Ceyear 思仪

87237 Series USB Thermal Power Sensor User's manual



Ceyear Technologies Co., Ltd.

This manual applies to the following models of USB Thermal Power Sensors based on the firmware version of 1.0 and higher.

- 87237D USB Thermal Power Sensor, frequency range DC~18 GHz, power range -35dBm~+20dBm
- 87237L USB Thermal Power Sensor, frequency range DC~67 GHz, power range -35dBm~+20dBm
- 87237P USB Thermal Power Sensor, frequency range DC~110 GHz, power range -30dBm~+20dBm

Version: A.2 February, 2026, Ceyear Technologies Co., Ltd.
Address: No. 98, Xiangjiang Road, Huangdao District, Qingdao, Shandong Province
Service consultation: 400-1684191
Quality supervision: 0532-86886614
Website: www.ceyear.com
Email: techbb@ceyear.com
Postal code: 266555

Foreword

Thank you for choosing and using the 87237 series USB Thermal Power Sensor developed and produced by Ceyear Technologies Co., Ltd.! Adopting advanced, sophisticated and cutting-edge technologies, the product has a high cost performance in the same kind of products.

We will take the responsibility to maximally meet your needs and provide you with high-quality measuring instruments and first-class after-sales service. We aim to provide "high quality and considerate service", and operate on the principle of making customers satisfactory with our products and services.

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Ceyear Technologies Co., Ltd.

Manual authorization

The contents of this manual are subject to change without notice. The contents and terms used in this manual are interpreted by Ceyear Technologies Co., Ltd.

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Product warranty

The warranty period of this product is 12 months from the date of shipment. The instrument manufacturer will repair or replace the damaged components according to the user's requirements and actual conditions within the warranty period. For specific maintenance issues, refer to the contract.

Product quality certificate

This product is guaranteed to meet the metrics in this manual from the date of shipment. The calibration and measurement are completed by measuring bodies with national qualification, with relevant data to be provided for reference by users.

Quality/environmental management

This product complies with the quality and environmental management systems during R&D, manufacturing and testing. Ceyear Technologies Co., Ltd. is qualified and has passed ISO 9001 and ISO 14001 management systems.

Safety precautions



The symbol "Warning" indicates a hazard. It reminds the user to pay attention to a certain operation process, operating instructions or the like. In case of any failure of observing the rule or maloperation, personal injury can occur. Further operation cannot be proceeded until the warning conditions are fully understood and met.



Notice mark, indicating some important information which will not cause danger. It reminds the user to pay attention to a certain operation process, operating instructions or the like. Failure to observe the rules or operate correctly may cause damage to the instrument or loss of important data. Proceed to the next step only after fully understanding and meeting the caution conditions indicated.

Calibration cycle

The calibration cycle of this product is one year.

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1. Manual navigation

This chapter introduces the user's manual functions, chapter structure and main contents of the 87237 series USB Thermal Power Sensor, as well as the instrument-related documents provided to users.

- About the manual.....1
- Related documents.....2

1.1. About this manual

This manual introduces the basic functions and operating instructions of the 87237 series USB Thermal Power Sensor produced by Ceyear Technologies Co., Ltd. It describes such contents as product characteristics, basic operating instructions, configuration guide, menu description, remote control, maintenance, specifications and test methods, etc. of the instrument to help users get familiar with and master the operating instructions and key points of the instrument as soon as possible. To facilitate your skillful use of such instrument, please read carefully and follow this manual in advance for correct operation.

This manual contains the following chapters:

- Overview

  This part introduces in general the main performance characteristics, typical application examples and safety precautions of operation for the 87237 series USB Thermal Power Sensor. The purpose is to enable users to have a preliminary understanding of the main performance characteristics of the instrument and to guide users to operate the instrument safely.

- Quick start

  This chapter introduces the pre-operation inspection, instrument browsing, basic measurement methods, measurement window instructions, and data saving of the 87237 series USB Thermal Power Sensor. so that users can have a preliminary understanding of the instrument itself and its measurement processes as a preparation for the comprehensive introduction of the measurement operations of the instrument hereinafter. This section contains some contents consistent with the relevant sections in the Quick start.

- Operation guide

  This guide introduces the operating instructions of various configuration functions of the instrument in detail, including: configuring the instrument, starting the configuration process and obtaining the configuration results, etc. This part mainly includes two parts: basic operation guide and advanced operation guide. For users who are not familiar with operating instructions of the 87237 series USB

Thermal Power Sensor, the function operation guide introduces and enumerates each function systematically and in detail so that users can understand and master basic usages of the USB Thermal Power Sensor, such as setting trigger, horizontal scale, and frequency, etc. The advanced operation guide introduces relatively complicated test processes and advanced operation skills for users who have basic knowledge about using the USB Thermal Power Sensor but are not familiar with some special usage, and guides them to implement the measurement processes.

- Menus

  This part introduces the menu structure and menu items according to the functions to facilitate the users to query for reference.

- Remote control

  The methods for remote control of the instrument are summarized to make users get familiar with remote control quickly. It is divided into four parts: programmed control fundamentals, introducing concepts related to programmed control, software configuration, programmed control ports, SCPI commands, etc; port configuration methods, introducing the connection methods and software configuration methods for programmed control ports of the 87237 series USB Thermal Power Sensor; basic programming methods for VISA interfaces, giving basic programming examples in the form of text description and sample codes to enable users to quickly master the programming methods; I/O library, introducing the basic concepts of instrument drivers and the basic installation and configuration instructions of IVI-COM/IVI-C drivers.

- Troubleshooting and repair

  This part includes the introduction of the operating principles of the instrument, troubleshooting, error message description and repair methods.

- Specifications and test methods

  This part introduces the product characteristics, main specifications and recommended test methods of the 87237 series USB Thermal Power Sensor.

- Annex

  Necessary reference information related to the 87237 series USB Thermal Power Sensor is provided, including term description, programmed control command zoom table, menu zoom table, error information zoom table, etc.

1.2 Related documents

The product documentation for the 87237 series USB Thermal Power Sensor includes:

- User's manual
- Programmed control manual
- Quick start guide
- Online help

User's manual

This manual describes the functions and operating instructions of the instrument in detail, including configuration, measurement, programmed control and maintenance, etc. It is used to guide users to fully understand the functional characteristics of the product and master common test methods of the instrument. Main chapters include:

- Manual navigation
- Overview
- Quick start
- Operation guide
- Menus
- Remote control
- Troubleshooting and repair
- Specifications and test methods
- Annex

Programmed control manual

This manual introduces remote programming fundamentals, SCPI fundamentals, SCPI, programming examples and I/O driver function library in detail. The purpose is to guide the user to quickly and comprehensively master the programmed control commands and methods of the instrument. Main chapters include:

- Remote control
- Programmed control commands
- Programming examples
- Error description
- Annex

Quick start guide

This manual introduces the basic operating instructions for configuration and start-up measurement of the instrument to enable users to quickly understand the characteristics of the instrument, and master the basic settings and basic operating instructions. Main chapters include:

- Get prepared
- Typical applications
- Get help

Online help

Online help is integrated in the instrument, providing fast text navigation help to make it convenient for users in local and remote control operation. Both the hard keys on the front panel of the instrument or the user interface tool bar offer corresponding shortcut keys to activate this function. Main chapters are identical to those of the user's manual.

2. Overview

This chapter introduces the main performance characteristics, main applications and main specifications of the 87237 series USB Thermal Power Sensor. It also gives introductions on correct operation of the instrument and precautions such as electrical safety.

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- Safe operation guide.....5

2.1 Product overview

The 87237 series USB Thermal Power Sensor features a frequency range spanning DC to 110 GHz and a power dynamic range from -35 dBm to +20 dBm. Compact, lightweight, and portable with hot-swap capability, it is widely applicable for average power measurement across various fields. The main performance characteristics of the 87237 series USB Thermal Power Sensor are as follows:

1) Characterized by a wide frequency range and high power accuracy, the 87237 power Sensor features a frequency range spanning DC to 110 GHz and a power measurement accuracy up to ±0.16 dB.

2) Featuring internal calibration, it ensures measurement precision through a built-in power reference and compensation algorithms, eliminating the need for external calibration sources and enhancing test efficiency.

3) With exceptional impedance matching, the power Sensor delivers outstanding port VSWR, significantly reducing measurement uncertainty caused by impedance mismatch between the DUT and the power Sensor.

2.2 Safe operation guide

Please read carefully and strictly observe the following precautions!

We will spare no effort to ensure that all production processes meet the latest safety standards and provide users with the highest safety guarantee. The design and test of our products and the auxiliary equipment used meet relevant safety standards, and a quality assurance system has been established to monitor the product quality and ensure the products to always comply with such standards. In order to keep the equipment in good condition and ensure operation safety, please observe the precautions mentioned in this manual. If you have any questions, please feel free to consult us.

In addition, the correct use of this product is also your responsibility. Please read

carefully and observe the safety instructions before starting to use this instrument. This product is suitable for use in industrial and laboratory environments or field measurement. Always use the product correctly according to its restrictions to avoid personal injury or property damage. You will be responsible for problems caused by improper use of the product or noncompliance with the requirements, and we will not be held responsible. **Therefore, please always observe the safety instructions to prevent personal injury or property damage caused by dangerous situations.** Please keep the basic safety instructions and the product documents properly and deliver them to end users.

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- Operation state and locations.....8
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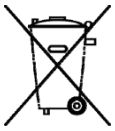
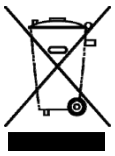
2.2.1 Safety marks

2.2.1.1 Product-related marks

Safety marks on the products are described as follows (Table 2.1):

Table 2.1 Products safety marks

Symbol	Meaning	Symbol	Meaning
	Notice, reminding users of information to be paid special attention to. It reminds users of the operation information or instructions to be paid attention to.		Power ON/OFF
	Take care when handling heavy equipment.		Standby indication
	Danger! Hazard of electric shock.		DC

Symbol	Meaning	Symbol	Meaning
	Warning! Hot surface.		AC
	Protective conductive end		DC/AC
	Ground		Reinforced insulation protection of the instrument
	Ground terminal		EU mark for batteries and accumulators. Please refer to item 1 of "2.2.8 Waste disposal/environmental protection" in this section for specific instructions.
	Notice, please handle classical sensitive devices with care.		EU mark for separate collection of electronic devices. Please refer to item 2 of "2.2.8 Waste disposal/environmental protection" in this section for specific instructions.
	Warning! Radiation. Please refer to item 7 of "2.2.4 Operation precautions" in this section for specific instructions.		

2.2.1.2 Manual-related marks

In order to remind users to operate the instrument safely and pay attention to relevant information, the following safety warning marks are used in the product manual, which are explained as follows:



Danger mark, personal injury or equipment damage may be caused if not avoided.



Warning mark, personal injury or equipment damage may be caused if not avoided.



Caution mark, slight or medium personal injury or equipment damage may be caused if not avoided.



Notice mark, indicating some important information which will not cause danger.



Tips on information about the instrument and its operation.

2.2.2 Operating state and locations

Please note before operating the instrument:

1) Unless otherwise specified, the non-operating temperature range for the 87237 series USB Thermal Power Sensors is -40℃ to +70℃; its operating temperature range is -10℃ to 50℃.

2) Unless otherwise specially stated, the instrument has not received any waterproof treatment, do not place the instrument on surfaces with water, vehicles, cabinets, tables and other objects that are not fixed and do not meet the load conditions. Please place the instrument securely and fix it on the surface of a solid object (e.g., an ESD workbench).

3) Do not place the instrument in an environment where mist is easily formed, for example, moving the instrument in a environment where cold and heat are in alternation, where water droplets formed on the instrument may cause electric shock and other hazards.

4) Do not place the instrument on the surface of a heat-dissipating object (e.g., a radiator). The operation environment temperature shall not exceed the value specified in the description of relevant metrics of the product. Overheating of the product will lead to electric shock, fire and other risks.

5) Do not insert any object into the instrument through the opening on the instrument casing, or cover up any notch or opening on the product, which is used for internal ventilation and preventing the instrument from getting overheat.

6) The instrument is required to be pre-heated for 30 min for cold start, and it will reach internal temperature balance after pre-heating for 2 hours at a stable ambient temperature. After the instrument is placed at ambient temperature for 2 h, preheated and passes thorough user calibration, it shall meet various performance metrics.

2.2.3 Electrical safety

Precautions for electrical safety of the instrument:

1) Unless otherwise allowed, do not open the housing of the instrument, which may expose internal circuits and devices of the instrument and cause unnecessary damage.

2) If the instrument needs to be fixed at the testing site, a qualified electrician is required to install the protective earth wire between the testing site and the instrument first.

3) Take appropriate overload protections to prevent overload voltage (caused by lightning, for instance) from damaging the instrument or causing personal injury.

4) When opening the housing of the instrument, do not place objects not belonging to the interior of the instrument, otherwise, short circuit, damage to the instrument and even personal injury may be caused.

5) Unless otherwise stated, the instrument has not received any waterproof treatment, so keep the instrument from contacting with liquid to prevent damage to the instrument or even personal injury.

6) Do not place the instrument in an environment where fog is easily formed, for example, moving the instrument in a environment where cold and heat are in alternation, where water droplets formed on the instrument may cause electric shock and other hazards.

2.2.4 Operation precautions

1) Instrument operators need to have certain professional and technical knowledge, good psychological quality, and certain emergency response capabilities.

2) Before moving or transporting the instrument, please refer to the relevant instructions in "2.2.7 Transportation" of this section.

3) The inevitable use of substances (e.g., nickel) in the production process of the instrument may cause allergy to personnel. If an operator of the instrument has allergic symptoms (e.g., rash, frequent sneezing, ophthalmia or dyspnea) during the operations, please seek medical care in time to find out the reason and solve the symptoms.

4) Please refer to the relevant instructions in "2.2.8 Waste disposal/environmental protection" of this section before disassembling this instrument for disposal.

5) RF instruments will generate high electromagnetic radiation, during which period, pregnant women and operators with cardiac pacemakers need special protection. If the radiation level is high, corresponding measures may be taken to remove the radiation sources to prevent personal injury.

6) In case of fire, the damaged instrument will release toxic substances. Therefore, the operators shall wear appropriate protective equipment (e.g., Protective masks and exposure suits) for safety.

7) Laser products shall have different warning signs according to the laser category, because the radiation characteristics of laser and such equipment have high-intensity electromagnetic power characteristics, which will cause harm to human body. If the product is integrated with other laser products (e.g., CD/DVD drive), it will not provide other functions except the settings and functions described in the product manual in order to prevent the injury of the laser beam to the human body.

8) Electromagnetic compatibility level (in accordance withEN 55011/CISPR 11, EN 55022/CISPR 22 and EN 55032/CISPR 32 standards)

— Class A equipment:

The equipment can be used except in residential areas and low-voltage power supply environment.

Note: Class A equipment is suitable for industrial operation environment, because it produces wireless communication disturbance in residential areas. Therefore, operators need to take relevant measures to reduce the impact of such disturbance.

— Class B equipment:

Equipment suitable for residential areas and low-voltage power supply environment.

2.2.5 Maintenance

1) Only authorized and specially trained operators are allowed to open the casing of the instrument. Before such operations, it is required to disconnect the power cord to prevent damage to the instrument or even personal injury.

2) The repair, replacement and maintenance of the instrument shall be performed by dedicated electronic engineers of the manufacturer, and the parts subject to replacement and maintenance shall receive safety tests to ensure safe use of the product in the future.

2.2.6 Transportation

1) If the instrument is heavy, please handle it with care. If necessary, use tools (a crane, for instance) to move the instrument so as to prevent damaging the body.

2) The handle of the instrument is suitable for personal handling of the instrument and cannot be fixed on the transportation equipment when during the transportation of the instrument. To prevent property loss and personal injury, please follow the manufacturer's safety regulations on the transportation of the instrument.

3) When operating the instrument on the vehicle, the driver shall drive carefully to ensure transportation safety, and the manufacturer is not responsible for any emergencies during the transportation. Therefore, please do not use this instrument during the transportation, and reinforcement and preventive measures shall be taken to ensure the transportation safety of the product.

2.2.7 Waste disposal/environmental protection

1) Do not dispose of devices marked with batteries or accumulators together with unclassified waste; Instead, such devices shall be collected separately and disposed of in a suitable collection location or through the customer service center of the manufacturer.

2) Do not dispose of waste electronic devices together with unclassified waste; Instead, such devices shall be collected separately. The manufacturer has the right and responsibility to help end users dispose of waste products. If necessary, please contact the customer service center of the manufacturer for corresponding disposal so as not to damage the environment.

3) During mechanical or thermal processing of the product or its internal components, toxic substances (dust of heavy metals, such as lead, beryllium, and nickel, etc.) may be released. Therefore, specially trained technicians with relevant experience are required to disassemble the product to avoid personal injury.

4) During the reprocessing, please refer to the safety operation rules recommended by the manufacturer to dispose of toxic substances or fuel released from the product with specific methods to avoid causing personal injury.

3 Quick Start

This chapter introduces the pre-operation precautions and the common basic configuration methods of the 87237 series USB Thermal Power Sensor. so that users can have a preliminary understanding of the instrument itself and its measurement processes.

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- Appearance description.....22
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3.1 Getting prepared

- Preparation before operation.....13
- Routine maintenance.....22

3.1.1 Preparations before operation

This chapter outlines important considerations before initial setting and use of the 87237 series USB Thermal Power Sensor.



Avoid damaging the instrument

Pay attention to the follow to avoid electric shock, fire and personal injury:

- Do not open the cabinet arbitrarily.
- Do not try to disassemble or refit any part of the instrument not mentioned in this manual. Otherwise, such consequences as reduced electromagnetic shielding property and internal component damage can occur, affecting product reliability. In this case, we will not provide any free maintenance any more even if the product is still in the warranty period.
- Read carefully relevant contents in "2.2 Safety operation instruction" of the user's manual as well as the following precautions on safe operation, and pay attention to the requirement on specific operation environment involved in the data pages.

NOTICE

Electrostatic protection

Take electrostatic protection measures at workplaces to avoid any damage caused by the instrument. For details, refer to relevant contents in "2.2 Safety operation instruction" of the user's manual.

NOTICE

Pay attention to the following when operating the instrument:

Improper operating or measuring position can damage the instrument or the one connected to it. Pay attention to the following before powering on the instrument:

- Keep the instrument dry;
- Keep the instrument level, and arrange it properly;
- Make sure the environment temperature meets with the requirement noted in the data page;
- Make sure the port input signal amplitude is within the range specified;
- Make sure the signal output port is connected properly, without any overload.

TIPS

Effect of electromagnetic interference (EMI):

Since EMI can affect the measurement result, pay attention to the following:

- Select proper shield cables. For example, to use the double-shielded RF/network connection cable;
- Please close any cable connection port that is enabled but temporarily unused or connect a matching load to the connection port in time;
- Please refer to the EMC level labels in the Data Page.

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3.1.1.1 Unpacking

1) Visual examination

Step 1: check whether the outer package and the shockproof packing of the instrument are damaged. If there is any damage, keep the outer package for standby and
proceed with the following examination steps.

