FJD 3D Excavator Guidance System
Hardware Installation Manual

FJ Dynamics Technology Co., Ltd.

Disclaimer

- The products, services, or features you purchase are subject to commercial contracts and terms thereof. All or part of the products, services, or features described herein may be excluded from the scope of your purchased or used products, services, or features. Unless otherwise agreed in the contract, FJD makes no statement, expressed or implied, with respect to this document.
- Due to product upgrades or other reasons, the contents of this document will be updated from time to time. FJD reserves the right to modify the contents of the document without any notice or prompt.
- This manual is only used as a guide. FJD has tried its best to ensure that the contents are accurate and reliable, but it doesn't guarantee that this manual is completely free of errors or omissions. Information in this manual does not constitute any express or implied guarantee.

Foreword

Thank you for using the products of FJ Dynamics Technology Co., Ltd. This manual covers detailed hardware installation instructions. If you encounter any problems in the process of using this manual, please contact the FJD customer service, and we will serve you wholeheartedly.

Scope of application

This manual mainly presents some physical characteristics of the product and specifies installation steps, technical specifications, as well as specifications and usage guidelines for harnesses and connectors. This manual applies to users who understand the above contents and have some experience in hardware installation and maintenance, assuming that users are familiar with related terms and concepts.

Technical support

FJD official website: https://www.fjdynamics.com/

Contents

I. Introduction 1
1.1 Main Hardware and Specifications 1
1.2 Main Performance Parameters 3
2. Preparation before Installation 3
2.1 Safety Instruction 3
2.2 Requirements for Installation Site 4
2.3 Installation Tools 5
2.4 Open-package Inspection 6
3. Installation 7
3.1 Check before Installation 8
3.2 Installation Process 9
3.3 Precautions for Installation 10
4.Installation Steps 10
4.1 Installation of Control Terminal 10
4.1.1 Required Materials 10
4.1.2 Installation Steps 11
4.2 Installation of Attitude Sensor 12
4.2.1 Required Materials 12
4.2.2 Installation Steps 12
4.3 Installation of Antenna 15
4.3.1 Required Materials 15
4.3.2 Installation steps 15
4.4 Installation of Harness 17
4.4.1 Required Materials 17
4.4.2 Installation Steps 17
4.5 Installation of SIM Card 19
4.5.1 Required Materials 19
4.5.2 Installation steps 20
5. System Commissioning 20
5.1 Check before Commissioning 20
5.2 Power-on and Startup 21
5.2.1 Inspection before Power-on 21
5.2.2 Inspection after Power-on 21
5.3 Specification Commissioning 21

I. Introduction

FJD 3D Excavator Guidance System is a rear-mounted excavator guidance system, which adopts Beidou high-precision real-time dynamic positioning technology. It gets the real-time precise 3D position information of the bucket by reading attitude sensors installed on the excavator and calculating the calibrated main pivot sizes. The current cut-and-fill workload is displayed in real time in coordination with the work tasks generated by the self-designed transformation software to complete the goal of digitally guided excavation and construction. The bucket is able to complete the work accurately even in blind areas with poor eyesight, completely changing people's understanding of the traditional construction method of excavators. This system is composed of RTK high-precision positioning equipment, data communication equipment, and on-board tablet computer (display equipment), attitude transducers, communication antennas, and harnesses. The on-board tablet computer is equipped with an excavator guidance software independently developed by FJD, namely FJD 3D Excavator Guidance System, which makes real-time statistics of the excavation depth, slope, elevation, and satellite positioning of the current operating equipment.

