15V125kg, Brushless Rudder
Motor Test Outline

Easy Technology (Hong Kong) Limited

Catalogue

1 . Mandate Rationale

1 1. Overview

The rudder servo is a servomechanism in the flight control system of drones. It receives control signals from the aircraft's control system computer, drives the rudder surfaces to deflect, and thus controls the aircraft's flight attitude and trajectory. Therefore, the performance of the rudder servo system directly impacts flight performance and safety. Before each flight mission and during maintenance, the relevant parameters of the rudder servo are measured, and its static and dynamic performance is tested.

1 2. Source and Preparation of Tasks

Rudder Control Technology Agreement;

[xxx] UAV System Design Report

1 3. Normative Reference Documents

GJB5434-2005 General Requirements for Flight Test of UAV System;

GJB8265-2014 General Specifications for UAV airborne Electronic Measurement Equipment;

GJB4108-2000 Military UAV System Force Test Regulations;

GJB5433-2005 General requirements for UAV systems;

GJB2347-95 General Specifications for UAV;

GJB6703-2009 General requirements for UAV measurement and control system;

2. Nature of the Experiment

This rudder test is part of the rudder performance verification and reliability test. Through this test, we will evaluate the performance parameters, operational stability, durability and safety of the rudder to ensure that it performs well in practical applications.

3. Purpose and Significance of the Experiment

Through special test, the functional performance of the rudder gear is evaluated to meet the technical indicators and use requirements of the KST rudder gear, and the functionality and safety of the servo mechanism are verified.

The main indicators are as follows:

Working voltage: 2S (8.4V), 3S (12.6V), 4S (16.8V) speed, current, torque;

Pulse range: 800 ~ 2200μsec

Purpose of this test:

The main purpose is to ensure that the rudder motor has stable performance under design conditions and can meet all the expected requirements of the target KST rudder motor in actual operation.

The main indicators are as follows:

Working voltage: 2S (8.4V), 3S (12.6V), 4S (16.8V) speed, current, torque;

Pulse range: 800 ~ 2200μsec

The Significance of This Test:

1) Verification of rudder performance: The test can verify the performance of the rudder, including its response speed, accuracy and stability;

2) Finding and solving problems: Through testing, the problems and faults of the rudder gear can be found in time, so that the repair and improvement can be carried out in time;

3) Optimization design: Test data can provide important reference for the design of rudder motor. Through the analysis of test data, the design of rudder motor can be optimized to improve its performance and efficiency.

4. Condition of Experiment

4.1. Samples and Quantities to Be Tested

The test items include rudder motor, test bench, DC power supply, remote control equipment, etc.

4.1.1 Subjects

Name of the sample: rudder gear, quantity 1;

Figure 1 Rudder

4.2. Accompanying Samples and Quantity

4.2.1. Control Samples

Test bench, 1;

