

WFU-500

Follow-up Steering Control System

User manual



User notice

► Disclaimer

Warning: Before using this product, please refer to the important safety information in the user manual and review all warnings, limitations and disclaimers.

This product is no substitute for proper training and careful seamanship. Proper installation and proper use of the equipment is the responsibility of the owner to avoid accidents, personal injury or property damage. The user of this product is solely responsible for compliance with maritime safety practices.

The owner is solely responsible for installing and using the equipment in a manner that will not cause accidents, personal injury or property damage. The user of this product is solely responsible for compliance with maritime safety navigation practices.

This document represents the product at the time of release. Ningbo SHANBEI Technology Co., Ltd. reserves the right to change product specifications at any time without prior notice. If you need any further assistance, please contact your nearest dealer.

► Governing language

This Statement, any instruction manuals, user guides and other Product-related information (documentation) may be or have been translated into another language (translation). If there is any conflict between any translated version of the document, the Chinese version of the document will be the official version of the document.

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► Cautions

- 1 Do not place the equipment at will without fixing it, so as to avoid serious damage when it is dropped due to turbulence or other factors during the voyage.
- 2 Do not use any power adapter that is not equipped with this product. Otherwise, the device may not work due to the different circuit design, or the performance may be affected or even damaged.
- 3 Do not disassemble the equipment. If the maintenance engineer is not authorized by the company to disassemble the equipment, the free warranty will be lost.
- 4 During use or cleaning, avoid any liquid or other objects falling into the equipment to avoid circuit damage or short circuit.
- 5 Do not place the device and its accessories in an environment prone to humidity or direct sunlight. Keep the device in a dry environment.
- 6 In case of hardware failure (such as damage to the machine shell or foreign matter falling into the machine, etc.), please stop using the machine immediately and contact the dealer in time.
- 7 The company shall not assume any legal or other liability for any maritime accident, monetary loss or loss of interests that occurs on vessels using this equipment.

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1 Introduction

1.1 Overview

The WFU-500 Follow-up Rudder Control System is employed to transmit rudder commands from the bridge to the power unit of the steering gear. It comprises components such as a follow-up rudder wheel, rudder angle feedback device, rudder angle indicator, and follow-up control unit. During operation, rudder commands are issued via the follow-up rudder wheel. The follow-up control unit compares the actual rudder angle with the command, outputs instructions to control left and right solenoid valves, continuously adjusts the steering gear angle, thereby enabling the steering gear to follow the rudder wheel's commands for rotation.

Characterized by simplicity and reliability, high precision, cost-effectiveness, ease of operation, support for independent dual rudder control, multiple rudder wheel appearances for selection to meet personalized needs, adjustable parameters to accommodate different hydraulic steering gears. Adjustable parameters include maximum rudder angle, full rudder time, rudder angle sensitivity, follow-up sensitivity, and fine-tuning coefficient, ensuring compatibility with any hydraulic steering gear and maintaining a rudder positioning accuracy within 0.5 degrees. Equipped with a calibration mode, it allows timely calibration of the rudder wheel and feedback device, guaranteeing control precision even after prolonged use.

An intelligent return-to-mid algorithm effectively addresses follow-up rudder oscillation issues. Both swing-cylinder type and fork-type hydraulic steering gears may experience follow-up rudder oscillation due to mismatches between hydraulic system circuits and follow-up sensitivity, leading to ship yawing or damage to the steering gear. Drawing on over a decade of practical ship application experience, this intelligent return-to-mid algorithm is embedded in the controller via software, enabling even novice operators to handle it effortlessly.

The engine room feedback device transmits signals digitally, offering long communication distances. In modern ship engine rooms with complex electromagnetic environments, digital communication effectively reduces interference, ensuring stable transmission of rudder angle signals.

The basic customization options for the product include the following categories, while other customization items are to be agreed upon separately at the time of ordering.

Basic Customization Options		(Note: Option 1 is the default)
Rudder	Single rudder, including tandem double rudders	
	Dual Rudder Independent	
Rudder Wheel Style	Aluminum Alloy Rudder Wheel	
	Plastic Steering Wheel	
Rudder Angle Feedback Indicator	Not containing	
	Contains 1 embedded 72-degree rudder angle indicator	
	Contains 1 96 embedded rudder angle indicator	

Table1.1

2 Product appearance diagrams, dimension diagrams, and wiring diagrams

2.1 Product Appearance Diagram

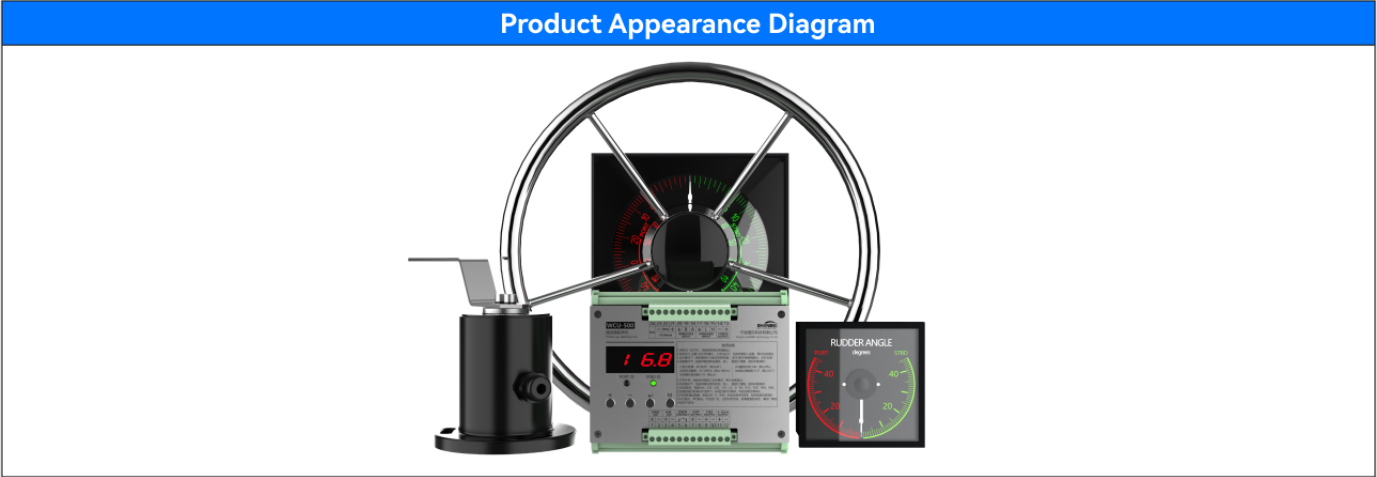


Figure 2.1

2.2 Product composition

numbers	Name	quantity
1	Follow-up Steering Wheel	1
2	Follow-up Steering Unit	1
3	Rudder Angle Indicator (Optional)	1
4	Rudder Angle Feedback Device	1
5	Certificate of Conformity	1
6	Warranty Card	1
7	Instruction Manual	1
8	Factory Test Report	1