1.1 Main Hardware and Specifications

S/N	Assembly	Component	Specification
1	Control terminal	Control terminal	Size: 300×190×43mm; 10.1" capacitive touch LED, backlight 1280*800 pixels, 700cd/m² LCD screen; double loudspeakers; 2G of run memory, 8G of storage memory; Covering a variety of digital and analog output interfaces, etc.; Power supply: 10V~30V; Covering radio, positioning satellites, 4G and other signals; Operating temperature: -30℃~+70℃; Storage temperature: -40℃~+85℃; IP rating: IP65;

			Relative humidity: 0%~95%, at 40 ℃ (non-condensation); Wi-Fi specification: 2.4GHz frequency band; Frequency range: 2.4GHz~2.5GHz; output power: 14dB±1.5dB;
2	Antenna assembly	GNSS antenna	Frequency range: GPS L1/L2, GLONASS L1/L2, BDS B1/B2/B3; Operating voltage: 3.3V~12V; Operating current: ≤45mA; Size: 152*63mm;
3		4G antenna	Sucker antenna: Frequency range: B1/B2/B3/B5/B8/B38/B39/B40/B41; VSWR:≤2.0; Gain(dBi): 2±0.5; Impedance(Ω): 50; Polarization: Linear, Vertical; Max. power: 100W; Antenna size: Φ375*82mm; Operating temperature: -20℃~ +65℃;
4		Radio antenna (optional)	Sucker antenna: Frequency range: 433/470MHz; VSWR:≤2.0; Gain(dBi): 2±0.5; Impedance(Ω): 50; Polarization: Linear, Vertical; Max. power: 100W; Antenna size: Φ495*82mm; Operating temperature: -20℃~ +65℃;
5	Attitude sensor	Attitude sensor	Axes (Tilt): Pitch； Roll; Range: Pitch ±70°, Roll±180° ; Resolution: <0.05°;

			Max Angular Rate: ≤400^0/s; Static Accuracy: 0.15°; Dynamic Accuracy: 0.50°; Temperature Stability： 0.05°; Axes (Acceleration): X,Y,Z; Range: ±78m/s/s; Resolution: 0.01m/s/s; Accuracy: ±0.1m/s/s; Output Data Rate (Hz): Selectable to 100 Hz; Operating voltage: 4.9V~32V; Power:<400mW; Operating temperature: -40℃~ +85℃; Protection class ： IP 67;

1.2 Main Performance Parameters

The system can currently guide and assist the excavator, and the operation accuracy is as follows:

Static accuracy	＜±3cm (RMS)
Assisted Operation accuracy	＜±5cm (RMS)

2. Preparation before Installation

2.1 Safety Instruction

In order to avoid harm to people and equipment, please read the safety recommendations herein carefully before installation.

Note: Not all risks are covered by the following safety recommendations.

Installation Safety

1. Don’t install this system in an environment susceptible to electromagnetic interference (large radar stations, transmitting stations, substations) which features high temperature, much dust, harmful gas, flammable and explosive articles, unstable voltage, much vibration or strong noise, as this environment is not conducive to the operation of the equipment.

2. Don’t install the equipment in places where water accumulation, water seepage, dripping, and moisture condensation most likely happen.

3. Install or remove the equipment as described in the hardware installation manual.

Removal Safety

1. Once installed, don’t frequently remove the equipment to avoid damages.

2. Turn off all power supplies and disconnect all power lines and cables before removal.

Electrical Safety

1. The local laws and regulations must be observed during electrical operations. The relevant personnel must be qualified.

2. Please carefully check for potential hazards in the work area, for example, wet ground.

3. Before installation, be familiar with the location of the emergency power switch and turn off the power switch first in the event of an accident.

4. Check carefully when it is necessary to turn off the power.

5. Do not put the equipment in a humid place, and no liquid is allowed to enter the equipment.

6. Keep away from wireless transmitting stations, radar transmitting stations, high-frequency and high-current equipment, microwave ovens, and other high-power wireless equipment.

7. Direct or indirect contact with high voltage or mains power through wet objects may cause fatal danger.

8. Irregular and incorrect electrical operations may cause accidents such as fire or electric shock, and even cause serious and fatal harm to the human body and equipment.

2.2 Requirements for Installation Site

To ensure the normal operation of the equipment and prolong its service life, the installation site is required to meet the following standards.

Installation Location Requirements

1. Install the equipment in an open environment, and ensure that the closed environment where the equipment is installed has a good ventilation and cooling system.

2.Ensure that the equipment is installed at a position firm enough to support the weight of control terminal and accessories.

3. Ensure that the installation location is suitable for the size of control terminal, with some space left

around to facilitate heat dissipation.