Step 2: unpack, and check the instrument and articles provided in the package for any damage;

Step 3: check carefully the articles mentioned above as per Table 3.1 for any problem;

Step 4: in case of any outer package damage, or damage or problem to the instrument or articles provided in the package, never power the instrument on or start it up! Please contact our service consultation center
with the service hotline provided on the cover, and we will repair or change it as soon as possible accordingly.

2) Model confirmation

Table 3.1 List of articles provided together with 87237

Name	Quantity	Function
Oscilloscope:		
✧ 87237	1	—
Standard:		
✧ USB interface cable (1.5 m)	1	USB power supply and communication
✧ CD	1	Program
✧ Packing list	1	—
✧ Product certificate	1	—

3.1.1.2 Environmental requirements

The operation sites of the 87237 series USB Thermal Power Sensor shall meet the following environmental requirements:

1) Operation environment

The operation environment shall meet the following requirements:

Table 3.2 Operation environment requirements of 87237

Temperature	-10℃~50℃
Temperature range during error adjustment	23℃ ±5℃ (allowable temperature deviation during error adjustment < 1 ° C)

NOTICE

The above environmental requirements are only applicable to the operation environment factors of the instrument, and are not with the scope of specifications.

2) Electrostatic protection

Static electricity is extremely destructive to electronic components and equipment. Usually we take two anti-static measures: conductive table mat and wrist strap; Conductive floor mat and ankle strap. Using the above two anti-static measurements at the same time can provide good antistatic protection. If using one of them, only the former can provide antistatic protection. 1MΩ earth isolation resistor must be provided for the antistatic components at least for ensuring user safety.

Correctly take the following antistatic measures to techniques to reduce electrostatic damages:

- Ensure all instruments are grounded properly, so as to avoid any static electricity;
- Let the internal/external conductor of the cable contact the ground shortly before connecting the coaxial cable with the instrument;
- Operators must wear anti-static wrist straps or take other antistatic measures before touching the joints, core or conducting any assembly.

WARNING

Voltage range

The above-mentioned anti-static measures cannot be applied when the voltage exceeds 500 V.

3.1.1.3 Power-ON/OFF

The 87237 series USB Thermal Power Sensor is powered by the USB2.0 interface of the host computer, with a supply voltage of +5 V and a supply current of 500 mA. During operation, the USB Thermal Power Sensor is connected to the USB interface of the host computer via USB cables. The USB cable is unplugged after use to power off the instrument.

3.1.1.4 Proper operation of connectors

Connectors are often used in various tests of the USB Thermal Power Sensor. Although the connectors of calibration pieces, test cables and analyzer measurement ports are designed and manufactured according to the highest standards, the service life of all these connectors is still limited. Due to the inevitable wear and tear during normal use, the performance metrics of the connectors will decrease or even be unable to meet the measurement requirements. Therefore, correct maintenance and measurement connection of the connectors can not only ensure accurate and repeatable measurement results, but also prolong the service life of the connectors and reduce the measurement costs. In actual use, the following aspects shall be paid attention to:

1) Connector check

When conducting connector inspection, anti-static wrist band shall be worn. It is recommended to use a magnifier to check the following items:

a) Whether the electroplated surface is worn or not and whether there are deep scratches;
b) Whether the thread is deformed;
c) Whether there are metal particles on the threads and the joint plane of the connector;
d) Whether the inner conductor is bent or broken;
e) Whether the screw sleeve of the connector rotates improperly.

CAUTION

Checking the connector to prevent damaging ports of the instrument

Any damaged connector may damage the good connector connected to it even when measuring the connection for the first time. In order to protect each interface of the power Sensor, the connector must be checked before connector operation.

2) Connection method

Before the connection, the connectors shall be inspected and cleaned to ensure cleanness and intactness. Anti-static wrist straps shall be worn before connection. The correct connection method and steps are as follows:

Step 1. As shown in Figure 3.1, align the axes of the two interconnecting devices to ensure that the pin of the male connector slides concentrically into the socket of the female connector.



Figure 3.1 Axes of interconnected devices in a straight line

Step 2: as shown in Figure 3.2, move the two connectors leveled together so that they can be smoothly engaged. Rotate the screw sleeve of the connector (note, not the rotating connector itself) until it is tightened, and there can be no relative rotational movement between the connectors during the connection.

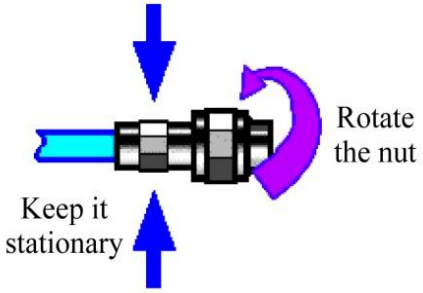


Figure 3.2 Connection method

Step 3: As shown in Figure 3.3, tighten the connectors with a torque wrench to complete the connection. Note that the torque wrench shall not exceed the initial turning point, and an auxiliary wrench can be used to prevent the connector from rotating.

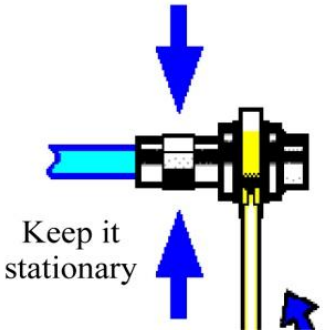


Figure 3.3 Finishing the connection with a torque wrench

3) Disconnection

Step 1: support the connectors to prevent any connector from being twisted, shaken or bent;

Step 2: An open-ended wrench can be used to prevent the connector body from rotating;

Step 3: loosen the screw sleeve of the connector with another wrench;

Step 4: Rotate the screw sleeve of the connector by hand to complete the disconnection;

Step 5. Pull the two connectors levelly apart.

4) Operating instructions of a torque wrench

The operating instructions of a torque wrench are shown in Figure 3.4. The following points shall be paid attention to when using it:

- Confirm that the torque of the torque wrench is correct set before use;
- Ensure that the angle between the torque wrench and another wrench (used to support a connector or a cable) is within 90° before applying force;
- Grasp the end of the torque wrench handle gently, and apply force in the direction perpendicular to the handle until reaching the folding point of the wrench.

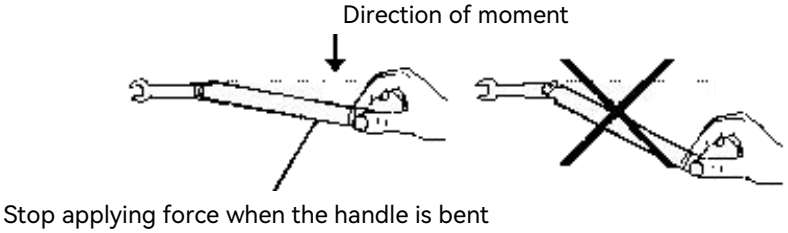


Figure 3.4 Operating instructions of a torque wrench

5) Use and storage of connectors

a) The connectors shall be covered by protective sleeves when not in use.
b) Do not mix various connectors, air lines and calibration kits in a box because this is one of the most common causes of connector damage.
c) Keep the connectors and the analyzer at the same temperature. Holding a connector by hand or cleaning a connector with compressed air will significantly change its temperature. The connectors shall be calibrated after its temperature is stable.
d) Do not touch the joint plane of the connectors because the grease and dust particles on the skin are difficult to be removed from the joint plane;
e) Do not put the contact surface of a connector downward on a hard table surface. Contact with any hard surface may damage the electroplated layer and the joint surface of the connector.
f) Always wear anti-static wrist straps and work on a grounded conductive workbench pad, which can protect the analyzer and the connectors from electrostatic discharge.

6) Connector cleaning

When cleaning the connectors, always wear antistatic wrist straps and observe the following steps:

a) Remove loose particles on the thread and joint plane of the connectors with clean low-pressure air, and thoroughly inspect the connectors. If further cleaning treatment is required, proceed as follows:
b) Soak (but not thoroughly soak) a lint-free cotton swab with isopropyl alcohol;
c) Remove the dirt and debris from the joint plane and threads of the connectors with cotton swabs. When cleaning the inner surface of a connector, be careful not to apply external force to the central inner conductor and not to leave the fibers of cotton swabs on the central conductor of the connector.
d) Let the alcohol volatilize, then blow the surface clean with compressed air;
e) Check the connector to make sure that it is free of particles and residues.
f) If any defects of the connector is still obvious after cleaning, it indicates that the connector may have been damaged and shall not be used again. Make clear the cause of the connector damage before connection.

7) Use of adapters

When the measurement port of the analyzer and the connector type used are different, adapters must be used for the connection before measurement. In addition, even if the measurement port of the analyzer and the connector type of port of the DUT

are the same, it is also advisable to use adapters. Both cases can protect the measurement port, prolong its service life and reduce the maintenance cost. Before connecting an adapter to the measurement port of an analyzer, it is required to carefully check and clean the adapter. And a high-quality adapter shall be used to reduce the influence of mismatching on measurement accuracy.

8) Joint plane of connectors

An important concept in microwave measurement is reference plane. It is the benchmark reference plane of all measurements for an analyzer. During the calibration, the reference plane is defined as the plane where the measurement port and the calibration standard are engaged. Good connection and calibration depend on thorough and level contact between the connectors on the joint plane.

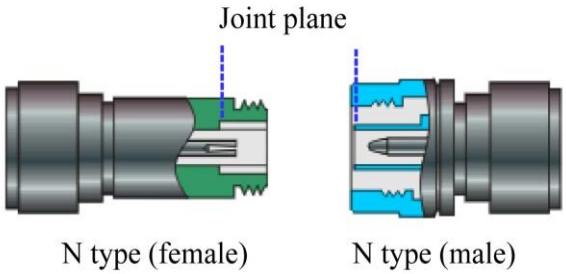


Figure 3.5 Calibration plane

3.1.1.5 User check

Connect the 87237 series USB Thermal power meter to a computer via USB cables and preheat it for at least 30 minutes. Set the instrument as follows:

Step 1. Initiate the power measurement and display software, click "Connect Device", select the equipment in the pop-up window, and confirm it.

Step 2. Observe the power noise fluctuations in the display area. Click "External Zeroing". Pay close attention to the alarm indication area in the power measurement and display software. If no alarms appear, the instrument is functioning normally. If an alarm appears, the instrument is malfunctioning. Contact our service center using the contact information provided on the inside front cover of this manual or in "6.4 Method to obtain after-sales services". We will promptly repair or replace the unit as needed.

3.1.2 Routine maintenance

This section describes the routine maintenance procedures of the 87237 series USB Thermal Power Sensor.

- Instrument surface cleaning.....22
- Test port maintenance.....22

3.1.2.1 Instrument surface cleaning

Please follow the steps below when cleaning the surface of the instrument:

Step 1: Shut down the instrument and disconnect the power cord connected to it;

Step 2: wipe the surface gently with dry or slightly wet soft cloth, and do not wipe the inside of the instrument.

Step 3: do not use chemical cleaners, such as alcohol, acetone or dilutable cleaners.

3.1.2.2 Test port maintenance

Damage to the connector of the 87237 series USB Thermal Power Sensor or the presence of dust inside the connector will affect the test results. Please maintain such kind of connectors as follows:

- The connectors shall be kept away from dust and kept clean.
- To prevent electrostatic discharge (ESD), do not directly contact the joint surface.
- Do not use damaged connectors;
- Please use an air blower to clean the connectors instead of using tools such as sandpaper to grind the surface of the joint.

3.2 Appearance description

This section describes the external components of the 87237 series USB Thermal Power Sensor and its functions. The appearance diagram is as follows (Figure 3.6), and the itemized explanation is shown in Table 3.4:



Figure 3.6 Instrument appearance

Table 3.3 Appearance description of 87237

Name	Description
power input	It is used to receive power signal input
USB interface	It is used for power supply and communication of the USB Thermal Power Sensor
Indicator light	It is used to indicate the working state of the instrument
Trigger input	External trigger input for synchronized measurements.

Table 3.4 87237 indicator light operating state

Color	State
Green	Normal working state
Flashing, green	Initial power-up and zeroing operation
Red	Working stop state
Red flashing	Hardware error
Red and green flashing	Firmware upgrade

If the indicator light flashes red, please unplug and replug the USB Thermal Power Sensor. If the red flashing persists, contact our service center using the contact information provided on the inside front cover of this manual or in "6.4 Method to obtain after-sales services". We will promptly repair or replace the unit as needed.

3.3 Configuration method

This chapter describes the hardware requirements and configuration methods for the 87237 series USB Thermal Power Sensor.

- Hardware requirements.....24

- Software installation.....24

3.2.1 Hardware requirements

Table 3.5 Basic configuration requirements of host computer

Host computer	
Operating system	Windows 11 64-bit Windows 10 32-bit and 64-bit Windows 7 32-bit and 64-bit
Hardware	Processor: 1 GHz or more (2 GHz or more recommended) Memory: 2 GB or more (4 GB or more recommended) Hard disk space: 1.0 GB or more Display: 1280 x 1024 or better

3.2.2 Software Installation

The installation of the instrument software consists of two parts: the VISA library and the instrument driver.

3.2.2.1 VISA Library Installation

If VISA is already installed, skip this step. If not installed, download and install it from the NI or Keysight official website.

Step 1: Using NI's VISA library as an example, double-click Setup.exe in the folder, as shown below.



Figure 3.7 VISA library installation

Step 2: Select the installation path and click Next, as shown below.

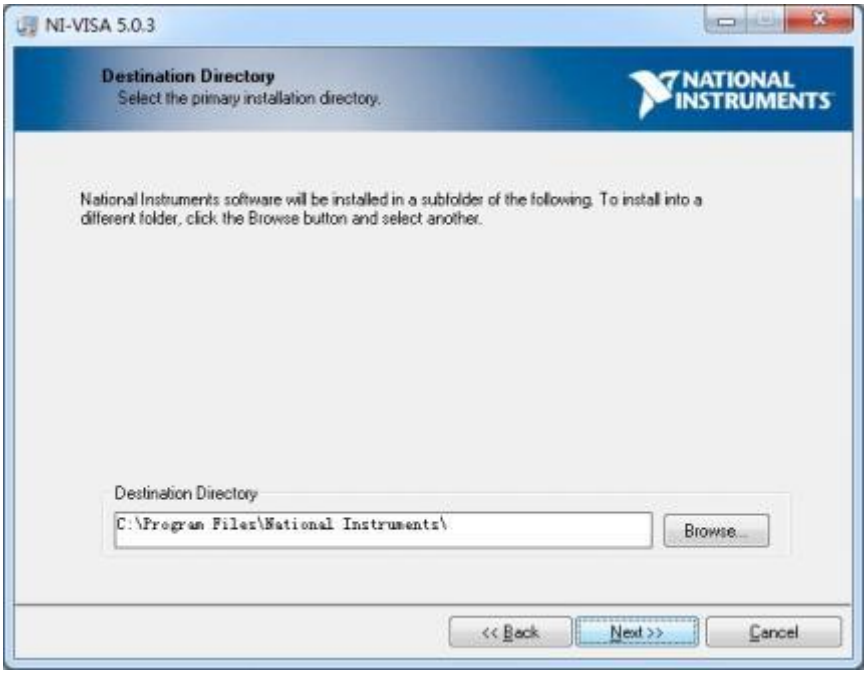


Figure 3.8 VISA library installation

Step 3: Install the default configuration or select all, click Next, as shown below.

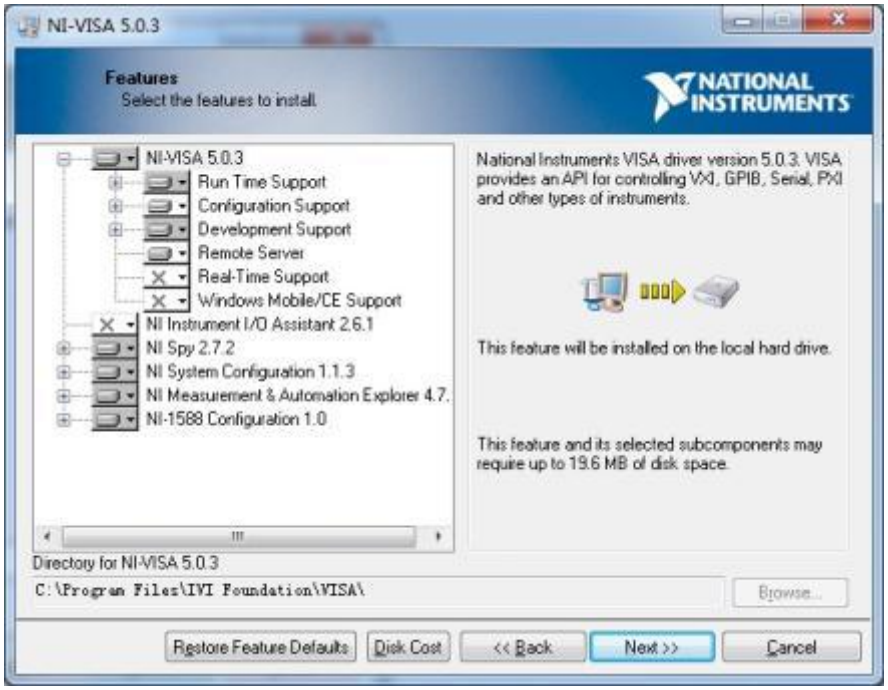


Figure 3.9 VISA library installation

Step 4: Click Next and select the appropriate option until Finish. The VISA library is installed.

Notice: The computer cannot have two or more VISA libraries installed at the same time. If you install more than one VISA library, you need to uninstall all VISA libraries completely, and reinstall any VISA library after the uninstallation is complete.

3.2.2.2 Hardware Driver Installation

After the USB Thermal Power Sensor is properly connected to the power Sensor, the system may automatically install the driver without prompting due to the difference in the original software configuration of the operating system, or the user may be prompted to install the instrument driver, or it may even be identified as other devices due to the original software configuration, as explained separately below.

(i) Automatic installation without prompts

To determine whether the hardware driver is automatically installed, right-click My Computer Management Device Manager. If there is a USB Test and Measurement Deice (IVI) in the device list, right-click the entry, select "Properties", then select the "Details" tab, and select "Hardware ID" in the properties drop-down menu to view the hardware ID property of the instrument as "USB\VID_04B4&PID_1010", which is the intrinsic ID of the instrument. as shown in the following figure.

At this point, it indicates that the hardware driver is automatically installed. This part of the operation can be omitted and go directly to the third part.

