SYSTEM DESIGN SPECIFICATION FOR RGME

BEIJING ENSONIC TECH CO., LTD.

Author: Li Shaoyang

March 2025

Contents

Abstract

Running Gear Monitoring Equipment (RGME) is a device used to Monitoring Running Gear's condition in real time. This device is equipped with multiple built-in microphones, which can accurately collect the acoustic signals information inside the train carriage. Through in-depth analysis of these acoustic signals, the acoustic fingerprint features of the running gear's rotating components (such as bearings and wheel treads) transmitted through the carriage can be successfully extracted.

By using advanced filtering algorithm,it can precisely strip the acoustic fingerprint features of the rotating components from the complex noise environment inside the carriage. By conducting a detailed and comprehensive analysis of these acoustic fingerprint features,real-time monitoring of the health status of bearings and wheel treads can be achieved. Compared with the traditional axle temperature monitoring technology solutions,this solution has significant advantages. It can initiate real time tracking of the health status of bearings and wheel treads as soon as early anomalies occur. By continuously and real-timely monitoring the health of the monitored targets over a long period, false alarms and misalarms can be effectively avoided, and strong support can be provided for predictive maintenance.

This document focuses on introducing the design specifications of the RGME system, covering aspects such as system architecture, component specifications, electrical schematic diagrams, mechanical design and installation, relevant safety design, and Man - Machine Interface (MMI) design.

1 Introduction

1.1 Background Introduction

Urban rail transit has many advantages such as large transportation capacity, high efficiency, low energy consumption, intensiveness, convenience for riding, safety and comfort, etc. It is an important way to solve the problem of urban traffic congestion, realize the adjustment of urban spatial layout and the balanced development of the city. Compared with high-speed railways, the train axle weight of urban rail transit is lighter and the operation speed is lower.

However, due to the influence of factors such as many small-radius curves, a large number of vibration-damping ballast beds, relatively low track smoothness standards, small train intervals, and frequent starting and stopping of trains, the interaction between the wheels and the rails is extremely intense, leading to frequent occurrence of faults such as wheel tread damage, abnormal bearing wear, and the rotating mechanism of the train running gear.

According to statistics, the faults of the running gear of urban rail trains in China (including axle box, gear box and traction motor bearing faults, transmission gear faults, and wheel tread damage) account for about 40 percent of the train faults. The wide application of vibration-damping ballast beds has made rail corrugation occur frequently, which has become an important challenge faced by urban rail transit operation departments and researchers. The resulting vibration and noise not only affect the physical and mental health and riding comfort of passengers, but also pose a major challenge to the safety of train operation and the normal operation of equipment.

1.2 Drawbacks of Traditional Solution

At present, in response to the faults of the train running gear, most urban rail trains in China are equipped with axle temperature detection devices. However, this method can only detect the axle temperature, and the parameter is single. Moreover, a significant temperature rise phenomenon will only occur when the bearing fault deteriorates to a certain extent, and early warning cannot be achieved.

Some developed cities such as Beijing, Shanghai, and Guangzhou have developed real-time monitoring systems for the running gear. These systems install composite sensors at the key parts of the bogie (such as the axle box, motor, gear box, etc.), and use relevant processors and diagnostic equipment to process and analyze multi-physical quantity signals such as vibration, impact, and temperature collected in real time. This significantly improves the real-time performance, accuracy, and stability of the fault detection of the running gear, and realizes the early warning of faults.

However, the installation of this system is relatively complex. It is necessary to make physical modifications to the detected components, and it involves a large number of cable connections, which increases the maintenance difficulty for operation and maintenance personnel. In addition, its high cost also limits

its widespread promotion.

1.3 Advantage of Acoustic Solution

Acoustic fingerprint recognition initially refers to the extraction and analysis of features from human acoustic signals to distinguish different speakers. Nowadays, researchers and engineers use acoustic fingerprint recognition technology to study the status of the detected objects and apply acoustic processing algorithms to the fault diagnosis and condition monitoring of equipment. When typical faults such as train bearing faults, wheel tread damage, and rail corrugation occur, obvious mechanical vibrations and noises with distinct characteristics will be generated.

In order to detect these faults in advance and determine their early-stage status, a specially designed on-board acoustic sensor array terminal can be installed on the vehicle body or inside the carriages to collect the acoustic signals generated by these faults. Combined with appropriate algorithms and acoustic fingerprint recognition technology, accurate identification of these faults can be achieved. Compared with traditional detection methods such as vibration and temperature detection, acoustic fingerprint recognition has the advantage of non-contact measurement. There is no need to make physical modifications to the detected components, and it will not affect the mechanical strength of the original structure. Moreover, it has a low cost, simple installation, and convenient maintenance.

By providing reliable operation data support, this technology can help the operation and maintenance department detect and eliminate faults in the early stages of faults, avoid the expansion and extension of typical faults, and is of great significance for ensuring the safety of train operation, improving riding comfort, reducing the workload of maintenance, and lowering operation and maintenance costs.

1.4 Document Organization

The document is organized as follows:

- Chapter 2: System Architecture
- Chapter 3: Working principle
- Chapter 4: Specifications of components
- Chapter 5: Electrical Schematic Diagrams
- Chapter 6: Mechanical Design and Installation
- Chapter 7: Safety Management Plan
- Chapter 8: Operational Harzard Log and Project Risk Register
- Chapter 9: Quality Plan

- Chapter 10: MMI Design
- Chapter 11: Complied Standards
- Chapter 12: Factory Test Report

2 System Architecture

2.1 System Overview

The system adopts a hierarchical architecture, which is mainly divided into the hardware layer, the driver layer, the operating system layer, the application layer and the Web layer.

- Hardware layer: includes microphones, signal processing modules, LED indicators, storage module and power supply units.
- Driver layer: includes drivers for microphones, control drivers, network drivers, storage drivers.
- Operating system layer: includes the operating system, firmware,network configurations and NTP services.
- Application layer: include two parts, one is the application program mainly for data acquisition, processing and storage, the other is the application program for web control.
- Web layer: includes the device configurations, device status, system log output, and storage management.

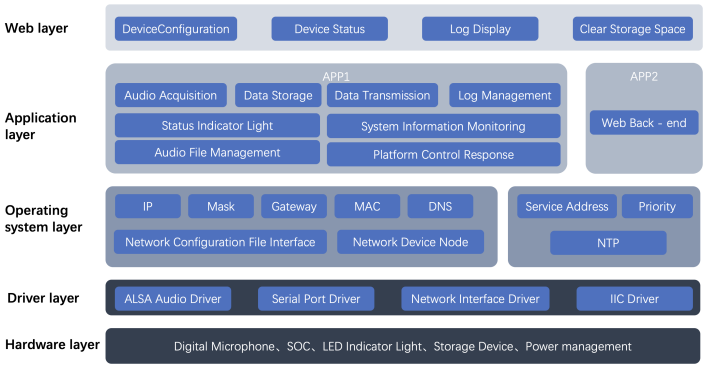


Figure 1: System Architecture Diagram

2.2 Working Flow

Working flow is shown in the following figure. When the RGME device

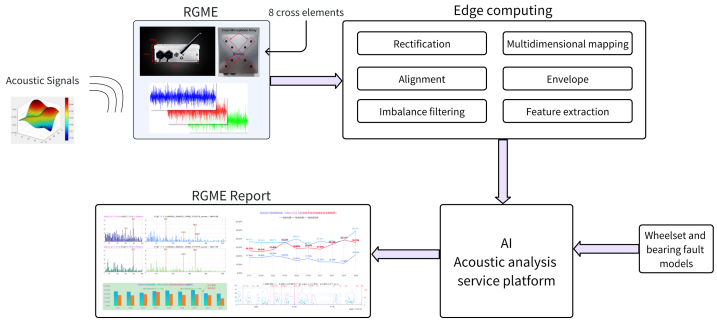


Figure 2: Working Flow Diagram

is powered on, it will automatically start the system and enter the working state. The device will automatically detect the microphone status, and if the microphone is not connected, it will automatically enter the self-check state. If the microphone is connected, it will enter the working state. The RGME device will continuously collect acoustic signals from the microphones, and after several edge compute functions process, the raw data can be transfered into preprocessed signal data, it will store them in the storage module.

The preprocessed data can be downloaded via the local web interface or the X-code interface. After download the data, the data can be transfered to ENSONIC's server for further analysis and processing. The detailed transfer way should be discussed later.

Because the RGME device could not connect to the train signal network bus, MTR should provide wheelset diameters and train speed record to generate reports.

2.3 Function Modules

1. Audio Signal Acquisition Module

   - Acquire audio data using ALSA library functions
   - Support for custom configuration of acquisition data channels
   - Can be codec configured, including phase adjustment, digital gain, gain calibration, high/low pass filters, etc.

2. Data Storage Module

   - Store the captured audio data as PCM and WAV format files
   - Configurable storage location (SD card, USB stick), storage data channel, and duration of a single storage file

- Support file size and storage space threshold management, automatically delete old files

3. Data transmission Module
   - Scaling PCM data into an agreed format (DSMQTT)***Not used in this project***
   - Upload data to the platform using the MQTT protocol ***Not used in this project***
   - Configurable MQTT protocol part parameters, data transmission network interface card, data packet size (interval), data channel ***Not used in this project***
4. Log Management Module
   - Record the system operation log, including audio acquisition, data storage, data transmission, platform control and other information
   - Support log level setting, log file size limit, log file management and other functions
5. Status Indication Module
   - Use LED indicators to display device status, including communication status, acquisition status, storage status, and working status
6. Platform Control Response Module
   - Receive control instructions issued by the platform, such as device status light control, audio data issued by the platform ***Not used in this project***
   - Execute the corresponding operation and return the execution result ***Not used in this project***
7. System Monitoring Module
   - Get real-time information about the system runtime, such as CPU usage, memory usage, storage space usage, device IP, etc
   - Log real-time information and upload it to the platform ***Not used in this project***
8. Web Module
   - Provides a web configuration page for easy device configuration and management
   - Provide device status and log display to facilitate users to view device status
   - Storage space management function to easily empty storage data
   - The front end uses HTML + Layui, and the back end uses Python 3.6 web.py framework

3 Working Principle

3.1 Rolling Bearing Fault Diagnosis Principle

Rolling bearings are one of the key components of the running part of the train. Good operation of the bearings is the premise to ensure the safe operation of the train. In order to ensure the safe and reliable operation of the train, it is essential to regularly check and maintain the bearings. The causes of rolling bearing failure are complex and diverse. Factors such as heavy loads, complex loads, excessive speed or acceleration, and extreme temperatures may all cause early failure. In addition, improper mechanical assembly and neglect of operating norms will also exacerbate this problem. The following is a brief analysis of the main types of failure of rolling bearings and their causes:

1. Wear: mainly caused by foreign body intrusion and insufficient lubrication. Wear usually occurs on the contact surface of the bearing inner ring, outer ring and rolling element, resulting in increased bearing clearance, decreased working accuracy and shortened service life, accompanied by increased vibration and noise.

2. Fatigue spalling: Rolling bearings are subjected to alternating loads for a long time, and cracks will occur between the rolling elements and the inner and outer rings, usually in the area of maximum shear force. As the bearing runs for more time, the cracks gradually expand, eventually leading to contact surface spalling, which in turn increases the impact load and the degree of failure.

3. Corrosion: The corrosion of rolling bearings mainly includes three types: chemical corrosion, electrical corrosion and micro-vibration corrosion. Chemical corrosion is caused by corrosive liquids, and electrical corrosion is caused by electric sparks generated by electric currents. The micro-vibration corrosion mainly occurs on the ferrule and is caused by small relative movements.

4. Plastic deformation: Dents or scratches on the surface of the rolling element and raceway due to overload, impact, improper installation or intrusion of hard objects. These defects can increase the impact load between the rolling element and the inner and outer rings, thereby aggravating the failure and causing plastic deformation of the bearing.

5. Fracture: When subjected to overload, the components of the rolling bearing may break, which in turn affects its normal operation. In addition, if there is a problem in the grinding, heat treatment or assembly process, the residual stress inside the component will increase, which will cause fracture.

6. Glue: When two metal surfaces adhere to each other, it is called gluing. The main reason is that the excess heat generated by the rolling bearing

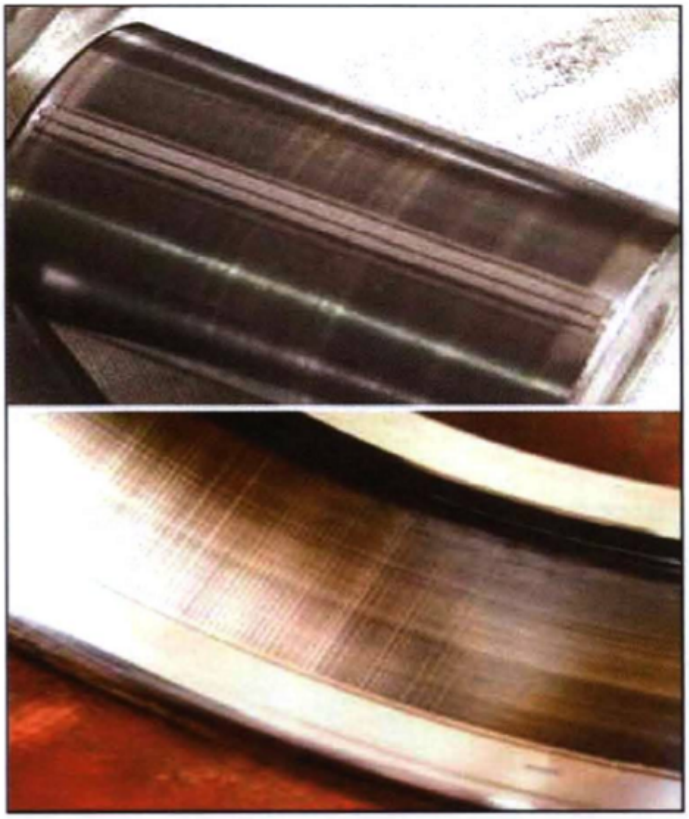


Figure 3: Bearing Scratch

cannot be dissipated in time, which is usually related to insufficient lubrication, high-speed movement or excessive load. Glue failures mostly occur between the cage and the rolling elements.

7. Cage damage: Improper assembly or overload can increase the friction between the cage and the rolling elements, causing the cage to deform, further causing friction to heat up, causing more failures, and even causing the rolling elements to get stuck, while increasing vibration and noise.

In the process of train running, the complex track environment, wheel-rail contact and other external excitation factors interact with the internal structural characteristics of the bearing, machining and assembly errors and potential failures, causing the vibration of the bearing.

During train operation, bearings are affected by uneven external forces. This imbalance of external forces, as well as changes in the number of rolling elements, can lead to periodic fluctuations in bearing carrying capacity, which can lead to vibration and noise. In addition, manufacturing errors or inconsistencies in the dimensions of bearing rolling elements can also lead to changes in support stiffness, which can be a potential factor in vibration generation. Irregularities in bearing surfaces, such as corrugations or bumps, can also cause random vibration.

During assembly, if the degree of fastening is not strictly controlled, too loose may cause the bearing to move in the axial direction, and too tight may cause local component deformation or changes in clearance, which can lead to periodic vibration. In addition, improper lubrication conditions can significantly affect the friction characteristics of bearings, which can lead to vibration and noise. During the operation of the bearing, any shock load may excite its natural vibration frequency, especially the natural frequency of the outer ring is relatively low, so it is most susceptible to excitation. When analyzing the frequency spectrum of vibration or acoustic signals, the natural frequency of the outer ring is usually particularly significant.

When there is a local defect in the bearing part, the collision between the rolling element and the inner and outer rings will produce an impact signal. This impact signal is significantly different from the vibration characteristics under normal working conditions, and the duration is extremely short. The impact frequency of each part is also different. This frequency is called the interval frequency of the local defect, which can reflect most of the fault conditions, so it is called the failure frequency of the bearing. In order to solve the problem of the failure frequency of the bearing, the following derivation can be made.

As shown in Figure 4, let the diameter of the bearing rolling element be d, the diameter of the bearing inner ring is D_i , the diameter of the bearing outer ring is D_o, the corresponding bearing middle diameter is D, the angular velocity of the outer ring is ω_o, the angular velocity of the inner ring is ω_i, and the contact angle between the rolling element and the inner ring raceway is α. According to the geometric relationship, the relationship between the diameter of the inner and outer rings of the bearing and the diameter of the rolling element can be deduced, as shown in the following formula:

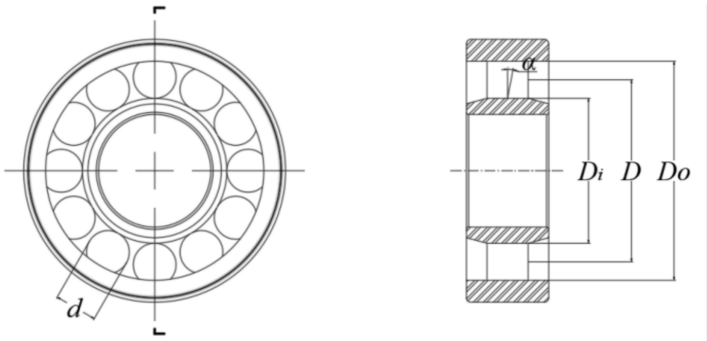


Figure 4: Bearing Structure Diagram

$$D_i = D - d\cos\alpha \tag{1}$$

$$D_o = D + d\cos\alpha \tag{2}$$

$$v_i = \frac{1}{2} \cdot w_i \cdot D_i \tag{3}$$

$$v_o = \frac{1}{2} \cdot w_o \cdot D_o \tag{4}$$

The linear speed of inside and outside scrolling is shown in the formula 3 and 4.

Assuming that the rolling element rolls purely in the raceway, and the rotational speed of the cage is the average of the rotational speed of the inner ring and the outer ring, the rotational linear speed of the cage is as shown in the formula 5.

$$v_c = \frac{1}{4}[\omega_b(D - d\cos a) + \omega_\omega(D + d\cos a)] \tag{5}$$

According to the formula 5, the angular velocity of the cage can be obtained as shown in the formula 6.

$$w_c = \frac{1}{2}\left[\omega_b\left(1 - \frac{d}{D}\cos a\right) + \omega_\omega\left(1 + \frac{d}{D}\cos a\right)\right] \tag{6}$$

Since $\omega = 2\pi f$, the rotation frequency of the cage is as shown in the formula 6.

$$f_c = \frac{1}{2}\left[f_i\left(1 - \frac{d}{D}\cos a\right) + f_o\left(1 + \frac{d}{D}\cos a\right)\right] \tag{7}$$

If the outer ring is fixed, then $f_o = 0$, so the formula 7 can be reduced to the formula 8.

$$f_c = \frac{1}{2} f_i \left(1 - \frac{d}{D}\cos a\right) \tag{8}$$

Formula 8 is also the rotation frequency of the cage relative to the outer ring. The rotation frequency of the cage relative to the inner ring is shown in Formula 9.

$$f_\alpha = f_i - f_c = \frac{1}{2} f_i \left(1 + \frac{d}{D}\cos a\right) \tag{9}$$

The rotation frequency of the roller is shown in the formula 10.

$$f_{bt} = f_{ci}\frac{D_i}{d} = \frac{1}{2} f_i \frac{D}{d}\left[1 - \left(\frac{d}{D}\cos a\right)^2\right] \tag{10}$$

The rotation of the cage relative to the inner ring causes the rolling elements to pass n times at the same contact point of the inner ring, where n represents the total number of rolling elements. The failure frequency of the bearing can be deduced by multiplying the relative rotation frequency of the component by the number of times it has passed. In the case of the inner ring rotating and the outer ring stationary, the rotation frequency of the bearing is the same as the rotation frequency of the inner ring. According to formula 11, the failure frequency of the outer ring of the rolling bearing can be calculated:

$$f_o = \frac{1}{2} \cdot \frac{r}{60} \cdot n \cdot \left(1 - \frac{d}{D}\cos a\right) \tag{11}$$

The calculation of the failure frequency of the inner ring of the rolling bearing is shown in the formula 12.

$$f_i = \frac{1}{2} \cdot \frac{r}{60} \cdot n \cdot \left(1 + \frac{d}{D}\cos a\right) \tag{12}$$

The calculation of the failure frequency of rolling bearings and rolling elements is shown in the formula 13.

$$f_b = \frac{1}{2} \cdot \frac{r}{60} \cdot \frac{D}{d} \cdot \left(1 - \left(\frac{d}{D}\right)^2 \cdot \cos^2 a\right) \tag{13}$$

The failure frequency calculation of the friction between the rolling bearing cage and the outer ring is shown in the formula 14.

$$f_{co} = \frac{1}{2} \cdot \frac{r}{60} \cdot \left(1 - \frac{d}{D}\cos a\right) \tag{14}$$

The failure frequency calculation of the friction between the rolling bearing cage and the inner ring is shown in the formula 15.

$$f_{ci} = \frac{1}{2} \cdot \frac{r}{60} \cdot \left(1 + \frac{d}{D}\cos a\right) \tag{15}$$

Table 1: Rolling Bearing Fault Characteristic Ratio Calculation Formula

Feature Order Ratio	Formula
Outer ring fault characteristic order ratio O_o	$\frac{n}{2} \cdot \left(1 - \frac{d}{D}\cos\alpha\right)$
Inner ring fault characteristic order ratio O_i	$\frac{n}{2} \cdot \left(1 + \frac{d}{D}\cos\alpha\right)$
Rolling element fault characteristic order ratio O_b	$\frac{n}{2} \cdot \left(1 - \left(\frac{d}{D}\right)^2 \cos^2\alpha\right)$
Cage friction fault characteristic order ratio O_c	$\frac{1}{2} \cdot \left(1 \pm \frac{d}{D}\cos\alpha\right)$

In the formulas 11 to 15:

- f_o is the failure frequency of the outer ring of the rolling bearing (Hz);
- f_i is the failure frequency of the inner ring of the rolling bearing (Hz);
- f_b is the failure frequency of the rolling element of the rolling bearing (Hz);
- f_{co} and f_{ci} is the failure frequency of the friction between the rolling bearing cage and the outer ring (Hz);
- r is the rotational speed of the rolling bearing (r/min);
- n is the number of rolling elements of the bearing;
- d is the diameter of the rolling element of the bearing (mm);
- D is the diameter of the rolling bearing pitch circle (mm);
- α is the contact angle of the rolling element.

