# Operation Manual

## for Elite GC2012 Gas Chromatograph

**V1.0.0**

# Statement

The manual is intended to help users to understand, use and maintain Elite GC2012. Our company does not assume the responsibility caused by business or special purpose use of the manual.

The information in this document is subject to change without notice and should not be construed as a commitment by us.

This manual is believed to be complete and accurate at the time of publication. Our company assumes no responsibility for any errors that may appear in this document.

In no event shall our company be liable for incidental or consequential damages in connection with, or arising form, the use of this manual.



Please read the document carefully before using Elite GC2012.

# Foreword

Thank you for purchasing our equipment. To ensure correct and safe use of the instrument, please read it carefully before using.

The details of the equipment’s composition, installation, method of using, maintenance, parts selection and other points are described in the manual. After reading, please keep it carefully. Please delivery the manual with the instrument.

# Entries

# 1 Instrument Introduction

## 1.1 Overview

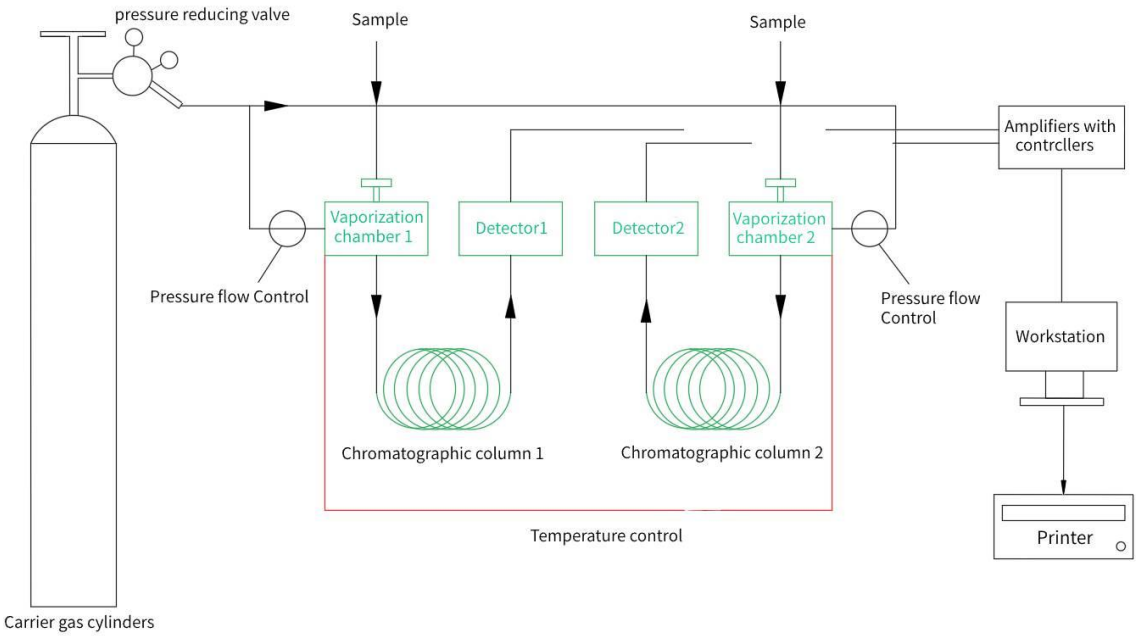
The Elite GC2012 Gas Chromatograph, a next-generation product meticulously engineered by us, integrates high integration, exceptional automation, user-friendly operation, and remarkable stability, designed for continuous reliable performance. This instrument excels in the analysis of organic/inorganic compounds and permanent gases at macro, micro, and trace levels, offering unparalleled cost-effectiveness in its class. It has become the preferred analytical tool across diverse fields, including petroleum exploration and refining, chemical production and quality control, environmental monitoring, food safety testing, disease prevention, and academic research.

The Elite GC2012 provides robust technical support for users in various industries with its precise analytical capabilities and broad applicability. Its superior performance and economic efficiency make it an indispensable tool for advancing industrial progress and enhancing research capabilities.

## 1.2 Working Principle of Gas Chromatography

Gas chromatography (GC) is a chromatographic separation method utilizing gas as the mobile phase. A vaporized sample is introduced into the chromatographic column by the carrier gas (mobile phase). Components in the sample interact differently with the stationary phase within the column, leading to varied retention times and subsequent separation. A detection and recording system generates a chromatogram displaying retention times and concentrations of each component. Qualitative analysis is performed based on peak retention times and orders, while quantitative analysis relies on peak heights and areas. GC is characterized by high efficiency, sensitivity, selectivity, speed, versatility, and ease of operation, suitable for volatile organic compound analysis. Non-volatile liquids and solids can be analyzed after pyrolysis and vaporization. GC can also interface with infrared spectroscopy or mass spectrometry for enhanced accuracy in complex sample separation.

A simplified schematic of its working principle is shown below:




**Key Features of Gas Chromatography:**

① High separation efficiency and rapid analysis: For example, over 200 chromatographic peaks from gasoline samples can be resolved within two hours, and typical analyses are completed within 20 minutes.

② Low sample consumption and high detection sensitivity: Gas samples require 1 mL, liquid

samples 0.1 μL, and solid samples a few micrograms. Appropriate detectors can identify impurities at concentrations ranging from parts per million (ppm) to parts per billion (ppb).

③ Excellent selectivity: Capable of separating azeotropes, close-boiling-point compounds, isotopes, geometric isomers (cis/trans), positional isomers (ortho/meta/para), and enantiomers.

④ Wide applicability: Primarily used for gases and volatile organics, but also capable of analyzing high-boiling-point substances and solids under specific conditions. Major applications include petroleum, environmental monitoring, clinical chemistry, pharmacology, and food industries.

GC is extensively utilized in sectors such as petrochemical, biochemical, pharmaceutical, sanitary inspection, food testing, and clinical diagnostics. It addresses challenges in quality control of industrial intermediates/products, scientific research, pollution monitoring, and production optimization.

## 1.3 Instrument Features

Leveraging decades of accumulated production and R&D expertise, our company has integrated cutting-edge industrial design and mainstream network communication technologies into the Elite GC2012, developing a next-generation gas chromatograph with internationally advanced capabilities. The instrument employs the latest high-integration industrial-grade chips, micro-flow gas control technology, and wide-range IV dynamic conversion technology, significantly enhancing precision in temperature control, gas pressure/flow regulation, signal acquisition, and amplification—thereby improving overall accuracy and reliability. Simultaneously, it incorporates bus technology, Ethernet, IoT, and intelligent data processing systems to achieve full automation, enhanced intelligence, and user-friendly operation.

**Key Features of the Elite GC2012 Series:**

★ Advanced Ethernet Connectivity: Equipped with 100/1000 Mbps Ethernet interfaces and a built-in IP protocol stack, the instrument seamlessly connects to laboratory LANs and workstations. This simplifies laboratory setup, streamlines configuration, and enables efficient data management. Users can freely transmit data and monitor instrument status in real-time within the LAN without complex setup, drastically improving laboratory efficiency and data accuracy.

★ IoT-Enabled Management: Advanced IoT technologies facilitate networked instrument and data management, streamlining equipment monitoring, configuration, maintenance, and

data analytics. This approach enhances operational efficiency, data accuracy, and system flexibility/scalability, laying the groundwork for remote supervision, intelligent decision-making, and deep data utilization.

★ 7-Inch HD Touchscreen: A capacitive touchscreen with an intuitively designed interface and simplified UI provides an exceptionally user-friendly operating experience.

★ Versatile High-Performance Detectors: The instrument supports optional detectors including FID (Flame Ionization Detector), TCD (Thermal Conductivity Detector), ECD (Electron Capture Detector), FPD (Flame Photometric Detector), NPD (Nitrogen/Phosphorus Detector), HID (Helium Ionization Detector), and PDECD (Pulsed Discharge Electron Capture Detector). Notably, it allows simultaneous installation of up to four detectors—a critical advantage for multi-component analysis of complex samples, ensuring comprehensive, accurate results and boosting experimental efficiency.

★ Modular Design: The modular architecture simplifies maintenance by allowing independent module removal. Routine inspections, cleaning, and fault-related replacements/repairs are expedited, reducing downtime and ensuring long-term stability.

★ Precision Temperature Control System: Featuring eight fully independent temperature control outputs, the system supports up to 99-stage programmable temperature programming (expandable to 999 stages) and an automatic column oven rear-door mechanism for ultra-fast heating/cooling rates. This meets stringent requirements for temperature precision in complex experiments while enhancing near-ambient control capabilities.

★ Cross-Platform Workstation: The standard workstation offers broad compatibility with mainstream Windows OS, domestic operating systems, and Android tablets, enabling stable, efficient data processing across devices—from desktops to mobile platforms—to meet diverse user needs.

★ Proprietary Chromatograph System: With built-in MODBUS/TCP, HTTP, and MQTT protocols, the system interfaces seamlessly with DCS (Distributed Control Systems), LIMS (Laboratory Information Management Systems), and other platforms, ensuring seamless data integration and sharing.

## 1.4 Technical Specifications

### 1.4.1 Main Technical Specifications

- Display: 7-inch HD capacitive touchscreen
- Temperature Zones: 8 independent channels
- Temperature Range: Ambient +5°C to 450°C (adjustable in 0.01°C increments, ±0.01°C accuracy)
- Programmed Heating Stages: 99 stages (expandable to 999 stages)
- Max Heating Rate: 120°C/min
- Gas Control: Precision mechanical valves with high-resolution pressure sensors
- Pressure Sensors: Up to 20 channels supported
- External I/O: 12 external events, 2 auxiliary outputs, 4 auxiliary inputs
- Injectors: Packed column, capillary, 6-port valve gas, and autosampler options
- Detectors: Optional FID, TCD, ECD, FPD, NPD, or HID
- Injection Modes: Manual or automatic operation
- Interfaces: Ethernet (IEEE802.3), Wi-Fi, and built-in instrument hotspot

### 1.4.2 Detector Specifications

**(1) Flame Ionization Detector (FID)**

- Detection limit: ≤$1.1\times10^{-12}$g/s(hexadecane/isooctane)
- Baseline noise: ≤$2\times10^{-14}$A
- Baseline drift: ≤$2\times10^{-13}$A/30min
- Linear range: ≥$10^7$

**(2) Thermal Conductivity Detector (TCD)**

- Sensitivity: S≥12000mV•ml/mg(benzene/toluene)
- Baseline noise: ≤0.05mV
- Baseline drift: ≤0.2mV/30min
- Linear range: ≥$10^5$

**(3) Electron Capture Detector (ECD)**

- Detection limit: ≤$1.0\times10^{-14}$g/ml (γ-BHC/isooctane solution)
- Baseline noise: ≤0.03mV
- Baseline drift: ≤0.2mV/30min
- Linear range: ≥$10^4$

● Radioactive source:$^{63}$ Ni

**(4) Flame photometric detector (FPD)**

● Detection limit: (S)≤8×$10^{-14}$g/s, (P)≤8×10g/s; (parathion-methyl/absolute ethanol)

● Baseline noise: ≤3×$10^{-13}$A

● Baseline drift: ≤2×$10^{-12}$A/30min

● Linear range: S ≥$10^2$, P ≥$10^3$

**(5) Nitrogen-phosphorus detector (NPD)**

● Detection limit: (N)≤1.0×$10^{-13}$g(N)/s(azobenzene), (P)≤5.0×10g (P)/s (parathion-methyl/absolute ethanol)

● Baseline noise: ≤5×$10^{-13}$A

● Baseline drift: ≤2×$10^{-12}$A/30min

● Linear range: N ≥$10^3$, P ≥$10^3$

## 1.5 Main Configuration Overview

The Elite GC2012 Gas Chromatograph consists of a carrier gas system, injector system, column system, detection system, temperature control system, data processing unit, and auxiliary components.

### 1.5.1 Carrier gas system

The Elite GC2012 employs precision mechanical pressure/flow regulation valves and electronic pressure/flow displays, offering:

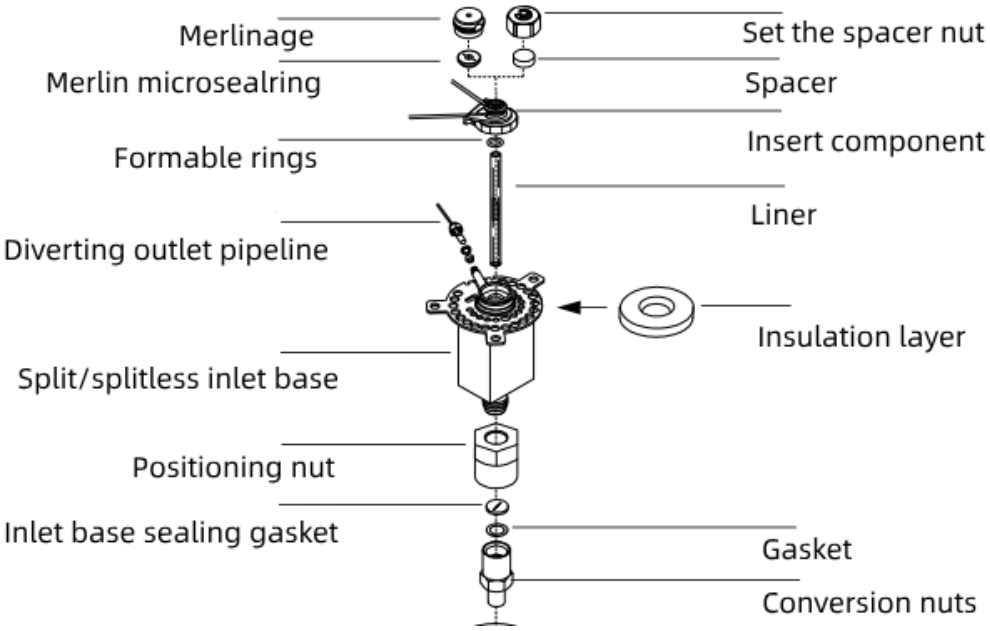
Stability: Robust mechanical design with minimal thermal drift and long service life.

Precision: Proprietary pressure-flow algorithms ensure accurate flow measurement.

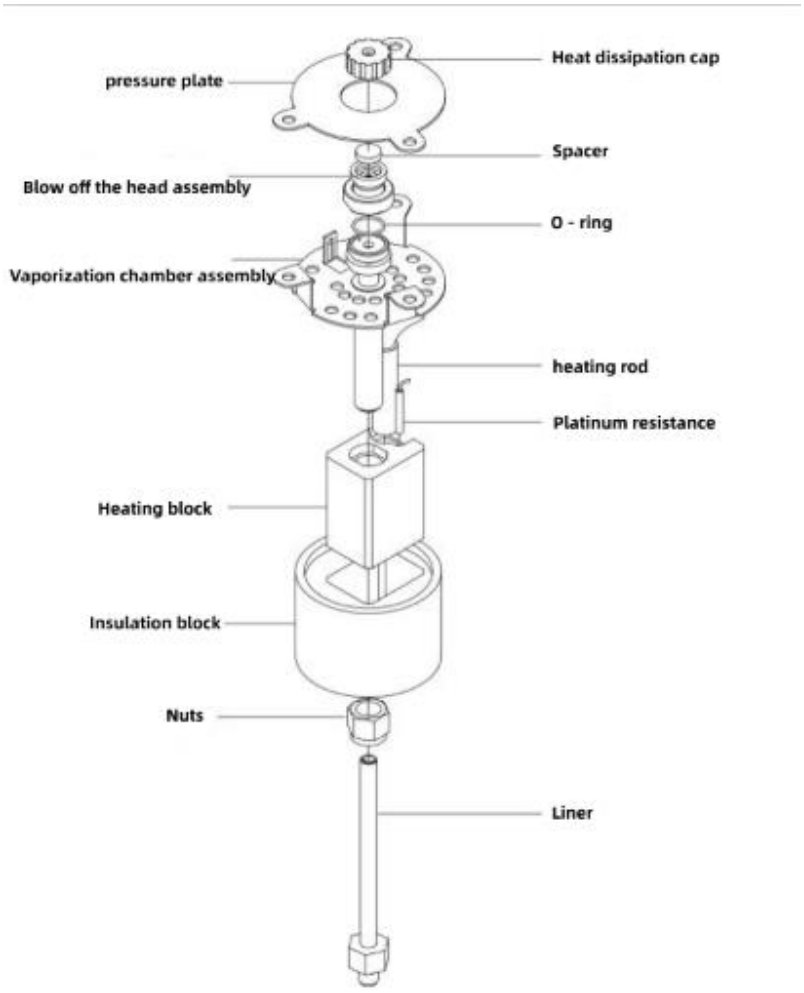
### 1.5.2 Injection System

The injector system, located on the front-left top of the column oven, includes:

**Capillary Injector:** Excels in high-resolution separation of complex mixtures, trace analysis, and high-sensitivity applications due to its low column capacity and rapid analysis speed.




