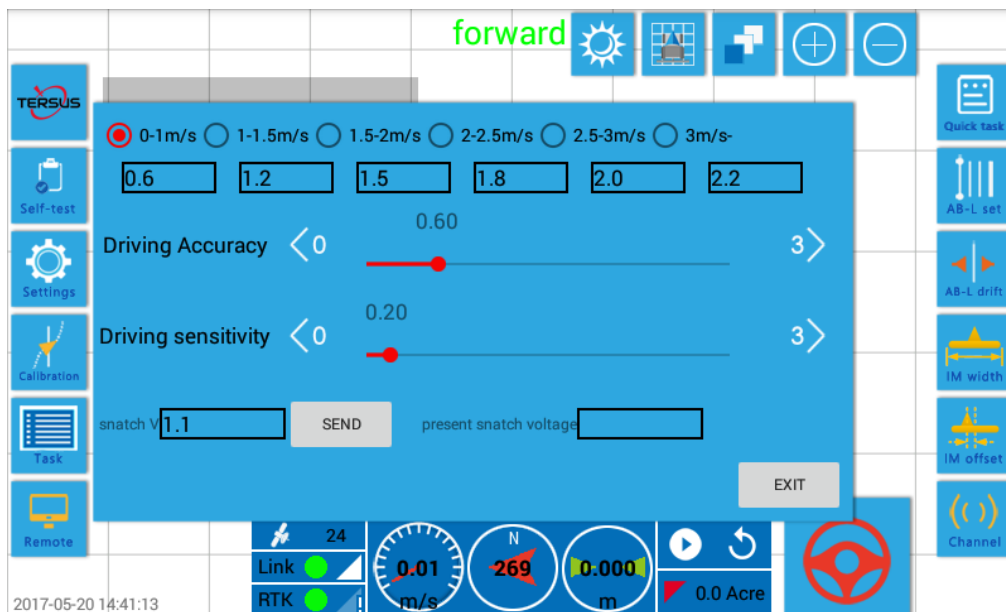


Figure 155 Driver sensitivity calibration sub-screen

The user needs to complete the commissioning of “Driver sensitivity” and “Operation precision” in the sub-screen “Driver sensitivity calibration”.

5.5.5.1 Driver Sensitivity Commissioning

The meaning of driver sensitivity is as below.

When the vehicle is switched to auto driving mode, if it approaches the Line AB from a position far away from Line AB with a large lateral deviation, in case of higher driver sensitivity, it will approach Line AB at a higher speed in a violent way, however, it may cause the vehicle passes Line AB without stopping and goes to the other side of Line AB. Therefore, the vehicle may repeat the cycle of approaching and passing Line AB for many times before it can drive stably along Line AB, or even worse, the vehicle may keep swaying around Line AB instead of along it.

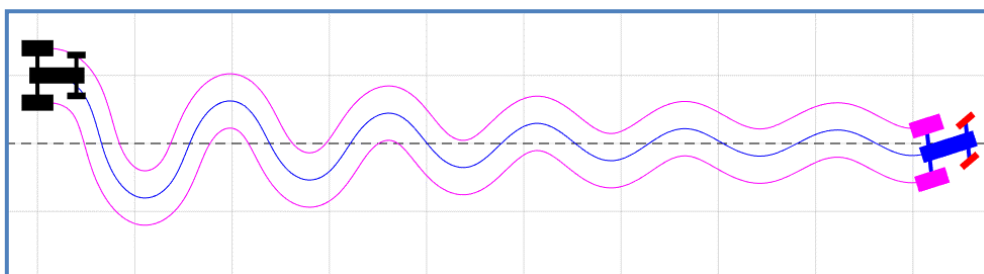


Figure 156 In case of excessive high driver sensitivity, the vehicle keeps swaying around the Line AB instead of along the line

In case of lower driver sensitivity, the vehicle will approach Line AB at a lower speed

in a gentle way. It may take a long time for the vehicle to reach Line AB and pass it again at a long cycle and the lateral deviation cannot be limited to center-meter level for a long time. And during the operation, if any large lateral deviation occurs due to the interference of terrain, it will take a long time to disappear and thus produces “Big bend”, which cannot satisfy the requirement of operation precision.

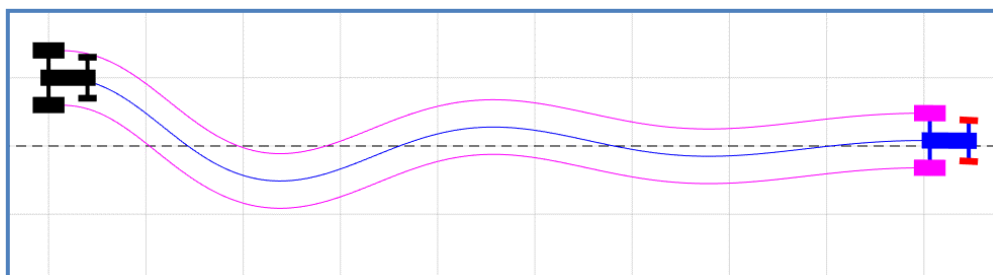


Figure 157 In case of excessive low driver sensitivity, the vehicle passes the Line AB slowly

Therefore, the higher the driver sensitivity is, the faster the vehicle tracks Line AB and the higher the operation precision is, but the driving stability is poor; the lower the driver sensitivity is, the slower the vehicle tracks Line AB and the lower the operation precision is, but the driving stability is superior.

In order to obtain a rapid, stable and correct Driver performance of the vehicle, the driver sensitivity has to be calibrated, so that the vehicle can track Line AB by one attempt and maintain a centimeter-level lateral deviation when it drives along Line AB. Based on the experiences in installation and commission, the typical value of Driver sensitivity is usually 0.2 and the range for normal commissioning usually is 0.1~1.5.



Figure 158 In case of appropriate driver sensitivity

The driver sensitivity is calibrated as per the following procedures.

Perform a Driver test at a speed of 1.0m/s~3.0m/s. During the process, manually move the farming vehicle to a position with a lateral deviation of around 1m and then switch to the auto driving mode. Observe the Driver process when the farming vehicle

drives at different speed and check if it can reduce the lateral deviation from 1m to several centimeters and manage to track the Line AB rapidly when the farming vehicle moves forward for no more than 5m since it is switched to the auto driving mode. If there is apparent vibration during line tracking process, reduce the driver sensitivity. If the line tracking process is too slow, increase the sensitivity.

5.5.5.2 Commissioning of Operation Precision

Similar with the driver sensitivity, the higher the operation precision is, the higher the straight line tracking precision is during normal operation. However, it is impossible to improve the operation precision without limit. Based on the experiences in installation and commissioning, the default value of forward operation precision is 0.6 (1.0m/s and less), 1.2 (1.0m/s~1.5m/s), 1.5 (1.5m/s~2.0m/s), 1.8 (2.0m/s~2.5m/s), 2.0 (2.5m/s~3.0m/s) and 2.2 (3.0m/s or above). During the commissioning, the difference between the actual operation precision at different speed and its default value is usually no more than 0.3m.

Calibrate the operation precision according to the following steps. Test the straight line driving precision when the vehicle drives along Line AB at a speed of 1.0m/s~3.0m/s. During the process, observe if the lateral deviation change at different speed is no more than 5 centimeter and the vehicle head does not have periodic swaying. If the lateral deviation is no less than ± 2 cm or more at certain speed, and the cycle of change takes a long time (more than 10 seconds), move to the right to increase the operation precision value at certain speed.

5.5.5.3 Commissioning of Override Voltage

For some products with steering wheel override function, it can exit from the auto driving mode by forcefully turn the steering wheel during turnaround in the farmland by setting an override voltage. The override voltage is usually 0.7v~0.9v and within a range of 0.6v~1.5v. The lower the override voltage is set, the easier the steering wheel is overridden, but it may cause unintended override during the auto driving process. If the user does not want to use this function, it is unnecessary to perform override voltage commissioning.

When the driver sensitivity is calibrated, enter “Calibration” again and it will be expected to see that the icon for driver sensitivity calibration turns green.

5.5.5.4 How to Perform Driver Sensitivity Commissioning by Non-professional Personnel

Perform auto driving directly by using the default values of driver sensitivity and operation precision. Observe if the auto driving is normal and if normal, it means that the commissioning is completed.

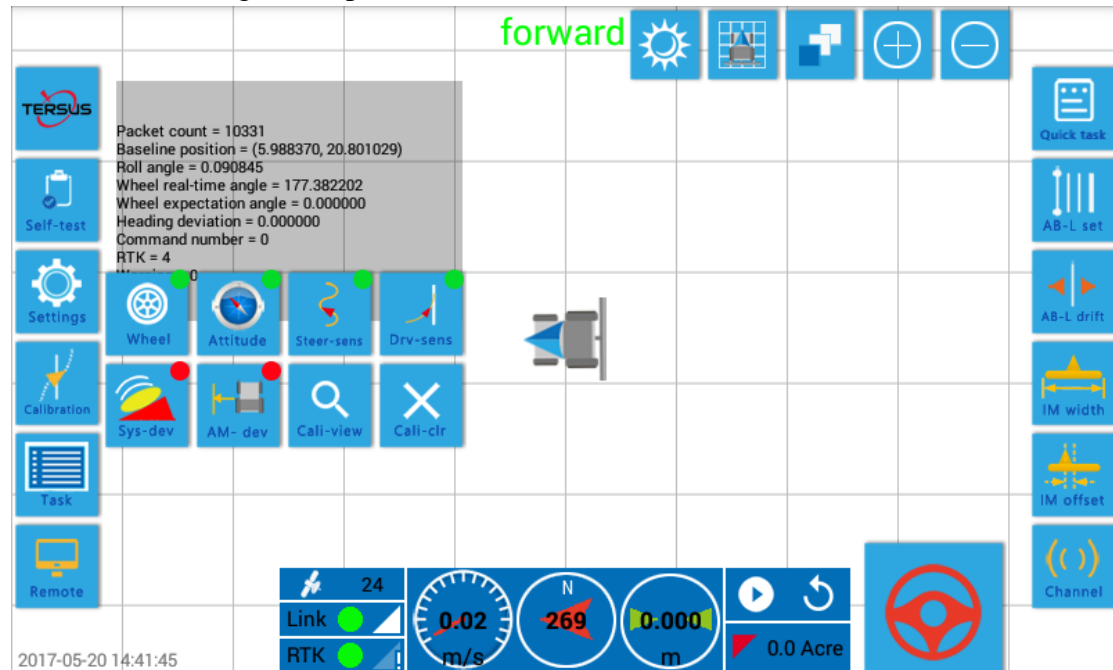


Figure 159 When the driver sensitivity is calibrated, the corresponding icon turns green

5.5.6 Calibration of System Deviation

When the driver sensitivity is calibrated, a scrupulous operator may find out that though the vehicle drives along an almost straight line in auto driving mode, the lateral deviation displayed in the screen fluctuates at a fixed value of several centimeters to over 10 centimeters with a fluctuation range of around 2 cm. For example, when the Driver sensitivity is calibrated, the operator notices that the lateral deviation of auto driving always keeps in a range of “14cm±2cm” or “-8cm ±2cm”. This fixed lateral deviation is called the “system deviation”.

Therefore, when the driver sensitivity is calibrated, the next step is system deviation



calibration. Touch “System deviation” in the “Calibration” screen to enter the sub-screen “System deviation calibration”. First the following dialogue box pops out to ask the commissioning personnel to select “CALIBRATE AGAIN” or

“CALIBRATE INTERATION”.

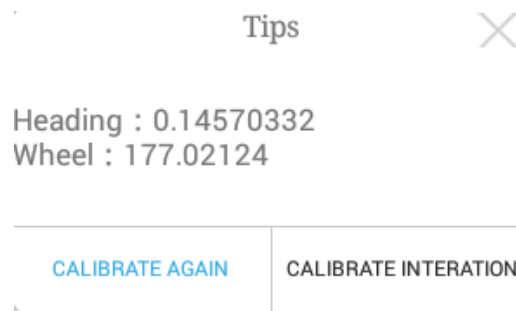


Figure 160 Dialogue box popped out when entering sub-screen “System deviation”

Note: It’s better to perform the system deviation calibration twice continuously.

In case of first installation and initial calibration, select “CALIBRATE AGAIN” (that is, clear the results of last system deviation calibration during the calibration process). When the calibration is done, enter the calibration options of “System deviation” again to select “CALIBRATE INTERATION” (that is, reserve the results of last system deviation calibration during the calibration process, and perform the calibration based on the data obtained during last calibration process to further eliminate the system deviation).

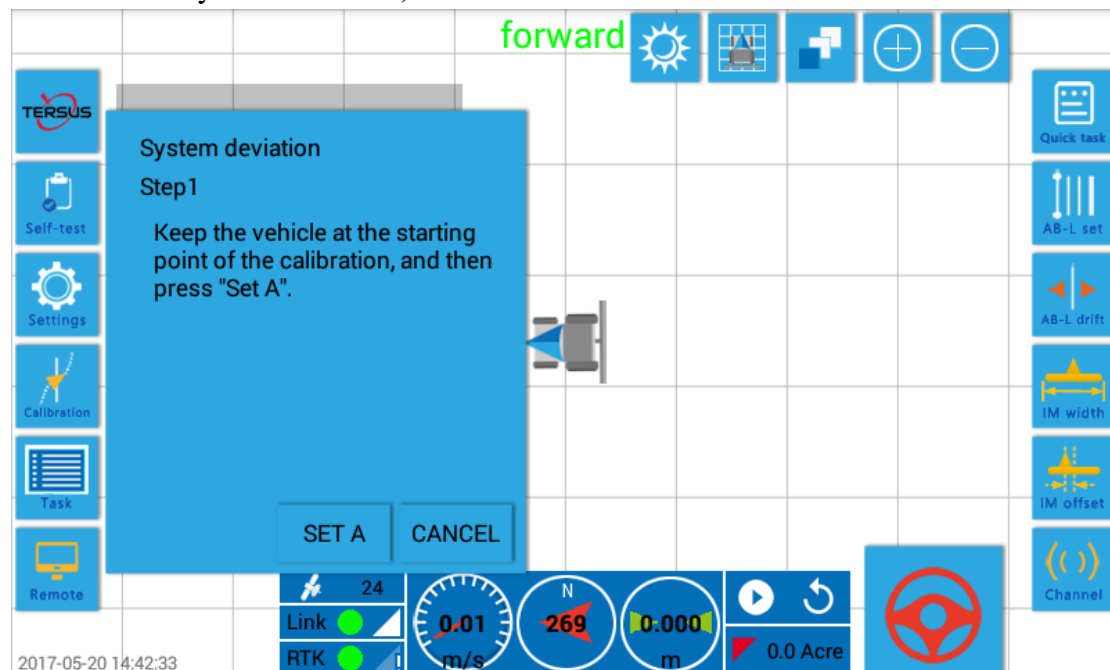


Figure 161 Perform system deviation calibration

As shown in the figure above, perform the system deviation calibration step by step as instructed in the pop-up box below.

5.5.6.1 Calibration of System Deviation – Step 1

As per the instructions in step 1, place the vehicle at the start point and touch the icon

“Establish Point A”  to go to step 2.