Temperature and Humidity Requirements

1. To ensure the normal operation and the service life of the equipment, temperature and humidity in the operating environment should be up to standard.

2. Long-term operation in an environment that does not meet the temperature and humidity requirements will cause damage to the equipment.

3. Operation in an environment with high relative humidity is most likely to cause poor insulation of the insulating material and even leakage. Sometimes, changes in the mechanical properties of materials and corrosion of metal parts are also prone to occur.

4. Operation in an environment with low relative humidity will cause the insulating sheet to dry and shrink, and meanwhile, most likely generate static electricity, which will harm the circuits in the equipment.

5. Operation in an environment with excessively high temperature will be more harmful and will greatly reduce the reliability of the equipment. The long-term high temperature will also affect the service life and accelerate aging.

Cleanliness Requirements

For the environment where the equipment is located, there are strict requirements on the salt, acid, and sulfide contained in the air. Some harmful substances will accelerate the corrosion of metals and the aging of certain parts. Intrusion of harmful gases (sulfur dioxide, hydrogen sulfide, nitrogen dioxide, chlorine, etc.) should be avoided.

Power Requirements

Kit voltage input:

1.The input voltage should be within the range of 12±1V; a lower input voltage is allowed, but it will affect the accuracy.

2.The input voltage should be within the range of 24±1.5V. The impact on accuracy will be reduced after the excavator is started.

2.3 Installation Tools

Before the installation, please prepare the following tools.

Assembly Tools for FJD 3D Excavator Guidance System				
S/N	**Tool**	**Model**	**Qty**	**Function**
1	Cross screwdriver	Mid-size	1	Install control terminal and bracket base plate
2	Hex key set	T3~T6	1	Install attitude sensor, bracket screws, etc.
3	Open-end wrench		1	Choose different wrenches depending on the actual screws of the excavator
4	Utility knife		1	Unpacking
5	Scissors		1	Cutting the straps and 3M double-sided tape
6	Multimeter		1	Measure voltage and circuit on/off
7	Total station		1	Calibrate measurement parameters
8	Strap		1	Fix harnesses
9	3M tape		1	Fix the sensor
10	Carburetor cleaner		1	Clean body oil stain

2.4 Open-package Inspection

After preparing the tools mentioned above, please check the following packing list.

Packaging Box of Excavator Guidance System				
S/N	**Item**	**Spec./model**	**Quantity**	**Remark**
1	Control terminal		1	
2	Attitude sensor		4	
3	RTK antenna		2	
4	4G sucker antenna		1	
5	Beidou 1 feeder		1	
6	Beidou 2 feeder		1	
7	Attitude sensor mount		2	

8	Protective cover for sensors		2	
9	Hexagon socket head cap screw	M5×12	9	
10	Hexagon socket head cap screw	M10×25	9	
11	Pan head bolt with elastic flat washer	M6×14	13	
12	Hexagon Nut Class 1	M4	18	
13	Standard Spring Washer	ϕ 10	9	
14	Flat Washer	ϕ 12	9	
15	Attitude sensor harness		1	
16	Power harness		1	
17	Smart main harness		1	
18	Adapter bracket of control terminal		1	
19	RTK bracket		2	
20	RTK bracket antenna mount		2	
21	Antenna convertor		2	
22	3M VHB double-sided tape		4	
23	Nylon Strap		Several	

The items listed above are delivered in general cases. The delivered items may slightly differ depending on the order contract. Please check the cargoes carefully in accordance with the packing list or the order contract. Please contact our dealers if any questions or mistakes.