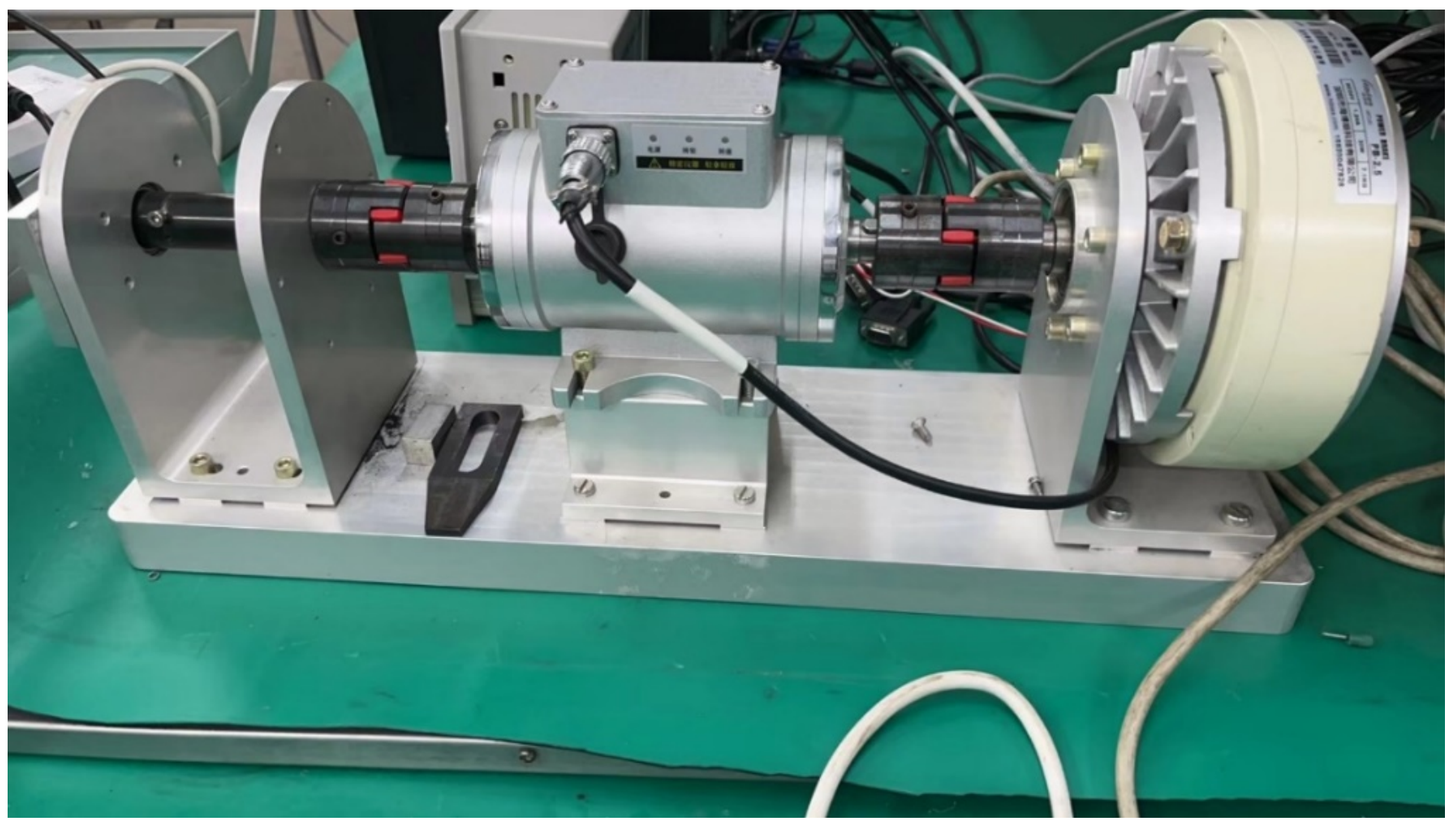

Figure 2 Test Bench

4.3. Test Equipment

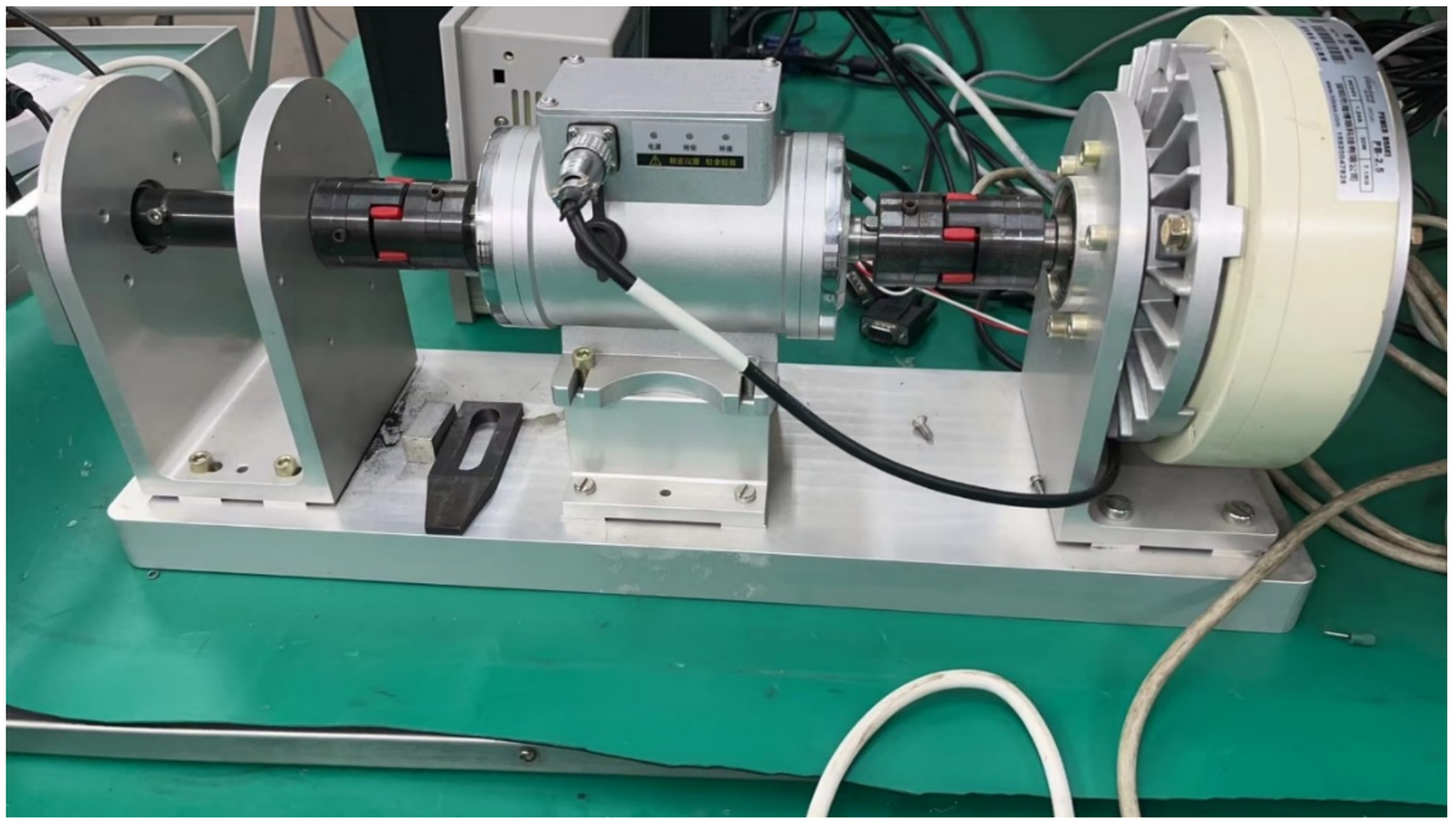

Figure 3 Test Site Conditions

4.5. Technical Status and Parameter Requirements of the Test Items

4.5.1. Test Samples

The test item is the test bench. The common parameters of the rudder motor test bench mainly include the following aspects:

1 Rated voltage: Common rated voltages are 3V,5V and 6V.

2 Working speed: the speed at which a steering gear rotates without load, usually measured in seconds per 60 degrees.

3 Working Angle: The range of angles to which the steering gear can rotate. Common working angles are 180 degrees and 360 degrees. A 180-degree steering gear can rotate 180 degrees, while a 360-degree steering gear can rotate 360 degrees.

4. Working temperature: refers to the temperature range in which the steering gear can work normally.

5. Torque: the torque generated by the steering gear, usually in N · cm.

6 Control signal: refers to the pulse signal used to control the steering gear rotation Angle.

7Working current: the current consumed by the steering gear during operation.

8 Accuracy: the ability of a steering gear to accurately control position or Angle.

In addition, the rotation angle, speed, torque, resolution, and operating voltage are also crucial parameters for testing a servo motor. The rotation angle indicates the maximum range of rotation, typically from 0 to 180 degrees, with some models capable of up to 360 degrees. The speed indicates the maximum rotational speed the servo motor can achieve. The torque represents the maximum torque the servo motor can handle, and a higher torque allows the servo motor to support a greater load. The resolution indicates the precision with which the servo motor can perform

The minimum angular change achieved, the higher the resolution, the higher the control accuracy of the rudder motor. The working voltage indicates the voltage range in which the rudder motor can work normally, generally between 4.8V and 7.2V.

