New Energy Vehicle Safety Compliance Testing Equipment Proposal Document

Qingdao Yidi Electronics Co., Ltd.

Company website: www.idi-e.com

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I. Company Profile

1.1 Company Profile

In 1998, Qingdao Yidi Electronics Co., Ltd. was founded on the principle of integrity. Over more than two decades, Yidi Electronics has embraced its inherent innovative spirit and pursued vigorous growth, establishing its distinctive position within the global high-end manufacturing landscape. With innovation at its core, the company specializes in the research and development of intelligent electronic measurement instruments for the high-end manufacturing sector, supporting premium manufacturing practices and safeguarding everyday safety. Dedicated to quality – our unwavering commitment.

The launch of each new product marks the beginning of a dream. Our seasoned R&D team, dedicated with full commitment, delivers high-quality products and comprehensive services to our customers.

Dozens of scientific and technological invention patents, information technology integration, 6S lean management practices, and international quality management system certifications such as ISO 9001 ensure that every minute detail is infused with technological innovation.

Yidi Electronics boasts a team of senior R&D technical experts and offers globally leading laboratory instruments. The company has established "High-Tech Product and Development Strategic Cooperation" partnerships with prestigious institutions such as the Ocean University of China and Qingdao University, as well as various universities and research institutes. Talent, technology, and innovation form the foundation upon which Yidi operates and serve as the inexhaustible driving force behind the company's sustainable development.

1.2 Scope of Services

As a pioneer in China's testing instrument industry, Yidi Electronics independently develops and manufactures a wide range of high-precision products, including fully automated safety compliance testing instruments, specialized safety compliance testing equipment for new energy vehicles, high-precision intelligent variable-frequency power supplies, comprehensive motor testing systems, and multifunctional power analyzers.

The product range includes over 100 product models, such as the IDI-V68XX series safety certification testing systems for new energy vehicles; the IDI-H3XX series testing systems for power batteries, vehicle controllers, and drive motors; the IDI-V2XX series charging function testing systems for new energy vehicles; the

IDI-V5XX series discharge function testing systems for new energy vehicles; safety certification testing instruments from the MN427X, MN428X, and MN429X series; comprehensive motor stator testing instruments; complete motor system testing systems; intelligent dynamometer testing systems; single-and three-phase variable-frequency power supplies; electrical parameter meters; electronic loads, and more.

Yidi Electronics has emerged as an integrated supplier offering one-stop solutions across a wide range of industries, covering applications such as household appliances, new energy, power tools, medical devices, and electric motors. The company's product sales and service network spans China, as well as regions across Asia, Europe, and North America.

The company is headquartered in Qingdao and has established branch offices in Guangdong, Zhejiang, Jiangsu, Chongqing, and other regions, creating a synergistic service network characterized by complementary resources.

Yidi Electronics' customers are widely distributed across:

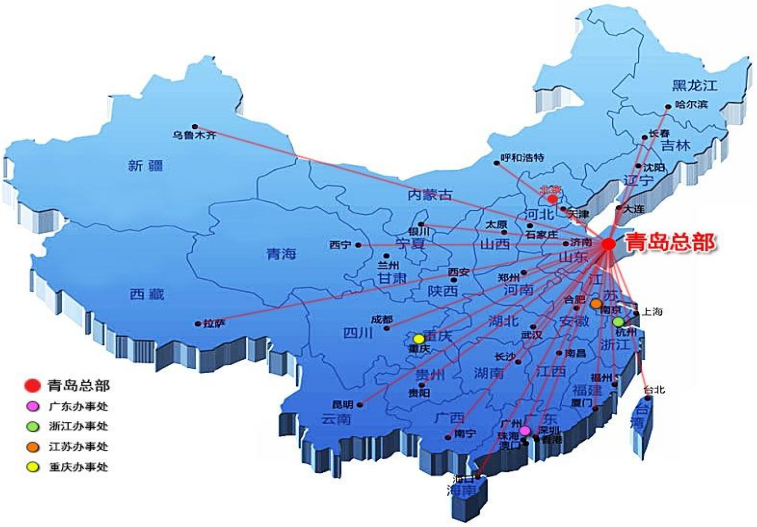
New energy sector: BAIC, Geely, Changan, FAW, SAIC, GAC, Great Wall, etc.

Home appliance sector: Haier, Midea, Gree, Hisense, Robam, Fotile, Philips, etc.

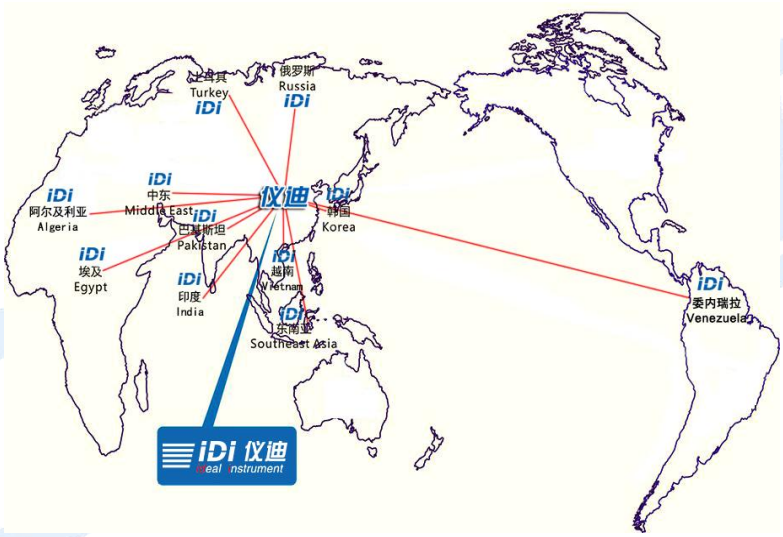
Motor industry: Leili, Wolong, Sanfeng, Grieb, Jingqi, Lake, Kaiheng, etc.

The trust and reputation of our customers serve as the driving force behind Yidi's relentless pursuit of excellence.

Thanks to its superior product quality, Yidi Electronics has been honored with numerous awards, including the National High-Tech Enterprise designation, the Qingdao Famous Trademark certification, the Qingdao SME Specialized, Refined, and Unique Product Technology Certificate, the Qingdao Outstanding Software Product Certificate, and the Software Product Certificate issued by the National Software Industry Association.



Domestic product sales and service network showcase



International product sales and service network showcase

In response to growing societal demand, an increasing number of manufacturers across the electrical equipment manufacturing sector and the innovative industries—specializing in new energy vehicles and their components—have emerged. To safeguard consumers' rights and establish unified safety standards for electrical products upon leaving the factory, regulatory authorities have also been established and are continuously updating new regulatory documentation in line with the evolving needs of these industries. For consumers, there is greater concern than ever about protecting their legal rights and interests; therefore, electrical products that do not meet safety standards should not reach end-users. For manufacturers, it is imperative to strive to elevate their products' safety performance to comply with national safety requirements; during product design, every effort must be made to eliminate any potential risk of electric shock for users—ensuring that no electric shock occurs even in the event

of improper operation by the user.

1.3 Safety Regulations Introduction

National standards for new energy vehicles, as well as European and American standards, require manufacturers to conduct a series of electrical safety performance tests during the design and manufacturing of new energy vehicles; these standards mandate that products undergo the following tests: "charging port insulation resistance test," "potential balancing test," "overall vehicle insulation resistance test," "insulation monitoring verification function test," and "capacitive coupling test."

To more comprehensively verify the safety of new energy vehicles, automakers may selectively incorporate additional tests such as "AC/DC withstand voltage tests" and "charging port leakage current tests." The test components targeted by these procedures may include the charging socket or high-voltage components. Additionally, out of concern regarding whether the vehicle's charging or discharging functions are operating correctly, automakers may introduce "charging function testing" and "discharging function testing" — using specialized testing equipment instead of conventional charging stations — to enable large-scale storage and traceability of test data.

Certain special product stages must undergo safety performance testing:

During the initial design phase – verify whether the functionality of the designed product meets the expected requirements.

Upon completion of product manufacturing – verify whether the manufactured products meet the specified specification requirements.

Product quality assurance testing – Verify whether the product meets the safety performance requirements specified at the time of factory release.