In order to solve the interference of non-stationary signal frequency conversion on fault frequency under variable speed conditions, ENSONIC research team use the fault characteristic order ratio to characterize the fault frequency characteristics. Compared with the traditional fault frequency calculation formula, the calculation method of the fault characteristic order ratio is simpler, and there is no need to introduce the independent variable of frequency conversion. For the specific calculation formula, please refer to the table 12.

3.2 Wheel Tread Fault Diagnosis Principle

As an important driving part of a vehicle, the health of wheels is directly related to the safety and efficiency of operation. Due to the operational characteristics such as fast start, frequent braking and start-stop, and poor track line status, the wheel tread of trains is at risk of various failures. The common forms of train wheel tread damage are local wheel damage such as flat scar and peeling, and full-circumferential wheel damage such as pit wear and wheel polygon. In addition to this, it also includes defects such as trauma, delamination, collapse, etc. The impact of these damages on the dynamic response of wheels and rails is similar to that of local wheel damage.

Tread failure not only exacerbates the wear and tear of the moving parts of the vehicle, but also induces vibration and noise problems, which affect the comfort of passengers. In some cases, wheel tread failure may also cause excessive local loads, resulting in unstable operation and increased safety risks. In addition, uneven tread wear can also affect the dynamic characteristics of the wheelset, increasing the dynamic wheel weight and accelerating the wear of the track structure.

Wheel thread out of roundness involves a variety of factors, such as the irregular initial shape of the wheel and the vibration excitation of the wheel and rail during long-term operation. The out of roundness can be divided into two types: partial out of roundness and full-circumference out of roundness. The partial out of roundness refers to the appearance of some radial defects on the wheel tread, such as scratches or peeling. The full-circumference out of roundness is mainly manifested as the wheel polygon, that is, the wheel radius changes periodically on the entire circumference.

When the train is running, the contact between the normal wheel tread and the rail will generate low-frequency and relatively stable noise; conversely, when the irregular wheel passes through the rail, it will cause abnormal impact vibration noise with different periodicity. Therefore, by analyzing the characteristics of the noise acoustic signal, potential causes of wheel roundness can be identified.

Scratches and peeling are common tread failures.Figure 5 is a schematic diagram of the faulty wheel running.

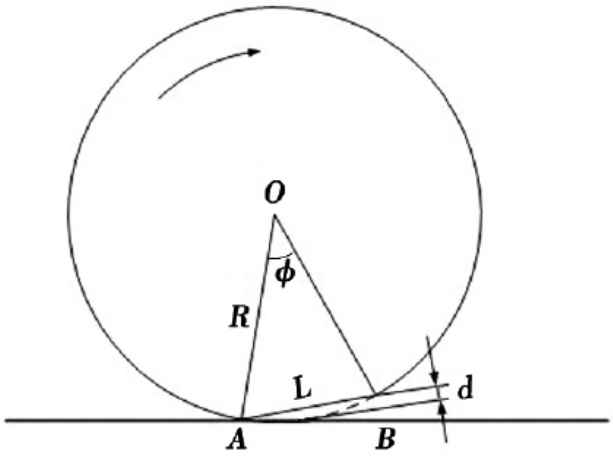


Figure 5: Wheel Rolling Schematic Diagram

At low speed, when the wheel rolls to the starting point A of the abrasion, it rotates with point A as the center of the circle and the length L of the abrasion as the radius until the entire abrasion surface touches the track. When all the abrasion surfaces hit the rail, the wheel will continue to rotate at the center of

the abrasion termination point B, thus applying additional power to the track until the wheel returns to normal rotation.

At high speed, the wheel will detach from the rail surface after reaching point A, rotate in the air and move forward inertia, and finally contact the track at point B, resulting in a certain amplitude of impact. When the time required for the wheel to move from state A to state B is equal to the time required for the wheel center to fall, the speed reaches the critical state of wheel-rail impact.

During driving, if only a single fault exists, the impact frequency of the track will be equal to the rotation frequency of the wheel, $f = V_c/2\pi R$ (f is the impact frequency, V_c is the running speed, R is the wheel radius). When the running speed is V_c less than the critical speed, the impact time t_r between the tread and the rail, the vertical impact speed is v_0.

$$t_r = \frac{L}{v_c} \approx \frac{2\sqrt{2Rd}}{v_c} \tag{16}$$

$$v_0 = v_c \sin\frac{\phi}{2} \approx v_c \frac{1}{2}\frac{L}{R} \approx v_c \frac{\sqrt{2Rd}}{R} \tag{17}$$

The impact mechanical kinetic energy generated during the impact process is.

$$E_M = \frac{1}{2}Mv_0^2 = Mv_c^2\frac{d}{R} \tag{18}$$

Where M is the mass of the wheel, d is the depth of the abrasion.

When the running speed V_c is greater than the critical speed, the impact time t_r and vertical impact speed v_0 between the tread and the rail are:

$$t_r = \frac{L}{v_c + \sqrt{\mu R}} \approx \frac{2\sqrt{2Rd}}{v_c + \sqrt{\mu R}} \tag{19}$$

$$v_0 = \frac{\mu L}{v_c + \sqrt{\mu R}} \approx \frac{2\mu\sqrt{2Rd}}{v_c + \sqrt{\mu R}} \tag{20}$$

$$\mu = \frac{M_1 + M_2}{M_2} g \tag{21}$$

Where M_1 is the sprung mass, M_2 is the unsprung mass, and g is the acceleration of gravity.

The impact mechanical kinetic energy generated during the impact process is:

$$E_M = \frac{1}{2}Mv_0^2 = 4M\frac{\mu^2 Rd}{(v_c + \sqrt{\mu R})^2} \tag{22}$$

According to the above analysis, tread failure will cause periodic vibration and shock between the wheel and the track. As the running speed increases, the impact effect between the wheel and the track will also increase. At the critical speed, the impact effect reaches its maximum value, after which it will gradually weaken and eventually stabilize.

The wheel polygon is a manifestation of the irregular shape of the wheel, which can be mathematically modeled by summing the harmonic waves of different orders. Theory and practice show that the order of the wheel polygon is usually between 1 and 20. In most cases, the wheel polygon is dominated by one of the orders.

When the train is running, if there is a wheel polygon, there will be a periodic dynamic force between the wheels and rails, resulting in shock and vibration of the wheel-rail system, which will significantly affect the stability and durability of the vehicle and other components of the rail system.

The first-order wheel polygon, that is, the eccentricity of the wheel, is a typical harmonic excitation. Due to the action of centrifugal excitation, the wheel-rail system will produce periodic forced vibration, and the cycle of the wheel-rail force change is roughly equivalent to the time it takes for the wheel to complete a week.

The second-order wheel polygon shows the elliptical shape of the wheel, and the period of wheel-rail force change is about half of the time of wheel rolling. By analogy, the existence of wheel polygon will affect the vibration and radiation noise of the vehicle during operation, which will lead to the generation of periodic pulse and impact frequency. Impact frequency $f = nV_c/2\pi R$ (n is the order of wheel polygon).

4 Specifications of components

4.1 RGME Device

The RGME device specifications are shown in the table 2.

Table 2: RGME Device Specifications

Class	Name	Specifications
Acoustic	Microphone	8
	Frequency Response Range	25Hz-22KHz(±3dB ref 1kHz)
	Sensitivity	-37dBFs @1000Hz
	Dynamic Range	28dBA to 120dBA
	Sampling Rate	⩽ 48KHz
	SNR	66dBA @ 1kHz
	THD	130.5dB @ 1kHz : 1% THD
Hardware	OS	Linux embedded
	CPU	ARM Cortex-A53
	RAM	1GB
	eMMC	8GB
	Storage	up to 256GB
Power	Power Supply	DC12V
	Power Consumption	⩽ 8W
Interface	Data	USB2.0 & TF card
	Ethernet	10/100/1000Mbps POE supported
	Power Interface	DC12V & POE 48V
Others	Operating Temperature	-40°C to 70°C
	Matrial	Aluminum alloy
	Size	160mm × 145mm × 55mm
	Weight	0.9kg
	Protection Level	IP66

4.2 Power Module

The power module specifications are shown in the table 3.

4.3 Battery Module

The battery module specifications are shown in the table 4.

Table 3: Power Module Specifications

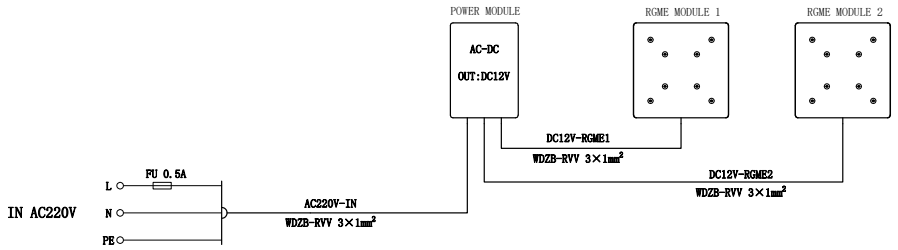
Name	Specifications
Size	140mm × 100mm × 50mm
Weight	0.97kg
Power Input	AC 220V
Power Output	DC 12V
Total Reserve Power	≈ 225W

Table 4: Battery Module Specifications

Name	Specifications
Size	140mm × 100mm × 50mm
Weight	***TBA***
Power Output	DC 12V
Total Battery Capacity	12V 9600mAh

5 Electrical Schematic Diagrams

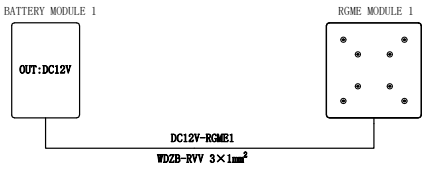
5.1 Power Module Schematic Diagram

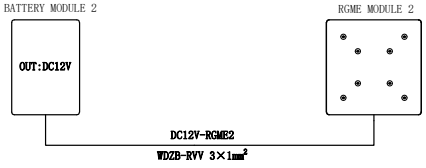


RGME MODULE 1: DC12V/8W
RGME MODULE 2: DC12V/8W
POWER MODULE: 225W(IN: AC 85V-264V ; OUT: DC 12V)

DRAWING NAME	RGME ELECTRICAL SCHEMATIC DIAGRAM			
DRAWING NUMBER				
	REV.	DESIGNED BY	REVIEWED BY	APPROVED BY
	TOTAL PAGES		PAGE	

5.2 Battery Module Schematic Diagram





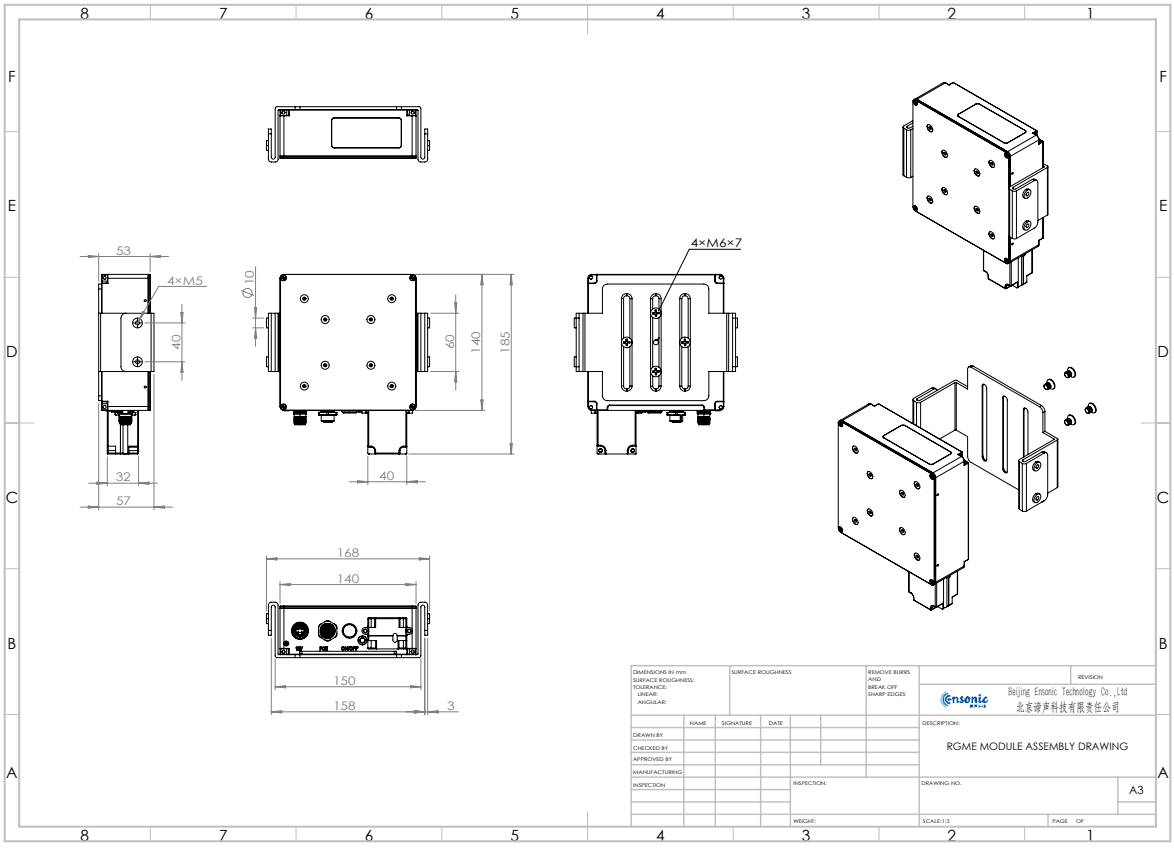
RGME MODULE 1: DC12V/8W
RGME MODULE 2: DC12V/8W
BATTERY MODULE: DC12V/9600mAh

DRAWING NAME	RGME ELECTRICAL SCHEMATIC DIAGRAM			
DRAWING NUMBER				
	REV.	DESIGNED BY	REVIEWED BY	APPROVED BY
	TOTAL PAGES		PAGE	

6 Mechanical Design and Installation

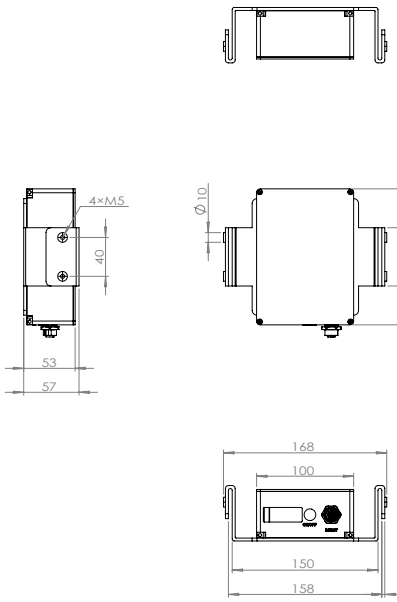
6.1 Mechanical Design

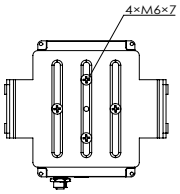
6.1.1 RGME Device

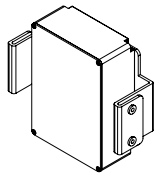


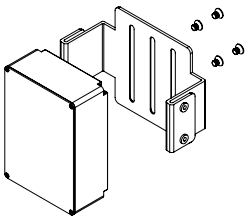
DIMENSIONS IN mm SURFACE ROUGHNESS: TOLERANCE: LINEAR: ANGULAR:	SURFACE ROUGHNESS			REMOVE BURRS AND BREAK OFF SHARP EDGES		REVISION
	NAME	SIGNATURE	DATE			Ensonic Beijing Ensonic Technology Co.,Ltd 北京诺声科技有限责任公司
DRAWN BY						DESCRIPTION: RGME MODULE ASSEMBLY DRAWING
CHECKED BY						
APPROVED BY						
MANUFACTURING						
INSPECTION				INSPECTION:		DRAWING NO. A3
				WEIGHT:		SCALE:1:3 PAGE OF

6.1.2 Battery Module



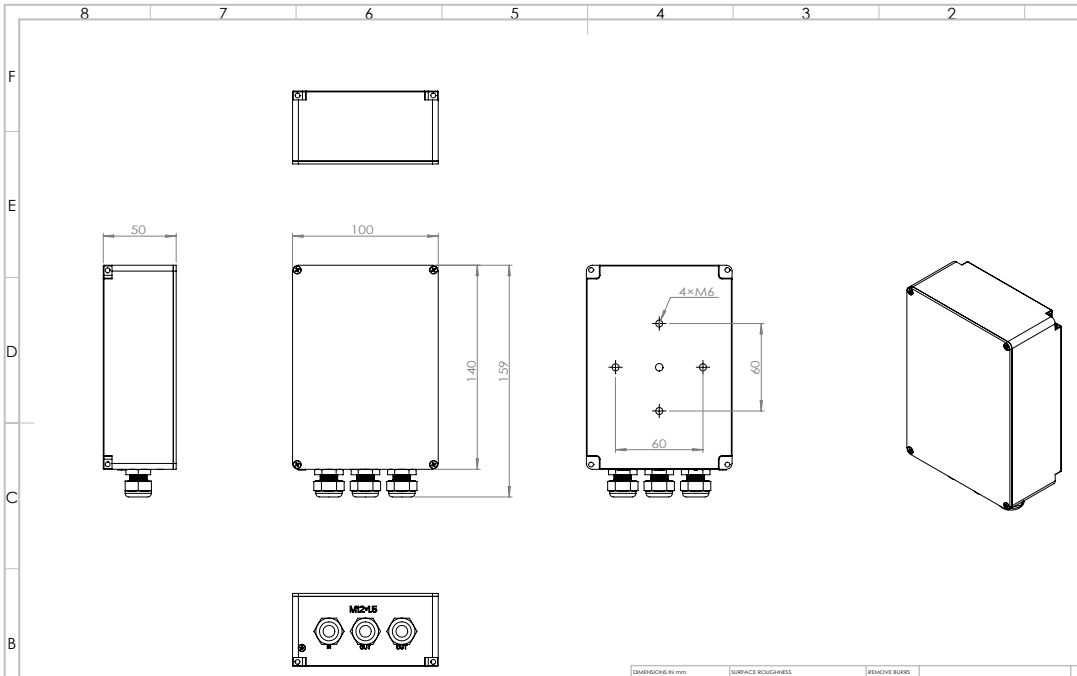






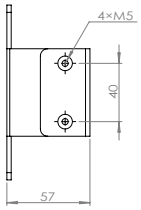
DIMENSIONS IN mm SURFACE ROUGHNESS: TOLERANCE: LINEAR: ANGULAR:		SURFACE ROUGHNESS		REMOVE BURRS AND BREAK OFF SHARP EDGES		REVISION	
	NAME	SIGNATURE	DATE			Beijing Ensonic Technology Co.,Ltd 北京诺声科技有限责任公司	
DRAWN BY						DESCRIPTION:	
CHECKED BY						BATTERY MODULE ASSEMBLY DRAWING	
APPROVED BY							
MANUFACTURING							
INSPECTION				INSPECTION:		DRAWING NO.	A3
				WEIGHT:		SCALE:1:3	PAGE OF