Please note that the specific parameters may vary depending on the model and manufacturer of the rudder motor. Therefore, when testing the rudder motor, refer to the relevant documentation and the manufacturer's specification instructions to ensure accurate and safe testing.

5. technical requirement

5.1. Functional Requirements

Rudder technology requirements:

The rudder is an important part of the aircraft, which receives instructions from the remote control and accurately controls the rudder, direction or path of the aircraft. The technical requirements of the rudder mainly include the following aspects:

1 Speed and response: The rudder motor needs to have enough rotation speed and the ability to respond quickly to remote control commands, ensuring that it can respond quickly, especially during high-speed flight or maneuvering.

2 Accuracy and stability: The rudder motor needs to be able to accurately control the Angle of the rudder surface, and maintain stable performance during long-term operation, so as to avoid the loss of control of the aircraft due to rudder motor failure.

3 Torque: Torque is an important parameter of a rudder motor. It determines the maximum force that can be provided by the rudder motor

5.2. Performance Requirement

Servo performance requirements:

1) Durability: The steering gear needs to withstand frequent start, stop and high speed rotation, so it needs to have high durability and can work for a long time in harsh environment.

2) Waterproof and dustproof: Because the rudder motor is often

used outdoors, it needs to have certain waterproof and dustproof ability to ensure normal operation under bad weather conditions.

3) Compatibility: The steering gear needs to be compatible with a variety of remote controls and receivers for easy assembly and debugging.