Upon completion of post-maintenance work – ensure that the product still meets the required safety performance standards after repair.

The new energy vehicle safety compliance testing items are as follows:

Mandatory test items: Charging port insulation resistance test, Potential balancing test, Overall vehicle insulation resistance test, Insulation monitoring verification function, Capacitive coupling;

Recommended test items: AC withstand voltage or DC withstand voltage test; charging port leakage current test; AC charging function verification; DC charging function verification; discharge function verification, etc.

Most vehicle manufacturers require the testing of the entire vehicle or of individual components—either some or all of these tests. Based on actual requirements, production cycle times, and other factors, manufacturers can comprehensively plan their workstation layouts; the Yidi Testing System allows for the flexible integration of these various testing items.

For organizations using safety measurement instruments, selecting high-quality safety measurement equipment is the primary task for optimizing production line structures, enhancing production line automation levels, and meeting stringent requirements for high-precision, high-efficiency, and high-standard metrology.

1.4 Quality Control

Yidi consistently adheres to its business philosophy of "Professional Quality, Unwavering Commitment," leveraging cutting-edge technology to jointly pursue the expansion of the testing market and strive to provide customers with high-quality products and services. As a result, the company has earned widespread respect and trust from both domestic and international clients.

Yidi boasts a highly skilled service team comprising over 20 customer service representatives. Across almost every region in China, Yidi's after-sales service personnel provide timely and attentive support. The company assigns dedicated staff to address customer inquiries, ensuring a response within 24 hours.

II. Testing Equipment System Composition

2.1 Equipment Introduction

This testing system is suitable for pure electric or hybrid-powered vehicles (series, parallel, or hybrid configurations); the equipment incorporates state-of-the-art design concepts and complies with the latest Chinese national standard requirements.

Table 2-1 – Equipment List

Order number	name	quantity	unit	test item	source
1	Specialized Safety Standard Testing System for New Energy Vehicles	1	Taiwan	Used for insulation resistance testing of vehicle charging ports, potential balancing testing, overall vehicle insulation resistance testing, insulation monitoring verification function, capacitive coupling calculation, steady-state contact current testing of charging sockets, and voltage drop testing of charging sockets.	Power supply: AC 380 V ±10%, 50/60 Hz ± 5% Rated power: 33 kW
Note: The testing system was independently developed, manufactured, and validated by Yidi Electronics, which also provides corresponding technical guidance, after-sales service, training services, and more.					

Table 2-2 – Equipment Configuration List

Order number	device	brand	Model/Specifications	quantity
1	IPC	Advantech	Advantech IPC-510, Intel Core	1

			i7-6700,16 GB RAM, 2 × 2 TB hard drives; Windows 10 64-bit Professional Edition	
2	indicator	Samsung	21.5 inches	1
3	UPSsource	Santek	Power supply for more than 30 minutes	1
4	Wireless 2D scanning gun	zebra	DS3678SR	1
5	National Standard AC Charging Cable	Yidi Customizatio n	10 meters	1
6	National Standard AC Charging Adapter Kit	Yidi Customizatio n	Used for controlling the on/off state of AC charging and signal acquisition	1
7	National Standard DC Charging Gun	Yidi Customizatio n	10 meters	1
8	National Standard DC Charging Adapter Kit	Yidi Customizatio n	Used for controlling the DC charging on/off operation and signal acquisition.	1
9	High-voltage test cable	Yidi Customizatio n	For connection to the vehicle's high-voltage busbar	1
10	OBD communication cable (including OBD II connector)	Qingdao Yidi	10 meters	1
11	Safety Compliance Tester	Qingdao Yidi	IDI-M680XGL	1
12	High-precision power analyzer	Qingdao Yidi	0.2-class measurement accuracy	1
13	Steady-state contact current tester	Qingdao Yidi	IDI682X Series	1
14	Handheld remote probe (for potential balancing test)	Qingdao Yidi	10 meters long	1
15	I/O control unit	Qingdao Yidi	IDI-M8100GN	1
16	New Energy Vehicle Interactive Unit	Qingdao Yidi	IDI-M8600GH	1
17	control cabinet	Yidi Customizatio n	RAL7035 color tone	1

18	Test the host computer software	Qingdao Yidi	ESRS	1

2.1.1 National Standards for Equipment Implementation

GB18384—2025; Safety Requirements for Electric Vehicles

GB/T 20234.1—2023; Connecting devices for the conductive charging of electric vehicles – Part 1: General requirements

GB/T 20234.2–2015; Connecting devices for the conductive charging of electric vehicles – Part 2: AC charging interfaces

GB/T 20234.3—2023; Connection devices for the conductive charging of electric vehicles – Part 3: DC charging interfaces

GBT 18487.1–2023; Electric vehicles – Conventional charging systems – Part 1: General requirements

GB 7258—2017; Technical Requirements for the Operational Safety of Motor Vehicles

QCT895–2011; Conductive On-board Charger for Electric Vehicles

GB 4793.1–2007; Safety requirements for electrical equipment for measurement, control, and laboratory use

2.1.2 Test Setup

New energy vehicle safety compliance testing equipment can be used in various stages, including new vehicle type approval testing, prototype testing for new vehicles, and final inspection during mass production.
Due to the equipment's high-voltage output capability, the testing station must be equipped with proper insulation protection measures, including the installation of insulating floor mats, to ensure the station remains orderly and clean; operators shall wear insulating protective gear as required and perform their tasks in strict accordance with the operating procedures.

2.1.3 Test System Features

- Test data is visually displayed on the computer and uploaded to the MES server to enable digital data management;
- High testing accuracy; the basic accuracy for safety compliance testing is 1%.
- Reliable operation: The entire circuitry of this series of testers incorporates multiple anti-interference

measures, ensuring strong immunity to electromagnetic interference. The instrument utilizes Sinusoidal Pulse Width Modulation (SPWM) technology to generate standard 50 Hz or 60 Hz sinusoidal waves, which are then driven out via high-power MOSFETs, enabling contactless adjustment of high voltage and high current. Additionally, the instrument features both hardware and software protection mechanisms, significantly enhancing its overall reliability.

- Safe operation: Features automatic short-circuit protection, ground fault protection, and a load self-locking switch for enhanced safety;
- Top-tier components are selected. The hardware configurationon utilizes high-quality components, with the majority sourced from leading international brands.

2.1.4 Test System Host Computer Software Features

- A barcode scanner can be used for scanning and testing, as well as for automatically retrieving test groups, etc.
- Upload test data to the MES system to enable systematic and digitalized management;
- Supports massive local data storage, with convenient and efficient generation and export of reports in various formats;
- The display interface is intuitive and user-friendly, with straightforward parameter settings;
- You can configure multi-level permissions (e.g.), for administrators) to protect instrument testing information.

2.2 Test System Detailed Description

2.2.1 Test Item Overview

2.2.1.1 Potential Balance Test

The potential balancing test for vehicle high-voltage components and charging ports involves the test system outputting an adjustable direct current; a test clamp, connected via the test system's potential balancing output port, is then attached to the exposed metal casing of each component to be tested; the charging gun, connected via its output port, is plugged into the corresponding charging port; simultaneously, a clamp is used as the circuit return connection to the vehicle frame; the conductive resistance between each component's measurement point and the

vehicle frame (within a distance of no more than 2.5 m) as well as the conductive resistance between the PE terminal of the charging port and the vehicle frame (within a distance of no more than 2.5 m) are measured.

The connection impedance between the PE wire of all tested high-voltage components or charging ports and the vehicle frame shall not exceed 0.1 Ω.

In the potential balancing circuit, the resistance between any two exposed conductive parts that can be touched by a person simultaneously—that is, between two conductive parts separated by a distance of no more than 2.5 m —shall not exceed 0.2 Ω.

The testing system can automatically calculate the connection resistance between any two high-voltage components.