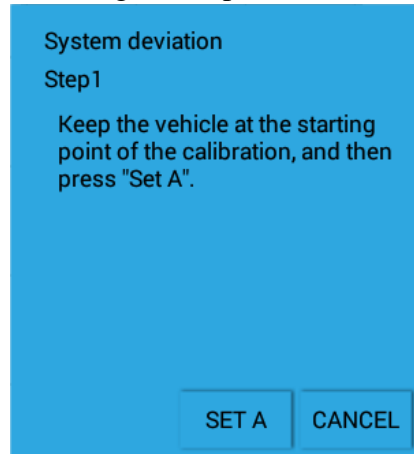


Figure 162 Establish operation Point A for system deviation calibration

5.5.6.2 Calibration of System Deviation – Step 2

Drive the tractor forward manually. During the driving process, the screen shows that the tractor starts from Point A in real time and displays the driving distance as well. When it is over 70m, the system will establish Point B automatically.

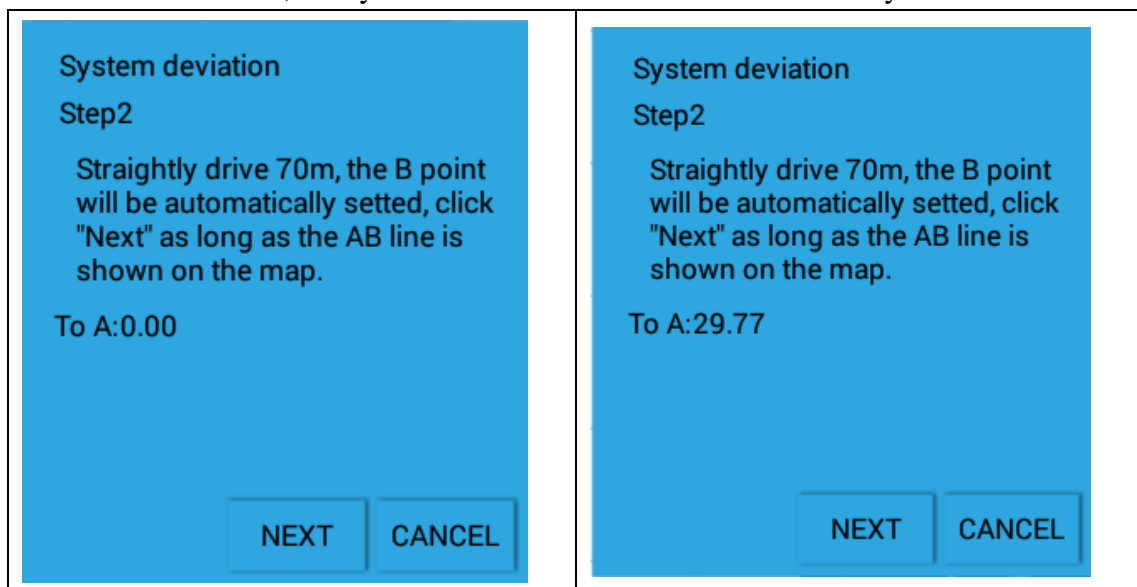


Figure 163 Drive forward manually and the screen shows the driving distance in real time

Starting from Point A, when the driving distance reaches 70m, the system will establish Point B automatically and display Line AB in the operation area. Now touch

“Next” button to go to step 3.

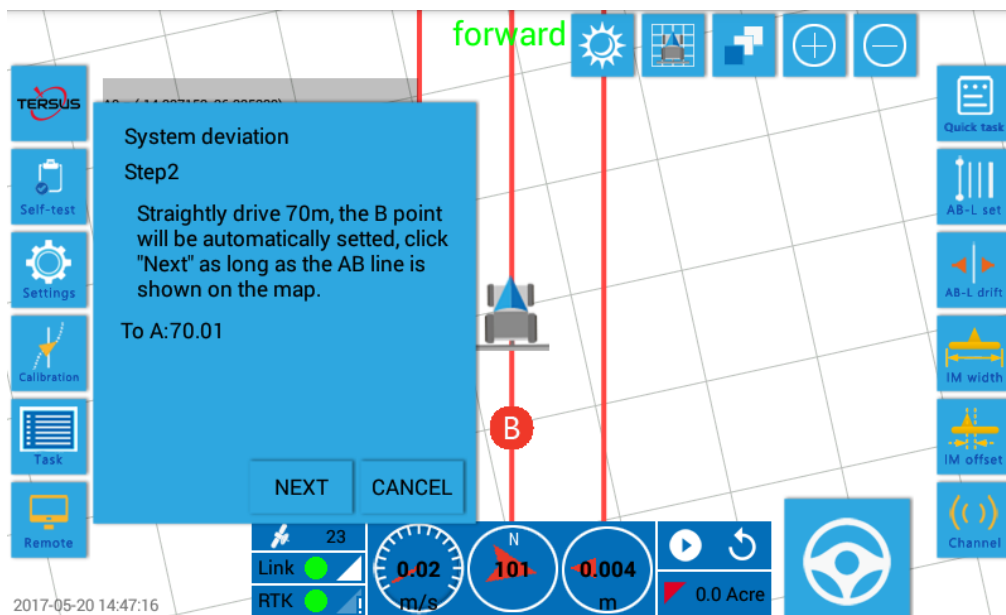


Figure 164 Drive forward manually for 70m, and Point B is automatically established

5.5.6.3 Calibration of System Deviation – Step 3

Turn the tractor around. Drive along Line AB for a round trip in auto driving mode at a speed of 1.5m/s~2.5m/s. When it is done, touch the button “Next” to go to step 4. It must be noted that the location where the tractor turns around should be far away outside from the end of Line AB to make sure that the path from Point A to B is all in the stable auto driving condition, or it may cause wrong calibration result.

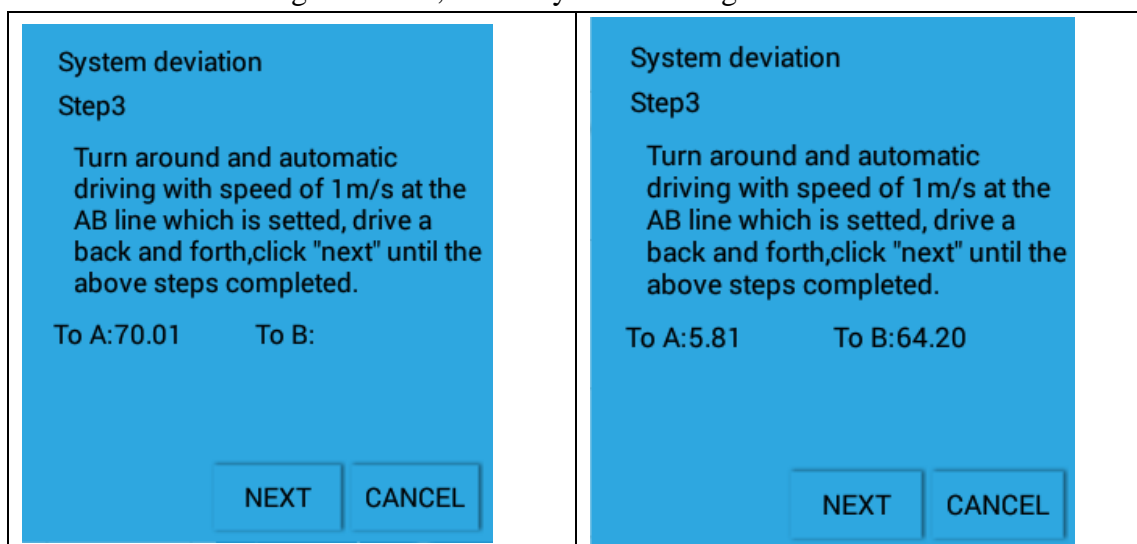


Figure 165 Drive along Line AB for a round trip in auto driving mode

5.5.6.4 Calibration of System Deviation – Step 4

The screen below shows that the calibration is done.

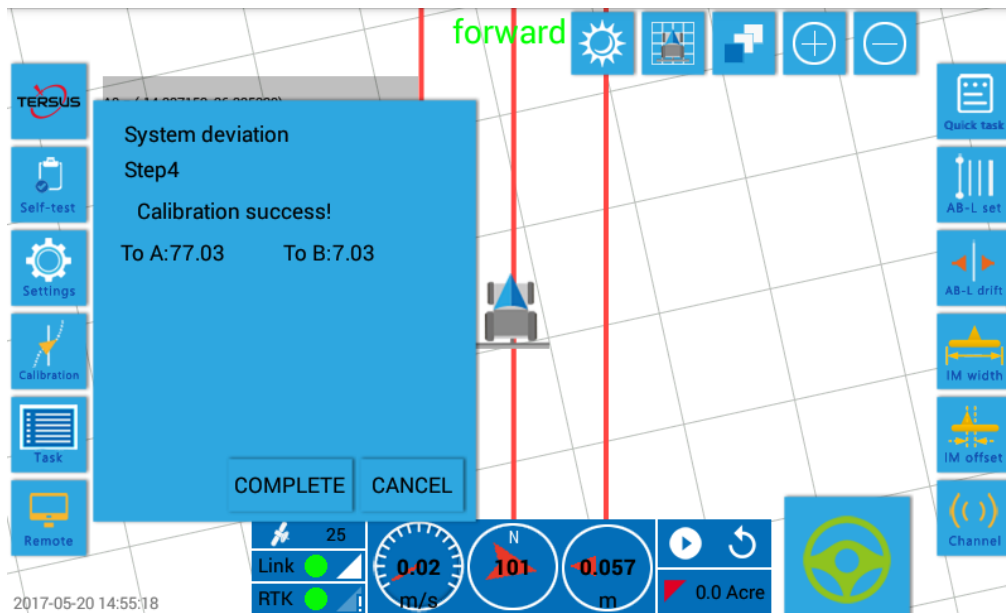


Figure 166 The calibration is done

When the calibration is done, the screen will display the calibration results. Observe the calibrated results, which should satisfy the following requirements.

- Calibrated path deviation: $\leq 3^\circ$
- Fine calibrated guide wheel deviation: $\leq 3^\circ$

When both the requirements are satisfied, the calibration of system deviation is correctly done.

When the calibration of “System deviation” is done, perform the calibration again by selecting “Iterative calibration” to make sure that the system deviation is completely eliminated.

When the calibration of system deviation is done, enter “Calibration” button again and it will be expected to see that the icon of system deviation calibration turns green.

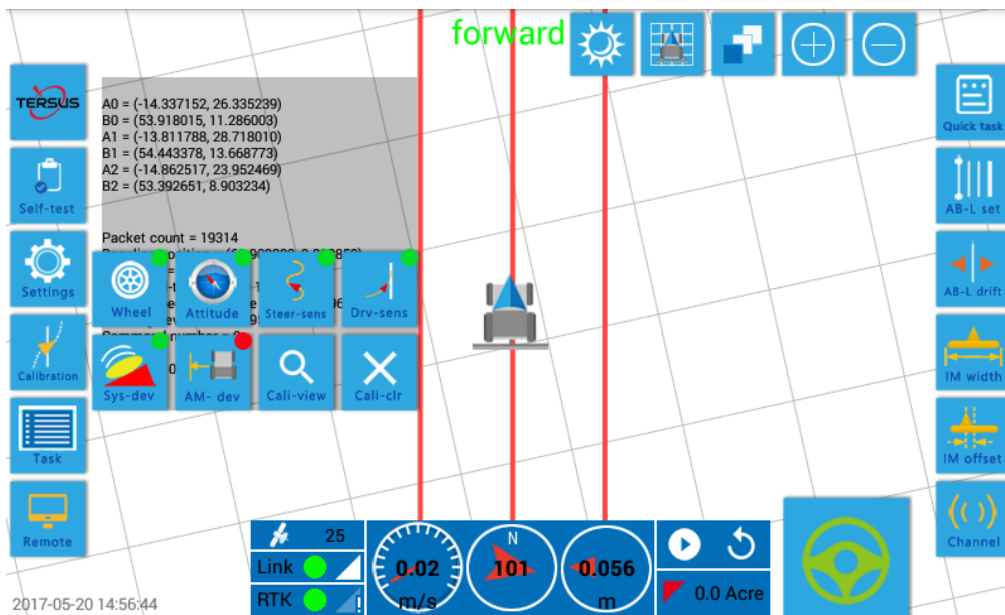


Figure 167 When the calibration of system deviation is done, the icon turns green

5.5.7 Agriculture Machine Deviation Calibration

When the calibration of system deviation is done, the last calibration item is “Agriculture machine deviation”. The purpose of this step is to eliminate the operation error resulted from asymmetrical dimension of the farming vehicle itself.

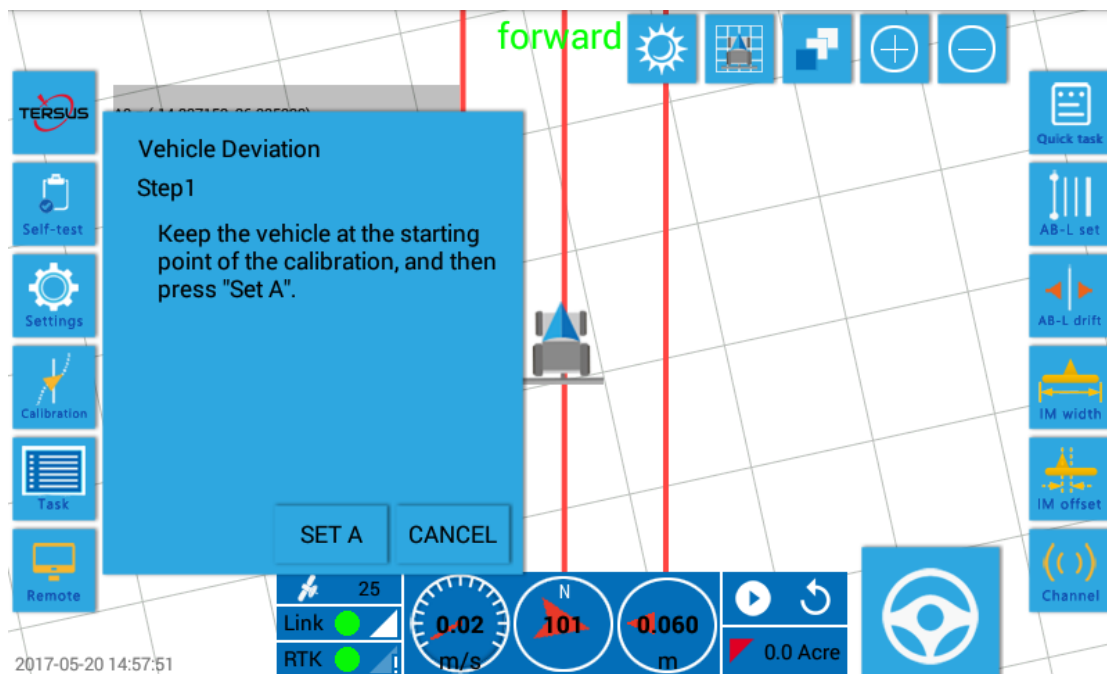


Figure 168 Enter the sub-screen “Agriculture machine deviation calibration”

Enter the sub-screen “Agriculture machine deviation calibration” to calibrate the tractor deviation step by step as instructed below.