1) Environmental conditions of use:

No.	Item	Specification
1-1	Storage temperature StorageTempera-ture Range	-30℃～70℃

1-2	Operating temperature OperatingTem-perature Range	-20℃～60℃

2) testing environment

No.	Item	Specification
2-1	Temperaturerange	25℃±5℃
2-2	Humidityrange	65%±10%

3) mechanical properties：

	Item	Specification
	size Size	64.0*32.8*76.5mm
	Weight	452g
	Geartype Geartype	SteelGear
	Institutional limit Angle, Limitangle	180°
	Bearings	2Ball bearings
	Output shaft Horn gear splined	25T 9.95mm
	Swing arm Horntype	Metal
	hull Case	AluminiumCNC
	Servo line Connectorwire	500mm
	motor Motor	BLSmotor
	Waterproof Splashwater resistance	Yes

4) Electrical Character

No.	working voltage	Operating Voltage Range	2S（8.4V）	3S（12.6V）	4S（16.8V）
4-1	no-load speed	No load speed	0.29sec/60°	0.18sec/60°	0.14sec/60°

4-2	No-load current (running current at no load)	150 mA	270 mA	400 mA
4-3	Maximum torque for turning. Peakstall-torque	90 kg.cm	120 kg.cm	150 kg.cm
4-4	Stall current	6.5 A	8 A	10A
4-5	Static current Idlecurrent	50 mA	50 mA	50 mA

5) control characteristic :

Item	Specification
Control signal Command signal	PWM 50-333Hz
Amplifier type Amplifier type	Digital Controller
Pulsewidth range	800 ~ 2200μsec
Neutral position	1500μsec
Running Angle: Runningdegree	90°(when 1000 ~ 2000μsec)
Dead zone width	4μsec
Rotation direction Rotatingdirection	CCW (when 1000 ~ 2000μsec)

5.3. Interface Requirements

PWM signal interface

order number	func-tion	pa-ram-eter	remarks
1	signal vol-tage	High voltage: minimum: 3.3v, maximum: 5.0v; Low voltage: minimum: 0. 0v, maximum: 1. 5v;	/
2	pulse le-ngth	900us-2100us	/
3	Location pulse length	1000us/1500us/2000us -50°/0°/+50°	/

Command/response frame

Byte number	description	remarks

1	Frame header (0 xFE)	
2	Version (0xCA)	
3	address	

4	Command code	
5	data	
6	data	
7	data	
8	data	
9	Check the total	
10	(OA) Frame end	

return signal

position feed back signal：

The position feedback signal is a square wave output signal directly related to the angular position of the output shaft. Reference is provided.