**Packed Column Injector:** Suitable for high-capacity samples and non-polar compound separation.




**Note:**

1. The Elite GC2012 series gas chromatograph is equipped with multiple injector ports, enabling simultaneous installation of packed column and capillary column injectors.
2. The injector supports direct installation of Φ4 mm packed columns and can accommodate Φ3 mm packed columns by adding a liner.

### 1.5.3 Column Oven System

The Elite GC2012 series gas chromatograph demonstrates significant advantages in column oven design, with the following key features:

**Large-Capacity Oven:**

Internal volume ≥23 L provides ample space for versatile column configurations (packed/capillary columns of varying dimensions), enhancing instrumental adaptability.

**Rapid Thermal Cycling:**

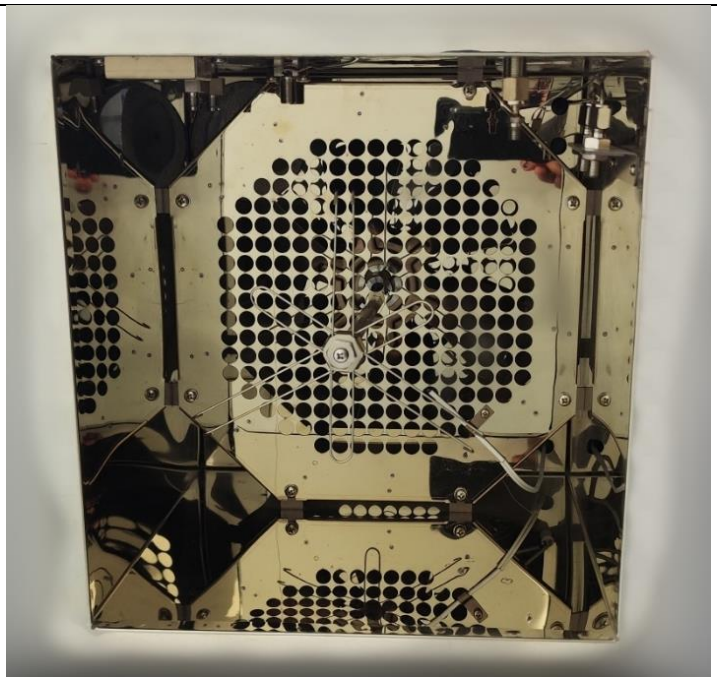
High-power heating elements combined with an intelligent rear-door mechanism and dedicated ventilation system enable ultra-fast heating/cooling rates, minimizing thermal equilibrium time and boosting throughput.

**Dual-Software Safety Interlock:**

Proprietary dual-software temperature supervision ensures strict adherence to predefined thermal limits, preventing column degradation from temperature excursions and ensuring operational reliability.

**Silent Thermal Agitation:**

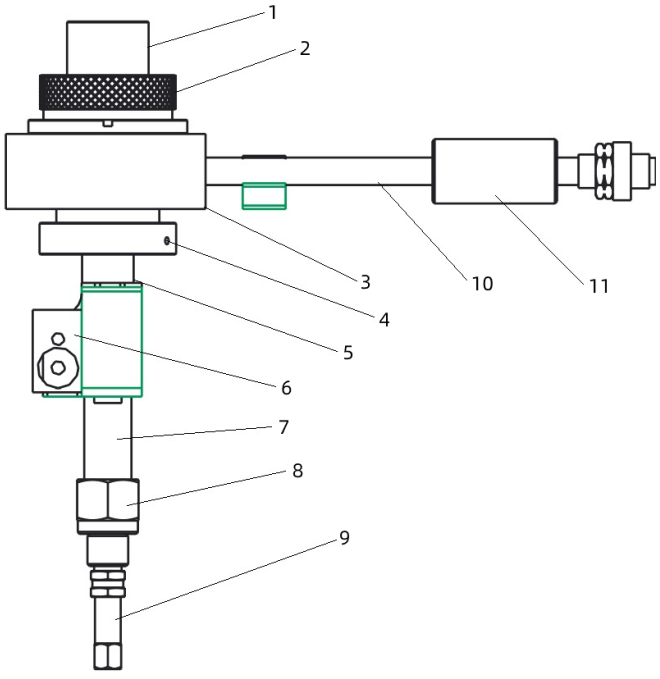
Low-decibel motor and corrosion-resistant stainless steel impeller assembly guarantee vibration-free operation, maintaining analytical precision while ensuring operator comfort.



### 1.5.4 Detection System

#### 1. Flame Ionization Detector (FID)

The FID is a mass-sensitive detector renowned for high sensitivity, broad linear range, and operational stability under varying conditions. It is ideal for routine analysis of macro/micro samples and excels in trace analysis when paired with capillary columns due to its rapid response time, making it the most widely adopted detector in gas chromatography.




1 Ignition wire 2 Fixing nut 3 Ion chamber base 4 Air inlet 5 Hydrogen inlet 6 Heating block 7 base

8 Adapter nut 9 Column nut 10 Signal tube 11 Magnetic ring

The FID detector is positioned on the top-right side of the main unit. Its base is mounted within a heating block that incorporates electrical heating elements and temperature sensors, connected to the temperature control system for precise regulation of the heating temperature. A polarized electric field is generated between the signal electrode and the detector body. The weak current signal collected at the collector is transmitted via an insulated signal tube to a microcurrent amplifier, where it is processed and subsequently forwarded to the chromatographic data system. Hydrogen and air enter through stainless-steel tubing from the gas control system connectors located on the left side of the main unit.

Operating Principle of the Flame Ionization Detector:The sample to be analyzed combusts in the hydrogen flame, generating an ion current. Under the influence of the polarized electric field, positive and negative ions migrate directionally to the collector electrode, producing a minute current signal. This signal is amplified and processed by a microcurrent amplifier before being transmitted to the chromatographic data processing system.

**Gas Source Management:**

- Hydrogen Safety: Do not introduce hydrogen to the FID before connecting the chromatographic column to prevent hydrogen accumulation in the oven, which could pose explosion risks.
- Shutdown Procedure: When powering off the instrument, first disable the hydrogen and air supplies to extinguish the flame and allow the detector to cool, followed by shutting off the carrier gas. This sequence ensures safe termination of the detection process and prevents equipment damage or safety incidents due to improper operational order.
- Gas Purity Requirements: As a high-sensitivity detector, the FID necessitates the use of ultra-high-purity carrier gas ($N_2$/He), hydrogen, and air (≥99.999% purity) to maintain detection accuracy and optimal detector performance, as any impurities could compromise results.

**Chromatographic Column Conditioning and Detector Protection:**

- Detector Isolation: During column conditioning, it is recommended to disconnect the column from the detector and seal the detector end with a blank nut. This prevents impurities or contaminants generated during conditioning from entering the detector and affecting its performance.
- Hydrogen Venting: If hydrogen is used for column conditioning, ensure safe exhaust

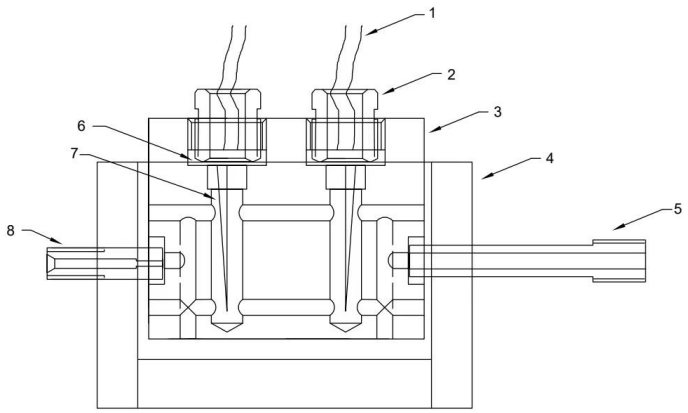
ventilation of hydrogen from the column outlet to a designated area to prevent flammable gas buildup and associated safety hazards.

**Electrical Safety:**

- Pre-Power Inspection: Prior to energizing the instrument, carefully verify the integrity and correctness of all electrical connections, as well as the compliance of gas types with instrument requirements. This step is crucial for ensuring safe and normal instrument operation.
- High-Voltage Warning: The collector electrode operates at 200 VDC. Strict adherence to electrical safety protocols is essential to prevent electric shock. Operators must avoid direct contact with high-voltage components during instrument operation.

**1. Thermal conductivity detector (TCD)**

The Elite GC2012 series gas chromatograph can be equipped with a thermal conductivity detector (TCD). The structure of the TCD detector is shown in the picture.




1 Tungsten wire lead 2 compression nut 3 chamber 4 Heating block 5 outlet connector 6 Copper gasket 7 tungsten wire 8 inlet connector

The thermal conductivity detector (TCD) is primarily composed of a thermal conductivity cell and associated detection circuitry. The thermal conductivity cell houses a thermally sensitive element (e.g., tungsten or platinum filament), which is configured as a component of a Wheatstone bridge circuit. The cell body is a metallic structure with internally machined chambers and channels designed to accommodate the thermally sensitive element while permitting the passage of carrier gas.

The operational principle of the thermal conductivity detector is based on the differential thermal conductivity of gases. When carrier gas flows through the thermal conductivity cell, the thermally sensitive element is resistively heated and dissipates thermal energy to the carrier gas.

Upon introduction of sample gas into the cell, the thermal conductivity of the resulting gas mixture undergoes alteration, thereby modifying the rate of heat dissipation from the thermally sensitive element. This thermal perturbation induces a temperature change in the element, which subsequently causes a variation in its electrical resistance. The resultant resistance imbalance disrupts the equilibrium of the Wheatstone bridge, generating a voltage signal that is directly proportional to the change in thermal conductivity. By analyzing the magnitude and temporal characteristics of this electrical signal, the composition and concentration of the sample gas can be quantitatively determined.

**Basic Operational Guidelines**

**Startup Sequence:**

Carrier Gas Flow → Temperature Ramping → Bridge Current Activation:

When using the TCD detector, the carrier gas must be introduced first to ensure unobstructed gas flow and stabilization. Detector heating should commence only after confirming stable carrier gas supply. Bridge current shall be applied only after the detector reaches thermal equilibrium. This sequence prevents thermal damage to the thermally sensitive element (e.g., tungsten filament) caused by direct heating without carrier gas protection.

**Shutdown Sequence:**

Bridge Current Deactivation → Controlled Cooling Under Carrier Gas → Carrier Gas Termination:

During shutdown, the bridge current must be disabled first to allow the detector to cool gradually under continuous carrier gas flow. Once the TCD temperature decreases to approximately 50°C below ambient laboratory temperature, the carrier gas supply may be safely terminated. This procedure protects the thermally sensitive element from thermal shock and extends its service life.

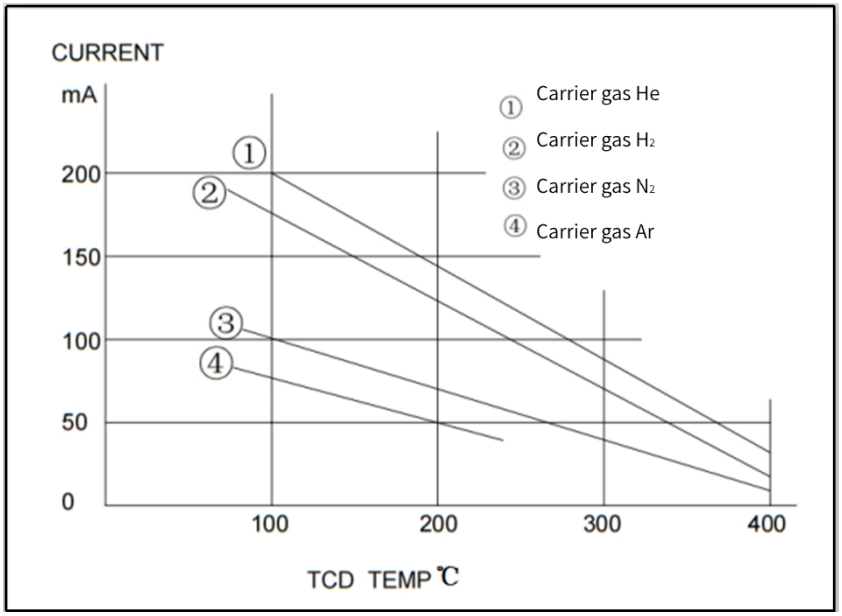
**Current and Carrier Gas Management**

**Bridge Current Optimization:**

Excessive bridge current should be avoided during operation. Elevated current levels accelerate oxidation of the tungsten filament, thereby degrading detector sensitivity and reducing operational lifespan. Bridge current settings must be optimized based on carrier gas type, detector temperature, and sample-specific parameters.

**Carrier Gas Compatibility:**

The allowable bridge current correlates with the thermal conductivity of the carrier gas and the detector's operating temperature. For example, helium (with high thermal conductivity) permits higher current settings compared to nitrogen. Refer to the manufacturer's operational guidelines for carrier gas-temperature-current compatibility relationships.




**Carrier Gas Selection and Purification:**

The type and purity of the carrier gas significantly impact TCD detector performance. Inert gases with high thermal conductivity, such as helium or hydrogen, are typically preferred. The carrier gas must undergo rigorous purification to remove contaminants like oxygen and moisture, which could otherwise damage the thermally sensitive element.

**Bridge Current Configuration and Data Retention:**

To prevent accidental damage to the TCD detector, many instruments are designed to reset the bridge current setting to zero upon shutdown. This means the bridge current value must be reconfigured by the user during each startup sequence. This safety feature minimizes risks associated with operational errors.

**Safety Warnings**

Carrier Gas Deoxygenation:

Residual oxygen in the carrier gas accelerates oxidation of the TCD tungsten filament, shortening its service life. Prior to using the TCD detector, ensure the carrier gas has been thoroughly deoxygenized.

