USER GUIDE

SMC20

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EXCAVATOR GUIDANCE SYSTEM USER GUIDE

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Contents

1. Pre-Use Notification

1.1. Key principles

(1) Before using the product, familiarize yourself with it and its operating requirements. Follow the national and regional "common sense health and safety operation regulations" as per the instruction manual.
(2) Adhere to accident prevention measures and common-sense safety technology, labor protection, medical and traffic regulations.
(3) Heed advice on product operation to prevent failures and accidents.
(4) Upon delivery, obtain the receiving list and instruction manual, and follow our company's technical guidance for installation and operation.

1.2. Personnel requirements

(1) The end user must operate the system while driving the excavator. This requires the operator to be proficient in operating the excavator and capable of handling safety-critical situations during the driving process.
(2) The operator should have a thorough understanding of the excavator's operation and must clearly know how to utilize the system's functions flexibly in different scenarios.
(3) The operator must understand the installation and operation principles of related hardware and software, and must be able to safely handle common faults.
(4) Personnel under the age of 18 and those with health conditions or disabilities that may hinder safe operation must not participate in related mechanical operations.

1.3. Pre-operation preparation

(1) Assess the area around the excavator for any obstacles or safety hazards, and ensure that unauthorized personnel are cleared from the operating zone.
(2) Perform a thorough inspection of the excavator guidance system for issues such as loosening, missing parts, excessive wear, or dirt accumulation, in alignment with daily maintenance protocols.
(3) The operator must have a thorough understanding of the product's operational devices and their functions.

1.4. Precautions for installation

Ensure that the GNSS antenna cable and IMU cable are properly connected. After connecting, use cable ties to organize the cables. Avoid pulling or compressing the cables to prevent damage, which could disrupt the system's normal operation.

2. Product Introduction

2.1. Overview

The SMC20 Excavator Guidance System is a smart solution for mining guidance. It is of high precision, high performance and can be visually operated. The system is characterized by the following parts. There is a GNSS high-precision positioning antenna. And it also has a 10.1-inch daylight-readable display terminal. Besides, it is equipped with an IMU module.

2.2. Advantage

The SMC20 Excavator Guidance System can be easily adapted to a wide variety of mining machinery. By offering precise operational guidance to excavators, it can boost their operational efficiency.

Additionally, the system can address the challenges of limited visibility and acts as a helpful assistant in carrying out common excavator tasks, such as site grading, trenching, slope brushing, and pond dredging.

2.2.1. System Benefits

The system possesses an RTK dynamic accuracy of ±2.5cm, accommodates multi-frequency high-precision positioning and orientation, and incorporates a built-in dual-SIM all-network module. This guarantees terminal Internet connectivity and data transmission even during power failures. Crafted to meet industrial standards and IP67 specifications, it can weather tough on-site conditions. The IMU integrates a high-performance microprocessor and cutting-edge filtering algorithms, delivering high-precision, stable measurements. The display terminal shows real-time bucket-to-benchmark deviation data, offering precise excavation guidance. It offers multi-angle job info displays, stretching to plan, side, and top views, compensating for excavator visibility limitations during digging. Featuring operation modes like full-plane, ditch-digging, and slope-brushing, it caters to diverse work scenarios. Moreover, it provides graphic and voice real-time prompts to prevent errors.

2.2.2. Benefits of the system

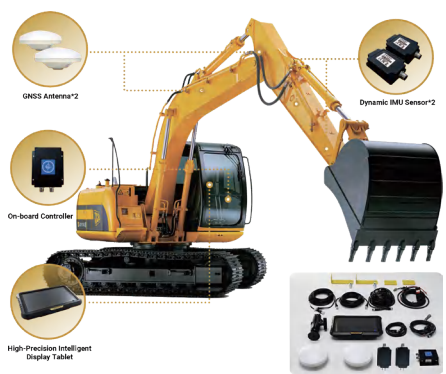
(1) **Boosting Construction Efficiency:** By offering real-time positioning and navigation, the system equips operators with precise control over the excavator's position and depth. This reduces the likelihood of errors inherent in manual methods, minimizing damage and rework. As a result, excavation tasks are performed more swiftly and accurately.

(2) **Reducing Operating Costs:** The system helps cut labor costs and energy use. Faster task completion shortens construction cycles, lowering labor expenses. Precise navigation also curbs material waste, further trimming costs.

(3) **Enhancing Safety:** The system helps operators steer clear of potential dangers by designating work areas and alerting them in real-time if the excavator veers into a dangerous zone. This allows for prompt action to maintain a safe construction process.

(4) **Adapting to Complex Environments:** In challenging settings like ditching or dredging where visibility is a problem, the system provides real-time positioning and navigation. This helps operators handle complex situations more effectively and ensures project completion.

(5) **Data Recording and Analysis:** The system records key construction data such as mining depth and location. This data is valuable for process control and management, as well as for analyzing and optimizing future construction efforts.