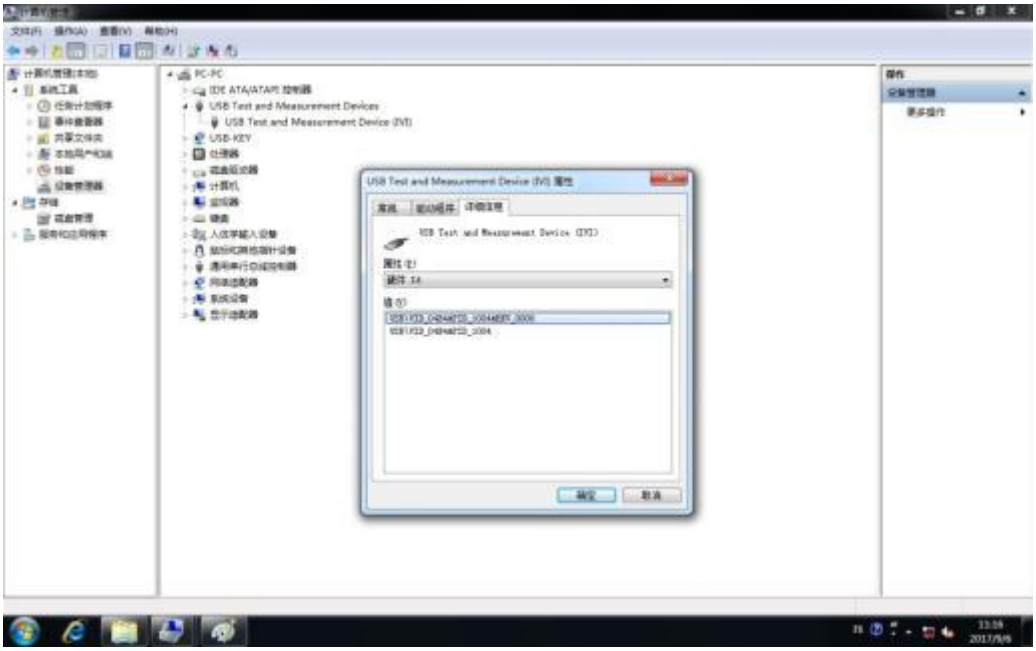


Figure 3.10 Hardware driver installation

(ii) Prompt the user to install the instrument driver

After inserting the USB Thermal Power Sensor, the system prompts to install the driver. as follows:

Step 1: After connecting the USB Thermal Power Sensor to the power Sensor properly, the hardware update wizard will pop up automatically as shown below.



Figure 3.11 Hardware driver installation

Step 2: Select Install from list or specified location and click Next, as shown in the figure below.



Figure 3.12 Hardware driver installation

Step 3: Select "Do not search, I will choose the driver to install", and click Next, as shown in the figure below.



Figure 3.13 Hardware driver installation

Step 4: Select "USB Test and Measurement Device" and click Next to complete the installation, as shown in the figure below.



Figure 3.14 Hardware driver installation

Step 5: Click Finish and restart the computer if necessary.

(iii) The system automatically identifies it as another device and installs the default driver

Due to the different software configurations installed on the original system, the system may automatically identify the USB Thermal Power Sensor as another device, which is usually located in the "Universal Serial Bus Manager" under Device Manager, as shown in the figure below.



Figure 3.15 Hardware driver installation

Repeatedly plug and unplug the USB Thermal Power Sensor to check the added or reduced devices in Device Manager, and right-click Properties to check whether the "Hardware ID" in the "Details" is "USB\VID_04B4&PID_1010". If the device is identified as such, right-click and select "Update Driver...". The specific steps are as follows:

Step 1: Select "Browse Computer for Driver Software" as shown in the figure below.



Figure 3.16 Hardware driver installation

Step 2: Select "USB Test and Measurement Device" and click Next to complete the installation, as shown in the figure below.

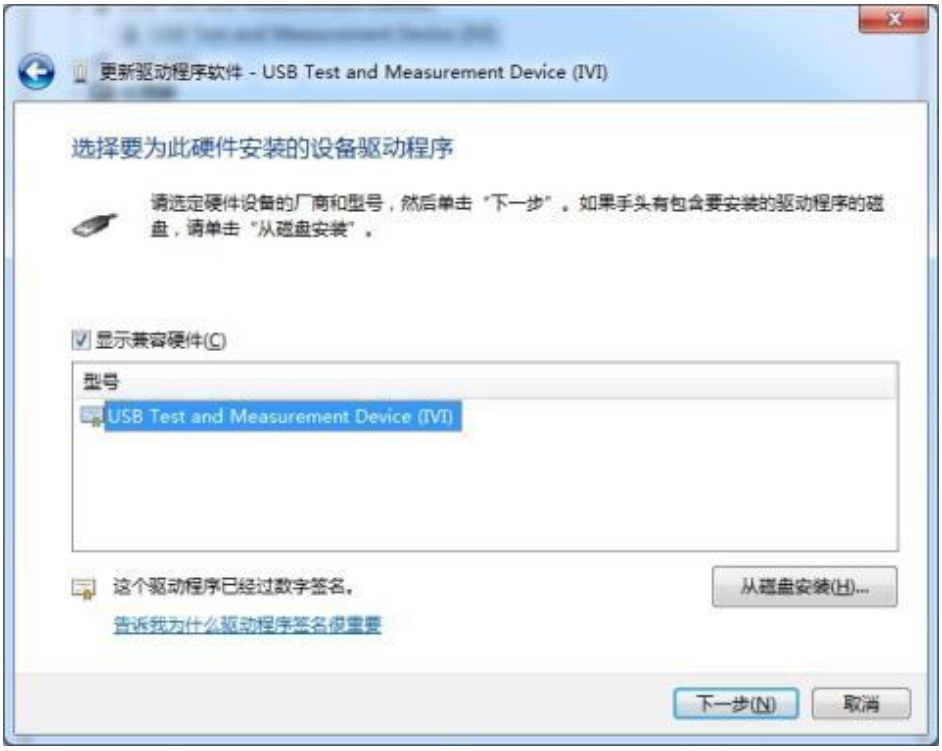


Figure 3.17 Hardware driver installation

Step 3: After successful installation, the Device Manager will show "USB Test and Measurement Device", as shown in the figure below.



Figure 3.18 Hardware driver installation

3.2.2.3 Power measurement and display software

1) Software installation

Open the "power measurement and display software" folder on the CD. This folder contains the installation program for the power measurement and display software: Ceyear_PowerMeterPanel_windows_Setup.exe. Double-click the exe file and follow the steps to install the power measurement and display software.

2) Software operation

Run the just installed "power measurement and display software". Click the soft toolbar "connect device" button (please ensure that the USB Thermal Power Sensor cable is connected to the USB interface of the computer host at this time) to pop up a dialog box as shown below. After selecting the device and clicking the Connect button, users can measure power as needed.

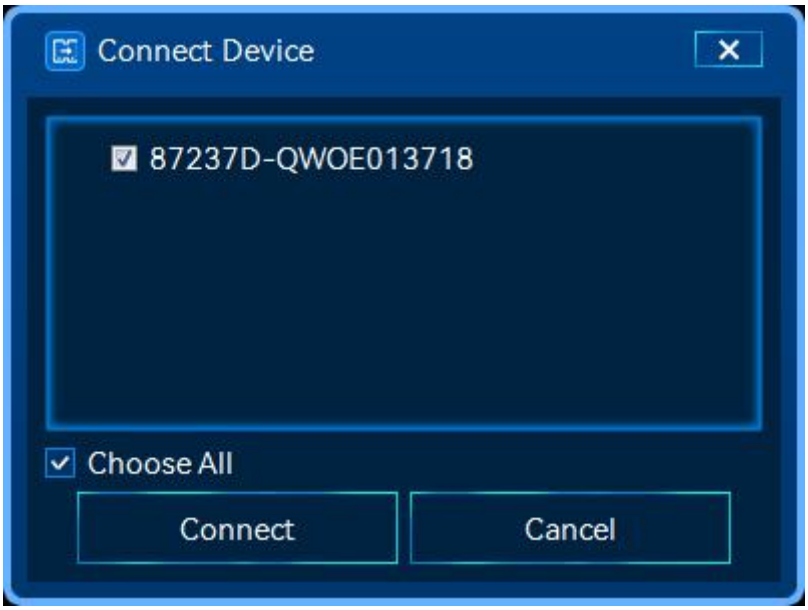


Figure 3.19 Equipment connector window

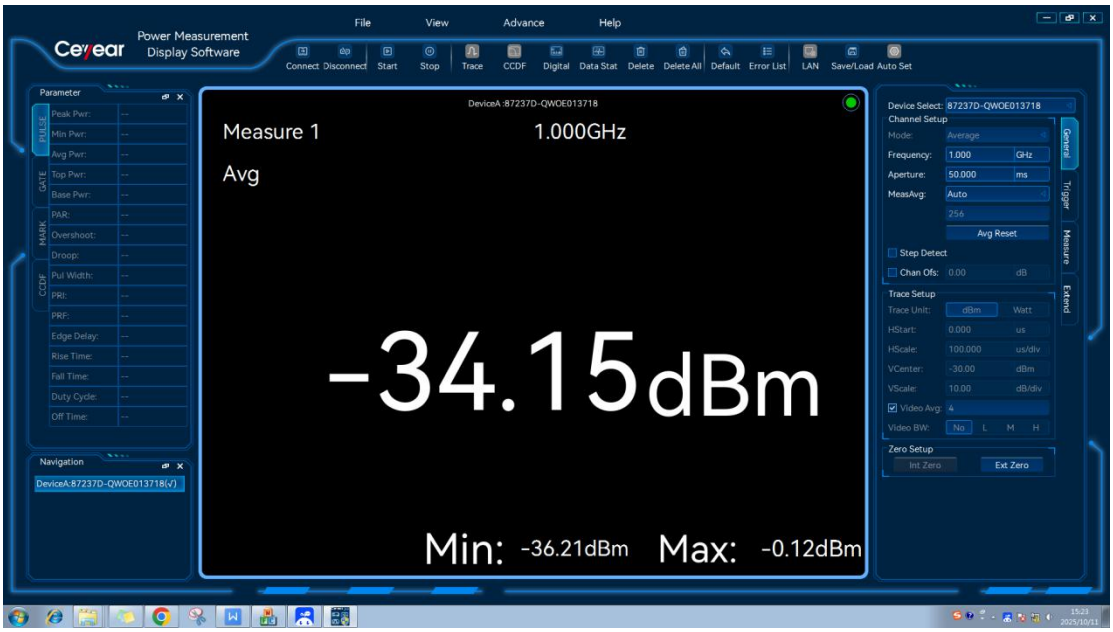


Figure 3.20 Main interface of the software

4 Operation guide

This chapter introduces the operating instructions of different measurement functions and details the measurement steps for the 87237 series USB Thermal Power Sensor.

- Introduction to power measurement and display software.....35
- Power measurement and display software operation.....48
- Average power measurement.....54
- Setting and using "offset".....56

4.1 Introduction to power measurement and display software

- Main interface.....35
- Menu bar.....37
- Tool bar.....40
- Function setting.....40
- Power display.....49

4.1.1 Main interface

The 87237 series USB Thermal Power Sensor can be set and display measurement results through the power measurement and display software. The power measurement software features a new intuitive graphical user interface. The entire interface is divided into distinct areas according to functional modules, allowing simultaneous operation of multiple modules. This section primarily introduces the partitioned composition of the power measurement and display software's user interface and relevant functions used by the 87237 series Sensor. The operating interface is shown in Figure 4.1, and the detailed description is shown in Table 4.1.

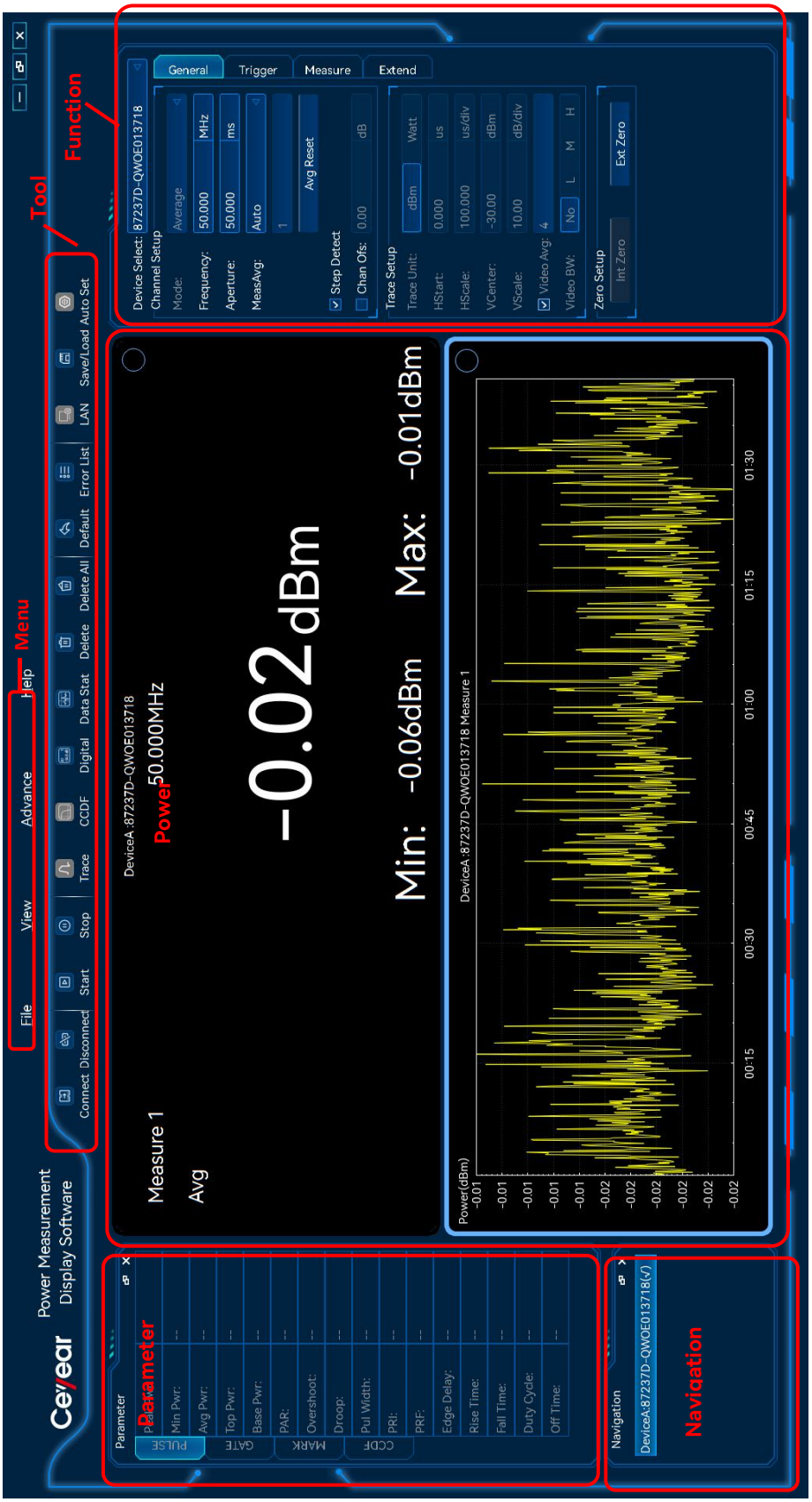


Figure 4.1 Main operating interface

Table 4.1 Operating interface description

No.	Name	Description
1	Menu bar	Function setting menu
2	Tool bar	Shortcuts to common tools
3	Function setting	Set the function menu
4	Power display	The numerical window displaying power measurement results and the numerical statistical window showing real-time power curves can accommodate 1 to 4 sub-windows.
5	Navigation bar	Display all connected devices
6	Parameter display	Display pulse parameters, gate parameters, marker parameters, and statistical parameters (not used by 87237).

4.1.2 Menu bar

4.1.2.1 File

The file menu primarily includes options such as Historical Data and Exit.

[Historical Data]

It is used for quick access to the file location storing historical data.

Users click [Historical Data] to enter a secondary menu containing types such as pulse trace, statistical trace, and data statistics. After users select the desired type and click, the software automatically opens the folder containing that category of historical data. The 87237 series USB Thermal Power Sensor only supports the Data Statistics type.

[Exit]

It is used to exit the power measurement and display software program.

4.1.2.2 View

The View menu primarily controls the display and hiding of floating windows such as the navigation bar and parameter display.

4.1.2.3 Advanced

The Advanced menu mainly includes options such as instrument report, programmed control command recording, frequency response offset table, multi-pulse parameters, multi-device measurement, firmware upgrade, Chinese/English switch, and

developer options.

[Instrument Report]

Display basic information for all connected power meters, including manufacturer, model, serial number, version, frequency range, power range, etc.

[Programmed Control Command Recording]

It records the corresponding programmed control commands corresponding to the parameter setting during software execution.

Upon clicking, the programmed control command recording and display window will open and automatically start recording. The corresponding programmed control commands are displayed in the window synchronously as the parameters are set.

The programmed control command recording and display window offers export function of programmed control commands. "Export as Text File" can be used to save recorded programmed control commands to a file, or "Export as Example Project" can be used to generate a Qt project containing the recorded programmed control commands, which enhances user programming efficiency.

[Frequency Response Offset Table]

It is used to set the desired frequency response at specific frequency points within the currently selected power meter.

It supports up to 10 frequency response offset tables, with each table capable of setting up to 4000 offset points. The 87230 series USB average power Sensor supports only 1 frequency response offset table which is capable of setting up to 80 offset points.

Each power meter can only enable one frequency response offset table at a time. When one table is active, all others are automatically disabled. Detailed operating instructions for frequency response offset tables are provided in 4.4.2 Setting frequency response offset.

[Multi-pulse Parameter]

It is used to display the power and time parameters of individual pulses when measuring pulse train signals of different periods using the currently selected power meter. This function is unavailable for the 87237 series USB Thermal Power Sensor.

[Multi-Device Measurement]

It is used to display power measurement results from all connected power meters.

Upon clicking, the multi-device measurement window pops up. In the window, each power meter has a measurement value subwindow displaying information such as the power meter model number, frequency, and power reading. Subwindows are arranged in a tiled layout and can be dragged with the mouse to adjust their relative positions.

[Firmware Upgrade]

It is used to upgrade the firmware of the currently selected power meter.

NOTICE

Precautions for firmware upgrade:

Do not disconnect power during the upgrade process, as this may cause device

damage!

[Chinese/English Switch]

It is used to switch the display language of the power measurement and display software.

[Developer Options]

It is used for advanced settings related to the power measurement and display software.

4.1.2.4 Help

The Help menu provides assistance for using this software, primarily including About and Help options.

[About]

It is used to display basic software information, such as the software name, version number, copyright, and contact details.

[Help]

It is used to pop up the help documentation. The Help documentation provides quick text navigation assistance, detailing the software's features and operating instructions to facilitate both local and remote control operations of users. Its main sections correspond to the user's manual.

4.1.3 Toolbar

Table 4.2 Toolbar

Icon	Function	Icon	Function
	Connect the device		Disconnect the device
	Start collecting measurement results		Stop collecting measurement results
	Create pulse trace display subwindow (unavailable for 87237)		Create statistical measurement (CCDF) subwindow (unavailable for 87237)
	Create a numerical display subwindow		Create a data statistics subwindow for displaying power value statistical curves
	Delete current display view		Delete all display views
	Restore default settings of the instrument		Open an error list window
	Set the network configuration for network port Sensors (unavailable for 87237)		Save/call
	Auto setting (unavailable for 87237)		

4.1.4 Function setting

Function settings apply to individual power Sensors. Since the 87237 USB Thermal Power Sensor is primarily designed for accurate measurement of average signal power, the power measurement and display software's menu settings mainly include channel setting, zeroing setting, trigger setting, measurement setting, and overload setting.