5.5.7.1 Agriculture Machine Deviation Calibration – Step 1

Place the tractor at the calibration starting point to establish Point A and then go to step 2.

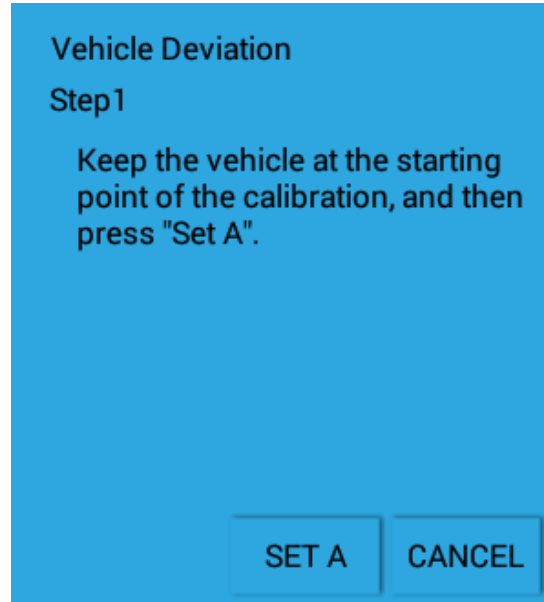


Figure 169 Step 1: establish Point A

5.5.7.2 Agriculture Machine Deviation Calibration – Step 2

Straightly drive a distance of 70m and the system will establish Point B automatically. When the operation area displays Line AB, touch “Next” button to go to step 3.

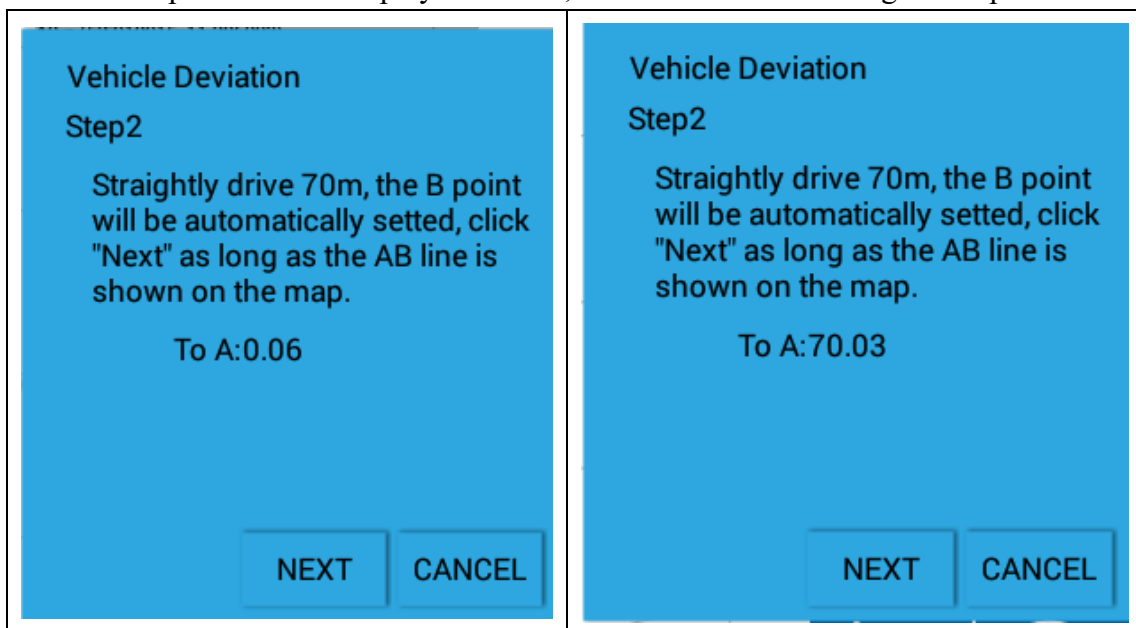


Figure 170 Step 2: straightly drive forward for 70m and Point B will be established automatically

5.5.7.3 Agriculture Machine Deviation Calibration – Step 3

Drive along Line AB for a round trip. When leaving, stop the tractor in the middle location of Line AB to make marks on the ground near the left and right edge of rear wheels and then continue driving. When returning, stop the vehicle at the same location to make marks in the same way. When all this is done, touch “Next” to go to Step 4.

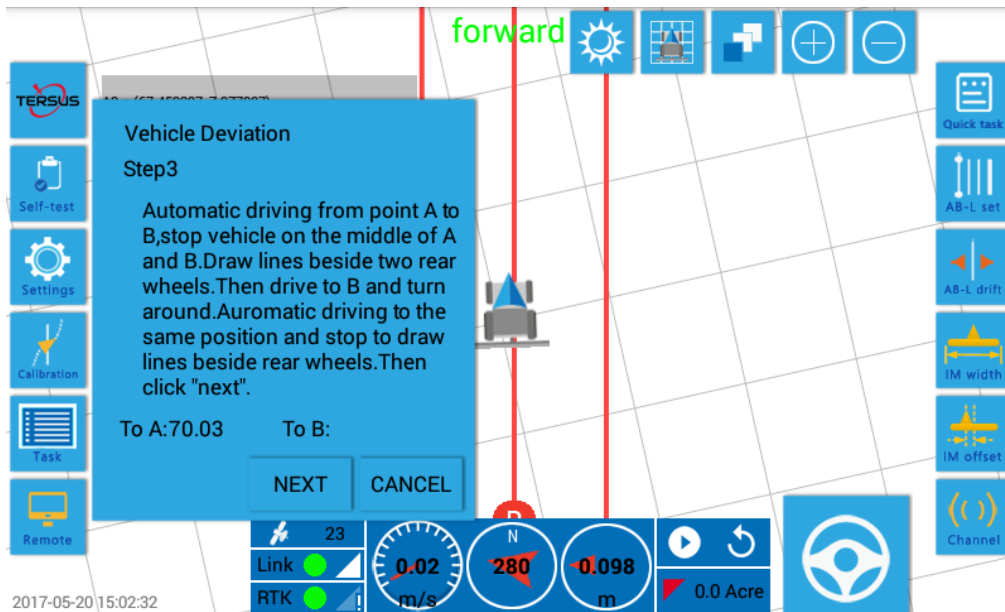


Figure 171 Step 3: automatically drive along Line AB for a round trip and make marks for tyres

5.5.7.4 Agriculture Machine Deviation Calibration – Step 4

Based on the relative position of marks that made in a round trip, i.e. marks made in the returning trip (the second trip) are at the left or right side of that made in the leaving trip (the first trip), and select the right picture in the screen.

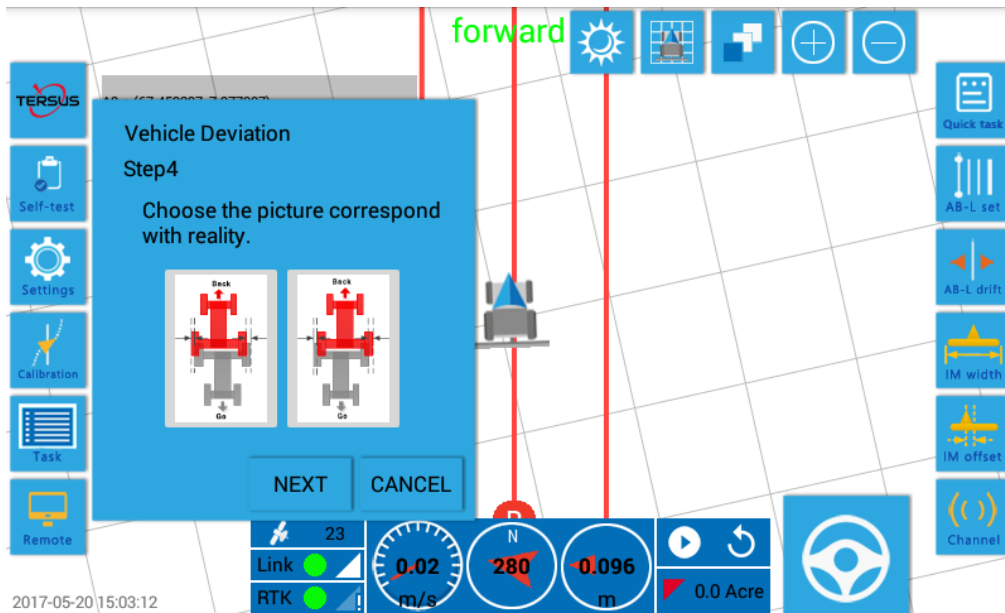


Figure 172 Step 4: Select the right picture based on the relative position of tyre marks made in a round trip

When the right picture is selected, the following figure pops out in the screen. Measure the distance between the marks made during a round trip, fill the value into the corresponding box and confirm it.

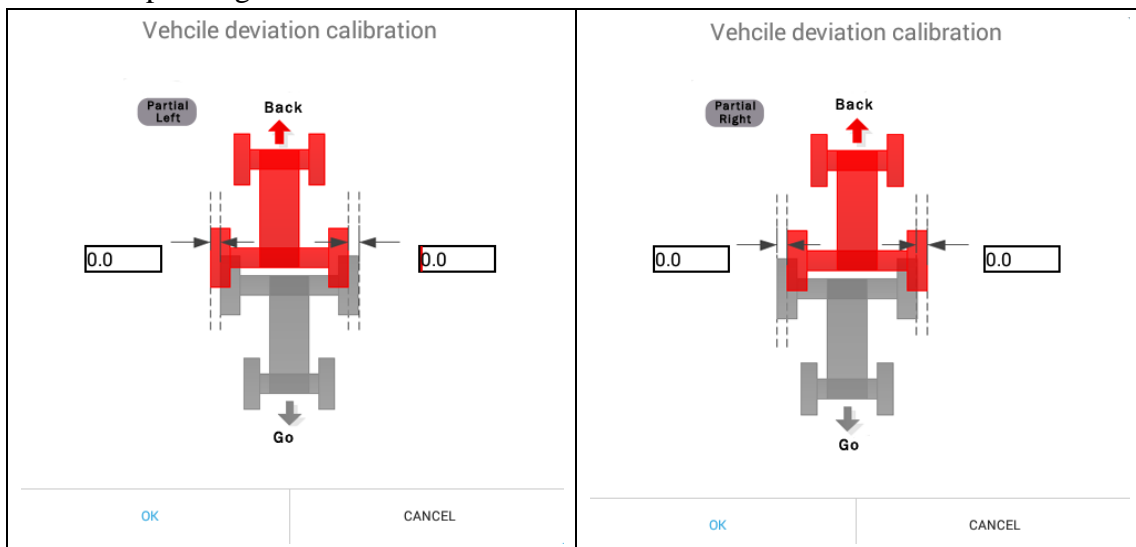


Figure 173 Step 4: fill in the distance between the tyre marks made in a round trip

5.5.7.5 Agriculture Machine Deviation Calibration – Step 5

The calibration is done successfully as below.



Figure 174 Step 5: calibration is done successfully

When the vehicle deviation is completed, if the tractor runs a round trip along the same Line AB, the traces of tyres during the two trips should be completely overlapped. (That is, even there is an inclination in any direction of the road, the traces of tyres during the leaving and returning trip should be completely overlapped.) This is the basis for judging if the calibration of “Agriculture machine deviation” is correctly done.

Therefore, when the calibration of vehicle deviation is done, drive the tractor along the same Line AB for a round trip. Check that the traces of the tyres are completely overlapped by placing or making marks on the ground so as to ensure that the calibration of vehicle deviation is correctly done.

When the calibration of vehicle deviation is done, enter the screen “Calibration” button again, and it will be expected to see that the icon for agriculture machine deviation calibration turns green.

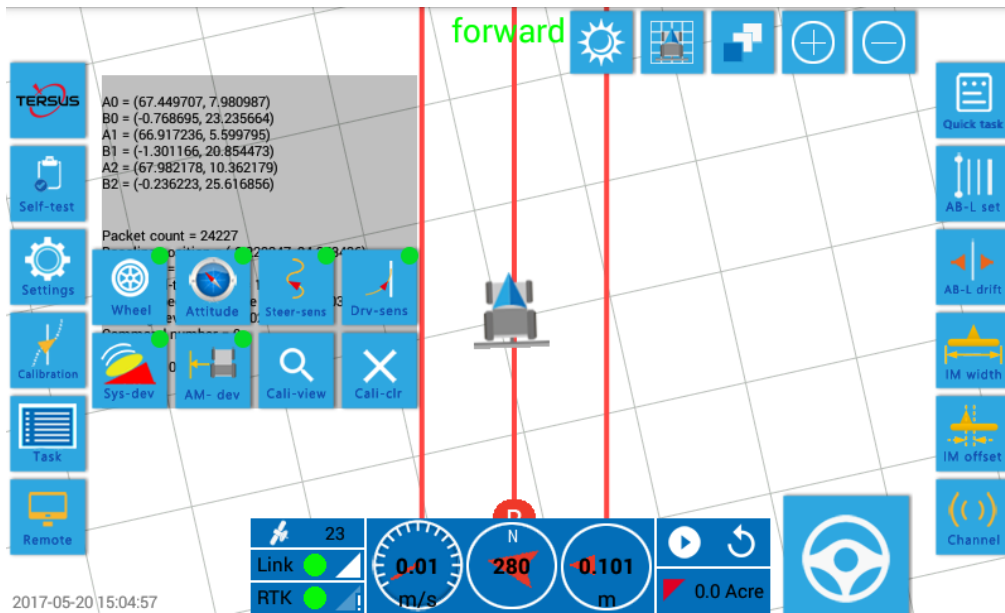
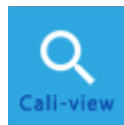


Figure 175 When the calibration of agriculture machine deviation is done, the corresponding icon turns green

5.5.8 Examine Calibration Value

When all calibration steps are completed, the red dots of all buttons in the calibration button group turn green, which means that all calibration items are completed.



Now touch “Cali-view” to view all calibration values, as shown in the figure below.

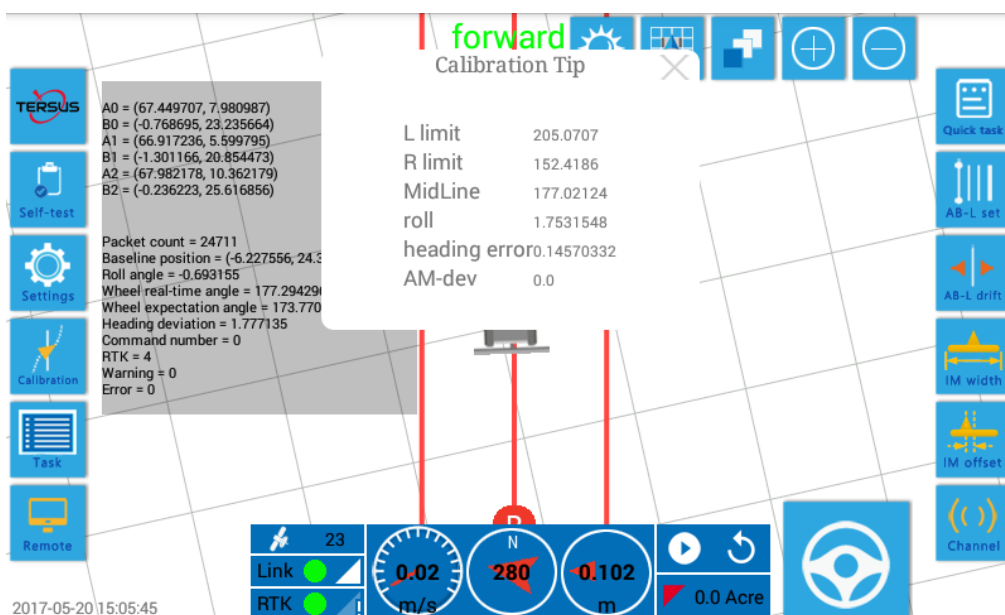


Figure 176 View of calibration parameters

In the calibration parameters, the operator can view the left/right limit and center line wheel of the guide wheel, the side inclination and path deviation of vehicle, vehicle deviation and etc. Each calibration value should be in the normal range to show that the calibration work is correctly completed.