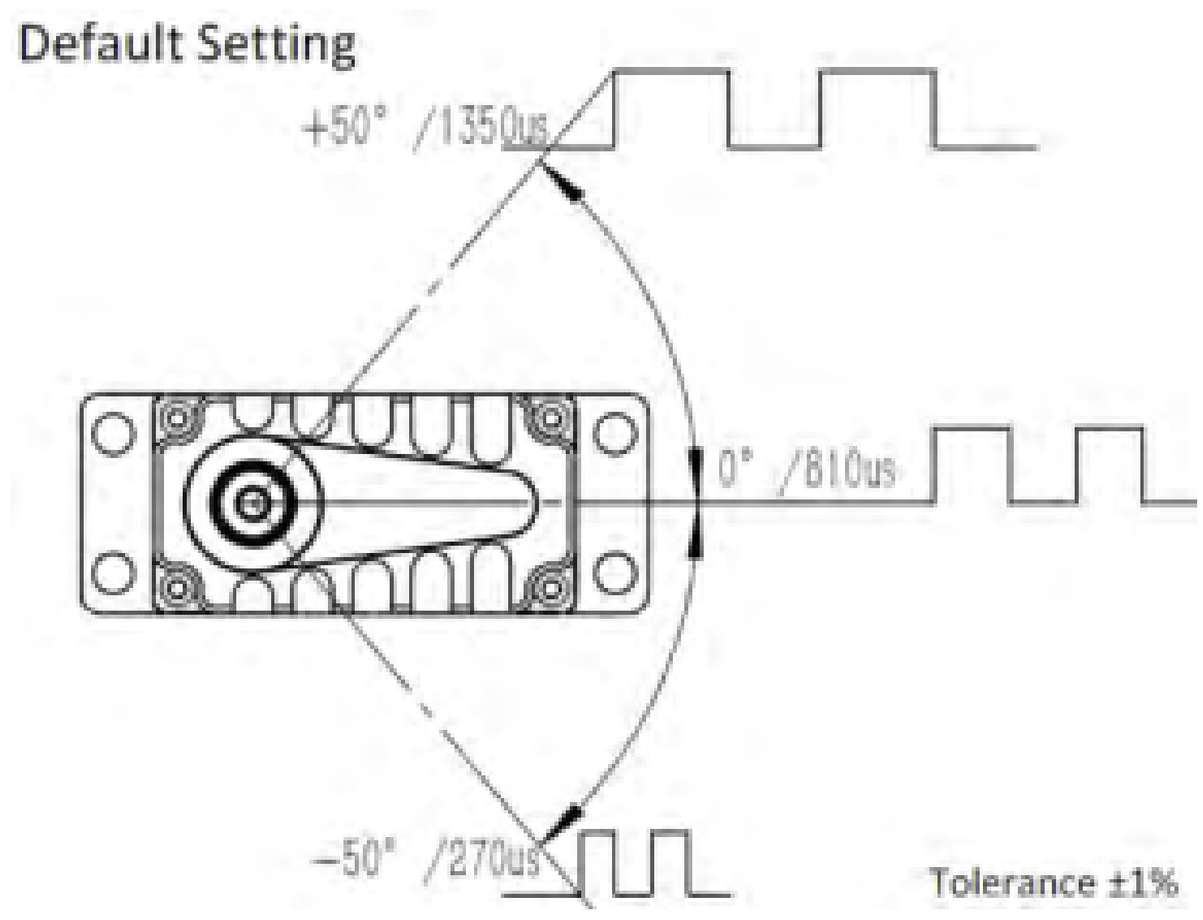

Figure 4 Default Settings

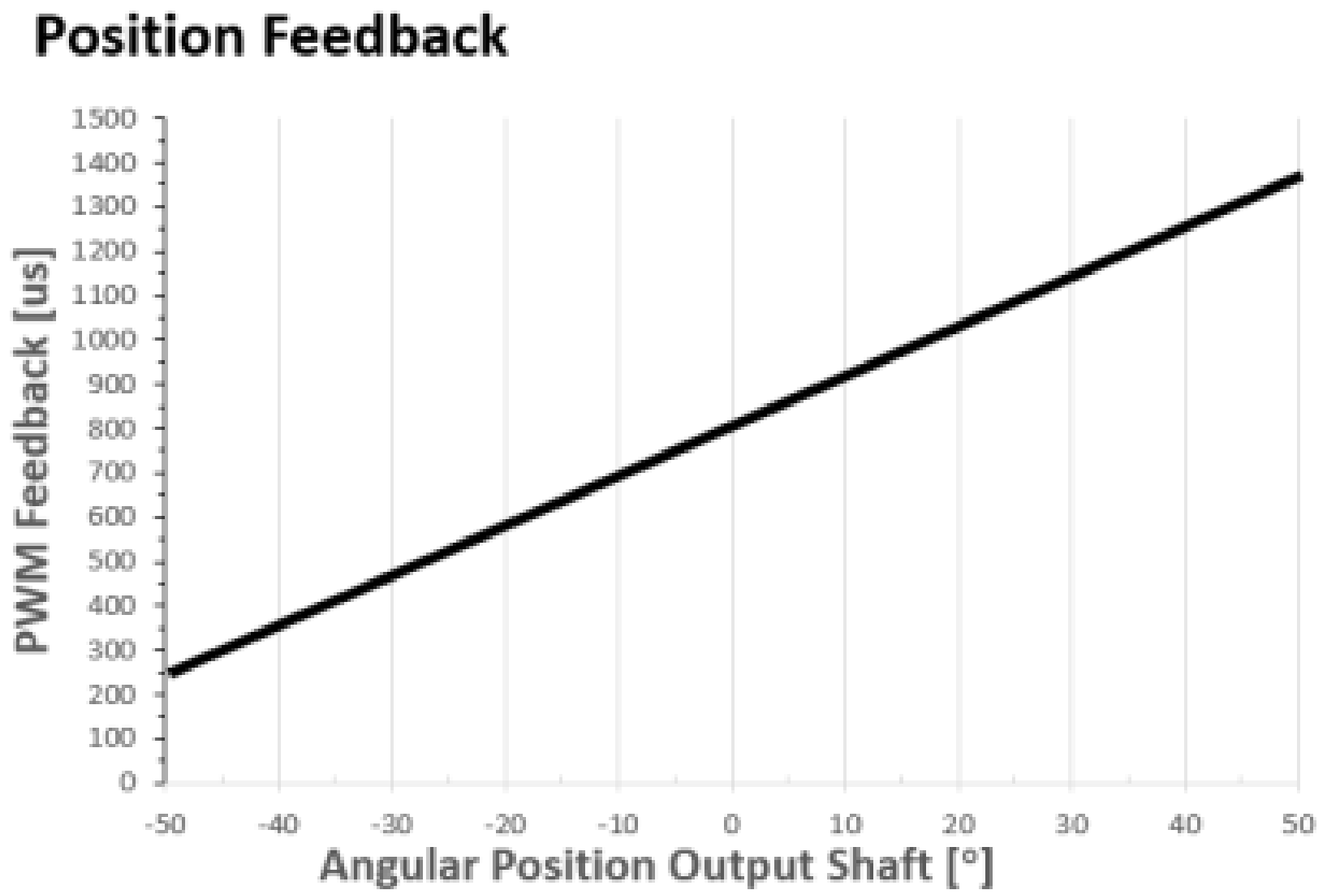

Figure 5 Position Feedback

Feedback value (bus version)

Feedback values integrated into the bus protocol, including Angle position, temperature, and current values. Values read by sending a request command.

6. Test methods and requirements

6.1. Test Method

1) Trial operation test:

Install the servo motor on the test bench and connect it to the loading system.

In the unloaded state, the steering gear is operated within a specified Angle range (e.g. ±5°, ±10°, ±15°, ±20° to ±35°) for 5 minutes.

Observe the operation of the rudder and loading system, check whether there is leakage at the oil pipe interface, whether the oil pump is running normally, and whether the left and right limit rudder angles of the rudder meet the design requirements.

2) breaking-down test：

Operate the rudder to the extreme rudder Angle, then increase the overflow line pressure of the system to 1.5 times the design pressure of the rudder system and maintain it for 5 minutes.

Observe whether there is leakage or permanent deformation of the

servo mechanism during this period.

3) Valve pressure adjustment:

In the left and right limit rudder angles of the rudder system, adjust the pressure of the double safety valve and relief valve to ensure

Set the pressure to meet the design pressure value of the system.

4) load test：

Operate the rudder motor within the range of ±35° and adjust the loading system so that the rudder motor operates at 25%,50%,75% and 100% loads of working pressure for 5 minutes each.

6.2. Testing Program

Solution one: Determine the speed of the rudder motor by measuring the time it takes for the rudder motor to turn 60° without load. Fix a fan-shaped cardboard on the rudder wheel and make two small holes at appropriate positions along the-30° to +30° angle line, between-45° and +45° (or-90° and +90°) (as shown in Figure A and B, where the infrared phototransistors are the information acquisition channels). This setup provides an information transmission channel for the infrared phototransistors. By collecting the signal changes at the starting and ending positions of the rudder motor's rotation within the 60° range through these two channels, the collected signals are processed by a comparator (LM393) and then sent to a microcontroller for further processing (the processed digital signal can be handled with a timer interrupt). This process determines the time required for the rudder motor to rotate 60°, and the time value is displayed on a digital tube, thereby measuring the speed of the rudder motor.