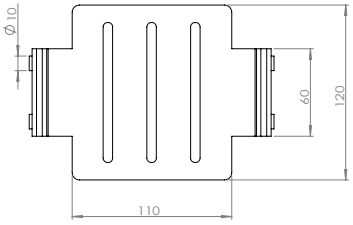
6.1.3 Power Module

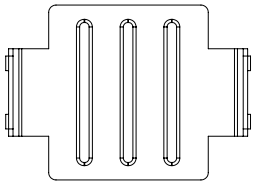


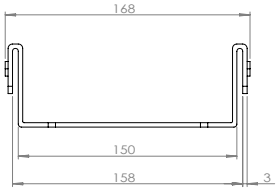
DIMENSIONS IN mm SURFACE ROUGHNESS: TOLERANCE: LINEAR: ANGULAR:	SURFACE ROUGHNESS		REMOVE BURRS AND BREAK OFF SHARP EDGES		REVISION
				Ensonic	Beijing Ensonic Technology Co.,Ltd 北京诺声科技有限责任公司
	NAME	SIGNATURE	DATE	DESCRIPTION:	
DRAWN BY				POWER MODULE	
CHECKED BY					
APPROVED BY					
MANUFACTURING					
INSPECTION			INSPECTION:	DRAWING NO.	A3
			WEIGHT:	SCALE:1:2	PAGE OF

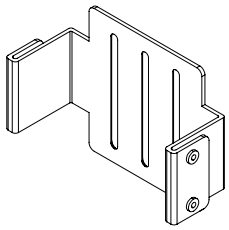
6.1.4 Installation Mounting











DIMENSIONS IN mm SURFACE ROUGHNESS: TOLERANCE: LINEAR: ANGULAR:		SURFACE ROUGHNESS		REMOVE BURRS AND BREAK OFF SHARP EDGES		REVISION	
	NAME	SIGNATURE	DATE			Beijing Ensonic Technology Co.,Ltd 北京诺声科技有限责任公司	
DRAWN BY						DESCRIPTION:	
CHECKED BY						MODULE MOUNT	
APPROVED BY							
MANUFACTURING							
INSPECTION			INSPECTION:			DRAWING NO.	A3
			WEIGHT:			SCALE:1:2	PAGE OF

6.2 Installation with Battery Module

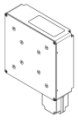
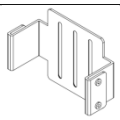
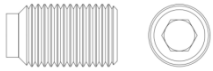
6.2.1 Installation Tools

Table 5: Tool list

Name	Usage	quantity
Torque wrench	Tighten the bolts to the correct torque	1
Scew driver	Assemble equipment mountings and plugs	1
Markpen	Screw anti-loose mark	1

6.2.2 Installation Equipment and Accessories

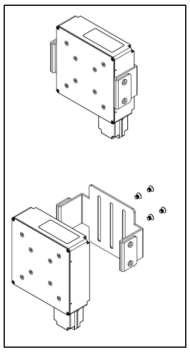
Table 6: Equipment and Accessories List

Sample Picture	Name/Model	Quantity
	RGME Module	2
	Battery Module	2
	Installation Mounting	2
	M6 × 7 cross countersunk head screw	16
	M5 × 8 304 stainless steel POM nylon tip bolt	16
Working in Progress	Power Cable for Battery with WDZB-RVV 3*1mm^2	2

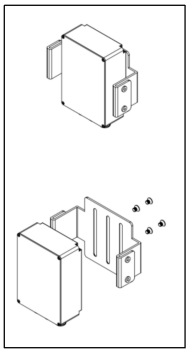
6.2.3 Pre-installation Preparation

1. Onsite installation position confirmation, RGME module and Power/Battery module are installed on the back of the decorative panel of the car near to Door 1 and Door 5 on the same side.

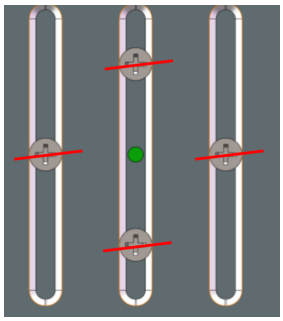
2. Select the RGME module and Installation Mounting from the equipment list, and fix them with M6 × 7 cross countersunk head screw. The relative position can be adjusted up and down according to the mutual influence of the actual installation positions on site.



3. Select the Battery module and Installation Mounting from the equipment list, and fix them with M6 × 7 cross countersunk head screw. The relative position can be adjusted up and down according to the mutual influence of the actual installation positions on site.

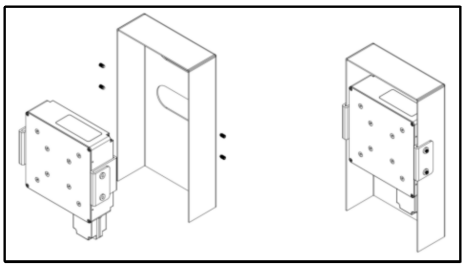


4. Tighten the screws with a torque of 10 N·m, and use a marker pen to draw a line as a mark to prevent loosening.



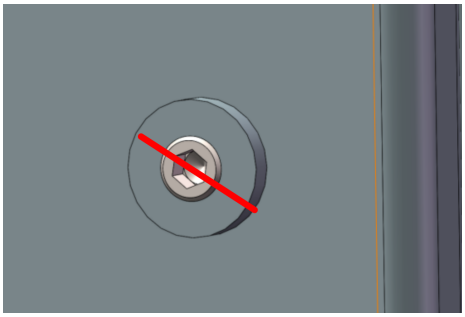
6.2.4 Installation on Car

1. Pick up the RGME module with the mounting, put it into the dedicated position inside the structure beam on car behind the decoration panel near door 1.



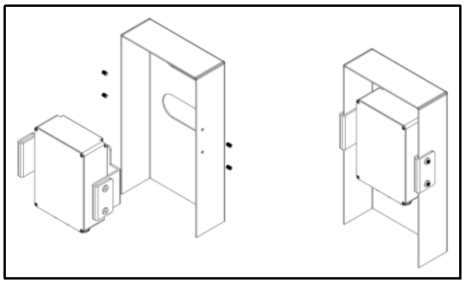
2. Screw it with M5 × 8 304 stainless steel POM nylon tip bolt to the structure beam, and tighten it with a torque of 6.5 N·m.

3. Use a marker pen to draw a line as a mark to prevent loosening.



4. Pick up the Battery module with the mounting, put it into the dedicated position inside the structure beam on car behind the decoration panel near

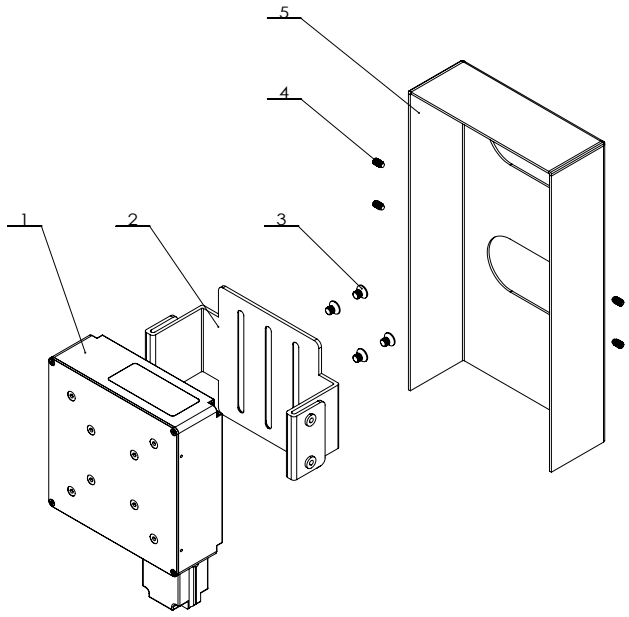
door 1. And also screw it with the same torque and line mark it.

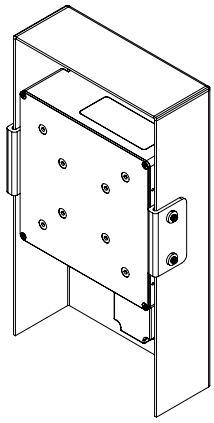


5. Connect the power cable to the RGME module and Battery module.

6. Repeat the above steps for the installation of RGME module and Battery module on the other side of the car.

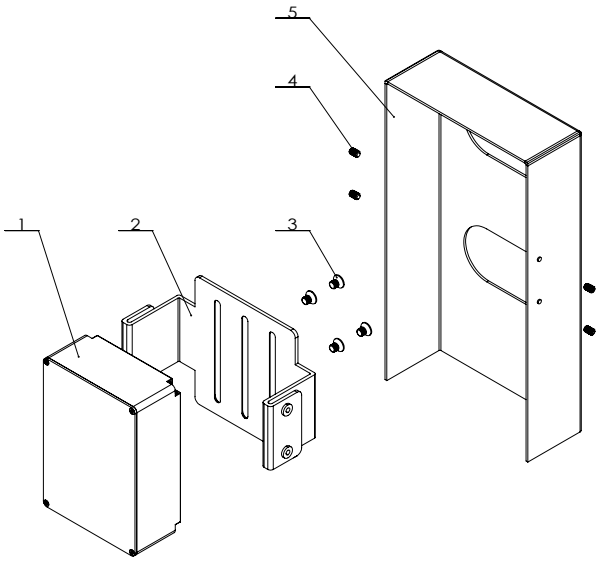
7. When tightening all the screws, use Loctite 222 thread locking adhesive to prevent the screws from loosening.

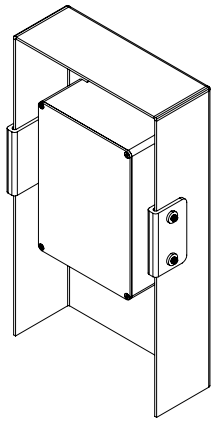




1. RGME Module
2. Installation Mounting
3. M6x7 cross countersunk head screw
4. 304 stainless steel POM nylon tip bolt M5x8
5. Structure Beam on Train

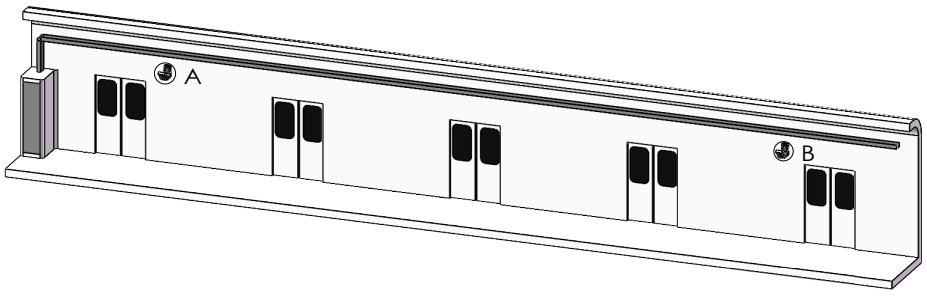
DIMENSIONS IN mm SURFACE ROUGHNESS: TOLERANCE: LINEAR: ANGULAR:		SURFACE ROUGHNESS			REMOVE BURRS AND BREAK OFF SHARP EDGES		REVISION
						Ensonic	Beijing Ensonic Technology Co.,Ltd 北京谛声科技有限责任公司
	NAME	SIGNATURE	DATE				DESCRIPTION:
DRAWN BY							
CHECKED BY							
APPROVED BY							
MANUFACTURING							
INSPECTION				INSPECTION:			DRAWING NO. A3
WEIGHT:						SCALE:1:3	PAGE OF

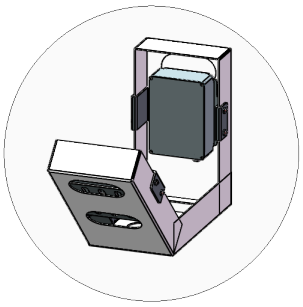




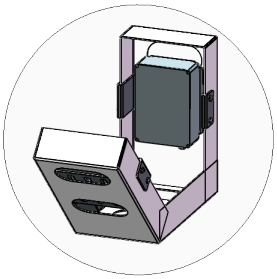
1. Battery Module
2. Installation Mounting
3. M6x7 cross countersunk head screw
4. 304 stainless steel POM nylon tip bolt M5x8
5. Structure Beam on Train

DIMENSIONS IN mm SURFACE ROUGHNESS: TOLERANCE: LINEAR: ANGULAR:		SURFACE ROUGHNESS		REMOVE BURRS AND BREAK OFF SHARP EDGES		REVISION	
						Ensonic 恩声士	Beijing Ensonic Technology Co.,Ltd 北京谛声科技有限责任公司
	NAME	SIGNATURE	DATE			DESCRIPTION:	
DRAWN BY							
CHECKED BY							
APPROVED BY							
MANUFACTURING							
INSPECTION				INSPECTION:		DRAWING NO.	A3
				WEIGHT:		SCALE:1:3	PAGE OF





A
1 : 5



B
1 : 5

DIMENSIONS IN mm SURFACE ROUGHNESS: TOLERANCE: LINEAR: ANGULAR:		SURFACE ROUGHNESS		REMOVE BURRS AND BREAK OFF SHARP EDGES		REVISION	
	NAME	SIGNATURE	DATE			Ensonic Beijing Ensonic Technology Co.,Ltd 北京诺声科技有限责任公司	
DRAWN BY						DESCRIPTION:	
CHECKED BY							
APPROVED BY							
MANUFACTURING							
INSPECTION				INSPECTION:		DRAWING NO.	A3
				WEIGHT:		SCALE:1:70	PAGE OF

6.3 Installation with Power Module

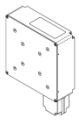
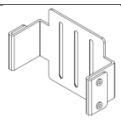
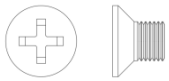
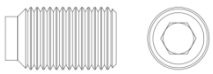
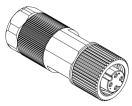
6.3.1 Installation Tools

Table 7: Tool list

Name	Usage	quantity
Torque wrench	Tighten the bolts to the correct torque	1
Scew driver	Assemble equipment mountings and plugs	1
Wire stripper	Strip the power cable	1
Crimping plier	Crimp the power cable with the cable gland	1
Diagonal plier	Cut the power cable	1
Electric soldering iron	Solder the power cable	1
Solder wire	Solder the power cable	1
Soldering flux	Solder the power cable	1
Heat gun	Heat shrink the power cable protection	1
Markpen	Screw anti-loose mark	1

6.3.2 Installation Equipment and Accessories

Table 8: Equipment and Accessories List

Sample Picture	Name/Model	Quantity
	RGME Module	2
	Power Module	2
	Installation Mounting	2
	M6 × 7 cross countersunk head screw	16
	M5 × 8 304 stainless steel POM nylon tip bolt	16
	Power Cable WDZB-RVV 3*1mm^2	30 meters
	A-code Plug	2
	Plug for AC220V	1
	X-code Plug for read data from RGME offline	1
	∅ 3mm Heat shrink tube	0.5 meters
	Cable protection tube	30 meters

6.3.3 Pre-installation Preparation

1. Onsite installation position confirmation, RGME module and Power/Battery module are installed on the back of the decorative panel of the car near to Door 1 and Door 5 on the same side.

2. Confirm the AC220V power socket position.

3. Verify the cable laying path and the grooves involved in the cable laying path, and measure and estimate the length of each cable.

   (a) The cable length from the power socket to the Power module.

   (b) The cable length from the Power module to the RGME module 1.

   (c) The cable length from the Power module to the RGME module 2.

4. Intercept the cable according to the measured length and paste the cable labels.

5. Cable protection measures: intercepted cable cover black cable protection tube.

6. Use scew driver to open the Power module cover, insert the corresponding cable from the gland hole and follow the instructions below to connect to the power connector.

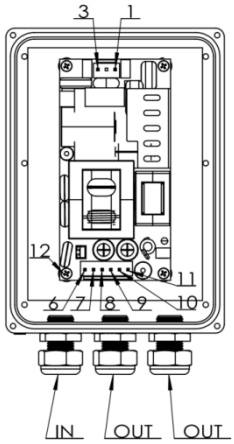


Figure 6: inside view of Power module

Table 9: Power module pin definition

PIN No.	Function	Core Color	Descrption
1	AC-N	RED	AC220V power supply input, cable through the IN gland
3	AC-L	BLACK	AC220V power supply input, cable through the IN gland
6,7,8	DC12V-	BLACK	DC12V power supply output, 2 cables through the OUT glands, seperatedly supply to 2 RGME module
9,10,11	DC12V+	RED	DC12V power supply output, 2 cables through the OUT glands, seperatedly supply to 2 RGME module
12	PE	WHITE	PE cable, 3 cables all connect to PIN 12

7. According to the above table, connect the power cable to the Power module. The power cable is connected to the Power module through the IN gland hole, and the other end is connected to the AC220V power socket. The RGME modules are connected to the Power module through the OUT gland holes.

8. According to the above table, connect the power cable to the A-code plug. Detailed connection method is as shown in the figure below.

Table 10: A-code Plug pin definition

PIN No.	Function	Core Color
1	DC12V+	RED
2	DC12V-	BLACK
3	PE	WHITE
4	NC	

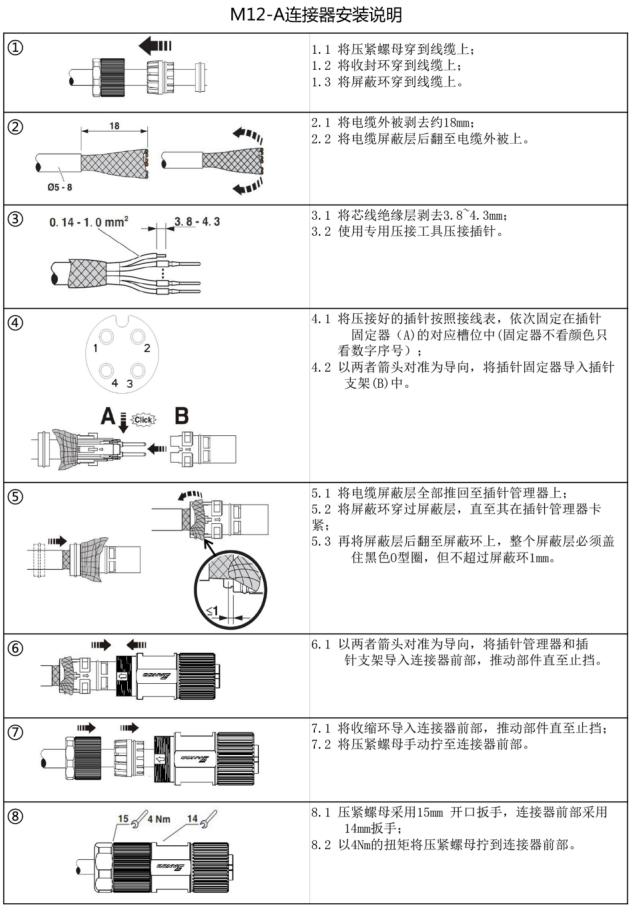


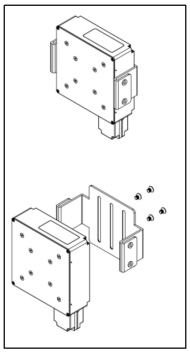
Figure 7: A-code plug connection

Table 11: A-code Plug pin definition

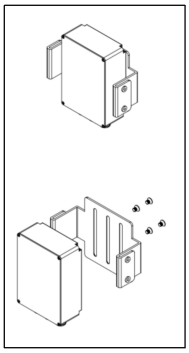
PIN No.	Function	Core Color
L	L	RED
N	N	BLACK
E	PE	WHITE

9. Lay the Power cable from the power socket to the Power module, after the cable is laid, wiring the cable with the plug according to the pins definition above.

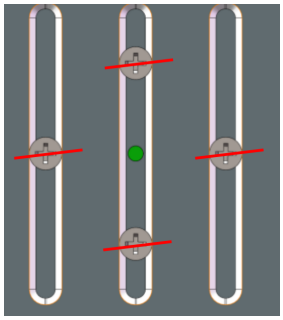
10. Select the RGME module and Installation Mounting from the equipment list, and fix them with M6 × 7 cross countersunk head screw. The relative position can be adjusted up and down according to the mutual influence of the actual installation positions on site.



11. Select the Power module and Installation Mounting from the equipment list, and fix them with M6 × 7 cross countersunk head screw. The relative position can be adjusted up and down according to the mutual influence of the actual installation positions on site.