Table 2.1

2 Product appearance diagrams, dimension diagrams, and wiring diagrams

2.3 Product size drawing

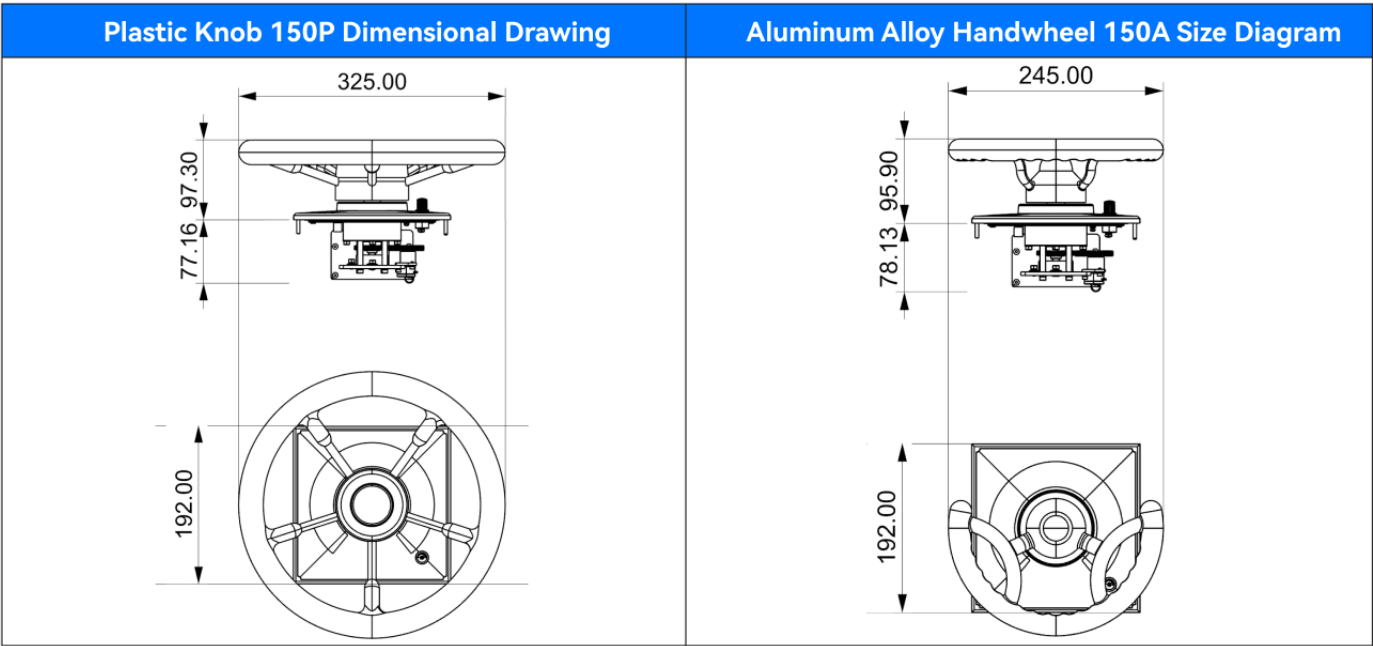


Figure2.2

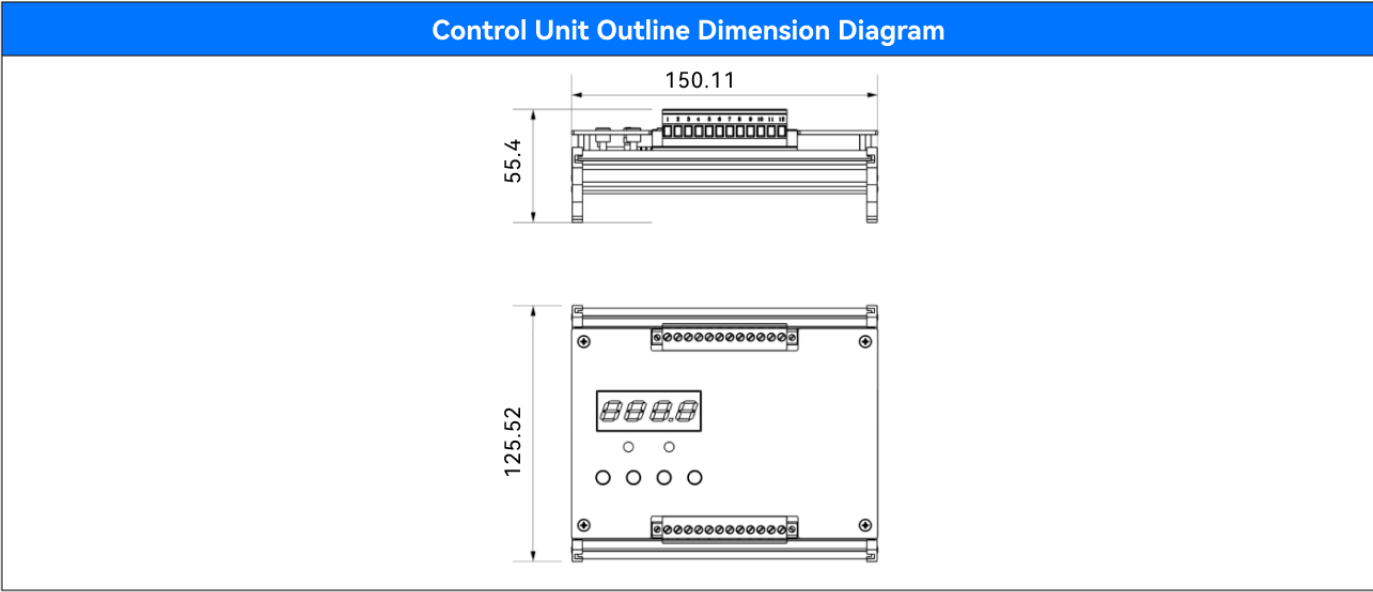


Figure2.3

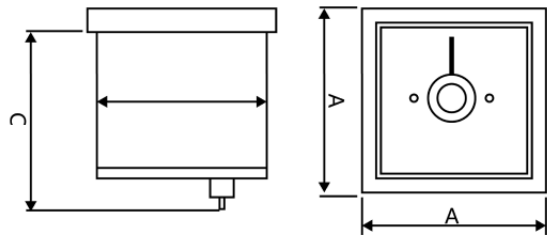
Rudder Angle Indicator Outline Dimension Diagram		Model	A Exterior design	B opening	C Depth
	Type 72	72	68	65	
	Type 96	96	92	65	

Figure2.4

2 Product appearance diagrams, dimension diagrams, and wiring diagrams

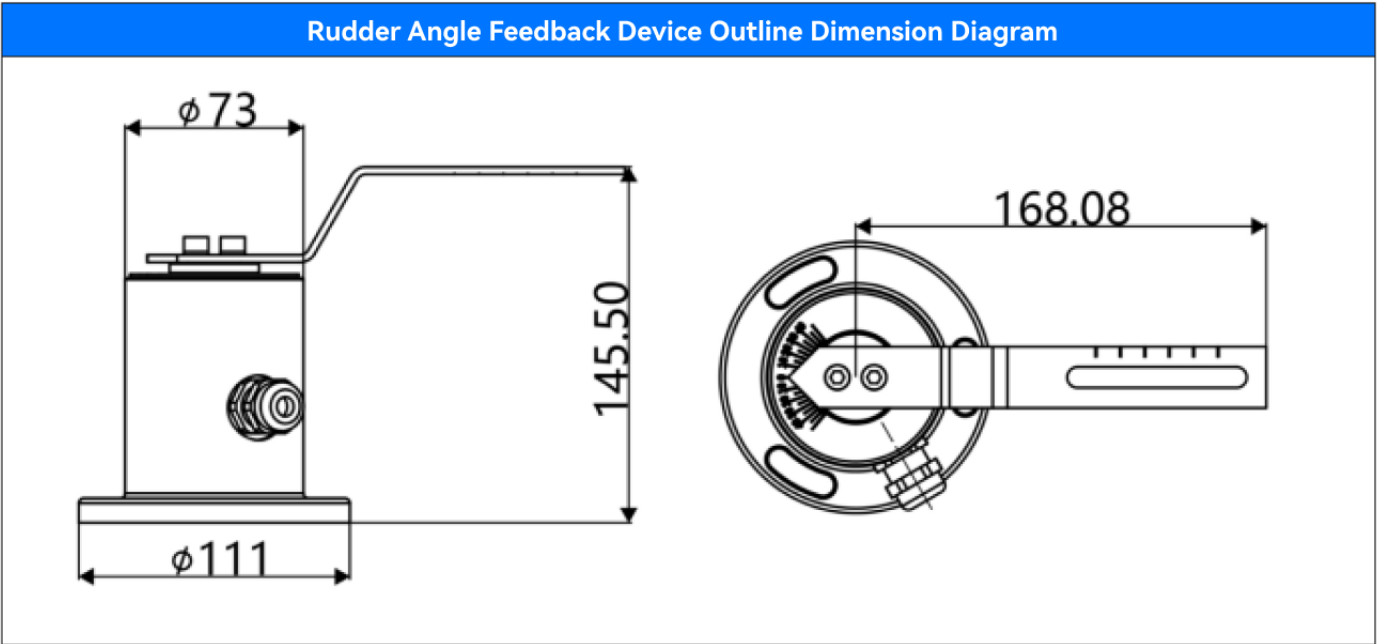


Figure2.5

2.4 System Composition

si-follow-up rudder control system solution is applicable to hydraulic rudders equipped with solenoid valves.