4.1.4.1 General setting

The general setting menu includes channel setting, trace setting, and zeroing setting. Since the 87237 USB Thermal Power Sensor is primarily designed for accurate measurement of average signal power, trace setting is not supported.

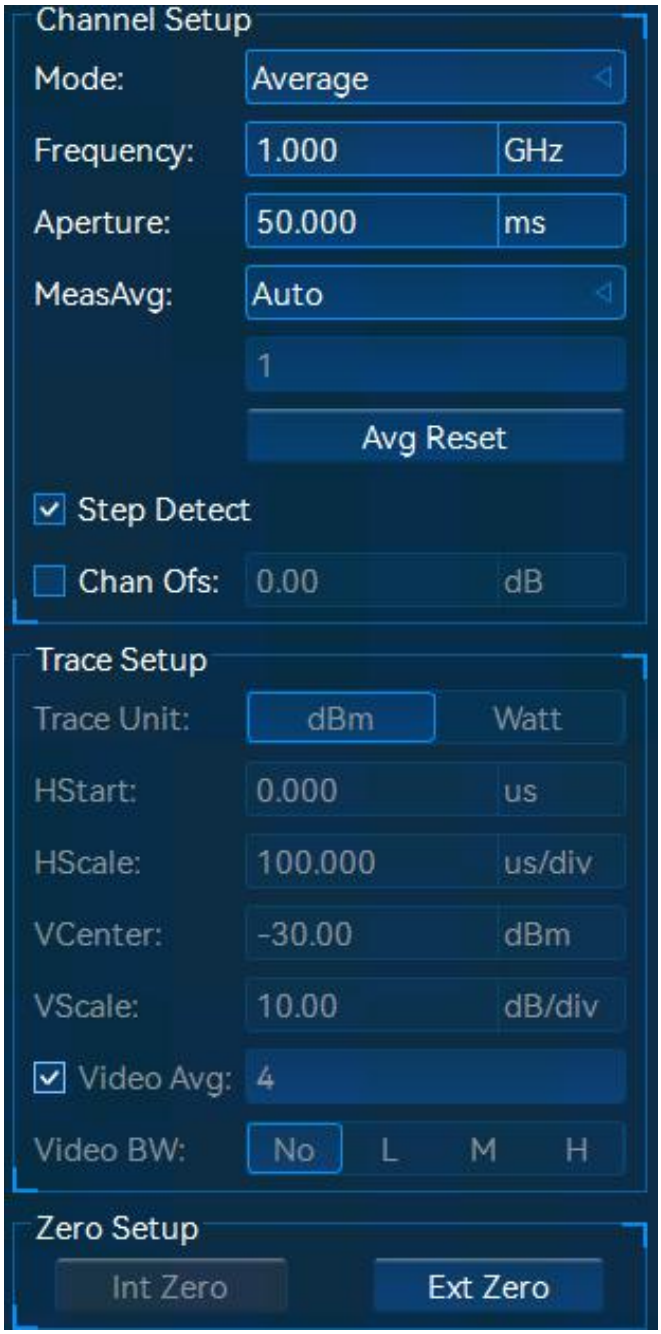


Figure 4.2 General setting

Table 4.3 Channel setting menu

Channel setting	
Mode	For detection measurement mode, the 87237 is always set to Average Only.
Frequency	Set measurement frequency.
Aperture	Set the size of aperture.

Measurement average	Turn off, automatically or manually set the number of averages with a setting range of 1-262144. Increasing the number of averages of measurements reduces measurement noise, but increases measurement time. See Table 4.4 for details. Average reset clears the measurement results in the buffer and re-caches and calculates them, effectively reducing the measurement time when the number of averages is high.
Step detection	The initialization filter increases the measurement speed when there is a large change in the measured power.
Channel offset	Set the channel deviation applied to the measured power before the mathematical operation.
Zeroing Setting	
Internal zeroing	Using an internal switch, zeroing operation can be performed without turning off the signal source output. The 87237 does not support this function.
External zeroing	Signal source output must be turned off to perform zeroing. Additionally, external zeroing is required, particularly for small signal measurements.

Table 4.4 Number of automatic averages

Mode	Power dynamic range	Resolution			
		1	2	3	4
Average Only	20 dBm ~ 0 dBm	1	1	1	8
	0 dBm ~ -5 dBm	1	1	1	8
	-5 dBm ~ -10 dBm	1	1	4	16
	-10 dBm ~ -15 dBm	1	1	8	64
	-15 dBm ~ -20 dBm	2	4	32	128
	-20 dBm ~ -25 dBm	4	16	64	256
	-25 dBm ~ -30 dBm	8	32	128	512
	-30 dBm ~ -35 dBm	16	64	256	512
	<-35 dBm	32	128	512	1024

4.1.4.2 Trigger setting

Trigger settings include trigger mode and trigger setting.



Figure 4.3 Trigger setting

Table 4.5 Trigger setting menu

Trigger setting	
Trigger mode	Set free-run, continuous trigger or single trigger mode.
Trigger Source	Internal or external trigger is set; the 87237 supports external trigger only.
Trigger Mode	Set to Auto Level, Normal or Auto (unavailable for 87237).
Trigger level	Set the trigger level manually in Normal and Auto Trigger mode (unavailable for 87237).
Trigger delay	Set the delay time between the trigger event and the gated start event.
Trigger edge	Set to trigger on the or last transition of the signal.

Trigger position	Set current trigger edge to left, center, or right (unavailable for 87237).
Trigger Holdoff	Set the trigger holdoff time, and disable the trigger within this time.
Trigger Hysteresis	Set trigger hysteresis (unavailable for 87237).
Trigger Output	Enable a TTL level synchronized with the input signal (unavailable for 87237).

4.1.4.3 Measurement Setting

The Measurement Setting menu includes measurement setting and gate setting, which is used to set the numerical display window and data statistics window, such as switching power units within the window. Since the 87237 USB Thermal Power Sensor-designed for accurate measurement of average signal power, gate setting is not supported.



Figure 4.4 Measurement setting

Figure 4.6 Measurement setting menu

Measurement setting	
Measurement selection	Select the current measurement, 4 in total.

units of measurement	Set the current measurement to logarithmic or linear measurement units.
Resolution	Set the measurement result display resolution of the current measurement.
Relative measurement	Enable relative mode of the current measurement, click relative power to set the reference value, and calculate the relative measurement result of the current measurement value and the reference value.
operation	Set input 1 and input 2 of the current measurement to perform difference or ratio calculations, or disable all operations.
Input	Set the channel, gate, and measurement type for input 1 and input 2 of the current measurement.
Measurement limit	Set the ON/OFF state for the measurement limit of the current measurement.
Measurement upper limit	Set the upper limit value for the current measurement.
Measurement lower limit	Set the lower limit value for the current measurement.

4.1.4.4 Extension setting

The extension setting menu includes CCDF setting, marker setting, reference line setting, pulse definition setting, and overload setting. Since the 87237 USB Thermal Power Sensor is primarily designed for accurate measurement of signal average power, it does not support CCDF setting, marker setting, reference line setting, or pulse definition setting.

The overload setting menu primarily controls whether to enable power overload warnings. When it is enabled, if an overloaded Sensor is detected, an overload warning window will automatically appear. This alerts the user that the input signal power of the Sensor is currently too high. Prolonged overload may damage the Sensor components, preventing its accurate measurements.

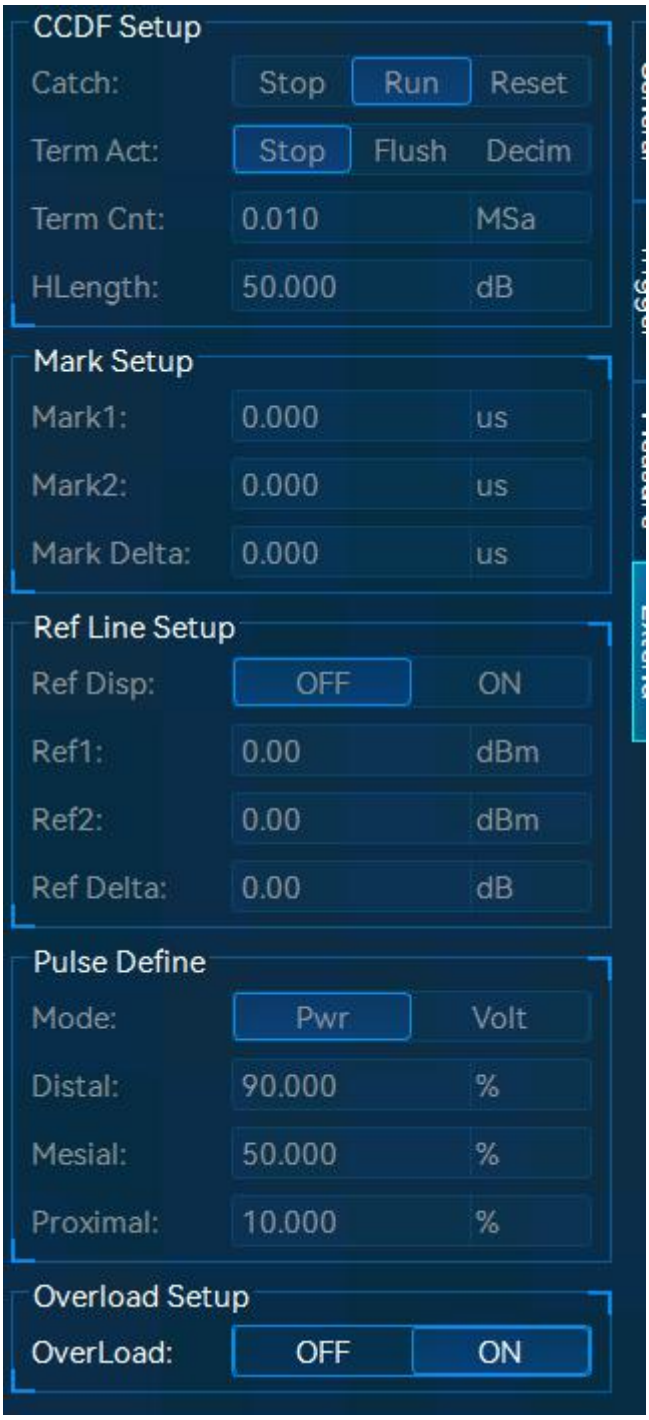


Figure 4.5 Extension setting

Figure 4.7 Measurement setting menu

Overload setting	
Overload ON/OFF	It enables or disables the power overload warning, which is enabled by default.

4.1.5 Power display

Since the 87237 USB Thermal Power Sensor is primarily designed for accurate measurement of average signal power, the power display area can include sub-windows such as a numerical display sub-window and a data statistics sub-window. Up to four sub-windows can be created.

4.1.5.1 Numerical display subwindow

The numerical display subwindow is primarily used to show power readings in various numerical formats, depending on the selected mathematical mode. Simultaneously, the subwindow will display the configuration state of the current Sensor. The interface is shown below, and the itemized explanation is shown in the table below:

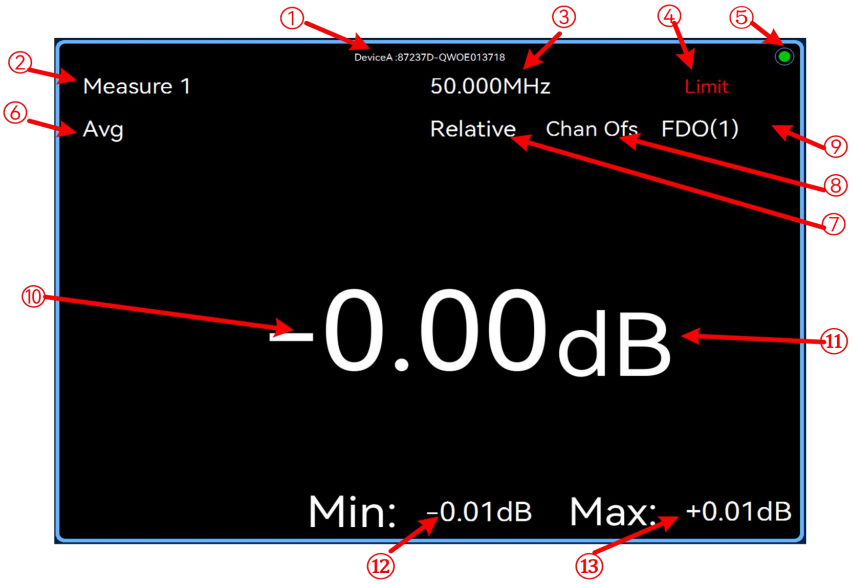


Figure 4.6 Numerical display subwindow

Table 4.8 Description of numerical display subwindow

No.	Name	Description
1	Product identification	Display product model-serial number
2	Measurement number	Display the current measurement number, and indicate that the power values in this window are bound to the settings in [Measurement Setting].
3	Frequency	Display the current frequency, which is consistent with the frequency setting in [Channel Setting].
4	Out of range	Indicate whether the current power value is out of range and consistent with the out-of-range setting in [Measurement

		Setting].
5	Run/stop indicator	Display the operating state of the current measurement.
6	Math mode	Display the mathematical mode for the current power value, which is consistent with the operation, input 1, and input 2 settings in [Measurement Setting].
7	Relative measurement	It is displayed when relative measurement is enabled, which is controlled by the relative measurement option in [Measurement Setting].
8	Channel offset	It is displayed when channel offset is enabled, which is controlled by the channel offset option in [Channel Setting].
9	Frequency response offset (x)	It is displayed when the frequency response offset table is enabled. The x in parentheses indicates the currently active table number.
10	Power value	Display the currently acquired power value.
11	Unit	Display the unit of the current power.
12	Minimum	Display the minimum power value encountered during continuous measurement, which can be cleared using the average reset in [Channel Setting].
13	Maximum	Display the maximum power value encountered during continuous measurement, which can be cleared using the average reset in [Channel Setting].

The numerical display subwindow can be accessed by clicking the  icon button on the toolbar. After users click the button, the measurement window selection dialog box will pop up, where users can select the desired power Sensor and its measurement number (measurement 1/measurement 2/measurement 3/measurement 4), as shown in Figure 4.7. The measurement number is bound to the corresponding setting in [Measurement Setting] of "Menu Setting Area", allowing users to set different power value calculation methods for display.

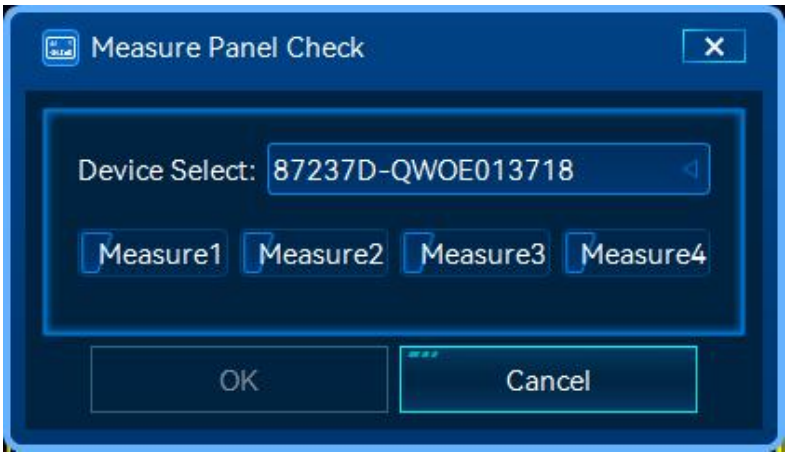


Figure 4.7 Measurement window selection dialog box

When creating a numerical display subwindow, users can either complete the relevant configuration in [Measurement Setting] first and then create the numerical display subwindow directly via the toolbar button. Alternatively, after creation, users can select the subwindow and configure it in [Measurement Setting].

4.1.5.2 Data statistics subwindow

The data statistics subwindow primarily displays real-time power variation curves of signals over a period and saves curve data as historical records in files. Historical data files can also be directly opened for viewing. The interface is shown below, and the itemized explanation is shown in the table below:

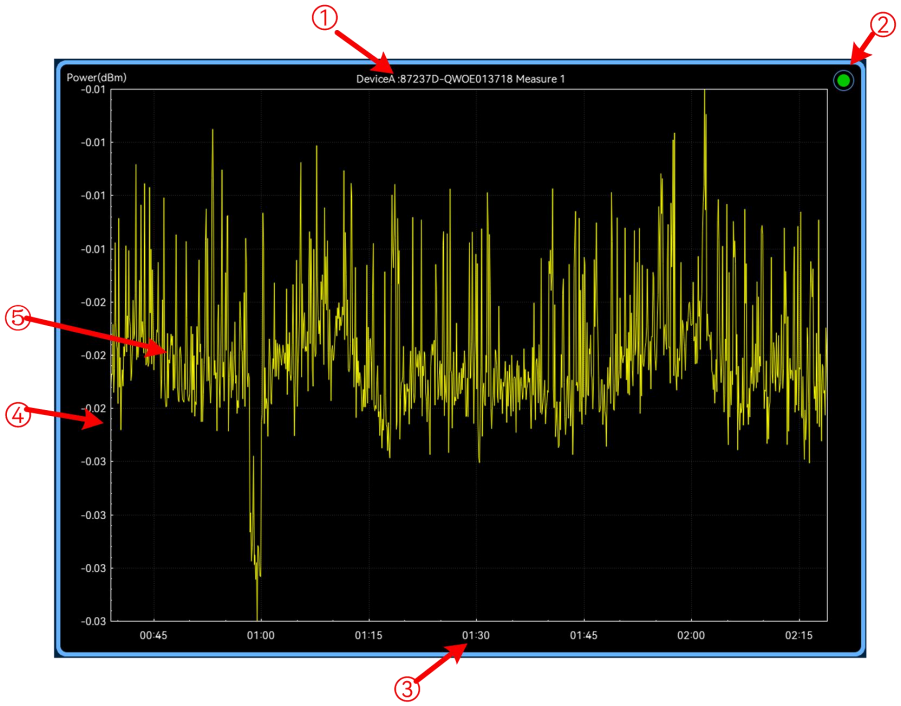


Figure 4.8 Data statistics subwindow

Table 4.9 Description of data statistics subwindow

No.	Name	Description
1	Product identification	Display product model-serial number
2	Run/stop indicator	Display the operating state of the current curve measurement.
3	x-axis	Display the time axis for the real-time curve. It is adjustable via the mouse scroll wheel.
4	y-axis	Display the power value axis for the real-time curve. It is adjustable via the mouse scroll wheel.

5	Real-time data curve	It shows the real-time power variation curve of the signal.

During operation of the data statistics subwindow, the y-axis automatically adjusts its range to accommodate curve changes. The x-axis scale can also be adjusted using the mouse scroll wheel. When it is stopped, the mouse scroll wheel can also be used to zoom in/out on specific areas for detailed inspection, or users can hold the left mouse button to drag the curve.

In addition, right-clicking in the window will bring up a menu with options such as selecting the number of data points in the current coordinate system, clearing data, auto-setting, exporting to a file, and so on, as shown in Figure 4.9.