- Values of left/right limits and center line wheel of the guide wheel increase or decrease sequentially with a difference of no less than 20 ° between two adjacent values
- Values of path angle, side inclination and pitch angle are no more than 5 °
- The deviation of farming vehicle is no more than 10cm

If the above requirements are not satisfied, the corresponding item should be recalibrated.

5.5.9 Auto Driving Test in Farmland

When all the calibration items of AG960 are completed, an auto driving test should be performed in the farmland to ensure the product conditions after commissioning.

Power off and restart the equipment which has been calibrated. Enter the user interface to complete the auto driving test in farmland. The duration should be at least 20min, and the distance should be at least 2000m for the auto driving test. The test is done as follows.

- Drive in auto driving mode at different speed, such as 1m/s, 2m/s, 3m/s and etc., and the vehicle should be able to run stably at all speeds. The vehicle head should not sway during the driving process and the driver does not feel discomfort.
- The instrument indicates a lateral deviation of no more than 2cm in both left and right side during the driving process. Observe the traces of wheels with eyes, which should be very straight without any bend apparent to the naked eyes.
- Track Line AB from an initial position of 0.5m lateral deviation, 1m lateral deviation, 0° path deviation and 30° path deviation. The vehicle can track Line AB within 5m at different speed and the vehicle passes Line AB once at the utmost during the tracking process. The following cases will not happen, i.e. the vehicle repeatedly tracks and leaves Line AB or even fails to track the line.

The equipment can only be delivered to the user when the above mentioned requirements are satisfied.



Figure 177 The tractor drives along a straight path in the farmland without any bend apparent to the naked eyes

6 Use of the System – AG960

6.1 Power up the Equipment

Press the gourd-shaped switch with hand to energize the equipment. When the gourd-shaped switch is pressed, the LED indicator on the switch lights up (blue) and the screen of the panel computer lights up at the same time.

When the panel computer is on, the screen displays the boot animation. When it is over, the log-in screen is displayed.

Disclaimer and License Agreement

User Instruction : You must agree to the following terms to use this product or any future updates of this product. If you do not agree to any of the following terms, please do not use this product or any of its updates. The use of this product means that you agree to the following terms.

I.Disclaimer

T This product has been tested in detail, but it is not guaranteed that the product is completely no error.

The Company shall not be liable for the loss of property or casualties resulting from misuse or abuse of any of its products.

Risk of use of this product is borne by the user and, to the maximum extent permitted by applicable law, damage and risks arising from the use or inability to use the product, including but not limited to direct or indirect personal injury, loss of business profits, trade Interruption, loss of business information or any other economic loss, the Company does not assume any responsibility.

The Company shall not be liable for any loss resulting from a telecommunications system, an Internet network failure, a computer malfunction or virus, information corruption or loss, computer system problems, or any other force majeure.

The Company and its suppliers shall not be liable for any loss caused by the self-

S

User

Figure 178 Log-in screen of panel computer

Browse through the “Disclaimer” and “License agreement”. If the user agrees, touch the “Agree” icon at the right lower corner of the log-in screen to enter the main user interface.

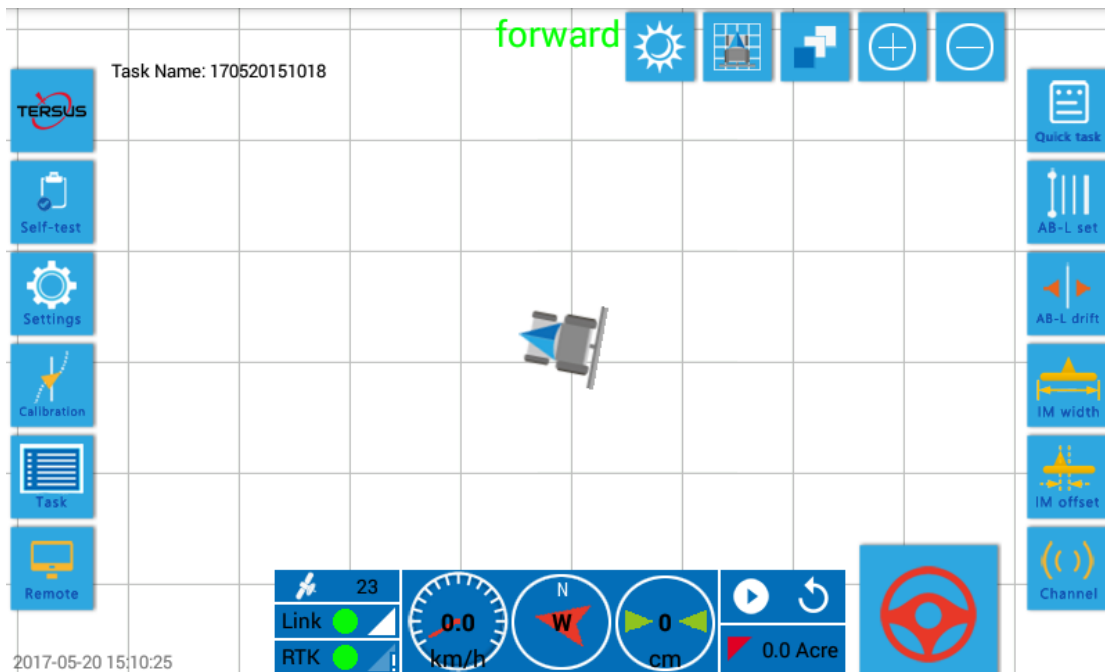


Figure 179 Main user interface

6.2 Task Management

AG960 provides a sound task management system for modern agricultural enterprise users and individual driver users, which can realize the driver information registration,

farmland information registration and task information documentation, as well as perform such operations as the establishing, editing, loading and deleting of task and facilitate the remote communication of task information to the farm cloud platform and the task schedule, management and statistical report.

If users have no demand for the management of task information, they can choose not enter the screen “Management of task”. All autopilot tasks can be completed through the shortcuts area at the right side of the screen.

6.2.1 Task Establishment



Touch the “Task” icon at the left side of the screen to enter the “Management of task” screen, which contains two sub-screens, namely “New task”

and “Load task”, with “New task” as the default sub-screen.

The screenshot shows the 'New Task' sub-screen. At the top, there is a blue navigation bar with three options: 'Back', 'New Task' (which is underlined), and 'Load Task'. Below the navigation bar, there are two main sections: 'Driver Info' and 'Task Info'. The 'Driver Info' section includes a dropdown menu for 'Chose driver' with the value 'test-18936652361'. Below this are input fields for 'Driver Name' (containing 'test'), 'Sex' (a dropdown menu with 'Male' selected), 'Tel' (containing '18936652361'), and 'Area' (containing 'a'). To the right of these fields is a blue button labeled 'ADD DRIVER'. The 'Task Info' section includes input fields for 'Farm name' (containing 'default'), 'landNo' (containing '0'), 'Task Type' (a dropdown menu with 'Subsoiling' selected), and 'Task Name' (containing 'Enter task name'). To the right of these fields is a blue button labeled 'NEW TASK'.

Figure 180 Sub-screen “New task”

In the sub-screen “New task”, the users can manage the driver information and task information.

- Driver information management. Fill “Driver’s name”, “Sex”, “Tel”, “Area” in the corresponding text boxes at the upper screen and touch “Add driver”

ADD DRIVER

to add the driver's information into the database. Open the pull-down menu "Select current driver" at the right upper corner to specify the driver responsible for the task currently.

- Task information management. Fill "Farm name", "Land No", "Task type", "Task name" in the corresponding text boxes at the lower screen, and touch "new task"

NEW TASK

to establish a new task. When a new task is established, the task name will be displayed at the left upper corner of main interface if go back to the main user interface.

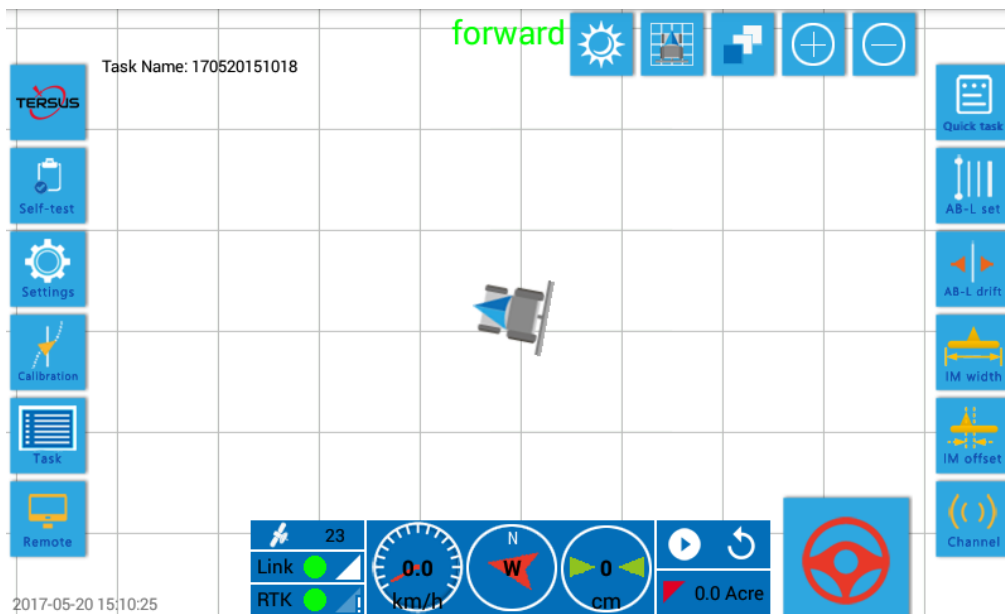


Figure 181 The name of new task is displayed at the left upper corner of main interface

When a task is established, various operations can be preceded under this task, for example, set Line AB, Line AB shift, Manual/Auto switchover etc.

6.2.2 Loading of Task

Load Task

Touch "Load task" icon at the upper part of the screen "Management of task" to enter the sub-screen "Load task". This sub-screen displays all tasks that have ever been established at this autopilot, including information such as "Task name", "Task time", "Task status" etc.

Task Name	Task time	Task status
170520151018	2017-05-20 15:10:18	进行中
170520141119	2017-05-20 14:11:19	暂停
170519160930	2017-05-19 16:09:30	暂停
170519091532	2017-05-19 09:15:32	暂停
170519081935	2017-05-19 08:19:35	暂停
ghy	2017-05-19 08:19:28	暂停
170508143457	2017-05-08 14:34:57	暂停
170508143407	2017-05-08 14:34:07	暂停
170508143329	2017-05-08 14:33:29	暂停
170508143225	2017-05-08 14:32:25	暂停
170508143127	2017-05-08 14:31:27	暂停
170508143119	2017-05-08 14:31:19	暂停
170505122217	2017-05-05 12:22:17	暂停

Operation:
Load Task
Click task to load task!

Job detail
Longtouch task to show the detail of task!

IMPORT TASK

EXPORT TASK

Figure 182 Sub-screen “Load task”

Touch the task name in the existing task information to load the specific task as the current task. Long press the task name with a finger to view the details about the task.

Task Name	170520151018	Task time	2017-05-20 15:10:18
Task area	a	Task status	进行中
Driver Name	test	Sex	Male
Tel	18936652361		
Vehicle Type	YTO-904	Tractor ID	fgt

DELETE TASK

BACK

Figure 183 Press the task name with a finger in a longer time to view the details about the task

In the sub-screen of task details, press “Delete task” button **DELETE TASK** to delete the task.

6.3 Use of Shortcut

The shortcuts area at the left screen contains the operational buttons required for all basic autopilot tasks. Taking advantage of the shortcuts, the user can learn to use the equipment in a very short time.

6.3.1 Establishment of Task with Shortcuts



Touch the first icon “Quick task” from the top at the right screen to establish a task easily. This function is the same as the function of “New task”, but it is much easier to operation and convenient for the use of the individual user. New task established with the shortcuts is named after the current Beijing time automatically.”



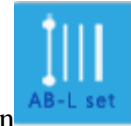
Next time the user can find the task in the screen “Task” of main interface so as to load the task and continue the task. For example, “20161023153207” represents a task established at Beijing time 15:32’07” dated Oct. 23rd, 2016. When a new task is establish with the shortcuts, the task name then is displayed at the left upper corner of the screen, as shown in the figure below.



Figure 184 Establish a new task with shortcuts

6.3.2 Set Line AB with Shortcuts

The setting of Line AB is to define the task path of the tractor. When the Line AB is set, the equipment will automatically plan 3 task paths parallel with the Line AB.



When a new task is established with the shortcuts, touch the second icon from the top at the right screen to set the Line AB under the current task.


First manually drive the tractor to the specified position of the farmland. Touch “Line


AB” icon , and the icon  appears at the left side.



Figure 185 Set Line AB with shortcuts, set Point A

Touch the icon to set the current position of the tractor as Point A. At the same time,

the icon  appears. Continue driving the tractor manually along the specified path

till it reaches the specified position. Touch the icon  to set the current position of the tractor as Point B.