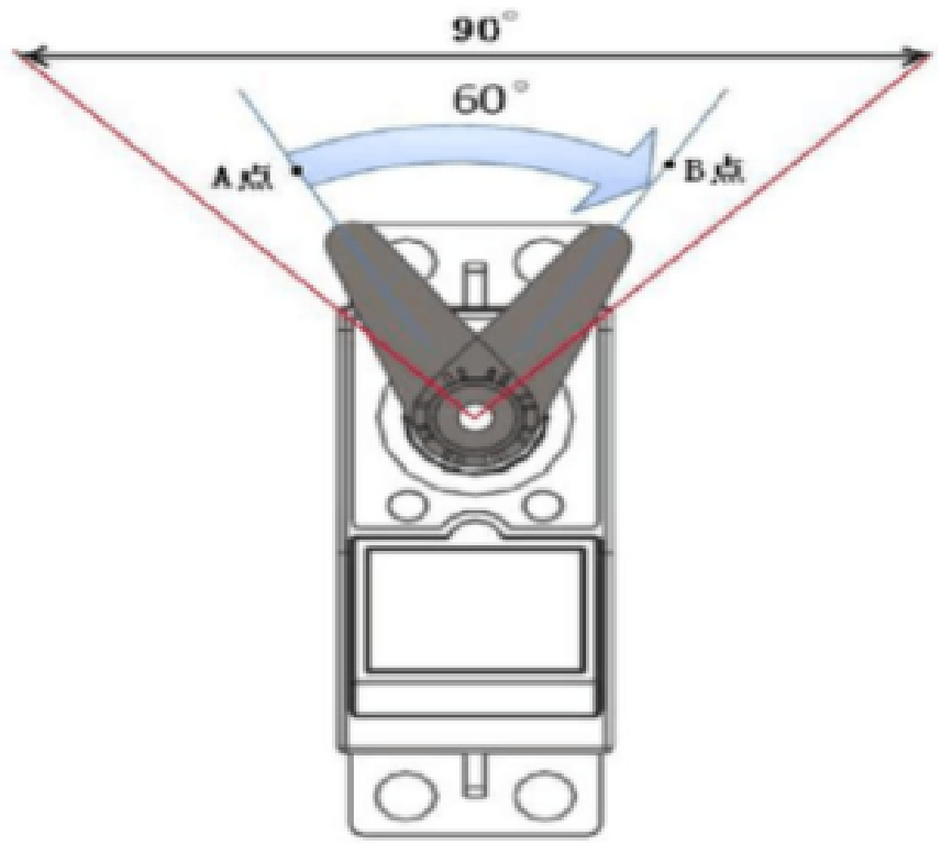

Figure 6 Structure of Infrared Tube Speed Measurement

Option 2: Test equipment: rudder motor controller, speed test stand

method of operation：

1) Set the steering gear supply voltage

2) The pulse width modulation of the rudder controller is 1.5ms, and the rudder is connected to make the rudder stand still at the central position of the rudder;

3) The servo is fixed on the Angle test stand, and the pointer is accurate at 90 degrees;

4) Set the pulse width output of the steering gear controller to 2 ms and record the time of forward 60 degree swing (forward 1);

5) Change the pulse width output of the steering gear controller back to 1.50ms, and record the time of the reverse 60 degree swing (reverse 1);

6) Set the pulse width output of the steering gear controller to 0.8 ms and record the time of the reverse 60 degree swing (reverse 2);

7) Change the pulse width output of the steering gear controller back to 1.50ms, and record the time of forward 60 degree swing (forward 2);

8) Change the power supply voltage of the servo and repeat steps 2 to 7.

torque measurement

Solution 1: Verify the torque of the rudder motor through actual testing. Because the unit of torque of the rudder motor is Kg ·

cm, so the rudder motor can be tested for carrying the weight of an object at a horizontal distance of 1cm from the center of the rudder motor shaft on the rudder.

Note: Because the higher voltage can improve the speed and torque of the motor, the working voltage of the rudder should be reasonably selected according to the specific situation when testing its performance parameters.

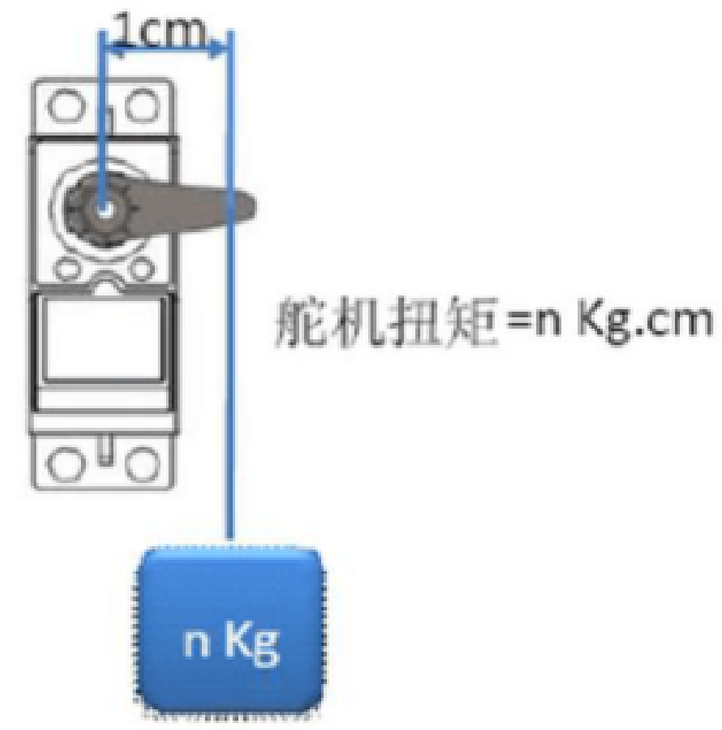

Figure 7 Torque Measurement Block Diagram

Option 2: Current detection method

It is known that the power of the rudder motor = speed x torque

As shown in the figure, the measurement circuit is on the right side of the figure is the steering gear plug, from top to bottom are the signal SIGNAL,

Power supply positive VCC, power supply negative GND.