3. Installation

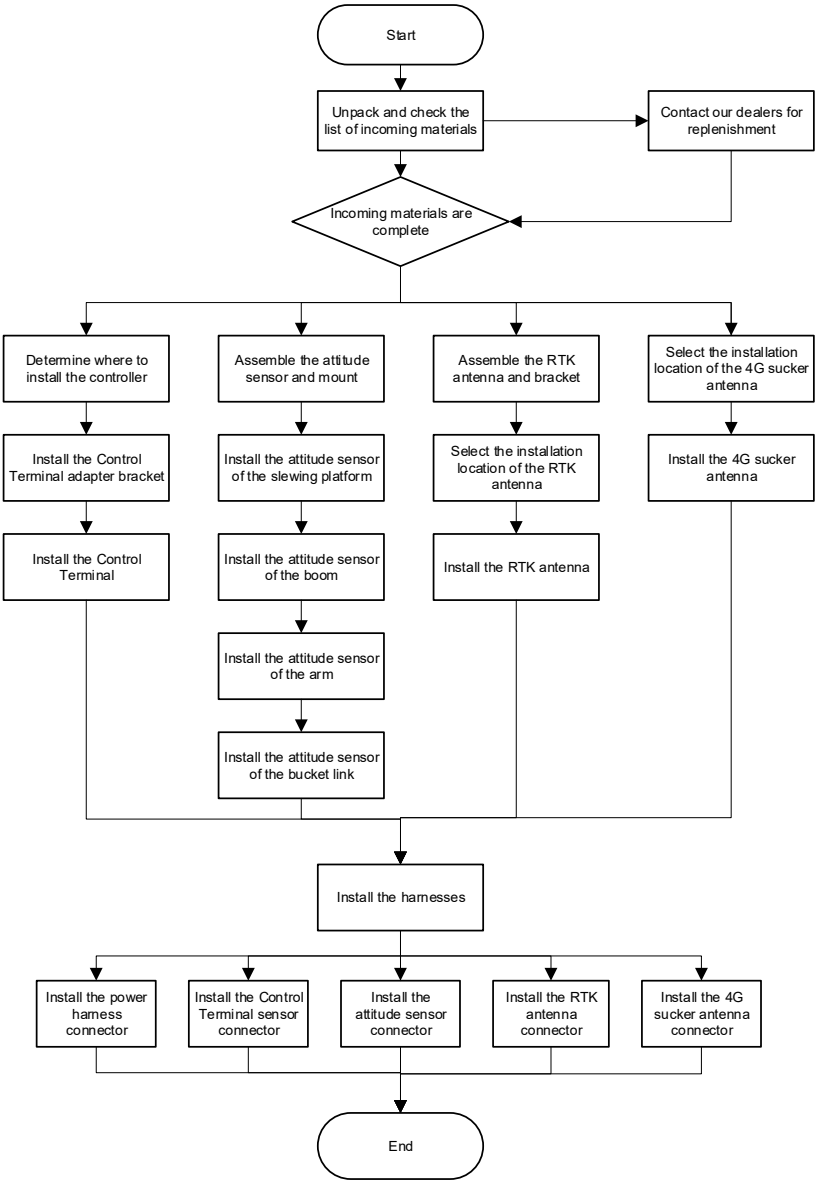
Please be sure that you have carefully read the content of Chapter 2 and that the requirements described in Chapter 2 have been met.

3.1 Check before Installation

Before installation, make thorough plans and arrangements for the installation location, power supply, and wiring of the equipment. Please verify the following points before installation:

1. Enough space should be provided at the installation location to meet the heat dissipation requirements.
2. The installation location must meet the environmental requirements of the equipment for temperature and humidity.
3. The installation location must meet the requirements of the equipment for power and current.
4. The selected power supply must meet the power requirements of the system.
5. The installation location must meet the requirements of the equipment for installation location selection.
6. For user-specific equipment, please check whether the equipment meets the specific requirements before installation.

3.2 Installation Process



3.3 Precautions for Installation

1. Do not power on the equipment when installing it.

2. Place the equipment in a well-ventilated environment.

3. Avoid placing the equipment in a high temperature environment.

4. Keep the equipment away from high-voltage cables.

5. Keep the equipment away from strong thunderstorms and strong electric fields.

6. Remove the power plug before cleaning the equipment.

7. Do not clean the equipment with liquids.

8. Do not open the enclosure.

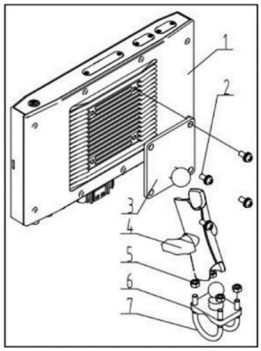
9. Fix the equipment firmly.