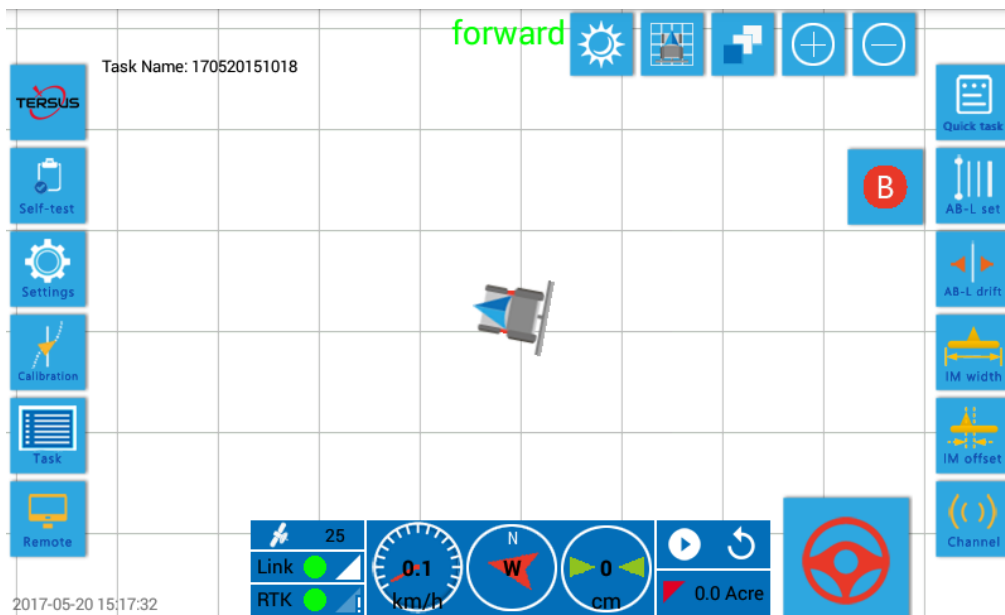


Figure 186 Set Line AB with shortcuts, set Point B

When both Point A and Point B are set, the task path of the tractor is defined and planned. 3 parallel lines will be displayed in the center of the screen respectively corresponding to three paths: the line in the middle is the current task path and the left one and right one are respectively next task path at a distance of “IM width” with the current path

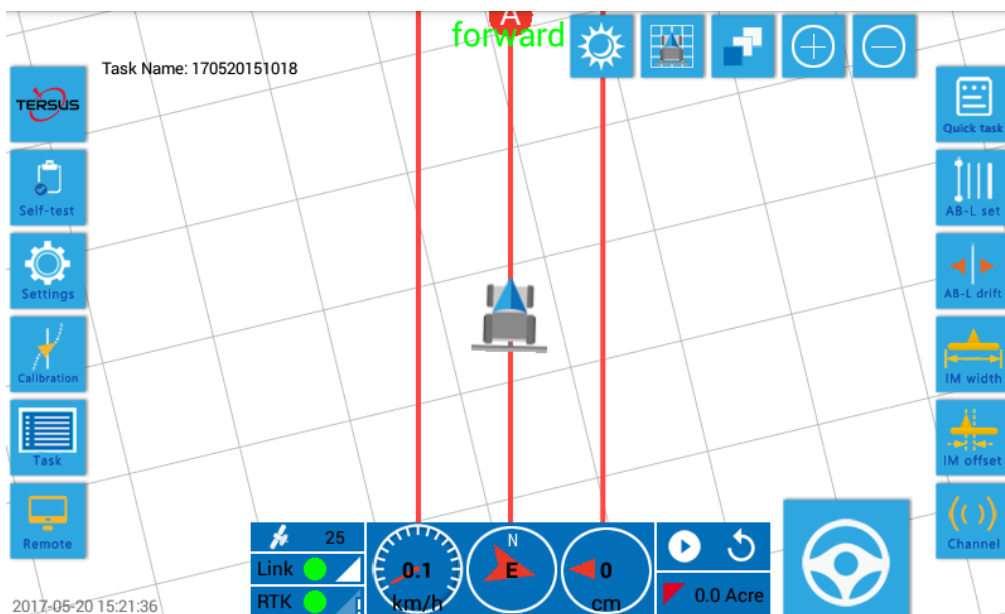




Figure 187 Set Line AB with shortcuts: three Line ABs are displayed when both Point A and Point B are set

Note:

- The prerequisite for setting Line AB is that a task is established or loaded


currently, that is, the left upper corner of the screen displays the current task name **Task Name: 170520151018**. Otherwise, it will be ineffective to touch the “Line AB” icon.

- When the icon  at the left lower corner of the screen is red, it means that the farming vehicle is not in the centimeter-level high precision positioning status and now it is ineffective to touch the “Line AB” icon. The Line AB cannot be set normally until the icon  turns green.

6.3.3 Shift of Line AB with Shortcuts

In some specific cases, it is required to shift the current task path of Line AB left or right for certain distance to satisfy the task requirement, for example, when the remaining part of the farmland is less than one operation width.



Touch the third icon  from the top at the right screen and the shift options pop out in center of the screen providing three methods to shift the Line AB.



- This icon is used to shift to the current position, that is, shift current Line AB to the position right above the rear axle center of the current tractor.



- This icon is used to shift to the left at a specified distance and the value of specified distance is entered manually.



- This icon is used to shift to the right at a specified distance and the value of specified distance is entered manually.

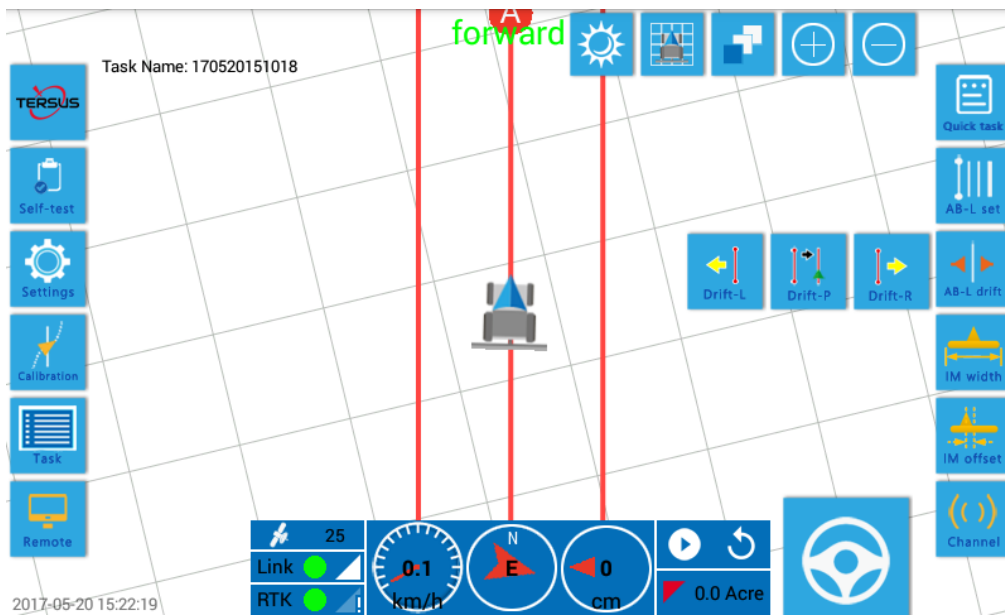
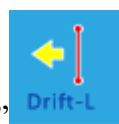



Figure 188 Shift Line AB with shortcuts



“Drift to the left” , and now a numerical box appear in the center of the screen. Enter “0.5” in the box and confirm it.

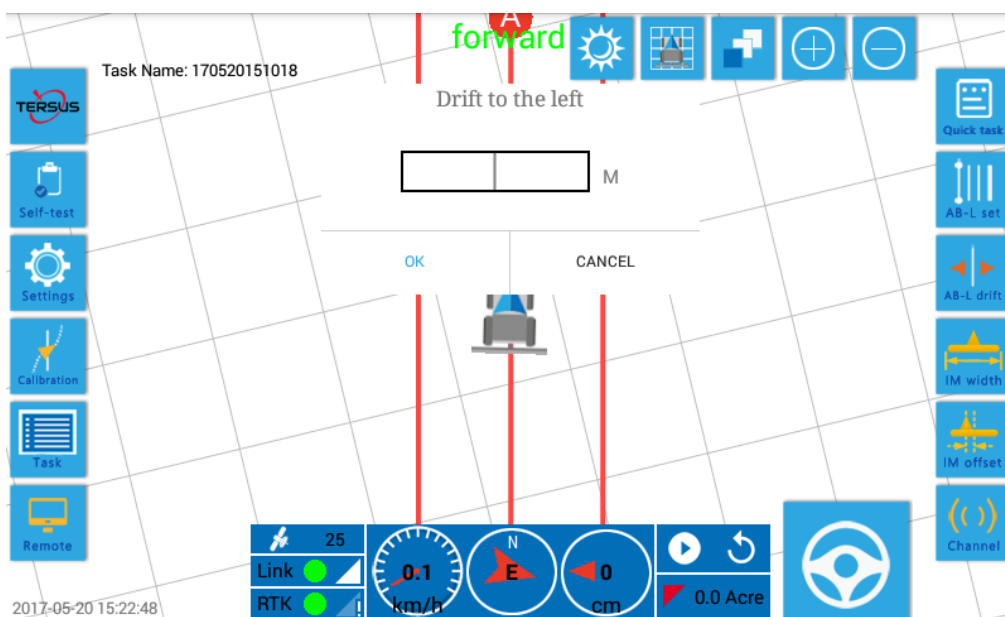


Figure 189 Enter the distance to shift left

When it is confirmed, the Line AB moves left accordingly, as shown in the figure below.

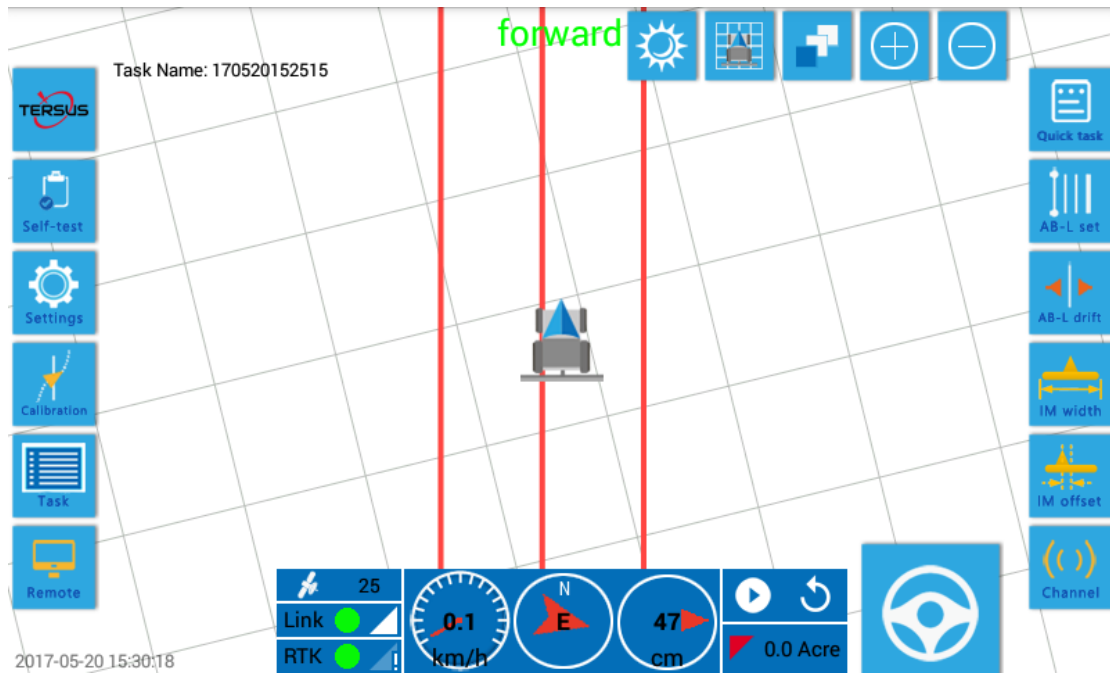


Figure 190 Result of Line AB shifting left

Note:

- Line AB must be shifted based on an existing task with a set Line AB, or there is no Line AB available to shift. In this case, it is ineffective to touch the icon.
- Once the Line AB is shifted, it will be saved in the database of the panel computer and is permanently valid, and the succeeding task path will be planned with reference to the shifted Line AB. Even if the equipment is powered off and restarted, when the task is reloaded, the task paths planned for the task also take reference to the shifted Line AB.

6.3.4 Setting of IM Width with Shortcuts

When the user changes the implement installed to the rear part of the farming vehicle,



use the fourth icon “IM width” from the top at the right screen to change the operation width of implement easily. The function is the same as what described in the sub-screen “Implement setting”, but it is much easier to operate.

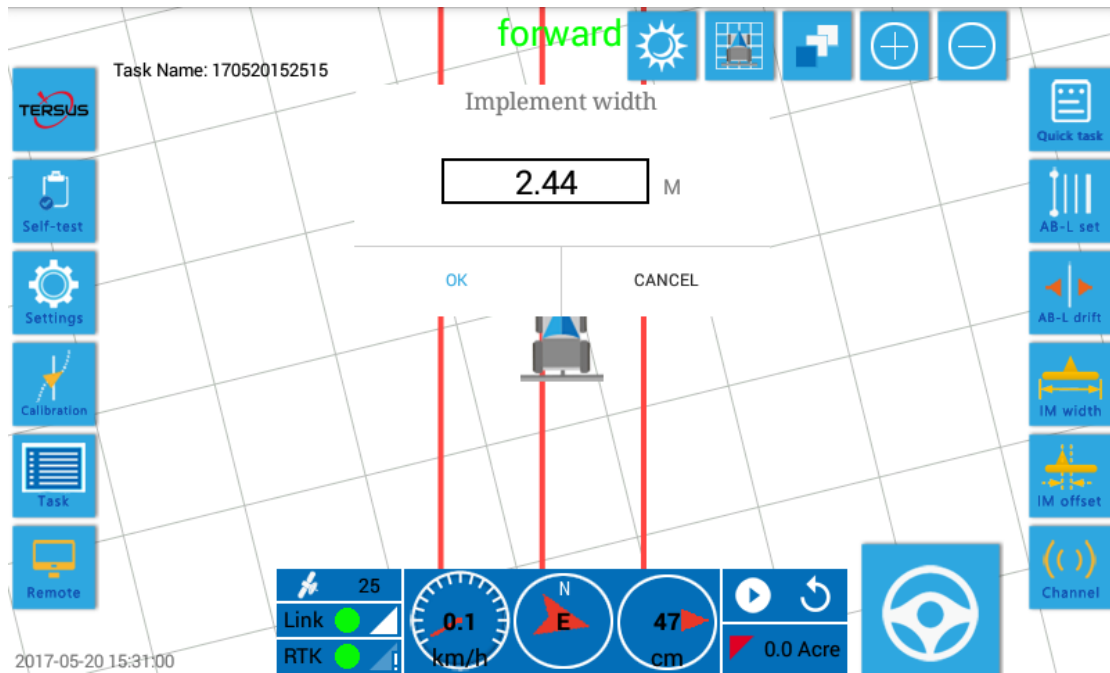


Figure 191 Set the operation width with shortcuts

The operation width is calculated as “the actual distance measured from the leftmost tip of the implement (or where the seed is planted) to the rightmost tip of the implement (or where the seed is planted) + internal row spacing of the implement”.

The following are some typical examples of calculation of the operation width of implement.