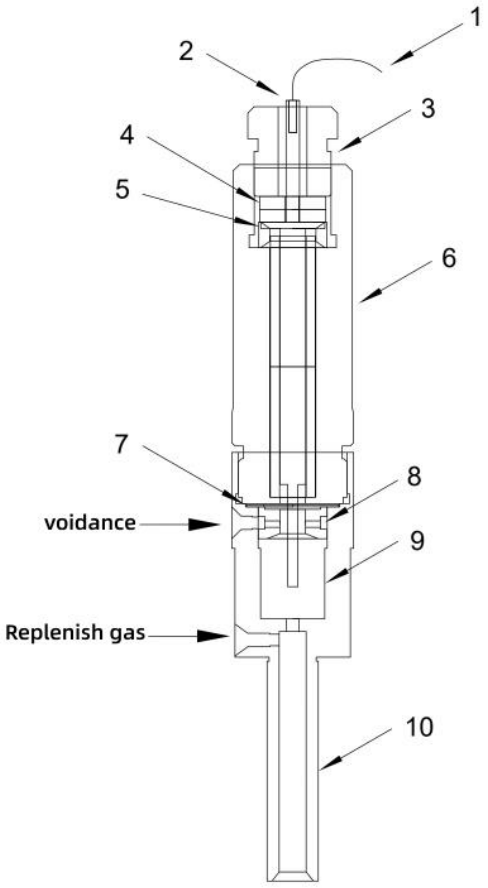
**Electric Shock Prevention:**

Exercise caution to prevent electric shock during instrument operation. High-voltage components,

such as the collector electrode, pose electric shock hazards when energized. Adherence to safety protocols is mandatory to ensure personnel safety.

**2. Electron Capture Detector (ECD)**

The electron capture detector (ECD) is an ionization-based detector renowned for its selectivity and high sensitivity. It responds exclusively to electronegative compounds (e.g., halogen-, sulfur-, phosphorus-, or nitrogen-containing substances), with detection sensitivity proportional to the electron affinity of the analyte. Electroneutral compounds, such as alkanes, produce no measurable signal.

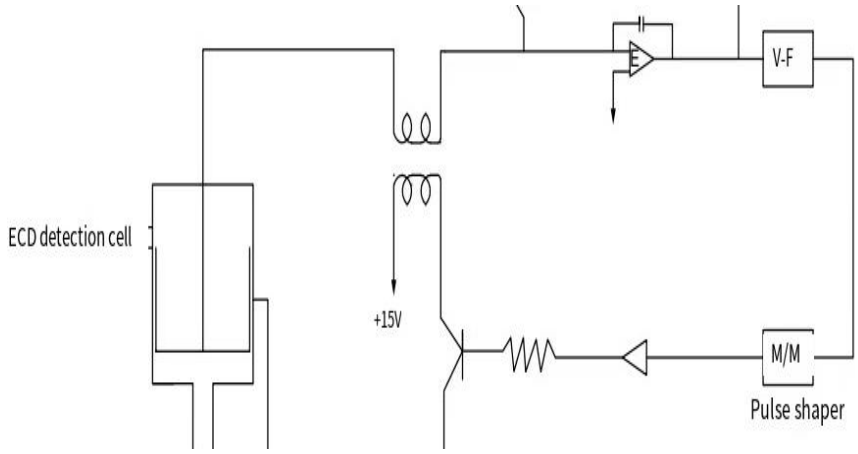



1. Signal lead; 2. Electrode; 3. Electrode compression cap; 4. Insulating PTFE gasket I; 5. Insulating PTFE gasket II; 6. Upper base; 7. Sealing gasket; 8. Purge septum; 9. Nickel-63 source; 10. Lower base.

The ECD detection cell contains a sealed radioactive source (Ni-63) that emits β radiation. This radiation ionizes the inert carrier gas (typically $N_2$) within the cell. A pulsed voltage is applied to the collector electrode, generating a baseline current through electron capture. When an electronegative analyte molecule enters the detection cell, it captures free electrons, forming negative ions. These charged molecules exhibit slower migration velocity compared to free

electrons, resulting in prolonged travel time to the positive electrode and increased recombination probability with positive ions. Consequently, the electron density within the detector decreases, reducing the number of electrons captured per pulse. To maintain a constant current per unit time, the system compensates by increasing the pulse frequency. The resultant pulse count variation correlates directly with the concentration of electronegative analyte molecules.

The schematic diagram of the ECD device is as follows:




The amplifier (E) compares the preset current (I_R) with the average pulse current generated by the ECD detection cell. The voltage required to equalize these two values is fed into the subsequent voltage-to-frequency converter (VFC). After the VFC conditions the pulses to appropriate amplitude and height, the output signals are routed back to the ECD detection cell, forming a closed-loop control circuit.

**Warning**:

**Unauthorized Disassembly Prohibited:** Disassembly of the ECD detector without professional radiation safety measures is strictly prohibited! Exposure to the Ni-63 radioactive source will harm your health.

**Regulated Waste Disposal:** ECD detectors containing Ni-63 are strictly controlled materials and must NOT be discarded as conventional waste.

Our company holds final-user exemption certification for radiation-containing instruments. Purchasers of our Ni-63-equipped instruments are exempt from local environmental bureau licensing requirements for Radiation Safety Permits. However, users must:

Maintain strict usage records for all radiation-containing instruments.

Cooperate with our company's regulatory compliance audits.

Notify us prior to instrument retirement for proper source recovery and filing.

Unauthorized disposal of Ni-63 sources by end-users is strictly prohibited.

**3. Flame Photometric Detector (FPD)**

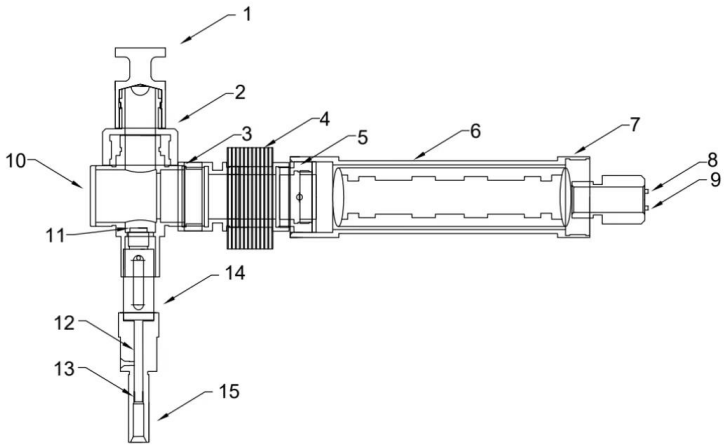
The flame photometric detector (FPD) is a gas chromatographic detector designed for highly selective and sensitive detection of phosphorus- and sulfur-containing compounds. When analytes combust in a hydrogen-rich flame:

Organophosphorus compounds primarily emit light at 526 nm (as HPO radicals).

Organosulfur compounds emit characteristic light at 394 nm (as $S_2$ molecules).

A photomultiplier tube converts these optical emissions into electrical signals, which are subsequently amplified via microcurrent amplification and recorded. The FPD achieves detection limits as low as $10^{-11}$ grams, with sensitivities ranging from tens to hundreds of coulombs per gram. Its phosphorus/sulfur-to-hydrocarbon response ratio exceeds $10^4$, enabling effective suppression of solvent peaks and hydrocarbon interferences. This makes the FPD indispensable for trace analysis of organophosphorus pesticides and sulfur pollutants.

As shown in Figure 1.12, the FPD consists of two main components: a flame emission assembly and an optical/electrical signal system.




1. Vent joint nut; 2. Vent joint; 3. Optical chamber; 4. Heat sink cylinder; 5. Filter and pressure pad; 6. Photomultiplier tube housing; 7. High-voltage base; 8. Signal output; 9. High-voltage input; 10. Optical window nut; 11. Light shield; 12. Glass liner tube; 13. Set screw; 14. Upper base; 15. Lower base.

The flame luminescence system comprises a burner assembly (combustion head) and a luminous chamber. The burner incorporates gas flow paths and nozzles—the universal nozzle consists of an inner bore and an annular outer orifice. Gas chromatograph column effluent mixes with air in the central bore, while excess hydrogen flows through the surrounding annular orifice. This configuration generates a large, diffusion-rich hydrogen flame where hydrocarbons, sulfur-

containing compounds, and phosphorus-containing compounds undergo pyrolysis and complex chemical reactions, emitting characteristic light. Sulfur and phosphorus species luminesce in the upper diffusion flame zone, while hydrocarbons primarily emit light in the oxygen-rich flame zone at the base. An opaque light shield is installed at the flame base to block hydrocarbon emission, enhancing FPD selectivity. To minimize luminous chamber volume, a glass or quartz liner tube may be installed above the nozzle, reducing the detector's response time constant.

The optoelectronic system (right side of diagram) isolates the luminous chamber from the photomultiplier tube assembly using a quartz window and heat sink, preventing adverse effects from water vapor, combustion byproducts, and high temperatures. Notably, the FPD does not convert all emitted light into electrical signals—a filter selectively transmits sulfur/phosphorus characteristic wavelengths (e.g., 526 nm for HPO* and 394 nm for $S_2$*).

Warning: Never activate the high-voltage power supply when the detector has light leaks!

**4. Nitrogen-phosphorus Detector (NPD)**

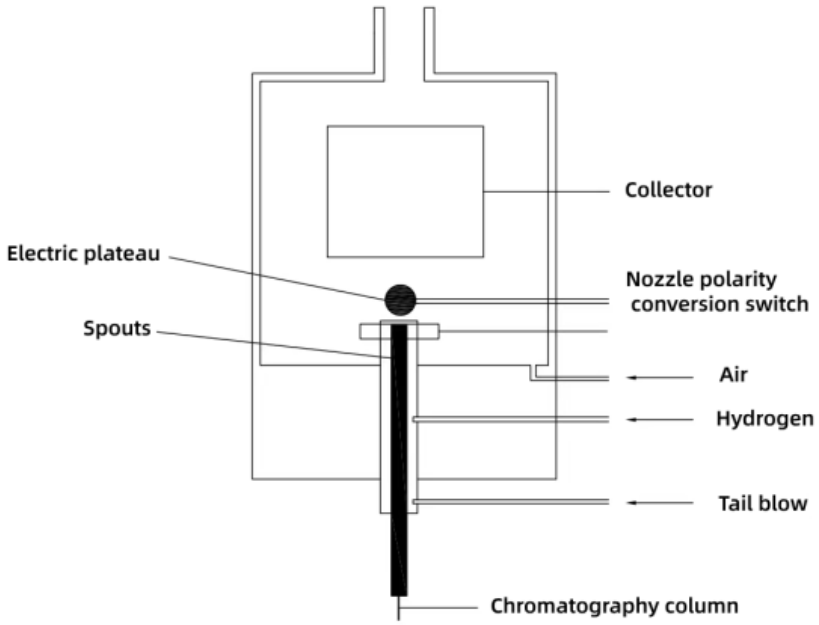
Nitrogen-Phosphorus Detector (NPD), also known as the Thermionic Ionization Detector (TID), is a highly sensitive, selective, and wide-linear-range detector specialized for analyzing nitrogen- and phosphorus-containing compounds. Developed initially by Cremer et al. in 1961 as a furnace-type thermionic detector, the early design positioned an alkali source above the nozzle of a flame ionization detector (FID) for heating. However, due to the use of volatile alkali metals as the alkali source, this prototype suffered from short service life, unstable sensitivity, and limited practical viability. In 1974, Kolb introduced a non-volatile rubidium carbonate ($Rb_2CO_3$) bead sintered with silica, forming a rubidium silicate bead. This innovation resolved the short lifespan issue, as the bead was electrically heated within a cold hydrogen flame. Consequently, detector stability improved significantly, sensitivity increased markedly, and the background baseline current decreased from $10^{-9}$ A to $10^{-13}$ A. These advancements propelled NPD to become one of the most commonly equipped detectors in gas chromatographs (GC), establishing itself as a specialized tool for trace nitrogen/phosphorus compound analysis across environmental monitoring, pharmaceuticals, clinical research, biochemistry, and food safety sectors.

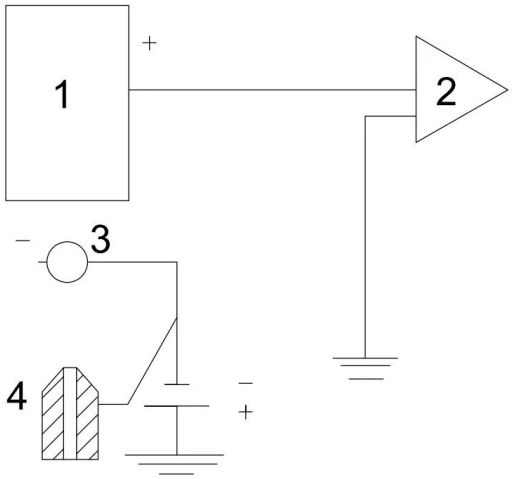
Structural and Operational Variability:

While NPD designs vary across product models, a typical configuration is illustrated in the figure (not provided here). Key components and operational principles remain consistent:

The Elite GC2012 detector's NPD operates in nitrogen-phosphorus mode with an ungrounded

nozzle configuration, as illustrated in the diagram.




1. Collection electrode 2. Amplifier 3. Ionization source 4. Nozzle

When the air and hydrogen flow rate is relatively small [V air < 150/ml/min, $VH_2$ < (4-9ml/min)] and the ionization source is electrically heated to red-hot, a cold flame is formed around the ionization source. Organic compounds containing N and P undergo cracking and excitation reactions here, forming a selective detection side of N and P. The selectivity for hydrocarbons can reach[2] $10\text{-}10^4$.

With relatively low air and hydrogen flow rates (V_air < 150 mL/min, V_H2 < 4-9 mL/min), gases are electrically heated to red-hot ionization sources, forming a cold flame around them. Within this environment, nitrogen/phosphorus-containing organic compounds undergo pyrolysis

and excitation reactions, enabling selective detection of N and P species while achieving a hydrocarbon selectivity ratio of $10^2$–$10^4$.

### 1.5.5 Temperature Control System

The temperature control circuitry, located inside the right-side chassis, heats the injection system, column system, detection system, and auxiliary components. The gas chromatograph's temperature control system serves the following critical functions:

**Ensuring Analytical Accuracy:**

Temperature is a key parameter for chromatographic separation conditions. Precise control of the vaporization chamber, column oven, and detector temperatures ensures optimal sample separation and detection conditions, thereby enhancing analytical accuracy and reliability.

**Enhancing Separation Efficiency:**

Adsorption interactions between analytes and the stationary phase vary, resulting in distinct retention times. Accurate column temperature control optimizes component separation, enabling peak resolution at their respective ideal temperatures.

**Protecting Instrument Components:**

Stable temperature regulation prevents component damage. For example, excessive detector temperature fluctuations could degrade sensitivity or stability. Precise control ensures detectors operate at optimal temperatures, extending service life.

**Meeting Diverse Analysis Requirements:**

The system supports temperature programming (e.g., isothermal, ramped) to accommodate varied sample matrices, expanding the GC's applicability across multiple fields.

**Operational Principle:**

The system integrates temperature sensors, controllers, and actuators:

**Temperature Sensing:** PT100 platinum resistors are employed, with resistance values increasing proportionally to temperature. Resistance changes are monitored in real time.

**Controller Processing:** Digital signals undergo PID-based computational processing. The controller compares actual and setpoint temperatures, generating corrective control signals.

**Heater Actuation:** Thyristors modulate power delivery to heating elements (e.g., heating rods, wires), enabling precise temperature regulation.

**Intelligent Rear Door Mechanism:** Facilitates rapid heat dissipation by expelling hot air while drawing in cool air, accelerating cooling rates. Adjustable door openings maintain near-ambient

temperature stability, critical for volatile compound analysis.