4.Installation Steps

4.1 Installation of Control Terminal

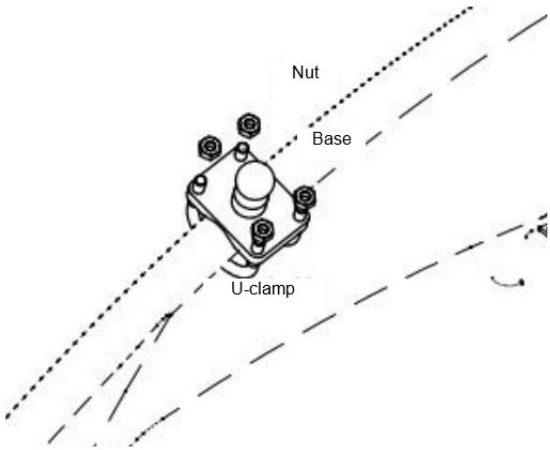
4.1.1 Required Materials

S/N	Item	Qty	Spec./model	Remark
1	Control terminal	1		
2	Pan head bolt with elastic plain washer	4	M5x12	
3	Control terminal baseplate	1		Supplied with control terminal bracket assembly
4	Adapter bracket	1	M6x20	
5	Hexagon nut	4	M6	
6	Base	1		
7	U-bolt	2		



4.1.2 Installation Steps

Step 1: Fix the base. Choose the round steel position on the door side of the cab for easy operation (depending on model structures). After determining the installation position, fix the bracket base of control terminal with U-bolts and nuts.



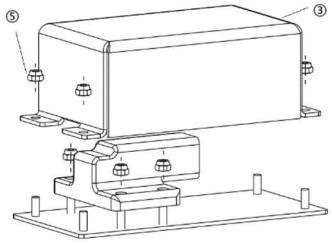
Step 2: Take control terminal, rotate the bracket handle counterclockwise, and then loosen the bracket ball socket to install the back ball of control terminal into the ball socket of the bracket.

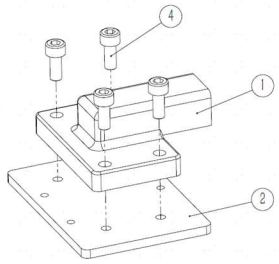
Step 3: Install control terminal assembled in Step 2 on the base ball, and turn the handle clockwise to tighten it. The control terminal is required to be well fastened.

4.2 Installation of Attitude Sensor

4.2.1 Required Materials

S/N	Name	Quantity	Spec./model	Remark
1	Attitude sensor	4		
2	Attitude sensor mount	4		
3	Protective cover for sensor	2		
4	Hexagon socket head cap screw	8	M5x12	
5	Hexagon Nut Class 1	18	M4	
6	3M VHB double-sided tape	4		





4.2.2 Installation Steps

1. Install the attitude sensor of boom and arm on its mounting plate and fasten it with M5x12 hexagon socket head cap screws. Install attitude sensors of bucket and car body on the base plate of protective cover and fasten it by M4 nuts.

2. Stick 3M VHB double-sided tape on the back of the angle sensor.

3. Stick the attitude sensors after selecting the positions of the slewing platform, boom, arm, and bucket link according to direction as shown in the figure（Note that all are mounted on the left side）.

(1) Attitude Sensor (Excavator body)

This sensor is intended to realize terrain data compensation to ensure the accuracy of the excavator in operating environments such as slopes, foundation pits, and water.

(2) Attitude Sensor (Boom)

This sensor is intended to monitor the boom extension angle and judge the boom angle in real time.

(3) Attitude Sensor (Arm)

This sensor is intended to monitor the arm extension angle and judge the arm angle in real time.

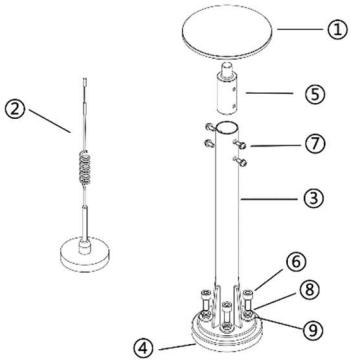
(4) Attitude Sensor (Bucket)

This sensor is intended to monitor the bucket extension angle and judge the bucket angle in real time.