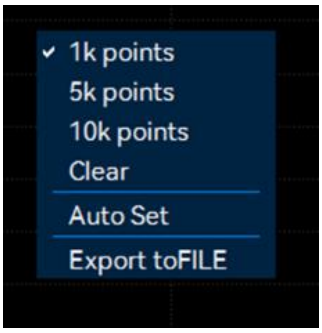


Figure 4.9 Menu options in the data statistics subwindow

Users can access the data statistics subwindow by clicking the icon button on the toolbar. After clicking, the data statistics window selection dialog box will pop up, which lists all power Sensors, as shown in Figure 4.10. Users can select the desired power Sensor and its measurement number (measurement 1/measurement 2/measurement 3/measurement 4) from the dialog box. Alternatively, users can open the data statistics window using historical data, and select the historical data file to be opened by clicking the "Select Historical Data" button.

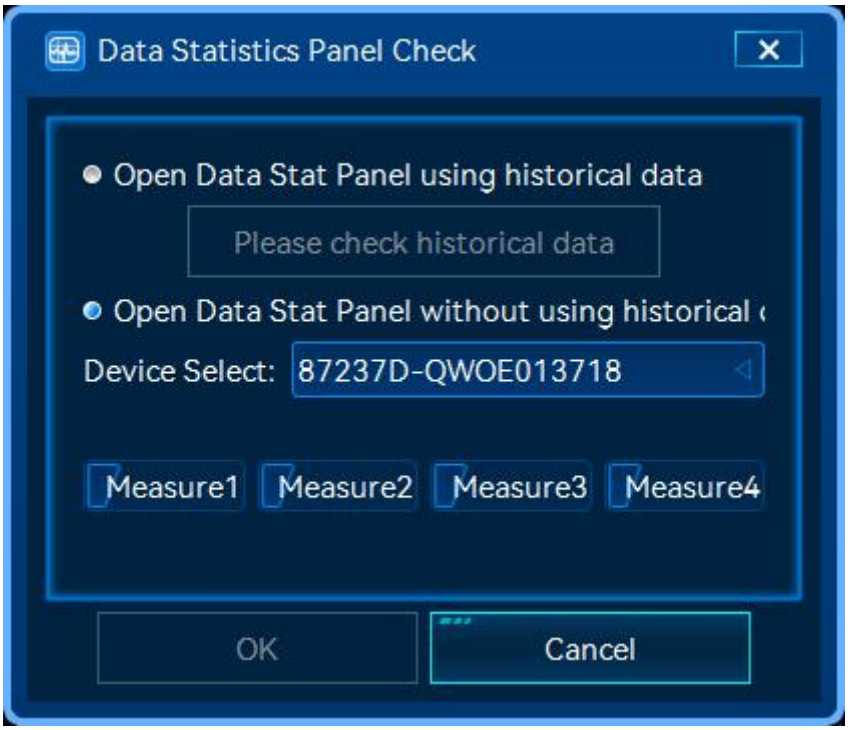


Figure 4.10 Data statistics window selection dialog box

4.2 Power measurement and display software operation

Step 1: Double-click to run the "power measurement and display software". Click the toolbar 连接设备 to select the test instrument in the pop-up window as shown in the figure below, and then click "Connect", as shown in the figure below;

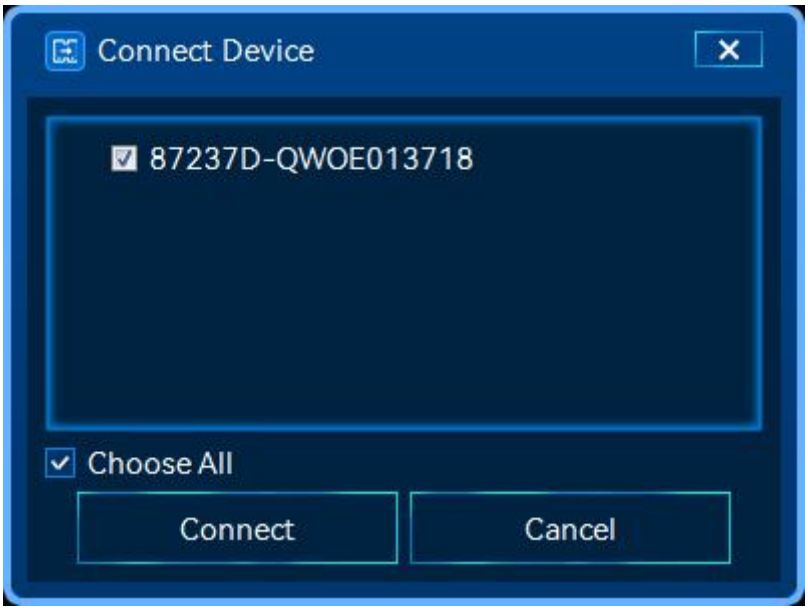


Figure 4.11 Equipment connector window

Step 2: Open the average power value display window in the test panel by default. The default measurement mode is set to Average Only, as shown in the figure below;



Figure 4.12 Average power display window

4.3 Average power measurement

The 87237 series USB Thermal Power Sensor enables average power measurements. The operation process is as follows:

Step 1: Set the signal generator amplitude to 0 dBm, frequency to 1 GHz and modulation mode to OFF;

Step 2: Conduct zeroing operation (when the measured signal is small, the source output needs to be turned off for external zeroing);



Figure 4.13 Zeroing setting

Step 3: Turn on the signal generator output and run the power measurement and display software with the measurement mode defaulted to Average Only. Set the frequency to 1 GHz. Set the appropriate aperture or choose the default aperture according to the measured signal cycle;

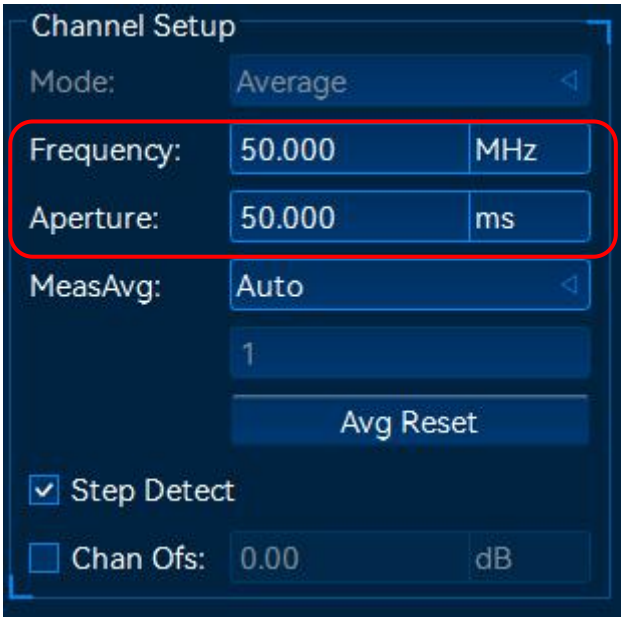


Figure 4.14 Measurement mode

Step 4: At this time, the measured signal power value can be observed in the power display window.



Figure 4.15 Power display window

NOTICE

When measuring low-level signals (lower than -15 dBm), it is necessary to conduct external zeroing first. When conducting external zeroing, it is necessary to turn off the output of the signal source, and then conduct the measurement, so as to ensure the accuracy of the measurement.

4.4 Setting and using "offset"

The 87237 can compensate for signal attenuation or gain in the test path. Offset can be set at two distinct positions within the measurement channel: "channel offset" and "frequency response offset". They apply to the entire channel and enable independent Sensor compensation.

4.4.1 Setting channel offset

If the measurement path includes amplification or attenuation circuits, the gain and attenuation are inherent to the measurement channel. Channel offset is measured in dB, ranging from -200 dB to +200 dB. Positive values compensate for the attenuation of attenuators, while negative values compensate for the gain of amplifiers.

Steps to set channel offset:

1) Select [Channel Setting] > [Channel Offset]. Click the checkbox to select and enable the channel offset function. "channel offset" will appear in the upper-right corner of the numerical display subwindow, indicating the channel setting is active.

2) Set [Channel Setting] > [Channel Offset]. Enter the offset value via keyboard.

If the entered offset value is positive, the measurement result plus the offset value is displayed. If the entered offset value is negative, the measurement result minus the offset value is displayed.

4.4.2 Setting frequency response offset

Frequency response offset varies with frequency, providing a rapid and effective compensation method for frequency-dependent variations in test system response. It is applied to the power Sensor. The 87237 can store up to 10 frequency response offset tables, each supporting a maximum of 4000 frequency points.

After activating the frequency response offset function, the power meter automatically sets correction factors based on the Sensor calibration table and frequency response offset table during power measurements. This ensures measurement accuracy by adjusting the measurement results.

Steps to enable frequency response offset:

1) Ensure the power measurement software is connected to the power Sensor;
2) Click the [Advanced] menu in the [Menu Bar], and then select [Frequency Response Offset Table] from the dropdown options to enter the frequency response offset window. This window displays a list of all available frequency response offset tables, as shown in Figure 4.16. The window includes columns for serial number, frequency response offset table name, number of points, and enable state;
3) Click the checkbox corresponding to a specific table in the "enable state"

column. For example, click the checkbox corresponding to the No.1 frequency response offset table to enable that table. Simultaneously, "frequency response offset (1)" will appear in the upper-right corner of the numerical subwindow, indicating that frequency response offset table 1 is active.

It is worth noting that the power measurement and display software can only open the frequency response offset table for the currently selected power Sensor in the operation navigation bar. The "frequency response offset (1)" will only appear in the numerical display subwindow corresponding to that power Sensor.

Additionally, only one entry in the "enable state" column of the window may be "selected" at a time. This means only one frequency response offset table can be active for a single power Sensor.



Figure 4.16 Frequency response offset table window

Steps to edit the frequency response offset table:

1) As per the frequency response offset enabling procedure, first open the frequency response offset table window;
2) Use the mouse to select the desired frequency response offset table within the

window. The selected table will display a light blue background;

3) Click the "Edit" button to open the editing window and modify the table contents, as shown in Figure 4.17. Alternatively, double-click any frequency response offset table to edit it;
4) Check the [FDO Enable] checkbox to activate the frequency response offset table;
5) Click the [Frequency Response Offset Table Name] input box to modify the table's name;
6) Click the [Add]/[Delete]/[Edit]/[Clear] buttons to perform operations on individual data entries within the table;
7) Click the [File Import] button to load data stored in spreadsheets (e.g., .csv files) with a single click;
8) Click the [File Export] button to save the data in the current window to a spreadsheet. When it is used in conjunction with [File Import], convenient batch editing of data in the frequency response offset table is possible.
9) Click the [OK] button to set the frequency response offset table. Clicking [Cancel] will discard all the above settings.

It is worth noting that steps 4) to 6) take effect only after users click [OK]. Any setting will be discarded if users close the window.



Figure 4.17 Editing window of frequency response offset table

If a frequency entered in the frequency response offset table exceeds the frequency range defined in either the Sensor calibration table or the frequency response offset table, the 87237 will use the highest or lowest frequency point in the table to set the calibration factor and offset.

In practical applications, if the frequency of the signal under test differs from the frequency points in the Sensor calibration table or the valid frequency response offset table, the 87237 will use linear interpolation to calculate the calibration factor and offset for that frequency point.

4.5. Use of trigger input

The 87237 can measure the average power of pulse-modulated signals using the trigger input function and aperture parameters. This refers to the average power over a period starting from the first transition of trigger, with the duration of this period being aperture-dependent.

The specific operations are as follows:

Step 1: Set the signal generator to pulse modulation mode, the amplitude to 0 dBm, the frequency to 1 Ghz, the pulse period to 100 us, and pulse width to 50 us;

Step 2: Run the power measurement and display software. Connect the 87237 Sensor device connected to the computer. Set the frequency to 1 GHz, the aperture to 50 ms, and the trigger mode to continuous trigger with an external trigger source.

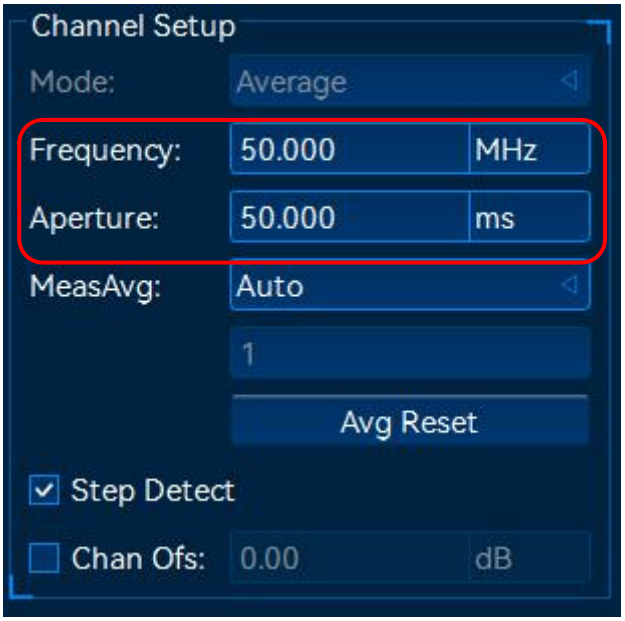
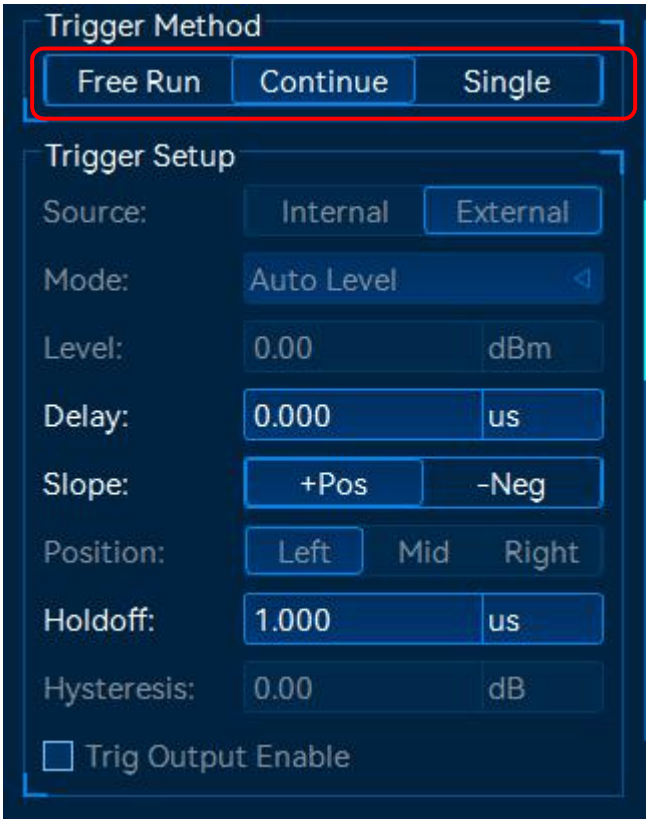


Figure 4.18 Measuring frequency and aperture



4.19 Trigger mode

Step 3: Connect the power Sensor to the signal generator's output port. Connect the signal generator's pulse sync to the power Sensor's trigger input.

Step 4: Activate the signal generator output. The measured signal power value will be visible in the numerical display subwindow. At this time, the power value represents the average power over 50 ms (aperture) starting from the first transition of trigger.

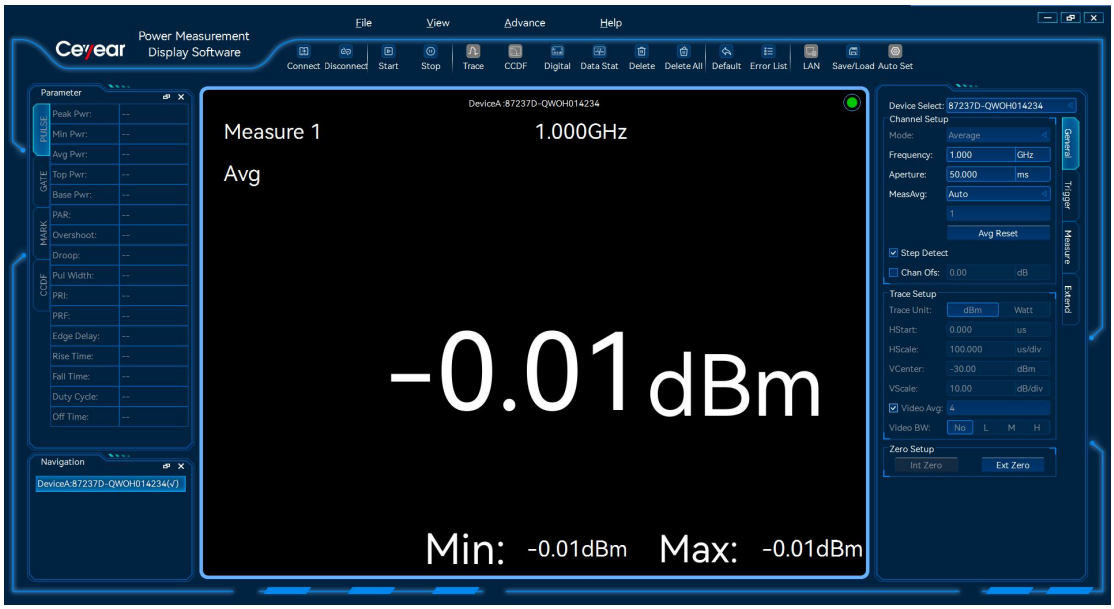


Figure 4.20 Numerical display subwindow

5. Remote control

This section introduces briefly the programmed control fundamentals, programmed control interface and configuration method, and basic VISA interface programming method of the 87237 series USB Thermal Power Sensor, as well as the concept and classification of the I/O instrument driver library, The purpose is to facilitate users to start to achieve remote control. Specific contents include:

- Remote control fundamentals.....63
- Instrument programmed control port and configuration.....83
- Basic VISA interface programming method.....84
- I/O library.....88

5.1 Remote control fundamentals

- Programmed control interface 63
- Message.....68
- SCPI command 69
- Command sequence and synchronization 79
- State reporting system 80
- Precautions for programming 83

5.1.1 Programmed control interface

Instruments with remote control function generally support four kinds of programmed control interfaces: LAN, GPIB, RS-232 and USB, and the type of port supported by the specific model of instrument is determined by the function of the instrument. The 87237 series USB Thermal Power Sensor supports only USB programmed control interfaces.

The programmed control interface and related VISA addressing string are described in the table below:

Table 5.1 Remote control interface type and VISA addressing string

Programmed control interface	VISA addressing string	Description
LAN (local area network)	**VXI-11 protocol:** TC PIP::Addressograph[::LAN_device_name][::INSTR] **Raw socket protocol:** TC PIP::Addressograph::port::SOCKET	The controller realizes remote control by connecting the instrument with the network port on the

Programmed control interface	VISA addressing string	Description
		rear panel of the instrument. For details of the protocol, please refer to: "6.1.1.1 LAN interface"
GPIB (IEC/IEEE Bus Interface)	GPIB::primary address[::INSTR]	The controller realizes remote control by connecting the instrument with the port on the rear panel of the instrument. The bus interface standard IEC 625.1/IEEE 418 is met. For details, please refer to: "6.1.1.2 GPIB interface"
RS-232 (RecommendedStandard-232)		Instrument rear panel port. For details, please refer to: "6.1.1.3 RS-232 interface"
USB (Universal Serial Bus)	USB::<vendor ID>::<product_ID>::<serial_number>[::INSTR]	Instrument rear panel port. For details, please refer to: "6.1.1.4 USB interface"

- LAN interface.....64
- GPIB interface.....67
- USB interface.....67

5.1.1.1 LAN interface

The measuring instrument can be controlled remotely by computers in LAN 10Base-T or 100Base-T. Various instruments are combined into a system in LAN and

controlled uniformly by computers in it. In order to realize remote control in LAN, the instrument shall be equipped with port connector, network card and relevant network protocol in advance, and provided with relevant network services. Meanwhile, the host computer in the network shall also be equipped with instrument control software and VISA library in advance. The three operating modes of the network card are:

- 10Mbit/s Ethernet IEEE802.3;
- 100Mbit/s Ethernet IEEE802.3u;
- 1Gbit/s Ethernet IEEE802.3ab.