**Note:** The column oven operates at 220 VAC, while all other heating zones use 40 VAC.

### 1.5.6 Data Acquisition & Processing System

The chromatography workstation is an auxiliary software platform designed to facilitate signal sampling from chromatographic instruments, collect voltage signals from detectors, and perform comprehensive data analysis and processing. It typically comprises hardware and software components:

Hardware: Includes signal acquisition devices (e.g., analog-to-digital converters) that convert analog signals from chromatograph detectors into digital signals processable by computers.

Software: Enables functions such as chromatogram visualization, peak detection, baseline correction, quantitative/qualitative analysis, and report generation.

The roles of chromatography workstations are mainly reflected in the following aspects:

**Data Acquisition and Processing**

Real-Time Acquisition: Capable of capturing real-time data generated by chromatographs, including chromatograms, peak areas, peak heights, and other critical parameters.

Data Processing: Performs analytical tasks such as peak identification, quantitative/qualitative analysis, and calibration to enhance accuracy and reliability of results.

**Data Storage and Management**

Data Archiving: Provides storage capabilities for experimental data, enabling researchers to retrieve historical records conveniently.

Data Organization: Facilitates categorization, annotation, and of data through integrated management systems, improving operational efficiency.

**Instrument Control**

Parameter Configuration: Allows users to set chromatograph operating parameters (e.g., temperature programs, flow rates) via graphical interfaces.

Automated Operation: Advanced workstations support unattended automation by adjusting instrument parameters according to predefined protocols.

**Result Reporting and Visualization**

Data Reporting: Generates analytical reports in graphical or textual formats to facilitate result presentation and dissemination.

Chromatogram Printing: Supports hardcopy output of chromatograms for archival or sharing

purposes.

**Network Connectivity and Expandability**

Network Integration: Enables connectivity to IoT platforms for data sharing and remote instrument control.

Expandability: Interfaces with ancillary devices (e.g., mass spectrometers) or software tools to extend functional scope.

**Experimental Design and Optimization Support**

Method Development: Assists in optimizing chromatographic conditions by providing analytical tools and historical data comparisons.

Diagnostic Capabilities: Monitors instrument status through self-diagnostic functions, enabling proactive fault detection and resolution to ensure experimental continuity.

### 1.5.7 Auxiliary equipment

**Display Screen**

The Elite GC2012 series chromatograph is equipped with a 7-inch capacitive touchscreen, significantly enhancing user experience. The high-resolution display and responsive touch controls enable intuitive, clear visualization of instrument status and operational parameters.

The touchscreen interface features a streamlined design with logically organized functional zones, icons, and menus, allowing users to quickly locate and operate required functions. Both novice and experienced operators can master instrument usage efficiently. Users can configure settings, monitor real-time experimental data, and perform preliminary data processing/analysis directly via the touchscreen. This integrated design improves workflow efficiency while simplifying experimental procedures.

*Refer to Chapter 3 of the Elite GC2012 User Manual for detailed operating instructions.*

**External Event Control**

External event control for the Elite GC2012 series gas chromatograph is internally routed, with primary I/O connections terminated at a rear-panel connector. Pin definitions are as follows:

**Black**: Common ground (GND)

**Red**: Instrument readiness status output (24 VDC)

**Yellow:** Start analysis input (short-circuit to common terminal)

**Instrument Communication**

The instrument employs a 10/100/1000BASE-T auto-sensing Ethernet interface for communication, supporting wired LAN or wireless Wi-Fi connectivity to workstation-equipped computers. To maintain high resolution and operational stability, the instrument integrates a 24-bit analog-to-digital (AD) conversion circuit and no longer outputs conventional analog signals. Communication is exclusively compatible with the manufacturer's proprietary workstation software.

## 1.6 Application Environment of the Instrument

### 1.6.1 Installation Environment

**Temperature and Humidity:** The optimal operating temperature range is 5°C to 35°C, with a relative humidity of 0% to 85%. For peak performance and extended instrument lifespan, operation under thermally and hygrometrically stable conditions (e.g., human-comfortable environments) is recommended.

**Corrosive Substances:** Avoid exposure to corrosive materials (gases, liquids, or solids) that may damage instrument components or materials.

**Workbench Stability:** The bench supporting the Elite GC2012 must be rigid to minimize vibration-induced instability.

**Space Allocation:**

- Rear Clearance: Maintain a minimum 30 cm space behind the instrument for column oven heat dissipation.
- Flammable Materials: Do not place combustible items near the rear panel.
- Service Access: Reserve a 30–40 cm corridor for installation and maintenance access.

**Network Interface:**

The Elite GC2012 requires a 10/100/1000BASE-T Ethernet interface. Network connectivity can be established via HUBs, switches, or Wi-Fi adapters.

Adherence to these environmental and installation specifications ensures reliable operation, optimal performance, and long-term stability of the Elite GC2012.

### 1.6.2 Power Supply Environment

**Voltage and Frequency:** The Elite GC2012 gas chromatograph requires a power supply of 220

VAC ±10% at a frequency of 50 Hz ±0.5 Hz. These specifications ensure stable instrument operation, preventing performance degradation or instability caused by power fluctuations.

**Power Capacity:** The power supply must provide a minimum of 2500 W to guarantee adequate electrical support for all operational functions.

**Grounding Standards:**

- **Safety and Noise Reduction:** The instrument panel and enclosure must be grounded in compliance with International Electrotechnical Commission (IEC) standards using a 3-wire power cord to ensure proper grounding.
- **Prohibited Practices:** Water pipes, gas lines, or neutral conductors are strictly prohibited as substitutes for dedicated grounding wires due to their inability to meet safety requirements, posing significant hazards.
- **Ground Resistance:** While specific resistance values are not prescribed, grounding systems typically require resistance <1 Ω (or lower) to ensure effectiveness.

**Importance of Grounding:**

- **Safety Protection:** Proper grounding prevents electric shock hazards arising from electrical faults or static discharge.
- **Noise Mitigation:** Grounding reduces electrical noise, enhancing measurement accuracy and operational stability.

**Conclusion:** Strict adherence to these power supply and grounding specifications is mandatory to ensure safe, reliable, and high-performance operation of the Elite GC2012 gas chromatograph.

### 1.6.3 Gas Supply Requirements

To optimize the performance of the Elite GC2012 gas chromatograph, gases must meet specified purity standards. Recommended purities are as follows:

| Detector | Gas Function | Gas Name | Purity |
|---|---|---|---|
| FID | Carrier | $N_2$ or He | ≥99.999% |
| TCD | Carrier | He, $H_2$, or $N_2$ | ≥99.999% |
| ECD | Carrier | $N_2$ | ≥99.999% (deoxygenated) |
| NPD | Carrier | $N_2$ or He | ≥99.999% |

| | | | |
|---|---|---|---|
| FPD | Carrier | $N_2$ or He | ≥99.999% |
| FPD | Makeup | $N_2$ | ≥99.99% |
| FPD | Fuel | $H_2$ | ≥99.99% |
| FPD | Auxiliary | Air | Clean and dry |

We recommend installing gas purifiers in the gas supply lines! After prolonged use, the molecular sieves and silica gel within these purifiers must undergo activation treatment to restore their purification capacity.

# 2 Instrument Installation

## 2.1 Unpacking the Instrument

Upon receipt of the instrument, immediately inspect the exterior packaging for damage. If any damage is observed, contact the manufacturer or supplier promptly. After unpacking, carefully verify all included components against the packing list to ensure completeness. In the event of missing parts or physical damage to the instrument, promptly notify the manufacturer or supplier to prevent financial loss or operational delays.

## 2.2 Instrument Installation

After verification, place the instrument on a stable workbench. The workbench must be rigid. Avoid storing flammable materials behind the instrument and ensure adequate space for maintenance access.

### 2.2.1 Gas Source Installation

Prior to operating the Elite GC2012 gas chromatograph, be sure to follow the preparation steps outlined in Section 1.5. Select an appropriate detector based on your analytical requirements and equip it with a compatible gas source.

The gas source must be installed in a safe location. If using gas cylinders, securely fasten them to prevent tipping hazards.

Regardless of gas source type (e.g., gas generator, cylinder, or air compressor), rigorously verify gas quality parameters (e.g., purity, stability) to ensure compliance with the stringent requirements of the Elite GC2012 gas chromatograph. Substandard gas sources not only directly compromise the accuracy of analytical results but may also contaminate the instrument or cause irreversible damage.

### 2.2.2 Pressure Reducing Valve Installation

**Preparation of Pressure Reducing Valves and Fittings:**

First, gently unscrew the low-pressure outlet heads from two oxygen pressure reducing valves and one hydrogen pressure reducing valve.

Next, attach the pressure reducing valve adapters to the low-pressure outlets of all three valves. Install the low-pressure output adjustment rod without tightening it fully—leave some clearance

for adjustment.

**Installation of Pressure Reducing Valves to Cylinder:**

Align the prepared pressure reducing valves with the cylinder's valve outlet, then gently screw on and tighten the nuts to ensure a tight connection between the valves and the cylinder.

Open the cylinder's high-pressure valve; at this point, the high-pressure gauge on the valve should display pressure readings, indicating the gas pressure inside the cylinder.

**Leak Check for Pressure Reducing Valves:**

After confirming the valves are properly installed and connected, close the cylinder's high-pressure valve.

Observe the high-pressure gauge—its indicated value must remain stable without any decrease. If the gauge reading drops, it indicates a leak at the pressure reducing valve or connections. Immediately discontinue use and thoroughly inspect to identify and resolve the leak source.

**Completion of Installation and Preparation for Use:**

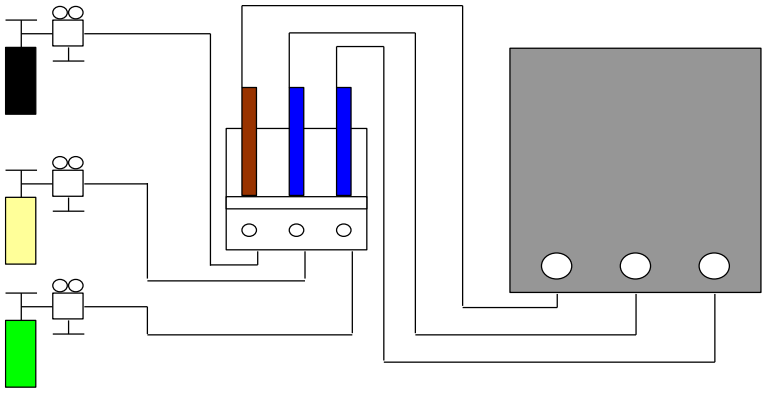
Once leak-free operation is confirmed, adjust the low-pressure output adjustment rod as needed to set the required gas pressure.

Ensure all connections are securely fastened without looseness, then power on the gas chromatograph for subsequent operations.

### 2.2.3 External Gas Line Installation

The Elite GC2012 gas chromatograph uses polyethylene, PTFE, stainless steel, or copper tubes with an outer diameter of Φ3×0.5 for external gas line connections.

The connection method is illustrated in the figure below:



**Note:**

1. Exhaust ports for gas circuit splitting and detector vents must be connected to outdoor

piping to prevent indoor air pollution when analyzing toxic or harmful substances.

2. During operation, regularly check for leaks! Even minor leaks may impair instrument function, while severe leaks (e.g., hydrogen leakage) could cause accidents such as explosions.

3. Carrier gas inlet pressure to the chromatograph: 0.5 MPa.

4. Air inlet pressure to the chromatograph: 0.5 MPa.

5. Hydrogen gas inlet pressure to the chromatograph: 0.4 MPa.

### 2.2.4 System Leak Check

After completing the gas line installation, perform a leak check to prevent accidents. Follow the steps below:

(1) Power off the main unit.

(2) Set the cylinder's low-pressure adjustment rod to the relaxed position, open the cylinder's high-pressure valve, then slowly adjust the low-pressure adjustment rod to achieve the following pressures on the low-pressure gauge:

Carrier gas cylinder: 0.5 MPa

Hydrogen gas cylinder: 0.4 MPa

Air cylinder: 0.5 MPa

(If using a gas generator, follow the pressure indication when the generator stops operating.)

(3) Close the cylinder's high-pressure valve and shut off the carrier gas, hydrogen, air, makeup gas, split flow, and purge valves on the chromatograph. Set the cylinder's low-pressure adjustment rod to the relaxed position. Monitor the pressure gauge for any pressure drop. If the pressure remains stable for 10 minutes, the system is leak-free. If the pressure drops, a leak exists in the gas circuit; inspect and repair segment by segment until resolved.

# 3 Operation of the Chromatograph

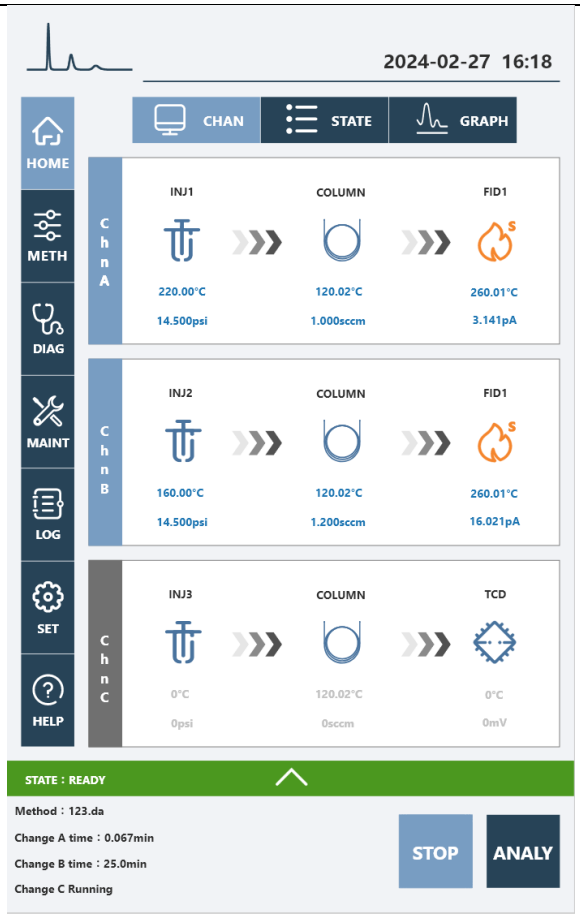
The Elite GC2012 gas chromatograph is equipped with a 7-inch color LCD screen featuring a flat design interface. It provides a comprehensive instrument status overview, enabling users to grasp the operational state at a glance, while also allowing detailed parameter configuration. With its full functionality, well-organized layout, and intuitive operation, users can thoroughly understand and operate this high-performance chromatographic analysis device.

## 3.1 Startup Interface

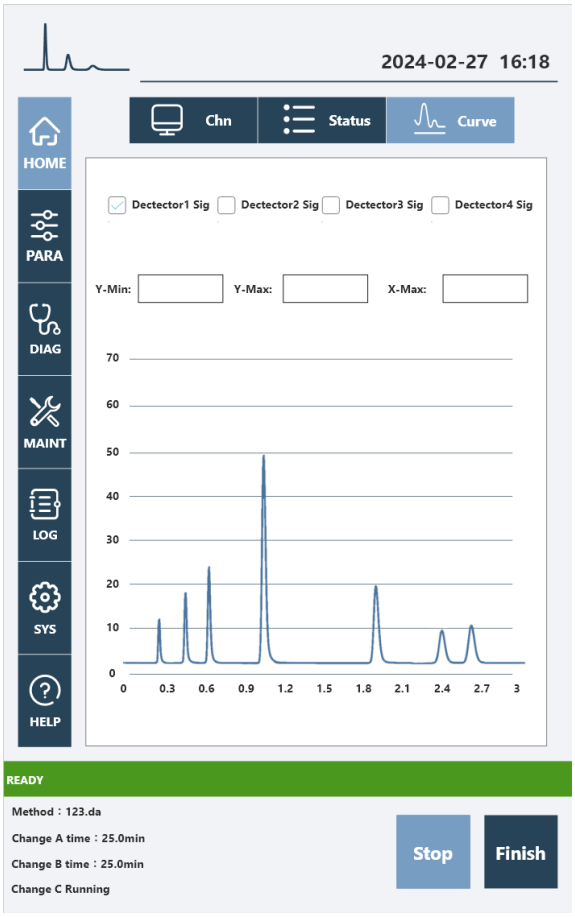

Upon powering on the instrument, the display shows the startup interface (as shown above).