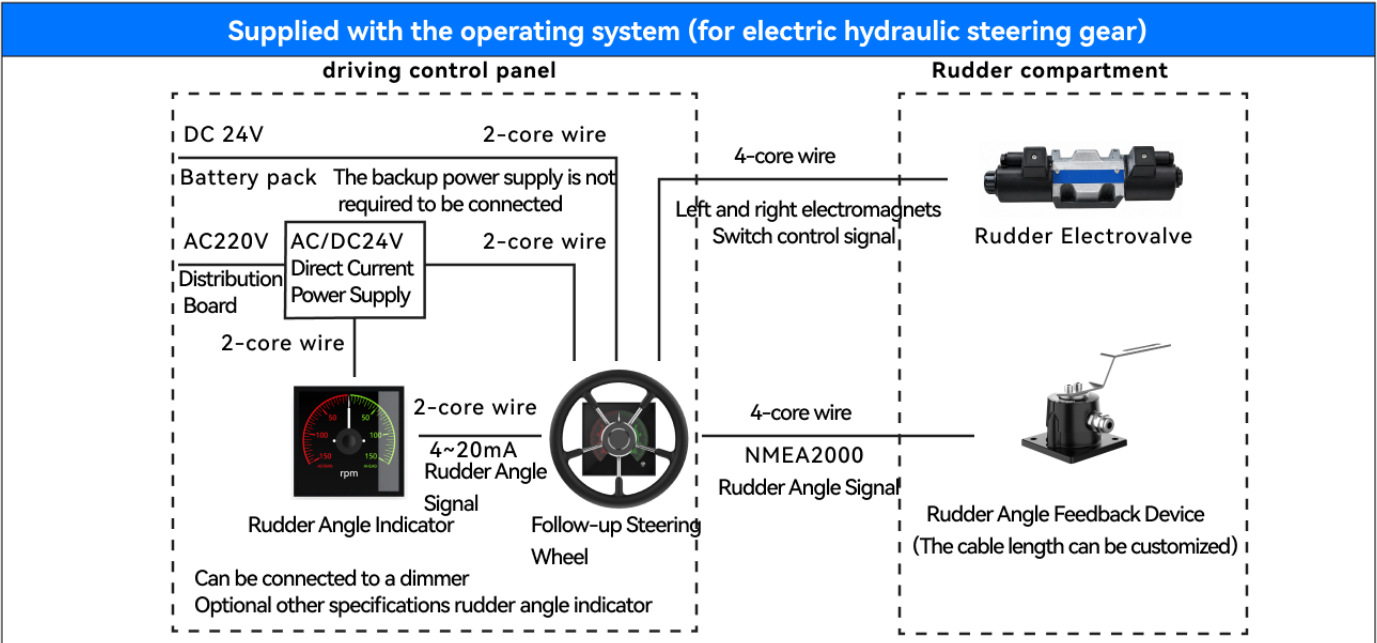


Figure2.6

Single rudder follow-up

Applicable to hydraulic rudders equipped with solenoid valves.