The controller computer and the instrument shall be connected to the common TCP/IP protocol network through the network port. The cable between the computer and the instrument is a commercial RJ45 cable (Category 5 cable with or without shielding). During data transmission, the transmission speed of LAN is faster when data packet transmission is applied. Generally, the length of the cable between the computer and the instrument shall not exceed 100m (100Base-T and 10Base-T). For more information about LAN communication, please refer to: http://www.ieee.org. LAN is introduced belowInterface-related knowledge:

1) IP address

Physical connection of the network shall be guaranteed for remote control on the instrument via the LAN. It is just required to set the address into the subnet of the host computer through the menu "Local IP" of the instrument. For example, if the IP address of the host computer is 192.168.12.0, the IP of the instrument shall be set to 192.168.12.XXX, whereas XXX is the figure between 1 and 255.

When establishing a network connection, only the IP address is required. The VISA addressing string is as follows:

TC PIP::host address[::LAN device name][::INSTR] or

TCPIP:: host address: port:: SOCKET

Where:

- TCPIP represents the network protocol used;
- host address represents the IP address or name of the instrument, and is used for identifying and controlling the controlled instrument;
- LAN device name defines the handle number of the protocol and subset (option);
  - VXI-11 protocol is selected for device 0;
  - More recent high speed LAN instrument protocol is selected for high speed LAN instrument 0;
- INSTR represents the instrument resource type (option);
- port identifies the socket port number;
- SOCKET represents the raw network socket resource class.

Example:

- The IP address of the instrument is 192.1.2.3, and the effective resource string of the VXI-11 protocol is:
  TCPIP::192.1.2.3::INSTR
- To establish a raw socket connection, use:
  TCPIP::192.1.2.3::5025::SOCKET

TIPS

Method of recognizing multiple instruments in the programmed control system

If multiple instruments are connected in the network, the individual IP address and related resource string are used to distinguish. The host computer applies its own VISA resource string for instrument identification.

2) VXI-11 protocol

The VXI-11 standard is based on the ONC RPC (Open Network Computing Remote Procedure Call) protocol, which is the network/transport layer of the TCP/IP protocol. The TCP/IP network protocol and associated network services are pre-configured for communication. Such connection-oriented communication, which follows the sequential exchange and can identify the interruption of the connection, ensures no loss of information.

3) Socket communication

The TCP/IP protocol connects a signal source over a LAN socket in the network. As a basic method used in computer network programming, the socket allows applications using different hardware and operation systems to communicate over a network. With this method, two-way communication between the instrument and the computer is realized through ports.

As a software class programmed specially, the socket defines the IP address, device port number and other necessary information for network communication, and integrates some basic operations in network programming. Sockets can be used after installing packaged libraries in the operation system. Two commonly used socket libraries are the Berkeley socket library for UNIX the Winsock library for Windows.

Sockets in the instrument are compatible with Berkeley sockets and Winsock through the application program interface (API). In addition, it is compatible with the API of other standard sockets. When SCPI are used to control the instrument, the socket program established in the program issues the command. Before using a LAN socket, the socket port number of the instrument must be set. The socket port number of the instrument is 5000.

5.1.1.2 GPIB interface

As an instrument programmed control interface widely used at present, GPIB interface is connected to different types of instruments through GPIB cable, so as to build a test system with the host computer. In order to realize remote control, the host computer shall be equipped with GPIB bus card, driver and VISA library in advance. During communication, the host computer first addresses the controlled instrument through the GPIB bus address. The user may set the GPIB address and ID query string, and the GPIB communication language may be in the form of SCPI by default.

GPIB and its associated interface operations are defined and described in detail in ANSI/IEEE Standard 488.1-1987 and ANSI/IEEE Standard IEEE Standard 488.2-1992. For details of the standards, please refer to the IEEE website: http://www.ieee.org.

GPIB processes information in bytes at the data transmission speed of up to 8MBps, which is fast. Since the data transmission rate is limited by the distance between the device/system and the computer, the following points shall be noted when connecting GPIB:

- Up to 15 instruments may be built through GPIB interface.
- The total length of the transmission cable shall not be more than 15 m or twice the number of instruments in the system. In general, the maximum length of the transmission cable between the devices shall not exceed 2 m;
- If multiple instruments are connected in parallel, a "live" cable is required.
- The end of the IEC bus cable shall be connected to the instrument or controller computer.

5.1.1.3 USB interface

To implement USB programmed control, a computer and a USB Thermal Power Sensor need to be connected via a USB B-type port with the VISA library installed in advance. VISA automatically detects and configures the instrument to establish a USB connection without the need to enter the instrument address string or install a separate driver.

USB address:

Addressing string format: USB::<vendor ID>::<product ID>::<serial number>[::RAW]

Where:

- <vendor ID> represents the manufacturer code;
- <product ID> represents the instrument code;
- <serial number> represents the serial number of the instrument;

Example:

USB::0x0AAD::0x00C6::100001::INSTR

0x0AAD: Manufacturer code;

0xC6: Instrument code;

100001: serial number of the instrument.

5.1.2 Message

The messages transmitted on the data cable are divided into the following two categories:

1) Interface message

During communication between the instrument and the host computer, the attention cable shall be pulled down first, and then the interface message will be transmitted to the instrument through the data cable. Only instruments with GPIB bus function can send interface message.

2) Instrument message

For the detailed structure and syntax of the instrument message, see Section "5.1.4 SCPI command". The instrument message can be divided into two types as per the transmission direction, namely, command and instrument response. Unless otherwise stated, all programmed control interfaces apply instrument message in the same way.

a) Commands:

Commands (programming messages) are messages sent by the host computer to the instrument for the remote control of instrument functions and the query of state information. Commands are divided into the following two categories:

- Based on the impact on the instrument:

-- Setting commands: change the set state of the instrument, such as reset or setting frequency.

-- Query commands: query and return data, for example: identify the instrument or query the parameter value. Query commands end with the suffix question mark.

- Based on the definition in the standard:

- Common commands: with functions and syntax to be defined by IEEE488.2, they are applicable to all types of instruments (if realized)

It is used for management of standard state register, resetting, self-detection, etc.

-- Instrument control commands: instrument characteristic commands, used to realize instrument functions, such as setting frequency.

The syntax also follows the specifications of SCPI.

b) Instrument responses:

Instrument responses (response message and service request) are the query result information sent by the instrument to the computer. Such information includes measurement results, instrument state, etc.

5.1.3 SCPI

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- Description of SCPI.....70

5.1.3.1 Introduction to SCPI

SCPI (standard commands for programmable instruments) are a command set for all instruments established based on Standard IEEE488.2. The main purpose is to make the same function have the same programmed control command to achieve the universality of programmed control commands.

SCPI consist of a command header and one or more parameters. The command header is separated from the parameters by spaces and contains one or more key fields. A command with direct suffix question mark is a query command. Commands are divided into common commands and instrument commands that have different syntactic structures. SCPI have the following characteristics:

1) Programmed control commands are oriented to test function rather than describing instrument operation;
2) Programmed control commands reduce the repeat typeof similar test function realization process, and ensure the compatibility of programming.
3) Programed control messages are defined in layers that are hardware independent of the communication physical layer.
4) Programmed control commands are independent of programming methods and languages. The test program of SCPI is easy to transplant.
5) Programmed control commands are scalable and can adapt to different scale of measurement control.
6) The extensibility of SCPI makes it a "living" standard.

If you are interested in learning more about SCPI, please refer to:

IEEE Standard 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation. New York, NY, 1998.

IEEE Standard 488.2-1987, IEEE Standard Codes, Formats, Protocols and Comment Commands for Use with ANSI/IEEE Std488.1-1987. New York, NY, 1998

Standard Commands for Programmable Instruments(SCPI) VERSION 1999.0.

For programmed control command set, classification and description of the 87237 series USB Thermal Power Sensor, please refer to:

1) "Annex B Zoom table of SCPI commands" of this manual;
2) "3 Programmed Control Commands" of the Programmed Control Manual;
3) "Annex A Zoom table of SCPI commands classified as per subsystems" of the Programmed Control Manual;
4) "Annex B Zoom table of SCPI commands classified as per menus" of the Programmed Control Manual.

5.1.3.2 Description of SCPI

- General terms....70
- Command type....71
- Instrument command syntax....71
- Command tree....73
- Command parameters and responses....74
- Number system of commands....78
- Command line structure....78

1) General terms

The following terms apply to this section. To better understand the chapters, you shall understand the exact definitions of the terms.

Controller

A controller is any computer used to communicate with the SCPI device. A controller may be a PC, minicomputer, or a plug-in card on a cage. Some AI devices can also be used as controllers.

Device

A device is any device that supports SCPI. Most of the devices are electronic measurement or excitation devices that use GPIB interfaces for communication.

Programmed control message

A programmed control message is the combination of one or more SCPIs that have been correctly formatted. Programmed control messages tell the devices how to measure and output the signals.

Response message

A response message is a set of data of specified SCPI formats. Response messages always come from the devices to controllers or listening devices. Response messages tell the controllers about the internal state or measurement values of the devices.

Command

A command is an instruction that satisfies the SCPI standard. The combination of commands controlling the devices forms a message. In general, a command includes keywords, parameters, and punctuation.

Event command

Event-type programmed control commands cannot be queried. An event command generally has no corresponding front panel key setting, and its function is to trigger an event at a specific time.

Query

A query is a special type of command. When a control device is queried, a response message appropriate to the controller syntax requirements is returned. A query statement always ends with a question mark.

2) Command type

There are two types of SCPI: common commands and instrument commands. Figure 5.1 shows the difference between the two commands. Common commands, defined by IEEE 488.2, are used to manage macros and state registers and for synchronization and data storage. Because common commands all start with an asterisk, they are easy to be recognized. For example, *IDN? *OPC, *RST are all common commands. Common commands are not part of any instrument commands, and the instrument interprets them in the same way regardless of the current path setting of the commands.

Instrument commands are easy to be recognized because they contain a colon (:). A colon is used in the beginning of an expression or between two keywords, for example: FREQuency[:CW?]. According to the internal function module of the instrument, instrument commands are divided into sub-sets of corresponding subsystem commands. For example, the power subsystem (:POWer) contains power-related commands, while the state subsystem (:STATus) contains commands for the state control register.

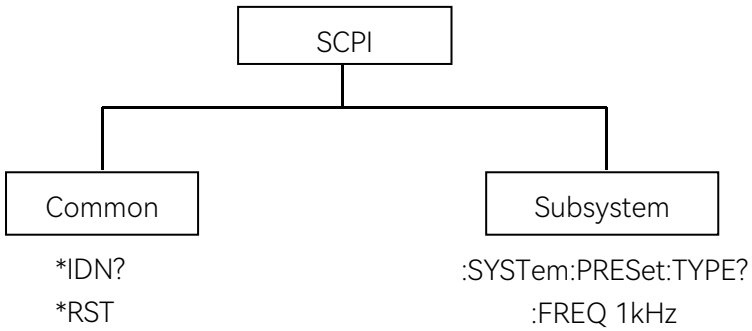


Figure 5.1 Types of SCPI

3) Instrument command syntax

A typical command consists of a keyword prefixed with a colon. The keyword is followed by parameters. The following is an example of a syntax declaration:

[:SOURce]:POWer[:LEVel] MAXimum|MINimum

In the example above, the [:LEVel] in the command follow: POWer closely without any space. MINimum|MAXimum immediately following [:LEVel] is the parameter. There is a space between the command and the parameter. Other parts of the syntax expression are described in Table 5.2 and Table 5.3.

Table 5.2 Special characters in command syntax

Symbol	Meaning	Example
|	The vertical bar between the keyword and the parameter represents multiple options.	[:SOURce]:AM: SOURce EXTernal|INTernal EXTernal and INTernal are optional
[]	A square bracket indicates that the contained keyword or parameter is optional when forming a command. The command will be executed even when such implied keyword or parameter is ignored.	[:SOURce]:AM[:DEPTh]:EXPon ential? SOURce and DEPTh are optional.
< >	The portion enclosed in angle brackets is not used literally in the command . It represents the part that must be contained.	[:SOURce]:FREQ:STOP <val><unit> In this command, <val> and <unit> must be replaced with actual frequency and unit. For example: :FREQ:STOP 3.5 GHz
{ }	The part in braces indicates that the parameter is optional.	[:SOURce]:LIST:POWer <val>{,<val>} For example: LIST:POWer 5

Table 5.3 Command syntax

Characters, keywords and syntax	Example
Uppercase characters represent the minimum set of characters required to execute a command. .	[:SOURce]:FREQuency[:CW]?, FREQ is the short format part of the command.
The lower case part of the command is	:FREQuency

optional; such flexible format is loaded called "flexible listening". For details, refer to "Command Parameters and Responses".	:FREQ,:FREQuency or or :FREQUENCY Either of them is correct.
When a colon is between two command mnemonics, it will move the current path down a level in the command tree. Please refer to the command path of "Command Tree" for more information.	:TRIGger:OUTPut:POLarity? TRIGger is the top-level keyword for the command.
If the command contains more than one parameter, adjacent parameters are separated by commas. The parameter is not part of the command path, so it does not affect the path layer.	[:SOURce]:LIST:DWELl <val>{,<val>}
The semicolon is used to separate 2 adjacent commands, without affecting current command path.	:FREQ 2.5GHZ; :POW 10DBM
Blank characters, such as <space> or <tab>, are usually ignored as long as they do not appear between or within keywords. However, you must separate the commands and parameters with blank characters, which does not affect the current path.	:FREQ uency or :POWer :LEVel6.2 is not allowed. :LEVel and 6.2 must be separated by a space, namely, :POWer:LEVel 6.2.

4) Command tree

Most remote control programs apply instrument commands. When parsing such commands, SCPI apply a file system-like structure called command tree, as shown in Figure 5.2:

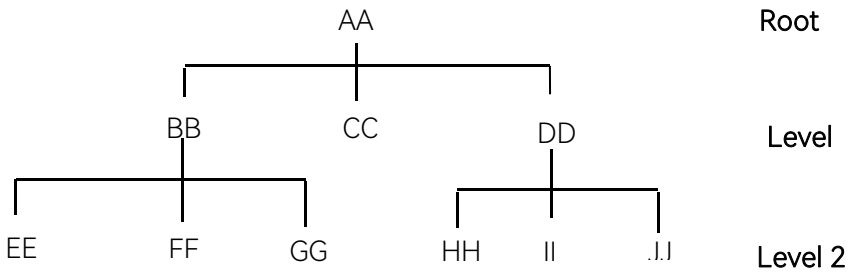


Figure 5.2 Simplified command

The top command is the root command, or "root" for short. When a command is parsed, follow a specific path to the next level of command according to the tree structure. For example, in :POWer:ALC:SOURce?, : POWer stands for AA, :ALC stands for BB, :SOURce stands for GG, and the entire command path is (:AA:BB:GG).

A software module in instrument software – **command interpreter**, is responsible for parsing each received SCPI. The command interpreter breaks commands into individual command elements by using a series of rules that distinguish the path of the command tree. After parsing the current command, keep the current command path unchanged. The advantage of this is to parse subsequent commands more quickly and efficiently since that the same command keyword may appear in different paths. After starting or *RST (reseting) the instrument, current command path is reset to root.

5) Command parameters and response

SCPI defines different data formats in the use of programmed control and response messages to comply with the principles of "**flexible listening**" and "**precise speaking**". For more information, please refer to IEEE488.2. "**Flexible listening**" means that the formats of the commands and parameters are flexible.

For example, to set the frequency offset state command for the USB Thermal Power Sensor: FREQuency:OFFSet:STATe ON|OFF|1|0,

the following command formats are all used to set the frequency offset function to ON:

:FREQuency:OFFSet:STATe ON, :FREQuency:OFFSet:STATe 1,

:FREQ:OFFS:STAT ON, :FREQ:OFFS:STAT 1

Each parameter type has one or more corresponding response data types. During query, a data type will be returned for a numerical parameter, and the response data is precise and strict, known as "**precise speaking**."

For example, during query of the power state (:POWer:ALC:STATe?), when it is ON, the response data returned is always 1 during query, regardless of whether the previously sent setting command is :POWer:ALC:STATe 1 or :POWer:ALC:STATe ON.

Table 5.4 Parameter and response types of SCPI

Parameter type	Response data type
Numerical	Real number or integer
Extended numerical	Integer
Discrete	Discrete
Boolean	Digital boolean
String	String
Blocks	Finite-length blocks
	Infinite-length blocks
Non-decimal numeric types	Hexadecimal
	Octal
	Binary

Numerical parameters

Numeric parameters can be used in both instrument-specific commands and common commands. A numeric parameter receives all the usual decimal counting methods, including signs, decimals, and scientific notation. If a device only accepts a specified numeric type, such as an integer, it will automatically round up the received numeric parameters.

Examples of numeric parameters:

0 No decimal point
100 Optional decimal point
1.23 Signed bit
4.56e<space>3 Index marker e can be followed by a space
-7.89E-01 Index marker e can be uppercase or lowercase
+256 Positive lookahead allowed
5 Decimal points can be used first

Extended numerical parameters

Most measurements related to instrument commands use extended numeric parameters to specify physical quantities. Extended numerical parameters receive all numeric parameters and additional special values. All the extended numeric parameters receive MAXimum and MINimum as parameter values. Whether other special values, such as UP and DOWN, will be received is determined by the ability of the instrument to parse. All effective parameters will be listed in the table of SCPI.

Notice: Extended numeric arguments do not apply to common commands or STATus subsystem commands.

Examples of extended numeric parameters:

101 Numeric parameter

1.2 GHz	GHz can be used as an index (E009)
200 MHz	MHz can be used as an index (E006)
-100 mV	-100 millivolt
10DEG	10°
MAXimum	Maximum effective setting
MINimum	Minimum effective setting

UP Increase by a step
DOWN Reduce by a step

Discrete parameters

When the number of parameter values to be set are finite, they are identified by discrete parameters. Discrete parameters use mnemonics to represent each valid setting. Like programmed control command mnemonics, discrete parameter mnemonics have two formats, long and short, and allow for mixture of upper and lower cases.

In the following examples, discrete parameters and commands are used together.

:TRIGger[:SEQuence]:SOURce BUS|IMMediate|EXTernal

BUS GPIB, LAN, RS-232 trigger
IMMediate Trigger immediately
EXTernal Trigger externally

Boolean parameters

A Boolean parameter represents a true or false binary condition, which can only have four possible values.