Figure 2-1 – Vehicle Schematic Diagram

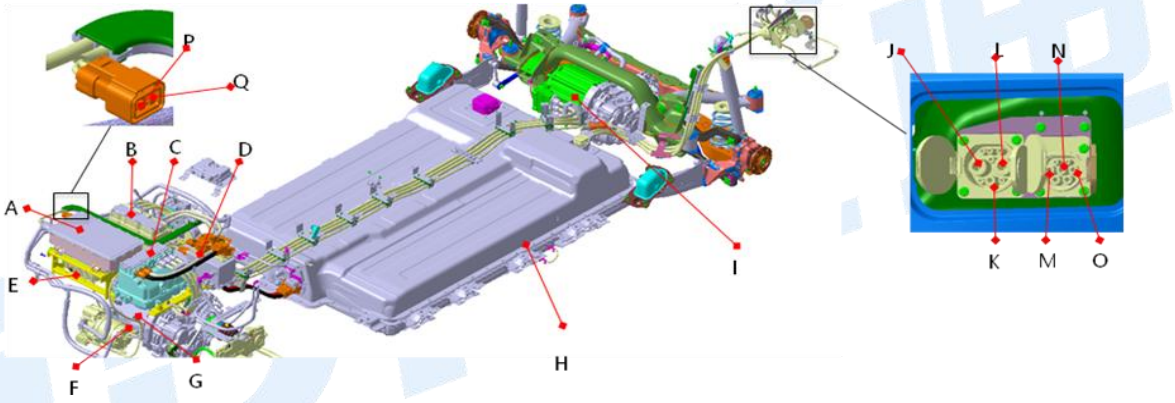


Table 2-3: Areas where potential balancing measurements are recommended for new energy vehicles

Order number	Potential equilibrium test site	Recommended test conditions	Acceptance standard	remarks
1	DC charging port (PE) – Vehicle Body	Test current ≥ 1 A; Voltage <60 V	< 0.1Ω	
2	AC charging port (PE) – Vehicle Body	Test current ≥ 1 A; Voltage <60 V	< 0.1Ω	

3	PTC housing relative to the vehicle body	Test current ≥ 1 A; Voltage <60 V	< 0.1Ω	
4	Motor housing relative to the vehicle body	Test current ≥ 1 A; Voltage <60 V	< 0.1Ω	
5	Air conditioning compressor for the vehicle body	Test current ≥ 1 A; Voltage <60 V	< 0.1Ω	
6	Controller for the vehicle body	Test current ≥ 1 A; Voltage <60 V	< 0.1Ω	
7	DCDC for the vehicle body	Test current ≥ 1 A; Voltage <60 V	< 0.1Ω	
8	OBC (Charger) – For vehicle body	Test current ≥ 1 A; Voltage <60 V	< 0.1Ω	

Note: The number of test channels required for the potential balancing test of high-voltage components shall be determined by Party A based on the total number of components to be tested;

The names of all high-voltage components can be edited; the edited names can then be uploaded to the server or printed alongside the test data.

Potential balancing detection method:

The operator holds a probe to test each item individually; the probe is equipped with an activation button, audible and visual alarm signals, and other features.

Potential Balance Testing Fixture

2.2.1.2 Charging Port Insulation Resistance Test

Charging port insulation resistance refers to the total resistance between the conductive components of the vehicle's charging port's high-voltage terminals and the charging port's PE terminal; it is the simplest and most commonly used method for evaluating the insulation performance of a vehicle's charging port. The basic measurement principle of insulation resistance is based on Ohm's Law: a specified DC voltage is applied across the conductive and non-conductive components of the vehicle under test, generating a leakage current across the insulating medium under this applied voltage; by measuring and calculating this current value, it can be converted into a resistance value.

The primary purpose of this test is to assess the safety performance between the charging port's high-voltage terminal and the vehicle chassis (ground) using fast-and slow-charging guns; it involves applying a DC high-voltage supply greater than the vehicle's operating voltage to detect any insulation failures, short circuits, or other faults between the charging port's high-voltage terminal and the vehicle chassis; during the test, the vehicle must be powered off to ensure that all electrical and electronic switches on the vehicle are in a non-activated state.

Test the insulation resistance of the charging socket using an AC/DC charging gun; the testing method is as follows:

① Disconnect the vehicle's power supply to ensure that all electrical and electronic switches on the vehicle are in the non-activated state;

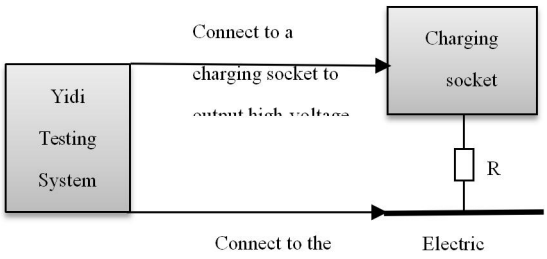
② Short-circuit the high-voltage terminals of the charging socket – namely the positive and negative terminals of the DC charging socket or the L1, L2, L3, and N terminals of the AC charging socket – using a conductive wire;

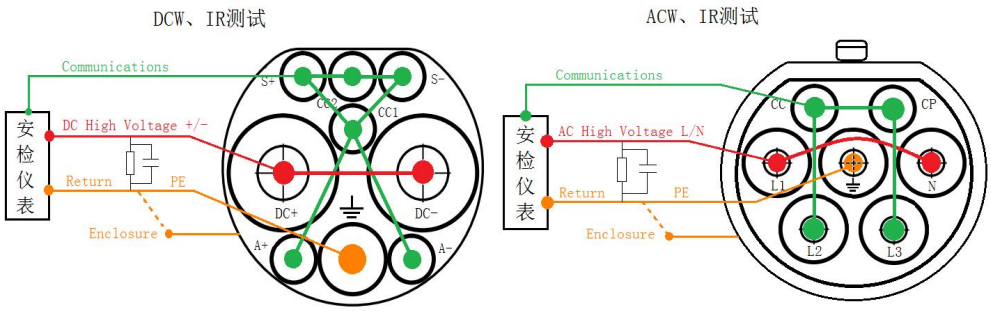
③ Connect the two probes of the insulation resistance testing device to the high-voltage terminal of the charging socket and the ground terminal, respectively.

The testing equipment's detection voltage shall be greater than the maximum operating voltage of the entire vehicle.

Note: Our testing system enables the detection of whether the charging gun is properly inserted before the high-voltage output is activated; this ensures that the charging gun is indeed connected, thereby preventing inaccurate insulation resistance measurements caused by improperly connected test cables.

Test Principle





DC port testing schematic diagram | AC port testing schematic diagram

DC port testing schematic diagram | AC port testing schematic diagram

2.2.1.3 Complete Vehicle Insulation Resistance Test

The entire vehicle insulation resistance test is available in two modes:

1、The vehicle to be tested is subjected to testing under Class B voltage conditions; this is known as active testing, which involves using the vehicle's own high-voltage power supply to perform an insulation resistance test on the entire vehicle system;

2、Testing of vehicles under conditions excluding Class B voltage is referred to as passive testing; this involves using an external device to apply high voltage to the vehicle in order to measure the insulation resistance value of the entire vehicle system.

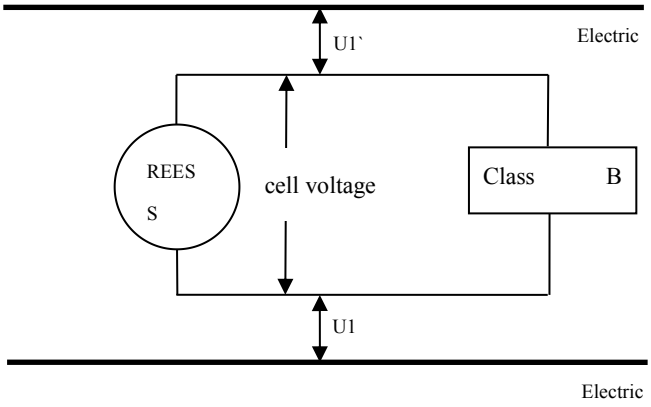
Full-vehicle insulation resistance active test:

carload insulation resistance test	The insulation resistance value of the entire vehicle is calculated by measuring the voltage value and adding a known standard resistor, in accordance with the formula specified in GB 18384-2025. A known standard resistor is built into the testing system; all changes to the test wiring throughout the entire testing process are automatically