Operation width of a corn planter = 350cm (Distance measured from the leftmost seed planting point to the rightmost seed planting point of farm tool) + 70cm (Internal row spacing of farm tool) = 420cm



Figure 192 Operation width calculation of corn planter

Operation width of a cotton planter = 385cm (Distance measured from the seed planting point of the leftmost hill-drop planter to the seed planting point of the rightmost hill-drop planter of farm tool) + 65cm (Internal row spacing of farm tool) = 450cm



Figure 193 Operation width calculation of cotton planter

Operation width of a wheat planter = 385cm (Distance measured from the leftmost seed planting point to the rightmost seed planting point of farm tool) + 65cm (Internal row spacing of farm tool) = 375cm

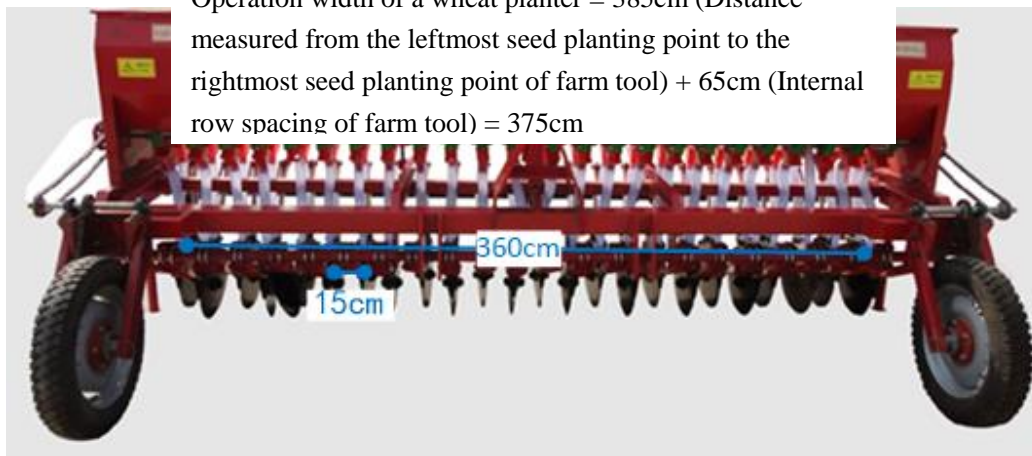


Figure 194 Operation width calculation of wheat planter

6.3.5 Setting the Shift of Implement with Shortcuts

During the operation process, the farm tool may have certain left or right deviation actually (usually several centimeters) because the farm tool cannot be absolutely symmetrical in term of the mechanical structure. This will result in deviation of transfer row during operation in auto driving mode. (For example, if the transfer row width is 65cm in theory, the actual width measured is 60m and 70m alternately, which is the transfer deviation caused by the shift of farm tool.).

When transfer row deviation appears, set the shift value of farm tool easily with the



fifth icon from the top at the right screen to eliminate the transfer row deviation. The function is the same as what described in the sub-screen “Farm tool setting”, but it is much easier to operate.

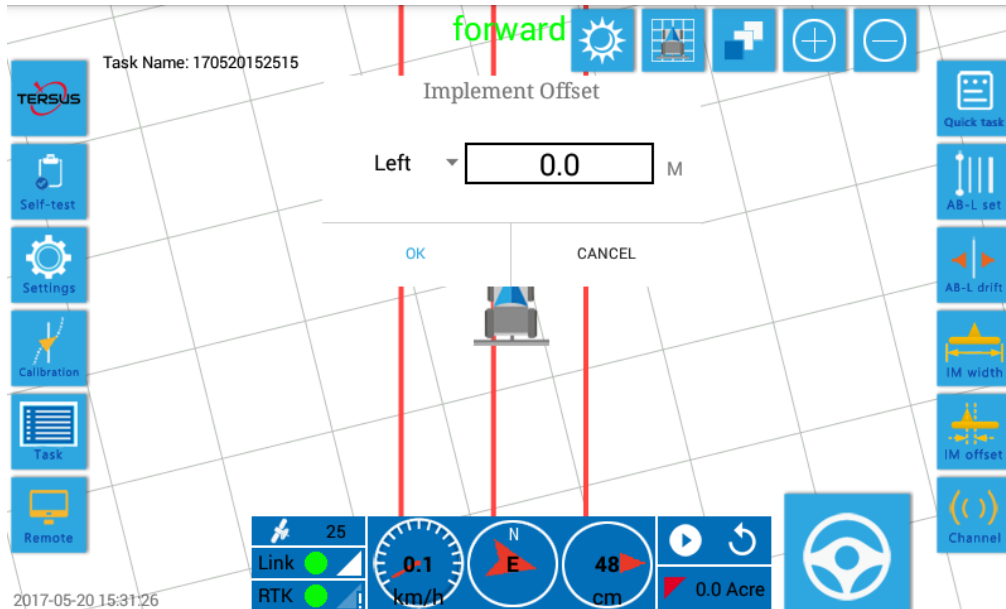


Figure 195 Set the deviation of farm tool with shortcuts

The method of speculating the deviation of farm tool by measuring actual transfer row deviation.

- Measure the actual transfer row at the left side of the tractor (left rear side from the driver’s first-person view). The transfer row width at the left side of the farming machine is less than the required value, which means the farm tool shifts left; and if it is more than the required value, it means the farm tool shifts right.
- Measure the actual transfer row at the right side of the tractor (right rear side from the driver’s first-person view). The transfer row width at the right side of the farming machine is less than the required value, which means the farm tool shifts right; and if it is more than the required value, it means the farm tool shifts left.
- Divide the difference between the measured transfer row width and the required value by 2 to obtain the shift value of farm tool.

Note:

To measure the actual transfer row width, select 3~5 separate points at a spacing of over 10m from a straight driving path of at least 50m long, and choose the average value as the actual transfer row width.



- The broken line in the figure indicates every row of seed caves. The transfer row width is required to be the same as the internal row, i.e., 65cm.
- Now measure the transfer row width at the left side of the tractor to speculate the actual left or right shift of the vehicle. At a spacing of 10m, remove the covering soil to find the seed cave. Measure the transfer row width, which is respectively 68cm, 66cm, 69cm and 67cm. The average value is 67.5cm, 2.5cm more than the required value. It means that the farm tool shifts right by 1.25cm. Fill this shift value into the shift farm tool, and thus the commissioning of the transfer row is completed.
- To complete the transfer row commissioning in one attempt, fill the right shift of 1.25cm into the farm tool shift and shift the Line AB 1.25cm to the left at the same time. Then continue driving the tractor forward and the transfer row width will reach the average value of 65cm as required. The user shall think for the reason on their own.

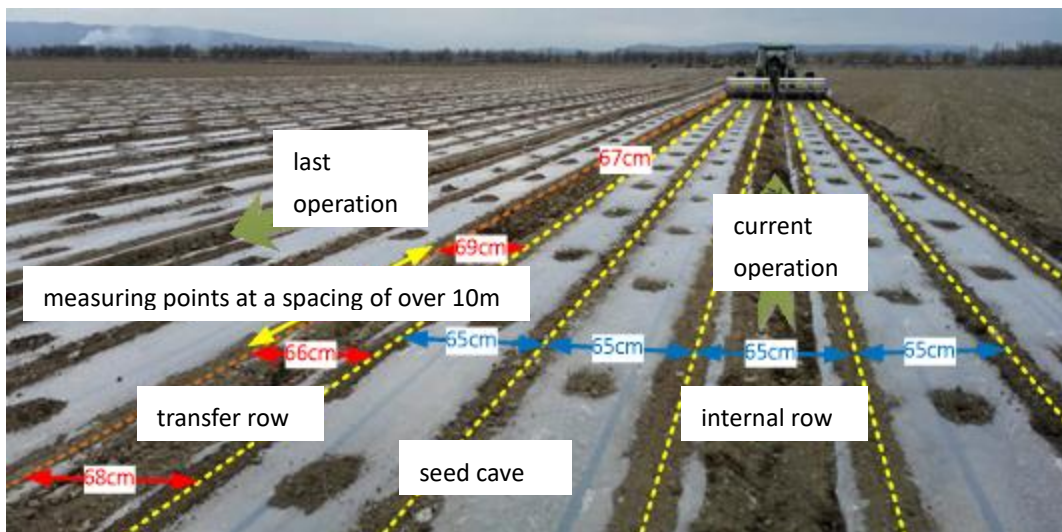


Figure 196 Speculate the shift of farm tool shift by measuring actual transfer row width at the left

side of the tractor

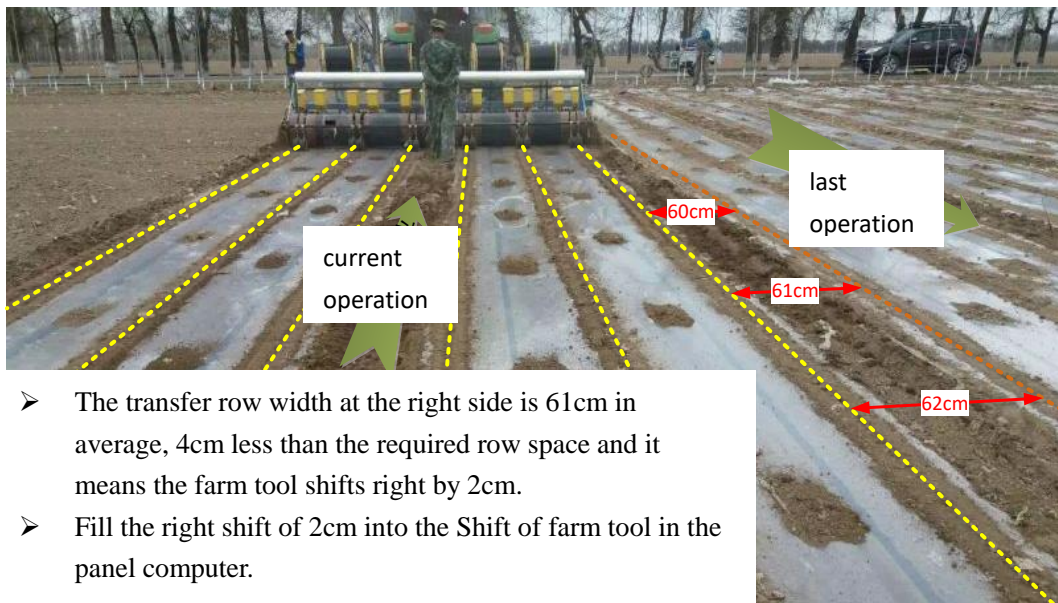


Figure 197 Speculate the farm tool shift by measuring actual transfer row width at the right side of the tractor


When the farm tool deviation is acquired through calculation, fill it into the dialogue box of “Shift of farm tool” so as to complete the adjustment of transfer row.

Note:

When the value is filled into the shift of farm tool, it had better shift the Line AB to the opposite direction by the same distance, so that the transfer row will be adjusted as desired in one attempt. For example, fill “Farm tool shifts right by 3cm”, and “Line AB shifts left by 3cm” at the same time.

6.3.6 Setting of Radio Channel Number with Shortcuts



The bottom icon at the right screen is the shortcut icon  to set the radio channel number. Touch this icon to switch the radio channel number by shortcut button. AG960 provides 16 channels for the users.

The channel number is to be switched usually in the following two cases.

- In case of stationary reference station, when the operation area of tractor changes from the place near one reference station to other place near another reference

station, the channel may be switched to the transmitting channel number of the nearest reference station to obtain better signal quality.

- In case of portable reference station, when the quality of signals decreases owing to the interference (for example, the interference from other portable reference station working nearby), switch the channels of the portable reference station and the autopilot at the same time to improve the signal quality.

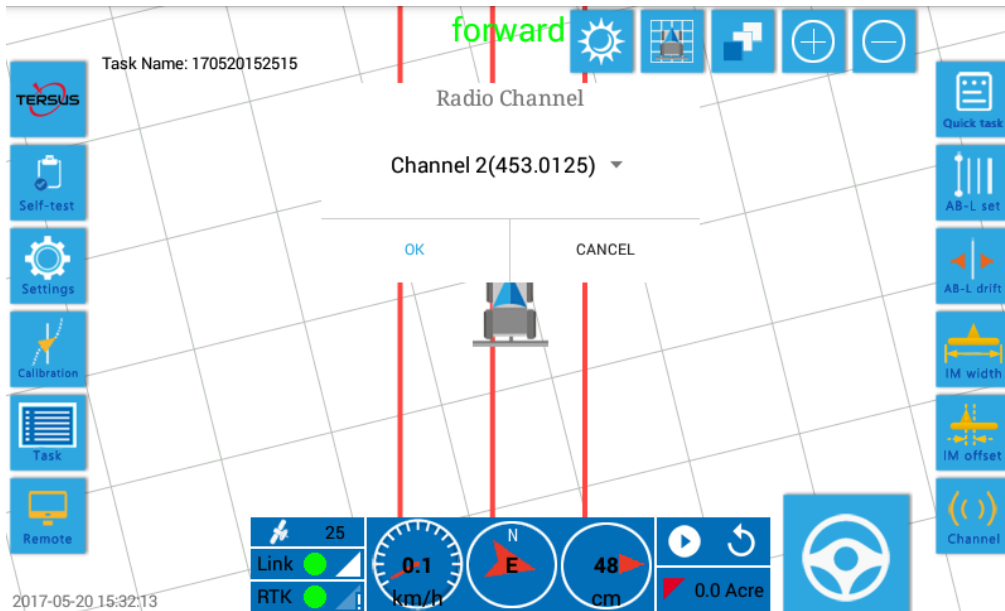


Figure 198 Set the radio channel number with shortcuts

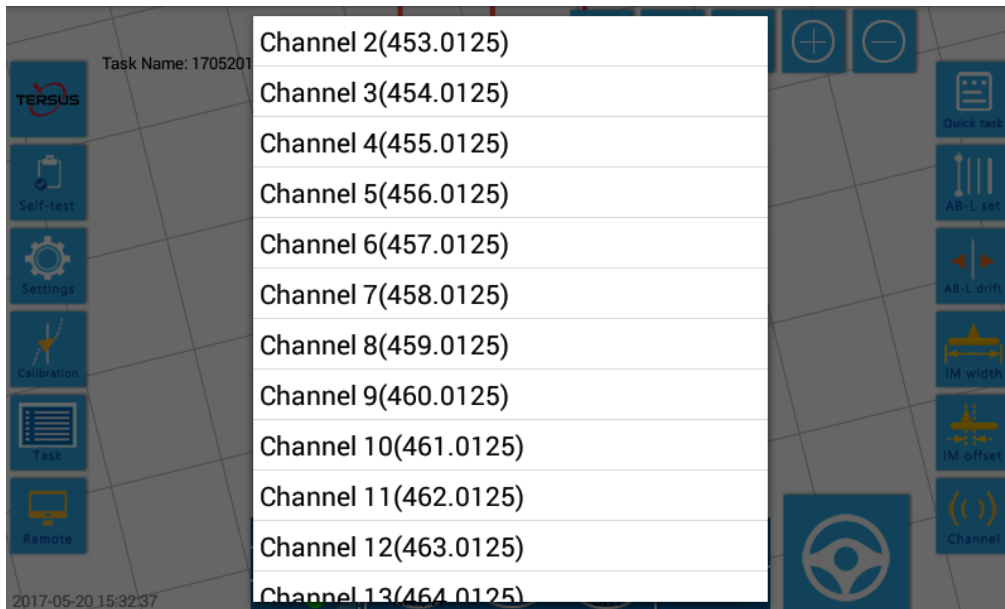






Figure 199 Select a proper channel

6.4 Manual/Auto Switching

There is a manual/auto switching button at the right lower corner of the screen. The

button can switch between four colors and their definition as below.

Table 6 Definition of manual/auto switching button

Item	Icon	Color	Description/Function/Meaning
1		White	It means that the vehicle is now in manual driving mode and is allowed to be switched to the auto driving mode.
2		Red	It means that the vehicle is now in manual driving mode and is not allowed to be switched to auto driving mode [in the cases such as no task is established, no Line AB is set, or the vehicle is too far away from the Line AB ($\geq 2m$), the angle between the vehicle and Line AB is too large ($\geq 30^\circ$)]
3		Green	It means the vehicle is now in auto driving mode
4		Yellow	

The manual/auto driving should be switched according to the following rules.