Boolean parameter examples:

ON	Logically true
OFF	Logically false
1	Logically true
0	Logically false

String parameters

String parameters allow ASCII strings to be sent as parameters. Single quotes and double quotes are used as separators.

The following are example of string parameters:

'This is Valid' "This is also Valid" 'SO IS THIS'

Real response data

Most of the test data are of real number type, and their formats can be basic decimal notation or scientific notation, which are supported by most advanced programmed control languages.

Examples of real number response data:

1.23E+0
-1.0E+2
+1.0E+2
0.5E+0
0.23
-100.0
+100.0
0.5

Integer response data

An integer response data is a decimal expression of an integer value containing signed bit. When querying the state register, most of the response data returned are of integer type.

Examples of integer response data:

0 Symbol bit optional
+100 Positive lookahead allowed
-100 Negative lookahead allowed
256 No decimal point

Discrete response data

Discrete response data are basically the same as discrete parameters, only that the return format of discrete response data is only a short form in uppercase.

Examples of discrete response data:

INTernal Stabilization mode is internal
EXTernal Stabilization mode is external
MMHead Stabilization type is millimeter wave source module

Digital bool response data

A binary value 1 or 0 is returned as Boolean response data.

String response data

String response data and string parameters are alike. The main difference is that the separators of string response data are double quotes instead of single quotes. Double quotes can also be embedded in string response data, and there may be no characters between the double quotes. Here are some examples of string response data:

"This is a string"

"one double quote inside brackets: ("")"

6) Numeration system of commands

The value of the command can be entered in binary, decimal, hexadecimal or octal format. When using binary, hexadecimal or octal format, a proper identifier is required before the value. Decimal format (the default format) does not require an identifier, and when a value is entered without a representation, the device will ensure that it is in decimal format. The following list shows the required representations for each format:

- #B indicates that the number is a binary number.
- #H indicates that the number is a hexadecimal number.
- #Q indicates that the number is an octal number.

The following are various representations of the decimal number 45 in SCPI:

#B101101

#H2D

#Q55

The following example sets the RF output power to 10 dBm (or a value of the equivalent value of the currently selected unit, such as DBUV or DBUVEMF) with a hexadecimal value of 000A.

:POW #H000A

When using a non-decimal format, a measurement unit, such as DBM or mV, is not used with the value.

7) Command line structure

Since one command line can contain multiple SCPI commands, the following methods can be used to indicate the end of current command line:

- Enter;
- Enter and EOI;
- EOI and the last data byte.

Commands on the command line are separated by semicolons, and commands belonging to different subsystems begin with a colon. For example:

MMEM:COPY "Test1", "MeasurementXY";:HCOP:ITEM ALL

The command line contains two commands: the first one belongs to the MMEM subsystem, and the second belongs to the HCOP subsystem. If adjacent commands belong to the same subsystem with repeated command path, they can be expressed in abbreviation. For example:

HCOP:ITEM ALL;:HCOP:IMM

The command line contains two commands: both of them belong to the HCOP subsystem, with the same first level. Therefore, the second command can start from the next level of HCOP, and the colon for starting the command can be omitted. It can be abbreviated as follows:

HCOP:ITEM ALL;IMM

5.1.4 Command sequence and synchronization

IEEE488.2 defines the difference between overlapping and sequential commands:

- Sequential commands are sequences of commands that are executed continuously. Each command is usually executed faster.
- An overlapping command is one that is not executed automatically before the next command is executed. It usually takes longer to process overlapping commands, and programs are allowed to process other events synchronously during the period.

Even if there are multiple setting commands on a command line, they may not be executed in the order they were received. To ensure that commands are executed in a certain order, each command must be sent on a separate command line.

Example: the command line contains setting and query commands

If multiple commands on a command line contain query commands, the query results are unpredictable. A fixed value is returned for the following command:

:FREQ:STAR 1GHZ;SPAN 100;:FREQ:STAR?

Returned value: 1000000000 (1 GHz)

The following command returns an unfixed value:

:FREQ:STAR 1GHz;STAR?;SPAN 1000000

The returned result can be current start frequency value of the instrument before such command is sent, since the power Sensor program will not execute the commands one by one until all command messages are received. If the command is executed after the power Sensor receives a command, the returned result may also be 1 GHz.

TIPS

Setting commands are sent separately from query commands

General rules: the setting command and query command shall be sent in different programmed control messages, so as to ensure the returned result of the query command is correct.

5.1.4.1 Prevention of overlapping execution of commands

In order to prevent overlapping execution of commands, multithreading or commands *OPC, *OPC? or *WAI may be applied, which are executed only after the hardware settings are completed. During programming, the computer may force a period of time to synchronize certain events. The descriptions are shown below:

- **Controller program using multi-threading**

Multi-threading is used to wait for command completion and synchronization between the user interface and programmed control, that is, to wait for *OPC? Completion in separate threading without interfering GUI or programmed control threading execution.

- The application of the three commands in synchronous execution is shown in the table below:

Table 5.5 Command syntax

Method	Action	Programming method
*OPC	After the command is executed, set it in the operation completion bit of the ESR register.	Set to ESE BIT0; Set to SRE BIT5; Send overlapping commands and *OPC; Wait for service request (SRQ) Service request represents that the overlapping command has been executed.
*OPC?	Stop executing the current command until 1 is returned . The command is returned only when it is in the operation completion bit of the ESR register, indicating that the previous command has been processed.	Terminate processing of the current command before executing other commands, and send the command directly after the current command.
*WAI	Before the execution of *WAI, wait for all commands to be sent before proceeding with unfinished commands.	Terminate the processing of the current command before executing other commands, and send the command directly after the current command is implemented.

5.1.5 State reporting system

The state report system stores all operation state information and error information of current instrument. They are stored in state registers and error queues respectively, and can be queried through a programmed control interface.

- Structure of state register 81
- Application of state reporting system.....82

5.1.5.1 Structure of state register

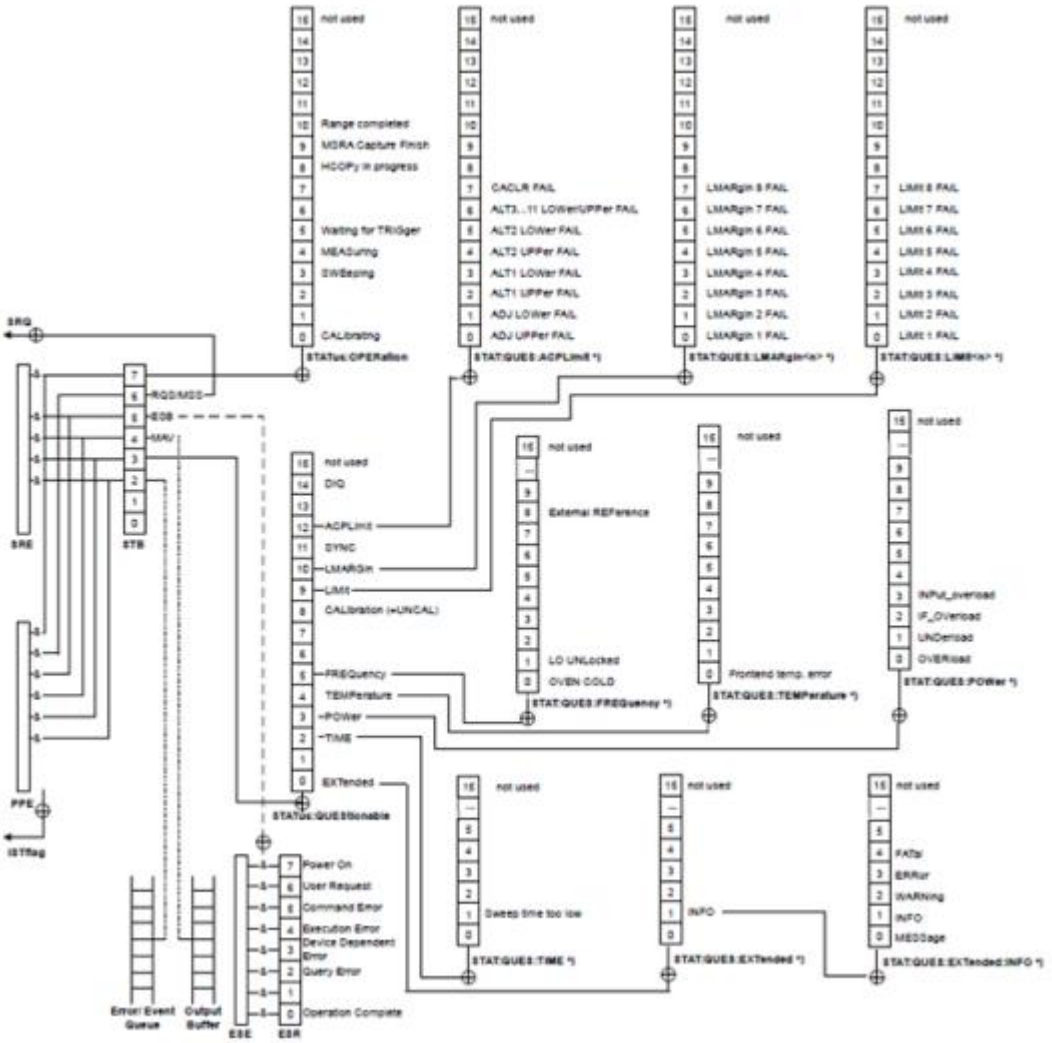


Figure 5.3 Hierarchical structure of the state register

State registers are described by classification below:

1) STB, SRE

The state byte (STB) register and its related mask register – service request enable register (SRE), comprise the top register of the state reporting system. STB saves the general operation state of the instrument by collecting the information of lower registers.

2) ESR, SCPI state register

STB receives information from the following registers:

- The value of the event state register (ESR) and the event state enable (ESE) mask register.
- SCPI state register includes: STATus:OPERation and STATus:QUEStionable registers (SCPI definition),

  which contain the specific operation information of the instrument. All SCPI state registers have the same internal structure

  (For details, refer to 2.1.5.2 "SCPI state register structure"

  of the programmed control manual).

3) IST,PPE

Similar with SRQ, IST ("Individual STatus") marks a separate bit consisting of all states of the instrument. The associated parallel poll enable register (PPE) determines the STB data bits for IST marking.

4) Output buffer zone

It stores the messages returned by the instrument to the controller. It is not part of the state reporting system, but determines the value of the M bit of STB.

For details on the registers mentioned above, refer to "2.1.5 State reporting system" of the programmed control manual.

TIPS

SRE, ESE

SRE may be used as the enable part of STB. Similarly, ESE may be used as the enable part of ESR.

5.1.5.2 Application of state reporting system

The state reporting system is used to monitor the state of one or more instruments in a test system. In order to correctly realize the function of the state reporting system, the controller in the test system must receive and evaluate the information of all instruments. Standard methods used include:

1) Service request (SRQ) initiated by the instrument;
2) Serial query of all instruments in the bus system, initiated by the controller in the system, in order to find the initiator of the service request and the reason.
3) Parallel query of all instruments;
4) Programmed control command to query the state of specific instruments;

For specific operating instructions, refer to "2.1.5 State report system application" of the programmed control manual.

5.1.6 Programming precautions

1) Please initialize the instrument state before changing settings

During remote instrument setting, initialize the instrument state (for instance, to send "*RST") first before realizing required state setting.

2) Command sequence

In general, setting commands and query commands shall be sent separately. Otherwise, the returned value of query commands will change with the current order of instrument operation.

3) Fault response

Service requests can only be initiated by the instrument. The controller program in the test system shall guide the instrument to initiate service request actively when there is an error, and then enter corresponding interrupt service program for processing.

4) Error queue

Each time the controller program processes a service request, it shall query the error queue of the instrument instead of the state register for a more precise cause of the error. Especially in the test phase of the controller program, the error queue shall be frequently queried to obtain the error command sent by the controller to the instrument.

5.2 Instrument programmed control port and configuration

The USB programmed control system controls the instrument based on the USBTMC protocol.

- Connection establishment 83
- Interface configuration 84

5.2.1 Connection Establishment

Use the USB cable to connect the 87237 series USB Thermal Power Sensor to an external controller (computer).

5.2.2 Interface Configuration

The VID and PID of this instrument are 0x04B4 and 0x3830 respectively, and the serial number is marked on the instrument. These three interface information are fixed and not user configurable.

5.3 Basic VISA interface programming

Take the following as an example to describe the basic method for realizing instrument programmed control programming via the VISA library. Take the C++ language as an example.

- VISA library.....84
- Initializing and setting default state.....85
- Sending setting command.....86
- Reading the state of measuring instrument 87
- Command synchronization.....87

5.3.1 VISA library

VISA is the generic name for the standard I/O function library and its associated specifications. VISA library function is a set of functions that can be easily called. Its core function can control various types of devices without considering the interface type of devices and the operating instructions of different I/O interface software. These library functions are used to write the driver program of the instrument and complete the command and data transmission between the computer and the instrument, so as to realize programmed control of the instrument. By initializing the addressing string ("VISA resource string"), a connection to an instrument with a programmed control port (LAN, USB, GPIB and RS-232, etc.) can be established.

To realize remote control, the VISA library must be installed first. The VISA library is encapsulated with the transmission function at the bottom layer with VXI, GPIB, LAN and USB interfaces, so as to facilitate users' direct calling. The programming interface supported by the USB Thermal Power Sensor is: USB. These interfaces, combined with the VISA library and programming language, allow remote control of the USB Thermal Power Sensor.

Taking the USB interface as an example, Figure 5.4 shows the relationship between the programmed control interfaces, VISA libraries, programming languages and the USB Thermal Power Sensor.

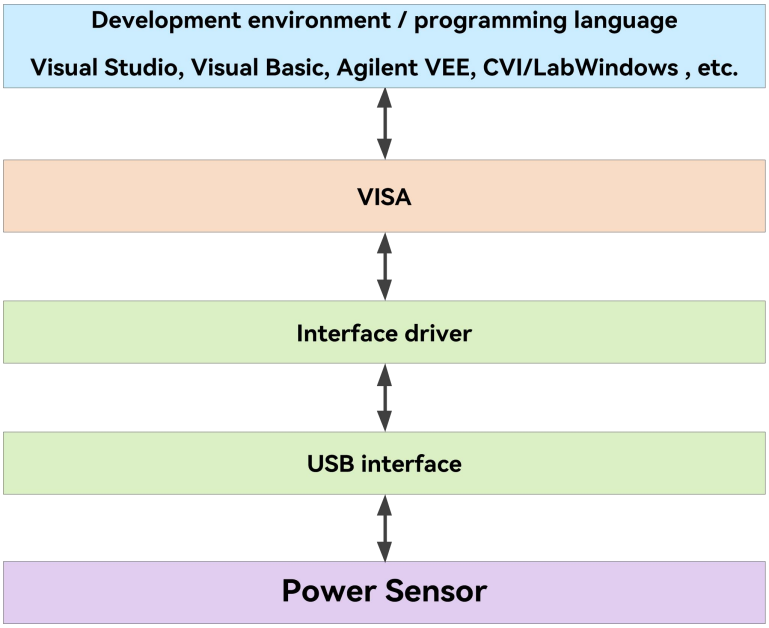


Figure 5.4 Programmable software/hardware layer

5.3.2 Initializing and setting default state

To start the program, the VISA resource manager must be initialized, so as to open and establish the communication connection between the VISA library and instrument. The specific steps are as follows:

5.3.2.1 Generation of global variables

Start by generating global variables that other program modules will call, such as instrument handle variables. The following example programs shall contain the following global variables:

ViSession iDevHandle;

ViSession iDefaultRM;

const char rgcDevRsc[MAX_RSC_LEN] = "USB0::04B4::1010::2019001::0::INSTR";

const int iTmo = 5000;

Where, the constant rgcDevRsc represents the instrument descriptor, "USB0" represents the controller, "04B4" represents the vendor ID of the instrument, 1010 is the product ID, and 2020001 is the product serial number.

If the instrument is controlled via the GPIB interface and the GPIB address is "20", then the value of the variable is

const char rgcDevRsc[MAX_RSC_LEN] = "GPIB0::20::INSTR";

If the instrument is controlled via a LAN socket interface with IP address 192.168.1.1

and port number 5025, then the value of the variable is

const char rgcDevRsc[MAX_RSC_LEN] = "TCPIP0::192.168.1.1::5025::SOCKET";

If the instrument is controlled via the LAN interface with IP address 192.168.1.1, then the value of the variable is

const char rgcDevRsc[MAX_RSC_LEN] = "TCPIP0::192.168.1.1::INSTR";

5.3.2.2 Initialization of the controller

```
/*****************************************************************************
The following examples show how to open and establish a communication
connection between the VISA library and the instrument (as specified by the
instrument descriptor).
//Initialize the controller: open the default resource manager and return the
instrument handle iDevHandle.
*****************************************************************************/
void InitController()
{
    ViStatus iStatus;
    iStatus = viOpenDefaultRM(&iDefaultRM);
    iStatus = viOpen(iDefaultRM, rgcDevRsc, VI_NULL, VI_NULL, &iDevHandle);
}
```

5.3.2.3 Initializing the instrument

```
/*****************************************************************************/
```

The following example shows how to initialize the default state of the instrument and empty the state register.

```
/*****************************************************************************/
void InitDevice()
{
    ViStatus iStatus;
    ViUInt32 uiRetCnt;
    iStatus = viWrite(iDevHandle, "*CLS\n", strlen("*CLS\n"), &uiRetCnt); //Status
    Reset
    iStatus = viWrite(iDevHandle, "*RST\n", strlen("*RST\n"), &uiRetCnt);
    //Instrument Reset
}
```

5.3.3 Sending setting command

```
/*****************************************************************************/
```

The following example shows how to set the frequency of the 87237 series USB Thermal Power Sensor.

```
/*****************************************************************************/
void SimpleSettings()
{
    ViStatus iStatus;
    ViUInt32 uiRetCnt;
    //Set the frequency to 128MHz
    iStatus = viWrite(iDevHandle, "FREQ 1.2e8\n", strlen("FREQ 1.2e8\n"),
    &uiRetCnt);
}
```

5.3.4 Reading the state of measuring instrument

```
/*****************************************************************************/
```

The following examples show how to read the set state of the instrument.

```
/*****************************************************************************/
void ReadSettings()
{
    ViStatus iStatus; //Status
    ViUInt32 uiRetCnt; //read the returned bytes
    char rgcBuf[256]; //Temporary buffer
    char* pcCmd = NULL; //Command pointer

    //QueryFreq
    pcCmd = "FREQ?\n";
    iStatus = viWrite(iDevHandle, pcCmd, strlen(pcCmd), &uiRetCnt);
    Sleep(10);
    iStatus = viRead(iDevHandle, rgcBuf, sizeof(rgcBuf), &uiRetCnt);
    //Print debugging information
    printf("frequency %s", rgcBuf);
}
```

5.3.5 Command synchronization

```
/*****************************************************************************/
```

The following examples illustrate the methods for command synchronization with sweep process.

```
/*****************************************************************************/
void SweepSync()
{
```

```
    ViStatus iStatus; //Status
    ViUInt32 uiRetCnt; //read the returned bytes
    ViEventType eType; //Event Type
    ViEvent eEvent; //Event
    int iStat; //State word
    char rgcOpcOk[256]; //OPC string
    char* pcCmd = NULL; //Command pointer

    /*****************************************************************/
    /* The command INITiate[:IMMediate] is used to start single sweep (when
continuous sweep is OFF, INIT:CONT OFF)*/
    /* Only at the end of single sweep can the next command in the command
buffer be executed                    */                    */
    /*****************************************************************/
    pcCmd = "INIT:CONT OFF\n";
    iStatus = viWrite(iDevHandle, " pcCmd ", strlen(pcCmd), &uiRetCnt);
    //Method 1 for waiting for the sweep to end: use *WAI
    pcCmd = "ABOR;INIT:IMM;*WAI\n";
    iStatus = viWrite(iDevHandle, " pcCmd ", strlen(pcCmd), &uiRetCnt);
    //Method 2 for waiting for the sweep to end: use *OPC?
    pcCmd = "ABOR;INIT:IMM; *OPC?\n";
    iStatus = viWrite(iDevHandle, " pcCmd ", strlen(pcCmd), &uiRetCnt);
    iStatus = viRead(iDevHandle, rgcOpcOk, 2, &uiRetCnt); //wait for *OPC to return
"1"
    //Main program continues……
}
```

5.4 I/O library

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- Installation and configuration of I/O library ……90

5.4.1 Overview of I/O library

I/O library is a pre-written software library for instruments, known as instrument driver. As a software between the computer and the instrument hardware, it consists of the function library, utility program, tool kit, etc. It is a combination of a series of software code modules and corresponds to operation of a plan, such as configuring the instrument, reading from the instrument, writing to the instrument and trigger the instrument, etc. Residing in the computer, it is the bridge and link between the computer and the instrument. By providing a high-level modular library for convenient

programming, users no longer need to learn the complex low-level programming protocol for a specific instrument. Application of instrument driver is the key to develop test and measurement applications quickly.