2 Product appearance diagrams, dimension diagrams, and wiring diagrams

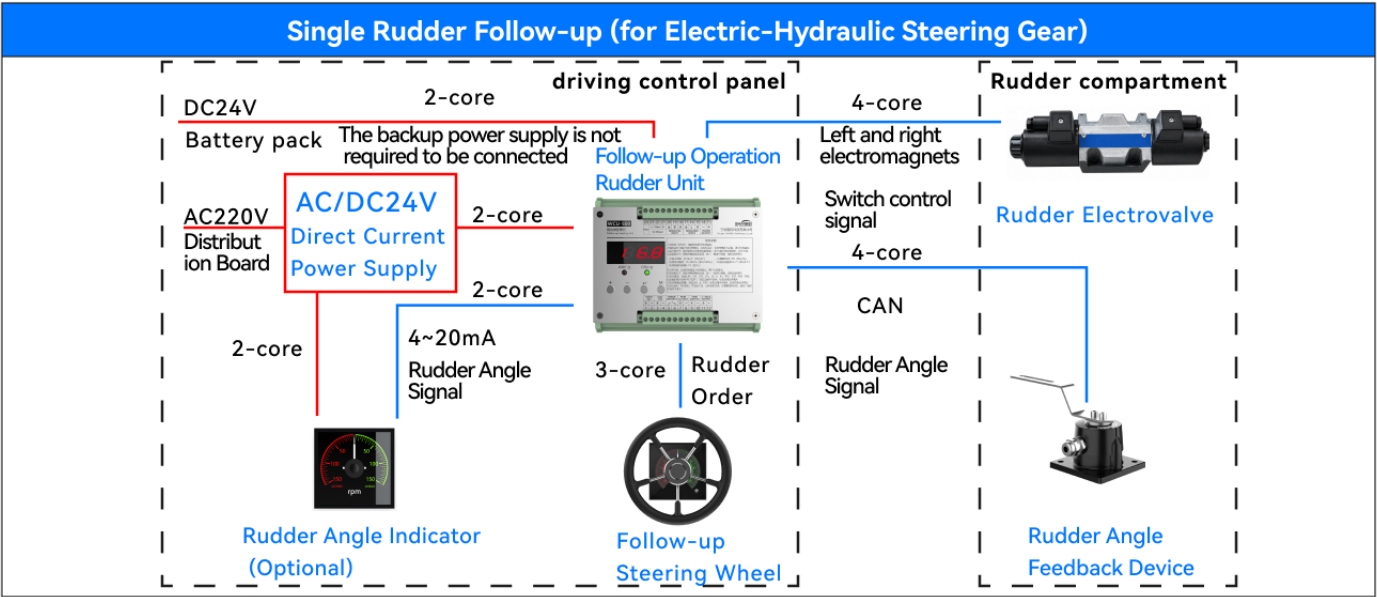


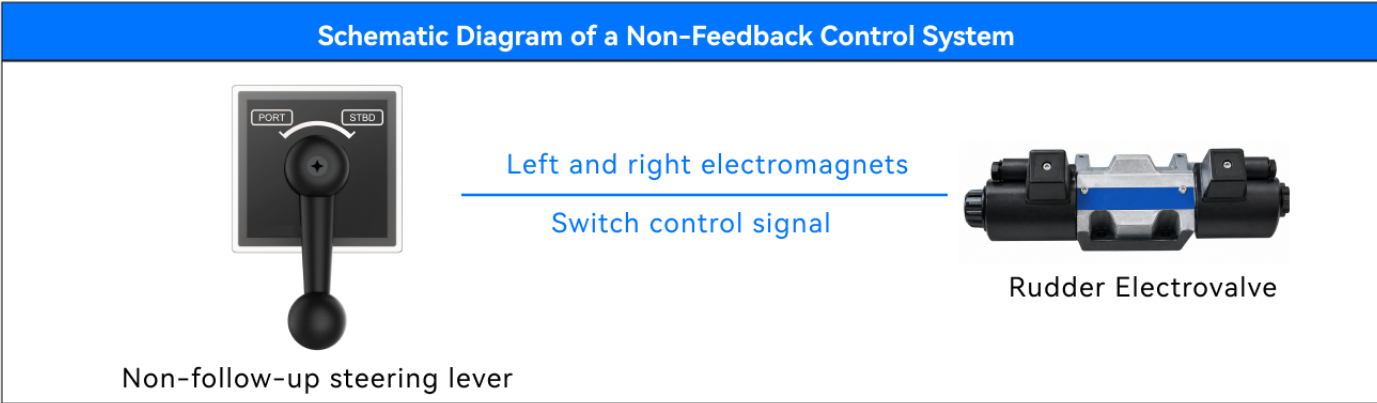
Figure2.7

Configuration Plan		
Follow-up Steering Wheel	WLF-150	Mandatory selection, with different rudder wheel styles available,including aluminum alloy, stainless steel, and plastic.
Rudder Angle Feedback Device	WSS-R106	Mandatory, standard 5-meter cable, digital signal output, with servo connection rod
Follow-up Steering Unit	WCU-500	Mandatory, with parameter configuration and calibration
Rudder Angle Indicator	WEI-96R	Optional, 4~20mA input signal, optional indication accuracy of 0.5° or 1.5°
Rudder Angle Indicator Dimmer	WDM-96P	Optional, aluminum alloy panel

Table2.2

Solution for Retrofitting Follow-up Steering Control Systems on Old Ships

Applicable Objects: Hydraulic rudder actuators equipped with solenoid valves. Originally controlled via a handle for left and right rudder operation, these can now be upgraded to follow-up steering. This scheme is not applicable if the original hydraulic rudder actuator is not an electro-hydraulic rudder actuator and employs a shaft-driven pump configuration.



2 Product appearance diagrams, dimension diagrams, and wiring diagrams

As illustrated, the traditional simple steering method employs a handle or handwheel switch to control the on/off state of an electromagnetic valve. When steering, continuous pressure must be maintained; if released, the electromagnetic valve immediately de-energizes. This not only leads to easy damage of the handle but also causes fatigue for the steering operator. The modified follow-up steering system is as shown in the following figure:

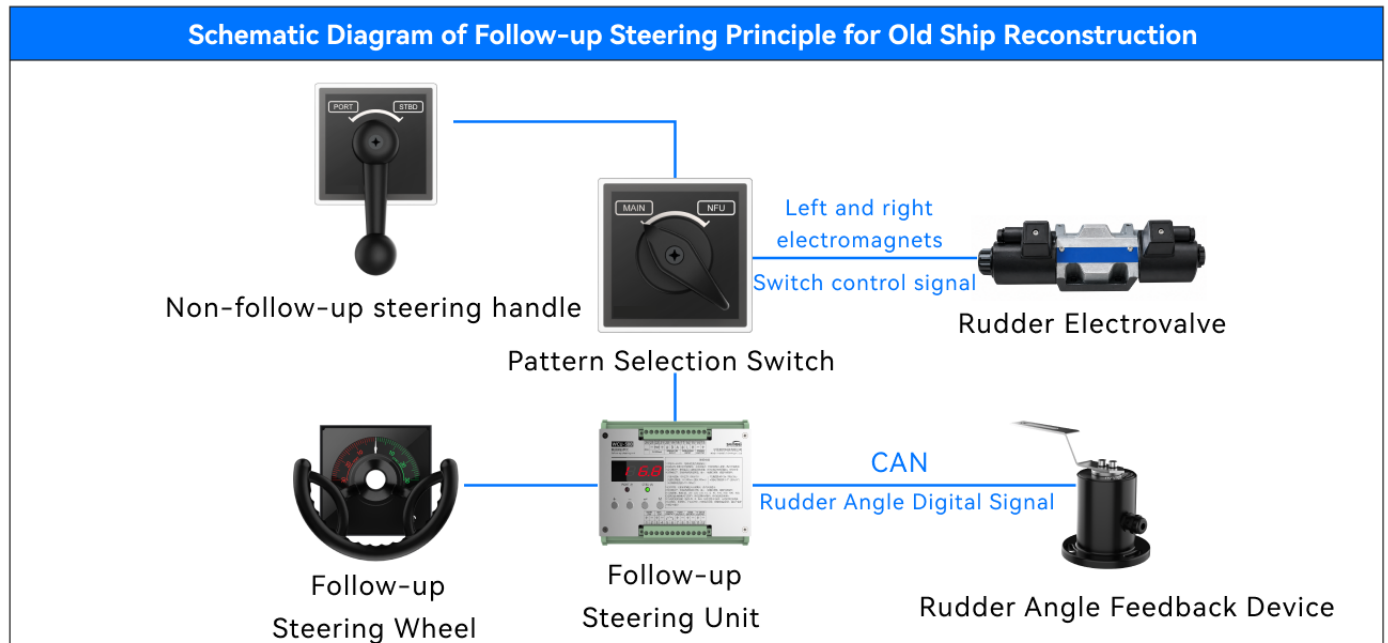


Figure2.10

By adding a mode selection switch, compatibility with the ship's existing simple steering system can be achieved. The solution offers the following advantages:

Rudder control is more effortless. With manual hand-steering, the steering wheel typically requires several rotations to adjust the rudder angle, whereas follow-up steering allows for single-handed operation with only a small rotation needed to change the rudder angle; existing manual hand-steering systems can be retained to enable multi-mode steering, ensuring navigational safety; one-button calibration facilitates installation; for vessels equipped with traditional manual hand-steering, we recommend installing electric hydraulic steering gear and solenoid valves, which offer the following advantages compared to traditional manual hand-steering:

1. Employing solenoid valves to control the rudder servo eliminates the need for hydraulic hoses to enter the cockpit, thereby reducing noise and enhancing comfort.
2. For high-speed boats, adopting a follow-up steering system that avoids hydraulic hoses entering the cockpit can reduce weight by more than 20 kilograms.
3. The system exhibits excellent compatibility; upgrading to an autopilot system requires only the addition of a display module, with all other modules remaining interchangeable.

2 Product appearance diagrams, dimension diagrams, and wiring diagrams

Configuration Plan		
Follow-up Steering Wheel	WLF-150	Mandatory selection, with different rudder wheel styles available, including aluminum alloy, stainless steel, and plastic.
Rudder Angle Feedback Device	WSS-R106	Mandatory, standard 5-meter cable, digital signal output, with servo connection rod
Follow-up Steering Unit	WCU-500	Mandatory, with parameter configuration and calibration
Pattern Selection Switch	WLF-75M	Mandatory, 2-level mode selection: Follow-up, Non-follow-up
Non-follow-up steering handle	WLF-75N	Mandatory, emergency rudder operation

Table2.3

Dual Rudder Independent Follow-up Steering Control System Solution
Applicable to vessels such as catamarans where two rudders cannot be interconnected via mechanical linkages, or to vessels with high maneuverability requirements.