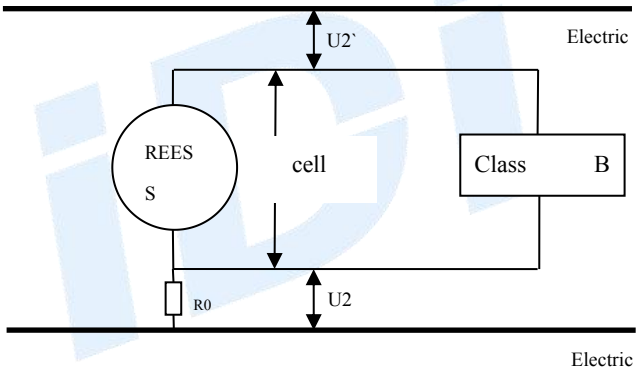
The testing method is as follows:

① Power on the vehicle to ensure that all electrical and electronic switches are in the activated state;

② Measure the voltage between the two terminals of RESS and the power supply using the voltage detection module 自制 by Yidi; as shown in the figure, the higher voltage is labeled U1 and the lower voltage is labeled U1′;



③ A known resistor R0 with a resistance value of 1 MΩ is connected in parallel between the U1-sidee terminal of the REESS and the reference platform; then, a custom-built voltage measurement module developed by Yidi is used to measure the voltage across the two terminals of the REESS and the reference platform; the measured values are denoted as U2 and U2′.



④ To calculate the overall vehicle insulation resistance (Ri), follow these steps:

Ri can be calculated by substituting R0 and the four voltage values U1, U1` U2 和 U2` and the internal resistance r of the voltage detection device into the formula:

$$R_i = \frac{1}{\frac{1}{R_0\left(\frac{U_2'}{U_2}-\frac{U_1'}{U_1}\right)}-\frac{1}{r}}$$

By following the above steps, the insulation resistance test for the entire vehicle under Class B voltage is completed. The testing process is fully automated; personnel only need to perform the wiring task prior to testing, and no equipment operation is required during the testing process.

The equipment is equipped with a wired OBD communication cable; when communicating with the vehicle's OBD system, the vehicle's insulation monitoring function must be disabled prior to conducting the B-class voltage vehicle insulation resistance test (Party A shall provide the protocol for disabling this function).

Full-vehicle insulation resistance passive test:

The overall insulation resistance of a vehicle refers to the total resistance between the conductive components of the vehicle's Class B voltage circuits and the non-conductive components of the vehicle frame; it is the simplest and most commonly used method for evaluating a vehicle's insulation performance. The fundamental measurement principle of insulation resistance is based on Ohm's Law: a specified DC voltage is applied across the conductive and non-conductive components of the vehicle under test, generating a leakage current across the insulating medium under this applied voltage; by measuring and calculating this current value, it is converted into a resistance value.

During testing, the test system applies a DC high-voltage supply (typically greater than 500 V DC) to the vehicle, which is no less than its maximum operating voltage, for a specified duration. Once the voltage stabilizes, the overall vehicle insulation resistance value is measured and displayed on the test interface.

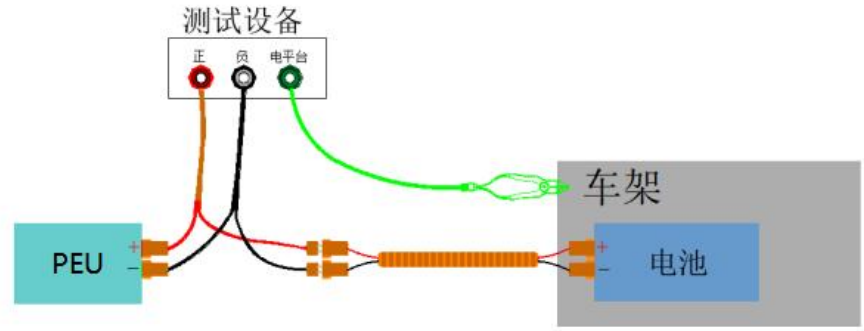
Before performing the vehicle insulation resistance test, the test cable must be connected to the vehicle's high-voltage system; there are two methods for making this connection:

① Connects to the vehicle's high-voltage system by interfacing with the vehicle's high-voltage components;

The equipment is configured with a Y-shaped test cable set, one end of which is connected to the equipment and the other two ends are connected to the vehicle;

The equipment's test cable is connected to the high-voltage component linked to the PEU's battery system (the specific high-voltage component to be connected shall be determined by Party A during the drawing approval process), thereby forming a complete circuit.

Figure 2-4 – Wiring Diagram

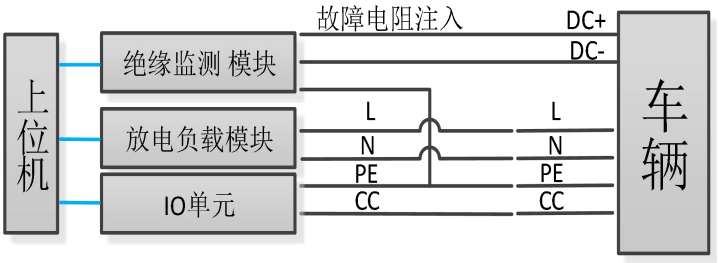


② Connect the test device directly to the fast-charging port using a fast-charging adapter, and then connect the test device from the DC charging port to the vehicle's high-voltage system (whether this wiring method is suitable for the customer's vehicle shall depend on the actual vehicle configuration; Party A shall be able to provide the appropriate protocol to control the operation of the internal relay to complete the high-voltage system connection).

2.2.1.4 Insulation Monitoring Verification

During the insulation monitoring function verification process, the vehicle shall be in the "operational mode." During the test, multiple resistors with different resistance values shall be used, with the maximum resistance value being ≥10 MΩ. The Yidi device provides a continuously adjustable fault resistor ranging from 10 kΩ to 10 MΩ.

For vehicles equipped with a V2L AC discharge function, the device supports verifying whether the vehicle's insulation monitoring function is operating correctly during V2L discharge.



Discharge Load Module: Applied across the vehicle's discharge terminal pair (L–N) to simulate the discharge load for V2L applications;

Insulation Monitoring Module: This module allows the adjustment of a fault resistance with a resistance value ranging from 10 kΩ to 10 MΩ, which is applied between the vehicle's DC+/DC-terminals and the vehicle frame to simulate an insulation fault; after the fault resistance is applied, the device can read the vehicle's

real-time diagnostic data via the OBD interface to monitor whether an insulation fault alarm has been triggered, or it can directly observe the alarm status from the vehicle.

The measurement procedure is as follows:

a) At ambient temperature, according to the test method specified in GB 18384-2025, the current insulation resistance value of the entire vehicle is measured as Ri;

b) Follow the normal operating procedure of the vehicle to switch it to "Driving Mode";

c) As shown in the figure below, a variable resistor is connected in parallel between the positive terminal of the REESS and the vehicle's battery terminal. At the start of measurement, the resistor value is set to its maximum value;

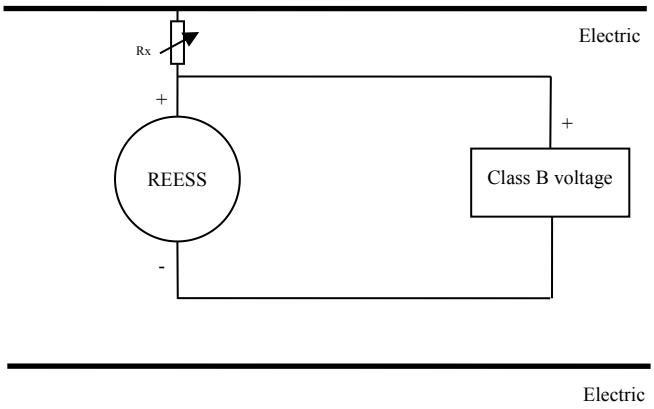
d) According to the national standard requirements, if the minimum insulation resistance requirement is 100 Ω/V, then simply select a resistor with an equivalent resistance value equal to the target value Rx; Rx shall be calculated using the following formula:

$$1/\left[1/\left(95U_{\text{REESS}}\right)-1/R_i\right] \le R_x < 1/\left[1/\left(100U_{\text{REESS}}\right)-1/R_i\right]$$

According to the national standard requirements, if the minimum insulation resistance requirement is 500 Ω /V, then simply select a resistor with an equivalent resistance value equal to the target value Rx; Rx is calculated using the following formula:

$$1/\left[1/\left(475U_{\text{REESS}}\right)-1/R_i\right] \le R_x < 1/\left[1/\left(500U_{\text{REESS}}\right)-1/R_i\right]$$

In the formula, UREESS represents the current total voltage of the battery pack.