- When the steering wheel icon is white, it is allowed to touch the icon. And now the autopilot takes over the control of vehicle steering immediately and the farming vehicle runs along the Line AB automatically
- When the steering wheel icon is red, it is ineffective to touch the icon
- When the steering wheel icon is green, touch the icon and the autopilot gives up the control of vehicle steering immediately and the vehicle enters manual driving mode
- For autopilots with “Steering wheel override” function, when the steering wheel icon is green, the driver can override the steel wheel (that is, force to turn the steering wheel manually when the vehicle is in auto driving mode) to release the vehicle from auto driving mode to manual driving mode.

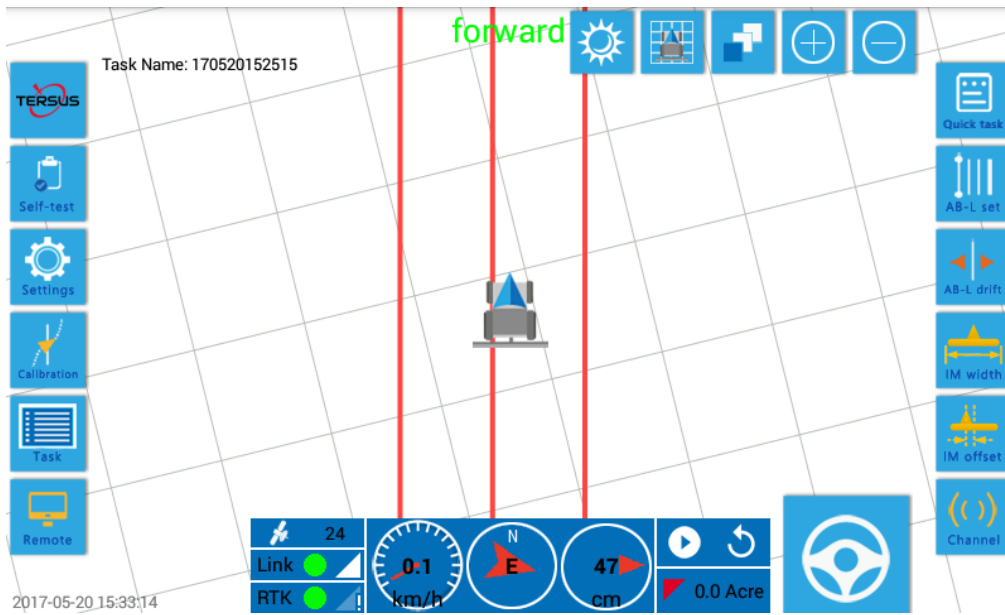


Figure 200 The vehicle is now in manual driving mode and allows to be switched to auto driving mode

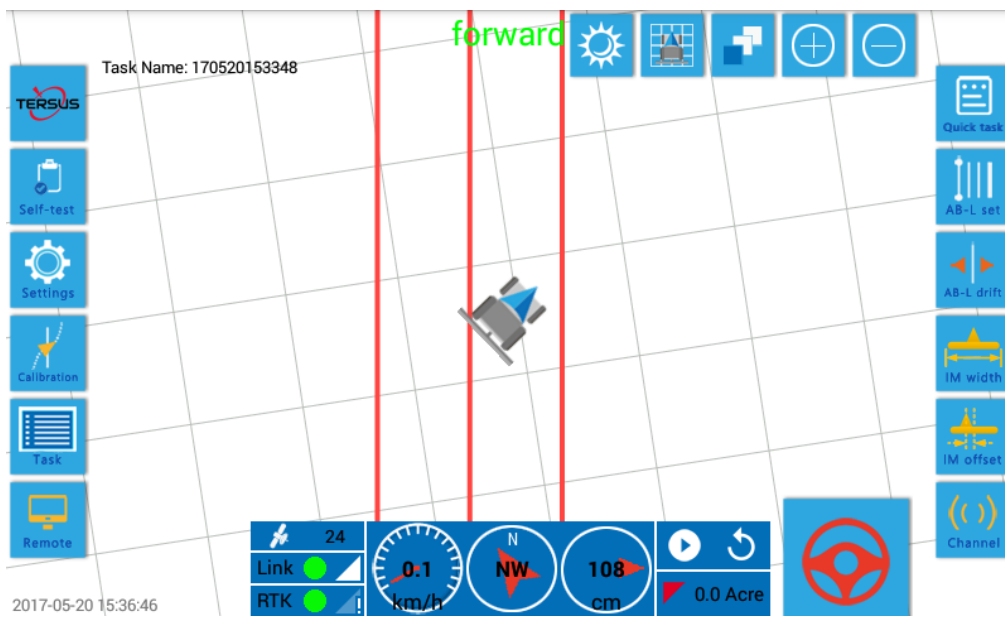


Figure 201 The vehicle is now in manual driving mode and does not allow to be switched to auto driving mode (Since the Line AB is not available now)


6.5 Monitoring of Instrument Panel


The instrument panel area at the lower part of the screen can monitor the working status of the autopilot.

6.5.1 Monitoring of the Number of Satellite Received

The instrument panel area at the lower part of the screen can monitor the working status of the autopilot.






The number in the leftmost icon  in the instrument panel area at the lower screen indicates the number of navigation satellites in the sky that are currently received. AG960 can receive signals from Beidou satellites of China, GPS satellites of USA and GLONASS satellites of Russia.

For example,  means that currently signals from 27 satellites are received.




If the equipment can receive signals from more than or equal to 25 satellites, it means the satellite condition is good. If the equipment can receive signals from less than 25 but more than or equal to 20 satellites, it means the satellite condition is average. If the equipment can receive signals from less than 20 satellites, it means the satellite condition is poor.

Check the connection status of satellite navigation antenna. If the vehicle is right under a forest belt, the auto driving mode shall be stopped or switch to manual mode.

6.5.2 Monitoring of Radio Status

The leftmost icon  in the instrument panel area at lower screen indicates whether the radio can receive the signals from Beidou reference station currently. Red light  means that no signals from reference station are received, and green light  means that signals from reference station are received. The right side indicates the strength of reference station signals received, full scale representing the strongest signals. In case of red indicator, check and eliminate the trouble as per the steps described in section of [View self-checking information of equipment].


6.5.3 Monitoring of Positioning Status

The leftmost icon  in the instrument panel area at the lower screen indicates whether the equipment is currently in centimeter-level high precision positioning status (i.e. RTK status). Red light  means that the equipment is not in RTK while green light  means that it is in RTK.

In case of red indicator, check and eliminate the trouble as per the steps described in section of [View self-checking information of equipment].


6.5.4 Monitoring of Driving Speed



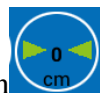
The second icon  from the left-to-right in the instrument panel area at the lower screen indicates the current speed of vehicle in kilometers per hour (km/h).

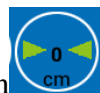
6.5.5 Monitoring of Direction

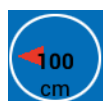


The third icon  from the left-to-right in the instrument panel area at the lower screen indicates the current direction of vehicle, including eight directions in total, namely East, South, West, North, Southeast, Southwest, Northwest and Northeast.

6.5.6 Monitoring of Operation Precision



The fourth icon  from the left-to-right in the instrument panel area at the lower screen is the most important real-time indication of the autopilot, which indicates the current driving error, i.e. the lateral distance in centimeters from the rear axle center of the vehicle to current Line AB. If the arrow in the icon points left, for example,







it means that the error is 100cm in the left. If the arrow in the icon points right, it means the error is in the right.

6.5.7 Monitoring of Operation Area



The rightmost icon in the instrument panel area at the lower screen indicates the operation area that currently has completed in mu. The product starts mu counting from the first time of auto driving since the task is established, and the counting of area is subject to no influence of any startup or shutdown of the equipment or other operations during the process. The mu counting will not be reset until the current task is changed.

The acre counting can be started or suspended by button  and reset by button . Green icon  indicates that the mu counting is in progress, while red icon  indicates that the mu counting is suspended.

6.6 Adjustment of the Display

The “Display adjustment area” at the upper screen can adjust the background, brightness of the display.

6.6.1 Adjustment of Day/Night Display Effect



Touch the icon in the display adjustment area at upper screen to switch the display background between modes of day or night. In day mode, the display background is white for clear display in the sunshine; while in night mode, the display background is black in order to prevent the intense light emitted by the display from interfering the sight of the driver.

The screen in night mode is as shown in the figure below.

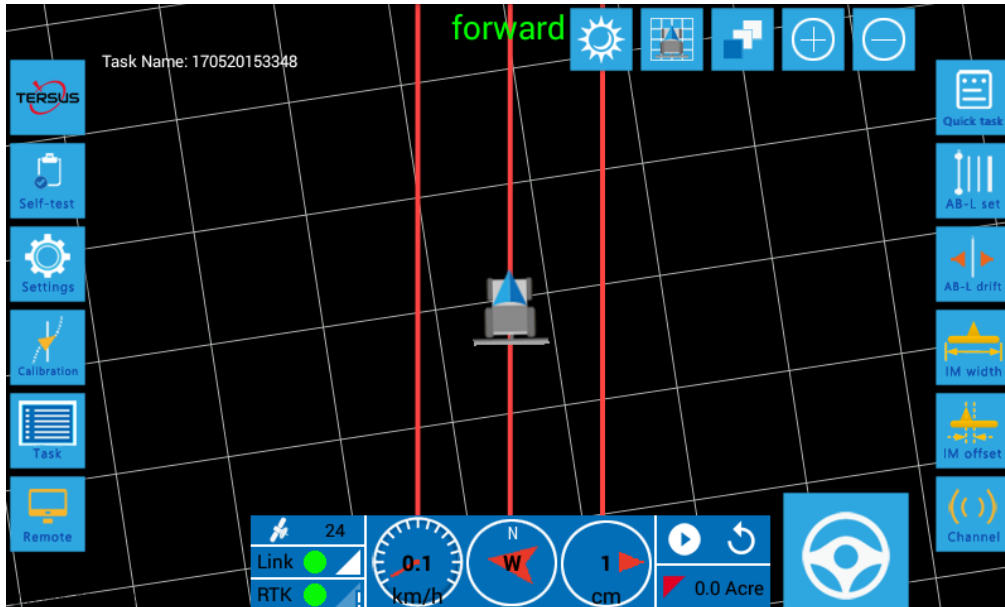



Figure 202 Display effect of screen in night mode

6.6.2 Adjustment of Background Grid Displace Effect

Touch the icon  in the display adjustment area at upper screen to conceal or display the grid in the display background.

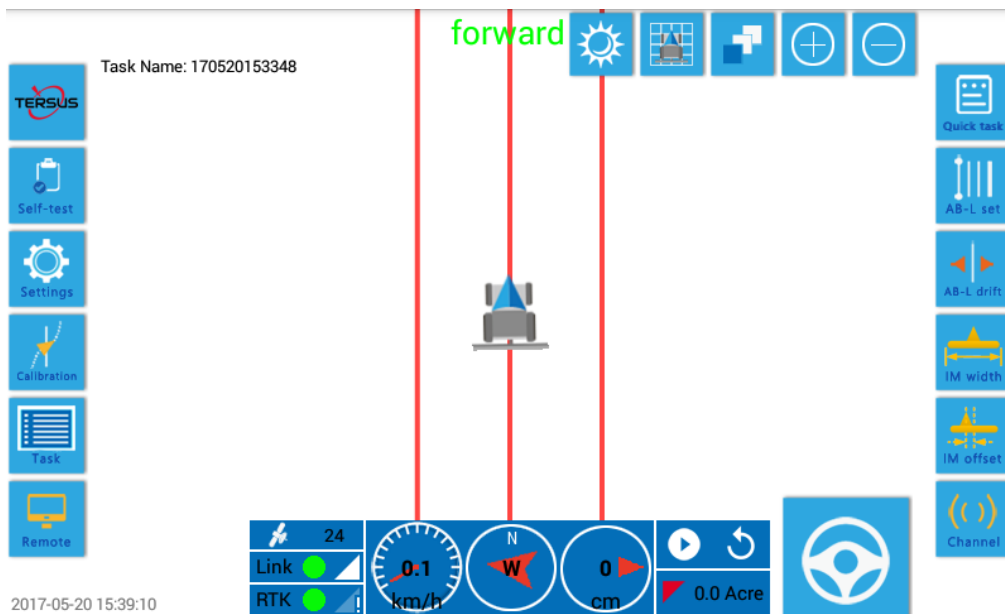



Figure 203 Display effect of background with concealed grid

6.6.3 Adjustment of Operation Highlight Display Effect

Touch the icon  in the display adjustment area at upper screen to display or hide the highlighted operation information. When this function is enabled, the area after operation is highlighted with green, while the area before operation is shown with background color. This function can provide indication for some seeding operations without mulching film or leaving obvious traces on the land, and such operations as pesticide spraying, fertilizing and etc. that are difficult to discern the area operated or unoperated with eyes and thus is highly practical.

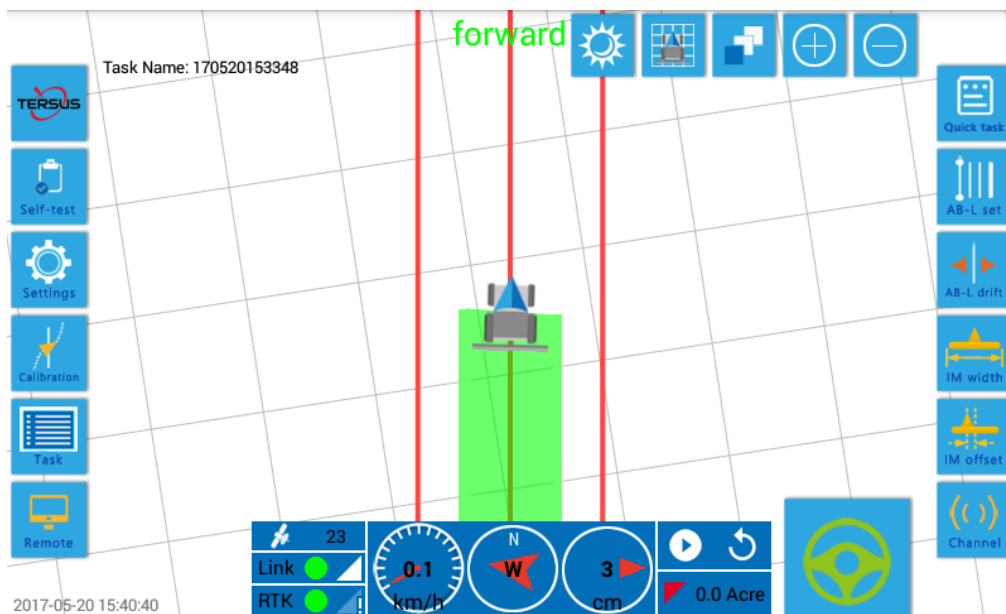





Figure 204 Enable the operation highlight function

6.6.4 Adjustment of the Zoom of Agriculture Vehicle

Icons  in the display adjustment area at upper screen are to adjust the zoom of the display. Touch the icon  to zoom in the display element in the middle of the screen and touch the icon  to zoom out the display element in the middle of the screen.