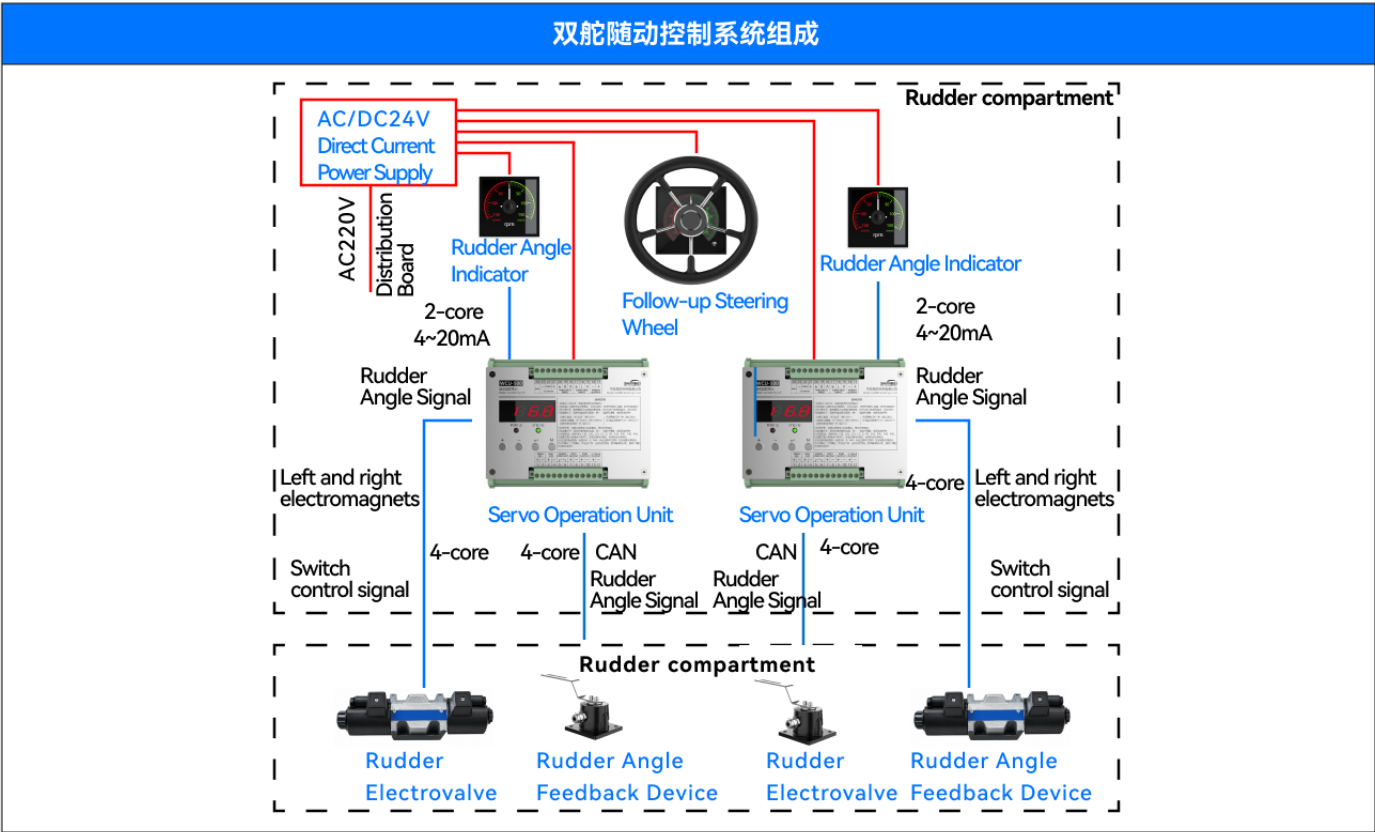


Figure2.11

The dual-channel control system is fully independent, allowing each rudder to be controlled individually or in synchronization.
Digital communication is employed between modules, with the maximum communication distance reaching up to 400 meters;
Equipped with advanced control algorithms to effectively address the oscillation issues of follow-up rudders.

2 Product appearance diagrams, dimension diagrams, and wiring diagrams

Configuration Plan		
Follow-up Steering Wheel	WLF-150-2	Mandatory, dual-channel output, with optional aluminum alloy, stainless steel, and plastic styles
Rudder Angle Feedback Device	WSS-R106	2 required items, standard 5-meter cable, digital signal output, with servo connection rod
Follow-up Steering Unit	WCU-500	Two mandatory items, including parameter settings and calibration
Rudder Angle Indicator	WEI-96R	Optional, 4~20mA input signal, 0.5° or 1.5° indication accuracy
Rudder Angle Indicator Dimmer	WDM-96P	Optional, aluminum alloy panel

Table 2.4

2.4 Product wiring diagram

1.Servo Steering Wheel

number	dentifier	Primary purpose
1	Ref1+	1# Potentiometer, Terminal (Standard Configuration)
2	Wiper1	1# Potentiometer, Center Tap (Standard Configuration)
3	Ref1-	1# Potentiometer, Terminal (Standard Specification)
4	Ref2+	Potentiometer, End (for Twin Rudders)
5	Wiper2	Potentiometer, Center Tap (for Twin Rudder)
6	Ref2-	Potentiometer, End (with Dual Rudder)
7	/	
8	/	
9	/	
10	/	
11	/	
12	/	
13	+24V	Positive terminal of the power supply
14	0V	Negative terminal of the power supply
15	/	
16	/	

Table 2.5

2 Product appearance diagrams, dimension diagrams, and wiring diagrams

2.Rudder Angle Feedback Device

Interface Number	Color	Primary purpose
1	rain Wire	Shield
2	red	Positive terminal of the power supply
3	Black	Negative terminal of the power supply
4	White	CANH
5	Blue	CANL

Table 2.6

There are 2x12P terminal blocks on the rudder control interface unit, defined as follows:

number	dentifier	Primary purpose
1	MAIN24V +	Main Power 24V Input
2	MAIN24V -	ain power 0V input
3	AUX.24V +	24V Input Standby Power Supply
4	AUX.24V -	Standby Power 0V Input
5	ERROR CONNACT NO	ourceless Alarm Signal Output (Normally Open)
6	ERROR CONNACT COM	Unpowered Alarm Signal Output (Common Terminal)
7	PORT OUTPUT +	Left-hand drive signal 24V output
8	PORT OUTPUT -	Left steering drive signal 0V output
9	STBD OUTPUT +	Right-hand drive signal 24V output
10	STBD OUTPUT -	Right-hand drive signal 0V output
11	4-20mA OUTPUT +	Rudder Angle Signal Current Positive Output
12	4-20mA OUTPUT -	Rudder Angle Signal Current Negative Output
13	POWER OUTPUT +	24V Power Supply Output (Load Current 0.5A)
14	POWER OUTPUT +	Power Supply 0V Output
15	NMEA2000 INPUT H	CAN communication bus H receives rudder angle signals
16	NMEA2000 INPUT L	CAN communication bus L receives rudder angle signals
17	PGND	Protected areas
18	NMEA0183 INPUT A	Communication Bus A of 485, receives rudder angle signal
19	NMEA0183 INPUT B	Communication Bus B 485, receives rudder angle signal
20	PGND	Protected areas
21	FU Wheel +	Rudder Wheel Ref + Port
22	FU Wheel Wiper	Rudder Wiper Port
23	FU Wheel -	Rudder Wheel Ref-Port
24	NULL	Not used