## 3.2 Homepage

Tap the startup interface to enter the instrument's main interface, where the overall operational status can be monitored (as shown below):


2024-02-27 16:18
HOME
METH
DIAG
MAINT
LOG
SET
HELP
CHAN
STATE
GRAPH
ChnA
INJ1
COLUMN
FID1
220.00°C
120.02°C
260.01°C
14.500psi
1.000sccm
3.141pA
ChnB
INJ2
COLUMN
FID1
160.00°C
120.02°C
260.01°C
14.500psi
1.200sccm
16.021pA
ChnC
INJ3
COLUMN
TCD
0°C
120.02°C
0°C
0psi
0sccm
0mV
STATE : READY
Method : 123.da
Change A time : 0.067min
Change B time : 25.0min
Change C Running
STOP
ANALY


2024-02-27 16:18
HOME
PARA
DIAG
MAINT
LOG
SYS
HELP
CHAN
STATE
GRAPH
NO.
Parameters
SV
RV
1 StandbyDisabled 0°C 0°C
2 Oven 200°C 200°C
3 Inj1 250°C 250.02°C
4 Dec1 280°C 279.98°C
5 Inj2 200°C 199.99°C
6 Dec2 250°C 250°C
7 Inj3Disabled 0°C 0°C
8 Dec3Disabled 0°C 0°C
Waiting
Method : 123.da
Change A time : 0.067min
Change B time : 25.0min
Change C Running
Stop
ANALY


2024-02-27 16:18
HOME
PARA
DIAG
MAINT
LOG
SYS
HELP
Chn
Status
Curve
Dectector1 Sig
Dectector2 Sig
Dectector3 Sig
Dectector4 Sig
Y-Min:
Y-Max:
X-Max:
70
60
50
40
30
20
10
0
0 0.3 0.6 0.9 1.2 1.5 1.8 2.1 2.4 2.7 3
READY
Method : 123.da
Change A time : 25.0min
Change B time : 25.0min
Change C Running
Stop
Finish

**Left navigation area:** Used for switching pages, it is divided into seven pages: Home Page, Parameter, Diagnostics, Maintenance, Logs, System Settings, and Help.

The home page is divided into three interfaces: Flow Path, Status, and Curve, which can be switched using the buttons located above.

**Flow Path:** Displays the main operational status of each channel, including inlet temperature, carrier gas pressure, column oven temperature, column flow rate, detector temperature, detector status, detector real-time signal, etc.

Different icons in the detector area represent different detectors and their statuses, as described below:

 FID (Not ignited/ignited)

 TCD (without bridging/with bridging)

 FPD (Without high voltage/with high voltage)

 NPD (Unactivated/activated)

 ECD (Unbase stream/base Stream)

 Zirconia (unheated/heated)

 HID (Unpressurized/pressurized)

 PDECD (No high voltage/High voltage)

**Status:** Used to display other parameters.

**Curve:** Used to display real-time plots generated from detector signals, with options to select displayed signals via checkboxes.

**Lower control area:** Displays instrument operational status, temperature control, and analysis controls.

The status bar uses three colors to indicate:

**Yellow** — Unready

**Green** — Ready

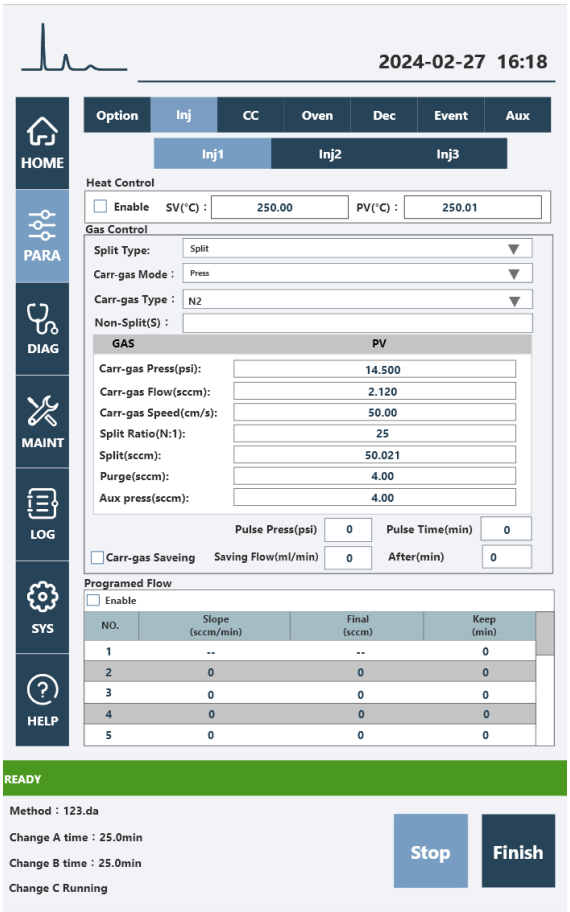
**Red** — Alarm

## 3.3 Methods

Clicking "PARA" on the left navigation bar opens the method parameters interface, which is further categorized into: Inlet, Column, Oven, Detector, Time, Auxiliary Heating, and Method Files.

### 3.3.1 Injection port

The inlet is categorized into capillary and packed column types. Inlet parameters are shown in the figure below:




Heat control:

Enable ---- Turn on the heating function

SV---- Target temperature for heating.

PV ---- Real-time temperature value

Gas Control:

Split type: Options include Split, Splitless, Pulse Split, and Pulse Splitless.

Carrier-gas Mode: Modes include Pressure Control, Flow Control, and Linear Velocity Control. After selecting the control type, input parameters in the corresponding setpoint field on the right.

Carrier-gas Type: Select the correct gas type to ensure accurate column flow calculations.

Channel: Configure the injection port into the corresponding channel.

Non-Split: The time to adjust the split flow rate when the non-split mode is selected.

Split ratio: Set either the split ratio or split flow, and the system will automatically calculate and adjust the flow.

Purge: Septum purging flow.

Aux press: When using a dual-channel carrier gas EPC, this item is the second channel carrier gas flow.

### 3.3.2 Chromatographic column

Click the navigation key "**CC**" above to bring the instrument into the chromatographic column parameters interface, as shown below:


This interface allows setting column parameters, including: film thickness, length, inner diameter, and maximum temperature. Additional columns can be downloaded from the column library via the workstation software.

### 3.3.3 Column oven

Click the navigation button "**Oven**" above to enter the instrument into the column oven

parameter interface:


The heat control is the same as that of the injection port.

Post-Run Temp: Controls temperature after analysis completion.

Post-Run Time: Duration for temperature control after analysis completion.

Balance Time: Stabilization period after reaching the set temperature before the instrument enters ready status.

Max Oven Temp: Protects the chromatographic column. After selecting a column, this value automatically updates to the minimum of all columns' maximum operating temperatures. Manual adjustment is also possible. Exceeding this temperature during operation will trigger protective action and automatic cooling.

**Temperature Programming**

Temperature programming refers to the process where the column oven temperature increases according to preset values during sample analysis. Example: Maintain 60℃ for 5 minutes, then ramp at 5℃/min to 200℃ and hold for 10 minutes. Settings follow the diagram above. Column oven temperature is configured in the temperature interface (not editable here). Subsequent stages follow the same logic.

**Note**: The final temperature of temperature programming must be higher than the column oven's set temperature. Each subsequent stage temperature must exceed the previous stage's temperature.

**Note**: If the temperature ramp rate of any stage is set to 0, the temperature programming for that stage and all subsequent stages will be invalidated. If the first stage's ramp rate is 0, the entire temperature programming sequence becomes invalid.

**Temperature Programming Operation:**

With the instrument powered on, press the "**HEAT**" button to enter temperature control mode. After the instrument reaches "**Ready**" status, press the "**ANALY**" button to initiate temperature programming.

Upon completing a full temperature programming cycle, the post-run program executes. After the post-run time elapses, the instrument automatically opens the column oven rear door to rapidly cool down to the initial temperature, shortening cooling time. When the column oven temperature reaches the initial temperature (±1℃), "**Ready**" is displayed, awaiting the next temperature programming cycle. This process repeats.

During temperature programming execution, pressing the "Stop" button under the temperature control system will interrupt the temperature programming sequence, returning the instrument to isothermal mode.

**Note: The** termination temperature of the program rise is set higher than the set temperature of the column furnace, and the temperature of the next stage is higher than that of the previous stage.

**Note:** When the heating rate of a certain stage is 0, the programmed heating of that stage and subsequent stages will be invalid; A rate of 0 for the first stage will render the entire programmed temperature content invalid.

**Programmed warming operation:**

While the instrument is powered on, press the "**HEAT**" key to bring the instrument into the temperature control state. When the instrument is in the "**Ready**" state, press the "**ANALY**" key again to start the programmed temperature control of the instrument.

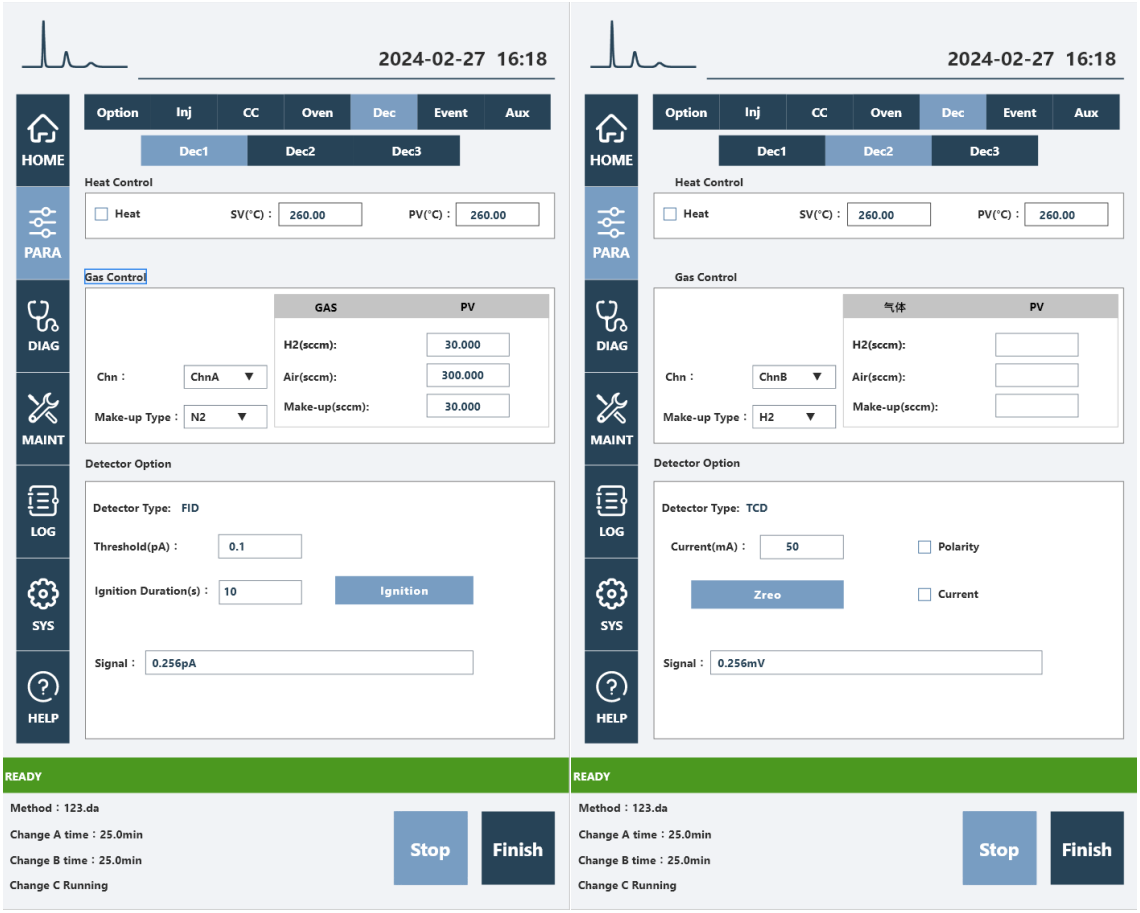
When the instrument has completed a full programmed temperature cycle, the post-run program is executed. After the post-run time is completed, the instrument will automatically open

the rear door of the column oven to allow the temperature inside the column oven to drop rapidly to the initial temperature, shortening the instrument's cooling time. When the column oven temperature drops to the initial temperature (±1 ° C), display "**Ready" and** wait for the next programmed temperature to begin. Repeat this process.

While the instrument is performing the programmed temperature rise, under the temperature control system, pressing the "**Stop**" key will interrupt the programmed temperature rise state and the instrument will return to the constant temperature state.

### 3.3.4 Detector parameters

Click the navigation key "**Dec**" above to bring the instrument into the detector parameters interface, where you can view the detector parameters for each channel as shown in the following figure:




The heating control is the same as the injection port.

Gas Control

Chn: Configure the injection port into the corresponding channel.

Make-up Type: The type of tail blowout gas should be selected correctly.

Set the appropriate hydrogen, air, and tail blow flow rate (different detector types require corresponding parameters)

Detector Option:

FID: Ignition duration, ignition threshold, detector ignition can be set, and signal values corresponding to the detector can be viewed.

TCD: Bridge current, polarity can be set, and signal values of corresponding detectors can be viewed.

ECD: You can set the base current and you can view the signal values of the corresponding detectors.

FPD: You can set the ignition duration, ignition threshold, high voltage value, perform ignition operations on the detector, and you can view the signal value of the corresponding detector.

NPD: You can view the signal value of the corresponding detector.

### 3.3.5 Events

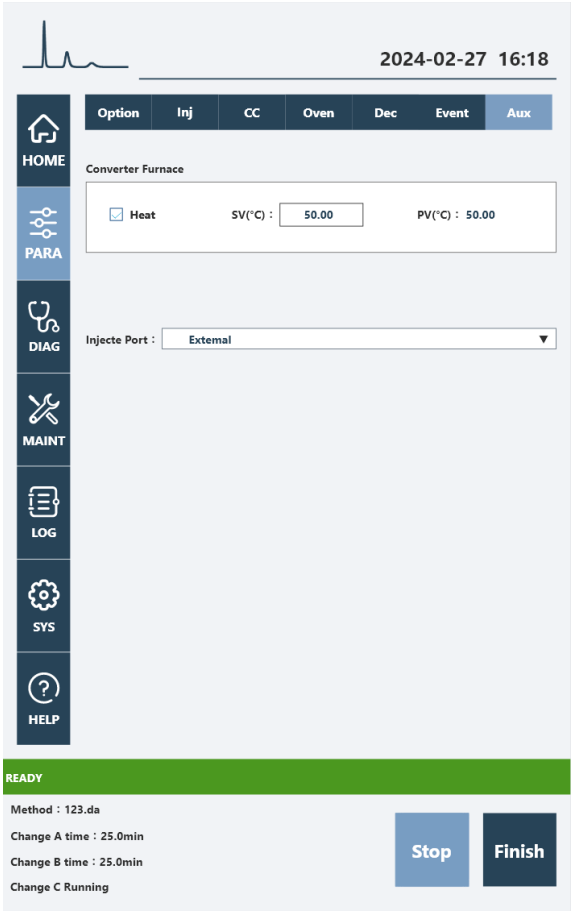
Click the navigation key "**Event**" above to bring the instrument into the event parameters interface, as shown below:

There are 8 events in this interface. If you need an external event, set it in this interface.