4.3 Installation of Antenna

4.3.1 Required Materials

S/N	Item	Qty	Spec./model	Remark
1	RTK antenna	2		
2	4G sucker antenna	1		
3	RTK bracket	2		
4	RTK bracket base	2		
5	Antenna convertor	2		
6	Hexagon socket head cap screw	8	M10×25	
7	Pan head bolt with elastic flat washer	8	M6x14	
8	Standard spring washer	8	ϕ 10	
9	Flat washer	8	ϕ 12	



4.3.2 Installation steps

1. Place the RTK antenna convertor in the welded sleeve of the RTK bracket, align the screw holes, and fasten it by M6x50 Pan head bolt with elastic flat washers.

2. Install the RTK antenna on top of the mounted bracket, and ensure that the threads are tightened.

3.Weld RTK bracket base to two symmetrical positions respectively on both end of excavator backside. The spray layer of the welded position needs to be polished before welding. The exposed surface needs to be panted for protection when welding is completed, and then fix the bracket to it with M10 x 25 head cap screws. (If welding is not available, the bracket can be fixed directly to excavator with 3M tape.)

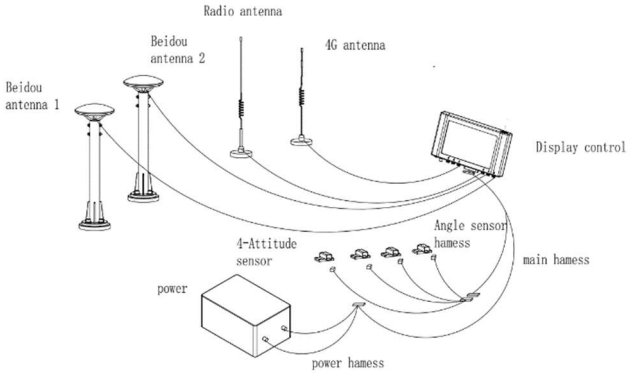
4. The antenna on the right side of excavator is Beidou 2 directional antenna, and that on the left side is Beidou 1 positioning antenna, as shown in the figure below.

5. The 4G sucker antenna should be arranged according to the on-site location as required below: (1) The magnet adsorption is available at the arrangement location; (2) The signal is unobstructed.

4.4 Installation of Harness

4.4.1 Required Materials

S/N	Item	Qty	Spec./model	Remark
1	Smart main harness	1		
2	Power harness	1		
3	Attitude sensor harness	1		
4	Strap	Several		
5	Strap fixing base	Several		



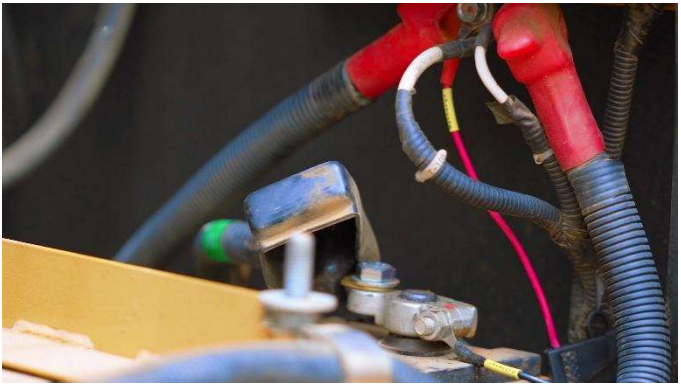
4.4.2 Installation Steps

1. Installation of Sensor Harness

First lay the harness straight and flat and ensure no dirt or other foreign objects is found in the various interfaces of the harness, and then route the sensor harness along the upper edge of the excavator boom. Fix the harness at the bucket, as well as the movable parts of the arm axis and the boom axis as shown in the figure below, and finally extend the butt end with the smart main harness into the cab depending on on-site situation.