Product configuration scheme: Dual antenna +2 IMUs

Note: In any state, the digging bucket can be fixed with elevation.

2.3. Product specification parameters

Tablet main technical parameters	
Parameter name	value
Operating voltage	5~32VDC
Screen size	10.1"
Brightness	750nits
Operating temperature	-20°C ~ +60°C
Water and dust resistant	IP67

Antenna main technical parameters	
Parameter name	value
Operating voltage	3.3 ~ 12 VDC
Impedance	50 ohms
Polarization	Right-handed circular polarization
Operating temperature	-40°C ~ +85°C
Water and dust resistant	IP67

Main technical parameters of attitude sensor	
Parameter name	value
Operating voltage	3.3 ~ 12 VDC
Resolution	0.01°
Update rate	100hz
Operating temperature	-40°C ~ +85°C
Water and dust resistant	IP67

2.4 Principle of Product Operation

Relying on Beidou RTK technology, the system gets the real-time 3D position data of the positioning antenna, collects values from angle sensors on the excavator, and calculates the main pivot's dimensions. It comprehensively processes these data to generate excavator operation information. The display terminal visually, numerically and audibly shows the excavator's real-time position, attitude and speed. This helps operators control the excavator's running track and working angle more accurately.

By following the set working mode, operators can perform filling and excavation tasks, skip construction lofting, enhance work efficiency and ensure construction quality.

3. Installation of SMC20

3.1. Double antennas +2 IMUs

Hardware installation diagram: Installation on the left side

Schematic diagram of overall wiring

3.2. Installation of the Tablet

The tablet's location should be easily accessible for the driver to operate and view, and it should be secured using a RAM mount and a suction cup mount. After determining the position of the tablet, lock the suction cup to prevent it from falling due to mechanical vibrations during operation.

3.3 Installation of cables

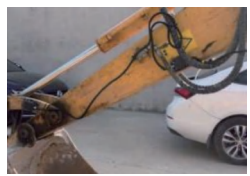
The main communications cable connector should be linked to the plate plug (ensuring the cable connector is securely inserted), while the main antenna cable's TNC connector is attached to the plate's ANT1 port, and the secondary antenna cable's TNC connector is connected to the plate's ANT2 port.

The "power supply" on the main communication cable is connected to the power cable connector. It can be powered via the cab's cigarette lighter or linked to the excavator battery's Deutsch power cable. When powering the system, ensure the equipment's power requirements (DC9-36V) are met. Also, direct connection between the power line and battery requires attention to the power's positive and negative poles to avoid reverse connection.

3.4 Installation of GNSS antenna

The GNSS antenna is installed on the left sides of the excavator's forearm and main arm. The main antenna is on the forearm's left side, and the secondary antenna is on the main arm's left side. The antenna is secured to a fixed support, which is welded to the left sides of the forearm and main arm. During installation, align the bottom edges of the main and secondary antenna supports with the forearm's axis in a straight line, ensuring a distance of over 1 meter between the two antennas. Once installed, the antennas should not be moved.

Installation of the antenna



Installation of IMU module

4. Function Introduction

4.1. Software registration

After installing the device, register the system.

Device Registration

This section outlines the main interface's status bar of the software:

1. System Time: Shows the system's time, syncing with the satellite time.
2. Satellite Icon: Clicking it takes users to the satellite signal Settings interface.
3. Number of Satellites: Reflects the real-time count of satellites detected by the GNSS antennas. Generally, if the number exceeds 28, the base station can connect normally. Clicking the icon opens the satellite sky map and SNR display interface.
4. RTK status: Display RTK status and differential delay data, RTKdisplay "fixed", and differential delay data does not exceed 5 for the available state, click the icon to set the base station.
5. Orientation Status: A value of 4 indicates normal, while 0 signifies abnormality.
6. IMU Status: Displays the forearm sensor value, bucket link sensor value, and IMU connection status. If any value is abnormal, a pop-up window will alert the user.

7. Light Target Guide Bar: Indicates the deviation of the bucket tip elevation from the reference elevation. The higher the value above the reference, the more red fill appears above the guide bar; the lower the value below the reference, the more red fill appears below.
8. Settings: Tap the icon to access the calibration screen.
9. Device Information: Click the icon to view the functional status and switch interface.
10. Whole Plane: Click the icon to adjust leveling data.
11. Ditching: Click the icon to modify ditching data.
12. Brush Slope: Click the icon to update brush slope data.
13. Expiration Time: Displays the system's expiration time.

"Save Button" : Saves the excavator control system's calibration settings. Click it to save after finishing all calibrations and confirming accuracy.

Data calibration settings

4.2.Device information and function settings

Switching functions allows for creating new jobs, with multiple modes like slope brushing, digging, and whole plane available.

Choose the mode based on site requirements and calibrate the reference points, lines, or planes for the selected mode.