The buttons below represent the status of each event on/off, and you can manually tap the event on/off.

### 3.3.6 Auxiliary Heating

Click the navigation key "**Aux** " above:




Configure the auxiliary heating system, including the conversion furnace and injection valve.

### 3.3.7 Options

Click the navigation key "Option" above:


This interface is for method file management and is independent of the host instrument Methods, the upper computer workstation can synchronize the methods stored in the instrument with the "Upload" and "Download" buttons.

## 3.4 Diagnostics

Click on "DIAG" in the left navigation bar to enter the instrument diagnostics interface, which is divided into zero point calibration and internal diagnostics.

### 3.4.1 Zero Calibration

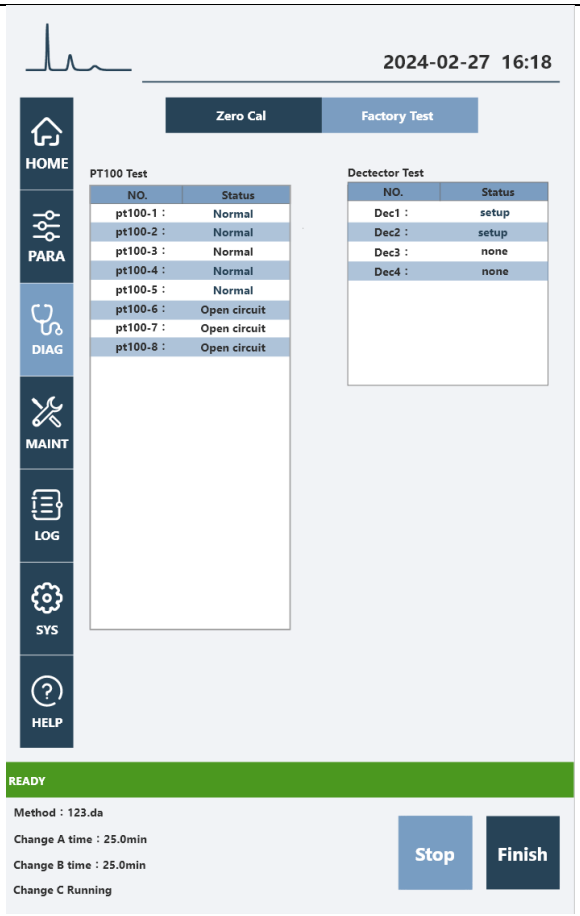
Zero calibration is used to calibrate the flow path sensors of the EPC as shown below:


Zero Calibration Procedure:

1. Shut off the gas supply.
2. Turn off the switches of inlet and outlet tubing connections of the EPC flow path requiring calibration.
3. Allow the system to stabilize for 10 seconds.
4. Click “Zero Cal” on the screen and wait until the measured value stabilizes at 0.

### 3.4.2 Factory Test

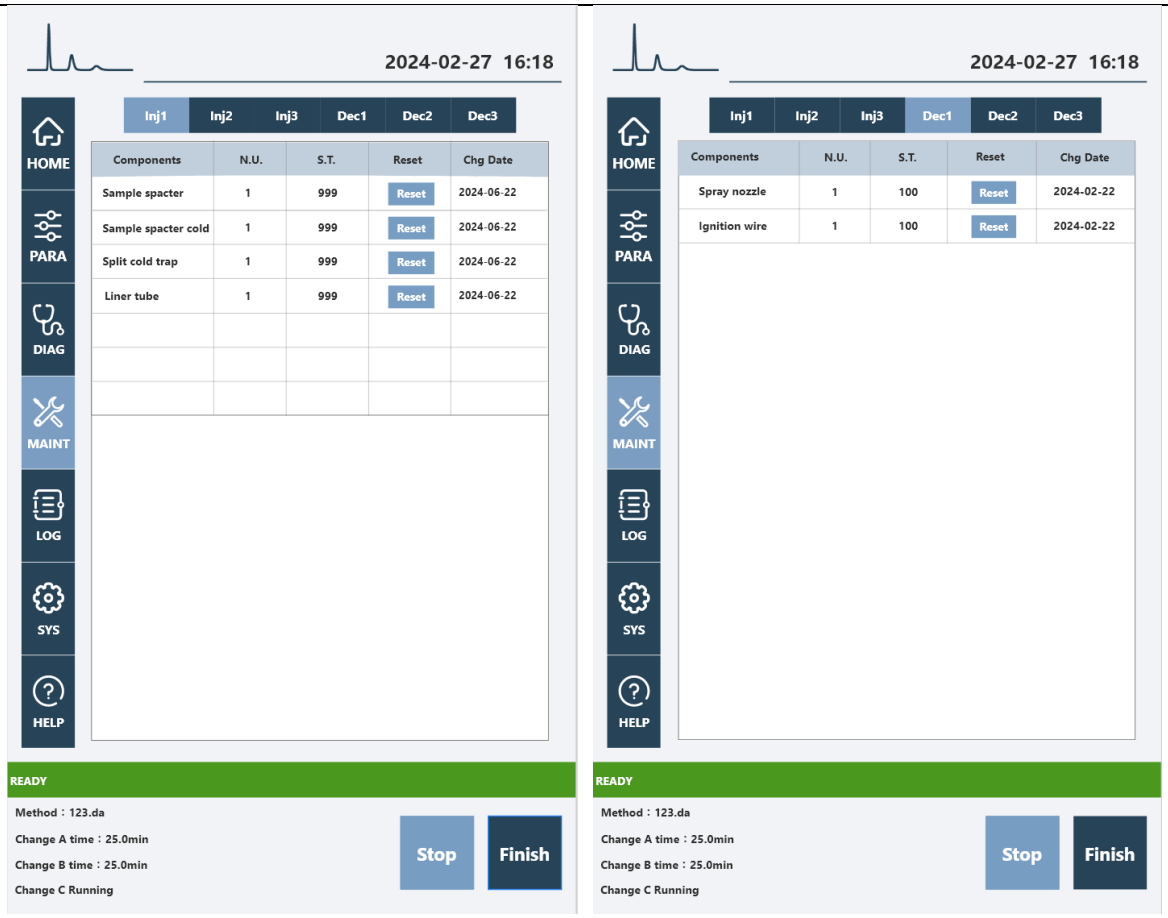
Click the navigation key " Factory Test " above:




This interface can detect whether major component connections are normal.

## 3.5 Maintenance

Click on "MAINT" in the left navigation bar to enter the instrument maintenance interface, which is used to view the usage of each injection port and detector consumable.

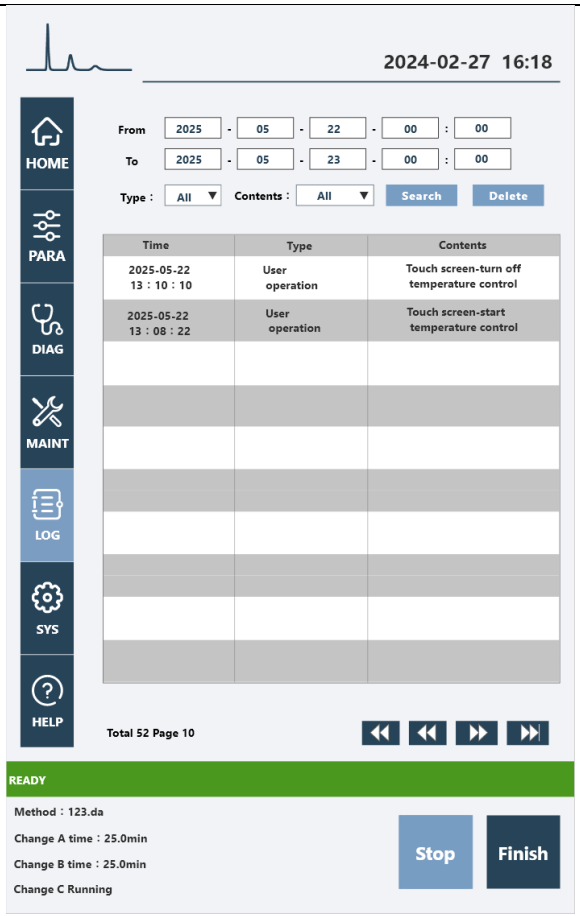



The injection port components include the injection septum, septum purge trap, split vent trap, and liner; the detector components include the nozzle and ignition filament.

Enter the recommended usage count. When actual usage exceeds this value, the system will prompt for replacement. After replacement, click “Reset” to reset the counter.

## 3.6 Log

Click on "LOG" in the left navigation bar to enter the Log view interface, which is used to view system operation, human operation, and various alarm records.

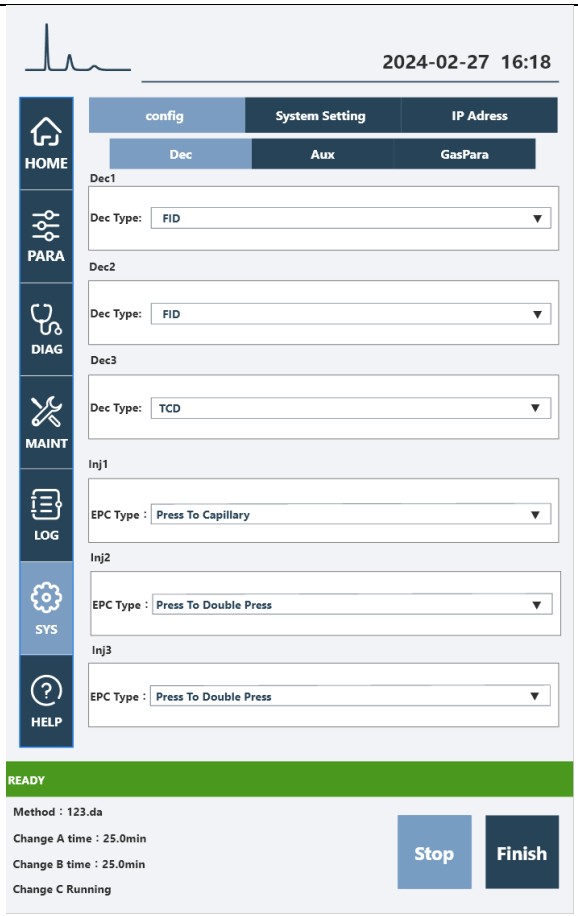



## 3.7 System Settings

Click on "**SYS**" in the left navigation bar to enter the instrument Settings interface.

### 3.7.1 Configuration

The injection port EPC is divided into capillary EPC, dual-channel flow EPC, and the detector can be FID, TCD, ECD, NPD, FPD, etc. This configuration is the manufacturer's configuration. Do not change it at will.




### 3.7.2 System Setting

The system Settings are as shown in the following figure:


System Time: Enter values and click the " System Setting" button.

Cycle Settings: Enter cycle duration and cycle count. For infinite cycling, set the cycle count to 9999.

Firmware Upgrade: Contact the manufacturer for the upgrade file. Save it to a USB drive, insert into the rear USB port, then click "Update" and wait for completion.

## 3．7．3 IP Adress

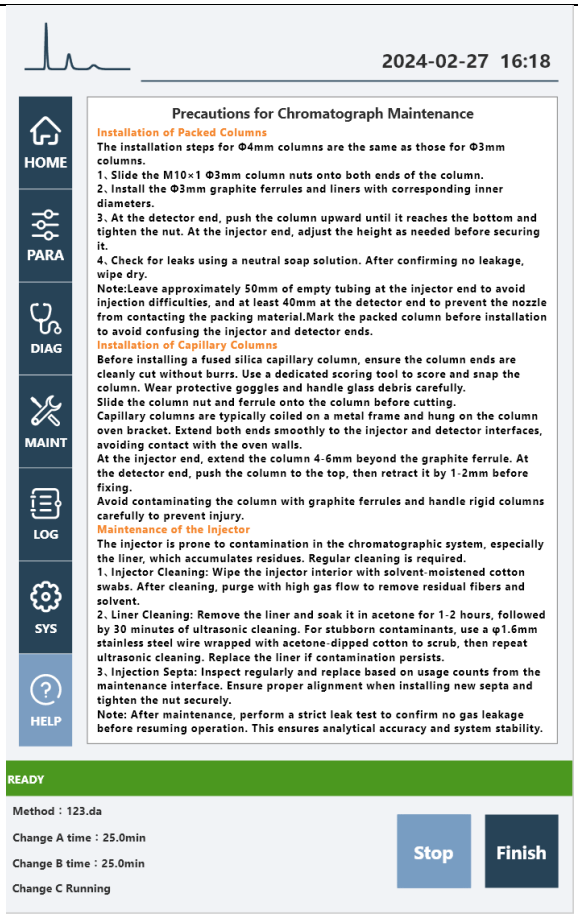
3.7.3 IP Address

The instrument supports Ethernet or Wi-Fi connectivity. After setting IP addresses respectively, click "IP Address".

Alternatively, the instrument can activate its hotspot. Connect a computer to this hotspot to access the workstation.


## 3.8 Help

Click on "HELP" in the left navigation bar to enter the Help interface, as shown below.


2024-02-27 16:18
HOME
PARA
DIAG
MAINT
LOG
SYS
HELP
Precautions for Chromatograph Maintenance
Installation of Packed Columns
The installation steps for Φ4mm columns are the same as those for Φ3mm columns.
1、Slide the M10×1 Φ3mm column nuts onto both ends of the column.
2、Install the Φ3mm graphite ferrules and liners with corresponding inner diameters.
3、At the detector end, push the column upward until it reaches the bottom and tighten the nut. At the injector end, adjust the height as needed before securing it.
4、Check for leaks using a neutral soap solution. After confirming no leakage, wipe dry.
Note:Leave approximately 50mm of empty tubing at the injector end to avoid injection difficulties, and at least 40mm at the detector end to prevent the nozzle from contacting the packing material.Mark the packed column before installation to avoid confusing the injector and detector ends.
Installation of Capillary Columns
Before installing a fused silica capillary column, ensure the column ends are cleanly cut without burrs. Use a dedicated scoring tool to score and snap the column. Wear protective goggles and handle glass debris carefully.
Slide the column nut and ferrule onto the column before cutting.
Capillary columns are typically coiled on a metal frame and hung on the column oven bracket. Extend both ends smoothly to the injector and detector interfaces, avoiding contact with the oven walls.
At the injector end, extend the column 4-6mm beyond the graphite ferrule. At the detector end, push the column to the top, then retract it by 1-2mm before fixing.
Avoid contaminating the column with graphite ferrules and handle rigid columns carefully to prevent injury.
Maintenance of the Injector
The injector is prone to contamination in the chromatographic system, especially the liner, which accumulates residues. Regular cleaning is required.
1、Injector Cleaning: Wipe the injector interior with solvent-moistened cotton swabs. After cleaning, purge with high gas flow to remove residual fibers and solvent.
2、Liner Cleaning: Remove the liner and soak it in acetone for 1-2 hours, followed by 30 minutes of ultrasonic cleaning. For stubborn contaminants, use a φ1.6mm stainless steel wire wrapped with acetone-dipped cotton to scrub, then repeat ultrasonic cleaning. Replace the liner if contamination persists.
3、Injection Septa: Inspect regularly and replace based on usage counts from the maintenance interface. Ensure proper alignment when installing new septa and tighten the nut securely.
Note: After maintenance, perform a strict leak test to confirm no gas leakage before resuming operation. This ensures analytical accuracy and system stability.
READY
Method：123.da
Change A time：25.0min
Change B time：25.0min
Change C Running
Stop
Finish

# 4 Instrument maintenance and upkeep

## 4.1 Maintenance of the injection port

The injection port is prone to contamination, especially the inner liner tube, which is prone to adhering contaminants. Therefore, it needs to be cleaned according to usage:

(1) Cleaning of the inlet: It can be cleaned directly with a solvent cotton ball and then blown with a large air flow (mainly to blow off the cotton ball fibers and dry the solvent);

(2) Cleaning of the inner liner tube: After removing the inner liner tube, soak it in acetone for 1-2 hours, then ultrasonicate for more than 30 minutes. If there are stubborn contaminants, use a ϕ1.6 stainless steel wire with a cotton swab dipped in acetone to remove them, then ultrasonicate again. If the inner liner tube is too contaminated to be cleaned, it needs to be replaced.