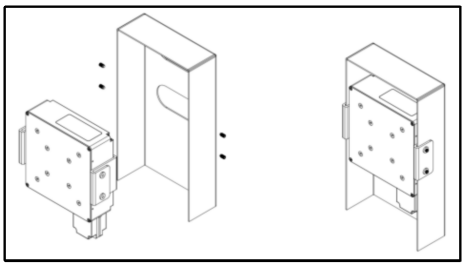


12. Tighten the screws with a torque of 10 N·m, and use a marker pen to draw a line as a mark to prevent loosening.



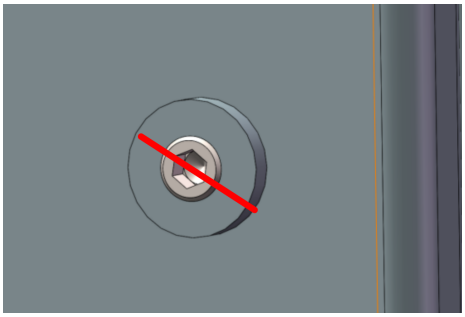
6.3.4 Installation on Car

1. Pick up the RGME module with the mounting, put it into the dedicated position inside the structure beam on car behind the decoration panel near door 1.

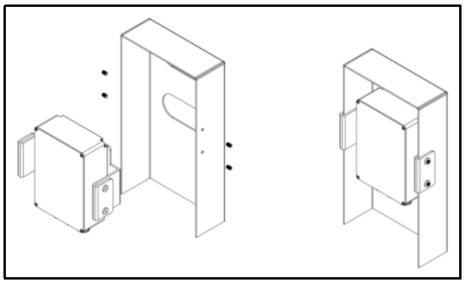


2. Screw it with M5 × 8 304 stainless steel POM nylon tip bolt to the structure beam, and tighten it with a torque of 6.5 N·m.

3. Use a marker pen to draw a line as a mark to prevent loosening.



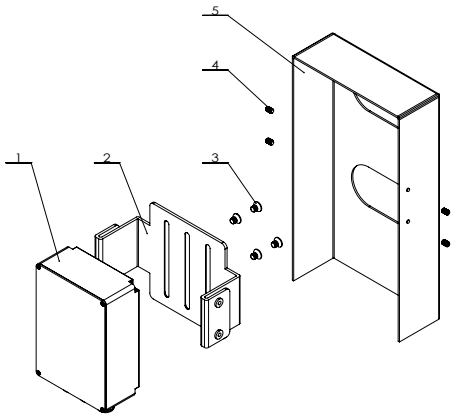
4. Pick up the Power module with the mounting, put it into the dedicated position inside the structure beam on car behind the decoration panel near door 1. And also screw it with the same torque and line mark it.

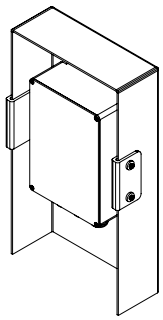


5. Connect the power cable from the Power module to the RGME module 1.

6. Repeat the above steps for the other side of the car's module 2.

7. When tightening all the screws, use Loctite 222 thread locking adhesive to prevent the screws from loosening.





1. Power Module
2. Installation Mounting
3. M6x7 cross countersunk head screw
4. 304 stainless steel POM nylon tip bolt M5x8
5. Structure Beam on Train

DIMENSIONS IN mm SURFACE ROUGHNESS: TOLERANCE: LINEAR: ANGULAR:	SURFACE ROUGHNESS			REMOVE BURRS AND BREAK OFF SHARP EDGES		REVISION
	NAME	SIGNATURE	DATE			DESCRIPTION:
DRAWN BY						
CHECKED BY						
APPROVED BY						
MANUFACTURING						
INSPECTION				INSPECTION:		DRAWING NO. A3
				WEIGHT:		SCALE:1:3 PAGE OF

Ensonic 声动
Beijing Ensonic Technology Co.,Ltd
北京动声科技有限责任公司

6.3.5 Cable Laying and Protection

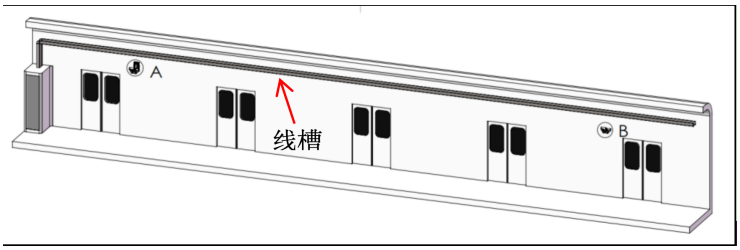
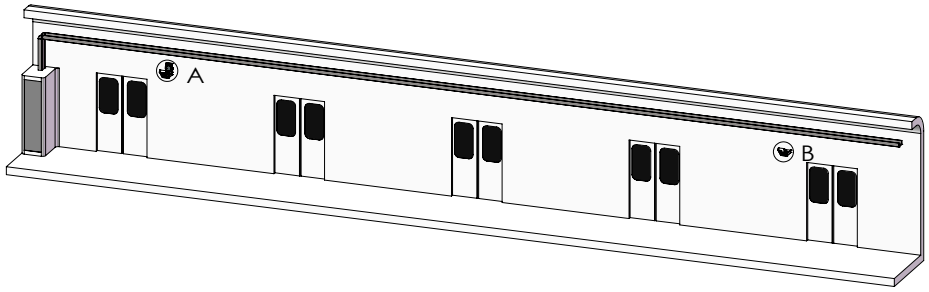
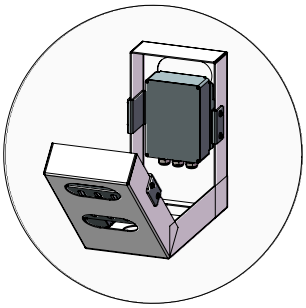


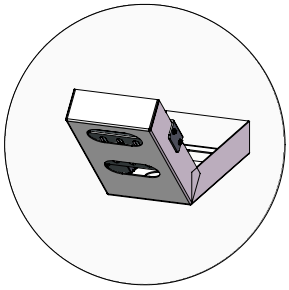
Figure 8: Cable laying diagram

1. The cable from the power socket to the Power module of A-side is AC220V, and the cable should be laid in a wire groove.
2. The output cable of the A-side Power module is DC12V, one is connected to the A-side RGME module 1 nearby, and the other is laid to the B-side RGME module through the wire groove.
3. Label both ends of the cable.
4. Cables that do not enter the slot should be tied evenly at intervals of 150mm-250mm.





A
1 : 5



B
1 : 5

DIMENSIONS IN mm SURFACE ROUGHNESS: TOLERANCE: LINEAR: ANGULAR:		SURFACE ROUGHNESS		REMOVE BURRS AND BREAK OFF SHARP EDGES		REVISION	
	NAME	SIGNATURE	DATE			Ensonic Beijing Ensonic Technology Co.,Ltd 北京诺声科技有限责任公司	
DRAWN BY						DESCRIPTION:	
CHECKED BY							
APPROVED BY							
MANUFACTURING							
INSPECTION				INSPECTION:		DRAWING NO.	A3
				WEIGHT:		SCALE:1:70	PAGE OF

6.4 Calculation Report of Installation

6.4.1 Each Module with Mounting

- Screw Specifications: Use M6 × 7 cross countersunk screws. M6 means the nominal diameter of the screw is 6mm.
- Material characteristics: Scew's material is 304 stainless steel, with a yield strength of 200-300MPa and a median value of 250MPa. Assuming the mounting is made of aluminum alloy, the friction coefficient μ between the stainless steel screw and the aluminum alloy is about 0.35 (experience value)
- Preload calculation: According to the preload formula $F_{max} = \frac{\pi}{4} \times d^2 \times \frac{\sigma_s}{n}$) (the safety factor n is 1.5), substitute the data to get$F_{max} = \frac{\pi}{4} \times 6^2 \times \frac{250}{1.5} \approx 11781N$.
- Torque calculation: Torque formula$T = K \times F \times d$, the torque coefficient K is related to the surface state of the screw and the lubrication situation. When there is no lubrication, it is usually between 0.18 and 0.22. Take$K = 0.2$ here. SubstituteF_{max} and K and d into,$T = 0.2 \times 11781 \times 0.006 \approx 14.1Nm$. Considering the convenience and safety of actual installation, it is recommended that the actual torque value be 9 - 11N · m.

6.4.2 Each Module with Structure Beam

- Screw Specifications: Use M5 × 8 304 stainless steel POM nylon tip bolts. M5 means the nominal diameter of the screw is 5mm.
- Material Characteristics: 304 stainless steel screws are connected to the steel structure beam, and the friction coefficient is about 0.3 (experience value).
- Calculation Idea: The yield strength of 304 stainless steel is generally between 200 - 300MPa, and the safety factor is 1.5. The maximum allowable preload force$F_{max} = \frac{\pi}{4} \times d^2 \times \frac{\sigma_s}{n}$. For M5 screws,$F_{max} = \frac{\pi}{4} \times 5^2 \times \frac{250}{1.5} \approx 6545N$. Torque coefficient K is 0.3.
- Torque Calculation: Substitute the torque formula $T = K \times F \times d$,$T = 0.3 \times 6545 \times 0.005 \approx 9.8Nm$. In practical applications, the recommended value is 6-8N · m, which can not only ensure the firmness of the connection, but also prevent damage to screws or structural beams due to excessive torque.

7 Safety Management Plan

7.1 Introduction

This safety management plan is developed to ensure the safe design, installation, operation and maintenance of the RGME device. The plan aims to identify potential hazards, implement appropriate safety measures, and establish procedures for managing safety related issues throughout the project lifecycle.

7.2 Safety Policy

The safety of the RGME system is of utmost importance. All activities related to the system, including development, installation, operation, and maintenance, shall comply with relevant safety standards and regulations. The project team is committed to preventing accidents, minimizing risks, ensuring the well-being of all personnel involved, and zero tolerance for affecting the safety of the subway system.

7.3 Harzad Identification and Risk Assessment

7.3.1 Harzard Identification

Identify potential hazards associated with the RGME system, including electrical hazards, mechanical hazards, electromagnetic hazards, and software - related hazards. For example, electrical hazards may include electric shock from exposed wires or malfunctioning power modules, mechanical hazards may involve improper installation leading to component detachment, electromagnetic hazards can be caused by interference with other train systems, and software related hazards may result in unreliable signal accquisition.

7.3.2 Risk Assessment

Assess the risks associated with each identified hazard based on the likelihood of occurrence and the potential consequences. Risks are classified as high, medium, or low, and appropriate risk mitigation measures are determined accordingly. For high - risk hazards, immediate actions are taken to reduce the risk to an acceptable level.

7.4 Safety Measures

Electrical Safety

- Ensure that all electrical components of the RGME system, such as power modules and wiring, comply with relevant electrical safety standards.
- Use appropriate insulation materials and protective enclosures to prevent electric shock.

- Implement proper grounding and bonding practices to minimize the risk of electrical faults.
- Conduct regular electrical safety inspections during installation and maintenance.

Mechanical Safety

- Design the RGME device, power module, and battery module with proper mechanical strength to withstand the vibration and shock of train operation.
- Use appropriate mounting brackets and fasteners to ensure the secure installation of components.
- Provide clear instructions for installation and maintenance to prevent mechanical failures.
- Conduct mechanical integrity checks during installation and periodically during operation.

Electromagnetic Safety

- Ensure that the RGME system complies with electromagnetic compatibility standards to prevent interference with other train systems and to ensure its own reliable operation.
- Use shielding materials for sensitive components to reduce electromagnetic interference.
- Conduct electromagnetic safety inspections during installation and maintenance.

Software Safety

- Develop and test the software of the RGME system to ensure its reliability and accuracy in acoustic signal accquisition.
- Implement error - handling and recovery mechanisms to prevent software failures from causing safety hazards.
- Regularly update the software to address any discovered vulnerabilities.

7.5 Safety Training

Provide safety training to all personnel involved in the development, installation, operation, and maintenance of the RGME system. The training should cover electrical safety, mechanical safety, electromagnetic safety, and software - related safety issues. Personnel should be trained on how to identify and report safety hazards, as well as how to follow safety procedures.

7.6 Emergency Response Plan

Develop an emergency response plan to address safety - related incidents. The plan should include procedures for reporting incidents, evacuating personnel if necessary, and providing first - aid. Emergency response drills should be conducted regularly to ensure that personnel are familiar with the procedures.

7.7 Monitoring and Review

Regularly monitor the implementation of safety measures and the effectiveness of the safety management plan. Conduct safety audits and reviews at least quarterly to identify any areas for improvement. Update the safety management plan as needed to address new hazards or changes in the system.

8 Harzard Log and Risk Register

8.1 Operational Harzard Log

1. Inaccurate signal acquisition:
   - Harzad Descrption: The RGME device may not accurately capture the acoustic signals from the running gear. Because of the unpredictable environment noise, failure of the RGME device hardware or software.
   - Potential Consequences: False alarms, misdiagnosis of running gear faults.
   - Likelihood: Medium.
   - Risk Level: High.
   - Mitigation Measures: Regularly check microphone status during system startup; have spare microphones available for quick switched to; establish a maintenance schedule for hardware and software updates.
   - Responsable Party: Maintenance team.
   - Monitoring and Review Frequency: Monthly when download data from the USB disk.
2. Transmission lose:
   - Harzad Descrption: The RGME device may lose the 4G transmission due to the electromagnetic interference from the train's electrical systems or other external factors.
   - Potential Consequences: Loss of NTP time synchronization, data transmission failure.
   - Likelihood: Medium.
   - Risk Level: Medium.
   - Mitigation Measures: ensure the system complies with electromagnetic compatibility standards; establish a maintenance schedule for hardware and software updates.
   - Responsable Party: Technical team.
   - Monitoring and Review Frequency: Quarterly.
3. Power Failure:
   - Harzad Descrption: The RGME device may fail to provide power to the system due to power supply failure or power outages.
   - Potential Consequences: Loss of system functionality, data loss.
   - Likelihood: Low.(High in the case of Battery mode, cause of battery depletion)

- Risk Level: High.
- Mitigation Measures: Replace the failed Power module or Battery module; Resetting the RGME device working schedule for every day; establish a maintenance schedule for hardware and software updates to reduce power consumption.
- Responsable Party: Technical team.
- Monitoring and Review Frequency: Monthly.

4. Mechanical Failure:

   - Harzad Descrption: Incorrect installation of the RGME device, power module, or battery module.
   - Potential Consequences: Malfunction of the system, inaccurate data collection, potential damage to devices, loosen of the screws even drop off.
   - Likelihood: Low.
   - Risk Level: High.
   - Mitigation Measures: Provide detailed installation training for installers; use torque wrenches and follow strict installation procedures; conduct post installation inspections.
   - Responsable Party: Installation team.
   - Monitoring and Review Frequency: Monthly after installation.

5. Algorithm Glitch:

   - Harzad Descrption: Software glitches in the data post-processing or analysis algorithms, due to inappropriate filter settings for the acoustic signal accquisied by installation position.
   - Potential Consequences: Incorrect fault diagnosis, false alarms, and ineffective predictive maintenance.
   - Likelihood: Medium.
   - Risk Level: Medium.
   - Mitigation Measures: Try different filter settings; conduct regular software updates and maintenance.
   - Responsable Party: Technical team.
   - Monitoring and Review Frequency: Monthly when download data from the USB disk.

8.2 Project Risk Register

8.2.1 Management Risks

1. Project Planning:

- Risk Descrption: Inaccurate estimation of project scope, difficulty, and resources.
- Potential Consequences: Project delays; cost overruns; failure to meet project goals.
- Likelihood: Medium.
- Risk Level: High.
- Mitigation Measures: Conduct a detailed feasibility study; involve experienced personnel in planning; use project management tools for resource and schedule management.
- Responsable Party: Project manager.
- Monitoring and Review Frequency: Weekly review of project progress; monthly reassessment of project scope and resources.

2. Insufficient Resources:

- Risk Descrption: Insufficient human resources, including skilled developers and managers.
- Potential Consequences: Project delays; reduced quality of work; potential project failure.
- Likelihood: Medium.
- Risk Level: High.
- Mitigation Measures: Recruit and train personnel in advance; cross - train team members; establish a talent pipeline for key roles.
- Responsable Party: Human resources department.
- Monitoring and Review Frequency: Monthly review of personnel resources.

3. Project Team Communication Issues:

- Risk Descrption: Lack of collaboration and communication among project team members.
- Potential Consequences: Reduced productivity; communication breakdowns; potential project delays.
- Likelihood: Low.
- Risk Level: Medium.
- Mitigation Measures: Establish clear communication protocols; conduct regular team meetings and updates; use project management tools for task tracking.
- Responsable Party: Project Manager.
- Monitoring and Review Frequency: Weekly team meetings; monthly project updates.

4. Core team members leave the project:
    - Risk Descrption: Core team members leave the project.
    - Potential Consequences: Knowledge loss; project delays; potential project failure.
    - Likelihood: Low.
    - Risk Level: High.
    - Mitigation Measures: Have succession plans in place; provide attractive incentives for key personnel; document knowledge and processes.
    - Responsable Party: Project Manager.
    - Monitoring and Review Frequency: Quarterly review of team member satisfaction and retention.
5. Project Resources or Budget Transfered:
    - Risk Descrption: Superior leadership transfers project resources or budget to other projects.
    - Potential Consequences: Project delays; cost overruns; potential project failure.
    - Likelihood: Medium.
    - Risk Level: High.
    - Mitigation Measures: Establish clear project priorities with senior management; communicate the importance of the project.
    - Responsable Party: Project Manager.
    - Monitoring and Review Frequency: Regular communication with senior management; monitor resource allocation.

8.2.2 Technical Risks

1. Hardware Compatibility Issues:
    - Risk Descrption: Hardware compatibility issues with the RGME device and additional components, such as 4G modules.
    - Potential Consequences: System failures; compatibility issues; potential data unreliable.
    - Likelihood: Medium.
    - Risk Level: High.
    - Mitigation Measures: Conduct thorough compatibility testing; have contingency plans for integration failures.
    - Responsable Party: Technical team.
    - Monitoring and Review Frequency: During integration testing and before deployment; continuously monitor for compatibility issues.

2. Lack experience in rapid develop :
    - Risk Descrption: Lack of experience in developing new features as project requirements change.
    - Potential Consequences: Delays in function development.
    - Likelihood: Medium.
    - Risk Level: Low.
    - Mitigation Measures: Have a flexible development process; involve experienced developers in the project; conduct regular code reviews.
    - Responsable Party: Technical team.
    - Monitoring and Review Frequency: Monthly code reviews; weekly development meetings.
3. High - level of technical challenges in the project:
    - Risk Descrption: The current developers cannot solve the High - level technical challenges in the project.
    - Potential Consequences: Delays in project schedule; increased costs; potential project failure.
    - Likelihood: Medium.
    - Risk Level: High.
    - Mitigation Measures: Conduct a detailed feasibility study; involve experienced personnel in planning; consult with external experts if needed.
    - Responsable Party: Project manager.
    - Monitoring and Review Frequency: Weekly review of project progress.
4. Out of Quality Control:
    - Risk Descrption: Lack of effective testing and quality control.
    - Potential Consequences: System failures; compatibility issues; potential safety risks.
    - Likelihood: Low.
    - Risk Level: High.
    - Mitigation Measures: Establish a comprehensive testing plan; allocate sufficient resources for testing; conduct peer reviews of test results.
    - Responsable Party: Testing team.
    - Monitoring and Review Frequency: Continuously during the development process; review test results weekly.

8.2.3 Business Risks

1. Sub - contractors or suppliers fail to deliver components on time or with the required quality:
   - Risk Descrption: Sub - contractors or suppliers fail to deliver components on time or with the required quality.
   - Potential Consequences: Delays in project schedule, increased costs, and potential impact on system performance.
   - Likelihood: Medium.
   - Risk Level: High.
   - Mitigation Measures: Select reliable sub - contractors and suppliers; establish contracts with clear delivery and quality requirements; Test components upon delivery.
   - Responsable Party: Procurement team.
   - Monitoring and Review Frequency: Before delivery.
2. Sub - contractors or suppliers go out of business:
   - Risk Descrption: Sub - contractors or suppliers go out of business.
   - Potential Consequences: Supply chain disruptions; increased costs for finding new partners; potential project delays.
   - Likelihood: Low.
   - Risk Level: High.
   - Mitigation Measures: Have contingency plans in place; diversify the supply chain; regularly assess the financial stability of sub - contractors and suppliers.
   - Responsable Party: Procurement team.
   - Monitoring and Review Frequency: Quarterly assessment of sub - contractors and suppliers.

Table 12: Quality assurance organizational structure and responsibilities

Department	Responsibility
Procurement	Screen qualified suppliers to ensure raw material con
Production	Production according to process standards, including tracking and supervising print circuit b
Test	Testing of purchased raw materials; testing of work in progress and
Technical	Design product processes, formulate technical specifications, a

9 Qualitiy Management Plan

9.1 Introduction

This Quality Plan is designed to ensure that the Running Gear Monitoring Equipment (RGME) system meets the required quality standards throughout its development, deployment, and operation. It outlines the quality assurance activities, responsibilities, and procedures to be followed to achieve and maintain the quality of the RGME system.