Function Status Settings

5. Other Functions

5.1. Brush slope mode

When defining the slope brushing mode, you need to set the AB plane distance, with the opening line defaulting to the upper one. Locate points A and B sequentially as per operational needs, collect their coordinates, determine the slope's bottom or top edge direction, and calculate the distance L_AB and height difference h_AB between them. You can directly edit the slope ratio, vertical height, and horizontal distance to adjust the hypotenuse data to achieve the desired slope ratio and angle. Confirm the accuracy of this information, then click "Start Operation" to complete the calibration for slope brushing mode.

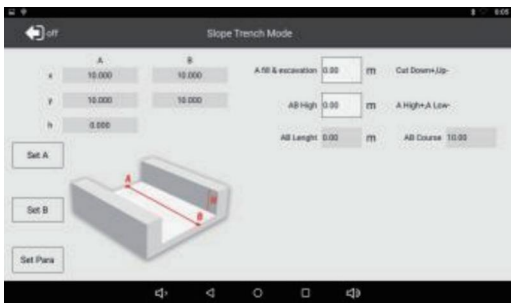
Parameter setting of slope brushing

5.2. Whole plane mode

Position the excavator bucket tip at the desired ground height, press the "Set reference plane" button to record the tip's elevation. Using the acquired coordinate data, you can directly input fill/dig parameters in the provided text box. Once the target benchmark data is confirmed, click "Close" to finish calibrating the leveling mode's operational model.

5.3. Bevel plane and digging channel mode

Sequentially mark point A and point B, gather their coordinates, and determine the excavation canal direction. Set the digging depth parameter for point A as per operational needs. If there's a height difference between A and B, input it in the designated text box; by default, A and B are at the same height. The plane defined by these two points represents the trench's ground elevation. After verifying this information, click "Close" to finalize the calibration for dig mode.



6. Equipment maintenance

Our company's instruments and equipment are designed for all-weather operation, with a protection rating of IP65 or higher, offering waterproof and dust-proof capabilities. However, to ensure optimal performance, proper maintenance of the system equipment after excavator operations is essential.
Here are some daily maintenance tips:

First, avoid frequent disassembly during system use to minimize the risk of component damage due to operational errors.

Second, after using the guidance system, store the antenna and attitude sensor in a rain-free, well-lit area. This extends the hardware's lifespan and maintains its performance.

Third, after using the guidance system, check for loose connections or damaged equipment. Address any abnormalities immediately.

When it comes to parts preservation, if the equipment is unused for a long time, disassemble and store all system components in a dry, ventilated, flat area, protected from sun and rain.

When storing cables, ensure the interfaces are intact. Avoid dropping cables from heights, especially in low temperatures. Keep cables away from acid, alkali, mineral oil, and other corrosive substances. The storage area should be free of harmful gases that could damage insulation or corrode metals.

Before storing the plate, clean off any surface dust and use a foam pad or similar material to separate it. This prevents scratches or impact damage to the plate.

7. Common problems and solutions

Problem 1: The number of tracked satellites shows 0.
Root Cause: This could be due to a loose or damaged cable connection, or abnormal voltage at the TNC interface (related to the antenna on the lower arm or front upper arm, connected to the ANT1 port on the panel).
Fix:

Inspect the GNSS cable linked to ANT1. If the connection is loose, resecure it; replace the cable if it's damaged.

Measure the voltage at the ANT1 interface. If it's not normal, replace the panel.

Problem 2: Secondary Antenna Signal Fluctuation

Root Cause: It might result from a loose or broken cable, or abnormal voltage at the TNC interface (related to the antenna on the main body or behind the big arm, connected to the ANT2 port on the panel).

Fix:

Check the GNSS cable connected to ANT2. Tighten the cable if the connection is loose, or replace it if damaged.

Measure the voltage at the ANT2 interface. Replace the panel if the voltage is abnormal.

Problem 3: RTK Single Point Issue

Root Cause: It can occur if there's no connection to a base station, or if the work site obstructs signal reception.

Fix:

Check the number of tracked satellites. If it's 28 and there's no base station connection, go to base station settings. Try logging into Beidou Base Station 1 or 2, or select a closer network base station.

Ensure the antenna is securely mounted. A tilted antenna may not receive signals properly.

Look around for tall trees, buildings, or high-voltage lines that might interfere with signal reception. If necessary, contact technical support to access the Beidou base station.

Problem 4: RTK Pseudorange or Float Issue

Root Cause: Poor signal quality from the base station.

Fix:

Switch to a closer network base station.

Contact technical support to access Beidou Base Station 3 or upgrade the board.

Problem 5: No Data from Attitude Sensor

Root Cause: It might be due to a loose or broken cable connection, or a problem with the panel.

Fix:

Switch to a closer network base station.

Inspect the cable connected to the attitude sensor. Retighten the cable if the connection is loose, or replace.