Connect the resistor in series with GND, in the circuit, and detect the voltage drop.

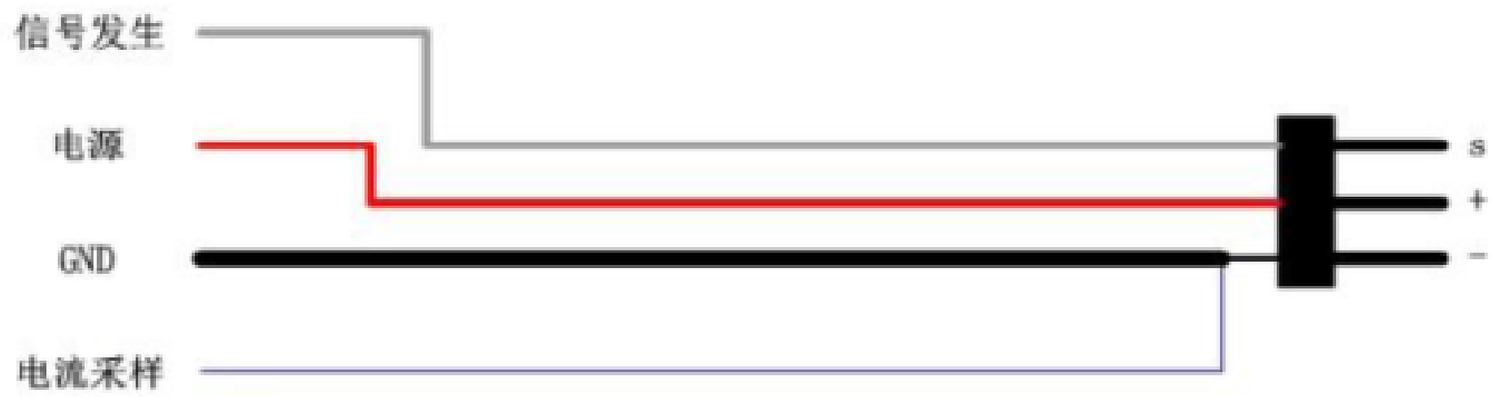

Figure 8 Measurement Circuit Diagram

Option 3: Use a force gauge

Test equipment: rudder motor controller, rudder motor fixture, torsion meter, ammeter 1) Set the power supply voltage of the rudder motor;

2) The rotating output shaft of the servo is fixed at the axis of the torsion meter;

3) The pulse width modulation of the rudder controller is 1.5ms, and the rudder is connected to make the rudder stand still at the central position of the rudder;

4) Use the rudder motor fixing fixture to clamp the rudder motor, pay attention not to let the rudder motor shaft force;

5) Change the pulse width output of the steering gear controller to 2ms, record the "forward blocking torque" displayed on the torsion meter and the current output by the power supply;

6) The pulse width output of the rudder motor controller is changed back to 1.50ms, and the torque meter is determined to be zero, indicating that the rudder motor is not under force;

7) Change the pulse width output of the steering gear controller to 0.8ms, record the "negative blocking torque force" displayed on the torsion meter and the current output of the power supply;

8) Change the power supply voltage of the servo and repeat steps 3 to 7.

Angle Test

Test equipment: rudder controller, Angle test stand

method of operation：

1) Set the steering gear power supply voltage;

2) The pulse width modulation of the rudder controller is 1.5ms. Connect the rudder to make the rudder stand still at the central position of the rudder;

3) The servo is fixed on the Angle test stand, and the pointer is accurate at 90 degrees;

4) The Angle of the steering gear is measured when the pulse width output of the steering gear controller is 0.8, 1.0, 1.5, 2.0 and 2.2ms

Pulse width 0.8, 1.0, 1.5, 2.0, 2.2

Angle 25±3, 45±3, 90±1, 135±3, 150±3

5) Change the power supply voltage of the servo and repeat steps 2 to 4.

6.3. Matters Need Attention

1. Operate in strict accordance with the test outline to ensure the safety and accuracy of the test process.

2 During the test process, detailed test data and observation results are recorded to provide basis for subsequent analysis and improveme-nt.

3 Pay attention to the abnormal situation in the test process, take timely measures to deal with it, and record relevant information.

4. After the test, a comprehensive inspection of the rudder motor is carried out to ensure that there is no damage or abnormal situation.

5. According to the test results, the performance of the rudder is evaluated and suggestions for improvement are put forward.

This test will comprehensively evaluate the performance of the rudder motor to ensure its reliable performance in practical application. At the same time, the test process will strictly comply with relevant regulations and precautions to ensure the safety and accuracy of the test.

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