Table 2.7

2 Product appearance diagrams, dimension diagrams, and wiring diagrams

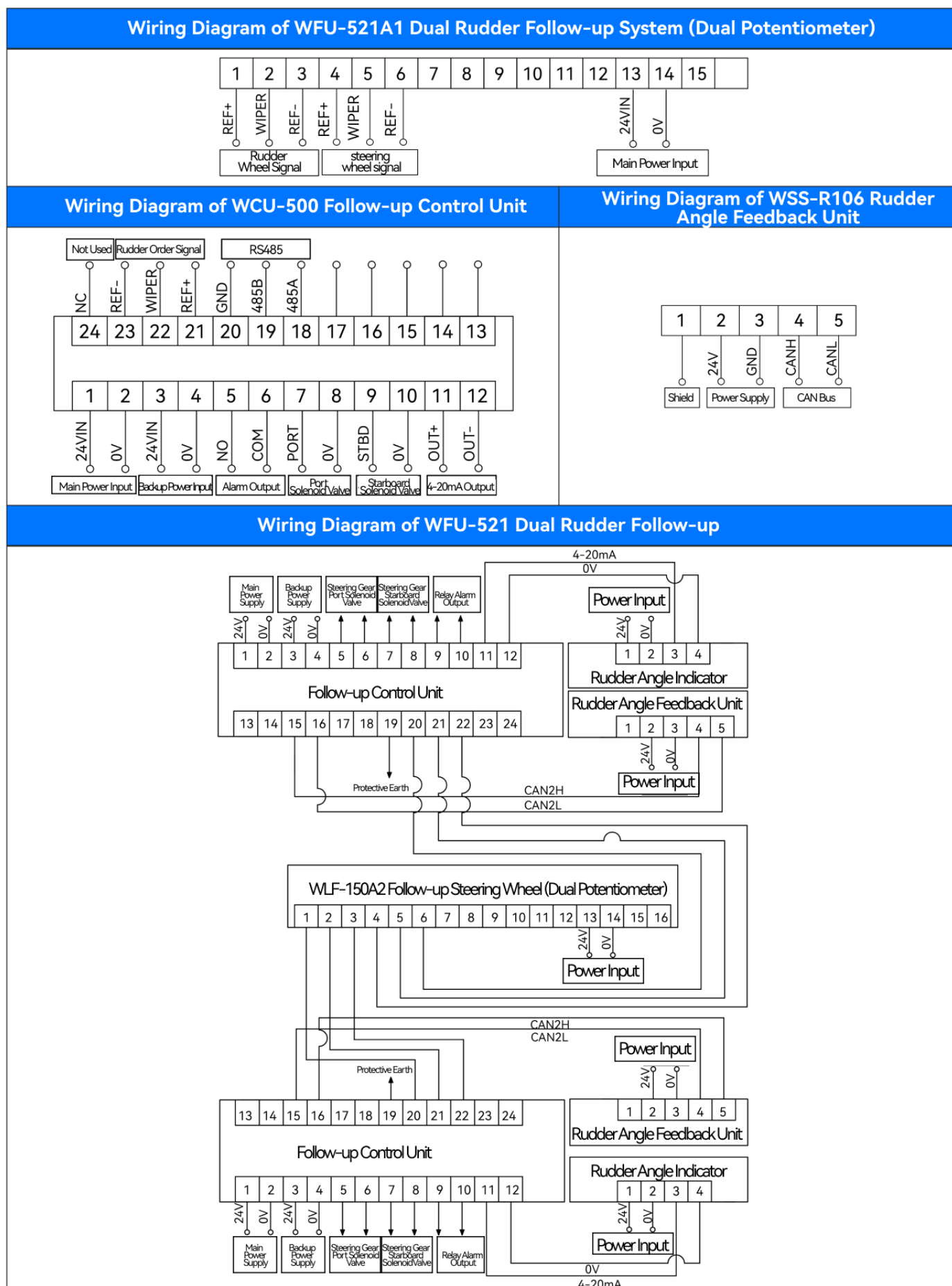


Figure2.13

3 Technical parameter

3.1 Product basic parameter

power source	24VDC
consumption	<1W
Control precision	1.2°
Rudder range	±45°
Protection Rating	IP56 or IP22
Electromagnetic valve signal	24VDC
Communication signals	CAN
Maximum communication distance	200m
Operating Temperature	0 ~ 55°C
Storage temperature	-20~70°C

Table 3.1

4 Installation instructions

4.1 Servo Steering Wheel Installation

Place the handwheel vertically into the opening in the installation plate as shown in the lower-right corner of Figure 4.1, align the screws with hole B, and if encountering protruding parts, rotate or tilt the handwheel to insert it.

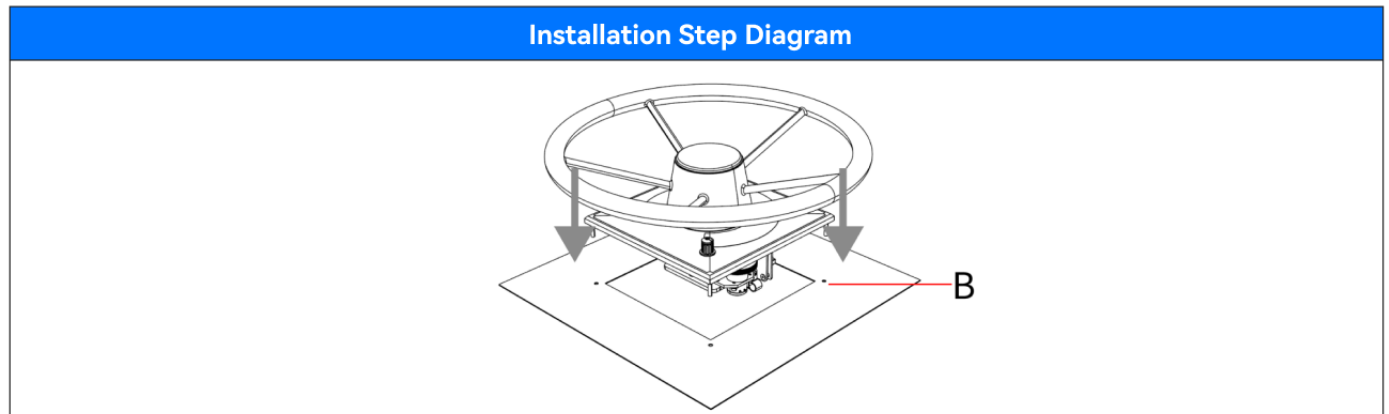


Figure 4.1

2. Secure the handwheel to the mounting plate by installing the studs and accessories, and tighten nut C. Ensure the handwheel is firmly and reliably fastened to the mounting plate. There must be no gaps at the contact surfaces, and no wobbling is allowed, as shown in Figure 4.2.

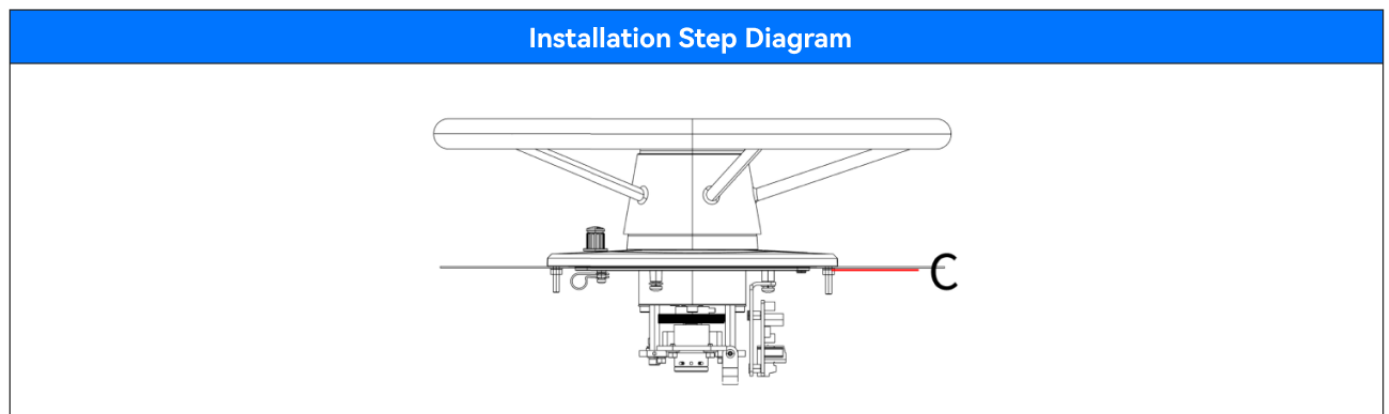


Figure 4.2

4.2 Installation of Follow-up Steering Unit

As shown in Figure 4.3, install the A clip of the follow-up rudder unit into the B slot, ensuring it is secure and reliable.