9.2 Quality assurance organizational structure and responsibilities

10 MMI Design

The following MMI is only for professional operators, please do not operate it without professional training.

10.1 Device Info

The device info page shows the basic information of the RGME device, including the device status, software version, firmware version, and hardware information. The product SN is a unique identifier for each RGME device.

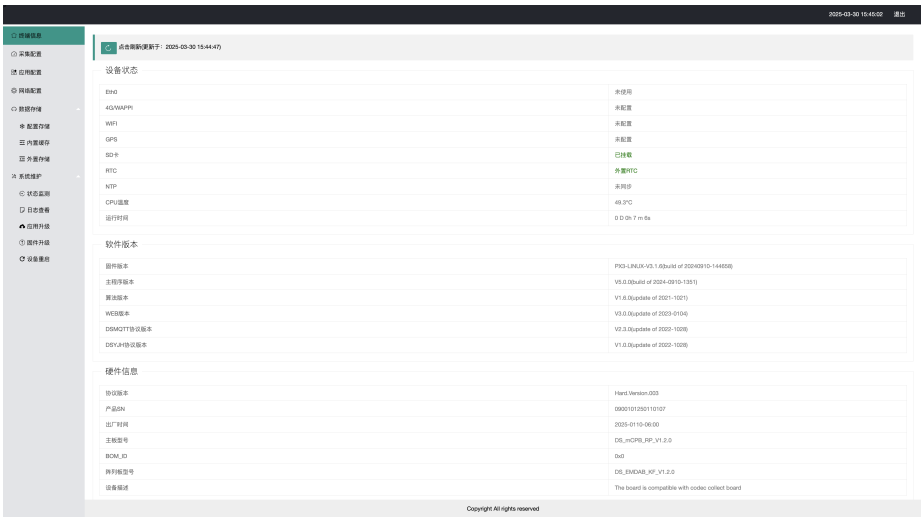


Figure 9: Device Info

10.2 Sampling Configurations

The sampling configurations page allows the user to set the sampling rate, filters, gain and other parameters related to the data acquisition process. The default sampling rate is 48KHz.

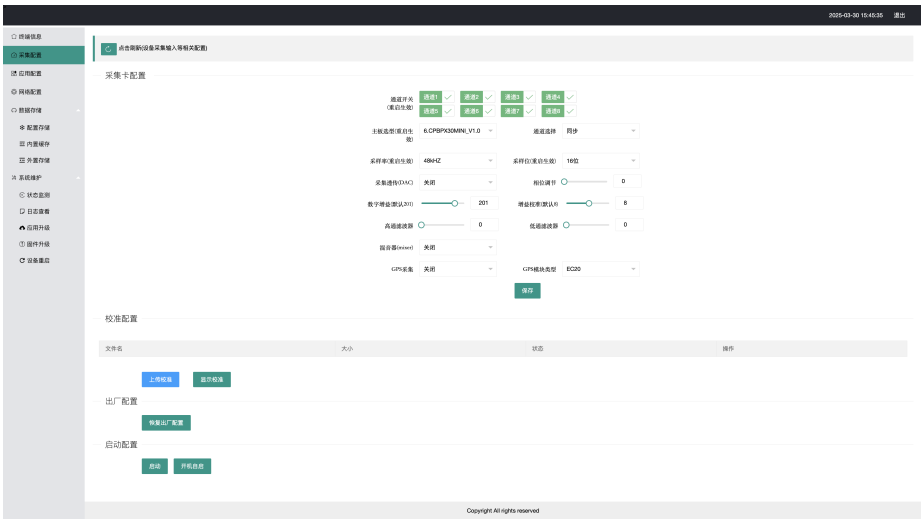


Figure 10: Sampling Configurations

10.3 Storage Configurations

The storage configurations page allows the user to set the storage mode, storage path, and other parameters related to the data storage process. The default storage mode is SD card storage. In MTR porject, the data will be stored in the external USB disk.

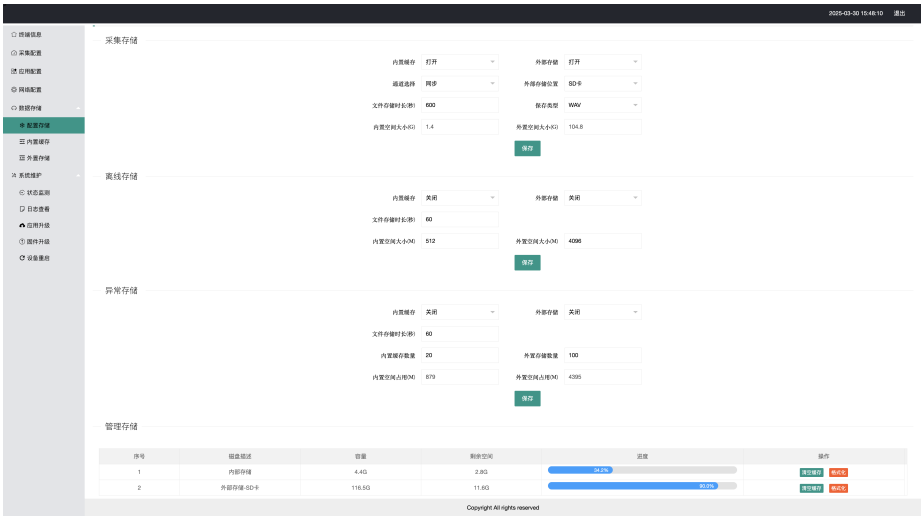


Figure 11: Storage Configurations

10.4 Network Configurations

The network configurations page allows the user to set the network mode, IP address, and other parameters related to the network connection. The default network mode is manual. The default IP address is 192.168.0.xxx, where xxx is the last three digits of the product SN.

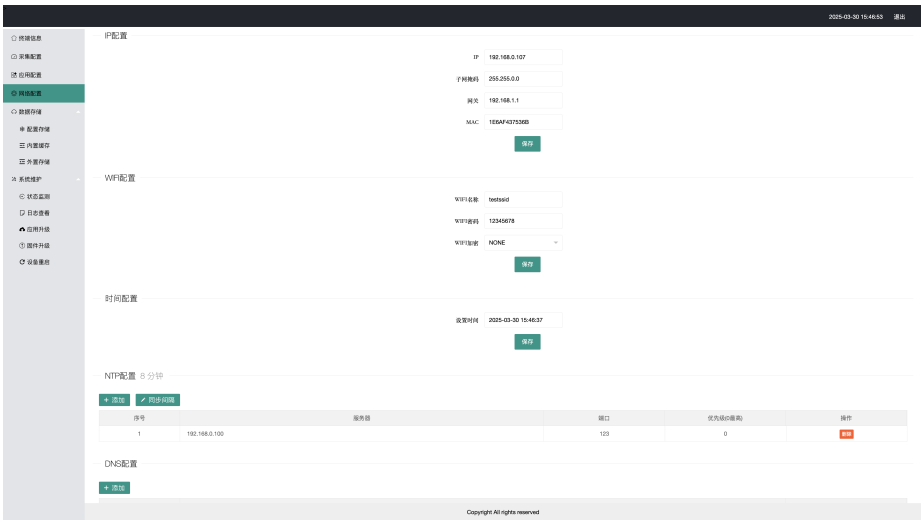


Figure 12: Network Configurations

10.5 Server Configurations

The server configurations page allows the user to set the server IP address, port number, and other parameters related to the data transmission process. In MTR project, the data will not be transmitted to the server, so this page is not used.

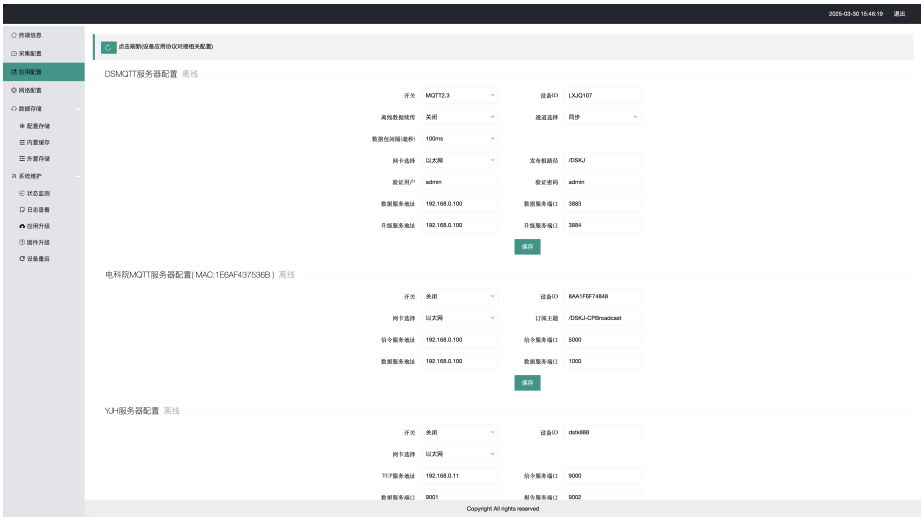


Figure 13: Server Configurations

10.6 Data Management

The data management page allows the user to view the data files stored in the device, delete the data files, and format the storage device. User can download the data files to the local computer or to the server. But in MTR project, the data can more easily be get by just remove the USB disk and replace it with a new one.

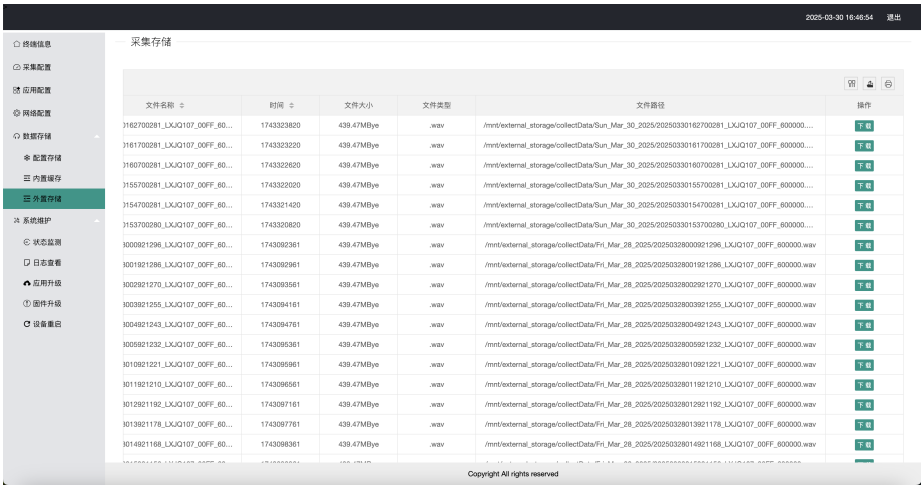


Figure 14: Data Management

10.7 Log Report

The log report page allows the user to view the log files generated by the device, delete the log files, and format the storage device. The log files are used for debugging and troubleshooting purposes. In MTR project, the log files are not used.

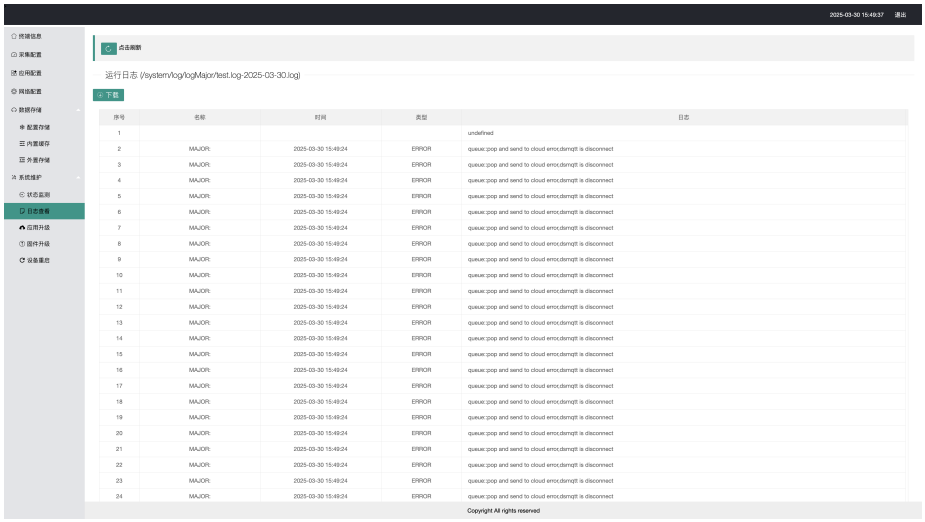


Figure 15: Log Report

11 Complied Standards

The RGME device needs to be installed in the car carriage of a subway train. Therefore, this device and its accessories need to meet various requirements for on-board equipment. The following standards are applicable:

- GB4943.1-2022/IEC62368-1:2018
  Audio/video,information and communication technology equipment Safety requirements
- GB5226-1-2019/IEC60204-1:2016
  Safety of machinery - Electrical equipment of machines General requirements
- GB/T4208-2017/IEC60529:2013
  Degrees of protection provided by enclosures (IP code)
- GB/T17626-2018/IEC61000:2008
  Electromagnetic compatibility (EMC)
- GB/T2423-2016/IEC60068:2012
  Environmental testing
- GB/T21563-2018/IEC61373:2010
  Railway applications — Rollingstock equipment — Shock and vibrationtests
- EN 50155:2017
  Railway applications — Rolling stock equipment — electronic equipment

11.1 Already Complied Standards

11.1.1 GB/T2423-2016/IEC60068:2012 *Environmental testing*

中国认可
国际互认
检测
TESTING
CNAS L10871

检　测　报　告

（正　本）

报告编号：T165R2023009

任务编号：231104

样品名称：灵鸮 AI 终端

委托单位：北京谛声科技有限责任公司

报告日期：2023 年 12 月 12 日

说　明

1、本报告无“检测报告专用章”或检测单位公章无效。

2、复制本报告未重新加盖“检测报告专用章”或检测单位公章无效。

3、本报告无测试、审核、批准人签字无效。

4、未经许可部分复制本报告无效，涂改无效。

5、本报告检测结果仅对受试样品有效。

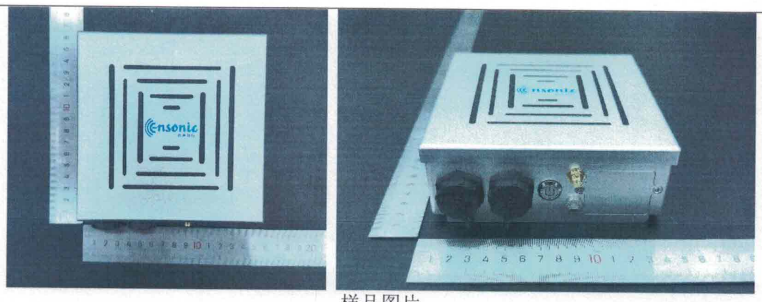
6、对本报告如有异议，请于收到本报告之日起十个工作日内提出。

北京神州泰科科技有限公司
地　址：北京市海淀区丰豪东路 9 号院 2 号楼 5 层 4 单元 502-1
邮　编：100094
Email：　service@bjsztech.com

样品名称	灵鹊 AI 终端	检测类别	委托检测
型　　号	DSKJ-UMA8-001	数　　量	1
委托单位	北京谛声科技有限责任公司	联 系 人	陈锡凯
单位地址	北京市海淀北二街 8 号中关村 SOHO A 区 916 室	联系电话	13501288323
来样日期	2023 年 11 月 24 日	来样方式	送样
检测依据	GB/T 2423.1-2008 电工电子产品环境试验 第 2 部分：试验方法 A：低温 GB/T 2423.2-2008 电工电子产品环境试验 第 2 部分：试验方法 B：高温 GB/T 2423.3-2016 环境试验 第 2 部分：试验方法 试验 Cab：恒定湿热试验 GB/T 2423.4-2008 电工电子产品 第 2 部分：试验方法 试验 Db 交变湿热（12h+12h 循环） 检测委托单		
检测项目	低温；高温；恒定湿热；交变湿热。		
检测日期	2023 年 11 月 25 日至 2023 年 11 月 30 日		
检测环境	温度：25-30 ℃；　　相对湿度：35-40 %RH；		
备　　注	无		
检测结论	依据标准方法及检测委托单，所检项目符合验收标准。 （检测单位盖章） 签发日期：2023 年 12 月 12 日		

测　试	审　核	批　准

一、 样品图片



样品图片

二、 检测项目清单

序号	测试项目	检测依据和判定标准	测试结果
1	低温	（1） 测试依据：GB/T 2423.1-2008 电工电子产品环境试验 第2部分：试验方法 A：低温 （2） 测试方法：低温-40℃，降温速率1℃/min，稳定后保持0.5小时，进行低温启动，启动完成后再持续2小时。 （3） 验收标准：试验期间及试验后，监测装置能正常工作。	符合验收标准
2	高温	（1） 测试依据：GB/T 2423.2-2008 电工电子产品环境试验 第2部分：试验方法 B：高温 （2） 测试方法：高温70℃，温变速率1℃/min，上电持续运行2小时。 （3） 验收标准：试验期间及试验后，监测装置能正常工作。	符合验收标准
3	恒定湿热	（1） 测试依据：GB/T 2423.3-2016 环境试验 第2部分：试验方法 试验 Cab：恒定湿热试验 （2） 测试方法：40℃，93%RH ，上电持续运行48小时。 （3） 验收标准：试验期间及试验后，监测装置能正常工作。	符合验收标准
4	交变湿热	（1） 测试依据：GB/T 2423.4-2008 电工电子产品环境试验 第2部分：试验方法 试验 Db 交变湿热（12h+12h 循环） （2） 测试方法： a） 将样机（工作状态）放入试验箱，环境温度设置为25℃，样机温度稳定后，将环境湿度提升	符合验收标准

		至 95%。 b) 开始升温至 55℃，所用时间为 3h±15min，湿度保持不小于 95%，最后 15min 相对湿度不小于 90%，持续 9 小时。 c) 开始降温，温度降低采用方法 1，即在 3h±15min 内降至 25℃，最初 15min 相对湿度不小于 90%外，其他时间相对湿度不小于 95%。 d) 稳定在 25℃，95%RH 下保持 9 小时为 1 个循环（24 小时）； e) 连续运行 2 个循环。 （3） 验收标准：试验期间及试验后，监测装置能正常工作。	

三、 试验记录

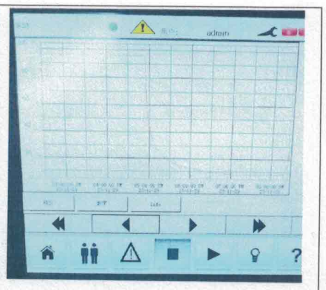
1. 低温

1.1 样品信息

名称	型号	备注
灵鸮 AI 终端	DSKJ-UMA8-001	N/A

1.2 试验设置





低温试验环境设置

1.3 检测结果

名称	型号	试验期间功能检查	试验后功能检查
灵鸮 AI 终端	DSKJ-UMA8-001	运行正常	运行正常

1.4 仪器设备清单

序号	名 称	型 号	编 号	校准有效期至
1	温湿度试验箱	Weiss WK3-340/40	BJSZ-CS0016	2024/7/24

2. 高温

2.1 样品信息

名称	型号	备注
灵鹊 AI 终端	DSKJ-UMA8-001	N/A

2.2 试验设置

高温试验环境设置

2.3 检测结果

名称	型号	试验期间功能检查	试验后功能检查
灵鹊 AI 终端	DSKJ-UMA8-001	运行正常	运行正常

2.4 仪器设备清单

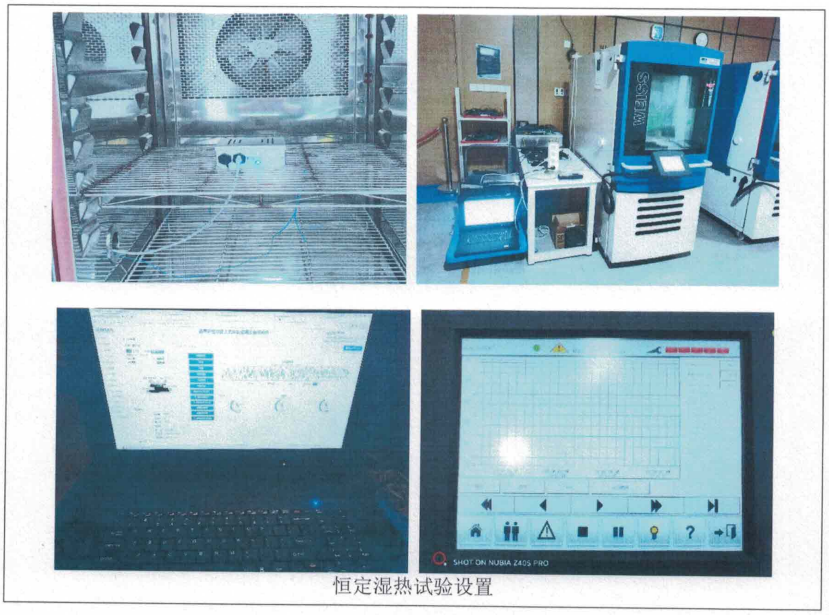
序号	名 称	型 号	编 号	校准有效期至
1	温湿度试验箱	Weiss WK3-340/40	BJSZ-CS0016	2024/7/24