(3) The injection pad needs to be replaced according to the number of times the maintenance interface is used. After installing the new injection pad, tighten the nut.

The instrument can only be used after a strict leak test after maintenance!

## 4.2 Cleaning of the hydrogen flame ionization detector

1、Remove the FID amplifier, pull out the signal tube, remove the outer cover fixing nut, then remove the collection tube and insulating gasket, clean the outer cover, collection tube and insulating gasket with acetone or alcohol and then dry;

2、If contamination is severe, the parts to be cleaned can be placed in the ultrasonic cleaning solution, after ultrasonic treatment, rinsed with clean water, then washed with alcohol and dried;

3、If the chromatographic stationary liquid is contaminated with the detector, a solvent that can dissolve the stationary liquid should be selected for dissolution.

4、If the nozzle is contaminated, remove the amplifier signal tube and the outer cover fixing nut, then remove the ion head fixing seat, and then use the sleeve to remove the nozzle. The cleaning method is the same as above.

## 4.3 Installation of the chromatographic column

### 4.3.1 Packing column installation

The installation of packed columns at both the injection port and the detector is similar. The injection port end of the packed column should be pushed to the top; At the detector end, it should also be pushed to the top.

Due to the rigidity of the glass, the glass-packed column must be installed at both ends of the injection port and the detector. The installation procedure for each end is the same. For column installation at the detector end, see the corresponding section according to the detector being used.

Connection of Elite GC2012 gas chromatograph Φ3, Φ4mm packed columns to the injection port.

Installation steps are as follows:

1) Insert the M10×1 Φ3mm column nuts into both ends of the chromatographic column first;

2) Install Φ3mm graphite rings at both ends of the chromatographic column, and then install the corresponding inner diameter liner. Push up to the bottom of the detector (to the bottom) and tighten the nut;

3) At the injection port end, adjust the height of the chromatographic column according to specific requirements and tighten the nut;

4) Check for leaks with neutral soap solution. There should be no gas leakage.

5) Dry the soap solution;

6) Φ4mm column installation steps are the same as above;

Note: The injection end of the packed column should have an empty tube about 50mm in length to avoid difficulties during injection. The injection end of the chromatographic column should not be confused with the detector end and should be marked when filling the packed column. A sufficient section of empty column (at least 40mm) should also be left at the detector end to prevent the bottom of the nozzle from touching the glass fiber or column packing filled at the column end.

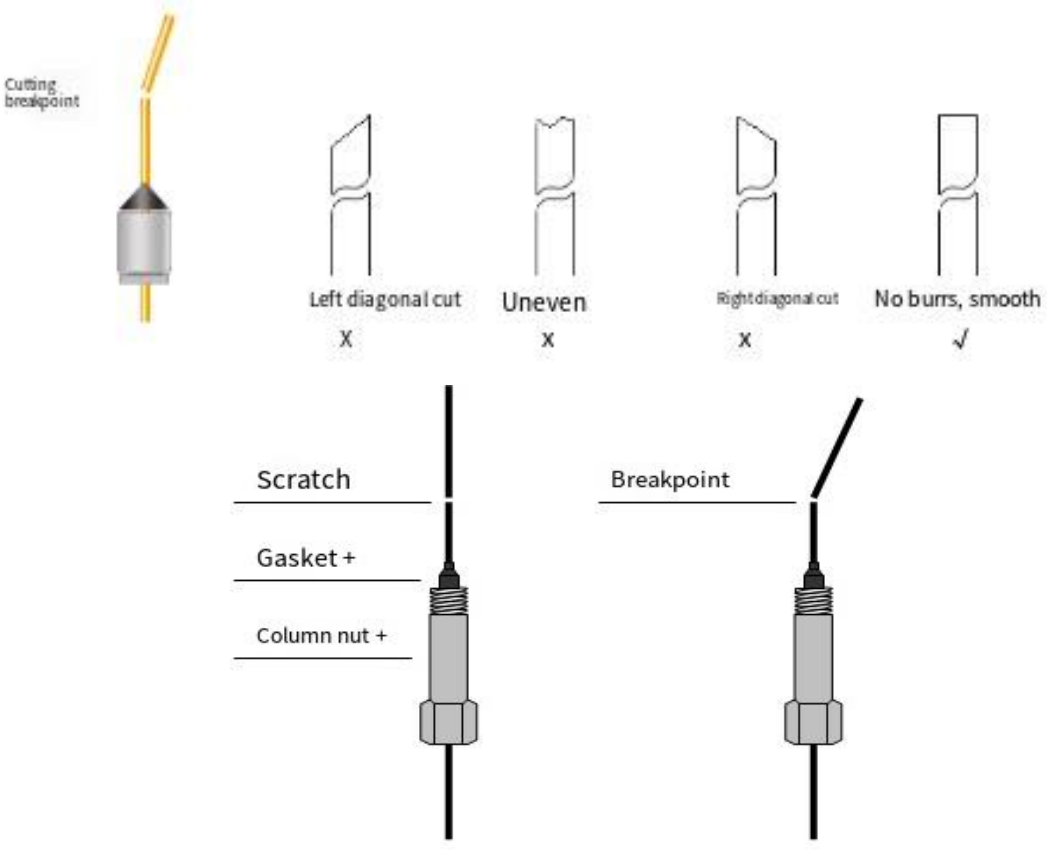
### 4.3.2 Installation of the capillary column

The fused silica capillary column is very regular and does not require tiling. But it is important that the column ends be freshly cut, hairless, and neatly edged, and that particulate matter from the column, the stationary phase, and the sealing gasket is removed.

For this purpose, the end of the column should be freshly cut, and scratches should be

made on the area to be cut with a suitable specialized cutting tool. Usually the column nuts and washers are installed before cutting.

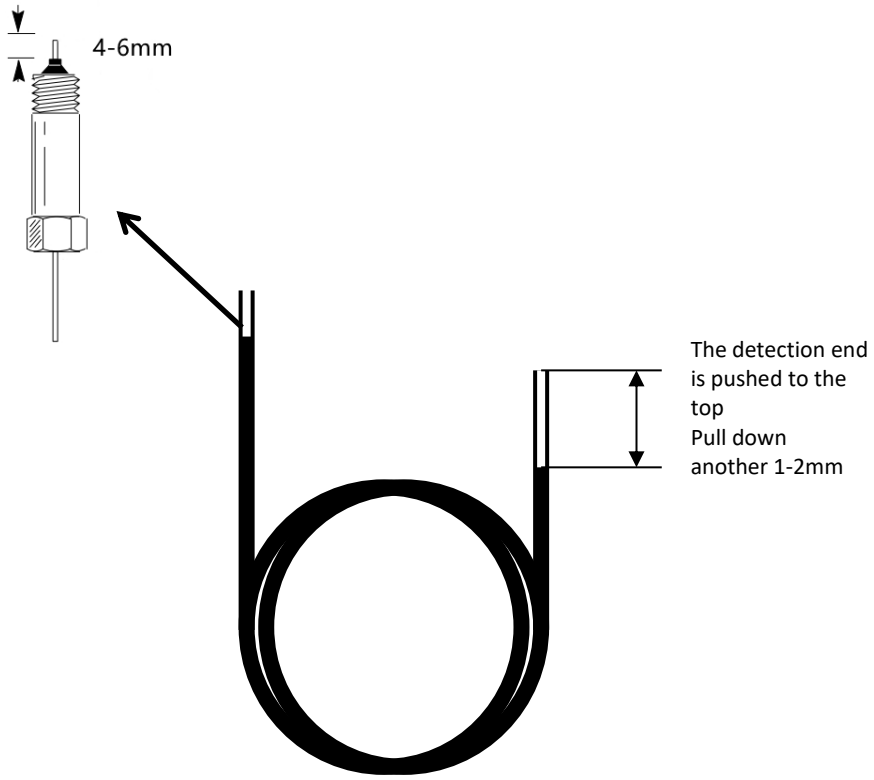
Note: Wear protective glasses to prevent possible eye injury from flying particulate matter that may be produced when handling cutting glass or fused silica capillary columns. Care should also be taken to prevent skin cuts when handling capillary columns. Since the column is quite rigid, it is important to be aware of these in advance when handling the capillary column.




The capillary column is wound around a metal frame, which is suspended from the capillary column bracket in the column box. The two ends of the column extend from the bottom of the frame and bend smoothly towards the interface of the injection port and detector, and do not let any part of the column touch the inner wall of the column box. Graphite gaskets may contaminate the column as they pass through it. Cut the column ends as described in "Preparing a Fused Silica

Capillary Column".

The following figure shows the reserved lengths for the injector end and FID end when installing the elastic quartz capillary column. The injector end should extend 4-6mm beyond the graphite pad, and the detector end should push the chromatographic column up to the top and then pull down 1-2mm.



# 5 Instrument faults and troubleshooting

## 5.1 Startup Issues

### 5.1.1 No response at startup

| Fault diagnosis | Check methods and repairs |
|---|---|
| Mains power issues | Check the mains voltage |
| The fuse has blown | Check the fuse and replace it |
| The display screen is not working. | Check if the motherboard lights up |

### 5.1.2 Not online

| Fault diagnosis | Check methods and repairs |
|---|---|
| Network cable problem | Check the network cable and PING this GC on your PC |
| The IP address is set incorrectly | Check the IP address and set it correctly |
| The computer operating system firewall is blocking | Remove the firewall blocking |
| Computer antivirus software blocks | Remove the blocking of antivirus software |
| The network indicator light of the computer or chromatograph is not on | Check the network cable, switch, chromatograph or computer |
| Connected but disconnected from time to time | Check whether the network and IP addresses are in conflict |

## 5.2 Chromatographic peak issues

### 5.2.1 No baseline

| Fault Diagnosis | Check methods and repairs |
|---|---|
| Amplifier malfunction | Replace the amplifier |
| Set the baseline and background colors to the same color | Modify the color |
| The chromatograph is not connected to the computer | Check the network and network parameters |

### 5.2.2 No chromatographic peaks

| Fault diagnosis | Check methods and repairs |
|---|---|
| The inlet temperature is too low | Increase the inlet temperature |
| The syringe is clogged. | Replace the syringe |
| There is no carrier gas passing through | Check if the carrier gas flow path is blocked or if the gas in the cylinder has run out |
| Silicone rubber leaks | Replace silicone rubber |
| No flame | Light up |
| FID amplifier broken | Replace the amplifier |
| The TCD is not bridged | Set the appropriate bridge current |

### 5.2.3 Normal retention time but decreased sensitivity

| Fault diagnosis | Check methods and repairs |
|---|---|
| Leaking syringe | Replace the syringe |
| Carrier gas leak | Test for leaks and deal with them accordingly |
| Improper selection of hydrogen and air flow (FID) | Adjust the flow rate accordingly |

### 5.2.4 Tail peak

| Fault Diagnosis | Check methods and repairs |
|---|---|
| Contamination of the injection tube | Clean the inlet tube |
| The oven temperature of the chromatographic column is too low | Increase the temperature of the chromatographic column |
| The injection temperature is too low | Raise the inlet temperature |
| Improper selection of the chromatographic column | Choose the appropriate chromatographic column |

### 5.2.5 Tongue Extension Peak

| Fault diagnosis | Check methods and repairs |
|---|---|
| The sample size is too large | Reduce the sample size |
| Samples are aggregated in the system | Raise the column temperature first, then select the appropriate inlet, chromatographic column, detector temperature |

### 5.2.6 Poor separation of chromatographic peaks

| Fault diagnosis | Check methods and repairs |
|---|---|

| | |
|---|---|
| The chromatographic column is too short | Choose a longer column |
| Loss of stationary phase | Replace the chromatographic column or age it |
| Column temperature too high | Lower the column temperature |
| The selection of the stationary liquid is incorrect | Select the appropriate chromatographic column |
| The carrier gas flow rate is too high or too low | Adjust the carrier gas flow rate |

### 5.2.7 Baseline mutation

| | |
|---|---|
| Fault diagnosis | Check methods and handling |
| External electric field interference | Eliminate external electric field interference that affects the normal operation of the instrument |
| Poor contact of the power plug | Install the power socket firmly |
| Improper selection of hydrogen and air flow | Readjust the flow rates of hydrogen and air |

### 5.2.8 Irregular baseline fluctuations during constant temperature operation

| | |
|---|---|
| Fault diagnosis | Check methods and repairs |
| The position where the instrument is installed is not good | Install the instrument in a place where there is no strong vibration. It is best to place the instrument on a concrete platform without vibration. |
| The instrument is poorly grounded. | Check and ensure proper grounding |
| The fixative is not appropriate | Choose the appropriate fixative |
| The carrier gas flow rate is not chosen properly | Adjust the carrier gas flow appropriately |
| Carrier gas leak | Leak test |
| Detector contamination | Clean the detector |
| Improper selection of hydrogen and air (FID) | Adjust the flow of hydrogen and air appropriately |

### 5.2.9 Prolonged retention time leads to low sensitivity

| | |
|---|---|
| Fault diagnosis | Check methods and repairs |
| The carrier gas flow rate is too slow | Increase the carrier gas flow rate |
| Change the carrier gas flow rate after injection | Change the injection port silicone rubber |
| Injection port silicone rubber leaks | Replace the injection port silicone rubber |

### 5.2.10 The signal suddenly returns below baseline and extinguishes the fire when

**the peak comes out**

| Fault diagnosis | Check methods and repairs |
|---|---|
| The sample size is too large | Reduce the sample size |
| The carrier gas flow rate is too high | Choose the appropriate carrier gas flow rate |
| The hydrogen or air flow rate is too low | Readjust the flow rate of hydrogen and air |
| Flame nozzle contamination | Clean the flamethrowers |
| The stationary phase in the chromatographic column has leaked | Re-age the column |

### 5.2.11 Baseline too high

| Fault Diagnosis | Check methods and repairs |
|---|---|
| Detector contamination | Clean the detector |
| Amplifier failure | Check the amplifier |

### 5.2.12 There are spike peaks in irregular distances

| Fault diagnosis | Check methods and repairs |
|---|---|
| Amplifier failure | Replace the amplifier |
| Flame flicker | Adjust the appropriate flow of hydrogen and air |
| High frequency signal tube failure | Check the high-frequency signal tube |
| Dust on the detector | Blow it off with an ear swab |