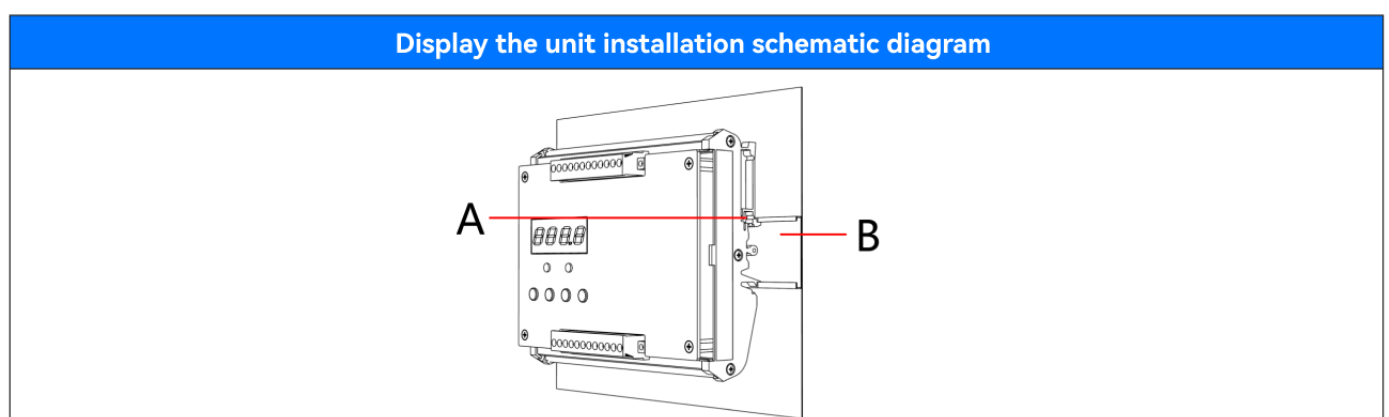


Figure 4.3

4 Installation instructions

4.3 Proper rudder angle indicator installation

As shown in Figure 4.4, install instrument A onto the mounting surface of B to ensure secure attachment.

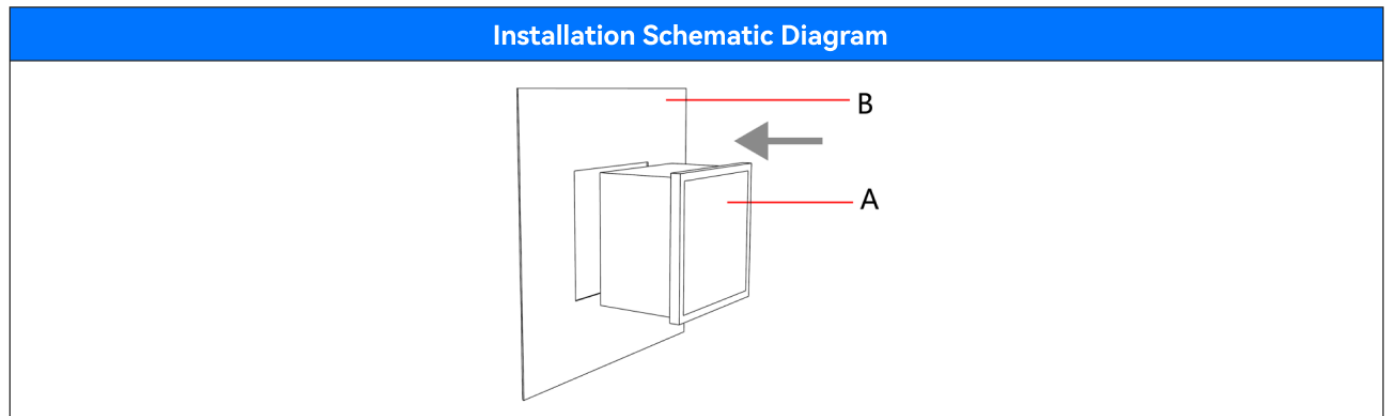


Figure 4.4

4.4 der Angle Distributor Installation

The rudder angle feedback device must be installed flexibly according to the type of rudder motor, secured with M8 triple combination screws and nuts. A threaded rod connects the lever arm and the rudder handle, forming a parallelogram linkage structure to ensure that the rotation angle of the rudder handle is equal to the rotation angle of the feedback device's lever arm.

1. Installation of the swing cylinder type rudder motor rudder angle feedback device: The swing cylinder type rudder motor rudder angle feedback device is suitable for installation on the front and rear sides of the rudder rod. Adjustments should be made based on the specific layout and positional space of the rudder motor compartment. First, straighten the rudder and keep the rudder angle at the neutral position. Referencing Figure 4.5, the distance from the center of the rudder handle to the center of the feedback device ($AC = BD$) should be approximately 500 MM in length, and the lengths of AB and CD should be approximately 150 MM, forming a parallelogram ABCD. Otherwise, significant linear errors and asymmetry will occur in the rudder angle feedback.

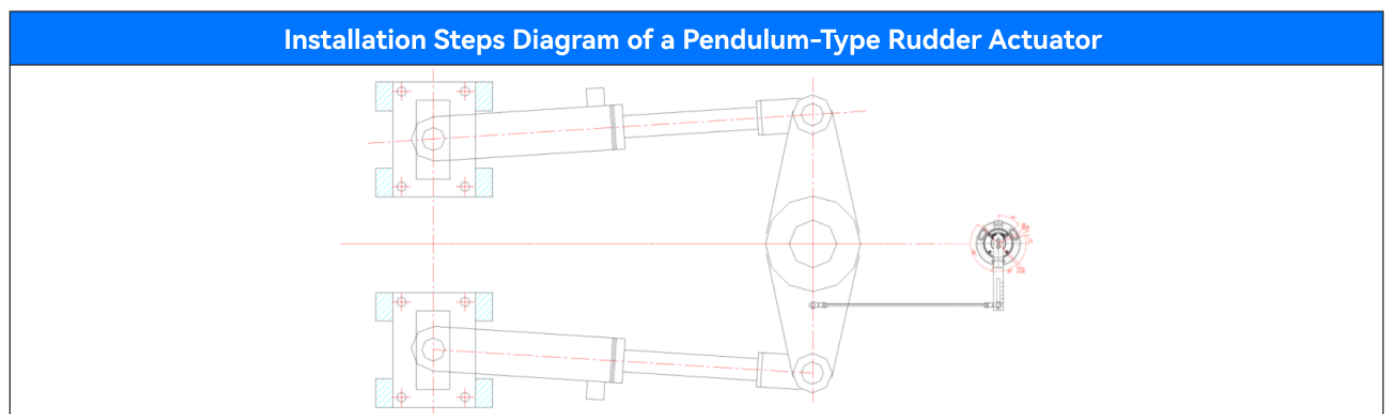


Figure 4.5

4 Installation instructions

2. Installation of the Fork-type Servo Rudder Angle Feedback Device: The fork-type servo rudder angle feedback device is suitable for installation on either the left or right side of the rudder rod. Adjustments should be made based on the specific layout and spatial position of the servo compartment. First, straighten the rudder and keep the rudder angle at the neutral position. Refer to Figure 4.6: the distance from the center of the rudder arm to the center of the feedback device ($AC = BD$) should be approximately 500 mm, and the length of $AB = CD$ should be approximately 150 mm, forming a parallelogram ABCD. Otherwise, significant linear errors and asymmetry between the left and right sides of the rudder angle feedback will occur.