3. 恒定湿热

3.1 样品信息

名称	型号	备注
灵鸮 AI 终端	DSKJ-UMA8-001	N/A

3.2 试验设置



恒定湿热试验设置

3.3 检测结果

名称	型号	试验期间功能检查	试验后功能检查
灵鸮 AI 终端	DSKJ-UMA8-001	运行正常	运行正常

3.4 仪器设备清单

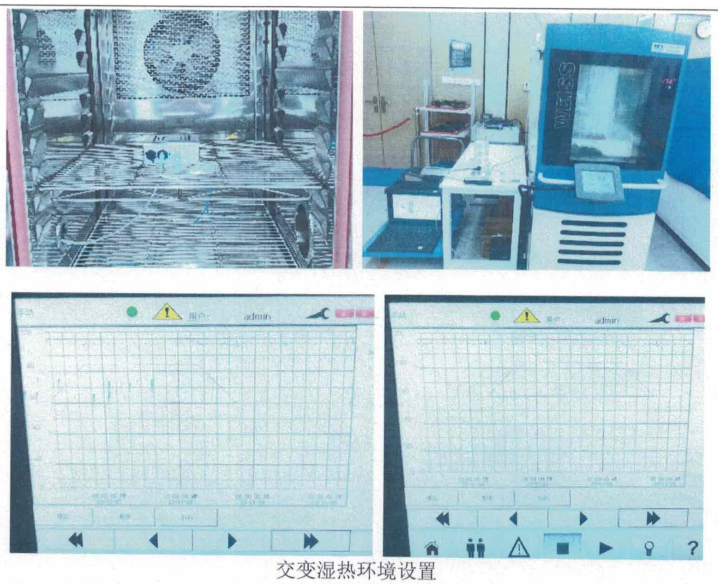
序号	名 称	型 号	编 号	校准有效期至
1	温湿度试验箱	Weiss WK3-340/40	BJSZ-CS0016	2024/7/24

4. 交变湿热

4.1 样品信息

名称	型号	备注
灵鸮 AI 终端	DSKJ-UMA8-001	N/A

4.2 试验设置



交变湿热环境设置

4.3 检测结果

名称	型号	试验期间功能检查	试验后功能检查
灵鸮 AI 终端	DSKJ-UMA8-001	运行正常	运行正常

4.4 仪器设备清单

序号	名 称	型 号	编 号	校准有效期至
1	温湿度试验箱	Weiss WK3-340/40	BJSZ-CS0016	2024/7/24

----------以下空白----------

11.1.2 GB/T17626-2018/IEC61000:2008 *Electromagnetic compatibility (EMC)*

210009349255

中国认可
国际互认
检测
TESTING
CNAS L0296

检验检测报告

INSPECTION&TESTING REPORT

北京尊冠科技有限公司
Beijing Zunguan Science & Technology Ltd.
国家电子计算机质量检验检测中心
China National Computer Quality Inspection and Testing Center

检验检测报告

INSPECTION&TESTING REPORT

No. A20231661

产品名称： 灵鹆 AI终端

规格型号： DSKJ-UMA8-001

委托单位： 北京谛声科技有限责任公司

生产单位： 北京谛声科技有限责任公司

检验检测类别： 一般委托

报告日期： 2023年11月24日

注 意 事 项

1. 报告须同时加盖本中心“检验检测专用章”、公章和骑缝章，否则无效；
2. 复制后的报告须重新加盖本中心“检验检测专用章”、公章和骑缝章，否则无效；
3. 报告无主检、审核和批准人签字或盖章者无效；
4. 报告内容涂改或部分复制无效；
5. 带“☆”检验检测项目或检验检测依据，不在 CNAS 授权认可范围内；
6. 报告首页样品的相关信息由委托方声明（如：产品名称、规格型号、生产单位、生产日期及商标、项目名称、检验检测地点、施工单位、施工单位地址等）；
7. 相关定义

通过、符合、合格、P：表示检验检测结果符合检验检测和判定依据的要求；

未通过、不符合、不合格、N、F：表示检验检测结果不符合检验检测和判定依据的要求；

不判定、—：表示检验检测项目不需判定，只给出检验检测结果；

不适用、NA：表示被检样品不适用该检验检测项；

未选：表示委托单位未选该检验检测项；

/:表示无内容；

8. 报告内容仅适用于被检样品；
9. 对本报告内容若有异议，请及时向本中心提出。

地　　址：北京市北四环中路 211 号
通信地址：北京 619 信箱 27 分箱
邮政编码：100083
联 系 人：周会芬
联系电话：400-6708-618，（010）89055851/5269
传　　真：（010）89055978，89055885
E-mail: zhouhf@nctc.org.cn
http://www.nctc.org.cn

关注公众号获取专业资讯

国家电子计算机质量检验检测中心

检 验 检 测 报 告

产品名称	灵鹃 AI终端	规格型号	DSKJ-UMA8-001
委托单位	北京谛声科技有限责任公司	商 标	/
生产单位	北京谛声科技有限责任公司	样品数量	1台
委托单位地 址	北京市海淀区中关村SOHO 916室	检验检测地 点	本单位实验室
生产日期	/	抽样数量	/
到样日期	2023年11月23日	送样人	陈锡凯
检验检测日 期	2023年11月23日	抽样基数	/
检验检测依据	GB/T 17626.2-2018 《电磁兼容 试验和测量技术 静电放电抗扰度试验》 GB/T 17626.3-2016 《电磁兼容 试验和测量技术 射频电磁场辐射抗扰度试验》 GB/T 17626.4-2018 《电磁兼容 试验和测量技术 电快速瞬变脉冲群抗扰度试验》 GB/T 17626.5-2019 《电磁兼容 试验和测试技术 浪涌（冲击）抗扰度试验》 GB/T 17626.6-2017 《电磁兼容 试验和测量技术 射频场感应的传导骚扰抗扰度》 GB/T 17626.8-2006 《电磁兼容 试验和测量技术 工频磁场抗扰度试验》 GB/T 17626.9-2011 《电磁兼容 试验和测量技术 脉冲磁场抗扰度试验》 GB/T 17626.10-2017《电磁兼容 试验和测量技术 阻尼振荡磁场抗扰度试验》 GB/T 17626.11-2008《电磁兼容 试验和测量技术 电压暂降、短时中断和电压变化抗扰度试验》		
判定（参考）依据	同检验检测依据		
检验检测项目	电磁兼容性		
检验检测结论	根据检验检测依据和判定（参考）依据栏中所列标准及要求，对送检样品进行了电磁兼容性项目检验检测（试验），检验检测结果全部符合要求。 签发日期：2023年11月24日		
备注	/		

批准：徐春锋 审核：殷智慧 主检：路天煜

本次检验检测用主要仪器设备			
序号	仪器设备名称	仪器编号	计量有效期
1	功率放大器	ZG-YQ-DC-208	2024年6月22日
2	微波对数周期天线	ZG-YQ-DC-204	/
3	信号源	ZG-YQ-DC-159	2024年3月1日
4	信号源	ZG-YQ-DC-160	2024年3月1日
5	功率放大器	ZG-YQ-DC-207	2024年6月22日
6	对数增益天线	ZG-YQ-DC-201	/
7	功率计	ZG-YQ-DC-174	2024年9月28日
8	功率放大器	ZG-YQ-DC-209	2024年6月22日
9	功率放大器	ZG-YQ-DC-210	2024年6月22日
10	功率计	ZG-YQ-DC-194	2024年9月28日
11	功率探头	ZG-YQ-DC-161	2024年3月1日
12	功率探头	ZG-YQ-DC-162	2024年3月1日
13	功率探头	ZG-YQ-DC-191	2024年9月27日
14	功率探头	ZG-YQ-DC-192	2024年9月27日
15	ESD模拟器	ZG-YQ-DC-125	2024年9月1日
16	电快速、浪涌测试设备	ZG-YQ-DC-120	2024年3月30日
17	屏蔽室	ZG-YQ-DC-126	2027年6月12日
18	连续波模拟器	ZG-YQ-DC-045	2024年6月9日
19	交流电源	ZG-YQ-DC-053	2024年11月26日
20	屏蔽室	ZG-YQ-DC-126	2027年6月12日
21	电感线圈及接口	ZG-YQ-DC-074	2024年11月26日
22	交流电源	ZG-YQ-DC-053	2024年11月26日
23	交流切换开关单元	ZG-YQ-DC-075	2024年11月26日
24	阻尼振荡波模拟器	ZG-YQ-DC-211	2024年2月7日
25	阻尼振荡磁场线圈	ZG-YQ-DC-217	2024年2月7日
此处空白			

样品分配情况		
样品编号	样品出厂编号	检验检测项目
A20231661-001	/	电磁兼容性
注：下文中“样品编号”仅保留后三位序列号，与此处后三位序列号相同的为同一样品。		

检验项目		技术要求	样品编号	检验结果	判定	测量不确定度（dB）
一、电磁兼容性	1.静电放电	应符合委托方要求和GB/T 17626.2-2018第5条表1等级4的规定（接触放电8kV,空气放电15kV），达到性能判据A的要求。	001	达到性能判据A的要求	符合	/
	2.连续射频电磁场骚扰	应符合委托方要求和GB/T 17626.3-2016第5条表1的规定（试验场强10V/m），达到性能判据A的要求。	001	达到性能判据A的要求	符合	/
	3.电快速瞬变脉冲群	应符合委托方要求和GB/T 17626.4-2018第5条表1等级4的规定（试验电压4kV），达到性能判据A的要求。	001	达到性能判据A的要求	符合	/
	4. 浪涌（冲击）	应符合委托方要求和GB/T 17626.5-2019第5条表1等级4的规定（试验电压：线-线2kV，线-地4kV），达到性能判据A的要求。	001	达到性能判据A的要求	符合	/
	5.连续射频感应骚扰	应符合委托方要求和GB/T 17626.6-2017第5条表1等级3的规定（试验电压10V），达到性能判据A的要求。	001	达到性能判据A的要求	符合	/
	6.工频磁场	应符合委托方要求和GB/T 17626.8-2006第5条表1等级5的规定（磁场强度100A/m），达到性能判据A的要求。	001	达到性能判据A的要求	符合	/
	7. 电压暂降和短时中断	应符合GB/T 17626.11-2008第5条表1、2的规定： 剩余电压＜5%、持续时间0.5周期，达到性能判据A的要求； 剩余电压＜5%、持续时间1周期，达到性能判据A的要求； 剩余电压＜60%、持续时间10周期，达到性能判据A的要求。 剩余电压＜30%、持续时间25周期，达到性能判据A的要求。 剩余电压＜20%、持续时间250周期，达到性能判据A的要求。 剩余电压＜5%、持续时间250周期，达到性能判据C的要求。	001	达到性能判据A的要求 达到性能判据A的要求 达到性能判据A的要求 达到性能判据A的要求 达到性能判据A的要求 达到性能判据A的要求	符合	/
	8.阻尼振荡磁场	应符合委托方要求和GB/T 17626.10-2017第5条表1等级5的规定（阻尼震荡磁场强度100A/m），达到性能判据A的要求。	001	达到性能判据A的要求	符合	/
	9.脉冲磁场	应符合委托方要求和GB/T 17626.9-2011第5条表1等级5的规定（磁场强度1000A/m），达到性能判据A的要求。	001	达到性能判据A的要求	符合	/

检验项目	技术要求	样品编号	检验结果	判定	测量不确定度（dB）
此处空白					

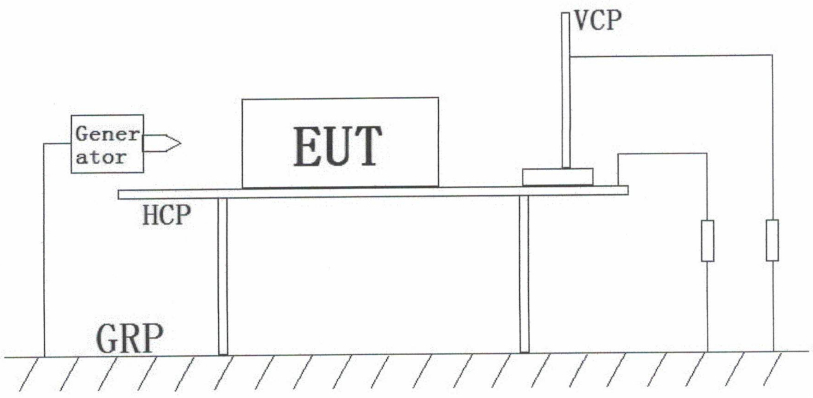
检验环境	温度：21℃～24℃；相对湿度：45%～51%；大气压力：(86～106)kPa
受试样品运行状态	样品上电，状态灯显示正常。
备注	/

静电放电

1. 试验等级

接触放电		空气放电	
等级	试验电压 kV	等级	试验电压 kV
1	2	1	2
2	4	2	4
3	6	3	8
4	8	4	15
X[a]	特定	X[a]	特定
[a] “X”可以是高于、低于或在其他等级之间的任何等级。该等级应在专用设备的规范中加以规定，如果规定了高于表格中的电压，则可能需要专用的试验设备。			

2. 测试布置图

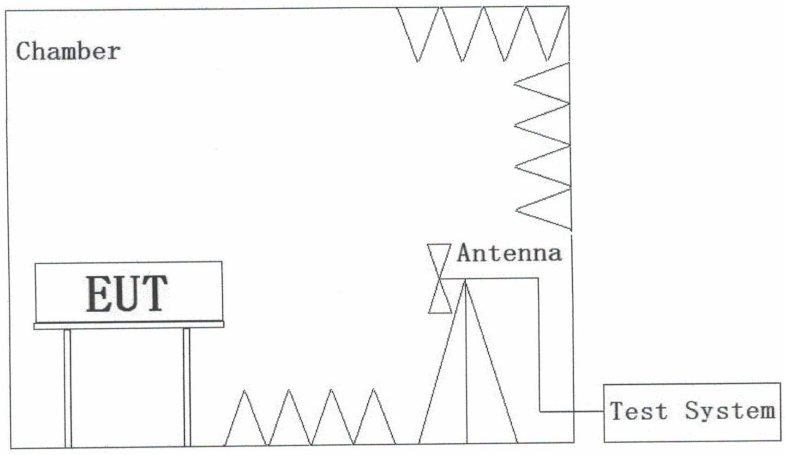


连续射频电磁场骚扰

1. 试验等级

等级	试验场强/（V/m）
	频率范围80MHz～1000MHz
1	1
2	3
3	10
4	30
X	特定
注：X是一开放等级，其场强可为任意值。该等级可在产品规范中规定。	

2．测试布置图

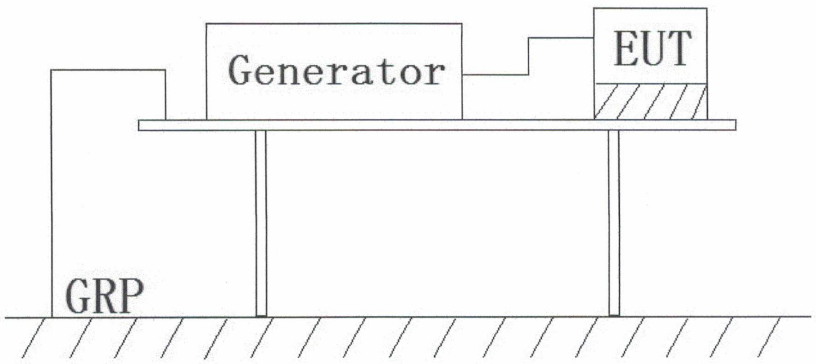


电快速瞬变脉冲群

1. 试验等级

开路输出试验电压和脉冲的重复频率				
等级	电源端口和接地端口（PE）		信号端口和控制端口	
	电压峰值 kV	重复频率 kHz	电压峰值 kV	重复频率 kHz
1	0.5	5或100	0.25	5或100
2	1	5或100	0.5	5或100
3	2	5或100	1	5或100
4	4	5或100	2	5或100
X[a]	特定	特定	特定	特定
传统上用5kHz的重复频率；然而，100kHz更接近实际情况。产品标准化技术委员会宜决定与特定的产品或者产品类型相关的那些频率。 对于某些产品，电源端口和信号端口之间没有清晰的区别，在这种情况下，应有产品标准化技术委员会根据试验目的来确定如何进行。				
[a] “X”可以是任意等级，在专用设备技术规范中应对这个级别加以规定。				

2. 测试布置图



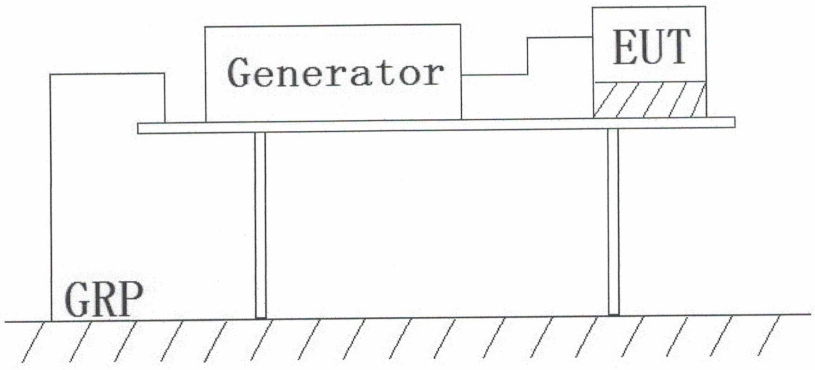
浪涌(冲击)

1. 试验等级

等级	开路试验电压 kV	
	线-线	线-地[b]
1	—	0.5
2	0.5	1.0
3	1.0	2.0
4	2.0	4.0
X[a]	特定	特定

[a] “X”可以是高于、低于或在其他等级之间的任何等级。该等级应在产品标准中规定。
[b] 对于对称互连线，试验能够同时施加在多条线缆和地之间，例如“多线-地”

2. 测试布置图

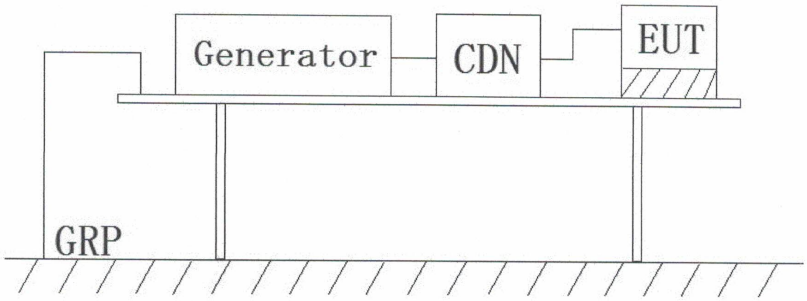


连续射频感应骚扰

1. 试验等级

频率范围150kHz～80MHz		
试验等级	电压（e.m.f）	
	U_0/V	U_0/dB（μV）
1	1	120
2	3	129.5
3	10	140
X	特定	
注：X是一个开放的等级，此等级应在专门的设备规范中规定。		