Upon completion of the vehicle's insulation resistance test, Yidi Equipment automatically initiates the insulation monitoring verification function; the tester adjusts itself accordingly and can directly read the vehicle's

alarm fault information. The alarm messages are displayed directly on the screen, eliminating the need for personnel to manually check the vehicle for any alarms.

The wiring method for insulation monitoring verification is the same as that used for measuring the overall vehicle insulation resistance; no secondary wiring is required.

2.2.1.5 Capacitive Coupling Test

Capacitive coupling refers to the amount of stored charge on the Y-capacitor of the vehicle's high-voltage bus (all B-class voltage circuits in the vehicle) under the maximum battery voltage.

In a Class B voltage circuit, the energy stored in the total capacitance between any charged component of the Class B voltage circuit and the common reference plane at its maximum operating voltage shall not exceed 0.2 J; this value of 0.2 J represents the maximum allowable stored energy requirement for either the positive-side Y capacitor or the negative-side Y capacitor of the Class B voltage circuit. Furthermore, where multiple Class B voltage circuits are isolated from one another, the 0.2 J requirement applies separately to each individually isolated circuit.

Based on actual test conditions, the recommended calculation method for capacitive coupling:

Calculation method (recommended method):

The maximum energy stored in the Y capacitors across all B-class voltage circuits of the entire vehicle is calculated.

$$Q = \sum_{x=1}^{n} \frac{C_x . U_x^2}{2}$$

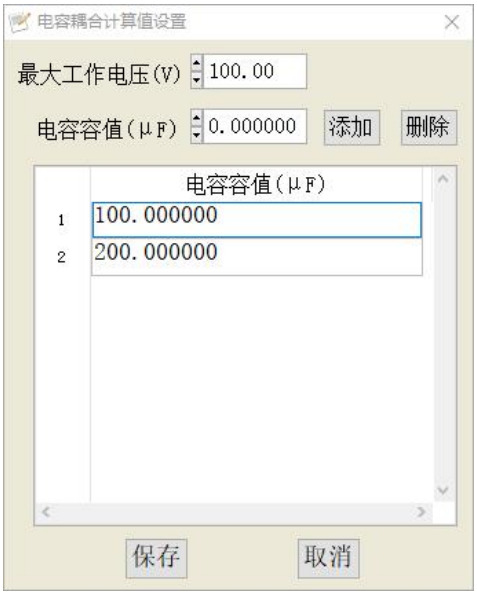
N – Number of Class B voltage units equipped with Y capacitors;

Cx – The capacitance value of the Y capacitor in a certain Class B voltage unit; unit: farad (F);

Ux – Maximum operating voltage of the Y capacitor in the Class B voltage unit; unit: volt (V).

The customer is required to provide the data needed for the calculation formula.

Capacitively coupled computational interface



As shown in the figure, customers can freely enter the maximum voltage and capacitor capacitance value, as well as specify the number of capacitors to be added.

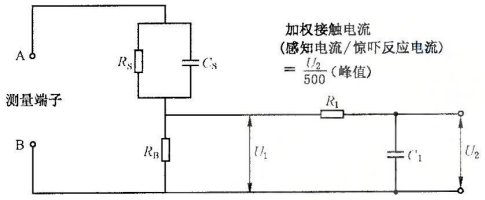
2.2.1.6 Charging socket voltage drop and steady-state contact current test

Upon completion of vehicle charging, within 1 second after the vehicle's charging plug is disconnected from the charging socket, the voltage between any two contact points of the charging socket and between each contact point and the common reference point shall be reduced to no more than 30 V (AC) (rms) or no more than 60 V (DC).

The device enables the vehicle to enter actual charging mode by performing AC or DC charging (AC charging supports the national standard for single-phase and three-phase compatibility, with a maximum charging power of 22 kW; DC charging supports a maximum charging power of 30 kW and a charging voltage up to 1000 V). A detection fixture is connected in series between the charging plug and the charging socket to perform relevant signal acquisition and on/off control; this allows the device to accurately measure the voltage change and the steady-state contact current within 1 second after the charging plug and socket are disconnected. The specific test results and data are then displayed on the host computer software.

The steady-state contact current shall be tested in strict accordance with Section 5.4.1 of GB/T 12113–2023; the equipment shall provide multiple human-body simulation impedances for test selection. For AC contact

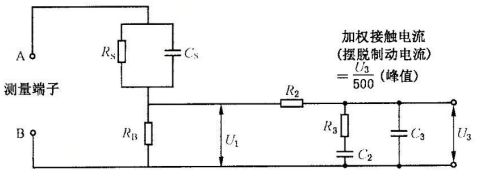
currents not exceeding 2 mA (rms), the measurement network specified in Figure 4 of GB/T 12113–2023 shall be used;



R_S 1 500 Ω　　R_1 10 000 Ω
R_B 500 Ω　　C_1 0.022 μF
C_S 0.22 μF

图 4　加权接触电流(感知电流或惊吓反应电流)的测量网络

For AC contact current greater than 2 mA (rms), use the measurement network specified in Figure 5 of GB/T 12113–2023;

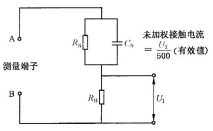


R_S 1 500 Ω　　R_3 20 000 Ω
R_B 500 Ω　　C_2 0.006 2 μF
C_S 0.22 μF　　C_3 0.009 1 μF
R_2 10 000 Ω

注：在特定条件下(见 5.1.2)使用这个网络。

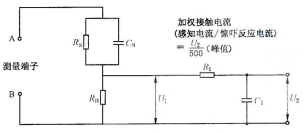
图 5　加权接触电流(摆脱制动电流)的测量网络

For DC contact current measurement, users may select any of the measurement networks shown in Figures 3, 4, or 5 as specified in GB/T 12113–2023; the user may freely choose the appropriate analog impedance circuit.