2. Installation of Power Harness

A spare power line is needed for the extension of the power line if it's not long enough. The positive terminal buckle of the power line must be screwed to the positive terminal of the relay, and the negative terminal to the cathode of the battery. Note that the voltage should be 24V. Pay attention to the harness to avoid direct contact with hot objects.



3. Installation of Smart Main Harness

It is required to arrange the smart main harness in concealed locations in the cab, which does not affect the operation of the excavator. The smart harness main switch should be installed in a position convenient for operating as required.

4. Installation of Control Terminal Interface

Connect the main harness interface, two RTK antennas (the Beidou1 interface is for the positioning antenna, and the Beidou2 interface is for the directional antenna), and the 4G antenna in turn. Turn on the power harness switch to check whether the power indicator of control terminal comes on and start control terminal to check whether it works normally.

5. Inspection of Harness Installation

Check in turn whether the power harness, smart main harness, sensor harness, RTK feeder, and 4G antenna feeder are firmly fixed and whether the excavator pulls the harness or involves other interference.

4.5 Installation of SIM Card

4.5.1 Required Materials

S/N	Item	Qty
1	SIM card	1
2	Ejector needle	1
3	Tweezers	1
4	Cross screwdriver	1

Precautions for purchasing SIM card:

1.Please purchase a SIM card that supports the 4G communication module frequency band of the control terminal. Please make sure that the SIM card supports the following 4G communication frequency bands before purchasing:

LTE FDD: B1/B3/B5/B8

LTE TDD: B38/B39/B40/B41

TD-SCDMA: B34/B39

WCDMA: B1/B8

GSM: 900/1800MHz

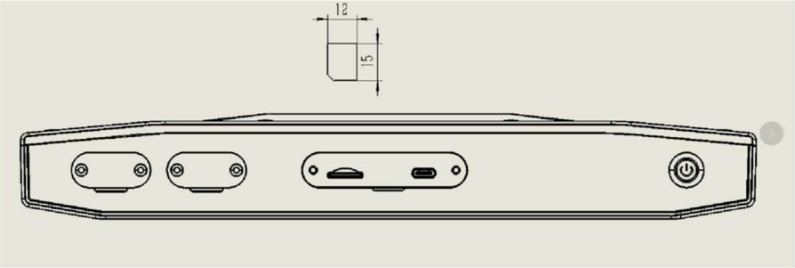
2. Please check that your SIM card has activated the data service.

3. After installing the SIM card, please refer to the SIM card manual to verify if APN and network type need to be set. If necessary, please turn on control terminal and complete the network configuration in the built-in Android system.

4.5.2 Installation steps

1. Unscrew the T3 cover on the top of control terminal with a Phillips screwdriver to expose the following SIM card interface.

2. Place the SIM card with the chip facing upwards, use an ejector needle and tweezers to slowly insert the SIM card into the proper position of the slot in the top T3 interface.



As above, the hardware part of FJD 3D Excavator Guidance System has been installed.

5. System Commissioning

5.1 Check before Commissioning

Excavator Condition Checking

It is necessary to ensure that the excavator is in a stable condition and all parts are working properly.

Site Checking

1. Confirm that there are no tall trees, buildings, or other obstacles that affect satellite signals around the Commissioning site.

2. There shall be no high voltage lines within 150 meters around the Commissioning site.

3. The Commissioning site should be a level ground with a length of not less than 50 meters and a width of not less than 10 meters.

4. The ground of the Commissioning site should be flat such as cement road or asphalt road.

5.The Commissioning should be carried out on a non-public road. During Commissioning, ensure that there are no unrelated persons around the excavator to prevent personal accidents.

5.2 Power-on and Startup

5.2.1 Inspection before Power-on

1. Check that the power supply is connected correctly.

2. Check that the power supply voltage is satisfactory.

5.2.2 Inspection after Power-on

1. After power-on, please check if the power indicator of control terminal turns on.

2. After pressing the switch of control terminal, please check if control terminal program can be started normally.

5.3 Specification Commissioning

Please refer to the *Software Instruction Manual for FJD 3D Excavator Guidance System* attached to the machine for details of the parameter Commissioning.