2.测试布置图

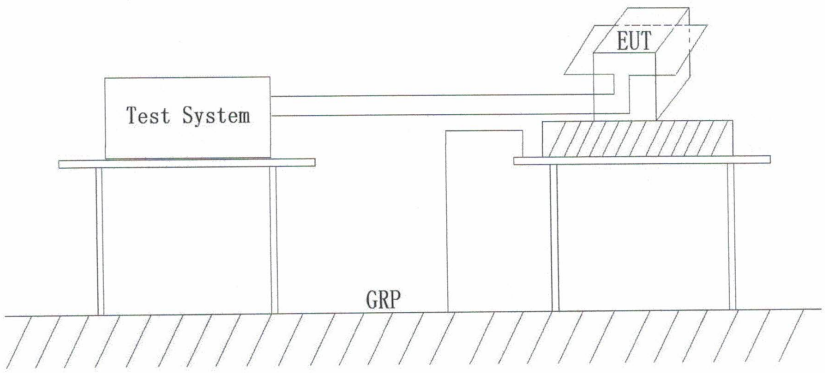


工频磁场

1. 试验等级

等级	稳定持续磁场试验
	磁场强度/（A/m）
1	1
2	3
3	10
4	30
5	100
X	特定
注：X是一个开放等级，可在产品规范中给出。	

2. 测试布置图



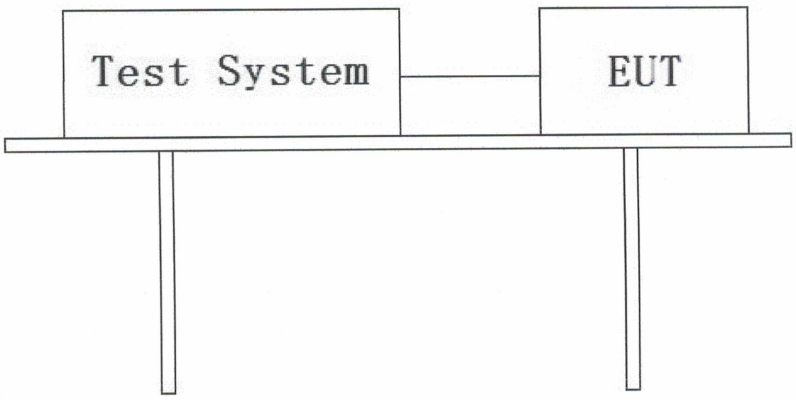
电压暂降和短时中断

1. 试验等级和持续时间

类别	电压暂降的试验等级和持续时间（t_s）（50Hz/60Hz）					短时中断的试验等级和持续时间（t_s）（50Hz/60Hz）
1类	依据设备要求依次进行					依据设备要求依次进行
2类	0% 持续时间 0.5周期	0% 持续时间 1周期	70% 持续时间25/30周期			0% 持续时间250/300周期[c]
3类	0% 持续时间 0.5周期	0% 持续时间 1周期	40% 持续时间 10/12周期[c]	70% 持续时间 25/30周[c]	80% 持续时间 250/300周期[c]	0% 持续时间250/300周期[c]
X类[b]	特定	特定	特定	特定	特定	X

[b] “X类”由有关的标准化技术委员会进行定义，对于直接或者间接连接到公共网络的设备，严酷等级不能低于2类的要求。
[c] “10/12周期”是指“50Hz试验采用10周期”和“60Hz试验采用12周期”。
“25/30周期”是指“50Hz试验采用25周期”和“60Hz试验采用30周期”。
“250/300周期”是指“50Hz试验采用250周期”和“60Hz试验采用300周期”。

2. 测试布置图

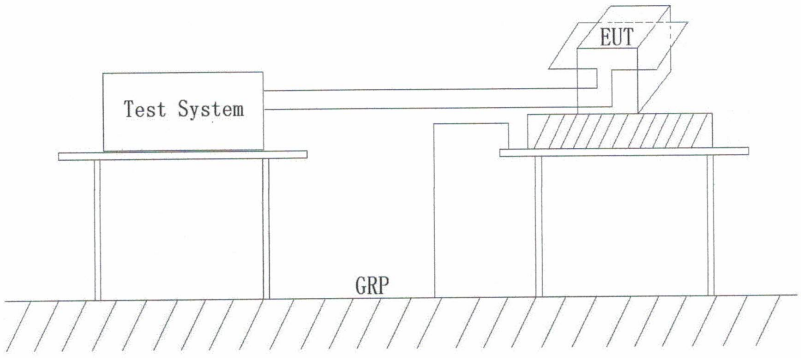


阻尼震荡磁场

1. 试验等级

试验等级	阻尼震荡磁场强度A/m（峰值）
1	n.a.[b]
2	n.a.[b]
3	10
4	30
5	100
X[a]	特定
[a]“X”为开放等级。该等级包括试验持续时间，可由产品规范中给出。 [b]“n.a”为不适用。	

2. 测试布置图



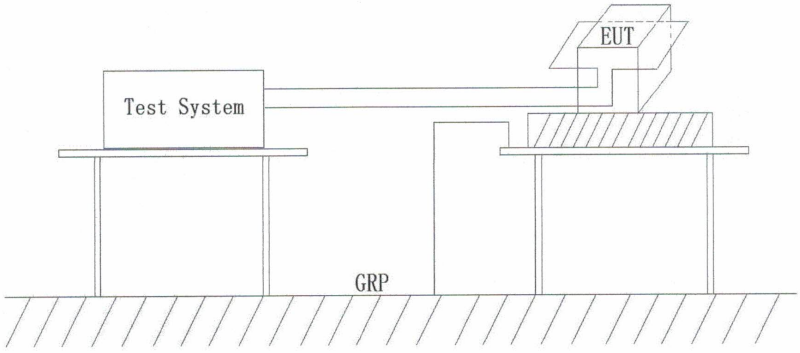
脉冲磁场

1. 试验等级

等级	脉冲磁场强度A/m（峰值）
1	_[b]
2	_[b]
3	100
4	300
5	1000
X_a	特定

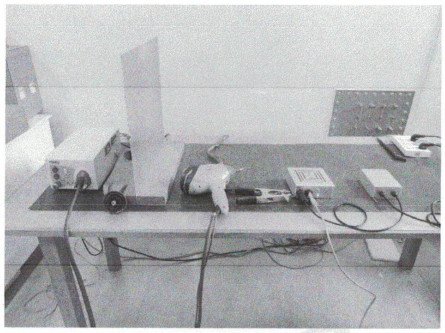
[a] “X”是一个开放等级，可以在产品规范中给出。
[b] “_”表示不适用。

2. 测试布置图

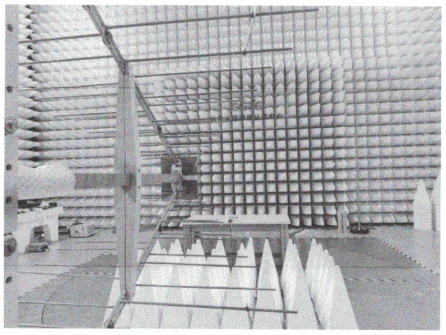


测试连接照片

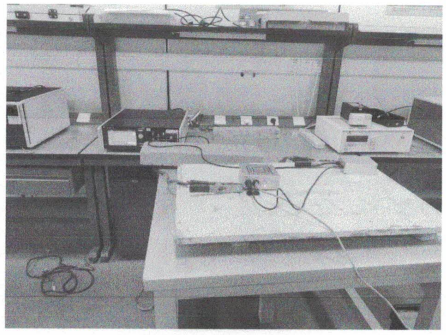
静电放电



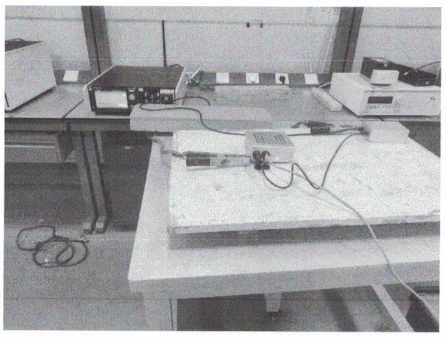
连续射频电磁场骚扰



电快速瞬变脉冲群

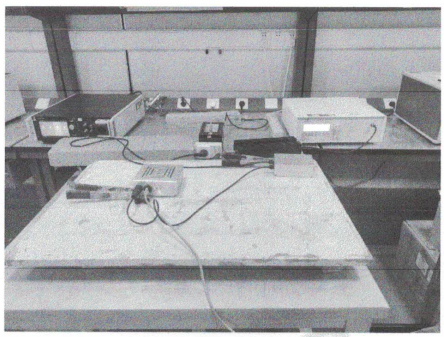


浪涌（冲击）

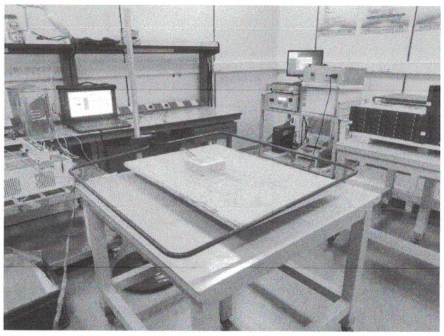


测试连接照片

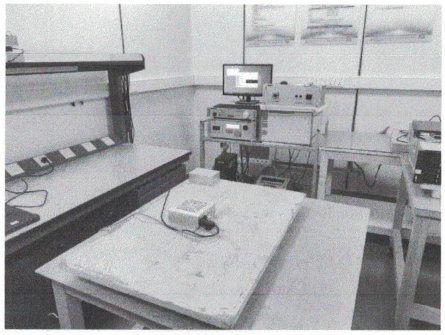
连续射频感应骚扰



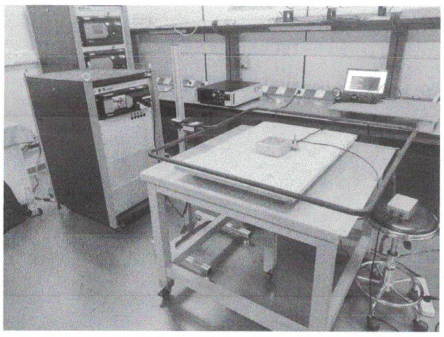
工频磁场



电压暂降和短时中断

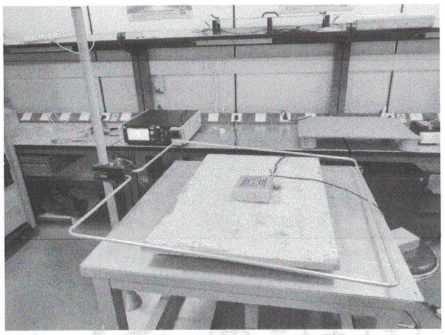


阻尼震荡磁场



测试连接照片

脉冲磁场



【====报告内容结束====】

11.1.3 GB/T4208-2017/IEC60529:2013 *Degrees of protection provided by enclosures (IP code)*

环试检测

中国认可
国际互认
检测
TESTING
CNAS L17371

检 测 报 告

Testing Report

NO.：HSJC23112902-01

样品名称： Name of Sample	灵鹜 AI 终端
型号规格： Model	DSKJ-UMA8-001
研制单位： Development Company	北京谛声科技有限责任公司
委托单位： Client Company	北京谛声科技有限责任公司

北京环试检测技术有限公司

Beijing Huanshi Testing Technology Co., Ltd

声　明

1.本报告无编制、审核、批准人签章无效。

2.本报告未加盖“检验检测专用章”无效，未加盖骑缝“检验检测专用章”无效。

3.本报告结论只对被试样品负责。

4.本报告涂改无效，未经本公司书面批准不得部分复制。

5.“*”标识的试验依据和试验项目不在本公司认可范围内。

6.如对检测结果有异议，请于报告收到之日起十五日内，向本公司提出申诉，同时附上报告原件，逾期不予受理。

7.不可重复性试验不进行复检，委托单位放弃异议权利。

8.未经本公司同意，委托方不得将检测报告用作广告、促销等以营利为目的的各种用途。

地　　址：　北京市大兴区黄村镇芦城工业区创业路 1 号

邮政编码：　102612

联系电话：　010-69269349

传　　真：　010-69269349

样品名称	灵鸮 AI终端	委托单位	北京谛声科技有限责任公司
样品型号	DSKJ-UMA8-001	单位地址	北京市海淀区海淀街道中关村SOHO A区916室
样品数量	1个	研制单位	北京谛声科技有限责任公司
来样日期	2023年11月29日	来样形式	送样
样品状态	外观良好		
样品编号	001		
试验时间	2023年11月29日		
试验地点	北京市大兴区黄村镇芦城工业区创业路 1 号		
参试人员	李树波、刘璐		
试验环境	温度：16.0℃	湿度：50%RH	大气压：101.0kPa
试验依据	GB/T 4208-2017《外壳防护等级（IP 代码）》		
试验项目	IP66试验。		

试 验 结 论

所检项目试验过程符合 GB/T 4208-2017《外壳防护等级（IP 代码）》标准方法，试验后样品结构完好，外观无变化，内部无进水，无进尘。

编制/日期：李树波 20231204 审核/日期：巫永楚 20231204 批准/日期：[illegible] 20231204

1.试验目的

通过对委托方提供的样品 IP66 试验，考核样品的环境适应性。

2.试验条件

2.1 IP66 试验

2.1.1 IPX6

1）喷嘴内径：12.5mm；

2）水流量：100±5 L /min；

3）主水流的中心部分：离喷嘴 2.5m 处直径为 120mm 的圆；

4）持续时间：1min/m^2，最少持续 3min；

5）喷嘴至外壳上表面距离：2.5m~3m。

2.1.2 IP6X

1）滑石粉：（用金属丝直径 50μm，筛孔尺寸为 75μm 的金属方孔筛滤过）；

2）滑石粉用量：2kg/m^3；

3）外壳类型：第一种类型；

4）抽气情况：抽气速度为每小时 40～60 倍外壳容积，压差不超过 2kPa 试验时间：2h。

3.试验设备

设备名称	设备型号	设备编号	校准有效期
防水试验系统	CFFS	HS2022001	20240601
智能涡轮流量计	WL-LWGA-20	220513	20240601
防尘试验箱	HL-1200	20171150	20240601
真空表	/	70243196	20240601

4.测试设备

无。

5.试验过程

5.1 IP66

5.1.1 IPX6

1）试验前，经确认样品结构完好，表面无损伤，将样品放入试验箱滴水台上；

2）喷嘴距样品 2.5m 处，以 100±5 L /min 的水流量喷样品表面 3min；

3）试验结束，对样品进行开盖检查，样品内部无进水。

5.1.2 IP6X

1）试验前，经确认样品结构完好，外观无损伤，将样品放入试验箱内，关闭箱门；

2）抽气速度为每小时 40～60 倍外壳容积，压差不超过 2kPa，进行 2h；

3）试验结束，样品结构完好，外观无损伤，内部无进尘。

6.试验结果

实验室依据标准方法及委托方提供的试验条件，对样品进行了 IP66 试验，试验过程符合标准方法及委托方的技术要求，试验后样品结构完好，外观无变化，内部无进水，无进尘。

7.附录

1）附录 A：检测参数表；

2）附录 B：试验照片。

以下无正文

附录 A：检测参数表

检测项目		合格判据
1	外观	样品结构完好，外观无变化。
2	内部	无进水、无进尘。

附录 B：试验照片

图 1：IPX6 试验前照片

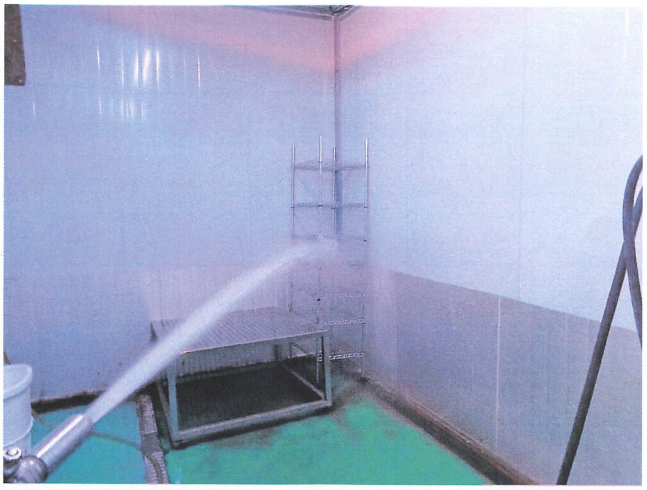


图 2：IPX6 试验中照片

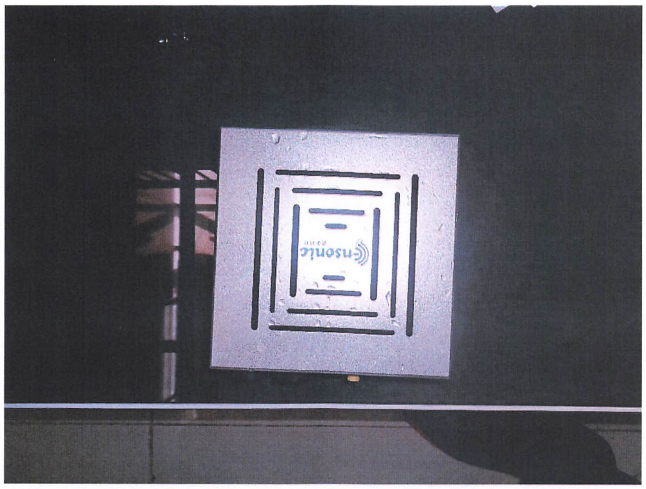


图 3：IPX6 试验后照片

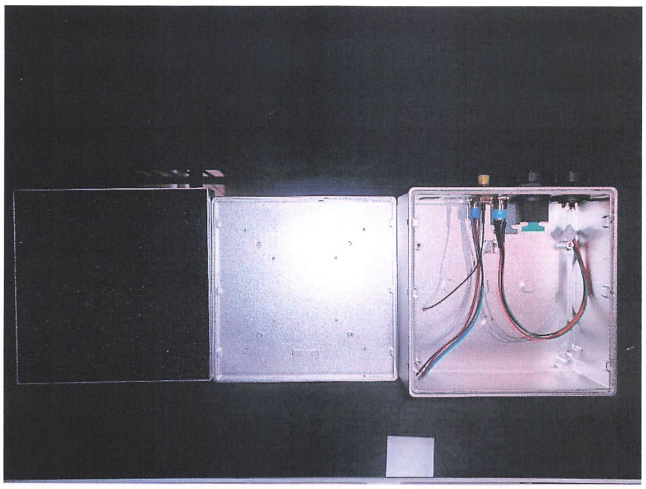


图 4：IPX6 试验后内部照片

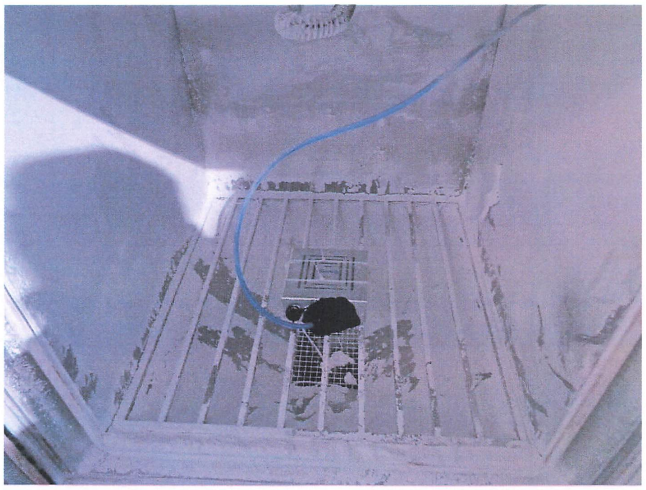


图 5：IP6X 试验前照片

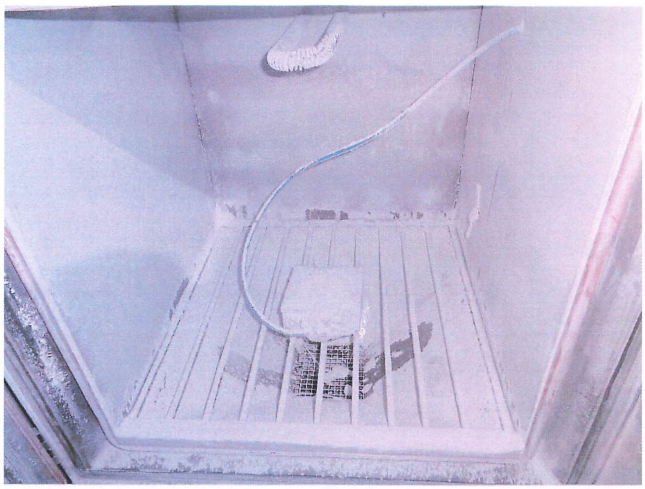


图 6：IP6X 试验后照片

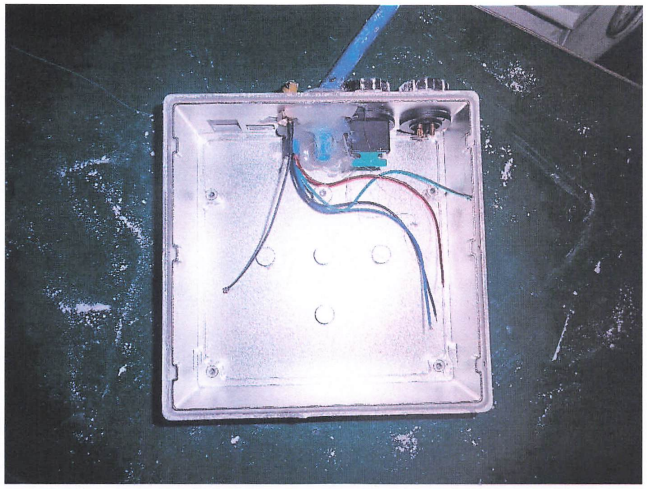


图 7：IP6X 试验后内部照片

*** 报告结束 ***

11.1.4 GB5226-1-2019/IEC60204-1:2016 *Safety of machinery - Electrical equipment of machines General requirements*
GB4943.1-2022/IEC62368-1:2018
Audio/video,information and communication technology equipment Safety requirements

EASYTEST

Efficient Accurate Sincere
Your best choice!