Functionally, a universal instrument driver generally consists of five parts: functor, interactive developer interface, programmer interface, subprogram interface and I/O interface, as shown in Figure 5.5.

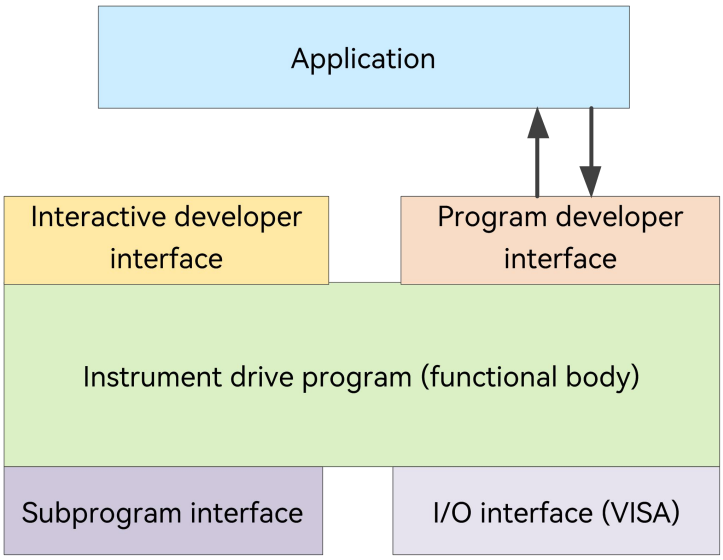


Figure 5.5 Structure model of instrument driver

The details are as follows:

1) Functor. As the main function part of the instrument driver, it may be understood as its framework program.
2) Interactive developer interface. Application development environment that supports instrument driver development is usually provided with graphical interactive developer interface for user convenience. For example, in Labwindows/CVI, the function panel is an interactive developer interface. In the function panel, each parameter of the instrument driver function is represented as a graphical control.
3) Programmer interface. It is a software interface for the application to call instrument driver function, such as dynamic link library file.dll of instrument driver in Windows system.
4) I/O interface. It completes the actual communication between the instrument driver and the instrument. The bus-specific I/O software, such as GPIB and RS-232, or the common standard I/O software applied cross multiple buses (VISA I/O) can be used.
5) Subprogram interface. It is a software interface for the instrument driver to access other support libraries, such as databases, FFT functions, etc. The subprogram interface is used when the instrument driver needs to call other

software modules, operation systems, programmed control code libraries and analysis function libraries to complete its task.

5.4.2 Installation and configuration of I/O library

Along with the application in test field, it has gone through different development stages from traditional instrument to virtual instrument. In order to solve the interchangeability of instruments and reusability of test program in automatic test system, instrument driver has gone through different development processes. IVI (Interchangeable Virtual Instruments) driver is relative popular and common at present. Based on IVI specification, it defines a new instrument programming interface, inserts the class driver and VPP architecture onto the VISA to make the test application and instrument hardware completely independent, adds such unique functions as instrument simulation, range sensing and state cache, improves the operation efficiency of the system, and realizes instrument exchange.

There are two types of IVI driver: IVI-C and IVI-COM, where the latter adopts the form of COM API based on the component object model (COM) of Microsoft, and the former adopts the form of C API based on ANSI C. Both types are designed according to the instrument class defined in the IVI specification and have the same application development environment, including Visual Studio, Visual Basic, Agilent VEE, LabVIEW, CVI/LabLinux, etc.

Two types of driver shall be provided at present to meet the needs of different users in different development environments. IVI driver of the USB Thermal Power Sensor is developed with Nimbus Driver Studio and directly generates IVI-COM and IVI-C driver and program installation package. For specific installation and configuration, please refer to the attached documentation of the control card and I/O library you selected.

IVI driver after installation are divided into IVI inherent function group and instrument function group (basic function group and extended function group). Specific function classification, functions and attributes are shown in the help document of the driver.

TIPS

Port configuration and IO library installation

Before using the computer to control the USB Thermal Power Sensor, please make sure you have the necessary ports and I/O libraries installed and configured correctly.

TIPS

Use of I/O library

The driver function panel, help document and driver function examples will be installed automatically when installing the attached IVI-COM/C driver installation package, so as to facilitate users to develop integrated programmed control functions.

6 Troubleshooting and after-sales services

This chapter will show you how to find problems and accept after-sales service. It also explains error messages of the USB Thermal Power Sensor.

If you encounter any problem when operating the 87237 series USB Thermal Power Sensor or want to buy relevant components or accessories, we can provide you with complete after-sales services.

Generally, causes of problems include hardware, software or user maloperation. In case of any problem, please contact us in time. If the USB Thermal Power Sensor is within the warranty period, we will repair it for free as per the provisions specified in the warranty bill. Otherwise, we will charge maintenance costs as per the contract requirement.

- Operation principles.....93
- Fault diagnosis and troubleshooting.....94
- Error message.....95
- Method to obtain after-sales services 95

6.1 Operation principles

The section introduces the basic operating principle and hardware function block diagram of the 87237 USB Thermal Power Sensor, so as to facilitate users' understanding on functions of the USB Thermal Power Sensor and solving problems encountered during operation.

6.1.1 Operating principle of the instrument

In this project, Thermal chips are used as power sensing elements. When the USB Thermal Power Sensor is used for power measurement, the internally balanced Thermal chips absorb microwave signal energy and output dual + and - detection voltages. Two microwave switches on the front of the channel conditioning board control the USB Thermal Power Sensor to either a measurement state or an internal zeroing state. When the switch is turned on for power measurement, the positive and negative detector signals are linearly amplified and enter four differential amplifiers with high and low ranges, respectively, and then enter the four-channel ADC for sampling. Internal zeroing is performed when the switch is turned off. In this project, the real-time sampling technology is used to realize data acquisition. The 14-bit 4-channel ADC performs analog-to-digital conversion at the rate of 20Msample/s of the master clock, and the rate at which the converted data is latched and written into DDR3 is controlled by the sampling clock given by the sampling rate generator of the time base unit circuit. The

sampled data stored in DDR3 is read out by the main processor at the end of each acquisition cycle and further processed by digital filtering, rapid calibration and compensation to obtain waveform data for display. The USB Thermal Power Sensor supports a high data transmission rate of up to 480Mb/s through the universal serial bus conforming to the USBTMC standard, and uploads the measured results to the host computer for display.

6.2 Fault diagnosis and troubleshooting

TIPS

Fault diagnosis and instructions

This section introduces the way on how to judge and handle failures (if any) of the 87237 series USB Thermal Power Sensor, and feed them back to the manufacturer as accurately as possible if necessary for quick solution.

The following failures and troubleshooting are listed as per function types.

- USB device not found.....94
- State indicator light not ON.....94
- Unexpected behavior.....95

6.2.1 USB Device not Found

If the USB device is not found in the computer's Device Manager after power-up, please follow the steps listed below for checking:

Step 1. Confirm whether the USB cable is connected properly and check whether the USB power supply is working properly;

Step 2. Confirm whether multiple USB devices are connected, using a USB HUB with an external power supply if necessary;

Step 3. Confirm whether the host have the device VISA library and drivers correctly installed.

6.2.2 State indicator light not ON

Check whether the USB2.0 interface of the host computer is working properly, replace other USB interfaces to observe whether the indicator light is working, or use other devices such as mouse, keyboard, U disk, etc. to verify that the USB interface is powered properly. If it is abnormal, check the external lines for any failure. After troubleshooting, power on the instrument again. If it is confirmed that it is caused by the power supply of the instrument itself, the product shall be sent back to the manufacturer

for repair.

6.2.3 Unexpected Phenomenon

In the process of use, there are many reasons for the unexpected phenomenon. Refer to the following test procedures to determine the cause of the problem with the instrument. Usually these tests can solve the problem or determine the cause of the problem clearly.

- Check whether the mechanical connection of USB cable is correct and whether the electrical characteristics are compatible;
- When problems occur after certain settings, check the actions taken to make sure all settings are correct. If the test is completed, check that the measurement results match the signal under test and that the performance specifications of the instrument are met.
- When the instrument shows unexpected results, if you are not sure whether the settings made are correct, replug it and then set it according to the signal under test and test requirements.

6.3 Error message

During actual use, the system will automatically provide error messages if it is not operated properly or configured correctly. Users can roughly determine the type of problem based on error prompts and take appropriate measures to troubleshoot or decide to return for repair.

In the User Power Test panel, click the Error List icon to view the recent error messages.

For detailed descriptions of error messages, please refer to the Programmed Control Manual of the 87237 Series USB Thermal Power Sensor.

6.4 Method to obtain after-sales services

- Contact us.....95
- Package and mailing.....95

6.4.1 Contacting us

In case of any failure to the 87237 series USB Thermal Power Sensor, check and save the error message, analyze possible causes, and refer to the methods provided in "6.2 Fault diagnosis and troubleshooting" for preliminary troubleshooting. If the problem cannot be solved, contact the service and consultation center of the Company as per the

contact information provided below and provide us with the error message collected. We will coordinate with you to solve the problem as soon as possible.

Contact information:

Service consultation: 400-1684191

Website: www.ceyear.com

Email: techbb@ceyear.com

Postal code: 266555

Address: No. 98, Xiangjiang Road, Huangdao District, Qingdao, Shandong Province, China

6.4.2 Package and mailing

In case of any failure to the USB Thermal Power Sensor that is difficult to be eliminated, contact us by telephone. If it is confirmed that the USB Thermal Power Sensor has to be returned for repair, pack it with the original packing materials and case by following the steps below:

1) Prepare a detailed description of USB Thermal Power Sensor malfunctions and place it into the packing box alongside with the Sensor.
2) Pack the USB Thermal Power Sensor with the original packing materials to minimize possible damage.
3) Place cushions at the four corners of the outer packing carton, and place the instrument in the outer packing carton.
4) Seal the opening of the packing carton with adhesive tape and reinforce the packing carton with nylon tape.
5) Specify text like "Fragile! Do not touch! Handel with care!" and so on.
6) Please check by precision instrument.
7) Keep a copy of all shipping documents.

NOTICE

Precautions for packaging the USB Thermal Power Sensor

Using other materials for packing the USB Thermal Power Sensor may damage the instrument. Never use polystyrene beads as packing materials because on the one hand, they cannot provide sufficient protection on the instrument, and on the other hand, they can be sucked in to the instrument fan by the static electricity generated, resulting in instrument damage.

TIPS

Instrument package and transportation

Please follow the precautions described in "3.1.1 Preparation before operation" when transporting or handling the instrument.

7. Specifications and test methods

The section introduces the specifications and test methods of the 87237 series USB Thermal Power Sensor.

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- Product characteristics.....99
- Technical specifications.....99
- Additional information.....101

7.1 Statement

The testing condition for all metrics is: The temperature of 23℃±5℃ half an hour after start, unless otherwise specified. The additional instrument information is to facilitate users to understand more clearly the instrument performance that is not contained in the range of specifications. Key word descriptions are shown below:

- **Specifications:** Place the calibrated instrument in the operation environment range for at least 2 h, and then warm it up for 45 min., so as to ensure its performance (including the measurement uncertainty), unless otherwise specified. All data in the document are specifications, unless otherwise specified.
- **Typical value (Typ):** It indicates 80% of the instruments can reach typical performance, which is not a guarantee, and excludes uncertainty factors during the measurement. It is valid only at the room temperature (about 25℃).
- **Nominal value (nom):** It indicates such performances as the expected average performance, designed performance characteristics or those that cannot be tested by limited testing means, for example, the 50 ohm connector. Products marked with nominal values are not included in the warranty, and such values are taken at the room temperature (about 25℃).
- **Measurement value (meas):** It indicates the performance characteristic measured during the design phase for comparing with the expected performance, for example, amplitude drifting change with time. Such data is not a guarantee, which is also taken at the room temperature (about 25℃).

7.2 Product characteristics

Table 7.1 Product characteristics

Product characteristics		
Display	Host computer display	
Operating interface language	Chinese/English	
Power supply requirement	+5 V, 500 mA	
Operation temperature range	-10℃~50℃	
Saving temperature range	-40℃~+70℃	
Elevation	0-4600 m	
Weight	< 0.3kg	
Boundary dimension (Width×Height×Depth)	87237D	52.0mm×34.0mm×148.0mm
	87237L	52.0mm×34.0mm×124.0mm
	87237P	52.0mm×34.0mm×122.0mm
Recommended calibration cycle	12 months	
Operating system	Windows 11 64-bit Windows 10 32-bit and 64-bit Windows 7 32-bit and 64-bit	
Hardware	Processor: 1 GHz or more (2 GHz or more recommended) Memory: 2 GB or more (4 GB or more recommended) Hard disk space: 1.0 GB or more Display: 1280 x 1024 or better	

7.3 Specifications

Table 7.2 Specifications

Specifications		
Frequency range	87237D	DC ~ 18 GHz
	87237L	DC ~ 67 GHz
	87237P	DC ~ 110 GHz
Power range	87237D	-35 dBm ~ +20 dBm
	87237L	-35 dBm ~ +20 dBm
	87237P	-30 dBm ~ +20 dBm
Max. input power	87237D/L/P	+23 dBm

Power measurement accuracy[1]	87237D	±0.16 dB (DC ≤ f ≤ 8 GHz) ±0.19 dB (8 GHz<f≤18 GHz)
	87237L	±0.19 dB (DC ≤ f ≤ 8 GHz) ±0.21 dB (8 GHz<f≤18 GHz) ±0.25 dB (18 GHz<f≤26.5 GHz) ±0.31 dB (26.5 GHz<f≤40 GHz) ±0.37 dB (40 GHz<f≤67 GHz)
	87237P	±0.19 dB (DC ≤ f ≤ 8 GHz) ±0.21 dB (8 GHz<f≤18 GHz) ±0.25 dB (18 GHz<f≤26.5 GHz) ±0.31 dB (26.5 GHz<f≤40 GHz) ±0.37 dB (40 GHz<f≤67 GHz) ±0.41 dB (67 GHz<f≤80 GHz) ±0.57 dB (80 GHz<f≤95 GHz) ±0.61 dB (95 GHz<f≤110 GHz)
Max Voltage Standing Wave Ratio	87237D	1.20
	87237L	1.19 (DC ≤ f ≤ 18 GHz) 1.25 (18 GHz<f≤26.5 GHz) 1.31 (26.5 GHz<f≤33 GHz) 1.48 (33 GHz<f≤50 GHz) 1.57 (50 GHz<f≤67 GHz)
	87237P	1.20 (DC ≤ f ≤ 18 GHz) 1.25 (18 GHz<f≤26.5 GHz) 1.31 (26.5 GHz<f≤33 GHz) 1.48 (33 GHz<f≤50 GHz) 1.57 (50 GHz<f≤67 GHz) 1.67 (67 GHz<f≤95 GHz) 1.79 (95 GHz<f≤110 GHz)
Calibration uncertainty	87237D	0.12 dB (DC ≤ f ≤ 8 GHz) ±0.15 dB (8 GHz<f≤18 GHz)
	87237L	0.15 dB (DC ≤ f ≤ 8 GHz) ±0.19 dB (8 GHz<f≤18 GHz) ±0.21 dB (18 GHz<f≤26.5 GHz) ±0.27 dB (26.5 GHz<f≤40 GHz) ±0.33 dB (40 GHz<f≤67 GHz)

	87237P	0.15 dB (DC ≤ f ≤ 8 GHz) ±0.19 dB (8 GHz<f≤18 GHz) ±0.23 dB (18 GHz<f≤26.5 GHz) ±0.29 dB (26.5 GHz<f≤40 GHz) ±0.37 dB (40 GHz<f≤67 GHz) ±0.43 dB (67 GHz<f≤80 GHz) ±0.53 dB (80 GHz<f≤95 GHz) ±0.57 dB (95 GHz<f≤110 GHz)
Zero setting	87237D/L/P	±70 nW
Measured noise	87237D/L/P	±80 nW
Connector	87237D	N-type
	87237L	1.85 mm
	87237P	1 mm
Programmed control interface	USB2.0 interface, USB-TMC compatible	
Maximum measurement speed	1000 readings per second	

1. The 87237D/L/P is effective within the power range of -15 dBm to +20 dBm and when the SWR of the DUT is less than 1.20. When the number of averages is set to 32, the average power measurement accuracy meets the requirements.

7.4 Option information

Table 7.3 Option Information

No.	Option No.	Option name	Function
1	2439D-H03	USB interface cable (1.5 m)	USB interface cable, 1.5 meters long
2	2439D-H04	USB interface cable (4.5 m)	USB interface cable, 4.5 meters long
3	87230-H05	Safety instrument transport case	Portable packing box with handle can accommodate one Sensor set
4	87230-H06	Safety instrument transport case	Portable packing box with handle can accommodate two Sensor sets
5	87237D-H12	English options	English label, manual, power measurement platform, etc.
6	87237L-H12		
7	87237P-H12		
8	87237D-JL	Measurement service	Measurement and calibration services and measurement reports are provided
9	87237L-JL		
10	87237P-JL		

11	87237D-EWT1	An extended warranty of one year beyond the standard warranty period is provided.	Extended warranty options are available for purchase after the standard warranty expires: one year, two years, and so forth. The service does not include calibration and covers only one-way shipping costs.
12	87237L-EWT1		
13	87237P-EWT1		