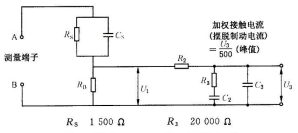
R_S 1 500 Ω
R_B 500 Ω
C_S 0.22 μF

图 3　未加权的接触电流的测量网络



R_S 1 500 Ω　　R_1 10 000 Ω
R_B 500 Ω　　C_1 0.022 μF
C_S 0.22 μF

图 4　加权接触电流(感知电流或惊吓反应电流)的测量网络

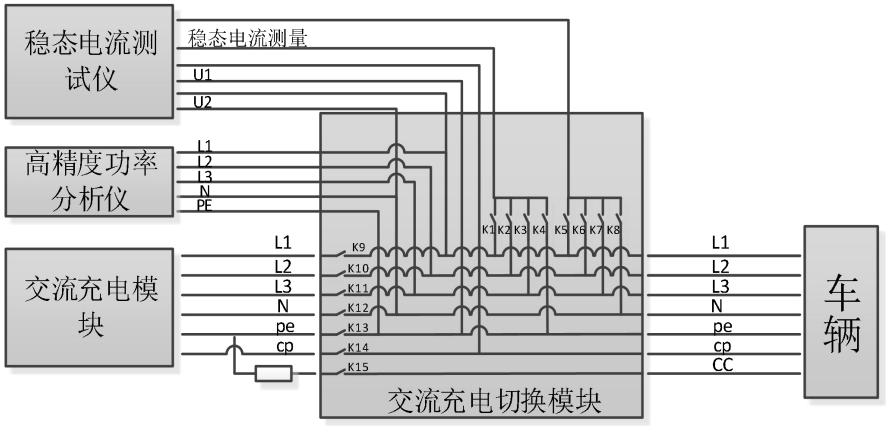


R_S 1 500 Ω　　R_3 20 000 Ω
R_B 500 Ω　　C_2 0.006 2 μF
C_S 0.22 μF　　C_3 0.009 1 μF
R_2 10 000 Ω

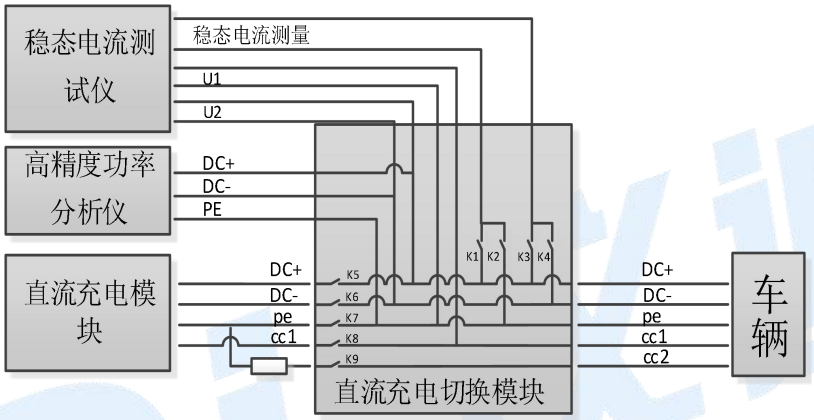
注：在特定条件下(见 5.1.2)使用这个网络。

图 5　加权接触电流(摆脱制动电流)的测量网络

Slow-charging socket steady-state current testing schematic diagram



Fast-Charging Socket Steady-State Current Testing Schematic Diagram



The charging switch tooling function is as follows:

1. Connect the shooting tip to the vehicle shooting mount;

2. After switching the test point locations, connect the output terminals—including AC L1, L2, L3, N, and PE; DC DC+, DC-, and PE—then connect them to the test module;

3. Enables control of the switching state of the guidance circuit, covering AC lines (L1, L2, L3, N, PE, CP, CC) and DC lines (DC+, DC-, PE, CC1, CC2);

4. The gun withdrawal operation is available in automatic and manual modes: in automatic mode, the charging completion status is determined by detecting U2 voltage, and the gun withdrawal action is simulated using a relay; in manual mode, the gun withdrawal action is determined by detecting U1 voltage;

In automatic mode, initiate the test by monitoring the voltage U2 in real time; when the voltage U2 falls below the set value, start the delay period. Upon completion of this delay period, deactivate the internal machine tool relay to simulate the gun-disassembly action, and then proceed with the steady-state current test. In manual

mode, initiate the test by monitoring the voltage U1 in real time; when the voltage U1 falls below the set value, assume that the gun has been disassembled by default, and then commence the steady-state current test.

Steady-state current tester: Used for steady-state current measurement; includes an analog human impedance circuit, signal sampling circuit, processing circuit, etc.

High-precision power analyzer: Used to measure the voltage value between the various contacts of a vehicle charging socket when the vehicle charging plug is disconnected.

2.2.2 Equipment Testing Procedure

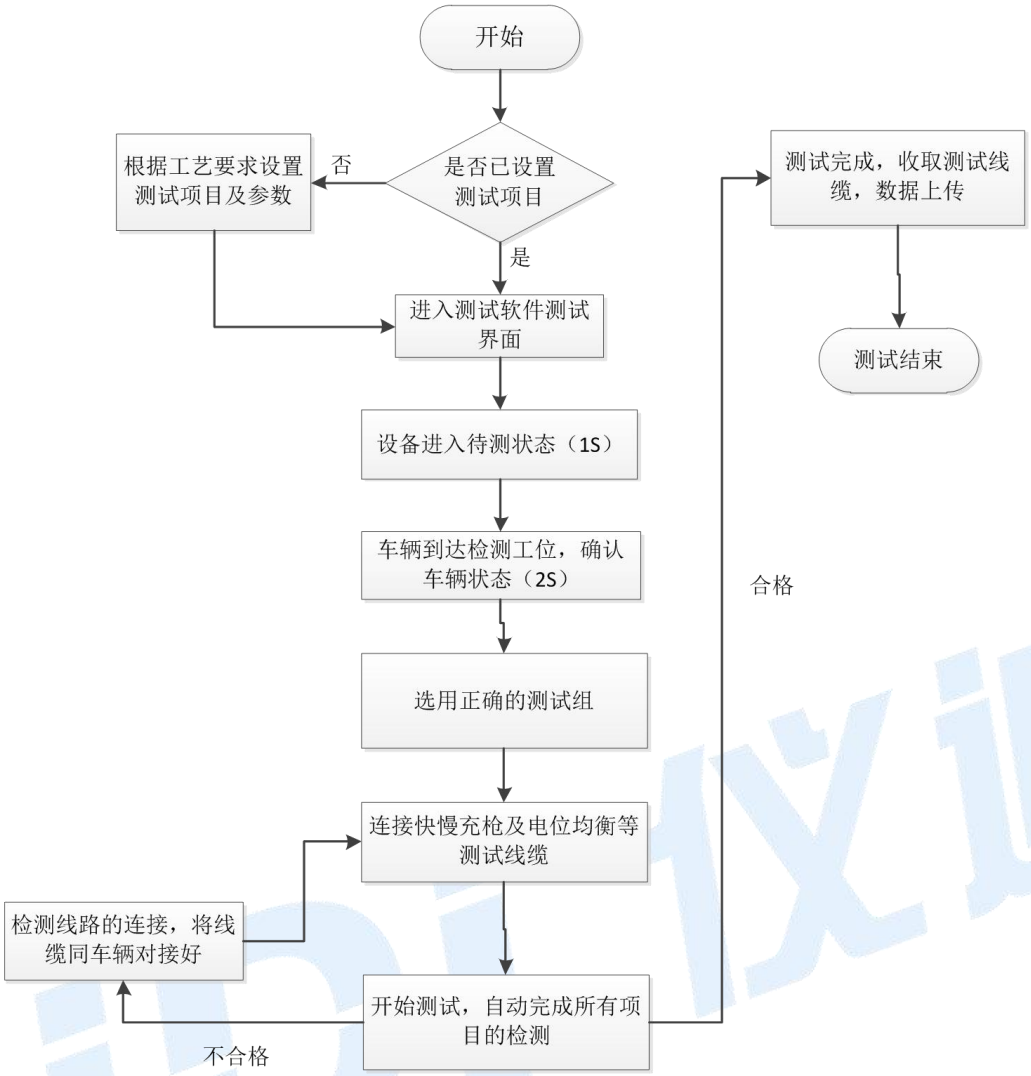
Step 1: Launch the testing system and configure the test items and their parameters;

Step 2: Connect the test cables (AC/DC charging gun, OBD communication cable, potential balancing test cable, etc.);

Step 3: Scan the vehicle's VIN code to initiate the test; the instrument cluster will automatically perform the relevant diagnostics, and upon completion, it will determine whether the vehicle meets the requirements;

Step 4: Remove the test cables, reposition them, upload the data to the server, and then store the corresponding test data;

Step 5: Proceed to measure the next vehicle.


开始
是否已设置测试项目
否
根据工艺要求设置测试项目及参数
是
进入测试软件测试界面
设备进入待测状态（1S）
车辆到达检测工位，确认车辆状态（2S）
选用正确的测试组
连接快慢充枪及电位均衡等测试线缆
检测线路的连接，将线缆同车辆对接好
开始测试，自动完成所有项目的检测
不合格
合格
测试完成，收取测试线缆，数据上传
测试结束

2.2.3 Equipment Appearance

Equipment Appearance Reference

Equipment exterior photo

The device features a cabinet-style integrated design with casters at the bottom and a locking mechanism for easy mobility;

Equipped with necessary hardware such as industrial PCs and barcode scanners; the industrial PCs must strictly comply with the Client-Provided Specification List;

The equipment cabinet features a clean and intuitive design philosophy, with a rational layout, high integration density, and a comprehensive range of functions—including an energy switch, emergency stop button, start/stop button, USB ports, and one-touch detection capability—all conveniently integrated.

The equipment cabinet features the standard RAL 7035 color; however, customization is also available to meet the client's specific color requirements for electrical cabinets.

The equipment cabinet can be designed with 20% to 50% reserved space, offering high scalability to accommodate future modification requirements; it also features excellent heat dissipation capabilities.