7 Daily Maintenance

This section summarizes the key points of daily maintenance of AG960 reference of technical support personnel and users of the system.

Table 7 Key points of daily maintenance of AG960

Description	Key point of maintenance
<p>Maintenance of the satellite navigation antenna</p>	<p>Frequently check if the mushroom head top is covered with mud or leaves. If yes, clean it in time. Otherwise it may cause reduced quality of the satellite signals received.</p> <p>Frequently check if the connection between the antenna rod and the pedestal as well as the antenna rod and the mushroom head get loose. If yes, tighten it in time. Otherwise it may cause reduced operation precision.</p> <p>Frequently check if the 3M glue at the antenna pedestal or the driving cab top of vehicle gets loose. If yes, secure it in time. If it is required to remove the glue and re-attach it, make sure that the attaching location completely coincides with the original location. Otherwise it may cause reduced operation precision.</p> <p>Frequently check if the connection between the mushroom head and the 3M RF cable gets loose. If yes, tighten it in time. Otherwise it may cause intermittent satellite signals and then make the normal operation impossible.</p> <p>Frequently check if there is any damage in the mushroom head and 3M RF cable. If any, contact the distributor to replace the component in time. Otherwise it may cause the failure of equipment to receive satellite signals and then make the normal operation impossible. If the replacement of component is caused by the improper operation of user or out-of-warranty period, the user should pay the purchasing cost of the component and charges for the installation and commissioning service.</p>
<p>Maintenance of radio receiving antenna</p>	<p>Frequently check if the connection between the rod and the pedestal of radio receiving antenna. If any, tighten it in time. Otherwise it may cause intermittent reference station signals and affect normal operation.</p> <p>Frequently check if the 3M glue between the radio receiving antenna pedestal and the driving cab top of vehicle gets loose. If yes, secure it in</p>

time. If it is required to remove the glue and re-attach it, try to attach it at the original location as far as possible. Otherwise it may cause falling down from the cab top or damage of the radio receiving antenna.

Frequently check if there is any damage in the radio receiving antenna and the cable. If any, contact the distributor to replace the component in time. Otherwise it may cause the failure of equipment to receive the reference station signals and then make the normal operation impossible. If the replacement of component is caused by improper operation of user or out-of-warranty period, the user should pay the purchasing cost of the component and charges for the installation and commissioning service.

Maintenance of panel computer

Frequently check if the connection between the back of panel computer and the cable is loose. If yes, secure it in time. Otherwise it may cause trouble in powering on the panel computer screen or communication faults.

Frequently check if two knobs of panel computer bracket are secure. If not, tighten them in time. Or the panel computer may drop down and makes it difficult to operate.

Frequently check if the screen or the body of panel computer is covered with dust or mud. If yes, clean it immediately. Otherwise it may cause ineffective touching operation of the panel computer.

Frequently check if the panel computer is stuck by any sharp object and thus leave traces. If yes, contact the distributor to replace the component in time to prevent any fault resulting in the failure of operation. If the replacement of component involves the improper operation of user or out-of-warranty period, the user should pay the purchasing cost of the component and charges for the installation and commissioning service.

Maintenance of Autopilot (Controller)

Frequently check if the Autopilot (Controller) is covered by mud or if the surrounding is too wet. If yes, clean the driving box promptly and make sure the surrounding is dry. Check if the front panel of Autopilot (Controller) is often kicked or impacted. If yes, take necessary protective measures in time.

Frequently check if the connections between 3 RF plugs and RF cables at the front panel of the Autopilot (Controller) get loose. If yes, tighten the connection in time. Check if the cable root bears too much stress. If yes, adjust the cable in time to reduce the stress.

Frequently check if the connections of vehicle standard 23-pin connector and the equipment harness at the front panel of the Autopilot (Controller)

get loose. If yes, firmly connect it in time. Check if the root of equipment harness bears too much stress. If yes, adjust the harness in time to reduce the stress.

Frequently check if the body and front panel of the Autopilot (Controller) get deformed or damaged owing to the extrusion or striking of external force. If yes, contact the distributor to replace the component in time. If the replacement of component involves the improper operation of user or out-of-warranty period, the user should pay the purchasing cost of the component and charges for the installation and commissioning service.

Maintenance of steering system

Frequently check if the steering system is covered by mud or stems or leaves of plants. If yes, clean it in time.

Frequently check if any of the various screws on the steering system is missing or loose. If any, tighten them in time.

Frequently check if any anchor ear on the front axle is loose or shifted. If any, re-tighten or restore it in time.

Frequently check if there is any damage in the components and assemblies of the steering system (including the cables from the steering sensor). If any, contact the distributor to replace the component in time. If the angle displacement measuring device is replaced, the equipment must be re-calibrated. If the replacement of component involves the improper operation of user or out-of-warranty period, the user should pay the purchasing cost of the component and charges for the installation and commissioning service.

Maintenance of electromagnetic hydraulic valve

Frequently check if the hanging of electromagnetic hydraulic valve on the farming vehicle gets loose. If yes, re-tighten or reinforce it in time.

Frequently check if any connector of the electromagnetic valve gets loose and if there is any sign of oil leakage. If yes, tighten the connector or replace the sealing washer to eliminate the problem.

Frequently check if the connection between the electric control connector of electromagnetic hydraulic valve and the harness gets loose. If yes, tighten it in time.

Frequently check if the valve body and the proportional valve of electromagnetic valve get deformed or damaged due to the extrusion or impact of external force. If yes, contact the distributor to replace the component in time. If the replacement of component involves the improper

operation of user or out-of-warranty period, the user should pay the purchasing cost of the component and charges for the installation and commissioning service.

Maintenance of equipment harness

Frequently check if the connection between drive harness and the battery gets loose. If yes, tighten it in time.

Frequently check if any line plug between the drive harness and the steering sensor gets loose. If yes, tighten it in time and wrap it with insulating tapes.

Frequently check if there is any damage in the protection of the extended port of the harness. If yes, fix it in time. Frequently check if there is any damage in the nylon cover of the harness. If yes, fix it with insulating tapes in time. Frequently check if there is any damaged cable or exposed metal wire on the harness. If yes, contact the distributor to replace the component in time. If the replacement of component involves the improper operation of user or out-of-warranty period, the user should pay the purchasing cost of the component and charges for the installation and commissioning service.

Precautions during cleaning the vehicle

Although TERSUS AP-960 autopilot for farming vehicle has a IP65 (rainproof) class water proof protection, the user still should protect the product from water as far as possible:

It is prohibited to directly use high-pressure water gun impacting on the satellite navigation antenna and the radio receiving antenna at the driving cab top.

The panel computer and Autopilot (Controller) inside the driving cab should be wrapped and protected with waterproof plastic bags during vehicle cleaning process to prevent water ingress. It is prohibited to directly use high-pressure water gun impacting on the wrapped panel computer and Autopilot (Controller).

It is prohibited to use high-pressure water gun directly impacting on the hydraulic valve, especially where the hydraulic valve is connected to the harness terminal to prevent short circuit resulted from water ingress.

It is prohibited to use high-pressure water gun directly impacting on the steering measuring mechanism.

Precautions in off season

In off seasons, if the driver use the farming vehicle for transportation or other activities, the following points should be noted with regard to the autopilot installed to the farming vehicle:

Do not dismantle the satellite navigation antenna, Autopilot (Controller),

hydraulic valve and steering system, or the calibrated data of the equipment will become ineffective. If recalibration is required due to the user's reason, the user has to pay for the commissioning work.

If the antenna rod of radio receiving antenna and panel computer are to be dismantled, please store the dismantled components properly. The cable connector left should be protected from dust and water ingress with insulating tapes. If any component is lost or damaged due to the user's reason, the user has to pay the purchasing cost of component and the charges for installation and commissioning work.

8 Troubleshooting

This section summarizes the common troubles that may occur during the operation and solutions for AG960.

Table 8 Issues and solutions – AG960 troubleshooting

Trouble	Description	Eliminating methods
<p>FA1: Link is red</p>	<p>Link indicator is red, and the radio icon in the self-checking information is red, the vehicle is unable to receive the data from the reference station</p>	<p>Make sure the farming vehicle is in an open area outdoor and there is no apparent obstacle around or above the farming vehicle;</p> <p>Check if any reference station is established near the farming vehicle;</p> <p>Check if the reference station functions normally and if the signals are available;</p> <p>Check if the farming vehicle is too far away from the reference station (it is best ≤ 20km for the stationary station and ≤ 3km for the portable station);</p> <p>Check if the radio configuration of the autopilot is correct;</p> <p>Check if the radio receiving antenna is correctly installed on the driving cab top;</p> <p>Check if the RF connector hanging down the radio receiving antenna from the top of driving cab is correctly connected to the “Radio antenna” sockets at the front panel of the Autopilot (Controller);</p> <p>Check if the RF connector is securely connected;</p>

		<p>Replace the radio receiving antenna;</p> <p>Replace the Autopilot (Controller);</p> <p>Contact the distributor or FAE department of the manufacturer.</p>
FA2: RTK is red	<p>RTK indicator is red, and the GNSS receiver (positioning) in the self-checking information is red, the vehicle is unable to enter the high precision positioning condition</p>	<p>Make sure the farming vehicle is in an open area outdoor and there is no apparent obstacle around or above the farming vehicle;</p> <p>Check if the Link lamp is green. If it is red, eliminate the trouble follow the steps as described in item 1.</p> <p>Check if the receiver configuration of the autopilot is correct;</p> <p>Check if both satellite navigation antennas are correctly installed on the driving cab top;</p> <p>Check if the RF connectors of both satellite navigation antennas are securely connected;</p> <p>Check if the RF connectors of both satellite navigation antennas hanging into the driving cab are correctly connected to the “GNSS main antenna” and “GNSS auxiliary antenna” sockets at the front panel of the Autopilot (Controller);</p> <p>Check if the RF connectors are securely connected;</p> <p>Replace both the satellite navigation antennas and their RF cables;</p> <p>Replace the Autopilot (Controller);</p> <p>Contact the distributor or FAE department of the manufacturer.</p>
FA3 Posture information is lost	<p>GNSS receiver (orientation) in self-checking information is red, the tractor icon in the screen rotates to the four directions and thus is unable to make the orientation</p>	<p>Make sure the farming vehicle is in an open area outdoor and there is no apparent obstacle around or above the farming vehicle;</p> <p>Check if the receiver configuration of the autopilot is correct</p> <p>Check if both satellite navigation antennas are correctly installed on the driving cab top;</p> <p>Check if the RF connectors of both satellite navigation antennas are securely connected;</p>

		<p>Check if the RF connectors of both satellite navigation antennas hanging into the driving cab are correctly connected to the “GNSS main antenna” and “GNSS auxiliary antenna” sockets at the front panel of the Autopilot (Controller);</p> <p>Check if the RF connectors are securely connected;</p> <p>Replace both the satellite navigation antennas and their RF cables;</p> <p>Replace the Autopilot (Controller);</p> <p>Contact the distributor or FAE department of the manufacturer.</p>
FA4	The steering sensor indicator in the self-checking information is red.	<p>Check if the connecting terminal of the steering measuring mechanism of the drive harness is correctly and securely connected to the steering measuring mechanism;</p> <p>Replace the steering sensor;</p> <p>Replace the drive harness;</p> <p>Replace the Autopilot (Controller);</p> <p>Contact the distributor or FAE department of the manufacturer.</p>
Guide wheel angle information is lost		
FA5	The hydraulic valve indicator in the self-checking information is red.	<p>Check if the hydraulic valve drive terminal of the drive harness is correctly connected to the hydraulic valve;</p> <p>Check if the hydraulic valve drive terminal of the drive harness is securely connected to the hydraulic valve;</p> <p>Replace the hydraulic valve;</p> <p>Replace the Autopilot (Controller);</p> <p>Replace the drive harness;</p> <p>Contact the distributor or FAE department of the manufacturer.</p>
The hydraulic valve information is lost		
FA6	During automatic Driver operation, the farming vehicle drives around instead of along the Line AB, and even keeps	<p>Perform calibration step 3 (Steering sensitivity calibration) on the technical support screen and observe if the square wave excitation can be normal.</p> <p>If it is normal, perform calibration step 4 (Driver sensitivity) on the technical support screen. Reduce the</p>
The farming vehicle fails to track the Line AB		

	rotating in the fields	Driver sensitivity properly to observe if the phenomenon disappears.
FA7	When the vehicle is in auto driving mode, the transfer row cannot reach the specified width	<p>Make sure that the correct width is set for the farm tool, see the steps in section 5.3.4;</p> <p>Make sure that the correct deviation is set for the farm tool; see the steps in section 5.3.5.</p>
The transfer row is incorrect		
FA8	When the vehicle is switched to auto driving mode, the guide wheel directly turns and holds at the limit position in the left or right	<p>Set a Line AB. Place the vehicle parallel with the Line AB at the left side. Observe that the lateral deviation is in the left. Now switch the vehicle to the auto driving mode. Observe the direction that the guide wheel turns and holds. Place the vehicle at the right side of Line AB and switch it to the auto driving mode. If the guide wheel turns and holds at the limit position in the left when it is at the left side of Line AB, while the guide wheel turns and holds at the limit position in the right when it is at the right side of AB, it means the hydraulic valve drive terminals are connected oppositely during connection. Just exchange the connection again and the trouble will disappear.</p> <p>If the guide wheel always turns and holds at the limit position in one direction no matter which side the vehicle is in, go to the technical support screen. Manually turn the guide wheel to the left and right limit repeatedly to observe if the angle information of guide wheel changes in a continuous way or in a normal range. If the angle is incorrect, it means that there's trouble at the steering system. Eliminate the trouble according to the methods described for FA4.</p> <p>If the guide wheel angle is normal, the sticking of hydraulic valve may be suspected. Continuously press the buttons by manual at both ends of the proportional valve in order to eliminate the sticking. If the trouble persists, dismantle the proportional valve on the hydraulic valve and modules LRDC and LPDC for cleaning, or even to replace the hydraulic valve.</p> <p>If both the steering system and the hydraulic valve are OK, go to the technical support screen and perform square wave excitation test in step 3 of calibration, i.e. Steering sensitivity calibration. If it is unable to complete the test, the damage of drive circuit of the</p>
The guide wheel holds at the limit position		

hydraulic valve may be suspected. Replace the Autopilot (Controller) and the drive harness and repeat the test.

Contact the distributor or FAE department of the manufacturer.

FA9 The steering wheel is heavy	When the engine is started to get ready for operation, it is found that the steering wheel become abnormally heavy during the manual operation	Push the engine throttle to the utmost and observe if the steering wheel get easier to operate. If yes, it means that the oil lines are normal. First check if the steering booster pump of the farming vehicle functions normally and if there is any excessive leakage or inadequate pressure. In case of inadequate pressure, adjust the pressure of the booster pump or replace the booster pump. Check the electromagnetic hydraulic valve for sticking or blockage. If necessary, dismantle the proportional valve on the hydraulic valve and modules LRDC and LPDC for cleaning, or even to replace the hydraulic valve.
FA10	The vehicle frequently escapes from the auto driving mode by itself without reason during the normal auto driving process	The override voltage of steering wheel is set too low. Directly set the override voltage to above 1.5V.

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