检 测 报 告

产品名称：灵鸮 AI 终端

申请型号：DSKJ-UMA8-001

申请人：北京谛声科技有限责任公司

依据标准：GB 4943.1-2022
GB/T 5226.1-2019

报告编号：ET202312130122-S

发布日期：2023年12月12日

声明：

本报告实验结果仅对受试样品有效，未经许可本报告不得复制，对本报告如有异议，请于收到报告之日起十五天内提出。

安全型式试验报告

样品名称：	灵鸮 AI 终端	申请人：	北京谛声科技有限责任公司
型号：	DSKJ-UMA8-001	申请人地址：	北京市海淀北二街 8 号中关村 SOHO A 区 916 室
商标：	/	制造商：	同申请人
数量：	1	制造商地址：	同申请人地址
生产序号：	/	生产厂：	同申请人
		生产厂地址：	同申请人地址

试验依据标准：

GB 4943.1-2022 《信息技术设备 安全 第 1 部分：通用要求》

GB/T 5226.1-2019《机械电气安全 机械电气设备 第 1 部分：通用技术条件》

试验结论：　本设备所测项目符合相关标准要求

主检：韩璨

签名：韩璨　日期：2023.12.12

审核：崔瑞超

签名：崔瑞超　日期：2023.12.12

签发：王子强

签名：王子强　日期：2023.12.12

Easy Test (Beijing) Technology Co., Ltd. 易测（北京）科技有限公司 检测专用章

（检测机构名称、盖章）

2023年12月12日

备　　注：/

样 品 描 述

安全样品描述及说明：

设备移动性：　[　]可移动式 [　]手持式 [　]驻立式 [√]可携带式 [　]永久性连接式
[　]直接插入式　[　]嵌装式

安全说明：　[√]汉文 [　]藏文 [　]蒙古文 [　]壮文 [　]维文 [　]其它

适用地区环境：[√] ≤海拔2000米 [　]≤海拔5000米 [　]不适用

适用气候条件：　[　]热带气候条件下 [√]非热带气候条件下

与电源的连接：　[√]可插式设备 [√]A型　[　]B型
[　]永久性连接式 [√]可拆卸电源软线 [　]不可拆卸电源软线
[　]不直接连接到电网电源

工作方式：　[√]连续工作　[　]短时工作　[　]间歇工作

接触区域：　[√]操作人员可触及的　[　]限制接触区域

过电压等级（OVC）：　[　]OVCI　[√]OVCII　[　]OVCIII　[　]OVCIV

电源容差（%）：±10%

进行IT配电系统试验：　[　]是　[√]否
进行IT配电系统试验，相－相电压（v）：/
设备类别：　[　]I类　[√]II类　[　]III类　[　]其他类
污染等级（PD）：　[　]PD1：　[√]PD2　[　]PD3
预定要安装在墙壁或天花板的设备：[　]是　[√]否
设备的质量（kg）：/
IP防护等级：/

安 全 测 试 报 告

1. 检验开始前对被检样品的确认
样品的包装完好 [√]　样品未发现异常 [√]　尚可满足检验需要 [√]
样品数量符合检验需要 [√]　样品实物与委托单填写内容相符 [√]
样品应带附件齐全 [√]　样品附带文件齐全 [ ]

2. 在本报告中: " P "表示该项检验结果符合标准要求;
" F "表示该项检验结果不符合标准要求;
" N "表示该项要求不适用; 或此次未进行检验。
在本报告中,以" [ ]"形式提供选项时, " [√]"表示该项被选中。
"(见附表)"指本报告的附加表格。

3. 在本次检验过程中:无补充、更换样品 [√]
曾补充样品　　个, 时间为　　年　月　日。[ ]
曾更换样品　　个, 时间为　　年　月　日。[ ]

4. 本次检验开始日期　2023 年 11 月 29 日
检验结束日期　2023 年 11 月 29 日

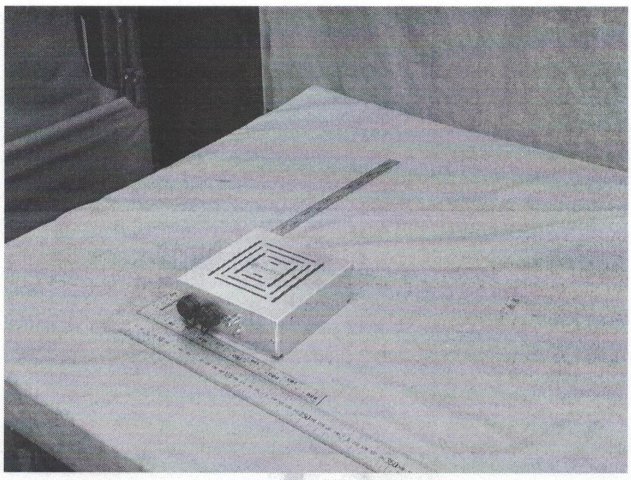
5. 本次试验使用了以下辅助设备 [ ]
设备名称:　　型号规格:
生产厂:　　连接方式:
工作状态:
本次试验没有使用辅助设备 [√]

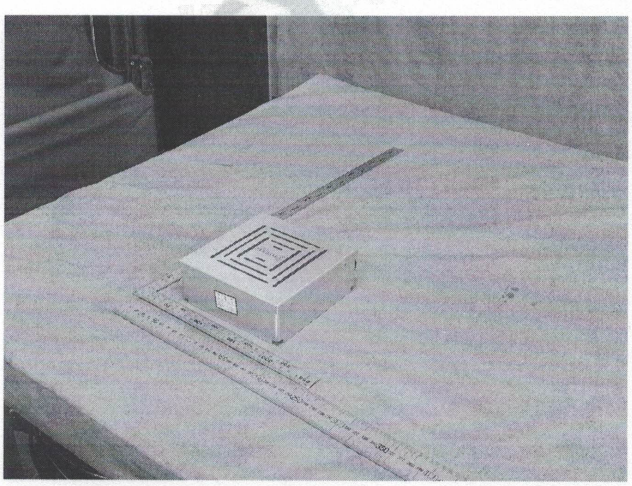
6. 本次检验无任何标准偏离。[ ]
本次检验有一些标准偏离,情况如下: [√]
经检查, 本设备内部不含有任何疑似吸湿材料, 因此与客户协商后, 耐压试验之前未进行潮湿预处理。

7. 本次检验覆盖型号与主检型号之间的差异见下表。
单一型号

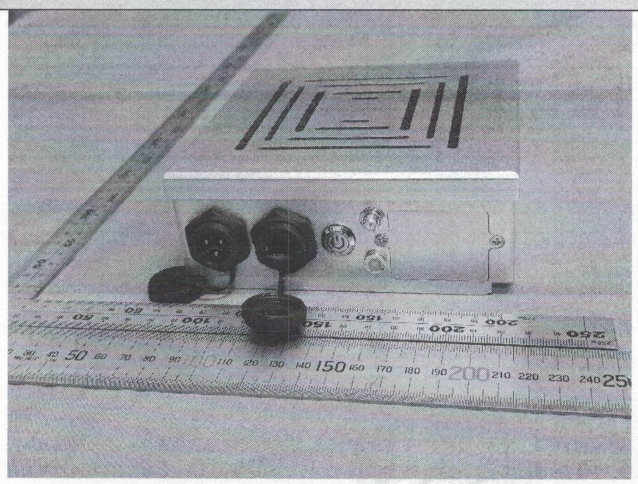
样 品 铭 牌
暂无

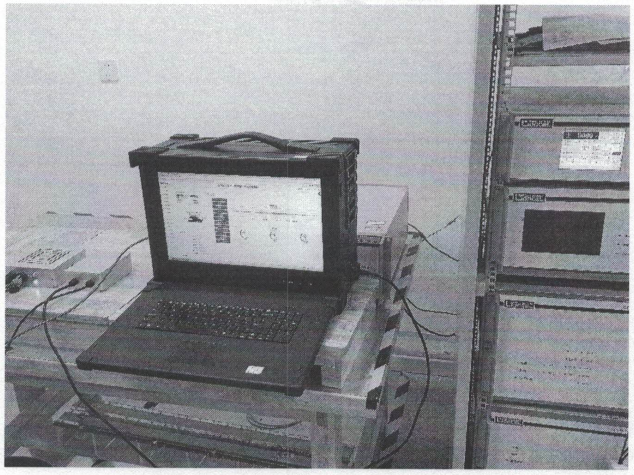
样 品 照 片





样 品 照 片





GB 4943.1-2022			
条款	试验要求	试验结果	结论
5.4.9	抗电强度试验		P
5.4.9.1	固体绝缘式试验的试验程序	(见附表5.4)	P
5.4.9.2	例行试验的试验程序	(见附表5.4)	P

5.4.9	表:抗电强度试验和电压冲击试验	P
试验电压施加部位:	试验电压(V)	击穿　是/否
N-适配器外壳	2000V	否
L-适配器外壳	2000V	否
适配器-产品内部	5000V	否
/		

GB/T 5226.1-2019			
条款	试验要求	试验结果	结论
18.3	当执行绝缘电阻试验时，在动力电路导线和保护联结电路间施加 500Vd.c 时测得的绝缘电阻不应小于 100MΩ。	见附表绝缘电阻检测 (18.3)	P

试验项目 TEST ITEM	绝缘电阻检测 (18.3) Insulation resistance tests		本项目 适用 ☒　不适用
测试位置 Accessible Conductive Part	测试电压(V) Voltage attained	测试电阻（要求不小于 1 00 MΩ） Resistance (not less than 100 MΩ).	
		实测电阻(MΩ) Resistance measured	限值(MΩ) Limit
L线到外壳	500	10096	100
N线到外壳	500	9674	100
备注：/			

试验仪器设备清单

序号	仪器设备名称	型　号	编　号	校准有效期至	本次使用（√）
1	耐压测试仪	CS2672CX	ET-S-001	2024/03/08	√
2	绝缘电阻测试仪	CS2676CX	ET-S-002	20240/3/06	√
3	示波器	TBS1102	ET-S-006	2024/03/05	
4	万用表	F15B+	ET-S-008	2024/03/05	√
5	卷尺	/	ET-S-011	2024/03/09	
6	游标卡尺	（0~200）mm	ET-S-014	2024/08/15	
7	接地阻抗测试仪	CS5800A	ET-S-015	2024/08/22	
8	多路温度测试仪	AT4532	ET-S-023	2024/04/10	
9	直流稳压电源	GPS-2303C	ET-S-024	2024/03/05	
10	交流稳压电源	JJ98DD63C	ET-S-025	2024/03/08	
11	泄漏电流测试仪	ST5540	ET-S-035	2024/08/15	
12	扭力扳手	TLB0-20N·m	ET-S-044	2024/08/14	
13	功率计	WT210	ET-S-045	2024/08/16	
14	电子负载	DL3021	ET-S-046	2024/08/16	
15	球压试验仪	AYQ	ET-S-048	2024/05/10	
16	0.5J 弹簧冲击锤	SZZT-103	ET-S-051	2024/08/15	
17	读数显微镜	JC-10	ET-S-064	2024/03/08	
18	数显推拉力计	VICTOR 500N	ET-S-065	2024/03/06	
19	100x 探头	HP9258	ET-S-067	2024/03/07	
20	声级计	UT352	ET-S-071	2024/08/14	
21	EMC 测试控制系统	SCU-614A	ET-E-006	/	√
22	雷击浪涌发生器	LSG-506CB	ET-E-011	2024/08/02	√

注：打“√”为本次检验使用仪器、设备，所有仪器、设备均在校准有效期内。

声　明

1. 本报告无本检测机构印章无效。
2. 本报告无编制人、主检人、审核人、批准人签字无效。
3. 报告涂改无效。
4. 试验结果仅对被试样品有效。
5. 报告部分复制无效。
6. 若对本报告如有异议，应于收到报告之日起十五天内向本检测机构提出，逾期不予受理。

检测机构：易通测（北京）科技有限公司

地址：北京市海淀区清河西三旗东路平房 11 幢 101-103

邮政编码：100084

电话：010-56211488

网址：www.easy-test.org

电子邮箱：info@easy-test.org

11.2 To Be Complied Standards

Test listed below will be complied around end of April 2025.

11.2.1 EN 50155:2017 *Railway applications — Rolling stock equipment — electronic equipment*

11.2.2 GB/T21563-2018/IEC61373:2010 *Railway applications — Rolling-stock equipment — Shock and vibration tests*

12 Factory Test Report

The following test report is not the final version, it is just a sample from another test batch. The final version will be provided after the manufacturing and test are completed.

Confidential

1. 项目信息

项目名称		项目编号	
项目阶段	已完成	项目型号	RK3588-SOM
测试开始日期	2024/11/18	测试结束日期	2024/12/2

2. 测试样品信息

样品序号	SN	ID	IP	位置	软件信息	ITS测试中测试地址	备注
1	0900101240307004	LS-07004-133	192.168.0.133				
2	0900101240307008	LS-07004-137	192.168.0.137				
3	0900101240307009	LS-07004-138	192.168.0.138				
4	0900101240307015	LS-07004-144	192.168.0.144				

飞力1.0 固件及硬件信息			
固件版本	FLY-LINUX-V3.1.0(build of 2024-0910-144658)	核心板型	6.1PSP130MINI_V1.0
实际内核版本	V5.0.0(build of 2024-0910-1551)		4GHZ/16Gb+
驱动版本	V1.0.0(update of 2021-1021)		无
固件版本	V1.0.0(update of 2021-0126)	MQTT	MQTT2.0
DONGTT固件版本	V2.0.0(update of 2022-1028)		以太网
DOTC固件版本	V1.0.0(update of 2022-1028)		192.168.0.100
静态版本	Rock_Version_003		中国
出厂日期	2024-0307-06:05	网络设置	255.255.0.0
主控型号	RK_mCPU_RP_V1.0.1		192.168.1.1
序列号版号	RK_EMBOX_RP_V1.0.1		国产
设备地址	The board is compatible with codec collect		192.168.0.100
Copyright © 2015 北京迅声科技 www.ensonictech.com All rights reserved		字幕设置	关闭
			关闭

3. 测试项目总览

测试项目	本次是否测试	结论	结果	问题描述	备注
外观检查	是	已完成	Pass		
组件完整性	是	已完成	Pass		
CAN 测试	否	否			
485测试	否	否			
以太网测试	否	否			
4G测试	否	否			

4. 初检问题

SN	硬件版本	软件版本	问题描述	问题状态

初检故障描述：

问题序号	问题描述	优先级	负责	进度	解决方案	状态
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Confidential

功能测试

硬件版本	FX3-LINUX-V3.1.6(build of 2024-0910-1446SD)	软件版本	V5.0.0(build of 2024-0910-1351)
测试人员	李丽	测试日期	2024/12/2

试验设备/环境照片

测试目的：检查设备外观，测试各项功能是否实现

测试项目	样机数量	测试条件和方法	测试标准	测试数据	测试结果
外观结构检查	4	1）装置采集箱应采取必要的防电磁骚扰措施，采集箱的外露导电部分应在电气上连成一起，并可靠接地； 2）机箱应满足发热元器件的通风散热要求； 3）机箱模件应插拔灵活、接触可靠、互换性好； 4）外表涂敷、电镀层应牢固均匀，光洁，不应有脱皮锈蚀	无明显外观缺陷，不能有与产品定义不一致信息		Pass
接口功能检查	4	根据产品定义，检查产品需支持的接口功能是否实现 包括不限于以下接口： USB/LAN/SATA/Audio/WIFI/HDMI/电源口/MircoSD/按键/I/O口等（产品定义超出此范围的按产品定义进行）	各接口功能正常 可以打开前端网页，功能模块正常显示，波形图正常显示，播放故障音能可预警。		Pass
Web端	4	1.Web正常打开显示 2.Web相关功能正常	可以打开Web端网页，可以正常配置网页。		Pass
端设备异常	4	1.短时断电（10s） 2.短时断网（10s） 3.长时断电（10min） 4.长时断网（10min） 5.交换机断电 6.服务器断网	断电、断网、交换机、服务器恢复通电、通网后，可以打开前端网页，功能模块正常显示，波形图正常显示，播放故障音能可预警。		Pass
数据存储	4	1.数据是否保存 2.导出wave 3.数据通断对算法的影响	1. 数据可以保存在终端上 2. 可以从终端导出wave文件 3. 数据断开再恢复后对于算法没有影响		Pass
平台端	4	1.平台端正常打开显示 2.平台端相关功能正常	可以打开平台端网页，可以正常显示设备，配置设备，相关功能正常。		Pass

样品情况

样品序号	初检问题	外观结构检查	接口功能检查	Web	端设备异常	数据存储	平台						测试结果
1													Pass
2													Pass
3													Pass
4													Pass
5													Pass
6													Pass
7													Pass
8													Pass

测 试 结 论： PASS

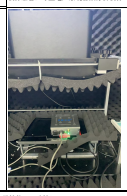
不 良 附 图：

附图1

附图2

Confidential

声学测试报告

软件版本	PX3-LINUX-V3.1.6(build of 2024-0910-1446S8)	软件版本	V5.0.0(build of 2024-0910-1351)
测试人员	陈采荣	测试日期	2024/12/2
测试条件	测试环境：消声箱 硬件准备：1、标准采集卡（低底噪+带输入/输出通道）；2、标实；3、网轴音箱 软件准备：专业电声系统音频分析软件-adobe音频分析软件		
试验设备/环境照片			

测试目的：测试灵讯产品的声学性能（一致性）

测试设备工作：测试灵讯产品的声学性能（一致性）

测试项目	样机数量	测试条件和方法	测试准备	测试标准	测试数据	测试结果
底噪测试	4	step1：将灵讯设备放置在消声箱中的固定位置，在平台软件端录制20s底噪信号，暂存wav文件 step2：使用adboe软件，导入标实底噪wav与灵设备底噪wav，对比分析其差异	step1：将标实连接采集卡并固定于消声箱中； step2：使用标实校准音箱，并输出校准后信号，作为标准信号源； step3：标实录制白噪/扫频/单频/底噪信号，并保存wav文件	二者采集的底噪信号差异是否满足要求	录制的wav文件存档至公盘	Pass
白噪频响	4	step1：将灵讯设备放置在消声箱中的固定位置，在平台软件端录制20s白噪信号（SD-20kHz），暂存wav文件 step2：使用adboe软件，导入标实白噪wav与灵设备白噪wav，对比分析其差异		二者采集的白噪信号差异是否满足要求	录制的wav文件存档至公盘	Pass
1kHz单频测试	4	step1：将灵讯设备放置在消声箱中的固定位置，在平台软件端录制10s单频信号（-20dB/1kHz正弦），暂存wav文件 step2：使用adboe软件，导入标实单频wav与灵设备单频wav，对比分析其差异		二者采集的单频信号差异是否满足要求	录制的wav文件存档至公盘	Pass
扫频测试	4	step1：将灵讯设备放置在消声箱中的固定位置，在平台软件端录制60s扫频信号（SD-20kHz步进扫频），暂存wav文件 step2：使用adboe软件，导入标实扫频wav与灵设备扫频wav，对比分析其差异		二者采集的单频信号差异是否满足要求	录制的wav文件存档至公盘	

样品情况

样品序号	初始问题			备注	测试结果

测 试 结 论：

不 良 附 图：

Confidential

稳定性测试报告

硬件版本	PX3-LINUX-V3.1.6(build of 2024-0910-1440S8)	软件版本	V5.0.0(build of 2024-0910-1351)
测试人员	陈朵朵	测试日期	2024/11/18-2024/12/2
试验设备/环境照片	 		

测试目的:测试设备长时间压力测试情况下的稳定性

测试项目	样机数量	测试条件和方法	测试标准	测试数据	测试结果
14Day运行	4	经过2天监控，每天检查在线设备状态	设备无掉线，重启，设备监测状态异常等情况		Pass

样品情况

样品序号	初检问题	第一轮48小时长时间运行	第一轮96小时长时间运行	第三轮96小时长时间运行	测试结果
1	无	无	无	无	
2					
3					
4					
5					
6					
7					
8					

测 试 结 论： PASS

不 良 附 图：	