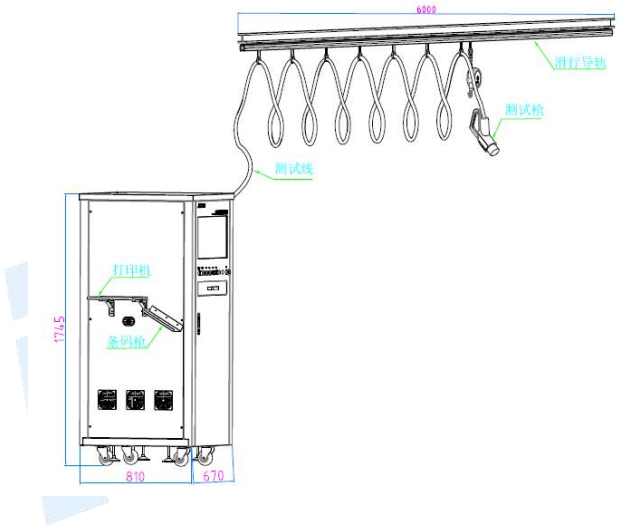
2.2.4 Test Cable Suspension

Equipment test cables can be suspended using various methods—such as swing arms, sliding tracks (manual or automatic trailing), or cable hanging carts—depending on the actual on-site requirements.

The tram track is equipped with a balancing crane, and a limit switch is installed at the end; this switch can be interlocked with the main conveyor line – when triggered, it will activate an alarm or halt the conveyor line – making this configuration particularly suitable for assembly-line operations.

The swing-arm design allows the arm to be mounted either on the ground or on the side panel of the equipment; when equipped with a balancing crane, it enables free rotation and telescoping movement at multiple angles, making it particularly suitable for fixed-workstation testing applications.

Cable Layout Diagram



2.2.5 Host Computer Software Interface Display

The ESRS Comprehensive Safety Performance Testing System is primarily designed for comprehensive safety performance testing and the collection of test data; it can be extended to incorporate data collection functionality for other process inspections on the production line, thereby forming a data collection system that covers all key quality control points across the production line. It features the following characteristics:

(1) The ESRS Measurement and Control Software uses the product barcode as the keyword for recording data across various manufacturing processes, thereby establishing comprehensive test records for each product and providing functions for data storage, querying, statistical analysis, and report generation.

(2) To meet requirements such as centralized quality management across multiple production lines and across different factory sites, as well as commodity inspection and customs clearance reporting, we provide a software

platform—including standalone production line versions, enterprise LAN server versions, and commodity inspection and customs clearance versions—as well as remote data transmission capabilities.

(3) It can integrate various programmable instruments and equipment, providing a unified control environment that enables rapid, efficient, and user-friendly operation.

(4) Provides a comprehensive open testing environment where users can edit and modify test workflows.

(5) The system architecture is designed to be modular and scalable, making system updates and expansion straightforward.

(6) Features a graphical user interface with excellent usability.

(7) Supports standard hardware interfaces: RS232, USB.

(8) The system provides predefined test items and allows users to create custom test items according to their specific needs.

(9) Report generation and report formatting file editing functionality, along with data statistical analysis features, facilitate users in reviewing statistical data.

Software Main Interface

Software Testing Interface

	测试项目	测试条件	合格范围	测试类型		测试输出	测试数据	测试数据	测试数据	时间	结果
1	绝缘电阻	500 V	(1-∞)MΩ	其他	1	500 V	>11000MΩ			3.0s	PASS
2	电位均衡	5.00 A	(1.0-100.0)mΩ	慢充	2	5.00 A	40.5 mΩ			3.0s	PASS
3	慢充功能	32 A	(1-32)A	慢充	3	220 V	16 A	3508 W	0.993	10.0s	PASS
4	绝缘电阻	500 V	(1-∞)MΩ	慢充	4	500 V	21.10 MΩ			3.0s	PASS
5	电容耦合	394 V	(0.0-200.0)mJ	快充	5	394 V	15.5 mJ			0.0s	PASS
6	电位均衡	5.00 A	(1.0-100.0)mΩ	快充	6	5.00 A	1.1 mΩ			3.0s	PASS
7	整车绝缘		(0.00-100.00)MΩ	快充	7		1.450 MΩ			3.0s	PASS
8	快充功能		(0-100)℃	快充	8		19 ℃			0.3m	PASS
9	监测验证	100 Ω/V	(0.0-0.0)KΩ	快充	9		15.2 KΩ			3.0s	PASS

2.2.7 Technical Specifications

Table 2-4 – Environmental Adaptability

project	Technical Specifications
Working power supply	AC 380V±10%,50/60Hz±5%
Operating ambient temperature	temperature:0~40℃
Environmental humidity	Humidity: 20–80% RH
Storage ambient temperature	Temperature: -40°°C to 55°°C
Storage environment humidity	Humidity: 20–80% RH at 40°°C

Table 2-5 Technical Specifications

Potential Balance Test	
Potential Balance Test Method	Four-wire system
No-load output voltage	< 8V
Output current setting range	DC: 1–32 A – continuously adjustable constant current output
Output current resolution	0.01A
Output current accuracy	1.00–9.99 A: ±(1% × setpoint + 0.20 A)
	10.00–32.00 A: ±(1% setpoint)
Potential Equalization Resistance Setting Range	Upper limit: 1.00–10.00 A; 0.0–630.0 mΩ 10.00–32.00 A; 0.1–RmΩ; R = 6300 / Set current; R <600 0 = Off
	Lower limit: 1.00–10.00 A; 0.0–630.0 mΩ 10.00–32.00 A; 0.1–RmΩ; R = 6300 / Set current; R <600; 0 = Off
Potential balancing resistor measurement range	1.00~10.00A 0.0-630.0 mΩ 10.00–32.00 A; 0.1–RmΩ; R = 6300 / Set current
Potential Equalization Resistance Measurement	0.1mΩ/1mΩ

Resolution	
Resistance reset to zero	0.0-100.0mΩ
Potential balancing resistor measurement accuracy	±(1% reading value + 3 mΩ)
Test Time Range	0.0, 0.1–999.9 s; 0.0 = Continuous output
Test time resolution	0.1S
Test time accuracy	±(0.1% setpoint + 0.05 s)

Insulation resistance test		
Output voltage ripple	Resistive load: 1000 V/1 mA, <5%	
Output voltage setting range	DC: 100–1000 V – continuously adjustable	
Output voltage resolution	1V	
Output voltage accuracy	±(1% setpoint + 3 V)	
Insulation resistance setting range	Upper limit: 0.0001–10 GΩ; when no upper limit is specified, it can be set to ∞.	
	Lower limit: 0.0001–10 GΩ	
Insulation resistance measurement range	100—499V:0.1MΩ-1000MΩ	
	500—1000V:1.5MΩ-10000MΩ	
Insulation resistance measurement resolution	0.01MΩ/0.1MΩ/1MΩ	
resistance compensation	> 30MΩ	
Insulation resistance measurementnt accuracy	100—499V	0.1 MΩ–100 MΩ: ±(5% of reading value + 0.5 MΩ) 100 MΩ–10,000 MΩ: ±(10% of the measured value + 5 MΩ)

	500 — 1000V	1.5–100 MΩ: ±(2% of measured value + 0.2 MΩ); 100 MΩ–1999 MΩ: ±(5% of reading value + 2 MΩ); 2000 MΩ–10000 MΩ: ±(10% of reading value + 5 MΩ);
delay time	0.5—999.9S	
Test Time Range	0.0, 0.1–999.9 S; 0.0 = Continuous output	
Test time resolution	0.1S	
Test time accuracy	±(0.1% setpoint + 0.05 s)	

Full-vehicle insulation test	
Insulation resistance setting range	Upper limit: 0.00–100.00 MΩ; 0 = Off Lower limit: 0.00–100.00 MΩ
Insulation resistance measurement range	0.20-100.00MΩ
Insulation resistance measurement resolution	0.01MΩ
Insulation resistance measurement accuracy	0.20–10.00 MΩ ± (2% reading value + 5 digits) 10.00–100.00 MΩ ± (5% of measured value + 5 digits)
Test Time Range	4—999.9S
Test time resolution	0.1S
Test time accuracy	±(0.1% setpoint + 0.05 s)

Insulation Monitoring Function Verification	
Test Time Range	2-999.9S 0.0 = Continuous output
resistivityRx	100-1000

Test time resolution	0.1S
Test time accuracy	±(0.1% setpoint + 0.05 s)
Classification Type	Is the automotive insulation monitoring system triggering a normal alarm?