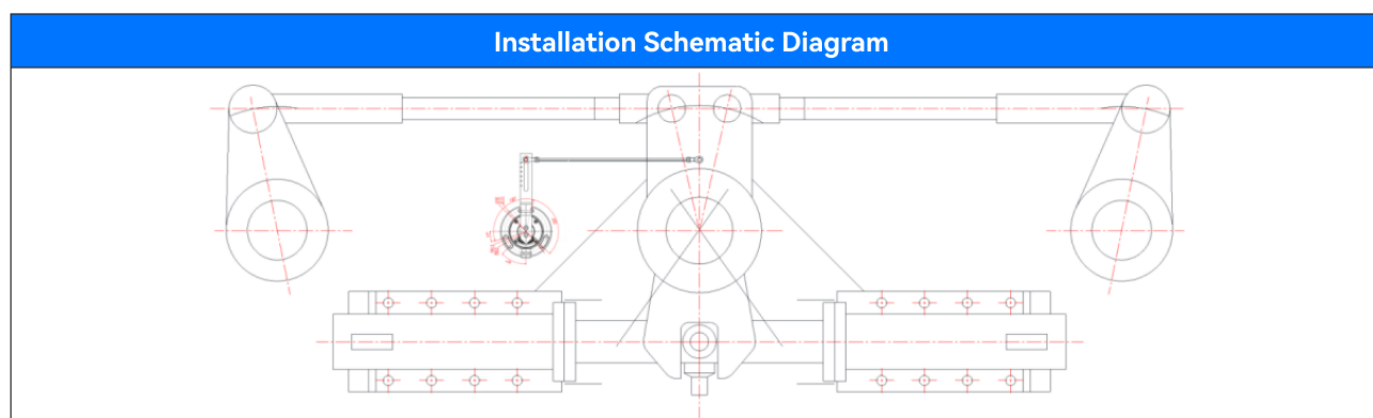


Figure 4.6

5 Instructions and precautions for use

5.1 Instructions for use

1. The system is powered by 24VDC $\pm$ 2V, and the solenoid valve control is active output;
 2. In the dual rudder follow-up control system, the follow-up steering unit corresponds one-to-one with the rudder wheel potentiometer and cannot be interchanged;
 3. Upon first use, check the left and right rudder drive signal outputs. If the signals are reversed, it may cause the rudder to turn fully in the opposite direction;
 4. To prevent excessive load on the rudder motor solenoid valve, follow-up steering units typically come equipped with relays at the factory. The drive signal is output through the relay to control the rudder motor solenoid valve;
 5. The follow-up steering unit includes three modes: Operation, Setting, and Calibration. It starts in Operation mode. Press and hold the M key to enter Setting mode, and press and hold again to exit;
 6. In Operation mode, the digital tube displays the current actual rudder angle value, and the LED indicator shows the solenoid valve output (left red, right green);
 7. In Setting mode, short-press the M key to select the setting item, adjust using the + and - keys, and save by pressing the Enter key;
 - (1) Set maximum rudder angle: 45° or 35° (default: 45°)
 - (2) Set full rudder time: 0-28s (default: 20s)
 - (3) Set rudder motor sensitivity: 25-500ms (default: 100ms)
 - (4) Set follow-up sensitivity: 0.5-2° (default: 0.5°)
 - (5) Set micro-adjustment area coefficient: 5-10 (default: 5)
 8. Open the aluminum alloy housing of the follow-up steering unit. Press and hold the MODE key to enter Calibration mode, and press and hold again to exit;
 9. In Calibration mode, short-press the M key to switch calibration items, adjust using the + and - keys, and save by pressing the Enter key. L represents Left, R represents Right;
 - (1) Calibrate rudder wheel: Includes L40, L30, L20, L10, L5, 0, R5, R10, R20, R30, R40, and the pre-set maximum rudder angle (45° or 30°). Indicator A flashes during calibration and remains lit after completion.
 - (2) Calibrate rudder angle feedback sensor: Includes L40, 0, R40. Indicator B flashes during calibration and remains lit after completion.
- The product is pre-calibrated at the factory. If re-calibration is required, it must be performed under the guidance of factory technical personnel!
- After system connection, the digital tube on the driver circuit board normally displays the rudder angle value;
- If the digital tube on the driver circuit board displays ER1, it indicates no rudder angle signal;
- If the digital tube on the driver circuit board displays ER2, it indicates the rudder angle value is out of the normal range;
- If the digital tube on the driver circuit board displays ER3, it indicates no rudder wheel potentiometer signal;
- If the digital tube on the driver circuit board displays ER4, it indicates drive signal overload;

5 Instructions and precautions for use

5.2 Matters needing attention

1. After the system is connected, the digital tube on the drive circuit board displays the rudder angle value normally;
2. If the digital tube on the drive circuit board displays ER1, it indicates that there is no rudder angle signal;
3. If the digital tube on the drive circuit board displays ER2, it indicates that the rudder angle value is out of the normal range;
4. If the digital tube on the drive circuit board displays ER3, it indicates that there is no signal from the rudder wheel potentiometer.

6 Fault analysis and elimination

number	Fault Phenomenon	Maintenance Methods
1	The system powers on with the rudder fully deflected.	Inspect the potentiometer for damage; recalibrate according to the procedure
2	The actual rudder angle is opposite to the rudder command	Check if the output wiring of the solenoid valve is reversed
3	After steering, the solenoid valve signal does not output	Check if the rudder angle feedback device and drive circuit board are burned out.
4	Rudder oscillations often occur during the steering process	Adjusting the non-sensitivity of the follow-up mechanism
5	The rudder angle indicator reading deviates significantly from the actual value	Rudder angle feedback sensor installation deviation, check if the linkage mechanism is loose
6	The steering wheel cannot be dimmed.	Inspect the dimming potentiometer and driver circuit board for damage

Figure 6.1

7 Safety protection and accident handling

7.1 Safety protection devices and precautions

1. Critical components of this product have been secured and sealed at the factory. Unauthorized disassembly is strictly prohibited. If the seal is compromised, any product quality issues arising thereafter shall be borne solely by the purchaser.
2. In the event that this product cannot be operated normally, immediately stop using it, disconnect the power supply, and contact our after-sales service engineer for consultation on a solution.

7.2 Troubleshooting procedures and methods

1. In the event of irreparable faults occurring during use, contact our after-sales service engineers.
2. During the warranty period, if faults arise due to product inherent issues, we shall provide a fully replaceable product at no cost to the buyer for replacement, along with technical support. For faults not caused by product inherent issues, we offer two options: a fully replaceable product or on-site service, with the buyer to choose freely. All associated costs shall be borne by the buyer.
3. Beyond the warranty period, in the event of faults, we offer two service options: a fully replaceable product or partial component replacement, with the buyer to choose freely. All required costs shall be borne by the buyer.

8 Maintenance and repair

8.1 Daily maintenance and maintenance

During non-operational daily periods, attention should be paid to the maintenance and upkeep of this product. Through proper maintenance and upkeep, the product's service life can be extended. Specific maintenance and upkeep methods are as follows:

1. Regularly wipe the product's surface with a dry cloth to ensure the external cleanliness and tidiness of the product.
2. Disconnect the product's external power supply, periodically rotate it back and forth approximately 10 times, with a cycle of within 2 to 3 weeks. This can ensure smooth operation and prevent the occurrence of 'aging' phenomena caused by long-term storage.

8.2 Operation precautions

1. Continue use of the device when the control switch fails to self-position. Contact our after-sales engineer.
2. During use, operations should be performed smoothly and at a uniform speed, avoiding rapid rotation. Excessive speed may generate impact forces that could damage the product.
3. The input voltage must be strictly adhered to as specified in the wiring instructions. Any product malfunction or other significant accidents resulting from non-compliance with these regulations shall be borne entirely by the purchaser.

8.3 Long-term maintenance and maintenance

The methods of maintenance and upkeep for long-term storage are the same as those for daily maintenance and upkeep.

9 Transportation, storage and warranty

9.1 Transportation precautions

During transportation, violent shaking and collisions that could cause physical damage to the product should be avoided.

9.2 Storage precautions

An environment at room temperature, dry and cool. Avoid exposure to high temperatures, intense sunlight, or low-temperature freezing, as these can cause irreversible damage to damping components and reduce their service life.

9.3 Warranty period

The warranty period for this product commences from the date the buyer receives the goods and lasts for 12 months. The basis for calculation is the date of the courier's delivery receipt or the date of the shipping invoice acknowledgment.

10 Other

10.1 Phone number of the after-sales engineer

Contact: Mr.Xu

Tel: 18067343163

10.2 Company information

Manufacturer: Ningbo SHANBEI Technology Co., LTD

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