### 5.2.13 There is a certain amount of burrs at equal intervals

| Fault diagnosis | Check methods and repairs |
|---|---|
| Water condenses in the hydrogen pipeline | Remove the water from the pipeline and replace or activate the desiccant |
| There is a blockage in the flow path | Remove impurities from the flow path |
| Leaking air | Test for leaks and take corresponding measures |
| Flame flicker | Adjust the appropriate flow of hydrogen and air |

### 5.2.14 Round peak

| Fault diagnosis | Check methods and repairs |
|---|---|

| | |
|---|---|
| Beyond detector linear range (TCD) | Reduce the sample volume |
| Improper bridge flow selection (TCD) | Reselect the appropriate bridge flow |

### 5.2.15 Baseline noise is high

| Fault diagnosis | Check methods and repairs |
|---|---|
| Contamination of the chromatographic column | Replace the chromatography column |
| Carrier gas contamination | Replace or regenerate the carrier gas filter |
| The carrier gas flow rate is too high | Readjust the carrier gas flow rate |
| Poor grounding | Check and make good grounding |
| Contamination of the injection port | Clean the inner liner tube of the injection port |
| Too high or too low air or hydrogen flow rate (FID) | Readjust the flow rate of air or hydrogen |
| Air or hydrogen contamination | Replace the hydrogen or air filter |
| Water condenses in the FID | Increase the FID temperature to remove the moisture |
| High frequency signal tube failure | Check the high-frequency signal tube |

### 5.2.16 Extra peaks

| Fault diagnosis | Check methods and repairs |
|---|---|
| Reconstituted peaks of the previous sample | Wait until the previous sample has been completely expelled before injecting |
| The water condensed in the chromatographic column is eluted again | The operating conditions for installing or regenerating the purifier should be chosen appropriately |
| Sample decomposition | Lower the inlet temperature |
| Samples contaminated | Make sure the sample is clean |

### 5.2.17 Serrated baseline

| Fault Diagnosis | Check methods and repairs |
|---|---|
| EPC flow oscillation | Replace EPC |
| The airflow is not flowing properly | Reset the flow rate of the airflow |

### 5.2.18 Reverse peak

| Fault diagnosis | Check methods and repairs |
|---|---|

| | |
|---|---|
| Excessive hydrogen flow (FID) | Adjust the hydrogen flow rate |
| Incorrect Polarity (TCD) | Change polarity |
| The tungsten filament leads of the reference cell and the measurement cell are mistaken (TCD) | Check the lead conditions of the tungsten wires in the reference cell and the measurement cell. |

### 5.2.19 Baseline unidirectional baseline drift (FID) without injection

| Fault diagnosis | Check methods and repairs |
|---|---|
| Detector temperature too low | Raise the detector temperature |
| Column temperature stops heating or gets out of control | Inspect and repair the temperature control system and the platinum resistance of the heating wire |
| Leaking air | Leak test |

### 5.2.20 Irregular baseline changes during heating

| Fault diagnosis | Check methods and repairs |
|---|---|
| Excessive column loss | Select the appropriate chromatographic column, use the column temperature which should be much lower than the maximum operating temperature of the stationary phase, and age the column |
| The appropriate operating conditions were not chosen | Choose the appropriate operating conditions |
| The chromatographic column is contaminated | Replace the chromatographic column |

### 5.2.21 Periodic baseline fluctuations

| Fault diagnosis | Check methods and repairs |
|---|---|
| Detector temperature control is poor | Check whether the contact is good |
| The carrier gas flow pressure is too low | Replace the carrier gas cylinder |
| The temperature of the chromatographic column furnace was not properly adjusted | Check if the platinum resistance contact is good |
| The carrier gas flow is not properly regulated | Re-adjust the carrier gas flow rate |
| Improper adjustment of air and hydrogen (FID) | Recalibrate the flow of hydrogen and air |

### 5.2.22 Baseline changes after programmed temperature rise

| Fault diagnosis | Check methods and repairs |
|---|---|
| Column loss increases as the temperature rises | Select an appropriate chromatographic column or an aged column |

| | |
|---|---|
| The column flow rate is not corrected properly | Correcting column flow rate |
| The chromatographic column is contaminated | Replace the chromatographic column |

### 5.2.23 Uninjected Signal output amplitude too large (TCD)

| Fault Diagnosis | Check methods and repairs |
|---|---|
| The tungsten wire in the cavity touches the pool wall | Contact the manufacturer for repair |
| The resistance values of the tungsten wire do not match | Contact the manufacturer for repair |
| The internal connectors and connection wires of the TCD thermal conductive power component are not properly inserted | Reinsert the plugs and sockets associated with it |

## 5.3 Thermal conductivity detector notes

**Carrier gas and bridge setting:** Do not set the bridge when no carrier gas is introduced. This is because the lack of the cooling effect of the carrier gas can cause excessive bridge current to overheat and burn out the tungsten filament. Therefore, make sure the carrier gas is properly fed in before setting the bridge current.

**Column aging and carrier gas treatment:** When aging the column for the first time, the carrier gas behind the column should be vented directly into the column box instead of being connected to the heat conduction cell. In addition, hydrogen is strictly prohibited during the aging process, and nitrogen is usually recommended for aging. Also, it is strictly forbidden to set the bridge current during aging to prevent damage to the detector.

**Thermal conductivity detector protection: A** thermal conductivity detector is a highly precise component with a complex and fragile internal structure. Therefore, do not attempt to disassemble the tungsten wire or other components inside the cell by yourself to avoid unnecessary loss or damage to the detector.

# Appendix A Electrical Condition Details

A qualified electrical technician should be able to supply the appropriate power supply to the system. This is required whether it is to retrofit existing electrical equipment or to install a brand new one.

* Estimate the total electricity demand in the area.

* Install a convenient output line.

* Make a plan for electrical safety.

* Ensure that all wiring complies with local regulations.

**Determine the power demand of the power supply**

Calculate the amount of electricity needed in your area.

Note: The total electricity should include the original equipment plus the additional equipment to be added for future expansion plans.

**Voltage limits**

At any location where the instrument is installed, when the system is powered on, the phase-line-neutral voltage should be maintained within the range of +10 to -10 percent of the rated voltage, and the voltage should be measured from the power input side of the system.

**Frequency limit**

The allowable line frequency limit depends on the device with the narrowestern limit range within the system (measured at the power line input of the instrument). The Elite GC2012 network gas chromatograph has a wide limit and can operate within the range of 50Hz to 60Hz.

**Harmonic quantity**

The maximum total harmonics of the instrument feeder must not exceed 5% (measured at the instrument's power input after the instrument is powered on).

**Unexpected power supply situations**

In some areas, the power lines used by the instrument system may experience excessive voltage drops, or impulse voltages, transient voltages, power outages, or other unexpected situations, making the operation of the instrument system unreliable. Therefore, the quality of the power supply must be checked. If it is found during the inspection that certain items do not meet the requirements of the system, corrections should be made.

**Power supply noise**

The Elite GC2012 network analysis instrument is structurally designed to withstand reasonable input line noise. But much of the noise from other electrical utilities is beyond the control of the network analysis instrument. The main source of this electrical noise comes from other electrical devices near the instrument, such as motors, solenoid valves, thyristor rectifiers and X-ray machines, etc.

In addition, there may be "neutral line-ground noise" due to poor contact of the neutral line and "ground-ground" noise due to poor floor grounding. The maximum allowable noise for wires is 3V (rms) from 30Hz to 50Hz.

A small "ground - neutral" voltage can be measured with an oscilloscope because if there is a distortion deviation in the voltage, the reading on the analog meter head will be distorted. Generally, there is a problem if the voltage is lower than the measurement result.

**Noise elimination**

If noise is to be eliminated from existing electrical appliances or those to be installed in the future, we stick to the recommendation that a qualified feeder be installed between the main distribution board and the instrument sub-distribution board. Check if the neutral line contact and grounding are good (see the "Grounding" section below).

If there are still poor transient phenomena after a qualified feeder is installed, then install a device that can reduce the input electrical noise.

**Power interference**

Input power noise that interferes with the power output, or input power noise that interferes with the signal lines in the system, can cause the instrument system to malfunction. These input interferences can be summarized as surges, drops and transients, as described below: "Surges" and "drops" are sudden changes in the positive or negative values of the input voltage, lasting between 5 milliseconds. In general, both "impulse" and "drop" should not exceed ±15% of the normal rated line voltage and should return to a stable state within 17 milliseconds (60Hz) and 20 milliseconds (50Hz).

A "power supply voltage transient" is a sudden change in the positive or negative value of the input voltage, lasting between 1 millisecond and 5 milliseconds. If the transient lasts longer than 20% of the rated voltage (depending on its energy), it will cause the instrument to malfunction.

It is useful to have a power input interference monitor when monitoring the quality of the input power and evaluating the characteristics of interference. Since power line interference can

occur every hour, every day, and every week, the monitor should be connected for at least a week. Also, do not take the measured results as absolute values, as the interference values can vary with the seasons.

The test involves using a spike signal with a rise time of 0.5 microseconds and a pulse duration of 10 microseconds, with an amplitude twice that of the power supply voltage.

**Power processing equipment**

If transient phenomena still occur after installing dedicated feeders and grounding, then equipment that reduces interference in the input power line should be installed. There are basically four types of devices that can do this:

1. Isolation transformer
2. Power voltage regulator
3. Electric motor - generator equipment
4. An undisturbed power supply system

The power of the line regulating equipment must meet current and future needs. Our factory recommends a minimum rating of 5KVA, which will meet the current requirements as well as the requirements for future expansion.

# Appendix B Grounding

In order for the instrument to operate safely and reliably, it is very important that the instrument is well grounded. In general, most countries and regions require electrical equipment to be grounded to ensure personal safety.

**Safe grounding**

All kinds of standards generally require safety conductors to be installed on electrical appliances. There is a general requirement in the standard that each live wire return wire (center wire) should be accompanied by a safety conductor. The size of the safety conductor must be the same as that of the live wire.

Generally, safety standards require that the safety conductor be attached to a conductive surface of an electrical device that an operator may touch, or a conductive surface that may be excited due to an electrical accident. Under normal operating conditions, this wire should not carry alternating current that returns. If the instrument's frame is not grounded, or if the live wire accidentally touches the frame, the voltage on that frame is likely to reach a certain level of hazard.

Connecting the safety ground wire to the chassis of the instrument can avoid the danger of electric shock, as this creates a very low impedance circuit, which can cause the circuit knife to trip or the fuse to blow. Each instrument product has a safety grounding device, and the circuit is completed by connecting the instrument to a connector with a ground wire, or by connecting the grounding ring in the instrument to the ground wire according to the specifications requested by the user.

As described below, the safety ground wire in the instrument is usually connected to the conduit of the building through an insulated grounding device, which in turn ground the distribution of the sub-circuit. In any case, local and national safety regulations must be followed.

The safety ground wire must be properly connected to the terminal of the main distribution grounding busbar. It should generally be known that the impedance of the ground wire returning from any load to the main grounding busbar must be less than 11 ohms.

**Noise-free ground**

In order to make the Elite GC2012 network instrument work well, we insist on recommending the use of a noise-free grounding device. This grounding is also called "insulating grounding"

because it is separate from other electrical grounding devices in the building. When connecting Elite GC2012 network instruments to other instruments, using "insulated grounding" will help maintain the reliability of the system.

In most cases, ordinary grounding does not meet the requirements because it is impossible for the grounding device not to bring in a little noise caused by poor grounding. The noise may also come from the radio announcer, and this ground wire may also carry a generally stable current.

Typical ground conditions that are prone to generating noise are as follows:

1. Conduit

2. Roofs and beams of buildings

3. Sprinkler pipes (Connecting the ground wire to these pipes is not permitted by most fire codes).

4 Raise the floor's support structure.

5. Gas pipe

Connecting the ground wire to these pipes makes them vulnerable to building noise due to poor grounding, and they also receive electrical frequency interference due to antenna interference.

The following are things that can be grounded (with consultation with the local electrical inspection department, choose the acceptable grounding method in the local area) :

1. Connect a wire of appropriate size to the main pipe line of the building or to the entry point of the main conduit.

2 Drive a long nail for grounding into the moist soil and connect it to the grounding point.

3. It can also be connected to other reliable grounding points.

The insulated ground wire must be firmly connected to the device. Do not clamp the ground wire to a pipe or grounding post. Do not use any other methods to connect that will loosen the joint. The joint must be copper-soldered or tin-soldered to minimize the drop in insulation resistance at the ground joint as much as possible. If not properly installed, resistance can be measured at the joint, and combined with the resistance on the ground wire, it will create an unwanted potential on the insulated grounding device. When installing the ground wire, prevent it from accidentally coming into contact with other ground wires, which can have a negative effect on insulation. The insulated wire must be connected to the insulated busbar of the distribution

board, and then from the distribution board to each unit of the instrument system through the connector and the power ground wire. Insulated busbars can be made up of grounding plates on the distribution board.

The wire size used should be such that the grounding resistance from the farthest point to the grounding point of the main distribution board is the lowest. Consult with your local electrical inspection department about the wire specifications to be used.

When a grid treatment device is installed in a multi-story building, the enclosure of the grid treatment device should be connected to the reinforcing bars in the building structure in order to reduce ground noise. One end of the ground wire should be connected to the enclosure of the line treatment unit, and the other end should be welded to the vertical beam reinforcement of the nearest building. It is better to connect the ground wire to the building's reinforcement than to connect it to a separate grounding column in the basement.

**Measurement of the quality of the centerline-ground connection**

Several devices are available on the market specifically for measuring the quality of a grounding system. These devices include a grounding detector that guides the current in the ground wire, then conducts the test, and can indicate the quality of the grounding (a display light or scale in ohms). Another is a ground wire tester, which is used to measure the resistance of a grounding system.

If the grounding impedance is too high, several items should be checked. If grid handling equipment is not installed and there is no specified grounding device, check whether the neutral line-ground (N-G) connection on the main distribution board of the building is in good condition. If line handling equipment is installed, check the N-G connection on the line handling device again. If the N-G connection is not installed properly at the time, move it to a suitable position, as an inappropriate installation position may cause unwanted current to be generated on the grounding wire.

Check if the connection of the grounding wire is in good condition. If the size of the grounding wire is smaller than the wire in the circuit, or if the grounding wire is not insulated, we recommend replacing it with an insulated wire of the same size as the wire in the circuit.

**The balance of electrical load**

It is important to balance the electrical load using three-phase and split phase systems. Because:

· Can reduce the adverse effects of external voltage drops and voltage changes on equipment driven by individual transformers.

· Can improve the performance of insulated transformers.

· Extend the service life of the transformer.

Unbalanced loads create a voltage difference between the neutral line and the ground line. Measuring this voltage will give you an idea of whether the load is balanced. When balancing the load, use a clip-on amperometer. First measure the current of each phase, then remove the power line from the instrument system distribution board, rearrange the load, and then measure again. Repeat this process until the neutral line current drops to its lowest value.

Measuring the voltage difference between the neutral line and the ground line can also be used to prove whether the load is balanced. After powering on the instrument, use an oscilloscope to measure the voltage difference between the neutral wire and the ground wire at the instrument's power input terminal. The shorter the connection of the ground clamp probe, the better. Remove the power line from the system distribution board, rearrange the load, and then repeat the measurement. Repeat this process until the voltage between the neutral line and the ground line drops to the lowest level.

The center-ground voltage may drop further when balancing the load on other feeders, or it will drop as well when increasing the size of the feeder. If the neutral line-ground voltage on the system distribution board is too high, hang out a dedicated feeder from the main distribution board.