Capacitive coupling (Calculation method – recommended)	
computational formula	$Q = \sum_{x=1}^{n} \frac{C_x . U_x^2}{2}$
Party A Input	n – Number of Class B voltage units equipped with Y capacitors
Party A Input	Cx – The capacitance value of the Y capacitor in a certain Class B voltage unit; unit: farad (F)
Party A Input	Ux – Maximum operating voltage of the Y capacitor in the Class B voltage unit; unit: volt (V).
Party A Input	Number of Y capacitors (can be added as needed)
acceptance condition	Q ≤ 0.2 J

Steady-state contact current test	
Current test type	AC, DC
Leakage current measurement range and error (RMS value)	Measurement range: 0.0000–0.9999 mA, 1.000–9.999 mA, 10.00–20.00 mA Resolution: 0.0001 mA, 0.001 mA, 0.01 mA accuracy: 0.0000–0.9999 mA: Resolution 0.0001 mA DC: ±(2% × measured value + 3 digits) 15 Hz ≤ f ≤ 100 kHz: ±(2% × measured value + 3 digits) 100 kHz < f ≤ 1000 kHz, 0.01 mA – 0.9999 mA: ±5%* reading value

	1.000–9,999 mA: Resolution 0.001 mA DC: ±(2% × measured value + 3 digits) 15 Hz ≤ f ≤ 100 kHz: ±(2% × measured value + 3 digits) 100 kHz < f ≤ 1000 kHz, 0.01 mA – 10.00 mA: ±5%* measured value 10.00–20.00 mA: Resolution 0.01 mA DC: ±(2% × measured value + 3 digits) 15 Hz ≤ f <1000 kHz, 0.01 mA – 20.00 mA: ±5%* of the measured value
Leakage current measurement range and error (peak value)	Upper and lower limit settings: 0.0000–0.9999 mA, 1.000–9.999 mA, 10.00–30.00 mA Resolution: 0.0001 mA, 0.001 mA, 0.01 mA accuracy: 0.0000–0.9999 mA: Resolution 0.0001 mA DC: ±(2% × measured value + 20 digits) 15 Hz <f ≤ 1000 kHz, 0.01 mA – 0.9999 mA: ±(10% × measured value + 20 digits) 1.000–9,999 mA: Resolution 0.001 mA DC: ±(2% × measured value + 2 digits) 15 Hz <f ≤ 1000 kHz, 0.01 mA – 10.00 mA: ±(10% × measured value + 2 digits) 10.00 mA–30.00 mA: Resolution: 0.01 mA DC: ±(2% × measured value + 2 digits) 15 Hz ≤ f ≤ 1000 kHz, 0.01 mA – 20.00 mA: ±(10% × measured value + 2 digits)
Analog impedance	A total of ten types

Time Settings	Test Time Range	0.0–999.9 s; 0.0 = Continuous Output
	Test time resolution	0.1S
	Test time accuracy	±(0.1% setpoint + 0.05 s)

2.3 Equipment Installation and Commissioning

We are responsible for the transportation, installation, and commissioning of the equipment, on-site personnel training, and technical support.

Table 2-6 – Equipment Installation and Commissioning

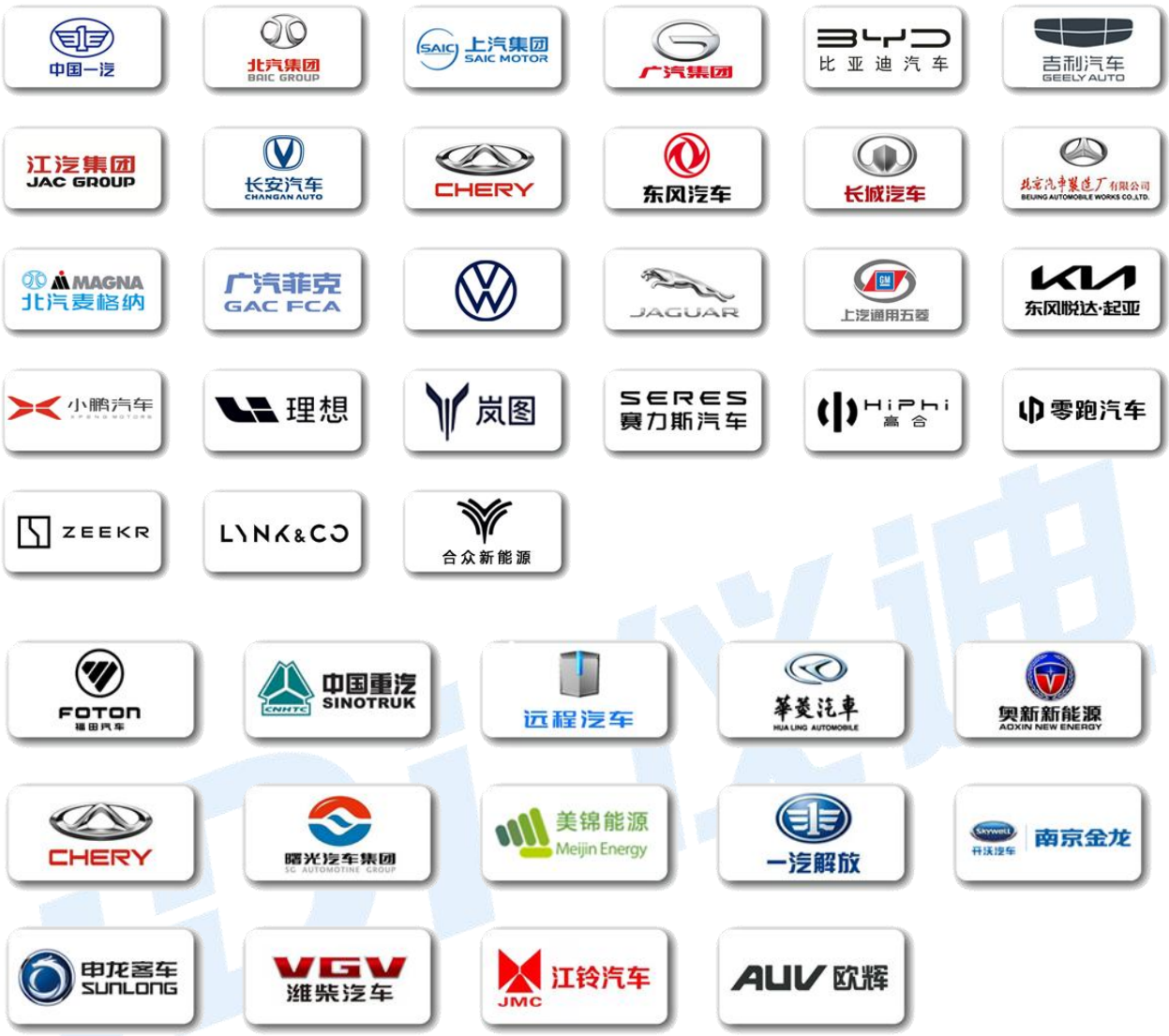
name	Working days (days)
Shipping and Transportation	3~7
installation and trial run	1~3
On-site Training	2

Training Content	Working days (days)
Equipment Safety	0.25
Test Principle	0.5
Equipment Operation	0.5
Software Operation	0.5
corrective maintenance	0.25

2.4 Qualification Documents

Yidi has always adhered to the principles of rigor, pragmatism, andovation, sustainability, and sharing, nurturing outstanding talent to provide customers with premium services and realizing the vision of bringing Chinese instrumentation to the world.

2.5 Successful Case Studies



As one of the earliest domestic manufacturers to engage in safety compliance testing for new energy vehicles, Yidi has successfully provided comprehensive safety compliance testing solutions and products to numerous commercial and passenger vehicle manufacturers.